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TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Internet of things and smart cities and communities – General

SERIES F: NON-TELEPHONE TELECOMMUNICATION SERVICES

Machine socialization: Overview and reference model

Recommendation ITU-T Y.4001/F.748.2

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Recommendation ITU-T Y.4001/F.748.2

Machine socialization: Overview and reference model

Summary

Recommendation ITU-T Y.4001/F.748.2 describes machine socialization, which enables machines to cooperate with one another via their relations with other machines. In machine socialization, machines can be identified, can communicate and can capture data using machine identifiers, features of machine capabilities and machine owners, etc. Machines can be socialized with the information of identified machines through the establishment of relations. This Recommendation provides an overview, requirements and a reference model for machine socialization.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.4001/F.748.2	2015-11-29	16	11.1002/1000/12621

Keywords

Internet of things (IoT), machine socialization, social Internet of things, socialization, social web of things.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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Introduction

Social relations existed between people before the appearance of social network services as known today. However, these social relations were constrained by time, location, space, etc.

A social networking service is a platform that enables the building of social networks or social relations among people who share interests, activities, backgrounds or real-life connections. Unlike traditional social networks or social relations, social network services make it possible to connect people who share interests and activities across political, economic, and geographic borders, etc. In addition, social network services make it easy to create, maintain, strengthen and extend social networks or social relations.

The most important factor in the use of social network services is the possibility of being able to cooperate with other people including crowd activities by sharing and exchanging information.

According to the definition of the Internet of things (IoT), things or machines collect data (either environmental or non-environmental) and transfer this data to the information world through communication networks. Though things or machines are interconnected with one another, the important point of the IoT is in providing the capability for communication and data (either environmental or non-environmental) capture to things or machines. Without collaboration or cooperation between things or machines, they may remain isolated and constrained from a capability point of view.

Because humans have an always-on networking capability, a social network service becomes a great way to share and exchange information. Using this capability, it is easy for humans to acquire information on the experience, knowledge and capability of other humans without the barriers associated with time, space, etc.

Consequently, it can be easily understood that all networked things or machines will:

– produce numerous items of meaningful information or more specifically, captured data, occasionally pre-processed by things or machines;

– evolve intellectually and then converse with one another, in other words, they will be socialized.

To enable things to communicate what they do or need, follow one another, discuss with one another, collaborate, create events and do things together demands the socialization of machines to a level corresponding to that of social relations among humans.

Recommendation ITU-T F.748.2

Machine socialization: Overview and reference model

1 Scope

This Recommendation specifies machine socialization which enables machines to cooperate with one another using their relations with other machines. This Recommendation covers the following:

– overview of machine socialization;

– requirements for machine socialization; and

– reference models of machine socialization including a service model and functional model.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.4000] Recommendation ITU-T Y.4000/Y.2060 (2012), *Overview of the Internet of things*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 Internet of things (IoT) [ITU-T Y.4000]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

NOTE 1 – Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

NOTE 2 – From a broader perspective, the IoT can be perceived as a vision with technological and societal implications.

3.1.2 thing [ITU-T Y.4000]: In the Internet of things, this is an object of the physical world (physical things) or of the information world (virtual things), which is capable of being identified and integrated into communication networks.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 machine: An object of the physical world which is capable of being identified and of communicating, computing and processing data.

3.2.2 machine socialization: Enabling things or machines to communicate what they do or what they need, as well as to follow one another, discuss with one another and collaborate with one another.

3.2.3 relation: An association between or among machines or things enabling machines or things to share or to provide the capability to achieve a task in collaboration. This includes scheduling of processes between or among machines or things to perform a task.

3.2.4 sociality: The tendency of things or machines to be in the state of socialization.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

E-R Entity Relationship

IoT Internet of Things

M2M Machine to Machine

QoS Quality of Service

RFID Radio Frequency Identification

XML Extensible Markup Language

5 Conventions

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus this requirement need not be present to claim conformance.

6 Overview of machine socialization

6.1 General overview of machine socialization

The Internet of things (IoT) is defined as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies. Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, while ensuring that security and privacy requirements are fulfilled. From a broader perspective, the IoT can be perceived as a vision with technological and societal implications [ITU-T Y.4000]. Other definitions on the IoT can be found, however they do not have any significant differences.

