KTH Royal Institute of Technology

VHF/UHF Wireless Uplink Solutions for Remote Wireless Sensor Networks

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Outline

- Background
- Problem
- Goals
- Communication Protocols
- Proposed Solutions
- Experiments
- Data & Conclusions
- Future Work
- Demo
- Questions

Background

- Atmel ATMega128RF-chip with IEEE 802.15.4Transceiver as Mote
- The mote software is based on the Contiki operating system.
- A mote automatically becomes a sink mote when connected via a TTL/USB converter
- Gateway is usually a Bifrost/Alix system or Raspberry Pi without internet connection

Problem

- Get the collected data out from the gateway of a WSN to a remote repository with internet access.
- 434 MHz and 144 MHz frequencies and associated protocol stacks to optimize the range and QoS
- From dedicated hardware solutions to software defined radio links to optimize power consumption and flexibility.

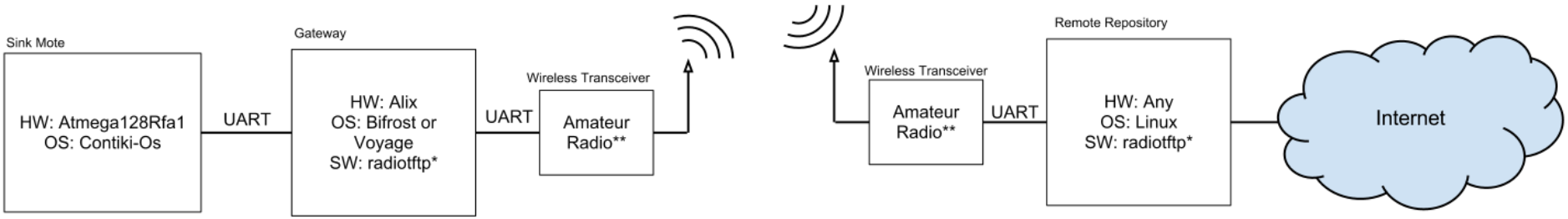
Communication Protocols

- Data-Link
  - AX.25? Ethernet? 802.15.4?
- Network
  - APRS? IPv4? IPv6?
- Transport
  - UDP? TCP?
- Application
  - HTTP? FTP? TFTP? APRS?

Proposed Solutions

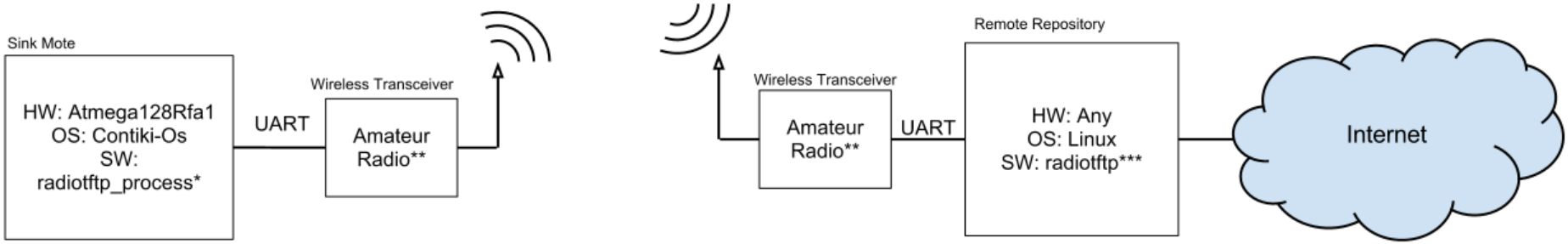
- RadioTftp
- RadioTftp Process for Contiki
- RadioTunnel
- Soundmodem
- APRS

