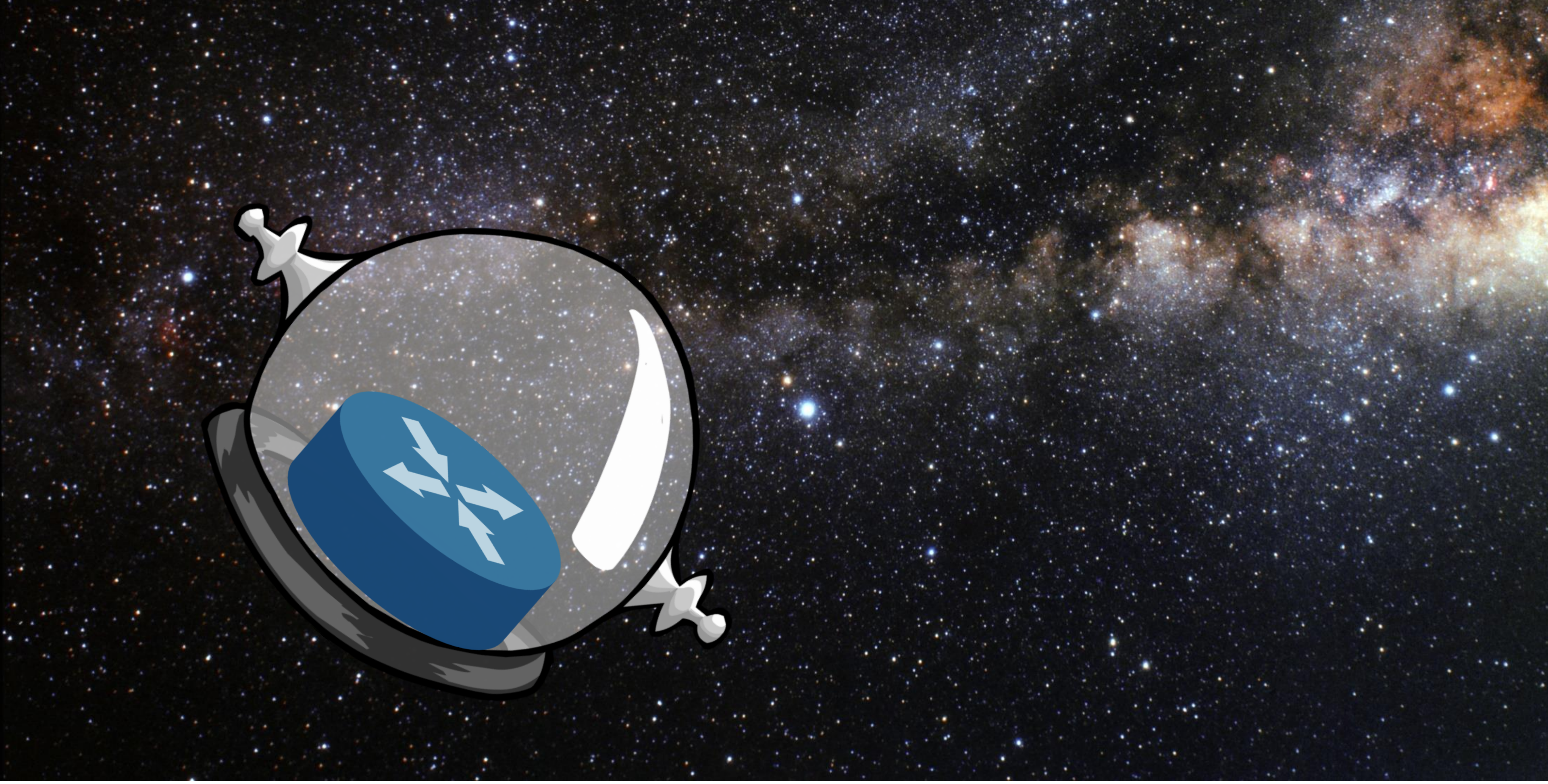
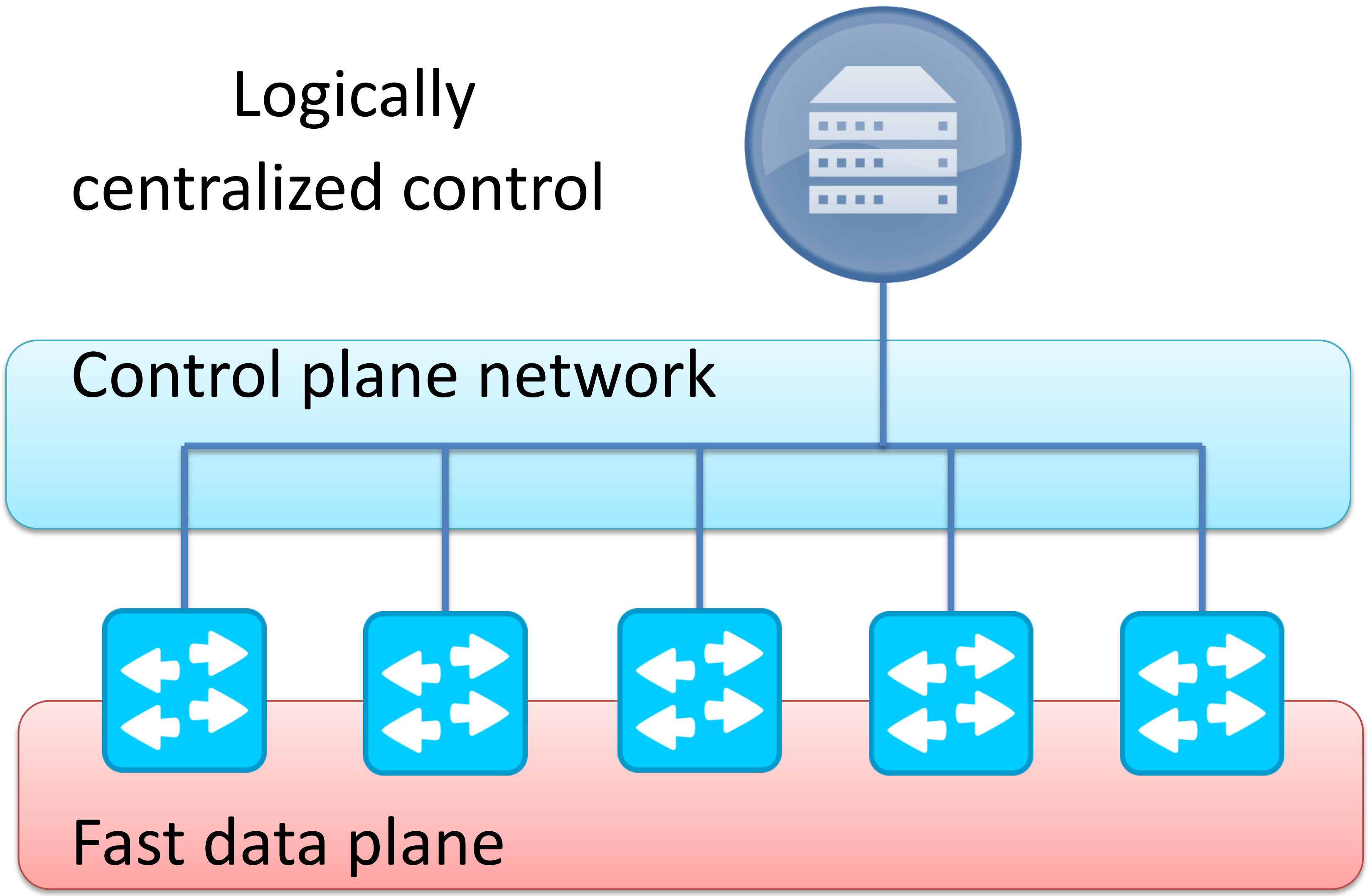


