New possibilities for the provision of value-added services in SIP-based peer-to-peer networks

A.Lehmann[1,2], W.Fuhrmann[3], U.Trick[1], B.Ghita[2]

[1] Research Group for Telecommunication Networks, University of Applied Sciences
Frankfurt/M., Frankfurt/M., Germany
[2] Network Research Group, University of Plymouth, Plymouth, United Kingdom
[3] University of Applied Sciences Darmstadt, Darmstadt, Germany
e-mail: lehmann@e-technik.org

Abstract

Service provisioning in future telecommunication networks, especially value-added services, is becoming more and more important. As a result providers will have to distinguish themselves sharply from their competitors. Newest insights based on the research of peer-to-peer networks will present an easy way to service provisioning. Furthermore this paper will present a solution for service discovery and the reuse of still existing services. These solutions are still the basis for future work which will have the goal to create a framework which will provide also the composition of new services in peer-to-peer networks.
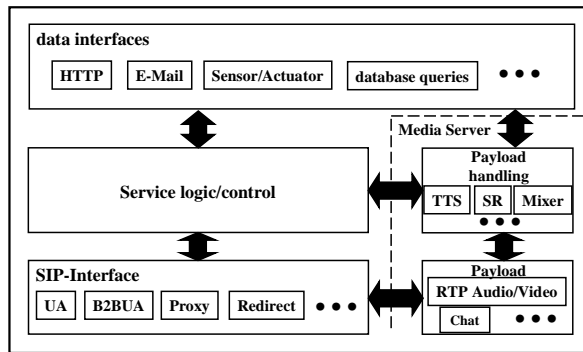
Keywords

NGN, SIP, Value-added services, peer-to-peer networks

1. Introduction

Service provisioning, especially value-added services (VAS), will play a key role in Next Generation Networks (NGN). An important distinguishing feature for providers will be the range of new services. This offer is determined by the rising and specified inquiry of the customers. In future customers will demand services which became tailor-made for them. To meet these increasing requirements, one of the critical steps is to implement in the future networks the support for openness towards new services. This will lead to a number of challenges, such as the management of new services, the conditions to be fulfilled by providers to ensure their provisioning, and the impact of involving peer-to-peer (P2P) technologies in such architectures. The aim of this paper is to review and discuss all these challenges

Through future networks and their service delivery platforms (SDP) the provision of value-added services will be facilitated. Value-added services are specialized telecommunications services. Their functionality will exceed teleservices, e.g. facsimile or short message service. To provide VAS there is a need for new functions which are not handled by the core network itself. For this purpose further network elements such as application servers (AS) and media servers (MS) are needed as shown in Fig.1.

Figure 1: Application and Media Server

The application servers will provide the services and will use/control other application servers and/or media servers to realize more complex services. Media servers will provide the handling of payload (e.g. for video conferences).

2. Overview of different peer-to-peer models

Based on advantages such as scalability, low costs, and openness for new services peer-to-peer models will play an important role in the future. Thus, we will discuss different peer-to-peer models in this section and will determine their possibilities of service provisioning. Three different models (generations) were proposed by prior research (Eisenschmid, 2005) as shown in Fig.2 (E. Harjula *et al.*, 2004).

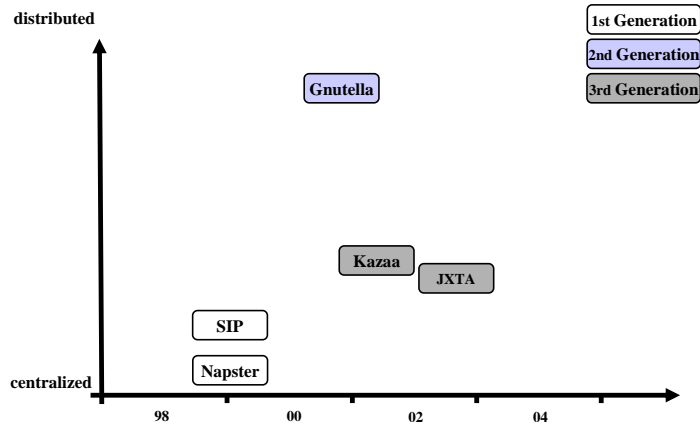**1st Generation (Hybrid P2P model):**
- e.g. Napster, Skype, SIP (Session Initiation Protocol)
- semi-centric (at least one centric checkpoint), e.g. one centric peer as an index server for available data
- client-server and P2P communication
- there is no need for specialized tracing service

