



AKARI Architecture Design Project

***2nd Japan EU Symposium on the “New-
Generation Network” and “Future Internet”***

October 13, 2009



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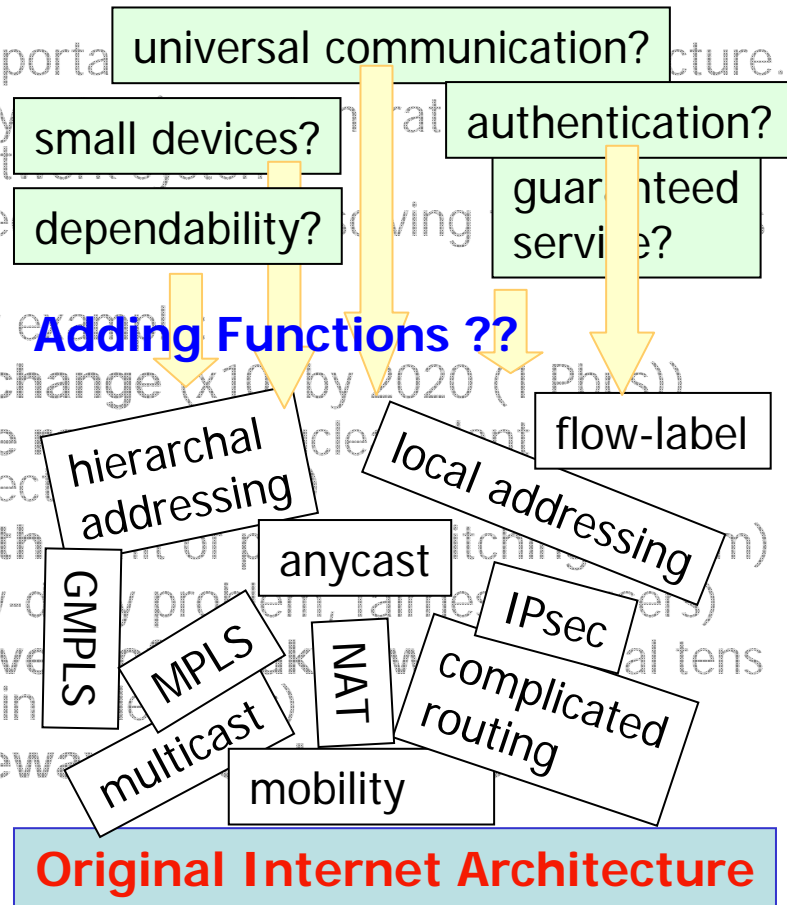
NICT

<http://akari-project.nict.go.jp/>

<http://www.akari-project.jp/>

Why New Generation Network?

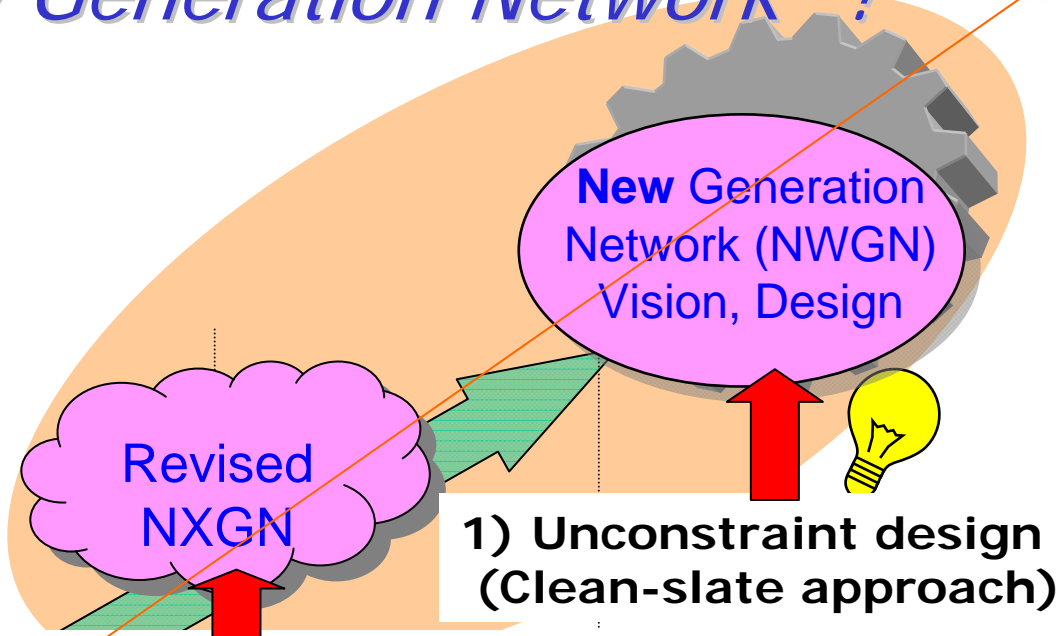
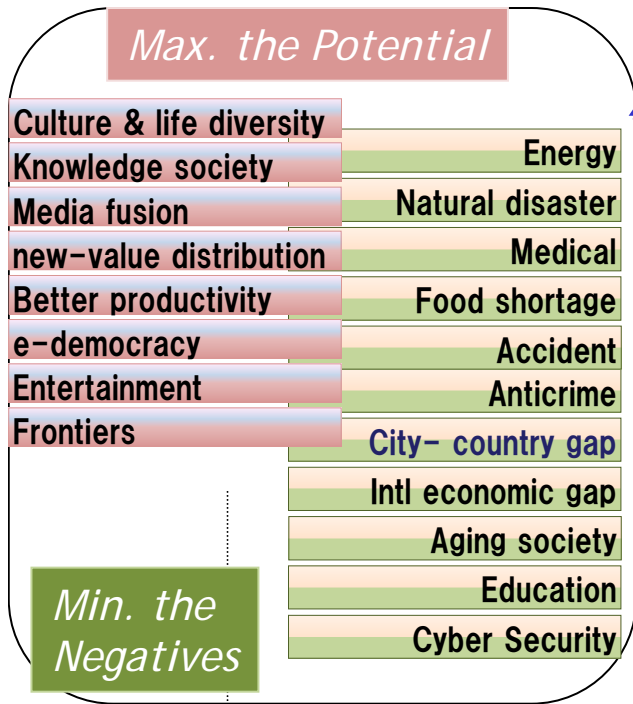
- Current & near-future situation
 - The Internet has grown as the most important network structure.
 - Telephone network will be renovated by IP network, which transport is constructed by IP network system.
 - NGN is expected to provide sophisticated services in the Internet, e.g. QoS, Security, etc.
- However, we have still many problems. For example,
 - Large capacity of transmission/exchange (x10 by 2020 (1 Pbps))
 - Electric power consumption of core network (generation per 100 devices of 1Pbps electricity)
 - Difficulty of guarantee of bandwidth
 - Difficulty of congestion control (bw-control problem, fairness)
 - Difficulty of avoidance or fast recovery (of seconds' order needed for rerouting in network)
 - Difficulty in introducing plural gateways (connection termination)
 - ...
 - Difficulty in building sustainable & evolvable network (patch??)



