La mobilité des réseaux IPv6, usage et démonstration
IPv6 Network Mobility, usage and demonstration

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Résumé

Cette présentation a pour but d'informer le lecteur des récentes recherches et usages de la mobilité des équipements et des réseaux dans le domaine de l'Internet. Nous expliquerons d'abord ce qu'est le protocole IPv6 et pourquoi un tel protocol est indispensable pour atteindre les buts que nous nous sommes fixés. Nous aborderons ensuite différents aspects de la mobilité : celle des stations puis celle d'un réseau tout entier, tout en essayant de démontrer les avantages et l'utilité de tels protocoles. Nous verrons ensuite que ces travaux nécessitent une étroite collaboration avec des équipes et laboratoires d'autres pays, afin de pouvoir lier nos efforts sur les spécifications, implémentations et démonstrations de ces nouvelles technologies.

Abstract

This presentation aims at informing the reader of the recent research and usages about host and network mobility in the Internet. We will first explain what is the IPv6 protocol, and why we need it to achieve our goals. We will then talk about the different aspects of mobility: host mobility and network mobility, trying to show advantages and usages of such protocols. We will also explain that research in this topic needs tight collaborations between several laboratories located in different countries, in order to work together on specifications, implementations and demonstrations of these new technologies.

Intoduction

Nowadays, more and more devices are connected to the Internet, and people would like to stay connected anywhere and anytime: we speak about ubiquitous internet computing. In order to satisfy these needs, we need to design and develop new solutions. The ones we use today in the network world were created at a time when we were not aware of those possibilities. The Nautilus6 working group [NAUTILUS6], based at Keio university, Japan, was established within the WIDE organization in spring 2003 to demonstrate how the IPv6 protocol and its mobility features could be deployed. We will thus discuss about the solutions and collaborations with foreign laboratories that can lead us to achieve these goals.

1.Basic knowledge of networking and IPv6

A sub-network or a link is a physical medium such an ethernet cable or a radio link on which two equipments can communicate directly. Two sub-networks are connected by means of routers and form a network. The Internet topology is an aggregation of networks, and end-to-end communications between computers (called hosts) are managed by protocols. The most famous one is the IP protocol that consists in allocating an unique address to each host on the Internet, so that they become reachable by any other host. This address identifies the host's location in the Internet topology.

In today's Internet, the most widely deployed IP protocol is IPv4. This protocol now has shown its limits, the most important issue today is the number of addresses it can support. More and more people and equipments (such as embedded devices like PDAs, or sensors, etc) are connected to the Internet and thus need an address, and we face an address allocation problem: in a few years, we will not be able to connect any new equipment on the internet. Few years ago, computers scientists started to work on a new version of this protocol, IPv6 [IPV6], in order to solve this problem and bring new functionnalities. IPv6 was designed to support much more addresses (2^{128} addresses, it means more than 6×10^{23} addresses for every square meter of the Earth's surface), and bring new security, mobility and quality of service mecanisms. The IPv6 protocol also introduces the notion of prefix. An IPv6 prefix is unique for each sub-network on the Internet, and is used to build IPv6 addresses. With the IPv6 protocol, each station must build its address from the prefix which is advertised on the link where the station is located (see **Fig.1**).

