Personal Internetworking Using P2P Architecture over IPv6

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Abstract —*The purpose of this paper is to study the feasibility of Personal Internetwork (PIN) and find the approach to achieve the real cooperation of multiple personal devices and improve the usability of Hybrid and Pure P2P architecture in personal scope. We proposed an IPv6 based Node Discovery Stack (NDS) to make the usage of Personal P2P application possible. This paper clarified the architecture of the PIN and shows how NDS could enhanced the personal communication with co-woking devices.*[1]

I. Introduction

Nowadays the trend of widely adoption of personal and residential on-line devices make small-scale network configured by end-users unavoidable and necessary. With the low price of broadband Internet connection, many families can afford high-speed Internet access, and thus makes the peer-to-peer connection more practical and important.

To reduce configuration difficulty in application and IP layer, Rapid Application/IP layer configuration method for end users is essential to populate the all kinds of intelligent appliances or consumer electronic devices.

We think that the personal-scope internetwork for personal access is still far from convenient, efficient, and lacked of researchers' attention. While the enterprise internetwork system, which can make employees access data from remote server, store and share their experiences almost everywhere if there provides the network access ability. The well cooperation of Online office/Net office optimises the usage of IT equipments to balance companies' investment.

Most articles about personal network are mainly focus on access technology, such as Bluetooth, Wi-Fi [1], or emphasize on physical configuration, such as plug-and-play [2]. Although all of them make the network access more convenient, those works are not encouraged enough for customers to own more and more network-enabled devices, which is the barrier of today's computer industry. To populate the consumer electric devices, finding ways to reduce configuration difficulty in application, network, and IP layer for end users is essential. For this circumstance, we defined a new word to describe the personal network devices: Personal InterNetwork (PIN) more precisely. PIN is the network which exchange digital contents between individual's units. Personal devices are not restricted to be placed in one place and all of them have variable degree of network access ability. To take security into consideration, Personal InterNetwork Group (PING) is restricted within those personal owned and controllable devices, such as home PC, Smart mobile phone, , Net-Music-player, Intelligent Appliances, Home Gateway...,etc. Associated devices such as desktop PC in Office should connect to PIN through VPN or other methods to ensure the robust security of PIN.

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II. IPv6 and P2P

From the network view: With a great number of network devices connecting to Internet, the address space problem of IPv4 becomes more and more crucial. The Next Generation Internet protocol, Internet Protocol version 6 (IPv6)[12], which benefits from the IPv4 development experiences, is accept as an standard Internet Protocol. It provides sufficient IP addresses, address autoconfiguration, QoS, security and mobility to enable all kinds of devices connecting to the Internet. With an autoconfiguration or DHCPv6 feature, nodes could retrieve IPv6 address automatically without handy IP address setup procedure. The multicast and anycast supported by IPv6 also provide more variable Internet transporting method.

From the application view: The higher and higher Internet throughput and availability requirements make traditional client-server architecture difficult to satisfy modern needs. Therefore, server-side technology evolves from a server to a server cluster, and then to a P2P network.

The first generation P2P technology usually uses a massive broadcasting approach to send queries and retrieve information to/from the peers [14, 4]. Many researches provide variable ways to reduce the network overhead, such as Oh-ishi [4] shows multicast could reduce the P2P network load. Modern P2P technology reduces the overhead mainly by using resource location algorithms.

There are already many P2P applications such as instant messaging, file sharing, web archive, network file system, distributed location service, and distributed computing. All of them are categorized as a hybrid P2P architecture. A tracker (or so-called bootstrap node) is needed for resource exchanging. In contrast, pure P2P is the fully distributed P2P architecture which is thoroughly discussed by researchers. But due to resource allocation problems, there are no popular pure P2P models currently.

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The rest of the paper is organized as follows: Section III presents the main consideration of PIN. To realize PIN, Session IV introduces node discovery stack and personal P2P application architecture. A prototyping mechanism details are given in Session V. Performance evaluation results are shown in Session VI. Finally, Section VII follows with a concluding remark.

III. PIN CONSIDERATIONS

We start to describe PIN by address the core of all the PIN problems. Six considerations are defined to evaluate the PIN:

Difficulty of network Settings for end-user
Difficulty of Server settings for end-user
How efficiency the data exchanged between individual devices
Are Nodes as robust as servers?
How to Claim Nodes (how to find nodes)
Bandwidth Reservation and Bandwidth Judgment

PIN is a fully configurable network and is also configuration sensitive. The first time adoption configuration and maintain process really matter the intension of further adopting new devices. Tedious configure processes will prevent the adoption and the usage of new devices. In contrast between PIN and Enterprise internetwork, the Enterprise internetwork has professionals to solve most of these problems.

