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Information technology — Future Network — Problem statement and requirements —

Part 1: Overall aspects

Technologies de l'information — Réseaux du futur — Énoncé du problème et exigences —
Partie 1: Aspects généraux

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Foreword

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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.

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ISO/IEC TR 29181-1 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*

The following parts are under preparation:

— *Part 2: Naming and addressing*

— *Part 3: Switching and routing*

— *Part 4: Mobility*

— *Part 5: Security*

— *Part 6: Media distribution*

— *Part 7: Service composition*

Introduction

The current Internet has become an essential communication infrastructure, not only for data transfer but also for social applications such as e-government, energy/traffic controls, finance, learning, health, etc.

Even though the current Internet is such an essential infrastructure, we see that there are many concerns about the following technical aspects of the current Internet, including IP based networks: scalability, ubiquity, security, robustness, mobility, heterogeneity, Quality of Service (QoS), re-configurability, context-awareness, manageability, economics, etc. Also, the advancement of mass storage units, high speed computing devices, and ultra broadband transport technologies (e.g., peta/exa/zeta bps) enables many emerging devices such as sensors, tiny devices, vehicles, etc. The resultant new shape of ICT architecture and huge number of new services cannot be well supported with current network technologies.

The Future Network (FN), which is anticipated to provide functionalities and services beyond the limitations of current networking technology, has been studied by researchers in the field of communication network and services worldwide. FN technologies have now been widely and deeply studied in many research organizations and standardization bodies.

This part of ISO/IEC TR 29181 describes overall aspects for FN including definition, general concept, problems and requirements. Also, it discusses a milestone for standardization on FN.

Information technology — Future Network — Problem statement and requirements —

Part 1: Overall aspects

1 Scope

This part of ISO/IEC TR 29181 describes the definition, general concept, problems and requirements for Future Network (FN). It also discusses a milestone for standardization on FN. The scope of this part of ISO/IEC TR 29181 includes:

— motivation of FN;

— definition, general concept, and terminologies of FN;

— services and applications in FN;

— problems with current networks;

— design goals and high-level requirements for FN;

— milestones for standardization on FN.

2 Normative references

There are no normative references.

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

3.2
clean-slate design approach
approach where a system and network are designed from scratch, based on a long-term, revolutionary approach

NOTE In clean-slate design approach, the backward compatibility may not be required [1],[2].

3.3
network virtualization
technology that enables the creation of logically isolated network partitions over shared physical network infrastructures so that multiple heterogeneous virtual networks can simultaneously coexist over the shared infrastructures

NOTE Network virtualization allows the aggregation of multiple resources and makes the aggregated resources appear as a single resource [3],[4].

3.4
cross-layer communication
technology that enables to create new interfaces between layers, redefine the layer boundaries, design protocol at a layer based on the details of how another layer is designed, joint tuning of parameters across layers, or create complete new abstraction

3.5
autonomous service
service that enables users or services in motion to configure autonomously and to mange networks

3.6
context-awareness service
service that enables applications or services to adapt their behaviour based on their physical environment

3.7
content-centric networking
technology that enables to support routing based on contents rather than physical location

3.8
service composition
technology that supports the composition of those activities required to combine and link existing services (atomic and, even composite services) to create new processes, i.e., the customizability of the services provided to the end users

3.9
customizable QoS/QoE
technology that enables to support preference setting and service composition/re-composition accordingly

3.10
economic incentives
encouragement, rewards and compensation which motivates the parties (components/participants) economically to contribute for networking and/or services and/or to provide their resources

3.11
Building Blocks (BB) approach
technique for development of a set of standards by creating some basic modules or elements that may be added together so as to obtain an overall architecture or entire operations

NOTE This approach may be used to develop a new challenging technology, such as Future Network, in which many of the basic associated elements have not been identified at the current stage.

[Note] The definitions of Internet and NGN:

- Internet: A collection of interconnected networks using the Internet Protocol which allows them to function as a single, large virtual network [5].The Internet: a global system of interconnected computer networks that interchange data by packet switching using the standardized Internet Protocol Suite (TCP/IP). It is a "network of networks" that consists of millions of private and public, academic, business, and government networks of local to global scope that are linked by copper wires, fiber-optic cables, wireless connections, and other technologies [5].

