Future-proof Technologies and Network Architectures in wireless communication

Roberto Borri

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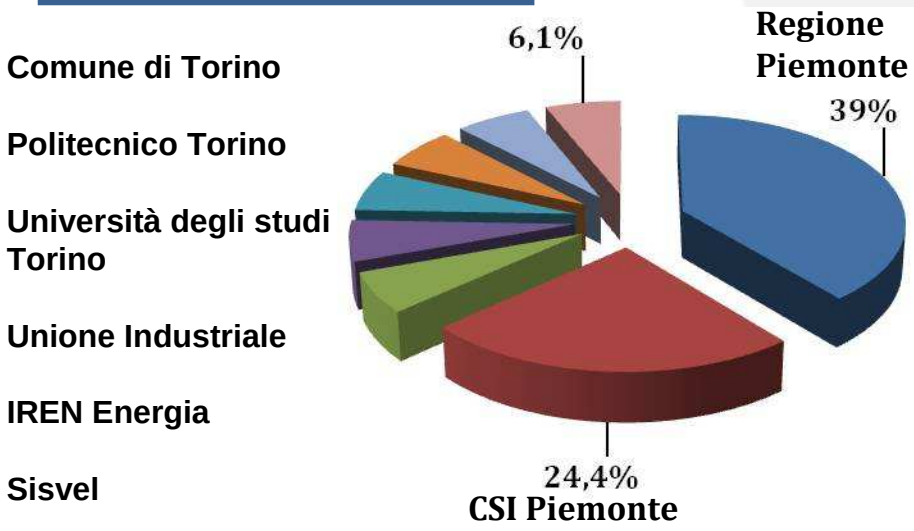
CSP at a glance

Shareholders



Status

Research body

- ✓ not for profit
- ✓ Applied and industry research
- ✓ Reuse of revenues in best practices dissemination and products/services research
- ✓ Equal and fair access to the CSP research services for members and third parties both

Personnel

Today: 48 employees and 42 young researchers

2000-2011: 483 guys worked or spent their first professional experience in CSP

- The talk will try to focus on
  - Which application pools are recognized as common needs and are there really all we need ?
  - What's the real need to boost ubiquity of "Internet" application delivery ?
  - The wireless, as we know today, is good enough ?
  - Possible suggestions on future proof scenario (conclusions)

Application pools

- Personal/Community access in social and media communication (i.e. client of telco services)
- Active user providing contents and deploying their own “services” (i.e. same of the above but managing personal services)
- Infrastructured services for the “internet society” (i.e. project specific frameworks, IoT……)

Their characterization

- Personal/Community:
  - high mobility
  - Few data in up and, often, huge amount in down (multimedia access)

- Active user add:
  - Self made sites
  - Peer-to-peer exchange
  - One to many communication
- "Internet society" looks at:
  - No bandwidth limitation
  - Good network performance (latency, jitter, resilience….)
  - Wide area deployment (ubiquity)

Toward the convergency

Keywords to boost the operations ubiquity

- Telco services:
  - Wired:
    - enhance the granted bitrate
    - support symmetric bandwidth (or reduce the gap in ADSL)
  - Wireless add: speed up the high end technology offering
- Infrastructures:
  - Public backbones, pubblic and private access provisioning
  - More integration between National/Regional wired infrastructures and local wireless areas
  - Reuse and sharing of existing structures

