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Information technology — Future Network — Problem statement and requirements —

Part 4: Mobility

Technologies de l'information — Réseaux du futur — Énoncé du problème et exigences —
Partie 4: Mobilité

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Foreword

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The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

In exceptional circumstances, when the joint technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide to publish a Technical Report. A Technical Report is entirely informative in nature and shall be subject to review every five years in the same manner as an International Standard.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/IEC TR 29181-4 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*.

ISO/IEC TR 29181 consists of the following parts, under the general title *Information technology — Future Network — Problem statement and requirements*:

— *Part 1: Overall aspects*

— *Part 2: Naming and addressing*

— *Part 3: Switching and routing*

— *Part 4: Mobility*

— *Part 5: Security*

— *Part 6: Media transport*

— *Part 7: Service composition*

Introduction

This part of ISO/IEC TR 29181 (Future Network: Problem Statement and Requirements) describes the problems of the current network and the requirements for Future Network in the mobility perspective. The general description on the problem statement and requirements for Future Network is given in ISO/IEC TR 29181-1. In addition, ISO/IEC TR 29181-4 establishes the problem statement and requirements for Future Network from the viewpoint of architecture and functionality for mobility support.

In general, the mobility issues can be classified into link-layer, network-layer, and transport/application layer mobility management. It is noted that the link-layer mobility issues have been addressed and well defined in the relevant SDOs, such as 3GPPs, IEEE 802, etc. The transport/application layer mobility issues are also associated with the particular transport/application protocols used by mobile nodes. On the other hand, the network layer mobility control issues are quite dependent on the network architecture. Accordingly, this part of ISO/IEC TR 29181 will focus on the mobility issues of Future Network in the network-layer perspective.

This part of ISO/IEC TR 29181 may be applicable to the overall design of Future Network architecture.

Information technology — Future Network — Problem statement and requirements —

Part 4: Mobility

1 Scope

This part of ISO/IEC TR 29181 describes the problem statements of current network and the requirements for Future Network in the mobility perspective. This part of ISO/IEC TR 29181 mainly specifies

— problems of the current network in mobile environment, and

— requirements for mobility support in Future Network.

In addition, this part of ISO/IEC TR 29181 gives information on

— existing mobility control schemes in the current network,

— examples of high-level mobility control architecture for Future Network,

— distributed mobility control in the Proxy Mobile IPv6 networks, and

— additional considerations for Future Network mobility.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC TR 29181 (all parts), *Information technology — Future Network — Problem statement and requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
Future Network
FN
network of the future which is made on clean-slate design approach as well as incremental design approach; it should provide futuristic capabilities and services beyond the limitations of the current network including the Internet

[SOURCE: ISO/IEC TR 29181-1]

3.2
Node Identifier
NID
globally unique identifier for a network node or host

[SOURCE: ISO/IEC TR 29181-2]

Note 1 to entry: Identifier (ID) is a generic term that is associated with various types of objects, whereas NID is used to represent a host in the network. In this part of ISO/IEC TR 29181, the term of ID is used with the meaning of NID.

3.3
Locator
LOC
IP address to connection mapping

[SOURCE: ISO/IEC TR 29181-2]

Note 1 to entry: In this part of ISO/IEC TR 29181, LOC is used to represent the location of a host in the network, which is also used for delivery of data packets in the network.

3.4
Mobility
ability for user to communicate or access the services, irrespective of changes of its location

[SOURCE: ITU-T Recommendation Q.1706/Y.2801]

4 Abbreviations

ACK	Acknowledgement
AR	Access Router
CN	Correspondent Node
FN	Future Network
GILL	Global Identifier and Local Locator
GW	Gateway
HA	Home Agent
HMI	Hierarchical MIP
ID	Identifier
IP	Internet Protocol
ISP	Internet Services Provider
LMC	Local Mobility Controller
LOC	Locator
MIP	Mobile IP
MN	Mobile Node
NID	Node ID
PMIP	Proxy Mobile IP

SCTP	Stream Control Transmission Protocol
TCP	Transmission Control Protocol
TR	Technical Report
UDP	User Datagram Protocol

5 General

5.1 Mobile environment in FN

With an explosive growth of the number of subscribers of 3G/4G cellular systems and also other wireless data systems such as WiFi and WiMAX, the mobile networks now become the key driver toward the Future Network (FN). The number of people who surf the network on their phones has doubled since 2006. In near future, there will likely be more mobile and wireless users than wired ones. In addition, a variety of new types of wireless access networks like ad hoc networks and sensor networks are emerging, and they will be the major access means to FN.

