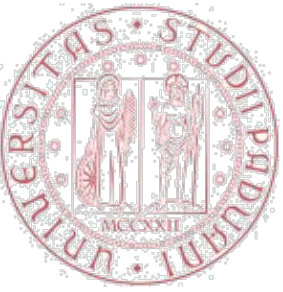


DIPARTIMENTO
DI INGEGNERIA
DELL'INFORMAZIONE

Latest advances of Low Power Wide Area networking technologies towards IoT

Andrea Zanella

The strange story of Long-range technologies ruled as Short-Range

An already crowded arena...

NB-IoT

WEIGHTLESS™

INGENU

LoRa™ Alliance
Wide Area Networks for IoT

SIGFOX
One network A billion dreams

waviot

M. Centenaro, L. Vangelista, A. Zanella, M. Zorzi, ``**Long-Range Communications in Unlicensed Bands: the Rising Stars in the IoT and Smart City Scenarios**" *IEEE Wireless Communications*, Volume: 23, Issue: 5, October 2016

ERC Recommendation 70-03

	Frequency Band	Power / Magnetic Field	Spectrum access and mitigation requirements	Modulation / maximum occupied bandwidth	Notes
h1.1	863-870 MHz (notes 3 and 4)	25 mW e.r.p.	≤ 0.1% duty cycle or LBT (notes 1 and 5)	≤ 100 kHz for 47 or more channels (note 2)	FHSS. Parts of the frequency band are also identified in Annexes 2 and 3
h1.2	863-870 MHz (notes 3 and 4)	25 mW e.r.p. Power density: -4.5 dBm/100 kHz (note 7)	≤ 0.1% duty cycle or LBT+AFA (notes 1, 5 and 6)	Not specified	DSSS and other wideband techniques other than FHSS. Parts of the frequency band are also identified in Annexes 2 and 3
h1.3	863-870 MHz (notes 3 and 4)	25 mW e.r.p.	≤ 0.1% duty cycle or LBT + AFA (notes 1 and 5)	≤ 100 kHz, for 1 or more channels modulation bandwidth ≤ 300 kHz (note 2)	Narrowband / wideband modulation. Parts of the frequency band are also identified in Annexes 2 and 3

Note 1 (rephrased): DC, LE ≤ 0.1% duty cycle or LBT + AFA (notes 1 and 5) all **not be user dependent/ adjustable**. DC always ap| **both** used

Note 5: Duty cycle may be s limited to 865-868 MHz.