- Next Generation Network (NGN): A packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users [6].

4 Abbreviations

AAA Authentication, Authorization, and Accounting

BB Building Blocks

DNS Domain Name System

FA Functional Architecture

FI Future Internet

FIRE Future Internet Research and Experiments

FN Future Network

FP7 Framework Program 7

GENI Global Environment for Network Innovations

ICT Information Communication Technology

IoT Internet of Things

IP Internet Protocol

IPv4 Internet Protocol version 4

IPv6 Internet Protocol version 6

ISP Internet Service Provider

NAT Network Address Translation

NGN Next Generation Networks

NwGN New Generation Network

P2P Peer-to-Peer

PI Provider Independent

QoE Quality of Experience

QoS Quality of Service

SOA Service Oriented Architecture

5 Overview

5.1 Needs to research and standardize FN

The current IP-based technology has significant deficiencies that need to be solved before it can be become a unified global communication infrastructure. Particularly, there are problems with a large number of hosts, such as sensors, the various wireless and mobile nodes, multiple interface and multi-homed nodes, the support of the flow mobility, support of fast mobile hosts, safe e-transactions, quality of service guarantees, business aspects, etc., on current IP-based networks, so various researches have been conducted to solve these problems. Further, there are now significant concerns that shortcomings would not be completely resolved by the conventional incremental and 'backward-compatible' style of current research and standardization efforts. That is the reason why the FN research effort is called a “clean-slate design for anew network’s architecture”. It is assumed that FN design must be discussed based on a clean-slate approach as well as an incremental design approach.

In this regard, we need to study and standardize the FN which overcomes the limitations of current networks, and enable new plentiful services.

5.2 Value and vision of FN

The business model of FN aims for profit sharing among infrastructure providers, service providers, application providers and end users by building cooperative eco-systems between them. It can be accomplished by openness and accommodating various requirements of each party.

Also, FN will be able to provide millions/billions of services, therefore flexible service composition is required to achieve the FN of context-aware services. Context-aware service composition is a key functionality required to provide dynamically adapted services, and a key feature to guarantee a seamless provisioning of media services, which will allow to generate enriched and novel services for end-users.

Figure 1 illustrates vision and roadmap of FN.

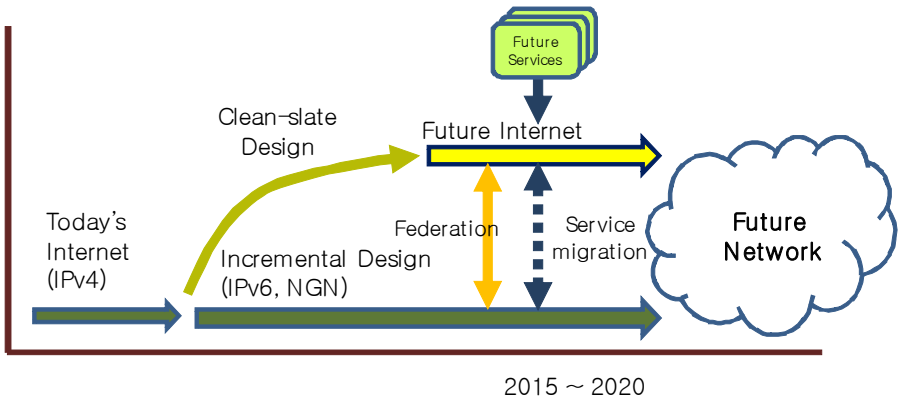

Figure 1 — Vision and Roadmap of FN

Today’s networks are mainly based on the IPv4 Internet. To enhance the Internet, there are two design approaches – clean-slate design and incremental design. Future Internet will be designed based on clean-slate approach and roughly prototyped and deployed between 2015 and 2020. At the same time, today’s networks will be evolved continuously. Thus, there will be two different network technologies and federation and service migration are required to support seamless integration. Federation is to be defined as an interconnection of multiple, heterogeneous networks (e.g, IPv4, IPv6, Future Internet, or non-IP based networks). In federation, networks would be normally be geographically dispersed and managed by different organizations/ISPs. They would however be considered as being part of single network, in so far as they are operated in a common management framework under a common management authority. So, multiple,

heterogeneous networks would be eventually seen as a single federated network – FN. The FN covers all the disruptive networks as well as existing networks. FN has a broader view than the Future Internet, and includes other non-IP networks (e.g., sensors, vehicular networks, satellite, etc.).

