Using SIP Presence for Remote Service Awareness

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Abstract

Residential networks usually protect its devices and services behind firewalls and use private IP addresses. Therefore, appliances within a residential network cannot be discovered and utilized from external networks by standardized technologies as UPnP. In this paper, we present our concept of "Service Presence", based on the 3GPP Presence Service that makes the service presence information remotely discoverable.

Introduction

Residential services are today becoming digitalized. This opens up for new possibilities in the home that are not possible with their analog counterparts. For example, photo albums can be replaced by media servers with digital photos. An important feature with digital residential services is that they can be interconnected and cooperate throughout multiple homes, users and devices.

For services to cooperate, they must become aware of each other and establish relationships. Many service discovery mechanisms already exist that enable this, such as Universal Plug & Play (UPnP), Bluetooth and ZigBee. With these mechanisms, the residential service network follows Service Oriented Architecture (SOA) principles.

However, all these mechanisms have limited coverage. UPnP is limited to private, local networks, whereas Bluetooth and ZigBee depend on the coverage area limited by the physical characteristics of their respective transmission technologies. Therefore, the services cannot be accessed from remote networks. This limitation is good for illegitimate access, but there are also legitimate scenarios that should be allowed. One such scenario is when the user is in a remote network and wants to access his personal digital photo album, which is located on a server in his home network. Another scenario is to allow service providers to deliver content to residential devices, such as delivering IPTV to any media player in the residential network.

Contributions

In [1] use cases for remote service access and a protocol for remote service usage are presented. However, usage of remote services depends on the knowledge of which services are available in the remote network. Within this paper, a solution for that problem is presented and a description of a prototype implementation is given. The solution compliments the Remote Service Usage protocol.

In the Remote Service Usage protocol the Session Initiation Protocol (SIP) [2] is used to establish the connectivity between the remote service and the user. Because SIP is also the core signaling protocol of the IP Multimedia Subsystem (IMS), Remote Service Usage can leverage the additional capabilities provided by IMS, including Quality of Service (QoS) and authentication, authorization and accounting (AAA). To also be able to leverage the IMS for remote service awareness the protocol is based on the 3GPP Presence Service [3]. Therefore, the solution has been termed "Service Presence".

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Structure of this paper

This paper is structured as following. First, background information is presented in the following section. Next, the "Service Presence" concept is introduced. Following, the protocol for "Service Presence" is described. Then, a prototype implementation of this protocol is shown followed by some early results. Finally, conclusions are given.

Background

Residential Networks and Service Discovery

Service discovery [4-6] is a mechanism to discover, and be aware of, services. Many standards for service discovery protocols exist [7-8], such as UPnP [9-10], Apple Bonjour [11], and Bluetooth [12].

UPnP provides standardized methods to describe and exchange device profiles, including available services (so-called *actions*) provided by the device, and their respective capabilities and requirements. The UPnP Forum standardizes Device Control Packages (DCP) for device types. One of these is the UPnP Audio-Video (AV) Architecture [13]. This architecture describes control points, media servers and media renderers, and relationships between them. In [14] an implementation of such a control point running on mobile phones is shown that can browse and select content from a media server and set a media renderer to play the selected content. The Digital Living Network Alliance (DLNA) architecture [15-16] leverages the UPnP AV architecture. It is used here as the foundation for user-friendly applications that require communication between entertainment devices within private homes through IP networks.

Similarly in Bluetooth, a service discovery protocol (SDP) has been standardized to search and identify other Bluetooth devices and their services in the vicinity.

However, these service discovery mechanisms only work in local networks, as described in [1]. Thus, they do not allow discovering services in an external network, and, consequently, do not support access to remote services. Use cases for such remote service access are described in [1] together with a proposal for a remote service usage protocol.

IP Multimedia Subsystem

IMS [17] is under deployment as IP based service control infrastructure. Devices (mobile or fixed) can register to central identification and access control nodes to obtain access to IP based services provided by the IMS infrastructure.

SIP is the underlying control protocol of IMS to initiate, operate and terminate so-called sessions between service providers and service consumers. In [18] a detailed outline of IMS' service layer is given.

Presence with the Session Initiation Protocol

Through the SIP Event Framework [19], SIP user agents (UA) can subscribe to event sources and be notified about changes in the event state. This event framework is generic and requires that usages of it, so called event packages, be defined for specific applications of it, like presence as explained in the following paragraph.

