Organization for the Advancement of Structured Information Systems

# Business Transaction Protocol

## An OASIS Committee Specification

***CURRENT STATUS : committee draft for review***

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Change marks relative to 0.9.5.1

## Copyright and related notices

## Acknowledgements

The members of the OASIS Business Transactions Technical Committee contributed to the development of this specification. The following were members of the committee for at least part of the time from July 2001 until the agreement of the specification are listed below. Some TC members changed their affiliation to OASIS members, but remained members of the TC; multiple affiliations are shown separated by semi-colons~~:~~

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We thank Pal Takacsi-Nagy of BEA Systems Inc and Bill Pope for their efforts in chairing the Technical Committee, and Karl Best of OASIS for his guidance on the organization of the Committee’s work.

*In memory of Ed Felt*

Ed Felt of BEA Systems Inc. was an active and highly valued contributor to the work of the OASIS Business Transactions Technical Committee.

His many years of design and implementation experience with the Tuxedo system, Weblogic’s Java transactions, and Weblogic Integration’s Conversation Management Protocol were brought to bear in his comments on and proposals for this specification.

He was killed in the crash of the hijacked United Airlines flight 93 near to Pittsburgh,

on 11 September 2001.

## Typographical and Linguistic Conventions and Style

The initial letters of words in terms which are defined (at least in their substantive or infinitive form) in the Glossary are capitalized whenever the term used with that exact meaning, thus:

> Cancel
> Participant
> Application Message

The first occurrence of a word defined in the Glossary is given in bold, thus:

> **Coordinator**

Such words may be given in bold in other contexts (for example, in section headings or captions) to emphasize their status as formally defined terms.

The names of abstract BTP protocol messages are given in upper-case throughout:

> BEGIN
> CONTEXT
> RESIGN

The values of elements within a BTP protocol message are indicated thus:

> BEGIN/atom

BTP protocol messages that are related semantically are joined by an ampersand:

> BEGIN/atom & CONTEXT

BTP protocol messages that are transmitted together in a compound are joined by a + sign:

