TNO Information and Communication Technology

Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek / Netherlands Organisation for Applied Scientific Research

Brassersplein 2
P.O. Box 5050
2600 GB Delft
The Netherlands

www.tno.nl

T +31 15 285 70 00
F +31 15 285 70 57
info-ict@tno.nl

TNO report RA 35084

Future Internet: towards context information brokering

Date	28 September 2009
Author(s)	Oskar van Deventer, Paul Tilanus, Mike Schenk, Eelco Cramer, Joost Adriaanse
Reviewer	Armin van der Togt
Customer	Jan Burgmeijer, TNO ICT VP Ambient Networks and Services
Projectname	Architectuur Future Internet
Projectnumber	035.32807

This report contains the paper “Future Internet: towards context information brokering”, published in the book “Towards the Future Internet", see http://www.booksonline.iospress.nl/Content/View.aspx?piid=12006

Future Internet: towards context information brokering

M. Oskar van Deventer[1], Paul Tilanus[1], Mike Schenk[1], Eelco Cramer[1] and Joost Adriaanse[1]

[1] TNO Information & Communication Technology
P.O. Box 5050, 2600 GB Delft, The Netherlands
{oskar.vandeventer, paul.tilanus, mike.schenk, eelco.cramer, joost.adriaanse}@tno.nl

Abstract. *Future Internet* is about combinations of communication, content and context services. Whereas the former two have achieved already a reasonable state of maturity, context information services are still at their infancy: at most stand-alone applications with limited on-line-or-off-line presence information. The critical success factor is still missing, namely context federation, which is the exchange of context information between different application, services and providers.

This article investigates how context services could be successfully federated by following the same pattern that many other information and communication services have successfully followed in the past. First *Context Information Aggregators* and later *Context Information Brokers* play a critical role in addressing the market need for federated context information services.

This article highlights challenges that have to be overcome to make this vision come true. If Europe takes the lead in overcoming these challenges, Europe can become a flourishing ground for a new context-brokering industry.

Keywords: Future Internet, Federation, Interconnection, Context, Presence.

1 Introduction

Future Internet is more than fast video communication and sharing of content. An important aspect is social networking (“Web 2.0”) and the context of the people that are networking: where are they, what are they doing, how do they feel, what do they have to share, how do they want to be reached. Ideally, your friends can easily obtain a full insight in your context, in a way that conforms your own wishes and policies while giving you a minimum of hassle, that respects your privacy, that is aggregated from multiple sources and over multiple service providers, and that is visualized with the best possible user experience for your friends. Currently, context information is rather limited and cumbersome in use. At most, your friends can see whether you are logged-in to a specific service. Moreover, they first need to log in to the same service from the same service provider to get that information.

Federation is a powerful concept in Information Society Technologies. The global coverage of telephony and Internet could only be achieved by the federation of the

networks of many telephony and Internet service providers. In order for context information to become as ubiquitously available as telephony or Internet, context federation is needed.

This article investigates how federation has developed in successful multi-operator services in the past. A pattern emerges that is subsequently applied to context services. This pattern starts with monolithic service providers, like pre-1970 telephony service providers. Stimulated by the arrival of pseudo federation providers, often identified as “parasitic” by the monolithic incumbents, the market need for federation is addressed. Over time, pseudo federation evolves into symbiotic federation and full federation, with a major role for Context Information Aggregators and later also Context Information Brokers.

This article does not intend to provide a complete solution for context federation. It is however our belief that federation at service level in general and context federation in particular is a key challenge in the development of the Future Internet. If Europe takes the lead in overcoming these challenges, it is well placed to become a flourishing ground for a new federated context-brokering industry.

Section 2 highlights the federation pattern. Section 3 applies the federation pattern to context information services. Section 4 presents the challenges associated with this vision. Section 5 concludes with a European view on the context information market.

2 The federation pattern, from monoliths to full federation

Service federation is an important feature of modern telecommunications. It refers to a situation where several service providers work closely together to provide a seamless service to their combined group of end-users. Prime examples of federation are international telephony and GSM roaming. In both cases, the end-user only has a formal relationship (the subscription) with its own operator, but is able to access users and resources in the domain of other operators. Technical and business agreements between all involved operators ensure that the end-users experience a seamless service, as if it were offered by one global telecom operator.

