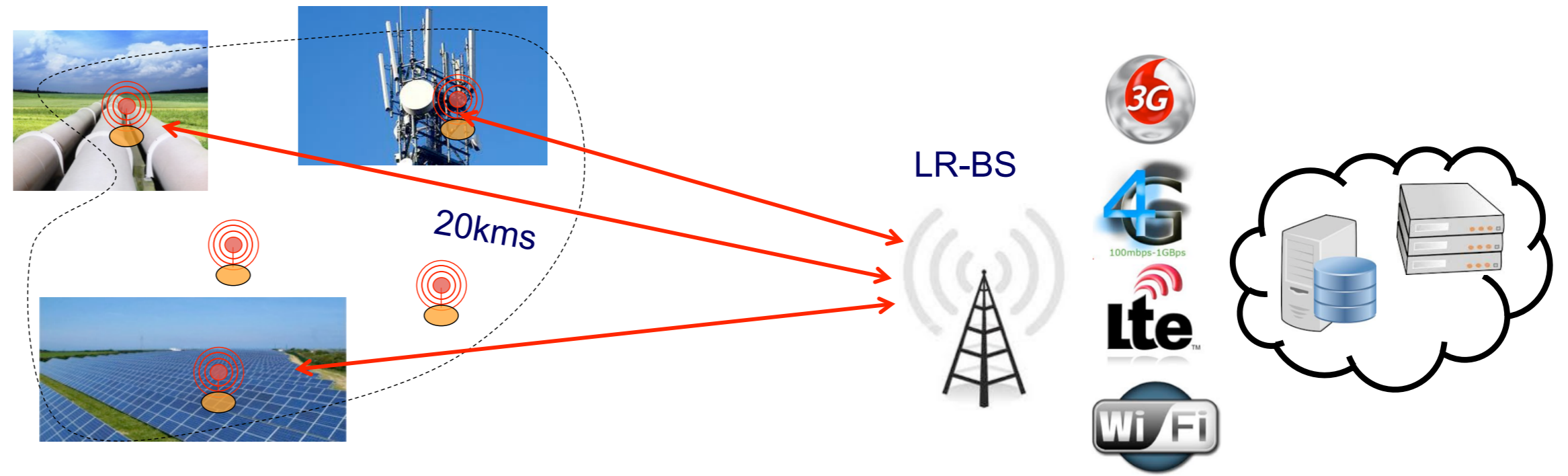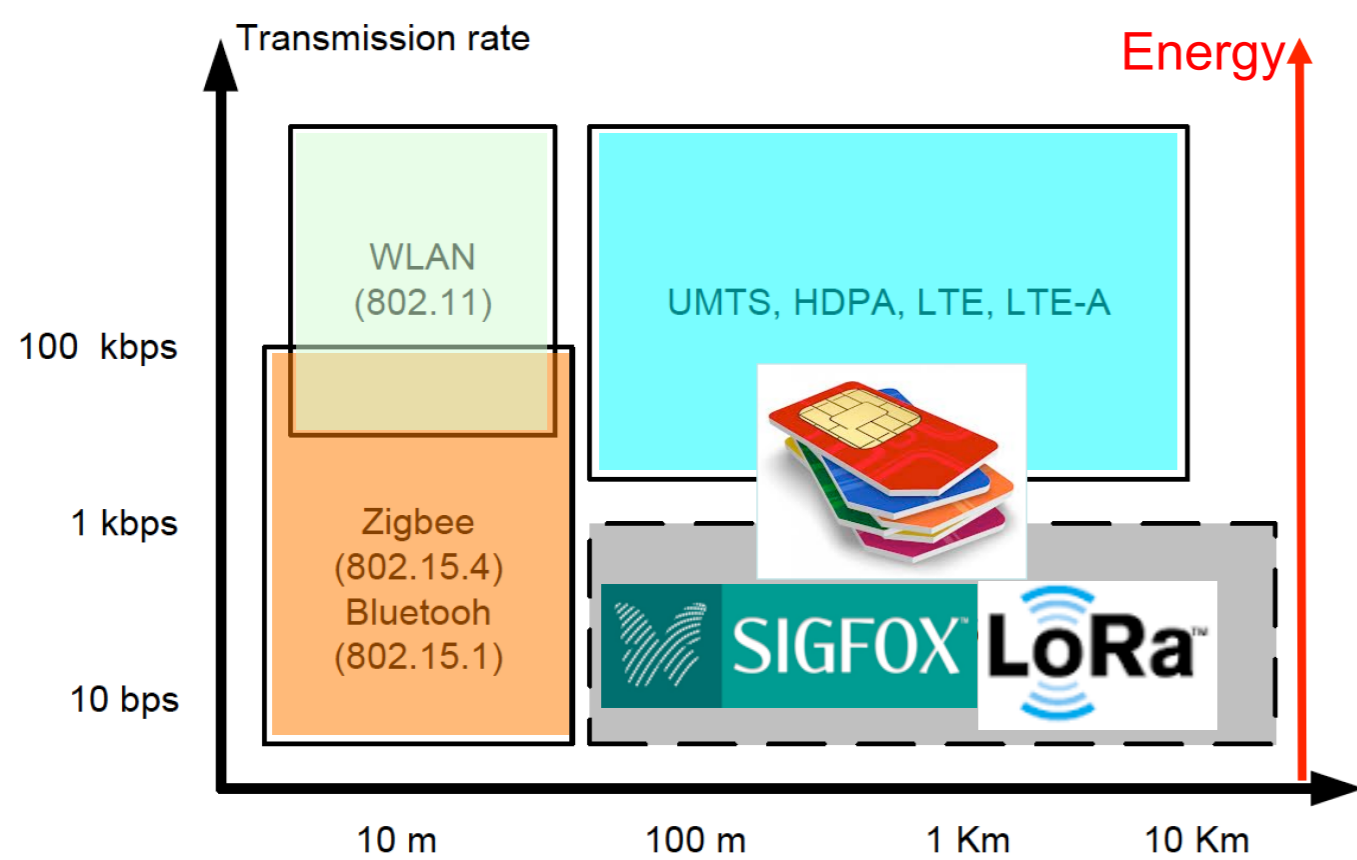# TOWARDS QUALITY OF SERVICE FOR LONG-RANGE IOT IN UNLICENSED RADIO SPECTRUM

