Running LTE Conformance Tests

- Test your own optimized receiver with LTE System Toolbox conformance tests
- Compare the performance of various schemes using LTE System Toolbox receiver

The 3GPP TS 36.101 User Equipment Radio Transmission and Reception standard defines conformance tests that specify minimum receiver performance for different scenarios. These conformance tests help ensure that equipment from different providers are compatible and perform at a given level.

LTE System Toolbox™ offers complete conformance testing including standard-compliant reference measurement and fixed reference channels (RMCs, FRCs); propagation channels (MIMO multipath fading channels); and reference receivers (MIMO equalizer, turbo coding) (Figure 1). The architecture of LTE System Toolbox enables you to insert your own receiver in the end-to-end simulation provided.
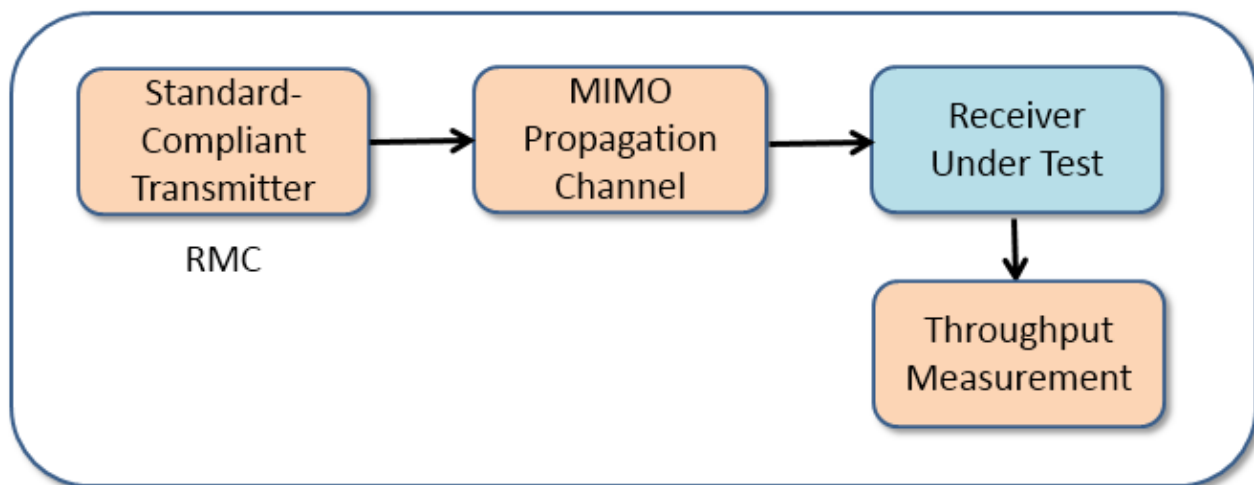

Figure 1. Conformance tests in LTE System Toolbox.

This example, included in LTE System Toolbox [1], shows how to perform conformance tests in order to assess performance of a UE receiver. This is an example of multilayer spatial multiplexing with two transmit antenna ports. This example implements wideband precoder matrix indication (PMI) feedback. Table 1, from 3GPP TS 36.101 [2], defines a required throughput of at least 70% of the maximum given an SNR of 14.3 dB. A total of eight hybrid automatic repeat request (HARQ) processes are used with a maximum of four retransmissions permitted.

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Test number	Band-width	Reference Channel	OCNG Pattern	Propagation Condition	Correlation Matrix and Antenna Configuration	Reference value		UE Category
						Fraction of Maximum Throughput (%)	SNR (dB)	
2	10 MHz	R.11 FDD	OP.1 FDD	ETU70	2x2 Low	70	14.3	2-8

Table 1. Minimum performance multilayer spatial multiplexing (FRC).

Using LTE-Compliant Transmitter

We generate a populated resource grid on a subframe-by-subframe basis when simulating at a particular SNR, and perform OFDM modulation to create a transmit waveform.

```
enb.RC = 'R.11';   % RMC number

ncw = 2;           % Number of PDSCH codewords

enb.PDSCH.TxScheme = 'SpatialMux';

rmc = lteRMCDL(enb, ncw);

txWaveform = lteRMCDLTool(rmc, data);
```

Passing the Waveform through the MIMO Propagation Channel

The generated waveform is passed through a noisy extended typical urban (ETU) channel.

```
cfg.DelayProfile = 'ETU';

cfg.DopplerFreq = 70;

rxWaveform = lteFadingChannel(cfg, txWaveform);
```

Demodulation, Equalization, and Decoding

We perform channel estimation, equalization, demodulation and decoding at receiver. The ltePDSCHDecode function performs MMSE equalization, demodulation, and descrambling, while the lteDLSCHDecode function performs decoding with HARQ combining.

