



Università degli Studi di Catania



*Dottorato di ricerca in
Ingegneria dei Sistemi, Energetica, Informatica e delle
Telecomunicazioni – XXXII ciclo*

Dipartimento di Ingegneria Elettrica, Elettronica e Informatica

Low power wireless sensor networks for real-time applications in Industry 4.0

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Tutor: Prof. Lucia Lo Bello

A.Y. 2018/2019

Research objective

A new solution for Dynamic Control of Mobile Industrial Wireless Sensor Networks for real-time applications in Industry 4.0.



Problem Statement

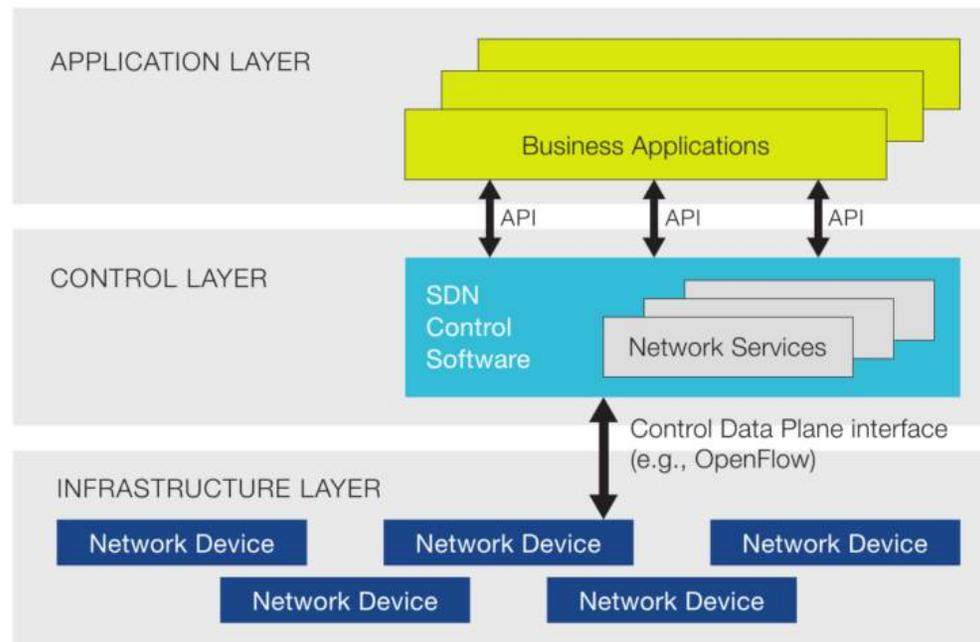
In Industrial Wireless Sensor Networks, alongside with reliability and real-time constraints, mobility support is becoming a compelling requirement.

Problem:
Existing standard protocols for Industrial Wireless Sensor Networks do not support mobility.



SDN Approach

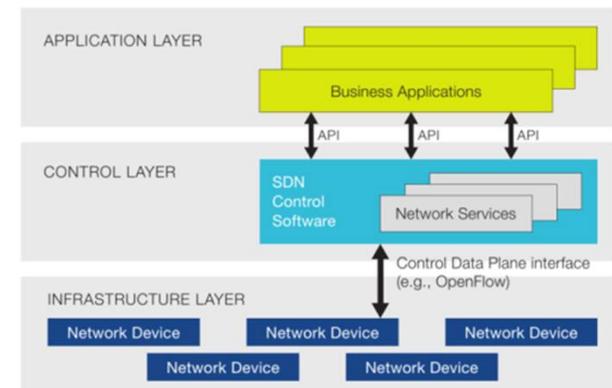
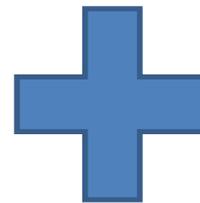
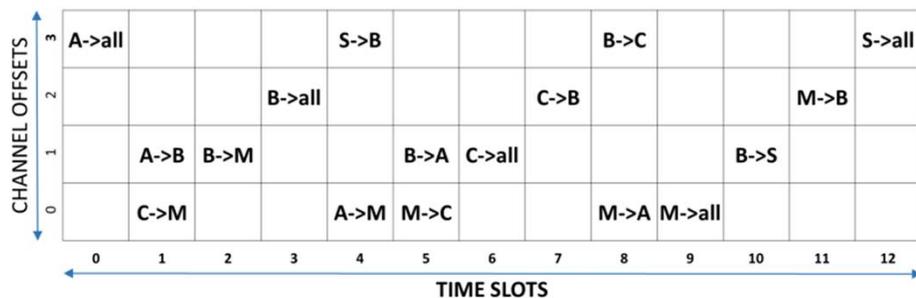
Software-Defined Networking (SDN) is considered a promising approach for reducing the complexity of network management in many contexts, including industrial automation networks.



