Networking Technology Trend in Japan

Smart Grid, Green ICT, and White Space

June 28, 2012

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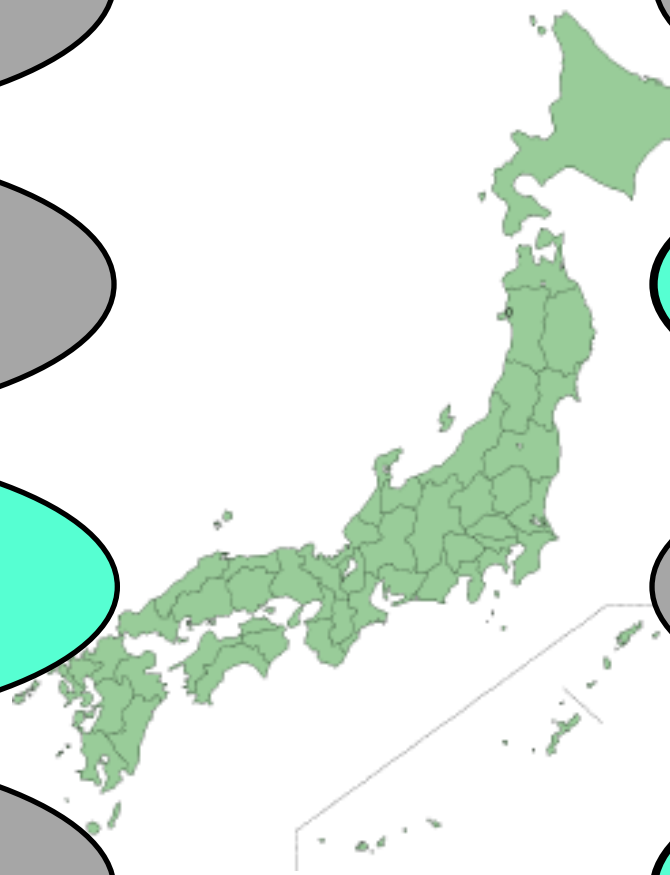
Networking Topics

- Next Generation Network
- Software Defined Network
- All Optical Networking
- Green ICT
- Smart Grid
- Network Security
- Long Term Evolution
- White Space

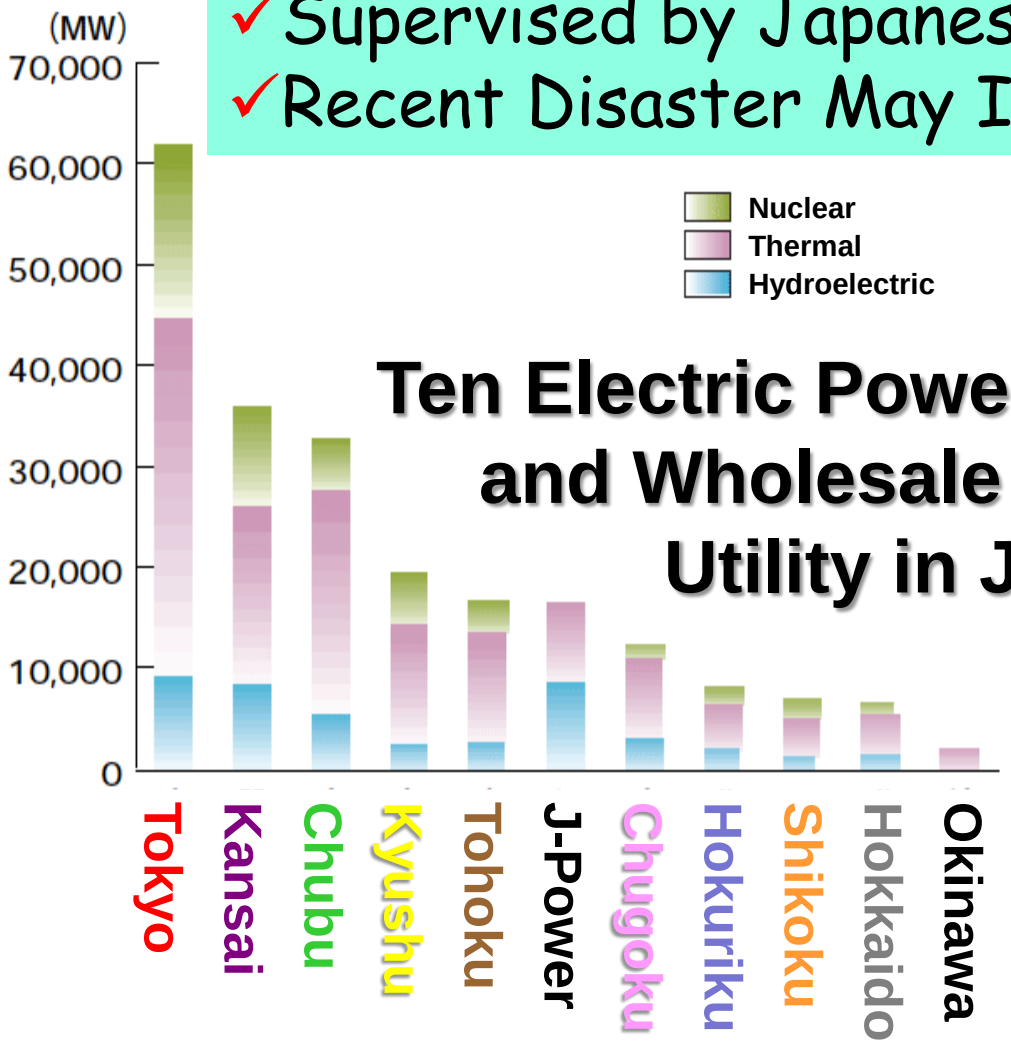


ToC

- Smart Grid and Japan's Situation
- Activities for Green ICT
- TV White Space in Japan

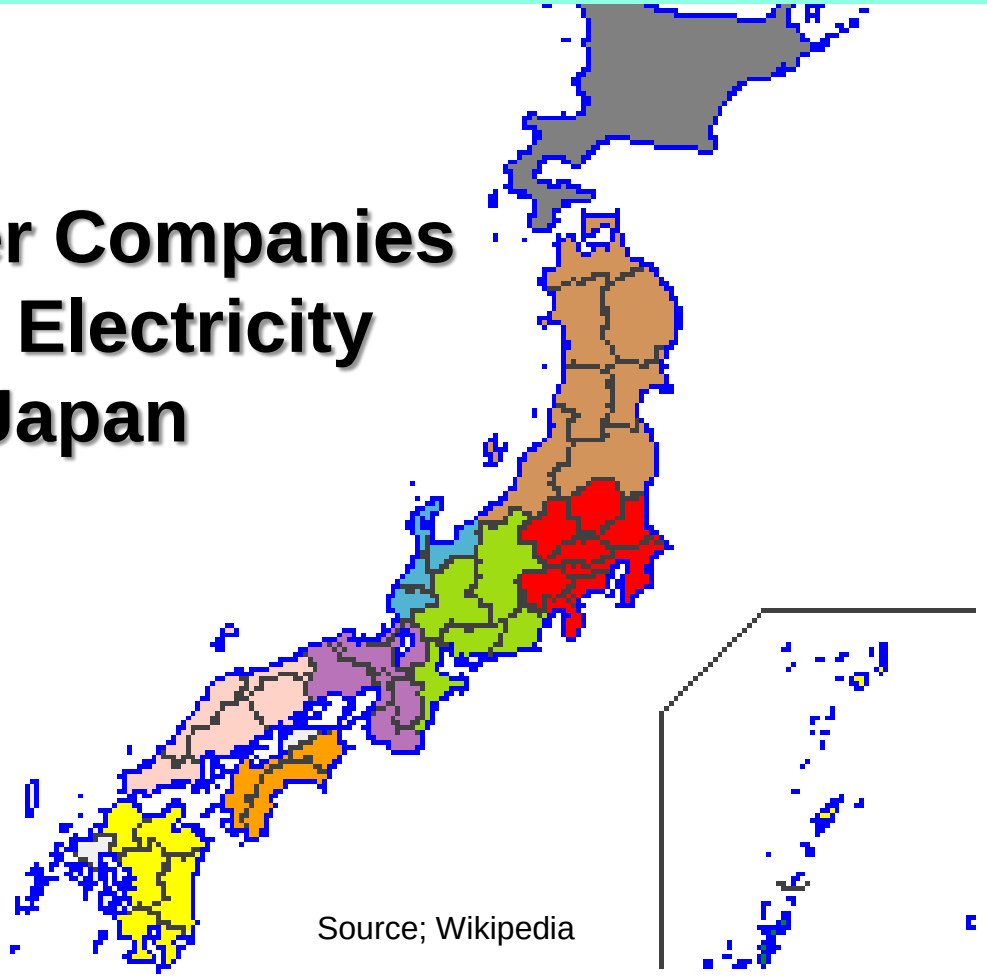
Electric Power Companies

- ✓Supervised by Japanese Government, but Not Owned
- ✓Recent Disaster May Impact the Situation



Ten Electric Power Companies and Wholesale Electricity Utility in Japan

March 2006



Source; Wikipedia

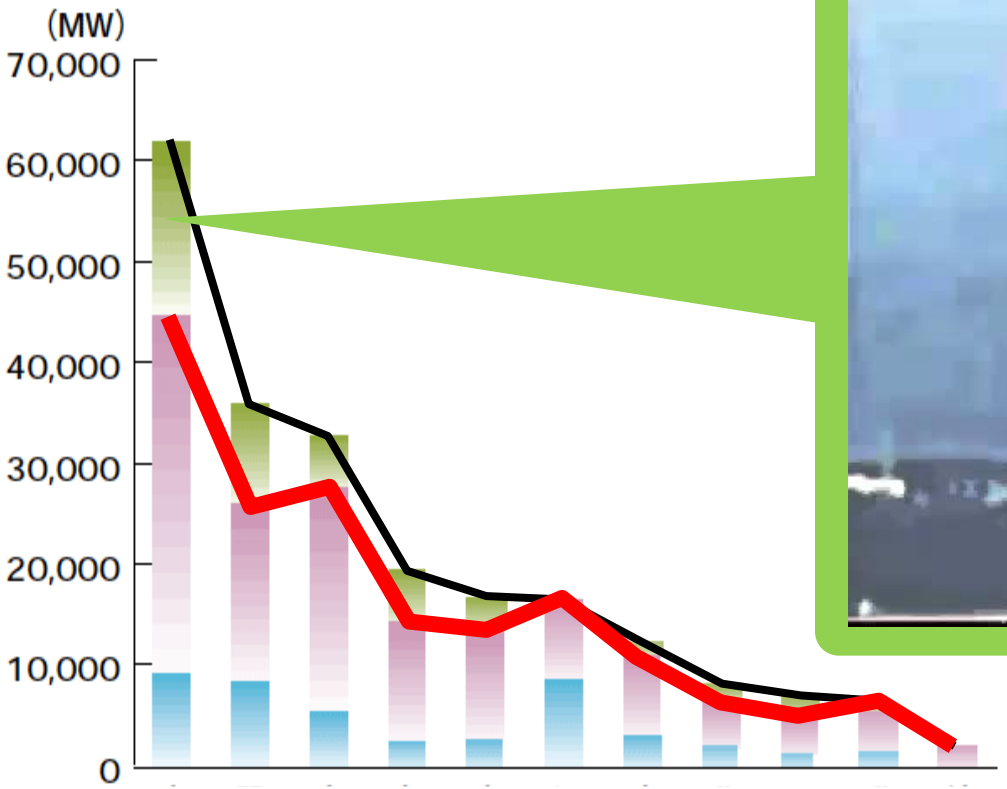
Source; J-POWER http://www.rist.or.jp/atomica/data/pict/13/13020214/08.gif

"Still I'm Alive!"

