Fachhochschule Gelsenkirchen

Structure of the Internet
→ A view

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Content

- Aim and outcomes of this lecture
- Structure of the Internet
- Connectivity of the Internet
- Data flow through the Internet
- Summary

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Structure of the Internet
→ Aims and outcomes of this lecture

Aims

- To introduce the idea of the Internet
- To explore the structure of the Internet
- To analyze the connectivity and the data traffic of the Internet
- To analyze the challenges we have with the Internet
- To assess the need of an Internet Early Warning System

At the end of this lecture you will be able to:

- Understand what the Internet from the communication point for view is.
- Know something of the structure of the Internet.
- Understand how the processes between provide works.
- Understand the motivation of the changes in the connectivity and the data traffic of the Internet.

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Internet (1/3)
→ Networks

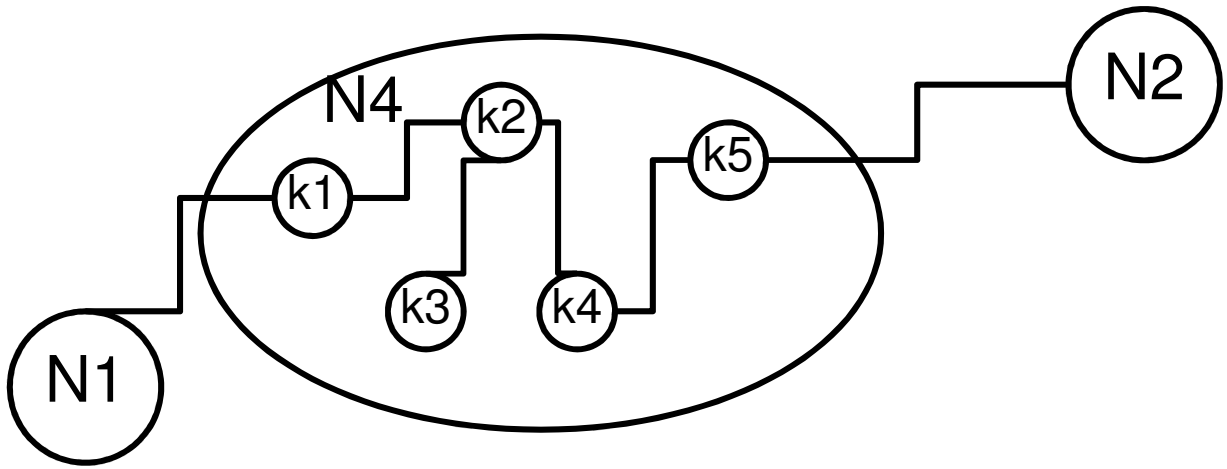
- A **network (N)** is an interconnected group of nodes (K), such as computers, hubs, switches, routers, and so on.

$$N =< K, L >$$

  - K := Number of nodes (k)

$$K = \{k_1, k_2, \ldots, k_n\}$$

  - L := Connection (links) between nodes (k)



Internet (2/3)
→ Autonomous Systems (AS)

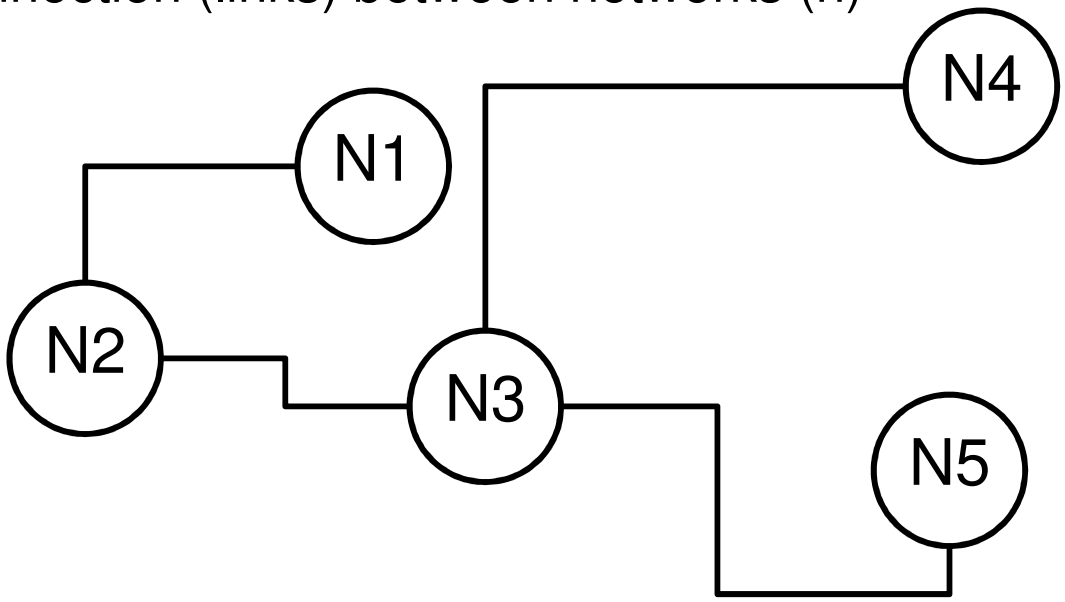
- „An **Autonomous Systems (AS)** is a connected group of one or more IP prefixes run by one or more network (N) operators, which has a SINGLE and CLEARLY DEFINED routing policy.“ [1]

