Dependable Network for Next Generation Lifeline and Business Creation

ARUTAKI Akira, KIKUCHI Yoshihide, EGAWA Takashi, KIRIHA Yoshiaki , IWATA Atsushi, KANOH Toshiyuki

Abstract

The Internet and IP technology have become the modern amenities, and are expected to become ICT infrastructure to support the future ubiquitous digital society. However, they show several vulnerabilities at present. Hence next generation lifeline and new digital business/revenue creation can be established by deploying dependable ICT systems.

This paper focuses on the concept designs of dependable networks, these architecture and emerging technologies. And new business creation is another aspect. Network-based new services/businesses can survive if and only if the network dependability is guaranteed. This topic is discussed as business model schemes in this paper. We also discuss antinomy relations between dependability and "ease-of-use," and open issues such as the social consensus.

Keywords

NGN, lifeline, safety and security, convenience, business creation

1. Introduction

PSTN is nowadays going to finish its solo-performance, the information and communication base, and even telephony except emergency communications started to rely on Internet technologies such as VoIP[1]. The Internet and IP technology has become the modern amenities. They are expected to become IT infrastructure (our computer systems and the Internet) to support the future ubiquitous computing society.

However, they show several vulnerabilities at present. The leakage of sensitive customer information is frequently reported these days. Whether the cause is intentional (cyber attacks), human error or system failure, these incidents erode public trust in the companies. In addition, these companies must bear the burden of gigantic compensation payments.

This trend will continue to grow; complicated systems are reliant on computer networks, greater amounts of information are stored, and the information is transmitted on high-speed, large-capacity links. A single trivial error could be the catalyst for enormous damages, in some cases the loss of human lives.

Rapid and extensive as the Internet development has been, however, the authors believe that there are several factors that have been overlooked, particularly when the Internet/IP transmission of information is examined from a "dependability" perspective.

This paper is composed as follows; first it explains necessities of network dependability on a basis of some statistics. Then it examines "dependability" characteristics and describes the ICT modeling scheme based on them. In the next section the authors propose the dependable network architecture and introduce some typical network services upon it. Business models follow the discussion, and related technologies are introduced, some of which are explained. Finally open issues are listed up, such as regal ones.

2. The Necessity of Dependability

2.1 Damages of Incidents

In the highly advanced information society in which we currently live, we are faced with the danger that the damage from one unfavorable incident can rapidly spread and impact a broad area via information and communications networks. The computer virus is a typical example of just such an event, but information leakage through problems with the system itself or unauthorized access, and other cases also have been reported and publicized in the news.

Table presents data on the extent and scale of damages related to ICT systems. As some of damages in the Table reach billions of yen, it is clear that insecure/unreliable systems pose a large and growing risk in corporate activities. Moreover, terminals that are "always connected" to the Internet are recently

*This paper is an abstract of one published in "ITU TELECOM WORLD 2006." The exhibition's overview and President's speech can be referred on the later 'NEC Information' pages.

Table Examples of damages in Japan.

	Company "A" (retail industry)	Company "B" (telecom industry)	Company "C" (stockbrokerage)
Date of incident	Nov. 2003	Jan. 2004	Dec. 2005
Category of incident	Leakage of personal data	Leakage of personal data	Erroneous order to stock market
Cause and damage	Cause: Leak originating from an outsourced mail server. Damage: leakage of 180,000 customer's name, address, mail address, etc. Distribution of cash coupon (1,000 yen) to each aggrieved person.	Cause: Illegal carrying out by internal staff. Damage: 4,510,000 customer's name, phone number, address, mail address, etc. Distribution of cash coupon (500 yen) to each aggrieved person.	Cause: Operation mistake of terminal computer by a trader. 610,000 shares of selling orders by 1 yen pricing. (correct: 1 stock, 610,000 yen) Damage: Repurchased with one-share 912,000 yen.
Estimated Loss(*)	180 million yen	2,300 million yen	40,000 million yen

(Extracted from articles by various newspaper publishers)
*Dose not include costs related to issuing a public apology (ad placement costs), cost of measures to correct the security problem, damage to corporate reparation (goodwill) from loss of trust, losses arising from self- imposed restrictions on business, etc.

