citi Center of Innovation in Telecommunications and Integration of Service lab

RECHERCHE

INSTITUT NATIONAL DES SCIENCES APPLIQUÉES DE LYON

Inria INVENTEURS DU MONDE NUMÉRIQUE

The Software Defined Radio for Wireless Systems

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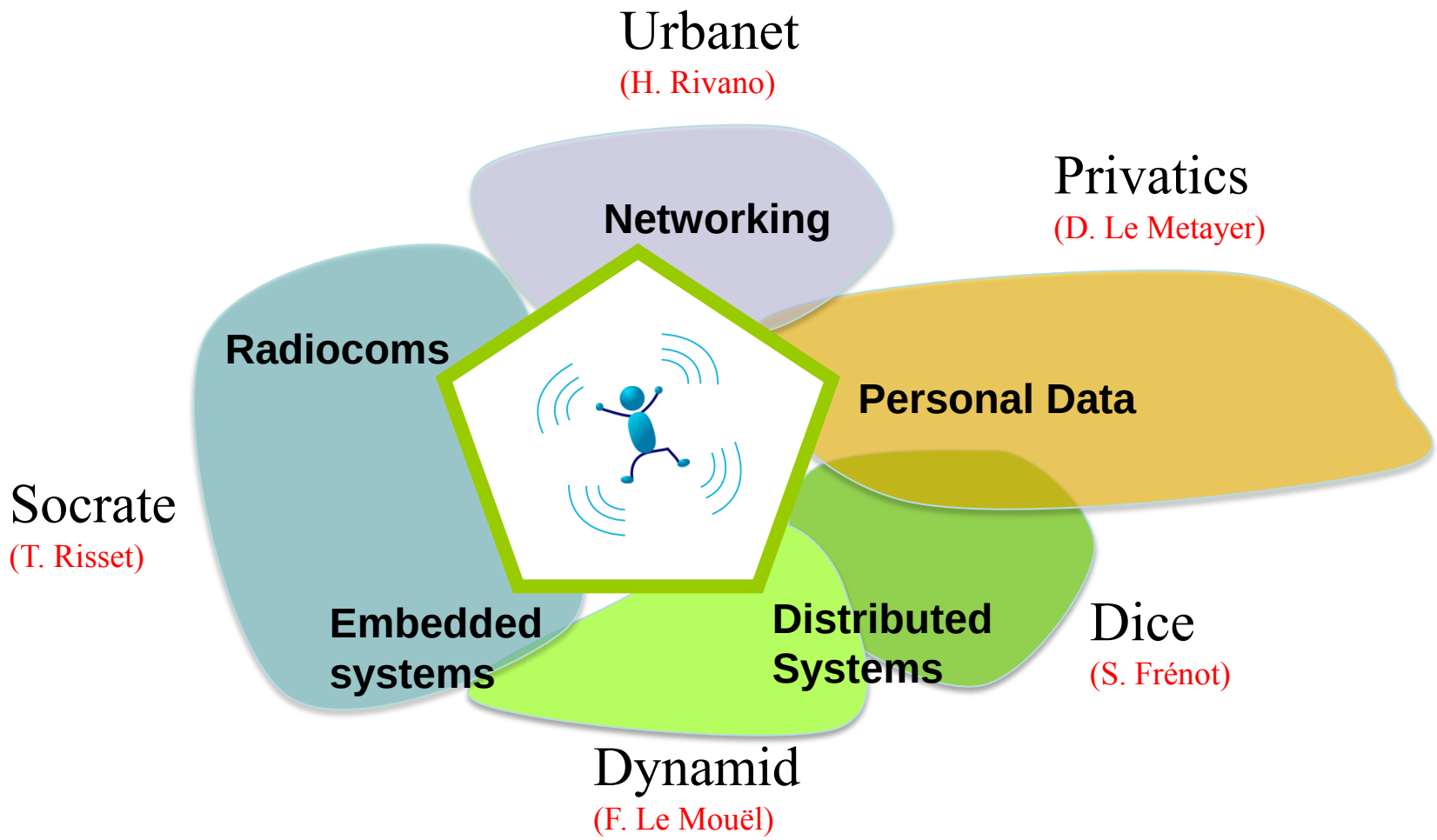
INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

The CITI lab in a nutshell



Technology-driven research

WSN

- Energy, delay, reliability
- Self-*
- Low resources
- Dedicated OS or middleware

RAN

- Capacity, energy
- Multi-standards
- Software radio
- Self-*
- Applications deployment

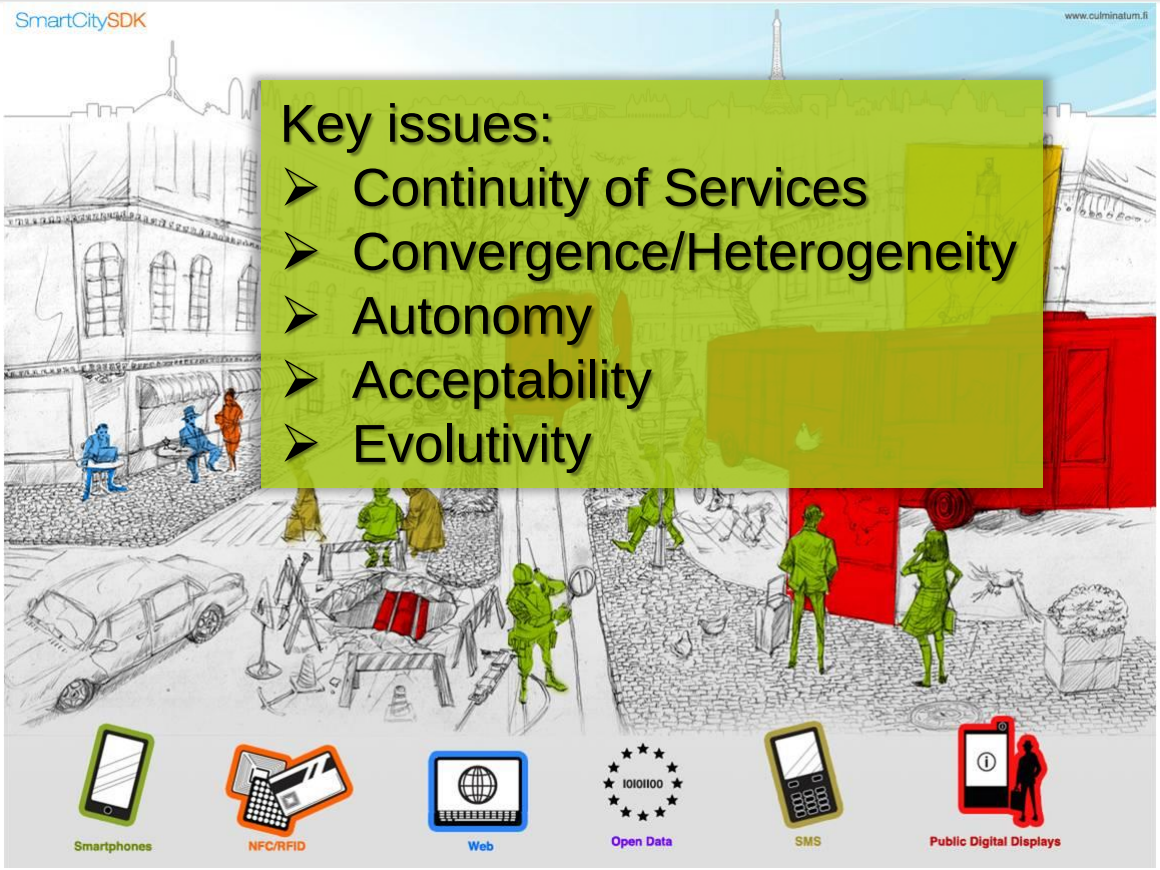
Social networks

- Privacy
- Pervasived computation
- Distribued approaches

IoT, Digital human, Digital society

New context

New challenge:
« Human connected to the Digital Society »



Main targets

Key issues:

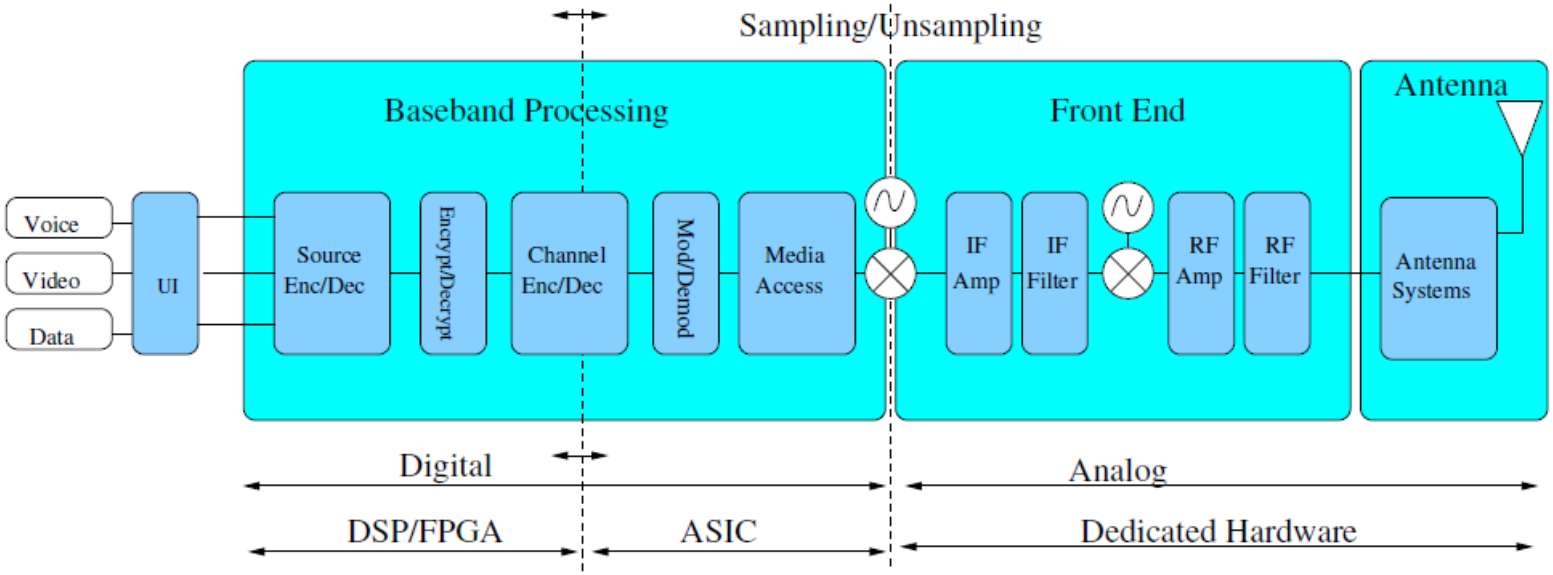
- Continuity of Services
- Convergence/Heterogeneity
- Autonomy
- Acceptability
- Evolutivity

High Performance Multi-*

WSN and Home Networks

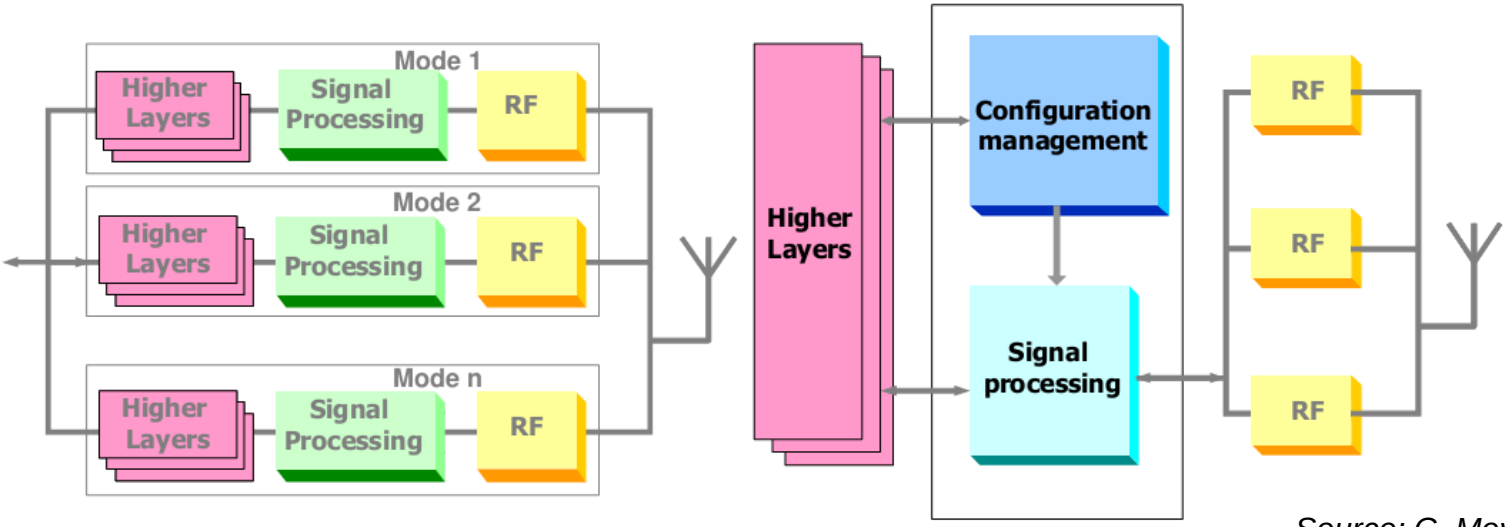
Software Defined Radio

Software Defined Radio: principle



The ideal Software Radio is not actually possible, the aim is to find the good balance between analog and digital part depending of the application

