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► **To cite this version:**

Ye-Qiong Song. Network interoperability and QoS for smart homes. International Workshop on Health & Well Being in conjunction with ICVS 2011, Sep 2011, Sophia Antipolis, France. 2011. hal-00647367

HAL Id: hal-00647367

<https://inria.hal.science/hal-00647367>

Submitted on 1 Dec 2011

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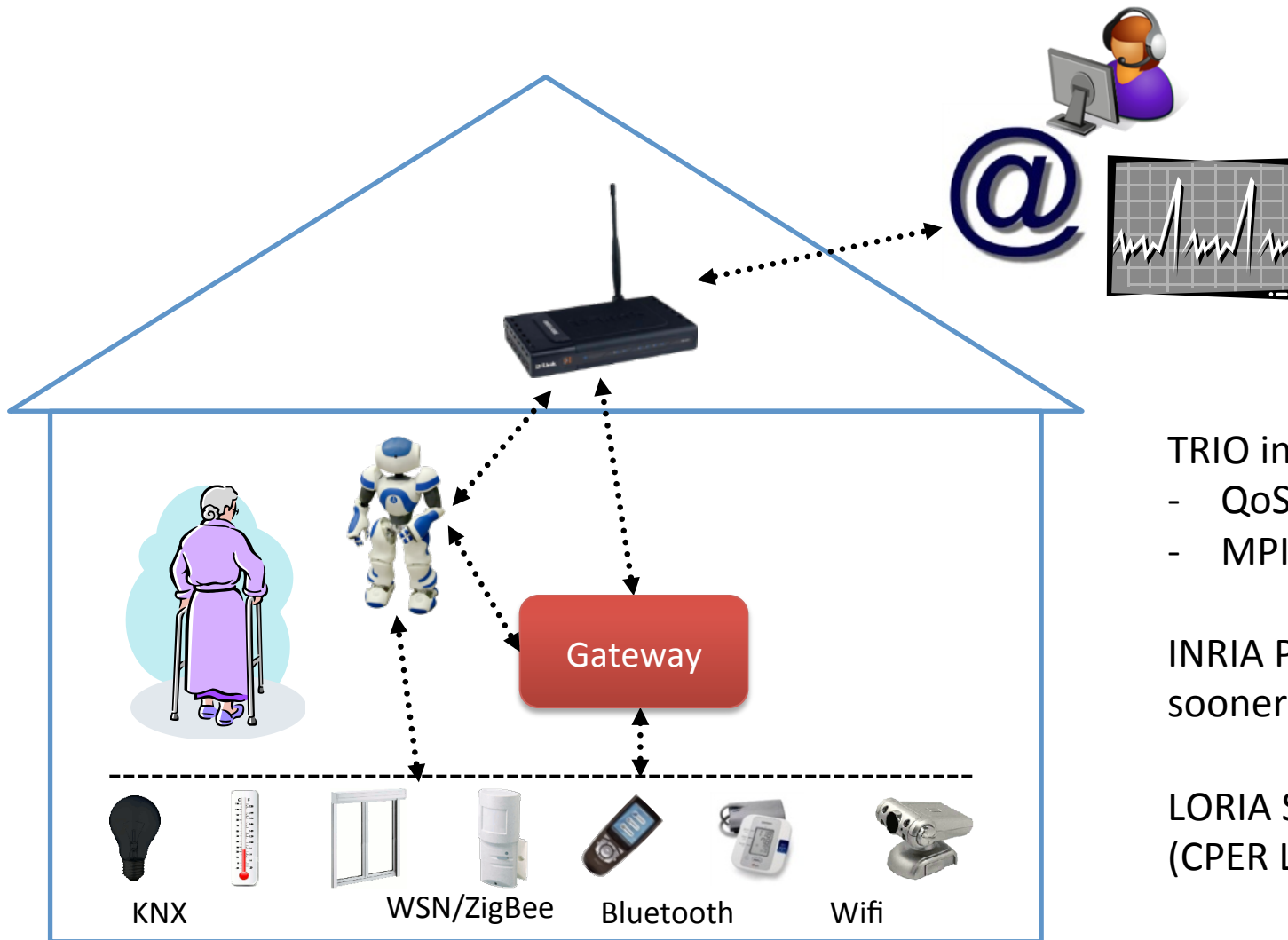
Network interoperability and QoS for smart homes

By:

