Multi-RATs Convergence: A New Spin Through the Edge

Ping-Heng (Wallace) Kuo and Alain Mourad

InterDigital, London, UK
Cambridge Wireless, 14 December 2017
Outline

• The Multi-RAT Landscape in 5G
• The Conventional Approach for Multi-RAT Convergence
• A New Approach through the Edge/Fog
• The 5G-CORAL Project
• Few Take-Aways
The Multi-RAT Landscape in 5G

Various types of radio access technologies (RATs) may co-exist in the same service area to support diverse services and categories of devices!

Cellular:
• 2G/3G/4G LTE
• 4G Evolution (e.g. 3GPP Rel-11~13)
• 5G NR (sub-6GHz)
• 5G NR (mmWave)

WiFi:
• Legacy WiFi
• IEEE 802.11ax
• IEEE 802.11ay
• IEEE 802.11ah

D2D:
• V2X
• V2V
• WiFi Direct
• ITS/DSRC
• Etc.

IoT-Oriented:
• LoRA
• ZigBee
• Bluetooth
• 6LoWPAN
• Etc.
Conventional Approach for Multi-RAT Convergence (1/3)

- **Intra-Cellular Interworking:**
  - Interworking between different generations within the cellular family: 2G, 3G, HSPA, LTE, 4G+, and 5G.
  - Examples – 4G/5G Interworking:
    - None-Standalone (NSA) 5G New Radio (NR) based on 4G core network (EPC), in which the control plane signaling is maintained by LTE-based connectivity, while the user plane traffic can be transmitted from both LTE and 5G NR. In this case 5G NR cannot be used without LTE radio.
    - Alternatively, we may have LTE radio embedded under 5G Core (5GC) to achieve inter-working between 4G and 5G.

Cellular-WiFi Interworking:
Inter-working between cellular and WiFi technology families has gradually moved from the core network to the RAN level.
Conventional Approach for Multi-RAT Convergence (3/3)

Cellular-WiFi Interworking at the Link Level:

- Link level integration: LTE-WiFi Aggregation (LWA)
  - The WiFi radio is used to transmit some of the PDCP packets from an LTE eNB.
  - An LWA adaptation protocol (LWAAP) will be used to “translate” PDCP packets before processing them by WiFi radio.

Source:
Computing for 5G: Cloud, Edge and Fog

- **Cloud** is the IT infrastructure that is typically distant from the RAN and users/devices.

- **Edge** is usually referred to as data centers near RAN:
  - ✓ Network aggregation points
  - ✓ Base Stations

- **Fog** may include any location distributed nearer the user or thing, where networking, computing and storage exist.
  - ✓ User's premise
  - ✓ In the device itself
  - ✓ In a specific chip in the device!
Three Key Observations

- Multiple various RATs (not only cellular and WiFi) will co-exist in 5G
- The scope of Multi-RATs convergence has so far been mostly focused on cellular and WiFi integration
- Pervasive Edge/Fog computing into the access opens new dimension for interworking between any RATs
A New Spin of Multi-RATs Convergence (1/2)

• If:
  • (1) one can pool all the computing resources in the Edge/Fog into one integrated programmable and virtualized platform;
  • (2) and that all the co-existing RATs in the same local access area can made to expose their context information in that local access area into this common platform;
  • (3) and that capabilities are provided for abstracting and sharing this context information amongst RATs and towards applications or functions executing locally in this platform.

• Then:
  • This provides a new way of interworking between any RATs that is based on the sharing of RATs data.
  • This complements the conventional approach of Cellular-Cellular and Cellular-WiFi integration and harmonization.
A New Spin of Multi-RATs Convergence (2/2)

Networking, Computing, Storage capabilities shift

- Context information
- Network optimization

Cloud, Central DC

Intelligent Edge

- Edge + Fog
- Integrated with cloud
- Multiple RATs

WiFi

- Better QoE

LTE

- Harmonize RAT protocol stacks
- Selection of best RAT
- Minimize interference
- Traffic offloading
- Etc.

User Device

© 2016 InterDigital, Inc. All Rights Reserved.
EU-Taiwan 5G-CORAL project in a nutshell

- Stands for “A 5G CONvergent Virtualized Radio Access Network Living at the Edge”
  - An H2020 international EU-Taiwan project launched in Sep 2017 until end of 2019
  - Granted ~5m Euros from EC and Taiwan MoEA
- Targets an integrated virtualized edge and fog solution where multi-RATs convergence can strive
- Focus on the edge and fog tiers of the distributed computing infrastructure, along with their interactions with the distant tiers (cloud/data centers)
5G-CORAL: Logical Components and Physical View

Main building blocks of 5G-CORAL:
- Orchestration and Control System (OCS)
- Edge and Fog computing System (EFS)
5G-CORAL Architecture - Based on ETSI NFV/MEC
5G-CORAL: Deployment Scenarios (2/2)

RATs:
- Cellular (Outdoor)
- WiFi (Indoor)
- IoT Connectivity (e.g. for sensors)

RATs:
- Cellular
- WiFi (on-board)
- IoT Connectivity
- GSM/LTE-R

RATs:
- Cellular
- V2X
- WiFi
- ITS
- IoT Connectivity

Multi-RATs interworking through 5G-CORAL Edge and Fog Solution in support of various applications such as:

- Augmented Reality navigation
- Robots assistance
- Localization and Identification

- Driverless vehicles
- Mobile office (train/car)
- Vehicles monitoring
Few takeaways

• 5G access is rich of multiple RATs extending beyond Cellular and WiFi

• An intelligent and integrated Edge/Fog opens the door for the sharing of RATs data and hence optimizing intra-RAT and inter-RATs operations towards seamless and efficient connectivity for applications

• 5G-Coral has started developing an integrated virtualized Edge and Fog solution as an exchange platform amongst multiple RATs in 3 scenarios (shopping mall, connected car, and high speed train)

• Trials are planned in Europe (Italy, Spain) and Taiwan throughout 2018 and 2019 – Stay tuned!
Acknowledgement

5G-CORAL is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No 761586