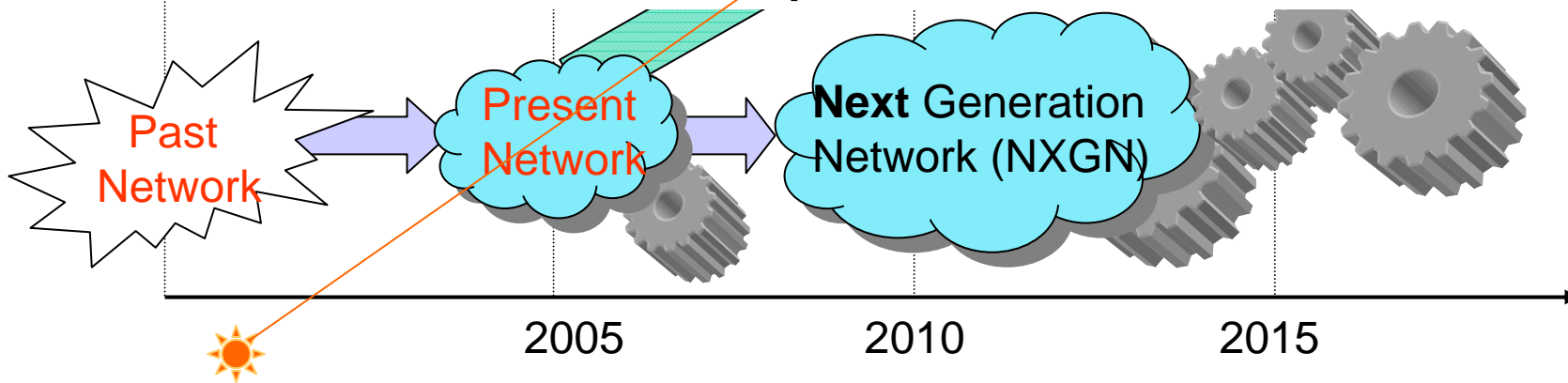
How to get to NWGN

"New Generation Network" ?

AKARI



2) Incremental development with a future direction



AKARI ... a small light in the dark pointing to the future



AKARI Architecture Design Project



- The primary mission is to design a network architecture of the future from a clean slate
- To develop novel technologies for New Generation Network by 2015
- To envision a new infrastructure for the next two or three decades

Sustainable Architecture Design Principles *Design Concept Paper*

Diversity Inclusion

1. Crystal Synthesis (KIS*)

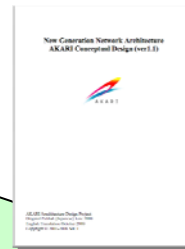
- Selection, integration, simplification
- Common layer (layer degeneracy)
- Refined end-to-end

2. Reality Connected

- Physical-logical separation
- Bi-directional authentication
- Traceability

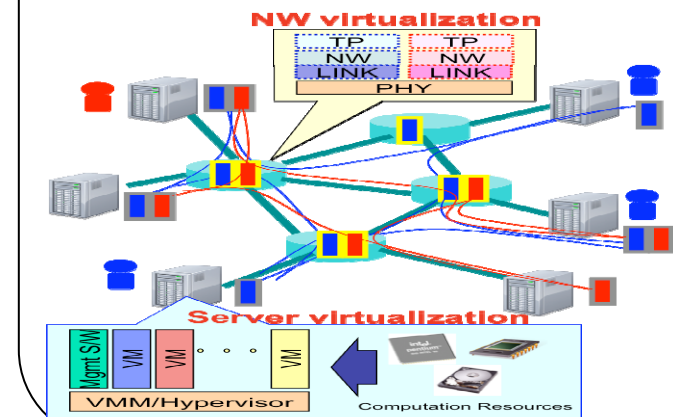
3. Sustainable & Evolutional

- Self-* properties (emergent)
- Autonomic distributed control
- Openness



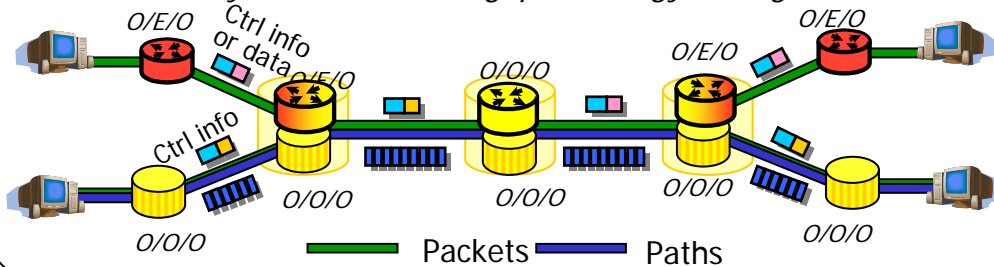
Reliable Network Space **Social Potentiality Promotion**