SDR for multimode: limitation



Source: C. Moy, HDR

Current SDR solutions are using parallel RF chains with a common digital processing resource

Key issues of multi-* receivers

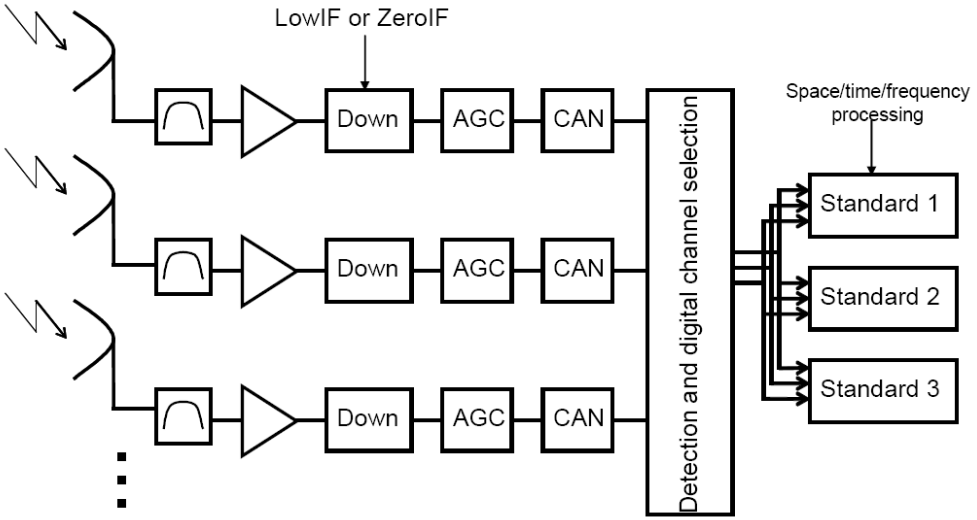
BER / Energy

Integration
Antenna coupling
Channel correlation

Multi-* architecture
Dirty RF
Components pooling

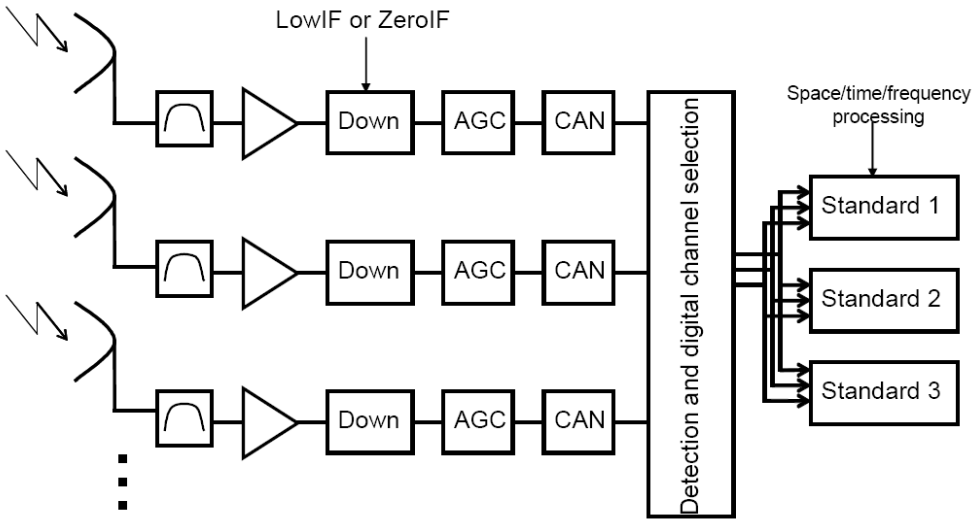
Sensing
Relay
Resource sharing

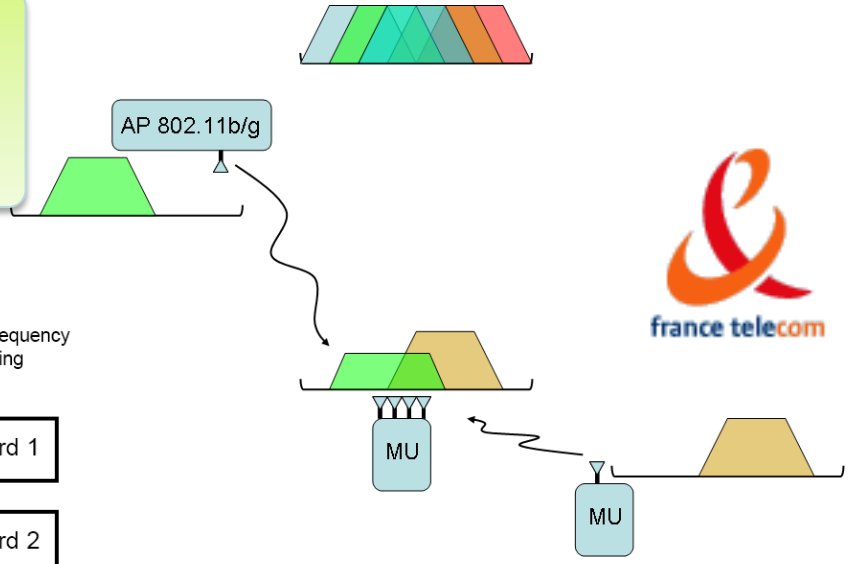
Joint processing
SDR
Green Radio
Implementation
Reconfiguration

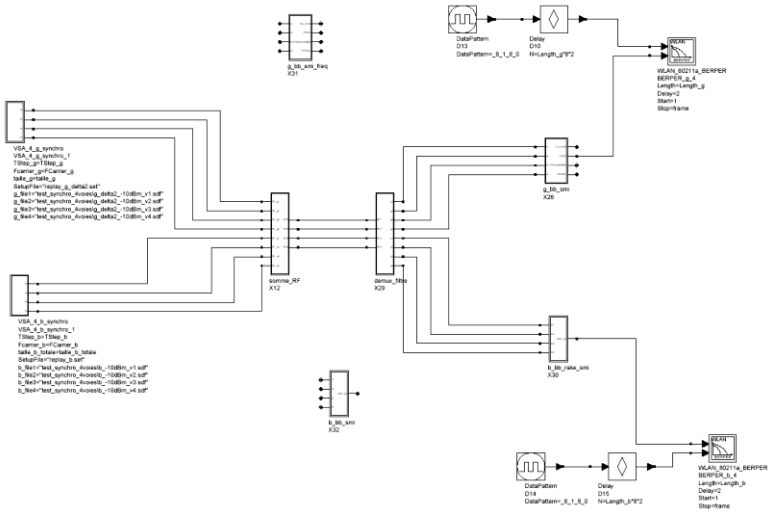


Multi-channel multi-antenna receiver

Main goal: to allow the simultaneous reception of overlapping WiFi channels in the 2.4 GHZ ISM band



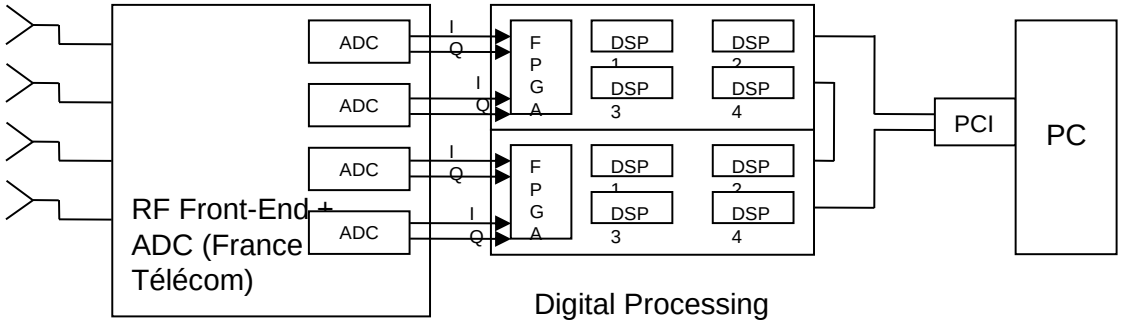


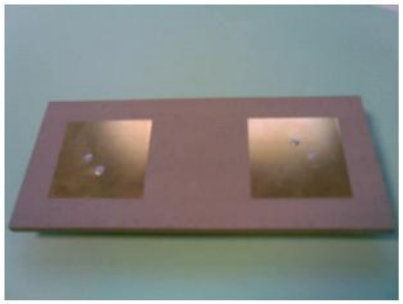


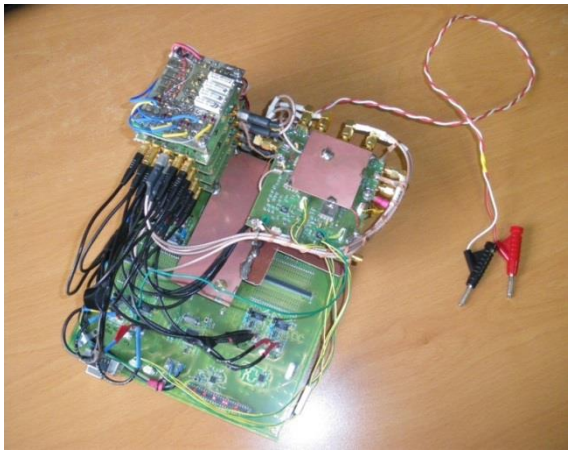
- 1st phase: ADS+radio testbed
- 2nd phase: SDR

