AKARI Project

- Design for the New Generation Network -

“The Japanese Approach”

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Outline

1. Background

2. Limitation and problems on the current IP net

3. The AKARI Project
   Challenge toward the New Generation Network

4. A way for promotion

5. Conclusion
What is NICT? Its History

Communications Research Laboratory (CRL)

October 1896: Research into radio communications begins at the electrical testing laboratory, Ministry of Communications

June 1948: Ministry of Education absorbs the Radio Physics Research Institute

August 1952: Ministry of Posts and Telecommunications opens a Radio Wave Research Institute

April 1988: Radio Wave Research Institute becomes the Communications Research Laboratory (Ministry of Posts and Telecommunications CRL)

January 2001: Ministry of Posts and Telecommunications reorganized as Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT CRL)

April 2001: Communications Research Laboratory becomes an Independent administrative institution

Telecommunications Advancement Organization (TAO)

August 1979: Communications and Broadcast Satellite Organization (CBSO) established

October 1992: Renamed as the Telecommunications Advancement Organization (TAO)

Commenced advanced R&D into telecommunications and broadcasting

Subsequently, TAO additionally undertook various support operations on R&D and dissemination/promotion of Communications and Broadcasting

July 2001: Commenced promotion of research into basic civilian technologies

March 2002: Satellite control operations terminated

April 2003: Partial takeover of the right of Basic Technology Research Promotion Center operations

April 1, 2004

The National Institute of Information and Communications Technology (NICT), an independent administrative agency, was established
NICT Focus on R&D

NICT must operate in close coordination with national policies in the information and communications field, so it focuses on the following three R&D fields based on “Research and Development for the Ubiquitous Network Society”.

**Universal Communication**
- Contents creation technology which can enhance individual intellectual creativity
- Communication technology which can overcome language, cultural, and physical ability boundaries

**New Generation Network**
- Network technology which can maintain and strengthen Japan’s global dominance in core technologies such as optical and mobile communications
- Latest fundamental technology to lead the world’s ICT development
- Establishment of the latest R&D testbed networks
- R&D of photonic network technology (Optical packet switching)

**ICT for Safety and Security**
- Technology to ensure safety and security of the ICT network which is the foundation for social and economic activities
- Technology which broadly ensures security by using ICT and realizes a safe and secure social environment
- Upgraded technologies to counter cyber attacks
- R&D of space and global environment
NICT R&D Schemes

- Combining with the variety of R&D schemes, collaborative research can be promoted effectively with Universities and Industries

**NICT research team**
Architecture, Photonic Node, Overlay Networking

**Strategic Headquarters on NWGN**
Director: NICT President Prof. Miyahara

**Commissioned research**
Dynamic Network, Photonic Networking
(Universities and Industries)

**Testbed Network for R&D**
JGN2 JGN2plus
Foresights of Network Technology

New Generation Network

New network concept where the existing issues of the architecture of IP networks (e.g. Qos, network control, etc.) are drastically resolved and included the ubiquitous network technologies.

Ubiquitous Networks

Cooperation between the real world and the network (RF-ID Tag, Sensor,...)

New Network Architecture

Next generation Network (NGN)

All IP based QoS, ...

New Generation Network

Telephone, Broadcasting

Assured quality (voice, video)

Mobile

(mobile phone, wireless LAN)

the Internet

Best effort (mail, web, P2P,...)

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Radical Increase in Internet Traffic

- The total traffic number across the country in May, 2007, was 721 gigabit per second (Estimated by Ministry of Internal Affairs and Communications from the total number of main Internet exchange points (IX))

Ultra fast, great capacity, and effective optical network infrastructure are necessary for covering the traffic that can reach terabit (1,000 gigabit) by 2008 and petabit (1,000 terabit) by 2020s.

Daily Traffic (long)
The maximum and minimum daily traffic volume on the IX backplane in bits per second.

Internet: It is hard to develop

Too Complicated/Conflicted → structural collapse

It cannot build up new functions and provide supporting services for a future society.

A single piece of the jigsaw looks good, but the pieces of the jigsaw do not fit.