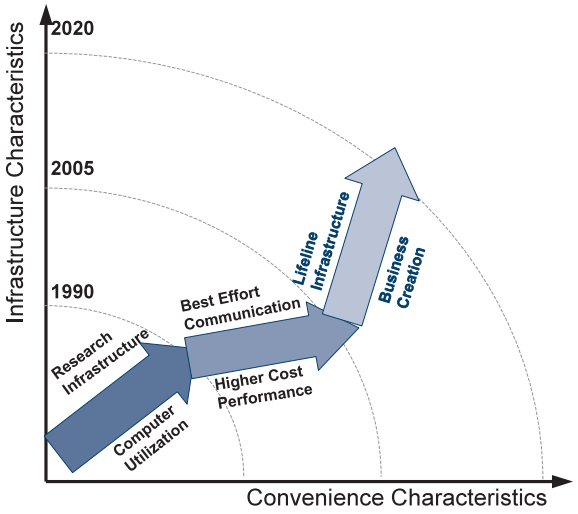


Fig. 1 Internet growth and its direction.

suffering an epidemic of malware such as viruses carried by file exchange software that trigger information leaks and viruses that make information stored on PCs visible to unauthorized parties via the web.

2.2 IT and Internet Technology at the Turning Point

In contrast to the flat, open characteristics of the Internet, the fixed telephone network system is stratified; accordingly, it can be clearly more defensive to malicious attacks on the terminal, network functions and other aspects of the system. However, in response to the needs of users who want the freedom to manage and exchange diverse digital information, it can be said that network resources are limited to a telephony service, because they are mainly devoted to voice traffic.

Serving as a universal service in the future, the Internet is expected to function as an information infrastructure to support the physical infrastructure of electric power, gas, water, traffic and transportation. In order to fulfill this role, it is necessary to achieve safe IP networks in which people can place their full trust and use with total confidence[2]. **Fig. 1** shows where the Internet grew in the past and how it should be enhanced.

By introducing and incorporating the approach of "dependability" in IT and networks as the social infrastructure, it becomes possible to overcome a variety of technical problems. We believe that the essence of "dependability" is "ideally no occurrence of faults or obstacles at all, but it also encompasses the ability to immediately grasp the situation when some abnormality appears and even predict such events in advance, and to maintain a situation of security without an event leading to social panic or development of catastrophic failure, and to do it at all at a reasonable cost[3, 4].

2.3 Requirements of Dependability

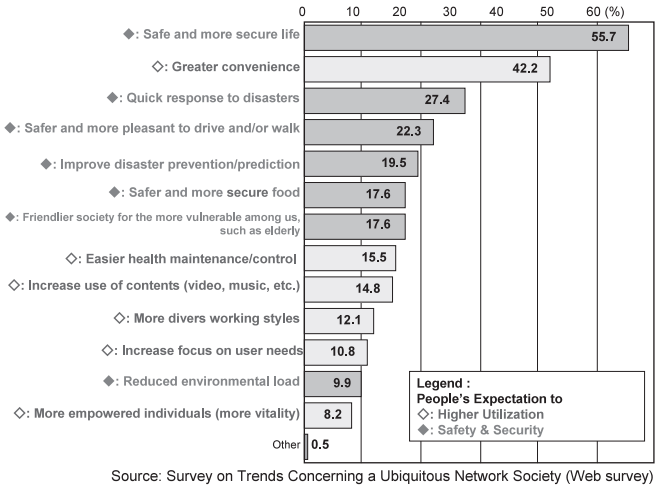
Dependability needs a diverse field of requirements, each of which must be realized by combining efficient and qualified technologies.

