

# FG INET: Internet Network Architectures

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<http://www.inet.tu-berlin.de/>

# INET: Research Group

## □ Location

- MAR-4

## □ Office hours

- Tuesday 12:30 – 13:00
- After the lecture or per e-mail

## □ Contact

- Best per e-mail 😊

## □ Teaching contact

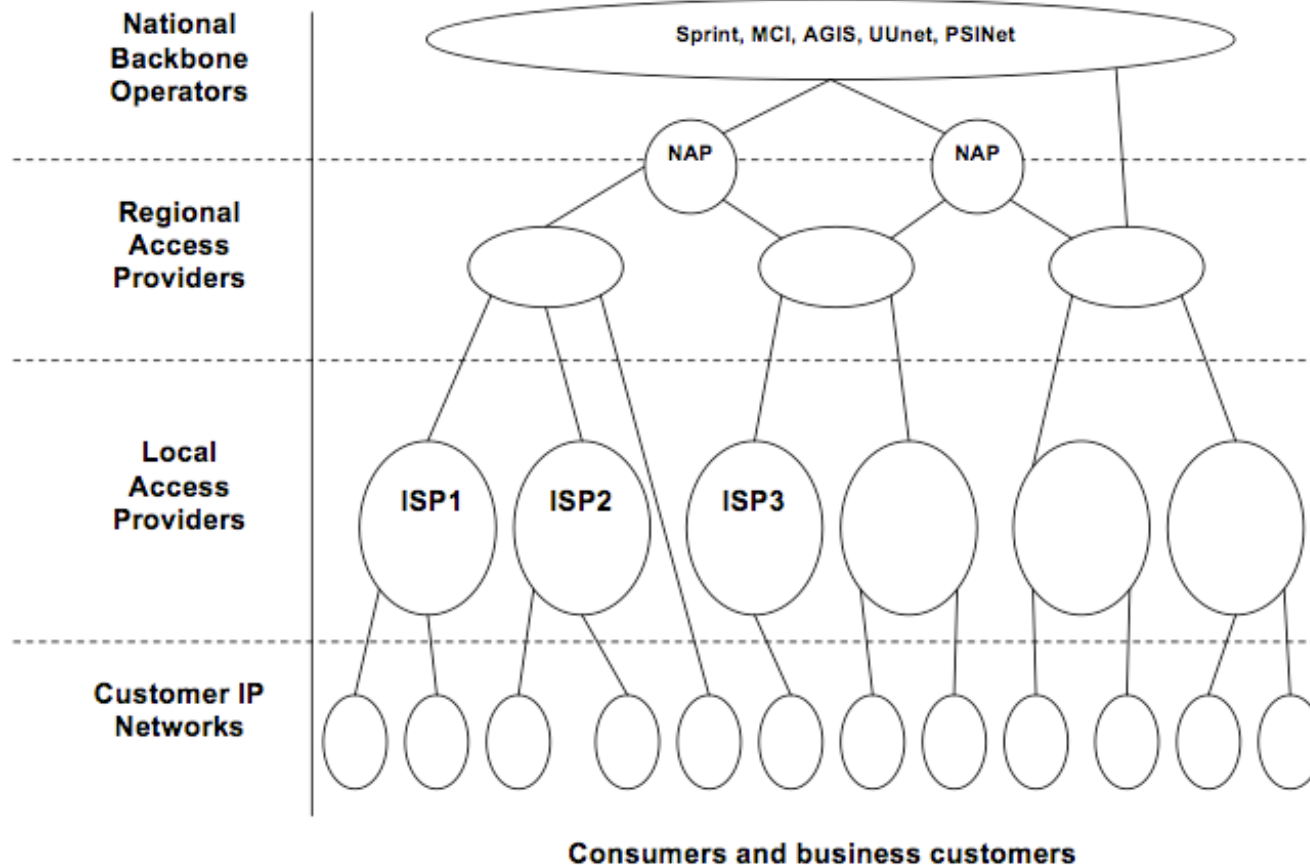
- Thorben Krüger

## □ Web site <http://www.inet.tu-berlin.de/>

# Current research topics

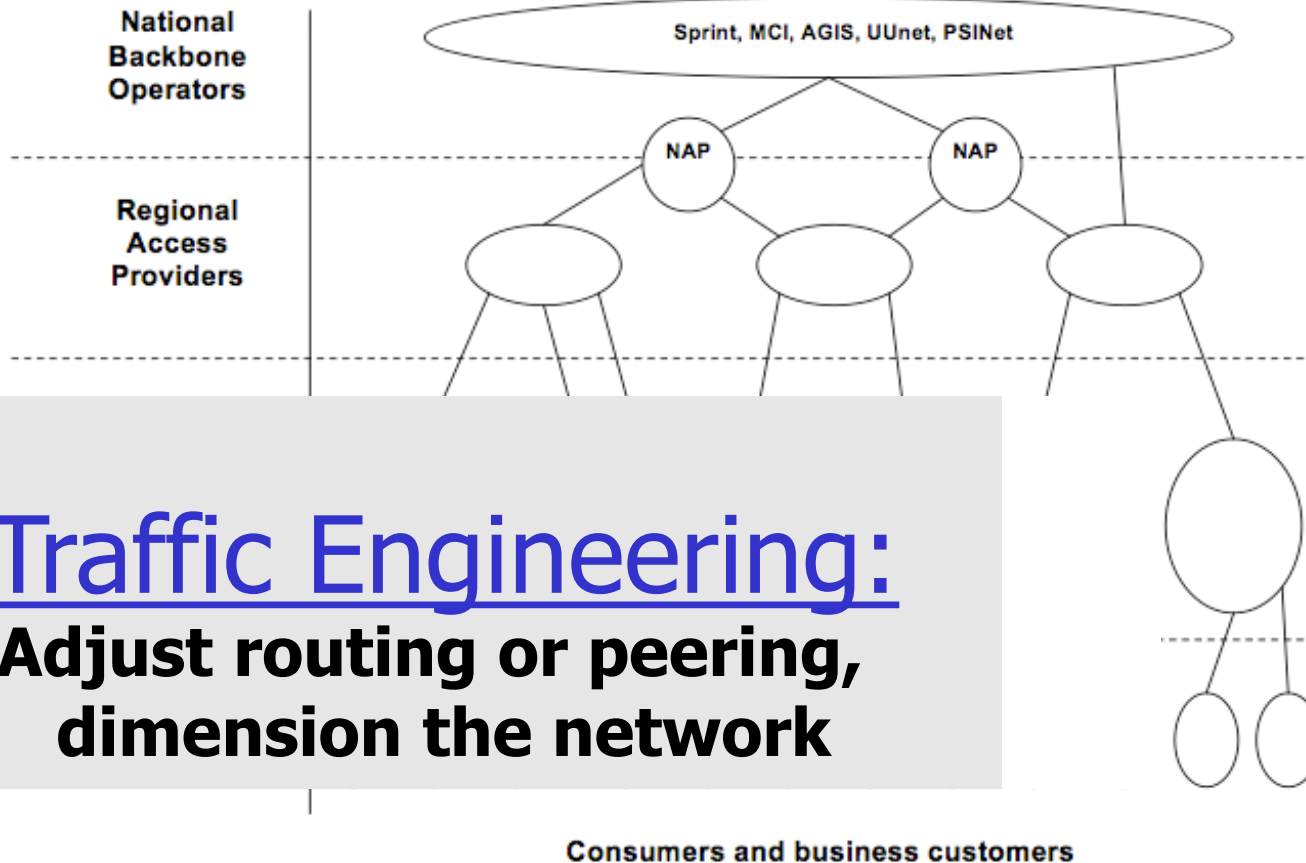
- ❑ IXP data analysis
- ❑ ISP-application collaboration
  - Content aware traffic engineering
  - Caching and content distribution networks
- ❑ Software defined networks
  - Berlin Open Wireless Mesh, OpenFlow, Software defined radios
- ❑ Broadband access evolution
  - Multipath TCP, Socket Intents Licensed/unlicensed spectrum, Mobile user experience
- ❑ Cloud Networking

