3 Service Ecosystem View

The *Service Ecosystem View* focuses on what a SOA-based system means for people to participate in it to conduct their business.[10] Business, in general, is characterized in terms of providing and consuming services to realize mutually desirable real world effects. In a SOA-based system, the conduct of business involves the effective connectivity of IT-accessible resources as an important element in how these real world effects are realized.

The people and organizations involved in a SOA-based ecosystem form a community; which may be a single enterprise or a large peer-to-peer network of enterprises and individuals. Many of the activities that people engage in are themselves defined by the relationships between people and by the organizations to which they belong.

However, the primary motivation for participants to interact with each other is to achieve goals – to get things done. While SOA implies the use of IT resources and artifacts, these are merely tools to an end and are usually not the primary interest of the participants. Describing what it means to *act* in the SOA ecosystem when participants may be in different organizations, with different rules and expectations is one of the primary modeling objectives of this section.

Since there is inherently some *mediation* involved when people interact using electronic means, we lay the foundations for how *communication* can be used to represent *action*. This foundation forms the backdrop for how services are realized – covered in Section 4 – as well as how SOA-based systems are managed as owned entities – covered in Section 5.

Thus, our tasks in this view are to model the people involved—the participants and other stakeholders—their goals and activities and the relevant relationships between people as they affect the utility and safety of actions that are performed.

The models in this view form the basis for many of the activities of SOA participants, especially in areas such as management and security. They lay a groundwork for those

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[10] By *business* we mean to include any activity entered into whose goal is to satisfy some need or desire of the participant.

624 areas and will be referenced in the other views to provide a consistent discussion
625 throughout this document.

626 In particular, the Acting in a SOA Ecosystem Model introduces the key concepts
627 involved in actions, the Social Structure Model introduces the key elements that underlie
628 the relationships between participants. The Acting in a Social Context model pulls the
629 two together and shows how ownership, risk and transactions are key concepts in the
630 SOA ecosystem.
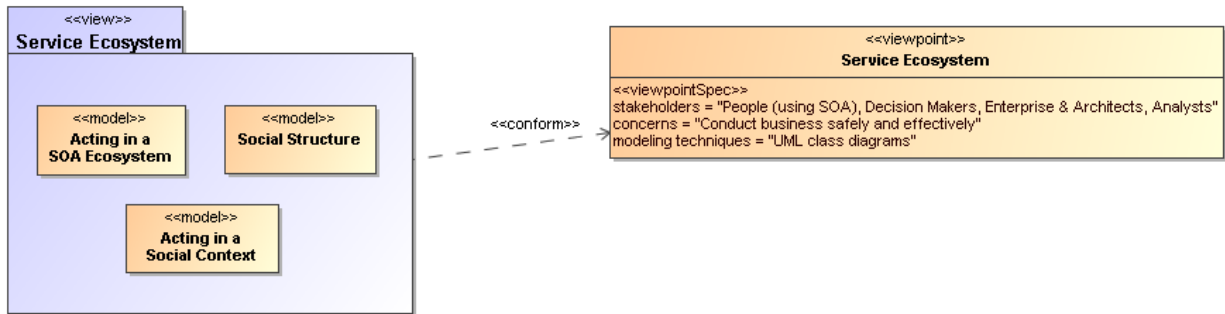
631

632 *Figure 3 Model elements described in the Service Ecosystem view*

3.1 Social Structure Model

634 The actions undertaken by participants, whether mediated by services or in some other
635 way, are performed in a context that defines the meaning of the actions themselves.
636 That context is fundamentally a *social context* – a context that includes other
637 participants. We can formalize that context as a **social structure**: the embodiment of a
638 particular social context.

639 The social structure model is important to defining and understanding the implications of
640 crossing ownership boundaries; it is the foundation for an understanding of security in
641 SOA and also provides the context for determining how SOA-based systems can be
642 effectively managed and governed.
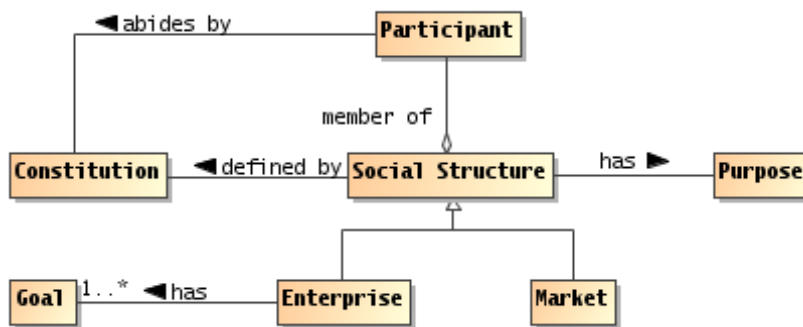
643

644 *Figure 4 Social Structure*

Social Structure

646 A **social structure**[11] embodies some of the cultural aspects that characterize the
647 relationships and **actions** among a group of **participants**.

648 A **social structure** may have any number of participants, and a given participant can be
649 a member of multiple social structures. Thus, there is frequent interaction among social
650 structures, sometimes resulting in disagreements when the goals of the social
651 structures do not align.

652 In the Reference Architecture, we are concerned primarily with **social structures** that
653 reflect the anticipated participants in SOA-based systems; these are often embodied in
654 legal and quasi-legal frameworks; i.e., they have some rules that are commonly
655 understood. For example, an **enterprise** is a common kind of **social structure**, as is an
656 online chat room. At the other extreme, the legal frameworks of entire countries and
657 regions also count as social structures.

658 It is not necessarily the case that the social structures involved in a service interaction
659 are explicitly identified. For example, when a customer buys a book over the Internet,
660 the social structure that defines the validity of the transaction is often the legal
661 framework of the region associated with the book vendor. This legal jurisdiction
662 qualification is typically buried in the fine print of the service description.

Purpose

664 A measurable condition ascribed to a thing or action relating it to a goal.

665 By their nature, purposes are *external* to the purposed entities, whereas goals are
666 *internal* to the entity.

667 A **social structure** has a *purpose* – the reason for which it exists. All **social structures**
668 have a purpose, some **social structures** also have **goals**.

Constitution

670 A **constitution** is an agreement shared by a group of **participants** that defines a
671 **social structure**.

672 Every **social structure** defines the rules by which **participants** interact with each other
673 within the structure. In most cases, the **constitution** is not explicitly written down, or is
674 only partially written down; However it is expressed, the **constitution** is that agreement
675 that identifies the **social structure** itself.

676 A **social structure's** rules are *abided to* by the **participants**. In some cases, this is
677 based on an explicit agreement, in other cases participants behave as though they
678 agree to the constitution without a formal agreement. In other cases, participants abide
679 by the rules with some degree of reluctance – this is an issue raised later on when we
680 discuss governance in SOA-based systems.

681 The SOA ecosystem is marked by two primary forms of **social structure** – the **market**
682 social structure which is primarily oriented to the interrelationship between participants

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[11] Social structures are sometimes referred to as social institutions.

683 within the ecosystem and the **enterprise** which represents a kind of *composite*
684 **participant** – an entity that has sufficient internal cohesiveness that allows us to
685 consider it as a potential **stakeholder** in its own right.

686 **Enterprise**

687   An **enterprise** is an organization with identifiable officers and with internally
688   established **goals** that reflect the purpose of the organization.

689 The **enterprise** is marked out as being associated with internal **goals** in a way that a
690 strict market type of social structure is not.   shows a simplified model of enterprises as
691 they relate to social structures.
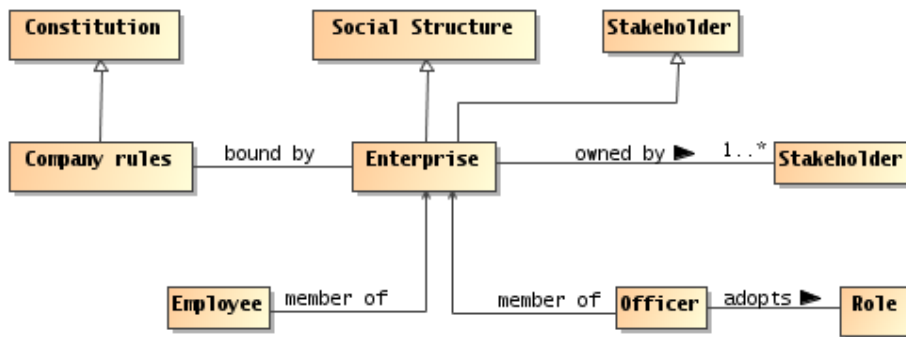
692

693 *Figure 5 Enterprise as a Social Structure*

694 **Market**

695   A **market** social structure is the locus of interaction between participants who are
696   peers of one another.

697 If an **enterprise** is often the focus of the differing **roles** and **responsibilities** of
698 members, a **market** or meeting place is more concerned with the exchange of goods
699 and services for mutual benefit.

700 It is entirely possible for a given interaction between participants to take place within a
701 social structure that is an **enterprise** as well as being a **market** place. However,
702 interactions within a **market** place are inherently across **ownership boundaries**.

