

# Keysight U5040A Open RAN Studio

This software is designed to run on a BittWare server and BittWare FPGA card.

Version 1.3.11201.0

Released Date:	11 January, 2022
Operating System:	Windows 10, 64-bit
N7631 Signal Studio Pro for 5G NR version:	6.X
PathWave Signal Generation for 5G NR version:	2.0

## Enhancements

- Added support for PathWave Signal Generation.

## Bug Fixes

- Make sure all items are removed when uninstalling the application.
- Several fixes for Extension Type 11.
- Fixed the error message when loading some LTE FDD scp file into Open RAN Studio.
- Fixed several error cases when generating PCAP files.
- Fixed an issue where the Resource Allocation block shows PRACH Format 0 for configuration Index 110 in place of Format A1B1.
- Fixed a case where constellation/sync not found occurs for PRACH Format 1 and Format B3 in VSA (part on Format B3).
- Fixed an issue with PRACH C0 test vector generation with 15KHz SC.
- Made some changes to Test Pattern 5.

## Version 1.3.10702.0

Released Date:	6 August, 2021
Operating System:	Windows 10, 64-bit
N7631 Signal Studio Pro for 5G NR version:	6.X

### Enhancements

- Updated the EULA.

### Bug Fixes

- Fixed an issue so that the code will recognize the latest version of VSA.
- Updated error message around N7624/N7625 applications to indicate the correct license needed.
- Fixed several LTE licensing and stimulus generation issues.

### Known Limitations

- For LTE TDD/FDD, Signal Studio LTE N7624C/N7625C version 2.3.7.2 or newer is required. Please contact product support if the required version is not available on Keysight.com.

## Version 1.3.10605.0

Released Date:	7 July, 2021
Operating System:	Windows 10, 64-bit
N7631 Signal Studio Pro for 5G NR version:	6.X

### Enhancements

- Added SRS support.
- Extension Type 6: Additional features added.
- Extension Type 9: (DSS) support added.
- Extension Type 10: Support for different beam IDs and consecutive beam ID for Section Type 1, 3, 5.
- Extension Type 11: Added support for Section Type 1 and 3.
- Integrated the LTE apps into the application. So, no more pseudo scp files needed.
- reMask for PUSCH supported.
- Improvements to the Beamforming user interface.

- Added PRACH support for LTE.
- Added support for symbol-based timing.
- Changed the IQ extraction file format from .csv to .orb, which can be imported into the latest version of VSA.
- Added PTP ESMC message support.
- Support better floating license usage for Signal Studio LTE apps.

## Bug Fixes

- Fixed several IQ data extraction issues.
- Fixed many smaller defects.

## Known Limitations

- It is recommended that customers using 10G data rates, should use 10G only (SFP+) modules, or if using SFP28 25G optics, verify that CRC errors are 0 for a sustained time on both ends of the link (this means inspecting O-RU statistics as well).
- When in DSS mode only DSS messages are handled.

## Version 1.2.11201.0

Released Date:	8 June, 2021
Operating System:	Windows 10, 64-bit
N7631 Signal Studio Pro for 5G NR version:	6.X

## Bug Fixes

- Fixed an issue that caused a “Failure communicating with the FPGA Module” error message to come up when starting the stimulus.
- Fixed a problem with symbols shifting when playing two radio frames.
- Allowed empty carriers to be loaded into the application.
- Fixed an issue, where a fatal error message would be displayed when trying to generate a PCAP file with LTE in some cases.
- Fixed an issue with generating PRACH IQ data with some MTU sizes.
- Announce messages now advertise both TIME\_TRACEABLE and FREQUENCY\_TRACEABLE as per G.8275.1.

## Version 1.2.10903.0

Released Date:	31 March, 2021
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Operating System:	Windows 10, 64-bit
N7631 Signal Studio Pro for 5G NR version:	6.X

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## Bug Fixes

- Updated error message to reflect the number of RF frames, which are supported for LTE implementation.
- Fixed a problem with recovering IQ for PRACH for some cases.
- Added some better error messaging when trying to load unsupported configurations in scp files.
- Fixes in LTE PRACH and user defined configurations.
- Updated the help content.

## Known Limitations

- For LTE U5040A does not support MIMO natively – you must create a unique SCP file for each layer, generate IQ (not pseudo scp) and then use the LTE menu options in Open RAN Studio to create a new LTE project and add each layer's IQ independently to the project.

