SFB 637 Autonomous Logistics

UHF-RFID in the Food Chain - From Identification to Smart Labels

Coldchain Manangement. 3rd International Workshop, 2.-3. June 2008, Bonn

Reiner Jedermann, University Bremen, IMSAS / MCB

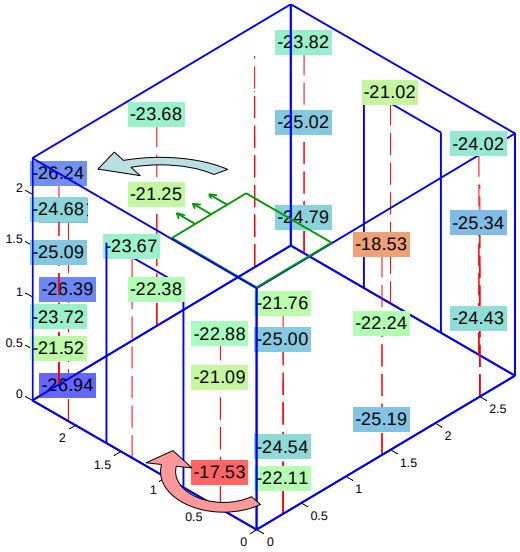
Universität Bremen

Food is different

- Not only identification
  - Temperature data
  - Quality data
  - Write back data to tag during transshipment (changed quality, max temp ….)
- Low cost RFID sensors might enable temperature tracking per pallet / item

Example for spatial temperature deviations

- Application of **HF**-Loggers
  - Local deviation of up to 9 °C in delivery truck
  - Deep freezer after 6 hours cool down
  - Slow 5 sec. per logger
  - Max. dist. 20 cm

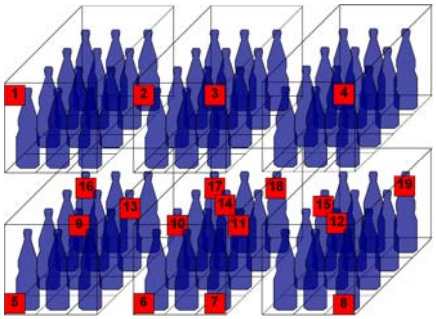


UHF in the food chain

- Benefits of **UHF** RFID
  - Reading range up to 3 meters
  - Gen-2 protocol offers highest data rate
- Limits of UHF-RFID
  - More sensitive against water containing goods
  - Fast enough for ‘large’ temperature histories ?
- Intelligent RFID / Smart (active) labels
  - On-chip processing of temperature data
- Update intelligent container

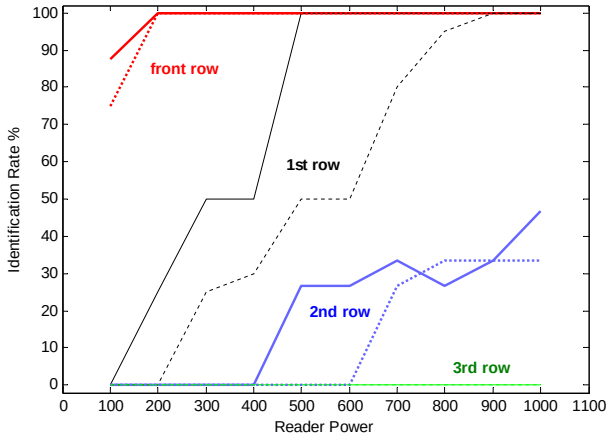
Test setting: Tags inside freight

- 6 Boxes with 12 bottles (1 l water)
- Distance 1 m
- UHF Gen-2 Tags NXP Ryparian



Identification rate as function of reader output power

- 200 mW for front tags
- 400 mW / 900 mW for 1st row
- Only 50% rate reached for 2nd row
- Sirit slightly better



Sirit Infinity (solid line)
Feig 200 (dotted)