> ENROL + VOTE

XML schemata and instances are given in Courier and are shaded:

```
<btp:begin> ... </btp:begin>
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Terms such as  MUST, MAY and so on, which are defined in RFC [TBD number], “[TBD title]” are used with the meanings given in that document but are given in lowercase bold, rather than in upper-case:

> An Inferior **must** send one of RESIGN, PREPARED or CANCELLED to its Superior.

# Contents

# Part 1. Purpose and Features of BTP

## Introduction

This document, which describes and defines the Business Transaction Protocol (BTP), is a Committee Specification of the Organization for the Advancement of Structured Information Standards (OASIS). The standard has been authored by the collective work of representatives of numerous software product companies (listed on page 3), grouped in the Business Transactions Technical Committee (BT TC) of OASIS.

The OASIS BTP Technical Committee began its work at an inaugural meeting in San Jose, Calif. on 13 March 2001, and this specification was endorsed as a Committee Specification by a [*** unanimous] vote on [*** date].

BTP is designed to allow coordination of application work between multiple participants  owned or controlled by autonomous organizations. BTP uses a two-phase outcome coordination protocol to ensure the overall application achieves a consistent result. BTP permits the consistent outcome to be defined *a priori* -- all the work is confirmed or none is -- (an atomic business transaction or atom) or for application intervention into the selection of the work to be confirmed (a cohesive business transaction or cohesion).

BTP's ability to coordinate between services offered by autonomous organizations makes it ideally suited for use in a Web Services environment. For this reason this specification defines communications protocol bindings which target the emerging Web Services arena, while preserving the capacity to carry BTP messages over other communication protocols. Protocol message structure and content constraints are schematized in XML, and message content is encoded in XML instances.

The BTP allows great flexibility in the implementation of business transaction participants. Such participants enable the consistent reversal of the effects of atoms. BTP participants may use recorded before- or after-images, or compensation operations to provide the "roll-forward, roll-back" capacity which enables their subordination to the overall outcome of an atomic business transaction.

The BTP is an interoperation protocol which defines the roles which software agents (actors) may occupy, the messages that pass between such actors, and the obligations upon and commitments made by actors-in-roles. It does not define the programming interfaces to be used by application programmers to stimulate message flow or associated state changes.

The BTP is based on a permissive and minimal approach, where constraints on implementation choices are avoided. The protocol also tries to avoid unnecessary dependencies on other standards, with the aim of lowering the hurdle to implementation.

## Deferred topics

Certain issues were considered in the development of this document, but final and complete resolutions were not included in this edition. These areas are potential subjects for future work of the BTP Technical Committee.

### Conformance

The BT Technical Committee recognizes that the approach to conformance taken in this Committee Specification (see section “Conformance” in part 2) may not fully meet the needs of consumers of an eventual OASIS Standard. We plan to evaluate the conformance requirements along with comments from implementers and users with a mind to decreasing the number of conformance points. Comments on this subject will be appreciated.

### Interoperation

BTP is an interoperation protocol: assuming unambiguous specification and faithful implementation any two independent implementations using an agreed carrier-protocol binding should exchange and process BTP messages (sometimes in association with application messages) in such a way that they are mutually intelligible, are processed in sequence and with consequences as defined in this specification to give effect to agreed business-defined coordinated updates in all parties participating in a transaction.

In its work the BT Technical Committee began discussion of the issues involved in testing interoperability between implementations of BTP 1.0. Such testing can only be effected when using an agreed application protocol and data, and a common carrier protocol. Implementations of the carrier protocol concerned (e.g. SOAP 1.1/HTTP 1.1) may themselves be non-interoperable, and that issue can only be addressed independently by the body or bodies responsible for establishing interoperability for such a carrier protocol.

### Security

The BT Technical Committee has consciously deferred addressing integration with security standards or technology. BTP version 1.0 therefore assumes that all actors are within a trust domain. Comments on this topic are invited.

### Transaction coordinator migration

Migration of the transaction coordination roles is an important feature for scalable transaction systems. The BT Technical Committee plans to examine this issue before moving to an OASIS standard. Please see the Informative Annex A for a first step in this direction.

## Development and Maintenance of the Specification

For more information on the genesis and development of BTP, please consult the OASIS BT Technical Committee’s website, at

http://www.oasis-open.org/committees/business-transactions/

As of the date of adoption of this specification the OASIS BT Technical Committee is still in existence, with the charter of

- maintaining the specification in the light of implementation experiences
- coordinating publicity for BTP
- liaising with other standards bodies whose work affects or may be affected by BTP
- reviewing the appropriate time, in the light of implementation experience and user support, to put BTP forward for adoption as a full OASIS standard

If you have a question about the functionality of BTP, or wish to report an error or to suggest a modification to the specification, please send a message to (and, if you wish, subscribe to):

business-transaction-commentt~~-spec~~@lists.oasis-open.org

Any employee of a corporate member of OASIS, or any individual member of OASIS, may subscribe to OASIS mail lists, and is also entitled to apply to join the Technical Committee.

The main list of the committee is:

business-transaction@lists.oasis-open.org

## Structure of this specification

This specification document includes, in Part 1, an explanation and description of the conceptual model of BTP, and, in Part 2, a fully normative specification of the protocol.

The use and definition of terms in the model can be regarded as authoritative but should not be taken to restrict implementations or uses of BTP. In case of (unintended) disagreement between the parts, Part 2 takes precedence over Part 1.

Part 1 contains

- Executive Summary
- This document structure description
- Conceptual Model

Part 2 contains the following sections:

- Actors, roles and relationships: defines the model entities used in the specification, their relationships to each other and indicates the correspondence of these to real implementation constructs; this section also lists which messages are sent and received for each role.
- Abstract message set: defines a set of abstract messages that are exchanged between software agents performing the various roles to create, progress and complete the relationships between those roles. For each abstract message the parameters are defined and the associated "contract" is stated – the contract defines the meaning of the message in terms of what the receiver can infer of the sender's state and the intended effect on the receiver. This section does not itself specify a particular encoding or representation of the messages nor a single mechanism for communicating the messages
- State tables: specifies the state transitions for the Superior and Inferior roles, detailing when particular messages may be sent and when internal decisions may be made that affect the state
- XML representation: defines an XML representation of the message set. Other representations of the message set, or parts of it are possible – these may or may not be suitable for interoperation between heterogeneous implementations.
- Carrier protocol bindings: defines a "carrier binding proforma" that details the information required to specify the mapping to a particular carrier protocol such that independent implementations can interoperate. The proforma requires an identification for the binding, the nature of the addressing information used with the binding, how the messages are represented and encoded and how they are carried (e.g. which carrier protocol messages or fields they are in) and may include other requirements.
- Using the carrier protocol proforma, this section fully specifies bindings to SOAP 1.1, using the XML representation of the abstract message set.

- Conformance definitions: defines combinations of facilities (expressed as roles) that an implementation can declare it supports

Part 3 contains a glossary that provides succinct definitions of terms used in the rest of the document.

Part 4 contains an informational annex that defines a format for the serialised state information of a BTP node.

## Conceptual Model

This section introduces the concepts of BTP. Its use and definition of terms can be regarded as authoritative but should not be taken to restrict implementations or uses of BTP. Part 2 of the specification is fully normative and in case of disagreement takes precedence over statements or examples in this section.

BTP is designed to make minimal assumptions about the implementation structure and the properties of the carrier protocols. This allows BTP to be bound to more than one carrier protocol. BTP implementations built in quite different ways should be able to interoperate if they are bound to the same carrier protocol. This flexibility requires that much of the text is abstract and may be difficult to visualise in the absence of a particular implementation pattern or carrier protocol. To aid understanding some possible implementation examples are presented in the following text.

### Example Core

An advanced manufacturing company (*Manufacturer A*) orders the parts and services it needs on-line. It has existing relationships with parts suppliers and providers of services such as shipping and insurance. All of the communications between these organizations is via XML messages. The interactions of these business transactions include:

1. *Manufacturer A's* production scheduling system sends an Order message to a *Supplier.*
2. The *Supplier's* order processing system sends back an order confirmation with the details of the order.
3. *Manufacturer A* orders delivery from a *Shipper* for the ordered parts.
4. The *Shipper* evaluates the request and based on its truck schedule it sends back a positive or negative reply.
5. Some shipments need to be insured based on their value, where they are shipped from, and method of transportation. *Manufacturer A* sends an Order message to an *Insurer* when this is necessary.
6. The *Insurer* responds with a bid or a no-bid response.

Problems have arisen with some of these interactions.

- Manufacturer A had ordered parts from a supplier and contacted shipper M about delivering the goods. Shipper M was busy and agreed to the contract but only for a scheduled delivery the day after the parts were needed. By the time this was addressed it was too late to schedule alternate shipping.
- There were communications problems with supplier Z that resulted in an order not being confirmed. The shipper arrived to pick up the order and supplier Z knew nothing about it.
- Goods have been shipped without insurance when company policy dictated that insurance was required.

These problems occur because of the unreliable nature of the Internet and the lack of visibility a company has into the workings and state of an outside organization. By using BTP in support of this supply application, these problems can be ameliorated.

BTP is a protocol, that is, a set of specific messages that get exchanged between computer systems supporting an application, with rules about the meaning and use of the messages. The computer systems will also exchange application-specific messages. Thus, within the example, the Manufacturer's system and the Supplier's system (say), will exchange messages detailing what the goods are, how many, what price and will also exchange BTP messages. The parts of the application in both systems that handle these different sets of messages can be distinguished, as in Figure 1. In each BTP-using party there is an **application element** and a **BTP element**. The application elements exchange the order information and cause the associated business functions to be performed. The BTP elements, which send and receive the BTP messages, perform specific roles in the protocol. These BTP elements assist the application in getting the work of the application done. The application element, as understood by this model, may include supporting infrastructure elements, such as containers or interceptors, as well as application-specific code.

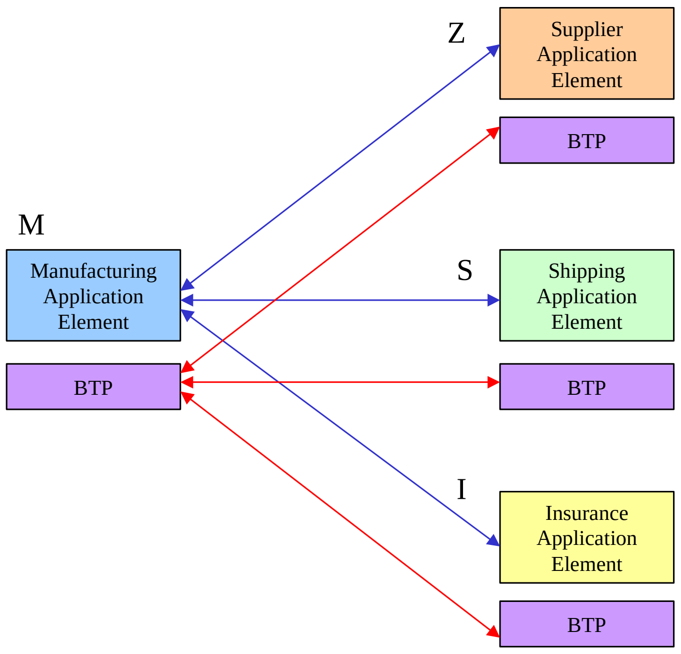

Z
Supplier Application Element
BTP
M
Manufacturing Application Element
BTP
S
Shipping Application Element
BTP
I
Insurance Application Element
BTP

**Figure 1 – Manufacturer Example**

## Business transactions

A **Business Transaction** can be defined as a consistent change in the state of a business relationship between two or more **parties**.  A business relationship is any distributed state held by the parties which is subject to contractual constraints agreed by those parties. For example, an master purchasing agreement, which permits the placing of orders for components by known buying organizations allows a buyer and a seller to create and subsequently exchange meaningful information about the creation and processing of an order. Such agreements (and the consequent specification of shared or canonical data formats and of the messages that carry those formats, and their permitted sequences, all of which are needed for an automated implementation of an agreement) stem from business negotiations and are specific to a particular trading or information exchange community (group of potential parties). This definition of a business relationship is deliberately silent on the nature of the "business" transacted between the parties: it might be trading for profit, verification of authorizations for expenditure or loans, consistent publication (replication) of government ordinances to multiple sites, or any other computerized interaction where the parties require high confidence of consistent delivery or processing of data. In each party or site where business relationship state resides an application system must exist which can maintain that state and communicate it as needed to other parties.The Business Transaction Protocol (BTP) assists the application systems of the various parties to bring about consistent and coordinated  changes in the relationship as viewed from each party.  BTP assumes that for a given business transaction, state changes occur, or are desired, in computer systems controlled by some set of parties, and that these changes are related in some application-defined manner. BTP assumes that the parties involved in a business transaction have distinct and autonomous application systems, which do not require knowledge of each others' implementation or internal state representations in volatile or persistent storage. Access to such loosely coupled application systems is assumed to occur only through service interfaces.

Thus the state changes that BTP is concerned with are only those affecting the immediate business relationship. Although these externally visible changes will typically correspond to internal state changes of the parties, use of BTP does not itself imply any constraints or requirements on the internal state.[1]

## External Effects

BTP coordinates the state changes caused by the exchange of application messages.  These state changes are part of the contract between BTP-using parties. In the manufacturing example, an interaction between the manufacturer and the supplier might involve the supplier receiving the order (an application message), checking to ensure that it had enough product on hand, reserving the product in the manufacturer's name and replying. When the manufacturer agrees to the purchase (assuming the shipping and insurance are also reserved), BTP messages are sent to confirm the purchase. In this case, the supplier is offering a **BTP-enabled service** – the application element and its supporting BTP elements together offer this service.

[1] Although a Business Transaction is defined as concerning a business relationship, the facilities of BTP make it suitable for other environments where loosely coupled systems require coordination and consistency.

In general, to be able to satisfy such contracts a BTP-enabled **service** must support in some manner provisional or tentative state changes (the transaction's **provisional effect**) and completion either through confirmation (**final effect)** or cancellation (**counter-effect).** The meaning of provisional, final, and counter-effect are specific to the application and to the implementation of the application. In the example, the reservation of the order is the provisional effect, the completion of the purchase is the final effect.

Some of the implementation approaches are shown in Table 1. From the perspective of BTP and the initiator application, all these are considered equivalent. Outside of BTP the underlying business relationship (or contract) between the parties can constrain the degree to which the effects are visible.

**Table 1 Some alternatives for provisional, final and counter effects**

| **provisional effect** | **final effect** | **counter effect** | **Comment** |
|---|---|---|---|
| Store intended changes without performing them | Perform the changes | Delete the stored changes, unperformed | Provisional effect may include checking for validity |
| Perform the changes, making them visible; store information to undo the changes | Delete undo information | Perform undo action | One form of compensation approach |
| Store original state, prevent outside access, perform changes | Allow access | Restore original state; allow access | a typical database approach |

These alternatives are not the only ones – they can be combined or varied. The visible state of the application information prior to confirmation or cancellation may be different from both the original state and the final state.

Especially in the compensation approach, if the changes are cancelled, the counter-effect may be a precise inversion or removal of provisional changes, or it may be the processing of operations that in some way compensate for, make good, alleviate or supplement their effect. There may be side-effects of various kinds from a counter-effected operation – such as levying of cancellation charges or the record of the operation may be visible, but marked as cancelled. The possibility of these side-effects is considered to be part of the overarching contract.

### Two-phase outcome

The BTP protocol coordinates the transitions into and out of the event states described above by sending messages between the transaction parties. This involves a two-phase exchange. First the application elements exchange messages thatdetermine the characteristics and cause the performance of the provisional effect; then a separate message, to the BTP element, asking for the performance of the final or the counter effect.

In general, the application elements in the systems involved having first communicated the application messages, each system that has to make changes in its own state:

- determines whether  it is able achieve its provisional effect and then ensure it will be able either to cancel (counter-effect) its operation or to confirm (give final effect to) its operation, whichever is subsequently instructed, and
- reports its ability to confirm-or-cancel (its preparedness) to a central coordinating entity.

And, after receiving these reports, the coordinating entity:

- determines which of the systems should be instructed to confirm and which should be instructed to cancel
- informs each system whether it should confirm or cancel (the "outcome").by sending a message to its BTP element

When there is more than one system that has to make changes such a two-phase exchange mediated by a coordinator is required to achieve a consistent outcome for a set of operations. The two-phases of the BTP protocol ensure that either the entire attempted transaction is abandoned or a consistent set of participants is confirmed.

### Actors and roles

BTP centres on the bilateral relationship between the computer systems of the coordinating entity and those of one of the parties in the overall business transaction. For each bilateral relationship in a business transaction, a software agent within the coordinating entity's systems plays the BTP role of Superior and a software agent within the systems of the party play the BTP role of Inferior. The concept "**role**" refers strictly to the participation in a particular relationship in a particular business transaction. The software agent performing a role is termed an **Actor**. An Actor is distinguished from other Actors by being distinguishably addressable. The same Actor may perform multiple roles in the same business transaction (including the case where a Superior is also an Inferior), and may also perform the same or different roles in multiple business transactions, either concurrently or consecutively.

### Superior:Inferior relationship

A basic case of a single Superior:Inferior relationship, including the association with application elements, is illustrated in Figure 2. In many cases, including the manufacturer supply example, the application element associated with the superior will directly initiate the application exchanges –as does the manufacturer's application client to the supplier's server, for example – but this is not invariably the case.  It is possible that the first direct communication between the application elements is from one associated with an inferior to the one associated with the superior – for example, with an application that requested quotes by advertising the identity and location of the Superior along with invitation to quote; incoming quotes would be the first direct application message exchanged. In all cases the topmost application element in a tree or subtree will be aware of the business transaction first. How the identity of the transaction and the address of the BTP Superior are communicated to the secondary application element is a matter for the application protocol and not strictly part of BTP, although it will commonly be done by associating a BTP CONTEXT message with application messages..

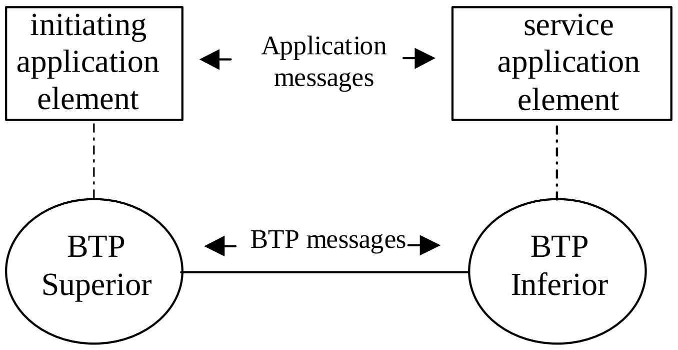


**Figure 2 Basic Superior:Inferior relationship for BTP**

An Inferior is associated with some set of application activities that create effects within the party, for a given business transaction. As stated above, commonly, though not invariably, this application activity within the party will be a result of some operation invocations from elsewhere (shown as the "initiating application element" in Figure 2), associated with the Superior to an application element associated with the Inferior (shown as "Service application element"). This second application element determines what activities the Inferior is responsible for, and then the Inferior is responsible for reporting to the Superior whether the associated operations' provisional effect can be confirmed/cancelled – this is called "becoming prepared", because the Inferior has to remain prepared to receive whichever order eventually arrives (subject to various exceptions and exclusions, detailed below).

### Business transaction trees

There are many patterns in which the service provider participants involved in a business transaction may be arranged in respect of the two-phase exchange and the determination of which are eventually confirmed. The simplest is shown in Figure 3involving only two parties – one (B) making itself subject to  the decision of confirm-or-cancel made by the other (A). This basic bilateral relationship, in which one side makes itself inferior to the other, is the building block used in all business transaction patterns. In this simplest case, the "coordination" by the superior, A, is just that A can be sure whether the operations at the inferior, B were eventually cancelled or confirmed.

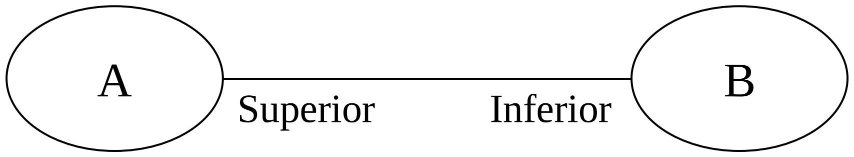


**Figure 3 Simple two-party business transaction**

In the next simplest case, as in ~~figure~~ Figure 4, a bilateral, Superior:Inferior relationship appears twice, with two Inferiors, D and E, both making themselves inferior to a single Superior, C. From the perspective of either D or E, they are in the same position as B in the previous case –they are unaware of and unaffected (directly) by each other. It is only within C that there is any linkage between the confirm-or-cancel outcomes that apply to D and E.

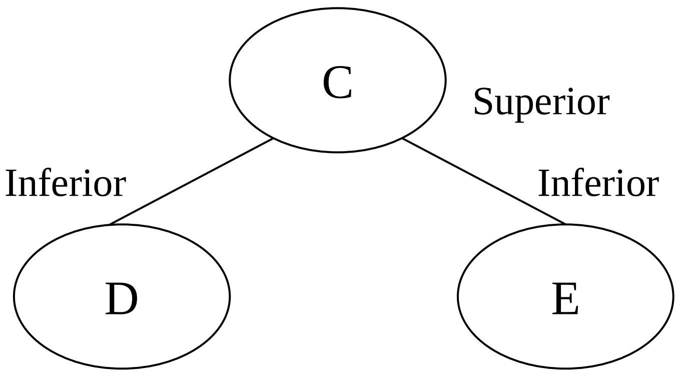


**Figure 4 Business transaction with two inferiors**

The same Superior:Inferior relationship is used in business transaction trees that are both "wider" – with more Inferiors reporting their preparedness to be confirm-or-canceled to a single Superior – and "deeper". In a "deeper" tree, as in ~~figure~~ Figure 5, an entity (G) that is Superior to one or more Inferiors (H, J), is itself Inferior to another entity (F) – it is said to be **interposed** or is an **Intermediate** (either term can be used). In this case, G will collect the information on preparedness of its Inferiors before passing on its own report to its Superior, F, and awaiting the outcome as advised by F.

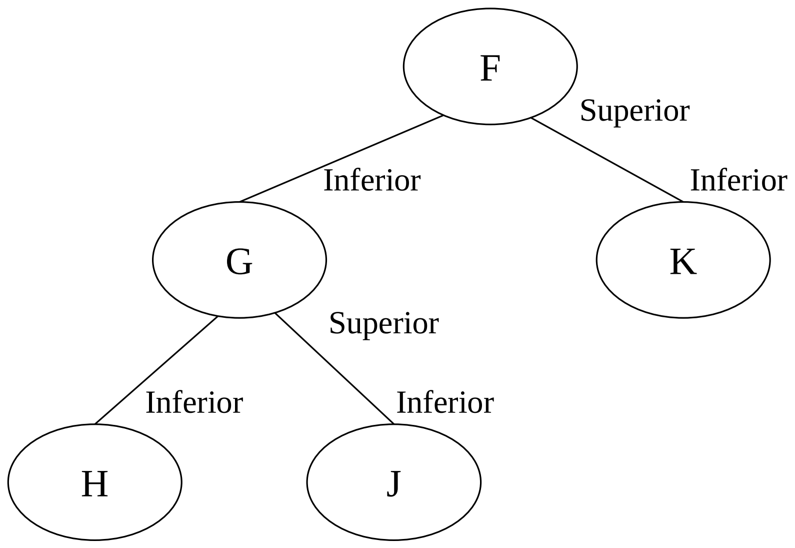


**Figure 5 Business transaction with an Intermediate (interpostion)**

A business transaction tree, made up of these bilateral Superior:Inferior relationships can, in theory, be arbitrarily "wide" or "deep" – there are no fixed limits to how many Inferiors a single Superior can have, or how many levels of intermediates there are between the top-most Superior (that is Inferior to none) and the bottom-most leaf Inferior. The actual creation of the tree depends on the behaviour and requirements of the application. Given the (potentially) inter-organisational nature of business transactions, there may be no overall design or control of the structure of the tree.

Each Inferior has only one Superior. However, a single Superior may (and commonly does) have multiple relationships with Inferiors, and may have such relationships with multiple Inferiors within each party to the transaction, and with Inferiors within multiple parties.

## Atoms and Cohesions

As described in the previous section, the Superior receives reports from its Inferiors as to whether they are prepared. It gathers these reports in order to ascertain which Inferiors should be cancelled and which confirmed - those that cannot prepare will have already cancelled themselves. This determined, directly or indirectly, by the application element responsible of the creation and control of the Superior, which determines the nature of the Superior. There are two dimensions of variation in the Superior: is it an Inferior to another Superior; does it treat its own Inferiors atomically or cohesively.  The distinction between atomic and cohesive behaviour is whether the Superior will choose or allow some Inferiors to cancel while others confirm – this is not allowed for atomic behaviour, in which all must confirm or all must cancel, but is for cohesive.

The possible cases for a Superior, given these two dimensions of variation, are:

a) the application element initiated the business transaction (causing the creation of the Superior), and instructed that all Inferiors of the Superior should confirm or all should cancel; the Superior is an **Atom Coordinator**;

b) the application element initiated the business transaction, but deferred the choice of which Inferiors should confirm until later, allowing it (the application element) to choose some subset to be confirmed, others to cancel; the Superior is a **Cohesion Composer**;

c) the application element was itself involved in an existing business transaction, and the Superior in this relationship is the Inferior in another one; this application element instructed that all Inferiors of this Superior should confirm, but only if confirmation is instructed from above or all should cancel; the Superior is an (atomic) **Sub-coordinator**;

d) the application element was itself involved in an existing business transaction, and the Superior in this relationship is the Inferior in another one; this application element deferred the choice of which Inferiors should be candidates to confirm until later, allowing it (the application element) to choose some subset to be confirmed, given that confirmation is instructed from above, others to cancel; the Superior is a (cohesive) **Sub-composer**.

In the atomic case, the two-phase outcome exchange means a Superior acting as an atomic Coordinator or sub-coordinator will treat any Inferior which cannot prepare to cancel/confirm as having veto power, causing the Superior to instruct all its Inferiors to cancel. A business transaction whose topmost Superior is atomic is an Atomic Business Transaction, or Atom – the superior is the Atom Coordinator.

In the cohesion case, with the Superior acting as a cohesive Composer or Sub-Composer, the controlling application element will determine the implications of an Inferior's failure to be prepared to confirm-or-cancel; the application element may cancel some or all other Inferiors, do other application work, which may involve new Inferiors or may just accept the cancellation of that one Inferior and carry on. A business transaction whose topmost Superior is cohesive is a Cohesive Business Transaction, or Cohesion – the Superior is the Cohesion Composer.

For a cohesion, the set of Inferiors that eventually confirm is called the **confirm-set**. The term is also used to mean the set of Inferiors that have been chosen to (potentially) confirm before the final outcome is decided – if the cohesion is eventually cancelled, then confirm-set cancels. (See section "Evolution of confirm-set"). The confirm-set of an Atom is all of the Inferiors.

If the Superior is itself an Inferior, its own action of becoming prepared, and reporting this to its own Superior will depend on the receipt of prepared reports from its Inferiors. If it is atomic (i.e. is a sub-coordinator), it will only become prepared if all Inferiors reported preparedness to it; if it is cohesive (i.e. is a sub-composer), the controlling application element will determine whether the set of Inferiors that have reported as prepared is sufficient.

If the Superior is not an Inferior, the determination of when, if and, for a Cohesion, what it should confirm depends on the controlling application. This "top-most" Superior has a different relationship to the controlling application to that of an Inferior to its Superior: an Inferior reports that it is prepared to the Superior, which instructs it whether to cancel or to confirm; the top-most Superior is asked by the application element to attempt to confirm, but, dependent on the preparedness of its Inferiors, the top-most Superior makes the final decision. Consequently the top-most Superior is termed the **Decider**; the application element that asks it to confirm is the **Terminator**.

### Participants, Sub-Coordinators and Sub-Composers

An Inferior may directly be responsible for applying the confirm-or-cancel decision to some application effects, or may in turn be a BTP Superior to which others will enrol. If it only handles application effects it is called a **Participant**, in the latter case it is called a **Sub-coordinator** or a **Sub-composer**, depending on whether it is atomic or cohesive with respect to its own future Inferiors. (If an Inferior is both responsible for application effects, and is a BTP Superior, it is not considered a Participant, according to the strict definitions, though informally it may be referred to as such.) The Superior is unaware, via the BTP exchanges, whether the Inferior is a Participant, Sub-coordinator or Sub-composer. This specification does not define messages or interfaces for the creation of Participants or for the application element to tell the Participant what the application effects are or how they are to be confirmed or cancelled as necessary. (Although out-of-scope for this specification, one or more APIs could be standardised.)

### Business transaction creation

This section describes in some detail how a BTP business transaction is created.  The interaction diagram in Figure 6 also shows this sequence. The messages shown in lower-case italics (between Factory and Coordinator) represent interactions that are not specified in BTP.

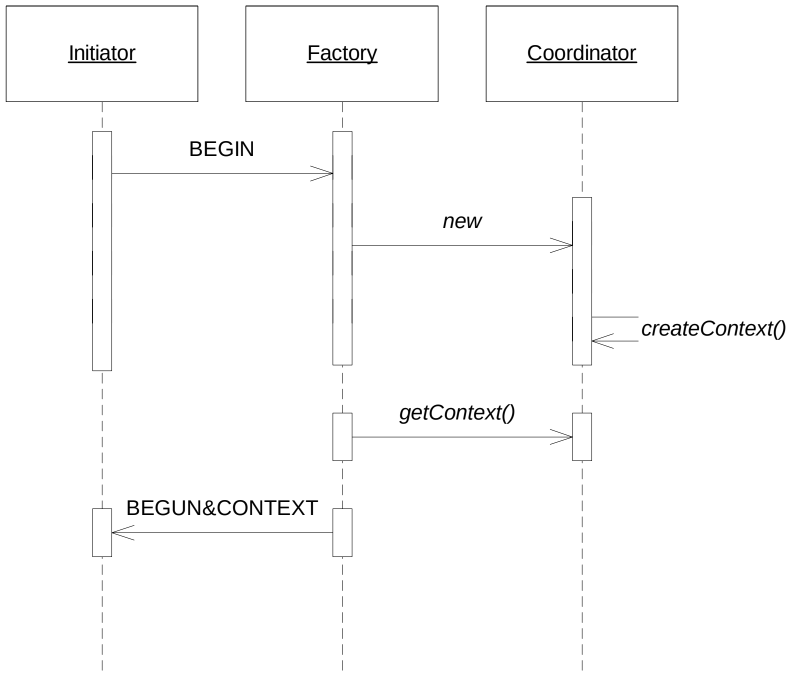


**Figure 6 – Creation of a business transaction**

A business transaction is started at the initiative of an application element, which causes the creation of a Coordinator or Composer. Any Inferiors participating in this transaction will enrol with this Superior. BTP defines abstract messages (BEGIN, BEGUN) to request this but the equivalent function can also be achieved using proprietary means, especially if the Factory or Coordinator is an internal component of the initiating application. If the BTP messages are used, the application element performs the role of Initiator and sends BEGIN to a Factory. The BEGIN message identifies whether a Coordinator (for an atom) or a Composer (for a cohesion) is desired. The Factory, after the creation of the new Coordinator or Composer, replies with related BEGUN and CONTEXT messages. "Related" means they are sent together in a manner that has semantic significance; how this is represented is determined by the binding in use. The Coordinator's or Composer's creation is the establishment of a new instance of a BTP role. It may involve only the assignment of a new identifier within an existing Actor (which may also be performing the Factory role, for example). Alternatively a new Actor with a distinct address may be instantiated. These and other alternatives are implementation choices, and BTP ensures other Actors are unaffected by the choice made.

The BEGUN message provides the addressing and identification information needed for a Terminator to access the new Coordinator or Composer as Decider; the application element performing the Initiator role may itself act as Terminator, or may pass this information to some other application element.

Whether this interoperable BTP Initiator:Factory relationship or some other mechanism is used to initiate the business transaction, a CONTEXT is made available. This identifies the Coordinator or Composer as a Superior – containing both addressing information and the identification of the relevant state information. The CONTEXT is also marked as to whether or not this Superior will behave atomically with respect to its Inferiors (i.e. is it a Coordinator or Composer).

## Business transaction propagation

The propagation of the business transaction from one party to another, to establish the Superior:Inferior relationships involves the transmission of the CONTEXT. This is commonly in association with, or related to, one or more application messages between the parties. In a typical case, an application message is sent from the application element that performed the Initiator role (the “sending application” in Figure 2) to some other element (the receiving application). The CONTEXT is sent with the application message in such a way that the application elements understand that work performed as a result of the application message is to be the subject of a confirm-or-cancel decision of the Superior.[2] The receiving application element causes the creation of an Inferior (which, as for the Superior may involve just assignment on a new identifier, or instantiation of an new Actor) and ensures the new Inferior is enrolled with the Superior identified in the received CONTEXT, using an ENROL message sent to the Superior using the address in that CONTEXT.

Figure 7 shows a sequence diagram of the propagation of a business transaction. It is assumed the transaction has already been created, and thus the application element and Coordinator exist. The diagram shows the Enroller as a distinct role, with non-standardised interactions between the application element, the Enroller and the new Inferior The Enroller role may in fact be performed by the application element, by the Inferior or by a distinct entity. At least the Superior-identifier and Superior-address from the CONTEXT has to be passed the Enroller and to the Inferior so they can communicate with the Coordinator (whose identifier and address these are).

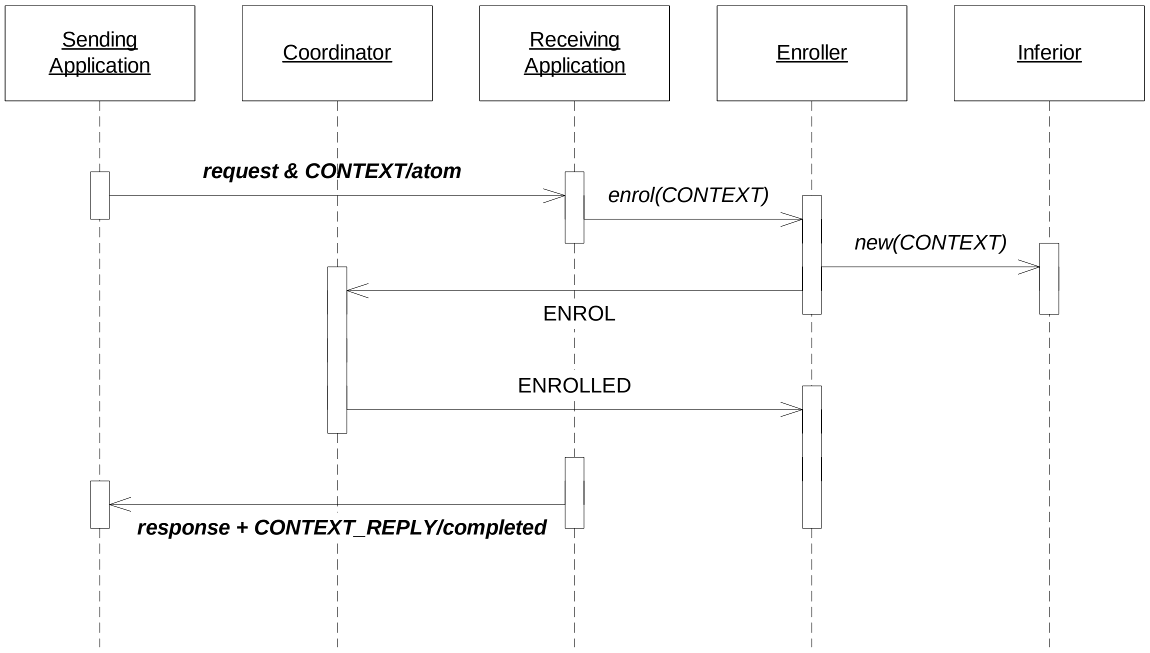


**Figure 7 Sequence diagram of propagation**

[2] The relationship between the application activity and BTP is subtle, and summarised in this sentence.

## Creation of Intermediates (Sub-Coordinators and Sub-Composers)

If the new Inferior is to be a Sub-coordinator or Sub-composer, this can be created using a non-standard mechanism or the Initiator:Factory relationship can be used again. Figure 8 shows a sequence diagram, using the latter mechanism. The application element, having received an application message and a CONTEXT from some Superior – shown as a Coordinator/a in the diagram - wants to create the new Inferior and acting in the Initiator role, issues BEGIN to the Factory, but the CONTEXT for the original Superior (Coordinator/a) is "related" to the BEGIN. The Factory is responsible for enrolling the new Sub-coordinator or Sub-composer as an Inferior of the Superior identified by the received CONTEXT. The reply from the Factory is a related BEGUN and CONTEXT – this being the CONTEXT for the new Sub-coordinator ('b') or Sub-composer as a Superior. The Sub-coordinator/Sub-composer is not a Decider, as its decision is subordinated to the outcome received from the Superior. For a Sub-coordinator, further control by the application is primarily a matter of relating the new CONTEXT to appropriate application activity. For a Sub-composer, there is ~~in addition~~also a requirement for the application to determine which of the Inferiors of the Sub-composer must have reported they are prepared before the Sub-composer can report that it is itself prepared to its own Superior, and then which of these Inferiors are to be ordered to confirm if the Sub-composer is ordered to confirm. This specification does not provide an interface or interoperable message to control this; like the relationship between application element and Participant, it is left to the implementation or independent standardisation.

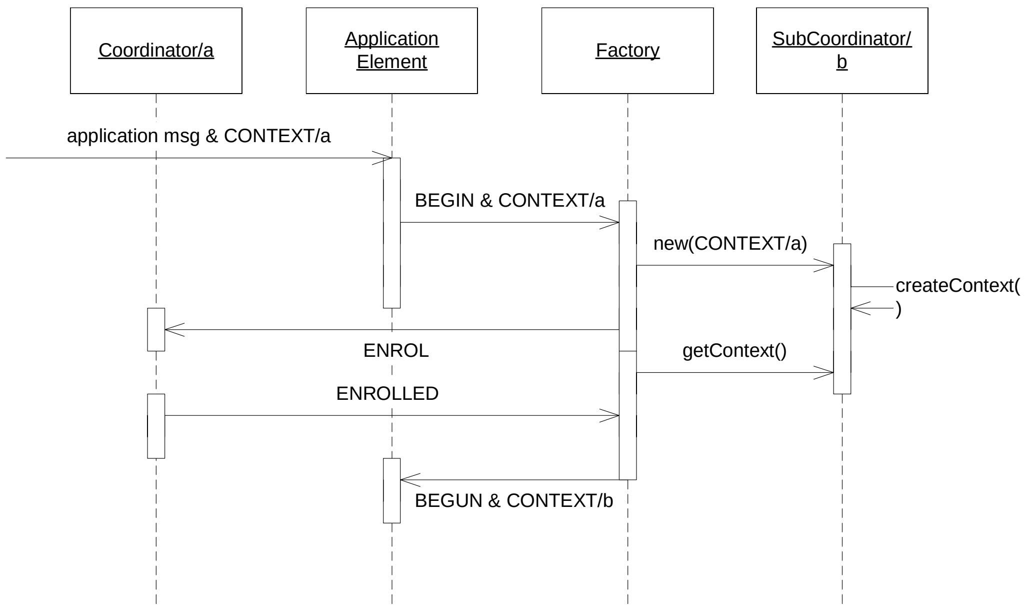


**Figure 8 – Creation of a Sub-coordinator**

The creation of a new Inferior and establishment of a Superior:Inferior relationship does not always imply that the BTP Actors are under the control of different business parties or application elements. In particular, an application element may begin a Cohesion, then create and enrol (atomic) Sub-coordinators as Inferiors of the Composer, then associate a different Sub-coordinator's CONTEXT with each of several aspects of the application work, transmitting that CONTEXT with the application messages for that aspect to the other parties in the business transaction. Those parties can then create Participants (or other Inferiors) that are enrolled with the appropriate Sub-coordinator. Later, the application element (as Terminator, or its equivalent) can choose which of the Cohesion Composers' Inferiors to cancel and which to confirm. By interposing its own atomic Sub-coordinator the initiating application element can indicate to the other parties that some associated set of application work will be confirmed or cancelled as a unit. This may allow the receiving parties to share information between application operations and to make one Participant responsible for applying the outcome to several operations.

### "Checking" and context-reply

In BTP, enrolment is at the initiative of an application element that has received or has access to the CONTEXT which creates an Inferior (BTP uses a "pull" paradigm for enrolment). An application element in possession of a CONTEXT can choose, perhaps constrained by an overarching business and application understanding, whether and how many Inferiors to create and enrol. Consequently, in general, an application element which propagates a CONTEXT to another (via whatever mechanisms it choose), cannot be sure how many Inferiors will be enrolled as a result. Without further controls, there would be a possibility that an application element receiving a CONTEXT might attempt to enrol an Inferior with a Superior after the Superior had been asked to confirm, or even had completed confirmation. In such a case application work that should have been part of a confirmed atomic business transaction could be cancelled, violating the atomicity in a manner that will not be apparent to the application.

To avoid this, whenever a CONTEXT is transmitted to another party by or on behalf of the application, the transmission of the CONTEXT itself can be replied to with a CONTEXT_REPLY message – this is required for an Atom, allowed for a Cohesion. An application element that has received a BTP CONTEXT is able, because it knows the Superior's identification and address in the CONTEXT, to enrol Inferiors (Figure 9).[3] Replying with CONTEXT_REPLY means that the sender (the earlier receiver of a CONTEXT) will not enrol any more Inferiors. Consequently the sender of a CONTEXT can keep track of whether there are any outstanding (un-replied to) CONTEXTs that could be used for an enrolment and can avoid requesting or permitting confirmation until everything is safe. This check is required for an Atom, but is not always essential when the CONTEXT is for a Cohesion. For a Cohesion, it is a matter for the controlling application whether all would-be Inferiors must be enrolled before a confirmation decision can be made; or whether it is acceptable to proceed to confirmation at some point in time with the already enrolled Inferiors (or a subset thereof), accepting the automatic cancellation of any late arrivals.

CONTEXT_REPLY can also indicate that attempted enrollments failed. This can occur if the Enroller is unable to contact the Superior, but it able to return a CONTEXT_REPLY to where-ever the CONTEXT came from.

### Message sequence

BTP messages are used in relationships between several pairs of roles. These particular pair-wise relationships can be categorised into:

[3] The "application element" from the perspective of BTP may include infrastructure software such as containers or interceptors, as well the application-specific code itself.

- Outcome relationships : the Superior:Inferior relationship (i.e. between BTP actors within the transaction tree) and the Enroller:Superior relationship used in establishing it

- Control relationships : the application:BTP actor relationships that create the nodes of the transaction tree (Initiator:Factory) and drive the completion (Terminator:Decider).

The outcome relationships and the messages used in them an essential part of BTP. For the control relationships, it would be possible to achieve the same general function using non-standardised messages or API mechanisms. There are other distinguishable relationships between roles defined by BTP that are not standardised in this specification.

Figure 9 shows the message exchange for the conventional progression of a simple transaction to confirmation with a single Superior:Inferior relationship, assuming the standard control relationship. Two application elements using a request/response application message exchange are involved – the first is represented as the Initiator and Terminator, the second as the Service and Enroller. The Decider/Superior is shown as a Coordinator, but with only one Inferior there would be no difference with a cohesion Composer.  The Factory:Coordinator events are non-standardised, but represent interactions that must occur in some form. There are other interactions between the various application groups – Initiator-Terminator and Participant-Enroller-Service that are not shown – in particular the Service:Participant relationship.

The message sequence is shown is the “conventional” sequence, with all messages explicitly present and sent separately. There are several variations and optimisations possible – these are discussed below.

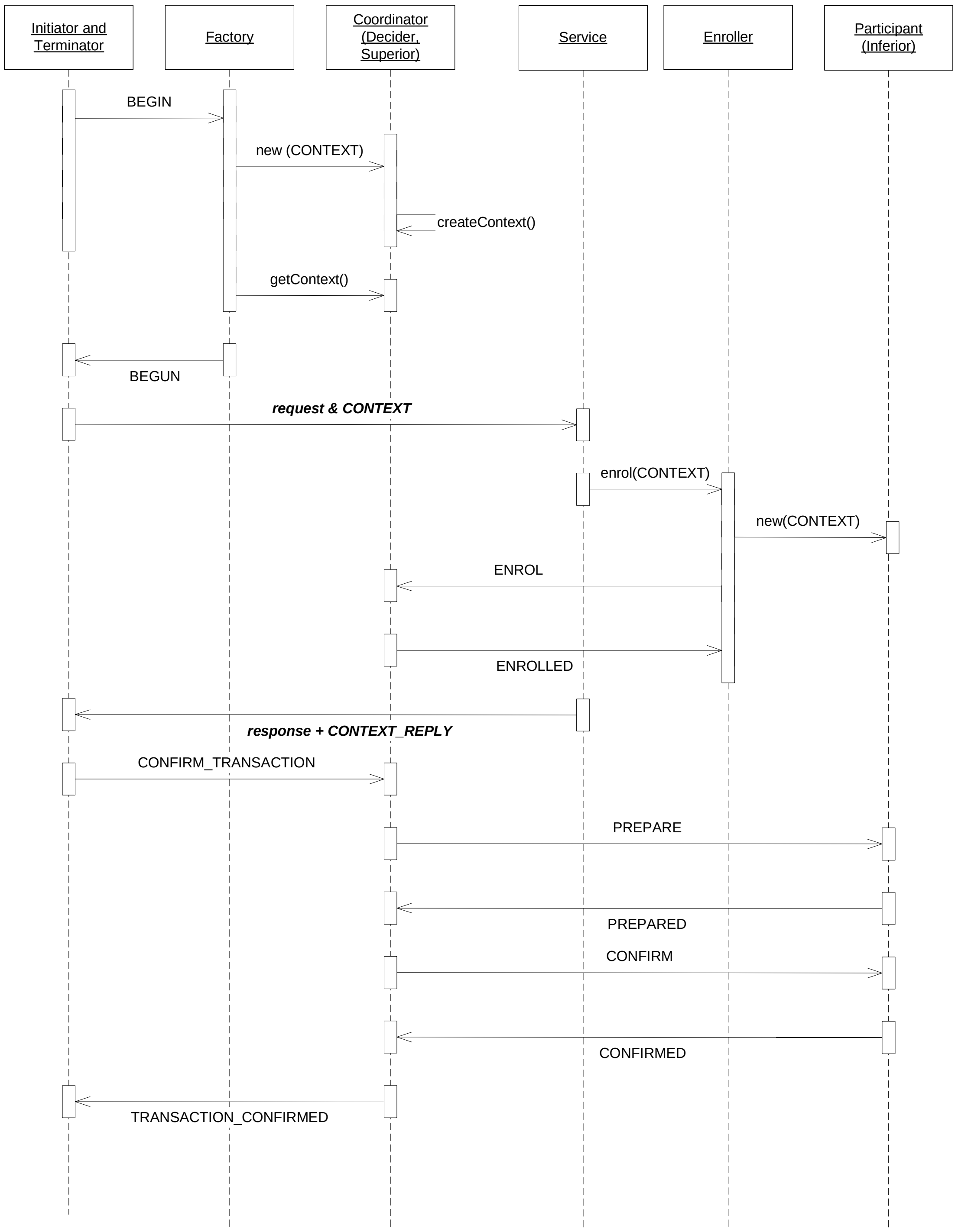


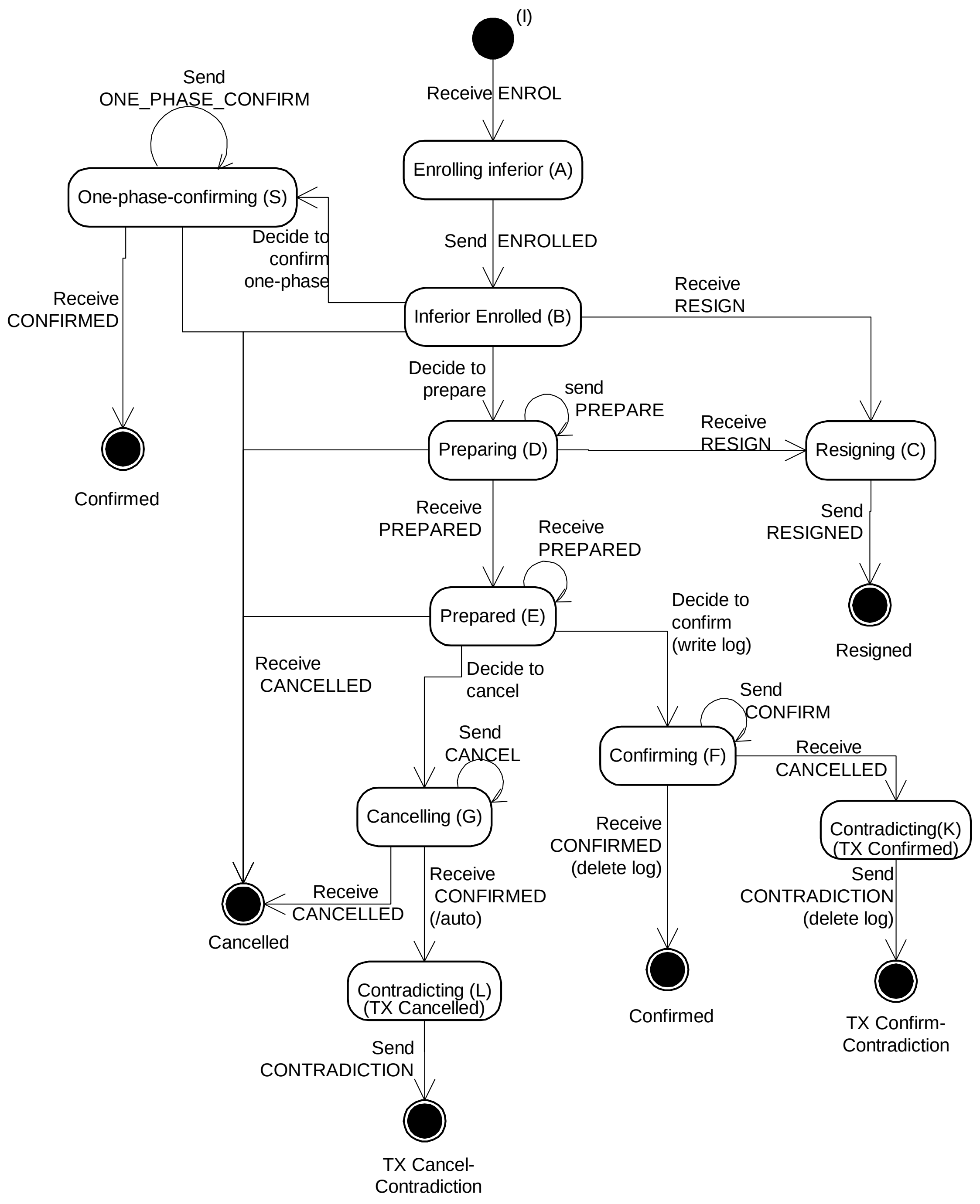
**Figure 9 A conventional message sequence for a simple transaction**

Note that CONTEXT has a "related" (&) relationship to BEGUN and to the application request (although in the latter case the meaning of this is defined by the application, not by BTP. The response + CONTEXT_REPLY has no semantic significance, and could be sent separately; provided the CONTEXT_REPLY is not sent until the ENROLLED has returned.

The progression of a single instance of the central outcome (Superior:Inferior) relationship can also be presented as a set of state transitions. The normative part of the specification includes state tables for the Superior side of such a relationship and for the Inferior. Since a single Superior (Coordinator, Composer, Sub-coordinator, Sub-composer) can have multiple Inferiors, each Superior will have multiple instances of the "Superior state". How these link together is discussed below in the section "Evolution of confirm-set", but the state transitions for the individual Superior:Inferior relationships include "decision events" which constrain the behaviour of the business transaction tree node as a whole, and thus define the semantics of the BTP messages.

The normative state tables distinguish some states that differ only in which messages can be received and thus allow for a level of error checking. The progress of the outcome relationship can be followed without dropping to such a detailed level, and the state diagrams shown here aggregate some of the states that are distinguished in the state tables. The single letters in parentheses in the diagrams correspond to the state names used in the tables. For simplicity, the state diagrams do not include the events leading to the sending of a HAZARD message – the detection and recording of a "problem" – meaning that the Inferior is unable to cleanly confirm or cleanly cancel the operations it is responsible for. As is specified in the state tables, such a problem can be detected in most states, and reported with a HAZARD message.

It should be noted that, with some exceptions, the transmission of a message **from** a Superior or Inferior does not cause a state change at that side. State changes are normally caused either by the receipt of a message from the peer, or by a "decision event" – which may be an internal change, including a change in the persistent information for the transactions, or may be the receipt of a message on another relationship (e.g. as when a Sub-coordinator receives CANCEL from its Superior, which is a decision event as perceived on the relationships to its Inferiors). It would be normal for an implementation on entering a new state to send the message it can now send (there will be only one). It may repeat this message at any interval – in practice only if there is reason to believe (due to lower-layer errors, timeout or known recovery events) that messages may have got lost.



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871 **Figure 10 State diagram for Superior side of a Superior:Inferior relationship**

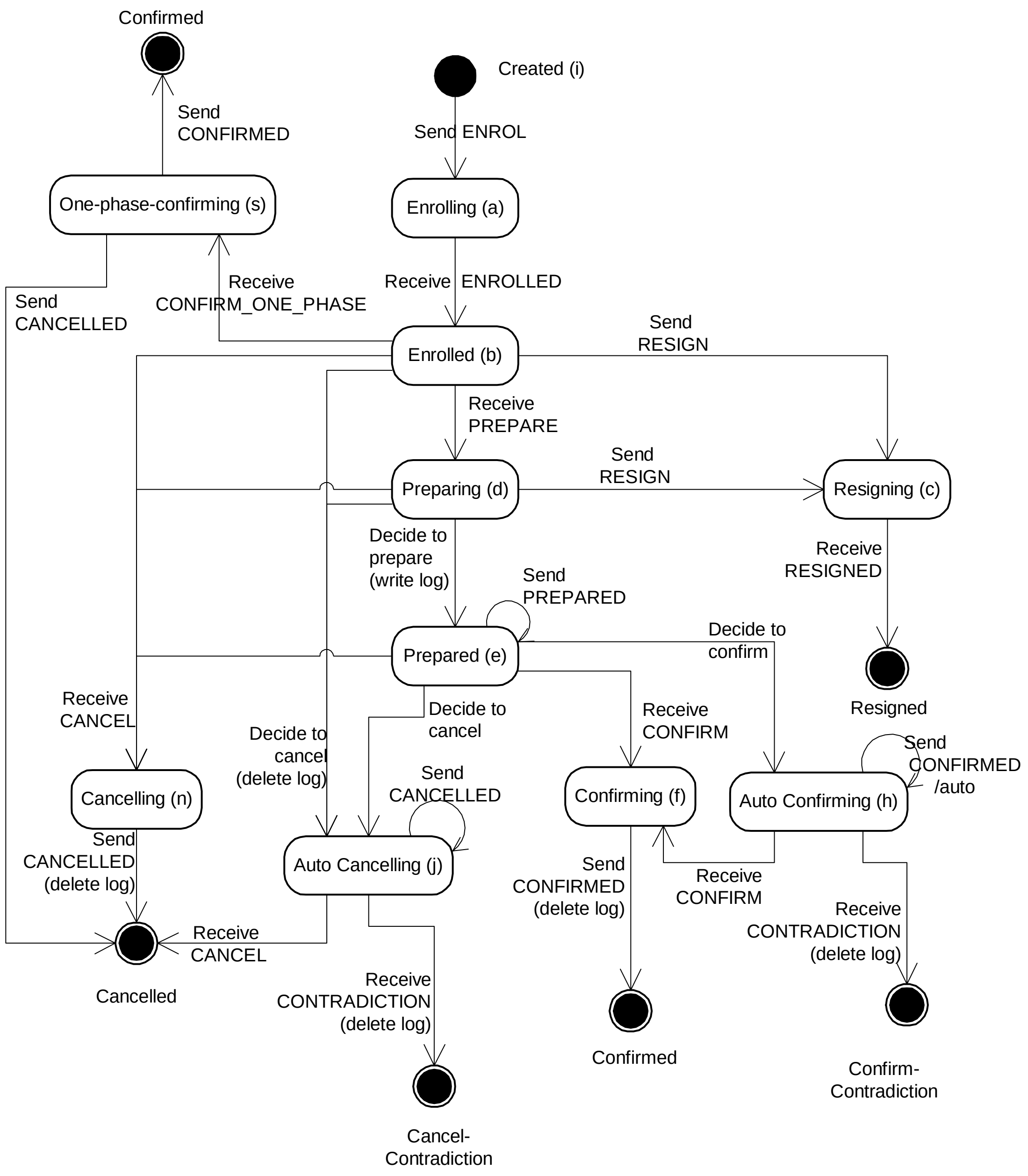

**Figure 11 State diagram for Inferior side of Superior:Inferior relationship**

## Control of inferiors

In the case as shown in Figure 12, where the CONTEXT has been propagated from one application element (A) to others (B, C, and from C to D,E), the determination of whether to create and enrol Inferiors is, in general, up to the receiving application element – this is an aspect of the fundamental autonomy of the parties involved in a business transaction. This autonomy may be constrained in particular situations, by inter-party agreement or where the application elements are in fact under common control.

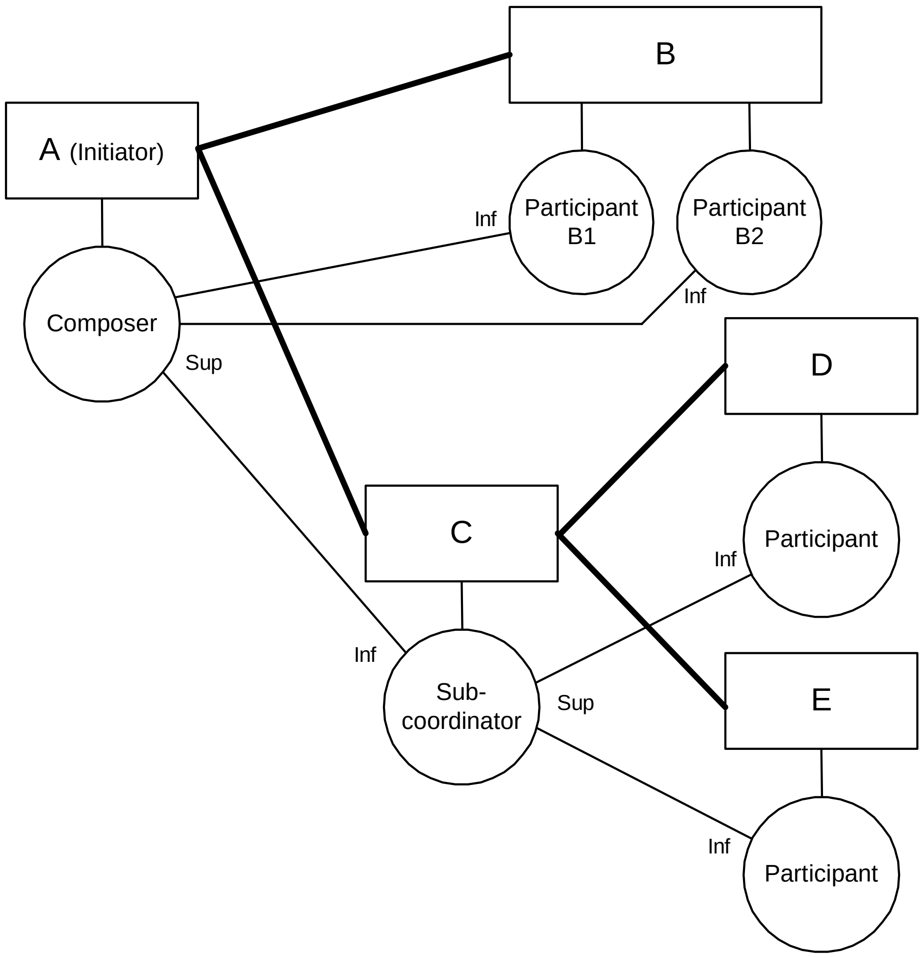

**Figure 12 Transaction tree showing various application:Participant relationships**

The relationship between the application messages and either the propagated CONTEXT or the ENROL message(s) sent to the Superior is strictly part of the application protocol (or the application-with-BTP combination protocol). However defined, this allows the Superior-side application element to be aware of what application work will be confirmed or cancelled under the control of an Inferior. However, from the perspective of the Superior, and the application element controlling it, the Inferior is opaque – it is not in general possible for the Superior or its controlling application element to determine whether an Inferior is a Sub-composer or Sub-coordinator (i.e. has Inferiors of its own) or is a Participant, with no further BTP relationships. Thus, if the Inferior is a Sub-composer or Sub-coordinator, the Superior has no visibility or control of its “grand-children” – the Inferiors of its Inferior (thus, in Figure 12, the Composer at A is unaware of D and E)

The opacity of an Inferior does not however apply to the control exercised by the immediately controlling application element. An application element, acting as Terminator to a Decider (i.e. to a Composer or Coordinator), can be aware of and distinguish the different Inferiors enrolled with that Decider (i.e. Inferiors enrolled with the Decider in its role as Superior). (E.g.in Figure 12, application element A knows of the Inferiors at C, B1 and B2) This is especially the case for a Cohesion Composer, where the Terminator will be able to control which of the enrolled Inferiors of the Composer are eventually confirmed – more exactly, the application will have control of the confirm-set for the Cohesion. For an Atom Coordinator, visibility of the Inferiors is useful but less important, since no selection can be made among which will be in the confirm-set – for an Atom, all Inferiors are ipso facto members of the confirm-set.

For this control of the Inferiors to be useful, the Terminator application element will need to be able to associate particular parts of the application work with each Inferior. In a traditional transaction system, users do not need to see participants, but they see services or objects. What participants are enlisted with a transaction on behalf of those services and objects is not really of interest to the user. When it comes to commit or rollback the transaction, it acts on the transaction and not on the individual participants.

In BTP that is still the case if we work purely with atoms. While an Atomic Coordinator knows its participants it cannot pick and choose among them. In contrast, a Cohesive Terminator must have significant, detailed knowledge and visibility of both the identities of its inferiors and association of parts of the application work with each Inferior. The user must be able to identify which participants to cancel/prepare/confirm. This identification can be achieved by various means. Taking the case of an application element controlling a Cohesion Composer:

a) The application element can create an Atom Sub-coordinator as an immediate Inferior of the Cohesion Composer and propagate the Sub-coordinator's CONTEXT associated with application messages concerned with the particular part of the application work; any Inferiors (however many there may be) enrolled with Sub-coordinator can be assumed to be responsible for (some of) that part of the application, and the Terminator application element can just deal with the immediate Inferior of the Composer that it created.

b) The application element can propagate the Composer's own CONTEXT, and the receiving application element can create its own Inferior (or Inferiors) which will be responsible for some part of the application, and send ENROL(s) to the Composer (as Superior). Application messages concerned with that part of the application are associated, directly or indirectly, with each ENROL, and the Terminator application element can thus determine what each Inferior is responsible for.

In both cases, the means by which the application message and the BTP CONTEXT or ENROL are associated are ultimately application-specific, and there are several ways this can be done.

- At the abstract message level, BTP  defines the concept of transmitting "related" BTP and application messages – particular bindings to carrier protocols can specify interoperable ways to represent this relatedness (e.g. the BTP message can be in a "header" field of the carrier protocol, the application message in the body).

- An application message may contain fields that identify or point to the BTP message (e.g. the "inferior-identifier" from the ENROL may be a field of the application message).

- BTP messages, including CONTEXT and ENROL, can carry "qualifiers" – extension fields that are not core parts of BTP or are not defined by BTP at all. The standard qualifier "inferior-name" or application-specific qualifiers can be used to associate application information and the BTP message. The qualifiers received from the Inferiors on ENROL are visible to the Terminator application on the INFERIOR_STATUSES message. The application design will need to ensure that the Terminator can determine which parts of the application work are associated with each Inferior.

*NOTE -- For example, a service receiving an invocation associated with a cohesion CONTEXT, but where the application design meant that there would be no more than one Inferior enrolled as a result of that invocation, could be required to include information identifying the service and the invocation in the "inferior-name" qualifier on the consequent ENROL. These qualifiers would be visible to the Terminator on INFERIOR_STATUSES, allowing the Terminator to determine which "inferior-identifiers" to include in the "inferiors-list" parameter of the CONFIRM_TRANSACTION which defines which Inferiors are to be confirmed. Among other alternatives, the "inferior-identifier" itself could be a field of the application response – this would also be applicable where there could be multiple Inferiors enrolled as a consequence of one invocation for the Terminator to choose between.*

These considerations about control of the Inferiors of a Decider also apply to the control of the Inferiors of a Sub-composer (and, again of less importance, a Sub-coordinator).

### Evolution of confirm-set

As mentioned above, the set of Inferiors of a Cohesion that will eventually confirm is called the Confirm-set. The determination of the Confirm-set is made by the controlling application, but is affected by events from the Inferiors themselves. If the standard control relationship is used, the control of the Cohesion Composer is expressed by the Terminator:Decider exchanges, and the progressive determination of the confirm-set (its evolution) is effectively the event sequence for the Terminator:Decider relationship.

An Atom also has a confirm-set, but this always includes all the Inferiors and so does not evolve in the same way as Cohesion's. With some exceptions, the Terminator:Decider relationship is the same for Atom Coordinators as for Cohesion Composers; this section deals with both, noting the exceptions.

The event sequence for a Composer or Coordinator is summarised in the state diagram in Figure 13. The step-by-step description refers to "Composer", but should be read as referring to Coordinators as well, unless stated otherwise.

Initially, the Composer is created (by the Factory, using BEGIN with no related CONTEXT), and has no Inferiors. The Composer is now in the active state.

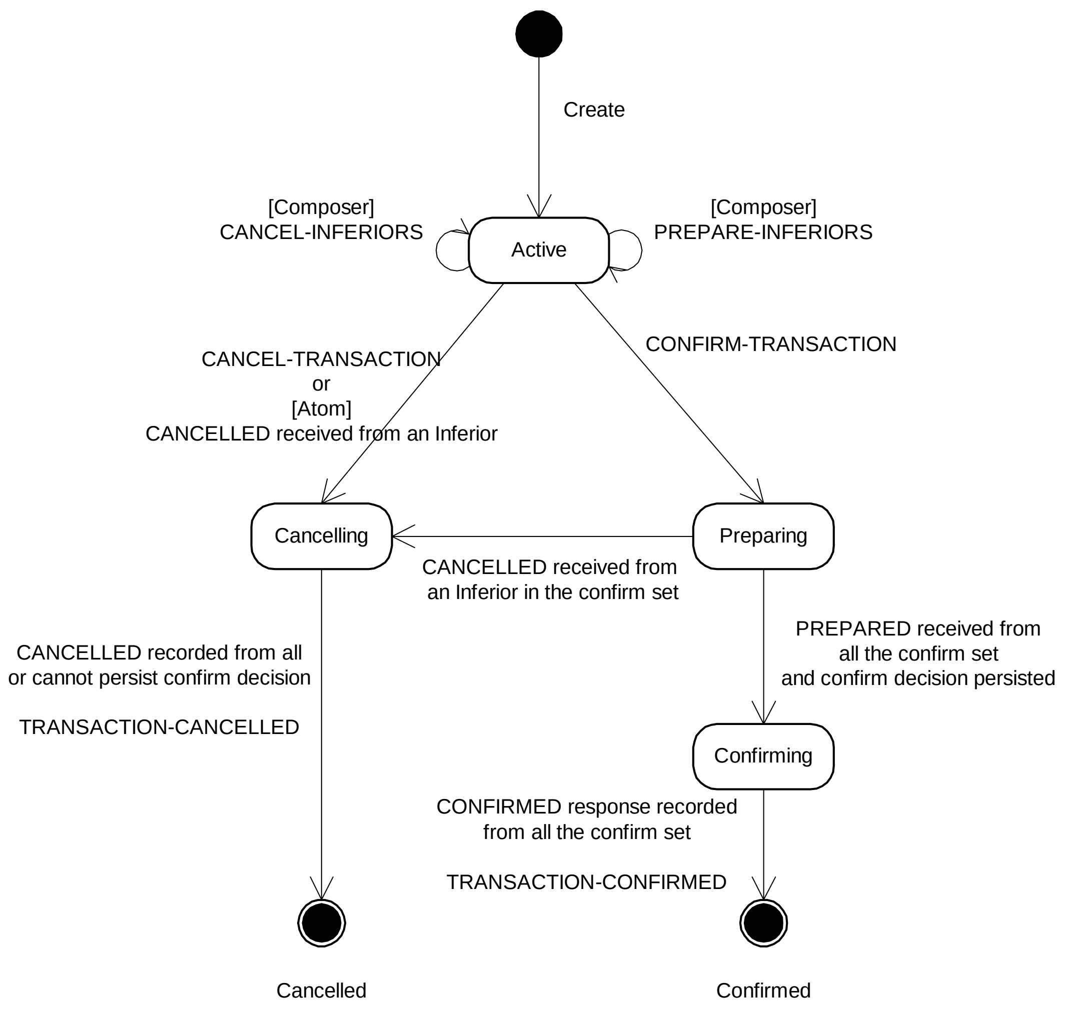

**Figure 13 State diagram for a Composer or Coordinator (i.e. Decider)**

While in the active state, the following may occur, in any order and with any repetition or overlapping:

- Inferiors are enrolled – ENROL is received by the Composer – adding to the set of Inferiors of the Composer.

- Inferiors may resign - RESIGN is received from an Inferior (see section Resignation below). The Inferior is immediately removed from the set of Inferiors, as if it had never been enrolled (a RESIGNED message may be sent to the Inferior, but it no longer “counts” in any of the Composer-wide considerations here.

- CANCELLED may be received from an Inferior; there is no required immediate effect, but if this is a Coordinator the Atom will certainly cancel eventually (and an implementation may choose to initiae cancellation immediately).

- PREPARED may be received; there is no immediate effect

- The Terminator may issue PREPARE_INFERIORS to the Composer (as Decider) for some subset of the Inferiors; PREPARE is sent to each and any of the Inferiors in the subset, excluding any from RESIGN, CANCELLED or PREPARED has been received; the sending of PREPARE will induce the Inferiors to reply with PREPARED, CANCELLED or RESIGN; when replies have been received from all, the Composer (as Decider) replies to the Terminator with INFERIOR_STATUSES, reporting the replies received (which may in fact have been received before the PREPARE_INFERIORS). PREPARE_INFERIORS is not issued to Atom Coordinators.

- The Terminator may issue CANCEL_INFERIORS to the Composer (as Decider) for some subset of the Inferiors; CANCEL is sent to each and any of the Inferiors in the subset, excluding any from RESIGN or CANCELLED has been received; the sending of CANCEL will normally induce the Inferiors to reply with CANCELLED – there are some exception cases; when replies have been received from all, the Composer (as Decider) replies to the Terminator with INFERIOR_STATUSES, reporting the replies received. CANCEL_INFERIORS is not issued to Atom Coordinators. CANCEL_INFERIORS may be issued for an Inferior regardless of whether PREPARED has been received from it.

- The Terminator may issue REQUEST_INFERIOR_STATUSES to the Composer (as Decider) for all or some subset of the Inferiors; the Composer immediately replies with INFERIOR_STATUSES, reporting the current state of the Inferiors as known to the Superior.

Eventually, the Terminator issues one of the completion messages – CANCEL_TRANSACTION or CONFIRM_TRANSACTION. These messages have a flag that determines whether the Terminator wishes to be informed of contradictory and heuristic decisions or hazards within the transaction – this affects when the reply from the Composer (as Decider) is sent to the Terminator. (See section "Autonomous cancel, autonomous  confirm and contradictions" for details on contradictory and heuristic cases).

If the message is CANCEL_TRANSACTION, CANCEL is sent to all Inferiors that it has not already been sent to, and from which neither RESIGN or CANCELLED have been received. If the Terminator indicates it does not want to be informed of contradictions, the Composer will immediately reply with TRANSACTION_CANCELLED. Otherwise, if and when CANCELLED or RESIGN has been received from all Inferiors, the Composer replies to the Terminator with TRANSACTION_CANCELLED; but if HAZARD or CONFIRMED is received from any Inferior, the reply is INFERIOR_STATUSES, identifying which Inferior(s) had problems.

If the completion message is CONFIRM_TRANSACTION, the inferiors-list parameter of the message defines the confirm-set. If the parameter is absent (which it must be for an atom Coordinator), then all Inferiors (excluding only those that have resigned) are the confirm-set; otherwise the confirm-set is only the Inferiors identified in the inferiors-list parameter (less any from which RESIGN has been received). The processing to arrive at the confirm decision is:

- If at the point of receiving CONFIRM_TRANSACTION or at any point before making the confirm decision (see below), CANCELLED is received, then the transaction is cancelled and processing continues as if CANCEL_TRANSACTION had been received.

- If there any Inferiors **not** in the confirm-set from which neither CANCELLED or RESIGN has been received, CANCEL is sent to them (this cannot happen for Atom Coordinators)

- If initially or later, there is exactly one Inferior in the confirm-set, and either PREPARE has not been sent to it, or PREPARED has been received from it, then at implementation or configuration option, CONFIRM_ONE_PHASE can be sent to that Inferior. This delegates the confirm decision to the Inferior

- If at any point, RESIGN is received from an Inferior, it is immediately removed from the confirm-set (this may trigger the decision making)

- If there are any Inferiors in the confirm-set from which none of PREPARED, CANCELLED has been received and to which PREPARE has not yet been sent, PREPARE is sent to that Inferior

- If initially or later, PREPARED has been received from all Inferiors in the confirm-set, the Composer *makes the confirm decision*; it persists (or attempts to persist) information identifying the Inferiors in the confirm-set; if this fails, the transaction is cancelled and processing continues as if CANCEL_TRANSACTION had been received; if the information is persisted, the confirm decision has been made.

When the confirm decision is made, CONFIRM is sent to all the Inferiors in the confirm-set. And, if on the CONFIRM_TRANSACTION the Terminator indicated it did not wish to be informed of contradictions, TRANSACTION_CONFIRMED is sent to the Terminator.

If the Terminator indicated it wanted to be informed of contradictions, the Composer replies to it with TRANSACTION_CONFIRMED if and when CONFIRMED has been received from all the Inferiors in the confirm-set and CANCELLED or RESIGN has been received from any other Inferiors. If other replies (CANCELLED from a confirm-set Inferior, CONFIRMED from other Inferiors, HAZARD from any) are received, the reply to the Terminator is INFERIOR_STATUSES, identifying which Inferior(s) had problems.

Figure 14 shows an example message sequence for a Composer with three Inferiors. The Terminator (application element) chooses to prepare Inferiors 1 and 3 explicitly – the numbers in parentheses on the Terminator:Composer messages represent the inferior-identifiers in the “inferior-list” parameters. Both 1 and 3 prepare successfully, but the Terminator then decides to make 1 and 2 the confirm-set; that is, if the transaction confirms only 1 and 2 are confirmed. The Terminator issues CONFIRM_TRANSACTION to the Composer. A PREPARED message has not been received from Inferior 2 yet, so the Composer issues PREPARE to it, and waits for the PREPARED. At the same time, it sends CANCEL to Inferior 3, which has been excluded from the confirm-set by the CONFIRM_TRANSACTION. After the PREPARED is received from Inferior 2, the Composer makes the confirm decision and issues CONFIRM to the Inferiors, and waits for the CONFIRMED messages before reporting to the Terminator. The CONFIRM_TRANSACTION in this case did not ask for reporting of hazards (see below) – if it had not, the TRANSACTION_CONFIRMED would have been sent at the same time as the CONFIRM messages.

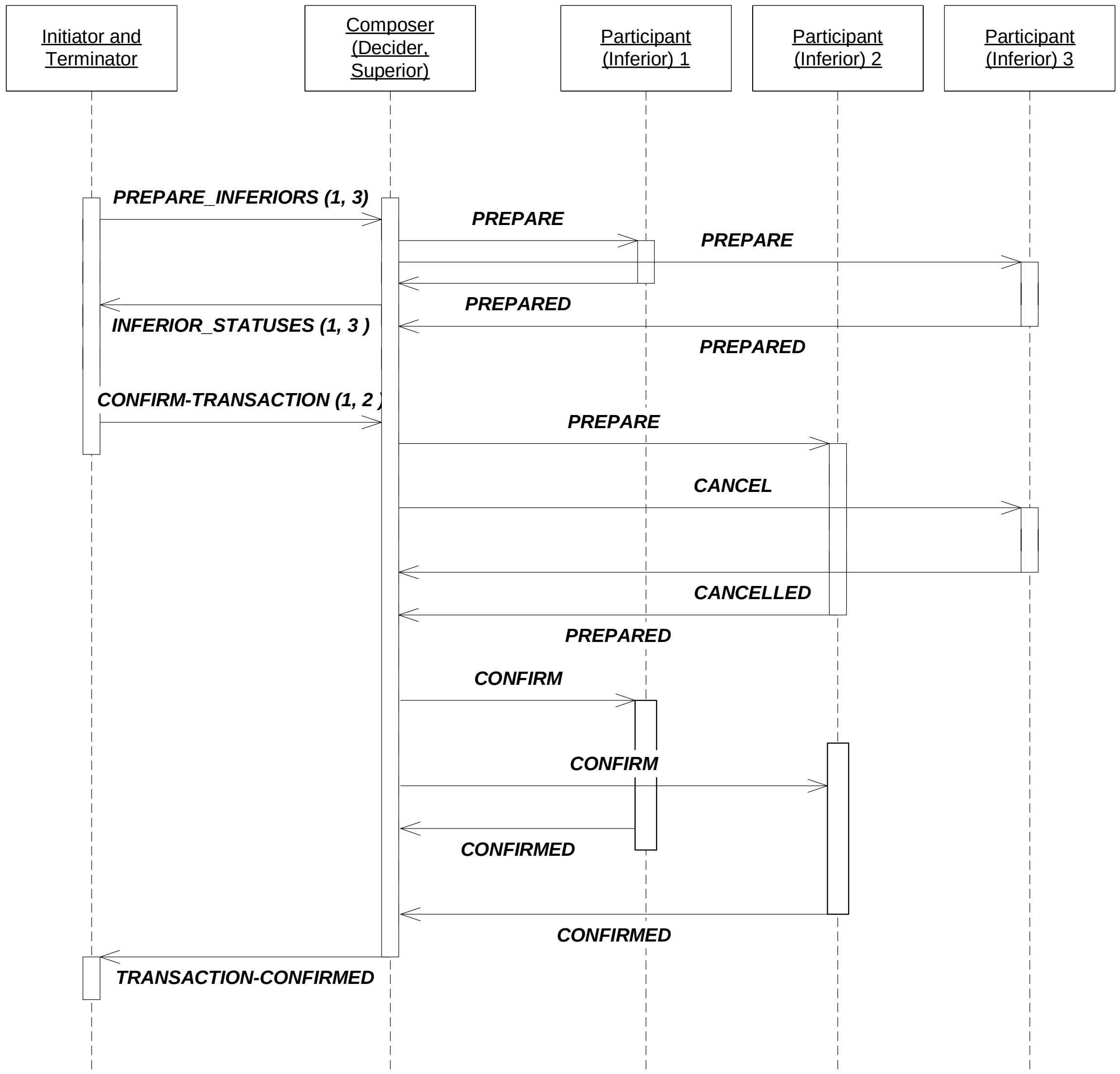

**Figure 14 Termination sequence for a composer**

## Confirm-set of intermediates

An Intermediate, that is a Superior that is also an Inferior, also has a confirm-set, but this is controlled rather differently to the top-most Superior (Decider) described above.

As an Inferior, the interface between the application and BTP elements is not fully defined in this specification. However, within the standard control relationship, issuing BEGIN with a related CONTEXT to a Factory will cause the creation of a Sub-coordinator or Sub-composer (depending on whether the BEGIN parameter asked for atomic or cohesive behaviour). Initially, of course, the new Intermediate has no Inferiors – however, unlike a Participant (in the strict sense of the term), it has a “superior-address” to which ENROL can be sent to enrol Inferiors. This address is a field of the new CONTEXT.

Figure 15 is a state diagram for a Sub-composer or Sub-coordinator.

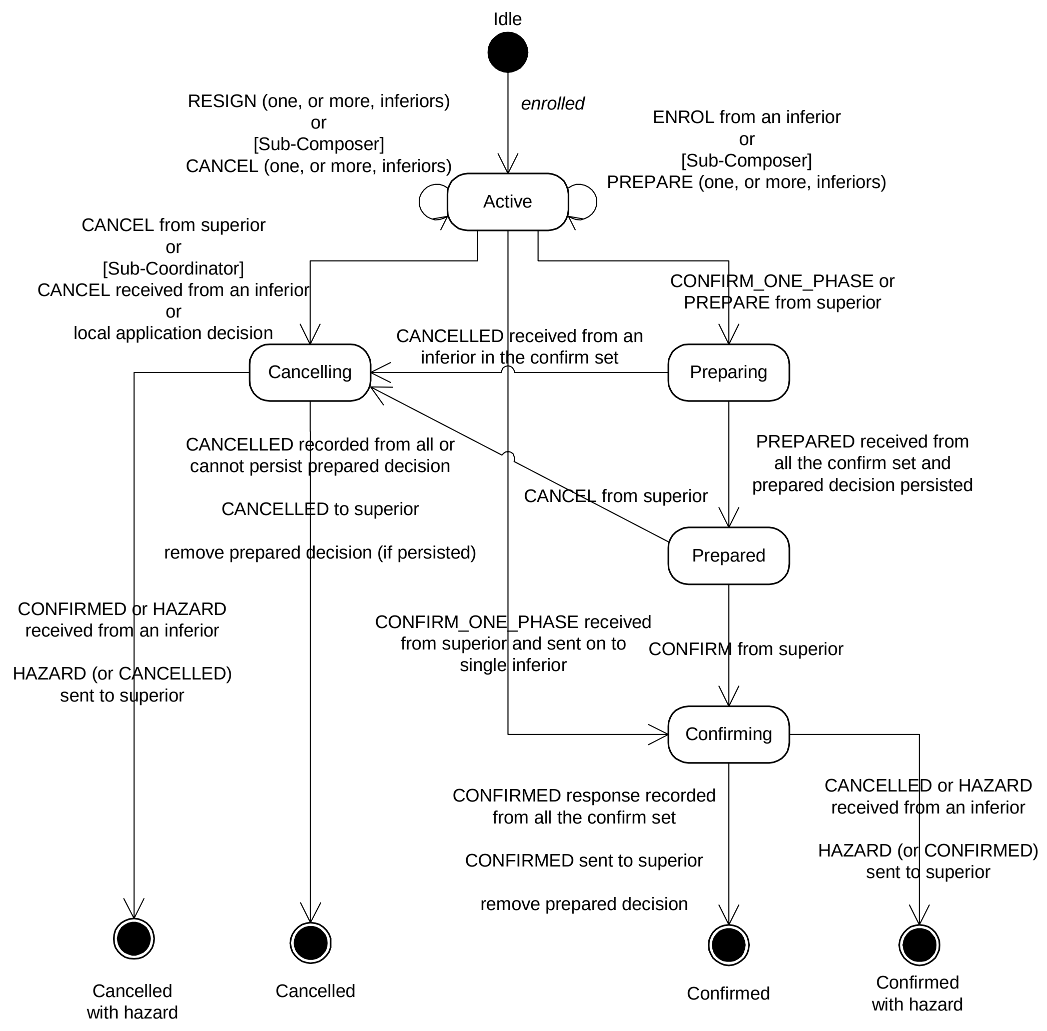
Idle
enrolled
RESIGN (one, or more, inferiors) or [Sub-Composer] CANCEL (one, or more, inferiors)
ENROL from an inferior or [Sub-Composer] PREPARE (one, or more, inferiors)
Active
CANCEL from superior or [Sub-Coordinator] CANCEL received from an inferior or local application decision
CONFIRM_ONE_PHASE or PREPARE from superior
CANCELLED received from an inferior in the confirm set
Cancelling
Preparing
CANCELLED recorded from all or cannot persist prepared decision
CANCELLED to superior
remove prepared decision (if persisted)
PREPARED received from all the confirm set and prepared decision persisted
CANCEL from superior
Prepared
CONFIRMED or HAZARD received from an inferior
HAZARD (or CANCELLED) sent to superior
CONFIRM_ONE_PHASE received from superior and sent on to single inferior
CONFIRM from superior
Confirming
CONFIRMED response recorded from all the confirm set
CONFIRMED sent to superior
remove prepared decision
CANCELLED or HAZARD received from an inferior
HAZARD (or CONFIRMED) sent to superior
Cancelled with hazard
Cancelled
Confirmed
Confirmed with hazard

**Figure 15 State diagram for Sub-coordinator or Sub-composer**

The behaviour of the Intermediate towards its Inferiors, during the active phase, is basically the same as for the Decider:

- ENROL messages can be received, adding a new Inferior
- Inferiors may resign - RESIGN is received from an Inferior. The Inferior is immediately removed from the set of Inferiors
- CANCELLED may be received from an Inferior
- PREPARED may be received from an Inferior

In some circumstances, receipt of an incoming message allows an Intermediate to determine that a state change for the whole transaction node takes place. The Intermediate is able to send messages to its Superior at its own initiative (whereas a Decider can only respond to a received message from the Terminator), so the receipt of a message from an Inferior can trigger the sending of messages. This is especially the case if the Intermediate knows (from application knowledge, perhaps involving received or sent CONTEXT_REPLY messages) that there will be no further enrolments. In particular:

- If CANCELLED is received from an Inferior, and this is a Sub-coordinator, the Sub-coordinator can itself cancel - CANCEL is sent to other Inferiors, and CANCELLED to the Superior

- If RESIGN is received from the only Inferior and there will be no other enrolments, the Intermediate can itself resign, sending RESIGN to the Superior

- If PREPARED is received from the Inferior~~Superior~~, it is known there will be no other enrolments and this is a Sub-coordinator, the Sub-coordinator can become prepared (assuming successful persistence of the appropriate information) and send PREPARED to the Superior.

For a Sub-composer, application logic will invariably be involved in determining what effect a CANCELLED and PREPARED from an Inferior have – though in a real implementation, this logic may be delegated to the BTP-support software.

