2nd ITU-T Kaleidoscope Academic Conference

A New Trend of ICT toward High Level of Information Society

August 31, 2009

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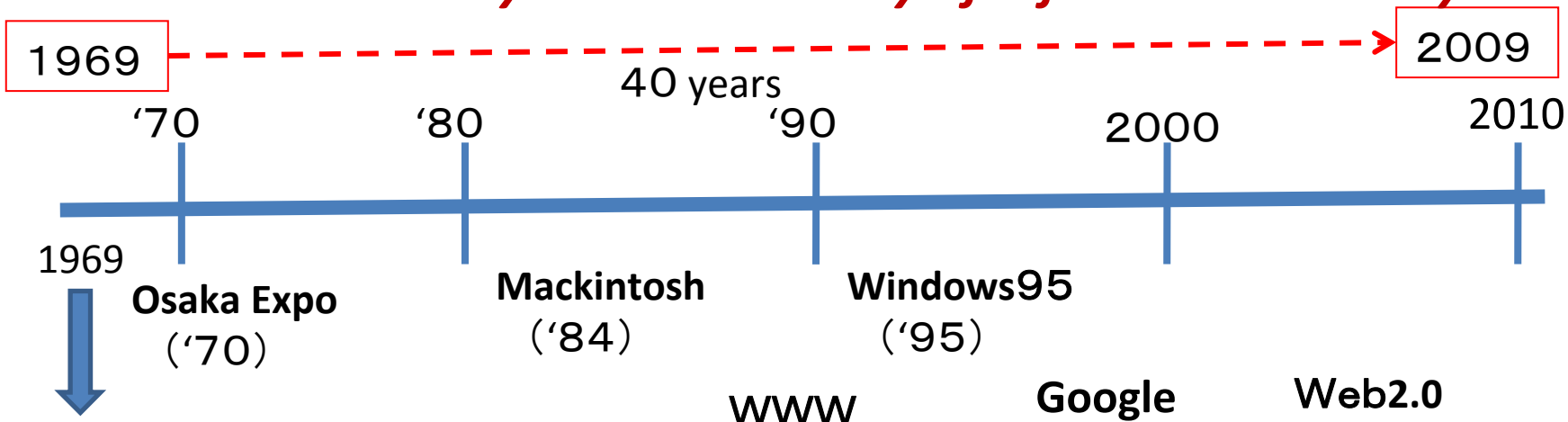
NICT

(National Institute of Information and Communications Technology)

Content

2009 celebrates 40 years anniversary of Information Society



Alain Touraine
"Post Industrial Society"

Yujiro Hayashi
"Information Society"

ARPANET
First Packet Transmission
Experiment between
UCLA and SRI

Apollo 11
TV broadcast of the first
mankind landing on the moon

WWW
('89)

Google
('98)

Web2.0
('04)

General users of the Internet expanded
('94～'95)

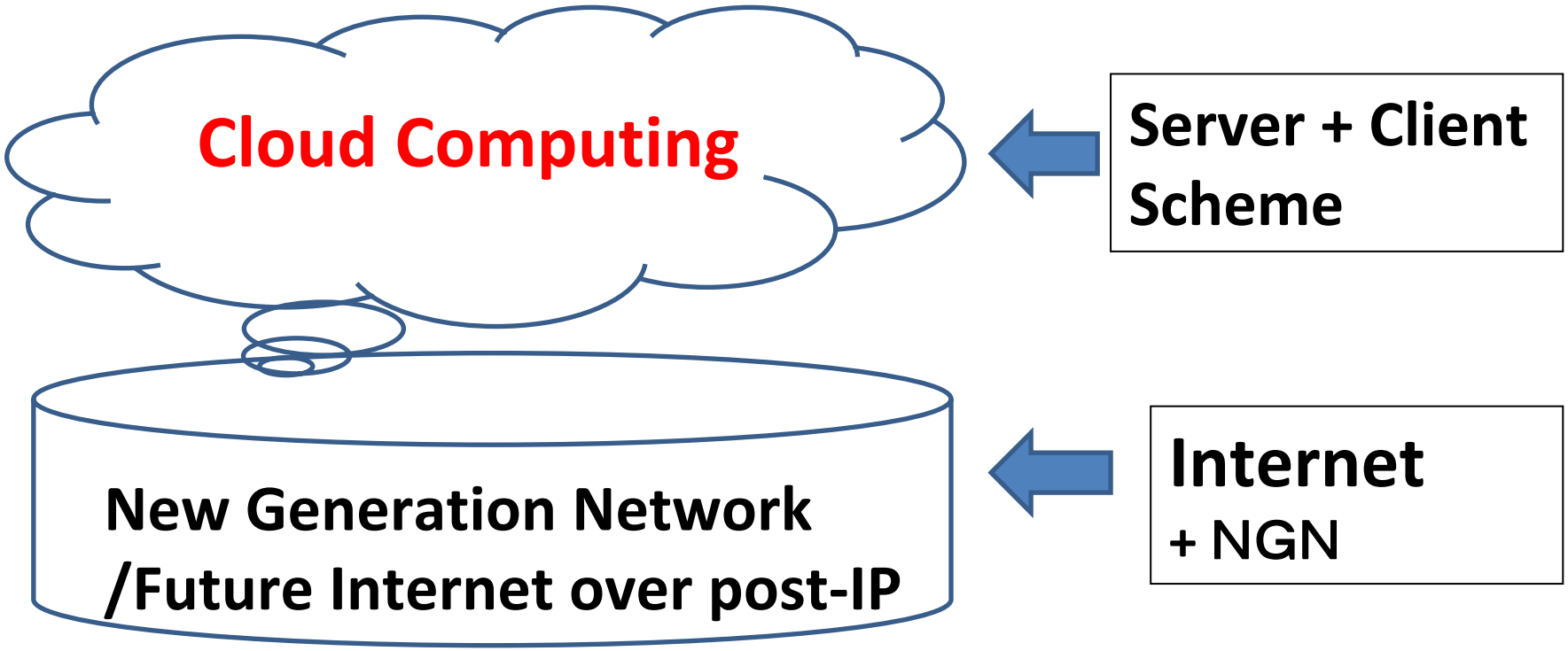
Cloud Computing ('06)

Shoulder Phone
('85)

Keitai Phone
('89)

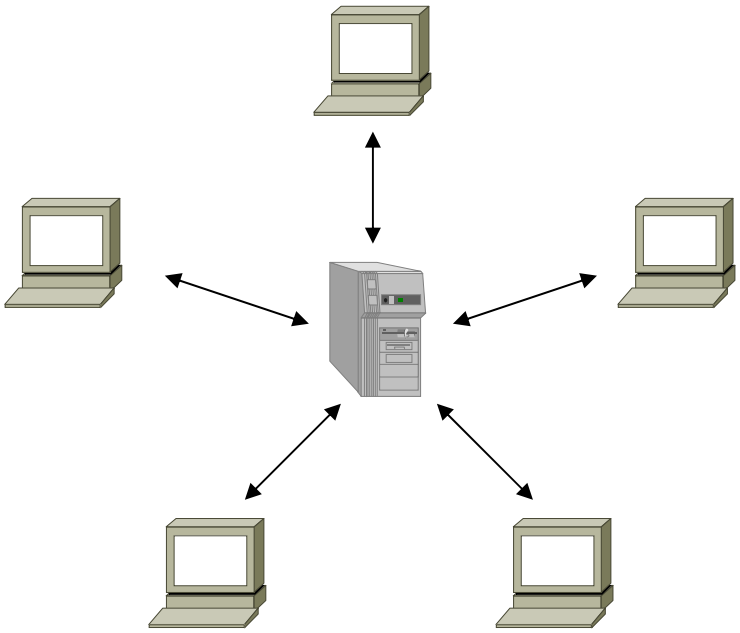
iMode
('99)

NGN
('08)

