openairinterface5g

Техническая документация

Сгенерировано: 2025-06-15 17:40

Описание проекта

OpenAirInterface License

- OAI License Model
- OAI License v1.1 on our website

It is distributed under **OAI Public License V1.1**.

The license information is distributed under LICENSE file in the same directory.

Please see NOTICE file for third party software that is included in the sources.

Where to Start

- General overview of documentation

- The implemented features
- System Requirements for Using OAI Stack
- How to build
- How to run the modems

Not all information is available in a central place, and information for specific sub-systems might be available in the corresponding sub-directories. To find all READMEs, this command might be handy:

```
find . -iname "readme*"
```

RAN repository structure

The OpenAirInterface (OAI) software is composed of the following parts:

```
openairinterface5g ├── charts ├── ci-scripts : Meta-scripts used by the OSA CI process. Contains also configuration files used day-to-day by CI. ├── CMakeLists.txt : Top-level CMakeLists.txt for building ├── cmake_targets : Build utilities to compile (simulation, emulation and real-time platforms), and generated build files. ├── common : Some common OAI utilities, some other tools can be found at openair2/UTILS. ├── doc : Documentation ├── docker : Dockerfiles to build for Ubuntu and RHEL ├── executables : Top-level executable source files (gNB, eNB, ...) ├── maketags : Script to generate emacs tags. ├── nfapi : (n)FAPI code for MAC-PHY interface ├── openair1 : Layer 1 (3GPP LTE Rel-10/12 PHY, NR Rel-15 PHY) ├── openair2 : Layer 2 (3GPP LTE Rel-10 MAC/RLC/PDCP/RRC/X2AP, LTE Rel-14 M2AP, NR Rel-15+ MAC/RLC/PDCP/SDAP/RRC/X2AP/F1AP/E1AP), E2AP ├── openair3 : Layer 3 (3GPP LTE Rel-10 S1AP/GTP, NR Rel-15 NGAP/GTP) ├── openshift : OpenShift helm charts for some deployment options of OAI ├── radio : Drivers for various radios such as USRP, AW2S, RFsim, 7.2 FHI, ... ├── targets : Some configuration files; only historical relevance, and might be deleted in the future └── tools : Tools for use by the developers/ci machines: code analysis and formatting
```

How to get support from the OAI Community

You can ask your question on the mailing lists.

Your email should contain below information:

- A clear subject in your email.

- For all the queries there should be [Query] in the subject of the email and for problems there should be [Problem].
- In case of a problem, add a small description.
- Do not share any photos unless you want to share a diagram.
- OAI gNB/DU/CU/CU-CP/CU-UP configuration file in `.conf` format only.
- Logs of OAI gNB/DU/CU/CU-CP/CU-UP in `.log` or `.txt` format only.
- In case your question is related to performance, include a small description of the machine (Operating System, Kernel version, CPU, RAM and networking card) and diagram of your testing environment.
- Known/open issues are present on GitLab, so keep checking.

Always remember a structured email will help us understand your issues quickly.

