Elodie MORIN

First year PhD Student follow-up

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Myself

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PhD Subject

Cross-layer Optimisation in Energy Harvesting Wireless Sensor Networks

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Large number of sensor/actuator nodes equipped with radio

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Cross-layer Optimisation in Energy Harvesting

Wireless Sensor Networks

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Grabbing energy from the environnement

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Cross-layer Optimisation in Energy Harvesting

Wireless Sensor Networks

Global approach of OSI Stack

Large number of sensor/actuator nodes equipped with radio

Grabbing energy from the environnement

Aim

Mutli-MACs architecture proposal to bring interoperability in WSN

Constraints

- Energy efficient (to reach autonomy thanks to EH)
- Per se multi-standard
- Contextually reconfigurable

Interests

- Context = IoT growth, wide range of protocols
- Customer PoV : Wants to buy any devices in any shop, bring it back home and … it works (no matter how !)
- Industrial PoV : Bring the market to a new level in terms of dual-technologies chips & energy harvesting platform (Greennet)
- Academical PoV : Create metrics and solutions to compare technologies and choose the best fitting one

Interoperability, how to ?

Two identified approaches for now :

- Over IP homogeneity, heterogenous network under it : one techno speaks while the other sleeps.
- Application homogeneity, heterogenous stack below : « Always Best Connected » approach

Starting the PhD

- Discovering Greennet platform
- Studying different protocols : identify scenarii & metrics to compare them

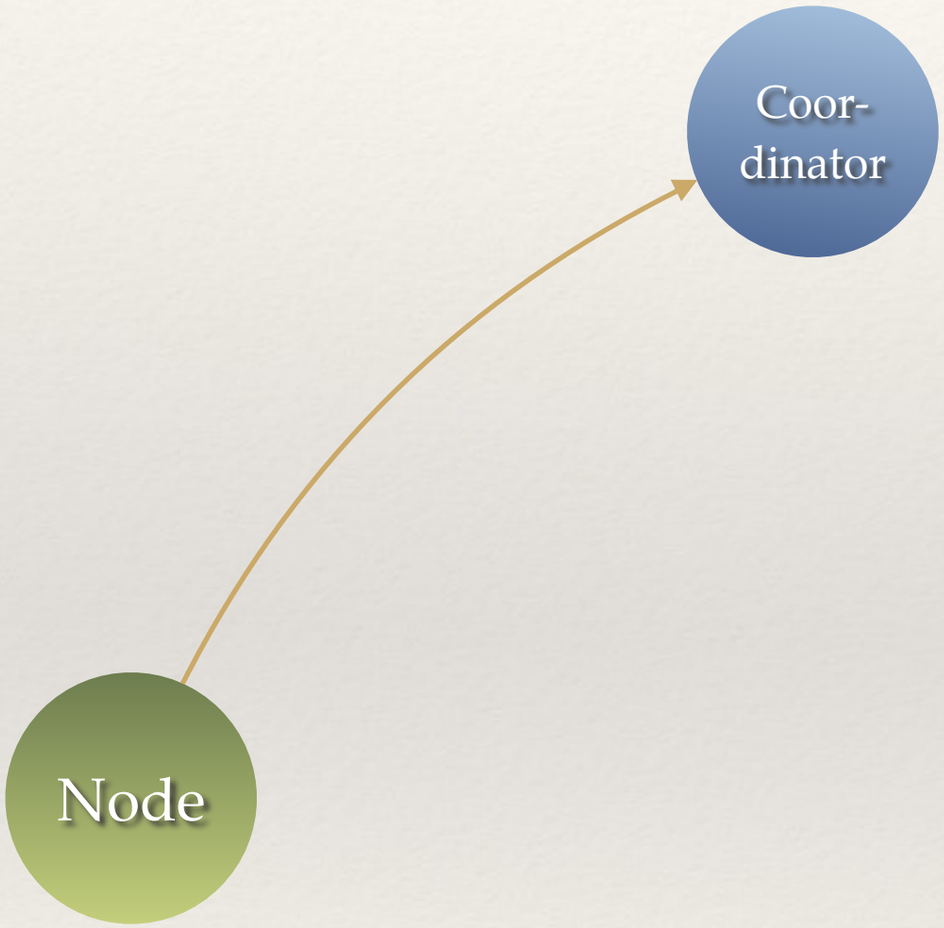
Greennet Platform

- Energy harvester : solar panel
- Sensors : Temperature / Accelerometer / Lightness / …
- Technology used : 15.4 / Greennet Stack

