Recent Trends: DTN Introduction & Applications

Sebastian Schildt, Lars Wolf
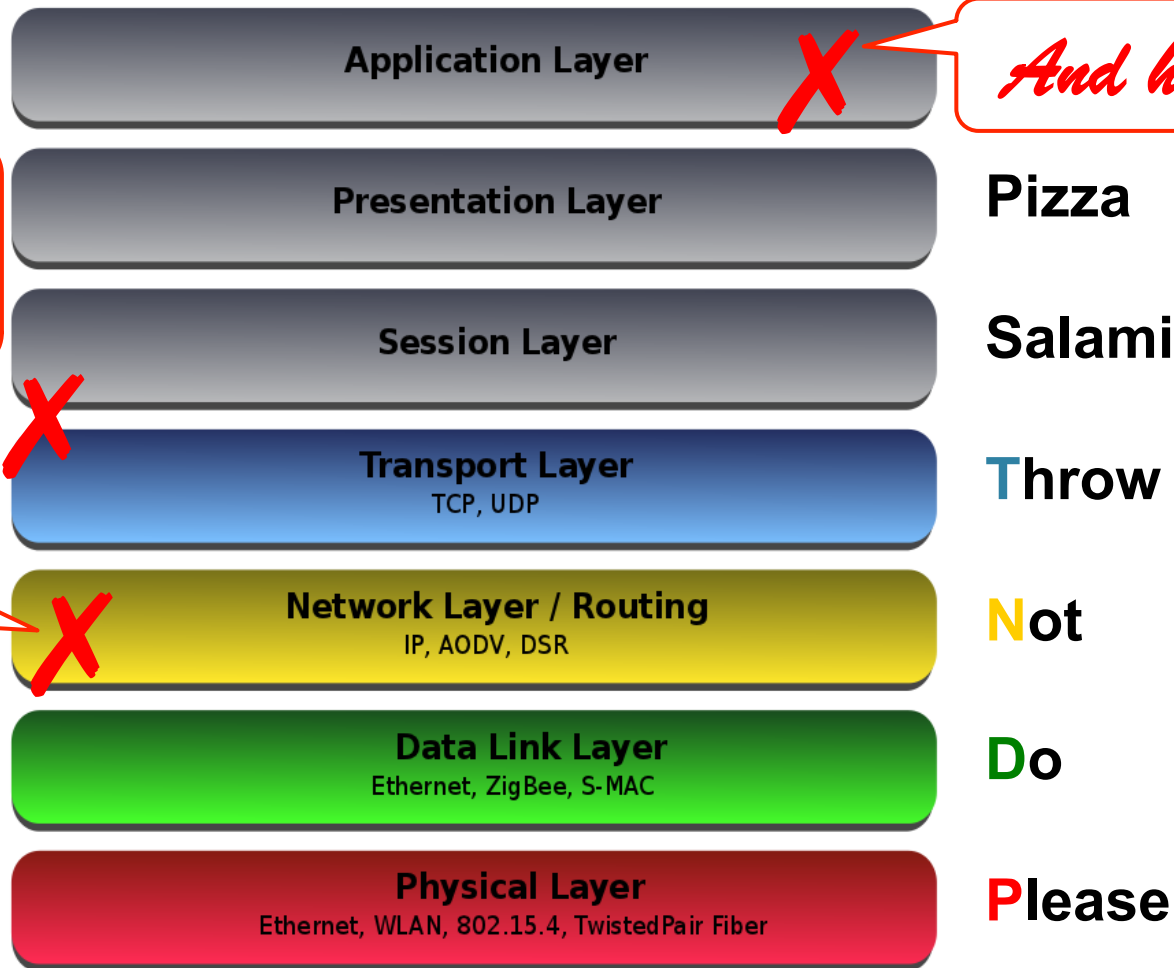
WS2011/12

DTN Protocol Stacks

Technische
Universität
Braunschweig

Institut für Betriebssysteme
und Rechnerverbund
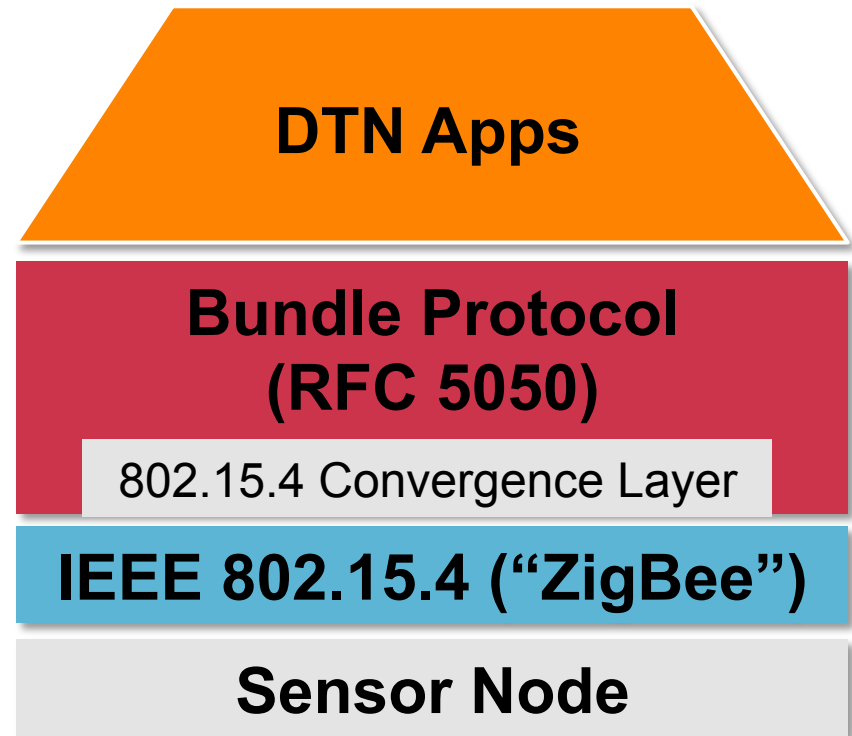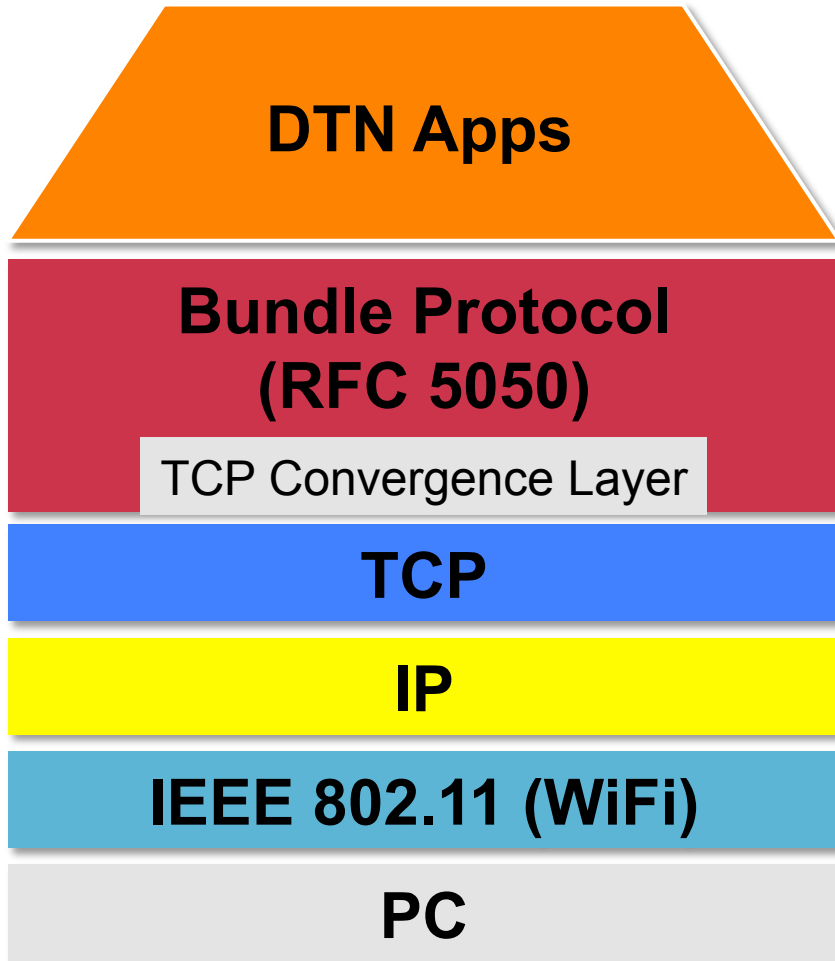
Delay and **D**isruption

Tolerant

Network

Technische
Universität
Braunschweig

Institut für Betriebssysteme
und Rechnerverbund

Argh, those dreaded mobility! Always a big headache with nodes moving around getting out of range and stuff!

What a wonderful thing mobility is. It helps me spreading data.

Technische Universität Braunschweig

Institut für Betriebssysteme und Rechnerverbund

DTN vs. Classical (Wireless) Networking

Links and routes can fail anytime. Luckily I am prepared for this horrible incidents by using sophisticated route recovery and repair mechanisms!

You are a "Horrible incident". Links will fail all the time. That's just the way wireless networks are.

Technische Universität Braunschweig

Institut für Betriebssysteme und Rechnerverbund

DTN vs. Classical (Wireless) Networking

I have so many powerful ways of routing. I can find shortest paths, most reliable paths, use location, interest and much more to make your data arrive!

I can do all that. And if even with all those measures I can't deliver your packet directly, I will travel into the future to deliver it!

Technische Universität Braunschweig

Institut für Betriebssysteme und Rechnerverbund

DTN vs. Classical (Wireless) Networking

I am the standard. The whole internet builds on my principles. After all, most networks, even wireless ones are more or less reliable and connected, and this is my domain!

