Karlstad University

Computer Science Department

University of Zagreb

Faculty of Electrical Engineering and Computing

Towards QoE-driven Multimedia Service Negotiation and Path Optimization with Software Defined Networking

Andreas Kassler[1], Lea Skorin-Kapov[2], Ognjen Dobrijevic[2], Maja Matijasevic[2], Peter Dely[1]

[1] Karlstad University, Computer Science Dept., Sweden

[2] University of Zagreb, FER, Dept. Of Telecommunications, Croatia

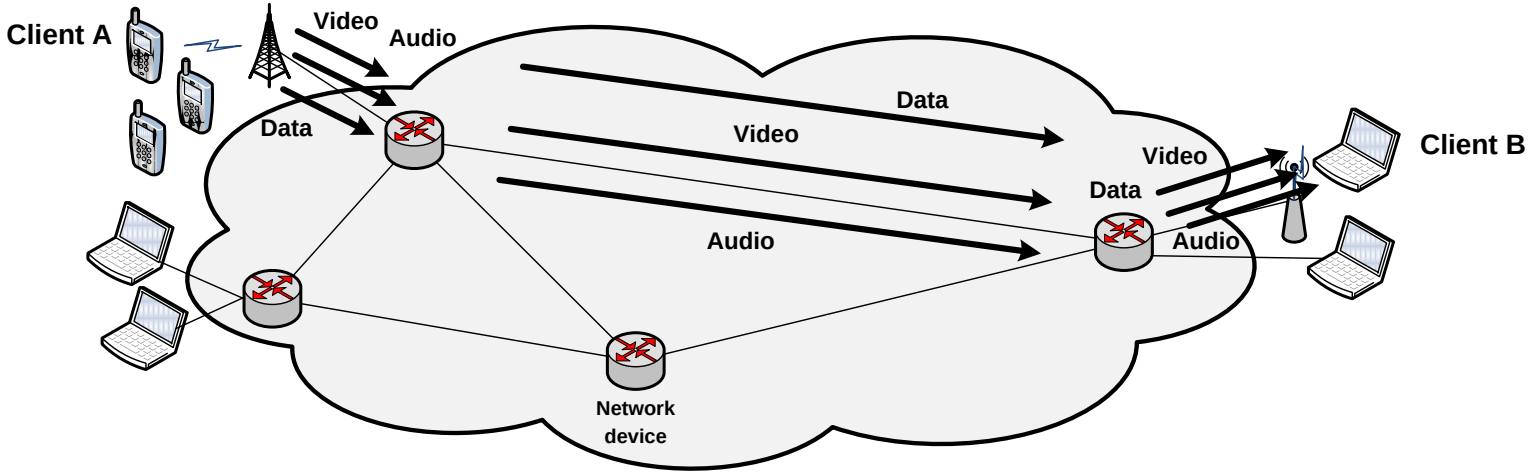
The 20th International Conference on Software, Telecommunications and Computer Networks (SoftCOM 2012)

Outline

- Problem and motivation
- Key enablers for the proposed approach
  - QoE-based service negotiation and resource optimization
  - Software defined networking
- The proposed architecture
  - QoS Matching and Optimization Function
  - Path Assignment Function
- Example scenario
- Conclusions and future work

Problem description

- How to deliver multimedia services under resource constraints according to user perceivable quality, or **QoE**
  - The need for mechanisms which allow negotiation on the content delivery and optimization of network resources
- In current systems all data flows follow the same path
  - This path may not be the “best” for a particular media flow type



