



# Simulation of a Honeycomb Network

The goal is to simulate the new network topology and to reach a precise view on various questions for the customer, like lean router configurations for the new network topologies, optimal distribution of caching systems and peering points and their service areas and how cost savings can be reached.



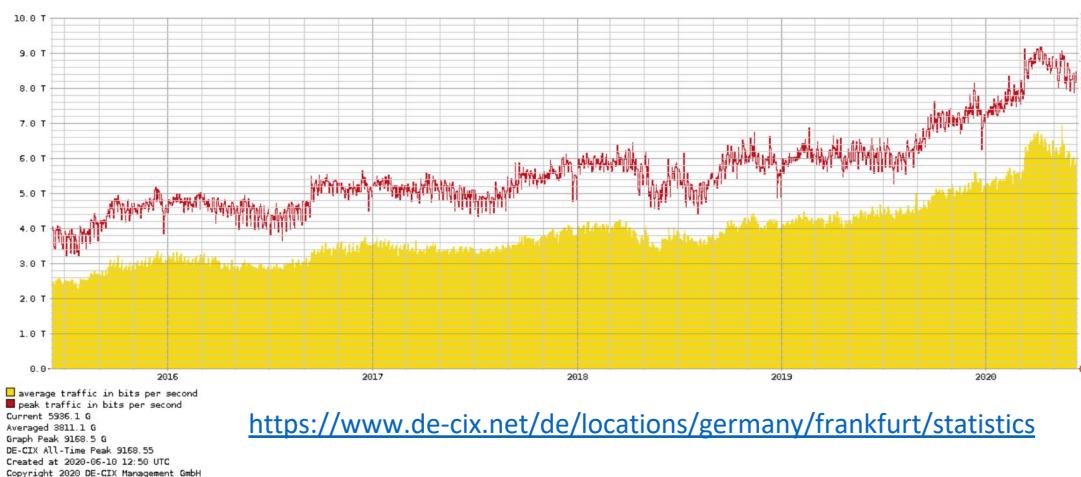
# The challenge...

The **continuously** growth in data traffic is a real challenge for operators. Several services adding traffic to the operator's networks

- streaming services like Netflix, Amazon and Google including YouTube
- video conferencing like Teams, WebEx or Skype
- online gaming platforms
- social networks.

Expectation is that some services will exponentially develop. Keep in mind, 95% of the German population is connected to the internet.

5-year graph



On top, web giants like Amazon and Google showing it is possible to save OPEX and CAPEX using Web Scale Technologies to deliver services, content and traffic.

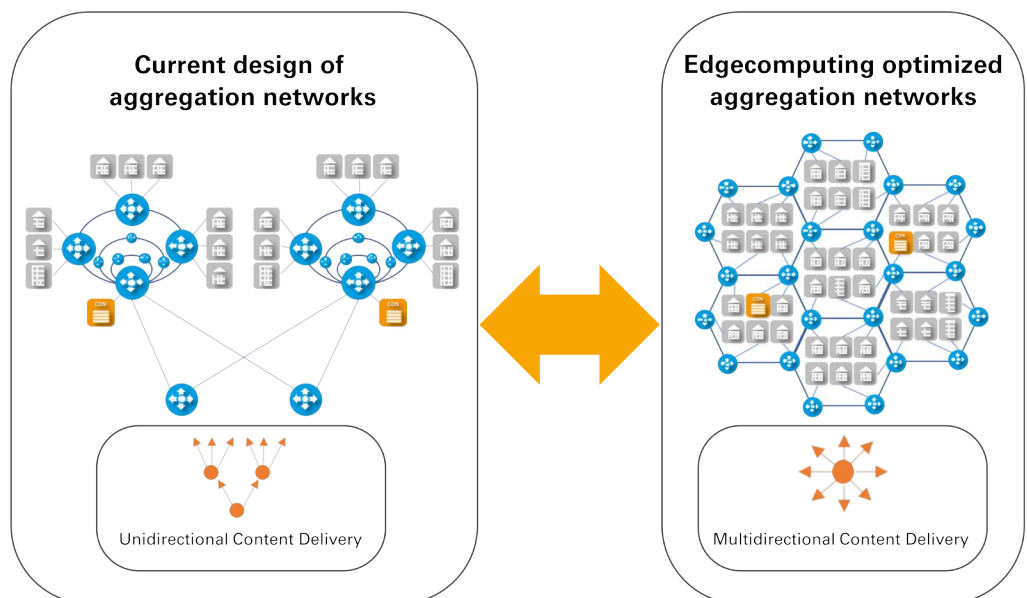
Operators must reconsider **new network topologies**, **disaggregated infrastructure** and **smarter locations of caching systems** to win the battle.

