

Scrutinizing IXPs

Insights into the World's Largest IXP
and Outlook on SDN and Beyond

Arnold Nipper

Chief Technology Evangelist and Co-Founder
arnold.nipper@de-cix.net

Dr. Thomas King

CTO/2
thomas.king@de-cix.net

Agenda

- » Introducing DE-CIX
- » Peering vs. Transit
- » Technical Insights
- » Looking into the SDN Future

Introducing DE-CIX

Definition: Internet eXchange Point (IXP)

- » A physical network facility operated by a separate legal entity
- » Interconnection of more than two independent Autonomous Systems (AS)
- » Interconnection of ASes only
- » Primarily facilitating the exchange of Internet traffic
- » Distinct from an Internet access network or a transit network/carrier
- » See <https://euro-ix.net/ixps/what-is-ixp/> for more details

DE-CIX Facts

- » Owns and Operates IXPs in
 - » Germany (Frankfurt, Hamburg, Munich, Dusseldorf)
 - » USA (New York, Dallas)
 - » Italy (Palermo)
 - » Turkey (Istanbul)
 - » France (Marseille)
- » Operates the IXP UAE-IX in Dubai
- » Designed, built and operates IXP angonix in Angola (Luanda)
- » Provides Internet exchange services such as peering: the settlement-free exchange of Internet traffic
- » Strictly carrier- and data center-neutral

DE-CIX Facts - eco Association

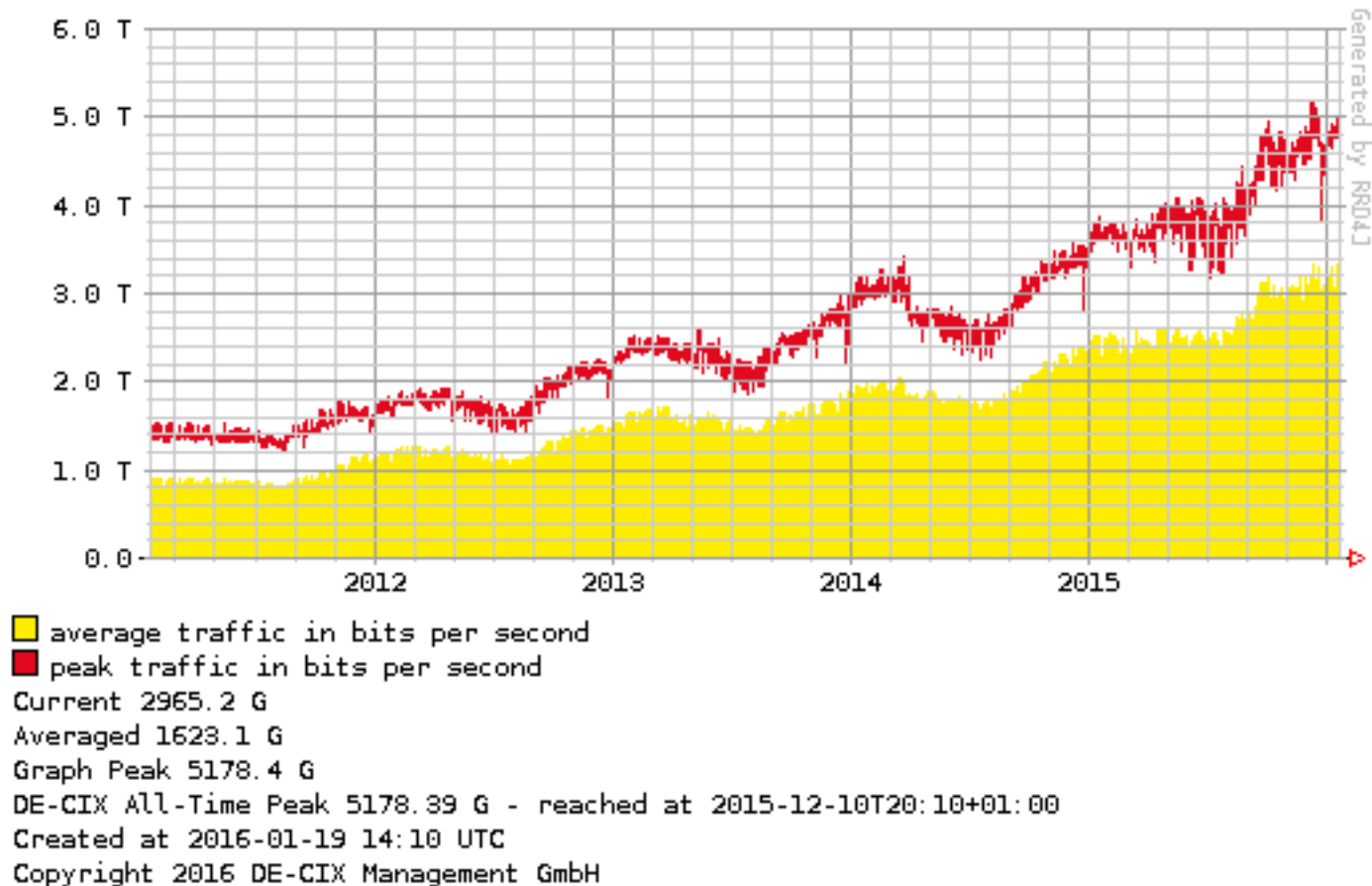
- » Name: eco – Verband der Internet Wirtschaft e.V.
- » Owner of DE-CIX
- » Non-profit association for the Internet industry
- » 830+ members (such as AT&T, Cisco, CloudFlare, Telekom, ...)
- » Representing its members interests in politics and in international bodies
- » Offers legal support
- » Brings together competence groups for hot topics (e.g., infrastructure security)



DE-CIX Frankfurt

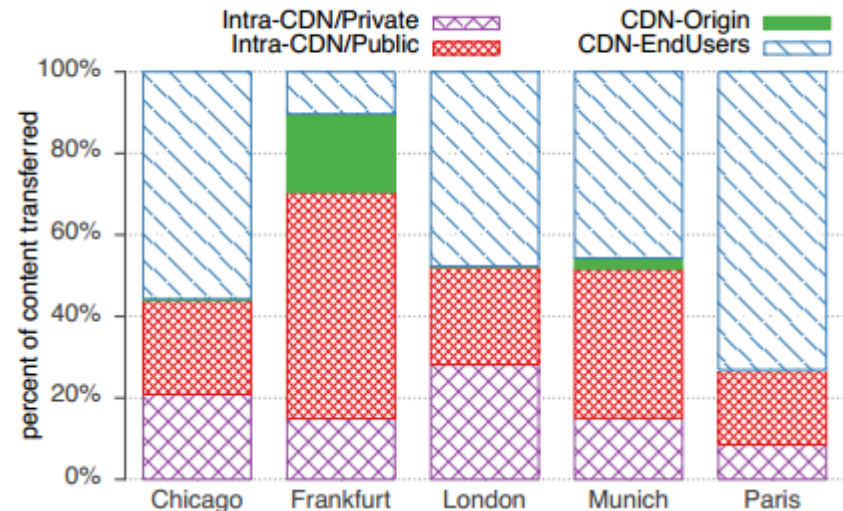
- » Founded in 1995
- » World's largest Internet exchange
 - » 01/2015: 3.8 Tbps peak, 2.2 Tbps average in December, 23.8 PB per day
 - » 01/2016: 5.1 Tbps peak, 3.0 Tbps average in December, 32.4 PB per day
 - » ~36% traffic growth (average)
- » Serves and connects more than 670 networks
- » Keeps 85,000 active peering sessions stable
- » Has 178x 1GE, 913x 10GE and 97x 100GE ports connected
- » Total connected capacity of 19 Tbps
- » Most valuable IXP with more than 7 Gbps per customer
- » Available in 18 data centers throughout the city of Frankfurt

DE-CIX Frankfurt – Traffic Growth



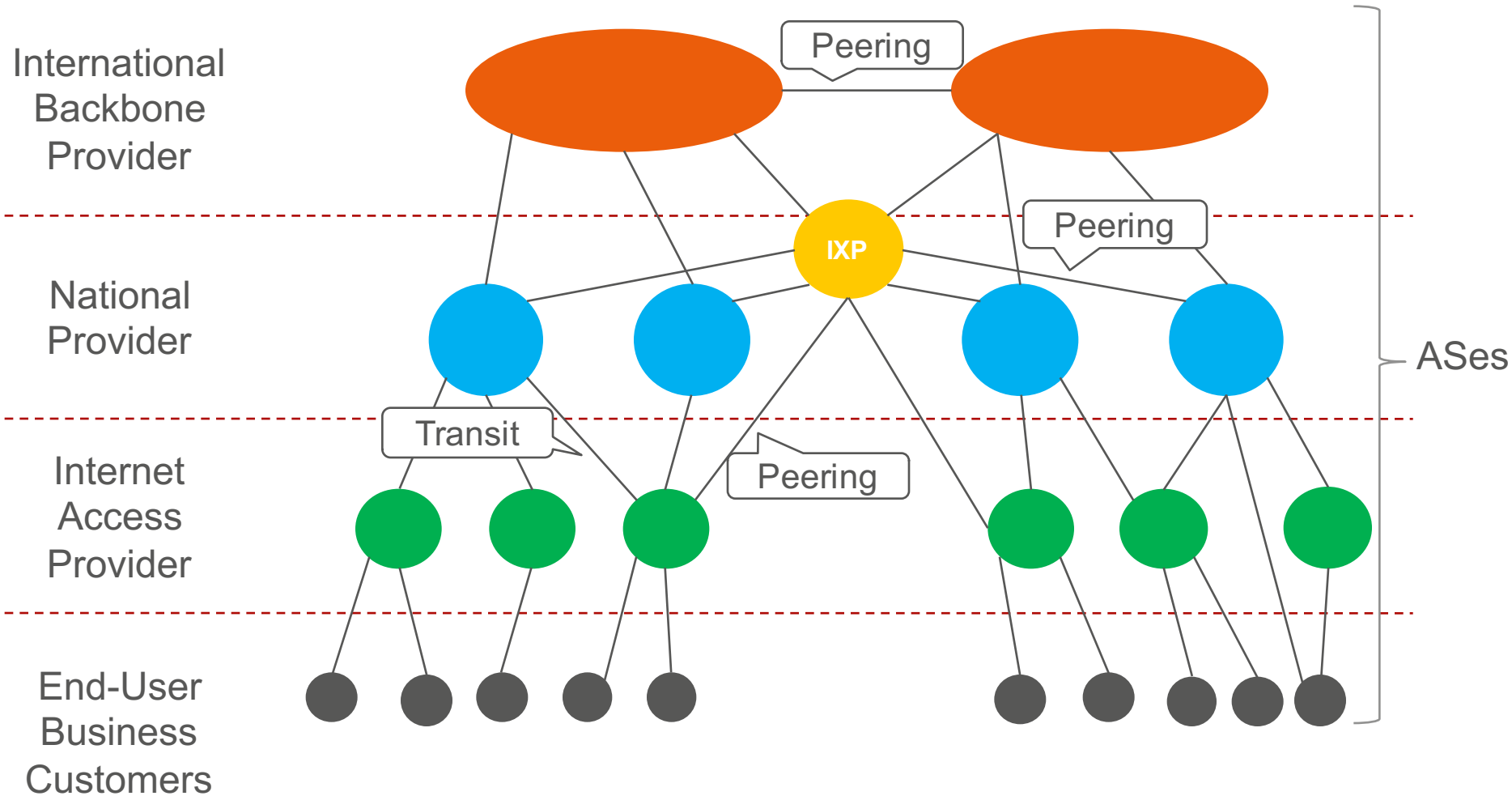
Frankfurt as a Data Hub

- » Biggest hub for voice and IP traffic in Central Europe
- » TeleGeography ranked Frankfurt the No. 1 Internet traffic hub in Europe
- » Less than 8 milliseconds from other European metropolitan areas
- » 51 data centers
- » All major Content Delivery Networks

