Open Smart Campus and Building System Design and Operation with IEEE1888

Professional operation, since 2009
- all-building, April 2011
- all-5-campuses, July 2011
- all faculty of engineering, Oct.2014

Electricity bill:
- $ 1M USD/Yr
- $60M USD/Yr
- $7.5M USD/Yr

IEEE1888 : UGCCNet (Ubiquitous Green Community Control Network)

Live E!

in 2005

ipv6 Promotion Council

Building Automation WG
in 2003 at ipv6 Promotion Council

Collaboration
with Tokyo Gov.
since 2004

Established FNIC in2006
(Facility Network Interop)

Since 2005
(7th at Kyoto)

APAN Asia-Pacific Networking Group

NiCT

DUMBO2006
with AIT

มหาวิทยาลัยเกษตรศาสตร์
Kasetsart University

KU+KUS with MIC+JGN2

JGN2 plus

IIT Hyderabad
With IMD

DISANET

Green university of Tokyo Project

グリーン東大工学部プロジェクト

In 2008

Consortium

w/ 50+ companies

Beijing Olympic
In 2008

清華大學 Tsinghua University

China-Japan Green IT
Project funded by MIC
in 2009

FIAP in 2009
(Live E! architecture)

ISO IEC

JTC1 SC6 WP7

IEEE

IEEE 1888 in Feb.2011

NIST

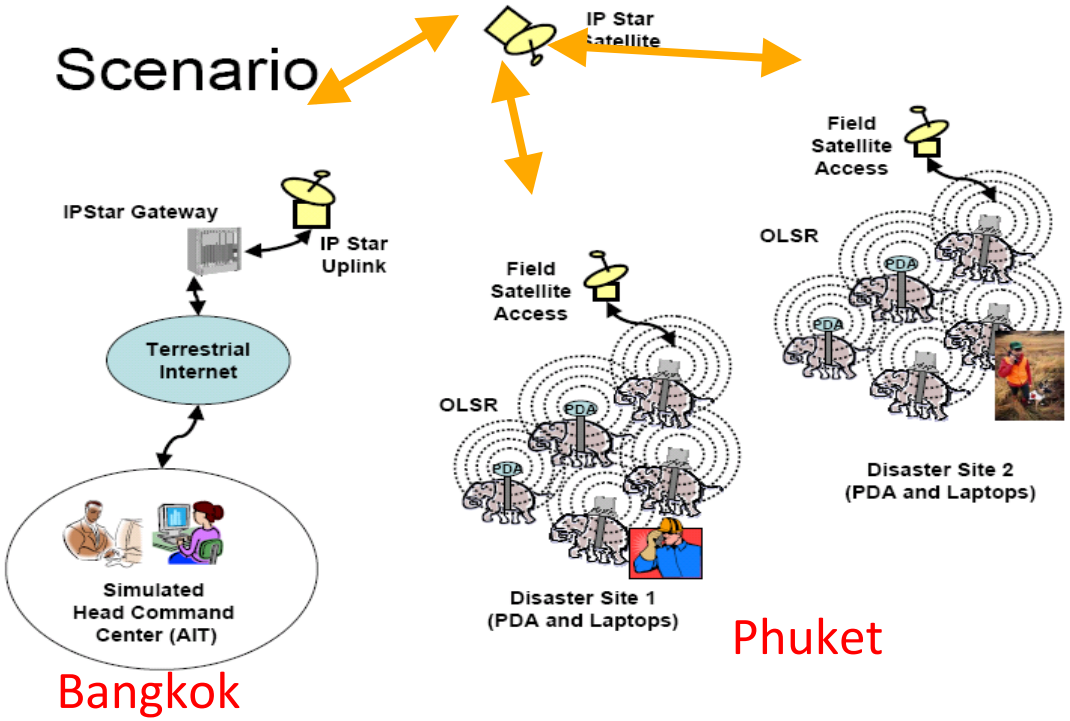
SGIP

BACnet

with NIST@USA
B2G in SGIP (Smart Grid Interoperability Panel)
toward CoS

DUMBO with AIT@th

- Digital Ubiquitous Mobile Broadband OLSR
- Bangkok & Phuket, Thailand
- December 1st 2006 (14:00 – 16:30)

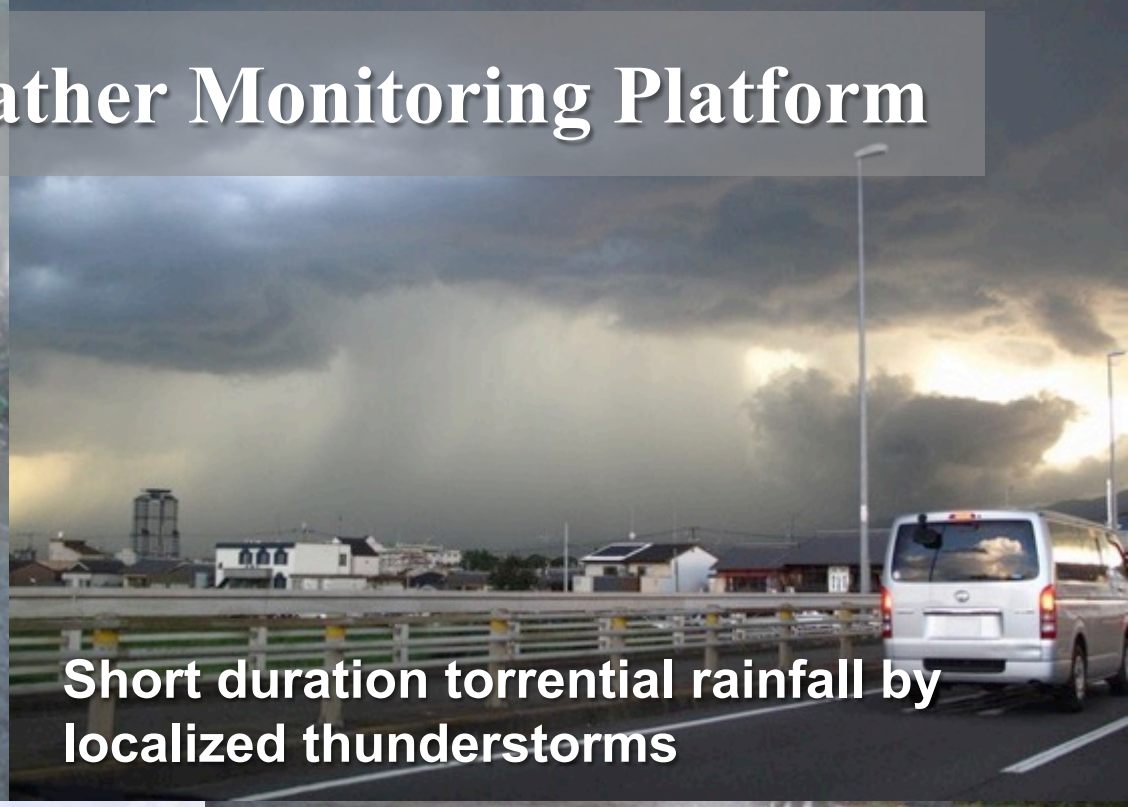


DUMBO Project in Thailand with AIT

- Emergency Responding
- Live-e sensor in OLSR

On-line Dense Weather Monitoring Platform

Flood in urban areas



Short duration torrential rainfall by localized thunderstorms

DISANET

東京大学
THE UNIVERSITY OF TOKYO

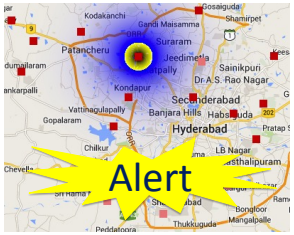
Applications

DISANET Hyderabad — Automatic Weather Stations

This page shows the current weather status. This automatically reloads in every 60 seconds.

