Research and development on Open Source 5G NG-CN in OAI Software Alliance

N. Nikaein, L. Gauthier, C. Bonnet, A. Ksentini, R. Knopp, A. Huang, I. Ghauri

Communication System Department, EURECOM

4th OAI workshop
7-8th of November, 2017
Paris
Observations

- 1:1 Interfaces between entities
- Transaction communication model
- Certain level of CP and UP separation
- Stateful network entities
- Common entity for user mobility and session management
3GPPP Network Sharing Models

- **Multi-operator RAN (MORAN)**
  - Shared RAN nodes, dedicated spectrum, but separated CN per operator

- **Multi-operator CN (MOCN)**
  - Shared RAN nodes and spectrum, but separated CN per operator with proprietary services

- **Gateway CN (GWCN)**
  - Shared RAN and part of core networks
3GPPP Core Network Slicing Model

- **Dedicated core (DECOR)**
  - deploy multiple dedicated CNs (DCNs) within a single operator network
  - one or multiple MMEs and SGWs/PGWs, each element potentially featuring different characteristics and functions

- **Evolved DECOR (eDECOR)**
  - Improvement in DCN selection and allocation procedures, as well as isolation among DCNs
  - UE assisted DCN selection
  - Network Node Selection Function (NNSF) at RAN to select directly the proper DCN towards which the NAS signaling needs to be forwarded
  - Congestion control and load balancing among multiple DCN with shared MME
3GPPP Rearchitects RAN and CN

- **RAN**: a 3 tier architecture (CU0 → DU[0-n] → RRU[0-m])
  - Functional split between CU and DU
  - Functions split between DU and RRU
  - Functional split between c-plane and d-plane

- **CN**: a service-centric architecture (1:N, N:1)
  - Network Service catalog and discovery
  - Functional split between UP and CP
  - Message bus communication
Next Generation Core Architecture 1

- Authentication Server Function (AUSF)
- Access and Mobility Management Function (AMF)
- Data network (DN)
  - e.g. operator services, Internet access or 3rd party services
- Policy Control function (PCF)
- Session Management Function (SMF)
- Unified Data Management (UDM)
- User plane Function (UPF)
- Application Function (AF)
- User Equipment (UE)
- (Radio) Access Network ((R)AN)

Closer to traditional CN with functions and IF
Next Generation Core Architecture 2

- Authentication Server Function (AUSF)
- Core Access and Mobility Management Function (AMF)
- Data network (DN)
  - e.g. operator services, Internet access or 3rd party services
- Network Exposure Function (NEF)
- NF Repository Function (NRF)
  - VNF catalog / store
- Policy Control function (PCF)
- Session Management Function (SMF)
- Unified Data Management (UDM)
- User plane Function (UPF)
- Application Function (AF)
- User Equipment (UE)
- (Radio) Access Network ((R)AN)

Service-centric control plane

SaaS:
Deliver control network functions as a service basis
Design Elements of NG-CN

- **NG-CN entities**
  - CN Functional split and evolution
    - Session management
    - Mobility management
  - CP and UP separation

- **Support of Flow based QoS**
  - E2E Bearer concept will be deprecated
  - Flow to DRB mapping (newly introduced SDAP layer)

- **Flexible UP**
  - Local breakout through integration with MEC
  - Session continuity (indoor-outdoor, local-remote)

- **Message bus communication interface**
  - Respective data model as specified by 3GPP
  - Consumer-producer model
Design Elements of NG-CN

- **Support of network slicing as defined in 3GPPP TR 28.801**
  - Slice selection, slice management and orchestration

- **Control plane APIs and data models in support of runtime programmability**
  - Statistics and control
  - Network intelligence

- **Cloud-native CN functions**
  - Stateless, composable, reusable CN network functions (NF) following micro-service principles
  - Decouple storage state from NF computing
OpenAir-CN and NG-CN
Overview

- Current Openair-CN architecture and status towards Rel. 10
- Evolution of openair-CN toward 3GPP Rel 15 with new network elements (on-going or planned work)
OpenAirCN Architecture and Status
Stable  Rel 10 compliant

- **Support for**
  - ✓ Attach procedures
  - ✓ Dedicated bearers
  - ✓ UE reachability procedures
  - ✓ Large number of UEs

- **On-going**
  - ✓ Production ready code
  - ✓ Multiple PDNs
  - ✓ HO messages
  - ✓ Scalability of data plane
    - ✓ OVS integration

- **Planned**
  - ✓ Certain EMM procedures not implemented
    - Paging
  - ✓ Release 14 for NB-IoT

Current OpenAirCN architecture
Step 2. AMF

- Split of MME into AMF and SMF

- Create the AMF module
  - MM code derived from openair-cn MME_APP module
  - Code derived from openair-cn NAS EMM layer
  - Implement N2, N3 and N11 interfaces
    - Evolution of S1AP to N2
Step 1. SMF and UPF

- **Split of**
  - X-GW into X-GW-C and X-GW-U
  - MME into AMF and SMF

- **Create a UPF module**
  - X-GW-U
  - UP abstraction layer to provide the required flexibility in data plane
    - Local
    - Remote
  - Data plane drivers
    - Legacy Linux
    - REST
    - OF

- **Create SMF-like module**
  - Separate NAS/ESM layer from MME
    - Isolate the ESM procedures and context information
  - **Optionally** include X-GW-C to **fully** separate UP and CP

![Diagram showing SMF (X-GW-C+MME/ESM) and UPF with UP Abstraction, OF, REST, and Linux tools. N4 connections are indicated.](image-url)
Step 3. AUSF, UDM, and PCF

- Split of HSS to UDM and AUSF
- Create UDM
  - Externalize the DB from HSS
    - CassandraDB
- Create AUSF from splitted-HSS and implement the associated interfaces
- Create PCF from PCRF
  - PCRF will be potentially contributed by a 3rd party partner
Step 4. Service Oriented 5G Core Network

- **Design principles**
  - Message bus communication interface (pub/sub in contrast to req/resp)
  - State less behavior (micro-service arch principles)

- **Interfaces**
  - Namf, Nsmf, Nausf, Npcf

- This work is in open discussion phase
Step 5. Flexible control of CN

- Enable control and monitoring in NG-openair-CN
  - Controller-agent south-bound control-plane interface
  - Per module API

- This work is partially done now
  - Agent implementation is done
  - API and SB-IF under specification
Summary

- Functional split of exiting OAI modules and their extension to release 15
- Message bus communication interface
- Control plane APIs and data models
- Flexible UP through integration with MEC
Design Elements of NG-CN

- **NG-CN entities**
  - CN Functional split and evolution
    - Mainly mobility and session managements
  - CP and UP separation
  - Cloud-native CN functions
    - Stateless behavior following micro-service principles

- **Message bus communication interface**
  - Respective data model as specified by 3GPP

- **Control plane APIs and data models in support of runtime programmability**
  - Statistics and control

- **Local breakout through integration with MEC**