703 ## 3.1.1 Actors, Delegates and Participants
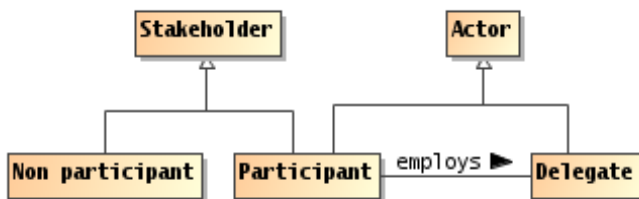
704

705 *Figure 6 Actors, Participants and Delegates*

706 **Actor**

707   An **actor** is an entity, human, non-human or organization of entities, that is
708   capable of **action**.

709 The concept of actor encompasses many kinds of entities, human and corporate
710 participants, even semi-autonomous computational agents. Two important kinds of actor
711 are **participants** and **delegates**.

712 **Stakeholder**

713 A **stakeholder** in the SOA ecosystem is an individual entity, human or non-
714 human, or organization of entities that has an interest in the state of the
715 ecosystem.

716 **Participant**

717 A **participant** is a **stakeholder** that is an **actor** in a SOA ecosystem.

718 A participant is a stakeholder whose interests lie in the successful use of and fulfillment
719 of services. However, human participants always require *representation* in an electronic
720 system – they require mechanisms to facilitate their interactions: they require delegates.

721 Note that we admit non-human agents that have no identifiable representative as an
722 extreme case: the normal situation is where participants are either human or
723 organizations.

724 **Non-Participant Stakeholder**

725 A **non-participant stakeholder** is any **stakeholder** who is not an **actor** in the
726 ecosystem.

727 Stakeholders do not necessarily participate in service interactions. For example, a
728 government may have an interest in the outcomes of commercial services deployed in a
729 SOA ecosystem for the purposes of collecting tax from one or more of the participants.
730 A government may also be interested in regulatory compliance as it affects service
731 interactions.

732 There are two main classes of such non-participatory stakeholders: third parties who
733 are affected by someone's use or provisioning of a service, and regulatory agencies
734 who wish to control the outcome of service interactions in some way (such as by
735 taxation). An example of an affected third party may be someone using the service
736 infrastructure whose activities are impeded because an errant participant is consuming
737 excessive bandwidth in another interaction.

738 **Delegate**

739 A **delegate** is an **actor** that is acting on behalf of a participant.

740 In order for people to be able to offer, consume and otherwise participate in SOA
741 service interactions, they require the use of an entity capable of directly interacting with
742 electronic communications – we use the term **delegate** to identify that entity. Common
743 examples are software applications that make use of services, hardware devices that
744 embody a particular mission, and enterprise systems that offer services.

745 We do not attempt to characterize **delegate**s in terms of their internal architecture,
746 computational requirements or platforms here.

747 There are many kinds of entities that may function in a SOA ecosystem. For example,
748 there may be software agents that permit people to offer and interact with services;
749 there may be **delegate**s that represent the interests of other stakeholders – such as
750 security agents charged with managing the security of the ecosystem.

751 In the different models in this architecture we use the **actor** concept when it is not
752 important whether the entity involved is a delegate, participant or some other entity. If
753 the entity is acting on behalf of another, then we use the **delegate** concept. If the entity
754 is a stakeholder in the ecosystem then we use **participant**.

3.1.1.1 Service Providers and Consumers

756 Section 1.1.1 defines the distinction between participants and nonparticipants. In a
757 SOA social structure, several types of participants play prominent roles.
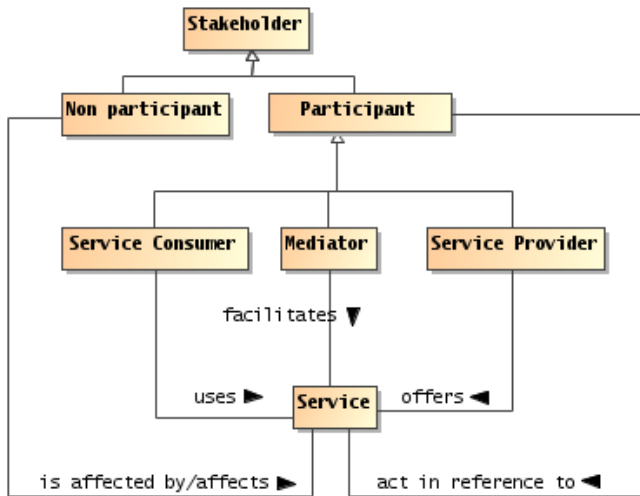
758

759 *Figure 7 Service Participants*

Service Provider

761   A service provider is a participant that offers a service that enables some
762   capability to be used by other participants.

763 Note that several kinds of stakeholders may be involved in provisioning a service.
764 These include but are not limited to the provider of the capability, an enabler that
765 exposes it as a service, a mediator that translates and/or manages the relationship
766 between service consumers and the service, a host that offers support for the service, a
767 government that permits the service and/or collects taxes based on service interactions.

Service Consumer

769   A **service consumer** is a **participant** that interacts with a service in order to
770   realize the real world effect produced by a capability to address a consumer
771   need.

772 It is a common understanding that service consumers typically initiate service
773 interactions. Again, this is not necessarily true in all situations (for example, in publish-
774 and-subscribe scenarios, a service consumer may initiate an initial subscription, but
775 thereafter, the interactions are initiated by publishers). As with service providers, several
776 stakeholders may be involved in a service interaction supporting the consumer.

777 Service providers and service consumers do not represent truly symmetric roles: each
778 participant has different objectives and often has different capabilities. However, the
779 objectives and the conditions under which those objectives align are critical for a
780 successful interaction to proceed.

Service Mediator

A service mediator is a participant that facilitates the offering or use of services in some way.

There are many kinds of mediator, for example a registry is a kind of mediator that permits providers and consumers to find each other. Another example might be a filter service that enhances another service by encrypting and decrypting messages. Yet another example of a mediator is a proxy broker that actively stands for one or other party in an interaction.

3.1.2 Roles in Social Structures

One of the primary benefits of formalizing the relationships between people in terms of groups, corporations, legal entities and so on, is that it allows greater efficiencies in the operation of society. However, corporations, governments and even society, are abstractions: a government is not a person that can perform actions – only people or automated processes following the instructions of people can actually do things.

For example, a fishing club is an abstraction that is important to its members. A club, however, is an abstraction that has no physical ability to act in the world. On the other hand, a person who is appropriately empowered by the fishing club can act. For example, when that person writes a check and mails it to the telephone company, that action counts as though the fishing club has paid its bills.
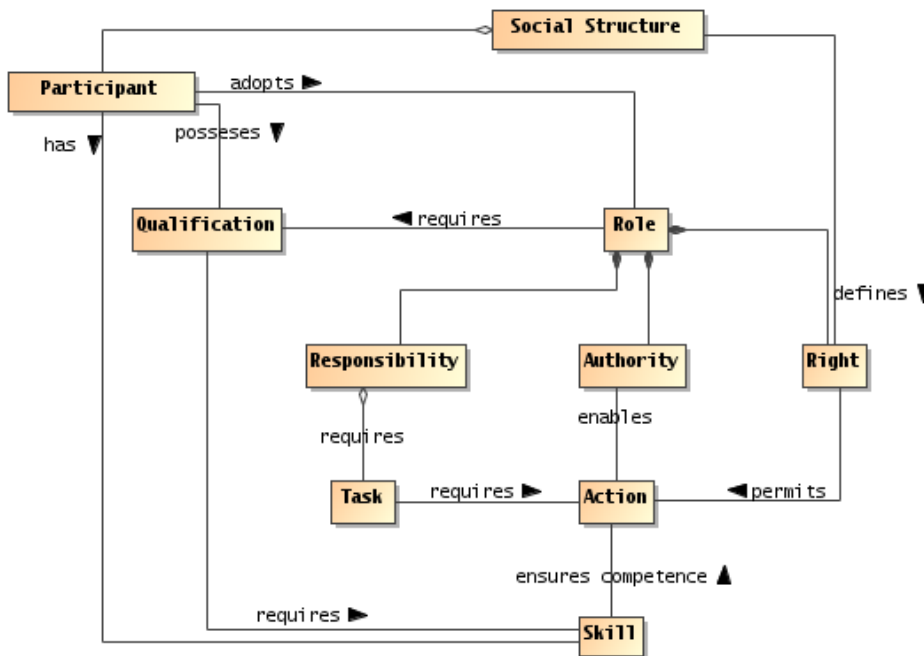
Figure 8 Roles, Rights and Responsibilities

Participants' actions within a social structure are often defined by the roles that they adopt.

Role

> A role is an identified relationship between a **participant** and a **social structure** that defines the **rights**, **responsibilities**, qualifications, and authorities of that participant within the context of the **social structure**.

For many scenarios, the roles of participants are easily identified: for example, a buyer uses the service offered by the seller to achieve a purchase. However, in particular in situations involving delegation, the role of a participant may be considerably more complex.

A participant can be identified with one or more **roles**. Someone in authority in the social structure may have formally designated the participant as assuming the role with associated rights and responsibilities. Qualification and skill describe the expectations of the social structure in who should fill the role, but formal certifications of those qualifications and skills may or may not be required of the designated participant.

Conversely, someone who exhibits qualification and skill may by consensus assume the role without any formal designation. Someone with some degree of qualification and skill may become identified with a role because they perform the associated tasks.