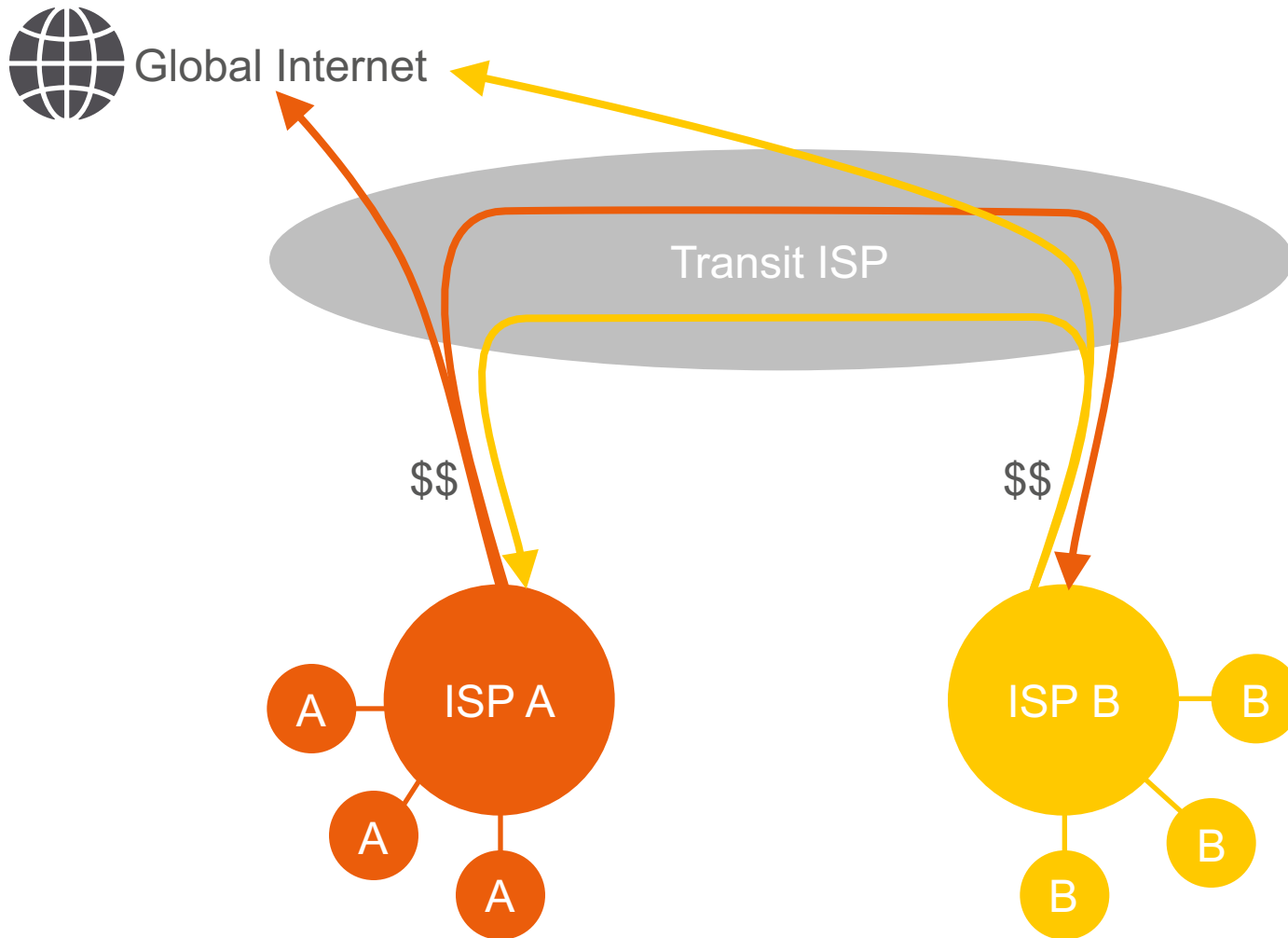


Peering vs. Transit

Internet Topology Revisited



Transit

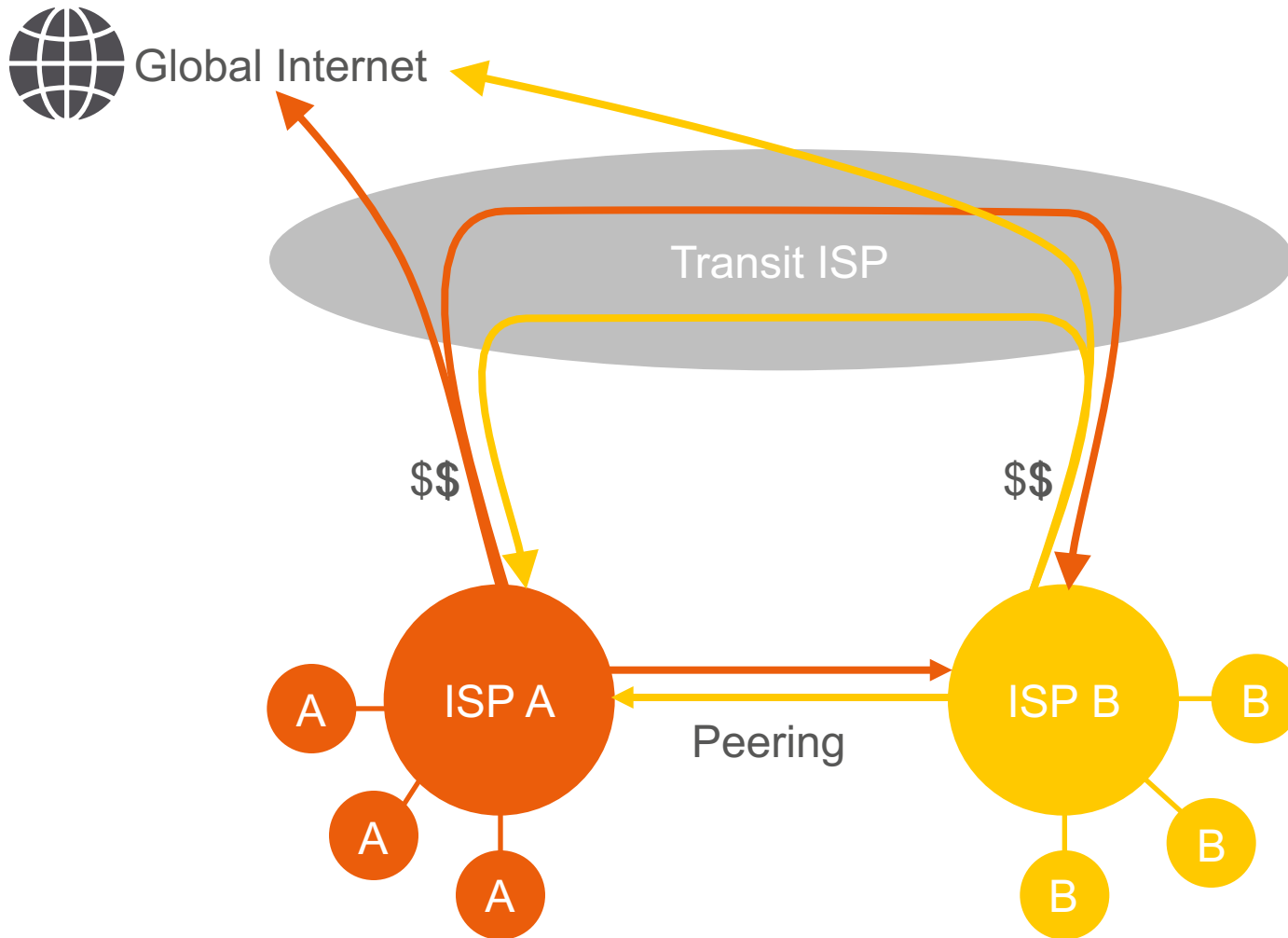


Transit

- » Internet transit is a business relationship where:
 - » A *Transit ISP* sells access to the global Internet (upstream)
 - » ISP *A* can reach ISP *B* through this Transit ISP and vice versa

- » Typical Internet pricing model
 - » 95th percentile measurement
 - » Service Level Agreements (SLAs)

