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***The New Frontier of  
Communications Research:  
Smart Grid and Smart  
Metering***

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# Overview

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- **Introduction**
- **Communication challenges of SG**
- **SG security and privacy**
- **Conclusion**

# Introduction

- **Communications research at cross road**

- Wireless communications: MIMO, cooperative relay, cognitive radio
- If PHY capacity has nearly reached the limit, how about networks and applications?
- The next big thing?

- **Smart grid**

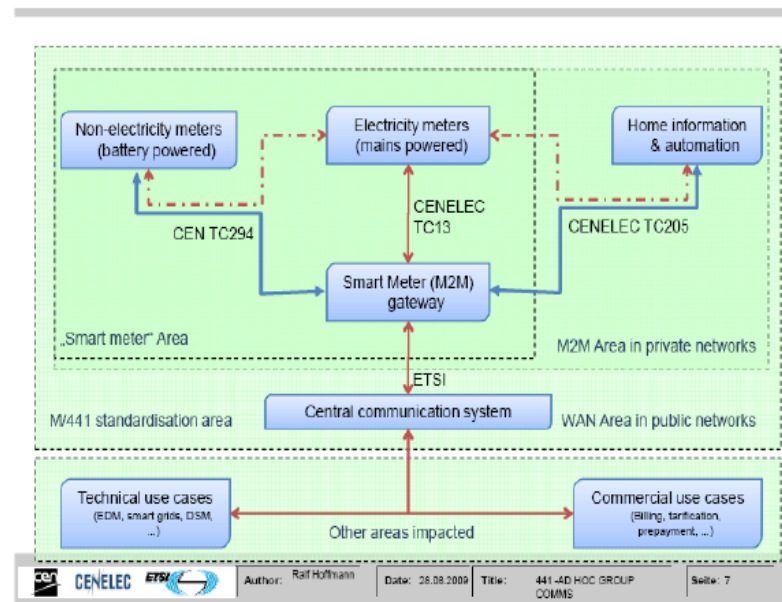
- Power grid + intelligence enabled by ICT
- Opportunities and challenges
- Lots of \$\$\$



# Communication challenges and issues for SG

- **ICT is a key enabler for SG**
- **Interoperability**
  - Heterogeneous technologies and standards
  - For example, Zigbee, PLC, or WLAN for smart metering networks or HANs?
  - How about wide area networks?
  - Standards: interfaces for interoperability
  - EU Mandate on SG and SM (M/441) – who does what in standards?

Main responsibility allocation



# Communication challenges and issues for SG

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- **Scalable internetworking solutions**
- **WSN**
  - Internet of things and M2M
  - IETF 6LoWPAN and ROLL
  - Reliability: how to handle mission-critical traffic
- **Internetworking**
  - New traffic and new requirements -> changes?
  - IETF: IP and SG
  - EU: Future Internet research program where SG is a key application
- **Overlay networks**
  - Dedicated infrastructure?
  - Self-organizing network overlaid over existing infrastructure?

