



Wireless Communication at the University of Rostock



Djamshid Tavangarian

University of Rostock
Department of Computer Science
Institute of Computer Engineering
Albert-Einstein-Str. 21, D-18059 Rostock / Germany
Tel: +49 (0)381 498 3385, Fax: +49 (0)381 498 3440
Email: tav@informatik.uni-rostock.de
Web: http://wiss.informatik.uni-rostock.de

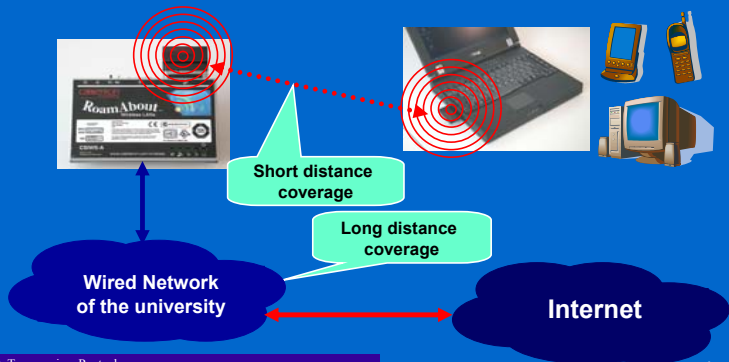
Contents:

- **Wireless Communication and hotspots**
 - Some experiences and Developments
 - Introduction and available Techniques
- **Wireless hybrid communication architectures**
 - Techniques and possibilities
 - Hotspot Architectures
- **What does the future hold?**
 - What the future has in store for us
 - Combination of technologies and their characteristics

WLAN access within the campus

Access point as base station for wireless access

Students and staffs with wireless or devices (notebook, palmtop, cellular phone,) or desktop computers



WLAN project of the University of Rostock:

Locations

Wireless Communications network of the University of Rostock

First stage of development April 2000



- | | |
|--------------------------------|----------------------------------|
| Computer pool | Faculty of Economic Sciences |
| Department of Computer Science | Faculty of Philosophy |
| Faculty of Engineering | Faculty of Agricultural sciences |
| Mechanical engineering | Faculty of Law |
| Electrical engineering | Audio Visual Media Centre |
| Faculty of Engineering | Department of Biology |
| Electrical engineering | |
| Main building | |
| Faculty of Science | |
| Physics | |
| Chemistry | |

The first European university-wide Hotspot

Hotspot at the University of Rostock / Germany



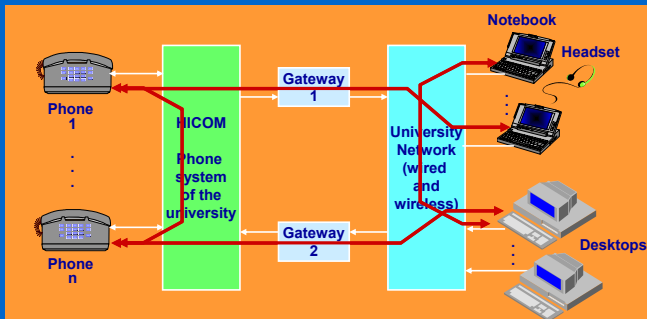
D. Tavangarian, Rostock

Our experiences

- WLAN is available since April 2000
- More than 200 Access Points are installed
- About 1000 users, approx. 3000 hour daily access
- Secure communication network with VPN and IPSec
- Mobility of the users within the whole university
- Access to internet from
 - lecture, meeting and working rooms, Labs etc.,
 - dormitories,
 - student restaurants and cafes,
 - libraries,
 - neighbourhood of the university, etc.
- Spontaneous networks by student groups

D. Tavangarian, Rostock

The Next Steps: Notebook phone within the WLAN-hotspot

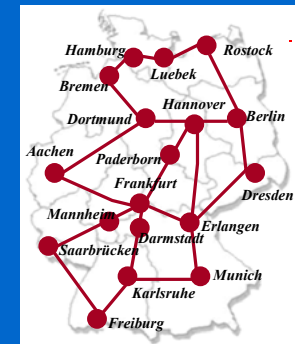


- Features of the mobile hotspot phone system:**
- calls from student to student,
 - calls to the teachers or university staff
 - to receive calls from within as well as from the outside of the university

