Networking and Wireless Communications Area

Wireless connectivity for IoT/M2M
Alternative approaches

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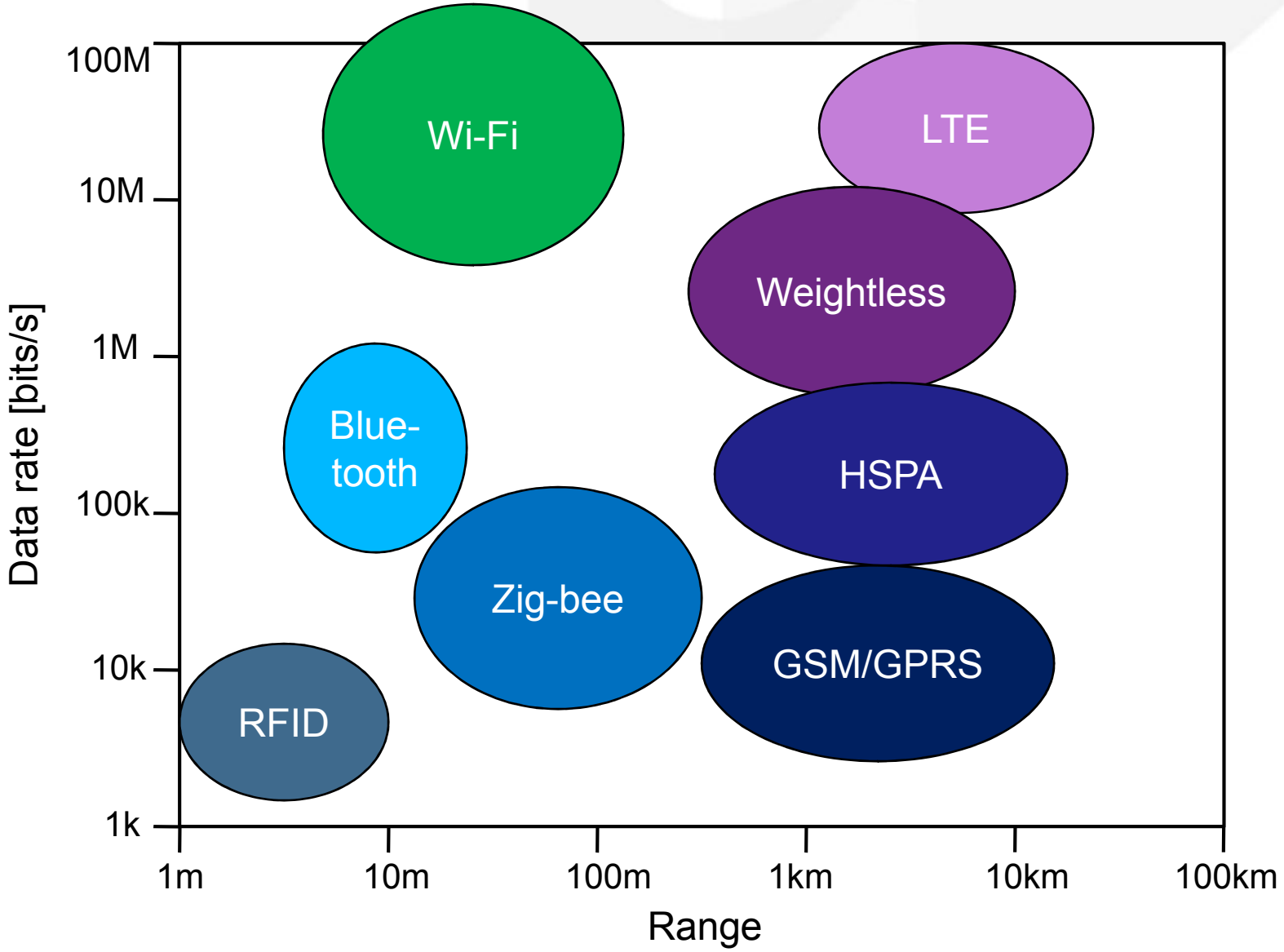
Foreword

- Mainstream development of wireless connectivity solutions for M2M and IoT: existing or forthcoming **wireless communications standards** (RFID, 802.15, Bluetooth, 802.11*, 2G, 3G, 4G, Weightless, …)
- We propose an alternative approach to address some of the most critical requirements, such as node size and power consumption, the need for coordination among nodes, **extended range**, **lack of infrastructure**.