# Internet and traffic engineering



Source: Arbor Networks  
2009

# Internet and traffic engineering

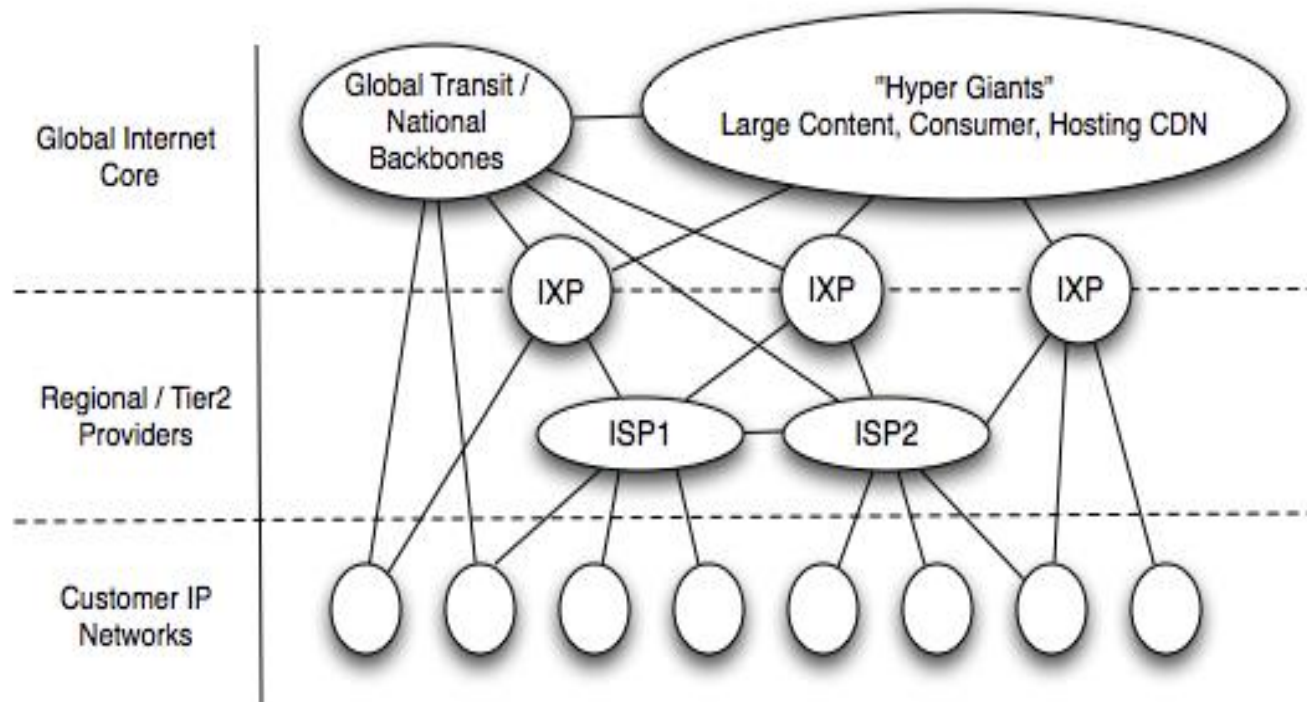


Traffic Engineering:  
Adjust routing or peering,  
dimension the network

→ **Offline Process**

Source: Arbor Networks  
2009

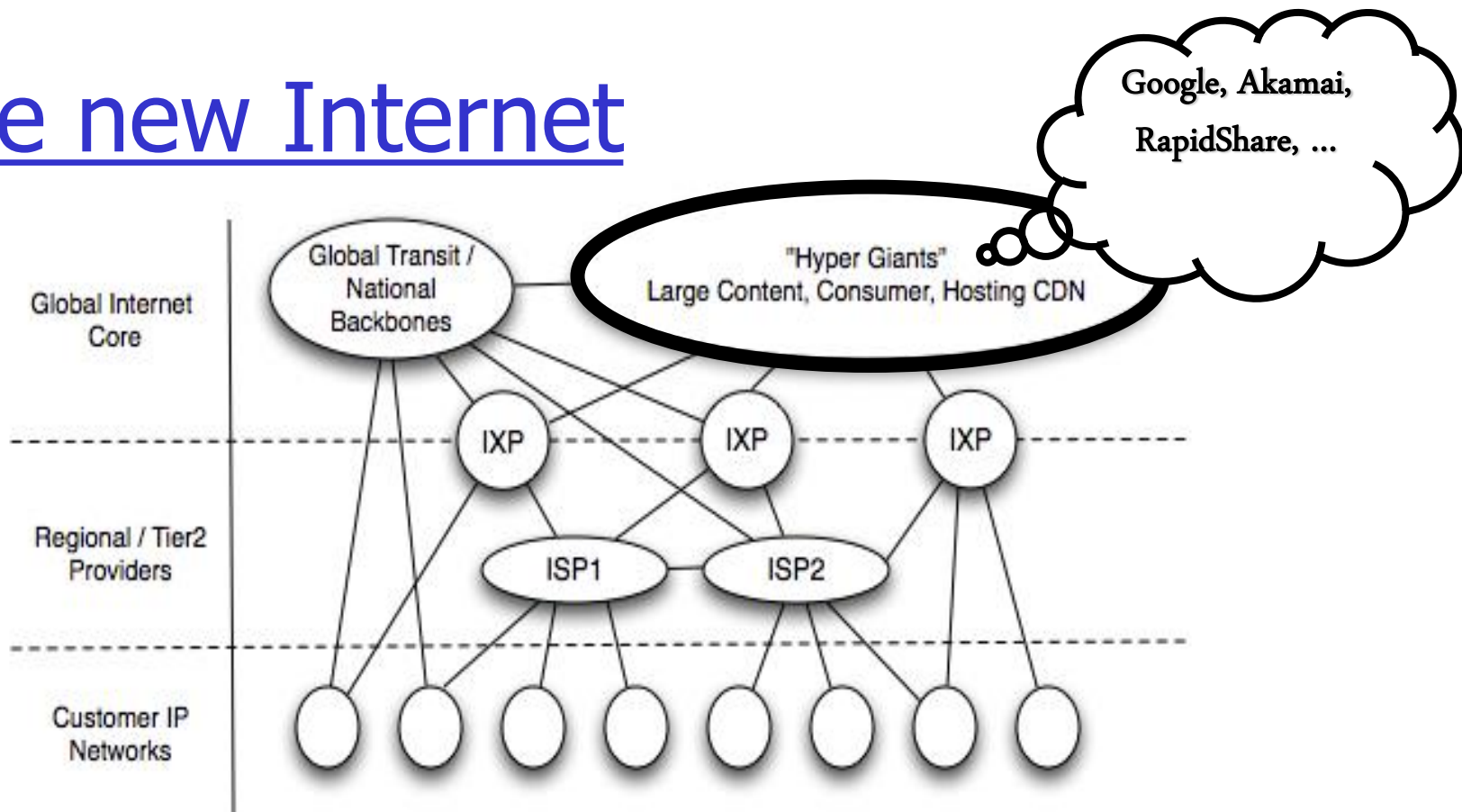