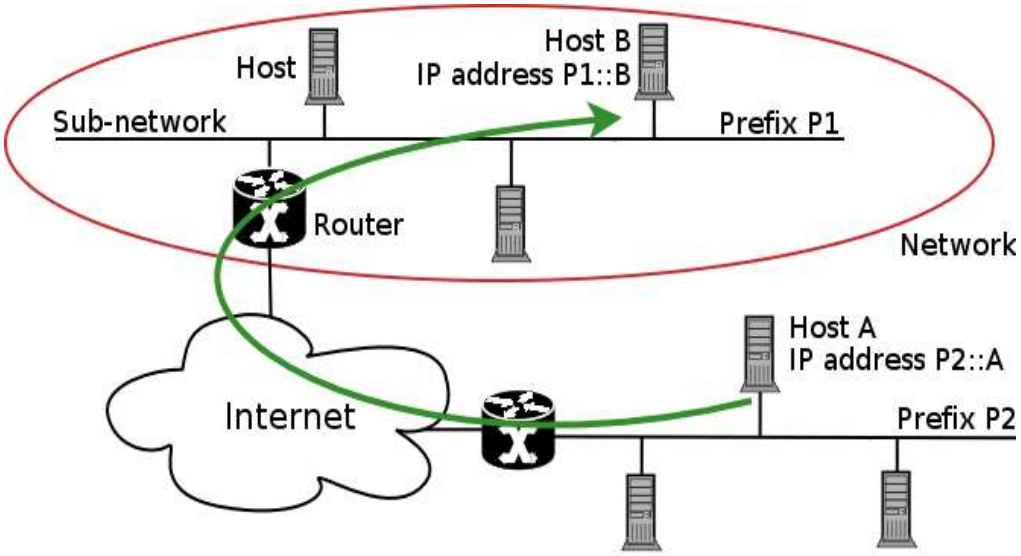

Fig.1: A host, a router and a network.
Two hosts (A and B) can communicate thanks to their IP address built from a prefix.

IPv6 is now widely used by researchers and computer scientists, and will be soon deployed in all the Internet.

2.What is Host Mobility?

In parallel to IPv6 development, wireless internet access technologies are being widely deployed. We can now enjoy the Internet with our laptop or PDA without any extra cable, for instance in meeting rooms, airport, bar or hotels.

Unfortunately, movements are extremely limited: as seen before, each host has at least one IPv6 address built from a prefix that identifies its location in the topology. Thus if the host changes its location in the Internet, it has to build a new address from the prefix advertised on the new link. This means that if a host comes out of the current access point coverage and reach a new one, in most cases this host will have to build a new address, and thus will become unreachable at its former address. As the IP address is also used as the identifier of the connection, all communications with correspondents (such as video streaming or audio streaming flow from the Internet) would break; the user will have to restart them each time he moves from one network to another (see **Fig.2**).

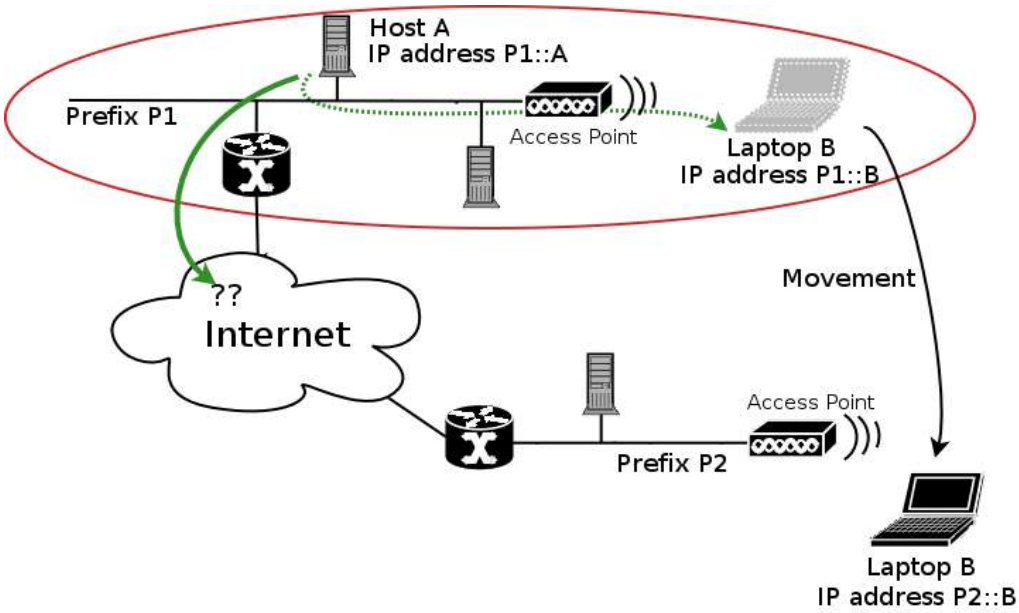

Fig.2: If the laptop B does not have any mobility function, the communication with its correspondent is broken

