Dynamic Topology Discovery in SDN-enabled Transparent Optical Networks (TON)

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OUTLINE

- The Need for a Dynamic Topology Discovery Mechanism
- Topology Discovery in SDN-enabled TONs
- Proposed Mechanism
- Experimental Validation & Results
- Conclusions

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The Need for a Dynamic Topology Discovery Mechanism

- Topology information usually configured in a static way which is prone to errors.
- No possibility of retrieving information from data flow as there is no electrical link termination at incoming fibre ports of optical subsystems.
- Other approaches consider control networks between control agents demanding additional resources.

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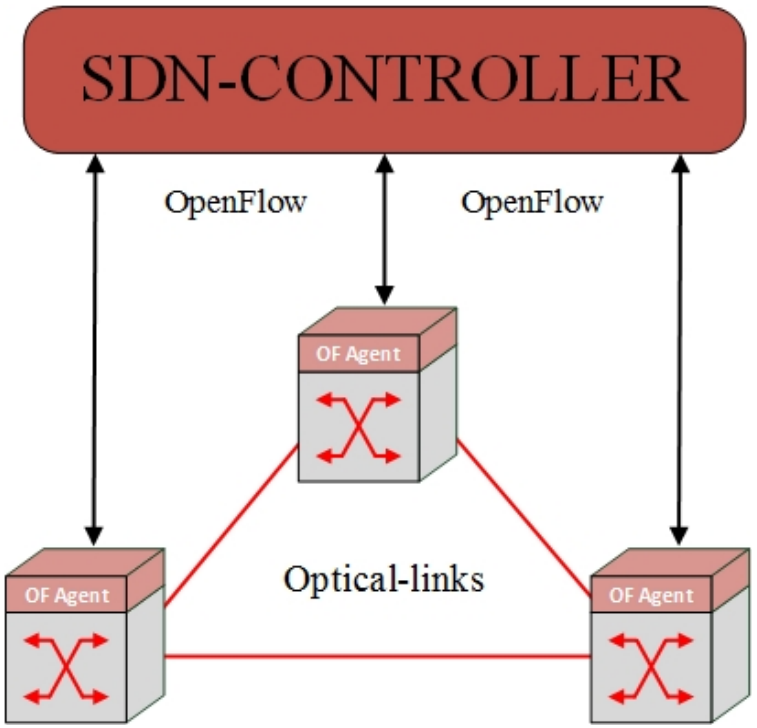
Topology Discovery in SDN-enabled TONs [1/2]

- SDN 3-layered architecture provides a more granular control of resources in TONs.
- Southbound protocols such as OF allow exposing optical capabilities and deploying instructions.



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Topology Discovery in SDN-enabled TONs [2/2]

- Miscorrelations can lead to an incorrect interpretation by the SDN controller of how resources are allocated.
- Applications & SDN modules depend on it to correctly deploy services/instructions over TONs.
- Correct mapping of the underlying physical network considered crucial to guarantee overall functionality across layers.