Low-power, Long-range radio technologies fill the market uncovered by both traditional WLAN/WPAN and cellular telecom industries

Deployment of large-scale sensing systems for surveillance tasks can be realized at an unprecedent level of flexibility and at very low cost due to the gateway-centric architecture: no more impossible-to-manage multi-hop networks!

Unlicensed radio bands
433MHz, 868MHz or 915MHz
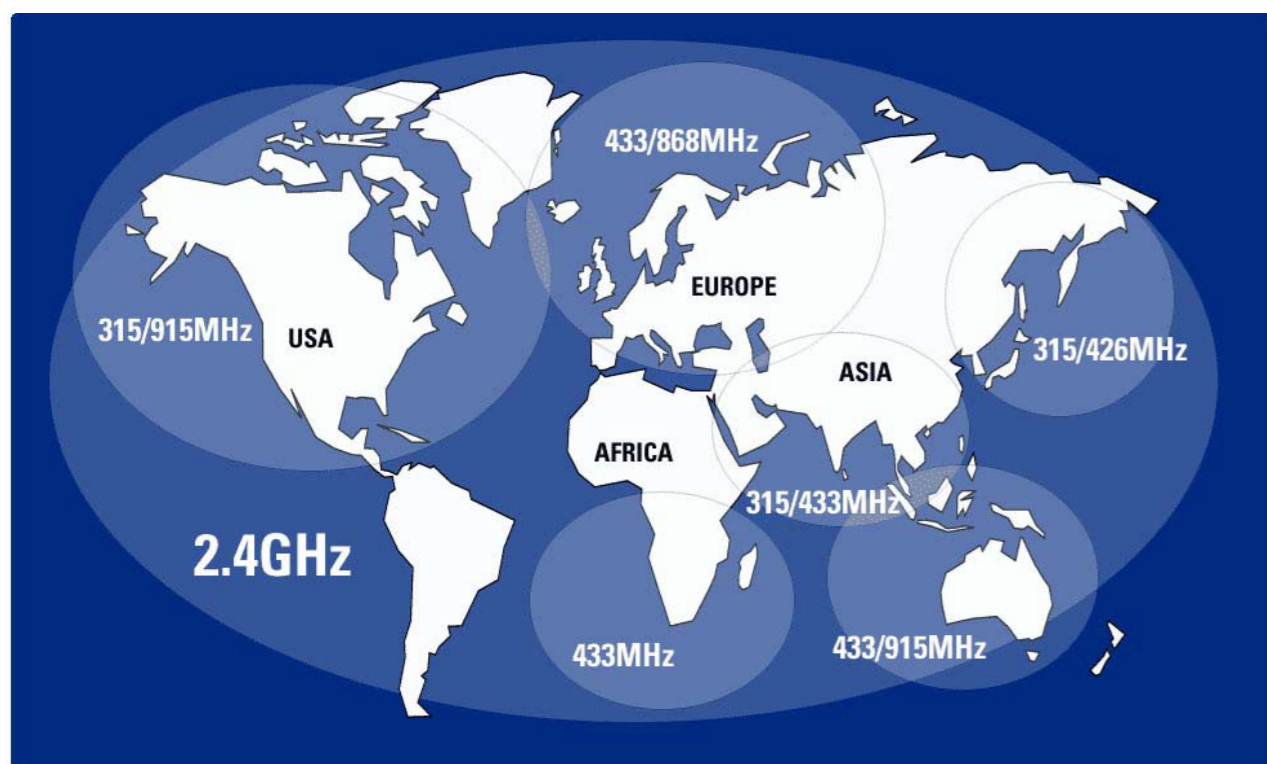
Band	Edge Frequencies		Field / Power	Spectrum Access	Band Width
	Fe-	Fe+			
g(Note 7)	865 MHz	868 MHz	+6.2 dBm /100 kHz	1 % or LBT AFA	3 MHz
g(Note 7)	865 MHz	870 MHz	-0.8 dBm / 100 kHz	0.1% or LBT AFA	5 MHz
g1	868 MHz	868.6	14 dBm	1 % or LBT AFA	600 kHz
g2	868.7 MHz	869.2 MHz	14 dBm	0.1% or LBT AFA	500 kHz
g3	869.4 MHz	869.65 MHz	27 dBm	10 % or LBT AFA	250 kHz
g4	869.7 MHz	870 MHz	7 dBm	No requirement	300 kHz
g4	869.7 MHz	870 MHz	14 dBm	1 % or LBT AFA	300 kHz

Activity time is constrained from 0.1%, 1% or 10% duty-cycle depending on frequency: 3.6s, 36s or 360s per hour

What if I still need to send more than 36s in the current hour because of an emergency situation?

