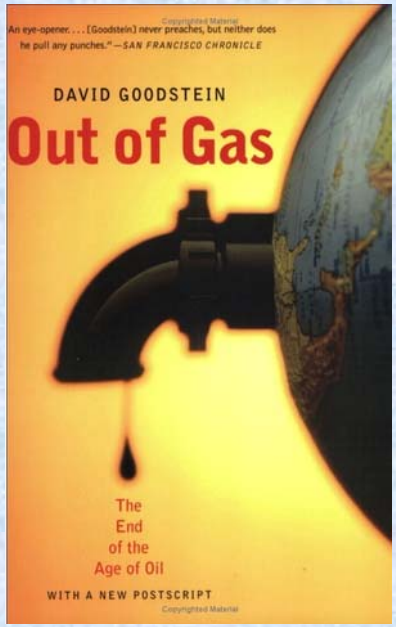
IEEE ICC 2009 PANEL P04
- Green Communications

Tuesday, June 16, Dresden, Germany

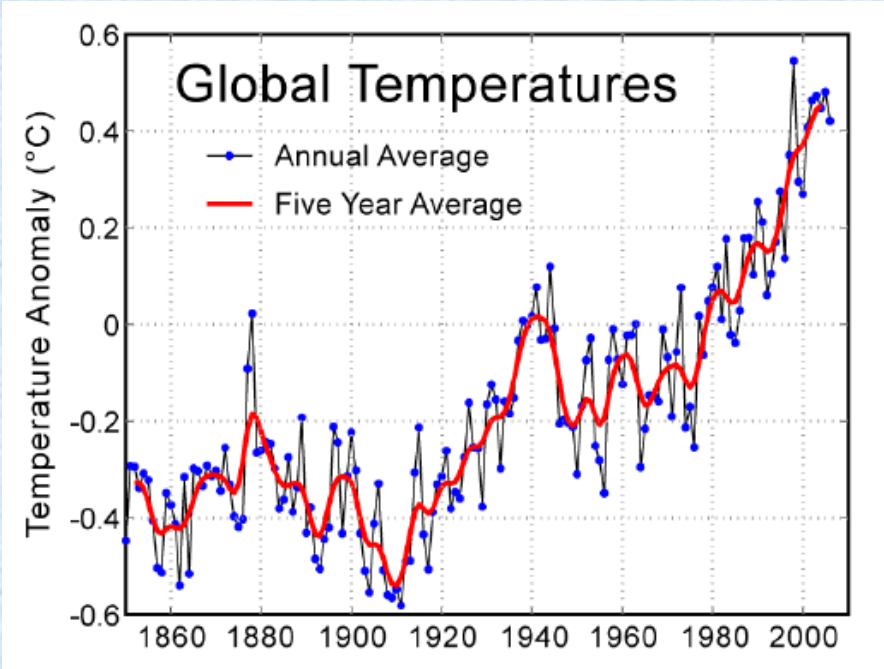
Dream Team of Global Leaders

1. **Mario Pickavet** - Professor, University of Ghent IBBT, Belgium
2. **Steven Gray** - CTO & VP of Corporate Research, Huawei Technologies Co., USA
3. **Zhifeng 'Jeffrey' Tao** - Principal Technical Staff, Mitsubishi Electronic Research Lab USA
4. **Werner Mohr** - Head of Research Alliances, Nokia Siemens Networks, Germany

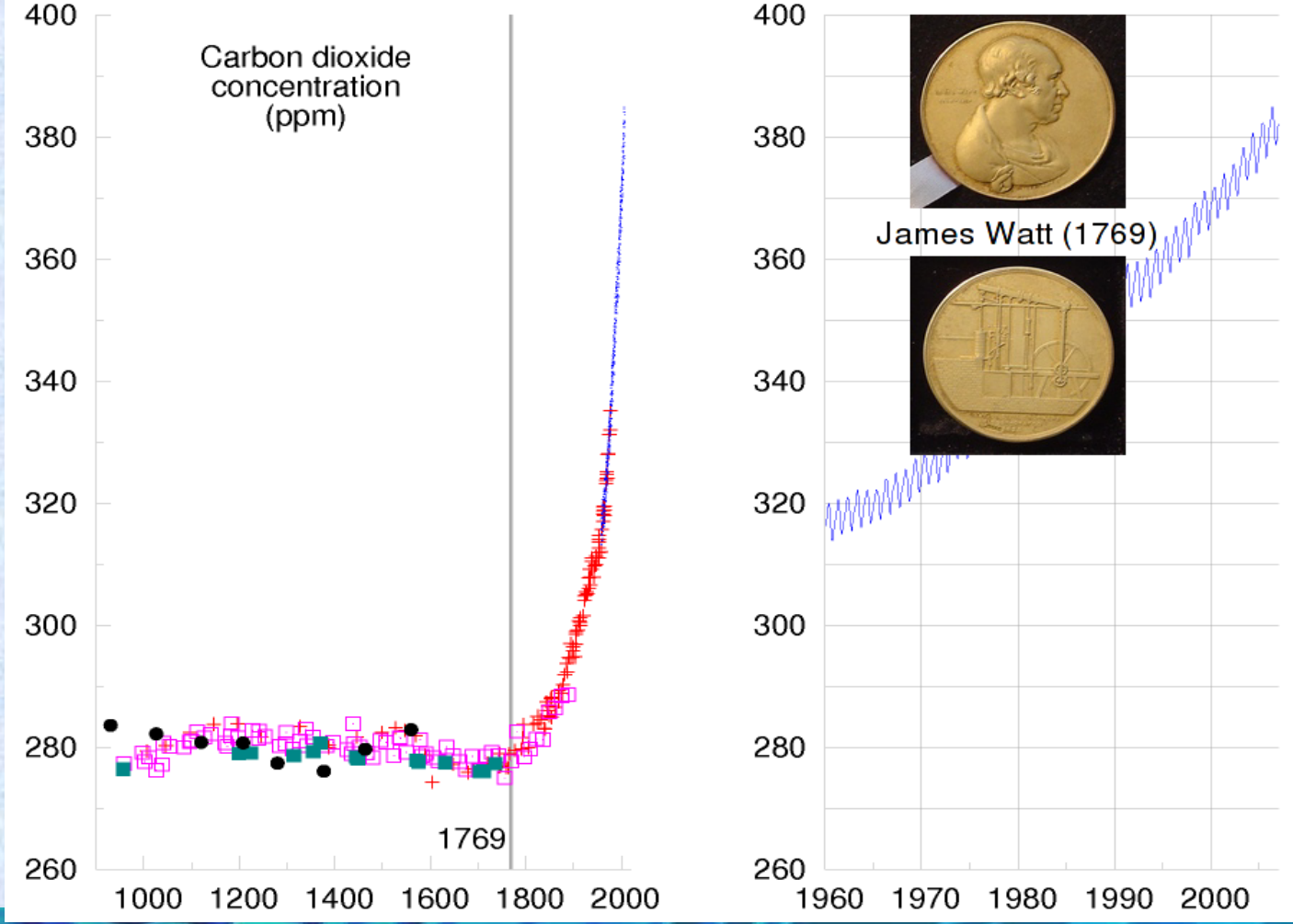
Global Warming – The Most Dangerous Threat



Global Temperatures Increasing & Warming in Arctic

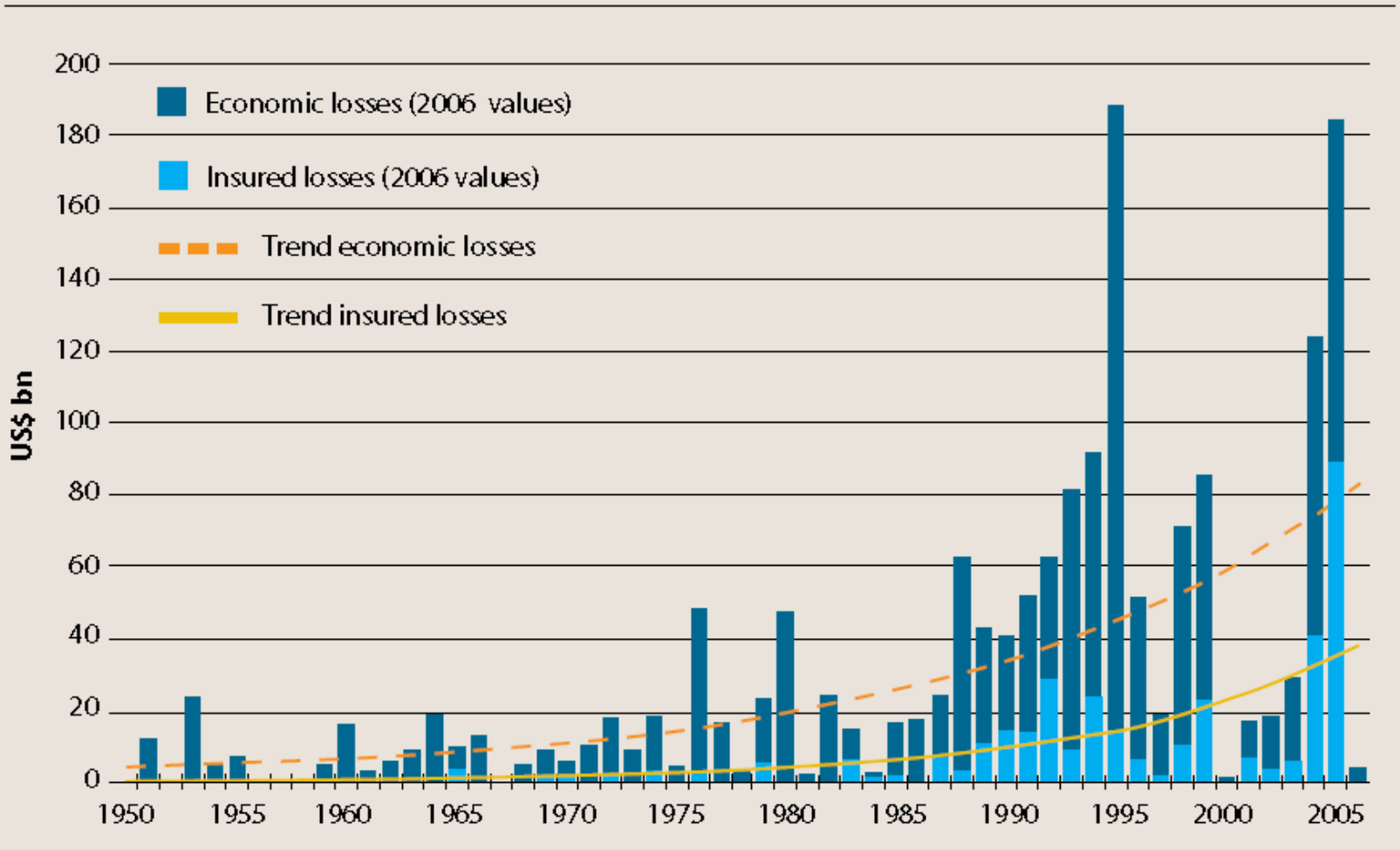


Indicators of the Human Influence on the Atmosphere during the Industrial Era



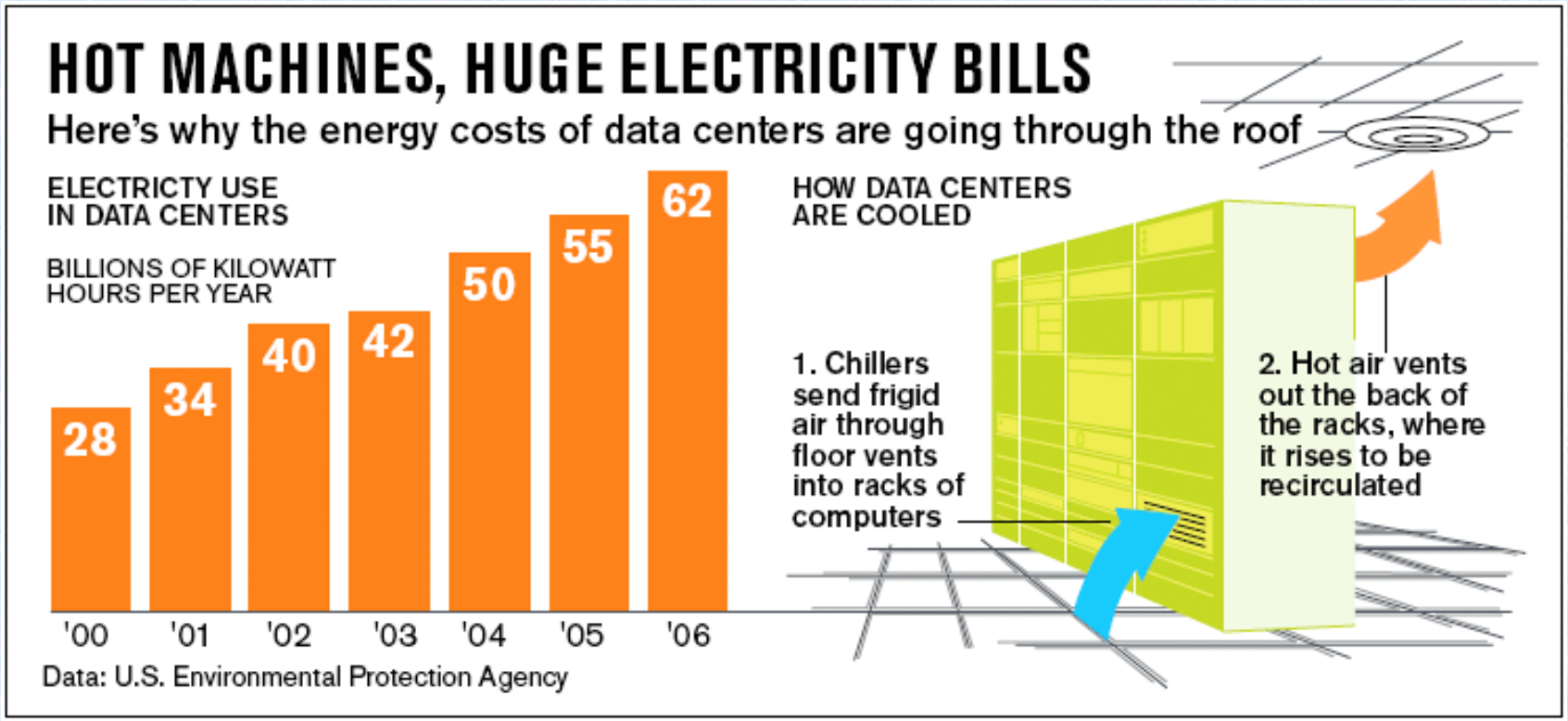
Source: http://www.phy.cam.ac.uk/ , Prof. David MacKay, Cambridge University

Global Costs of Extreme Weather Events from 1950–2006 (Adjusted for Inflation)

