Peer-to-Peer Networks
01: Organization and Introduction

Christian Ortolf
Technical Faculty
Computer-Networks and Telematics
University of Freiburg
People

- Christian Ortolf
  - PhD in computer science
- Christian Schindelhauer
  - Professor for Computer Networks and Telematics
  - Coauthor of the book „Peer-to-Peer-Netzwerke – Methoden und Grundlagen“
- Aditya Oak
  - Tutor for the Lecture
General

- Web page
  - [http://cone.informatik.uni-freiburg.de/lehre/aktuell/p2p-WS16/](http://cone.informatik.uni-freiburg.de/lehre/aktuell/p2p-WS16/)

- Lecture
  - starts 17.10.2016
  - Monday, 4pm-6pm, 101-01-018
  - Wednesday, 10am-11am, 101-01-018

- Exercise classes
  - Wednesday, 11am-12am, building 101-01-018

- Oral exam
  - no prerequisites
  - register on-line (in time)
Exercises

- **Exercise class**
  - Wednesday, 11am-12pm, building 101, 101-01-018
  - starts 26.10.2016

- **Exercises**
  - appear every Wednesday on the web-page
  - voluntary, but are the basis for the oral exam
  - solutions of the exercises are discussed in the following week
Exam

- Oral exam
  - based on the lecture and the exercises
  - register online for the exam
  - Mandatory registration
Materials

- **Slides**
  - appear before the lecture on the web-page

- **Book**
  - ~60% of the lecture can be found in *Mahlmann, Schindelhauer, Peer-to-Peer-Netzwerke — Methoden und Algorithmen, Springer 2007*

- **Further Literature**
  - Research papers will be presented during the lecture on the slides and on the web-page
Internet Traffic

Terabytes per Month

2010: 0.24 EB
2011: 0.6 EB
2012: 1.2 EB
2013: 2.2 EB
2014: 3.8 EB
2015: 6.3 EB

92% CAGR 2010-2015
Increase of Internet Traffic

Cisco prediction 2016:
>250 Pbit/s
>1 Zbit/s

Cisco: 966 Exabyte/y 2015
Global Internet Traffic Shares
1993-2004

CacheLogic Research
Trends of Internet Protocols 1993-2004
Internet Traffic of a German ISP
August 2009

- HTTP most traffic
- BitTorrent most upload

Top ten services of the average user

Source: Alsbih, Janson, S. Analysis of Peer-to-Peer Traffic and User Behaviour ITA 2011
BitTorrent User Behavior of a German ISP
August 2009

Online period length probability

Source: Alsbih, Janson, S. Analysis of Peer-to-Peer Traffic and User Behaviour
ITA 2011
BitTorrent User Behavior of a German ISP
August 2009

- Fourier analysis shows 12h and 24h peak
- 24h periodicity roughly resembles sin curve

Fourier analysis of traffic & periodicity

Source: Alsbih, Janson, S. Analysis of Peer-to-Peer Traffic and User Behaviour
ITA 2011
Internet Traffic 2010

- Cisco Visual Networking Index Usage
- contains data of 20 anonymous service providers

![Traffic Study](image)

# Internet Traffic 2014-2017

## Cisco Prediction 2014 (PB/mo)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet Traffic</td>
<td>39912</td>
<td>47811</td>
<td>58321</td>
<td>72261</td>
<td>90090</td>
<td>112000</td>
</tr>
<tr>
<td>Internet Video</td>
<td>20485</td>
<td>25452</td>
<td>33000</td>
<td>43000</td>
<td>67700</td>
<td>74300</td>
</tr>
<tr>
<td>Filesharing</td>
<td>6044</td>
<td>6081</td>
<td>6046</td>
<td>6080</td>
<td>6147</td>
<td>5961</td>
</tr>
<tr>
<td>Web, Email, Data</td>
<td>5018</td>
<td>6382</td>
<td>7500</td>
<td>8820</td>
<td>10019</td>
<td>10763</td>
</tr>
<tr>
<td>Consumer IP Traffic</td>
<td>31548</td>
<td>37916</td>
<td>46527</td>
<td>58125</td>
<td>72938</td>
<td>91043</td>
</tr>
</tbody>
</table>

---

![Graph showing Internet Traffic 2014-2017](graph.png)
Skype Traffic

Increase in International Phone and Skype Traffic

Source: TeleGeography
Internet Traffic of a German ISP
August 2009

Download

- BitTorrent 24.1%
- HTTP 44.4%
- SHOUTcast 6.4%
- RTMP 5%
- eDonkey 4%
- RTSP 0.8%
- NNTP 14.2%

Upload

- BitTorrent 64.3%
- HTTP 14.6%
- eDonkey 16.3%
- RTSP 0.1%
- NNTP 0.7%

Source: Alsbih, Janson, S. Analysis of Peer-to-Peer Traffic and User Behaviour ITA 2011
Milestones P2P Systems

- Edonkey (2000)
  - later: Overnet uses Kademlia
- FreeNet (2000)
  - Anonymized download
- JXTA (2001)
  - Open source P2P network platform
- FastTrack (2001)
  - known from KaZaa, Morpheus, Grokster
- Bittorrent (2001)
  - only download, no search
- Skype (2003)
  - VoIP (voice over IP), Chat, Video
Milestones Theory

- Distributed Hash-Tables (DHT) (1997)
  - introduced for load balancing between web-servers
- CAN (2001)
  - efficient distributed DHT data structure for P2P networks
- Chord (2001)
  - efficient distributed P2P network with logarithmic search time
- Pastry/Tapestry (2001)
  - efficient distributed P2P network using Plaxton routing
- Kademlia (2002)
  - P2P-Lookup based on XOR-Metrik
- Many more approaches
  - Viceroy, Distance-Halving, Koorde, Skip-Net, P-Grid, ...
- Further Developments
  - Network Coding for P2P
  - Anonymity, Security
  - P2P Streaming
What is a P2P Network?

- What is P2P NOT?
  - a peer-to-peer network is not a client-server network

- Etymology: peer
  - from latin par = equal
  - one that is of equal standing with another
  - P2P, Peer-to-Peer: a relationship between equal partners

- Definition
  - a Peer-to-Peer Network is a communication network between computers in the Internet
    - without central control
    - and without reliable partners

- Observation
  - the Internet can be seen as a large P2P network
Contents

- Short history
- First Peer-to-Peer Networks
  - Napster
  - Gnutella
- CAN
- Chord
- Pastry und Tapestry
- Game theory
- P2P traffic
- Codes
- P2P in the real world
Peer-to-Peer Networks
01: Organization and Introduction

Christian Ortolf
Technical Faculty
Computer-Networks and Telematics
University of Freiburg