

Bringing Experimentation to Wireless Live Networks

Universidad de Málaga

Mobile Networks and Software Reliability Labs

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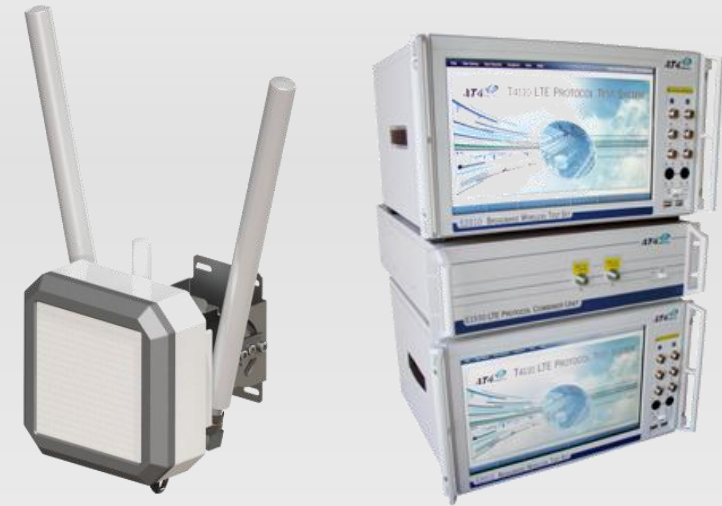


Mobile Networks and Software Reliability Lab

University of Málaga (Spain)

Research topics in mobile networks

- Advanced services
- Quality of Service and Quality of Experience
- Energy Saving
- Protocol Stacks for 3G and LTE networks
- LTE for critical services
- Novel network architectures



Experimental facility (PerformLTE)

- LTE Pico Cell Lab
- LTE Core Network
- LTE Conformance Testing Equipment
- Power Analyzer
- Networks Tools (TestelDroid, Fleximon)
- SDR Equipment

Mobile Networks and Software Reliability Lab

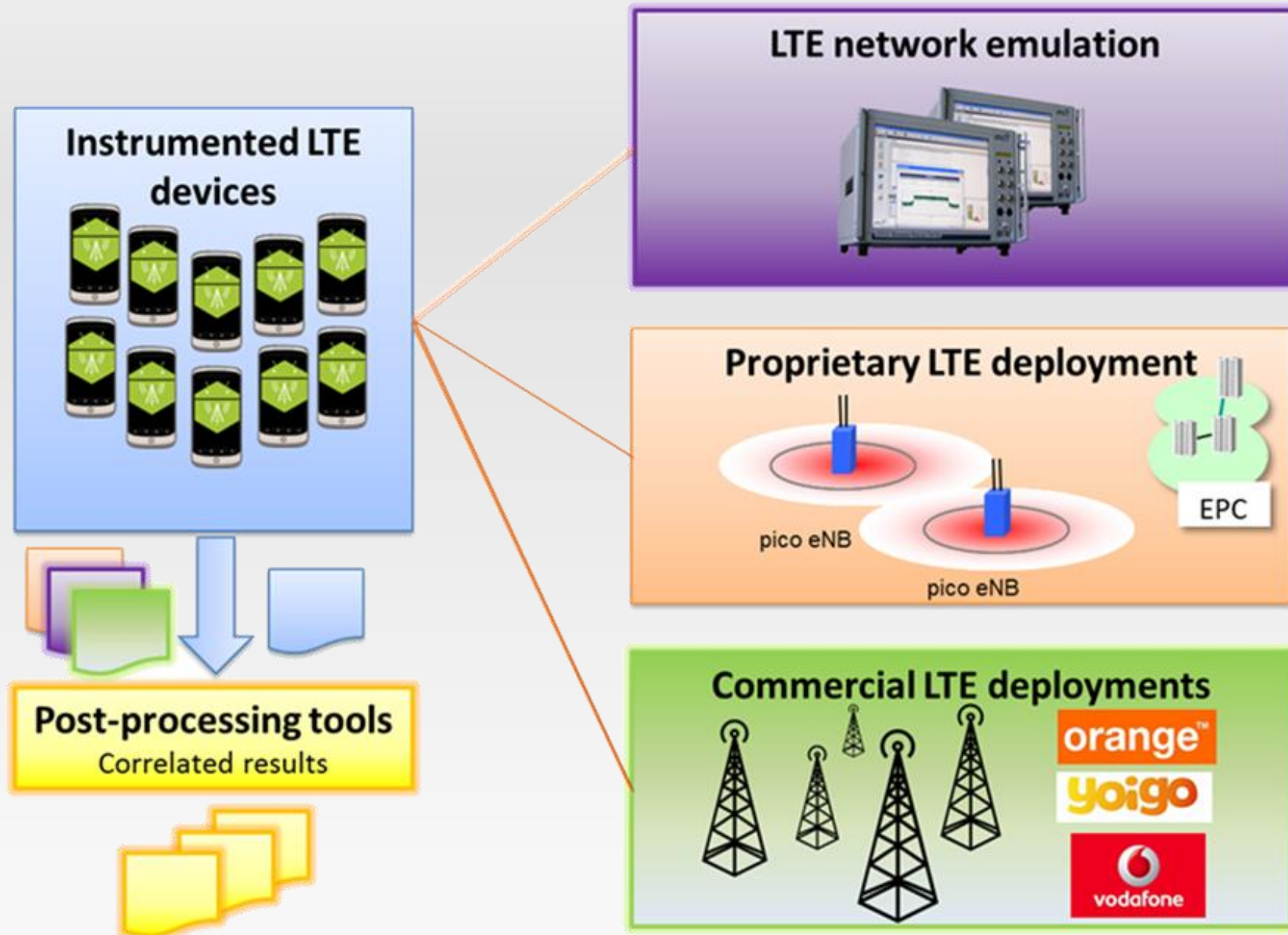
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Recent projects and partners

- **Protocols stacks** for eNB emulators (AT4 wireless, formerly CETECOM)
- Migration from GSM-R to **LTE for railway** signalling (Alcatel-Lucent, AT4 wireless, ADIF, MetroMadrid)
- Configuration tools for **LTE testing equipments** (Keysight Technologies)
- Integrating **PerfomLTE** into FP7 Fed4Fire (coordinated by iMinds)
- Integrating **PerformLTE** into FP7 FLEX (coordinated by UTH)
- New H2020 projects starting the next year and evolving PerformLTE towards 5G communications



PerformLTE Initial Testbed Philosophy



PerformLTE resources (I)

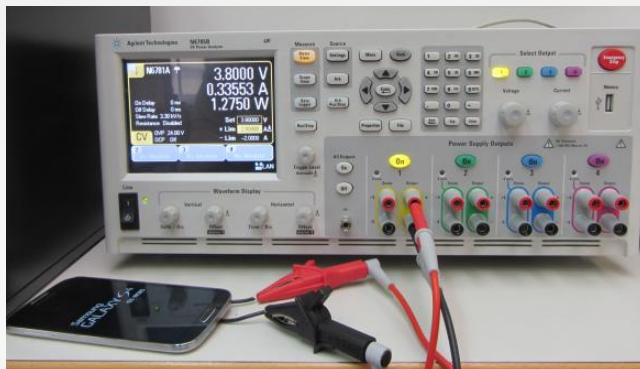


LTE Emulator T2010A

- RRC and NAS signaling
- KPIs from all the stack
- Conformance testing and design verification
- FLEX extensions to provide S1 interface

Athena Wireless Pico Cells

- Release 8 compliant
- Band 7, configurable EARFCN and bandwidth
- Transmission power 2W