Location Name	Sublname	Time (IST)	Temperature (Deg C)	Relative Humidity (%)	Pressure (GLZ) (mB)	Rain Intensity (mm/hr)	Day's Rain Fall (0000 IST) (mm)	Wind Direction (Degrees)	Wind Speed (m/s)	Wind Speed (Knots)	Dew Point Temp (Deg C)
IMD Hyderabad, Begumpet	WXTS10+	2014-07-12, 10:45:00	29.9	47.6	946	0	0	263	0.8	1.56	17.6
	WMT700	2014-07-12, 10:45:00						271	4.95	9.62	
IMD Hyderabad (Terrace), Begumpet	WXTS10	2014-07-12, 10:44:00	29.3	49.3	945	0	0	237	1.7	3.3	17.6
IIT Hyderabad (Tentative Campus)	WXTS10	2014-07-12, 10:45:01	28.5	53	939	0	0	286	5.6	10.89	18
IIT Hyderabad (Permanent Campus)	WXTS10	2014-07-12, 10:45:00	29.4	58.2	945	0	0	264	5	9.72	19.4
Gitam University (GITD), Rudraram	WXTS10+	2014-07-12, 10:45:00	28.9	52	944	0	0	244	3.6	7	18.1

Daily Observation



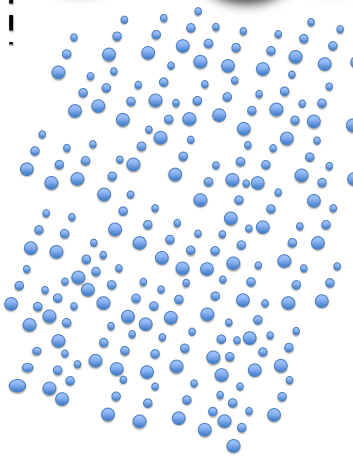
Heavy Rain Alarm

Water Management

Agricultural Study

Micro-Scale Weather Phenomenon

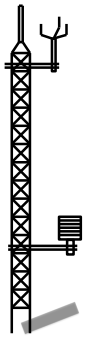
i.e., very local heavy rain



Weather Observation Data Flow

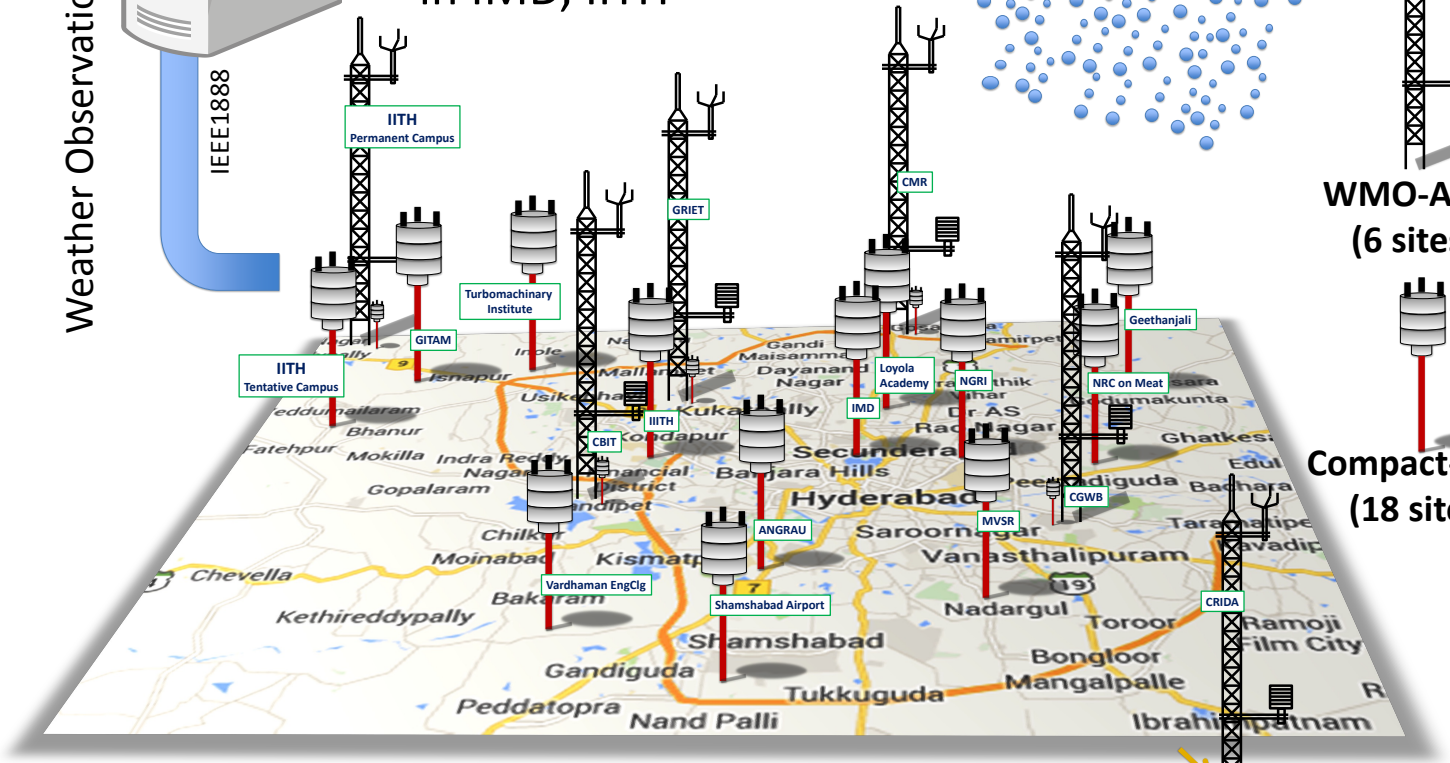
IEEE1888

Data Server in IMD, IITH



WMO-AWS (6 sites)

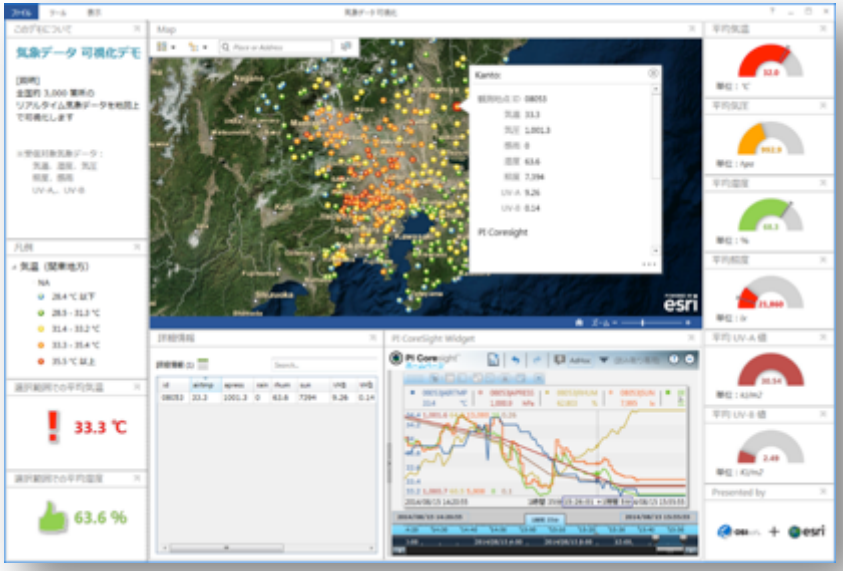
Compact-AWS (18 sites)

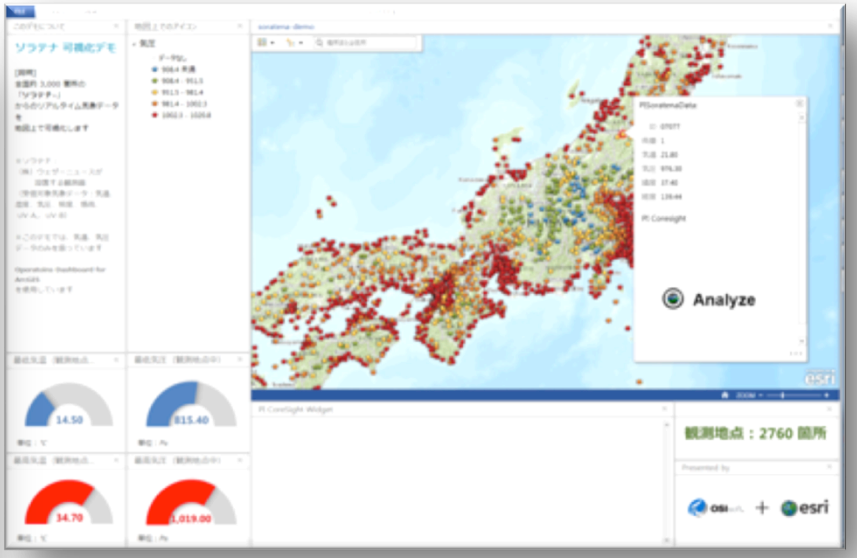


DISANET AWS Deployment in Hyderabad

Strategic collaboration in Japan

- 3,000 On-line Weather nodes in Japan
  - Cellular Phone Platform by KDDI
  - Weather News Inc., WNI weathernews
  - High performance DB platform By OSIsoft.
  - GIS (Geographic Information System) esri

