

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

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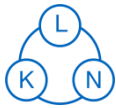


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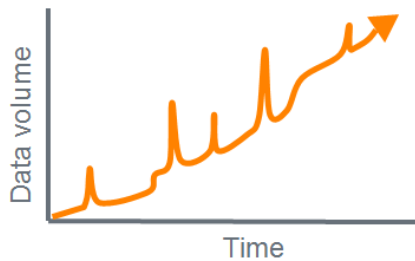
# Future network requirements?



## Requirements towards the network constantly change



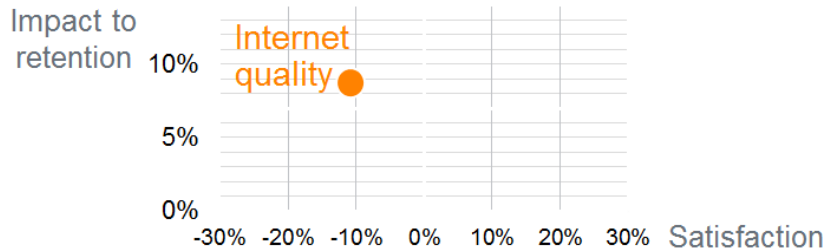
### Unpredictable data growth



Drivers:

- 3D & HD video
- Video integrated everywhere
- Connected objects

### Drastic reduction of TCO per GB needed



Network experience becomes a revenue driver

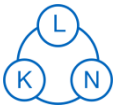
### Time from code to production launch

- Telco approach months
- Cloud approach minutes

-> OTTs expect higher agility

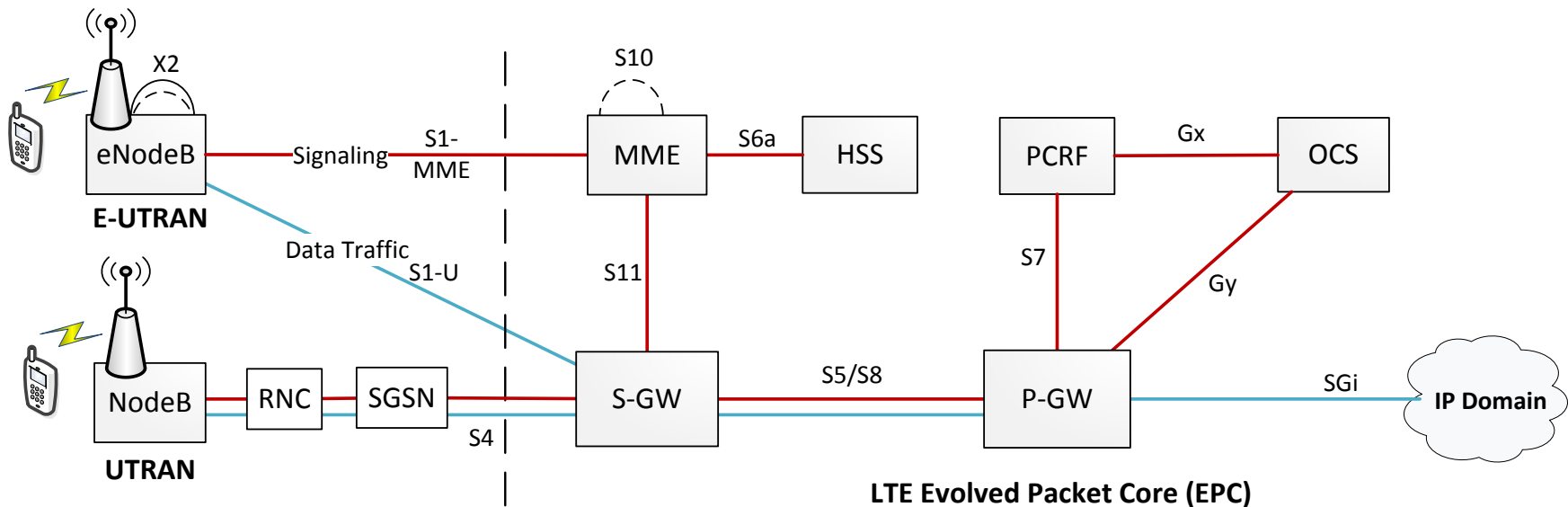
Faster innovation cycles for topline growth