Network Virtualization *Sustainable, Service Diversity*



Optical Packet & Circuit Integrated Networking

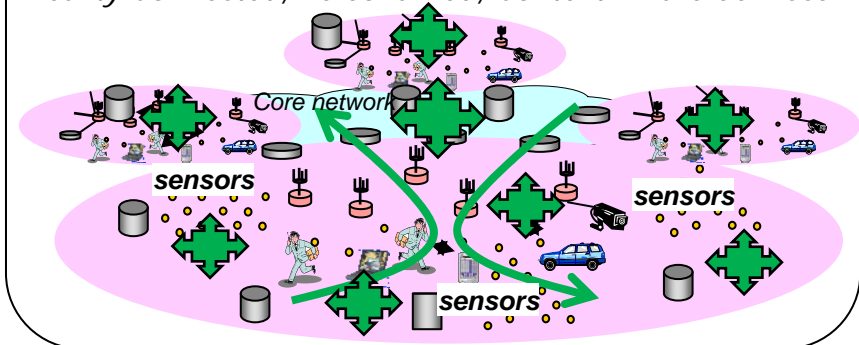
Diversity Inclusion, Throughput, Energy Saving



ID/Loc Split, Robust, Self-Organized Network...

Regional Wireless/Sensor Platform Network

Reality Connected, Personalized, Context-Aware Services

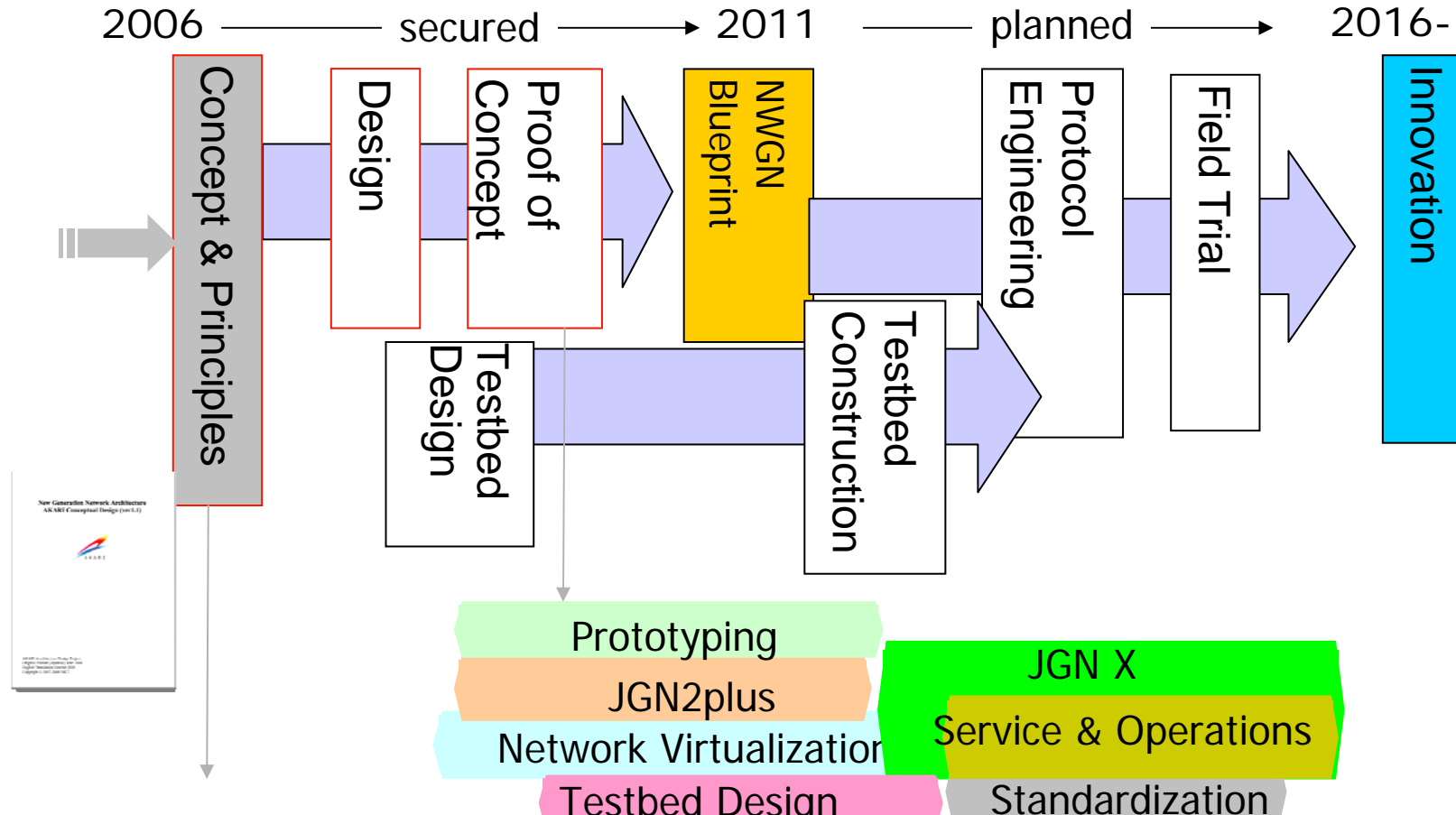


AKARI Design Project R&D Plan



Grand-Designing a New Generation Network beyond 2015 -

- (1) Design ideal network under clean-slate concept (2) Bridge current network and ideal network



"AKARI Architecture Conceptual Design"