- ✓Megaquake and Tsunami on March 11, 2011
- ✓Once a Millennium Disaster in Northern Japan

Intentionally Blank

Hit Nuclear Power Plant



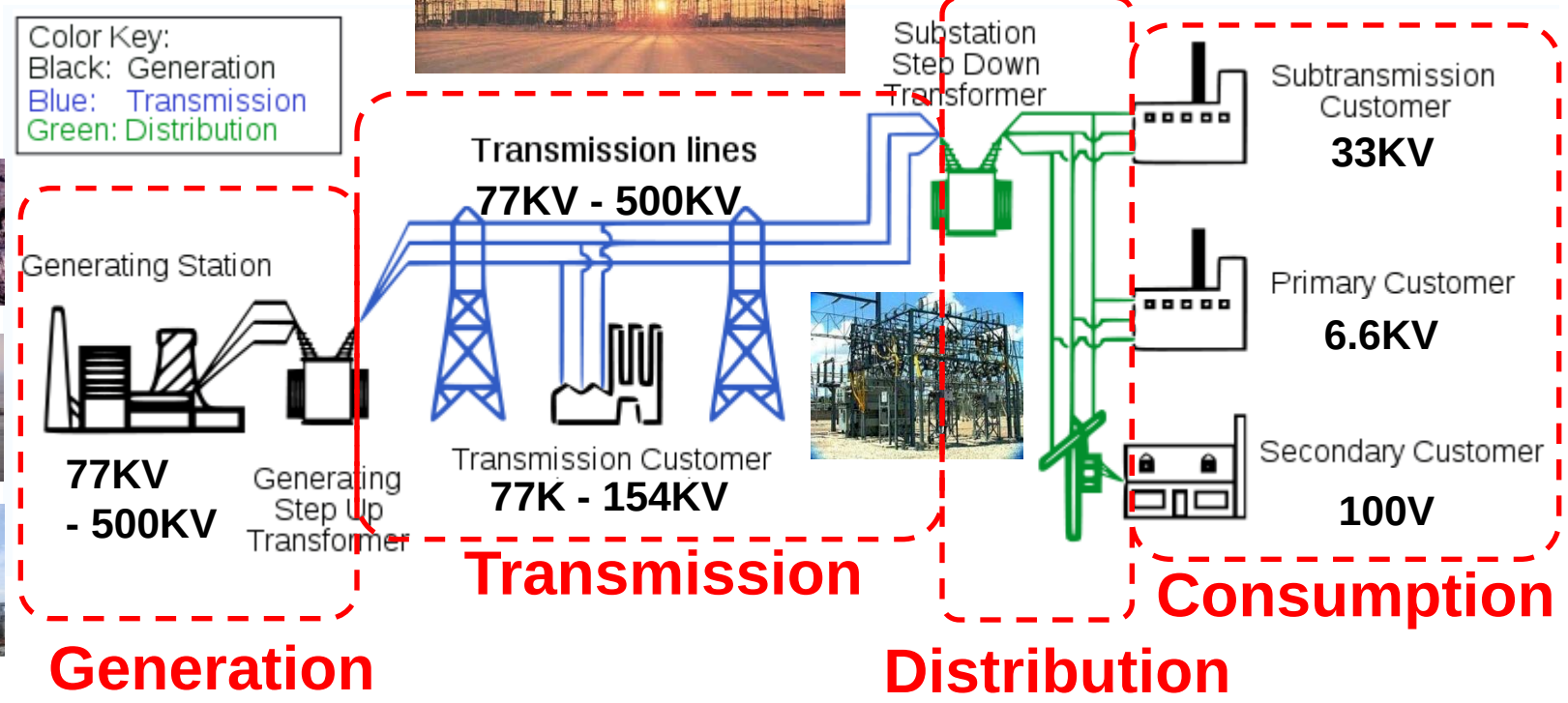
Source; http://www.youtube.com/watch?v=31QiQbTS7eE

- ✓Stopped All Nuclear Reactors in Japan
- ✓Needs More Efficient Power System

Electric Grid in Japan*

- ✓Relatively Low Voltage for Transmission and Distribution
- ✓Strategic and Planned Evolution, not a Patch Work

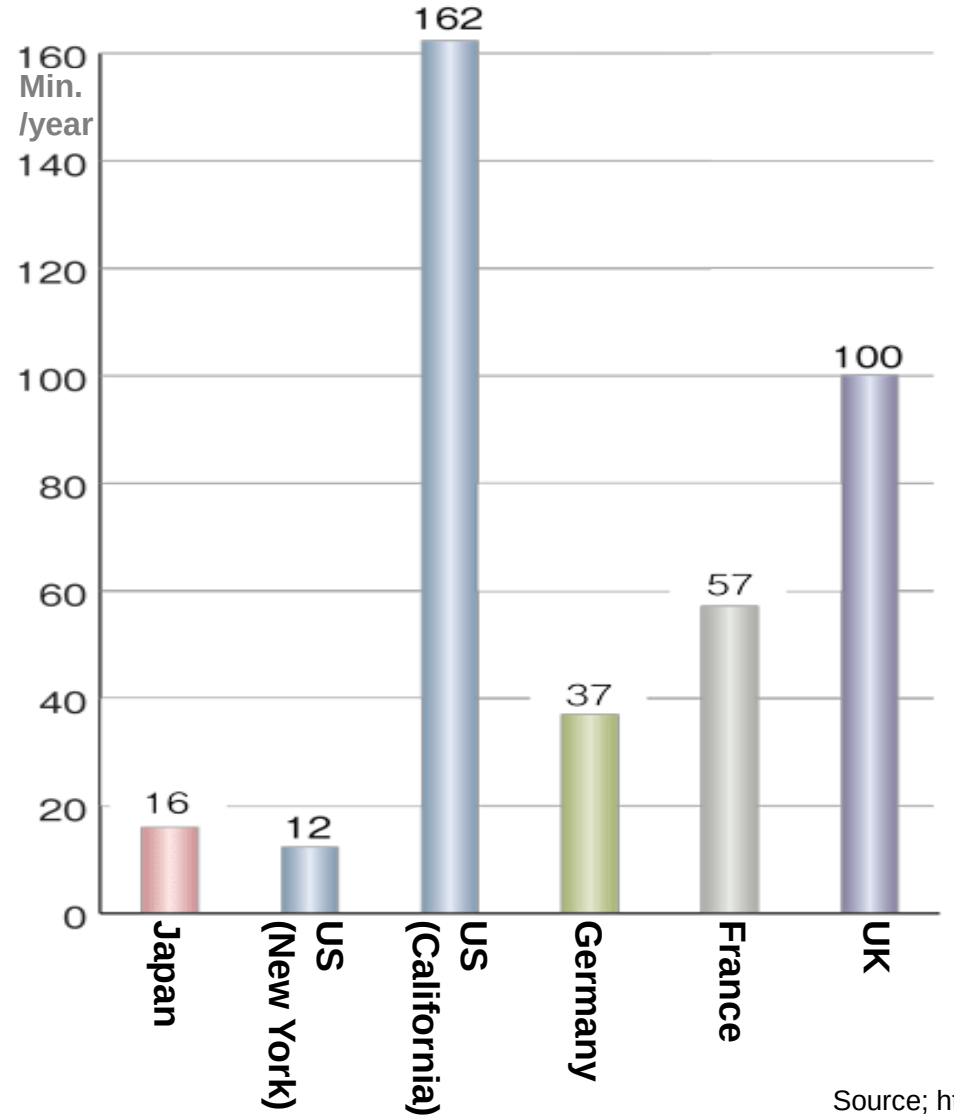
*Note; Analogy to the US Grid



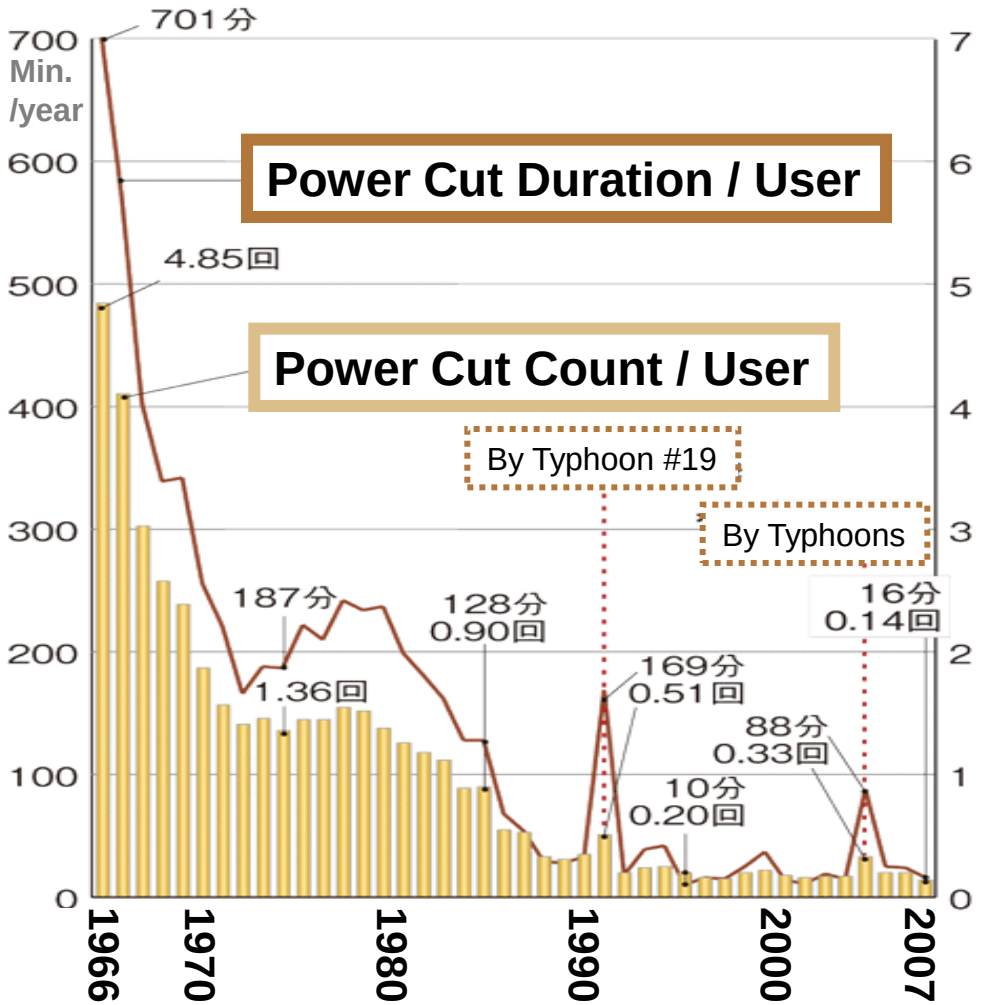
Source; http://maryland.sierraclub.org/action/p0204.asp,
http://www.chuden.co.jp/ryokin/information/chishiki/mame_hatsuden/index.html

Quality

✓Power Cut per User: Comparison (2007)



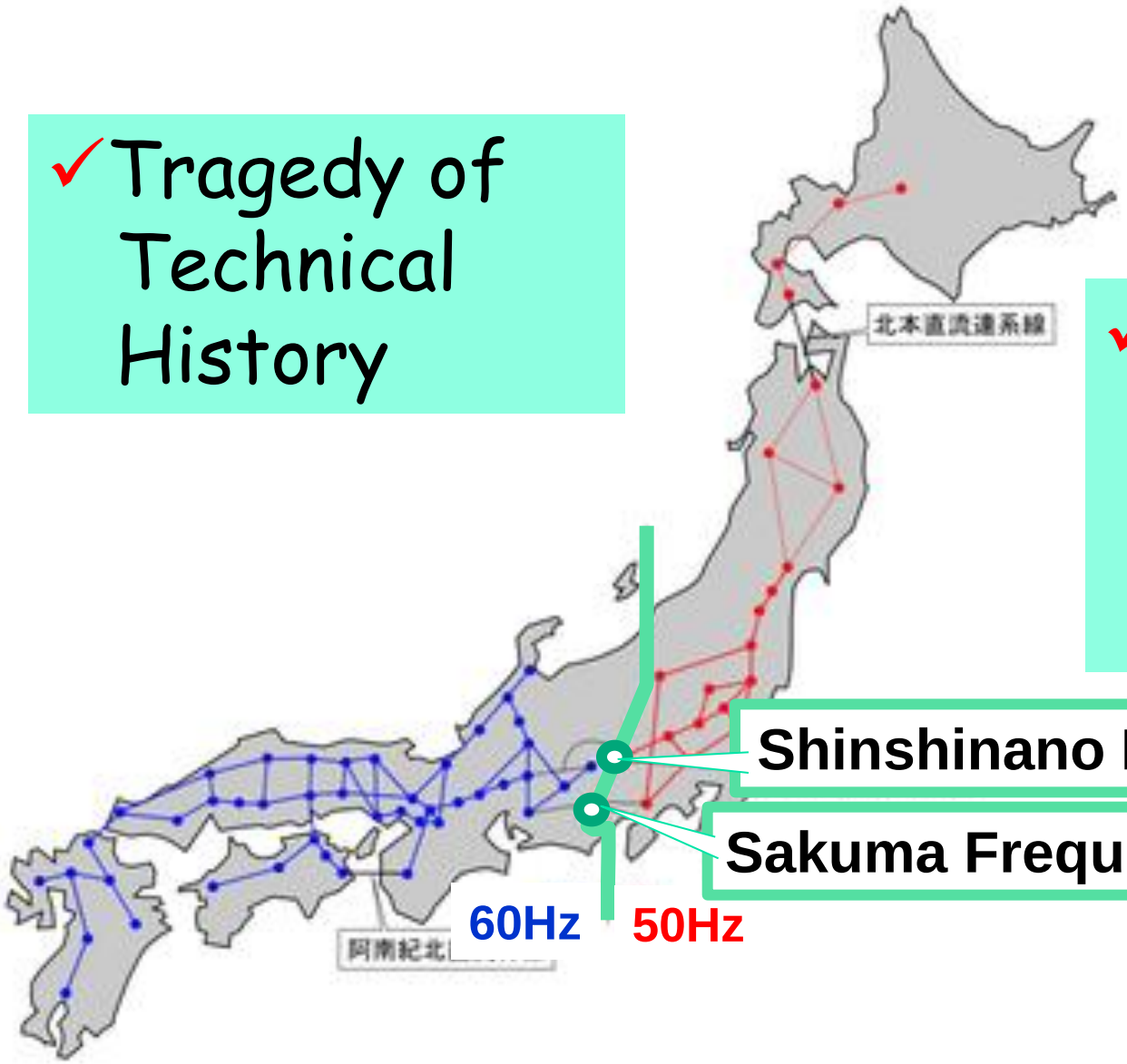
✓Improvement of Power Cut in Japan



Source; http://www.impressrd.jp/idc/story/2009/02/03/705?page=0%2C3

High Voltage Transmission

- ✓Tragedy of Technical History
- ✓Two Frequency Converting Stations on the Border

