Cisco Ultra Platform
Evolution to 5G

Laurentiu Spiridon, Consulting System Engineer
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Agenda

• “5G” Defined
• 5G Market Status
• Cisco Ultra solution and its evolution
• 5G Ready Technologies and 5G Non-Standalone Core
• Next Generation 5G Mobile Core
Agenda

• “5G” Defined
• 5G Market Status
• Cisco Ultra solution and its evolution
• 5G Ready Technologies and 5G Non-Standalone Core
• Next Generation 5G Mobile Core
The Next Mobile Generation

1980s
- Analog
- AMPS
- Voice

1990s
- Digital
- GSM, IS-95, IS-136
- Voice capacity

2000s
- 3G
- WCDMA, CDMA2000
- Voice & data

2010s
- 4G
- LTE/LTE-A
- Broadband data & video

2020s
- 5G
- Digitization
5G is led by new services

- **Ultra Reliability** (Wherever + Whenever)
  - AR/VR
  - Broadband access everywhere
  - Higher user mobility
  - Massive Internet of Things

- **Ultra Capacity and Coverage**
  - UHD Video
  - Average 1 Gbps per device
  - High Speed Train
  - Sensor Networks

- **Ultra High-Speed** (up to 20 Gbps to cell site)
  - Extreme real-time communications
  - Lifeline communications
  - Ultra-reliable communications
  - Broadcast-like services

- **Ultra Low Latency** (1 ms End-to-End)
  - Tactile Internet
  - Natural Disaster
  - E-Health Services
  - Broadcast Services

Source: NGMN
5G Use Cases

- xMBB (Ultra-Reliable, Low-Latency Communications)
- uMTC (Ultra-Reliable, Low-Latency Machine Communications)
- mMTC (Massive Machine-Type Communications)

Data rate vs. Latency/Reliability vs. Number of devices
5G Radio Architecture

- Key capabilities:
  - Various spectrum bands
  - Millimeter waves (mmWaves)
  - Massive MIMO
  - Optimized OFDM waveform
  - Scalable numerology
  - RAN considerations

Source: IHS Markit
© 2017 IHS Markit
Next Gen Mobile Core Capabilities

- Key capabilities:
  - Virtualization (*)
  - Stateless VNF
  - Control/User Plane Separation (*)
  - Mobile Edge Computing (*)
  - IoT Capabilities (*)
  - Network Slicing
  - Service Based Architecture
  - Access agnostic inc. 3GPP & non-3GPP RAN and FMC
  - API Exposure
  - Cloud scale Network
  - Automation and Orchestration *

The marked (*) are in scope for LTE Advanced and 5G core
Network Slicing

Divide and Conquer
5G Security Challenges

- IoT / Massive Machine Type Communications
  - Increased threat vectors due to weak inbuilt security in IoT devices, attacks using encrypted traffic

- Virtualized mobile network functions, services and applications
  - Increased complexity in mitigating side channel attacks, Internal I/Fs exposed to attacks, LI

- Ultra Low Latency application use cases
  - Increased threat vectors due to Distributed Data Center, Multi Access Edge Networks, NW Slicing

- Co-existence of 5G and Legacy Network
  - Multiple technologies, higher traffic to manage

- Adhering to Regulatory requirements (GDPR, DLP,....)
3GPP Standards Timelines for 5G

<table>
<thead>
<tr>
<th>Year</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2018</td>
<td></td>
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</tbody>
</table>

NR anchored on EPC
NR Non-Standalone (NSA)

NR anchored on 5G Core
NR Standalone (SA)

5G Radio Groups
Option 3
Option 2
Option 4, 5 and 7

ASN.1

Architecture completion
Details completion
Stage 2
Stage 3
3GPP 5G Deployment Options

- 2 Radio technologies
  - LTE and eLTE
  - 5G NR
- 2 Core Networks
  - LTE
  - 5G NG Core
- Dual Connectivity
  - LTE developed functionality using Master eNB and Secondary eNB setup
  - Allows fast adoption of 5G and performance robustness.
5G Architecture Options

Option 1

Option 2

Option 3

Option 4

Option 5

Option 7

Option 6
5G Schedule

Innovators  Early Adopters  Early Majority  Late Majority  Laggards

We are here!