Networks for sissies? I am just as good as you in those networks!

Technische Universität Braunschweig

Institut für Betriebssysteme und Rechnerverbund

DTN vs. Classical (Wireless) Networking

Ordinary Networking	DTN Networking
Mobility is a challenge	Mobility is exploited
Link failures are handled as accidents	Failing links are considered as normal
Routing through space	Routing through space and time
The Standard	Superset of ordinary networking

A network for Interplanetary Networks

- Originating in NASA surroundings
- Small problem: Since currently FTL transmission are not possible, there are long delays communicating in space
  - It already takes 8 min to reach the sun…
  - Common protocols do not work (well) with such high delays
- Big problem: Other effects, like orbiting spacecraft disappearing behind the horizon of stellar objects, yield even longer delays
 - Can not always send data when they are available

Technische
Universität
Braunschweig

Institut für Betriebssysteme
und Rechnerverbund

- Long delays

- Highly deterministic

- Develop general protocols and paradigms for networks with large delays and temporary disruptions

- Story-Carry-Forward paradigm: Store your data until the next contact comes into radio range

Extending the concept to dynamic wireless networks

- People noticed that disrupted networks are not a thing of the heavens alone: They are quite common on earth to

  - More and more wireless communication networks with mobile participants (WiFi, WSNs, …)

  - Mostly unstructured with no static topology

- Adapting the store-carry-and-forward methodology can make networks useful, that couldn't be used before

