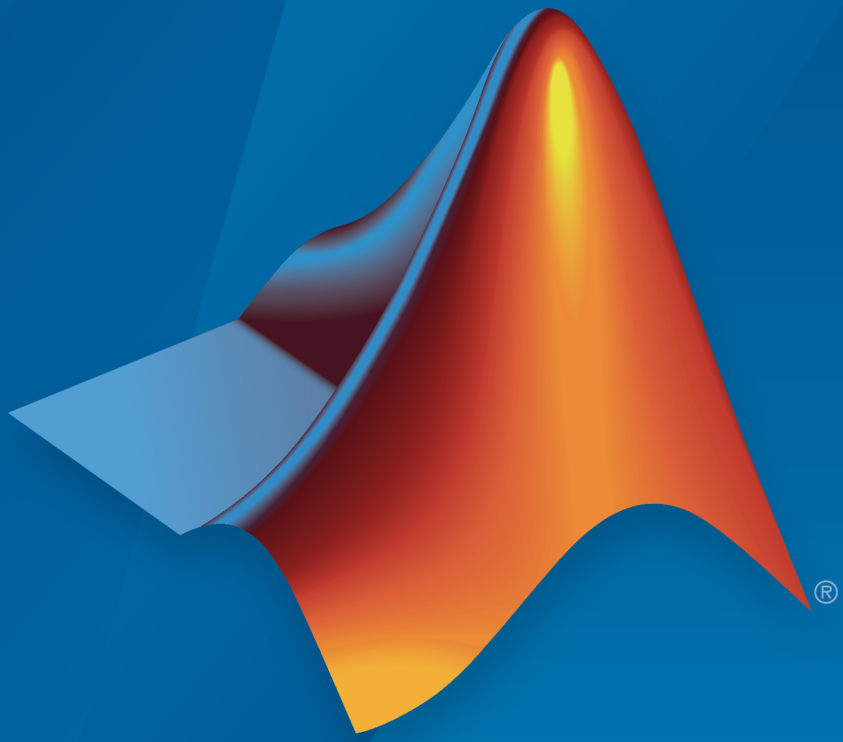
# LTE System Toolbox™ Release Notes



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*LTE System Toolbox™ Release Notes*

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# R2015b

Version: 2.1

New Features

Bug Fixes

Compatibility Considerations

## Release 12 256QAM: Simulate small cell PDSCH 256QAM modulation and coding schemes

`lteTBS`, `lteMCS`, and all PDSCH/DL-SCH related functions have been updated adding support for 256QAM modulation. These functions extend TBS tables and add the alternative PDSCH MCS table for Release 12 MCS determination.

## Release 11 Multiple Zero Power CSI-RS Bitmaps: Model multicell ZP CSI-RS patterns

`lteCSIRS`, `lteCSIRSIndices`, `lteEPDCCHIndices`, and `ltePDSCHIndices` functions now support multiple zero-power CSI-RS resources. Using these functions when assigning resource elements, a transmitting cell can now avoid assigning resource elements used by other cells for CSI-RS transmission.

## Release 11 PUSCH/PUCCH DRS Virtual Identities: Model uplink Release 11 Coordinated Multipoint (CoMP) scenarios

The following functions now support virtual cell identities and alternative scrambling, enabling modeling of uplink Release 11 Coordinated Multipoint (CoMP) scenarios with the LTE System Toolbox™:

| | | |
|---|---|---|
| `ltePUSCHDRS` | `lteULChannelEstimate` | `lteULChannelEstimatePUCCH2` |
| `ltePUCCH1DRS` | `lteULFrameOffset` | `lteULFrameOffsetPUCCH2` |
| `ltePUCCH2DRS` | `lteULChannelEstimatePUCCH1` | `lteULChannelEstimatePUCCH3` |
| `ltePUCCH3DRS` | `lteULFrameOffsetPUCCH1` | `lteULFrameOffsetPUCCH3` |
| `lteRMCULTool` | `ltePUCCH2DRSDecode` | |

## Cell Search Enhancements: Detect multiple cells in an LTE downlink waveform

The `lteCellSearch` now enables you to:

- Detect multiple cells
- Perform post-FFT-based SSS detection

- Compare the strength of detected cells

The following feature examples show the cell search enhancements:

- "Reference Signal Measurements (RSRP,RSSI,RSRQ) for Cell Reselection" determines the quality of the detected cells. The cell reselection test environment, described in TS 36.133 Annex A.4.2.2.1, is configured in this example.
- "Cell Search, MIB and SIB1 Recovery" fully synchronizes, demodulates and decodes live eNodeB signal.
- "Time Difference Of Arrival Positioning Using PRS" calculates the position of a User Equipment (UE) within a network of eNodeBs via the Time Difference Of Arrival (TDOA) positioning approach in conjunction with the Release 9 Positioning Reference Signal (PRS).

## Waveform Generation: Improved control of PDCCH, DCI, and OCNG for test and measurement

The uplink and downlink waveform generator functions (`lteRMCDLTool`, `lteRMCDL`, `lteRMCULTool`, and `lteRMCUL`) now enable:

- Uplink waveform generator control of the bandwidth associated with each RMC
- Downlink waveform generator control of the DCI format, the PDCCH format, and PDCCH power. OCNG generation for PDSCH and PDCCH, has been enhanced as follows:
  - New parameters to enable or disable the PDSCH and PDCCH OCNG
  - OCNG power control
  - Control over the RNTI of the PDSCH OCNG, modulation scheme, and the transmission scheme

The "PDCCH Conformance Test" feature example demonstrates some of the enhanced waveform generation controls.

## LTE Obsolete Interface Support

This interface is provided for backwards compatibility. It will now result in runtime errors indicating which new functions to use.

## Compatibility Considerations

Previous versions of the LTE System Toolbox product contained a different set of function names. The term *Obsolete LTE Toolbox interface* refers to these previous versions, prior to version 1.0. If you wrote scripts using any of the old function names used in previous versions, you should modify the scripts to use the new function names. Also, you should modify many of the scripts to expect column vectors for output arguments where row vectors were previously returned.

# R2015a

Version: 2.0

New Features

Bug Fixes

## UMTS Downlink and Uplink Waveform Generation Functions: Generate standard-compliant W-CDMA, HSPA and HSPA+ signals

This release adds UMTS (W-CDMA, HSPA and HSPA+) waveform generation functions, umtsDownlinkWaveformGenerator and umtsUplinkWaveformGenerator. Additionally reference channel functions, umtsDownlinkReferenceChannels and umtsUplinkReferenceChannels, are provided so that you can readily produce a configuration structure initialized to define RMC, FRC H-Set and test models defined in 3GPP standards. The reference channel function output configuration structure serves as input to the associated waveform generation function.

## Coordinated Multipoint (CoMP) Transmission and Reception Simulation: Mitigate interference and improve performance at the edge of an LTE cell

This release features an example demonstrating CoMP dynamic interference mitigation cooperation between multiple base stations.

- CoMP Dynamic Point Selection with Multiple CSI Processes

## SIB1 Message PDSCH Support: Generate and receive LTE downlink waveforms carrying SIB1 for cell search and network access

This release enables you to generate LTE waveforms carrying SIB1 message using the lteRMCDLTool function.

## TM9/TM10 RMC waveform generation: Create TM9/TM10 waveforms containing CSI-RS for channel quality measurements

The lteRMCDL function now returns the 3GPP standard defined CSI-RS RMC configurations and the lteRMCDLTool can now generate these waveforms containing CSI-RS. New RMCs added to lteRMCDL and the lteRMCDLTool GUI in this release are `'R.43'`, `'R.44'`, `'R.45'`, `'R.45-1'`, `'R.48'`, `'R.50'`, and `'R.51'`.

