Toward the Internet 2.0

Hiroshi Esaki, Ph.D.

Professor, The University of Tokyo

Vice President, JPNIC(Japan Network Information Center)

Executive Director, IPv6 Promotion Council of Japan

Board member, WIDE Project

Board of Trustee, ISOC

Important activities by ISOC

- "IPv6 is critical issue" to resolve, i.e., deployment of IPv6 is very important

  http://www.isoc-ny.o

  as OECD and IGF(Inte

  Governance Forum) t

2. Officially Identify as t

   major strategic initiat

   "Trust and Identifier

   Resolution on Decembe

IPv6 deployment
&
IPv4 Address Depletion

Japanese MIC formed study group

- Mission: "How to achieve smooth IPv6 introduction"
- Some interesting discussion and analysis
  - There is no free lunch ! All must pay money on IPv6.
  - Squeezing out the global IPv4 address from existing network looks so hard…. JPNIC had got less than 2% of address space…..
  - IPv4 address exchanging market may generate the company accounting issue, since IPv4 address may become as an asset.
  - Broadband Internet consumes a lot of global IP(v4) addresses
  - RIPE is large IPv4 address consumption as well as BRICs area

Japanese MIC formed study group

- Mission: "How to achieve smooth IPv6 introduction"
-

2. **The largest sacrifice is business/service deployment for "new" companies and for "legacy" companies**

4. **Contents provider and system integrator should/must join, see the Google's IPv6 site**

RIPE is large IPv4 address consumption as well as BRICs area

Japanese MIC formed study group

- Mission: "How to achieve smooth IPv6
-

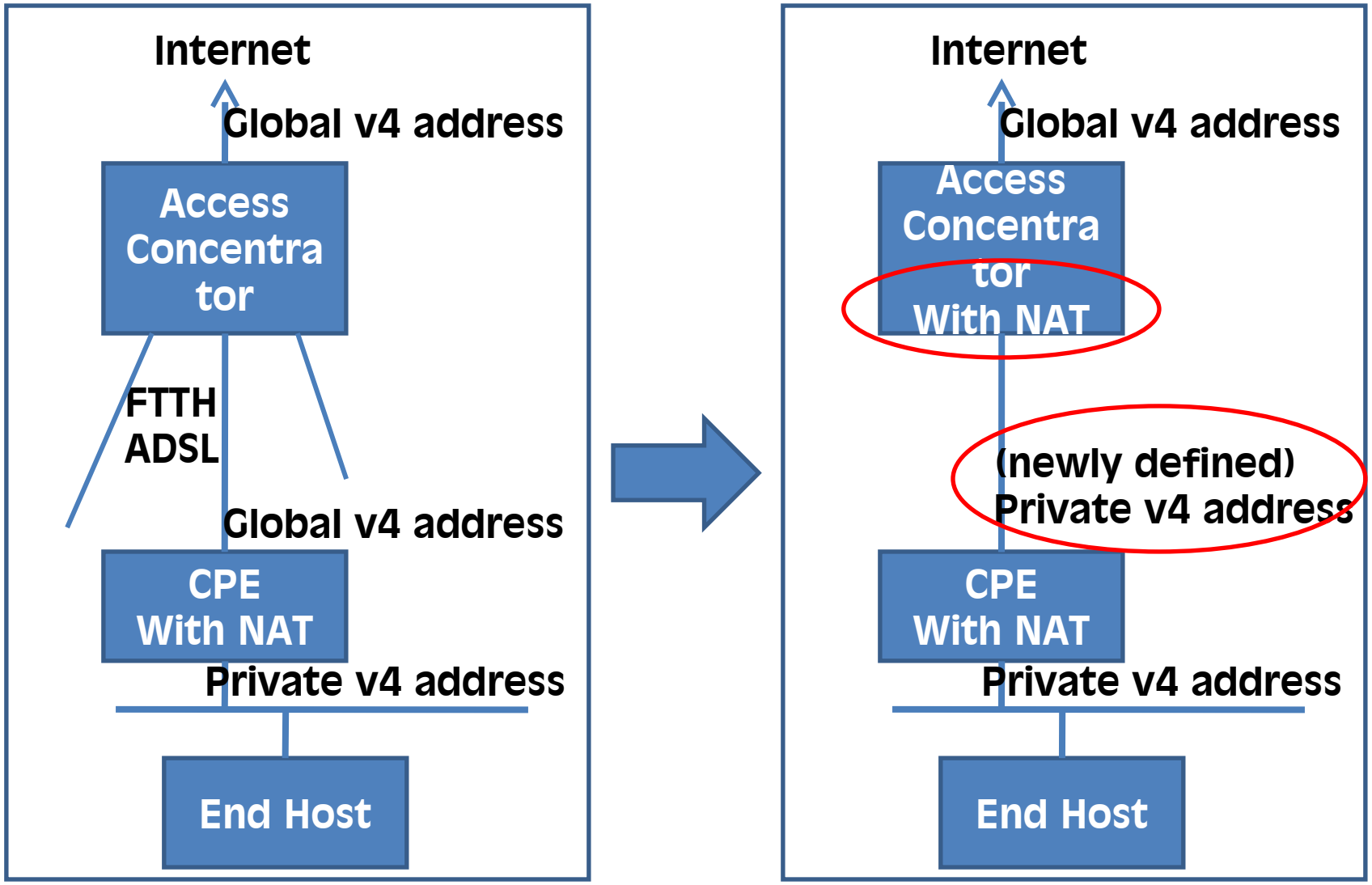
1. We may need carrier-class NAT boxes in the network.
   But, serious technical issue will occur, regarding the number of TCP sessions……

RIPE is large IPv4 address consumption as well as BRICs area

NTT Communications

Shin Miyakawa, Ph.D

Introduction of "Carrier-Grade NAT"



However……

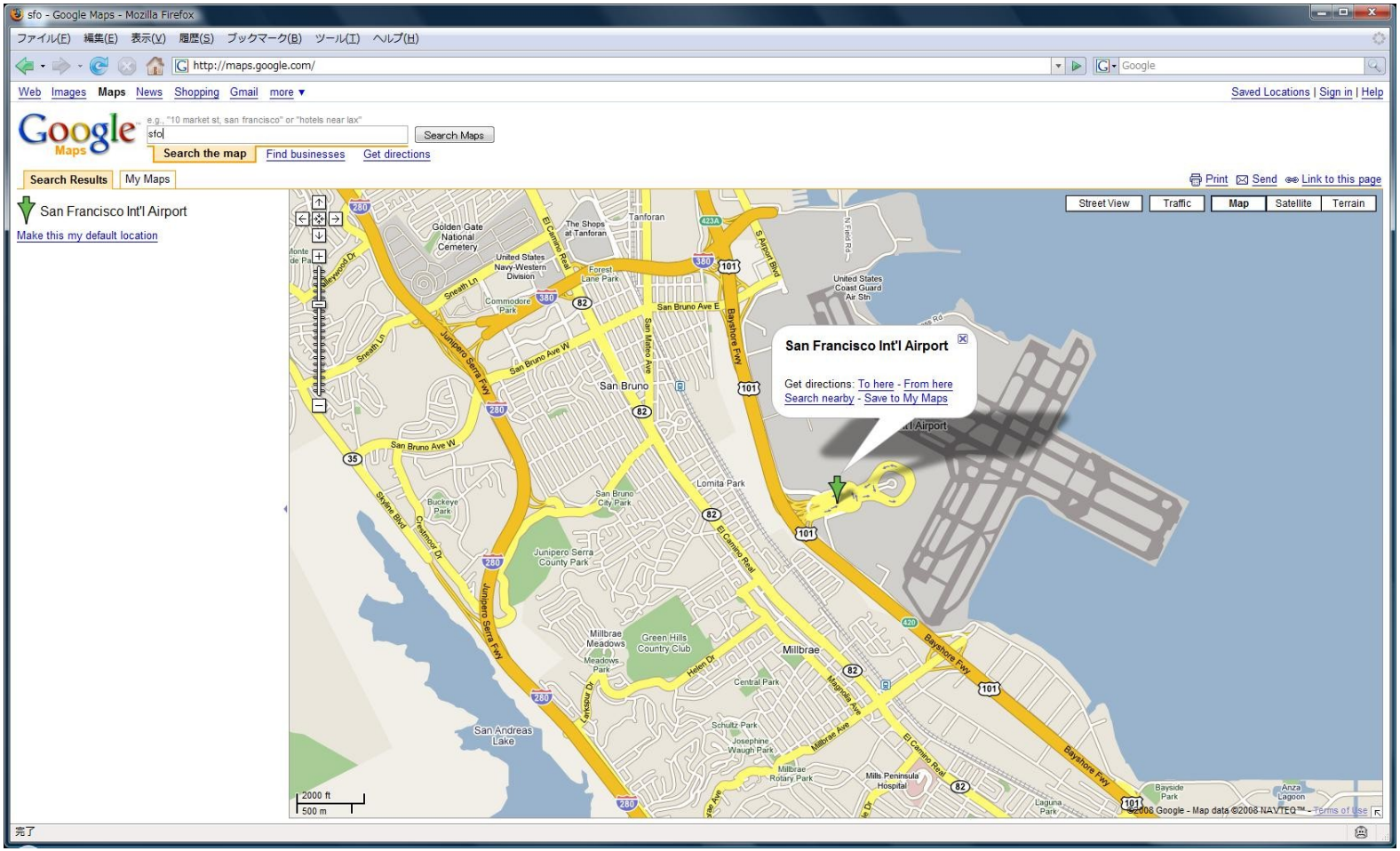
- Limitation on the number of session states for NAT operation
- Each user could use certain number of sessions
  - How many sessions ?
  - Even as the best case, 65,536 is the maximum number of sessions, shared by customers accommodated into a single IPv4 address

    ➔ When the number of users is 2,000, it will be only 30 sessions

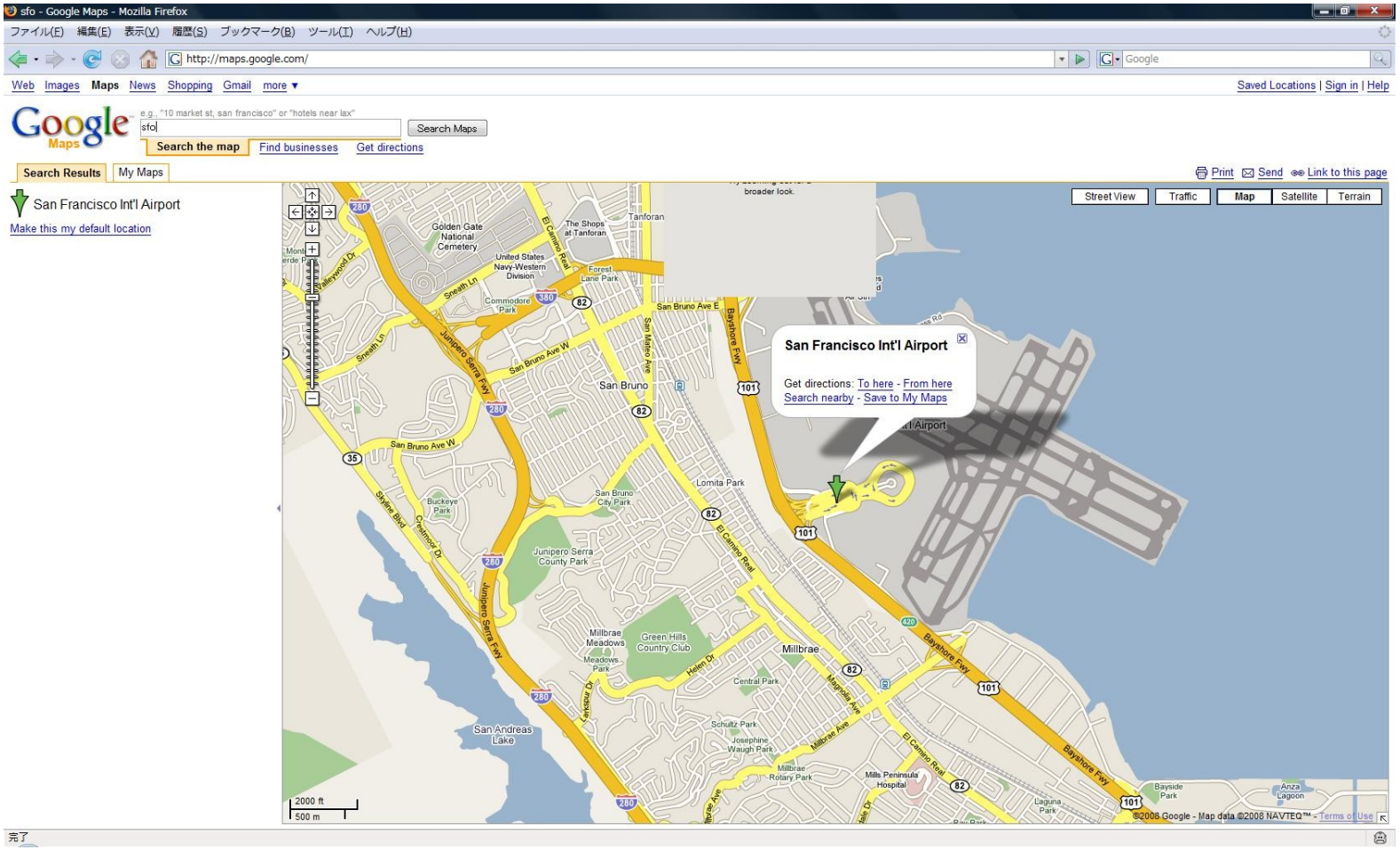
➔ This means……..

