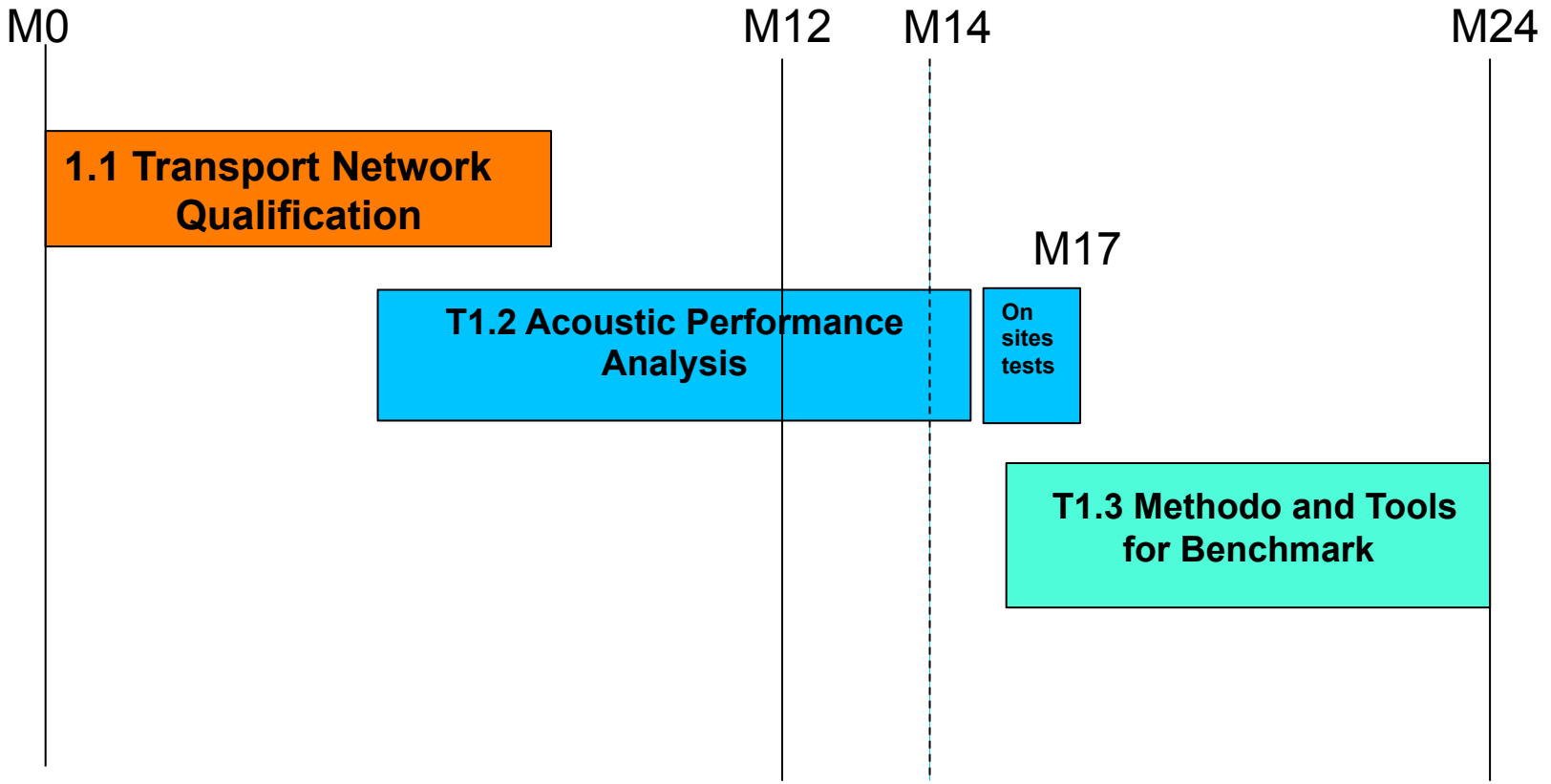
WP1 Test bed qualification for acoustic

Qualify and Benchmark Test-beds for Acoustics in Deployment of Targeted Applications

C. Pham and P. Cousin

Brussels, 4th, December 2013.

WP1 tasks


M0
M12
M14
M24
1.1 Transport Network Qualification
M17
T1.2 Acoustic Performance Analysis
On sites tests
T1.3 Methodo and Tools for Benchmark


EAR-IT
the sounds of smart environment
T1.1 Transport network
Qualification
UNINOVA
Instituto de Desenvolvimento de Novas Tecnologias
Fraunhofer
IDMT
UC
UNIVERSIDAD DE CANTABRIA
MANDAT
INTERNATIONAL
CDT
SmartSensingStars

SmartSantander IoT node

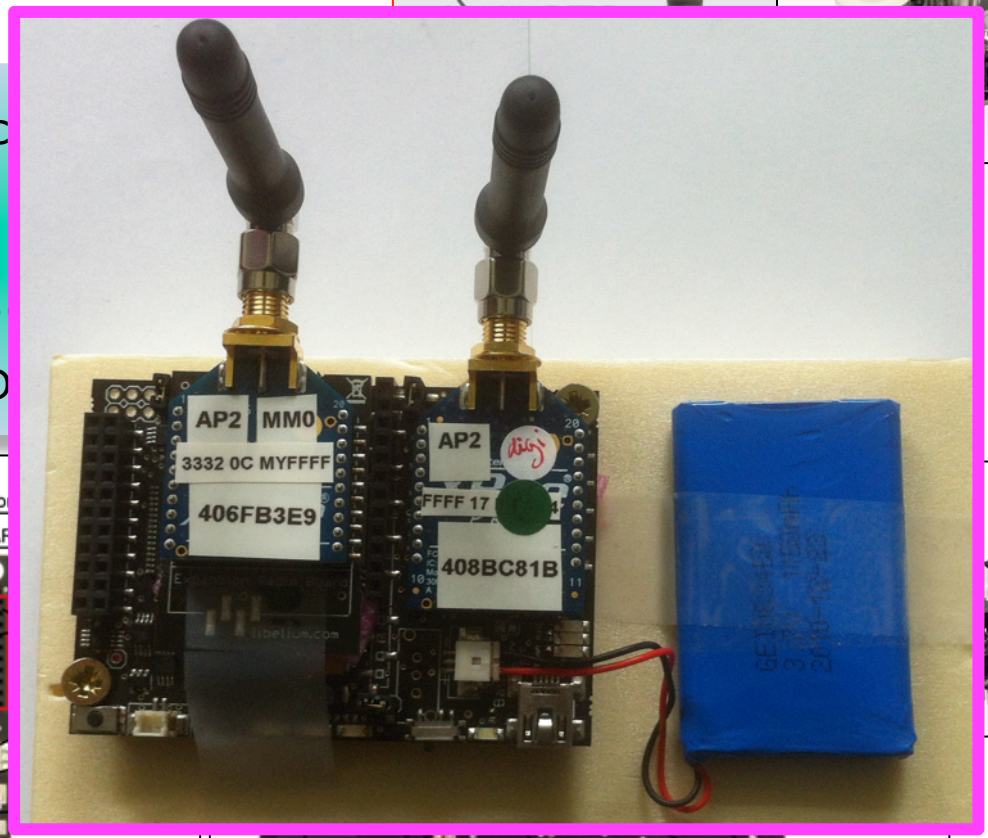
libelium
comunicaciones inalámbricas distribuidas

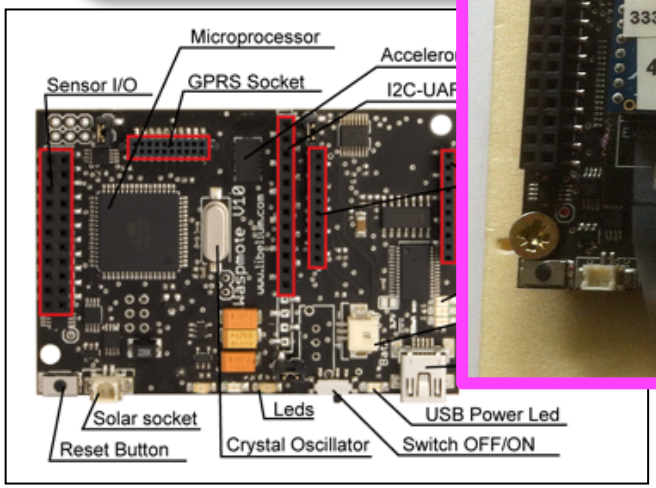
ATmega1281 mic

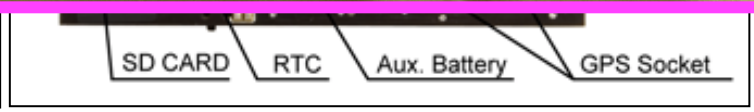
8Mhz, 4K RAM &

2.4GHz IEEE 802

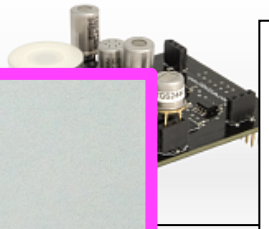
Arduino-based ID







Gases



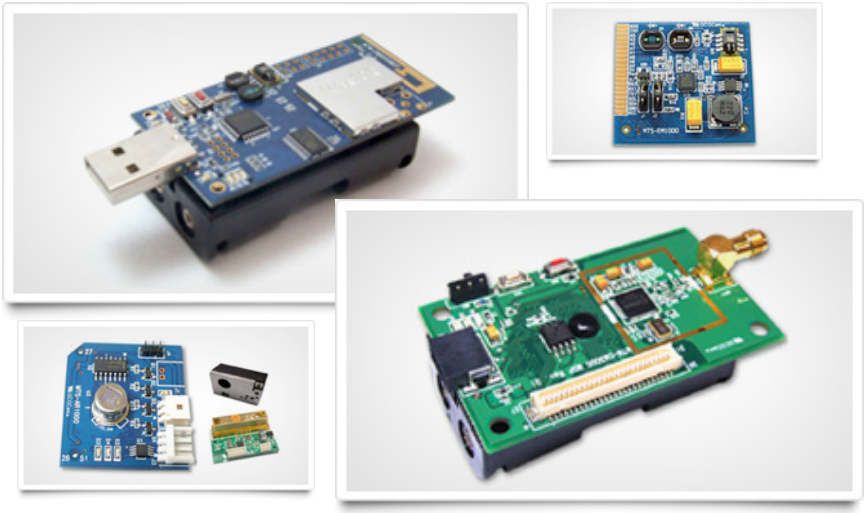
- Carbon Monoxide – CO
- Carbon Dioxide – CO2
- Oxygen – O2
- Methane – CH4
- Hydrogen – H2
- Ammonia – NH3
- Isobutane – C4H10
- Ethanol – CH3CH2OH
- Toluene – C6H5CH3
- Hydrogen Sulfide – H2S
- Nitrogen Dioxide – NO2
- Temperature
- Humidity