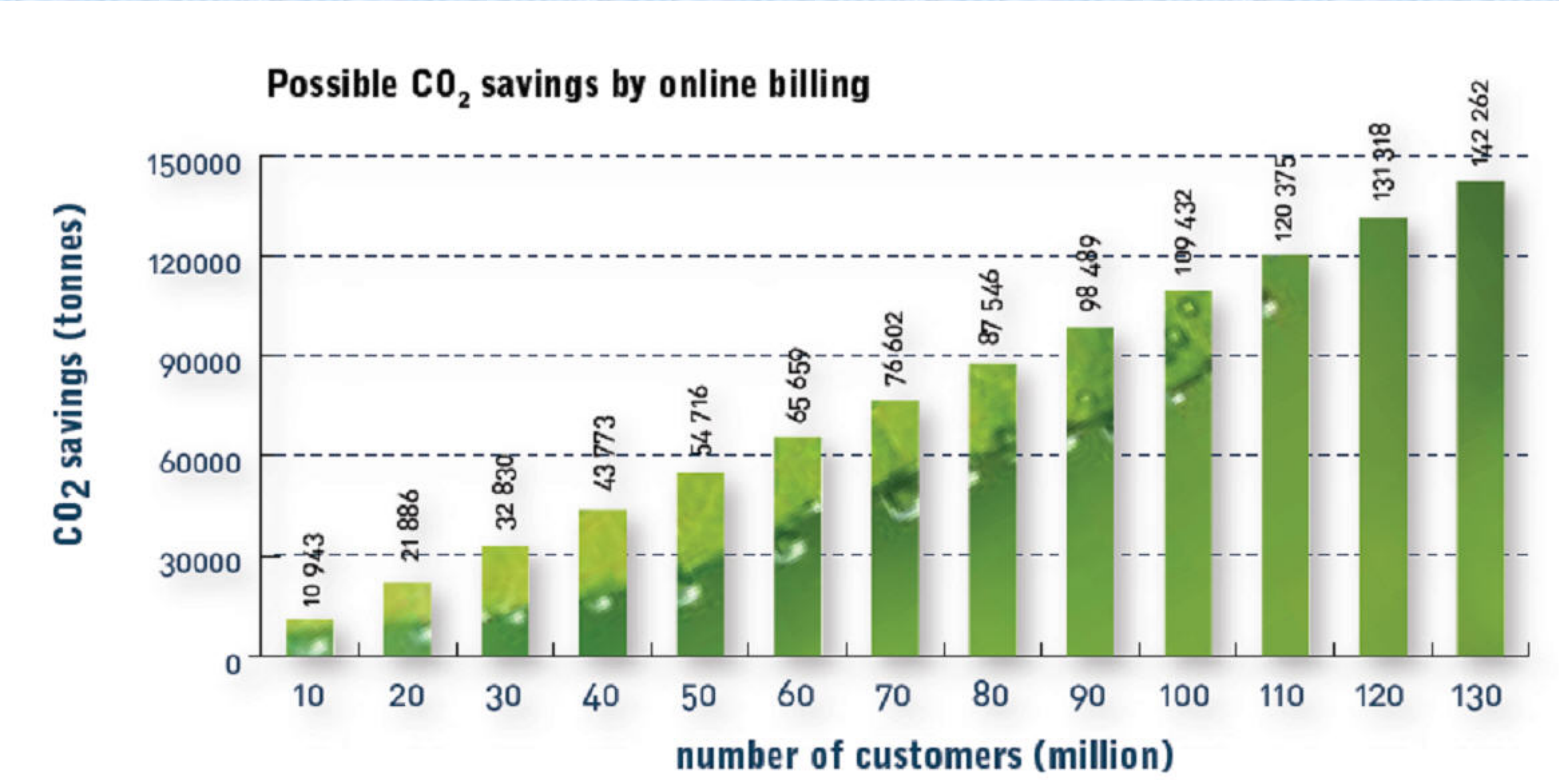


Source: IPCC 2001, Rauch 2007

Energy Cost and Power Consumption Increasing with Telecommunications (cont.)



Green Communications - Telecommunications Value in Promoting Environmental Improvement



- **Telecommunications applications can have a direct, tangible impact on lowering greenhouse gas emissions, power consumption, and achieving efficient recycling of equipment waste.**

Source: Saving the climate @ the speed of light, WWF, ETNO

Thank You !

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Is ICT green ?

Mario Pickavet
Ghent University - IBBT
Belgium

Some quotes…

2007, Justin Mann, TechSpot.com

"Server power doubled over the past 5 years…"

IBBT

Some quotes…

1999, Marc Mills, ‘The internet begins with coal’

“… It now seems reasonable to forecast that in the foreseeable future, certainly within two decades, 30 to 50 percent of the nation’s electric supply will be required to meet the direct and indirect needs of the Internet. …”

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Some quotes…

2002, Walter Baer et al., ‘Electricity requirements for a digital society’

“… ICT networks, computers, and office equipment … In none of our 2021 scenarios does this percentage exceed 5.5 percent of the national electricity total. …”

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1. Realistic assessment

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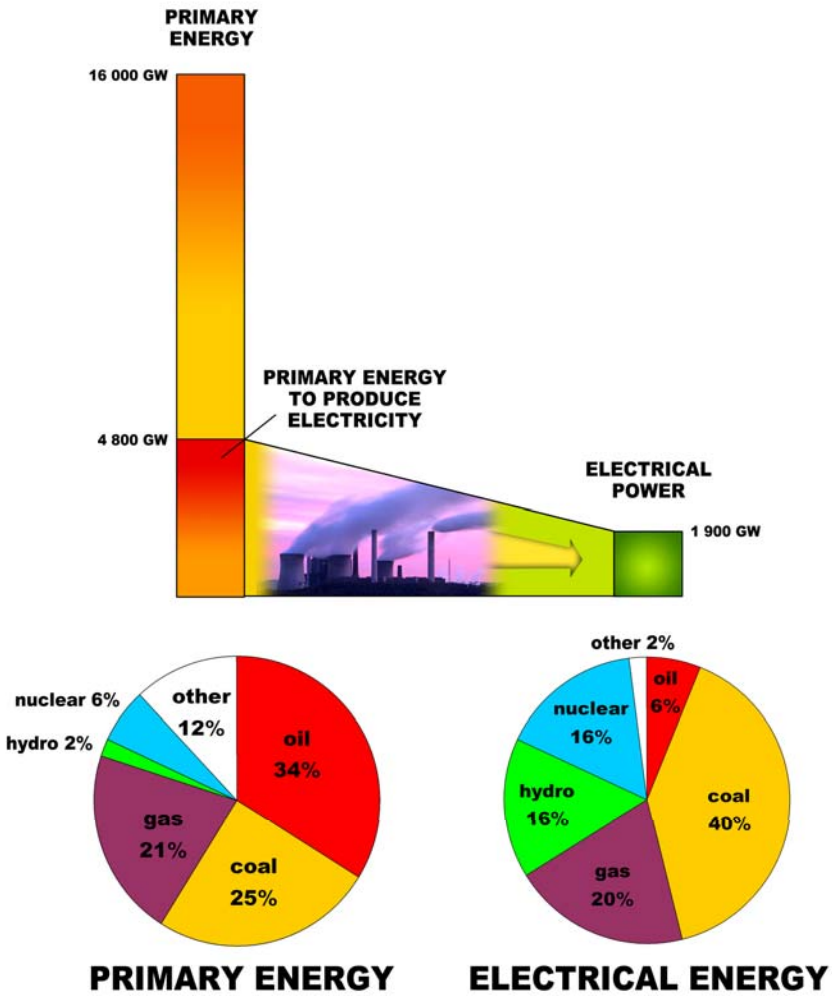
Energy worldwide today



Some key conclusions:

- Electricity = 30% of energy
- In terms of CO_2 emissions:

  1 W of electrical energy ≈ 2.1 W of primary energy

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ICT use phase: typical figures

Equipment type	Power consumption during active mode (average load)
desktop PC with LCD display	100 W
desktop PC with CRT display	150 W
laptop PC	30 W
CRT TV	150 W (0.34 W per square inch)
LCD TV	190 W (0.29 W per square inch)
Plasma TV	330 W (0.34 W per square inch)
Gaming console	190 W
Volume server	220 W
Mid-range server	700 W
High-end server	10000 W
Core routers and switches	5 W per Gbit/s throughput
Access routers and switches	> 10 W per Gbit/s
Home gateway	7 W
GSM Base Station	700 W
WiMAX Base Station	400 W

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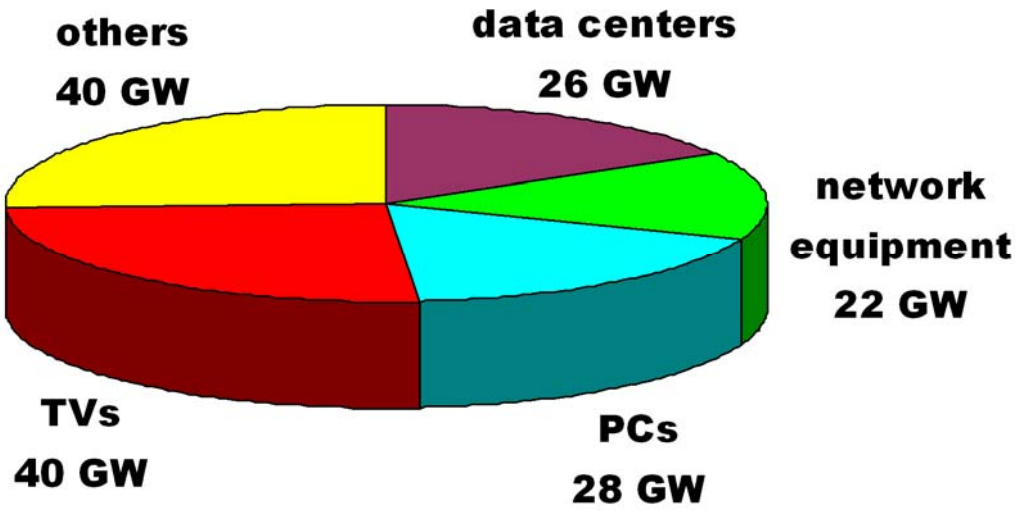
ICT use phase: worldwide today



Conclusions:

- Total = 156 GW = **8%** of global electricity consumption
- No dominating front, several fronts are important

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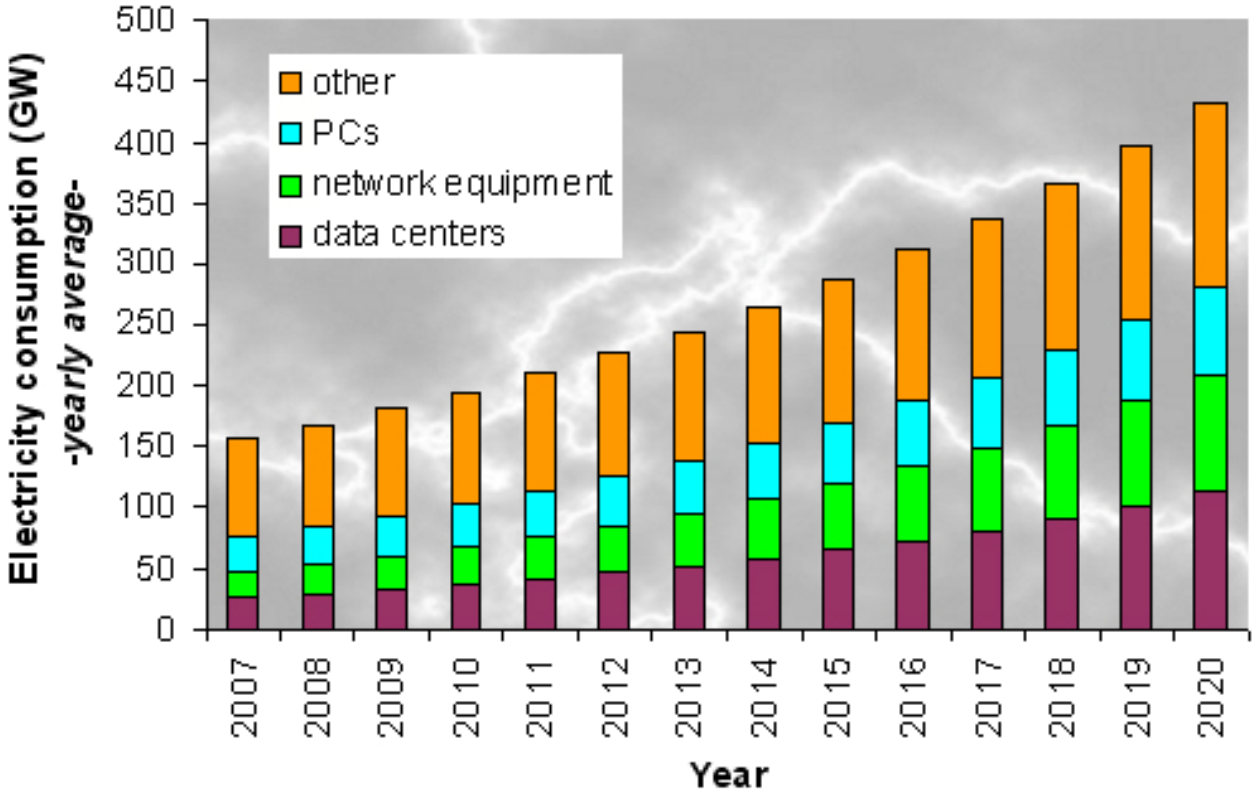
Future estimations



Conclusions:

- 1/7th of electricity goes to ICT use phase in 2020
- **Power efficiency key research topic !!!**

(despite ICT being enabler of EE in other sectors)

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ICT complete life cycle

- Example*: typical PC with CRT screen (2000)
  - Manufacturing phase:
    - Electrical: 1550 MJ → 3875 MJ primary energy
    - Non-electrical: 4850 MJ primary energy
  - Use phase:
    - Electrical: 3500 MJ → 8800 MJ primary energy
  - Disposal phase:

    Highly depending on recycling/landfill/…

- Conclusions:

  Manufacturing phase and use phase: same order of magnitude

  →longer life cycle is key challenge

* E. Williams, "Energy Intensity of Computer Manufacturing: Hybrid Assessment Combining Process and Economic Input-Output Methods", Environmental Science & Technology, Vol. 38, No. 2, November 2004, p. 6166-6174

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2. Directions for improvement

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Hardware improvements

- Room for improvement ?
  - Example 1: electricity use laptop vs. desktop: 1/4th
  - Example 2: different TV technologies
  - Standby power losses
  - Efficiency of power supplies
  - …
- Driving forces:
  - Growing LT energy prices
  - Governmental actions to reduce greenhouse gas emission
  - Energy labels
  - ‘Green’ as marketing factor

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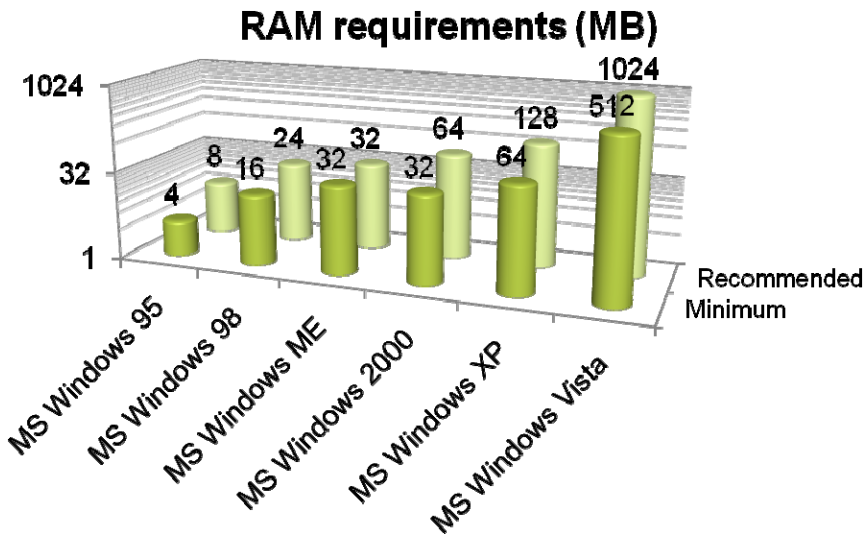
Software optimizations

