Remote area Access Network for 5th GEneration

November 23rd 2017

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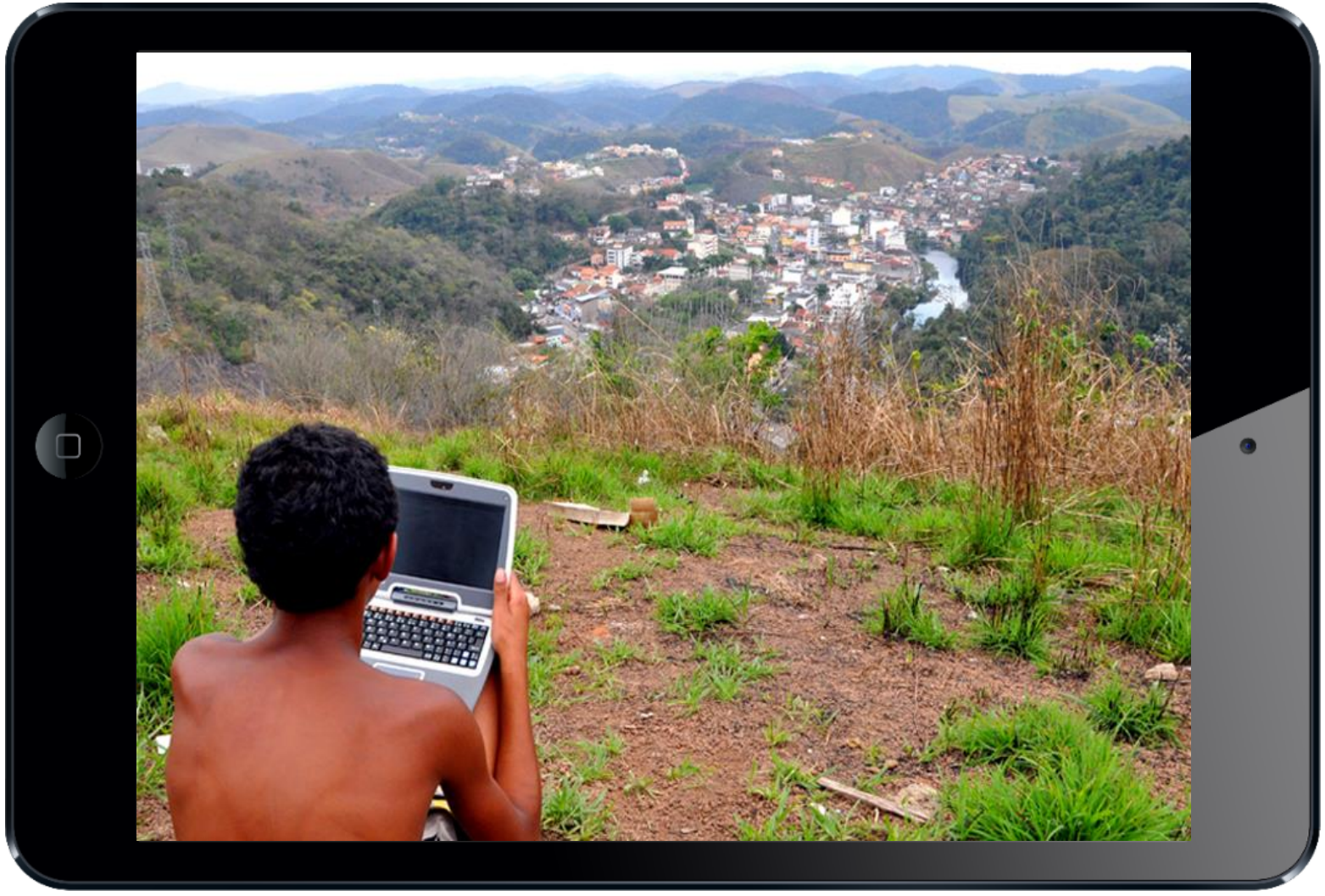
5G-RANGE: Motivations

- Up to 4.4 Billion people do not have Internet access.
- Internet access in remote areas has huge social benefits:
  - Education;
  - Digital Integration;
  - e-Government;
  - Health care.