- Pressure/Weight
- Bend
- Vibration
- Impact
- Hall Effect
- Tilt
- Temperature (+/-)
- Liquid Presence
- Liquid Level
- Luminosity
- Presence (PIR)
- Stretch

the sounds of smart environments

IMAGES ARE FROM LIBELIUM COMPANY

HobNet test-bed at UNIGE

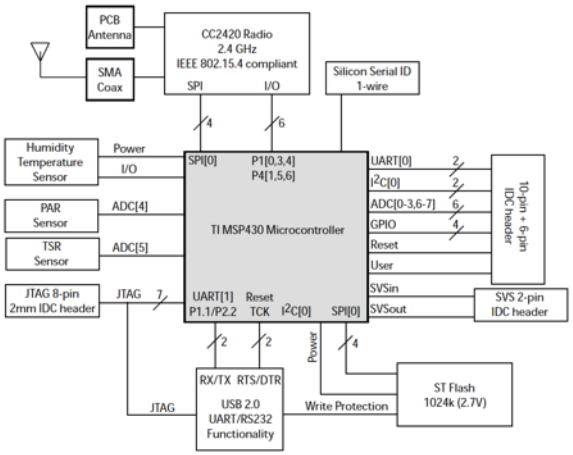


MSP430F1611 microcontroller

8Mhz, 48K flash, 10K RAM

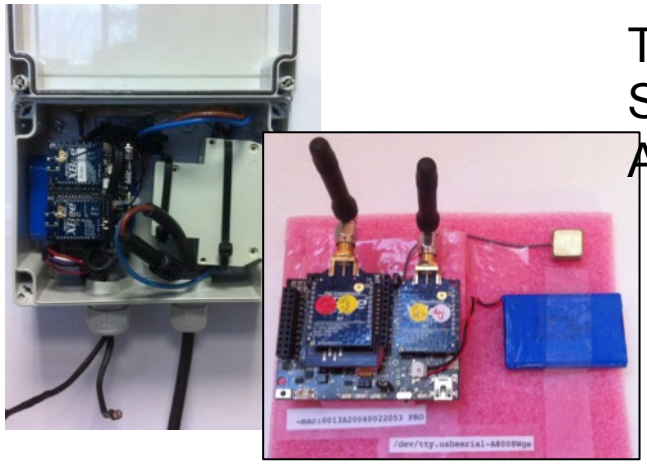
2.4GHz IEEE 802.15.4 CC2420

Programmed under TinyOS

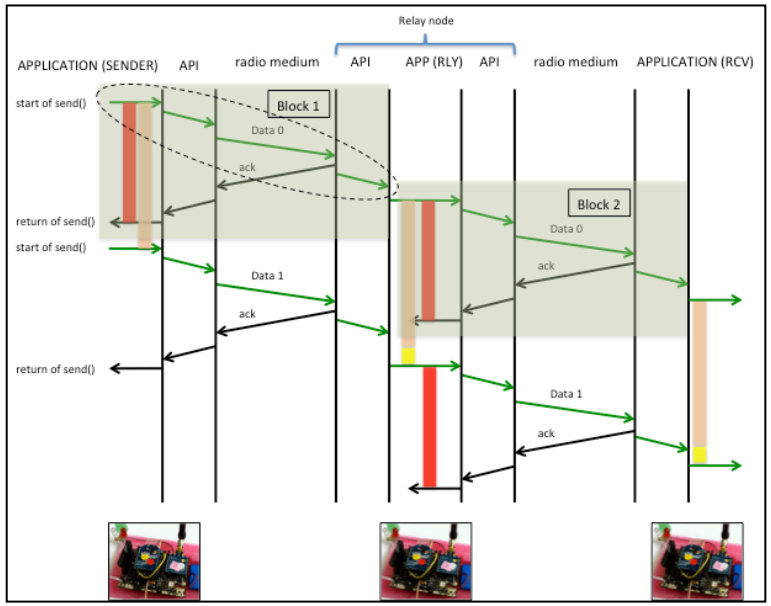


Qualification phase 1

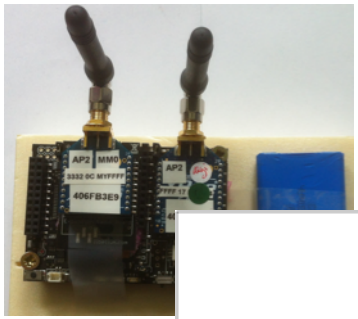
- Phase 1
  - Determine upper bounds on performances of a single IoT node
  - Determine upper bounds on performances of multi-hop transmissions



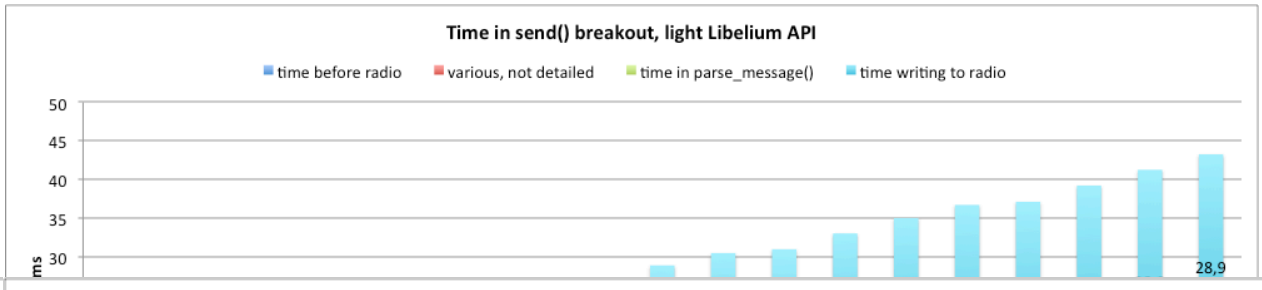
Traffic Generators
Sniffers
Advanced timing

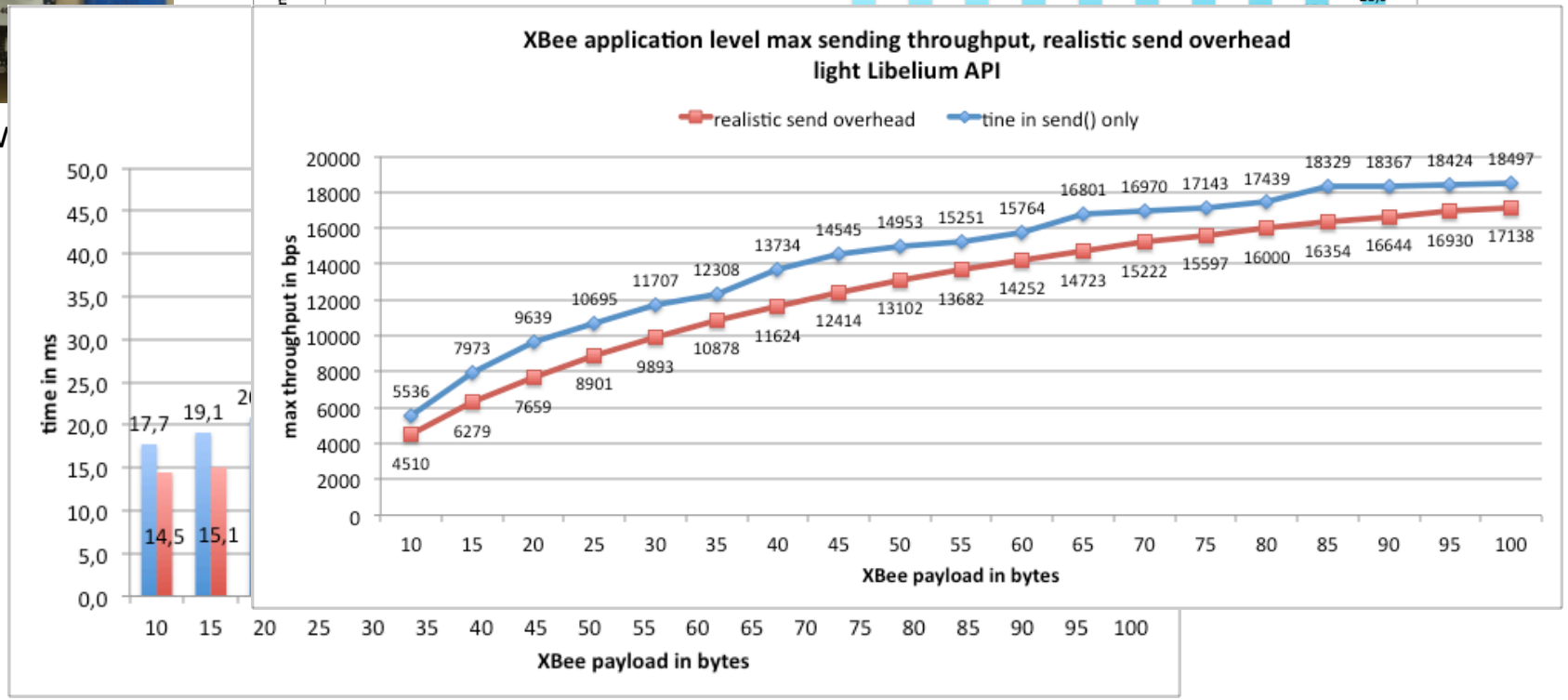


IoT node WaspMote (1)

