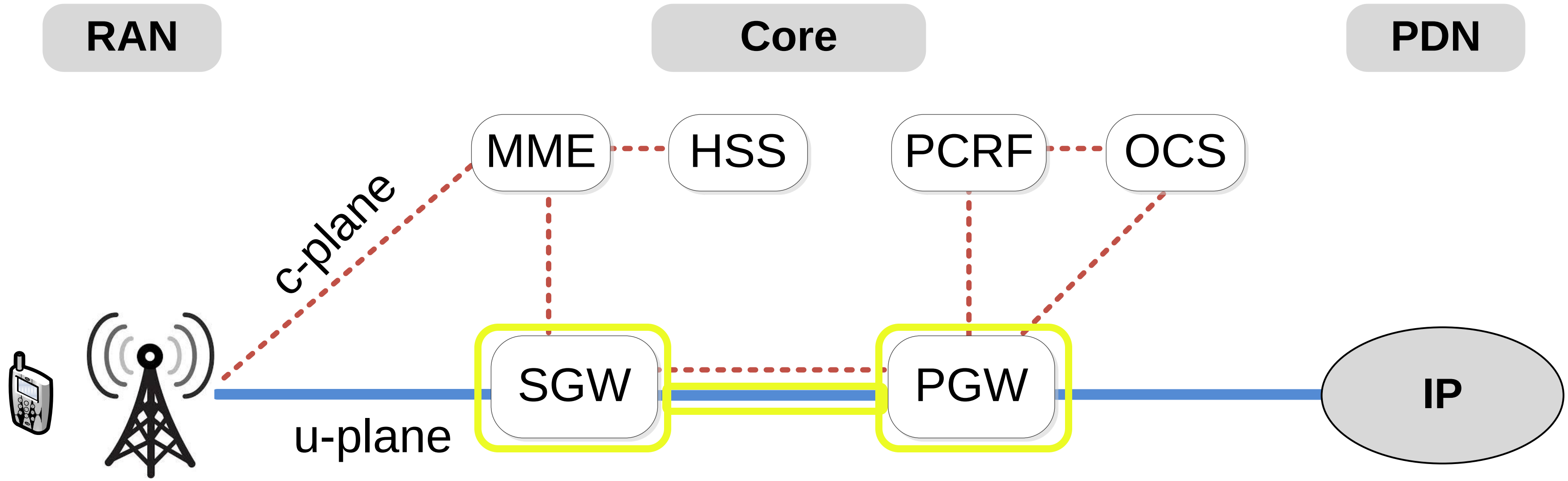
Applying NFV and SDN to LTE Mobile Core Gateways
The Functions Placement Problem

Arsany Basta[1], Wolfgang Kellerer[1],
Marco Hoffmann[2], Hans Jochen Morper[2], Klaus Hoffmann[2]

[1] Technische Universität München, Germany
[2] Nokia Solutions and Networks, Munich, Germany

Mobile core potential for NFV and SDN?

- First migration steps? focus?