According to the existing definitions of the IoT, things or machines collect data (either environmental or non-environmental) and transfer it to the information world through communication networks. In other words, current understating of the IoT is reduced to merely a collection of world-wide sensor networks and radio frequency identification (RFID) systems and global machine-to-machine (M2M) systems. Though things or machines are interconnected with one another, the point of interest of the IoT is in providing capability for communication and data capture to things or machines. However, expectations for the IoT go beyond sensor networks, RFID and M2M, etc., as these are just some of the enablers for the IoT.

Like the human experience of using social network services to obtain information on the knowledge and capabilities of other people, unrestricted by barriers of time and place, etc., machines can communicate and say what they do or what they need, they can follow one another, discuss, collaborate, create events and do things together. This involves the socialization of machines to a level corresponding to that of the social relations of humans.

Figure 1 depicts a conceptual model of machine socialization. In machine socialization, machines are capable of basic communication and computing. For machine socialization, machines should at least be able to discover other machines and obtain information about the properties of other machines such as capability (service that the machine can provide) and interface.

In Figure 1, M3 locates in the home and office whereas M2 locates in public and the home. When M3 locates in the office, M3 has M4 and M5 as its neighbourhood. M4 and M5 have different properties from the properties of M1 and M2 which locate in M3's home. If M3 is socialized with M4 and M5, M3 is able to collaborate with M4 and M5.

M3 can do different jobs when M3 is socialized with M4 and M5 compared to the socialization with M1 and M2 because M4 and M5 provide different services. M2 also has M1, M3 and M6 and M7 as its neighbourhood in home and public. From the socialization with both neighbourhoods in home and public, M2 can do different jobs when it locates in home and in public respectively.

The capability of machines can be extended through socializations supporting collaboration, and machines can be socialized with many other types of machines. This means that machines can extend their capability in different ways using various socializations.

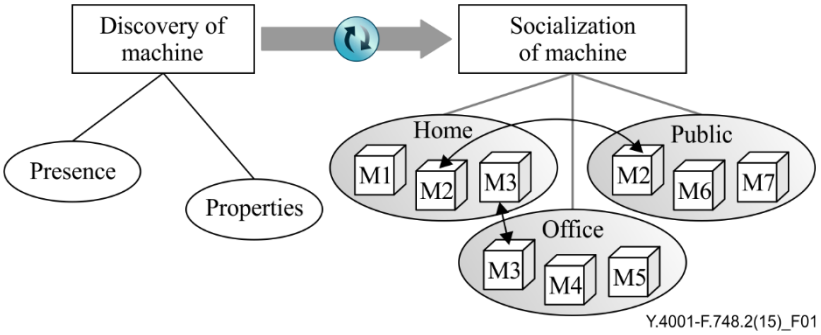

Figure 1 – Conceptual model of machine socialization

6.2 Relations for socialization

As defined in clause 3, a relation is an association between or among machines to share or provide capability. A relation also specifies the schedule of processes between or among machines while performing the task in collaboration.

Establishing a relation enables machines to collaborate with other machines in a form of capabilities sharing.

Figure 2 depicts an entity relationship (E-R) diagram of socialization which associates two machines by a relation.