6 Services and applications in FN

In the clause, the following future services are envisioned and considered as benchmark services to achieve to build the FN.

Though the listed services are shown as examples (not normative), they imply essential, societal and infrastructural services, and require considerable network resources that current Internet technology cannot support.

Research projects	Envisioned future services
GENI [7] (Global Environment for Network Innovations)	– Ubiquitous health care – Participatory urban sensing – Dealing with personal data – Tele-presence
NwGN [8] (New Generation Network Architecture)	– Essential services: medical care, transportation, emergency services
EU FP-7 [9] (European Union Framework Program-7)	– Personal service creation – Future home – Future of traffic – Virtual reality – Productivity tools
Korean Future Internet Development and Deployment Strategies [10]	– Smart Network services – Cloud Network services – Internet of Things services –

Distinguished from the traditional CT (communication technology) or IT (information technology) services, the services of the future should be reconsidered with broader concept since the FN will encompass wide range of heterogeneous networks [11]:

- The problem of scope, functionality, capability, granularity, time, scale, intelligence, roles, people and their stuff, and “at your service”

FN (or future) services can be stated as:

- the services which emerge by the year 2020
- the services which are provided and inter-work on top of both clean slate based new networks and/or existing networks

  : Since services are inherently transport /access network independent, it may span across the exiting and clean slate based infrastructures.

- the services whose features are both user centric (I-Centric) and network centric (Net-Centric)

  : The purpose of future services is to satisfy and provide best convenience for end users with optimal usage of network resources.

And it would cover the IT, telecom, media and cloud computing areas, which can be provided on any layers of network (Figure 2): for example, future ICT resource services may be provided directly on transport and resource layers, or may be provided on transport/resource control layer in case with quality controls. Likewise, immersive communication services may be provided on application/service support layer, or service control layer according to provider's own service policy and capabilities. Capabilities of each network layer may be accessed with open standardized interfaces.

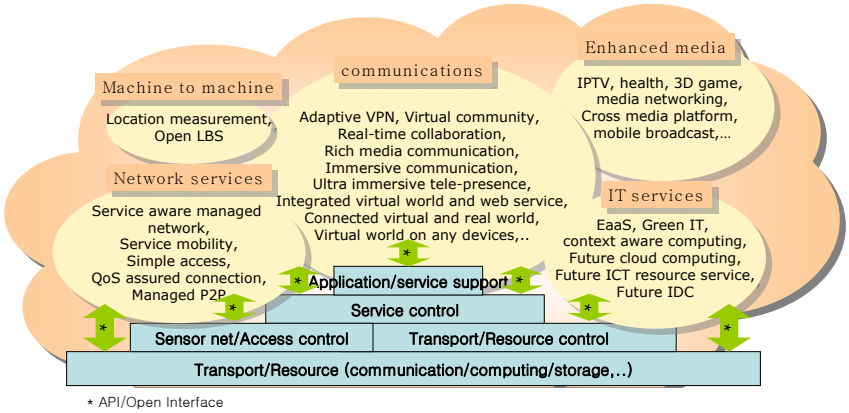

Figure 2 — Services Concept of FN

The key features the FN services should support include:

- Context awareness
- Dynamic adaptiveness
- Self organization and self-configuration
- Self-detection and self-healing
- Distributed control
- Mass data control

7 Problem statement

The problems for the FN could be classified into i) basic problems and ii) problems with fundamental design principles of current Internet. Most of them are also studied and researched in many organizations and research projects such as IETF/IRTF[12, 13], ITU-T [14], EU FIA Arch group [15].

7.1 Basic problems

7.1.1 Routing failures and scalability

The today's Internet is facing challenges in scalability issues on routing and addressing architecture. The problems have been examined as being caused by mobility, multi-homing, renumbering, provider independence (PI routing), IPv6 impact, etc. on the today's Internet architecture. The problem is known to be caused by current Identifier-Locator integration architecture within IP address scheme. As the Internet continues to evolve, the challenges in providing a scalable and robust global routing system will also change over time.