D. Tavangarian, Rostock

The next Steps: Roaming between the German Universities

- University of Aachen
- Universities in Berlin
- University of Bremen
- University of Erlangen
- Techn. University of Darmstadt
- Techn. University of Dresden
- University of Frankfurt
- University of Feiburg
- University of Hamburg
- University of Karlsruhe
- University of Luebeck
- University of Mannheim
- Universities in Munich
- University of Paderborn
- University of Rostock
- University of Saarbruecken
- University of Wuerzburg



D. Tavangarian, Rostock

Conclusion

WLAN communication in German universities

- We were the first university in Europe and world-wide one of the three universities with a university-wide WLAN.
- Country wide support of 45 universities on behalf of the German Ministry of Research & Education (10 Mio. DM)
- Start of the research program for the realization of „Notebook-Universities“ in Germany (50 Mio. DM)

Our Goal:

Use of WLAN hotspots for an ubiquitous University!



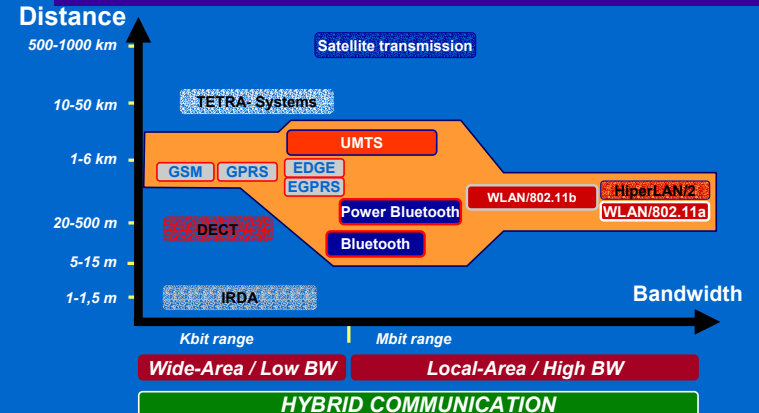
Research and Developments

One of our research fields

Wireless communication (wireless LAN)

- Infrastructure (WLAN public and private hotspots) of the wireless communication with WLAN systems regarding to the IEEE standard 802.11b, a, h, g, i, x ...
- Research and development fields:
 - The efficiency of a communication infrastructure
 - Safety and security aspects in local and in wide area communication networks
 - Multicast and broadcast communication
 - Hybrid Communication
 - Voice-over-IP (VoIP)
 - etc.

Hybrid Communication with Wireless Communication Techniques

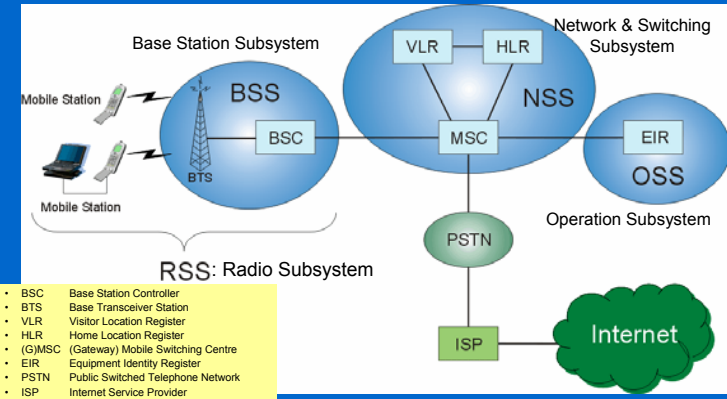


Mobile Communication Techniques (I)

- **GSM** (Global System for Mobile Communications) worldwide mobile communication standard, 9600 (14.400) Bit/s, basic "framework" for many extensions
 - GSM Radio Modems (PC Card)
 - cellular phone and interface to notebook or handheld computer



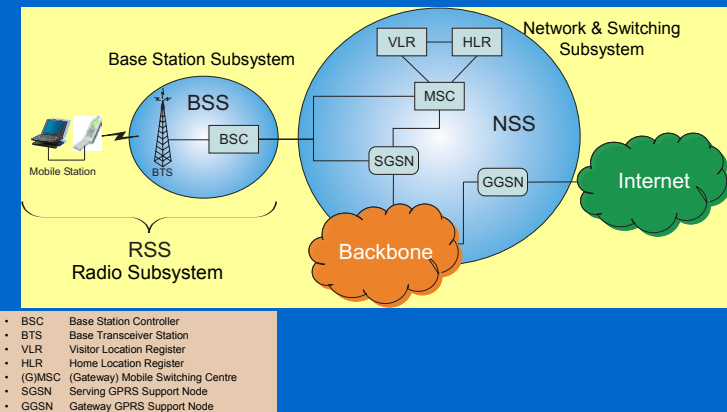
Architecture of a GSM-Network



Mobile Communication Techniques (II)