The Intermediate may initiate cancellation or the two-phase outcome exchange, either as a result of receiving the corresponding message (CANCEL, PREPARE) from the Superior, or triggered by its own controlling application element. For a Sub-composer, this may be partial - a Sub-composer might be instructed by the application element to cancel some Inferiors and send PREPARE to others. Receipt of PREPARE from the Superior will often have a similar effect to a Decider receiving CONFIRM_TRANSACTION – PREPARE is propagated to all Inferiors that have not indicated they are PREPARED. However, exactly what happens on receiving PREPARE will depend on the application – receipt of the PREPARE may be visible to the application element and cause it to initiate further application activity (perhaps causing enrolment of new Inferiors) before it is determined whether to propagate PREPARE, and with a Sub-composer, some of the Inferiors may be instructed to cancel instead.

Assuming the Intermediate does not cancel as a whole (in which case CANCEL would be sent to all Inferiors), the Intermediate will at some point attempt to become prepared. If it is a Sub-coordinator, this will require that PREPARED has been received from all Inferiors. For a Sub-composer, application logic will determine from which Inferiors PREPARED is required, with the others being cancelled. In either case, the Intermediate will persist the information about the Inferiors that are to be in the confirm-set and about the Superior, if this persisting is successful, send PREPARED to its own Superior.

If CANCEL is subsequently received from the Superior, this is propagated to all the Inferiors and the persistent information removed (or effectively removed as far as recovery is concerned). It is not important which order this is done in, since the recovery sequence will ensure that a cancel outcome is eventually delivered anyway.

If CONFIRM is received from the Superior (which can only be after sending PREPARED to the Superior), this is likewise propagated to the Inferiors. For a Sub-coordinator, CONFIRM is invariably sent to all Inferiors. However, for a Sub-composer it is possible further application logic intervenes and some of the Inferiors are rejected from the confirm-set at this late stage.

(This can only occur when the application work, as defined by the contract to the Superior, can be performed by some sub-set of the Inferiors.)  The Intermediate may, but is not required to, change the persistent information to reflect the confirm outcome (though a Sub-composer that selects only some Inferiors probably will need to re-write the information to ensure the correct subset are confirmed despite possible failures). If the information is not changed, then, on recovery, the Intermediate will find itself to be in a prepared state and will interrogate the Superior to re-determine the outcome. If the information is changed, a recovered Intermediate can immediately continue with ordering confirmation to its Inferiors.

If CONFIRM_ONE_PHASE is received from the Superior, either before or after the Intermediate has become PREPARED, the effect is very similar to a Decider receiving CONFIRM_TRANSACTION. If there is only one Inferior, the CONFIRM_ONE_PHASE may be propagated to that Inferior. Otherwise, the Intermediate behaves as a Decider, making a confirm decision if it can.

If one or more Inferiors make contradictory autonomous decisions, or HAZARD is received from an Inferior, the Intermediate may report this to the Superior using HAZARD. However, BTP does not require this. Since the Superior may be owned and controlled by a different organisation, there may be business reasons not to report such problems.

## Optimisations and variations

### Spontaneous prepared

As described above, before a Superior can order confirmation to an Inferior, the Inferior must become “prepared”, meaning that it is ready to confirm or to cancel as it so ordered and send the PREPARED message as a report of this. In the conventional message sequence, as shown above, the Inferior attempts to become prepared when it receives a PREPARE message from the Superior. The PREPARE in turn is sent by the Superior when it receives an appropriate request from its controlling application (or from its own Superior, if there is one). The application controlling the Superior will request the sending of PREPARE  when it determines that no further application work associated with this Inferior (or, perhaps with the whole business transaction) will occur.

However, for some applications, the application element controlling the Inferior will know that the application work for which the Inferior will be responsible is complete before a PREPARE is sent from the Superior. In fact, because the application element has autonomy in determining how application work is to be allocated to Inferiors, it is possible for the Inferior-side application element to know the work is complete **for a particular Inferior** when Superior-side application element will be sending more message to the Inferior-side. (The future work will, probably, require the enrollment of additional Inferiors.)

BTP consequently allows the application element controlling an Inferior to cause the Inferior to become prepared, and to send PREPARED to the Superior without PREPARE having been received from the Superior. From the perspective of the BTP Superior the Inferior sends PREPARED spontaneously. Apart from this, a spontaneous PREPARED message is the same as, and has the same effect and implications as one induced by a PREPARE message.

### One-shot

In the “conventional” message sequence shown above and assuming the Initiator, Terminator and Coordinator on the one side, and “Service”, Enroller and Participant on the other are located within their respective parties, there are eight messages passed in one direction or the other between the two parties. There are four round-trip exchanges: the application request and response exchange, the ENROL/ENROLLED exchange (going in the opposite direction and overlapped with the application exchange), then PREPARE/PREPARED and the CONFIRM/CONFIRMED. However, if  the application exchange is a single request/response, it is possible to reduce these eight to two round-trips– the first of which merges the first three of the conventional sequence. The fundamental two-phase nature of BTP (or any coordination mechanism) means there have to be at least two round trips – one before the confirm-or-cancel decision is made at the Superior, one after. This merging of the exchanges is termed “one-shot”, as it requires only one exchange to take the relationship from non-existent to waiting for the confirm-or-cancel decision.

Figure 16 shows a typical “one-shot” message sequence. The diagram distinguishes an additional aspect of the application elements, labelled “context-handler”. This is not a role in the BTP model, but is used only to distinguish a set of responsibilities and actions. In a real implementation these might be performed by the user application itself, or might be performed by the BTP-supporting infrastructure on the path between the application elements. (Figure 9 could be redrawn to show the context-handlers, but to no particular benefit) As in the conventional case, the CONTEXT is sent related to the application request (the creation of the CONTEXT by the Factory is not shown and is the same as the conventional case). The “context-handler” is aware of the sending of the CONTEXT.

On the responder (service side), however, when the application element creates the Inferior, the ENROL is not sent immediately, but retained. The application performs the “provisional effect” implied by the received message and the Inferior becomes prepared and issues a PREPARED message, which is also retained. When the application response is available, it is sent with the retained messages and the CONTEXT_REPLY (which indicates that the related ENROL will complete the enrolments implied by the earlier transmission of the CONTEXT.

When this group of messages is received by the context-handler on the client side, the contained ENROL and PREPARED messages are forwarded to the Superior (whose address was on the original CONTEXT and so is known to the context-handler). An ENROLLED message is sent back to the context-handler, assuring it that the enrolment was successful and the application can progress. If enrollment fails and the business transaction is atomic, confirmation must be prevented – this responsibility falls on the context-handler and the client  application, since the failure of the enrolment implies that Superior itself is inaccessible. If enrolment fails and the business transaction is a cohesion, the appropriate response is a matter for the application.

With “one-shot”, if there are multiple Inferiors created as a result of a single application message, there is an ENROL and PREPARED message for each one sent related with the CONTEXT_REPLY. If an operation fails, a CANCELLED message may be sent instead of a PREPARED – if the Superior is atomic, this will ensure it cancels, if cohesive, the client application will be aware of this and behave appropriately.

Whether the “one-shot” mechanism is used is determined by the implementation on the responding (Inferior) side. This may be subject to configuration and may also be constrained by the application or by the binding in use.

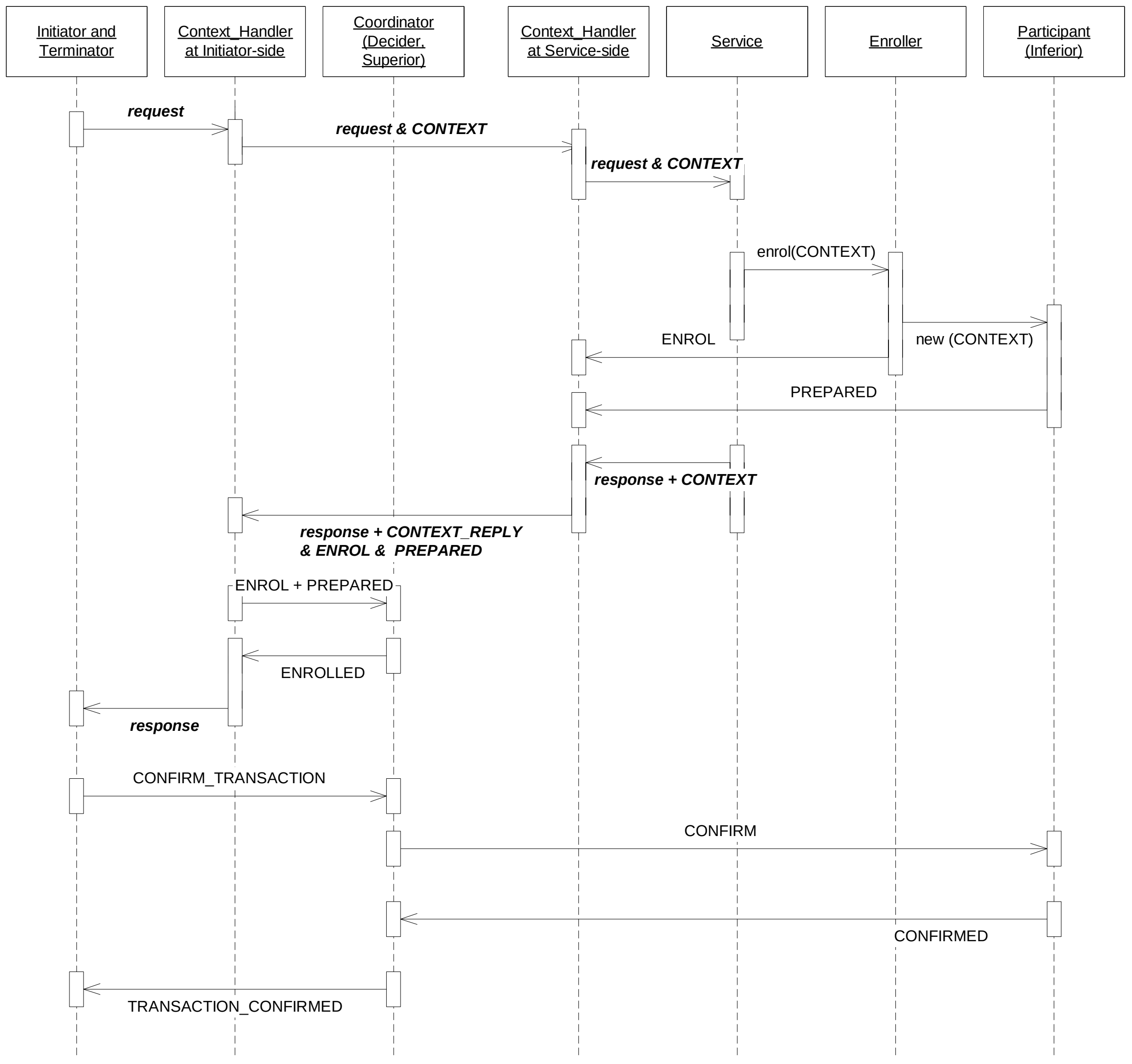

**Figure 16 A message sequence showing the “one-shot” optimisation**

## Resignation

After an Inferior is enrolled, it may be determined that the application work it is responsible for has no real effect – more exactly, that the counter-effect, if cancelled, and the final effect, if confirmed, will be identical. In such a case the Inferior can effectively un-enrol itself by sending a RESIGN message to the Superior. This can be done “spontaneously” (as far as BTP is concerned) or as a response to a received PREPARE message. It cannot be done after the Inferior has become prepared.

An Inferior from which RESIGN has been received is not considered an Inferior in discussion of the confirm-set – the phrase “remaining Inferiors” is used to mean only non-resigned Inferiors.

### One-phase confirmation

If a Coordinator or Composer that has been requested to confirm has only one (remaining) Inferior in the confirm-set, it may delegate the confirm-or-cancel decision to that Inferior, just requesting it to confirm rather than performing the two-phase exchange. This is done by sending the CONFIRM_ONE_PHASE message. Unlike the two-phase exchange (PREPARED received, CONFIRM sent), it is possible with CONFIRM_ONE_PHASE for a failure to occur that leads to the original Coordinator or Composer (and its controlling application element – the Terminator) being uncertain whether the outcome was confirmation or cancllation.

### Autonomous cancel, autonomous  confirm and contradictions

As described above, BTP does not require a Participant, while it is responsible for holding application resources such that can be confirmed or cancelled, to use any particular mechanism for maintaining this state. A Participant that "becomes prepared" may choose to let the "provisional effect" be identical to the "final effect", and hold a compensating "counter effect" ready to implement cancellation; or it may make the provisional effect effectively null, and only perform the real application work as the final effect if confirmed; or the "provisional effect" may involve performance of the application work and locking application data against other access; or other patterns, as may be constrained or permitted by the application.

Although a Participant is not required to lock data (as would be the case with some other transaction specifications) on becoming prepared, it is nevertheless in a state of doubt, and this doubt may have application or business implications. Accordingly it is recognised that a Participant (or, rather the business party controlling the application element and the Participant) may need to limit the promise made by sending PREPARED, and retain the right to apply its own decision to confirm or cancel to the Participant and the application effects it is responsible for. This is described as an "autonomous" decision. It is closely analogous to the heuristic decisions recognised in other transaction specifications. The only difference is the conceptual one that heuristic decisions are typically considered to occur only as a result of rare and unpredictable failure, whereas BTP recognises that the right to take an autonomous decision may be critical to the willingness of a business party to be involved in the business transaction at all. BTP therefore allows Participants (and all Inferiors) to indicate that there are limits on how long they are willing to promise to remain in the prepared state, and that after that time they may invoke their right of taking an autonomous decision.

Taking an autonomous decision will of course run the risk of breaking the intended consistency of outcome across the business transaction, if the autonomous decision of the Inferior contradicts the decision (for this Inferior) made by the Superior. The Superior will have received the PREPARED message and thus be permitted to make a confirm decision (directly, or through exchanges with a Terminator application element or with its own Superior). An Inferior taking an autonomous decision informs the Superior by sending CONFIRMED or CANCELLED, as appropriate, without waiting for an outcome order from the Superior. This may cross the outcome message from the Superior, or the Superior may not make its decision till later. If the decisions agree, the normal CONFIRM or CANCEL message is sent. In the case of CANCEL, this completes the relationship – the CANCEL and CANCELLED messages acknowledge each other, regardless of which travels first. In the case of CONFIRM, another CONFIRMED message is needed.

If the Superior's decision is contradicted by the autonomous decision, the Superior may need to record this, report it to management systems or inform the Terminator application or its own Superior. When this has been done (details are implementation-specific, but may be constrained by the application), the Superior sends a CONTRADICTION message to the Inferior. If an outcome message was sent earlier (crossing the announcement of the autonomous decision), the Inferior will already know there was a contradiction, but the receipt of the CONTRADICTION message informs the Inferior that the Superior knows and has done whatever it considers necessary to cope.

As mentioned, BTP allows an Inferior to inform the Superior, with a qualifier on the PREPARED message, that the promise to remain in the prepared state will expire. In turn this allows the application on the Superior side to avoid risking a contradictory decision by making and sending its own decision in time. The Superior side can also indicate, with another qualifier, a minimum time for which it expects the prepared promise to remain valid.

As well as deliberate and forewarned autonomous decisions, BTP recognises that failures and exceptional conditions may force unplanned autonomous decisions  In the protocol sequence these are treated exactly like planned autonomous decisions – if they contradict, the Superior will be informed and a CONTRADICTION message sent to the Inferior.

Autonomous decisions, planned or unplanned, are equivalent to the heuristic decisions of other transaction systems. The term is avoided in BTP since it may carry implications that it only occurs in an unplanned manner.

## Recovery and failure handling

### Types of failure

BTP is designed to ensure the delivery of a consistent decision for a business transaction to the parties involved, even in the event of failure. Failures can be classified as:

> **Communication failure**: messages between BTP actors are lost and not delivered. BTP assumes the carrier protocol ensures that messages are either delivered correctly (without corruption) or are lost, but does not assume that all losses are reported nor that messages sent separately are delivered in the order of sending.

> **Node failure (system failure, site failure)**: a machine hosting one or more BTP actors stops processing and all its volatile data is lost. BTP assumes a site fails by stopping – it either operates correctly or not at all, it never operates incorrectly.

Communication failure may become known to a BTP implementation by an indication from the lower layers or may be inferred (or suspected) by the expiry of a timeout. Recovery from a communication failure requires only that the two actors can again send messages to each other and continue or complete the progress of the business transaction.

A node failure is distinguished from communication failure because there is loss of volatile state. To ensure consistent application of the decision of a business transaction, BTP requires that some state information will be persisted despite node failure. Exactly what real events correspond to node failure but leave the persistent information undamaged is a matter for implementation choice, depending on application requirements; however, for most application uses, power failure should be survivable (an exception would be if the data manipulated by the associated operations was volatile). In all cases, there will be some level of event sufficiently catastrophic to lose persistent information and the ability to recover– destruction of the computer or bankruptcy of the organisation, for example.

Recovery from node failure involves recreating an accessible communications endpoint in a network node that has access to the persistent information for incomplete transactions. This may be a recreation of the original actor using the same addresses; or using a different address; or there may be a distinct recovery entity, which can access the persistent data, but has a different address; other implementation approaches are possible. The recovered, and possibly relocated actor may or may not be capable of performing new application work  Restoration of the actor from persistent information will often result in a partial loss of state, relative to the volatile state reached before the failure. In some states, there may be total loss of knowledge of the business transaction, including particular Superior:Inferior relationships. After recovery from node failure, the implementation behaves much as if a communication failure had occurred.

### Persistent information

BTP **requires** that certain state information is persisted – these are information that records an Inferior's decision to be prepared, a Superior's decision to confirm and an Inferior's autonomous decision . Requiring the first two to be persistent ensures that a consistent decision can be reached for the business transaction and that it is delivered to all involved nodes, despite failure. Requiring an Inferior's autonomous decision to be persistent allows BTP to ensure that, if the autonomous decision is contradictory (i.e. opposite to the decision at the Superior), the contradiction will be reported to the Superior, despite failures.

BTP also permits, but does not require, recovery of the Superior:Inferior relationship in the active state (unlike many transaction protocols, where a communication or node failure in active state would invariably cause rollback of the transaction). Recovery in the active state may require that the application exchange is resynchronised as well – BTP does not directly support this, but allows continuation of the business transaction if the application desires it. Apart from the (optional) recovery in active state, BTP follows the well-known presume-abort model – it is only **required** that information be persisted when decisions are made (and not, for example, on enrolment). This means that on recovery one side may have persistent information while the other does not. This occurs, among other cases, when an Inferior has decided to be prepared but the Superior never confirmed (so the decision is "presumed" to be cancelled), and when the Superior did confirm, the Inferior applied the confirmation and removed its persistent information but the acknowledgement message (CONFIRMED) was never received by the.Superior.

Information to be persisted when an Inferior decides to be prepared has to be sufficient to re-establish communication with the Superior, to apply a confirm decision and to apply a cancel decision. It will thus need to include the addressing and identification information for the Superior. The information needed to apply the confirm or cancel decision will depend on the application and the associated operations.

A Superior must persist the corresponding information to allow it to re-establish communication with the Inferior – that is the addressing and identification information for the Inferior. When it must persist this information depends on its position within the transaction tree. If it is the top of the tree – i.e. it is the Decider for the business transaction -- it need only persist this information if and when it makes a decision to confirm (and, for a Cohesion, only if this Inferior is in the confirm-set). A Superior that is an intermediate in the tree – i.e. it is an Inferior to some other Superior –must persist the information about each of its own Inferiors as part of (or before) persisting its own decision to be prepared. For such an intermediate, the "decision to confirm" as Superior is made when either CONFIRM is received from its Superior or it makes an autonomous decision to confirm. If CONFIRM is received, the persistent information may be changed to show the confirm decision, but alternatively, the receipt of the CONFIRM can be treated as the decision itself and the CONFIRM message propagated to the Inferiors without changing the persistent information. If the persistent information is left unchanged and there is a node failure, on recovery the entity (as an Inferior) will be in a prepared state, and will rediscover the confirm decision (using the recovery exchanges to its Superior) before propagating it to its Inferior(s).

Since BTP messages may carry application-specified qualifiers, and the BTP messages may be repeated if they are lost in transit (see next section), the persistent information may need to include sufficient to recreate the qualifiers, to allow them to be resent with their carrying BTP message. This applies both to qualifiers on PREPARED (which would be persisted by the Inferior) and on CONFIRM (which would be persisted by the Superior).

In some cases, an implementation may not need to make an active change to have a persistent record of a decision, provided that the implementation will restore itself to the appropriate state on recovery. For example, an implementation that, as Inferior, always used the default-is-cancel mechanism, and recorded the timeout (to cancel) in the persistent information on becoming prepared, and always updated or removed that record when it applied a confirm instruction could treat the presence of an expired record as effectively a record of an autonomous cancel decision.

### Recovery messages

Once the Superior:Inferior relationship has entered the completion phase – BTP does not generally use special messages in recovery, but merely permits the resending of the previous message – thus, for example, PREPARE, PREPARED, CANCEL, CONFIRM can all be sent repeatedly. Resending the previous message means a possible loss of the original message may be invisible to the receiver. The trigger for this re-sending is implementation dependent – a reported communication failure, a timeout expiry while waiting for a reply, the re-establishment of communications or the general restoration of function after a node failure are all possible triggers. An incoming repetition of the last message received, if it has already been replied to (e.g. receiving PREPARE after PREPARED has been sent), should normally trigger a resending of the last message sent – since that sent message may have got lost.[4]

While in the active phase – i.e. prior to entering completion – there is no appropriate last message that can be sent. However, for active-phase recovery there needs to be some way for the BTP actors to determine that the peer is still there and still aware of the Superior:Inferior relationship. In this case, the peers can interrogate each other using the INFERIOR_STATE or

[4] BTP's capability of binding to alternative carrier protocols is part of the motivation for not having a distinct recovery message sequence, since the carrier binding does not necessarily have a well-defined communication failure indication.

SUPERIOR_STATE messages, informing the peer of their own state and requesting a response – which may be the opposite message, or one of the main BTP messages (which perhaps had been lost). If it is another SUP|INFERIOR_STATE message, that reply does not ask for a response. Receiving a SUP|INFERIOR _STATE messages that asks for a response does not require an immediate response – especially if an implementation is waiting to determine a decision (perhaps because it is itself waiting for a decision from elsewhere), an implementation may choose not to reply until it wishes too.

The SUP|INFERIOR_STATE messages are also used as replies when the receiver of **any** of the Superior:Inferior message has determined that there is no corresponding state information – the targeted Superior or Inferior does not exist (or is known to have completed and is no longer an active entity). The SUP|INFERIOR_STATE messages with a status of “unknown” is the indication that the state information does not exist.

The SUP|INFERIOR_STATE messages are also available as replies to any Superior:Inferior message in the (transient, one hopes) case where, after failure an implementation cannot currently determine whether the persistent information exists or not, or what its state is, and so cannot give a definitive answer. The SUP|INFERIOR_STATE messages with a status of “inaccessible” is the indication that the existence of state information cannot be determined. The receiver of such a message should normally treat it as a “retry later” suggestion.

### Redirection

As described above, BTP uses the presume-abort model for recovery. A corollary of this is that there are cases where one side will attempt to re-establish communication when there is no persistent information for the relationship at the far-end, because that side either never reached a state where the state was persisted, or had been persisted, but then progressed to remove the state information. In such cases, it is important the side that is attempting recovery can distinguish between unsuccessful attempts to connect to the holder of the persistent information and when the information no longer exists. If the peer information does not exist, the side that is attempting recovery can draw appropriate conclusions (that the peer either was never prepared, never confirmed or has already completed) and complete its part of the transaction; if it merely fails to get through, it is stuck in attempting recovery.

Two mechanisms are provided to assist implementation flexibility while allowing completion of Superior:Inferior relationships when only one side has any persistent information. The mechanisms are:

- Address fields which provide the address that will be used by the peer to send messages to an actor (effectively a “callback address”) can be a set of addresses, which are alternatives, one of which is chosen as the target address for the future message. If the sender of that message finds the address does not work, it can try a different alternative.

- The REDIRECT message can be used to inform the peer that an address previously given is no longer valid and to supply a replacement address (or set of addresses). REDIRECT can be issued either as a response to receipt of a message or spontaneously.

The two mechanisms can be used in combination, with one or more of the original set of addresses just being a redirector, which does not itself ever have direct access to the state information for the transaction, but will respond to any message with an appropriate REDIRECT.

REDIRECT as a message is only used on the Superior:Inferior relationship, where each side holds the address of the other. On the other relationships (e.g. Terminator:Decider), one side (e.g. Terminator) has the address of the other, and initiates all the message exchanges. However, the entity whose address is known to the other may itself move - e.g. if a Coordinator, which will be both Decider and Superior changes its address as a Superior, it will probably change its address as a Decider too. In this case, a FAULT reply to a misdirected message can be used, assuming there is some entity available at, or on the path to the old address that understands BTP sufficiently to provide the redirection information.

Some implementations, in which  a single addressable entity with one, constantaddress deals with all transactions, distinguishing them by identifier, will  not need to supply “backup” addresses (and would only use REDIRECT if permanently migrated).

### Terminator:Decider failures and transaction timelimit

BTP does not provide facilities or impose requirements on the recovery of Terminator:Decider relationships, other than allowing messages to be repeated. A Terminator may survive failures (by retaining knowledge of the Decider’s address and identifier), but this is an implementation option. Although a Decider (if it decides to confirm) will persist information about the confirm decision, it is not required, after failure, to remain accessible using the address it originally gave to the Initiator (and used by the Terminator). Any such recovery is an implementation option.

A Decider has no way of initiating a call to a Terminator to ensure that it is still active, and thus no way of detecting that a Terminator has failed. The Decider always has the right to initiate cancellation, but if the application (Terminator) and the Decider have different views about how long a “long time” is, then either the Decider might wait unnecessarily for a completion request (e.g. CONFIRM_TRANSACTION) that will never arrive, or it might initiate cancellation while the application is still active. To avoid these irritations, a standard qualifier “Transaction timelimit” can be used (by the Initiator) to inform the Decider when it can assume the Terminator will not request confirmation and so it (the Decider) should initiate cancellation.

### Contradictions and hazard

As described above (see “Autonomous cancel, autonomous  confirm and contradictions”), in some circumstances an Inferior may apply a decision that is contradictory to the decision of the Superior. This can occur in a semi-planned manner, when the Inferior has announced a timeout on the PREPARED message but no outcome message has been received, or as a result of an exceptional condition that forces the Inferior to break the promise implicit in PREPARED, regardless of timers. In both cases, this is considered an autonomous decision by the Inferior. An autonomous decision, of itself, does not imply a contradiction – it only results in a contradiction if the decision is opposite to that of the Superior (in the case of a cohesive Superior, opposite to the decision that applies to this Inferior).

In order to ensure that a contradiction is detected despite node and communication failures, it is required that information about the taking of the autonomous decision be persisted until a BTP message received from the Superior indicates either that there was no contradiction (the decisions were in line – CANCEL is received after an autonomous cancel or CONFIRM is received after an autonomous confirm) or that the Superior is aware of the contradiction (CONTRADICTION is received). Note that the Inferior will become aware of the fact of the contradiction when it receives the “wrong” message, but must retain the record of its own decision until it receives the CONTRADICTION message, which tells it the Superior knows too.

The Superior’s action on becoming aware of the contradiction is not determined by this specification. In particular, if the Superior is a Sub-coordinator or Sub-composer, it is not required by this specification to report the contradiction to its own Superior (which may, for example, be controlled by a different organisation). The Superior may report the problem to management systems or record it for manual repair. However, BTP does provide mechanisms to report the contradiction to the next higher Superior (if there is one) or to the Terminator application element.

A contradiction occurring in an Inferior will usually mean the immediate Superior has a “mixed” condition – some of the application work it was responsible for has confirmed, some has cancelled (and contrary to any cohesion confirm-set selection). If the Superior is a Sub-coordinator or Sub-composer, it can report the mixed condition to its own Superior with the HAZARD message. If the Superior is the top-most in the tree, it can report the problem with the INFERIOR_STATUSES message, which will detail the state of all the Inferiors. Figure 17 shows a message sequence in a transaction tree with two levels. The Participant makes an autonomous cancel decision, but the Coordinator decides to confirm. The confirm decision from the Coordinator, passed on by the Sub-coordinator crosses with the CANCELLED message from the Participant. The Participant waits for the CANCELLED from the Sub-coordinator, which chooses to report the problem with HAZARD to the Coordinator.

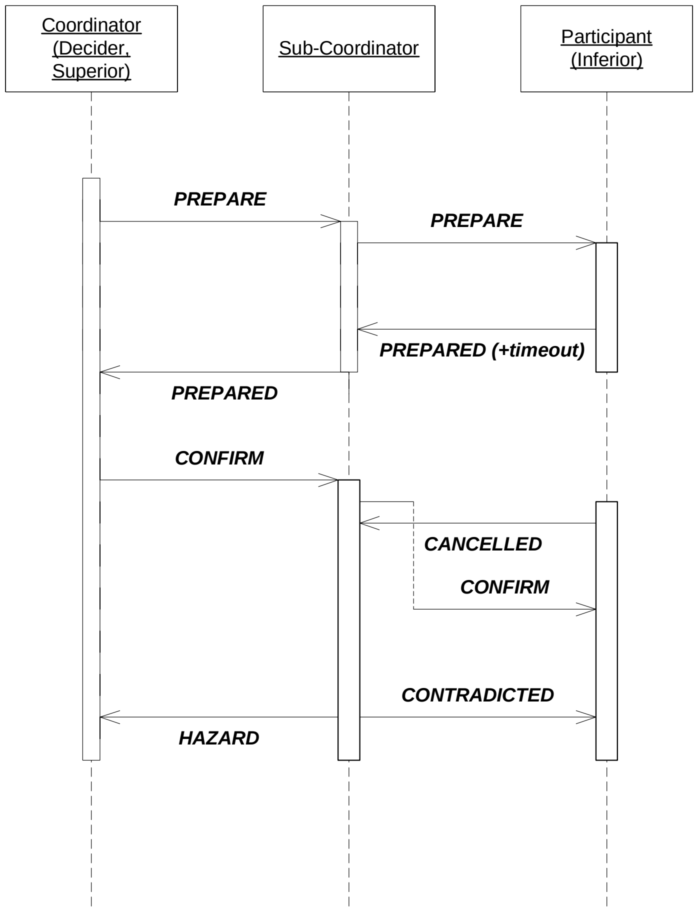

**Figure 17 Message sequence showing contradiction, reported with HAZARD**

If a Sub-coordinator or Sub-composer having sent (or attempted to send) the outcome message to its Inferiors, is temporarily unable to get a response (CONFIRMED or CANCELLED), it may either wait until a response does come back or choose to reply to its own Superior with a HAZARD message indicating that a contradiction is “possible”. If it does choose to send HAZARD, it is required to persist a record of this until it receives a CONTRADICTION message from the Superior, or a message from the Inferior indicating there was no contradiction in fact.

HAZARD is also used to indicate that it has become impossible to cleanly and consistently achieve either a confirmed or a cancelled state for the application work. In this case, there is can be no guarantee that the problem will be reliably reported – especially because it may be the inability to persist information that is the cause of the problem.

## Relation of BTP to application and carrier protocols

BTP messages are communicated between actors in two distinguishable circumstances:

a) in establishing and progressing the outcome and control relationships between BTP actors, and between application elements and BTP actors – Initiator:Factory, Terminator:Decider, Superior:Inferior etc.

b) in association with application messages that are communicated between application elements.

In the first case, interoperable communication requires a specification of how the abstract BTP messages are represented and encoded, and how they are transmitted. This specification is a **carrier protocol binding** (or just “binding”, if the context is clear)**.** BTP allows bindings to a multiplicity of carrier protocols. The only requirement that BTP makes is that the transmission of a message either delivers an uncorrupted message or fails. BTP does not require that the carrier report failure to deliver a message, to either side, nor that messages are delivered in the order they are sent (though implementations can take advantage of information from a richer carrier, which can improve performance in various ways). BTP messages communicated in this way have semantics that are defined in this specification – a PREPARE message (for example), refers back to the ENROL via the “inferior-identifier” parameter and is an instruction to the Inferior to become and report that it is prepared.

In the second case, the full semantics cannot be defined in this specification. Interoperation with BTP requires that the parties have a common understanding of what is being confirmed or cancelled, but this mutual understanding is defined by the contract of the application, not by BTP. (The contract may be explicit or implicit, declared by one side as take-it-or-leave-it, or may be negotiated in some way.) Part of this contract will include how the combination of the application protocol (i.e. the application messages and their sequencing) and BTP operate such that the two sides are agreed as to which application operations are part of which business transaction. This will often be achieved by sending application messages and BTP messages in “association” in some way – thus an application message sent in association with a CONTEXT can be specified (by the application contract) to mean that if work is done as result of the receipt of the message, one or more Inferiors should be enrolled to apply the confirm/cancel decision to that work. Similarly, an application message may be sent associated with an ENROL with the contractual understanding that the message refers to some application work that has been made the responsibility of the Inferior being enrolled.

The concrete representation of this “association” is also a matter for the application protocol specification. There are several ways this can be done, including:

- the BTP message is contained within the application message, or both are contained within a larger construct;
- the application message contains a field that is the superior-identifier or inferior-identifier that is also present on the CONTEXT or the ENROL
- the BTP message contains a qualifier that references (a field of) the application message in some way (e.g. if the application message is an invoice, the qualifier might contain the invoice number)
- the encoding of the BTP and application messages reference each other (e.g. using XML id and refid attributes)

In all cases, the application specification[5] will need to define the mechanism so that both parties have common understanding. Many applications will use the same mechanism and their specifications can therefore take advantage of standard patterns, and their implementations of standard tools.

The association of an application message with a BTP message is analogous to the concept of "related" BTP messages. "Related" BTP messages are sent as a group, with a declared and defined semantic for the group. Associated application and BTP messages can be considered as "related", with the proviso that the semantic is defined by the application, not by BTP.

There is no necessary relationship between how the application messages and any associated BTP messages are transmitted by carrier protocols, and the carrier binding for the BTP messages. BTP messages are invariably sent to a BTP actor whose address has been passed to the sender by some means – thus a CONTEXT contains the address of the Superior to which ENROLs will be sent, and the ENROL contains the address of the Inferior. Similarly, BEGUN contains the address (as Decider) of the new Composer or Coordinator. These addresses are all sets of addresses (possibly of cardinality one), and each individual address identifies which binding is to be used. Thus, for example, when a CONTEXT is sent associated with an application message, the ENROL will travel on a carrier binding identified by the particular address from the CONTEXT that the Enroller chooses to use – which may have no relationship to how the application message arrived.

Despite this, it will be common that the application binding and the BTP binding will use the same carrier. This is the case in the bindings specified in this edition of the specification, which define a binding of BTP to SOAP 1.1 over HTTP. Included in this SOAP/HTTP binding specification, are rules that allow an application to associate (relate) a single CONTEXT or a single ENROL (carried in the SOAP header) with the application message(s) carried in the SOAP body.

## Other elements

### Identifiers

An Identifier is a globally unambiguous identification of the state corresponding to one of Decider, Superior or Inferior. Where a single entity has more than one of these roles (at the same node in the same transaction, as with a Sub-coordinator that is both Superior and Inferior), the Identifiers may be the same or different, at implementation option - they are distinguished by which messages the Identifier is used on. (A Superior has only one Superior-identifier, although it may be in multiple Superior:Inferior relationships, each with a separate state in terms of the state table).

The state identified by an Identifier can be accessed by BTP messages sent to any of the addresses supplied with the Identifier in the appropriate message (CONTEXT, BEGUN, ENROL), or as updated by REDIRECT. An Identifier itself has no location implications. (Identifiers are specified, in the XML representation, as syntactically URIs - by their use as names of BTP

[5] The "application specification", or "application protocol specification" may be very informal or may be a standardised agreement.

entities, they are URNs. If an Identifier happens to specify an network location (i.e. it is a URL), it is treated as an opaque value by BTP)

Identifiers are specified as being globally unambiguous - the same Identifier only ever identifies one Decider, Superior or Inferior over all systems and all time. In practice, an Identifier could be re-used if there is no possibility of the colliding values being confused. However implementations are recommended to use truly unambiguous Identifiers (that is to use them as URNs).

### Addresses

In most cases, BTP actors that need to communicate are informed of each others addresses from received BTP messages. When an Inferior is to be enrolled, a CONTEXT message which contains the address of the Superior will have been received or otherwise passed to the Enroller and the Inferior. The ENROL message received by the Superior contains the address of the Inferior. The BEGUN returned from a Factory to the Initiator contains the address of the Decider, and this can be passed to the Terminator or any Status Requestor.

The addresses carried in these messages (which are effectively “call-back” addresses, to be used as the destination of future messages) are sets of tripartite addresses. Each contains an identifier (binding name) for the binding to an underlying transport, or carrier protocol, a “binding address”, in a format specific to the carrier which is the information necessary to connect using that carrier, and an optional additional information field. This additional information is opaque to all but the future destination (which also created this address for itself) and is used however the implementation there wishes (e.g. it can be used to distinguish a particular program object, or to relay on, perhaps over a different protocol). The multiple members of the set allow support of multiple carrier bindings (including both different versions of standard bindings and proprietary bindings) and for relocation of the BTP actor.

When a message is actually to be sent, the sender, possessing the set of addresses for the destination, chooses one - restricting its choice to bindings that it supports obviously, but not otherwise constrained by the specification. The binding address will be used by the senders carrier implementation (depending on the protocol, the address may or may not be transmitted – with http, for example, it is), The additional information, if present, will be included in the BTP message. The chosen address is considered the “target-address” when considering the abstract message, but only the additional information will normally appear within the encoded BTP-message (the encoding used is part of the binding specification, which could require that all of the address is (redundantly) transmitted, if the specifier so chose).

Where a BTP message invokes a reply – as with the Initiator:Factory, Terminator:Decider and Status Requestor:various roles – the receiver (Factory, Decider, etc) of the message will not know *a priori* the address of the sender. Accordingly, in these cases the abstract messages are specified as containing a single “reply-address”. Depending on the binding, and the particular use of the binding, the “reply-address” may be directly represented in the encoding of the BTP message, or may be implicit in the carrier protocol. Similar considerations apply in the Superior:Inferior relationship, where although the addresses are normally known by the other side, there are cases when a message is received, and must be responded to, but the peer is unknown. Accordingly, the Superior:Inferior messages contain (in abstract) a single “senders-address”. As with the “reply-address”es, it may be implicit in the carrier protocol.

The CONTEXT message does not contain a “target-address”, even as an abstract message, as it is never transmitted between BTP actors on its own – it is always either related to a BTP BEGIN or BEGUN message, or is passed between application elements with some (application-detailed) association with application messages.

### Qualifiers

Qualifiers are elements of the BTP messages used to exchange additional information between the actors. Qualifiers can be specified in the BTP specification (“standard qualifiers”), by industry groups, by BTP implmentors or for the purposes of particular applications. Of the standard qualifiers in this version of the specification some are constraints on the BTP contract, such as time limits, and some are further identifiers used to distinguish specific parties in the BTP interchange. Non-standard qualifiers could extend the protocol or carry application-specific information.

# Part 2. Normative Specification of BTP

## Actors, Roles and Relationships

Actors are software agents which process computations. BTP actors are addressable for the purposes of receiving application and BTP protocol messages transmitted over some underlying communications or carrier protocol. (See section "Addressing" for more detail.)

BTP actors play roles in the sending, receiving and processing of messages. These roles are associated with responsibilities or obligations under the terms of software contracts defined by this specification. (These contracts are stated formally in the sections entitled "Abstract Messages and Associated Contracts" and "State Tables".) A BTP actor's computations put the contracts into effect.

A role is defined and described in terms of a single business transaction. An implementation supporting a role may, as an addressable entity, play the same role in multiple business transactions, simultaneously or consecutively, or a separate addressable entity may be created for each transaction. This is a choice for the implementer, and the addressing mechanisms allow interoperation between implementations that make different choices.

Within a single transaction, one actor may play several roles, or each role may be assigned to a distinct actor. This is again a choice for the implementer. An actor playing a role is termed an "actor-in-role".

Actors may interoperate, in the sense that the roles played by actors may be implemented using software created by different vendors for each actor-in-role. The section "Conformance", gives guidelines on the groups of roles that may be implemented in a partial, interoperable implementation of BTP.

The descriptions of the roles concentrate on the normal progression of a business transaction, and some of the more important divergences from this. They do not cover all exception cases – the message set definition and the state tables provide a more comprehensive specification.

*Note – A BTP role is approximately equivalent to an interface in some distributed computing mechanisms, or a port-type in WSDL. The definition of a role includes behaviour.*

### Relationships

There are two primary relationships in BTP.

- Between an application element that determines that a business transaction should be completed (the role of Terminator) and the BTP actor at the top of the transaction tree (the role of Decider);
- Between BTP actors within the tree, where one (the Superior) will inform the other (the Inferior) what the outcome decision is.

These primary relationships are involved in arriving at a decision on the outcome of a business transaction, and propagating that decision to all parties to the transaction. Taking the path that is followed when a business transaction is confirmed:

1. The Terminator determines that the business transaction should confirm, if it can; or (for a Cohesion), which parts should confirm

2. The Terminator asks the Decider to apply the desired outcome to the tree, if it can guarantee the consistency of the confirm decision

3. The Decider, which is Superior to one or more Inferiors, asks its Inferiors if they can agree to a confirm decision (for a Cohesion, this may not be all the Inferiors)

4. If any of those Inferiors are also Superiors, they ask their Inferiors and so on down the tree

5. Inferiors that are not Superiors report if they can agree to a confirm to their Superior

6. Inferiors that are also Superiors report their agreement only if they received such agreement from their Inferiors, and can agree themselves

7. Eventually agreement (or not) is reported to the Decider. If all have agreed, the Decider makes and persists the confirm decision (hence the term “Decider” – it decides, everything else just asked); if any have disagreed, or if the confirm decision cannot be persisted, a cancel decision is made

8. The Decider, as Superior tells its Inferiors of the outcome

9. Inferiors that are also Superiors tell their Inferiors, recursively down the tree

10. The Decider replies to the Terminator’s request to confirm, reporting the outcome decision

There are other relationships that are secondary to Terminator:Decider, Superior:Inferior, mostly involved in the establishment of the primary relationships. The various particular relationships can be grouped as the “control” relationships – primarily Terminator:Decider, but also Initiator:Factory; and the “outcome” relationships – primarily Superior:Inferior, but also Enroller:Superior.

The two groups of relationships are linked in that a Decider is a Superior to one or more Inferiors. There are also similarities in the semantics of some of the exchanges (messages) within the relationships. However they differ in that

1. All exchanges between Terminator and Decider are initiated by the Terminator (it is essentially a request/response relationship); either of Superior or Inferior may initiate messages to the other

2. The Superior:Inferior relationship is recoverable – depending on the progress of the relationship, the two sides will re-establish their shared state after failure; the Terminator:Decider relationship is not recoverable

3. The nature of the Superior:Inferior relationship requires that the two parties know of each other's addresses from when the relationship is established; the Decider does not need to know the address of the Terminator (provided it has some way of returning the response to a received message).

### Roles

Figure 18 and Figure 19 show the BTP roles that are specialisations of the central Superior and Inferior roles.

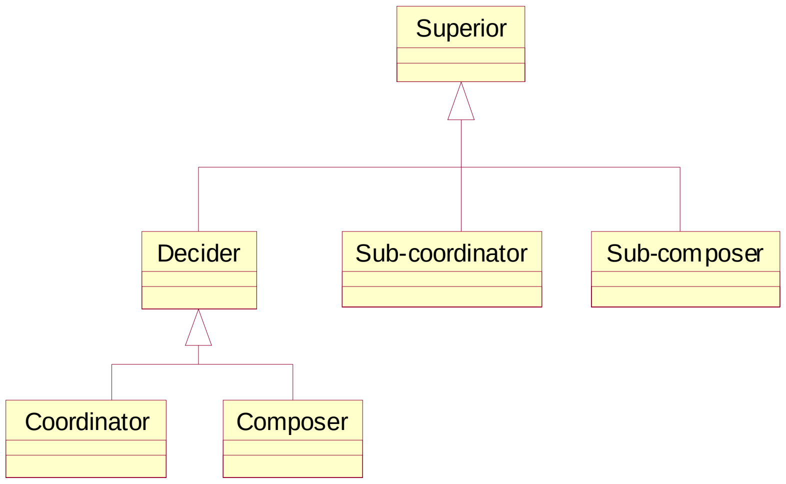

**Figure 18 Superior and derived roles**

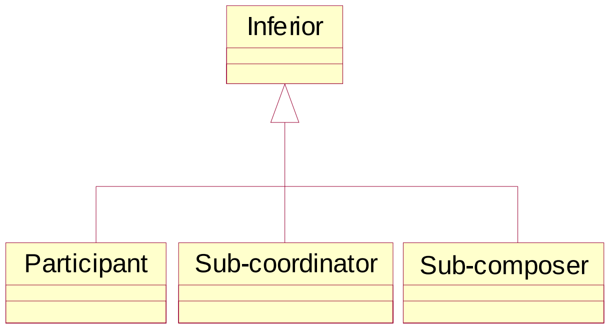

**Figure 19 Inferior and derived roles**

In the following sections, the responsibility of each role is defined, and the messages that are sent or received by that role are listed. Note that some roles exist only to have a name for an actor that issues a message and receives a reply to that message. Some of these roles may be played by several actors in the course of a single business transaction.

For each role, a table shows which messages are received and sent. Where the messages appear on the same line, the second is a reply to the first. (Consequently the columns are sometimes sent first, received second, sometimes vice versa.)

## Roles involved in the outcome relationships

### Superior

Accepts enrolments of Inferiors from Enrollers, establishing a Superior:Inferior relationship with each. In cooperation with other actors and constrained by the messages exchanged with the Inferior, the Superior determines the **Outcome** applicable to the Inferior and informs the Inferior by sending CONFIRM or CANCEL. This outcome can be confirm only if a PREPARED message is received from the Inferior, and if a record, identifying the Inferior can be persisted. (Whether this record is also a record of a confirm decision depends on the Superior's position in the business transaction as a whole.). The Superior must retain this persistent record until it receives a CONFIRMED (or, in exceptional cases, CANCELLED or HAZARD) from the Inferior.

A Superior may delegate the taking of the confirm or cancel decision to an Inferior, if there is only one Inferior, by sending CONFIRM_ONE_PHASE.

A Superior may be *Atomic* or *Cohesive;* an Atomic Superior will apply the same decision to all of its Inferiors; a Cohesive Superior may apply confirm to some Inferiors and cancel to others, or may confirm some after others have reported cancellation. The set of Inferiors that the Superior confirms (or attempts to confirm) is called the "confirm-set".

If RESIGN is received from an Inferior, the Superior:Inferior relationship is ended; the Inferior has no further effect on the behaviour of the Superior as a whole.

| **Superior receives** | **Superior sends** |
|---|---|
| ENROL | ENROLLED |
| | PREPARE |
| | CONFIRM |
| | CANCEL |
| | RESIGNED |
| | CONFIRM_ONE_PHASE |
| | CONTRADICTION |
| | SUPERIOR_STATE |
| PREPARED | |
| CONFIRMED | |
| CANCELLED | |
| HAZARD | |
| RESIGN | |
| INFERIOR_STATE | |
| REQUEST_STATUS | STATUS |
| REQUEST_INFERIORS_STATUS | INFERIOR_STATUSES |

Receipt of ENROL establishes a new Superior:Inferior relationship (unless the ENROL is a duplicate). ENROLLED is sent only if a reply is asked for on the ENROL.

### Inferior

Responsible for applying the Outcome to some set of associated operations – the application determines which operations are the responsibility of a particular Inferior.

An Inferior is **Enrolled** with a single Superior (hereafter referred to as "its Superior"), establishing a Superior:Inferior relationship. If the Inferior is able to ensure that either a confirm or cancel decision can be applied to the associated operations, and can persist information to retain that condition, it sends a PREPARED message to the Superior. When the Outcome is received from the Superior, the Inferior applies it, deletes the persistent information, and replies with CANCELLED or CONFIRMED as appropriate.

If an Inferior is unable to come to a prepared state, it cancels the associated operations and informs the Superior with a CANCELLED message. If it is unable to either come to a prepared state, or to cancel the associated operations, it informs the Superior with a HAZARD message.

An Inferior that has become prepared may, exceptionally, make an autonomous decision to be applied to the associated operations, without waiting for the Outcome from the Superior. It is required to persist this autonomous decision and report it to the Superior with CONFIRMED or CANCELLED as appropriate. If, when CONFIRM or CANCEL is received, the autonomous decision and the decision received from the Superior are contradictory, the Inferior must retain the record of the autonomous decision until receiving a CONTRADICTION message.

| Inferior receives | Inferior sends |
|---|---|
| PREPARE | |
| CONFIRM | |
| CANCEL | |
| RESIGNED | |
| CONFIRM_ONE_PHASE | |
| CONTRADICTION | |
| SUPERIOR_STATE | |
| | PREPARED |
| | CONFIRMED |
| | CANCELLED |
| | HAZARD |
| | RESIGN |
| | INFERIOR_STATE |
| REQUEST_STATUS | STATUS |
| REQUEST_INFERIORS_STATUS | INFERIOR_STATUSES |

### Enroller

Causes the enrolment of an Inferior with a Superior. This role is distinguished because in some implementations the enrolment request will be performed by the application, in some the application will ask the actor that will play the role of Inferior to enrol itself, and a Factory may enrol a new Inferior (which will also be Superior) as a result of receiving BEGIN&CONTEXT.

| **Enroller sends** | **Enroller receives** |
|---|---|
| ENROL | ENROLLER |

ENROLLED is received only if the Enroller asked for a response when the ENROL was sent.

An ENROL message sent from an Enroller that did not require an ENROLLED response may be modified *en route* to the Superior by an intermediate actor to ask for an ENROLLED response to be sent to the intermediate. (This may occur in the "one-shot" scenario, where an ENROL/no-rsp-req is received in relation to a CONTEXT_REPLY/related; the receiver of the CONTEXT_REPLY will need to ensure the enrolment is successful).

### Participant

An Inferior which is specialized for the purposes of an application. Some application operations are associated directly with the Participant, which is responsible for determining whether a prepared condition is possible for them, and for applying the outcome. ("associated directly" as opposed to involving another BTP Superior:Inferior relationship, in which this actor is the Superior).

The associated operations may be performed by the actor that has the role of Participant, or they may be performed by another actor, and only the confirm/cancel application is performed by the Participant.

In either case, the Participant, as part of becoming prepared (i.e. before it can send PREPARED to the Superior), will persist information allowing it apply a confirm decision to the operations and to apply a cancel decision. The nature of this information depends on the operations.

*Note – Possible approaches are:*

- *The operations may be performed completely and the Participant persists information to perform counter-effect operations (compensating operations) to apply cancellation;*
- *The operations may be just checked and not performed at all; the Participant persists information to perform them to apply confirmation;*
- *The Participants persists the prior state of data affected by the operations and the operations are performed; the Participant restores the prior state to apply cancellation;*
- *As the previous, but other access to the affected data is forbidden until the decision is known*

Since a Participant is an Inferior, it sends and receives the messages for an Inferior.

### Sub-coordinator

An Inferior which is also an Atomic Superior.

A sub-coordinator is the Inferior in one Superior:Inferior relationship and the Superior in one or more Superior:Inferior relationships.

From the perspective of its Superior (the one the sub-coordinator is Inferior to), there is no difference between a sub-coordinator and any other Inferior. From this perspective, the “associated operations” of the sub-coordinator as an Inferior include the relationships with its Inferiors.

A sub-coordinator does not become prepared (and send PREPARED to its Superior) until and unless it has received PREPARED (or RESIGN) from all its Inferiors. The outcome is propagated to all Inferiors.

Since a Sub-coordinator is both an Inferior and a Superior, it sends and receives the messages for both.

### Sub-composer

An Inferior which is also a Cohesive Superior.

Like a sub-coordinator, a sub-composer cannot be distinguished from any other Inferior from the perspective of its Superior.

A sub-composer is similar to a sub-coordinator, except that the constraints linking the different Inferiors concern only those Inferiors in the confirm-set. How the confirm-set is controlled, and when, is not defined in this specification.

If the sub-composer is instructed to cancel, by receiving a CANCEL message from its Superior, the cancellation is propagated to all its Inferiors.

Since a Sub-composer is both an Inferior and a Superior, it sends and receives the messages for both.

## Roles involved in the control relationships

### Decider

A Superior that is not also the Inferior on a Superior:Inferior relationship. It is the top-node in the transaction tree and receives requests from a Terminator as to the desired outcome for the business transaction. If the Terminator asks the Decider to confirm the business transaction, it is the responsibility of the Decider to finally take the confirm decision. The taking of the decision is synonymous with the persisting of information identifying the Inferiors that are to be confirmed. An Inferior cannot be confirmed unless PREPARED has been received from it.

A Decider is instructed to cancel by receiving CANCEL_TRANSACTION.

A Decider that is an Atomic Superior (all Inferiors will have the same outcome) is a Coordinator. A Decider that is a Cohesive Superior (some Inferiors may cancel, some confirm) is a Cohesion.

| Decider receives | Decider sends |
|---|---|
| CONFIRM_TRANSACTION | TRANSACTION_CONFIRMED<br>TRANSACTION_CANCELLED<br>INFERIOR_STATUSES |

| Decider receives | Decider sends |
|---|---|
| CANCEL_TRANSACTION | TRANSACTION_CANCELLED<br>INFERIOR_STATUSES |
| REQUEST_INFERIOR_STATUSES | INFERIOR_STATUSES |

A Decider is also a Superior and thus sends and receives the messages for a Superior.

### Coordinator

A Decider that is an Atomic Superior. The same outcome decision will be applied to all Inferiors (excluding any from which RESIGN is received).

PREPARED must be received from all remaining Inferiors for a confirm decision to be taken.

A Coordinator must make a cancel decision if

- it is instructed to cancel by the Terminator
- if CANCELLED is received from any Inferior
- if it is unable to persist a confirm decision

Since a Coordinator is a Decider, it receives the mssages appropriate for a Decider and a Superior.

### Composer

A Decider that is a Cohesive Superior. If the Terminator requests confirmation of the Cohesion, that request will determine the confirm-set of the Cohesion.

PREPARED must be received from all Inferiors in the confirm-set (excluding any from which RESIGN is received) for a confirm decision to be taken.

A Composer must make a cancel decision (applying to all Inferiors) if

- it is instructed to cancel by the Terminator
- if CANCELLED is received from any Inferior in the confirm-set
- if it is unable to persist a confirm decision

A Composer may be asked to prepare some or all of its Inferiors by receiving PREPARE_INFERIORS. It issues PREPARE to any of those Inferiors from which none of PREPARED, CANCELLED or RESIGN have been received, and replies to the PREPARE_INFERIORS with INFERIOR_STATUSES.

A Composer may be asked to cancel some of its Inferiors, but not itself, by receiving CANCEL_INFERIORS.

| **Composer receives** | **Composer sends** |
|---|---|
| PREPARE_INFERIORS | INFERIOR_STATUSES |
| CANCEL_INFERIORS | INFERIOR_STATUSES |

### Terminator

Asks a Decider to confirm the business transaction, or instructs it to cancel all or (for a Cohesion) part of the business transaction.

All communications between Terminator and Decider are initiated by the Terminator. A Terminator is usually an application element.

A request to confirm is made by sending CONFIRM_TRANSACTION to the target Decider. If the Decider is a Cohesion Composer, the Terminator may select which of the Composer's Inferiors are to be included in the confirm-set. If the Decider is an Atom Coordinator, all Inferiors are included. After applying the decision, the Decider replies with TRANSACTION_CONFIRMED, TRANSACTION_CANCELLED or (in the case of problems) INFERIOR_STATUSES.

A Terminator may ask a Composer (but not a Coordinator) to prepare some or all of its Inferiors with PREPARE_INFERIORS. The Composer replies with INFERIOR_STATUSES.

A Terminator may send CANCEL_TRANSACTION to instruct the Decider to cancel the whole business transaction.,. The Decider replies with CANCEL_COMPLETE if all Inferiors cancel successfully, and with INFERIOR_STATUSES in the case of problems.. If the Decider is a Cohesion Composer, the Terminator may send CANCEL_INFERIORS to cancel some of the Inferiors; the Decider always replies with INFERIOR_STATUSES.

A Terminator may check the status of the Inferiors of the Decider by sending REQUEST_INFERIOR_STATUSES. The Decider replies with INFERIOR_STATUSES.

| **Terminator sends** | Terminator receives |
|---|---|
| CONFIRM_TRANSACTION | TRANSACTION_CONFIRMED<br>TRANSACTION_CANCELLED<br>INFERIOR_STATUSES |
| CANCEL_TRANSACTION | TRANSACTION_CANCELLED<br>INFERIOR_STATUSES |
| PREPARE_INFERIORS | INFERIOR_STATUSES |
| CANCEL_INFERIORS | INFERIOR_STATUSES |
| REQUEST_INFERIOR_STATUSES | INFERIOR_STATUSES |

### Initiator

Requests a **Factory** to create a Superior – this will either be a Decider (representing a new top-level business transaction) or a sub-coordinator or sub-composer to be the Inferior of an existing business transaction.

| Initiator sends | Initiator receives |
|---|---|
| BEGIN | BEGUN & CONTEXT |
| BEGIN & CONTEXT | BEGUN & CONTEXT |

The received CONTEXT is that for the new Superior.

#### Factory

Creates Superiors and returns the CONTEXT for the new Superior. The following types of Superior are created :

- Decider, which is either
  - Composer or
  - Coordinator
- Sub-composer
- Sub-coordinator

| Factory receives | Factory sends |
|---|---|
| BEGIN | BEGUN & CONTEXT |
| BEGIN & CONTEXT | BEGUN & CONTEXT |

If the BEGIN has no related CONTEXT, the Factory creates a Decider, either a Cohesion Composer or an Atom Coordinator, as determined by the “superior type” parameter on the BEGIN.

If the BEGIN has a related CONTEXT, the new Superior is also enrolled as an Inferior of the Superior identified by the CONTEXT. The new Superior is thus a sub-composer or sub-coordinator, as determined by the “superior type” parameter on the BEGIN.

### Other roles

#### Redirector

Sends a REDIRECT message to inform a Superior or Inferior that an address previously supplied for the peer (i.e. an Inferior or Superior, respectively)  is no longer appropriate, and to supply a new address or set of addresses to replace the old one.

A Redirector may send a REDIRECT message in response to receiving a message using the old address, or may send REDIRECT at its own initiative.

If a Superior moves from the superior-address in its CONTEXT, or an Inferior moves from the inferior-address in the ENROL message, the implementation **must** ensure that a Redirector catches any inbound messages using the old address and replies with a REDIRECT message giving the new address. (Note that the inbound message may itself be a REDIRECT message, in which case the Redirector shall use the new address in the received message as the target for the REDIRECT that it sends.)

After receiving a REDIRECT message, the BTP actor **must** use the new address not the old one, unless failure prevents it updating its information.

| Redirector receives | Redirector sends |
|---|---|
| Any message for Superior or Inferior | REDIRECT |

### Status Requestor

Requests and receives the current status of a transaction tree node – any of an Inferior, Superior or Decider, or the current status of the nodes relationships with its Inferiors, if any. The role of Status Requestor has no responsibilities – it is just a name for where the REQUEST_STATUS and REQUEST_INFERIOR_STATUSES comes from (REQUEST_INFERIOR_STATUSES is also issued by a Terminator to a Decider).

| Status Requestor sends | Status Requestor receives |
|---|---|
| REQUEST_STATUS | STATUS |
| REQUEST_INFERIOR_STATUS | INFERIOR_STATUSES |

The receiver of the request can refuse to provide the status information by replying with FAULT(StatusRefused). The information returned in STATUS will always relate to the transaction tree node as a whole (e.g. as an Inferior, even if it is also a Superior).

## Summary of relationships

Figure 20 summarises the relationships between the BTP roles. BTP can be implemented using proprietary equivalents of the Terminator and Decider roles.

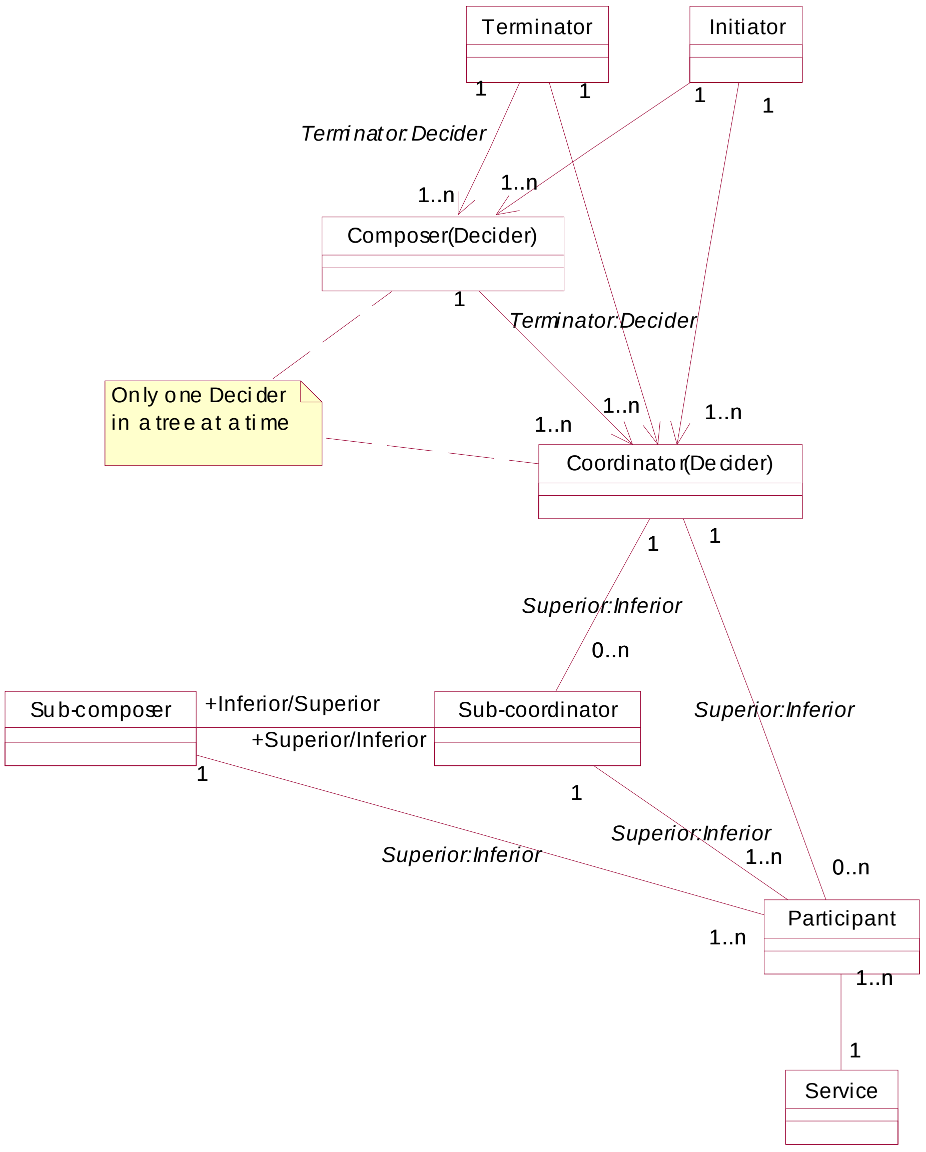

**Figure 20 Summary of relationships between roles**

## Abstract Messages and Associated Contracts

BT Protocol Messages are defined in this section in terms of the abstract information that has to be communicated. These abstract messages will be mapped to concrete messages communicated by a particular carrier protocol (there can be several such mappings defined).

The abstract message set and the associated state table assume the carrier protocol will

