

FG INET: Intelligent Networks

An-Institut Deutsche Telekom Laboratories

Prof. Anja Feldmann, Ph.D.

anja@net.t-labs.tu-berlin.de

<http://www.net.t-labs.tu-berlin.de/>

INET: Research Group

❑ Location

- Telefunkenhochhaus, 16. Stock

❑ Office hours

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

❑ Contact

- Best per e-mail 😊

❑ Teaching contact

- Nadi Sarrer / Oliver Hohlfeld

❑ Web site

<http://www.net.t-labs.tu-berlin.de/>

T-Labs

- ❑ Institute at TU Berlin funded by Deutsche Telekom AG
- ❑ Co-locates researchers from TU Berlin and project managers of Deutsche Telekom
- ❑ Two parts
 - Strategic research
 - 7 Research Groups + 30 Researchers + 40 Ph.D. students so far: INET, Quality and Usability (QU Lab), Security in Telecommunications (SecT), Service Centric Networking (SNET)
 - Innovation development
 - Project work, e.g., IP-TV, Overarching AAA

Dr. Stefan Schmid

□ Biography:

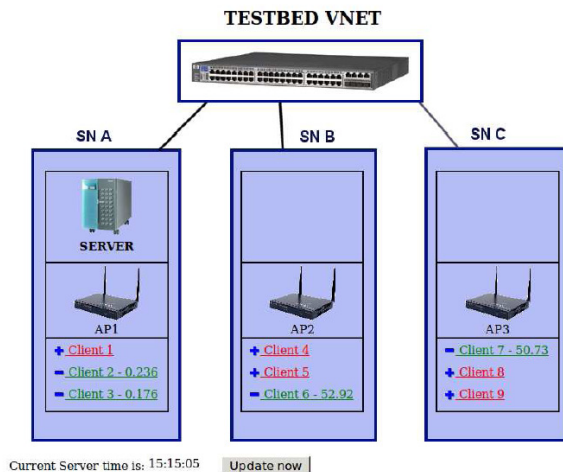
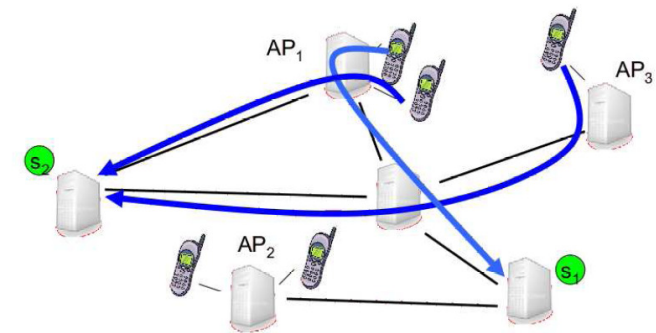
- PhD in *Distributed Computing Group* (DISCO) @ ETH Zürich
- Postdoc at *Chair for Efficient Algorithms* (TU München) and *Chair for Theory of Distributed Systems* (Uni Paderborn)
- Senior Research Scientist @ Deutsche Telekom Laboratories

□ Research Interests:

- Robust and scalable architectures for distributed systems (dealing with churn, self-stabilization, etc.)
- Network virtualization (e.g., embeddings or service migration)
- (Distributed) algorithms
- Peer-to-peer systems (e.g., BitThief), wireless networks (e.g., robust medium access), social networks (e.g., Wuala)
- Incentives, mechanism design, game theory

Example: Network Virtualization

- Virtual networks
 - Decoupling of services from resource infrastructure
 - Virtual networks embedded dynamically, where and when most useful!
 - No knowledge of future requests: online embedding algorithms needed!



- Use case: Agile mobile provider
 - Move servers "closer to requests"
 - Improves Quality-of-Service...
 - ... but need to take into account migration costs!
 - How to be „competitive“?
 - We also develop prototypes...

Florin Ciucu, Ph.D.

□ Biography:

- B.Sc. in Informatics, Faculty of Mathematics, University of Bucharest
- M.Sc. in Computer Science, George Mason University, USA
- Ph.D. in Computer Science, University of Virginia, USA
- Senior Research Scientist at Deutsche Telekom Laboratories

□ Research Interests:

- Performance analysis of computer and communication systems
 - Overflow and delay analysis in queueing networks
 - Optimal resource allocation (e.g., buffer size in routers)
 - Capacity of multi-hop wireless networks
- Randomized algorithms
 - Medium Access Control (Aloha, CSMA/CD)
 - Scheduling in multi-hop wireless networks
 - Traffic policing

