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Network Virtualization Based on Flows

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Outline

- Background
 - Network virtualization
 - Flows
- OpenFlow
- OpenFlow within FEDERICA
 - Virtual network architecture for based on OpenFlow
 - Project status

Virtualization Background

- Making a physical network appear as multiple virtual networks
 - Sharing (slicing)
- Separation of functionality as well as traffic
 - Banking, IPTV, web surfing, ...
- Diversity of networking disciplines on the same, shared infrastructure
- Enables network researchers to experiment with new protocols and services

Virtualization Background (2)

- Limitations in network infrastructure
- Network nodes are closed
 - Lack of support for user-defined protocols, management, etc.
- In practice, experimentation and innovation confined to end nodes
 - Overlays, provider-based VPNs, etc.

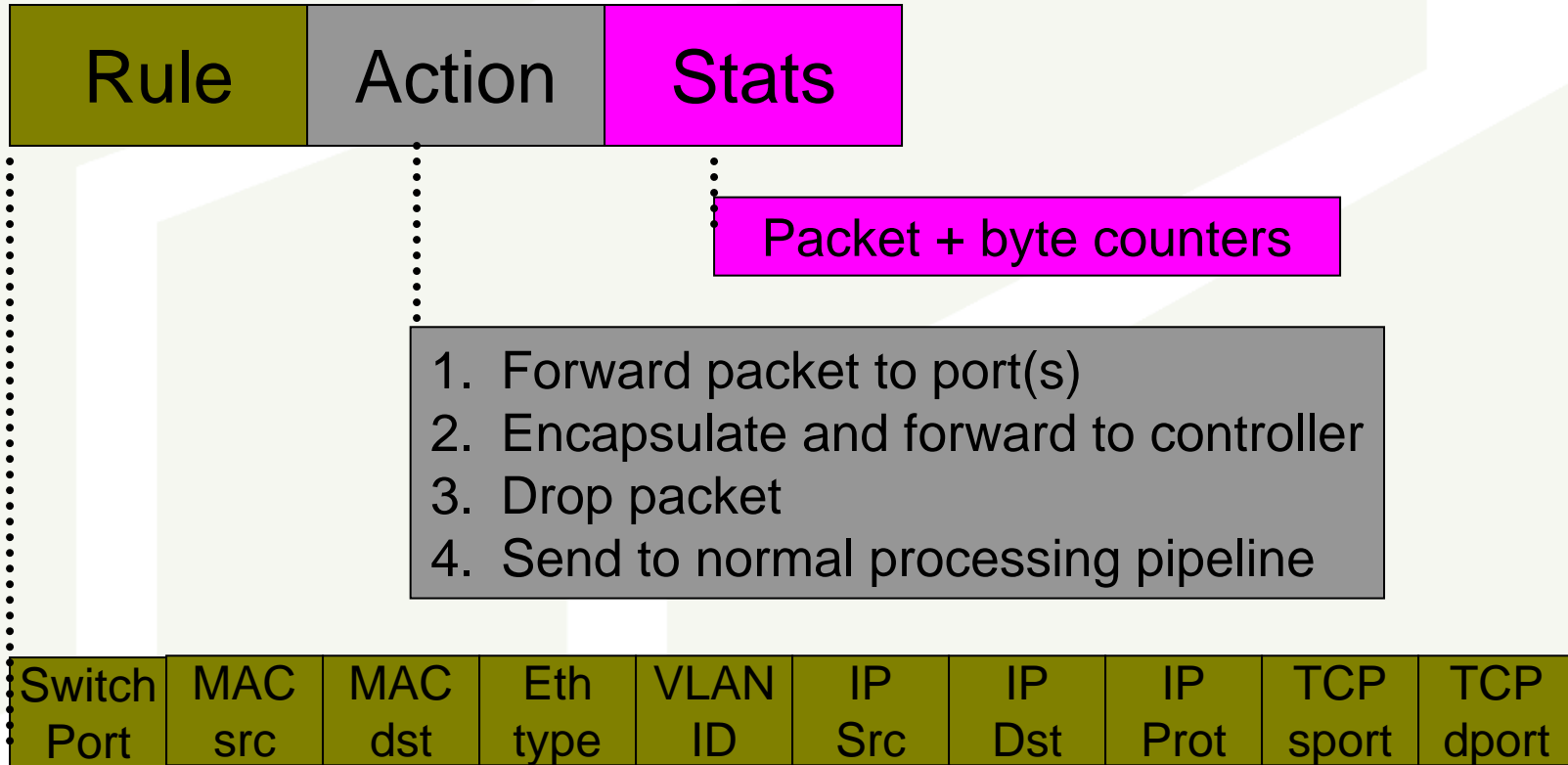
Flows

- Characterizes traffic
 - “All traffic to The Pirate Bay’s web server”
 - “All traffic between KTH and Terena”
 - “All UDP traffic”
 - ...
- Expressed in terms of header patterns (“filters”)
- General way of describing traffic
- Backwards compatibility
 - Tunnels, VLANs, etc, can be represented as flows
- No packet modifications required
 - No need for encapsulation or decapsulation
- No end-point modifications