The today wireless

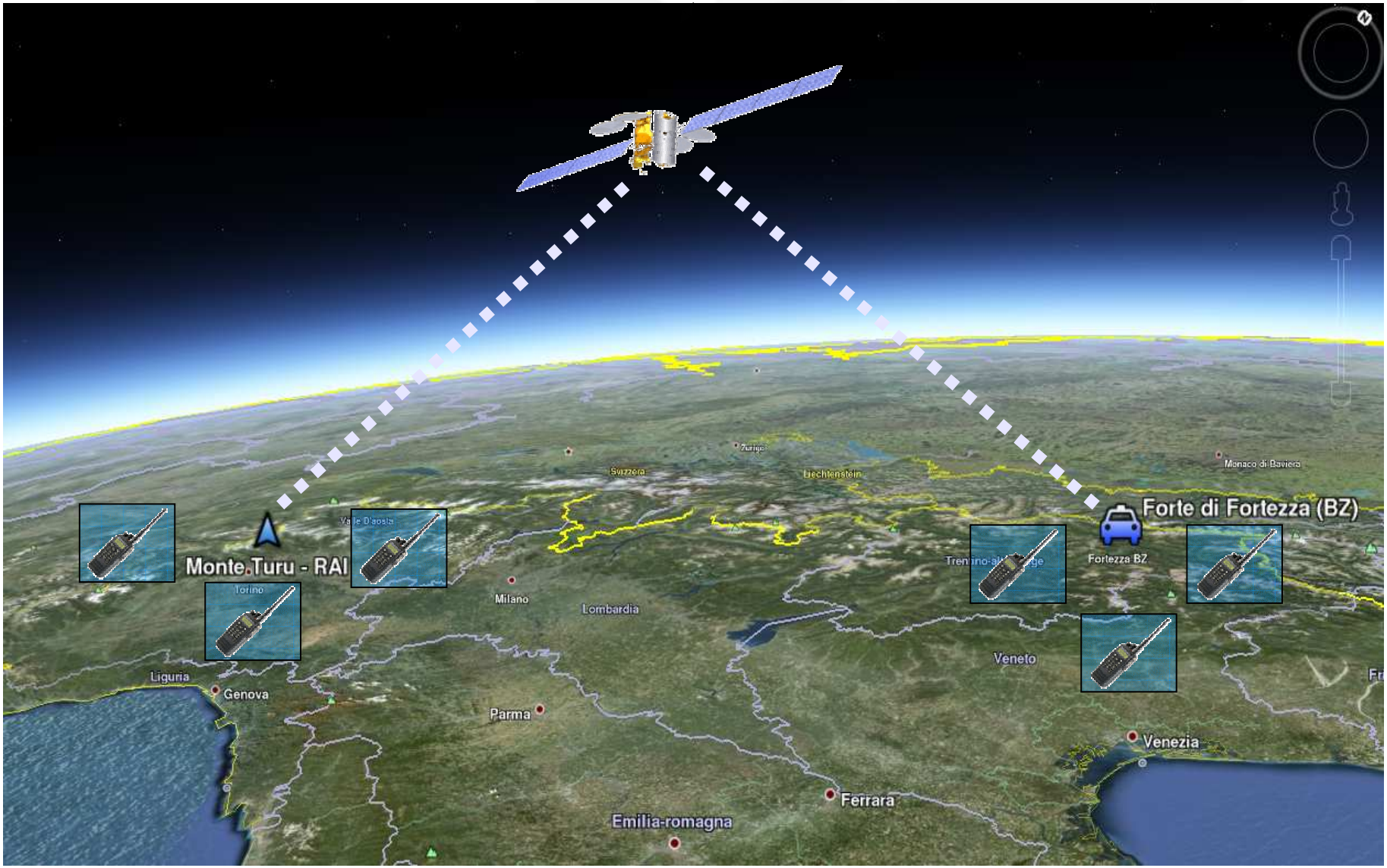
Telco 3G, 4G....next G

Wisp and the 802.11 protocol family (the ISM band fenomena)

Narrow band services (and the IoT world)

The Satellite option

KA-SAT


Monte.Turu - RAI
Forte di Fortezza (BZ)
Fortezza BZ
Svizzera
Liechtenstein
Monaco di Baviera
Milano
Lombardia
Veneto
Liguria
Genova
Parma
Venezia
Ferrara
Emilia-romagna

Satellite: KA-SAT (Tooway 2 service)

Parabolic Dish Antenna

Diameter: 77 cm - Weight: 15 Kg

Dish pointing direction: KA-SAT: 9°Est

Ka band frequencies: Rx 19.7 - 20.2 Ghz / Tx 29.5 - 30.0 GHz

Polarization: Circular

Transmission power: 3 W

Modem

Dimensions: 23x23x3,8 cm - Weight: 0,6 Kg

Input port: 1 coaxial Rx/Tx port (F connector)