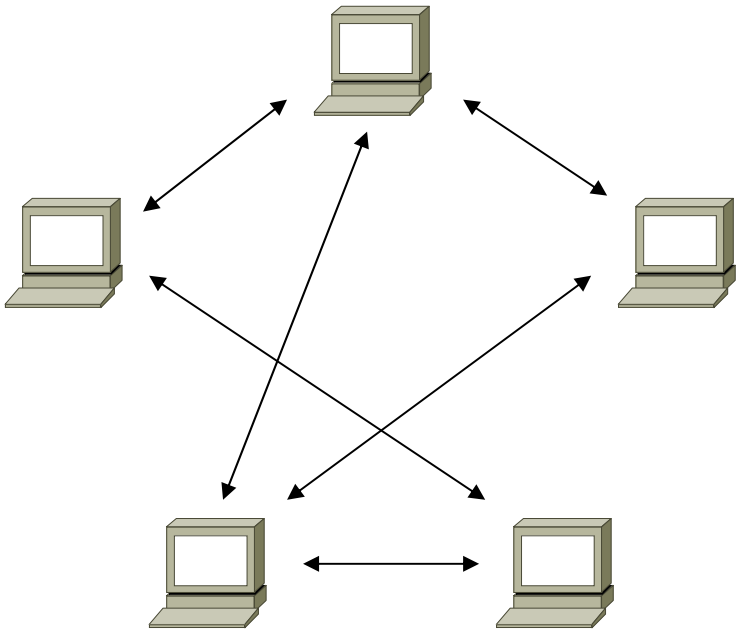


New ICT Paradigm in 2020s/2030s

Server-Client Model and P2P Model

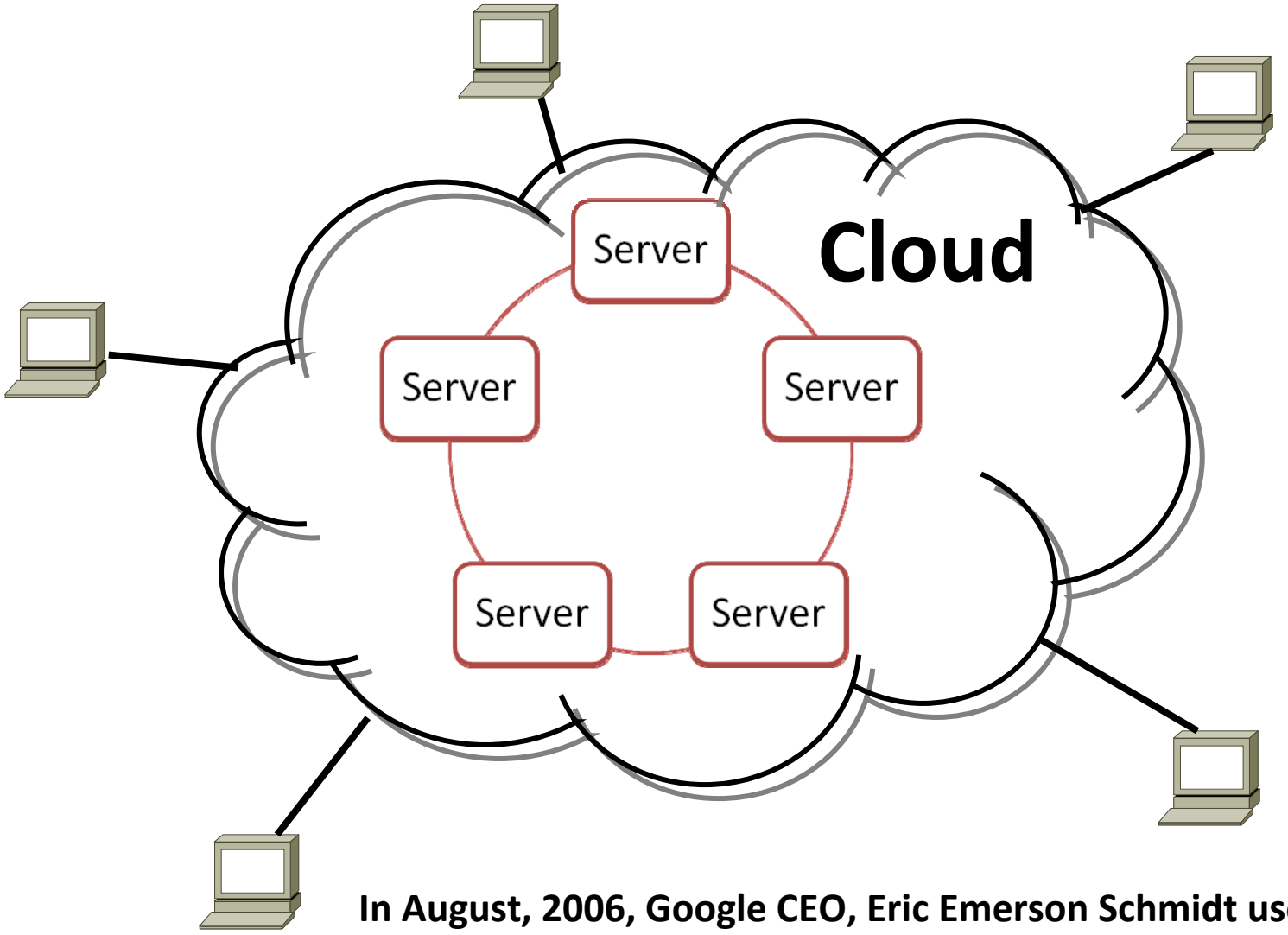


Server-Client Model



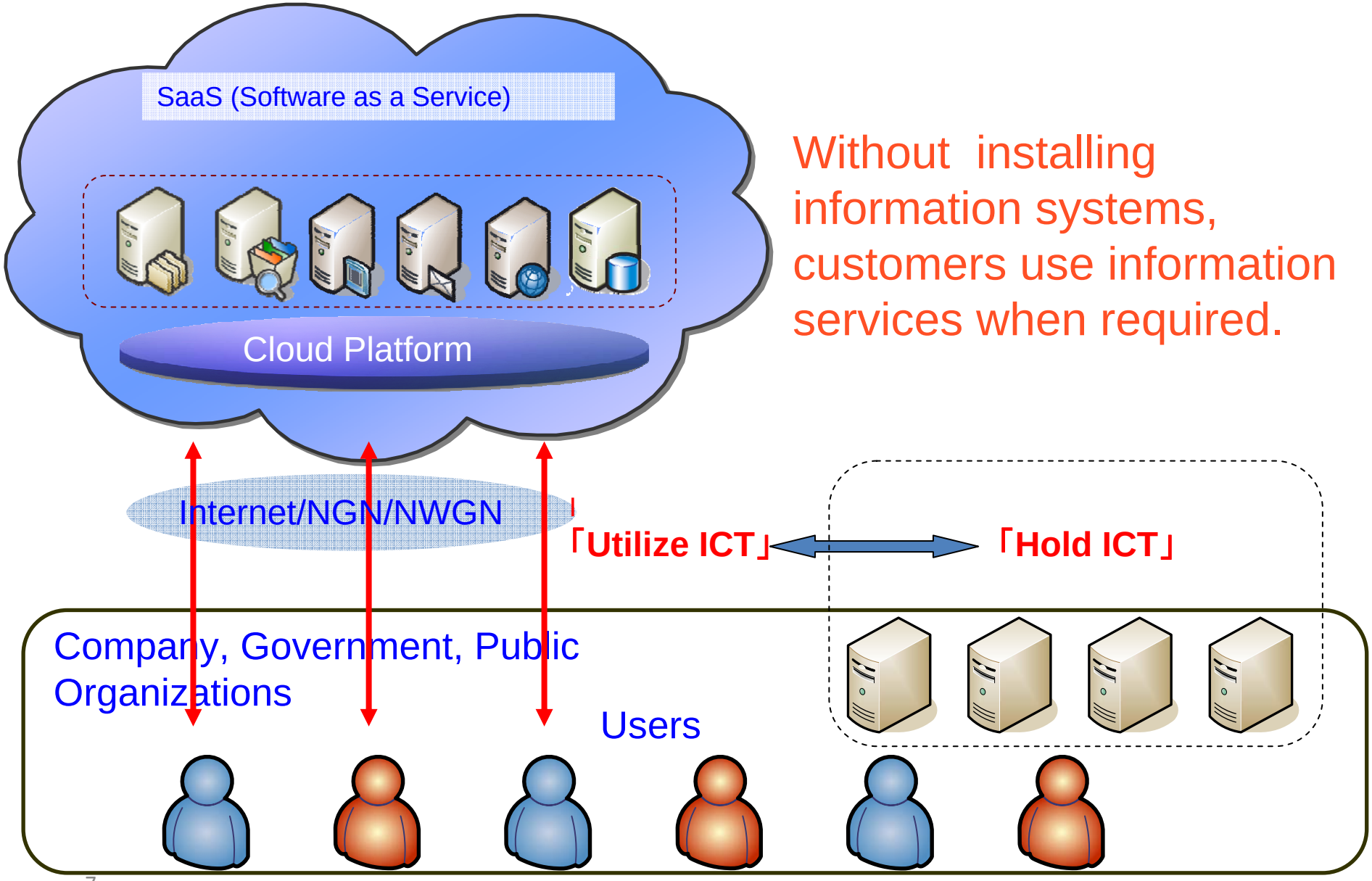
P2P Model

Cloud Computing Model



In August, 2006, Google CEO, Eric Emerson Schmidt used the term, " Cloud Computing" first in the world.

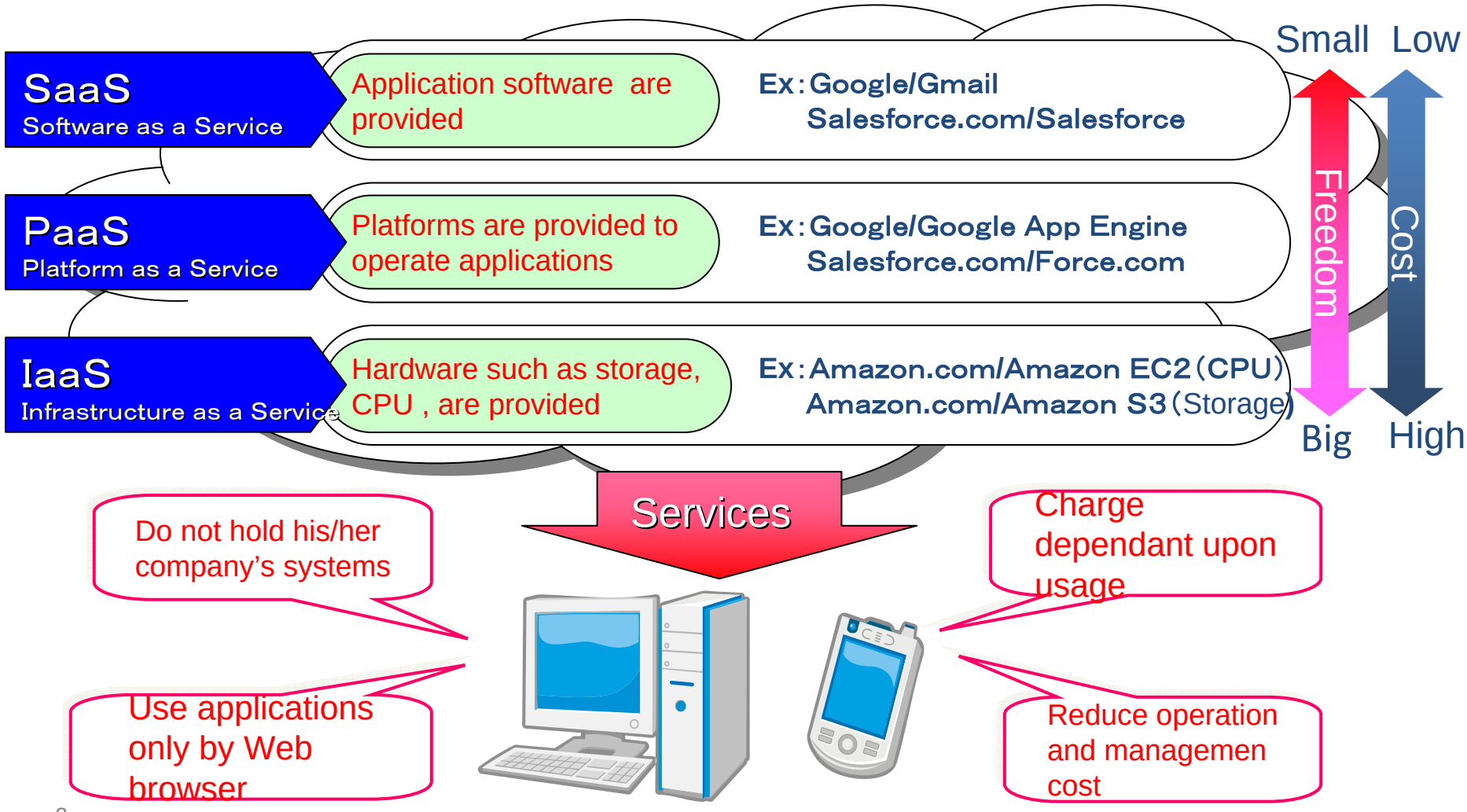
Image of Cloud Computing



Without installing information systems, customers use information services when required.

