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ISO/IEC JTC1/SC6 Secretariat Ms. Jooran Lee, KSA (on behalf of KATS)

Korea Technology Center #701-7 Yeoksam-dong, Gangnam-gu, Seoul, 135-513, Republic of Korea ;

Telephone: +82 2 6009 4808 ; Facsimile: +82 2 6009 4819 ; Email : jooran@kisi.or.kr

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The P2P (peer-to-peer) is a very popular service which enables end-users to share data and resources. The popularity has caused P2P traffic to consume over 70% of Internet resources from the year 2006. Various standardization activities have recognized this problem and have initiated standardization to overcome part of this problem. However, the problem of P2P is that it is user based communication services, thus, P2P service is not manageable nor is provided with efficiency to the network. New P2P service needs to be defined which is controllable and provide efficiency in the network.

This document proposes to discuss about possible future new work items in JTC 1/SC 6 on Standardization on Managed Peer-to-Peer (P2P) technologies. This document is submitted for discussion to the ISO/IEC JTC 1/SC 6 meeting which will be held in Barcelona, January 2010.

Contacts:

- Sung Hei Kim (shkim@etri.re.kr, ETRI/Korea)
- Wook Hyun (whyun@etri.re.kr, ETRI/Korea)
- Shin-Gak Kang (sgkang@etri.re.kr, ETRI/Korea)

Standardization Initiative of JTC 1/SC 6 on Managed P2P Technology

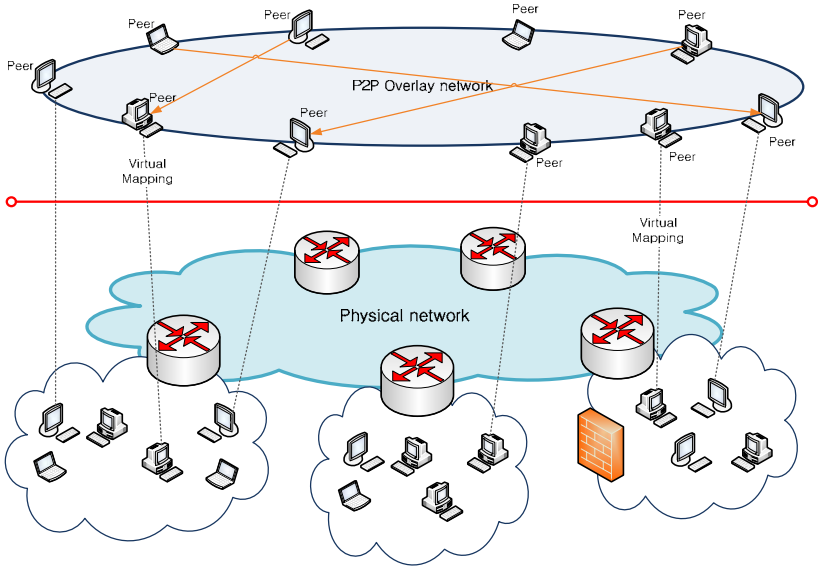
1. Background

This document describes initial considerations on new work item “Standardization on Managed Peer-to-Peer (P2P) Framework”. During the JTC 1/SC 6/WG 7 Tokyo meeting in June 2009, introductory presentation on Managed P2P was made by the Korean Experts to collect various suggestions in initiating new standardization work items for the Managed P2P technologies. The SC 6/WG 7 meeting showed positive response and consensus about the further study and continuation of the initiation of formal proposal for new work item on Managed P2P. Based on the meeting result of WG7 June 2009 meeting, this document is prepared for further considerations of detailed standardization issues for P2P technologies.

This document provides some useful informative materials for consideration of possible new standardization work items on managed P2P technology in JTC 1/SC 6. It describes technical issues and problems of P2P and the necessity for standardization initiative of JTC 1/SC 6 on Managed P2P along with standardization activities on P2P of various relevant standards development organizations.

