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A Cloud Computing Architecture for Content Management in Media Domain

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Abstract

Cloud computing is a new paradigm that offers scalability, reliability and availability when accessing resources across Internet. Media management is among the most outstanding aspects of cloud computing, since the cloud makes possible to retain and share large amounts of digital media. Current home devices can produce, store and deliver high quality media that can be finally distributed towards social networks and communities where constituent members might be family or friends. However, there is no infrastructure to keep data under control or even find a concrete media in the home environment or outside it. Media cloud has been designed to cope with this problem letting users constitute a cloud with friends, family or with people with the same interests with the sole objective of managing media transparently even if media is located outside their domains.

Keywords**:** *Cloud computing, Content Management, Content Distribution, Social Networks.*

1. Introduction

Computer paradigms evolved from the mainframe to grid computing, bringing new paradigms that changed our way to use and understand computers. Personal devices and consumer electronics have been influenced by those changes. There is an increasing interest in sharing media files with family and friends. However, UPnP or DLNA were not designed for media distribution beyond the boundaries of a local network and manage media files through web applications can be tedious. To overcome this problem, we propose Media Cloud, a middleware for Set-top boxes for classifying, searching, and delivering media inside home network and across the cloud that interoperates with UPnP and DLNA.

Universal Plug and Play (UPnP) and Digital Living Network Alliance (DLNA) alleviate the problems of sharing contents among devices in the home network but they lack a mechanism for searching across multiple repositories in parallel. They require users to organize contents in repositories and to define rules for sharing them. Moreover, they were not designed for managing media outside the home domain. To cope with this problem, this article describes a solution for bringing the cloud computing concept to the home domain.

2. Cloud Computing

The boom in cloud computing over the past few years has led to a situation that is common to many innovations and new technologies: many have heard of it, but far fewer actually understand what it is and, more importantly, how it can benefit them.

In an attempt to gain a competitive edge, businesses are increasingly looking for new and innovative ways to cut costs while maximizing value – especially now, during a global economic downturn. They recognize that they need to grow, but are simultaneously under pressure to save money. This has forced the realization that new ideas and methods may produce better results than the tried and tested formulas of yesteryear. It is the growing acceptance of innovative technologies that has seen cloud computing become the biggest buzzword in IT.

However, before an organization decides to make the jump to the cloud, it is important to understand what, why, how and from whom. Not all cloud computing providers are the same. The range and quality of services on offer varies tremendously.

Cloud computing describes highly scalable computing resources provided as an external service via the internet on a pay-as-you-go basis. The cloud is simply a metaphor for the internet, based on the symbol used to represent the worldwide network in computer network diagrams. Economically, the main appeal of cloud computing is that customers only use what they need, and only pay for what they actually use. Resources are

available to be accessed from the cloud at any time, and from any location via the internet. There's no need to worry about how things are being maintained behind the scenes – you simply purchase the IT service you require as you would any other utility. Because of this, cloud computing has also been called utility computing, or 'IT on demand'. This new, web-based generation of computing utilizes remote servers housed in highly secure data centers for data storage and management, so organizations no longer need to purchase and look after their IT solutions in-house.

2.1 Services of Cloud Computing

Cloud computing consisting of three sections:

2.1.1 Cloud Application

The applications are run and interacted with via a web browser, hosted desktop or remote client. A hallmark of commercial cloud computing applications is that users never need to purchase expensive software licenses themselves. Instead, the cost is incorporated into the subscription fee. A cloud application eliminates the need to install and run the application on the customer's own computer, thus removing the burden of software maintenance, ongoing operation and support.

2.1.2 Cloud Platform

It provides a computing platform or framework as a service. A cloud computing platform dynamically provisions, configures, reconfigures and de-provisions servers as needed to cope with increases or decreases in demand. This in reality is a distributed computing model, where many services pull together to deliver an application or infrastructure request.

2.1.3 Cloud Infrastructure

It is the delivery of IT infrastructure through virtualization. Virtualization allows the splitting of a single physical piece of hardware into independent, self governed environments, which can be scaled in terms of CPU, RAM, Disk and other elements. The infrastructure includes servers, networks and other hardware appliances delivered as Infrastructure "Web Services", "farms" or "cloud centers". These are then interlinked with others for resilience and additional capacity.

