Multicode based communications in Impulse Radio UWB systems

Eric A. Bouton[1] Philippe Ciblat[1] Christophe J. Le Martret[2]

[1] Département Communications et Electronique
TELECOM ParisTech, Paris, France

[2] THALES Land and Joint Systems, Colombes, France

3rd AIBan Conference
Porto, Portugal, June 19, 2009

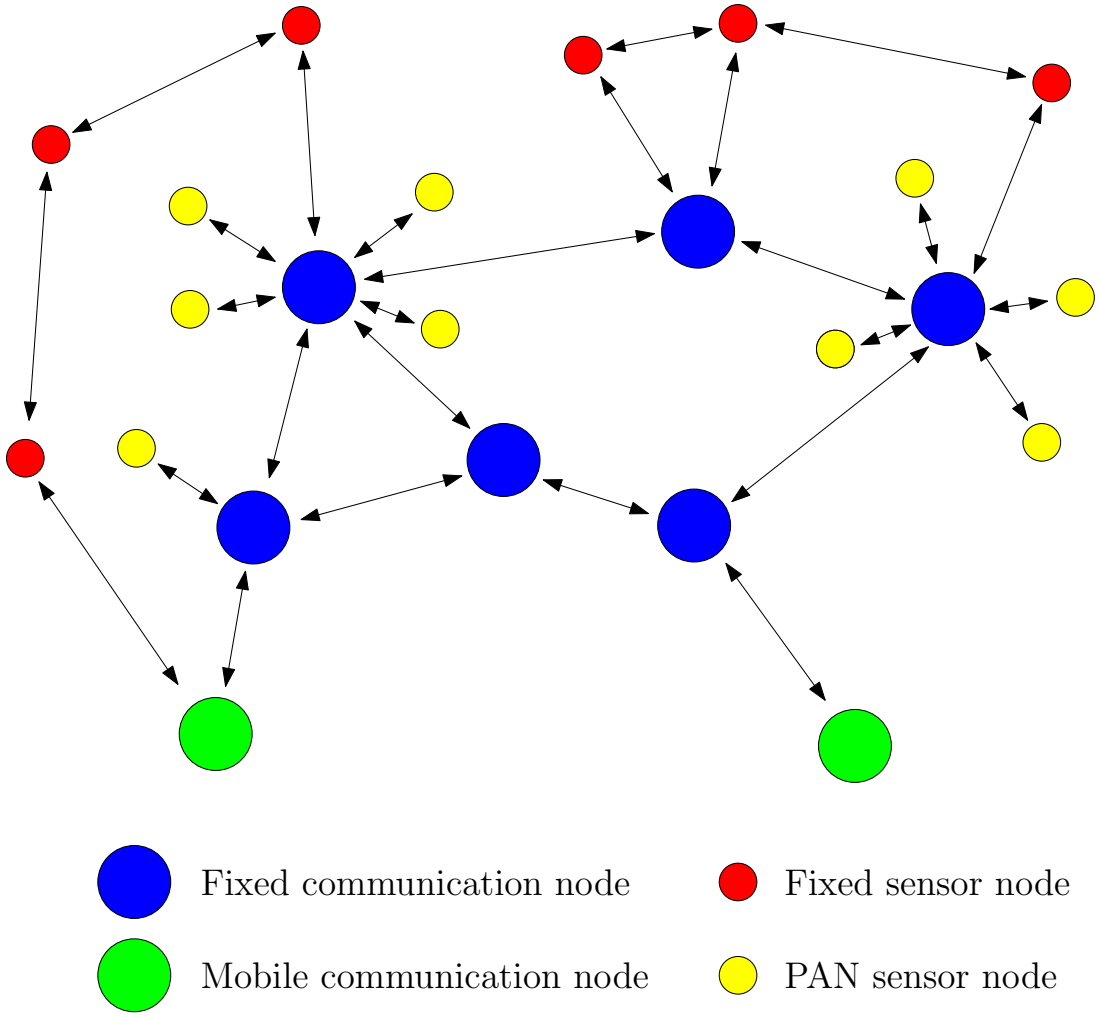
Outline

1. Introduction and motivation;
2. general context and system model;
3. numerical results;