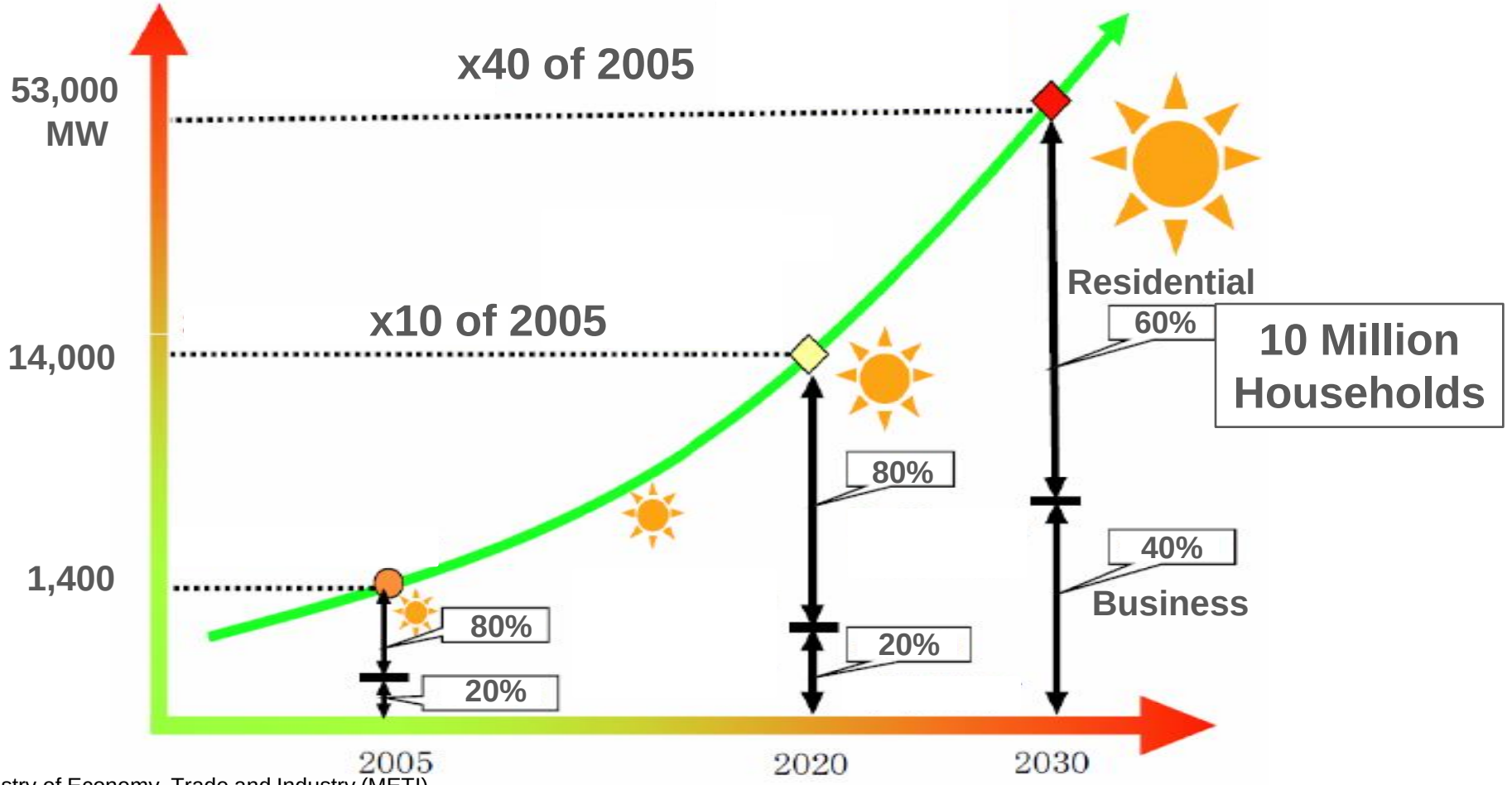


Shinshinano Freq. Conv. Station

Sakuma Frequency Conv. Station

Japan's Motivation

- ✓Promoting Solar Power Generation
- ✓Adverse Currents (Backflow) at Distribution

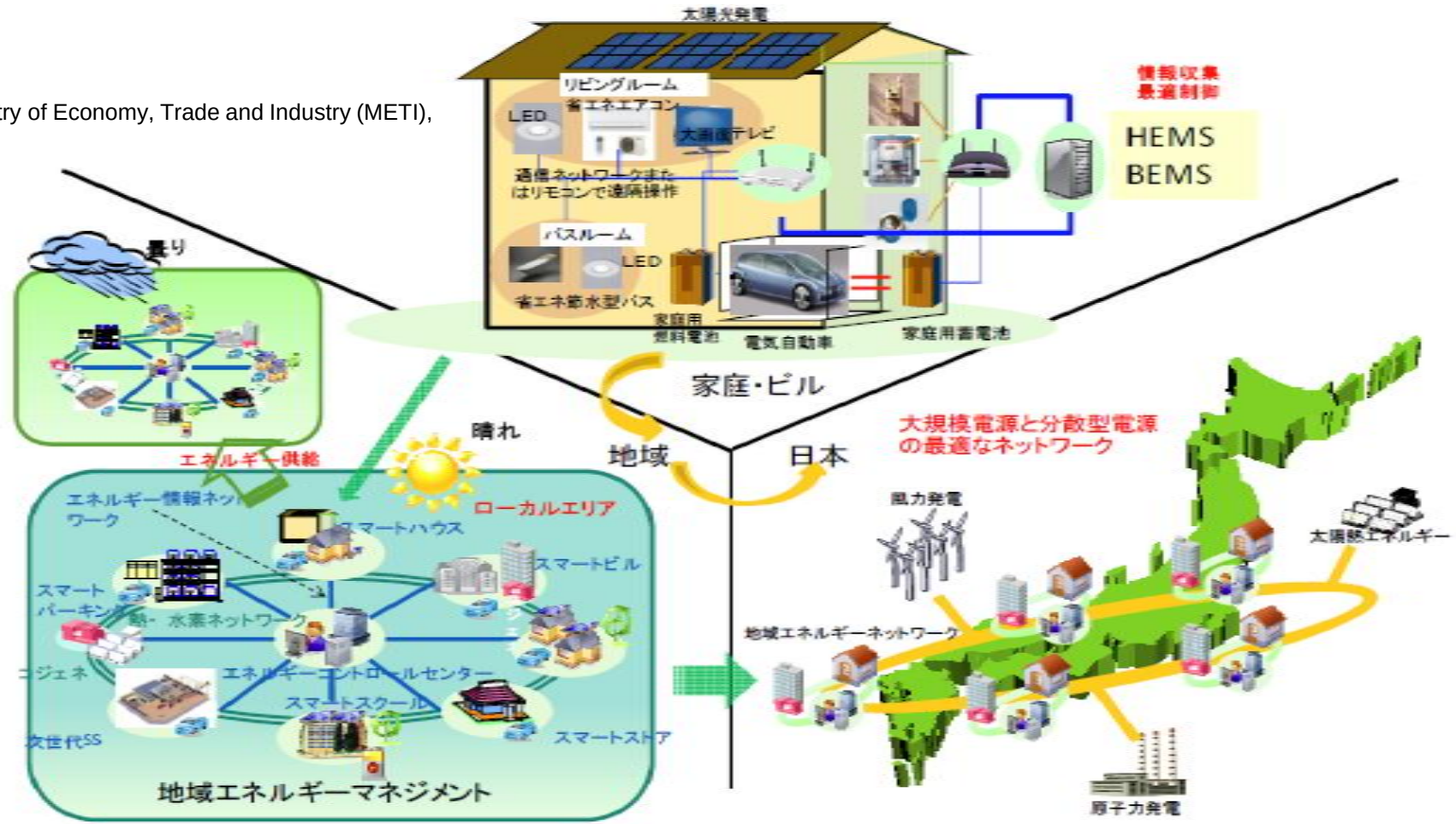


Source; Ministry of Economy, Trade and Industry (METI),

Smart Grid Evolution in Japan

- ✓Starting at HEMS/BEMS, then Distribution
- ✓Follows Networking for Wider Area

Source; Ministry of Economy, Trade and Industry (METI),



Power Company's View

- ✓Decided to Invest $10+ Billion for Smart Grid
- ✓Focusing on Convergence of Demand/Supply