The concept of presence [20] and how to handle it is defined by the IETF. Amongst other definitions, it defines a presentity (presence entity) as an entity that provides presence information to a presence service. An event package has been defined for presence [21], thereby allowing UAs to be notified about presence state changes. This role of the UA is known as a Presence Watcher. The most commonly used presentity today is a person [22-23], although also solutions with other presentities, such as sensors, are possible. The 3GPP Presence Service [3] leverages this Presence Framework for use in IMS.

Service Presence

Currently, the IETF Presence data model [24] targets people's presence and communication devices. This can be seen from the definitions of "service" and "device" within that specification, where they are defined as people's communication devices with communication services. These definitions exclude many kinds of services, as a service does not necessarily need to do any communication in the context of a user. Moreover, in this model a service's presence is directly related to a user, and that is also not necessarily true for all services. For example, a temperature sensor in a user's house and a media server's presence does not need be included in a person's presence.

The vision with the concept of *Service Presence* is to extend the Presence data model with definitions for generic services. This allows a Presence Watcher to be aware of the presence of a service. Whereas presence information of a person includes elements such as mood, context and contact information, the presence information for a service mainly includes a description of the service.

Furthermore, this concept enables remote service discovery, transport and provision of service related information through SIP networks, such as IMS. Information about services discovered in one service network is transported via the common communication infrastructure to another service network (remote network). In the remote network the service presence information can be used to establish control sessions using [1]. The basic concept is illustrated in Fig. 1 and explained in the section below.

Architecture

Consider two local network environments, Residential network 1 and Residential network 2, as illustrated in Fig. 1. Each Residential network uses its own distinct communication and SDP mechanism, depending on the types of devices and services within the network. These residential networks are inter-connected, for example with an

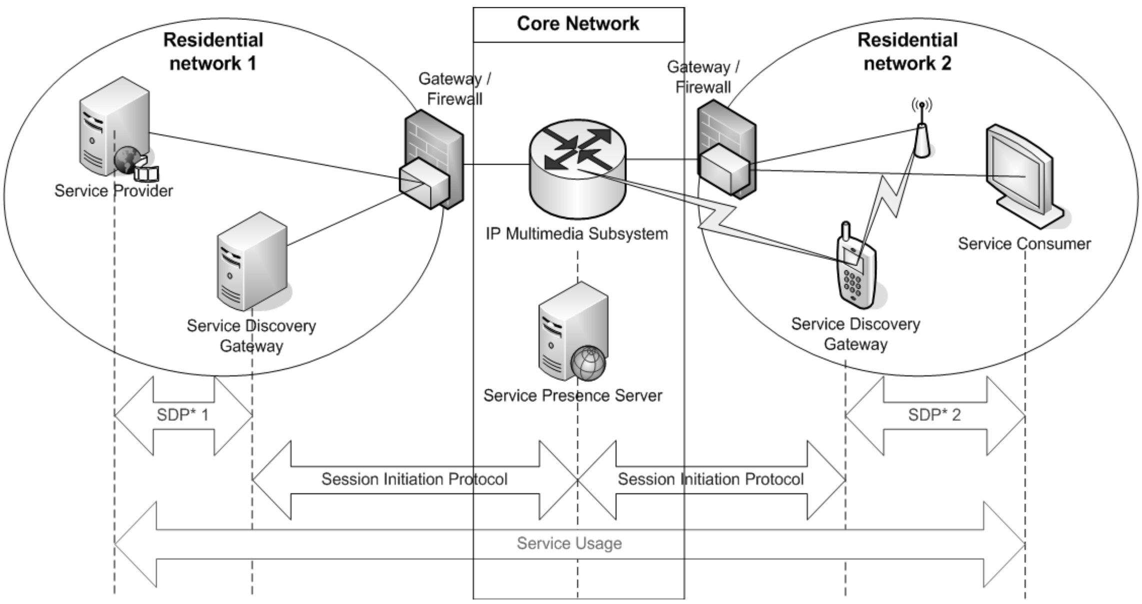

Fig. 1 Service Presence concept. Two service networks are connected through a common core network, IMS, and can share services. (*) SDP = Service Discovery Protocol.

IMS enabled fixed and/or wireless access infrastructure. These two residential networks cannot access each other's services directly, as earlier explained. Therefore, an architecture for service presence is necessary. This architecture includes four logical nodes, as explained in the following.