Duty cycle → data traffic

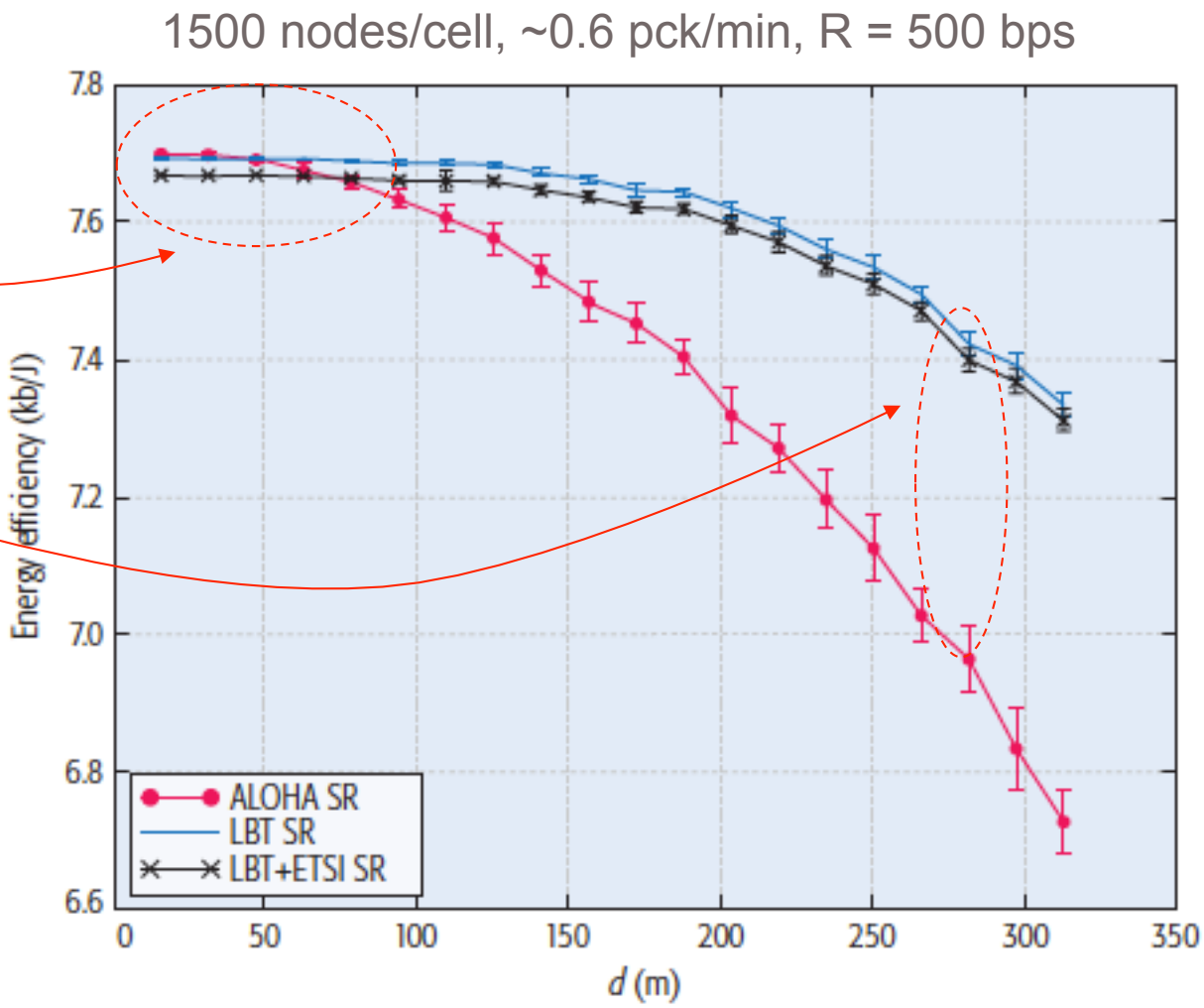
- SigFox
  - UL: max **140 messages/day/node** (12 bytes)
  - DL: max **4 messages/day/node** (8 bytes)
- LoRa
  - On-air time (10 bytes): 56 ms (max rate) to1400 ms (lowest rate)
  - Duty cycle 0.1%
    - **UL 1440 pck/day/node** to ~**600 pck/day/node**
    - **DL: same features, but in total!**
  - 2 channels @ 0.1%, 3 channels at 1%, 1 channel @ 10%→ higher traffic is possible by widely exploiting different channels
- However, management of external interferers is an issue!

Better LBT or pure ALOHA?

ALOHA is better for nodes close to the GW

LBT wins for longer distances

Performance strongly depends on distance → Further away nodes suffer the most!

