BUILDING AN INFRASTRUCTURE FOR 5G NETWORKS

Service Provider Transformation Journey

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TOPICS

An Infrastructure for the next generation

- **5G Requirements**
  - vRAN
  - Network slicing
  - NG-Core
- **Architecture**
  - Microservices & Application re-factoring
  - Scale & Distribution of Functionality
  - Performance & Latency
  - Availability & Assurance
- **Summary**
Usage Scenarios for 5G

Three Fundamental 5G Use Cases

1. **Enhanced Mobile Broadband**: User Experienced data rate, Peak data rate, Spectral efficiency, Traffic density, Network energy Efficiency, Mobility
2. **Massive Machine Type Communications**: Connection Density, Low Cost, Low Power Consumption
3. **Ultra-reliable and Low Latency Communications**: Latency, Reliability, Mobility

The 5G Use Cases will have differing requirements across various parameters.

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Diagram:

- **Enhanced Mobile Broadband**
  - Gigabytes in a second
  - 3D video, UHD screens
  - Smart Home/Building
  - Voice

- **Future IMT**
  - Work and play in the cloud
  - Augmented reality
  - Industry automation
  - Mission critical application
  - Self Driving Car

- **Massive Machine Type Communications**

- **Ultra-reliable and Low Latency Communications**
Virtualized RAN: Virtualized BBU (LTE/4G), CU/DU (5G)
3GPP CU/DU SPLIT OPTIONS –

“High Layer (latency) Splits” (1-3) [LTE TN: 1.5-10ms OWD]

“Low Layer (latency) Splits” (4-8) [LTE TN: 100us...250us OWD]

Downlink:
- RRC
- PDCP
- High-RLC
- Low-RLC
- High-MAC
- Low-MAC
- High-PHY
- Low-PHY

Uplink:
- RRC
- PDCP
- High-RLC
- Low-RLC
- High-MAC
- Low-MAC
- High-PHY
- Low-PHY

EPC / MEC

Increasing Interface Bandwidth Requirement @split point

Decreasing Real-Time / Latency Constraints

“Traditional” eNodeB (BBU+RH)

Single-Stage BBU split (CPRI to RRH)

Dual-Stage BBU split (≠CPRI)

Baseline BBU-Pool is also like this

“Backhaul” (0)
“Midhaul” (8)
“Fronthaul” (8)
In BBU
In DU
In RRHs
In CU
In DU
In RRHs
In CU
In DU
In RRHs

Always at (R)RH

Hi-Split (2)
Lo-Split (7)
In CU
In DU
In RRHs

In RR(s)
SLICING OF RESOURCE SETS/SUBSETS

From the pool of resources
A slice is a subset of resources at each point of reference

All Edge Cloud and Core Cloud are planned to be implemented by NFV (with SDN control)
Packet Core Evolution

- **Box / Device centric LTE/4G**
- **5G - Cloud Based**
  - **Control Plane - Mobility, Sessions & Service Management**
  - **Localized GW or Central GW Data Plane**
  - **CP-DP Separation**
  - **UPF is controlled by AMF and SMF**
  - **Data plane extensibility**

Additional elements:
- HLR
- HSS
- OCF
- PCR
- eNB
- SGW (CP, DP)
- PGW (CP, DP)
- MME
- 5G RAN
- 4G RAN
- AUSF
- PCF
- AF
- OpenStack
- vBBU
- vMME
- vSGW
- vPGW
- vPCR
- vHSS/HLR
- vCP
- vDP
- CP-DP Separation
- UPF is controlled by AMF and SMF
- Data plane extensibility

Virtualized RAN: Virtualized BBU (LTE/4G), CU/DU (5G)
NG-CORE with UPF and NGWIF, AMF etc
NG-CORE AND CRAN – 5G SUMMARY REQUIREMENTS