- Store-carry-and-forward means:

  - More opportunities to communicate

  - Much higher delays, end-to-end acknowledge hard

- Applications need to be aware of this

Technische
Universität
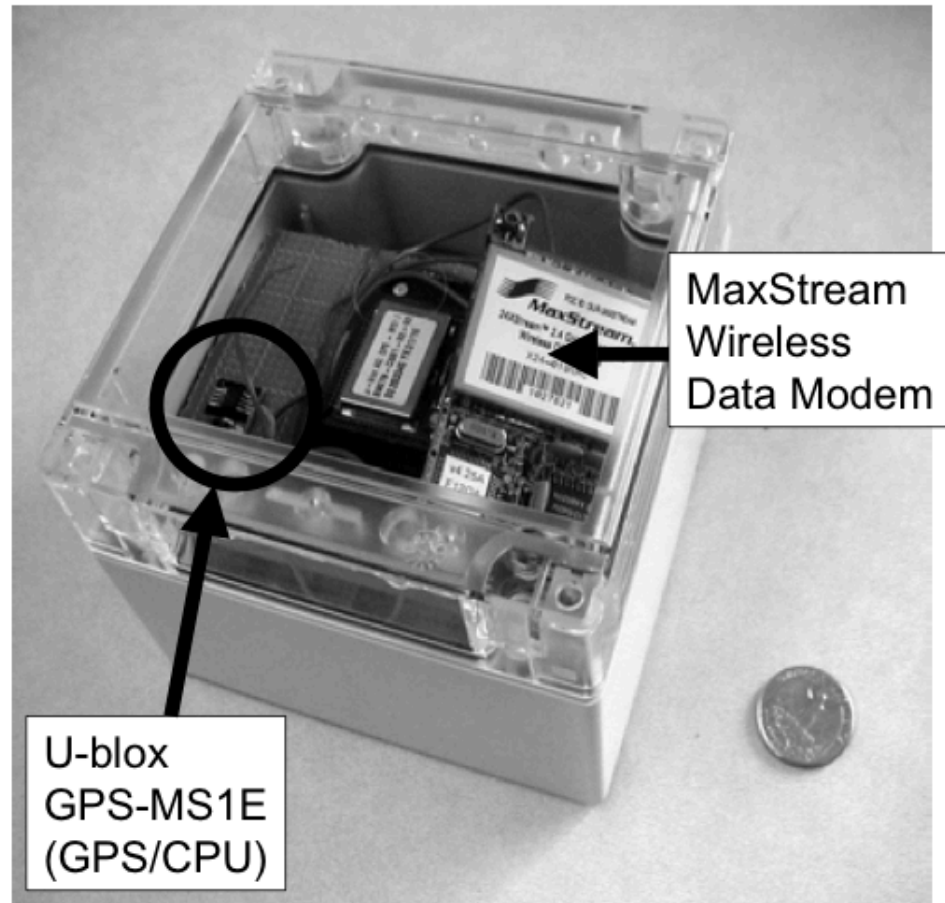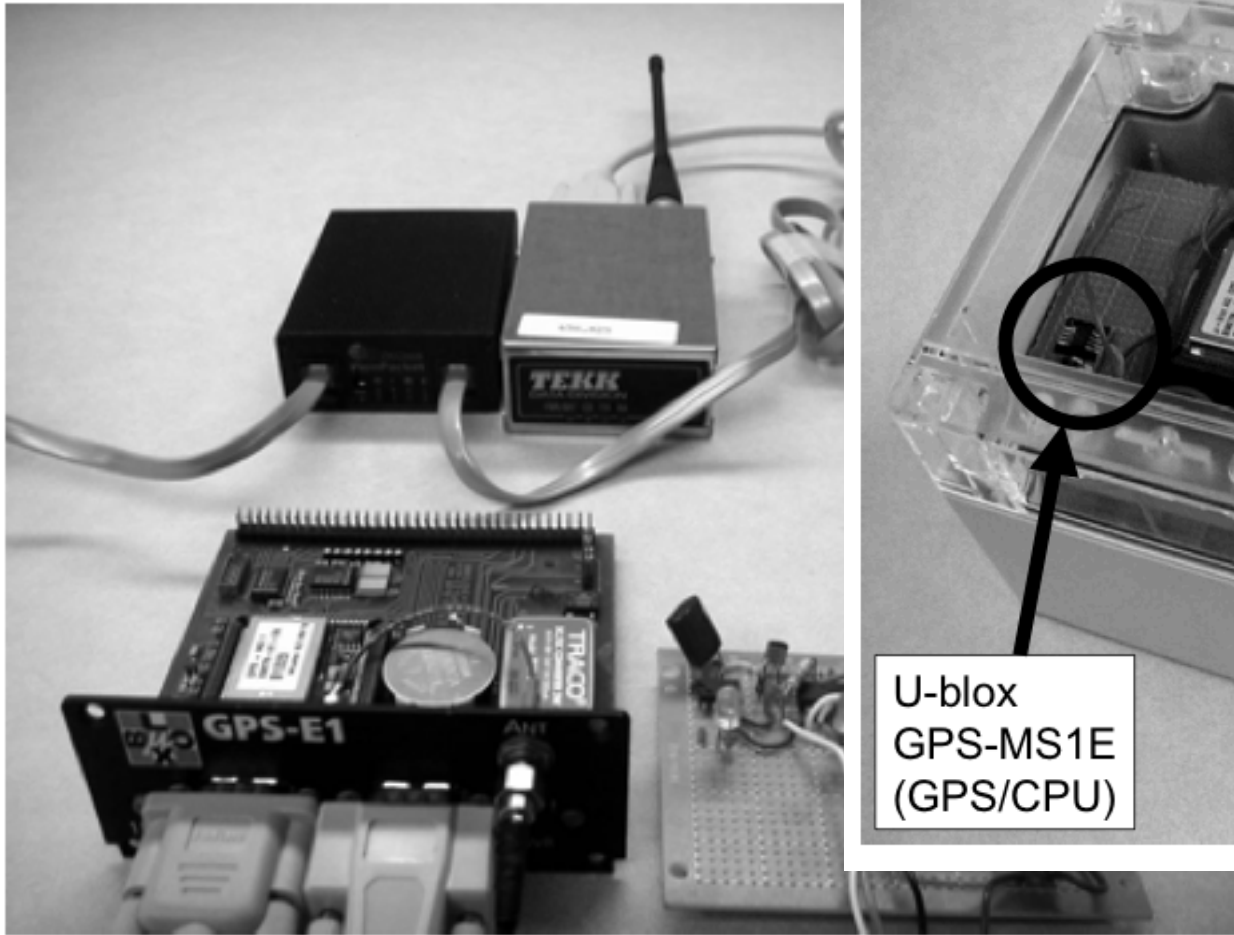Braunschweig