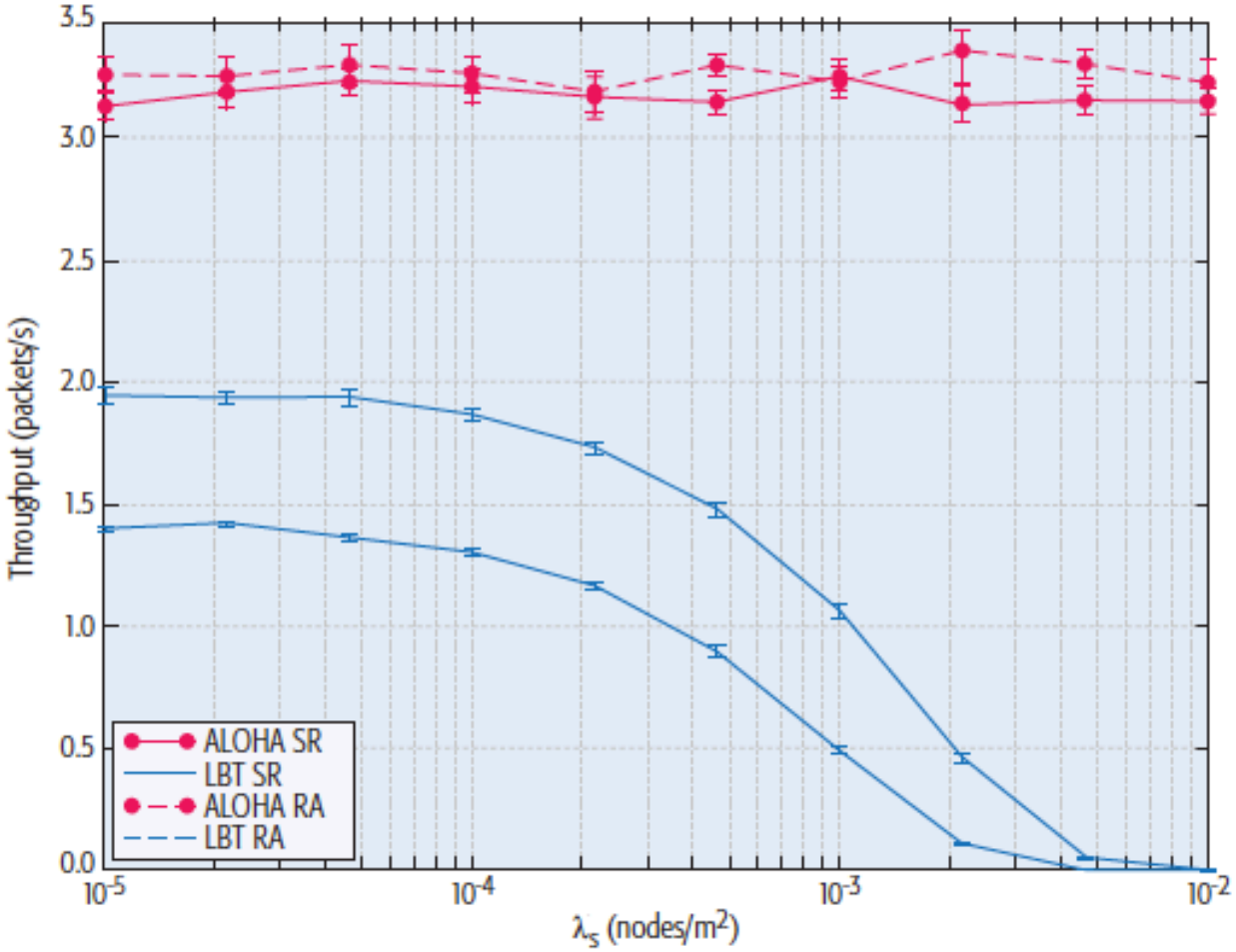


D. Zucchetto, A. Zanella, "Uncoordinated access schemes for the IoT: approaches, regulations, and performance" *IEEE Communications Magazine* vol. 55, no. 9, pp. 48-54, 2017

Coexistence issues

ALOHA & LBT systems in the same area?

Not a good idea... for LBT in particular!



D. Zucchetto, A. Zanella, "Uncoordinated access schemes for the IoT: approaches, regulations, and performance" *IEEE Communications Magazine* vol. 55, no. 9, pp. 48-54, 2017

Ways forward

- Relaxing (a bit) the rules
  - Dynamic idle periods (exploit regulatory flexibility)
  - Ascribe ACK to on-air time of transmitter (alleviate constraint at the GW)
  - Adapt dc constraints to medium congestion level
- Improving technology
  - Multiple gateways → improve coverage, bitrates, reliability (but also NetServer load)
    - Add processing/packet filtering @ gateways to reduce NetServer load

Contacts

Andrea Zanella – zanella@dei.unipd.it