Fraunhofer
FOKUS

Fraunhofer Institute for Open
Communication Systems

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Outline

- Fraunhofer
- Fokus structure
- 'History' of Mesh Networks / 'History' of our research
- Goals
- Introduction – A WiBACK network
- Implementation and Testbeds
  - Deployment in Macha, Zambia
- Practical Consideration
- Research Issues
- Smart Grids
- Cooperation

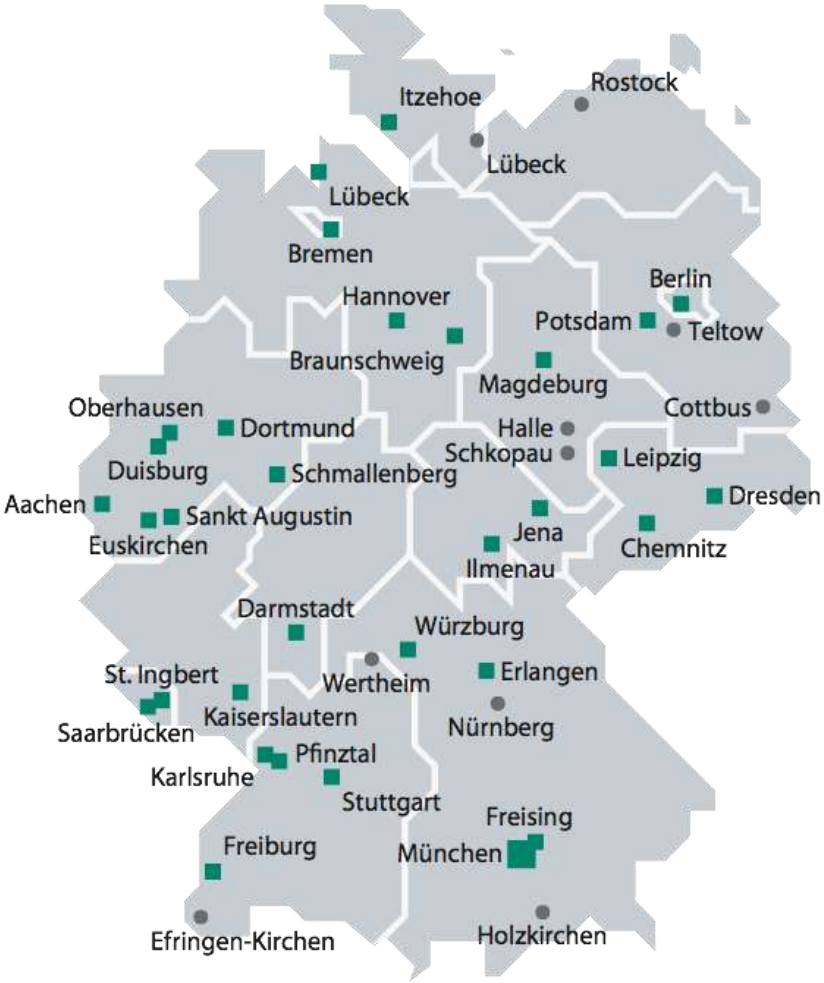
Fraunhofer in Germany and Worldwide

At present Fraunhofer Germany maintains

- 60 Fraunhofer institutes
- with a staff of 18.000 scientists & engineers
- 1.7 billion € annual budget

Worldwide

- 2009: Fraunhofer Portugal, Austria
- 2009: Fraunhofer is founding member of the eCAESAR Association in Romania
- Fraunhofer USA, Inc. maintains 7 centers next to the headquarters in Plymouth, MI
- In Asia, Fraunhofer offices are located in China, Indonesia, Korea and Japan



FOKUS
Organizational structure – corresponding to R&D domains

Directorate

Prof. Dr. Dr. h.c.
Radu Popescu-Zeletin

Dipl.-Ing. Berthold Butscher

Corporate Communications & Business Development **CoCo**

Resources & Management **RM**

Infrastructure/Communication **VST**

COMPETENCE CENTERS

ASCT	Automotive Services and Communication Technologies Dr. Ilja Radusch
ELAN	Electronic Government and Applications / BerliOS Dipl.-Inform. Gerd Schürmann
FAME	Future Applications and Media Dr. Stefan Arbanowski, Dr. Stephan Steglich
MOTION	Modelling and Testing for System and Service Solutions Prof. Dr. Ina Schieferdecker
NGNI	Next Generation Network Infrastructures Prof. Dr. Thomas Magedanz
RESCON	Resource Optimized Networks Dr. Thomas Luckenbach, Prof. Dr. Karl Jonas

