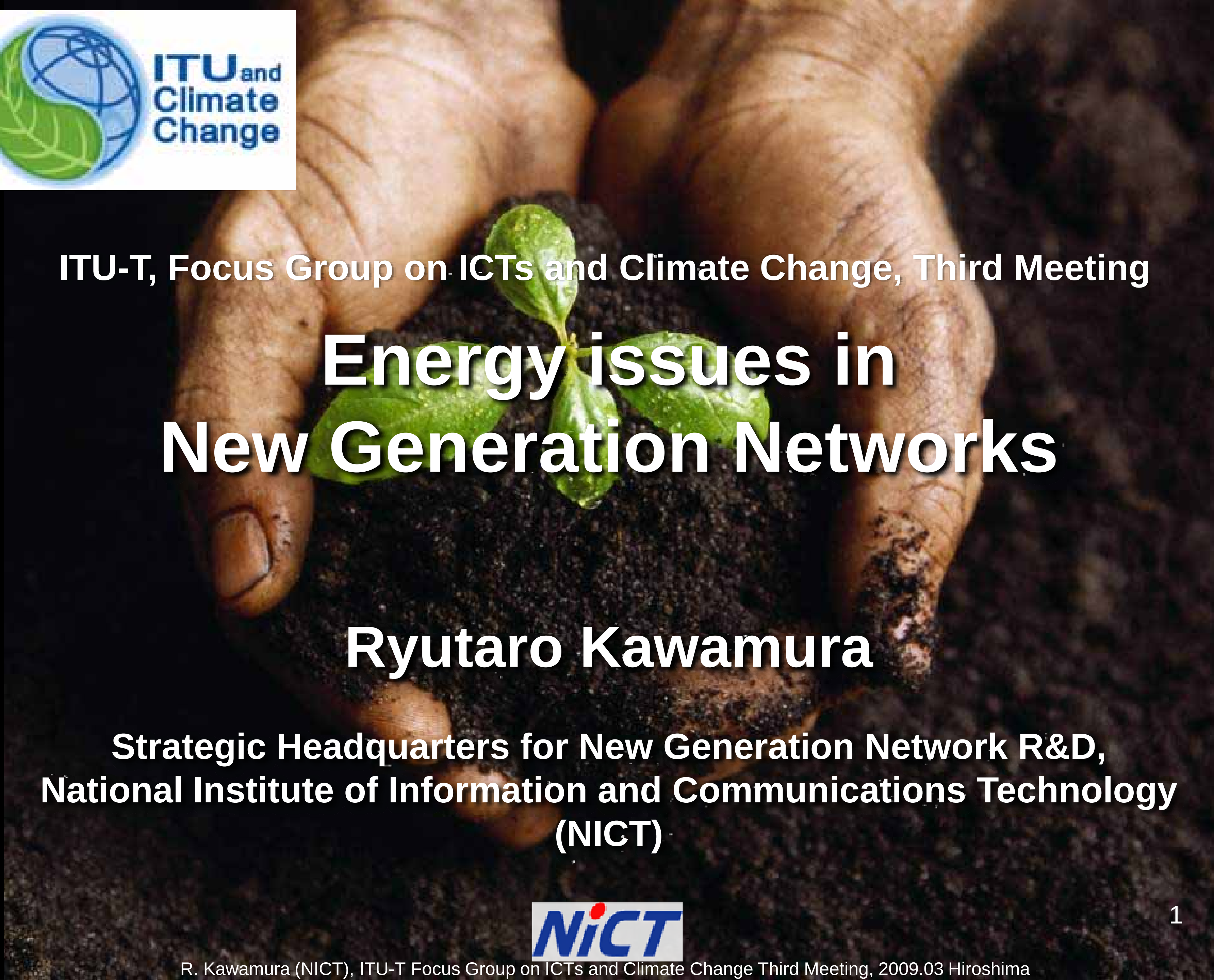


ITU and Climate Change

ITU-T, Focus Group on ICTs and Climate Change, Third Meeting

Energy issues in New Generation Networks

Ryutaro Kawamura

Strategic Headquarters for New Generation Network R&D,
National Institute of Information and Communications Technology
(NICT)

NICT

Who I am

- Research Expert, Strategic HQ for New Generation Network R&D, NICT.
  - My additional position from last April.
- Senior Manager in NTT Laboratories.
  - 20 years R&D of network technologies.
- Board of Directors and VP of OSGi Alliance (www.osgi.org) for 6 years.

outline

R&D of New Generation Networks.

Four key issues for Energy and Future Networks.

The amount of energy consumed by networks, and our challenge.

Reduction in energy consumption of social activities by utilizing ICT.

Summary.

Motivation of Future Network R&D

- NGN services were launched in Japan in March 2008.
- It is time to tackle the challenges involved in creating a Future Network on the basis of mid- and long-term perspectives.
- Similar activities of FP7's ICT Challenge-1 were found in EU and FIND/GENI projects in the US.

NWGN and FI

- We use "NWGN" in place of "Future Internet (FI)."
- NWGN stands for "New-Generation Network."
- Future networks may not be the continuous evolution of the current Internet / IP technologies.
  - Clean-slate approach
- We plan to put NWGN to practical use in ~2015.
- "NGN" can also be called "NXGN" to distinguish it from NWGN.

Annual funding for R&D on NWGN-related projects in the Industry, Academia, & NICT in 2008

- **US$ 21M for NWGN technology**
- **US$ 36M for Photonic Network technology**
- **US$ 15M for Ubiquitous Network platform**

(* Conversion rate: 1 US$ = 100 JP)

Reference：

FP7 Challenge 1: 200 M Euro (2007-2008)

FIND : 29 M USD (2006-2008)

Overview of NWGN activities in Japan

Research Communities

AKARI

Industry

- Vendors
- Carriers

Academia

- Univs
- Societies

NiCT

Strategic HQs for NWGN R&D

MIC
Ministry of Internal Affairs and Communications

Testbed Networks

JGN2 plus

International Cooperation Activities

Forum

- NWGN Promotion Forum

新世代ネットワーク推進フォーラム
New Generation Network Promotion Forum

NICT's vision for NWGN

Diversity and Inclusion - Networking the Future -

Natural disaster

Food shortage

Gap between counties

Global warming

Gap between cities and countries

Energy problems

Aging society with a low birth rate

Information explosion

Population explosion

Digital divide

◆ **Minimize the Negatives**

- To minimize environmental impact.
- To establish new societal systems.
- To establish a sustainable society.
- To improve disaster management.
- ...

◆ **Maximize the Potential**

- To promote the wisdom of human beings.
- To improve QOL.
- To promote innovation.
- ...

◆ **Inclusion**

- To respect diversity in civilization, culture, and people.
- To involve people in ICT on a global scale ...

outline

R&D of New Generation Networks.

Four key issues for Energy and Future Networks.

The amount of energy consumed by networks, and our challenge.

Reduction in energy consumption of social activities by utilizing ICT.

Summary.