2017 - 2020  2020 - 2022  2025+
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5G – Global Market Trials

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Verizon tests multi-vendor 5G with Cisco, Samsung

• https://newsroom.cisco.com/press-release-content?articleId=1844370&type=webcontent
## Market Status

Planned 5G spectrum auctions/allocations

<table>
<thead>
<tr>
<th>Country</th>
<th>Authority</th>
<th>Details</th>
<th>Date</th>
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<tr>
<td>Australia</td>
<td>ACMA</td>
<td>Planned auction of 3600 MHz band</td>
<td>Oct-Dec 2018</td>
</tr>
<tr>
<td>Australia</td>
<td>ACMA</td>
<td>Planned auction of mmWave bands</td>
<td>Jul-Sep 2019</td>
</tr>
<tr>
<td>Canada</td>
<td>ISED</td>
<td>Planned auction of mmWave bands</td>
<td>TBC</td>
</tr>
<tr>
<td>Czech Republic</td>
<td></td>
<td>700 MHz</td>
<td>TBC</td>
</tr>
<tr>
<td>France</td>
<td>ARCEP</td>
<td>Planned allocation of 3400–3800 MHz bands</td>
<td>TBC</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>OFCA</td>
<td>Planned allocation of 3400–3700 MHz and mmWave (24.25–28.35 GHz) bands</td>
<td>TBC</td>
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<tr>
<td>Latvia</td>
<td>PUC</td>
<td>Planned auction of the 3400–3450 MHz and 3650–3700 MHz bands</td>
<td>TBC</td>
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<tr>
<td>Mexico</td>
<td>IFT</td>
<td>Planned auction of 600 MHz</td>
<td>TBC</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Dutch Ministry of Economic Affairs</td>
<td>Auction of the 700 MHz, 1400 MHz and 2100 MHz frequency bands</td>
<td>2019</td>
</tr>
<tr>
<td>Pakistan</td>
<td>PTA</td>
<td>Planned auction in 2021</td>
<td>2021</td>
</tr>
<tr>
<td>Poland</td>
<td>Digitization Ministry</td>
<td>Planned allocation of 700 MHz for 5G, 3400–3800 MHz and 26 GHz</td>
<td>2020 and 2021</td>
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<td>South Korea</td>
<td>Ministry of Science and ICT</td>
<td>Planned auction of 3.5 GHz and 28 GHz bands</td>
<td>2018</td>
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<tr>
<td>Spain</td>
<td>Ministry of Energy, Tourism and Digital Agenda</td>
<td>3600–3800 MHz, 1500 MHz</td>
<td>2018</td>
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<tr>
<td>Switzerland</td>
<td>Swiss Federal Council</td>
<td>Planned auction of 700 MHz band; 1400 MHz band; 3.5–3.6 GHz and 3.6–3.8 GHz band</td>
<td>2H 2018</td>
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<td>Thailand</td>
<td>NBTC</td>
<td>Planned auction of 2.6 GHz band</td>
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<td>UK</td>
<td>Ofcom</td>
<td>Planned auction of 2300 MHz, 3400–3800 MHz band; and 700 MHz</td>
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<td>Planned auction of mmWave frequencies</td>
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<tr>
<td>US</td>
<td>FCC</td>
<td>Planned auction of 3550–3700 MHz</td>
<td>TBC</td>
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</tbody>
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Cisco Mobile Core Evolution

Native HW
- Hardware based Platform
- Scalable and reliable

Ultra
- Virtualized EPC
- VNF Automation

Ultra CUPS
- Scale bandwidth
- High session throughput
- Distributed IP anchor
- Low latency