Example: Buffer Size in Routers

- Buffers needed to handle the frequent situation

$$\textit{incoming_data_rate} > \textit{router_data_rate}$$

- Interesting tradeoff: Large vs. Small

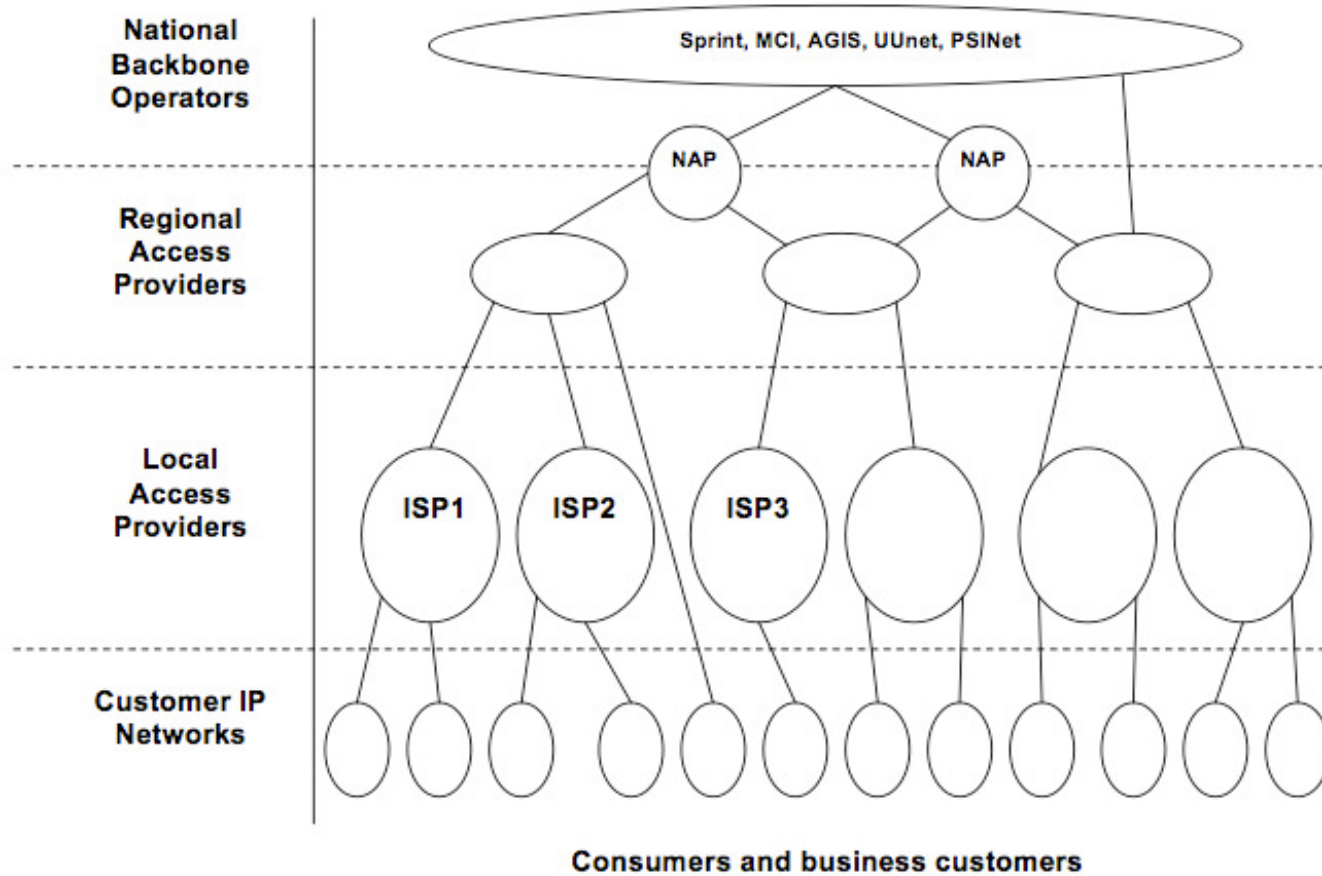
Buffer Size	Loss	Delays	Costs	All-Optical Networks
Large	small	large	large, e.g, \$15000	no
Small	large	small	small	yes

- Topics of interest
 - The impact on end-to-end multimedia quality (e.g., video)
 - How small buffers should be? (Nobody knows after 40 years)

Current research topics

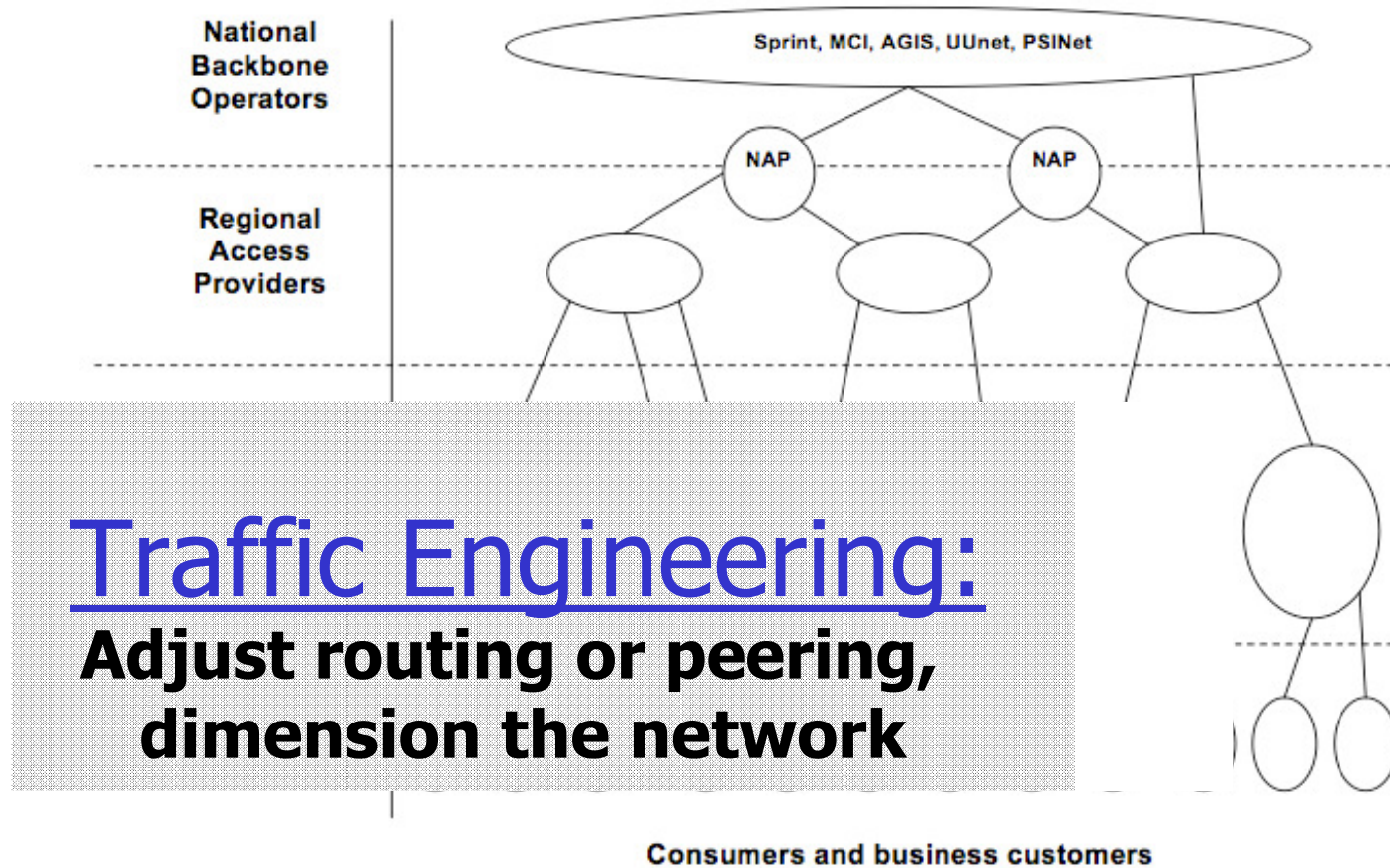
- ❑ ISP-application collaboration
 - Content aware traffic engineering
 - Caching and content distribution networks
- ❑ Programmable networks
 - Berlin Open Wireless Mesh, OpenFlow, Software defined radios
- ❑ Broadband access evolution
 - Licensed/unlicensed spectrum, Mobile user experience
- ❑ Community-inspired optimization
- ❑ Cloud Networking