Agilent DC power analyzer N6705B

- Power consumption
- Battery emulation

PerformLTE resources (II)

Commercial LTE devices Monitored using TestelDroid

- Samsung Galaxy S4
- HTC One
- Samsung Galaxy Tab



Micro-core own implementation

- Supports basic procedures and end to end connectivity



Drive testing tools

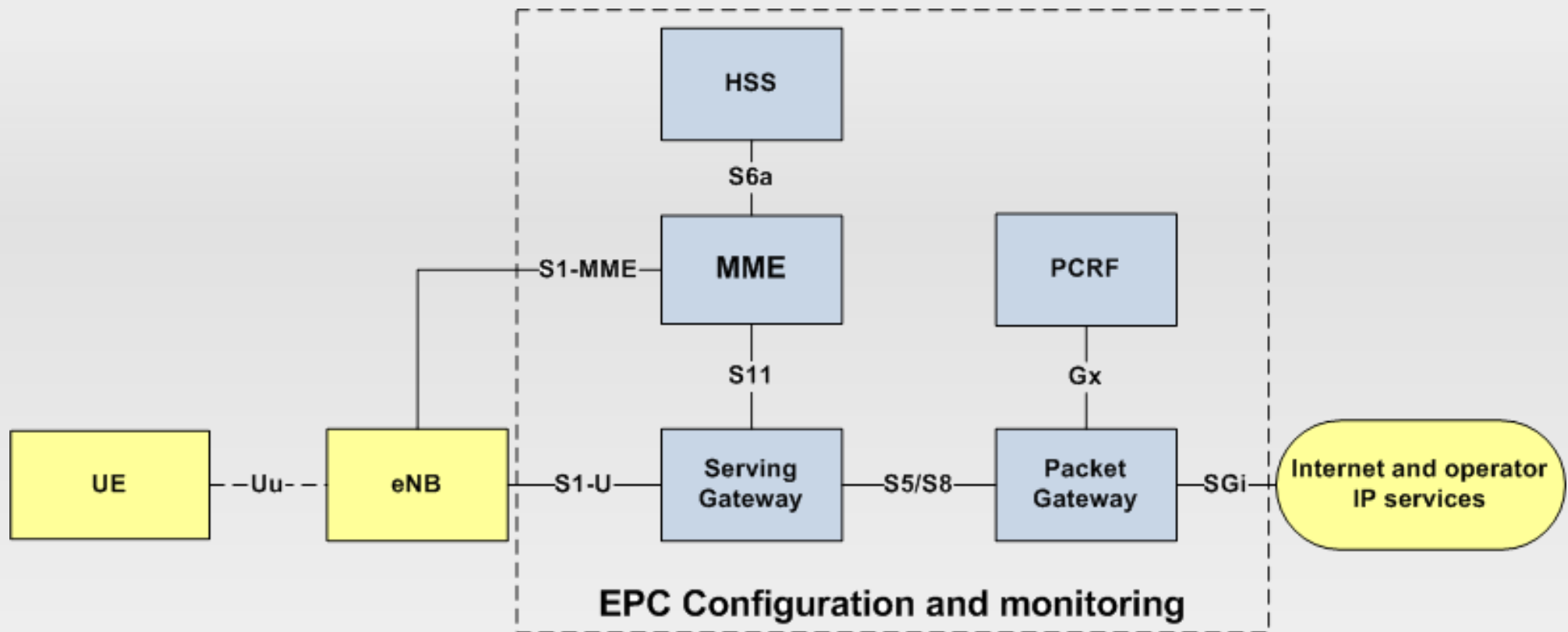
- Provides information from the stack of commercial devices (Qualcomm chipsets)

Open Source Stacks and SDR

- OpenAirInterface working on ExpressMimo2



PerformLTE resources (III)



Commercial Core Network

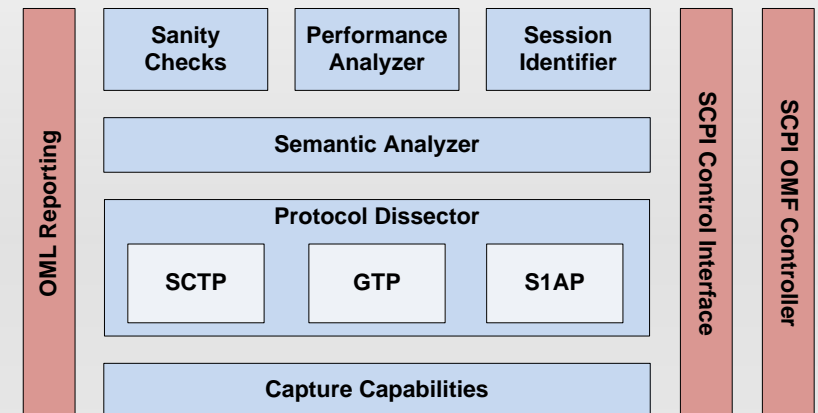
- On demand network scenarios definition
- Complex scenarios (multiple PLMN, roaming, etc) and negative testing
- FLEX Extensions to support dynamic creation of networks
- Monitoring of all the interfaces in the network

PerfomLTE FLEX Evolution

Towards Interconnection of Testbeds

Fleximon Tool (release soon)

- Tool for remote monitorization of communication interfaces and interoperability testing



S1 extensions to the conformance testing equipment

- To operate with other FLEX and Fed4fire testbeds, ongoing core network topology design using jFed.