LAN interface: 10/100/1000 Mbps

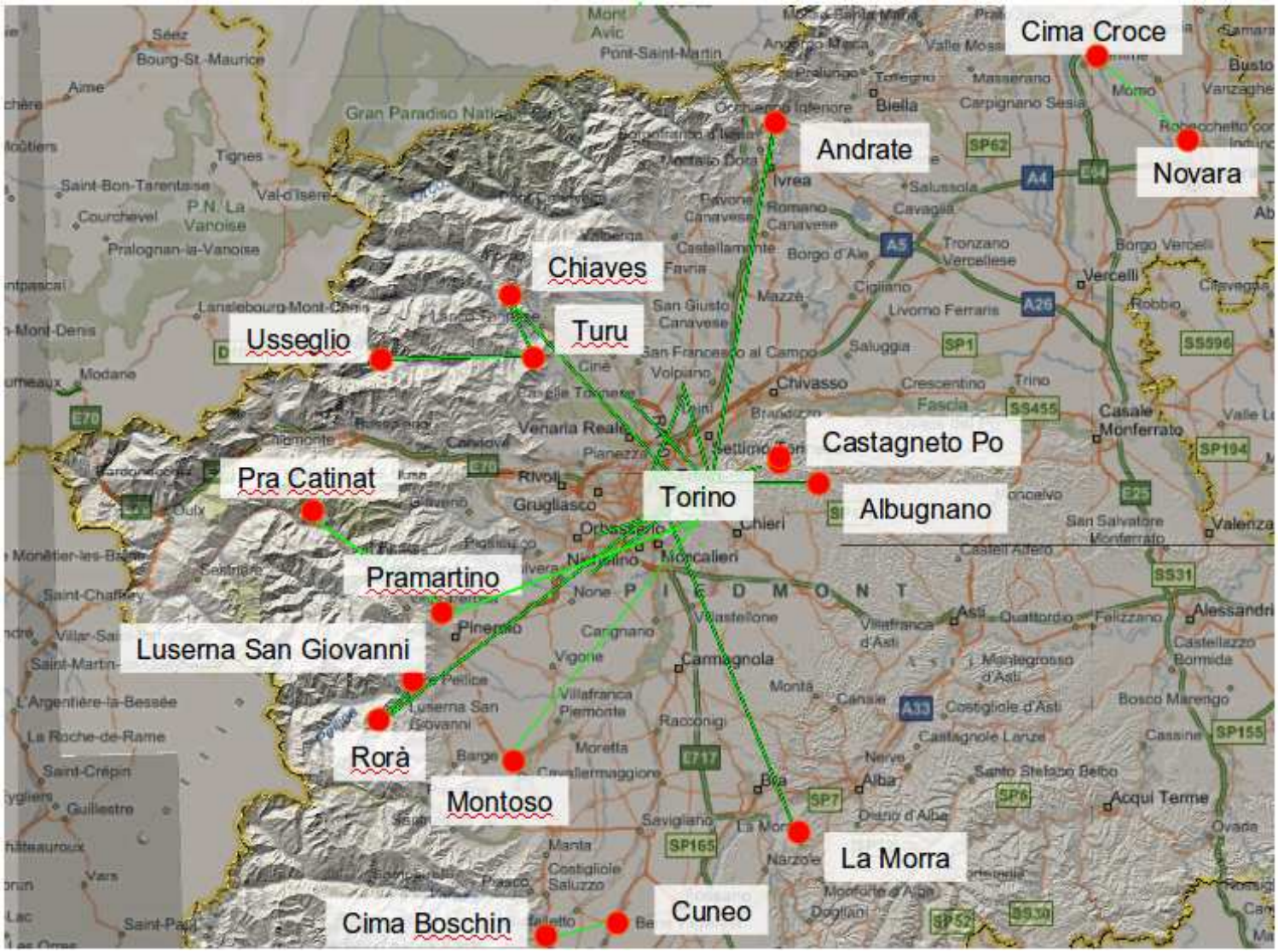
Power consumption: 30V – max 2.5**A**

Performance

Download speed: up to 18 Mbps

Upload speed: up to 6 Mbps

HPWnet: an implementation of a research wireless infrastructure



The radiocommunication nightmare: the spectrum availability

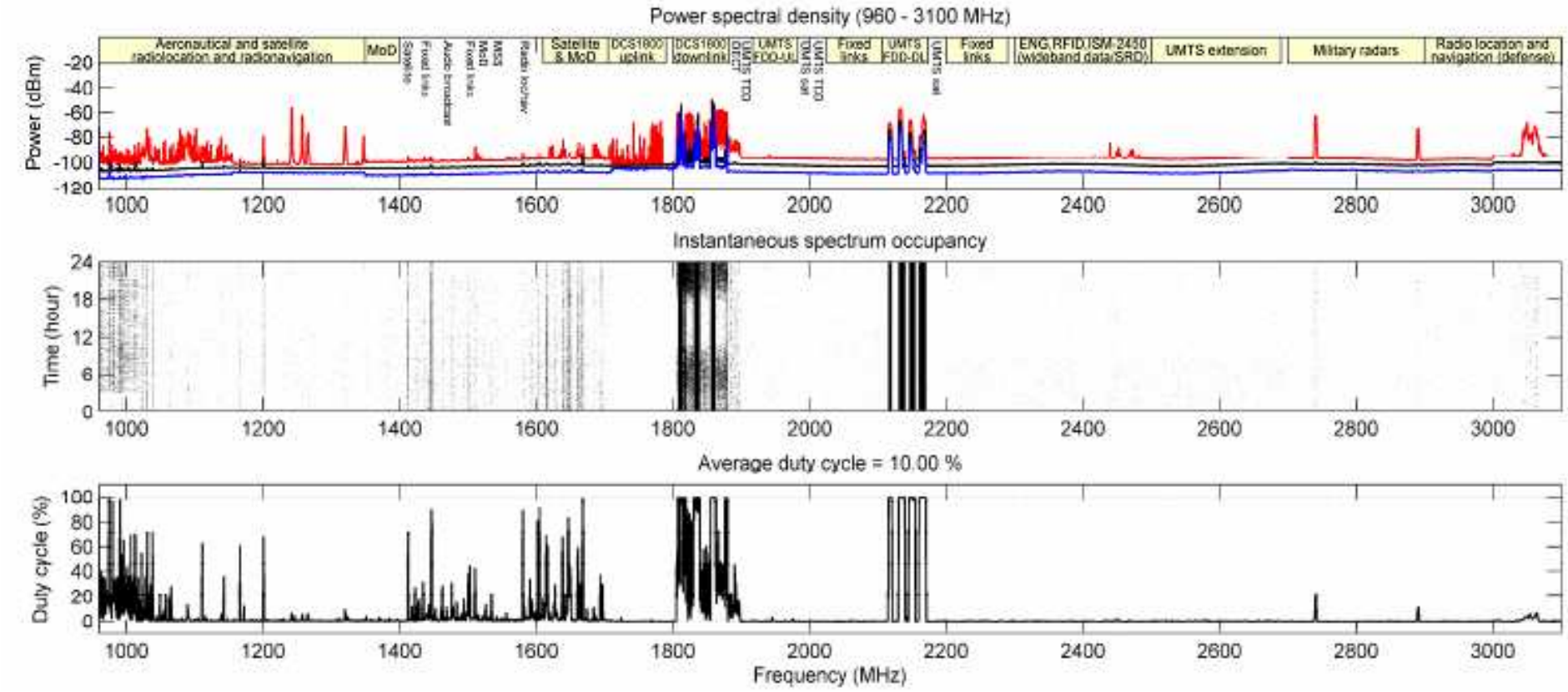
YES, it's true !

.... due to policy and regulatory plans

but in terms of physical availability...

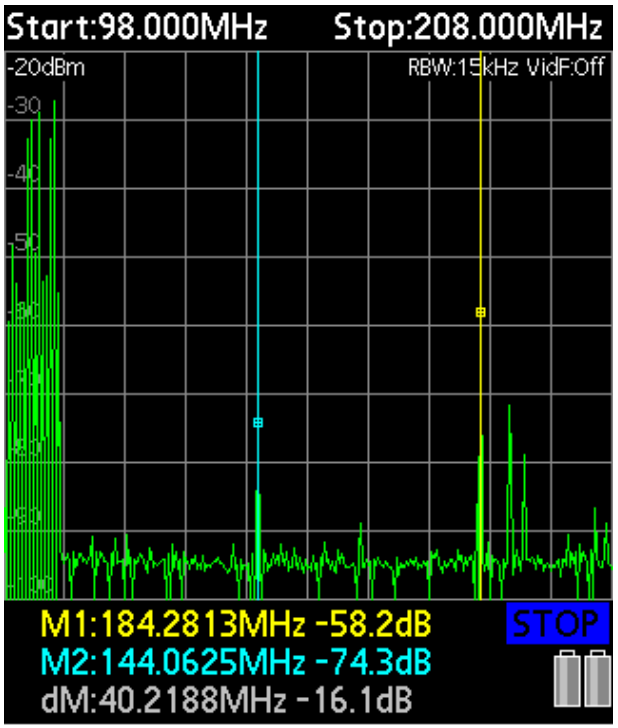
Occupation of radio spectrum
960 MHz – 3100 GHz (i.e. Barcellona 2009)

[1] M. Lopez-Benitez et al., "Spectral occupation measurements and blind standard recognition sensor for cognitive radio networks",



The Openspectrum perspective

openspectrum.info



What is Open Spectrum?