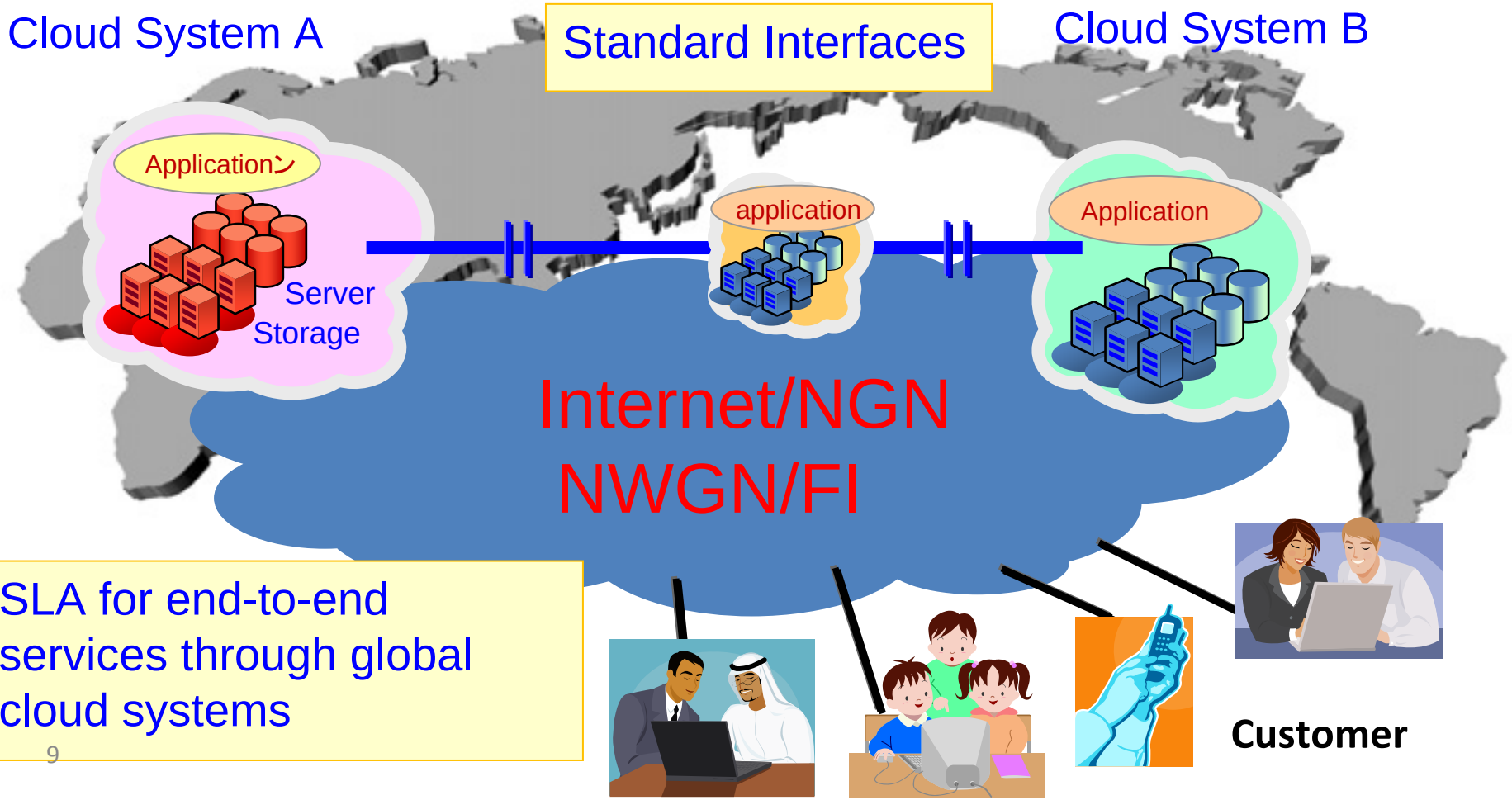
Services over cloud computing

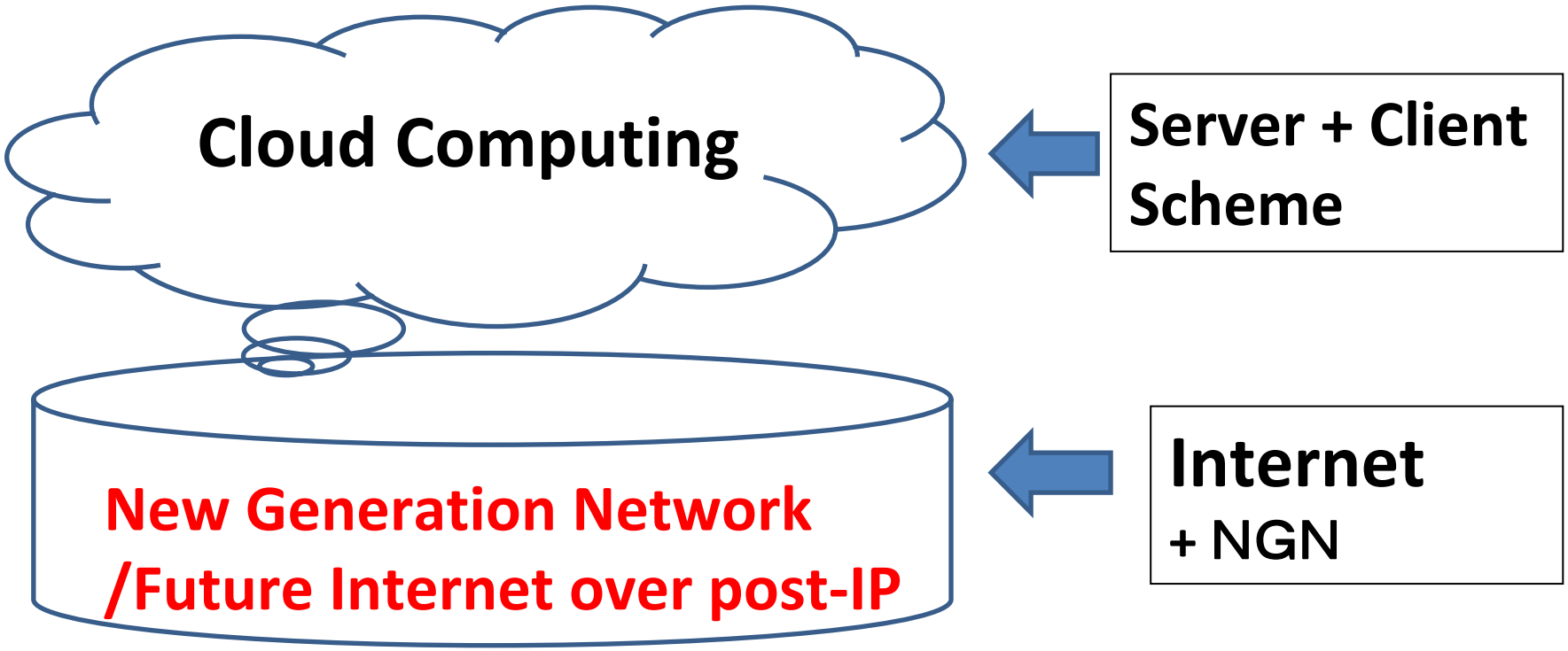
Utilize various ICT resources as a service on a network



Interconnection of cloud computing systems

- Standard interfaces to interconnect golobal cloud systems
- Establishment of SLA for end-to-end cloud services





New ICT Paradigm in 2020s/2030s

R&D Marathon for a new paradigm network has just started globally.

Who will win ?

Research on New Generation Networks/FI started in the world !

The United States

FIND

- NSF's ambitious program to develop the future Internet architecture through a clean slate approach.
- make a small scale, but a large number of projects converge into a fewer number of full scale architectures, and to verify using GENI
- A total of 1,200 million dollars to 26 projects by 2006

GENI

- Aimed at developing a testbed organization to succeed Planet Lab's development. programmable
- Aimed at a large scale facility development's budget in NSF. International cooperation is also included as a target.
- Project Bureau (GPO) is BBN. Planning to offer prototype, 1,500 million dollars in December 2007 over a two year period.
- A scale of construction budget is 367 million dollars,

E.C.

FP7

- EC's Funding structure towards the total fields of science and technology
- Begin by selected 133's new projects in Call 1
- Call 4 and Call 5 are on going.

＜main individual programs＞

-Network of the Future
(Call 1, D bureau) 2 billion Euros)

-FIRE
(Call2, F bureau) 4,000 million Euros

GÉANT3

- EC's research network
- The E.C. Budget for GÉANT was 9,300 million Euros over 4 years since 2004.
- It is in the middle of preparations for upgrading and for greater capacity by transforming it into GEANT3 from 2008.

Japan

NWGN R&D projects

- NWGN AKARI architecture research project was started in 2006
- Network virtualization project
- A number of NICT funding projects for industry and academia are promoted.