History

Timeline and Development Stages – Where we come from

- WSN (Wireless Sensor Networks)
- MANET (Mobile Adhoc Networks)
- WMN (Wireless Mesh Networks)
- MR-WMN (Multi-Radio Wireless Mesh Networks)
- MRMC-WMN (Multi-Radio Multi-Channel Wireless Mesh Networks)
- WiBACK (Wireless Back-Haul Networks for Carrier Networks)
- SolarMesh ('Green' WiBACK)

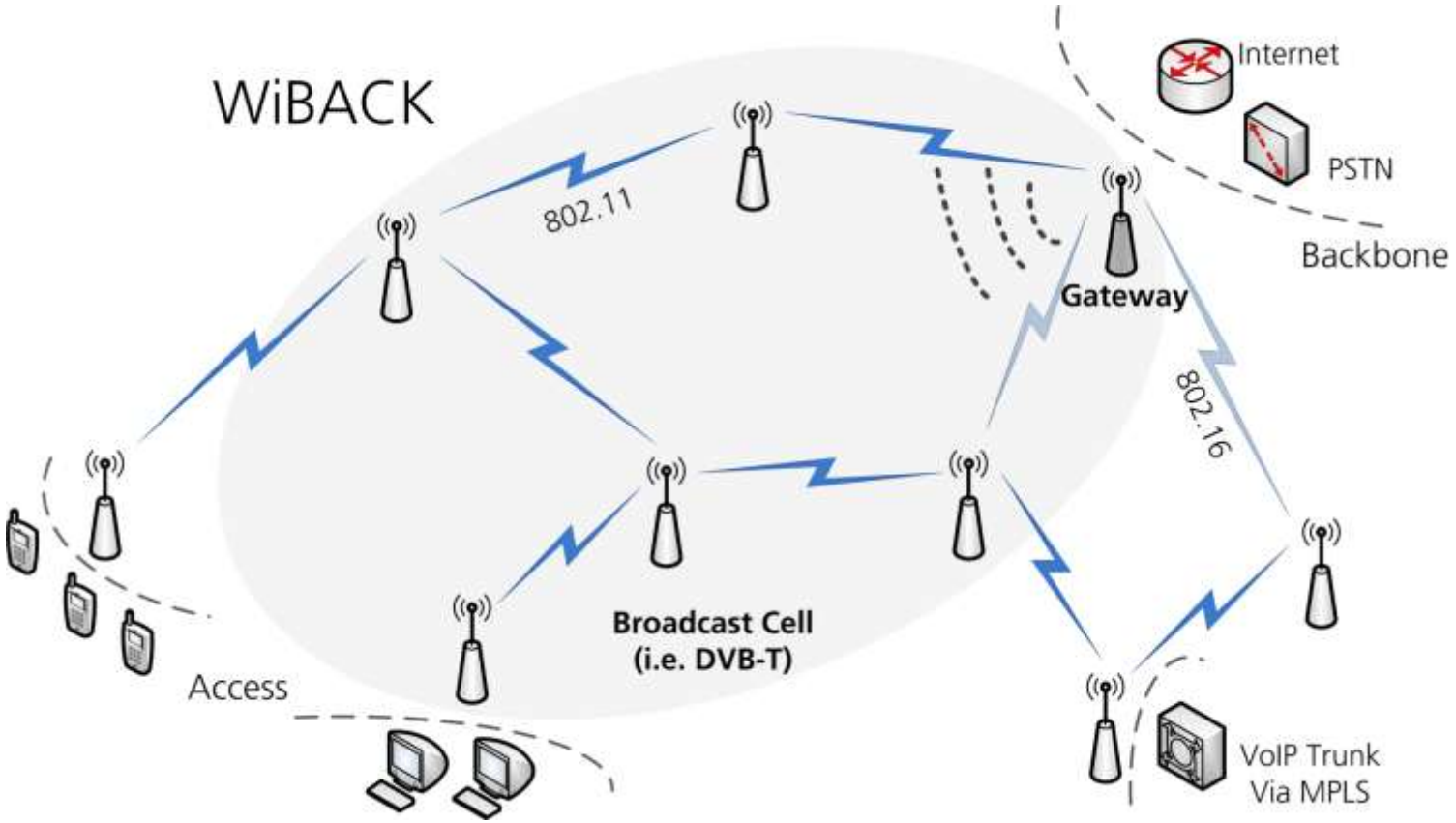
Goals

What we want to see

- **Possibility**: Technology for carrier-grade low-cost wide-area wireless-communication exist on the market
- Technical Interfaces to operator networks are defined and implemented
- **Sustainability:** Business concepts for community networks and for incumbents have been tested (blue-print / best practice)
- **Local:** Training concepts exist and are offered in many developing countries
- **Relevance:** E-learning is a successful service provided in rural areas