OpenFlow Initiative

- Originally perceived as a way to open up commercial networking hardware for experimentation
 - Promote innovations in networking
- Gives access to flow tables in switches
 - Lookup tables, access control lists, classification, etc.
 - Control packet forwarding in switches and routers
- OpenFlow Switch Consortium
 - www.openflowswitch.org
- OpenFlow hardware

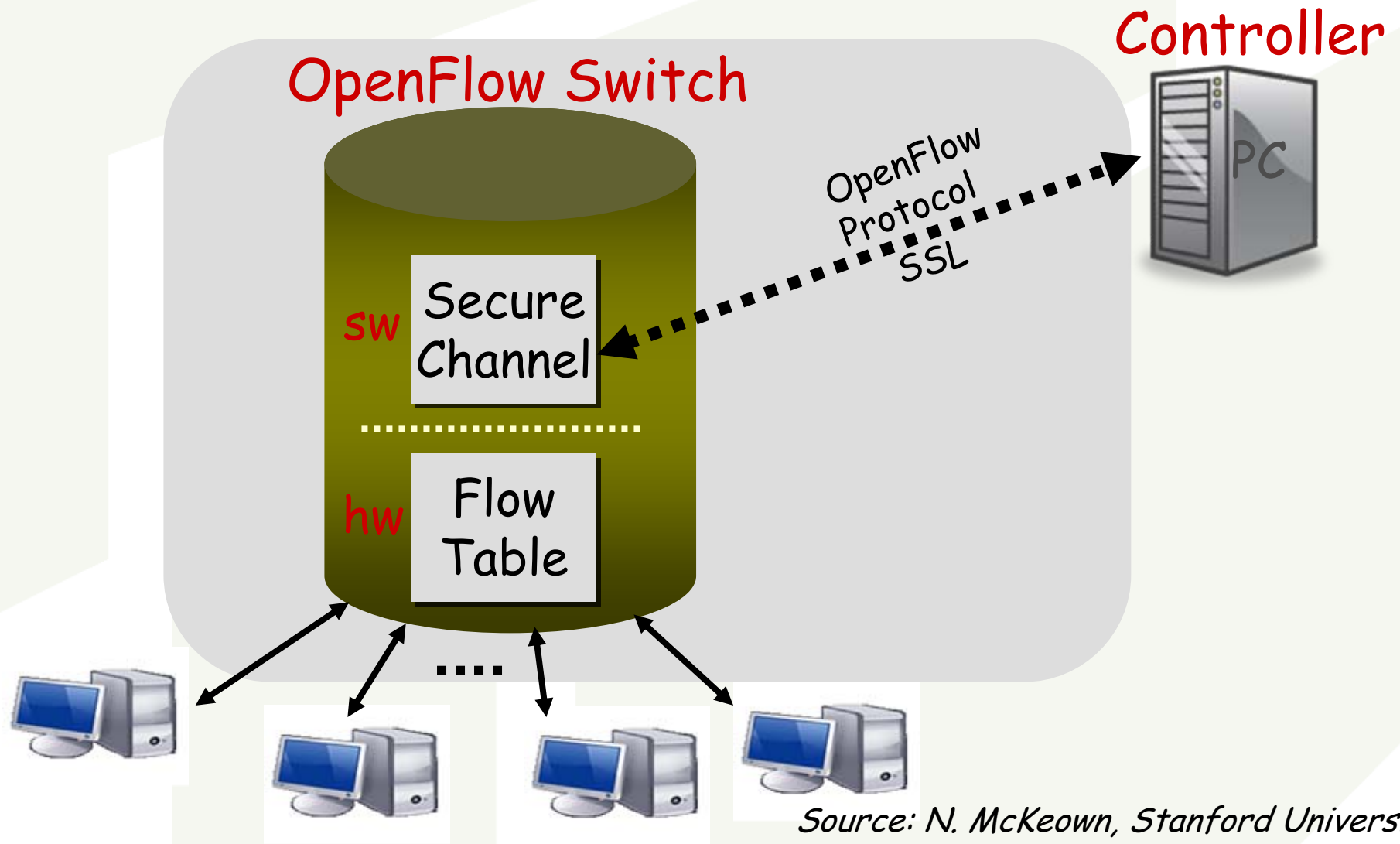
OpenFlow Table Entry



- 10-tuple with mask
 - Wild cards, prefixes, etc.