Service

Presentity discovered through a service discovery mechanism. In Fig. 1 this can be seen as the "service provider" node.

Service controller

Service controller is an entity that discovers services, using a SDP, in the local network and can control them. This node is illustrated in Fig. 1 as "service consumer".

Service Discovery Gateway

The Service Discovery Gateway (SDG) is responsible for discovering services in its vicinity and making their presence available for remote access. Furthermore, it can subscribe to receive service presence information from other SDGs. This enables it to be aware of remote services as well.

To make presence information available it needs SIP UA functionality. This allows the SDGs to take advantage of SIP functionality, such as locating user agents. This allows services of residential networks to indirectly be part of SIP sessions as well.

Service Presence Server

To support the SDGs this node is introduced in the core network and collects presence state from them. This offloads the SDGs with the task of notifying all presence watchers. In addition, it can schedule command requests to avoid overloading the SDGs with requests to a service. This is especially important for residential services that often are not designed for high load usage.

As described later, in the *Deployment options* section, this gives two different deployment options for service presence.

SDP interoperability

As illustrated in Fig. 1 it is possible that different service discovery mechanisms are used within different residential networks. Accordingly, the service discovery gateways have to support different service discovery protocols SDP*1 and SDP*2. By translating the service discovery protocol specific service information into a generic service presence information format within each service discovery gateway, and exchanging this generic service presence information by means of the introduced service presence framework, it becomes possible that different service discovery mechanisms can cooperate in a way that the corresponding services can be utilized between different residential networks. Each service discovery gateway translates the received generic service information into the format that is used by the service discovery protocol within its network, and then publishes this information about the remote service within the local network in the format supported by the local devices.

From a control plane point of view, this interoperability functionality enables for example that a Bluetooth device (like a wireless headset) plays out media provided by a UPnP media server, given that the protocols of the underlying media plane are compatible.

Deployment options

In principle, two different deployments of the service presence concept are possible:

- *Peer-to-peer deployment:* In this case, the service discovery gateways within different residential networks exchange the SIP presence messages with the service presence information directly between each other. Therefore, no presence support from the operator core network is necessary.
- *Operator-centric deployment:* With this option, the operator provides a service presence server that operates as service presence relay between service discovery gateways.

We consider the latter deployment option as the standard deployment, and it is used in the rest of this paper. The former option is good for few SDGs, but it scales fairly bad without further optimizations. Finally, the former option makes it possible to use service presence as an enabler for other services.

Remote Service Awareness Protocol

Our "PIRANHA" protocol presented in [1] has been extended with support for Service Presence. These extensions are based on the 3GPP Presence Service [3]. An example of the protocol signaling is shown in Fig. 2.

The set of extensions includes two actions: service presence publication and service presence subscription. In addition, it specifies an extension to the Presence Information Data Format [25] for describing services. These are described in the following sub-sections.

Service presence publication

"Session Initiation Protocol (SIP) Extension for Event State Publication" [26] differentiates between event hard and soft state. The main difference between them is that in the latter case the event state has a defined lifetime before it will expire, while in the former case the event state does not expire. Therefore, the former is used to describe