Note that, while many roles are clearly identified, with appropriate names and definitions of the responsibilities, it is also entirely possible to separately bestow rights, responsibilities and so on; usually in a temporary fashion. For example, when a CEO delegates the responsibility of ensuring that the company accounts are correct to the CTO, this does not imply that the CTO is adopting the full role of CFO.

In order for a person to act on behalf of some other person or on behalf of some legal entity, it is required that they have the power to do so and the authority to do so.

Right

> A **right** is a predetermined permission that permits an **actor** to perform some action or adopt a stance in relation to the **social structure** and other **actors**.

For example, in most circumstances, sellers have a right to refuse service to potential customers; but may only do so based on certain criteria.

Authority

> **Authority** is the **right** to act as agent on behalf of an organization or another person.

Usually, **authority** is constrained in terms of the kinds of actions that are authorized, and in terms of the necessary skills and qualifications of the persons invoking the authority.

An entity may authorize or be assigned another entity to act as its agent. Often the actions that are so authorized are restricted in some sense. In the case of human organizations, the only way that they can act is via an agent.

Rights, authorities, responsibilities and roles form the foundation for the security architecture of the Reference Architecture. Rights and responsibilities have similar structure to permissive and obligation policies; except that the focus is from the perspective of the constrained participant rather than the constrained actions.

Responsibility

846   A **responsibility** is an obligation on a **role** player to perform some **action** or to
847   adopt a stance in relation to other role players.

848 **Skill**

849   A **skill** is a competence or capability to achieve some real world effect.

850 Skills are typically associated with **roles** in terms of requirements: a given role
851 description may require that the role player has a certain skill.

852 **Qualification**

853   A **qualification** is a public determination by an issuing authority that an **actor**
854   has achieved some state.

855 The issuing authority may require some successful actions on the part of the **actor**
856 (such as demonstrating some skills). The qualification may have constraints attached to
857 it; for example, the certification may be time limited.

858 There is a distinction between a **skill** – which is capability that a participant may have to
859 act – and a publicly accepted right to act. For example, someone may have the skills to
860 fly an airplane but not have a pilot's license. Conversely, someone may have a pilot
861 license, but because of some temporary cause be incapable of flying a plane (they may
862 be ill for example).

863 Qualifications are often used as constraints on roles: any entity adopting a role within an
864 organization (or other social structure) must have certain qualifications.

3.1.3 Shared State and Social Facts

866 Many of the actions performed by people and most of the important aspects of a
867 person's state are inherently social in nature. The social context of an action is what
868 gives it much of its meaning. We call actions in society social actions and, those facts
869 that are understood in a society, social facts. It is often the case that social actions give
870 rise to social facts.

871 Compared to facts about the natural world, **social facts** are inherently abstract: they
872 only have meaning in the context of a social structure.

873
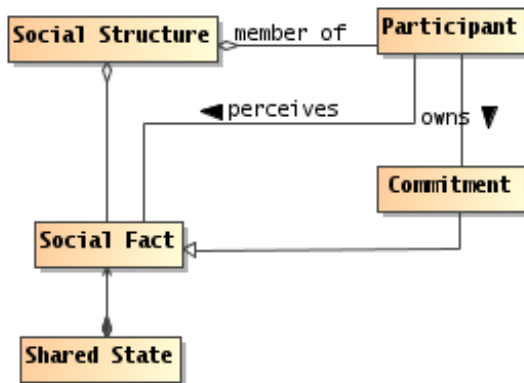
Social Fact

> A **social fact** is an element of the state of a social structure that is defined by that social structure.

Social structures provide a context in which social facts are given their meaning. For example, the existence of a valid purchase order with a particular customer has a meaning that is defined primarily by the company itself, together with the society that the company is part of.

Social facts typically require some kind of ritual to establish the validity of the fact itself. For example, the existence of an agreed contract typically requires both parties to sign papers and to exchange those papers. If the signatures are not performed correctly, or if the parties are not properly empowered to perform the ritual, then it is as though nothing happened.

In the case of agreements reached by electronic means, this involves the exchange of electronic messages; often with special tokens being exchanged in place of a hand-written signature.

State

> State is the condition that an entity is in at a particular time.

State is characterized by a set of facts that is true of the entity – in effect we are concerned only with aspects of an entity that are potentially measurable.

Private State

> Private state is the set of facts that is known and understood by a participant.

Shared State

> The set of facts that are knowable by participants as a result of their communicative actions.

Note that shared state *does not* imply the state *is* known to all participants. It simply refers to the elements of state that *may* be known.

Note that any **participant** has only a partial view of the world. Furthermore, the **participant** will have internal **private state** that is not accessible to other participants directly. However, elements of the shared state are in principle accessible to participants even if a given participant does not have access to all elements at any given time.

Public Semantics

> The **public semantics** of a **communicative action** is the set of facts that any observer of the action would be sanctioned to infer by virtue of the observer's situation in a **social structure**.

Of course, the most obvious observer of a communication is the intended recipient of the communication. However, the key is that the **public semantics** of a communication would enable *any* observer to make the same inferences.

For example, a standard purchase order denotes a commitment to buy some goods or services. Any observer of the purchase order would be entitled to interpret it as a purchase order (whether or not the purchase order was targeted at the observer).

916 **Public semantics** is often couched in terms of the **shared state** of the various
917 members of the social structure – a purchase order is interpreted relative to the **social**
918 **structure** within which it is made.

919 **Commitment**

920 A **commitment** is a **social fact** about the future: in the future some fact will be
921 true and a participant has the current responsibility of ensuring that that fact will
922 indeed be true.

923 A **commitment** to deliver some good or service is a classic example of a fact about the
924 future.

925 Other important classes of social facts include the policies adopted by an organization,
926 any agreements that it is holding for participants, and the assignment of participants to
927 roles within the organization.

928 Facts have the property of being verifiable (technically, a social fact can be verified to
929 determine if it is satisfied in the social context). If, as a result of interacting with a
930 service, a buyer incurs the obligation of paying for some good or service, this obligation
931 (and the discharge of it) is measurable (perhaps by further interactions with the same or
932 other services).

3.1.4 Social Actions

934 In the context of SOA ecosystems, actions are often social in nature — one participant
935 is asking another to do something that is directly related to the organization(s) that they
936 are part of — and goal oriented — the purpose of interacting with a service is to satisfy
937 a need by attempting to ensure that a remote entity applies its capabilities to the need.
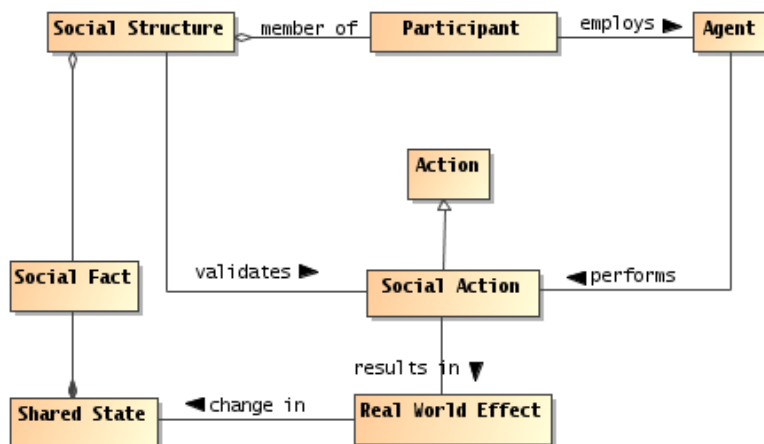
939 *Figure 10 Acting within Social Structures*

940 **Social Action**

941 Social actions are actions that are performed in order to achieve some result
942 within a social structure.

943 A social action is an action that is defined primarily by the effect it has on the
944 relationship between participants and state of a social structure by establishing one or
945 more new social facts.

946 Social actions are always contextualized by a social structure: the organization gives
947 meaning to the action, and often defines the requirements for an action to be
948 recognized as having an effect within the organization.

3.1.4.1 Proposition

950 When a participant wishes to share knowledge of a social fact or commitment, it may
951 take the form of one or more Propositions.

952 **Proposition**

953   A proposition is an expression, normally in a language that has a well-defined
954   written form, that expresses some property of the world from the perspective of a
955   stakeholder.

956 In principle, the truth of a proposition must be verifiable – using a decision procedure –
957 by examining the world and checking that the proposition and the world are consistent
958 with each other.[12]
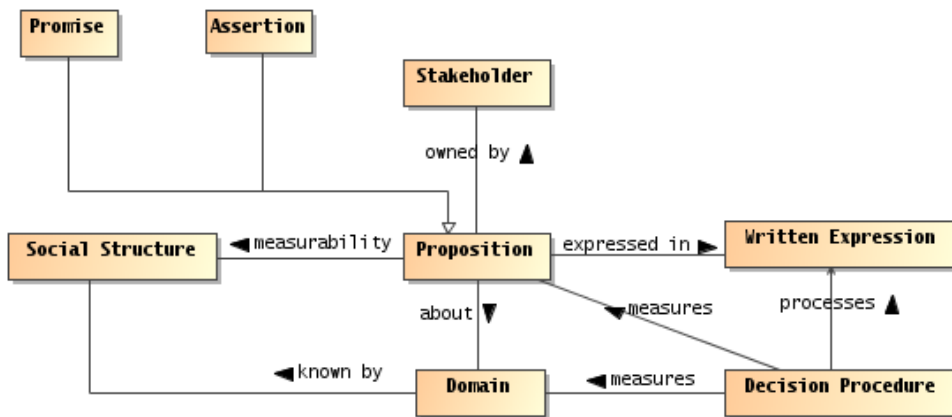
959

960 *Figure 11 Propositions*

961 **Decision Procedure**

962   A decision procedure is a process for determining whether an expression is true,
963   or is satisfied, in the world.

