**Telecommunications and Information Exchange Between Systems**

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This document is drafted by a group of Chinese experts discussing what Future Network Naming and Addressing scheme (FN-NAS) should like and how the standardization of FN-NAS should be conducted. This document is to be discussed at SC6 WG7 meeting at London Interim Meeting in Feb., 2011.

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# Future Network - Problem Statement and Requirements - Part 2, Naming and Addressing

*Élément introductif — Élément central — Partie XX: Élément complémentaire*

## FOREWORD

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

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ISO/IEC TR.FNPSR was prepared by Technical Committee ISO/IEC JTC1/SC6, TELECOMMUNICATION AND INFORMATION EXCHANGE BETWEEN SYSTEMS, Working Group 7.

## INTRODUCTION

This technical report is Part 2 of the Technical report on Future Network – Problem Statement and Requirements developed by ISO/IEC JTC1 SC6 WG7. As Part 1 (the General Report) provides an overall perspective of the missions and requirements of the Future Network project, this part focuses on the issue of naming and addressing. The objective of this report discusses how to develop a clean slate designed new naming and addressing schemes (NAS) to help Future Network project achieve its lofty ambitions.

Naming and addressing schemes are the corner stones of telecommunication networks and information systems. NAS designs not only provide fundamental building blocks for network designs, but may also influence network characteristics, performance and capabilities. Therefore, NAS should be among the top priorities of network design projects.

NAS plays an even more important role in Future Network. As a project aimed at designing a totally new network with a clean slate design approach, Future Network has to produce a clean slate designed naming and addressing scheme. However, as the new network has to produce a network structure which would allow information to flow more smoothly, fast and securely among various networks with various kinds of naming and addressing structures, designing a new NAS which would not only function within the new system, but also interoperate with other naming and addressing systems (such as old systems like DNS or telecom networks and new systems such as RFID and sensor networks) is a very challenging task.

Unlike evolutionary approaches which seeks to engage gradual improvement with available technologies while protecting the integrity of overall structure of old networks, Future Network has to produce a totally new naming and addressing scheme. A clean slate design needs thorough analysis, full understanding of the demand, careful planning and collective work. In order to achieve the maximum benefits and find the best solution, a strategic planning document is needed before specific schemes are standardized.

This report may serve as a strategic planning document for the design of FN-NAS. It explains the missions of FN-NAS and discusses how it should be developed.

This document could be used in the technical development process to stimulate interests and innovation, to be used in the NAS standardization process as reference criteria for evaluating NAS proposals, and it could also be used in implementation process as assessment, testing and compliance references.

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## 1. Scope

This Technical Report (TR) is about Naming and Address Schemes, an important subject field in the standardization of Future Network in ISO/IEC. It describes the general characteristics of Future Network Naming and Addressing Schemes including problem statement, objectives, gap analysis, and development directions.

- Requirements: The general characteristics of Future Network are discussed and their impact on NAS design.
- Problem Statement: the characteristics and deficiencies of existing NAS in old networks will be discussed.
- Gap analysis: Examines the gap between old network NAS and future network performance expectations.
- Design Objectives: Specify objectives and principles for NAS design. The design principles are major rules that FN-NAS designers should consider and follow in their design activities in order to have their products fits properly with the overall characteristics of Future Network.
- Technical Challenges: a list of major technical challenges, overcoming of which would help assure that the new NAS will be able to provide solid technical support from the base level to satisfy the ambitious objectives of Future Network.
- Development Guidance: How to future NAS standardization can progress.

Excluded from this TR is discussion of specific NAS unless they are used as examples to explain technical concepts. Rather than presentation of a specific technology, the report will focus on the general issues surrounding naming and addressing, such as problems, goals, gaps etc. At this early stage, we will avoid focusing on any specific technology. Nevertheless, some advanced research projects such as China's IPV9 or concept such as geographic address scheme may provide valuable insights or experiences which may inevitably be referred to when we come into specific technical analysis. Without those experiences, we may not be able to find out fully the deficiencies of old naming and addressing schemes and may not be confident about whether Future Network design goals can be met.

## 2. Normative references

ISO/IEC JTC1/SC6 WG7 TR.FNPSR "Future Network: Problem Statement and Requirements", editor Myung-Ki Shin, Jan. 2010

## 3. Definitions

This Technical Report (TR) uses the following terms and definitions.

- Future Network Naming and Addressing Schemes: A system of mechanisms to provide identify and locate for information exchange in Future Network. The system may design new naming schemes, new addressing schemes or an integrated scheme that combines identification and location.

- Naming: a scheme which gives identity to every computer or object connected with the network or the party who is going to send or receive information from the network.

- Addressing: a scheme which provides information on the point where the sender or receiver is located in the networks. It contains two mechanisms, one is to define the location (address format) and another is to specify how to find the addresses.

## 4. ABBREVIATIONS

| | |
|---|---|
| ARP | Address Resolution Protocol |
| ATM | Asynchronous Transfer Mode |
| DDNS | Decimal Domain Name Scheme |
| FDDI | Fibre Distributed Data Interface |
| FN | Future Network |
| FTP | File Transfer Protocol |
| GAS | Geographic Address Scheme |
| ICMP | Internet Control Message Protocol |
| IMP | Internet Mixed Protocol |
| IP | Internet Protocol |
| MAC | Media Access Control |
| NAS | Naming and Addressing Schemes |
| OSI | Open System Interconnect |
| RARP | Reverse Address Resolution Protocol |
| RPC | Remote Procedure Call Protocol |
| SMTP | Simple Mail Transfer Protocol |
| SNMP | Simple Network Management Protocol |
| TCP | Transmission Control Protocol |
| TCP/IP | Transmission Control Protocol/Internet Protocol |
| UDP | User Datagram Protocol |

## 5. BACKGROUND AND PROJECT OUTLOOK

### 5.1 PAST WORK ON FN-NAS

This technical report is a continuation of the discussion and exploration in ISO/IEC to find ideal Naming and Addressing Schemes and to standardize them to provide a solid support for FN activities.

Such an effort started from the beginning of ISO/IEC Future Network activity. In the first dedicated FN meeting in Paris, Oct. 2007, a presentation from China (by Xie Jianping) focused on the issue of naming and addressing and offered many valuable insights into the subjects including the exploration of new NAS in China.

After the Paris meeting, Chinese experts provided more comments, stressing that NAS is a very core and critical component in Future Network research and it should receive priority status in standard development.[note] Korean experts meanwhile presented a new concept of position-based Geographical Addressing Scheme .[note] Although it is too early to discuss specific addressing schemes, the value of this presentation is that it highlighted the importance of a new scheme.

SC6 recognized the significance of NAS and encouraged Chinese experts to lead the efforts to addressing this issue {note}. In May 2009, Chinese experts presented a document entitled "Future Network Naming and Addressing Schemes: Problem Statement and Design Objectives" (6N13948). The 6N13948 report find a huge gap between the ambitious objectives of Future Network and the existing naming and addressing schemes. It also described how a new NAS may help FN to achieve its objectives. In the end of the report, it says:

*"Chinese experts are encouraged to draft a document on Technical guidelines for Future Network Naming and Addressing Schemes. This document may serve as a directional guidance for FN-NAS research and/or as a base for evaluating technical proposal contributions on NAS."*

Again, SC6 is satisfied with the 6N13948 report and also encouraged China to continue research and move the initiative forward. In the meantime, Korean experts continued to send in contribution further developing the concept of geographic address scheme.

In Spain meeting (Jan. 2010), SC6 adopted an action plan to speed up Future Network Standardization process in which SC6 urged China to submit a NP proposal on NAS technical report as soon as possible and assigned Chinese experts Jianping Xie, Kingston Zhang and Korean expert Hyun-Kook Kahng as project leaders.

In London meeting (September 2010), SC6 decided to split the existing technical report (TR.FNPSR) into seven parts and NAS was made Part 2. Xie, Zhang and Kahng were nominated as project editors. This strategic move greatly accelerated the development of this document.

### 5.2 Current Achievement on FN-NAS Research

Through several years of studying, the Future Network project has achieved several objectives on NAS. The most significant achievement is some common understandings have been established.

1). It is understood that Future Network as a clean slate design project must have a clean slate designed new NAS.

2). It is understood that NAS is an essential building block of a new network and NAS standardization should be among the top priorities.

