OpenAirInterface Core Network: Recent enhancements in OAI EPC

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Outline

- EPC fundamentals
- OAI Core Network Overview
- Recent developments
- Future plans
Outline

- **EPC fundamentals**
  - High level functions
  - 3GPP picture of network functions and interfaces.

- OAI Core Network Overview
- Recent developments
- Future plans
Core Network Fundamentals

- High level functions
  - Network Access Control Functions.
    - Authentication and authorization, admission control, Policy and charging enforcement
  - Packet Routing and Transfer Functions: IP header compression function, packet screening.
  - Mobility Management Functions.
    - Reachability management for UE in ECM-IDLE state
  - Security Functions.
  - Radio Resource Management Functions.
  - Network Management Functions (O&M)
    - GTP-C signaling based Load and Overload Control, Load balancing between MME, MME control of overload, PDN GW control of overload
Figure 4.2.1-1: Non-roaming architecture for 3GPP accesses
Outline

- EPC fundamentals

- OAI Core Network overview
  - Architecture overview
  - Source Code
  - License
  - Deployment

- Recent developments

- Future plans
Today
Very short term is NSA-3X
OAI EPC – next step is NSA option 3X

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<tr>
<th>EN-DC</th>
<th>My understanding</th>
<th>TR 38.804 Figure 5.2.1.2-1, 5.2.1.2-2, and 5.2.1.2-3</th>
<th>TR 38.801 Figure 10.1.2.2-1 and 10.1.2.4.1-2</th>
<th>TR 38.801 Figure 7.2-2 and 10.1.2.4.1-1</th>
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OAI Core Network – Source code

OAI Core network source code

- **Download** is free, no registration required.
  - GitHub main page
  - [https://github.com/OPENAIRINTERFACE/openair-cn](https://github.com/OPENAIRINTERFACE/openair-cn)
    - Repository of MME, HSS network functions.
  - [https://github.com/OPENAIRINTERFACE/openair-cn-cups](https://github.com/OPENAIRINTERFACE/openair-cn-cups)
    - Repository of SPGW-C, SPGW-U network functions.

- **Is open source**
  - all binaries can be generated from what is in the git repository, and on internet, for 3rd party software.
  - If there is generated source code in the repository, you will find the code generator in it.

- **Contribution is opened** to any people who signs the license agreement.
License is Apache v2 (differ from RAN)

 Compatibility chart

Source: https://en.wikipedia.org/wiki/License_compatibility
OAI Core Network – License

**License Apache v2**

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Source: [https://tldrlegal.com/license/apache-license-2.0-(apache-2.0)](https://tldrlegal.com/license/apache-license-2.0-(apache-2.0))
- **Openair-cn-cups** repository license is **OAI Public License v1.1**

  - This repo contains code that can be reused in 5G Core network (PFCP for example).
  - 5G Core network license is OAI Public License v1.1
OAI Core Network – Deployment

- **Target OS**
  - Linux, interest is no proprietary stacks, open-source.
  - The OS target is Ubuntu 18.04 (Bionic).
  - A RedHat EL7/8 declination is available on openair-k8s repo on github/OPENAIRINTERFACE.

- **Hardware requirements**
  - CPU:
    - Target is X86-64 (Intel, AMD).
    - No plans for ARM, we cannot guarantee the endianness-proof.
  - RAM
    - Some work is needed there.
  - Network interfaces
    - 1 network device may be a minimalistic solution for any network function.

- **Linux Kernel**
  - Any kernel that comes along the OS for all NFs is fine assuming it supports pthread scheduling priorities and SCHED_FIFO policy at least.
  - (No more Kernel 4.9.x dependency for the SPGW data plane).

- **Practically**
  - Tested on bare metal servers, VM, docker.
Outline

- EPC fundamentals
- OAI Core Network overview

Recent developments
- MME
- SPGW
- HSS

Future plans
Recent developments – MME (Blackned)

- **Actualizing the code:**
  - Merging different branches for most actual version (develop branch).
  - Thereby rework on the whole code, reviewing the layers, contexts and procedures.
    - Clear separation between EMM and rest of the layers.