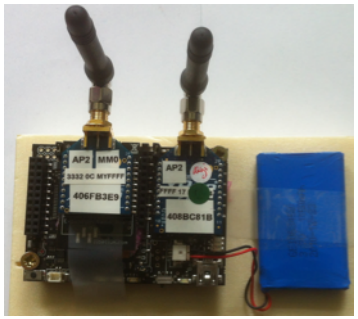


LIBELIUM V

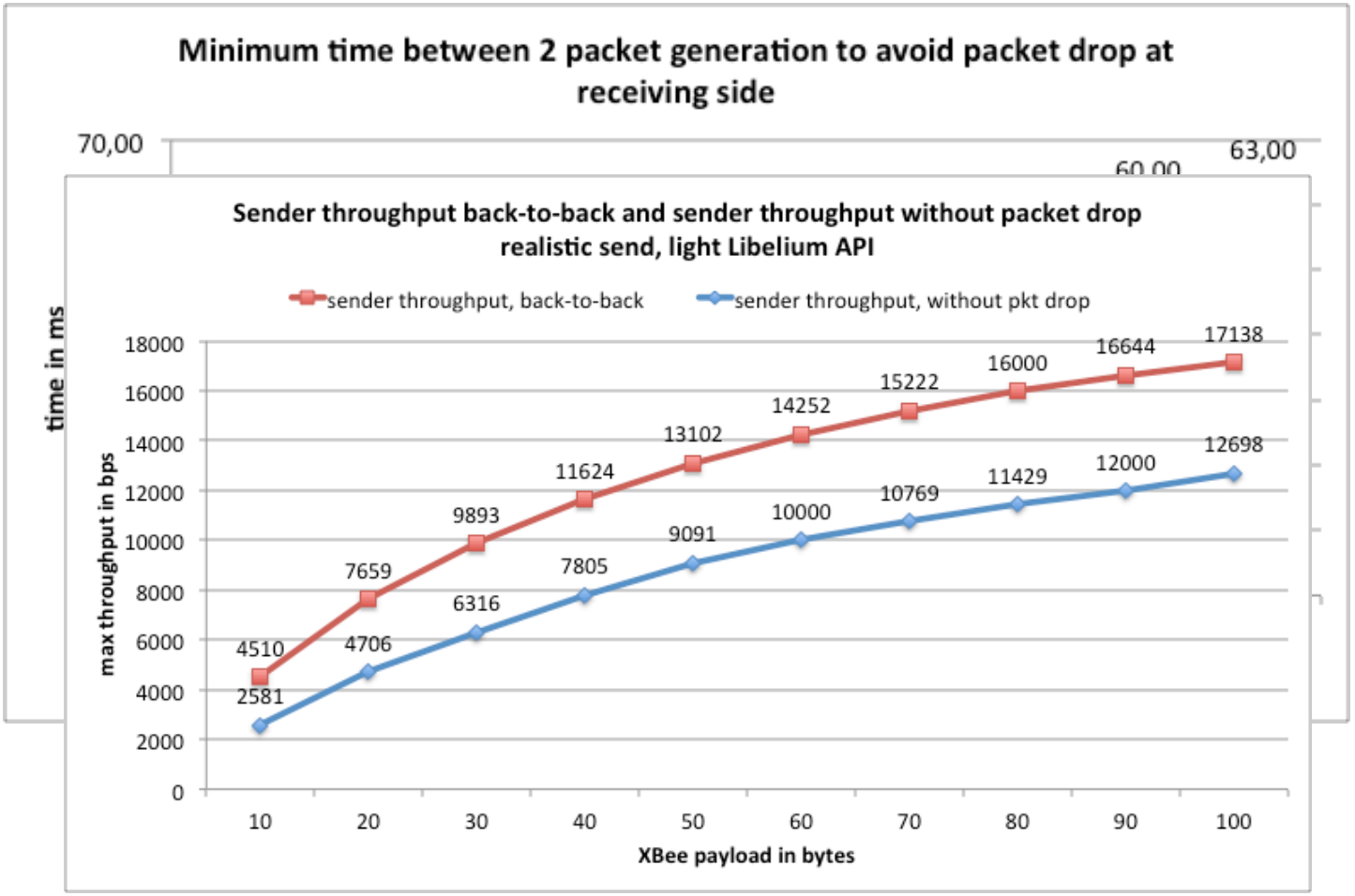




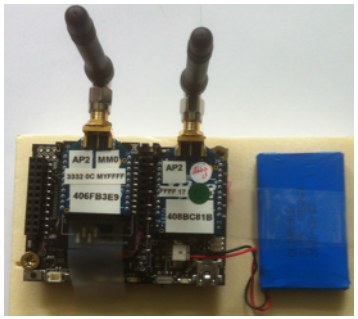
IoT node WaspMote (2)