There comes a time to rework it from the beginning near at hand.

Layers have been naturally wedged.

Original Internet Architecture

been rapidly built without unified functions

universal communication?
small devices?
dependability?
authentication?
guaranteed service?
flow-label

hierarchal addressing
local addressing
anycast
multicast
mobility
IPSEC
complicated routing
NAT

L2: Datalink Layer
L2.5: MPLS
L3: Internet Layer
L3.5: Mobile IP
L3.5: Mobile IP
L4: Transport Layer
L4.5: Platform
L4.5: Bundle
LX.5: Overlay

GMPLS
MPLS
unicast
multicast
anycast
IPSEC
complicated routing
NAT

L4.5: Platform
L4.5: Bundle
L3.5: Mobile IP
L3: Internet Layer
L2.5: MPLS

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Security issues

Threats to network security are getting malicious and sophisticated, like Bot.

- Victim Individuals who experienced some kind of damage: 54.7%
- Number of reported virus victims: 85,700
- Victim corporations that experienced some kind of damage: 68.1%
- Market products related information security throughout service
  About U.S. $180 billion (estimated cost)

→ Time is coming to re-creation from the origin!
Very large number of devices should maintain

IP is inappropriate in effective transmission of information concerning environment, context awareness, etc.,

**Medical/Health Care**
- Health Care
  - (physical condition/movement)

**Security**
- Improvement of
  - security, safety, and comfort
- Security and building condition
  - (invasion, warp, temperature, brightness, and oscillation)
- Fire, earthquake, flood, collapsing buildings
  - (smoke, temperature, oscillation, warp, water level)
- Fracture wires and bolts slackness
  - (oscillation and elastic wave)
- Distribution condition and quality
  - (temperature, humidity, and oscillation)
- Growing condition and cultivation environment
  - (growing, temperature, humidity, and oscillation)
- Distribution management of products
- Distribution condition and quality
  - (temperature, humidity, and oscillation)

**Disaster Management**
- Urban and natural disaster monitoring
- Fire, landslides, liquefaction
  - (temperature, smoke, and ground displacement)
- Construction degradation monitoring
- Security and building condition
  - (invasion, warp, temperature, brightness, and oscillation)
- Fire, earthquake, flood, collapsing buildings
  - (smoke, temperature, oscillation, warp, water level)
- Fracture wires and bolts slackness
  - (oscillation and elastic wave)

**Approach to Environment Risk**
- Various Production Process of Agricultural Products
- Approach to Environment Risk
  - Growing condition and cultivation environment
    - (growing, temperature, humidity, and oscillation)
- Fracture wires and bolts slackness
  - (oscillation and elastic wave)
- Weather and water quality
  - (rainfall and water quality)
- Air pollution and oscillation
  - (SOx, NOx, oscillation)
- Emergency supervisor of plants and equipment

**Others**
- A variety of service
- Control Center
- Distribution management of products
- Various Production Process of Agricultural Products
IT strategic plan: e-Japan to u-Japan

Promote Use

Resolve Issues

7 Leading Areas

Resolve Issues

New IT Reform Strategy (January 2006)

World’s front runner of IT evolution

Realising a society where anytime, anywhere and by anyone benefits from IT. (Ubiquitous Network Society)

Realization of a self-sustaining IT Society

Priority Policy Program - 2004 (June 2004)

World’s cutting-edge IT evolution

World’s front runner of IT evolution

Priority Policy Program - 2006 (July 2006)

IT Policy package (February 2005)

New IT Reform Strategy (January 2006)

World’s front runner of IT evolution


Infrastructure development such as broadband infrastructure

Valuation IT applications (7 leading areas)

1. Medical
2. Food
3. Life
4. Small and medium enterprises (finance)
5. Knowledge
6. Employment
7. Administration service

Minittry of Internal Affairs

and Communications

u-Japan Emergence of New Values

- A society where ICT will be everywhere in daily life and can easily be used
- Person to Person plus Person to Goods, and Goods to Goods
- In every aspect, communication will play an even more important role

Ubiquitous

Connects everyone and everything

Easy connection to networks “anytime, anywhere, by anything and anyone”.