The range-data rate trade-off



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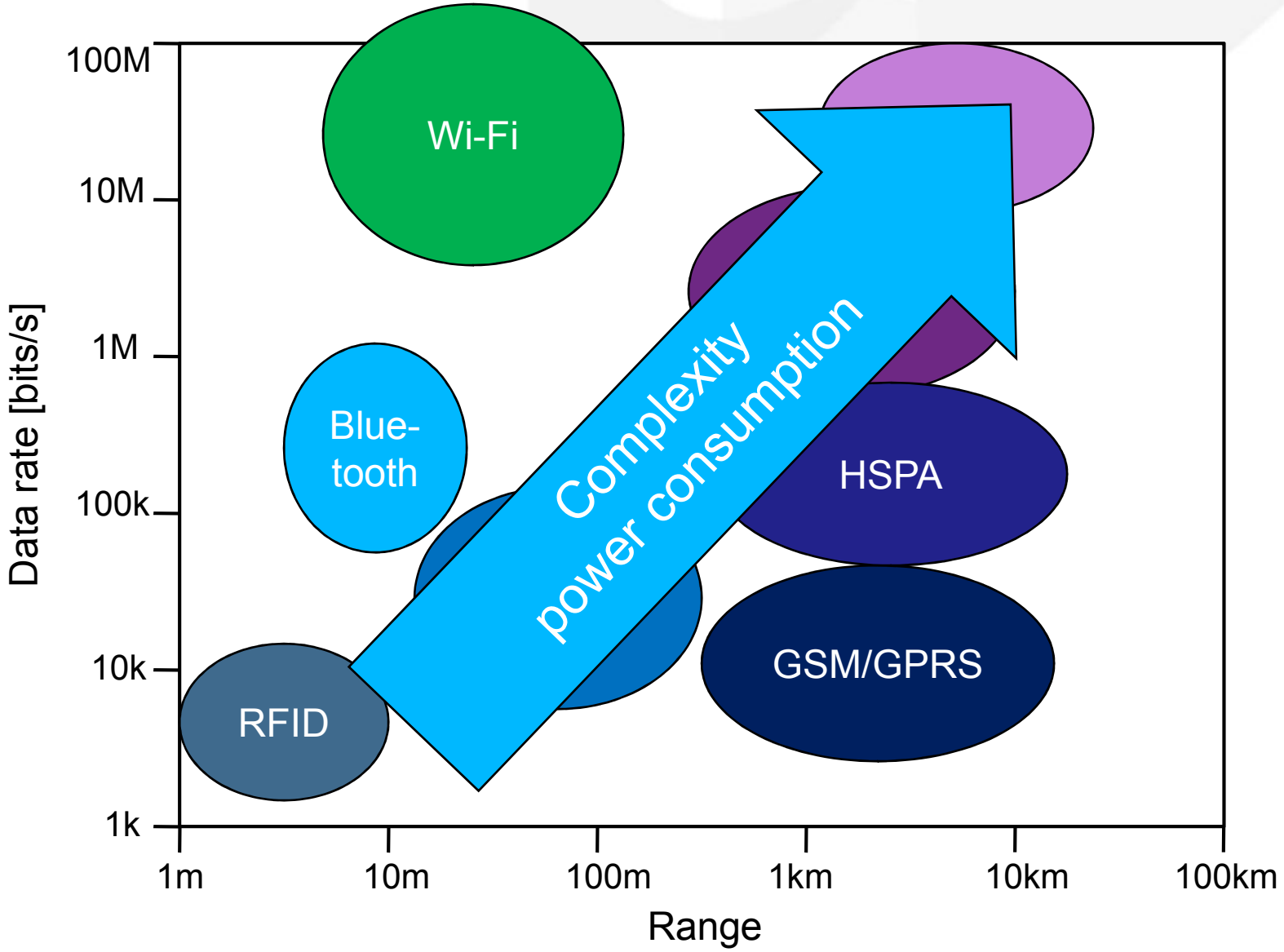