Ground Control to Major Faults: Towards Fault Tolerant and Adaptive SDN Control Network

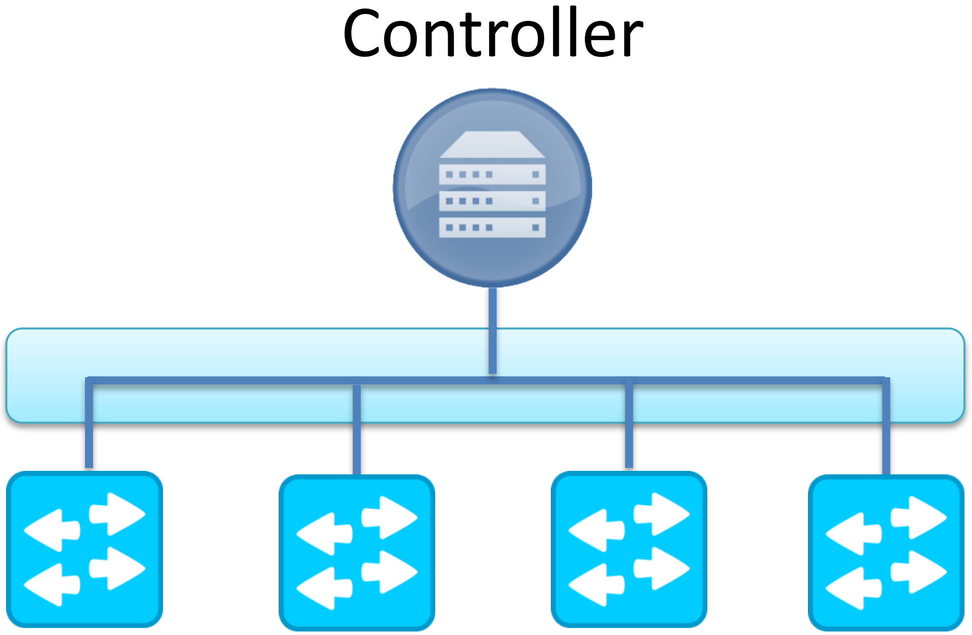
Liron Schiff (Tel Aviv University)
Stefan Schmid (TU Berlin, Germany & Aalborg University, Denmark)
Marco Canini (Université catholique de Louvain)

Software Defined Network (SDN)



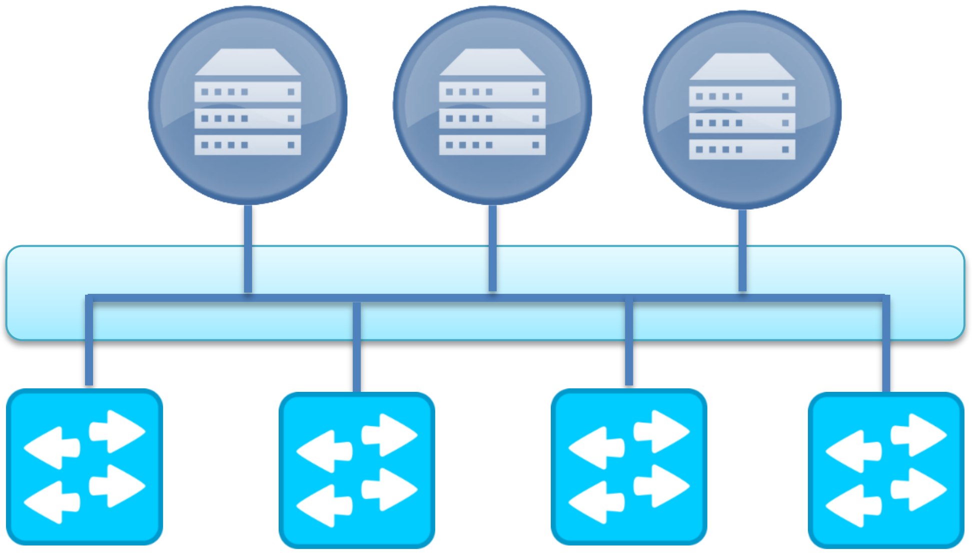
SDN control-plane

- Main function:
  - Connect the controller with each switch



SDN control-plane

- Main function:
  - Connect the controller with each switch
- Can be distributed
  - Handle failures
  - Load balancing
  - Need synchronization