2nd Generation (Pure P2P model):
- e.g. Gnutella
- fully distributed
- structured (linked to a special topology) or non-structured organization of peers
- no support for searching by keywords
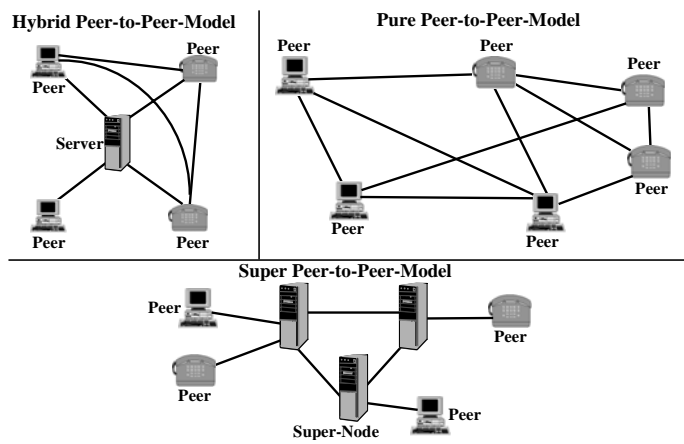- transient peers are not supported

3rd Generation (Super P2P model):
- e.g. KaZaa, Skype
- enhancement of the hybrid P2P model
- centralized checkpoints are substituted by P2P network of super nodes
- interaction between super nodes and normal peers is based on client-server model

Figure 2: Peer-to-peer Generations

A summary of these different peer-to-peer variants is shown in Fig. 3.

Figure 3: Overview of different Peer-to-Peer variants

With respect to the requirements from the view of public communication networks the different P2P variants have been analyzed within the research project TeamCom (Lehmann, 2008). In this connection the hybrid P2P model is favored by the networks view listed in Table 1 (Lehmann, 2008).

Requirements	Hybrid P2P	Super P2P	Pure P2P
Openness for new services	++	++	++
Teleservices	++	++	++

Supplementary services	++	++	+
Value-added services	++	++	+
Mobility	++	+	0
Regulatory Requirements	+	-	--
Integrated Security Functions	++	+	-
appropriate charging for services	++	+	0

Table 1: Requirements for Networks

The above shown table is only an extract of the requirements list developed in the project. But this extract already illustrates the preferences of the hybrid model. Major criteria e.g. mobility (service mobility, session mobility and personal mobility), compliance to regulatory requirements (such as lawful interception), integrated security functions (such as authentication or encryption of payload and signalling) and appropriate charging for services are better supported by the hybrid P2P model than by the distributed variants. Furthermore we will have a look on the architecture of such a hybrid model for service provisioning.

3. Service provisioning in Hybrid P2P model

Based on the SIP specification (Rosenberg *et al.*, 2002) a hybrid P2P model can be realized. SIP essentially supports P2P communication as shown in Fig. 3 because a clearly specified client-server model does not exist. According to (Rosenberg *et al.*, 2002) a hybrid SIP P2P model has already been defined as shown in Fig. 4. Based on the typical SIP elements (User Agent, Proxy Server, Registrar Server, and Location Server) a P2P infrastructure can be realized. This infrastructure already enables client-to-client communication as shown in Fig. 4.
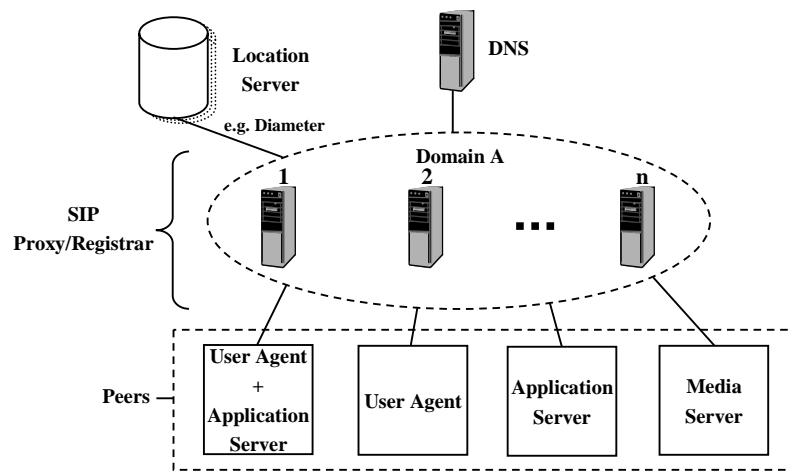

