The LENA Project

a product-oriented open source LTE/EPC Network Simulator based on ns-3

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About the project

- CTTC working with Ubiquisys, the leading femtocell manufacturer
- Objective: develop a common platform for LTE femto/macro cell vendors to evaluate their different solutions
  - e.g., make sure that large and small cells from different vendors will work harmoniously before they are deployed
  - Open Source to foster adoption and contributions
  - Based on ns-3
- Use case: LTE-based Self Organized Networks
  - Need to test SONs algorithms before deployment
  - Ubiquisys made extensive use of simulation to design its first generation of WCDMA intelligent femtocells
- Product –oriented:
  - Real-world interfaces for SON algorithms
  - FemtoForum MAC Scheduler API specification
  - Allow testing real code in the simulator

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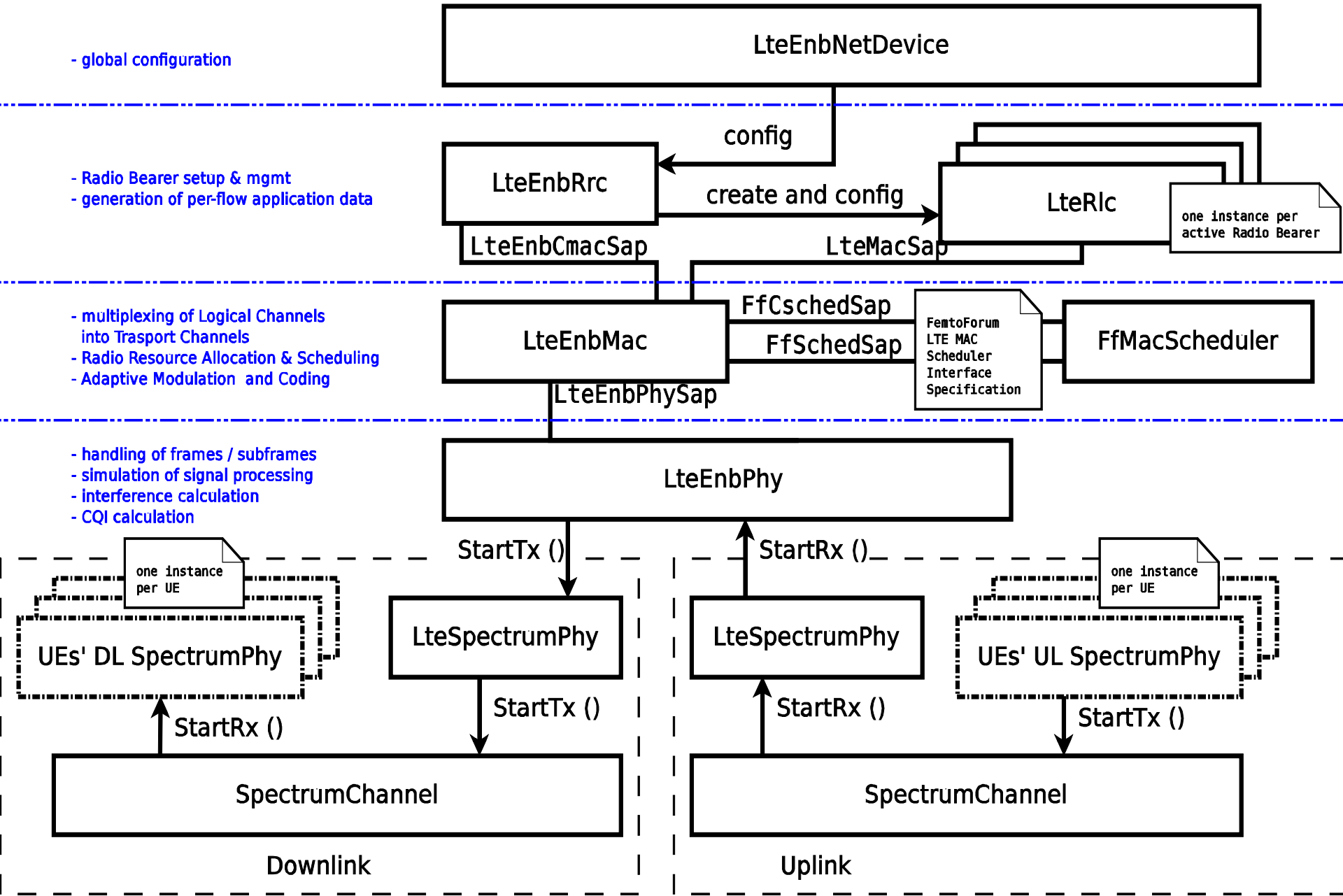
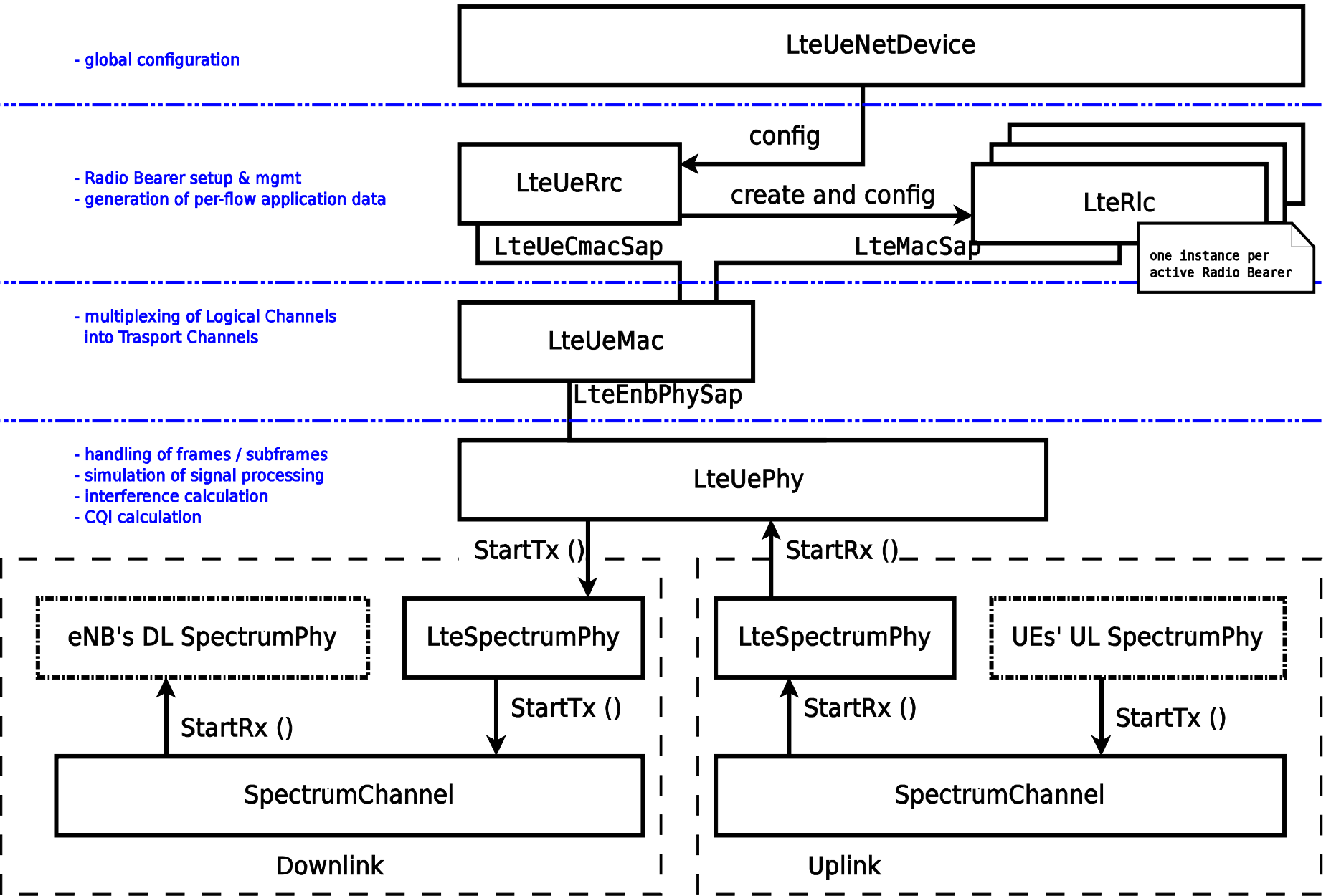
Current Features

- PHY and MAC for UL and DL
  - frame/subframe structure
  - Ideal control channel
  - Adaptive Modulation and Coding
- Inter-cell interference modeling
- Packet Scheduling
  - FemtoForum MAC Scheduler API
  - Round Robin and Proportional Fair schedulers available
- Abstract RLC model
  - PDU generator with infinite queue
- Simplified RRC
  - UE Attach procedure
  - Bearer setup
- Configuration via ns-3 attribute system
- Output: MAC and RLC statistics