SDN control-plane

- Main functions:
  - Connect the controller with each switch
  - Inter-connect the controllers
- Can be distributed
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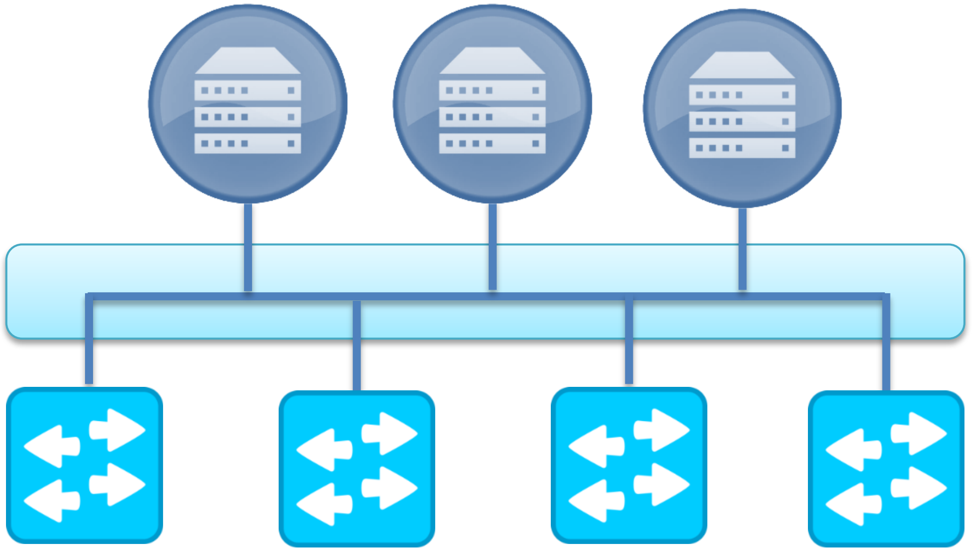
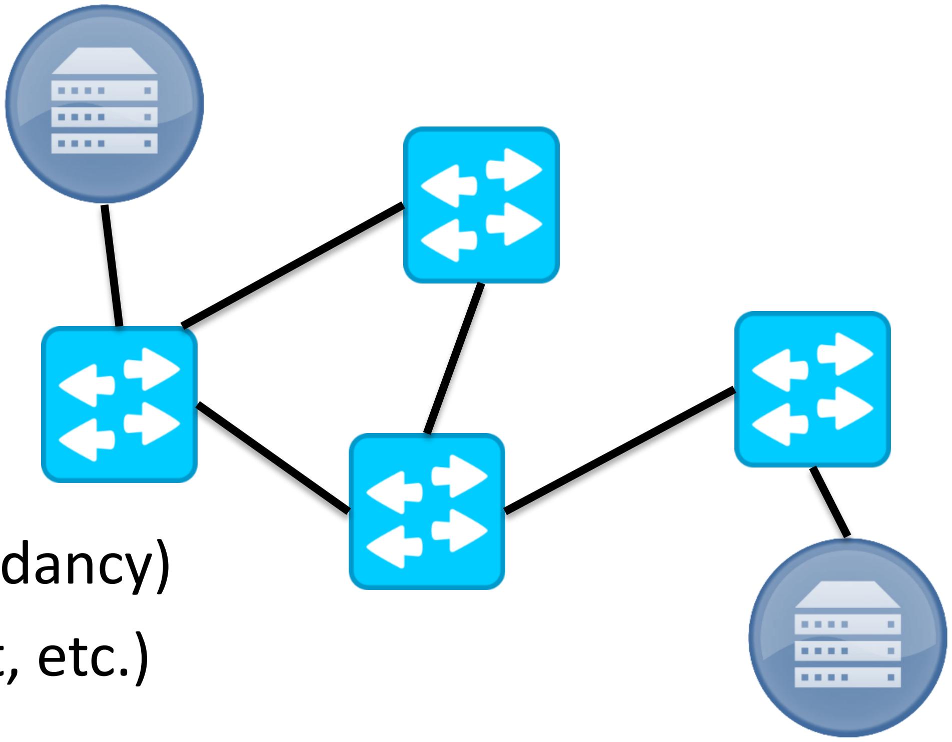