First prototype

First experience of developing a software defiend radio prototype

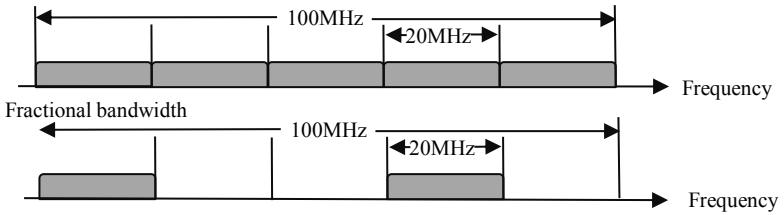


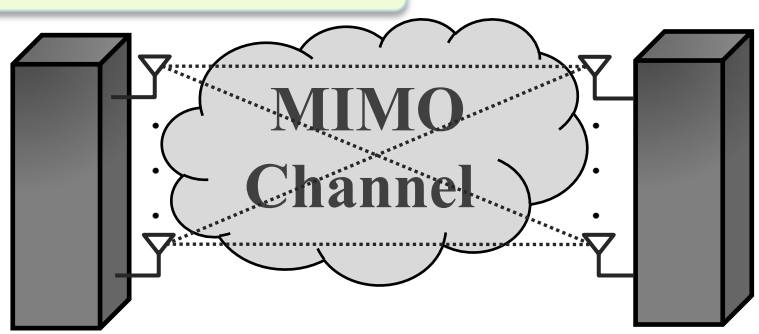


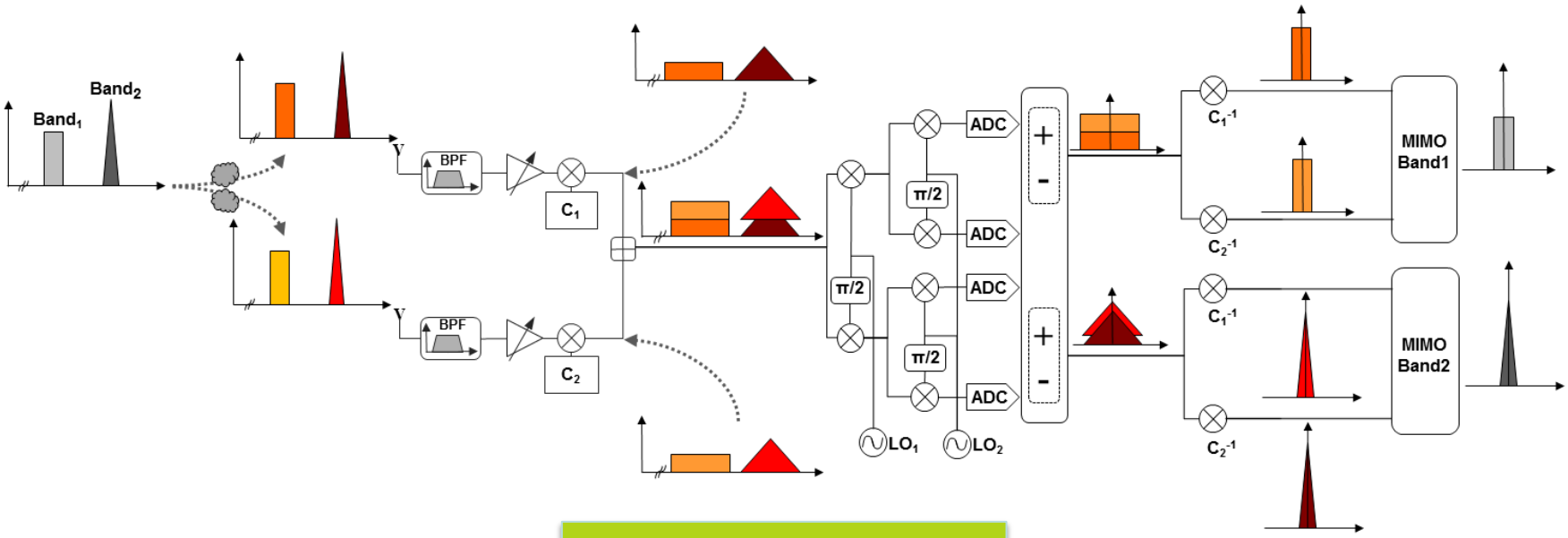


Multi-band, multi-antenna

LTE-Advanced receiver for fractional bandwidths combined with MIMO

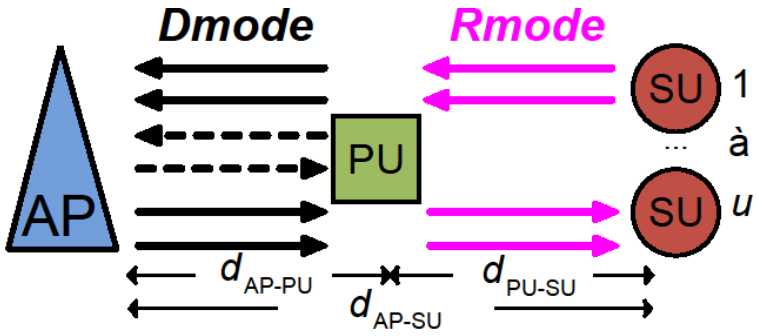




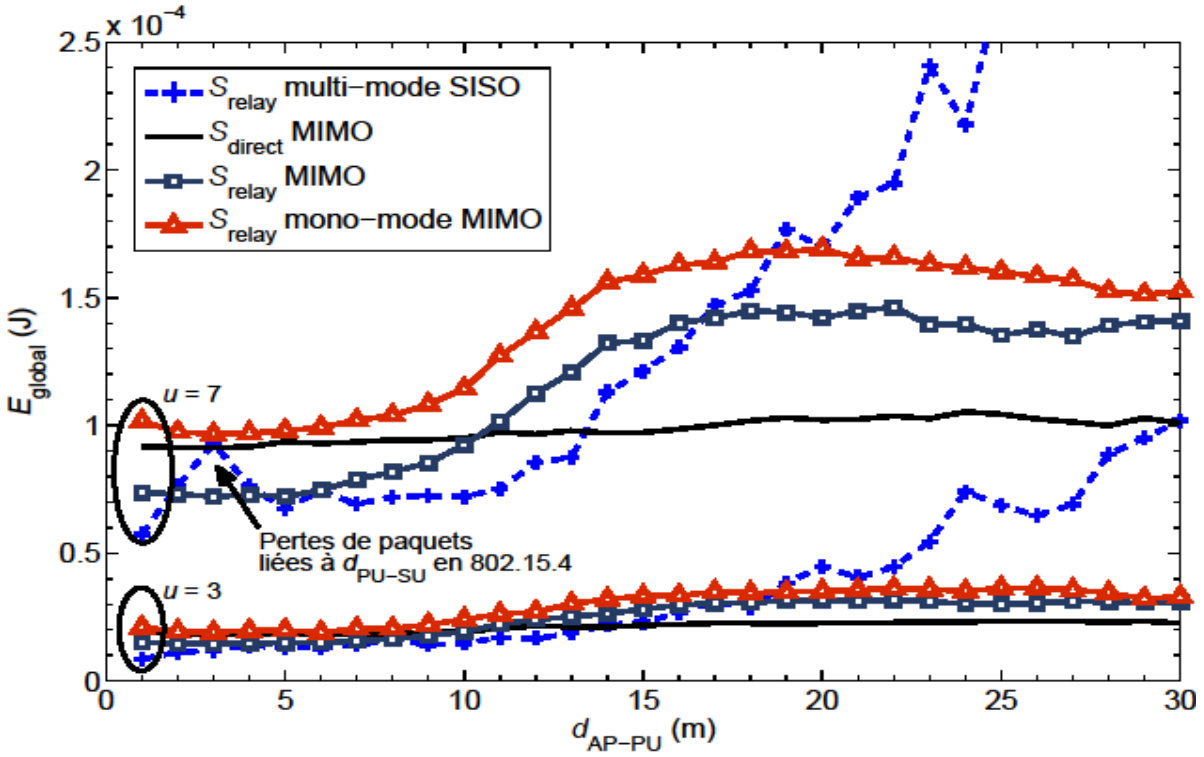


33% less consuming

Multi-* relaying

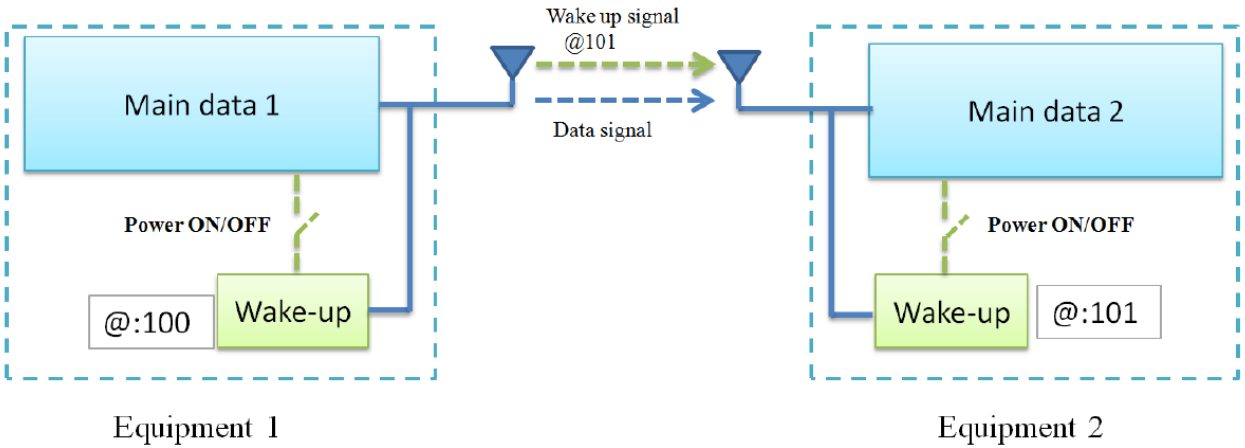


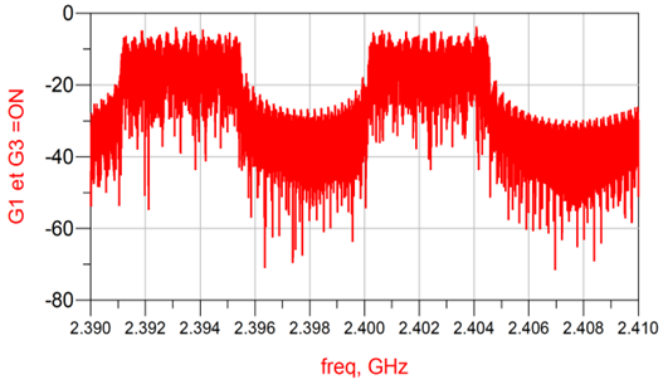
Network simulator: WSNet

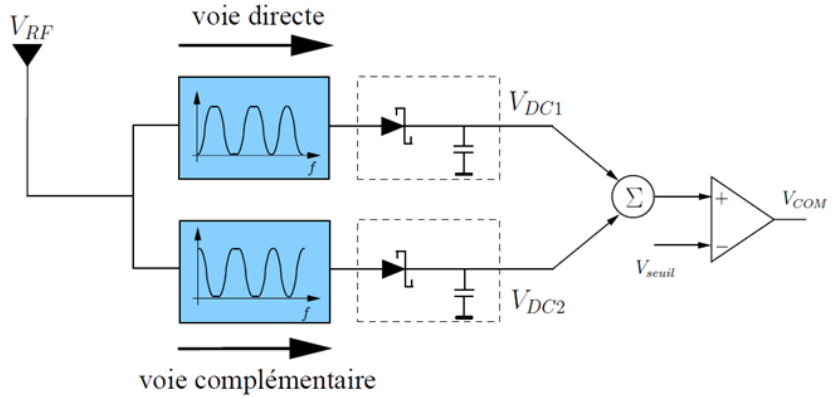


Home Networking

FUI EconHome: Wake-Up radio

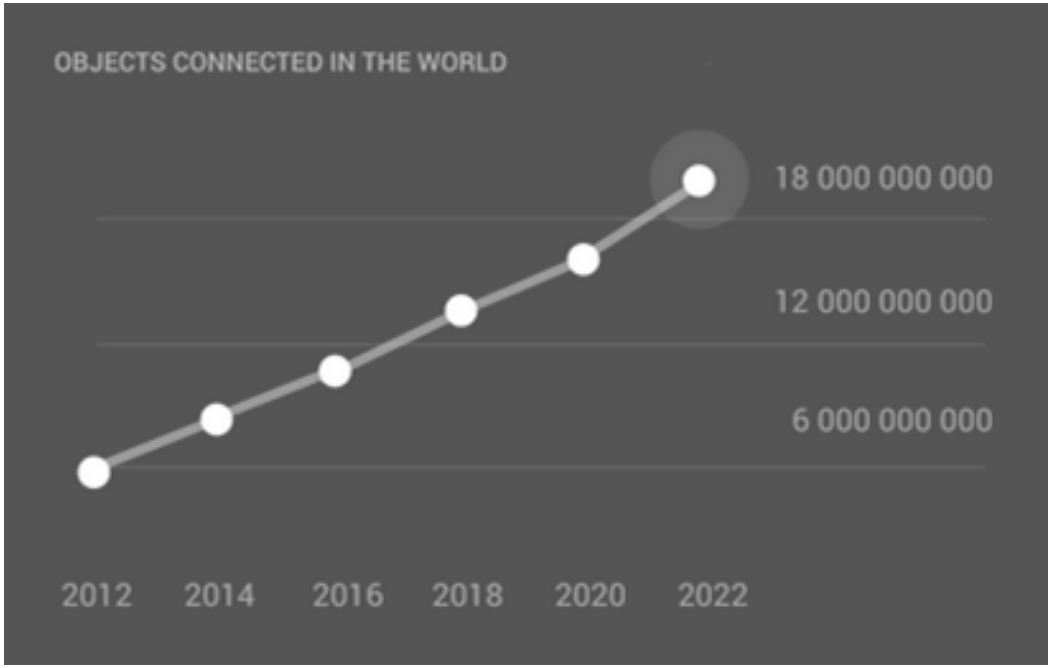






Could be complementary to SDR solutions

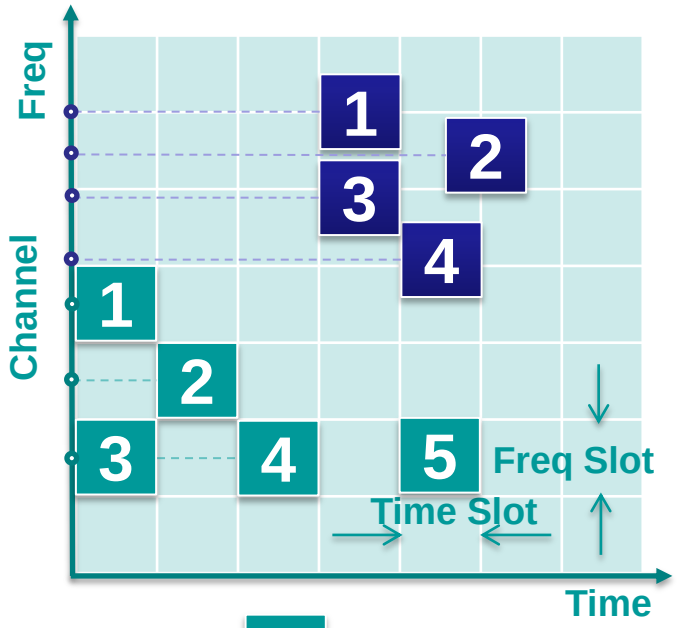
Specific scenario: UNB



Source: Sigfox

Ultra Narrow Band communications for very wide range WSN

