Computer Standards & Interfaces 36 (2014) 368–379

Contents lists available at ScienceDirect

Computer Standards & Interfaces

journal homepage: www.elsevier.com/locate/csi

Location service and session mobility for streaming media applications in home networks

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ARTICLE INFO

Article history:
Received 23 September 2010
Accepted 18 August 2013
Available online 7 September 2013

Keywords:
Service Location Protocol
Session Initiation Protocol
Session mobility
Home network
Open Service Gateway initiative

ABSTRACT

In the near future, home networks are expected to become an important part of the user's ubiquitous environment. However, how to provide service discovery and multimedia services in such networks becomes a great challenge. In the paper, we propose an extension header, referred to as the "MediaService" header, into the Session Initiation Protocol to provide video streaming service. The streaming control and session mobility functions are also considered in the MediaService header. We also propose a peer to peer Service Location Protocol architecture for users to search for location of services across domains. We added a Substitute Request Message and cache policy into the Service Location Protocol to search for location of services across domains. A prototype implementation shows the performance of our prototype.

1. Introduction

In recent years, both mobile and fixed communication technologies have evolved to offer opportunities for interoperation between mobile devices and devices residing in a home network. The network interface embedded into various home appliances improves our daily life at home. Using these home networked appliances, users can remotely access and control home electrical appliances from their office, and the network services can access appliances in the kitchen, living room, or bathroom. The long expected intelligent home network will come of age in the near future.

The rapid advancement of communication technologies has increased the demand for network multimedia services in home. These multimedia services are proliferating at an accelerated pace and today include: video blogs, YouTube, and audio or video streaming. Due to the various multimedia services, the processes of accessing, managing, and searching for desired information have become a great challenge. Numerous different protocols, standards, and transmission modes, such as Service Location Protocol (SIP) [1], Service Location Protocol (SLP) [2,3], Universal Plug and Play (UPnP) [4], and Juxtapose (JXTA) [5] have been proposed for interconnection or discovery with these home networked devices and services.

In this research, we will propose a digital home environment with multimedia services. We utilize the SIP to create and maintain the multimedia session. SIP is an application layer signaling protocol, and has been adopted by the Voice over Internet Protocol (VoIP) and third Generation Partnership Project (3GPP) communities for their signaling protocol. SIP can be used to create, modify, and terminate sessions using one or more devices. However, SIP cannot be used to create and control a video streaming with RTP.

Thus, we design an extension header, referred to as the "MediaService", to provide a video streaming service using SIP with RTP [27]. The control functions for the video streaming service, such as pause, replay, and session mobility, are considered in the MediaService header. We implement the MediaService header in a SIP user agent (UA) based on the results proposed in [6]. We also integrated the SLP user agent function into the results proposed in [6]. Thus, the user can use the SLP UA to discover the video streaming or channel information which is provided by the media server, and initiate a video streaming session with the media server using SIP.

Moreover, the user may access the video stream from the Internet, such as MOD. The user can discover these potential video streams using a search engine via his or her computer. These search results are maintained only in the local host and cannot be shared by any other user. The Substitute Request Message and a cache mechanism are introduced into the SLP directory agent. Based on the Substitute Request Message, the SLP directory agent can discover services from another SLP directory agent and caches these search results in the SLP directory agent. To evaluate the ability of the proposed architecture, we implement the proposed architecture through modification of the code from several open source projects.

The remainder of this paper is organized as follows. The related literatures and standards are discussed in Section 2. A digital home environment with a multimedia services architecture is proposed in Section 3. Section 4 presents the digital home environment implementation with multimedia services. A performance evaluation for the proposed

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http://dx.doi.org/10.1016/j.csi.2013.08.008

system is provided in Section 5. Our conclusions and future works are given in Section 6.

2. Related works

2.1. Related protocols and standards

Universal Plug and Play (UPnP) [4] was proposed by Microsoft. UPnP uses a Peer-to-Peer network architecture and works with existing standard protocols such as HTTP, TCP, UDP, IP, and XML. The simple Service Discovery Protocol (SSDP) is defined in UPnP and can be used to provide service discovery. Based on UPnP standards, when the UPnP device joins the network, it announces its services by multicasting. The control point, which works as a UPnP device manager and can receive UPnP service and device descriptions, automatically receives the advertisement and subsequently uses their capabilities. The control points can also proactively the desired devices and services using SSDP, then subsequently control these services and devices.

Service Location Protocol (SLP) is a standard protocol defined by the IETF [2]. Three network components are involved in the SLP architecture to efficiently manage and discover services: They are Service Agents (SAs), Directory Agents (DAs), and User Agents (UAs). The SLP UA is a software entity used to search for network services, while SLP SA is a device that provides one or more services in a network. The SLP DA is a process that manages the services registered by the SLP SAs, or service manually configured in the DA's local database.

