OpenFlow Enlightenment

Extending lightpaths through the campus network

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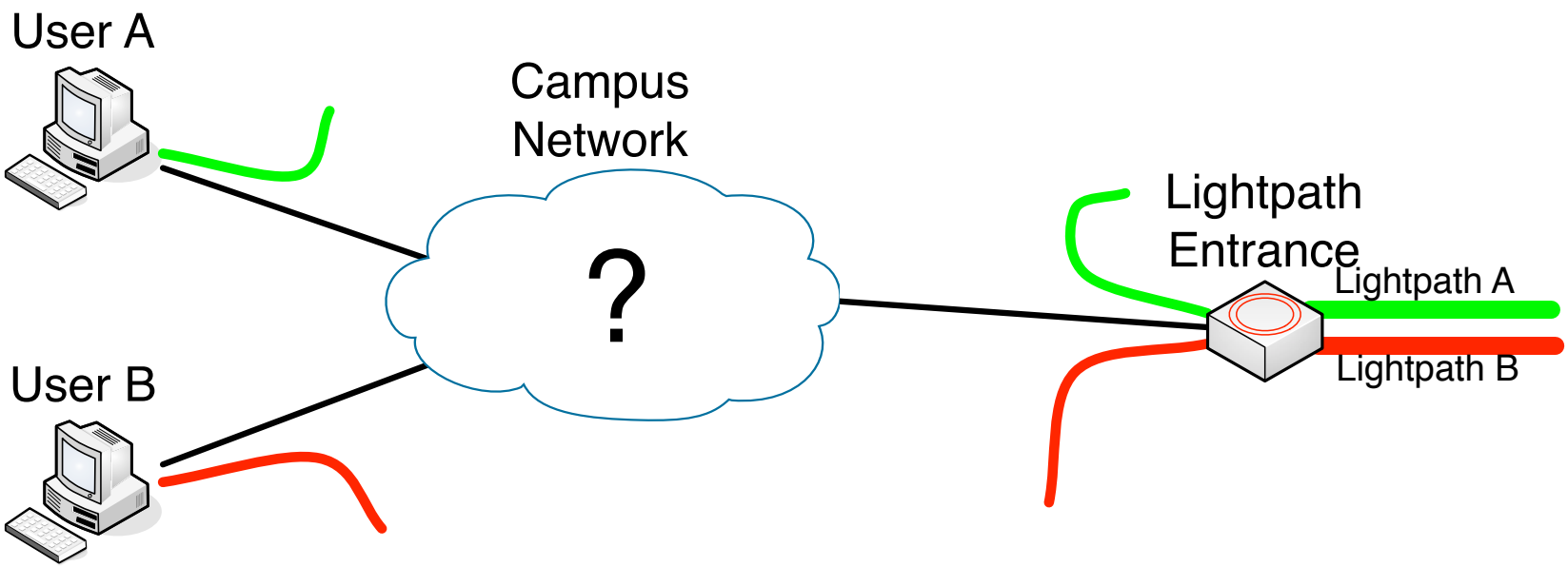
Problem


User A
Campus
Network
Lightpath
Entrance
Lightpath A
?
User B
Lightpath B

OpenFlow

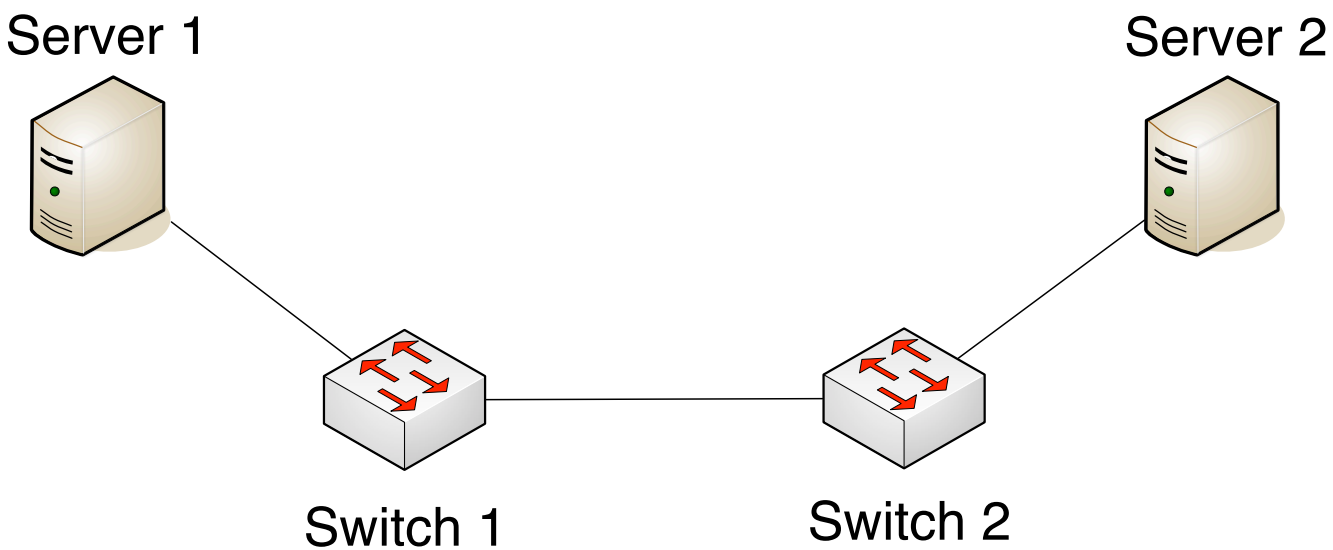
- Software defined networking.
- Dynamic programmable switching/routing.
- Forwarding based on various fields.
- Open interface to network hardware.