Four key issues for energy and future networks

1. The amount of power consumed by networks.

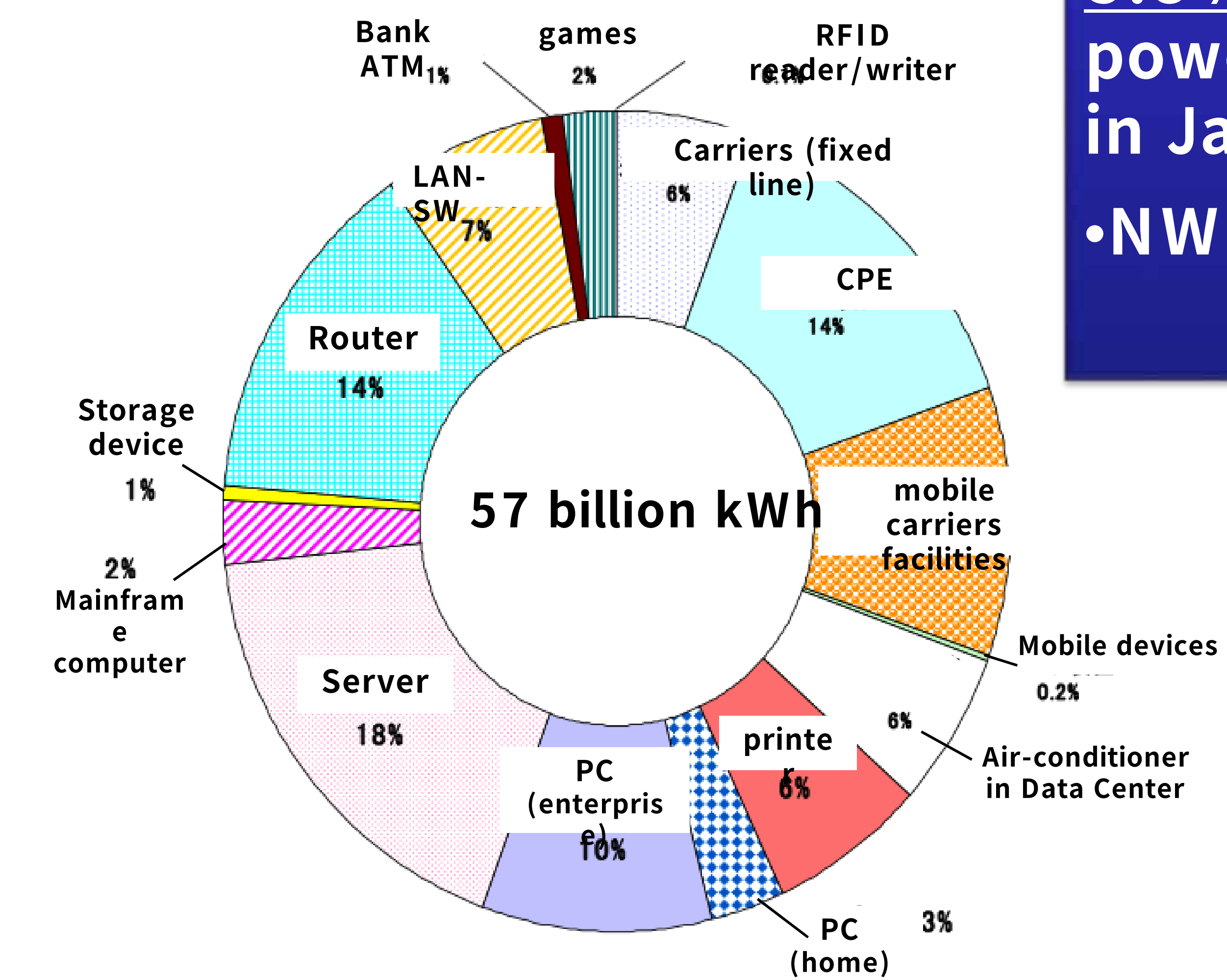
2. Reduction in energy consumption of social activities by utilizing ICT.

3. Environment monitoring and sensing utilizing network and sensor technologies.

4. International contributions by Green Future Network technologies.

An overview of power usage of ICT in Japan

(expected in 2012, Ministry of Internal Affairs and Communications in Japan)



- ICT accounts for 5.8% of the total power consumption in Japan (Year 2006).
- NW: 51% of ICT

R. Kawamura (NICT), ITU-T Focus Group on ICTs and Climate Change Third Meeting, 2009.03 Hiroshima

Summary of energy consumption analysis in Japan
(estimate value from public information)

1. NW accounts for approximately half of the total power consumption of ICT.

2. <u>CPE</u>s (e.g., wireless telephone, broadband router, ONU, DSL modem, and LAN-SW) are dominant and share around <u>50–80%</u> of the total energy consumption of NW.

3. <u>Accesses networks</u>, including the manufacturing and cabling the fibers, and share around <u>20–30%</u>.
   - PON can reduce the power in comparison with the Single Star.

4. Regarding the Cellular Phone Network, the power consumption of handsets are very small, and the base-station needs amount of power.

Could be inaccurate.
Lack of standardized definitions and methods to evaluate

For energy discussion in future networks

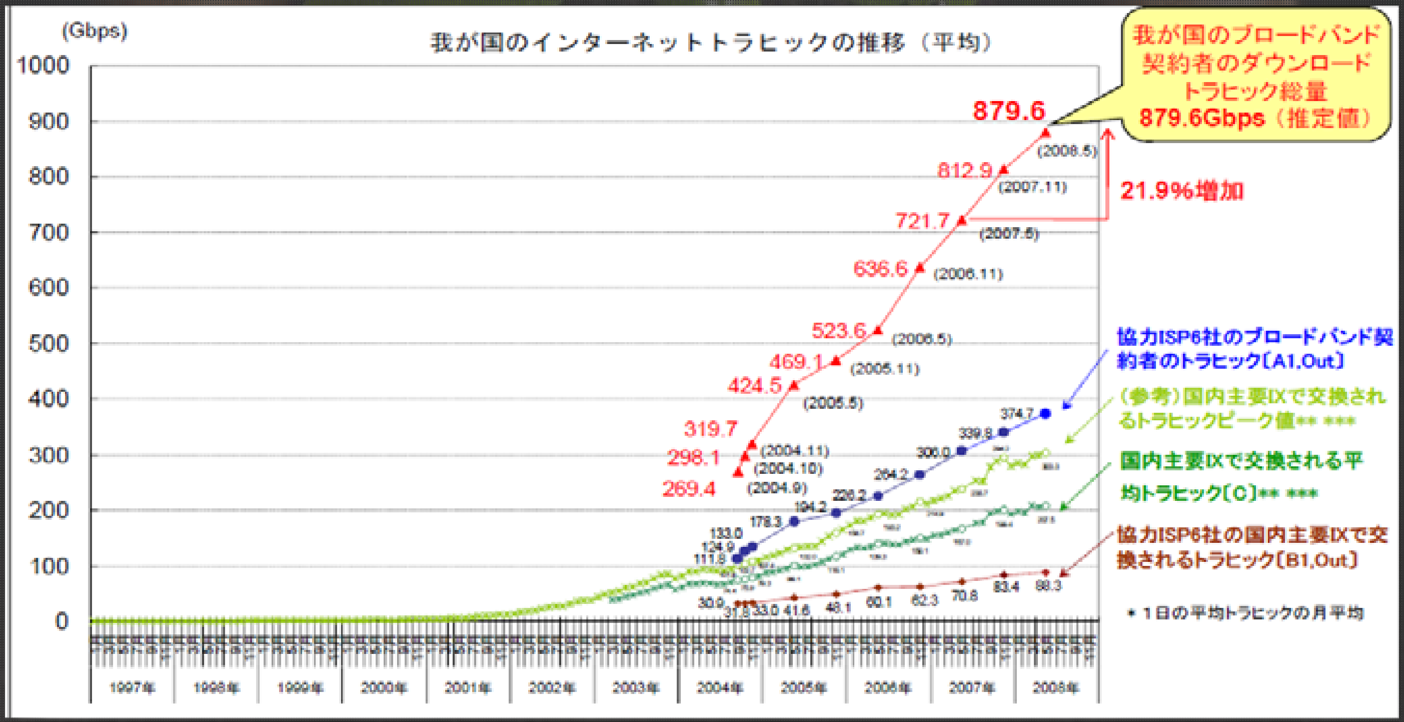
- It is very important to **define and standardize the exact index and methods to measure**.

