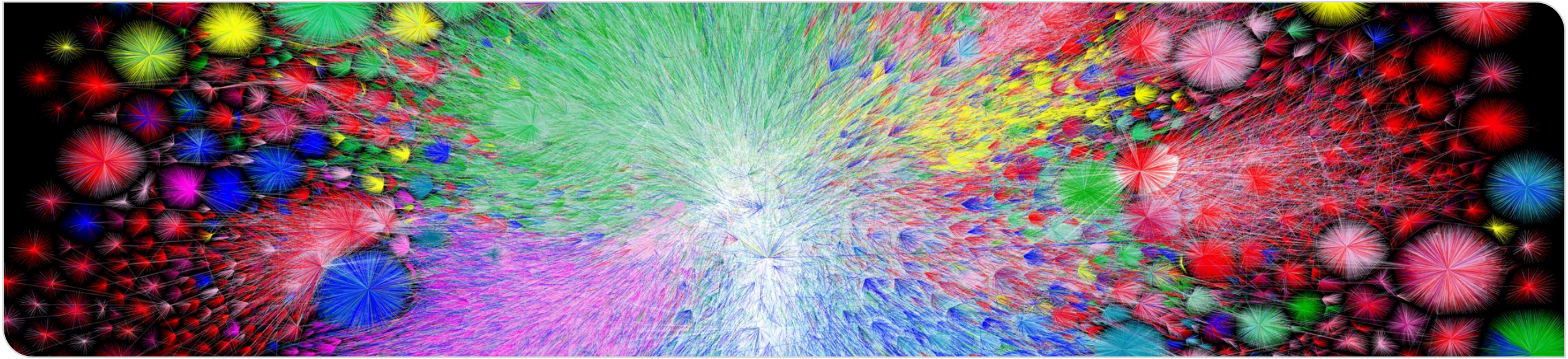
Karlsruher Institut für Technologie

Telematik

Prof. Dr. Martina Zitterbart
Institute of Telematics



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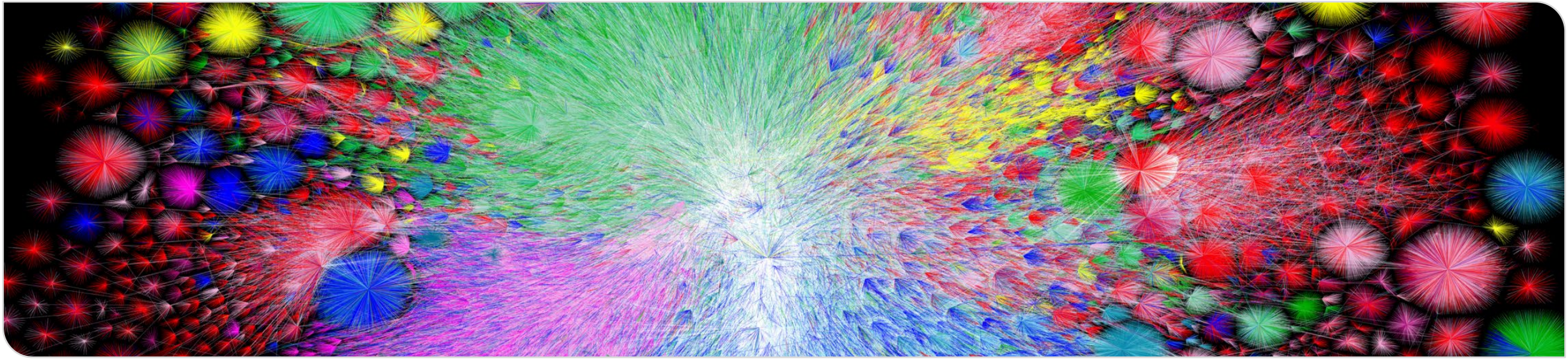
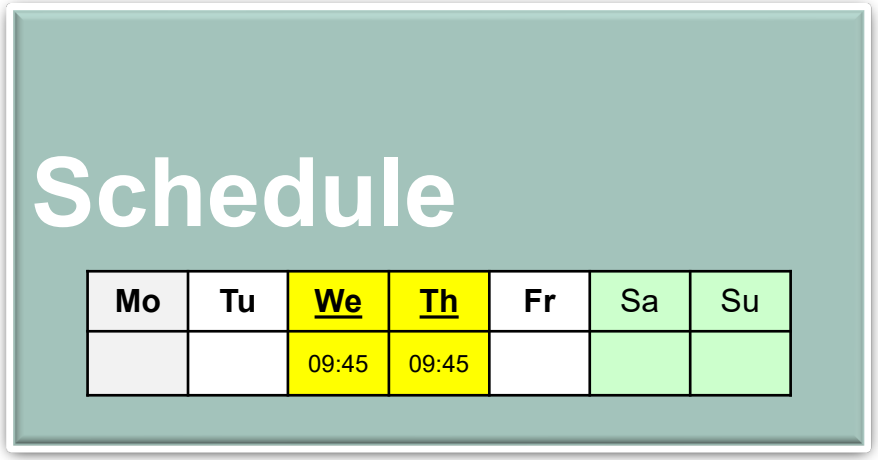
TeleMatics