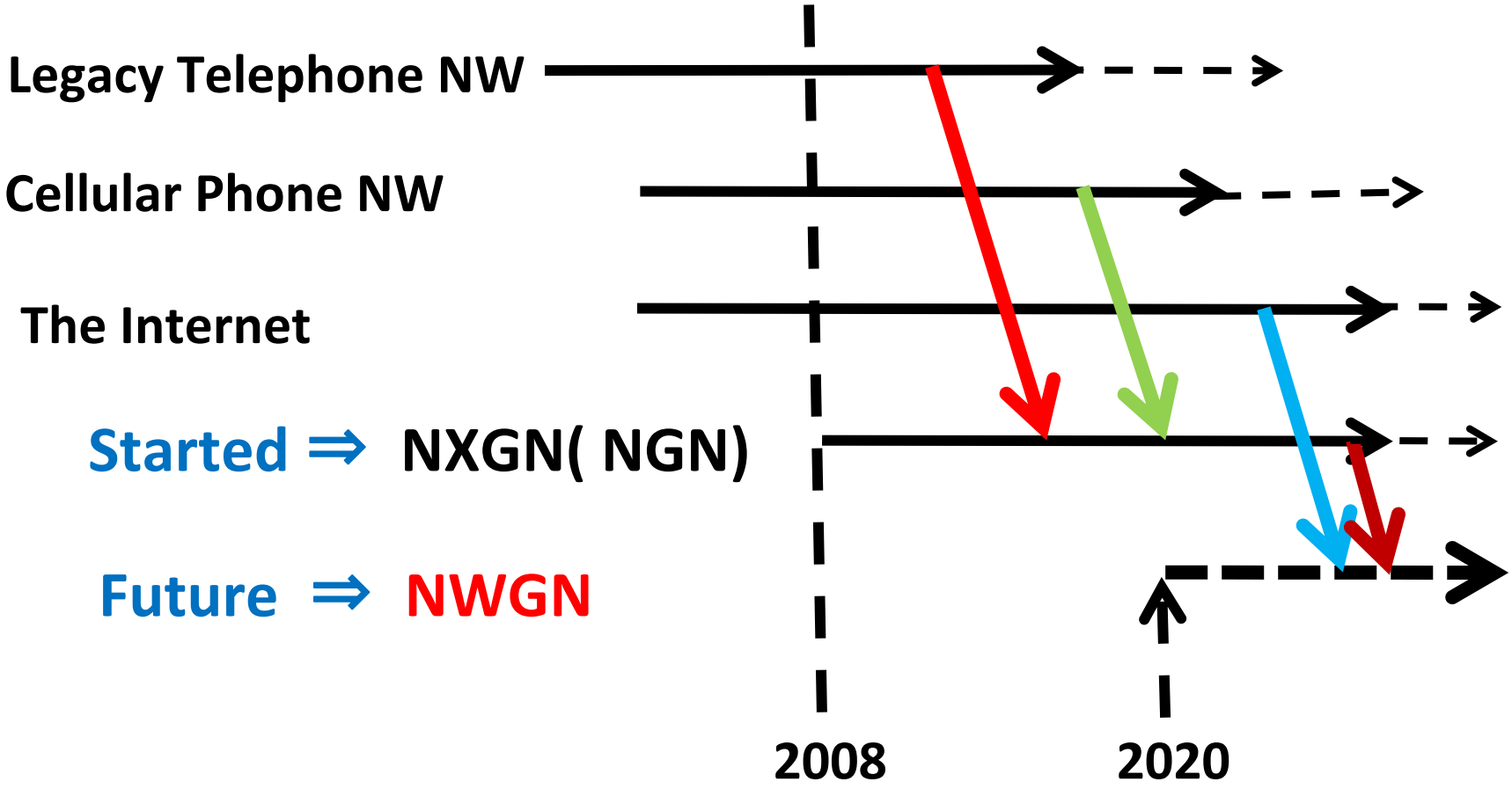
NWGN R&D promoting structure

- "The head quarter of NWGN research development strategy" in October, 2007, NICT.
- "NWGN promoting forum," established in November, 2007. Working in 4 WGs Ministry of International Affairs and Communications and NICT are a co-secretariat.
- Global Inter Cloud Technology Forum has just stared.

JGN2plus Testbed

- NICT's Testbed network for research development
- To provide "JGN2plus" from 2008 – 2010.

An image of a network evolution



NXGN: Next Generation Network (NGN)

NWGN: New Generation Network

NXGN vs NWGN
(Next) (New)

- **NXGN (NeXt Generation Network): NGN**

  Replacement of legacy telephone networks using IP-based networks to provide triple-play/quadruple-play services

In Japan NTT started NGN services in March, 2008. ICT industry is investing their resources to the NXGN deployment in Japan.

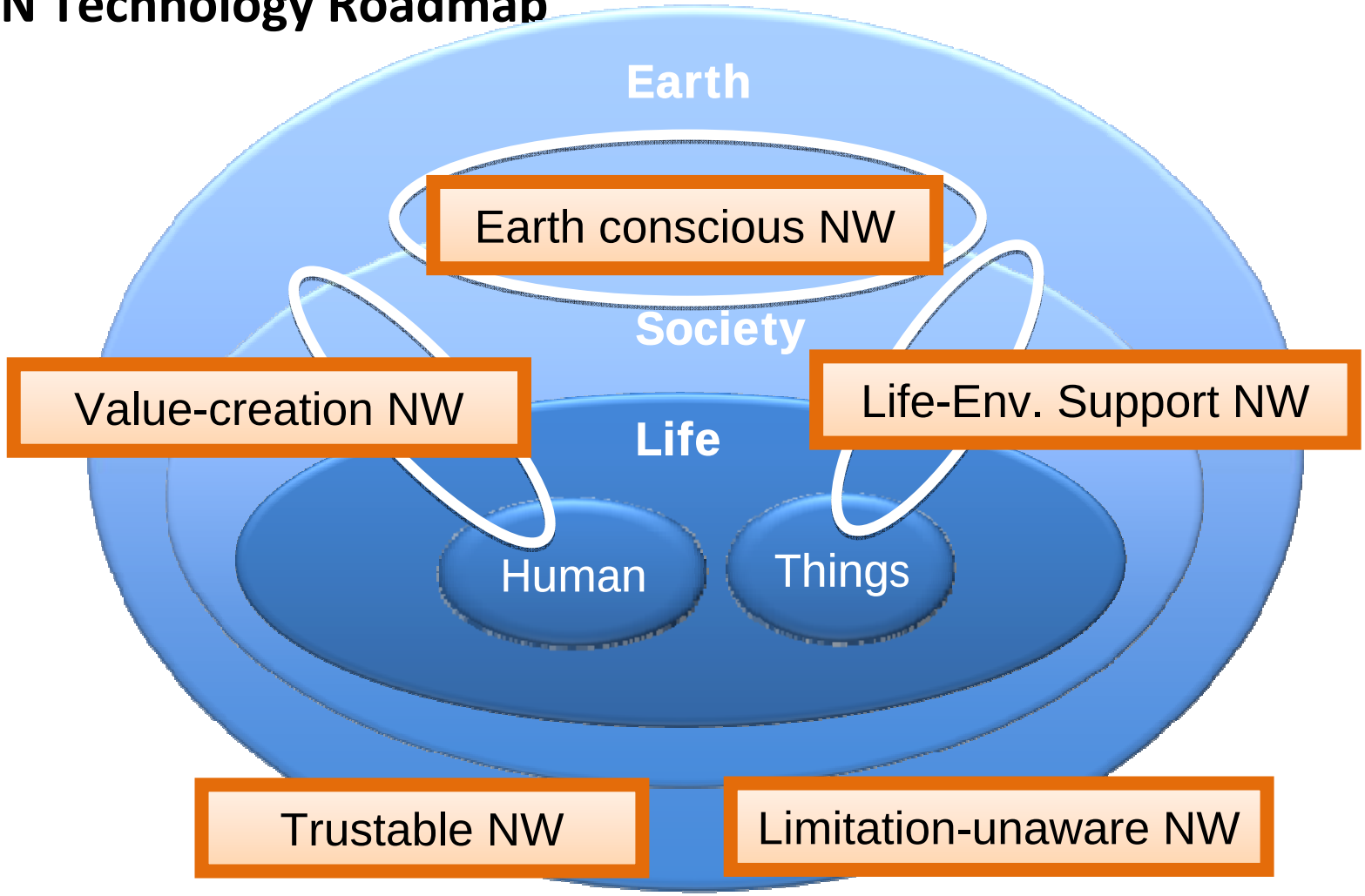
- **NWGN（NeW Generation Network)**

  Clean-slate designed network architectures and main protocols different from IP-based networks , which can be post-Internet/NGN

In Japan, NICT contributes to promote R&D on NWGN.