- As an index, “the amount of energy usage per 1 byte transmission in network (i.e., energy efficiency of data transmission)” could be a reasonable index.

  - However, data (contents) could be relocated by considering the energy.

How serious the problem is

- The amount of data-traffic in Japan grows exponentially at an annual rate of 1.4–1.7 times.
- This means that the amount of <u>data traffic could reach thousand to hundred thousand times in 15 years from now</u>.
  - The future traffic strongly depends on (killer) applications that will be generated in the future, number of subscribers, etc.



Reference: MIC report, 2008.

Challenge

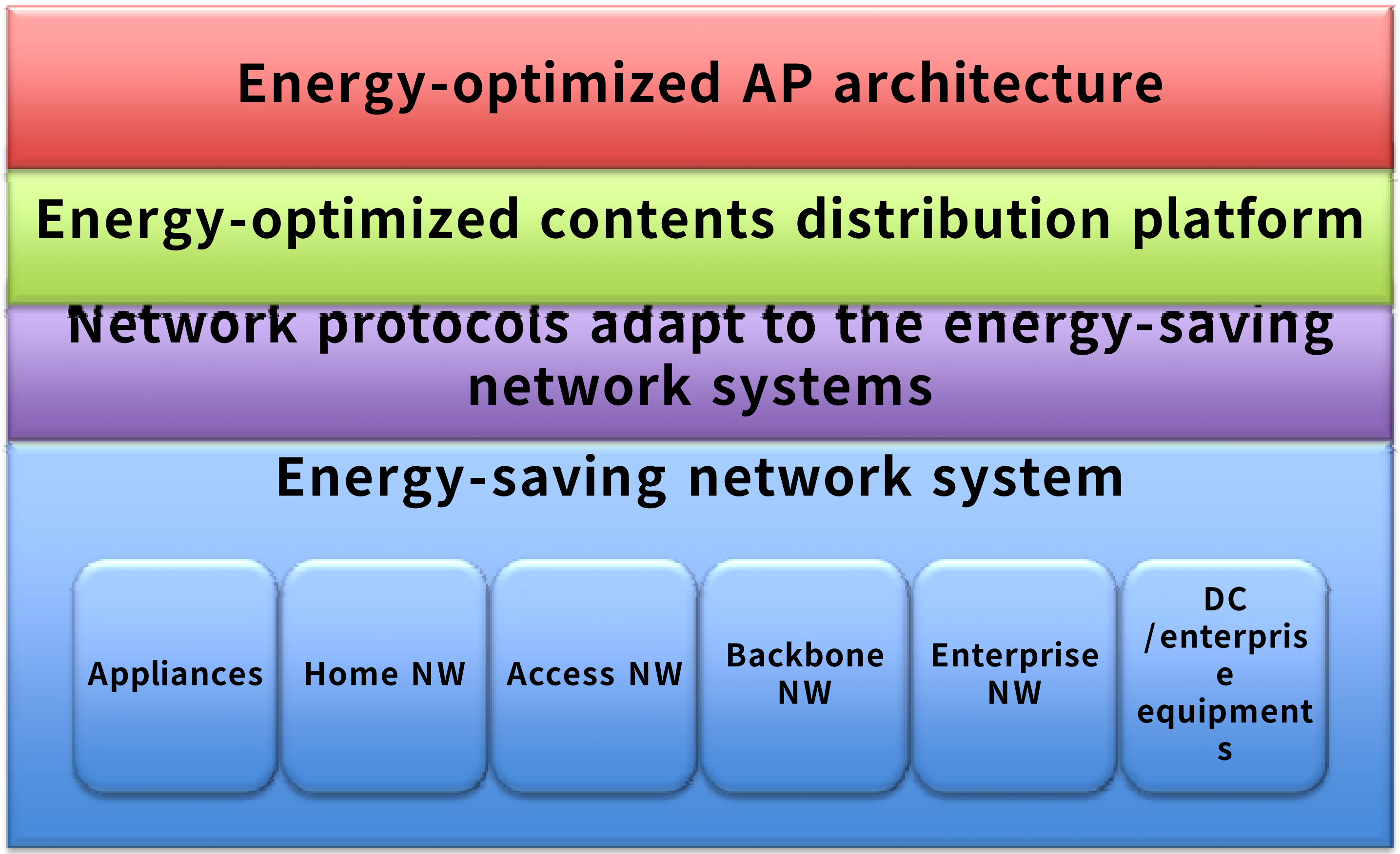
- **To improve the energy efficiency of unit data transmission to 10^3～10^5 times from the current network.**
  - **To transmit 10^3～10^5 times of data using the same amount of energy consumption.**

How can we overcome such a difficulty?

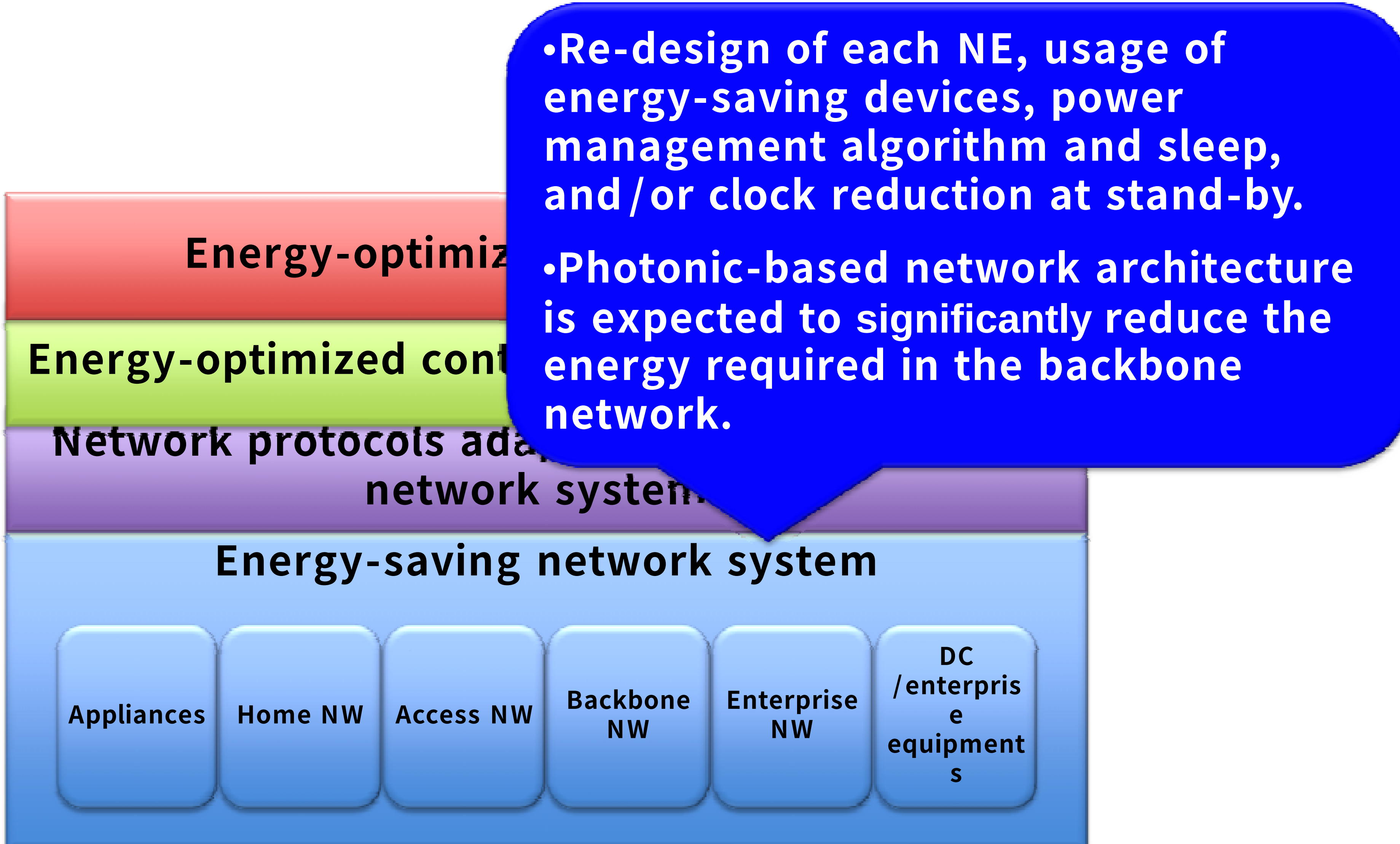
Current efforts and its anticipated limitations