3). It is understood that old NAS in existing networks are unable to fulfil the high demand of Future Network and new NAS must be developed. Major deficiencies have been identified and discussed.

4). Some new NAS concept and schemes have been presented and discussed. It is understood that those ideas are valuable and may be subject to further analysis when the project enters technical proposal stage.

5). It seems that ISO/IEC has been a step ahead of other Future Network projects in the area of naming and addressing scheme development. The work on NAS In ISO/IEC has also attracted attention from other standard organizations such as ITU-T and IETF and have received inquiries and requests for information exchange and collaboration from those organizations.

6). It seems that SC6 members have possessed enough knowledge and experience with new NAS design and are confident in its success.

7). SC6 has also given consideration to the most troubling conflict between clean slate design and backward compatibility. Member contributions on new NAS have give a hope that this conflict can be resolved through new NAS designs.

### 5.3 FN-NAS Development Challenges

Future Network is an ambitious project. It wants to create a network that would avoid the deficiencies of exiting networks and also would be able to satisfy future long-term technical and socio-economic needs. To achieve these objectives, FN would abandon the conventional evolutionary approach, and is determined to take the clean slate design approach, which means to design a new network based on fresh new ideas, principles, rules, methods and structures.

The clean slate design approach would face several problems. The first is that for many years network designers have been accustomed to doing maintenance and amending work. The clean slate approach would create challenges to them both mentally and technically. Mentally, researchers have to learn how to adjust their mentality from an evolutionary to a revolutionary, from conservatives into radicals. Technically, the old ways of research and technical knowledge would be insufficient for the new work (for example, conventionally, standards developers only look at technological trends in 3-5 years. But for FN, they have to look at trends in 10-15 years).

Another problem is the complication of networks. One of the objectives of Future Network is to allow information run smoothly among various networks. The new design has to take into account of characteristics of various networks and provide a coherent plan for more efficient information exchange among the networks, both old and new.

Furthermore, FN would involve a lot more factors other than technology. Factors such as politics, law, economy, culture and defence would have huge impact upon the way how FN standardize. How technical experts handle those non-technical influences?

On NAS, the situation is the same. For example, there are many different schemes in naming and addressing in existing networks. A new NAS has to know the advantages and deficiencies of existing NAS so that advantages can be preserved and defects are corrected or avoided in the new NAS. Naming and addressing schemes may also involve political and regulatory issues, making the design more complicated.

Facing these hard challenges, it is wise for Future Network to take a cautious approach by developing technical report first before formal standards are developed. This approach would allow technical experts and network designers see the whole picture of the situation and have a clear and common view of the objectives.

This technical report is more like part of a strategic planning for FN-NAS work. It does not create a standard, but makes some preparation for formal start of standardization of FN-NAS in the near future. Considering the nature of FN, such a preparation is very necessary.

### 5.4 FN-NAS Development Plan

FN-NAS development plan include five steps:

Step 1 Situation Analysis: to study the need for NAS and its relationship with and position in Future Network. The focus is on whether NAS be included as a project in FN.  This step has mostly completed during 2007-2008.

Step 2 Project Visioning: To set missions for FN-NAS, set project objectives, identify major problems, look for approaches, establish development guidelines, etc. Chinese expert contribution in 6N13948 has produced a solid ground for this work. This technical report will incorporate 6N13948 and go a step further by taking the work specified in step 3.

Step 3 Technical challenges: To achieve the lofty visions of Future Network, FN-NAS has to overcome many technical challenges. A successful NAS design has to show the ability to support technologies that would satisfy demands from all kinds of applications in the future. Knowing what the challenges are would help developers to produce a well planned scheme.

This technical report describes design principles and technical requirements for FN-NAS. The purpose of producing this report is to provide general guidelines for network researches to assist their research and design new NAS that would be usable in FN. Another purpose is to set a list of technical performance standards based on which prospective technical proposals can be evaluated and selected.

Developing NAS is a very daunting task, requiring a lot of thinking, experimenting, huge resources and technical challenges. ISO/IEC does not have the resources to develop the technologies. ISO/IEC Future Network can invite members to contribute mature new NAS technologies and standardize them as

International Standards. However, ISO/IEC should not sit and wait for new NAS to appear and take what is available. As the organization controlling the standardization process, ISO/IEC can set guidelines, directions, requirements and qualifications for NAS technical proposals.

Step 4 Proposal evaluation: After Step 3 is complete (common criteria for evaluation of NAS technical strength is set) SC6 should send out calls for proposals which would compete for acceptance as FN-NAS candidate and technology provider. Competing proposals then will be evaluated or organized. The proposal or a combination of proposals which meet the prerequisite conditions and can overcome the most challenges will be accepted as core FN-NAS project.

Step 5 Standard development: NAS standards will be developed based on the core FN-NAS technology.

## 6. PROBLEM STATEMENT AND GAP ANALYSIS

Problems in existing networks are discussed in TR.FNPSR Part 1. In this report, we will focus on the problems in old NAS designs are how they are related to the deficiencies of existing networks. Many of the problems in existing networks are rooted in the naming and addressing structures which are too old.

### 6.1 Naming and Addressing in Network Operation

Naming and addressing are two closely related core schemes in any network designs.

Naming is a scheme which gives identity to every computer or object connected with the network or the party who is going to send or receive information from the network.

Addressing is a scheme which provides information on the point where the sender or receiver is located in the networks. It contains two mechanisms, one is to define the location (address format) and another is to specify how to find the addresses.

To understand the significance of naming and addressing in networks, we can look at how the post office networks operate. When people visit a post office to send a package to another place, they must provide critical information, which are the recipient name and address. Using the address, post network will be able to move the package to the place where the recipient is located. Using the name, mail man can deliver the package to the right person. If the name and address are wrong, the package would be either delivered to a wrong person or returned to the sender whose name and address are also recorded on the package. Therefore, naming and addressing are the two most crucial components without which no post network can operate.

Similar to the post office systems, communication networks (composed of telecom networks and computer networks) are designed to deliver information from one point to another remote point or from one person to another person. In order to conduct the delivery, the sender must know the other party’s name and where the other party is located. Therefore, a network system must contain the naming and addressing schemes as the most fundamental protocols so that the telecommunication networks and information systems know whom and where to send the information.

### 6.2 NAS Types

Generally speaking, there are two generations of telecommunication networks and information systems which uses two different types of NAS.

The first generation of network is the traditional telecom network which is typically known for telephone system sending analogue signals through circuit switches and copper lines (or modernized fibre optical lines). The phone network connects people at two ends of the communication line.

The second generation of network is represented by Internet which mostly sending digital signals through routers and fibre optical backbones to connect computer hosts. For convenience, we refer these two generations as analogue networks and digital networks and analogue and digital is the most fundamental difference distinguishing these two kinds of networks.

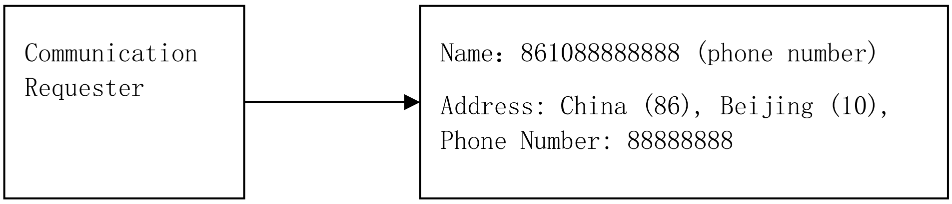
#### 6.2.1. Telecom Network Naming and Addressing Schemes

In first generation telecom network environment, people mostly use telephone numbers. The phone numbers have two different characteristics. One is a pure object identifier (a name), the other is function as an address. When in use, there are two situations, one is the need to know the name (identifier) and the other is just need to know the address.

For fixed line communication in first generation telecom networks, the fixed line telephone number is a simply address mode. A phone number actually contains information about the location and path. For example, when people dial number 861088888888， the telecom switch instantly know the identification of the party been called, but also knows which country (86) which city (10) and which location (88888888) the party is located. The telephone address is fixed, but the person who was called is unsure or not a requirement for communication.