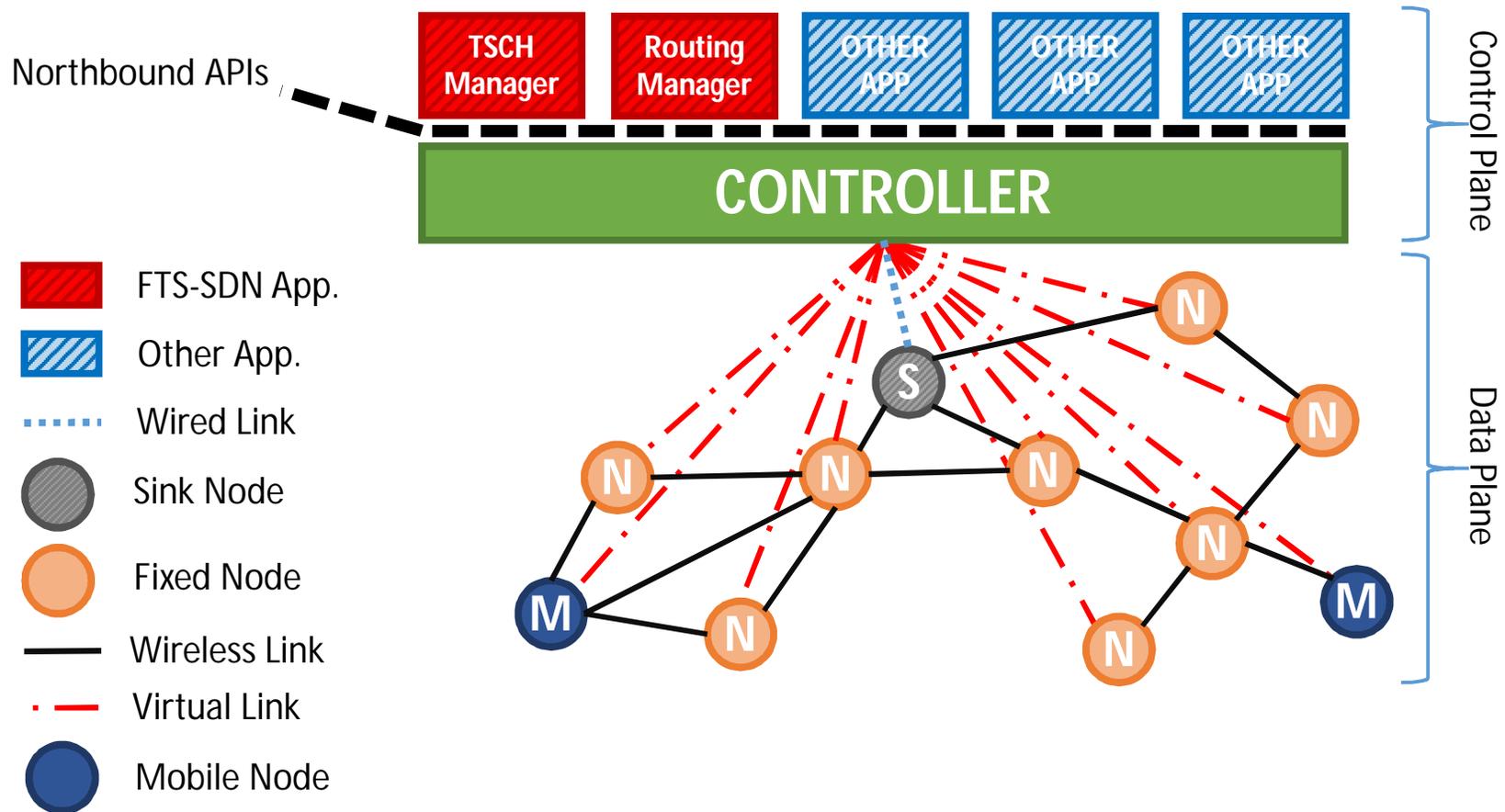
Proposed Solution

Forwarding and TSCH Scheduling over SDN (FTS-SDN)

- FTS-SDN combines the real-time support and reliability of TSCH with the SDN ability to promptly react to topology changes, thus supporting mobility.