Studied protocols

	802.15.4	802.15.4e	BLE	Wifi
Topology	Meshed + Coordinator	same 15.4	Point to point // Scatternet	Star (formule 2hop)
Rate maximum	250 kpbs	250 kbps	1 Mbps	*54 Mbps*
Max PDU	127 bytes	127 bytes	27 bytes (4.0) / 247 bytes (4.2)	1280 bytes
Peak power consumption	10 mA	10 mA	15 mA	*116 mA*
Range	10-100m	same 15.4	up to 80m (but design for 10m)	100m
Frequency	2,4 Ghz (ISM) + 868 Mhz	2,4 Ghz (ISM)	2,4 GHz (ISM)	2,4 Ghz /!\ ah = sub-Ghz (868)
Latency	*20 ms*	10 ms (1 TS)	*3 ms for one hop*	*1,5 ms*

Scenario



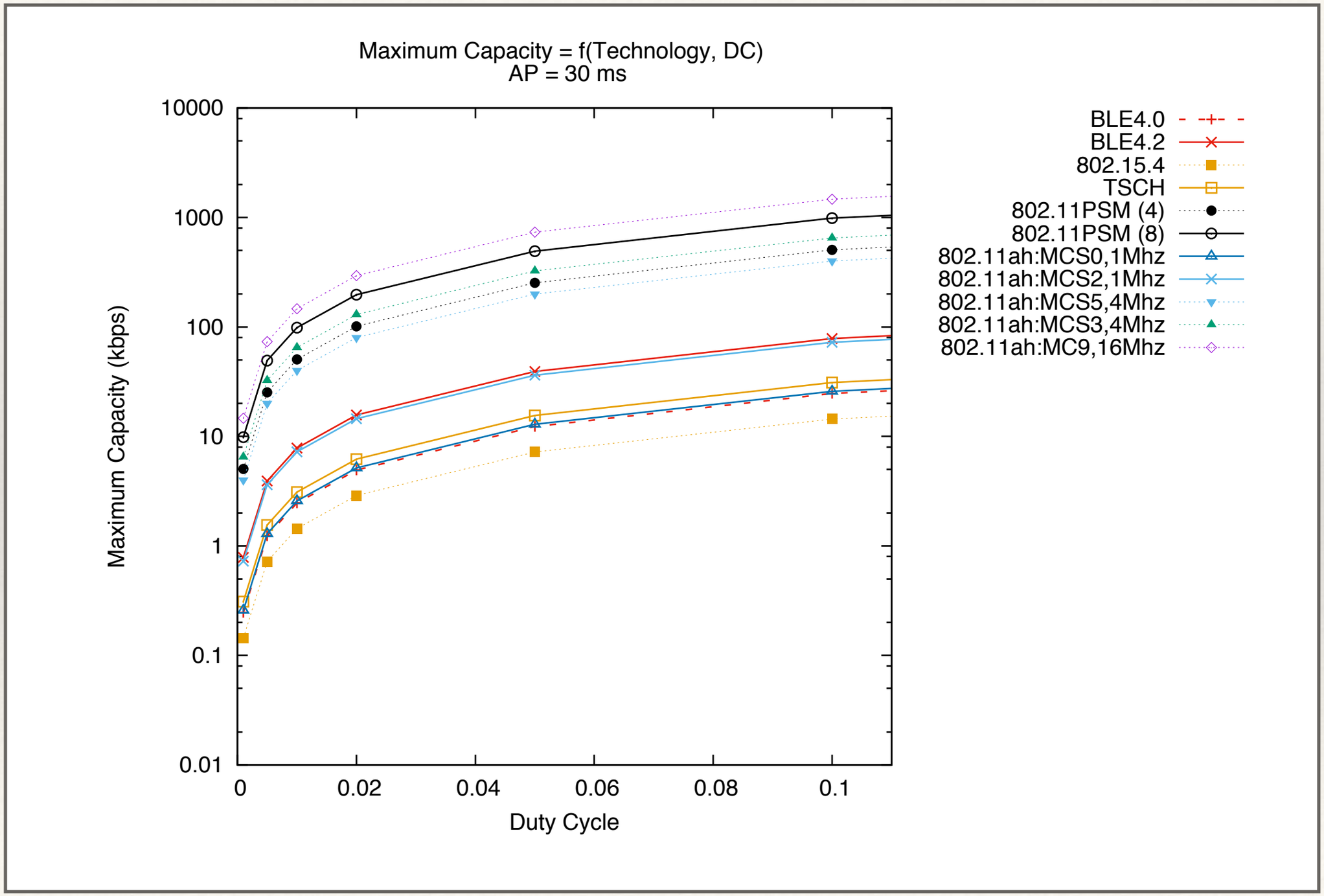
<u>Assumptions</u>:

- No one else on the channel
- Perfect channel

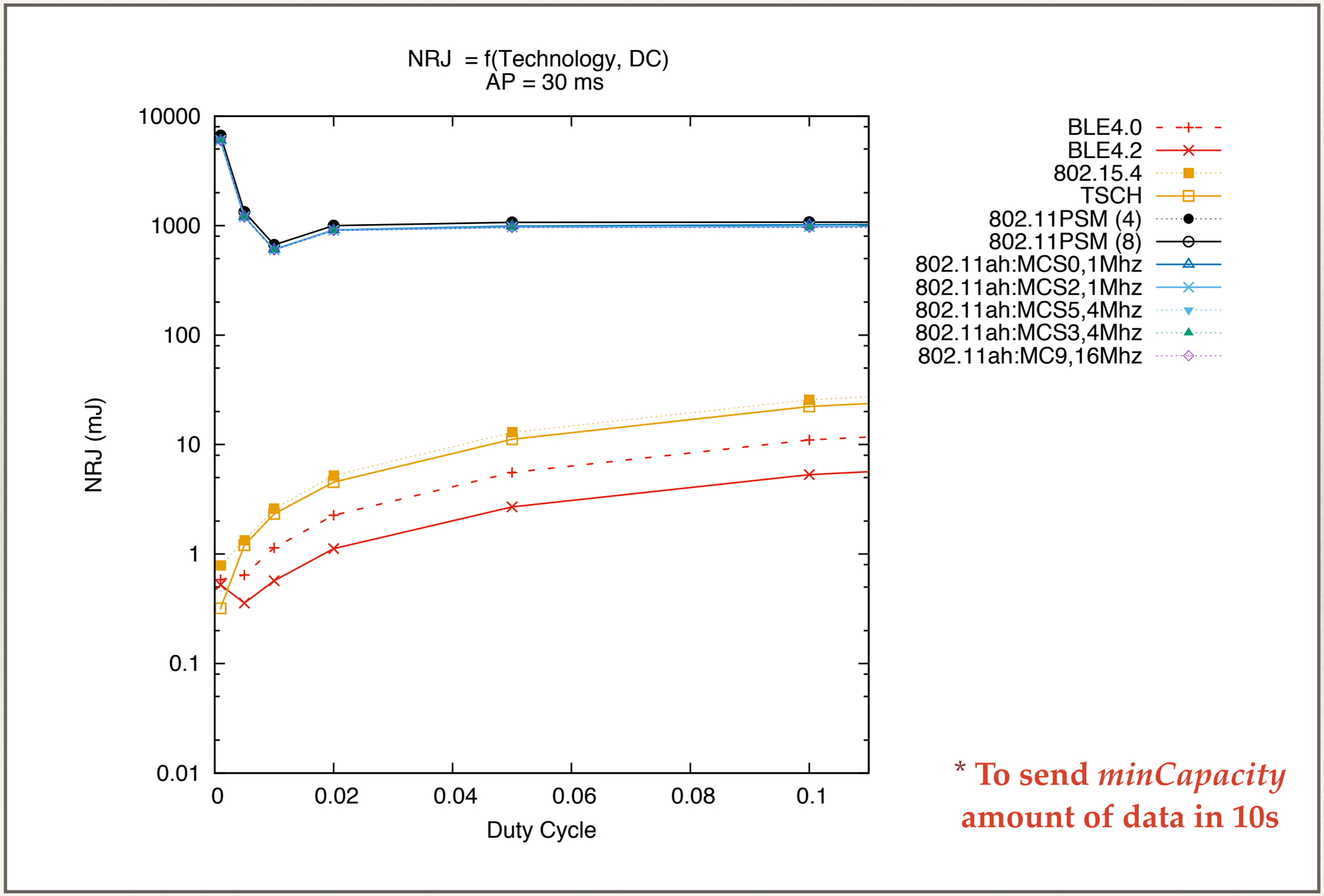
==> *No retransmission & no backoff*

- Transmission at 0dbm
- CPU consumption negligible (will be modified)
- Stationnary mode

Capacity


Maximum Capacity = f(Technology, DC)
AP = 30 ms
Maximum Capacity (kbps)
10000
1000
100
10
1
0.1
0.01
0
0.02
0.04
0.06
0.08
0.1
Duty Cycle
BLE4.0
BLE4.2
802.15.4
TSCH
802.11PSM (4)
802.11PSM (8)
802.11ah:MCS0,1Mhz
802.11ah:MCS2,1Mhz
802.11ah:MCS5,4Mhz
802.11ah:MCS3,4Mhz
802.11ah:MC9,16Mhz

Energy consumption*



* To send *minCapacity* amount of data in 10s

Future Work

- Establish more accurate comparison
- Determine metrics to find best technology for a given application traffic and ressources
- Finish porting of openWSN on Greennet nodes

Questions ?

Thanks for your attention !

