Contents

- Broadband Networks in Japan
- Next (NXGN) and New (NWGN)
- Key Technologies for NWGN
No. of broadband customers in Japan

Total 25 Million
More than 50% of household

- NTT’s Target 30 M in 2010
- CATV
- ADSL
- FTTH

FTTH exceeded 7 Million

Source: MIC
Rapid Expansion of Internet Traffic in Japan

1000 times in 10 years

http://www.jpix.ad.jp/jp/technical/traffic.html
NGN is entering into the deployment phase in Japan.

- Carriers and vendors are investing their resources to the deployment of NGN.
- Standards for NGN are being established in the ITU-T.
- NTT has started the field trial of NGN services.
- Actual services over NGN may start around 2007.
NGN Architecture standardized by ITU-T

- Application
  - API
    - UNI
    - Service Stratum
      - Service Control Function
    - NNI
      - Transport Stratum
        - Transport Function
  - Other Network
- End User System
NXGN and NWGN

- NGN (NeXt Generation Network): NXGN
  Improvement of IP networking to provide Triple-/Quadruple-play services

- NWGN (NeW Generation Network)
  Network architectures and main protocols are different from IP networks, Post-NGN
Next Generation Network and New Generation Network

Variety of Appliances

Ubiquitous Appliances

Quadruple Play
Triple Play

NXGN / IP

NWGN / (IP + α) or post-IP

Year

2010
2020
Multi-layer Control Mechanism

Application

Overlay Network

(IP+ α) NW / Post IP NW

Underlay Network

Photonic NW

Mobile NW

Sensor NW

Study Items for NWGN Architecture
Research Projects related to NWGN in Japan

Network Architecture: AKARI Project in NICT

Underlay Network

- Optical Packet Network Research in NICT
- 4 Photonic Network Projects funded by NICT
- Cognitive Wireless Network Research in NICT

Overlay Network

- Joint Research Project among NICT and Universities
- Five Ubiquitous Network related projects funded by MIC

Applications for NWGN

- 4K and 8K Super High Definition Video Applications
- Grid Computing and its applications for e-Science
Requirements for NWGN

1. Network Capacity
   Backbone Node: 1Pb/s ,  Backbone Link: 10 Tb/s
   FTTH: 10Gb/s

2. No. of Appliances
   100 billion appliances / 1 million broadcast stations

3. Capacity of contents
   From 100 bit (sensor/RFID) to 5 TB (2 hour 4K non-compressed digital cinema contents) and more

4. Transparency / Openness / Simplicity
   KISS principle
   Controlled transparency for security
Contents in the ubiquitous society
From tiny to huge

Access frequency [page/day]

Capacity of content [bit]

B2B
IP TV
Cine-grid
HD TV
Digital Cinema
> 100GB
SDTV
P2P
Web content
WebTV
>$ 10kB/page
MP3>MB/musice
Digital Cinema
> 100GB
Web~10kB/page

InternetTVガイド
11Mpage/day
Yahoo
300Mpage/day

B2C

Sensor & RF ID
S2M

Both directions
Requirements for NWGN

5. Robustness: More than four nine

6. Reliability: Protection of Privacy, Traceability

7. Ubiquity: Ubiquitous appliances and contents
   Full mobility support

8. Sustainability and Adaptability for technological advances


10. Low power consumption
   Prediction: ICT systems will occupy about 50%
   of total power consumption with current technology
   in 10 years.
NICT’s Mission

**Research**

**Testbed**

**Funding**

**NWGN Architecture and Key Technologies**

JGN 2 → JGN2+ → JGN 3

**Funding for Research Projects in Univ. and/or Industry**

**AKARI Project**

- a small light in the dark pointing to the future -

Designing new generation network architecture

- pick up techniques for NWGN
- integrate & simplify them under the clean slate design concept for NWGN
NWGN Architecture Study in AKARI Project

Connectionless Datagram Packet

Combination of Packet and Circuit Switched Networking

Identification & Location ➔ Separate Structure

Naming & Discovery ➔ New Scheme should be needed

Layered Architecture ➔ Cross-layered Architecture

Mobile Networking ➔ PDMA (Packet Division Multiple Access)

Overlay network ➔ Overlay testbed over JGN2

AAA Function

Autonomous/Self-organization mechanism
Optical Packet & Path Combination Architecture

Assumptions:
Packet loss due to small buffer size
OCS for guaranteed services
(current buffer size by NICT = 31 p at 10Gbps)

Questions:
OPS: Label Swapping? at L2
OCS: GMPLS?

Hirabaru & Harai
2006-10-19
Akari meeting

10GHz? 1Gbps
100GHz? 10Gbps
200GHz? 40Gbps

* to avoid too short packet length
All-optical Terabit-class LAN

- Access-to-backbone seamless networking

WAN/MAN

Ether-frame aggregation
- Aggregation sw interface
- Aggregation sw engine

>100Gbps transmission
- 100Gb/s Tx & Rx
- Dispersion tolerance

Opt. IF
User

Seamless networking
- Dynamic λ/λ-band
- Signalling

NG Ethernet protocol
- Carrier-class network manage.
- Standardization activities

Opt. IF
User

Megabyte-frame switching
- Megabyte buffering
- MAC protocol

Multi-gigabit streaming
- Dynamic multi-lane trans.