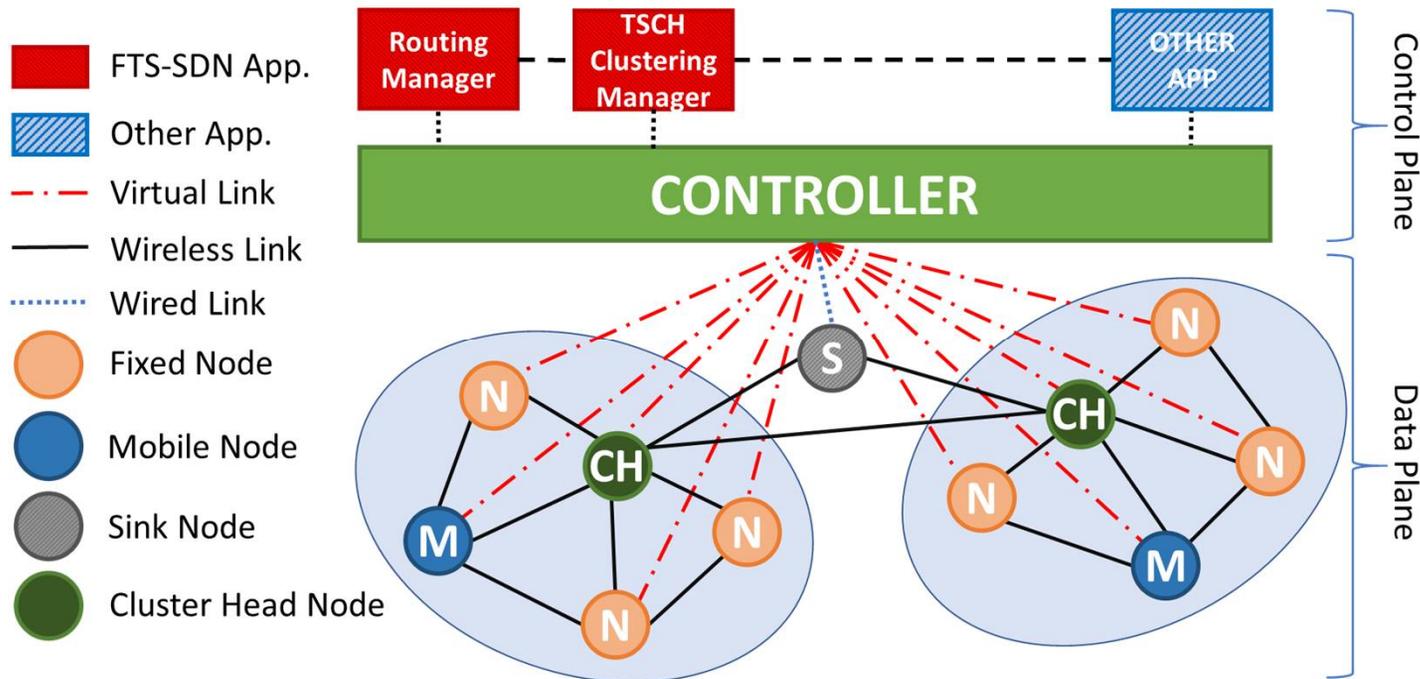
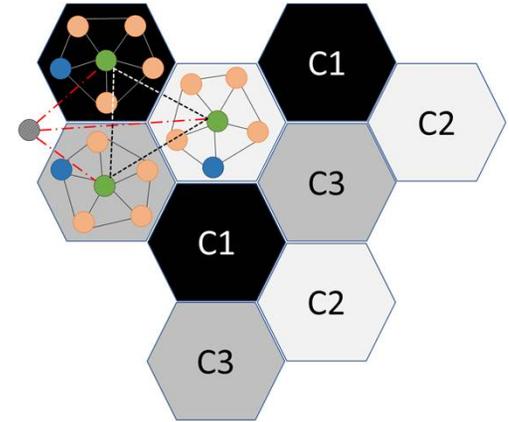
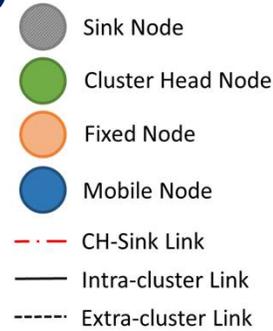