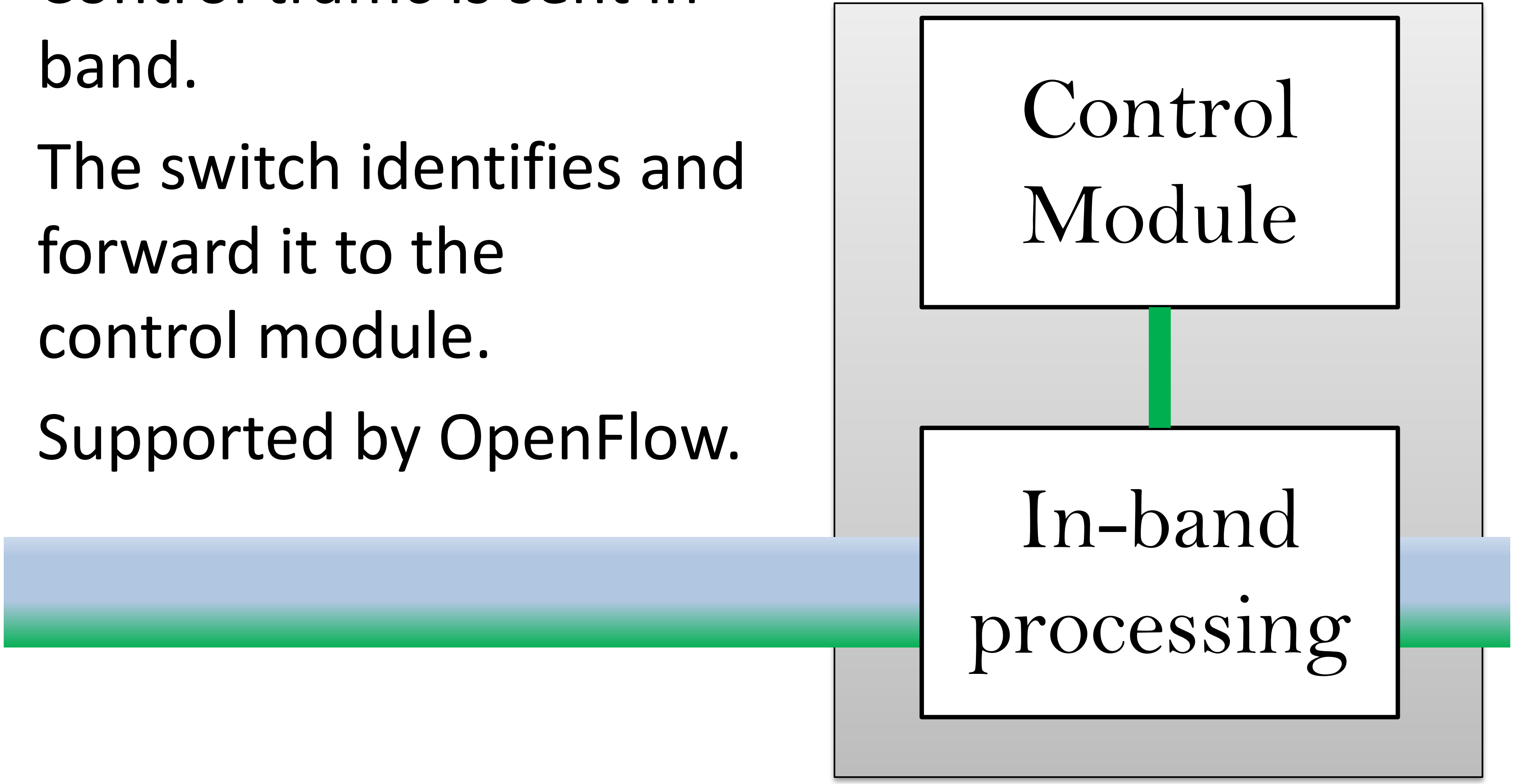
SDN control-plane

- Main function:
  - Connect the controller with each switch
  - Inter-connect the controllers
- Can be distributed
  - Handle failures
  - Load balancing
  - Need synchronization
- Can be in-band
  - Cheaper
  - More provisioned (redundancy)
  - More flexible (TE, unicast, etc.)

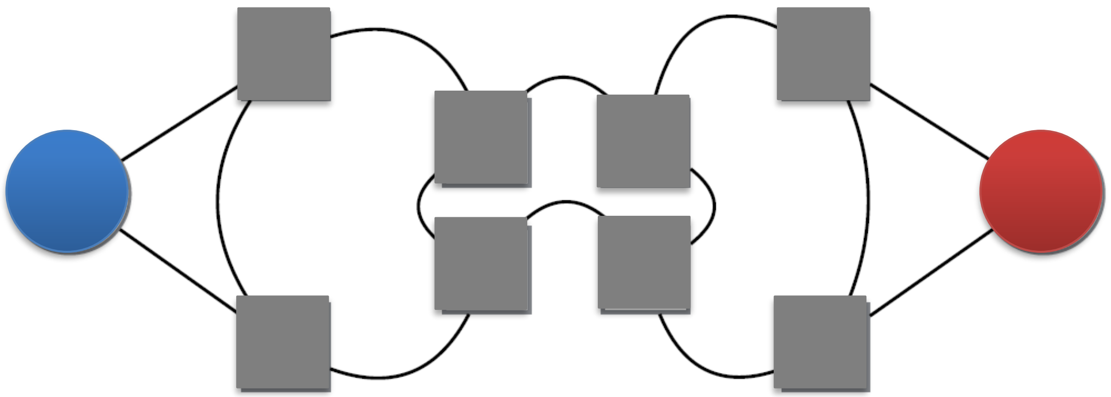


Switch Structure (Model)

- Control traffic is sent in-band.
- The switch identifies and forward it to the control module.
- Supported by OpenFlow.

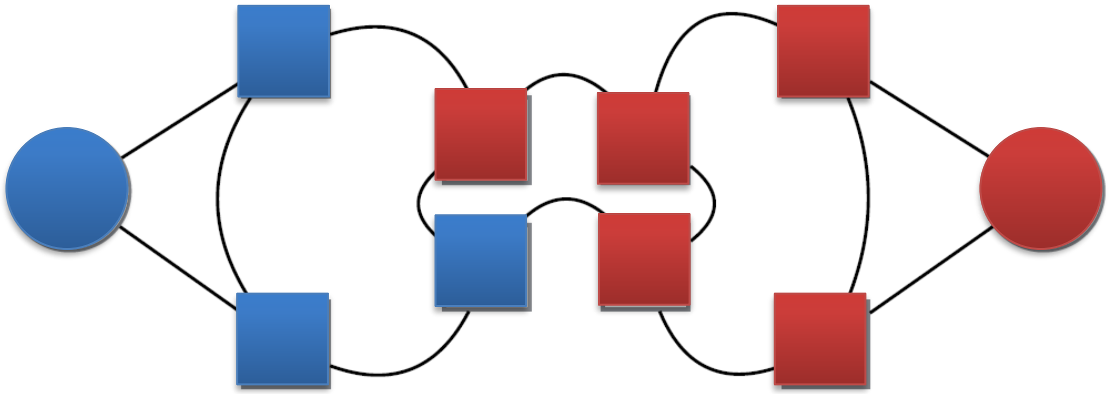


Challenge: Boot Up



- Switches start as unmanaged.
- Switches should be configured to forward control in-band.