- **GPRS** (General Packet Radio Service) GSM extension: packet oriented transmission with all 8 slots (bundled) of a GSM connection, max. 170 kBit/s, accounting based on transmitted data volume
 - requires new hardware on both sides, the operator's and the user's
 - already available

GPRS Architecture



Mobile Communication Techniques (III)

• UMTS / W-CDMA

(Universal Mobile Telecommunications System / Wideband-CDMA)

new mobile communication network with packet oriented transmission, accounting based on transmitted data volume

- 3 modes:
 - 2MBit/s (stationary),
 - 512 kBit/s (< 60 km/h),
 - 128 kBit/s (> 60 km/h)
- use of IP (from radio reception down to the Backbone)
- "Voice over IP"
- requires new hardware on both sides, the operator's and the user's (2-3 times higher density of transmitters in comparison to GSM)
- frequencies: 1,9 - 2,2 GHz
- probably available in 2003

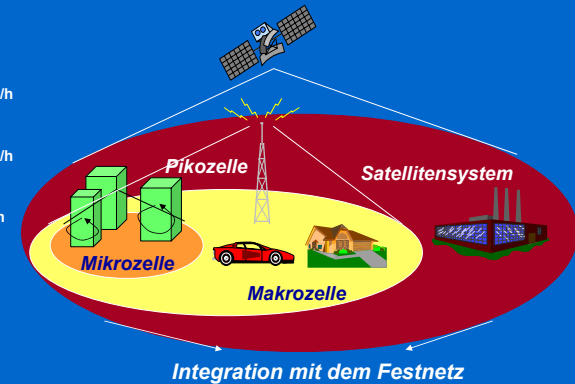
UMTS-Architecture Hierarchical Structure of UMTS Radio-LAN

Data rates:

Macro-Level:
Up to 144 kBit/s
Speed max. 500 km/h

Micro-Level:
Up to 384 kBit/s
Speed max. 120 km/h

Piko-Level:
Up to 2 MBit/s
Speed max. 10 km/h



Radio LANs (II)

• HiperLAN/2

- frequency: 5,2 and 5,6 GHz
- with channel bundling up to 54 Mbit/s (HiperLAN/2)
- originally developed on the basis of wireless ATM research
- standardization not yet finished
- supports QoS (Quality of Service)
- DES encryption
- includes authentication mechanism
- capable of multicasts

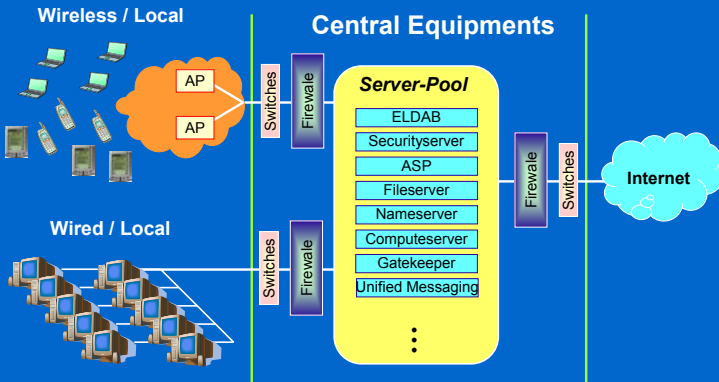
WLAN-standards

	802.11f: Inter Access Point Protocol			
	802.11e: QoS Enhancement			
	802.11i: Security Enhancement			
	IEEE 802.11			
MAC-Layer				
	802.11h Power Transmit Control			
PHY-Layer	802.11a 5 GHz 54 Mbit/s	802.11g 2,4 GHz >20Mbit/s	802.11b 2,4 GHz 11 Mbit/s	802.11 2,4 GHz 2 Mbit/s