"Open Spectrum" is based on the realization that technology can reduce or even eliminate the need for governments to micro-manage wireless communication. In different contexts it can be viewed as

- **an ideal of freedom in the use of radio frequencies;**
- **a critique of traditional spectrum management;**
- **a possibility arising from new trends in radio design.**

In fact *it is all of these...* *[more]*

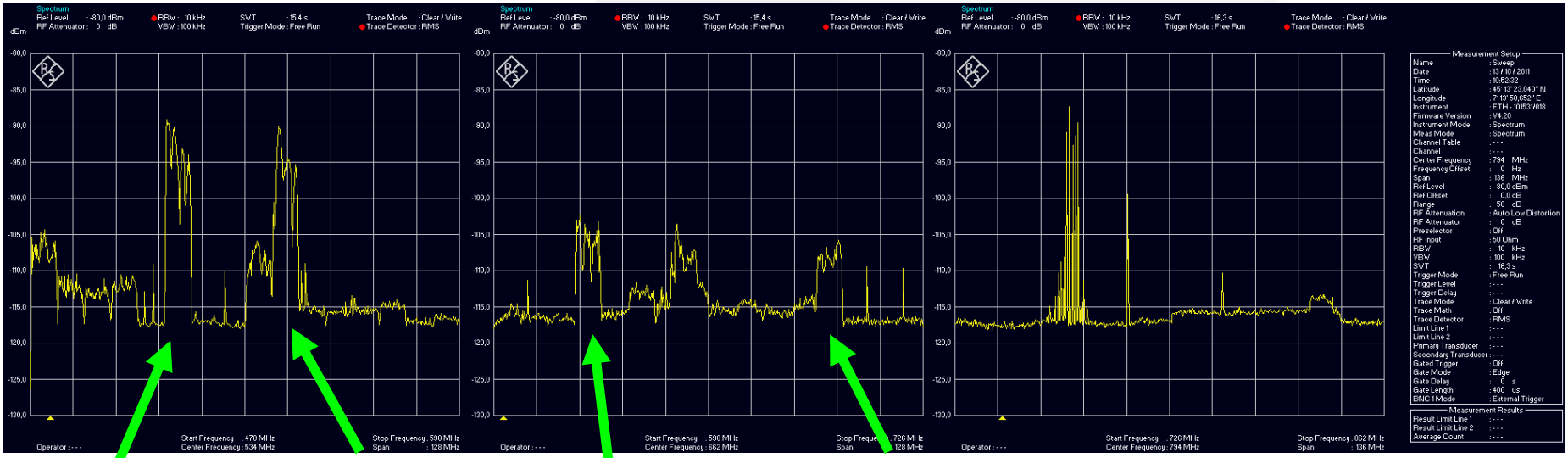
The Cognitive Radio approach

A cognitive radio can …

- autonomously exploit locally unused spectrum to provide new paths to spectrum access
- roam across borders and adjust themselves to stay in compliance with local regulations
- negotiate with several service providers (networks) to connect a user at the lowest cost (or optimal performance)
- adapt themselves and their emissions without user intervention
- understand and follow actions and choices taken by the users and over time learn to become more responsive and to anticipate their needs

White spaces: an application test case (i.e. Usseglio in Valli di Lanzo - Torino)

