μDTN: Unifying DTNs and WSNs

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Interstellar Communication

Radio Communication
- Direct (LOS) not possible
- Never continuous end-to-end

→ Disruption Tolerance needed
Disruption Tolerant Networks (DTN)

Store-Carry-Forward Principle
- Handle delays and disruptions
- Carry data through time and space
  - ... and vice versa
Summary: Interstellar Communication – e.g. Mars Rover “Curiosity”

Aim
- Collect data, transfer it to earth

Challenges
- Harsh environment
- Huge delays
- No continuous end-to-end connection

Approach
- Store, carry, forward principle

Solutions / Standards
- Delay-Tolerant Networking Architecture (RFC 4838)
- Bundle Protocol Specification (RFC 5050)
Delay Tolerant Networks (DTNs) in WSNs

Many different projects

- Zebranet
  - Zebras in Kenya
- DakNet
  - Internet/E-Mail access for developing countries
- Vineyard Computing
  - Vineyards in USA
- …
Summary: DTNs in WSN

Aim
- Collect data, transfer it to base station(s)

Approach
- Store, carry, forward principle

Challenges
- Harsh environment
- Huge delays
- Often disrupted connection

Solutions
- Many individual!

Standards
- None!

Recommendation
- Look above!
Concept: Use Standard Protocols in DT-WSNs

“Standards”
- Delay-Tolerant Networking Architecture (RFC 4838)
- Bundle Protocol Specification (RFC 5050)

Pros
- It’s existent and works
  - People are using it in space!
- It’s an RFC

Cons
- Not very lightweight
  - Specialized solution more efficient
- RFC is not a standard
Implementation for Contiki

- Should be easy portable

Compatible to RFC 5050

- Only Compressed Bundle Header Encoding (CBHE) supported
  - Bundle Protocol: Addressing by strings
  - dtn://node/service → 42:23

Located above MAC-Layer

- Contrast to most other implementations
- Reduced overhead
Evaluation: Frame Loss (Cooja, NullMac)

- RIME (NullMAC)
- UDP/IP (NullMAC)
- μDTN

Measured Packet/Bundle Loss vs. Adjusted Frame Loss
Evaluation: Frame Loss (Cooja, CSMA)

The diagram shows the measured packet/bundle loss compared to the adjusted frame loss for different protocols:

- **RIME (CSMA)**: 0%, 5%, 11%, 20%, 46%, 91%
- **UDP/IP (CSMA)**: 0%, 2%, 5%, 12%, 46%, 91%
- **µDTN**: 0%, 1%, 20%, 46%, 91%

The x-axis represents the adjusted frame loss, while the y-axis shows the measured packet/bundle loss. The diagram illustrates the performance of these protocols under varying loss conditions.
Evaluation: Throughput (TMote Sky)

Throughput [bit/s] vs Payload [Byte]

- RIME
- UDP/IP
- μDTN

Payload values: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90

Throughput values:
- RIME: 3,533, 10,262, 20,521, 41,036, 81,967
- UDP/IP: 5,131, 14,132, 27,826, 47,594
- μDTN: 2,108, 4,156, 7,342, 13,401, 22,794
Current State

µDTN successfully tested
- Cooja simulator
- Tmote Sky
- INGA

Heterogeneous Communication
- Tmote <-> INGA
- INGA <-> USB-Gateway
- Interoperable with other standard BP implementations
Conclusion

Similar requirements for DTNs in space and WSNs

- Demand of robust and reliable communication
- Use standards, wherever applicable

μDTN is RFC 5050 conform Bundle Protocol implementation

Use it!

- http://www.ibr.cs.tu-bs.de/projects/mudtn

Thanks for your attention!

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