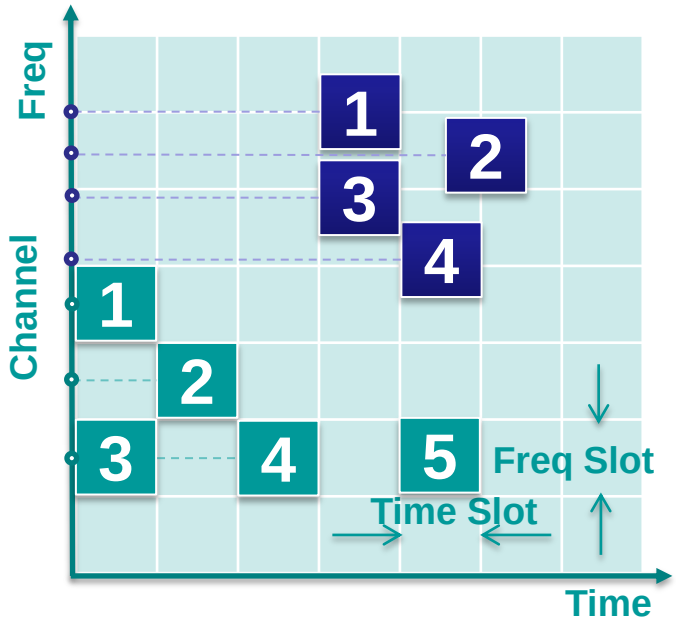
Medium Access with UNB

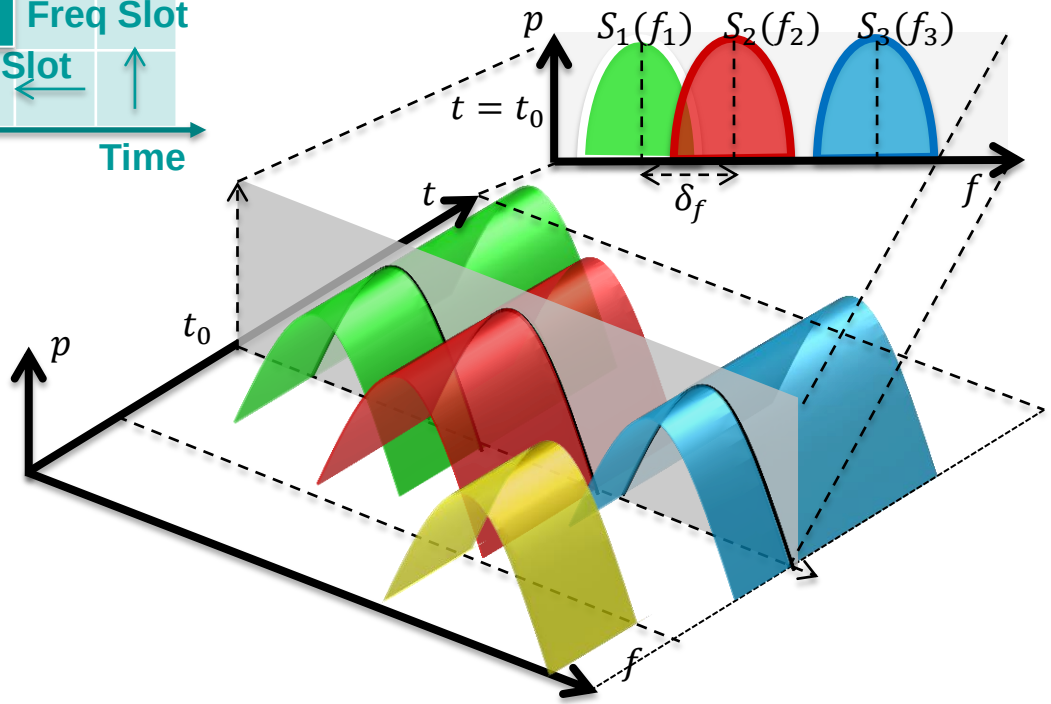


Other MAC

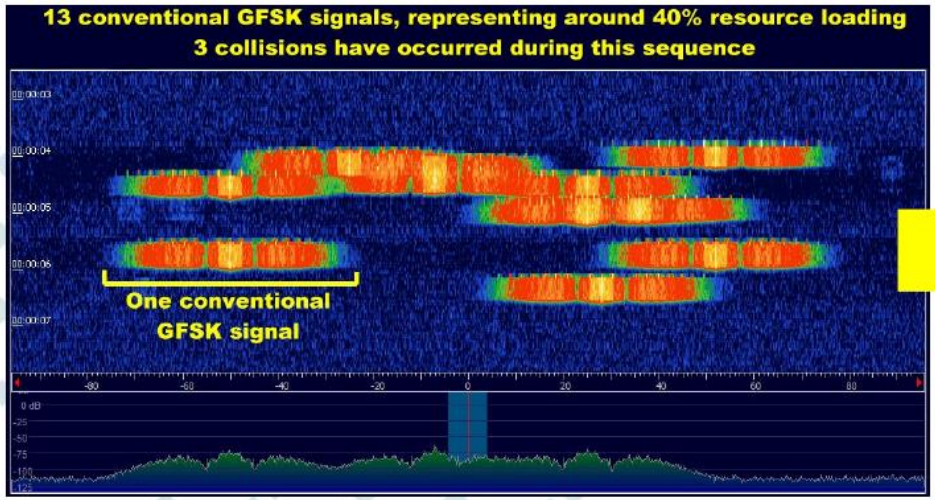
Random-Frequency Multiple Access (R-FDMA) schemes

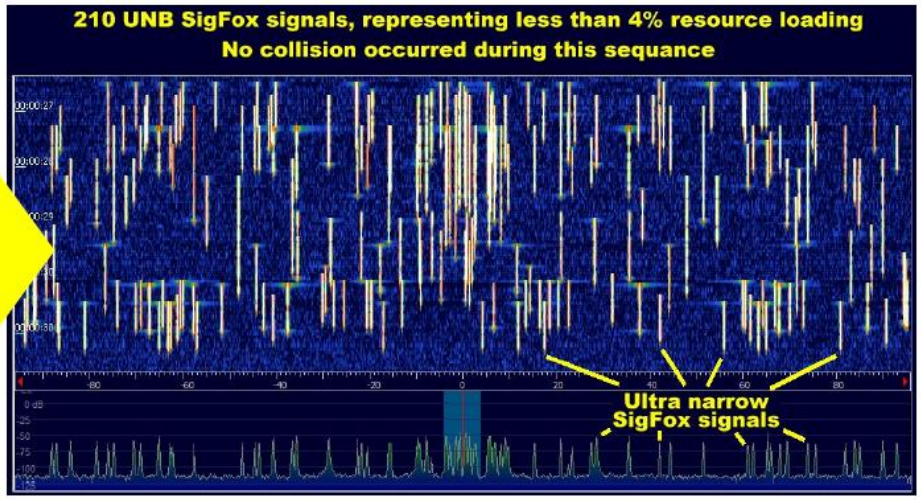
Medium Access with UNB





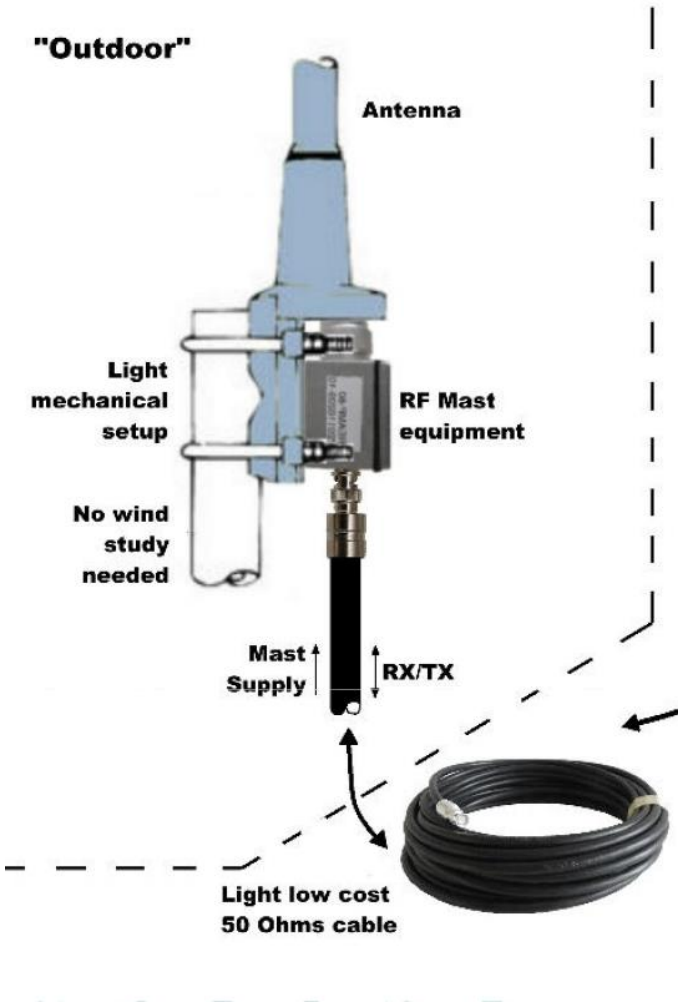
Solution: SDR gateway



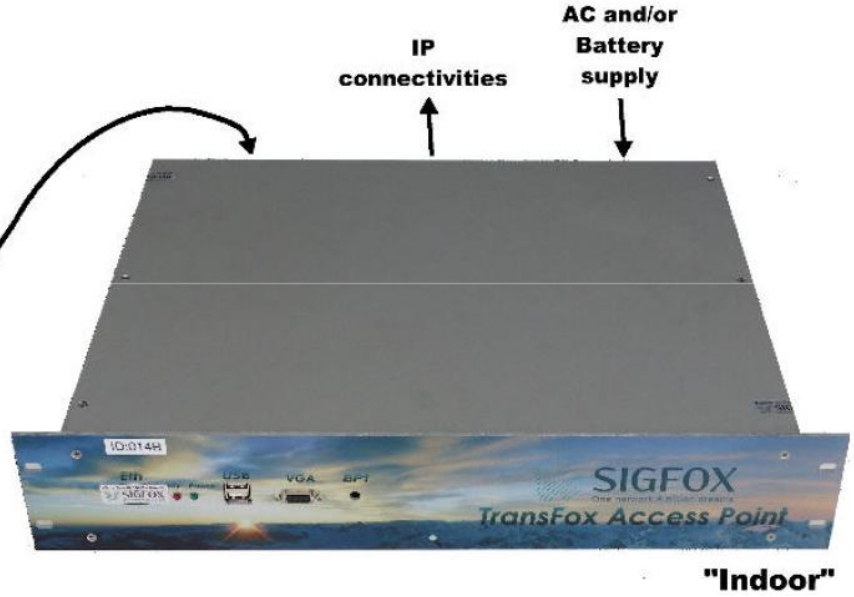


The drastic reduction of complexity for the emitter side is compensated by the capacity of the SDR basestation

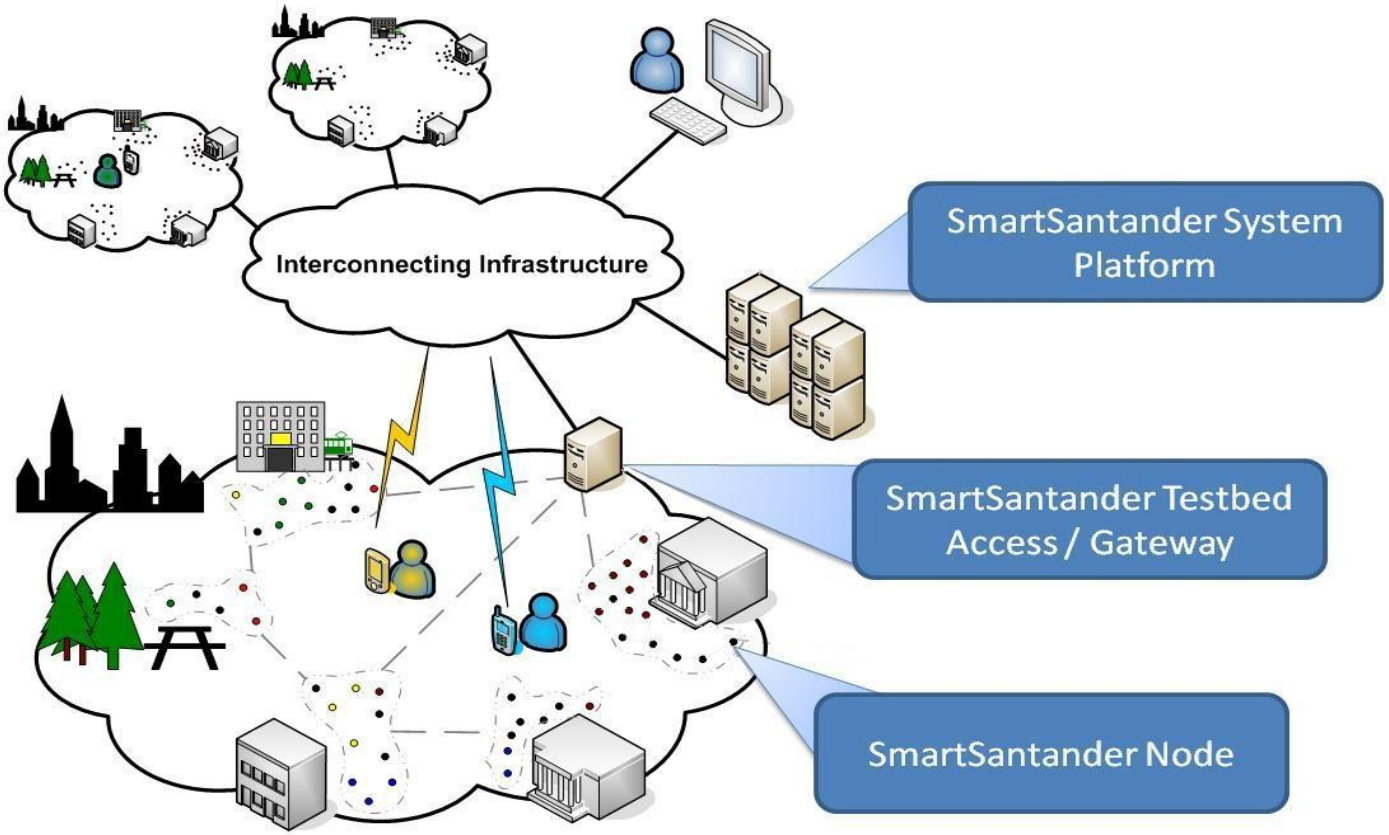
Solution: SDR gateway



- High capacity « SDR cognitive » station
- Designed for extreme RF environment
- No equivalent SDR Design
- No equivalent signal processing techniques
- Original State of the art critical system techniques
- Highly configurable
- Total distant control
- More than 1000 square miles coverage comes true