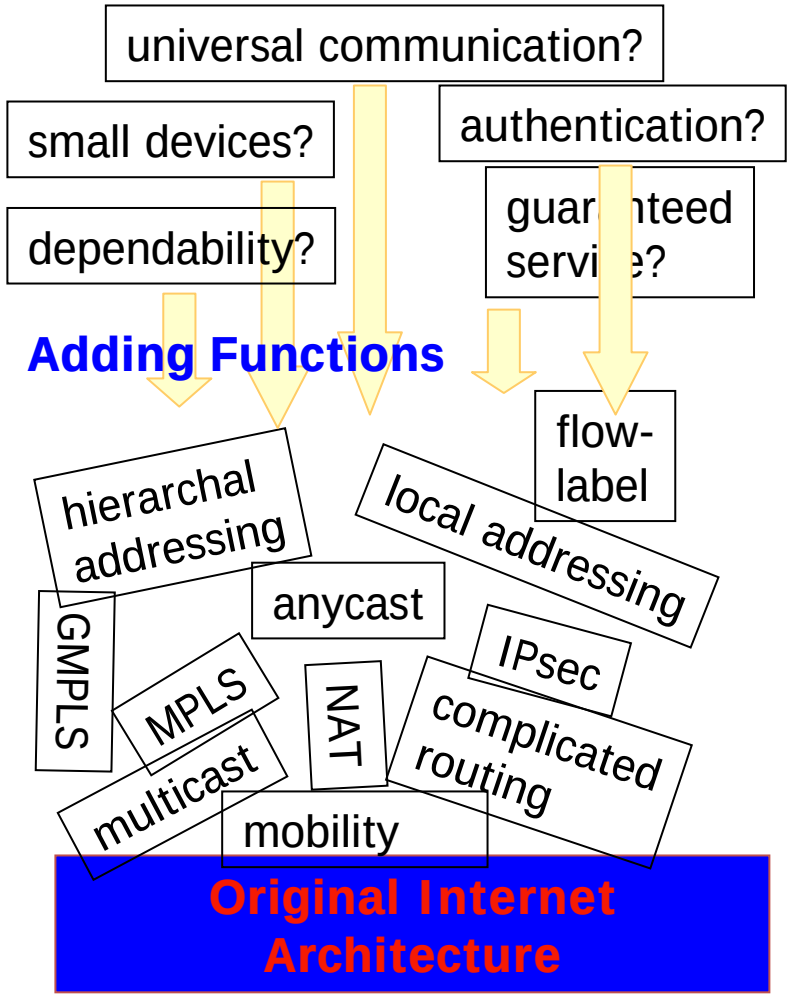
Five Future-Network Targets in NWGN R&D

- **5 Network Targets & NWGN Fundamentals**
- **NWGN Technology Roadmap**

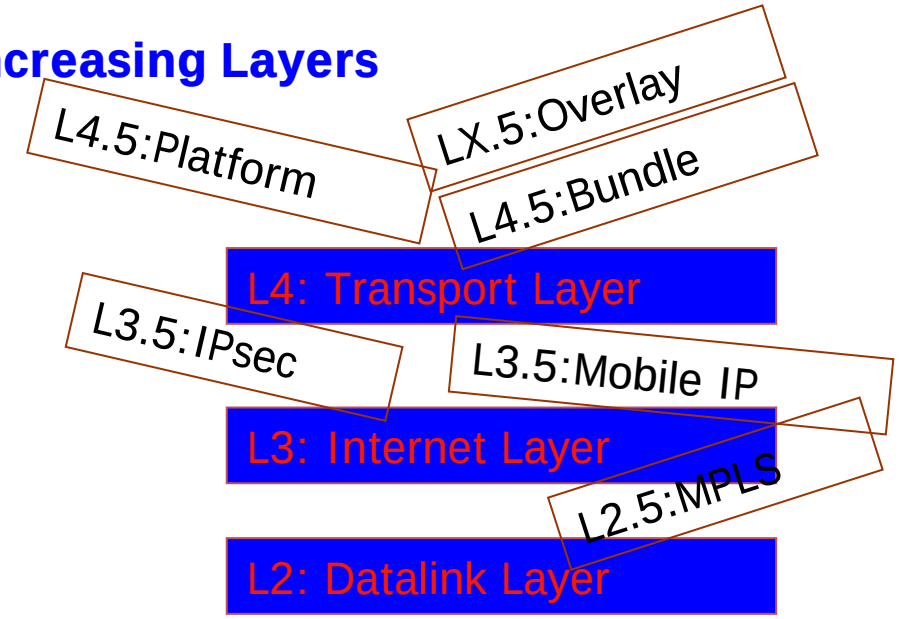


Current Internet – Too Much Complicated

Cannot add new functions Cannot provide services for future society

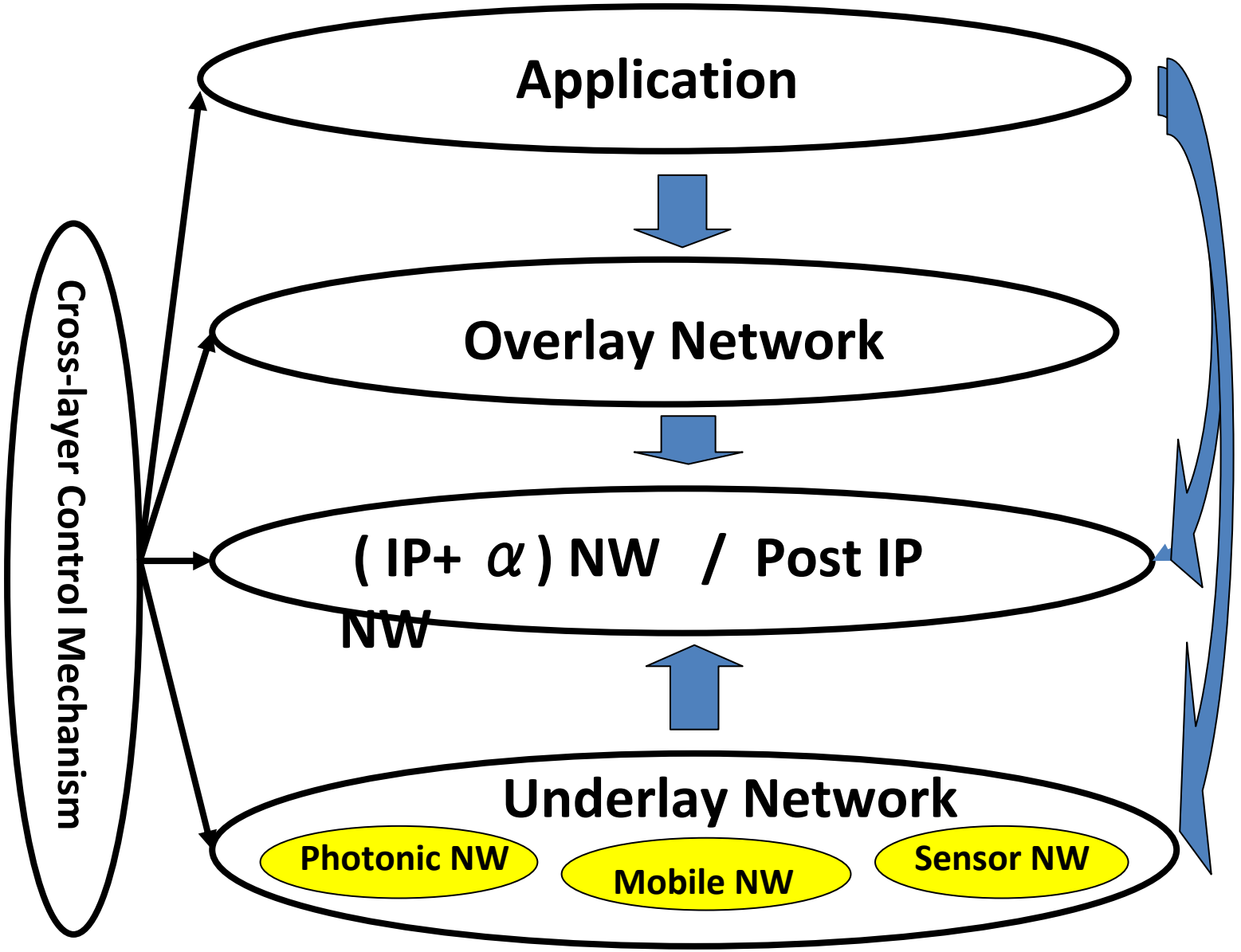


- Entrust network with your life & living ?
  (tele-medicine, ITS & anticrime, finance)
- Rich life? (connecting sensor, RFID)
- Safe? Secure? (spam, DDoS)
- Never broken? how long? (sustainable society)
- Flexible to future change? (nobody knows future)



Individual optimum but NOT global optimum

Design from scratch has come!



Study Items for NWGN Architecture

Network architecture to be reconsidered

End-to-end argument ⟶ How to allocate networking functions ?

Open & Transparency vs Security

How to handling data formats ?

- **Datagram Packet**
- **Flow**
- **Path/Circuit**

How to make control planes ⟶ Cross-layered control

Identifier / Locator Separation

Network Virtualization

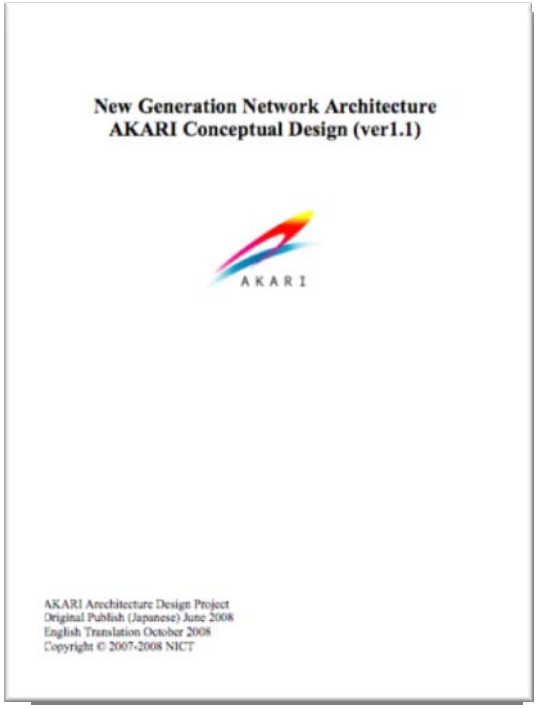
. . . . . .

NICT AKARI Architecture Design Project
(May 2006 - Present)

Designing the future, diverse, new generation network beyond 2015

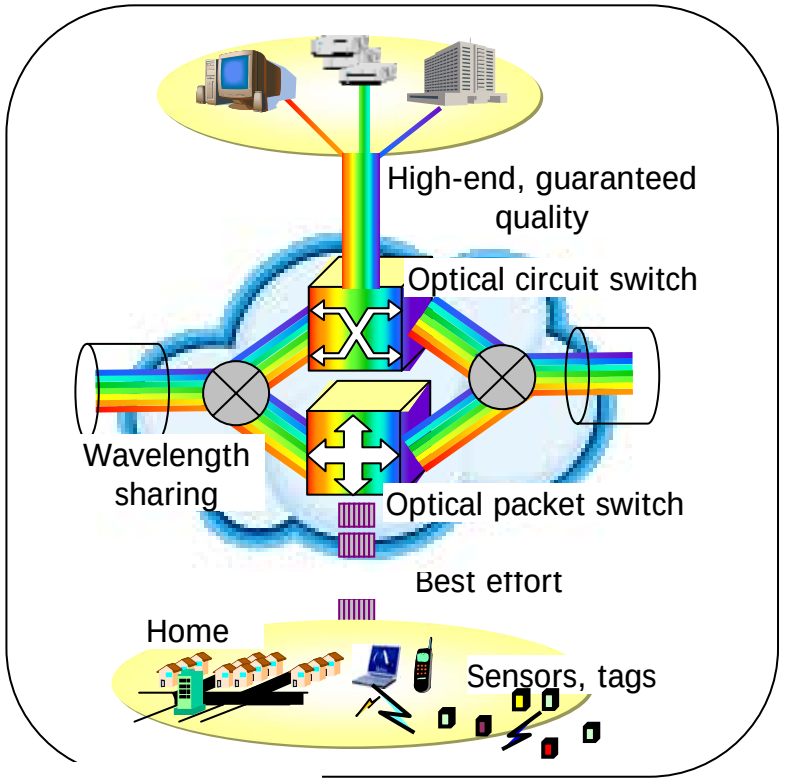
White paper of concept design is available from the web below.

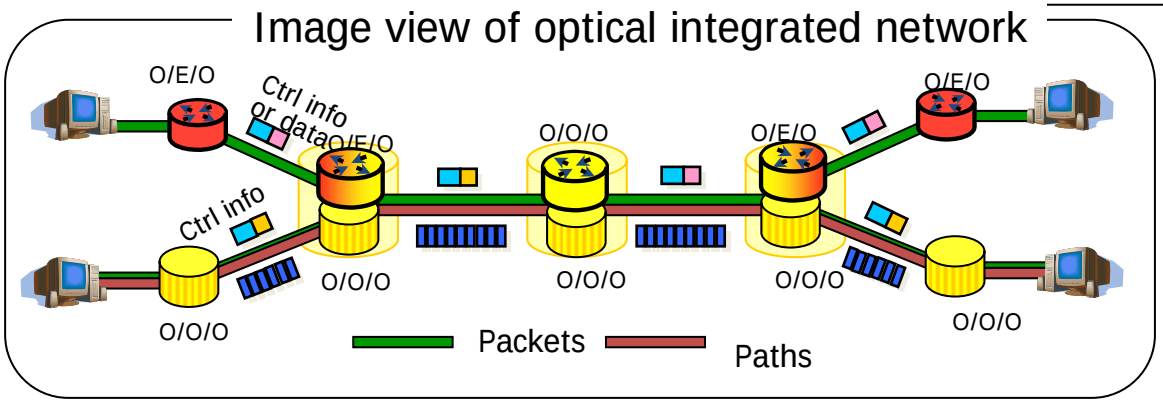
http://akari-project.nict.go.jp/
http://www.akari-project.jp/