Figure 1 illustrates the network environment, in which the users or things in FN will benefit from a variety of access ways to the network anytime, anywhere, and through any interfaces. In particular, it is expected that 'mobile' users/things, rather 'fixed' ones, will become more dominant in FN. In this context, a crucial requirement for FN is to provide seamless services for the mobile users/things through the mobile-oriented FN.

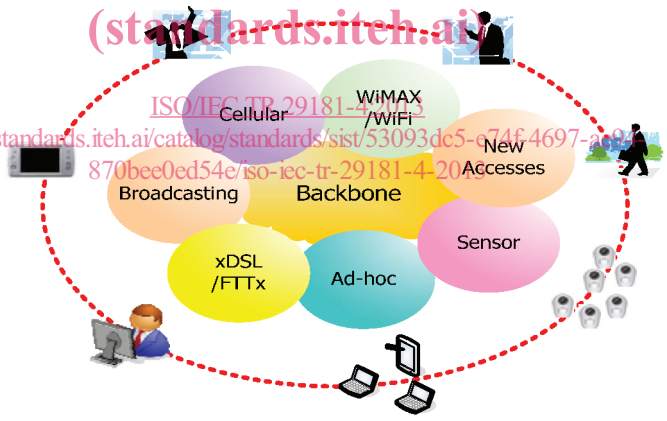

Figure 1 — Network environment in FN

With a recent trend of network convergence, it is expected that the all kinds of networks will be evolved or revolved toward a unified network, i.e. 'mobile-oriented convergence network' as shown in Figure 2, including computer or telecommunication networks.

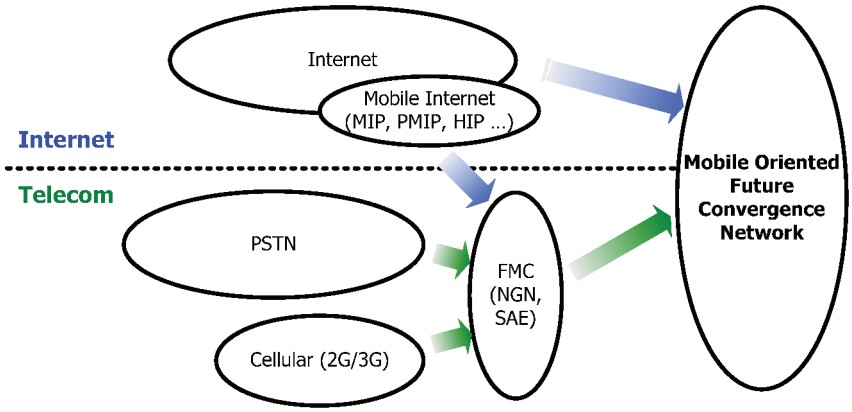

Figure 2 — Convergence of Internet and telecommunication in FN

Historically, the computer networks (i. e., Internet) and the telecommunication networks have been evolved until now, with quite different design philosophy and business purposes. From the perspective of the convergence trends, however, FN should be designed to make full use of the pros of both computer networks and telecommunication networks.

In addition, it is noted that the current cellular system is a very successful model in the wireless/mobile systems and provides a lot of desirable features to support the mobile environment. Therefore, it is recommended to readily exploit the useful features of cellular mobile systems in the design of FN architecture, to the extent possible.

5.2 Related works on mobility in FN

It is noted that the current network, such as Internet, was basically designed for fixed network environment, rather than for the mobile network environment. This has enforced Internet to add a lot extensional features to satisfy the requirements for mobile networks, as shown in the example of Mobile IP (MIP) that has been made in the IETF. The examples of mobility schemes for current network are described in the Annex A, which include the transport-layer and application-layer mobility schemes that have been so far proposed in the IETF. However, this patch-on approach seems to be just a temporal heuristic to the problems in the mobile environment, rather than an optimization approach to substantially solve the mobile-related issues.

