

Static Evaluation of a Wheel Topology for an SDN-based Network Use Case

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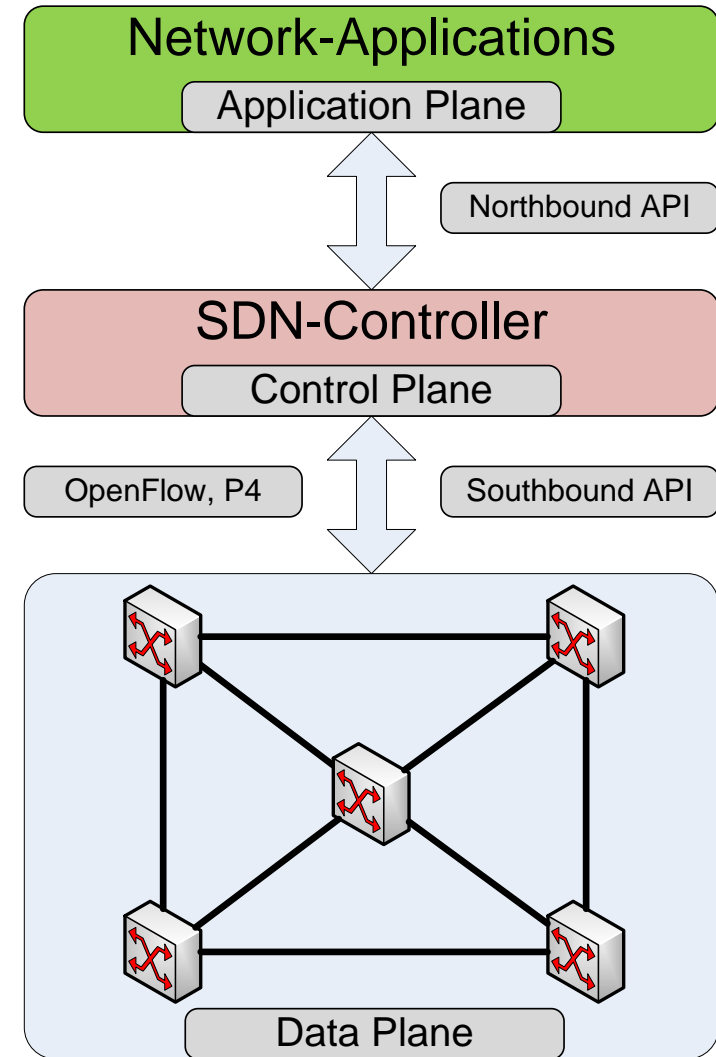
- Motivation
- SDN Basics
- Network Topologies
- Introducing the Wheel Topology
- Wheel Topology with SDN
- Conclusion
- Outlook



- Trend of cloud application and smart systems
- New hardware with some form of "intelligence" e.g.:
 - Network interface: WiFi chips
 - Additional chips for voice recognition
 - SoC with various networking capabilities
- Software control the hardware
 - Adds and defines functionalities
 - Controls the lifecycle
 - e.g. *Amazon Dash Buttons*
 - End of service
 - Deactivate the hardware
- This concept is called **Software-Defined-Systems (SDS)**
 - **Software-Defined-Networking (SDN)**
 - New possibilities with SDN

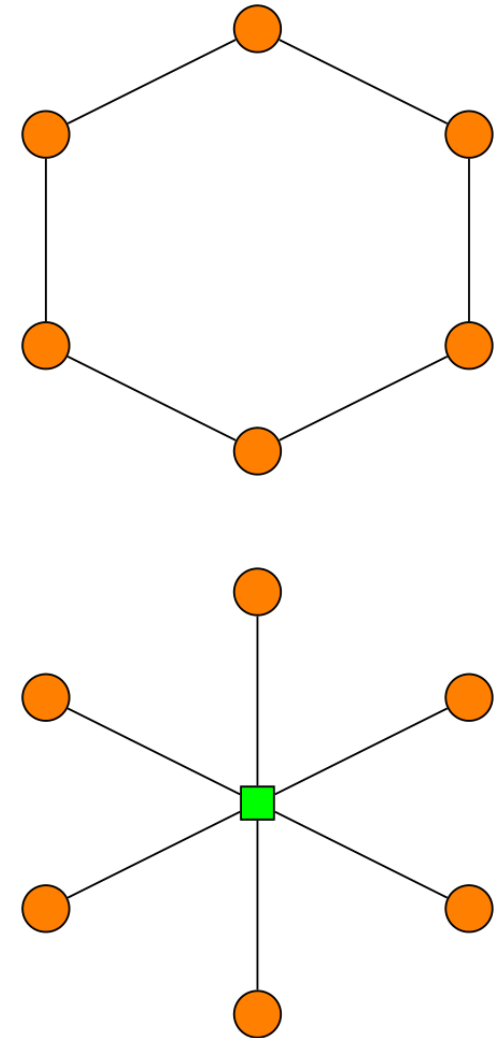
Software-Defined-Networking (SDN)