However **changes** of this **significance** comprise risks which might **lead** to **additional spending**.

# The idea - simulation of the network.

## Requirements for the simulation

- Flexibility in simulating different network topologies
- Easy definition and configuration of traffic scenarios with different cache locations, varying service areas and traffic streams
- Usage of real router configurations including the real routing protocols, MPLS, BGP, etc.
- Flexible distribution of the data sources
- Graphical representation of network utilization
- Graphical representation of the paths through the network
- Simulation of failure scenarios - at least node failure, link failure and data source failures - including the representation of how traffic flows and traffic loads change in the network
- Usage of virtual routers e.g. Juniper vMX as substitute for real MX960
- Flexible and automated configuration incl. Segment Routing, MP-BGP peering and MPLS forwarding
- Flexible traffic models 1:x

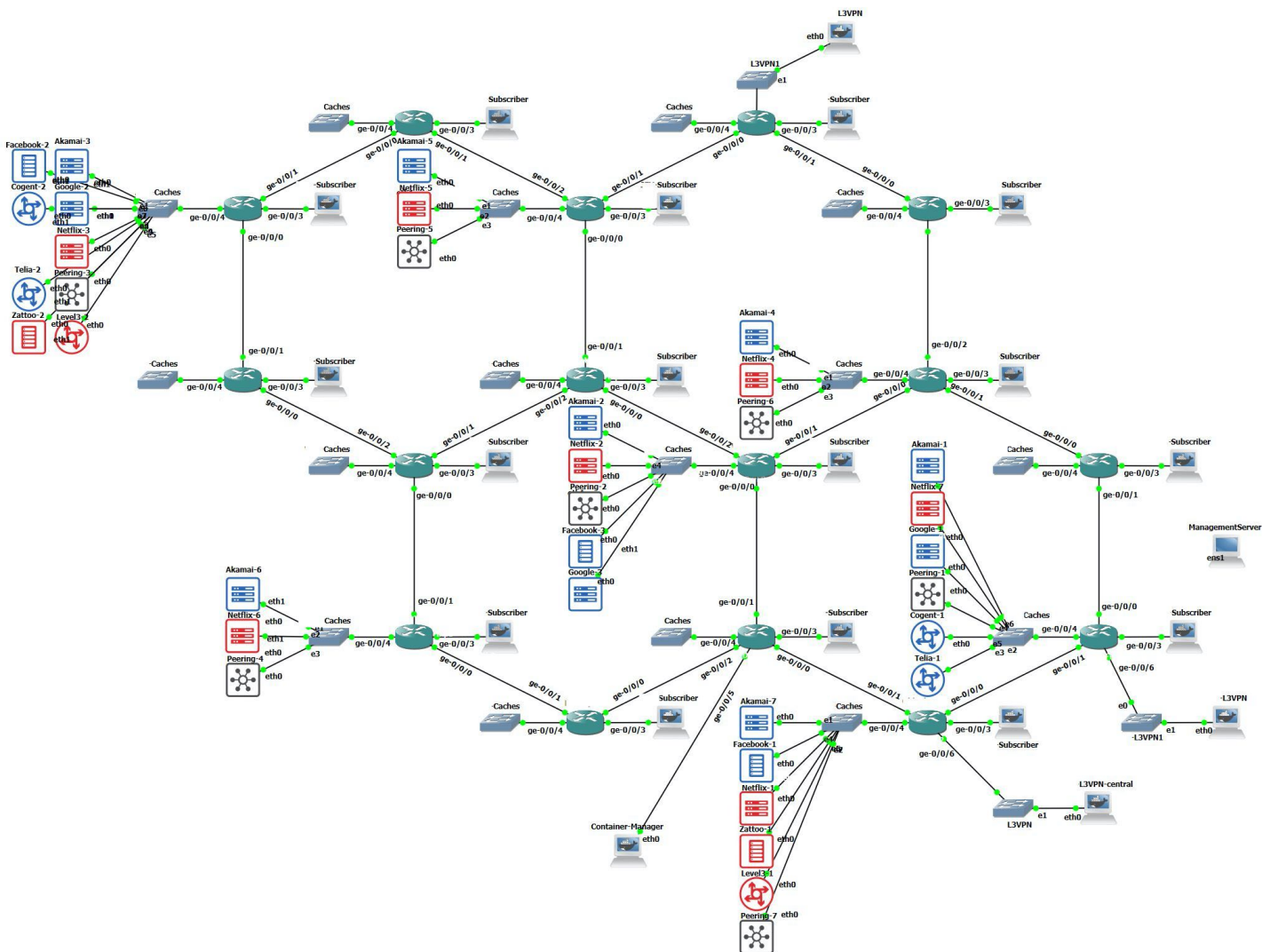


# Simulation overviews and samples.

Core of the solution is the graphical network simulator GNS3. Missing functionalities have been implemented in Python.



Find below an example how it looks like in the GNS3 overview.

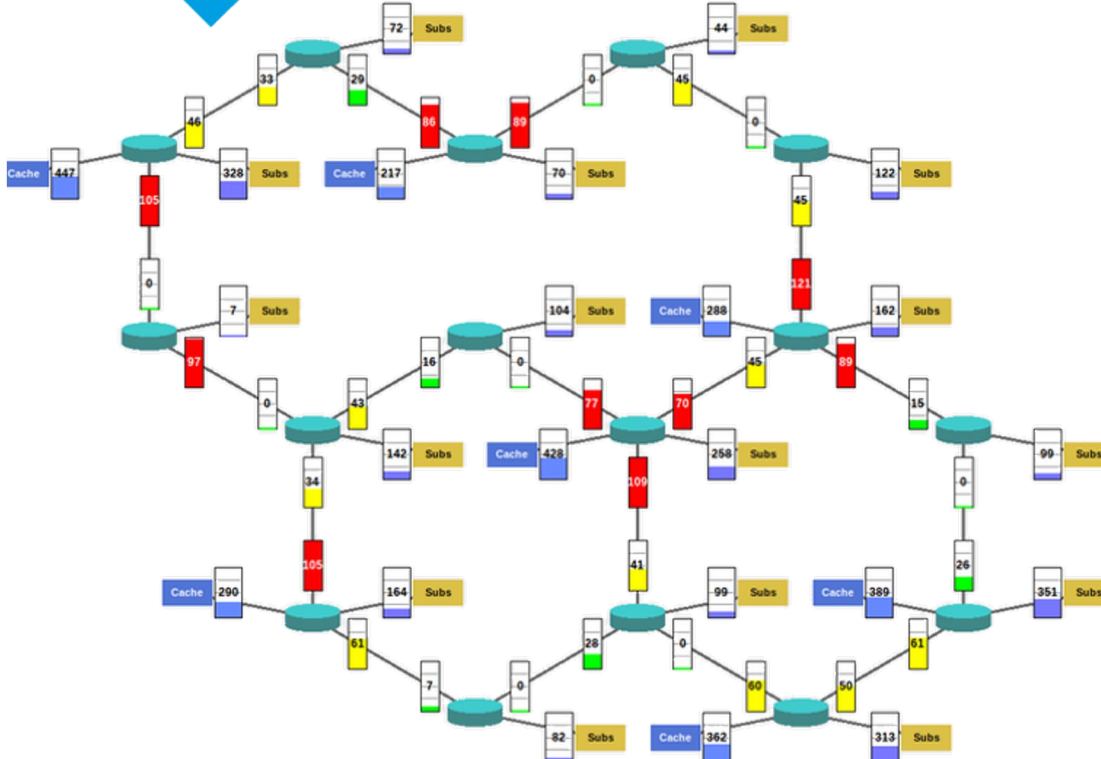
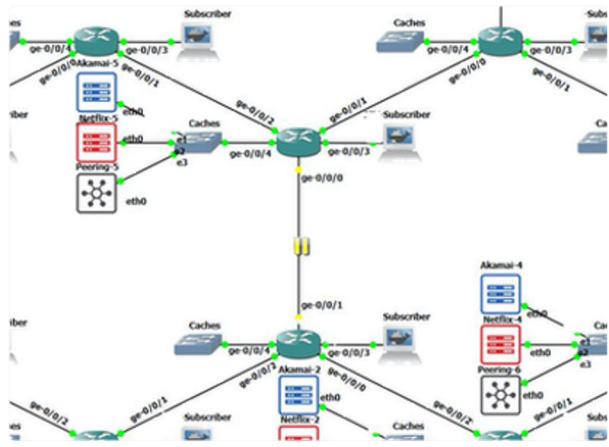
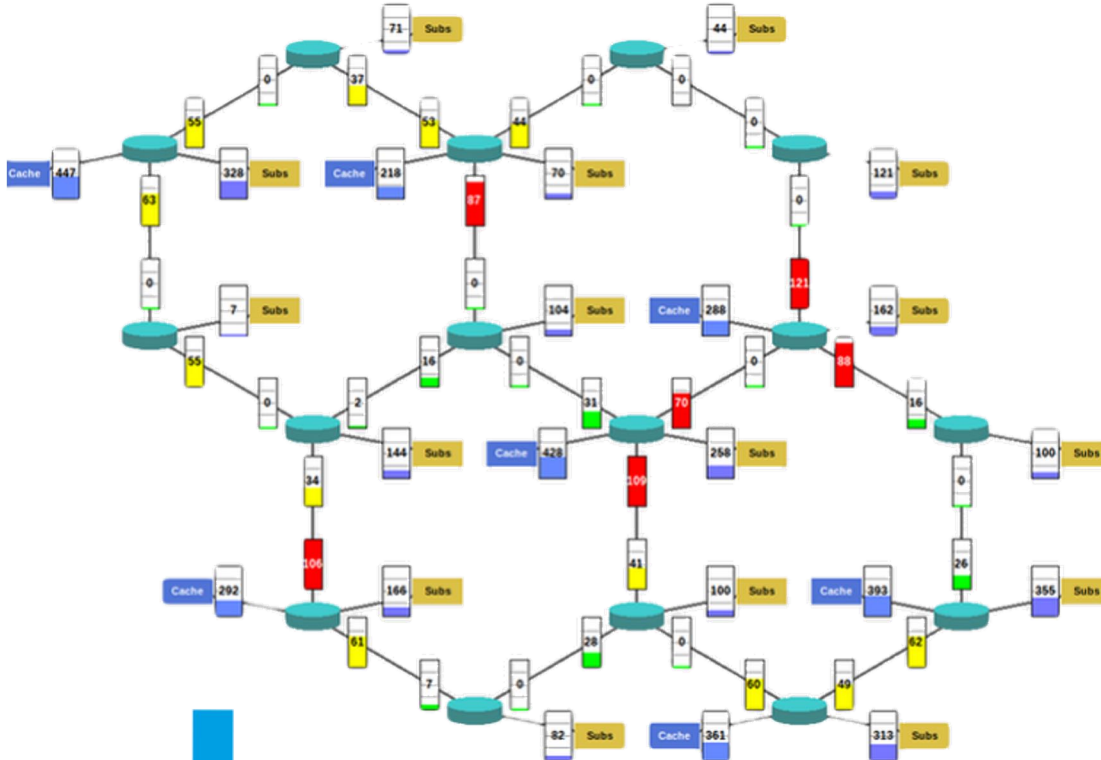


Visualiza-  
tion of the  
network  
load with  
link failure

On the next page you can see a link failure scenario and how the user can the the changes in the traffic in the overall network.



Visualiza-  
tion of the  
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## Findings and opportunities.

The simulation succeeded and delivered answers and findings to

- **different traffic scenarios**
- **lean router configurations** for the **new network topologies**
- **optimal distribution** of caching systems and peering points and their service areas
- **network utilization** over the coming years with the forecasted traffic growth - **identification** of overload conditions
- **different strategies** for bandwidth management e.g. increase number of caches vs increase bandwidth on links
- network **behavior** in case of **failures**
- impact of the **network architecture** on the **link utilization**
- the **mathematic models**
- the **right balance** for the upcoming **bandwidth planning**

Overall the simulation gave **a precise view on how cost savings** can be **reached**.

It has been shown as well, that the **simulation is not limited on numbers** of network elements. The **solution is scalable** and allows the **automatic simulation** of an operator network **including various failure scenarios**.

**Automated deployments** of the necessary test resources, software and configurations made it easy and fast to test.

On top, compared with traditional procedures the simulation saved OPEX and CAPEX spending.

Overall  
achievement

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