## Additional Featured Examples: SIB1, EPDCCH, working with live LTE signals, multicell interference, EVM measurement, HDL verification, UMTS

This release adds and/or enhances several examples

- Cell Search, MIB and SIB1 Recovery
- Enhanced Physical Downlink Control Channel (EPDCCH) Generation
- Working with Live LTE Signals using Software-Defined Radio (SDR)
- Effect of Inter-Cell Interference on PDSCH Throughput
- PDSCH Error Vector Magnitude (EVM) Measurement
- Verification of HDL Implementation of LTE OFDM Modulator and Detector
- UMTS Downlink Waveform Generation
- UMTS Uplink Waveform Generation

# R2014b

Version: 1.2

New Features

Bug Fixes

## Enhanced physical downlink control channel (EPDCCH) and its demodulation reference signal (DM-RS) generation functions in support of 3GPP Release 11

R2014b adds support for the creation of Release 11 compliant enhanced physical downlink control channel (EPDCCH) transmissions. For details, see the command line help for lteEPDCCH and lteEPDCCHIndices. Additionally, lteEPDCCHDMRS and lteEPDCCHDMRSIndices allow you to generate the associated demodulation reference signals (DM-RS).

## Channel quality indicator (CQI) and rank indicator (RI) estimation functions for modulation and coding scheme (MCS) selection

R2014b adds support for adaptive modulation and coding scheme (MCS) selection. lteCQISelect performs channel quality indicator (CQI) estimation, lteRISelect performs rank indicator (RI) estimation, and lteMCS provides a lookup between MCS values and the corresponding transport block size (TBS) and modulation order.

## Unifying function for extracting physical channel symbols and signals from a resource grid

R2014b adds support for extracting physical channel symbols and signals from a resource grid. For details, see the command line help for lteExtractResources.

## Zero-power channel state information reference signals (CSI-RS) generation functions in support of 3GPP Release 10

R2014b adds support for zero-power CSI-RS. New parameters added to lteCSIRS, lteCSIRSIndices, and ltePDSCHIndices allow you to define zero-power CSI-RS via the standardized 16-bit bitmap representation.

# R2014a

Version: 1.1

New Features

Compatibility Considerations

## Standard-compliant models for LTE and LTE-Advanced (Releases 8, 9, and 10)

The LTE System Toolbox product provides standard-compliant functions and tools for the design, simulation, and verification of long-term evolution (LTE) and LTE-Advanced communications systems. LTE-Advanced comprises changes made to releases 9 and 10 of the LTE Standard.

## End-to-end physical layer transmit and receive processing functions, including OFDM (downlink) and SC-FDMA (uplink)

The LTE System Toolbox product provides standard-compliant functions for end-to-end physical layer transmit and receive processing. These functions include OFDM modulation for downlink and SC-FDMA modulation for uplink.

## MIMO antenna transmission and UE-specific beamforming functions

The LTE System Toolbox product provides standard-compliant functions for multiple-input, multiple-output (MIMO) antenna transmission and user equipment (UE)-specific beamforming.

## Channel estimation, synchronization, and MIMO receiver functions

The LTE System Toolbox product provides standard-compliant MIMO receiver functions for synchronization, channel estimation, equalization, and signal recovery procedures.

## Standard-compliant propagation channel models

The LTE System Toolbox product provides standard-compliant functions for modeling propagation channels. These functions include models for MIMO fading channel, EPA, EVA, and ETU, moving propagation channel, and high-speed train MIMO channel.

## Test models and reference measurement channel (RMC) waveform generators

The LTE System Toolbox product provides standard-compliant functions and tools for generating E-UTRA test models (E-TM) and reference measurement channel (RMC) waveforms.

## Interactive tools for conformance and BER testing

The LTE System Toolbox product provides interactive tools for conformance and BER testing. You can create and reuse a conformance test bench to verify that your designs, prototypes, and implementations comply with the LTE standard.

## Recovery of low-level parameters, such as cell identity

The LTE System Toolbox product provides for the recovery of low-level parameters, such as cell identity.

## Apps for generating waveforms and analyzing throughput

This release adds the following four new apps to the MATLAB® apps gallery.

- **LTE Downlink RMC Generator** — used for selection of parameters for and generation of downlink reference measurement channel (RMC) waveforms. For more information, see lteRMCDLTool
- **LTE Uplink RMC Generator** — used for selection of parameters for and generation of uplink reference measurement channel (RMC) waveforms. For more information, see lteRMCULTool
- **LTE Test Model Generator** — used for selection of parameters for and generation of E-UTRA test model (E-TM) waveforms. For more information, see lteTestModelTool
- **LTE Throughput Analyzer** — used to perform the PDSCH demodulation performance test and plot throughput performance graphs. For more information, see lteDLConformanceTestTool

## Function names and output behavior changed

Previous versions of the LTE System Toolbox product used different function names. In version 1.0, the LTE System Toolbox product contains an entirely new set of function names. Also, many functions in previous versions of the LTE System Toolbox product returned row vectors for output arguments. In version 1.0, many of the new equivalent functions return column vectors for output arguments.