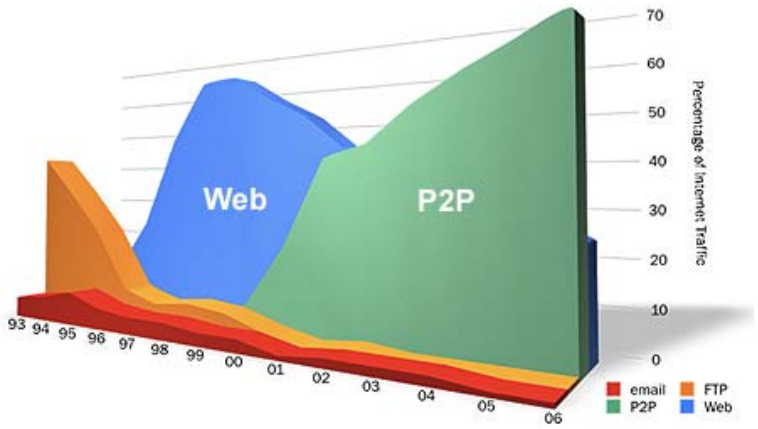
2. Introduction

A peer-to-peer(P2P) distributed network architecture is composed of participants that make a portion of their resources (such as processing power, disk storage or network bandwidth) directly available to other network participants, without the need for central coordination instances (such as servers or stable hosts)[1]. The characteristic of P2P which lets users share their resources directly attracted many people. As a result, P2P services which enable end-users to share data and resource are used very popularly world-widely. File-sharing, distributed computing, and media streaming are some of the popular services using P2P.



<Figure 1 – P2P overlay network>

The peers in the P2P distributed network forms an overlay network. The application level routing is used to route P2P service in the overlay network. This architecture allows peers to create new service or application without the intervention from the network infrastructure or central instance.



<Figure 2 – P2P Traffic in the Internet> [2]

The popularity of P2P service has caused P2P traffic to consume over 70% of Internet resources from the year 2006. It has surpassed various used-to-be dominate network applications such as ftp, web, etc.

2.1. Characteristics of P2P

P2P has the following two characteristics which make it different from conventional client-server architecture.

2.1.1. Distributed resource sharing

In P2P architecture participating nodes share it resources. The resources may include, for example, data, application, computing power, connectivity, and presence. Each node can be connected with other nodes and can be distributed independent of geographical limitation. In P2P network, content-based routing can be conducted because the target of routing is not physical address but content or resource. Since the content is provided not from the specific central server but from other peers, bottleneck effect is not occurred which can be observed in server-based architecture.

2.1.2. Distributed self-organization

Each peer in the P2P network performs both client function and server function and conducts self-organization. As a result, P2P network can be re-organized dynamically. Pros and cons of P2P are summarized in the following table.

<Table 1 - Pros and Cons of P2P>

Pros	Cons
- Resilient to failures & network dynamics - Unlimited network bandwidth (donated by participants) - Easy deployment without a network support - Good scalability with distributing loads to participants - Users can share various resources	- High Churn note1) - QoS are dependent on the access network capacity - Selfish participants note2)

N ote1) Frequent join/leave of users cause P2P service instability
Note 2) User tends to limit(minimize) uplink bandwidth

2.2. P2P applications

There are various types of P2P protocol and application that are being used in Internet, nowadays. Table 2 shows the usage and example of applications of P2P.

<Table 2 - Type of P2P applications>

Usage	Applications
File Sharing	Napster, Gnutella, BitTorrent, KaZaA
Video/Voice over IP	Skype
Multimedia streaming	CoolStreaming, PPLive, GridMedia

2.2.1. File sharing

Napster, E-donkey, and BitTorrent are some of the most popular application using P2P technology. In the early stage, two types of architecture were dominant in P2P. The first type is centralized architecture which requires database server for managing index and group, and the second type is pure P2P architecture which does not have any server (i.e., Gnutella, Freenet)[3]. Currently, the hybrid architecture which uses central index server (i.e., instance tracker) is popularly used. In the hybrid architecture, each peer gets peer list from the central index server. Peer communicates with other peers directly to share resources. BitTorrent is one of the typical examples of the hybrid architecture. DHT-based P2P is also popularly used which discovers peer through DHT(Distributed Hash Table).

2.2.2. Video/Voice over IP

P2P technology can be also used in video/voice over IP service. Skype is a well-known P2P application used for Video/Voice over IP.

2.2.3. Multimedia streaming

From few years back, P2P technology has started to be used in multimedia streaming service like UGC(User-Generated Contents)/UCC(User-Created Contents)/CGM(Consumer-Generated Media). The most popular P2P-based multimedia streaming services are Zoost, CoolStreaming, and PPLive.