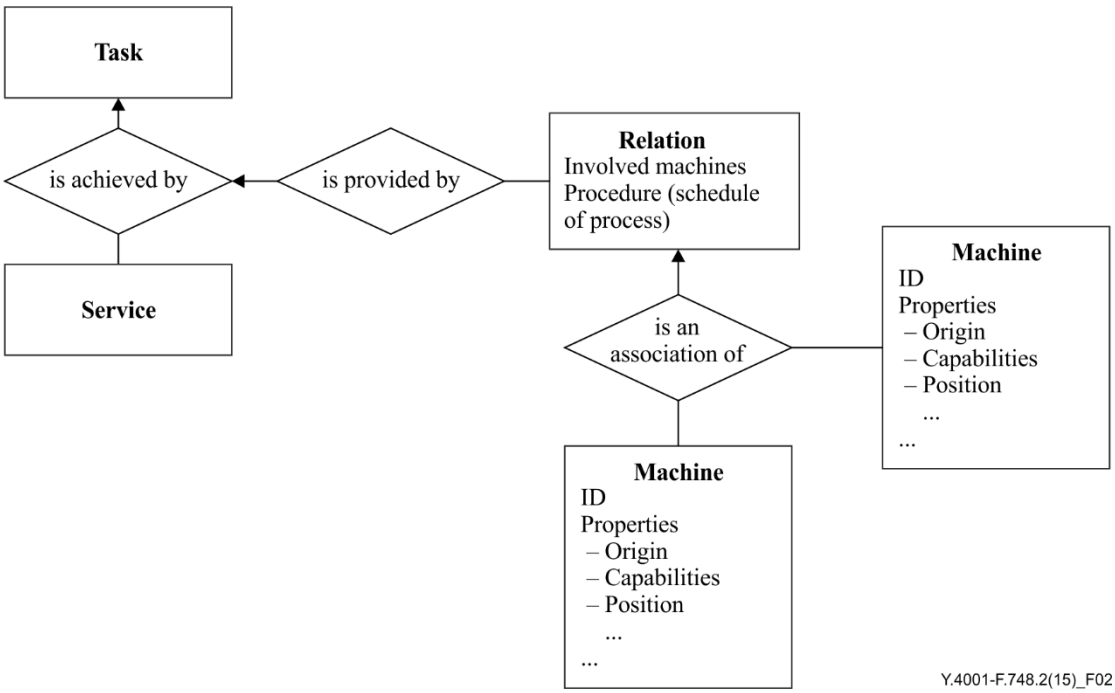

Figure 2 – E-R diagram of socialization

As shown in Figure 2, socialization can be established by establishing a relation or relations. A relation is an association between or among machines to enable a machine to expose its capabilities to other machines for collaboration. Once a machine is associated with other machine(s) as a relation, their capabilities can be exchanged to achieve a given task.

Figure 3 presents an E-R diagram of a relation as an example. In this example, three machines are associated as a relation. Each machine has different properties and capabilities. This relation includes machine information of machines that are involved in socialization and also includes procedures to be carried out in each machine to achieve a given task. This procedure defines sequential actions for each machine and the relationship between or among capabilities of the machines.

In a relation, output from one machine can be transferred to another machine as an input. Display mirroring is an example of this property. Some vehicles can be associated with a smart phone for mirroring a smart phone's display. In this case, navigation information can be displayed in a vehicle with the aid of a smart phone, even if the vehicle does not have a navigation system.