- Impact of operating system
  - Electricity consumption
  - Lifetime



- Intelligent power management of computers and screens

- Server parks
  - Virtual server configurations
  - Switching off servers during quiet hours

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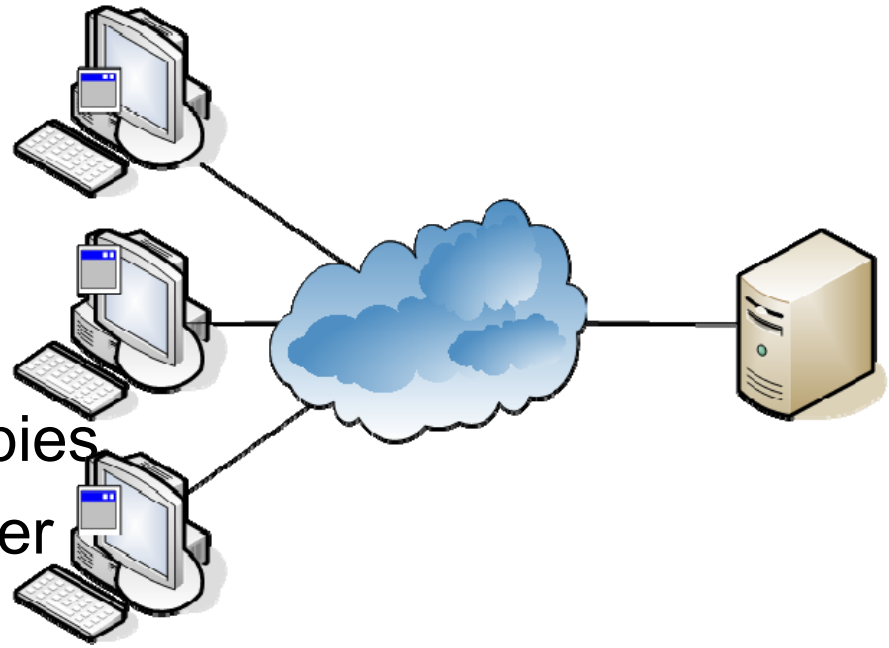
New network paradigms

- Initiatives today:
  - IEEE Study Group on Energy-Efficient Ethernet
  - ADSL low power mode
  - Low power access technologies
  - …

- Clean slate approaches

  E.g.
  - Terminals: only I/O
  - Content: reduction of #copies
  - Energy-efficiency key driver



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3. Conclusions

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Main conclusions

- Is ICT green ?
  - About 4% of primary energy today
  - About 8% of primary energy by 2020

- Is the situation hopeless ?
  - Much room for improvement
  - Research actions to be taken urgently
    - Careful comparison of different solutions:
      - EE + full LCA
      - End-to-end picture
      - Efficient information transport media
    - New concepts and paradigms

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June 16, 2009

Security Level:

Huawei Green Solutions

Steven D. Gray, Ph.D.

CTO and VP Huawei Corporate Research

www.huawei.com

Green Communications, Green Huawei, Green World

HUAWEI TECHNOLOGIES CO., LTD.

Outline

1 Background

2 Energy Efficiency

Wireless

Central Office

Broadband

Transport

Huawei corporate green policy

“Green communications, Green Huawei, Green world”

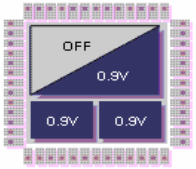
“**HUAWEI is committed** to social responsibility and environmental protection…, Ultimately we aim to achieve the goal to reduce operators’ power consumption, our own power consumption and the entire …”

Sun Yafang, Chairperson of HUAWEI

Green Action in Product Life Cycle

Design for Environment

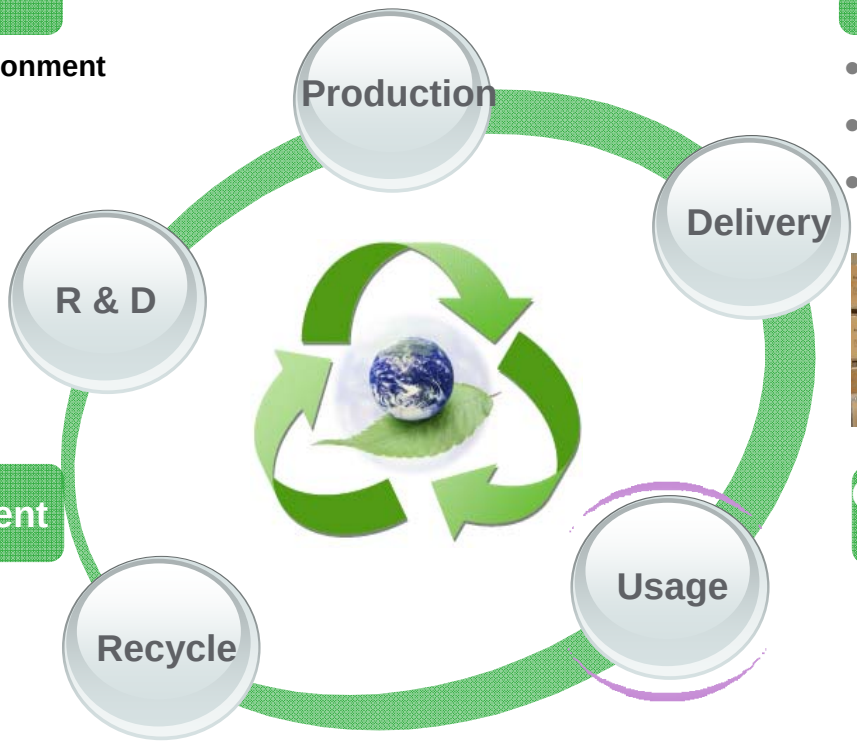
- Use material for eco-environment
- Energy saving frame, middleware, ASIC chip



power saving

End-of-life management

- Removal
- Collecting
- Recycling



Supply chain management

- 6R strategy in logistics
- Supply chain audit management
- Recycling package

Operation & environment management

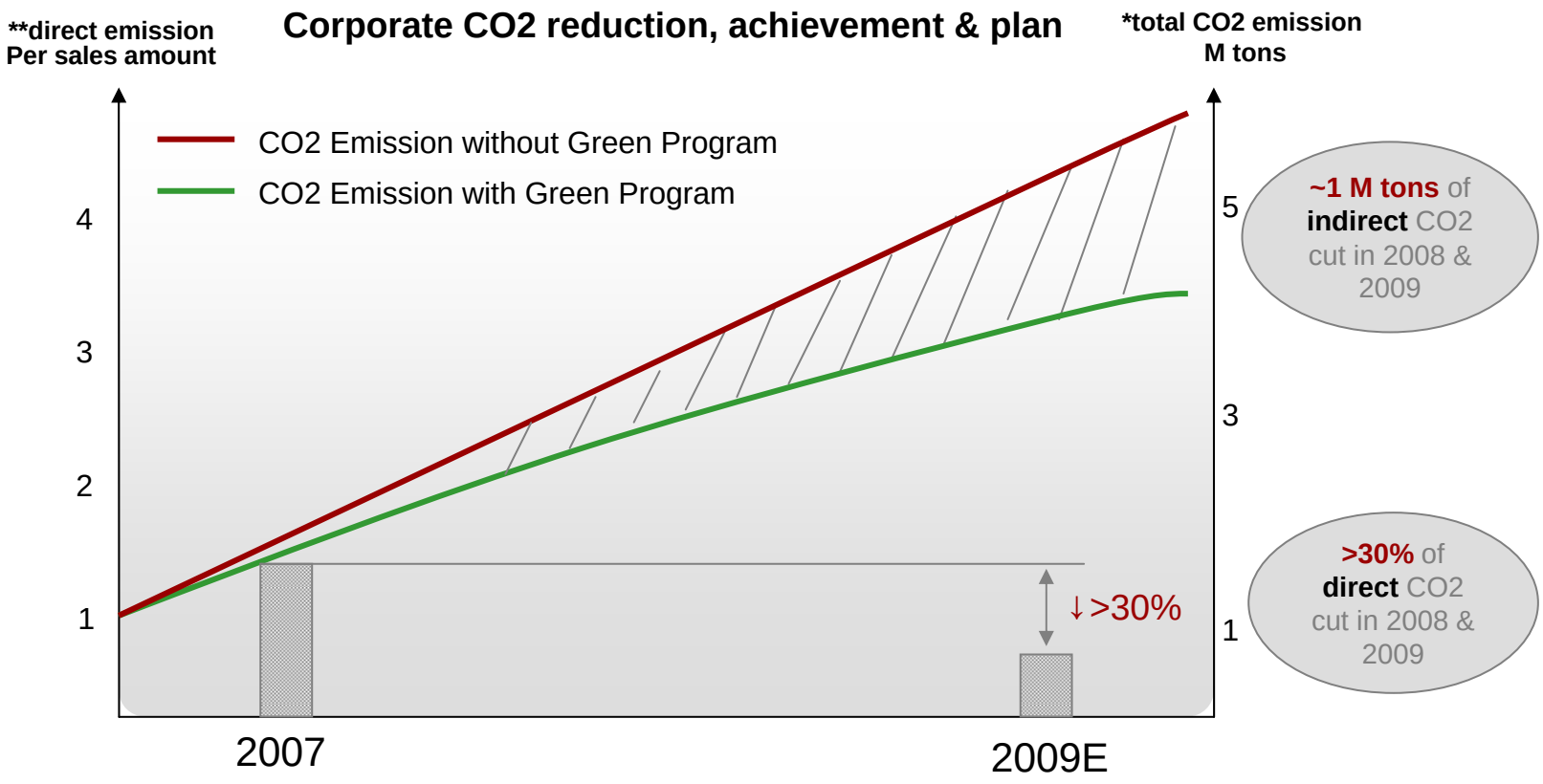
- EHS management
- Auto logistic center
- Recycling chopsticks

16,800 trees saved

Green Solutions of All levels of network

Corporate emission reduction

direct emission indirect CO2 emission



*The total CO2 emission includes direct emissions & indirect emissions, based on ISO 14046 standard
indirect emissions refers to the product annual shipped majority equipment of Huawei, which are wireless / wireline access network products
**internal operation includes manufacture and operational consumption of Huawei HQ, The unit is defined as K tons of emissions per 100M US dollars shipments

Fully Committed to Standards Work

Huawei has been involved with six different regional organizations developing energy efficiency proposals