- Decouple hardware from software
- Control Plane
 - Controls the network
 - Replaces software and firmware
- Data Plane
 - Network hardware for transmitting
 - Controls by SDN-Controller
- Application Plane
 - MAC learning
 - Routing algorithms
 - and much more

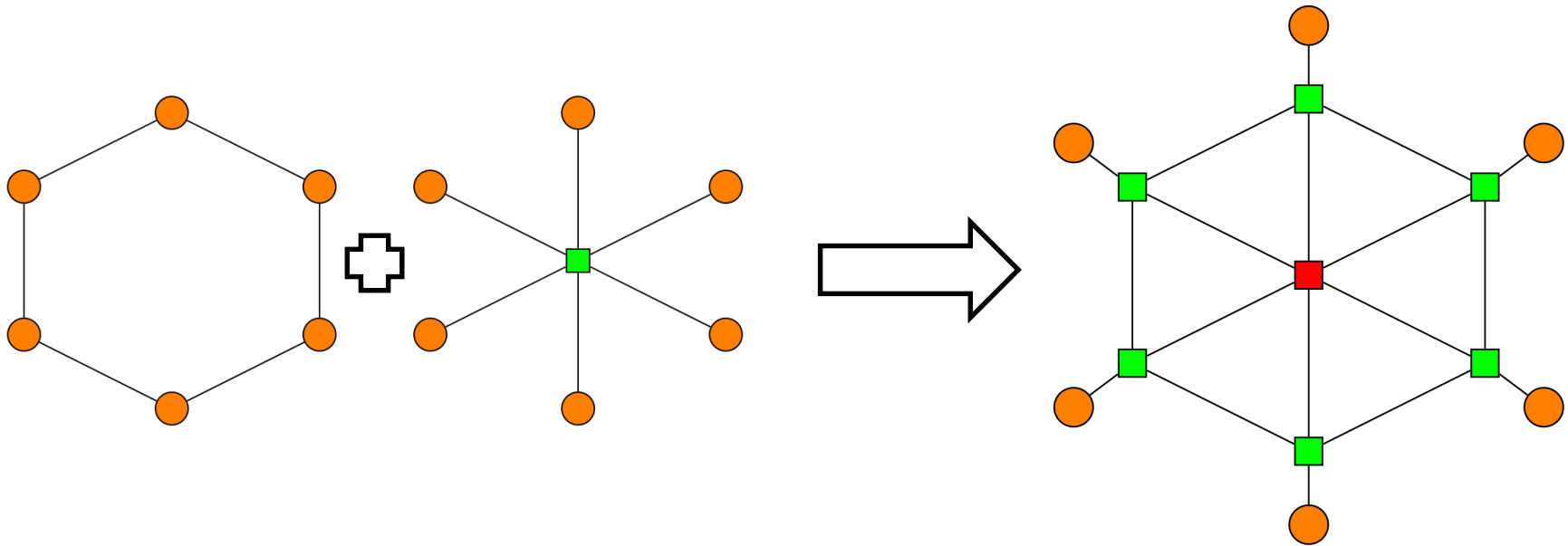


Network Topologies

- Ring topology
 - Daisy chain in a closed loop
 - Nodes on the ring
 - Transmitting around the ring
- Star topology
 - All nodes connected to a central node
 - Central node work like a hub or switch
- Other topologies:
 - Bus
 - Tree
 - Point-to-Point
 - Mesh
 - Fully connected
 - Partially connected