Telematik

0. Prefix



Telematik Schedule



Date	Week	W/T	#	Content
29.10.25	1	W	1	01. Introduction, 02. Router
30.10.25		T	2	02. Router
05.11.25	2	W	3	02. Router
06.11.25		T	4	02. Router
12.11.25	3	W	5	Excercises
13.11.25		T	6	03. Internet Routing
19.11.25	4	W	7	03. Internet Routing
20.11.25		T	8	03. Internet Routing
26.11.25	5	W	9	03. Internet Routing
27.11.25		T	10	
03.12.25	6	W	11	
04.12.25		T	12	
10.12.25	7	W	13	
11.12.25		T	14	
17.12.25	8	W	15	
18.12.25		T	16	
24.12.25		W		Christmas Break
25.12.25		T		
31.01.25		W		
01.01.26		T		
07.01.26	9	W	17	
08.01.26		T	18	
14.01.26	10	W	19	
15.01.26		T	20	
21.01.26	11	W	21	
22.01.26		T	22	
28.01.26	12	W	23	
29.01.26		T	24	
04.02.26	13	W	25	
05.02.26		T	26	
11.02.26	14	W	27	
12.02.26		T	28	
18.02.26	15	W	29	
19.02.26		T	30	

DRAFT

Team

Our current team for the course Telematik

Hendrik Mahrt, M.Sc.

Paul Seehofer, M.Sc.

Daniel Helmig, M.Sc.

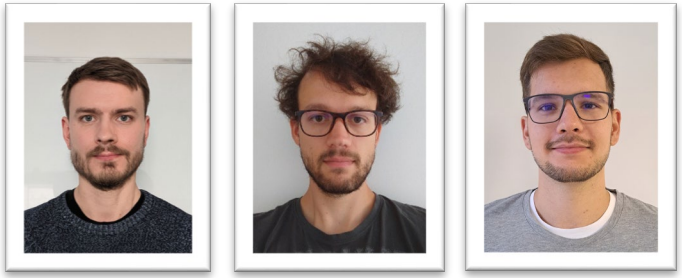
Prof. Dr. Martina Zitterbart

Components of the Course

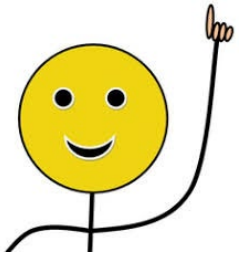
Traditional lectures … with interactive parts	
Slides with complete course content	
Recorded, short videos … (older version of lecture)	
Pingos … interactive polls	
Kahoot ... small quizes	Kahoot!
Homeworks – try to solve them on your own	
Exercise lecture typically after each chapter	
Matrix Space for discussion among students and for questions	
Literature… books, papers … preparations before and after videos / live sessions / homework	

Exercises

- Interactive sessions with members of the Telematics team



- Brief summary of recent lecture contents
- Discussion of tasks and solutions
  - Homeworks from the lecture
  - Tasks from previous exams
- Presentation/discussion of recent research



Ilias

- Password to access Ilias
  - **tele2025matics**
- All material will be added here

- You can use Matrix Space to discuss with other course members and to post questions

Website (contains a link to Ilias):
https://telematics.tm.kit.edu/tm.php

Matrix Space “**Telematik WS25/26**”
https://to.matrix.kit.edu/#/#tm-25:kit.edu

„Timing“ … when to expect what?

- Slides for lecture or complete chapter
  - Version without Pingos and Kahoots
    - Typically day before lecture
  - Version with Pingos and Kahoots
    - After chapter is completed
    - Also separate slide set with solutions for Pingos and Kahoots after chapter is completed
- Slides for exercises
  - After exercise
- Old video material covering (basic) content (in German)
  - Completely available at start of semester
  - Be aware: current content has changed in some parts !

Some video material is available.
It was recorded during winter semester 2020/21 !!

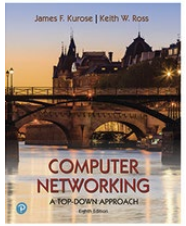
20/21 … some changes 25/26

The 2025/26 material is relevant for the exam

Videos might help if you were unable to attend a lecture or if you want to repeat a certain aspect.
Also think about studying (parts of) a book (e.g., Kurose) or a relevant paper/standard.

Literature

- Books
  - J.F. Kurose, K.W. Ross; Computer Networking: A Top-Down Approach, Addison-Wesley
    - by now “the” text book in computer networking, focuses on the Internet
  - W. Stallings; Data and Computer Communications. Prentice Hall
    - covers a majority of topics



- Internet standards
  - Published Internet protocol standards are freely available at http://www.ietf.org
  - RFC-Search (http://rfc-editor.org/rfcsearch.html)

- Research Papers
  - IEEE library (http://ieeexplore.ieee.org)
  - ACM library (http://portal.acm.org)
  - Free access from inside KIT network

… references related to each topic are included in the corresponding lecture slides

Symbols

Reference to literature / website

Additional information, not required for exam

Research / experiments

Tools that you can try out yourselves

Links to other lectures (chair of Prof. Dr. Zitterbart)

Next Generation Internet

Network Security: Protocols and Architectures

Mobile Communication

Internet of Everything

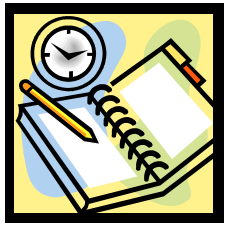
Participate in our Research?!

- If you are interested in
  - Hiwi position
  - BA/MA thesis
  - PhD position
  - ...
  - Contact anyone of us

- We are located at Kaiserstr. 40

Exam

- Date
  - **Monday, March 23rd, 2026**
  - **11:00h – 13:00h**
  - **Duration: 90 minutes**



- Location
  - **Audimax (30.95) and „Hörsaal am Fasanengarten“ (50.35)**
- Registration
  - February 1st – March 16th
  - Deregistration possible until exam start
- Exam tasks are given in both German and English

Good luck!