Motivation and proposed approach

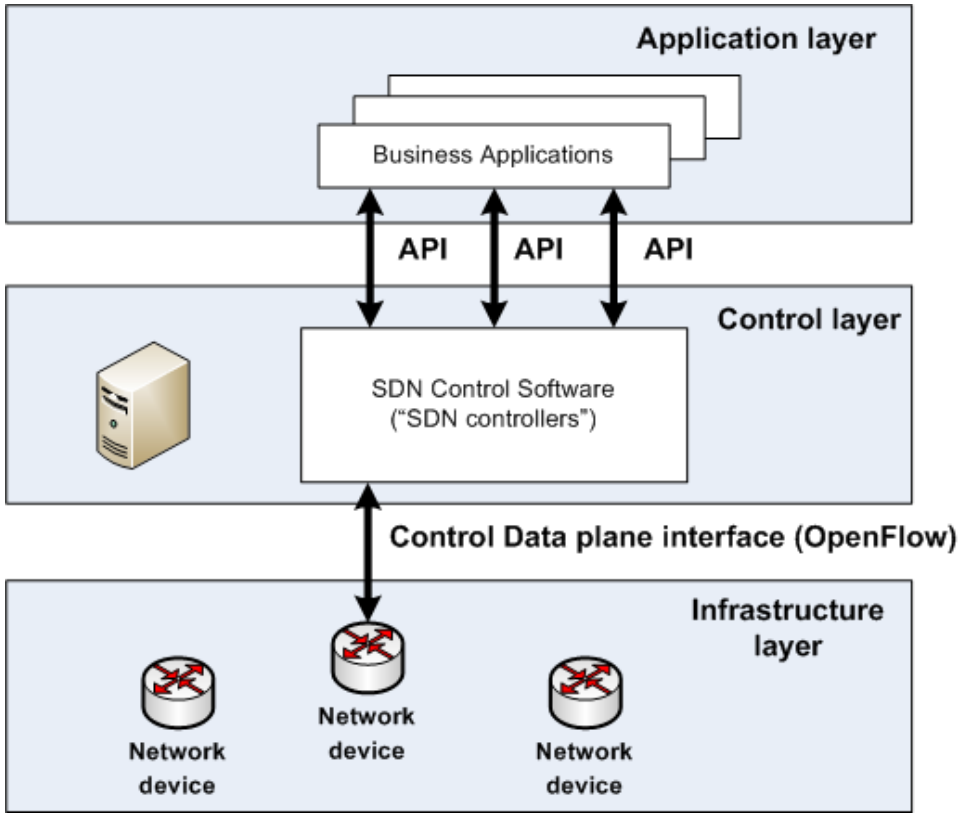
- The **joint** consideration of end-user **QoE** and **path assignment** may enable **path optimization** for multimedia flows so as to **maximize QoE**
  - Optimizing the configuration of network devices and end-hosts requires grained control over the packet forwarding
- We propose a new system within the framework provided by Software Defined Networks (**SDNs**)
  - To allow delivering each media flow over the “best available” path using the “best service configuration” in order to maximize the total QoE for all users
  - SDNs offer hardware vendor-independent APIs to implement such functionality

Key enablers: Service negotiation & optimization

- QoE is influenced by a wide range of factors
  - Related to the user, service, network, device, context of use, etc.
- Allocation of network resources optimized based on QoE
  - QoE-driven decisions on the allocation need to consider the correlation between network performance and QoE
  - Also need to account for the influence of additional factors (e.g., user-related and context-related)
- Service negotiation precedes the optimization
  - Feasible session parameters need to be negotiated between actors involved in the service delivery chain
- Domain-wide resource allocation across multiple sessions