# The new Internet



Source: Arbor Networks  
2009

→ **New core of interconnected content and consumer networks**

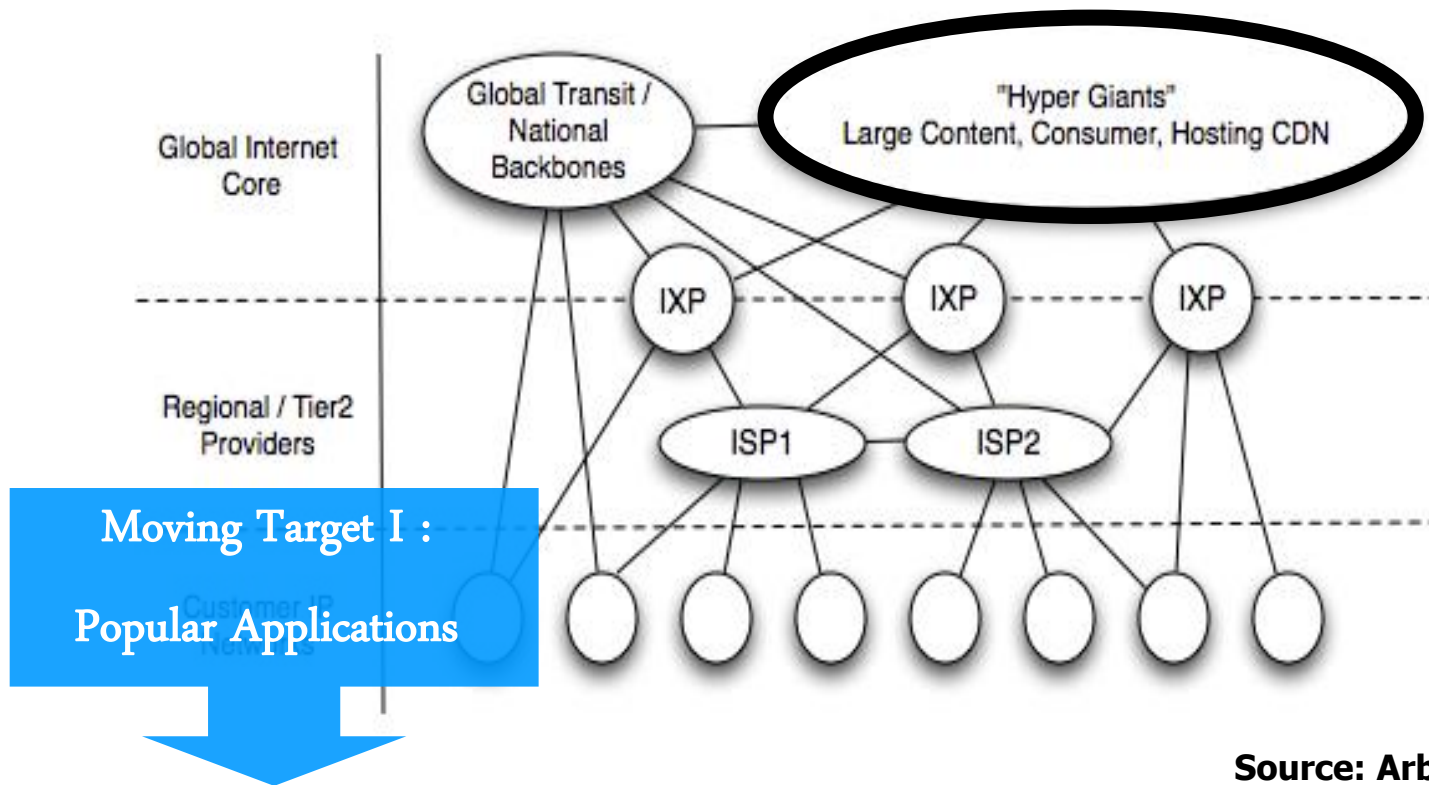
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Source: Arbor Networks  
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# The new Internet