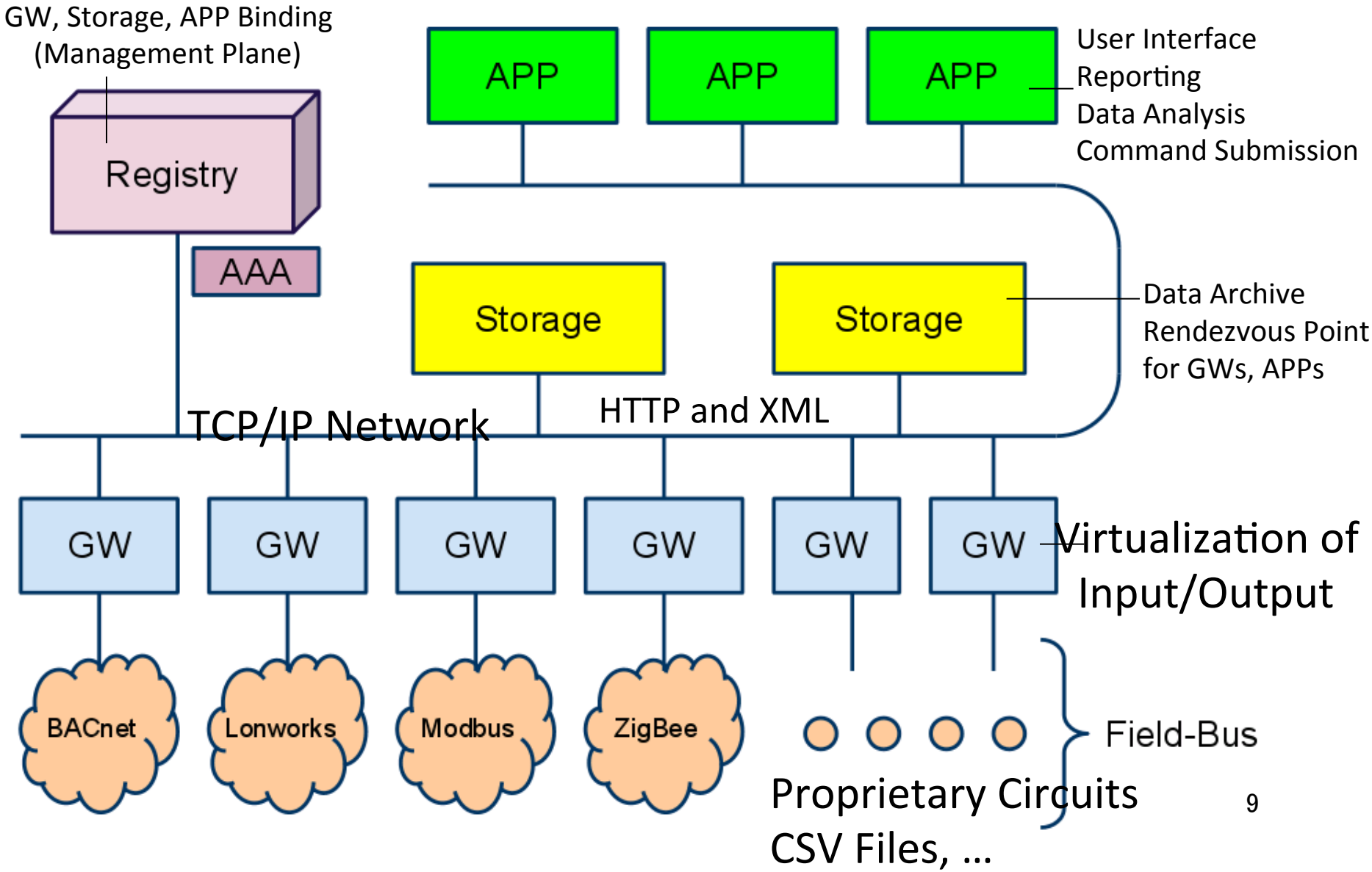




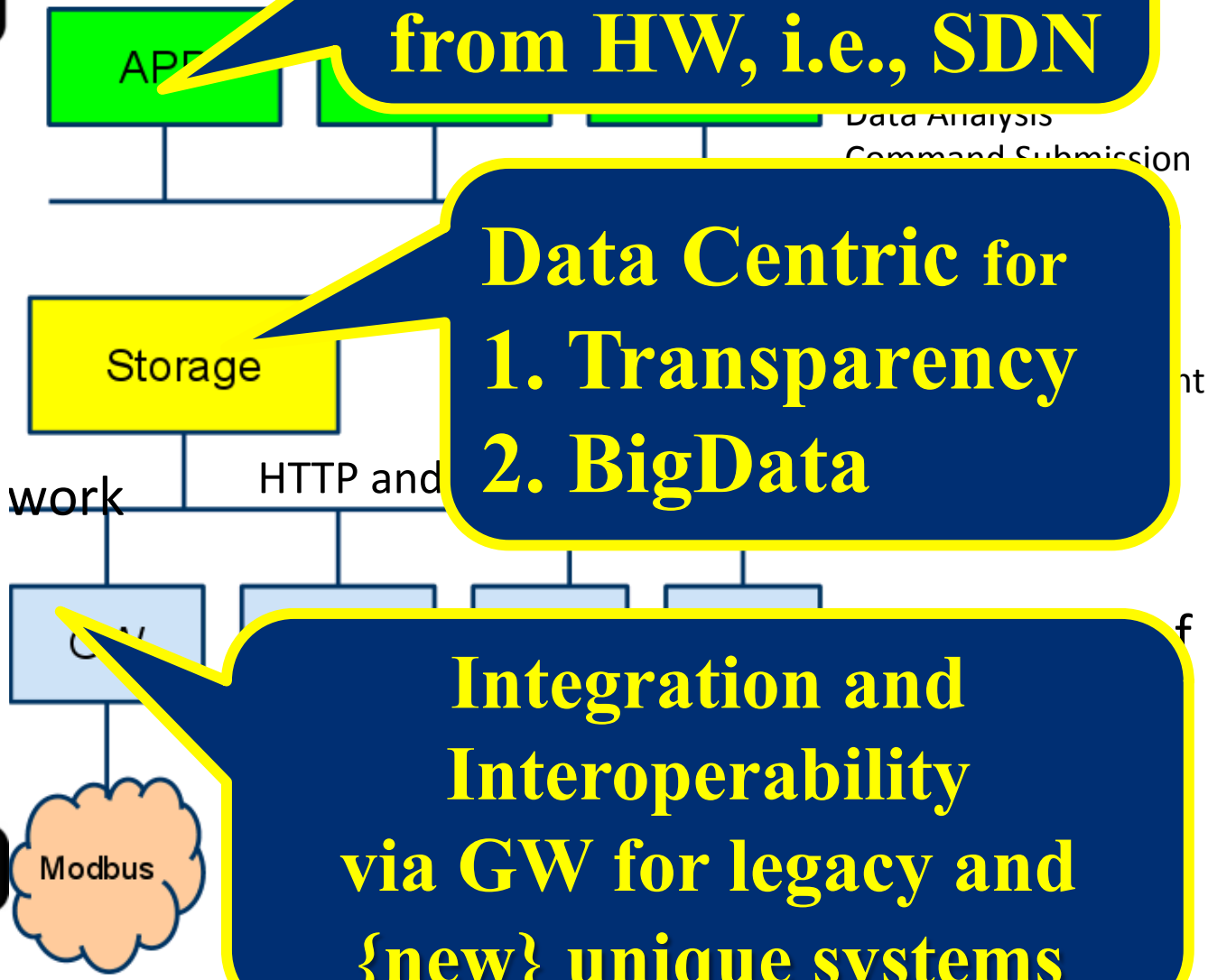
AWS installation in city of Hyderabad

6 WMO-Standard AWS and 18 Compact AWS

IEEE1888 System Architecture



IEEE1888 Syst



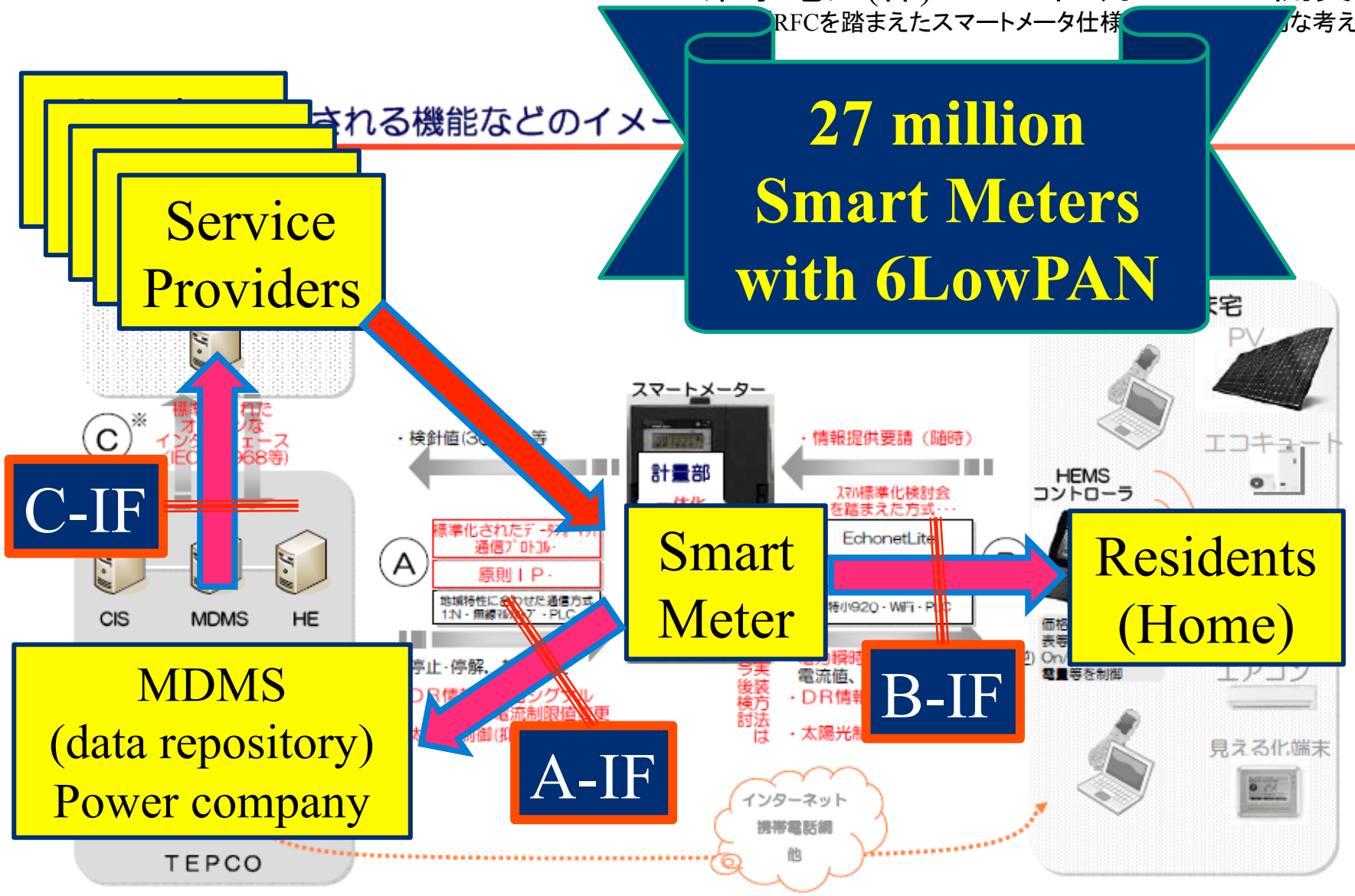
Independency of SW players from HW, i.e., SDN