964 Decision procedures are algorithms, programs that can measure the world against a
965 formula, expression or description and answer the question whether the world
966 corresponds to the description. If the truth of a proposition is indeterminable, then a
967 decision procedure does not exist, and the logic is undecidable.

968 **Domain**

969   A domain is a 'world' that is used as the basis for the truth of a proposition.

970 When we say 'world', we are not restricted to the physical world. The criterion is an
971 ability to discover facts about it. In our case governmental, commercial and social

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[12] We exclude here the special case of proposition known as a tautology. Tautologies are important in the study of logic; the kinds of propositions that we are primarily interested in are those which pertain to the world; and as such are only *contingently* true.

972 structures that form the backdrop for SOA-based systems are important examples of
973 modeled worlds.

Written Expression

975 The written expression of a proposition is a formula written in a systematic
976 system of marks that denotes the proposition.

977 Note that not all `systems of marks' have a decision procedure. However, for the uses
978 to which we put the concept of proposition: policies, service descriptions, and so on, we
979 require that the language used to write policy and other propositions have a decision
980 procedure.

981 Propositions, as used in reference to needs, policies and contracts can be further
982 analyzed in terms of facts that are about the world as it is, will be, or should be. The
983 latter are particularly of concern in policies and contracts and other propositions
984 concerning the relationships between people.
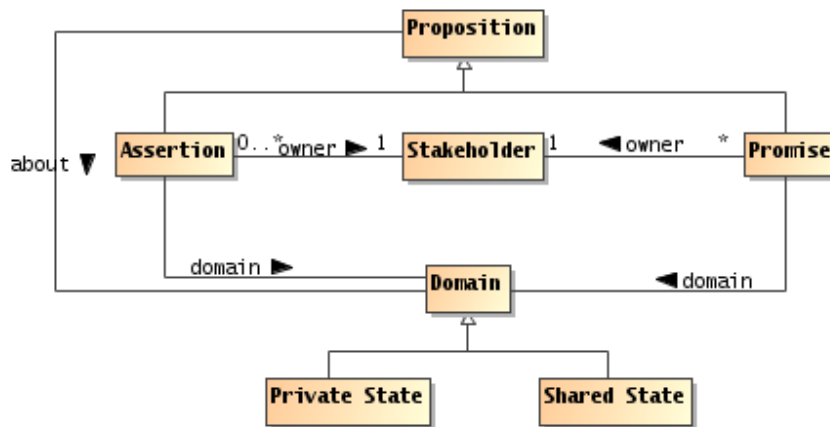
985
986 *Figure 12 Assertions and Promises*

Assertion

988 An assertion is a proposition that is held to be true by a stakeholder. It is
989 essentially a claim about the state of the world.

Promise

991 A promise is a proposition regarding the future state of the world by a
992 stakeholder. In particular, it represents a commitment by the stakeholder to
993 ensure the truth of the proposition.

994 For example, an airline may report its record in on-time departures for its various flights.
995 This is a claim made by the airline which is, in principle, verifiable. The same airline may
996 promise that some percentage of its flights depart within 5 minutes of their scheduled
997 departure. The truth of this promise depends on the effectiveness of the airline in
998 meeting its commitments.

999 Another way of contrasting assertions and promises is to see what happens when the
1000 propositions fail: a stakeholder that makes a false assertion about the world might be
1001 classified as a liar; a stakeholder that makes a false promise is said to break its
1002 promises.

1003 ### 3.1.5 Ownership

1004 A fundamental aspect of a resource is that it is owned by a stakeholder. Ownership is
1005 also important in understanding the various kinds of obligations participants may enter
1006 into. Fundamentally, we view ownership as a relationship between a stakeholder and a
1007 resource, where the owner has certain rights over the resource.

1008 **Ownership**

1009   Ownership is a set of rights and responsibilities that a stakeholder has in relation
1010   to a resource; including the right to transfer that ownership to another entity.
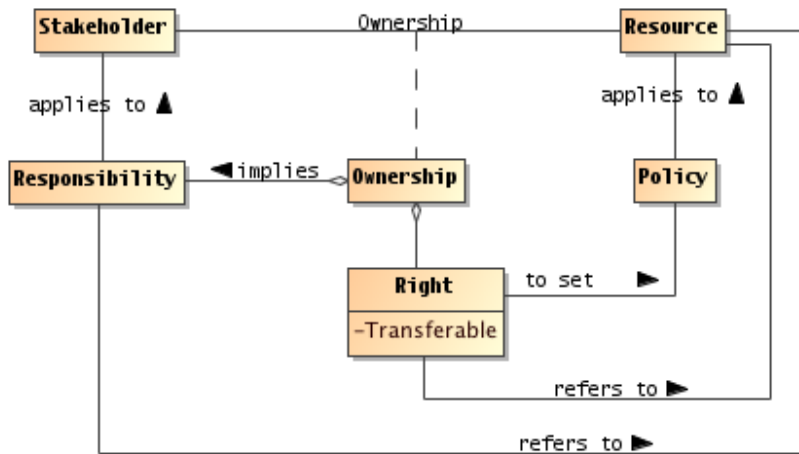
1011
1012 *Figure 13 Resource Ownership*

1013 To own a resource implies taking responsibility for creating, maintaining, and if it is to be
1014 available to others, provisioning the resource. More than one stakeholder may own
1015 different rights, such as one stakeholder having the right to deploy a capability as a
1016 service, another owning the rights to the profits that result from using the capability, and
1017 yet another owning the rights to use the service.

1018 One who owns a resource may delegate rights and responsibilities to others, but
1019 typically retains some responsibility to see that the delegated responsibilities are met.
1020 There may also be joint ownership of a resource, where the responsibility is shared.

1021 A crucial property that distinguishes ownership from a more limited right to use is the
1022 right to transfer ownership to another person or organization. When a resource is being
1023 used without being owned, there is an implied requirement that at the end of a period of
1024 time the rights and responsibilities relating to the resource will be returned to the original
1025 owner of the resource.

1026 Ownership is defined in relation to the social structure relative to which rights and
1027 responsibilities are exercised. In particular, there may be constraints on how ownership
1028 may be transferred. For example, a government may not permit a corporation to transfer
1029 assets to a subsidiary in a different jurisdiction.

1030 **Ownership Boundary**

1031   An **ownership boundary** is the **social structure** within which the **rights** and
1032   **responsibilities** associated with a particular ownership may be recognized.

1033 Individual participants are *within* an ownership boundary in relation to a specific owned
1034 **resource** if they are members of the **social structure** that owns the **resource**.

3.1.5.1 Resources

1036 In the SOA-RM and this Reference Architecture, we discuss service, underlying
1037 capabilities, and numerous other entities that are part of the SOA ecosystem. We
1038 categorize these as Resources, and define **Resource** as follows:
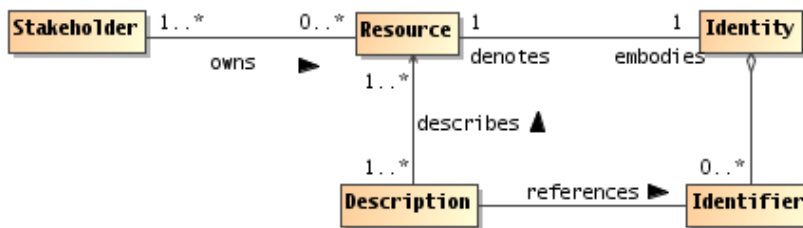
1039

1040 *Figure 14 Resources*

1041 **Resource**

1042   A resource is any entity of some perceived value that has identity.

1043 A resource may have more than one identifier, but any well-formed identifier should
1044 unambiguously resolve to the intended resource.

1045 An important class of resource is the class of capabilities that underlie services. Other
1046 examples of resources are services themselves, descriptions of entities (a kind of meta-
1047 resource), IT infrastructure elements used to deliver services, contracts and policies,
1048 and so on.

1049 **Identity**

1050   Identity is the collection of individual characteristics by which an entity, human or
1051   nonhuman, is recognized or known.

1052 The ability to unambiguously identify a resource in a SOA interaction is critical to
1053 determine such things as authorizations, to understand what functions are being
1054 performed and what the results mean, and to ensure repeatability or characterize
1055 differences with future SOA interactions.

1056 **Identifier**

1057   An identifier is any block of data – such as a string – that unambiguously
1058   connects a resource with a particular identity.

1059 Identifiers typically require a context in order to establish the connection between the
1060 identifier and the resource. A given resource may have multiple identifiers, with different
1061 utility for different contexts.