The above example is probably the most mature type of service federation possible. It has the characteristics of a political federation, as is defined below:

> *“A federation (Latin: foedus, covenant) is a union comprising a number of partially self-governing states or regions united by a central ("federal") government. In a federation, the self-governing status of the component states is typically constitutionally entrenched and may not be altered by a unilateral decision of the central government.”*
> Source: Wikipedia

In the context of federation for ICT services, the “federal government” is often a standard-setting body, such as: ITU, IETF or GSMA.

2.1 Types of service federation

The following important types of service federation are distinguished in this paper:

- Communication service federation
- Content service federation
- Context service federation

Communication service federation is about the establishment of service sessions with two or multiple end-points, where each of these end-points is in a similar role and may have immediate reactions to the actions of other endpoints. Examples are phone/video calls and instant messaging.

Content service federation is about the delivery of content from content providers to consumers. The end-points in the established service sessions play different roles. Architectures for content federation are currently elaborated by the EUREKA CELTIC RUBENS project [1].

Context service federation is about the distribution of context information between providers and consumers. Context information may be (semi) static (e.g. address information) or (highly) dynamic (e.g. location, mood, availability). The issues with context federation are standardization of the various contexts, privacy management and the vast amount of data involved. Context federation can be used to enrich and link content and communication services.

These types of service federation are not mutually exclusive. A single service, offered across domains, may include several types of service federation. The types of federation are named after the group of services where they are most important.

2.2 The four stages of service federation

Full service federation is thought to be the most mature stage in the development of ICT services. However, when looking at the developments in ICT services other stages can be identified, some of them offering a quite acceptable substitute for federation. These stages and their characteristics are described below; see also Figure .

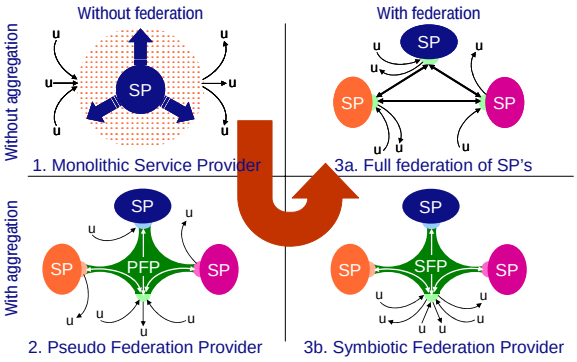

Figure 1: The four stages of service federation.

2.2.1 Monolithic: Service Providers competing for market share

The monolithic stage is believed to be the first stage in the development of services. Each Service Provider is striving to offer a unique service and wants a large market share. Because of the fierce competition, the providers are not concerned with working together to offer a seamless service to their combined user base.

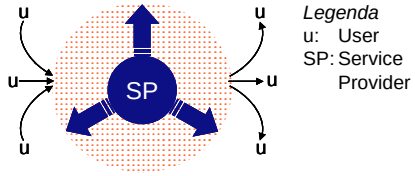

Figure 2: Monolithic Service Provider competing for market share.

The most obvious current example is Instant Messaging (IM). There are several IM providers such as ICQ, Google Talk and Windows Live Messenger (WLM). They all want to achieve the highest market share and lure away end-users by creating a community feeling. An individual end-user that wants to use IM with a buddy that is connected to another IM provider will usually try to influence that buddy to "join the club" and subscribe to their IM service. As a result, end-users with buddies in several communities are forced to subscribe to several IM service providers and implement the interworking themselves (by installing several IM clients or reverting to multi-headed clients such as Pidgin[1], AdiumX[2] or Miranda[3]).

2.2.2 Pseudo ("parasitic") federation: disruptive innovation

The pseudo federation stage is entered when a service becomes successful, with several monolithic Service Providers offering a similar service. End-users will grow weary of the fact that they have to implement interworking themselves and are inclined to divert to any provider that offers a solution for their predicament. This is the time when the Pseudo Federation Provider arises.

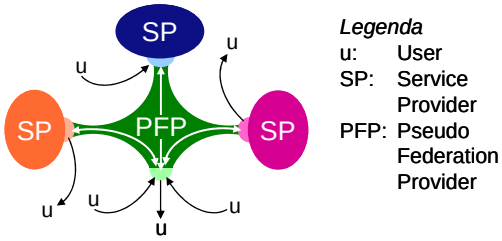

Figure 3: Pseudo-federation, disruptive third parties addressing a market need.