## Compatibility Considerations

If you wrote scripts using any of the old function names used in previous versions, you must modify the scripts to use the new function names in the LTE System Toolbox

product, version 1.0. Also, you must modify many of the scripts to expect column vectors for output arguments where row vectors were previously returned. Refer to the following table for a mapping of the previous function names to their new equivalent function names.

In R2014a, by default, all the functions listed in the **Previous Function Name** column are on the MATLAB path. To remove these functions from the path, call the rmlteobsolete function. To add these functions to the path again, call the addlteobsolete function.

| Previous Function Name | New Function Name |
|---|---|
| `LteACKDecode` | lteACKDecode |
| `LteACKEncode` | lteACKEncode |
| `LteBCH` | lteBCH |
| `LteBCHDecode` | lteBCHDecode |
| `LteCFI` | lteCFI |
| `LteCFIDecode` | lteCFIDecode |
| `LteCQIDecode` | lteCQIDecode |
| `LteCQIEncode` | lteCQIEncode |
| `LteCRC` | lteCRCEncode |
| `LteCRCDecode` | lteCRCDecode |
| `LteCSICodebook` | lteCSICodebook |
| `LteCSIRS` | lteCSIRS |
| `LteCSIRSIndices` | lteCSIRSIndices |
| `LteCellRS` | lteCellRS |
| `LteCellRSIndices` | lteCellRSIndices |
| `LteCellSearch` | lteCellSearch |
| `LteCodeBlkDeseg` | lteCodeBlockDesegment |
| `LteCodeBlkSeg` | lteCodeBlockSegment |
| `LteConvCode` | lteConvolutionalEncode |
| `LteConvDecode` | lteConvolutionalDecode |
| `LteDCI` | lteDCI |

| Previous Function Name | New Function Name |
|---|---|
| `LteDCIDecode` | lteDCIDecode |
| `LteDCIDims` | lteDCIInfo |
| `LteDCIEncode` | lteDCIEncode |
| `LteDLChannelEstimation` | lteDLChannelEstimate |
| `LteDLConformanceTestBench` | lteDLConformanceTestTool |
| `LteDLDeprecoder` | lteDLDeprecode |
| `LteDLFrameOffset` | lteDLFrameOffset |
| `LteDLPerfectChannelEstimation` | lteDLPerfectChannelEstimate |
| `LteDLPrecoder` | lteDLPrecode |
| `LteDLResourceGrid` | lteDLResourceGrid |
| `LteDLResourceGridDims` | lteDLResourceGridSize |
| `LteDLSCH` | lteDLSCH |
| `LteDLSCHDecode` | lteDLSCHDecode |
| `LteDLSCHDims` | lteDLSCHInfo |
| `LteDMRS` | lteDMRS |
| `LteDMRSIndices` | lteDMRSIndices |
| `LteDuplexDims` | lteDuplexingInfo |
| `LteEVM` | lteEVM |
| `LteEqualizeMIMO` | lteEqualizeMIMO |
| `LteEqualizeMMSE` | lteEqualizeMMSE |
| `LteEqualizeULMIMO` | lteEqualizeULMIMO |
| `LteEqualizeZF` | lteEqualizeZF |
| `LteFadingChan` | lteFadingChannel |
| `LteFreqCorrect` | lteFrequencyCorrect |
| `LteFreqOffset` | lteFrequencyOffset |
| `LteHSTChan` | lteHSTChannel |
| `LteLayerDemapper` | lteLayerDemap |