4. concluding remarks.

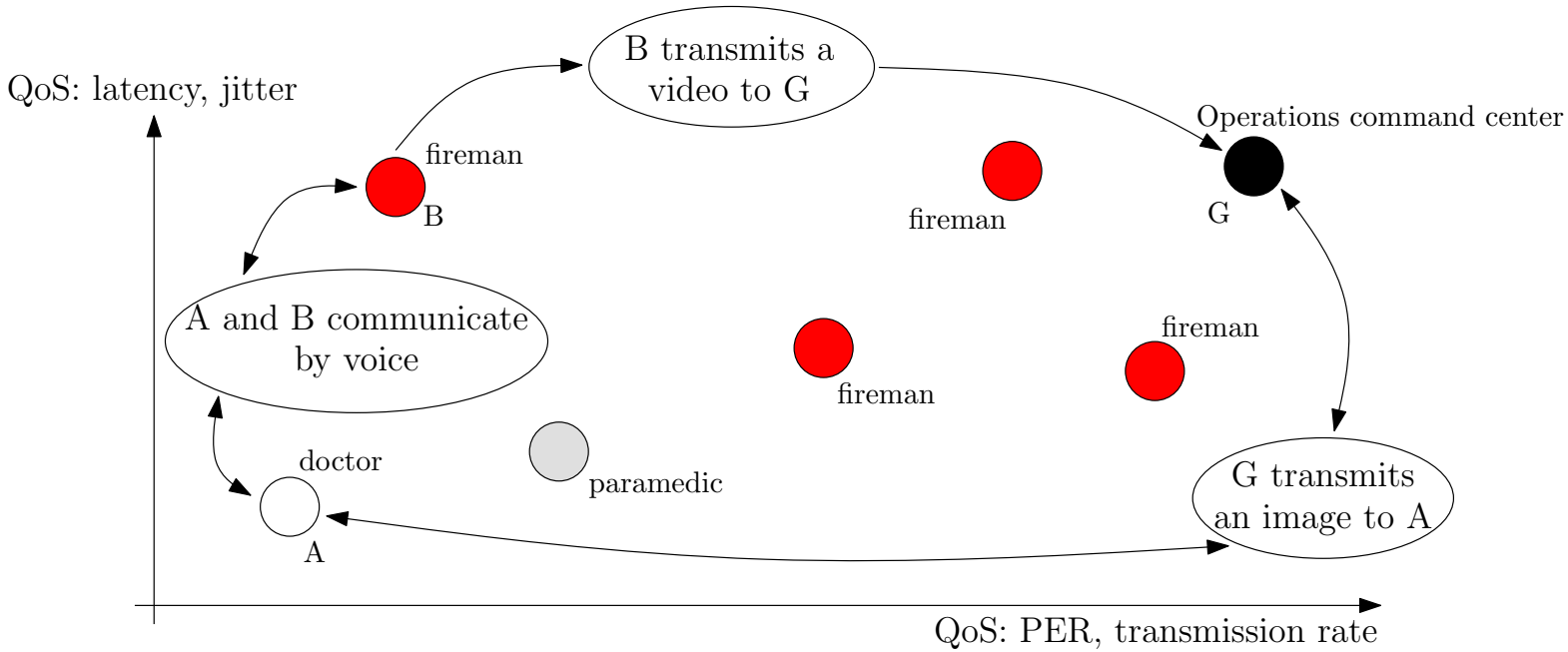
Introduction and motivation

- Today, state-of-the-art communications systems allow very high information transmission rates;
- many different types of system coexist and thus generate interference between each other;
- this interference limits the data rates and can eventually lead to network saturation;
- the main objective of this project is to use this heterogeneous infrastructure in a crisis situation.

