Green communications in 5G

Tim Van Den Driesschen
Rodrigo Arias Mallo

Universitat Politècnica de Catalunya

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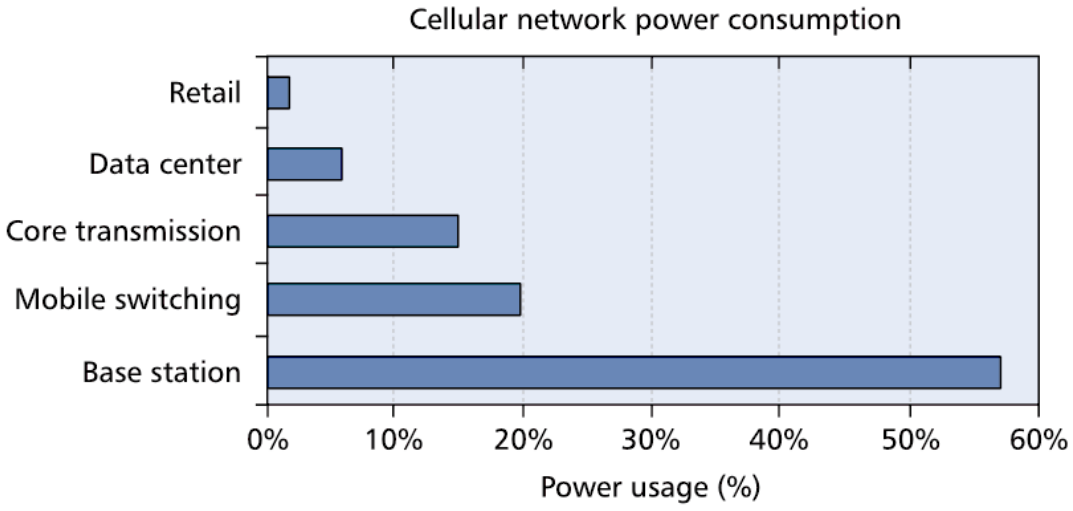
- In the next decade, the number of connected devices is expected to increase 100 times and the data volume by 1000 times
- Operators are already facing significant power bills
- Moving towards green communications is important both for **environmental** and **economic** reasons

Network planning and deployment

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.

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

User-centric designs

Smaller frame overhead [1]