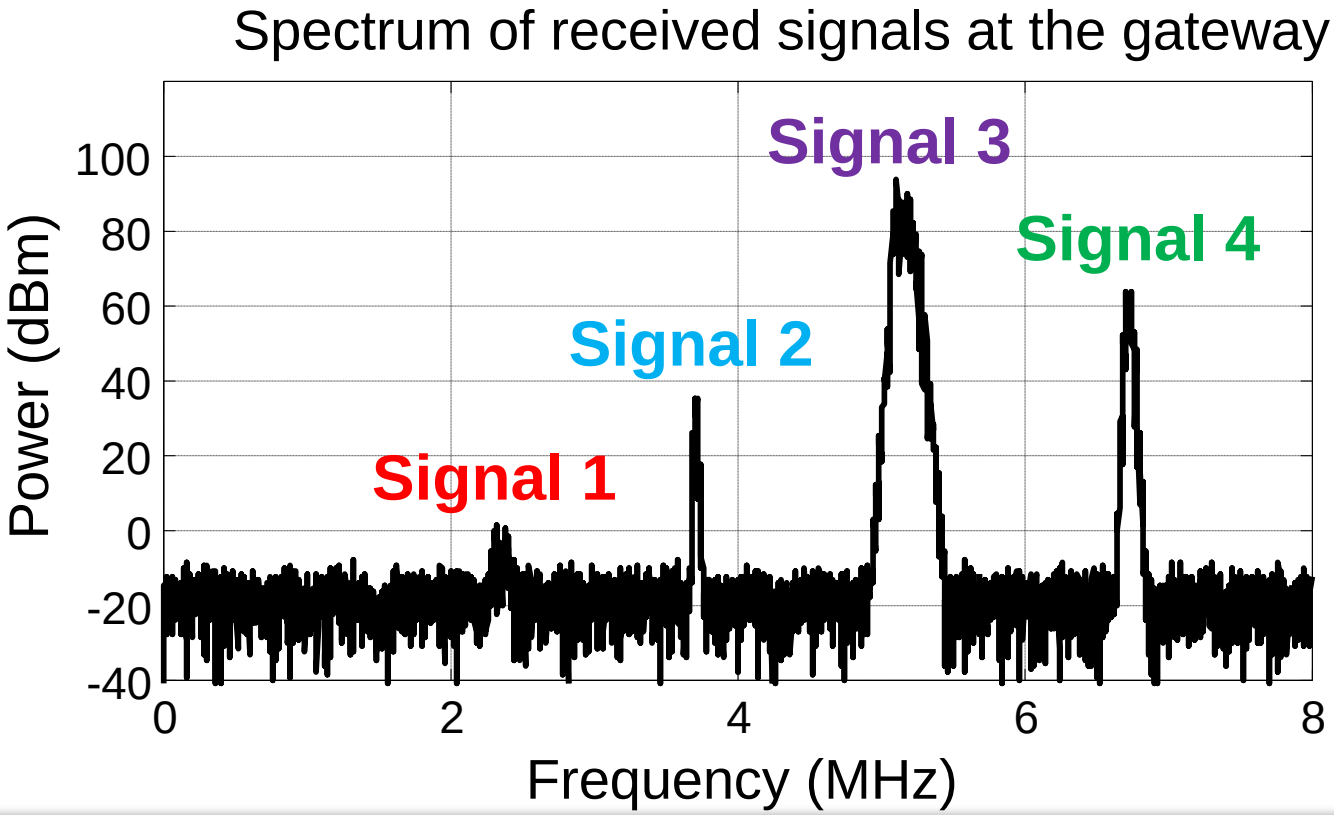


SDR: Urban Sensors Gateway



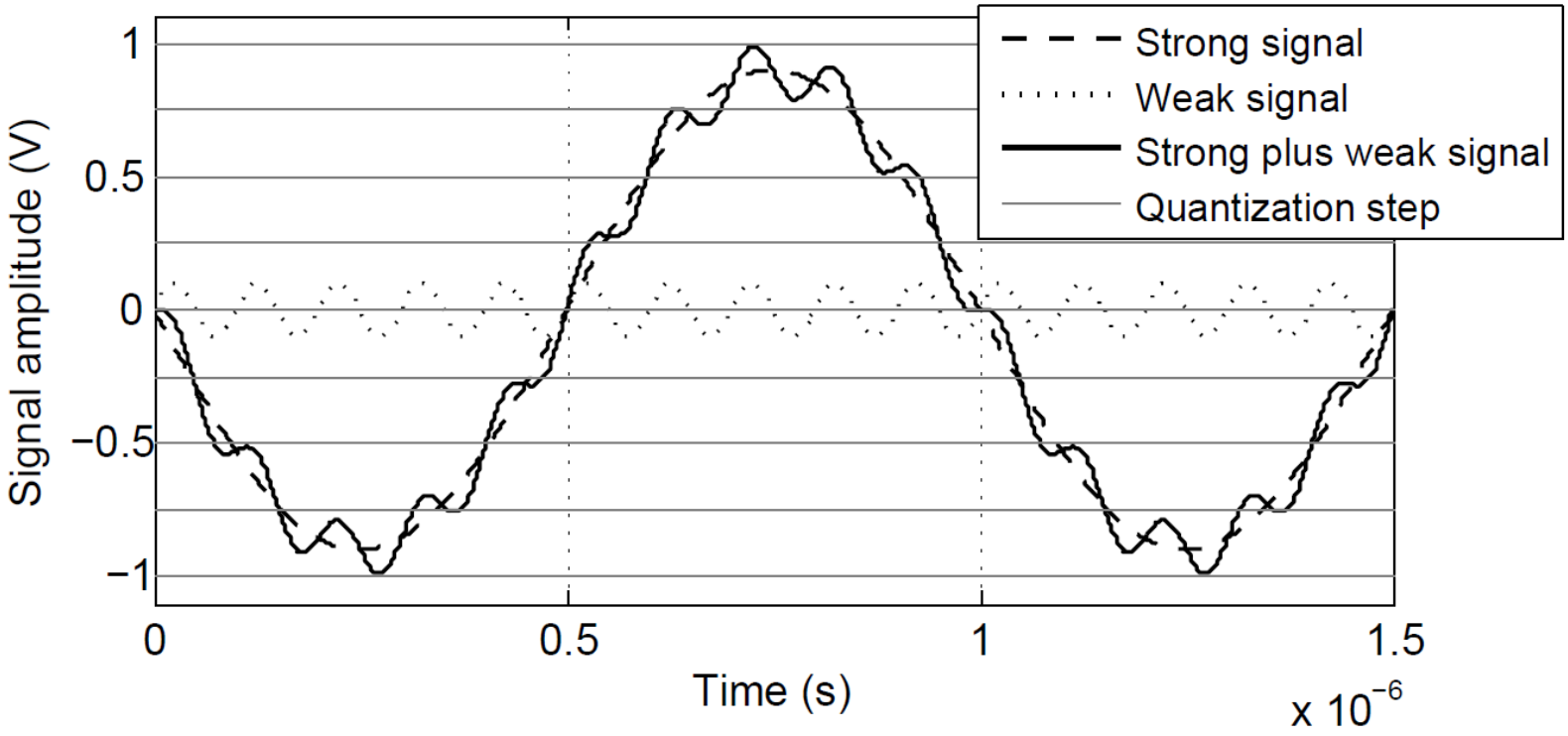
Up to thousands of nodes connected to a gateway (low duty cycle), with different standards

SDR: Urban Sensors Gateway



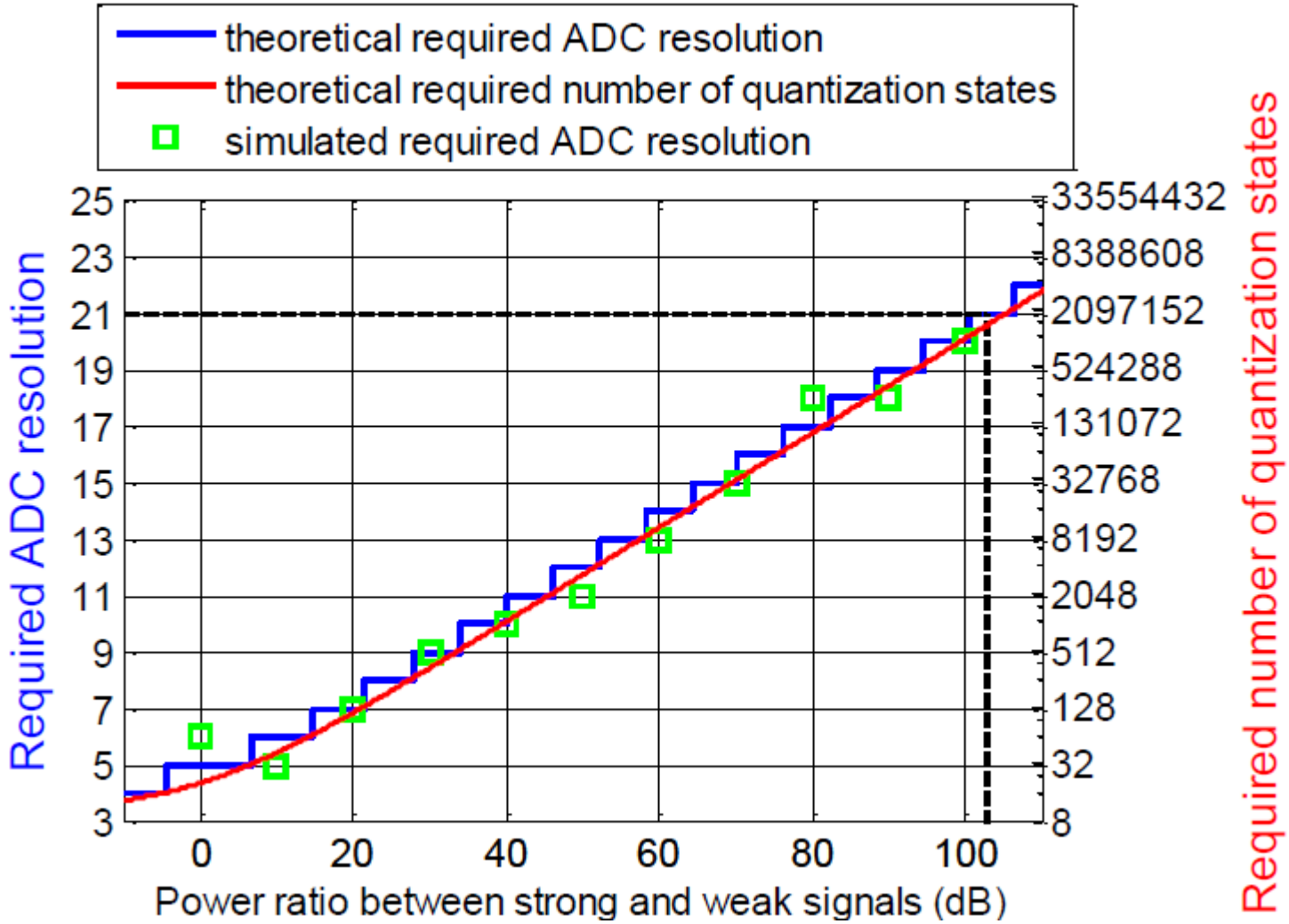
Sporadic reception of multiple channels with multiple waveforms in the whole 868 MHz band