Research Question

Given the wide variety of campus networks, what solutions exist to provide end users with fast and easy access to lightpaths in a dynamic and secure way, using OpenFlow on Pica8 3290 switches?

Testbed

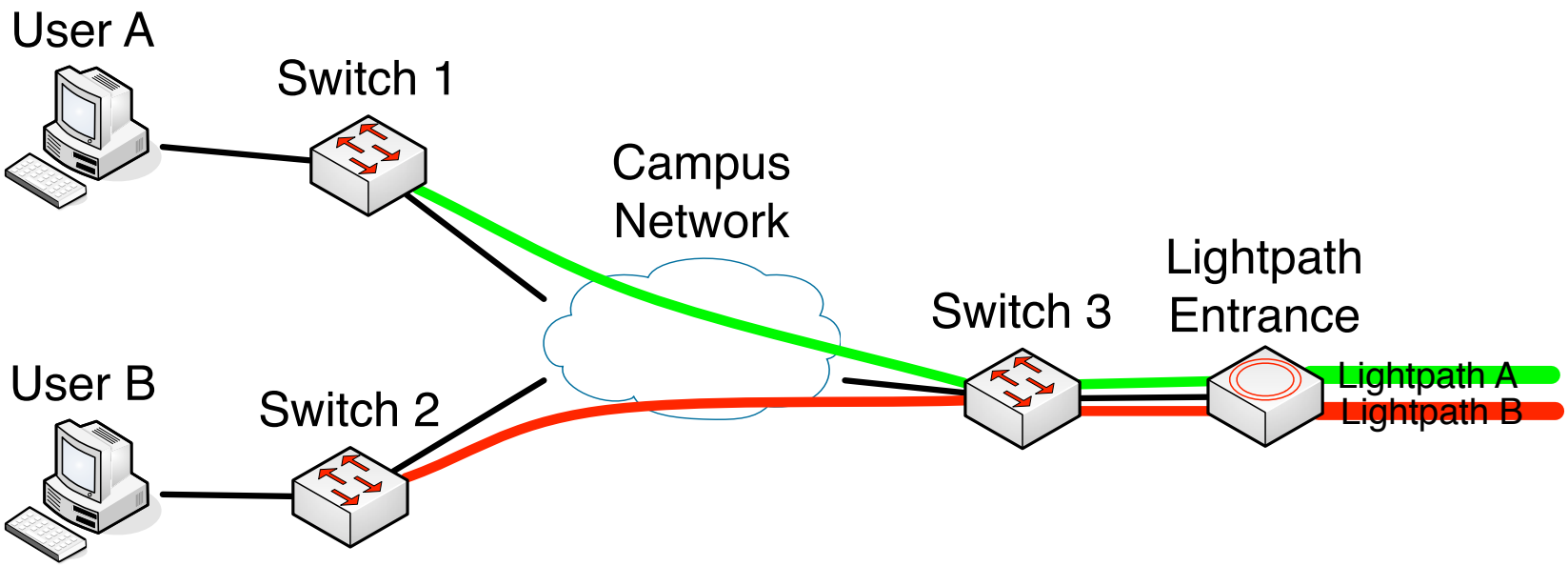
- 2x Pica8 3290 OpenFlow switches (with Open vSwitch)
- 2x Linux server



Generic Solution

Routing:

- Create 'tunnel' between switches over supported protocol.



Generic Solution (2)

Authorization:

- Use one field in header to provide access token.
- Check token on other side of tunnel.
- Update token every interval.

Scenario 1: Layer 2 Switched Network

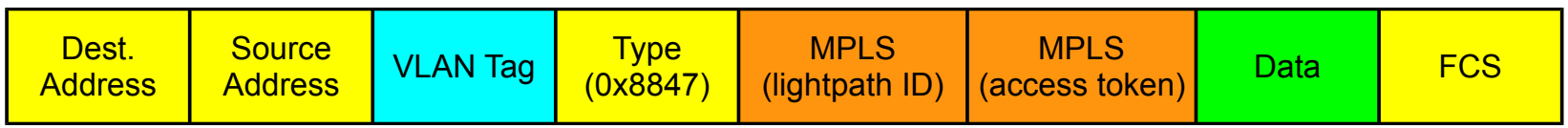
Characteristics:

- Layer 2 path possible between end user and lightpath entrance (same VLAN).
- No IP routing involved.
- Headers above layer 2 remain unaltered.

Layer 2 Switched Network (2)

Solution: VLAN/MPLS.