High volume data traffic

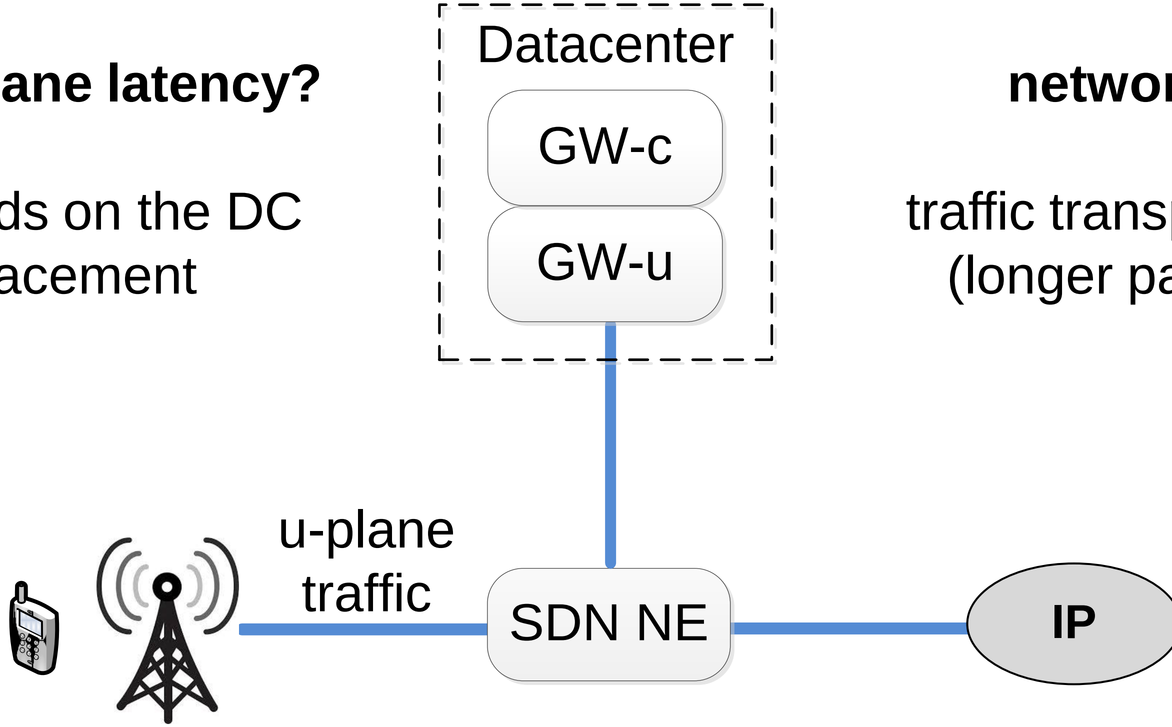
High speed packet processing

How to re-design the core gateways?

- NFV → virtualized GW functions [1]

data-plane latency?

depends on the DC placement



network load?

traffic transported to DC (longer path → cost)