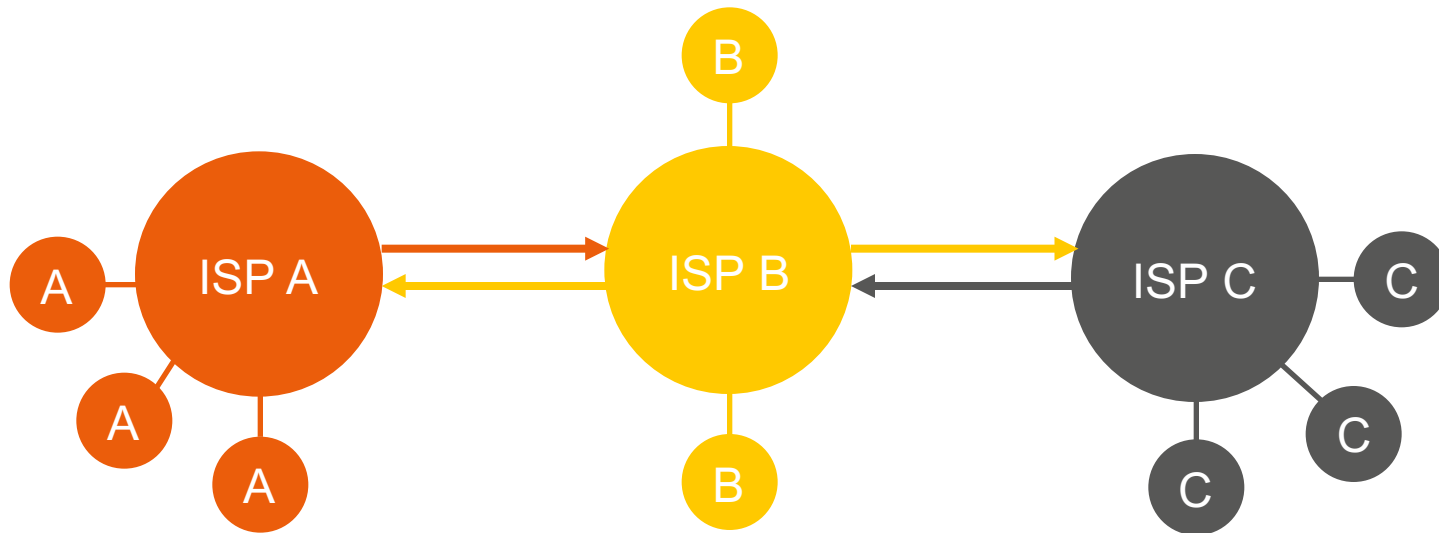
Peering



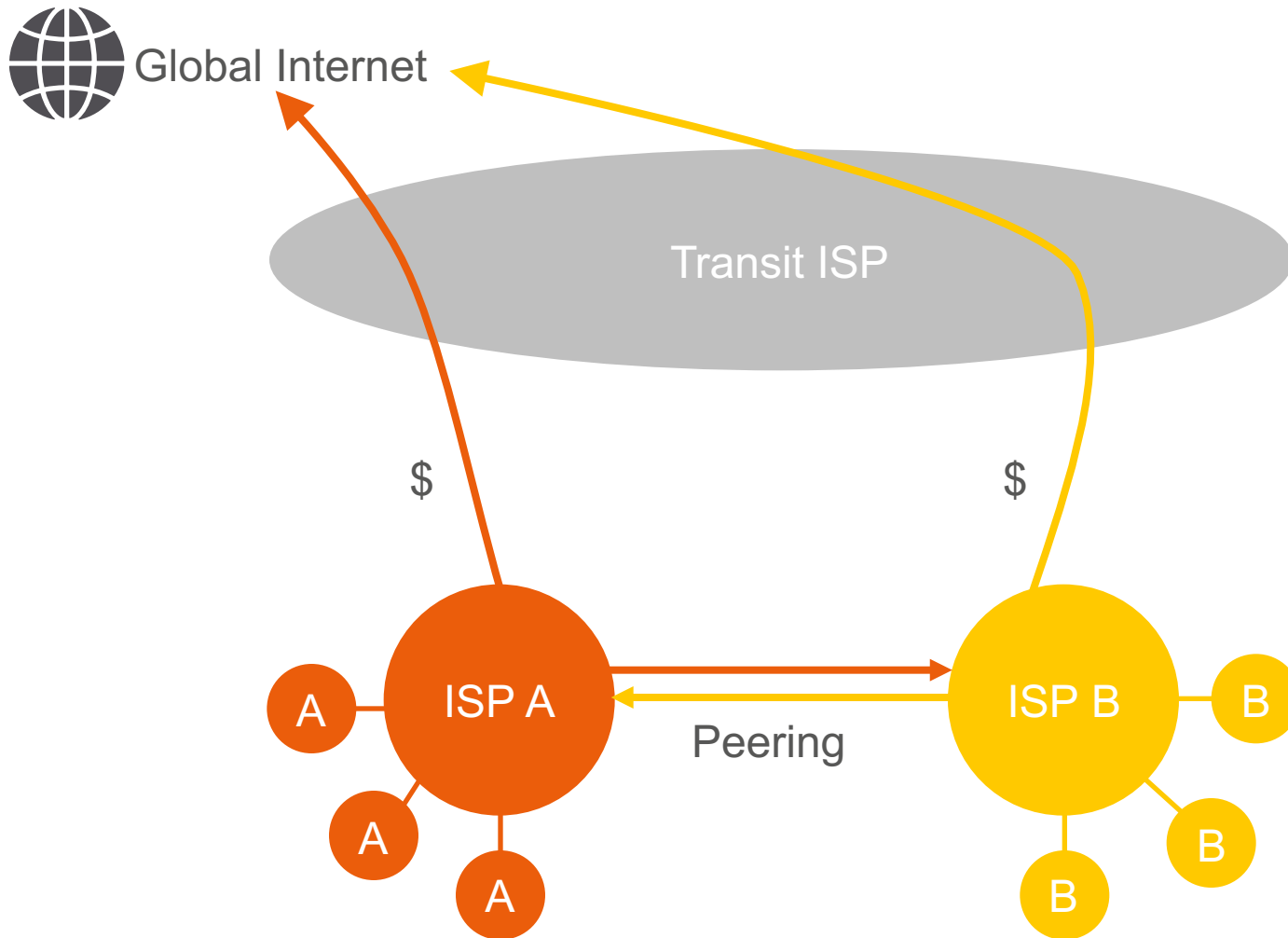
Peering

- » Internet peering is a business relationship where:
 - » Two ASes reciprocally provide access to each others networks
 - » AS *A* and *B* connect to exchange traffic
 - » Only traffic for the own network (+ own customer networks) is accepted
 - » Typically settlement free
 - » Not a substitute for transit
- » Peering pricing model
 - » Port with fixed bandwidth (1, 10, 100 GE)
 - » Fixed prices
 - » Some discount for upgrades or bulk purchases

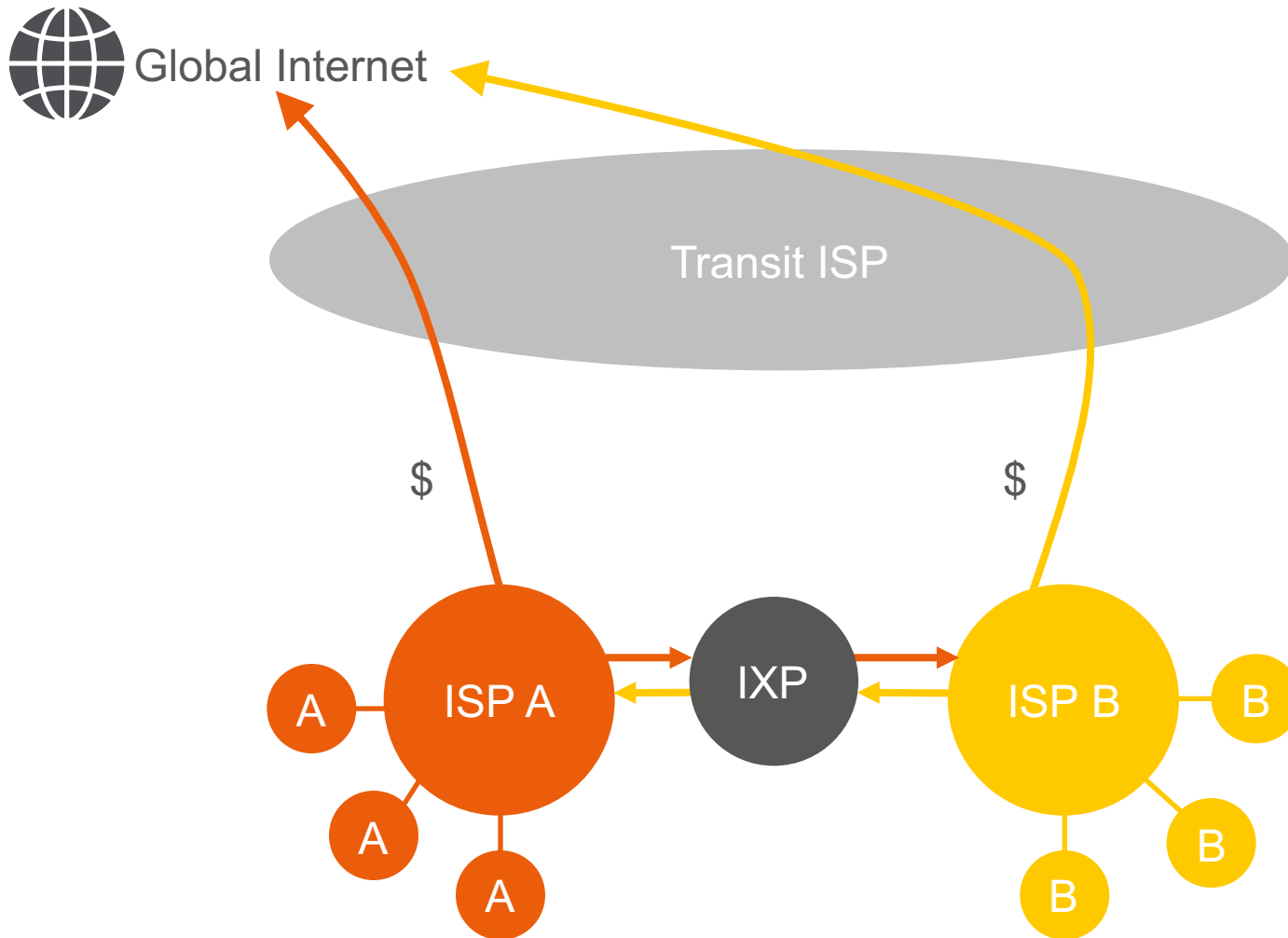
Peering - Non Transitive



Peering at IXPs



Peering at IXPs



Peering: Pros and Cons

Benefits

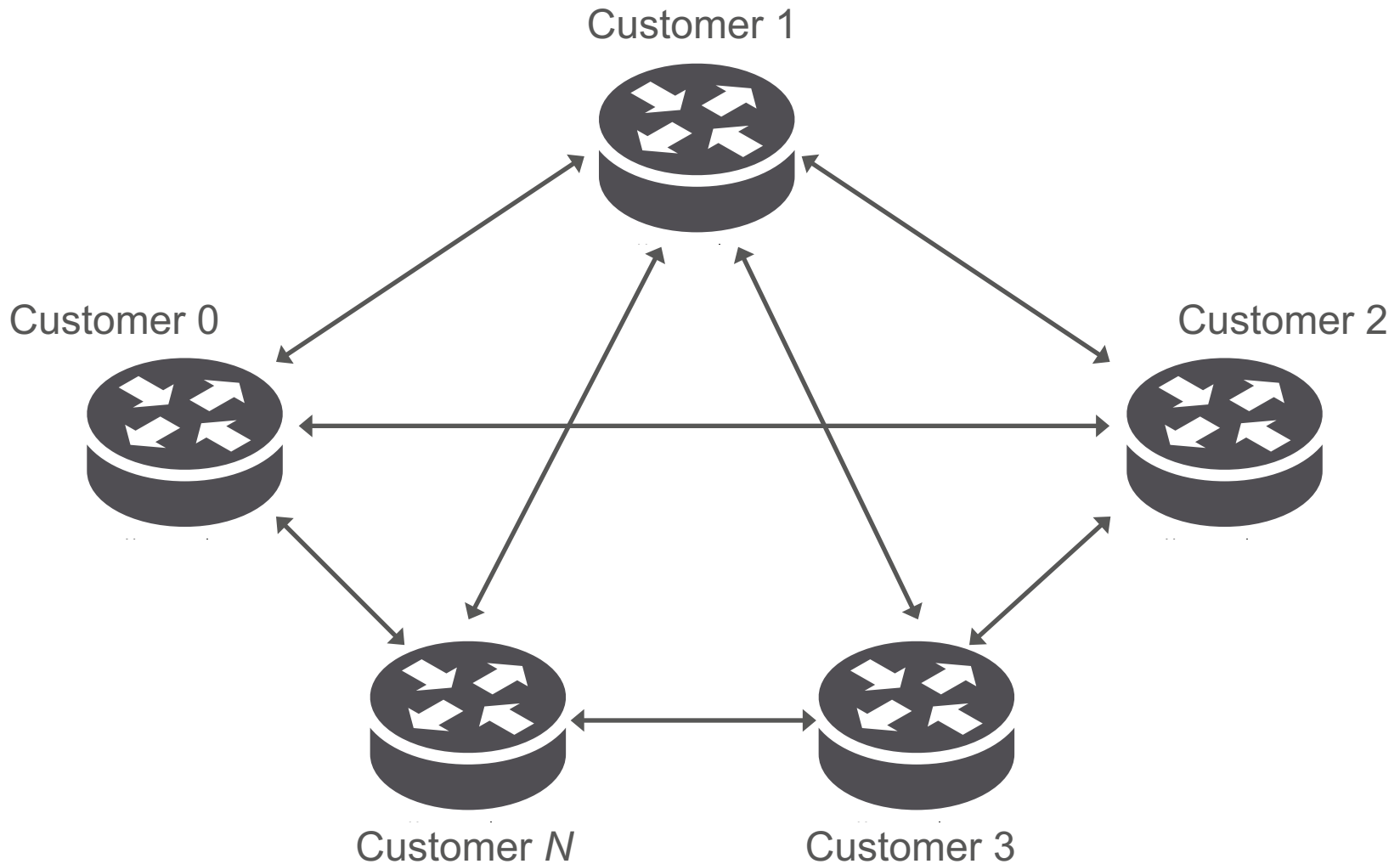
- » Low costs (mainly for large ISPs)
 - » Settlement free
- » Direct control
 - » BGP based traffic engineering available per peer
- » Low latency
 - » Peering interconnects networks directly leading to shorter paths from source to destination
- » Additional redundancy to transit link
 - » Peering links are preferred vs a transit link.