ETSI / JRC
ATIS / NEBS
CCSA / etc

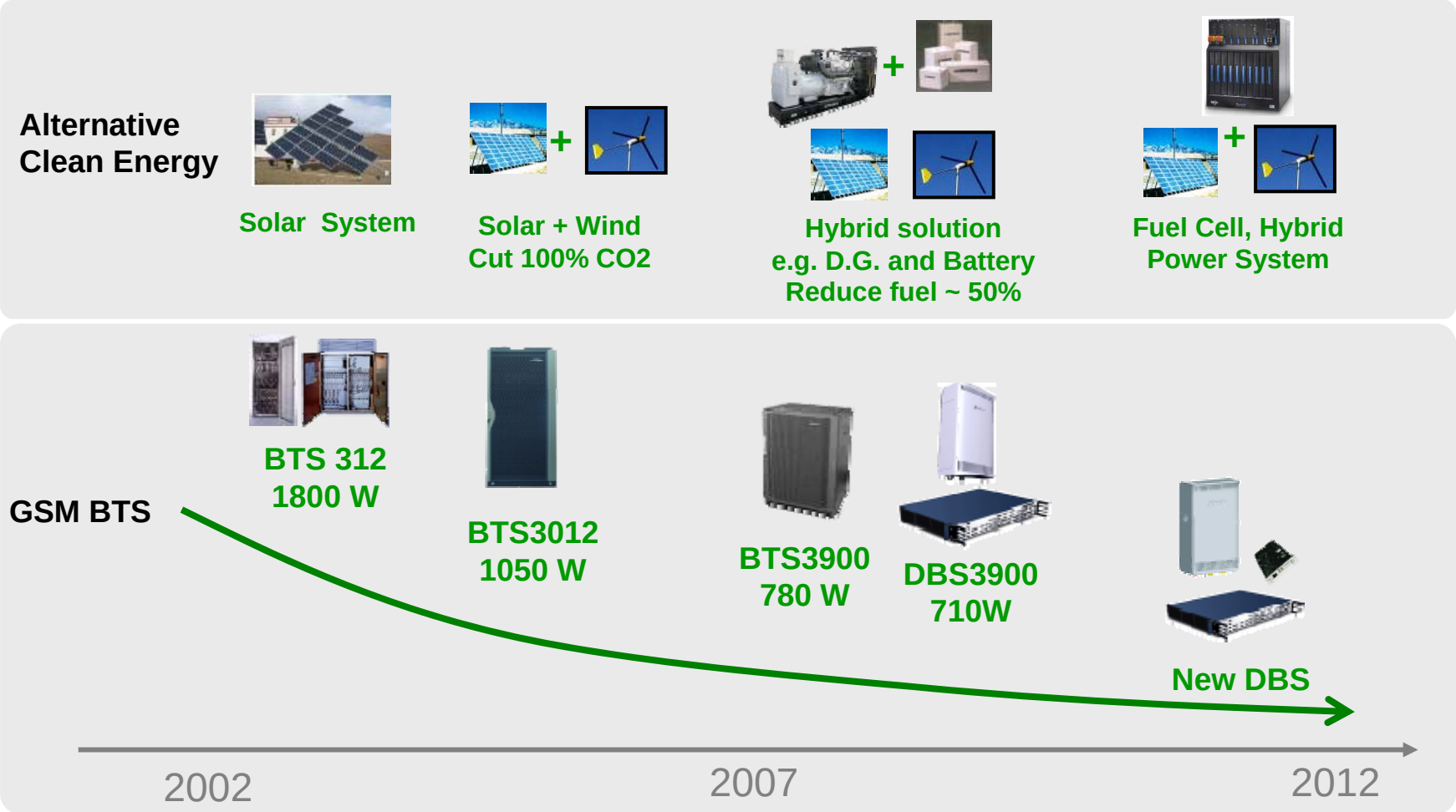
Example

EE
- **BB, BTS, LCA**

ATTM
- **Site, DC, CN, AN, User**

Huawei Wireless site efficiency

BTS product and alternative clean energy

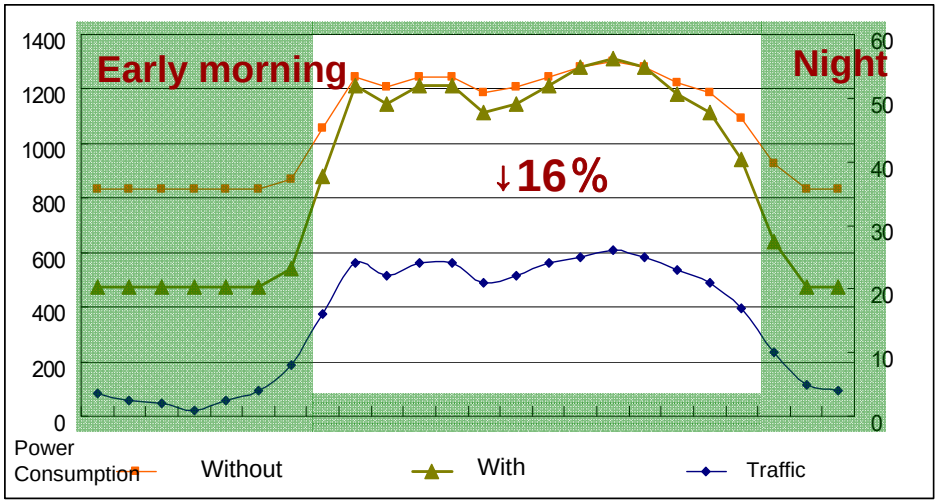


*D.G=Diesel Generator
**BTS S444 Load @30% , 15 W TOC

Example key technology

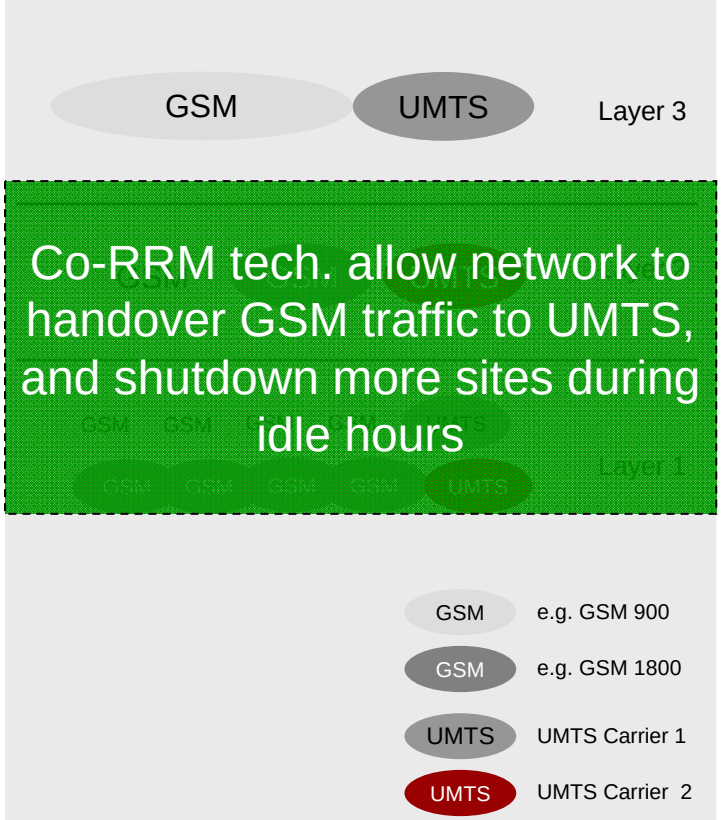
More flexible shutdown feature – Single RAN / TRX / Site shut-down

Software shut-down to save power



- Software shut-down feature allow to shut idle TRX according to save ~*16%
- Site level shutdown technology could achieve more significant saving, especially
- Co-RRM technology allow the network to balance traffic between GSM & UMTS, thus save more energy

Site Shut-down & **Co-RRM



*Huawei site experiences & internal lab data
**RRM =Radio Resource Management

Case: Energy solution in Africa

Site A
Bukoto Uganda, MTN

D.G. and battery hybrid solution

- Fuel cost reduced up to **60%** compare with traditional diesel generation
- D.G. system basement construction reduce up to **50%**
- Maintenance reduce up to **80%**

Site B
Nairobi Kenya, Safaricom

Solar + D.G. hybrid solution

- Fuel cost reduced up to **80%** compare with traditional solution
- Fuel transportation cost save up to **80%**
- Maintenance reduce up to **80%**

Case: Huawei high density BTS

reduces both power consumption and footprint in China Mobile

Before Swap, existing 5 racks **After Swap, 1 rack**

QTRU cuts 80% of footprint, high density & high energy efficiency (Shutdown tech.) saves ~30% power cost compared with existing BTS

Source: CMCC swap case

CO Efficiency Improvement

Hardware / software improvement and thermal management

Thermal Mgmt.	Precision aircon +Traditional layout	Precision aircon + Optimized layout *PUE=2.5	Precise Ventilation PUE=1.8	Direct cooling / Liquid cooling PUE=1.5
Product e.g. Core	 C&C08 Private Platform 12.6 KW / M Subs	 SoftX CPCI 2.8 KW / M Subs	AdvancedTCA® SoftX ATCA 1.7 KW / M Subs	 NG computing platform

2002 2007 2012

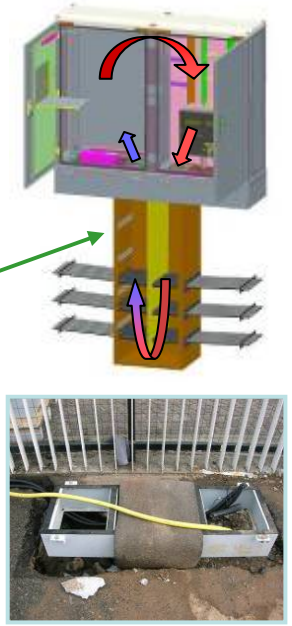
PUE: Power usage efficiency=Total power of DC/IT equipment power

CASE: Geothermal cooling cabinet

Telecom Italia saves 70% of cooling energy in Turin

TI LAB Turin, Italy

Geothermal cooling cabinet



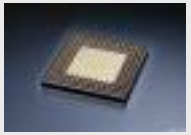
The test results confirmed:

1. cooling energy cost saves up to 70%
2. Coefficient of performance is twice that of the heat exchanged cabinet

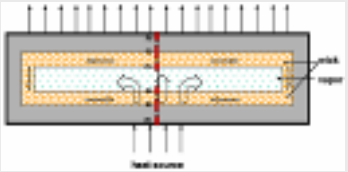
Transport Products improvement

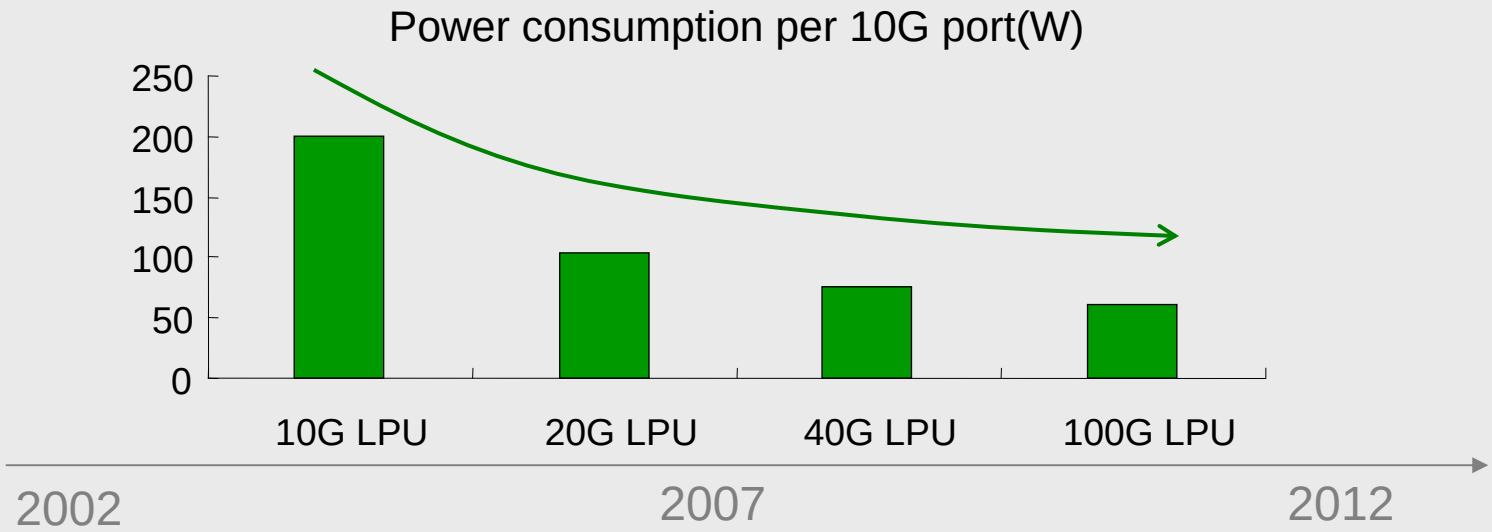
chipset & cooling technology development avoids trips

Chipsets



Cooling

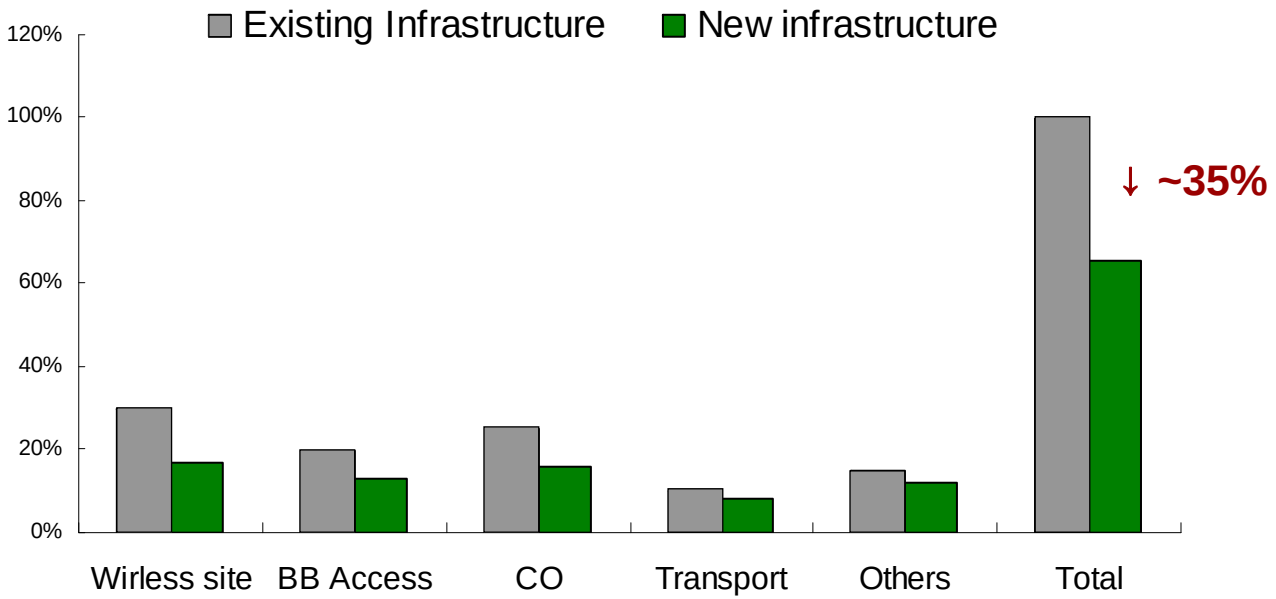




Scenario analysis

Huawei solutions cut carbon emissions and operating expenses

Existing solution	Green solution
Description ● Traditional infrastructure (TDM) ● Equipments deployed for 4-8 yrs ● Air conditioning	**Description** ● New infrastructure (ALL IP based) ● Green equipments (e.g. 4th generation BTS) ● Air Con / direct cooling / alternative energy



Source: Huawei cases (summary) for EU / China operators, 2005~2008

Thank you

www.huawei.com

Smart Grid

A New Paradigm of Green Communications

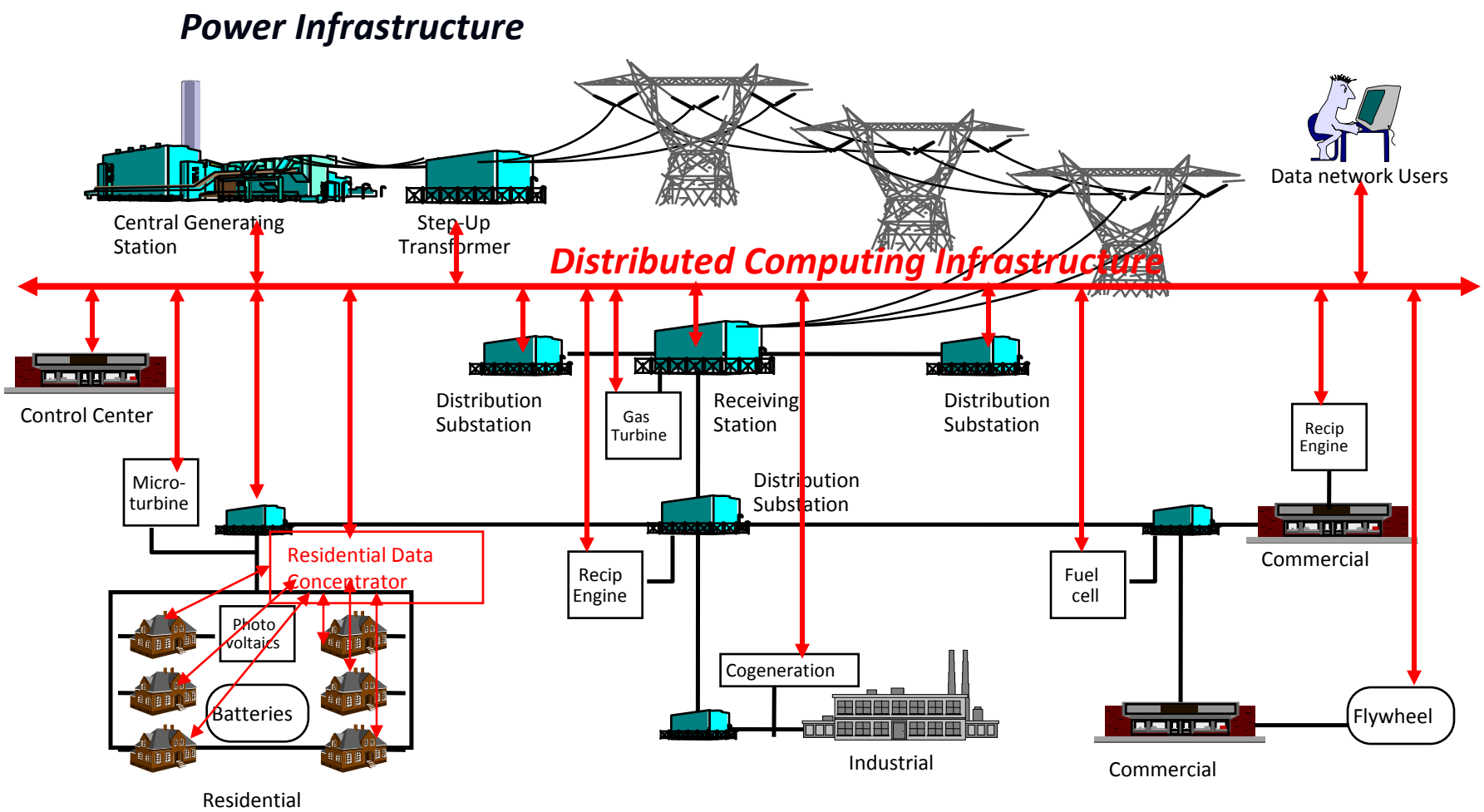
Dr. Zhifeng (Jeff) Tao
Mitsubishi Electric Research Lab (MERL)