Micro Services / Container
- 5G-Ready
- Multi Access

Cloud Native
- Fully Programmable
- 5G Any Use Case

Native HW

Ultra

Ultra CUPS

Micro Services / Container

Cloud Native

Native HW

Ultra

Ultra CUPS

Micro Services / Container

Cloud Native

Native HW

Ultra

Ultra CUPS

Micro Services / Container

Cloud Native

Native HW

Ultra

Ultra CUPS

Micro Services / Container

Cloud Native

Native HW

Ultra

Ultra CUPS

Micro Services / Container

Cloud Native
# Cisco Ultra Solution – NG Mobile Core solution

## Ultra Policy Platform
- Carrier-grade policy, charging, and subscriber data management solution
- Rapid service creation environment
- Monetization opportunities for 3G, 4G, 5G and IMS service architectures

## Ultra Gateway Platform
- Cloud-ready VNF, fully featured packet core
- Multiple functions (EPC, ePDG, SaMOG)
- CUPS - Separated control and user-planes
- Remotely deployable user plane for ultimate elasticity and scalability

## Ultra Services Framework
- Pluggable framework for in-line, subscriber-aware, enhanced services
- Integrated as separately upgradeable software packages
- Native life-cycle management and automated configuration

## VNF Element Manager, VNFM Proxy, Service Manager, Monitoring

## NFVI
(DC infrastructure)

## VNFM
(e.g. Cisco ESC)

## NFV-O
(e.g. Cisco NSO)

## VIM
Openstack / Vmware
Cisco Ultra Gateway

- Proven platform - serving 1.5B subscribers; deployed many of Tier 1s, total 350
- Creating with the goal of supporting multiple services in the same load
- High performance, scalable up and down

Cisco StarOS Infrastructure Platform

- PGW/GGSN
- SGW
- SAEGW
- MME/SGSN
- Small Cell GW
- ePDG/SaMOG
- InLine services
- CSGN

Charging/Reporting | Overload Protection | Resiliency
Cisco Ultra Policy

- Proven platform - deployed in many tier 1 service providers
- High performance, scalable up and down
- Highly available and extensible
Cisco Cellular IOT

- Multi-access core with unified policy, charging and service layer for different types of devices
- Interface with IoT applications via standardised/open Restful APIs based on ETSI framework
- Core network support all 3GPP wireless IOT connectivity (NB-IoT, LTE-M and 2G/3G/LTE)
- Includes 3GPP compliant SCEF and SCE capabilities
Ultra GW
Control Plane Architecture

Control Function Platform management tasks

Session Function Demux Tasks  
IP address Management

Session Function x2  
Session Tasks  
State replication

Session Function Redundant tasks

HyperVisor
VM
CF
StarOS
VM
HyperVisor
VM
CF
StarOS
VM
HyperVisor
VM
CF
StarOS
VM
HyperVisor
VM
SF
StarOS
VM
SF
StarOS
VM
SF
StarOS
VM
SF
StarOS
VM
Session Function
Redundant tasks

Standby tasks
Ultra GW
Bearer Plane Architecture

User Plane
GTP-U, DPI tasks

Standby tasks
S/P-GW Design – CUPS based

- APN cisco.com
  - ip pool group cisco.com
    - ip pool1 – UP1
    - ip pool2 – UP2
    - ip pool3 – UP3

- Subscriber ip address is allocated in round robin through ip pool group in order to balance traffic between UP

- IP pool advertisement via BGP (no ECMP)

- UP packet goes straight to allocated UP VM

- S1U address advertisement via BGP (no ECMP)
Cisco Traffic Steering

Cisco USP Instance

GTP Packet on S1-U

NSH Packet by SAEGW (Pkt metadata included in NSH Header)

SAEGW-C

Traffic Classifier

SAEGW-U

3rd Party App

NSH-Proxy

Apps not supporting NSH

L2 based forwarding

RAN+EPC

S1-U

Sx-ab

PCRF

Gx

Internet

SGi

App processed SGi Packet
3GPP FMSS compliant

- 3GPP FMSS (TS 23.718) compliant solution.
- Gx based Traffic steering policy control.
- NSH based service chaining (RFC 7665) compliant.

