Séminaire Mathématique de Béjaïa (LaMOS)
Volume 9, 2010, pp. 25 - 29

5

Performance and Optimization of P2P Networks for IP Multimedia applications

Mourad AMAD et Djamil AÏSSANI

Laboratoire de Modélisation et d'Optimisation des Systèmes (LAMOS)
Université de Béjaïa, Béjaïa 06000, Algérie
Tél. (213) 34 21 51 88

Résumé In this paper, we propose a novel P2P architecture for improving dependability, adaptability, and scalability, whereas maintaining low complexity and rapid convergence for lookup algorithm. The new architecture is termed HPM, because it is organized as a set of hierarchical rings, which connect neighboring nodes in terms of both physical and logical locations, facilitating inter and intra routing mechanisms. In particular, we show that lookup cost of HPM is $O(\sum_{i=1}^{4} log_2(n_i))$, where n_i represents the number of nodes on ring level i.

Key Words : P2P, Routing Optimization, Physical Proximity

5.1 Introduction

P2P computing refers to a class of systems that employ distributed resources to perform critical functions, such as resources localization, in a decentralized manner. According to different design goals, a number of system variants has been seen in P2P community. For example, P2P system proposed in [2] allows file sharing or computer resources and services by direct exchange between systems, or, P2P is defined as a class of applications that takes advantage of resources-storage, cycle, content, human presence-available in the Internet.

In this paper, we propose a new P2P architecture for resources discovery called *HPM*. HPM can be classified as a structured P2P system. The nodes in HPM architecture are organized as a multi-levels hierarchical set of rings, closed in terms of physical and logical proximities. Each level is composed of several rings. A ring is composed of at most 256 nodes. A node can belong simultaneously to two rings. One of the main benefits of our proposed architecture is the rapid convergence of the lookup process optimizing the cost lookup, while providing an efficient mechanism for fault tolerance and scalability. The routing table is also better optimized compared to the main P2P architecture.

5.2 Related Work

The process of routing in P2P networks operates at application layer. The overlay P2P network may lead to routing inefficiency, as opposed to routing service provided by the transport layer (IP). Our proposed HPM routing objectives are : minimizing the number of hops and delay, locating nodes that store data or resources in purely decentralized P2P networks, but also, controlling the overhead while considering the physical proximity of nodes. In this context, HPM is considered as a scalable P2P protocol that optimizes resources discovery and localization function in a decentralized manner. It is based on cryptographic hash function for resource identifier, IP addresses and port number for node identifier. HPM architecture belongs to the third generation of P2P systems, which is based on specific topology that consider physical proximity. The following section describes and analyses the HPM architecture.

5.3 HPM : Concept, Principle and Architecture

HPM is organized as a set of hierarchical rings (*see figure 5.1*). Each layer or level i is composed of 2^{i-1} rings that connect neighboring nodes. In HPM, each node n is identified by a unique identifier, which is the i^{th} part of its IP address divided on four equal parts. i represents the level to which the node n belongs. The resources are also identified by a unique identifier. Each resource key is also composed of four parts (a.b.c.d). Each ring has 256 (2^8) nodes. The first level is composed of one ring and contains the nodes with IP addresses that are different in the first part, with no restriction on the other parts. From the example illustrated on figure 5.1, a first node n with IP addresses : 176.x.y.z, belongs to level 1, and gets identifier N176, while the other nodes with IP addresses, such as 176.a.b.c do not belong to the same ring (*level 1*) as node n. Each level connects a maximum of 256^{i-1} rings. One of the main HPM characteristics is that nodes with the network IP address such as : 50.31.60.**123**, 50.31.60.**125** belong to the same ring on the same level (*level 4*). In this way, the physical and logical proximities are somehow taken into account. On each ring of each level, nodes are organized and ordered increasingly based on their identifiers.

Each resource with an "a.b.c.d" type identifier, will be placed and located at the node with IP address w.x.y.z, where w (*respectively x,y,z*) is the lowest value greater or equal to a (*respectively b,c,d*). In figure 5.1, data with key K50.31.240.252 is placed on node N254, with IP address 50.31.240.254 on level 4, because 50 (*respectively 31, 240 and 252*) is the lowest value greater or equal to 50 (*respectively 31, 240 and 254*).