Cautions

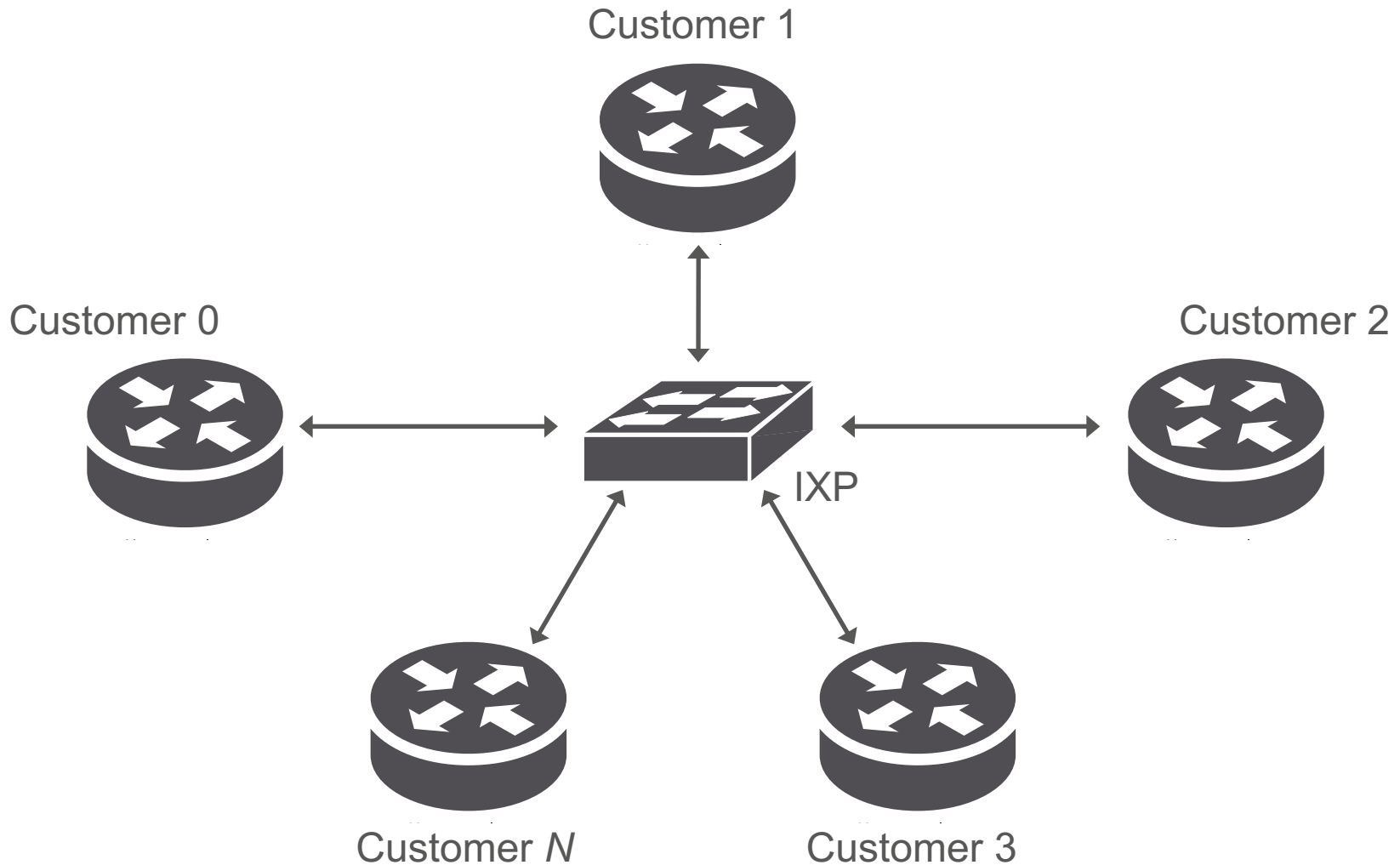
- » More administration effort
 - » Managing lots of individual peering sessions

Technical Insights

Generic IXP Topology – Layer 3 View



Generic IXP Topology – Layer 2 View



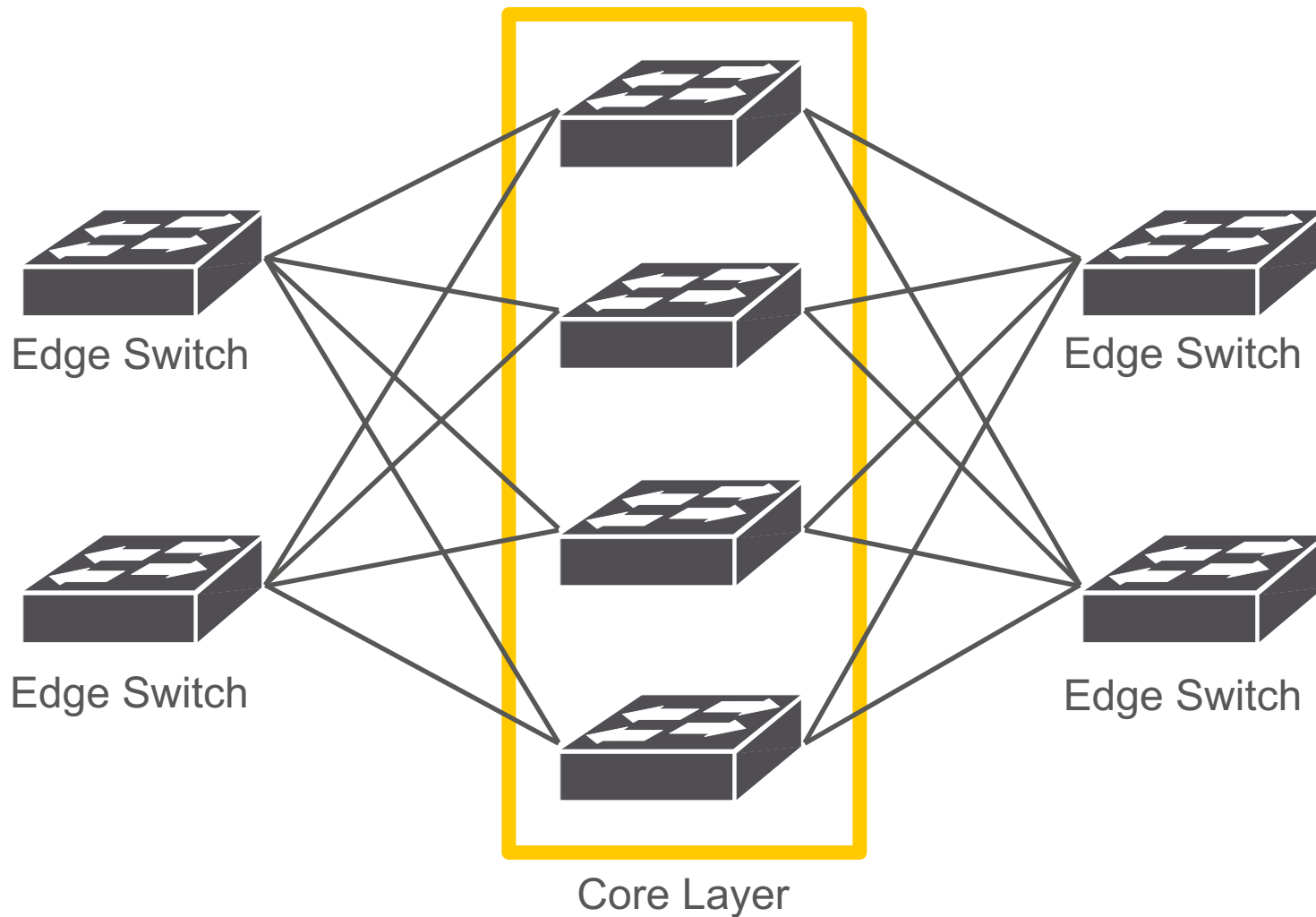
DE-CIX Topology



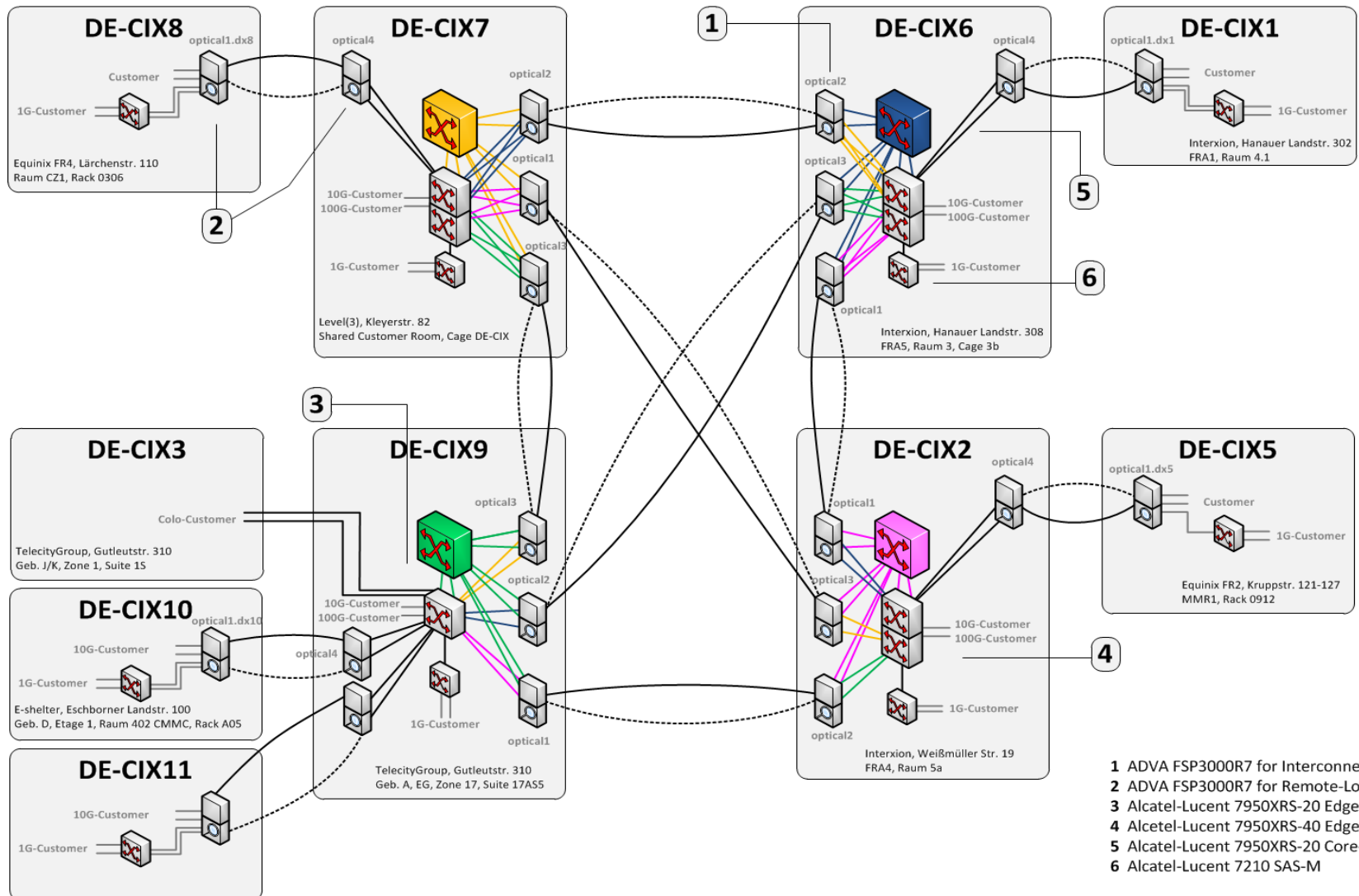
Apollon Requirements

- » Layer 2 Switch with:
 - » Enormous port density
 - » Scalability
 - » Resilience
 - » Redundancy