Limitation of NAT Solution

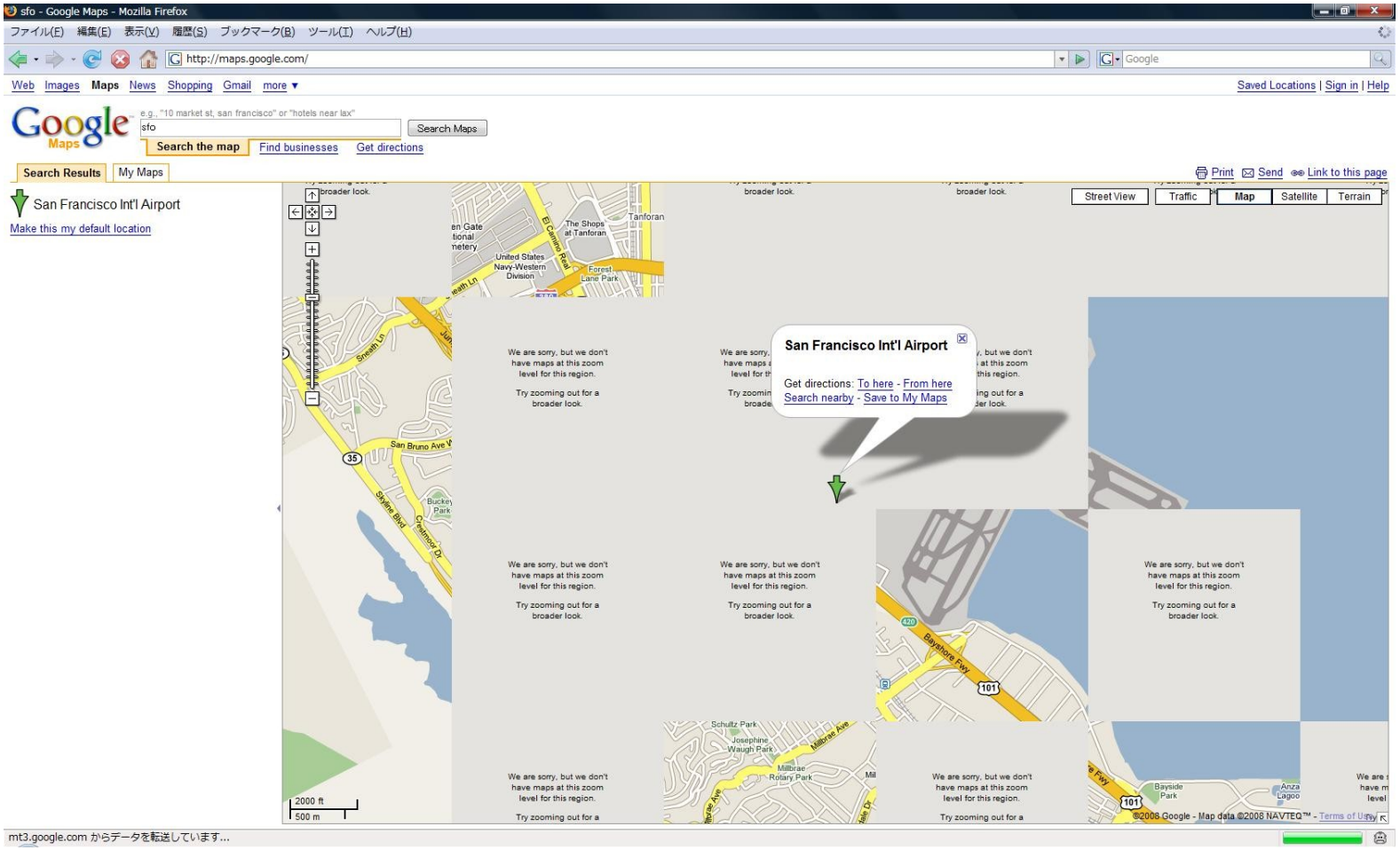
Max 30 Connections



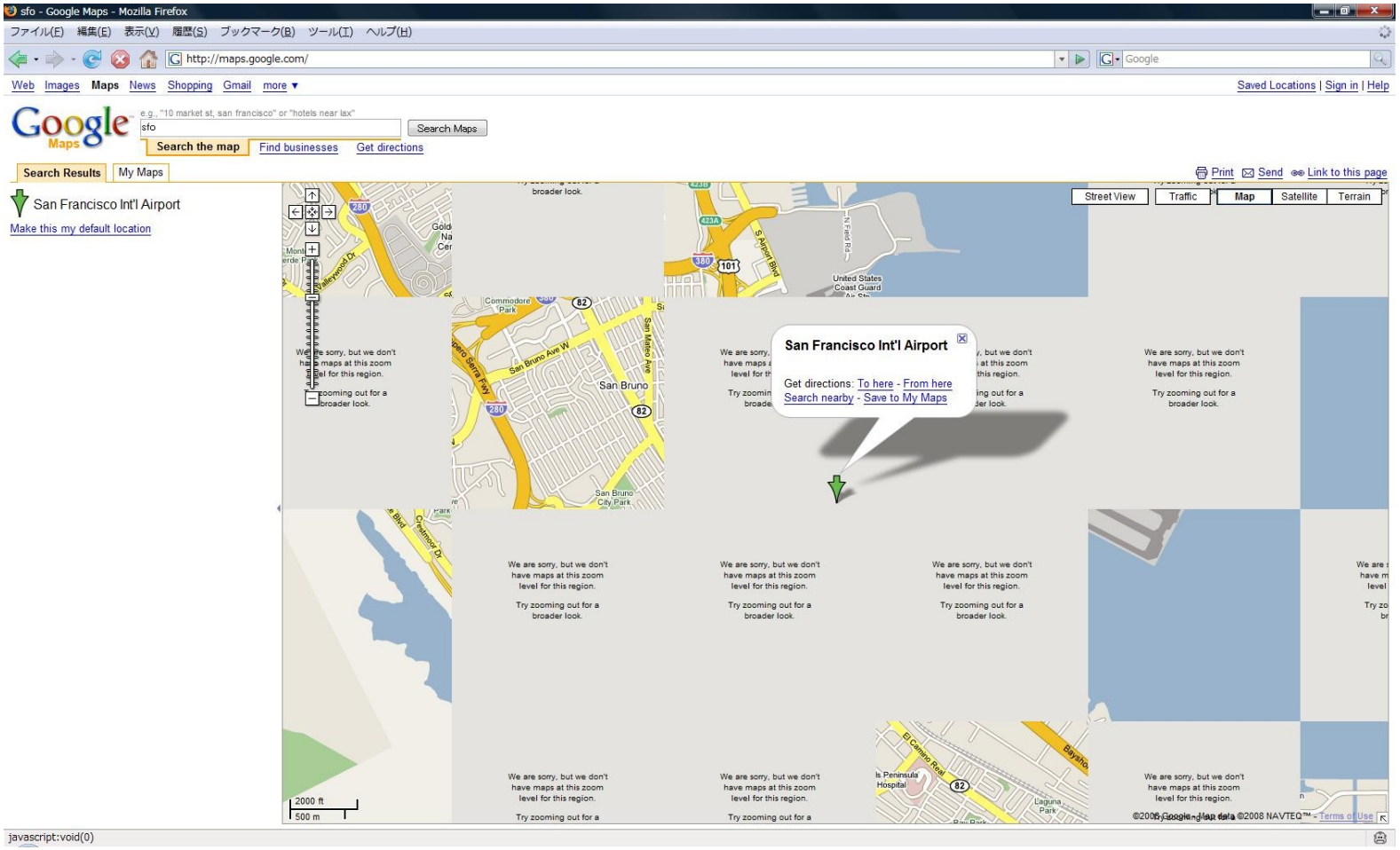
Max 20 Connections



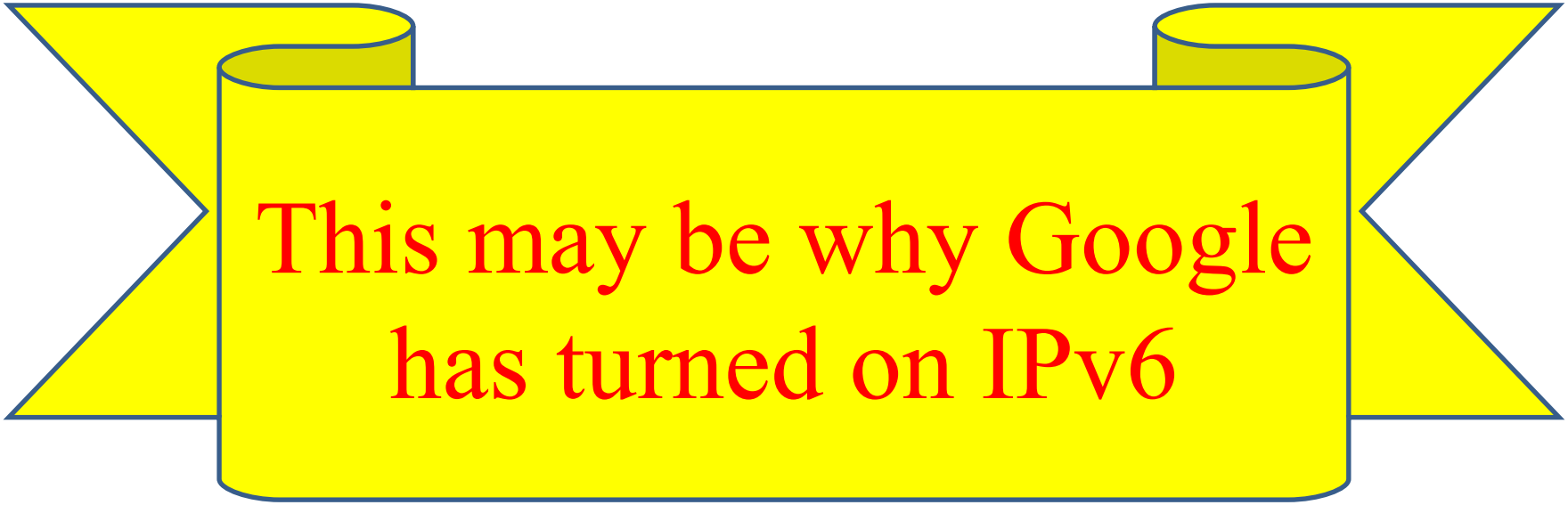
Max 15 Connections



Max 10 Connections



Max 5 Connections


This may be why Google
has turned on IPv6

Some examples of major Web site

Application	# of TCP sessions
No operation	5 ～ 10
Yahoo top page	10 ～ 20
Google image search	30 ～ 60
ニコニコ動画	50 ～ 80
OCN　photo friend	170 ～ 200+
iTunes	230 ～ 270
iGoogle	80 ～ 100
楽天 (Rakuten)	50 ～ 60
Amazon	90
HMV	100
YouTube	90

Task Force coming up with IPv4 Depletion

Kicked off on September 2008

http://kokatsu.jp/index.html

Founding Organizations

- IPv6普及・高度化推進協議会（IPv6 Promotion Council）
- 財団法人インターネット協会 (IAJapan)
- 次世代IX研究会 (DISTIX)
- 情報通信ネットワーク産業協会 (CIAJ)
- 社団法人テレコムサービス協会（テレサ協）
- 社団法人電気通信事業者協会 (TCA)
- 財団法人電気通信端末機器審査協会 (JATE)
- 社団法人日本インターネットプロバイダー協会 (JAIPA)
- 社団法人日本ケーブルテレビ連盟 (JTCA)
- 社団法人日本ネットワークインフォメーションセンター (JPNIC)
- 日本ネットワーク・オペレーターズ・グループ (JANOG)
- 日本 UNIX ユーザ会 (JUS)

IPv4 EXHAUSTION

Two important messages;

1. **Even if you have large IPv4 addresses, you must be suffered**

2. **There are a lot of IPv6 Ready equipments, thanks VISTA (and Windows7) and Mac OS X**

Premise and Our Missic..

- "Migration to IPv6" is not our primary mission.
  But, "Correspondence against the IPv4 address depletion is our mission".
- Premise ;
  - ✓In about 2 or 3 years, you will experience the difficulty to obtain the global IPv4 address.
    - ➢The most suffering player and area is for the introduction of new business and for the expansion of business.
  - ✓All the stakeholder will be suffered.
    - ➢We need the collaboration and harmonization among stakeholders.

Recognized Stakeholders

- System Owner (Public and Private Sector)
- System Integrator
- Hosting, ASP
- System Operator (out-source, self-operation)
- Network Provider
- ICT Equipment Vendor
- ICT Software developer/vendor
- End-User, e.g., residential customer
- Corporate user
- Analyst, investigator
- Educational Organization (e.g., university)

How you should implicate

- As a Business Opportunity
  - Innovation, revolution and creation of businesses regarding the system and network industry.
- As a Risk Management
  - Preferential treatment for the existing operators will be hard
  - Even existing operators (i.e., ISP, ASP) will experience the difficulties
  - Expectation to “IPv4 address trading market” would be of risk.
  - System, network and service security

Message to ISP

- In order to provide the network connectivity for IPv6 only servers, ISP must carry IPv6 packets
- Carrier-Grade NAT is just transitional solution.
- The system development/deployment against IPv4 address depletion is against the business risk.
- The cost for system development may be ought to be considered as a risk management..

Message to iDC, ASP, CSP

- Server operators will be suffered, first, since the server node needs global (IPv4) address.
- At least, after the IPv4 address pool depletion, the IDC that have available global IPv4 address would have better business superiority than the IDC that does not have.
- Many IDC companies and operators may not have correct technical understanding, and may anticipate the

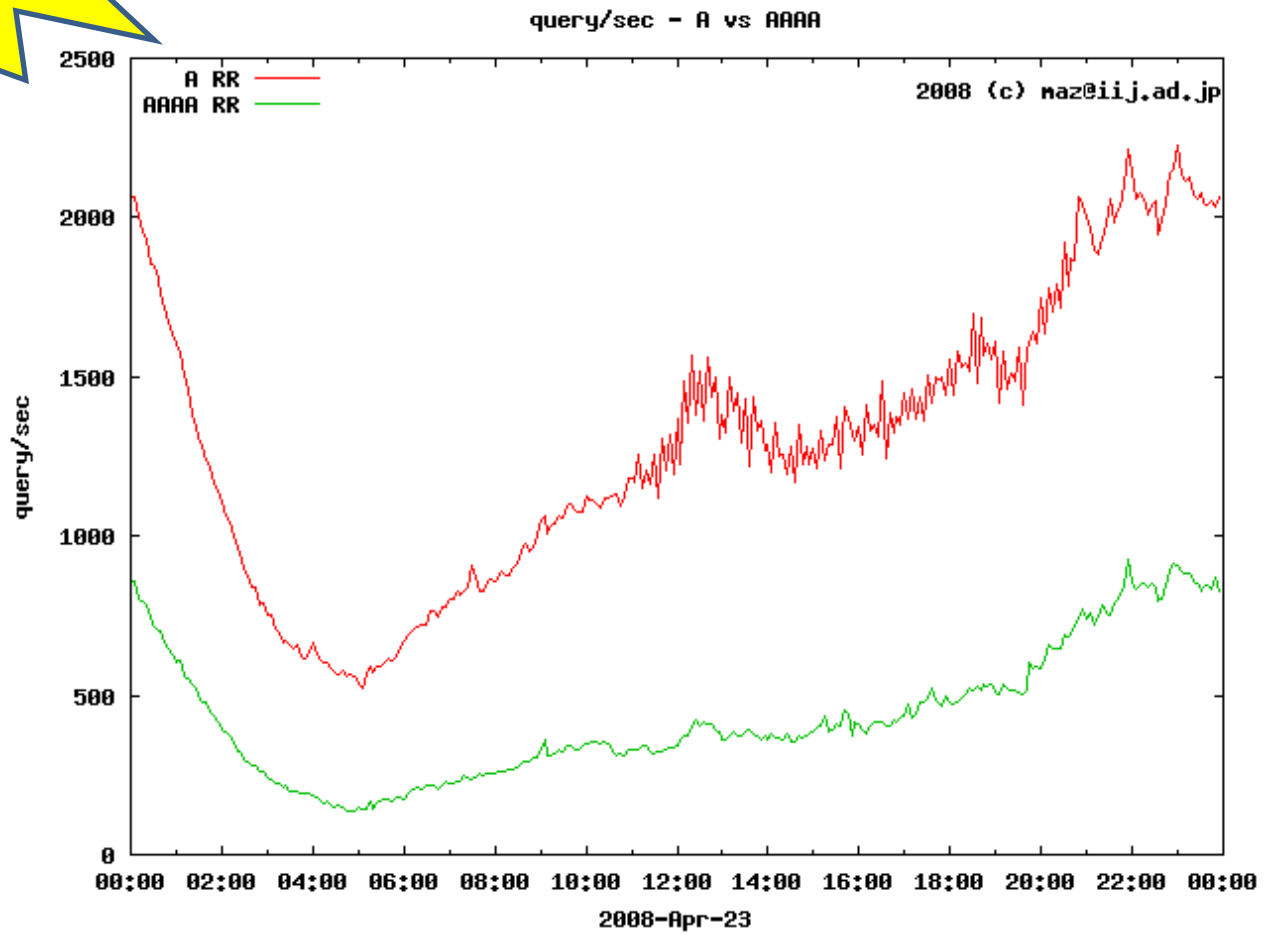
Action Items by the Task Force

- List up the issues to solve by each player
- Information sharing among related organizations
- Establish the Q&A center
- Design and operation of testbed
- Design and operation of education package
- Issues and it's solution of security during the transition process

Linier scale, not log-scale

Source; Mr,Y.Matsuzaki of IIJ

A vs AAAA



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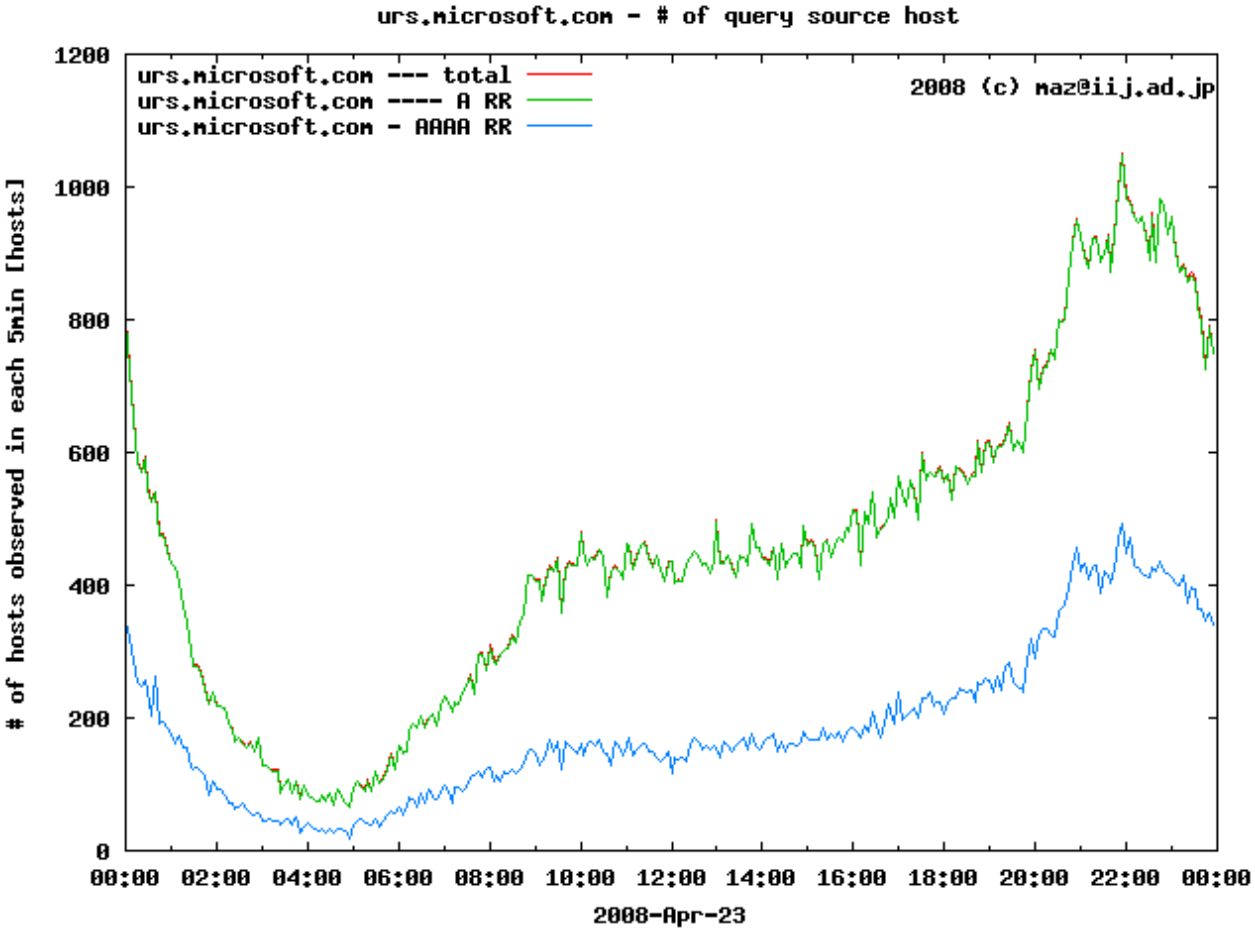
Source; Mr.Y.Matsuzaki of IIJ

Number of source node for Oueries



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IPv6 Glue on the Root

- A/F/H/J/K/M have add AAAA record
- February 04, 2008.
  - A.ROOT-SERVERS.NET. 2001:503:ba3e::2:30
  - F.ROOT-SERVERS.NET. 2001:500:2f::f
  - H.ROOT-SERVERS.NET. 2001:500:1::803f:235
  - J.ROOT-SERVERS.NET. 2001:503:c27::2:30
  - K.ROOT-SERVERS.NET. 2001:7fd::1