[Schematic diagram with nodes and connections]

(Uplink Traffic to Internet) → (S)Gi-LAN systems* → (Downlink Traffic from Internet)

(S)Gi Interface

PCEF (supporting ADC)

* Contains service functions and infrastructure to route traffic between them
Cisco Ultra MANO Compliant

- Fully featured mobile core VNF
- Integrates with MANO stack through standard interfaces
- Automation tools to simplify the NFVI resources and VNF instantiation
- Leveraging Cisco contributions into Industry Standard and Open-source based technologies including IETF, ETSI NFV, OPNFV

Virtualization

- Compute
- Network
- Storage

OSS/BSS

Ultra Web GUI

Ultra-EM

UGP

NFVO

VNFM (ESC)

VIM

Staging Server
Cisco Ultra Platform Management / Automation

- Ultra Element Manager
- Automation Services
  - Configuration Management
  - VNFM Lifecycle
  - SDN Integration
  - NFVI/VIM Support
  - WebScale-IT Automation

Diagram:

- OSS/BSS
- NFVO
- Ultra Web GUI
- VNFM
- Ultra-EM
- UGP
- Virtualization
- Compute
- Network
- Storage
- VIM
- Staging Server
Cisco Ultra Platform
Element Manager

- Management plane of the USP VNF
- Heartbeats & Monitors liveliness of all VNF-Cs within USP VNF
- Provides Day-0 & Day-N configurability for all enabled use-cases
- Monitors & Measures performance to enable SLA reporting
- Provides single northbound integration point of the VNF
- Monitors system tasks & lifecycle events to perform failover and recovery
Automation
Day-0/Day-N Provisioning & Deployment

Site & VNF Inventory

Monitoring

Deployment Validation

Full VNF Deployment

VNFM & VNF-EM Installation

Cloud Installation

NFVI Installation
Automation Day-N Operations

- Software Qualification
- Software Validation
- Software Upgrade
- Service Level Monitoring

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Packet Core Evolution

- **EPC**
  - First version of EPC as was introduced in 3GPP Rel 8.
  - Monolithic physical appliance based Network functions.

- **vPC**
  - First version of virtual EPC introduced as NFV.
  - Monolithic virtualized Network functions.
  - Later even Cloud enabled.

- **SDN-enabled vPC**
  - Applying SDN to EPC by introducing CUPS.
  - Control and User Plane separated virtualized Network functions.
  - Cloud-enabled.

- **Cloud-Native EPC**
  - Cloud-Native Microservices Architecture based.
  - Disaggregated stateless virtualized Network functions.
Cisco Ultra
Cloud Native Evolution

- VNFs decomposed as a set of microservices
- A module or a group of modules will form a microservice
- Use off the shelf best of breed Microservices components
- Each Microservice runs on its own VM/Container and is a stateless application
- Decomposed VNF with multiple microservices need to still look like single EPC element
Cisco Ultra Gateway
Cloud Native

- SAEGW-C & SAEGW-U are independent VNFs.
- SAEGW-C & SAEGW-U each will have one or more microservices.
- Off the shelf best of breed Microservices components are used
- SAEGW-U User plane functions with different capabilities can be instantiated
Cisco Policy Platform
First container based Ultra solution => 2017

- Docker micro-services orchestration
- MANO/NFV support on top
- Continuous Integration
- Self healing operations
- Micro-CPS (small footprint)
- Optimized spin-up and upgrades
- Netconf/Yang native integration with orchestration
Cisco Ultra alignment to NFV initiatives

SDN, Controllers
- ONF
- OPEN DAYLIGHT

APIs, Service Chaining
- IETF
- OPEN DAYLIGHT
- OPNFV

Data Models, Config. Management
- OASIS
- OpenConfig
- ONAP
- MANO

Cloud Orchestration
- OpenStack

Data Plane
- DPDK
- Open vSwitch
- OpenDataPlane.org

Infrastructure
- OPNFV
- ETSI
- OCP

End-to-End Reference Architecture for NFV
Agenda

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5G Ready
Bring your own radio

LTE Enabled Technologies

CUPS: Control/User Plane Separation

NB-IOT

5G NSA Option

Network Slicing

Option 3
Control & User Plane Separation Overview

- SAEGW-C + MME scale based on connections memory footprint and signaling processing overhead.
- Single VNF can present smaller number of interfaces to policy systems.
- Data plane function programmed and DC SDN configured.
- Forwarding function handles user plane functions.
Ultra Platform
Remote Network Architecture