東電など電力各社

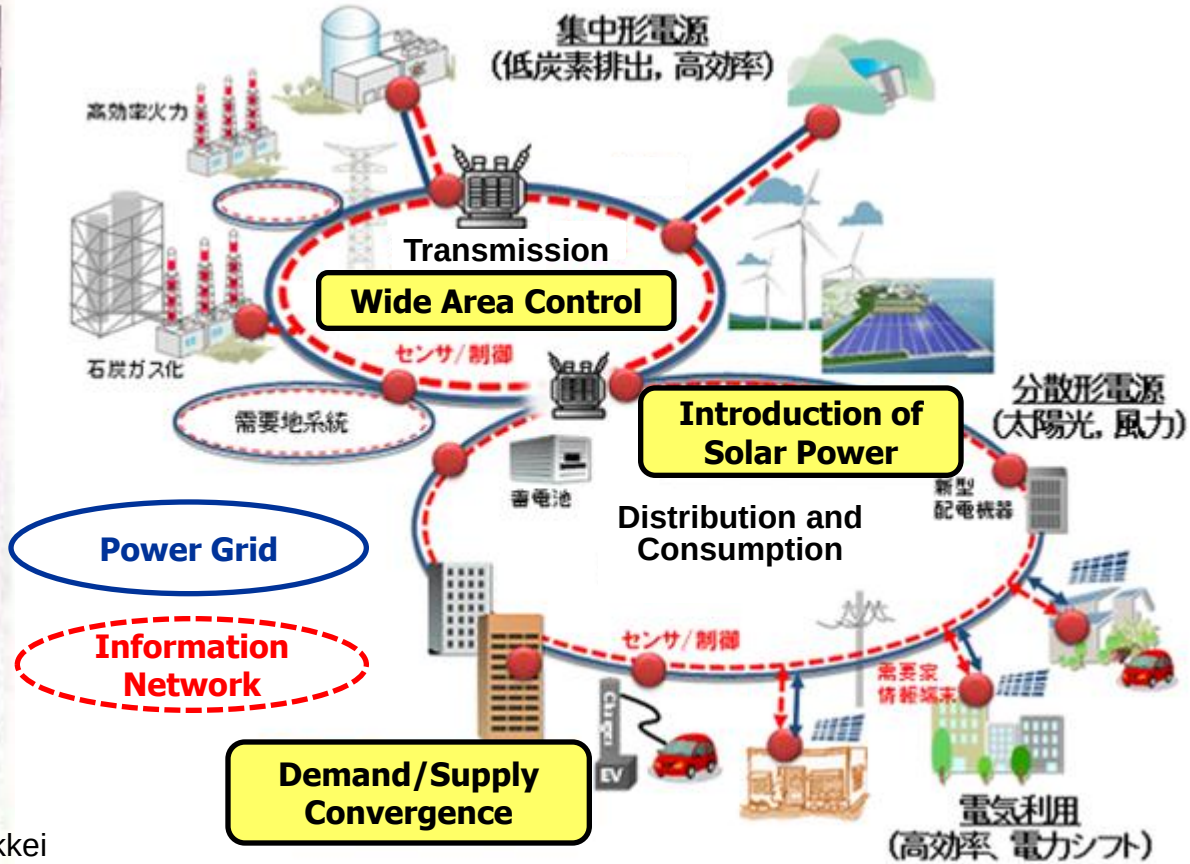
各家庭に専用メーター

「太陽光」急増に備え

次世代送電網に1兆円

スマートグリッドの仕組み

Source; Nikkei
Jan. 12, 2010

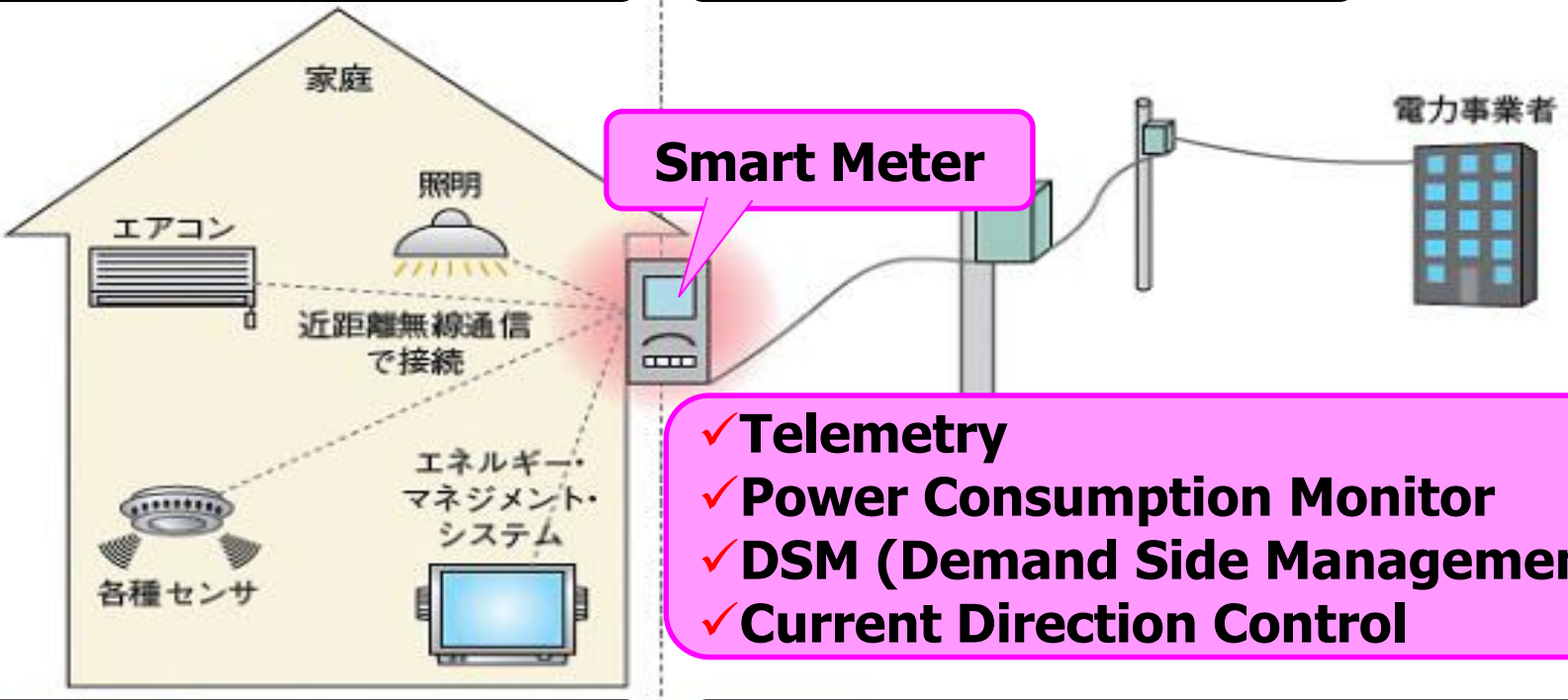


Source; CRIEPI http://criepi.denken.or.jp/research/news/pdf/den458.pdf

Intelligent House

- ✓Started Installing Smart Meters for Trial
- ✓No Standardization yet, but Proprietary

LAN Side | **WAN Side**



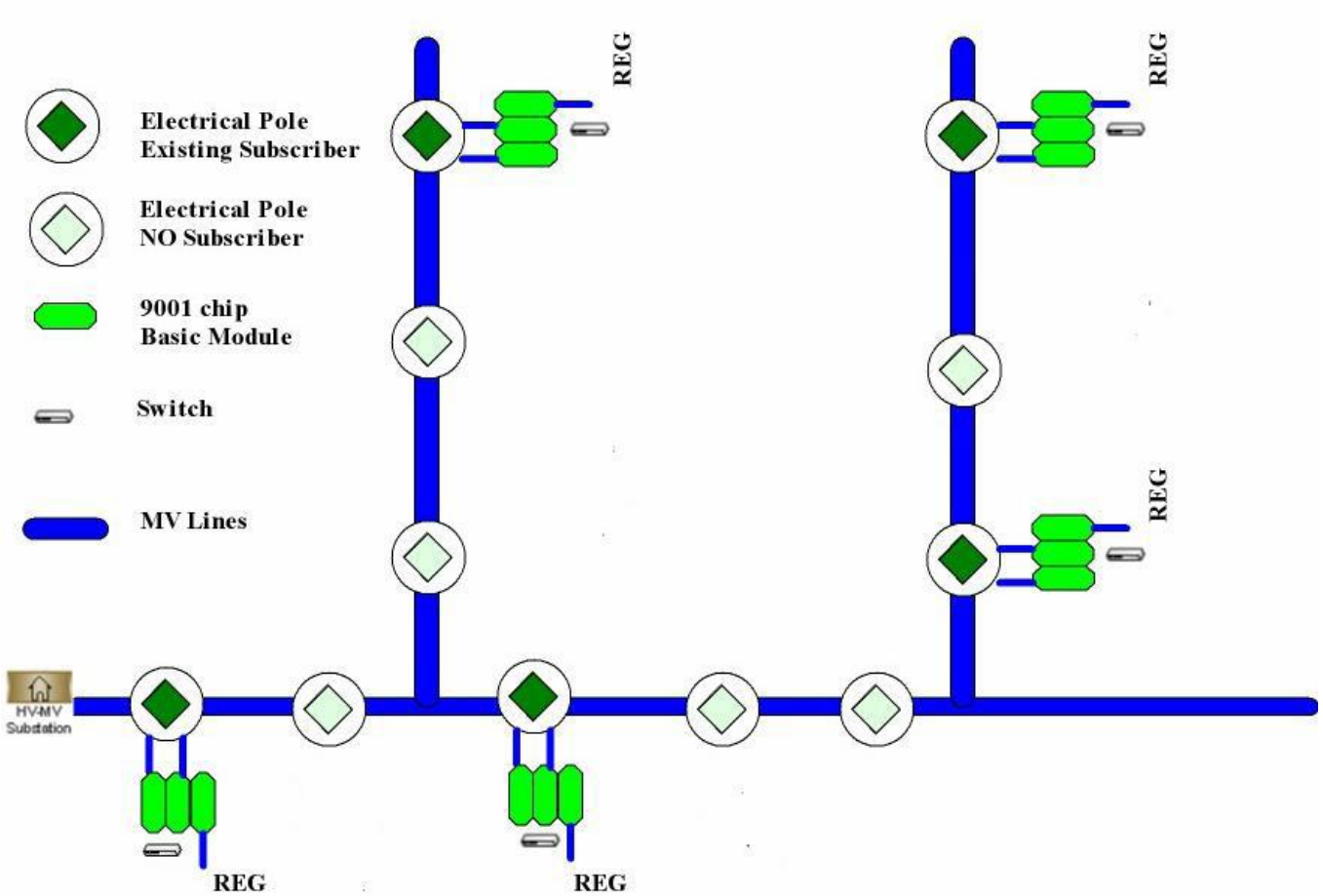
- ✓**Telemetry**
- ✓**Power Consumption Monitor**
- ✓**DSM (Demand Side Management)**
- ✓**Current Direction Control**

WLAN, NFC, PLC, etc. | **LTE, WiMAX, AdHoc, PON, etc.**

Source; Cosmo Home Co, Ltd., etc.

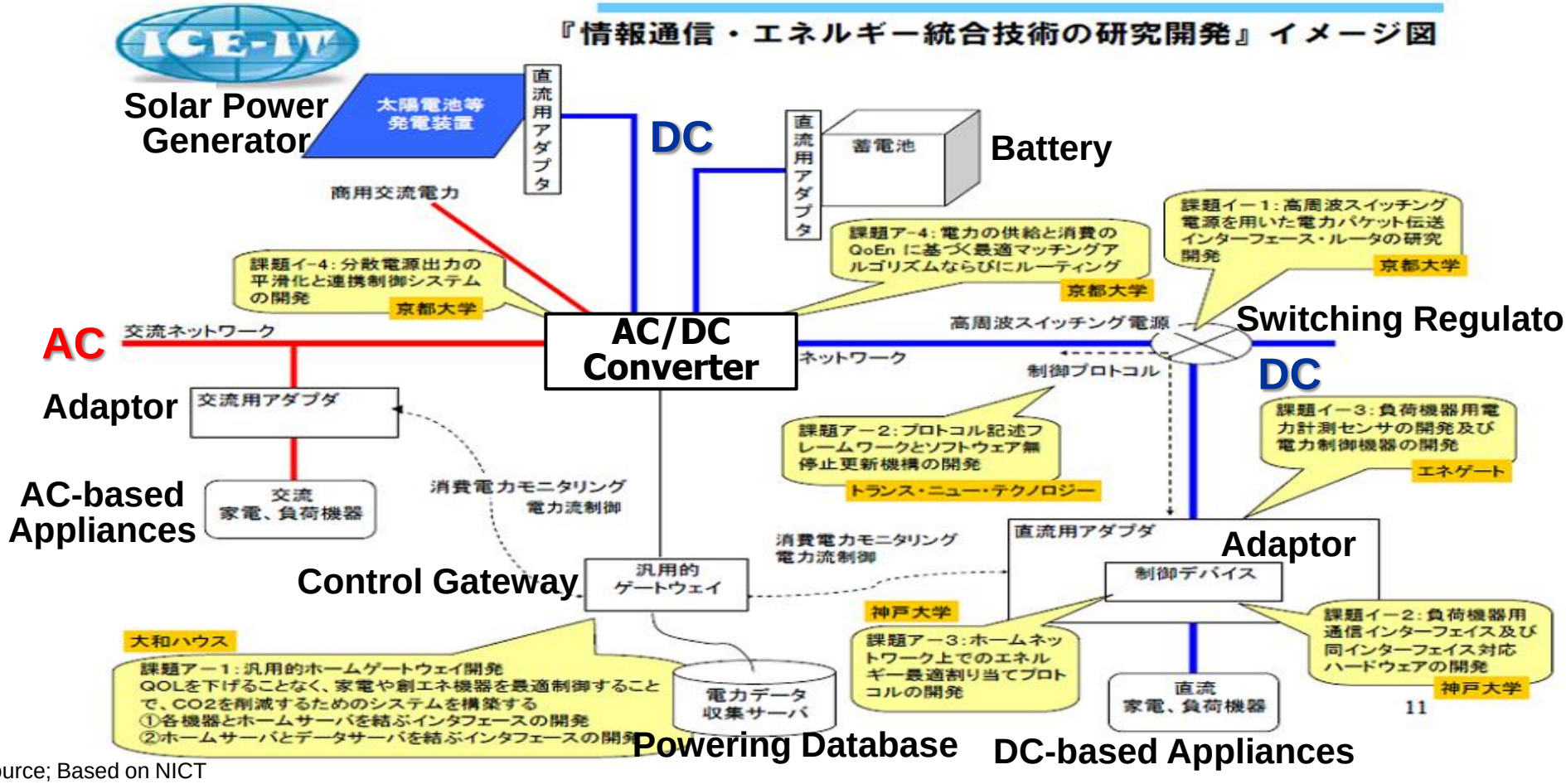
PLC

- ✓ Delivers Reliable 10 Mbps Throughput
- ✓ Legal in LAN, but Illegal in WAN in Japan



DC-based Powering in House

- ✓Motivated by DC-based Generator and Battery
- ✓Expected Long Term Research Work



