Second Workshop of India-EU Collaboration on Standardization for Select Technologies [5G,NFV/SDN and ITS]

Performance Benchmarking Framework Standardization of VNF (vEPC) workload

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Outline

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Introduction

Challenges in implementing VNF

Identifying bottlenecks

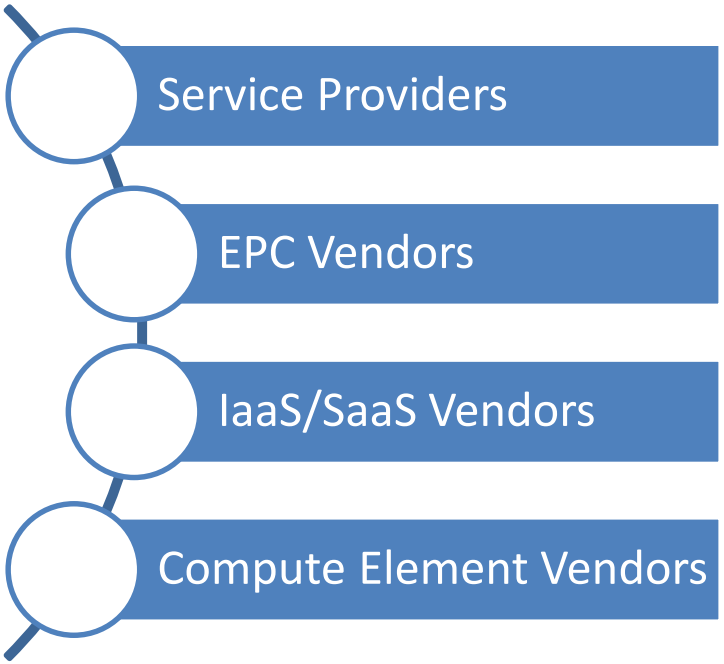
Existing Standards

Addressing the Gaps

Introduction

- Network function virtualization (NFV) promises
  - Significant cost savings
  - Flexibility and
  - Ease of deployment

- Multiple Stakeholders in the Telecom Ecosystem involved in the implementation of NFV



Challenges and Opportunity

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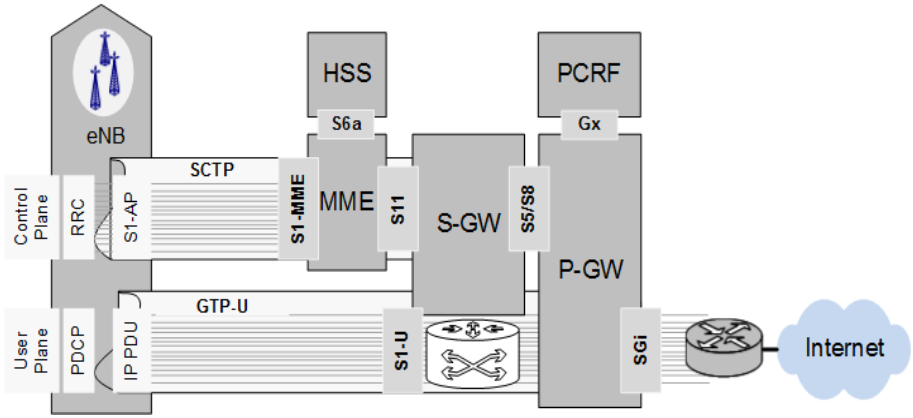
- Challenges
  - Significant challenges in implementing virtualized network elements: e.g. cellular packet core (EPC) supporting real-world performance requirements with efficient resource and power use
  - Porting software from its proprietary platform to a generic hardware platform loses the benefits of specialized hardware and performs poorly
- Compared to traditional networks
  - Tightly coupled control- and data/user planes in cellular networks
  - It is important to understand interdependency in order to design and allocate resources optimally to user and control plane elements
  - In contrast the demand for control and data capacity is fairly independent in data centric world.