$$AS =< N, L >$$

  - N := Number of networks (n)

$$N = \{n_1, n_2, \ldots, n_m\}$$

  - L := Connection (links) between networks (n)



Internet (3/3)
→ Interconnected networks

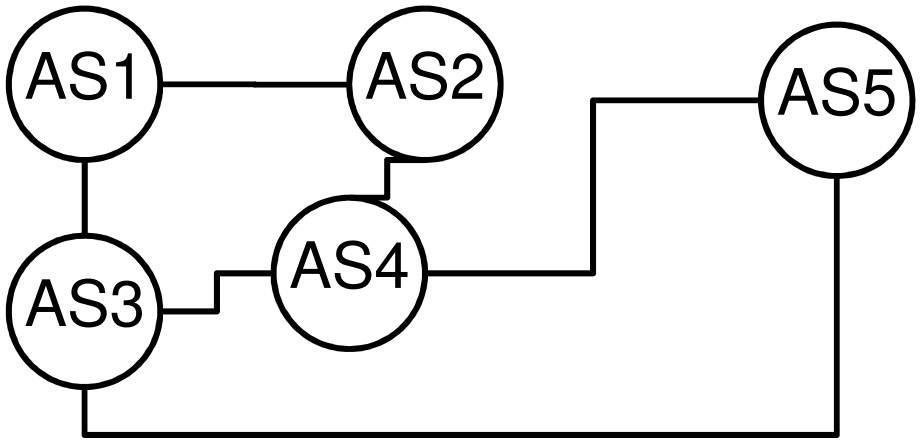
- The **Internet (I)** consists of independent networks, the Autonomous Systems (AS) which are connected.

$$I =< AS, L >$$

  - AS := Number of Autonomous Systems (AS)

$$AS = \{as_1, as_2, \ldots, as_N\}$$

  - L := Connection (links) between Autonomous System (AS)



Structure of the Internet
→Autonomous Player

- **Autonomous Systems (AS)**
  - The global Internet consists of thousands of independent networks, the Autonomous Systems (AS)
  - Currently there are about 27.000 different ASs advertised in the global Routing table
  - The AS operators have different policies for the size and expansion of their network
  - An AS needs a strategy to connect with other ASs using upstreams, private or public peerings
  - There are more than 60.000 logical connections between ASs at the moment

- **Different types of Autonomous Systems**
  - Large Companies, e.g. business consumer (41 %)
  - Internet Service Providers, e.g. IP-carrier (35 %)
  - Universities (11 %)
  - Internet Exchange Points, e.g. public data exchange nodes (2 %)
  - …