RadioTftp



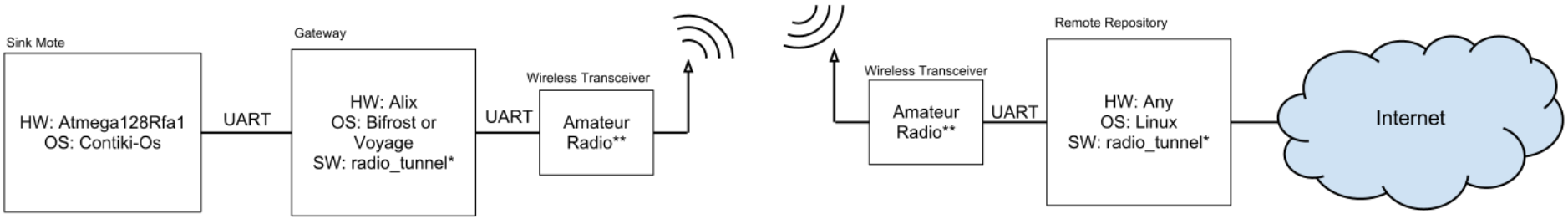
*radiotftp is a software written by Alp Sayin, which implements the TFTP protocol over a serial port
**Radio can be any Radiometrix radio transceiver, e.g. Bim2A, UHX1

RadioTftp Process for Contiki



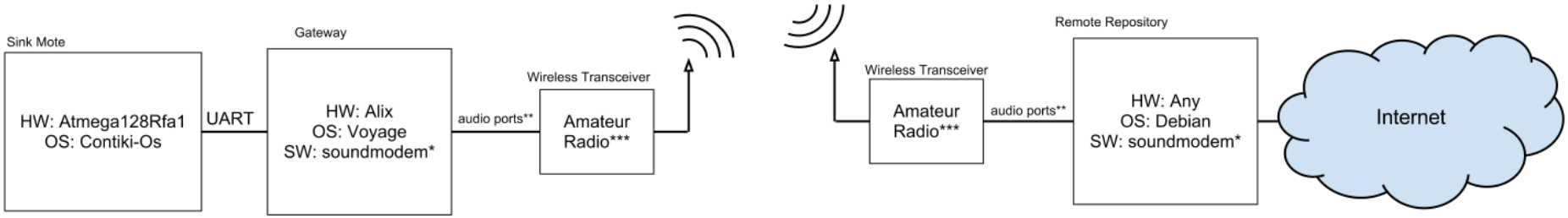
*radiotftp_process is a Contiki-Os process written by Alp Sayin, which implements the TFTP protocol over a serial port
**radiotftp is a software written by Alp Sayin, which implements the TFTP protocol over a serial port
***Radio can be any Radiometrix radio transceiver, e.g. Bim2A, UHX1

RadioTunnel



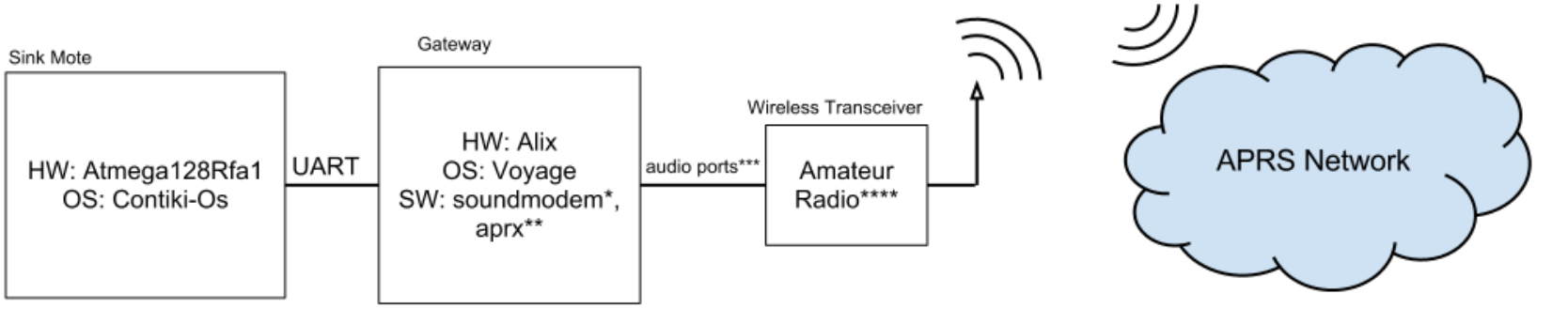
*radio_tunnel is a software written by Alp Sayin, which encapsulates the IP packets coming from user programs with AX.25 frames and encodes them to send them through radio
**Radio can be any Radiometrix radio transceiver, e.g. Bim2A, UHX1