In some situations, a phone number may be shared by many users, such as a public phone or a phone in a business unit. In private phone situation such as a residential phone, if the caller knows a person name but has no phone number, he cannot make the call. He has to use other methods such as searching the telephone book or directory assistance to find the phone number first. Therefore, fixed line telephone number is a system that mostly relies on addressing schemes. We call it communication based on addressing mode.

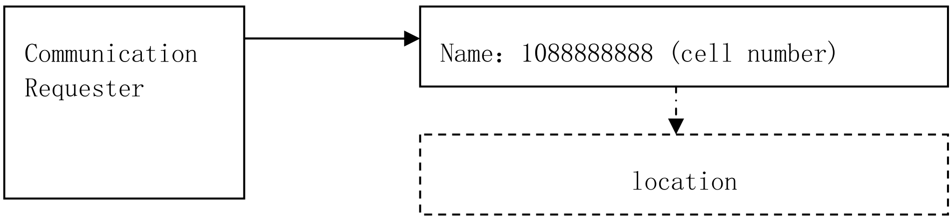
Chart 1, Combined NAS (Telecom network)




The century old telephone networks have been proven to be a reliable, useful, secure and affordable communication tool.

Other than the fixed line telecom networks, there is another type of network which sends communication signals not through wire but through the air. In the beginning, it is radio, then mobile networks. In these kinds of networks, the users are not fixed to one place, but may be in constant movement. Since they move, there is no way to use addresses. What needed is identifier. The network sending calls to the air and the parties establish communication by caller IDs. This is single communication on naming mode.

Chart 2, Name only NAS (Mobile network)



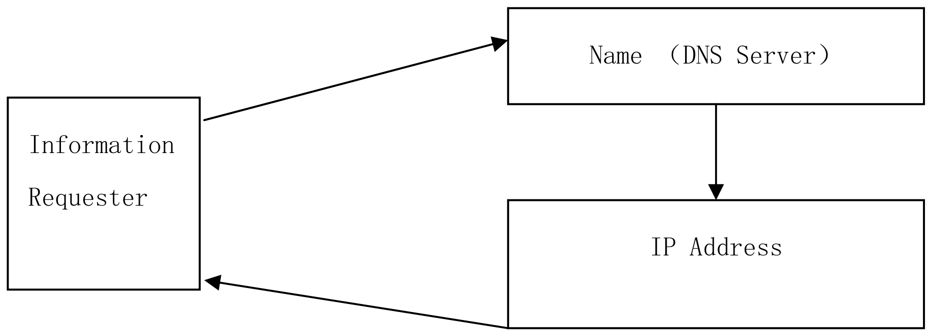

### 6.2.2. Computer Network Naming and Addressing Schemes

In computer networks (Internet), there is also an address only communication mode. When a person uses his computer to access internet, his personal identity and name is hidden. The trace he leave behind is his IP address. Current internet networks rely on TCP/IP versions 4 and 6 (IPV4 and IPV6) to conduct communication and connection. Every machine has a unique identity-bound IP address, so to distinguish the millions of users and computers from each other on the networks. The network adopted a unique and standard address format, giving a unique IP address to every network connected sub-network or machine, so that it can recognize and distinguish them. In order to ensure the uniqueness of IP addresses of every computer on the network, a registration scheme is adopted in older network designs. User has to apply for registration from designated central registry administration agency. The agency considers the applicants size and future development outlook and allocates IP addresses.

Both IPV4 and IPV6 utilize separate schemes for naming and addressing. IP addresses are designed for machines to find destinations of information delivery. Domain names are mainly composed of characters whose combination can help people to identify and memorize names of the location. Every domain name has one dedicated IP address to match. Domain names make it easier for people to visit locations on the network. The combination of IP addresses, domain names, allocation, registration and management systems forms the core mechanism of current communication networks.

There is a dual mode NAS in telecommunication and information networks, in which both name and address are required for information exchange. IP based computer networks are typical dual mode NAS. IP network communication relies on domain name and IP addresses which are two different structures. Most of the computer communication involves a process imputing a domain name, finding matches involving a DNS server and converting into registered IP address.

Chart 3, Dual Mode NAS (IP network)




IP based computer network invented a new communication method which we call it communication based on domain name. Domain name is the object identifier for the computer on internet. This domain name has to be centrally registered in order to maintain network uniqueness. After registration, the domain name has to be linked to a fixed address where it is hosted. This domain name and address binding scheme make a dual mode DNS and Address communication scheme. When people find a party's domain name on the internet, he enters the name into computer which then sends information to routers. The routers will look for addresses from the zone files. This process is called DNS translation.

The advantage of this DNS system is that domain names are usually made of English Characters, which can form meaningful words or combination easier for people to recognize and remember. Domain names are more human friendly than the digital addresses. Domain names are useful for people, corporation, organizations and government agencies to establish publicly known domain to attract visitors.

For this advantage, the second (next) generation internet IPV6 did not touch the DNS system, only changing the address format. This is also the reason we regard IPV6 as an evolutionary approach, and the reason we believe IPV6 is not a proper candidate to be listed as core protocol for Future Network. Notwithstanding its conveniences, DNS system is also one of the structural deficiencies of Internet. Many problems of internet are related to the DNS system. For example, the zone files that contain the binding information of domain name and IP addresses are so huge that it is causing growing problems in searching and management. There is a proposal to convert OID's to be used by internet of things into Domain names. Imaging how troublesome would it be if the zone files to have billions and billions of object names of goods produced each year.

Future network have to find a way which can retain the advantages of DNS but also can avoid its deficiencies.

### 6.3 DIFFICULTY IN NETWORK INTEGRATION

The brief review of the first and second generation network naming and addressing schemes indicate some problems for any attempt to integrate existing networks.

1). Telecom networks and computer networks have different addressing formats.

2). Telecom networks and computer networks have different naming formats.

3). Telecom networks and computer networks have different method in addressing searching, transporting and forwarding.

4). Within these two generations of networks, there are differences in naming and addressing methods.

5). In order to avoid duplicating construction, sharing network resources, providing more and better services, there is a tendency to integrate various kinds of networks into one system to allow information seamlessly transmitted among networks. This is one of the objectives for Future Network.

6). But, the many forms of naming and addressing in old networks make the network integration very complicated, if not impossible. Even though technicians can find technologies to allow information shared among the networks, it would be a huge effort to overhaul the existing network infrastructures.

7). Considering the fact that IP networks have the potential to be a platform for future network integration, its own deficiencies should be fundamentally resolved. Otherwise, if they are spread into other networks, it would bring more broad and severe problems.

8). Instead of focusing on reforming the old networks, a better way would be to create a totally new network. We should open our mind, plan for complete new and advanced network architecture. The old networks can be left untouched and keep running.。

### 6.4 NAS and Network Performance

In network designs, naming and addressing are not only essential and indispensable, but should also occupy top priority in design schedules. Reasons are:

1). Only after naming and addressing schemes are set, the whole architecture and other subsystems such as router designs and application services can have a base to start work on.

2). NAS structures may affect network performances

3). NAS format influences network security

4). NAS format influences accuracy for information delivery, etc.

For example, the simpler naming and addressing structure of old phone network system make the phone networks more stable and secure while the newer general computerized internet faces all kinds of problems partly due to its flawed naming and addressing structure designs.

In Future Network research, the study on naming and addressing is indispensable. This is not only because of the fact that a new network needs a new design of naming and addressing, but also because the old networks naming and addressing schemes have structural limitations and cannot be simply copied and used to support the Future Network.

In discussing the deficiencies of old network naming and addressing schemes, our focus will be on the IP based networks, because it is more complicated o because it is an unavoidable tendency to use IP networks as the platform to support the interconnection of all networks.

### 6.5 Historical limitations of old naming and addressing system

When evaluate the current IP naming and addressing schemes, we have to take two perspectives: one is historical and the other futuristic.

In historical perspective, we have to give current IP naming and addressing schemes the credit for what they have achieved. They become the base for world-wide networks that connect billions of people across the world.

In futuristic perspective, we have to realistically acknowledge that current IP naming and addressing schemes, because of their inherent weaknesses, is incapable of doing what we would ask them to do. We have to search for alternatives.

Current IP naming and addressing schemes rely on a design concept which was formed about 40 years ago and is therefore outdated.

