Software-Defined Networking
an der Universität Münster

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Kolloquium Erneuerung des Kommunikationssystems der WWU,
1. Quality of Service with SDN
Problems with QoS in Traditional Networks

- Network components (routers, switches) are closed systems
- Control logic managing the forwarding of data packets is integrated in the components
- Only limited possibilities for influencing packet forwarding decisions
- No possibilities to dynamically react to problems like congestion of specific routes
- Current Quality of Service (QoS) standards (e.g. IntServ, DiffServ) are static and not widely supported

→ Nearly all applications use the network on a best-effort basis
Exploiting SDN for Improving QoS

- With *Software-Defined Networking (SDN)*, applications can dynamically reconfigure the network for their purposes
- **Our goal:** Provide QoS for real-time applications using SDN
- **Our work:** Novel API and its implementation for QoS specification and monitoring
- **Central research challenge:**
  Translation: application QoE $\rightarrow$ network QoS

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Game Client

Game Server

SDN Network

Controller adapts network to fulfil QoS

Server sends network QoS requirements to SDN Controller

Controller

QoS API

QoS

Game Server

2
QoS API Basic Architecture

- QoS requirements are specified by the developer for a particular flow using the application-level API ①
- The QoS requirements are automatically reported to the SDN controller by the SDN Module via the network-level API ②
• Problem: the SDN controller can only understand and manage QoS requirements which are based on network-level metrics, e.g., throughput, packet loss, etc.
• These are too low-level from the developers point of view and not directly related to application-level metrics
• SDN Module provides application-level metrics for the specification of QoS requirements to the developer, e.g., response time
• Automatic translation into network-level metrics at runtime
• Design goal: transparent for the developer, no different usage of application- and network-level metrics in the SDN Module
Once an application-level requirement has been specified, steps b) – d) are continuously repeated and the translated QoS requirement is adapted if the runtime monitoring data changes.
2. Multicast with SDN
**Traditional networks:** IP multicast, key properties:

- Receiver initiated: receivers subscribe at local MC router (IGMPv3/MLDv2)
- No membership control possible for the sender
- Every host can send to any MC group without joining it
- Distributed MC routing (e.g., using PIM)

→ **Not desirable** in many application use-cases
Multicast (MC)

Our approach: multicast exploiting the centralized SDN architecture

- Sender initiated: no action required from the receivers
- Full membership control for the initiator
- Only the initiator is able to send data to the MC group
- Centralized MC routing by the SDN controller

→ Alternative to IP multicast, not a replacement
Example scenario: host 1 sends data to hosts 2 and 3 using multicast
The multicast is initialized in 4 steps
**Step 1:** Host 1 specifies a multicast group with IP addresses of 2 and 3.
Step 2: the group specification is sent to the SDN controller
Step 3: the SDN controller installs the multicast in the network
New rules are added to the flow tables of switches A and B
Step 4: the multicast address is returned by the SDN controller to host 1
Host 1 sends a multicast packet to the multicast address
(d = 20.0.0.1)
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SDN-based Multicast: Sending Data

The packet matches the new rule in switch A and is forwarded to B.
SDN-based Multicast: Sending Data

The packet matches the new rule in switch A and is forwarded to B.
In switch B, the multicast packet is transformed into a unicast packet: the multicast address $d$ is replaced by the unicast address $d^+$ of host 2.
In switch B, the multicast packet is transformed into a unicast packet: the multicast address d is replaced by the unicast address d* of host 3.
The modified packets are forwarded to hosts 2 and 3, respectively.
SDN-based Multicast: Sending Data

The modified packets are forwarded to hosts 2 and 3, respectively.
Advantages of SDN-based Multicast

Sender initiated

- Sender specifies the MC group and initiates the MC
- Receivers can be added and removed dynamically
- Minimized management overhead in the network: no IGMP needed

Receiver transparent

- MC packets are transformed into unicast packets before their delivery
- Minimized frame filtering in receivers NIC and IP stack
- Receivers cannot send to MC group without sender

Also works with IPv6 (requires OpenFlow 1.2 support)
Potential problem of SDN-based MC (also of IP MC):

- MC forwarding rules are stored in the switches
- Flow table size is a potential bottleneck for MC scalability

→ limited number and/or size of MC groups

Central research challenges:

- Reduce the number of switches for realizing MC
- Save flow table space by reusing unicast entries
Traditional MC routing: find a path to all receivers of a MC group by using Shortest-Path Trees (SPT)
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Applying our so-called *Branch-aware Modification (BAM)* to an SPT allows for reusing unicast entries.
3. SDN-Pilotprojekt zur Netz sicherheit
Zugangsschutz zum LAN mit SDN

- Kooperation zwischen dem Institut für Informatik und dem ZIV
- Bachelorarbeit zum Thema Zugangsschutz mit SDN als Alternative zu IEEE 802.1X
- Motivation: Erfahrungsaufbau mit SDN
- Ziele des Projekts:
  - Endgeräte anhand ihrer MAC-Adresse autorisieren
  - Einfache, zentrale Konfiguration
  - Gruppierung von Switches/Ports zu Zugangsbereichen
  - Filtern bestimmter Diensten
  - Keine zusätzliche Software für die Endgeräte
- Umsetzung als Modul für den *HPE VAN SDN Controller*
- Fortsetzung des Projekts in Abschlussarbeiten und Seminaren
Konzept des Zugangsschutzes mit SDN

CoreEdge
SDN
Controller
Administrator
configure
access rules

Edge
Core
SDN
Controller
Administrator
configure
access rules
Konzept des Zugangsschutzes mit SDN

Core

Edge

Core Edge

set rules

normal switching

SDN Controller

Controller
Konzept des Zugangsschutzes mit SDN
Konfiguration der Zugangsschutz-App

Web-Portal zur Konfiguration des Zugangsschutzes für den Administrator
Vielen Dank!