Virtualized GW

[1] A. Basta et al., A Virtual SDN-enabled EPC Architecture : a case study for S-/P-Gateways functions, SDN4FNS 2013.

How to re-design the core gateways?

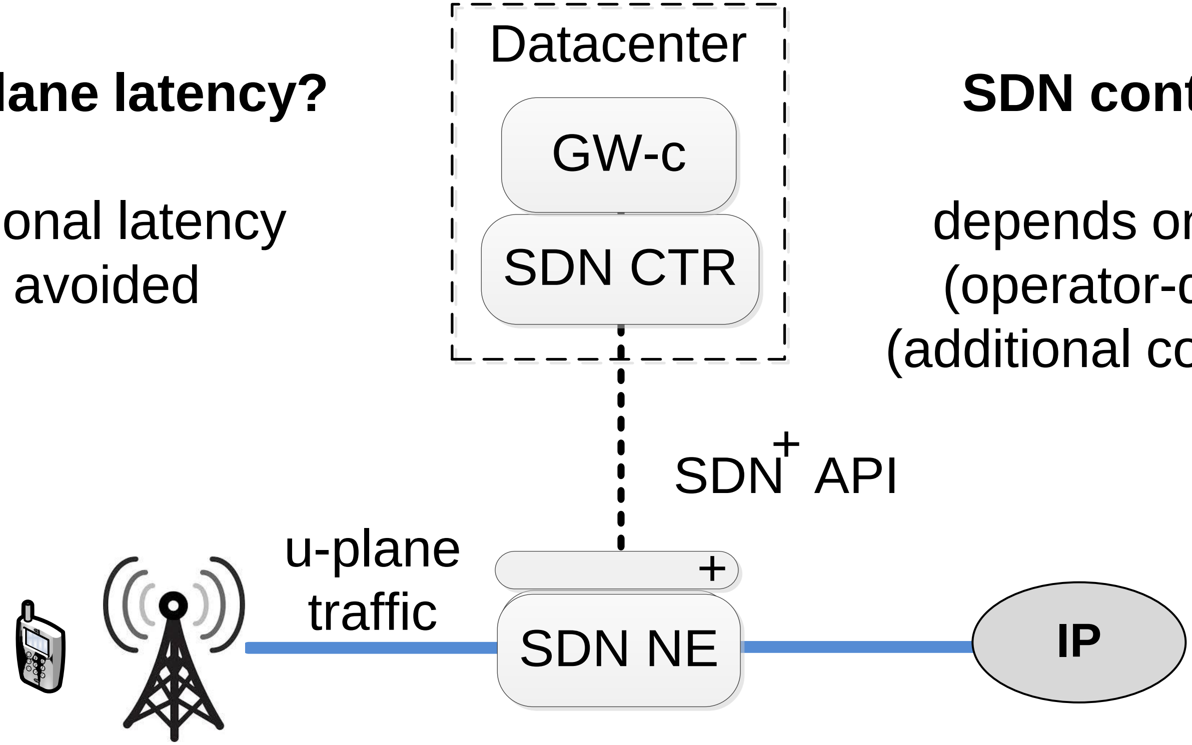
- SDN → decomposed GW functions [1]