DE-CIX Topology



DE-CIX Topology

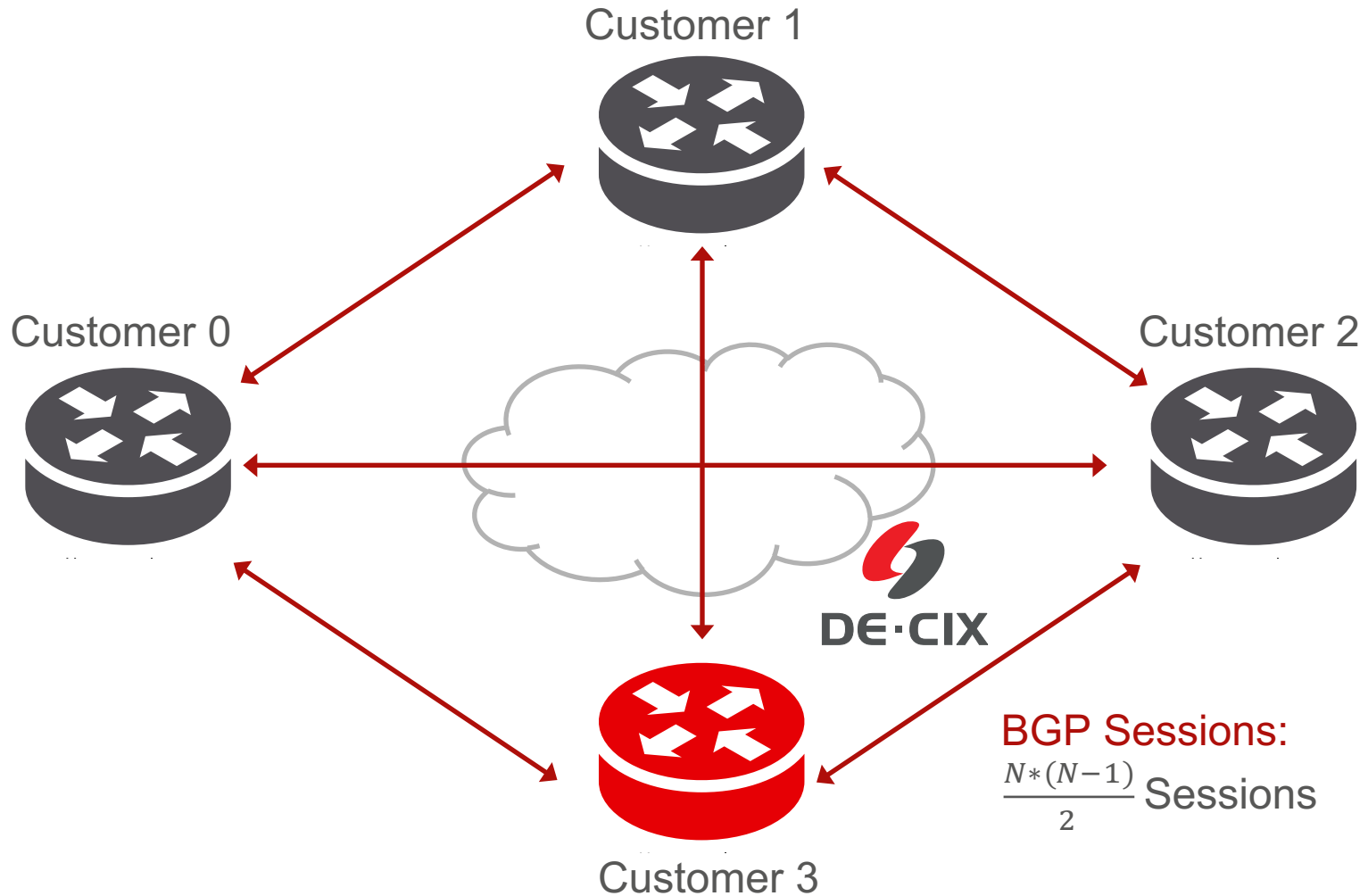


DE-CIX Technology

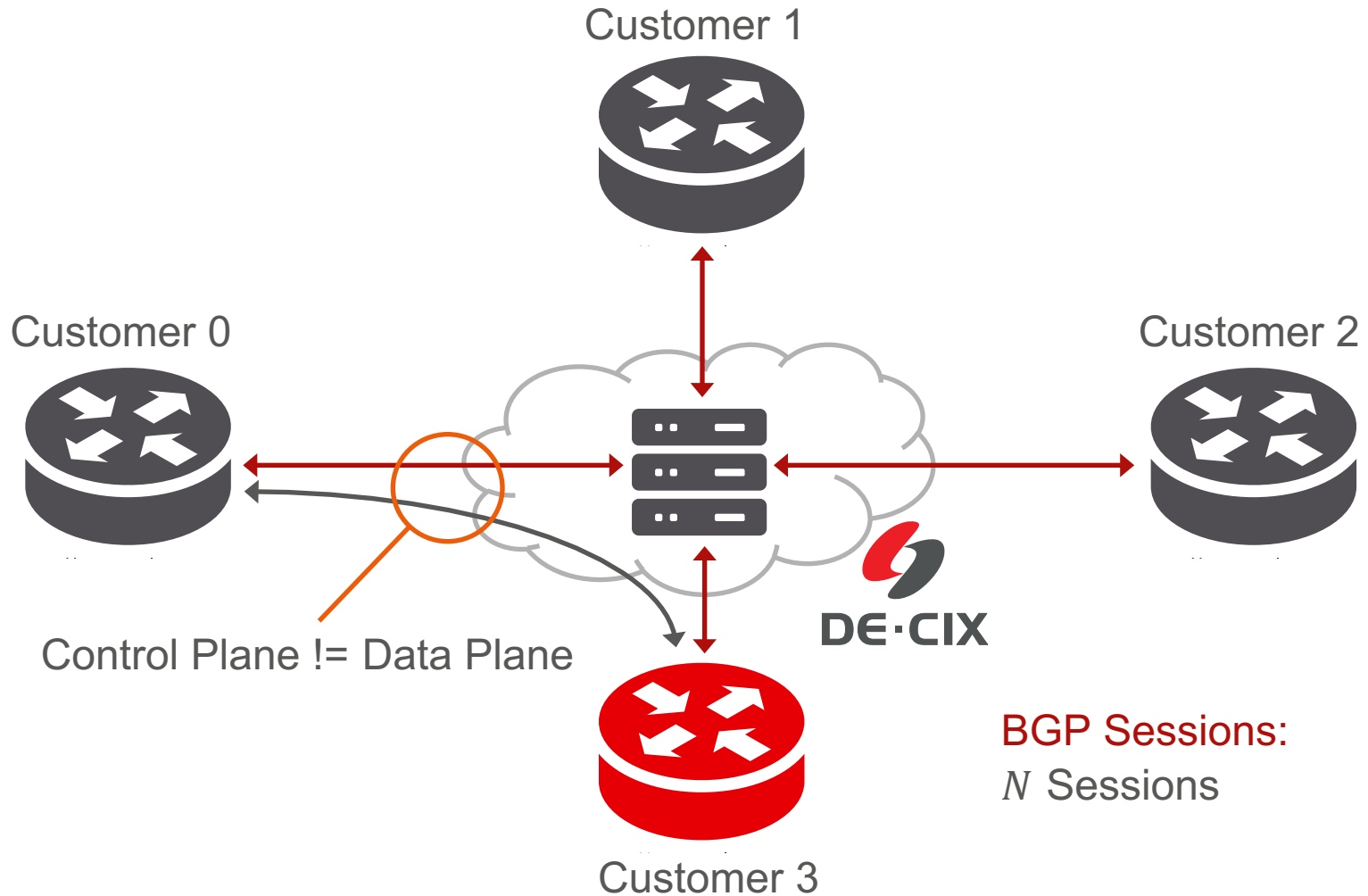
- » Optical Layer
 - » Adva FSP3000 DWDM
 - » Up to 80 x 28 Gbps (=2 Tbps per fiber pair)
- » Switching Layer
 - » Alcatel-Lucent 7950 XRS-20/40
 - » Up to 160 x 100GE per switch
 - » 11 chassis in total incl. 4 x core switches in 4 secure locations



Route Server I



Route Server II



Route Server Discussed

Benefits

- » Easy to configure
 - » Traffic from day one
- » Easy to maintain
 - » Maintain one BGP sessions
 - » No changes in router configuration for new peers
 - » Configuration via DE-CIX web interface
- » Filtering of advertisements
 - » Using IRR objects
 - » Quality assurance
 - » Transparent list of blocked announcements