That's why Mobile IPv6 [MIP6] has been introduced in order for hosts to move transparently from one network to another, without breaking sessions even if their addresses changed. With Mobile IPv6, a host has 2 addresses while moving in the Internet topology: one permanent address that identifies the host, and the other representing the location in the Internet topology. The Mobile IPv6 protocol takes care of the binding between these two addresses, and ensures that the host is always reachable at its permanent address even if it moves in the Internet topology. With Mobile IPv6 we can enjoy host mobility, and use multimedia applications while moving, without disruptions (see **Fig.3**).

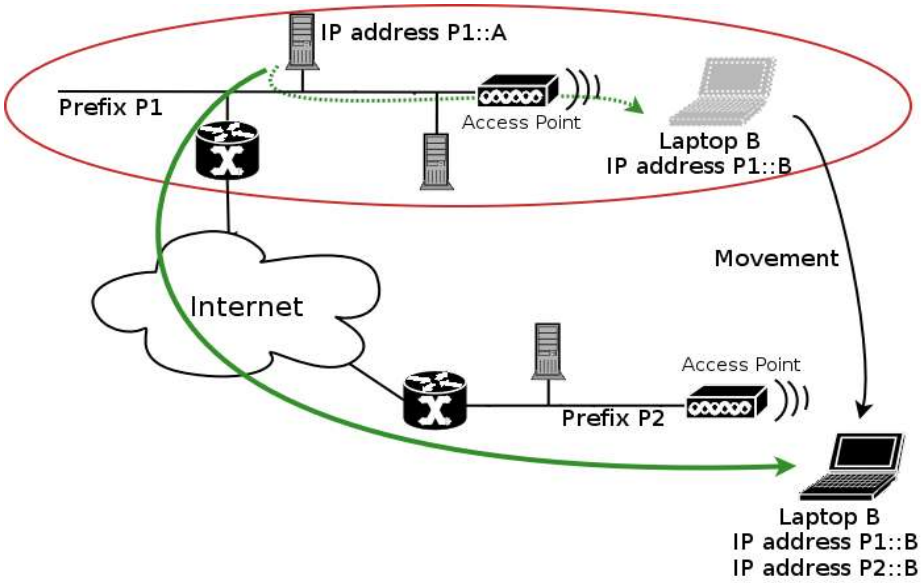

Fig.3: With Mobile IPv6, the laptop B is still reachable when moving to another network.

Such new protocols are defined at the IETF (Internet Engineering Task Force [IETF]), an international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture.

3.What is Network Mobility?

On one side Mobile IPv6 manages mobility for only one host, on the other side NEMO Basic Support (defined at the IETF in the Network Mobility working group [NEMO]) manages mobility for one whole network (see **Fig.4**). Such a network can be for instance a PAN (Personal Area Network, a small network made of IPv6 sensors and PDAs), or an access network deployed in cars, buses or trains. Thanks to NEMO Basic Support, the only computer that needs to have mobility functionnalities when the whole network moves is the one that connects the network to the Internet (this computer is called a router), whereas with the Mobile IPv6 approach each host in the network would have to handle mobility.