Identifying Bottlenecks[1]



Traditional cellular EPC with logical interfaces

Network Load Dimension	Stress Vector	System Impact	Relationships
Control Plane	SCTP terminations	Total number of eNBs supported	↑ SCTP ≅ ↑ UE ≅ ↑ GTP-U
	NAS event rate	Aggregate UE & applications signaling	↑ NAS rate (Nps) ≅ Machine to Machine (IoT), VoLTE applications
User Plane	GTP-U terminations	Total number of supported bearers	↑ GTP-U ≅ ↑ UE or ↑ bearers/UE
	Packet Rate (Pkt_Rate)	Traffic throughput	Gbps= Pkt_Rate (Mpps) x Av. Pkt Size (Bytes)

Cellular workload dimensions & stress vectors

- The **number of SCTP terminations** on the MME and the **event arrival rate** in terms of NAS procedures per second are the two key parameters for Control plane dimensioning.
- The **number of GTP-U tunnels** terminating on the SGW from the attached UEs and the **packet arrival rate** across these tunnels are the two key parameters for User plane dimensioning
- The **capacity of an EPC** system is the **aggregate** of the User Plane **packet arrival rate** across all the GTP-U tunnels it can sustain and a Control plane **event arrival rate** from the connected eNBs
- The current EPC architecture does not scale independently across User and Control planes
- Control plane events are transactional while User plane packets are atomic (packet forwarding)

[1]**Understanding Bottlenecks in Virtualizing Cellular Core Network Functions;** IEEE LANMAN 2015 (*Best Paper Award*)
Ashok Sunder Rajan*, Sameh Gobriel*, Christian Maciocco*, Kannan Babu Ramia*, Sachin Kapur†, Ajaypal Singh†, Jeffrey Erman‡, Vijay Gopalakrishnan‡ and Rittwik Jana‡
*Intel Labs, †Brocade, ‡AT&T Labs

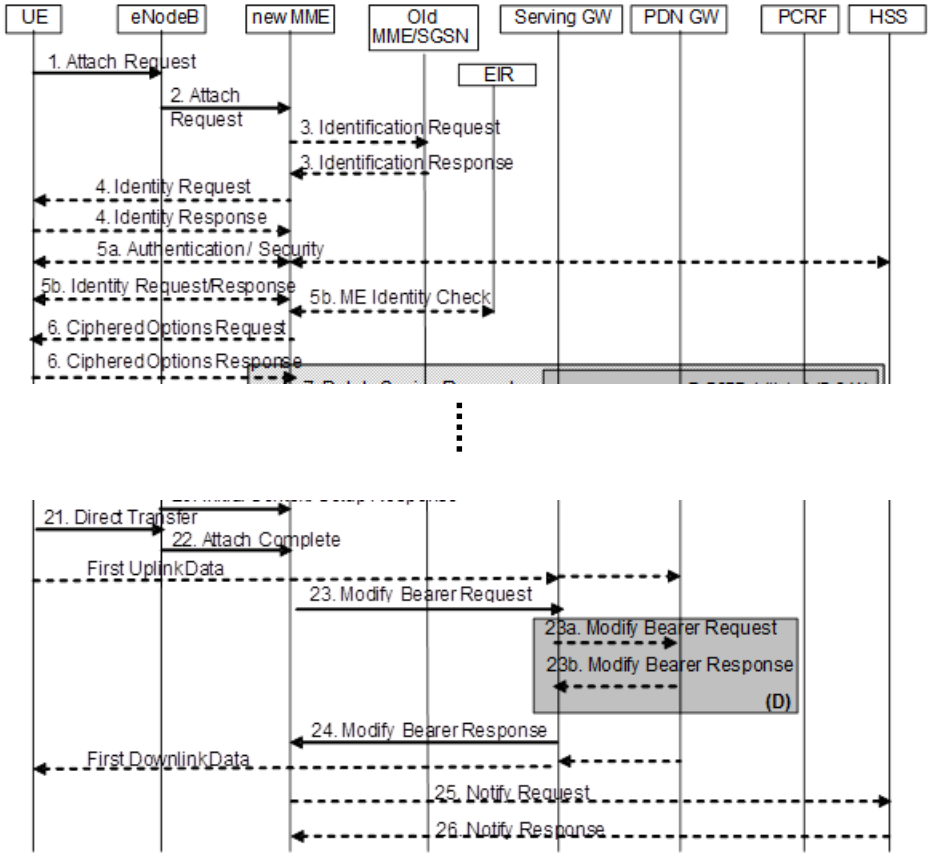
Example: 3GPP Attach Procedure; TS 23.401[2]