We determine the throughput performance of the PDSCH using the block CRC result at the output of the channel decoder.

```
rxSubframe = lteOFDMDemodulate(rmc, rxWaveform);

[estChannel, nEst] = lteDLChannelEstimate(rmc, cec, rxSubframe);

rxBits = ltePDSCHDecode(rmc, rmc.PDSCH, rxSubframe, estChannel, nEst);

[decbits, crc, State] = lteDLSCHDecode(rmc, rmc.PDSCH, TBSs, rxBits, State);
```

Measuring Throughput

Figure 2 is an example of receiver performance that meets the 70% requirement at 14.3 dB. The simulation was run over 100 frames.
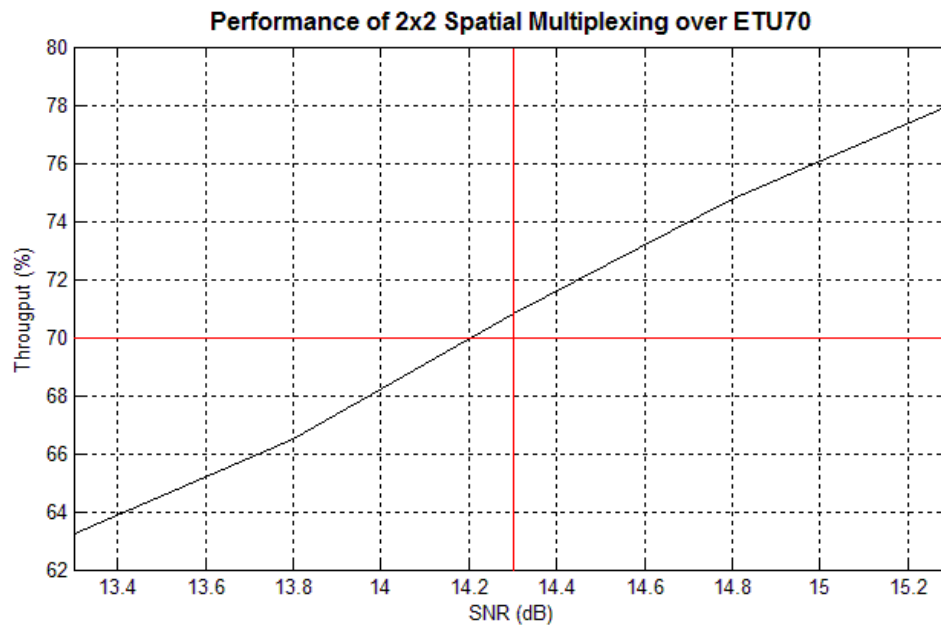

Figure 2. Performance of 2x2 spatial multiplexing over ETU70 that meets requirements.

Summary

LTE System Toolbox includes conformance tests set up from the 3GPP TS 36.101 - User Equipment Radio Transmission and Reception standard, which assess performance of your receiver or of the reference receiver provided with LTE System Toolbox. This example takes minimal time to define and execute. In addition, access to MATLAB code opens unlimited design modifications and access to the algorithms used.

LTE System Toolbox includes both downlink and uplink conformance tests. Refer to Release 10 PUSCH Multiple Codeword Throughput Conformance Test [3] and PUCCH3 ACK Missed Detection Probability Conformance Test [4] for more examples that include full MATLAB code.

References

[1] *PDSCH 2x2 Spatial Multiplexing Throughput Conformance Test*,

mathworks.com/help/releases/R2014a/lte/examples/pdsch-2x2-spatial-multiplexing-throughput-conformance-test.html

[2] 3GPP TS 36.101 – User Equipment Radio Transmission and Reception Standard: Table 8.2.1.4.2-2.

[3] *Release 10 PUSCH Multiple Codeword Throughput Conformance Test*,

mathworks.com/help/releases/R2014a/lte/examples/release-10-pusch-multiple-codeword-throughput-conformance-test.html

[4] *PUCCH3 ACK Missed Detection Probability Conformance Test*,

mathworks.com/help/releases/R2014a/lte/examples/pucch3-ack-missed-detection-probability-conformance-test.html

Products Used

MATLAB

LTE System Toolbox

Learn More

PRACH False Alarm Probability Conformance Test (Example)
mathworks.com/help/lte/examples/prach-false-alarm-probability-conformance-test.html

Communications Systems Design and Analysis
mathworks.com/communications-systems/design-simulation.html

NOTE: Some steps and details, such as detailed modeling of HARQ, have been omitted from the code excerpts in order to focus on the transmitter and receiver algorithms.