- Energy-saving efforts against network equipments by not disrupting the operations of the current network.
  - Routers, ADSL (ADSL2), LAN-SWs, WiFi, Servers, and PCs.
- Through these efforts, a certain reduction in the energy efficiency could be expected; however, a study has argued that the gain of that approach will be saturated up to a ceiling of 10 times.
- In order to achieve a level of 10^3～10^5 times, we require innovative approaches beyond the conventional efforts, including re-designing network architectures on the basis of energy minimization.

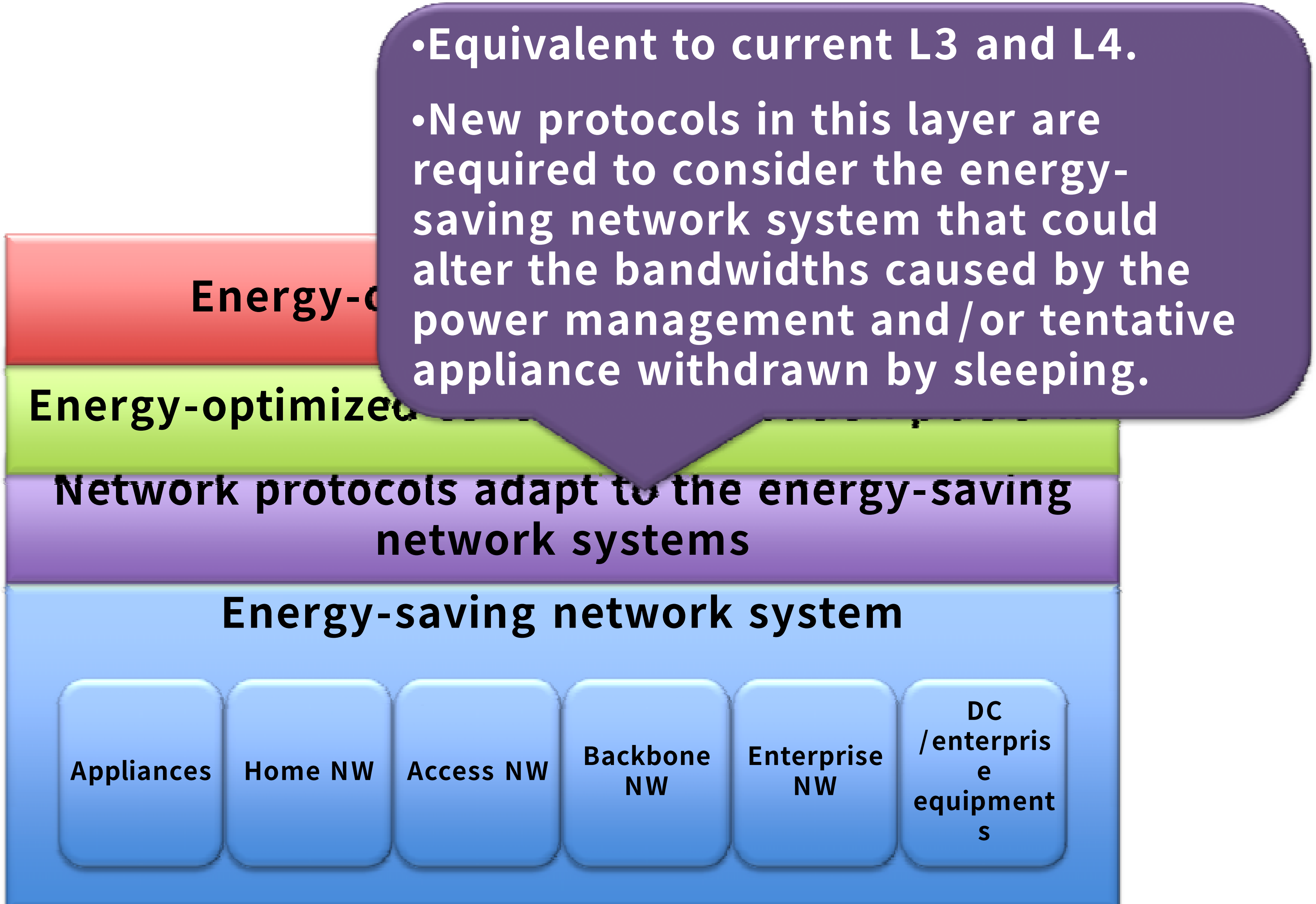
Proposed architecture



Energy-saving network system



Network protocols adapt to the energy-saving network systems



Energy-optimized contents distribution platform

- Contents distribution middleware using a metrics of energy optimization.
- For example, current CDN algorithms do not consider the energy; however, a new technology could optimize the total energy of network, servers, and clients.
    - e.g., YouTube