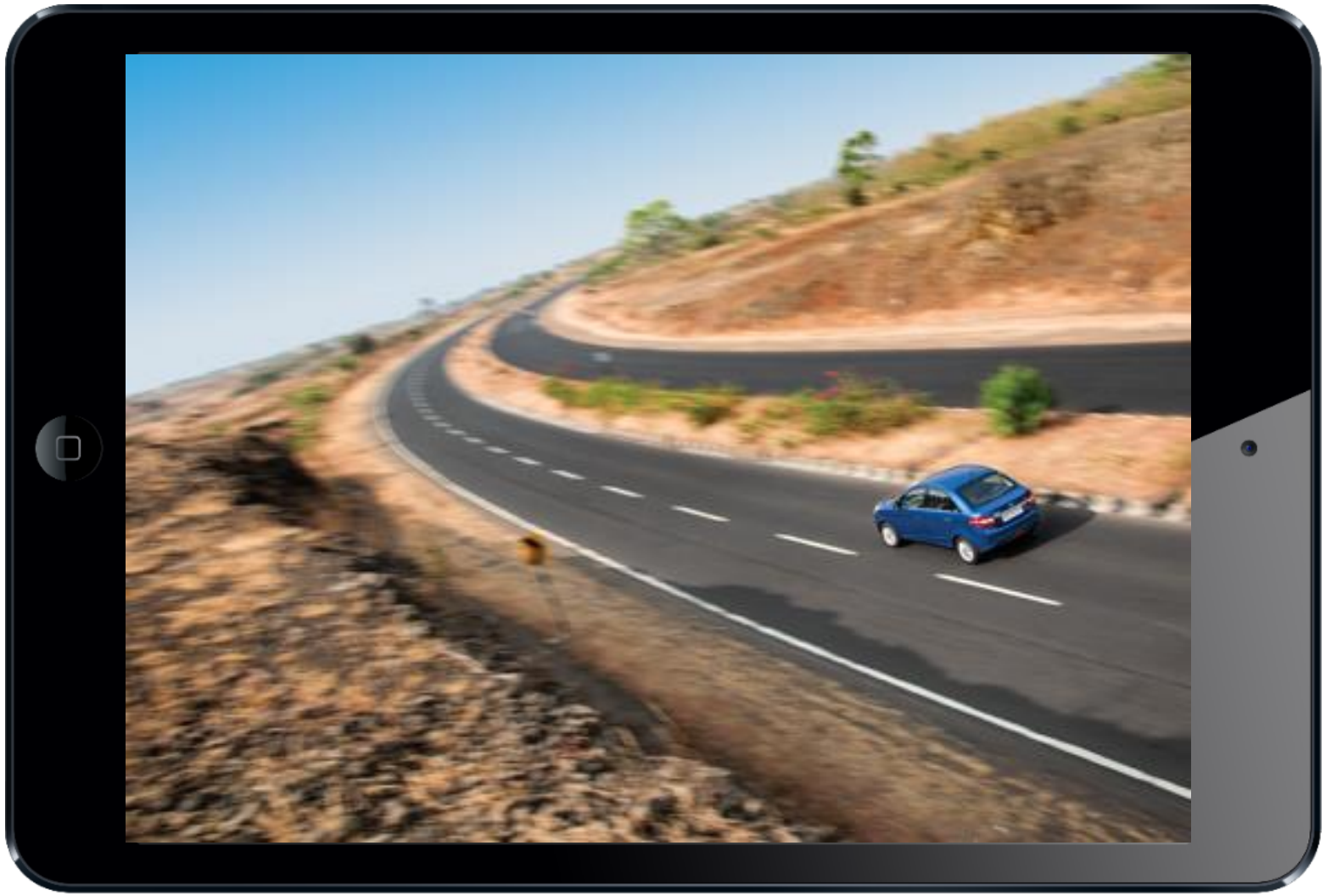


5G-RANGE: Motivations

- Long range coverage will have significant impact on agribusiness.
  - e-farming: automation of the field production;
  - cattle monitoring;
  - transportation monitoring;
  - environment monitoring.
- New subscribers for operators.
- New business model: rural operators.