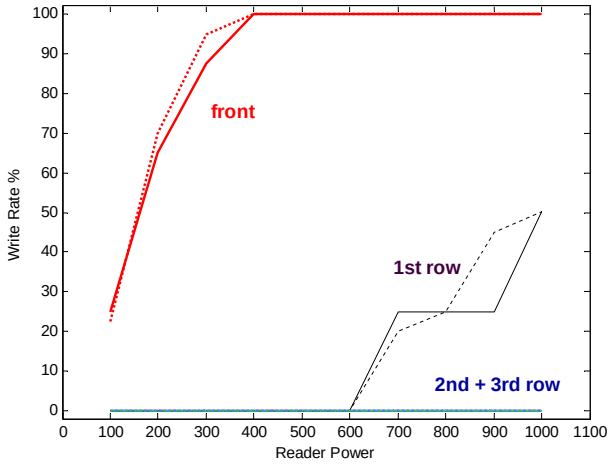
Write rate

- 400 mW for writing front tags
- For 1st row only 50% reached

Conclusions

- UHF has a low penetration into moisture containing goods

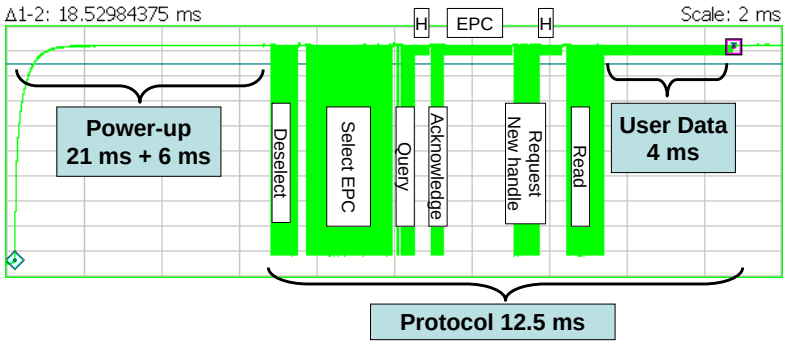
→ Access only to tags at surface



Data transfer speed: Read

- Reading 28 Bytes of user memory
- Amplitude modulation recorded by spectral analyzer

- Setting:
  - Tari 12.5 ms
  - Symbol rate 80 KBit/sec
  - Feig 2000 Reader
- H = Handle
- EPC = Electronic Product Code



Prediction for UHF temperature loggers

- Currently only 28 or 64 byte user memory available
- UHF temperature tags announced by semiconductor manufactures
- Formula to calculate protocol time for reading large blocks

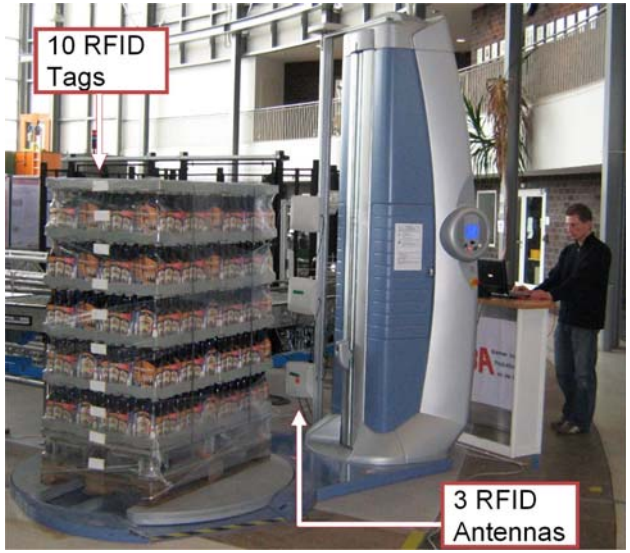
$$T_{Read} = T_{up} + (283 + 61 \cdot N_R) \cdot T_{Bit} + (194 + N_R \cdot (N_B + 39)) \cdot T_{Sym}$$

- Time to transfer 700 temperature values = 1 kByte (N_R=32 blocks with N_B=256 bytes each)

→ 175 ms per temperature logger required
→ Optimistic maximum 5 loggers per second

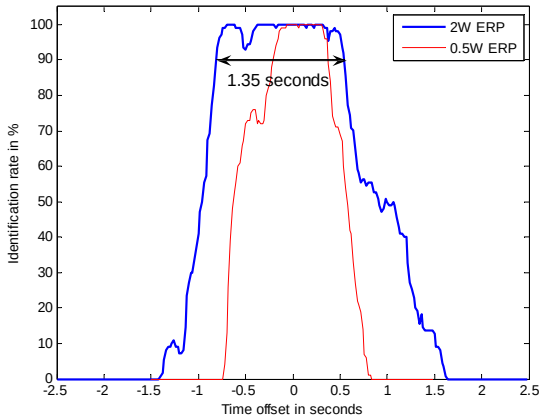
Test with pallet wrapping machine

- Test at palette wrapper
- 10 rpm = 0.6 m/sec
- Performance of ID and write for moving freight