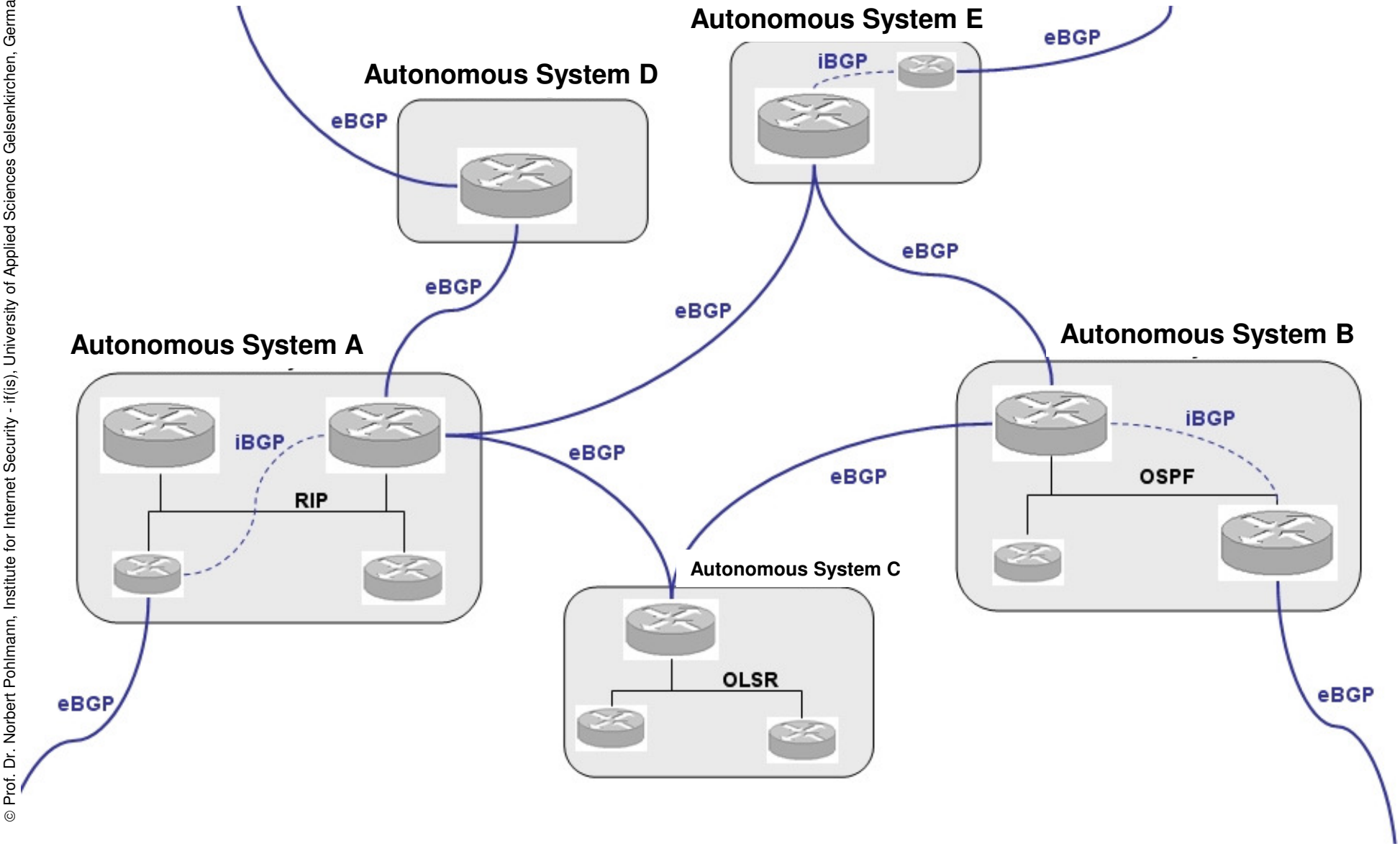
Structure of the Internet
→ Connect with other ASs

- **Upstream**
  - For upstream the **small AS** have to **pay** to the **bigger AS**
- **Private peering**
  - Private peering is a **connection between AS of the same level**
  - Normally there is **no payment** for the exchanged data
- **Public peering**
  - Public peering is a data exchange nodes (e.g. Switches), where a lot of AS make a **central peering**.