Internet and traffic engineering



**Source: Arbor Networks
2009**

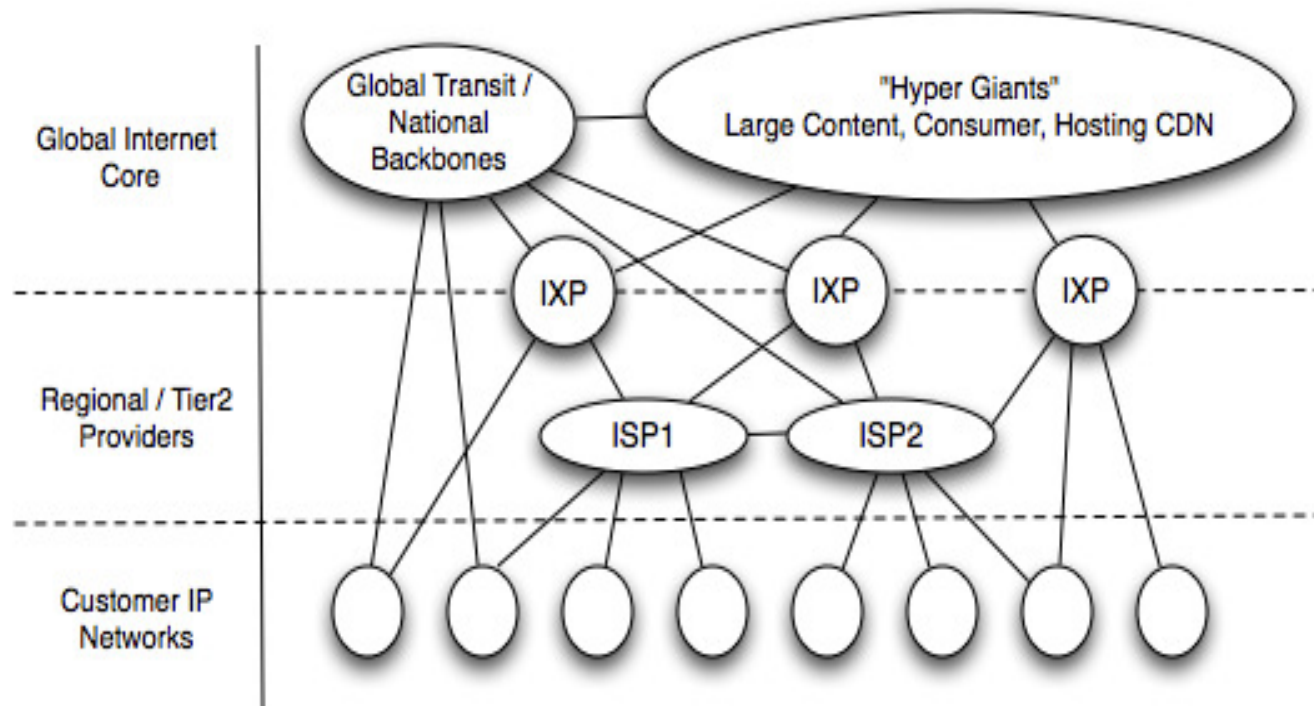
Internet and traffic engineering



→ **Offline Process**