Universal

Friendly communication

- Can be used by anyone without thinking of the equipment or network
- The aged and disabled will be able to actively participate in society with ICT

Contact from heart to heart

- Heart-to-heart communication and overcoming barriers between generations and localities to create togetherness

User-oriented

Based on users’ viewpoints

Close to the user

- A society that is even more aware of user convenience than the latest in the supply side
- Developing technologies and services that are closely connected to our needs
- Libraries can be suppliers, too
- Using the power of networking to make 100 million “sponsors”

Unique

Creative and vigorous

Creation of vitality of the individual

- A new society where it is easy for dreams and ideas to flourish and be realized

Visible the society

- Creation of new social systems and business services
- Get out of stereotype and realize local revitalization with creativity

Hopes and Fears of Networks

• Can it be entrusted with people’s life?
  (remote medical care, transportation, emergency reports...)
• Can it be entrusted with people’s livelihood?
  (security, contractual actions, and finance)
• Can it enhance people’s lives?
  (sensors and RF tag)
• Whether or not people can live without worries
  (anti-spam and anti-attacks)
• How long can people use it?
  (infrastructure and sustainable society)
• Is there any possibility of a future revolution in networks
  (unknown demands)
Problems that Need to be Solved:
Presently existing, What might happen in the Future, and the Unknown.

• Large capacity transmission/exchange
  – 1,000 times by 2020 (Peta bps)

• Core router electric power consumption
  – 1 atomic power generation per 100 devices

• Difficulty of guarantee of bandwidth
  – essential limitation of packet exchange

• Difficulty of congestion control
  – long fat pipe (bandwidth·delay product) problem, fairness of users

• Difficult to introduce plural gateways
  – explosion of routing table by multi-homing

• Avoidance of break down
  – several tens of seconds’ order needed for rerouting in broad areas
Objectives of the New Architecture

The “New” Generation Network Architecture which will satisfy demands of the Ubiquitous Network Society around 2015 – 2020, shall be studied by approaching from “Clean-Slate” design not by extension of the existing Internet or the “Next” Generation Network (NGN).

NICT plays the role of the National Research Center bringing up Japanese research community towards developing the “New” Generation Network Architecture (NWGN).

AKARI Project has been studying the New Generation Network Architecture.
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Significance of NWGN

Looking toward 2020, the focus is on promoting R&D of a new network architecture toward dramatically resolving the IP network problems.
The study began in April 2004 to seek after an ideal network from a clean-slate in response to the future needs, which won’t be able to realize as an extension of the present network technology.

**AKARI Conceptual Design** (White paper 1st edition) published on 30 April 2007

At present, a detailed design of NWGN is under discussion. Some ideas are going to be tried prototyping and experimental implementation over the testbed used JGN 2 plus.

Creation of a set of NWGN Blueprint is the next target for around 2011, and finally realizing sustainable network architecture and practical use should come after 2015.

**Evaluation & Verification Concept**

**Specific Design**

**NWGN Accomplishment of blueprint**

**Testbed Formulation**

**Demonstration Experiment**

**Overlay Environment**

**Prototyping**

**Standardization**

Released AKARI Conceptual Design

http://akari-project.nict.go.jp/eng/index2.htm
Principles of New generation Network Architecture

Designing the three fundamental principles and operating a grand design as an entire network as social infrastructure.

1. KISS (Keep It Simple, Stupid) principle
   - Crystal synthesis (selection, conversion, simplify)
   - Common layering (concatenation)
   - End-to-End (original Internet)

2. Sustainable & Evolutionary principle
   - Self-* properties
   - Robust large-scale network
   - Scalable, distributed control
   - Openness

3. Reality Connection principle
   - Separation of physical & logical addressing
   - Bi-direction authentication
   - Traceability

Designing the future, diverse, new generation network
- pick up techniques for the future under the principles
- integrate & simplify them with design methods
Approaches to the New Architecture

Needs from Social/Economical point of view (privacy, etc.)

