On Practical Sender Diversity for Industrial Robust Low-Latency Wireless Communication

Topic

Wireless industrial networks have gained increasing interest in the research community over the last years. The focus currently shifts towards realizing critical control loops over wireless networks. Application scenarios can be found in the area of factory automation and robotics. Using wireless networks allows control processes to be more flexible and less costly in terms of maintenance as compared to wired networks. The associated requirements are novel as comparably small packets need to be exchanged with very *short latencies* and *high reliabilities*. Meeting such extreme requirements with wireless networks is challenging.

Diversity is a fundamental property of wireless networks. Recent years have witnessed the emergence of many distributed protocols like ExOR[1] and MORE[2] that exploit *receiver diversity* in 802.11-like networks. However, ongoing research shows that also *sender diversity* can be utilized, i.e. TDiCOR [3] and SourceSync [4].

Goal

A protocol for a low-latency & high reliability wireless network is EchoRing [4], a token-passing protocol that allows to bound latencies while achieving high reliability. The task is to further optimize the EchoRing protocol with respect to latency & reliability by extending the protocol to exploit *sender diversity* on the last hop from relay nodes to the destination, i.e. relays transmit signals simultaneously to achieve spatial diversity at destination node. The nodes participating in the simultaneous transmission need to be carefully selected. Thus, in this thesis, the candidate first has to clarify the principle performance improvement possible through sender diversity on the respective platform. The next step consists in devising and realizing protocol schemes that integrate sender diversity into EchoRing. Finally, various candidate selection algorithms need to be developed and evaluated in a network simulator (ns-3).
The thesis can be based on previous work regarding sender diversity and the corresponding protocol extensions. Also, the thesis needs to be carried out in collaboration with the Berlin-based start-up R3 Communications GmbH. In particular, the implementation steps will be carried on their platform.

Requirements

- Knowledge of the Linux operating system and experience in C kernel programming,
- Experience in device driver low-level programming (EchoRing is implemented in Firmware of Atheros 802.11n chip),
- Good understanding how Wi-Fi (IEEE 802.11) works,

Contact

Dr. Zubow (TU Berlin, zubow@tkn.tu-berlin.de), Dr. Dombrowski (R3 Communications GmbH, christian.dombrowski@r3coms.com)

[1] Biswas, Sanjit, and Robert Morris. "ExOR: opportunistic multi-hop routing for wireless networks." *ACM SIGCOMM Computer Communication Review* 35.4 (2005): 133-144.
[2] Chachulski, Szymon, et al. *Trading structure for randomness in wireless opportunistic routing*. Vol. 37. No. 4. ACM, 2007.
[3] Kurth, Mathias, Anatolij Zubow, and J-P. Redlich. "Cooperative opportunistic routing using transmit diversity in wireless mesh networks." *INFOCOM 2008. The 27th Conference on Computer Communications. IEEE*. IEEE, 2008.
[4] Rahul, Hariharan, Haitham Hassanieh, and Dina Katabi. "SourceSync: a distributed wireless architecture for exploiting sender diversity." *ACM SIGCOMM Computer Communication Review*. Vol. 40. No. 4. ACM, 2010.
[5] Dombrowski, Christian, and James Gross. "EchoRing: a low-latency, reliable token-passing MAC protocol for wireless industrial networks." *European Wireless 2015; 21th European Wireless Conference; Proceedings of*. VDE, 2015.