Omnidirectional antenna (2 dBi), BW: 470-862 MHz

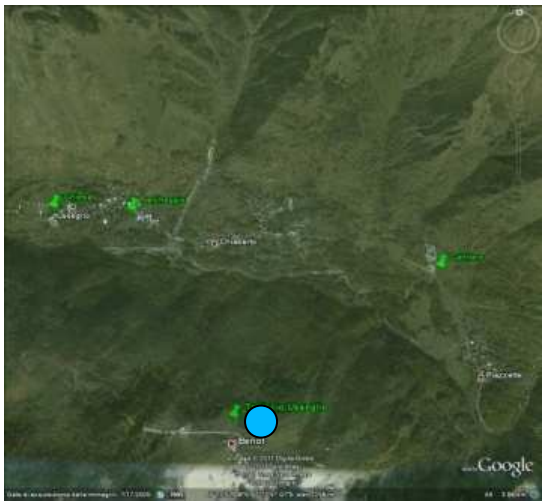


ch26
514 MHz
Eremo (TO)
RAI MUX3

ch30
546 MHz
Germagnano
RAI MUX2

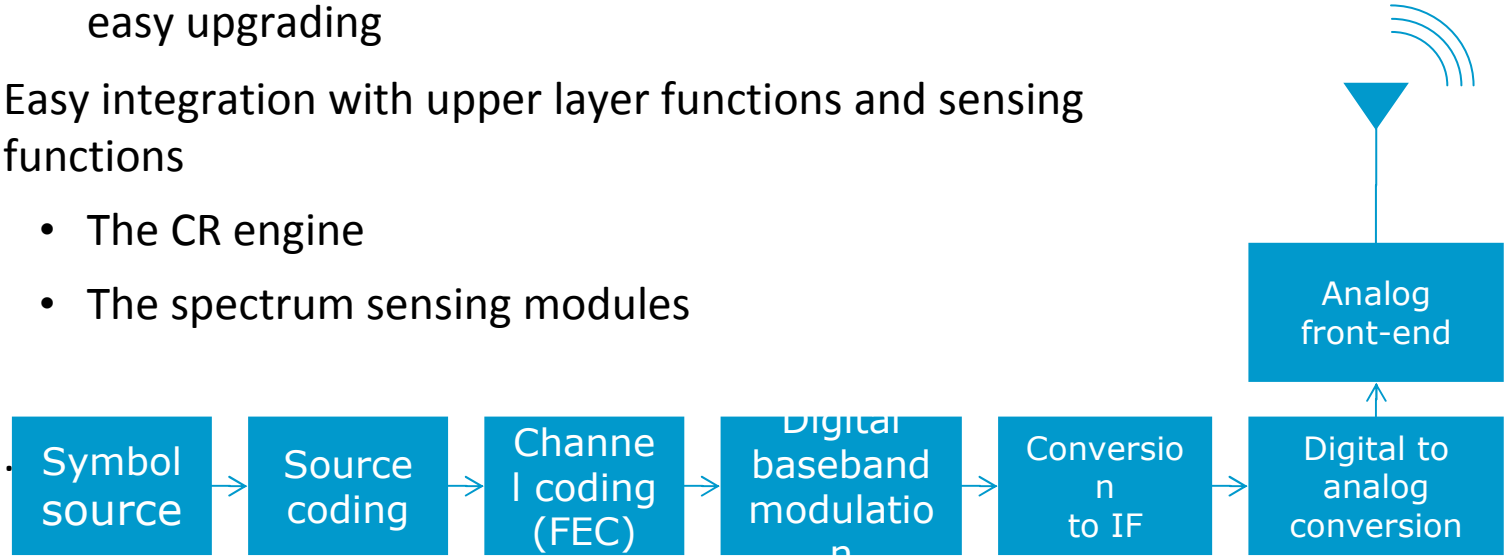
ch40
626 MHz
Germagnano
RAI MUX4

ch49
698 MHz
Corio (TO)
MEDIASET
MUX4



SDR technology and “procedures”

- Main motivations for software-defined radio
  - Multimode/multistandard adaptive transceivers
    - A CR transceiver must be capable of supporting multiple communication schemes, offer fast mode switch and easy upgrading
  - Easy integration with upper layer functions and sensing functions
    - The CR engine
    - The spectrum sensing modules
  - .



DB based and distributed sensing information set

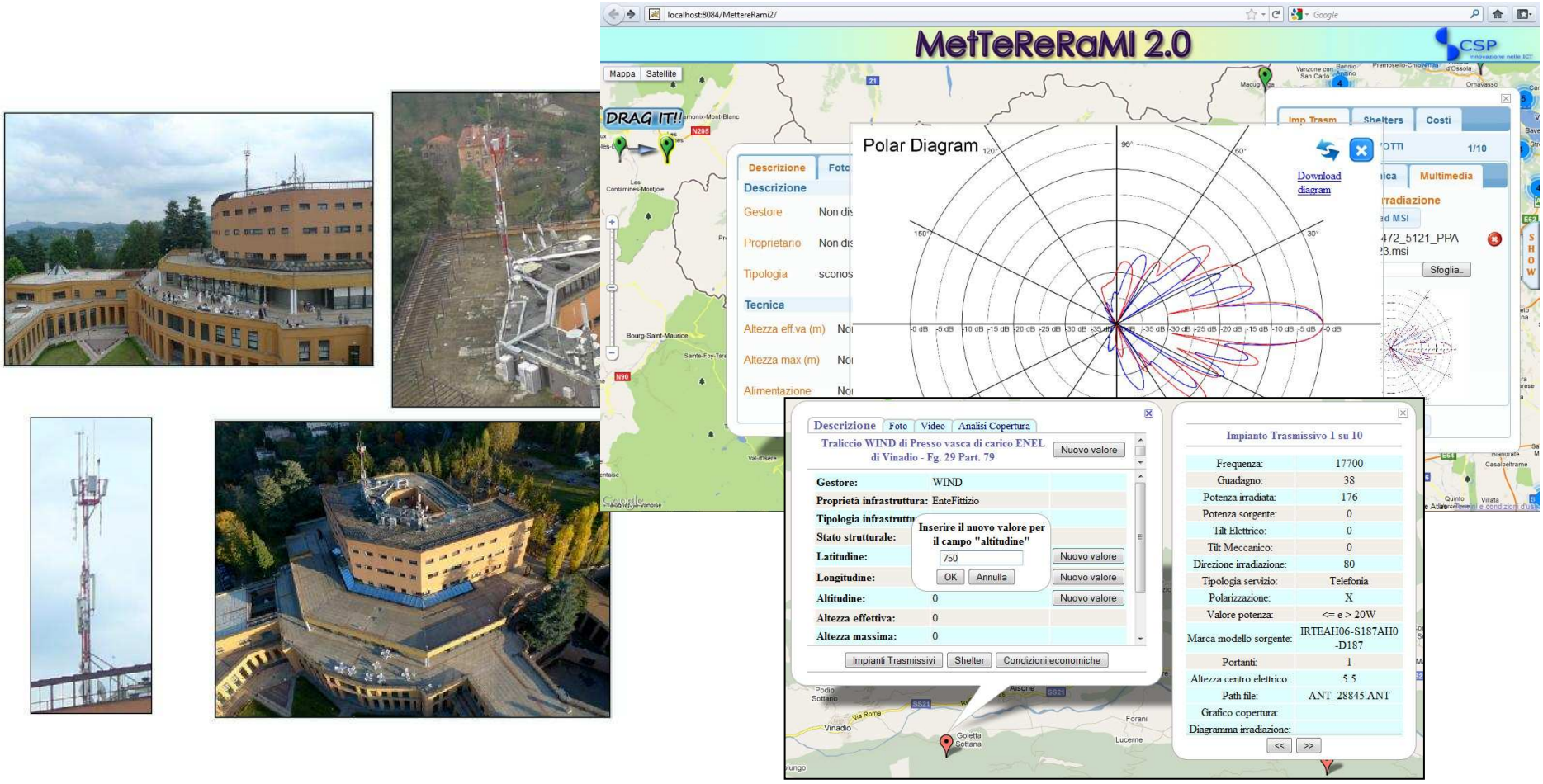
The GNUradio project

- [Wikipedia] "…a free software toolkit for learning about, building, and deploying software-defined radio systems…"
- It consists of
  - a library of signal processing blocks for the implementation of digital transceivers
    - Filters, encoders and decoders, mo-demodulators, synchronization blocks, ...
    - Written in C++
  - a runtime component that, starting from a model description (written in Python), schedules the execution of signal processing blocks
  - a graphical user interface, the GNUradio Companion
    - Easy creation of new models
    - Open file format (XML)
    - Exports executable Python code