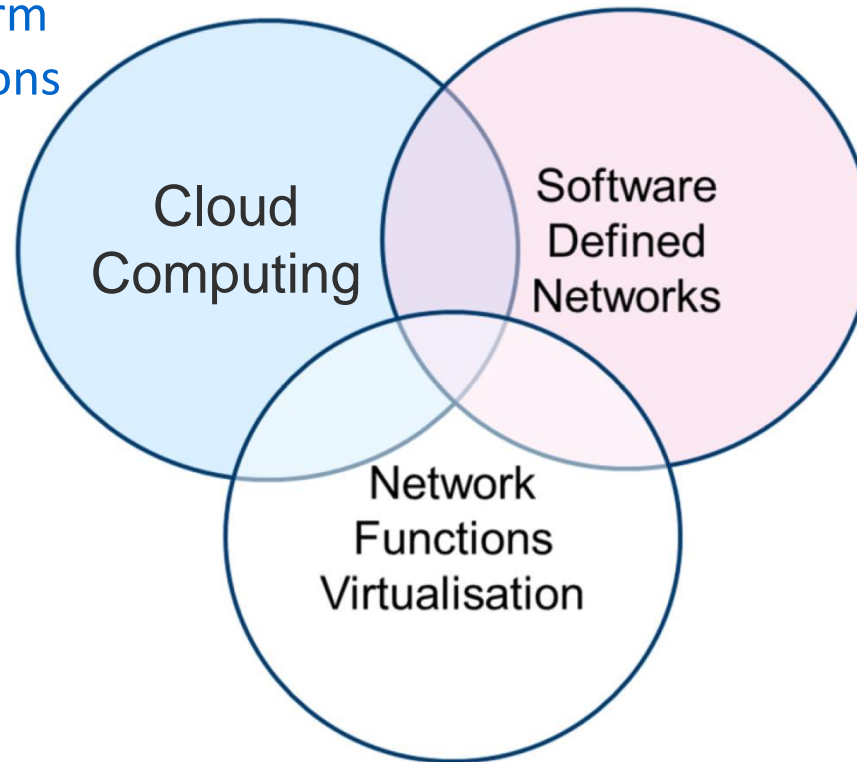


# Why change the current EPC architecture?

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

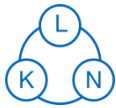


Automated platform  
for network functions  
in software



Network abstraction  
and flexible dynamic  
programmability

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

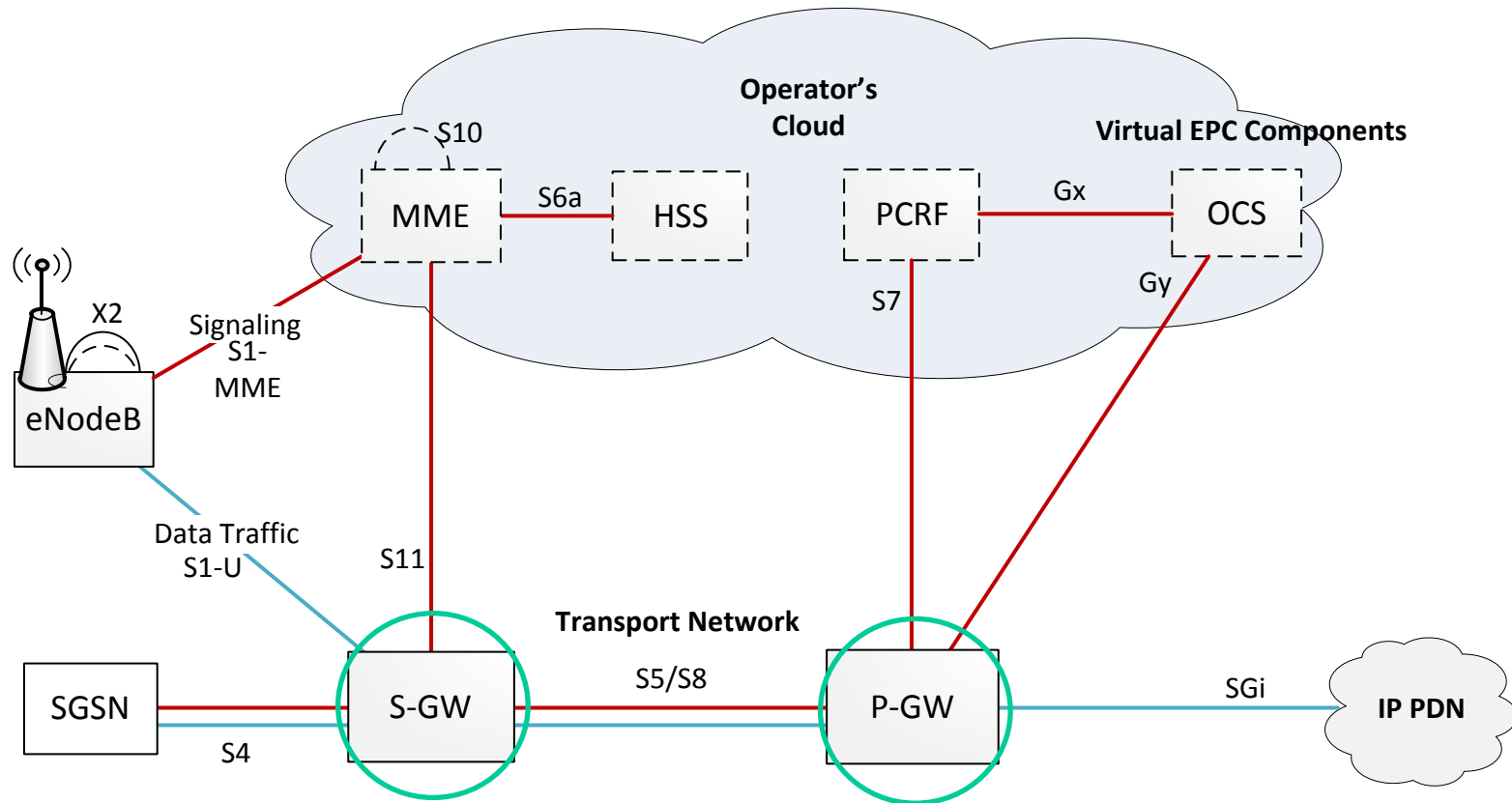
**NFV + SDN** ⇒ **Optimizing** network configuration and topology



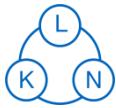
- Potential to reduce **time to market**
- Potential for reducing **energy consumption**
- Potential for a reduced capex and opex **cost**