These requirements can be categorized as below: 1) technologies related to prevention and guarantee (technologies of "preparation"), 2) technologies related to cure and measures (technologies to make up for "preparation"), and 3) technologies related to both 1) and 2). Conventionally, "high-reliability" systems are conceptualized within the five categories called RASIS (Reliability, Availability, Serviceability, Integrity and Security)[5], but the authors propose the extension of these categories within the overall framework of "dependability."

2.4 Technology That Complements Both Convenience and Safety/Security

From the perspective the keywords "convenience" and "safety/security", **Fig. 2** categorizes the needs of Japanese people[6] related to the ubiquitous networks that will inter-relate and fuse IT and IP networks. By examining this chart, it is possible to grasp expectations for the provision of enhanced convenience but premised on a certainty of safety and security.

From these prerequisites, we can see the functions that are demanded to realize services high in convenience and those



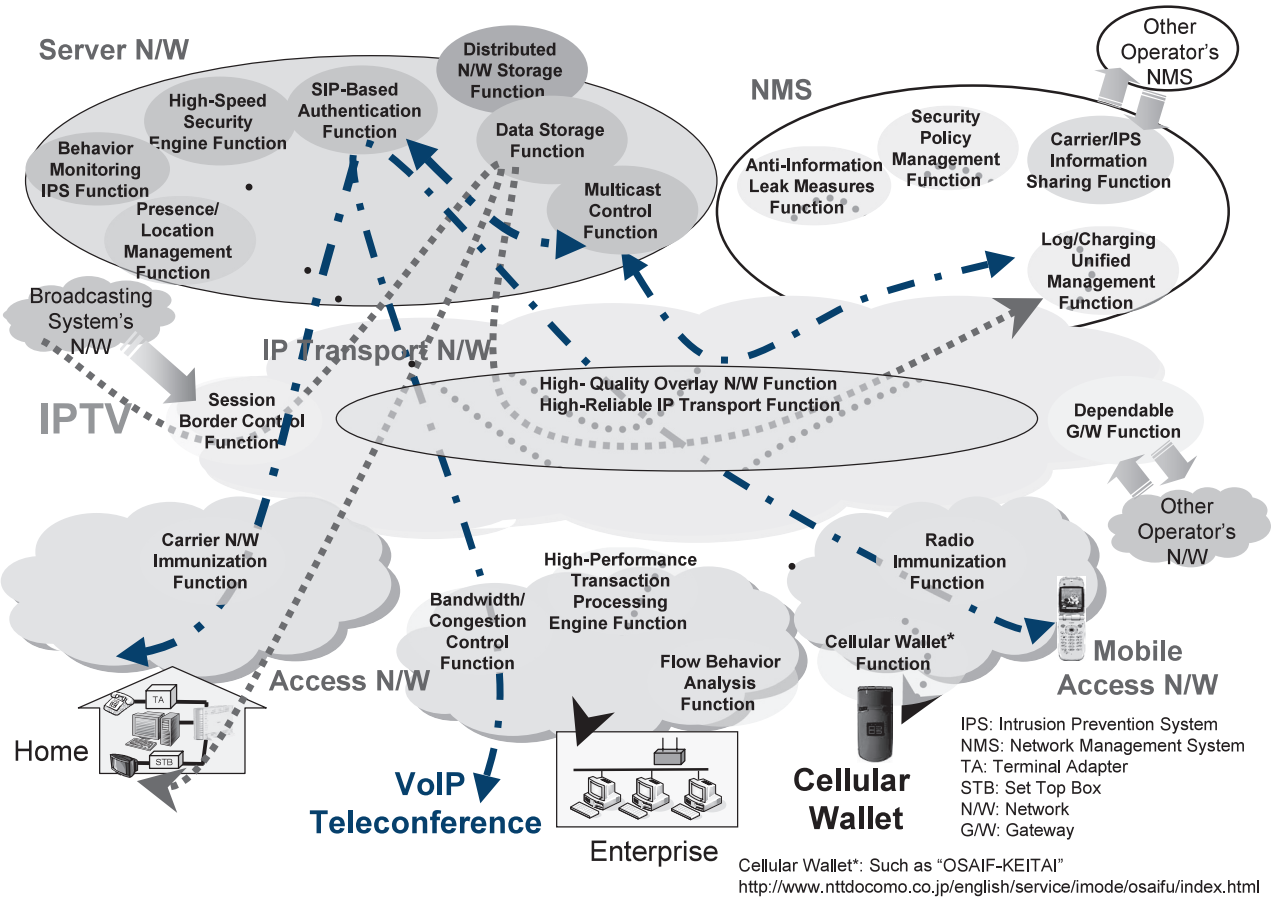
Source: Survey on Trends Concerning a Ubiquitous Network Society (Web survey)