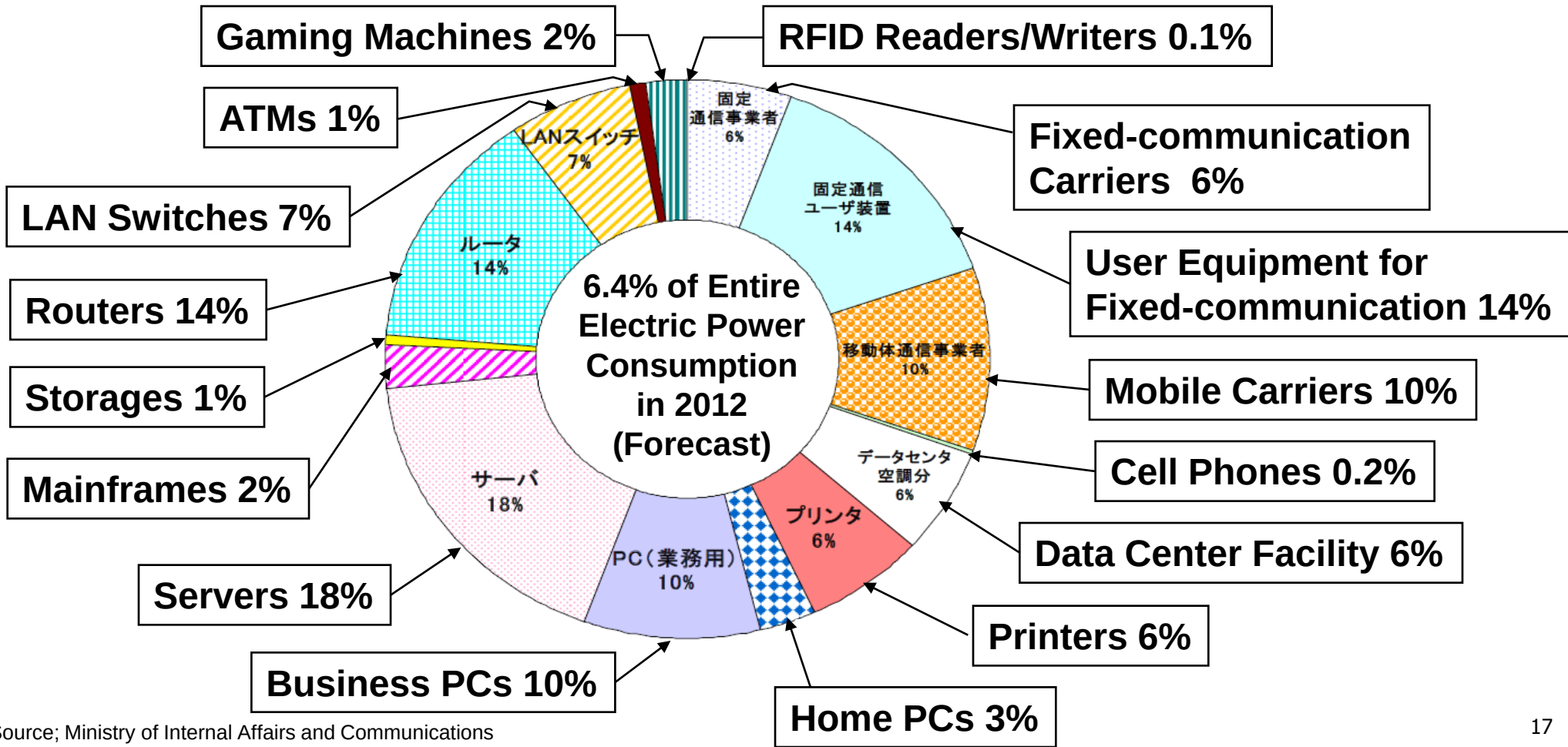
Source; Based on NICT

ToC

- Smart Grid and Japan's Situation
- **Activities for Green ICT**
- TV White Space in Japan

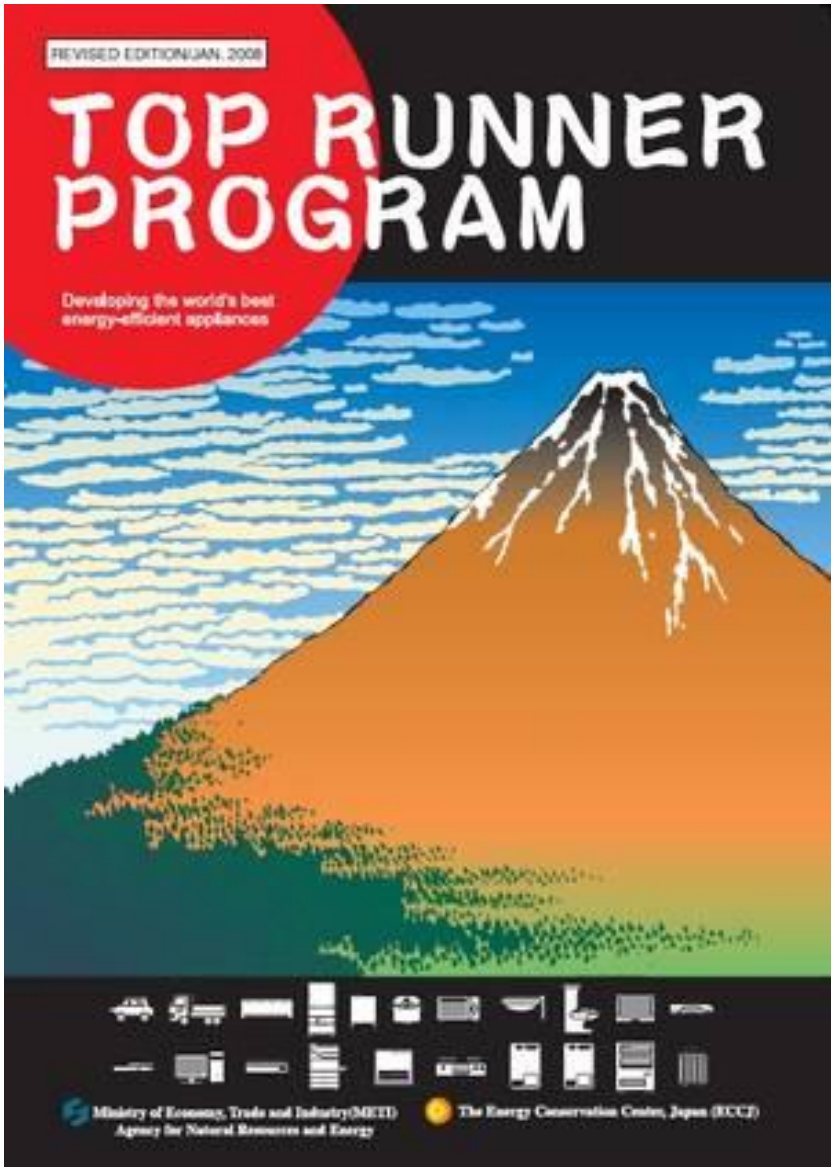
ICT Power Consumption

- ✓6.4% of Entire Electric Power Consumption
- ✓Increasing according to Traffic Growth



Source; Ministry of Internal Affairs and Communications

Government Promotes.....

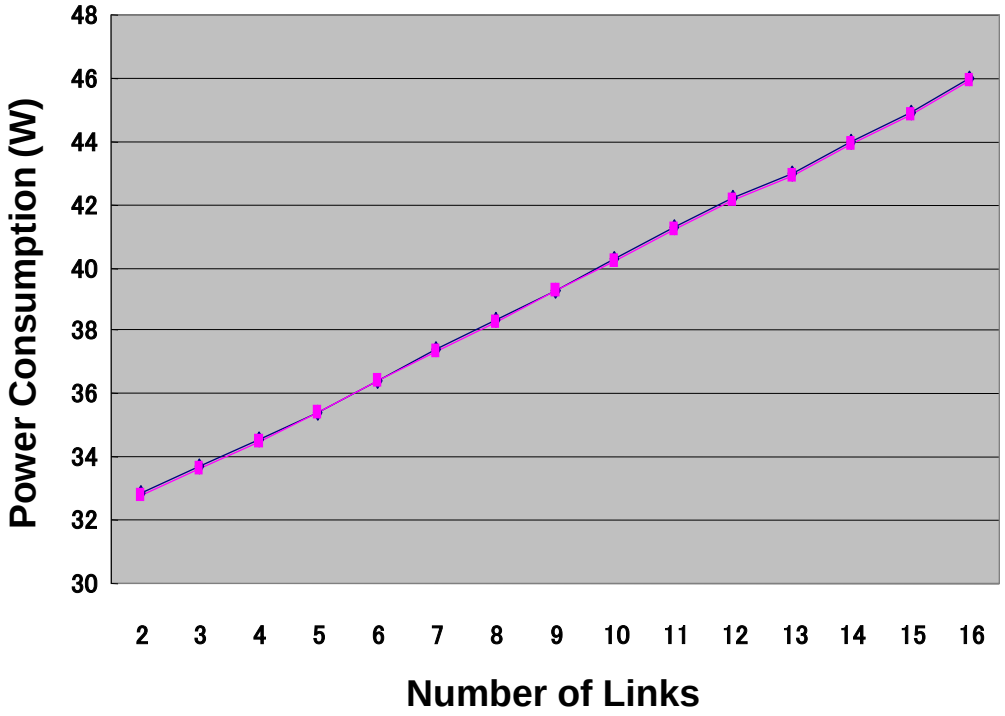


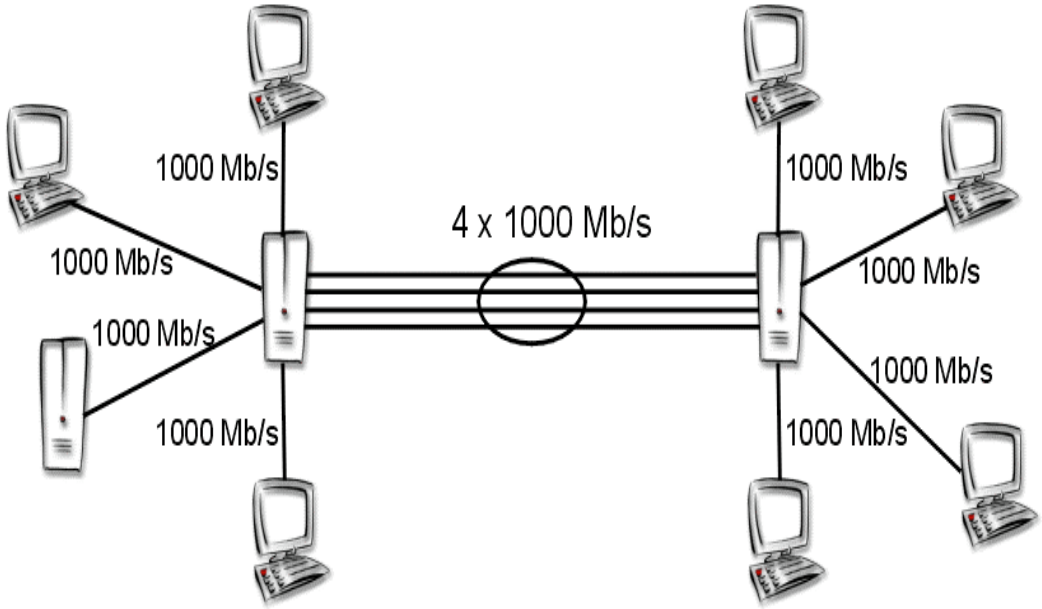
- ✓Since 1990 for More Energy Saving
- ✓Certification Stickers
- ✓Routers/Switches Are Listed since Last FY.

Source; Agency for Natural Resources and Energy

Observation

- ✓Popular Multi-link Connection in Backbone
- ✓0.2W(10Mbps), 0.3W(100Mbps), 1W(1Gbps) measured by KIT
- ✓Combination of LACP and Power Elimination?