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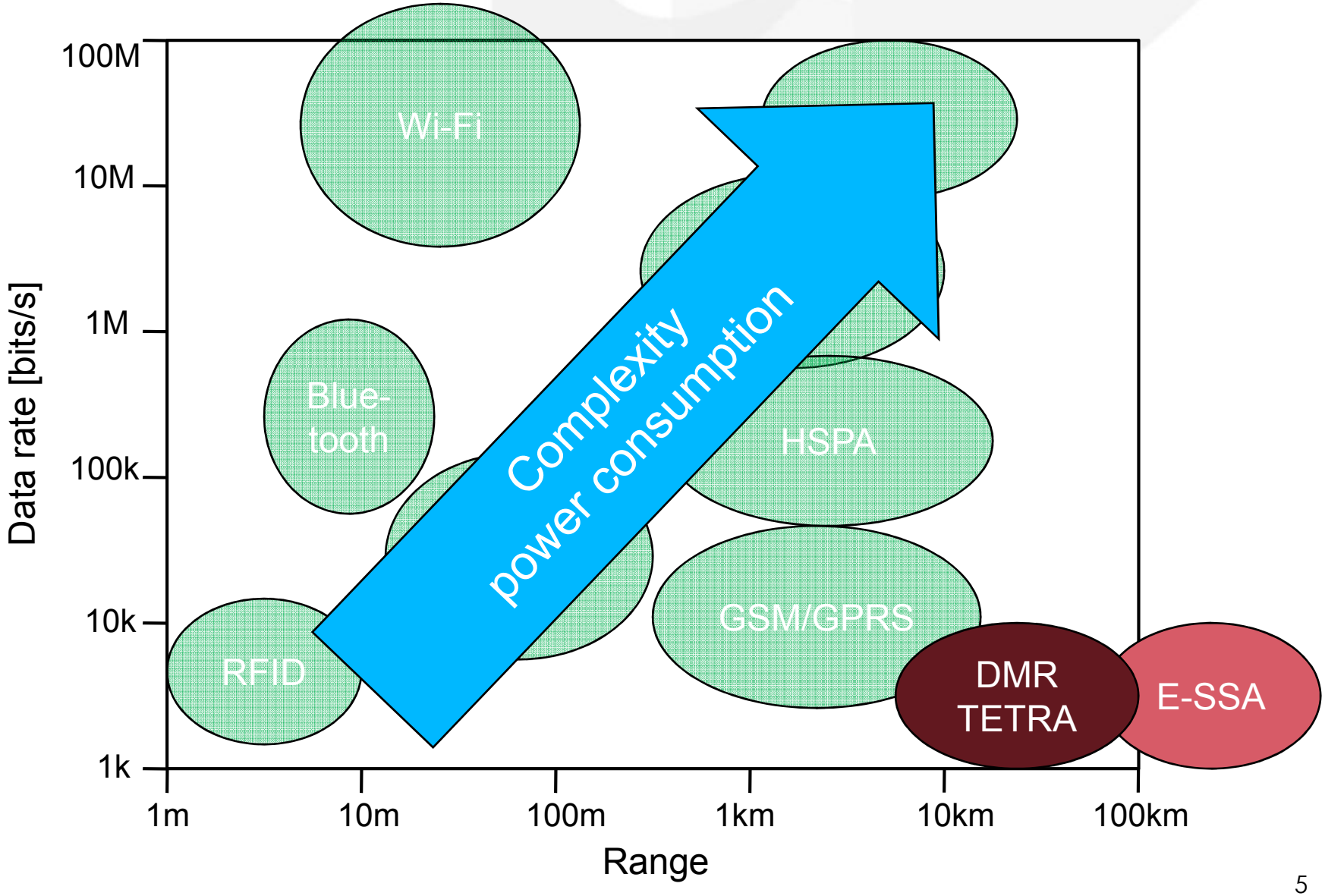
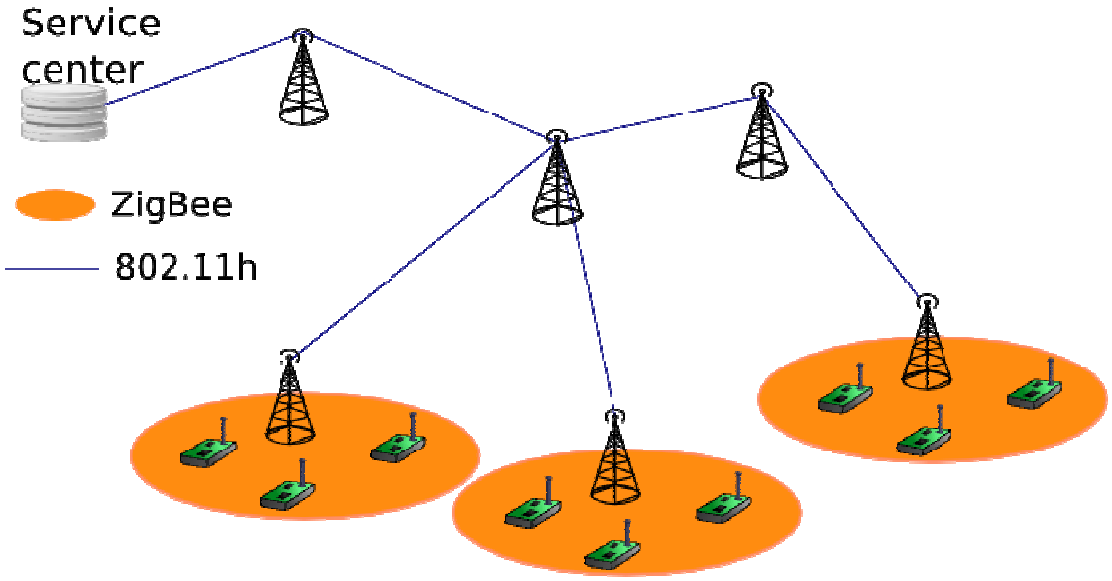