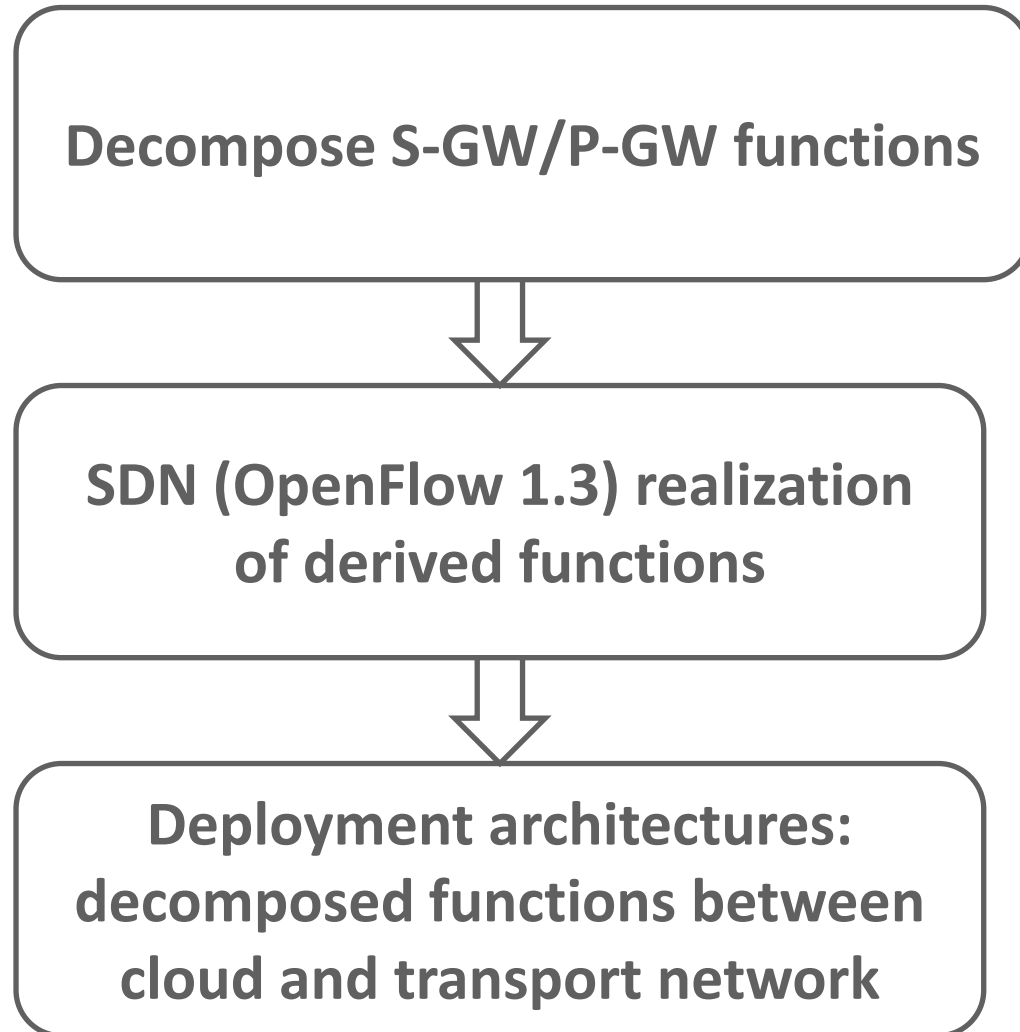
- Migration to the operator's cloud can start with control-plane EPC nodes such as MME, HSS, PCRF, etc...

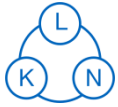


- Focus of our study is the data-plane coupled EPC nodes: S-GW and P-GW



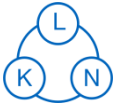
# What are the study steps?