Fig. 2 Growing need for ubiquitous networks.

that will make possible the safety and security of IT and networks as a lifeline. Though the dependable ICT services are realized by terminal-, network- and server-related functions, it should be understood that these functions are not independent but are mutually interrelated. Also note that the function overlap in the lifeline network/server may predict the integrated implementation of router and server functions.

3. Dependable Network Architecture and Communication Services

The dependable information and telecommunications network which the authors propose has a point of view in alignment with the NGN architecture overviews in which standardization is advanced by ITU-T now. The following descriptions are focusing on dependability in the architecture and services (see **Fig. 3**), which is discussed so far.



Cellular Wallet*: Such as "OSAIF-KEITAI"
http://www.nttdocomo.co.jp/english/service/imode/osaifu/index.html

Fig. 3 Dependable NGN architecture and services.

3.1 Dependable Network

IP Transport Network: The session border control function and dependable gateway function used as an interface with other network are allocated in the network.

Access Network: A carrier network immunization function is allocated on the home access network. For enterprise access network, bandwidth and congestion control function, high-performance transaction processing engine function, flow behavior analysis function, etc. are allocated. Mobile network has radio immunization function and a Cellular Wallet[7] (Personal Wallet) function.

Server Network: This network has behavior monitoring IPS (Intrusion Prevention System) function, high-speed security engine function, SIP-based attestation function, data storage function and presence/location controlling function, as various service server functions.

NMS: Anti-information-leak measures function, security policy management function, carrier/IPS information sharing function and log/accounting unified management function are allocated.

3.2 Relation of Function for Providing Dependable Services and Operations

These functions are allocated in order to realize dependable communication service on an IP network.

Each function operates cooperating for every service to provide. The arrows in Fig. 3 are illustrated as service examples, and explained below.

VoIP-based Teleconference Service: This example is the case of multicast telephone calls among enterprise and mobile/fixed phone by VoIP for conference purposes. The bandwidth and the congestion control function of accesses network, the SIP based-authentication function of servers network, and the radio immunization function of the mobile accesses network carry out coordinated movements, respectively. Note that multicast function of the IP transport network is taken advantage of, which is not depicted in the figure.

IPTV Service: Contents (TV programs) distributed from the broadcasting system network are stored in the storage function of servers network through the session border control function of the IP transport network. And according to subscriber's demands, contents are delivered through access network to home.

"Cellular Wallet[7]" Service: There are many utility scenarios. This example is a simple case where electronic money is charged into the prepaid function of cellular phone. High-speed security engine function of server network, anti-information leak measures function of NMS, security policy management function, and high-performance processing engine function of accesses network for enterprise carry out coordinated movements, respectively. As the result, the authorized amount is shaken out from a cellular-phone subscriber's banking account or credit account, and it is charged by the prepaid function of a cellular phone.