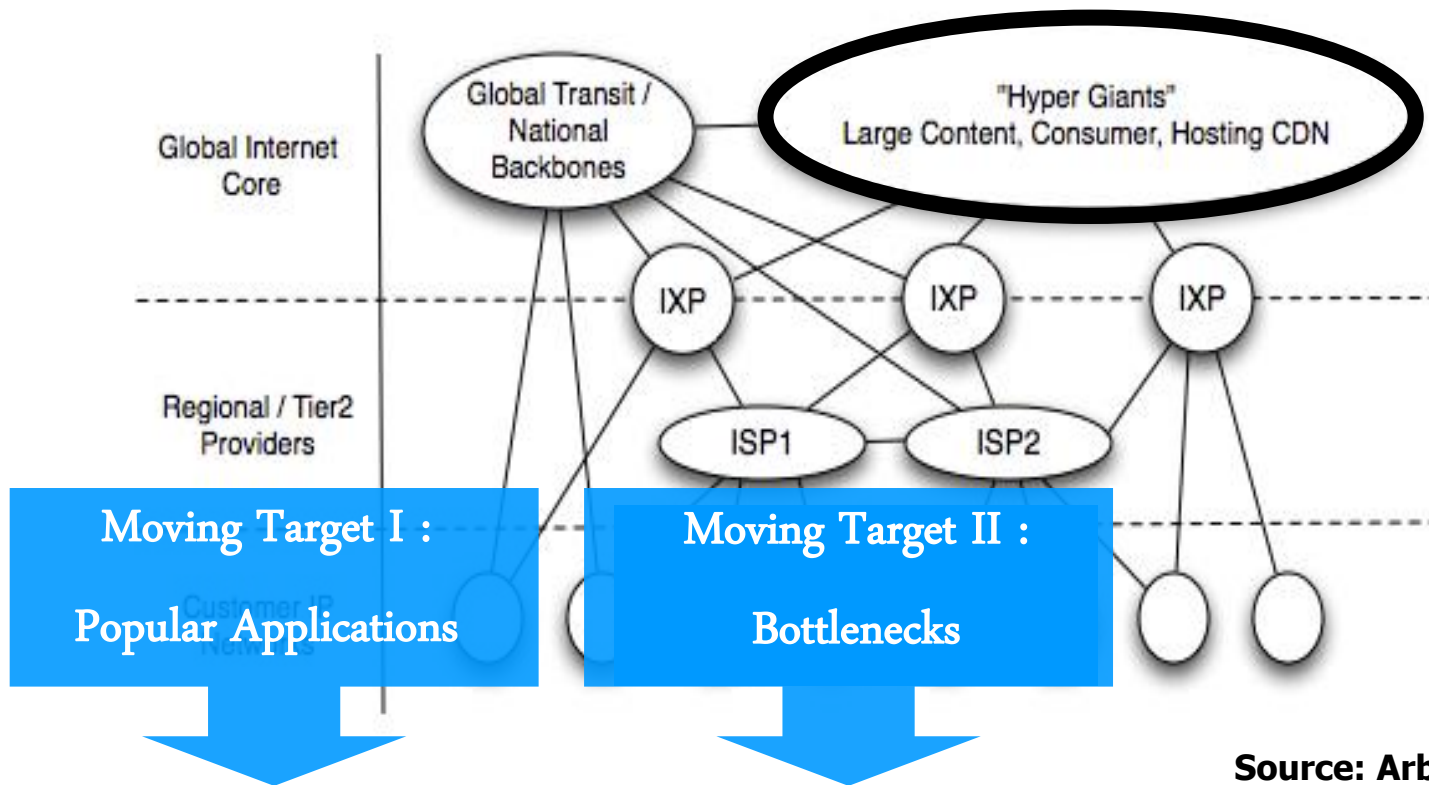


Source: Arbor Networks  
2009

→ **New core of interconnected content and consumer networks**



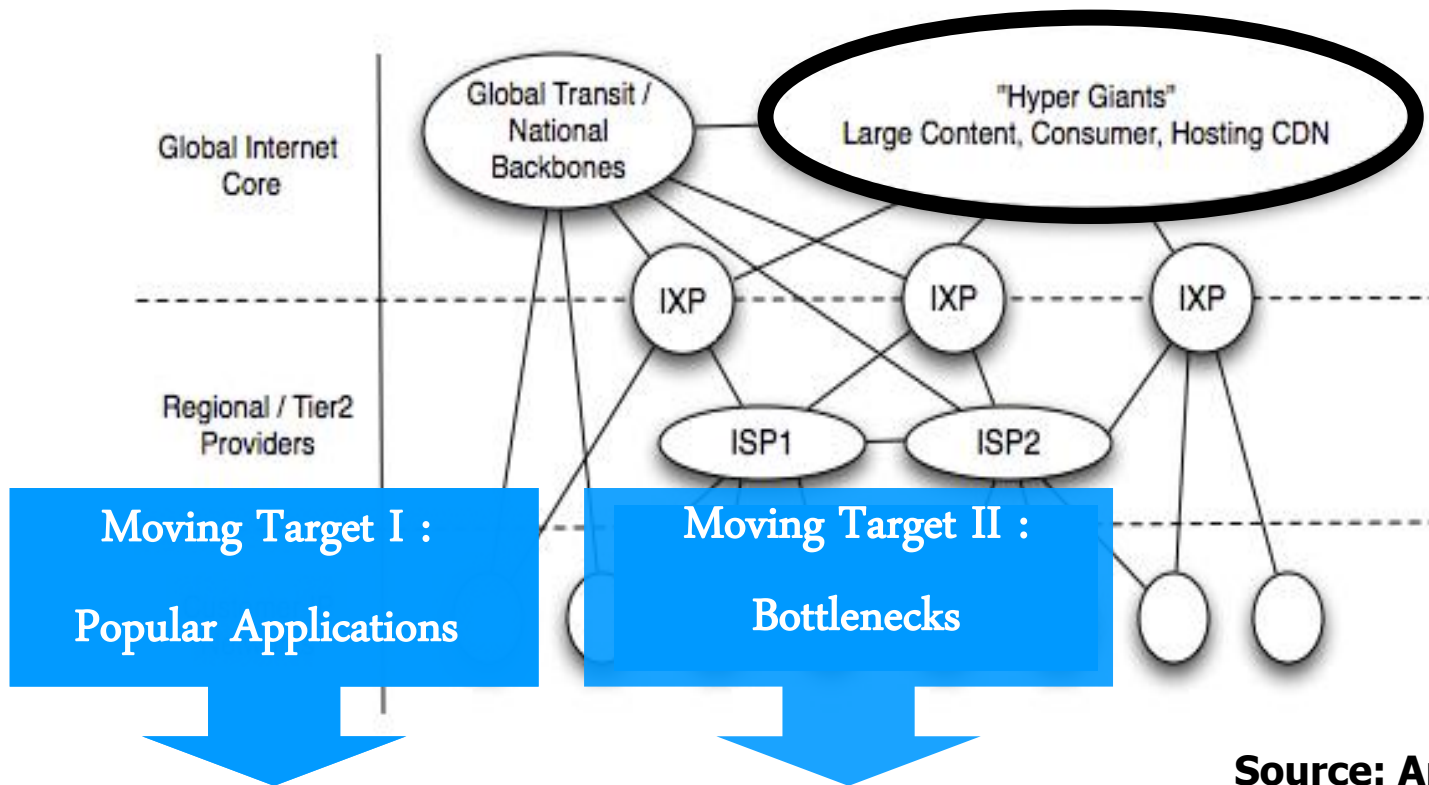
# The new Internet



Source: Arbor Networks  
2009

→ **New core of interconnected content and consumer networks**

# The new Internet



Source: Arbor Networks 2009

→ **New core of interconnected content and consumer networks**

→ **ISPs lost control of their traffic**

# The new Internet

Global Internet Core

Regional / Tier2 Providers

Moving Target I :  
Popular Application

→ New content  
→ ISPs

The screenshot shows the Financial Times website in a Mozilla Firefox browser. The page features a navigation menu on the left, a search bar, and a main article titled "Google accused of YouTube 'free ride'". The article discusses the dispute between Google and European telecoms groups over bandwidth usage. A sidebar on the right includes a "Global mobile telecoms market" chart and a "SUBSCRIBE TO THE FT AND SAVE" section. A large blue arrow points from the "Moving Target I : Popular Application" text to the article. A large white text box at the bottom right contains the quote: "Telekom's chief executive, said Google and others should pay telecoms groups for carrying content on their networks".

FT.com / Technology - Google accused of YouTube 'free ride' - Mozilla Firefox

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**Google accused of YouTube 'free ride'**

By Andrew Parker in London and Richard Waters in San Francisco  
Published: April 9 2010 22:42 | Last updated: April 9 2010 22:42

Some of Europe's leading telecoms groups are squaring up for a fight with Google over what they claim is the free ride enjoyed by the technology company's YouTube video-sharing service.

**Telefónica, France Telecom and Deutsche Telekom** all said Google should start paying them for carrying bandwidth-hungry content such as YouTube video over their networks.

It underlines how Google's relationship with leading telecoms groups is becoming increasingly fractious, partly because YouTube video is fuelling an explosion of data traffic on their networks.

**EDITOR'S CHOICE**

- Backlash as data traffic explodes - Apr-09
- Agencies and developers welcome Apple's iAd - Apr-09
- Lex: Apple v Google - Apr-09
- In depth: Apple - Jul-16
- In depth: Google - Mar-22
- Apple to battle with Google for mobile ads - Apr-09

**Some European telecoms groups fear Google will reduce them to "dumb pipes"** because the internet search and advertising company pays the network operators little or nothing for carrying its content.