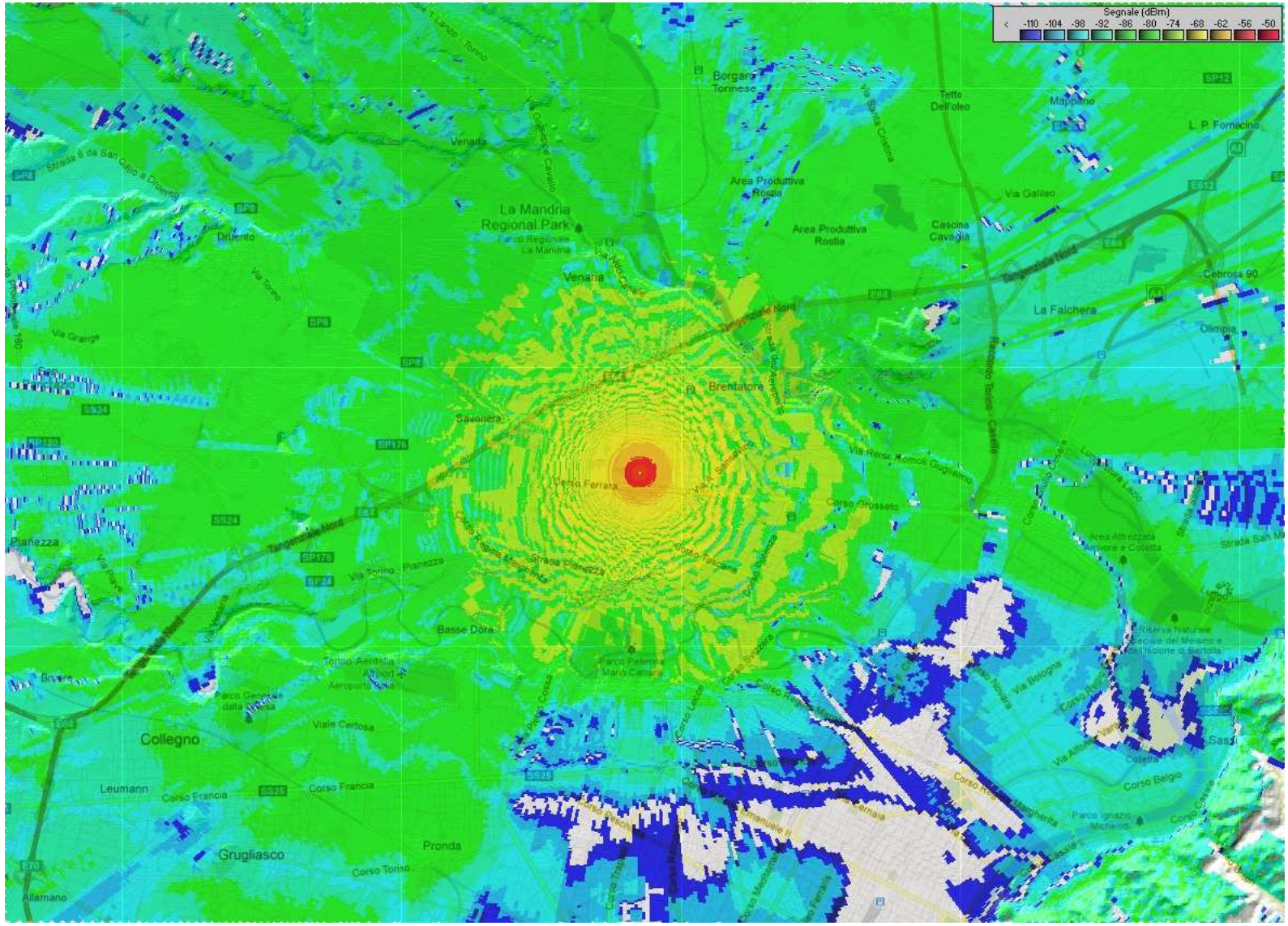
The SDR opensource toolkit

Well known site usage and frequency allocation

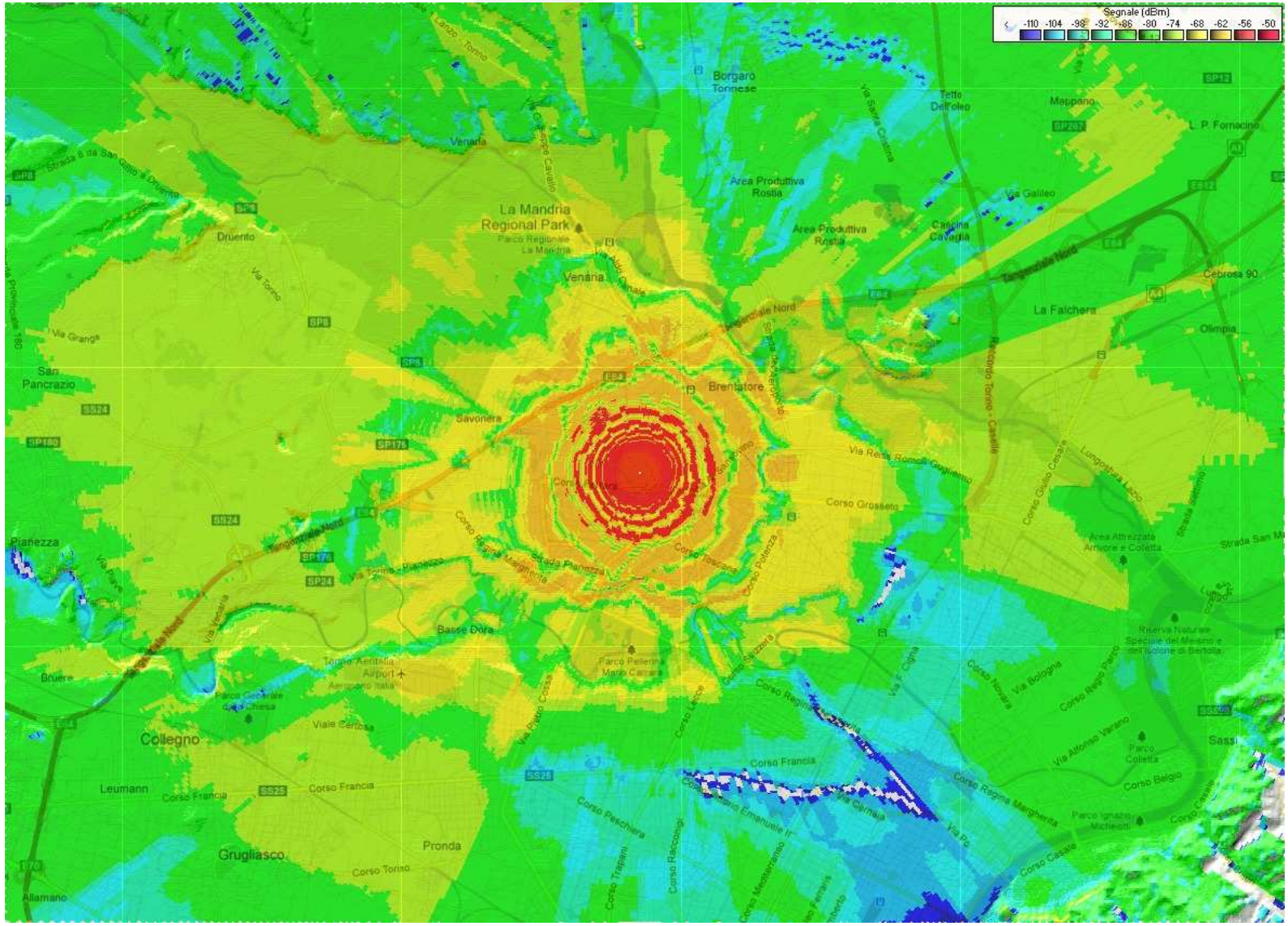