Time window for identification and write

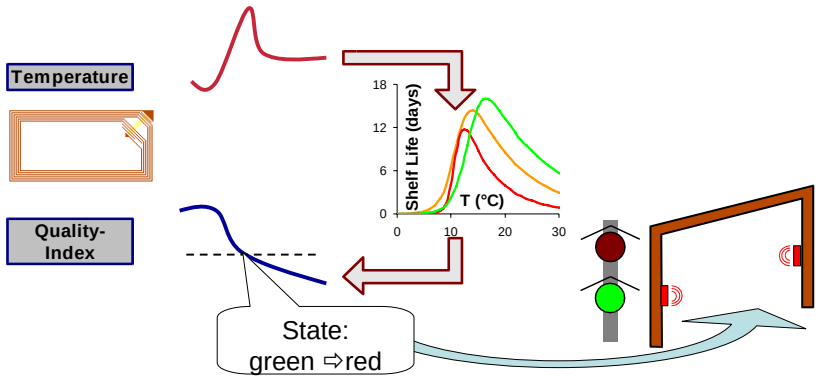
- Identification
  - Tags are for 1.35 seconds visible for the reader
  - At least 29 Identifications per tag and round
- Writing user memory
  - Measured for 28 Bytes = 267 ms
  - At reduced speed of 4 rpm 82% of the tags could be written



Identification rate per tag within a time window of ± 75 ms

Solutions for the communication bottleneck

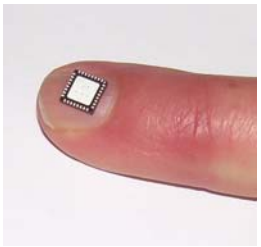
- On-Chip processing of sensor data by smart label
- Semi-passive tag as Intelligent RFID
- Temperature logger + shelf life model

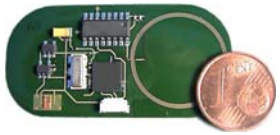


Smart labels

- Is it feasible to squeeze a shelf life model into a micro-chip?

Type of Resource	Calculation of Arrhenius equations
Processing time	1.02 ms
Program memory	868 bytes
RAM memory	58 bytes
Energy	6 µJoule





Integration into commercial active wireless sensor

- Currently no UHF hardware available
  - Class 3 battery assisted tags supposed to be available end 2008

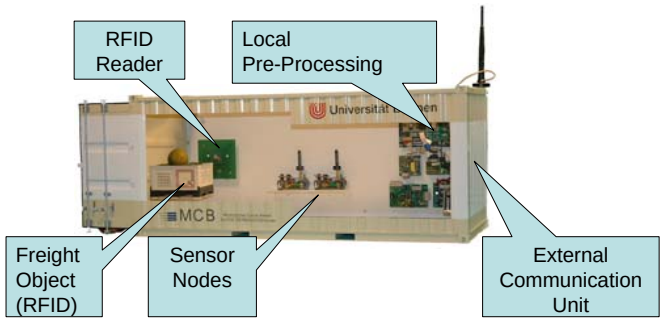
→ Apply approach to active wireless sensors
  - Smart active label

- New cooperation with Ambient Systems
  - Manufacturer of wireless meshed sensor networks for logistical applications