IoT/M2M wireless access

- Many devices
  - Cheap, small, low-power
  - Low, **asymmetric** data rates
  - Deployed over wide areas → difficult to coordinate
- Commonly adopted solutions
  - 802.15.x, Bluetooth are short range
  - **802.11*, 2G, 3G, 4G, ad-hoc solutions**
- Our approach
  - **Professional Mobile Radio (PMR)** systems used as **long-range** connectivity systems



Wireless connectivity with PMR and satellite

- Professional Mobile Radio (PMR) systems
  - Standards defined to provide highly reliable long-range voice communicaton

- Available options
  - **Digital Mobile Radio (DMR)**
  - **TErrestrial Trunked RAdio (TETRA)**

- If PMR range is still not enough...
  - Enhanced-Spread Spectrum Aloha (E-SSA)
  - Recent (2012) ETSI standard: S-MIM

Our current applications

- Our current applications
  - Environment monitoring
  - Weather stations
  - Monitoring of energy microgeneration sites
  - Pollution sensors
  - ……..
- Common features
  - Moderate to low bit rates
  - Low duty cycles or sporadic transmissions

Wireless connectivity with DMR

- **Digital Mobile Radio (DMR)**
  - Recent ETSI standard
  - Narrow band: 12.5kHz → lots of channels (trunking)
  - Long range: up to 100km (operates on VHF and low UHF bands)
  - Large **single-frequency networks** (SFN) with **few base stations** → low-cost infrastructure
  - On-demand network activation → low power consumption
  - Low per-node data rates: 1600÷6400 bits/s
  - Spectral efficiency: 0.13÷0.51 bits/s/Hz