R&D on Future Internet, i.e., Internet 2.0

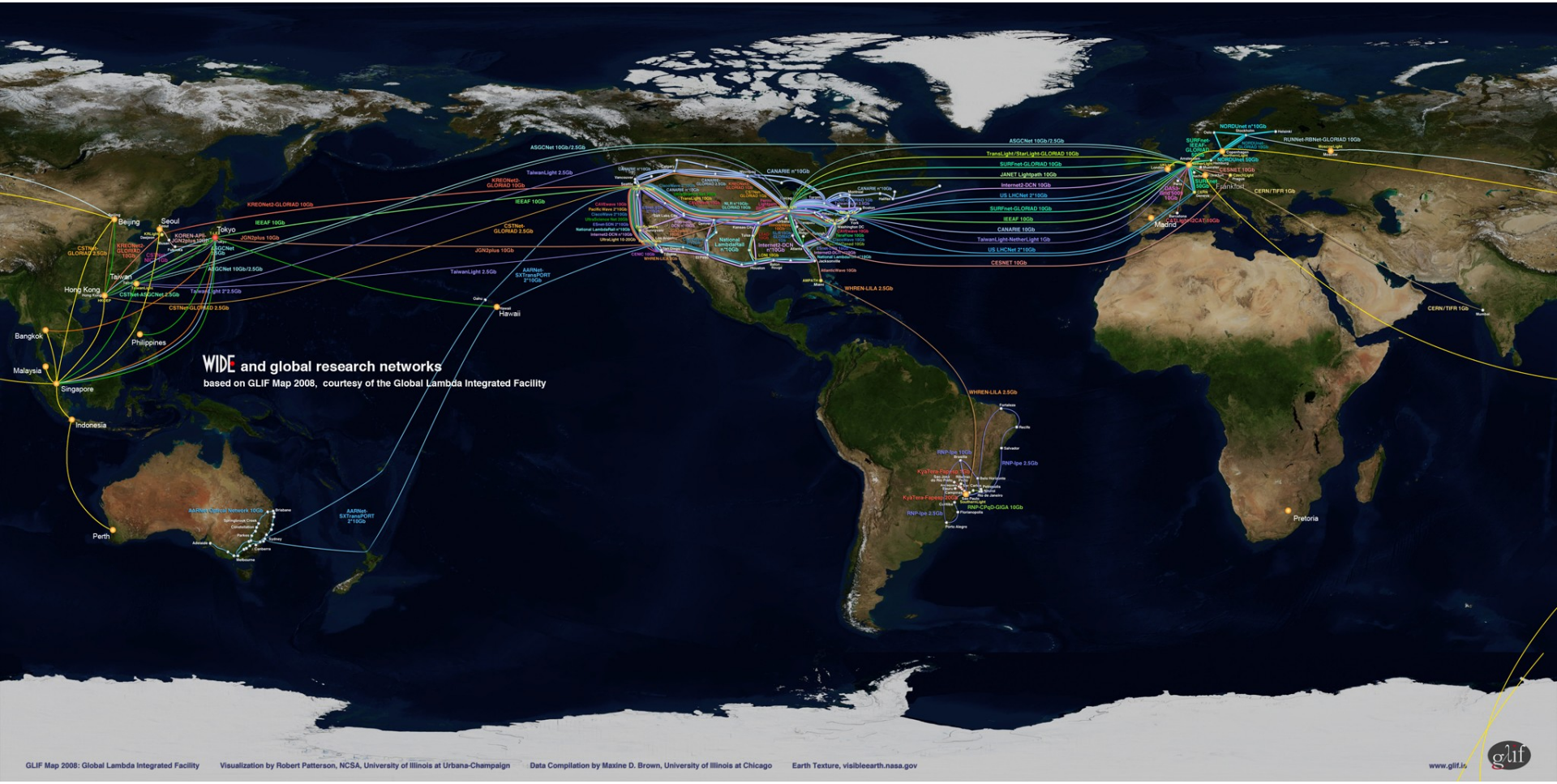
How does the future Internet look like ?
&
What is going on the current Internet ?

Internet and ICT have change the world

- some legacy and old conventional wisdoms -

1. User and end-station is poor and stupid
2. Users' terminal only turns on, when it's needed
3. Fixed terminal is far major and superior than mobile nodes
4. Link is bi-directional and stable
5. "Service" must be provided either by provider or by enterprise.
6. Cost of transmission, store and copy, is

Global Lambda Integrated Facility
GLIF World Map – 2005

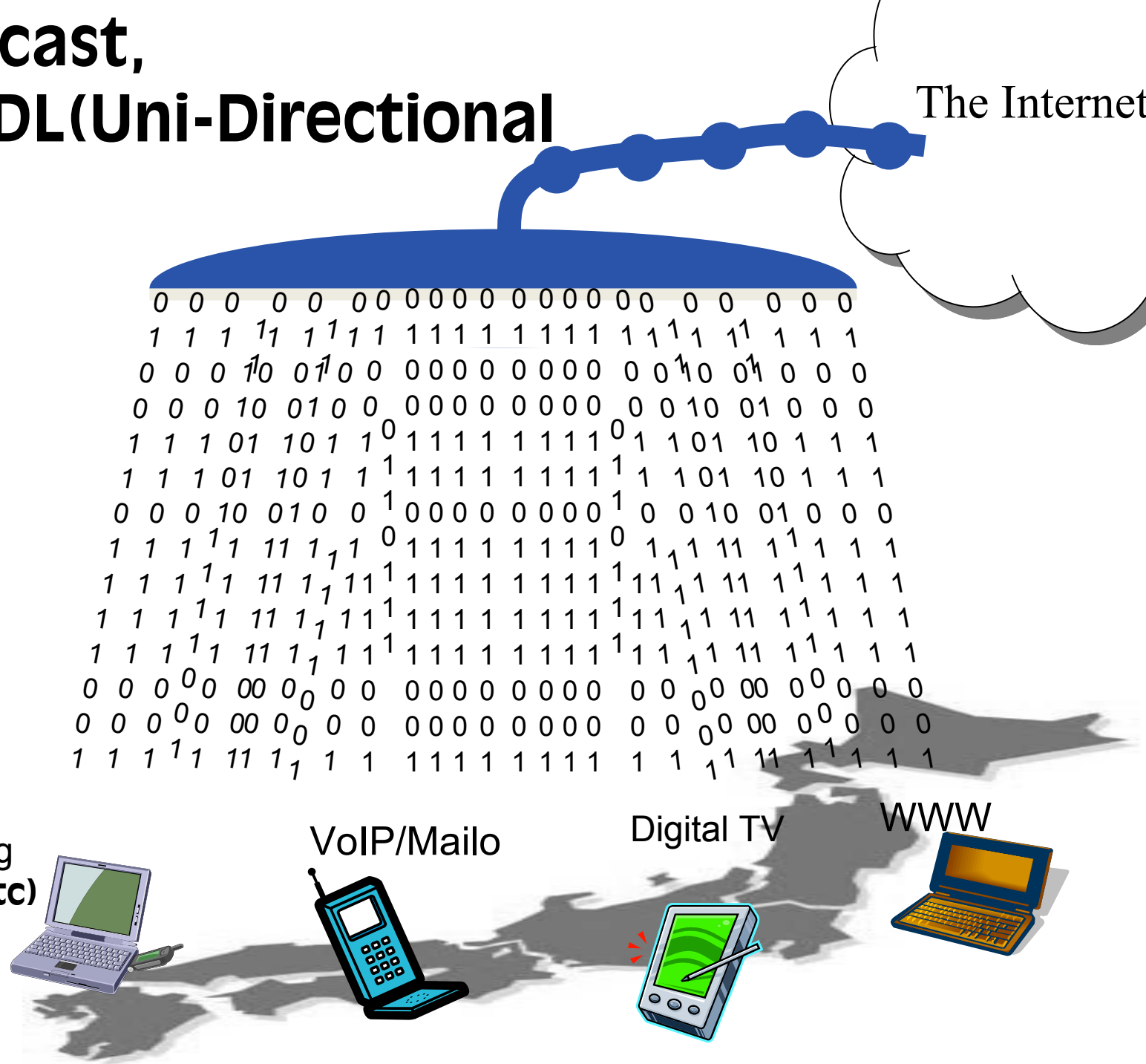


www.glif.is

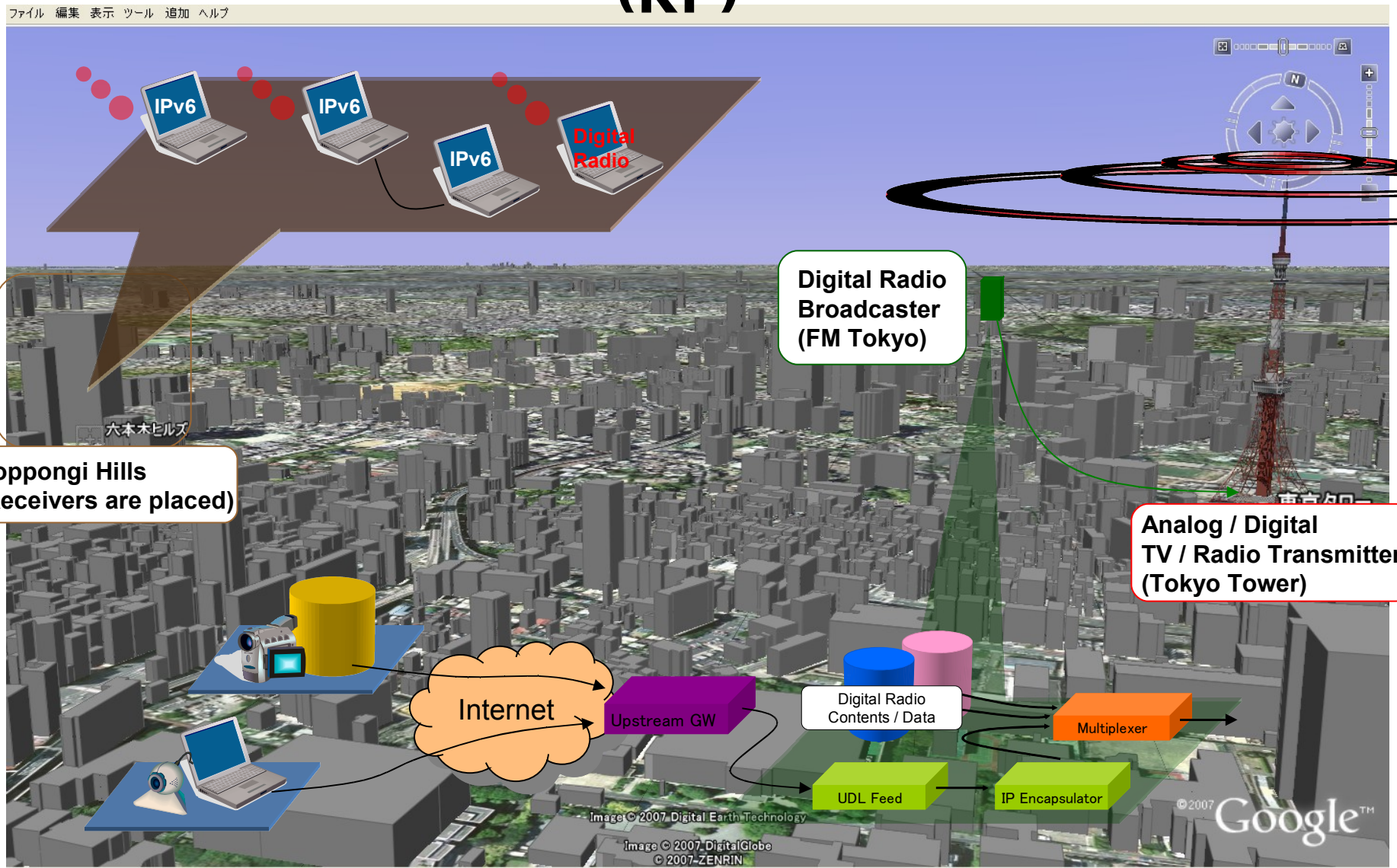
Visualization by
Bob Patterson, NCSA.

GLIF Participants

Broadcast, aka UDL(Uni-Directional Link)



Experiment to Transmit IPv6 Multicast over “Digital Radio (RF)”

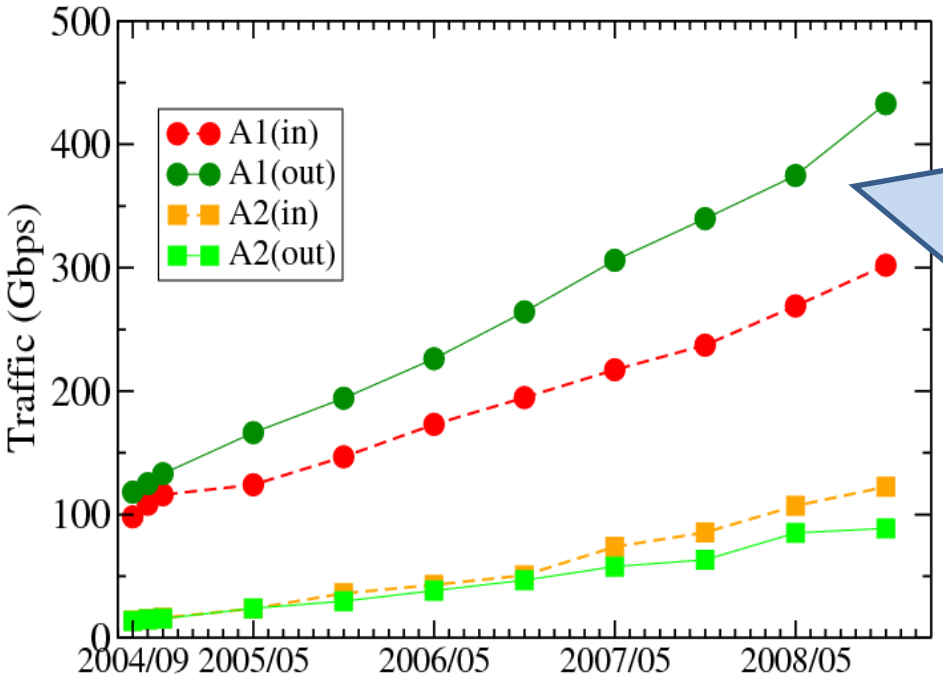


Traffic measurement and analysis of Japanese commercial ISP Traffic

(*) Seven major ISPes in Japan has been

collaborated with us, i.e., OCN, KDDI,

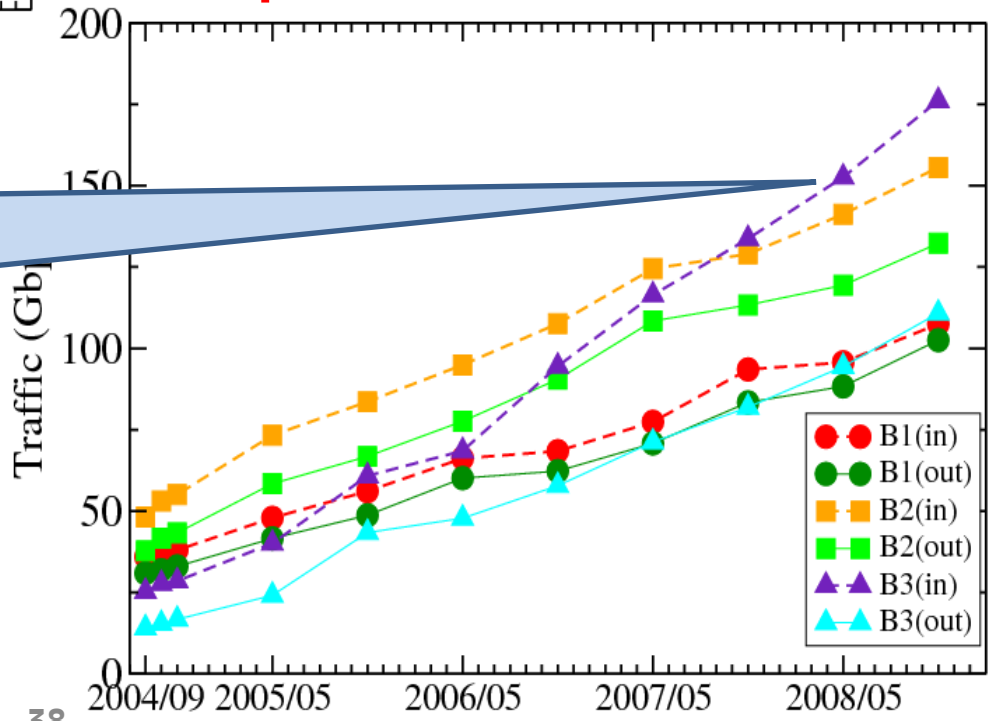
Yahoo BB!, K-Opticom, Softbank



Total residential customer traffic

- Large contribution by residential customer traffic, small contribution by corporate networks
- Total traffic volume in Japan (2007)
  Internet → Home : 998.4 Gbps
  Home → Internet : 689.5 Gbps