MITSUBISHI ELECTRIC
Changes for the Better

ICC 2009
June 14-18 Dresden, Germany

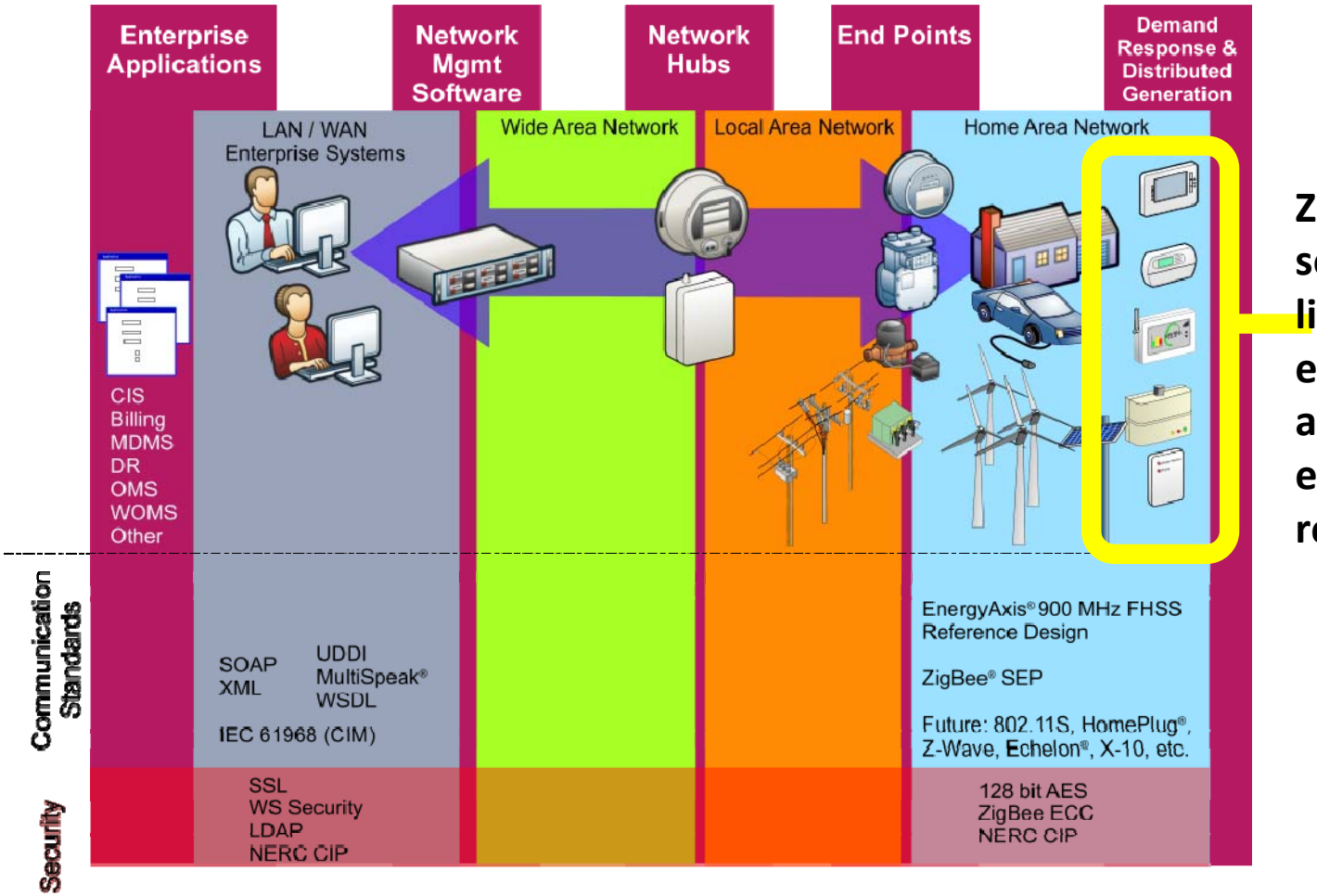
What is Smart Grid?

- **"a smart grid is the electricity delivery system (from point of generation to point of consumption) integrated with communications and information technology"**



Applications

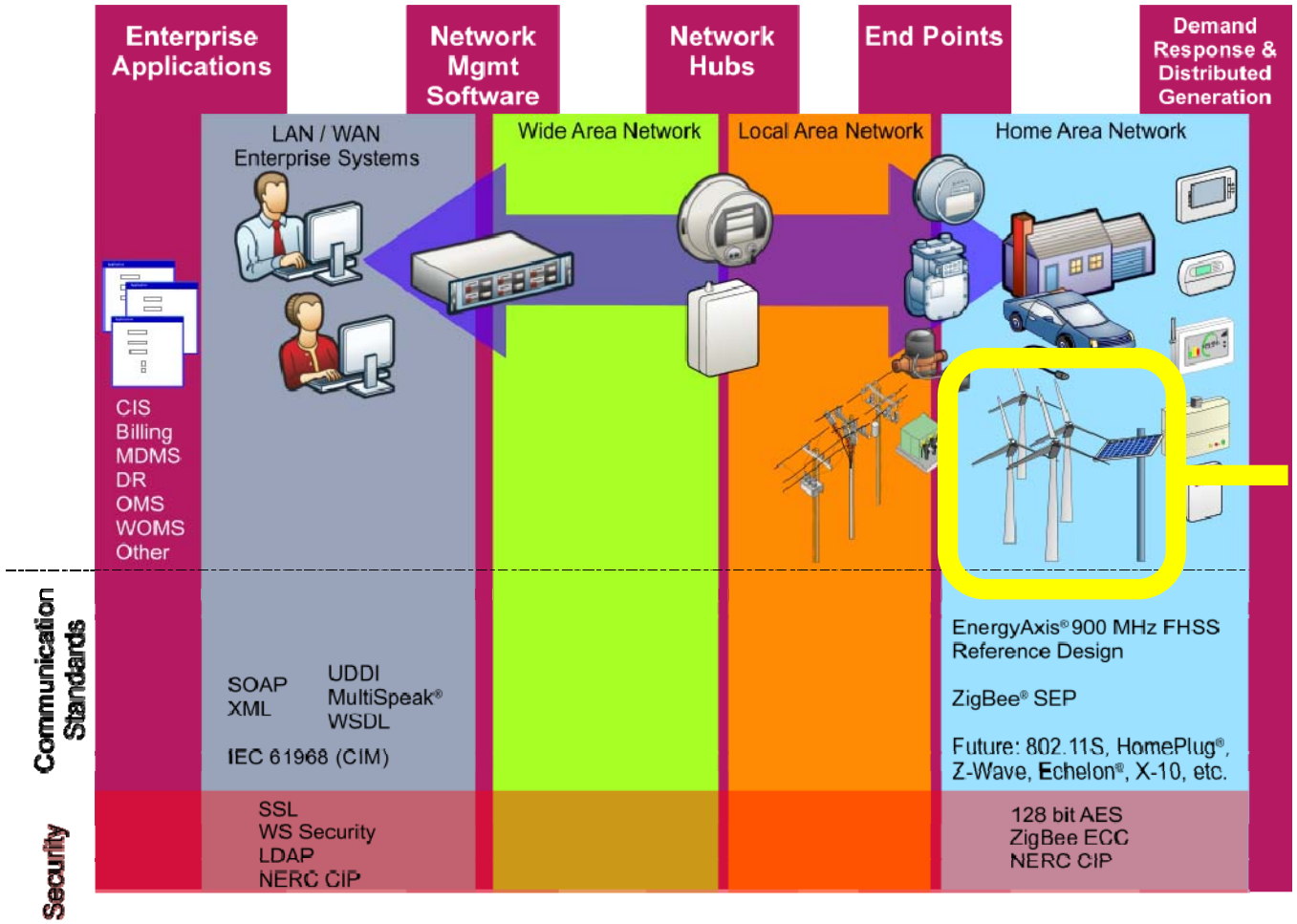
- A wide variety of communication/computing systems will be deployed to enable an amazingly rich services



Zigbee sensor/Power-line/IPv6 in every home appliance to enable demand response

Applications

- A wide variety of communication/computing systems will be deployed to enable an amazingly rich services

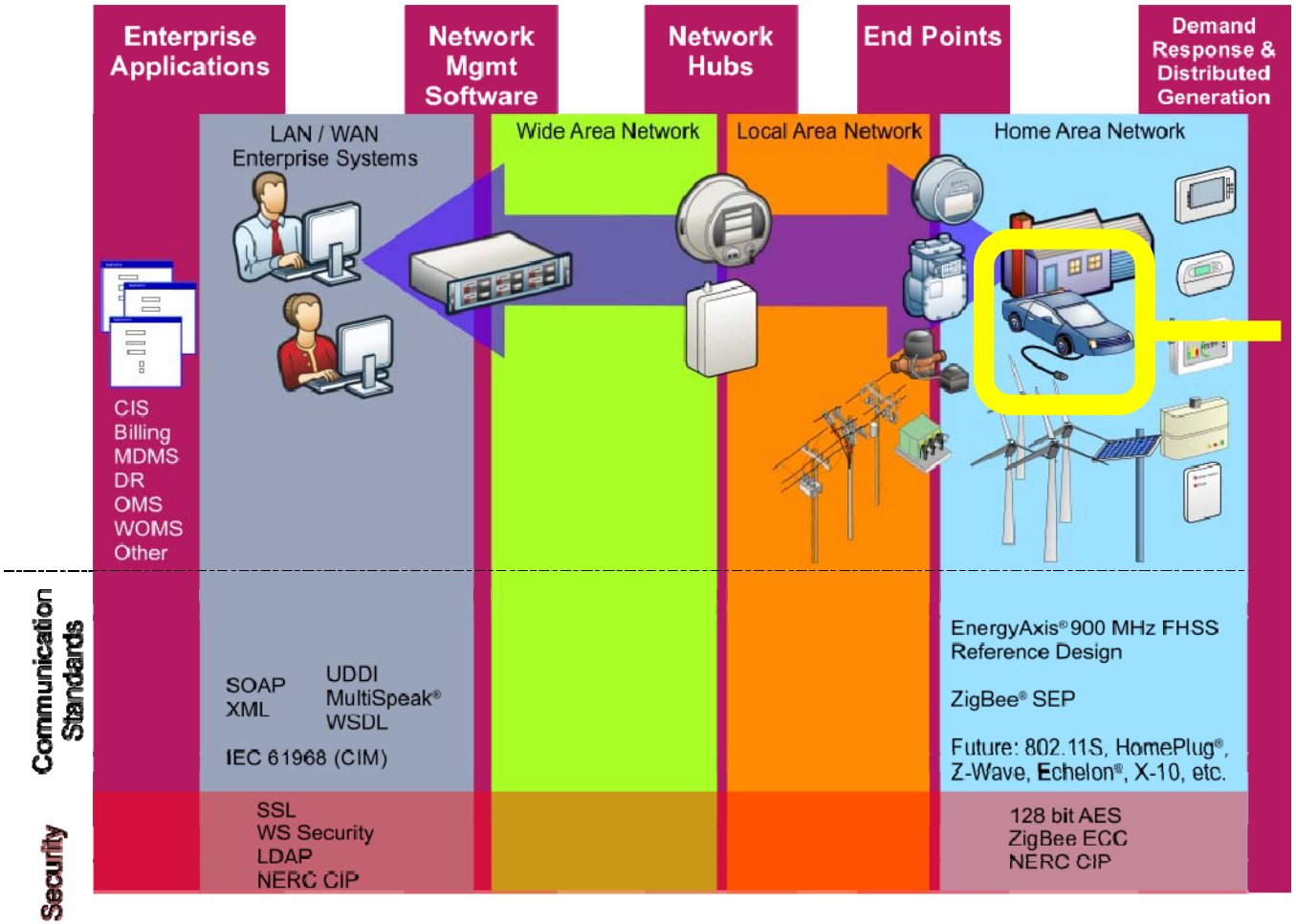


Enable a two-way integration of renewable energy sources (PV, wind) into power grid

© 2009 Z. Tao

Applications

- A wide variety of communication/computing systems will be deployed to enable an amazingly rich services

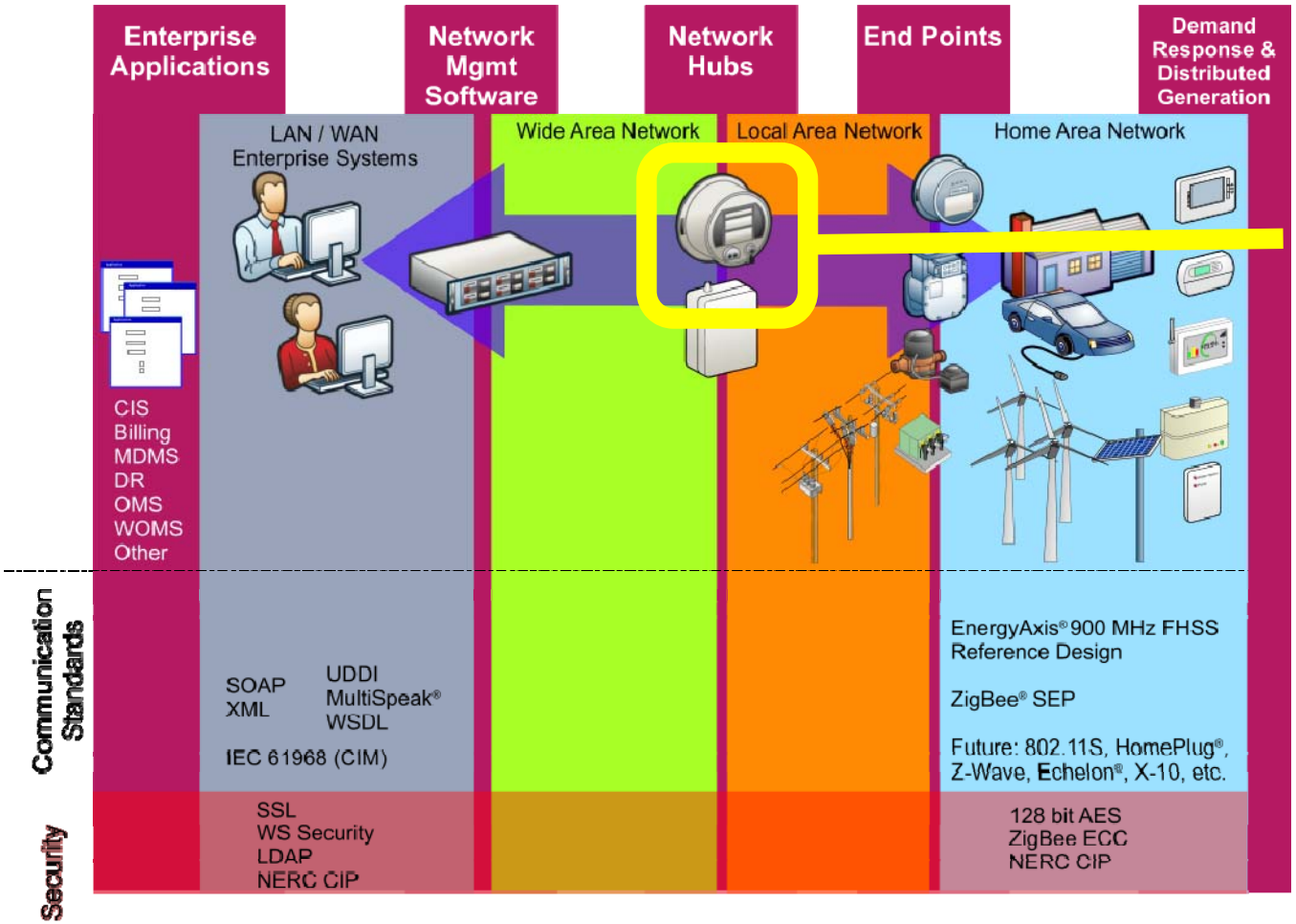


Two-way power flow between electric vehicle and power grid helps balance the peak