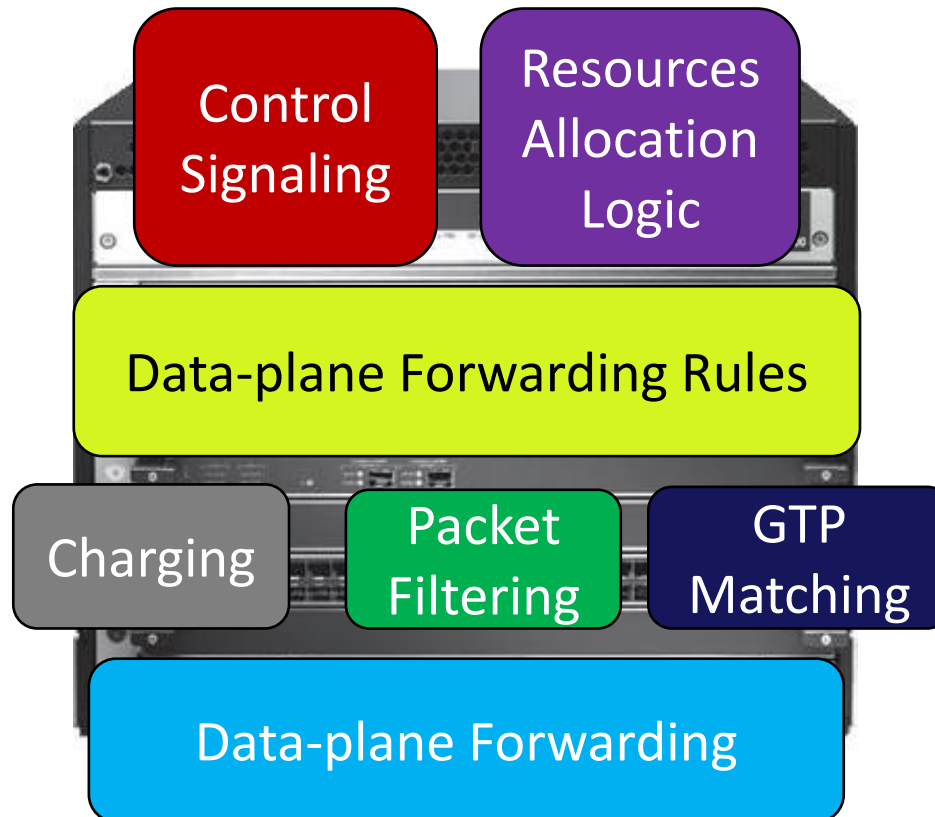
# S-GW / P-GW ANALYSIS

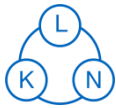




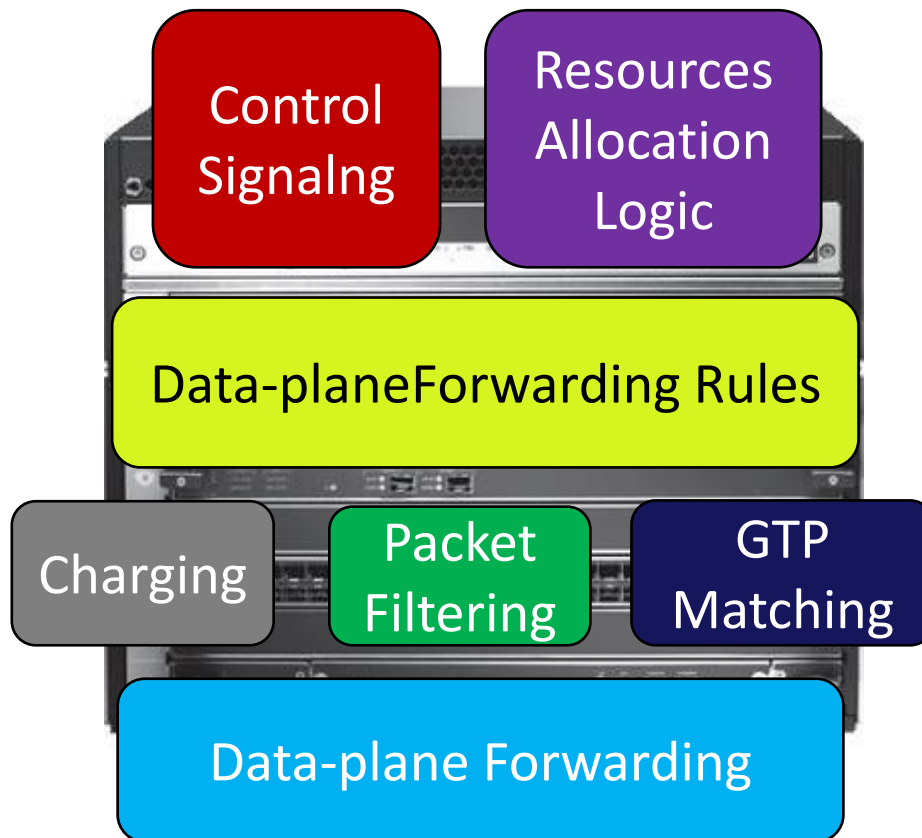
# S-GW and P-GW Analysis

- 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 ..