Proposed Architecture FTS-SDN

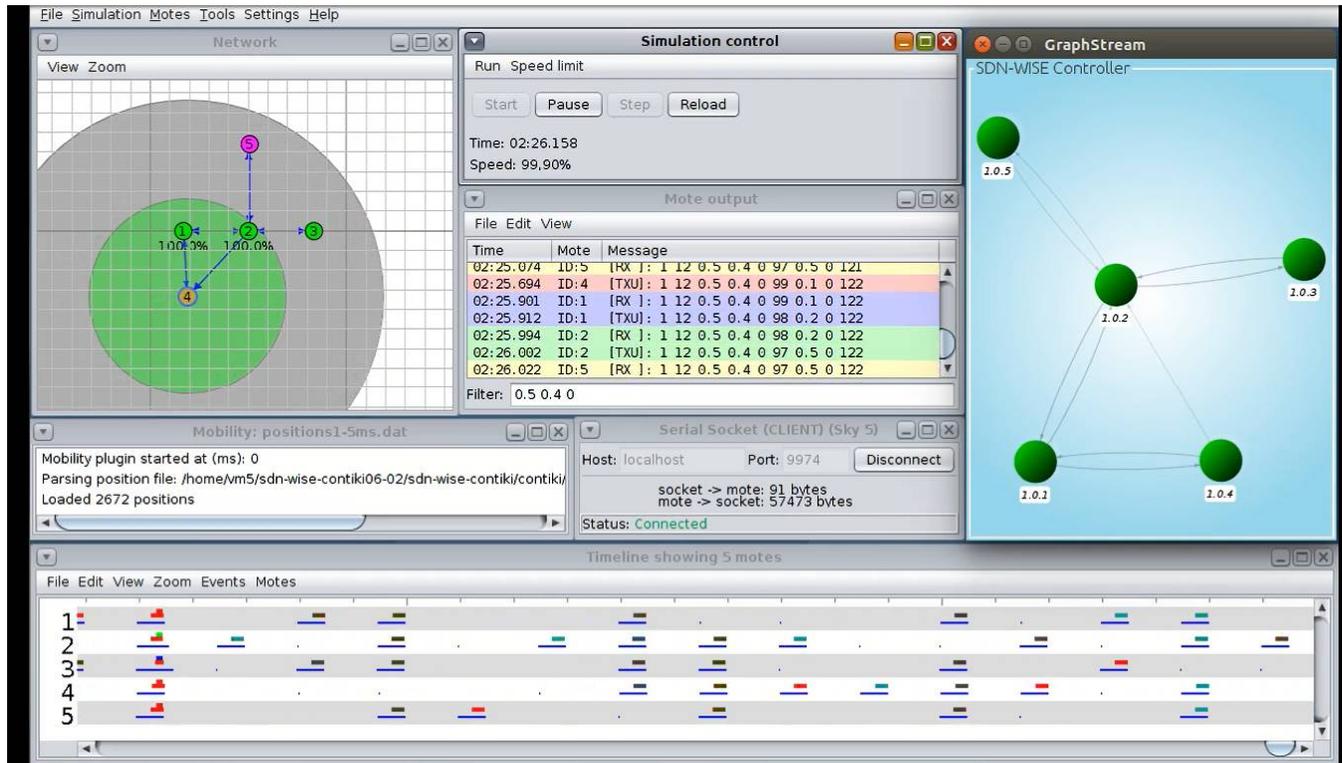


FTS-SDN: Clustering

Another step of this work involves the use of the SDN approach to manage dynamic TSCH scheduling and proposes a platform for the evaluation of strategies for dynamic clustering which can be applied to scalable mobile IWSN.