IPV4 naming and addressing schemes were originated in the 1960s and 70s. At that time, computer communications has limited usage. The designers never envisioned how fast and how broadly the networks have developed and expanded worldwide. There are millions of computers and billions of users on the network everyday. There is a conflict between the limited usage design and unlimited actual usage request. This creates many problems. The shortage of IP addresses was one example of the problems.

Although IPV6 adopted a new addressing scheme, it does not deal with all the problems. The advantage of IPV6 is its expansion of available IP addresses. However, because IPV6 continued an "evolutionary" approach and never intended to do complete structural reshaping, it left many problems untouched.

## 6.6 Technical limitations of old naming and addressing system

Current naming and addressing schemes have the following major limitations:

### 6.6.1 Central Registration Authority

The Old schemes require the Central registration authority, which maintains the control of the key facilities of the Internet. This causes widely concerns of information security among the international community.

### 6.6.2 Address costs

The centralized domain name registration schemes create economic burdens for heavy IP address users or nations.

### 6.6.3 Routing Table

Routing tables are becoming more and more bulky. It causes problems for management and maintenance and increases router work load.

### 6.6.4 Vertical Structure

Centralized domain name system forms a vertical structure, with multiple bottlenecks which generate or increase heavy network congestion.

### 6.6.5 DNS Translation

The separation of domain names and IP addresses requires a Domain name to IP Address conversion process. It reduces information delivery speed and causes many burdens.

### 6.6.6 Data Encryption

IPV4 can only utilize data encryption (IPV6-IPSec), but its addresses cannot be encrypted. It cannot provide address confidentiality.

### 6.6.7 Category addresses

IPV4 addresses can only provide "type" addresses, but can not provide "leveled" addresses which are essential for high quality communication applications such as multi-media and real time information transmissions.

### 6.6.8 Lack Geographic Consideration

Existing naming and addressing schemes lacks consideration or respect for geographical or national boundary considerations. It creates problems for national government in network management and information security.

### 6.6.9 No address in native language

IPV4 name and address schemes do not provide language (such as Chinese, Korean, Japanese, Russian, French, German, etc.) direct routing function, and have to rely on domain name conversion schemes.

However, current domain name conversion systems do not provide language supports other than English, therefore, it cannot create allow or convert domain names based on other languages such as Chinese, Korean, Japanese, Russian, French, German, Arabian, etc.

#### 6.6.10 No decimal naming system

Current domain name conversion system cannot provide all decimal name systems such as telephone number, OID coding, mobile phone number, merchandise code, etc. Those numbers have to be inserted into English domain names for conversion. This complicates a simple process. It reduces data security and waste network resources.

#### 6.6.11 IPV6 Limitations

The major improvements from IPV6 are that it increases the length of IP addresses and expands address resources. However, IPV6 does not make significant changes to other aspects of the IPV4 naming and addressing structure. Therefore, IPV6 carries most of the IPV4 deficiencies in naming and addressing. Furthermore, IPV6 eliminates the geographical concept in addressing scheme. This is not good for management, security and economic efficiency.

# 7. GAP ANALYSIS

## 7.1. The need for a Clean Slate Design

From above analysis of the limitations of current IP-based network technologies, we can derive the following views:

- Current IP-based networks have many deficiencies.
- Those deficiencies result from structural designs.
- Problems in current IP-based networks were largely related to flaws in naming and addressing schemes.
- It is impossible to overcome those problems without structural overhaul.
- The evolutionary approaches such as IPV6 are inadequate to fix the problems.
- Future Network's clean slate design principle is justified.
- A clean-slate design must include redesigning the naming and addressing schemes.
- In order to achieve the design goals of Future Network, we have to find out what kind of gaps are there between the goals and current systems.

## 7.2. Future Network Design Goals

In document 6N13490, SC6 described the design goals of Future Network as including eight aspects: [1]

- Scalability
- Security
- Mobility
- Robustness
- Heterogeneity
- Quality of Service
- Customizability
- Economic incentive

## 7.3. The Gaps

If we compare section 5 of this document which analyze the technical strengths and weaknesses of current IP naming and address schemes with the design goals of Future network described in Section 6.2, we can clearly see the gaps between the two.

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[1] ISO/IEC JTC1 SC6 document, 6N13490, Design Goals and General Requirements for Future Network.

The design goals describe idealistic objectives that Future Network is intended to achieve or perform. They are based on the overall observation or evaluation of the existing IP-based networks. Using the design goals as a base for evaluation, we will find that current IP-based network naming and addressing schemes cannot satisfy the needs of Future Network.

#### 7.3.1. On scalability

The rigid structure of centralized domain registration and hierarchical routing systems in IPV4-IPV6 prevent scalable networks from emerging.

#### 7.3.2. On security

The centralized domain name conversion and exposed IP addresses cause wide security concerns.

#### 7.3.3. On mobility

Current domain names and address protocols does not fit well into the future network environment which will have more and more new communication devices or services such as mobile phones, RFID, sensors, etc.

#### 7.3.4. On Quality of Service

The future network should support quality of service (QoS) from user and/or application perspectives. The current IP-based network naming and addressing schemes needs to give more freedom to users and more rooms of expansion for applications.

#### 7.3.5. On Heterogeneity

Current domain names and address is incapable of providing name and address structural support for accommodating the integrated networks.

#### 7.3.6. On Robustness

The centralized domain name conversion and hierarchical network routing structures in current IP-based networks is one of the causes for network congestion.

#### 7.3.7. On Customizability

Current naming and addressing schemes has too rigid policies and does not provide flexibility for customized network communications.

#### 7.3.8. On economic incentives

Current IP names and address fee systems are too expansive for users. Better designed naming and addressing structures also may produce economic incentives resulting from more security and network efficiency.

## 8. FN-NAS DESIGN GUIDELINES

Above discussions not only demonstrate the need for a new naming and addressing scheme for Future Network, but also provide valuable information on what kind of goals we should have when considering and evaluating possible candidates of new naming and addressing schemes. Before formatting standardizing work on naming and address starts, we should develop an strategic plan for the work to ensure what we do will be always in the right direction.

### 8.1. FN-NAS Design Objectives, scope and strategies

#### 8.1.1. Design Goals:

Future Network naming and addressing scheme is an integral part of Future Network program. Its goal is to develop a whole set of new naming and addressing scheme for Future Network.

#### 8.1.2. Working Scope:

FN-NAS working scope cover the following areas:

1). As part of the Future Network program, need to follow closely the development of Future Network research, maintain close relationship with other projects, provide mutual support to other projects, make contribution to the success of the whole effort.

2). Study the basic characteristics and requirement for naming and addressing under Future Network environment, produce a proper core naming and addressing system.

3). At proper time, roll out the formal standardization procedure on Future Network naming and addressing schemes.

4). After shaping the fundamental plan for FN-NAS, make it available to other projects so that it becomes a corner stone for the whole network structure.

5). Establish communication, liaison and cooperation with other organizations regarding network naming and addressing.

#### 8.1.3. Working Strategy:

During the development of making new generation of naming and addressing for Future Network, according to ISO/IEC's characters and principles, should adopt the following strategies:

1). Not engage in original exploration and research, but to provide a integration and internationalization platform for NAS researchers and technical developers worldwide. It is because new NAS research needs huge resources, including environment, policies, infrastructure, funding, manpower, etc., ISO/IEC does not possess these kinds of resources. ISO/IEC can strategically position itself as a platform for technical integration and international standardization, encourage new NAS developers submit their best technologies to ISO/IEC for standardization and internationalization.

2). Strengthen communication and collaboration with member bodies and encourage them to submit their technologies to ISO/IEC. According to development experiences, such a huge effort on developing a whole system of network, no private entities can afford taking leadership. The most likely funding for fundamental research will be from public funding. Recognized as major international standardization organizations, ISO/IEC have most of the countries as member bodies and can attract member technologies.

3). Instead of waiting for technologies to appear, ISO/IEC can be proactively, providing a leadership role, by making calls and setting up requirements. As the adopter of technology and developer of international standardization, ISO/IEC can produce technical requirements, listing clear measuring criteria, producing guidelines, making assessing formats, so to force the developing or to be developed technologies comply with ISO/IEC's Future Network visions and objectives.

4). Take a two step strategy: Future Network NAS can take two steps. The first step is to from "none" to "have" which is to find at least one proposal as a foundation to work on, then take the second step from "have" to "good", which is to refine the proposal and make it a well functioned system.