## Version 1.2.10801.0

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Released Date:	10 February, 2021
Operating System:	Windows 10, 64-bit
N7631 Signal Studio Pro for 5G NR version:	6.X

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## Enhancements

- The Open RAN Studio application should use the latest version of VSA that is installed. If using the GenerateBlerXmlFile() function in the Open RAN Studio API in a standalone application, the *VSAVersions.xml* must be copied into the same directory as the *application.exe* using the API. See the Getting Started > Standalone Deployment section in the API online help for more details (Help > Show C-Plane Builder API Help).

## Bug Fixes

- Modified the scheduling of the C/U-Plane messages correctly in such cases, where the CPlane messages from the next radio frame interleaves with U-Plane messages of a radio frame.
- Fixed an issue where, for some cases, IQ data for LTE was not recovered.
- Added the appropriate error messages when trying to use the LTE converter utility on an unsupported configuration.
- Fixed an issue with the numbering method for the eCPRI Sequence IDs.

- Modified the code so that the settings of the Test Modules can be saved, to be preserved through power cycles.
- Fixed an issue where Frame Numbers could be wrong near the radio frame boundary.
- Fixed an issue so that the application will not crash when selecting Stock Test D with PTRS density 2.

## Version 1.2.10720.0

Released Date:	29 January, 2021
Operating System:	Windows 10, 64-bit
N7631 Signal Studio Pro for 5G NR version:	6.X

## Enhancements

- BLER/BER measurement support. (requires U504MULA license) - M-Plane client application.
- M-Plane passthrough support.
- Uplink emulation.
- reMask uplink support for UCI/PUCCH/DMS-RS
- SymbInc support for Uplink.
- Beam ID GUI improvements.
- rb parameter for downlink support.
- Support a way to export decoded explorer messages to a file.
- Have support for A, B, C, and D Stock Test Frames.
- Added support for Section Extensions 6, 7, and 8
- Added support for Section Type 6 and 7.
- Channel-Information-Base Beamforming
- Added support for the U5040MULA license.
- When using the capture 1, 2, 3, etc. setting for a specific number of radio frames, the capture will generally include 2 extra radio frames. For example, if the "1" capture setting is used, normally 3 radio frames will be captured. However, the first and last radio frames may be partial radio frames depending on the capture conditions. This ensures that at least the specified number of complete radio frames will be captured.

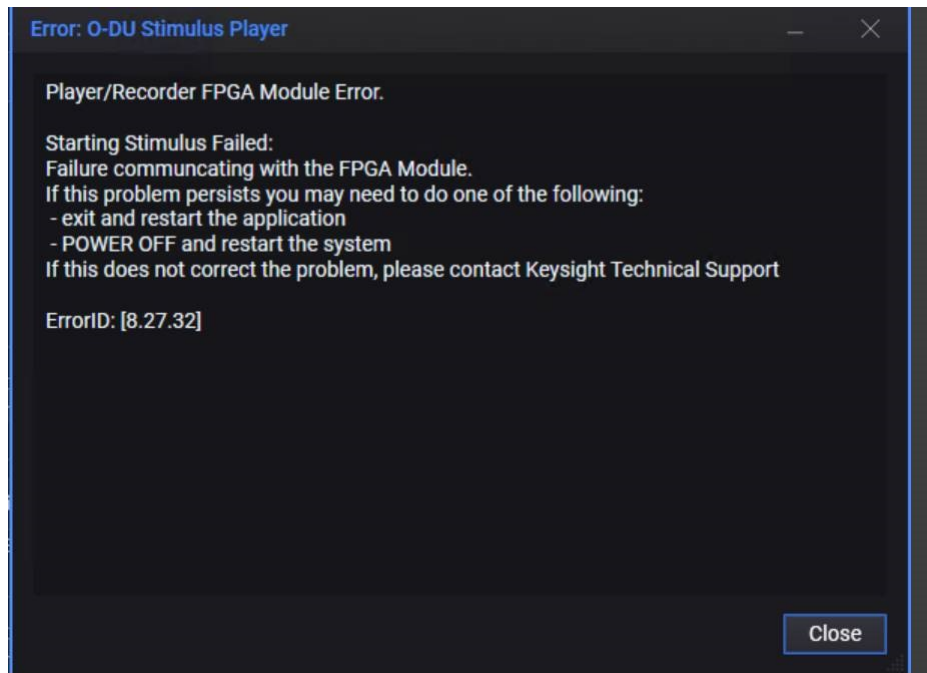
## Bug Fixes

- PTP Master mode activates properly.
- Install the 5.4 version of KLM, which fixes an issue with transportable licenses.
- Beamforming is not applicable to stock data frames at present. The ORAN conformance test specification does not cover this feature in any detail at present with respect to methodology or approach.