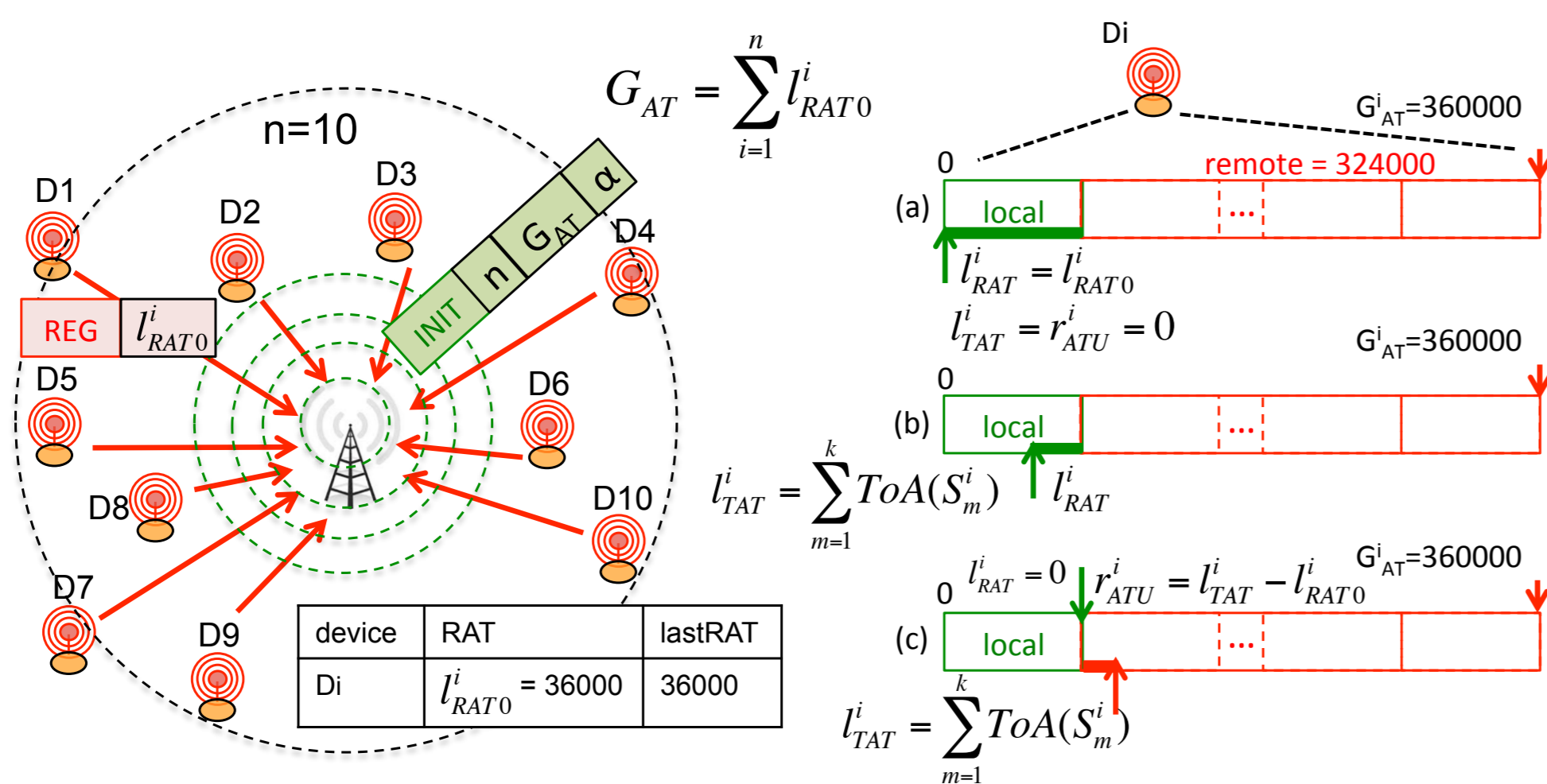☐ stop transmitting?
☐ violate regulation?

Ad-hoc

Operator-based

Whatever the deployment approach, the gateway knows how many devices are deployed by a given organization

Our proposition is to view all device' activity time in a global manner, with the gateway taking care of radio time usage consistency

DIY

$$G_{AT} = \sum_{i=1}^{n} l_{RAT0}^i$$

$$l_{RAT}^i = l_{RAT0}^i$$

$$l_{TAT}^i = r_{ATU}^i = 0$$

$$l_{TAT}^i = \sum_{m=1}^{k} ToA(S_m^i) + l_{RAT}^i$$

$$l_{RAT}^i = 0 \quad r_{ATU}^i = l_{TAT}^i - l_{RAT0}^i$$

$$l_{TAT}^i = \sum_{m=1}^{k} ToA(S_m^i)$$

device	RAT	lastRAT
Di	$l_{RAT0}^i = 36000$	36000

(a) local — remote = 324000 — $G_{AT}^j = 360000$

(b) local — $G_{AT}^j = 360000$

(c) local — $G_{AT}^j = 360000$

n=10

A device can transmit more if needed, provided that other devices will decrease their radio activity time accordingly.

Each device willing to share its activity time can register with the gateway (REG msg) to participate in the pool.

Gateway determine Global Activity Time and broadcasts to end-devices (INIT msg).

Each device has a local and a remote amount of activity time, see (a).

Every data packet consumes local activity time, see (b).

Gateway keeps track of remaining activity time of each node and detects remote activity time usage, see (c).

Amount of extra activity time usage will be charged to other devices, reducing accordingly their local remaining activity time.

Gateway will keep coordination and consistency of the system by periodically broadcast UPDT message.

Not intended to be used on a regular basis but only to provide a « last chance » solution for providing better service guarantees.

Implementation is available for devices (tested on Arduino) and gateway (tested on Raspberry).

☐ Minimise number of UPDT messages: cumulative behavior
☐ Support sleep periods of devices
☐ Dynamic insertion of new devices into a running pool
☐ Seamlessly allows to increase gateway activity time (ACK)

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