Data Centric for 1. Transparency 2. BigData

Integration and Interoperability via GW for legacy and {new} unique systems

東京電力(株) 2012年7月12日 公開資料

RFCを踏まえたスマートメータ仕様 な考え方」



※Cルートについてはスマートメーター制度検討会で検討されたようにスマートメーターの情報を直接サービス事業者が収集するケースも考えられる。

http://www.tepco.co.jp/corporateinfo/procure/rfc/repl/t_pdf/2_concept-j.pdf

Which is better ?

- Multi-hop ad hoc network
- 1:N cell-phone network

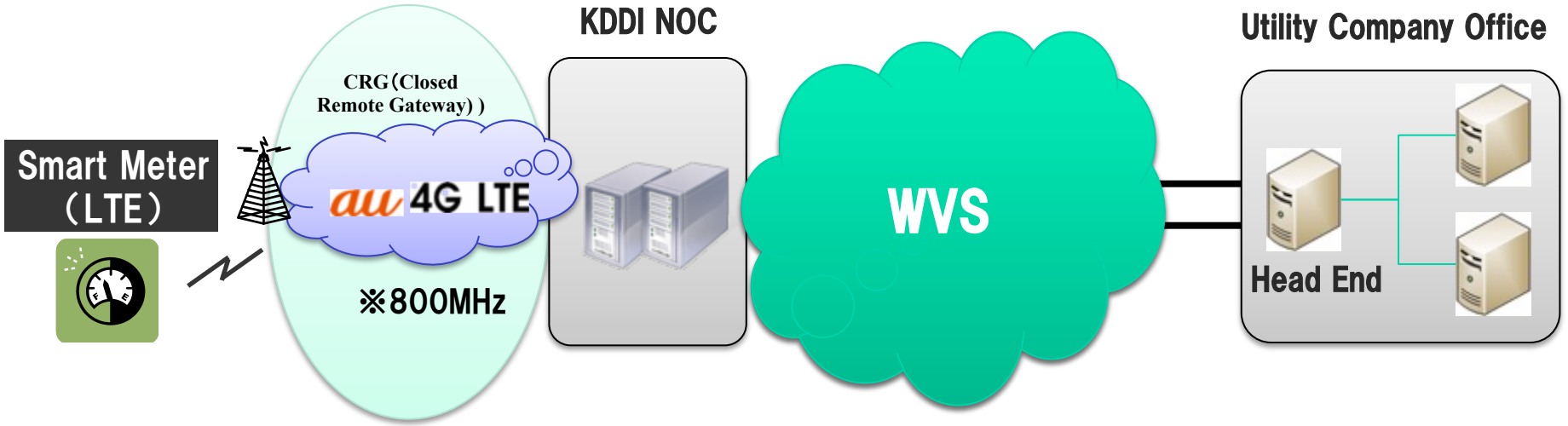
Type of Cost	Multi-Hop	1:N
Equipment	Cheap	(getting) Cheap
Installation	Hard	Easy
Operation		
- Technology change	Hard	Easier
- Density change	Increase is good, decrease is hard	Easy

4G LTE Network for Smart Meter Access with IPv6

- Available both IPv4 and IPv6
- Fixed IP address assignment to every Smart Meter with CRG
- AAA function at KDDI NOC

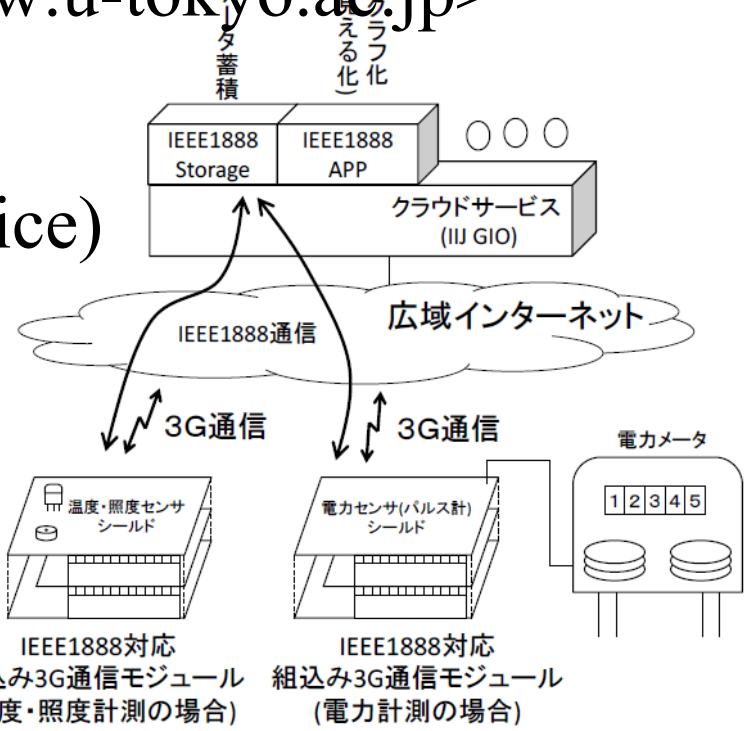
CRG: Closed Remote Gateway
WVS: Wide-area Vertual Switch

【1:N Wireless access with LTE】



IEEE1888 over 3G

- Partners
  - Internet Initiative Japan (IIJ) Inc., <www.iij.ad.jp>
  - 3G Shield Alliance <www.tabrain.jp/newfolder1/a3gsa.html>
  - The University of Tokyo www.u-tokyo.ac.jp>
- Feature of the System
  - IIJ GIO Service (Cloud Service)
  - IEEE1888 sensor module with 3G link



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グリーン東大工学部プロジェクト

In 2008

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w/ 50+ companies

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China-Japan Green IT
Project funded by MIC
in 2009

FIAP in 2009
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ISO IEC

JTC1 SC6 WP7

IEEE

IEEE 1888 in Feb.2011

NIST

SGIP

BACnet

with NIST@USA
B2G in SGIP (Smart Grid Interoperability Panel)
toward CoS

- Established in June 2008.
  - ✓ R&D **consortium by Stakeholders**
  - ✓ **"Design by Internet", beyond & more than energy saving**
  - ✓ Global Collaboration
    - ➢ USA, France, China, Thailand, India, Taiwan, etc.,
  - ✓ Technical Standardization
    - ➢ **IEEE1888** in March 2011, with China Team
    - ➢ **ISO/IEC JTC1 SC6 WP7**, as fast track
    - ➢ Domestic **standard in China** (i.e., GB)

- Building No.2, in Hongo Campus, since Mar.2011
  - ✓ 12 floor high, R&D and R&E activities
  - ✓ Established October 2005, Operation start in March 2006
  - ✓ **1 MW in peak and $1Million USD per year bill**