Central Data Center

Ultra Services Platform

Management Plane
VM
VM

Control Plane
VM

User Plane
VM
VM
VM
VM
VM

User Plane
VM
VM
VM
VM
VM

Service Component
Service Component
Service Component
Service Component
Service Component
Service Component

Remote Data Center

Remote Data Center
Sx interface

- New protocol **PFCP (Packet Forwarding Control Protocol)**; 3GPP TS 29.244
- Sx Session Establishment Request message is a very rich message that includes a set of Identifiers together with composite Information Elements/Rules such PDR (Packet Detection Rule), FAR (Forwarding Action Rule), URR (Usage Reporting Rule), QER (QoS Enhancement Rule), and BAR (Buffering Action Rule)
CUPS UP Selection

- Static Configuration based. UP associated with IP pool.

- DNS lookup based. This includes Location based lookup. 3GPP compliance.

- Dynamic UP selection based on
  - APN/IMSI/Pool
  - Location (ULI)
  - Load
  - UP Capabilities
  - Slice ID/RAT
  - NSA Capability
Distributed 4G Architecture

Central Data Center
- HSS/SPR
- PCRF
- MME
- SAE-GWc
- S6a
- Gx
- Sp
- S11

Ultra Automation

Remote DC
- SAEGW-U
- IP Services
- S1-MME
- S1-U
- eNB
- eNB
- LTE
- SGI Services/Internet
- VNF-EM
- Remote DC, Different domain
- IoT Services
- VoLTE/IMS
- IP Services

Optimized for user plane
Mobile Edge Computing with CUPS

- A very flat mobile core architecture based on CUPS
  - Internet access is via “Edge UP”
  - IMS and special APNs are accessed via “centralized UP”
  - Edge UP includes services as DPI, ADC, NAT, FW etc.

- Benefits
  - Offloaded traffic can be directed to regional and metro POP
    - Caches for OTT video
    - Low latency apps
  - Offloaded traffic is much simpler to networking as it can be express directed to an Internet POP
Ultra CUPS UP Options

Ultra Automation
- Provisioning
- Lifecycle
- Slice Instantiation
- Service Orchestration
- AutoQA
- AutoSLA

Lifecycle and operation tools

Ultra Centralized Control & Management

Re-purposed ASR5500

Distributed User Plane VMs

UPF Specific VNF-EM

Edge Compute User Plane Micro Services

N:M

1:1
CUPS Redundancy features

ICSR for CP

1:1 Redundancy for UP

N:M Redundancy for UP
3GPP IoT Architecture
Cisco Ultra IoT Core

Ultra Gateway optimized for high density

Ultra Policy for application interworking via API
Cisco eSCEF = SCEF + SCS (OneM2M Gateway)

- Middleware between the network and IoT applications delivering service capabilities and exposing network data to the applications via REST API, based on OneM2M architecture
- Built on CPS/Ultra Policy platform
Data Delivery via API

- 3GPP Non-IP Data Delivery (NIDD) over SCEF: Simple way to transfer small data between Non-IP UE and application, no need for EPC bearer

- Cisco Solution: Adding optional element may allow to normalize data from SGi and make it available via the same APIs as on SCEF.
Enhancements for IoT

• Optimizations / enhancements targeted for efficient support of MTC devices in the network
  ✓ Focus is on congestion prevention/avoidance
  ✓ Support for any 3GPP RAT access for IoT devices (2G/3G/4G/NB-IoT)

• Support for NB-IoT enhancements
  • NAS PDU (Small Data)
  • S11-u to SGW
  • IP / Non-IP data through SGW/PGW
  • NIDD (T6a interface to SCEF)
• eNB shall use different TACs for NB-IoT cell and route NB-IoT request to an MME that support NB-IoT

• DeCOR (Rel-13): subscription based (UE-Usage-Type), MME in one DeCN may redirect to another MME in another DeCN

• eDeCOR (3GPP Rel-14): device assisted, eNB routes UEs to the proper DeCN based on UE indication
5G NSA
(Option 3)
5G Non Stand-alone Option 3 Flavors