- Issues with the Linkup status not reflecting the correct state.
- Fixes to SFN.
- Changing External Reference Clock In sources is now much more stable. Normally the system will not need to be shut down when changing External Reference Clock In sources in the GUI. Please be sure to make sure the External Reference clock is not removed while the system is running.
- Fixed it so that when recording the data, both sides will be of equal length.

## Known Limitations

- When running a test with uplink and downlink traffic, it is recommended to use capture "Until Full" mode or use a larger number of frames to capture. It may require 10 or 20 as an input value in the combo box: "Record Length (in units of radio frames)" to get a few complete radio frames.
- It is recommended to use Signal Studio 5G NR 2020 (version 6.0.0.0) with this release 1.2 of Open RAN Studio. To use MIMO, a patch version of Signal Studio is required which can be provided from technical support upon request.
- Some features in this version of Open RAN Studio only work with PathWave Vector Signal Analysis (89600 VSA) version 2021.
- reMask does not work with Extension Type 6.
- When troubleshooting PTP traffic, it is recommended to use the capture "Until Full" setting. Other capture settings which capture a specific number of radio frames may fail to capture PTP traffic if it is the only traffic on the link.
- Ethernet Auto-negotiate is not supported. This may be supported in a future patch.
- In some cases, if the Ethernet Link does not initially come up successfully, PTP may not work even after the Link is good (Green). It may be necessary to close and re-open the Open RAN Studio application to resolve this.
- Programs created using the Open RAN Studio API will now have additional Assembly (.dll) dependencies. Please refer to the Open RAN Studio API Online help for more details (Help > Show C-Plain Builder API Help... in the GUI).
- When upgrading from pre-1.2 version to 1.2, the following error message might be displayed when trying to Play Stimulus:



- o Here is a workaround if this message is displayed:
  - Shut down the machine
  - Power it back up
  - Log in
  - Reboot from the start menu
  - Log in and try again with Open RAN Studio.

## Version 1.1.10901.0

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Released Date:	9 December, 2020
Operating System:	Windows 10, 64-bit

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### Bug Fixes

- Fixed a problem with floating licenses not being dynamically checked in/out. Also added OPENRANSTUDIO as a selection in Keysight License Manager 6.
- Fixed a problem where 25G modes (25G No FEC and 25G RS-FEC) would not achieve link up or block lock on the first attempt.

## Version 1.1.10702.0

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Released Date:	21 October, 2020
Operating System:	Windows 10, 64-bit

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## Bug Fixes

- When Open RAN Studio is launched on BittWare hardware with no Internet access, the following error occurred: "Cannot load CclBridge.dll".

## Version 1.1.10701.0

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Released Date:	07 October, 2020
Operating System:	Windows 10, 64-bit

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## Enhancements

- Added LTE TDD and LTE FDD support applications to the installation.
- Added documentation for the hardware REST API.
- On-line help has been updated.
- Added support for the U5040MDLA license.

## Bug Fixes

- In some cases, the Frame ID would not increment on the second frame of a two-frame stimulus file.
- In some cases, Stimulus generated with a large tcp\_adv\_dl value would cause every other radio frame to be skipped during continuous playback. This has been fixed and radio frames are not skipped.
- When Trigger Out is enabled and set to "Trigger on Start Stimulus", the trigger is now correctly scheduled at time 0.0 relative to the PCAP file timing (10ms before the "air time" of the first radio frame).
- When an error occurs writing out a capture file, an error dialog is displayed.

## Known Limitations

- The LTE applications only support 10ms waveforms and does not support 15MHz carriers.
- The timestamp accuracy for captured packets is currently about 80 ns. This occasionally results in small back-to-back packets having the same timestamp.
- When C-Plane messages overlap and should be scheduled before the final U-Plane messages of the prior radio frame, they are not interleaved with the U-Plane messages, but rather will be send immediately after the last U-Plane message of the prior radio frame.



# Version 1.1.10521.0

Released Date:	31 August, 2020
Operating System:	Windows 10, 64-bit

## Enhancements


- External Reference Clock in support
- PTP Slave support
- SFN support
- API to control the hardware programmatically
- Modulation compression support
- MIMO (<4 layers) support
- Downlink reMask support
- Downlink SymInc support
- DCI support
- PUCCH support
- For 25Gbps Ethernet, Clause 108 Reed-Solomon Forward Error Correction (RS-FEC) is now supported. When selecting a 25G port speed, there are now two options that can be selected: "25G NO FEC" or "25G RS-FEC".