【Companies】

- Azbil Corporation
- CiMX Corporation.
- Cisco Systems, Inc.
- Citrix Systems Japan K.K.
- ComZeit Inc.,
- Daikin Industries, Ltd.
- DSI, Inc.
- EMC Corporation
- Fujitsu Limited
- Hitachi Co.Ltd.
- INTEC Inc.,
- Intercom Inc.,
- Internet Initiative Japan Inc.,
- KAJIMA Corporation
- Kantokowa Co., Ltd.
- KDDI Corporation
- KDDI R&D Laboratories
- Kyosera Maruzen Systems Integration
- Mitsubishi Heavy Industries Ltd.
- Mitsubishi Research Institute Inc.
- Mitsui Fudosan Co.,Ltd
- Murata Manufacturing Co.Ltd.,
- NEC Corporation
- Nippon Steel & Sumikin Engineering Co.Ltd.
- Nitto Kogyo Corp
- NTT Comware Corp.
- NTT Corporation
- NTT Data Corporation
- NTT Data Customer Service Corporation
- NTT Data Intellink Coroporation
- NTT Facilities Inc.
- OSIsoft Japan K.K.
- OTSUKA Corporation
- Panasonic Corporation
- RICHO Co., Ltd.
- Sakura Internet Inc.,
- Sanki Engineering Co., Ltd.
- SEIKO SOLUTIONS Inc.,
- SHINRYO Corporation
- Tamachi Electric Industry Co.Ltd.
- Toko Takaoka Electric Mfg. Co.Ltd.,
- Takenaka Corporation
- Toshiba Corporation
- Toyo Denki Seizo K.K.
- Toyo Standard Corporation
- Ubiteq Inc.
- Ubiquitous Corporation

【Non Profitable Organizations/Universities】

- IPv6 Promotion Council.
- The Institute of Electrical Engineers of Japan
- The Institute of Electrical Installation Engineers of Japan
- LONMARK JAPAN
- ALFAE (Area-wide e-Laboratory for Food Agriculture & Environment)
- OKAYAMA IPv6 CONSORTIUM.
- Yamaguchi Prefectural Industrial Technology Institute
- WIDE Project.
- Tokyo Metropolitan Research Institute for Environmental Protection
- Chularonkorn University (Thailland)
- SRM University (India)
- IIT Hyderabad (India)
- Tsinghua University (China)
- National Taiwan University (Taiwan)
- Kanazawa University
- Gufu University
- Keio University.
- Kyushu Institute of Technology
- NAIST (Nara Institute of Science and Technology)
- Niigata University
- Nagoya University
- Shizuoka University
- Tokyo Metropolitan University
- Yamaguchi University
- Yamagata University
- Yamagata Research Institute of Technology
- The University of Tokyo

“Strategic use of Cloud & DC”

1. Facility on the Net(Cloud)
2. Computers into the Net (Cloud/DC)

東京大学
THE UNIVERSITY OF TOKYO

Energy Saving
at The University of Tokyo in Summer of 2011

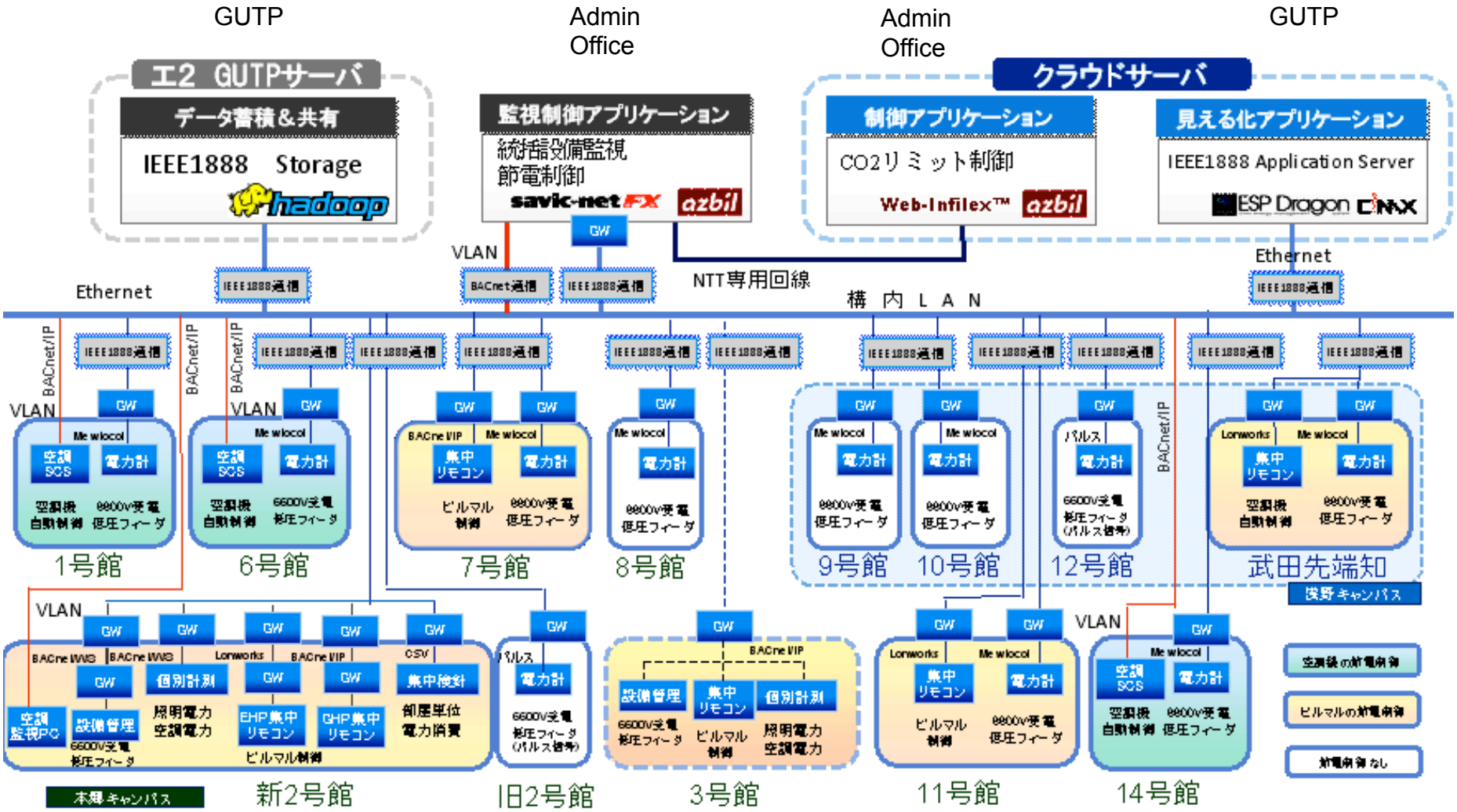
	Peak (2010)	**Peak (2011)**	**Total (2011)**	**RoI**
Major 5 campus	66 MW ($60M/yr)	69% (△31%)	75%-78% (22%-25%)	less than 1 month
Eng. No2 Bldg.	1 MW ($1M/yr)	56% (△44%)	69% (△31%)	2 yrs