**Key idea**
- Traffic split across 4G and 5G happens at eNB
- May be inefficient depending on backhaul architecture (as 5G traffic may need to be sent via S1 and X2 to 5G gNB)

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- Traffic split across 4G and 5G happens at eNB
- May be inefficient depending on backhaul architecture (as 5G traffic may need to be sent via S1 and X2 to 5G gNB)

**Key idea**
- Traffic split across 4G and 5G happens at eNB
- More efficient than Option 3 as less traffic to be sent to the eNB via X2 interface.
## Option 3 Comparison

<table>
<thead>
<tr>
<th>Topics</th>
<th>Options</th>
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<tbody>
<tr>
<td><strong>RAN Impacts</strong></td>
<td><strong>Option 3</strong></td>
</tr>
<tr>
<td>☀️ ☀️ ☀️ Legacy eNB platform needs significant upgrade to process Gbps of data</td>
<td>☀️ Processing of NR data on new platform (gNB)</td>
</tr>
<tr>
<td><strong>X2 load</strong></td>
<td>☀️ Possibly all traffic goes over X2</td>
</tr>
<tr>
<td><strong>Mobility Impacts on Core Network</strong></td>
<td>☀️ None</td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>☀️ Not preferred due to major impacts to legacy eNB platform</td>
</tr>
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</table>

Most operators and RAN vendors prefer Option 3x
## CN Impacts for Option 3x

<table>
<thead>
<tr>
<th>Feature</th>
<th>RAN</th>
<th>MME</th>
<th>HSS</th>
<th>SPG W-C</th>
<th>SPG W-U</th>
<th>PCRF</th>
<th>Interfaces Impacted</th>
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<tbody>
<tr>
<td>1. Subscription Control</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>S6a, S1-MME</td>
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<tr>
<td>2. <em>5G</em> UI Display Control</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>S6a, NAS</td>
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<tr>
<td>3. Dual Connectivity Mobility Support</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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<td>S1-MME (Rel-12)</td>
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<td>4. Max data rate values (Terabit/s)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Gx, Rx, S5, S1-MME, X2, NAS</td>
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<tr>
<td>5. Voice Support</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>6. (Possibly) Security impacts</td>
<td>✓</td>
<td>✓</td>
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<td>NAS, S1-MME, S10</td>
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<tr>
<td>7. S/PGW Selection</td>
<td></td>
<td></td>
<td>✓</td>
<td>*Only for CUPS</td>
<td>✓</td>
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<td>NAS, S11</td>
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<tr>
<td>8. NR Usage reporting/charging</td>
<td>✓</td>
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<td>S1-MME, S11, S5, Rf</td>
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<td>9. Low latency support</td>
<td>✓</td>
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<td>Gx, S5, S1-MME</td>
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4G Core

- HSS
- SPR
- MME
- S/PGW-C
- S/PGW-U
- UE
- E-UTRAN
- S1-MME
- NAS
- S6a
- S1-U
- Gx
- Sx
- Sp
- Rx
- AF
- SCEF
- PCRF
- DNS
- SCEF
- Policy and Charging Rules Function
- SCEF
- Service Capability Exposure Function
- PCRF

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Access and mobility management function (AMF)

- Registration management, access control and mobility management function for all accesses (incl. WLAN)
- Location Services
- SMS transport
- Terminates NAS signaling for all accesses (single AMF per UE)
- Difference compared to EPC
  - AMF = 4G MME – session management
  - AMF provides NAS termination for non-3GPP accesses (e.g. WLAN)
  - AMF receives mobility related policies from PCF (e.g. mobility restrictions)
  - Reporting of events to the PCF that the PCF has subscribed to
  - AMF forwards mobility related policies to the UE (via N1)
Overview

- Common session management for all accesses (incl. WLAN)
- SMF handles all session management signaling with UE (relayed by AMF)
- Configures traffic steering at UPF to route traffic to proper destination
- Charging data collection; Control and coordination of charging data collection at UPF
- Multiple SMFs supported per UE (one per session)
  - Enables different SMFs for different network slices