© 2009 Z. Tao

Applications

- A wide variety of communication/computing systems will be deployed to enable an amazingly rich services



Smart meter communicates (WiMAX, cellular network, mesh) with utility back office and reports realtime price

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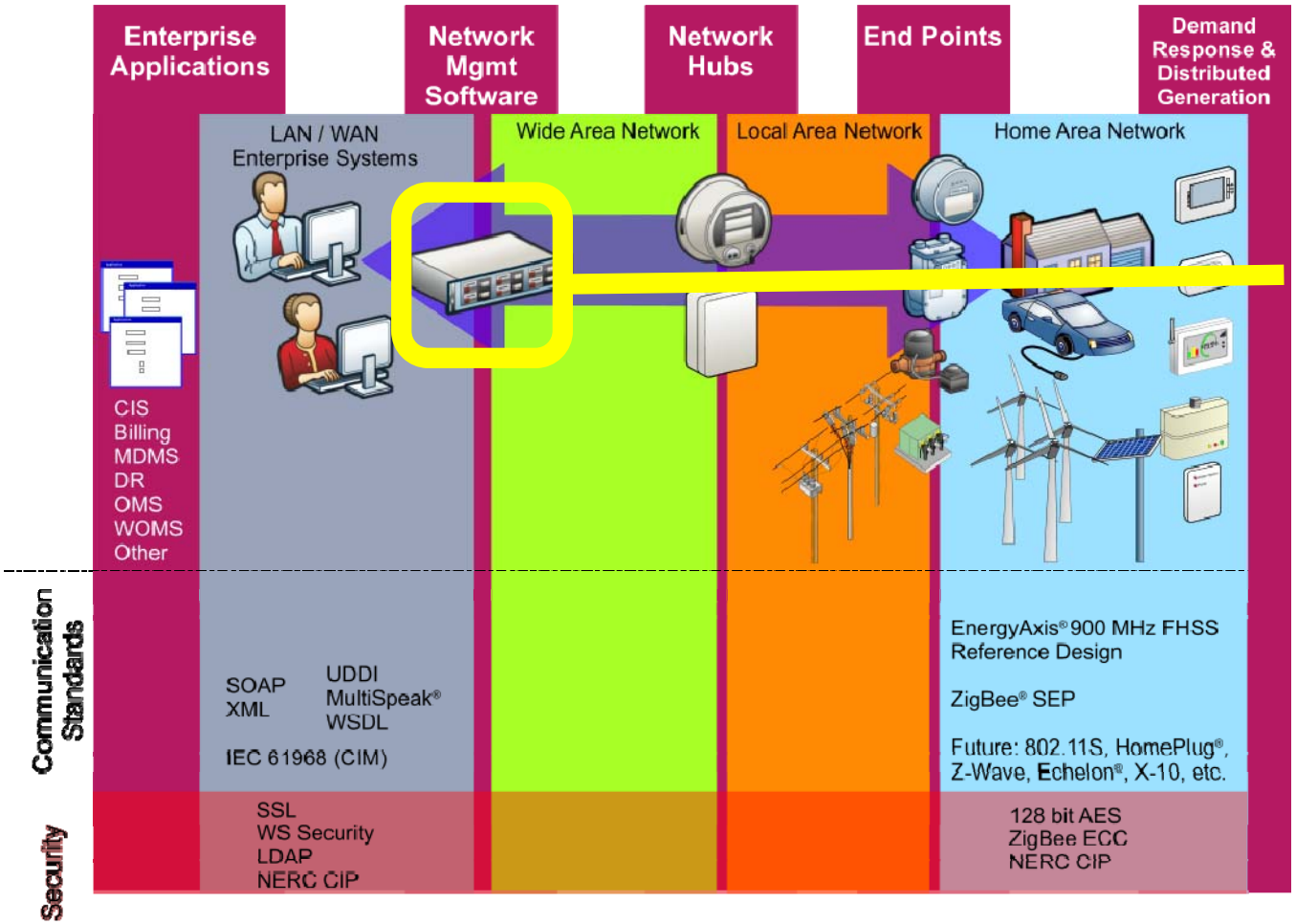
Applications

- A wide variety of communication/computing systems will be deployed to enable an amazingly rich services



Condition monitoring and reporting in utility's power grid can help avoid cascade effect and blackout

© 2009 Z. Tao

Policy

- **Energy Independence and Security Act (EISA) of 2007**
  - **Title XIII, Section 1305. Smart Grid Interoperability Framework**

- **President Obama's economic stimulus package allocates *4.5* billion dollars to modernize the nation's electricity system and put smart-grid technology on the fast track.**
  - Much more is expected to be spent on this initiative to make US's grid *"smart"*.

- ***It's an urgent US national priority***

US Secretary of Energy
Dr. Steven Chu
美国能源部长
朱棣文

National Coordinator
Dr. George Arnold

US Secretary of Commerce
Gary Locke
美国商务部长
駱家輝

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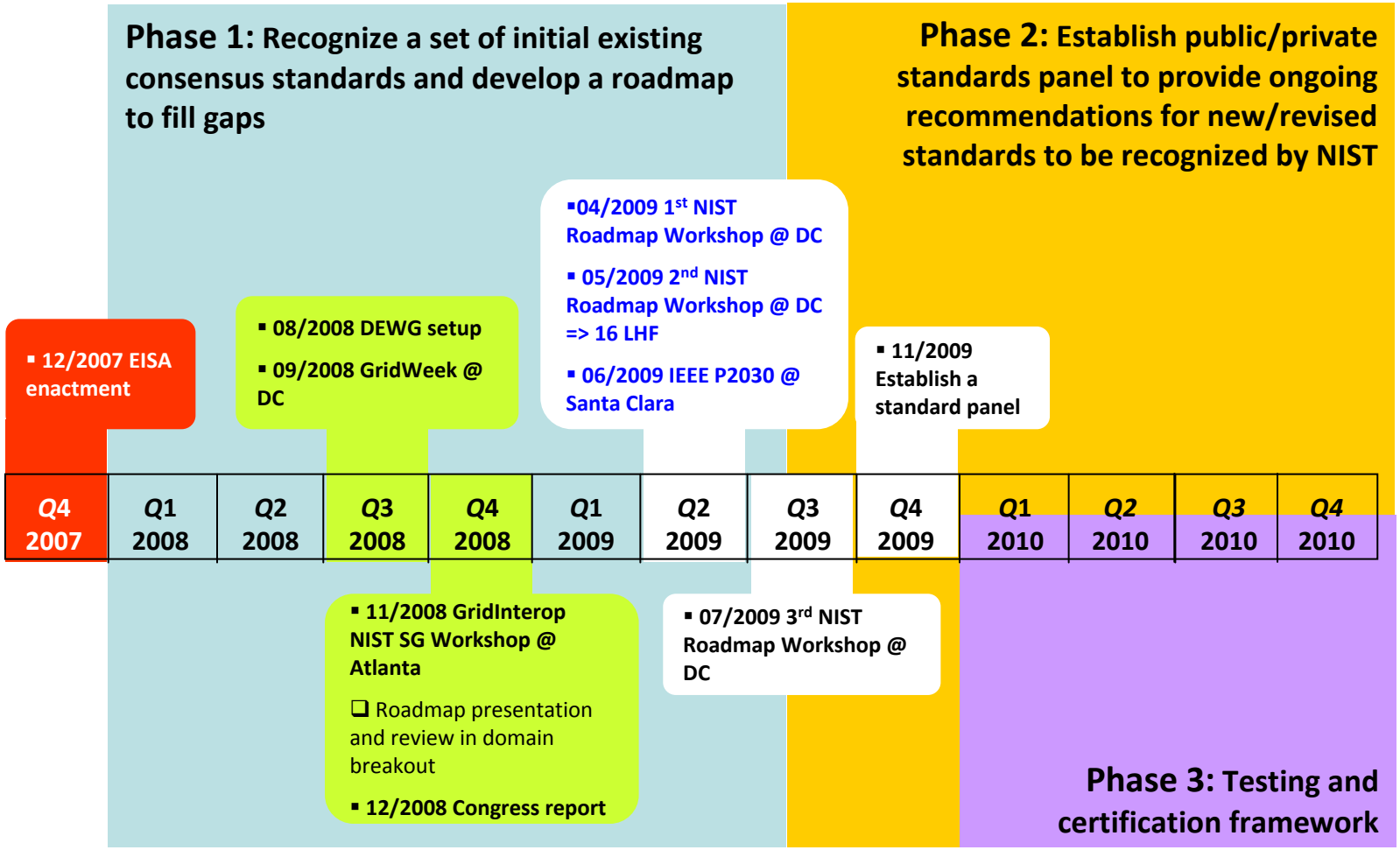
Standardization

- US National Institute of Standards and Technology (NIST) "… shall have primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems …"



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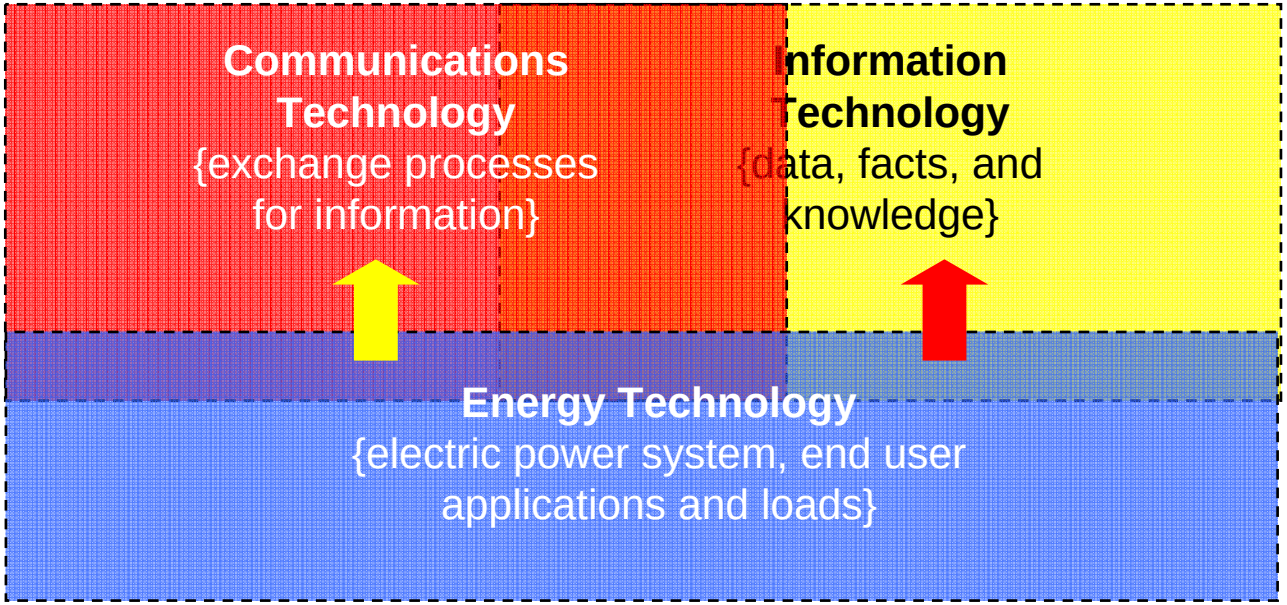
IEEE P2030 Standard

- Scope:
  - This document provides guidelines for smart grid interoperability.

- Unify Power, Communications and IT for Smart Grid
  - TF-1 should drive the work of TF-2 and TF-3
  - Potential merge/joint work between TF-2 and TF-3



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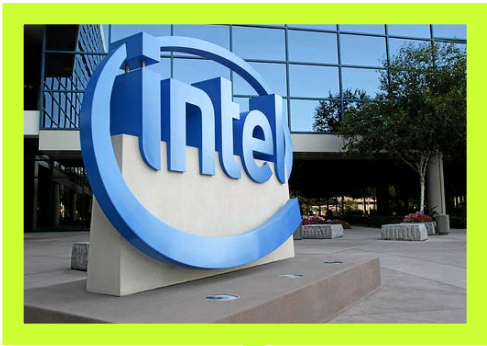
IEEE P2030 Standard

- Timeline



03/19
PAR approved

1st WG mtg

TF-1 mtg

TF-3 mtg

2nd WG mtg

03 2009	04 2009	05 2009	06 2009	07 2009	08 2009	09 2009	10 2009	11 2009	12 2009	Q1 2010	Q2 2010	Q3 2010

TF-2 mtg

Ratification expected

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Business – A Billion Dollar Market

- Wireless operators
  - Backbone (machine-to-machine) communications for smart grid
- Communications system vendors
  - Communications equipment, routers, base stations, …
- System integrator
- Sensor startups
  - ZigBee or proprietary system
- Data management
  - Database
- Vehicle manufacturers
  - Electric vehicle
- Utility companies
- Smart meter compa
- and no surprise
  - Power efficient data center
  - Web application of meter readings

Also,

- ❑ ***Powerline communications***
- ❑ ***Security company***
- ❑ ***Interest group advocating dedicated spectrum for smart grid***
- ❑ ***WiFi mesh companies***
- ❑ ***IT consulting firms***
- ❑ ***…***

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Research

- According to Dr. George Arnold: IT and Communications for the Smart Grid Communications infrastructure for smart grid is “the wild west”
  - Most of the phy/mac layer standards used are IEEE’s
  - Guidance is needed on their application in smart grid
  - Additional standards needs identified in roadmap

- Technologies across the entire 7 OSI layers will be involved.
  - Many existing technologies may can be applied directly.
  - Many need to be revised.
  - Many need to be invented.