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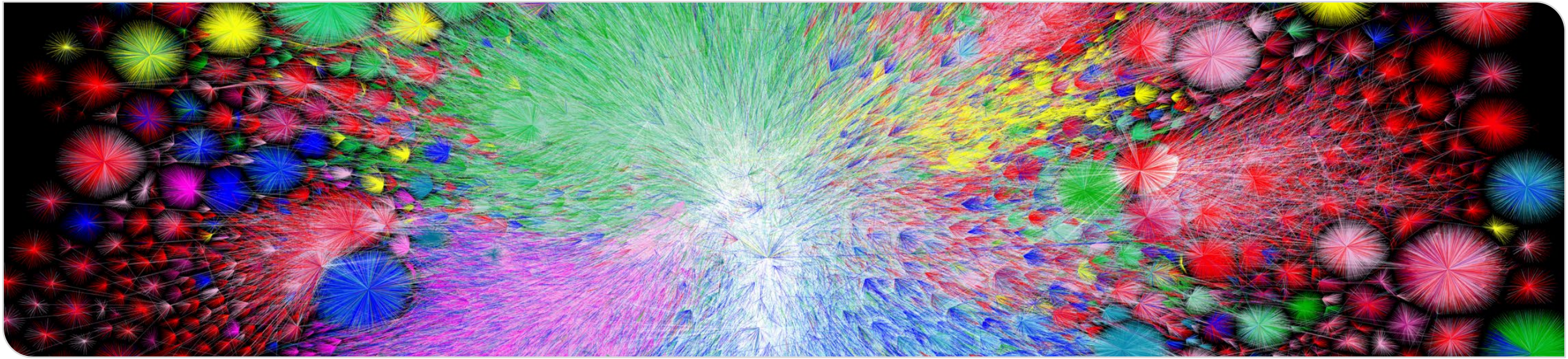
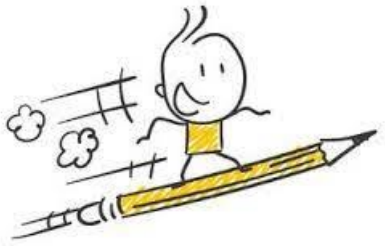
Telematik

01. Introduction



Let´s get Started



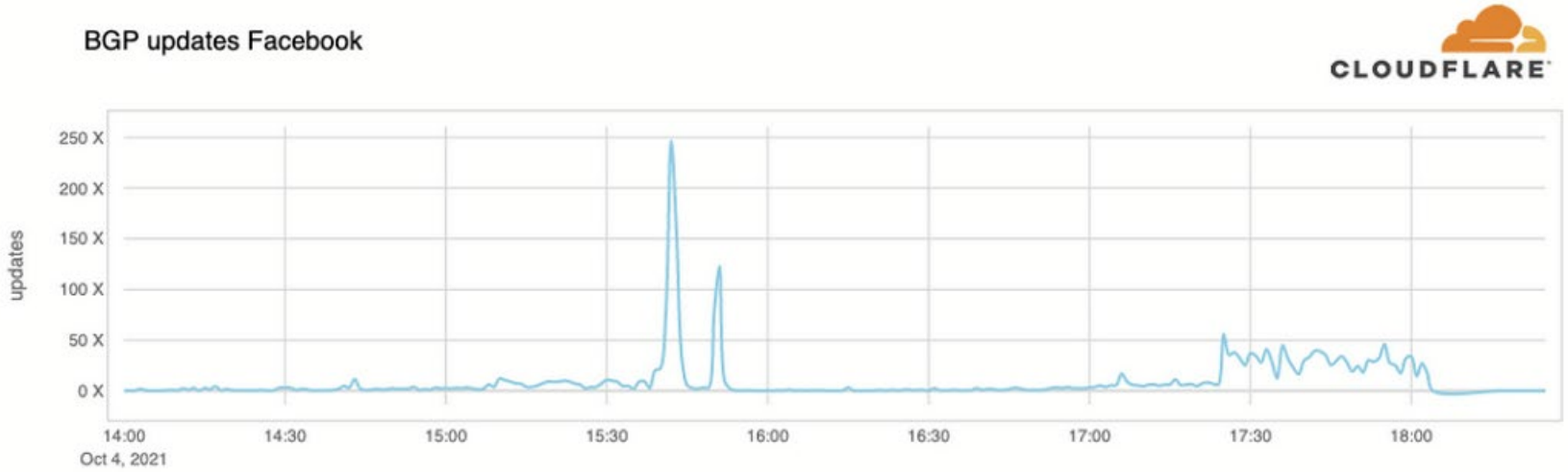
Facebook not availabe

Facebook not available

- Facebook, WhatsApp, Instagram were down
  - October 4th 2021, ~ 15:50 UCT until ~21:20 UCT
- Attack, configuration fault … ???