Ye-Qiong SONG

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Context: Smart home for elderly



TRIO internal projects:

- QoS for WSN
- MPIGate

INRIA PAL project and
sooner ADT PERCEE

LORIA Smart home project
(CPER Lorraine)

LORIA smart apartment for concept and technology validation

The screenshot displays a software application window titled "Main Form". The interface is divided into several sections:

- 3D Model:** A 3D perspective view of an apartment floor plan. The layout includes a living area with a sofa and coffee table, a dining area with a table and chairs, a kitchen, a bathroom with a toilet and sink, and a bedroom with a bed. A green icon is visible in the top-left corner of the model area.
- Top Right Panel:** A date and time display showing "19/12/2010 14:31:32". Below it is a table with the following data:

LocationId	SensorId	NetworkId	SensorX	SensorY
1	1	101	77	62
2	2	201	115	155
3	3	123	57	156
4	1	455	1	-1
*				
- Control Panel:** A set of input fields for configuring a sensor:
 - Location Id:
 - Sensor Id:
 - Network Id:
 - Sensor X:
 - Sensor Y:
 - Id:
 - Time:
 - Sensor Net Id:
 - Value:
- Data Table:** A table showing sensor data over time:

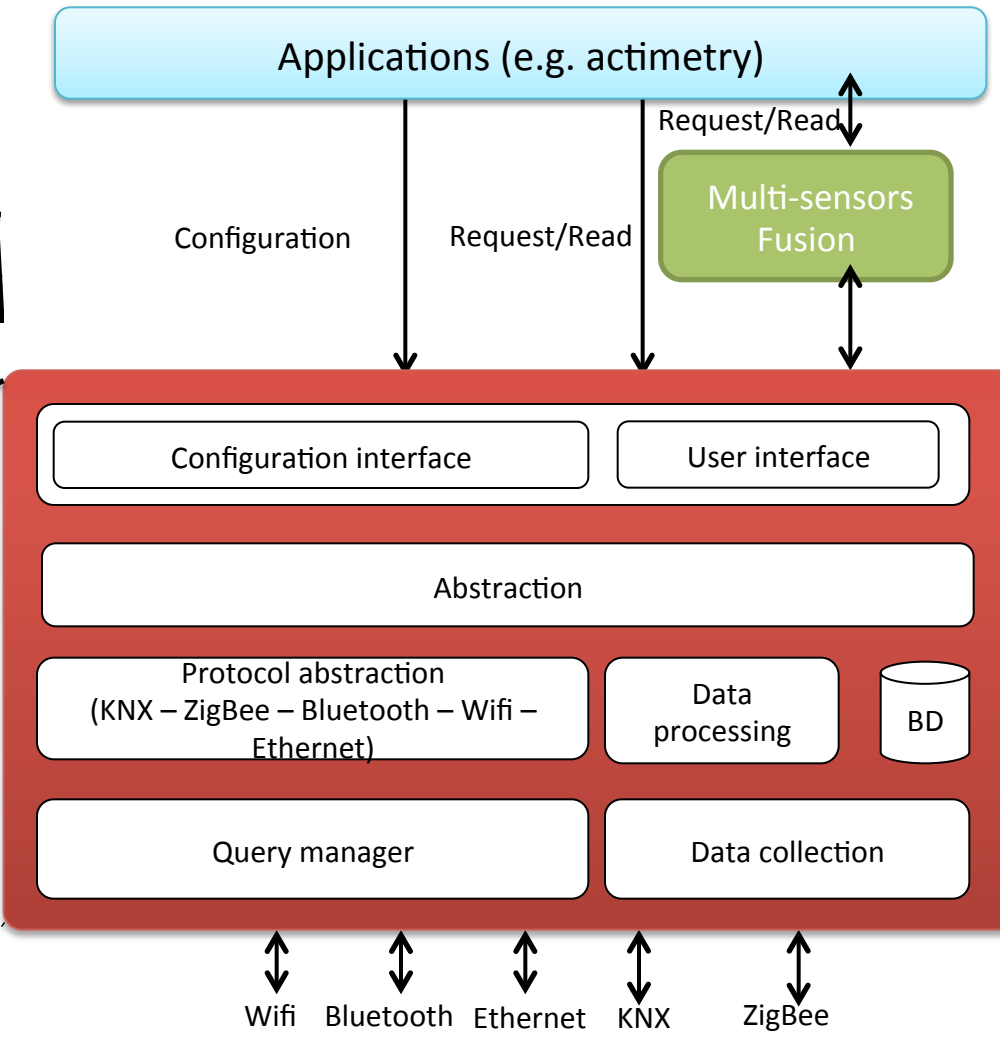
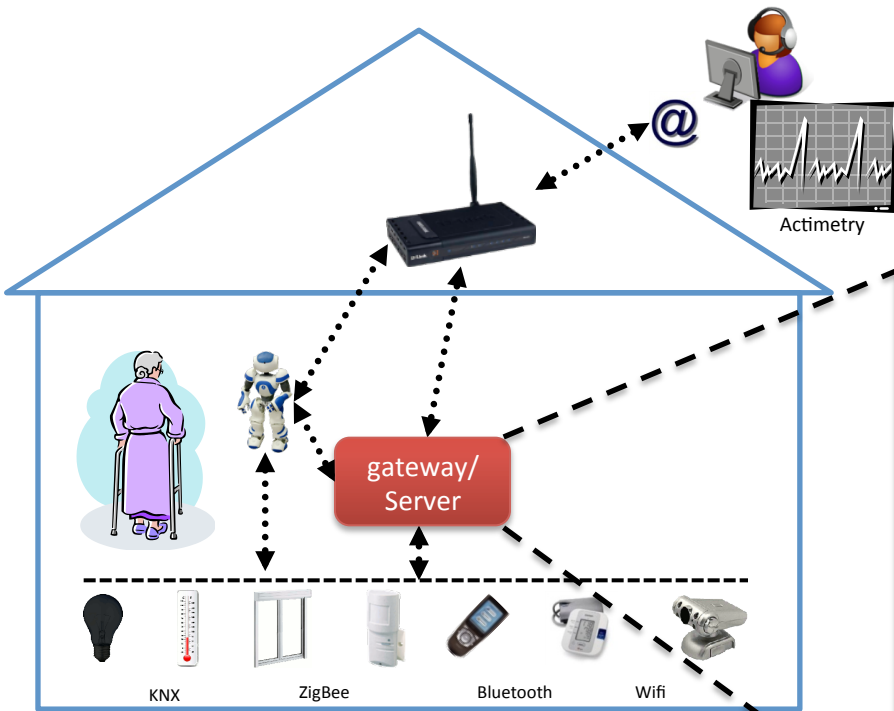
Id	Time	SensorNetId	Value
1669	06/12/2010 10:06	101	1214
1670	06/12/2010 10:06	201	0
1671	06/12/2010 10:06	101	791
1672	06/12/2010 10:06	201	0
1673	06/12/2010 10:06	201	0
1674	06/12/2010 10:06	101	801
1675	06/12/2010 10:06	201	0
1676	06/12/2010 10:06	101	811
1677	06/12/2010 10:06	201	0
- Bottom Panel:** A status bar with the following information:
 - Time:
 - Location:
 - Value:
 - Buttons:

Main R&D topics and our approaches

- Interoperability of heterogeneous communication protocols
 - A communication **gateway**
- Easy data access
 - A middleware-based **interface** over gateway
- QoS support (in both WSN and the whole heterogeneous network)
 - **QoS** mechanisms in WSN (IEEE802.15.4/Zigbee)
 - QoS management at the gateway/middleware

MPIGate:

Multi **P**rotocol **I**nterface and **G**ateway
for Tele-homecare, Environment Monitoring and Control



MPIGate - Components

- **Configuration manager:** is an interface to configure different parameters of the system. By using this interface one can provide and modify necessary information to process the data in “Data processing layer”.
- **User interface:** provide a graphical user interface for the user to visualize the state of each sensor and actuator, their historical information and the reports generated by the system.
- **Abstraction:** this layer hides the heterogeneity of the system for the users, by providing communication facilities between the interface layer and the other parts of system. The user doesn't need any prior knowledge of the protocols behind the system.

MPIGate - Components

- **Data processing:** this layer is the main part of the system. It process the information collected from the network and save the results in the data base.
- **Query manager:** receives the query from user interface, create the query and sends them to the network. The query might be a command to control an actuator or a request to read a sensor data.
- **Protocol abstraction:** provides necessary information about each communication protocol used in the network.
- **Data collection:** collects the data from the network and send them to the data processing layer.