Optical Packet/Path Integration

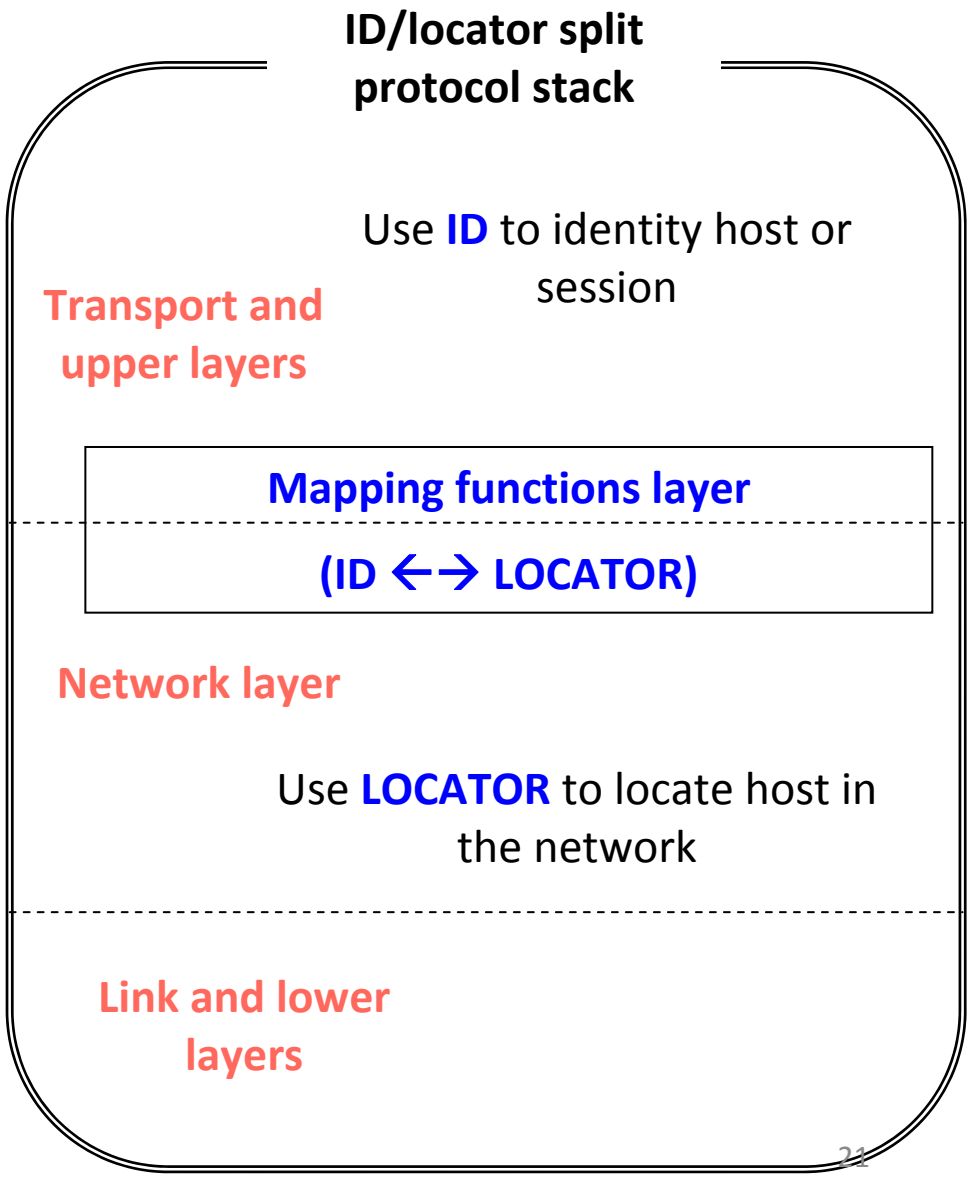
- Objective
  - Providing diverse user requirements w/ large capacity
- Advantage
  - High switching capacity
  - Low power consumption
  - Using common WDM infrastructure
  - Simple control plane
- Design principle
  - Crystal synthesis (QoS)
  - Sustainable (throughput, power, usage)





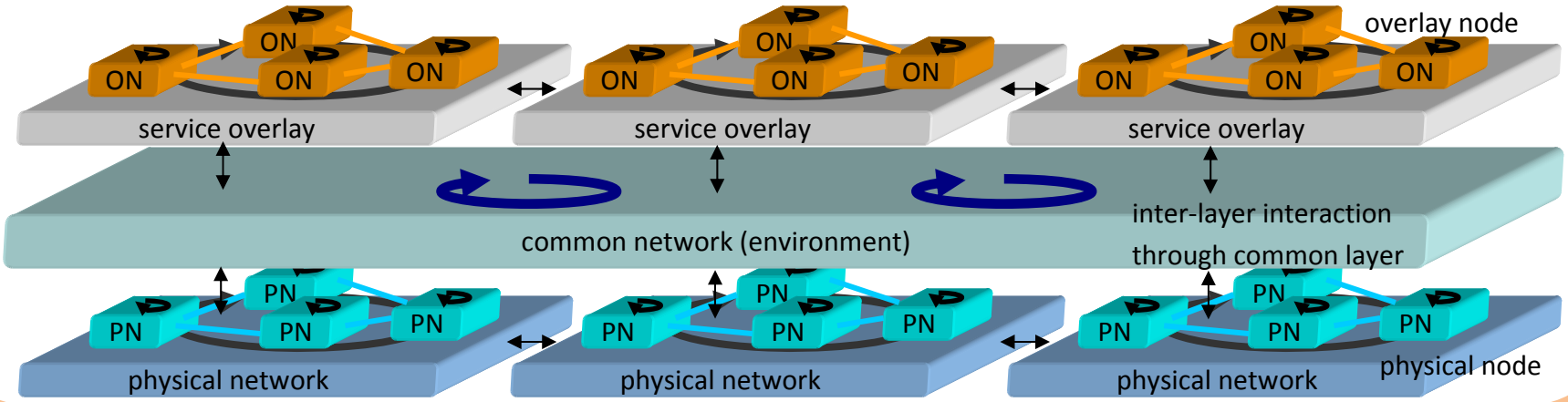
ID/locator Split Internetworking Architecture

- Objectives
  - Diversity inclusion through IDs and locators separation
  - Handling network dynamism more effectively
- Advantages
  - Support heterogeneous network layer protocols
    - IP, post-IP, non-IP
  - Helpful for mobility, multihoming, security, and routing functions
- Design principle
  - ID/locator split
  - Diversity in networks
  - Reliable network space



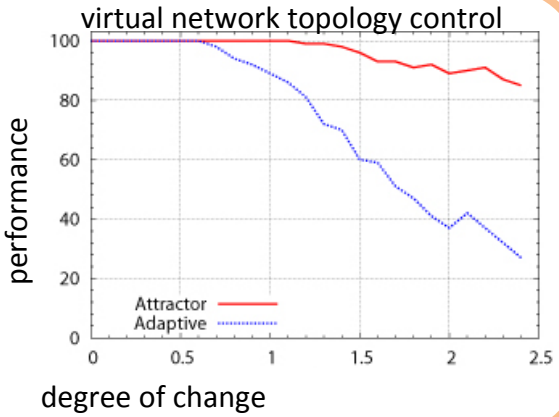
Self-organizing Network Architecture

- **Three-layered architecture**
  - **Service overlay, physical network, and common layer as mediator**