Soundmodem



*radiotftp is a software written by Thomas Sailer, which creates a software AX.25 KISS TNC interface from audio ports
**Audio ports mean, the 'speaker out' and the 'mic in' channels
***Radio can be any radio transceiver that allows transmission and reception of 1200 baud AFSK signals, e.g. Maas AHT-2, Yaesu FT8900R, Radiometrix Bim2A, Radiometrix UHX1

APRS



*radiotftp is a software written by Thomas Sailer, which creates a software AX.25 KISS TNC interface from audio ports
**aprx is a APRS software designed to gate or beacon APRS messages
***Audio ports mean, the 'speaker out' and the 'mic in' channels
****Radio can be any radio transceiver that allows transmission and reception of 1200 baud AFSK signals, e.g. Maas AHT-2, Yaesu FT8900R, Radiometrix Bim2A, Radiometrix UHX1

Experiments

- Outdoor Experiments (Around Riddarfjärden)
  - General Hardware Testing (i.e. RSSI vs. Distance)
  - RadioTftp
- Indoor Experiments (Lab Testing)
  - RadioTunnel
  - Soundmodem

Data & Conclusions

- Maximum Distance with 2m band with 10 mw: 2.1 km
  - Packet Error Rate with RadioTftp = 15%
- Maximum Distance with 70cm band with 10 mw: 400 meters
  - Packet Error Rate with RadioTftp = 35%

	Transfer Time 127 bytes	Transfer Time 2 kbytes
radiotftp uhx1	00:08.915	00:21.727
radiotftp bim2a	00:00.873	00:02.414
radiotunnel uhx1	02:56.029	12:09.429
radiotunnel bim2a	02:00.120	02:05.261
soundmodem	02:09.707	02:59.324

Table 3. Average transfer times with minimum distance between transceivers

Data & Conclusions

- RadioTftp
  - Effect of protocol overhead can be heavily observed.
  - The bitrate has a direct effect on throughput.
  - RadioTftp has the greatest throughput, since it utilizes the channel the most efficiently.

Data & Conclusions

- Concerning all solutions:
  - RadioTunnel solution shows a great decrease in throughput with respect to transfer size.
  - Soundmodem is better than RadioTunnel from most aspects.
  - 2m band has much greater range with respect to 70cm band with same power output.
  - Obstructions on the signal path are fatal.
  - Having a high ground is always better.

Conclusion

- There is no one best solution.
- Depending on the situation any of the solutions could be desirable.

Future Work

- The radiotunnel code should not be improved anymore, but instead, an actual device driver should be written for fine tuning.
- The radiotftp code base should be improved to have multiple-size queues and multiple timers.
- The soundmodem solution should be moved on to work with Radiometrix devices.
- The uhx1_programmer can be extended to be able to program the frequency of the UHX1 devices.