General context of the project

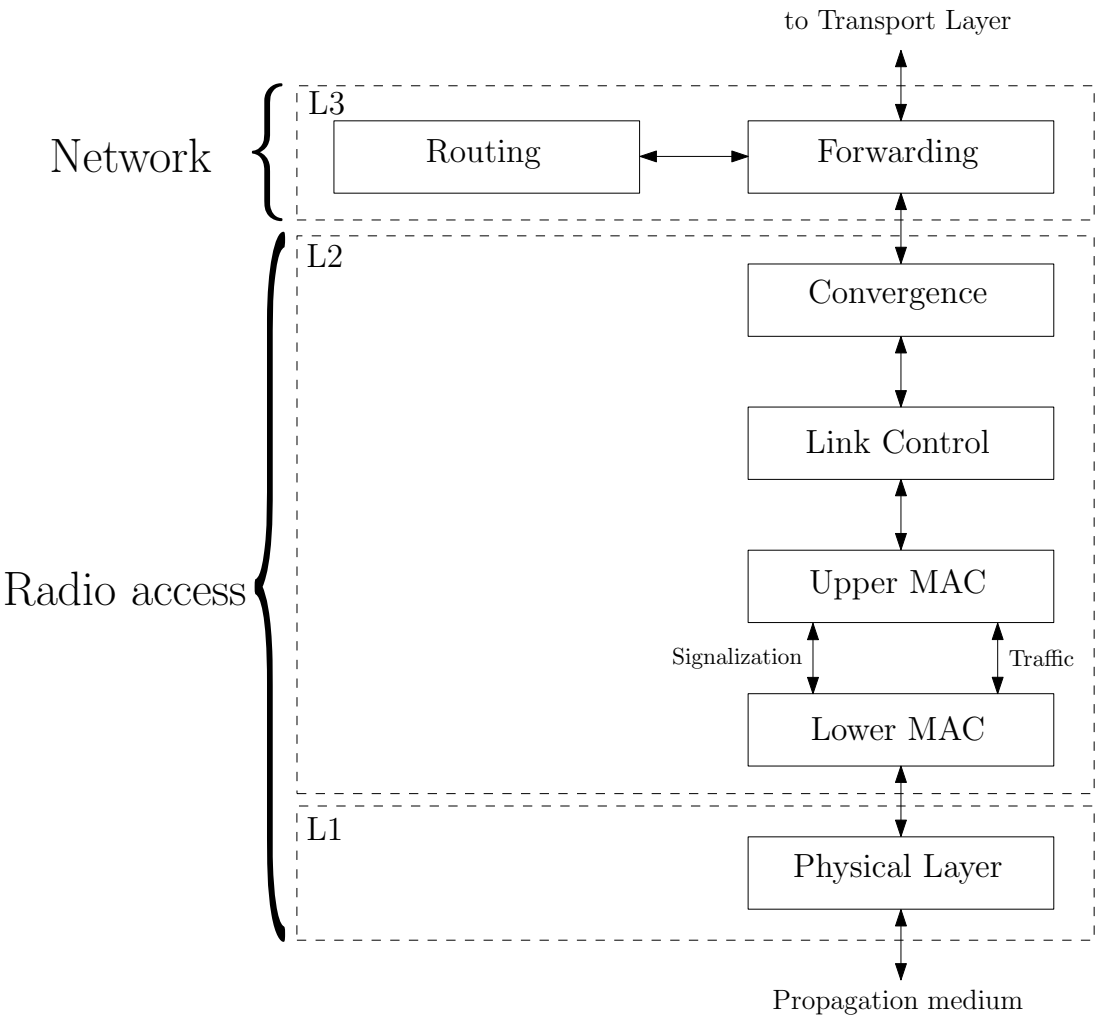


Example scenario



- A fireman (B) is aiding a victim and requests medical assistance;
- the operations command center (G) links B with a doctor (A), by voice;
- B sends a video to G, which extracts a picture and sends it to A.

Layer organization



- L1 establishes the links and establishes the comm. constraints;
- L2 orchestrates the way how the different links access the network;
- L3 ensures routing, in order to obtain a more reactive setting.