Open solutions could be those targeting systems where constituent members can be end-users. The objective of these open solutions is to help users to create a community for managing contents located inside or outside their local networks. The originality of this approach is to make the user equipment part of the cloud instead of hiring cloud services from third parties. Moreover, this approach is especially meaningful when the cloud deals with sensitive content, as user generated content, since trust in private clouds, as Media Cloud, is feasible to achieve and maintain.

3. Media Cloud Architecture

The objective of media cloud:

- Content Classification is done by providing indexing service.
- It is used for sharing large amounts of media with family and friends.
- It is reducing toughness and time consuming aspect of social network.
- It provides distributed search and transparent access.

Media Cloud considers transparency as a main goal: it allows devices from different home networks to communicate as if they were in the same local network. It uses well known protocols as DLNA and UPnP for interfacing the home network whereas uses HTTP and RTP over a secure channel for communications across Internet. Moreover, the solution is open since new protocols can be supported using the plug-in system. The cost effectiveness is achieved by sharing resources that could be underused in other cases. Media Cloud encourages cooperation among home networks facilitating media classification, management and sharing.

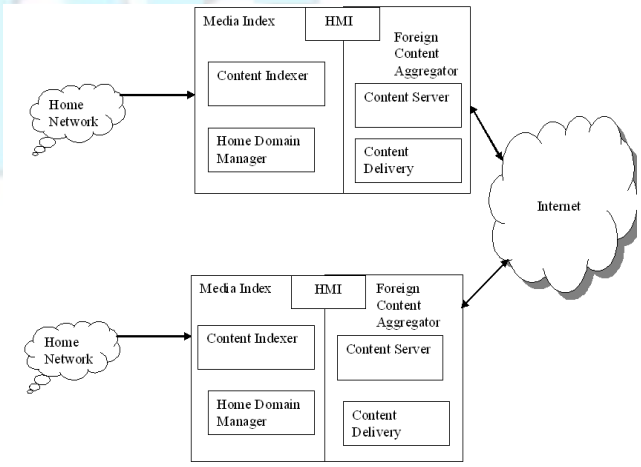

Fig. 1 Architecture.

Distributed search and content delivery over the cloud are among the most important features of Media Cloud. Fig. 1 sketches out the architecture of Media Cloud. It consists of home network, media cloud, media indexer and foreign content aggregator.

3.1 Home Network

A home network or home area network is a residential local area network (LAN). It is used for communication between digital devices typically deployed in the home, usually a small number of personal computer and accessories, such as computers and mobile computing devices. In the home networks they use UPnP and DLNA protocols to share the media content with their families and friends**.**

3.2 Media Cloud

Media Cloud is a middleware for enabling media-centered cooperation among home networks. Media Cloud is the bridge to an open architecture that allows users to join their home equipments to constitute a cloud. Media Cloud abstracts the underlying complexity to provide a new content distribution model that simplifies classifying, searching and accessing user-generated and commercial content within the home networks. Media Cloud consists of two modules: the Media Indexer and the Foreign Content Aggregator. Aside those modules there is a security layer which enforces security policies and filter contents.

3.3 Media Indexer

The Media Indexer discovers devices located in the home domain and interrogates them to gather information about the contents they retain. It uses content information to produce an index that will be used by the Foreign Content Aggregator to facilitate search operations. The Media Indexer has two functional blocks: the Content Indexer and the Home Domain Manager. The Content Indexer collects information about the content as media type, creation date, metadata, and user's annotations. It also registers access information as the hardware identifier or the network address of the device holding that content, protocols that can be used to access the content. With that information, it builds an index and stores it in the Home Media Indexes (HMI) database. Home Domain Manager (HDM) handles interaction with devices.

3.4 Foreign Content Aggregator

The Foreign Content Aggregator handles cloud communications. It makes content stored in devices at the home network available to other Media Cloud instances through Internet. The module is composed by a Content Server and a Content Delivery module. The Content Server facilitates foreign clients to search within the HMI database. The Content Delivery module sends content to other Media Cloud instances located outside the home domain. The authentication is handled by the Security Layer that issues a security token after a foreign client is successfully authenticated and authorized.