Upcoming programmable attenuation scenarios

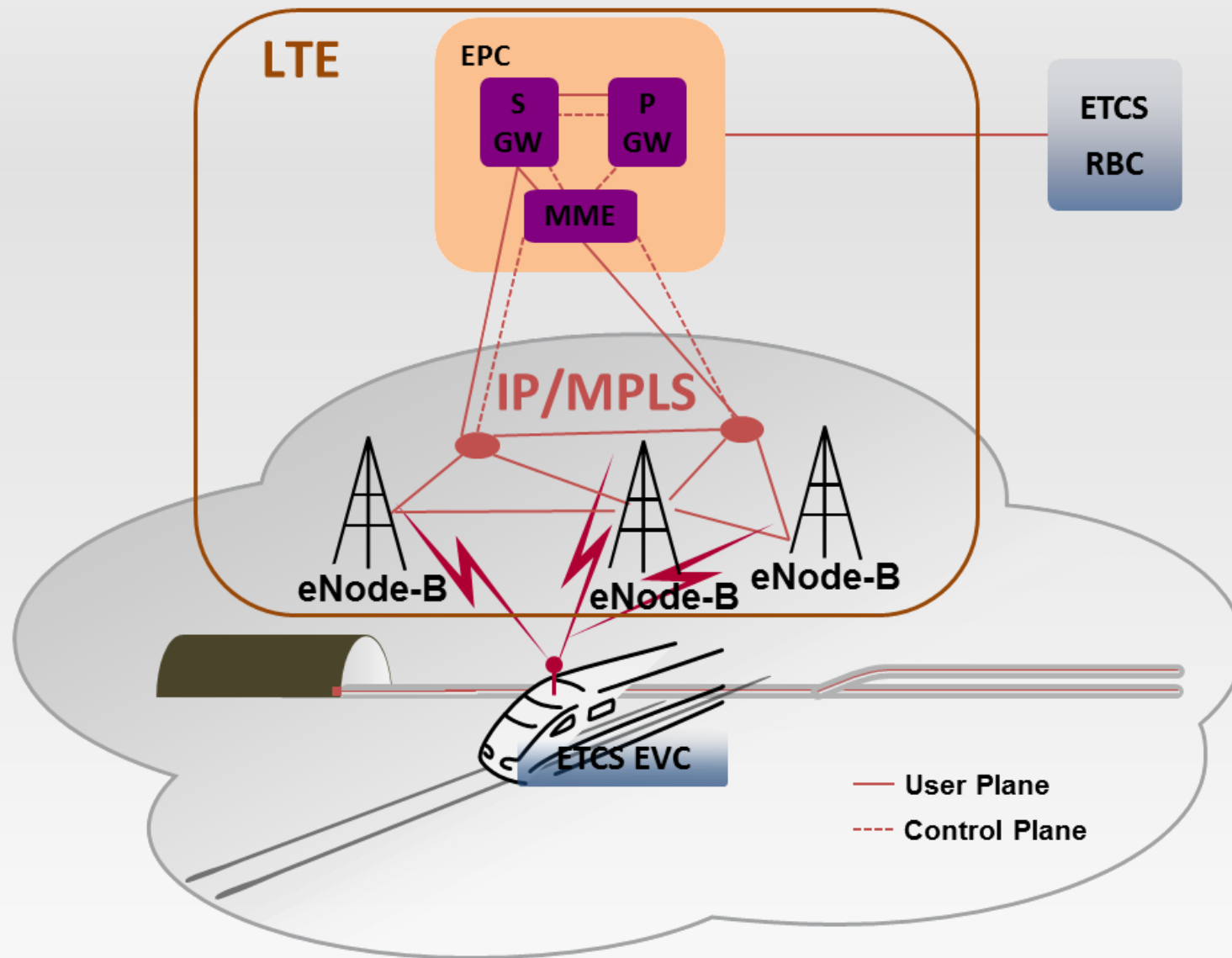
Layer 2 connectivity

- To operate with other FLEX and Fed4fire testbeds, ongoing core network topology design using jFed.