Facebook not available

- Cloudflare: „Facebook DNS lookup returning SERVFAIL“
  - ~15:40 UCT: peak of routing changes from Facebook
  - 15:58 UCT: Facebook stopped announcing routes to their DNS prefixes

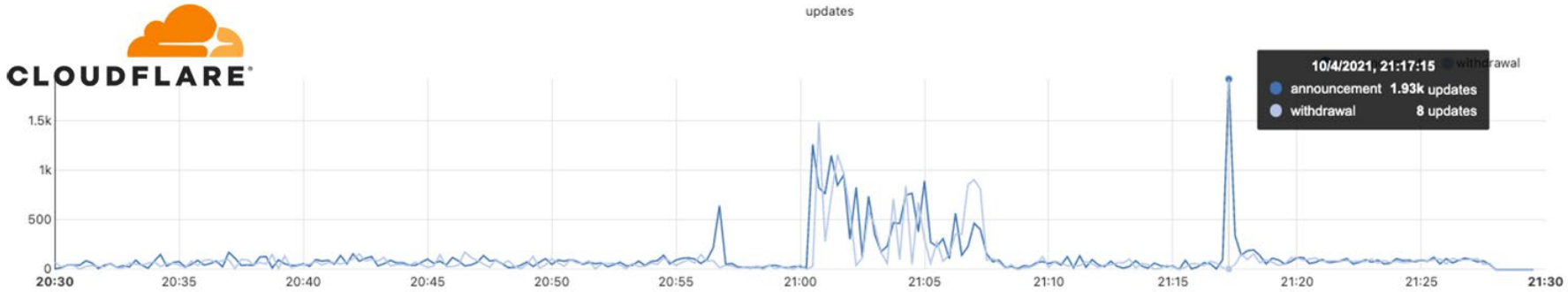


[https://blog.cloudflare.com/october-2021-facebook-outage]

- Announcements and withdrawals (light blue)

Facebook not available

- Update
  - ~21:00 UCT: renewed BGP activity from Facebook



[https://blog.cloudflare.com/october-2021-facebook-outage]

Facebook not available

- Centralized infrastructure
  - All peering routers operated in own infrastructure
  - All DNS servers operated in own infrastructure

- No routes available to Facebooks systems
  - DNS systems not reachable although they were still operational

  - Internal systems not reachable from outside
    - Internal tools could not operate as usual
  - Networked locking system caused problems

  - Engineers were sent to facility
    - High levels of physical and system security … access difficult

DNS

BGP

[https://www.heise.de/-6209377]

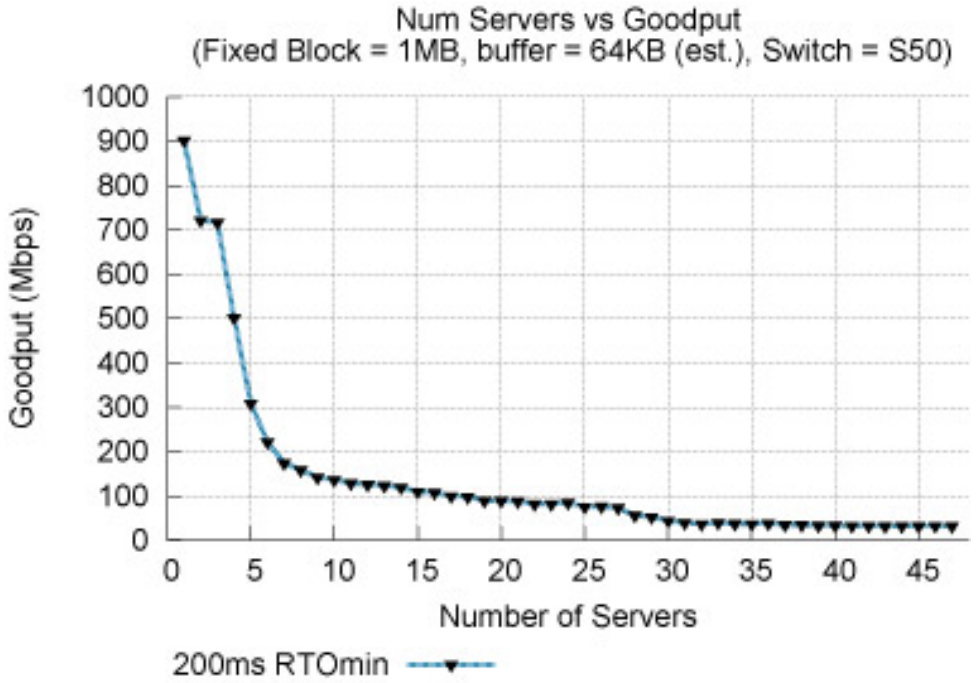
Facebook not availabe

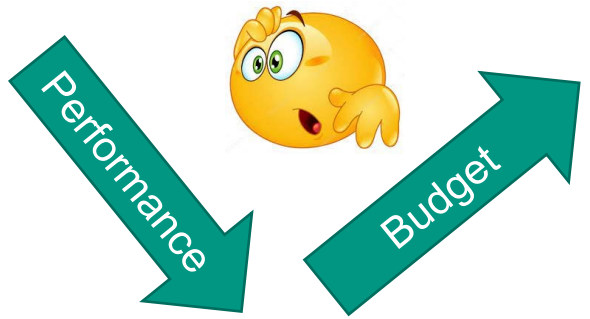
More Servers – less Performance

Increase Data Center Performance

- → Buy some additional servers

- Application scenario
  - Requests 1 MByte of data blocks
  - Each server responds with $^1/_N \ of \ 1 \ MByte$