To fit the trend of future networking environment, we choose developing our PIN over IPv6 in local network. With IPv6 we can ease the network configuration by its autoconfiguration[13] feature and the global IPv6 address make real peer-to-peer communications possible. To ease the server settings and use less effort to achieve PIN, by adapting P2P architecture, we get the benefit of easy server configuration, directly maintain individual devices'join, leave, resource search and share procedures.

Even if we have the infrastructure of IPv6 network, end-users still have not much choice to access their remote devices with current network application. For a nomadic network the long and hardly recognized IPv6 address sill be the psychology barrier for end-users. Interpreting the address to domain name through Home Gateway [3] is a good idea, but in some cases we don't want route through gateway to communicate with destination devices. The node discovery (to get the remote resources addresses) through DNS is common in Internet, but not quite familiar for personal and home scale devices. The reason is those personal devices are not typical always-on servers like most servers over Internet. For example, Mobile Node is an reliable DNS node, but it is also an unstable (mobility) IP node and cost expensive node.

IV. NODE DISCOVERY STACK (NDS) AND PERSONAL P2P APPLICATION (PP2P)

In spite of using personal gateway or broker to handle multiple devices, the P2P approach over IPv6 is considered to achieve PIN. In our proposal, the new type of P2P software is introduced to serve the existing problems of communication between personal devices, which called Personal P2P Applications (PP2P). The PP2P applications should act as normal P2P applications while they are doing resources searching, data publishing, data transmission, and data slicing. The differences of P2P and normal P2P applications are the sharing target and sharing scope. Because of the sharing target is focus on individual's devices, like PC1 to smart mobile phone, smart mobile phone to Net-Music-player, PP2P will lead the totally different kind of sharing file behaviour, and cause no Intelligent property's issues because these electronic resources are exchanged between the logical local network which owned by somebody. And as while PIN is a fully configurable network, pure P2P mechanisms are adoptable.

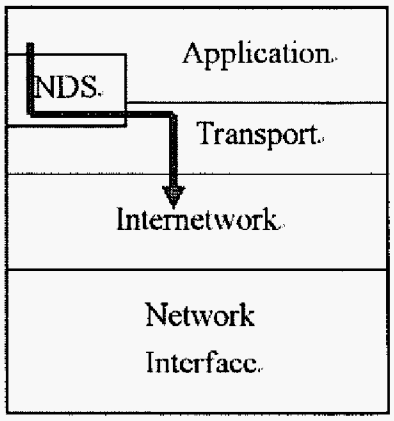

Fig. 1 Node Discovery stack

V. NODE ALLOCATION MECHANISM

As shown in Fig. 3, all of the computers and communication devices are belong to an individual user, and all of them are connecting to core router through wire or wireless connection. The user sends a NodeList Request message to the nearest Host A. While the user sets his personal anycast IP to a new device B, node B can acquire the nearest node A via Anycast options. NodeList Request message could contain loopback Node information for correspondent nodes (in this case, Node A), or transmit the Node information in the following secure procedure. For the features of time and space locality in PIN, we take the gauge of adoptable scale for several types of anycast [5] including IP layer anycast [6-7], Global IP layer anycast [8], Application layer anycast [9], and DNS.