LIBELIUM WASPMOTE

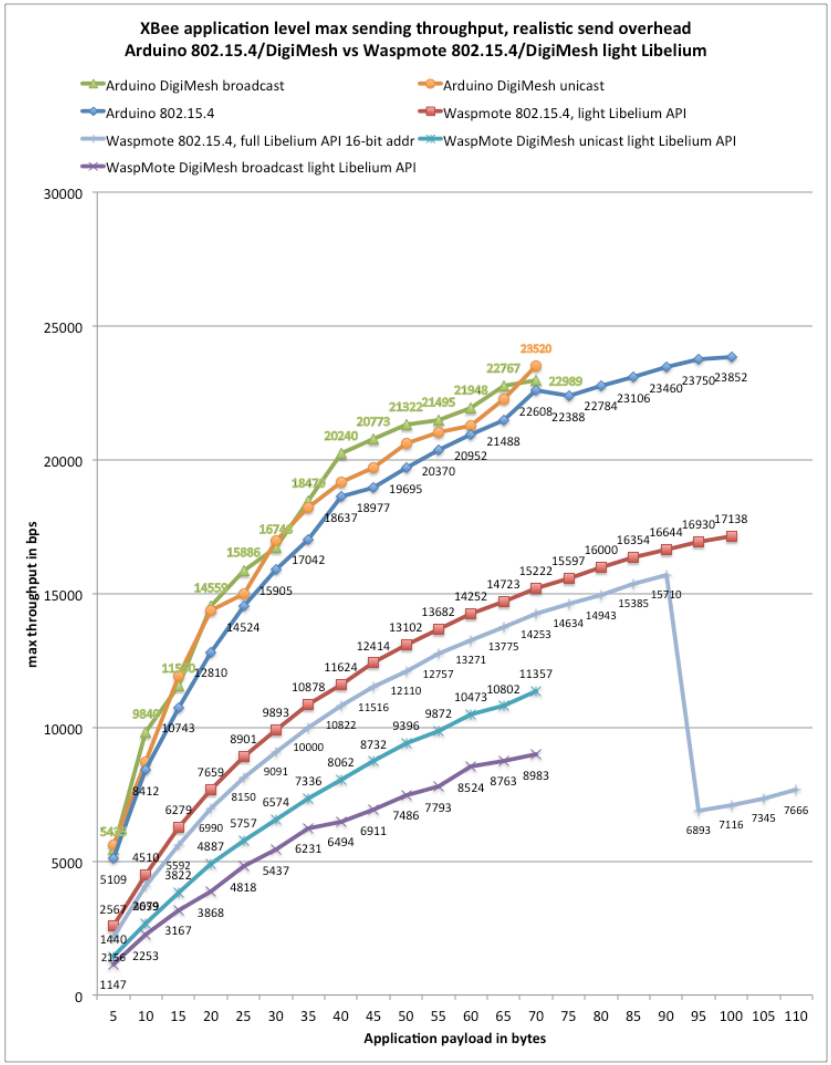


Technology comparison



LIBELIUM WASPMOTE

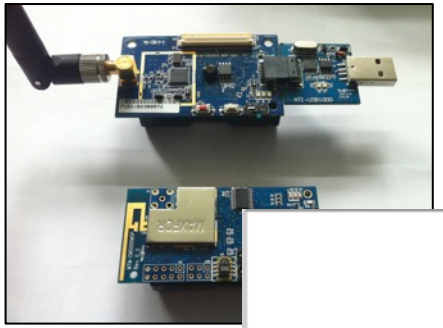
ARDUINO MEGA2560



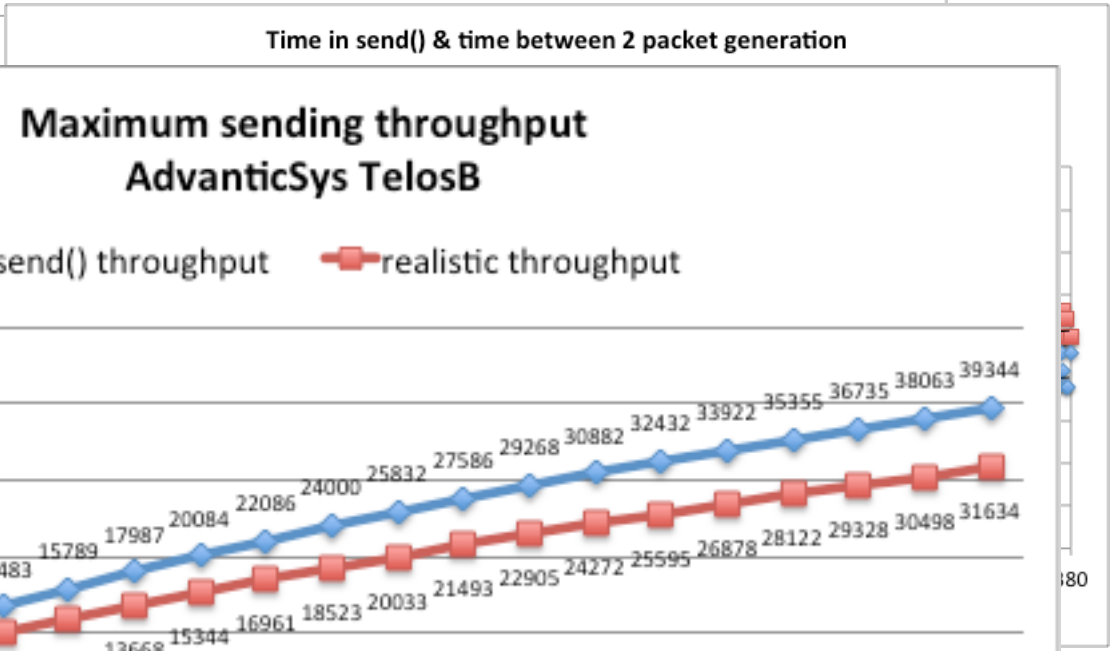
XBEE 802.15.4

XBEE DIGIMESH

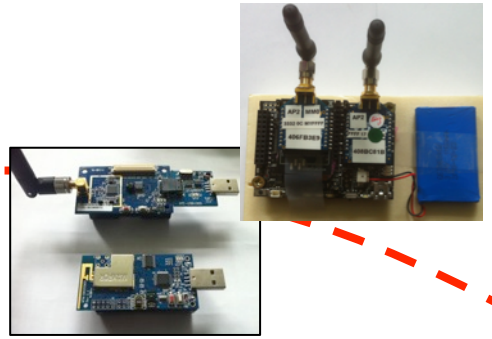
IoT node AdvanticSys



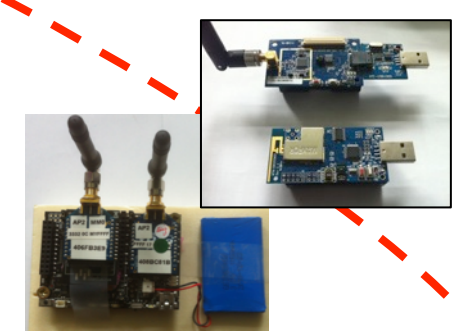
ADVANTICSY
CM5000, CI



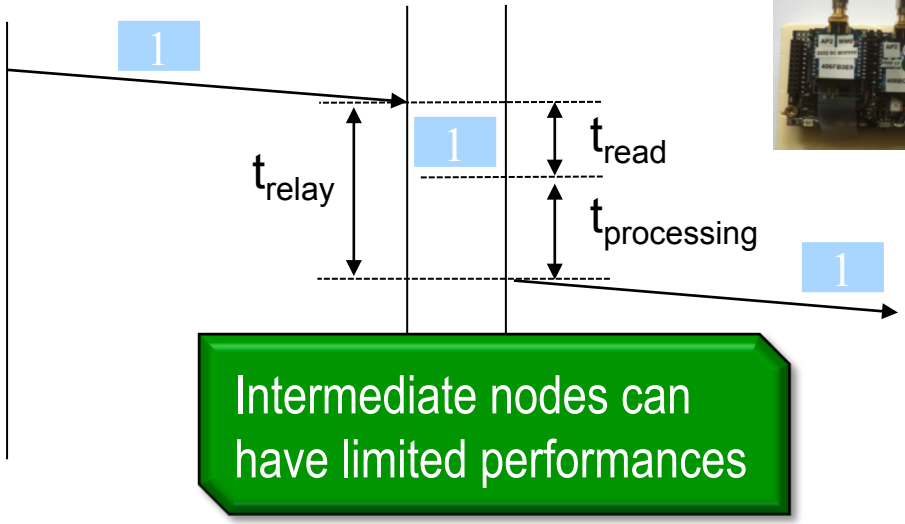
Multi-hop audio constraints



RELAY

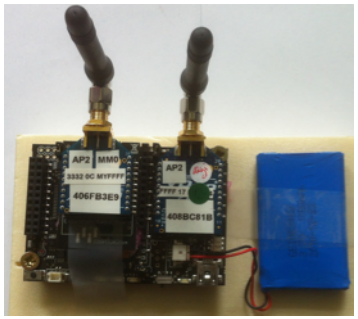


RELAY

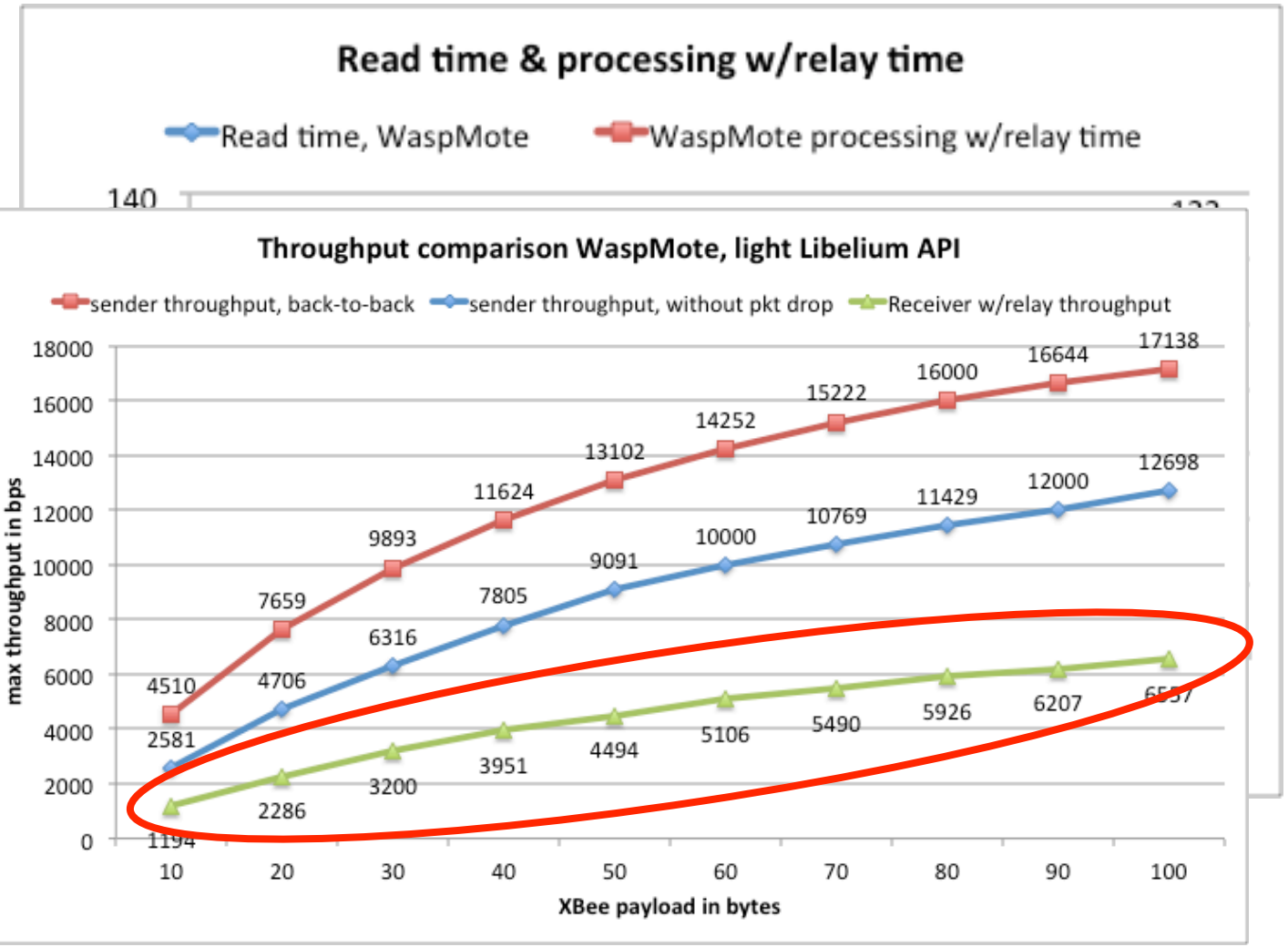


Intermediate nodes can have limited performances

