LTE Layer 1 Experiments

LTE PHY Lab Software Tool

LTE PHY Lab is a comprehensive implementation of the 3GPP Release 8 E-UTRA physical layer (both FDD and TDD). LTE PHY Lab can be used at all stages of the LTE software, hardware and IPR development, from research, prototyping and implementation, up to system benchmarking, verification and testing.

LTE PHY Lab is implemented according to TS 36.211-870, TS 36.212-870 and TS 36.213-870. It includes, from day one, both the downlink and the uplink processing chains covering all the PHY steps such as FEC, modulation, MIMO processing, resource mapping, OFDMA and SC-FDMA signal generation. Thanks to that, baseband models of both the eNB and also the UE, can be easily created. High detail of functional blocks' implementation allows for great flexibility in customized and proprietary designs. In addition, it is very useful in applications of the LTE PHY Lab in education, where it is often important to evaluate the role of every single component block. The summary of all the supported channels and signals is shown in the table below.

	Transport channels and control information	**Physical channels and signals**
Downlink	DL-SCH, BCH, CFI, HI, DCI	PDSCH, PBCH, PDCCH, PCFICH, PHICH, RS, P-SS, S-SS
Uplink	UL-SCH, UCI, RACH	PRACH, PUSCH, PUCCH, DRS for PUSCH, DRS for PUCCH, SRS

The LTE PHY Lab functions are easily and broadly parametrizable, and external sources of information can be used to drive the created models (for example to fill out the user plane data). In addition, plenty of examples on how to use the functions are provided, together with the test files and representative channel models.

More information about LTE PHY Lab can be found on our webside:
http://www.is-wireless.com/products/lte_phy_lab

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Some available plots from the operation of the LTE PHY Lab are presented in the figures 1-6.