MetTeReRaMI project: a first example of setting an up to date DB of TLC infrastructures



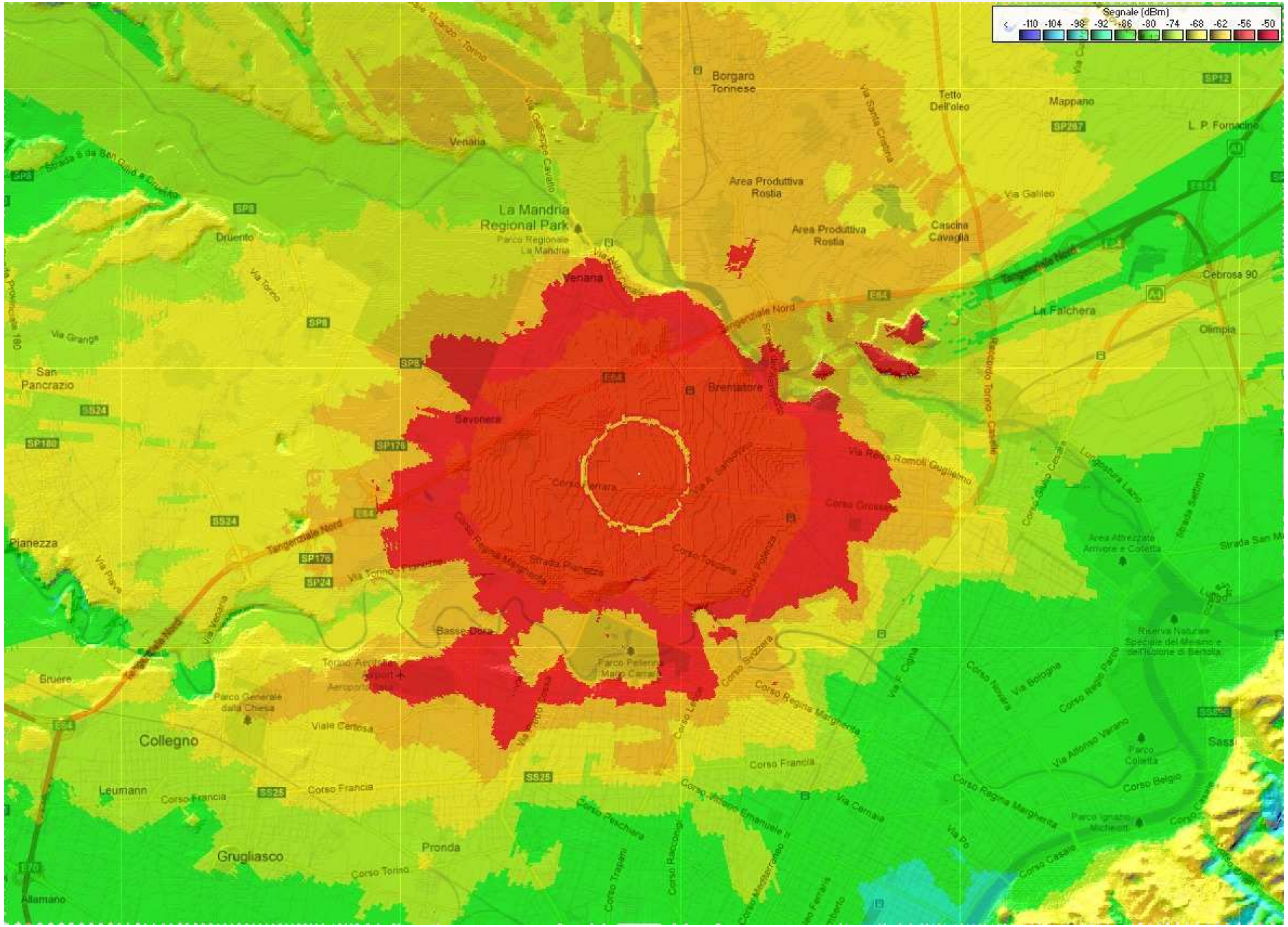
RF propagation impact on wireless services