Figure 2 – Historical development of Ethernet speeds
Dynamic Light Path Experiment over JGN II

World first experiment to transfer non-compressed 4K digital cinema contents over GMPLS controlled dynamic end-to-end optical path networks

18
Ubila Akihabara Ubiquitous Network Test Room

- ユビキタスネットワーク技術の実証実験空間
- ユビキタスコラムシステム

可動式の中空柱の設置場所を変更することで、空間を自由にレイアウト可能
センサやアクチュエータの装着や各種ケーブルの配線が容易に可能

所在地: 東京都千代田区外神田1-18
秋葉原ダイビル13F

問い合わせ先: 東京大学 森川研究室
電話: 04-7136-3897
メール: akihabara@mlab.k.u-tokyo.ac.jp

一般公開: 2006年08月29日に開催。今後も月1回のペースで開催予定

Copyright © Morikawa Laboratory / Ubila Project / Interior Design: Hiroshi Shoji Architect & Associates / Photo: Mas
Context-aware service

Applications of Sensor Data

Sensor Array

Pre-process & feature extraction

Accelerometer sensor

Clustering
Overlay Network

• Role of overlay
  – Testbed for distributed applications (general view)
  – Testbed for new architecture (general view)
  – “Infrastructure” enabling highly flexible service composition and on-demand setup of virtual networks in accordance with users’ needs

• Key technologies
  – Control plane integrating underlay and overlay
  – Interoperability

• NICT’s activities
  – Core Project
    • JGNII Overlay Testbed
  – PlanetLab Japan
JGN II Overlay Testbed

- 50 PCs
- Multi-home connectivity
  - SINET, APAN, JGNII L3,…
- Future plans
  - Wireless network integration
  - Photonic network integration
Conclusion

• NXGN is now being deployed, standardized, and invested toward the service start in 2007.

• NWGN is in the research phase.
  Various Projects from underlay networking to applications

  MIC is making a new report on a policy for future network research projects which Japanese Government should supports.

  All Japan Forum for future network research will be established soon for global collaboration.
Current Photonic Network R&D supported by NICT

**PHASE I**
- All-optical transport (1996〜2005)
- Photonic node enabling broadband access (2000〜2005)
- Optical burst switching network (2001〜2005)
- Control plane for terabit-class network (2001〜2005)

**PHASE II**
- Photonic node with multi-granularity switching capability (2005〜2009)
- λ Access (2006〜2010)
- λ Utility (2005〜2009)
- Photonic RAM (2005〜2009)

NICT R & D
Road Map of Photonic Networks

Government Funded Projects

Bandwidth Control Using Photonic Labels

Static Wavelength Operation

Dynamic Control of Wavelength

Optical Burst Switching NW

Optical MPLS NW (Distributed Control)

Optical MPLS Router

Optical Burst Switch

Optical Packet Switching NW

NICT Project

Optical Cross-connect (OXC)

Optical Add/Drop Multiplexer (OADM)

P-to-P WDM Transmission

WDM

Static Wavelength Operation

Several 100Gb/s

>10Tb/s

1T~10Tb/s

Hour

~ Day

Day

Min.

msec

Packet / Burst / Stream

Commercially introduced

2001

2005

2010~
Optical Packet Routing

- Optical Packet Switching with optical label
100Tbps-Class Photonic Node

- Nano-second switching capability for optical burst handling
- Multiple granularity switching node up to waveband for throughput expansion
- Architecture and networking of photonic NW with multiple switching granularity

Architecture and networking of photonic NW with multiple granularity nodes
Optical RAM for all-optical packet switching

Pwr consumption of telecom: 7.4億teraWh, Growth rate : +5%/yr.

Cisco CRS-1
1000 kW
80 shelves

Optoelectric packet router
13 kW
10 shelves

All-optical packet router
3 kW
2 shelves

Figure of Merit

Scheduler
Label Proc. Buffer Switch

Data transparency
Power consumption
Size

Photonic crystal bit memory

Growth rate : +5%/yr.
Integration of Real World and Virtual World

Ubiquitous Society will be established on the integrated world.
e - Coaching

Ex.

Cold weather:
  Let’s warm up for 10 minutes
Low pulse rate:
  Try harder, bring your pace up
Walking form:
  Watch your motion, keep it steady
2K vs 4K

K : 1K=1024 Pixel
2K=2048
4K=4096

30 frames/s Interlace

【テレビの画素数】
テレビ
=720×483
テレビ（ハイビジョン放送）
=1920×1080

24 frames/s Progressive

【デジタルシネマの画素数】
=2048×1080（2K）
=4096×2160（4K）
Structure of the 4K Pure Cinema Trial

Source: NTT
“4K Pure Cinema” Prototype In-Theater System

In the projection room of VIRGIN TOHO CINEMAS

4K Projector

Secure Media Box (SMB)

Theater Control Box (TCB)

Corpse Bride
Harry Potter 4 V for Vendetta
DaVinci Code
Poseiden
Mission Impossible 3
+ Tokyo Film Festival
Batman Begins Stealth

Source: NTT
World first experiment:
Switch of non-compressed 4K image contents over wavelength paths

- IP streaming image from Keio Univ.
  - 4K Camera (30fps) shooting

- IP Streaming image from NTT R&D Center
  - 4K digital cinema contents (24fps)

JGN2 Symposium in Sendai, January 2006
OptIPuter 100 MegaPixel Displays

55-Panel Display
100 Megapixels

30 x 10GE interfaces
1/3 Tera bit/sec

Driven by 30 unit Cluster of 64 bit Dual Opterons

60 TB Disk

Linked to OptIPuter

Working with NASA ARC Hyperwall Team to Unify Software

Source: Jason Leigh, Tom DeFanti, EVL@UIC
World First 4K Digital Cinema Prototype System

Vertical scan lines  2000 Lines
Horizontal pixels  4000 Pixels (4K)

Developed in 2001

Source: NTT Labs.
Distant lecture showing the Gutenberg Bible with the 4K digital camera

iGrid2005 held on September 26, 2005
Combined 4K image of a car-race game using 4 PS3 game machines
Network Structure of a car-race game with 4 PS3
GLIF: Global Lambda Integrated Facility