TCP

More Servers – less Performance

Internet not Available

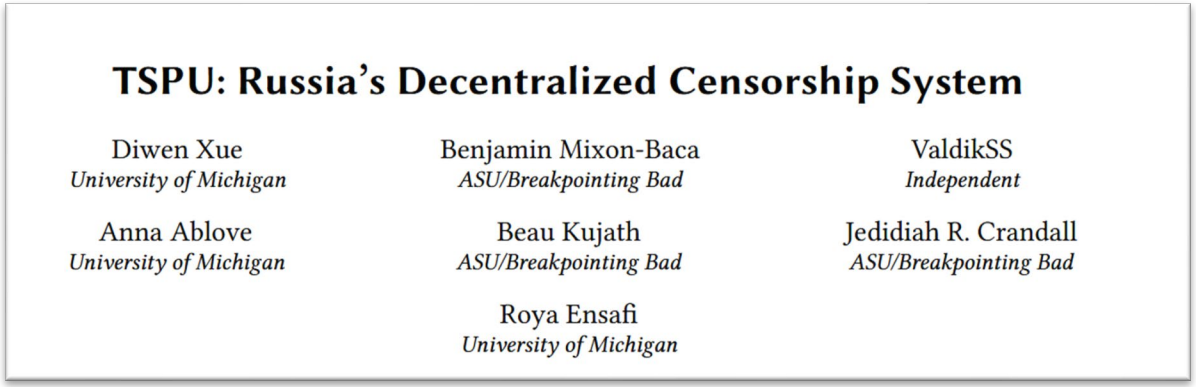
Afghanistan: Internet Shutdown

- Lasted 48 hours
  - Total shutdown not ultimative goal
  - But: filtering of webpages …
  - Like in other countries
    - Russia, China …

https://radar.cloudflare.com/
https://netblocks.org/
https://www.tagesschau.de/ausland/asien/afghanistan-taliban-internet-102.html
https://www.heise.de/news/Afghanistan-Taliban-kappen-zahlreichen-Provinzen-das-Internet-ueber-Glasfaser-10665552.html

Russia: Limited Internet Access

- Legal and technical frameworks constructed over the last years
- 2019: „Sovereign RuNet“ law signed
  - Requires operators to install TSPUs on their networks
  - Result: government can centrally control traffic passing through ISPs
- TSPUs are located in-path
  - E.g., drop packets, manipulate TCP flags …



TSPU: Russia's Decentralized Censorship System

Diwen Xue
University of Michigan

Benjamin Mixon-Baca
ASU/Breakpointing Bad

ValdikSS
Independent

Anna Ablove
University of Michigan

Beau Kujath
ASU/Breakpointing Bad

Jedidiah R. Crandall
ASU/Breakpointing Bad

Roya Ensafi
University of Michigan

[D. Xue et al; TSPU: Russia´s Decentralized Censorship System; ACM Internet Measurement Conference; October 2022, Nice, France]

Internet not Available

Lecture Telematics

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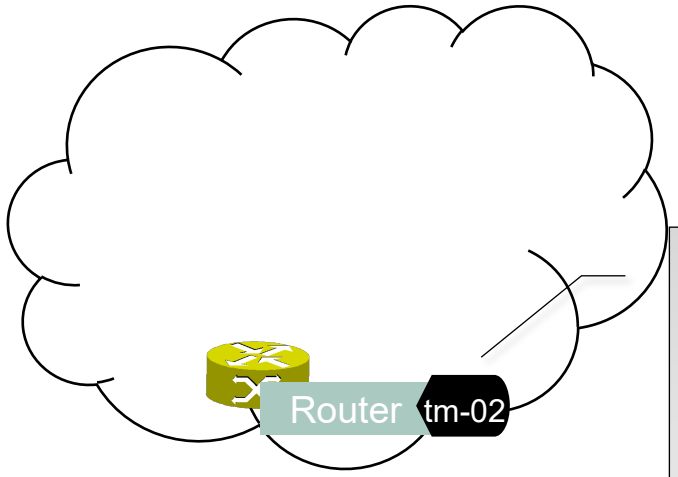
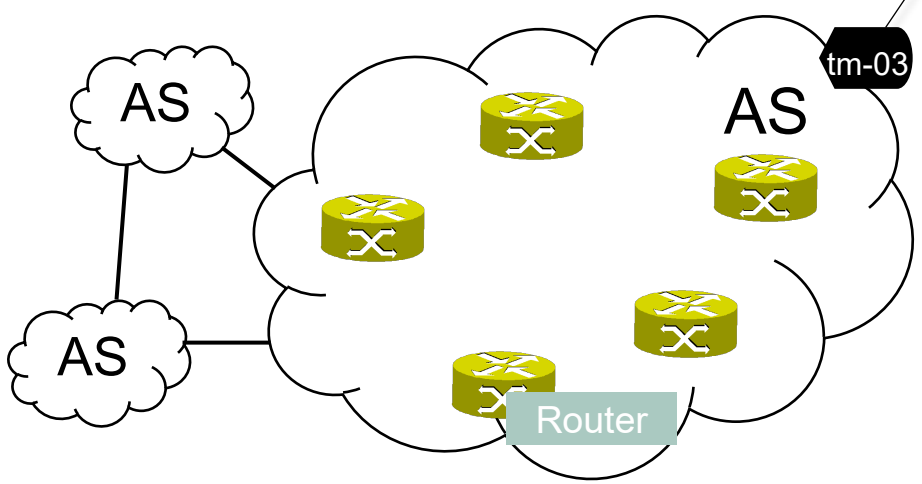
tm-01	tm-02	tm-03	tm-04	tm-05
Introduction	Router	Internet Routing	Label Switching	Programm-able Networks

tm-06	tm-07	tm-08	tm-09
Access Networks	Internet Congestion Control	Data Center Networking	Data Transport Evolution