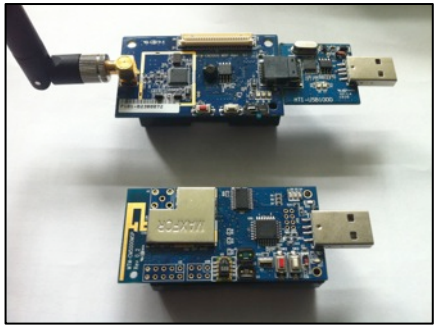
WaspMote multi-hop overheads



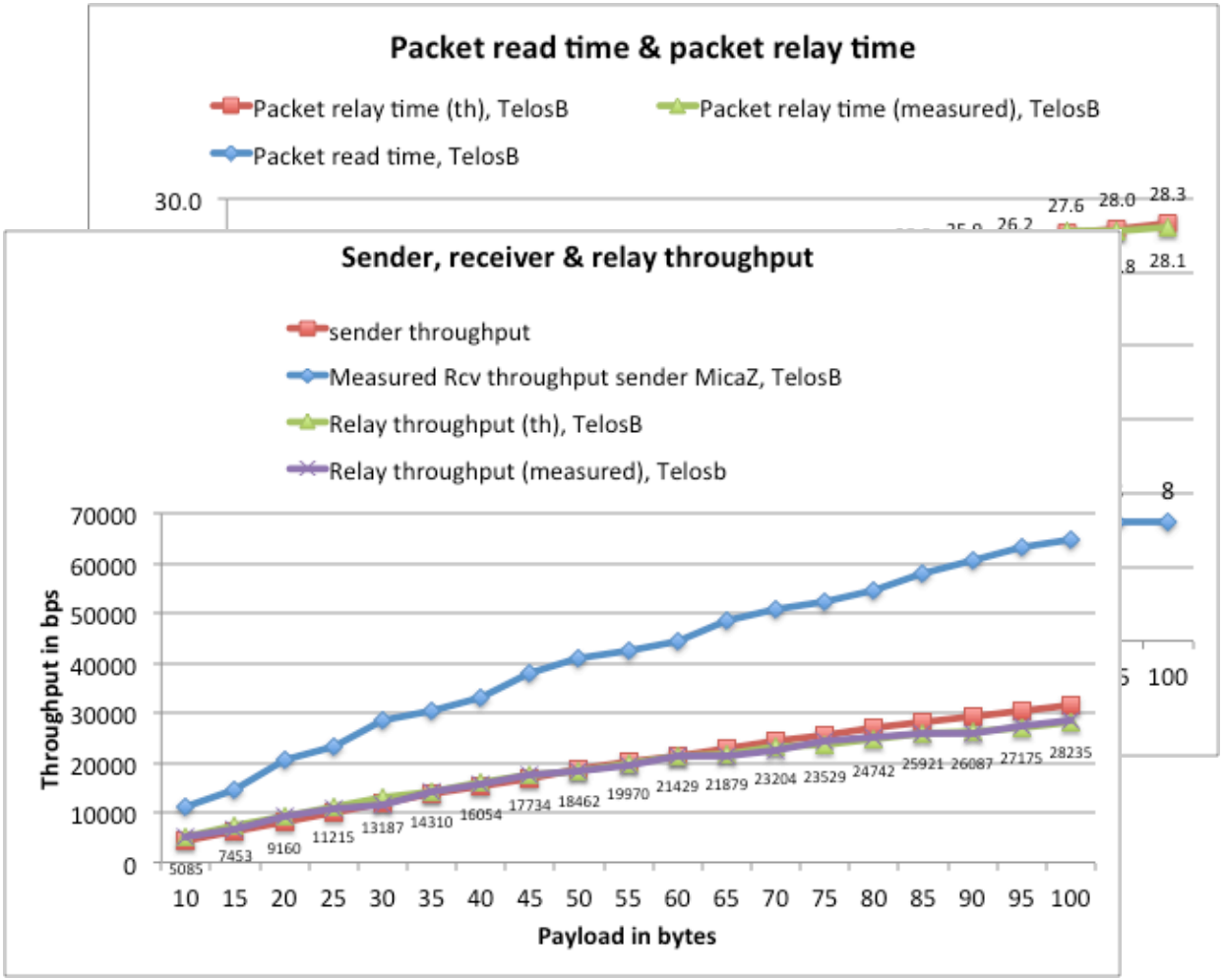
LIBELIUM WASPMOTE



AdvanticSys multi-hop overheads

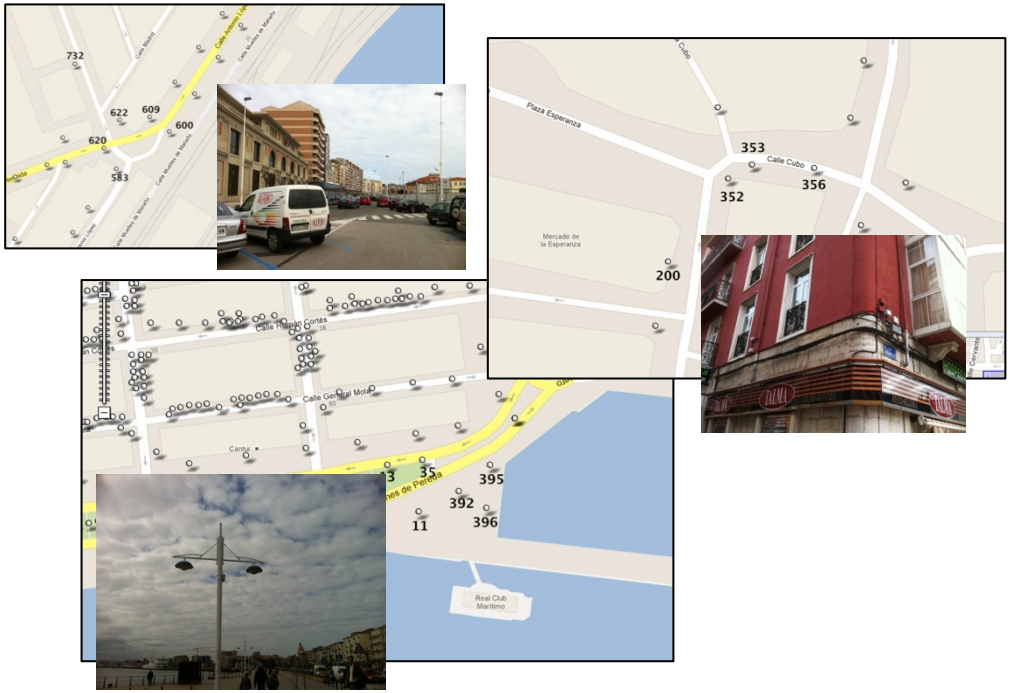


AdvanticSys
CM5000, CM3000



Qualification phase 2

- Phase 2
  - Performances in a networked environment: node density, traffic loads

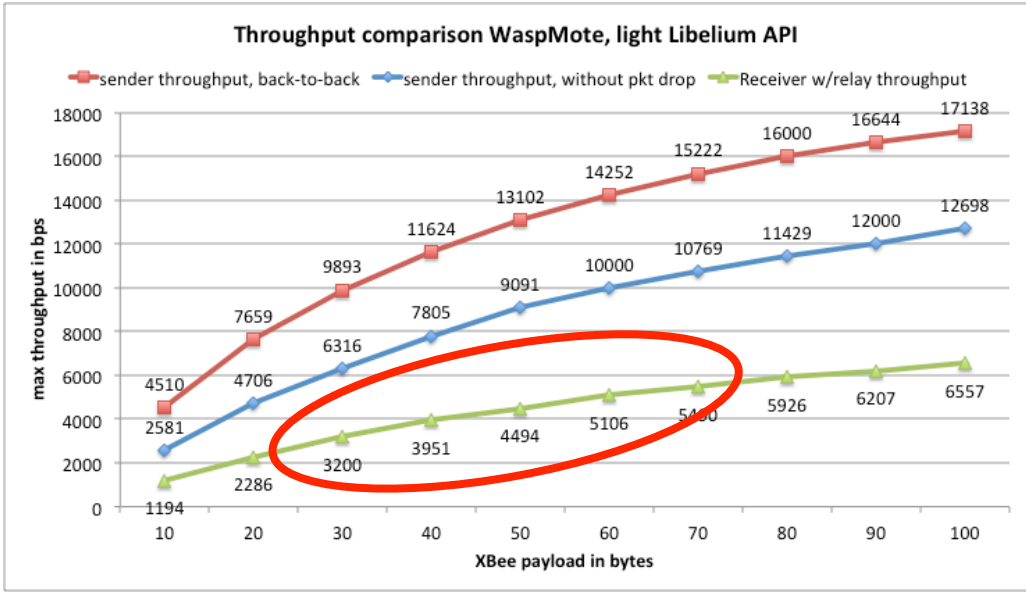


- Use representive locations in Santander for on-site test campaigns
- Deploy on IoT nodes traffic generators & sniffers
- Use mobile traffic generators & sniffers for dynamic traffic patterns
- Throughput, packet losses, latency,…