QoS requirements

- QoS at gateway
 - Service differentiation
 - For time-constrained data exchanges (e.g. sensor-network-robot loops, home automation control, alarms, ...)
 - E2E delay specification and verification
 - Time consistency for multi-sensor data
- QoS at WSN
 - Reliability and E2E delay under stringent power constraint

QoS in WSN

- QoS-aware MAC protocols for low power WSN
- Multi-hop WSN for increasing transmission reliability (even for in door applications)
- QoS-aware and energy-aware routing protocols

Example of CoSens over IEEE802.15.4,
an auto-adaptive QoS mechanism
(PhD work of B. Nefzi, LORIA – INPL)

CoSens principle

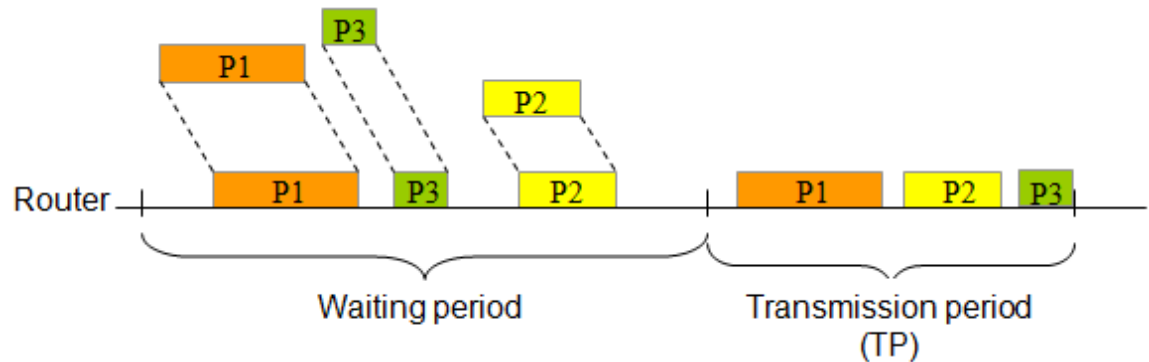
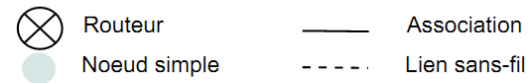
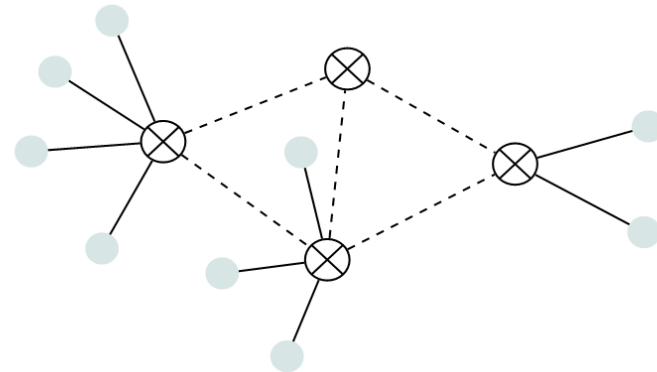
- CSMA/CA is a widely spread MAC protocol (used in IEEE802.11x and 15.4)
- Bad performance under heavy load
- CoSens (Collect and Send Burst) scheme
 - improves the performance of CSMA/CA
 - resolves the problem of scheduling difficulty