International Incoming traffic is exception; steep increase

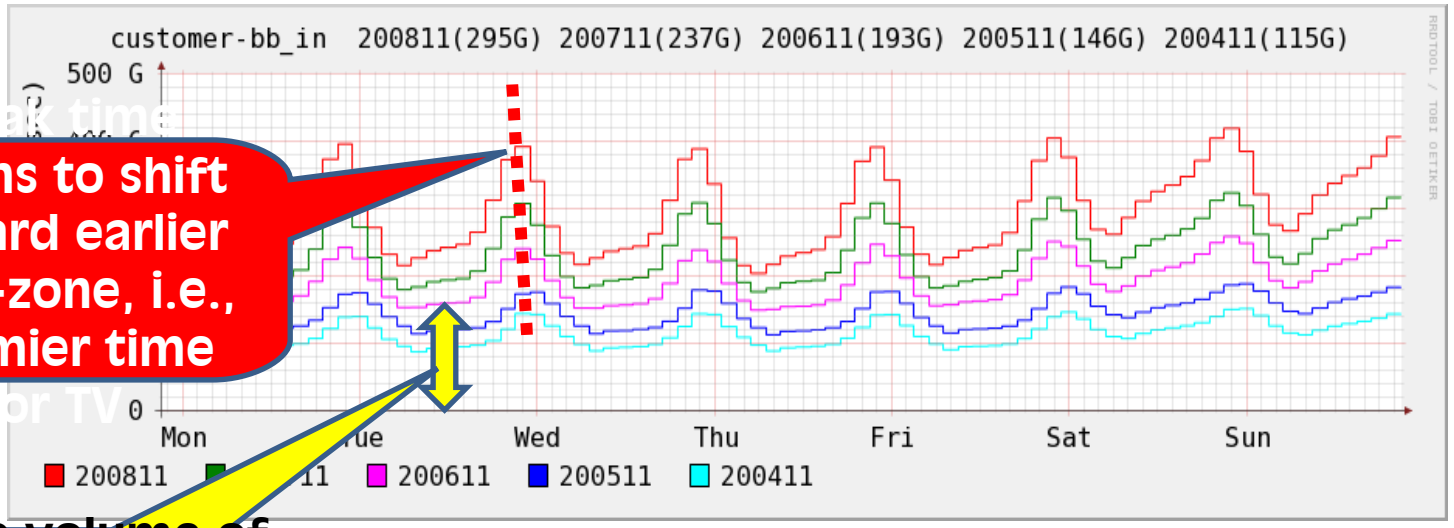


Non-residential customer traffic

[note]
A=Residential customers
A1: Broadband users
A2: Non-Broadband users
B=Non-residential customers
B1: Traffic exchanged through IXes
B2: Traffic exchanged private peerings
B3: Oversea traffic

38

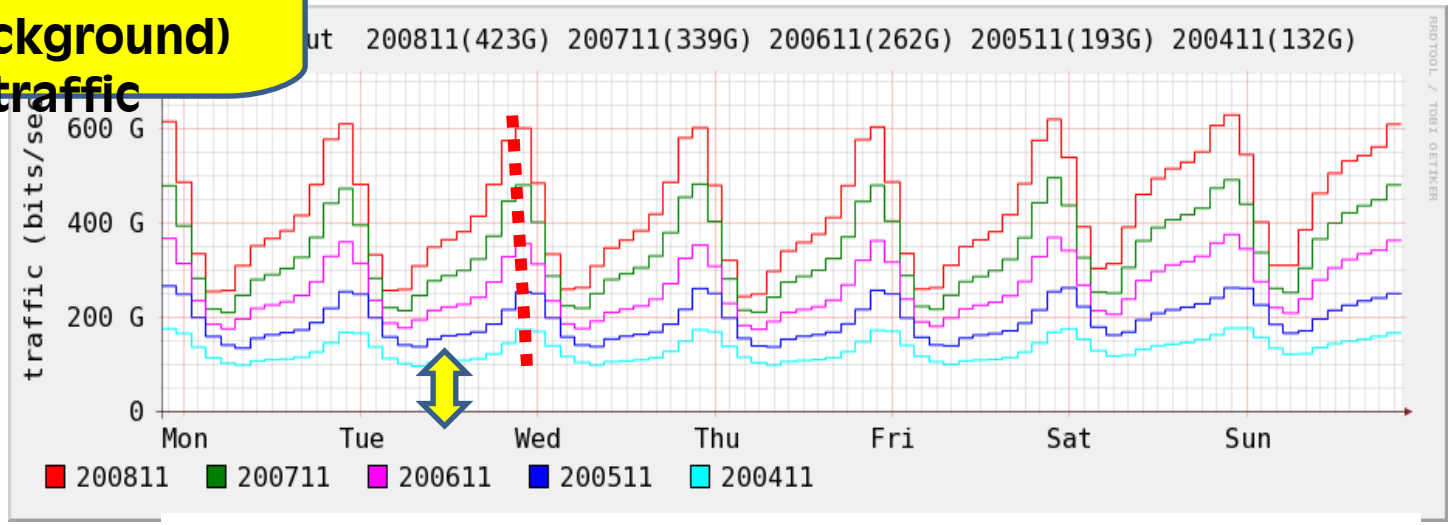
Weekly Broadband customer traffic for three years



seems to shift toward earlier time-zone, i.e., premier time

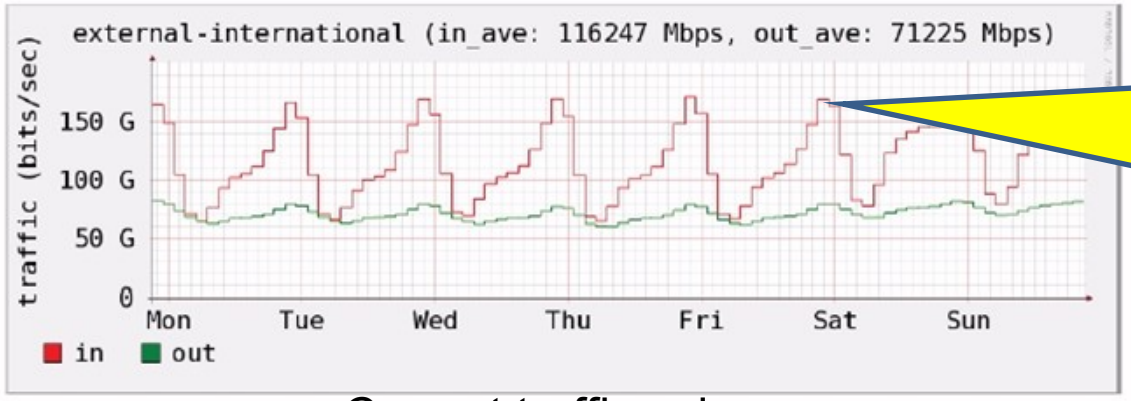
Large volume of ambient (background) traffic

<< Uploading traffic : Customer ➔ Network >>



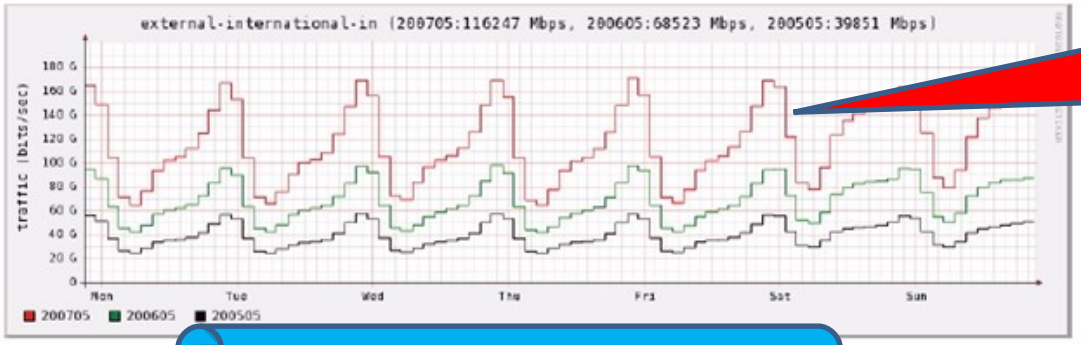
<< Downloading traffic : Network ➔ Customer >>

Weekly International Traffic Volume for three years



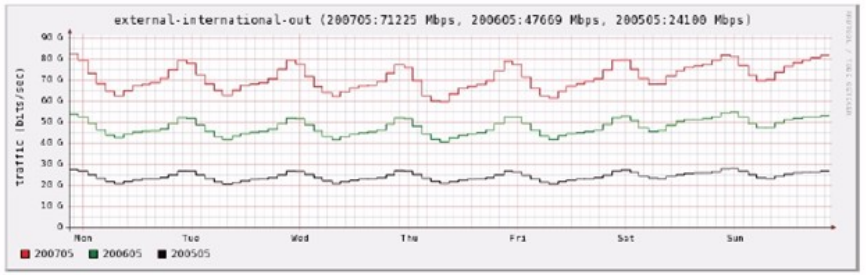
<< Current traffic volume >>

1. **Incoming(import) traffic dominates outgoing(export) traffic**
2. **Large variation in incoming, i.e., interactive traffic**



amplitude increases significantly. Due to interactive

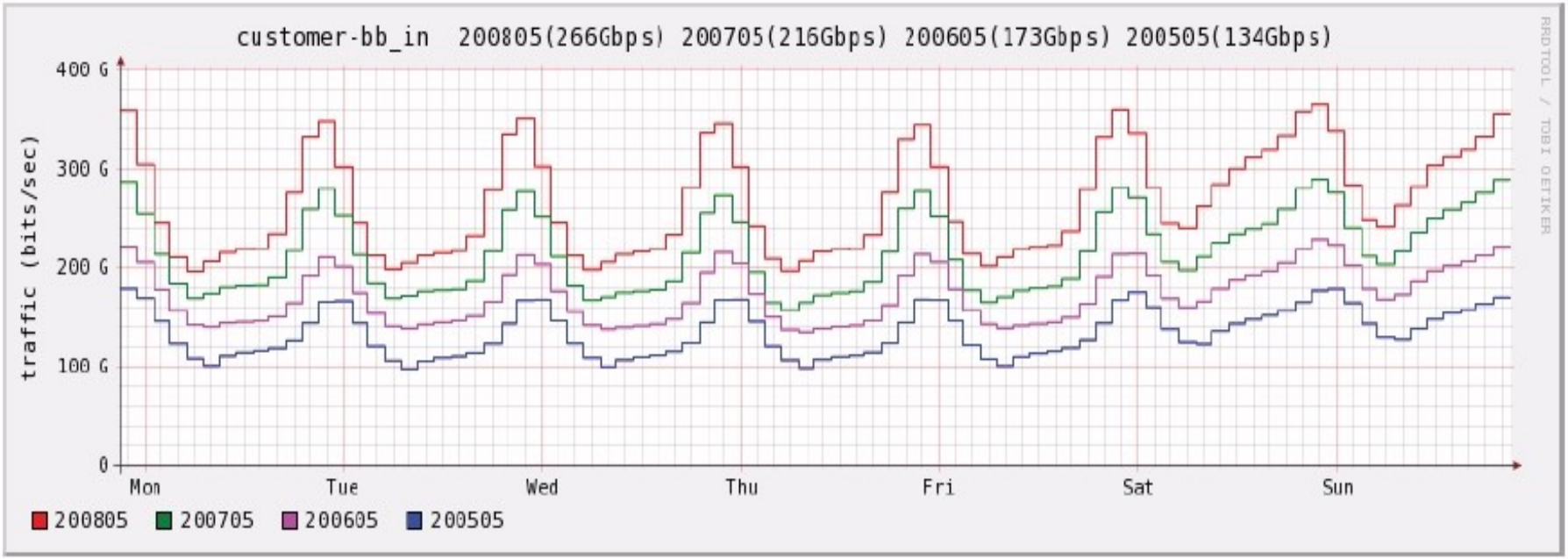
<< In **Mirroring or caching in Japan may improve this situation** rseas



<< Outgoing traffic ; Japan ➔ Overseas >>

Which is a headache for ISP,

P2P or Interactive

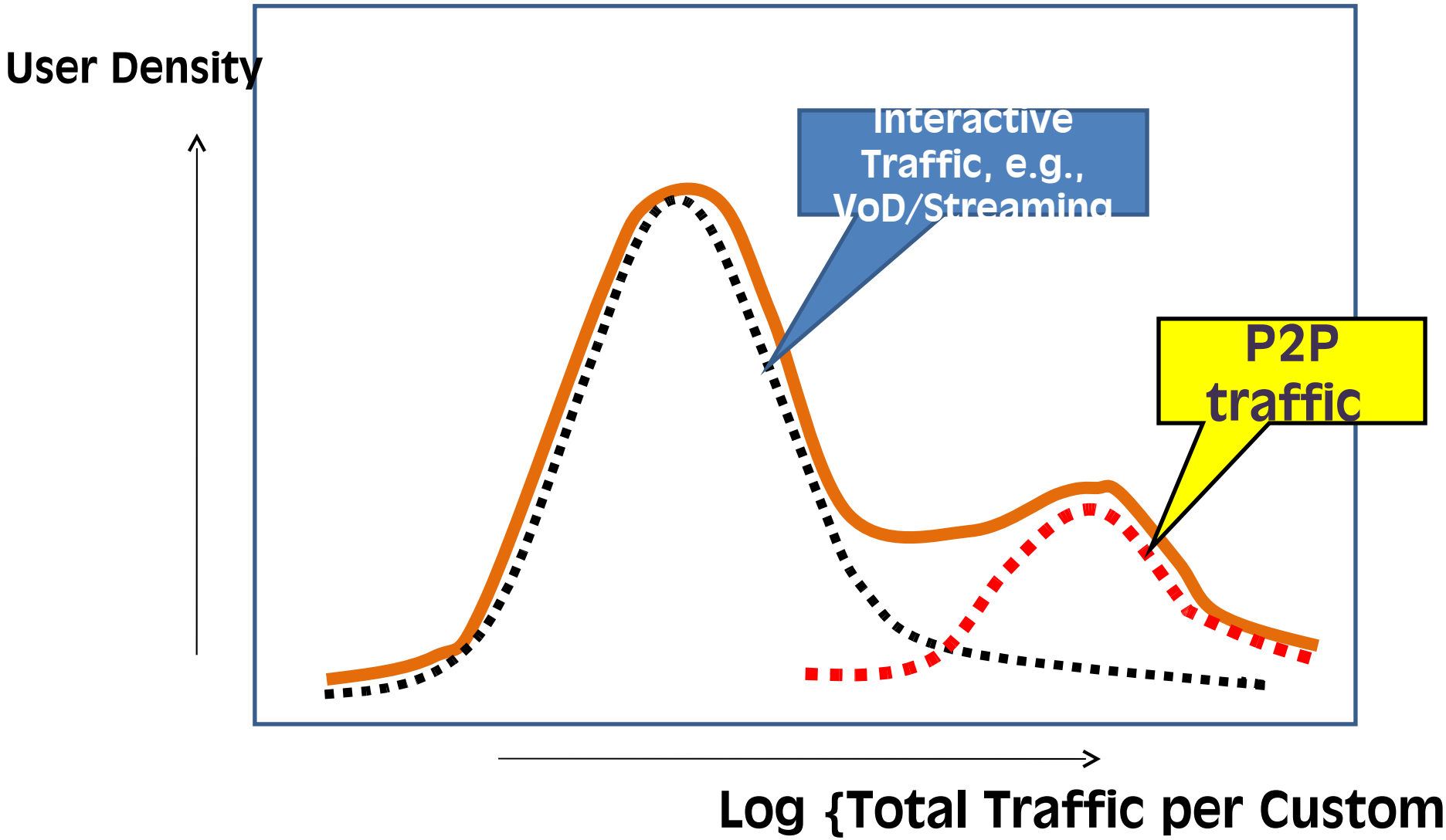


P wave seems to have small amplitude

mplitude of wave by interactive traffic seems to be l

Appeared at CoNEXT2008

User Density versus Total Traffic Volume per Customer



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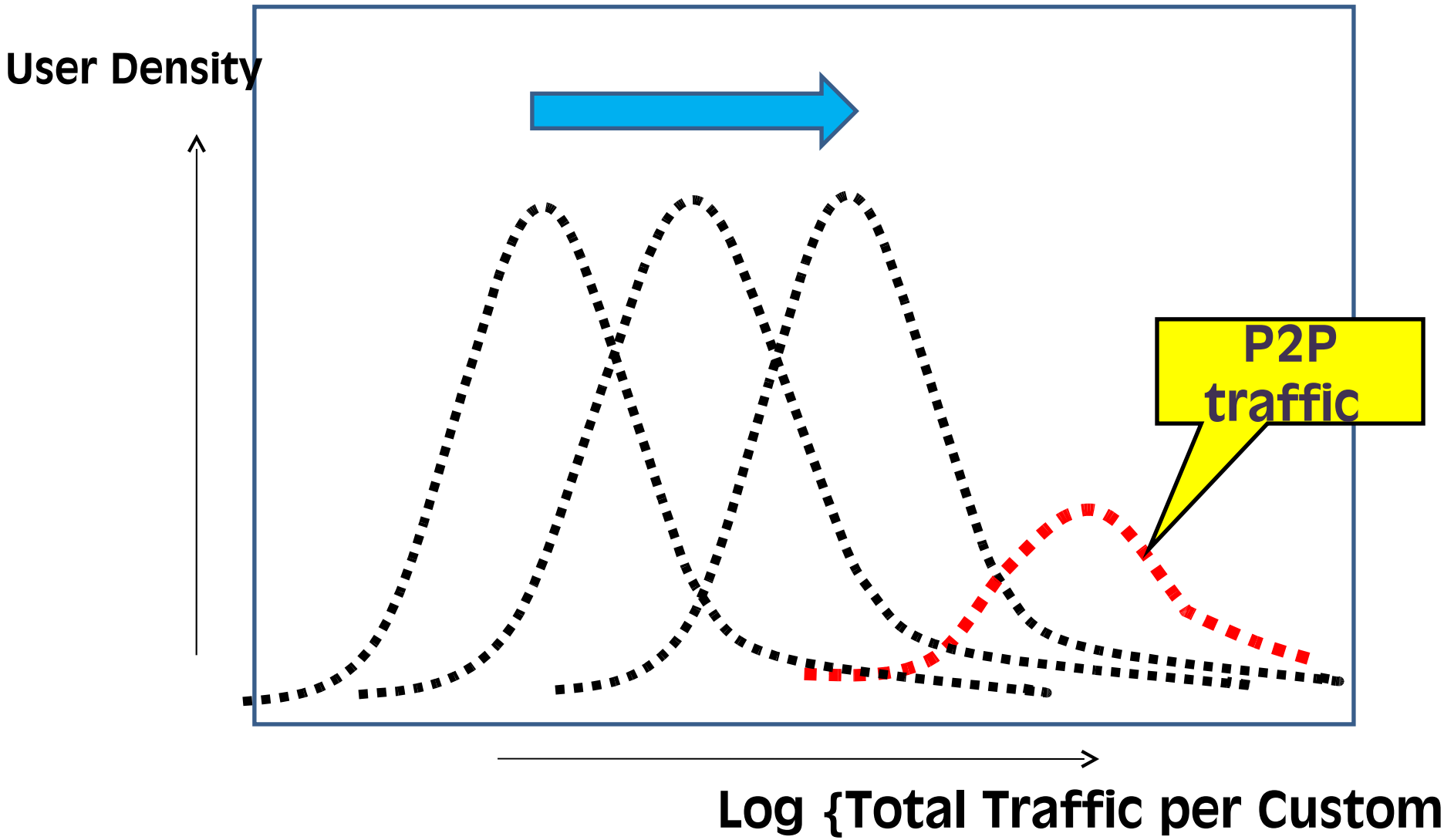


protocols/ports ranking

classify client-type/peer-type with thr

More than 80% of TCP session does not use Well-Known Port

.....