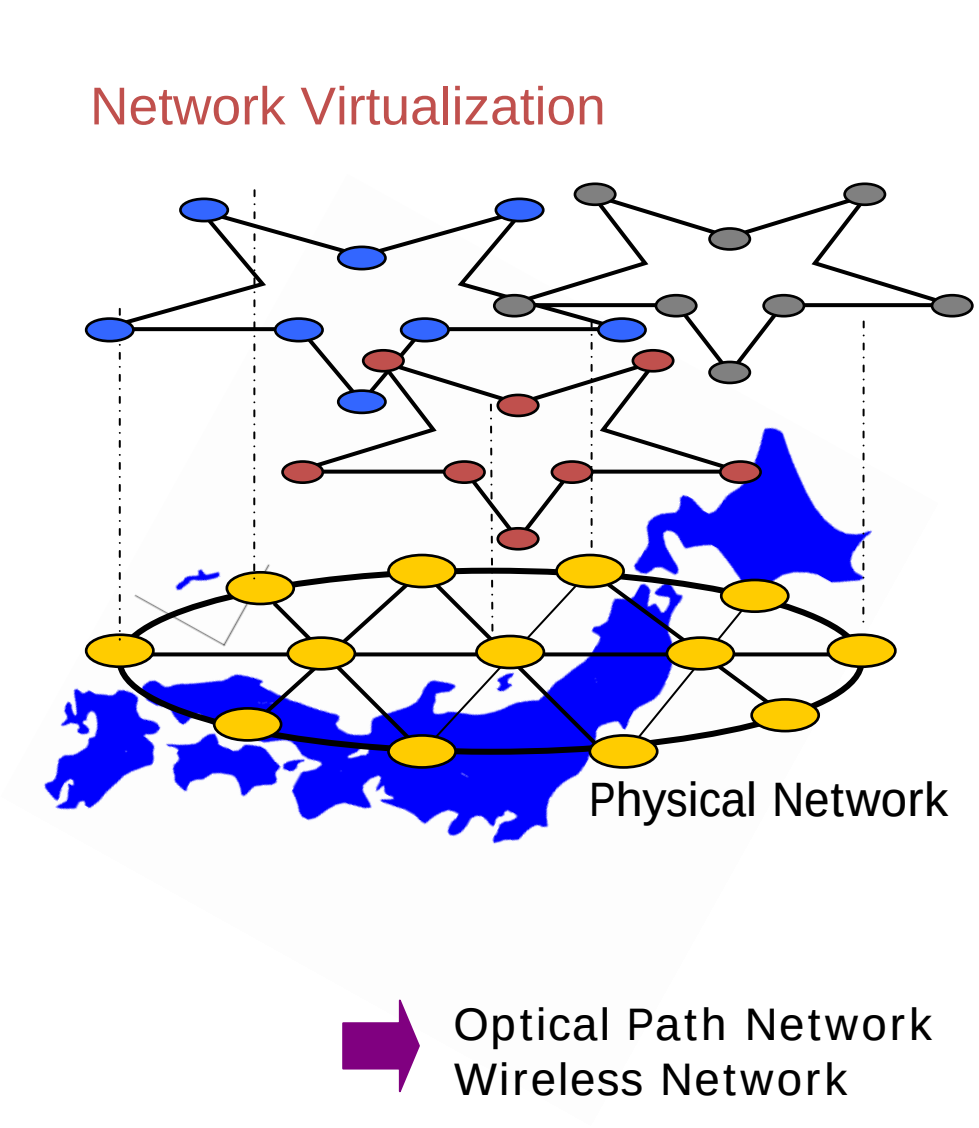


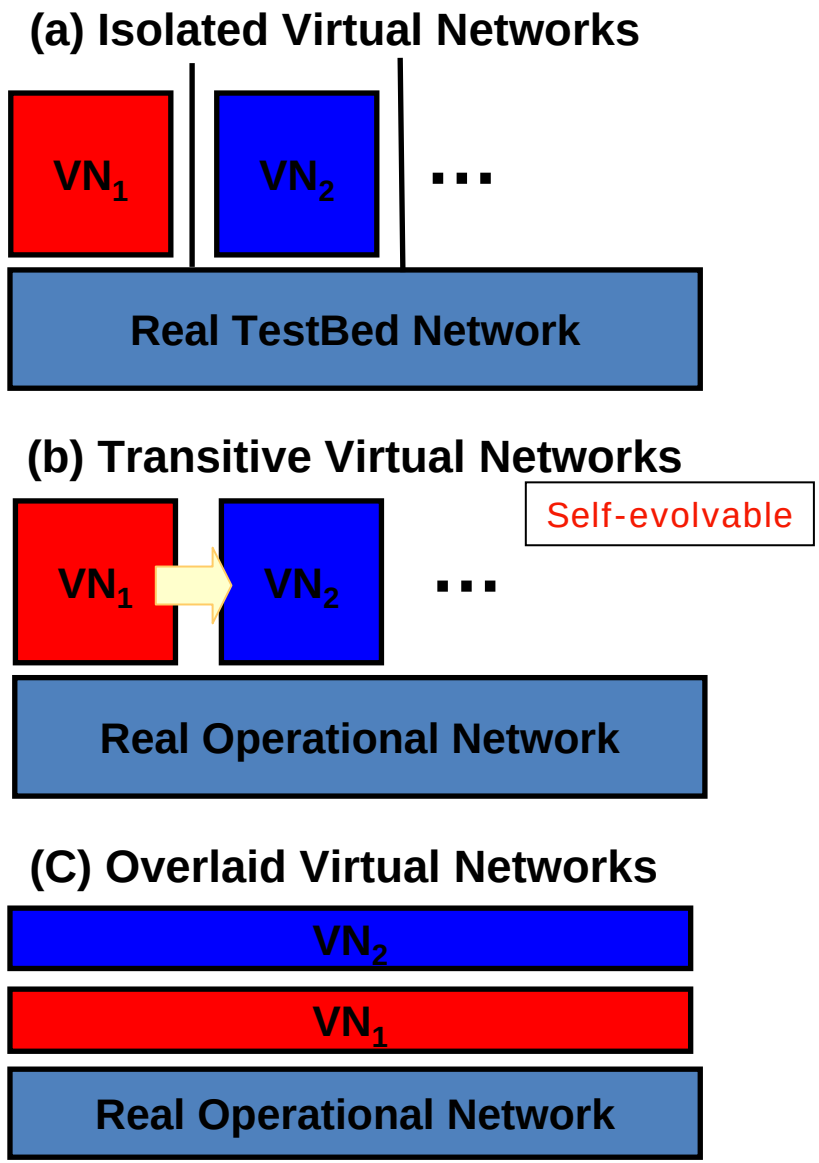
- **Nodes operate on Self-Organization engines adopting nonlinear models**
  - **Pulse-Coupled Oscillator**
  - **Reaction Diffusion**
  - **Attractor Selection**
  - **Response Threshold ...**

➢ Achieves higher robustness



Network Virtualization





Network testbed is a key R&D facilities.

- ARPANET ⇒ NESNET ⇒ The Internet

- New concept, new ideas, new theories, and new technologies should be tested to prove their validity.

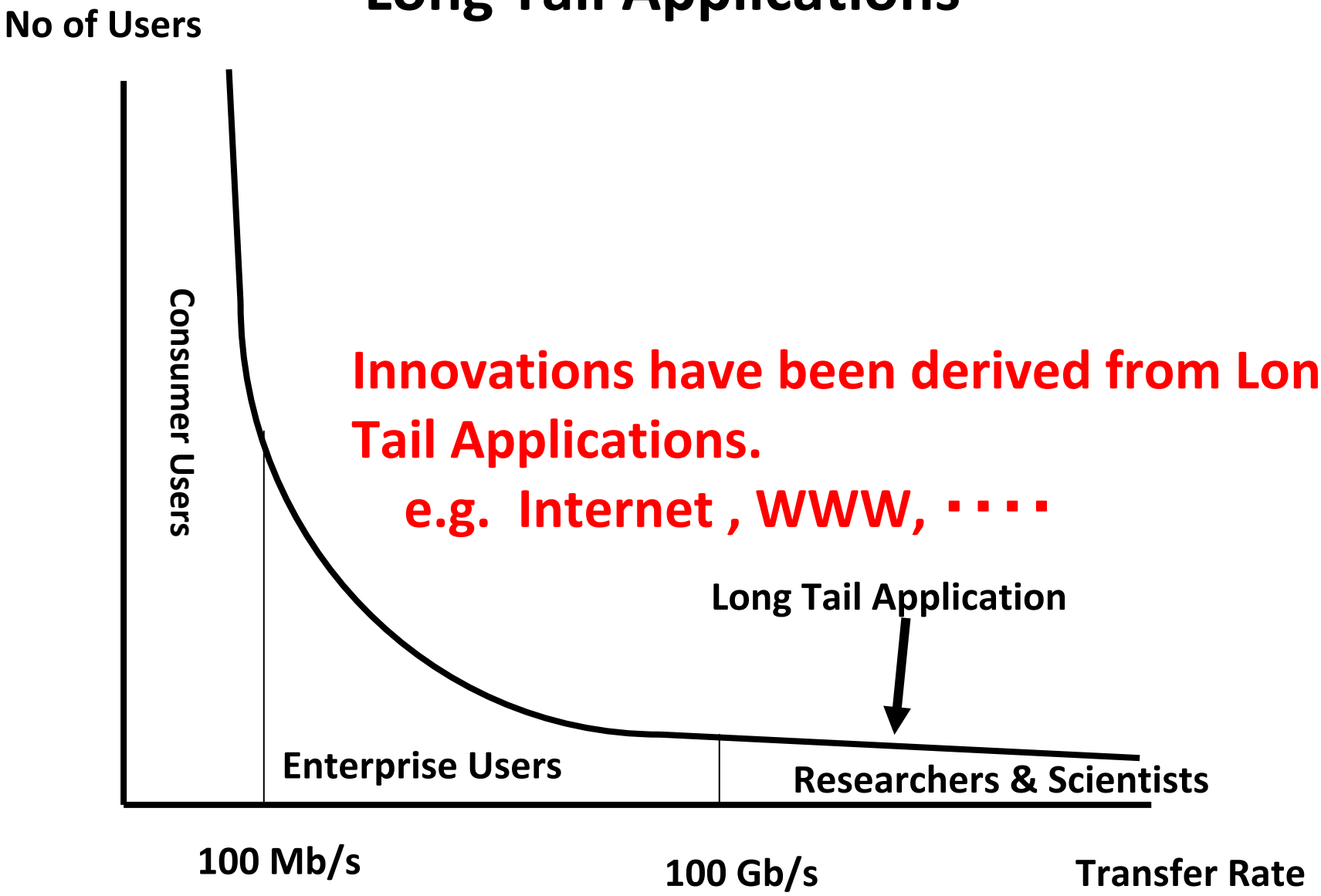
- Testbeds for NWGN/FI

  US: GENI

  EU: FIRE and Gean 3

  Japan: JGN2plus and JGN3 (to be started in 2011)

Long Tail Applications



Examples of long tail applications over NWGN

- Services over Cloud Computing

  SaaS, PaaS, HaaS

- Connection of big tailed display for visualization of e-science data

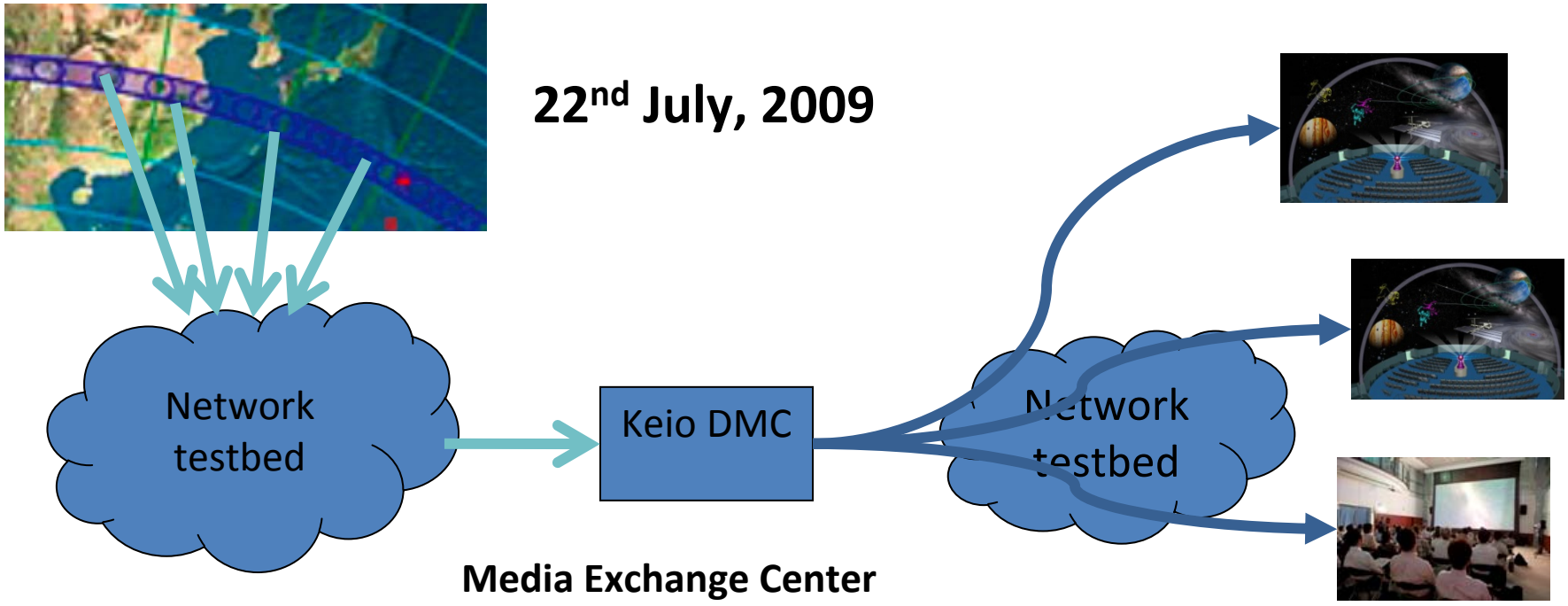
- Distribution of digital entertainment contents with ultra high quality such as digital cinema & ODS*