■ Current subjects of Standardisation

Architecture of an Ubiquitous WLAN Hotspot

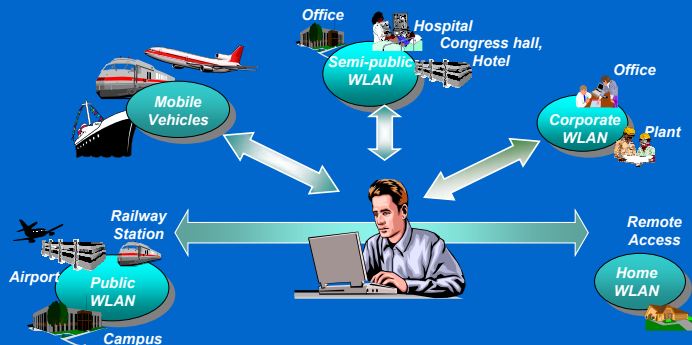
Notebook University of Rostock



Kind of WLAN Hotspots

- Public Hotspots (billing needed)
 - Open Community (Conferences, Hotels, ...)
 - Selected Users (Airport, Pre-paid, subscribers, tickets)
- Private Hotspots (no billing needed)
 - Closed Communities (Universities, Enterprise, Hospitals, Companies, ...)

The WLAN Hotspots as killer alternatives...?



Wireless Communication Technologies

	Frequency [GHz]	Data Rate	Transmission Power [W]	Encryption	Standard	Connection Fees	Availability
wide-range	GSM	0.9/ 1.8 (1.9) 9.6kBit/s (14.4kBit/s)	1-2	-	different frequencies	yes	ok
	HSCSD	(GSM) 43.2 kBit/s	(GSM)	-	yes	yes	ok
	GPRS	(GSM) 170 kBit/s	(GSM)	?	yes	yes	2000
	EDGE	(GSM) 384 kBit/s	(GSM)	?	yes	yes	2001
	UMTS/ W-CDMA	1.9 ... 2.17 128 kBit/s ... 2 Mbit/s	1-2	yes	yes	yes	2003
TETRA		28.8 kBit/s	1-30	yes	ETSI	no	ok
short-range	Bluetooth	2.402 - 2.480 1-2Mbit/s	0.001 (0.1)		yes	no	ok
	HomeRF	2.4 (FHSS) 1-2Mbit/s	0.1	yes	yes	no	2001
	WLAN	2.412 - 2.472 (DSSS) 1-11 Mbit/s	0.05-0.1	WEP 40/128 Bit	IEEE 802.11(b)	no	ok
	HiperLAN2	5.2 / 5.6 24 Mbit/s	≈0.1	yes	ETSI	no	2001 / 2002

Combination of Wireless systems for a Hybrid Communication

Wide-area communication

• Mobile phone systems

- GSM
- GPRS
- HSCSD
- UMTS
- W-CDMA



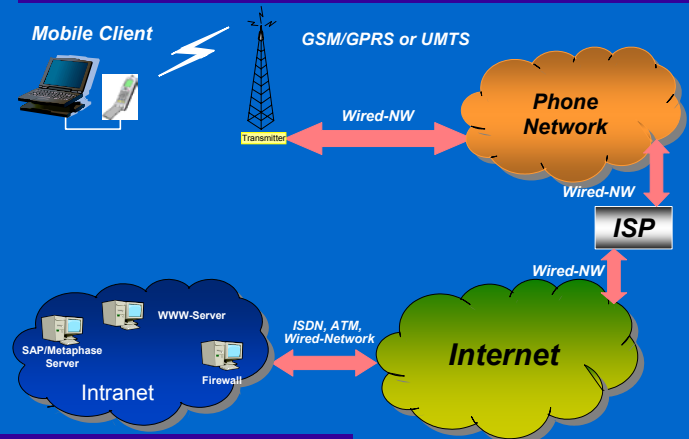
Local-area communication

• Wireless Technics (Radio LANs)

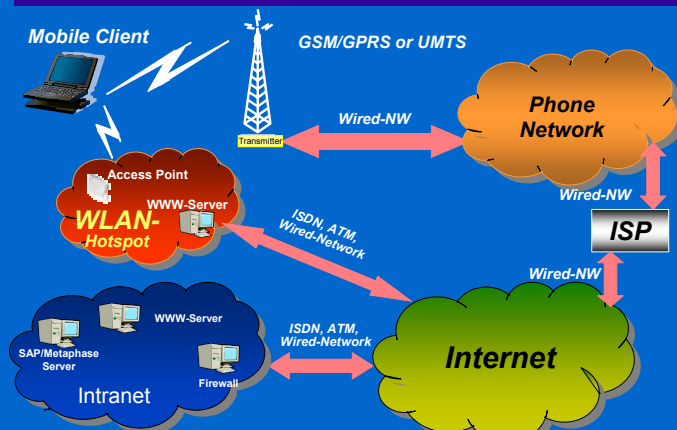
- WLAN
- Bluetooth
- HomeRF
- HiperLAN/2
- ...