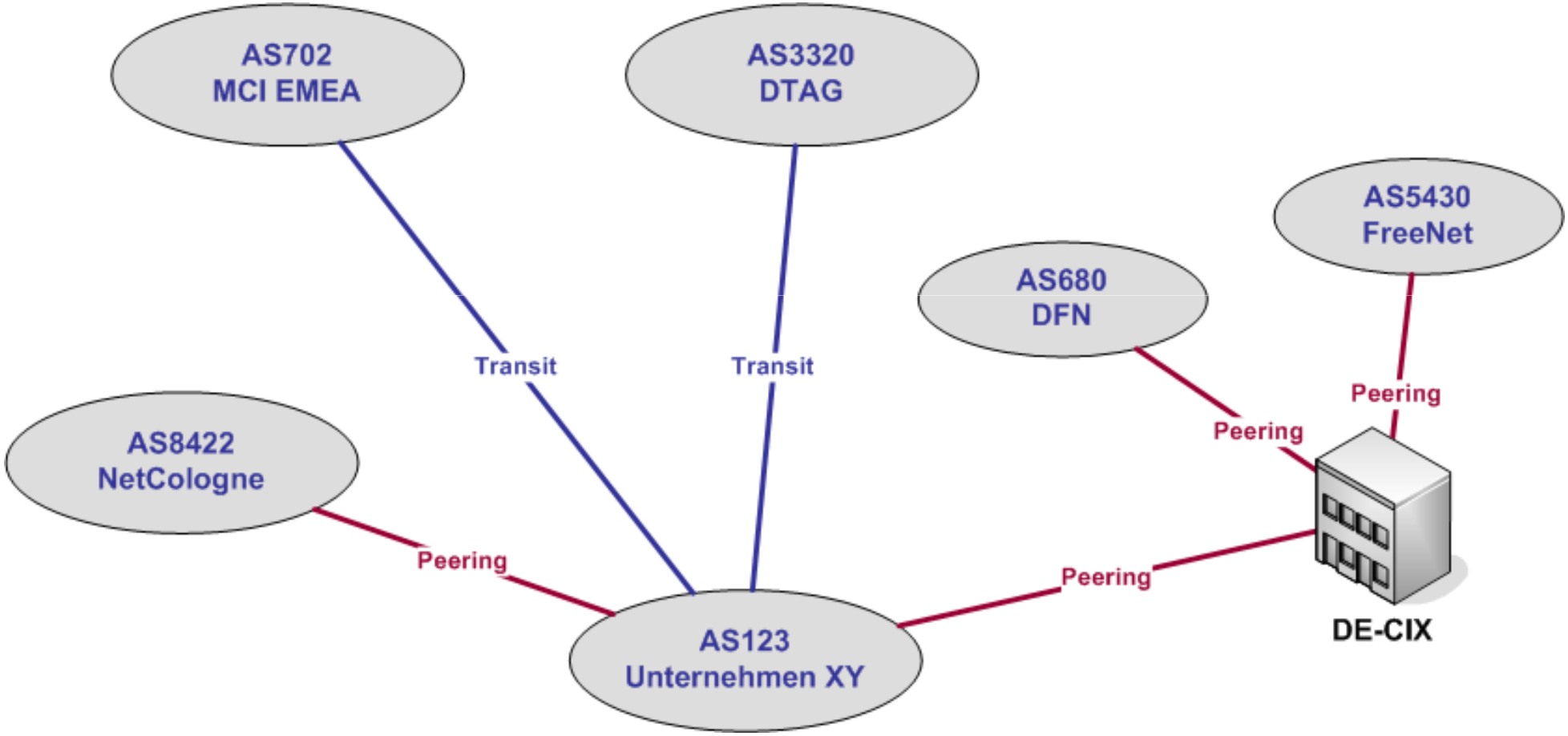
Networks / AS
→ Overview

- **Autonomous System (AS):**
  - Network(s) having one integrated management.
  - One AS can be set up by a number of networks, which are connected by routers.
- **Interior Gateway (IG):**
  - Interner Router of an Autonomous Systems (AS)
- **Exterior Gateway (EG):**
  - Router at the boarder from one AS to another (border router)