1062 In a SOA eco-system, it is good practice to use globally unique identifiers; for example
1063 globally unique IRIs. An identifier must uniquely disambiguate the indicated resource
1064 from other resources but more than one identifier may uniquely resolve to the same
1065 resource.

Description

> A description is a structure that may be interpreted as containing assertions about a resource.

This model of resource is a simplification and an elaboration of the concept that underlies the Web Architecture **[WA]**. Being more abstract, we do not require that the identity of a resource be in any particular form (although in practice, many resource identifiers are URIs), nor do we require resources to have representations. However, we do require resources to have owners.

3.1.6 Life-cycle of Social Structures

Life Cycle

> A **social structure** has a **life cycle** associated with it.

3.2 Acting in a SOA Ecosystem Model

At the core of participants' interest in a SOA ecosystem is the concept of **action** – participants act in order to achieve their **goal**s. Critically, participants' actions may involve systems that do *not belong to them*; this necessitates interaction and communication between participants and joint activities.

For example, if a consumer wishes to fly somewhere, she must interact with the airline reservation system in order to purchase a ticket which represents a contract that the airline will take her to the agreed destination at a particular date and time.

When the consumer purchases a ticket, the action is to purchase the ticket but the means of doing so involves an interaction with the airline. However, both the interaction itself and the purchase are actions that must be understood at different levels – at the level of the IT systems through which messages are communicated and at the level of the reservation service through which the effects of the purchase are recorded and as an agreement that the airline will help the consumer achieve her goal of traveling to her destination.

There are many parallels between the way that human society is organized, and the way that humans can act using the power of others. There are also parallels in satisfying business needs and satisfying the mechanistic needs of the systems and processes that enable the bringing together of needs and capabilities to satisfy our goals

In this section we establish the key principles of **action** as an abstract concept. We elaborate on **action** in the context of acting in a social context as **joint action**. And we also establish the connections necessary between the different levels of understanding of action that allow participants to interact as a means of getting things done.

A key aspect is that both parties must exhibit willingness to act and a mutual understanding of the information exchanged and the expected results.

3.2.1 Action and Joint Action

Entities act in order to achieve their **goal**s. In this model, we look at the most basic form of action – an action performed by a single actor. Figure 15 depicts a model of action showing the relationships between action, goals and effects of action.

3.2.1.1 Action and Actors

Within this initial model of action, we focus on the actions of individual entities. However, we should remark that for the most part within a SOA ecosystem, the actions we are most interested in are actions involving multiple participants – we address this further in Section 3.2.1.2.
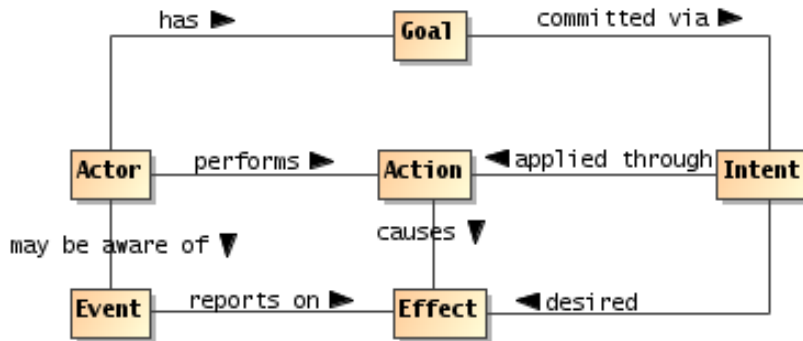
Figure 15 Actions, Real World Effect and Events

The most important concept in any model of actions and effects is that of **action** itself:

Action

> An **action** is the application of **intent** to achieve an **effect** (within the SOA ecosystem).

This concept is simultaneously one of the fulcrums of the Service Oriented Architecture and a touch point for many other aspects of the architecture: such as policies, service descriptions, management, security and so on.

The aspect of **action** that distinguishes it from mere force or accident is that someone or something intended the **action** to occur.

Goal

> A **goal** is a measurable state of the ecosystem that an actor is seeking to establish.

Goals are conditions that people, and more generally actors, are seeking to satisfy. A key aspect of goals is measurability: it should be possible to know if a goal has been satisfied.

Intent

> **Intent** is the commitment of an **actor** to achieve a **goal**.

An actor's **intent** in performing an **action** is to further one or more of the actor's **goals**.

1132 In some situations it may be difficult to determine an **actor**'s actual **intent**. This is
1133 particularly true for social actions such as those performed within a SOA-based system.

1134 However, in most cases, entities in a SOA ecosystem make an assumption of *implied*
1135 *intent*. I.e., if an **actor** performs an **action**, it is assumed that the **actor** also intended to
1136 perform the **action** – it was not an accident, or the action of another actor.

1137 Much of the infrastructure of interaction is there to eliminate the potential for accidental
1138 or malicious actions.

1139 **Effect**

1140   An **effect** is a measurable change in the state of the ecosystem.

1141 Note the normal **intent** of applying an **action** is to cause an **effect** that reflects the
1142 actor's goals. However, there is often the possibility that the actual effects will include
1143 unintended consequences that fall outside of, and may run counter to, the intent of the
1144 actor.

1145 Changes in the ecosystem may be *reported* by means of **events**:

1146 **Event**

1147   An **event** is the report of an **effect** of which at least one participant has an
1148   interest in being aware.

1149 In effect (sic), an **event** is a corollary to **action**: in a public arena, actions result in
1150 changes to the state of ecosystem (primarily changes to the states of individual
1151 **participant**s); these changes may be manifested as **events** of which participants in the
1152 arena have an awareness.

1153 Note that, while performing an **action** may be an **event** that other participants have an
1154 interest in, an **event** that reports an **action** is not the same as the **action** itself.

1155 **3.2.1.2 Joint Actions**

1156 Joint actions are the foundation for understanding interaction between participants in a
1157 SOA ecosystem. In this Reference Architecture, we see joint actions at two levels: as
1158 communication and as participants using and offering services.
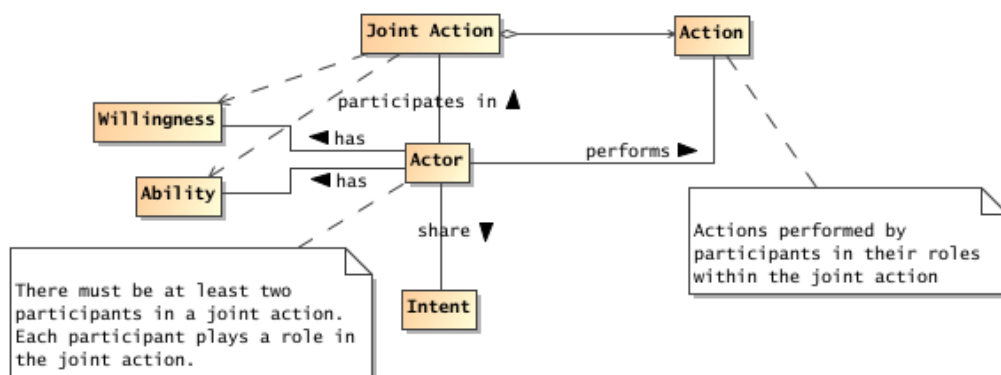
1159

1160 *Figure 16 Joint Action*

1161 **Joint Action**

1162   A **joint action** is a coordinated set of **actions** involving the efforts of two or more
1163   **actors** to achieve an **effect**.

1164 In order for multiple actors to participate in a **joint action**, they must each act according
1165 to their role within the **joint action**. For example, a common example of a **joint action**
1166 is for one **actor** to speak to another.[14] A communication between **actors** cannot take
1167 place unless there is both a speaker and a listener – although it is not necessarily
1168 required that they both be active simultaneously. The two **actors** involved have different
1169 roles – one is a speaker and the other is a listener.

1170 By definition, **joint actions** are **actions** that cannot be performed by single
1171 **participants**. Sometimes this is because no single participant has the ability to perform
1172 the action on his own; or, in the case of the speaker and listener, the 'joint-ness' of joint
1173 actions is inherent.

1174 In any social context **joint actions** abound: people talking to each other, people buying
1175 and selling, people arranging their lives. In addition, joint action is at the heart of
1176 interactions within the context of a SOA ecosystem.

1177 There is another sense in which **joint actions** abound: even within a single incident of
1178 interaction there are typically several overlapping **joint actions**.

1179 For example, when one person says to another: "it is stuffy in here" there is an
1180 immediate sense in which there is a **joint action** – a joint communicative action (see
1181 below). The intended effect being that the listener believes that the speaker intends him
1182 to understand that the speaker believes that the atmosphere is uncomfortable. (The
1183 listener may also believe that the atmosphere *is* uncomfortable as a result of the
1184 communication.)

1185 However, in the right context, there may be another joint action: the apparent
1186 declaration may in fact be a command. The intent being that the speaker wishes the
1187 listener to understand that the door should be opened, the effect being that of actually
1188 opening the door.

1189 There may be a further layer to this scenario: the speaker might be aware that there is
1190 someone who is waiting to be let in. The command to open the door is actually a
1191 command to admit the visitor to the room.