- **Stabilisation**
  - Burst attaches with NG4T, Out of coverage scenarios with real eNBs.
Recent developments – MME (Blackned)

- **Inter-MME S1 Handover & S1-TAU:**
  - Fallback methods and validations: **VERY fault tolerant.**
    - Rejects, Missing Messages (TAC after HO, HO-Notify)
    - Failed Authorizations → Fallback to local security.
    - Return to local cell during handover.
    - Burst tests with NG4T.
  - Multi-APN is supported, Multi-Bearer in works.
Recent developments – MME (Blackned)

- Intra-MME S1 Handover & S1-TAU & X2:
  - Up to 50 eNBs on a single node, same or different TAC.
  - X2: No SP-GW relocation considered.
Recent developments – MME (Blackned)

- **Dynamic QoS:**
  - Multiple Dedicated Bearer Establishment, Modification and Removal.
  - Default Bearer QoS update based on PCRF authorized values.
  - All TFT operations supported.
    - Fault Detection: Verifying Packet Filters and Precedences.
    - Update of TFT & filter rules, precedence, QoS, IP-Filter supported.
  - Bearer QoS Update supported.
  - Transaction based: Update of contexts only if success in access network.
  - Congestion support.
    - Implicit Indicators: Handover/Service Request failures.
    - Explicit Indicator: Bearer Resource Command, Delete Bearer Command.
Recent developments – MME (Blackned)

- **Dynamic QoS (Handover):**
  - X2, S1 and S10 Handover, as well as idle TAU support dedicated bearers completely (session initiation on target side with dedicated bearers and bearer modification on the target side immediately after handover).
  - Complete support for IPv6 filter rules and messaging.
Recent developments – MME (Blackned)

- **EMM/ESM separation**
  - Independent processing to reduce dependency errors.
  - Towards an AMF/SMF like structure in the MME.
  - No ESM context, only transactions.

- **IPv6 Testing**
  - S1, S11 and S10 interfaces are now IPv4 and IPv6 capable.
  - Further bugfixes in UE IPv6 handling.

- **Valgrind Testing**
  - Fixed all known memory leaks.

- **Further Achievement**
  - Multi-APN
  - Paging
Recent developments - SPGW

- New SPGW and CUPS: Why?
  - Develop a CUPS SPGW in order to also have the benefit of starting to develop for 5G-CN (UPF).
  - This v1.0.x release has no ambition for performance (handle big amount of users, data).
  - The main objective is to be an easy to use SPGW.
Recent developments - SPGW

- SPGW CUPS
  - So SPGW is composed of almost 2 network functions:
    - 1 SPGW-C, 1 SPGW-U.
  - Written entirely in C++ (-std=c++17).
    - Internal design still asynchronous (ITTI based API).
    - Use spdlog, libfolly (nolock collections).
  - Difference with tag v0.7.0
    - Should handle GTP fragmentation (+)
    - NAT (based on iptables) (+)
    - Easy to install, no kernel dependency (+)
    - Switch talking natively PFCP. (+)
    - Data is copied/handled in user space (no zero copy) (-)
      - This enables us to do easily whatever we want to do with it. (+)
Recent developments - HSS

- No major release
- Only Fixes regarding the SQN synchronization.
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CN Future Plans

- **Multicast (eMBMS) Support for MME**
  - MCE (Multicast/Multicell Coordination Entity) implementation & integration with M3AP interfaces towards the MME and the eNBs.

- **NSA mode option 3X ASAP.**

- **ProSe Still under progress.**

- **SPGW-U Zero-Copy solution (opendataplane + DPDK)**

- **LTE-M, SCEF ~mid 2020.**

- **Dedicated bearers in SPGW.**
Magma and OAI 4G Core Network

https://github.com/facebookincubator/magma
Magma and OAI CN (2)

- Magma MME and HSS are openair-cn fork
- They had their own evolution
- Effort to:
  - Upstream magma bug fixes and new features back to OAI
  - Resync latest OAI features back to magma
QUESTIONS ?