- deliver messages completely and correctly, or not at all (corrupted messages will not be delivered);
- report some communication failures, but will not necessarily report all (i.e. not all message deliveries are positively acknowledged within the carrier);
- sometimes deliver successive messages in a different order than they were sent; and
- does not have built-in mechanisms to link a request and a response

Note that these assumptions would be met by a mapping to SMTP and more than met by mappings to SOAP/HTTP.

However, when the abstract message set is mapped to a carrier protocol that provides a richer service (e.g. reports all delivery failures, guarantees ordered delivery or offers a request/response mechanism), the mapping can take advantage of these features. Typically in such cases, some of the parameters of an abstract message will be implicit in the carrier mechanisms, while the values of other parameters will be directly represented in transmitted elements.

The abstract messages include **Delivery parameters** that are concerned with the transmission and delivery of the messages as well as **Payload parameters** directly concened with the progression of the BTP relationships. When bound to a particular carrier protocol and for particular implementation configurations, parts or all of the Delivery parameters may be implicit in the carrier protocol and will not appear in the "on-the-wire" representation of the BTP messages as such.  Delivery parameters are defined as being only those parameters that are concerned with the transmission of this message, or of an immediate reply (thus address parameters to be used in repeated later messages and the identifiers of both sender and receiver are Payload parameters). In the tables in this section, Delivery parameters are shown in shaded cells.

### Addresses

All of the messages except CONTEXT have a “target address” parameter and many also have other address parameters. These latter identify the desired target of other messages in the set. In all cases, the exact value will have been originally determined by the implementation that is the target or intended target.

The detailed format of the address will depend on the particular carrier protocol, but at this abstract level is considered to have three parts. The first part, the “binding name”, identifies the binding to a particular carrier protocol – some bindings are specified in this document, others can be specified elsewhere. The second part of the address, the “binding address”, is meaningful to the carrier protocol itself, which will use it for the communication (i.e. it will permit a message to be delivered to a receiver). The third part, “additional information”, is not used or understood by the carrier protocol. The “additional information” may be a structured value.

When a message is actually transmitted, the “binding name” of the target address will identify which carrier protocol is in use and the “binding address” will identify the destination, as known to the carrier protocol. The entire binding address is considered to be “consumed” by the carrier protocol implementation. All of it may be used by the sending implementation, or some of it may be transmitted in headers, or as part of a URL in the carrier protocol, but then used or consumed by the receiving implementation of the carrier protocol to direct the BTP message to a BTP-aware entity (BTP-aware in that it is capable of interpreting the BTP messages). The “additional information” of the target address will be part of the BTP message itself and used in some way by the receiving BTP-aware entity (it could be used to route the message on to some other BTP entity). Thus, for the target address, only the “additional information” field is transmitted in the BTP message and the “additional information” is opaque to parties other than the recipient.

For other addresses in BTP messages, all three components will be within the message.

All messages that concern a particular Superior:Inferior relationship have an identifier parameter for the target side as well as the target address. This allows full flexibility for implementation choices – an implementation can:

a) Use the same binding address and additional information for multiple business transactions, using the identifier parameter to locate the relevant state information;

b) Use the same binding address for multiple business transactions and use the additional information to locate the information; or

c) Use a different binding address for each business transaction.

Which of these choices is used is opaque to the entity sending the message – both parts of the address and the identifier originated at the recipient of this message (and were transmitted as parameters of earlier messages in the opposite direction).

BTP recovery requires that the state information for a Superior or Inferior is accessible after failure and that the peer can distinguish between temporary inaccessibility and the permanent non-existence of the state information. As is explained in “Redirection” ~~Below~~in the conceptual model, BTP provides mechanisms – having a set of BTP addresses for some parameters, and the REDIRECT message – that make this possible, even if the recovered state information is on a different address to the original one (as may be the case if case c) above is used).

## Request/response pairs

Many of the messages combine in pairs as a request and its response. However, in some cases the response message is sent without a triggering request, or as a possible response to more than one type of request. To allow for this, the abstract message set treats each message as standalone; but where a request does expect a reply, a “reply-address” parameter will be present.  For any message with a reply address parameter, in the case of certain errors, a FAULT message will be sent to the reply address instead of the expected reply.

Between Superior and Inferior the address of the peer is normally known (from the “superior-address” on an earlier CONTEXT or the “inferior-address” on a received ENROL). However, in some cases a message will be received for a Superior or Inferior that is not known – the state information no longer exists. This is not an exceptional condition but occurs when one side has either not created or has removed its persistent state in accordance with the procedures, but a message has got lost in a failure, and the peer still has state information. The response to a message for an unknown (and logically non-existent) Superior is SUPERIOR_STATE/unknown, for an unknown Inferior it is INFERIOR_STATE/unknown. However, since the intended target is unknown, there is no information to locate the peer, which sent the undeliverable message. To enable the receiver to reply with the appropriate *_STATE/unknown, all the messages between Superior and Inferior have a “senders-address” parameter. If a FAULT message is to be sent in response to message which (as an abstract message) has a “senders-address” parameter, the FAULT message is sent to that address.

*Note – Both reply-address and senders-address may be absent when the carrier protocol itself has a request/response pattern. In these cases, the reply or sender address is implicitly that of the sender of the request (and thus the destination of a response)*

## Compounding messages

BTP messages may be sent in combination with each other, or with other (application) messages. There are two cases:

a) Sending the messages together where the combination has semantic significance. One message is said to be “related to” the other – the combination is termed a “group”.

b) Sending of the messages where the combination has no semantic significance, but is merely a convenience or optimisation. This is termed “bundling” – the combination is termed a “bundle”.

The form A&B is used to refer to a combination (group) where message B is sent in relation to A (“relation” is asymmetric). The form A+B is used to refer to A and B bundled together- the transmission of the bundle "A+B" is semantically identical to the transmission of A followed by the transmission of B.

Only certain combinations of messages are possible in a group, and the meaning of the relation is specifically defined for each such combination in the next section. A particular group is treated as a unit for transmission – it has a single target address. This is usually that of one of the messages in the group – the specification for the group defines which.

A “bundle” of messages may contain both unrelated messages and groups of related messages. The only constraint on which messages and groups can be bundled is that all have the same binding address, but may have different “additional information” values. (Messages within a related group may have different addresses, where the rules of their relatedness permit this). Unless constrained by the binding, any messages or groups that are to be sent to the same binding address may be bundled – the fact that the binding addresses are the same is a necessary and sufficient condition for the sender to determine that the messages can be bundled.

A particular and important case of related messages is where a BTP CONTEXT message is sent related to an application message. In this case, the target of the application message defines the destination of the CONTEXT message. The receiving implementation may in fact remove the CONTEXT before delivering the application message to the application (Service) proper, but from the perspective of the sender, the two are sent to the same place.

The compounding mechanisms, and the multi-part address structures, support the “one-wire” and “one-shot” communication patterns.

In “one-wire”, all message exchanges between two sides of a Superior:Inferior relationship, including the associated application messages, pass via the same “endpoints”. These “endpoints” may in fact be relays, routing messages on to particular actors within their domain. The onward routing will require some further addressing, but this has to be opaque to the sender. This can be achieved if the relaying endpoint ensures that all addresses for actors in its domain have the relay’s address as their binding address, and any routing information it will need in its own domain is placed in the additional information. (This may involve the relay changing addresses in messages as they pass through it on the way out). On receiving a message, it determines the within-domain destination from the received additional information (which is thus rewritten) and forwards the message appropriately. The sender is unaware of this, and merely sees addresses with the same binding address, which it is permitted to bundle. The content of the “additional information” is a matter only for the relay – it could put an entire BTP address in there, or other implementation-defined information. Note that a quite different one-wire implementation can be constructed where there is no relaying, but the receiving entity effectively performs all roles, using the received identifiers to locate the appropriate state.

“One-shot” communication makes it possible to send an application message, receive the application reply, enrol an Inferior to be responsible for the confirm/cancel of the operations of those message and inform the Superior that the Inferior is prepared, all in one two-way exchange across the network (e.g. one request/reply of a carrier protocol).. The application request is sent with a related CONTEXT message. The application response is sent with a relation group of CONTEXT_REPLY/related, ENROL/no-rsp-req message and a PREPARED message. This is possible even if the Superior address is different from the address of the application element that sends the original message  (if the application exchange is request/reply, there may not even be an identifiable address for the application element). The target addresses of the ENROL and PREPARED (the Superior address) are not transmitted; the actor that was originally responsible for adding the CONTEXT to the outbound application message remembers the Superior address and forwards the ENROL and PREPARED appropriately.

With “one-shot”, if there are multiple Inferiors created as a result of a single application message, there is an ENROL and PREPARED message for each sent related to the CONTEXT_REPLY. If an operation fails, a CANCELLED message is sent instead of a PREPARED.

If the CONTEXT has “superior-type” of “atom”, then  subsequent messages to the same Service, with the same related CONTEXT/atom, can have their associated operations put under the control of the same Inferior, and only a CONTEXT_REPLY/completed is sent back with the response (if the new operations fail, it will be necessary to send back CONTEXT_REPLY/repudiated, or send CANCELLED). If the “superior type”on the CONTEXT is “cohesive”, each operation will require separate enrolment.

Whether the “one-shot” mechanism is used is determined by the implementation on the responding (Inferior) side. This may be subject to configuration and may also be constrained by the application or by the binding in use.

### Extensibility

To simplify interoperation between  implementations of this edition of BTP with implementations of future editions, the “must-be-understood” sub-parameter as specified for Qualifiers may be defined for use with any parameter added to an existing message in a future revision of this specification. The default for “must-be-understood” shall be “true”, so an implementation receiving an unrecognised parameter without a “false” value for “must-be-understood” shall not accept it (the FAULT value “UnrecognisedParameter” is available, but other errors, including lower-layer parsing/unmarshalling errors may be reported instead). If “must-be-understood” with the value “false” is present as a sub-parameter of a parameter in any message, a receiving implementation **should** ignore the parameter.

How the sub-parameter is associated with the new parameter is determined by the particular binding.

No special mechanism is provided to allow for the introduction of completely new messages.

## Messages

### Qualifiers

All messages have a Qualifiers parameter which contains zero or more Qualifier values. A Qualifier has sub-parameters:

| **Sub-parameter** | **Type** |
|---|---|
| qualifier name | string |
| qualifier group | URI |
| must-be-understood | Boolean |
| to-be-propagated | Boolean |
| content | Arbitrary – depends on type |

**Qualifier group** ensures the Qualifier name is unambiguous. Qualifiers in the same group need not have any functional relationship. The qualifier group will typically be used to identify the specification that defines the qualifier’s meaning and use. Qualifiers may be defined in this or other standard specifications, in specifications of a particular community of users or of implementations or by bilateral agreement.

**Qualifier name** this identifies the meaning and use of the Qualifier, using a name that is unambiguous within the scope of the Qualifier group.

**Must-be-understood** if this has the value “true” and the receiving entity does not recognise the Qualifier type (or does not implement the necessary functionality), a FAULT “UnsupportedQualifier” shall be returned and the message shall not be processed. Default is “true”.

**To-be-propagated** if this has the value “true” and the receiving entity passes the BTP message (which may be a CONTEXT, but can be other messages) onwards to other entities, the same Qualifier value shall be included. If the value is “false”, the Qualifier shall not be automatically included if the BTP message is passed onwards. (If the receiving entity does support the qualifier type, it is possible a propagated message may contain another instance of the same type, even with the same Content – this is not considered propagation of the original qualifier.). Default is “false”.

**Content** the type (which may be structured) and meaning of the content is defined by the specification of the Qualifier.

## Messages not restricted to outcome or control relationships.

The messages in this section are used between various roles.CONTEXT message is used in the Initiator:Factory relationship (when it is related to BEGIN or to BEGUN), and related to an application ‘message’ to propagate the business transaction between parts of the application.CONTEXT_REPLY is used as the reply to a CONTEXT.REQUEST_STATUS can be issued to, and STATUS returned by any of Decider, Superior or Inferior. FAULT can be used on any relationship to indicate an error condition back to the sender of a message.

### CONTEXT

A CONTEXT is supplied by (or on behalf of) a Superior and related to one or more application messages. (The means by which this relationship is represented is determined by the binding and the binding mechanisms of the application protocol.) The “superior-type” parameter identifies whether the Superior will apply the same decision to all Inferiors enrolled using the same superior identifier (“superior-type” is “atom”) or whether it may apply different decisions (“superior-type” is “cohesion”).

| Parameter | Type |
|---|---|
| superior-address | Set of BTP addresses |
| superior-identifier | Identifier |
| superior-type | cohesion/atom |
| qualifiers | List of qualifiers |
| reply-address | BTP address |

**superior-address** the address to which ENROL and other messages from an enrolled Inferior are to be sent. This can be a set of alternative addresses.

**superior-identifier** identifies the Superior. This shall be globally unambiguous.

**superior-type** identifies whether the CONTEXT refers to a Cohesion or an Atom. Default is atom.

**qualifiers** standardised or other qualifiers. The standard qualifier “Transaction timelimit” is carried by CONTEXT.

**reply-address** the address to which a replying CONTEXT_REPLY is to be sent. This may be different each time the CONTEXT is transmitted – it refers to the destination of a replying CONTEXT_REPLY for this particular transmission of the CONTEXT.

There is no “target-address” parameter for CONTEXT as it is only transmitted in relation to the application messages, BEGIN and BEGUN.

The forms CONTEXT/cohesion and CONTEXT/atom refer to CONTEXT messages with the “superior-type” with the appropriate value.

### CONTEXT_REPLY

CONTEXT_REPLY is sent after receipt of CONTEXT (related to application message(s)) to indicate whether all necessary enrolments have already completed (ENROLLED has been received) or will be completed by ENROL messages sent in relation to the CONTEXT_REPLY or if an enrolment attempt has failed. CONTEXT_REPLY may be sent related to an application message (typically the response to the application message related to the CONTEXT). In some bindings the CONTEXT_REPLY may be implicit in the application message. CONTEXT_REPLY is used in some of the related groups to allow BTP messages to be sent to a Superior with an application message.

| **Parameter** | **Type** |
|---|---|
| superior-identifier | Identifier |
| completion-status | completed/incomplete/related/repudiated |
| qualifiers | List of qualifiers |
| target-address | BTP address |

**superior-identifier** the “superior-identifier” from the CONTEXT

**completion-status:** reports whether all enrol operations made necessary by the receipt of the earlier CONTEXT message have completed. Values are

| **Value** | **meaning** |
|---|---|
| *completed* | All enrolments (if any) have succeeded already |
| *incomplete* | Further enrolments are possible (used only in related groups with other BTP messages) |
| *related* | At least some enrolments are to be |

| Value | meaning |
|---|---|
| | performed by ENROL messages related to the CONTEXT_REPLY. All other enrolments (if any) have succeeded already. |
| *repudiated* | At least one enrolment has failed. The implications of receiving the CONTEXT have **not** been honoured. |

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the CONTEXT_REPLY is sent. This shall be the "reply-address" from the CONTEXT.

The form CONTEXT_REPLY/completed, CONTEXT_REPLY/related and CONTEXT_REPLY/repudiated refer to CONTEXT_REPLY messages with status having the appropriate value. The form CONTEXT_REPLY/ok refers to either of CONTEXT_REPLY/completed or CONTEXT_REPLY/related.

If there are no necessary enrolments (e.g. the application messages related to the received CONTEXT did not require the enrolment of any Inferiors), then CONTEXT_REPLY/completed is used.

If a CONTEXT_REPLY/repudiated is received, the receiving implementation **must** ensure that the business transaction will not be confirmed.

### REQUEST_STATUS

Sent to an Inferior, Superior or to a Decider to ask it to reply with STATUS. The receiver may reject the request with a FAULT(StatusRefused).

| Parameter | Type |
|---|---|
| target-identifier | Identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| reply-address | BTP address |

**target identifier** The identifier for the business transaction, or part of business transaction whose status is sought. If the target-address is a "decider-address", this parameter shall be the "transaction-identifier" on the BEGUN message. If the "target-address" is an "inferior-address", this parameter shall be the "inferior-identifier" on the ENROL message. If the "target-address" is a a "superior-address", this parameter shall be the "superior-identifier" on the CONTEXT.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the REQUEST_STATUS message is sent. This can be any of "decider-address", "inferior-address" or "superior-address".

**reply-address** the address to which the replying STATUS should be sent.

Types of FAULT possible (sent to "reply-address")

***General***

***Redirect*** *– if the intended target now has a different address*

***StatusRefused*** *– if the receiver is not prepared to report its status to the sender of this message*

***UnknownTransaction*** *– if the target-identifier is unknown*

## STATUS

Sent by a Inferior, Superior or Decider in reply to a REQUEST_STATUS, reporting the overall state of the transaction tree node represented by the sender.

| Parameter | Type |
|---|---|
| responders-identifier | Identifier |
| status | See below |
| qualifiers | List of qualifiers |
| target-address | BTP address |

**responders-identifier** the identifier of the state, identical to the "target-identifier" on the REQUEST_STATUS.

**status** states the current status of the transaction tree node represented by the sender. Some of the values are only issued if the sender is an Inferior. If the transaction tree node is both Superior and Inferior (i.e. is a sub-coordinator or sub-composer), and two status values would be valid for the current state, it is the sender's option which one is used.

| status value | Meaning from Superior | Meaning from Inferior |
|---|---|---|
| *Created* | Not applicable | The Inferior exists (and is addressable) but it has not been enrolled with a Superior |
| *Enrolling* | Not applicable | ENROL has been sent, but ENROLLED is awaited |

| **status value** | **Meaning from Superior** | **Meaning from Inferior** |
|---|---|---|
| *Active* | New enrolment of inferiors is possible | The Inferior is enrolled |
| *Resigning* | Not applicable | RESIGN has been sent; RESIGNED is awaited |
| *Resigned* | Not applicable | RESIGNED has been received |
| *Preparing* | Not applicable | PREPARE has been received; PREPARED has not been sent |
| *Prepared* | Not applicable | PREPARED has been sent; no outcome has been received or autonomous decision made |
| *Confirming* | Confirm decision has been made or CONFIRM has been received as Inferior but responses from inferiors are pending | CONFIRM has been received; CONFIRMED/response has not been sent |
| *Confirmed* | CONFIRMED/responses have been received from all Inferiors | CONFIRMED/response has been sent |
| *Cancelling* | Cancel decision has been made but responses from inferiors are pending | CANCEL has been received or auto-cancel has been decided |
| *Cancelled* | CANCELLED has been received from all Inferiors | CANCELLED has been sent |
| ~~*c*~~*Cancel-contradiction* | Not applicable | Autonomous cancel decision was made, CONFIRM received; CONTRADICTION has not been received |
| ~~*c*~~*Confirm-contradiction* | Not applicable | Autonomous confirm decision was made, CANCEL received; CONTRADICTION has not been received |
| *Hazard* | A hazard has been reported from at least one Inferior | A hazard has been discovered; CONTRADICTION has not been received |
| *Contradicted* | Not applicable | CONTRADICTION has been received |
| *Unknown* | No state information for the target-identifier exists | No state information for the target-identifier exists |
| *Inaccessible* | There may be state information for this target-identifier but it cannot be reached/existence cannot be determined | There may be state information for this target-identifier but it cannot be reached/existence cannot be determined |

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the STATUS is sent. This will be the "reply-address" on the REQUEST_STATUS message

Types of FAULT possible

***General***

## FAULT

Sent in reply to various messages to report an error condition . The FAULT message is used on all the relationships as a general negative reply to a message.

| Parameter | Type |
|---|---|
| superior-identifier | Identifier |
| inferior-identifier | Identifier |
| fault-type | See below |
| fault-data | See below |
| fault-text | Text string |
| qualifiers | List of qualifiers |
| target-address | BTP address |

**superior-identifier** the "superior-identifier" as on the CONTEXT message and as used on the ENROL message (present only if the FAULT is sent to the superior).

**inferior-identifier** the "inferior-identifier" as on the ENROL message (present only if the FAULT is sent to the inferior)

**fault-type** identifies the nature of the error, as specified for each of the main messages.

**fault-data** information relevant to the particular error. Each "fault-type" defines the content of the "fault-data":

| **fault-type** | **meaning** | **fault-data** |
|---|---|---|
| *CommunicationFailure* | Any fault arising from the carrier mechanism and communication infrastructure. | Determined by the carrier mechanism and binding specification |
| *DuplicateInferior* | An inferior with the same address and identifier is already enrolled with this Superior | The identifier |
| *General* | Any otherwise unspecified problem | None |
| *InvalidDecider* | The address the message was sent to is not valid (at all or for this Terminator and transaction identifier) | The address |
| *InvalidInferior* | The "inferior-identifier" in the message or at least one "inferior-identifier"s in an "inferior-list" parameter is not known or does not identify a known Inferior | One or more invalid identifiers |
| *InvalidSuperior* | The received identifier is not known or does not identify a known Superior | The identifier |
| *StatusRefused* | The receiver will not report the requested status (or inferior statuses) to this StatusRequestor | None |
| *InvalidTerminator* | The address the message was sent to is not valid (at all or for this Decider and transaction identifier) | The address |
| *UnknownParameter* | A BTP message has been received with an unrecognised parameter | None |
| *UnknownTransaction* | The transaction-identifier is unknown | The transaction-identifier |
| *UnsupportedQualifier* | A qualifier has been received that is not recognised and on which "must-be-Understood" is "true". | Qualifier group and name |
| *WrongState* | The message has arrived when the recipient or the transaction identified by a related CONTEXT is in an invalid state. | None |
| *Redirect* | The target of the BTP message now has a different address | Set of BTP addresses, to be used instead of the address the BTP message was received on |

**fault-text** Free text describing the fault or providing more information. Whether this parameter is present, and exactly what it contains are an implementation option.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the FAULT is sent. This may be the "reply-address" from a received message or the address of the opposite side (superior/inferior) as given in a CONTEXT or ENROL message

*Note – If the carrier mechanism used for the transmission of BTP messages is capable of delivering messages in a different order than they were sent in, the "WrongState" FAULT is not sent and should be ignored if received.*

#### REQUEST_INFERIOR_STATUSES, INFERIOR_STATUSES

REQUEST_INFERIOR_STATUSES may be sent to and INFERIOR_STATUSES sent from any Decider, Superior or Inferior, asking it to report on the status of its relationships with Inferiors (if any). Since Deciders are required to respond to REQUEST_INFERIOR_STATUSES with INFERIOR_STATUSES but non-Deciders may just issue FAULT(StatusRefused), and INFERIOR_STATUSES is also used as a reply to other messages from Terminator to Decider, these messages are described below under the messages used in the control relationships.

### Messages used in the outcome relationships

#### ENROL

A request to a Superior to ENROL an Inferior. This is typically issued after receipt of a CONTEXT message in relation to an application request.

The actor issuing ENROL plays the role of Enroller.

| Parameter | type |
|---|---|
| superior-identifier | Identifier |
| response-requested | Boolean |
| inferior-address | Set of BTP addresses |
| inferior-identifier | Identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| reply-address | BTP address |

**superior-identifier**. The "superior-identifier" as on the CONTEXT message

**response- requested** true if an ENROLLED response is required, false otherwise. Default is false.

**inferior-address** the address to which PREPARE, CONFIRM, CANCEL and SUPERIOR_STATE messages for this Inferior are to be sent.

**inferior-identifier** an identifier that identifies this Inferior. This shall be globally unambiguous..

**qualifiers** standardised or other qualifiers. The standard qualifier “Inferior name” may be present.

**target-address** the address to which the ENROL is sent. This will be the “superior-address” from the CONTEXT message.

**reply-address** the address to which a replying ENROLLED is to be sent, if “response-requested” is true. If this field is absent and “response-requested” is true, the ENROLLED should be sent to the “inferior-address” (or one of them, at sender’s option)

Types of FAULT possible (sent to “reply-address”)

***General***

***InvalidSuperior*** – if “superior-identifier” is unknown

***Redirect*** *– if the Superior now has a different superior-address*

***DuplicateInferior*** – if inferior with at least one of the set “inferior-address” the same and the same “inferior-identifier” is already enrolled

***WrongState*** – if it is too late to enrol new Inferiors (generally if the Superior has already sent a PREPARED message to its superior or terminator, or if it has already issued CONFIRM to other Inferiors).

The form ENROL/rsp-req refers to an ENROL message with “response-requested” having the value “true”; ENROL/no-rsp-req refers to an ENROL message with “response-requested” having the value “false”

ENROL/no-rsp-req is typically sent in relation to CONTEXT_REPLY/related. ENROL/rsp-req is typically when CONTEXT_REPLY/completed will be used (after the ENROLLED message has been received.)

### ENROLLED

Sent from Superior in reply to an ENROL/rsp-req message, to indicate the Inferior has been successfully enrolled (and will therefore be included in the termination exchanges)

| Parameter | Type |
|---|---|
| inferior-identifier | Identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**inferior-identifier** The “inferior-identifier” as on the ENROL message

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the ENROLLED is sent. This will be the “reply-address” from the ENROL message (or one of the “inferior-address”s if the “reply-address” was empty)

**sender-address** the address from which the ENROLLED is sent. This is an address of the Superior.

No FAULT messages are issued on receiving ENROLLED.

### RESIGN

Sent from an enrolled Inferior to the Superior to remove the Inferior from the enrolment. This can only be sent if the operations of the business transaction have had no effect as perceived by the Inferior.

RESIGN may be sent at any time prior to the sending of a PREPARED or CANCELLED message (which cannot then be sent). RESIGN may be sent in response to a PREPARE message.

| Parameter | type |
|---|---|
| superior-identifier | identifier |
| inferior-identifier | identifier |
| response-requested | Boolean |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**superior-identifier** The “superior-identifier” as on the ENROL message

**inferior-identifier** The “inferior-identifier” as on the earlier ENROL message

**response-requested** is set to “true” if a RESIGNED response is required. Default is “false”.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the RESIGN is sent. This will be the superior address as used on the ENROL message.

**sender-address** the address from which the RESIGN is sent. This is an address of the Inferior.

*Note -- RESIGN is equivalent to readonly vote in some other protocols, but can be issued early.*

Types of FAULT possible (sent to "sender-address")

***General***

***InvalidSuperior*** – if "superior-identifier" is unknown

***InvalidInferior*** – if no ENROL had been received for this "inferior-identifier"inferior-

***WrongState*** – if a PREPARED or CANCELLED has already been received by the Superior from this Inferior

The form RESIGN/rsp-req refers to an RESIGN message with "response-requested" having the value "true"; RESIGN /no-rsp-req refers to an RESIGN message with "response-requested" having the value "false"

### RESIGNED

Sent in reply to a RESIGN/rsp-req message.

| **Parameter** | **Type** |
|---|---|
| inferior-identifier | Identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**inferior-identifier** The "inferior-identifier" as on the earlier ENROL message for this Inferior.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the RESIGNED is sent. This will be the "inferior-address" from the ENROL message.

**sender-address** the address from which the RESIGNED is sent. This is an address of the Superior.

After receiving this message the Inferior will not receive any more messages with this "inferior-identifier".

Types of FAULT possible (sent to "sender-address")

***General***

***WrongState*** - if RESIGN has not been sent

## PREPARE

Sent from Superior to an Inferior from whom ENROL but neither CANCELLED nor RESIGN have been received, requesting a PREPARED message. PREPARE can be sent after receiving a PREPARED message.

| Parameter | Type |
|---|---|
| inferior-identifier | Identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**inferior-identifier** the “inferior-identifier” as on the earlier ENROL message.

**qualifiers** standardised or other qualifiers. The standard qualifier “Minimum inferior timeout” is carried by PREPARE.

**target-address** the address to which the PREPARE message is sent. This will be the “inferior-address” from the ENROL message.

**sender-address** the address from which the PREPARE is sent. This is an address of the Superior.

On receiving PREPARE, an Inferior **should** reply with a PREPARED, CANCELLED or RESIGN.

Types of FAULT possible (sent to “sender-address”)

***General***

***InvalidInferior*** – if “inferior-identifier” is unknown

***WrongState*** – if a CONFIRM or CANCEL has already been received by this Inferior.

## PREPARED

Sent from Inferior to Superior, either unsolicited or in response to PREPARE, but only when the Inferior has determined the operations associated with the Inferior can be confirmed and can be cancelled, as may be instructed by the Superior. The level of isolation is a local matter (i.e. it is the Inferiors choice, as constrained by the shared understanding of the application exchanges) – other access may be blocked, may see applied results of operations or may see the original state.

| Parameter | Type |
|---|---|
| superior-identifier | Identifier |

| **Parameter** | **Type** |
|---|---|
| inferior-identifier | Identifier |
| default-is cancel | Boolean |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**superior-identifier** the “superior-identifier” as on the ENROL message

**inferior-identifier** The “inferior-identifier” as on the ENROL message

**default-is cancel** if “true”, the Inferior states that if the outcome at the Superior is to cancel the operations associated with this Inferior, no further messages need be sent to the Inferior. If the Inferior does not receive a CONFIRM message, it will cancel the associated operations. The value “true” will invariably be used with a qualifier indicating under what circumstances (usually a timeout) an autonomous decision to cancel will be made. If “false”, the Inferior will expect a CONFIRM or CANCEL message as appropriate, even if qualifiers indicate that an autonomous decision will be made.

**qualifiers** standardised or other qualifiers. The standard qualifier “Inferior timeout” may be carried by PREPARED.

**target-address** the address to which the PREPARED is sent. This will be the Superior address as on the ENROL message.

**sender-address** the address from which the PREPARED is sent. This is an address of the Inferior.

On sending a PREPARED, the Inferior undertakes to maintain its ability to confirm or cancel the effects of the associated operations until it receives a CONFIRM or CANCEL message. Qualifiers may define a time limit or other constraints on this promise. The “default-is cancel” parameter affects only the subsequent message exchanges and does not of itself state that cancellation will occur.

Types of FAULT possible (sent to “sender-address”)

***General***

***InvalidSuperior*** – if “superior-identifier” is unknown

***InvalidInferior*** – if no ENROL has been received for this “inferior-identifier”, or if RESIGN has been received from this Inferior

The form PREPARED/cancel refers to a PREPARED message with “default-is cancel” = “true”. The unqualified form PREPARED refers to a PREPARED message with “default-is cancel” = “false”.

### CONFIRM

Sent by the Superior to an Inferior from whom PREPARED has been received.

| **Parameter** | **Type** |
|---|---|
| inferior-identifier | Identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**inferior-identifier** The “inferior-identifier” as on the earlier ENROL message for this Inferior.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the CONFIRM message is sent. This will be the “inferior-address” from the ENROL message.

**sender-address** the address from which the CONFIRM is sent. This is an address of the Superior.

On receiving CONFIRM, the Inferior is released from its promise to be able to undo the operations of associated with the Inferior. The effects of the operations can be made available to everyone (if they weren’t already).

Types of FAULT possible (sent to “sender-address”)

***General***

***InvalidInferior*** – if “inferior-identifier” is unknown

***WrongState*** – if no PREPARED has been sent by, or if CANCEL has been received by this Inferior.

### CONFIRMED

Sent after the Inferior has applied the confirmation, both in reply to CONFIRM or when the Inferior has made an autonomous confirm decision, and in reply to a CONFIRM_ONE_PHASE if the Inferior decides to confirm its associated operations.

| **Parameter** | **Type** |
|---|---|
| superior-identifier | Identifier |
| inferior-identifier | Identifier |
| confirm-received | Boolean |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**superior-identifier** the "superior-identifier" as on the CONTEXT message.

**inferior-identifier** the "inferior-identifier" as on the earlier ENROL message.

**confirm-received** "true" if CONFIRMED is sent after receiving a CONFIRM message; "false" if an autonomous confirm decision has been made and either if no CONFIRM message has been received or the implementation cannot determine if CONFIRM has been received (due to loss of state information in a failure).

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the CONFIRMED is sent. This will be the Superior address as on the CONTEXT message.

**sender-address** the address from which the CONFIRMED is sent. This is an address of the Inferior.

Types of FAULT possible (sent to "sender-address")

***General***

***InvalidSuperior*** – if "superior-identifier" is unknown

***InvalidInferior*** – if no ENROL has been received for this "inferior-identifier", or if RESIGN has been received from this Inferior.

*Note – A CONFIRMED message arriving before a CONFIRM message is sent, or after a CANCEL has been sent will occur when the Inferior has taken an autonomous decision and is not regarded as occurring in the wrong state. (The latter will cause a CONTRADICTION message to be sent.)*

The form CONFIRMED/auto refers to a CONFIRMED message with "confirm-received" = "false"; CONFIRMED/response refers to a CONFIRMED message with "confirm-received" = "true".

### CANCEL

Sent by the Superior to an Inferior at any time before (and unless) CONFIRM has been sent.

| Parameter | Type |
|---|---|
| inferior-identifier | Identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**inferior-identifier** the "inferior-identifier" as on the earlier ENROL message.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the CANCEL message is sent. This will be the "inferior-address" from the ENROL message.

**sender-address** the address from which the CANCEL is sent. This is an address of the Superior.

When received by an Inferior, the effects of any operations associated with the Inferior should be undone. If the Inferior had sent PREPARED, the Inferior is released from its promise to be able to confirm the operations.

Types of FAULT possible (sent to "sender-address")

***General***

***InvalidInferior*** – if "inferior-identifier" is unknown

***WrongState*** – if a CONFIRM has been received by this Inferior.

### CANCELLED

Sent when the Inferior has applied (or is applying) cancellation of the operations associated with the Inferior. CANCELLED is sent from Inferior to Superior in the following cases:

1. before (and instead of) sending PREPARED, to indicate the Inferior is unable to apply the operations in full and is cancelling all of them;

2. in reply to CANCEL, regardless of whether PREPARED has been sent;

3. after sending PREPARED and then making and applying an autonomous decision to cancel.

4. in reply to CONFIRM_ONE_PHASE if the Inferior decides to cancel the associated operations

As is specified in the state tables, cases 1, 2 and 3 are not always distinct in some circumstances of recovery and resending of messages.

| **Parameter** | |
|---|---|
| superior-identifier | Identifier |
| inferior-identifier | Identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**superior-identifier** the “superior-identifier” as on the CONTEXT message.

**inferior-identifier** the inferior identifier as on the earlier ENROL message.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the CANCELLED is sent. This will be the Superior address as on the CONTEXT message.

**sender-address** the address from which the CANCELLED is sent. This is an address of the Inferior.

Types of FAULT possible (sent to “sender-address”)

***General***

***InvalidSuperior*** – if “superior-identifier” is unknown

***InvalidInferior*** – if no ENROL has been received for this ”inferior-identifier”, or if RESIGN has been received from this Inferior

***WrongState*** – if CONFIRM has been sent

*Note – A CANCELLED message arriving before a CANCEL message is sent, or after a CONFIRM has been sent will occur when the Inferior has taken an autonomous decision and is not regarded as occurring in the wrong state. (The latter will cause a CONTRADICTION message to be sent.)*

## CONFIRM_ONE_PHASE

Sent from a Superior to an enrolled Inferior, when there is only one such enrolled Inferior. In this case the two-phase exchange is not performed between the Superior and Inferior and the outcome decision for the operations associated with the Inferior is determined by the Inferior.

| **Parameter** | **Type** |
|---|---|
| inferior-identifier | Identifier |
| report-hazard | boolean |

| Parameter | Type |
|---|---|
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**inferior-identifier** The "inferior-identifier" as on the earlier ENROL message for this Inferior.

**report hazard** Defines whether the superior wishes to be informed if a mixed condition occurs for the operations associated with the Inferior. If "report-hazard" is "true", the Inferior will reply with HAZARD if a mixed condition occurs, or if the Inferior cannot determine that a mixed condition has not occurred. If "report-hazard" is false, the Inferior will report only its own decision, regardless of whether that decision was correctly and consistently applied. Default is false.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the CONFIRM_ONE_PHASE message is sent This will be the "inferior-address" on the ENROL message.

**sender-address** the address from which the CONFIRM_ONE_PHASE is sent. This is an address of the Superior.

CONFIRM_ONE_PHASE can be issued by a Superior to an Inferior from whom PREPARED has been received (subject to the requirement that there is only one enrolled Inferior).

Types of FAULT possible (sent to "sender-address")

***General***

***InvalidInferior*** – if "inferior-identifier" is unknown

***WrongState*** – if a PREPARE has already been sent to this Inferior

**HAZARD**

Sent when the Inferior has either discovered a "mixed" condition: that is unable to correctly and consistently cancel or confirm the operations in accord with the decision , or when the Inferior is unable to determine that a "mixed" condition has not occurred.

HAZARD is also used to reply to a CONFIRM_ONE_PHASE if the Inferior determines there is a mixed condition within its associated operations or is unable to determine that there is not a mixed condition.

*Note - If the Inferior makes its own autonomous decision then it signals that decision with CONFIRMED or CANCELLED and waits to receive a confirmatory CONFIRM or*

*CANCEL, or a CONTRADICTION if the autonomous decision by the Inferior was the opposite of that made by the Superior.*

| **Parameter** | **Type** |
|---|---|
| superior-identifier | Identifier |
| inferior-identifier | Identifier |
| level | mixed/possible |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**superior-identifier** The “superior-identifier” as on the ENROL message

**inferior-identifier** The “inferior-identifier” as on the earlier ENROL message

**level** indicates, with value “mixed” that a mixed condition has definitely occurred; or, with value “possible” that it is unable to determine whether a mixed condition has occurred or not.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the HAZARD is sent. This will be the superior address from the ENROL message.

**sender-address** the address from which the HAZARD is sent. This is an address of the Inferior.

Types of FAULT possible (sent to “sender-address”)

***General***

***InvalidSuperior*** – if “superior-identifier” is unknown

***InvalidInferior*** – if no ENROL has been received for this “inferior-identifier”, or if RESIGN has been received from this Inferior

The form HAZARD/mixed refers to a HAZARD message with “level” = “mixed”, the form HAZARD/possible refers to a HAZARD message with “level” = “possible”.

### CONTRADICTION

Sent by the Superior to an Inferior that has taken an autonomous decision contrary to the decision for the atom. This is detected by the Superior when the 'wrong' one of CONFIRMED or CANCELLED is received. CONTRADICTION is also sent in response to a HAZARD message.

| Parameter | Type |
|---|---|
| inferior-identifier | Identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**inferior-identifier** The "inferior-identifier" as on the earlier ENROL message for this Inferior.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the CONTRADICTION message is sent. This will be the "inferior-address" from the ENROL message.

**sender-address** the address from which the CONTRADICTION is sent. This is an address of the Superior.

Types of FAULT possible (sent to "sender-address")

***General***

***InvalidInferior*** – if "inferior-identifier" is unknown

***WrongState*** – if neither CONFIRMED or CANCELLED has been sent by this Inferior

### SUPERIOR_STATE

Sent by a Superior as a query to an Inferior when

1. in the active state

2. there is uncertainty what state the Inferior has reached (due to recovery from previous failure or other reason).

Also sent by the Superior to the Inferior in response to a received INFERIOR_STATE, in particular states.

| Parameter | Type |
|---|---|
| inferior-identifier | Identifier |

| Parameter | Type |
|---|---|
| status | *see below* |
| response-requested | Boolean |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**inferior-identifier** The “inferior-identifier” as on the earlier ENROL message for this Inferior.

**status** states the current state of the Superior, in terms of its relation to this Inferior only.

| status value | Meaning |
|---|---|
| *active* | The relationship with the Inferior is in the active state from the perspective of the Superior; ENROLLED has been sent, PREPARE has not been sent and PREPARED has not been received (as far as the Superior knows) |
| *prepared-received* | PREPARED has been received from the Inferior, but no outcome is yet available |
| *inaccessible* | The state information for the Superior, or for its relationship with this Inferior, if it exists, cannot be accessed at the moment. This should be a transient condition |
| *unknown* | The Inferior is not known – it does not exist from the perspective of the Superior. The Inferior can treat this as an instruction to cancel any associated operations |

**response-requested** true, if SUPERIOR_STATE is sent as a query at the Superior’s initiative; false, if SUPERIOR_STATE is sent in reply to a received INFERIOR_STATE or other message. Can only be true if status is active or prepared-received. Default is “false”

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the SUPERIOR_STATE message is sent. This will be the “inferior-address” from the ENROL message.

**sender-address** the address from which the SUPERIOR_STATE is sent. This is an address of the Superior.

The Inferior, on receiving SUPERIOR_STATE with “response-requested = true, should reply in a timely manner by (depending on its state) repeating the previous message it sent or by sending INFERIOR_STATE with the appropriate status value.

A status of unknown shall only be sent if it has been determined for certain that the Superior has no knowledge of the Inferior, or (equivalently) it can be determined that the relationship with the Inferior was cancelled. If there could be persistent information corresponding to the Superior, but it is not accessible from the entity receiving an INFERIOR_STATE/*/y (or other) message targeted to the Superior or that entity cannot determine whether any such persistent information exists or not, the response shall be Inaccessible.

SUPERIOR_STATE/unknown is also used as a response to messages, other than INFERIOR_STATE/*/y that are received when the Inferior is not known (and it is known there is no state information for it).

The form SUPERIOR_STATE/abcd refers to a SUPERIOR_STATE message status having a value equivalent to “abcd” (for active, prepared-received, unknown and inaccessible) and with “response-requested” = “false”. SUPERIOR_STATE/abcd/y refers to a similar message, but with “response-requested” = “true”. The form SUPERIOR_STATE/*/y refers to a SUPERIOR_STATE message with “response-requested” = “true” and any value for status.

### INFERIOR_STATE

Sent by an Inferior as a query when in the active state to a Superior, when (due recovery from previous failure or other reason) there is uncertainty what state the Superior has reached.

Also sent by the Inferior to the Superior in response to a received SUPERIOR_STATE, in particular states.

| **Parameter** | **Type** |
|---|---|
| superior-identifier | Identifier |
| inferior-identifier | Identifier |
| status | *see below* |
| response-requested | Boolean |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| sender-address | BTP address |

**superior-identifier** The “superior-identifier” as used on the ENROL message

**inferior-identifier** The “inferior-identifier” as on the ENROL message

**status** states the current state of the Inferior for the atomic business transaction, which corresponds to the last message sent to the Superior by (or in the case of ENROL for) the Inferior

| **status value** | **meaning/previous message sent** |
|---|---|
| *active* | The relationship with the Superior is in the active state from the perspective of the Inferior; ENROL has been sent, a decision to send PREPARED has not been made. |
| *inaccessible* | The state information for the relationship with the Superior, if it exists, cannot be accessed at the moment. This should be a transient condition |
| *unknown* | The Inferior is not known – it does not exist from the perspective of the Superior. The Inferior can be treated as cancelled |

**response-requested** "true" if INFERIOR_STATE is sent as a query at the Superior's initiative; "false" if INFERIOR_STATE is sent in reply to a received SUPERIOR_STATE or other message. Can only be "true" if "status" is "active" or "prepared-received". Default is "false"

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the INFERIOR_STATE is sent. This will be the "target-address" as used the original ENROL message.

**sender-address** the address from which the INFERIOR_STATE is sent. This is an address of the Inferior.

The Superior, on receiving INFERIOR_STATE with "response-requested" = "true", should reply in a timely manner by (depending on its state) repeating the previous message it sent or by sending SUPERIOR_STATE with the appropriate status value.

A status of "unknown" shall only be sent if it has been determined for certain that the Inferior has no knowledge of a relationship with the Superior. If there could be persistent information corresponding to the Superior, but it is not accessible from the entity receiving an SUPERIOR_STATE/*/y (or other) message targetted on the Inferior or the entity cannot determine whether any such persistent information exists, the response shall be "inaccessible".

INFERIOR_STATE/unknown is also used as a response to messages, other than SUPERIOR_STATE/*/y that are received when the Inferior is not known (and it is known there is no state information for it).

A SUPERIOR_STATE/INFERIOR_STATE exchange that determines that one or both sides are in the active state does not require that the Inferior be cancelled (unlike some other two-phase commit protocols). The relationship between Superior and Inferior, and related application elements may be continued, with new application messages carrying the same CONTEXT. Similarly, if the Inferior is prepared but the Superior is active, there is no required impact on the progression of the relationship between them.

The form INFERIOR_STATE/abcd refers to a INFERIOR_STATE message status having a value equivalent to "abcd" (for active, unknown and inaccessible) and with "response-requested" = "false". INFERIOR_STATE/abcd/y refers to a similar message, but with "response-requested" = "true". The form INFERIOR_STATE/*/y refers to a INFERIOR_STATE message with "response-requested" = "true" and any value for status.

#### REDIRECT

Sent when the address previously given for a Superior or Inferior is no longer valid and the relevant state information is now accessible with a different address (but the same superior or "inferior-identifier").

| Parameter | Type |
|---|---|
| superior-identifier | Identifier |
| inferior-identifier | Identifier |
| old-address | Set of BTP addresses |
| new-address | Set of BTP addresses |
| qualifiers | List of qualifiers |
| target-address | BTP address |

**superior-identifier** The "superior-identifier" as on the CONTEXT message and used on an ENROL message. (present only if the REDIRECT is sent from the Inferior).

**inferior-identifier** The "inferior-identifier" as on the ENROL message

**old-address** The previous address of the sender of REDIRECT. A match is considered to apply if any of the "old-address" values match one that is already known.

**new-address** The (set of alternatives) "new-address" values to be used for messages sent to this entity.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the REDIRECT is sent. This is the address of the opposite side (superior/inferior) as given in a CONTEXT or ENROL message

If the actor whose address is changed is an Inferior, the "new-address" value replaces the "inferior-address" as present in the ENROL.

If the actor whose address is changed is a Superior, the "new-address" value replaces the Superior address as present in the CONTEXT message (or as present in any other mechanism used to establish the Superior:Inferior relationship).

## Messages used in control relationships

### BEGIN

A request to a Factory to create a new Business Transaction. This may either be a new top-level transaction, in which case the Composer or Coordinator will be the Decider, or the new Business Transaction may be immediately made the Inferior within an existing Business Transaction (thus creating a sub-Composer or sub-Coordinator).

| Parameter | Type |
|---|---|
| transaction-type | cohesion/atom |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| reply-address | BTP address |

**transaction-type** identifies whether a new Cohesion or new Atom is to be created; this value will be the "superior-type" in the new CONTEXT

**qualifiers** standardised or other qualifiers. The standard qualifier "Transaction timelimit" may be present on BEGIN, to set the timelimit for the new business transaction and will be copied to the new CONTEXT. The standard qualifier "Inferior name" may be present if there is a CONTEXT related to the BEGIN.

**target-address** the address of the entity to which the BEGIN is sent. How this address is acquired and the nature of the entity are outside the scope of this specification.

**reply-address** the address to which the replying BEGUN and related CONTEXT message should be sent.

A new top-level Business Transaction is created if there is no CONTEXT related to the BEGIN. A Business Transaction that is to be Inferior in an existing Business Transaction is created if the CONTEXT message for the existing Business Transaction is related to the BEGIN. In this case, the Factory is responsible for enrolling the new Composer or Coordinator as an Inferior of the Superior identified in that CONTEXT.

*Note – This specification does not provide a standardised means to determine which of the Inferiors of a sub-Composer are in its confirm set. This is considered part of the application:inferior relationship.*

The forms BEGIN/cohesion and BEGIN/atom refer to BEGIN with "transaction-type" having the corresponding value.

Types of FAULT possible (sent to "reply-address")

***General***

***Redirect*** – if the Factory now has a different address

***WrongState*** - only issued if there is a related CONTEXT, and the Superior identified by the CONTEXT is in the wrong state to enrol new Inferiors

### BEGUN

BEGUN is a reply to BEGIN. There is always a related CONTEXT, which is the CONTEXT for the new business transaction.

| **Parameter** | **Type** |
|---|---|
| decider-address | Set of BTP addresses |
| inferior-address | Set of BTP addresses |
| transaction-identifier | Identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |

**decider-address** for a top-most transaction (no CONTEXT related to the BEGIN), this is the address to which PREPARE_INFERIORS, CONFIRM_TRANSACTION, CANCEL_TRANSACTION, CANCEL_INFERIORS and REQUEST_INFERIOR_STATUSES messages are to be sent; if a CONTEXT was related to the BEGIN this parameter is absent

**inferior-address** for a non-top-most transaction (a CONTEXT was related to the BEGIN), this is the "inferior-address" used in the enrolment with the Superior identified by the CONTEXT related to the BEGIN. The parameter is optional (implementor's choice) if this is not a top-most transaction; it shall be absent if this is a top-most transaction.

**transaction-identifier** if this is a top-most transaction, this is an globally-unambiguous identifier for the new Decider (Composer or Coordinator). If this is not a top-most transaction, the transaction-identifier shall be the inferior-identifier used in the enrolment with the Superior identified by the CONTEXT related to the BEGIN.

*Note – The "transaction-identifier" may be identical to the "superior-identifier" in the CONTEXT that is related to the BEGUN*

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the BEGUN is sent. This will be the "reply-address" from the BEGIN.

At implementation option, the "decider-address" and/or "inferior-address" and the "superior-address" in the related CONTEXT may be the same or may be different. There is no general requirement that they even use the same bindings. Any may also be the same as the "target-address” of the BEGIN message (the identifier on messages will ensure they are applied to the appropriate Composer or Coordinator).

No FAULT messages are issued on receiving BEGUN.

### PREPARE_INFERIORS

Sent from a Terminator to a Decider, but only if it is a Cohesion Composer, to tell it to prepare all or some of its inferiors, by sending PREPARE to any that have not already sent PREPARED, RESIGN or CANCELLED to the Decider (Composer) on its relationships as Superior. If the inferiors-list parameter is absent, the request applies to all the inferiors; if the parameter is present, it applies only to the identified inferiors of the Decider (Composer).

| **Parameter** | **Type** |
|---|---|
| transaction-identifier | Identifier |
| inferiors-list | List of Identifiers |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| reply-address | BTP address |

**transaction identifier** identifies the Decider and will be the transaction-identifier from the BEGUN message.

**inferiors-list** defines which of the Inferiors of this Decider preparation is requested for, using the “inferior-identifiers” as on the ENROL received by the Decider (in its role as Superior). If this parameter is absent, the PREPARE applies to all Inferiors.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the PREPARE_INFERIORS message is sent. This will be the decider-address from the BEGUN message.

**reply-address** the address of the Terminator sending the PREPARE_INFERIORS message.

For all Inferiors identified in the inferiors-list parameter (all Inferiors if the parameter is absent), from which none of PREPARED, CANCELLED or RESIGNED has been received, the Decider shall issue PREPARE. It will reply to the Terminator, using the “reply-address” on the PREPARE_INFERIORS message, sending an INFERIOR_STATUSES message giving the status of the Inferiors identified on the inferiors-list parameter (all of them if the parameter was absent).

If one or more of the “inferior-identifier”s in the "inferior-list" is unknown (does not correspond to an enrolled Inferior), a FAULT/Invalid-inferior shall be returned. It is an implementation option whether CANCEL is sent to any of the Inferiors that are validly identified in the "inferiors-list".

Types of FAULT possible (sent to Superior address)

***General***

***InvalidDecider*** – if Decider address is unknown

***Redirect*** *– if the Decider now has a different "decider-address"*

***UnknownTransaction*** – if the transaction-identifier is unknown

***InvalidInferior*** – if one or more inferior-identifiers on the inferiors-list is unknown

***WrongState*** – if a CONFIRM_TRANSACTION or CANCEL_TRANSACTION has already been received by this Composer.

The form PREPARE_INFERIORS/all refers to a PREPARE_INFERIORS message where the "inferiors-list" parameter is absent. The form PREPARE_INFERIORS/specific refers to a PREPARE_INFERIORS message where the "inferiors-list" parameter is present.

## CONFIRM_TRANSACTION

Sent from a Terminator to a Decider to request confirmation of the business transaction. If the business transaction is a Cohesion, the confirm-set is specified by the "inferiors-list" parameter.

| Parameter | Type |
|---|---|
| transaction-identifier | Identifier |
| inferiors-list | List of Identifiers |
| report-hazard | Boolean |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| reply-address | BTP address |

**transaction-identifier** identifies the Decider. This will be the transaction-identifier from the BEGUN message.

**inferiors-list** defines which Inferiors enrolled with the Decider, if it is a Cohesion Composer, are to be confirmed, using the "inferior-identifiers" as on the ENROL received by the Decider (in its role as Superior). Shall be absent if the Decider is an Atom Coordinator.

**report-hazard** Defines whether the Terminator wishes to be informed of hazard events and contradictory decisions within the business transaction. If "report-hazard" is "true", the receiver will wait until responses (CONFIRMED, CANCELLED or HAZARD) have been received from all of its inferiors, ensuring that any hazard events are reported. If "report-hazard" is "false", the Decider will reply with

TRANSACTION_CONFIRMED or TRANSACTION_CANCELLED as soon as the decision for the transaction is known.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the CONFIRM_TRANSACTION message is sent. This will be the “decider-address” on the BEGUN message.

**reply-address** the address of the Terminator sending the CONFIRM_TRANSACTION message.

If the “inferiors-list” parameter is present, the Inferiors identified shall be the “confirm-set” of the Cohesion. It the parameter is absent and the business transaction is a Cohesion, the “confirm-set” shall be all remaining Inferiors. If the business transaction is an Atom, the “confirm-set” is automatically all the Inferiors.

Any Inferiors from which RESIGN is received are not counted in the confirm-set.

If, for each of the Inferiors in the confirm-set, PREPARE has not been sent and PREPARED has not been received, PREPARE shall be issued to that Inferior.

*NOTE -- If PREPARE has been sent but PREPARED not yet received from an Inferior in the confirm-set, it is an implementation option whether and when to re-send PREPARE. The Superior implementation may choose to re-send PREPARE if there are indications that the earlier PREPARE was not delivered.*

A confirm decision may be made only if PREPARED has been received from all Inferiors in the “confirm-set”. The making of the decision shall be persistent (and if it is not possible to persist the decision, it is not made). If there is only one remaining Inferior in the “confirm set” and PREPARE has not been sent to it, CONFIRM_ONE_PHASE may be sent to it.

All remaining Inferiors that are not in the confirm set shall be cancelled.

If a confirm decision is made and “report-hazard” was “false”, a TRANSACTION_CONFIRMED message shall be sent to the “reply-address”.

If a cancel decision is made and “report-hazard” was “false”, a TRANSACTION_CANCELLED message shall be sent to the “reply-address”.

If "report-hazard" was "true", TRANSACTION_CONFIRMED shall be sent to the "reply-address" after CONFIRMED has been received from each Inferior in the confirm-set and CANCELLED or RESIGN from each and any Inferior not in the confirm-set.

If “report-hazard” was “true” and any HAZARD or contradictory message was received (i.e. CANCELLED from an Inferior in the confirm-set or CONFIRMED from an Inferior not in the confirm-set), an INFERIOR_STATUSES reporting the status for all Inferiors shall be sent to the “reply-address”.

If one or more of the "inferior-identifier"s in the "inferior-list" is unknown (does not correspond to an enrolled Inferior), a FAULT/Invalid-inferior shall be returned. The Decider shall not make a confirm decision and shall not send CONFIRM to any Inferior.