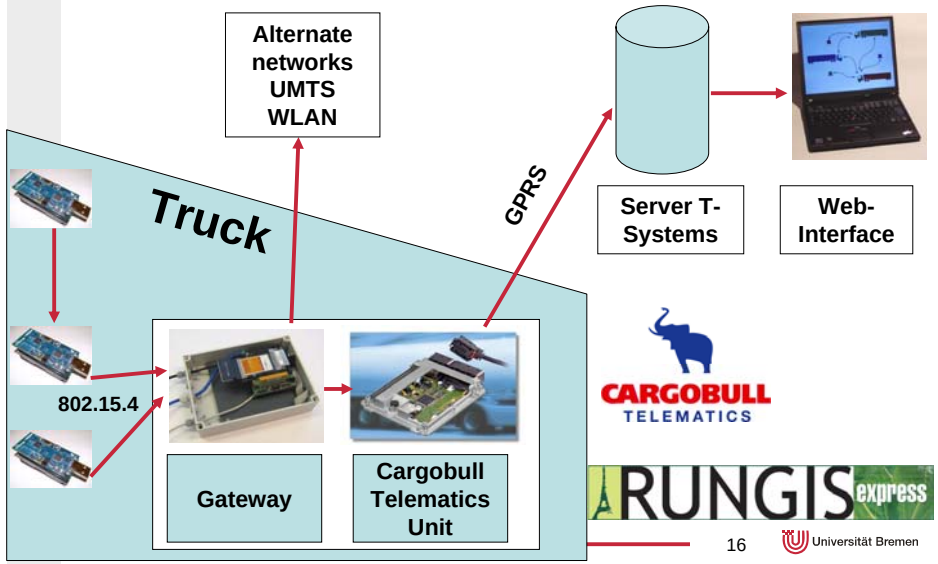
ambient

Integration into real time remote monitoring

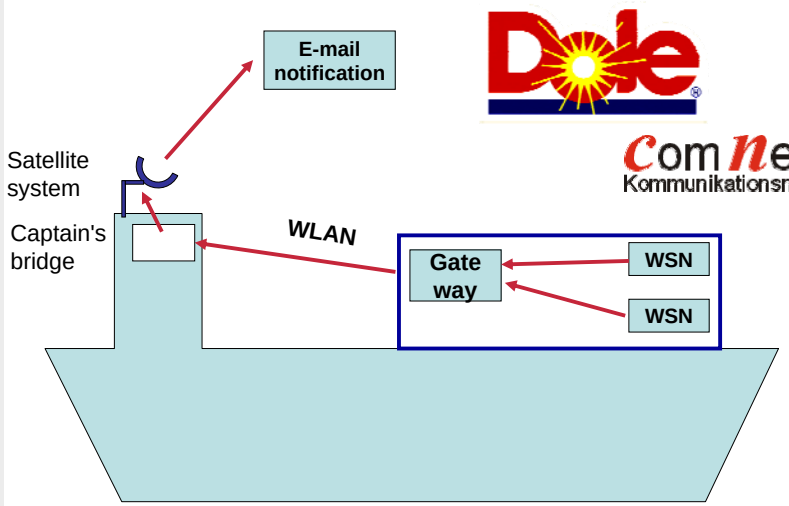
- Project ‘intelligent container’
- Transfer project since January 2008
  - Field test will start in autumn
  - Partnership with Eurocoldchain / FP7 planned



Setting for real-time monitoring of delivery trucks

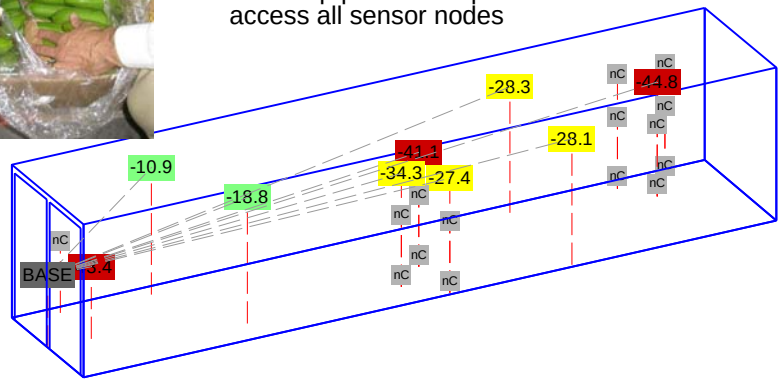


Setting for sea transports



Reading range of wireless sensors

- Test in Dole warehouse / Antwerp
- Container with Bananas was equipped with wireless sensors
- Base station could only 1/3 of all sensors
- RSSI Received signal strength indicator
- Multi hop protocol required to access all sensor nodes



The End

Thanks for your attention

www.intelligentcontainer.com

Contact address
Dipl.-Ing. Reiner Jedermann
Universität Bremen, FB1 (IMSAS/MCB), Otto-Hahn-Allee NW1,
D-28359 Bremen, GERMANY
Phone +49 421 218 4908, Fax +49 421 218 4774

rjedermann@imsas.uni-bremen.de