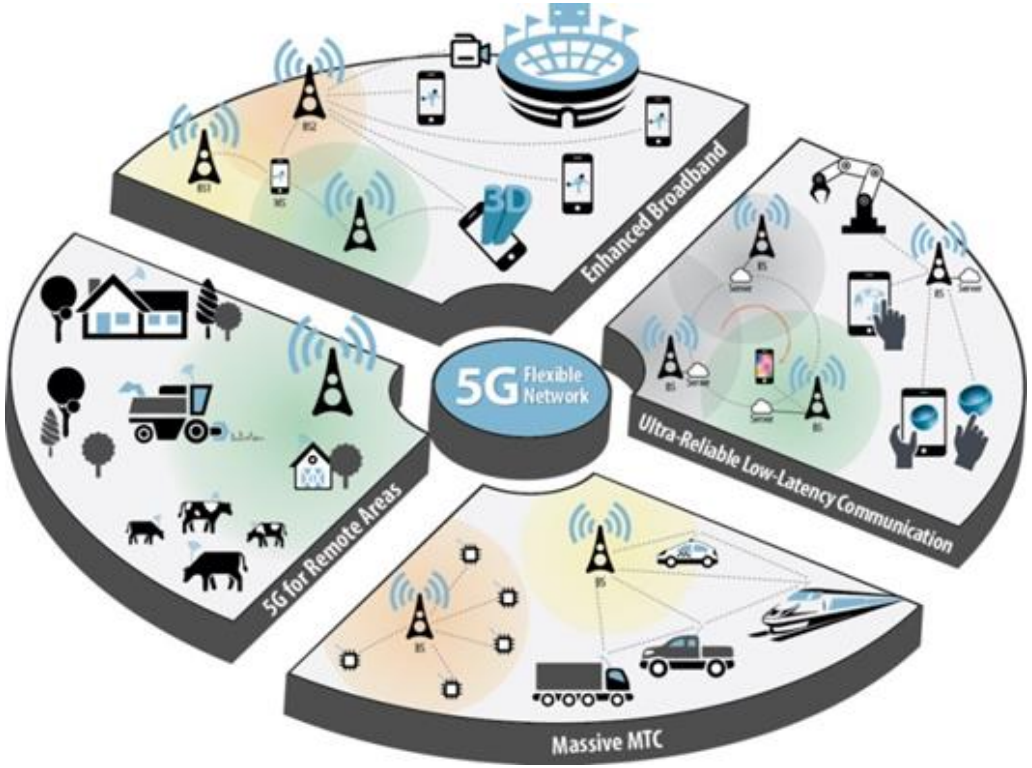
5G-RANGE: Motivations

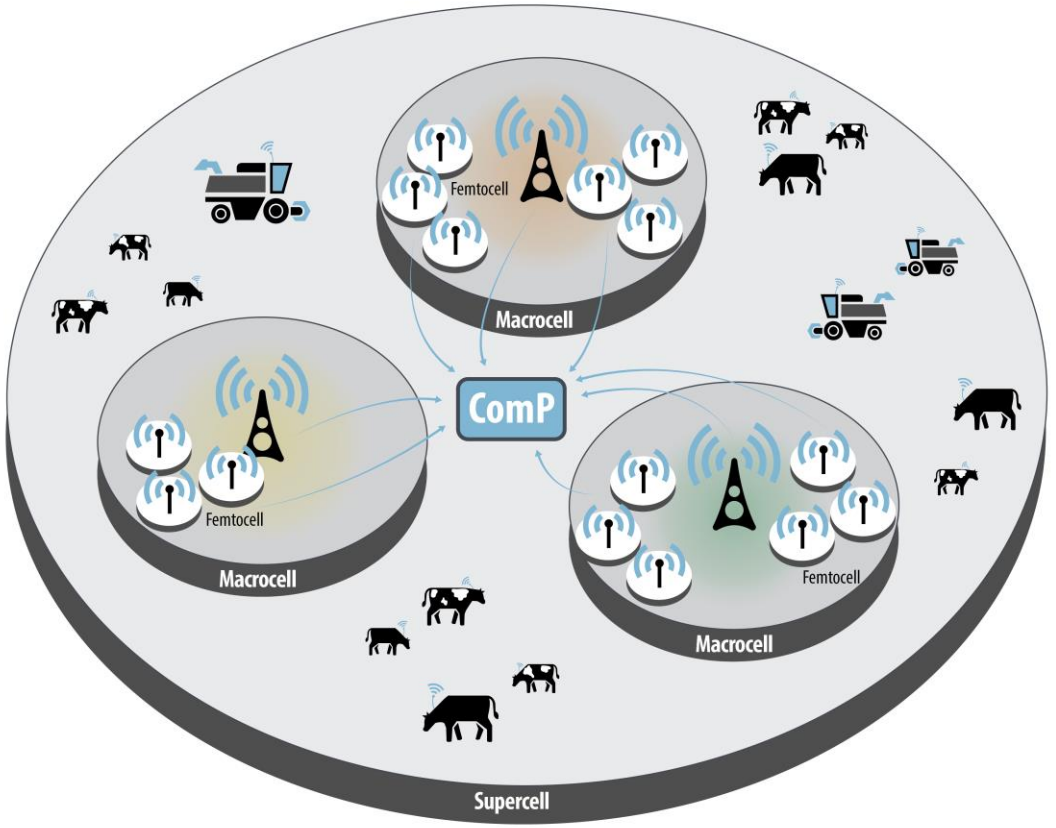
- Coverage on-the-way.
  - connection everywhere;
  - entertainment and safety support;
  - traffic monitoring.
- Interesting solution for V2I communication.
- Not limited for road
  - Trains, ships and even airplanes.



