A Virtual SDN-enabled LTE EPC Architecture: a case study for S-/P-Gateways functions

15. November 2013
Treffen der VDE/ITG-Fachgruppe 5.2.4

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Future network requirements?

Requirements towards the network constantly change

Unpredictable data growth
- Drivers:
  - 3D & HD video
  - Video integrated everywhere
  - Connected objects

Drastic reduction of TCO per GB needed

Impact to retention
- Internet quality

Network experience becomes a revenue driver

Faster innovation cycles for topline growth

Source: Marco Hoffmann, NSN
Why change the current EPC architecture?

- Current EPC built out of monolithic entities on dedicated hardware
- Inflexible and lacks dynamic deployment
- Induces high cost to setup and maintain
How to change EPC architecture?

Automated platform for network functions in software

Network abstraction and flexible dynamic programmability

Cloud Computing

Software Defined Networks

Network Functions Virtualisation

Enabler for cost, energy consumption and space reduction by sharing, isolating and splitting of network functions [1]

What do NFV and SDN bring to the mobile core?

**NFV** → Availability of *incremental functionality additions* to the network

**SDN** → More flexibility *in network management* and control

**NFV + SDN** → More *elasticity* in adding or removing services

**NFV + SDN** → Optimizing network configuration and topology

- Potential to reduce *time to market*
- Potential for reducing *energy consumption*
- Potential for a reduced capex and opex *cost*
EPC potential for virtualization?

- Migration to the operator’s cloud can start with control-plane EPC nodes such as MME, HSS, PCRF, etc...

- Focus of our study is the data-plane coupled EPC nodes: S-GW and P-GW
What are the study steps?

1. Decompose S-GW/P-GW functions
2. SDN (OpenFlow 1.3) realization of derived functions
3. Deployment architectures: decomposed functions between cloud and transport network
S-GW / P-GW ANALYSIS
S-GW and P-GW Analysis

- The roles of the S-GW and P-GW were observed in fundamental 3GPP standard scenarios such as UE attach/detach, handover, TA update, etc..
OPENFLOW REALIZATION OF DERIVED FUNCTIONS
• **Control-related** functions can be integrated in an SDN controller

• **Forwarding rules** and **data forwarding** are fundamental functions of a basic OF switch

• **Packet filters** (*P-GW*) can be provided based on the IP-five tuple [2] starting from OF 1.0

• **Charging** (*P-GW*) and **GTP header matching** (*S-GW and P-GW*) still need further evaluation

Charging (Offline and Online) Frameworks

- **Controller** collect offline CDRs based on **OF stats**
- Optimize OF stats to match different **charging models**

**a) Offline charging**

- **OF Switch** keeps no data flow state
- **No charging events** possible on switch
- **Controller** keeps track of charging events and **update rules** accordingly
GTP Matching Frameworks

a) Controller handling GTP matching

b) Middlebox handling GTP matching

c) NE+ with customized HW

d) NE+ with SW platform
DECOMPOSED FUNCTIONS
DEPLOYMENT ARCHITECTURES
Functions deployment possibilities?

1) Full Cloud Migration

- **noticeable cost savings**
- **control-plane** scalability
- **standard** OF switch

- **limited** by cloud domain
- **all data traffic** to cloud
- **SDN** is not fully exploited
Functions deployment possibilities?

2) Control-plane Cloud Migration

+ **control-plane** scalability

+ **data-plane** scalability

+ **on-demand** data plane

  – enhanced OF switch

  – data overhead between cloud and transport

  – cost savings are reduced
Functions deployment possibilities?

3) Signaling control Cloud Migration

+ **less** configuration delay
+ **less** data overhead
+ more **resilient** to cloud outages

– cloud migration is **minimal**
– **global network view** is not available anymore
4) Scenario based Cloud Migration

+ possible **offloading** of certain EPC operations or service types

+ **highest** scalability and flexibility

- state **sync** overhead

- **orchestration** between functions is needed

- **additional** cost induced
Conclusion

Study goals?

- **EPC analysis**: decompose S-GW and P-GW functions
- **SDN capabilities** to achieve the EPC functionalities
- Alternative solutions to **enhance OF** network elements:
  - a) Controller-based processing
  - b) Middlebox-based processing
  - c) NE+ with HW customized functions
  - d) NE+ with a programmable SW extension
- **Deployment possibilities** of the EPC nodes and functionalities
  - Four alternative deployment architectures, between cloud and transport network
  - Each architecture has its own advantages and limitations
Outlook

• **Performance evaluation** and trade-offs:

  **current EPC architecture** Vs **virtual SDN-enabled architectures**

  • Cost evaluation
  • Exchanged data overhead
  • Observed additional delays

Optimal functions’ splitting solution considering performance

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Performance evaluation and trade-offs:

- **current EPC architecture**
- **virtual SDN-enabled architectures**

- Cost evaluation
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Optimal functions’ splitting solution considering performance
Thank you for your attention

Questions?