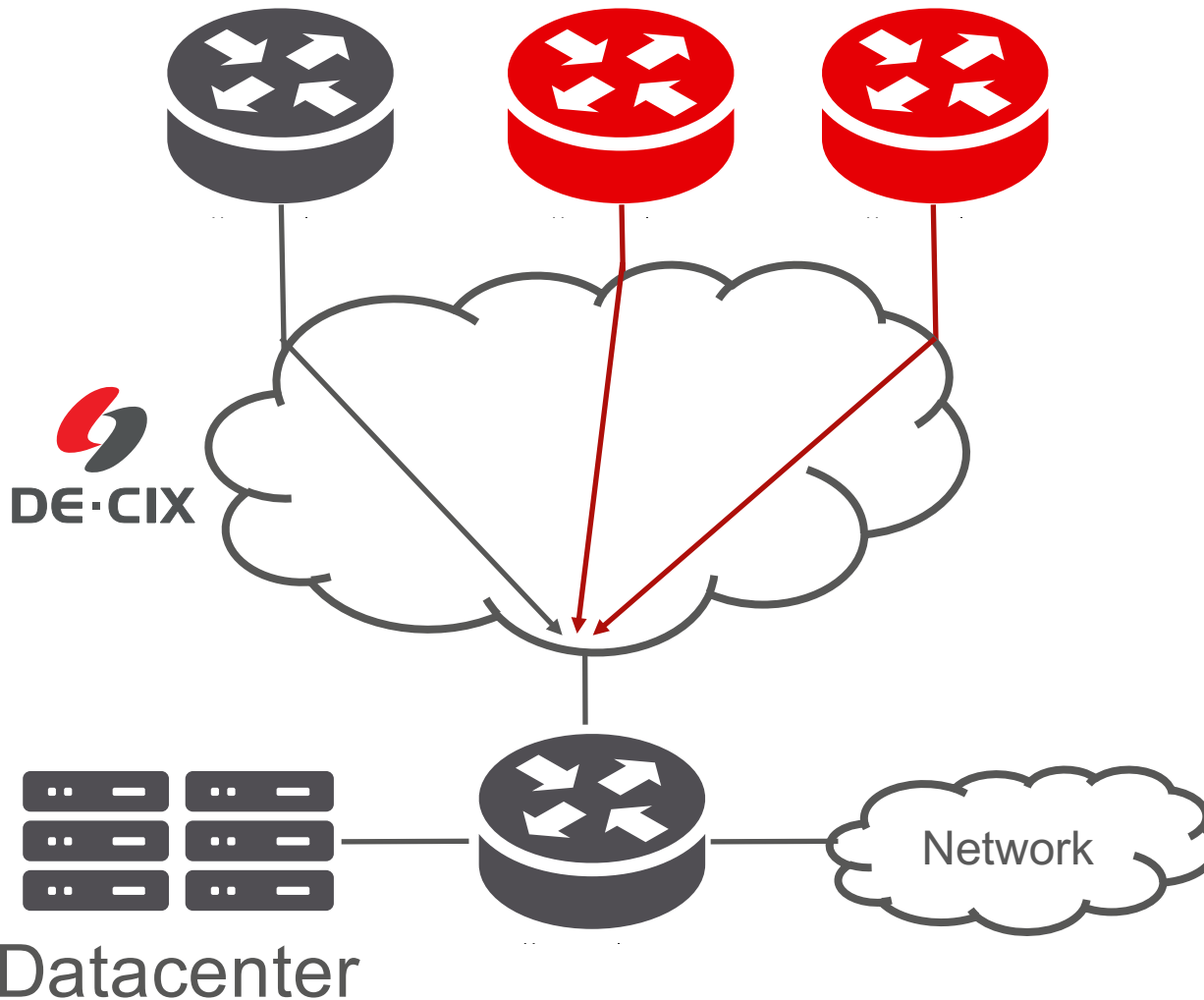
Cautions

- » Control plane != data plane
 - » Addressed by RS BFD [0]
- » Limited traffic engineering capabilities
 - » Only one route available through the route server

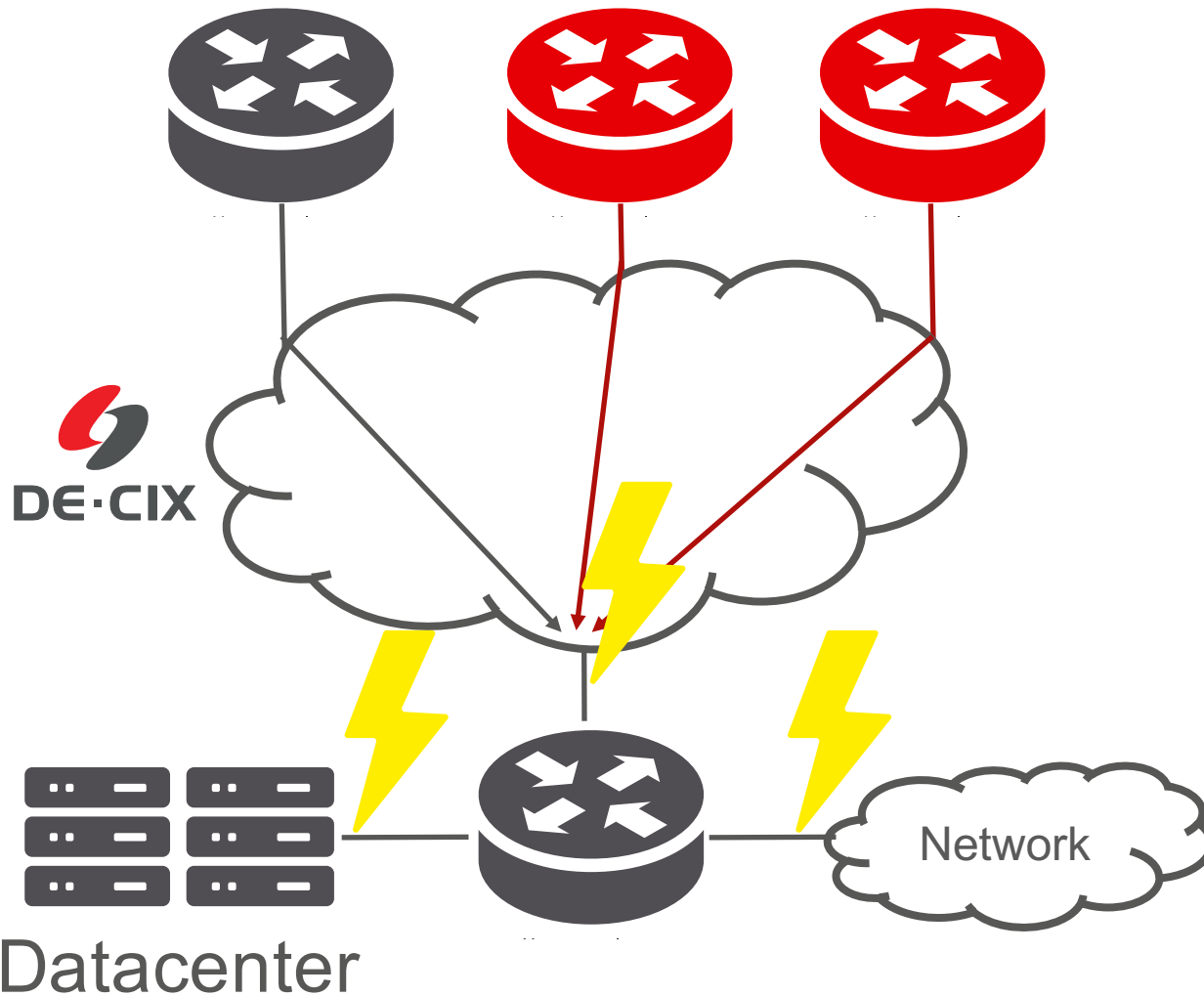
Route Server Facts

- » About 65,000 announced prefixes
- » More than 90% of members are using the RS
- » From the existing 85,000 peering links some 80% are carrying traffic
- » About 80% of total traffic is send towards RS prefixes