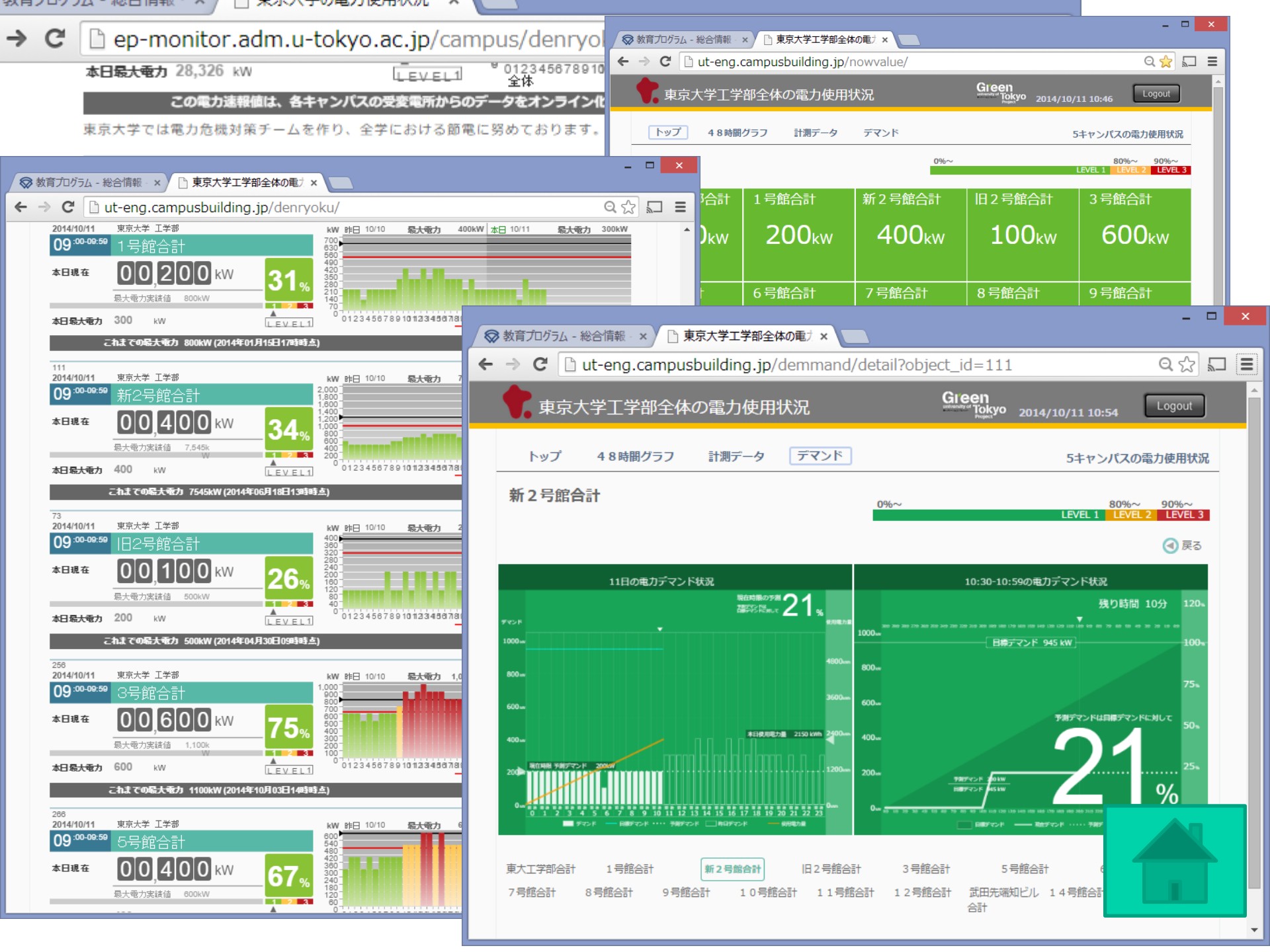

12 Fl. EECS & Machinery Dept.

【Contributions】
1. Multi-Vender for sustainability
2. Global Standards for procurement

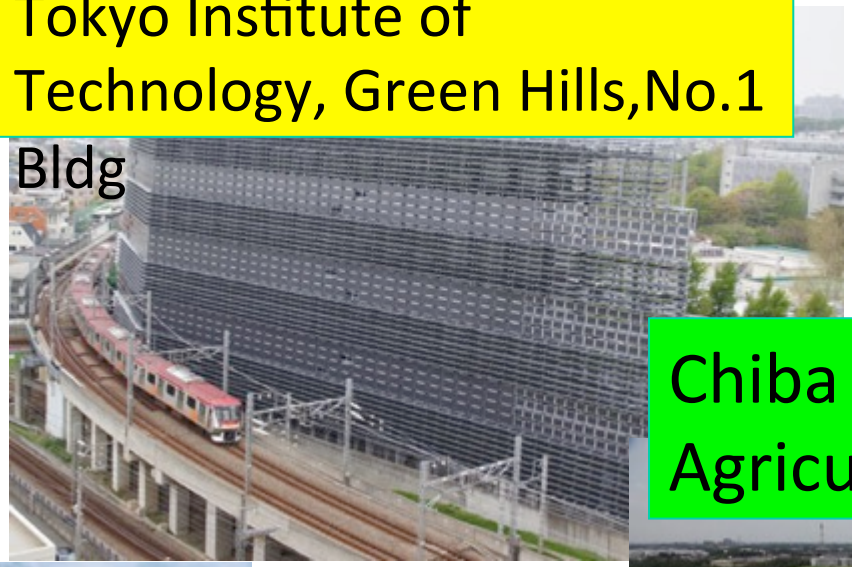
Green university of Tokyo Project

Faculty of Engineering Campus




ep-monitor.adm.u-tokyo.ac.jp/campus/denryo
本日最大電力 28,326 kW
LEVEL1
全体
この電力速報値は、各キャンパスの受変電所からのデータをオンライン化
東京大学では電力危機対策チームを作り、全学における節電に努めております。
ut-eng.campusbuilding.jp/nowvalue/
東京大学工学部全体の電力使用状況
Green Tokyo
2014/10/11 10:46
Logout
トップ
４８時間グラフ
計測データ
デマンド
5キャンパスの電力使用状況
0%～ LEVEL 1
80%～ LEVEL 2
90%～ LEVEL 3
1号館合計 200kW
新２号館合計 400kW
旧２号館合計 100kW
3号館合計 600kW
6号館合計
7号館合計
8号館合計
9号館合計
ut-eng.campusbuilding.jp/denryoku/
09:00-09:59 1号館合計
本日現在 00,200 kW 31%
最大電力実績値 800kW
本日最大電力 300 kW
これまでの最大電力 800kW (2014年01月15日17時時点)
09:00-09:59 新2号館合計
本日現在 00,400 kW 34%
最大電力実績値 7,545kW
本日最大電力 400 kW
これまでの最大電力 7545kW (2014年06月18日13時時点)
09:00-09:59 旧2号館合計
本日現在 00,100 kW 26%
最大電力実績値 500kW
本日最大電力 200 kW
これまでの最大電力 500kW (2014年04月30日09時時点)
09:00-09:59 3号館合計
本日現在 00,600 kW 75%
最大電力実績値 1,100kW
本日最大電力 600 kW
これまでの最大電力 1100kW (2014年10月03日14時時点)
09:00-09:59 5号館合計
本日現在 00,400 kW 67%
最大電力実績値 600kW
ut-eng.campusbuilding.jp/demmand/detail?object_id=111
東京大学工学部全体の電力使用状況
Green Tokyo
2014/10/11 10:54
Logout
トップ
４８時間グラフ
計測データ
デマンド
5キャンパスの電力使用状況
新２号館合計
0%～ LEVEL 1
80%～ LEVEL 2
90%～ LEVEL 3
戻る
11日の電力デマンド状況
現在時間の予測デマンド値 21%
本日使用電力量 2150 kWh
10:30-10:59の電力デマンド状況
残り時間 10分
目標デマンド 945 kW
予測デマンドは目標デマンドに対して
21%
東大工学部合計
1号館合計
新２号館合計
旧２号館合計
3号館合計
5号館合計
7号館合計
8号館合計
9号館合計
１０号館合計
１１号館合計
１２号館合計
武田先端知ビル合計
１４号館合計

Tokyo Institute of Technology, Green Hills,No.1 Bldg



HQ, Otsuka Corp.

Microsoft Japan HQ in Tokyo

Chiba Univ. Agriculture plant

Hitachi Info& Tele Eng Ltd. Nakai Development Center

SEIKO Solutions Factory in Thailand

CANON S Tower (Canon MJ HQ)

Thang Long
Industrial Park
（Vietnam)

Hamamatsu City
（Metropolis）

Global/International collaboration

1. **Beijing team** (e.g., Tsinghua Univ., China Telecom), **China**
   (*) Including Standardization: IEEE1888
2. **CAS(Chinese Academy of Science), Shanghai, China**
3. **Chulalongkorn University, Thailand**
4. **IIT Hyderabad, India**
5. UCB with Intel in **USA**
6. SGIP of NIST in **USA**



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7. NTU(National Taiwan University), **Taiwan**
8. **Vietnam** with MIC (Japanese gov. support)
9. iDA in **Singapore**
10. UMPS/LIP6/CNRS in Paris, **France**