5). For the first step, Future Network should not be too idealistic, rather than waiting endlessly for the "perfect system" to appear, we should starting by taking the "best available" as the base for start.

6). Future Network should overcome the scepticism and pessimism; we should demonstrate confidence and determination.

### 8.2. FN-NAS Design Principles

In order to achieve the Future Network goals, NAS designers, researchers and proposal evaluation should know and uphold the following principles.

#### 8.2.1. Clean Slate Design

FN-NAS must be a clean slate design to comply with the overall guiding principle of Future Network project.The new network is built from scratch on a "clean white paper" with everything new. Old networks are mentioned only as comparisons or when showing new network capabilities to interoperate.

#### 8.2.2. Freedom from old network rules

When developing FN-NAS, we should not be restricted by old and existing network rules, but will focus on establishing new rules to promote the forming, surviving, expanding and application of the new network.

#### 8.2.3. Looking to the Future

When developing FN-NAS, we should look first into the future, consider what will be the social need in the future and how to do best to satisfy them. Backward compatibility will be secondly consideration.

#### 8.2.4. Reserve Expansion Space

The consideration of future needs should be longer enough, to reserve enough room for expanded use, allow to the best enough structural flexibility for incorporating future technologies and should give FN about twenty years of development time (not making the infrastructure obsolete in twenty years).

#### 8.2.5. Research

The need research should take the social needs comprehensively, and to create supporting conditions for applications from the base structures.

#### 8.2.6. Consider New Applications

FN-NAS has to consider the requirement for new NAS from emerging network concepts. Especially, needs from new networks such as sensor networks, internet of things and mobile networks should be put into top priority.

#### 8.2.7. Cross Boundaries

In order to produce a new NAS system that would satisfy various needs from many fields, FN-NAS should take a cross-layer, cross-platform, cross-field approach, and place no restrictions on innovation.

#### 8.2.8. Self-Networking Principle

As a product of clean slate design, the new network must not rely on old networks facilities to exist and operate. It must have the capability to independently form a network and showing its technical advantages. If a NAS mechanism relies on old network structures to perform, it should be submitted to other evolutionary projects.

#### 8.2.9. Network Backbone or Platform

FN-NAS has to take into consideration of the possibility of FN becoming the network backbone or integration platform for future network integration or federation. FN-NAS has to consider making the new scheme capable of provide support for this function.

#### 8.2.10. Seek Proposals Globally

ISO/IEC Future Network is a technical integration and standardization project, should be openly search globally for suitable proposals on new NAS.

#### 8.2.11. Proposal Competition

In order to find the best and strongest technology for Future Network, ISO/IEC should encourage competitive submission of NAS proposals. The candidate proposals should be evaluated according to common criteria and those having the characteristics of best innovation, best performance and most potential shall become the core plan.

#### 8.2.12. Call for Proposals

After FN-NAS form a strategic plan including guidelines and requirements (this technical report), ISO/IEC should issue a call for proposals, and formulate a method for proposal evaluation and selection.

#### 8.2.13. Mandatory and Optional Requirements

In the call for proposals and selection guidelines, distinctions should be made about mandatory and optional requirements. The Mandatory requirements are conditions that proposal must satisfy in order to qualify for selection. The optional conditions are preferable but can be either developed later on or in combination with other proposals.

#### 8.2.14. Feasibility Principle

The new NAS must demonstrate feasibility. NAS new design or technical proposals must show theoretical analysis and engineering experiment to show that the design is theoretically feasible, engineering workable and practically usable.

#### 8.2.15. Whole System

In order to perform self-networking, the new NAS must show its potential to develop into a complete new network system, including the capability to form new protocols, routing and applications.

#### 8.2.16. Total Solution Principle

When evaluating NAS proposal, priority should be given to those which can provide a total solution package, which means that one design can resolve all technical challenges and achieve all network design objectives. Those proposals which can partially solve problems should find ways to be integrated into the total solution or be denied.

#### 8.2.17. Integration Principle

New NAS designs may contain many new technologies which may also fall into the scope of other standardization organizations. While there is no restriction for NAS technologies to be standardized in other appropriate standardizing entities, the Future Network is the place to provide both an integrated NAS system and certain technologies the project sees fit for hosting.

#### 8.2.18. Performance Principle

NAS designers or technical proposals must demonstrate how the new design would enhance the new network performances  NAS proposal should describe what the new design structure is and how it would create better performances in areas such as security, efficiency, and better economic and environmental benefits.

#### 8.2.19. The Non Harm Principle

the new NAS must not create harmful impacts upon existing networks such as disrupting old network services or conflicting with established network protocols.

#### 8.2.20. Member Body Perspective Principle

Although Future Network design works are mostly conducted by technical experts, the final approval will be based on the views and feelings of ISO/IEC member bodies. Therefore, NAS design should not only consider technical merits, but also has to take consideration of expectations of national bodies.

#### 8.2.21. Aim High Principle

Future Network design is not just putting together what are available in technology and standardize them. It is a process first to determine what should be achieved and then either find available solutions or develop new technologies. The aim should be high in order to make the new network suitable for future needs.

### 8.3. FN-NAS Technical Objectives

We believe, an ideal Future Network naming and addressing scheme should strive to achieve the following objectives:

#### 8.3.1. New Types of Addresses

Future Network must develop a new type of address which would form a new network space. The new address must be different from the IPV4-IPV6 address in format.

#### 8.3.2. Horizontal structure

The new naming and addressing scheme must have horizontal structures so that it can provide services that the old vertical structures are unable to do.

#### 8.3.3. Geographical boundaries in Digital World

The new naming and addressing must consider and respect geographic boundaries, especially the national sovereignty in digital world.

### 8.3.4. Address confidentiality
The new naming and addressing schemes should provide room for installing mechanisms aimed at improving address confidentiality.

### 8.3.5. Flexibility in domain name management
Users (individuals, institutions or public authorities) should have more freedom and flexibility to create, register and manage domain names.

### 8.3.6. Enhanced security
The new naming and addressing schemes should provide better security for information exchange through the networks, but also take into consideration of wider security issues, such as the need to maintain rule and order, public facility, personal safety and national security.

### 8.3.7. PTP connections
The new naming and addressing schemes should provide a base for Point to Point (PTP) connections which would bring better services, more efficiency and more security.

### 8.3.8. Cultural awareness
The new naming and addressing schemes should take consideration of the special needs of different cultures and provide technical support for multi-cultural network environment.

### 8.3.9. Information transmission speed
The new naming and addressing schemes should be able to increase the speed of information distribution in Future Network. The may take new naming mechanisms and new address architectures. They should be able to support ideas such as direct routing (without the need for name-address conversion) or character routing.

### 8.3.10. Multi-dimensional structure
FN-NAS should consider the concept of multi-dimensional network so that the limitations of current hierarchical structure are resolved. Multi-dimensional structure may include concepts such as grid computing, position based addressing schemes, layered addressing schemes, etc.

### 8.3.11. Address availability
FN-NAS should design a new address architecture that would offer truly unlimited resources of addresses to whoever wants them and at an affordable cost.

### 8.3.12. Address allocation
FN-NAS should reduce the inequality in current address allocation systems. For example, China which possesses 20 percent of world population should be able to should have enough addresses to satisfy the need of its huge population.

### 8.3.13. Reduce Network Congestion
FN-NAS must aim at using the new schemes to help reduce network congestion. There should be clear response to bottlenecks exist in current networks.

### 8.3.14. Intelligent networks
FN-NAS must have a scheme to support the intelligent networks. The issues of mobility, scalability and reprogramming should be considered.

### 8.3.15. Economic benefits
The new naming and addressing schemes should increase efficiency so that users would have less economic burden.

### 8.3.16. Integration and harmonization
FN-NAS must provide mechanisms to support the integration and harmonization of various kinds of services,

applications and networks, so that a network platform is established to support the concept of all-service network.

#### 8.3.17. Pure decimal world

FN-NAS must have designs for pure decimal network communications so that the new network can provide support to some special applications such as mobile phones, RFID, etc.

#### 8.3.18. Name and Address integration

Looking into the future, there will for sure be a demand from special applications for integration of name and addresses into one entity, but current IP-based networks always separate the two. FN-NAS must find a way to bridge the gap.