Test on SmartSantander

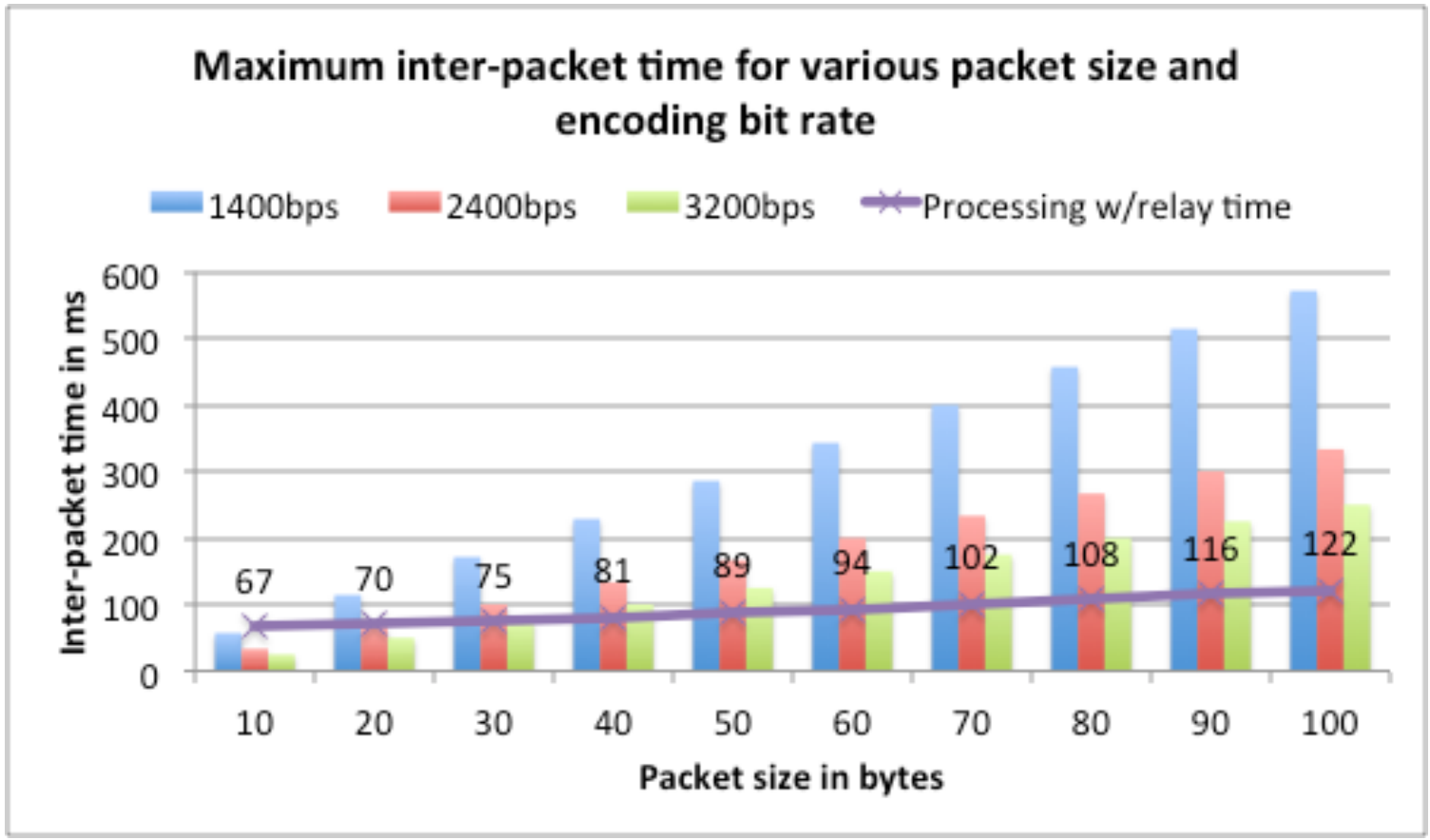
Test on SmartSantander

Preliminary tests with codec2 audio



- Open-source codec
- codec2: http://codec2.org
- Can be as low as 1400bps (1600, 2400 and 3400bps available)
- All encoding/decoding tools are available in code source
- Encoded file is robust against packet losses

Can we meet the constraints?



IEEE iThing'13: 1-hop results

1-relay scenario									
bit rate	1400bps			2400bps			3200bps		
pkt size	40	50	60	40	50	60	40	50	60
n_{pkt}	59	47	39	101	81	67	134	108	90
t_{pkt}	105	110	120	105	110	120	105	110	120
n_{lost}	8	6	7	6	5	5	8	9	8
t_{pkt}	110	120	125	110	120	125	110	120	125
n_{lost}	1	0	0	0	2	2	3	1	3
t_s, s	6.5	5.6	4.8	11.1	9.7	8.3	14.7	14.4	11.2
t_{rcv}	6.9	6.4	5.2	11.6	10.1	8.8	15.4	15	11.7
t_{play}	4.7	4.5	3.7	8.4	8.2	6.1	13.1	12.8	9.8

"EAR-IT" at http://web.univ-pau.fr/~cpham/SmartSantanderSample/

IEEE iThing'13: 2-hop results

2-relay scenario									
bit rate	1400bps			2400bps			3200bps		
pkt size	40	50	60	40	50	60	40	50	60
n_{pkt}	59	47	39	101	81	67	134	108	90
t_{pkt}	105	110	120	105	110	120	105	110	120
n_{lost}	9	7	7	7	7	7	8	8	10
t_{pkt}	110	120	125	110	120	125	110	120	125
n_{lost}	2	1	1	0	1	2	2	1	2
t_s, s	6.4	5.6	4.9	11.2	9.8	8.3	14.6	14.4	11.3
t_{rcv}	7.1	6.6	5.3	11.8	10.2	9	15.7	15.2	12
t_{play}	4.9	4.8	3.9	8.7	8.5	6.4	13.3	13	10.1

"EAR-IT" at http://web.univ-pau.fr/~cpham/SmartSantanderSample/

Test campaign – April 9th-10th 2013


EAR-IT
the sounds of smart environment
T1.2 Acoustic Performance Analysis
UNINOVA
Instituto de Desenvolvimento de Novas Tecnologias
Fraunhofer
IDMT
UC
UNIVERSIDAD DE CANTABRIA
MANDAT INTERNATIONAL
CDT
SmartSensingStars

T1.2

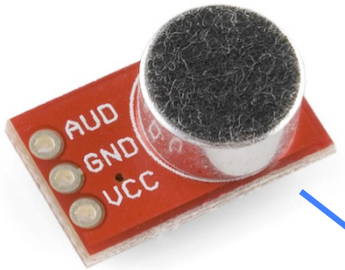
- Objectives- While network condition well established under previous task and links established to allow audio data stream, this part will investigate the minimum requirements and quality necessary for the exploitation of audio data as well as repeatability of the experiments. This will be done by specific audio measurement to qualify the environment and this will performed in close coordination with WP2 and WP3.
- Work plan- The general work plan for achieving the objectives of this task is:
  - Prepare for audio tests: Defined the condition where audio data will be collected and adapt if necessary the sensor for acoustic measurements;
  - Do audio-on-IP tests: perform test campaigns to collect audio-on-ip measurements on several different settings on the Santander and Geneva test sites. Measurement data can be on throughput, latency. Jitter, Packet loss rate, Packet loss patterns;
  - Provide overall data and analysis: provide several data and analysis to be used for benchmarking and could also lead to MOS (Mean Opinion Score).

Performance indicators

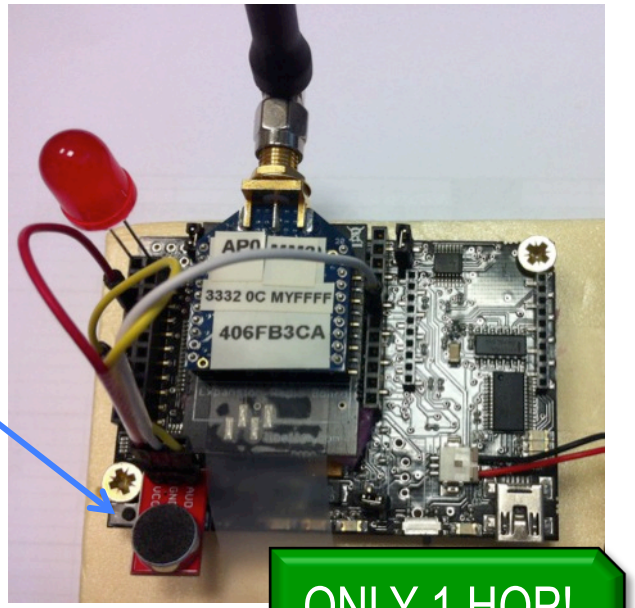
- Audio-on-network indicators
  - 1-hop latency, relay latency, end-to-end latency
  - Packet jitter, packet los rate
- Audio quality indicators
  - Can use Mean Opinion Score (MOS) to have a quantitative value to rank audio quality

1-hop: XBee in raw mode

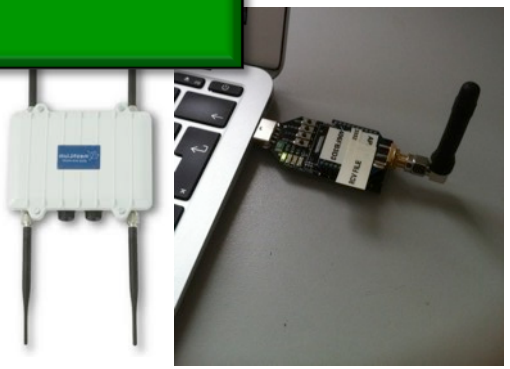
- Electret mic with amplifier



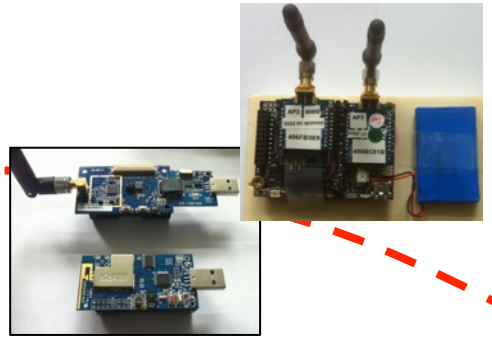
- XBee in AP0 mode (transparent mode)
- 8-bit 4Khz sampling gives 32000bps
- 8Khz sampling gives 64000bps, requires custom API

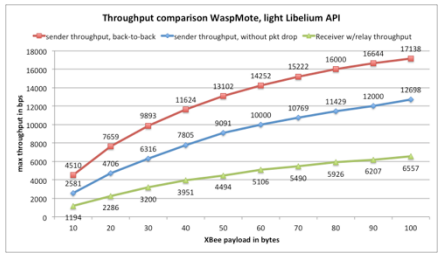


ONLY 1 HOP!