User Experiences: TECRAIL Pilot

TECRAIL Project Concept

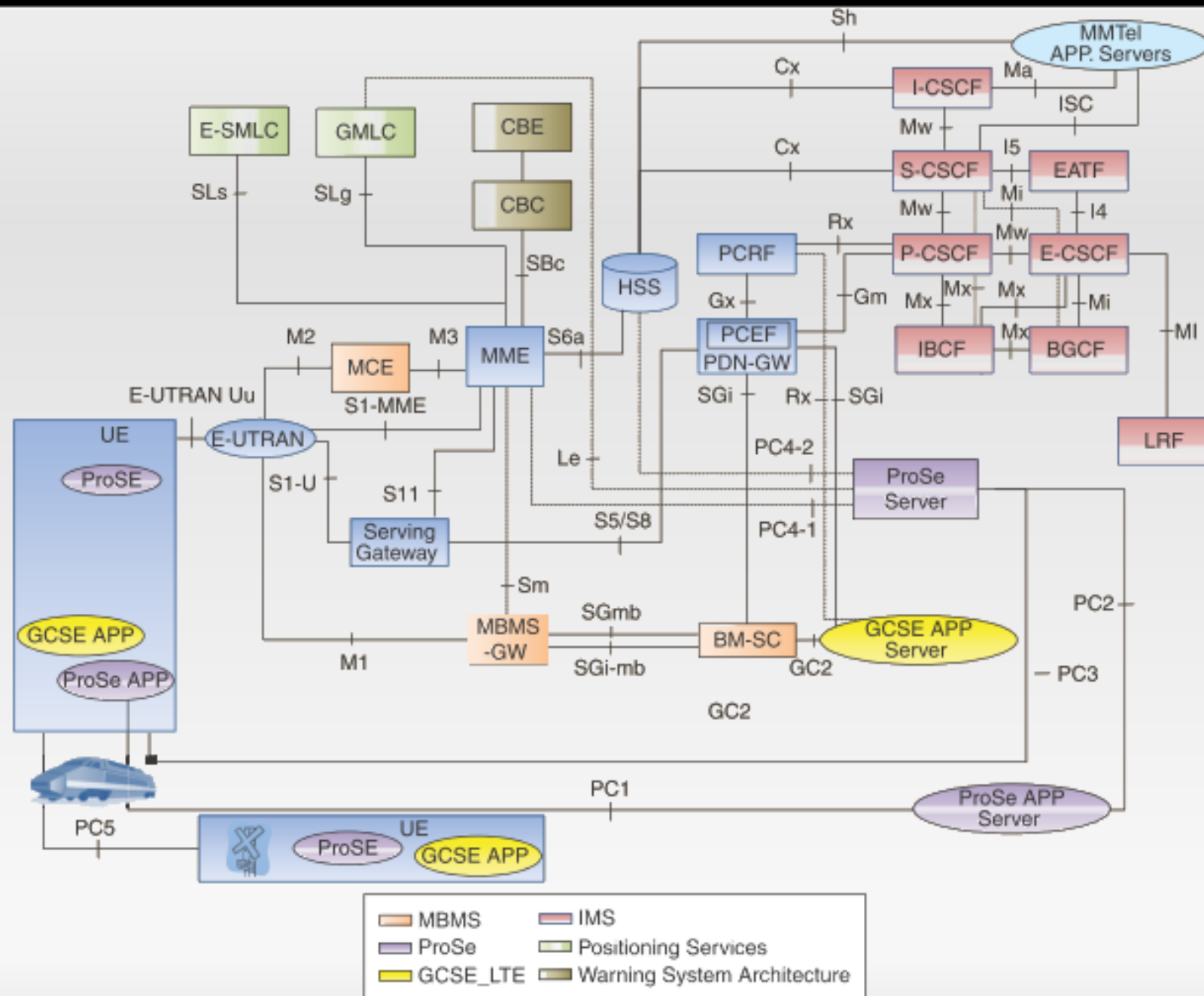


TECRAIL

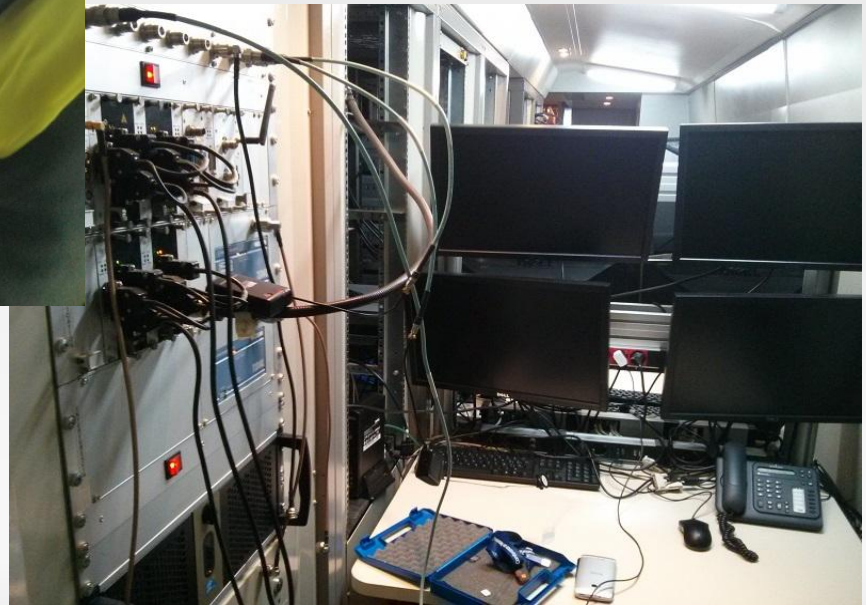
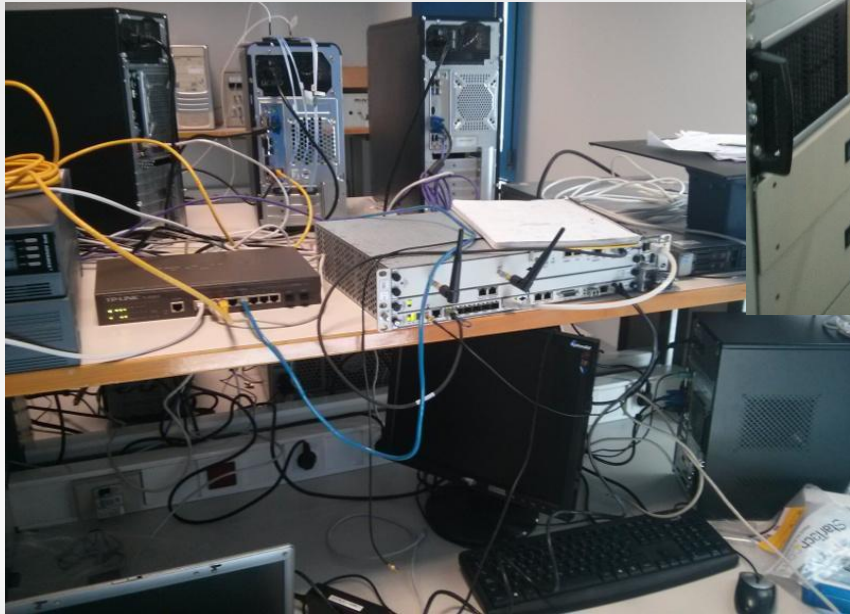
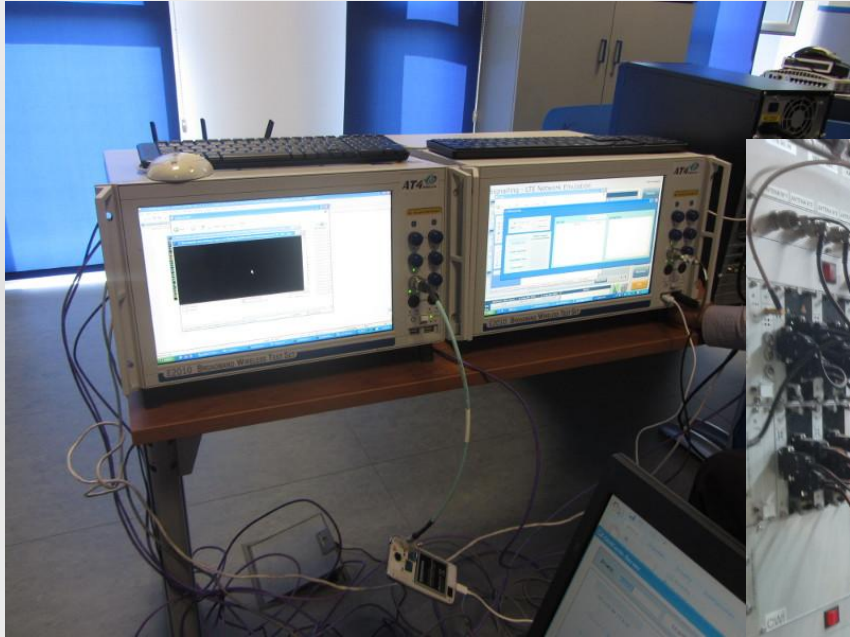
- Evaluation of LTE as replacement of GSM-R.
- Partners: final users, research centres and vendors.
- Final objective: Provision of pilot evaluating the technology.

User Experiences: TECRAIL Pilot

TECRAIL COTS Architecture



User Experiences: TECRAIL Pilot Pilot Story



User Experiences: Innovative SMEs

SAFE Project

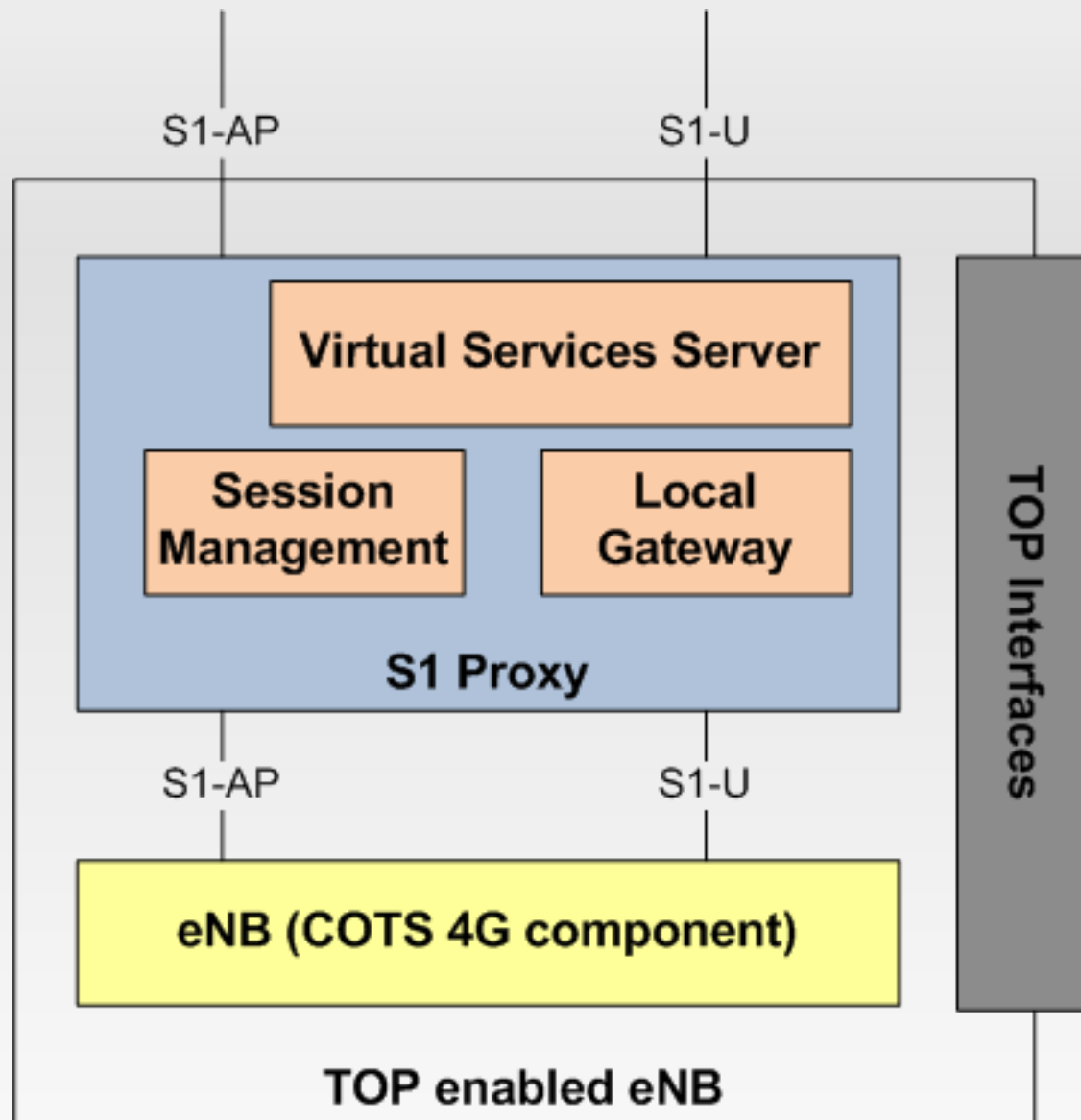


Fed4Fire Experiment

- Evaluation of a head mounted real time video streaming for mission critical services.
- Work in laboratory with commercial base stations
- Final users interested in testing on field.
- OTT configuration of network QoS.