5G-RANGE: Goals

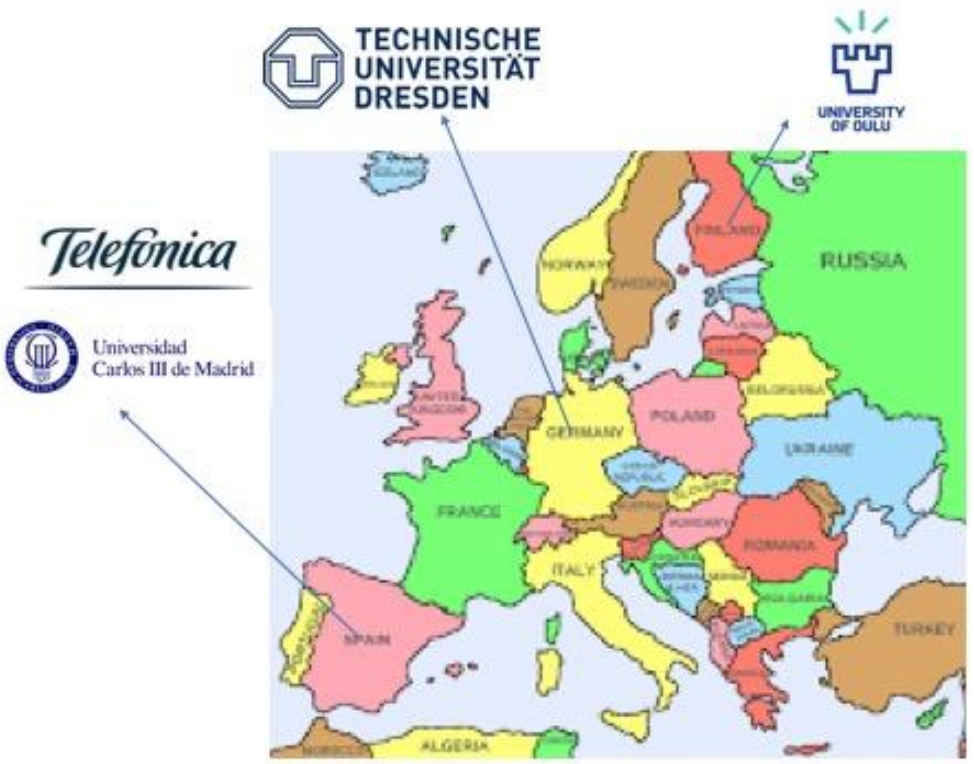
- Main goal: design, develop, implement and validate the mechanisms to enable the 5G network to provide an economically effective solution for Internet access for remote areas.
- A fully operational proof-of-concept will be developed for real-time demonstrations and performance evaluation.
- A new operation mode will be suggested for 5G networks to include long range coverage.
- 100 Mbps will be provided to a receiver at 50 km from the BS.