System model

- The physical layer in this project is Impulse Radio Ultra Wide Band (IR UWB)

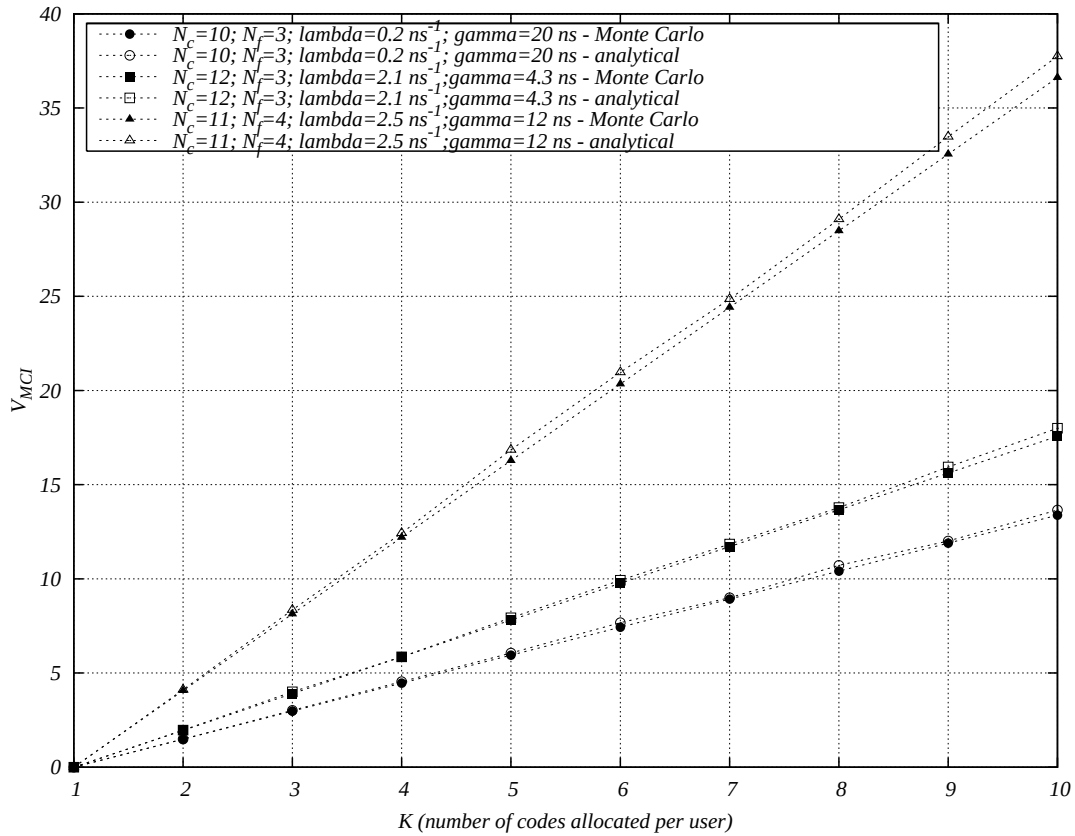
Advantages:

- data waveforms can be used to accurately measure node positions;
- IR UWB is naturally secure against wiretaps and frequency jams.