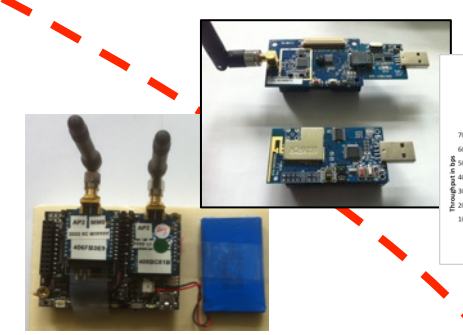


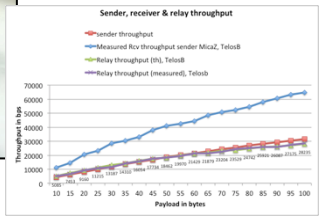
Multi-hop audio constraints





RELAY





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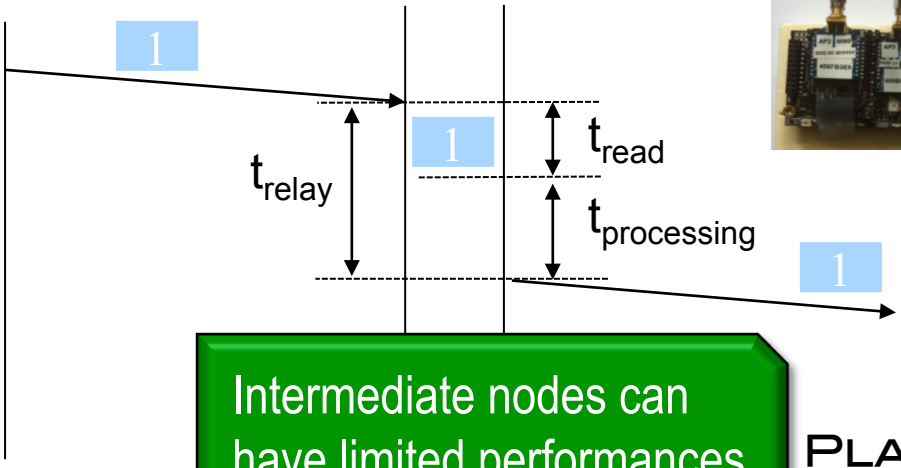
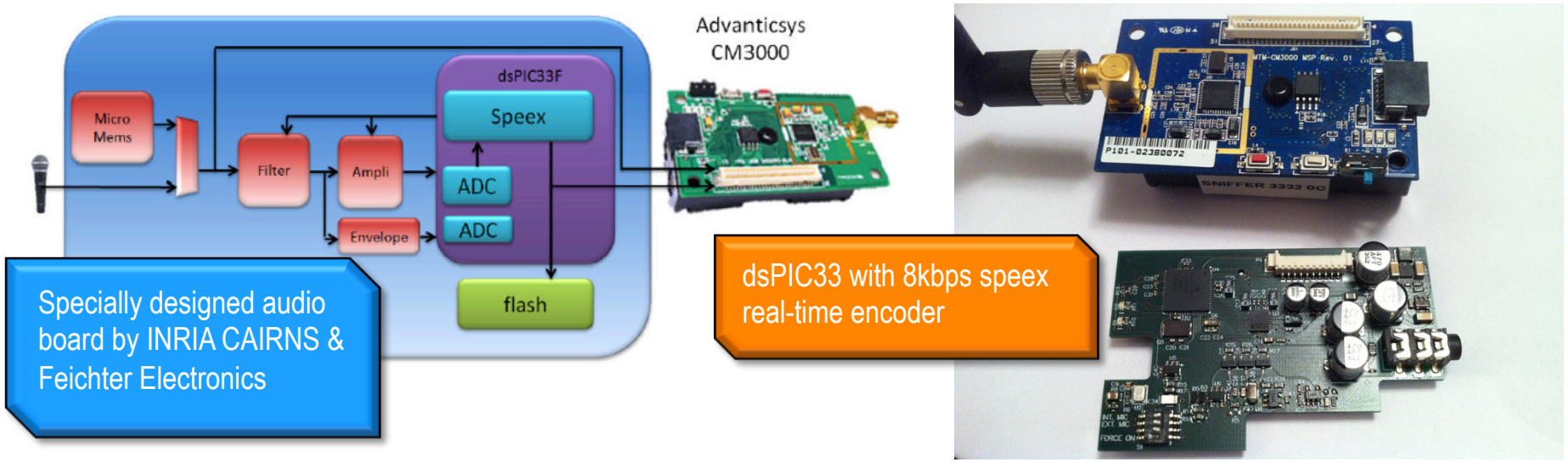


Intermediate nodes can have limited performances

PLAY RECEIVED FILE

Multi-hop audio solution

- Use dedicated audio board for sampling/storing/encoding at 8kbps



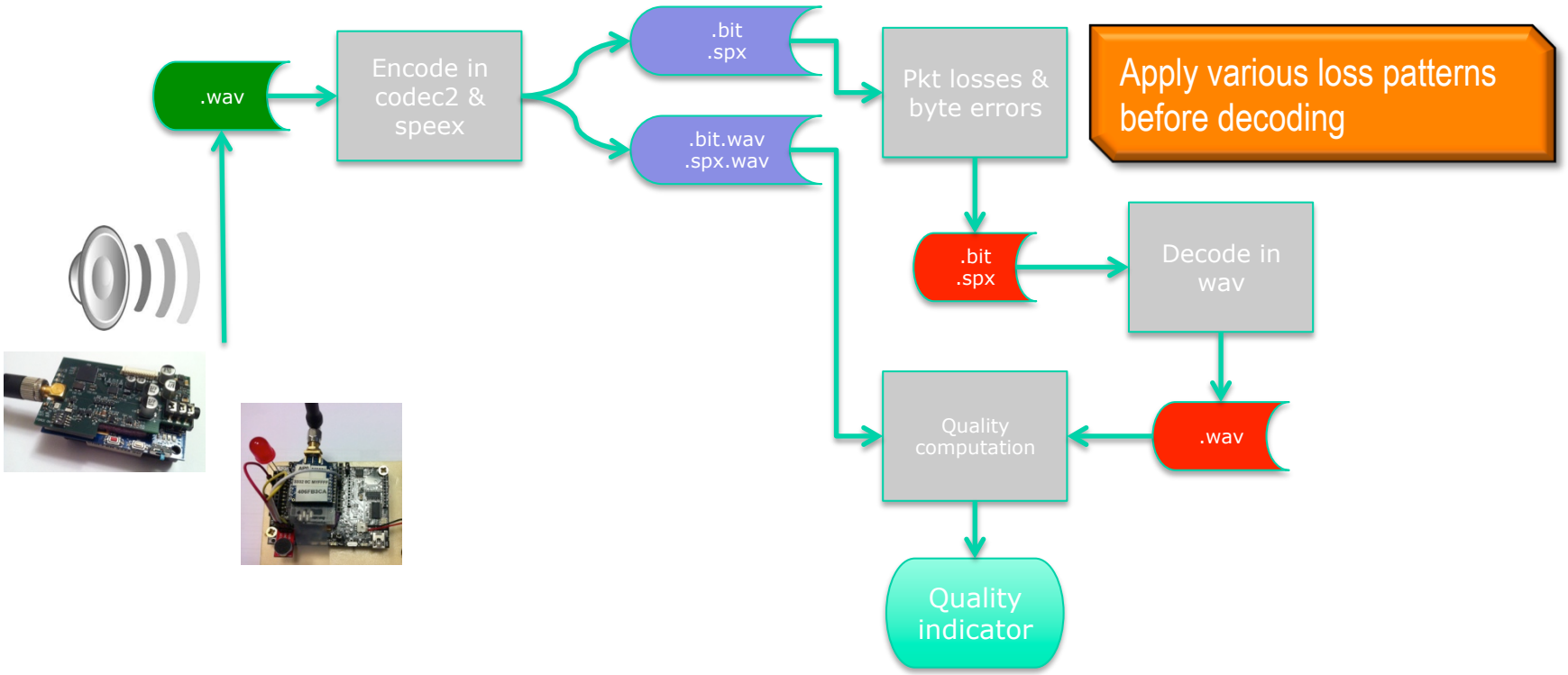
- Allows for multi-hop, encoded audio streaming scenarios

Benchmark methodology

1. Determine sensitivity of codec against packet losses, lab tests
   - audio benchmarking, apply controlled packet error rates
   - MOS computation
2. Determine channel condition in selected areas, in-situ tests
   - Synthetic workload to determine packet loss rates
3. Determine latencies and jitter in multi-hop scenario, lab tests & in-situ tests
   - Controlled transmission of packetized/encoded audio
   - Measure latencies and jitter at intermediate nodes