Mobile Client in a GSM, GPRS or UMTS Network



Seamless Hybrid Roaming



Interco-operation in a Hybrid Mobile Network

Conceptions:

Loose Coupling:

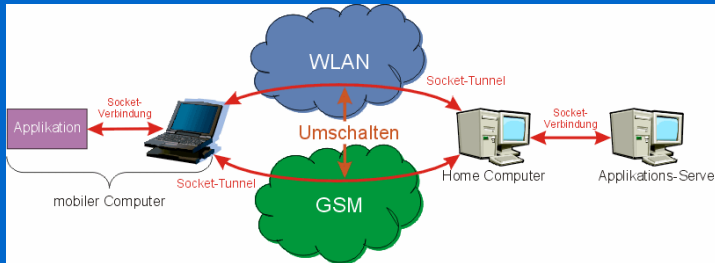
Only Authentication, Authorization and Accounting of WLAN access is performed by the mobile network operator.

Tight Coupling:

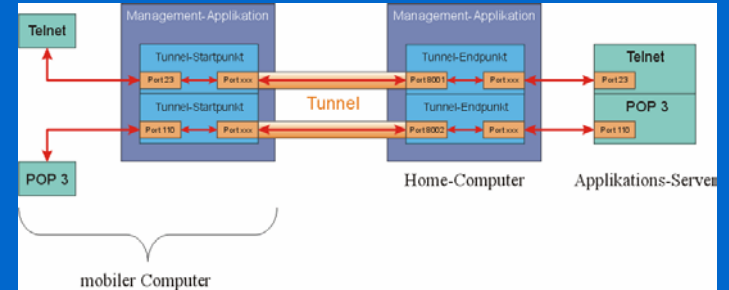
WLAN as just another radio access technology with all necessary conditions (security, billing, AAA ...) given by the same mobile operator.

Realization of the Hybrid Roaming

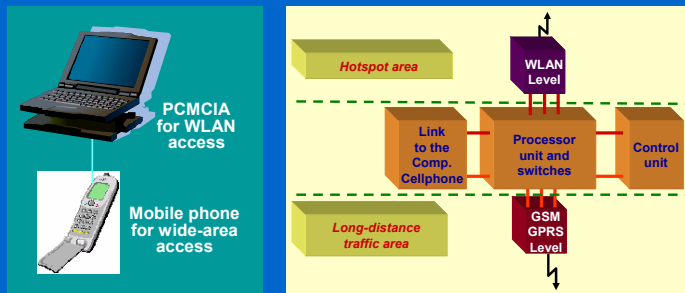
Method of Socket-Tunneling



Hybrid-Roaming Components



Seemless Roaming and Handover Unit for WLAN/GPRS, WLAN/UMTS



Our Current and future Projects

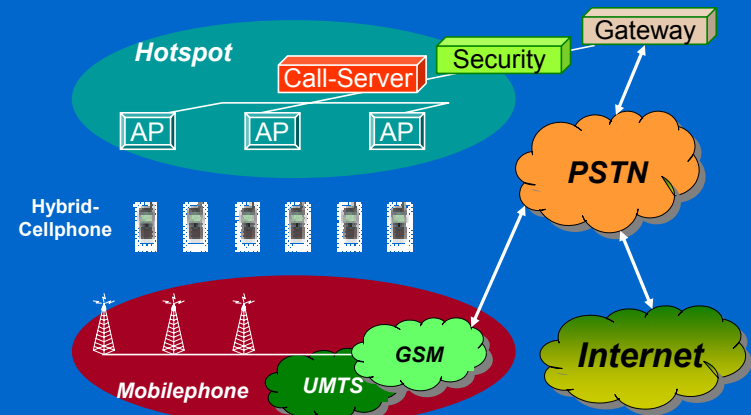
- Notebook-University
- Hybrid Communication systems for WLAN-UMTS
- Hybrid cellphone system
- Our Proposal for the 6th FP Call of EU entitled "Complete electronic traceability of food chains" within "Food Quality and Safty"
- **Our Projects**
 - **TOPAS:**
Complete traceability of cool food chains:
Temperature measurement, Object identification, Positioning, Archiving, Security of Cool and frozen Chains from producer to consumer
Participants: Germany, Spain, France, Norway (GSM/SMS, UMTS, WLAN)
 - **Local Web:**
Wireless Portal for Local-based services like entertainment (movie, video, games, ...), education (languages, dictionaries,...), local services (restaurants, cinema, disco, ...), ...
Participants: Iceland, Holland, Germany, Greece (WLAN / UMTS)