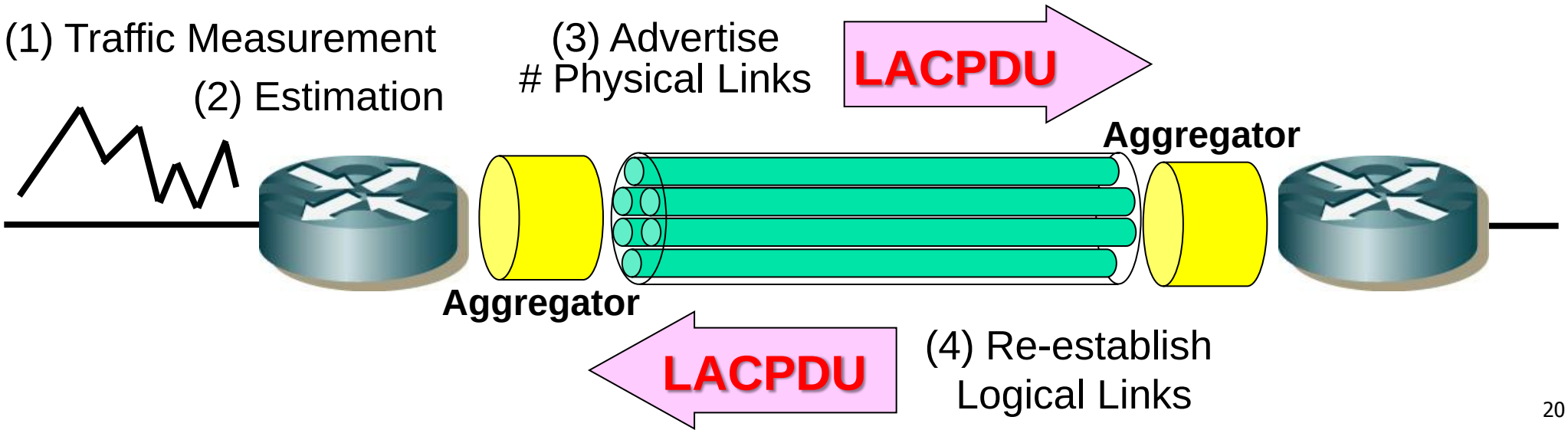




Source; SysKonnect

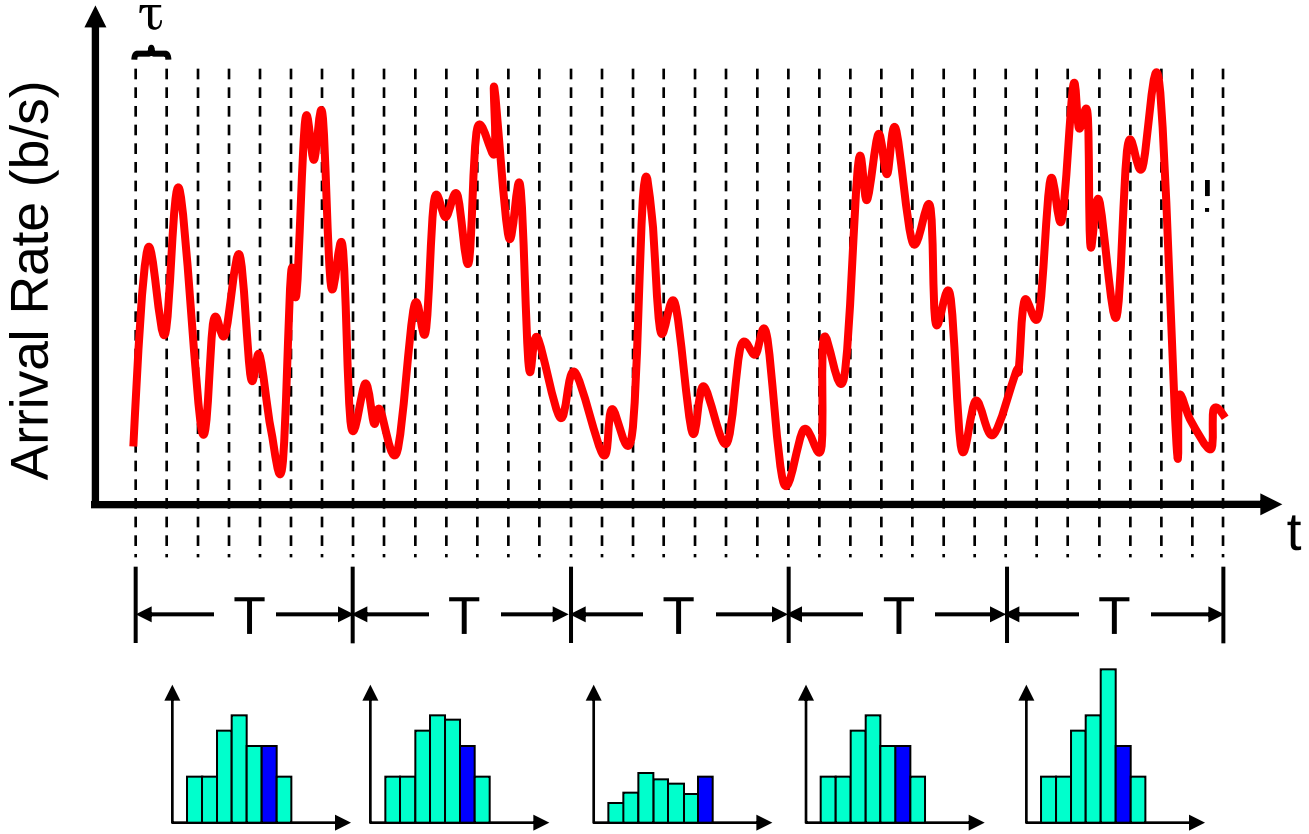
Using LACP Data Unit

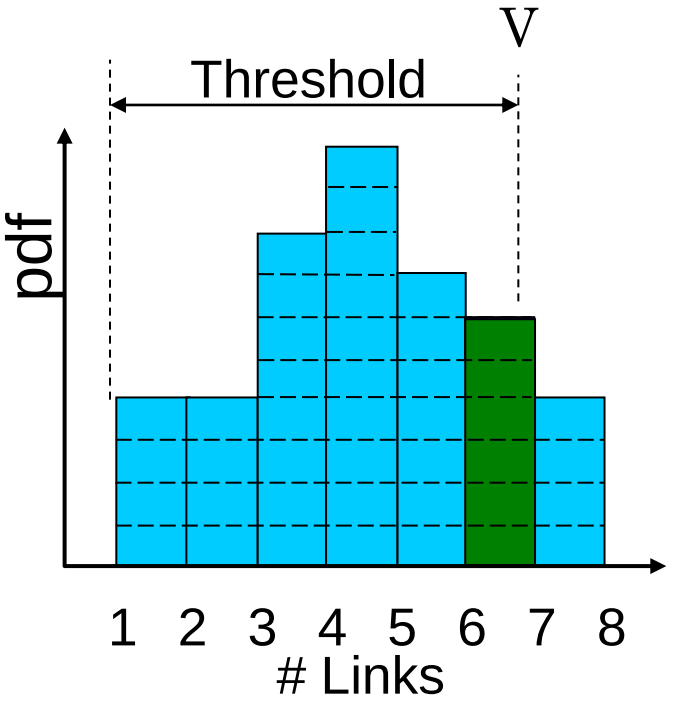
- ✓ Link Aggregation Control Protocol (IEEE 802.3ad)
- ✓ Original Purpose
  - ➢ Load Sprit for taking advantage of Slower Physical Trunks
  - ➢ Higher Reliability; Isolation of Faulty Links
- ✓ Adding New Features
  - ➢ Traffic Measurement and Estimation
  - ➢ Periodical Alternation of # Physical Links



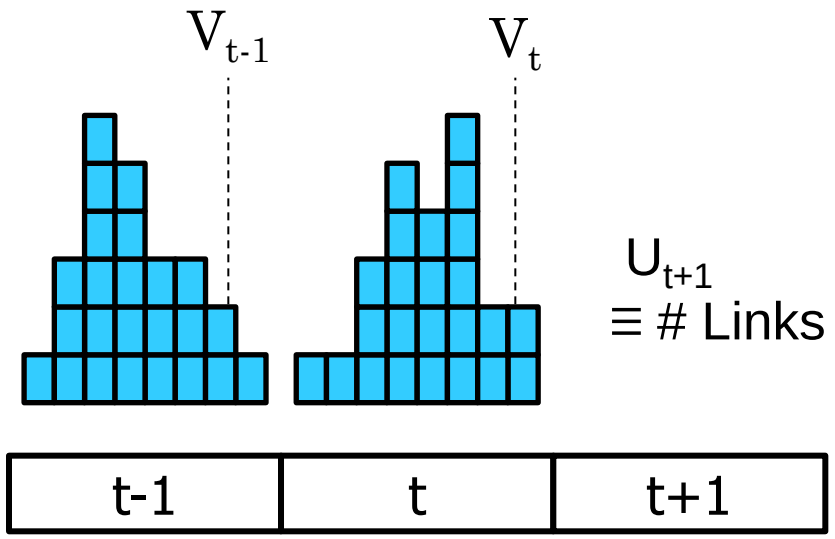
Traffic Measurement

- ✓Measuring Peak Rate during τ
- ✓Making Histogram of # Necessary Links during T
- ✓Estimating # Links for Next T, i.e., V





Three Algorithms



✓Ceiling

$$U_{t+1} = \text{ceil}\{V_t\}$$

Introducing EWMA

$$\bar{U}'_{t+1} = \alpha \bar{U}_t + (1-\alpha) U_{t+1}$$

✓MAXEL

$$\bar{U}_{t+1} = \text{MAX}\{U_{t+1}, \bar{U}'_{t+1}\}$$

✓EDCL

$$\bar{U}_{t+1} = U_{t+1}, \text{ where } |U_{t+1} - \bar{U}'_{t+1}| > \beta$$

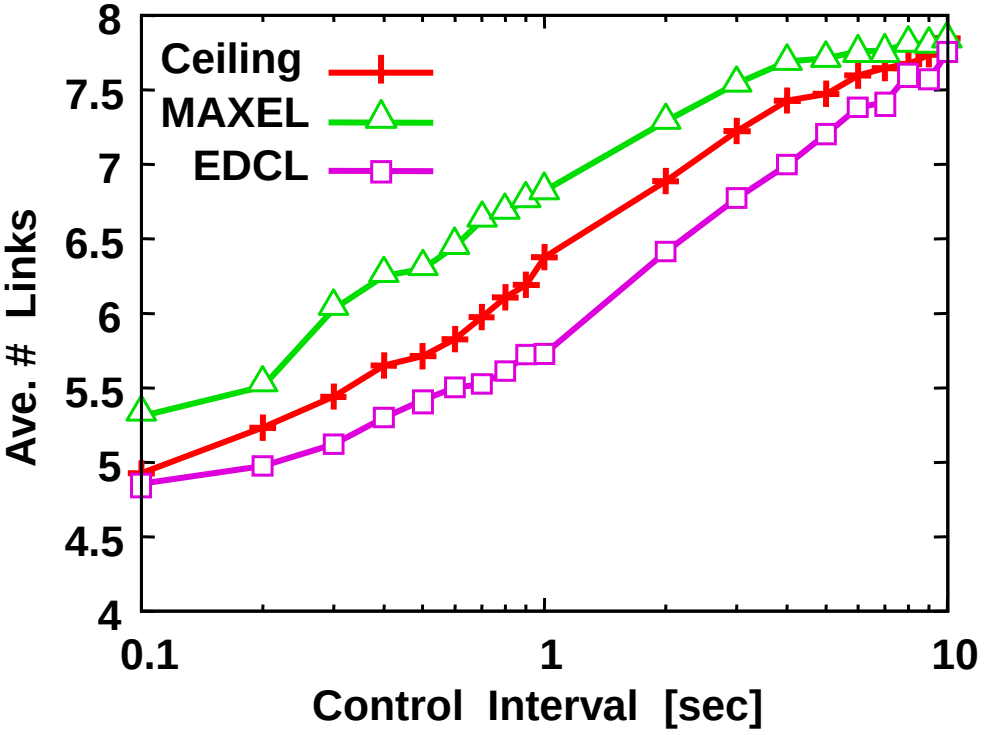
or

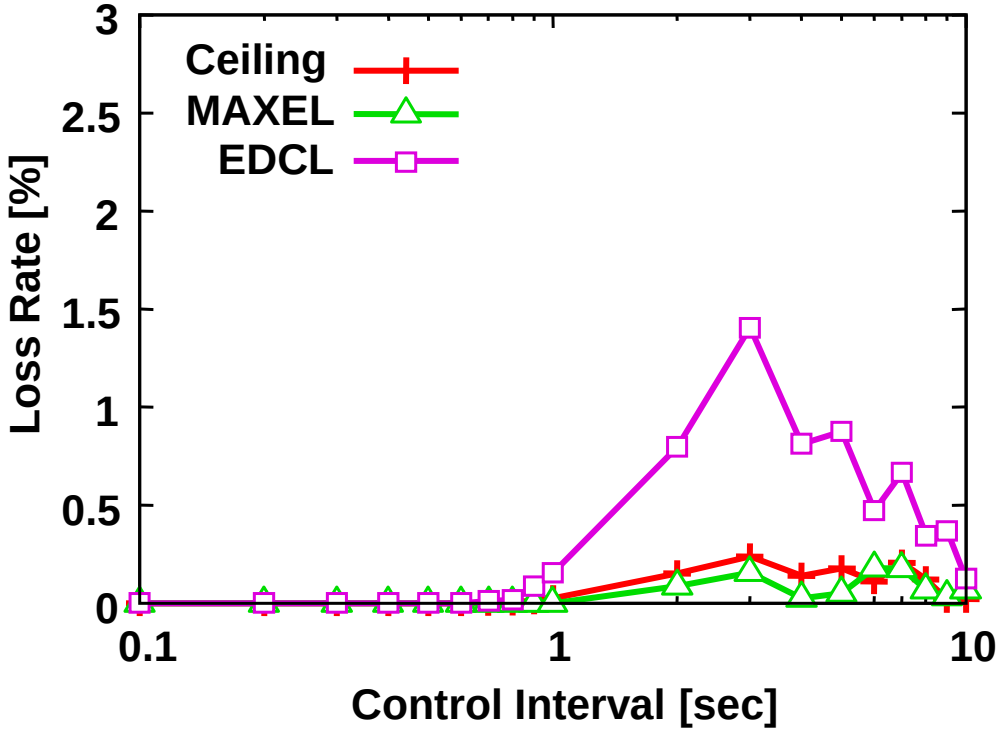
$$\bar{U}_{t+1} = \bar{U}'_{t+1}, \text{ where } |U_{t+1} - \bar{U}'_{t+1}| \leq \beta$$