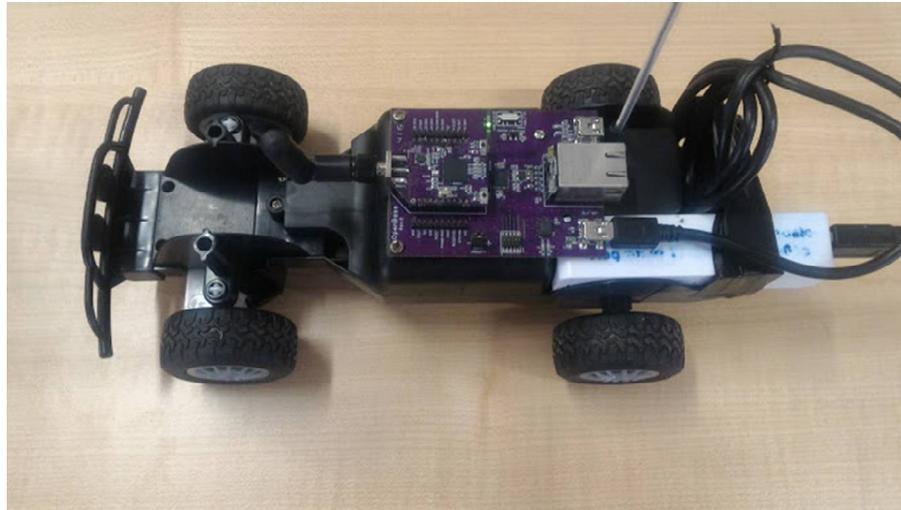


FTS-SDN: Simulation

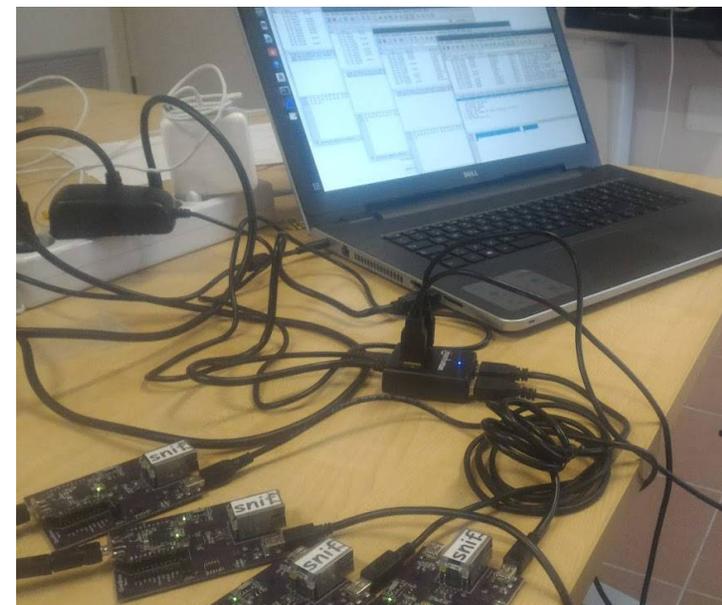
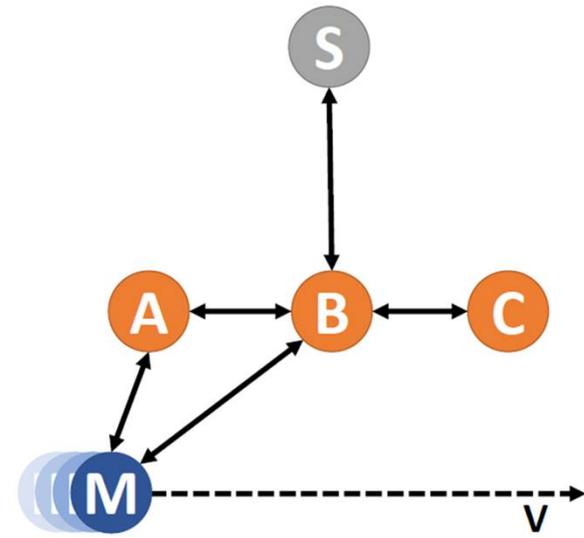


To test the feasibility and the performance of the FTS-SDN, we run an extensive simulation campaign in a virtual IWSN scenario, involving both fixed and mobile nodes, using Cooja and Contiki.