Figure explains the concept of pseudo ("parasitic") federation. A Pseudo Federation Provider connects to the existing interfaces offered by each of the monolithic Service Providers and then provides a new interface towards the end-

[1] http://www.pidgin.im/about/
[2] http://trac.adiumx.com/wiki/AboutAdium
[3] http://www.miranda-im.org/about

users. End-users that find interworking important will start obtaining the service from the Pseudo Federation Provider, while other users will stay with the existing Service Provider. As a result, the Pseudo Federation Provider is in direct competition with the Service Providers and is regarded as parasite by these monoliths.

In the context of Instant Messaging (IM), Palringo[4], Fring[5], Nimbuzz[6] and many others can be regarded as the first Pseudo Federation Providers. However, these have not yet gained much momentum, as apparently not enough end-users are bothered by the lack of federation in IM.

Pseudo-federation is difficult to block for the monoliths because the required technology is rather simple. They can try to make life difficult for the Pseudo Federation Provider, but they cannot go very far in this. Because the Pseudo Federation Provider uses the same interface as the regular end-users, barriers implemented here will also drive away the regular users.

2.2.3 Symbiotic federation: maturing of the market

The next stage is symbiotic federation. From a technical point of view, it is similar to pseudo federation. However, the monolithic Service Providers have started to accept the fact that there are Pseudo Federation Providers and they also start to see the value of those parties. Especially for niche markets they will refer their end-users towards the Symbiotic Federation Provider.

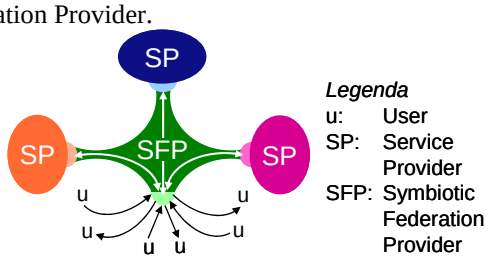

Figure 4: Symbiotic Federation Providers becoming accepted players.

Paypal[7] is an example of a Symbiotic Federation Provider. A web shop that wants to provide its users with the ability to pay with credit cards can either obtain the services from Paypal or from each of the individual credit card companies. However, with Paypal the web shop owner requires only one connection and corresponding contract instead of hooking up with each of the credit card companies. Likewise, the credit card companies are not that interested to directly deal with each individual small web shop and will refer a small starting web shop to Paypal.

2.2.4 Full federation, towards global service coverage

Full federation is federation as we know it from telephony. It does not matter from which service provider the end-user obtains the service; it can interwork with all of

[4] http://www.palringo.com/features
[5] http://www.fring.com/fring_is/what_is_fring/
[6] http://www.nimbuzz.com/en/about/nimbuzz_for_you
[7] https://www.paypal-media.com/aboutus.cfm

the service providers resulting in global coverage for the service. There is no intermediate federation provider.

Important in full federation is standardization; each service provider offers a similar interface to both end-users as well as the other service providers.

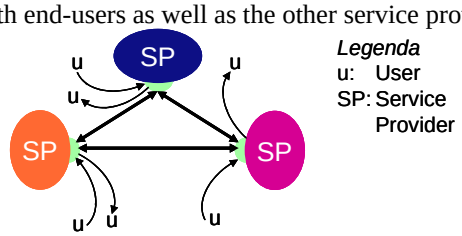

Figure 5 Full federation; integrating the Service Provider and Federation Provider roles.

3 Applying the pattern to context services: towards brokering

As described, the federation pattern is market-driven. It is the user that ultimately requires federation. Regulators often play a key role in this process.

This section applies the federation pattern to context information services. Figure sketches the exchange of context information at a conceptual level. Following the IETF terminology [2], the “presentity” is the identity to which the presence or context information relates. In its most basic form, a presentity would be the identity of a device or application, e.g. a mobile phone or PC being on-line or off-line. In a more advanced form, the presentity could refer to a person with multiple devices and accessing multiple applications simultaneously. A watcher is the identity that requests and consumes presence or context information.

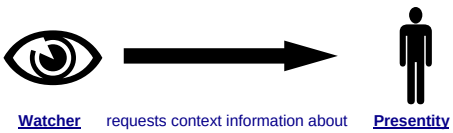

Figure 6: Conceptual representation of a context information service.

Figure applies the four stages of the federation pattern to context services. The following business roles are distinguished.

CIP: Context Information Provider. This is the Service Provider for whom at least some form of context information (e.g. simple on-line-off-line presence information) is part of the service offering.