protocol port	2005 total (%)	2005 client type	2005 peer type	2008 total (%)	2008 client type	2008 peer type
TCP *	97.43	94.93	97.66	96.00	95.51	96.06
(< 1024)	*13.99*	*58.93*	*8.66*	*17.98*	*76.16*	*11.35*
80 (http)	9.32	50.78	5.54	14.06	64.96	8.26
554 (rtsp)	0.38	2.44	0.19	1.36	8.21	0.58
443 (https)	0.30	1.45	0.19	0.58	1.63	0.46
20 (ftp-data)	0.93	1.25	0.90	0.24	0.17	0.25
(>= 1024)	*83.44*	*36.00*	*89.00*	*78.02*	*19.35*	*84.71*
6346 (gnutella)	0.92	0.84	0.93	0.94	0.67	0.97
GRE	0.07	0.12	0.06	0.09	0.08	0.09
ICMP	0.01	0.05	0.01	0.02	0.05	0.02

Yet, another important fact is; large number of TCP /UDP connections are established by every single end-station

Internet and ICT have change the world

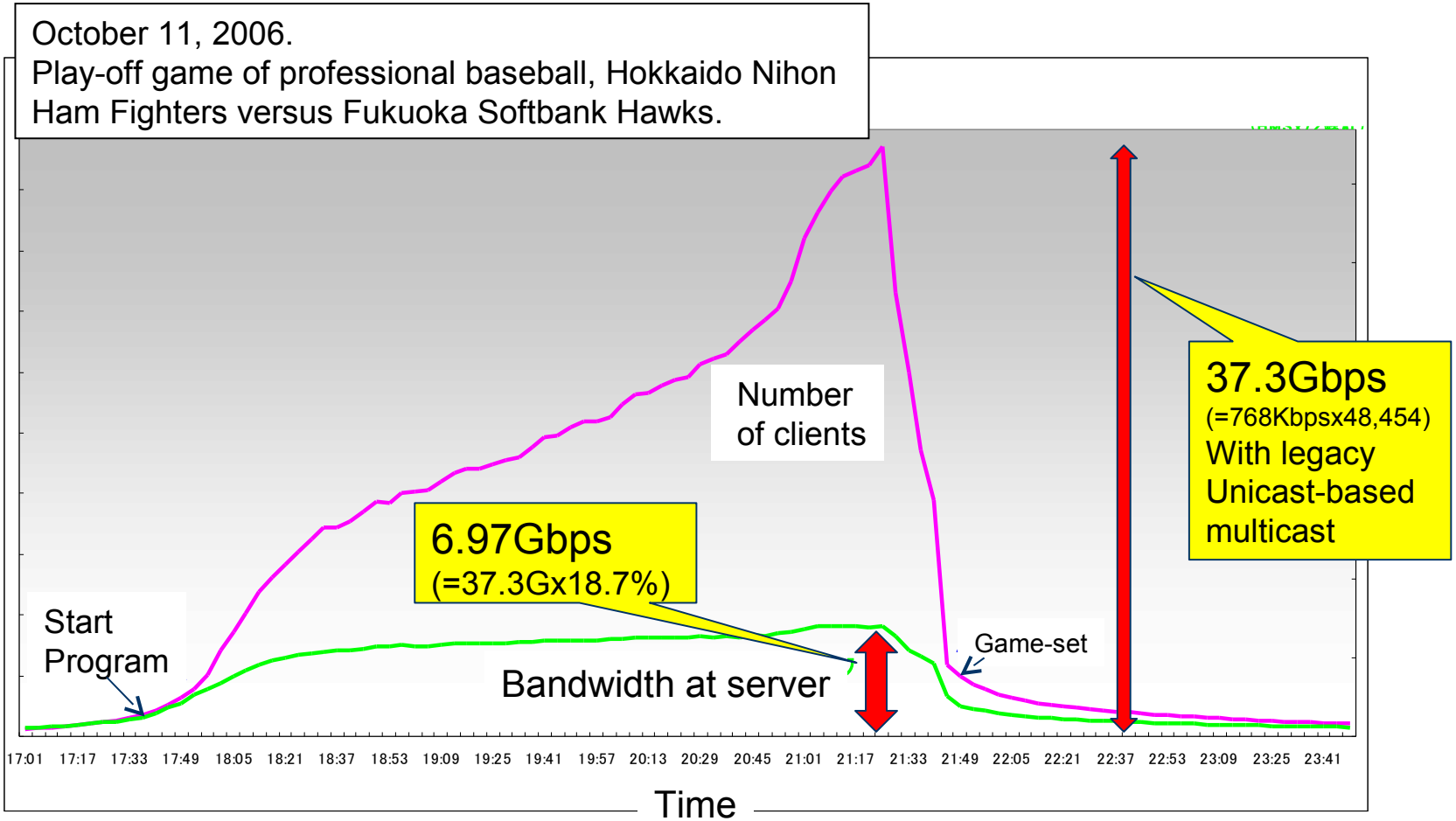
- some legacy and old conventional wisdoms -

- User and end-station is poor and stupid
- Users' terminal only turns on, when it's needed
- Fixed terminal is far major and superior than mobile nodes
- "Service" must be provided either by provider or by enterprise.
- Cost of transmission, store and copy, is

Unawared technical evolution ?

- Two of drastic cost down in ICT
  - Copying
  - Recording and saving

- However, logistics of information may not be aware of this evolution…
  …
  - Have BitTorrent or Joost been awared ?
  - BB-TV! by SoftBank YBB has operated, silently…

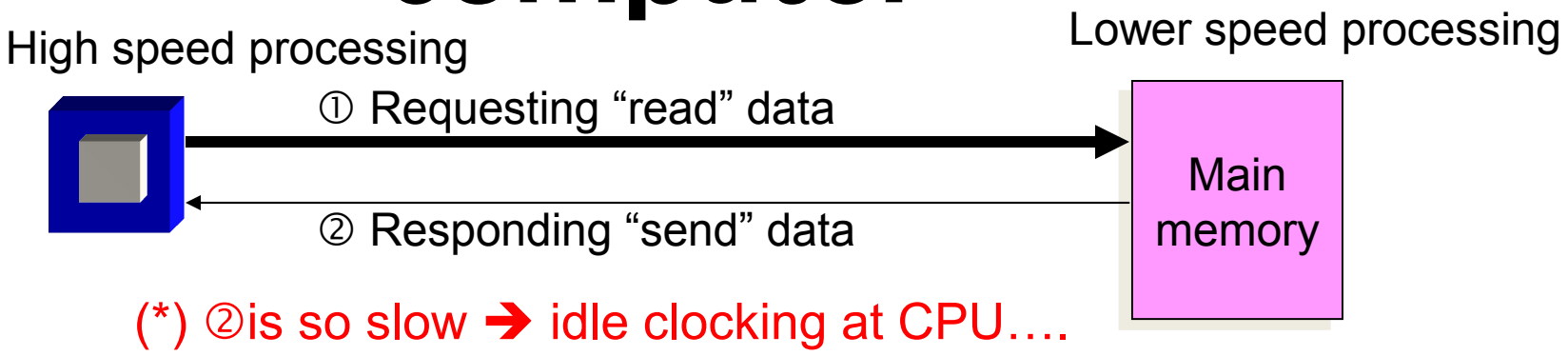


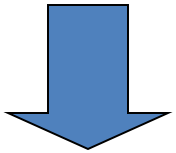
P2P Technology contributes to more than 80% cost reduction for bandwidth capacity at server site in iDC.

What has Peer-to-Peer introduced ?

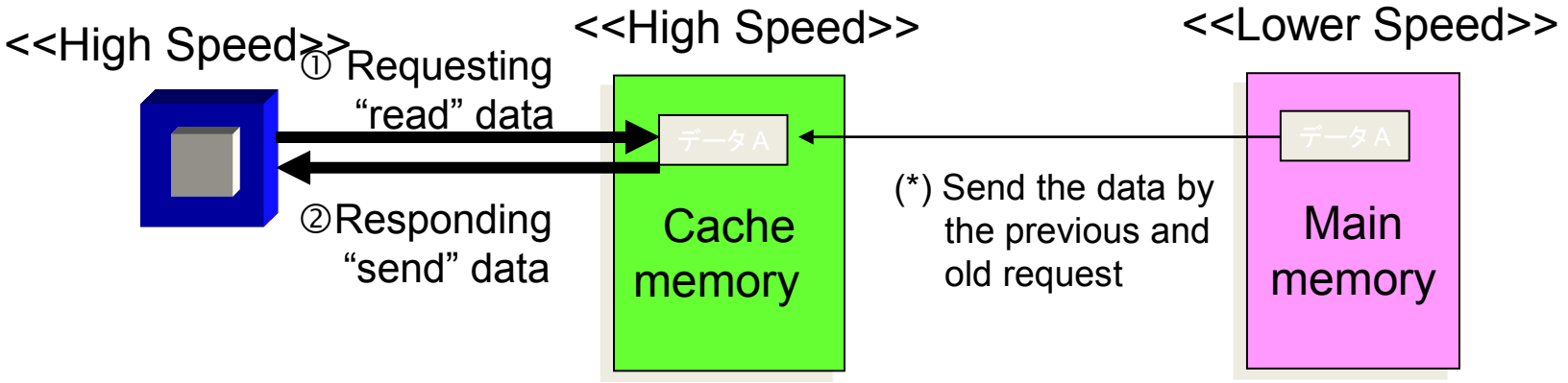
1. {networked} Cache and Proxy
2. {networked} DMA (Direct Memory Access)
3. {networked} Virtual memory system (by DHT)
   - Separate contents handler(identifier) and real storeing address
   - Access heterogeneous and multiple device with single {virtual} interface
4. Abstraction of contents by number (by DHT)

Cache memory in computer





Introduction of cache memory system



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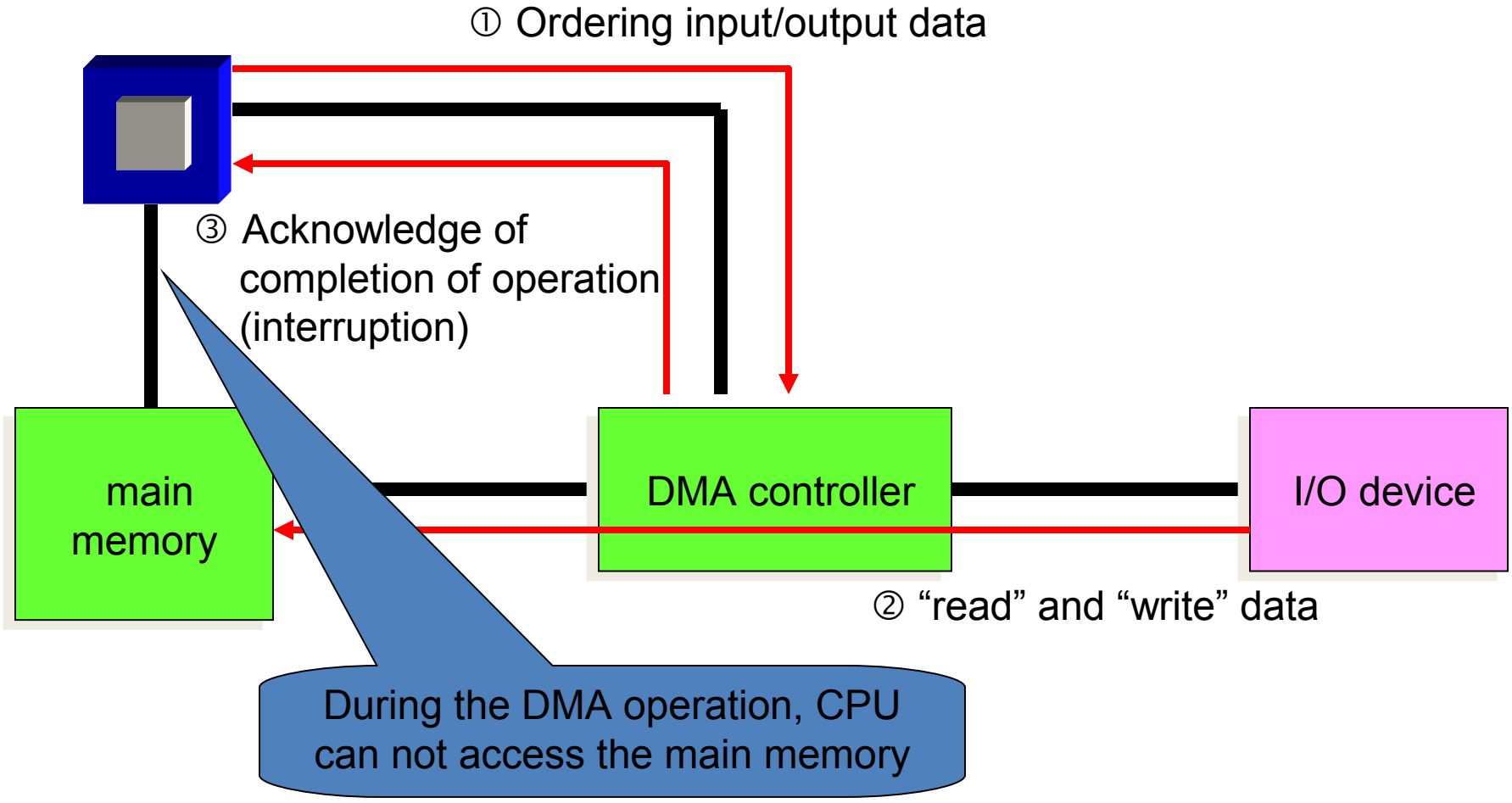
DMA; Direct Memory Access



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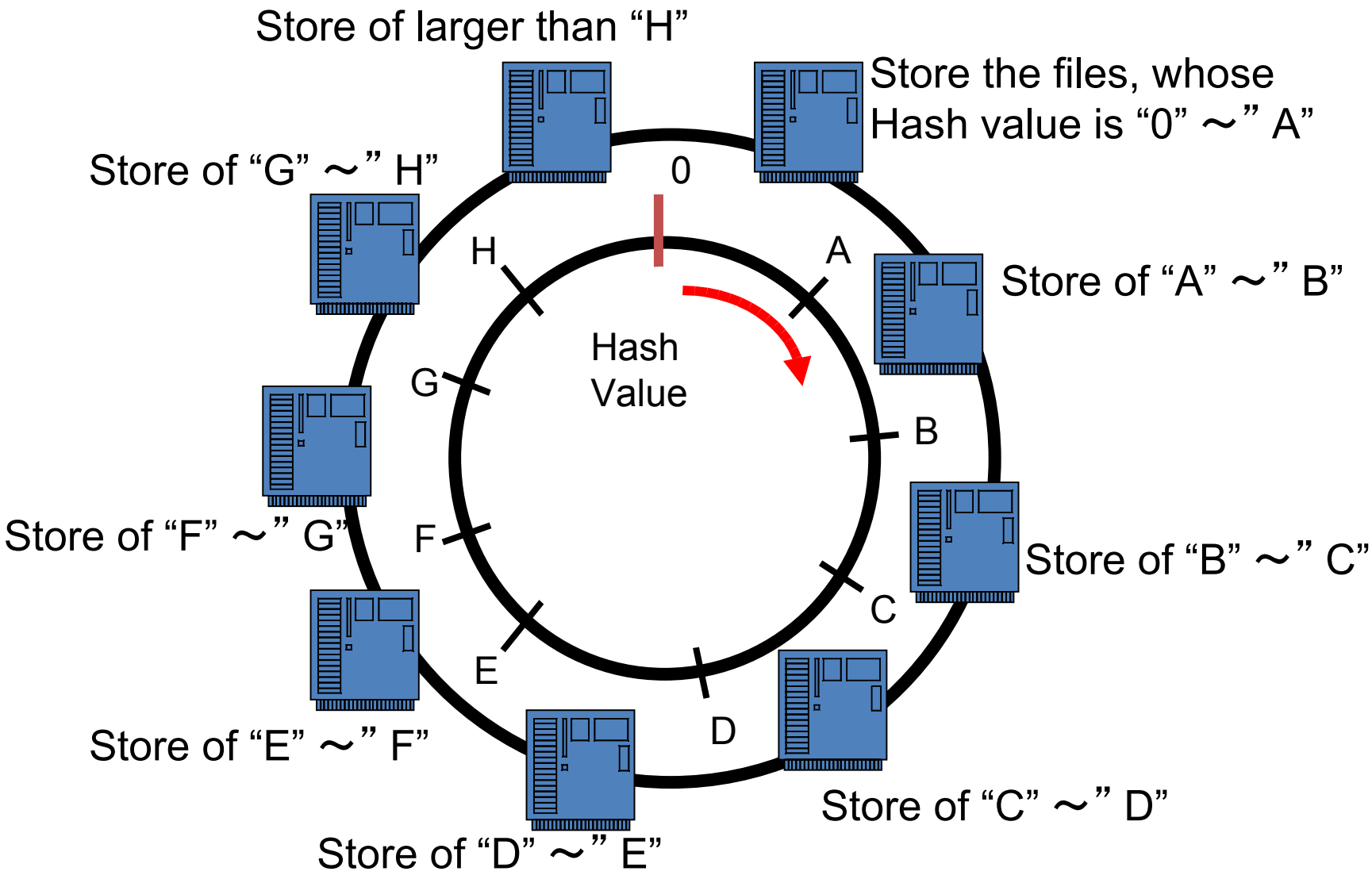