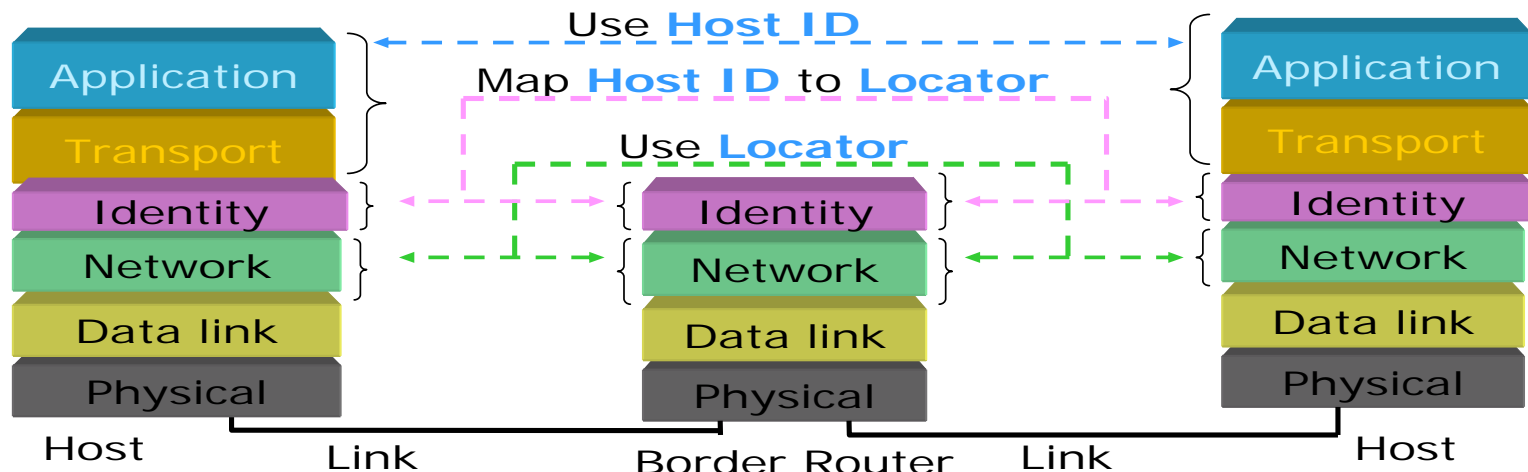
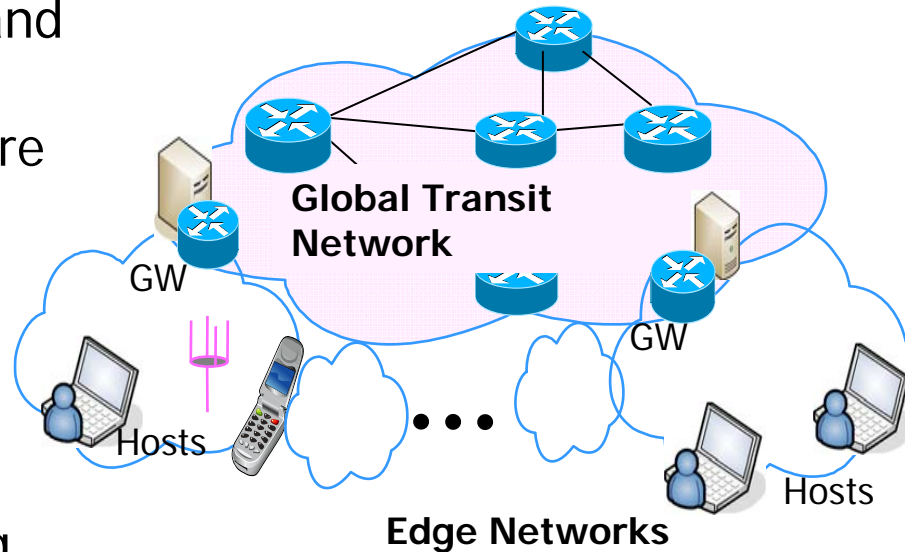
See <http://akari-project.nict.go.jp/eng/conceptdesign.htm>





ID/locator Split Internetworking Architecture

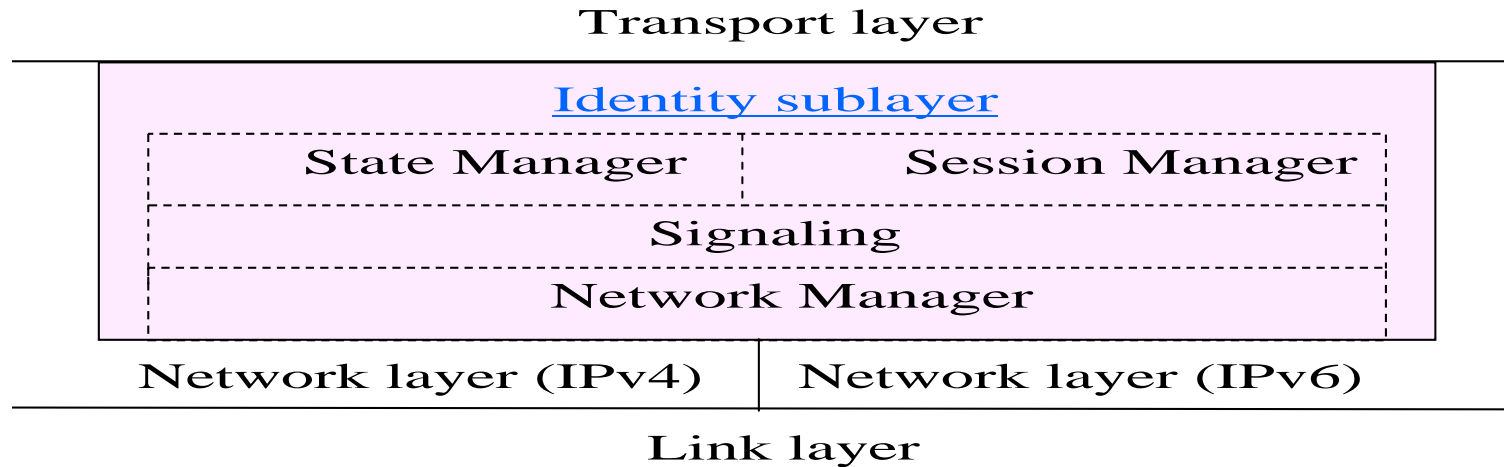
- Objectives
 - Diversity inclusion through IDs and locators split
 - Handling network dynamism more effectively
- Advantages
 - Support heterogeneous network layer protocols
 - IP, post-IP, non-IP
 - Helpful for mobility, multihoming, security, and routing functions