CoSens Principle

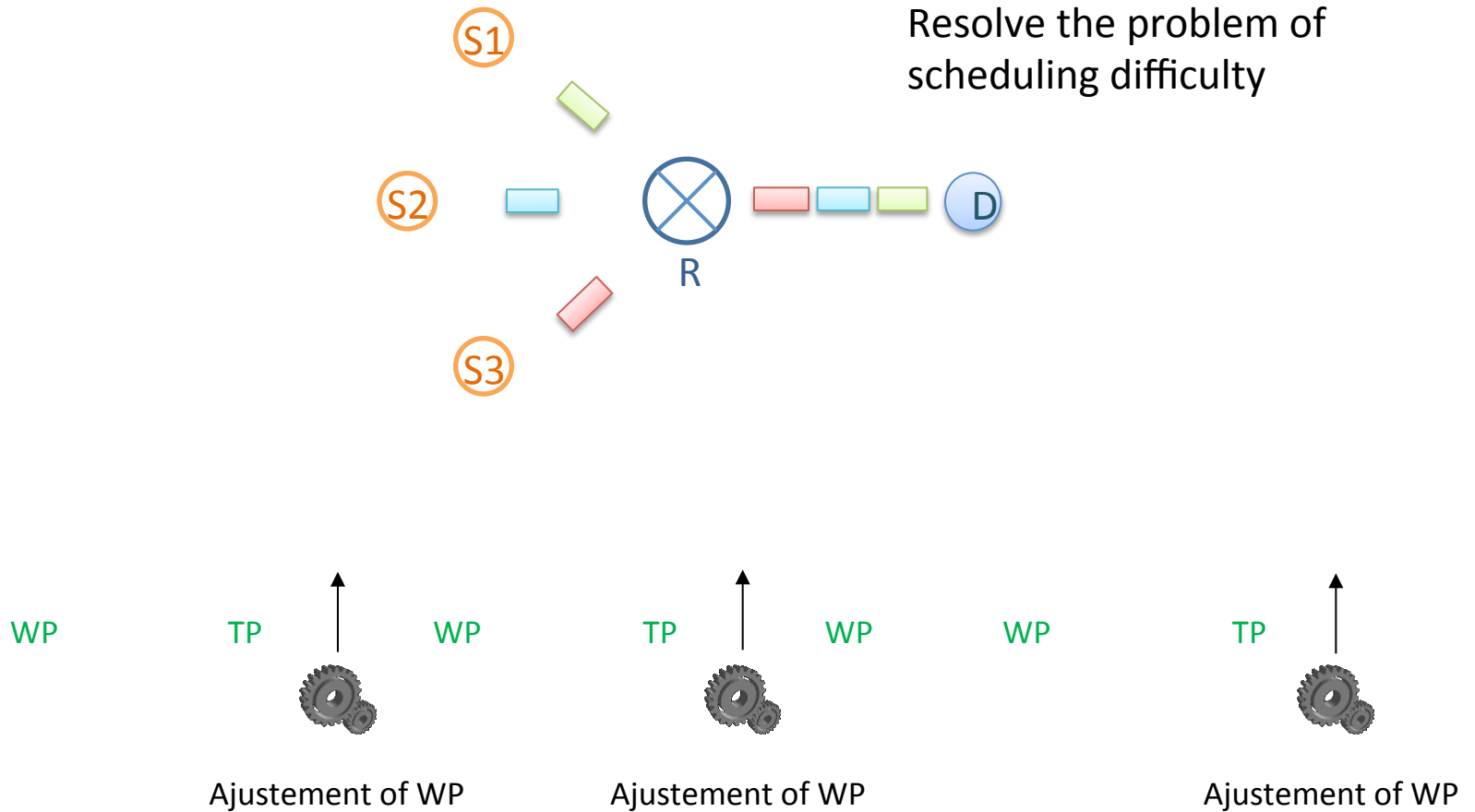
Architecture 2-tiers:
simple nodes and
routers

Router working cycle:
WP + TP

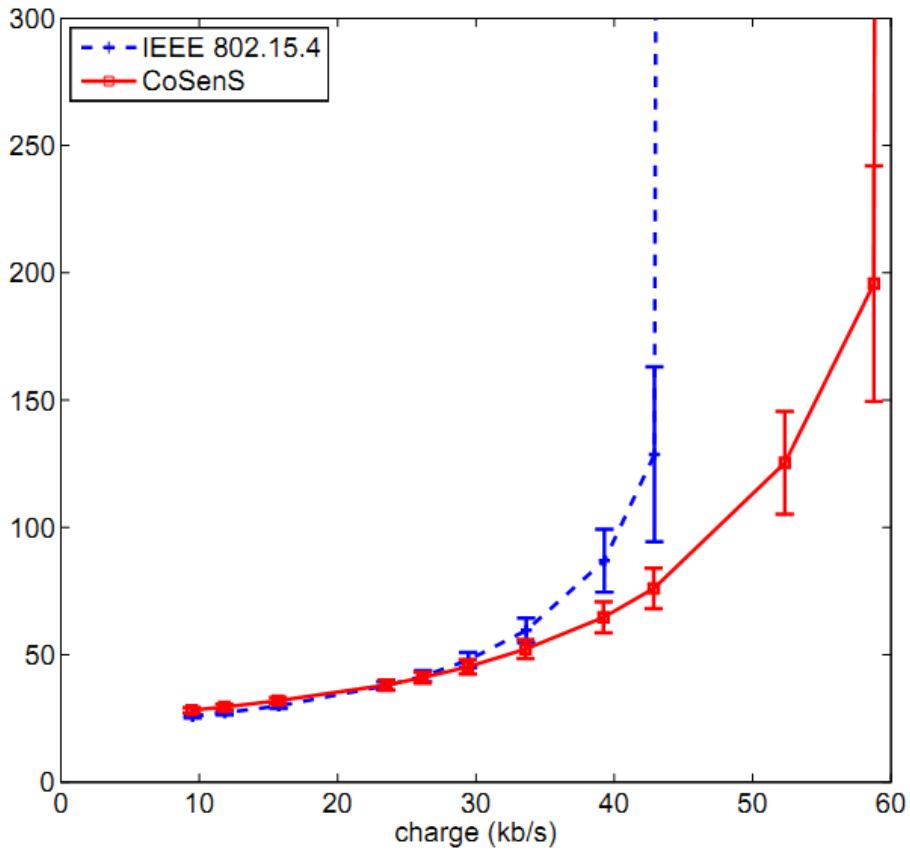
Dynamic WP adjusting
according to the on-
line traffic estimation
algorithm (sliding
exponential average)