- Advanced Key Technologies
  - Network Virtualization
  - Evolution from Wireless/Mobile
  - Evolution from Optical Network

- Design Principle

- New Network Architecture

- Promotion of New Applications
- Maintain Information Security
Examples of key technologies for NWGN (1)

(1) Photonic Network Projects

Key technologies and prototype systems are studied towards very high-speed and high capacity but very low power consumption all optical transport networks.
Examples of key technologies for NWGIN (2)

(2) Overlay Network Research and Environment (Testbed)

Overlay environment capable to support heterogenous networks including Mobile/Wireless services

Inter-working among Overlay Networks

GEN, PlanetLab, etc.

Overlay environment capable to efficiently manage the optical core networks
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Establishment of a New Forum

New Generation Network Promotion Forum

- established on Nov. 6, 2007

- President:
  Tadao SAITO (Professor Emeritus, Univ. of Tokyo)

Vice President:
  Tomonori AOYAMA (Professor of Keio Univ.)
  Yasuhiko ITOH (Vice President of KDDI)
  Noritaka UJI (Vice President of NTT)

- 214 members (as of 12/4/2007)
  from Industry, Academy and Government

Web site: (Japanese only)
  http://forum.nwgn.jp/index.html

Minister of MIC

President of the forum

ALL JAPAN
R&D Promoting Structure and Collaboration between Industry, Academia, and Government

NICT (National Institute of Information and Communications Technology)

“Headquarters of NWGN Research Development Strategy”

(Chief of Headquarters: President, Dr. Hideo Miyahara

- Formulating mid- and long-term research development strategy to realize New Generation Network
- Promoting methods of research development related to New Generation Network in NICT and examination of implementation structure
- Examination for cooperation methods with other countries

◆ NICT operates new generation network architecture and implements research development of the component. Also, it examines the network architecture and its elemental technology by using test-bed network.

◆ The related research development project is implemented through private corporations, and broad research development is promoted.

NWGN Network Promotion Forum

- The Organization Meeting, November 6, 2007. Member: 241
  (President: Dr. Tadao Saito Professor Emeritus, The University of Tokyo) http://forum.nwgn.jp/

Activities
- Research Development Approach and Roadmap Investigation
- Investigations of social and economic aspects
- Promoting international cooperation through symposiums and workshop

Reflecting knowledge from other fields for their strategies

In the initial round, not sticking with specific methods or logics, multiple ideas and methods are conducted in parallel. A technical “bud” that is coming from these ideas and methods can be taken care of. Also, from a clean state, a research development that designs a future network will be promoted.
Organization of NWGN Promotion Forum

General Assembly
President: Tadao Saito (Professor emeritus, Univ of Tokyo)
Vice President: Tomonori Aoyama (Keio University)
Yasuhiko Itoh (Vice President of KDDI)
Noritaka Uji (Vice President of NTT)

R&D Strategy Working Group
Chairman: Masayuki Murata (Osaka University) 70 members

Assessment Working Group
Chairman: Osamu Sudoh (University of Tokyo) 44 members

Testbed Network Promotion Working Group
Chairman: Yuji Inoue (President of TTC) under preparation

Project Promotion Working Group
Chairman: Hideyuki Tokuda (Keio University) 36 members

Investigation of research development strategy from the fundamental to application researches
Investigation of NWGN’s social and economic aspects
Promotion of testbed network and demonstration experiments
Sharing, transmitting vision of NWGN and diffusion activities
Promotion for international cooperation in the West and Asia.

NWGN Promotion Committee
Chairman: Tomonori Aoyama (Keio University)
- Advise to GA on international cooperation from the academic viewpoint

Secretariat: MIC, NICT

http://forum.nwgn.jp
(written in Japanese)
The R&D Strategy WG

(1) plans a **strategy** of R&D of NWGN, and
(2) makes technical **roadmap** from basic to applied research of NWGN.

**Chairman:** Masayuki MURATA (Professor of Osaka University)

**Members:** 70

**Activities:**
- Discussions based on a draft roadmap and strategy proposed by NICT and other bodies, taking into account requirements from the assessment WG.
- The WG has started preliminary study with its mailing list:
  - listing up study items,
  - discussions about study approaches,
  - identifying problems to solve with NWGN,
  - goals of the NWGN.