Types of FAULT possible (sent to "reply-address")

***General***

***InvalidDecider*** – if Decider address is unknown

***Redirect*** – if the Decider now has a different "decider-address"

***UnknownTransaction*** – if the transaction-identifier is unknown

***InvalidInferior*** – if one or more "inferior -identifiers" in the inferiors-list is unknown

***WrongState*** – if a CANCEL_TRANSACTION has already been received .

The form CONFIRM_TRANSACTION/all refers to a CONFIRM_TRANSACTION message where the "inferiors-list" parameter is absent. The form CONFIRM_TRANSACTION/specific refers to a CONFIRM_TRANSACTION message where the "inferiors-list" parameter is present.

**TRANSACTION_CONFIRMED**

A Decider sends TRANSACTION_CONFIRMED to a Terminator in reply to CONFIRM_TRANSACTION if all of the confirm-set confirms (and, for a Cohesion, all other Inferiors cancel) without reporting hazards, or if the Decider made a confirm decision and the CONFIRM_TRANSACTION had a "report-hazards" value of "false".

| **Parameter** | **Type** |
|---|---|
| transaction-identifier | identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |

**transaction-identifier** the "transaction-identifier" as on the BEGUN message (i.e. the identifier of the Decider as a whole).

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the TRANSACTION_CONFIRMED is sent., this will be the "reply-address" from the CONFIRM_TRANSACTION message

Types of FAULT possible (sent to "decider-address")

***General***

***InvalidTerminator*** – if Terminator address is unknown

***UnknownTransaction*** – if the transaction-identifier is unknown

### CANCEL_TRANSACTION

Sent by a Terminator to a Decider at any time before CONFIRM_TRANSACTION has been sent.

| Parameter | Type |
|---|---|
| transaction-identifier | Identifier |
| report-hazard | Boolean |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| reply-address | BTP address |

**transaction-identifier** identifies the Decider and will be the transaction-identifier from the BEGUN message.

**report-hazard** Defines whether the Terminator wishes to be informed of hazard events and contradictory decisions within the business transaction. If “report-hazard” is “true”, the receiver will wait until responses (CONFIRMED, CANCELLED or HAZARD) have been received from all of its inferiors, ensuring that any hazard events are reported. If “report-hazard” is “false”, the Decider will reply with TRANSACTION_CANCELLED immediately.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the CANCEL_TRANSACTION message is sent. This will be the decider-address from the BEGUN message.

**reply-address** the address of the Terminator sending the CANCEL_TRANSACTION message.

The business transaction is cancelled – this is propagated to any remaining Inferiors by issuing CANCEL to them. No more Inferiors will be permitted to enrol.

If "report-hazard" was "false", a TRANSACTION_CANCELLED message shall be sent to the "reply-address".

If "report-hazard" was "true" and any HAZARD or CONFIRMED message was received, an INFERIOR_STATUSES reporting the status for all Inferiors shall be sent to the "reply-address".

If "report-hazard" was "true", TRANSACTION_CANCELLED shall be sent to the "reply-address" after CANCELLED or RESIGN has been received from each Inferior.

Types of FAULT possible (sent to Superior address)

***General***

***InvalidDecider*** – if Decider address is unknown

***Redirect** – if the Decider now has a different "decider-address"*

***UnknownTransaction*** – if the transaction-identifier is unknown

***WrongState*** – if a CONFIRM_TRANSACTION has been received by this Composer.

### CANCEL_INFERIORS

Sent by a Terminator to a Decider, but only if is a Cohesion Composer, at any time before CONFIRM_TRANSACTION or CANCEL_TRANSACTION has been sent.

| **Parameter** | **Type** |
|---|---|
| transaction-identifier | Identifier |
| inferiors-list | List of Identifiers |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| reply-address | BTP address |

**transaction-identifier** identifies the Decider and will be the transaction-identifier from the BEGUN message.

**inferiors-list** defines which of the Inferiors of this Decider are to be cancelled, using the "inferior-identifiers" as on the ENROL received by the Decider (in its role as Superior).

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the CANCEL_TRANSACTION message is sent. This will be the decider-address from the BEGUN message.

**reply-address** the address of the Terminator sending the CANCEL_TRANSACTION message.

Only the Inferiors identified in the inferiors-list are to be cancelled. Any other inferiors are unaffected by a CANCEL_INFERIORS. Further Inferiors may be enrolled.

*Note – A CANCEL_INFERIORS for all of the currently enrolled Inferiors will leave the cohesion 'empty', but permitted to continue with new Inferiors, if any enrol.*

If one or more of the "inferior-identifier"s in the "inferior-list" is unknown (does not correspond to an enrolled Inferior), a FAULT/Invalid-inferior shall be returned. It is an implementation option whether CANCEL is sent to any of the Inferiors that are validly identified in the "inferiors-list".

Types of FAULT possible (sent to Superior address)

***General***

***InvalidDecider*** – if Decider address is unknown

***Redirect*** *– if the Decider now has a different "decider-address"*

***UnknownTransaction*** – if the transaction-identifier is unknown

***InvalidInferior*** – if one or more inferior-identifiers on the inferiors-list is unknown

***WrongState*** – if a CONFIRM_TRANSACTION or CANCEL_TRANSACTION has been received by this Composer.

**TRANSACTION_CANCELLED**

A Decider sends TRANSACTION_CANCELLED to a Terminator in reply to CANCEL_TRANSACTION or in reply to CONFIRM_TRANSACTION if the Decider decided to cancel. In both cases, TRANSACTION_CANCELLED is used only if all Inferiors cancelled without reporting hazards or the CANCEL_TRANSACTION or CONFIRM_TRANSACTION had a "report-hazard" value of "false.

| **Parameter** | |
|---|---|
| transaction-identifier | identifier |
| qualifiers | List of qualifiers |
| target-address | BTP address |

**transaction-identifier** the "transaction-identifier" as on the BEGUN message (i.e. the identifier of the Decider as a whole).

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the TRANSACTION_CANCELLED is sent. This will be the "reply-address" from the CANCEL_TRANSACTION or CONFIRM_TRANSACTION message.

Types of FAULT possible (sent to "decider-address")

***General***

***InvalidTerminator*** – if Terminator address is unknown

***UnknownTransaction*** – if the transaction-identifier is unknown

## REQUEST_INFERIOR_STATUSES

Sent to a Decider to ask it to report the status of its Inferiors with an INFERIOR_STATUSES message. It can also be sent to any actor with a "superior-address" or "inferior-address", asking it about the status of that transaction tree nodes Inferiors, if there are any. In this latter case, the receiver may reject the request with a FAULT(StatusRefused). If it is prepared to reply, but has no Inferiors, it replies with an INFERIOR_STATUSES with an empty "status-list" parameter.

| **Parameter** | **Type** |
|---|---|
| target-identifier | Identifier |
| inferiors-list | List of Identifiers |
| qualifiers | List of qualifiers |
| target-address | BTP address |
| reply-address | BTP address |

**target-identifier** identifies the transaction (or transaction tree node). When the message is used to a Decider, this will be the transaction-identifier from the BEGUN message. Otherwise it will be the superior-identifier from a CONTEXT or an inferior-identifier from an ENROL message.

**inferiors-list** defines which inferiors enrolled with the target are to be included in the INFERIOR_STATUSES, using the "inferior-identifiers" as on the ENROL received by the Decider (in its role as Superior). If the list is absent, the status of all enrolled Inferiors will be reported.

**qualifiers** standardised or other qualifiers.

**target-address** the address to which the REQUEST_ STATUS message is sent. When used to a Decider, this will be the "decider-address" from the BEGUN message. Otherwise it may be a "superior-address" from a CONTEXT or "inferior-address" from an ENROL message.

**reply-address** the address to which the replying INFERIOR_STATUSES is to be sent

Types of FAULT possible (sent to reply-address)

***General***

***Redirect*** *– if the intended target now has a different address*

***StatusRefused*** *– if the receiver is not prepared to report its status to the sender of this message. This "fault-type" shall not be issued when a Decider receives REQUEST_STATUSES from the Terminator.*

***UnknownTransaction*** – if the transaction-identifier is unknown

The form REQUEST_INFERIOR_STATUSES/all refers to a REQUEST_STATUS with the inferiors-list absent. The form REQUEST_INFERIOR_STATUS/specific refers to a REQUEST_INFERIOR_STATUS with the inferiors-list present.

### INFERIOR_STATUSES

Sent by a Decider  to report the status of all or some of its inferiors in response to a REQUEST_INFERIOR_STATUSES, PREPARE_INFERIORS, CANCEL_INFERIORS, CANCEL_TRANSACTION with “report-hazard” value of “true” and CONFIRM_TRANSACTION with “report-hazard”value of “true”. It is also used by any actor in response to a received REQUEST_INFERIOR_STATUSES to report the status of inferiors, if there are any.

| Parameter | Type |
|---|---|
| responders-identifier | Identifier |
| status-list | Set of Status items - see below |
| general-qualifiers | List of qualifiers |
| target-address | BTP address |

**responders-identifier** the target-identifier used on the REQUEST_INFERIOR_STATUSES.

**status-list** contains a number of Status-items, each reporting the status of one of the inferiors of the Decider. The fields of a Status-item are

| Field | Type |
|---|---|
| inferior-identifier | Inferior-identifier, identifying which inferior this Status-item contains information for. |
| status | One of the status values below (these are a subset of those for STATUS) |
| qualifiers | A list of qualifiers as received from the particular inferior or associated with the inferior in earlier messages (e.g. an Inferior name qualifier). |

The status value reports the current status of the particular inferior, as known to the Decider (Composer or Coordinator). Values are:

| status value | Meaning |
|---|---|
| *active* | The Inferior is enrolled |
| *resigned* | RESIGNED has been received from the Inferior |

| status value | Meaning |
|---|---|
| *preparing* | PREPARE has been sent to the inferior, none of PREPARED, RESIGNED, CANCELLED, HAZARD have been received |
| *prepared* | PREPARED has been received |
| *autonomously confirmed* | CONFIRMED/auto has been received, no completion message has been sent |
| *autonomously cancelled* | PREPARED had been received, and since then CANCELLED has been received but no completion message has been sent |
| *confirming* | CONFIRM has been sent, no outcome reply has been received |
| *confirmed* | CONFIRMED/response has been received |
| *cancelling* | CANCEL has been sent, no outcome reply has been received |
| *cancelled* | CANCELLED has been received, and PREPARED was not received previously |
| *cancel-contradiction* | Confirm had been ordered (and may have been sent), but CANCELLED was received |
| *confirm-contradiction* | Cancel had been ordered (and may have been sent) but CONFIRM/auto was received |
| *hazard* | A HAZARD message has been received |
| *invalid* | No such inferior is enrolled (used only in reply to a REQUEST_INFERIOR_STATUSES/specific) |

**general-qualifiers** standardised or other qualifiers applying to the INFERIOR_STATUSES as a whole. Each Status-item contains a "qualifiers" field containing qualifiers applying to (and received from) the particular Inferior.

**target-address** the address to which the INFERIOR_STATUSES is sent. This will be the "reply-address" on the received message

If the inferiors-list parameter was present on the received message, only the inferiors identified by that parameter shall have their status reported in status-list of this message. If the inferiors-list parameter was absent, the status of all enrolled inferiors shall be reported, except that an inferior that had been reported as *cancelled* or *resigned* on a previous INFERIOR_STATUSES message **may** be omitted (sender's option).

Types of FAULT possible (sent to "decider-address")

#### *General*

***InvalidTerminator*** – if Terminator address is unknown

***UnknownTransaction*** – if the transaction-identifier is unknown

## Groups – combinations of related messages

The following combinations of messages form related groups, for which the meaning of the group is not just the aggregate of the meanings of the messages. The "&" notation is used to indicate relatedness. Messages appearing in parentheses in the names of groups in this section indicate messages that may or may not be present. The notation A & B / & C in a group name in this section indicates a group that contains A and B or A and C or A, B and C, possibly with any of those appearing more than once.

### CONTEXT & application message

**Meaning:** the transmission of the application message is deemed to be part of the business transaction identified by the CONTEXT. The exact effect of this for application work implied by the transmission of the message is determined by the application – in many cases, it will mean the effects of the application message are to be subject to the outcome delivered to an enrolled Inferior, thus requiring the enrolment of a new Inferior if no appropriate Inferior is enrolled or if the CONTEXT is for cohesion.

**target-address**: the "target-address" is that of the application message. It is not required that the application address be a BTP address (in particular, there is no BTP-defined "additional information" field – the application protocol (and its binding) may or may not have a similar construct).

There may be multiple application messages related to a single CONTEXT message. All the application messages so related are deemed to be part of the business transaction identified by the CONTEXT. This specification does not imply any further relatedness among the application messages themselves (though the application might).

The actor that sends the group shall retain knowledge of the Superior address in the CONTEXT. If the CONTEXT is a CONTEXT/atom, the actor shall also keep track of transmitted CONTEXTs for which no CONTEXT_REPLY has been received.

If the CONTEXT is a CONTEXT/atom, the actor receiving the CONTEXT shall ensure that a CONTEXT_REPLY message is sent back to the "reply-address" of the CONTEXT with the appropriate completion status.

*Note – The representation of the relation between CONTEXT and one or more application messages depends on the binding to the carrier protocol. It is not necessary that the CONTEXT and application messages be closely associated "on the wire" (or even sent on the same connection) – some kind of referencing mechanism may be used.*

### CONTEXT_REPLY & ENROL

**Meaning:** the enrolment of the Inferior identified in the ENROL is to be performed with the Superior identified in the CONTEXT message this CONTEXT_REPLY is replying to. If the "completion-status" of CONTEXT_REPLY is "related", failure of this enrolment shall prevent the confirmation of the business transaction.

**target-address**: the "target-address" is that of the CONTEXT_REPLY. This will be the "reply-address" of the CONTEXT message (in many cases, including request/reply application exchanges, this address will usually be implicit).

The "target-address" of the ENROL message is omitted.

The actor receiving the related group will use the retained Superior address from the CONTEXT sent earlier to forward the ENROL. When doing so, it changes the ENROL to ask for a response (if it was an ENROL/no-rsp-req) and supplies its own address as the "reply-address", remembering the original "reply-address" if there was one.

If ENROLLED is received and the original received ENROL was ENROL/rsp-req, the ENROLLED is forwarded back to the original "reply-address".

If this attempt fails (i.e. ENROLLED is not received), and the "completion-status" of the CONTEXT_REPLY was "related", the actor is required to ensure that the Superior does not proceed to confirmation. How this is achieved is an implementation option, but must take account of the possibility that direct communication with the Superior may fail. (One method is to prevent CONFIRM_TRANSACTION being sent to the Superior (in its role as Decider); another is to enrol as another Inferior before sending the original CONTEXT out with an application message). If the Superior is a sub-coordinator or sub-composer, an enrolment failure must ensure the sub-coordinator does not send PREPARED to its own Superior.

If the actor receiving the related group is also the Superior (i.e. it has the same binding address), the explicit forwarding of the ENROL is not required, but the resultant effect – that if enrolment fails the Superior does not confirm or issue PREPARED – shall be the same.

A CONTEXT_REPLY & ENROL group may contain multiple ENROL messages, for several Inferiors. Each ENROL shall be forwarded and an ENROLLED reply received before the Superior is allowed to confirm if the "completion-status" in the CONTEXT_REPLY was "related".

When the group is constructed, if the CONTEXT had "superior-type" value of "atom", the "completion-status" of the CONTEXT_REPLY shall be "related". If the "superior-type" was "cohesive", the "completion-status" shall be "incomplete" or "related" (as required by the application). If the value is "incomplete", the actor receiving the group shall forward the ENROLs, but is not required to prevent confirmation (though it may do so).

### CONTEXT_REPLY (& ENROL) & PREPARED / & CANCELLED

This combination is characterised by a related CONTEXT_REPLY and either or both of PREPARED and CANCELLED, with or without ENROL.

> **Meaning:** If ENROL is present, the meaning and required processing is the same as for CONTEXT_REPLY & ENROL. The PREPARED or CANCELLED message(s) are forwarded to the Superior identified in the CONTEXT message this CONTEXT_REPLY is replying to.
>
> *Note – the combination of CONTEXT_REPLY & ENROL & CANCELLED may be used to force cancellation of an atom*
>
> **target-address**: the "target-address" is that of the CONTEXT_REPLY. This will be the "reply-address" of the CONTEXT message (in many cases, including request/reply application exchanges, this address will usually be implicit).
>
> The "target-address" of the PREPARED and CANCELLED message is omitted – they will be sent to the Superior identified in the earlier CONTEXT message.
>
> The actor receiving the group forwards the PREPARED or CANCLLED message to the Superior in as for an ENROL, using the retained Superior address from the CONTEXT sent earlier, except there is no reply required from the Superior.
>
> If (as is usual) an ENROL and PREPARED or CANCELLED message are for the same Inferior, the ENROL shall be sent first, but the actor need not wait for the ENROLLED to come back before sending the PREPARED or CANCELLED (so an ENROL+PREPARED bundle from this actor to the Superior could be used).
>
> The group can contain multiple ENROL, PREPARED and CANCELLED messages. Each PREPARED and CANCELLED message will be for a different Inferior.. There is no constraint on the order of their forwarding, except that ENROL and PREPARED or CANCELLED for the same Inferior shall be delivered to the Superior in the order ENROL first, followed by the other message for that Inferior.

### CONTEXT_REPLY & ENROL & application message (& PREPARED)

This combination is characterised by a related CONTEXT_REPLY, ENROL and an application message. PREPARED may or may not be present in the related group.

> **Meaning:** the relation between the BTP messages is as for the preceding groups, The transmission of the application message (and application effects implied by its transmission) has been associated with the Inferior identified by the ENROL and will be subject to the outcome delivered to that Inferior.
>
> **target-address**: the "target-address" of the group is the "target-address" of the CONTEXT_REPLY which shall also be the "target-address" of the application message. The ENROL and PREPARED messages do not contain their "target-address" parameters.

The processing of ENROL and PREPARED messages is the same as for the previous groups.

This group can be used when participation in business transaction (normally a cohesion), is initiated by the service (Inferior) side, which fetches or acquires the CONTEXT, with some associated application semantic, performs some work for the transaction and sends an application message with a related ENROL. The CONTEXT_REPLY allows the addressing of the application (and the CONTEXT_REPLY) to be distinct from that of the Superior.

The actor receiving the group may associate the “inferior-identifier” received on the ENROLwith the application message in a manner that is visible to the application receiving the message (e.g. for subsequent use in Terminator:Decider exchanges).

#### BEGUN & CONTEXT

**Meaning:** the CONTEXT is that for the new business transaction, containing the Superior address.

**target-address:** the “target-address” is that of the BEGUN message – this will be the “reply-address” of the earlier BEGIN message.

#### BEGIN & CONTEXT

**Meaning**: the new business transaction is to be an Inferior (sub-coordinator or sub-composer) of the Superior identified by the CONTEXT. The Factory (receiver of the BEGIN) will perform the enrolment.

**target-address:** the “target-address” is that of the BEGIN – this will be the address of the Factory.

## Standard qualifiers

The following qualifiers are expected to be of general use to many applications and environments. The URI “`urn:oasis:names:tc:BTP:1.0:qualifiers`” is used in the Qualifier group value for the qualifiers defined here.

### Transaction timelimit

The transaction timelimit allows the Superior (or an application element initiating the business transaction) to indicate the expected length of the active phase, and thus give an indication to the Inferior of when it would be appropriate to initiate cancellation if the active phase appears to continue too long. The time limit ends (the clock stops) when the Inferior decides to be prepared and issues PREPARED to the Superior.

It should be noted that the expiry of the time limit does not change the permissible actions of the Inferior. At any time prior to deciding to be prepared (for an Inferior), the Inferior is **permitted** to initiate cancellation for internal reasons. The timelimit gives an indication to the entity of when it will be useful to exercise this right.

The qualifier is propagated on a CONTEXT message.

The “Qualifier name” shall be “`transaction-timelimit`”.

The “Content” shall contain the following field:

| Content field | Type |
|---|---|
| Timelimit | Integer |

**Timelimit** indicates the maximum (further) duration, expressed as whole seconds from the time of transmission of the containing CONTEXT, of the active phase of the business transaction.

### Inferior timeout

This qualifier allows an Inferior to limit the duration of its “promise”, when sending PREPARED, that it will maintain the ability to confirm or cancel the effects of all associated operations. Without this qualifier, an Inferior is expected to retain the ability to confirm or cancel indefinitely. If the timeout does expire, the Inferior is released from its promise and can apply the decision indicated in the qualifier.

It should be noted that BTP recognises the possibility that an Inferior may be forced to apply a confirm or cancel decision before the CONFIRM or CANCEL is received and before this timeout expires (or if this qualifier is not used). Such a decision is termed a heuristic decision, and (as with other transaction mechanisms), is considered to be an exceptional event. As with heuristic decisions, the taking of an autonomous decision by a Inferior **subsequent** to the expiry of this timeout, is liable to cause contradictory decisions across the business transaction. BTP ensures that at least the occurrence of such a contradiction will be (eventually) reported to the Superior of the business transaction. BTP treats “true” heuristic decisions and autonomous decisions after timeout the same way – in fact, the expiry in this timeout does not cause a qualitative (state table) change in what can happen, but rather a step change in the probability that it will.

The expiry of the timeout does not strictly require that the Inferior immediately invokes the intended decision, only that is at liberty to do so. An implementation may choose to only apply the decision if there is contention for the underlying resource, for example. Nevertheless, Superiors are recommended to avoid relying on this and ensure decisions for the business transaction are made before these timeouts expire (and allow a margin of error for network latency etc.).

The qualifier may be present on a PREPARED message. If the PREPARED message has the “default-is cancel” parameter “true”, then the “IntendedDecision” field of this qualifier shall have the value “cancel”.

The “Qualifier name” shall be “`inferior-timeout`”.

The “Content” shall contain the following fields:

| Content field | Type |
|---|---|
| Timeout | Integer |
| IntendedDecision | “confirm” or “cancel” |

**Timeout** indicates how long, expressed as whole seconds from the time of transmission of the carrying message, the Inferior intends to maintain its ability to either confirm or cancel the effects of the associated operations, as ordered by the receiving Superior.

**IntendedDecision** indicates which outcome will be applied, if the timeout completes and an autonomous decision is made.

### Minimum inferior timeout

This qualifier allows a Superior to constrain the Inferior timeout qualifier received from the Inferior. If a Superior knows that the decision for the business transaction will not be determined for some period, it can require that Inferiors do not send PREPARED messages with Inferior timeouts that would expire before then. An Inferior that is unable or unwilling to send a PREPARED message with a longer (or no) timeout **should** cancel, and reply with CANCELLED.

The qualifier may be present on a CONTEXT, ENROLLED or PREPARE message. If present on more than one, and with different values of the MinimumTimeout field, the value on ENROLLED shall prevail over that on CONTEXT and the value on PREPARE shall prevail over either of the others.

The “Qualifier name” shall be “`minimum-inferior-timeout”.`

The “Content” shall contain the following field:

| Content field | Type |
|---|---|
| MinimumTimeout | Integer |

**Minimum Timeout** is the minimum value of timeout, expressed as whole seconds, that will be acceptable in the Inferior timeout qualifier on an answering PREPARED message.

### Inferior name

This qualifier allows an Enroller to supply a name for the Inferior that will be visible on INFERIOR_STATUSES and thus allow the Terminator to determine which Inferior (of the Composer or Coordinator) is related to which application work. This is in addition to the “inferior-identifier” field. The name can be human-readable and can also be used in fault tracing, debugging and auditing.

The name is never used by the BTP actors themselves to identify each other or to direct messages. (The BTP actors use the addresses and the identifiers in the message parameters for those purposes.)

This specification makes no requirement that the names are unambiguous within any scope (unlike the globally unambiguous “inferior-identifier” on ENROLLED and BEGUN). Other specifications, including those defining use of BTP with a particular application may place requirements on the use and form of the names. (This may include reference to information passed in application messages or in other, non-standardised, qualifiers.)

The qualifier may be present on BEGIN, ENROL and in the “qualifiers” field of a Status-item in INFERIOR_STATUSES. It is present on BEGIN only if there is a related CONTEXT; if present, the same qualifier value **should** be included in the consequent ENROL. If INFERIOR_STATUSES includes a Status-item for an Inferior whose ENROL had an inferior-name qualifier, the same qualifier value **should** be included in the Status-item.

The “Qualifier -name” shall be “`inferior-name`”

The “Content” shall contain the following fields:

| Content field | Type |
|---|---|
| inferior-name | String |

**Inferior name** the name assigned to the enrolling Inferior.

## State Tables

The state tables deal with the state transitions of the Superior and Inferior roles and which message can be sent and received in each state. The state tables directly cover only a single, bi-lateral Superior:Inferior relationship. The interactions between, for example, multiple Inferiors of a single Superior that will apply the same decision to all or some (of them , are dealt with in the definitions of the “decision” events which also specify when changes are made to persistent state information (see below).

There are two state tables, one for Superior, one for Inferior. States are identified by a letter-digit pair, with upper-case letters for the superior, lower-case for the inferior. The same letter is used to group states which have the same, or similar, persistent state, with the digit indicating volatile state changes or minor variations. Corresponding upper and lower-case letters are used to identify (approximately) corresponding Superior and Inferior states.

The Inferior table includes events occurring both at the Inferior as such and at the associated Enroller, as the Enroller’s actions are constrained by and constrain the Inferior role itself.

In the state tables, each side is either waiting to make a decision or can send a message. For some states, the message to be sent is a repetition of a regular message; for other states, the INFERIOR_STATE or SUPERIOR_STATE message can be sent, requesting a response. Normally, on entry to a state that allows the sending of any message other than one of the *_STATE messages, the implementation will send that message – failure to do so will cause the relationship to lock up. The message can be resent if the implementation determines that the original message (or the next message sent in reply) may have been lost.

## Status queries

In BTP the messages SUPERIOR_STATE and INFERIOR_STATE are available to prompt the peer to report its current state by repeating the previous message (when this is allowed) or by sending the other *_STATE message. The “reply_requested” parameter of these messages distinguishes between their use as a prompt and as a reply. An implementation receiving a *_STATE message with “reply_requested” as “true” is not required to reply immediately – it may choose to delay any reply until a decision event occurs and then send the appropriate new message (e.g. on receiving INFERIOR_STATE/prepared/y while in state E1, a superior is permitted to delay until it has performed “decide to confirm” or “decide to cancel”). However, this may cause the other side to repeatedly send interrogatory *_STATE messages.

Note that a Superior (or some entity standing in for a now-extinct Superior) uses SUPERIOR_STATE/unknown to reply to messages received from an Inferior where the Superior:Inferior relationship is in an unknown (using state “Y1”). The *_STATE messages with a “state” value “inaccessible” can be used as a reply when **any** message is received and the implementation is temporarily unable to determine whether the relationship is known or what the state is. Receipt of the *_STATE/inaccessible messages is not shown in the tables and has no effect on the state at the receiving side (though it may cause the implementation to resend its own message after some interval of its own choosing).

## Decision events

The persistent state changes (equivalent to logging in a regular transaction system) and some other events are modelled as “decision events” (e.g. “decide to confirm”, “decide to be prepared”). The exact nature of the real events and changes in an implementation that are modelled by these events depends on the position of the Superior or Inferior within the business transaction and on features of the implementation (e.g. making of a persistent record of the decision means that the information will survive at least some failures that otherwise lose state information, but the level of survival depends on the purpose of the implementation). Table 3 and Table 4 define the decision events.

The Superior event “decide to prepare” is considered semi-persistent. Since the sending of PREPARE indicates that the application exchange (to associate operations with the Inferior) is complete, it is not meaningful for the Superior:Inferior relationship to revert to an earlier state corresponding to an incomplete application exchange. However, implementations are not required to make the sending of PREPARE persistent in terms of recovery – a Superior that experiences failure after sending PREPARE may, on recovery, have no information about the transaction, in which case it is considered to be in the completed state (Z), which will imply the cancellation of the Inferior and its associated operations.

Where a Superior is an Intermediate (i.e. is itself an Inferior to another Superior entity), in a transaction tree, its “decide to confirm” and “decide to cancel” decisions will in fact be the receipt of a CONFIRM or CANCEL instruction from its own Superior, without necessary change of local persistent information (which would combine both superior and inferior information, pointing both up and down the tree).

### Disruptions – failure events

Failure events are modelled as “disruption”. A failure and the subsequent recovery will (or may) cause a change of state. The disruption events in the state tables model different extents of loss of state information. An implementation is **not** required to exhibit all the possible disruption events, but it is not allowed to exhibit state transitions that do not correspond to a possible disruption. The different levels of disruption describe legitimate states for the endpoint to be in after it has been restored to normal functioning.The absence of a destination state for the disruption events means that such a transition is not legitimate – thus, for example, an Inferior that has decided to be prepared will always recover to the same state, by virtue of the information persisted in the “decide to be prepared” event.

In addition to the disruption events in the tables, there is an implicit “disruption 0” event, which involves possible interruption of service and loss of messages in transit, but no change of state (either because no state information was lost, or because recovery from persistent information restores the implementation to the same state). The “disruption 0” event would typically be an appropriate abstraction for a communication failure.

### Invalid cells and assumptions of the communication mechanism

The empty cells in state table represent events that cannot happen. For events corresponding to sending a message or any of the decision events, this prohibition is absolute – e.g. a conformant implementation in the Superior active state “B1” will not send CONFIRM. For events corresponding to receiving a message, the interpretation depends on the properties of the underlying communications mechanism.

For all communication mechanisms, it is assumed that

a) the two directions of the Superior:Inferior communication are not synchronised – that is messages travelling in opposite directions can cross each other to any degree; any number of messages may be in transit in either direction; and

b) messages may be lost arbitrarily

If the communication mechanisms guarantee ordered delivery (i.e. that messages, if delivered at all, are delivered to the receiver in the order they were sent) , then receipt of a message in a state where the corresponding cell is empty indicates that the far-side has sent a message out of order – a FAULT message with the “fault-type” “WrongState” can be returned.

If the communication mechanisms cannot guarantee ordered delivery, then messages received where the corresponding cell is empty should be ignored. Assuming the far-side is conformant, these messages can assumed to be “stale” and have been overtaken by messages sent later but already delivered. (If the far-side is non-conformant, there is a problem anyway).

### Meaning of state table events

The tables in this section define the events (rows) in the state tables. Table 2 defines the events corresponding to sending or receiving BTP messages and the disruption events. Table 3 describes the decision events for an Inferior, Table 4 those for a Superior.

The decision events for a Superior, defined in Table 4 cannot be specified without reference to other Inferiors to which it is Superior and to its relation with the application or other entity that (acting ultimately on behalf of the application) drives it.

The term “remaining Inferiors” refers to any actors to which this endpoint is Superior and which are to be treated as an atomic decision unit with (and thus including) the Inferior on this relationship. If the CONTEXT for this Superior:Inferior relationship had a “superior-type” of “atom”, this will be all Inferiors established with same Superior address and “superior-identifier” except those from which RESIGN has been received. If the CONTEXT had “superior-type” of “cohesion”, the “remaining Inferiors” excludes any that it has been determined will be cancelled, as well as any that have resigned – in other words it includes only those for which a confirm decision is still possible or has been made. The determination of exactly which Inferiors are “remaining Inferiors” in a cohesion is determined, in some way, by the application. The term “Other remaining Inferiors” excludes this Inferior on this relationship. A Superior with a single Inferior will have no “other remaining Inferiors”.

In order to ensure that the confirmation decision **is** delivered to all remaining Inferiors, despite failures, the Superior must persistently record which these Inferiors are (i.e. their addresses and identifiers). It must also either record that the decision is confirm, or ensure that the confirm decision (if there is one) is persistently recorded somewhere else, and that it will be told about it. This latter would apply if the Superior were also BTP Inferior to another entity which persisted a confirm decision (or recursively deferred it still higher). However, since there is no requirement that the Superior be also a BTP Inferior to any other entity, the behaviour of asking another entity to make (and persist) the confirm decision is termed "offering confirmation" - the Superior offers the possible confirmation of itself, and its remaining Inferiors to some other entity. If that entity (or something higher up) then does make and persist a confirm decision, the Superior is "instructed to confirm" (which is equivalent BTP CONFIRM).

The application, or an entity acting indirectly on behalf of the application, may request a Superior to prepare an Inferior (or all Inferiors). This typically implies that there will be no more operations associated with the Inferior. Following a request to prepare all remaining Inferiors, the Superior may offer confirmation to the entity that requested the prepare. (If the Superior is also a BTP Inferior, its superior can be considered an entity acting on behalf of the application.)

The application, or an entity acting indirectly on behalf of the application, may also request confirmation. This means the Superior is to attempt to make and persist a confirm decision itself, rather than offer confirmation.

**Table 2 : send, receive and disruption events**

| Event name | Meaning |
|---|---|
| send/receive ENROL/rsp-req | send/receive ENROL with response-requested = true |
| send/receive ENROL/no-rsp-req | send/receive ENROL with response-requested = false |
| send/receive RESIGN/rsp-req | send/receive RESIGN with response-requested = true |
| send/receive RESIGN/no-rsp-req | send/receive RESIGN with response-requested = false |
| send/receive PREPARED | send/receive PREPARED, with default-cancel = false |

| Event name | Meaning |
|---|---|
| send/receive PREPARED/cancel | send/receive PREPARED, with default-cancel = true |
| send/receive CONFIRMED/auto | send/receive CONFIRMED, with confirm-received = true |
| send/receive CONFIRMED/response | send/receive CONFIRMED, with confirm-received = false |
| send/receive HAZARD | send/receive HAZARD |
| send/receive INF_STATE/***/y | send/receive INFERIOR_STATE with status *** and response-requested = true |
| send/receive INF_STATE/*** | send/receive INFERIOR_STATE with status *** and response-requested = false |
| send/receive SUP_STATE/***/y | send/receive SUPERIOR_STATE with status *** and response-requested = true (“prepared-rcvd” represents “prepared-received”) |
| send/receive SUP_STATE/*** | send/receive SUPERIOR_STATE with status *** and response-requested = false (“prepared-rcvd” represents “prepared-received”) |
| disruption *** | Loss of state– new state is state applying after any local recovery processes complete |

**Table 3 : Decision events for Inferior**

| Event name | Meaning |
|---|---|
| decide to resign | • Any associated operations have had no effect (data state is unchanged)). |
| decide to be prepared | • Effects of all associated operations can be confirmed or cancelled;<br>• information to retain confirm/cancel ability has been made persistent |
| decide to be prepared/cancel | • As “decide to be prepared”;<br>• the persistent information specifies that the default action will be to cancel |
| decide to confirm autonomously | • Decision to confirm autonomously has been made persistent;<br>• the effects of associated operations will be confirmed regardless of failures |

| **Event name** | **Meaning** |
|---|---|
| decide to cancel autonomously | • Decision to cancel autonomously has been made persistent<br>• the effects of associated operations will be cancelled regardless of failures |
| apply ordered confirmation | • Effects of all associated operations have been confirmed;<br>• Persistent information is effectively removed |
| remove persistent information | • Persistent information is effectively removed; |
| detect problem | • For at least some of the associated operations, EITHER<br>o they cannot be consistently cancelled or consistently confirmed; OR<br>o it cannot be determined whether they will be cancelled or confirmed<br>• AND, information about this is not persistent |
| detect and record problem | • As for the first condition of "detect problem"<br>• information recording this has been persisted (to the degree considered appropriate), or the detection itself is persistent. (i.e. will be re-detected on recovery) |

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3342 **Table 4: Decision events for a Superior**

| **Event name** | **Meaning** |
|---|---|
| decide to confirm one-phase | • All associated application messages to be sent to the service have been sent;<br>• There are no other remaining Inferiors<br>• If an atom, all enrolments that would create other Inferiors have completed (no outstanding CONTEXT_REPLYs)<br>• The Superior has been requested to confirm |
| decide to prepare | • All associated application messages to be sent to the service have been sent;<br>• The Superior has been requested to prepare this Inferior |
| decide to confirm | • Either<br>o PREPARED or PREPARED/cancel has been received from all other remaining Inferiors; AND |

| Event name | Meaning |
|---|---|
| | o Superior has been requested to confirm; AND<br>o persistent information records the confirm decision and identifies all remaining Inferiors;<br>• Or<br>o persistent information records an offer of confirmation and has been instructed to confirm |
| decide to cancel | • Superior has not offered confirmation; OR<br>• Superior has offered confirmation and has been instructed to cancel; OR<br>• Superior has offered confirmation but has made an autonomous cancellation decision |
| remove confirm information | • Persistent information has been effectively removed; |
| record contradiction | • Information recording the contradiction has been persisted (to the degree considered appropriate) |

## Persistent information

Persisted information (especially prepared information at an Inferior, confirm information at a Superior) may include qualifications of the state carried in Qualifiers of the corresponding message (e.g. inferior timeouts in prepared information). It may also include application-specific information (especially in Inferiors) to allow the future confirmation or cancellation of the associated operations. In some cases it will also include information allowing an application message sent with a BTP message (e.g. PREPARED) to be repeated.

The “effective” removal of persistent information allows for the possibility that the information is retained (perhaps for audit and tracing purposes) but some change to the persistent information (as a whole) means that if there is a failure after such change, on recovery, the persistent information does not cause the endpoint to return the state it would have recovered to before the change.

In all cases, the degree to which information described as “persistent” will survive failure is a configuration and implementation option. An implementation **should** describe the level of failure that it is capable of surviving. For applications manipulating information that is itself volatile (e.g. network configurations), there is no requirement to make the BTP state information more persistent that than the application information.

The degree of persistence of the recording of a hazard (problem) at an Inferior and recording of a detected contradiction at a Superior may be different from that applying to the persistent prepared and confirm information. Implementations and configuration may choose to pass hazard and contradiction information via management mechanisms rather than through BTP. Such passing of information to a management mechanism could be treated as “record problem” or “record contradiction”.

**Table 5 : Superior states**

| State | summary |
|---|---|
| I1 | CONTEXT created |
| A1 | ENROLing |
| B1 | ENROLLED (active) |
| B2 | ENROLLED – repeat ENROL received |
| C1 | resigning |
| D1 | PREPARE sent |
| E1 | PREPARED received |
| E2 | PREPARED/cancel received |
| F1 | CONFIRM sent |
| F2 | completed after confirm |
| G1 | cancel decided |
| G2 | CANCEL sent |
| G3 | cancelling, RESIGN received |
| G4 | both cancelled |
| H1 | inferior autonomously confirmed |
| J1 | Inferior autonomously cancelled |
| K1 | confirmed, contradiction detected |
| L1 | cancelled, contradiction detected |
| P1 | hazard reported |
| P2 | hazard reported in null state |
| P3 | hazard reported after confirm decision |
| P4 | hazard reported after cancel decision |
| Q1 | contradiction detected in null state |
| R1 | Contradiction or hazard recorded |
| R2 | completed after contradiction or hazard recorded |
| S1 | one-phase confirm decided |
| Y1 | completed queried |
| Z | completed and unknown |

3369 **Table 6 : Inferior states**

| State | summary |
|---|---|
| i1 | aware of CONTEXT |
| a1 | enrolling |
| b1 | enrolled |
| c1 | resigning |
| d1 | preparing |
| e1 | prepared |
| e2 | prepared,default to cancel |
| f1 | confirming |
| f2 | confirming after default cancel |
| g1 | CANCEL received in prepared state |
| g2 | CANCEL received in prepared/cancel state |
| h1 | Autonomously confirmed |
| h2 | autonomously confirmed, superior confirmed |
| j1 | autonomously cancelled |
| j2 | autonomously cancelled, superior cancelled |
| k1 | autonomously cancelled, contradicted |
| k2 | autonomously cancelled, CONTRADICTION received |
| l1 | autonomously confirmed, contradicted |
| l2 | autonomously confirmed, CONTRADICTION received |
| m1 | confirmation applied |
| n1 | cancelling |
| p1 | hazard detected, not recorded |
| p2 | hazard detected in prepared state, not recorded |
| q1 | hazard recorded |
| s1 | CONFIRM_ONE_PHASE received after prepared state |
| s2 | CONFIRM_ONE_PHASE received |
| s3 | CONFIRM_ONE_PHASE received, confirming |
| s4 | CONFIRM_ONE_PHASE received, cancelling |
| s5 | CONFIRM_ONE_PHASE received, hazard detected |
| s6 | CONFIRM_ONE_PHASE received, hazard recorded |
| x1 | completed, presuming abort |
| x2 | completed, presuming abort after prepared/cancel |
| y1 | completed, queried |

| State | summary |
|---|---|
| y2 | completed, default cancel, a message received |
| z | completed |
| z1 | completed with default cancel |

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## Superior state table

**Table 7: Superior state table – normal forward progression**

| | I1 | A1 | B1 | B2 | C1 | D1 | E1 | E2 | F1 | F2 |
|---|---|---|---|---|---|---|---|---|---|---|
| `receive ENROL/rsp-req` | A1 | A1 | B2 | B2 | | D1 | | | | |
| `receive ENROL/no-rsp-req` | B1 | | B1 | B1 | | D1 | | | | |
| `receive RESIGN/rsp-req` | Y1 | | C1 | C1 | C1 | C1 | | | | |
| `receive RESIGN/no-rsp-req` | Z | | Z | Z | Z | Z | | | | |
| `receive PREPARED` | Y1 | | E1 | E1 | | E1 | E1 | | F1 | |
| `receive PREPARED/cancel` | Y1 | | E2 | E2 | | E2 | | E2 | F1 | |
| `receive CONFIRMED/auto` | Q1 | | H1 | H1 | | H1 | H1 | | F1 | |
| `receive CONFIRMED/response` | | | | | | | | | F2 | F2 |
| `receive CANCELLED` | Y1 | | Z | Z | | Z | J1 | J1 | K1 | |
| `receive HAZARD` | P1 | P1 | P1 | P1 | | P1 | P1 | P1 | P3 | |
| `receive INF_STATE/active/y` | Y1 | A1 | B1 | B2 | | D1 | | | | |
| `receive INF_STATE/active` | | | B1 | B2 | | D1 | | | | |
| `receive INF_STATE/unknown` | | | Z | Z | Z | Z | | | | |
| `send ENROLLED` | | B1 | | B1 | | | | | | |
| `send RESIGNED` | | | | | Z | | | | | |
| `send PREPARE` | | | | | | D1 | ~~E1~~ | ~~E2~~ | | |
| `send CONFIRM_ONE_PHASE` | | | | | | | | | | |
| `send CONFIRM` | | | | | | | | | F1 | |
| `send CANCEL` | | | | | | | | | | |
| `send CONTRADICTION` | | | | | | | | | | |
| `send SUP_STATE/active/y` | | | B1 | | | | | | | |
| `send SUP_STATE/active` | | | B1 | | | | | | | |
| `send SUP_STATE/prepared-rcvd/y` | | | | | | | E1 | E2 | | |
| `send SUP_STATE/prepared-rcvd` | | | | | | | E1 | E2 | | |
| `send SUP_STATE/unknown` | | | | | | | | | | |
| `decide to confirm one-phase` | | | S1 | S1 | | | S1 | S1 | | |
| `decide to prepare` | | | D1 | D1 | | | | | | |
| `decide to confirm` | | | | | | | F1 | F1 | | |
| `decide to cancel` | | | G1 | G1 | | G1 | G1 | Z | | |
| `remove persistent information` | | | | | | | | | | Z |
| `record contradiction` | | | | | | | | | | |
| `disruption I` | Z | Z | Z | Z | B1 | Z | Z | Z | | F1 |
| `disruption II` | | | | | Z | | D1 | D1 | | |
| `disruption III` | | | | | | | B1 | B1 | | |
| `disruption IV` | | | | | | | | | | |

**Table 8: Superior state table – cancellation and contradiction**

| | G1 | G2 | G3 | G4 | H1 | J1 | K1 | L1 |
|---|---|---|---|---|---|---|---|---|
| receive ENROL/rsp-req | G1 | G2 | | | | | | |
| receive ENROL/no-rsp-req | G1 | G2 | | | | | | |
| receive RESIGN/rsp-req | G3 | Z | G3 | | | | | |
| receive RESIGN/no-rsp-req | Z | Z | Z | | | | | |
| receive PREPARED | G1 | G2 | | | | | | |
| receive PREPARED/cancel | G1 | G2 | | | | | | |
| receive CONFIRMED/auto | L1 | L1 | | | H1 | | | L1 |
| receive CONFIRMED/response | | | | | | | | |
| receive CANCELLED | G4 | Z | | G4 | | J1 | K1 | |
| receive HAZARD | P4 | P4 | | | | | | |
| receive INF_STATE/active/y | G1 | G2 | | | | | | |
| receive INF_STATE/active | G1 | G2 | | | | | | |
| receive INF_STATE/unknown | Z | Z | Z | Z | | | | |
| send ENROLLED | | | | | | | | |
| send RESIGNED | | | | | | | | |
| send PREPARE | | | | | | | | |
| send CONFIRM_ONE_PHASE | | | | | | | | |
| send CONFIRM | | | | | | | | |
| send CANCEL | G2 | G2 | Z | Z | | | | |
| send CONTRADICTION | | | | | | | | |
| send SUP_STATE/active/y | | | | | | | | |
| send SUP_STATE/active | | | | | | | | |
| send SUP_STATE/prepared-rcvd/y | | | | | | | | |
| send SUP_STATE/prepared-rcvd | | | | | | | | |
| send SUP_STATE/unknown | | | | | | | | |
| decide to confirm one-phase | | | | | | | | |
| decide to prepare | | | | | | | | |
| decide to confirm | | | | | F1 | K1 | | |
| decide to cancel | | | | | L1 | G4 | | |
| remove persistent information | | | | | | | | |
| record contradiction | | | | | | | R1 | R1 |
| disruption I | Z | Z | Z | Z | Z | Z | F1 | Z |
| disruption II | | | G2 | G2 | E1 | E1 | | G2 |
| disruption III | | | | | D1 | D1 | | |
| disruption IV | | | | | B1 | B1 | | |

**Table 9: Superior state table – hazard and request confirm**

| | **P1** | **P2** | **P3** | **P4** | **Q1** | **R1** | **R2** | **S1** |
|---|---|---|---|---|---|---|---|---|
| `receive ENROL/rsp-req` | | | | | | | | S1 |
| `receive ENROL/no-rsp-req` | | | | | | | | S1 |
| `receive RESIGN/rsp-req` | | | | | | | | Z |
| `receive RESIGN/no-rsp-req` | | | | | | | | Z |
| `receive PREPARED` | | | | | | | | S1 |
| `receive PREPARED/cancel` | | | | | | | | S1 |
| `receive CONFIRMED/auto` | | | | | Q1 | R1 | R1 | S1 |
| `receive CONFIRMED/response` | | | | | Z | R2 | R2 | Z |
| `receive CANCELLED` | | | | | | R1 | R1 | Z |
| `receive HAZARD` | P1 | P2 | P3 | P4 | | R1 | R1 | Z |
| `receive INF_STATE/active/y` | | | | | | | | S1 |
| `receive INF_STATE/active` | | | | | | | | S1 |
| `receive INF_STATE/unknown` | P1 | P2 | | P4 | | R2 | R2 | Z |
| `send ENROLLED` | | | | | | | | |
| `send RESIGNED` | | | | | | | | |
| `send PREPARE` | | | | | | | | |
| `send CONFIRM_ONE_PHASE` | | | | | | | | S1 |
| `send CONFIRM` | | | | | | | | |
| `send CANCEL` | | | | | | | | |
| `send CONTRADICTION` | | | | | | R2 | | |
| `send SUP_STATE/active/y` | | | | | | | | |
| `send SUP_STATE/active` | | | | | | | | |
| `send SUP_STATE/prepared-rcvd/y` | | | | | | | | |
| `send SUP_STATE/prepared-rcvd` | | | | | | | | |
| `send SUP_STATE/unknown` | | | | | | | | |
| `decide to confirm one-phase` | | | | | | | | |
| `decide to prepare` | | | | | | | | |
| `decide to confirm` | | | | | | | | |
| `decide to cancel` | | | | | | | | |
| `remove persistent information` | | | | | | | Z | |
| `record contradiction` | R1 | R1 | R1 | R1 | R1 | | | |
| `disruption I` | Z | Z | Z | Z | Z | | R1 | Z |
| `disruption II` | D1 | | F1 | G2 | | | | |
| `disruption III` | B1 | | | | | | | |
| `disruption IV` | | | | | | | | |

**Table 10: Superior state table – query after completion and completed states**

| | **Y1** | **Z** |
|---|---|---|
| receive ENROL/rsp-req | Y1 | Y1 |
| receive ENROL/no-rsp-req | Y1 | Y1 |
| receive RESIGN/rsp-req | Y1 | Y1 |
| receive RESIGN/no-rsp-req | Z | Z |
| receive PREPARED | Y1 | Y1 |
| receive PREPARED/cancel | Y1 | Y1 |
| receive CONFIRMED/auto | **Q1** | Q1 |
| receive CONFIRMED/response | Z | Z |
| receive CANCELLED | Y1 | Y1 |
| receive HAZARD | P2 | P2 |
| receive INF_STATE/active/y | Y1 | Y1 |
| receive INF_STATE/active | Y1 | Z |
| receive INF_STATE/unknown | Z | Z |
| send ENROLLED | | |
| send RESIGNED | | |
| send PREPARE | | |
| send CONFIRM_ONE_PHASE | | |
| send CONFIRM | | |
| send CANCEL | | |
| send CONTRADICTION | | |
| send SUP_STATE/active/y | | |
| send SUP_STATE/active | | |
| send SUP_STATE/prepared-rcvd/y | | |
| send SUP_STATE/prepared-rcvd | | |
| send SUP_STATE/unknown | Z | |
| decide to confirm one-phase | | |
| decide to prepare | | |
| decide to confirm | | |
| decide to cancel | | |
| remove persistent information | | |
| record contradiction | | |
| disruption I | Z | |
| disruption II | | |
| disruption III | | |
| disruption IV | | |

## Inferior state table

**Table 11: Inferior state table – normal forward progression**

| | i1 | a1 | b1 | c1 | d1 | e1 | e2 | f1 | f2 |
|---|---|---|---|---|---|---|---|---|---|
| send ENROL/rsp-req | a1 | a1 | | | | | | | |
| send ENROL/no-rsp-req | b1 | | b1 | | | | | | |
| send RESIGN/rsp-req | | | | c1 | | | | | |
| send RESIGN/no-rsp-req | | | | z | | | | | |
| send PREPARED | | | | | | e1 | | | |
| send PREPARED/cancel | | | | | | | e2 | | |
| send CONFIRMED/auto | | | | | | | | | |
| send CONFIRMED/response | | | | | | | | | |
| send CANCELLED | | | z | | z | | | | |
| send HAZARD | | | | | | | | | |
| send INF_STATE/active/y | | a1 | b1 | | d1 | | | | |
| send INF_STATE/active | | | b1 | | d1 | | | | |
| send INF_STATE/unknown | | | | | | | | | |
| receive ENROLLED | | b1 | b1 | c1 | | e1 | e2 | | |
| receive RESIGNED | | | | z | | | | | |
| receive PREPARE | | d1 | d1 | c1 | d1 | e1 | e2 | | |
| receive CONFIRM_ONE_PHASE | | s2 | s2 | z | | s1 | s1 | | |
| receive CONFIRM | | | | | | f1 | f2 | f1 | f2 |
| receive CANCEL | | n1 | n1 | z | n1 | g1 | g2 | | |
| receive CONTRADICTION | | | | | | | | | |
| receive SUP_STATE/active/y | | b1 | b1 | c1 | | e1 | e2 | | |
| receive SUP_STATE/active | | b1 | b1 | c1 | | e1 | e2 | | |
| receive SUP_STATE/prepared-rcvd/y | | | | | | e1 | e2 | | |
| receive SUP_STATE/prepared-rcvd | | | | | | e1 | e2 | | |
| receive SUP_STATE/unknown | | z | z | z | z | x1 | x2 | | |
| decide to resign | | | c1 | | c1 | | | | |
| decide to be prepared | | | e1 | | e1 | | | | |
| decide to be prepared/cancel | | | e2 | | e2 | | | | |
| decide to confirm autonomously | | | | | | h1 | | | |
| decide to cancel autonomously | | | | | | j1 | z1 | | |
| apply ordered confirmation | | | | | | | | m1 | m1 |
| remove persistent information | | | | | | | | | |
| detect problem | | p1 | p1 | | p1 | p2 | p2 | p2 | p2 |
| detect and record problem | | | | | | | | | |
| disruption I | | z | z | z | z | | | e1 | e2 |
| disruption II | | | | | b1 | | | | |
| disruption III | | | | | | | | | |

**Table 12: Inferior state table – cancellation and contradiction**

| | g1 | g2 | h1 | h2 | j1 | j2 | k1 | k2 | l1 | l2 |
|---|---|---|---|---|---|---|---|---|---|---|
| send ENROL/rsp-req | | | | | | | | | | |
| send ENROL/no-rsp-req | | | | | | | | | | |
| send RESIGN/rsp-req | | | | | | | | | | |
| send RESIGN/no-rsp-req | | | | | | | | | | |
| send PREPARED | | | | | | | | | | |
| send PREPARED/cancel | | | | | | | | | | |
| send CONFIRMED/auto | | | h1 | | | | | | l1 | |
| send CONFIRMED/response | | | | | | | | | | |
| send CANCELLED | | | | | j1 | | k1 | | | |
| send HAZARD | | | | | | | | | | |
| send INF_STATE/active/y | | | | | | | | | | |
| send INF_STATE/active | | | | | | | | | | |
| send INF_STATE/unknown | | | | | | | | | | |
| receive ENROLLED | | | h1 | | j1 | | | | | |
| receive RESIGNED | | | | | | | | | | |
| receive PREPARE | | | h1 | | j1 | | | | | |
| receive CONFIRM_ONE_PHASE | | | s3 | | s4 | | | | | |
| receive CONFIRM | | | h2 | h2 | k1 | | k1 | | | |
| receive CANCEL | g1 | g2 | l1 | | j2 | j2 | | | l1 | |
| receive CONTRADICTION | | | l2 | | k2 | | k2 | k2 | l2 | l2 |
| receive SUP_STATE/active/y | | | h1 | | j1 | | | | | |
| receive SUP_STATE/active | | | h1 | | j1 | | | | | |
| receive SUP_STATE/prepared-rcvd/y | | | h1 | | j1 | | | | | |
| receive SUP_STATE/prepared-rcvd | | | h1 | | j1 | | | | | |
| receive SUP_STATE/unknown | x1 | x2 | l1 | | j2 | j2 | k2 | k2 | l1 | |
| decide to resign | | | | | | | | | | |
| decide to be prepared | | | | | | | | | | |
| decide to be prepared/cancel | | | | | | | | | | |
| decide to confirm autonomously | | | | | | | | | | |
| decide to cancel autonomously | | | | | | | | | | |
| apply ordered confirmation | | | | | | | | | | |
| remove persistent information | n1 | n1 | | m1 | | z | | z | | z |
| detect problem | p2 | p2 | | | | | | | | |
| detect and record problem | | | | | | | | | | |
| disruption I | e1 | e2 | | h1 | | j1 | j1 | k1 | h1 | l1 |
| disruption II | | | | | | | | j1 | | h1 |
| disruption III | | | | | | | | | | |

**Table 13: Inferior state table – confirm, cancel ordered and hazard recording**

| | m1 | n1 | p1 | p2 | q1 |
|---|---|---|---|---|---|
| send ENROL/rsp-req | | | | | |
| send ENROL/no-rsp-req | | | | | |
| send RESIGN/rsp-req | | | | | |
| send RESIGN/no-rsp-req | | | | | |
| send PREPARED | | | | | |
| send PREPARED/cancel | | | | | |
| send CONFIRMED/auto | | | | | |
| send CONFIRMED/response | z | | | | |
| send CANCELLED | | z | | | |
| send HAZARD | | | p1 | p2 | q1 |
| send INF_STATE/active/y | | | | | |
| send INF_STATE/active | | | | | |
| send INF_STATE/unknown | | | | | |
| receive ENROLLED | | | p1 | p2 | q1 |
| receive RESIGNED | | | | | |
| receive PREPARE | | | p1 | p2 | q1 |
| receive CONFIRM_ONE_PHASE | | | s5 | s5 | s6 |
| receive CONFIRM | m1 | | | p2 | q1 |
| receive CANCEL | | n1 | p1 | p2 | q1 |
| receive CONTRADICTION | | | z | z | z |
| receive SUP_STATE/active/y | | | p1 | p2 | q1 |
| receive SUP_STATE/active | | | p1 | p2 | q1 |
| receive SUP_STATE/prepared-rcvd/y | | | | p2 | q1 |
| receive SUP_STATE/prepared-rcvd | | | | p2 | q1 |
| receive SUP_STATE/unknown | | z | p1 | p2 | q1 |
| decide to resign | | | | | |
| decide to be prepared | | | | | |
| decide to be prepared/cancel | | | | | |
| decide to confirm autonomously | | | | | |
| decide to cancel autonomously | | | | | |
| apply ordered confirmation | | | | | |
| remove persistent information | | | | | |
| detect problem | | | | | |
| detect and record problem | | | q1 | q1 | |
| disruption I | z | z | z | | |
| disruption II | | d1 | | | |
| disruption III | | b1 | | | |

**Table 14: Inferior state table – request confirm states**

| | s1 | s2 | s3 | s4 | s5 | s6 |
|---|---|---|---|---|---|---|
| send ENROL/rsp-req | | | | | | |
| send ENROL/no-rsp-req | | | | | | |
| send RESIGN/rsp-req | | | | | | |
| send RESIGN/no-rsp-req | | | | | | |
| send PREPARED | | | | | | |
| send PREPARED/cancel | | | | | | |
| send CONFIRMED/auto | | | | | | |
| send CONFIRMED/response | | | z | | | |
| send CANCELLED | | | | z | | |
| send HAZARD | | | | | z | z |
| send INF_STATE/active/y | | | | | | |
| send INF_STATE/active | | | | | | |
| send INF_STATE/unknown | | | | | | |
| receive ENROLLED | | | | | | |
| receive RESIGNED | | | | | | |
| receive PREPARE | | | | | | |
| receive CONFIRM_ONE_PHASE | s1 | s2 | s3 | s4 | s5 | s6 |
| receive CONFIRM | | | | | | |
| receive CANCEL | | | | | | |
| receive CONTRADICTION | | | s3 | | z | s6 |
| receive SUP_STATE/active/y | | | | | | |
| receive SUP_STATE/active | | | | | | |
| receive SUP_STATE/prepared-rcvd/y | | | | | | |
| receive SUP_STATE/prepared-rcvd | | | | | | |
| receive SUP_STATE/unknown | x1 | z | z | z | z | z |
| decide to resign | | | | | | |
| decide to be prepared | | | | | | |
| decide to be prepared/cancel | | | | | | |
| decide to confirm autonomously | | s3 | | | | |
| decide to cancel autonomously | | s4 | | | | |
| apply ordered confirmation | | | | | | |
| remove persistent information | s2 | | | | | |
| detect problem | | | | | | |
| detect and record problem | | s6 | | | | |
| disruption I | e1 | z | | z | z | |
| disruption II | | | | | | |
| disruption III | | | | | | |

**Table 15: Inferior state table – completed states (including presume-abort and queried)**

| | x1 | x2 | y1 | y2 | z | z1 |
|---|---|---|---|---|---|---|
| send ENROL/rsp-req | | | | | | |
| send ENROL/no-rsp-req | | | | | | |
| send RESIGN/rsp-req | | | | | | |
| send RESIGN/no-rsp-req | | | | | | |
| send PREPARED | | | | | | |
| send PREPARED/cancel | | | | | | |
| send CONFIRMED/auto | | | | | | |
| send CONFIRMED/response | | | | | | |
| send CANCELLED | | | | z1 | | |
| send HAZARD | | | | | | |
| send INF_STATE/active/y | | | | | | |
| send INF_STATE/active | | | | | | |
| send INF_STATE/unknown | | | z | | | |
| receive ENROLLED | | | y1 | y2 | z | z1 |
| receive RESIGNED | | | y1 | | z | |
| receive PREPARE | | | y1 | y2 | y1 | z1 |
| receive CONFIRM_ONE_PHASE | | | y1 | y2 | y1 | y1 |
| receive CONFIRM | | | | y2 | m1 | y2 |
| receive CANCEL | | | y1 | z | y1 | y1 |
| receive CONTRADICTION | | | z | z | z | z |
| receive SUP_STATE/active/y | | | y1 | y2 | y1 | y2 |
| receive SUP_STATE/active | | | y1 | y2 | z | z1 |
| receive SUP_STATE/prepared-rcvd/y | | | | y2 | | y2 |
| receive SUP_STATE/prepared-rcvd | | | | y2 | | y2 |
| receive SUP_STATE/unknown | x1 | x2 | y1 | y2 | z | z |
| decide to resign | | | | | | |
| decide to be prepared | | | | | | |
| decide to be prepared/cancel | | | | | | |
| decide to confirm autonomously | | | | | | |
| decide to cancel autonomously | | | | | | |
| apply ordered confirmation | | | | | | |
| remove persistent information | z | z | | | | |
| detect problem | | | | | | |
| detect and record problem | | | | | | |
| disruption I | e1 | e2 | | | | |
| disruption II | | | | | | |
| disruption III | | | | | | |

## Persistent information

The BTP recovery mechanisms require that information is persisted by the BTP actors that perform the Superior and Inferior roles. To ensure consistent application of the outcome, despite failures, the Inferior must persist some state information at the point of becoming prepared, and the Superior at the point of making a confirm decision. If the Superior is a Sub-coordinator or Sub-composer, it must persist information when, as an Inferior it becomes prepared.  The minimum information to be persisted is the identifiers and addresses of the peer Inferiors and Supeior – the fact of the persistence being itself an indication of the preparedness or confirm decision. However, BTP allows recovery of a Superior:Inferior relationship to occur in other cases – during the active phase, and before a confirm decision has been made. Thus, in general, the BTP actors will need to persist the current state of the relationships.

Since BTP messages may carry application-specified qualifiers, which may need to be re-sent in the case of failure (because the first attempt got lost). BTP actors should be prepared to persist such qualifiers as well.

A Participant will normally also need to persist some information concerning the application work whose final or counter effect it is responsible for. The nature of this information is not considered further in this specification.

Information to be persisted for an Inferior's "decision to be prepared" must be sufficient to re-establish communication with the Superior, to apply a confirm decision and to apply a cancel decision. It will thus need to include

"superior-address"(as on CONTEXT as updated by REDIRECT)

"superior-identifier" (as on CONTEXT)

"default-is-cancel" value (as on PREPARED)

A Superior must record corresponding information to allow it to re-establish communication with the Inferior. Thus, for each Inferior

"inferior-address" (as on ENROL, as updated by REDIRECT)

"inferior-identifier" (as on ENROL)

In order to recover their own function, both Superior and Inferior will need to persist their own Identifer ("superior-identifier" and "inferior-identifier") and, depending on the implementation, may need to persist their original "superior-address" or "inferior-address".

## XML representation of Message Set

This section describes the syntax for BTP messages in XML. These XML messages represent a midpoint between the abstract messages and what actually gets sent on the wire.

All BTP related URIs have been created using Oasis URI conventions as specified in RFC 3121

The XML Namespace for the BTP messages is urn:oasis:names:tc:BTP:1.0:core

In addition to an XML schema, this specification uses an informal syntax to describe the structure of the BTP messages. The syntax appears as an XML instance, but the values contain data types instead of values.  The following symbols are appended to some of the XML constructs: ? (zero or one), * (zero or more), + (one or more.) The absence of one of these symbols corresponds to "one and only one."

The Delivery parameters are shown in the XML with a darker background.

### Addresses

As described in the "Abstract Message and Associated Contracts – Addresses" section, a BTP address comprises three parts, and for a "target-address" only the "additional information" field is inside the BTP messages. For all BTP messages whose abstract form includes a "target-address" parameter, the corresponding XML representation includes a "target-additional-information" element. This element may be omitted if it would be empty.

For other addresses, all three fields are represent, as in:

```
<btp:some-address>
  <btp:binding-name>...carrier binding ~~URI~~name...</btp:binding-name>
  <btp:binding-address>...carrier specific address...</btp:binding-address>
  <btp:additional-information>...optional additional addressing information...</btp:additional-information> ?
</btp:some-address>
```

A "published" address can be a set of <some-address>, which are alternatives which can be chosen by the peer (sender.) Multiple addresses are used in two cases: different bindings to same endpoint, or backup endpoints. In the former, the receiver of the message has the choice of which address to use (depending on which binding is preferable.) In the case where multiple addresses are used for redundancy, a priority attribute can be specified to help the receiver choose among the addresses- the address with the highest priority should be used, other things being equal. The priority is used as a hint and does not enforce any behaviour in the receiver of the message. Default priority is a value of 1.

### Qualifiers

The "Qualifier name" is used as the element name, within the namespace of the "Qualifier group".

Examples:

```
<btpq:inferior-timeout
       xmlns:btpq="urn:oasis:names:tc:BTP:1.0:qualifiers"
       xmlns:btp="urn:oasis:names:tc:BTP:1.0:core"
       btp:must-be-understood="false"
       btp:to-be-propagated="false">1800</btpq:inferior-timeout>
<auth:username
       xmlns:auth="http://www.example.com/ns/auth"
       xmlns:btp="urn:oasis:names:tc:BTP:1.0:core"
       btp:must-be-understood="true"
       btp:to-be-propagated="true">jtauber</auth:username>

```

Attributes must-be-understood **has default value “true”** and to-be-propagated has default value “false”.

### Identifiers

Identifiers shall be URIs "

*Note – Identifiers need to be globally unambiguous. Apart from their generation, .the only operation the BTP implementations have to perform on identifiers is to match them.*

### Message References

Each BTP message has an optional id attribute to give it a unique identifier. An application can make use of those identifiers, but no processing is enforced.

## Messages

### CONTEXT