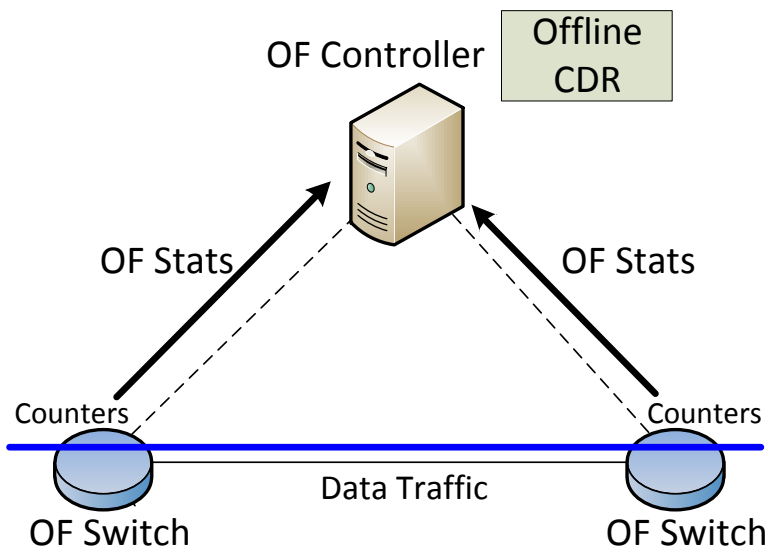




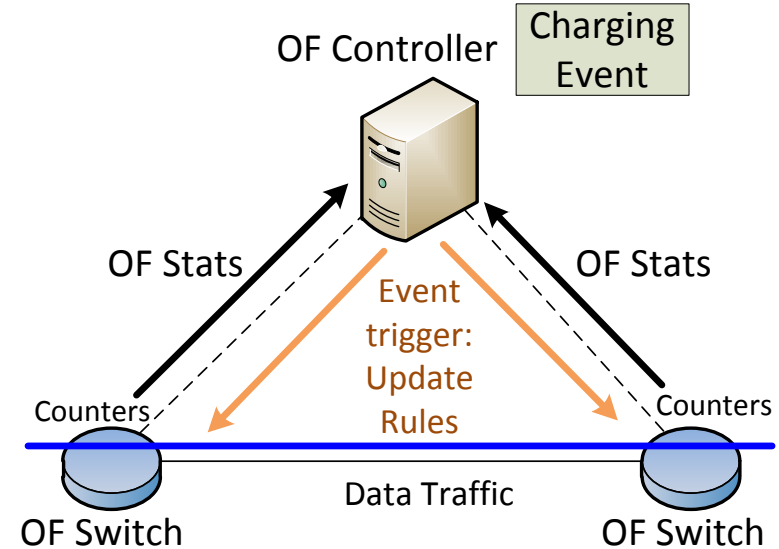
# OPENFLOW REALIZATION OF DERIVED FUNCTIONS



- **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

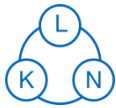


a) Offline charging

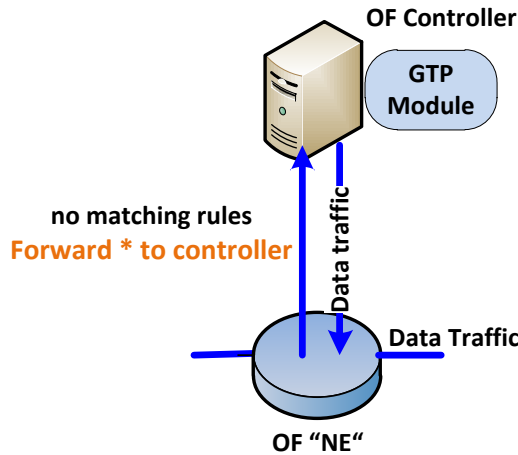


b) Online charging

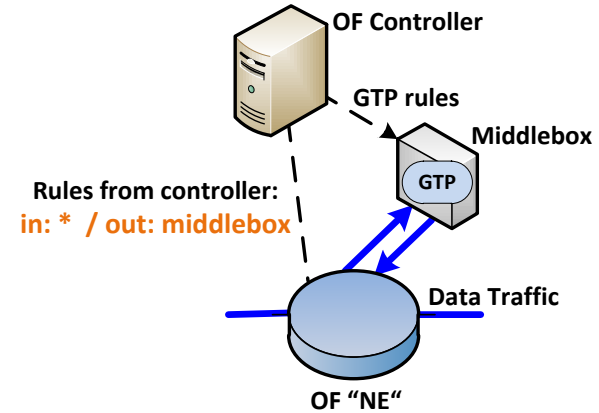
- **Controller** collect offline CDRs based on **OF stats**
- Optimize OF stats to match different **charging models**
- Of switch keeps **no data flow state**
- **No charging events** possible on switch
- **Controller** keeps track of charging events and **update rules** accordingly