Institut für Betriebssysteme
und Rechnerverbund
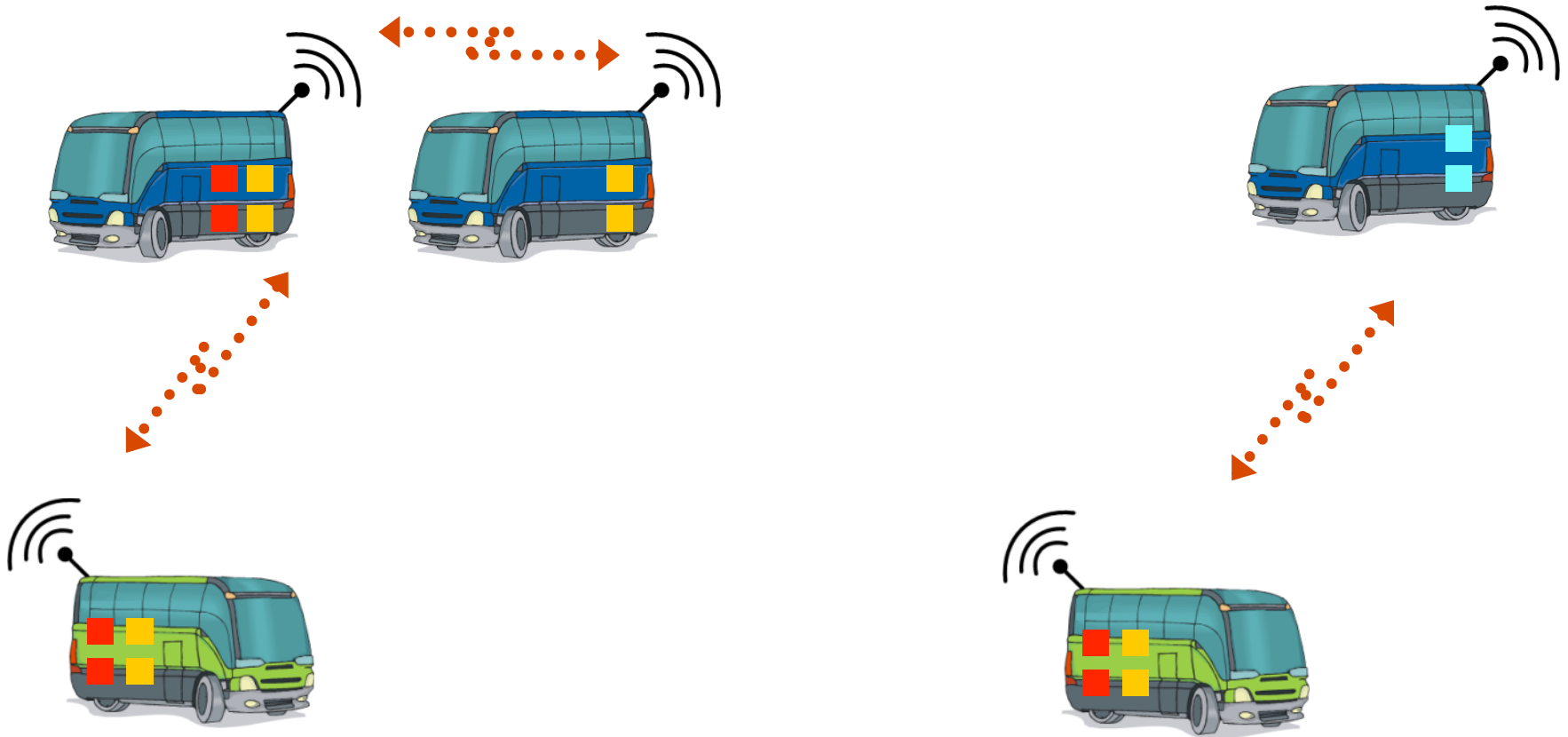
Wildlife Tracking

- Using sensor nodes

- Track position of animals

- Tracking data is replicated when animals are in reach of each other

- Tracking data can be gathered daily or weekly using a base station in a car or plane (called a "ferry")

- Project did not use the term "DTN"

http://www.princeton.edu/~mrm/zebranet.html

Technische Universität Braunschweig

Institut für Betriebssysteme und Rechnerverbund

ZebraNet Prototype Hardware

MaxStream
Wireless
Data Modem

U-blox
GPS-MS1E
(GPS/CPU)