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MITSUBISHI ELECTRIC
Changes for the Better

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Panel P04: Green Communication

Werner Mohr
Dresden
June 16, 2009

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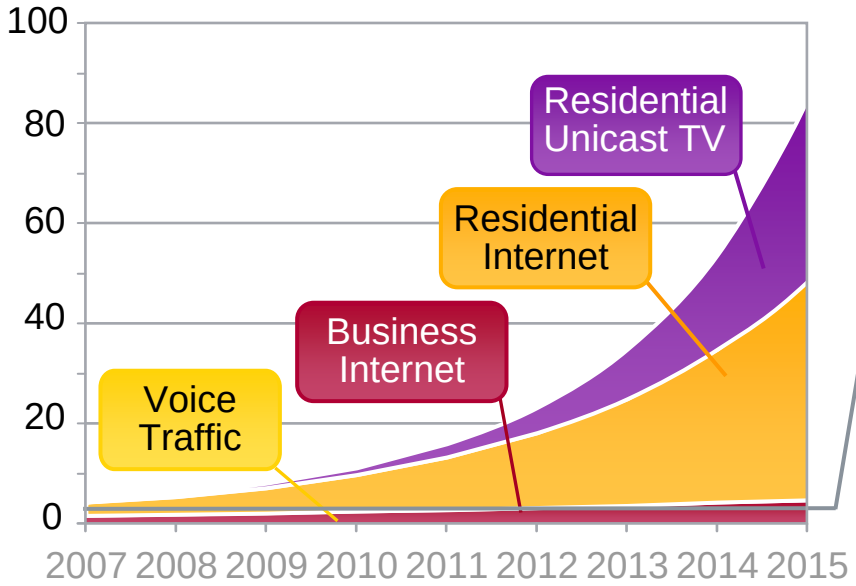
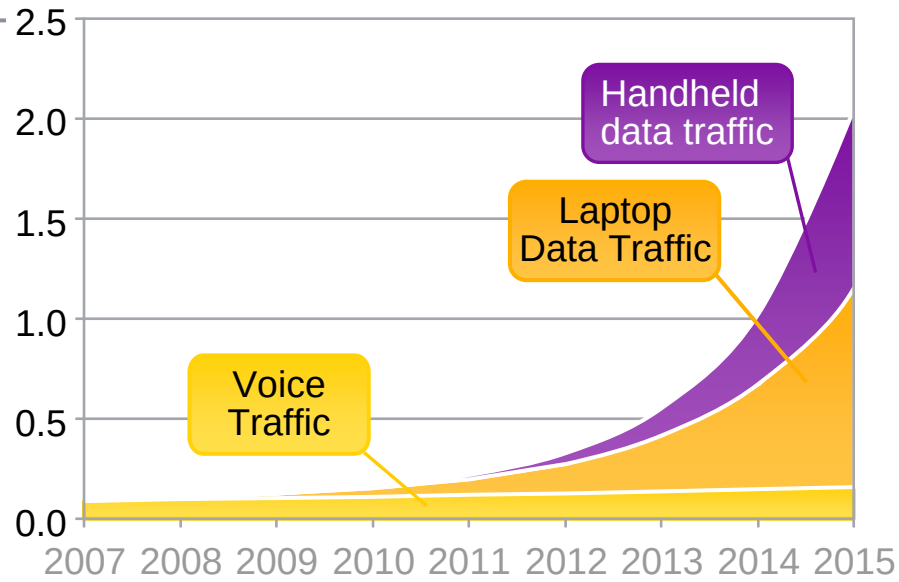
Industry Challenge
- the global traffic explosion

Global FIXED traffic (ExaByte/month)



Global MOBILE traffic (ExaByte/month)



Fixed broadband traffic is 40x mobile in 2015

Mobile data traffic grows 300 fold

Source: Nokia Siemens Networks

Source: analyst reports and internal research

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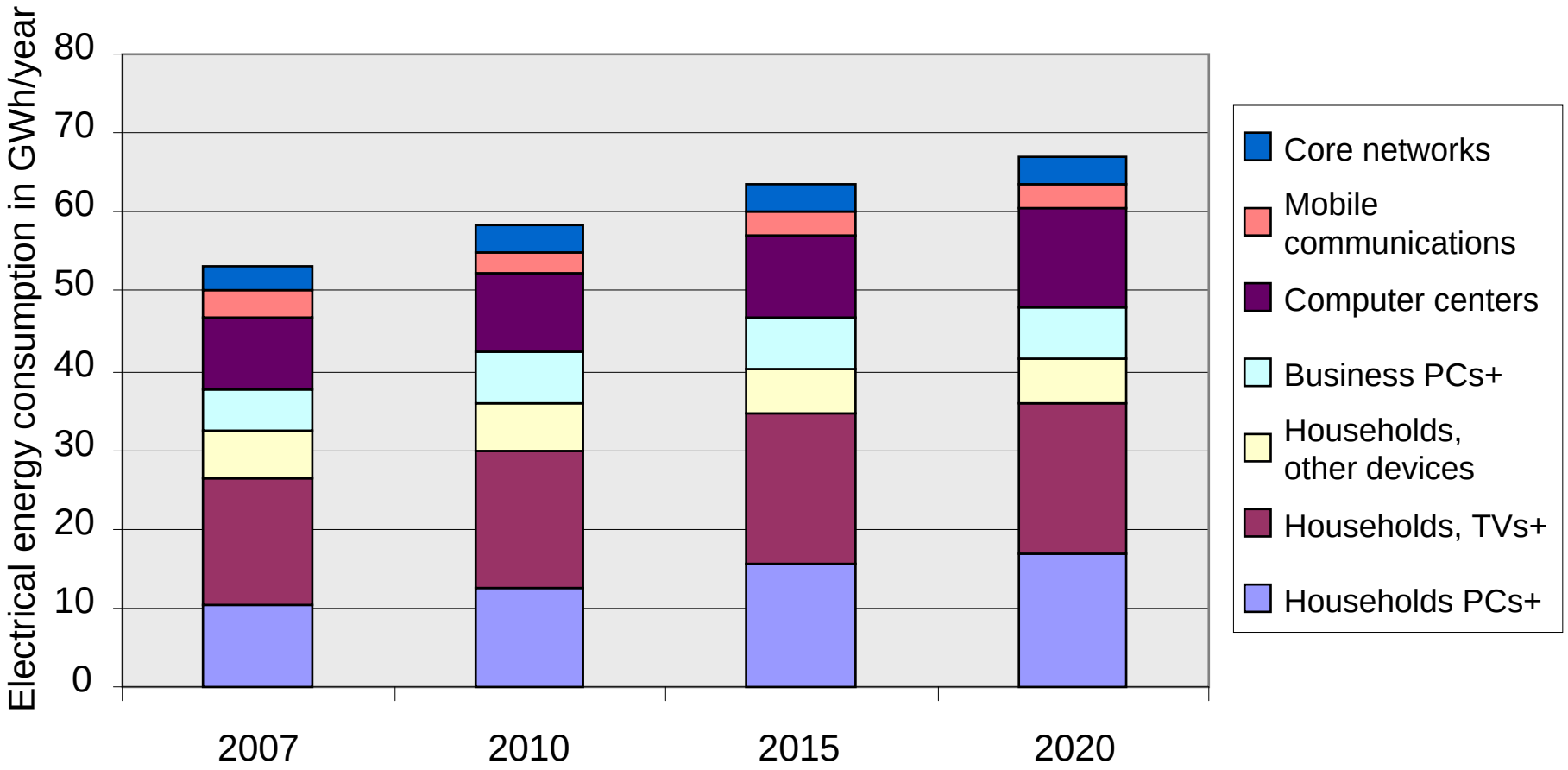
Estimate: High data volume / Extended use / Video & TV

Example: Expectation of ICT-related energy needs in Germany until 2020



Source: Fraunhofer IZM, TU Berlin

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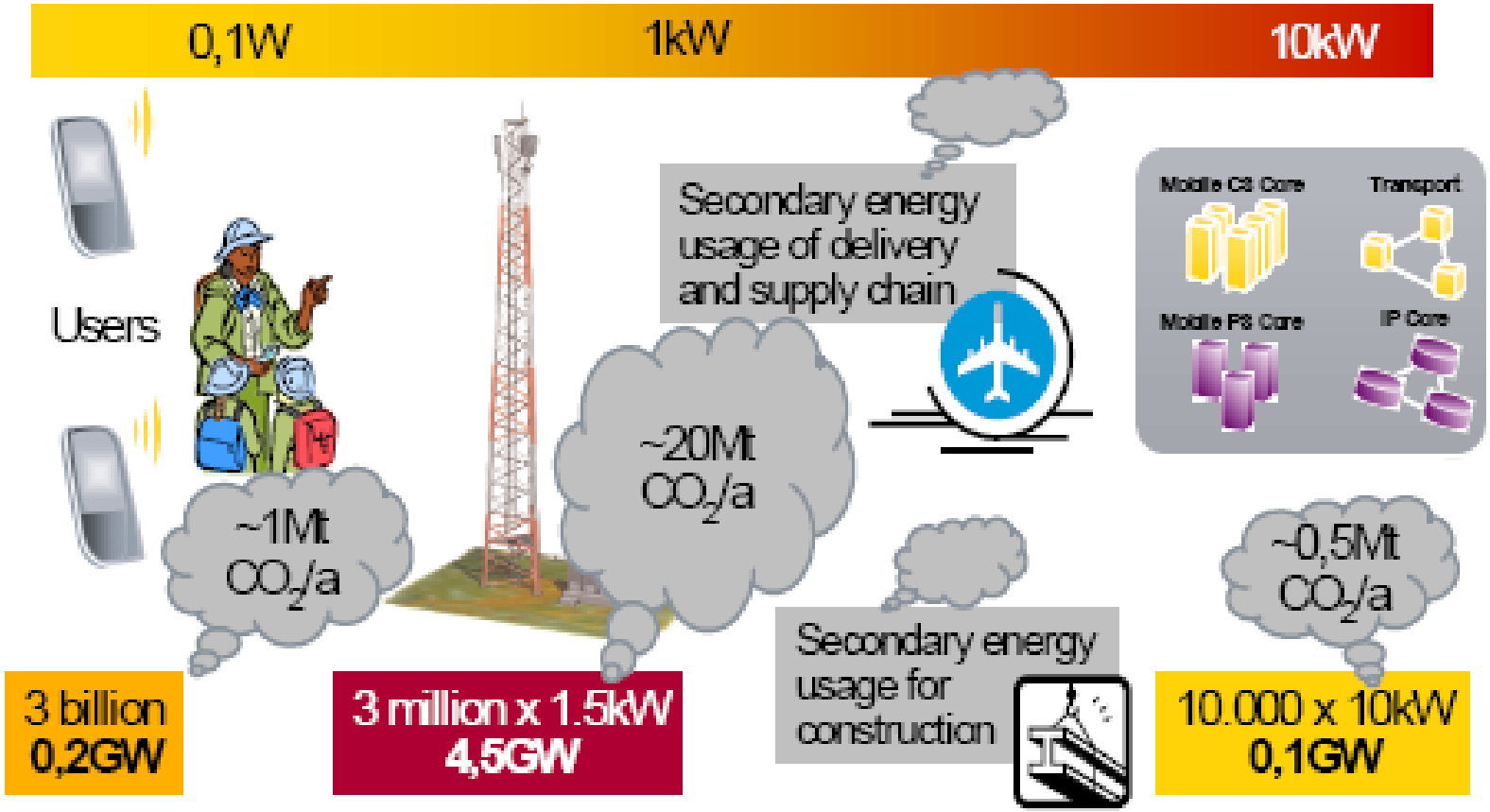
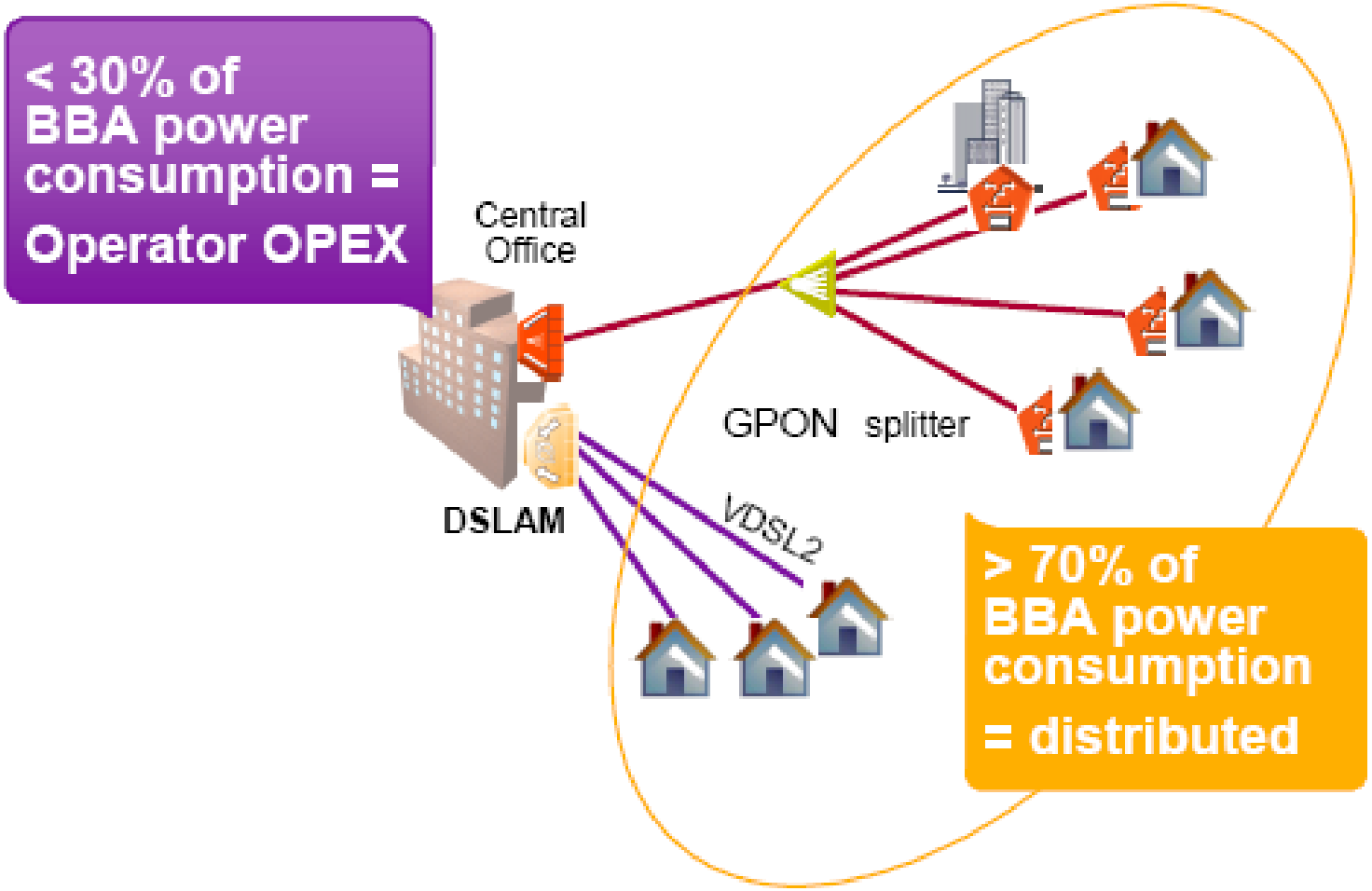
Estimate for global annual CO_2 emissions of mobile network elements



- Biggest part of energy consumption in mobile base stations

Source: Nokia Siemens Networks

Power consumption in a fixed network



- Biggest part of energy consumption in access network

Source: Nokia Siemens Networks

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Building environmentally sustainable networks starts with two key questions

- Total energy consumption: 2 % ICT, 98 % for other sectors

How energy efficient is the network?

How is the energy produced?