```
<btp:context id?>
  <btp:superior-address> +
    ...address...
  </btp:superior-address>
  <btp:superior-identifier>...URI...</btp:superior-identifier>
  <btp:superior-type>cohesion|atom</btp:superior-type>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:reply-address> ?
    ...address...
  </btp:reply-address>
</btp:context>
```

### CONTEXT_REPLY

```
<btp:context-reply  id?>
  <btp:superior-identifier>...URI...</btp:superior-identifier>
  <btp:completion-
status>completed|incomplete|related|repudiated</btp:completion-
status>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
</btp:context-reply>
```

### REQUEST_STATUS

```
<btp:request-status id?>
  <btp:target-identifier>...URI...</btp:target-identifier>
    <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:reply-address> ?
    ...address...
  </btp:reply-address>
</btp:request-status>
```

### STATUS

```
<btp:status id?>
  <btp:responders-identifier>...URI...</btp:responders-identifier>
  <btp:status-value>created|enrolling|active|resigning|
          resigned|preparing|prepared|
          confirming|confirmed|cancelling|cancelled|
          cancel-contradiction|confirm-contradiction|
          hazard|contradicted|unknown|inaccessible</btp:status-
value>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
</btp:status>
```

### FAULT

```
<btp:fault id?>
  <btp:superior-identifier>...URI...</btp:superior-identifier> ?
  <btp:inferior-identifier>...URI...</btp:inferior-identifier> ?
  <btp:fault-type>...fault type name...</btp:fault-type>
  <btp:fault-data>...fault data...</btp:fault-data> ?
  <btp:fault-text>...string data ...</btp:fault-data> ?
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
</btp:fault>
```

The following fault type names are represented by simple strings, corresponding to the entries defined in the abstract message set:

- communication-failure
- duplicate-inferior
- general
- invalid-decider
- invalid-inferior
- invalid-superior
- status-refused
- invalid-terminator
- unknown-parameter
- unknown-transaction
- unsupported-qualifier
- wrong-state
- redirect

Revisions of this specification may add other fault type names, which shall be simple strings of letters, numbers and hyphens. If other specifications define fault type names to be used with BTP, the names shall be URIs.

Fault data can take on various forms:

Identifier:

```
<btp:fault-data>...URI...</btp:fault-data>
```

Inferior Identity:

```
<btp:fault-data>
  <btp:inferior-address> +
    ...address...
  </btp:inferior-address>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
   </btp:fault-data>
```

## ENROL

```
<btp:enrol id?>
  <btp:superior-identifier>...URI...</btp:superior-identifier>
  <btp:response-requested>true|false</btp:response-requested>
  <btp:inferior-address>  +
    ...address...
  </btp:inferior-address>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:reply-address>  ?
    ...address...
  </btp:reply-address>
</btp:enrol>
```

## ENROLLED

```
<btp:enrolled id?>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
</btp:enrolled>
```

## RESIGN

```
<btp:resign id?>
  <btp:superior-identifier>...URI...</btp:superior-identifier>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:response-requested>true|false</btp:response-requested>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:resign>
```

## RESIGNED

```
<btp:resigned id?>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
```

```
</btp:resigned>
```

#### PREPARE

```
<btp:prepare id?>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:prepare>
```

#### PREPARED

```
<btp:prepared id?>
  <btp:superior-identifier>...URI...</btp:superior-identifier>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:default-is-cancel>true|false</btp:default-is-cancel>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:prepared>
```

#### CONFIRM

```
<btp:confirm id?>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:confirm>
```

#### CONFIRMED

```
<btp:confirmed id?>
  <btp:superior-identifier>...URI...</btp:superior-identifier>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:confirmed-received>true|false</btp:confirmed-received>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:confirmed>
```

## CANCEL

```
<btp:cancel id?>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:cancel>
```

## CANCELLED

```
<btp:cancelled id?>
  <btp:superior-identifier>...URI...</btp:superior-identifier>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier> ?
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:cancelled>
```

## CONFIRM_ONE_PHASE

```
<btp:confirm-one-phase id?>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:report-hazard>true|false</btp:report-hazard>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:confirm-one-phase>
```

## HAZARD

```
<btp:hazard id?>
  <btp:superior-identifier>...URI...</btp:superior-identifier>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:level>mixed|possible</btp:level>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:hazard>
```

## CONTRADICTION

```
<btp:contradiction id?>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:contradiction>
```

## SUPERIOR_STATE

```
<btp:superior-state id?>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:status>active|prepared-
received|inaccessible|unknown</btp:status>
  <btp:response-requested>true|false</btp:response-requested>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:superior-state>
```

## INFERIOR_STATE

```
<btp:inferior-state id?>
  <btp:superior-identifier>...URI...</btp:superior-identifier>
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:status>active|inaccessible|unknown</btp:status>
  <btp:response-requested>true|false</btp:response-requested>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:sender-address> ?
   ...address...
  </btp:sender-address>
</btp:inferior-state>
```

## REDIRECT

```
<btp:redirect id?>
  <btp:superior-identifier>...URI...</btp:superior-identifier> ?
  <btp:inferior-identifier>...URI...</btp:inferior-identifier>
  <btp:old-address>  +
    ...address...
  </btp:old-address>
  <btp:new-address>  +
    ...address...
  </btp:new-address>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
</btp:redirect>
```

## BEGIN

```
<btp:begin id?>
  <btp:transaction-type>cohesion|atom</btp:transaction-type>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:reply-address> ?
    ...address...
  </btp:reply-address>
</btp:begin>
```

## BEGUN

```
<btp:begun id?>
  <btp:decider-address> *
    ...address...
  </btp:decider-address>
  <btp:inferior-address> *
    ...address...
  </btp:inferior-address>
  <btp:transaction-identifier>...URI...</btp:transaction-
identifier>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
</btp:begun>
```

## PREPARE_INFERIORS

```
<btp:prepare-inferiors id?>
  <btp:transaction-identifier>...URI...</btp:transaction-
identifier>
  <btp:inferiors-list> ?
       <btp:inferior-identifier>...URI...</btp:inferior-
identifier> +
  </btp:inferiors-list>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:reply-address>  ?
    ...address...
  </btp:reply-address>
</btp:prepare-inferiors>
```

## CONFIRM_TRANSACTION

```
<btp:confirm-transaction id?>
  <btp:transaction-identifier>...URI...</btp:transaction-
identifier>
  <btp:inferiors-list> ?
       <btp:inferior-identifier>...URI...</btp:inferior-
identifier> +
  </btp:inferiors-list>
  <btp:report-hazard>true|false</btp:report-hazard>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:reply-address> ?
    ...address...
  </btp:reply-address>
</btp: confirm_transaction>
```

### TRANSACTION_CONFIRMED

```
<btp:transaction-confirmed id?>
  <btp:transaction-identifier>...URI...</btp:transaction-
identifier>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
</btp:transaction-confirmed>
```

### CANCEL_TRANSACTION

```
<btp:cancel-transaction id?>
  <btp:transaction-identifier>...URI...</btp:transaction-
identifier>
  <btp:report-hazard>true|false</btp:report-hazard>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:reply-address> ?
    ...address...
  </btp:reply-address>
</btp:cancel-transaction>
```

### CANCEL_INFERIORS

```
<btp:cancel-inferiors id?>
  <btp:transaction-identifier>...URI...</btp:transaction-
identifier> ?
  <btp:inferiors-list>
    <btp:inferior-identifier>...URI...</btp:inferior-identifier> +
  </btp:inferiors-list>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:reply-address> ?
    ...address...
  </btp:reply-address>
</btp:cancel-inferiors>
```

### TRANSACTION_CANCELLED

```
<btp:transaction-cancelled id?>
  <btp:transaction-identifier>...URI...</btp:transaction-
identifier>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
</btp:transaction-cancelled>
```

### REQUEST_INFERIOR_STATUSES

```
<btp:request-inferior-statuses id?>
  <btp:target-identifier>...URI...</btp:target-identifier>
  <btp:inferiors-list> ?
       <btp:inferior-identifier>...URI...</btp:inferior-
identifier> +
  </btp:inferiors-list>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
    ...additional address information...
  </btp:target-additional-information>
  <btp:reply-address> ?
    ...address...
  </btp:reply-address>
</btp:request-inferior-statuses>
```

### INFERIOR_STATUSES

```
<btp:inferior-statuses id?>
  <btp:responders-identifier>...URI...</btp:responders-identifier>
  <btp:status-list>
       <btp:status-item> +
          <btp:inferior-identifier>...URI...</btp:inferior-
identifier>
          <btp:status>active|resigned|preparing|prepared|
               autonomously-confirmed|autonomously-cancelled|
               confirming|confirmed|cancelling|cancelled|
               cancel-contradiction|confirm-contradiction|
               hazard|invalid</btp:status>
          <btp:qualifiers> ?
               ...qualifiers...
         </btp:qualifiers>
       </btp:status-item>
  </btp:status-list>
  <btp:qualifiers> ?
    ...qualifiers...
  </btp:qualifiers>
  <btp:target-additional-information> ?
```

```
    ...additional address information...
  </btp:target-additional-information>
</btp:inferior-statuses>
```

## Standard qualifiers

The informal syntax for these messages assumes the namespace prefix “btpq” is associated with the URI “`urn:oasis:names:tc:BTP:1.0:qualifiers`”.

### Transaction timelimit

```
<btpq:transaction-timelimit>
  <btpq:timelimit>
    ...time in seconds...
  </btpq:timelimit>
</btpq:transaction-timelimit>
```

### Inferior timeout

```
<btpq:inferior-timeout>
  <btpq:timeout>
    ...time in seconds...
  </btpq:timeout>
  <btpq:intended-decision>confirm|cancel</btpq:intended-decision>
</btpq:inferior-timeout>
```

### Minimum inferior timeout

```
<btpq:minimum-inferior-timeout>
  <btpq:minimum-timeout>
    ...time in seconds...
  </btpq:minimum-timeout>
</btpq:minimum-inferior-timeout>
```

### Inferior name

```
<btpq:inferior-name>
  <btpq:inferior-name>
    ...string...
  </btpq:inferior-name>
</btpq:inferior-name>
```

## Compounding of Messages

Relating BTP to one another, in a “group”is represented by containing them within the btp:related-group element, with the related messages as child elements. The processing for the group is defined in the section “Groups – combinations of related messages”. For example

```
  <btp:related-group>
       <btp:context-reply>
         ...<completion-status>related</completion-status> ...
       </btp:context-reply>
```

```
                <btp:enrol>...</btp:enrol>
                 <btp:prepared>...</btp:prepared>
            </btp:related-group>
```

If the rules for the group state that the “target-address” of the abstract message is omitted, the corresponding target-address-information element shall be absent in the message in the related-group. The carrier protocol binding specifies how a relation between application and BTP messages is represented.

Bundling (semantically insignificant combination) of BTP messages and related groups is indicated with the "btp:messages" element, with the bundled messages and related groups as child elements. For example (confirming one and cancelling another inferiors of a cohesion):

```
            <btp:messages>
              <btp:confirm>...</btp:confirm>
              <btp:cancel>...</btp:cancel>
            </btp:messages>
```

## XML Schemas

### XML schema for BTP messages

```
<?xml version="1.0" encoding="UTF-8"?>
<schema
    xmlns="http://www.w3.org/2001/XMLSchema"
    targetNamespace="urn:oasis:names:tc:BTP:1.0:core"
    xmlns:btp="urn:oasis:names:tc:BTP:1.0:core"
    elementFormDefault="qualified">

    <!-- Qualifiers -->
    <complexType name="qualifier-type">
        <simpleContent>
            <extension base="anyType">
                <attribute name="must-be-understood" type="boolean"/>
                <attribute name="to-be-propagated" type="boolean"/>
            </extension>
        </simpleContent>
    </complexType>

    <element name="qualifier" type="btp:qualifier-type" abstract="true"/>

    <element name="qualifiers">
        <complexType>
            <sequence>
                <element ref="btp:qualifier" maxOccurs="unbounded"/>
            </sequence>
        </complexType>
    </element>
    <!-- example qualifier:
        <element name="some-qualifer" type="btp:qualifier-type"
substitutionGroup="btp:qualifier"/>
```

```
    -->

    <!-- Message set data types -->
    <simpleType name="identifier">
        <restriction base="anyURI" />
    </simpleType>
    <simpleType name="additional-information">
        <restriction base="string" />
    </simpleType>
    <complexType name="address">
        <sequence>
            <element name="binding-name" type="string"/>
            <element name="binding-address" type="string"/>
            <element name="additional-information" type="btp:additional-
information" minOccurs="0" />
        </sequence>
    </complexType>
    <simpleType name="superior-type">
        <restriction base="string">
            <enumeration value="cohesion"/>
            <enumeration value="atom"/>
        </restriction>
    </simpleType>
    <simpleType name="transaction-type">
        <restriction base="string">
            <enumeration value="cohesion"/>
            <enumeration value="atom"/>
        </restriction>
    </simpleType>

    <!-- Compounding -->
    <element name="messages">
        <complexType>
            <sequence>
                <element ref="btp:message" minOccurs="0"
maxOccurs="unbounded"/>
            </sequence>
        </complexType>
    </element>
    <element name="related-group" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element ref="btp:message" minOccurs="0"
maxOccurs="unbounded"/>
            </sequence>
        </complexType>
    </element>

    <!-- Message set -->
    <element name="message" abstract="true" />
    <element name="context" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="superior-address" type="btp:address"
maxOccurs="unbounded"/>
```

```
                <element name="superior-identifier" type="btp:identifier"/>
                <element name="superior-type" type="btp:superior-type"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="reply-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="context-reply" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="superior-identifier" type="btp:identifier"/>
                <element name="completion-status">
                    <simpleType>
                        <restriction base="string">
                            <enumeration value="completed"/>
                            <enumeration value="incomplete"/>
                            <enumeration value="related"/>
                            <enumeration value="repudiated"/>
                        </restriction>
                    </simpleType>
                </element>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="request-status" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="target-identifier" type="btp:identifier"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="reply-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="status" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="responders-identifier"
type="btp:identifier"/>
                <element name="status-value">
                      <simpleType>
                    <restriction base="string">
                        <enumeration value="created"/>
                        <enumeration value="enrolling"/>
                        <enumeration value="active"/>
                        <enumeration value="resigning"/>
                        <enumeration value="resigned"/>
                        <enumeration value="preparing"/>
                        <enumeration value="prepared"/>
                        <enumeration value="confirming"/>
                        <enumeration value="confirmed"/>
                        <enumeration value="cancelling"/>
                        <enumeration value="cancelled"/>
                        <enumeration value="cancel-contradiction"/>
                        <enumeration value="confirm-contradiction"/>
                        <enumeration value="hazard"/>
                        <enumeration value="contradicted"/>
                        <enumeration value="unknown"/>
                        <enumeration value="inaccessible"/>
                    </restriction>
                      </simpleType>
                </element>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="fault" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="superior-identifier" type="btp:identifier"
minOccurs="0"/>
                <element name="inferior-identifier" type="btp:identifier"
minOccurs="0"/>
                <element name="fault-type">
                    <simpleType>
                    <restriction base="string">
                        <enumeration value="communication-failure"/>
                        <enumeration value="duplicate-inferior"/>
                        <enumeration value="general"/>
                        <enumeration value="invalid-decider"/>
                        <enumeration value="invalid-inferior"/>
                        <enumeration value="invalid-superior"/>
                        <enumeration value="status-refused"/>
                        <enumeration value="invalid-terminator"/>
                        <enumeration value="unknown-parameter"/>
                        <enumeration value="unknown-transaction"/>
                        <enumeration value="unsupported-qualifier"/>
                        <enumeration value="wrong-state"/>
                        <enumeration value="redirect"/>
                    </restriction>
                    </simpleType>
                </element>
                <element name="fault-data" type="anyType" minOccurs="0"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="enrol" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="superior-identifier" type="btp:identifier"/>
                <element name="response-requested" type="boolean"
minOccurs="0" default="false"/>
                <element name="inferior-address" type="btp:address"
minOccurs="1" maxOccurs="unbounded"/>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="reply-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="enrolled" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="resign" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="superior-identifier" type="btp:identifier"/>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element name="response-requested" type="boolean"
minOccurs="0" default="false"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="resigned" substitutionGroup="btp:message">
        <complexType>
            <sequence>
```

```
                <element name="inferior-identifier" type="btp:identifier"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="prepare" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="prepared" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="superior-identifier" type="btp:identifier"/>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element name="default-is-cancel" type="boolean"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="confirm" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="confirmed" substitutionGroup="btp:message">
```

```
        <complexType>
            <sequence>
                <element name="superior-identifier" type="btp:identifier"/>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element name="confirmed-received" type="boolean"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="cancel" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="cancelled" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="superior-identifier" type="btp:identifier"/>
                <element name="inferior-identifier" type="btp:identifier"
minOccurs="0"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="confirm-one-phase" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element name="report-hazard" type="boolean"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="hazard" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="superior-identifier" type="btp:identifier"/>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element name="level">
                    <simpleType>
                        <restriction base="string">
                            <enumeration value="mixed"/>
                            <enumeration value="possible"/>
                        </restriction>
                    </simpleType>
                </element>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="contradiction" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="superior-state" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element name="status">
                    <simpleType>
                        <restriction base="string">
                            <enumeration value="active"/>
                            <enumeration value="prepared-received"/>
                            <enumeration value="inaccessible"/>
                            <enumeration value="unknown"/>
                        </restriction>
                    </simpleType>
                </element>
                <element name="response-requested" type="boolean"
minOccurs="0" default="false"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="inferior-state" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="superior-identifier" type="btp:identifier"/>
                <element name="inferior-identifier" type="btp:identifier"/>
                <element name="status">
                    <simpleType>
                        <restriction base="string">
                            <enumeration value="active"/>
                            <enumeration value="inaccessible"/>
                            <enumeration value="unknown"/>
                        </restriction>
                    </simpleType>
                </element>
                <element name="response-requested" type="boolean"
minOccurs="0" default="false"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="sender-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="redirect" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="superior-identifier" type="btp:identifier"
minOccurs="0"/>
                <element name="inferior-identifier" type="btp:identifier"
/>
                <element name="old-address" type="btp:address"
maxOccurs="unbounded"/>
                <element name="new-address" type="btp:address"
maxOccurs="unbounded"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="begin" substitutionGroup="btp:message">
        <complexType>
            <sequence>
```

```
                <element name="transaction-type" type="btp:superior-type"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="reply-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="begun" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="decider-address" type="btp:address"
minOccurs="0" maxOccurs="unbounded"/>
                <element name="inferior-address" type="btp:address"
minOccurs="0" maxOccurs="unbounded"/>
                <element name="transaction-identifier"
type="btp:identifier" minOccurs="0"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="prepare-inferiors" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="transaction-identifier"
type="btp:identifier"/>
                <element name="inferiors-list" minOccurs="0">
                    <complexType>
                        <sequence>
                            <element name="inferior-identifier"
type="btp:identifier" maxOccurs="unbounded"/>
                        </sequence>
                    </complexType>
                </element>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="reply-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="confirm-transaction" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="transaction-identifier"
type="btp:identifier"/>
                <element name="inferiors-list" minOccurs="0">
                    <complexType>
```

```
                        <sequence>
                            <element name="inferior-identifier"
type="btp:identifier" maxOccurs="unbounded"/>
                        </sequence>
                    </complexType>
                </element>
                <element name="report-hazard" type="boolean"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="reply-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="transaction-confirmed" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="transaction-identifier"
type="btp:identifier"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="cancel-transaction" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="transaction-identifier"
type="btp:identifier"/>
                <element name="report-hazard" type="boolean"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="reply-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="cancel-inferiors" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="transaction-identifier"
type="btp:identifier" minOccurs="0"/>
                <element name="inferiors-list">
                    <complexType>
                        <sequence>
                            <element name="inferior-identifier"
type="btp:identifier" maxOccurs="unbounded"/>
                        </sequence>
                    </complexType>
                </element>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="reply-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>
    <element name="transaction-cancelled" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="transaction-identifier"
type="btp:identifier"/>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="request-inferior-statuses"
substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="target-identifier" type="btp:identifier"/>
                <element name="inferiors-list" minOccurs="0">
                    <complexType>
                        <sequence>
                            <element name="inferior-identifier"
type="btp:identifier" maxOccurs="unbounded"/>
                        </sequence>
                    </complexType>
                </element>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
                <element name="reply-address" type="btp:address"
minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

    <element name="inferior-statuses" substitutionGroup="btp:message">
        <complexType>
            <sequence>
                <element name="responders-identifier"
type="btp:identifier"/>
                <element name="status-list">
                  <complexType>
                    <sequence>
```

```
                      <element name="status-item" maxOccurs="unbounded">
                        <complexType>
                          <sequence>
                            <element name="inferior-identifier"
type="btp:identifier"/>
                            <element name="status">
                              <simpleType>
                                <restriction base="string">
                                    <enumeration value="active"/>
                                    <enumeration value="resigned"/>
                                    <enumeration value="preparing"/>
                                    <enumeration value="prepared"/>
                                    <enumeration value="autonomously-
confirmed"/>
                                    <enumeration value="autonomously-
cancelled"/>
                                    <enumeration value="confirming"/>
                                    <enumeration value="confirmed"/>
                                    <enumeration value="cancelling"/>
                                    <enumeration value="cancelled"/>
                                    <enumeration value="cancel-
contradiction"/>
                                    <enumeration value="confirm-
contradiction"/>
                                    <enumeration value="hazard"/>
                                    <enumeration value="invalid"/>
                                  </restriction>
                                </simpleType>
                              </element>
                            <element ref="btp:qualifiers" minOccurs="0"/>
                          </sequence>
                        </complexType>
                      </element>
                    </sequence>
                  </complexType>
                </element>
                <element ref="btp:qualifiers" minOccurs="0"/>
                <element name="target-additional-information"
type="btp:additional-information" minOccurs="0"/>
            </sequence>
            <attribute name="id" type="ID" use="optional"/>
        </complexType>
    </element>

</schema>
```

## XML schema for standard qualifiers

```
<?xml version="1.0"?>
<schema
    xmlns="http://www.w3.org/2001/XMLSchema"
    targetNamespace="urn:oasis:names:tc:BTP:1.0:qualifiers"
    xmlns:btpq="urn:oasis:names:tc:BTP:1.0:qualifiers"
    xmlns:btp="urn:oasis:names:tc:BTP:1.0:core"
    elementFormDefault="qualified">