data-plane latency?

additional latency
is avoided

SDN control load?

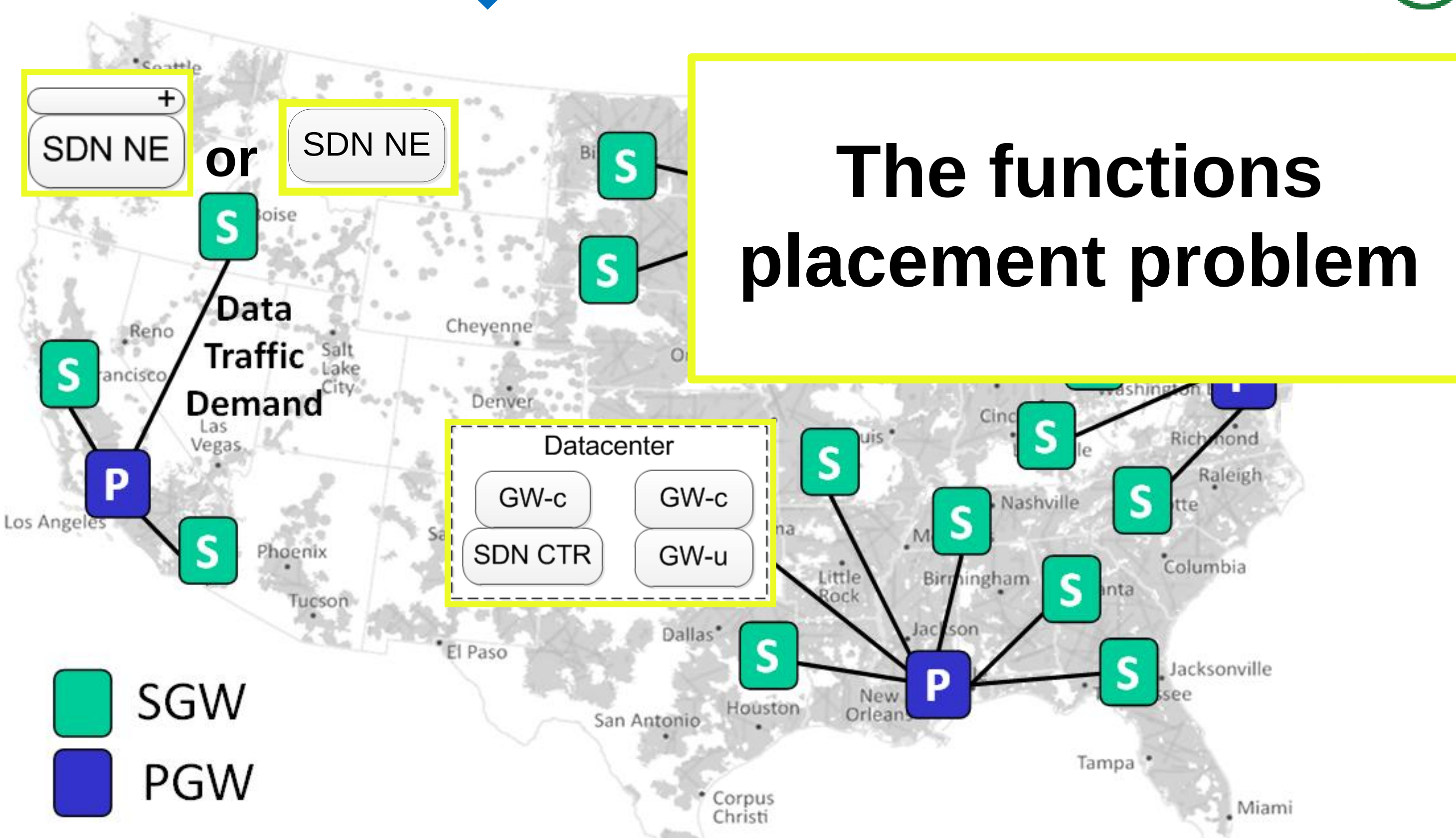
depends on SDN^+ API
(operator-dependent)
(additional control → cost)