| Previous Function Name | New Function Name |
|---|---|
| `LteLayerMapper` | lteLayerMap |
| `LteMIB` | lteMIB |
| `LteMovingChan` | lteMovingChannel |
| `LteOFDM` | lteOFDMModulate |
| `LteOFDMDemod` | lteOFDMDemodulate |
| `LteOFDMDims` | lteOFDMInfo |
| `LtePBCH` | ltePBCH |
| `LtePBCHDecode` | ltePBCHDecode |
| `LtePBCHIndices` | ltePBCHIndices |
| `LtePBCHPRBS` | ltePBCHPRBS |
| `LtePCFICH` | ltePCFICH |
| `LtePCFICHDecode` | ltePCFICHDecode |
| `LtePCFICHDims` | ltePCFICHInfo |
| `LtePCFICHIndices` | ltePCFICHIndices |
| `LtePCFICHPRBS` | ltePCFICHPRBS |
| `LtePDCCH` | ltePDCCH |
| `LtePDCCHDecode` | ltePDCCHDecode |
| `LtePDCCHDeinterleave` | ltePDCCHDeinterleave |
| `LtePDCCHDims` | ltePDCCHInfo |
| `LtePDCCHIndices` | ltePDCCHIndices |
| `LtePDCCHInterleave` | ltePDCCHInterleave |
| `LtePDCCHPRBS` | ltePDCCHPRBS |
| `LtePDCCHSearch` | ltePDCCHSearch |
| `LtePDCCHSpace` | ltePDCCHSpace |
| `LtePDSCH` | ltePDSCH |
| `LtePDSCHDecode` | ltePDSCHDecode |
| `LtePDSCHIndices` | ltePDSCHIndices |

| Previous Function Name | New Function Name |
|---|---|
| `LtePDSCHPRBS` | ltePDSCHPRBS |
| `LtePHICH` | ltePHICH |
| `LtePHICHDecode` | ltePHICHDecode |
| `LtePHICHDeprecoder` | ltePHICHDeprecode |
| `LtePHICHDims` | ltePHICHInfo |
| `LtePHICHIndices` | ltePHICHIndices |
| `LtePHICHPRBS` | ltePHICHPRBS |
| `LtePHICHPrecoder` | ltePHICHPrecode |
| `LtePHICHTxDivDecode` | ltePHICHTransmitDiversityDecode |
| `LtePMIDims` | ltePMIInfo |
| `LtePMISelection` | ltePMISelect |
| `LtePRACH` | ltePRACH |
| `LtePRACHDetect` | ltePRACHDetect |
| `LtePRACHDims` | ltePRACHInfo |
| `LtePRBFromDCI` | lteDCIResourceAllocation |
| `LtePRBS` | ltePRBS |
| `LtePRS` | ltePRS |
| `LtePRSIndices` | ltePRSIndices |
| `LtePSS` | ltePSS |
| `LtePSSIndices` | ltePSSIndices |
| `LtePUCCH1` | ltePUCCH1 |
| `LtePUCCH1DRS` | ltePUCCH1DRS |
| `LtePUCCH1DRSIndices` | ltePUCCH1DRSIndices |
| `LtePUCCH1Decode` | ltePUCCH1Decode |
| `LtePUCCH1Indices` | ltePUCCH1Indices |
| `LtePUCCH2` | ltePUCCH2 |
| `LtePUCCH2DRS` | ltePUCCH2DRS |

| Previous Function Name | New Function Name |
|---|---|
| LtePUCCH2DRSDecode | ltePUCCH2DRSDecode |
| LtePUCCH2DRSIndices | ltePUCCH2DRSIndices |
| LtePUCCH2Decode | ltePUCCH2Decode |
| LtePUCCH2Indices | ltePUCCH2Indices |
| LtePUCCH2PRBS | ltePUCCH2PRBS |
| LtePUCCH3 | ltePUCCH3 |
| LtePUCCH3DRS | ltePUCCH3DRS |
| LtePUCCH3DRSIndices | ltePUCCH3DRSIndices |
| LtePUCCH3Decode | ltePUCCH3Decode |
| LtePUCCH3Indices | ltePUCCH3Indices |
| LtePUCCH3PRBS | ltePUCCH3PRBS |
| LtePUSCH | ltePUSCH |
| LtePUSCHDRS | ltePUSCHDRS |
| LtePUSCHDRSIndices | ltePUSCHDRSIndices |
| LtePUSCHDecode | ltePUSCHDecode |
| LtePUSCHDeprecoder | ltePUSCHDeprecode |
| LtePUSCHIndices | ltePUSCHIndices |
| LtePUSCHPrecoder | ltePUSCHPrecode |
| LteRIDecode | lteRIDecode |
| LteRIEncode | lteRIEncode |
| LteRMCDL | lteRMCDL |
| LteRMCDLTool | lteRMCDLTool |
| LteRMCUL | lteRMCUL |
| LteRMCULTool | lteRMCULTool |
| LteRateMatchConv | lteRateMatchConvolutional |
| LteRateMatchTurbo | lteRateMatchTurbo |
| LteRateRecoverConv | lteRateRecoverConvolutional |