Key enablers: Software defined networking

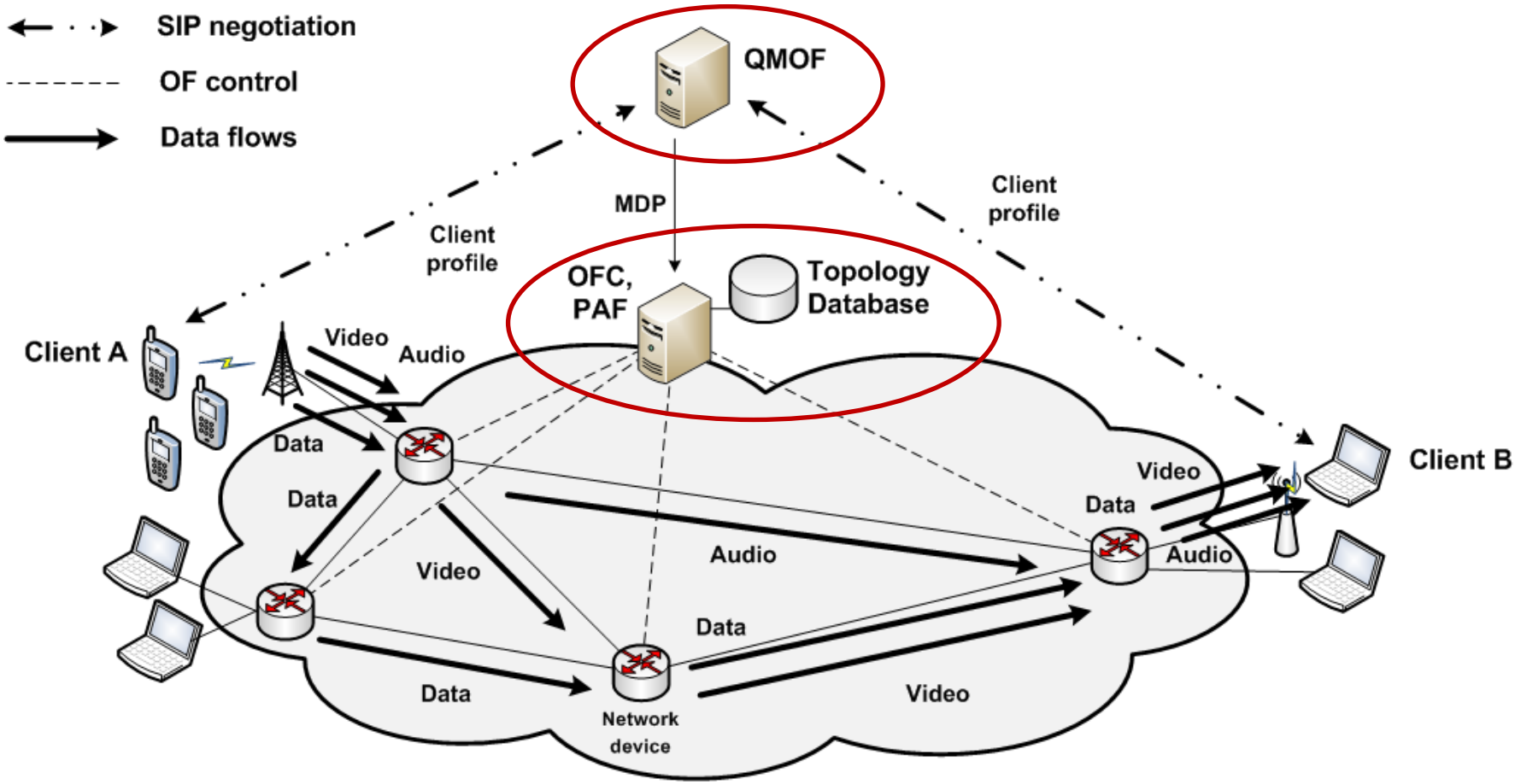
- SDN decouples the data and control planes
  - The control is logically centralized and programmable via standardized interfaces - flexible control over network services



Key enablers: Software defined networking (cont'd)