Decomposed GW

Study Goal

- Virtualize all GWs? decompose all? mixed deployment?
- Which GWs should be virtualized? decomposed? DC(s) placement?
  - minimize core load $
  - satisfy data-plane latency



The functions placement problem

LTE Coverage Map Source (*not including gateways). http://www.mosaik.com/marketing/cellmaps/

Core Data-plane Latency

$= \text{processing}_{SGW} + \text{propagation}_{SGW-PGW} + \text{processing}_{PGW}$

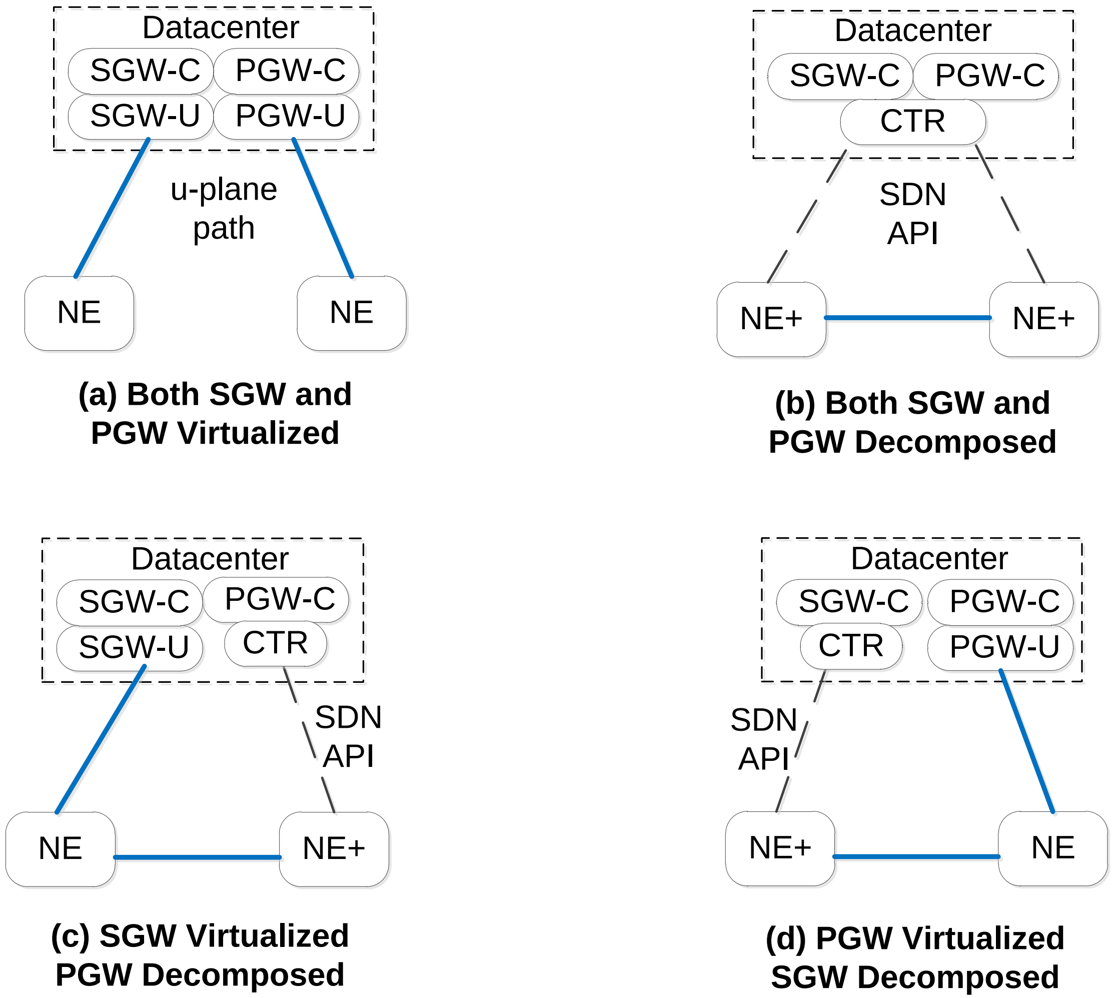
- Mean packet processing latency (95% conf):
  - not considering the initial signaling latency