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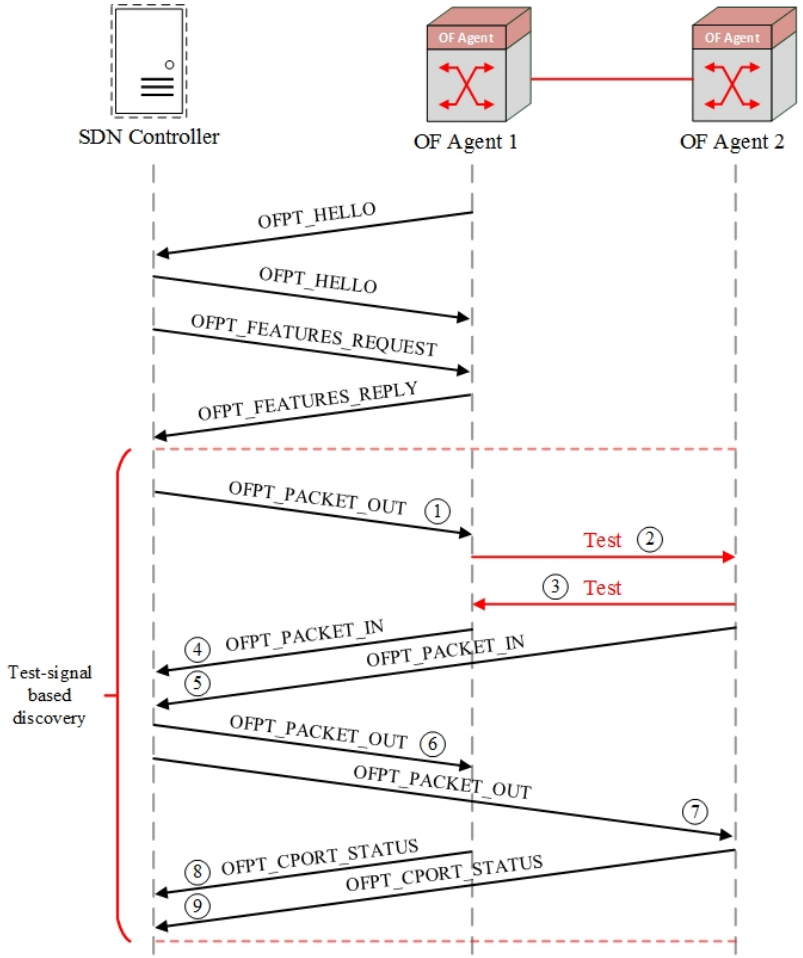
Proposed Mechanism [1/2]

- SDN-Controller triggered mechanism.
- Message exchange sequence based in extended OF v1.0.
- Use of Test-Signal to confirm active connections.



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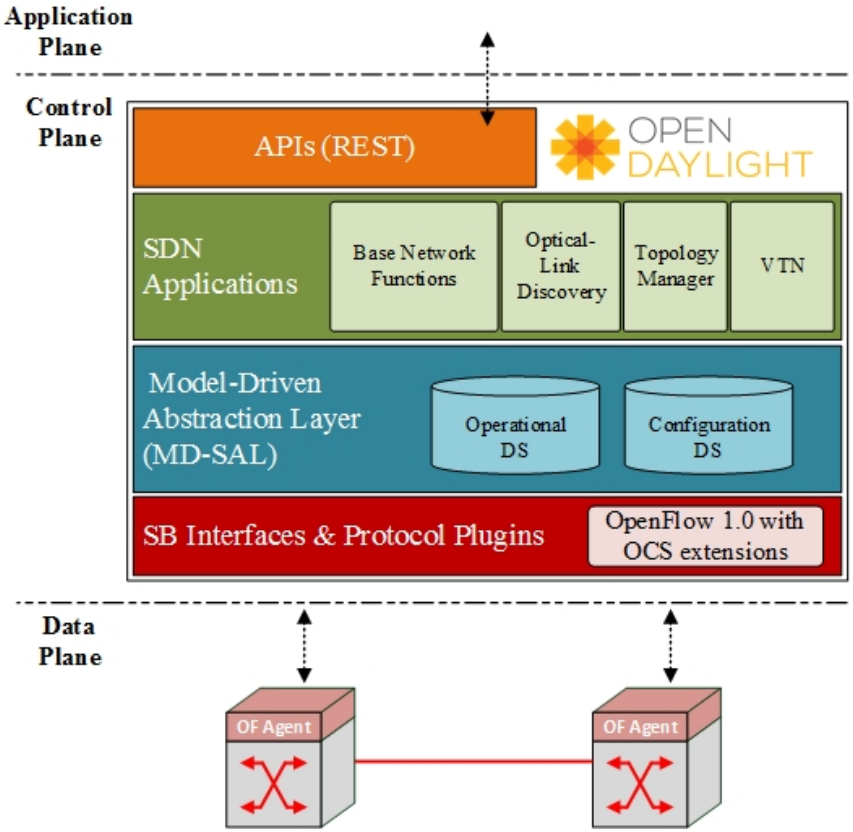
Proposed Mechanism [2/2]



- Implemented extensions in OF Plugin, OF Java, VTN and TM modules.
- Design of OLD module to coordinate discovery process.
- Extended OF Agents