Distributed file storage image in DHT system

Challenge on P2P deployed in ISP

- Traffic engineering on P2P system
  - –Intra-domain
    - ➔ P4P ?
  - –Inter-domain
    - ➔ new routi
    - matrix

Collaborating with P2P Promotion Council
http://www.fmmc.or.jp/p2p_web/index.html

Reduce of Inter-Domain Traffic

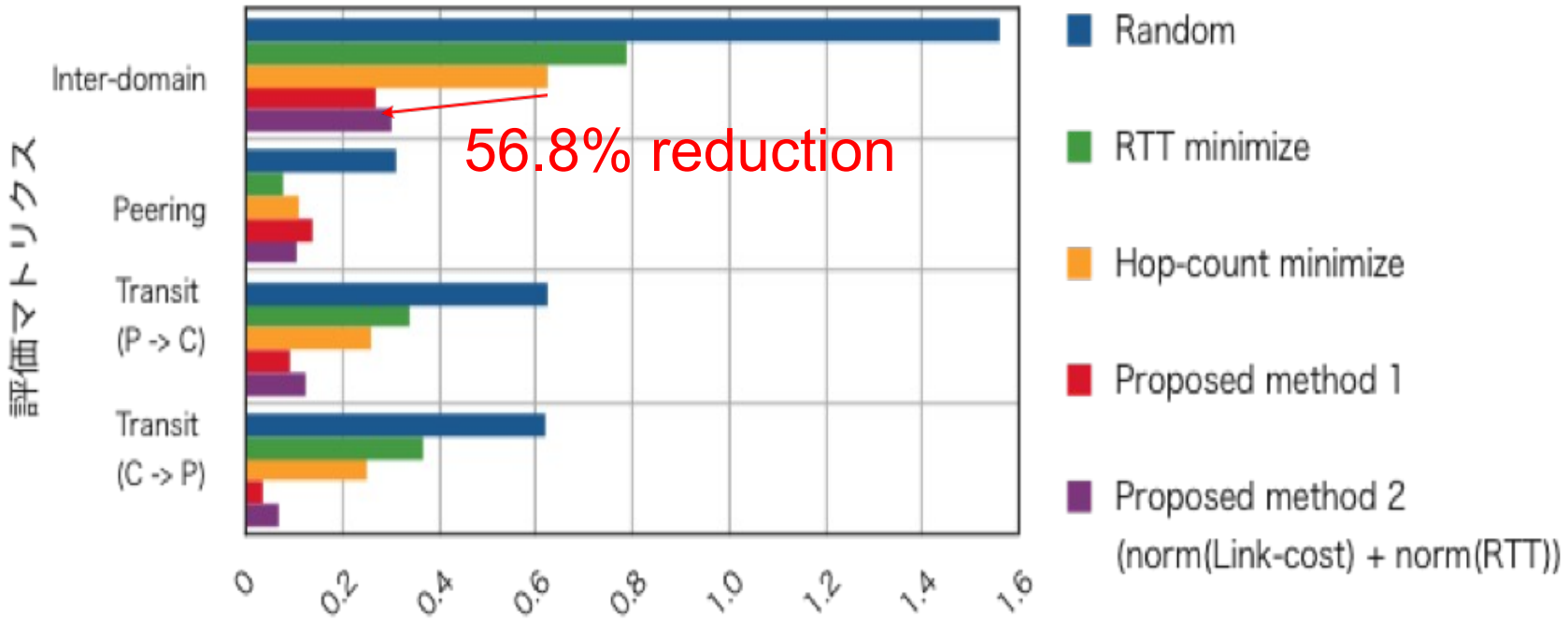


Fig. Inter-domain traffic

How the real network looks like ?

1. Covering our “Earth” with high speed network
2. Impossible to accommodate earth with single technology
3. Investment and operation is always autonomous
4. We have large area, where we could not wire
5. We have large area where, even, wireless would be hard to use
6. Uni-Directional Digital Link

Toward the new continent

Why we go to new continent ?

- Contribution of revenue by ICT industry in the GDP is less than 10%.
- More than 90% revenue in GDP is come from non-ICT industries.
- Almost all the companies, including non-ICT industries, depends on ICT technology on their corporate operation.
- How to use the ICT defines the marketing power and operating power of companies

Flagship Projects

1. Facility Networking for energy saving
2. Live E! ; Weather Sensor N

Live E!

How to use the sensor network e.g., saving energy in building system

1. Energy saving and preserving the Earth is now "Global" agenda, while there is an economical benefit and incentive for private companies.
2. Integration of separated sub-systems, e.g. Air-conditioning, lightening, security, IT.

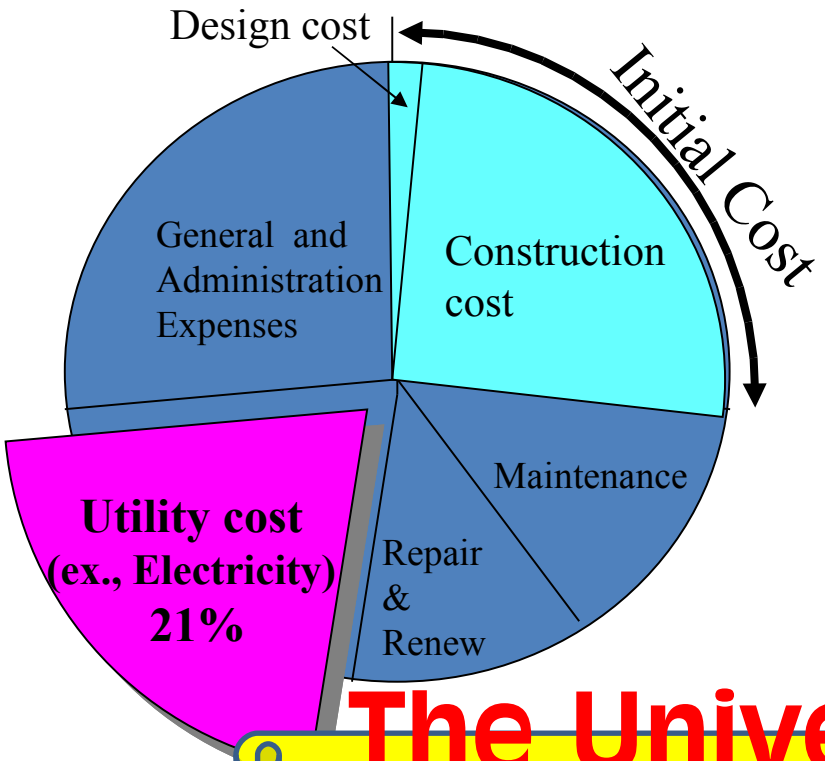
- ➔ Let it with open TCP/IP technology (i.e., IPv6)
- CO2 by United Nation
  - 10%

Large number of sensors/actuators, and they do not care about the version of IP and protocol

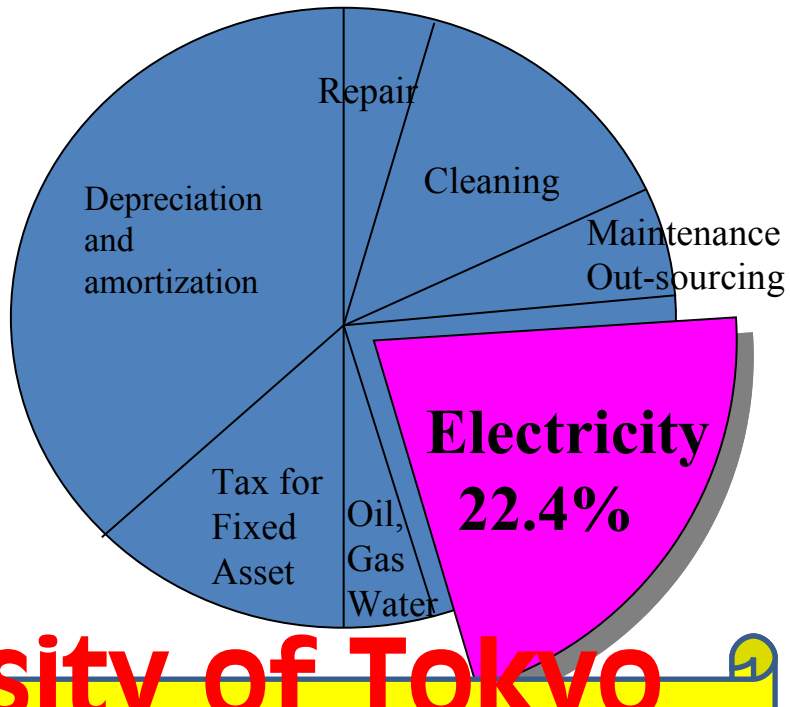
1. Let available any digital information computing device or resource on the earth for any device on the earth, for other usage
2. We should not leads the restraint of human and social activity by energy saving, but we achieve the less energy consumption through increased efficiency and innovation.

Life-time cost in Building System

Life time portfolio
(in office building)



Yearly portfolio
(in office building)



The University of Tokyo pays $60M/year on Electricity !!!

tml

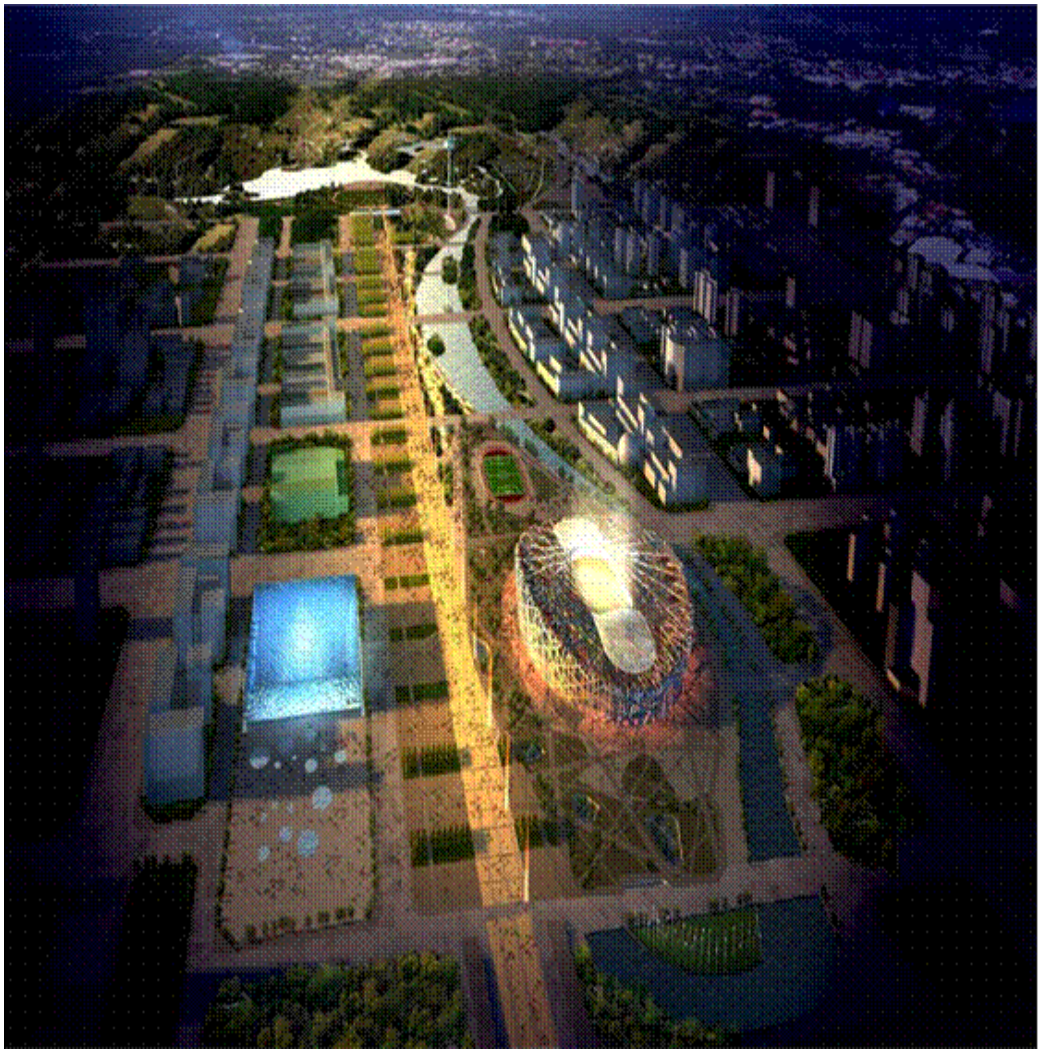
Business in FY2007 and 2008

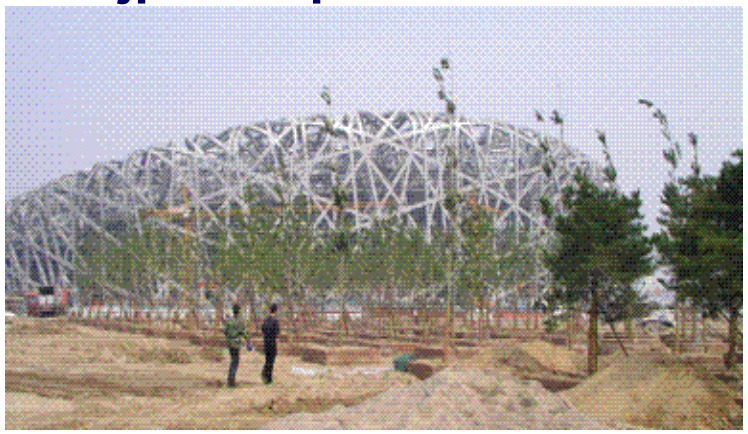
- 2007
  - Integration with Digital Home Appliances
  - TV set by Panasonic works as window for facility control and management in residential area
  - Live E! WS at APNG Camp (Aug.2007)
- 2008
  1. Beijing Olympic Game 2008
  2. Energy Saving Field Trial in the Univ. of Tokyo
  3. Live E! WS deployment in As

東京大学 THE UNIVERSITY OF TOKYO

Beijing Olympic 2008 Main Stadium District
Lighting System Control by IPv6 Facility Manage & Control

Operated by Matsushita Electric Works (MEW)
http://www.mew.co.jp/e/corp/index.html

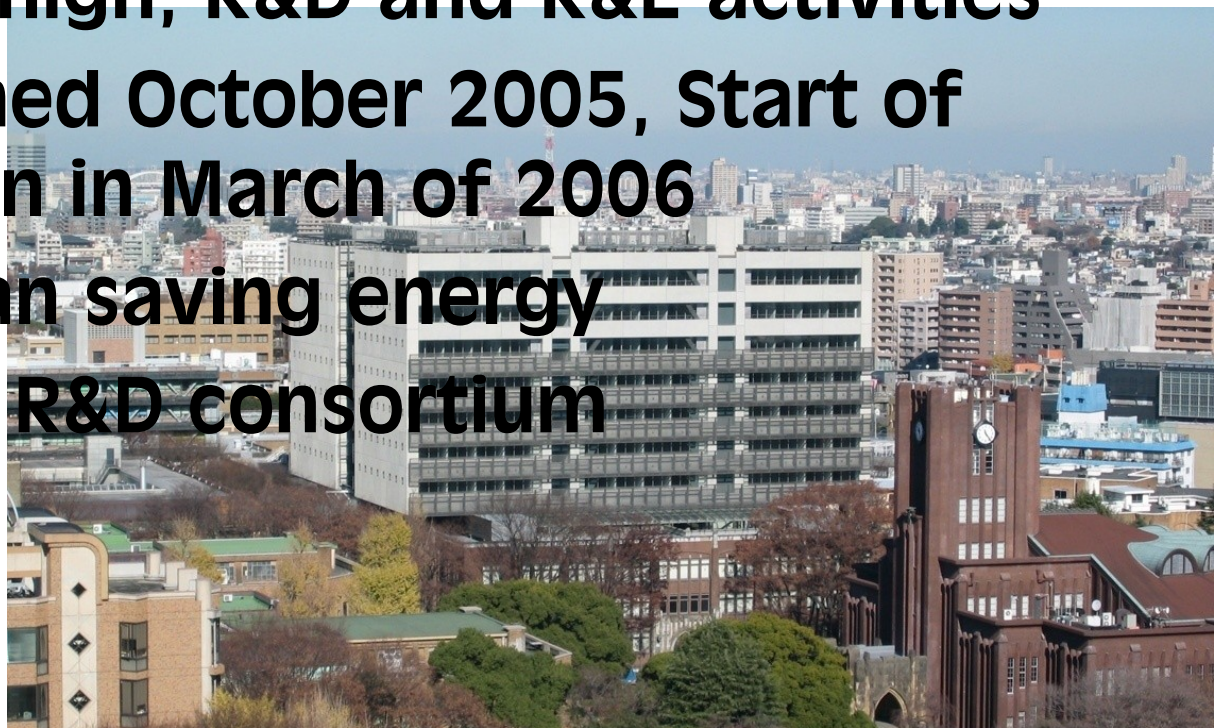




Lightening Management & Control
- Using IPv6 based Facility Networking
- Area Management System, i.e., not single facility but multiple facilities
- 1.4kmx2.4km with 18,000 lights
- 340 IPv6-based control nodes
- 10% Energy saving