CIA: Context Information Aggregator. This is the Pseudo Federation Provider whose core business is the aggregation of context information aggregation.

CIB: Context Information Broker. This is the Symbiotic Federation Provider whose core business is the brokering of context information aggregation.

The following subsections explain the model of Figure in more detail.

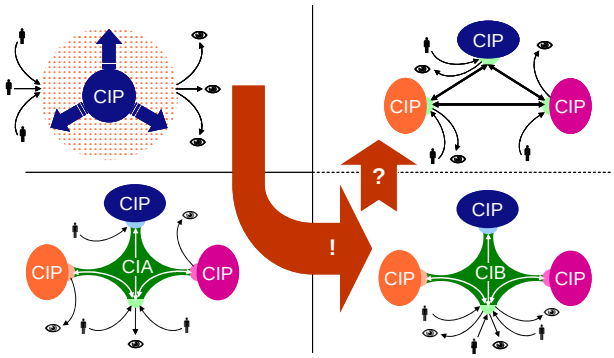

Figure 7: Applying the pattern to context services.

3.1 Monolith: Context Information Providers have no interest in federation

Currently, presence is not a stand-alone service. Context information is usually delivered as part of a larger service, like instant messaging and voice/video communication services. Examples of such communication services are Skype[8], Windows Live Messenger[9] and Google Talk[10]. Users can see whether other users of the same service are on-line or not, and that is about it.

The context information is available for users to see whether other users are available for communication through the particular service. These services are typically paid by advertisements [3]. The main driver for players in this market is to attract more customers, getting a larger market share and obtain more advertisement revenues, see Figure . Notice that context information is not the core business of parties acting as Context Information Provider.

Even though it would be more practical for users to use a single service to communicate with any other users, the advertisement revenues of the service providers provides no incentives to offer such communication interconnection, let alone the sharing of context information.

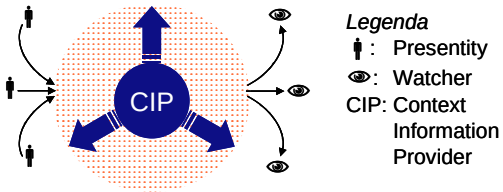

Figure 8: Context Information Provider's main driver is market share.

[8] http://about.skype.com/
[9] http://en.wikipedia.org/wiki/Windows_Live_Messenger
[10] http://www.google.com/talk/about.html

3.2 Context Information Aggregators fill in an upcoming the market demand

Context information aggregation is a first step to address the market demand for context information services. Two types of presence aggregation can be distinguished: watcher aggregation and presentity aggregation:

Watcher aggregation is the aggregation of presence information from multiple sources offered/tailored to watchers. Watchers can attribute different sources of presence information to a single presentity, and watch the aggregated presence information through a single application.

Presentity aggregation is the aggregation of presence information from multiple sources about a single presentity, which is typically a person in the case of presentity aggregation. The presence information could be about availability to communicate through different channels (fixed phone, mobile phone, instant messaging, SMS), about the location/speed of the presentity or about the activities of the presentity. It depends on the configured policies what information specific watchers may see and at what level of aggregation and detail. Presentity federation is complex, as it requires identity federation [4].

As monolithic Context Information Providers have no interest in federation,this offers a business opportunity to external Context Information Aggregators to deliver context information aggregation services, see Figure . Initially, such a service would focus on watcher aggregation, as it the easier to implement by a third party. The Jabber network[11] can be seen as an example of a Context Information Aggregator. Context Information Providers perceive Context Information Aggregators as “parasitic” as they use the Context Information Provider’s capabilities without respecting the Context Information Provider’s business model.

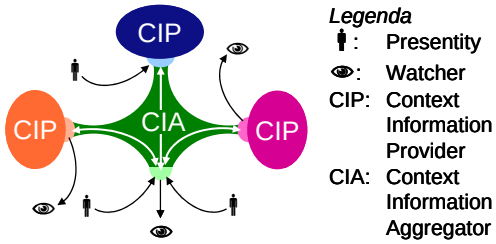

Figure 9: Market demand for aggregation addressed by third parties, Context Information Aggregators.

3.3 Symbiotic federation: a role for Context Information Brokers

Symbiotic federation is a next step to address the market demand for context information services. This will induce changes in the business model for context information. Currently this information is “for free”, paid for through advertising following the classical Internet business model. Over time, other business models will

[11] http://www.jabber.org

arise. Watchers and/or presentities may recognize the value of good context information and become willing to pay for the publication and/or reception of this information. Alternatively, the costs related to context information may be subsidized by the paid communication services that they induce in a similar way that “free” SS7 signaling is being paid for by phone calls. In this alternative, “presence” has become tomorrow’s dial tone [5][6].