Data path
Router architecture



Structure of the Internet
Autonomous systems (AS)
…

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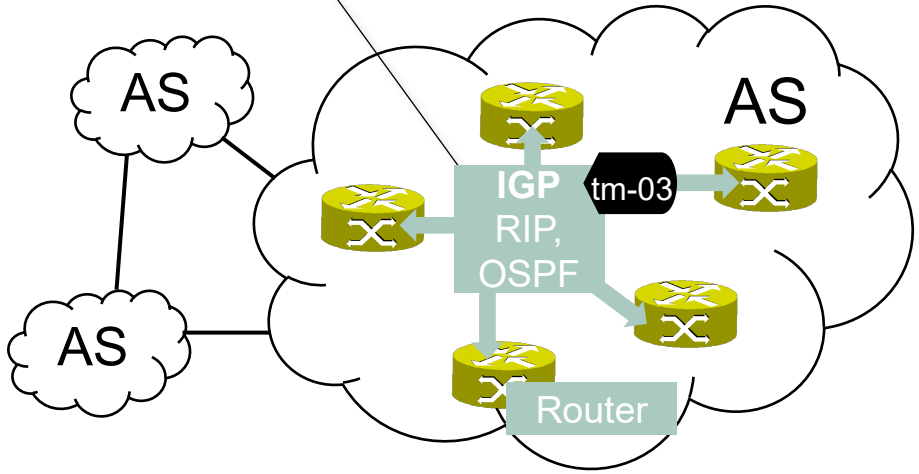
Control path
Routing protocols inside ASes



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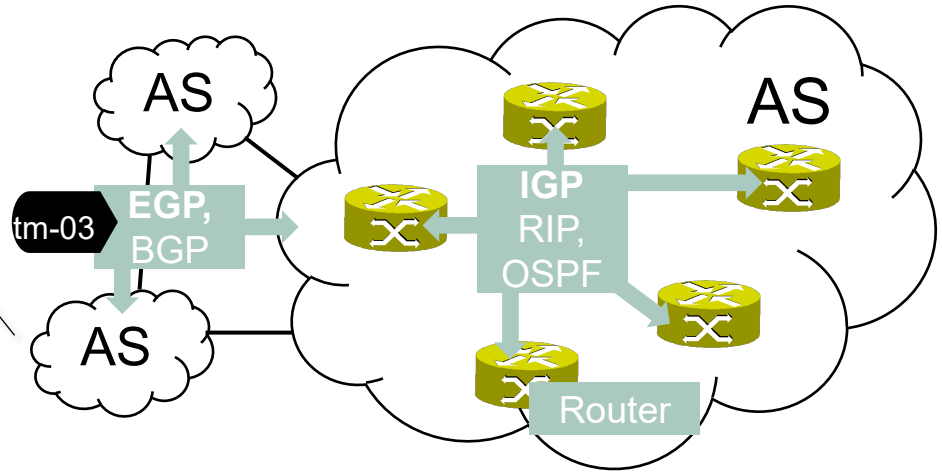
Control path
Routing between ASes



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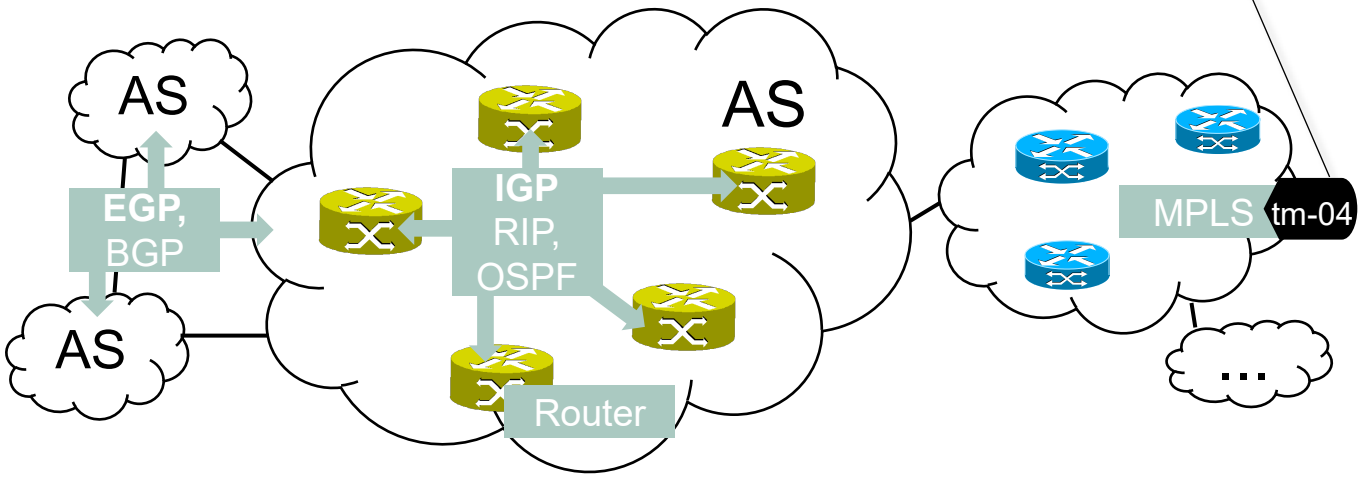
Label switching