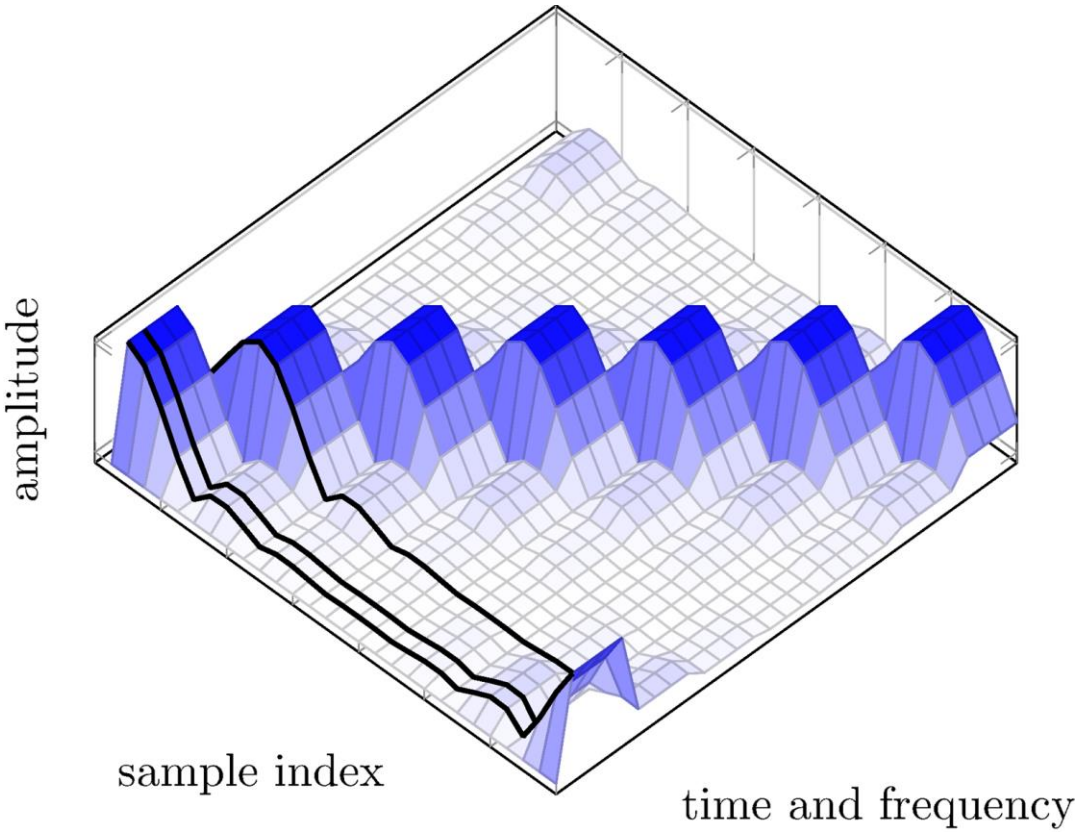
5G-RANGE: Consortium

- Consortium: Brazilian and European institutes funded by RNP (Brazil) and H2020 (Europe).
  - EU Partners: University Carlos III (Spain), TU Dresden (Germany), University of Oulu (Finland) and Telefonica I+D (Spain).
  - BR Partners: Inatel, USP, UFC, UnB, CPqD and Ericsson do Brasil.
- Overall budget: €1M + €1M



5G-RANGE: Main technologies

- Waveform:
  - Flexibility to cover all 5G Scenarios;
  - Low out-of-band emission;
  - High spectrum efficiency;
  - Robustness against time and frequency dispersive channels;
  - Manageable implementation complexity;
  - Integration with advanced communication techniques.