Case of two signals

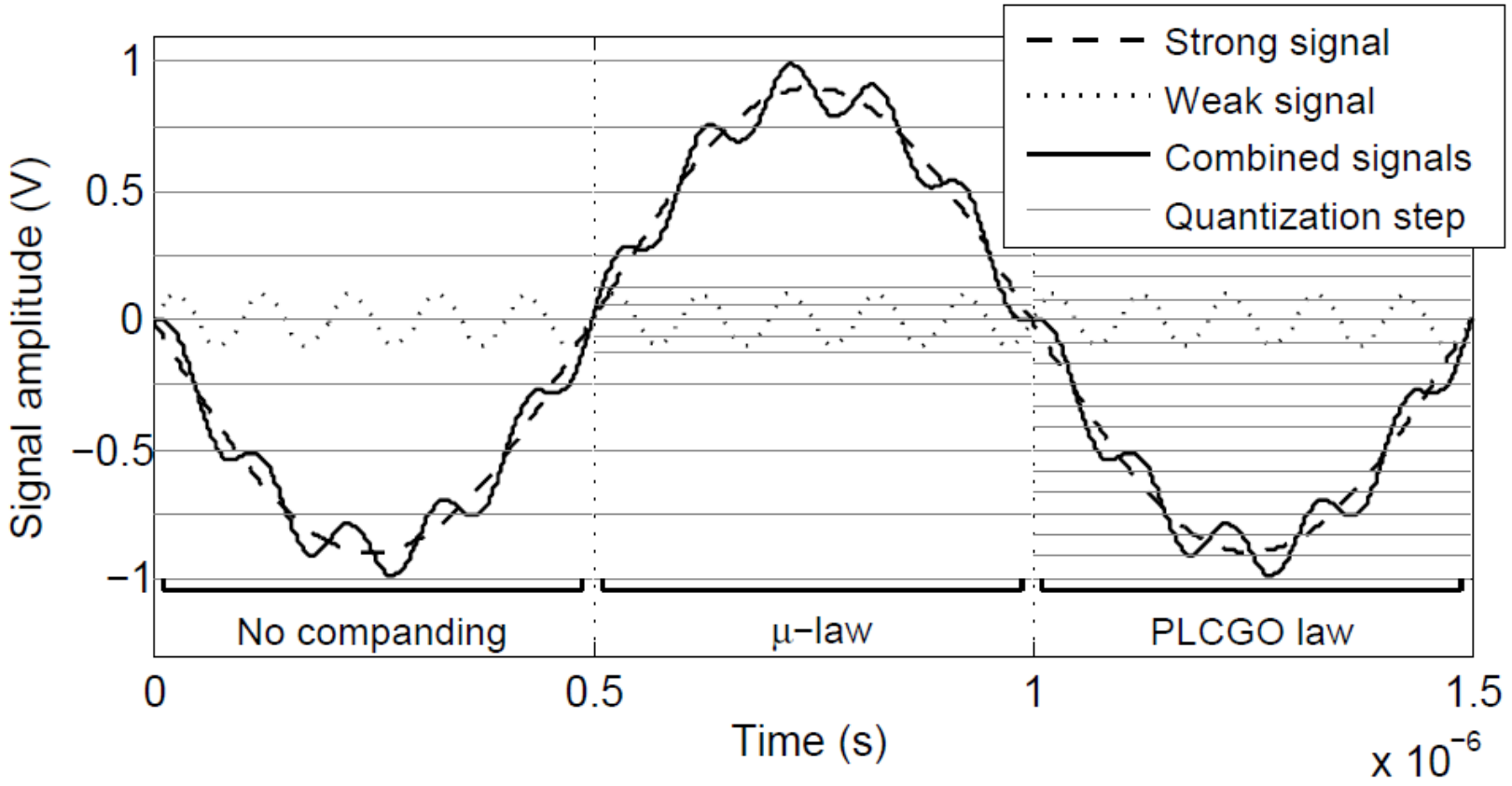


Problem: as two signals are received at the same time and digitized together, what is the required resolution of the common ADC ?

Required number of bits

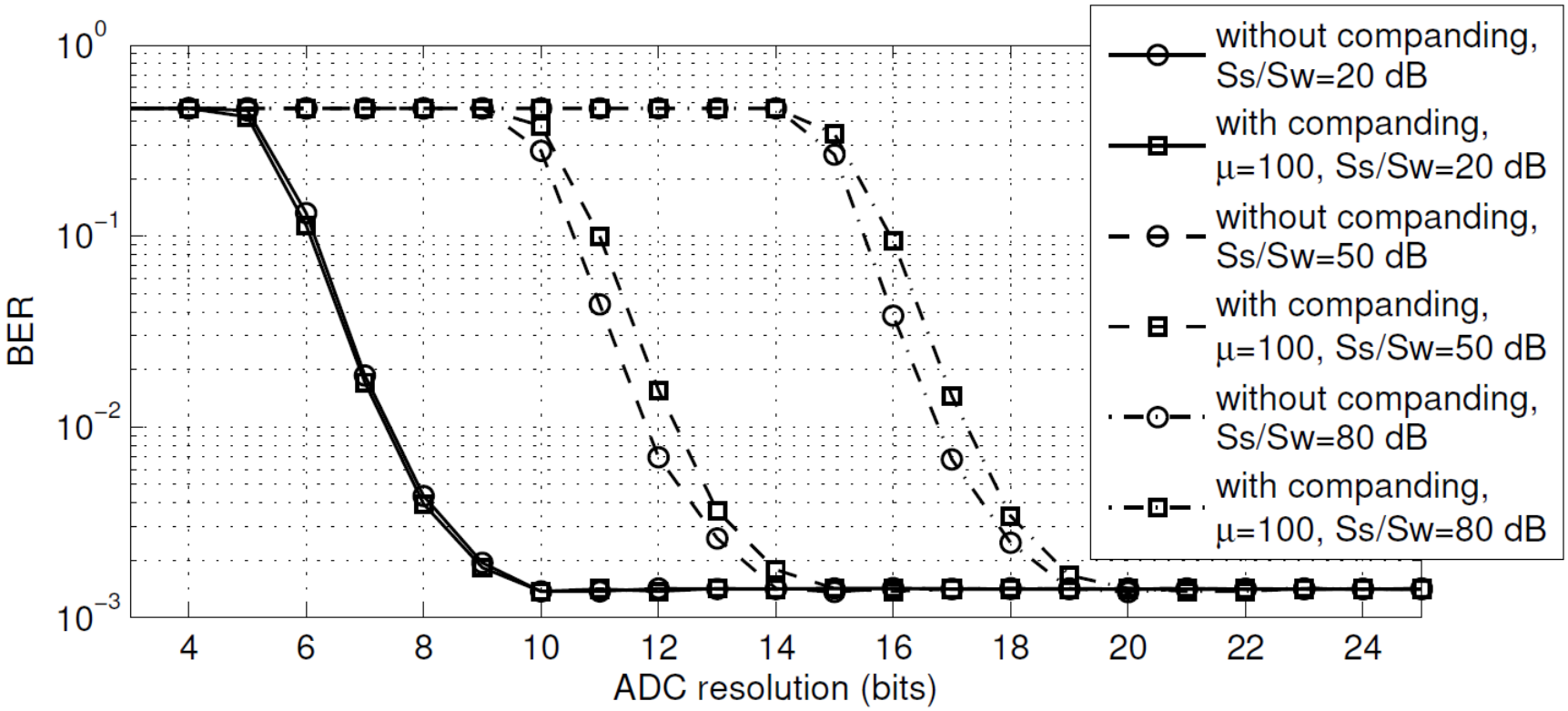


Different companding solutions



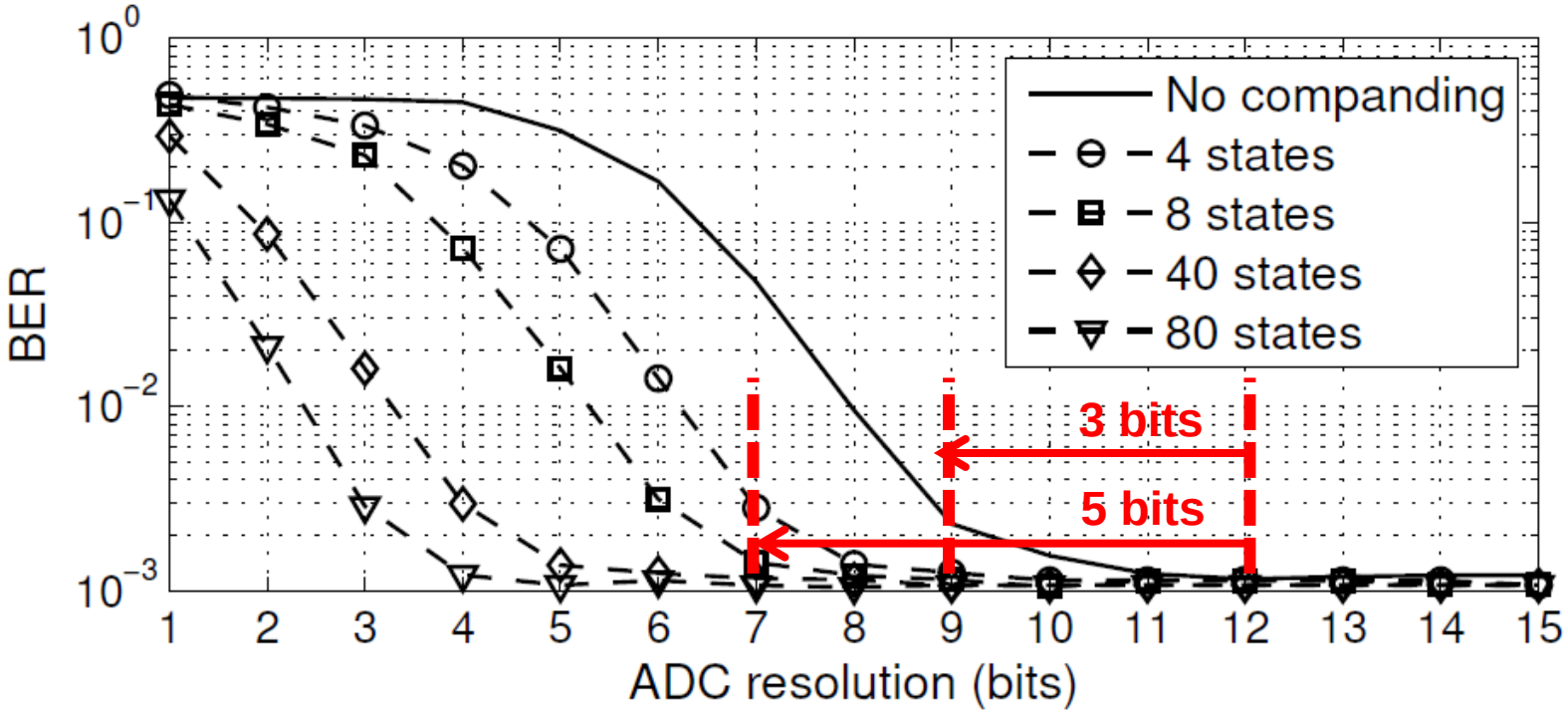
First solution: companding technique to reduce the dynamic between strong and weak signals