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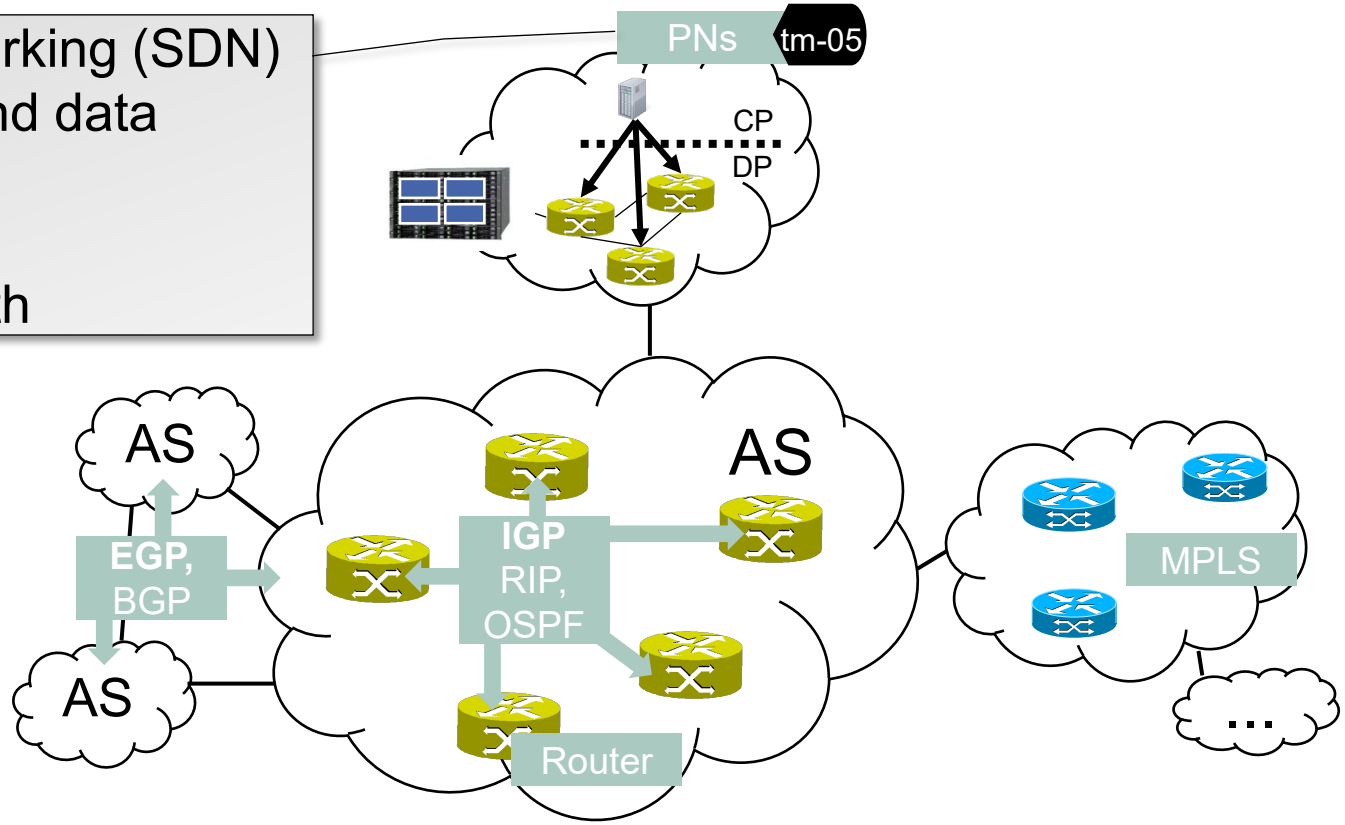