With the changing business models, the relationship between “parasitic” Context Information Aggregators and the “incumbent” Context Information Providers will evolve into a more symbiotic one. Upcoming Context Information Brokers would collect and aggregate context information on behalf of presentities, enabling users to provide a self-controlled presentity-aggregated view to watchers.

Context Information Brokers would play a complementary role to the Context Information Providers in a rich context-information ecosystem, with the Context Information Providers focusing on communication services and providing context information to Context Information Brokers with context information, see Figure .

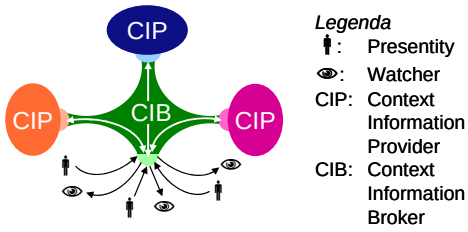

Figure 10: Context Information Brokers aggregating and brokering context information in association with Context Information Providers.

3.4 Full interconnection-based context federation.

Full interconnection-based context federation would in theory be the final step in the evolution of presence into context services. This step assumes the arrival of pure Context Information Providers to whom context information services is core business. Context Information Providers use direct interconnection to share context information with other Context Information Providers, see Figure .

We consider such a scenario unlikely, as presence and context services are typically supplementary to communication services. So, even if the communication services themselves are interconnected, the brokering of context information may remain the field of specialized Context Information Brokers.

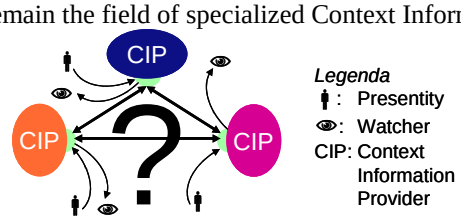

Figure 11: Full federation for Context Information

4 Challenges

This section presents the challenges that need to be tackled to turn the vision of the last section into reality. These topics should be addressed in a research program focusing on context federation in the Future Internet.

4.1 Current developments on service federation

The traditional telecom operators have applied a closed and central federation model for many years. With the newly evolved VoIP services, we see new and open federation models being applied once VoIP islands need to be interconnected, mainly because of the different business models applied (see for example the IETF SPEERMINT initiative [7]). As the requirements of specific communication services differ, there is also a need for different federation models. Although still unclear, it is expected that different communication federation models will coexist [8].

A currently important subject for context service federation is performance. Although current protocols standards are sufficient to support small-scale presence and messaging environments, support of large scale and federated environments is lacking. Even in new IETF drafts on the optimization of SIP as presence and messaging protocols, we see doubt on applicability of the current SIP protocol in large multi domain implementations [9]. Possible solutions are proposed where the client uses a different protocol than the central servers [10] or modifications are made to SIP [11].

Furthermore we see that federation of the identity management context service, implemented over different organisations, is becoming more and more important [12].

4.2 Business role and model challenges

Business roles and changing business models are a major challenge for context information brokering. The emergence of lucrative context information business will depend on successful business models, either evolutionary or disruptive. As is stated in [13] federation is the next best thing as seen from a user's perspective but there is often no incentive for the business parties involved to give up their direct link with the end-user. While the referred paper focuses on identity federation, it is our belief that similar issues will arise with any kind of federation in the Future Internet. Current services in the Internet are provided by monoliths with business revenues based on the number of end-users they serve. They are unlikely to give up their direct user contact without a fight.

Therefore, it is likely that federation will be slowly introduced and an analysis should be made of the characteristics of the business roles in the different market evolution stages. It should be studied to what extent the different forms of presence aggregation (presentity aggregation versus watcher aggregation) relate to similar or distinct business roles. It should also be studied how business roles could gradually evolve and which business roles can only emerge in a disruptive way, see Figure .