Exponentially Weighted Moving Average; *EWMA*

Simulation

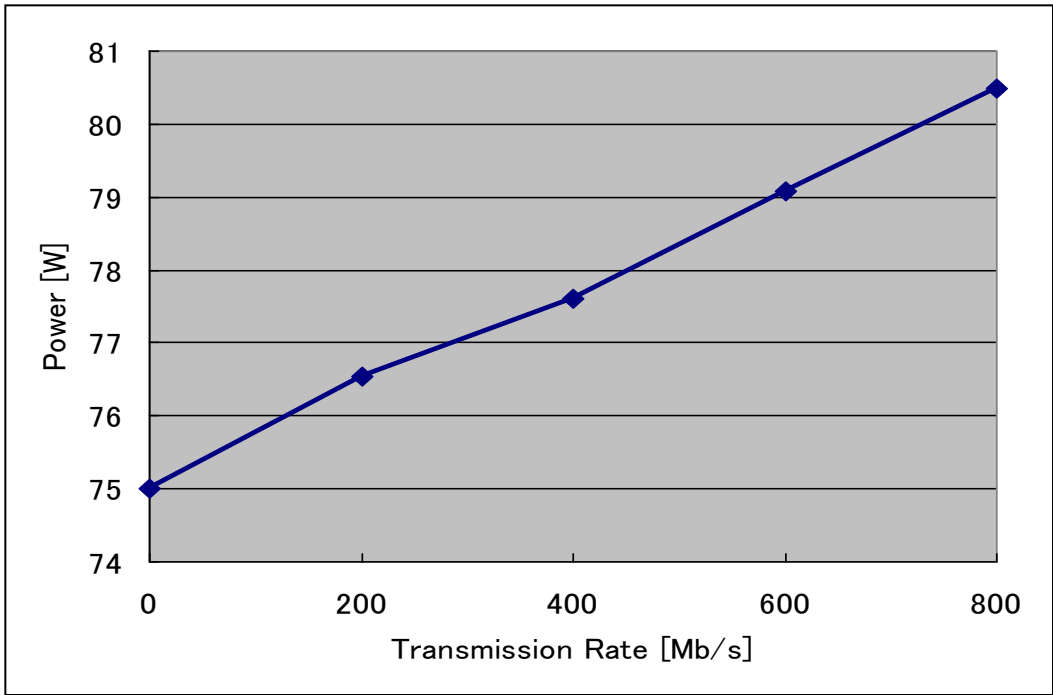
- ✓ Model
  - 1Gbps/Link, # Max. Links = 8, Load = 0.5(random)
- ✓ Energy Saving
  - Saving 35%, if T < 1sec





Experiment

- ✓Configuration
  - ➢2 PCs Connected via 8x 100Mbps Ethernet
  - ➢Control Interval T = 0.8sec
- ✓Energy Saving
  - ➢Linear Saving Effect

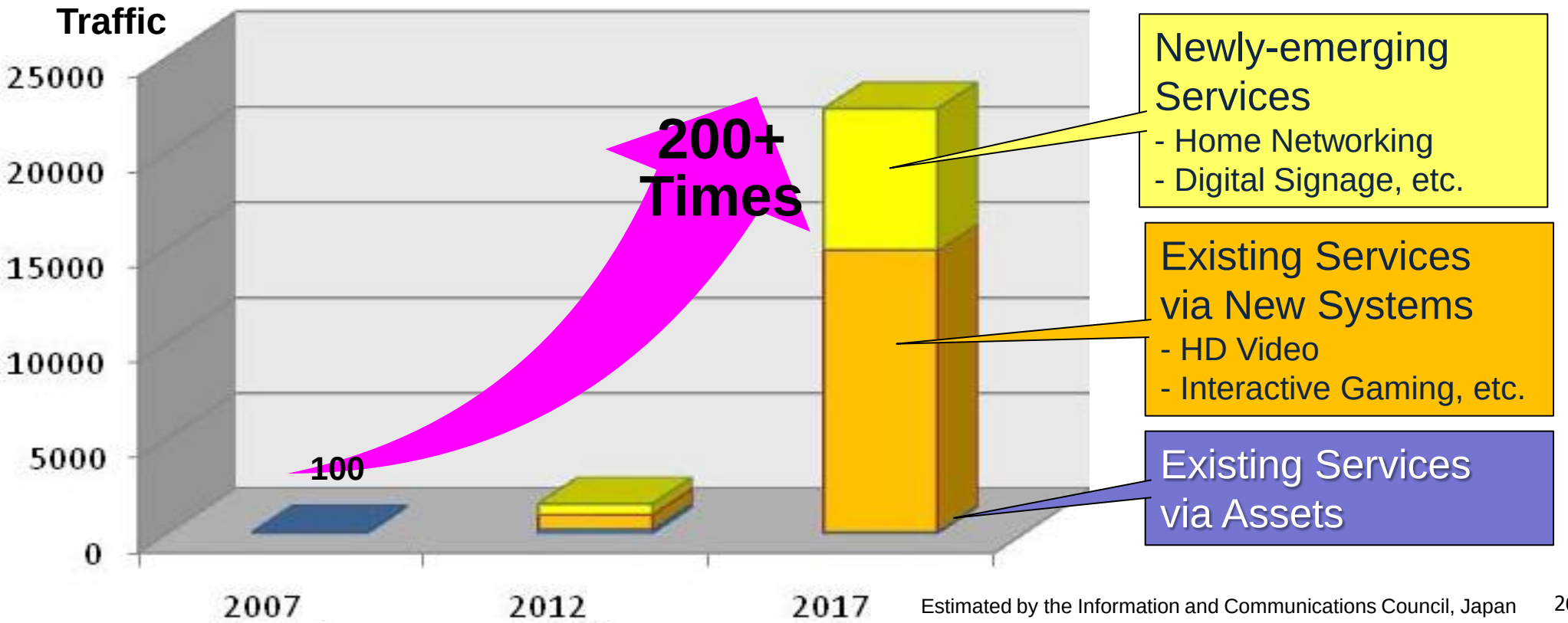


ToC

- Smart Grid and Japan's Situation
- Activities for Green ICT
- **TV White Space in Japan**

Mobile Traffic Forecast

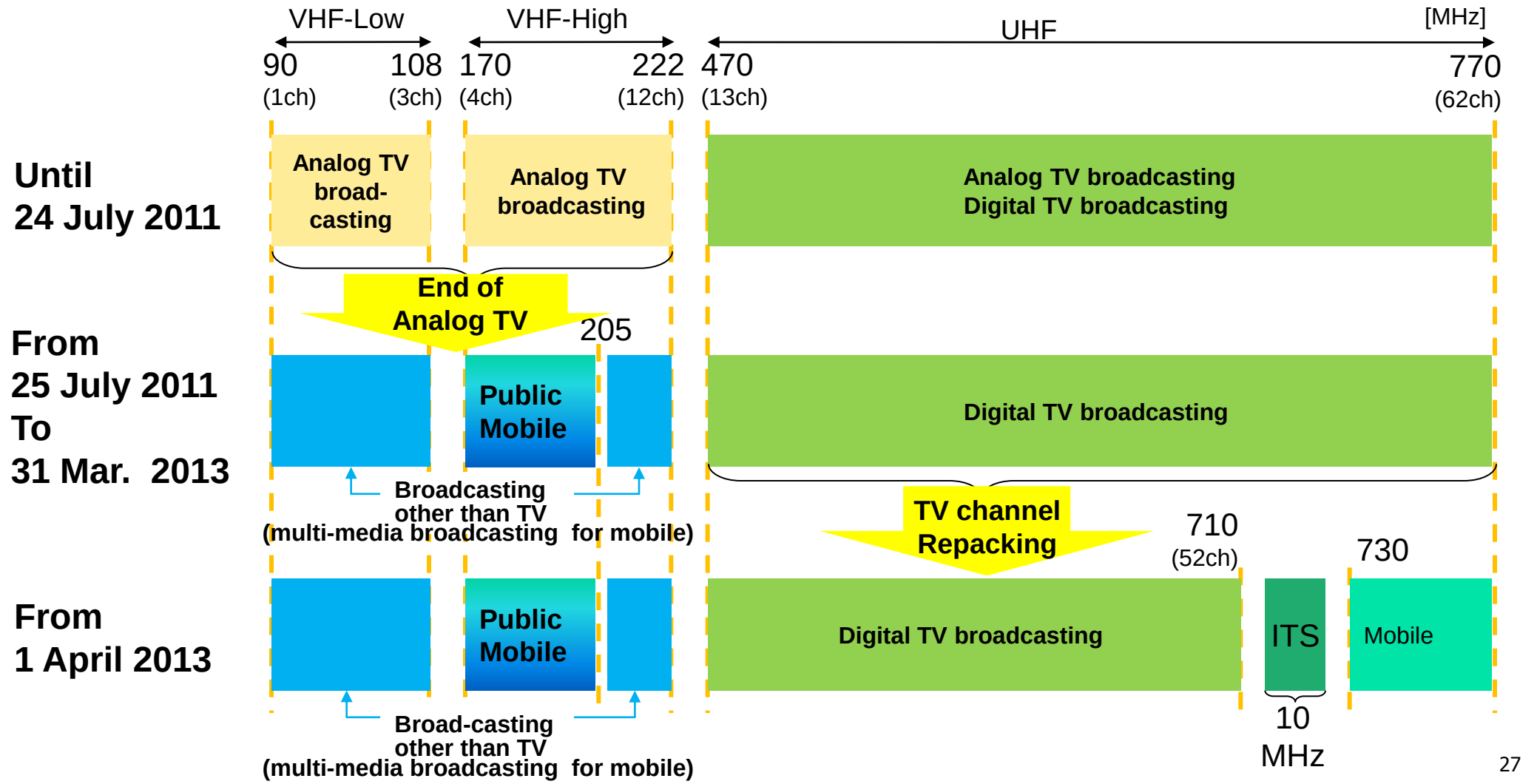
- ✓200+ Times Explosion of Traffic (Forecast)
- ✓Need More Frequency!
  - ➢Limited Spectrum vs. Access Explosion



Estimated by the Information and Communications Council, Japan

Re-allocation of TV bands

✓Start of "White Space" and Freq. Re-allocation



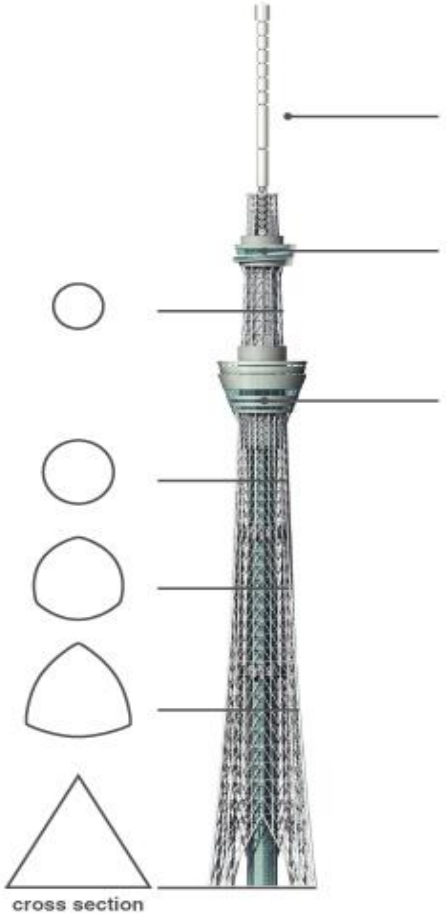
Tokyo Sky Tree

- ✓Opened Last Month
- ✓Will Be Used for DTV Broadcasting Next Year

Tokyo Tower

Source; http://ebato.info/travel/2011.htm

Perspective drawing of completed tower
Provided by Tobe Railway Co., Ltd. & Tobu Tower Sky Tree Co., Ltd.



cross section

Digital Broadcasting Antennas
Mainly to house television broadcastig antennas.

Antenna Tower
The long and slender uppermost section is the "antenna tower" for digital-terrestrial broadcasts, with many antennas for TV stations set around it.

Second Observatory (450m)
This observatory has two decks, with a spiraling aerial corridor around it. The glass-walled corridor leads you from the arrival lobby upstairs to the world' s highest observation deck.

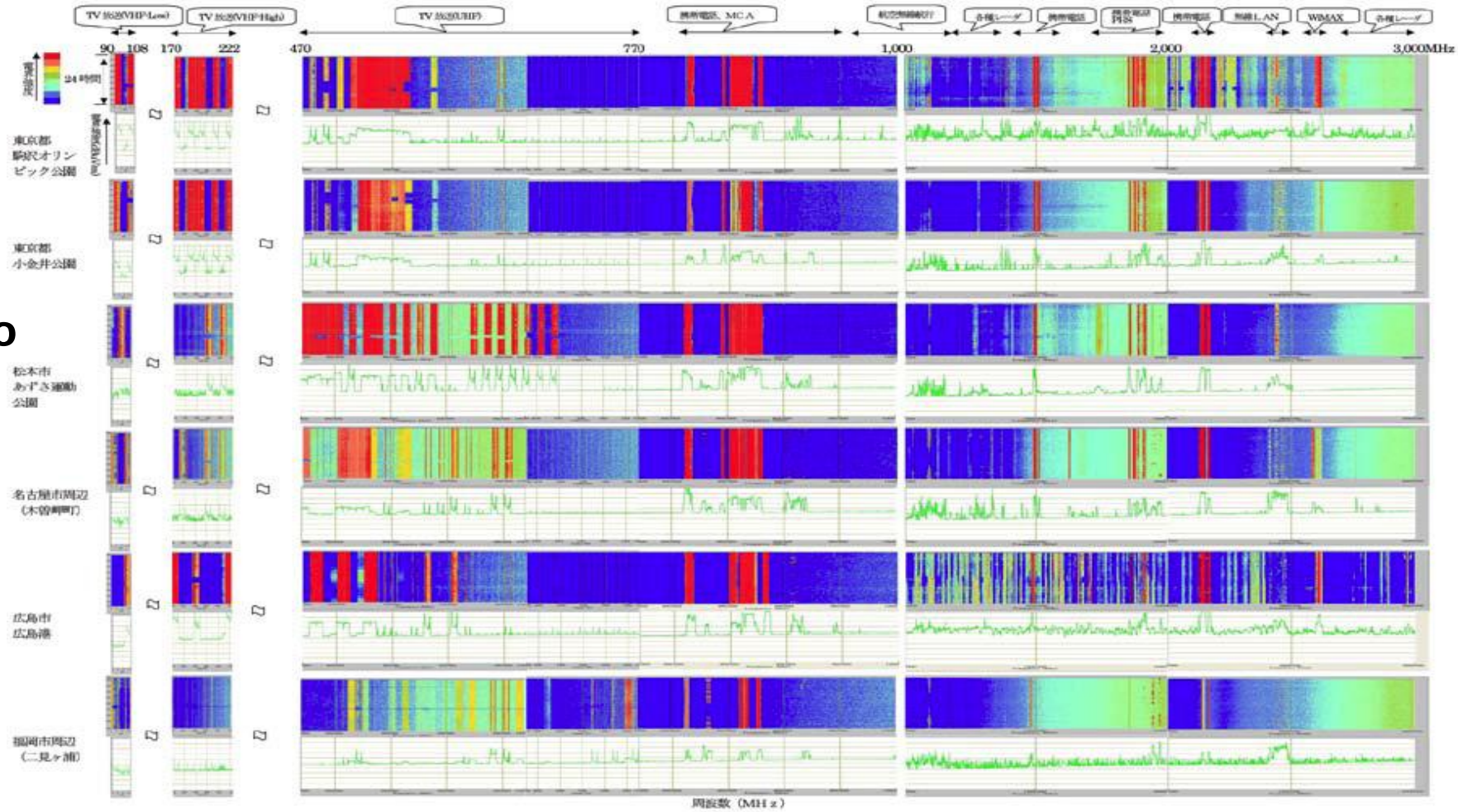
First Observatory (350m)
This three-story observatory houses the observation decks and shops. The elevators to the second observatory are located here.