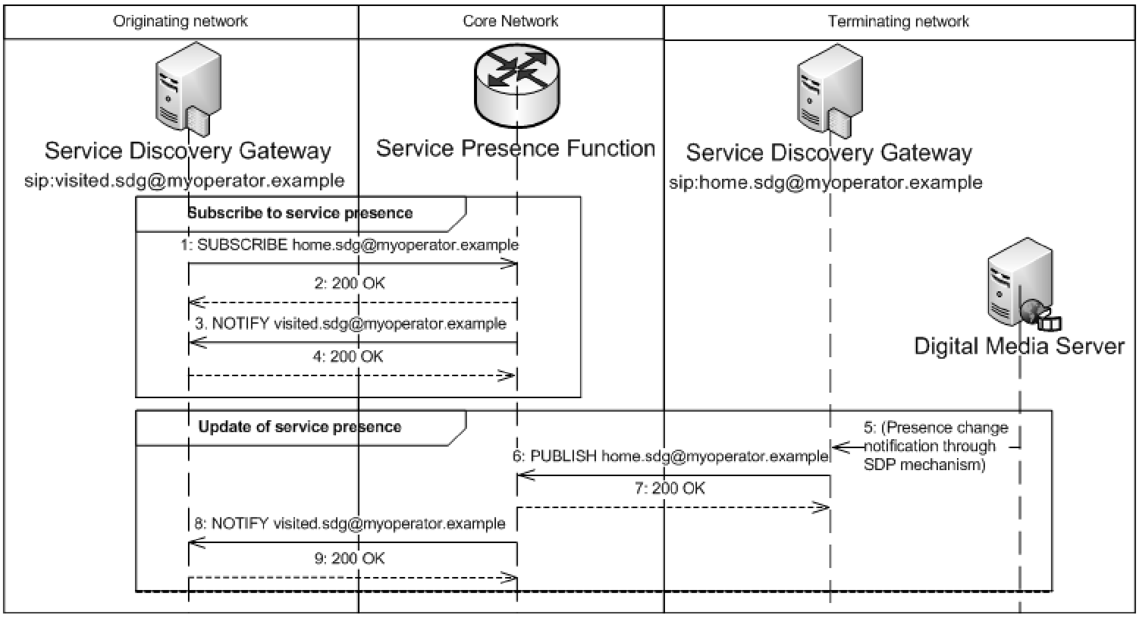

Fig. 2 Service presence signaling. An SDG in a visited network ("Visited SDG") subscribes to the services of another SDG ("Home SDG"). When the "Home SDG" updates the status of its services, the "Visited SDG" is notified by the Service Presence Function.

```
<?xml version="1.0" encoding="UTF-8"?>
<filter-set xmlns="urn:ietf:params:xml:ns:simple-filter">
 <ns-bindings>
  <ns-binding prefix="pidf" urn="urn:ietf:params:xml:ns:pidf"/>
  <ns-binding prefix="utl" urn=http://schemas.agdermobilitylab.com/UTL/">
 </ns-binding>
 <filter id="1234" uri="sip:home.sdg@myoperator.com">
  <what>
   <include type="xpath">/pidf:presence/pidf:tuple/upnp-root-
device/device/deviceType[urn:schemas-upnp-org:deviceType:MediaServer:1]</include>
  </what>
  <trigger>
   <changed from="CLOSED"
to="OPEN">/pidf:presence/pidf:tuple/pidf:status/pidf:basic</changed>
  </trigger>
 </filter>
</filter-set>
```

Fig. 3 Subscription filter for being notified about media servers when they are switched on.

initial, or default, states, while the latter is used for transient states. Event hard states can be modified through [27], while event soft states can be modified using the SIP PUBLISH mechanism defined in [26].

In the service presence concept introduced in this paper, the event hard state is used for all basic services that are provided continuously by a service network. Changes in the status of these services and other service-related information about temporarily available services are made available through event soft states, such as a service status changing from offline to online. This way, resources are not wasted to refresh the state information of default services, while temporary changes of service states will expire when they are no longer in effect. After the temporary state expires, the service will fall back to the default state.

Furthermore, to reduce even more of the amount of information sent for service state changes, only the differences since the last publication are necessary to be sent. These resource savings are important since a service presence information document can become very large as it includes all information about a service and how to use it (actions it supports, service parameters, etc).

Moreover, another mechanism to increase the resource efficiency when acquiring these documents is content indirection [28]. With content-indirection, the client can download the service presence information document using a different access link than the one used for signaling. For example, mobile phones with both a cellular link and a Wi-Fi link can receive the signaling through the cellular link and download the service presence information document through the Wi-Fi link.

SDGs publish event states to the SPS. The SPS is responsible for notifying all subscribing SDGs about the new or changed service event states.

Service presence subscription

An SDG can subscribe to an SPS to be notified on the service presence information of services that are under control of another SDG. A subscribe request can include filters [29-30] that support queries in the W3C XQuery [31] language. These filters can be used to restrict notifications about service presence information with regards to particular service types and when the notifications should be sent. For example, notifications can be requested only from services of type 'media servers' when their status changes to 'online', as shown in Fig. 3.