Telecoms groups are spending billions of euros on fixed-line and mobile infrastructure to increase broadband capacity, but some fear they may struggle to secure a return on their investment.

**Global mobile telecoms market**

Broadband users (m)

300

Transferring data from markets.ft.com...

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**"Telekom's chief executive, said Google and others should pay telecoms groups for carrying content on their networks"**

# Challenge

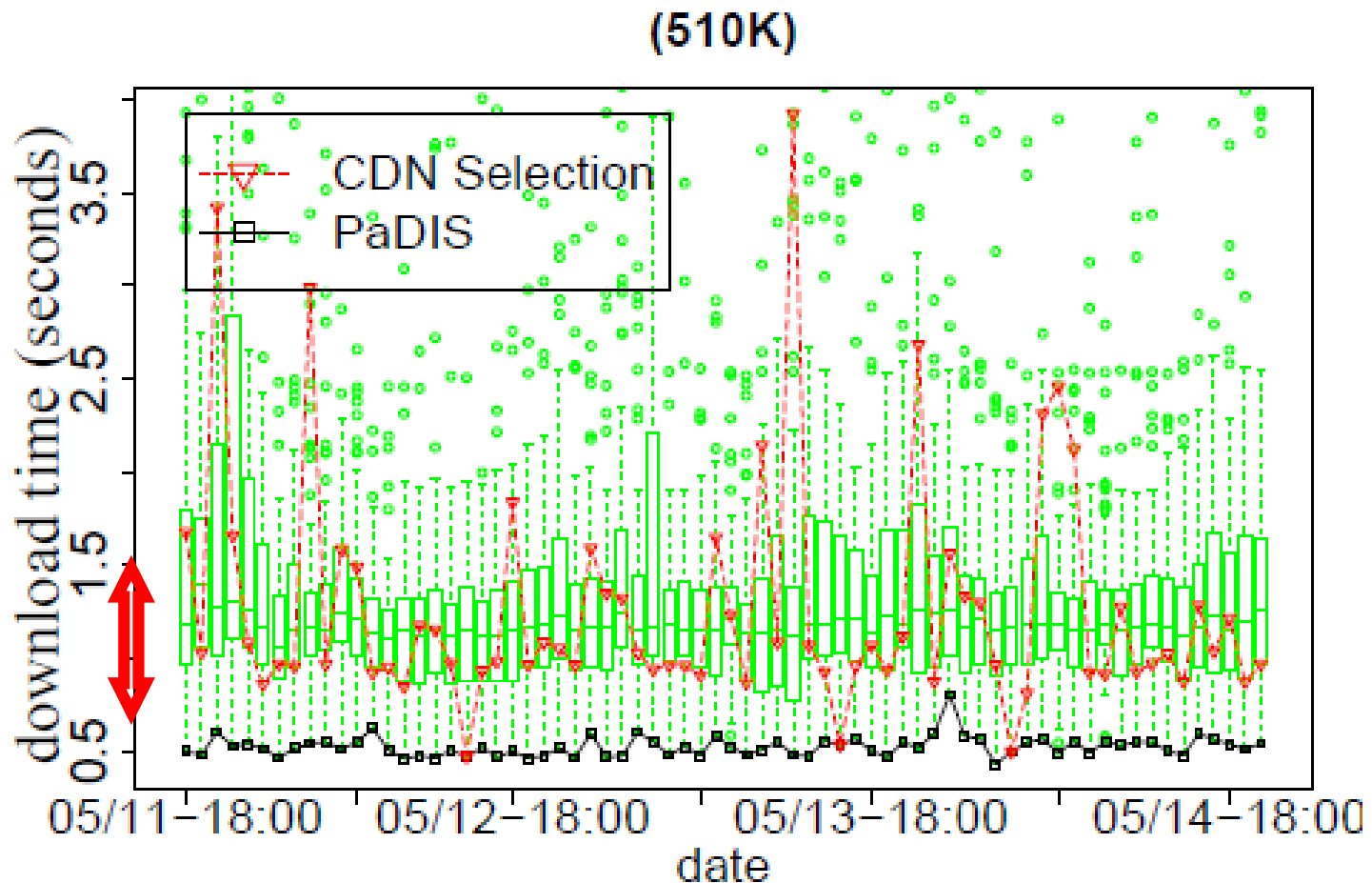
**Content-aware**

**Traffic Engineering**

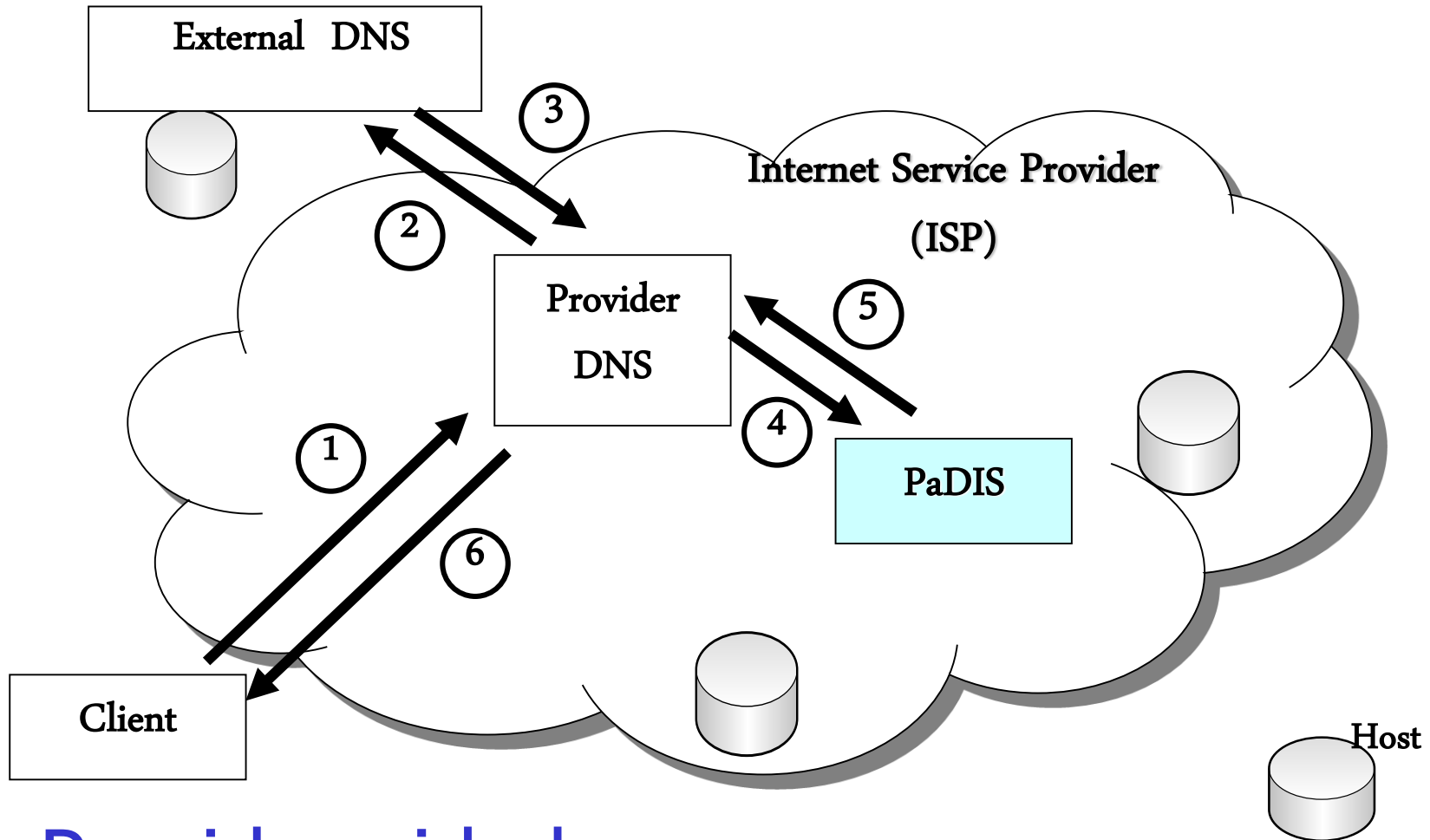
**ISPs re-gain control of their traffic  
by biasing host selection**