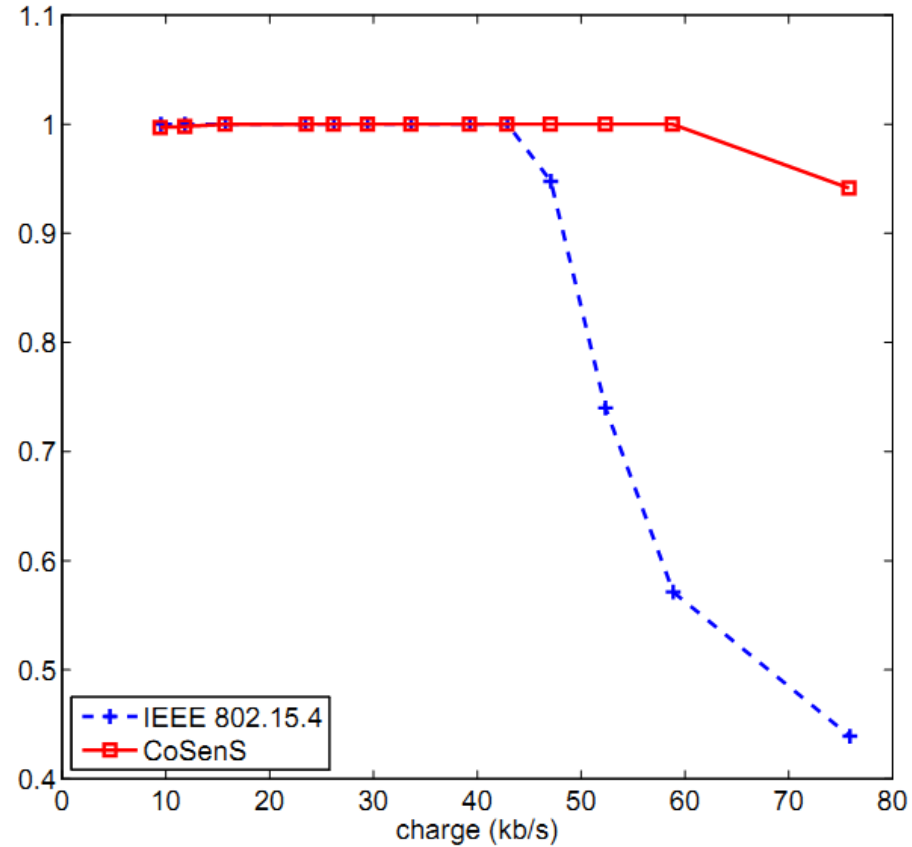
CoSens principle



Cosens performance



E2E delay vs. load



Tx success rate

Concluding remarks

- WSN represents a promising technology for smart homes but reliability and QoS remain to be enforced.
- Still very limited IEEE802.15.4/Zigbee devices
- Several wireless protocols co-exist for still long time
→ need of gateway solutions
- From AAL application point of view, it lacks an open development platform (see UniversAAL efforts)
- WSN tightly interacting with mobile robots calls for further research efforts

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- LORIA smart apartment: <http://infositu.loria.fr>
- UniversAAL <http://universaal.org/>

Thank you for your attention!