User Experiences: Operator and Vendor

Reducing Latency over COTS stations



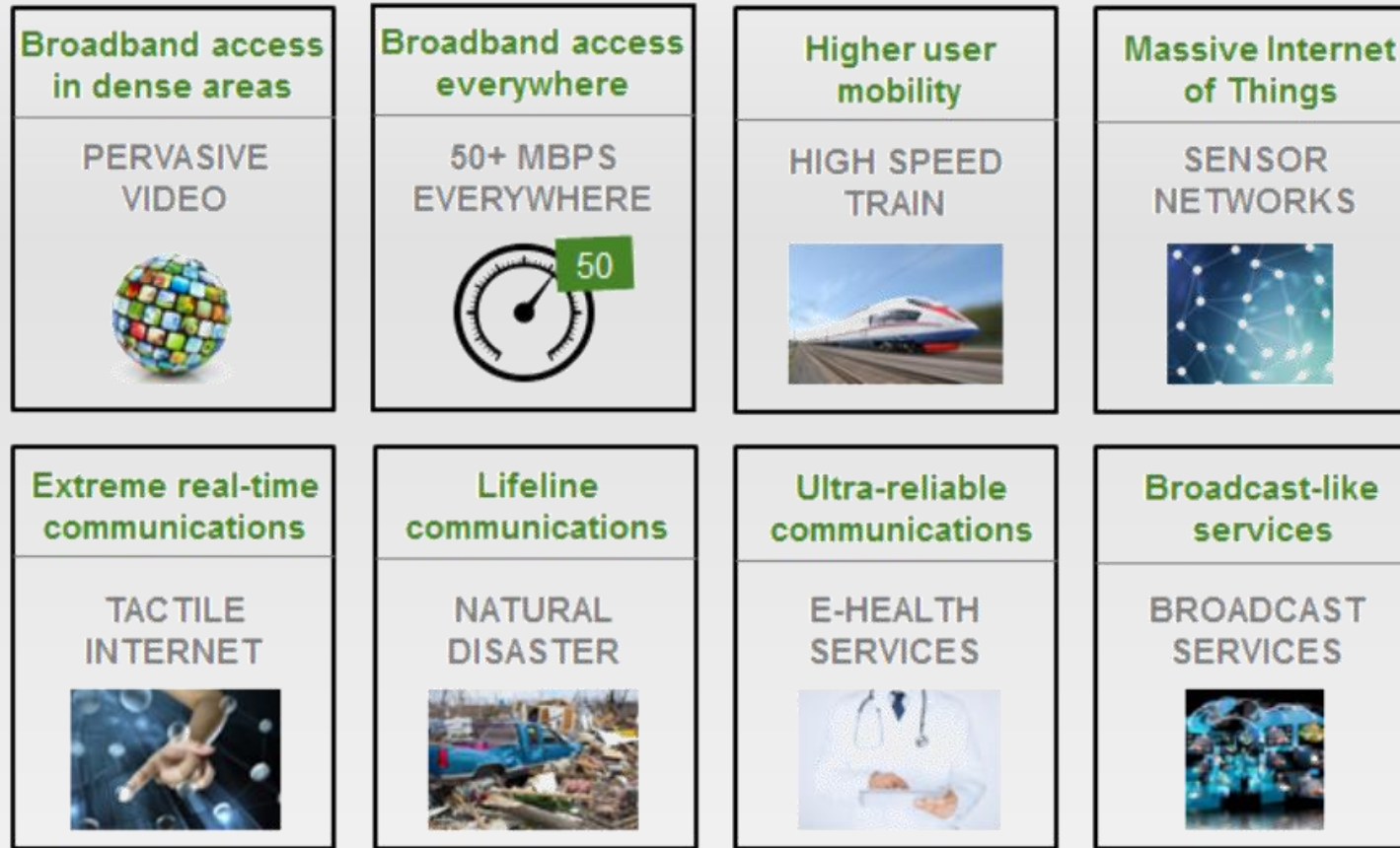
Proposal for pre-5G tech.

- Provide an architecture to support the provision of local services in a commercial node.
- Pilots to be produced during major events in Spain (Fallas in Valencia).
- Evaluate impact in non local services as well as QoE for blue light local services.

Experimentation on Live Networks

5G Communications

Image from NGMN 5G white paper



5G technologies demands experimentation on real networks

- Not only new radio access, new services, new architectures, etc.
- Very aggressive KPIs. Simulating macro behaviour won't be enough
- Use (and mix) the already existing testbeds for SDN and Mobile net.

Experimentation on Live Networks

IoT Pilots



Image from jdc.com

Upcoming IoT pilots

- H2020 ICT IoT-01-2016 demands high scale pilots.
- Communication of Things in smart cities is challenging.
- Evaluation of QoS/QoE in urban environments.
- Integration of CPS
- M2M Communications