Figure 4: SIP-based client-to-client communication

As shown in Fig. 4, the SIP Registrar and SIP Proxy servers are only needed to lookup the location of the callee (SIP User Agent B). Therefore the temporary SIP URI (Uniform Resource Identifier) is resolved to route the initial SIP requests (INVITE and 200 OK). It is obvious that the three-way-handshake (by sending ACK) is completed directly between the single peers respectively clients. From this point all data (payload and signalling) will be exchanged in peer-to-peer manner.
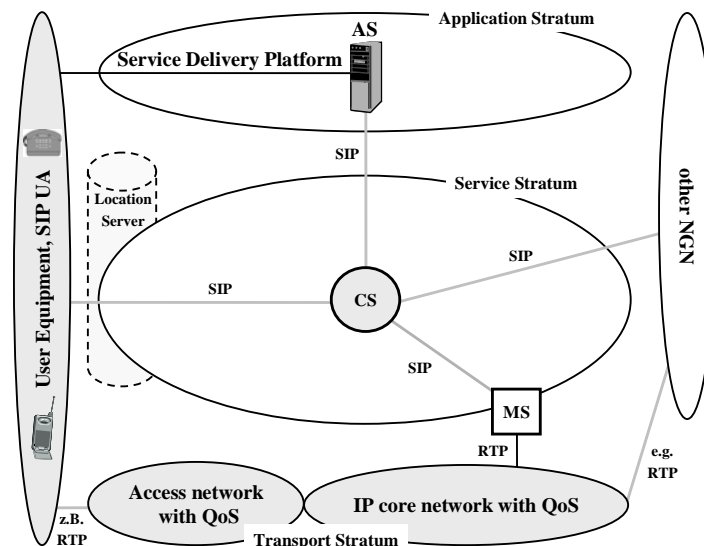
Such a hybrid P2P infrastructure can be used to provide quick and easy services, especially value-added services.

First a P2P overlay composed of SIP Registrar/Proxy servers has to be created. The domain for these elements can be resolved by DNS (Domain Name System) (Mockapetris, 1987, I), (Mockapetris, 1987, II) or dynamic DNS (Vixie *et al.*, 1997). Now further SIP network elements can simply register with the overlay network. A pool of location servers is connected to the overlay. The location server pool is holding the data of the registrations from the peers to provide the routing. Now application servers and media servers can easily be connected to the overlay as peers to provide value-added services. An overview of this architecture is presented in Fig. 5.

Figure 5: Hybrid SIP P2P Model

The general architecture of NGN is presented in Fig. 6. The described hybrid P2P model can represent a special characteristic of NGN.

Figure 6: NGN architecture as a strata-structure

To manage the addressability of application and media servers by their SIP URI these servers also have to register with the overlay network. This architecture offers the following benefits:
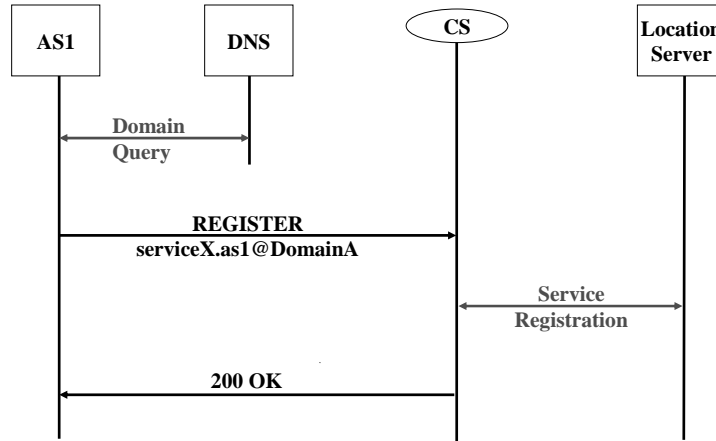
- − usage of existing specifications such as SIP, DNS