| Previous Function Name | New Function Name |
|---|---|
| `LteRateRecoverTurbo` | lteRateRecoverTurbo |
| `LteResourceGrid` | lteResourceGrid |
| `LteResourceGridDims` | lteResourceGridSize |
| `LteSCFDMA` | lteSCFDMAModulate |
| `LteSCFDMADemod` | lteSCFDMADemodulate |
| `LteSCFDMADims` | lteSCFDMAInfo |
| `LteSRS` | lteSRS |
| `LteSRSDims` | lteSRSInfo |
| `LteSRSIndices` | lteSRSIndices |
| `LteSSS` | lteSSS |
| `LteSSSIndices` | lteSSSIndices |
| `LteSymbolDemod` | lteSymbolDemodulate |
| `LteSymbolMod` | lteSymbolModulate |
| `LteTBS` | lteTBS |
| `LteTestModel` | lteTestModel |
| `LteTestModelTool` | lteTestModelTool |
| `LteTurboCode` | lteTurboEncode |
| `LteTurboDecode` | lteTurboDecode |
| `LteTxDiversityDecode` | lteTransmitDiversityDecode |
| `LteUCI3Decode` | lteUCI3Decode |
| `LteUCI3Encode` | lteUCI3Encode |
| `LteUCIDecode` | lteUCIDecode |
| `LteUCIEncode` | lteUCIEncode |
| `LteUeRS` | Removed. Use lteDMRS instead. |
| `LteUeRSIndices` | Removed. Use lteDMRSIndices instead. |
| `LteULChannelEstimation` | lteULChannelEstimate |
| `LteULChannelEstimationPUCCH1` | lteULChannelEstimatePUCCH1 |

| Previous Function Name | New Function Name |
|---|---|
| `LteULChannelEstimationPUCCH2` | lteULChannelEstimatePUCCH2 |
| `LteULChannelEstimationPUCCH3` | lteULChannelEstimatePUCCH3 |
| `LteULDeprecoder` | lteULDeprecode |
| `LteULDescrambler` | lteULDescramble |
| `LteULFrameOffset` | lteULFrameOffset |
| `LteULFrameOffsetPUCCH1` | lteULFrameOffsetPUCCH1 |
| `LteULFrameOffsetPUCCH2` | lteULFrameOffsetPUCCH2 |
| `LteULFrameOffsetPUCCH3` | lteULFrameOffsetPUCCH3 |
| `LteULPMIDims` | lteULPMIInfo |
| `LteULPMISelection` | lteULPMISelect |
| `LteULPerfectChannelEstimation` | lteULPerfectChannelEstimate |
| `LteULPrecoder` | lteULPrecode |
| `LteULResourceGrid` | lteULResourceGrid |
| `LteULResourceGridDims` | lteULResourceGridSize |
| `LteULSCH` | lteULSCH |
| `LteULSCHDecode` | lteULSCHDecode |
| `LteULSCHDeinterleave` | lteULSCHDeinterleave |
| `LteULSCHDims` | lteULSCHInfo |
| `LteULSCHInterleave` | lteULSCHInterleave |
| `LteULScrambler` | lteULScramble |
| `LteVersion` | Removed. Use the MATLAB version function instead. |
| `LteWarning` | lteWarning |
| `LteZadoffChu` | Removed. Use lteZadoffChuSeq in the Communications System Toolbox™ product instead. |