#### 8.3.19. Room for new applications

FN-NAS must have forward looking mentality and leave rooms for providing naming and addressing support to new applications that would emerge in many years to come.

#### 8.3.20. Consistency

Although there will be too many aspects to consider, FN-NAS must maintain consistency. It must have thorough theoretic research and engineering proof of soundness in concepts. Position based addressing scheme.

#### 8.3.21. Compatibility and interoperability

Clean slate design does not mean elimination of old facilities. FN-NAS will not be bound by old naming and addressing rules, however, we should not mislead to believe that the new future network would have conflict with networks build on old naming and addressing schemes. FN-NAS should take into consideration of compatibility and interoperability between old and new future network and show a way how it can be achieved (probably it can be done through engineering works).

#### 8.3.22. Environment protection

FN-NAS should find ways to contribute to the protection of environment. Possible options are NAS designs that could reduce the use of energy in network operation and information processing and transmission.

# 9. FN-NAS Technical Requirements

## 9.1. Content Description

This chapter describes technical requirements for FN-NAS design, including the following aspects:

1). System Requirements: Including design concepts, system architecture, etc.;

2). Special NAS requirements: including address format, network space, network communication structure, routing, DNS, communication protocols, security, etc.

3). Foreseeing mechanism: consider how the Future Network will change and benefit the human society in the future.

4). Compatibility Requirement: considering the emergence of FN-NAS will largely influence Future Network's basic technological designs including network space, network resources, communication protocols, network architectural modes, security, QoS, routing protocols, upper layer protocols, interoperability, it is desirable to have considerations and design to allow compatibility and interoperability with existing networks.

5). Others: Future network forward compatibility, future continuous development and testing and compliance requirements.

Reasons for specifying these technical requirements are:

1). From the perspective of network performance, demonstrative Future Network's main characteristics and capabilities, and to show a more clear future outlook for the development of Future Network.

2). To point out objectives and directions for global research on new generation networks.

3). To produce clear criteria for technical assessment in the next stage (proposal evaluation)

4). To provide reference criteria for other research projects in Future Network program.

## 9.2. System Technical Requirements

### 9.2.1. R001. SYSTEM INTEGRITY REQUIREMENT

From the perspective of system requirements, a complete NAS system should include at least the following elements: naming, network space, network resources, addresses, network architecture, predictive mathematic model, application, experiment, testing, etc. FN-NAS plan must have these elements. (From historical experiences, some communication system may requirement single mode, such as naming only or address only. If a proposal specifies only one mode, reasons must be given.

### 9.2.2. R002. INTER SYSTEM COHERENCE REQUIREMENT

Besides having many sub-systems inside FN-NAS, it is also a part of a larger Future Network system. FN-NAS should not only study and seek coherence among its sub-systems, but also should seek compatibility and mutual support with the larger system. FN-NAS should consider how to be consistent, supportive, benefit and interoperate with other systems in Future Network. FN-NAS should not produce conflict with other systems and should avoid lowering the Future Network performance to meet the lower requirements caused by deficient NAS design.

### 9.2.3. R003. STRUCTURAL REQUIREMENT

Future Network should have a complete new addressing structure with the following requirements:

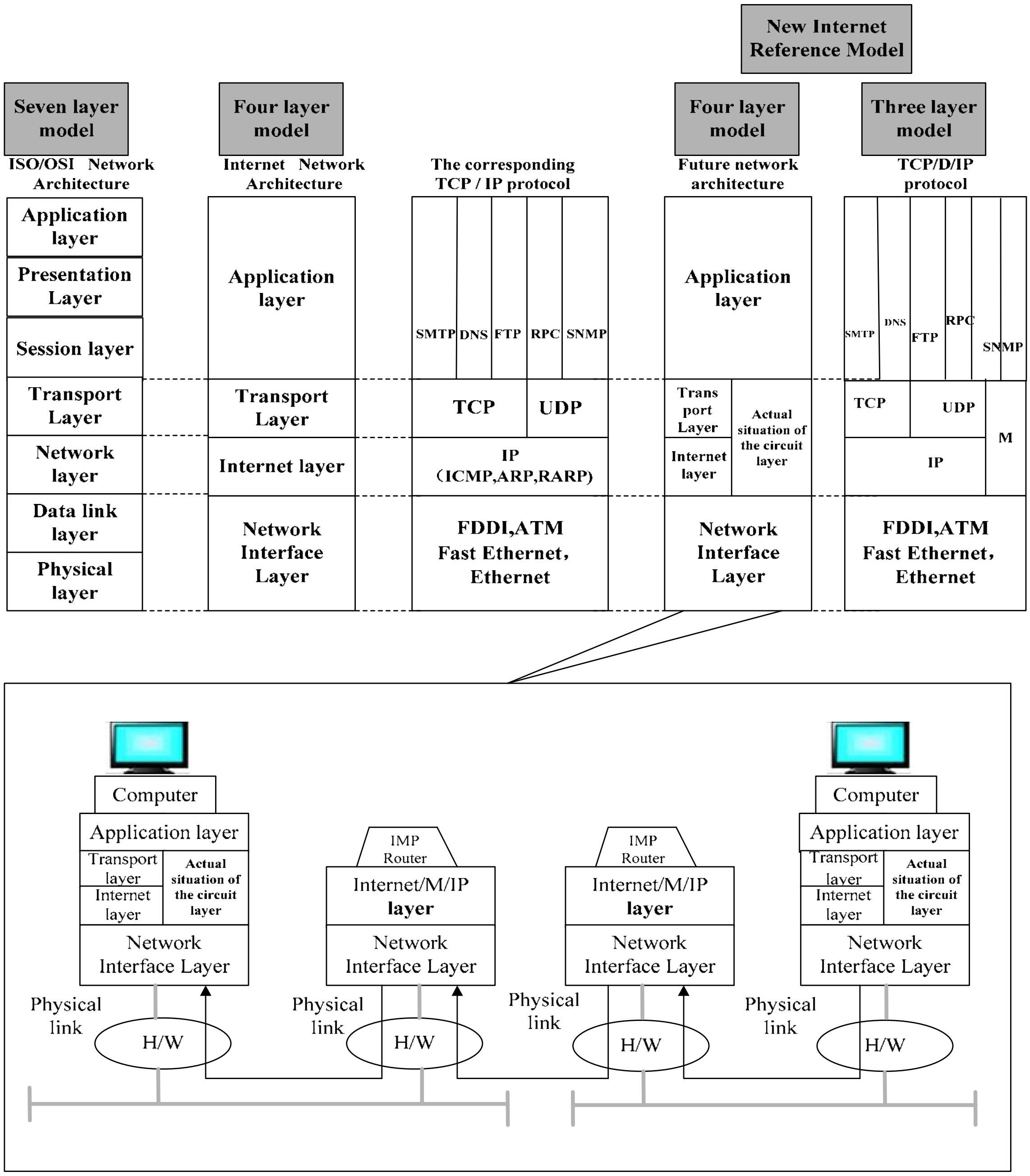
1) Good human-machine interface
2) Support conventional computing, future quantum computing, biological computing and other computing language and various human languages based computing, and their compatibility and interoperability.
3) Protocol, addressing format and addressing solution schemes that would form a secure network structure supporting and satisfying the concept of authentication before communication
4) A communication method mixing virtual layer-three circuit switching and Layer-four packet switching.
5) Direct routing network architecture that will reduce carbon emission and produce greener networks.
6) Fast and large capacity network services.
7) Been able to interoperate with existing networks, allowing lower cost and seamlessly upgrade of old networks, ability to maintain forward compatibility and potential for continuous development.
8) Having better performance than existing networks and continuous expansion and function in the 21st century or beyond.

#### 9.2.3.1. A NETWORK STURCUTURE MIXING VIRTUAL LAYER-THREE CIRCUIT SWITCHING AND LAYER-FOUR PACKET SWITCHING

In the Future Network, layer-four packet switching is similar to current TCP/IP protocol; but the layer-three virtual circuit switching is different from TCP/IP. In Layer-three, in the real circuit, there will be a virtual circuit, preserve some bandwidth based on demand， and the data transmitted in the virtual circuit is based on always connected, continuous, long and reliable information stream, not data packets; It is essentially a circuit transmission, different from conventional QoS definition. When a online video program or voice communication is requested, the protocol would assess the needed bandwidth and make preservation to allow seamlessly information streaming transmission in the time reserved; This process omitted the procedure of cutting a movie or dialogue into many small packets and then on the other end regroup them into a whole content. The new scheme would significantly help resolve the problems surrounding voice and video quality transmission quality, transmission content and bandwidth distribution, packet switching and circuit switching, routing selection.