**Scope includes:**
- Testbed and Field Trial
- Funding
- Standardization
- Human resource development
- Cooperation with EU, USA, Asia, etc.
The Assessment WG studies **social and economic aspects** of NWGN.

**Chairman:** Osamu SUDOH (Professor of University of Tokyo)

**Members:** 44

**Activities:**

(a) Studying social and economic aspects of NWGN
   - Research of social problems to solve and social roles of NWGN
     (Clarifying the concept and social needs of NWGN)
   - Research of economic effects of NWGN
   - Evaluation of new technologies from social and economic viewpoints

(b) Inputs results of the above study into other WGs and general assembly of the forum, and also publishes them outside the forum

**Approach:**

1. To select research items by classifying opinions from WG members
2. To survey by interview or questionnaire on the selected research items
3. To analyze results of the survey, and repeat this process if necessary
4. To make recommendations from the results and findings
The Project Promotion WG

(1) **disseminates** the idea of NWGN to the public and facilitate **collaboration** for information exchange, and

(2) shares the **vision** of NWGN among relevant communities and keep them **educated** about NWGN.

**Chairman:** Hideyuki TOKUDA (Professor of Keio University)

**Members:** 36

**Activities:**
- collecting and sharing related information, and coordination among other WGs
- vision making
- advertising the forum’s activities and providing updated information timely, in order to facilitate interactions with outside
  - by convening symposia, workshops and/or seminars on NWGN
  - with Web pages and brochures
# NWGN Promotion Committee

Mission: Advise to GA on international cooperation from the academic viewpoint

<table>
<thead>
<tr>
<th>Name</th>
<th>Position/University</th>
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<tbody>
<tr>
<td>Tomonori AOYAMA (Chairperson)</td>
<td>Program Coordinator for New Generation Network Architecture, NICT, and Professor for Research Institute for Digital Media and Content (DMC), Keio University</td>
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<tr>
<td>Shigeki GOTO</td>
<td>Professor for School of Science and Engineering, Waseda University</td>
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<td>Jun-ichi HAMADA</td>
<td>Professor for Interfaculty Initiative in Information Studies, Graduate School of Interdisciplinary Information Studies, The University of Tokyo</td>
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<tr>
<td>Yuji INOUE</td>
<td>President, The Telecommunication Technology Committee</td>
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<td>Jun MURAI</td>
<td>Professor for Faculty of Environmental Information, Keio University</td>
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<td>Masayuki MURATA</td>
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<td>Yoshiaki NEMOTO</td>
<td>Professor for Graduate School of Information Sciences, Tohoku University</td>
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<td>Yuji OIE</td>
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<tr>
<td>Susumu YOSHIDA</td>
<td>Professor for Graduate School of Informatics, Kyoto University</td>
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Cooperation and Collaboration with Other Countries

■ The NWGN Promotion Committee promotes cooperation with other countries.
■ Joint international symposiums, academic exchanges, and people-to-people exchanges will be supported.

Cooperation and Collaboration with Other Countries

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<tr>
<th>NSF GENI Project</th>
<th>NWGN Promotion Forum</th>
<th>European Commission FP7 Projects</th>
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<td>FIND Project</td>
<td><strong>NXGN Promoting Committee</strong></td>
<td>consortiums driven by Industry.</td>
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<td>cooperation among industry, universities and government</td>
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<td>universities are active.</td>
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Cooperation/ Collaboration

Cooperation/ Collaboration
Conclusion

◆ The New Generation Network is an emergent research target which will be introduced in around 2020.
◆ Its network architecture should be studied based on requirements for future ubiquitous network society.
◆ Prototype systems and a set of standards based on new key networking technologies including photonic, wireless and sensor network technologies should be developed in 2015-2020 time frame.
◆ Network testbed is essential for R&D, and especially, large scale overlay network test environment is important.
◆ Global collaborations participated by industry, universities and government should be pursued. Japan has established the NWGN Promotion Forum for this mission.
Thank you for your attention!