Energy-optimized contents distribution platform

Network protocols adapt to the energy-saving network systems

Energy-saving network system

Appliances

Home NW

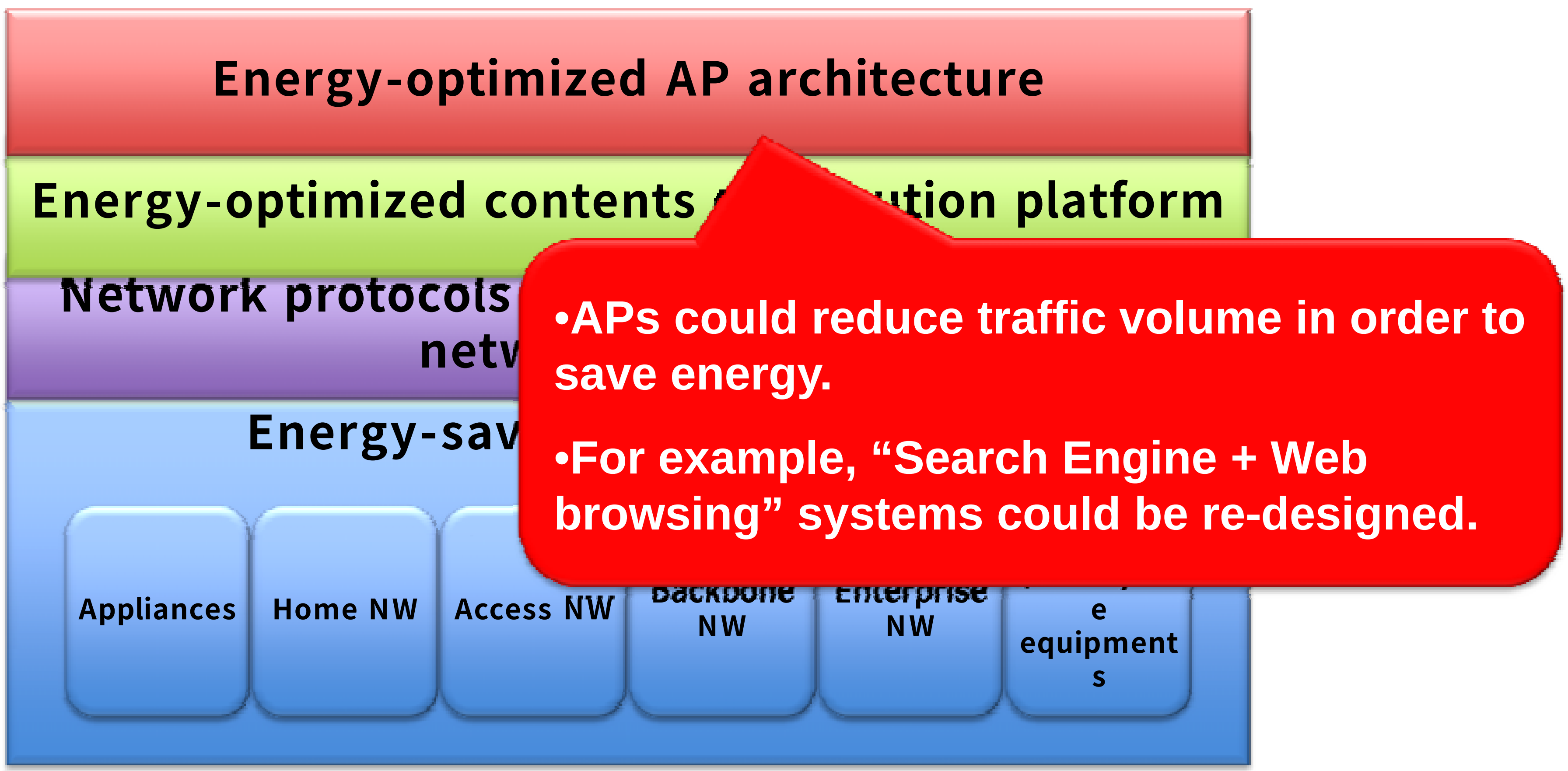
Access NW

Backbone NW

Enterprise NW

DC /enterprise equipments

Energy-optimized AP architecture



Wait a minute.

- **Let us keep cool ourselves before tackling such a great challenge.**

- **Fundamentally, there is a trade-off between conserving the global environment and enjoying the benefits of ICT as long as the fact remains that NW uses energy.**

- **ICT plays an increasingly important and indispensable role in modern society. The increase in network traffic is a desirable for the ICT industry. No doubt.**

- **However, we must always carefully consider whether the BYTES transmitted in NW have**

An example: cumulative frequency distribution of network traffic and users

- Only 1% of active users consume 60% of total traffic.
  - 10 % users for 90% of traffic.
  - The killer application is P2P.

- Do such BYTES have sufficient value in exchange for the environmental price?

“Value” vs. “Energy”?

- We should face this issue by considering the “total value maximization of exchange bytes/information in the network.”
- We are not the first person to face that “value or energy” problem.
  - Metallurgical engineering, Gasoline-fueled vehicle, etc.
- It would be out of the scope of ITU-T; however, we cannot hide ourselves from this view point if we address this problem.
- “pay-as-you-go” would be a choice.
  - Users do the equivalent exchange between the volume of traffic (energy) and money (value).
- Another one is to reduce the traffic by optimizing the information distribution/exchange.

Four key issues for energy and future networks

1. The amount of power consumed by networks.

2. <u>Reduction in energy consumption of social activities by utilizing ICT.</u>

3. Environment monitoring and sensing utilizing network and sensor technologies.

4. International contributions by Green Future Network technologies.

Energy reduction of social activities utilizing ICT

- The reduction of CO_2 emissions / energy caused by society's use of networks is also an important issue in New-Generation Network era.

- Large reductions in CO_2 emissions can be achieved by using networks as much as possible for social activities.

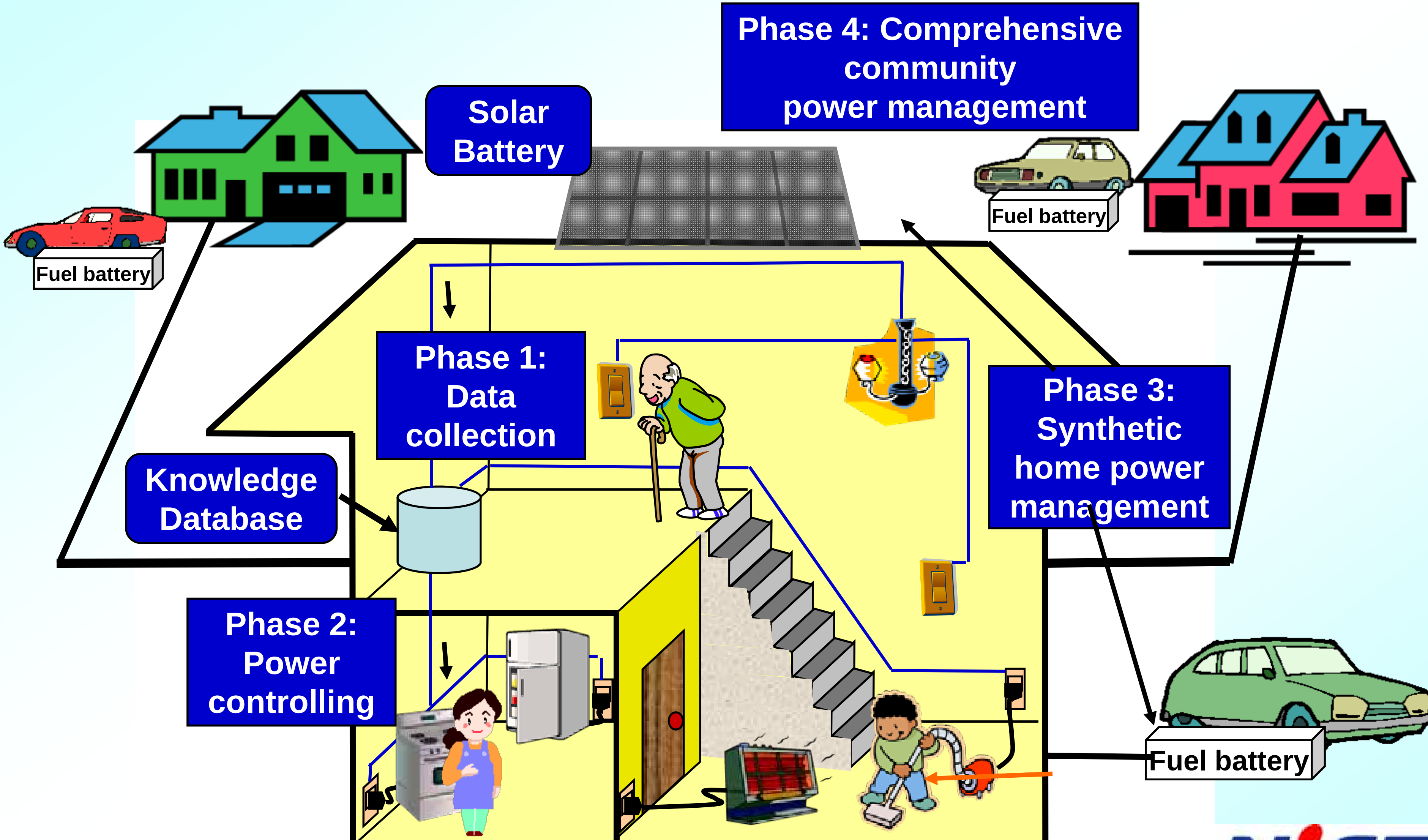
Estimate of reductions in CO_2 Emissions by utilization of ICT
(Reference: MIC Report, 2008)