Base station sites consume up to 90 % of energy in the network

Bring down energy consumption by up to 70 %

Scale up use of renewable energy in the network

Source: Noki

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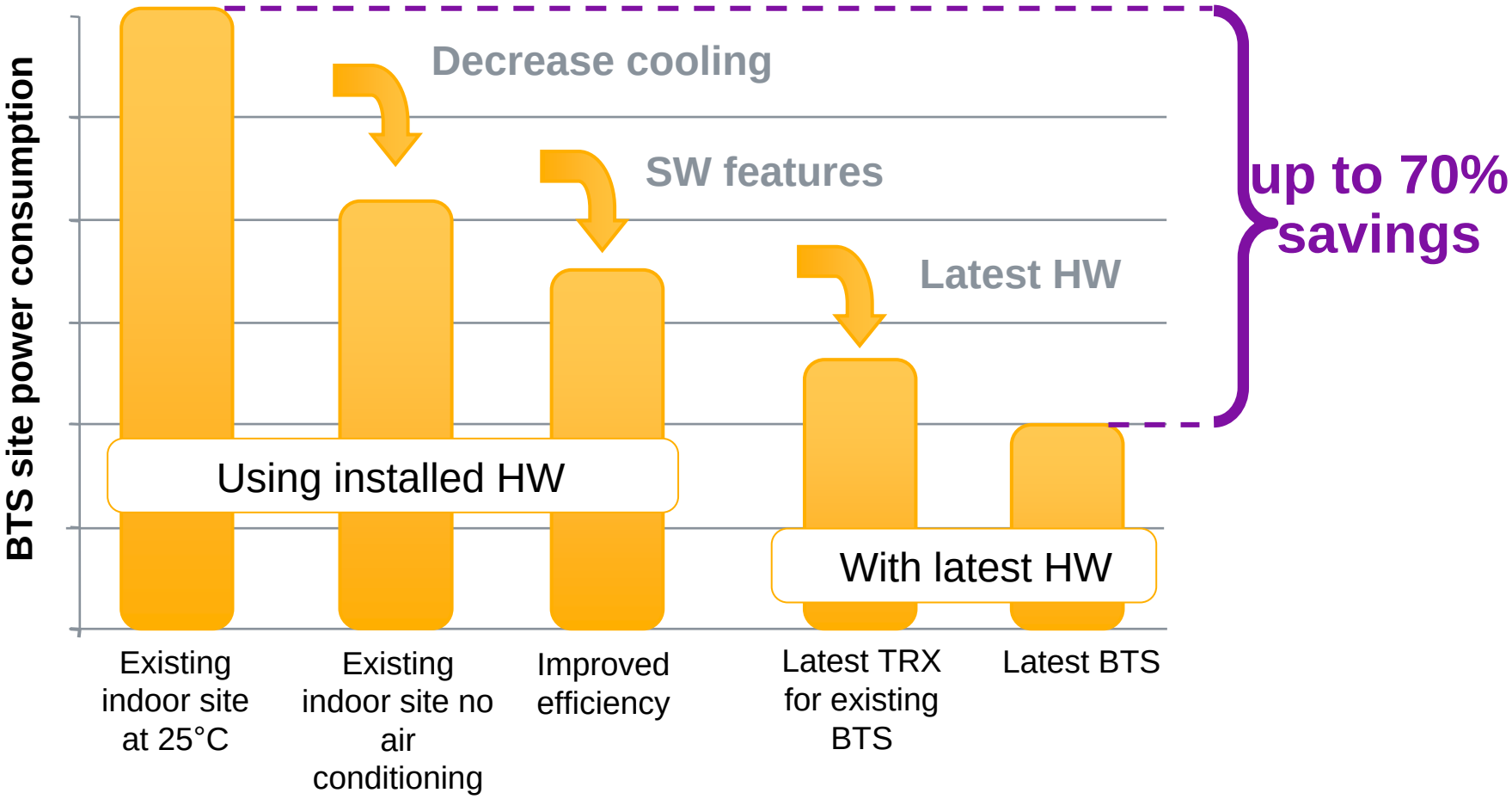
Nokia Siemens Networks

Substantially increase energy efficiency by new technologies



Source: Nokia Siemens Networks

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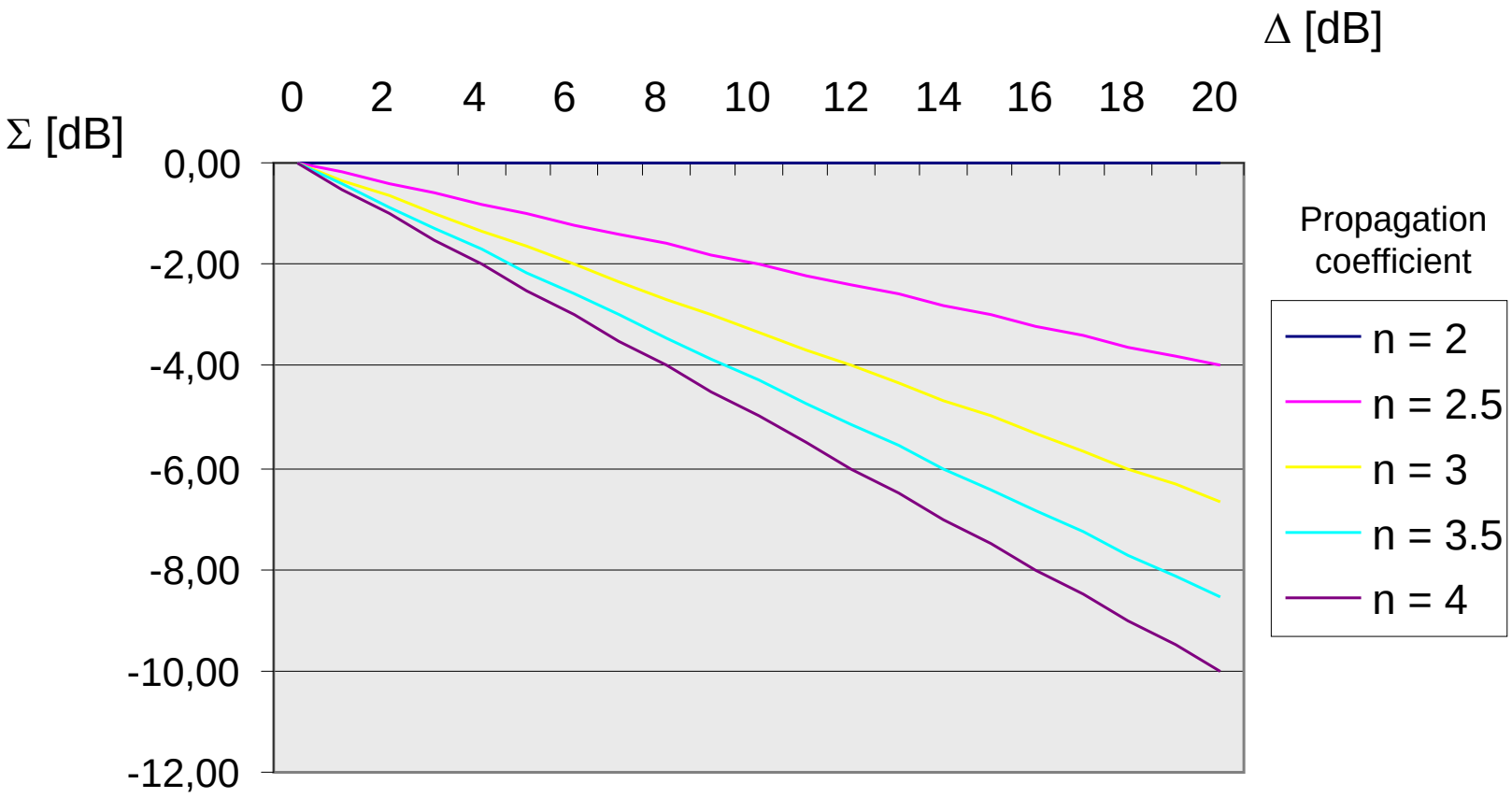
Potential in network deployment concepts: Small cells



Δ – Base station transmit power reduction

Σ – Overall transmit power saving in network

- Assumption: Hexagonal cell layout, uniform propagation conditions

Source: Nokia Siemens Networks

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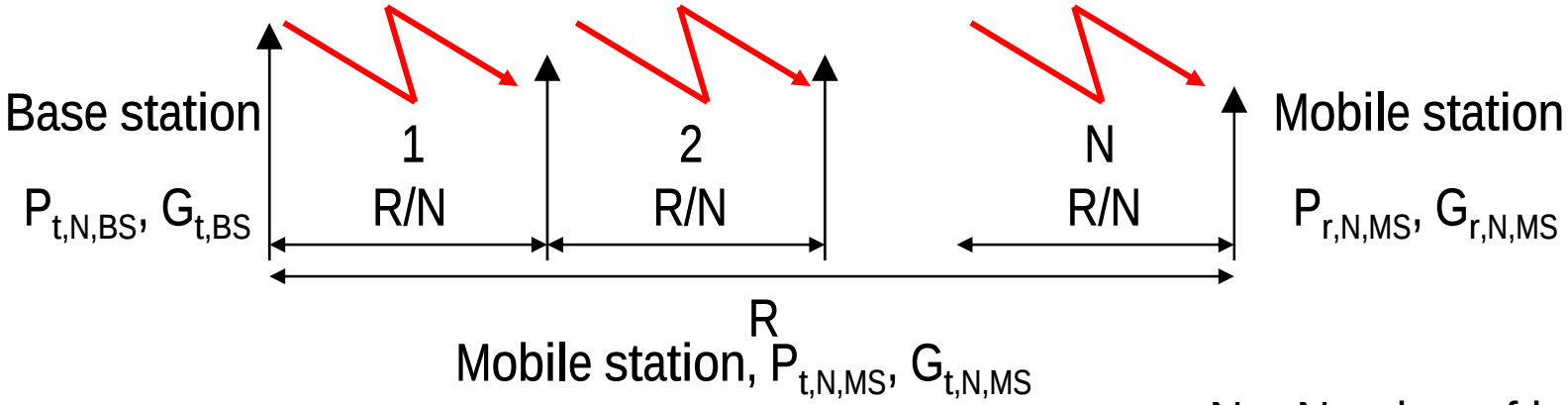
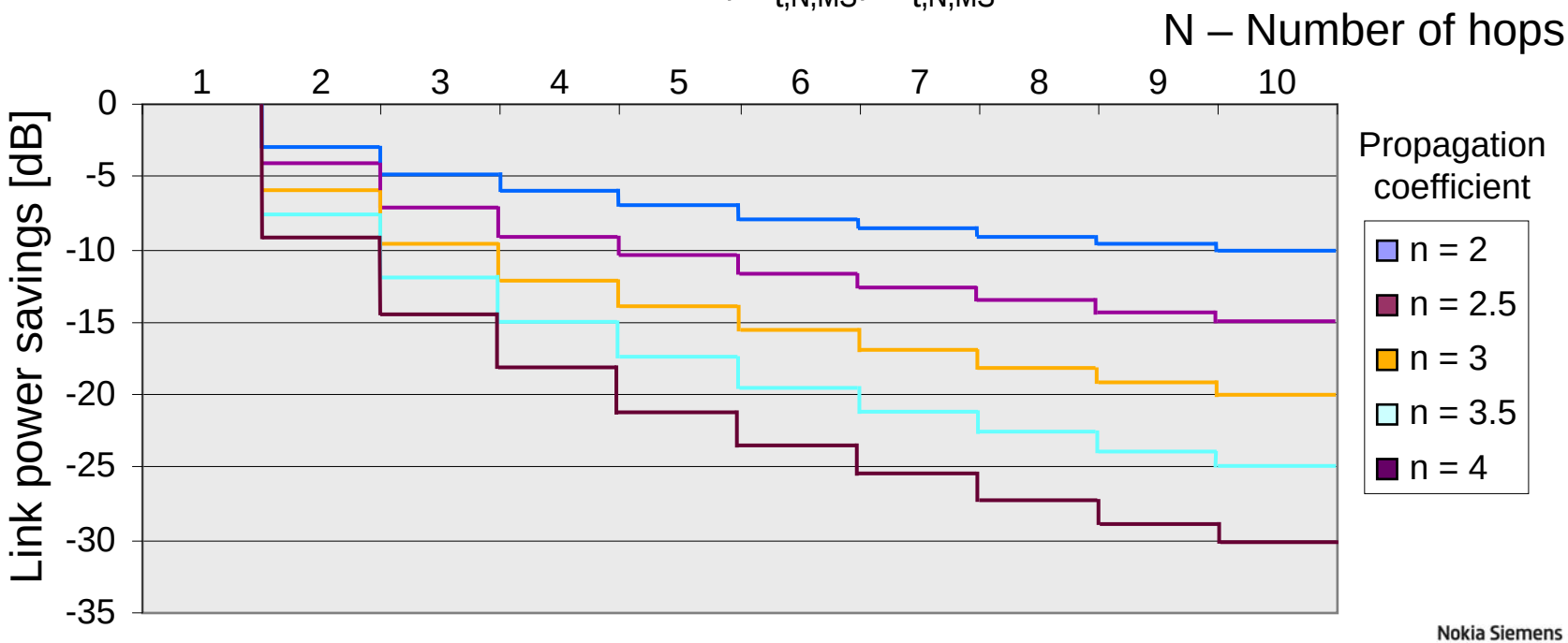
Potential in network deployment concepts: Multihop transmission





Source: Nokia Siemens Networks

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The rural network challenge

Communications networks are increasingly reaching to areas with no electricity grid or other infrastructure

- Base station sites need to run autonomously

Traditionally, base stations have been powered by diesel generators

- Fossil fuels are environmentally unfriendly

Total cost of ownership is high and increasing

- Require regular refueling and maintenance

Solution

- Use renewable energy based on sun and wind

Bring down CO^2 emissions – bring down operational expenses

Source: Nokia Siemens Networks

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Comparison of renewable energy sources

How is the energy produced?

	Solar Cells	Wind Power	Fuel Cell	Bio Fuels
+	High Reliability Mature Technology Increasing Efficiency 20 Years Life Time No operational expenditure	Medium initial investment Can be combined with solar cells Can be mounted on top of antenna tower Very low operational expenditure	High Reliability Increasing efficiency New fuels and technologies emerging	Not dependent on fossil fuel Low initial investment
-	Initial investment Space needed	Erratic nature of wind	Noise level Infrastructure still developing Cooling is needed for high load	Impact on local food industry Generator efficiency only 30% Acoustic noise High operational expenditure

Source: Nokia Siemens Networks

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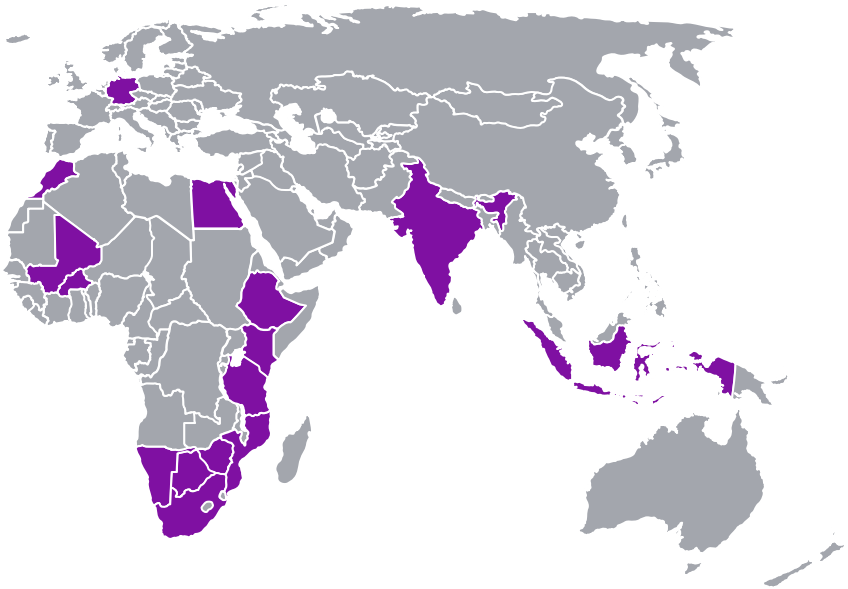
Examples of Renewable Energy BTS Sites



Source: Nokia Siemens Networks

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Conclusion

- Traffic in communication networks will increase further
- Main areas for energy savings in ICT of 2 % of total consumption
  - ICT equipment more power efficient including protocols
  - Network deployment concepts
  - Renewable power generation
- In mobile communications main power consumption in base stations
- In fixed networks main power consumption in access networks

☞ Use of ICT to reduce energy consumption in other sectors, which correspond to 98 % of total consumption

- Combination of different measures necessary to reduce energy consumption and CO_2 emissions

Source: Nokia Siemens Networks

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