In addition to these filters, the SPS can apply restrictions regarding the availability of services to an SDG, through a policy document specified in the Presence Authorization Rules [32] format. This document can be stored either in the SPS or in an OMA XML Document Management Server [33].

```xml
<?xml version="1.0" encoding="utf-16"?>
<presence
 xmlns="urn:ietf:params:xml:ns:pidf" entity="pres:sip:higa.home1@ims.ict-fiesta.test">
 <tuple id="uuid:89665984-7466-0019-5b46-051c73783736">
  <status><basic>open</basic></status>
  <upnp-root-device xmlns="http://schemas.agdermobilitylab.com/ServicePresence">
   <device
    xmlns="http://schemas.agdermobilitylab.com/UTL"
    UDN="uuid:89665984-7466-0019-5b46-051c73783736"
    deviceType="urn:schemas-upnp-org:device:MediaServer:1"
    friendlyName="Media Server by TwonkyVision"
    manufacturer="" modelName="">
    <serviceList>
     <service
      controlURL="http://192.168.1.9:9000/ContentDirectory/Control"
      eventSubURL="http://192.168.1.9:9000/ContentDirectory/Event"
      serviceId="urn:upnp-org:serviceId:ContentDirectory"
      serviceType="urn:schemas-upnp-org:service:ContentDirectory:1" />
     <service
      controlURL="http://192.168.1.9:9000/ConnectionManager/Control"
      eventSubURL="http://192.168.1.9:9000/ConnectionManager/Event"
      serviceId="urn:upnp-org:serviceId:ConnectionManager"
      serviceType="urn:schemas-upnp-org:service:ConnectionManager:1" />
    </serviceList>
   </device>
  </upnp-root-device>
 </tuple>
</presence>
```

Fig. 4 Service presenence information document for a media server.

Service presence information document

In the body of the notification messages, sent in steps 3 and 8 in Fig. 2, the service presence information document is included. This document is formatted using the Presence Information Document Format (PIDF) [25] with extensions for describing services. In particular, each service is included as a presence information tuple containing the service status and a description of the service itself. An example of such a document is given in Fig. 4.

Notice that the document includes private IP-addresses. The consuming SDG needs to replace these when using the device. This can be done *after* establishing a service usage session.

Security and privacy

Extending the Presence Service to include information about devices and services implies that users share more information about their private environment with their operator. The metadata associated with a device is one concern, because it includes information about the manufacturer, product model and other details. For example, burglars might like to get this information to find out which locations are attractive for theft, especially if location information is included with the presence information. Moreover, residential security devices may be included as well. Knowledge of corresponding security services, and possibly even control them, would make burglars' job easier.

Furthermore, there are other possibilities for misuse of this information as well. For example, being aware of the media devices (as e.g. networked TV devices) people own, and getting information about how to access them from outside the home network, can make it easier to target them with advertisements.

Now, these security and privacy aspects are basically the same as those that apply to a person's presence data. Therefore, the same countermeasures used in the basic User

Presence service, such as Presence authorization rules [32], applies to service presence as well.

Prototype for Remote Service Awareness

For a proof of concept, a prototype of the service presence concept has been implemented. This prototype includes both the SDG and SPS nodes. The SDG functionality has been incorporated into our earlier prototype described in [1] to enhance it with service presence.

Both parts of the prototype were implemented utilizing the Ericsson Service Development Studio (SDS) 4.0.

SDG Application

The SDG application includes a Web-based management portal ("Service Management"), depicted in Fig. 5, that shows all available UPnP devices in the same local network as the SDG, and lets the user select ("Registered at SDG-Core" column in Fig. 5) which devices should be made available in SPS. Availability in the SPS is accomplished through service presence publication of the selected devices (and their services), as described above. The major components of the SDG application are described in the following sub-sections.

Presence Awareness Handling

This component keeps track of local devices / services, currently only UPnP. It allows other components to be notified when the service presence status changes. For example, both the Piranha and Service Management components receive such notifications.
HTTP Server: A lightweight HTTP server has been implemented to host the Service Management component and the UPnP devices by receiving SSDP (unicast) and SOAP requests.

Piranha

Implements the service presence protocol based on the Ericsson IMS Client Platform (ICP) API, which is part of the Ericsson SDS.

It uses the W3C Document Object Model (DOM) API for creating the service presence publication documents and parsing the service presence notification documents. The Apache Xerces [34] library has been used as an implementation of the W3C DOM API.

Service management website

As shown in Fig. 5, this web site allows users to see and manage which local services should be made available for remote SDGs, through the SPS. Also, it supports subscribing to service presence events notified by another SDG. These functionalities are realized through the Piranha and PAH components.

This functionality has been implemented using Hypertext Markup Language (HTML), Cascading Style Sheets (CSS) and JavaScript. On the server side, dynamic parts of the page, such as table content, are created by simply replacing well-known HTML-comments with the actual content.