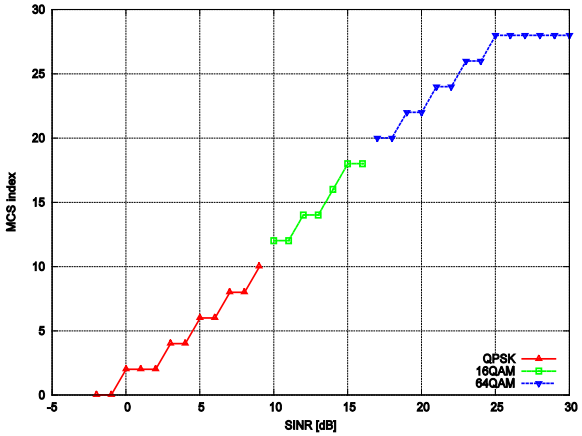
eNB protocol stack architecture



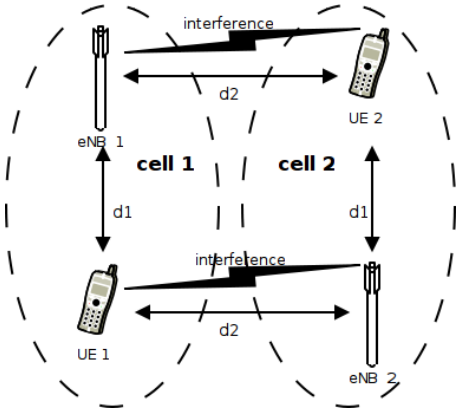
UE protocol stack architecture



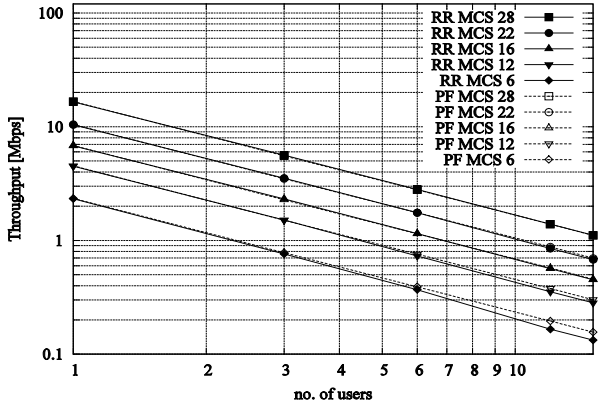
Testing and Validation: some examples

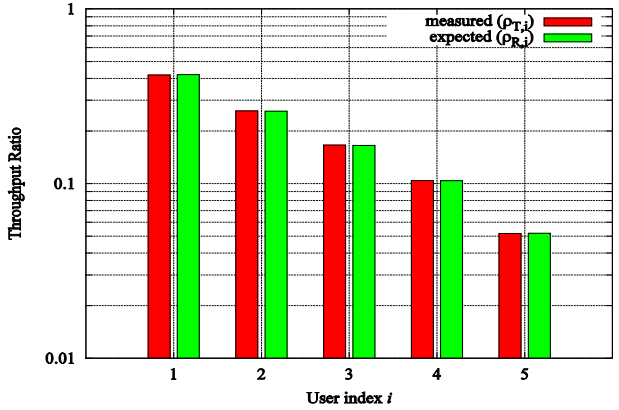


Unit test: AMC



System test: interference





System tests: RR & PF scheduler performance

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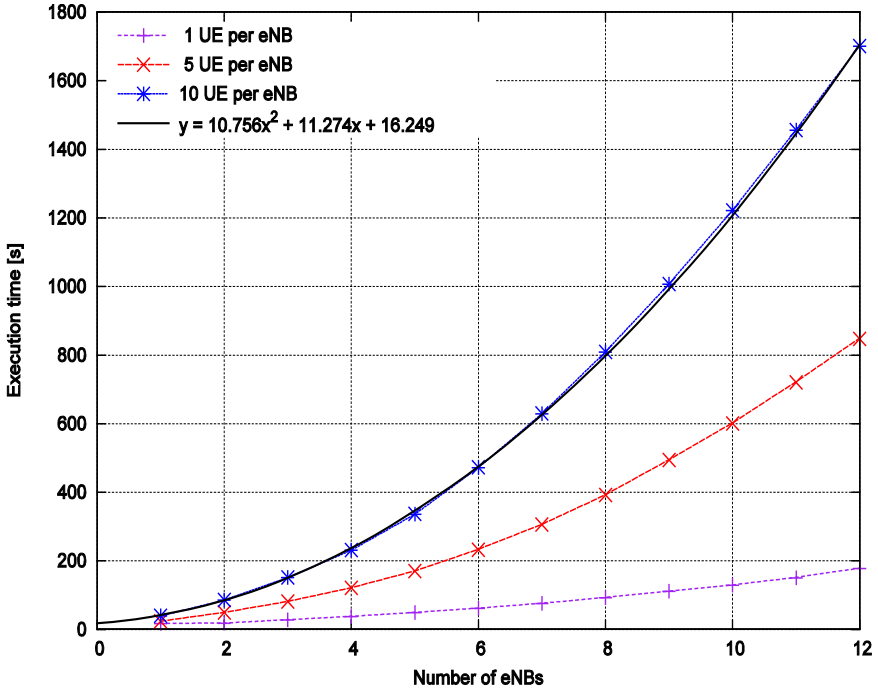
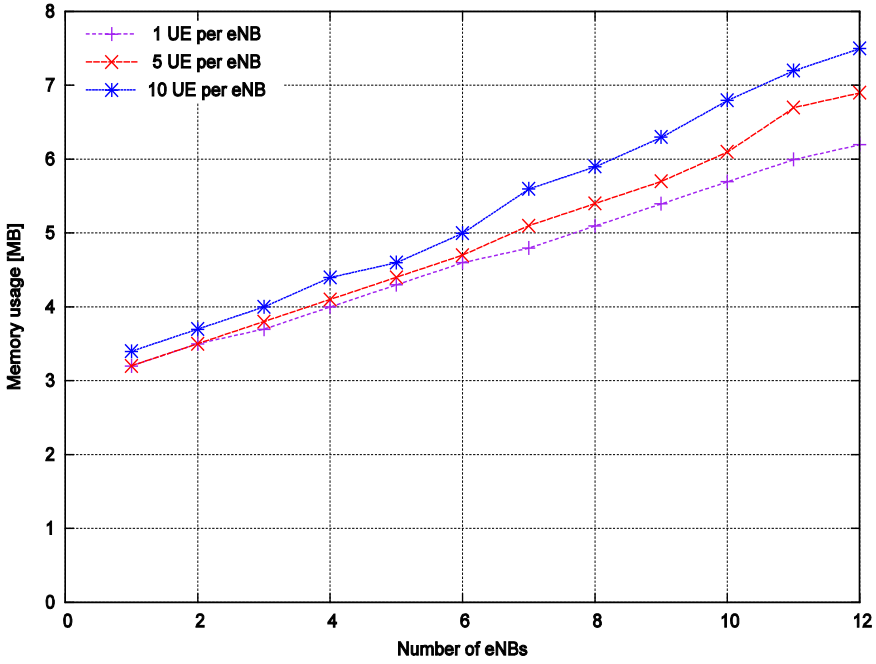
run-time performance





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Work in progress

- Path loss models
  - Well known models
    - Path loss: OH, ITU-R 1411, ITU-R 1238…
    - Shadowing, fading, building penetration loss
  - Appropriate combination selected at runtime based on the topology
- E-UTRA protocol stack
  - RLC UM & AM
  - PDCP
- EPC Data Plane
  - SGW / PGW
  - S1-U interface
  - GTP over UDP/IP
  - Traffic Flow Templates

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Future development

- PHY enhancements:
  - Error model
  - HARQ
  - MIMO
- More EPC features:
  - MME
  - X2 interface
    - Handover support
    - Inter-cell interference coordination support
    - Neighbor Discovery support

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Check it out!

- Links:
  - http://www.cttc.es
  - http://iptechwiki.cttc.es/LTE-EPC_Network_Simulator_(LENA)
  - http://www.nsnam.org
  - http://code.nsnam.org/nbaldo/ns-3-lena-dev
- Documentation:
  - User Docs, Design Docs & Testing Docs
    - distributed with source code
    - pdf available
  - API documentation
    - doxygen
- Feedback & contributions welcome!
- Contact: Nicola Baldo <nbaldo@cttc.es>