5G-RANGE: Main technologies

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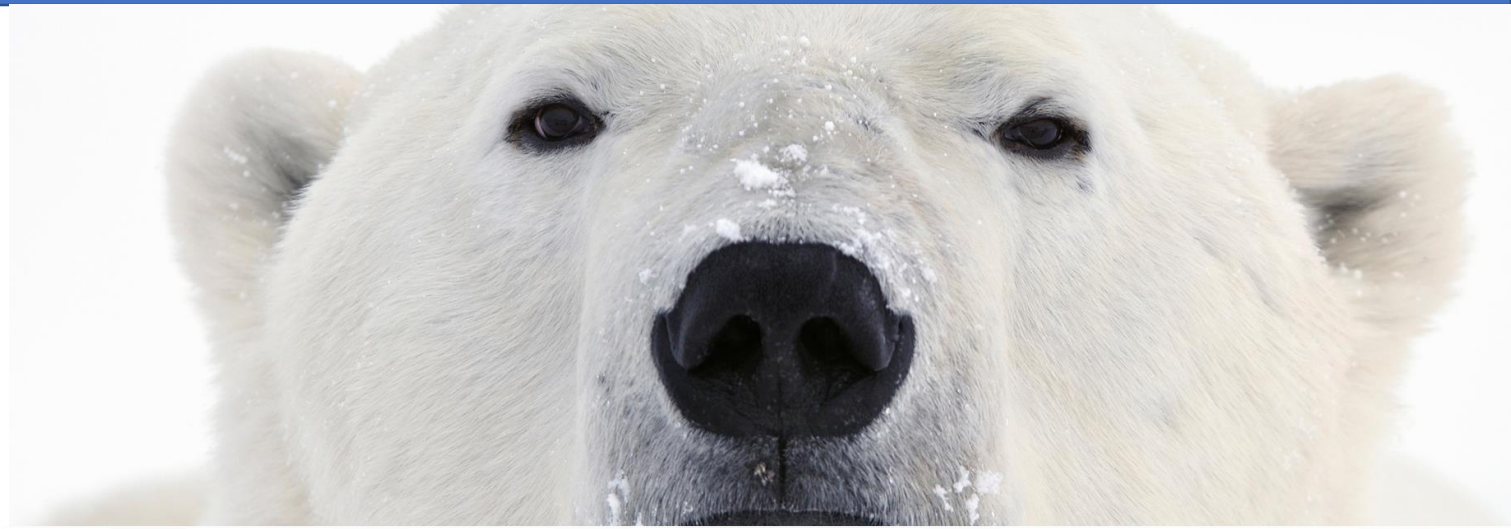
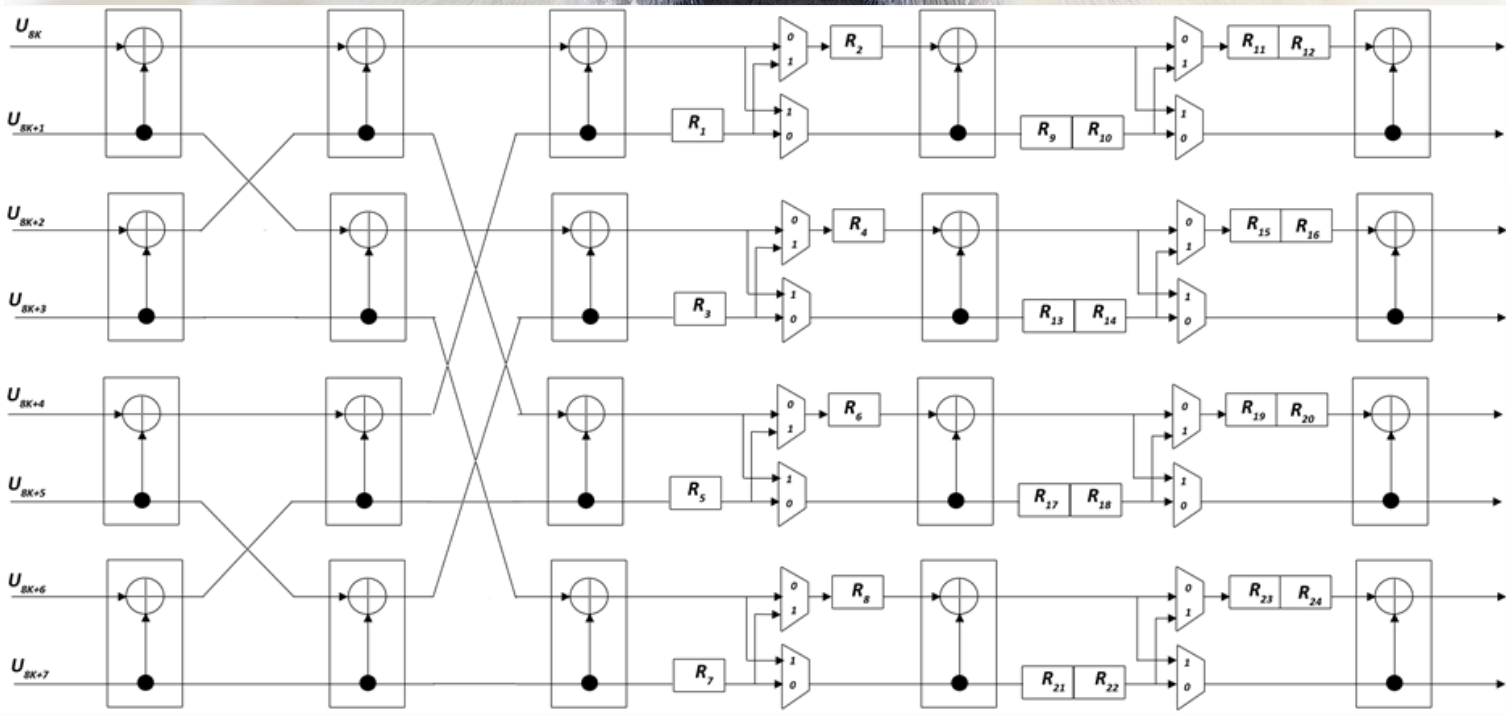
- Channel Coding:
  - several coding rates and easy adaptability;
  - robustness;
  - high spectrum efficiency;
  - low complexity.