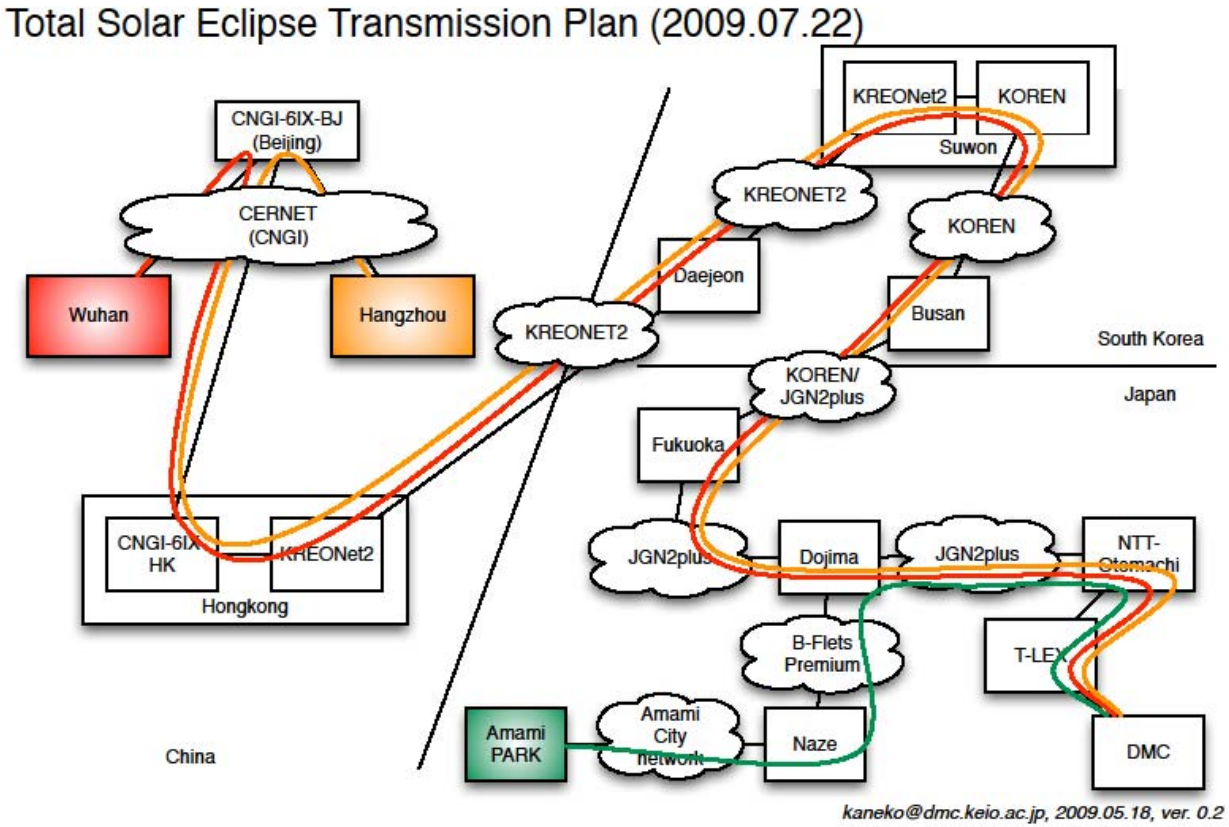
  ODS* : Other Digital Stuff

  musical, opera, drama, sports, etc.

Large Scale Tiled Display System developed by UC San Diego

- **High-quality pictures of "Total Solar Eclipse observation" from multiple points in Asia (via Keio Univ.) was distributed to the world**





The Cine-grid community was involed for distribution and projection.

PIF (Photonic Internet Forum in Japan), KOIF(Korea Optical Internet Forum) and OIFC (Optical Internet of China) supported this astronomical event this July.

Network Requirement for 4K SHD Images

2-hour 4K digital cinema contents

Non-compressed : 5TB

JPEG2000 Compressed : 250GB (1/20 compressed ratio)

File Transfer

10 hours over 1Gb/s link Non-compressed

30 minutes over 1Gb/s link 1/20 compressed

Real time streaming

6Gb/s Non-compressed

300Mb/s 1/20 compressed

Multicast function

Distribution of contents to theaters, halls and home theaters

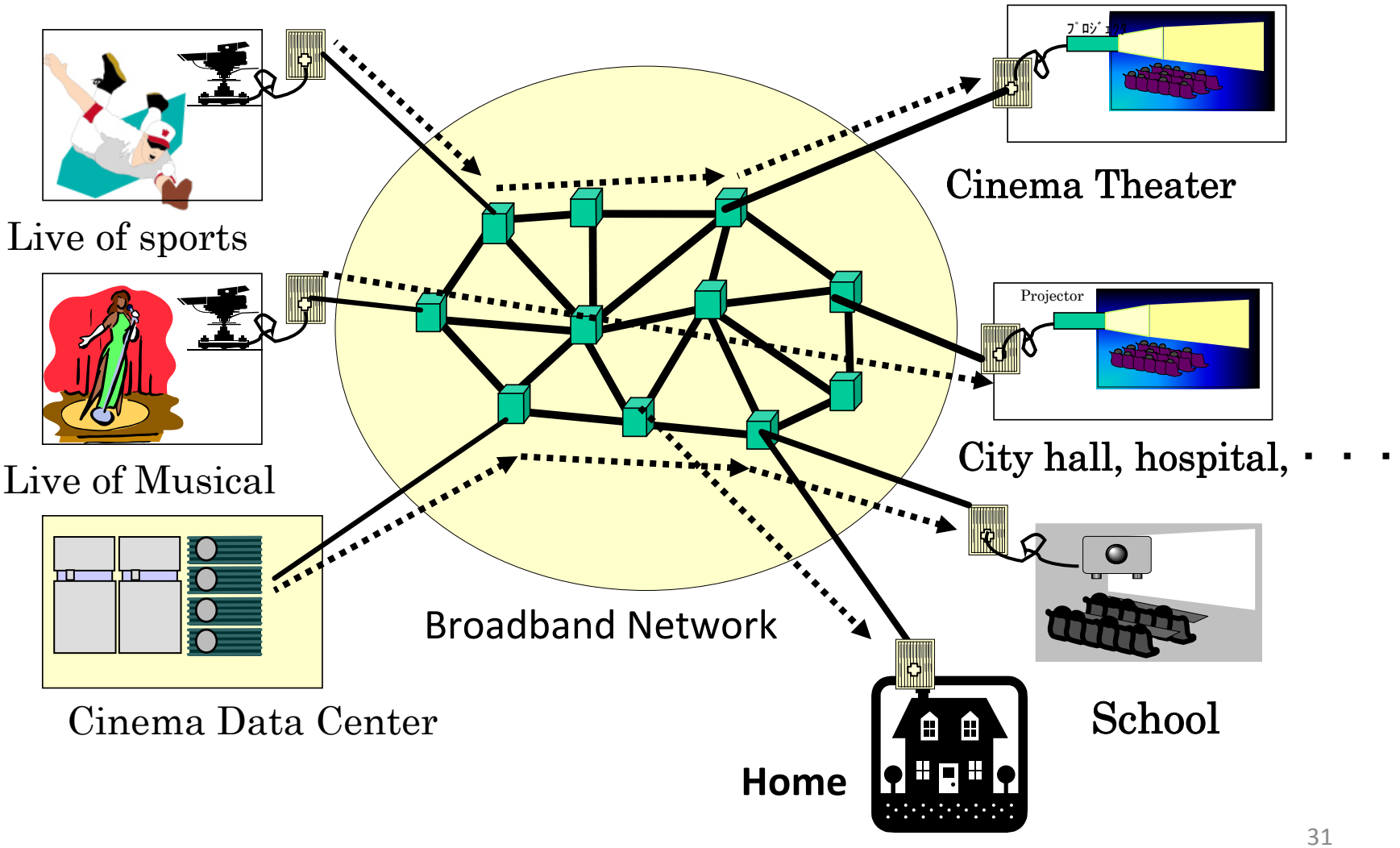
QoS Requirements

Packet Loss30303030

Latency

Synchronization

Image of digital cinema and ODS distribution over a network



Worldwide Competition and Collaboration

Research Collaboration from the Japanese Side

US-Japan Joint Workshop on NWGN/FI

October31-Novbember 1,2008 at Palo Alto in 2009

EU-Japan Symposium on Future Network

June 9-10, 2008 at Brussels

China-Japan ICT Forum (China Academy of Science – NICT)

July 8-9, 2008 in Shanghai

participation in Asia-FI activities

Standardization in ITU-T

ITU-T hosted the Kaleidoscope Academic Conference jointly with IEEE ComSoc

ITU-T established a focus group (FG) in Study Group 13 to discuss about future networks

Other standardization bodies such as ISO, IEEE, IETF, 3GPP should be watched.

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US-Japan Joint Workshop on New Generation Network/ Future Internet

October 31-November 1, 2008 at Palo Alto

Summary

- *Paradigm Shift in ICT will be envisaged in ten years.*
  - *Cloud Computing*
  - *NWGN/FI*

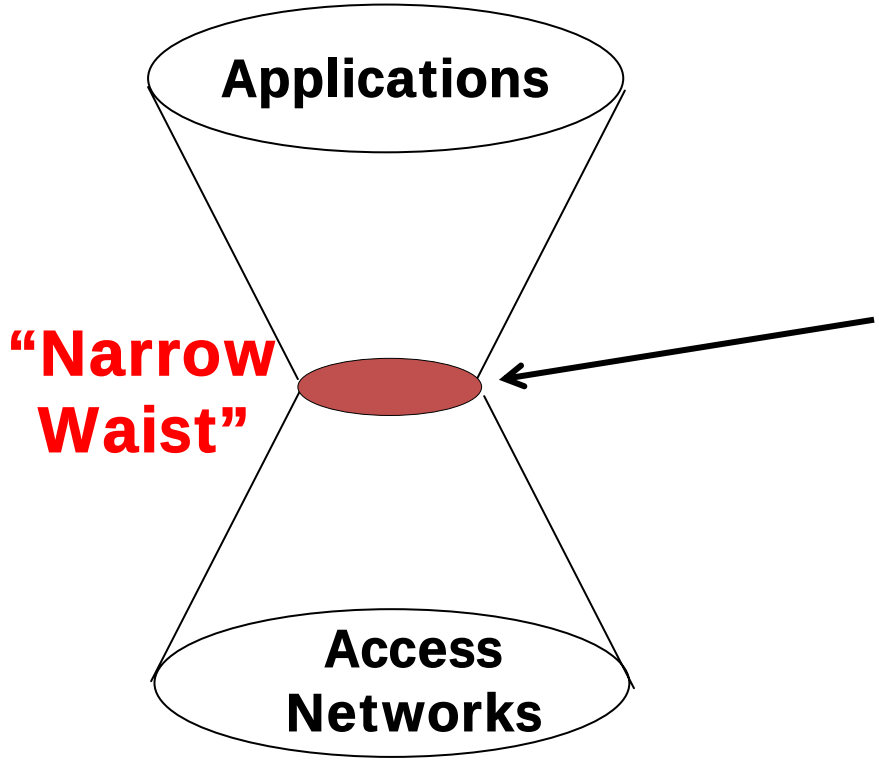
- *Proof-of-concept prototype, protocol design, network-testbed design, ..., showing blueprint of NWGN/FI design is work-in-progress.*

- *Global collaboration for R&D and global standardization is important.*

- *Kaleidoscope Academic Conference is playing an important role to start up discussions on new study items to be standardized.*

Thank you for your attention !

Can the current IP Protocol handle the explosion of information over networks in 2020s ?



- **Applications**
  - **Web**
  - **Email**
  - **Video / Audio**
- **TCP / IP**
- **Access Networks**
  - **Ethernet (LAN)**
  - **Wireless (LMDS, WLAN, Cellular)**
  - **Cable**
  - **ADSL**
  - **Satellite**