P2P multimedia streaming can be classified into two types. First type is full-mesh based multimedia streaming in which every peers has the same qualification sharing media resources. The full-mesh approach suffers from quality degradation and buffering delay if the required data is not gathered at the time of the play.

Second type is tree-based method in which peers construct an overlay tree. The child peer can receive resources only from its parent. In the tree-based approach, failure in the middle peer results in service failure for every subordinate peers of the failed peer.

3. Problem statements of current P2P technologies

3.1. Disregarding underlying networks

Current P2P does not have the information of the underlying network, peers are randomly selected. Thus, the selected peer has small possibility of being the peer of the shortest path from the underlying network perspective. The overlay network configured in the P2P is not an efficient network path. This characteristic results in unnecessary P2P traffic increase.

3.2. No guarantee on QoS

Current P2P cannot support/guarantee QoS. Due to the overlay characteristic of P2P, the P2P path consists of path to several peer nodes. Visiting peer node means visiting the access node of the pertaining peer, therefore this problem leads to serious QoS degradation.

The concept of P2P can be used in various applications. However, this characteristic prevents P2P from being used in service or application requiring certain level of low latency, high reliability, and priority.

3.3. Lack of reliability

Current P2P has high churn characteristic in which large number of users leaves and joins the P2P in a short period of time. The P2P application and service rely on interaction with one or more peers. If the selected peer abruptly leaves the P2P service, P2P service can suffer from service discontinuity. The extreme peer dynamics and flash crowd results in lack of service reliability and robustness.

3.4. Network load concentration on specific peers/networks

P2P resources are not evenly distributed throughout the network which results in network load concentration on specific peer or specific part of the network. Network status changes frequently from extreme peer dynamics and flash crowd. Unpredictable behavior of P2P peers makes it impossible to predict traffic flow.

3.5. Security and privacy concerns

The network participants of P2P are individual who are not verified. The contents or resources that are provided by the network participant, i.e. peer, may be unreliable which may contain viruses, worms, Trojan horses, malware, and spyware.

In some P2P service, personal information of the peer may be exposed to the public during information exchange process.

Another problem of P2P is that it is impossible to control the transmission direction of P2P traffic and to prevent illegal distribution of contents. It is copyright problem is one of the serious problem in P2P which is impossible to control.

3.6. Lack of control of P2P service

P2P is an overlays at application layer, thus routing layer functionality is duplicated in network layer and application layer. Due to the overlay characteristics, it is impossible to control the transmission direction of P2P traffic and to prevent illegal distribution of contents.

Explosive increase of P2P traffic has cause problem to other Internet service provided by the ISP. Filtering P2P traffic may cause regulation problem in some countries, and filtering task itself is an exhaustive task on the network layer.

4. Technical issues for Managed P2P

Chapter 3 has stated some problems of P2P. Many of the P2P problems can be resolved through P2P manageability, i.e. managed P2P. There are more technical issues that should be dealt with in P2P then just solving the P2P problems. This chapter discusses some technical issues that should be considered for managed P2P.

4.1. P2P traffic control

The current P2P has the advantage for the content owner to distribute contents easily without additional cost and without intervention from the ISP. This advantage has caused tremendous increase in popularity of P2P and increase in P2P traffic. As a result, the ISP is faced with increase in network maintenance cost.

Therefore, ISP and the P2P service provider need to cooperate and find to provide efficient P2P service and control P2P traffic. Research is needed to define efficient cooperation method between ISP and P2P to resolve issues such as traffic regulation, efficient distribution, QoS-enabled service, etc.

4.2. Cooperation with ISP

The overlay network configured in the P2P is not an efficient network path. If the underlying information is available to P2P, then it would be more efficient to select peer from the shortest path. This would also means an efficient overlay network. P2P service can be improved, if the overlay network is created based on the efficient path of the underlying network.

Research on coordination method with ISP is needed to provide effective P2P service and enhanced performance. Research is needed to define effective protocol between ISP and P2P

service provider. Research details include defining secure entity to communication with ISP, information exchanged, information used.