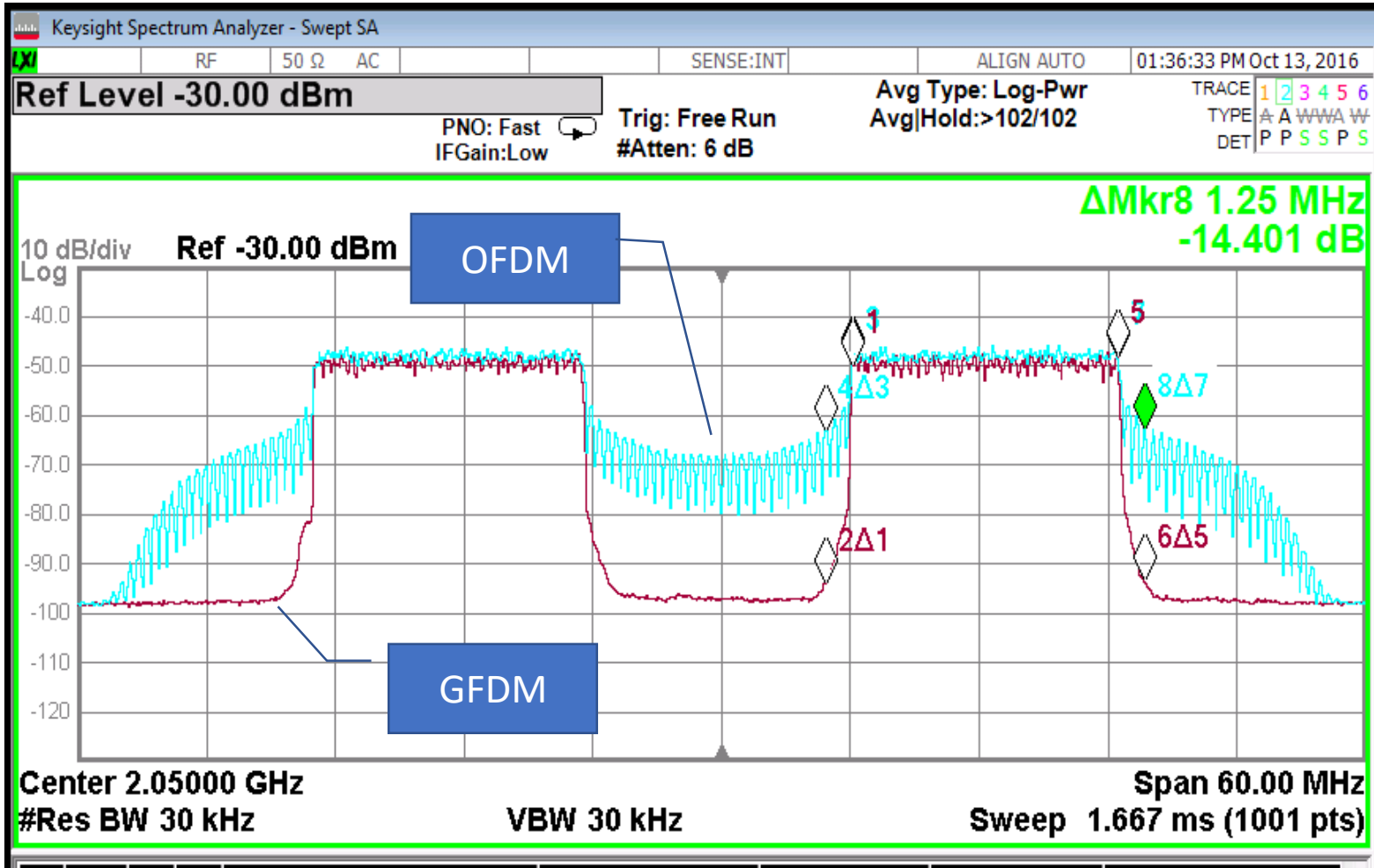


5G-RANGE: Main technologies

- MIMO:
  - diversity gain;
  - higher spectrum efficiency;
  - robustness against dispersive channels;
  - range enhancement.

5G-RANGE: Main technologies

- Cognitive Radio:
  - dynamic spectrum access;
  - fragmented spectrum allocation;
  - TV white space exploitation;
  - robust spectrum sensing;
  - co-existence with legacy technology;
  - interference mitigation.



