RETHINK PROTOCOL STACK

Dr. Chih-Lin I
CMCC Chief Scientist, Wireless Technologies
CMRI, China Mobile
Rethink Fundamentals

Green Communication Research Center established in Oct. 2011, initiated 5G Key Tech R&D.

- **Rethink Shannon**: To start a green journey of wireless systems
- **Rethink Ring & Young**: For no more “cells”
- **Rethink Signaling & Control**: To make network application/load aware
- **Rethink Antenna**: To make BS invisible
- **Rethink Spectrum & Air Interface**: To enable wireless signal to “dress for the occasion”
- **Rethink Fronthaul**: To enable Soft RAN via NGFI
- **Rethink Protocol Stack**: To enable User Centric Cell and real-time flexible air interface

5G: UCN + SDAI

UCN (NMC) + SDAI

OFDM + MIMO

SDAI: Software defined Air Interface
UCN: User Centric Network
NMC: No More “Cells”

ETS Summit
5G: FROM MYTH TO REALITY
E2E 5G System Key Tech

Unified RAN architecture + Common high layer protocol (UCN, enabled by C-RAN/NGFI)

High Freq. RIT

Low Freq. RIT

Massive-MTC RIT

Mission-Critical RIT

PTN

Transportation network

PON

Core Network

SDN/NFV

Unified RAN architecture + Common high layer protocol (UCN, enabled by C-RAN/NGFI)

SDAI (enabled by MCD)

Low Freq. New RIT

High Freq. RIT

Massive-MTC RIT

Mission-Critical RIT

LTE evolution Low freq. eMBB

NB-IOT

Latency redu. V2X

Seamless wide-area coverage

Hotspot & high data rate

Low-power & massive-connections

Low-latency & high-reliability

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**Software defined Air Interface (SDAI)**

**SDAI:** configurable for multi-use cases

- Scenarios and service
- Flexible and efficient
- Configurable functions and parameters
  - Beamforming
  - Modulation and coding
  - Multiple access
  - Frame structure
  - Duplex
  - Spectrum

**3D-MIMO/mMIMO**
- Coverage enhancement
- Capacity enhancement
- Performance improvement

**Flexible frame structure**
- Flexible DL/UL
- Latency reduction

**Multi-cell Cooperation**
- Full frequency access
- Multi-cell interference suppression

**Half/Full duplex**
- Mixed duplex deployment
- Efficiency improvement

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*5G: From Myth to Reality*

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Rethink Fronthaul: NGFI (xHaul)

**NGFI**

**NGFI based C-RAN network structure**

**NGFI considerations**

**The objectives of NGFI**

- Enable statistical multiplexing for FH
- Decoupling cell proc. & UE proc, and UL&DL
- Support 5G key tech., Massive MIMO etc.

**The key is function re-split between BBU and RRU, & re-design of underlined transport networks.**

**Ethernet as promising (Low-cost & Flexible)**

- NGFI encapsulation: IEEE 1904.3 WG (2-3 Jun 2015 in Beijing hosted by CMCC)
- Latency enhancement: TSN
- Synchronization: IEEE 1588WG & ITU-T

**Features:**

- Separation of ant-related processing and non-ant-related processing
- Separation of baseband upper and lower layer processing
- Layered coordination to address interference for area of different scale
- Support 5G new technologies e.g. UDN, massive MIMO
NGFI References

- IEEE 1914 (NGFI) WG officially approved in Feb. 2016, led by CMCC
- 1st NGFI WS held & NGFI WP released in June, 2015
  - MoU signing with Broadcom, Intel, Alcatel-Lucent, HuaWei, ZTE, Nokia, Xilinx & Altera
- Co-founder of IEEE 1904.3
- NGFI as the key component in NGMN 5G WP, FuTURE 5G WP
- NGFI/FH promotion and study in ITU-T, IEEE and 3GPP
- NGFI Paper in IEEE Communication Magazine & GLOBECOM 2015

“NGFI, The xHaul”, GLOBECOM 2015
NGFI in IEEE (1914 WG)

- Sponsor: IEEE COM/SDB
- 7 founding companies with more than 50 subscribers so far from ~30 companies
- Target: efficient & scalable FH for 5G
- Scope of 1914.1 project:
  - NGFI transport network architecture
  - Requirements
  - Function split analysis for LTE

- [http://grouper.ieee.org/groups/1914/](http://grouper.ieee.org/groups/1914/)
- The first NGFI WG meeting to be held on 25 – 28 April, San Jose

Contact: huangjinri@chinamobile.com
Protocol Stack Revolution

- Technical solution/design principles:
  - To sink cell to air interface from S1 and make UE the basic management element as well as cell
  - Semi-static and Real-time controlling
  - Centralized and distributed RRC
  - Centralized and distributed MAC
  - Centralized data process in PDCP and RLC
  - Flexible controlling of Hybrid PHY
Liberating “UE” from “Cell”

- CoF: the sole fundamental element
- CoF: cells
- “cell”: “UE”, Resource
- “UE”: Context, Data
- Resource: Common/Shared/OM resources

- CoF and UoF: the fundamental elements
- CoF: Resource
- UoF: Context, Data, Resource bonded
- CoF and UoF: Real-time mapping
New definition for the Logical “Cell”

Traditional “Cell”:
• Physical Cell : D-MIMO or traditional RRH
• Logical Cell : the protocol stack of air interface, PHY/MAC/RLC/PDACP/RRC

New “Cell”:
• Physical Cell : D-MIMO or traditional RRH
• Logical Cell : parts of the protocol stack of air interface, PHY/Part MAC/Part of RRC

New “UE” Entity:
Part MAC/PDCP/RLC/Part of RRC

CoF/UoF:
Virtual labels and maybe disappear as a management unit

Meanings of Physical cell Unchanged
- **C/U Redefinition**
  1. Control Plane: Combination of RRC (slow control) and MAC (fast control)
  2. User Plane: dynamic centralized and distributed function definition

- **Dynamic configuration for Fronthaul**
  1. FC-MAC control DRC and RLC dynamically based on RRC signaling
  2. Based on ideal/non-ideal fronthaul, two types of MAC/RLC function split
  3. DRC flexible control: a) Independent protocol function entity; b) new function for PDCP; c) new function for RLC
  4. DRC does not affect existing functions of PDCP and RLC
  5. New MAC consists of FC-MAC and RT-MAC
  7. Keep back compatibility for new MAC
MCD: Protocol Stack Redistribution

RCC-RRS Distributed Network Arch

1. FC-MAC consists of “RRC_{FC}“ and MAC_{RT}
2. “RRC_{FC}” denotes sinking RRC signaling control procedure
3. MAC_{RT} denotes functions except RT-MAC
4. RRC_{FC} denotes functions except “RRC_{FC}”
5. Transmit-receive function split for RLC (transmit side in RRS, and receive side in RCC)
6. RCF includes all the control functions
7. RDF includes all the data link functions
Thank you!

icl@chinamobile.com