Source: N. McKeown, Stanford University

OpenFlow Switching

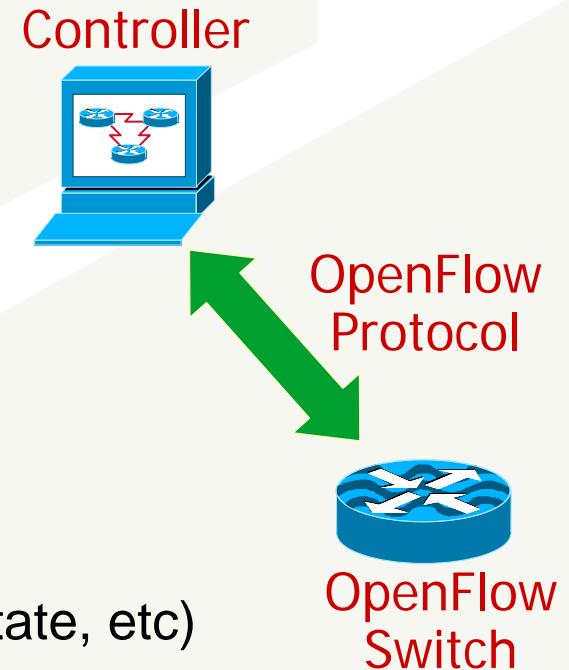


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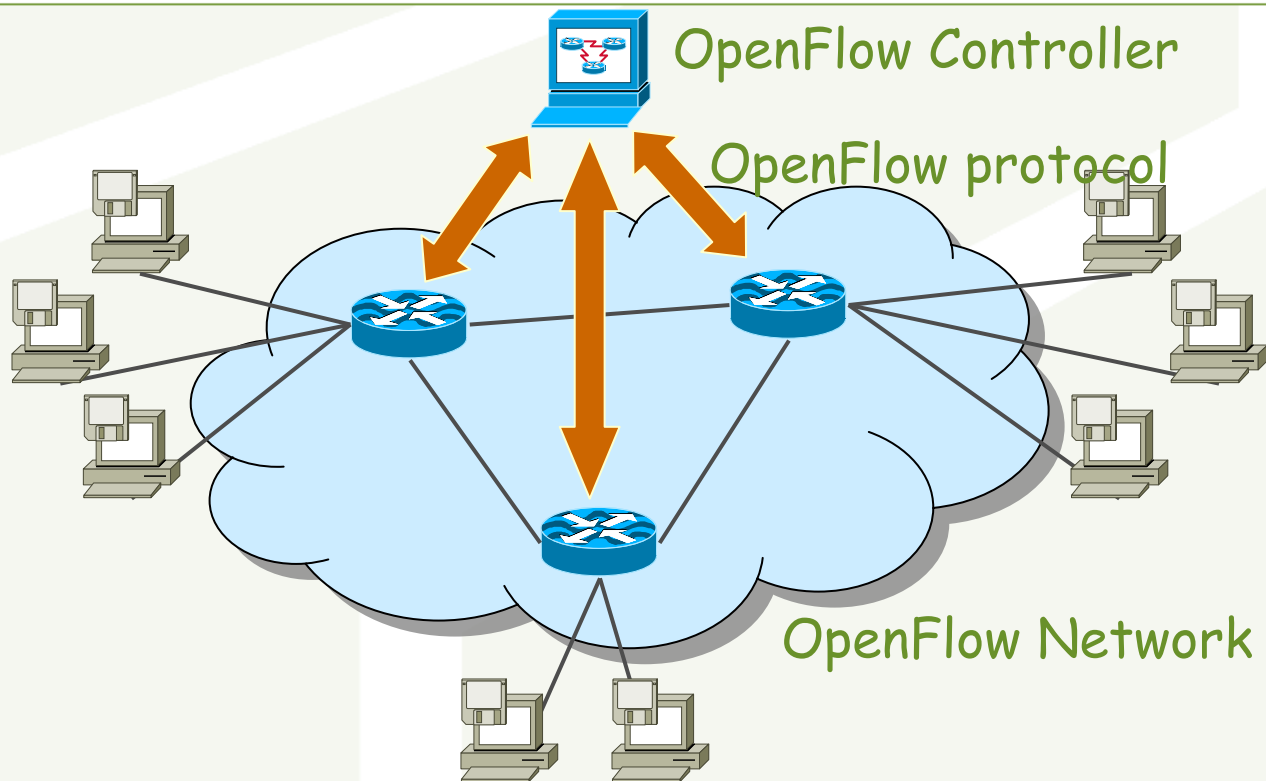
OpenFlow Protocol