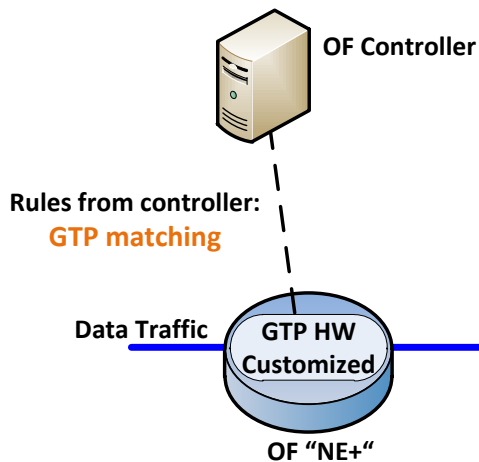
# GTP Matching Frameworks



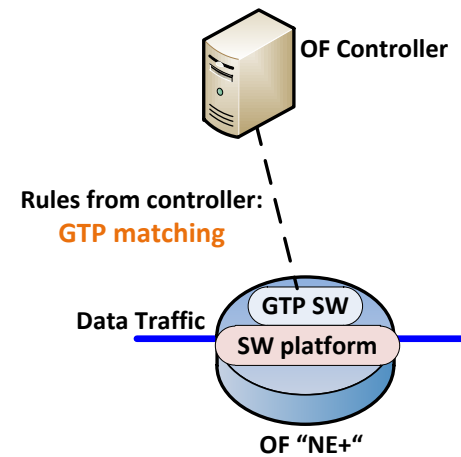
a) Controller handling GTP matching



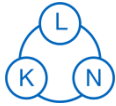
b) Middlebox handling GTP matching



c) NE+ with customized HW

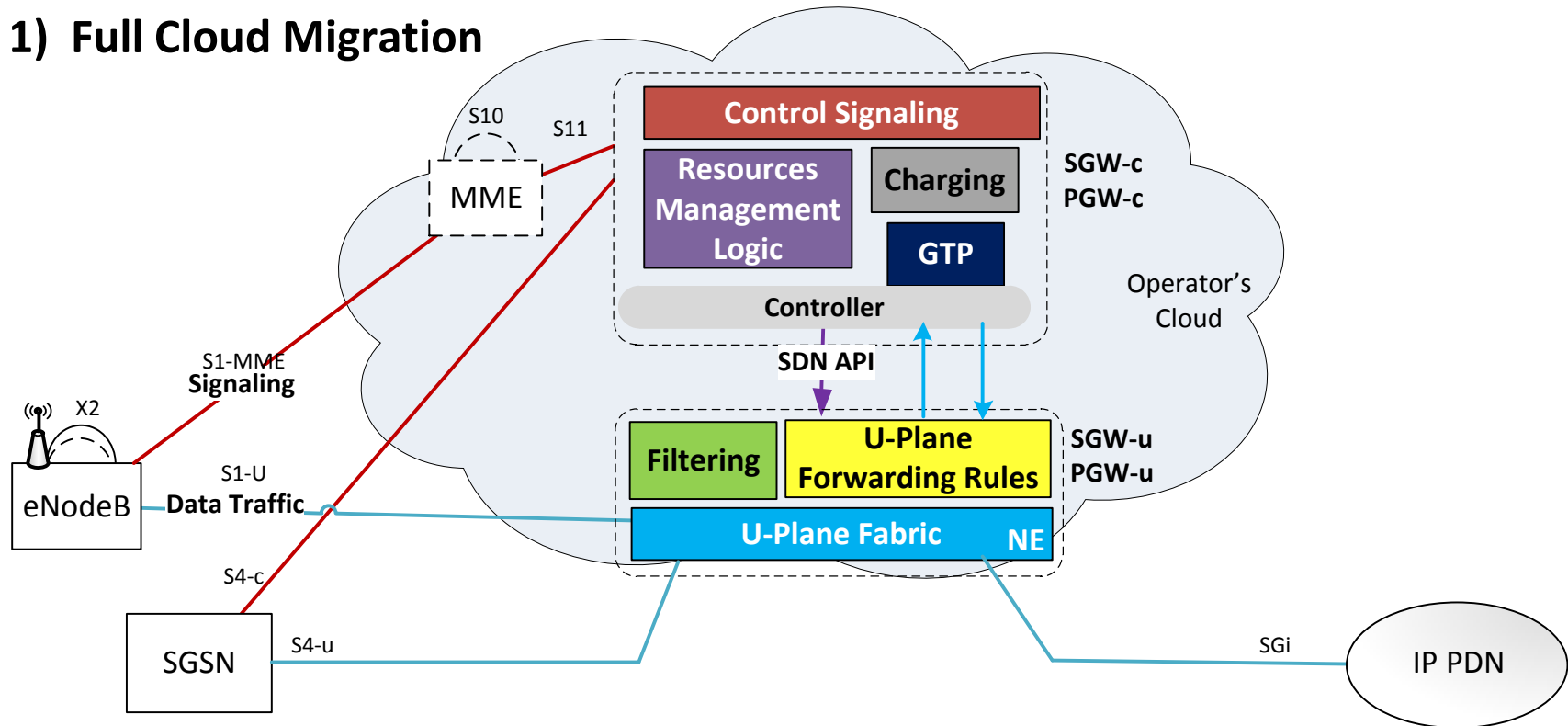


d) NE+ with SW platform



# DECOMPOSED FUNCTIONS DEPLOYMENT ARCHITECTURES

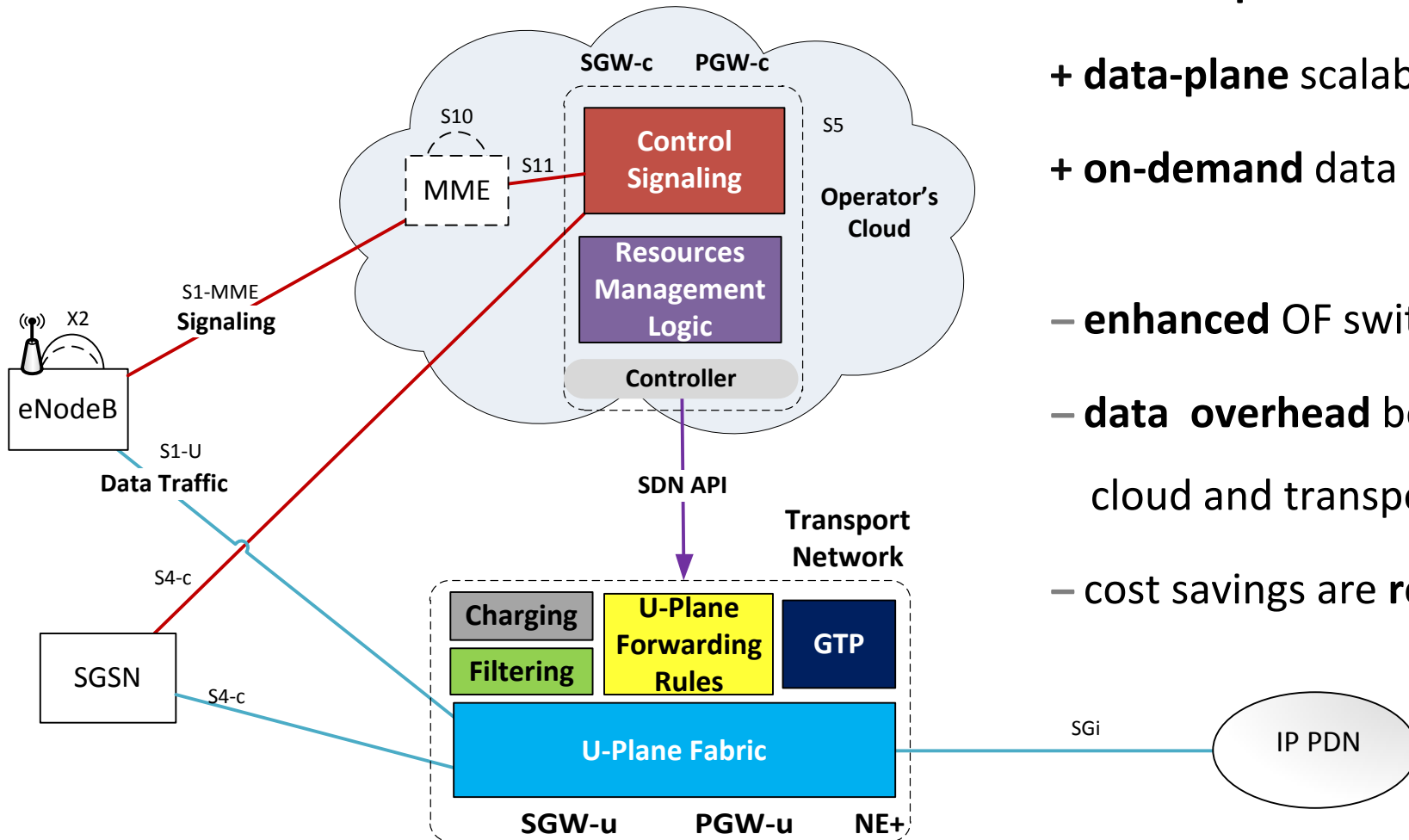
## 1) Full Cloud Migration



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

- **limited** by cloud domain
- all **data traffic** to cloud
- **SDN** is not fully exploited