#### 9.2.3.2. REFERENCE ARCHITECTURE

Existing networks mainly use two types of switching. In telecom networks (mainly telephone network) circuit switching is the primary form. In computer networks (mainly Internet), the dominant protocol is TCP/IP (simply referred as IP protocol) uses mainly packet switching. Future Network faces the task of offering both data communication and video/voice communication in one network. To solve this problem, we think that Future Network should employ a transmission architecture model constructing a mixed layer structure, using the layer three for virtual circuit switching to transmit video broadcasting and voice communication while using the layer four structure for IP dada transmission. (see following diagram).




**Network model for the future**

(Note: M = mixed protocol)

## 9.2.4. R004. SPECIFIC TECHNICAL REQUIREMENTS

### 9.2.4.1. ADDRESSING TECHNICAL REQUIREMENTS

#### 9.2.4.1.1. ADDRESS FORMAT

Future Network NAS should consider having a new address system which will create a totally new network space for the Future Network to exist, operate and expand.

A new address format is the foundation of a new address system. FN-NAS should have an new format of addresses that is different from all existing NAS, but it should have the potential to allow compatibility with existing address formats.

FN-NAS address format should go beyond of serving computer, but also make it more human friendly, to allow users easier operate the addressing scheme while maintaining the efficiency for computing.

Digital Coding: The ten digits Arabian numerals are globally used language. Pure decimal encoding is one of the most commonly used way of expressing. Future Network should consider the need for pure decimal coding from real applications such as commercial good coding, sensor coding, cell phone number, geographic location, Space object location coding, molecule order coding for living bodies, etc.

Character coding: the FN-NAS address format could be in characters, such as Arabian numerals, Latin Characters or other symbols that is easy for computer recognition and human interaction. In other words, the address format should support various language environments.

#### 9.2.4.1.1. ADDRESSING MODEL

1) Addressing through subnet prefix in address:

Future Network can use subnet prefix in address to fulfil addressing. A certain subnet prefix can be linked to only one link circuit or to multiple link circuit. A certain link circuit can possess multiple subnet prefix in the same time.

2) Addressing through direct character addressing and direct routing

Future Network can consider using the direct addressing through character addressing and routing, omitting the process of DNS translation. The benefits of this method is unifying the naming and addressing, enhance network performance efficiency. For compatibility considerations, the DNS translation interface should be reserved.

#### 9.2.4.1.2. ADDRESS SPACE

Address space is one of the most important requirements for Future Network. Address is the foundation of the network space. Address not only determine the existence of a network, but also determines how big is the space of the network. The longer the address, the larger the network space will be.

The length of addresses should be long enough to create an address space which would increase the number of addresses and to satisfy the demand for longer addresses in some situations.

The first generation Internet (IPV4) address length is only 32 bits which created a problem of address shortage. IPV4 addresses ran out only twenty years after its opening to commercialization. The next (or 2nd) generation of Internet (IPV6) has 128 bits in address format. However, as the attachment to this document about geographic location based addressing scheme indicates, 128 bits are not long enough to satisfy the needs of future applications.

Therefore, Future Network should establish a new base address format with longer length of 256 bits. This would allow larger network space and long enough to satisfy most needs in the future.

#### 9.2.4.1.3. VARIABLE ADDRESS LENGTH

In contrast with first generation and second generation internet protocols which both have fixed length address format, Future Network may consider variable length address format to satisfy the demand of various applications, to achieve transmission efficiency and to allow long term expansion.

While setting the base length at 256 bits, Future Network may consider allowing other length formats such as 16 bits (there will be needs for it and would cut transmission time) and longer length up to 1024 bits (allowing more complicated address situations and large address resources with more expansion potential).

#### 9.2.4.1.4. ADDRESS TYPES

Future Network must go beyond the category addresses in existing networks and consider a layered address structure. The layered structure can provide layered address to satisfy the demand of high quality communication applications, such as the need for simultaneous transmission of multimedia real-time information transmission and data packet transmission. It will expand network application space and optimize addressing and routing technologies.

1) Direct Routing Addresses

When characters coding are used as addresses, the routing addresses are determined by the location of the router and select the geographic regional address code as directing address method.

2) Emergency Routing Addresses

FN-NAS should consider setting emergency routing addresses. In situations where networks are partially destroyed by unforeseen catastrophes, network administers can use the method of router broadcast, revise routing table, acquire other routers for emergency use.

3) Verification Addresses

This type of verification addresses is the verification code to be used with address encryption/decryption.

#### 9.2.4.1.5. ADDRESS SELECTION

All existing networks used fixed length and fixed bit location approach. IPV4 is 32 bits length, IPV6 is 128 bits length. Future Network considers setting the base length of 256 bits to allow forward expansion. But Future Network would also allow variable lengths.

This variable length requirement along with the multiple address types, there will be requirement for setting address length option in the header to distinguish address types and lengths, to identify virtual circuit addresses (virtual circuit broadcasting address, virtual circuit unicast address).

There will be three address selection methods:

1) Fixed length and fixed bits location addressing scheme

2) Fixed length and non-fixed bits location addressing scheme

3) Addressing scheme based non-fixed length and non-fixed bits location

### 9.2.4.2. FUTURE NETWORK DOMAIN NAME TRANSLATION

Future Network proposes a distributed and cross boundary domain name translation system, which would allow national bodies to manage their own root servers, establishing distributed and over-the-boundary network links, straight localized translation. These approaches would reorganize global network information flow, reduce network congestion, optimize network performances, save energy and cut network costs.

### 9.2.5. R005. COMPLEMENTARY TECHNICAL REQUIREMENTS

#### 9.2.5.1. Security Technical Requirement

##### 9.2.5.1.1. NEW COMMUNICATIONS RULES TO SUPPLEMENT NEW NAS

In order to protect the addressing security, Future Network may consider adopting a new communication rule requiring verification of source address and destination address before sending message to the networks. The new rules should design and utilize better and newer authentication and verification systems to achieve system wide security.

1) Construct a true identity authentication, verification and certification system. Change from previous afterwards certification into prior certification.
2) Change from passive and defensive network security into proactively managed cyber security.
3) Prove communicator true identity, verify network (internet) address and routing path authenticity, prevent unauthorized access, and realize trusted connection.
4) Though certifying the authenticity of software and the consistency of software identity and software data, achieve trusted computing.
5) Trusted connection is the key for trusted systems. Trusted routing is the key for realizing trusted connection.

##### 9.2.5.1.2. ADDRESS ALLOCATION ENCRYPTION SYSTEM REQUIREMENT

Future Network should consider address encryption in address allocation system, so to form a more secure network environment and prevent addresses and user information are used for hostile or malicious purposes.

This requirement can be realized in address allocation management system and DHCP system.

The address encryption is used during the communication process, local address display does not require showing of encrypted form.

##### 9.2.5.1.3. HEAD REQUIREMENT

Address encryption system requires head to have sufficient expansion function. During the transmission process, only those nodes which are related to expanded head will process them, the middle routers only pay attention to the hopping limit field (跳极限字段) and routing head. The head can be flexibly reorganized according application and network demand, to achieve the option of mobility.

The system support IP level certification authentication, carried-on encryption negotiation, and some specially defined applications.

The system should have enough addresses to allow one host machine to be used in different location and different times, to perform irregular frequency hoping. These methods would prevent attackers from getting hold and locking on the user IP address value, which means better network security.

##### 9.2.5.1.4. EMERGENCY ROUTING

In Future Network protocol, there should have an emergency status code, so that emergency routing acquisition function can be established.

#### 9.2.6. R006. Extension technical requirement

Conventional internet is based on territorial surfaces. Because of the increased space activities and the advantage of been free from landscape limitations and earth catastrophes and the advantage in data communication by internet, future space communication and space-earth communication will rely more and more on internet system. There will be a new application area in Space Internet.

The Space Internet would require a new set of naming and addressing schemes. FN-NAS also should consider how to make interconnection and interoperability between earth internet and future space internet.