4.3. Guarantee of QoS/SLA

Legacy Internet has limitation to provide end-to-end QoS. Moreover, it is impossible to provide QoS in the P2P, since the P2P network status changes frequently from extreme peer dynamics and flash crowd. P2P network tries to deal with this problem through over-provisioning with data redundancy and replication in the overlay network. However, it is impossible to provide QoS through such method for unpopular contents, i.e. contents that are shared by only small number of peers.

For P2P, new QoS concept and new method of QoS guarantee are needed to be defined to accommodate various types of P2P applications. For example, in order to provide high quality real-time P2P service, concept of time should be added to the QoS parameter.

4.4. Contents/resource protection

The greatest problem of P2P application is the copyright problem. Currently, tremendous contents that are exchanged in the P2P applications are contents with copyrights (e.g. music, movie, software, documents). Protecting content through encryption is one of the methods to resolve this problem. Another method is to find effective method to stop illegal distribution of contents in the network. Research in both methods is needed to resolve this problem.

4.5. NAT/Firewall traversal

There is no NAT traversal problem for normal streaming and download service, since the traffic flows in one direction. In P2P, peer delivers received traffic to other peer which means bidirectional traffic flows, thus in some cases NAT traversal problem can occurs. Therefore, P2P needs to resolve the NAT traversal problem. There are various activities in resolving NAT problem which are STUN (Simple Traversal of User Datagram Protocol), ICE (Interactive Connectivity Establishment), TURN (Traversal Using Relay NAT) in IETF and UPnP (Universal Plug and Play) Forum.

4.6. Reliability and robustness

In order to solve reliability problem, managed P2P needs to deal with problem of frequent state changes of peer (join, leave, stop, etc.) to provide stable and robust P2P services. In order to provide P2P in mobile environment, managed P2P also needs to consider issues related to changes of heterogeneous network environment.

4.7. Seamless service continuity during topology adjustment

The overlay network of P2P changes due to frequent join and leave of P2P peers. Thus, service can be affected during the network adjustment. Managed P2P needs to define method to provide seamless service continuity during changes to network topology through self-organization, self-configuration of the overlay network.

4.8. Incentive mechanism

The success of P2P is from contribution by many participants who share their contents, computing and networking resource to the public. However, many participants are being selfish peers, that is, peers who get their desired contents or resources but do not share to the public. There are issues relating to differentiating selfish peers and unselfish peers and provide incentives to the unselfish peers. It is difficult to maintain incentive information, since P2P is not member-based service. Research on effective incentive mechanism is needed to resolve this issue and provide sophisticated P2P service.

5. Standardization activities on P2P-related issues

Various standardization activities have recognized the P2P problem and have initiated standardization to overcome some of the described problem. This chapter looks at the activities of the standardization organization on P2P-related issues.

5.1. IETF ALTO WG

When selecting peer, P2P can use the network information by calculating link performance with the candidate peers. However, this process is time consuming and is not appropriate for dynamically changing P2P environment. The calculated link performance is not accurate and can vary due to dynamic network environment.

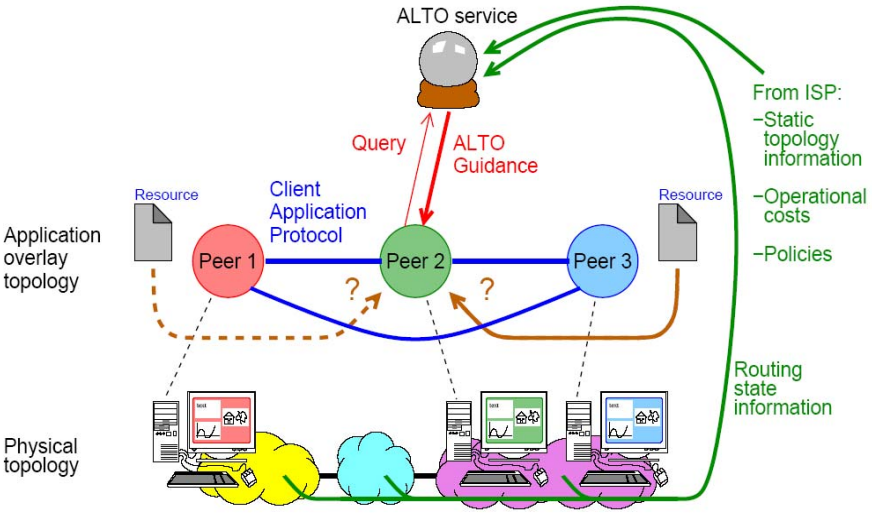
IETF ALTO WG is working on method to define efficient peer selection mechanism compared to random selection method used in current P2P. The goal of IETF ALTO WG is to maximize bandwidth, minimize cross-domain traffic, and decrease traffic cost in P2P. It uses the underlying network information in selecting peer to increase P2P performance and decrease ISP cost.