Difference to 4G

- Control plane parts of SGW and PGW
- Session management from MME collapsed into SMF
- SMF interfaces directly with UDM to receive subscription information (no need to go via AMF)
User plane function (UPF)

Overview
- Anchor point for Intra-/Inter-RAT mobility (when applicable).
- Packet routing & forwarding
- Packet Inspection
- Traffic usage reporting
- QoS handling
- One or multiple chained UP functions can be activated and configured by SMF per session as needed for a scenario

Difference to 4G
- No distinct u-plane entities like SGW-U or P-GW-U anymore
- UPF is essentially a generalized version of the user-plane parts of 4G SGW, PGW and TDF
- Enables flexible chaining and functional combinations of user plane functions e.g. Local hosting of content / local compute (MEC)
Evolution to 5G
Possible way

Virtualize

• Understand how to deploy VNF on NFVI
• Automation and integration tools
• Create new slices

CUPS

• Re-architect the GW
• High speed UP
• Scale the UP and CP independently
• New LCM

2018

5G NSA

• Augment RAN capacity
• Optimize the deployment
• Define new services

2018

5G SA

• Upgrade eNB to NGCN
• Introduce SMF, AMF etc nodes
• New 5G core services
• Cloud native implementation

2019

5G Services

• Introduce low latency services
• Create slice per service
• Address new verticals

2020
Deploy 5G Radio alongside 4G Core

Option 3 - 5G radio is deployed and high BW traffic is passed through optimized user plane

Limited network changes
- Focus on the Radio and Transport changes
- New MME, HSS and policy features
- High Speed connection use case deployments
Deploy 5G Radio alongside 4G Core with CUPS

- Enables selection of S/PGW-U close to RAN
- Can support AR/VR services and provide low-latency service
Upgrade 4G core with 5G capabilities

As standards mature, upgrade SPGW-C with SMF capabilities
SPGW-U upgraded to UPF

SP Operation Considerations:
Quick SW only change
5G production friendly
Test opportunity before 5G radio is ready

PCF + PCRF
SMF + SPGW-C
UPF + SPGW-U
HSS + UDM
MME
LTE NR (Opt. 3)
S1-C S1-U
N7/Gx N4/Sx
X2

Control
Data
4G/5G Interworking

EPC

Non 5G capable devices

PGW
SGW
MME

LTE

NR (Option 3)

4G UE

“Option 3” 5G UE

5G capable devices

PCF + PCRF

SMF + SAEGW-C

UPF + SAEGW-U

HSS + UDM

AMF

NGCN

N11

N15

N2

N3

N26

N7/Gx

N4/Sx

Xn

X2

S1-C

S1-U

S11

N26

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HTTP/2 adopted as the application layer protocol for the service based interfaces with some exceptions;
JSON adopted as the serialization protocol;
REST-style service design whenever possible and custom (RPC-based) methods otherwise.

** New NF with no 4G equivalent functions
Slicing - NSSF
Essential 3GPP Requirements

1. NSSF shall provide a network slice instance selection function for UE.
2. It shall be possible to determine whether to allow the network slice requested by UE.
3. It shall be possible to select an appropriate AMF or candidate AMF set for UE.
4. Based on operator configuration, the NSSF may determine the NRF(s) to be used to select NFs/services within the selected Network Slice instance(s).
4. NSSF and the control plane NE within 5GNC system shall be interworked through SBI.

NSSF is mandatory in 3GPP 5G architecture
Slicing - NRF
Essential 3GPP Requirements

1. NRF shall provide an NF and service discovery function.
2. NRF shall provide an authorization function for NF and service discovery requests.
3. NRF shall be able to save the information on the services supported by each NF and the NF configuration within the 5GNC system and network slice.
4. NRF and the control plane NE within 5GNC system shall be interworked through SBI.
5. NRF shall be able to provide a discovery function for the NFs and services belonging to the entire PLMN, a single network slice, or a network slice set, depending on the system configuration and operator settings.

NRF is mandatory, assuming SBA option implemented
Cisco Ultra Solution
5G NG Mobile Core solution
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Thank you
You’re it