

# Green communications in 5G

Tim Van Den Driesschen  
Rodrigo Arias Mallo

Universitat Politècnica de Catalunya

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- In the next decade, the number of connected devices is expected to increase 100 times and the data volume by 1000 times
- Operators are already facing significant power bills
- Moving towards green communications is important both for **environmental** and **economic** reasons

# Network planning and deployment

# Harvesting renewable energy resources

In order to power the Base Stations (BS), energy can be obtained from renewable sources:

- Natural sources: Sun, wind, vibration
- External: Batteries, fuel cells

Solar energy has been tested to power BS installed in road lamps, with the solar panel on top [175]. It has been observed that it can run fully autonomous, with the exception of the January month, where external power was needed.

Other sources of energy may not be so profitable, as sun is the source with the highest amount of power, about  $100 \text{ mW cm}^{-2}$ , followed by the wind with  $12 \text{ mW cm}^{-2}$ .

## User-centric designs

- Bursty traffic cause devices to change state between idle and connected with the associate **power consumption**
- Significant **overhead** with small packets
- Contention based method have been proposed

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<sup>1</sup>Following [178] paper in depth: Uplink Contention Based Multiple Access for 5G Cellular IoT

Expand based on reference 178

# Uplink contention based methods

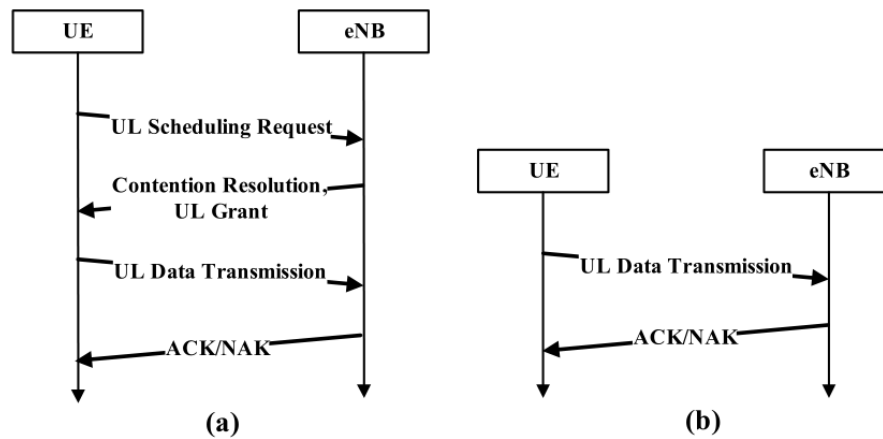


Figure 2: Data reporting via optimized Random Access procedure.

- Small signalling payload
- Direct small data packet

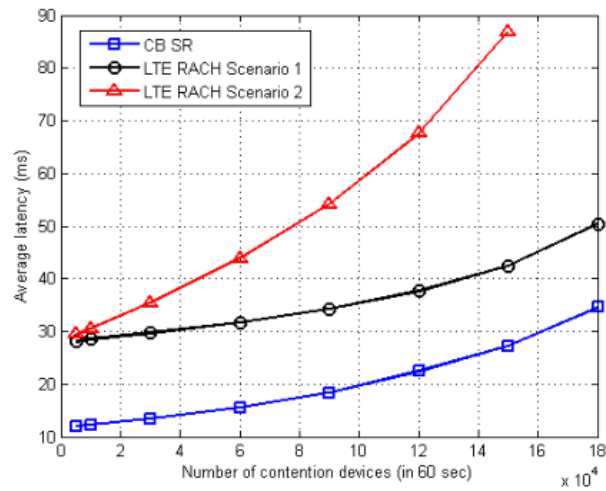


Figure 6. Latency performance improvement by proposed CB SR



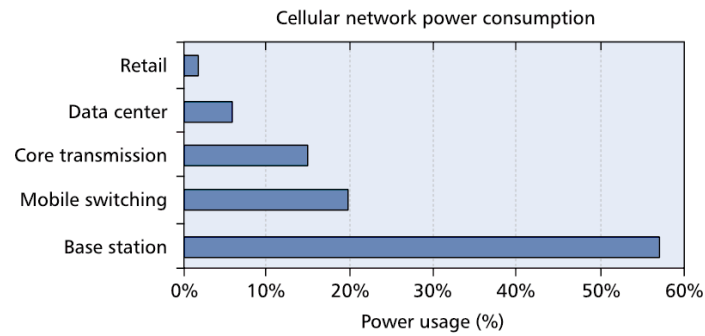
- Power control in green communications
- Energy efficient hardware
- Energy efficient network architecture
- Battery technology enhancement: sugar bio-batteries <sup>2</sup>

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<sup>2</sup>Following [183] paper in depth: *A high-energy-density sugar biobattery based on a synthetic enzymatic pathway*

- The typical density of energy of a Lithium cell is around  $0.54 \text{ MJ kg}^{-1}$
- But the combustion energy of glucose can release up to  $15.5 \text{ MJ kg}^{-1}$
- Sugars are non toxic, safe and carbon neutral

# Reducing power consumption [181]



- The base station is the most power intensive element (more than 50%).
- Also the usual lifetime is around 10–15 years, while smartphones is 2.
- By reducing the power consumption of the largest element, the whole consumption is reduced.