# Communication challenges and issues for SG

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- **Home networks**

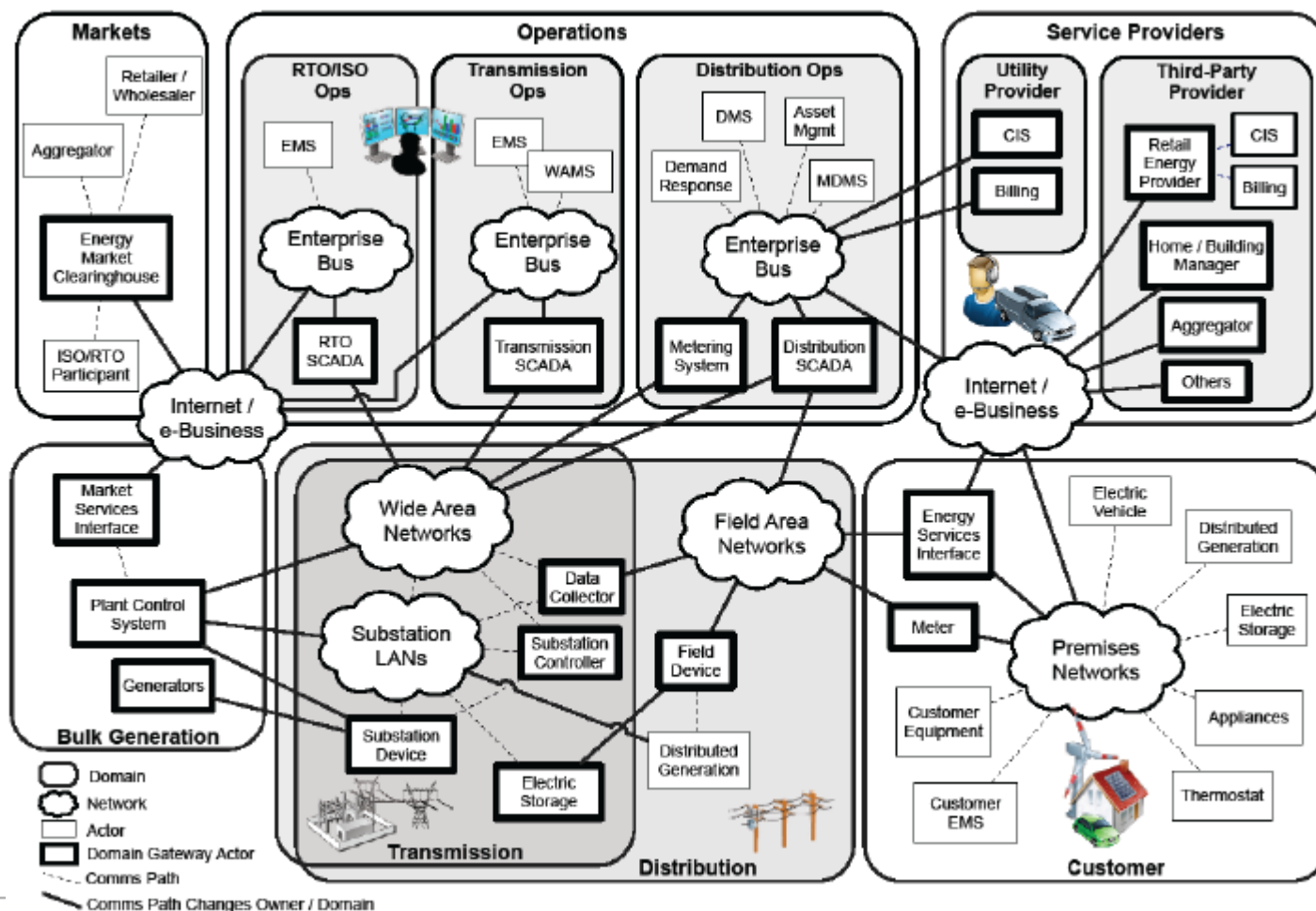
- SM integrated into home gateways (WLAN or femtocell APs)
- Home energy management systems (HEMS) and fine-granularity energy monitoring

- **The power of networking: How networking can help power management**

- Networking ideas/concepts applied to power management
- Load levelling: the ability to shift the demand in time so as to match the available supply and in so doing improve utilisation of resources and reduce (ideally avoid) the reliance on environment unfriendly reserve sources of energy as much as possible
- Formulated as a resource optimization (scheduling) problem
- Details in a separate paper in submission to SIGCOMM Green Networking Workshop

# Smart grid security

- Extremely complex system with different stakeholders
- NIST report on smart grid risks and vulnerabilities