Wireless connectivity with DMR

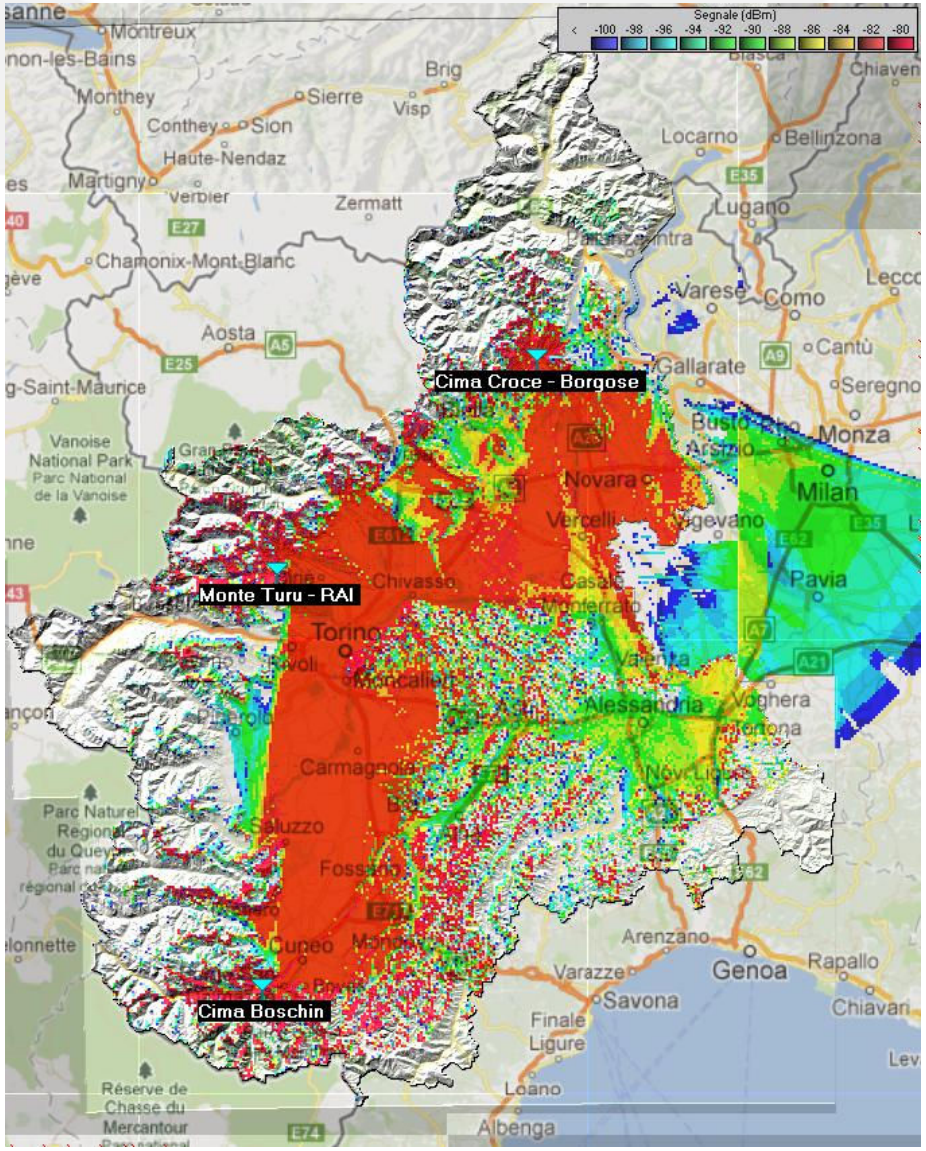
- **Digital Mobile Radio (DMR)**
  - Capacity estimation
    - Uncompressed UDP/IP over DMR packet data protocol
    - Single DMR channel/slot
    - PHY data rate: 3.2 kbits/s
    - Assumption: no collisions
  - Available data modems: none

We are developing a software-defined DMR modem using low-power embedded hardware

Number of nodes		Payload [bytes]			
		32	**128**	**1k**	**64k**
Polling interval	**10s**	47	22	3	0
	1m	285	133	22	0
	10m	2857	1333	224	3
	1h	17142	8000	1348	21

Single-frequency DMR network

- Coverage of Piedmont by a single-frequency network of **three DMR base stations**
- Approx. area: 25000 sq.km.