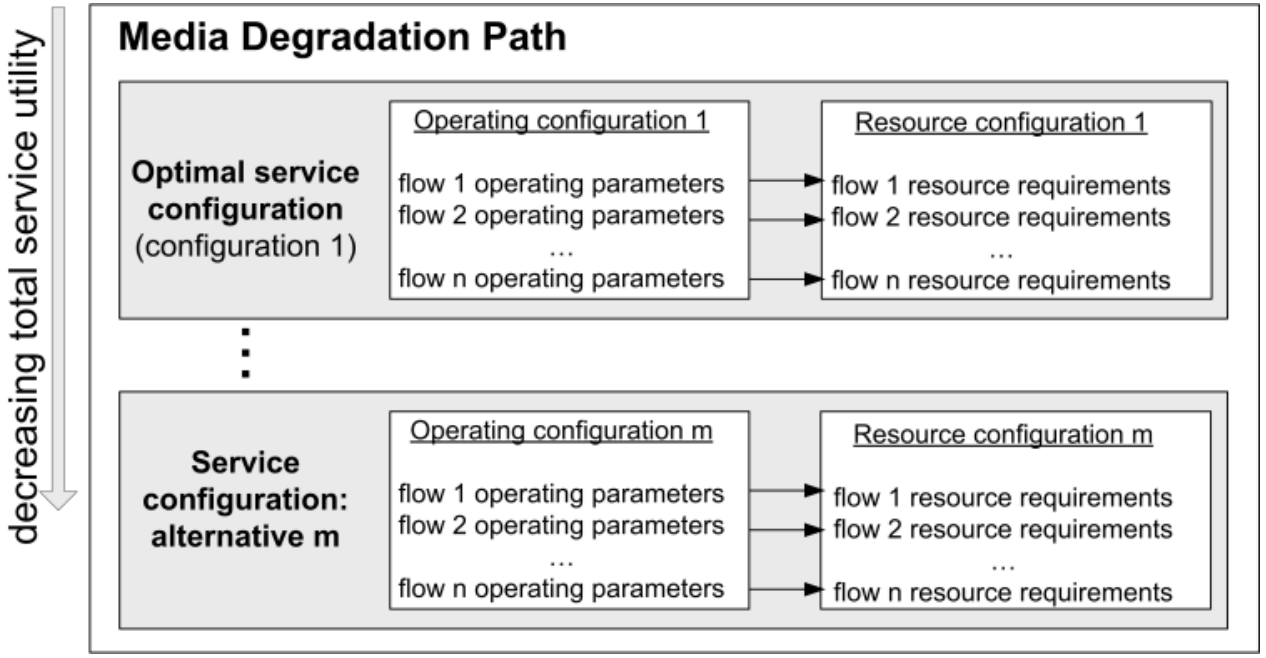
- The **OpenFlow** protocol: provides a standardized interface between the SDN controllers and the network devices
- Ongoing effort to provide open APIs between the SDN control layer and applications layers
  - Applications can use network services and capabilities as needed, **without knowing the network specifics**
- The SDN control layer has a "global view" on the network topology graph
  - Ability to implement control applications that use traditional graph optimization algorithms for traffic engineering

The proposed architecture



The QoS Matching and Optimization Function (QMOF)