- Attach NAS event, EPC Transactions

  MME: 10 HSS: 2

  S-GW: 3 P-GW: 2

  PCRF: 1



- For attach success, dependent transactions also required to be successful

[2]3GPP TS 23.401: General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN), online http://www.3gpp.org/DynaReport/23401.htm

Identifying Bottlenecks

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Transactions per Control Plane (NAS) event by EPC Element

Event Type	MME	HSS	S-GW	P-GW	PCRF
Attaches	10	2	3	2	1
Add. Default Bearer Setups	4	0	3	2	1
Dedicated Bearer Setups	2	0	2	2	1
Idle-to-Connected	3	0	1	0	0
Connected-to-Idle	3	0	1	0	0
X2-based Handovers	2	0	1	0	0
S1-based Handovers	8	0	3	0	0
Tracking Area Updates	2	0	0	0	0
Total	34	2	14	6	3

- 14 of the 34 NAS (41%) events arriving at the MME are also handled by the SGW
- Only 6 of these 34 NAS (18%) events are incident on the PGW, confirming the **SGW is in the critical path** of control plane signaling and user plane packet processing.
- Accounting for only transaction intensive events (e.g. 'Attach' and 'S1-based handover'): 33% of the MME load is also handled by the SGW.

Identifying Bottlenecks: Problems and Key Takeaways

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- Serving Gateway (SGW) is the critical bottleneck between Control and User planes
- 33% of Control plane events arriving at the MME is also incident on the SGW
- Control plane signaling driven by triggers while user plane processes packets in real time

Existing Standards

- ETSI NFV Industry Specification Group[3]

- GS NFV-INF 001 NFV; Infrastructure Overview
- GS NFV-INF 004 NFV; Infrastructure; Hypervisor Domain
- GS NFV-REL 001 NFV; Resiliency Requirements
- GS NFV 002 NFV; Architectural Framework
- GS NFV 003 NFV; Terminology for Main Concepts in NFV
- GS NFV-INF 003 NFV; Infrastructure; Compute Domain
- GS NFV-INF 005 NFV; Infrastructure; Network Domain
- GS NFV-INF 010 NFV; Service Quality Metrics
- GS NFV-MAN 001 NFV; Management and Orchestration
- GS NFV-SWA 001 NFV; Virtual Network Functions Architecture
- GS NFV-SEC 003 NFV; NFV Security; Security and Trust Guidance
- GS NFV-PER 001 NFV; NFV Performance & Portability Best Practises
- GS NFV-PER 002 NFV; Proofs of Concept; Framework
- GS NFV-INF 007 NFV; Infrastructure; Methodology to describe Interfaces and Abstractions
- GS NFV-SEC 001 NFV; NFV Security; Problem Statement
- GS NFV 001 NFV; Use Cases

- 3GPP TS 32.455[4] provides the definitions of Key Performance Indicators (KPI) for Evolved Packet Core (EPC).

- These KPIs are classified into the following categories
  - ◊ Accessibility KPI (Section 5.1 of 32.455)
  - ◊ Mobility KPI (Section 5.2 of 32.455)
  - ◊ Utilization KPI (Section 5.3 of 32.455)

[3]ETSI, Network Function Virtualization, Technology Cluster, online http://www.etsi.org/technologies-clusters/technologies/nfv

[4]3GPP TS 32.455: Telecommunication Management; Key Performance Indicators (KPI) for the Evolved Packet Core (EPC); Definitions, online http://www.3gpp.org/DynaReport/32455.htm

Gap in Standards

- Consider 3GPP KPI: EPS Attach Success Ratio[4]