Bringing Wireless Live Experimentation

Major challenges

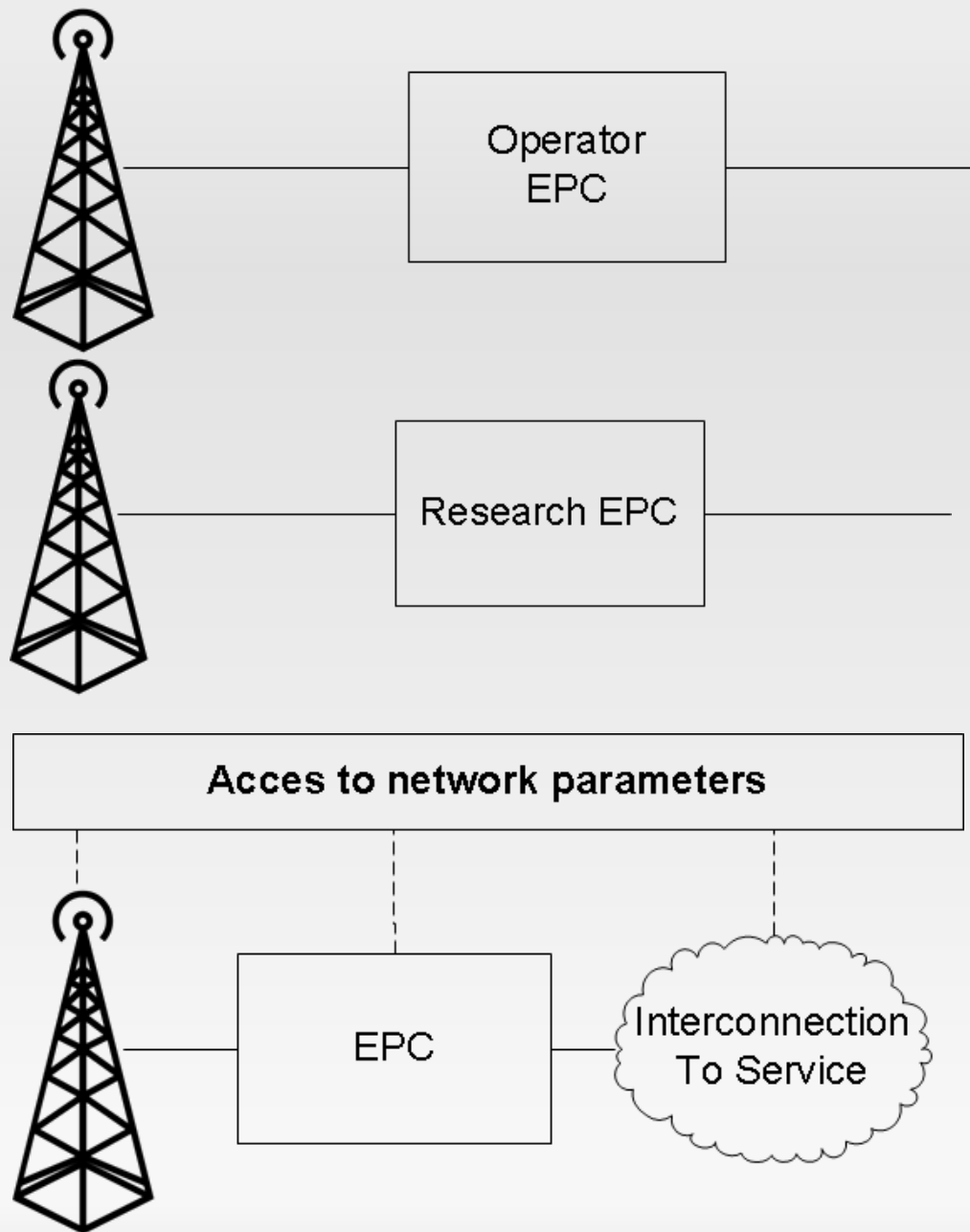


Major challenges

- Gap between researchers and commercial deployment.
- Not only equipment costs also deployment and operation.
- Spectrum is (a very) valuable resource. Access is forbidden to non operator organizations.
- Costs are very high
- Operators are reluctant to leasing equipment and even spectrum!
- Configuration inconsistencies can lead to outages

Bringing Wireless Live Experimentation

First approaches



SciWiNet
Enabling Research in the Wild

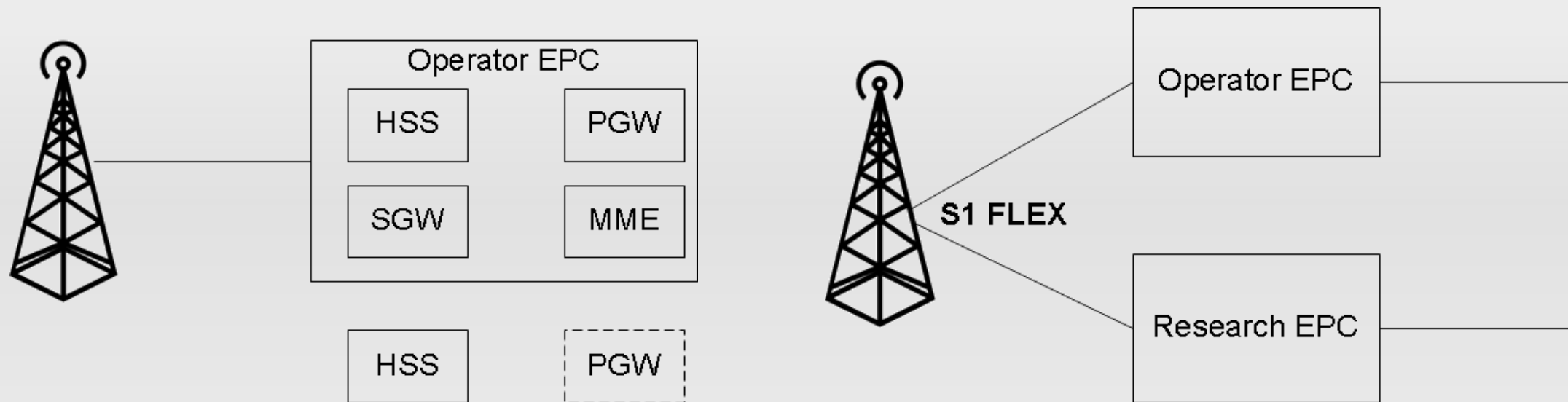
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First approaches

- Redirection of the data plane
- Full outdoor research deployment
- Dedicated sector for research