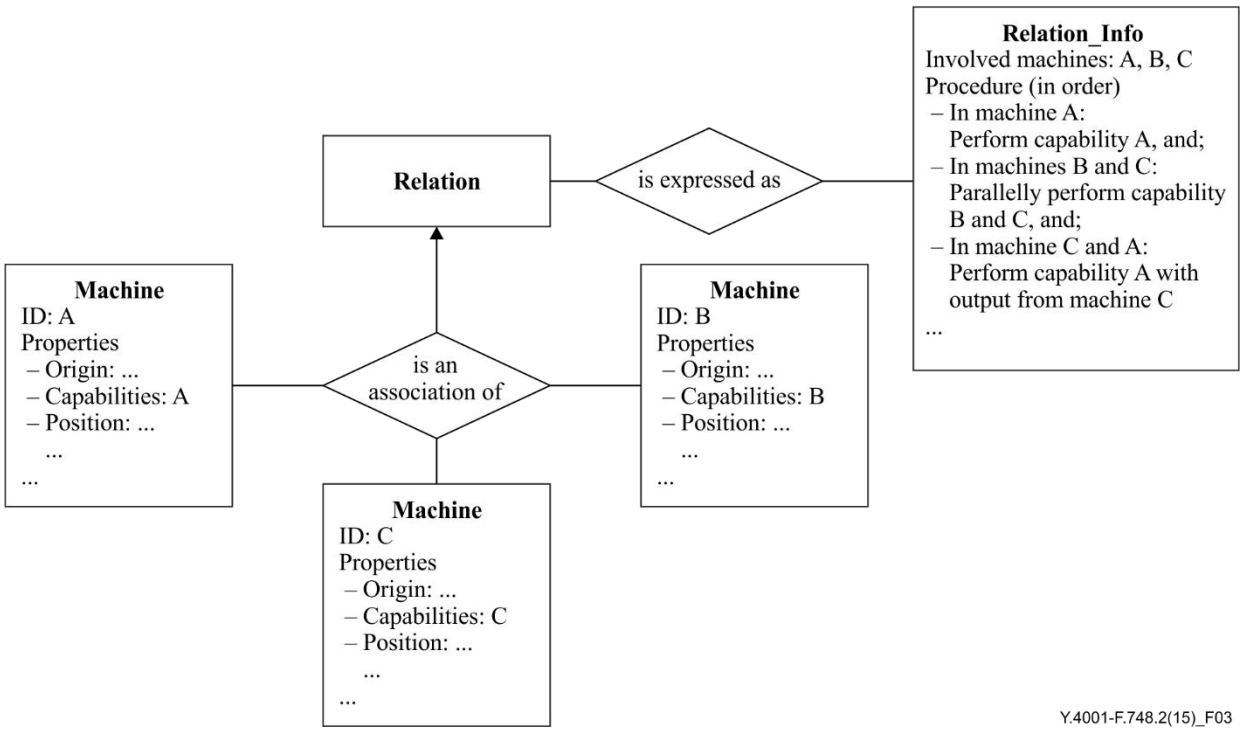

Figure 3 – E-R diagram of relation (example)

6.3 Socialization under the same ownership of machines

Typically, machine socialization is established between or among machines which are under the same ownership. In the case of machine socialization under the same ownership, particular authentication and authorization of access to a machine is not necessary.

6.4 Socialization under different ownerships of machines

A user of a machine can configure his/her machine to expose its capability to other machines which are under different owners, or vice versa. When machine socialization is necessary between or among machines which are under different ownerships, particular authentications and authorizations are needed with respect to machine socialization under the same ownership.

6.5 General procedures of machine socialization

Figure 4 shows socialization procedures.

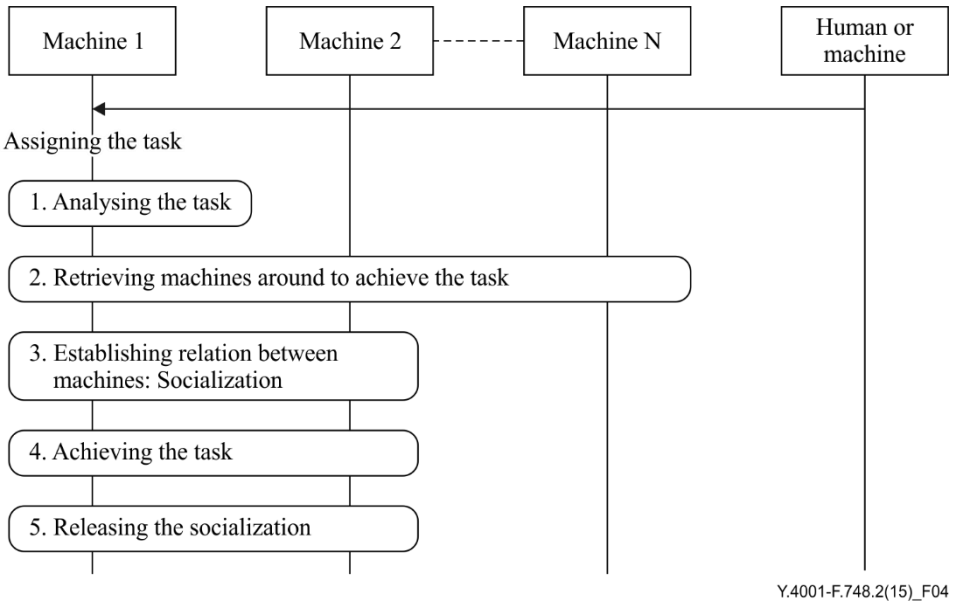

Figure 4 – Socialization procedures

A user can be a human or a machine. When a user assigns a task to a machine, the machine analyses the task. Through an analysis of the task, the machine obtains information about the capabilities needed to achieve the task. If capabilities that are needed are not supported by the machine, the machine starts to retrieve machines to provide those capabilities. Once the machine finds another machine to provide the capability, the machine tries to establish a relation with that machine and achieve the task through that relation. After achieving the task, the relation is released and socialization is also released.

7 Requirements for machine socialization

This clause describes requirements for machine socialization from an application point of view; therefore, communication specific requirements are not covered.

7.1 Standardized description of a machine

In a machine socialization, a machine has to find other machines from the perspective of their capability with which to be associated by a relation. To do this, the machine is required to present its machine capability(s) in a standardized way. Machine presentation is used to perform service discovery.