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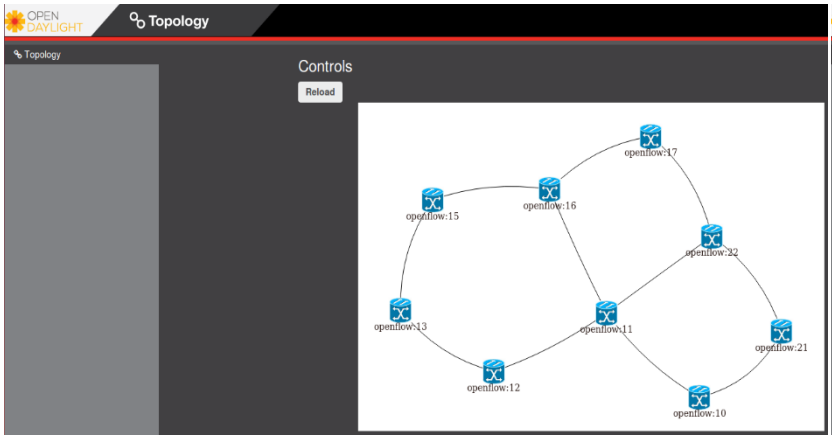
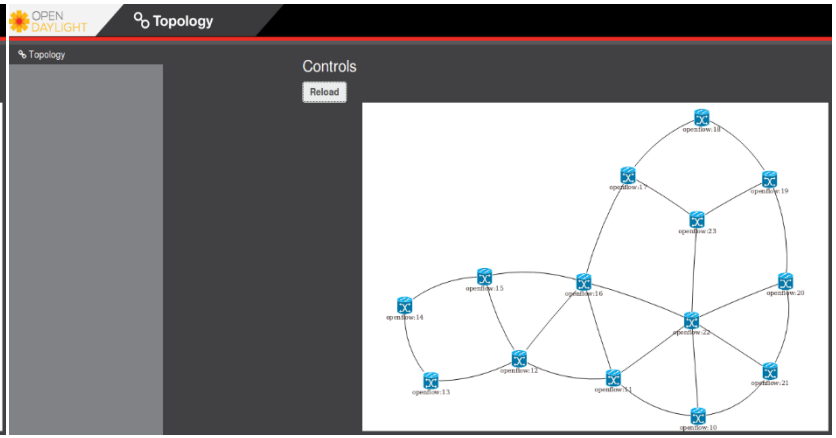
Experimental Validation & Results [1/3]

- 9-node and 14-node emulated TON scenarios.
- Bidirectional links between nodes.
- As seen in Opendaylight DLUX GUI.





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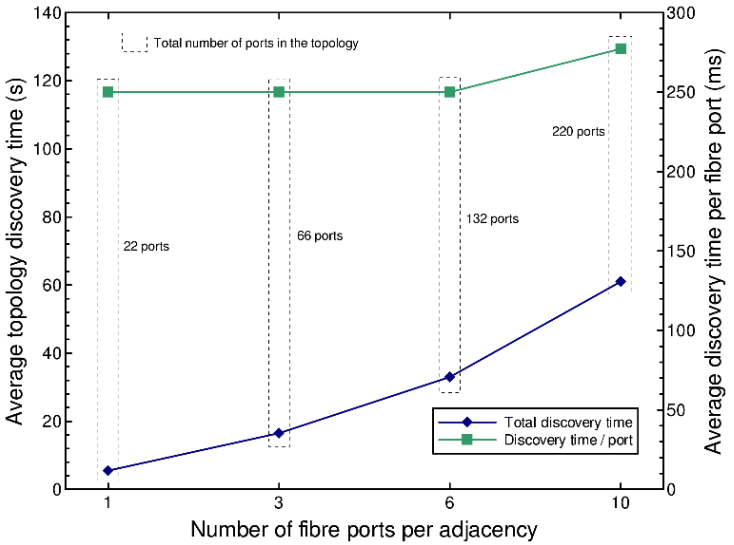
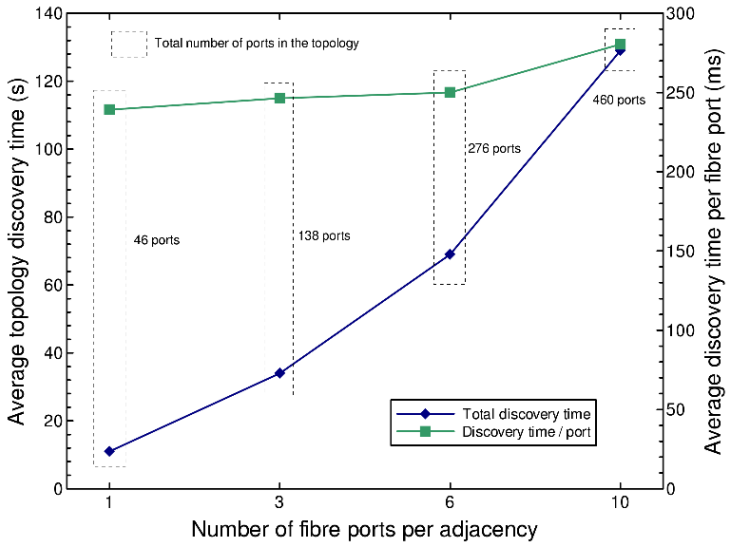
Experimental Validation & Results [2/3]