# Improving content access time

## Case study: CDN



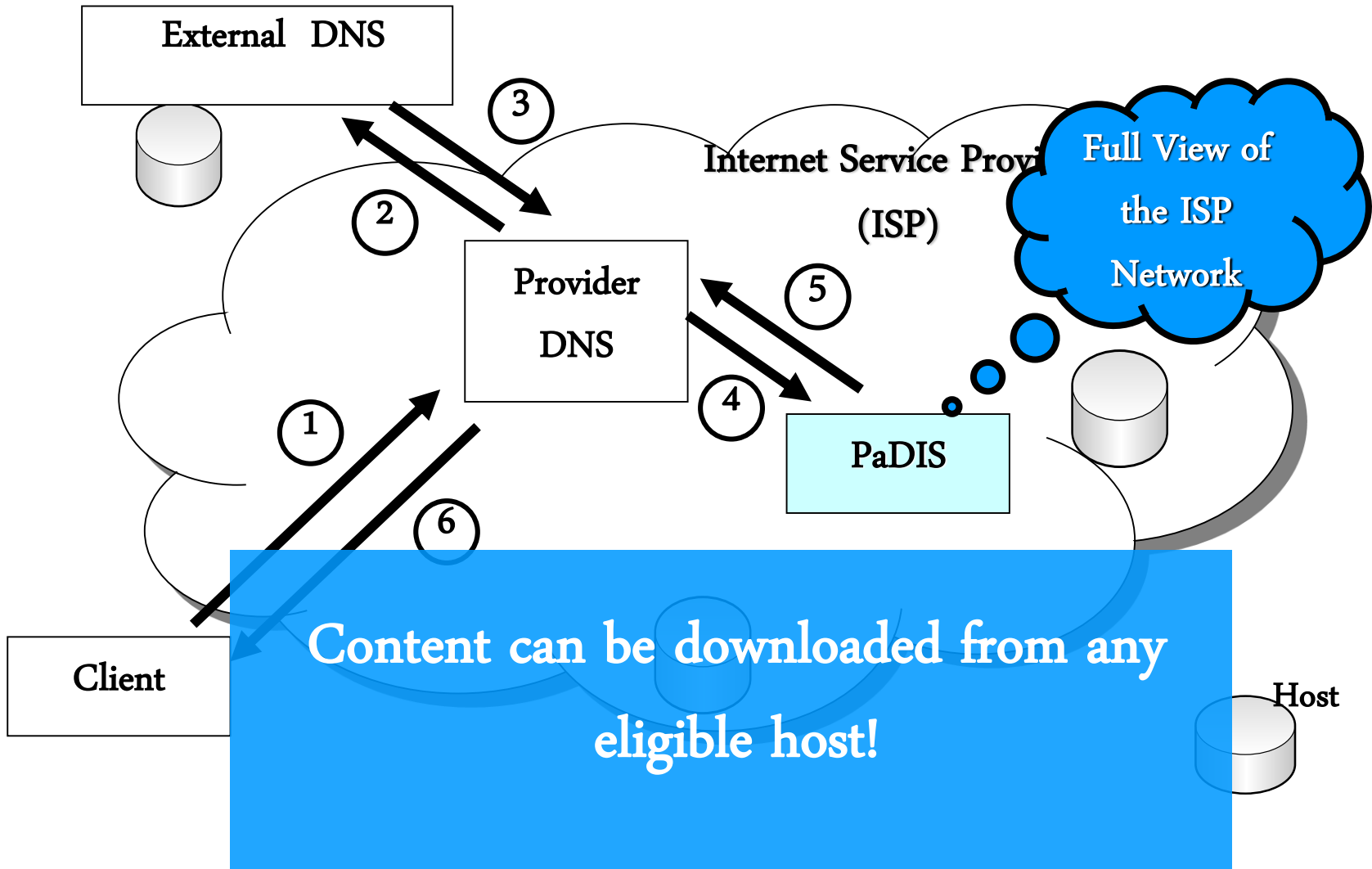
# PaDIS



## Provider-aided

## Distance Information System

# PaDIS



# ISP-Application cooperation

- Insight: **ISP knows its network**
  - Node: bandwidth, geographical location, service class
  - Routing: policy, OSPF/BGP metrics, distance to peers
- **PADIS concept**
  - Service of AS / ISP
  - Input: list of possible dst IPs
  - Output: ranked list of dst IPs
    - E.g., according to distances between src IP and dst IPs
- **Applicable, whenever there is a choice!**



# Teaching

- ❑ Lectures (Vorlesungen)
- ❑ Seminars (Seminare)
- ❑ Lab course (Praktika)
- ❑ Projects (Projekte)
- ❑ Theses (Diplom / Master / Bachelor)
  
- ❑ PGT: Project Group Meeting (Ph.D. Seminar)
- ❑ NLS: Networking Lecture Series (External visitors)

# Lectures

- ❑ Network protocols and architectures (VL+UE)
  - Design principles of the Internet....
  - Base for all other INET classes
  
- ❑ Internet Routing (VL)
- ❑ Internet Security (VL)
  
- ❑ Network Algorithms (VL+UE)
- ❑ Internet Measurement (VL)

# Seminars

- ❑ Internet Routing
- ❑ Internet Measurement