7.2 Service discovery

For a machine to find other machines with the necessary capabilities, service discovery is required. Through service discovery, a machine can find other machines to be associated with.

7.3 Standardized expression of relation

It is required to express relation information in a standardized form, for example as an extensible markup language (XML) schema. Relation information encompasses the machines involved, their association information with other machines and task information which is given to the machines, etc.

7.4 Dynamic update of relation

Once a relation is established among machines under a given task, it is required to update a relation in runtime. This includes an update of the association status (leaving or joining the association of a machine) and an update of a given task.

7.5 Multiple ways of establishing a relation

When a task is given to a particular machine, that machine is required to be capable of establishing relations with other machines in various ways. These may include that a separate object (server) analyses the task to determine machines with which it should be associated, or these procedures may be carried out by the machine itself.

7.6 Caching of relation information

A device may have patterns to establish a relation in a specific area such as a home or an office where neighbouring devices are seldom changed. In this case, it is recommended to maintain or cache relation information in a device after accomplishing the task for rapid re-establishment of the relation.

7.7 Fault recovery for a relation

When a fault occurs in a device performing a task in a form of machine socialization, it is recommended to recover the relation information after fault recovery in the machine.

7.8 Resilience of relation

When a fault occurs in a relation, it is required to isolate the faulty device from a relation to keep a relation unaffected by the fault. The task performed by the faulty device can be taken over by another machine if available.

7.9 Negotiation of QoS

In machine socialization, tasks are allocated to each machine in a relation according to capability. However, this does not mean that a machine can satisfy the full level of quality of service (QoS) for the given task. Therefore, it is required to be able to negotiate QoS when establishing a relation.

7.10 Verification of ownership of a machine

A relation can be established under both the same ownership of machines and under different ownerships of machines. For this reason, it is required to verify the ownership of a machine.

8 Reference models of machine socialization

The objective of machine socialization is to enable things to communicate what they do or what they need, follow one another, discuss with one another, collaborate, create events and do things together. This clause describes reference models of machine socialization including a service model and functional model.

8.1 Service model of machine socialization

Feasible services by machine socialization may be varied and numerous from simple services such as display mirroring to complex services in which different functionalities are utilised by multiple socialized participants.

However, a service model of machine socialization can be considered as one providing any services through relations between different machines.

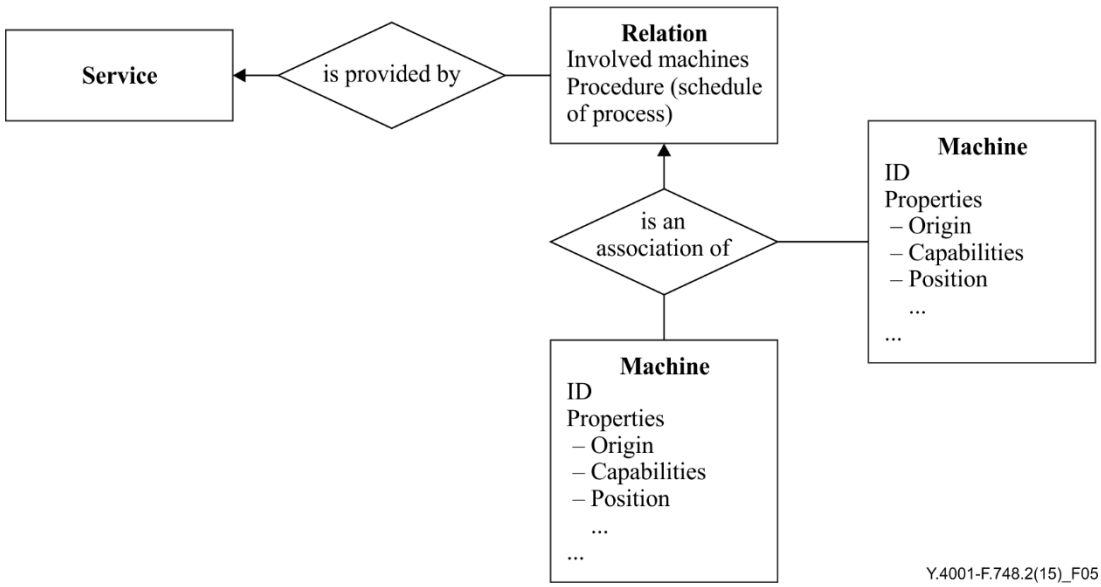

Figure 5 – Abstract service model

Figure 5 depicts a service model of machine socialization. Machine socialization is a procedure of establishing relations among different machines to make machines communicate with one another what they do or what they need, follow one another, discuss with one another and collaborate with one another.