1192 Fundamentally all three of these senses of joint action are superimposed on top of each
1193 other. However, there is a strong sense in which the different joint actions may be quite
1194 interchangeable. For example, instead of declaring that the "room is stuffy", the speaker
1195 might have simply said "open the door". Or the speaker might have said "please let
1196 John in". In each case the effect would have been the same – modulo the sensitivities of
1197 the speaker and listener – the door being open and the visitor admitted to the room.

1198 The relationship between the communicative joint action: the utterance of the
1199 declaration and the command joint action is a `uses' relationship. The speaking joint
1200 action is used to convey the command joint action; which in turn is used to convey the
1201 visitor admittance action.

1202 In many situations the best predicate that describes the relationship between these
1203 different joint actions is the 'counts as' predicate. The utterance action counts as the

---

[14] Where speaking and listening includes electronic message sending and receiving.

1204 command to open the door. The command to open the door counts as the request to
1205 admit the visitor.

1206 It can be extremely useful to identify and separate the different overlapping senses of
1207 joint action. It allows us to separately describe and process the communicative actions
1208 from the command joint actions. This, in turn, reflects the fact that each layer has its
1209 own logic and ontology.

1210 For example, at the utterance level, the issues are to do with the successful
1211 understanding of the content of the communication – did the listener hear and
1212 understand the words, did the speaker intend to say them, and so on.

1213 At the level of the command to open the door, the issues center on whether there is a
1214 predisposition on the part of the listener to obey commands given to him by the
1215 speaker.

1216 In the context of a SOA ecosystem we can separately capture the logic and mechanics
1217 of what is involved in electronic communication – the sending of messages, the security
1218 of the communication and so on; from the logic and mechanics of command -- does the
1219 listener believe that the speaker has the appropriate authority to issue the command.

1220 As with human communication, electronic interactions are similarly interchangeable: the
1221 commitment to purchase a book requires some form of communication between buyer
1222 and seller; but the purchase action itself is unchanged by the use of email or an HTTP
1223 post of an XML document.

1224 In summary, the concept of joint action allows us to honor the fact that both parties in an
1225 interaction are required for there to be an actual effect; it allows us to separate out the
1226 different levels of the interaction into appropriate semantic layers; and it allows us to
1227 recombine those layers in potentially different ways whilst still achieving the intended
1228 real world effects of action in a SOA ecosystem.

1229 3.2.2 Real World Effects

1230 **Actor**s participating in a SOA ecosystem are often attempting to get other **actor**s to *do*
1231 something. For example, a customer trying to buy a book has to convince the book
1232 selling **service** to deliver the book. Conversely the book selling service has to convince
1233 the customer to pay for it. The one of the primary functions of the SOA ecosystem is
1234 that of a medium in which participants' **needs** and **capabilities** may be brought
1235 together.

1236 3.2.2.1 Needs and Capabilities

1237 The Reference Model defines SOA in terms of a bringing together of needs and
1238 capabilities – the primary *motivation* for actors to engage with each other. A provider
1239 has a capability of generating a set of real world effects and making that capability
1240 available contributes to the satisfaction of some set of provider needs. The consumer
1241 has a need for those real world effects and has the capability of providing monetary or
1242 other return (for example, acknowledgement of effort) to the provider.
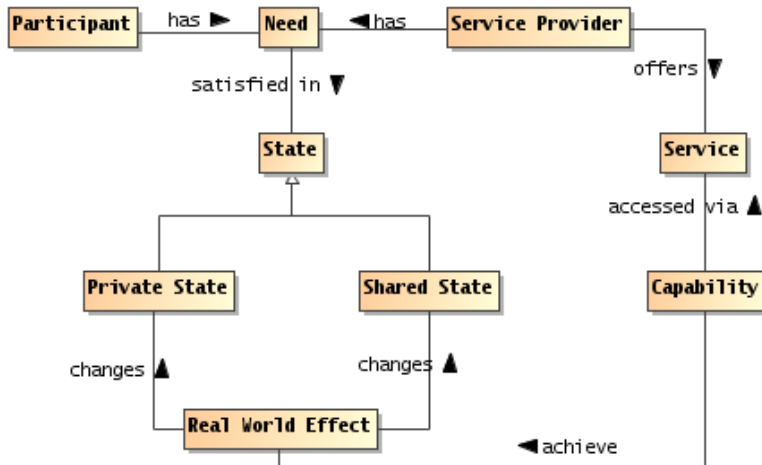
1243

Figure 17 Needs and Capabilities

1244

Need

1245

1246 A need is a measurable requirement that a service participant is actively seeking
1247 to satisfy.

1248 A need may or may not be publicly measurable; the needs that this Reference
1249 Architecture finds in scope are those that are publicly measurable. However, the
1250 satisfaction of a participant's need can only be determined by that participant.

1251 The extent to which a need is captured in a formal way is likely to be very different in
1252 each situation.

Capability

1253

1254 A capability is an ability to achieve a real world effect.

1255 The model in Section 1.1.1 shows that there is often some indirection between needs
1256 and having them satisfied. Both needs and the effects of using capabilities are
1257 expressed in terms of state: a need is expressed as a condition on the desired state and
1258 the Real World Effect of using capabilities is a change in the state of the world.

1259 By making a capability available for use, the owners aim to address their needs as well
1260 as the needs of other participants who use the service. The extent to which a capability
1261 is exposed via a service (or via multiple services) is controlled by the owner of the
1262 capability but may also be limited by the service provider. As noted in the Reference
1263 Model, a given service is not required to provide access to all aspects of an underlying
1264 capability.

3.2.2.2 Satisfying Needs

1265

1266 When an actor agrees to a course of **action** as a result of its interactions with other
1267 **actor**s it is **adopting** an **objective**.

Objective

1268

1269 An **objective** is a **real world effect** that an **actor** wishes to achieve.

1270 **Objectives** refer to **Real World Effects** that **actor**s may actively consider achieving.

1271 In general, there is a *subsumption* relationship between **actor**s' **goal**s and their
1272 **objective**s: an **objective** can be considered to be *consistent* with one of more **goal**s.
1273 Generally, a **goal** is a long term state of the world that may be, in practice, difficult to
1274 measure. On the other hand, an **objective** is a directly measurable and preferably
1275 predictable outcome of a particular **action** or set of **actions**.

Objective Adoption

1277   An **actor** may adopt an **objective** as a result of interacting with another **actor**.

1278 A consequence of an **actor** adopting an **objective** on behalf of another **actor** is that the
1279 actor becomes **accountable** to the latter for the successful satisfaction of the **objective**.

Accountability

1281   An **actor** is **accountable** to another **actor** when the former consents to achieve
1282   an identified **objective**.

1283 An **objective** adopted by one **actor** as a result of an interaction need not be consistent
1284 with the **objective**s of the originating **actor**. In many situations, the adopted **objective**
1285 is not all the same and may even be contrary to the desires of the original **actor**.

1286 It is possible to characterize an **actor**'s **accountability** in terms of obligation **policies**
1287 that are in force in relation to that **actor**.

3.2.3 Trust, Risk and Willingness

1289 For interactions to be possible within the SOA ecosystem, each actor must have a
1290 sufficient degree of trust in other actors to form a basis for willingness to engage in the
1291 interactions.

Trust

1293   **Trust** is a private assessment or internal perception that some entity will perform
1294   actions that will lead to an identifiable set of real world effects**.**

1295 The reference to real world effects implies the existence of measurements or other
1296 observations of shared state that represent the real world effect.

Willingness

1298   **Willingness** is the internal commitment of an actor to carry out its part of an
1299   interaction.

1300 As discussed in the Reference Model, willingness on the part of actors to interact is not
1301 the same as a willingness to perform requested actions. A service provider that rejects
1302 all attempts to cause it to perform some action may still be fully willing and engaged in
1303 interacting with the consumer.

Trusting Actor

1305   A **Trusting Actor** is an actor who establishes and maintains willingness to
1306   proceed with an interaction based on its trust of other actors.

1307 Typically, it is not important to know the specific actions undertaken by any given actor
1308 because these may be private. Additionally, it is not important to share or even to know

1309 the goals of the individual actors as long as the Trusting Actor believes that individual
1310 actions by others will be sufficient to result in expected real world effects. For example,
1311 the Trusting Actor may have a desired real world effect of an important message being
1312 delivered and is willing to pay for this business service; those delivering the message
1313 have no interest in the importance of the message but want to do what is necessary to
1314 ensure payment. Successful completion of the interaction will result in both (and
1315 possibly other) real world effects to be realized.

1316 **Trusted Actor**

1317 A **Trusted Actor** is an actor with which a Trusting Actor has sufficient trust for
1318 that Trusting Actor to be willing to proceed with an interaction.

1319 The relationship of Willingness to the Trusting and Trusted Actors is shown in Figure 18.
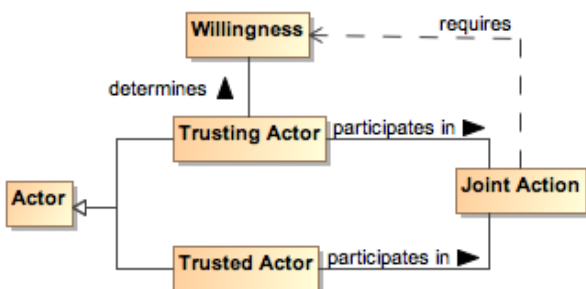
1320
1321 *Figure 18 Trusting Actor and Willingness*

1322 **Risk**

1323 **Risk** is a private assessment or internal perception that certain undesirable real
1324 world effects may come into being.