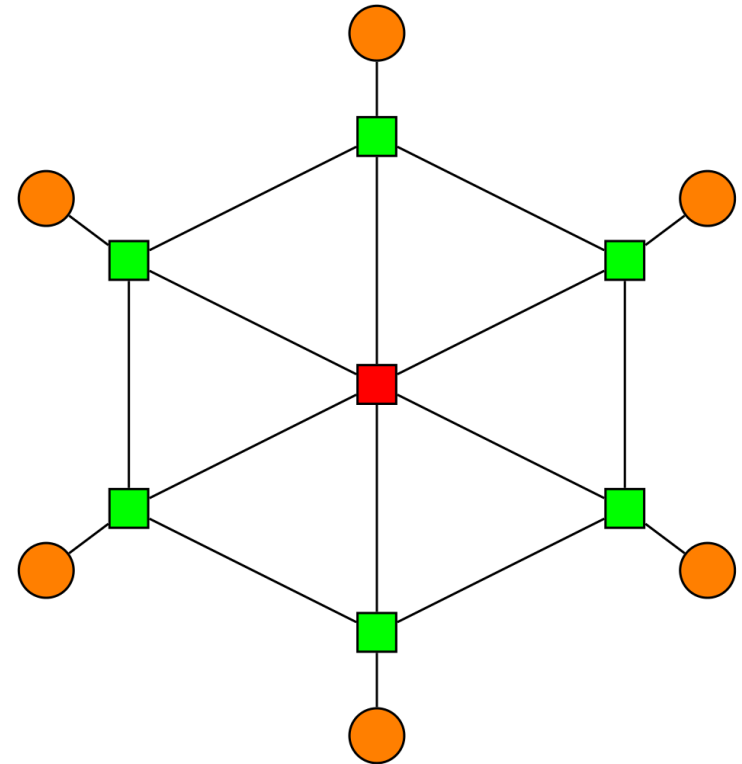
Introducing the Wheel Topology



- Combine the advantages of the ring and star topology
- Achieve improvement in
 - Bandwidth
 - A reduction of latency
 - Higher level of robustness

Introducing the Wheel Topology

- Combination of ring and star topology
- Differs from other ones
 - All „nodes“ on the ring and star are switches (squares)
 - Actual *nodes* are connected such as leaves (circles)
- Switches (squares ■): N
 - Connected bidirectionally
 - $N - 1$ switches form the ring
 - Satellite switches ■
 - 1 switch in center
 - Central switch ■
 - Minimum $N \geq 5$ (4 satellite switches)
- Nodes (circles ●): M
 - Connected bidirectionally to the satellite switches
 - Each satellite switch has M nodes

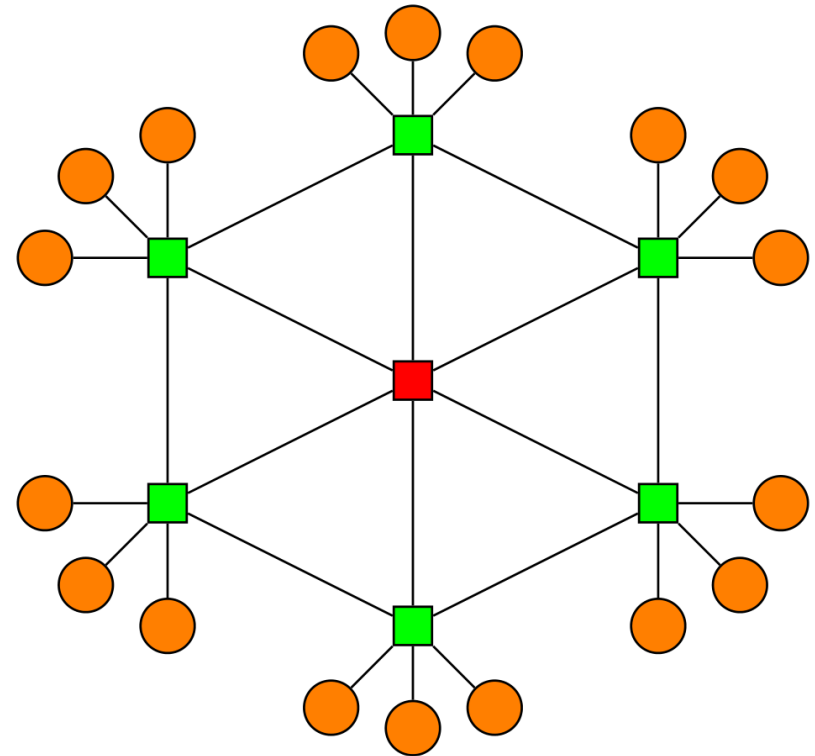


wheel topology with $N = 7$ and $M = 1$

Introducing the Wheel Topology

Characteristics of the wheel topology

- *Diameter* $\emptyset = 4$
- Number of bidirectional connections *degree* for a
 - Node: $Pt = 1$
 - Satellite switch: $Pt = M + 3$
 - Central switch: $Pt = N - 1$
- Connectivity K for a
 - Node: $K = 1$
 - Satellite switch: $K = 3$
 - Central switch: $K = N - 1$
- Bisection width B :
 - $B = \left\lfloor \frac{N}{2} + 2 \right\rfloor$



wheel topology with $N = 7$ and $M = 3$

Introducing the Wheel Topology

Characteristics of the wheel topology

- *Connection Complexity* V_b

$$V_b = 2 \cdot (M + 2) \cdot (N - 1)$$

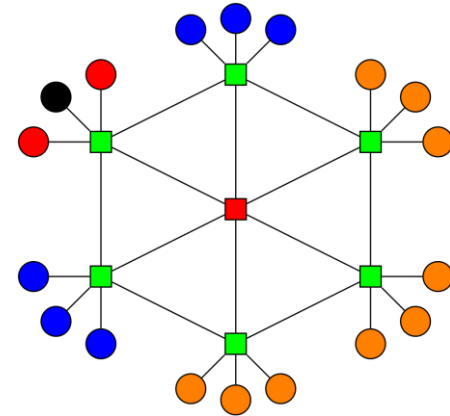
- Average path length of all possible sender-receiver pairs