no. of tunnels	10	100	1 K	10 K
bit/sec	1 Mbps	10 Mbps	100 Mbps	1 Gbps
pckt/sec	83	830	8.3 K	83 K
Virtualized GW T_{proc}	62 µs	83 µs	109 µs	132 µs
Decomposed GW T_{proc}	15 µs	15 µs	15 µs	15 µs

Processing latency has **less** impact on core data-plane latency!

Core Data-plane Latency

- Propagation latency depends on path SGW - PGW:



(a) Both SGW and PGW Virtualized

(b) Both SGW and PGW Decomposed

(c) SGW Virtualized PGW Decomposed

(d) PGW Virtualized SGW Decomposed

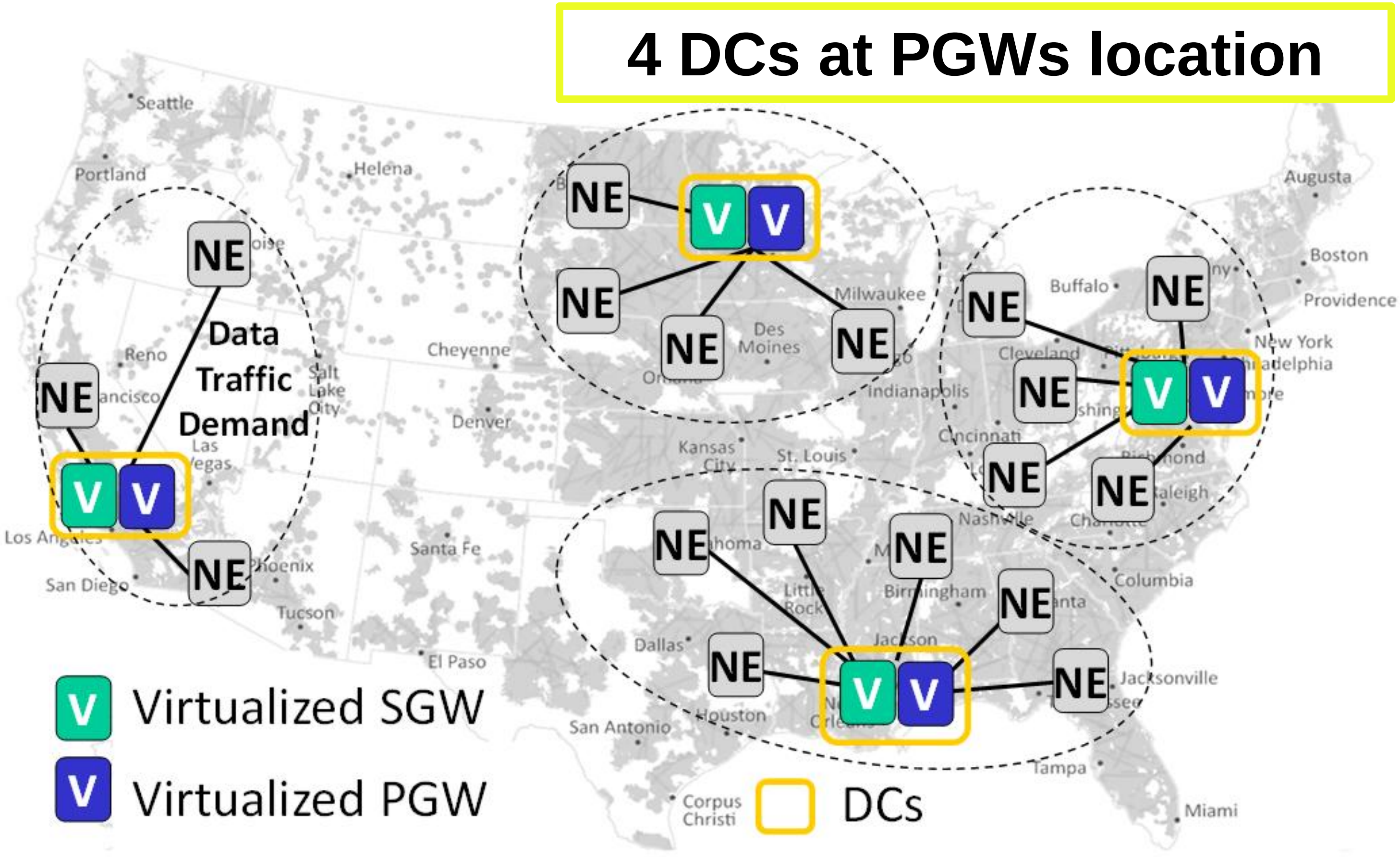
Model and Evaluation Parameters

- Problem formulated as a MILP
- Load = $\sum_l capacity_l * length_l \quad \forall l \in mobile\ core\ links$
- Presumed US topology
- First migration steps → DC(s) co-located with GWs
- Traffic demands are assumed to be uniform
  - Time-varying traffic, check our extended work in [2]
- SDN control load as % of data-plane load

[2] A. Basta et al., SDN and NFV Dynamic Operation of LTE EPC Gateways for Time-varying Traffic Patterns, (accepted for publication) MONAMI 2014.