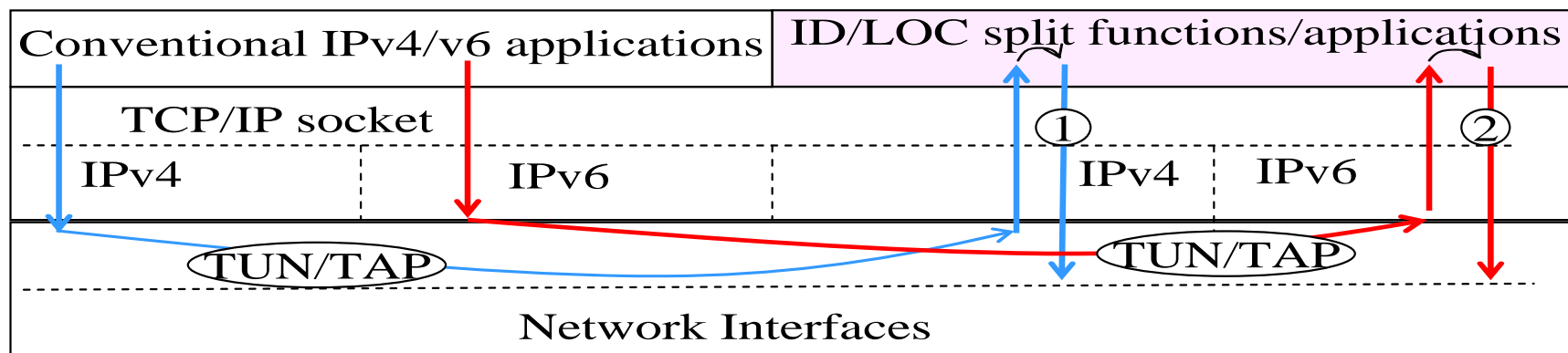
ID/Loc Split Implementation Layout



➤ Implementation in Linux

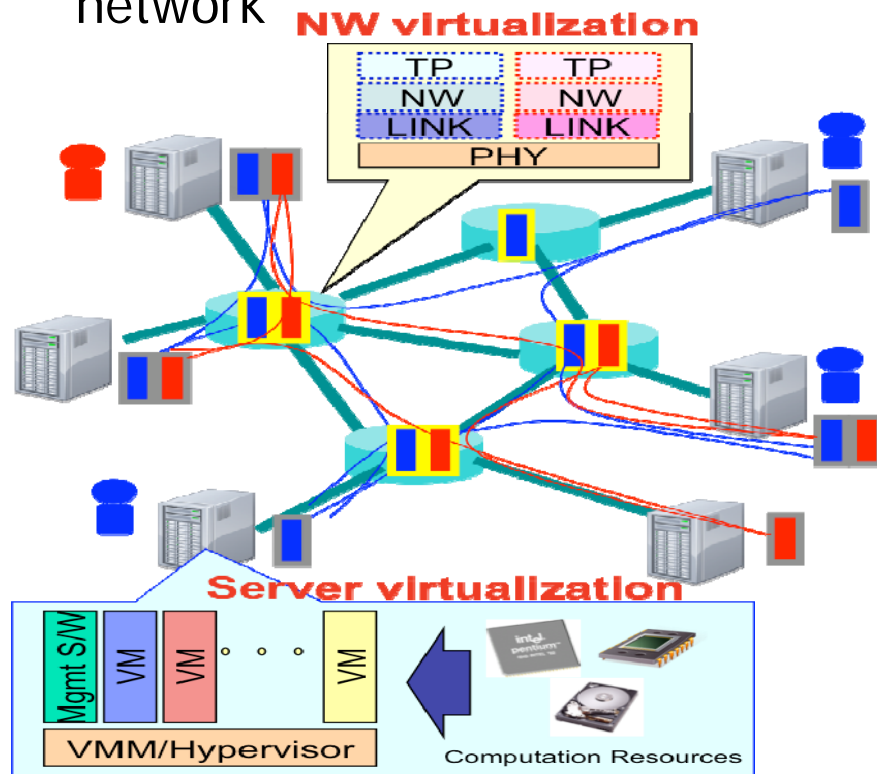


➤ ID/locator split functions supporting conventional protocol stack



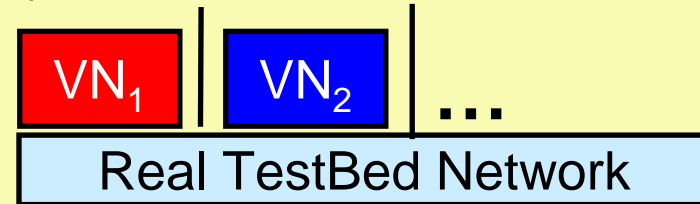
Network Virtualization

- As a network testbed for NWGN
- As a **sustainable & evolvable** network

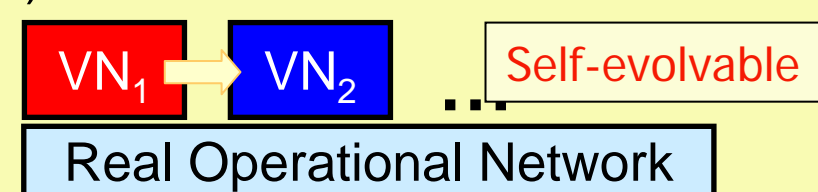


Optical Path Network
Wireless Network

(a) Isolated Virtual Networks

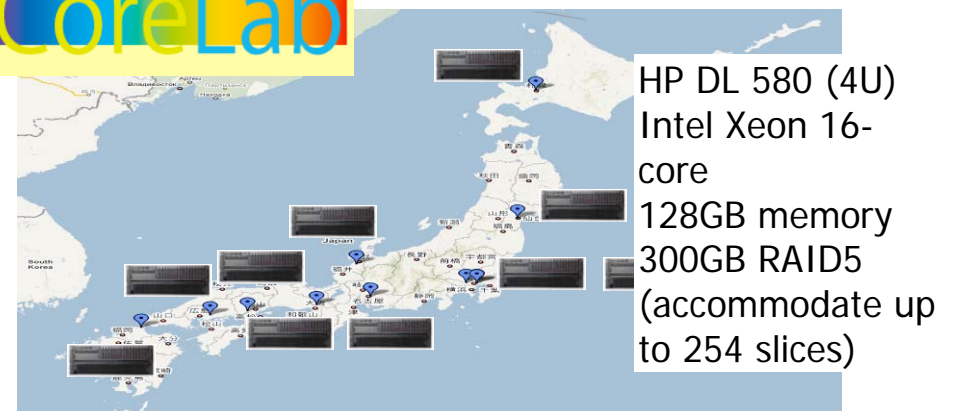