Technische
Universität
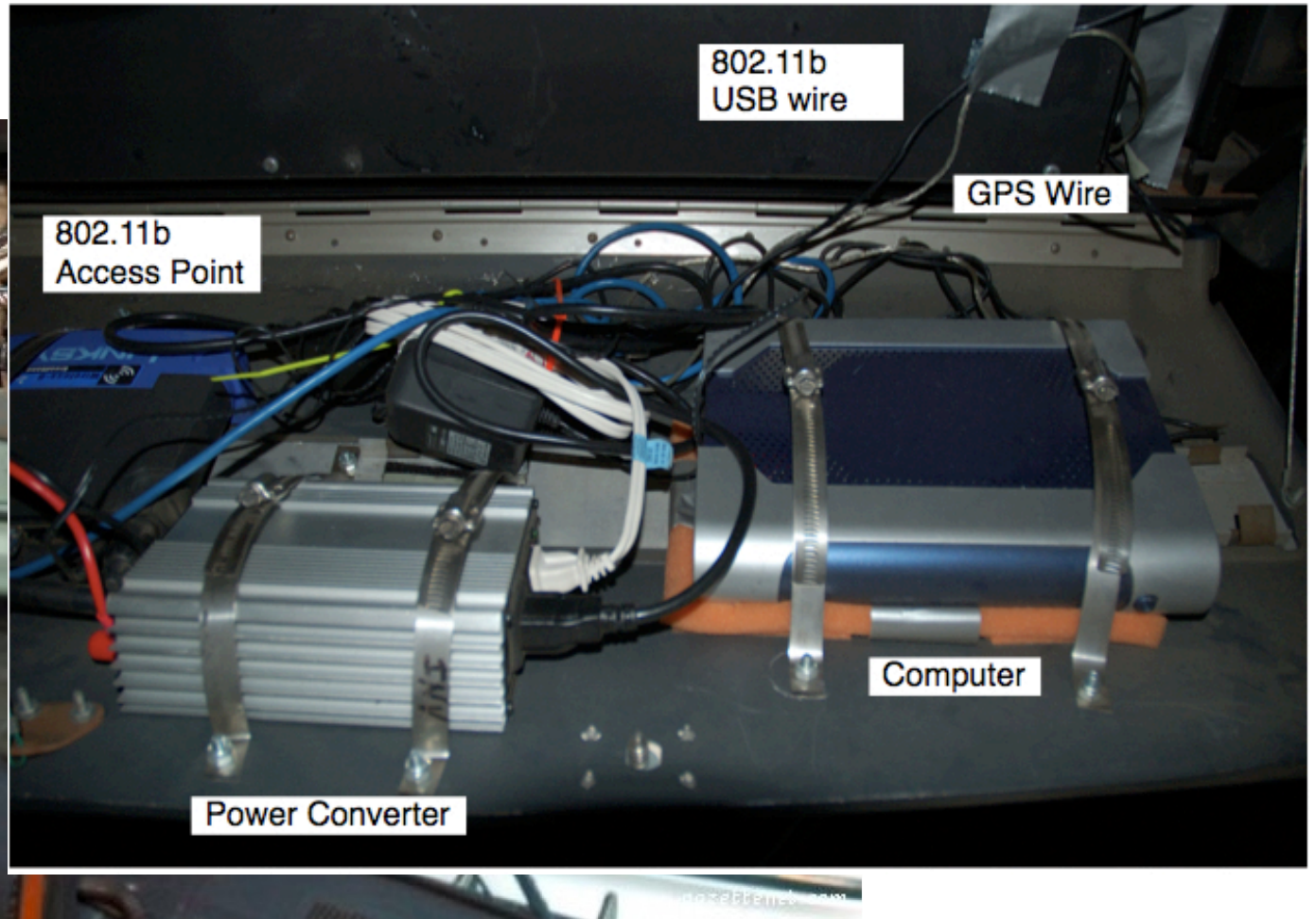Braunschweig

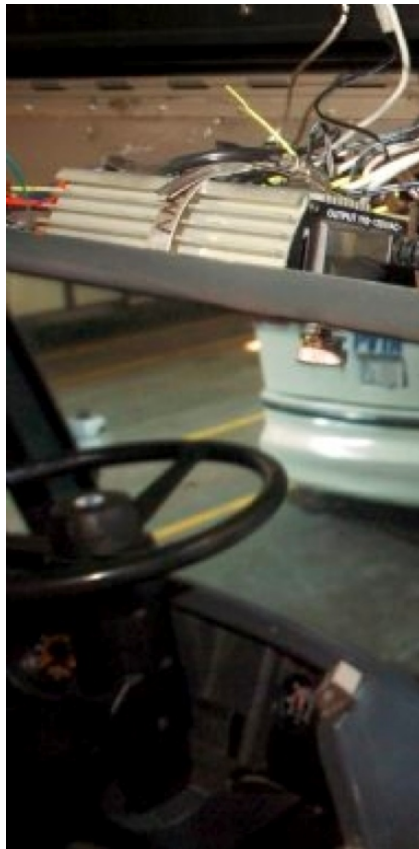Institut für Betriebssysteme
und Rechnerverbund
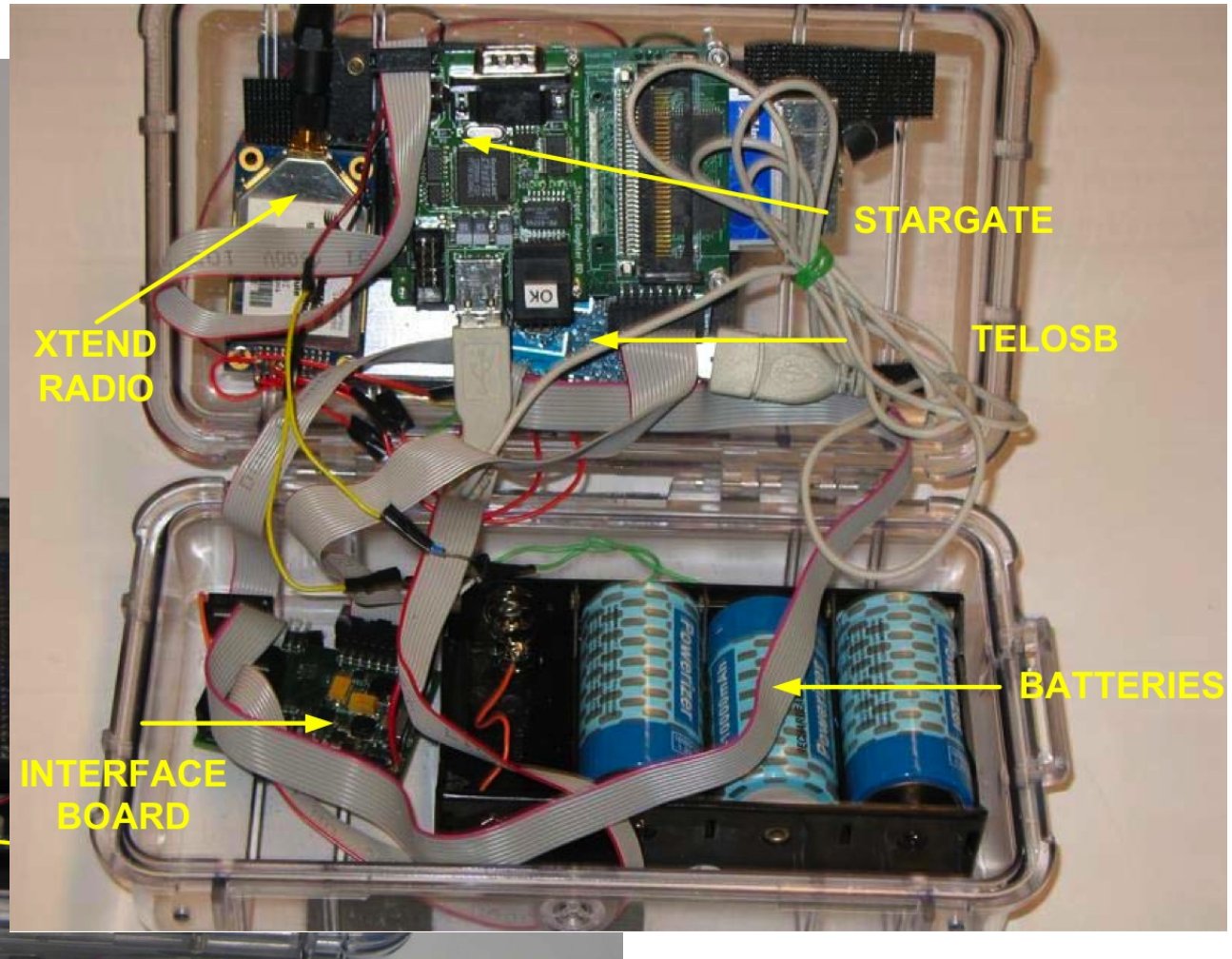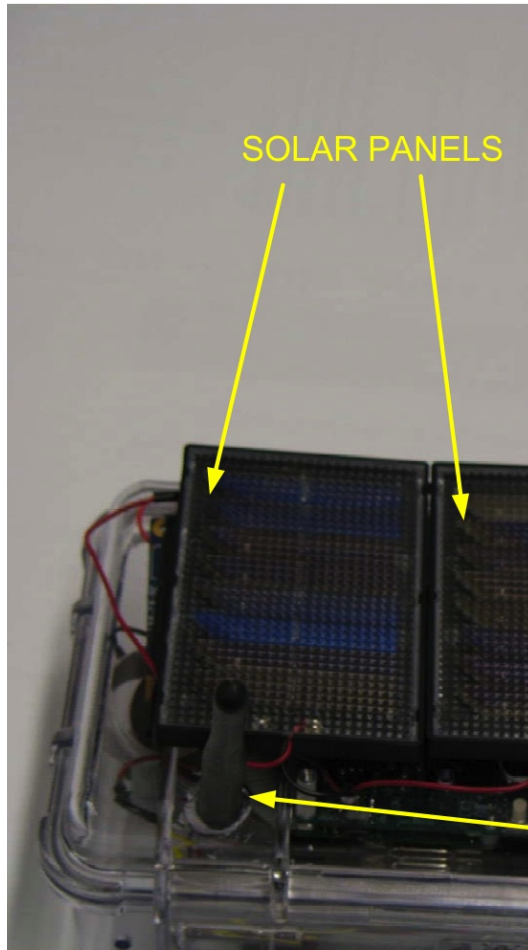
Dieselnet Testbed

- 35 busses with a "Diesel Brick"
  - X86 CPU , 577MHz, 256 MB RAM
  - 2x 802.11b: 1xAP, 1xClient
  - MaxStream Xtend 900MHz radio
  - GPS
- Stationary "Throwboxes" that can communicate with the busses using the 900 MHz link
- Throwboxes can operate on Battery+SolarCell
- Throwboxes will only activate their 802.11 interface when a bus is approaching (requested by the low-power 900MHz link)

http://prisms.cs.umass.edu/dome/umassdieselnet

Technische Universität Braunschweig

Institut für Betriebssysteme und Rechnerverbund

DieselBrick

ThrowBox

SOLAR PANELS

XTEND RADIO

STARGATE

TELOSB

INTERFACE BOARD

BATTERIES

Technische
Universität
Braunschweig

Institut für Betriebssysteme
und Rechnerverbund

Haggle

- "AdHoc Google": Centered around social web applications
- Idea is DTN, but the architecture is quite different form RFC5050 based DTNs
- Push based, data centric
- Metadata represent the address of an item, similar attributes between two items are represented in a relation graph. The weight of a relation depends on the number of similar attributes (yes, this should remind you of distributed diffusion from last time)

Haggle Applications

- PhotoShare: Make photos, tag them, automatically get other photos according to desired tags

- FileDrop: Distribute data in a Haggle network, by moving them into a special folder. Metadata are automatically extracted.