- Message exchange between adjacent nodes (Wireshark).
- PACKET_OUT(I) -> PACKET_IN(II) -> PACKET_OUT(II) -> CPORT_STATUS(II) Sequence.

No.	Time	Source	Destination	Protocol	Length	Info
124	13.787155000	192.168.101.21	192.168.3.1	OpenFlow	76	Type: OFPT_HELLO
126	13.787737000	192.168.3.1	192.168.101.21	OpenFlow	84	Type: OFPT_FEATURES_REQUEST
127	13.788223000	192.168.101.21	192.168.3.1	OpenFlow	76	Type: OFPT_HELLO
129	13.824290000	192.168.101.21	192.168.3.1	OpenFlow	340	Type: OFPT_FEATURES_REPLY
131	13.827185000	192.168.3.1	192.168.101.21	OpenFlow	80	Type: OFPT_STATS_REQUEST
132	13.836056000	192.168.101.21	192.168.3.1	OpenFlow	1136	Type: OFPT_STATS_REPLY
134	13.905168000	192.168.3.1	192.168.101.21	OpenFlow	176	Type: OFPT_PACKET_OUT
174	14.111269000	192.168.3.1	192.168.101.10	OpenFlow	88	Type: OFPT_STATS_REQUEST
175	14.111732000	192.168.101.10	192.168.3.1	OpenFlow	80	Type: OFPT_STATS_REPLY
177	14.111813000	192.168.101.10	192.168.3.1	OpenFlow	87	Type: OFPT_PACKET_IN
179	14.113726000	192.168.3.1	192.168.101.21	OpenFlow	88	Type: OFPT_STATS_REQUEST
181	14.114671000	192.168.101.21	192.168.3.1	OpenFlow	80	Type: OFPT_STATS_REPLY
183	14.114789000	192.168.101.21	192.168.3.1	OpenFlow	87	Type: OFPT_PACKET_IN
185	14.124050000	192.168.3.1	192.168.101.10	OpenFlow	100	Type: OFPT_PACKET_OUT
186	14.124126000	192.168.3.1	192.168.101.21	OpenFlow	100	Type: OFPT_PACKET_OUT
187	14.126141000	192.168.101.10	192.168.3.1	OpenFlow	164	Type: OFPT_PORT_STATUS
188	14.126141000	192.168.101.21	192.168.3.1	OpenFlow	164	Type: OFPT_PORT_STATUS

Experimental Validation & Results [3/3]





- Low total times for the overall discovery process (≈1min w/9-node/220 links & ≈2min w/14-node/460 links).
- An average per-fibre port discovery time of 250ms.

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Conclusions

- A novel SDN-based mechanism has been presented to address the need for dynamic topology discovery in TONs.
- The mechanism allows the correct mapping of optical topologies at the controller level while presenting low total times of network discovery and a scalable per-fibre port discovery time.
- Future Work:
  - Implementation over physical optical networks
  - Tests with larger emulated considered networks to further prove scalability

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