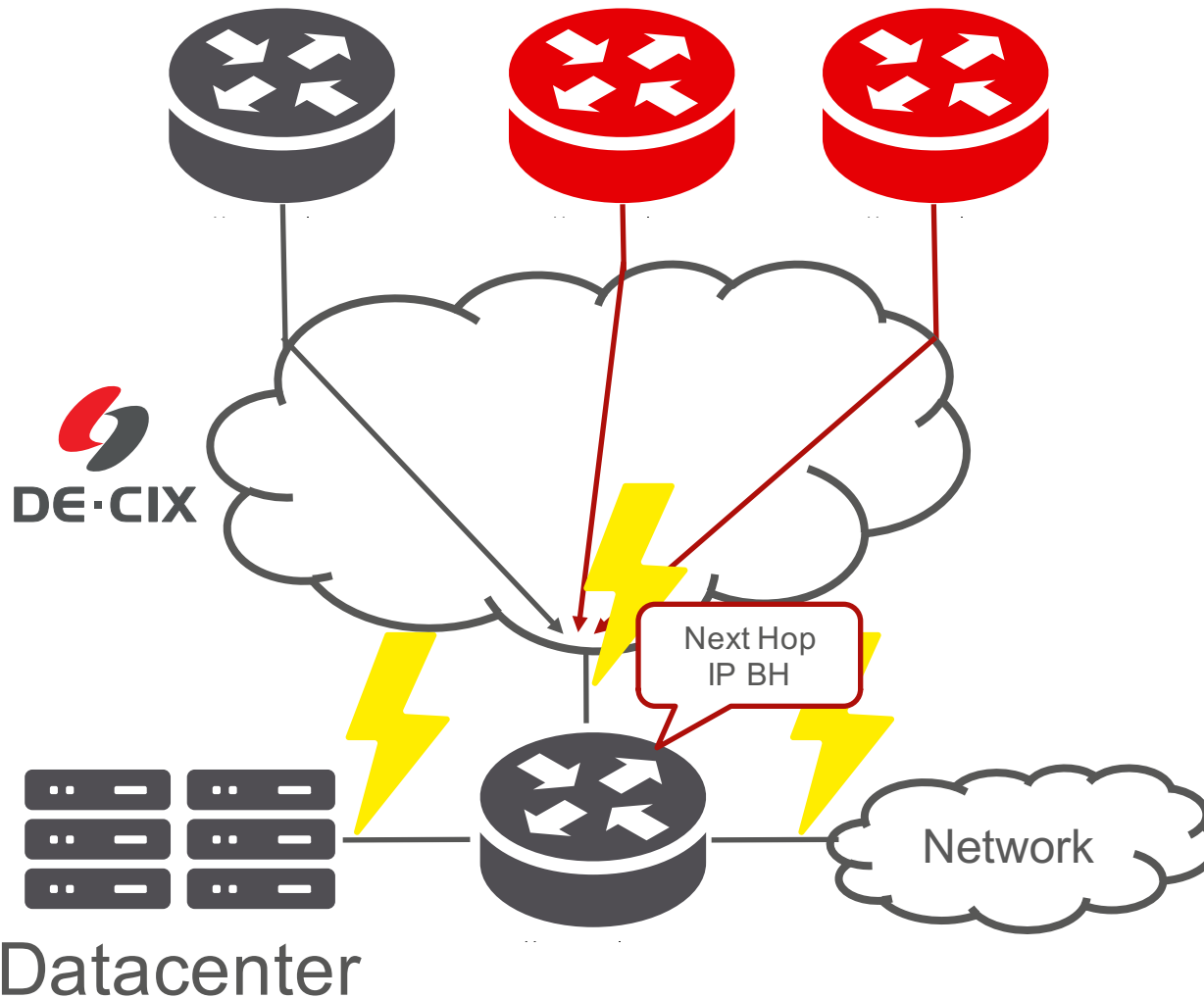
DDoS Mitigation – Massive DDoS Attack



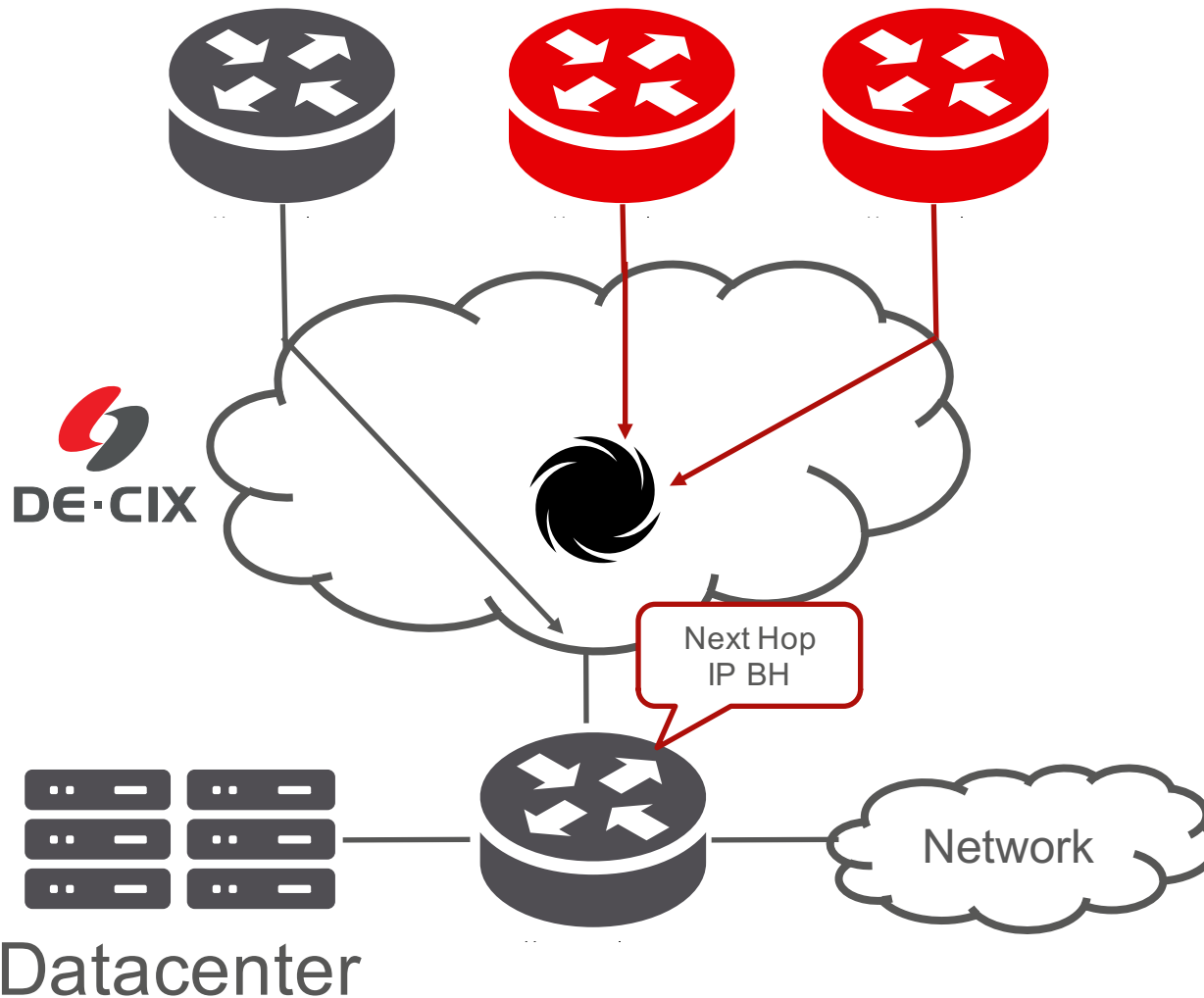
DDoS Mitigation – Port Congestion



DDoS Mitigation – Next Hop Announcement



DDoS Mitigation – Blackhole



DDoS Mitigation

- » Reactive large scale DDoS mitigation
- » Problem: Customer port congestion caused by massive DDoS attack
- » Internet traffic is dropped (blackholed) at customer's request
- » Customers advertise their own prefix with predefined IP address as next hop for DDoS mitigation
- » Filtered ingress at edge switch(es) based on predefined IP address

DDoS Mitigation Discussed

Benefits

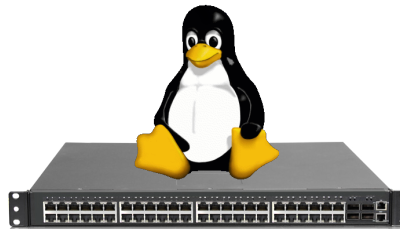
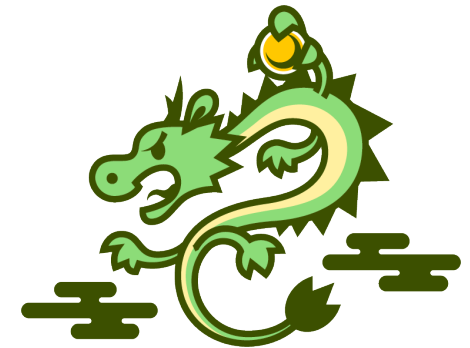
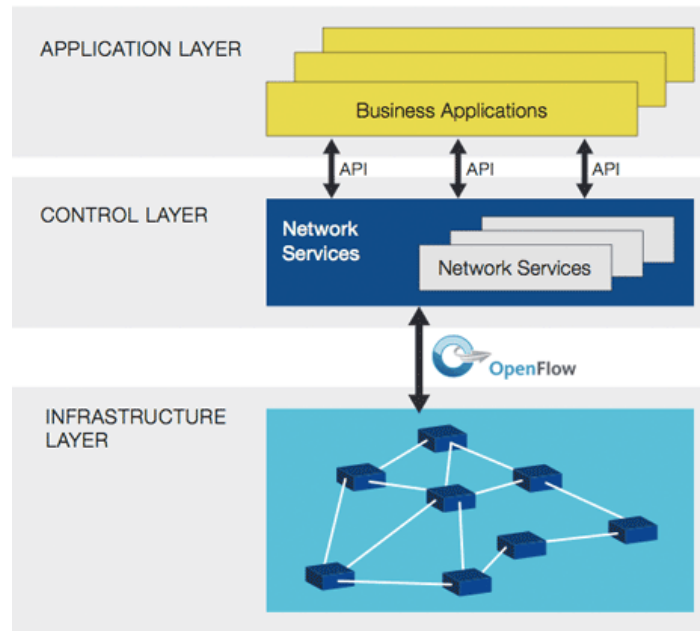
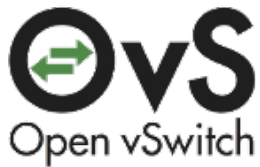
- » Large scale DDoS mitigation
 - » Discarding simple but effective
- » Reactive protection for massive DDoS attacks
- » Avoidance of port/network congestion
 - » Overloading traffic can be discarded

Cautions

- » All traffic of an specific peer for a specific prefix is dropped (binary state)
- » Propagation through the Internet
 - » More specific prefixes
- » Effective but requires manual detection
 - » Customer triggered only
 - » No autonomous detection yet

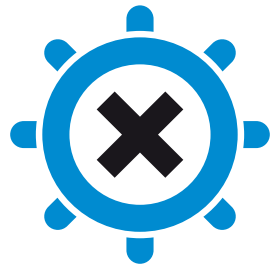
Looking Into the SDN Future

You already now SDN...



... but how to bring it to Inter-Domain?

- » Towards a flexible software-defined network ecosystem
- » Goal: Bringing SDN to the Inter-domain settings
- » Project of the EU Commision
- » Academic and industrial partners
 - » Queen Mary University of London
 - » Université catholique du Louvain
 - » University of Cambridge
 - » Centre National de la Recherche Scientifique
 - » IBM



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SDN for IXPs Discussed

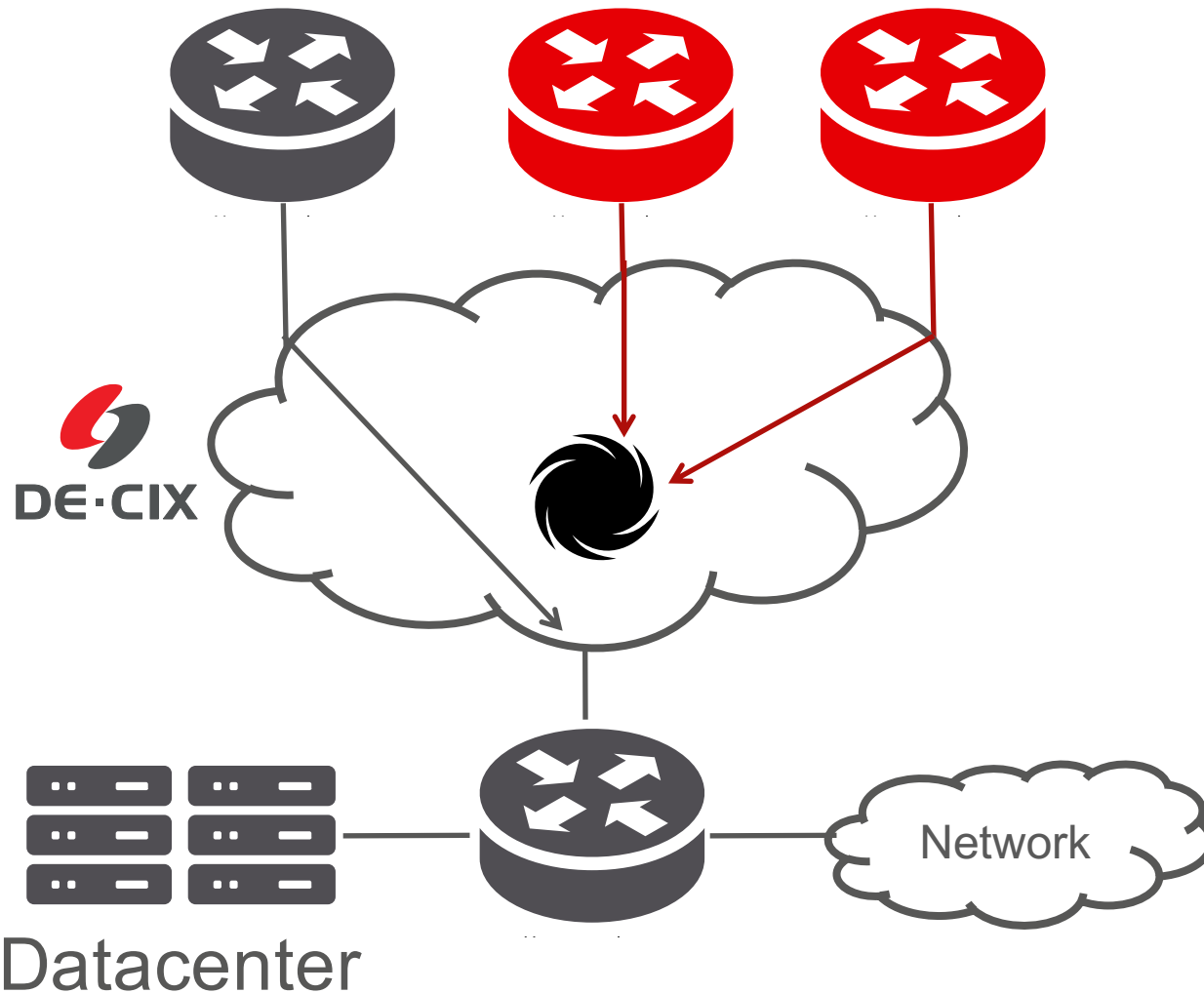
Benefits

- » Possible impacts hundreds of networks
- » Relatively small and static network setup
- » All network devices within a metropolitan area

Cautions

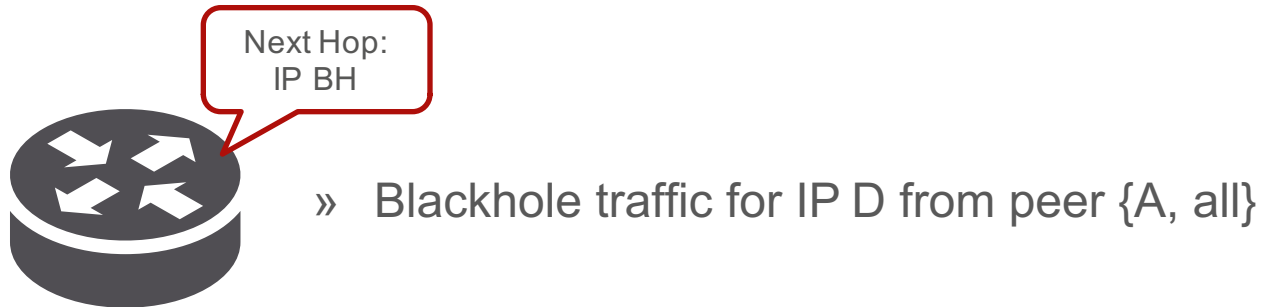
- » No available hardware at required scale
- » Clean slate approach challenging
- » No operational experience
- » Redundant controller software required