Prof. Bundhit Eua-arporn
Prof. David Banjerdpongchai

EECU-BEMS Project
Building Energy Management System

Department of Electrical Engineering
Chulalongkorn University

11 November 2014

SOLAR FRONTIER

Energy Policy and Planning Office
MINISTRY OF ENERGY

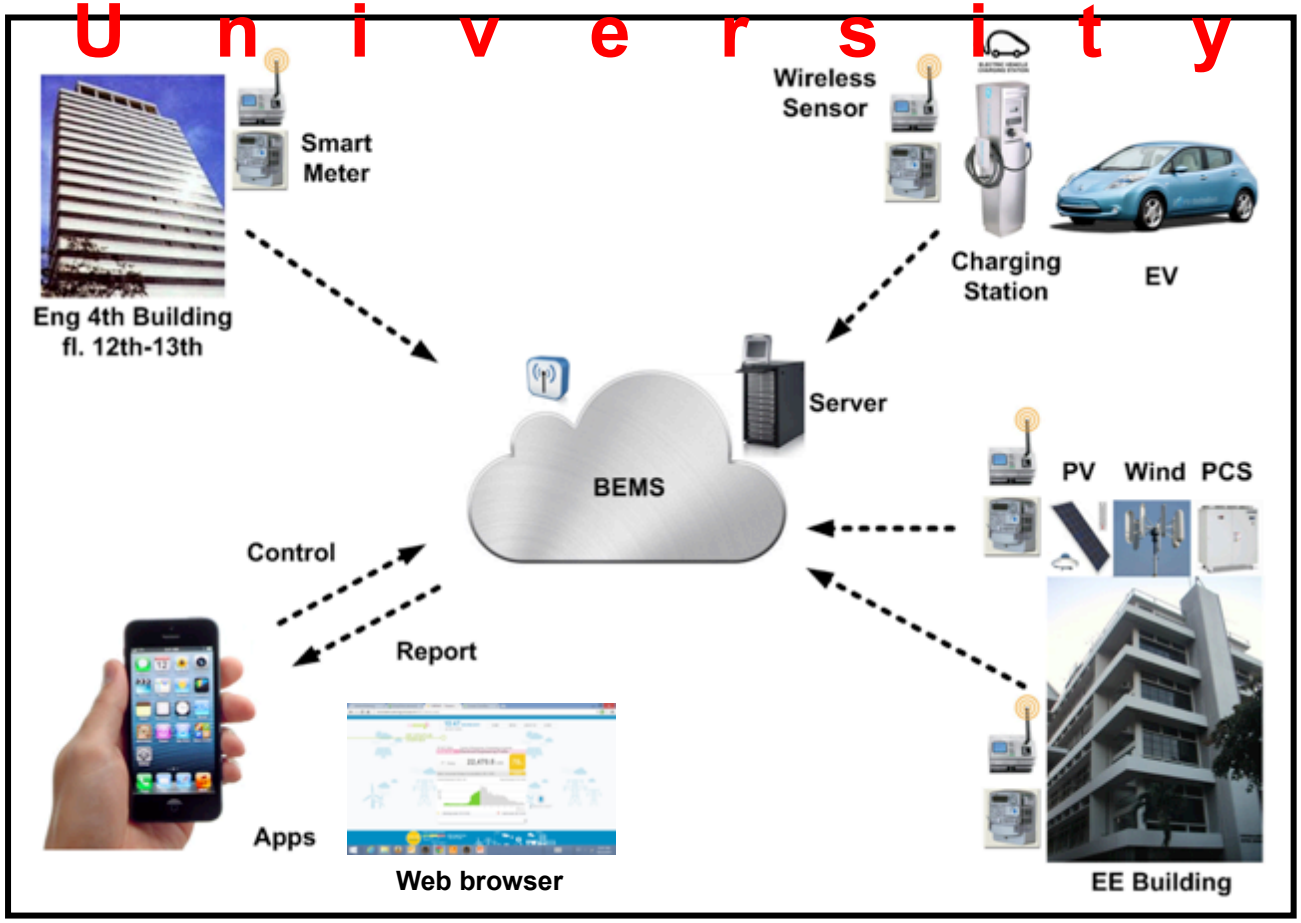
ENERGY RESEARCH INSTITUTE

ELECTRICAL ENGINEERING
CHULALONGKORN UNIVERSITY

THE UNIVERSITY OF TOKYO

CU-BEMS STRUCTURE

- **Prototype of Future BEMS at EE Department, Chulalongkorn University**



- IEEE1888 Protocol
  - Collaboration with University of Tokyo
- Smart Meter
  - Designed by ESID and TIN Labs
- Renewable Energy Source (PV system)
  - Showa Shell Sekiyu K.K. supported Copper Indium Selenide (CIS) - PV Module

Installation Category	Number of Sales
Supermarkets and Shopping Malls (All and partial)	54
Factories	7
Drug stores	151
Buildings	3
“Pachinko” stores	227

[Standardization]
- IEEE1888 (March 2011)
- IEEE1888.1 Wide-area operation management
- IEEE1888.2 Scalable GW function
- IEEE1888.3 Security

- ISO/IEC JTC1 TC6 : Fast Track
- NIST SGIP B2G
- China GB (domestic)

About 50 Bldg.s in Beijing
Bldg at CAS Shanghai campus

New Works

Design by Security and Privacy

- **NIST SGIP CoS mandates Cyber Security**
- **Privacy by Design** ➔ Encryption by Default
  - IAB Announcement on Nov.13, 2014
  - https://www.iab.org/documents/correspondence-reports-documents/2014-2/iab-statement-on-internet-confidentiality/
- **Security by Design**
  - For IoT and M2M, in all industry systems

I-REF Building

1. Multi-vendor operation with IEEE1888
   - HVAC
   - LED Lights
   - Power panel
   - Smart Tap

2. LED Lights controlled by PoE(Power on Ethernet)

3. **Software-Defined Digital Media**

4. Campus scale integration
   - University, Faculty, Departments, Floor, Room

5. Integration with Logistics and scheduler

Software Defined Media WG

- Objective
  - New media environment based on digital native media, while assuming all devices are connected to the Internet. All devices has intelligence and computing power, so called “Cloud with Virtual Machine over TCP/IP”.
- Core Members
  - Univ. of Tokyo
  - Keiko University
  - YAMAHA
  - BANDAINAMCO
  - KDDI
  - Dolby Japan
  - NTT
  - Panasonic

SDM-WG Technology Portfolio

SDM WG core member

東京大学 THE UNIVERSITY OF TOKYO — **IPv6 and Network Virtualize**

Keio University 1858 CALAMVS GLADIO FORTIOR — **Media Design**

YAMAHA — **Audio with Dante**

DOLBY — **ATMOS & HDR (High Dynamic Range) Video**

KDDI R&D LABS — **3D object oriented video**

NTT — **Phased Array Microphone**

BANDAI NAMCO — **Game envitronments**

Panasonic ideas for life — **Official sponsor of 2020 Olympic game**

Potential partner

AEON — **More than 80 theaters**

intel

NTTビズリンク

Pioneer

International partner

Queen Mary University of London centre for digital music

MANDAT INTERNATIONAL

UPMC PARISUNIVERSITAS

भारतीय प्रौद्योगिकी संस्थान हैदराबाद Indian Institute of Technology Hyderabad

uni.lu UNIVERSITÉ DU LUXEMBOURG


Next Step :
(1) 3D Video (4K/3D?)
(2) HDR (High Dynamic Range)

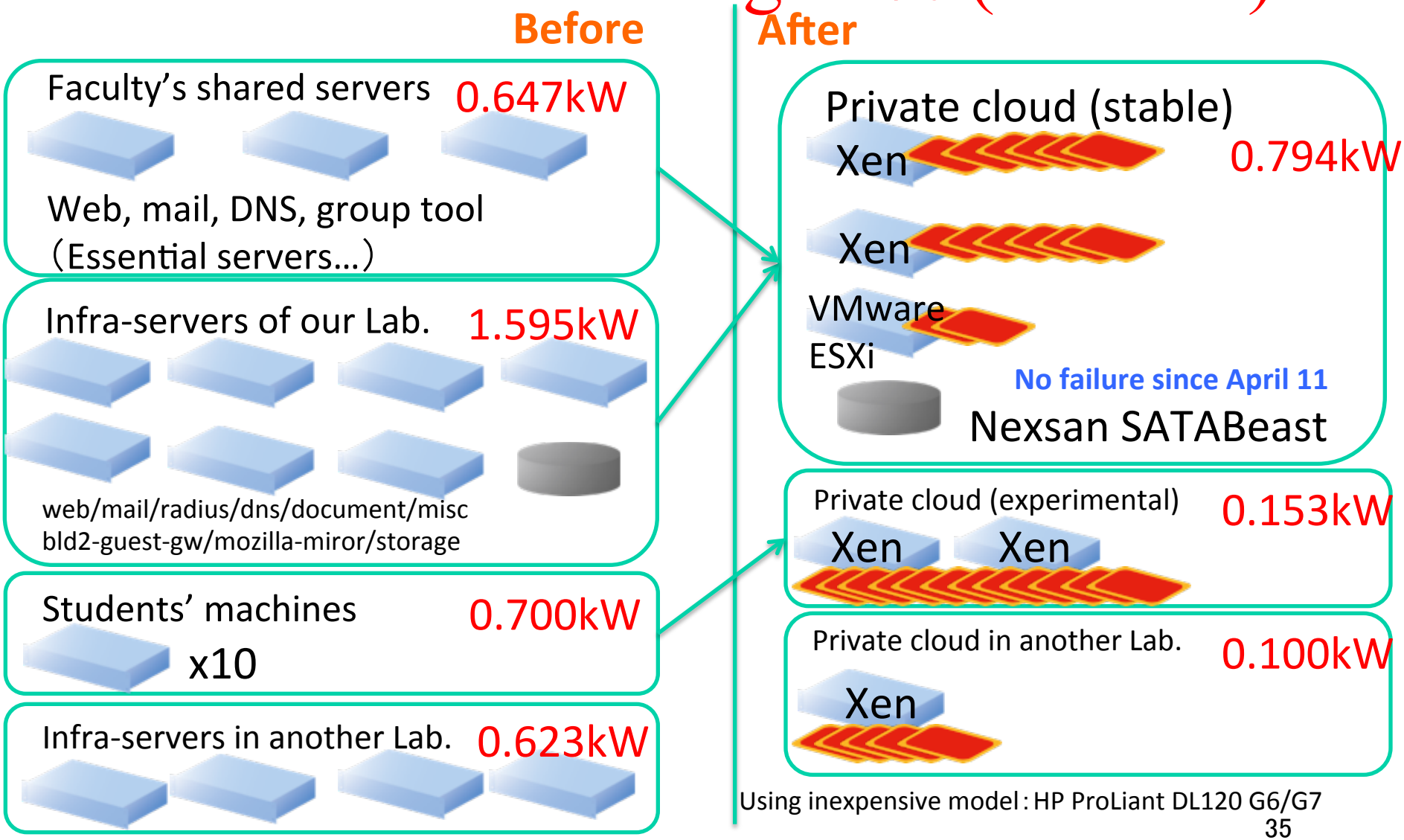
“Strategic use of Cloud & DC”

1. Facility on the Net(Cloud)
2. **Computers into the Net (Cloud/DC)**

東京大学
THE UNIVERSITY OF TOKYO

Private Cloud in our Lab.