## 2) Control-plane Cloud Migration



+ control-plane scalability

+ data-plane scalability

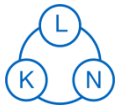
+ on-demand data plane

– enhanced OF switch

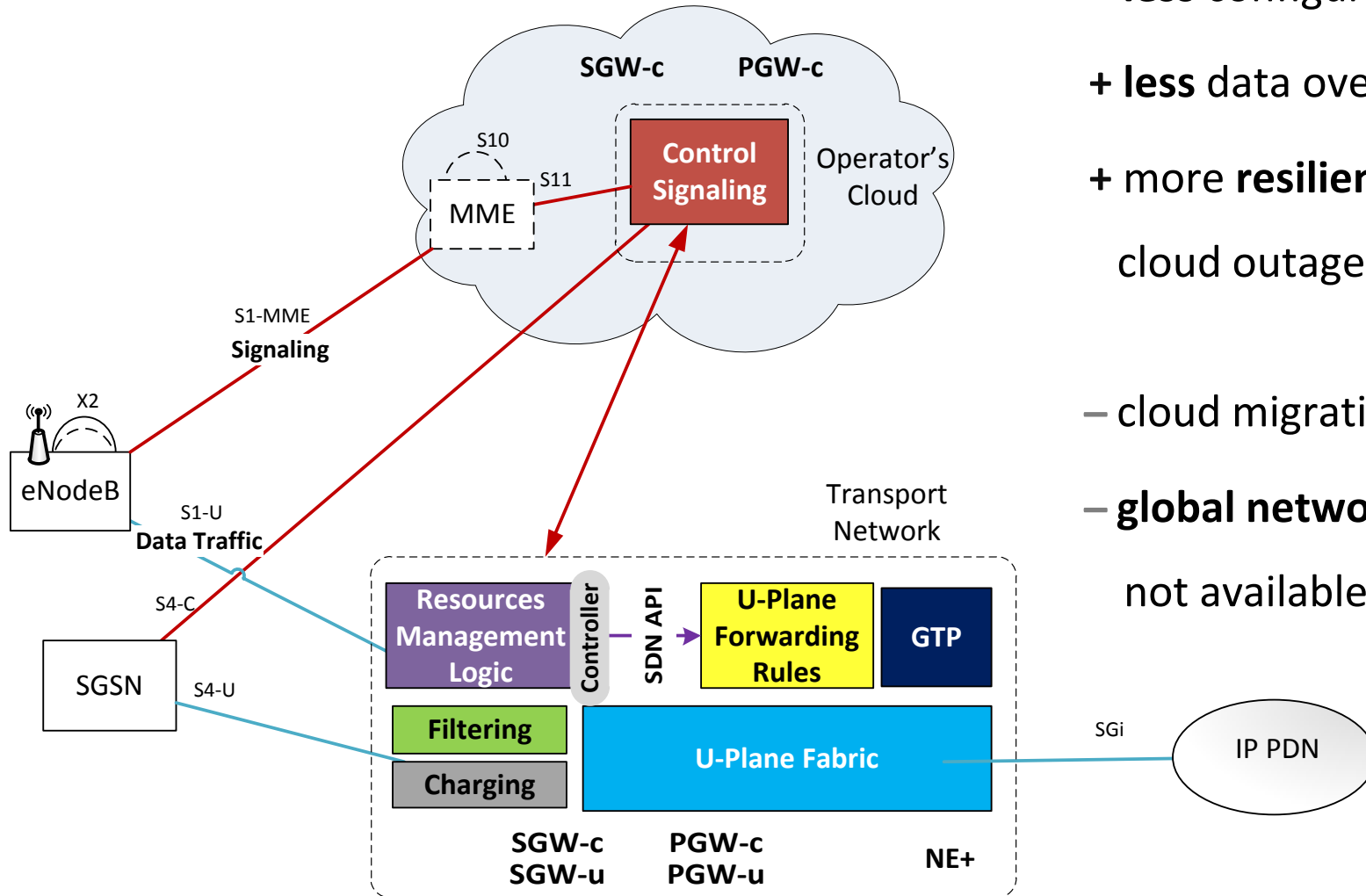
– data overhead between cloud and transport