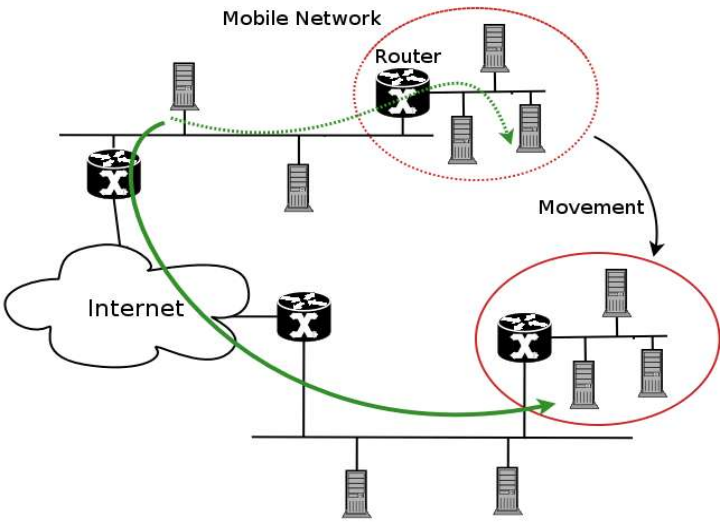

Fig.4: Network Mobility allows movements for whole networks

Running Mobile IPv6 on each node can be expensive, especially for little devices such as sensors. NEMO Basic Support only requires changes on the router, all others hosts in the moving network do not need any new feature (see **Fig.5**). Thus all movement in the Internet topology will be handled by the router, transparently to the hosts.

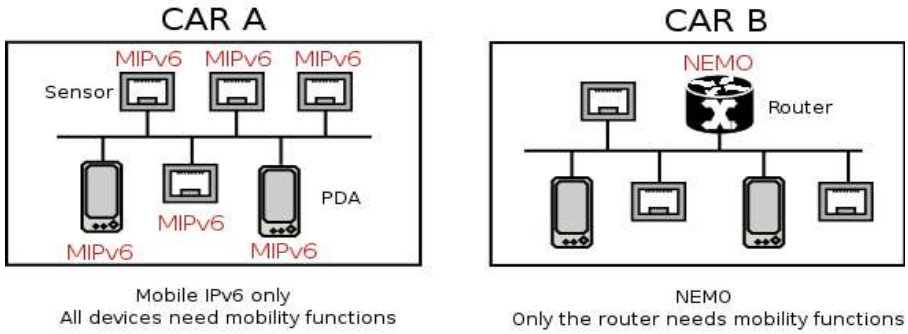

Fig.5: Difference between Mobile IPv6 and NEMO Basic Support

4.Network Mobility usages

With Network Mobility, we can now imagine lots of senarii where mobility can play an important role. Using Network Mobility in a train would allow the customers to stay connected to the Internet without disruption during all their trip. Network Mobility in a car, as described in [NEMO-ITS] and [NEMO-IPv6], can allow to set up a PAN (Personal Area Network) made of little IPv6 sensors that can be queried from outside, and PDAs that can have permanent access to the Internet. We can also imagine how to use this technology for health caring, by setting up little sensor networks for disabled people. This is the aim of the E-weelchair project [E-WHEEL] on which Nautilus6 is working.

In order to demonstrate such benefits, the Nautilus6 working group has set up an indoor testbed that includes several equipments dedicated to Mobile Networks research. This testbed helps us to develop and study new key features, such as multihoming in Mobile Networks. Multihoming allows a single host to have several points of attachement to the Internet, thus the host can enjoy different Internet access technologies and can be more tolerant to fault. We believe that this feature is important if we expect wide deployment of the technology, that's why we use our testbed to perform tests with multihomed Mobile Networks.

5.Collaborations

Such projects cannot be led alone, that's why we believe that collaboration between universities and researchers from different countries will allow us to enjoy competences from each of our associates. The Nautilus6 working group has established a collaboration with French universities, for instance the University Louis Pasteur in Strasbourg and their Networks and Protocols Team [ULP-R2]. We collaborate on the security, multihoming and seamless mobility issues in Mobile Networks, and they deployed an indoor Mobile Network testbed for a shared usage with our laboratory. Student exchanges for internship, co-authored papers by people from different entities and countries, and knowledge exchange are some of the ways we run this collaboration. Nautilus6 has also recently

started a collaboration with the USAGI project [USAGI] and the GO-Core Project [GO-Core] in order to develop a new implementation of NEMO Basic Support on the Linux operating system.

Conclusion

Network Mobility deployement is really linked to the deployement of IPv6. That's why Nautilus6 [NAUTILUS6] aims at improving IPv6 mobility and applications environment, and demonstrating the utility of such mecanisms. Collaboration with foreign laboratories and universities is the best way to share our knowledge and stay synchronised with the other research domains related to IPv6.

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