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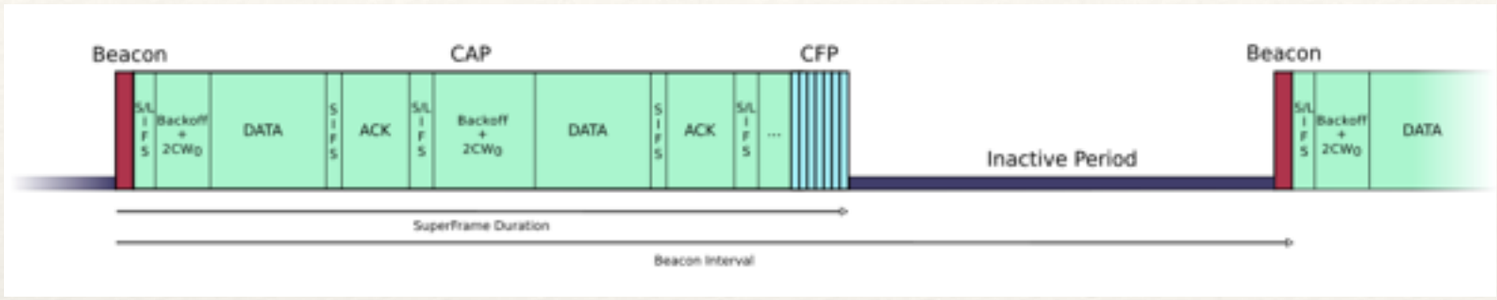
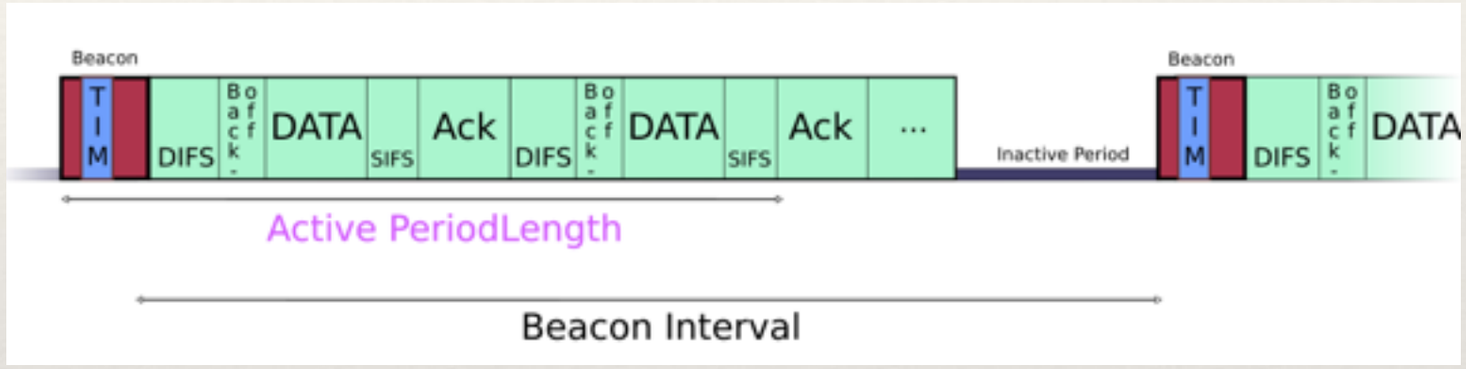