# Smart grid security

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- **Privacy**

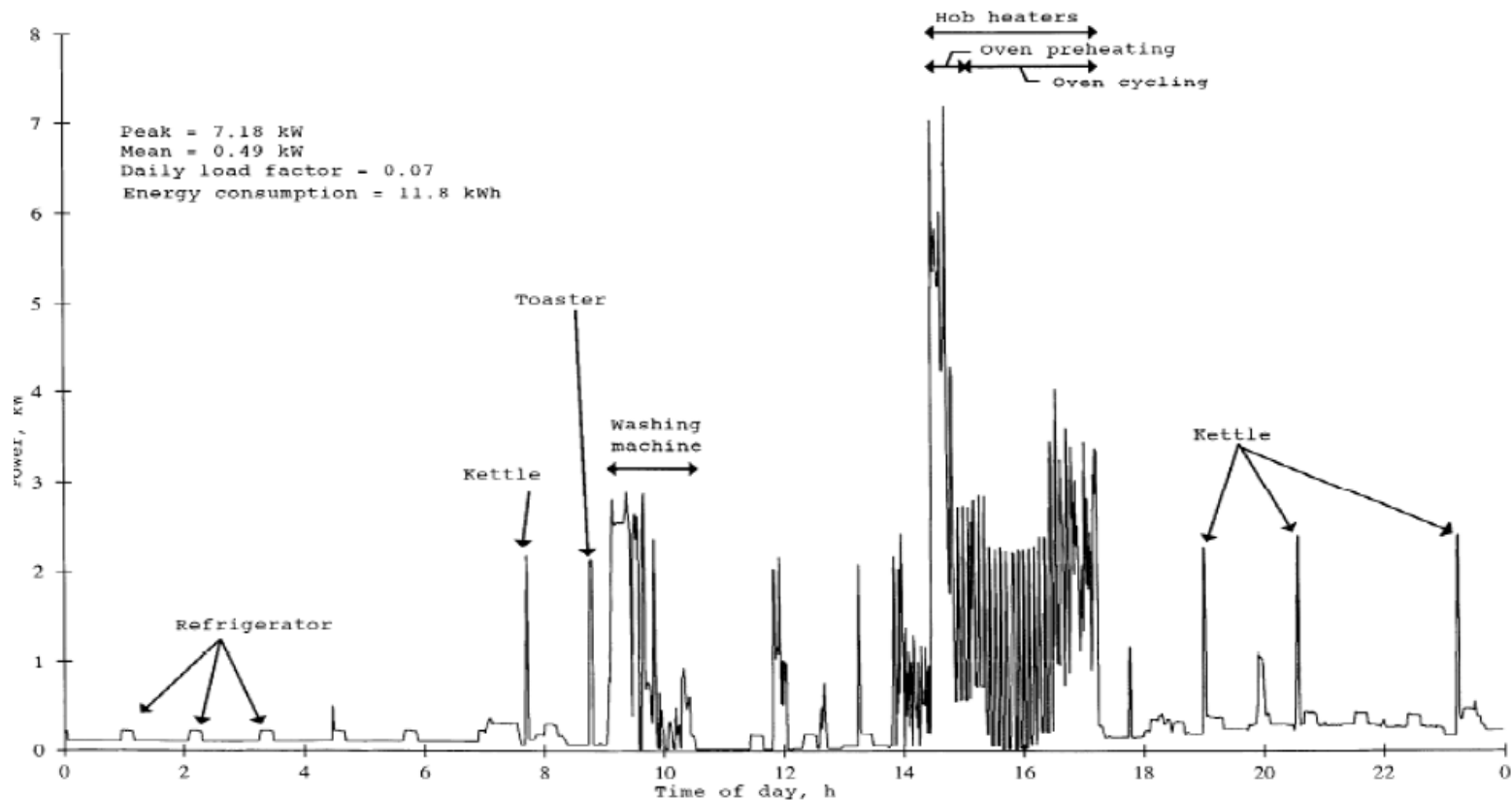
- Smart grid (metering) data infer directly where and when people were, and what they were doing
- The major benefit provided by the smart grid, i.e. the ability to get richer data to and from customer meters and other electric devices, is also its Achilles' heel from a privacy viewpoint
- Huge impact on the successful deployment
- Still unclear what levels of data are required by utility companies, and what level of privacy expected from consumers
- A challenging problem from both theoretical and practical perspectives, e.g. how to quantify privacy?



# Smart grid privacy

- **Load signatures**

- Frequent data collection
- Smart meter data may be used to determine device usage in the home



# Smart grid security

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- **Security challenges**

- Protection of smart metering data against unauthorized access and repudiation
- AMI communication security requirements can be addressed by combining existing cryptographic protocols and tamper-proof hardware solutions, by exhaustively testing equipment and software against all sorts of attacks, and by adopting an open architecture for further testing and secure updating.
- Enforcement: Smart metering data should belong, in principle, to the users. For example, a digital rights management system could be used to allow utility providers to use the data in an ‘acceptable’ manner.
- Reaction: There should be mechanisms that will detect (in retrospect) misuse of smart metering data.
- Secure integration

# Conclusion

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- **Smart grid is a new frontier for communications and networking research**
- **Unique challenges and opportunities, e.g. interoperability, scalability, and security/privacy**
- **Results from much existing communications research can be applied to the extremely large-scale and complex smart grid, which will become a killer application**
- **Other interesting issues**
  - Power saving technologies
  - Distributed/centralized data processing
  - Infrastructure management
  - Smart grid and future Internet
  - ...

# Current status of SG communications research

- **New conferences - clearly an upcoming area!**



Innovative Smart Grid  
Technologies Europe

**The 1st IEEE LCN Workshop  
on Smart Grid Networking  
Infrastructure**

**ACM GreenMetrics 2010  
Workshop**

**First ACM SIGCOMM  
Workshop on Green  
Networking**