Source: Arbor Networks
2009

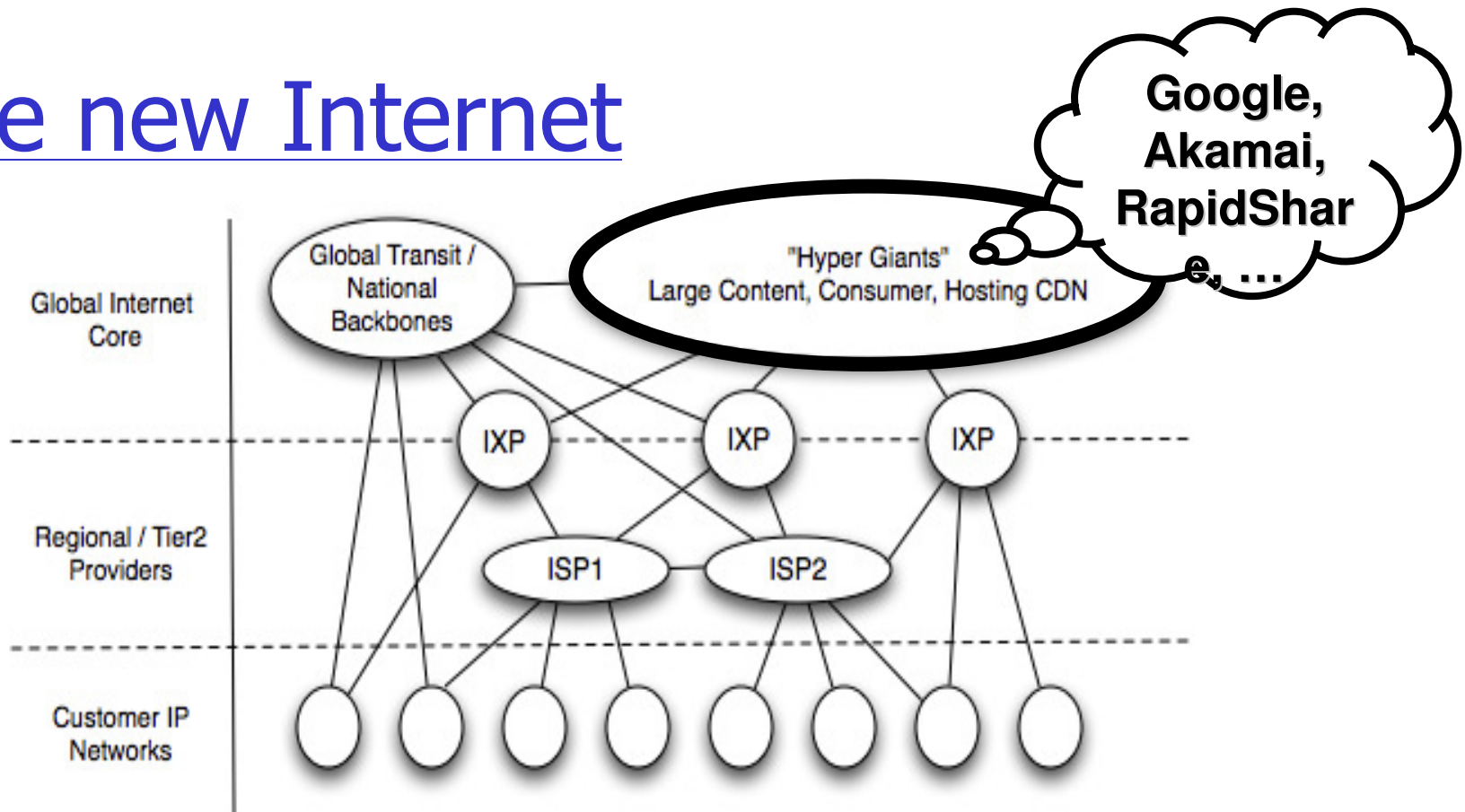
The new Internet



Source: Arbor Networks
2009

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