(b) Transitive Virtual Networks



Implementation at Net Virtualization Lab (NICT & U-Tokyo)

CoreLab



Regional Platform Network with Managed Mesh



➤ Objective

➤ **Realize a regional platform network** as a future access network

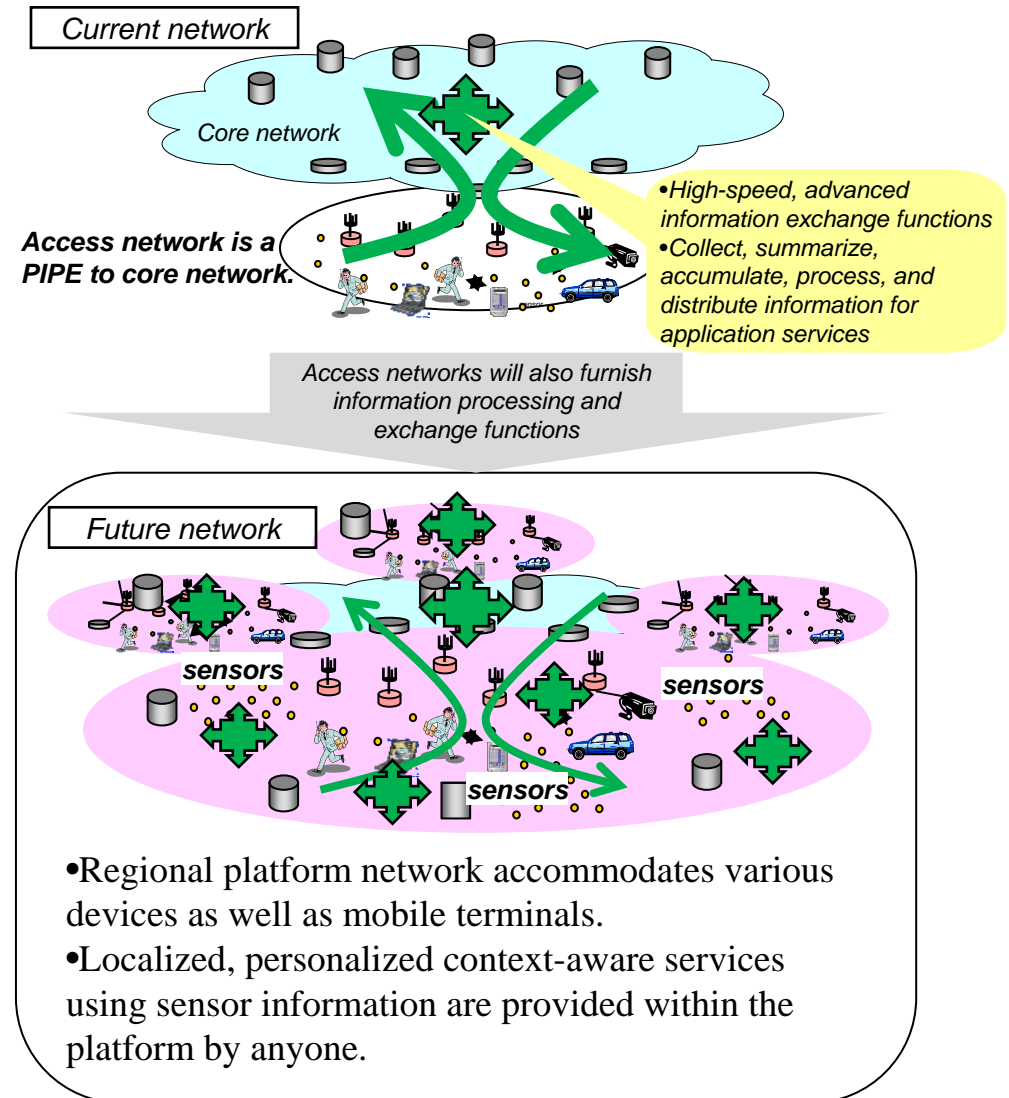
➤ it provides localized, personalized, context-aware services with the use of diverse kinds of sensor information

➤ Advantage

➤ Secure sensor info transport through dynamic mobile path with bi-directional auth.