CO2 emissions reduction effects by utilization of ICT

Evaluated field	Cited Areas of use	2006		2010		2012	
		10000t-CO_2	Percentage (%)	10000t-CO_2	Percentage (%)	10000t-CO_2	Percentage (%)
e-trade for individuals	Online shopping	198	0.1%	542	0.4%	712	0.5%
	Online air ticket issuing	2	0.0%	5	0.0%	6	0.0%
	Purchase of ticket at convenience stores	31	0.0%	60	0.0%	64	0.0%
	Installation of automatic Cash Dispensers	261	0.2%	291	0.2%	319	0.2%
e-trade for corporate business	Online transaction	527	0.4%	767	0.6%	836	0.6%
	Supply chain management	532	0.4%	1,839	1.4%	1,839	1.4%
	Reuse market	577	0.4%	1,154	0.8%	1,197	0.9%
e-digitization of substances	Music content	35	0.0%	114	0.1%	133	0.1%
	Visual content	15	0.0%	21	0.0%	25	0.0%
	PC software	11	0.0%	53	0.0%	61	0.0%
	Newspapers and books	4	0.0%	91	0.1%	95	0.1%
Movement of people	Telework	30	0.0%	50	0.0%	63	0.0%
	TV conferences	105	0.1%	194	0.1%	305	0.2%
	Remote control	5	0.0%	5	0.0%	5	0.0%
Advanced road traffic system	ITS	308	0.2%	370	0.3%	401	0.3%
e-government and e-municipality	e-tender	0	0.0%	2	0.0%	2	0.0%
	e-application (tax filing)	0	0.0%	8	0.0%	8	0.0%
	e-application (online receipt)	0	0.0%	1	0.0%	1	0.0%
Energy control	BEMS, HEMS	468	0.3%	730	0.5%	730	0.5%
Total		3,110	2.3%	6,297	4.6%	6,802	5.0%

Note) Percentage shows the percentage in respect to total greenhouse gas emissions in Japan for 2005

power management researches in NICT

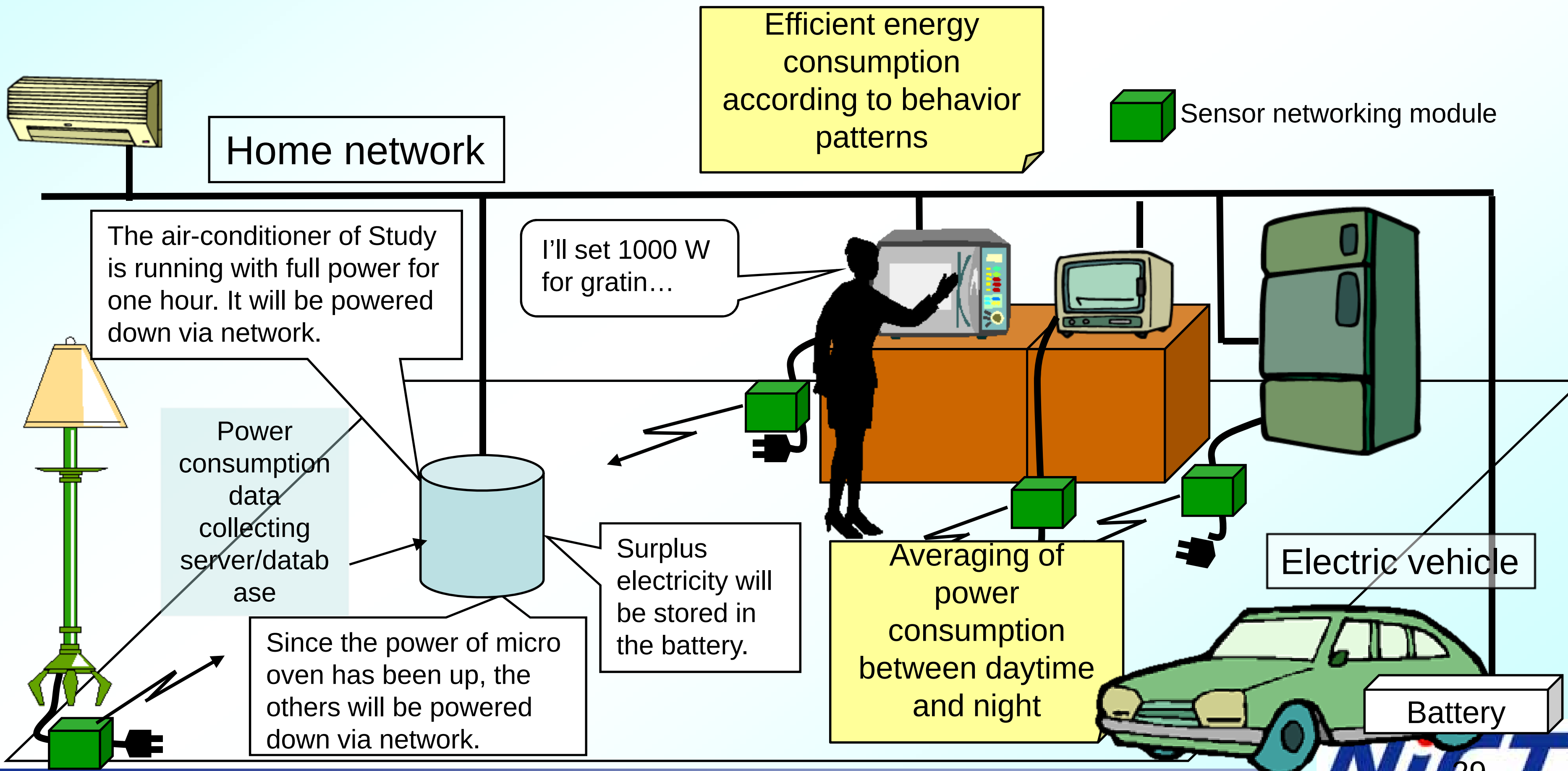


Reference: Tatsuya Yamazaki (NICT), 2009.