Структура модулей и логика

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```

API и роутинг

- Нет маршрутов

Зависимости

- Нет зависимостей

Release Notes & Latest Changes

- **2025.w24** — 2025-06-13
  Integration 2025 week 24 * !3354 Preparation Work for N2 Handover * !3383 Add configurable values of NR RLC and NR PDCP to the configuration file * !3468 Resolve "SSB frequency at gnb.sa.band78.fr1.24PRB.usrpb210.conf is invalid" * !3466 YAML related updates * !3460 SRS configuration * !3474 Fix AMF selection fallback by PLMN ID when no UE identity is present or matching * !3473 Fix various bugs and inconsistencies in config read, SCTP, ITTI, GTP * !3169 NR RU improvements for analog beamforming * !3456 CI: update config for AW2S pipeline * !3369 Add Security Mode Reject lib/unit test and adopt in stack * !3457 Fix NR reestablishment * !3412 [E2 agent] E2AP README update and OAI-FlexRIC CI pipeline improvements
- **2025.w23** — 2025-06-04
  Integration 2025 week 23 * !3302 Enhance UE identity management in Initial UE Message and other NGAP improvements * !3400 T bugfix: check input data a bit better * !3459 Improvements in NR band tables according to Rel.17 * !3465 Fix checking that amf_ip_address section is not set. * !3463 Move RRC radio parameters file to DU * !3389 Relax NR_UE_CAPABILITY_SLOT_RX_TO_TX asserts * !3417 Imscope updates * !3443 Fix data race in NR UE MSG3 scheduling * !3467 remove dead globals
- **2025.w22** — 2025-05-28
  Integration 2025 week 22 * !3415 several fixes and cleanup for nrLDPC_coding_t2 * !3448 T: macpdu2wireshark: dump to file instead of sending UDP packets * !3449 bugfix: pass correct buffer * !3453 CI: revert modification of SSB per RACH occasion in SC-FDMA test * !3440 Update NAS documentation * !3451 fix the number of preambles per SSB at UE in case PRACH is configured with groupB * !3441 Replace hashtable with epoll_event_t in rfsimulator * !3277 Add CI test to force RRC IDLE and new connection setup with 5G-S-TMSI * !3454 Keep old MAC stats after re-establishment * !3450 Make number of UL/DL actors in NR UE fully configurable * !3458 (doc): update README with build icons for dedicated arch and os
- **2025.w20** — 2025-05-20
  Integration 2025 week 20 * !3168 Improvements for LDPC encoding * !3386 E1 Bearer Context Release enc/dec lib and unit test * !3394 Fix Liteon with MTU 1500 and update the FHI docs * !3437 CI: RFsim F1/HO: Use hanging-workaround to avoid blocking of second client * !3384 Add enc/dec library and unit test for E1 Bearer Context Modification Failure * !3418 Use common function to generate CSI-RS signal * !3379 Add physim tests into ctest framework * !3420 Added intercommunication between namespaces * !3422 Tutorials: updates for NR SA Tutorials * !3436 Beam switching small fixes * !3439 Fix RRC

resources periodicity determination according to number of slots per period * !3434 Remove EPC/UE main.py parameters * !3423 Fix PDSCH and PUSCH BWP Start and Size when PXSCH is scheduled with a DCI format x_0 in any type of PDCCH common search space * !3442 Fix UL chanel estimates mapping in 2-layer MMSE receiver

- **2025.w19** — 2025-05-13
  Integration 2025 week 19 * !3409 Correctly handle minimum RB condition in MAC * !3421 Fix DMRS for PUCCH format 2 * !3424 limit the number of HARQ processes in case of DCI00 and 10 * !3116 ue txData more contextual, but still global as it is entangled with usrp driver * !3408 Handling 2 search spaces per slot in SIB1 * !3419 PRACH configuration index warning * !3429 CI: Add `-l` option for the UL iperf test * !3381 Add 5GMM Authentication Failure enc/dec lib and unit test
- `8c0641c` — 2025-06-13 (Robert Schmidt): Merge branch 'integration_2025_w24' into 'develop'
- `736ea53` — 2025-06-13 (luis_pereira87): Only reestablish RLC while processing reconfiguration complete after a RRCReestablishment and not for every RRCReconfiguration
- `5b9d770` — 2025-06-13 (Robert Schmidt): Merge remote-tracking branch 'origin/e2-fixes-updates' into integration_2025_w24 (!3412)
- `9513d48` — 2025-06-13 (Robert Schmidt): Merge remote-tracking branch 'origin/fix_nr_reestablishment' into integration_2025_w24 (!3457)
- `dfadcab` — 2025-06-12 (Robert Schmidt): Store spCellConfig during reestablishment for reconfiguration
- `81dbaf0` — 2025-06-12 (Robert Schmidt): Add comment on reestablishment in MAC-RRC DL handler
- `15370e7` — 2025-06-12 (Robert Schmidt): Implement RB suspend at gNB MAC
- `f3802d7` — 2025-06-12 (Robert Schmidt): Merge remote-tracking branch 'origin/nr-ue-nas-sec-mode-reject' into integration_2025_w24 (!3369)
- `690be9c` — 2025-06-12 (Robert Schmidt): Merge remote-tracking branch 'origin/ci-asue-test' into integration_2025_w24 (!3456)
- `27ece7e` — 2025-06-12 (Jaroslava Fiedlerova): CI: update AmariUE configuration file, add RF configuration

Содержание

- title_page.html
- project_description.html
- module_structure.html
- api_routes.html
- dependencies.html
- release_notes.html
- md_CHANGELOG.html

RELEASE NOTES:

v2.2.0 -> November 2024.