Triangular to Circular in Plan
The lowest section of the tower is triangular in plan and supported by three legs. The shape is gradually rounded, until at the height of about 300 meters it becomes a perfect circle.

Source; http://www.obayashi.co.jp/english/special/2010032622.html

Frequency Usage in Japan

✓Still Vacant Freq., Location, and Time



Central Tokyo

Suburban Tokyo

Matsumoto

Nagoya

Hiroshima

Fukuoka

Source; MIC, Japan(http://www.soumu.go.jp/main_content/000079911.pdf)

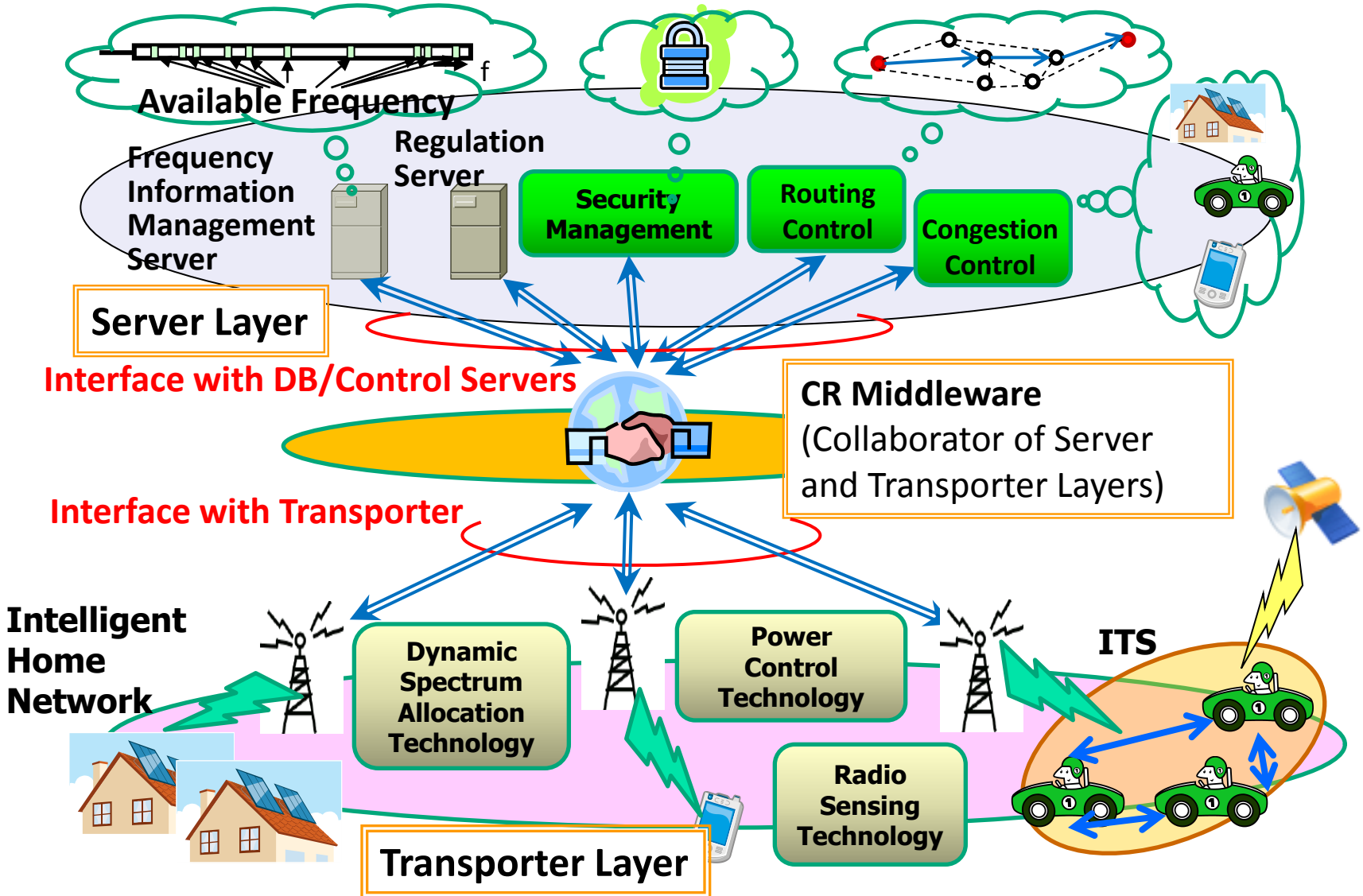
Government Action

- Radio Wave Policy Panel (Oct.2008-July 2009)
  - investigated the policies for effective use of radio frequencies in 2010s
  - published "the New Radio Wave Industry Creation Strategy"
- Investigation Team Concerning Ideas for the Use of New Radio Waves (Dec.2009-July 2010)
  - promoted the effective use of new radio waves, including the practical use of "White Space"
  - called for public opinions and ideas

Cognitive Radio;
Finding Vacant Frequency, Time, and Location
For Secondary Users' Operation

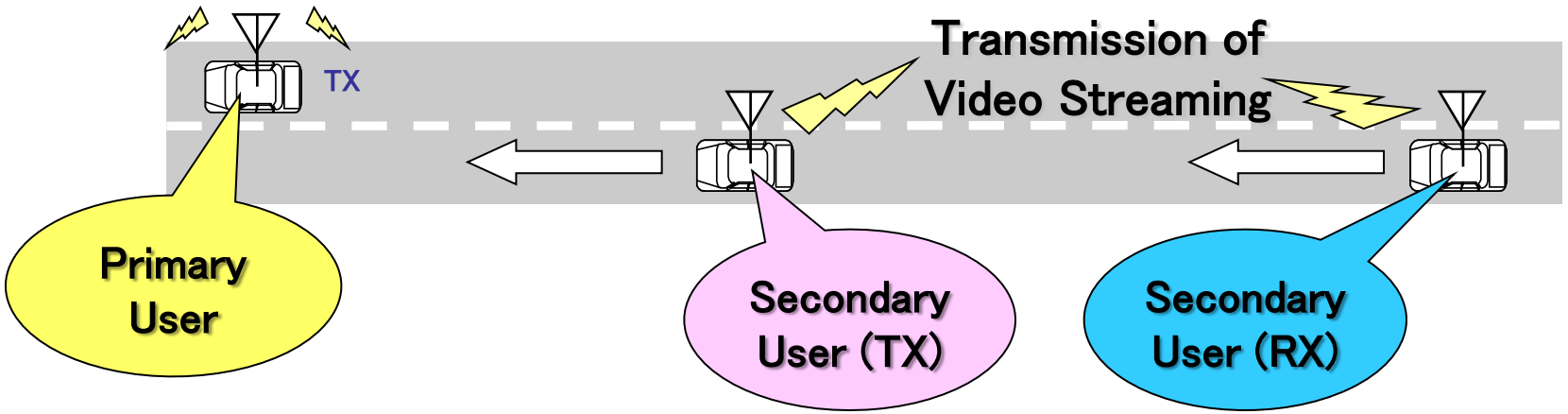
CR System Model

- ✓ Secondary (Licensed) Users Can Transmit Data While Primary Users Don't.



Field Trial in Kyushu Area

- ✓ 1 Primary and 2 Secondary Moving Users



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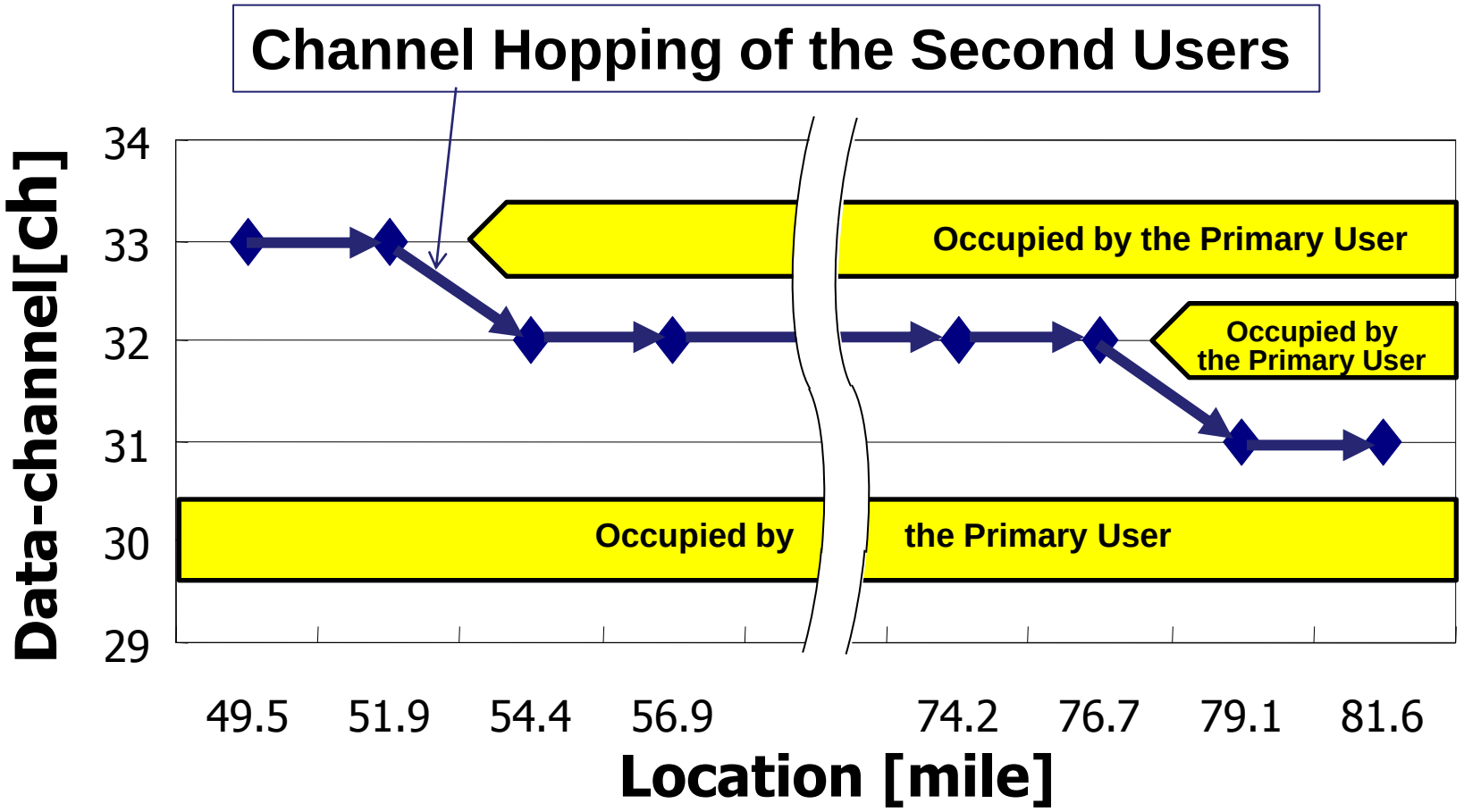
Freq. : 477, 480, 481, 483, 486, 487, 489, 491, 492MHz

Output: 40mW

Mod. : GMSK

Channel Hopping Control

- Dodging Primary User's Interruptions....



Summary

- ✓ Introduced Recent Networking Topics in Japan.
- ✓ Some May Be Advanced, but Some May Not.
- ✓ Possible Future Collaborations??

Thank you for your attention!!