NICT ICT Value Chain

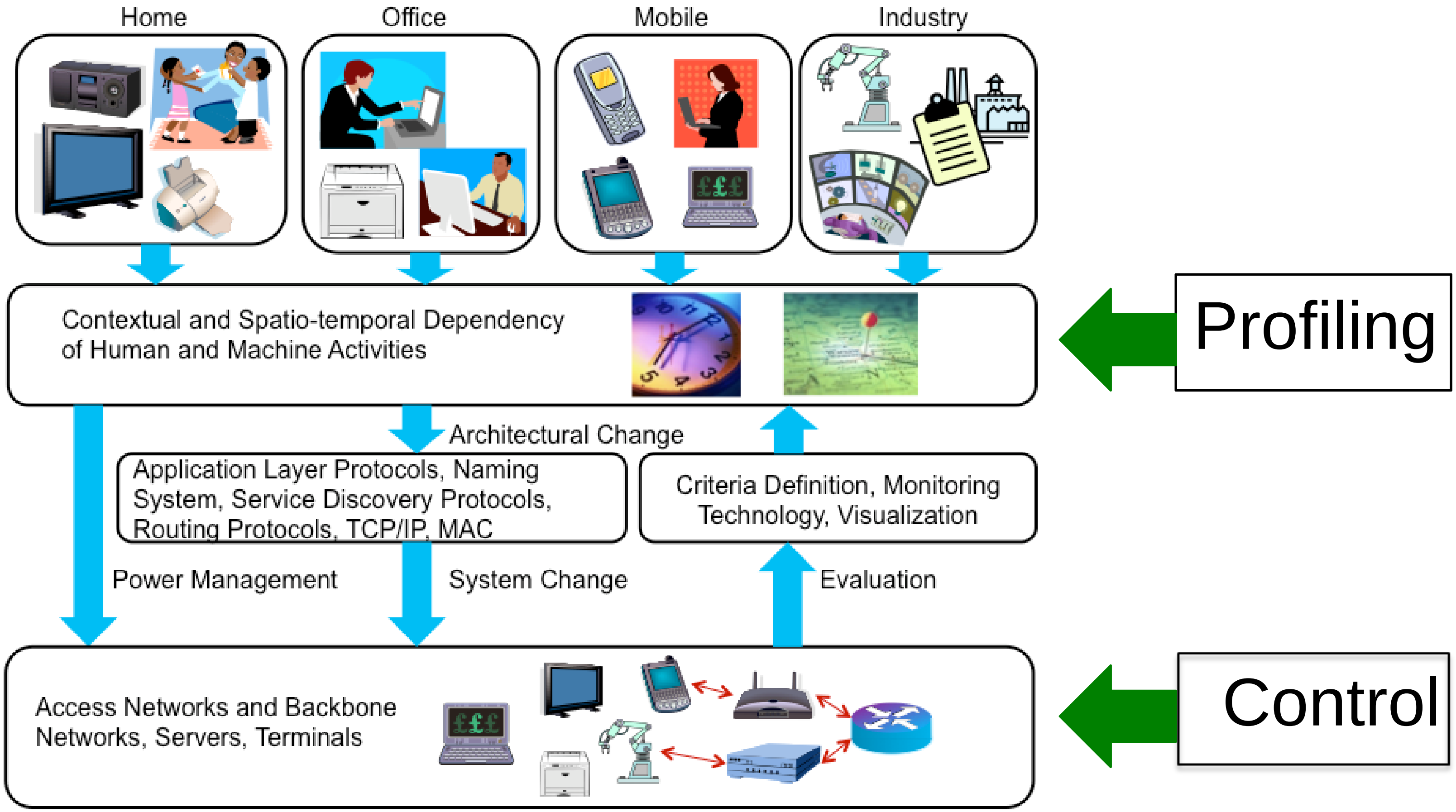
Appliance Control by Home Network Technology

- Appliance control function in addition to power consumption sensing
- Making life safe by realizing self-supporting in an emergency as well as making life economical by averaging power consumption.



Reference: Tatsuya Yamazaki (NICT), 2009.

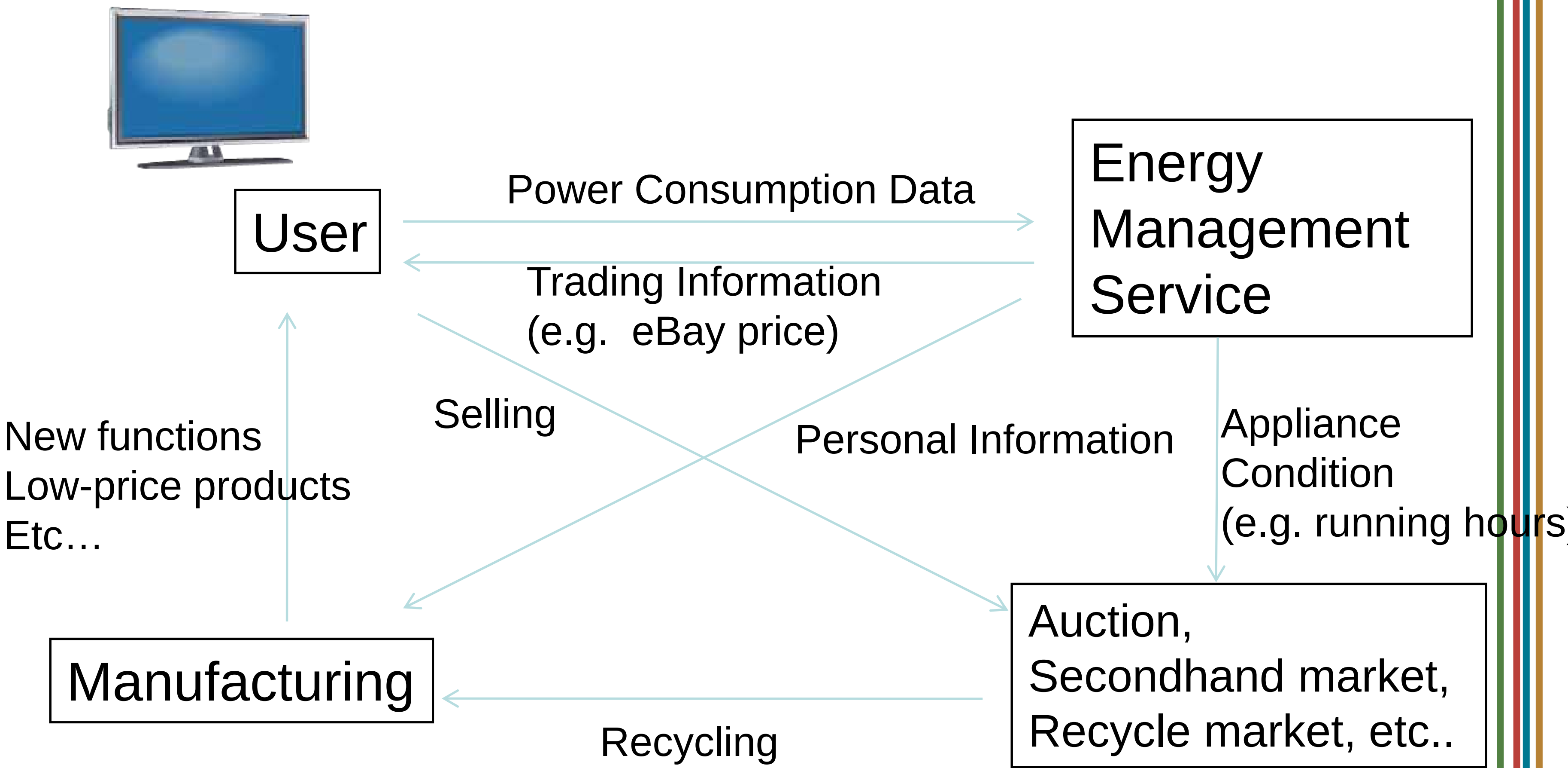
Research Activities of Prof. Morikawa and Prof. Minami (Univ. of Tokyo)



Reference: Hiroyuki Morikawa and Masateru Minami (Univ. of Tokyo), 2008.

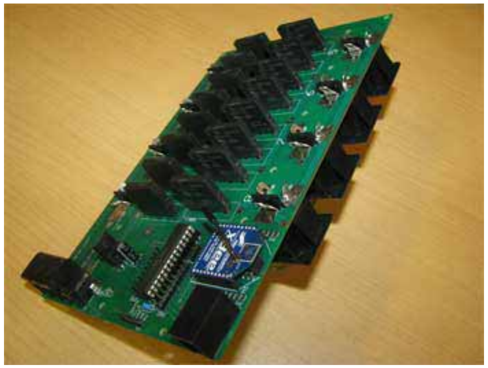
Energy Management Service

MORIKAWA
LABORATORY



Reference: Hiroyuki Morikawa and Masateru Minami (Univ. of Tokyo), 2008.