- − non-modified standard SIP User Agents can be used (based on the SIP specification)
- − fast lookups (resolving the temporary SIP URI from the permanent SIP URI) are provided better than by pure P2P models
- − bottlenecks and single points of failure are eliminated
- − possibility for more complex searching
- − possibility to register and deregister new services
- − reduction of expenses
- − scalability

To offer access to the new services to end users implemented in SIP application servers, application servers must be extended by a new functionality. An application server uses the request REGISTER, such as a SIP Digest (Rosenberg *et al.*, 2002), in order to register with the network. To sign on implemented services the same request as shown above is used (Schmidt *et al.*, 2006). The URI to use for registration and authentication respectively originates from the subdomain model (e.g. "sub.domain.de"). The following example will clarify the usage. Assuming that an application server has registered the following URI "as1@DomainA", he sends the following SIP request to the SIP Proxy resolved by DNS:

REGISTER sip:DomainA SIP/2.0

To: <sip:serviceX.as1@DomainA>;tag=1234
Contact: <sip:serviceX.as1@88.88.88.88>
Expires: 3600

By using the model presented in Fig. 7 registered application servers can provide any number of services. The SIP header field "Expires:" sets the period of time for the validity of the registration which in this case is valid for one hour. As a result the application server has to register the service in defined intervals of time to set the service accessible. With the same SIP request the service can also be deregistered from the network, setting the SIP header field "Expires:" to "0".

Figure 7: Service registration in hybrid P2P model

The provided services hosted by the application servers can be easily applied and SIP User Agents or other application servers can make use of them. This mechanism fully supports "openness for new services".

The next section will describe the procedures used for publishing and discovery of services.
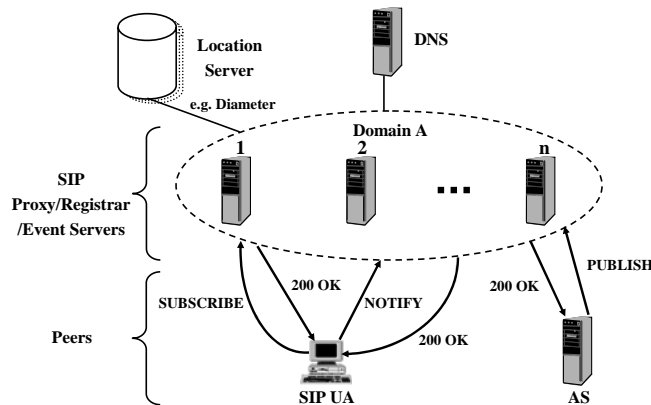
4. Service Publishing and Discovery

Publishing and discovery of services is an essential part of a service provisioning architecture as mentioned before. To realize an architecture which supports publishing and discovery of services the overlay network has to be extended with some new features. During the past years the Internet Engineering Task Force (IETF) has standardized SIP and several extensions, particularly the SIP event framework (Roach, 2002) as an architecture for status delivery from and to any host in IP-networks and the SIP extension for event state publication (Niemi, 2004). Using these standards it is possible to create such a service provisioning architecture.

For realizing the publication of new services the SIP PUBLISH method will be used. The body of this SIP method contains the service description (such as the service name, human readable service description, service id, and service URI) specified by the use of XML (Extensible Markup Language) (Rahman *et al.*, 2006). The

PUBLISH method is sent to the overlay network. The SIP Proxy /Registrar servers are extended by a so-called SIP event server to support the publishing and discovery of services. All information belonging to the events are hosted by the SIP event server (see Fig.8).

To realize the discovery functionality two further SIP messages are used, namely SUBSCRIBE and NOTIFY. The SIP message SUBSCRIBE will be used to do a service query and the SIP message NOTIFY will be used to answer the service query. In the following the service discovery is described. A subscriber (here: SIP UA) sends the SUBSCRIBE message to initially subscribe to an event (here: service query) and receives NOTIFY for the initial notification (here: service information) and all subsequent messages that relate to this subscription. Each subscription carries a desired lifetime of the subscription. In case of a lifetime of zero, the SIP event server merely sends back all available and matching services at this point of time. If the lifetime is greater zero, an availability subscription to services in the future is established (Rahman *et al.*, 2006; Trossen and Pavel, 2005). The concluding hybrid P2P architecture is shown in Fig.8.