#### 9.2.7. R007. Evaluation and Test Requirement

During the process of Future Network development and design, the testing and experimenting technologies and certification requirements should also be developed and standardized. Criteria should include but not limited to functions, media transport, equipment, performance, network management, power usage, environment, security and economic benefits.

In the meantime, for the innovative address formats and addressing protocols, there should be related verification theories and experimenting systems and specially made protocol analytic and testing tools.

#### 9.2.8. R008. Infrastructure Requirement

FN-NAS should consider the need and time requirement from the perspective of network infrastructure establishment such as:

1) The construction of Future Network experimental platform
2) Construction of Future Network Backbone
3) Experiment of transition of existing networks to Future Network
4) Construction Future Network system and connect with existing networks.
5) Building management systems.
6) Building application platforms.
7) Testing and compliance

## 10 FN-NAS Research Plan

This technical report outlines the objectives, tasks and requirements for FN-NAS and produces many important claims. If these claims are agreed by national bodies, they will form a solid ground to start. When objectives and directions are clear, the next is to find a rout for going forward.

Making an action plan for FN-NAs is also an important objective for this report. This plan should not only cover what to do, but also a general time line.

### 10.1. Major Tasks in the Future

The major tasks in the future for FN-NAS include：

1) Refine and complete this technical report

2) Look for and select the best proposal for a general framework on FN-NAS

3) Standardize the general framework of FU-NAS

4) Make standards of specific schemes under the general framework of FN-NAS

5) Make complementary standards or imbedding FN-NAS into Future Network system

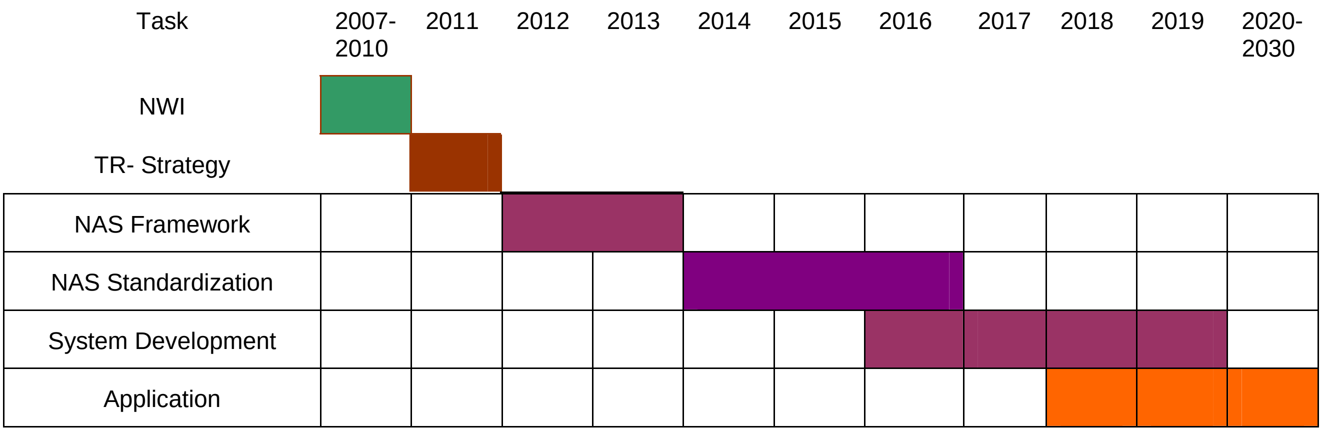
6) Provide NAS assistance to study of Future Network applications

7) Start work on registration and distribution of numbers and addresses for Future Network

8) Make a plan for address resources management policies

### 10.2. Time Line

**Timeline of FN-NAS Development**




### 10.3. Next Step

After this draft is produced, we plan the following actions for FN-NAS on the next step:

1) After the June 2011 meeting, this report is circulated to SC6 national bodies for review and comment as PDTR document.

2) While the review and revision on this document continues, SC6 may consider encouraging Chinese experts to prepare for further step on FN-NAS.

3) The work should start on drafting a "Call for Proposal on the overall framework of Future Network Naming and Addressing Scheme". This document should be drafted no later than December 1, 2011 and submitted to SC6 for consideration.

4) 2012 will be focusing on the evaluation and selection of FN-NAS Framework Proposals.

### 10.4. Coordination with other organizations

Future Network NAS research would have an extensive impact on network research and would therefore attract attention from many organizations. How to coordinate with other organizations? The following are some guiding principles:

1). Maintain Independence: Future Network is developing a new set of naming and addressing schemes, without complying to restrictions in any old rules. Therefore, Future Network project should have self-determining rights regarding the format and content of FN-NAS. Any relationship with other organizations should not undermine this right.

2). FN-NAS will face two types of issues when interacting with other organizations. The first kind is how to deal with old NAS schemes, and the other is how to deal with new NAS projects that is developed in parallel with the ISO/IEC project. Different guiding principles should be developed for these two situations.

3). For old NAS systems and their developers/maintainers, Future Network can adopt the following policies: Clearly explain the difference between evolutionary and clean slate designed NAS projects; state clearly that FN does not oppose the continued existence and improvement of old NAS; the new NAS would not seek to disrupt or destroy old network; the old and new networks can have a peaceful coexistence, develop in parallel path, utilize each other's advantages and strengths; the New NAS development work does not discriminate or reject research and development on technologies providing compatibility and interoperability between old and new network systems; when new technologies emerges which can enhance both old and new networks, we will consider mutual beneficial actions such as either joint development, dual adoption or making recommendation.

4). As to other new NAS projects, FN-NAS will follow the ISO/IEC directives regarding avoiding overlapping, duplication and contradictions. We will seek information sharing, comment invitation, joint development and other methods to seek a compatible and international recognized NAS system.

5). FN-NAS will adopt an open attitude and will consider all new network concepts and technologies from the international community. As long as proposals that is compatible with Future Network visions and structures, they will be considered carefully and adopted following ISO/IEC rules.

6). As ITU-T SG2 has indicated interest and collaboration intention on ISO/IEC FN-NAS research, we recommend to sending this document via liaison channel to SG2.

## ANNEX A: AN APPLICATION SCENARIO – REQUIREMENT FOR GEOGRAPHIC ADDRESSING SCHEME

Subtract from Korean National Body contribution with some modification by editors

To apply a new geographic addressing scheme and routing protocol based on the address scheme, the following is technical requirements.

**Requirements for a new geographic addressing scheme**

- A new geographic address contains physical and logical information
- The addressing scheme is a 256 bit length as a default.
- The addressing scheme should contain location information such as latitude, longitude, altitude,
- The addressing scheme should be able to represent a certain point or a geocast area as destination.
- A geographic address representing a point as a destination should consist of location information field and ID field such as a MAC (Media Access Card) address of a device.
- ID filed is used to identify a destination node from error of location information via GPS.
- A geographic address representing an area as a destination should consist of location information field indicating a reference point and range field indicating the area based on reference point.
- The addressing scheme should be able to represent various formats such as a circle, rectangle and polygon with altitude as a destination area.

**Requirements for node using a geographic addressing scheme**

- Nodes using a geographic address scheme should be able to obtain own location information such as a latitude, longitude and altitude through GPS (Global Positioning System) or similar mechanism..
- Nodes without GPS or in indoor should be able to obtain location information from adjacent node(s) with GPS such as an Access point.
- To forward packet as a router, nodes in wireless multi-hop network is required a location based on routing protocol which performs packet routing by location information of destination address.

**Requirements for interoperation with global network**

- To interoperate between global network and location based on network, a gateway is required.
- The gateway should understand global IP addressing scheme and geographic addressing scheme.
- The gateway should support global routing protocol for global network and location based routing protocol for wireless multi-hop network with geographic addressing scheme.
- To communicate with global network for nodes, the gateway should be able to translate from a geographic address into global IPv6 address for a source node of outgoing packet.
- The gateway can create the global IP address for the source by using gateway's external prefix, MAC address of the source node.
- The gateway should be able to translate from a global IP address into a geographic address for destination node of incoming packet.
- During maintaining a session, the gateway should keep the translated addresses pair in mapping table. 2

[2] ISO/IEC JTC1/SC6 6N14390: "Consideration for Routing and Addressing in Future Network" (August 26, 2010).