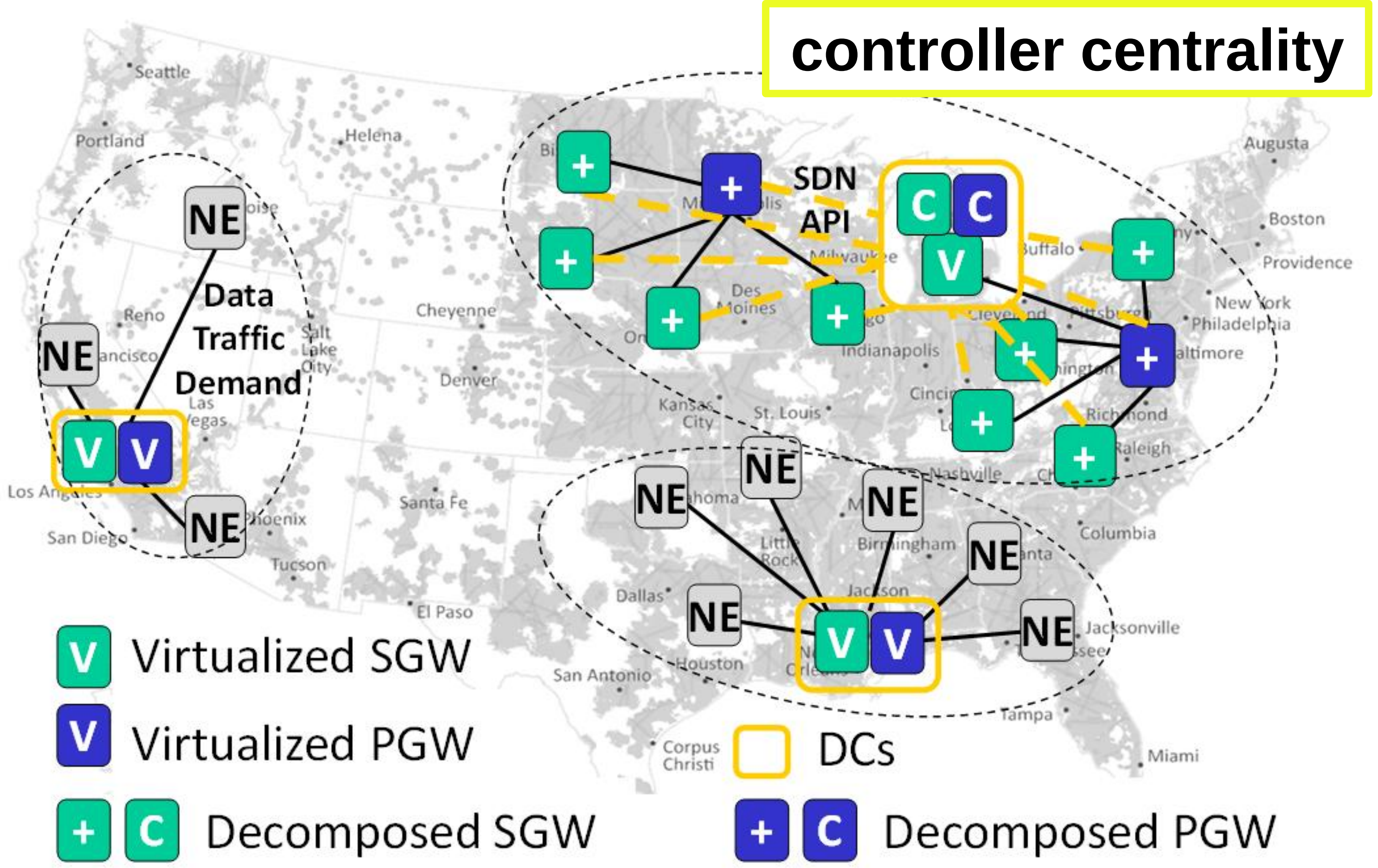
Evaluation

- How many DCs needed to virtualize all GWs?
  - keep data-plane budget: 5.3 ms



Evaluation

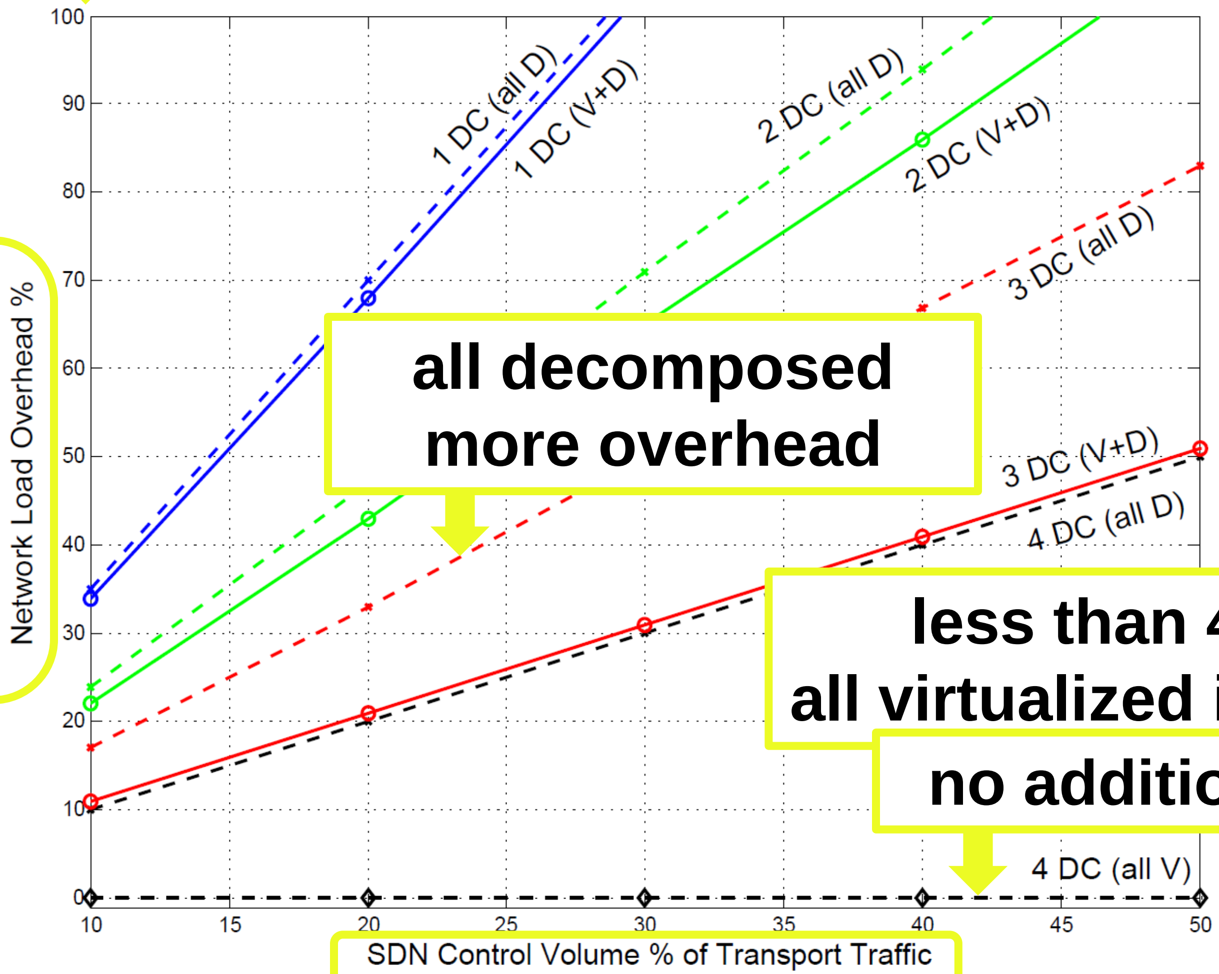
- If less DCs are available?
  - example placement with 3 DCs and SDN load = 10% data-plane load



Evaluation

- Network load?

load overhead vs no. of DCs?
Operator's decision! → Tool!



normalized by original load in the topology

all decomposed more overhead

less than 4 DCs all virtualized infeasible

no additional load

Further Evaluation in Paper

- DC placement, no. of available DCs = 1, …, 4
- The number of required NE and NE+ in each case
- Delay budget relaxation to 10 ms

Summary

- Virtualized + decomposed GWs result in **least load overhead**
- Virtualizing all GWs may not be possible due to **data-plane latency** budget, depending on no. of DCs
- Decomposing all GWs adds **additional load** on the network, depending on the SDN control load
- **Operators now have a tool!**

Next steps

- Integrate other core **components** → start with MME
- Consider **control-plane latency** in the tool → initial attach
- **Traffic patterns** influence on the placement
- Other **objectives** → e.g. minimize data-plane latency (5G)
- Other **constraints** → e.g. datacenter capacity

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Thank you for your attention!

Questions?