Figure 8: Hybrid P2P architecture for service provisioning and discovery

As an example the SIP messages PUBLISH, SUBSCRIBE and NOTIFY are shown in the following.

PUBLISH sip:servicex.as1@DomainA.de SIP/2.0
To: < sip:servicex.as1@DomainA.de>
From: < sip:servicex.as1@DomainA.de>;tag=1234
Expires: 3600
Event: x-servinfo
Content-Type: application/servinfo+xml
Content-Length: ...
[Published document]

SUBSCRIBE sip:servicex.as1@DomainA.de SIP/2.0
To: < sip:servicex.as1@DomainA.de>
From: <sip:userA@DomainA.de>;tag=4567

Event: x-servinfo
Accept: application/servinfo+xml
Expires: 0
Content-Length: 0

NOTIFY sip:userA@DomainA.de SIP/2.0
To: <sip:userA@DomainA.de>;tag=4567
From: < sip:servicex.as1@DomainA.de>
Event: x-servinfo
Content-Type: application/servinfo+xml
Content-Length: ...
[Published document]

Within the research project TeamCom (Lehmann, 2008) the above described architecture shown in Fig. 5 will be realized with the JAIN (Java APIs for Integrated Networks) SLEE (Service Logic and Execution Environment). This API (Application Programming Interface) uses SBBs (Service Building Block), which may represent services. These SBBs can also be shared via the presented model. Within the body of both PUBLISH and NOTIFY methods the location (e.g. an FTP (File Transfer Protocol) URI) from where the SBB can be obtained can be included, so that other peers may use these SBB and deploy it on their own application servers to also provide the same service.

5. Conclusion

With the approaches presented in this paper any service provider has the ability to easily make new value-added services accessible for users or other providers. Users can search for new services for their own use or implementation. Also the whole architecture benefits from the advantages provided by the P2P networks. Furthermore the presented architecture should be verified against still existing centralised models.

6. Annotation

7. References

Eisenschmid, W. (2005), "Peer-to-Peer-Architekturen", Universität Ulm - Ulm University, Proseminar Virtuelle Präsenz

E. Harjula et al. (2004), "Plug-and-Play Application Platform: Towards Mobile Peer-to-Peer", 3rd International conference on Mobile and Ubiquitous multimedia (MUM2004), College Park, Maryland, USA

Lehmann, A., Eichelmann, E., Trick, U. (2008), "Neue Möglichkeiten der Dienstebereitstellung durch Peer-to-Peer-Kommunikation", 13. VDE/ITG Mobilfunktagung Osnabrück

Rosenberg, J., Schulzrinne, H., Camarillo, G., Johnston, A., Peterson, J., Sparks, R., Handley, M., Schooler, E. (2002), RFC 3261, "SIP: Session Initiation Protocol", IETF

Mockapetris, P. (1987), (I), RFC 1034, "DOMAIN NAMES - CONCEPTS AND FACILITIES", IETF

Mockapetris, P. (1987), (II), RFC 1035, "DOMAIN NAMES - IMPLEMENTATION AND SPECIFICATION", IETF

Vixie, P., Thomson, S., Rekhter, Y., Bound, J. (1997), RFC 2136, "Dynamic Updates in the Domain Name System (DNS UPDATE)", IETF

Schmidt, H., Guenkova-Luy, T., Hauck, F.J. (2006), "Service Location using the Session Initiation Protocol (SIP)", International conference on Networking and Services (ICNS)

Roach, A. B. (2002), RFC 3265, "Session Initiation Protocol (SIP)-Specific Event Notification", IETF

Niemi, A. (2004), RFC 3903, "Session Initiation Protocol (SIP) Extension for Event State Publication", IETF

Rahman et al. (2006), "Service Discovery using Session Initiation Protocol (SIP)", United States Patent Application Publication

Trossen, D., Pavel, D. (2005), "Service discovery & availability subscriptions using the SIP event framework", IEEE International Conference on Communications