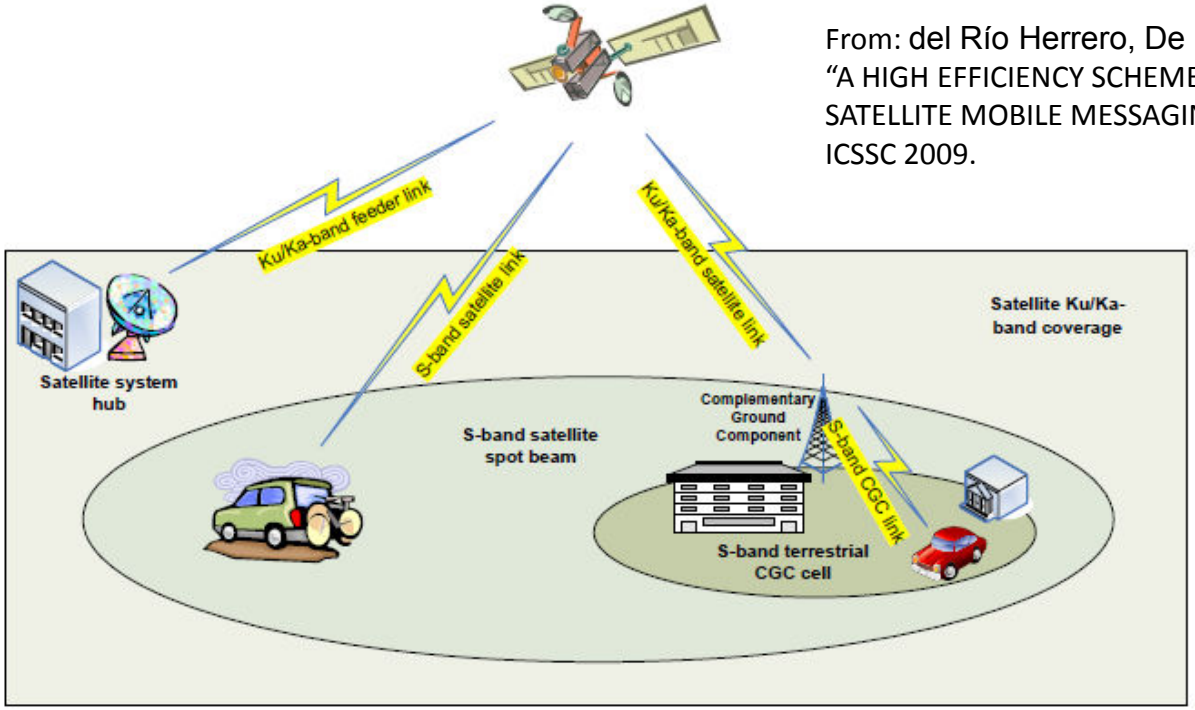


Wireless connectivity with TETRA

- **TErrestrial Trunked RAdio (TETRA)**
  - Established ETSI standard
  - Narrow band: 25kHz with 4-slot TDMA
  - Shorter range: up to 58km
  - Data rates: 28.8 kbits/s (538 kbits/s for TEDS)
  - Higher spectral efficiency:
    1.15 bits/s/Hz
    Up to 3.59 bits/s/Hz for TEDS with shorter range

Wireless connectivity with E-SSA

- Enhanced Spread-Spectrum Aloha (E-SSA)
  - Recently proposed for *satellite mobile messaging systems*: location-based services, data acquisition services
  - A large number of low data rate terminals
  - Achieves a *high spectral efficiency*, close to 2 bits/s/Hz



From: del Río Herrero, De Gaudenzi, "A HIGH EFFICIENCY SCHEME FOR LARGE-SCALE SATELLITE MOBILE MESSAGING SYSTEMS," ICSSC 2009.

Wireless connectivity with PMR

- Attractive solution when
  - Long range is required
  - No available infrasctructure
  - Low data rates are enough
- Pros, cons
  - (+) Long range
  - (+) Alternative to 2/3/4G
  - (+) Flexibility (trunking)
  - (+) Low complexity
  - (+-) Cost of infrastructure
  - (-) Few products available
- Applications
  - Weather monitoring
  - Fleet management
  - ...

THANK YOU!

Contact

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