Based on these observations, some activities already started to design the FN for mobile environment rather than fixed environment. A typical example is eMobility, which is a FP7 project of EU. eMobility envisions the third generation Internet as the wireless/mobile Internet with the name of 'Post-IP.' The 4WARD, another FP7 project for design of FN architecture, is also targeted to effectively support the mobile environment. The other European projects for mobility include Trilogy.

We also note a lot of Future Internet Design (FIND) projects, which are very closely related with wireless/mobile environments. Especially, the "Mobility First" project is recently proposed as a candidate approach for FN. This proposal is with the recognition that the network is changing very rapidly from fixed hosts to mobile devices, in which it is stated that a FN architecture should support mobile devices as 'first-class' users and also provide a variety of new applications efficiently, securely, and at a large scale. The Global Environment for Network Innovation (GENI), a representative testbed project for FN, also agrees that wireless/mobile will be the major access means for FN. We note that some design documents of GENI already covers the issues including ad hoc and sensor networks.

AKARI is a representative research activity on FN in Japan, which deals with the issues on the separation of Identifier (ID) and Locator (LOC) and the managed mesh network to support mobile environment. Especially, the ID-LOC split architecture covers the primary issues in mobile environment such as mobility and multi-homing, etc. On the other hand, Mobile Oriented Future Internet (MOFI) is a project of designing the architecture and protocols of FN in Korea.

In the perspective of standardization activities, the ITU-T has so far identified the mobility management requirements and frameworks for next-generation networks, which include ITU-T Q.1706, Q.1707, Q.1708, and Q.1709. It is noted that some preliminary works for Future Networks are also in progress in the ITU-T SG13.

From these observations, we can see that there is a crucial need to design the architecture of FN to more effectively support the mobile environment.

6 Problem statement of current network in mobile environment

6.1 Overloaded semantics of IP address

In the current IP-based networks, an IP address has overloaded semantics as Identifier (ID) and Locator (LOC). In mobile environment, however, the location of mobile host is likely to continue to change by movement. This means that the static allocation of LOC (IP address) to a host may become problematic in mobile networks. In the meantime, ID needs to be kept persistently (without change) to maintain an on-going sessions against movement of a host. Accordingly, ID and LOC should be separated to support the mobility in Future Network.

Another critical concern is that an IP address, as an ID, is allocated to a network interface of a host, rather the host itself. Accordingly, if a host has multiple interfaces, multiple IP addresses must be allocated to a single host. This may give serious inefficiency to a multi-homing host, since the same host has to use different IDs for communication. Therefore, ID needs to be allocated to a host itself rather than its network interface.

As for the allocation of IP address, it does not make sense to allocate IP address to a mobile host, since it may continue to move on. Accordingly, in mobile environments, it is suggested that an address or LOC should be allocated to a certain fixed node in the network, rather than the host itself.

6.2 Single common protocol for heterogeneous networks

It is expected that future mobile networks will consist of a variety of heterogeneous wireless networks. Such wireless networks are likely to have quite different characteristics, ranged from managed mobile networks to light-weight senor networks. On the other hand, the backbone network will be evolved to optical network with high bandwidth, which is quite different from wireless access networks. Accordingly, a single common IP protocol and/or addressing scheme of current Internet may not effectively support the FN with optical backbone and heterogeneous wireless access networks.

6.3 Integration of data delivery and control function

In most of current Internet protocols, data delivery and control function are integrated and implemented at the same devices, and the data and control traffics are routed along the same path, as shown in the IP and ICMP protocols. However, the control information for signalling is mission-critical and thus needs to be delivered more urgently and reliably, compared to usual data traffics. Thus, the control function needs to be separated from data traffics.

6.4 Centralized mobility control

Most of the current mobility control schemes in IP-based networks are based on a centralized mobility anchor, such as Home Agent (HA) of Mobile IP. This is because the existing mobile networks were originally designed as a hierarchical architecture to support circuit-based voice traffics. In the centralized control, however, the routing path through a centralized anchor tends to be longer, which results in non-optimal routes and performance degradation. Moreover, the centralized approach is vulnerable to a single point of failure or attack.

It is noted that an ever-increasing demand of mobile Internet traffics has enforced non-hierarchical or flat architecture on mobile networks, so as to provide data services more cost-effectively. Accordingly, we need to consider the distributed mobility control to support a flat architecture of future mobile networks.