“Service Presence Core” Service

The SPC Service has been implemented as a SIP Servlet [35], utilizing Ericsson SDS for testing and development. It implements the “Service Presence Server” functionality described in the *Service Presence* section above. In the following, the components of this application are described.

Service Presence Database

A simple SQL-database with tables for presentities, subscribers and presence publications.

Event Manager

Handles publications and subscriptions by storing them in the Service Presence Database, and schedules tasks to handle expiration of these.

To be able to notify subscribers, it also keeps session state (javax.servlet.sip.SipSession objects) for them in a separate table with an implicit relationship to the subscriber database table. The reason for this split of where state is stored is due to simplifying the implementation.

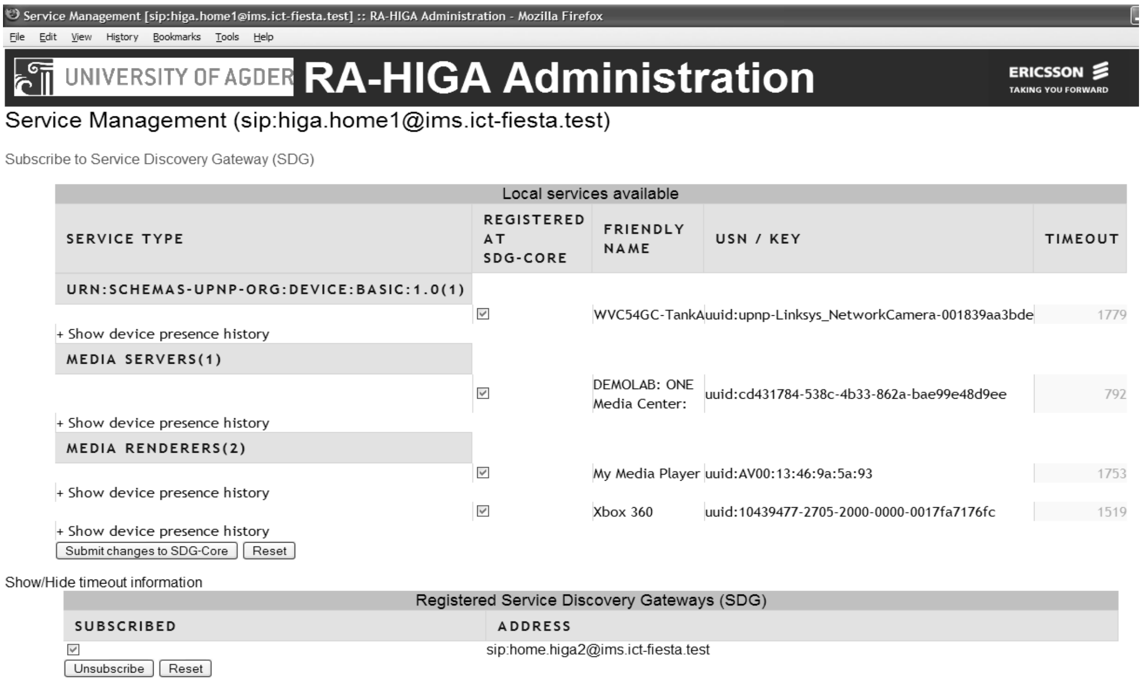

Fig. 5 Service management web page.

Service Presence Servlet

Handles requests and responses for PUBLISH and SUBSCRIBE requests using the Event manager component.

Deployment

The prototype has been deployed as illustrated in Fig. 1 with an IMS core network and two residential networks. The core network consists of the OpenIMS [36] implementation of the IMS core nodes and a Sailfin [37] application server that hosts the Service Presence Core service. In the residential networks, some UPnP devices (media server, media renderer and a gateway device) are available, in addition to a computer hosting the SDG.

Each SDG makes a NAT-binding in the local gateway device for its signaling with IMS, using UPnP, before registering with the core network. For security reasons, some gateways support that such NAT-bindings are bound to a remote host address that may use it to stop illegitimate access.

Results

With the prototype, we have found that the service presence protocol described in *Remote Service Awareness Protocol* above works as expected. The SDGs publish status information about the selected local services, and subscribers are notified when the status changes. For example, if a media renderer device is shutdown its presence status will be updated and subscribers are notified.

Conclusion

In this paper we have introduced the concept of service presence. With our prototype we have shown how it can be realized, and that the protocol works as expected.

This concept enables many new scenarios related to residential services, and services in general. For example, it allows Internet services to deliver content directly to residential services, such as media players.

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