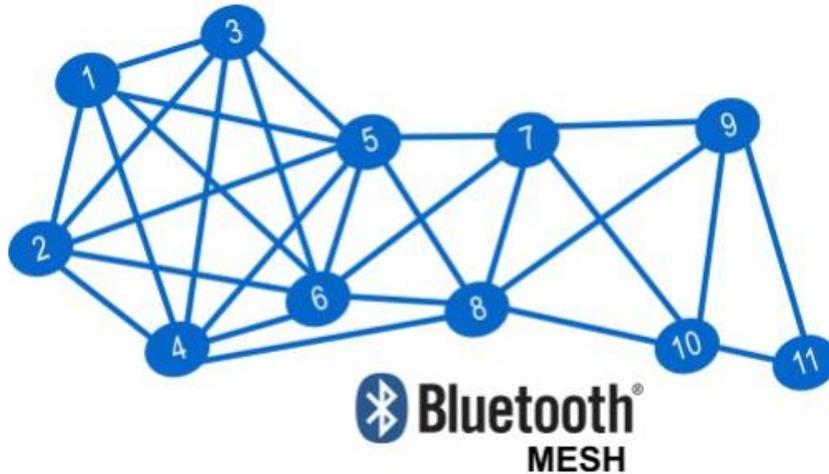
FTS-SDN: Testbed



Porting and testing of the FTS-SDN on the OpenMote Platform (Open-Source Prototyping Platform for the Industrial IoT).



Mittuniversitetet



Relay Selection in Bluetooth Mesh (BM) Networks:

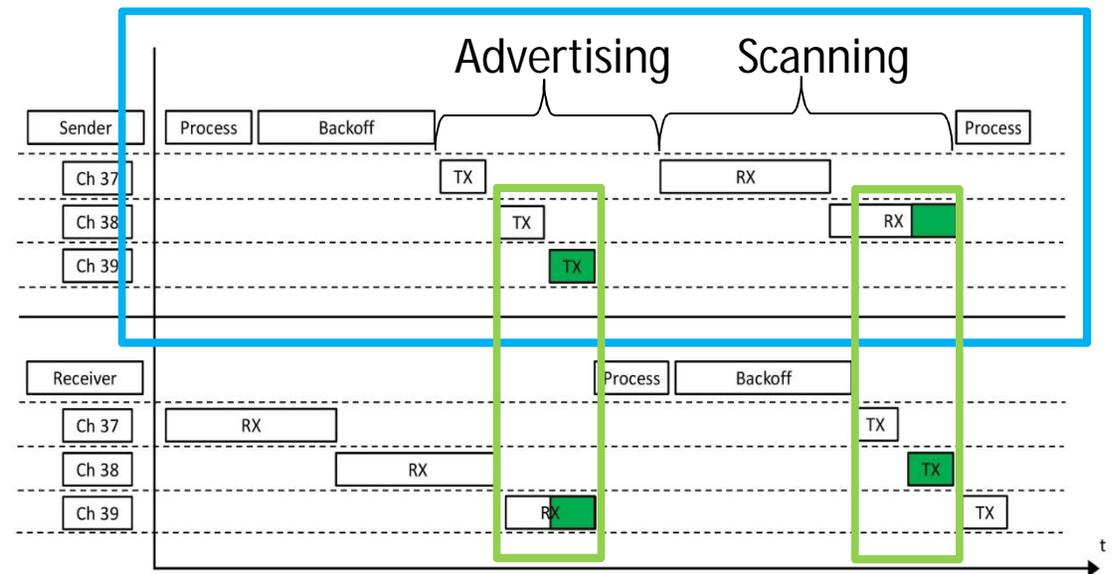
- I. The goal of the work at Mittuniversitetet is the evaluation of the performance of the BM networks using algorithms for the selection of relay nodes.
- II. Assigning the relay role only to a subset of the devices is an efficient way of reducing the amount of traffic due to duplicated packets.
- III. Assigning the relay role to nodes with a optimum distribution is therefore a non-trivial task in Mesh network management.

The BM managed flood technique

The BM uses a managed flood technique. It sends a message, called an advertisement, to the nodes that are within range. The receiving nodes rebroadcast, or relay, this message to other nodes within their range.