The Session Initiation Protocol (SIP) as in RFC 3261 [1] is a signaling protocol for Internet conferencing, telephony, and event notification. There are many elements that can be part of the SIP architecture: These elements involve Proxy Servers, Redirect Servers, Registrar Servers, and User Agents (UAs). A SIP UA is a software entity used to create or manage a SIP session. The Proxy Server acts as a SIP router and is responsible for forwarding SIP messages sent from other Proxy Servers or SIP UAs, to other Proxy Server or to one or more destination SIP UAs. The Redirect Server simply returns redirection information rather than forwarding a SIP request. A Registrar Server maintains a database that is used to resolve a SIP URI into an IP address of one or more SIP User Agents.

The Open Service Gateway initiative (OSGi) is an open standard service platform defined by the OSGi Alliance [7]. The OSGi Service Platform is an industry plan that proposes a residential gateway to connect internal and external networks. The OSGi Service Platform is composed of three key components: the framework, bundle, and service. The OSGi framework is built on top of a Java virtual machine. This framework is responsible for computing applications. The bundles are entities for deploying Java-based applications. Each bundle is a Java Archive (JAR) file that is comprised of Java classes and other resources. The bundle can provide its own Service Export to other bundles and also import services from other services into its applications. Each service is a set of java classes and interfaces implemented in bundles. These bundles are dynamically loaded, managed, and instantiated by the framework.

2.2. Related works

Numerous researchers have examined the services discovery issue. In [8], the authors proposed a strategy to provide a service location in SIP. The author used the SIP REGISTER method with the SLP registration to provide SLP registration, and defined a new header to carry the service message. They also used the SIP OPTIONS method to carry the service discovery information, and to retrieve the service information. In [9], the authors propose a service discovery mechanism in a home environment. They implement the service discovery mechanism into the OSGi platform. The OSGi platform can provide interconnection between heterogeneous network devices, but it cannot provide service discovery between heterogeneous devices. Therefore, the authors proposed an architecture for service discovery between heterogeneous devices. With the proposed architecture the users can easily search and access services available via different networks.

In [10], the authors proposed to integrate IPS into the OSGi platform to provide service discovery and interconnection in a SIP-based mobile network. They added a SIP device registration method into the SIP and OSGi platform. Thus, a SIP Device can registry the OSGi Service Registry. The authors also implemented a SIP bridging bundle to import heterogeneous services and devices into the OSGi platform and export to the SIP service. With their proposed architecture the users can easily search and access heterogeneous services using SIP.

Henning et al. proposed a smart home network environment for ubiquitous computing [11]. In their environment, the system can detect the user's location using sensor nodes or a GPS receiver within the user's handset device. The user can discover services and devices using Bluetooth and SLP and access these services and devices using SIP or HTTP through a wireless local area network (WLAN).

We proposed a residential gateway based on the OSGi architecture for a smart home network in [12]. To achieve automated heterogeneous discovery, registry, and management an SLP bridge bundle worked as SLP SA to discover the UPnP devices and services from the Service Registry of the OSGi platform, and to register these services and devices into SLP DA. An SIP bridge bundle was a module that can provide interconnection service between a SIP UA at outer network and UPnP devices at home network. Based on our proposed architecture, the user can easily discover and access UPnP devices and service using the SLP UA and SIP UA.

Session mobility is the key issue in SIP mobility management. A lot of researches were proposed in the services discovery issue. Shacham et al. proposed mechanisms to provide session mobility over multiple devices [13,25]. Their mechanisms can be divided into two different modes. The Mobile Node Control (MNC) mode using the Third Party Call Control (3PCC) [14] control mechanism and the Session Handoff (SH) mode using the REFER method [15]. In the MNC mode, 3PCC was introduced to establish a SIP session with each device used in the transfer in order to update its session with the corresponding node. The SH mode uses the REFER method to establish a SIP session with each device. The Multi-Device System was introduced to efficiently manage the transferred session between multiple devices in SH mode. In [16], the authors integrate the service discovery mechanism into the architecture proposed in [13]. They add the service discovery function into the Multi-Device System Manager. The SIP UAs will work as a SLP SA to advertise their services to the Multi-Device System Manager, which works as a SLP DA. Thus, the SLP UA can be integrated into a SIP UA, enabling them of a service from the Multi-Device System Manager.

We propose the session mobility over multiple devices using SIP [6,17]. In [17], we add the extension header “Mobility” to the REFER method to make transparent to the remote party and introduce the concept of an “Association” to solve the problem of the user having to terminate all devices separately when a session is split over multiple devices. In [6], we propose a complete mechanism, referred to as a “Session Integration Service”, to transfer and retrieve a session over multiple devices. The Nested Refer mechanism [18] was used to achieve the retrieval session action and the session manager transformation (SMT) and session manager acquirement (SMA) were proposed to provide much more flexibility in the session mobility. Based on the Session Integration Service, the user can transfer, split, and retrieve a session over multiple devices. Moreover, the split session can be integrated at any devices.

Mukhtar et al. proposed session mobility for multimedia streaming service using UPnP [19]. They used a control point to establish one-way streaming between the media server and media renderer and used the UPnP Action control message to provide session mobility from one media renderer to another. The Action control message can also be used to control one-way streaming services, such as pause and replay. Martínez et al. proposed another architecture to distribute the services between two different home networks, and to create end to end connections between two hosts in the different home networks [24]. They used