Three message types:

- **Controller-to-switch messages**
 - Configuring the switch
 - Managing the flow table
 - Figuring out switch capabilities
- **Asynchronous messages**
 - From switch to controller
 - Report events (switch state, network state, etc)
- **Symmetric messages**
 - Sent in either direction
 - Diagnose problems in switch-controller connection



Centralized Model of Control



- Separation of control and data
- Controller maintains network view
- Flexibility in routing decisions, management policies, etc

FEDERICA OpenFlow Research

- Flow-based network virtualization
- Short-term: Support for automatic configuration of virtual networks
- Long-term: Explore this as a powerful abstraction for network management
- Activities
 - Design a virtual network layer on top of OpenFlow
 - Provide virtualization service interface

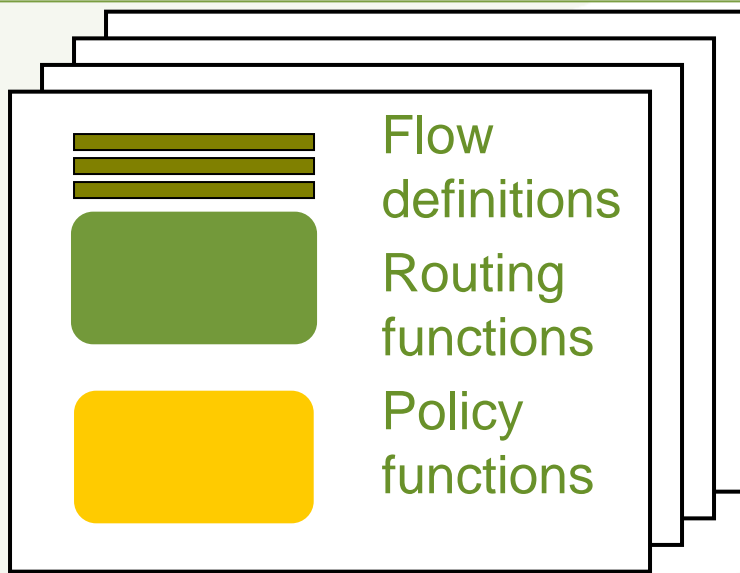
Can we use OpenFlow as the basis for an open virtual network architecture with a powerful management interface, and with efficient support in hardware?

Key Issues

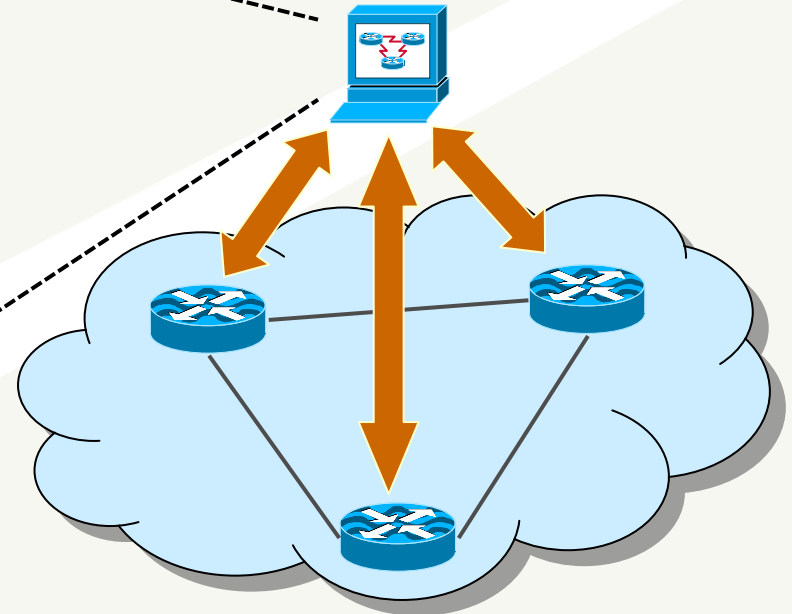
- Definition of virtual network abstraction
 - Knowledge about the network
 - Virtual network specification
- Provisioning of virtual networks
 - Mapping to OpenFlow operations
- Access control, authorization and validation
 - Resolving conflicts between virtual networks