General 5G improvements (both gNB and UE):

- Make standalone mode (SA) the default (see `RUNMODEM.md`)
- Experimental support for FR2 operation
- Support for GEO NTN and simulation of GEO satellite channel in RFsimulator (see `RUNMODEM.md`)
- Support 2-step RA
- Add optional LTTng logger in logging module (see `lttng_logs.md`)
- Support for YAML-based config files (alongside libconfig) (see `gnb.sa.band78.106prb.rfsim.yaml` and `nrue.uicc.yaml`)
- Add new L1 scope based on Dear ImGui (see `readme.md`)
- Allow cross-compilation on ARM (via SIMDE SIMD emulation library)
- Allow to build and run with clang
- Support/check for Linux capabilities, allow to run without sudo (see `tuning_and_security.md`)
- OAI does not modify CPU frequency and networking stack (`tuning_and_security.md`)
- Bugfixes in the entire stack (e.g. #547, #663, #674, #687, #712, #736, #739, #741, #756, #762, #773, ...)

5G gNB:

- Support for FR2 interoperability with COTS UE (no beam switching supported yet)
- Add 4-layer DL MIMO (experimental)
- Add gNB Neighbour configuration and Mobility over F1 interface (see `handover-tutorial.md`)
- Enhance O-RAN FHI 7.2: (see `ORAN_FHI7.2_Tutorial.md`)
    - Support different bandwidths (40/60/80/100MHz) and antenna configs (1x1 up to 4x4) for Benetel/VVDN/LITEON RUs

    - Add support for multi-RU support (single-cell/distributed antenna)
- Support AMD T2 Telco card look-aside L1 accelerator (see `LDPC_T2_OFFLOAD_SETUP.md`)
- Support Nvidia Aerial/ARC in-line L1 accelerator (see `Aerial_FAPI_Split_Tutorial.md`)
- Various fixes for multi-UE operation: by default support of up to 16 UEs concurrently
- Documentation for
    - 5G MAC (see `mac-usage.md`)
    - 5G RRC (see `rrc-usage.md`)
    - E1 (see `E1-design.md`)
    - F1 (see `F1-design.md`)

5G UE:

- Basic interoperability with COTS gNB (Nokia gNB)
- Implement PHR reporting
- Implement RRC re-establishment
- Implement PUCCH/PUSCH/SRS power control
- Implement UCI on PUSCH and aperiodic CSI reporting
- Support of cell search (within the selected UE bandwidth) (see `RUNMODEM.md`)
- Enhance connection control: implement timers, resync
- A lot of internal cleanup

This release also includes many fixes and documentation updates. See `doc/README.md` in the repository for an overview of documentation.

v2.1.0 -> February 2024.

This release improves existing 5G support and adds various new features.

- 5G gNB
    - Add support for O-RAN 7.2 fronthaul interface (tested with 3 O-RUs: Benetel, LITEON, VVDN)
    - Add support for 2-layer UL MIMO
    - FDD interoperability with COTS UE

    - Compiles on ARM (through SIMDE)
    - Introduce E2 agent and basic support for E2SM-KPM and E2SM-RC
    - Add support for E1AP
    - Add support for multiple DUs and CU-UPs at one CU-CP
    - FR2 SA with OAI UE
    - Improve computational efficiency
- 5G UE
    - Cleanup in MAC and RRC towards support of 3rd-party gNB
    - FR2 SA with OAI gNB
    - Improve computational efficiency

Overall the stability is improved for the same resource usage.

There is basic FR2 support between OAI gNB and OAI nrUE. COTS UE interoperability is under testing.

This release also includes many fixes and documentation updates.

v2.0.0 -> August 2023.