WSN Team 2012

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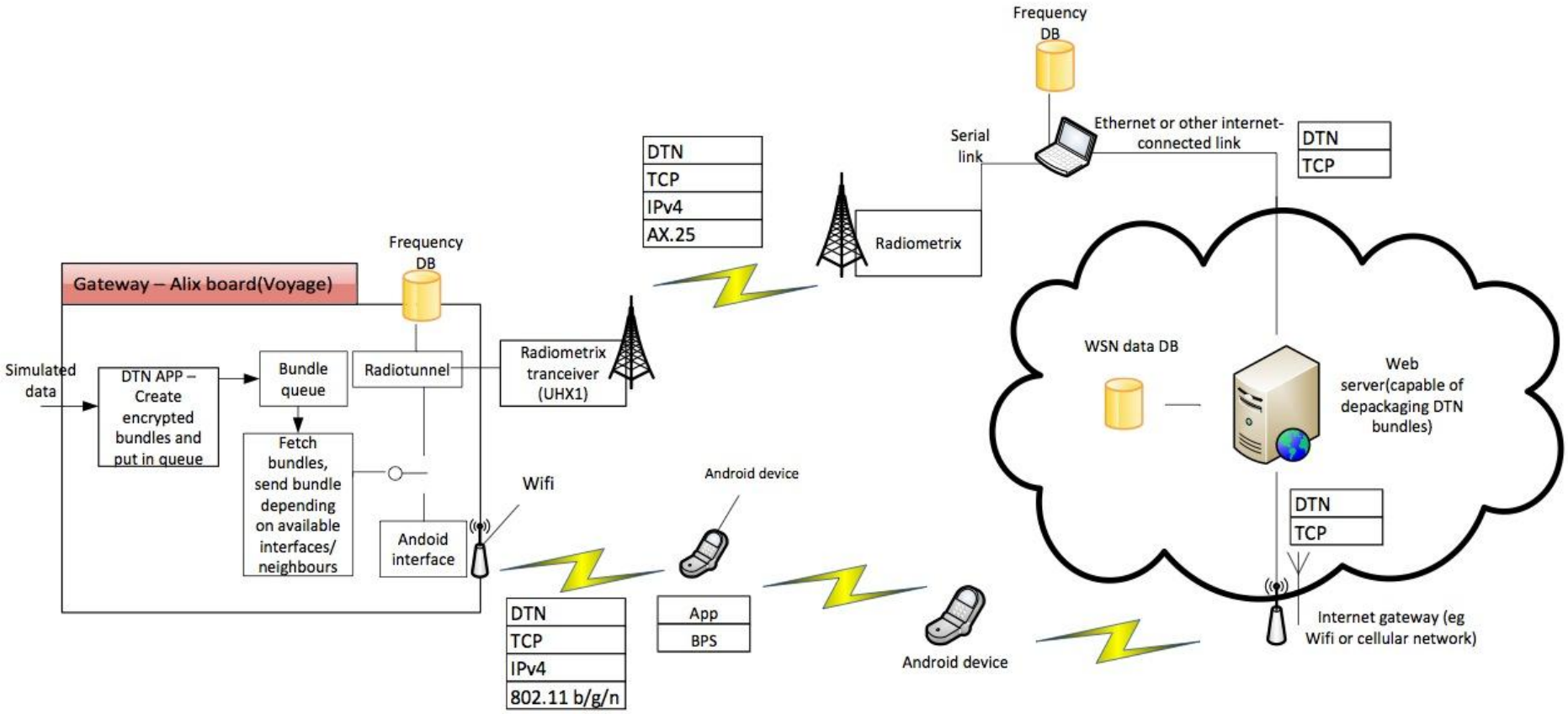
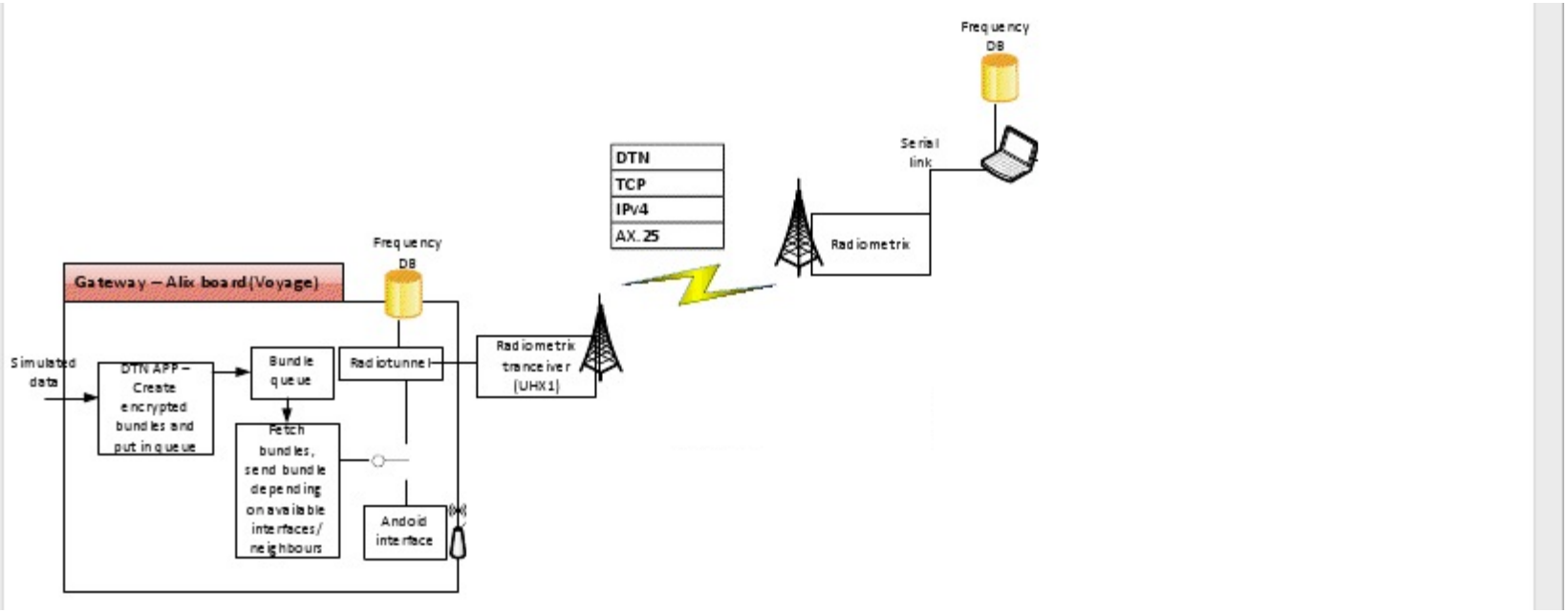
Future Work