The work item of IETF ALTO WG is as follows:

- "Problem Statement" document: To describe problem of P2P traffic and define common terminology
- "Requirement" document
- "Request/Response protocol" for querying ALTO service
- "Core request/Response formats and semantics" to communicate network preferences to application
- "Service Discovery Mechanism"

The IETF ALTO WG defines ALTO server with the following concept:

- Can the ALTO service realistically discover that information?
- Is the distribution of that information allowed by the operators of that service?
- Is it information that a client will find useful?
- Can a client get that information without excessive privacy concerns (e.g. by sending large lists of peers)?
- Is it information that a client cannot find easily some other way?

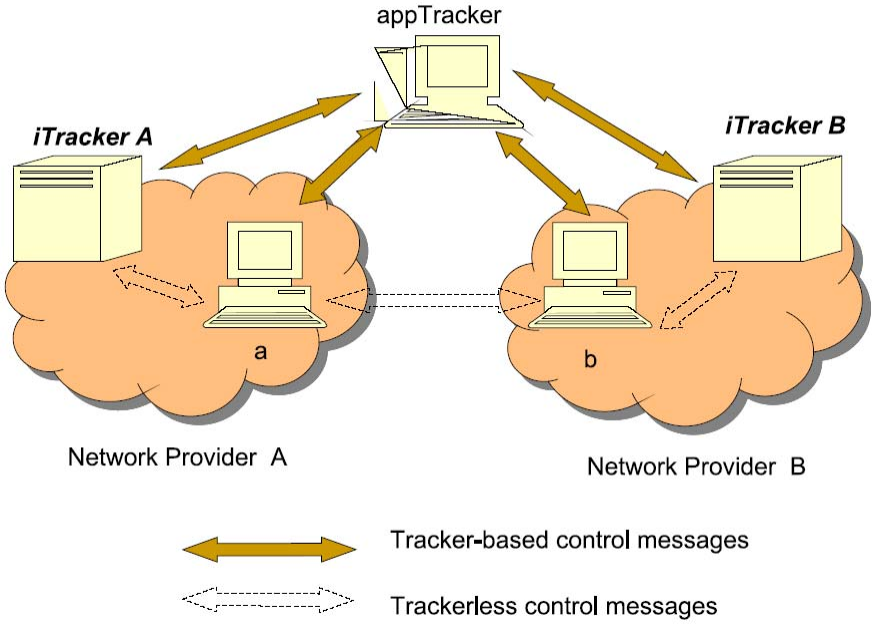


<Figure 3 – ALTO scenario> [4]

The ALTO WG focuses on communication protocol between ALTO service and P2P application (i.e. ALTO client) to provide application level traffic optimization. However, in order to realize the ALTO protocol, transport and network layer along with application layer needs to acknowledge the ALTO protocol. Thus, application-layer protocols for Internet coordinate systems and routing protocol extensions for ISP-based solutions are needed for ALTO protocol.

5.2. P4P (Proactive Provider Assistance for P2P)

P4P(Proactive Provider Assistance for P2P) is a framework that enables ISPs and P2P service providers to work jointly and cooperatively[2]. The purpose of the P4P framework is to accelerate distribution of content and to optimize utilization of ISP network resources in order to provide the best possible performance to end-user customers. To accomplish this purpose, P4P uses iTrackers and appTrackers. The appTracker is a dedicated equipment of P2P system to provide peering information from iTracker. The iTracker is a dedicated entity owned by individual network providers to provide appTracker network information of peer.



