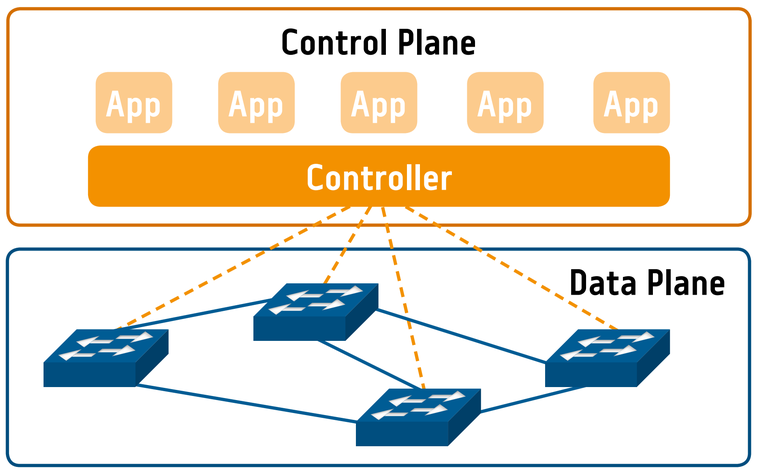
Reliable and Fault Tolerant Communication in Smart Energy Grids based on Software-Defined Networking / OpenFlow

Communication Infrastructure for Smart Grid Systems

A highly available and secure communication infrastructure is one of the major prerequisites for modern power systems. In our work we evaluate the use of a Software-Defined Networking (SDN) infrastructure in the domain of energy communication networks. The advantages and potential risks of using Software-Defined Networking at the current stage of development in productive networks are investigated. Test scenarios are defined based on the IEC 61850 traffic specification to perform traffic measurements in a real SDN network infrastructure. Software-Defined networks have the potential to offer significant advantages over conventional networks.

Software-Defined Networking (SDN) is a new networking architecture that decouples the control plane from the data plane. One common standard for the implementation of Software-Defined Networking is OpenFlow which defines a communication protocol between network switches (forming the data plane) and one or multiple controllers (forming the control plane).

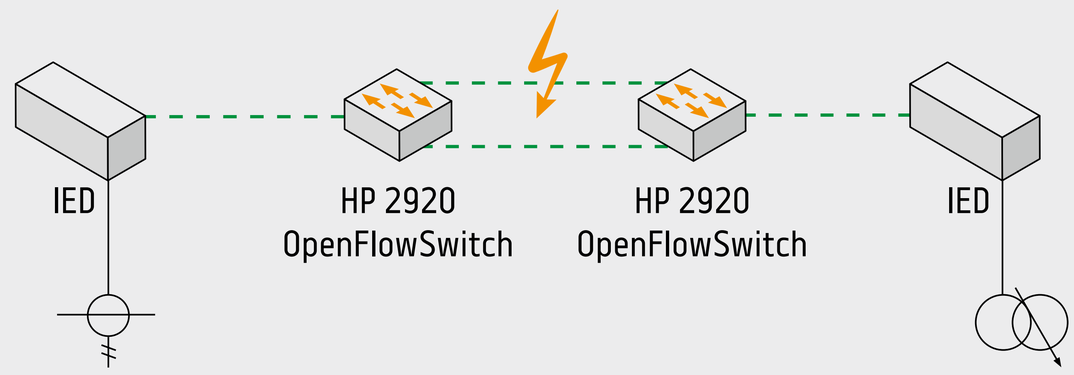


Advantages of SDN

- Automatic network configuration, testing and deployment
- Predefined paths and behaviour
- Dynamic traffic engineering
- Traffic isolation
- Central real-time network information available