4. Business Creation and Dependable Network

Since the business using the conventional Internet technologies had been built on the existing communication networks, it was able to provide service extremely inexpensive overwhelmingly compared with the existing communication service. That is one of major reasons for a great success. However, on the other hand, it comes out lack of dependability. In this section, by means of analyzing the evolutions of IT business models, we consider future new business creation and the necessity for the dependable network.

·The Legacy Model

This business model is realized by providing end users with strictly regulated communication services and obtaining profits as the counter value of those. A typical example of this is PSTN service, which is comprised of end users (subscribers) and carriers, which are the only business players. The guaranteed communication services (see blue solid arrows in **Fig. 4**(1)) and the corresponding charges (see red solid arrows) are set up. This model was the typical one available before the Internet came to being.

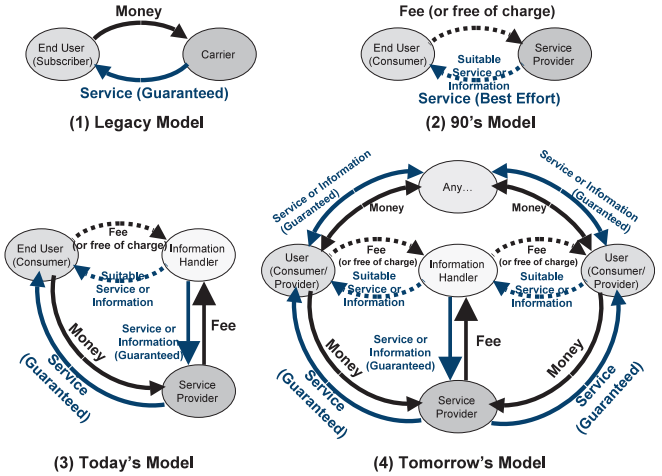


Fig. 4 Evolution of IT business model.

· The 90's Model

This business is the conventional "Internet" model whose features are "best effort" and "low cost". This is comprised of end users (consumers), and providers of various services such as information search engine, news-web, etc. The business player is the service provider only. End users are able to receive services (see blue dotted arrow of Fig. 4(2)) and those services are free of charge or extremely low price (see red dotted arrow). But, instead of those, the contents and the reliability of such services are not guaranteed by the providers. Mainly, provider's profits are from online web advertising pages or banners.

· Today's Model

There are two types of co-existing business players depicted in Fig. 4(3). One that is providing guaranteed services (see blue solid arrows) to end users via today's "best-effort" Internet. And end users pay money for those service/product providers. The other player acts as an information handler, who provides services with the "best effort" model (see blue dotted arrow), and their services are free of charge (see red dotted arrow) to end users. Instead of free service providing to end users, they receive fee from service/product providers.

· The Tomorrow's Model

As indicated in Fig. 4(4), we can predict a model that will involve the end user as a business player. In this model, the users are not only consumer; they will play roles also as providers. Furthermore, we will see the emergence of game providers that makes profits from linking a number of consumers (game opponents) for network battle games, or information handlers that aids users with information on game menus and opponents free of charge.

As is discussed above, the dependable information exchange (solid lines) via NGN is getting important, when new business models are commonly implemented as well as the conventional best effort exchange.

5. Technical Examples for Realizing Dependable Systems

We can improve particular aspects of system dependability, and thus can realize optimized system for field operation by adding some of the technologies described in this section to the network system basis in the previous section.

5.1 Secure Routing Protocols

We propose to protect routing information by using public key encryption of routing protocols, and thus to prevent intrusion itself. The routing information is encrypted at the egress router of each ISP, and authentication and information consistency is checked at the ingress router of each ISP by using PKI-based public-key decryption.

5.2 Ensuring Security of Control Servers

Detection of system trouble by doing traffic analysis etc. results in forced discards of server requests or messages that protect the system. Pertinent ports of edge devices are also ordered closed. Furthermore, a decoy server is configured to sink and discard malicious traffic during DoS attacks, etc. This technology of decoy servers can be used for the protection of various servers.