## Bug Fixes

- Allow a program to include both the ORAN Studio API and the Signal Studio API.

## Known Limitations

- It is recommended to use Signal Studio 5G NR 2020 (version 6.0.0.0) with this release 1.1 of Open RAN Studio. To use MIMO, a patch version (6.1.1.3) of Signal Studio is required which can be provided from technical support upon request.
- In some cases, the Linkup will show a false positive.
- When running the O-DU emulator in PTP Slave mode, the eCPRI Frame numbers may not match the SFN specification (see ORS-WG4.CUS.0-v02.00 section 9.7.2 for a definition of the SFN computation). Normally after launching Open RAN Studio, or after disabling and re-enabling PTP Slave mode, the SFN will be correct. However, after several minutes the SFN will skip one number and will be off until PTP slave mode is disabled and re-enabled or the Open RAN Studio application is restarted.
- When using an external reference clock, the following clock types can be used o 10 MHz external reference. In this case, the clock signal must be a square wave with 50% duty cycle.
  - o 100 MHz external reference. In this case the clock signal can be a square or sine wave.

- Please be sure that the external reference clock is connected before selecting 10 MHz or 100 MHz external reference clock. If there is not a good clock signal, the system will revert to the internal oscillator. However, the system may require being shutdown to a power off state and restarted to recover the clock.
- When changing the reference clock, sometimes two error messages will be displayed. This is normal on some systems and the system must be shutdown to a power off state and restarted to properly apply the reference clock settings.
- When running the O-DU emulator in PTP Slave mode, it takes about 1 minute for PTP to synchronize. After synchronization, the status bar should show the PTP Status as "Slave" in Green . This indicates that PTP is synchronized within 100 nanoseconds.
- The code does not support Auto-Negotiate so the connection speed will have to be set manual on both ends.
- If a stimulus file has a large Tcp\_adv\_dl value, when played continuously, the C-Plane messages for the next radio frame will not be interleaved properly with the U-Plane messages at the end of the current radio frame.

## Version 1.0.10601.0

Released Date:	16 June, 2020
Operating System:	Windows 10, 64-bit

## Enhancements

- When PTP is in Master mode, the announced clock parameters simulate a locked GPS grandmaster.

## Bug Fixes

- Fixed a bug with generating pcap file for PDSCH with IQ Bitwidth equal to 16.
- Several fixes to the following API.
  - o Flow\_TableEntry
  - o Beam\_TableSize
  - o Beam\_TableEntryBeamWeights
- Added support for the next Signal Studio version that will be released later.

## Known Limitations

- O-RAN System Frame Number (SFN), which assigns the radio frame number based on PTP time is not supported.

Released Date:	16 April, 2020
Operating System:	Windows 10, 64-bit

## Enhancements

- Initial release of the software.

## Known Limitations

- Ethernet Forward Error Correction (FEC) and Auto-negotiation are not supported. Please pay attention to the following notes:
  - o When connecting to a 25G Ethernet port on a radio (O-RU), FEC must be disabled on the O-RU.
  - o When connecting to a 10G Ethernet port on a radio (O-RU), FEC does not apply, so no changes should be necessary.
- Since Auto-negotiation is not supported, the Ethernet port must be manually configured in Open RAN Studio for the correct speed setting. To configure the port settings, select the menu item Setup → Instrument Configuration.... Then under Port Settings, change the speed drop down setting to 10G or 25G. When the link is established, the Port Status icon in the status bar at the bottom of the application should turn green.
- In some cases, in order to get the link to come up, you may need to switch the port back to Disabled or Loopback and then to 10G or 25G to get the link to establish successfully.
- For a "Complete" install, fast startup will be disabled in Windows. This is necessary because after FPGA updates the system must shutdown to a power off state. If fast startup is enabled, the system may not completely power off on shutdown.
- When capturing traffic in Open RAN Studio, the application will capture all packets transmitted and received on the Ethernet port. However, only eCPRI/O-RAN packets will be displayed in the Explorer view. If you need to look at other packets (e.g. PTP), use another tool to examine the capture file. Note that the extension on captured files is .pcap, however, they are actually pcapng format.
- When capture is configured to capture a specific number of radio frames by selecting 1 through 4 in the Record Length dropdown, the size of what is actually captured will be larger than what was specified, to make sure that you get at least the selected number of radio frames.
- Captures are not trimmed to full radio frames. It is common to see partial radio frames at the beginning or the end of the capture.

- When capturing data until full, the uplink or downlink side can have more frames at the end of the file than the other side in some cases.

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