1325 The Actor perceiving risk may take actions to mitigate the risk. For example, the actor
1326 may assess a high degree of risk to clicking on an email link where the actor believes
1327 the email to be spam, and the actor forgoes any possible benefit by not clicking on the
1328 link. Alternately, the actor may see a risk in having a hard drive fail and mitigate the
1329 effect of losing files by backing up those files considered important.

1330 **3.2.3.1 Assessing Trust and Risk**

1331 The assessments of trust and risk are based on evidence available to the Trusting
1332 Actor.

1333 **Evidence**

1334 **Evidence** is the accumulation of real world effects by which a Trusting Actor can
1335 assess trust and risk.

1336 The evidence may be physical artifacts or a set of information from which the Trusting
1337 Actor can assess the degree of trust. The evidence may include a history of previous
1338 interaction between the Trusting and Trusted Actors or previous interactions of the
1339 Trusted Actor with other actors for which the real world effects of their interactions are
1340 public. Such an accumulation of real world effects forms the basis of the Trusted
1341 Actor's reputation.

Reputation

Reputation is the social assessment of an actor with respect to an expectation of behavior or skill, where the assessment is made on the basis of evidence.
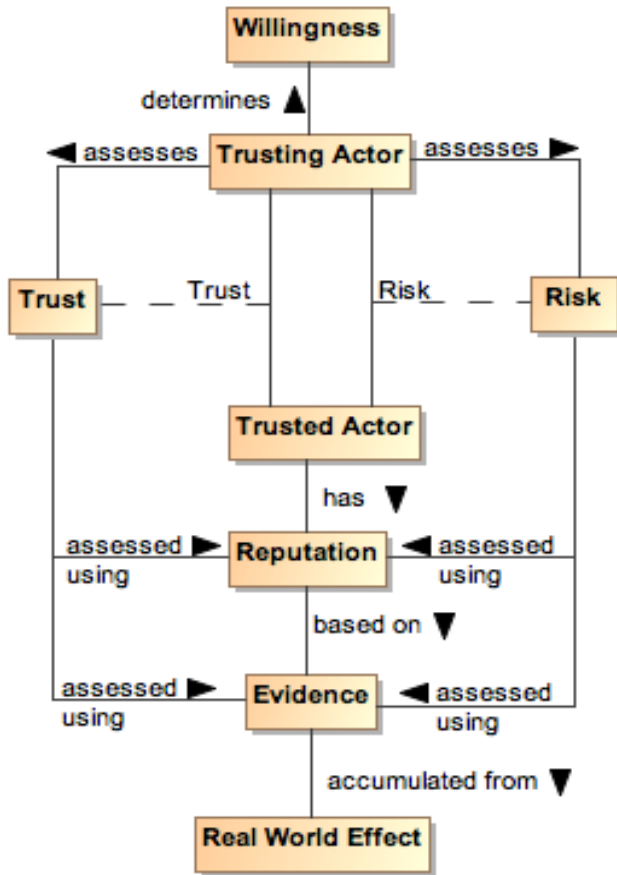
Figure 19 Assessing Trust and Risk

Trust is based on the confidence the Trusting Actor has in the accuracy and sufficiency of the gathered evidence and the degree to which any assessment is appropriate for the situation for which trust is being assessed. Trust is not binary, i.e. an Actor is not completely trusted or untrusted, because there is typically some degree of uncertainty in the accuracy or completeness of the evidence or the assessment. Similarly, there is uncertainty in the amount and consequences of potential risk.

The balance between perceived trust and perceived risk results in a willingness or unwillingness to proceed. If there is little or no perceived risk, then the degree of trust may not be relevant in assessing possible actions. For example, most people consider there to be an acceptable level of risk to privacy when using search engines, and submit queries without any sense of trust being considered.

As perceived risk increases, the issue of trust becomes more of a consideration. There are recognized risks in providing or accepting credit cards as payment, and standard procedures have been put in place to increase trust or, at a minimum, bringing trust and risk into balance by mitigating risk. For interactions with a high degree of risk, the Trusting Actor requires stronger or additional evidence when evaluating the balance between risk and trust when deciding whether to participate in an interaction.

3.2.3.2 Trust and SOA

1365 In traditional systems, the balance between trust and risk was achieved by severely
1366 restricting the interactions and those that could participate: the more trust and the higher
1367 the perceived risk, the more tightly coupled we made the corresponding system.

1368 Realizing many of the perceived benefits of SOA will require a fuller understanding of
1369 what trust and risk mean in the relevant business processes and what is an appropriate
1370 balance to be achieved. Actors need to assess trust and risk and act on those
1371 assessments while remaining part of the ecosystem and not just in a walled garden.

1372 **3.2.4 Transactions and Exchanges**

1373 An important class of **joint action** is the **business transaction**, or **contract exchange**.
1374 Many interactions between participants in the SOA ecosystem are based around
1375 business transactions.
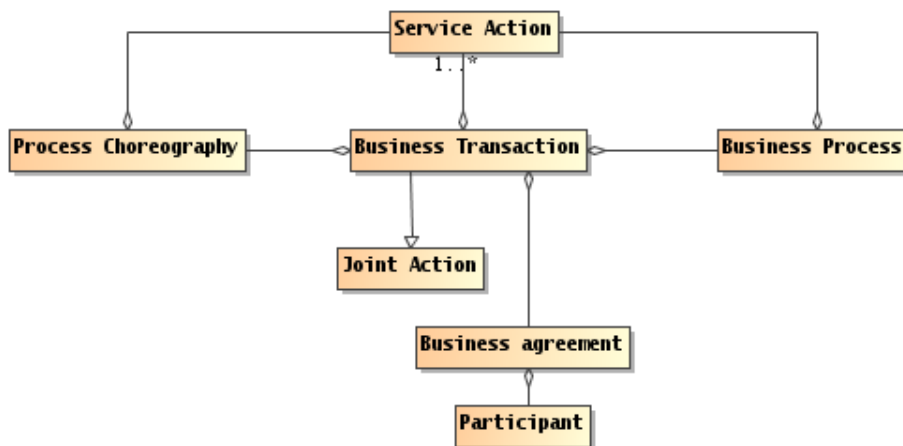
1376

1377 *Figure 20 Business Transaction*

1378 **Business Transaction**

1379   A **business transaction** is a **joint action** engaged in by two or more
1380   **participants** in which the **ownership** of one of more **resources** is exchanged.

1381 A classic business transaction is buying some good or service, but there is a huge
1382 variety of kinds of possible business transactions.

1383 Key to the concept of business transaction is the contract or agreement to exchange.
1384 The form of the contract can vary from a simple handshake to an elaborately drawn
1385 contract with lawyers giving advice from all sides.

1386 A completed transaction establishes a set of social facts relating to the exchange;
1387 typically to the changes of ownerships of the resources being exchanged.

1388 **Business Agreement**

1389   A **business agreement** is an agreement entered into by two or more partners
1390   that constrains their future behaviors and permitted states.

1391 A business agreement is typically associated with business transactions: the transaction
1392 is guided by the agreement and an agreement can be the result of a transaction.

1393 Business transactions often have a well defined life-cycle: a negotiation phase in which
1394 the terms of the transaction are discussed, an agreement action which establishes the
1395 commitment to the transaction, an action phase in which the agreed-upon items are
1396 exchanged (they may need to be manufactured before they can be exchanged), and a
1397 termination phase in which there may be long-term commitments by both parties but no
1398 particular actions required (e.g., if the exchanged goods are found to be defective, then
1399 there is likely a commitment to repair or replace them).

1400 From an architectural perspective, the business transaction often represents the top-
1401 most mode of interpretation of service interactions. When participants interact in a
1402 service, they exchange information and perform actions that have an effect in the world.
1403 These exchanges can be interpreted as realizing part of, and in support of, business
1404 transactions.

Business Process

1406   A **business process** is a description of the tasks, participants' roles and
1407   information needed to fulfill a business objective.

1408 Business processes are often used to describe the actions and interactions that form
1409 business transactions. This is most clear when the business process defines an activity
1410 involving parties external to the organization; however, even within an enterprise, a
1411 business process typically involves multiple participants and stakeholders.

1412 In the context of transactions mediated and supported by electronic means, business
1413 processes are often required to be defined well enough to permit automation. The forms
1414 of such definitions are often referred to as choreographies:

Process Choreography

1416   A process choreography is a description of the possible interactions that may
1417   take place between two or more participants to fulfill an objective.

1418 A choreography is, in effect, a description of what the forms of permitted joint actions
1419 are when trying to achieve a particular result. Joint actions are by nature formed out of
1420 the individual actions of the participants; a choreography can be used to describe those
1421 interlocking actions that make up the joint action itself.

3.2.5 Communication for Action

1423 Because there is inherently some separation between **actors** in a SOA ecosystem, they
1424 are effectively driven to use communication techniques to 'get their business done'.
1425 When an **actor** sends a message to another **actor** there are actually two (at least)
1426 senses in which the **actor** can be said to be acting: by communicating with other
1427 **actors**; and the purpose of the communication is also **action**.