5.3 Visualizing and Improving Quality of VoIP

We propose to visualize service quality by including RTCP reporting items VoIP quality, network congestion, network delay, etc. Using this method, responsibility for failure can be fairly assigned through quality measurement. Through monitoring quality per section (of routers, switches, and provider's networks), we can also specify the responsible section for the deterioration of quality.

5.4 Overlay Network for High-Reliability Communications

Constructing an overlay network (L4) on the existing IP network (L3) is the method to support for high-reliability com-

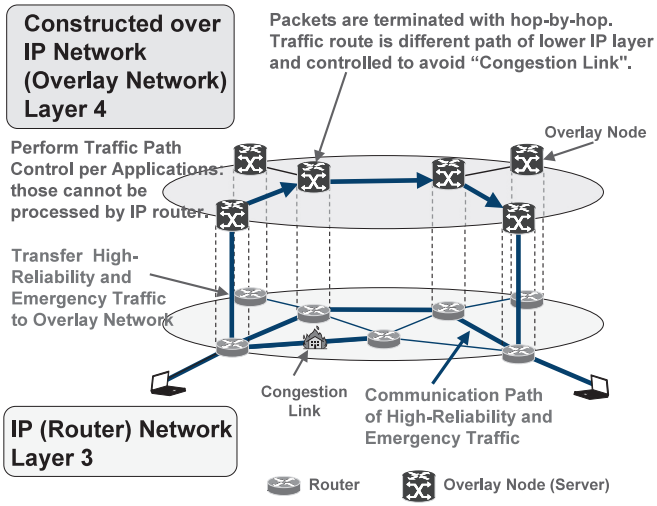


Fig. 5 High reliable overlay networks.

munications. As shown in **Fig. 5**, allocating an overlay node (server) independent of the IP router ensures that routing communication between nodes is independent from the IP network and can be controlled separately. Access routers within the network is connected with the overlay nodes 1:1, and user traffic is lead to these overlay nodes using the routers as an interface.

Overlay nodes carry out application level control that is impossible for IP routers, and they also secure communication links that is not affected by congested links or failed routers. Besides the emergency voice traffic, the overlay network can be used for critical data communications such as for data storage systems or for financial transactions.

6. Conclusion

The Internet has many good points; it is essentially open, simple and anybody can create a part of it. It invited many new participants, and the interplay of competition and evolution has made it to the current mature form. At the dawn of the Internet age, all these characteristics certainly played as the driving forces that support its drastic evolution. However, we have to construct of safely usable secure networks to act as a future social infrastructure.

This paper has described the concept design of dependable networks. The new technologies are taken advantage of to construct dependable NGN without spoiling the Internet "good news." The authors believe that much research and development for the dependable IT/NW technology described in this study has already reached at a practically applicable level.

However, in order to apply these technologies into real networks, a research and development activities of different dimension from ours must be explored; we believe that it is the global issue for the future how to form a social consensus on the points described below, and how to make dependability and ease-of-use compatible. Considerations from an economic perspective are also important for the building of infrastructure.

- Social Ethics: "Centralized control of information vs. privacy"
- Legal Regulations: "Copyright and applications of technologies"
- Social Capital: "Universal services and effective business"

We simply raise these questions in this paper, but believe these are important themes to solve at the national and international level.

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Authors' Profiles

ARUTAKI Akira
Associate Senior Vice President,
NEC Communication Systems, Ltd.,

KIKUCHI Yoshihide
Chief Manager,
Research Planning Division,
NEC Corporation

EGAWA Takashi
Principal Researcher,
Standardization Promotion Division,
NEC Corporation

KIRIHA Yoshiaki
Senior Manager,
System Platforms Research Laboratories,
NEC Corporation

IWATA Atsushi
Senior Manager,
System Platforms Research Laboratories,
NEC Corporation

KANOH Toshiyuki
General Manager,
System Platforms Research Laboratories,
NEC Corporation