Autonomous Systems
→ Overview



Autonomous Systems
→ Strategy of the Provider



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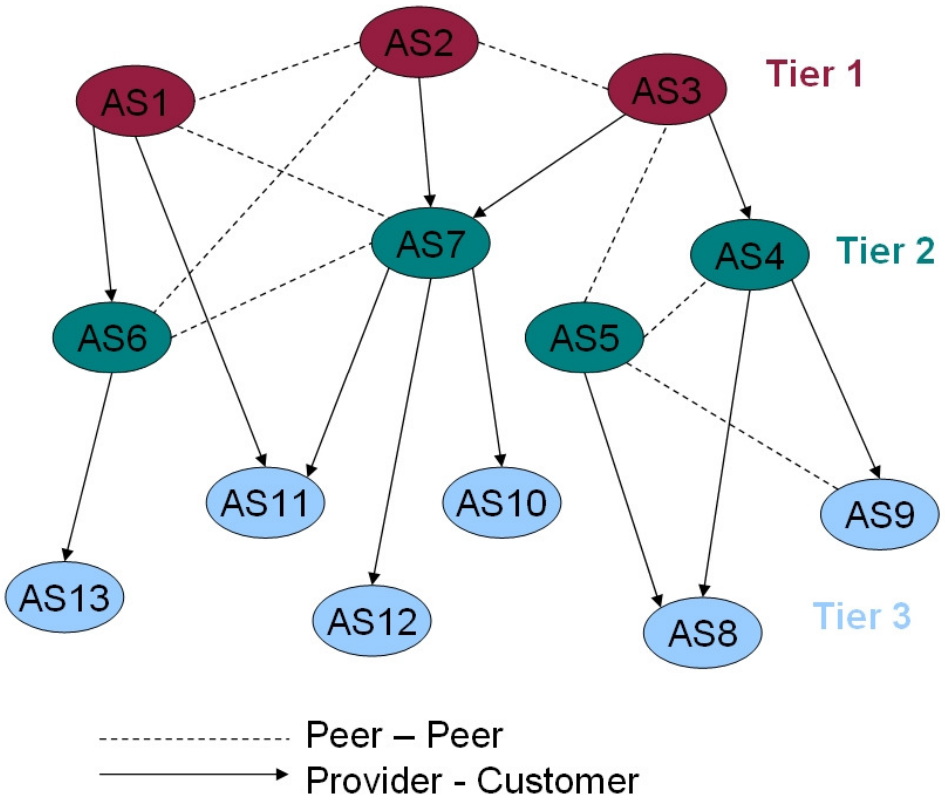
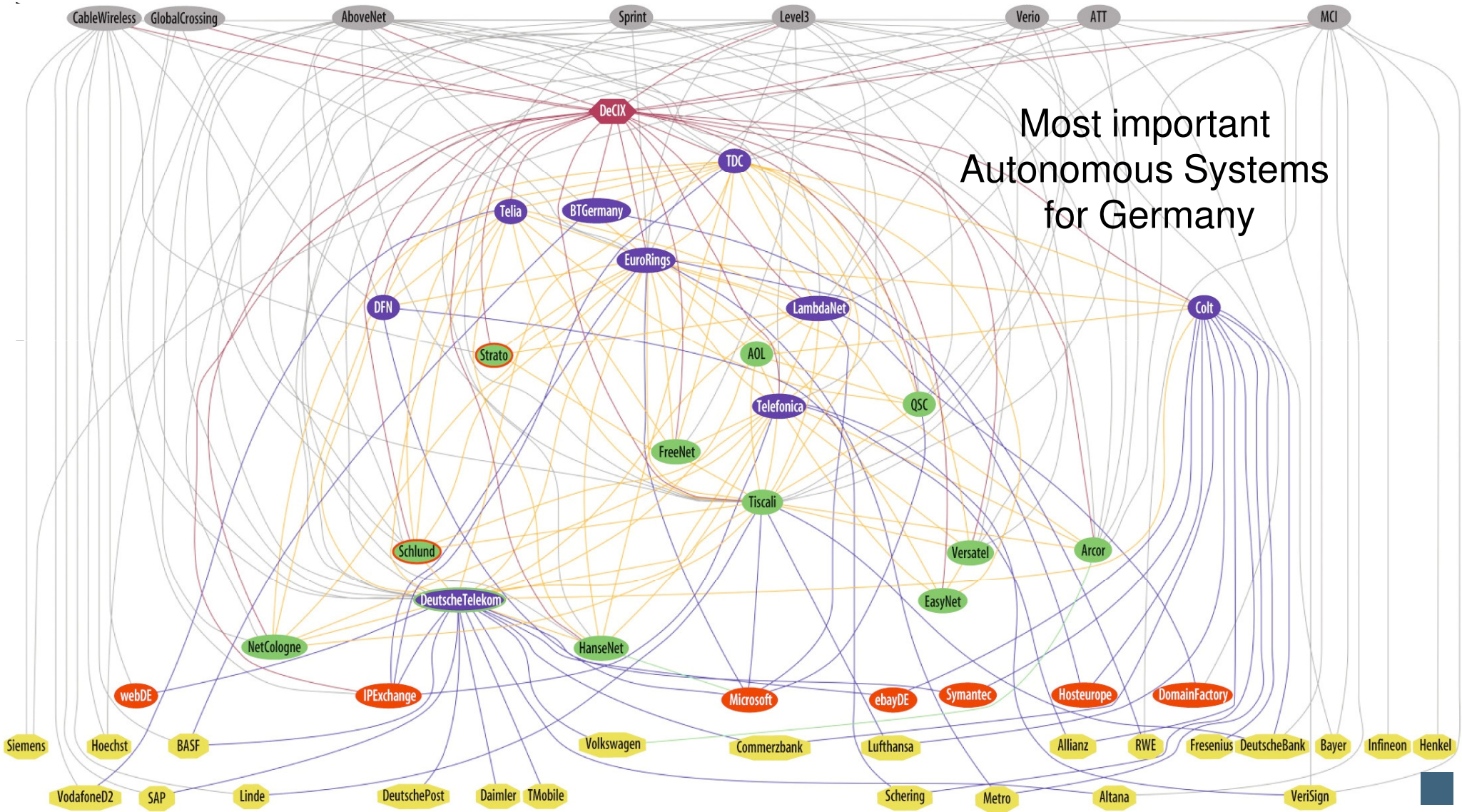
Structure of the Internet
→Connectivity of the Internet

- **Ongoing analysis on the Route Views Snapshot**
  - <= 2 = 63 %
    <=10 = 94 %
    >10 = 6 %
    >100 = 0,4 %
    >300 = 0,1 %
  - Economical necessities affect the carrier‘s proceeding
  - This yields to a destabilization of the internet infrastructure



- **What is imported in this field?**
  - We need an entity which keeps an eye on the level of connection and the reliability of all ASs in the Internet