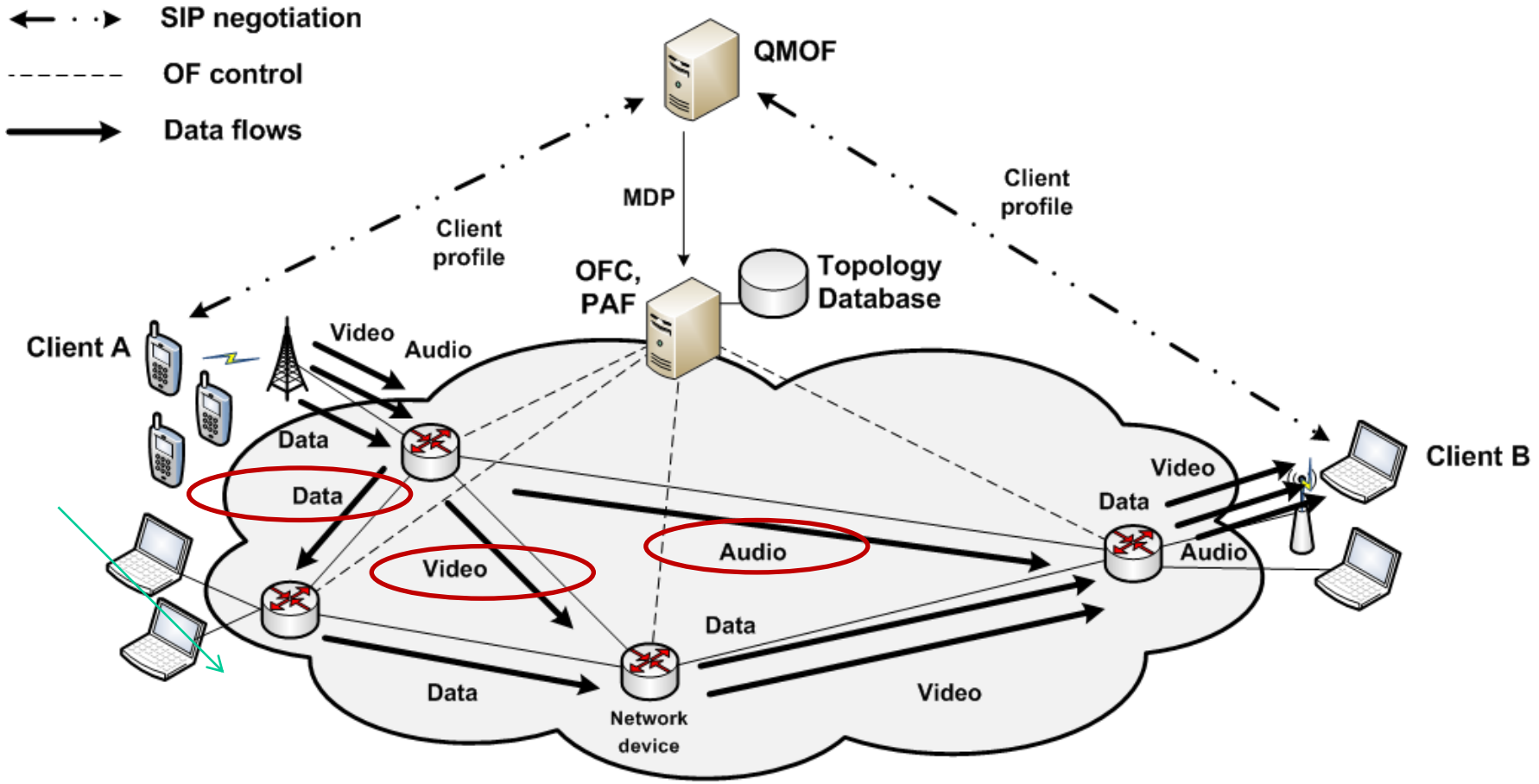
- QMOF resides in the SDN **application layer**
- It conducts an initial parameter **matching** process to produce **feasible service configurations**
- The *optimization* process calculates the optimal configuration and several suboptimal configurations - **Media Degradation Path** (MDP)