➤ Design principle

➤ "Reality Connected"

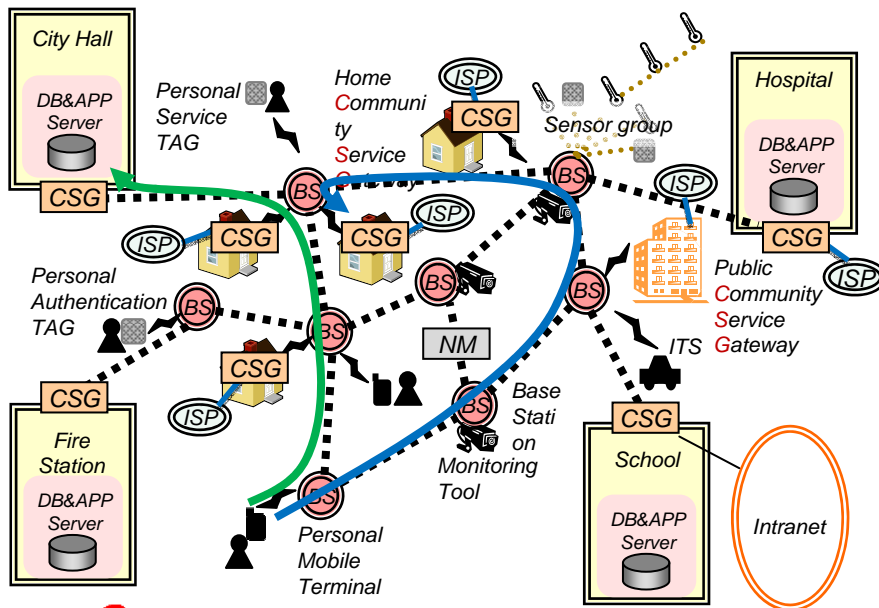


Regional Platform Net with Managed Mesh (2/2)



- Design Overview -

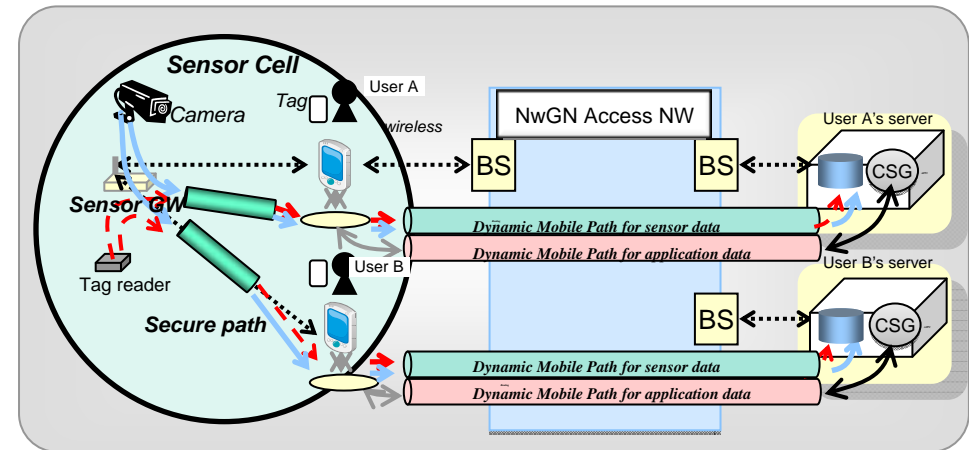
- Densely located mesh BSs with wireless/wired I/F accommodate new devices such as sensors as well as 4th generation mobile phones.
- Community service gateway (CSG) works as device manager, sensor DB, gateway to the Internet, and sensor applications server.
- CSG can organize multiple logical domains over the shared physical network with the use of info about logical paths between any two BSs.



BS: Base station with terminal service gateway (TSG) function

CSG: Community Service Gateway

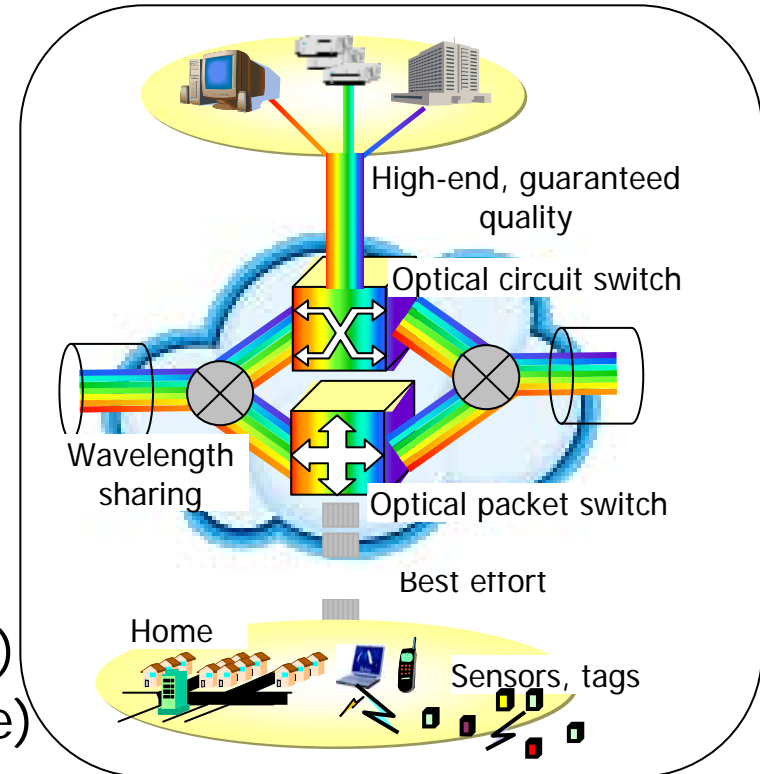
NM: Network manager



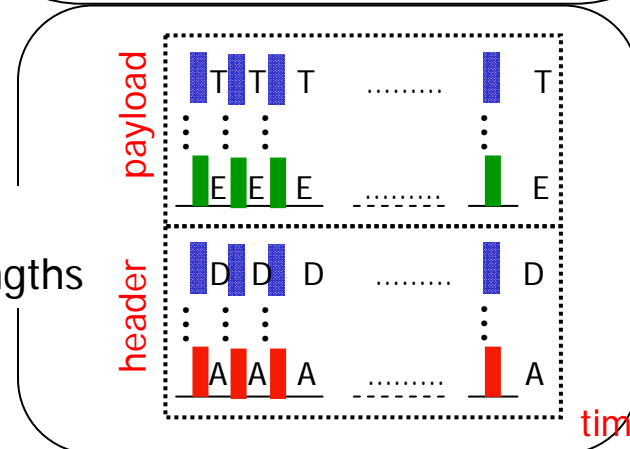
Optical Packet & Circuit Integrated Networking