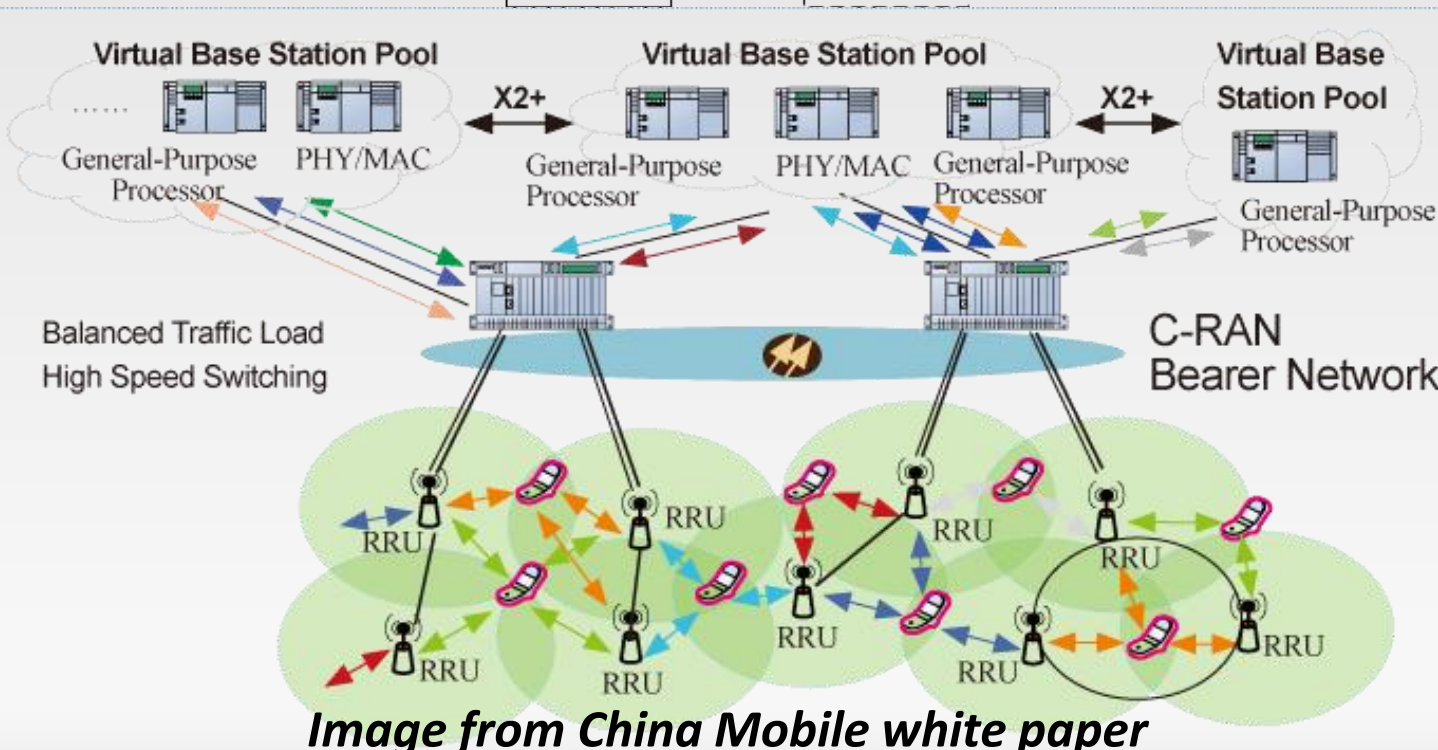
Bringing Wireless Live Experimentation

Improving flexibility

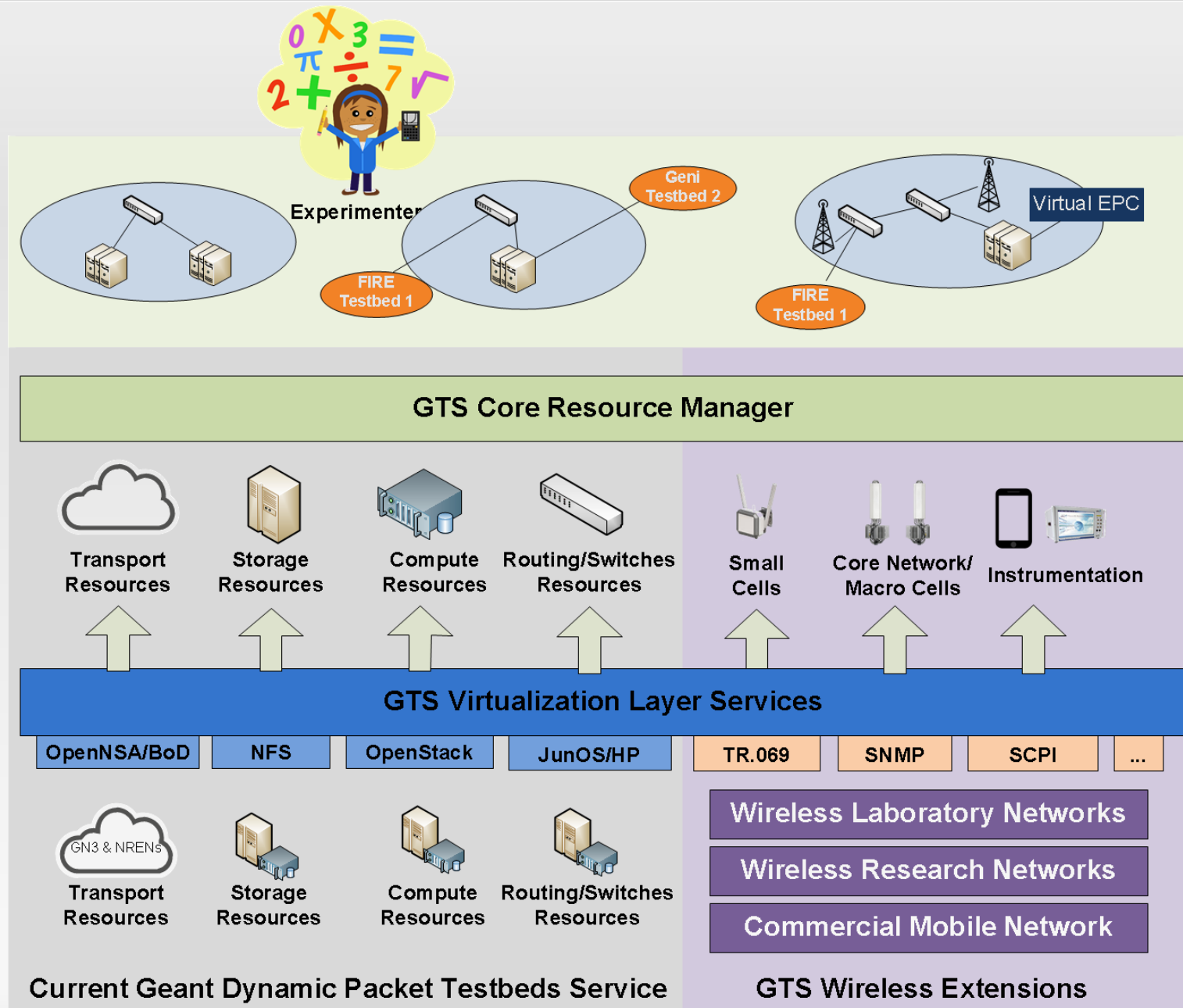


Improving Flexibility

- Roaming scenarios
- S1-FLEX
- Full C-RAN network
- Cognitive Radio



Bringing Wireless Live Experimentation Conclusions



Requirements

- Virtualization of wireless nodes
- Remote deployment of VMs
- Security layer
- Latency reduction

Thank you!

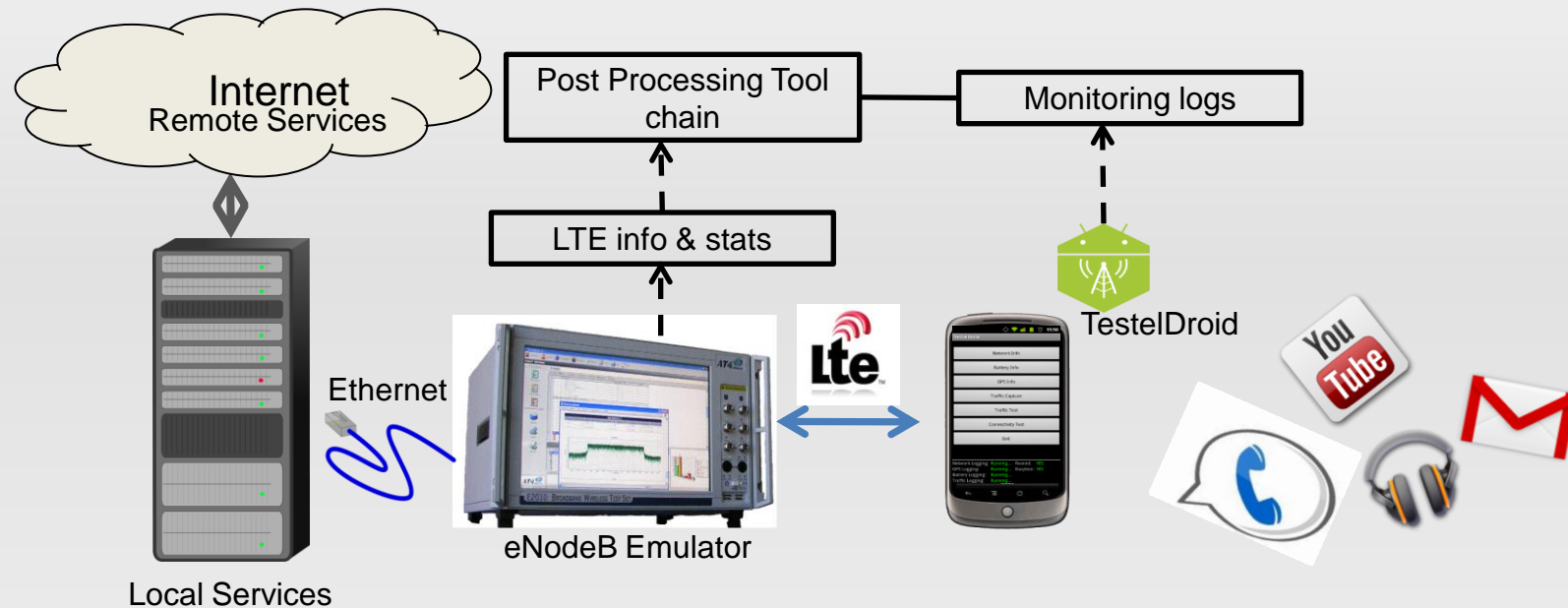
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Experimentation scenario