Introduction – A typical WiBACK Network

Heterogeneous Multi-Radio Nodes – convergence to all-IP Network



WiBACK Implementation and Test Beds

- Based on SENF (**S**imple and **E**xtensible **N**etwork (C++) **F**ramework) & NetEMU
- Use of x86 hardware
  - Linux 3.x (mac80211)
  - Ported to MIPS & ARM
- Three FOKUS test beds (on campus)
  - Seven multi(2+)-radio nodes
    - WLAN and DVB-T (in progress)
  - Eleven dual-radio WLAN nodes
  - Five dual-radio WLAN nodes
    - 4-hop connection, 2 hops >10km

Deployment in Macha, Zambia
Initial trial to gather experience

- No stable power grid or no power at all
- Local staff is curious
  - Pro: Eager to learn and setup gear
  - Con: Might try any configuration option
    => limit configuration options,
    color-coded sockets, etc
- Successful deployment depends on local caretaker and acceptance by leaders
- Lightning-Protection

Practical Considerations
Deployment issues in rural areas

- **External**
  - Lack of skilled personal
  - Lack of (stable) power grid
  - Climate, environmental issues, theft, animals
  - Regulatory issues/licenses
  - CAPEX & OPEX limitations due to limited spending capabilities of target group
- **Implementation**
  - Cost-effective multi-radio board with low power CPU hard to find
  - Low power devices provide limited resources
  - Antenna pointing support (i.e. audible signal)
  - Trade-off high gain antenna and pointing precision/stable mast
  - Auto-Configuration and manual administration

Research Issues

- **Topology/Network Management**
  - Resilience to node and link failures
  - Cognitive management and optimization
  - Delay Tolerant Services

- **Energy Management**
  - Energy model for wireless nodes and interfaces
  - Derive metrics for topology organization and capacity allocations
  - Optimization of routing and link configuration
  - Energy-optimized hardware platform

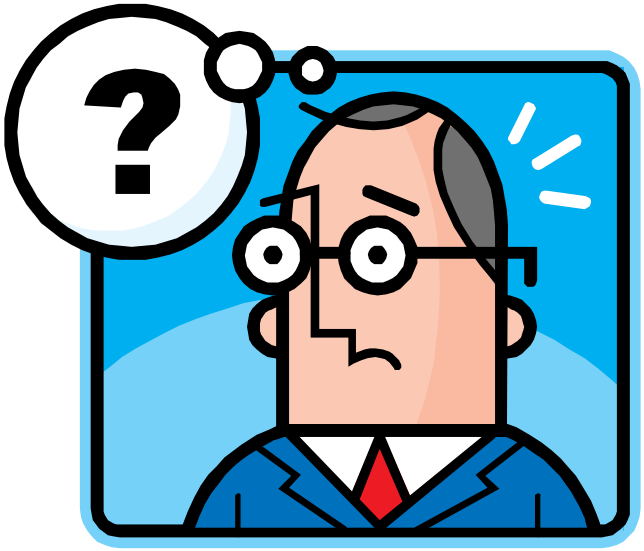
- **Usability**
  - Deployment

Smart Grids
A Future Necessity

- Efficient and reliable energy supply
  - Efficient energy distribution
  - Integration of distributed energy sources
  - Cope with dynamic supply by renewable energy sources
  - Outage prevention
- Energy saving efforts
  - Consumer Awareness
  - Flexible Tariffing
  - Dynamic energy supply / consumption
- „Smart" provided by WiBACK
  - Backbone for telemetrie and measure data

Cooperation

- Since 2009: annual organisation of the Africomm conference with Darelle van Greunen
- Joint project with the GRA Global Research Alliance, CSIR Meraka, and others, started Jan 2012: **Green and Low-Cost Wireless Communication Network for Africa**; R&D project to implement a wireless infrastructure in rural Zambia
- Joint EU FP7 Call8 proposal with Rhodes University and the University of Fort Hare (**International Research Staff Exchange Scheme)**
- Discussions with UNTel about a pilot wireless network in South Africa, possibly supported by DST



Thank you – Questions ?

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