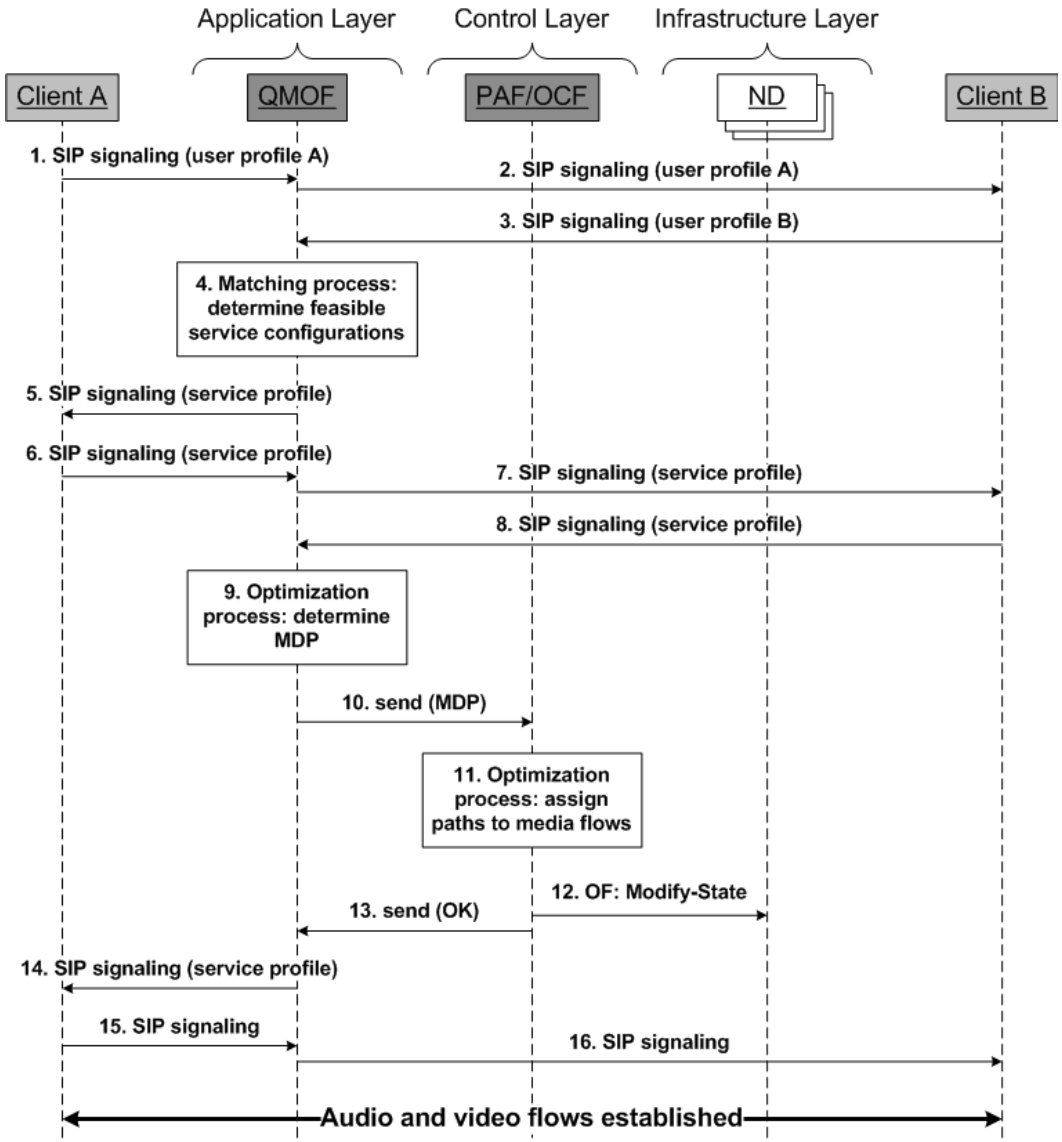
The Path Assignment Function (PAF)

- PAF is located in the SDN control layer and executed on the **OpenFlow controller (OFC)**
- It **optimizes the network paths** to meet the resource requirements of a currently active service configuration
- It **exposes an API**, which the QMOF uses to inform the PAF about the MDP referring to a set of flows in a session
  - Using the MDP configurations, the PAF tries to assign such paths to each of the flows, so as to meet the specified service requirements
- It **configures the forwarding tables** of the network devices by using the OpenFlow protocol
  - The PAF can specify at each network device, which is the next-hop of a flow and what the minimum rate is

Example scenario outline



Example scenario: high-level control interaction



Conclusions and future work

- The system does not require the network devices to have any other special capabilities, except for the OpenFlow support
  - Independence of the used link layer technology
- The system is more lightweight and flexible comparing to overlay networks
  - No overlays need to be maintained
  - The routing does not depend on any overlay structures
- We plan to implement the proposed system in an emulated network environment
  - Proof-of-concept prototype
  - Performance experiments

- Backup slides