<Figure 4 – P4P structure> [5]

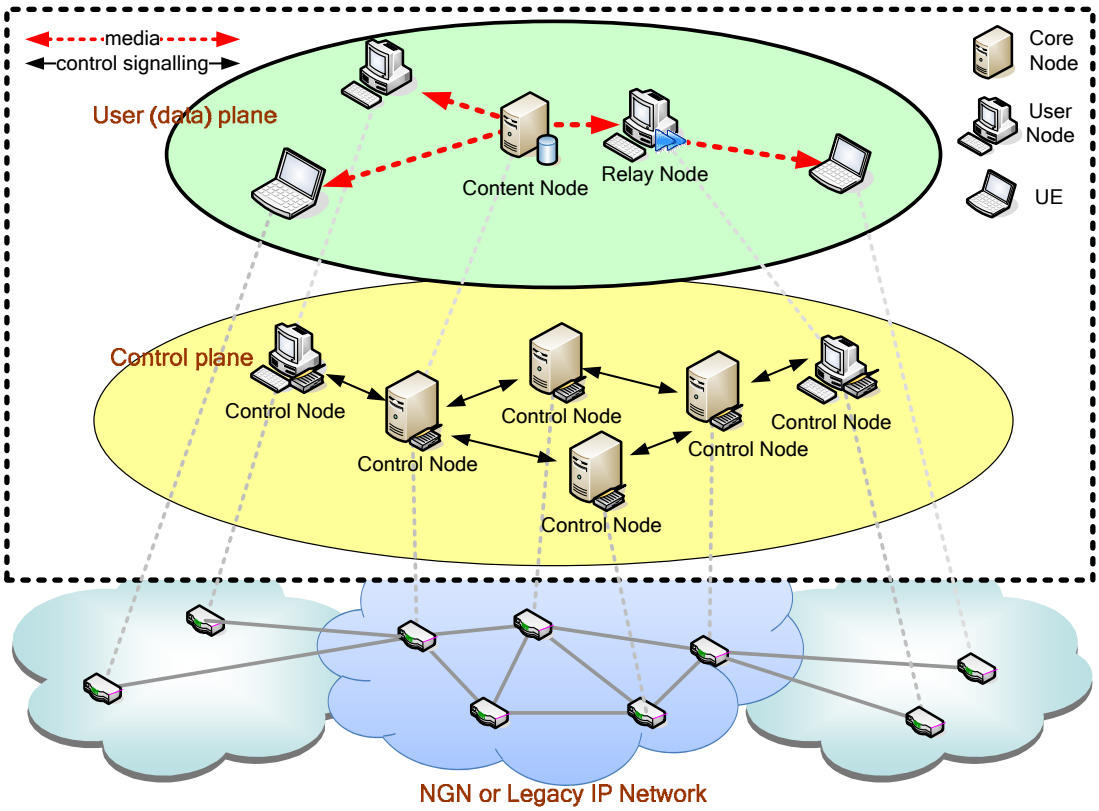
P4PWG has been conducting P4P field tests as of March 2008 and has shown that both ISP and P2P service can benefit from P4P. Nowadays, P4PWG is working on applying iTracker technology to IETF ALTO protocol and has recently finished IETF RFC 5632 entitled "Comcast's ISP Experiences in a Proactive Network Provider Participation for P2P (P4P) Technical Trial"[6].

However, P4PWG still has some challenges to be solved. First, last-mile network congestion is not addressed yet. Second, P4P is not applicable to the vast majority of P2P traffic today. In addition the majority of P2P traffic is unmanaged even if P4P is useful to manage content delivery network[2].

5.3. ITU-T DSN (Distributed Service Network)

ITU-T is standardizing P2P related works through DSN(Distributed Service Network) in SG 13. The first official meeting of DSN has started in January 2009.

DSN is based on the distributed technology such as P2P and mesh technology to create an overlay network to share resources within the managed network. The DSN has the self-configuring, self-managing, and self-healing functions to provide efficient distributed and manageable service. The DSN provides distributed functionalities which includes distributed rout ing and distributed storage capabilities.



<Figure 5 - DSN Model> [7]

The DSN defines two types of peers which are classified in terms of the position of the service domain. The peer residing inside the service provider's domain (i.e., core node) manages and controls the peer residing outside the service provider's domain (i.e. user node). The user node itself does not have the ability to initiate distributed service. The ultimate purpose of the DSN is to defines business solution and tools for the service provider in providing distributed service including the P2P service

Currently, ITU-T DSN standardization is in the early stage of standardization which is working on DSN requirements and architecture. Thus, it is too early to discuss the precise status of the standardization activities on ITU-T DSN.