- 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

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

Uplink contention based methods

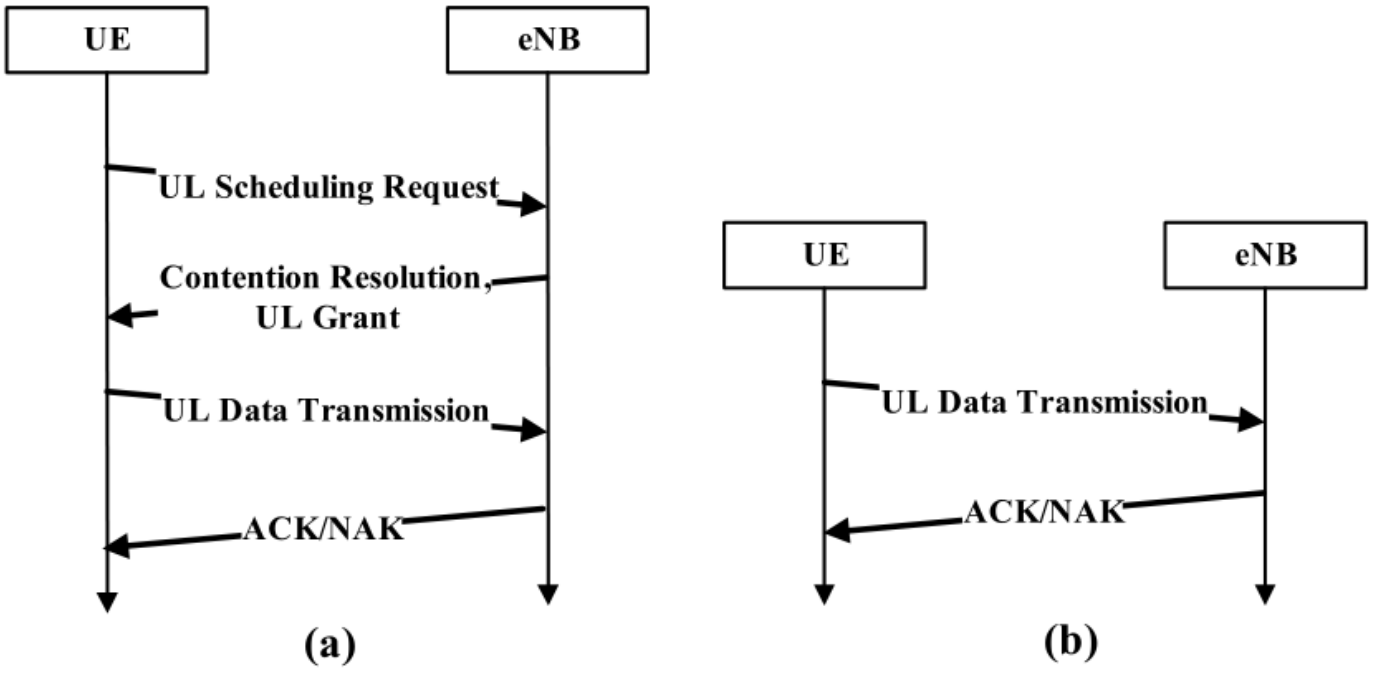


Figure 2: Data reporting via optimized Random Access procedure.

- Small signalling payload
- Direct small data packet

Results of simulation

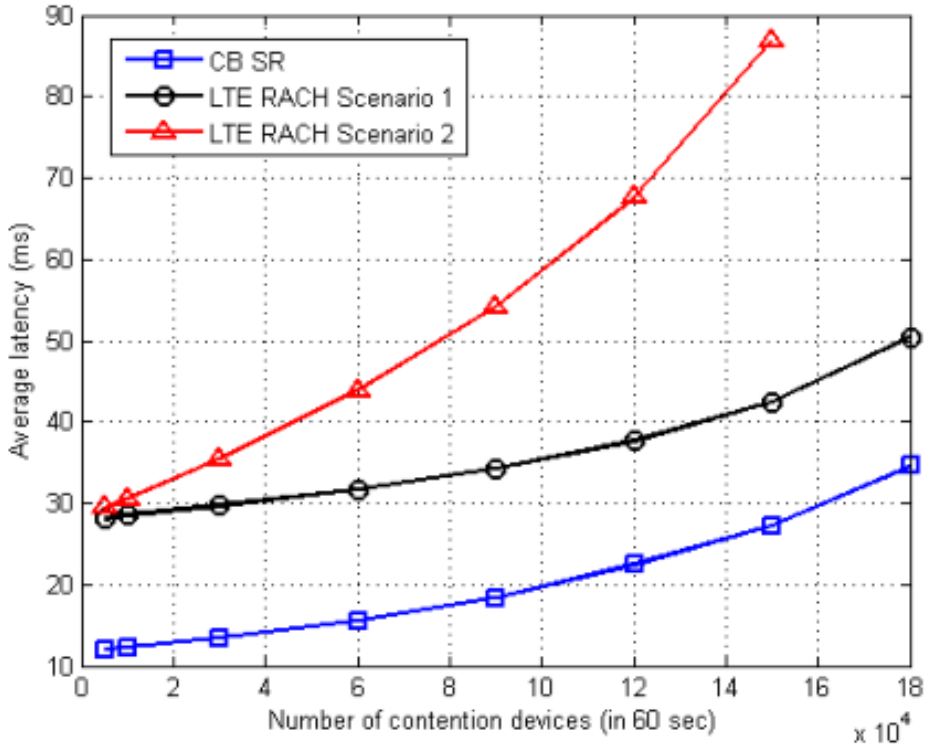


Figure 6. Latency performance improvement by proposed CB SR

Open problems

- Power control: max power BS, sunlight.
- Energy efficient hardware: transceivers
- Energy efficient network architecture: SDN, NFV, data/control plane
- New battery technologies: sugar bio-batteries[2], photo-MFC

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

Sugar bio-batteries [183]

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

Sugar bio-batteries [183]

- Maltodextrin (food additive), produced from starch.
- Sugars are non toxic, safe and carbon neutral
- The lifetime of enzymes is very short (weeks)
- They have to be recharged regularly.