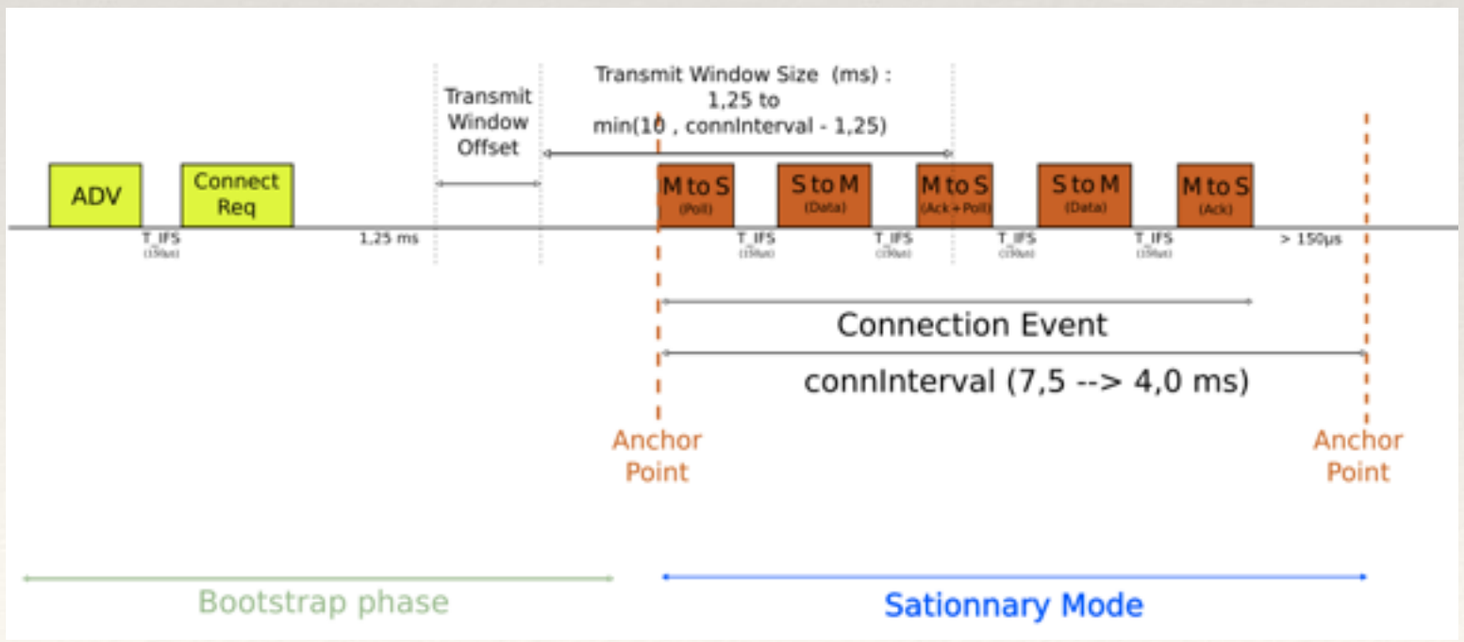
Scenarii



802.15.4

802.11 (PSM & ah)





BLE 4.0 & 4.2

Scenarii

TSCH