Challenge: Boot Up



- Switches start as unmanaged.
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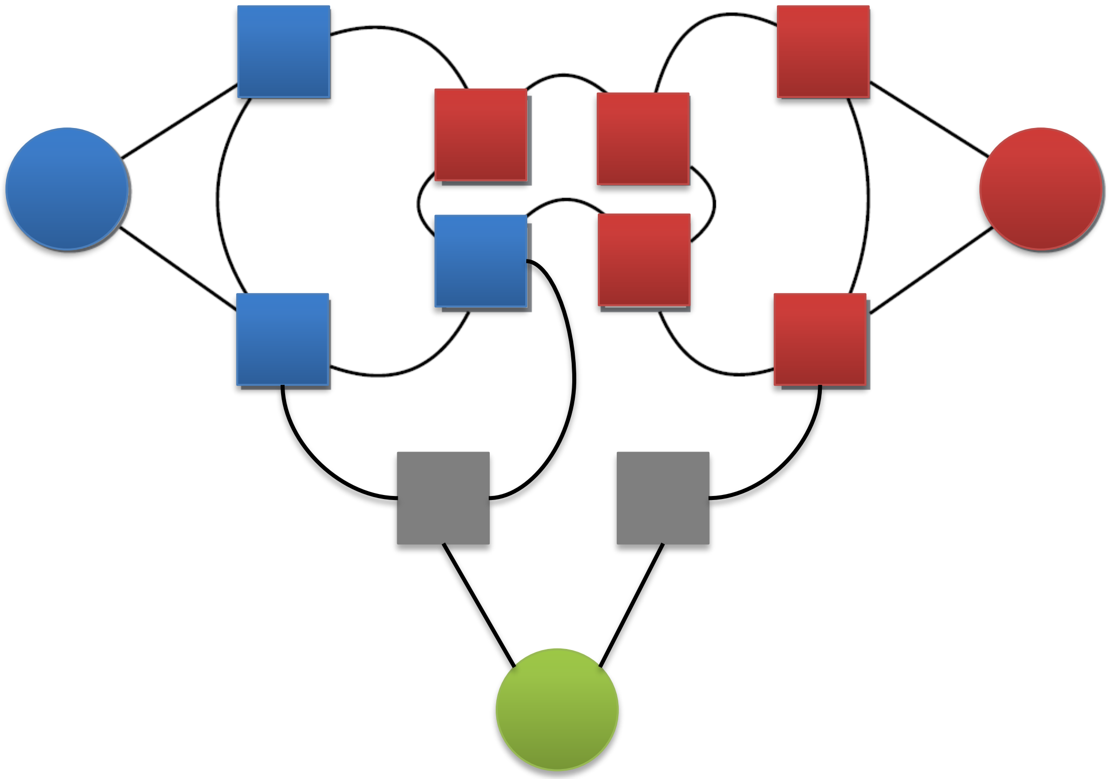
Challenge: Plug&Play

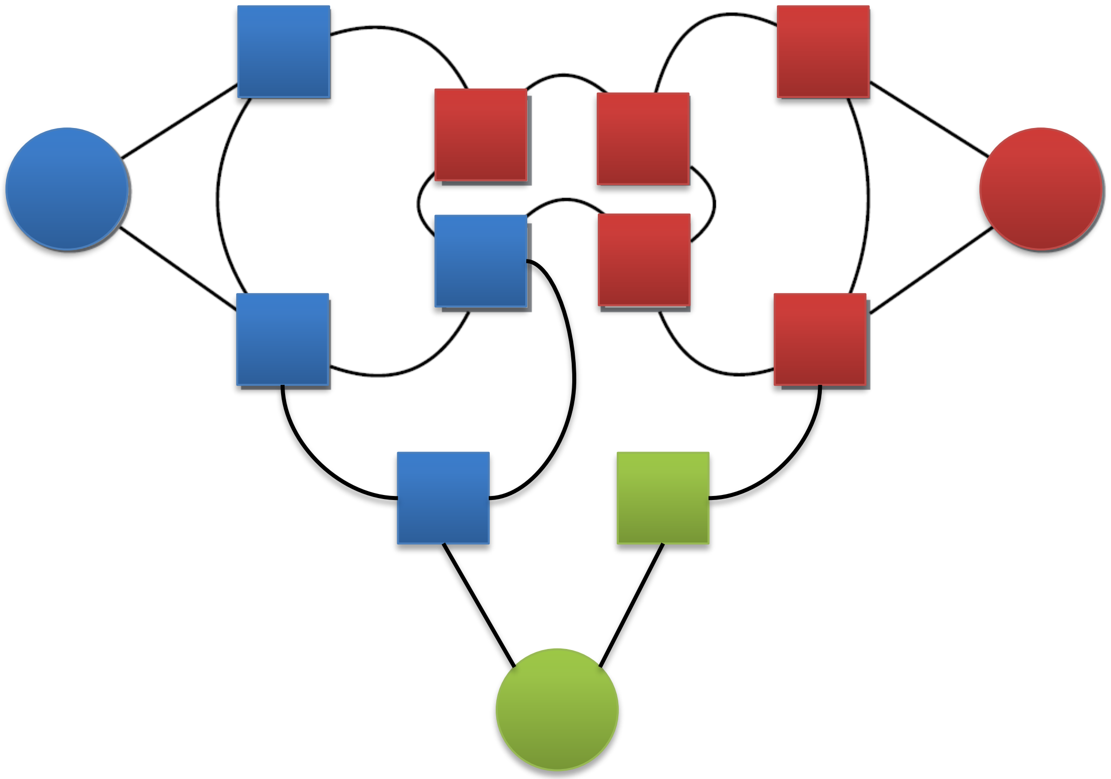
- Support new links / switches / controllers



- Switches can’t be configured with all possible controllers.