Special Project at the Univ. of Tokyo "Green ICT Building"

- Building No.2, Hongo Campus
  - Targeted reduction;
    - 15%=$4M USD (in 2012), 50%=$30M USD (in 2030)
  - 12 floor high, R&D and R&E activities
  - Established October 2005, Start of Operation in March of 2006
  - More than saving energy
  - Forming R&D consortium



東京大学
THE UNIVERSITY OF TOKYO

Participants

Kicked-off on June 09, 2008

- アイビー テクノス 株式会社
- 株式会社インターネット総合研究所
- 株式会
- 株式会
- 鹿島建
- 清水建
- CiTRI
- シムッ
- ダイタ
- 株式会
- 株式会
- T&Y
- 株式会
- 株式会
- 株式会
- 日本
- 日本電
- 株式会
- 富士通
- 松下電器産業 株式会社
- 松下電工 株式
- 株式会社 三菱総合
- •東京大学

Stakeholders on Facility Business

- Developer, e.g., landlord
- General Contractor/Con”s”tractor
- System Integrator
- System Designer
- ICT Vendor
- Component vendor, e.g., sensor
- Standardization Body
- R&D organization, e.g., University
- Local government, e.g., Tokyo

Integration of legacy systems

Visualization

Analysis

Reaction / control

中央変電室

I/F

ルータ

ルータ

Web 配信

端末

学生

端末

教授

端末

施設

端末

Data Center

IPv 4/6

キャンパスネットワーク

BACnet / WS

LON

BX

PC

WEB

CSV

Savic 山武

EHP 三菱電機

GHP 三菱重工

N－MAST 松下電工

集中検針 愛知時計

動力監視制御
代表EHP監視、電力計量

Air Condition
（EHP）

Air-Condition
（G HP）

Lightening

電力量
水道量

DU

DU

DU

CT

電流
（200V）

BCRN

BCRN

BCRN

PLC

コンセント

電力監視
電源制御
（100V）

動態サーバ

無線 LAN

AP

AP

AP

AP

ID

ID

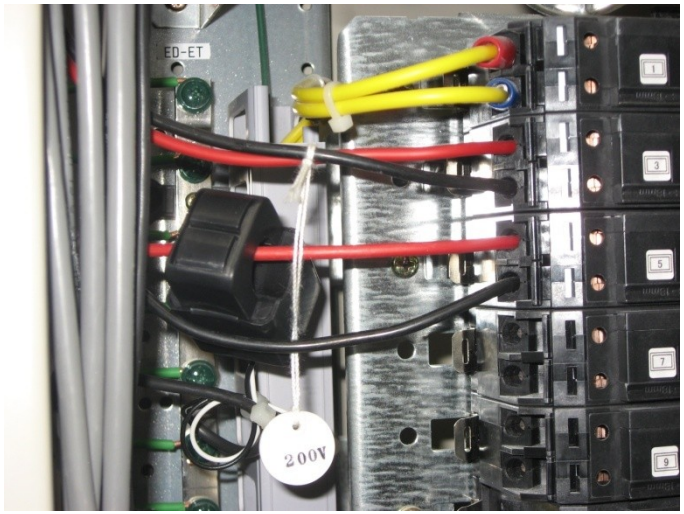
ID

動態管理
入退室管理（セキュリティ）

Integration with IP

Additional System

Security System

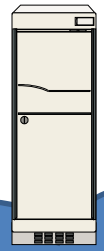


Real-time monitoring of Electric Power Consumption with CIMX Inc

Lights Control and Monitoring by MS Instant Messenger

Available commands
- Get address
- Get state
- Turn on/off

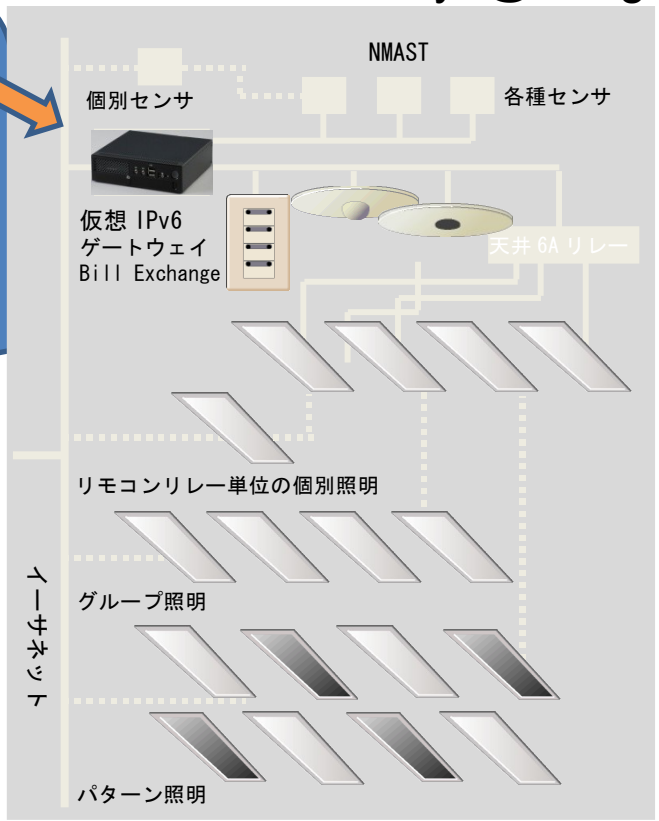
IM-BX Translator
(Installed at MEW Tokyo HQ)



Internet
IPv6/IPv4

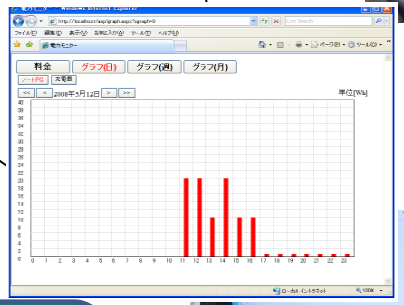
Anywhere
On any platform

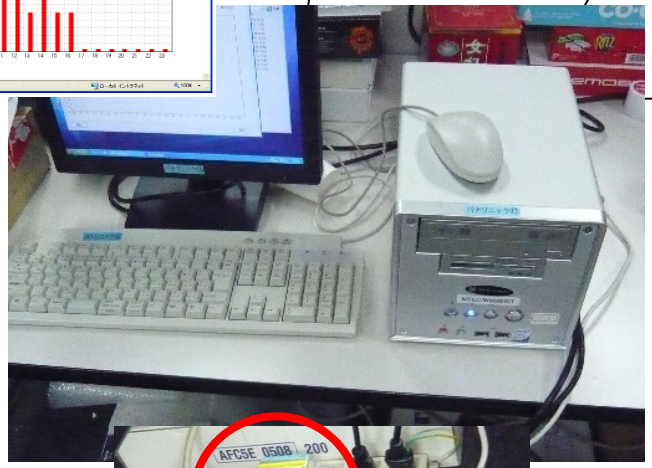
Univ. of Tokyo@Hongo

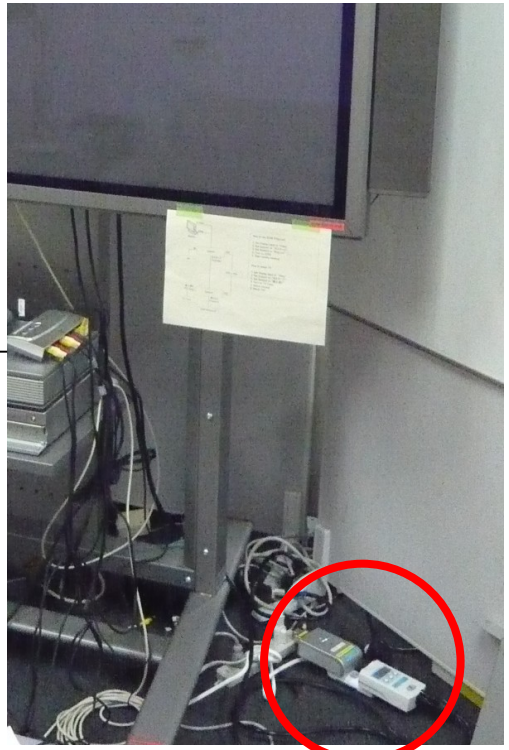


Measurement via PLC for 100V appliances

Powered by Panasonic



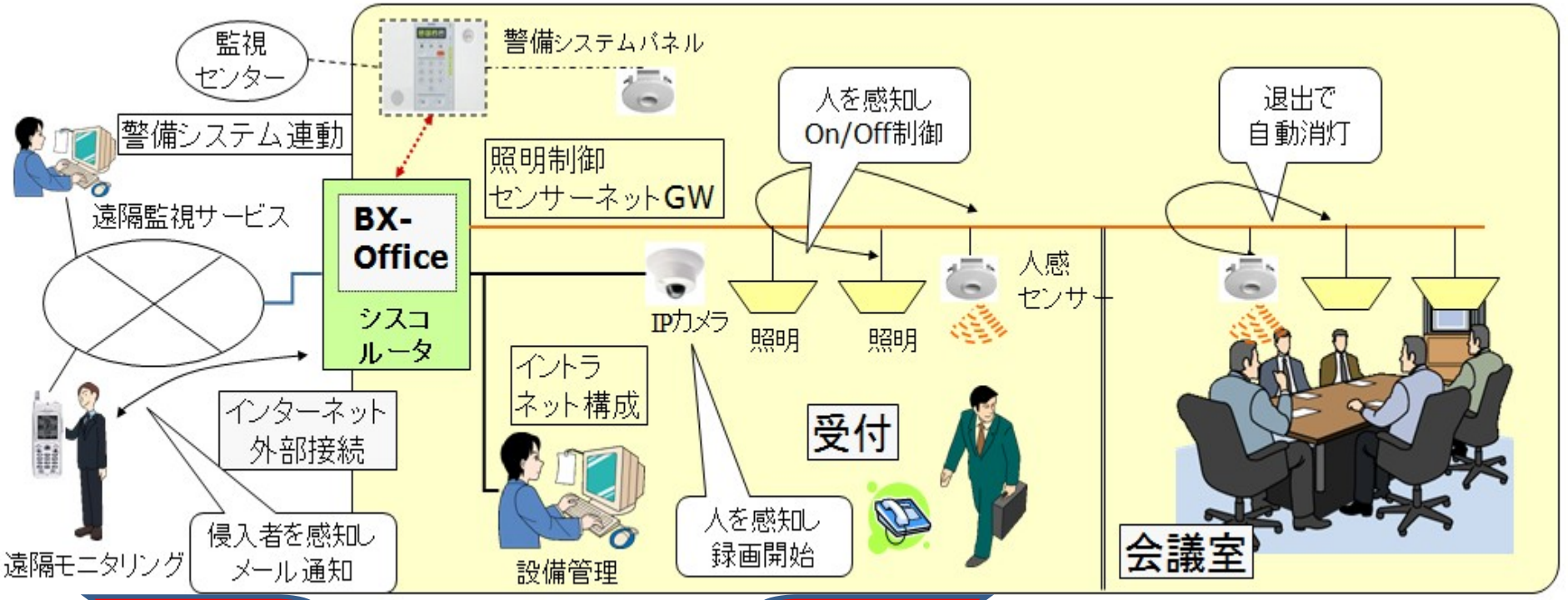




Experimental operation

UBITEQ, Panasonic EW, Cisco Systems, {Yamatake}

◆システム構成

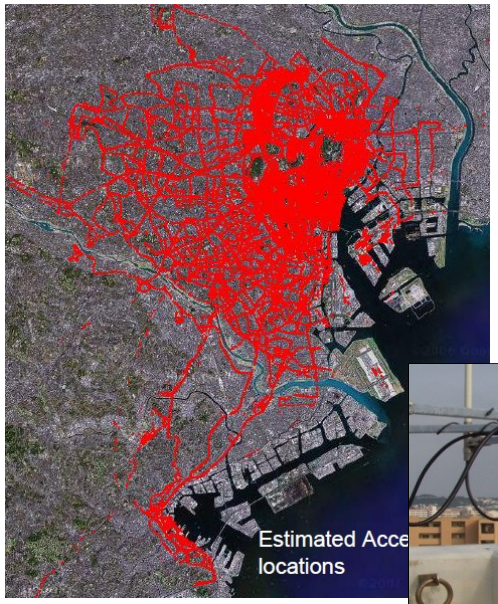


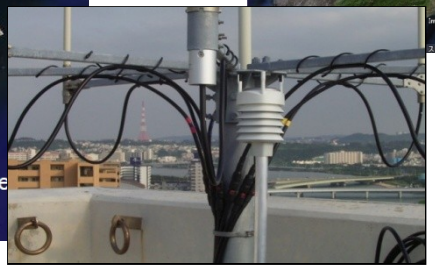
In operation since Nov.15 2008

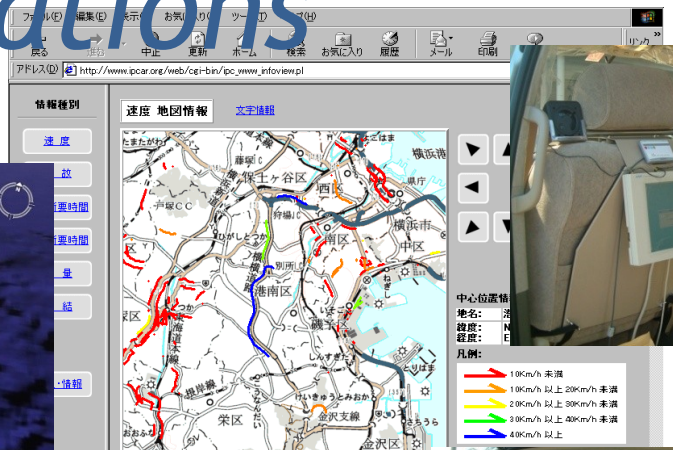
UBITEQ
UBIQUITOUS TECHNOLOGY

“Live E!” Project -- Sensor network for the earth –

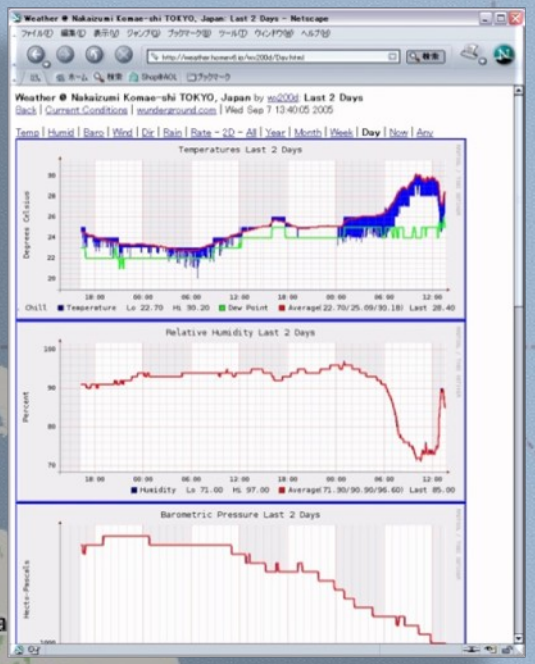
Sharing the any information for innovations