DDoS Mitigation– Massive DDoS Attack

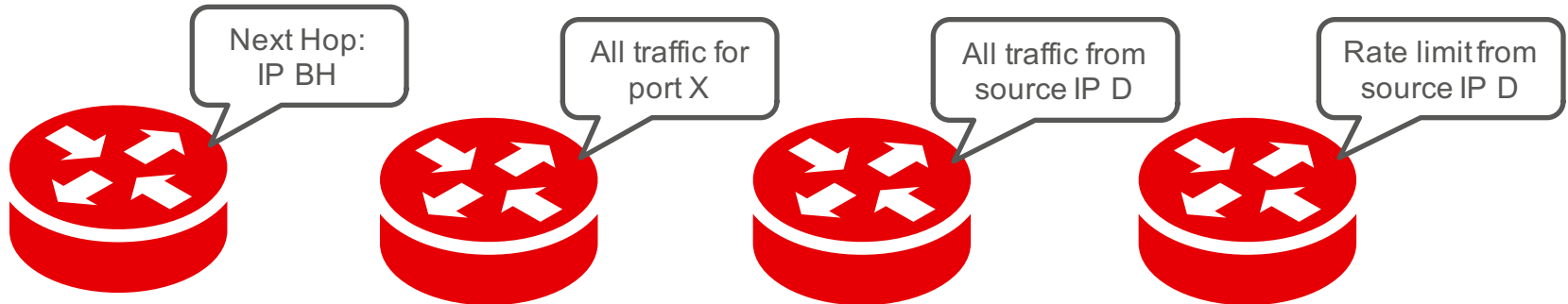


SDN Use Case – Advanced DDoS Mitigation

Today a router can announce:

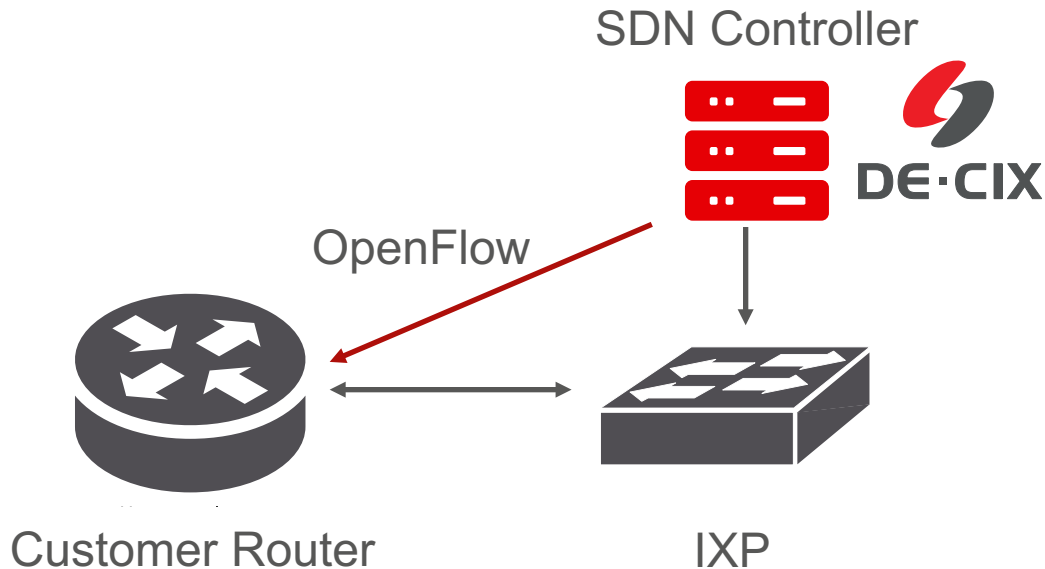


In the future a router can announce:



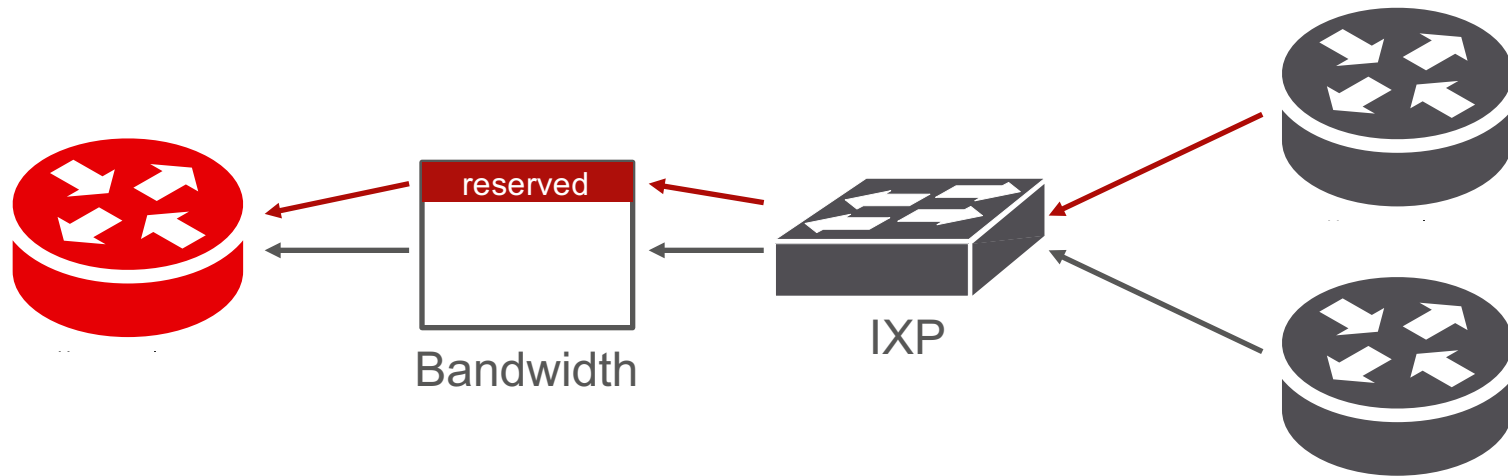
- » Blackhole traffic for IP D from peer {A, all}
- » Blackhole traffic for {port X, IP D, source IP D,} from peer {A, all}
- » Rate limit traffic for {port X, IP D, source IP D,} from peer {A, all}

SDN Use Case – Peering Router-as-a-Service



- » Customer router is substituted with an SDN switch
- » Can also be a virtualized switch (e.g., Open vSwitch)
- » IXP configures and manages peering router
- » Simplifies operation for customer with less experience

SDN Use Case – Virtualized Private Peering



- » Mimic private peering: guaranteed bandwidth per peer
 - » Allow customer to flexible allocate bandwidths
 - » Non blocking reservation

SDN Challenges - Scalability



Alcatel Lucent 7950 XRS-40
32 Tbps (backplane capacity)

VS



Dell Z9100
3.2 Tbps
(Broadcom Tomahawk)

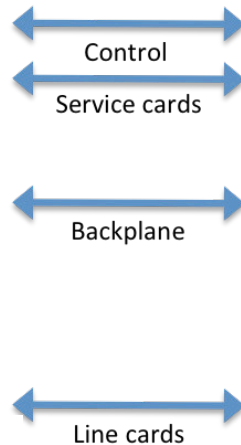
SDN Challenges – Scaled-up SDN Hardware



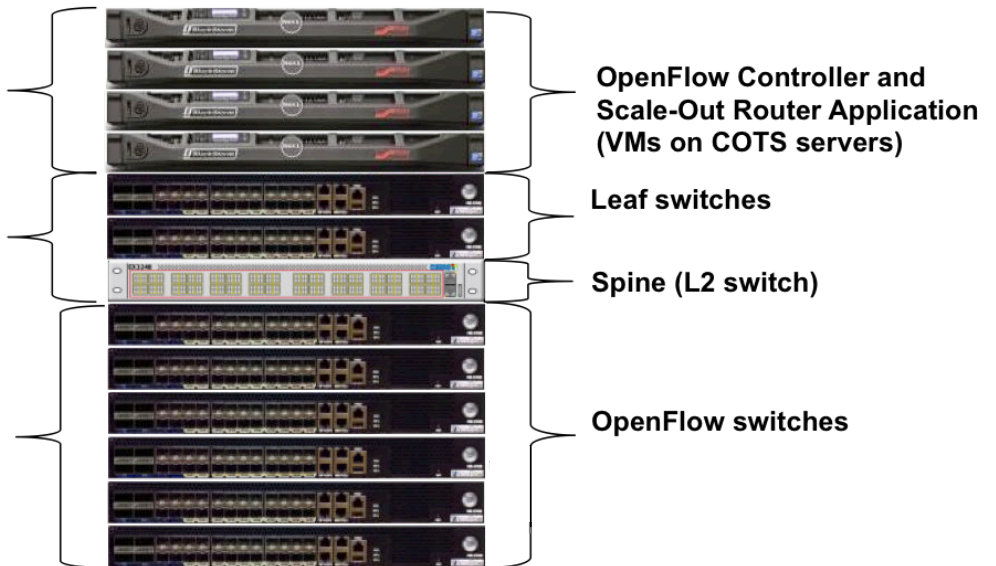
- » Need for IXP grade (huge) boxes
- » A lot more ports per switch (512 x 100GE and more)
- » Increasing table space (e.g., more TCAM)

SDN Challenges – Scale-Out SDN Hardware

Typical (Scale-Up) router



Scale-Out router



Further Open Challenges

Continuity

- Stay stable and secure
- Keeping pace with transit
- Keeping pace with traffic growth

Innovation

- Introduction of more value added services
- Advanced monitoring
- Accurate measurements
- Misconfiguration protection

Competition

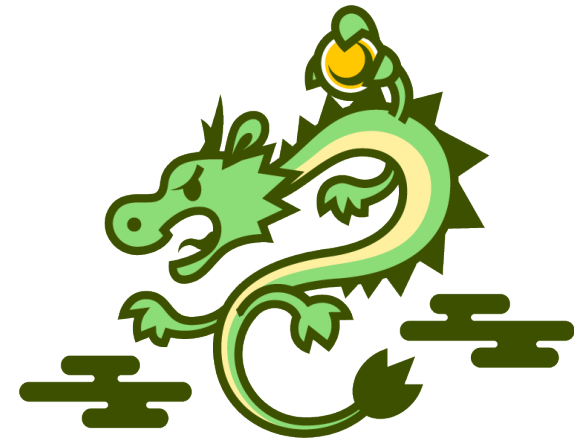
- National competitors
- International competitors

Get involved!

- » We are seeking for
 - » Talented and passionate SDN programmer
 - » Curious people who want to get hands-on experience with SDN
 - » A team player for supporting our research



- » Experience in Ryu and OpenFlow is a bonus
- » Help us build the next generation IXP



- » **Become part of our team as a working student or intern**
- » **Send your application to sascha.bleidner@de-cix.net**



By joining DE-CIX, you become
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DE-CIX Management GmbH
Lindleystr. 12
60314 Frankfurt
Germany
Phone +49 69 1730 902 0
rnd@de-cix.net

www.de-cix.net