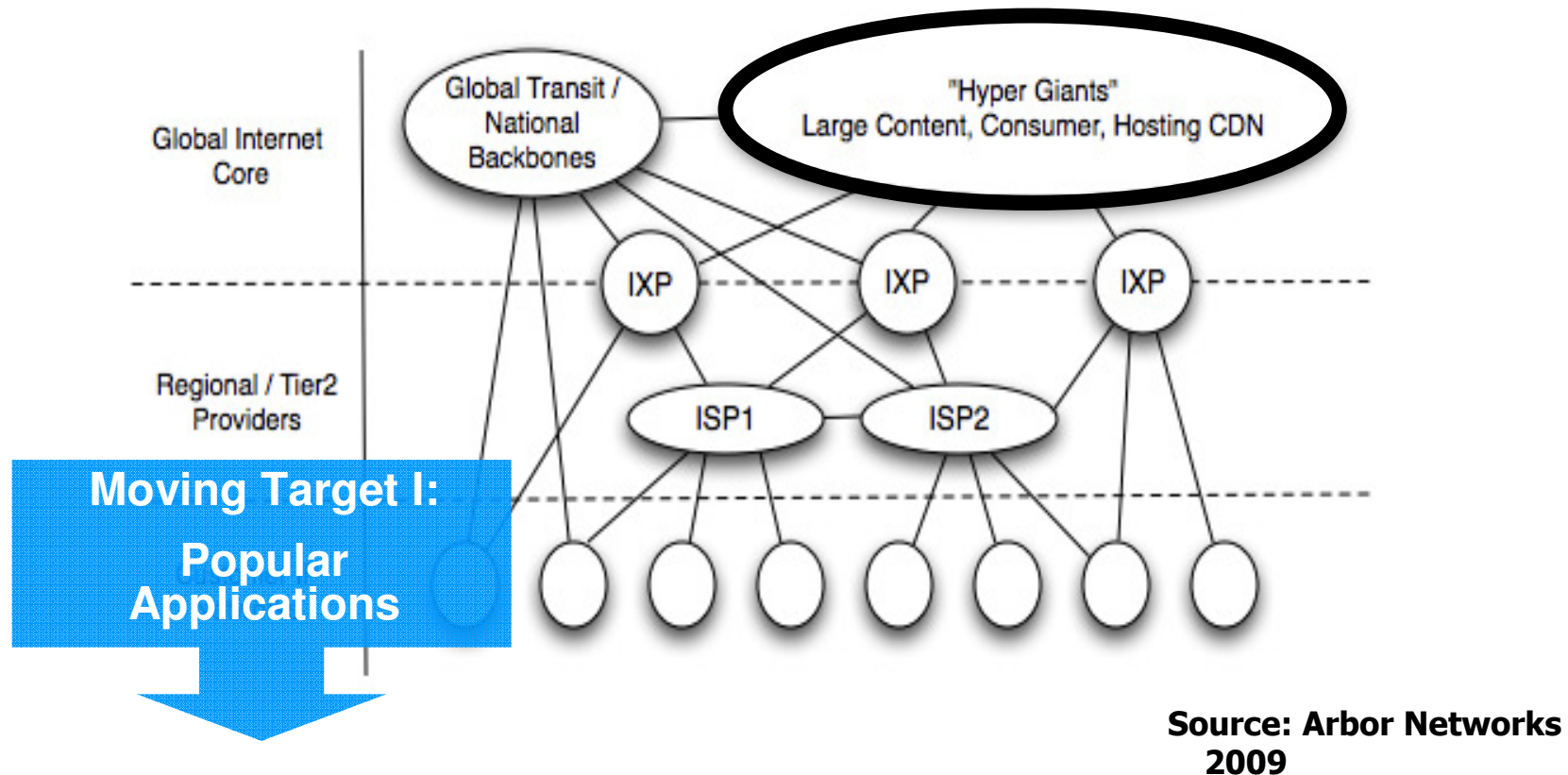
The new Internet



Source: Arbor Networks
2009

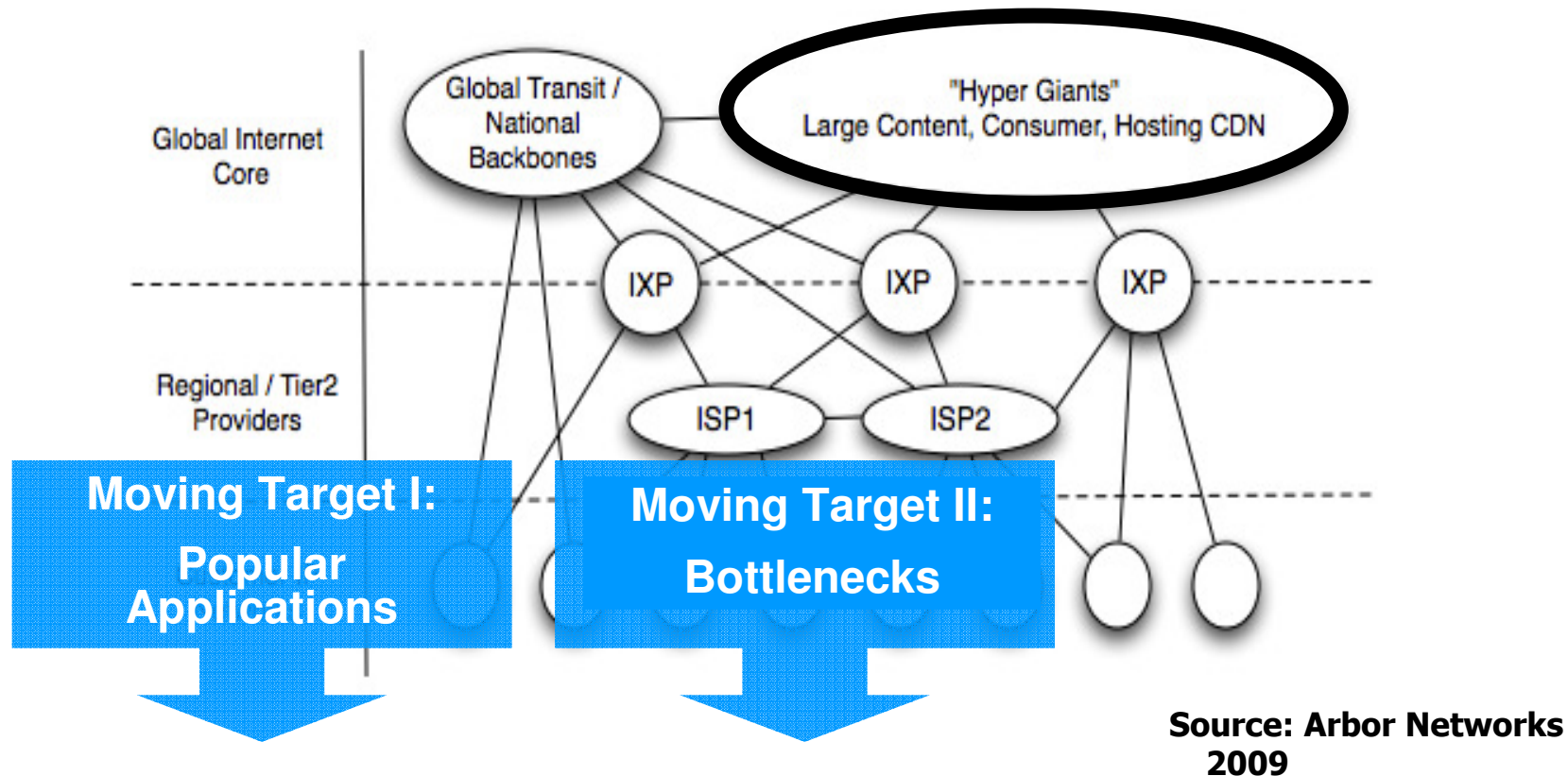
→ **New core of interconnected content and consumer networks**