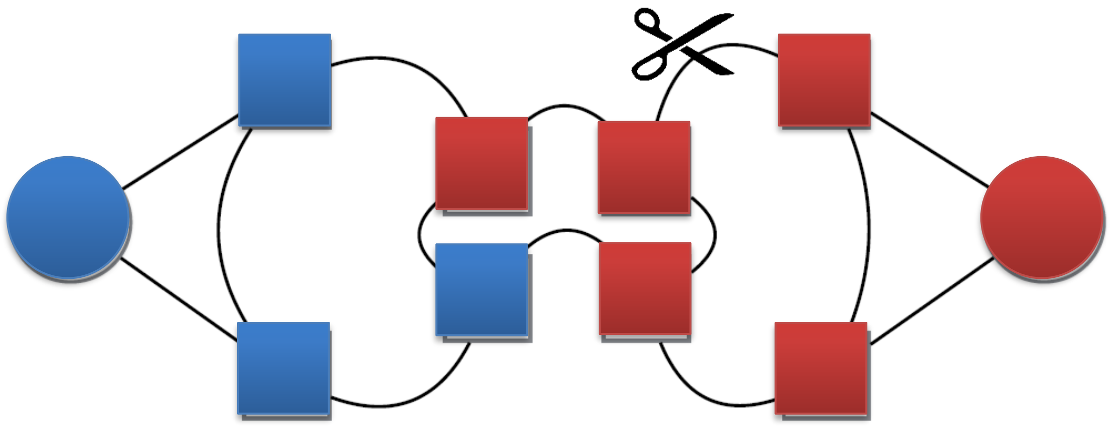
Challenge: Plug&Play

- Support new links / switches / controllers

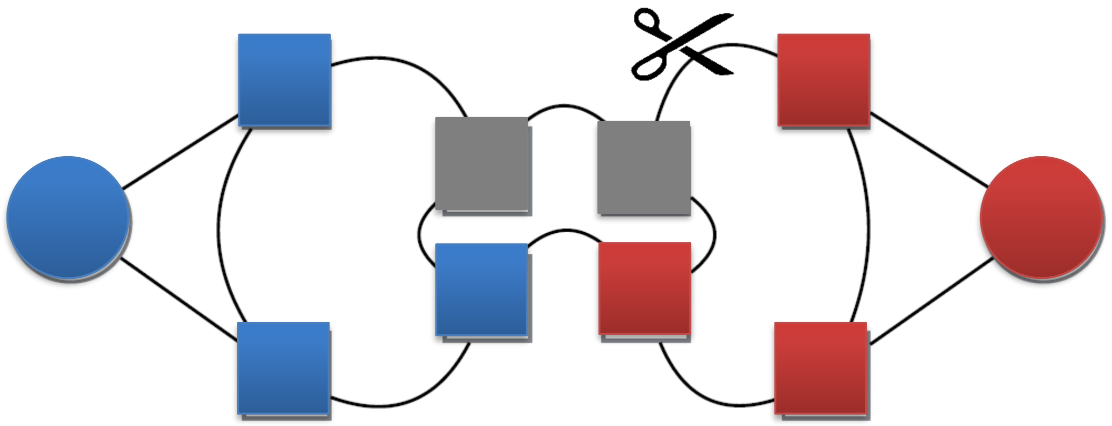


- Switches can't be configured with all possible controllers.

Challenge: Handle Failures



Challenge: Handle Failures



- Goal: Network should return to **a good state.**

Model

“Good network state” :=

- Every switch is connected to a controller.
- Controllers can communicate and make joint decisions.

Our Contributions

A Plug & Play Distributed SDN Control Plane

- Flexible controller membership (additions, removals, failures)
- Automatic switch discovery & topology awareness
- Supports ONIX, ElastiCon, Beehive, STN, and more.