- VLAN configured between OpenFlow switches.
- MPLS tag added with lightpath identifier.
- MPLS tag added with access token.
- Tunnel endpoint checks tags and forwards to appropriate lightpath.



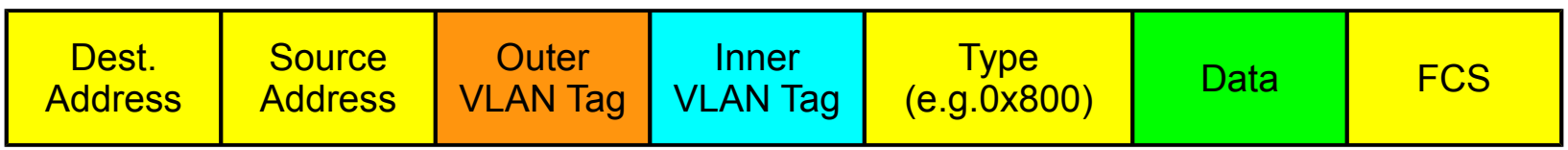
Layer 2 Switched Network (3)

Solution: Q-in-Q (802.1ad).

- Architecture similar to MPLS solution.
- Lightpath ID and access token combined in inner VLAN tag.

Drawbacks:

- Campus network has to support Q-in-Q (uses other ethertype).



Support

Action	OpenFlow v1.2	Pica8 3290
VLAN push	Optional, suggested	Implemented
VLAN pop	Optional, suggested	Implemented
VLAN modify	Optional, suggested	Implemented
MPLS push	Optional	Implemented
MPLS pop	Optional	Implemented
MPLS modify	Optional	Implemented
Q-in-Q	Optional	Not implemented

Support (2)

- All necessary actions are optional in specifications.
- VLAN tag strip does not work as expected.
- MPLS tag push only works for the first packet in an IP/IPv6 flow.

Solutions cannot be implemented on Pica8 3290 with current firmware.

Scenario 2: MPLS Switched Network

Characteristics:

- MPLS label switched path (LSP) between end user and lightpath possible.
- No IP routing involved.
- Multiple MPLS labels can be pushed.

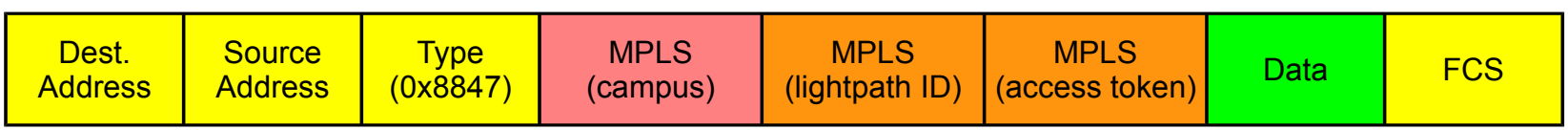
MPLS Switched Network (2)

Solution: more MPLS.

- MPLS LSPs configured between OpenFlow switches.
- MPLS tag added with lightpath identifier.
- MPLS tag added with access token.
- Tunnel endpoint checks tags and forwards to appropriate lightpath.

Drawbacks:

- Both OpenFlow switches need to participate in routing/label distribution protocols to set up LSP.
- Original ethernet header is stripped.



Support

Action	OpenFlow v1.2	Pica8 3290
MPLS push	Optional	Implemented
MPLS pop	Optional	Implemented
MPLS modify	Optional	Implemented

Again:

- All necessary actions are optional in specifications.
- MPLS tag push only works for the first packet in an IP/IPv6 flow.

Solution cannot be implemented on Pica8 3290 with current firmware.

Scenario 3: IP Routed Network

Characteristics:

- No layer 2 path required between OpenFlow switches.
- layer 2 and IP headers can be altered.

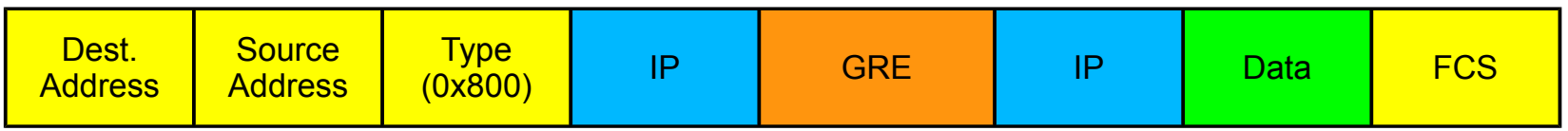
IP Routed Network (2)

Solution: Generic Routing Encapsulation (GRE).

- Set up GRE tunnel between both switches.
- Use GRE key field for lightpath ID and access token.

Drawbacks:

- Original ethernet header is stripped.



Support

OpenFlow v1.2 support:

- GRE is not included in OpenFlow specification.
- OpenFlow does allow 'logical ports' for tunnels.

Pica8 3290 support:

- GRE is supported.
- Only IP over GRE possible.

Conclusion

- Multiple solutions to lightpath problem are possible.
  - MPLS
  - Q-in-Q
  - GRE
- OpenFlow (optionally) supports most of those.
- Implementation on Pica8 3290 not yet mature.

Questions?