The new Internet



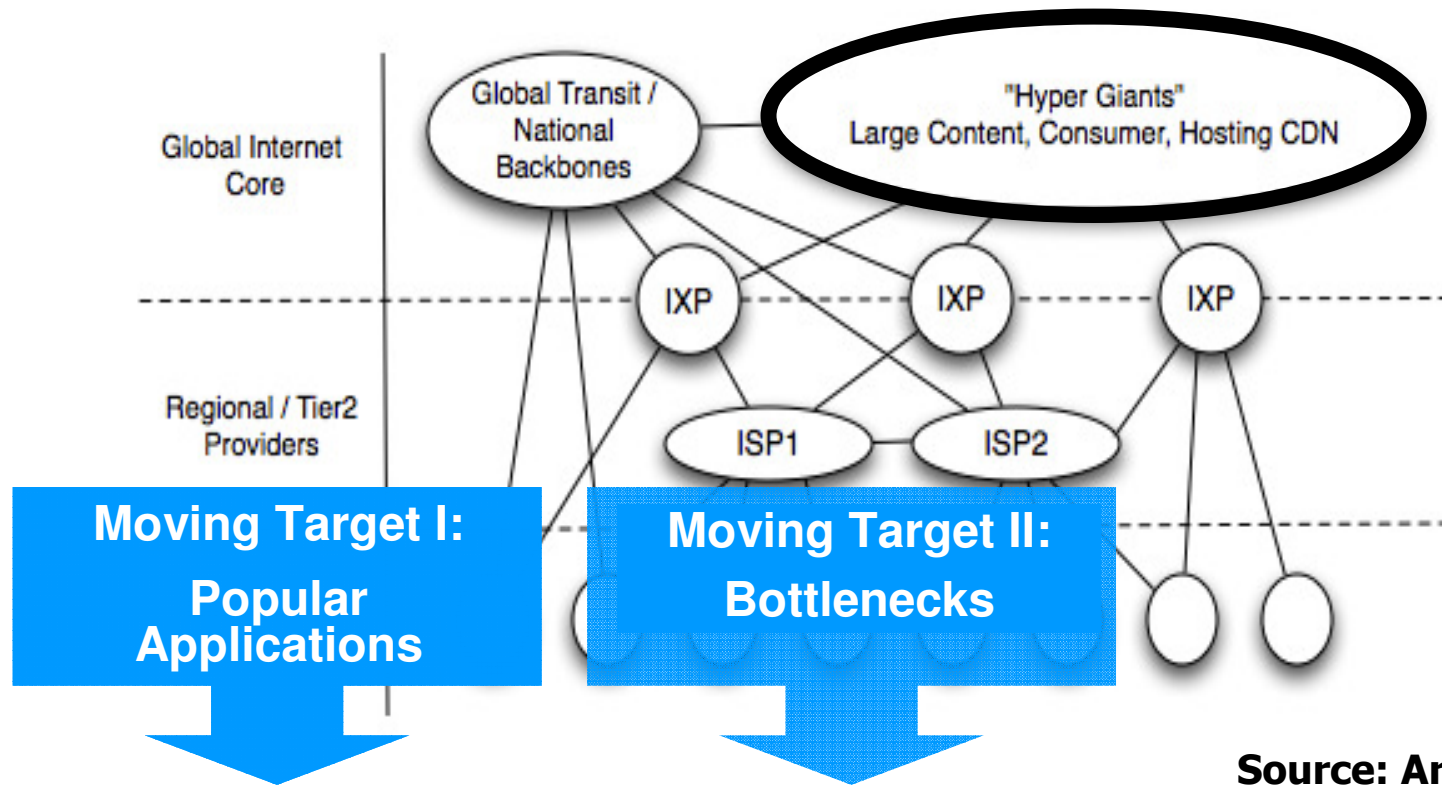
→ **New core of interconnected content and consumer networks**

The new Internet



→ **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
Popular Applications

→ New content
→ ISPs

The screenshot shows the Financial Times website's Technology section. The main article is titled "Google accused of YouTube 'free ride'" and discusses the legal and financial tensions between Google and European telecoms groups like Telefónica, France Telecom, and Deutsche Telekom. The article mentions that Google should start paying for bandwidth-hungry content like YouTube videos. A sidebar on the left lists various categories like Digital Business, Tech Blog, and Science. A right sidebar contains a subscription offer and another survey promotion. The browser's address bar shows the URL: http://www.ft.com/cms/s/2/8f5d6128-4400-11df-9235-00144feab49a.html.