1428 The primary mechanism whereby **actor**s interact with each other is through the
1429 *exchange of messages*, where the messages may cross ownership boundaries.
1430 Communication and the interpretation of communicated content is the foundation of all
1431 interaction within the SOA ecosystem.

1432 However content is actually communicated, communicating is also a form of **action**.
1433 We define the **communicative action** as the **action** of message exchange:
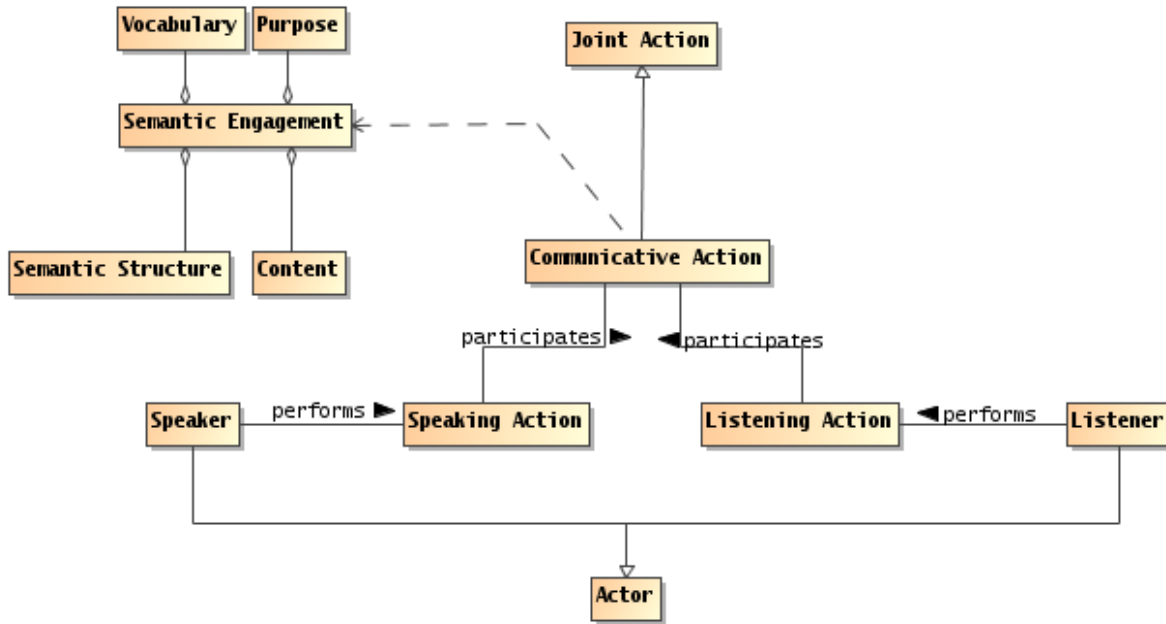
1434

Figure 21 Communication as Joint Action

Communicative Action

A **communicative action** is a **joint action** in which an **actor** communicates with one or more other **actors**.

A **communicative action** has a speaker and a listener; each of whom must perform their part for the communicative action to occur.

The concept of **communicative action** is important in the explanation of how we can use the exchange of messages to realize interaction between service participants. The Reference Model defines interaction as the activity that is involved in making use of a capability offered. A **communicative action** is the **joint action** involved in the exchange of messages.

Speaking Action

A **speaking action** is the **action** required of an **actor** in order to communicate a desired content.

Listening Action

A **listening action** is the **action** required of an **actor** in order to acquire and comprehend communicated content.

Notice that an **actor** listening to a message not only acquires the message but is also able to understand it. The implications of this are discussed further below.

Speaker & Listener

A **speaker** is an **actor** who performs the speaking action; A **listener** is an **actor** who performs the **listening action**.

Speaking and listening are roles that (normally) different actors play in a given communicative action.

1459 Typically, a **communicative action** involves one participant speaking and the other
1460 listening simultaneously; although there are many potential important variations, such
1461 as broadcast, writing and so on.

1462 A given **speaking action** may have any number of **listeners**. Indeed, in some
1463 situations, it may not be possible for the **speaker** to be aware of the **listener** in a
1464 communicative action; however, this does not change the fundamentals of
1465 communication: without both a **speaker** and a **listener** there is no communication.

1466 **Content**

1467   **Content** is the information passed from the **speaker** to the **listener** in a
1468   **communicative action**.

1469 Even though communication is effected through **action**, it is not actually effective if the
1470 **listener** cannot understand the content of the communication. We can characterize the
1471 necessary modes of understanding in terms of a shared *vocabulary* and a shared
1472 understanding of the communicated *intent*.

1473 The meaning of a communication is typically conveyed as a combination of the syntax
1474 of the content, its **semantics** and its **illocutionary force**.

1475 Typically, the syntax takes the form of highly regular tree structure, with a well-defined
1476 method for interpreting the structure. For example, an invoice will often follow pre-
1477 established standards for communicating invoices.

1478 **Semantics**

1479   The **semantics** of a **communicative action** is the meaning of the content being
1480   communicated.

1481 The semantics of a fragment of content can be characterized in terms of the
1482 **vocabulary** of terms referenced in the content and the relationships between those
1483 terms that are represented by the syntactic form of the content.

1484 **Vocabulary**

1485   A **vocabulary** is a set of terms together with an interpretation that is shared by
1486   **actor**s involved in a **communicative action**.

1487 In order for there to be any communication, there must be sufficient shared
1488 understanding of the elements of interaction and of terms used in communication. A
1489 shared vocabulary may range from a simple understanding of particular strings as
1490 commands to a sophisticated collection of terms that are formalized in shared
1491 ontologies.

1492 Note that, while it is often easier to visualize the semantics of communication in terms
1493 that reflect human experience, it is not required for interactions between service
1494 consumers and providers to particularly look like human speech. Machine-machine
1495 communication is typically highly stylized in form, it may have particular forms and it
1496 may involve particular terms not found in everyday human interaction.

1497 **Illocutionary Force**

1498   The **illocutionary force** of a **communicative act** is the proximate *purpose* of the
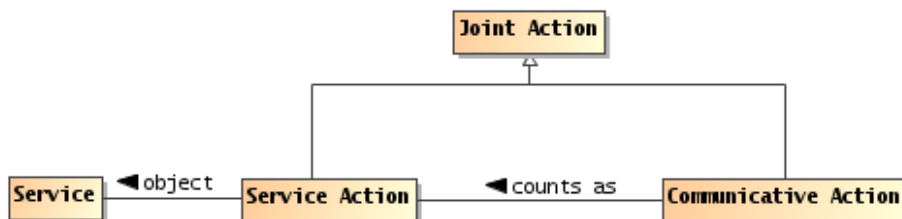1499   communication.

1500 For example, a **communicative action** may be a *request*, or it may *inform* the listener
1501 of some fact.

1502 Of course, the *ultimate purpose* for a communication may not be closely related to the
1503 proximate purpose. For example, a bank service may *inform* a customer that their
1504 account balance is too low; the ultimate purpose being to persuade the customer to
1505 augment the account.

1506 Taken together, the syntax, **semantics**, **vocabulary**, and the **illocutionary force** of
1507 communicated **content** is the basis of all interaction in the SOA ecosystem.

3.2.6 Using Communication for Service Action

1509 Like **communicative actions**, service actions, or actions involving a service, are
1510 inherently **joint actions** – there can be no **service action** without both the **service** and
1511 the **actor** originating the **action**. However, because there is a gap between the
1512 participant performing a service action and the service being acted upon, there must be
1513 a bridge across that gap; bridging this gap relies on the *count as* relationship.

1514
1515 *Figure 22 Communicative actions as Service Actions*

1516 **Service Action**

1517   A **service action** is an element of the action model of the service.

1518 **Service actions** are inherently **joint actions**; they require both the entity performing the
1519 action and the service itself to participate in the action.

1520 **Counts as**

1521   **Counts as** is a relationship between two logical systems in which an **action**,
1522   **event** or **concept** in one system can be understood as another **action**, **event** or
1523   **concept** in another system.

1524 The two systems involved in SOA-based systems are the system of communication on
1525 the one hand and the system of services on the other.

1526 When we state that a **communicative action counts as** a **service action**, we are
1527 relating a system of communication to a system of action against services.[18] Since a
1528 **participant** cannot (normally) act directly on a **service** it must use some means of
1529 mediating the **action**. However, from the perspective of all the participants involved,
1530 when a participant uses a communicative action appropriately, the participants are

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[18] Acting against a service should not be understood to mean acting to foil the effectiveness of the service; but simply
as an action involving the normal operation of the service.

1531 *expected* to understand the communication *as though* a **service action** were actually
1532 performed.

1533 When a customer 'tells' an airline service that it 'confirms' the purchase of the ticket it is
1534 simultaneously a communication and a service action – two ways of understanding the
1535 same event, both actions, one layered on top of the other, but with independent
1536 semantics.

1537 ### 3.2.7 Architectural Implications

1538 ### 3.2.7.1 The Role of Identity

1539 ### 3.2.7.2 The Role of Policies

1540 ### 3.2.7.3 The Role of Communication

1541 ### 3.2.7.4 Communications as a Means of Mediating Action

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