- ❑ How
  - Topics: Current research papers
  - Task:
    - Summary paper + presentation
    - Participation in discussion during the seminar
  - En-block after the end of term

# Lab courses

- ❑ Hands on exercises

- ❑ **Wireless Lab**

- Understanding various wireless concepts (e.g., interference, MAC layer, multi-hop routing)  
Experiments with mesh routers in the BOWL indoor network

- ❑ Router Lab

- Configuring and managing networks
- Internet experiments in a Lab

# Projects and theses

## □ Topics:

- See Web pages
- Talk to members of INET
- Suggest your own topic

## □ Work flow:

- Literature/background search
- Presentation of idea at students' talks series (20 minutes 😊)
- Execution of idea / preparation of thesis document
- Presentation of results at students' talks (20 minutes)

# Teaching at INET / Anja Feldmann

## Topics

Internet Protocols:

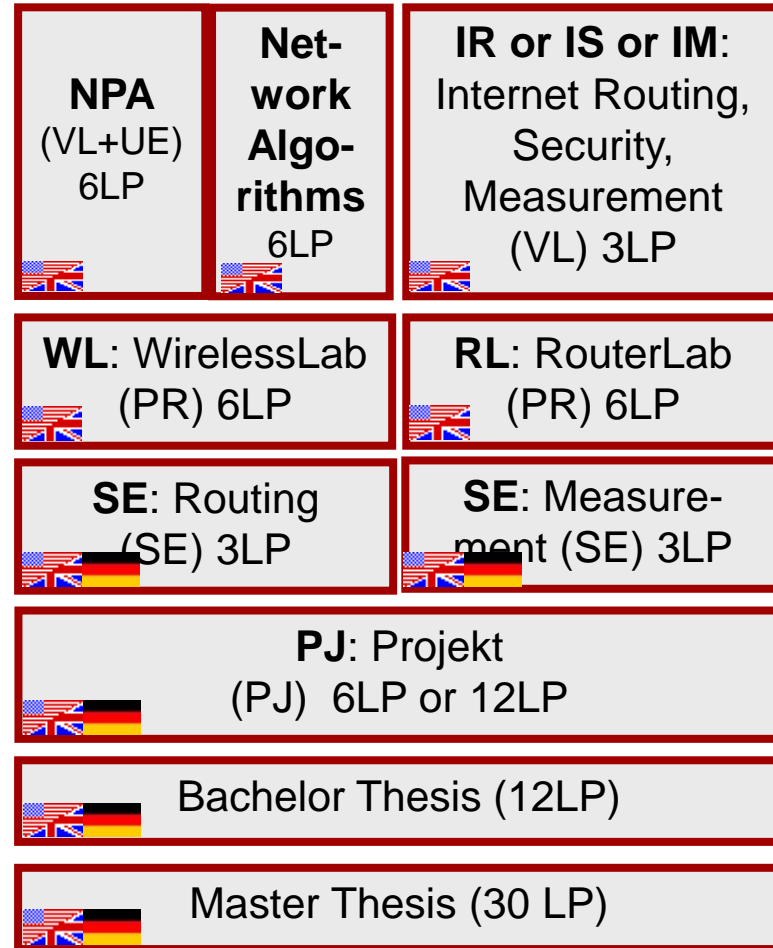
- Routing and IP
- Transport (TCP/UDP)
- Applications
- Future Internet

- Traffic Measurement
- Workload Modeling
- Wireless
- Performanceanalysis
- Network Security

## Course Overview

WiSem

SoSem



## Example Module Paths

