

# Distributed Multimedia Content with P2P JXTA Technology

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## Abstract

The peer to peer paradigm is explored through JXTA technology. In the first section an overview of JXTA peer to peer technology is presented. Secondly an application is built as proof of concept. This application is related to image access and retrieval. Support is provided both for metadata (VOTable) and the SIAPS image access protocol.

## 1 JXTA Peer to Peer Technology

Peer to peer (P2P) computing is a network model where possibly any node (peer) may be interconnected. A peer may also operate as a consumer or provider, unlike the traditional client/server architecture. JXTA ("JXTA," 2003) is an open source project (created by Sun Microsystems) that defines the following set of six language independent protocols ("Protocols," 2002) to provide a P2P infrastructure:

- |  |                                    |
|--|------------------------------------|
| • <i>Peer Discovery Protocol (PDP)</i>   | Resources search and advertisement |
| • <i>Peer Resolver Protocol (PRP)</i>    | Generic query service              |
| • <i>Peer Information Protocol (PIP)</i> | Net monitoring                     |
| • <i>Pipe Binding Protocol (PBP)</i>     | Addressable messaging              |
| • <i>Rendezvous Protocol (RVP)</i>       | Propagation service                |
| • <i>Endpoint Routing Protocol (ERP)</i> | Routing                            |

These protocols establish a ubiquitous, secure and pervasive virtual network (Traversat et al., 2002) on top of internet and non-IP networks, allowing peers to directly interact and be organized independently of their network locations, even behind firewalls and NATs (network address translation).

JXTA has been designed with the objective of making it ubiquitous. Any device including mobile phones, PDAs, pagers, electronic sensors through to desktop computers and servers, has the potential of being JXTA enabled. In order to maximise its platform independence and interoperability, widely accepted standards like XML form the basis of JXTA communications. The issue of security ("Security," 2001) is considered through the use of Transported Layer Security (TLS), Digital Certificate and Certificate Authorities.

JXTA protocols may be used to build different types of application, e.g. instant messaging, file sharing, data search, remote sensor communication, agent based systems (Babaoğlu, Meling & Montresor, 2002). It can also be used to implement a wide range of services. Thus, this technology provides the ability to integrate heterogeneous information sources in a decentralized, self-organized and secure way.

## 2 Simple P2P Image Service

A simple scenario has been considered to implement a peer to peer service as proof of concept. In this case, the basic idea is to implement a service where a user can search for an image in a P2P environment. To give more flexibility to this scenario, once the image has been located, different wavelet transform and multi-resolution ("MR," 2002) analyses can also be applied invoking MR software.

In this context, the Java binding ("Builds," 2002) of JXTA is used to create a virtual P2P network and the JXTA Content Management System ("CMS," 2002) is used to transfer the digital content. In addition, some extensions to the CMS core libraries are implemented to announce particular services.

Figure 1 shows how using this technology, the user is provided with a flexible application in order to access and analyse images. First, a provider advertises some image files by name and/or a free text content description. The multi-resolution service for this particular image is included in this 'content' advertisement. When a user searches for a particular image a JXTA query is propagated. When the content advertisement is located, the user can apply a multi-resolution analysis if desired, the image is compressed and sent to the requesting peer. When the image is received it is decompressed and displayed to the user.

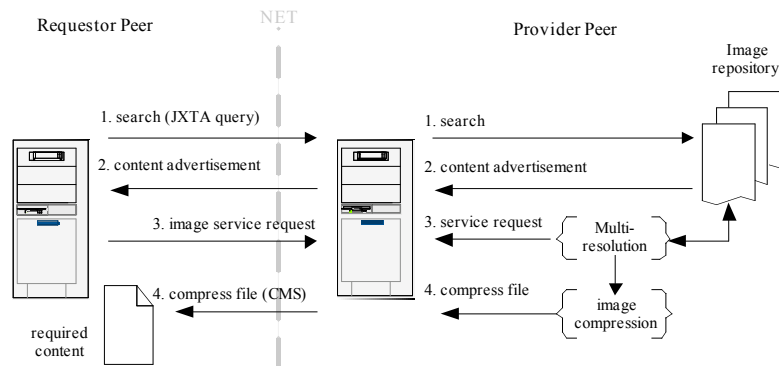
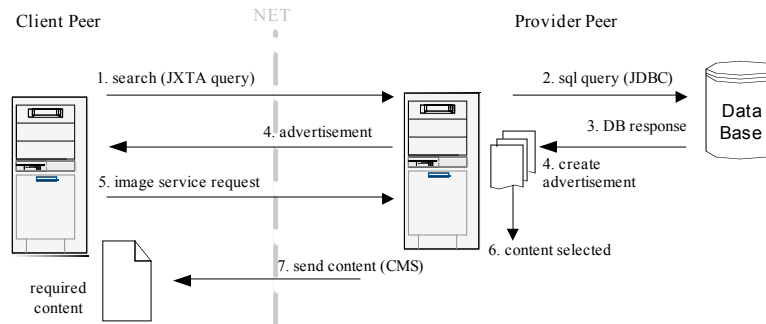