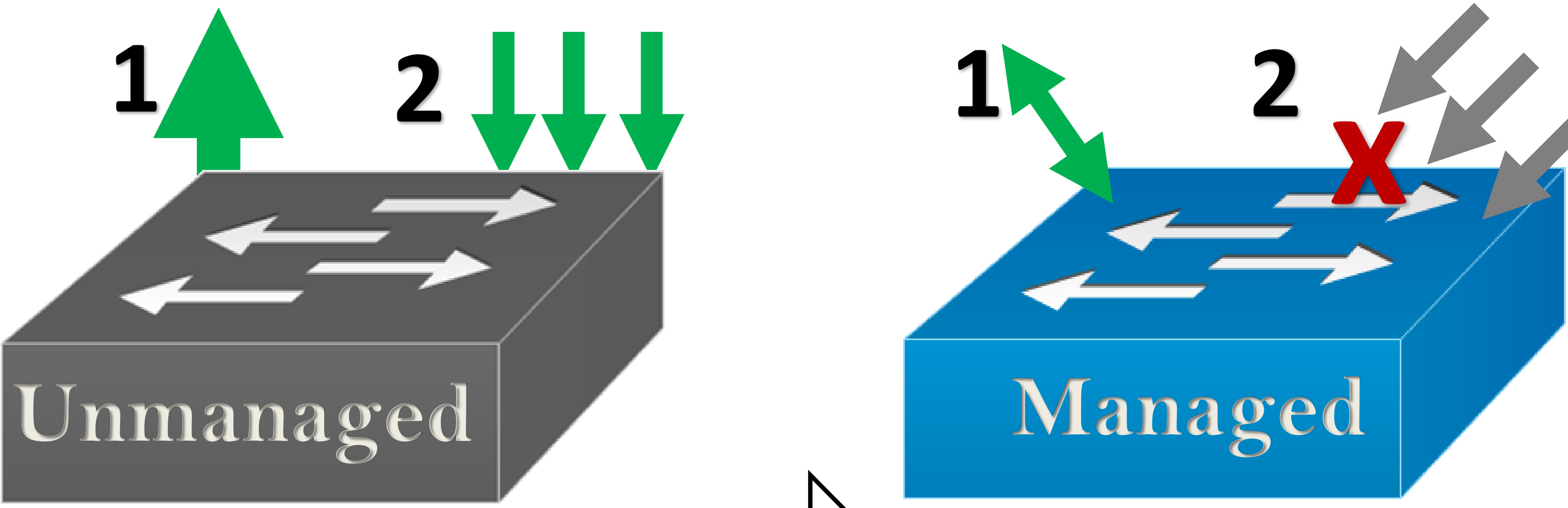
Self Adjusting

- Converges to "good state" from unmanaged states.
- Tolerates failures and delays: low re-convergence times

The Medieval Scheme

- Controllers aim to continuously grow their management regions…
- … and "conquer" unmanaged switches.

Switch States



1. Broadcast
2. Any controller can respond

Session established

No keep-alive timeout

1. Controller traffic is passed through
2. Other controllers are blocked

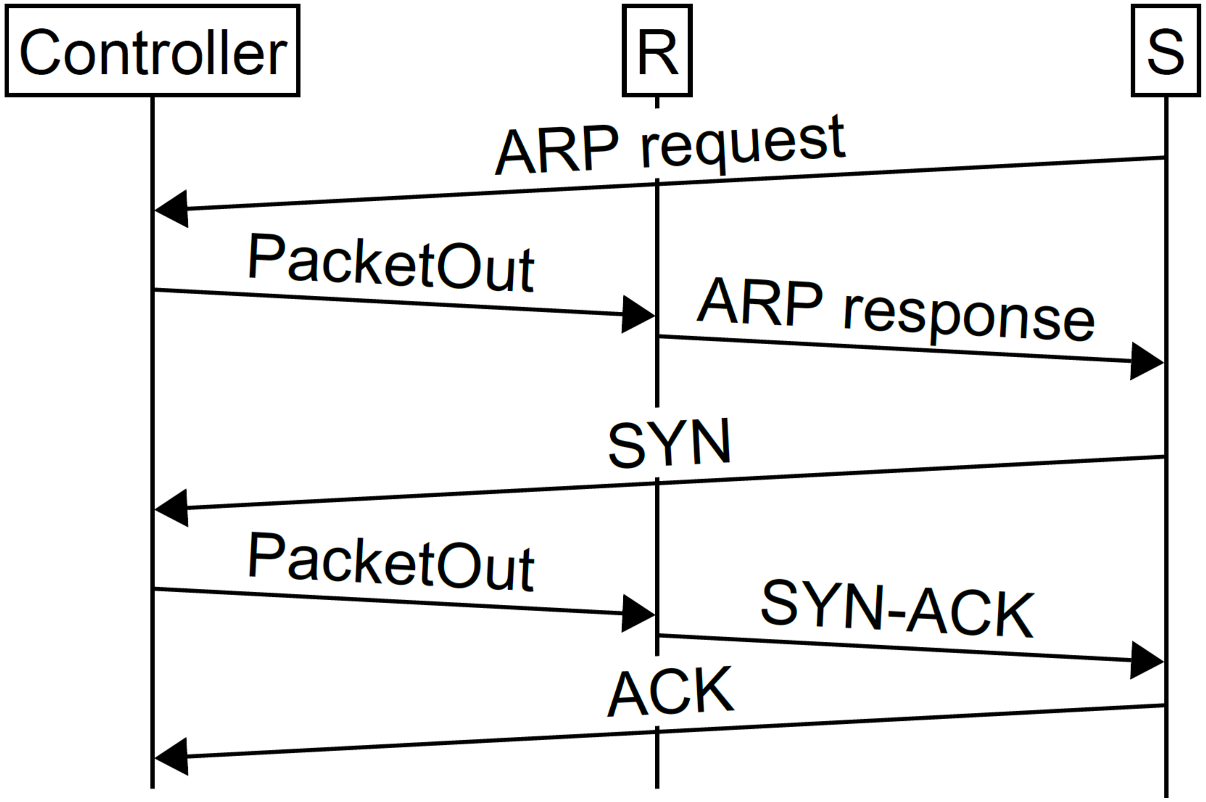
Switch State Configurations

A priori configured

Rules	Properties
Managed	Priority 2, with timeout
Unmanaged	Priority 1, no timeout

Maintained by controller

The Protocol



Controller uses a managed switch, R, to detect and establish connection to a new switch S.