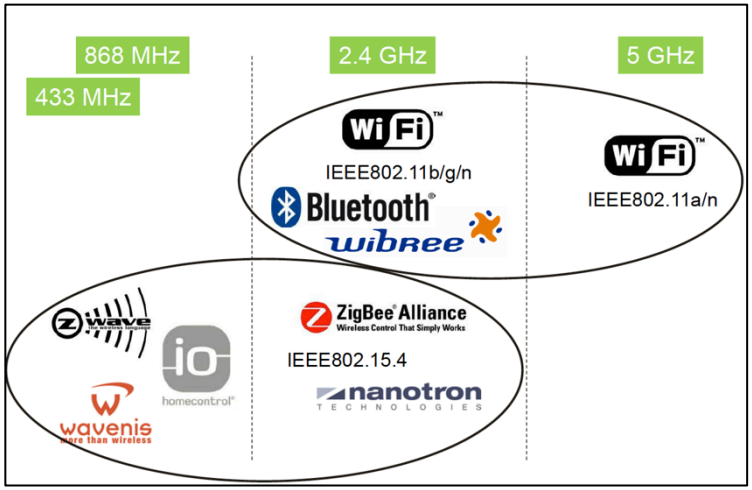
Sensitivity of codecs

LAB TESTS

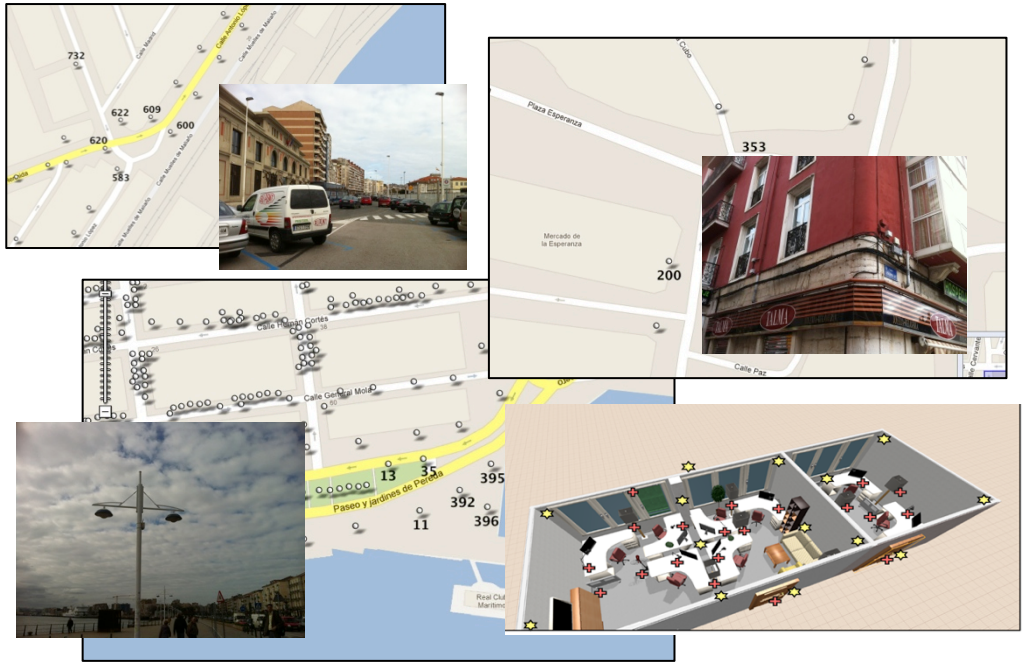


Channel condition in selected areas

IN-SITU TESTS



Source: M. Dohler, “M2M in SmartCities”



- Use representive locations in Santander & Geneva buildings
- Deploy IoT nodes traffic generators & sniffers
- Vary 802.15.4 channel and determine packet loss rates at various workload

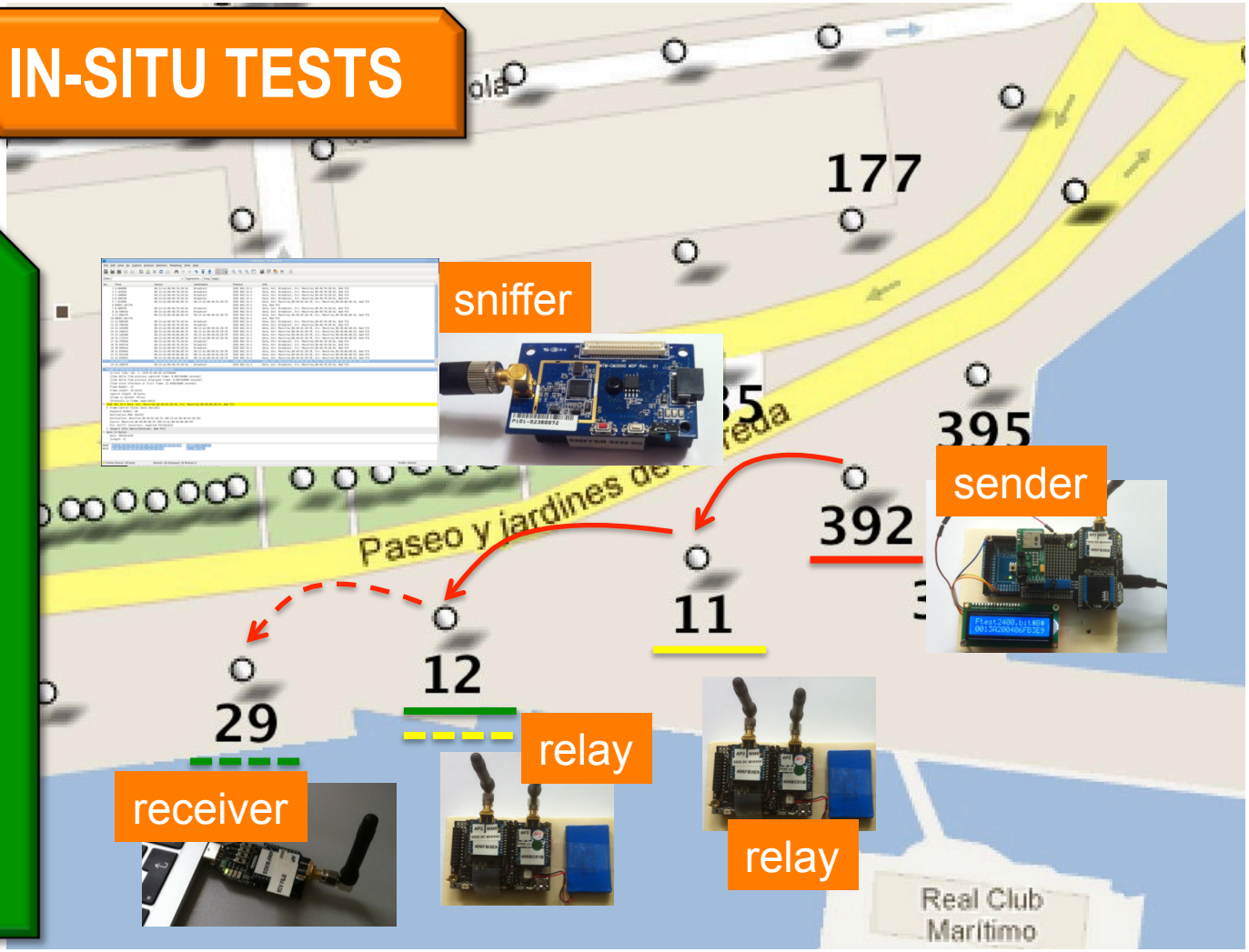
Latency and jitter in multi-hop

LAB TESTS

IN-SITU TESTS

Sniffer node will capture all frames in order to measure inter-node latencies

Jitter will be measured at intermediate node as inter-packet time in known at sender side



Audio quality: PESQ & MOS (1)

- ITU-T P.862 Perceptual evaluation of speech quality (PESQ): An objective method for end-to-end speech quality assessment of narrow-band telephone networks and speech codecs.
- Download software at : https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-P.862-200511-I!Amd2!SOFT-ZST-E&type=items

Audio quality: PESQ & MOS (2)

- We can use ITU-T PESQ tool to determine the MOS value for error-free encoded audio (codec2, speex). MOS-LQO value greater than 2.6 are considered quite acceptable
- 5=Excellent, 4=Good, 3=Fair, 2=Poor, 1=Bad

REFERENCE	DEGRADED	PESQMOS	MOSLQO	SAMPLE_FREQ
test.wav	test.wav	4.500	4.549	8000
test.wav	test2150.spx.wav	2.757	2.472	8000
test.wav	test5950.spx.wav	3.428	3.454	8000
test.wav	test8000.spx.wav	3.652	3.757	8000
test.wav	test11000.spx.wav	3.941	4.093	8000
test.wav	test13000.spx.wav	3.941	4.093	8000
test.wav	test15000.spx.wav	4.085	4.235	8000
test.wav	test1600.bit.raw.wav	2.648	2.323	8000
test.wav	test1400.bit.raw.wav	2.625	2.293	8000
test.wav	test2400.bit.raw.wav	2.768	2.487	8000
test.wav	test3200.bit.raw.wav	2.801	2.533	8000

PESQ & MOS of iThing'13 results

REFERENCE	DEGRADED	PESQMOS	MOSLQO	SAMPLE_FREQ
test2400.bit.raw.wav	test2400-44-105-6L-F77.bit.raw.wav	2.752	2.465	8000
test2400.bit.raw.wav	test2400-44-110-0L.bit.raw.wav	4.500	4.549	8000
test2400.bit.raw.wav	test2400-54-110-5L-F77.bit.raw.wav	2.725	2.427	8000
test2400.bit.raw.wav	test2400-54-120-2L-F77.bit.raw.wav	3.239	3.178	8000
test2400.bit.raw.wav	test2400-64-120-5L-F77.bit.raw.wav	2.737	2.444	8000
test2400.bit.raw.wav	test2400-64-125-2L-F77.bit.raw.wav	3.689	3.804	8000
test2400.bit.raw.wav	test2400.bit.raw.wav	4.500	4.549	8000

test.wav	test2400-44-105-6L-F77.bit.raw.wav	2.600	2.260	8000
test.wav	test2400-44-110-0L.bit.raw.wav	2.768	2.487	8000
test.wav	test2400-54-110-5L-F77.bit.raw.wav	2.310	1.919	8000
test.wav	test2400-54-120-2L-F77.bit.raw.wav	2.648	2.323	8000
test.wav	test2400-64-120-5L-F77.bit.raw.wav	2.307	1.916	8000
test.wav	test2400-64-125-2L-F77.bit.raw.wav	2.679	2.365	8000
test.wav	test2400.bit.raw.wav	2.768	2.487	8000
test.wav	test.wav	4.500	4.549	8000

Next steps

- Finalize lab tests with agreed indicators
- Prepare in-situ tests in Santander and Geneva in the period jan-feb
- Consolidate indicators and methods for 1.3 (benchmark)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the sounds of smart environment
Thank you
Demo ?