Results with logarithmic law

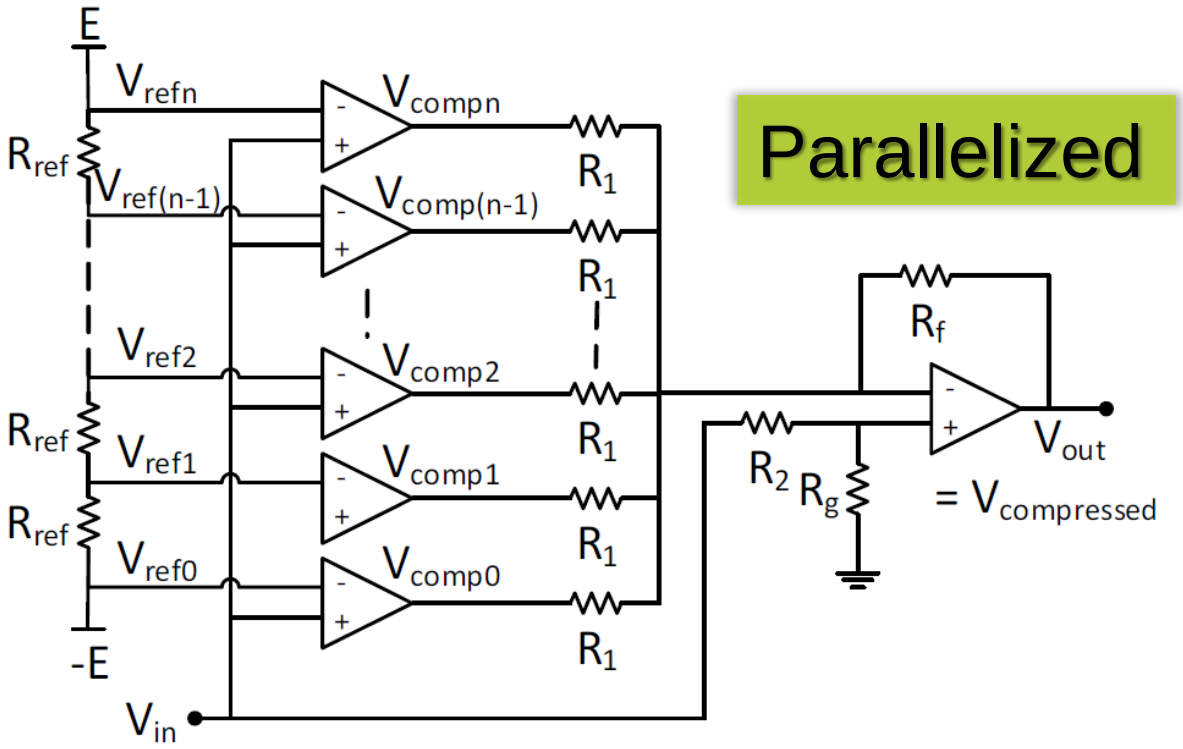


Logarithmic solution is not interesting for this purpose

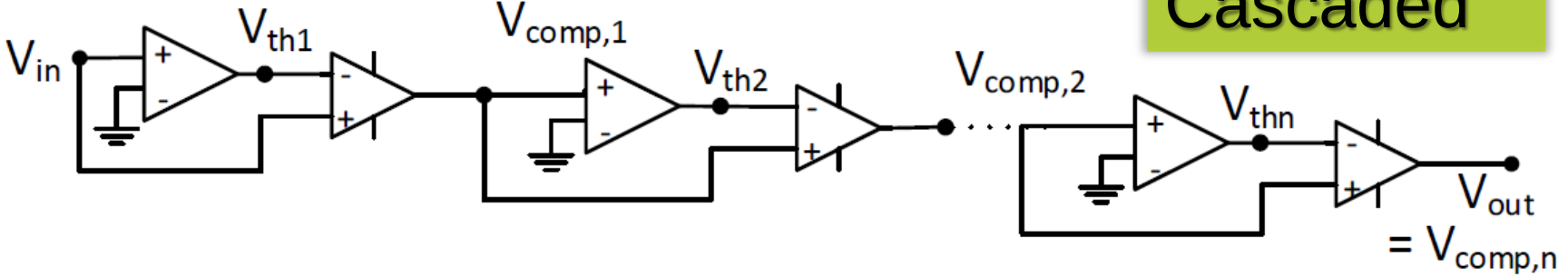
Gain in resolution with PLCGO



Possible implementations

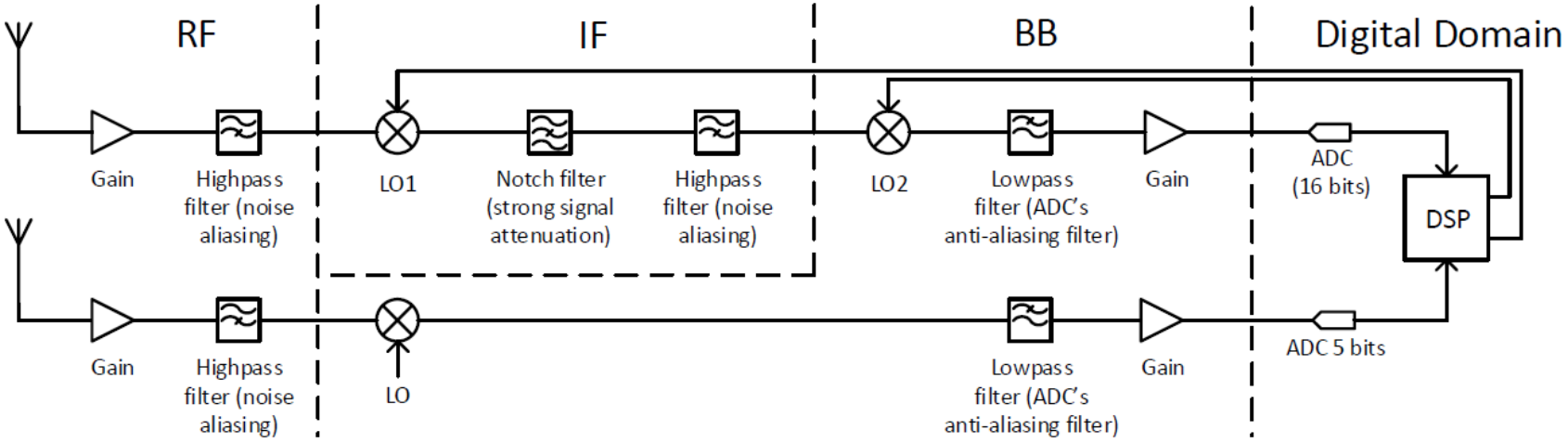


Parallelized



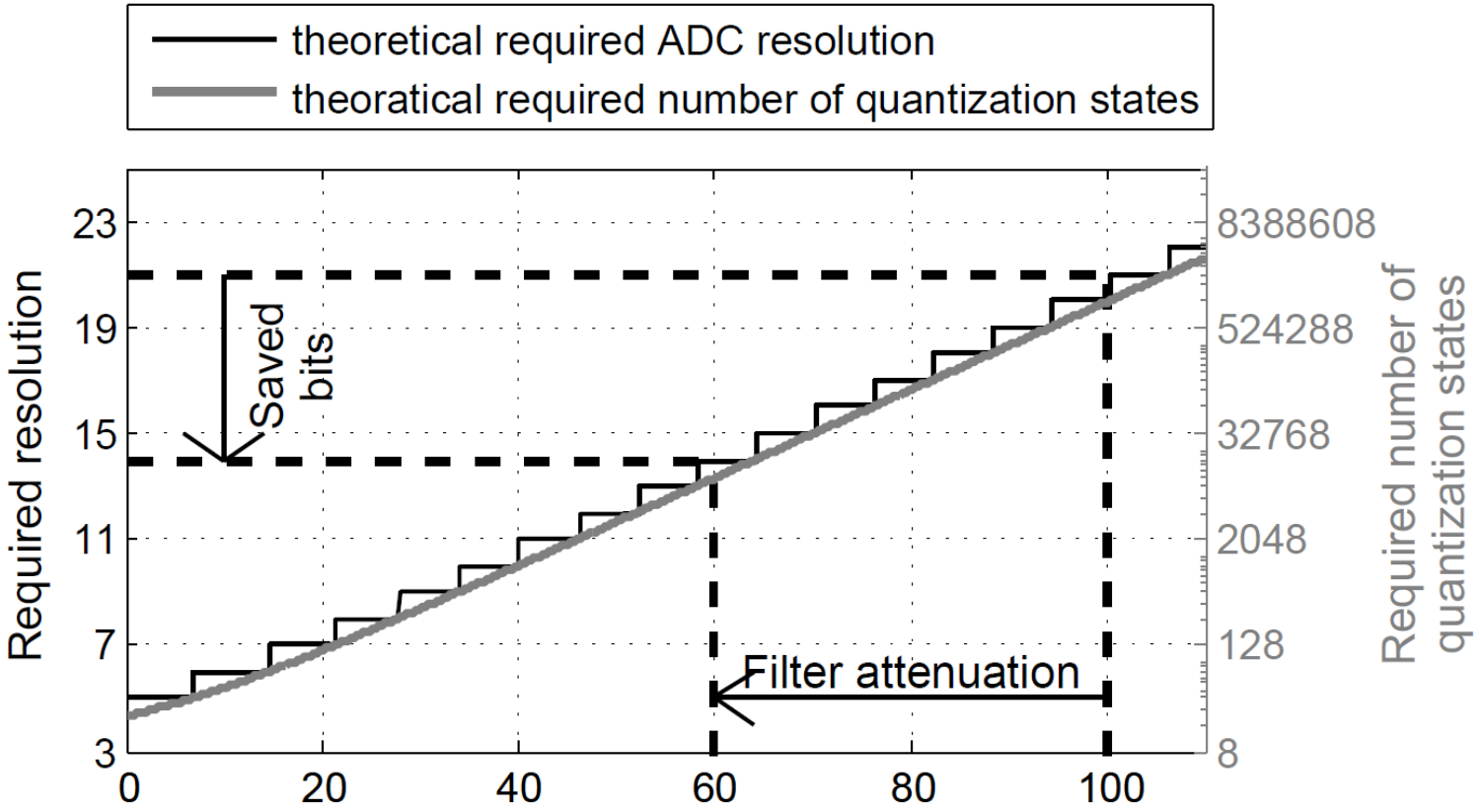
Cascaded

Other possible solution

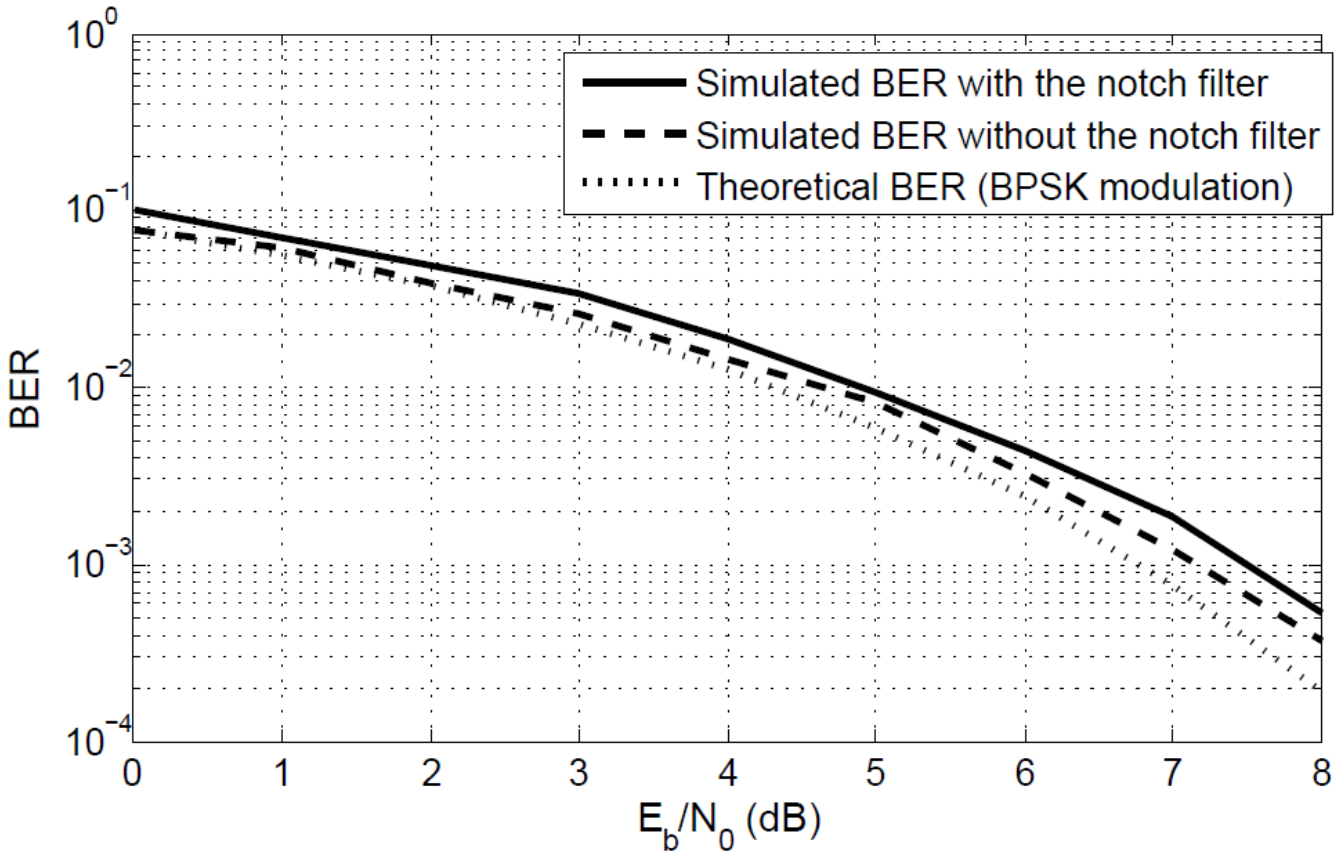


Dualbranch solution: two asymetric branches with different digitization capabilities