Energy Profiling

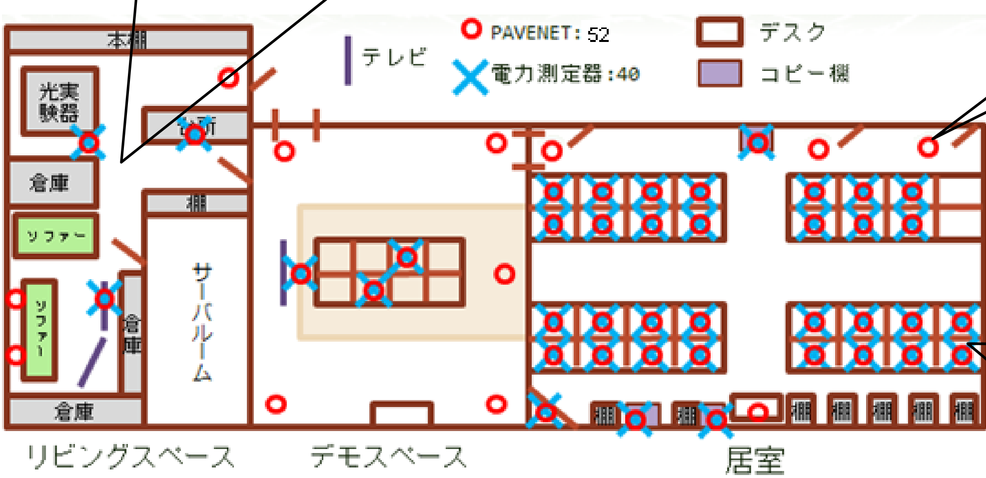


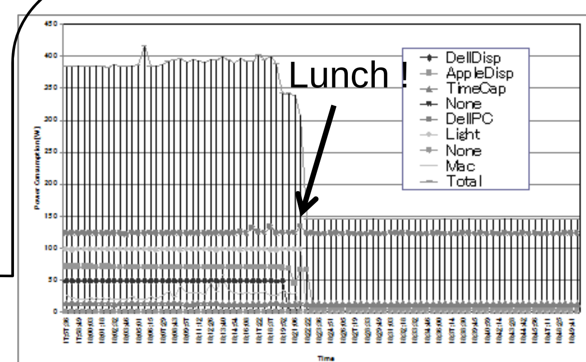
Wireles LAN

IEEE802.15.4

8 Channel Wireless Energy Meter with Remote ON/OFF Switch

WSN node (PAVENET)

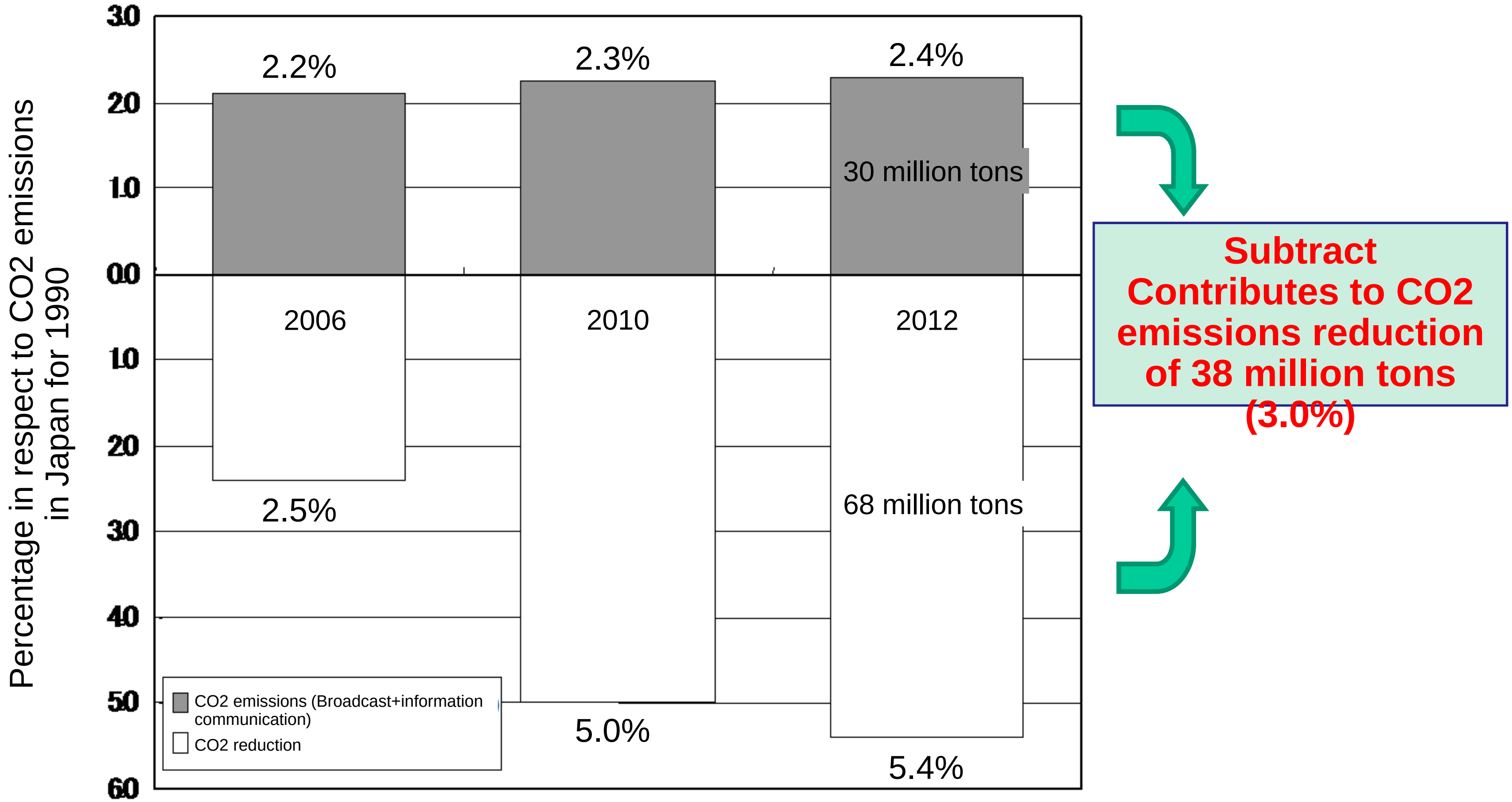




Profiling connection between energy and context

Reference: Hiroyuki Morikawa and Masateru Minami (Univ. of Tokyo), 2008.

Estimate of reductions in CO_2 Emissions by utilization of ICT
(Reference: MIC Report, 2008)



In 2012, 30 million tons of CO_2 are expected to be emitted in the ICT field, but the use of ICT will produce CO_2 reduction effects of 68 million tons, contributing to CO_2 emissions reduction of 38 million tons (Equivalent to 3.0% of 1990 CO_2 emissions in Japan)

* This calculation includes “reduction potentials” which do not appear immediately, and efforts are required to realize these potentials.

Requirements to NWGN

- **Network dependability** is a key in order to promote and accelerate the transformation of social activities into network-based.
  - Reliability,
  - Survivability against disasters,
  - Security,
  - Low delay / jitters, etc.

Four key issues for energy and future networks

1. The amount of power consumed by networks.

2. Reduction in energy consumption of social activities by utilizing ICT.

3. Environment monitoring and sensing utilizing network and sensor technologies.

4. International contributions by Green Future Network technologies.

Summary

- For future networks, energy issue is definitely the centerpiece.
- We can categorize four issues to discuss.
- The methods to calculate the energy usage in networks and its standardizations are strongly required.
- We need innovative approaches beyond the conventional ones, including re-designing network architectures on the basis of energy minimization.

FYI:

http://www.green-communications.net/icc09/home.html

Thank you very much for your attention.

Q&A