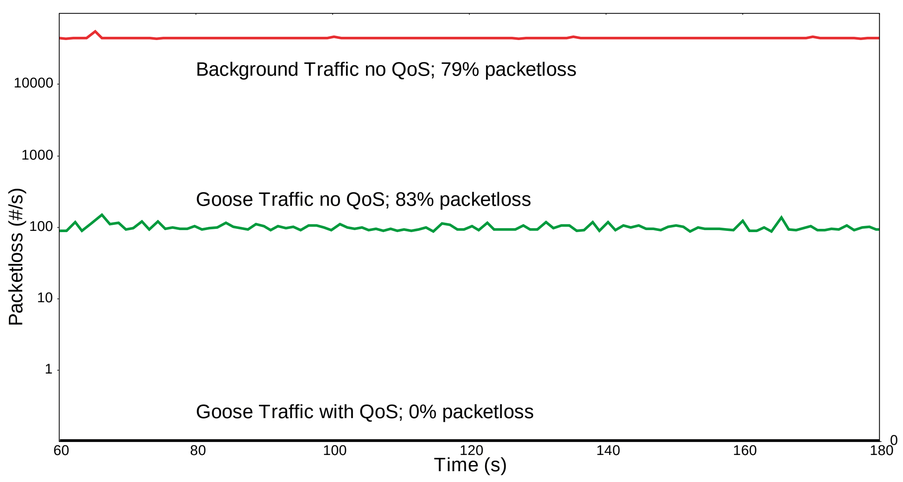
Evaluation of a Reliable and Fault Tolerant Communication Network based on SDN

The scope of our practical evaluation is to benchmark the communication performance and behaviour of our system under test (SUT). The SUT simulates a very simple IED communication. The emulated traffic between the IEDs includes GOOSE traffic based on IEC 61850 specifications. We define two test cases. The first one evaluates the support of Quality of Service for a prioritised flow. The second test case validates the fast failover behaviour of OpenFlow during a link failure when the traffic is automatically switched to the second working link.



Test case Quality of Service

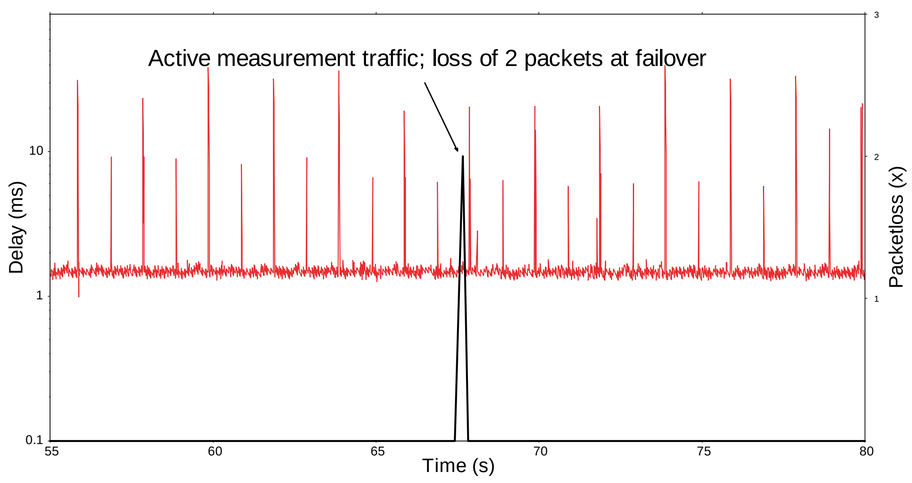
Flow Prioritisation



Prioritized GOOSE flow with 0 packet loss

Test case Fast Failover

Failover Groups



Failover time < 30ms (event happens at 67.5s), Peaks in delay

Conclusion

- SDN can offer significant advantages in network control and management
- Our tests evaluated behaviour of OpenFlow with traffic prioritisation and in a fault tolerant network setup
- OpenFlow implementations are ready for prototyping but not yet for productive use (technology is advancing very quickly)

Weitere Projekte / geplante Projekte

- **OFSE-Grid** – Study: SDN for energy systems
- **OPOSSUM** – SDN for shared but isolated wide-area energy communication networks
- **IPEN** – Reliable use of IEC 61850 in wide-area networks
- **SCISSOR (EU)** – Security in Smart Grids

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