Applications

- Mobile Robots in industrial environment
 - Secur communication for robot control (better safe than sorry!)
 - Normal communication: WLAN in enterprise hotspots
 - If necessary: GSM communication
 - Spontaneous networks

Applications

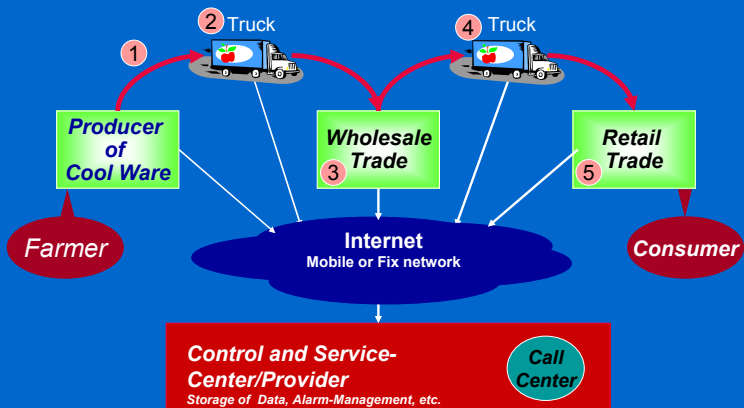
WLAN-GSM Cellphone



Applications

eService Architecture

Conception of Complete traceability of cool food chains



Further Developments



Facts and Trends

Current developments:

- More Internet connections
- High performance PDAs and Notebooks
- More mobility
- New „Wireless Informations Devices“
e.g. SmartPhones: bigger displays, Cameras, GPS, ...
- A high number of processors in embedded-systems

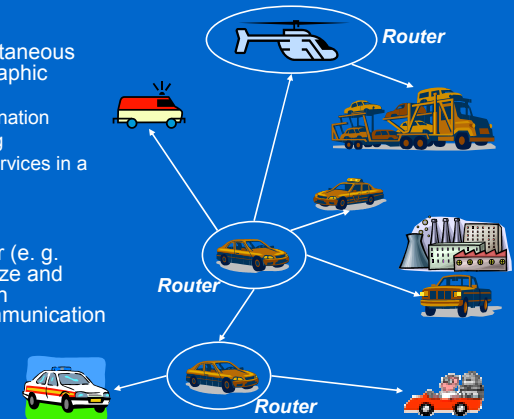


- **Fact:** Cheap and small electronic devices, therefore, more and more mobile (networked!) devices!

- **Trends and Challenges:** Spontaneous networking, new communication architectures, utilisation of spontaneous services, Ubiquitous networks, etc.

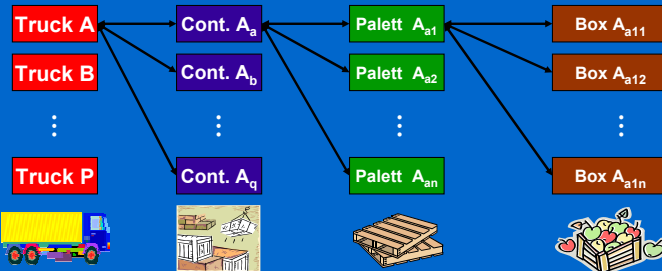
Challenges Spontaneous Networks

- Independent spontaneous networks in geographic defined area
 - position determination
 - Multi hop routing
 - Availability or services in a defined area
- Example: Cars of a producer (e. g. BMW or VW) realize and organize their own spontaneous communication networks.



Challenges Spontaneous networking

Addressing method of packing materials in a truck



Addresspattern: 64 bit

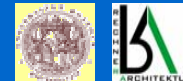
4 bit Kateg.	20 bit Firmen	16 bit LKW	8 bit Container	8 bit Paletts	8 bit Kisten
-----------------	------------------	---------------	--------------------	------------------	-----------------

Contact address

Thank you for
your attention!

Prof. Dr.-Ing. habil.

Djamshid Tavangarian



University of Rostock
Department of Computer Science
Institute of Computer Engineering

Albert-Einstein-Str. 21, D-18059 Rostock / Germany
Phone: +49 (0)381 498-3386 (Tavangarian), -2360 (Burchert)
Fax: +49 (0)381 498-3440
E-Mail: tav@informatik.uni-rostock.de
Web: <http://wlan.informatik.uni-rostock.de>