Characteristics of a relation depend on the characteristics of services to be provided. For example, display mirroring in a vehicle between a smart phone and display unit of a vehicle is provided by a simple relation of display capability. In the case of a complex service, relations may be complex where various capabilities of different machines are associated.

8.2 Functional model of machine socialization

From a functional viewpoint, machine socialization is a process of establishing relations as explained above.

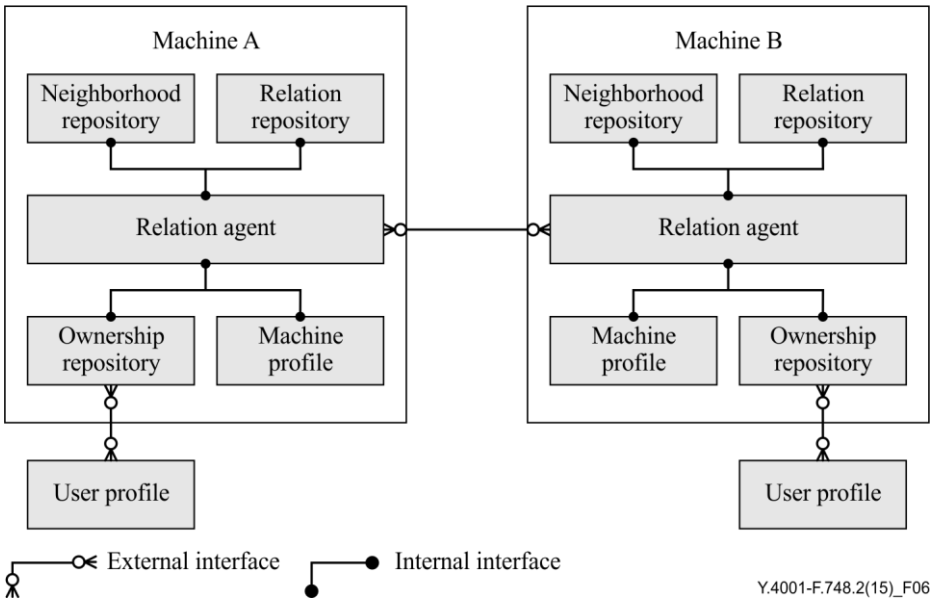

Figure 6 – Functional model

Figure 6 depicts a functional model of machine socialization. Each machine has internal function blocks and internal interfaces as well as outgoing interfaces with external entities such as user profile or other machines.

8.2.1 Machine profile

Machine profile maintains capabilities with a standardized description of a machine as defined in clause 7.1. Machine profile is used to negotiate QoS as described in clause 7.9.

8.2.2 Neighbourhood repository

A neighbourhood repository stores information of machines with which associations are needed. Once a relation agent discovers the machines with the necessary capabilities which are needed for accomplishing the given task, as described in clause 7.2, the information of those machines is stored in a neighbourhood repository.

8.2.3 Relation repository

When a relation is established, the relation is represented as a standardized expression as described in clause 7.3. A relation repository maintains standardized expressions of established relations. Dynamic update of a relation as described in clause 7.4, caching of relation information as described in clause 7.6, fault recovery and resilience of relation as described in clauses 7.7 and 7.8, respectively are carried out on this relation repository.

8.2.4 Relation agent

A relation agent performs service discovery as described in clause 7.2, relation establishment and management are carried out as described in clauses 7.3, 7.4, 7.5, 7.6, 7.7, 7.8 and 7.9. A relation agent may perform limited functions in the case where preparation of a relation is carried out by a separate object (server) as described in clause 7.5.

8.2.5 Ownership repository

An ownership repository maintains the ownership information of a machine. When a relation is established, the ownership of a machine should be verified as described in clause 7.10. The ownership repository is involved in verification of ownership. The ownership repository may also interface with outside user profiles to check permissions for the establishment of a relation with the different ownerships of machines. In this case, a user profile outside the machine maintains the user's permission information for a relation.

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