- Objective
 - Providing diverse user requirements w/ large capacity
- Advantage
 - High switching capacity
 - Energy saving
 - Using common WDM infrastructure
 - Simple control plane
- Design principle
 - Crystal synthesis (quality & best effort)
 - Sustainable (throughput, power, usage)



Optical packet by many wavelengths



time 1

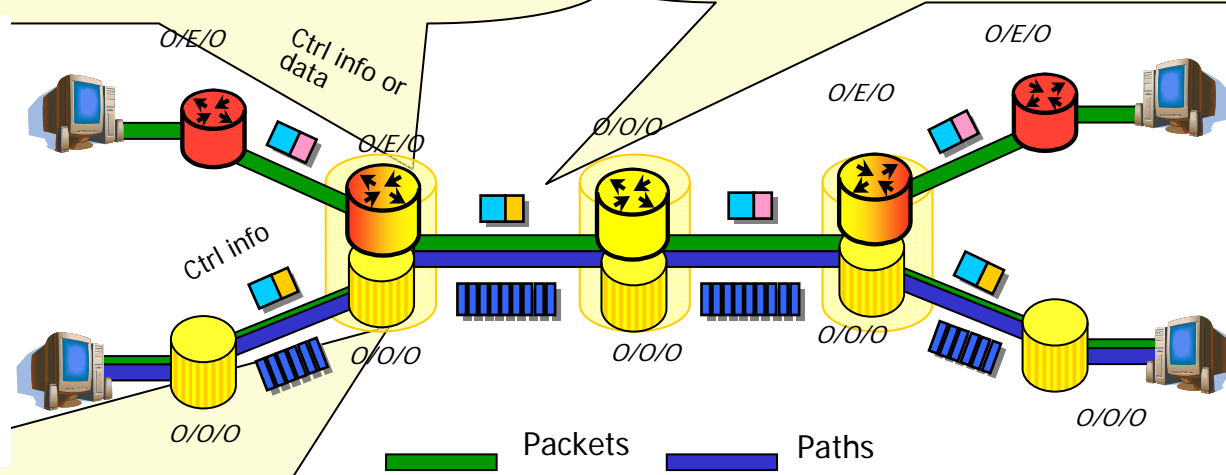
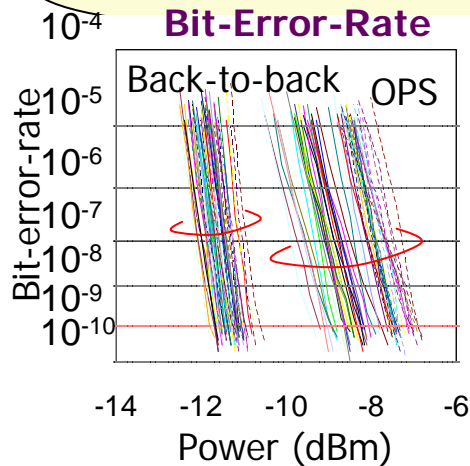
Optical Packet/Path Integration (2/2)

- Design & (Partial) Development Overview -

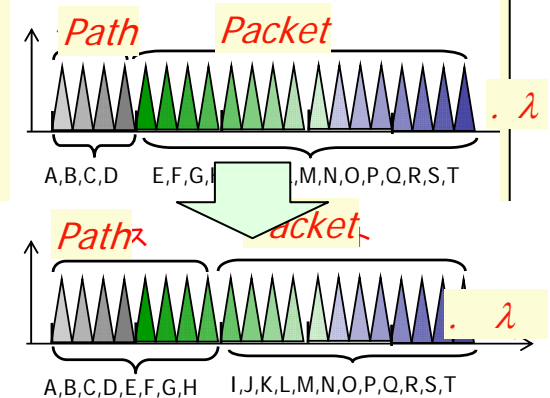


Switching of 640 Gbps multi-wavelength packet (10G x 64 lambdas) w/ optical buffering (Furukawa et al. ECOC 2008)

Lightpath-control message over multi-wavelength packets (under implementation)



- Dynamic wavelength-bandwidth-range control and optical system for packet switching and packet switching
- Dynamic bandwidth-range change aware distributed control for circuit switching
- Dissemination of link states for each node to obtain available wavelengths for lightpath setup



AKARI Architecture Design Project Major Members:

NICT: Harai: Network Architecture Group Leader
Xu (Lightpath), Miyazawa (Opt. Access), Otsuki (Net Control),
Inoue (Regional Net), Kafle (Addressing), Nakauchi (Overlay),
Umezawa (Personal Net), Ohnishi (Wireless Net), Yagi, Fujikawa (QoS),
Li, Peng, Decugis, Andre, Kamiya, Kuri, Furukawa

Prof. M. Murata (Osaka U., Network Science)

Prof. H. Morikawa (U. Tokyo, Ubiquitous)

Prof. F. Teraoka (Keio U., Mobility)

Prof. M. Ohta (Tokyo Inst. Tech., Packet Switching)

Prof. A. Nakao (U. Tokyo, Network Virtualization)

Prof. H. Imaizumi (U. Tokyo, Optical Net)

Program Coordinator Prof. T. Aoyama

Launched by the late Masaki Hirabaru

Summary

- Towards New Generation Networks
 - Network Architecture Design
 - Enabling Technologies
 - New layer architecture (ID-loc split)
 - Network virtualization,
 - Wireless regional network, Optical core network
 - Proof-of-concept prototyping, protocol design (on-the-way...)
- Next steps
 - network testbed design, ..., showing blueprint of new-generation network design (current concept is work-in-progress)

Thank you