OpenFlow Virtualization

Virtualization Controller

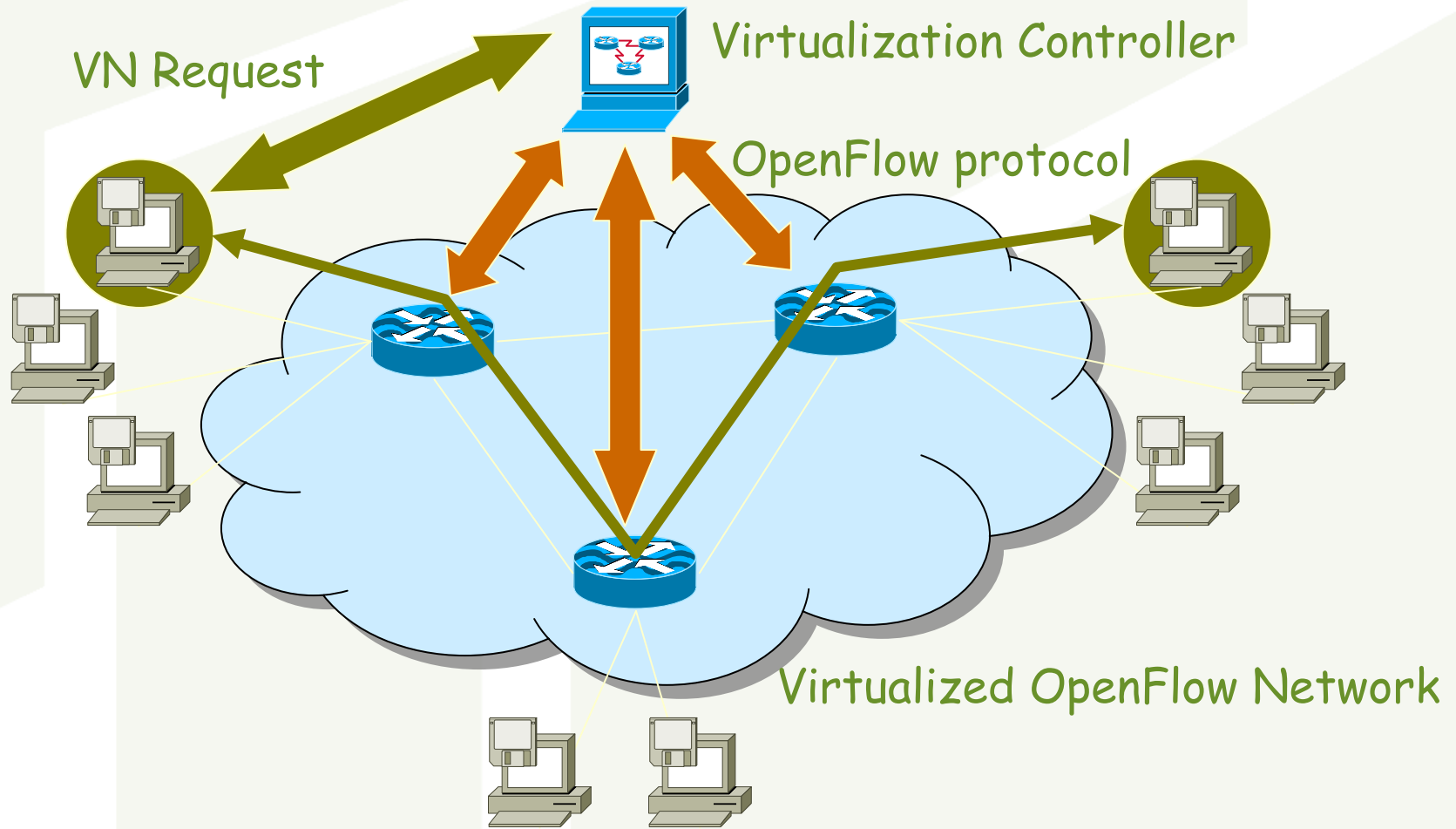


Virtual Network Definitions



- Virtual network defined in terms of flows and functions
 - Routing
 - Policy
 - ...
- Controller sets up flow table entries according to routing and policies
 - Traffic-driven or pre-configured (or a combination)

OpenFlow Virtualization



Approach

- Design and implementation
 - Key components
 - Virtual network controller
 - Based on NOX platform (<http://www.noxrepo.org>)
- Small-scale experimental study
 - Linux environment
- Large-scale experimental evaluation
 - FEDERICA infrastucture
 - OpenFlow-enabled equipment

Conclusions

- Network virtualization based on flows
 - General and flexible
- OpenFlow
 - Open up infrastructure for experimentation and innovation
 - Hardware support
- Virtualization mechanism for FEDERICA
 - OpenFlow Virtual Network definition
 - Management for flow-based virtual networks
- Work in progress on design and evaluation

Thank you for listening!