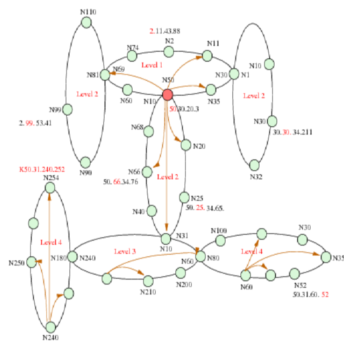

Figure 5.1. HPM architecture

5.3.1 Finger table in HPM

Each node n maintains a routing table of at most m entries, called the finger table. The i^{th} entry in the finger table of node n contains the identifier of the first node s, that succeeds n by at least 2^{i-1} on the identifiers circle. We call node s the i^{th} finger of node n. A finger table entry includes both HPM identifier and IP address of the relevant node. Figure 5.2 shows the finger table of a node with IP address **50.10**.20.3, belonging to two levels, and then has two identifiers : N50 on level 1 and N10 on level 2.

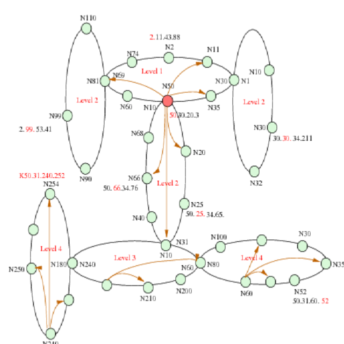

Figure 5.2. Finger table in HPM

5.3.2 Lookup process in HPM

For each ring k at level i, we use the i^{th} part of the data key for the lookup process, as in Chord. If the request succeeds on this ring k, the cost lookup is $O(log_2(n_i))$. In case where the resource does not exist on the active covered ring, the search or localization is done on ring level $i+1$ or $i-1$, in a deterministic manner (*greedy routing*), then the lookup process cost is $O(\sum_{i=1}^{4} log_2(n_i))$, where n_i is the number of nodes on the covered ring at level i (*on which the request succeeded*). Algorithm 1 gives a pseudo code for the lookup process in HPM.

Algorithm 1 : Lookup data pseudo code (HPM) **Lookup (Key** $c_1c_2c_3c_4$**)**

1 : Begin
2 : Locate the node X (*in the same ring*) of IP Address $p_1p_2p_3p_4$, where p_i is the smallest value greater or equal to c_i, $\forall i \in [1..4]$.
3 : **If** $\exists\, c_j$ where $c_j > p_j$ and $j < i$ **Then**
4 : go to level $(i-1)$ and call **lookup (Key** $c_1c_2c_3c_4$**)** (*if* $i > 1$, *otherwise, data does not exist*)
5 : **Else If** the data is present **Then**
6 : Loading data from resulting node.
7 : **Else**
8 : go to level $(i+1)$ and call **Lookup (Key** $c_1c_2c_3c_4$**)** (*if* $i < 4$, *otherwise, data does not exist*)
9 : End.

5.4 Conclusion and Future Work

In this paper, we have proposed a new approach aims to efficient resource discovery and location. Our proposed HPM architecture provides this discovery/localization service, based on a complete decentralized architecture, by determining with efficiency the node responsible for storing the requested key's value. The node identifier is built from one part of its IP address, while the resources identifier is generated by a hashing function from the resource name as key. In N-node HPM network, each node maintains routing information for only $2 * O(log_2(n_i))$. HPM takes into consideration the physical topology and proximity. So, higher the level is, higher the physical nodes proximity is. In terms of perspectives, recent technique for application layer multicast [4] can be implemented using the proposed HPM for real time oriented applications.

Références

1. Detlef Schoder and kai Fischbach, The Peer-to-Peer Paradigm, in Proc of the 38th Hawaii International Conference on System Sciences, IEEE Internet computing, 2005.
2. Peer-to-Peer Working Group, Bidirectional Peer-to-Peer communication with interposing Firewalls and NATs, Peer-to-Peer Working group, White Paper, 2001.
3. Haiying Shena, Cheng-Zhong Xua and Guihai Chenb, Cycloid : A constant-degree and lookup-efficient P2P overlay network, Journal of performance evaluation, 63(3), Elsevier, Pages 195-216, 2006.
4. Mourad Amad and Ahmed Meddahi, A Scalable Approach for Application Layer Multicast in P2P Networks, in Proceedings of Sixth Annual IEEE International Conference, on Pervasive Computing and Communications, Hong Kong, 2008.

5. Hari Balakrishnan, Frans Kaashoek, David Karger, Robert Moris and Ion Stoica, looking up data in P2P systems, Com of the ACM, Vol 46(2), P43-P48, 2003.
6. Karl Aberer, Luc Onana Alima, Ali Ghodsi, Sarunas Girdzijauskas, Seif Haridi and Manfred Hauswirth, The essence of P2P : A reference architecture for overlay networks, in Proceedings the 5th IEEE International conference on Peer-to-Peer computing, 2005.