4. Implementation

The major constraint of the searching service is RAM since processing a request requires allocating memory for the request and for the associated security policy, whereas internal search operation over the index uses resources already allocated. Searching over the index takes usually the same time so the difference between modes is the RAM they allocate for this purpose. In the relaxed mode, we dedicate 8 Mb of RAM to the searching services limiting the CPU consumption to 20%. The loaded mode consumes 16 Mb of RAM and a 25% of the CPU. We tested our implementation with a STB for both modes of operation. The scenario was a cloud with 50 participants making one request at the same time to the Media Cloud node instantiated in the STB. I repeated the process 50 times. The Media Cloud STB used an index derived from 10 thousand media files. The memory consumption and the test time are shown in Fig. 2 for the relaxed mode and in Fig. 3 for the loaded mode.

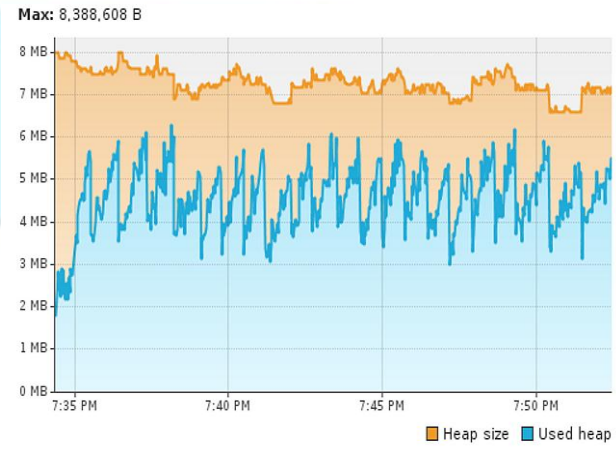

Fig. 2 Test results for relaxed mode using 8Mb of RAM.

The test for the relaxed mode lasted 1102 seconds. The Content Server used 547 seconds of that time to process the 2500 requests. The rest of the CPU time was used to parse the request, check the security policy, generate the response, and send it. The average used heap was about 5.6 Mb.

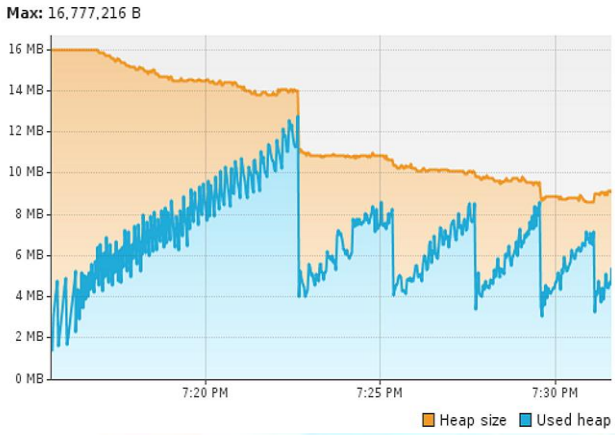

Fig. 3 Test results for loaded mode using 16Mb of RAM.

The test for the loaded mode lasted 950 seconds. The Content Server used 541 seconds of that time to process the 2500 requests, which is reasonably similar to the time the Content Server used in the relaxed mode tests, showing that the search operation time is, in practice, constant. Besides the average used heap was also around 5.6 Mb, the bigger heap allows Media Cloud to accommodate more requests without needing to free part of the heap making this mode a 15% faster.

5. Conclusion

Media Cloud provides an easy to manage, cost-effective solution for bringing cloud computing paradigm to content sharing among federated home networks.

The solution is easy to manage since it supports different devices by performing content adaptation. Media Cloud considers transparency as a main goal: it allows devices from different home networks to communicate as if they were in the same local network. It uses well known protocols as DLNA and UPnP for interfacing the home network whereas uses HTTP and RTP over a secure channel for communications across Internet. Moreover, the solution is open since new protocols can be supported using the plug-in system.

The cost effectiveness is achieved by sharing resources that could be underused in other cases. Media Cloud encourages cooperation among home networks facilitating media classification, management and sharing. Distributed search and content delivery over the cloud are among the most important features of Media Cloud. Unlike other cloud computing solutions, Media Cloud, due to its private character, mitigates privacy problems.

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