- MobiClique: Social Network App. Allows adding friends, discussion and filesharing

- BBS: Haggle based BBS

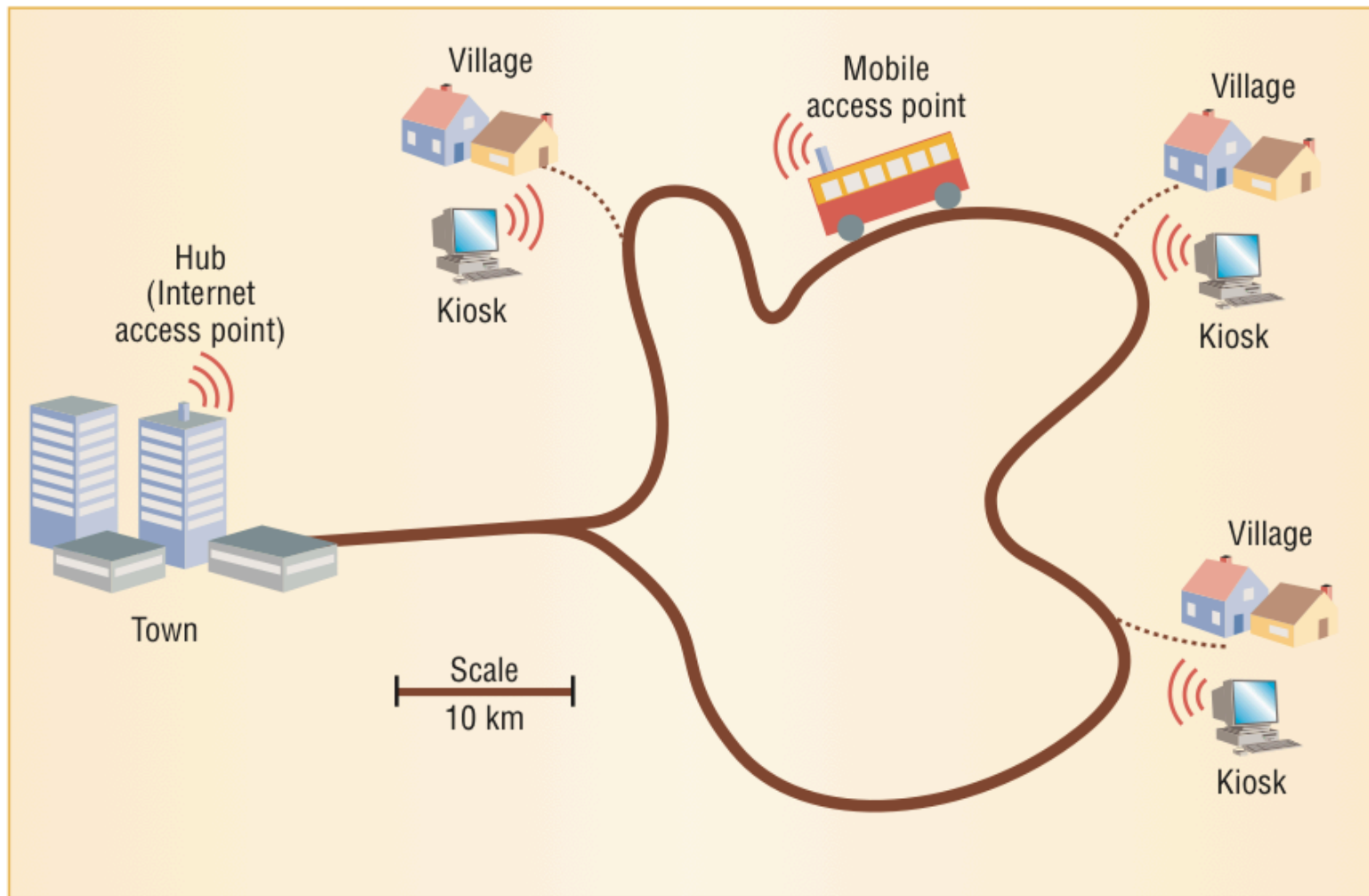Institut für Betriebssysteme
und Rechnerverbund

DakNet / FirstMileSolutions

- Goal: Enable the use of internet applications in rural areas with no infrastructure

- Can be used when even wireless directional radio is not economically feasible

- Idea: Use vehicles as data-mules

- Developed by the MIT Media Lab

- Now commercialized by FirstMileSolutions in India

Technische
Universität
Braunschweig

Institut für Betriebssysteme
und Rechnerverbund

DakNet Architecture

Goals

- Pollution monitoring in a large area
- Common infrastructure complex and expensive

Idea

- Use public transportation Systems
- Measure data on vehicles

How to get all those data off the vehicles to their destination?

- DTN!