2.4 GHz


Segnale (dBm)
-110 -104 -98 -92 -86 -80 -74 -68 -62 -56 -50
La Mandria Regional Park
Parco Regionale La Mandria
Venaria
Druento
Borgaro Torinese
Meppano
Area Produttiva Rostia
Cascina Cavaglia
La Falchera
Cebrosa 90
Olimpia
San Pancrazio
Savonera
Brentatore
Pianezza
Basse Dora
Bruere
Collegno
Leumann
Grugliasco
Pronda
Allamano
Corso Grosseto
Corso Francia
Corso Torino
Sassi
Corso Belgio

866 MHz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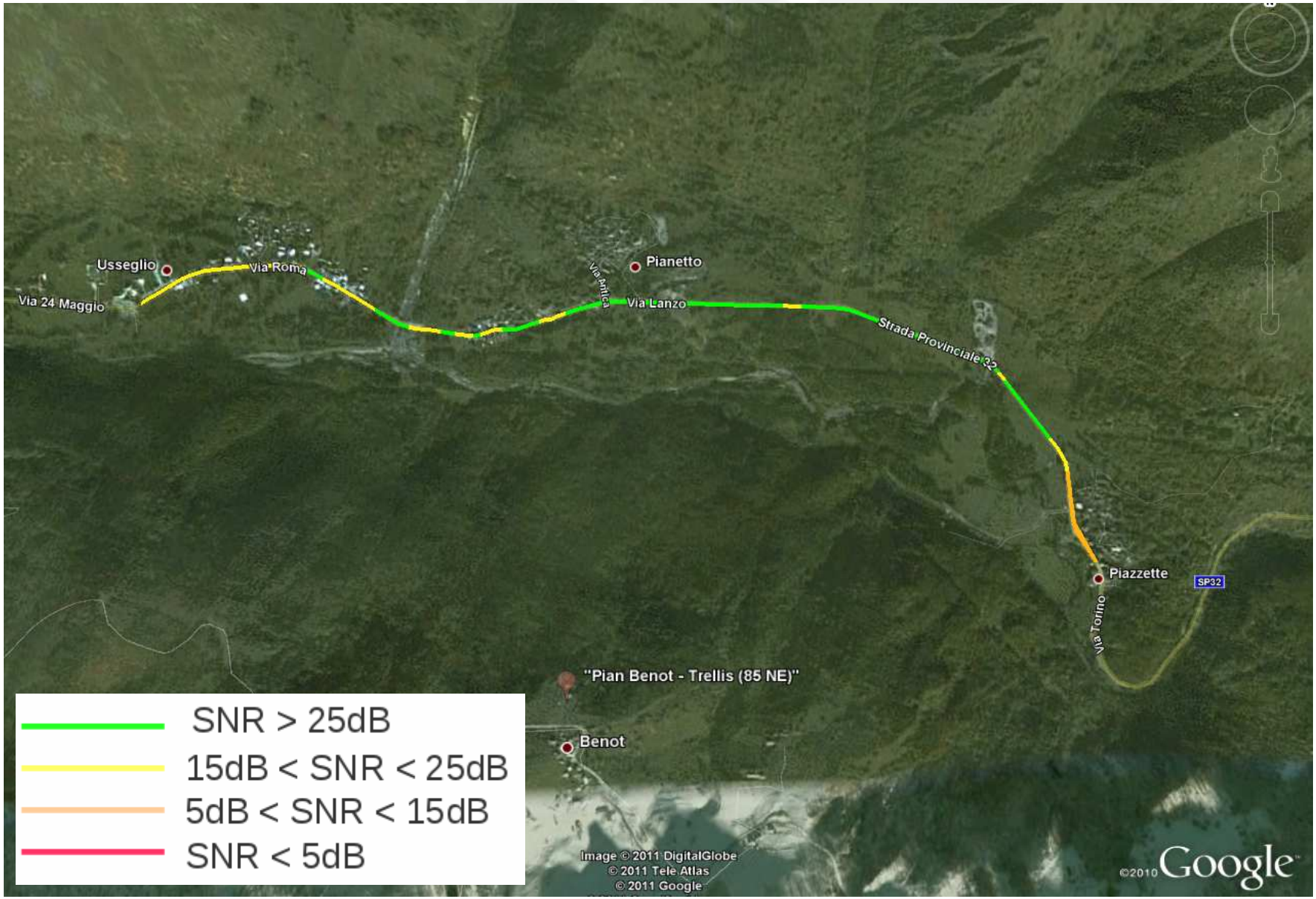
Pianezza
Collegno
Leumann
Grugliasco
Pronda
Alpignano
Bruere
Tangenziale Nord
Corso Francia
Sassi

170 MHz

And the orography weightiness

Service availability at 5 GHz frequency

Service availability at 763 MHz frequency (TV ch 57)



Conclusions

- Wideband is not the unique need; quality and ubiquity is much more important!
- ….this require compromise (6-10 Mbps/user?)

- ISM usage open to easy and low cost infrastructure
- New bands (i.e. 900 MHz) are required

- Static assignments waste the spectrum usability
- We need new “ISM like” RF slices where study and apply the research on OpenSpectrum paradigm (i.e. a couple of 8 MHz channels of “white space”)

- Narrowband technologies must grow to cover IoT evolution
- Dedicated 12.5/25 kHz channels in VHF and UHF bands may help

Roberto Borri
R&D director

mail: roberto.borri@csp.it
tel. +39 011 4815184

CSP innovazione nelle ICT s.c. a r.l.

Via Nizza n. 150 – 10126 Torino – Italy
(ingresso da Via Alassio, 11/c)

Tel +39 011 4815111
Fax +39 011 4815001
E-mail: innovazione@csp.it

www.csp.it
rd.csp.it