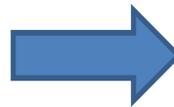
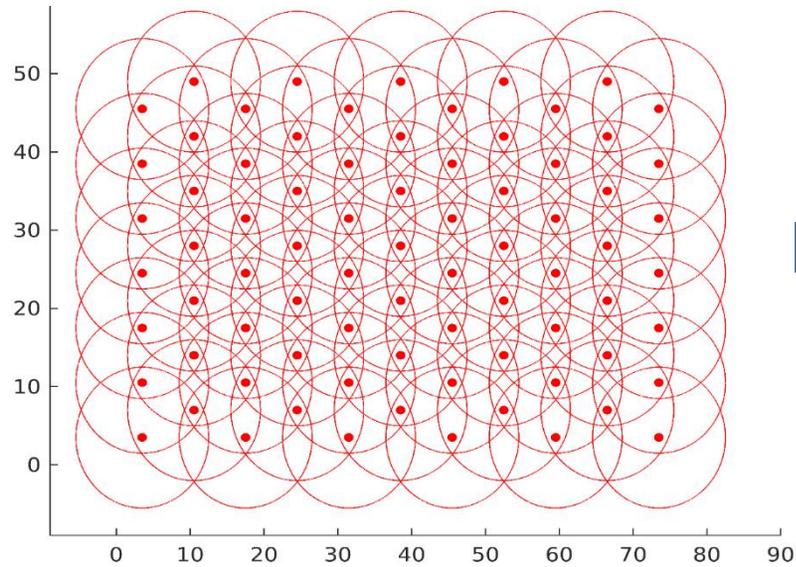
BM features:

- Relay nodes, resending received packets
- Advertising and scanning
- Limited by TTL
- Message cache

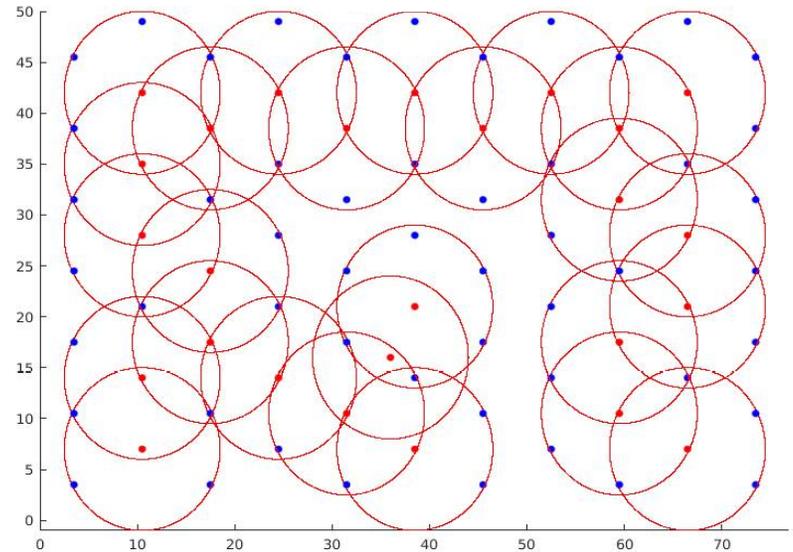


Relay Selection algorithms in BM Networks

All relay nodes



Relay selection example



AUTOMATION SERVICE SRL

Investigation about FTS-SDN
and BM in real contexts



International PhD Schools

- International School on Informatics and Dynamics in Complex Networks, Catania.
- 5G International PhD School, Roma.

Other activities

- Course on Routing and Switching, Connecting Networks at the Cisco Networking Academy

Achievements

- L. Lo Bello, A. Lombardo, S. Milardo, G. Patti, M. Reno. *“Software-Defined Networking for Dynamic Control of Mobile Industrial Wireless Sensor Networks”*, in Proc. of the 23rd IEEE International Conference on Emerging Technologies and Factory Automation (ETFA), Turin, 4-7 Sept. 2018. - Paper presentation at the IEEE conference ETFA 2018.
- L. Lo Bello, A. Lombardo, G. Patti, M. Reno. *“A platform for evaluating clustering strategies in mobile IEEE 802.15.4-TSCH networks”*, in Proc. of the 24rd IEEE International Conference on Emerging Technologies and Factory Automation (ETFA), Zaragoza, Spain, 10-13 Sept. 2019.
- L. Lo Bello, A. Lombardo, S. Milardo, G. Patti, M. Reno. *“ Experimental Assessments and Analysis of an SDN Framework to Integrate Mobile Nodes Management in Industrial Wireless Sensor Networks”* (submitted to an international peer-reviewed journal)
- Member of the organizing committee of the *“European Wireless 2018”* (EW) conference, Catania, 2018.