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

Challenge

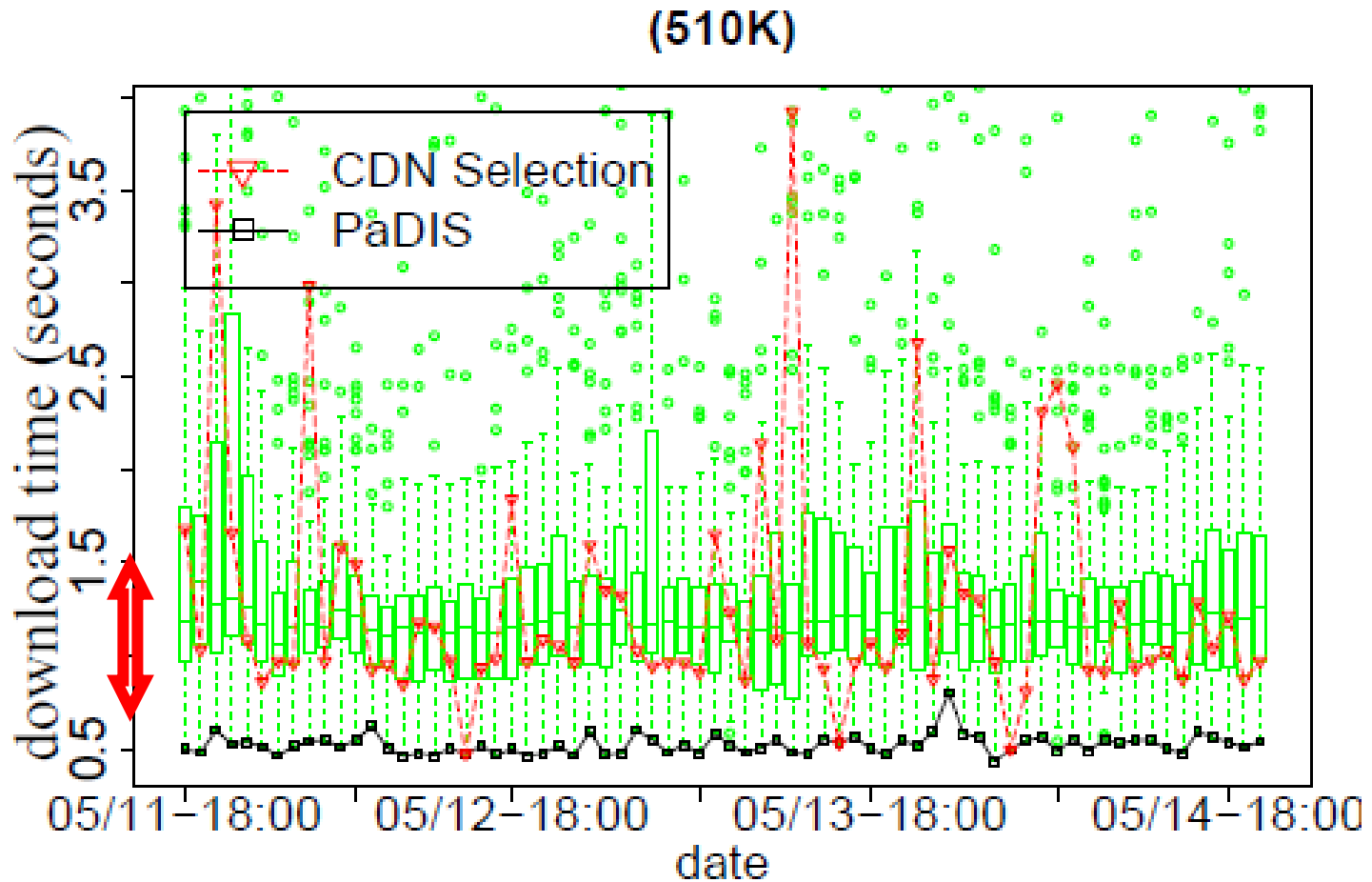
Content-aware

Traffic Engineering

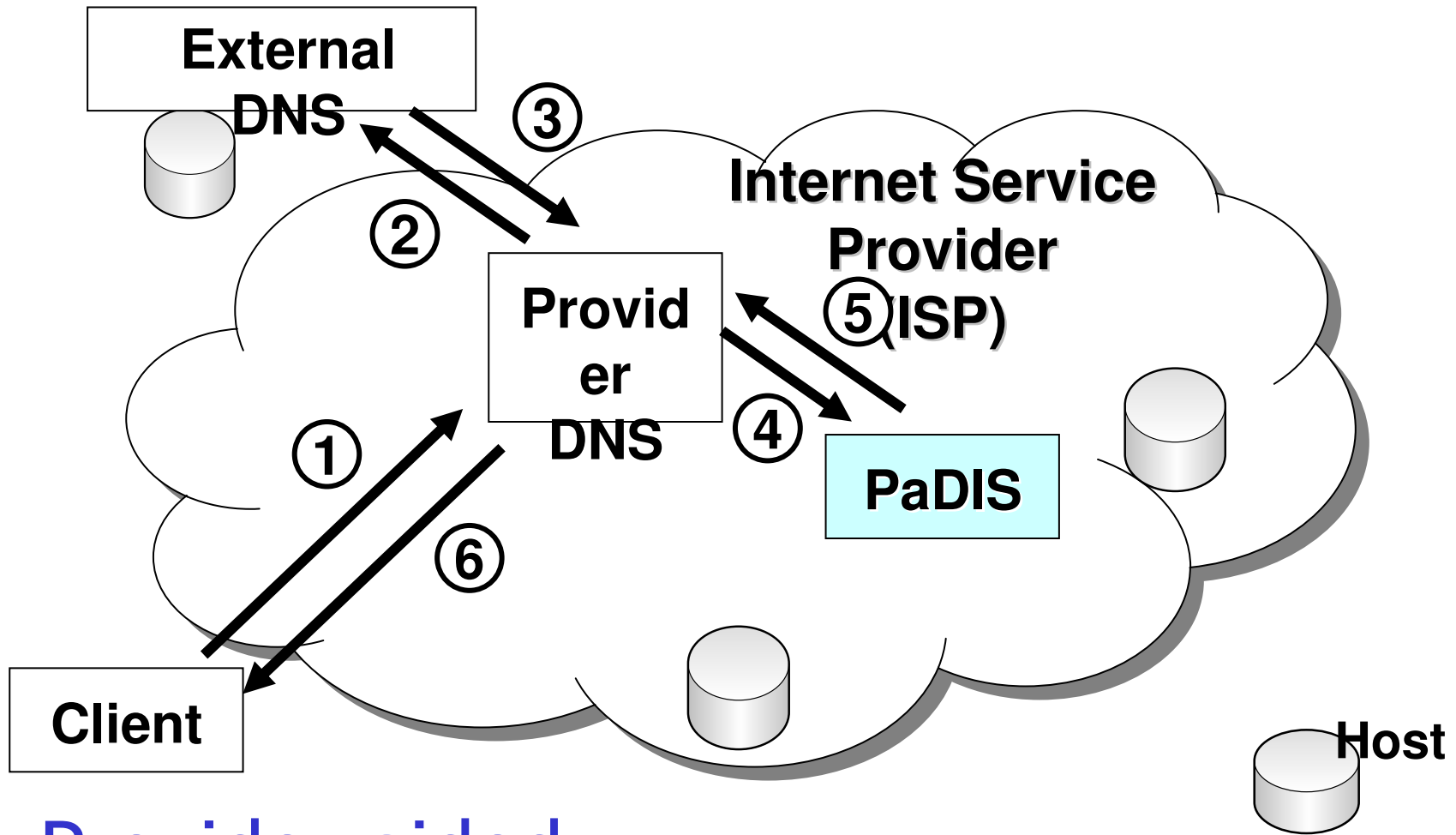
**ISPs re-gain control of their traffic
by biasing host selection**