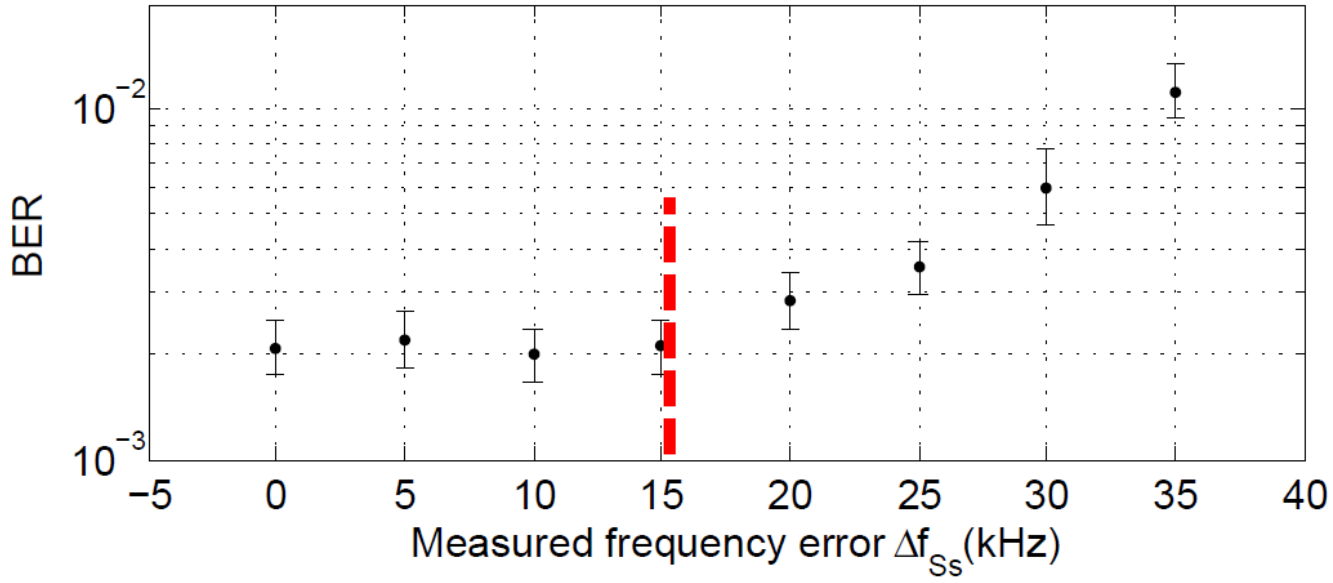
Gain in resolution

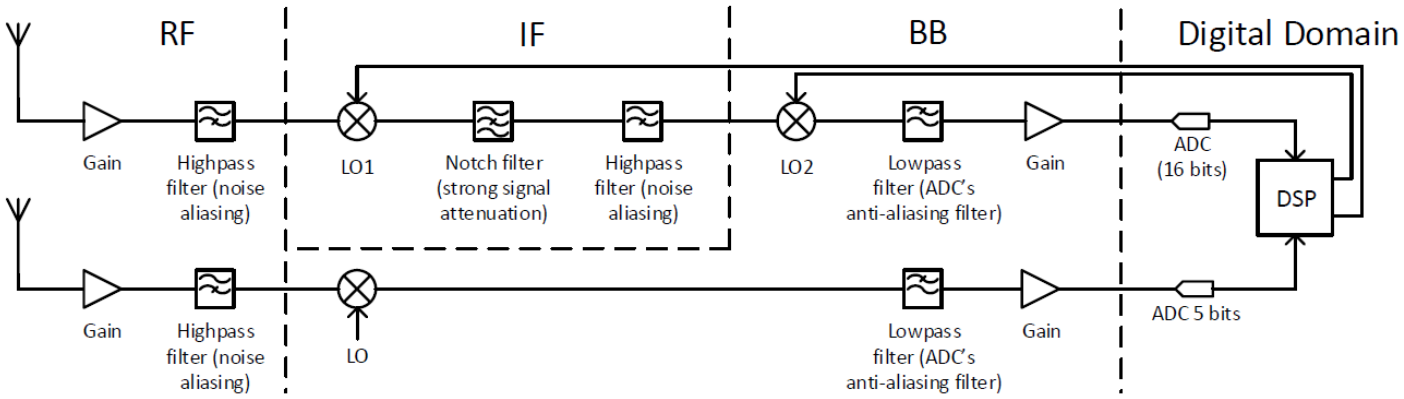


Simulated results



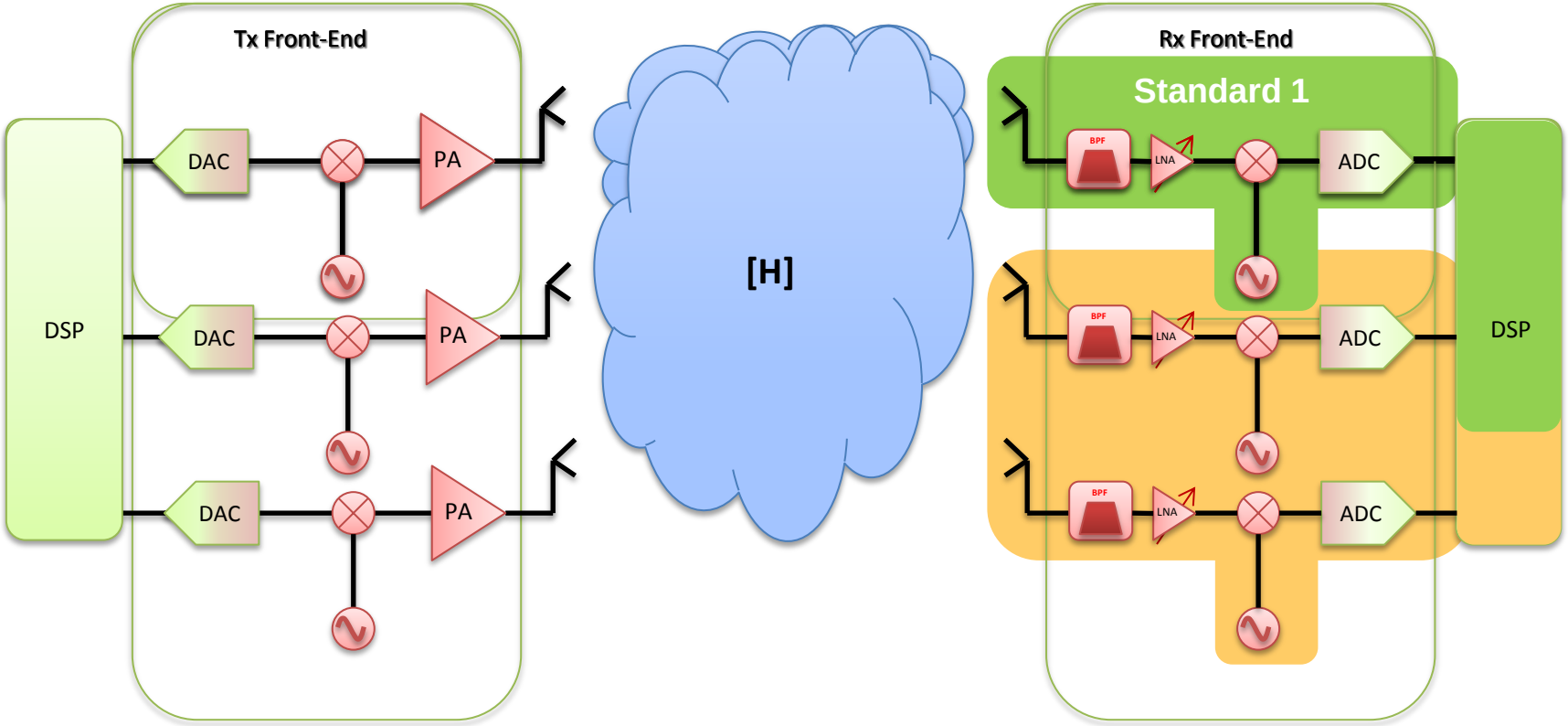
Sensitivity to frequency





Conclusion

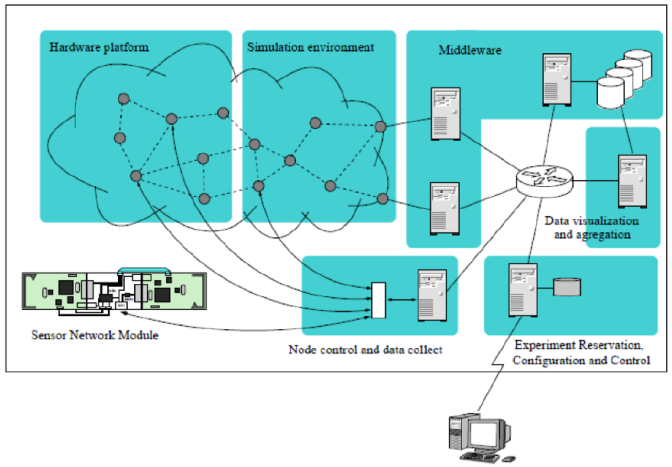
Combination of flexible RF front-ends and flexible processing capabilities is the key to offer multistandard gateways. A common equipment combining wireless standards plus RFID reader could be developed with the same approach.



New testbed: FIT-CorteXlab

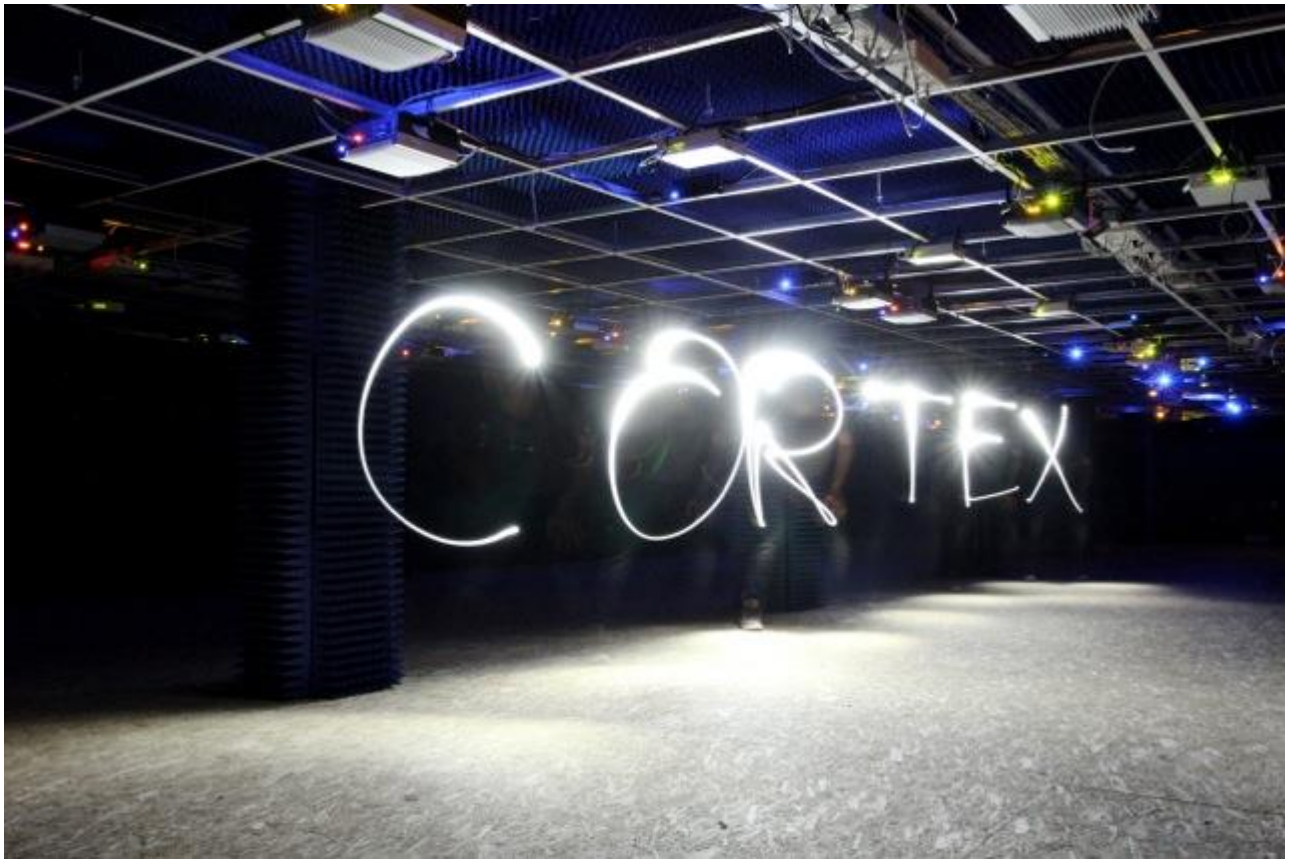
A 200 m² experimental testbed, entirely faradized and partially anechoid, based on SDR nodes remotely configurables.

- 42 industrial PCs Aplus
- 24 USRP National Instruments
- 18 picoSDR Nutaq (5 MIMO 4x4, 13 MIMO 2x2)



www.cortexlab.fr

Thank you for your attention



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