• Massive Distribution of sites - Scale
• DU, CU and vBBU – Real time requirements & Container/VM Models
• 5G NG-Core - Separate Control and User Plane allows flexible deployment of functions
  – => Orchestration models needed to place functions - Kubernetes
  – => Granularity functions or services for flexibility – Microservices and re-usability
• Support for Edge computing and efficient UPF re-selection/redirection
  – => Common orchestration of core and other functions
  – => Re-usability of components
• Support Network Slicing based on modular design and multi slice connectivity from UEs
  – => Resource partitioning from edge to core
• Stateless functions – compute decoupled from storage
ARCHITECTURE
“Cloud native computing uses an open source software stack to deploy applications as microservices, packaging each part into its own container, and dynamically orchestrating those containers to optimize resource utilization. Cloud native technologies enable software developers to build great products faster”

WHAT DOES CLOUD-NATIVE MEAN?

- Scale elastically
- Resilient to failures
- Instrumented to provide insights
- Repeatable
- Automated
- Utilize – cloud storage, queuing, caching, messaging etc

https://www.cncf.io/
CLOUD NATIVE COMPONENTS & COMMON MICROSERVICES

Service Specific Microservices
(e.g., building blocks of AMF, SMF, UPF, etc.)

Data Center IP Network

- **Acuitas EMS**
- **Licensing**
- **REST**
- **Oper Dispatch**
- **Sentinel CLOUD**
- **Security**
- **RFC 6749**
- **Cloud VNF Manager**
- **openstack**
- **kubernetes**
- **etcd**
- **In-Memory Replication**
- **mongoDB**
- **In-Memory / Durable**
- **CONSUL Service Registry**
- **docker REGISTRY**
- **Logging**
- **Fault Mgmt**
- **Performance**
- **NETCONF CLI, REST**
- **Prometheus**
- **fluuentd**
- **Oper & Config. Mgr**
- **ACU!TA&H!T&N S!R!V!C!ES**
- **Network & Routing Common Microservices**
- **Protocol Handling & Load Balancing Common Microservices**

- **INTERNET**
- **IPX/GRX**
- **Access**

**Courtesy : Affirmed Networks**
SCALE TO EDGE
- MASSIVE DISTRIBUTION OF FUNCTIONALITY

Placement of functionality at Edge
- Requires orchestration of multiple location
- Global view for placement of workloads
- KPI Monitoring
- SDN Control

Automation : Key to Scale
PERFORMANCE & LATENCY

• Performance
  – Higher density of functions – more data throughput per sector/per site (Small 100 cell sectors and Large 1500 cell sectors BBU pool) => 15 Servers to 1K Servers
  – 40Gbps or even 100Gbps throughput
  – Current pps throughput requires allocation of core almost 4 cores per 10G
  – Smart NIC or FPGA based data plane acceleration (OpenStack Cybrg Project)

• Real Time
  – 1ms delay budget at the DU node
  – Packet traversal from NIC to VM/App/code/decode function and back
  – RT-Linux and RT-KVM requirements

• Timing Synchronization and redistribution
  – PTP
  – SynchE

• Platform/OS must support the above
AVAILABILITY & ASSURANCE

• Cloud Native design
  – Applications – live and die on demand – elastic models
  – Applications (including AMF, SMF) can auto scale
• Load balancers for distribution of traffic
• Use Service chaining to stitch micro services together
• Evacuation of Nodes for workload movement, upgrades and serviceability
• Assurance – Monitoring and Management of Infra and applications
Cloud Native Platform for 5G Infra

5G Platform

- Discovery
- Logging
- Monitoring
- Authentication
- Build, Deployment Pipeline
- Container Mgmt.
- Resilience
- Tracing
- Messaging / IPC
- Invocation
- Load Balancing, Scaling / Elasticity

PaaS (cloud-based)

Edge Compute

Application lifecycle management

Mobile
SUMMARY

Create an open platform that evolves to accommodate change

- Build a platform that evolves – No rip and replace strategy
- Leverage your existing investment
- Freeze an architectural model for trials
  - Run containers where you can and use an IaaS/OpenStack for Infra management
  - Hybrid Workloads
- Drive VNF change to cloud native – Push vendors for cloud native VNFs for 5G
  - Leverage Hardware offload for performance improvements further
THANK YOU