The Medieval Scheme

- Controllers aim to continuously grow their management regions...
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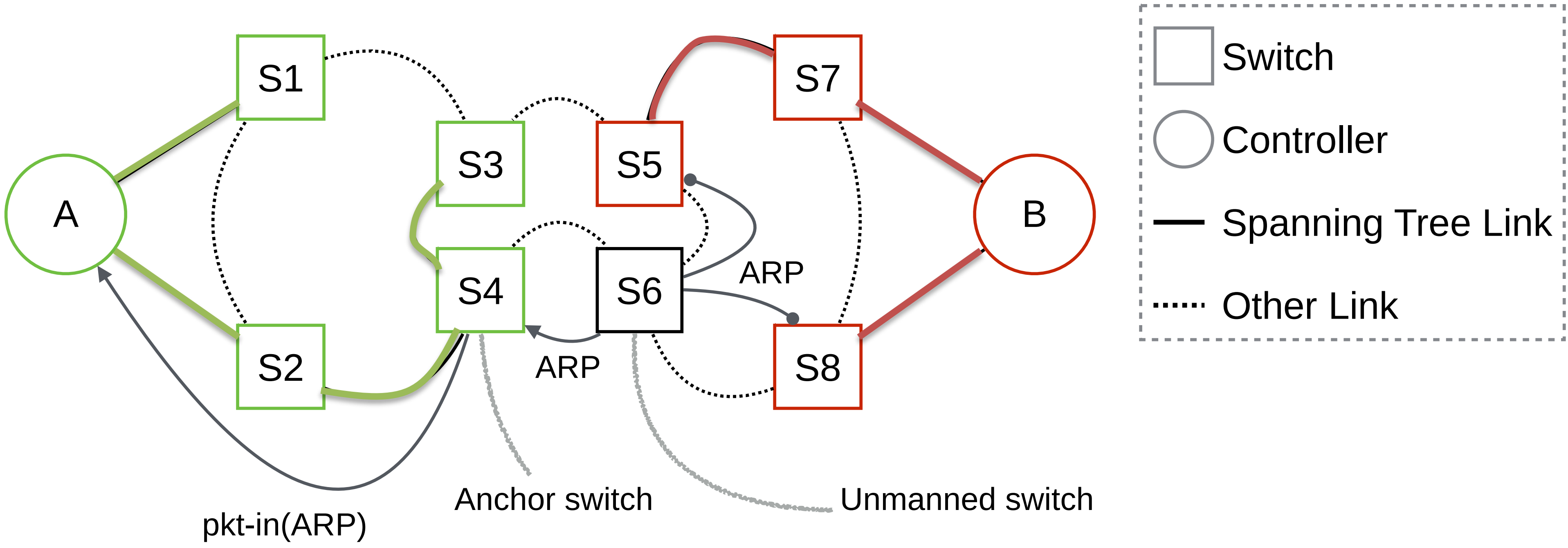
The Medieval Scheme

- Controllers aim to continuously grow their management regions...
- … and "conquer" unmanaged switches.
- Management with two spanning tree types:

  (1) Per-region spanning tree
  (bidirectional, owned by controller)

Controller to Switch Connectivity



Controllers "conquer" switches adjacent to their regions of control and build a spanning tree for controller-to-switch connectivity.

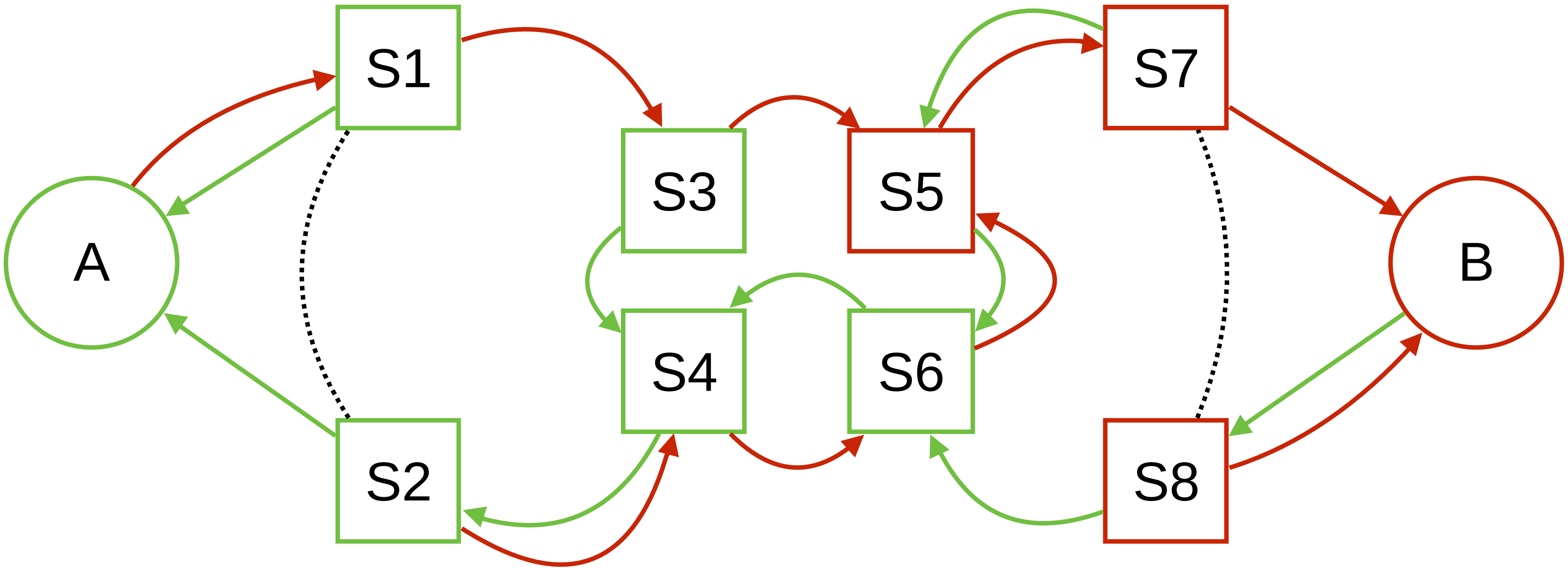
The Medieval Scheme

- Controllers aim to continuously grow their management regions...
- … and “conquer” unmanaged switches.
- Management with two spanning tree types:

    (1) Per-region spanning tree
        (bidirectional, owned by controller)

    (2) Network-wide spanning tree
        (to connect controllers)

Controller to Controller Connectivity



Per-controller global spanning trees provide controller-to-controller connectivity.

Prototype Implementation

- Emulator in Java
- OpenFlow switches and controllers: light-weight threads
- Links modelled by message queues
- Fat-tree topology (k=4), 1-8 controllers
- Measured time to manage switches

# ctrls	1	2	3	4	5	6	7	8
Time(ms)	9382	6983	6150	4224	6035	5104	3704	3680

Prototype Implementation

Conclusions

- Medieval: a robust distributed SDN control plane.
- Fully supported by OpenFlow.
- Convergence can be proved and easily tested.
- Extended analysis and simulation are coming soon.

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