eNB emulator and instrumented devices

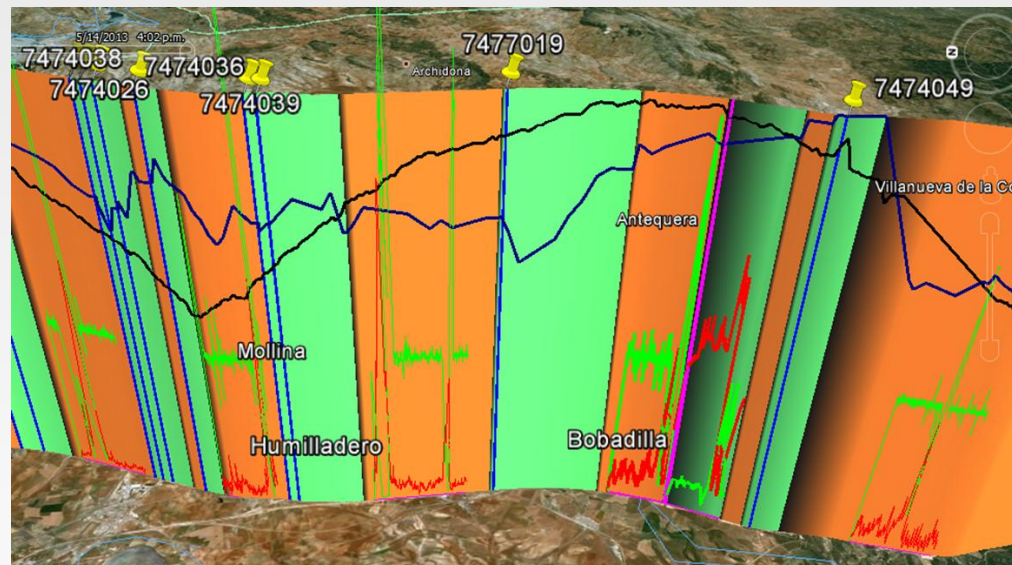


Cell Configuration	Duplex Mode, Frequency Band, DL and UL EARFCN, DL and UL Bandwidth, Cell Id, TDD Frame Conf., Cell Power, Simulated Path Loss, MCC and MNC.
HARQ	Maximum HARQ Rtx., TDD feedback mode and the redundancy version list.
Measurements	Enable/Disable CQI/PMI/RI reporting, CQI/PMI Feedback Type, CQI/PMI and RI Report Configuration Indexes, Enable/disable RSRP/RSRQ Measurements Configuration, Filter Coefficient, Periodic Measurement Report Interval.
RRC/NAS	Several RRC Timers (T300, T301, T310, T311, N310, N311) Access Point Name, IP version, IP address and Radio Link Failure Detection.
Channel Emulation	Fading Channel Emulation (Several profiles defined by the 3GPP: EPA5, EVA5, EVA70, ETU70, ETU300 and HST), Noise Generation.

Experimentation scenario

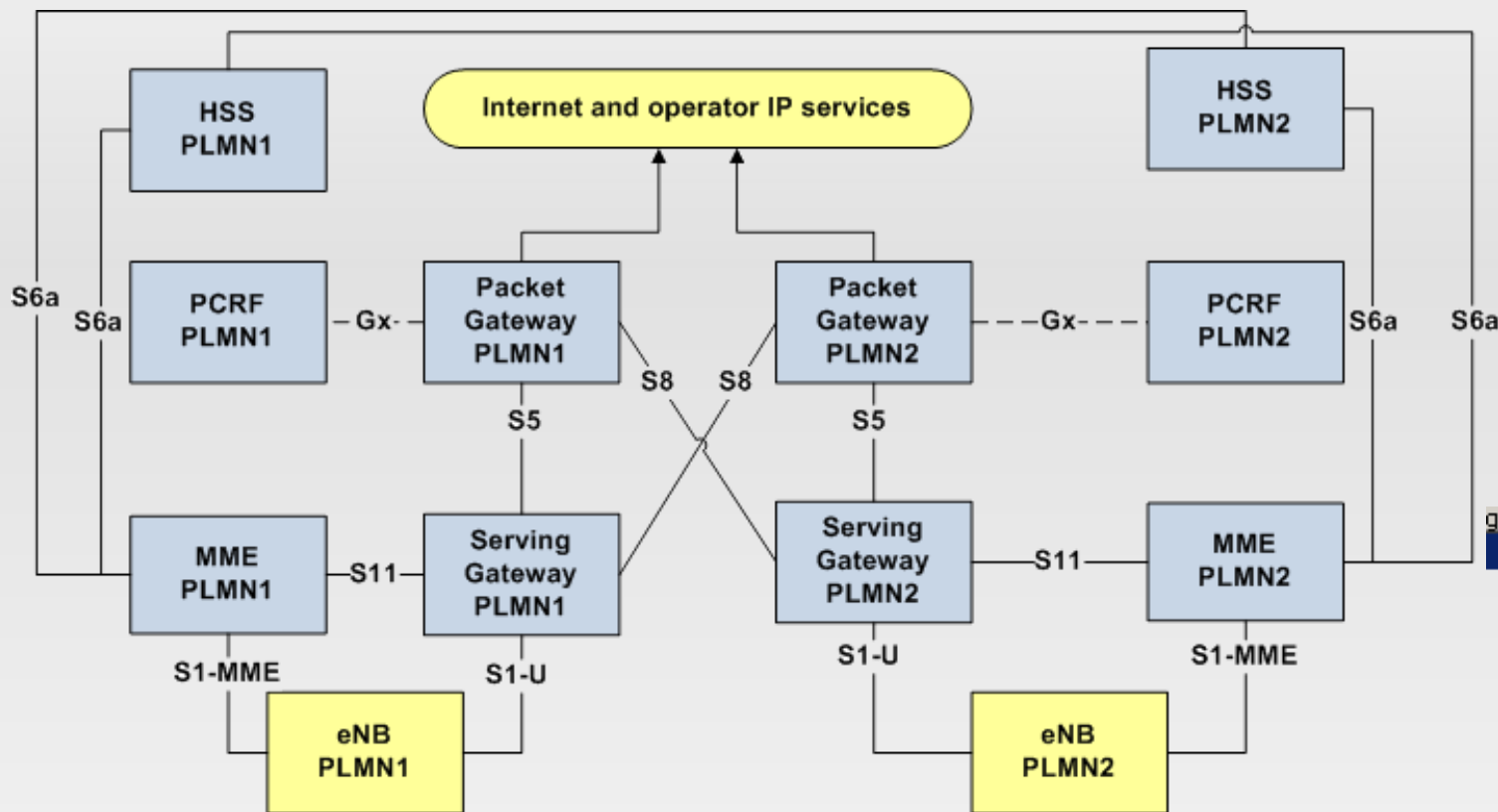
Monitoring LTE live deployments

Radio measurements	RAT, Cell ID, LAC, RSSI, PSC, cell changes
Neighbouring cells	PSC, RSSI, RSCP (Received Signal Code Power) RAT (Radio Access Technology)
IP traffic capture	Pcap file, Arrival timestamps, Promiscuous mode
Traffic generation	Ping, mobile-to-mobile TCP transfer
Battery consumption	Battery level, Temperature, Voltage, Current
Geographical location	Based on cell identifier and GPS



Experimentation scenario

LTE Core Network use case example



gth	Info
162	id-initialUEMessage, Attach req
110	SACK id-downlinkNASTransport, I
122	id-uplinkNASTransport, Identity
142	SACK id-downlinkNASTransport, A
122	id-uplinkNASTransport, Authenti
118	SACK id-downlinkNASTransport, s
122	id-uplinkNASTransport, Security
114	SACK id-downlinkNASTransport, I
130	id-uplinkNASTransport, Identity
258	SACK id-InitialContextsetup, Ir
106	id-InitialContextsetup, Initial
114	id-UEcapabilityInfoIndication
126	id-uplinkNASTransport, Attach c
134	id-uplinkNASTransport, Detach r
114	SACK id-downlinkNASTransport, C
86	id-UEContextRelease, UEContextR
86	id-UEContextRelease, UEContextR

- Two different operators networks
- Testing from one network to another
- Integration of eNB from different vendors
- NAT of control interfaces to integrate non configurable nodes