This release adds support for 5G and maintains previous features:

- 5G SA in gNB
    - PHY, MAC, RLC, PDCP, SDAP, RRC layers
    - 2x2 MIMO and 256-QAM for UL/DL
    - 15 and 30 kHz subcarrier spacings; 10-100 MHz bandwidths
    - Up to 800Mbps throughput or 5ms latency
    - F1, basic E1, 5G FAPI (SCF 222.10.02), split 8 split options
    - Handling of up to 16 UEs
    - RRC procedures for connection setup, multiple PDU sessions, reestablishment
- 5G SA in UE
    - PHY, MAC, RLC, PDCP, SDAP, RRC layers
    - 2x2 MIMO and 256-QAM for UL/DL
    - 15 and 30 kHz subcarrier spacings; 10-100 MHz bandwidths
    - Custom FAPI-like MAC/PHY interface

    - RRC procedures for connection setup and cell measurement
- Basic 5G NSA in gNB
    - X2 sgNB Addition Request between OAI eNB and gNB
- 4G eNB and UE
    - Bugfixes in fairRR scheduler (eNB)
    - Non-standard F1 midhaul removed (eNB)
    - FlexRAN removed (eNB)
    - Sync fixes (UE)
- LTE-M supported
- Support for AW2S devices, RFsimulator channel emulation support

For more information on supported features, please refer to the **feature set**.

v1.2.1 -> February 2020.

- Bug fix for mutex lock for wake-up signal

v1.2.0 -> January 2020.

This version adds the following implemented features:

- LTE-M : eNB support for Mode A repetitions
    - PUSCH CE - 8 Repetitions
- Improved CDRX implementation for monolithic eNB
- Experimental eMBMS support (now also on eNB side)
- Experimental MCE - Multicast Coordination Entity
- Bug fixes

This version also has an improved code quality:

- Better Test Coverage in Continuous Integration:
    - Initial framework to do long-run testing at R2LAB

v1.1.1 -> November 2019.

- Bug fix in the TDD Fair Round-Robin scheduler

v1.1.0 -> July 2019.

This version adds the following implemented features:

- Experimental support of LTE-M
  - Single LTE-M UE attachment, legacy-LTE UE attachment is disabled
- X2 interface and handover (also X2-U interface)
  - In FDD and TDD
- CU/DU split (F1 interface)
  - Tested only in FDD
- CDRX
  - Tested only in FDD
- Experimental eMBMS support (only on UE side)
- Experimental multi-RRU support
  - Tested only in TDD

This version has an improved code quality:

- Simplification of the Build System
  - A single build includes all full-stack simulators, S1/noS1 modes and one HW platform (such as USRP, BladeRF, ...)
- TUN interface is now used as default for the data plane
  - for UE, eNB-noS1 and UE-noS1
- Code Cleanup
- Better Static Code Analysis:
  - Limited number of errors in cppcheck
  - Important Decrease on high Impact errors in CoverityScan
- Better Test Coverage in Continuous Integration:
  - TM2, CDRX, IF4.5, F1
  - OAI UE is tested in S1 and noS1 modes with USRP board
  - Multi-RRU TDD mode
  - X2 Handover in FDD mode

v1.0.3 -> June 2019.

- Bug fix for LimeSuite v19.04.0 API

v1.0.2 -> February 2019.

- Full OAI support for 3.13.1 UHD

v1.0.1 -> February 2019.

- Bug fix for the UE L1 simulator.

v1.0.0 -> January 2019.

This version first implements the architectural split described in the following picture.

Block Diagram

- Only FAPI, nFAPI and IF4.5 interfaces are implemented.
- Repository tree structure prepares future integrations of features such as LTE-M, nbIOT or 5G-NR.
- Preliminary X2 support has been implemented.
- S1-flex has been introduced.
- New tools: config library, telnet server, ...
- A lot of bugfixes and a proper automated Continuous Integration process validates contributions.

Old Releases:

- v0.6.1 -> Mostly bugfixes. This is the last version without NFAPI.
- v0.6 -> RRH functionality, UE greatly improved, better TDD support, a lot of bugs fixed.
    - WARNING: oaisim in PHY abstraction mode does not work, you need to use v0.5.2 for that.
- v0.5.2 -> Last version with old code for oaisim (abstraction mode works)
- v0.5.1 -> Merge of bugfix-137-uplink-fixes. It includes stablity fixes for eNB
- v0.5 -> Merge of enhancement-10-harmony-lts. It includes fixes for Ubuntu 16.04 support

- v0.4 -> Merge of feature-131-new-license. It closes issue#131 and changes the license to OAI Public License V1.0
- v0.3 -> Last stable commit on develop branch before the merge of feature-131-new-license. This is the last commit with GPL License
- v0.2 -> Merge of enhancement-10-harmony to include NGFI RRH + New Interface for RF/BBU
- v0.1 -> Last stable commit on develop branch before enhancement-10-harmony