Structure of the Internet
→ Analysis of „Internet Germany“



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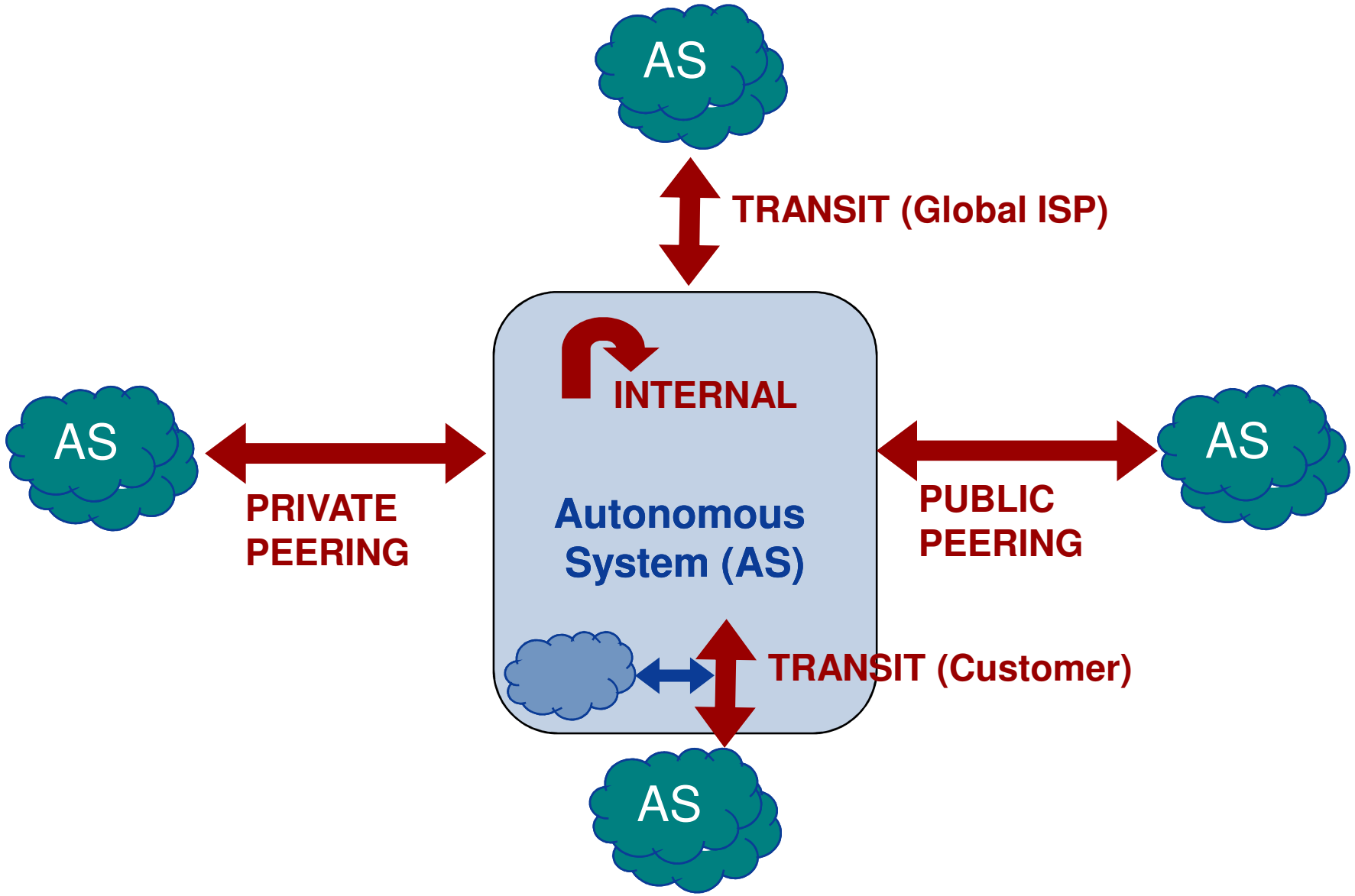
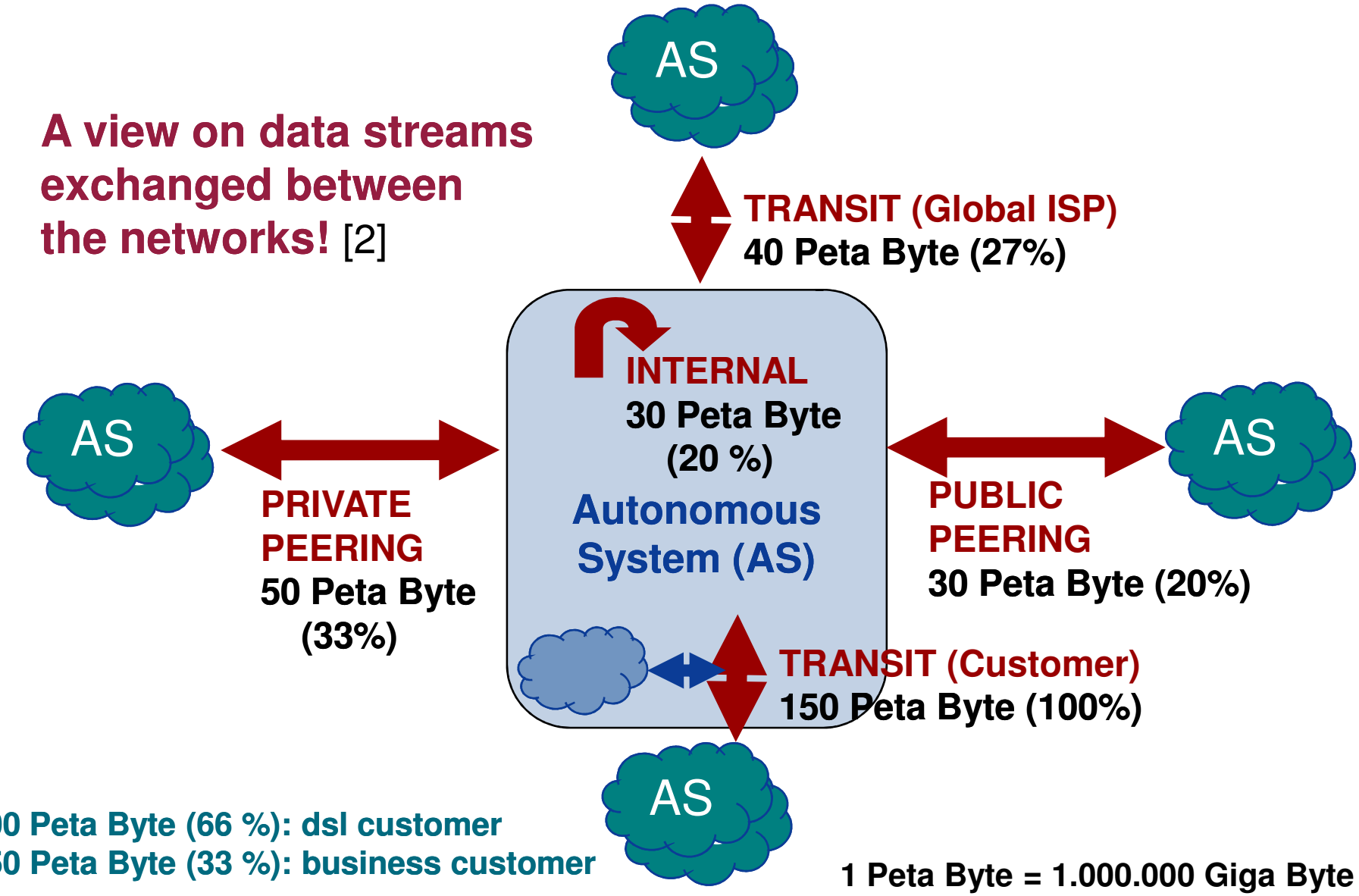
Data volume
→ Model for Internet Germany