*Courtesy of WSN Team 2012 (KTH Communications System Design, Design Project Team)

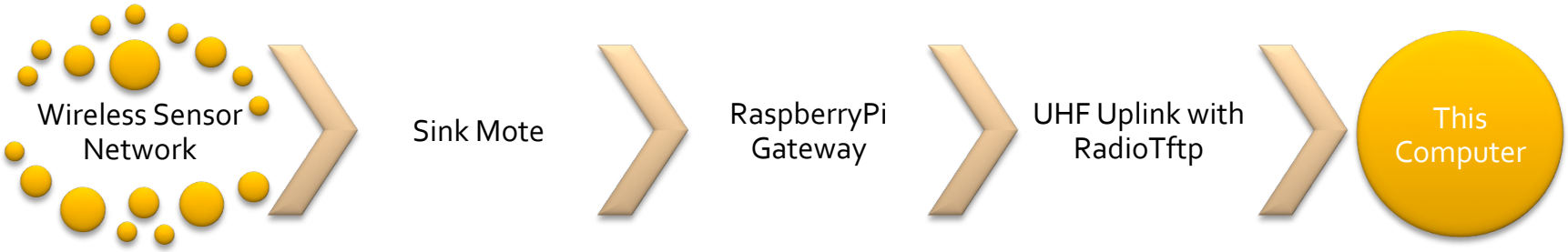
Delay Tolerant Network



- Spectrum Database Radio(SDB) Solution
- Selection Mechanism Implementation

*Courtesy of WSN Team 2012 (KTH Communications System Design, Fall 2012 Design Project Team)

Demo


Wireless Sensor Network
Sink Mote
RaspberryPi Gateway
UHF Uplink with RadioTftp
This Computer

Questions

- Thank you for listening
- More information:
  - http://alpsayin.com/vhf_uhf_uplink_solutions_for_remote_wireless_sensor_networks
  - http://github.com/alpsayin
  - http://code.google.com/p/kth-wsn-longrange-radio-uplink/ (old)
  - sayin[at]kth[dot]se
- WSN Team 2012
  - http://ttaportal.org/menu/projects/wsn/fall-2012/
  - https://github.com/organizations/WSN-2012
  - https://docs.google.com/presentation/pub?id=1rL40Es9D6Z0AD4bN72XcnrYqhL56eWsP8E4WOMR8C-E&start=false&loop=false&delayms=3000