5G-RANGE: Implementation strategy

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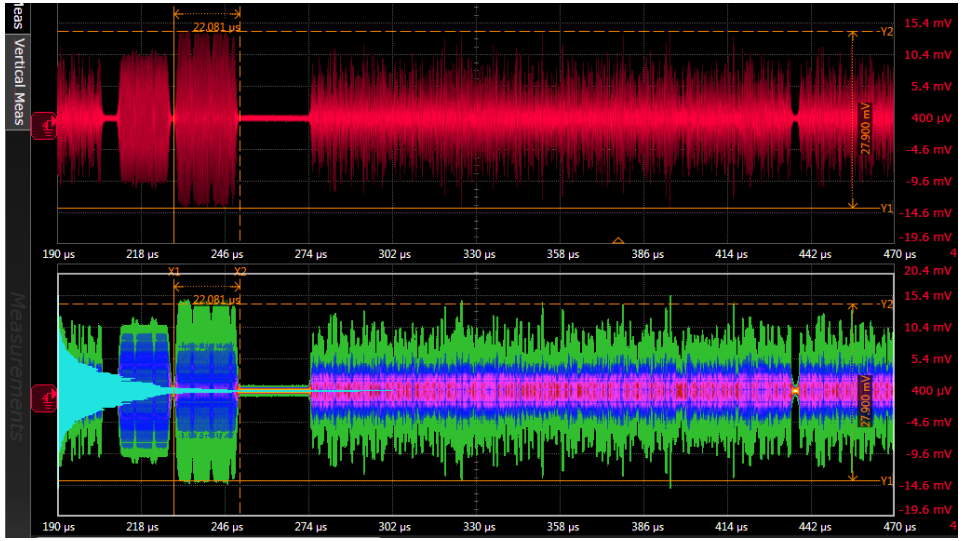
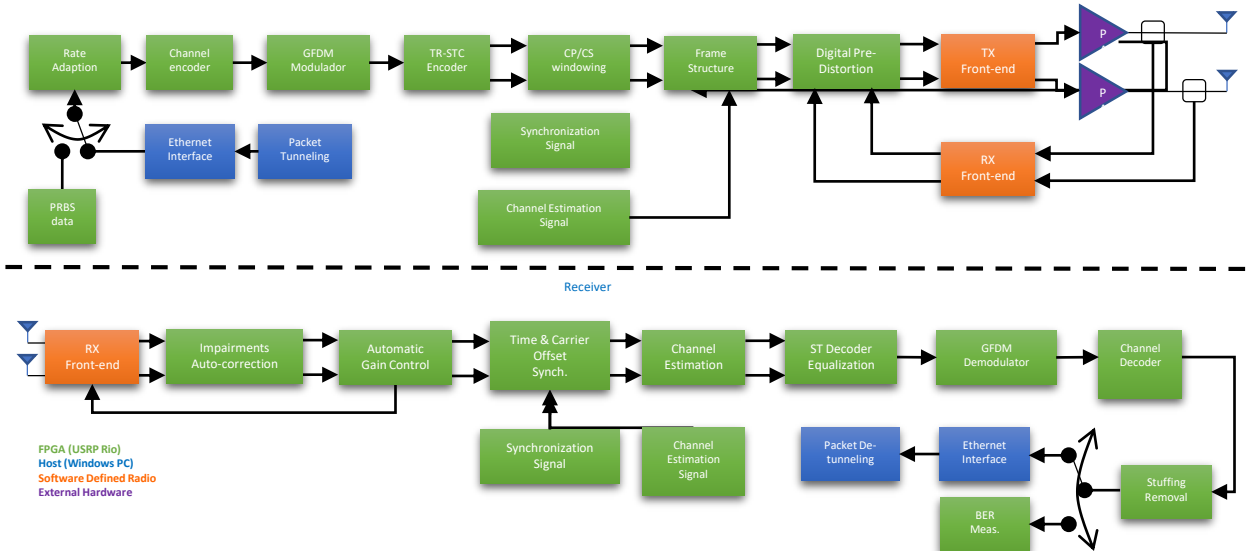
- Software Defined Radio:
  - USRPs with powerful FPGA for real-time processing;
  - PXIs with powerful processor for control and off-line processing;
  - Easy integration of different implementation languages;
  - Integration with NS3 and Open Air Interface for upper layers implementation.

5G-RANGE: Implementation strategy

- MIMO-GFDM Transceiver already fully operational.





5G-RANGE: Conclusions

- Remote areas applications is an important 5G scenario with huge social and economic impacts.
- 5G for Remote Areas are being superficially discussed by academia, industry and operators.
- Current technology can be tailored to cover this scenario and surpass the last frontier for a universal Internet access.
- 5G-RANGE will demonstrate that high data rate at long distance from the BS is possible with the most recent digital communication techniques.
- Further questions:

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