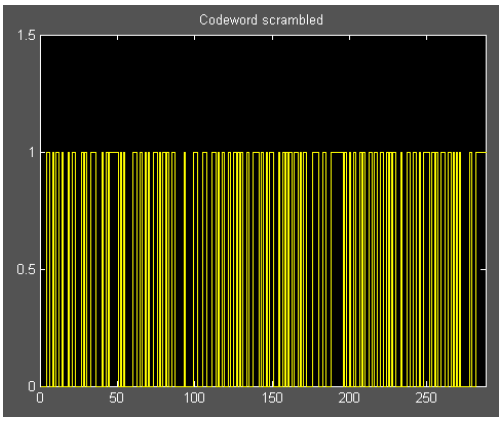

Figure 1: Channel Coding

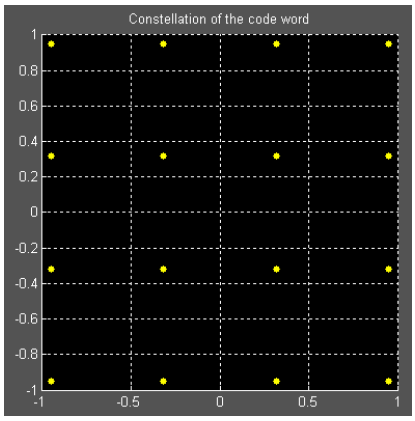

Figure 2: Constellation

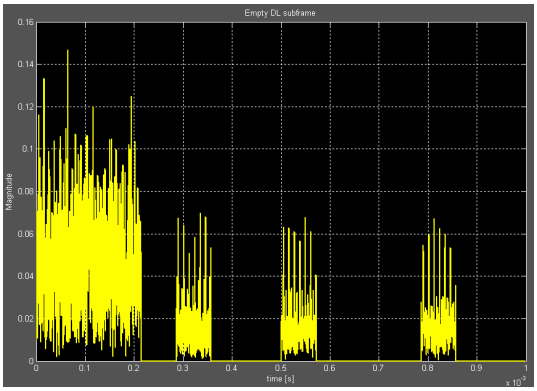

Figure 3: Time domain signal

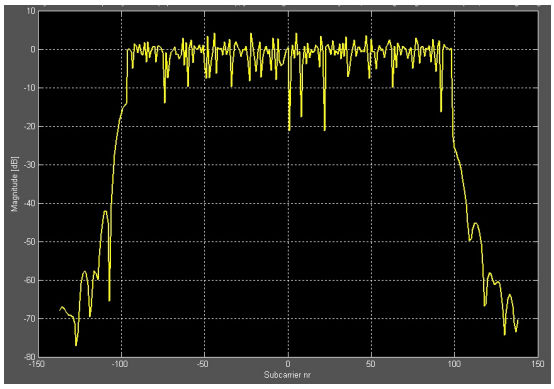

Figure 4: PSD of the OFDMA Signal

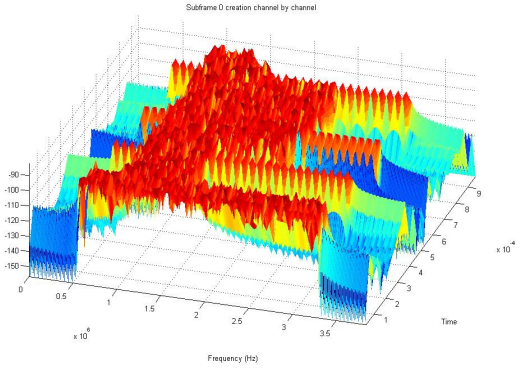

Figure 5: PSD over time (subframe 0)

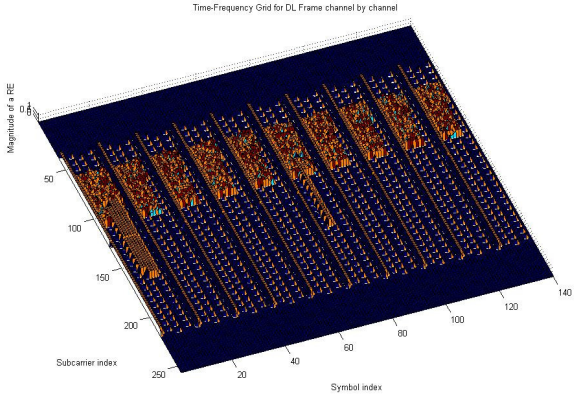

Figure 6: Time and frequency representation of the DL frame

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Description of the experiments

The standardization work carried within the 3GPP Long Term Evolution (LTE) has attracted significant attention of the wireless community in the last couple of years. This was accompanied by the implementations of the network gear compliant with the 3GPP Evolved-UTRAN Release 8 specs (with E-UTRAN term often used interchangeably with LTE). The purpose of these experiments is to present real-life simulations showing baseband analog waveforms and PSDs generated by the modulators of the eNB and UE and its relation to EMC/EMI. We will base this exercises on implementations of the Release 8. Thanks to a number of experiment examples, students will have a much better opportunity to understand the operation of the LTE base and mobile stations.

The simulation cases, based on the state-of-the-art LTE PHY Lab, include generation and observation of the eNB and UE signals. Students are guided through the of eNB and UE Layer 1 waveforms. In addition to that, they evaluate the influence of transmit side, multipath channel and receive side distortions such as pulse shaping, CCI and uncompensated synchronization offsets. Observations are made either in the time domain (oscilloscope function), or in the frequency domain (spectrum analyzer function) or on the IQ plane (scatterplot) so the students are getting prepared to work with real measurement tools in implementation or testing of the real equipment.

The experiments addresses the aspects that can be expected during work with the real devices in the lab while implementing, testing and measuring. The co-channel interference as well as inter-channel impairments problems are raised here to have a good insight into electromagnetic interference in case of the next generation wireless network.

The experiments outline includes:

- OFDMA and SC-FDMA processing:
  - signals in the time and the frequency domain, PSD,
  - Influence of the impairments on the received signal present in the wireless environment: uncompensated sync offsets, uncorrected multipath channel, co-channel interference, TDD DL-to-UL and UL-to-DL mismatches
  - Transmit side impairments: OoB distortions, pulse shaping impact on OoB distortions, PAPR problems
- eNB signals:
  - Time and Frequency (PSD) signals of the base station.
  - Placement of the Physical channels to time and frequency resource in the downlink radio frame
- UE signals:
  - Time and frequency (PSD) signals of the mobile.
  - Placement of the Physical channels to time and frequency resources in the uplink radio frame

About the presenter

Marcin Dryjanski holds M.Sc. degree (magister inzynier) in Telecommunications from the Poznan University of Technology, Poland. During his studies he implemented WiMAX transmitter on FPGA platform. Marcin was also the recipient of the Erasmus studentship and he spent 6 months in the Faculty of Electrical and Computer Engineering at the Technische Universitaet Kaiserslautern in Germany. Since May 2008 Marcin serves as Senior R&D Engineer and Consultant at Innovative Solutions. He is responsible for the development of the LTE PHY LAB implementation and supervision of the WiMAX PHY Lab implementation. In addition, Marcin is a designer and trainer of the technical courses, specializing in the area of LTE and WiMAX.