– Generally:

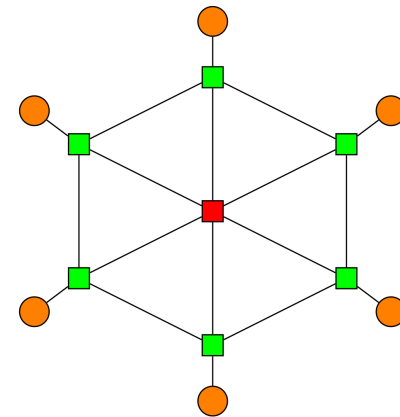
$$\bar{r} = \frac{2 \cdot (M - 1) + 3 \cdot 2M + 4 \cdot (N - 4)M}{(M \cdot (N - 1)) - 1}$$

– For $M = 1$

$$\bar{r} = \frac{4N - 10}{N - 2}$$



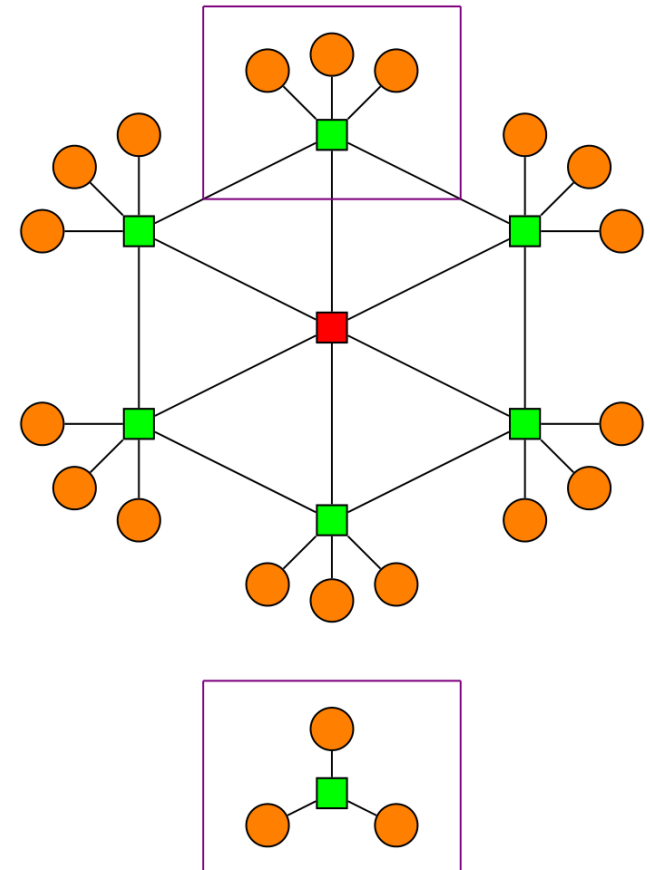
wheel topology with $N = 7$ and $M = 3$



wheel topology with $N = 7$ and $M = 1$

Wheel Topology with SDN

- The application of SDN opens new possibilities
- Topologies like the wheel topology can be realized easier
- Realize wheel topology with SDN
 - All switches must be SDN switches
 - Central switch require large degree
 - SDN controller
 - Connect to central switch
- Expand with several SDN controllers
 - i.e. for local areas in satellite switches
 - Run its own local SDN application
 - Make redundant SDN Controller backup
 - Use the advantages of the wheel topology
 - To combine SDN application
 - Create logical star and logical ring topologies
 - Run parallel topology specific tasks



Conclusion

- SDN Basics
 - Control plane
 - Data plane
 - Application plane
- Network topologies
 - Ring topology
 - Star topology
- Proposed the wheel topology
 - A hybrid topology
 - Nodes as leaves from satellite switches on the ring
 - Presented the advantages
- Presented
 - The static characteristics
 - A possible implementation with SDN

- Investigate the wheel topology with network mechanisms
 - Link Layer Discovery Protocol (LLDP)
 - Intent-based forwarding
 - And more
- Simulate the wheel topology for dynamic characteristics
 - OMNeT++
 - ns-3
 - Mininet
- Observe the behaviour transmitting
 - Evaluate the buffers
 - Transmit operation
 - Prevent potential problems

Thanks!