Technische
Universität
Braunschweig

Institut für Betriebssysteme
und Rechnerverbund

The OpTraCom infrastruture can be used for various task

- Gather envrionmental data
- Gather operating data of the public transportation provider (e.g. status of railroad switches, diagnostic data of vehicles)
- Update public displays with new timetables or advertisments

Technische
Universität
Braunschweig

Institut für Betriebssysteme
und Rechnerverbund

OpTraCom Development Plattform

- 680 MHz MIPS24k
- 128 MiB RAM
- WiFi connectivity
- USB2.0 Host
- OpenWRT
- IBR-DTN

Technische
Universität
Braunschweig

Institut für Betriebssysteme
und Rechnerverbund
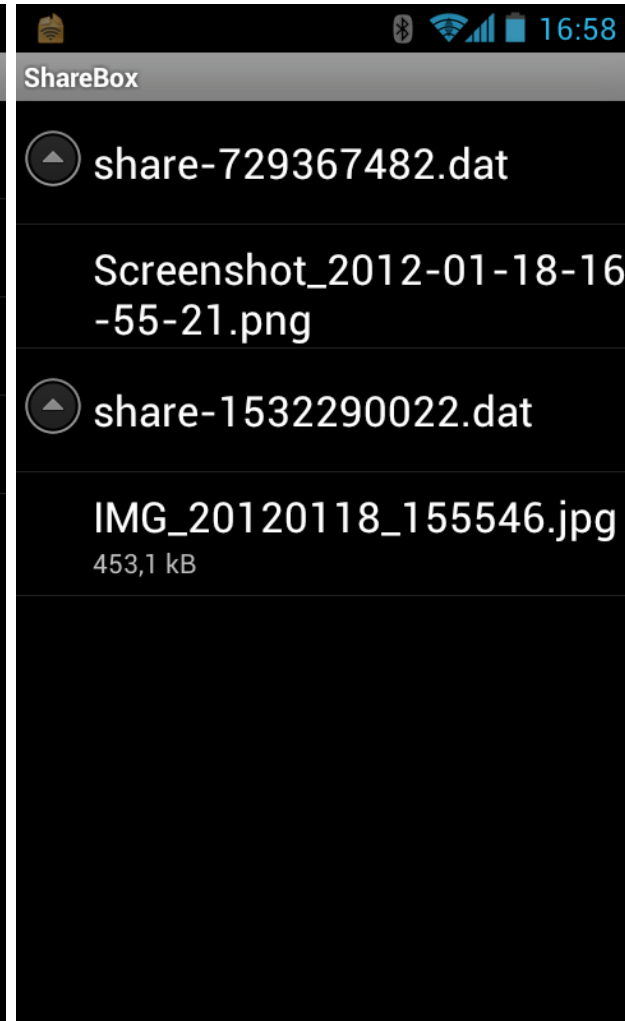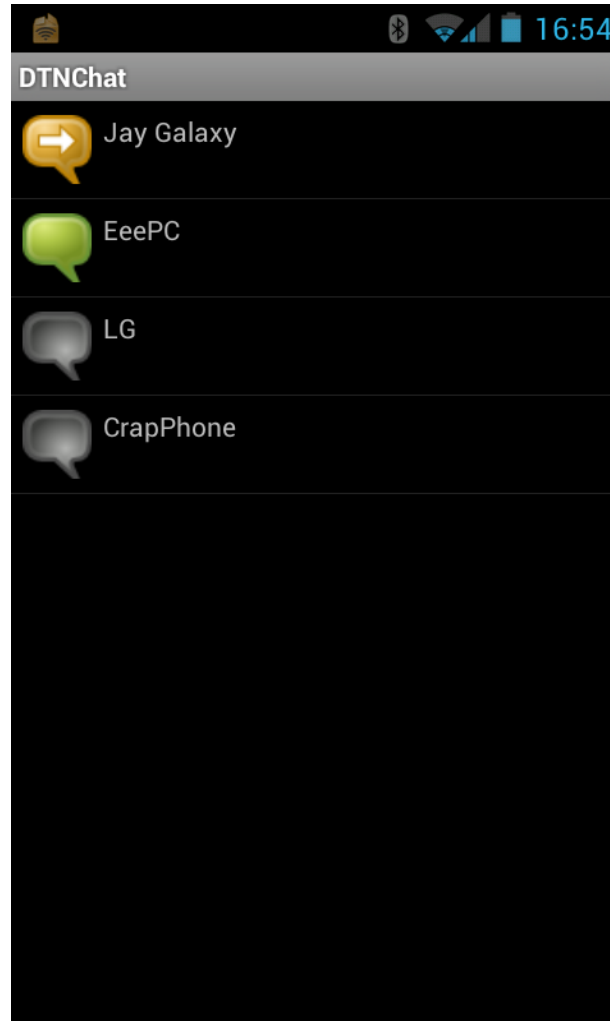
The next Battlefield: Mobile Phones

- SmartPhones seem to be a logical choice for DTN applications
    - Plenty of computing power and communication capabilities
    - Cellular network still not ubiquitous, and speed much slower than WiFi
- IBR-DTN (more on this later) has been ported to Android Phones
- Demo applications do exist

Technische
Universität
Braunschweig

Institut für Betriebssysteme
und Rechnerverbund

IBR-DTN on Android

Technische
Universität
Braunschweig

Institut für Betriebssysteme
und Rechnerverbund

The Application Gap

- Lots of DTN research
    - Mostly focused on technical aspects
- Plenty of described applications
    - Many of them can be considered merely toys
- Really useful in sensing areas (ZebraNet, OpTraCom)
    - Still need to build mindshare to make it a commercially visible and recognized option
- Still need a sexy killer app for the general public
    - Android implementation is a first building block

Your chance!

Technische
Universität
Braunschweig

Institut für Betriebssysteme
und Rechnerverbund