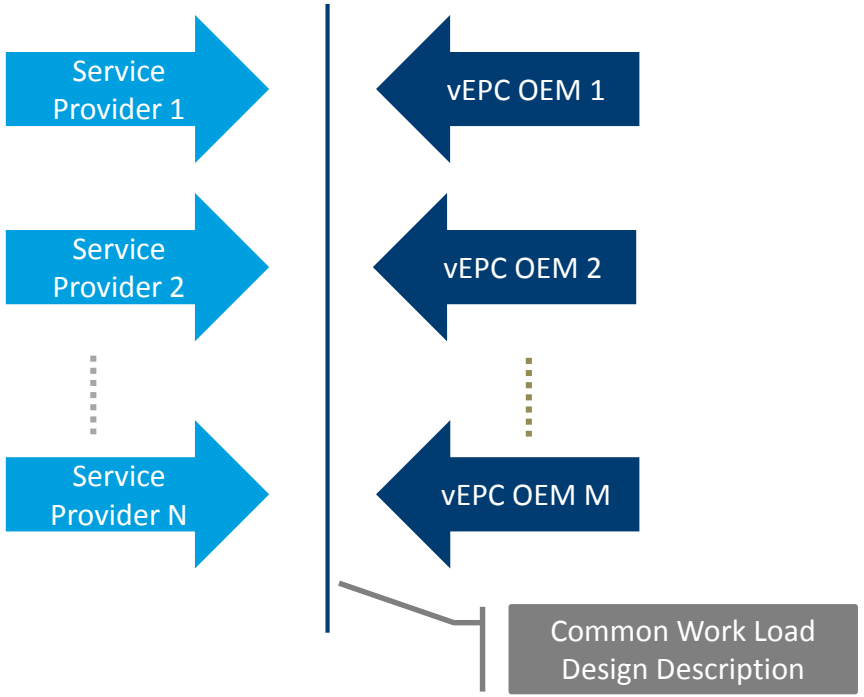
$$\mathrm{EASR} = \frac{\sum_{\mathrm{Type}} \mathrm{MM.\,EpsAttachSucc.\,Type}}{\sum_{\mathrm{Type}} \mathrm{MM.\,EpsAttachAtt.\,Type}} * 100\%$$

Note:
The following are defined in 3GPP TS 32.426
MM.EpsAttachAtt.*Type*
MM.EpsAttachSucc.*Type*

- ◊ Evaluating the EPS Attach Success Ratio KPI in isolation does not provide the complete picture
- ◊ S11 bottlenecks for a LTE Packet core identified
- ◊ Need to have common stress vectors, input definition under which the VNF is tested.

Addressing the Gap

- Common Workload Description
  - Market design parameters
  - Call flow models
  - Traffic models



Conclusion

- NFV an active area of research and standardization
- Better understanding of performance benchmarking of virtualized EPC required
- Need to have common stress vectors, input definition under which the VNF is tested

CN WG Update

- Tracking well for Generate TRs before year end..
  - Wireless Core Network; Technical Report on Work Load Design for NFV performance evaluation
  - Gap Analysis for Centralized Management of Large Scale WLAN Networks

- Following SWIPs are approved to be part of sections of TRs
  - **D01**: TSDSI-SG1-WI1-[SI6]-V1.0.0-20150814
  - **D02**: TSDSI-SG1-WI1-[SI6]-V1.0.0-20150814
  - **D03**: TSDSI-SG1-WI1-[SI6]-V1.0.0-20150814
  - **D04:** TSDSI-SG1-WI1-[SI17]-V1.0.0-20150928
  - **D05:** TSDSI-SG1-WI1-[SI17]-V1.0.0-20150928

References

[1] Understanding Bottlenecks in Virtualizing Cellular Core Network Functions, Ashok Sunder Rajan∗, Sameh Gobriel∗, Christian Maciocco∗, Kannan Babu Ramia∗, Sachin Kapur†, Ajaypal Singh†, Jeffrey Erman‡, Vijay Gopalakrishnan‡ and Rittwik Jana‡, ∗Intel Labs, †Brocade, ‡AT&T Labs,
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THANK YOU

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