6. Proposed work items in JTC1/SC6 on Managed P2P

6.1. Managed P2P issues for standardization in SC6

A peer-to-peer (P2P) distributed network architecture is composed of participants sharing resources without the central coordination instances. This characteristic of P2P has attracted many people which results in world-wide popularity. However, unmanageable characteristics of P2P have caused various technical and social problems. The future P2P applications and services need to resolve these problems by applying manageability and enhancing capabilities.

SC6 needs to resolve the fundamental problem of P2P and to define advance features for managed P2P. Some of the issues that need to be covered by the SC6 to realize manageability of P2P are as follows:

- P2P traffic control: Research P2P traffic to resolve issues such as traffic regulation, efficient distribution, QoS-enabled service, etc.
- Cooperation with ISP: Research on coordination method with ISP to achieve P2P manageability.
- Guarantee of QoS/SLA: New QoS concept and method of QoS guarantee needs to be defined to accommodate various types of P2P application
- Content/resource protection: Research on content distribution method to control P2P contents/resources from the network perspective.
- Reliability and robustness: Define method to deal with various state changes of peer (join, leave, stop, etc.) to provide stable and robust P2P services.
- Seamless service continuity during topology adjustment: Define method to provide seamless service continuity during changes to network topology through self-organization, self-configuration of the overlay network.
- Incentive mechanism: Since the P2P overlay network is based on resource contribution, research on effective incentive mechanism is needed to provide sophisticated P2P service.

6.2. Direction of standard development work in JTC 1/SC 6

The direction of standard development in JTC 1/SC 6 consists of two stages. The first stage is to develop the framework of managed P2P technologies which includes definition, concepts and requirements of managed P2P. Various use cases for the managed P2P will be included in the first stage. The framework document can be used as a base document for development of the protocol issues of the second stage of standardization of managed P2P.

The second stage is to develop specific protocols in according to requirements and each use cases which specified in the framework document of the first stage.

6.3. Proposed work on standardization of Managed P2P

This proposal is to initiate standardization issues on managed P2P of the first stage which is to develop the framework of managed P2P. The proposed framework of managed P2P standard will need to cover following issues:

- Classify of various problems of conventional P2P
- Define taxonomy and concept of managed P2P
- Define various issues and requirements to support managed P2P
- Define framework for managed P2P that are independent of P2P mechanism
- Define various use cases to support various features of managed P2P

There are other standardization organizations such as ITU-T and IETF that are currently standardizing P2P related issues. These organizations are working to resolve some parts of P2P problems. However, none of them aims to deal with the fundamental problems and issues of P2P especially in the networking perspective. JTC 1/SC 6 needs to lead in standardizing of managed P2P technologies by working on unresolved P2P problems. JTC 1/SC 6 will not re-invent the wheel of the related activities of other organization but cooperate in the standardization process.

As a result of discussions and considerations, it is proposed to initiate NP text to establish new work item in JTC 1/SC 6 following by NP ballot processing.

Reference

[1] Rüdiger Schollmeier, A Definition of Peer-to-Peer Networking for the Classification of Peer-to-Peer Architectures and Applications, Proceedings of the First International Conference on Peer-to-Peer Computing, IEEE (2002)

[2] http://www.openp4p.net/

[3] Mihajlo A. Jovanovic, et.al, “Scalability Issues in Large Peer-to-Peer Networks - A case study of Gnutella”

[4] Jan Seedorf, et.al, "Traffic Localization for P2P-Applications: The ALTO Approach", Ninth International Conference on Peer-to-Peer Computing (IEEE P2P 2009), IEEE, September 2009.

[5] Haiyong Xie, et.al, “P4P: Provider Portal for Applications”, ACM SIGCOMM Computer Communication Review, Volume 38, Issue 4, October 2008.

[6] Jason Livingood, Rich Woundy, "Comcast’s Experiences In a P4P technical Trial", IETF RFC 5632, Sept. 2009.

[7] ITU-T SG13, Draft Recommendation Y.dsnarch, Architecture of DSN, 2009