Data volume / month in Germany
→ Estimation (2007)



Trend
→ Everything over IP (all-IP)

- **Triple-Play;** Internet, IPTV and VoIP using one single line
  - Decouple from the telephone line
  - IPTV has highest requirements of the available data rates (Downstream)
    - SDTV: from 2 - 6 Mbit/s (depending on used compression; for each TV channel)
    - HDTV: from 6 - 16 Mbit/s (depending on used compression; for each TV channel)
    - (VoIP: maximal 100 kbit/s, depending on used compression; for each parallel call)
  - Till 2015 an increase of the IPTV users to more than 7 million is expected in Germany (population about 82 million)
  - **QoS can only be guaranteed within one AS ! ! !**

Traffic 2011:	Traffic 2006:
40% Internet	80 % Internet
60% AS-Traffic	20 % AS-Traffic

Global data traffic
→ Cisco survey

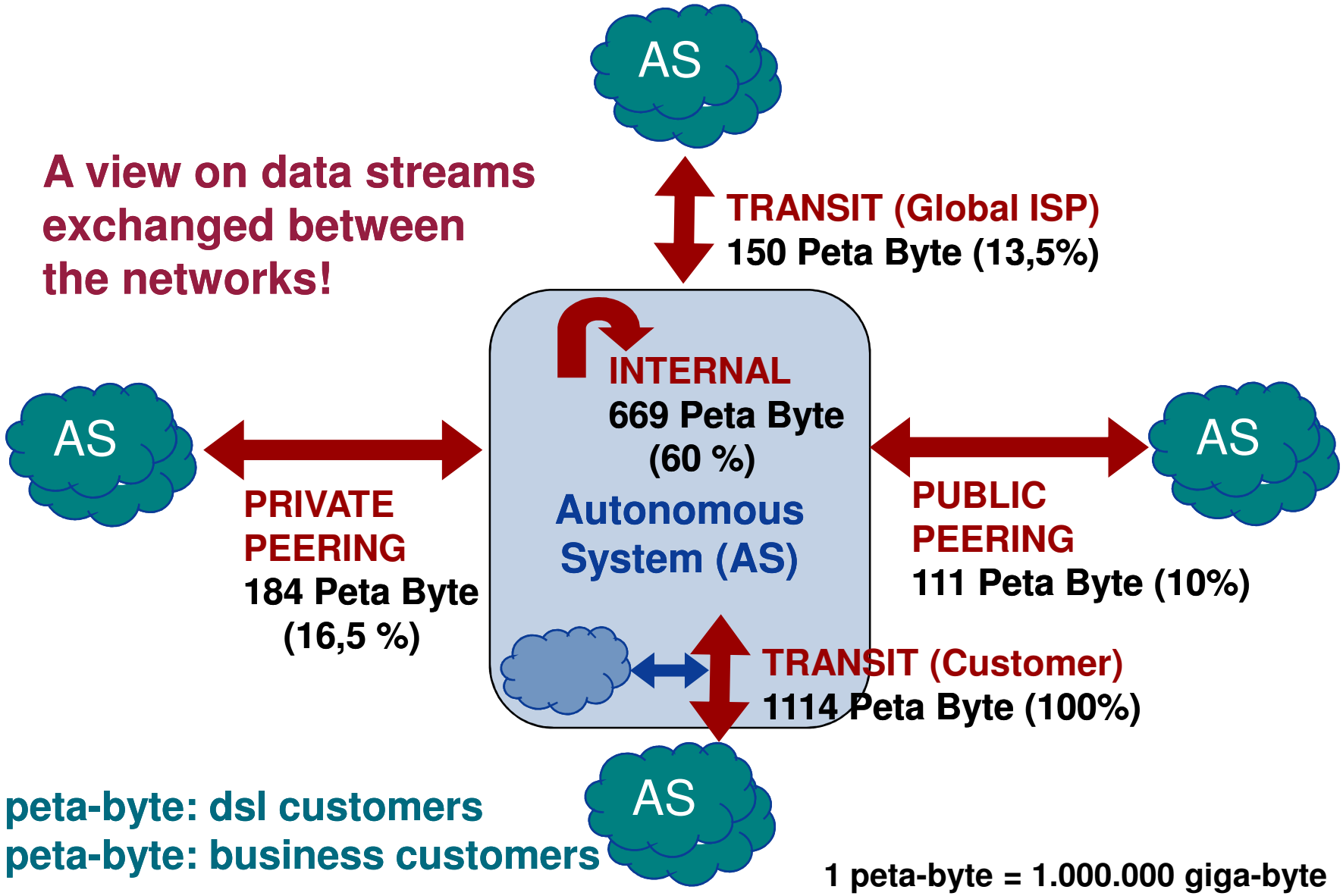
- Annually growth from 2006 till 2011: [3]
  - 58% growth by private users
  - 21% growth by businesses

- Just the video content on **YouTube** is responsible for about **10 percent of the data traffic**; still increasing!
- Important for the boarders to other AS, due to the fact that the content is most of the time in another country (another AS).

year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
privat	***100*** ***(66%)***	158	250	395	623	***984*** ***(88%)***
business	***50*** ***(33%)***	60	73	89	107	***130*** ***(12%)***
sum	**150**	**218**	**323**	**484**	**730**	**1114**

(peta-byte per month!)

Data volume / month in Germany
→ Estimation (2010)



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Structure of the Internet
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- Structure of the Internet is self regulated.
- Only few organisations really knows what happens in the Internet.
- The connectivity will have less strategic meaning for some provider in the future, due to new strategies and services (e.g. IPTV).
- **A open question is:**
  Do we need another internet for business customers in the future?
- What we need is an entity which keeps an eye on the level of connection, the data traffic and the reliability of all ASs in the Internet.

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Thank you for your attention! Questions?

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Structure of the Internet
→ Literature

- [1] http://en.wikipedia.org/wiki/Autonomous_system_(Internet)
- [2] N. Pohlmann: “Wie verlässlich ist das Internet?“ http://www.internet-sicherheit.de/fileadmin/docs/publikationen/IP-Sicherheit-Verlaesslichkeit-12-02-08.pdf
- [3] M. Gröne: „Datenraten im Internet“ http://www.internet-sicherheit.de/fileadmin/docs/publikationen/Studienarbeit-Groene-Datenraten-im-Internet.pdf

Links:

AiconViewer: http://www.internet-sicherheit.de/aiconviewer/