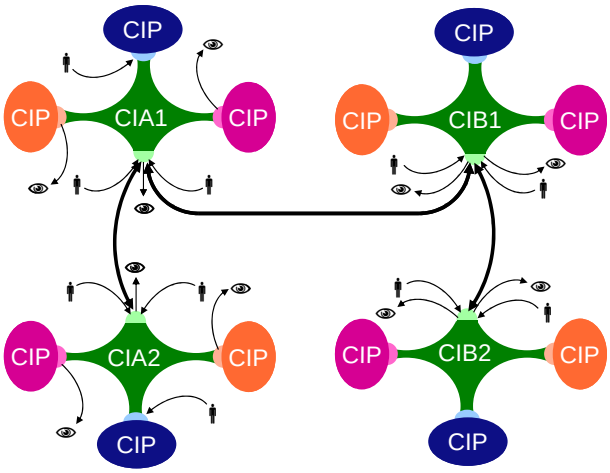

Figure 12: Elaboration of business roles and associated technical interfaces

Also business models should be further elaborated, starting with a value analysis. In an advertisement-based business model the value is in the watched advertisements, and the focus is on stimulating the use of the service. In a watcher aggregation model, the value is in the context information itself and the aggregation of this information, which implies that the model should fuel on revenue streams related to watchers. In a presentity aggregation model, it is the presentity that uses context information to publish his reachability for communication services, which implies that the model may be fueled from communication services revenues ("dial-tone of the future").

Finally, migration and evolution of business models should be studied. For instance, commercial television channels used to be paid from advertisement revenues and broadcast networks would share advertisement revenues with television stations.

4.3 Architecture and traffic management challenges

Defining technical solutions for aggregation services and context information brokering implies the design of one or more architectures.

Traffic analyses will form an important input to the architecture design. An analysis should be made on the flow of context information, including realistic estimates on amounts of context information traffic, aggregated and not-aggregated and traffic matrices. Different traffic scenarios may be worked out depending on the use of the context information. For example, a semi-continuous stream of context information may cause serious congestion in mobile networks.

Based on traffic analyses, recommendations can be made on a high-level architecture. For instance, a client-server-based architecture would aggregate context information in servers, which has the advantage of central processing, limited context information traffic and simpler (hence cheaper) end terminals. On the other hand, a peer-to-peer-based architecture would limit the centralized operation to a minimum, most likely only group list management, and have the context information be

exchanged directly between end devices without any direct interference of the context information broker.

One or more functional architectures should be worked out in terms of services supported, elementary functions, functional elements, data model, reference points/interfaces, protocol flows and protocols used. Part of the analysis is the question which interfaces require standardization, either from a multi-vendor perspective of the technical interfaces between different business roles. Reuse of existing standards, possible modifications and profiling, and making contributions to standardization bodies are part of this challenge.

4.4 Privacy protection and policy management challenges

Privacy protection and policy management are essential aspects of any context information ecosystem. An end user should be able to rely that his precious context information is treated confidently and only be disclosed to selected watchers.

A first step is a thorough privacy threat analysis. An evaluation should be made which different types of context information there are and what levels of sensitivity should be distinguished. For example, simple on-line-or-off-line information would in most cases be much less sensitive than accurate GPS location information, let alone health sensor information. One analysis would be primarily from the presentity point of view: who is entitled to watch which context information, which person is currently actively watching. Another analysis would be from the service provider perspective, which does not want its user information be “data-mined” by potential competitors. Finally, an analysis from a context information broker perspective is applicable, focusing establishing trust as key value, similar to the role of e.g. a bank.

Directly related to privacy protection is policy management. A user wants to control which other users can watch what types of information. For example, direct colleagues may access most information in one’s electronic agenda, whereas customers would be restricted to aggregated in-office-or-out-of-office information. Such policies are typically coded in XML [15]. An analysis should be made on the types of policies required from the end-user perspective. Following the “80/20” rule, a limited number of “default policies” should be defined.

5 Conclusion: Europe should become a flourishing ground for a new context-brokering industry

This article explains the four-stage federation pattern associated with the maturing of communication, content and context services. By applying the pattern to Context Information services, it is shown that the market for context information is still at its infancy, and that there are major business opportunities for Context Information Aggregators and Context Information Brokers.

In the past, Europe has shown its force in the federation of mobile communication services. Stimulated by European collaborative projects and European-scale

standardization, technologies like GSM and UMTS have reached maturity. Federation has been the critical success factor here.

The market, architectures, technology and standards for context information services are at a similar infant stage as GSM and UMTS respectively in the early 1980's and 1990's. Europe has the opportunity to take the lead in overcoming both technical and business model challenges. If Europe takes this lead, then Europe can become a flourishing ground for a new context-brokering industry.

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