    <element name="transaction-timelimit"
substitutionGroup="btp:qualifier">
        <complexType>
            <complexContent>
                <extension base="btp:qualifier-type">
                    <sequence>
                        <element name="timelimit"
type="nonNegativeInteger"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
    </element>
    <element name="inferior-timeout" substitutionGroup="btp:qualifier">
        <complexType>
            <complexContent>
                <extension base="btp:qualifier-type">
                    <sequence>
                        <element name="timelimit"
type="nonNegativeInteger"/>
                        <element name="intended-decision">
                            <simpleType>
                                <restriction base="string">
                                    <enumeration value="confirm"/>
                                    <enumeration value="cancel"/>
                                </restriction>
                            </simpleType>
                        </element>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
    </element>
    <element name="minimum-inferior-timeout"
substitutionGroup="btp:qualifier">
        <complexType>
            <complexContent>
                <extension base="btp:qualifier-type">
                    <sequence>
                        <element name="minimum-timeout"
type="nonNegativeInteger"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
    </element>
    <element name="inferior-name" substitutionGroup="btp:qualifier">
        <complexType>
            <complexContent>
                <extension base="btp:qualifier-type">
                    <sequence>
                        <element name="inferior-name" type="string"/>
                    </sequence>
                </extension>
            </complexContent>
        </complexType>
    </element>
</schema>
```

## Carrier Protocol Bindings

The notion of bindings is introduced to act as the glue between the BTP messages and an underlying transport. A binding specification must define various particulars of how the BTP messages are carried and some aspects of how the related application messages are carried. This document specifies two bindings: a SOAP binding and a SOAP + Attachments binding. However, other bindings could be specified by the Oasis BTP technical committee or by a third party. For example, in the future a binding might exist to put a BTP message directly on top of HTTP without the use of SOAP, or a closed community could define their own binding. To ensure that such specifications are complete, the Binding Proforma defines the information that must be included in a binding specification.

A registry of bindings, with links to the binding specifications is maintained on the OASIS website, linked from the BTP page (http://www.oasis-open.org/committees/business-transactions). Any party may submit a binding specification and request its addition to this registry. The presence of an entry in the registry does not, of itself, imply ratification or approval by OASIS or the BTP Technical Committee.

### Carrier Protocol Binding Proforma

A BTP carrier binding specification should provide the following information:

**Binding name:** A name for the binding, as used in the "binding name" field of  BTP addresses (and available for declaring the capabilities of an implementation). Binding specified in this document, and future revisions of this document have binding names that are simple strings of letters, numbers and hyphens (and, in particular, do not contain colons).  Bindings specified elsewhere shall have binding names that are URIs. Bindings specified in this document use numbers to identify the version of the binding, not the version(s) of the carrier protocol.

**Binding address format:** This section states the format of the "binding address" field of a BTP address for this binding. For many bindings, this will be a URL of some kind; for other bindings it may be some other form

**BTP message representation:** This section will define how BTP messages are represented. For many bindings, the BTP message syntax will be as specified in  the XML schema defined in this document, and the normal string encoding of that XML will be used.

**Mapping for BTP messages (unrelated)** : This section will define how BTP messages that are not related to application messages are sent in either direction between Superior and Inferior. (i.e. those messages sent directly between BTP actors). This mapping need not be symmetric (i.e. Superior to Inferior may differ to some degree to Inferior to Superior). The mapping may define particular rules for particular BTP messages, or messages with particular parameter values (e.g. the FAULT message with "fault-type" "CommunicationFailure" will typically not be sent as a

BTP message). The mapping states any constraints or requirements on which BTP may or must be bundled together by compounding.

**Mapping for BTP messages related to application messages**: This section will define how BTP messages that are related to application messages are sent. A binding specification may defer details of this to a particular application (e.g. a mapping specification could just say "the CONTEXT may be carried as a parameter of an application invocation"). Alternatively, the binding may specify a general method that represents the relationship between application and BTP messages.

**Implicit messages**: This section specifies which BTP messages, if any, are not sent explicitly but are treated as implicit in carrier-protocol mechanisms, application messages or other BTP messages. This may depend on particular parameter values of the BTP messages or the application messages.

**Faults**: The relationship between the fault and exception reporting mechanisms of the carrier protocol and of BTP shall be defined. This may include definition of which carrier protocol exceptions are equivalent to a FAULT/communication-failure message.

**Relationship to other bindings**: Any relationship to other bindings is defined in this section. If BTP addresses with different bindings are be considered to match (for purposes of identifying the peer Superior/Inferior and redirection), this should be specified here.

**Limitations on BTP use**: Any limitations on the full range of BTP functionality that are imposed by use of this binding should be listed. This would include limitations on which messages can be sent, which event sequences are supported and restrictions on parameter values. Such limitations may reduce the usefulness of an implementation, but may be appropriate in certain environments.

**Other**: Other features of the binding, especially any that will potentially affect interoperation should be specified here. This may include restrictions or requirements on the use or support of optional carrier parameters or mechanisms or use of standard or other qualifiers.

## Bindings for request/response carrier protocols

BTP does not generally follow a request/response pattern. In particular, on the outcome relationship either side may initiate a message – this is an essential part of the presume-abort recovery paradigm although it is not limited to recovery cases. However, there are some BTP messages, especially in the control relationship, that do have a request/response pattern. Many (potential) carrier protocols (e.g. HTTP) do have a request/response pattern. The specification of a binding specification to a request/response carrier protocol needs to state what rules apply – which messages can be carried by requests, which by responses. The simplest rule is to send all BTP messages on requests, and let the carrier responses travel back empty. This would be inefficient in use of network resources, and possibly inconvenient when used for the BTP request/response pairs.

This section defines a set of rules that allow more efficient use of the carrier, while allowing the initiator of a BTP request/response pair to ensure the BTP response is sent back on the carrier response. These rules are specified in this section to enable binding specifications to reference them, without requiring each binding specification to repeat similar information. These rules also allow the receiver of a message between Superior and Inferior (in either direction) on a carrier protocol request to send any reply message on the carrier response – the "sender-address" field is implicitly considered to be that of the sender of the carrier request.

A binding to a request/response carrier is not required to use these rules. It may define other rules.

### Request/response exploitation rules

These rules allow implementations to use the request and response of the carrier protocol efficiently, and, when a BTP request/response exchange occurs, to either treat the request/response exchanges of the carrier protocol and of BTP independently, if both sides wish, or allow either side to map them closely.

Under these rules, an implementation sending a BTP request (i.e. a message, other than CONTEXT, which has "reply-address" as a parameter in the abstract message definition), can ensure that it and the reply map to a carrier request/response by supplying no value for the "reply-address". An implementation receiving such a request is required to send the BTP response on the carrier response.

Conversely, if an implementation does supply a "reply-address" value on the request, the receiver has the option of sending the BTP response back on the carrier response, or sending it on a new carrier request.

Within the outcome relationship, apart from ENROL, there is no "reply-address", and the parties normally know each other's "superior-address" and "inferior-address". However, these messages have a "sender-address", which is used when the receiver does not have knowledge of the peer. In this case, the "sender-address" is treated as the "reply-address" of the other messages – if the field is absent in a message on a carrier request, the "sender-address" is implicitly that of the request sender. Any message for the peer (including the three messages mentioned, FAULT but also any other valid message in the Superior:Inferior relationship) may be sent on the carrier response. Apart from this, both sides are permitted to treat the carrier request/response exchanges as opportunities for sending messages to the appropriate destination.

The rules:

a) A BTP actor **may** bundle one or more BTP messages and related groups that have the same binding address for their target in a single btp:messages and transmit this btp:messages element on a carrier protocol request. There is no restriction on which combinations of messages and groups may be so bundled, other than that they have the same binding address, and that this binding address is usable as the destination of a carrier protocol request.

b) A BTP actor that has received a carrier protocol request to which it has not yet responded, and which has one or more BTP messages and groups whose binding address for the target matches the origin of the carrier request **may** bundle such BTP messages in a single btp:messages element and transmit that on the carrier protocol response.

c) A BTP actor that has received, on a carrier protocol request, one or more BTP messages or related groups that require a BTP response and for which no "reply-address” was supplied, **must** bundle the responding BTP message and groups in a btp:messages element and transmit this element on the carrier protocol response to the request that carried the BTP request.

d) A BTP actor that has received, on a carrier protocol request, one or more BTP messages or related groups that, as abstract messages, have a “sender-address” parameter but no “reply-address” was supplied and does not have knowledge of the peer address, **must** bundle the responding BTP message and groups in a btp:messages element and transmit this element on the carrier protocol response to the request that carried the BTP request. If the actor does have knowledge of the peer address it **may** send one or messages for the peer in the carrier protocol response, regardless of whether the binding address of the peer matches the address of the carrier protocol requestor.

e) Where only one message or group is to be sent, it shall be contained within a btp:messages element, as a bundle of one element.

f) A BTP actor that receives a carrier protocol request carrying BTP messages that do have a “reply-address”, or which initiate processing that produces BTP messages whose target binding address matches the origin of the request, **may** freely choose whether to use the carrier protocol response for the replies, or to send back an “empty carrier protocol response”, and send the BTP replies in a separately initiated carrier protocol request. The characteristics of an “empty carrier protocol response” shall be stated in the particular binding specification.

g) A BTP actor that sends BTP messages on a carrier protocol request **must** be able to accept returning BTP messages on the corresponding carrier protocol response and, if the actor has offered an address on which it will receive carrier requests, must be able to accept “replying” BTP messages on a separate carrier protocol request.

## SOAP Binding

This binding describes how BTP messages will be carried using SOAP as in the SOAP 1.1 specification, using the SOAP literal messaging style conventions. If no application message is sent at the same time, the BTP messages are contained within the SOAP Body element. If application messages are sent, the BTP messages are contained in the SOAP Header element.

**Binding name**: soap-http-1

**Binding address format:** shall be a URL, of type HTTP.

**BTP message representation:** The string representation of the XML, as specified in the XML schema defined in this document shall be used. The BTP XML messages are embedded in the SOAP message without the use of any specific encoding rules (literal style SOAP message); hence the encodingStyle attribute need not be set or can be set to an empty string.

**Mapping for BTP messages (unrelated)**: The “request/response exploitation” rules shall be used.

BTP messages sent on an HTTP request or HTTP response which is not carrying an application message, the messages are contained in a single btp:messages element which is the immediate child element of the SOAP Body element.

An "empty carrier protocol response" sent after receiving an HTTP request containing a btp:messages element in the SOAP Body when the implementation chooses just to reply at the lower level (and when the request/response exploitation rules allow an empty carrier protocol response), shall be any of:

a) an empty HTTP response

b) an HTTP response containing an empty SOAP Envelope

c) an HTTP response containing a SOAP Envelope containing a single, empty btp:messages element.

The receiver (the initial sender of the HTTP request) shall treat these in the same way – they have no effect on the BTP sequence (other than indicating that the earlier sending did not cause a communication failure.)

If an application message is being sent at the same time, the mapping for related messages shall be used, as if the BTP messages were related to the application message. (There is no ambiguity in whether the BTP messages are related, because only CONTEXT and ENROL can be related to an application message.)

**Mapping for BTP messages related to application messages**: All BTP messages sent with an application message, whether related to the application message or not, shall be sent in a single btp:messages element in the SOAP Header. There shall be precisely one btp:messages element in the SOAP Header.

The "request/response exploitation" rules shall apply to the BTP messages carried in the SOAP Header, as if they had been carried in a SOAP Body, unrelated to an application message, sent to the same binding address.

*Note – The application protocol itself (which is using the SOAP Body) may use the SOAP RPC or document approach – this is determined by the application.*

Only CONTEXT and ENROL messages are related (&) to application messages. If there is only one CONTEXT or one ENROL message present in the SOAP Header, it is assumed to be related to the whole of the application message in the SOAP Body. If there are multiple CONTEXT or ENROL messages, any relation of these BTP messages shall be indicated by application specific means.

*Note 1 – An application protocol could use references to the ID values of the BTP messages to indicate relation between BTP CONTEXT or ENROL messages and the application message.*

*Note 2 -- However indicated, what the relatedness means, or even whether it has any significance at all, is a matter for the application.*

**Implicit messages**: A SOAP FAULT, or other communication failure received in response to a SOAP request that had a CONTEXT in the SOAP Header shall be treated as if a CONTEXT_REPLY/repudiated had been received. See also the discussion under "other" about the SOAP mustUnderstand attribute.

**Faults**: A SOAP FAULT or other communication failure shall be treated as FAULT/communication-failure.

**Relationship to other bindings**: A BTP address for Superior or Inferior that has the binding string "soap-http-1" is considered to match one that has the binding string "soap-attachments-http-1" if the binding address and additional information fields match.

**Limitations on BTP use**: None

**Other**: The SOAP BTP binding does not make use of SOAPAction HTTP header or actor attribute. The SOAPAction HTTP header is left to be application specific when there are application messages in the SOAP Body, as an already existing web service that is being upgraded to use BTP might have already made use of SOAPAction. The SOAPAction HTTP header shall contain no value when the SOAP message carries only BTP messages in the SOAP Body.

The SOAP mustUnderstand attribute, when used on the btp:messages containing a BTP CONTEXT, ensures that the receiver (server, as a whole) supports BTP sufficiently to determine whether any enrolments are necessary and replies with CONTEXT_REPLY as appropriate. The sender of the CONTEXT (and related application message) can use this to ensure that the application work is performed as part of the business transaction, assuming the receiver's SOAP implementation supports the mustUnderstand attribute. If mustUnderstand if false, a receiver can ignore the CONTEXT (if BTP is not supported there), and no CONTEXT_REPLY will be returned. It is a local option on the sender (client) side whether the absence of a CONTEXT_REPLY is assumed to be equivalent to aCONTEXT_REPLY/ok (and the business transaction allowed to proceed to confirmation).

Note – some SOAP implementations may not support the mustUnderstand attribute sufficiently to enforce these requirements.

### Example scenario using SOAP binding

The example below shows an application request with CONTEXT message sent from client.example.com (which includes the Superior) to services.example.com (Service).

```

<soap:Envelope
    xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/"
    soap:encodingStyle="">
  <soap:Header>
    <btp:messages xmlns:btp="urn:oasis:names:tc:BTP:1.0:core">
      <btp:context superior-type="atom">
        <btp:superior-address>
          <btp:binding>soap-http-1</btp:binding>
          <btp:binding-
address>http://client.example.com/soaphandler</btp:binding-
address>
          <btp:additional-information>btpengine</btp:additional-
information>
        </btp:superior-address>
        <btp:superior-
identifier>http://example.com/1001</btp:superior-identifier>
        <btp:qualifiers>
          <btpq:transaction-timelimit
xmlns:btpq=”urn:oasis:names:tc:BTP:1.0:qualifiers”><btpq:timelimit
>1800</btpq:timelimit></btpq:transaction-timelimit>
        </btp:qualifiers>
      </btp:context>
    </btp:messages>
  </soap:Header>
  <soap:Body>
    <ns1:orderGoods
xmlns:ns1="http://example.com/2001/Services/xyzgoods">
      <custID>ABC8329045</custID>
      <itemID>224352</itemID>
      <quantity>5</quantity>
    </ns1:orderGoods>
  </soap:Body>
</soap:Envelope>
```

The example below shows CONTEXT_REPLY and a related ENROL message sent from services.example.com to client.example.com, in reply to the previous message. There is no application response, so the BTP messages are in the SOAP Body. The ENROL message does not contain the target-additional-information, since the grouping rules for CONTEXT_REPLY & ENROL omit the “target-address” (the receiver of this example remembers the superior address from the original CONTEXT)

```
<soap:Envelope
    xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/"
    soap:encodingStyle="">
  <soap:Header>
  </soap:Header>
  <soap:Body>
    <btp:messages xmlns:btp="urn:oasis:names:tc:BTP:1.0:core">
       <btp:related-group>
        <btp:context-reply>
         <btp:target-additional-information>btpengine</btp:target-
additional-information>
        <btp:superior-
identifier>http://example.com/1001</btp:superior-identifier>
        <completion-status>related</completion-status>
        </btp:context-reply>
        <btp:enrol response-requested="false">
          <btp:target-additional-
information>btpengine</btp:target-additional-information>
          <btp:superior-
identifier>http://example.com/1001</btp:superior-identifier>
```

```
            <btp:inferior-address>
              <btp:binding>soap-http-1</btp:binding>
              <btp:binding-address>
                 http://services.example.com/soaphandler
              </btp:binding-address>
            </btp:inferior-address>
            <btp:inferior-identifier>
                 http://example.com/AAAB
            </btp:inferior-identifier>
           </btp:enrol>
         </btp:related-group>
      </btp:messages>
    </soap:Body>
</soap:Envelope>
```

## SOAP + Attachments Binding

This binding describes how BTP messages will be carried using SOAP as in the SOAP Messages with Attachments specification. It is a superset of the Basic SOAP binding, soap-http-1. The two bindings only differ when application messages are sent.

**Binding name**: soap-attachments-http-1

**Binding address format:** as for soap-http-1

**BTP message representation:** As for soap-http-1

**Mapping for BTP messages (unrelated)**: As for “soap-http-1” , except the SOAP Envelope containing the SOAP Body containing the BTP messages shall be in a MIME body part, as specified in SOAP Messages with Attachments specification. If an application message is being sent at the same time, the mapping for related messages for this binding shall be used, as if the BTP messages were related to the application message(s).

**Mapping for BTP messages related to application messages**: MIME packaging shall be used. One of the MIME multipart/related parts shall contain a SOAP Envelope, whose SOAP Headers element shall contain precisely one btp:messages element, containing any BTP messages. Any BTP CONTEXT in the btp:messages is considered to be related to the application message(s) in the SOAP Body, and to also any of the MIME parts referenced from the SOAP Body (using the “href” attribute).

**Implicit messages:** As for soap-http-1.

**Faults**: As for soap-http-1.

**Relationship to other bindings**: A BTP address for Superior or Inferior that has the binding string “soap-http-1” is considered to match one that has the binding string “soap-attachements-http-1” if the binding address and additional information fields match.

**Limitations on BTP use**: None

**Other**: As for soap-http-1

*Example using SOAP + Attachments binding*

```
Content-Type: Multipart/Related; boundary=MIME_boundary;
type=text/xml;
        start="someID"
--MIME_boundary
Content-Type: text/xml; charset=UTF-8
Content-ID: someID
<?xml version='1.0' ?>
<soap:Envelope
    xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/"
    soap:encodingStyle=" ">
  <soap:Header>
    <btp:messages xmlns:btp="urn:oasis:names:tc:BTP:1.0:core">
      <btp:context superior-type="atom">
         <btp:superior-address>
           <btp:binding>soap-http-1</btp:binding>
           <btp:binding-address>
               http://client.example.com/soaphandler
           </btp:binding-address>
         </btp:superior-address>
        <btp:superior-
identifier>http://example.com/1001</btp:superior-identifier>
      </btp:context>
    </btp:messages>
  </soap:Header>
  <soap:Body>
    <orderGoods href="cid:anotherID"/>
  </soap:Body>
</soap:Envelope>
--MIME_boundary
Content-Type: text/xml
Content-ID: anotherID
    <ns1:orderGoods
xmlns:ns1="http://example.com/2001/Services/xyzgoods">
      <custID>ABC8329045</custID>
      <itemID>224352</itemID>
      <quantity>5</quantity>
    </ns1:orderGoods>

--MIME_boundary--
```

## Conformance

A BTP implementation need not implement all aspects of the protocol to be useful. The level of conformance of an implementation is defined by which roles it can support using the specified messages and carrier protocol bindings for interoperation with other implementations.

An implementation may implement some roles and relationships in accordance with this specification, while providing the (approximate) functionality of other roles in some other manner. (For example, an implementation might provide an equivalent of the control relationships using a language-specific API, but support roles involved in the outcome relationships using standard BTP messages.) Such an implementation is conformant in respect of the roles it does implement in accordance with this specification.

An implementation can state which aspects of the BTP specification it conforms to in terms of which Roles it supports. Since most Roles cannot usefully be supported in isolation, the following Role Groups can be used to describe implementation capabilities:.

| **Role Group** | **Roles** |
|---|---|
| **Initiator/Terminator** | Initiator |
| | Terminator |
| **Cohesive Hub** | Factory |
| | Composer (as Decider and Superior) |
| | Coordinator (as Decider and Superior) |
| | Sub-composer |
| | Sub-coordinator |
| **Atomic Hub** | Factory |
| | Coordinator |
| | Sub-coordinator |
| **Cohesive Superior** | Composer (as Superior only) |
| | Sub-Composer |
| | Coordinator (as Superior only) |
| | Sub-coordinator |
| **Atomic Superior** | Coordinator (as Superior only)) |
| | Sub-coordinator |
| **Participant** | Inferior |
| | Enroller |

The Role Groups occupy different positions within a business transaction tree and thus require presence of implementations supporting other Role Groups:

Initiator/Terminator uses control relationship to Atomic Hub or Cohesive Hub to initiate and control Atoms or Cohesions. Initiator/Terminator would typically be a library linked with application software.

Atomic Hub and Cohesive Hub would often be standalone servers.

Cohesive Superior and Atomic Superior would provide the equivalent of Initiator/Terminator functionality by internal or proprietary means.

Cohesive Hubs, Atomic Hubs, Cohesive Superior and Atomic Superior use outcome relationships to Participants and to each other.

Participants will establish outcome relationships to implementations of any of the other Role Groups except Initiator/Terminator. A Participant "covers" a resource or application work of some kind. It should be noted that a Participant is unaffected by whether it is enrolled in an Atom or Cohesion – it gets only a single outcome.

An implementation may support one or more Role Groups. The following combinations are defined as commonly expected conformance profiles, although other combinations or selections are equally possible.

| **Conformance Profile** | **Role Groups** |
|---|---|
| **Participant Only** | Participant |
| **Atomic** | Atomic Superior<br>Participant |
| **Cohesive** | Cohesive Superior<br>Participant |
| **Atomic Coordination Hub** | Initiator/Terminator<br>Atomic ~~Coordination~~ Hub<br>Participant |
| **Cohesive Coordination Hub** | Initiator/Terminator<br>Cohesive ~~Coordination~~ Hub<br>Participant |

BTP has several features, such as optional parameters, that allow alternative implementation architectures. Implementations should pay particular attention to avoid assuming their peers have made the same implementation options as they have (e.g. an implementation that always sends ENROL with the same inferior address and with the "reply-address" absent (because the Inferior in all transactions are dealt with by the same addressable entity), must not assume that the same is true of received ENROLs)

# Part 3. Glossary

| | |
|---|---|
| **Actor** | An entity that executes procedures, a software agent. (See also BTP Actor) |
| **Address** | An identifier for an endpoint. |
| **Application** | An actor, which uses the Business Transaction Protocol (in the context of this specification).<br><br>Also, a group of such actors, which may be distributed, that perform a common purpose.<br><br>(When used in phrases such as “determined by the Application”, it is not relevant to BTP whether this is determined by the owner of a single system or is explicitly part of the contract that defines the distributed collaborative application. When it is necessary to distinguish the responsibilities of a single party, the term “Application element” is used.) |
| **Application element** | An actor that communicates, using application protocols, with other application elements, as part of an overall distributed application. A single system may contain more than one application element. |
| **Application Endpoint** | An endpoint of an application message. |
| **Application Message** | A message produced by an application element and consumed by an application element. |
| **Application Operation** | An operation, which is started when an application message arrives. |
| **Appropriate** | In accordance with a pertinent contract or specification. |
| **Atom** | A set of participants, which are the direct inferiors of a node (which may have only one member), all of which will receive instructions that will result in a homogeneous outcome. That is they will be issued instructions to all confirm or all cancel. (Transitively, a set of operations whose effect is capable of counter effect.) |

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| **Atomic Business Transaction** | A complete business transaction that follows the atom rules for every node in the transaction tree over space and time, so that all the participants in the transaction will receive instructions that will result in a homogeneous outcome. That is they will be issued instructions to all confirm or all cancel. (Transitively, a set of operations whose effect is capable of counter effect.) |
| **Become prepared** | Ensure that of a set of procedures is capable of being successfully instructed to cancel or to confirm. |
| **BTP Actor** | A software entity, or agent, that is able to take part in Business Transaction Protocol exchanges i.e. that sends or receives BTP messages. A BTP Actor may be capable of only playing a single role, or of playing several different roles concurrently and / or sequentially. A BTP Actor may be involved in one, or more, transactions, concurrently and / or sequentially. |
| **BTP element** | A BTP actor that supports an application element (or elements) but is not itself concerned with application messages or semantics. |
| **(Business) Application Protocol** | The messages, their meanings and their permitted sequences used to effect a change in the state of a business relationship. |
| **(Business) application system** | A system that contains one, or more, business applications, and resources such as volatile and persistent storage for business state information. It may also contain other things such as an operating system and BTP elements. |
| **Business relationship agreement** | The contract and / or set of agreements that govern and constrain a business relationship between two, or more, parties. |
| **Business relationship** | A *business relationship* is any distributed state held by the parties, which is subject to contractual constraints agreed by those parties. |
| **Business Transaction Protocol (BTP)** | The messages, their meanings and their permitted sequences defined in this specification. Its purpose is to provide the interactions (or signalling) required to coordinate the effects of application protocol to achieve a business transaction. |

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| **BTP-Address** | A compound address consisting of three parts. The first part, the “binding name”, identifies the binding to a particular carrier protocol – some bindings are specified in this document, others can be specified elsewhere. The second part of the address, the “binding address”, is meaningful to the carrier protocol itself, which will use it for the communication (i.e. it will permit a message to be delivered to a receiver). The third part, “additional information”, is not used or understood by the carrier protocol. The “additional information” may be a structured value. |
| **Business transaction** | A set of state changes that occur, or are desired, in computer systems controlled by some set of parties, and these changes are related in some application defined manner. A *business transaction* is subject to, and a part of, a *business relationship*. (BTP assumes that the parties involved in a *business transaction* have distinct and autonomous application systems, which do not require knowledge of each others’ implementation or internal state representations in volatile or persistent storage. Access to such loosely coupled systems is assumed to occur only through service interfaces.) |
| **Cancel** | Process a counter effect for the current effect of a set of procedures. There are a number of different ways that this may be achieved in practice. |
| **Carrier Protocol** | A protocol, which defines how the transmission of BTP messages occur. |
| **Carrier Protocol Address (CPA)** | The address of an endpoint for a particular carrier protocol. |
| **Client** | An actor, which sends application messages to services. |
| **Cohesion** | A set of participants, which are the direct inferiors of a node that may receive instructions that may result in different outcomes for each participant. That is they will be issued instructions to confirm or cancel according to the application logic. Participants may resign or be instructed to cancel until the confirm set is fixed. Once the confirm set for a cohesion is fixed, then all participants in the confirm set are treated atomically. That is they will all be instructed to confirm unless one, or more, cancel in which case all will be instructed to cancel. All participants not in the confirm set will be instructed to cancel. |

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| **Cohesive Business Transaction** | A complete business transaction for which at least one node over space and time follows the cohesion rules.  The other nodes in the transaction tree of a cohesive business transaction may follow either the cohesion rules or the atom rules. |
| **Confirm** | Ensure that the effect of a set of procedures is completed.  There are a number of different ways that this may be achieved in practice. |
| **Context** | Information pertinent to a single transaction, or branch of a transaction. |
| **Contract** | Any rule, agreement or promise which constrains an actor's behaviour and is known to any other actor, and upon which any other knowing actor may rely. |
| **Control relationship** | The application element:BTP element relationships that create the nodes of the transaction tree (Initiator:Factory) and drive the completion (Terminator:Decider). |
| **Coordinator** | A BTP actor, which is the top 'node' of a transaction and decides the outcome of its immediate branches according to the atom rules defined in this specification.  It has a lifetime, which is coincident with that of the atom.  A coordinator can issue instructions to prepare, cancel and confirm.  These instructions take the form of BTP messages.  A coordinator is identified by its transaction-identifier.  A coordinator must also have a BTP Address to which participants can send BTP messages. |
| **Counter effect** | An appropriate effect intended to counteract a prior effect. |
| **Counter effect contract** | The contract, which governs the relationship between the effect and the counter effect of a procedure.  In the absence of any other overriding contracts the counter effect contract is the promise that the **Counter effect** will attempt so far as is possible to reverse or cancel the **Effect** such that an observer (on completion of the **Counter effect**) is unaware that the **Effect** ever occurred, but this attempt cannot be guaranteed to succeed. |

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| **Decider** | The top node of a transaction tree, a composer or a coordinator (so called because the Terminator can only request confirmation – the Decider makes the final determination). The term can always be interpreted as “Composer or Coordinator”.<br>It is the role at the other end of a control relationship to a Terminator. |
| **Delivery parameter** | A parameter of an abstract message that is concerned with the transmission of the message to its target or the transmission of an immediate reply.. Distinguished from Payload parameter. |
| **Effect** | The changes induced by the incomplete or complete processing of a set of procedures by an actor, which are observable by another contemporary or future actor, and which are made in conformance with a contract known to any such observer. This contract must state the counter effect of the effect, and this is known as a counter effect contract. An effect is **Completed** when the change inducing processing of the set of procedures is finished. |
| **Endpoint** | A sender or receiver. |
| **Enroller** | The BTP Actor role that informs a superior of the existence of an inferior. |
| **Factory** | The BTP Actor role that creates transaction contexts and deciders. |
| **Inappropriate** | In violation of a pertinent contract or specification. |
| **Ineffectual** | Describes a set of procedures, which has no effect. |
| **Inferior** | The end of end of a BTP node to BTP node relationship governed by the outcome protocol that is topologically further from the top of the transaction tree. |
| **Inferior-Address** | The address used to communicate with an actor playing the role of an Inferior. |
| **Inferior-identifier** | A globally unambiguous identification of a particular Inferior within a single transaction (represented as an URI or equivalent). |
| **Initiator** | The BTP Actor role (an application element) that starts a transaction. |

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| **Intermediate** | A node that is a sub-composer or a sub-coordinator. An alternative term to interposed. |
| **Interposed** | A node that is a sub-composer or a sub-coordinator. An alternative term to intermediate. |
| **Message** | A datum, which is produced and then consumed. |
| **Node** | A logical entity that is associated with a single transaction. A node is a composer, a coordinator, a sub-coordinator, a sub-composer, or a participant. |
| **Operation** | A procedure, which is started by a receiver when a message arrives at it. |
| **Outcome** | A decision to either cancel or confirm. |
| **Outcome relationship** | The Superior:Inferior relationship (i.e. between BTP actors within the transaction tree) and the Enroller:Superior relationship used in establishing it. |
| **Participant** | A participant is part of an application system that also contains one, or more, applications, which manipulate resources. It is a role of a BTP Actor that is (or is equivalent to) a set of procedures, which is capable of receiving instructions from another BTP Actor to prepare, cancel and confirm. These signals are used by the application(s) to determine whether to effect (confirm) or counter effect (cancel) the results of application operations. A participant must also have a BTP Address, to which these instructions will be delivered, in the form of BTP messages. A participant is identified by an inferior-identifier. |
| **Payload parameter** | A parameter of an abstract message that is will be received and processed or retained by the receiving BTP actor. The various identifier parameters are considered Payload parameters . Distinguished from Delivery parameter. |
| **Peer** | The other party in a two-party relationship, as in Superior to Inferior, or Sender to Receiver. |
| **Provisional Effect** | The changes induced by the incomplete or complete processing of a set of procedures by an actor, which are subject to later completion or counter-effecting. The provisional effect may or may not be observable by other actors. |
| **Receiver** | The consumer of a message. |

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| **Relationship parties** | The legal entities that enter into an agreement that forms the basis of the relationship. |
| **Responders-identifier** | An identifier carried in a BTP message that can be interpreted as transaction-identifier, a superior-identifier, or an inferior-identifier according to the nature of the role in a BTP actor that is responding to a received message. |
| **Role** | The participation of a software agent in a particular relationship in a particular business transaction. The software agent performing a role is termed an **Actor**. |
| **Sender** | The producer of a message. |
| **Service** | An actor (an application element), which on receipt of application messages, may start an appropriate application operation. For example, a process that advertises an interface allowing defined RPCs (remote procedure calls) to be invoked by a remote client. |
| **Status requestor** | The BTP Actor role that requests the status of another BTP actor. |
| **Sub-composer** | An actor, which is not the top 'node' of a transaction. It receives an outcome from its superior and decides the outcome of its immediate branches according to the cohesive rules defined in this specification. It has a lifetime, which is coincident with that of the cohesion. A sub-composer can issue instructions to prepare, cancel and confirm on individual branches. These instructions take the form of BTP messages. A sub-composer must also have at least one BTP Address to which lower nodes can send BTP messages. |
| **Sub-coordinator** | An actor, which is not the top 'node' of a transaction. It receives an outcome from its superior and propagates the outcome to its immediate branches according to the atom rules defined in this specification. It has a lifetime, which is coincident with that of this atom. A sub-coordinator can issue instructions to prepare, cancel and confirm. These instructions take the form of BTP messages. A sub-coordinator must also have at least one BTP Address to which lower nodes can send BTP messages. |

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|---|---|
| **Superior** | The BTP role that will accept enrolments of Inferiors and subsequently inform the Inferior of the Outcome applicable to it.<br>A Superior will be one of Composer, Coordinator, Sub-composer, or Sub-coordinator.<br>A Superior is considered to be a Superior even if it currently has no enrolled Inferiors. |
| **Superior-address** | The set of BTP-addresses used to communicate with an actor playing the role of a Superior. |
| **Superior-identifier** | A globally unambiguous identifier of a particular Superior within a particular transaction (represented as an URI or equivalent). |
| **Target-identifier** | An identifier carried in a BTP message that can be interpreted as transaction-identifier, a superior-identifier, or an inferior identifier according to the nature of the role in a BTP actor that receives this identifier. |
| **Terminator** | A BTP role performed by an Application element communicating with a Decider to control the completion of the Business Transaction. Frequently will be identical to the Initiator, but distinguished because the control of the Business Transaction can be passed between Application elements. |
| **Transaction** | A complete unit of work as defined by an application. A transaction starts when a part of the distributed transaction first initiates some work that is to be a part of a new transaction. The transaction tree may grow and shrink over time and (logical) space. A transaction completes when all the participants in a transaction have completed (that is have replied to their confirm or cancel instruction). |
| **Transaction tree** | A pattern of BTP nodes that provides the coordination of a distributed application transaction. There is single top node (a Decider) that interacts with the initiating application (which is a part of a distributed application). The Decider node has one, or more outcome relationships with other BTP nodes (sub-composer, sub-coordinator, or participant nodes). Any intermediate nodes (Sub-composer or Sub-coordinator nodes) have exactly one relationship up the tree in which they act as Inferior, and one, or more, relationships down the tree in which they act as Superior. Participants are leaves of the tree. That is they have exactly one relationship up the tree in which they act as Inferior and no down tree relationships. |

| | |
|---|---|
| **Transaction-identifier** | A globally unambiguous identifier for a particular a Decider(represented as an URI or equivalent). A Decider is the top ‘node’ of the transaction and thus this identifier also unambiguously identifies the transaction. Often identical to the Superior-identifier of the Decider in its role as Superior, though the protocol does not require this. |
| **Transmission** | The passage of a message from a sender to a receiver. |

# Part 4. Annexes

## Informational annex A Node State Information Serialisation

This Annex provides a simple, but standardised format for the serialised essential state information of a node. It does not specify the events that would cause serialisation to take place, nor does it specify how this serialisation format is extracted from a node and transferred elsewhere. The format is specified in abstract form and as an XML Schema.

## NODE STATE INFORMATION

### Abstract Format for Node State Information

The node state information represents the BTP state information for a single BTP node in some transaction tree. It contains information for a single transaction that was extant at the node at the time the serialisation was performed.

| Parameter | Sub-Parameter | Type |
|---|---|---|
| date and time | | Date and Time |
| Role | | composer/coordinator/sub-composer/sub-coordinator/participant |
| own information | transaction type | cohesion/atom |
| | own-identifier | Identifier |
| | own-address | Set of BTP addresses |
| information as inferior | transaction type | cohesion/atom |
| | inferior-state-identification | State identifier |
| | superior's identifier | Identifier |
| | superior's address | Set of BTP addresses |
| | Qualifiers | List of qualifiers |
| Set of information as superior | superior-state-identification | State identifier |
| | inferior's identifier | Identifier |
| | inferior's address | Set of BTP addresses |
| | Qualifiers | List of qualifiers |

**date and time** the date and time that this node state information was generated to an agreed resolution and accuracy. The presence of this information is optional.

**role** the type of the node. Its value is one of composer / coordinator / sub-composer / sub-coordinator / participant.

**own information** identification information for this node. This information is required. It consists of the following information:

- **transaction type** the type of this part of the transaction propagated to inferiors. Its value is one of cohesion or atom.
- **own identifier** identifies this node. This may be the superior identifier from the CONTEXT for the node and/or the inferior identifier on the ENROL for the node. This shall be globally unambiguous.
- **own address** the address at which this node may be accessible. This can be a set of alternative addresses.

**information as inferior** information relevant to the node's role as an inferior. Should be present, once only, if the node is a sub-composer or a sub-coordinator or a participant, otherwise absent. It includes information about the superior of this node and consists of the following information:

- **transaction type** the type of this part of the transaction that applies to the node acting as an inferior as indicated in the CONTEXT for the node. Its value is one of cohesion or atom.
- **inferior-state-identification** identifies the state of the inferior state machine at this node. This is represented as a small letter followed by a number, which designates the inferior state. Refer to the section on 'State Tables' and in particular Tables 6 and 11 - 14.
- **superior's identifier** identifies the Superior of this node. This shall be globally unambiguous.
- **superior's address** the address to which ENROL and other messages from this enrolled Inferior were sent. This can be a set of alternative addresses.
- **qualifiers** list of the qualifiers and their values in force for this node as an inferior.

**set of information as superior** information relevant to the node's role as superior. Should be present, if the node is a composer, coordinator, sub-composer, or a sub-coordinator, and shall be absent if the node is a participant. It may be present multiple times, once for each inferior that this node has a relationship with. It includes information about an inferior of this node and consists of the following information:

- **superior-state-identification** identifies the state of the superior state machine for this particular inferior. This is represented as a capital letter followed by a number, which designates the superior state. Refer to the section on 'State Tables' and in particular Tables 7 and 7 - 10.
- **inferior's identifier** identifies an Inferior of this node. This shall be globally unambiguous.
- **inferior's address** the address to which PREPARE, CONFIRM, CANCEL and SUPERIOR_STATE messages for this Inferior have been or are to be sent. This can be a set of alternative addresses.

**qualifiers** list of the qualifiers and their values in force for this node as superior to this inferior.

### Informal XML for Node State Information

```
<btpst:node-information>

  <btpst:date-time>2002-05-31T13:20:00.000-05:00</btpst:date-time>?

  <btpst:role>composer|coordinator|sub-composer|sub-
coordinator|participant</btpst:role>?

 <btpst:own-information>
  <btpst:trx-type>cohesion|atom</btpst:trx-type>
  <btpst:own-identifier>...URI...</btpst:own-identifier>
  <btpst:own-address> +
    <btp:binding-name>...carrier binding name...</btp:binding-name>
    <btp:binding-address>...carrier specific address...</btp:binding-
address>
    <btp:additional-information>...optional additional addressing
information...</btp:additional-information> ?
  </btpst:own-address>
 </btpst:own-information>

 <btpst:information-as-inferior> ?
  <btpst:trx-type>cohesion|atom</btpst:trx-type>
  <btpst:I_state>.. statename from inferior state table e.g.
d1..</btpst:I_state>
  <btpst:superiors-identifier>...URI...</btpst:superiors-identifier>
  <btpst:superiors-address> +
    <btp:binding-name>...carrier binding name...</btp:binding-name>
    <btp:binding-address>...carrier specific address...</btp:binding-
address>
    <btp:additional-information>...optional additional addressing
information...</btp:additional-information> ?
  </btpst:superiors-address>
  <btp:qualifiers> ...qualifiers...  </btp:qualifiers> ?
 </btpst:information-as-inferior>

 <btpst:information-as-superior> +
  <btpst:S_state>.. statename from superior state table e.g.
D1..</btpst:S_state>
  <btpst:inferiors-identifier>...URI...</btpst:inferiors-identifier>
  <btpst:inferiors-address> +
    <btp:binding-name>...carrier binding name...</btp:binding-name>
    <btp:binding-address>...carrier specific address...</btp:binding-
address>
    <btp:additional-information>...optional additional addressing
information...</btp:additional-information> ?
  </btpst:inferiors-address>
  <btp:qualifiers> ...qualifiers... </btp:qualifiers> ?
 </btpst:information-as-superior>

</btpst:node-information>
```

## XML schema for Node State Information

```
<?xml version="1.0" encoding="UTF-8"?>
<schema
    xmlns="http://www.w3.org/2001/XMLSchema"
    targetNamespace="urn:oasis:names:tc:BTP:1.0:node_state_information"
    xmlns:btst="urn:oasis:names:tc:BTP:1.0:node_state_information"
    xmlns:btpq="urn:oasis:names:tc:BTP:1.0:qualifiers"
    xmlns:btp="urn:oasis:names:tc:BTP:1.0:core"
    elementFormDefault="qualified">

<import namespace="urn:oasis:names:tc:BTP:1.0:qualifiers"/>
<import namespace="urn:oasis:names:tc:BTP:1.0:core"/>


<!--  Main node – information element definition  -->

<element name="node-information">
  <complexType>
   <sequence>

 <element name="date-time" type="dateTime" minOccurs="0"/>

 <element name="role" minOccurs="0">
  <simpleType>
   <restriction base="string">
    <enumeration value="composer"/>
    <enumeration value="coordinator"/>
    <enumeration value="sub-Composer"/>
    <enumeration value="sub-Coordinator"/>
    <enumeration value="participant"/>
   </restriction>
  </simpleType>
 </element>

<element name="own-information">
  <complexType>
   <sequence>
    <element ref="btst:trx-type"/>
    <element name="own-identifier" type="btp:identifier"/>
    <element name="own-address" type="btp:address" minOccurs="1"
maxOccurs="unbounded"/>
   </sequence>
  </complexType>
 </element>

 <element name="information-as-inferior" minOccurs="0">
  <complexType>
   <sequence>
    <element ref="btst:trx-type"/>
    <element name="I_state">
     <simpleType>
      <restriction base="string">
       <pattern value="[a-z][0-9]"/>
      </restriction>
      </simpleType>
    </element>
    <element name="superiors-identifier" type="btp:identifier"/>
    <element name="superiors-address" type="btp:address" minOccurs="1"
maxOccurs="unbounded"/>
    <element ref="btp:qualifiers" minOccurs="0"/>
   </sequence>
  </complexType>
 </element>

 <element name="information-as-superior" minOccurs="0"
maxOccurs="unbounded">
  <complexType>
   <sequence>
    <element name="S_state">
     <simpleType>
      <restriction base="string">
       <pattern value="[A-Z][0-9]"/>
      </restriction>
     </simpleType>
    </element>
    <element name="inferiors-identifier" type="btp:identifier"/>
    <element name="inferiors-address" type="btp:address" minOccurs="1"
maxOccurs="unbounded"/>
    <element ref="btp:qualifiers" minOccurs="0"/>
   </sequence>
  </complexType>
 </element>

  </sequence>
 </complexType>
</element>

<!--  Common elements and datatypes  -->

    <element name="trx-type">
     <simpleType>
      <restriction base="string">
       <enumeration value="atom"/>
       <enumeration value="cohesion"/>
      </restriction>
     </simpleType>
    </element>

</schema>
```