Achievement: Saving 71% (2.52kW)!



Using inexpensive model : HP ProLiant DL120 G6/G7

Private Cloud in our Lab

RoI of investment

➔ 6 months (w/ PUE=2.0)

“True” benefits for us;

1. Manageability of system
2. BCP for power incidents
3. Comfortable environment

Tokyo Institute of Technology
Green Hills,No.1 Bldg

Best Current Practice
for Commercial Building
and for MicroSoft

1. Facility management control by IEEE1888
2. Servers go to Data Center
   = No server room in the bldg

Microsoft Japan
HQ in Tokyo

CANON S Tower
(Canon MJ HQ)

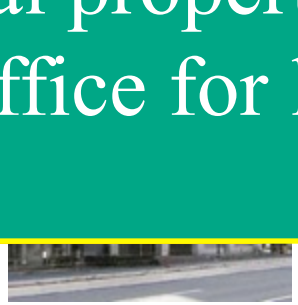
1 Bldg

【Cost-saving & QoE】

1. Initial cost for computer room
2. During use of office
3. Move out cost for restoration

【BCP】

a. Intellectual property
b. Remote office for ladies and others



(Canon MJ HQ)

What happened on Tokyo Local Government officer ?

1. Initial (Spring 2008)
   - **i.** **"Hate"** Data Center, because of huge power consumption and continuous increase.
2. Beginning 2010
   - i. Data Center is **"good"** for reduce the power consumption
3. Now
   - i. Include the **"exception"** for iDC into the **"regulation"** on the CO_2 carbon footprint reduction
   - ii. **"Promoting"** to use iDC and cloud platform

What happened on Tokyo Local Government officer ?

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   i. **"Hate"** Data
      and continuous inc
2. Beginning 2010
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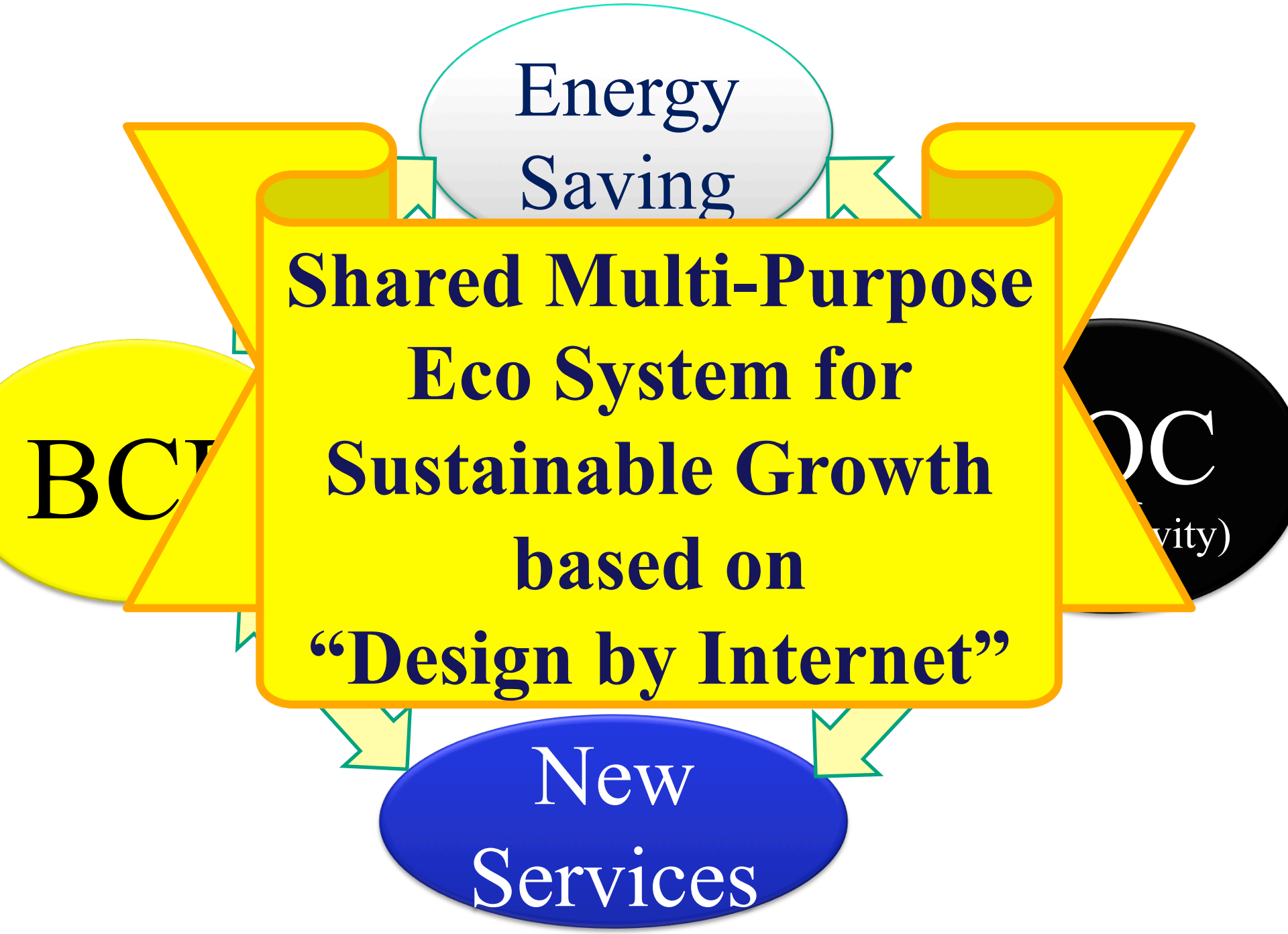
3. Now
   i. Include the "excep
      CO_2 carbon footpri
   ii. **"Promoting"** to use iDC and cloud platform

Energy
"Consumer"
↧
to "Saving", i.e.,
"Nega-watt"


Energy
Saving
Shared Multi-Purpose
Eco System for
Sustainable Growth
based on
“Design by Internet”
New
Services

Thank you !

- Hiroshi ESAKI, Ph.D.,
  Professor, Professor,
  Graduate School of Information Science and Technology,
  The University of Tokyo,
  102A2, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan
  Email hiroshi@wide.ad.jp, hiroshi-sec@hongo.wide.ad.jp
  TEL : +81-3-5841-7465
  http://www.i.u-tokyo.ac.jp/
  http://hiroshi1.hongo.wide.ad.jp/hiroshi/index.html

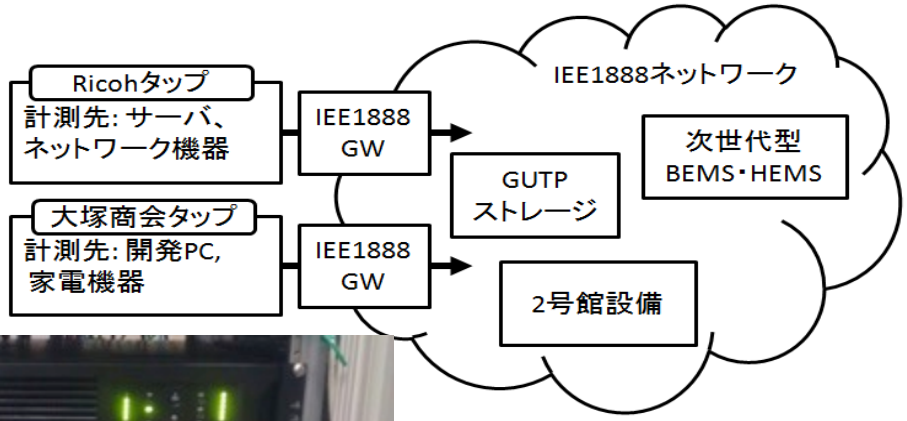
What GUTP provides

1. Technical specification via IEEE-SA and other standardization institutes, e.g., ISO/IEC
2. SDK
   a. Referenced implementation, with Linux VM
   b. OpenADR over IEEE1888
   c. Gateway function, e.g., BACnet, Lonworks, Modbus, KNX
   d. IEE1888 over WebSocket
3. Testing Environment
   a. Specification and software
   b. Certification / logo

Smart Tap Integration with IEEE1888

- Esaki-Lab at The Univ.of Tokyo

  1. Ordinary Smat-Tap By Plugwise Inc.,
  2. Smart-Tap for Rack in computer room by RICHO Company Ltd.



IEEE1888 Development Kits by FUTABA Kikaku