Deployment in Asian Countries



Live E! Sensor Deployment Status

as of December 2008

Europe & Africa

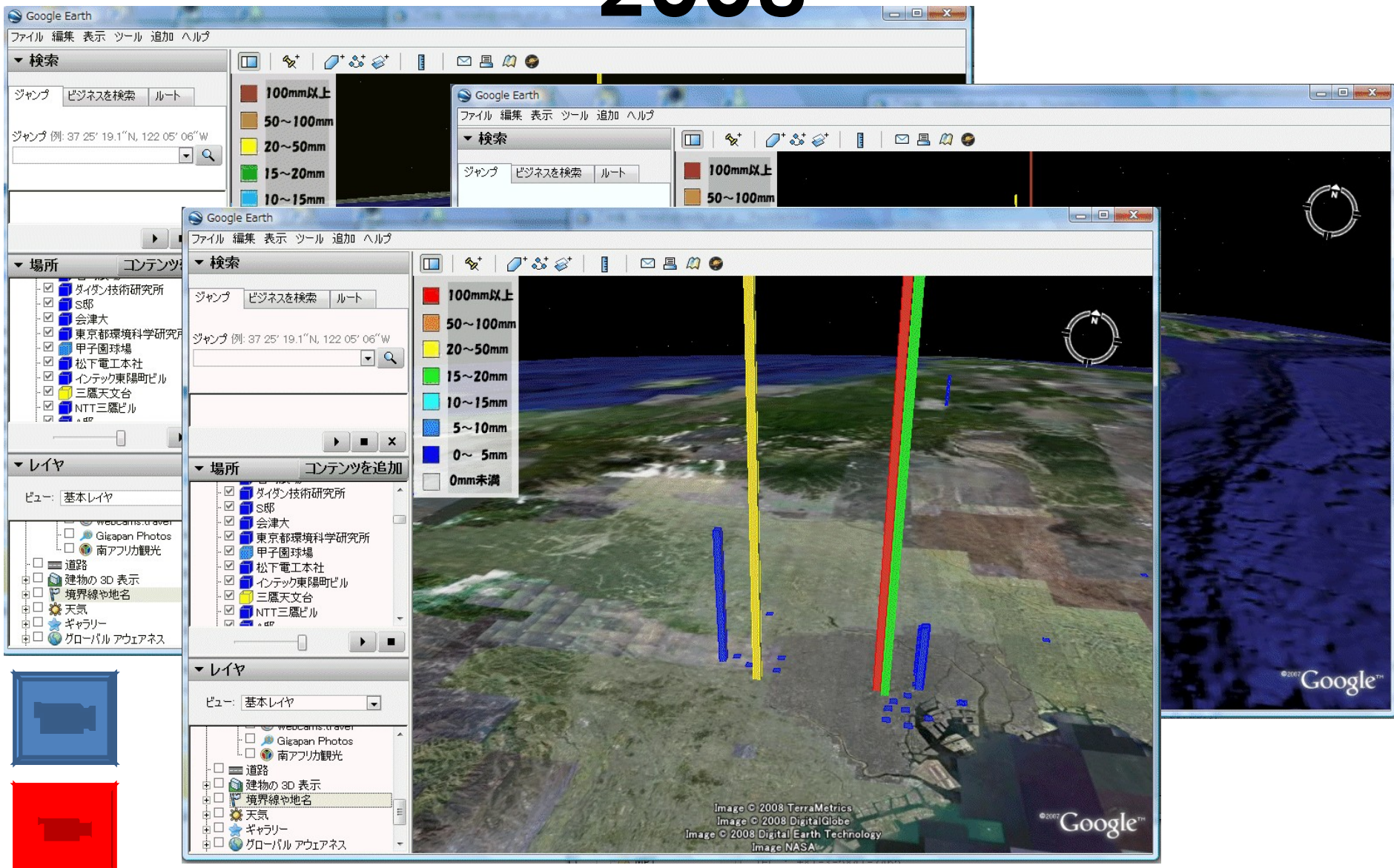
North America

Asia

Dense Installation Areas

- Minato-ku in Metropolitan Tokyo
  - Education for elementary schools
  - Public service, e.g., against heat-island phenomenon or evacuation guide for earthquake
- Kurashiki City in Okayama
  - Disaster protection (against flooding by heavy rain)

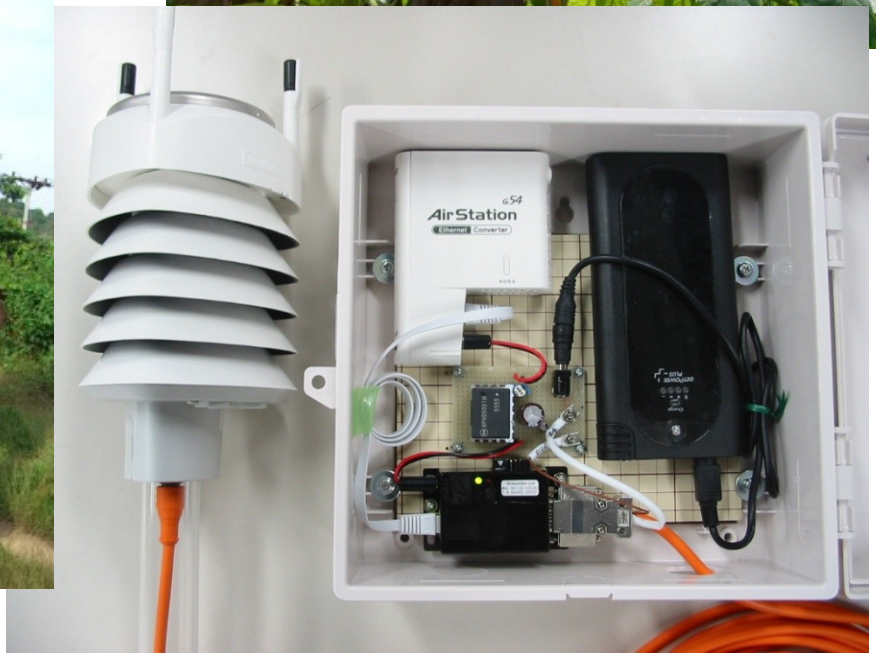
Heavy Rain in Tokyo, Aug.29, 2008



東京都 エリア

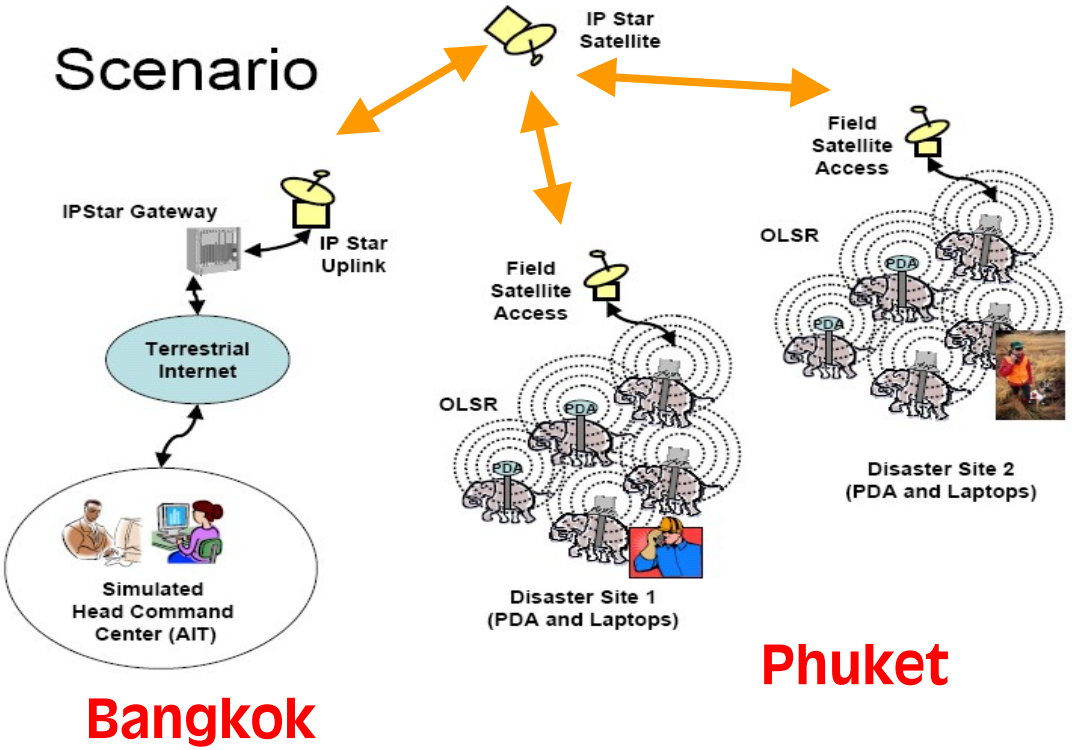
DUMBO Project in Thailand with AIT

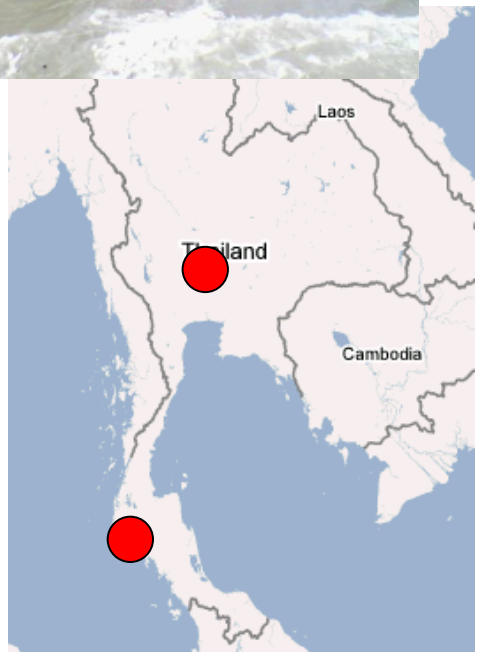
- Emergency Responding
- Live E! sensor in OLSR



DUMBO with AIT@th

- Digital Ubiquitous Mobile C
- Bangkok & Phuket, Thai
- December 1st 2006 (14:00 –





Live E! Project into Asia-Pacific

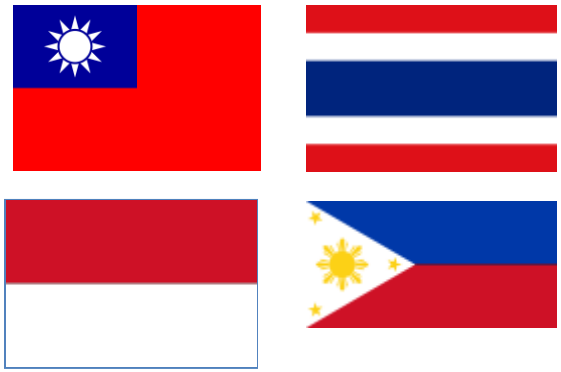
ASIA PACIFIC NETWORKING GROUP
10th Camp 2008
August 11-15 2008
Asian Institute of Technology, Klong Luang, Pathumthani 12120, Thailand

10th CAMP 2008
ICT VISION FROM, BY AND FOR NEXT GENERATION
August 11-15, 2008

Login to router

[Existing Installation]

- Chinese Taipei
- Thailand
- Indonesia
- Philippine

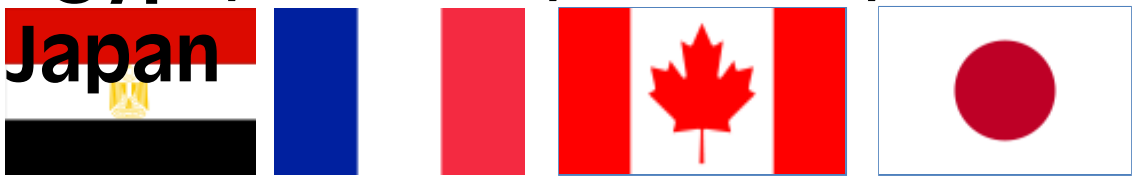


[New Installation]

- Malaysia
- Fiji
- Vietnam
- Sri Lanka
- Pakistan
- China
- India
- Myanmar
- Bangladesh
- New Zealand
- Cambodia

[Other Installation]

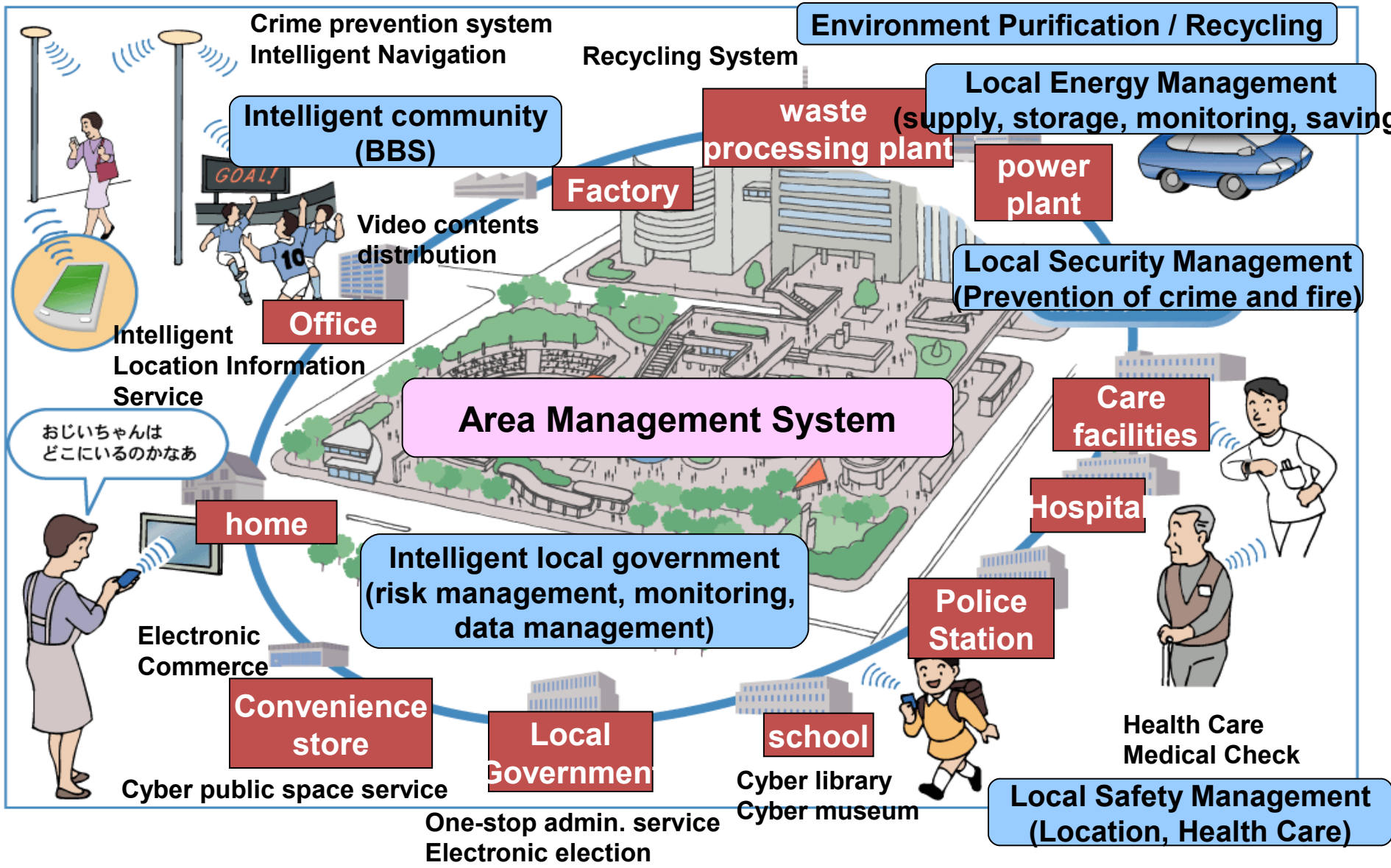
- Egypt, France, Canada, Japan



ストリートビュー
その他...
地図
航空写真
地形
Uzbekistan
Kyrgyzstan
Turkmenistan
Türkiye
Turkey
Ελλάς
Greece
Syria
Iraq
Iran
Afghanistan
Pakistan
中国
China
N Korea
S Korea
日本
Japan
Egypt
Saudi Arabia
Oman
Yemen
Sudan
Ethiopia
Somalia
Kenya
India
Vietnam
Malaysia
DR Congo
Tanzania
Angola
Zambia
Mozambique
Namibia
Zimbabwe
Botswana
Madagascar
South Africa
Indian Ocean
Papua New Guinea
Australia
NT
QLD
WA
SA
NSW
VIC
TAS
New Zealand
2000 km
1000 マイル
©2008 Google - 地図データ ©2008 ZENRIN, Tele Atlas, AND, Europa Technologies - 利用規約

Metropolitan design; Real-Space Internet with IPv6

Source: Matsushita Electric Works

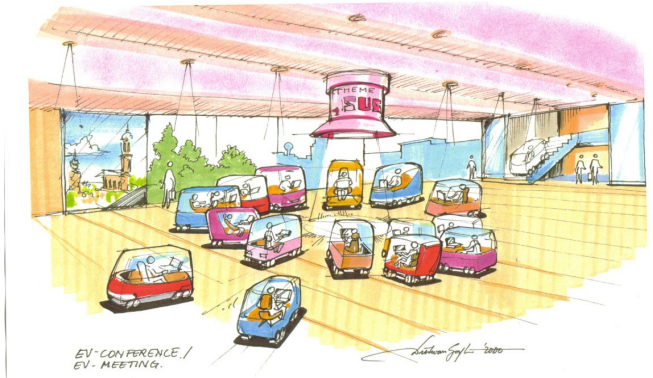


Innovation of Metropolitan Design Principle

- Foods(= Water)
- Religious (= Information(Authority, Wisdom))
- Exported goods(= logistics { +inform. })
- Transportation(= ship, train, car)
- Energy (= Coal, Atomic, Solar) and Information network

What is the impact/implication of Electronic Car ?

- Communication among car
  - Avoiding the traffic congestion
  - Virtual car-train



- Remove the combustion engine
  - Why car need long distance driving capacity ?
  - Car can be into the living

Innovation of Metropolitan Design Principle

Past requirements :

- Agriculture (river, canal)
- Manufacturing (logistics=train, road)

Future:

Control of “Energy and information flow” with ubiquitous energy sources

➔ SCM of energy flow

What we (really) expected ?

- Win-Win relationship between Environment /Energy-saving and Ubiquitous networking

Step.1 Mandatory components

1. Sensors and actuators network
2. Collaborative operation among individual components

Step.2 Ubiquitous digital space sharing all the digital information

(*) Each equipments and components are

applications

This is the "internet End-to-End Model"

www.wide.ad.jp

Thank you

IPv6 Promotion Council of Japan:
http://www.v6pc.jp/en/index.html
e-mail: info@v6pc.jp

Task Force on IPv4 Address Exhaustion
http://kokatsu.jp/

Live E! Project
http://www.live-e.org/
e-mail: live-e-info@mri.co.jp