Our contribution

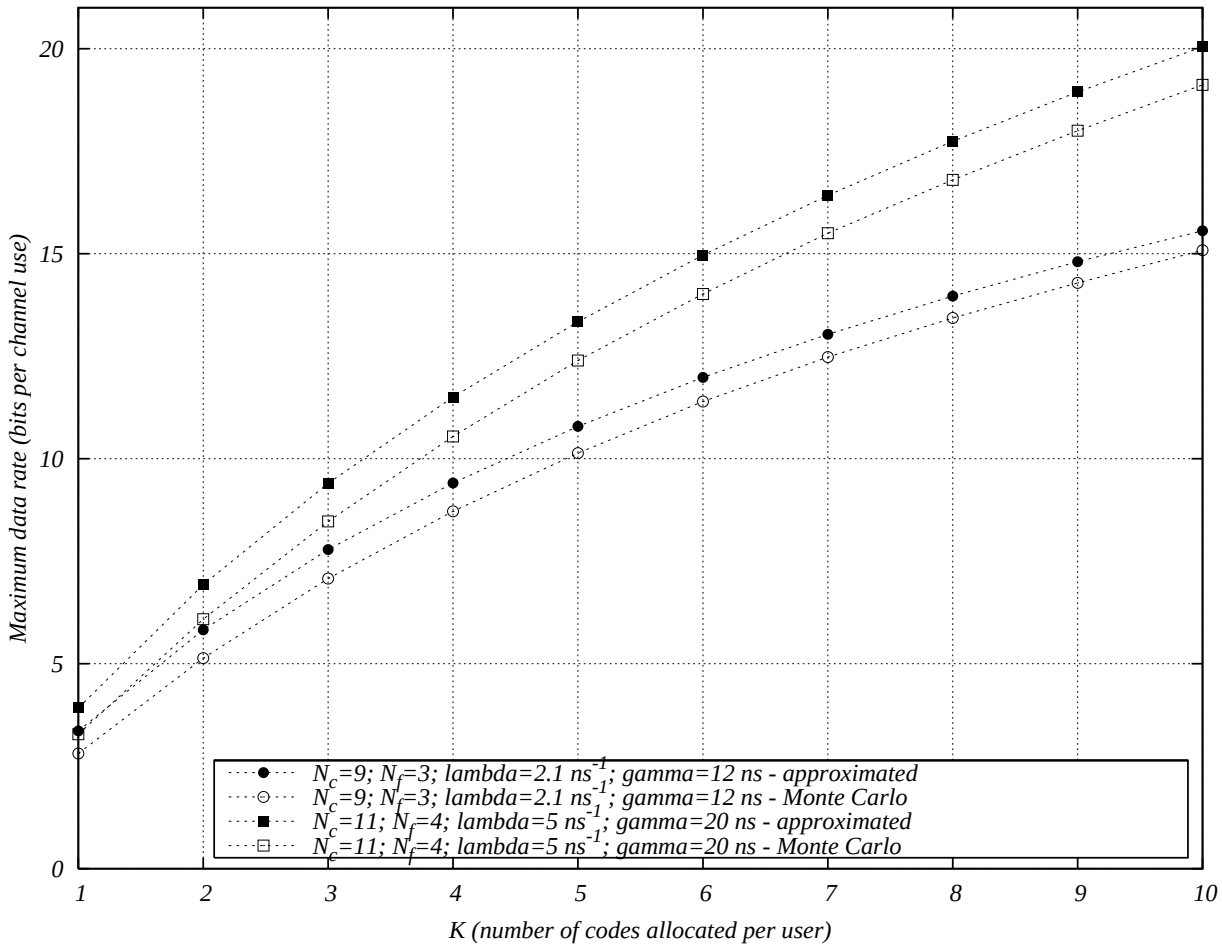
1. We propose a novel way of increasing the total data rate of the system;
2. we derive approximations that allow us to efficiently analyze the system's performance in a crisis situation.

Results and numerical illustrations



- Simulated (monte-carlo) and approximated interference are very close;
- the analytical solution is calculated approximately 1000 times faster.

Results and numerical illustrations



- the approximated expression gives a rough, but good enough estimate of the system's data rate.

Concluding remarks

- Multicode based UWB systems provide a novel way to boost communication data rates;
- The derived closed formula for the multicode interference highlight the influence of the channel and system parameters;
- This analytical result allows a rough, but very fast estimate of the achievable data rates of the system.

Maximum transmission rate

- The benefits of the multicode approach can be seen in terms of maximum transmission rate.
- Our approximations allow us to efficiently estimate the maximum rate.
  - ergodic maximum rate:

$$R_{max}^{(e)} = \mathbb{E}_{a,\tau,c}\left[K \log_2\left(1 + \frac{z_u^2}{z_{mci}^2 + \sigma_\eta^2}\right)\right],$$

  - approximated maximum rate:

$$R_{max}^{(a)} = K \log_2\left(1 + \frac{U}{V + \mathbb{E}_{a,\tau}[\sigma_\eta^2]}\right).$$