Improving content access time

Case study: CDN



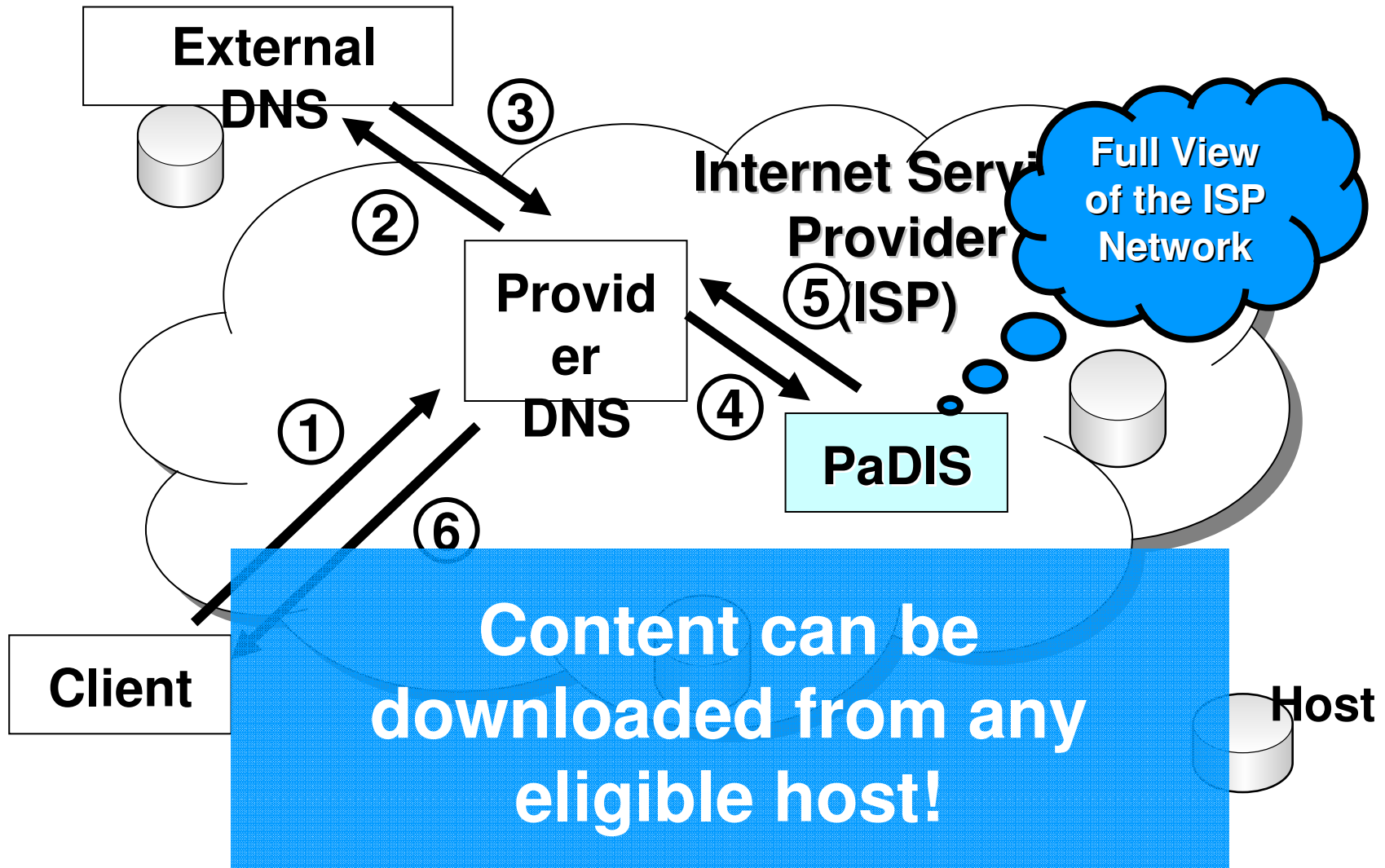
PaDIS



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 courses (Praktika)
- ❑ Projects (Projekte)
- ❑ Theses (Diplom / Master / Bachelor)

- ❑ PGT: Project Group Meeting (Doktorandenseminar)
- ❑ 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)
- ❑ 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

- **Mesh 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

□ Topic:

- 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 series (20 minutes)



Teaching at INET / Anja Feldmann

Topics

Internet Protocols:










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

- Traffic Measurement
- Workload Modeling
- Wireless
- Performance Analysis
- Network Security

Course Overview

WiSem

SoSem

NPA: Network Protocols & Architectures (VL+UE) 6LP 	IR or IS or IM: Internet Routing, Security, Measurement (VL) 3LP 
ML: MeshLab (PR) 6LP 	RL: RouterLab (PR) 6LP 
SE: Routing (SE) 3LP 	SE: Measurement (SE) 3LP 
PJ: Projekt (PJ) 6LP or 12LP 	
Bachelor Thesis (12LP) 	
Master Thesis (30 LP) 	

Example Module Paths

Bachelor 0-15 LP	NPA (6LP)	NPA (6LP)	
		SE+PJ (9LP)	
Master 12-27LP	IR, IS, IM, SE (6/9LP)	IR, IS, IM, SE (6/9LP)	NPA (6LP)
	ML or/and RL (6/12 LP)	ML or/and RL (6/12 LP)	IR, IS, IM, SE (6/9LP)
			ML or/and RL (6/12 LP)