Figure 1: Simple P2P Image Service

## 3 Distributed P2P Database Access

To incorporate flexibility database searching is added to the model. In our particular approach the MySql database system and JDBC drivers are used to connect to and retrieve information from the database. In addition, multi-resolution processes and compression-decompression, as described above, may also be applied.

Figure 2 shows the process where a user searches for a particular multimedia content. The query is propagated through the peer network group and then received by the provider peer. The provider looks into the database and if this content exists, the provider creates a content advertisement with the result, which is returned to the user. Once this is done, the user can select a particular content advertisement and use this in order to retrieve the file.



**Figure 2:** Retrieval process in a JXTA database context

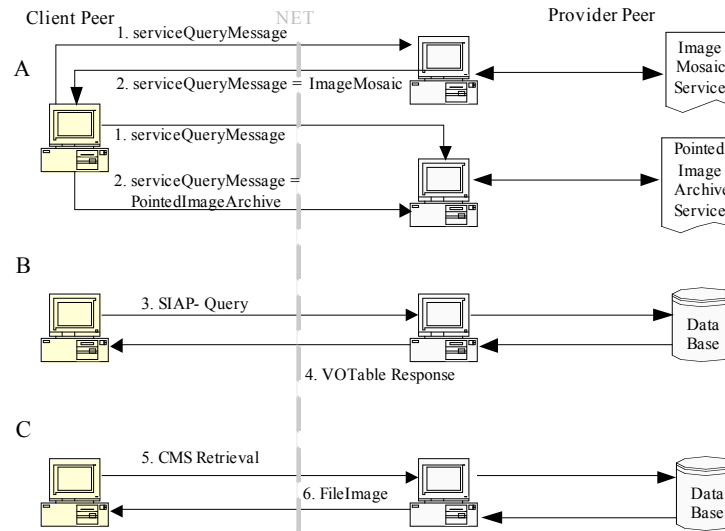
Bearing the above example in mind more complex scenarios may be created, depending on user requirements or specific service requirements.

## 4 P2P Distributed Image Repository

A tailored architecture for a wide range of applications could be created, taking into consideration the above examples. We have taken an astronomy example and implemented a peer to peer distributed image repository. JXTA provides a transport layer for collaborative and distributed work on image data. The image access infrastructure uses standards like “Simple Image Prototype Specification” (“SIAPS,” 2002) to provide services specification and VOTable (Williams et al., 2002) is used as the communication standard. We can access and query databases through the peer as well as hard drive repositories or other sources of information.

Figure 3 shows how the P2P distributed image repository works. The figure has been split in three sections to clarify the architecture. Section *A* shows a user performing a search for available image services within their current peer group. This query is marked ‘1’. The response received by the user is a list of the currently available image services, marked with ‘2’.

In section *B* the user has chosen a specific service to which a request using the SIAPS specification is sent. The response to this query is in the form of a VOTable, which includes a list of image names and their respective properties. The next step is described in section *C*. After the user has selected the files that they wish to retrieve, a retrieval request is sent to the provider and the requested files may be sent to the requesting peer. For the image retrieval process the JXTA CMS libraries are used.



**Figure 3: P2P distributed image repository**

## 5 Conclusion

The JXTA framework allows for the implementation of flexible and scalable infrastructure in order to build distributed and ubiquitous systems. We use this technology mainly in the image data case. However, distributed digital library scenarios or multimedia content could be applied with minimal effort.

It is necessary to consider that JXTA is relatively new. Thus, in some cases and given the actual implemented libraries, JXTA is not yet mature enough to resolve the entire range of problems that exist. E.g. the JXTA Java binding search mechanisms are still in development and therefore they could be improved.

There are currently scalability issues with any P2P solution and these do not escape JXTA. The main problem is the consumption of bandwidth due to the very nature of a P2P network. If every peer is to be fully independent and hold equal status then every peer must receive any messages broadcast within any given peer group. This has obvious bandwidth usage implications. This does however open up new avenues of interest in improving the efficiency of P2P networks by improving search mechanisms and routing decisions.

Our P2P distributed image repository will be improved in future developments, and new services will be included. Also, the incorporation of small devices like PDAs will be explored as well. These services will be tested for scalability and some solutions to the afore-mentioned problems will be proposed.

## 6 References

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