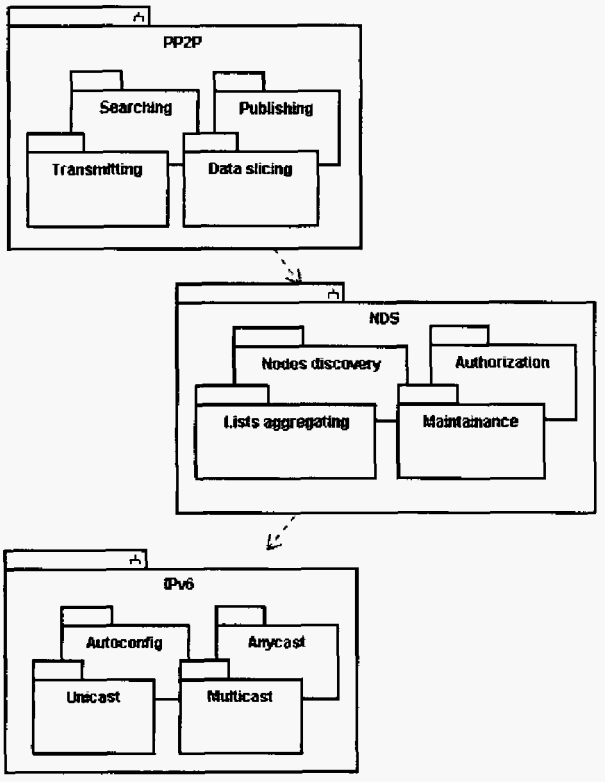

Fig. 2 PIN Architecture

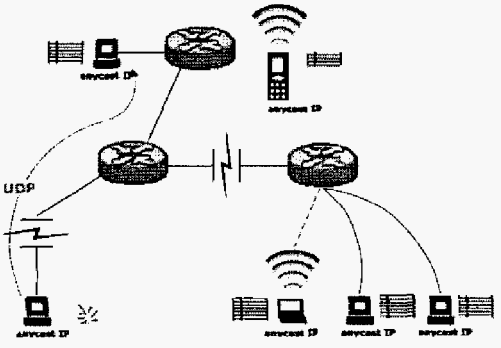

Fig. 3 Node request

As shown in Fig. 4, after proper authorization procedures are done and the node is authorized, node A would send back the NodeList Acknowledgement message that brings the "Node Maintain List" (these are information including global-link address and bandwidth etc., about all nodes in the PIN Group) to the node that requested the list.

As shown in Fig. 5, when a node requests for Node Maintain List receive the list, it would add all node IP into Group. Then send Unicast/Multicast Validate Request message to make sure the nodes on the list are available. The advantage of using Multicast is not clear in hybrid P2P mode. But in pure P2P mode, multicast can reduce the requirement of bandwidth. Furthermore, it can reduce the cost when send requests to lots of other nodes on the list (some ISPs used to bill their customers according to the data bits they have sent).

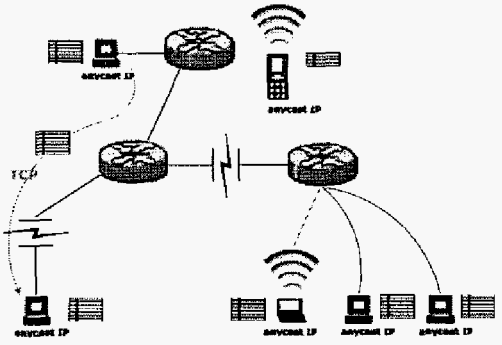

Fig. 4 Node Response

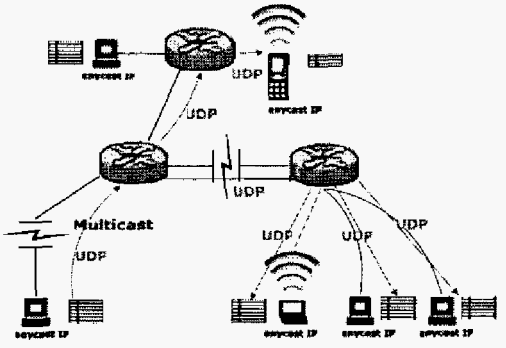

Fig. 5 Send multicast request to group, or send request to each nodes

As shown in Fig. 6, all of the nodes that are alive in the list reply the request node their "Node Maintain List". While Validate Request is received, nodes will compare the Record in its Node Information List. If all node records are the same, the node will return an Validate Acknowledgement message with Null payload. Request node must compare all of these "Node Maintain List", delete the repetition node, and connect the nodes that never be reached until a well maintained PIN Group List is done. The maintain procedure should repeat periodically to make sure the Node information List is correct. After received an Validate Acknowledgement, Node will calculate the SRTT (Smoothed Round Trip Time Estimate) and schedule the next maintain time to Current time plus random value scaled in Interval parameter.

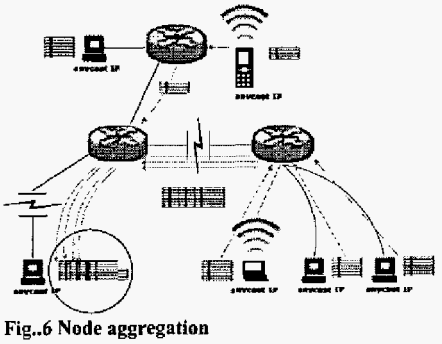

Fig..6 Node aggregation