– cost savings are **reduced**





## 3) Signaling control Cloud Migration



+ less configuration delay

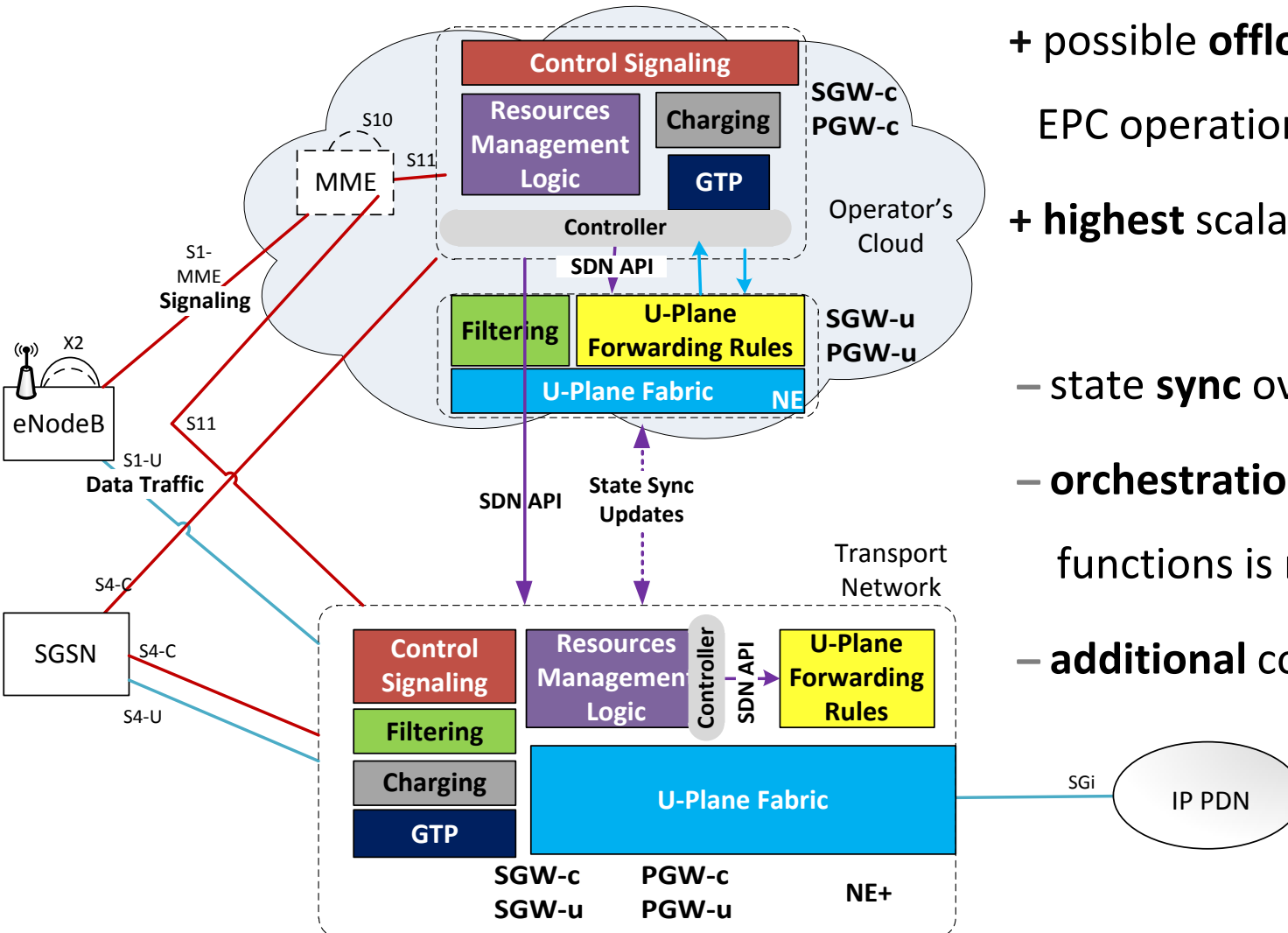
+ less data overhead

+ more **resilient** to cloud outages

- cloud migration is **minimal**

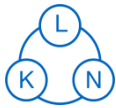
- **global network view** is not available anymore

## 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



## 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

- Performance evaluation and trade-offs:

**current EPC architecture**

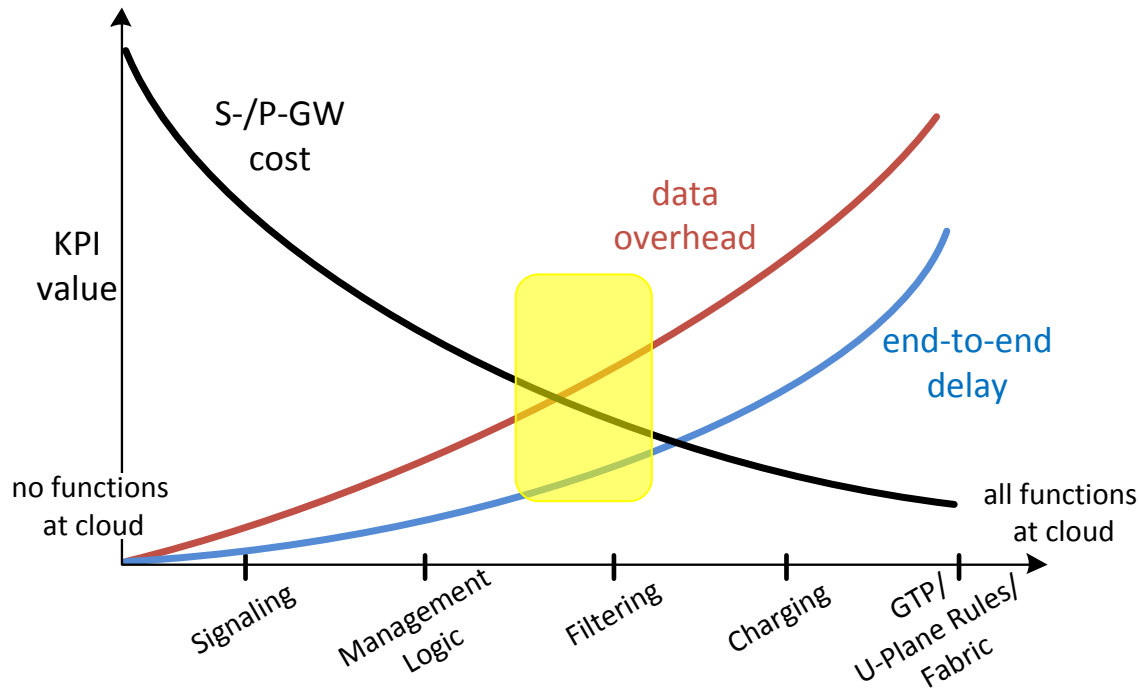
Vs

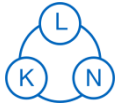
**virtual SDN-enabled architectures**

- Cost evaluation
- Exchanged data overhead
- Observed additional delays



Optimal functions' splitting solution  
considering performance





Thank you for your attention

Questions?

A.Basta, W. Kellerer, M. Hoffmann, K. Hoffmann, E.D. Schmidt, "A Virtual SDN-enabled LTE EPC: Architecture: a case study for S-/P-gateways functions", IEEE SDN4FNS, Trento, 2013