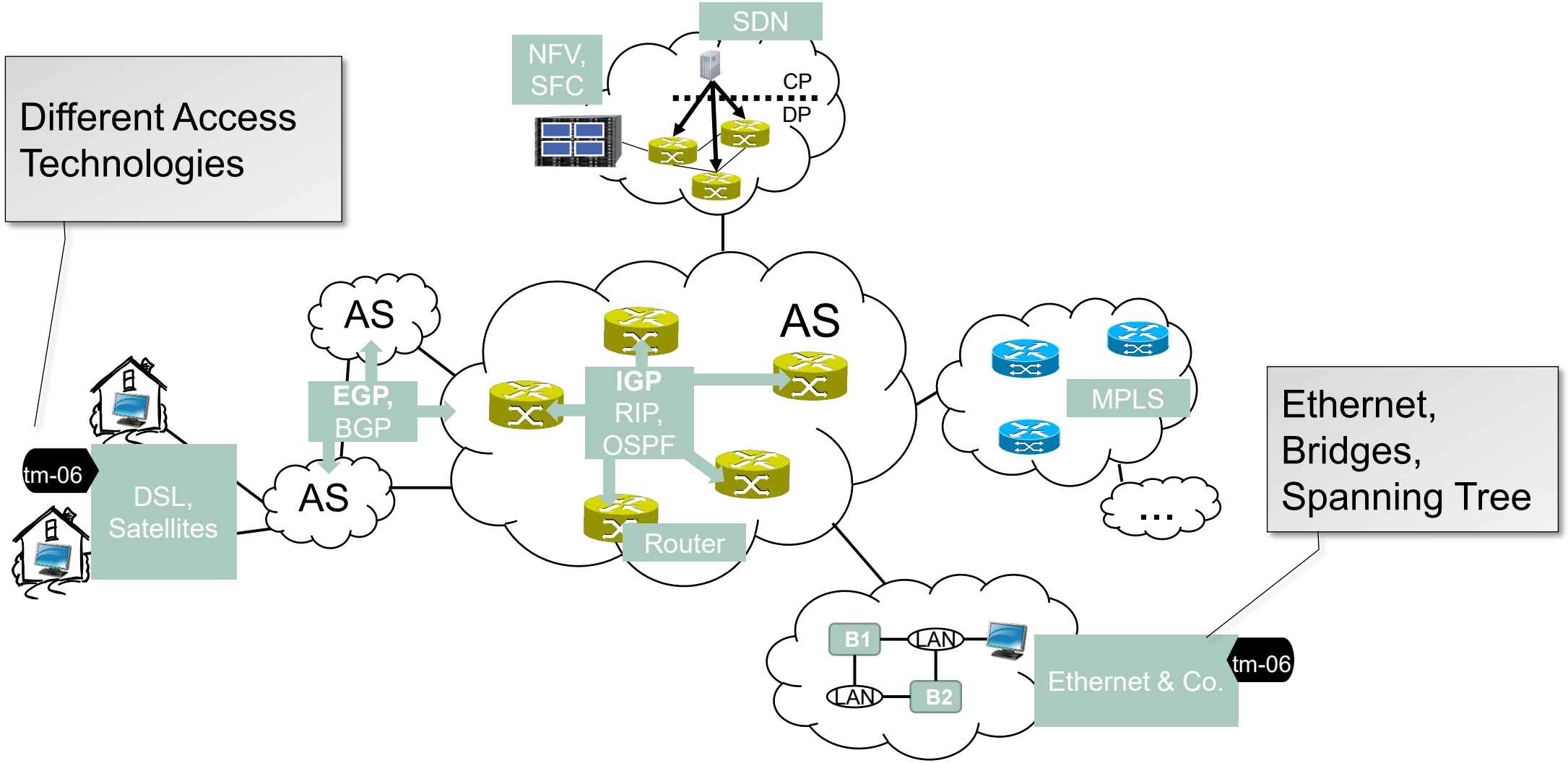
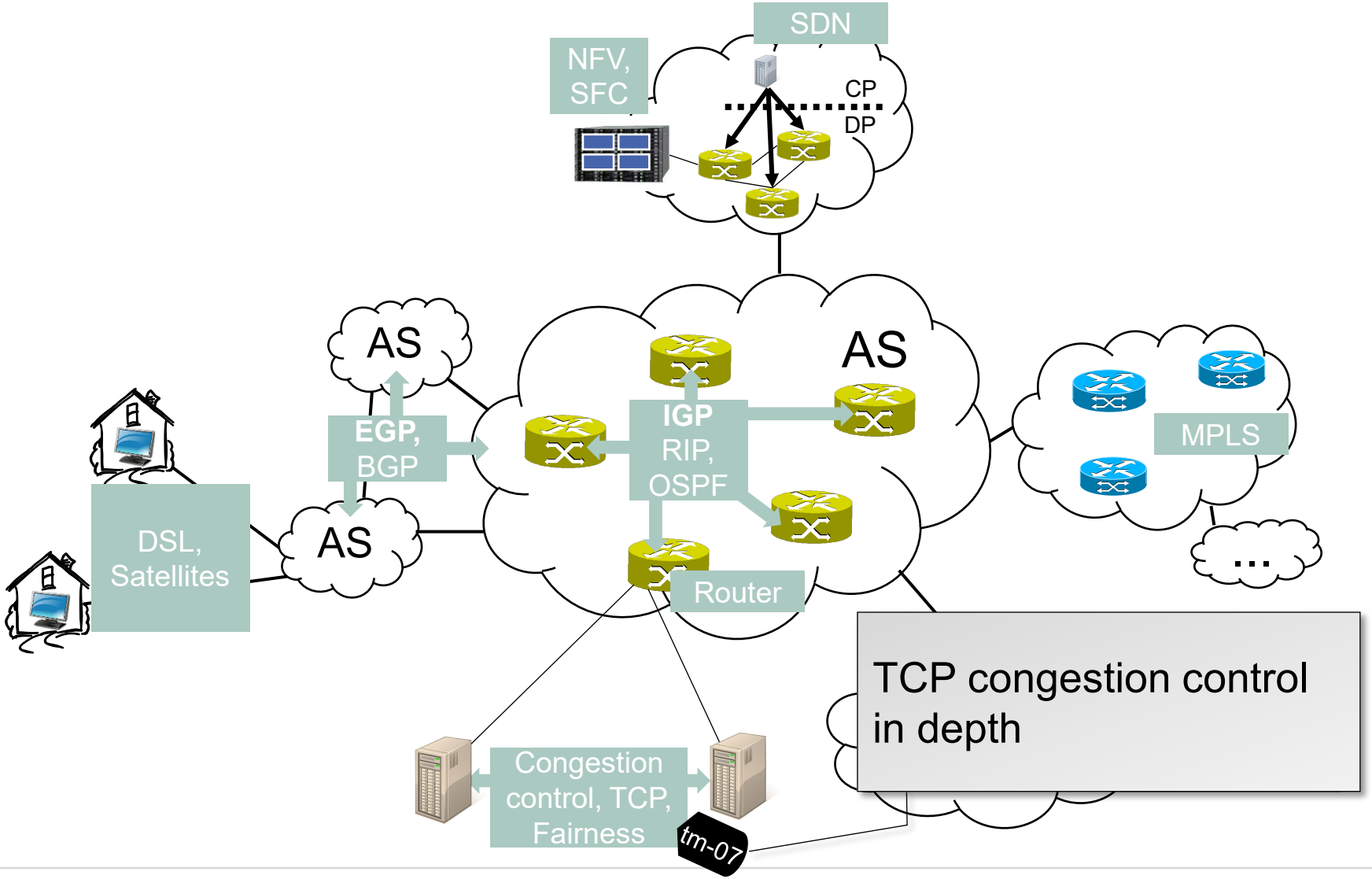
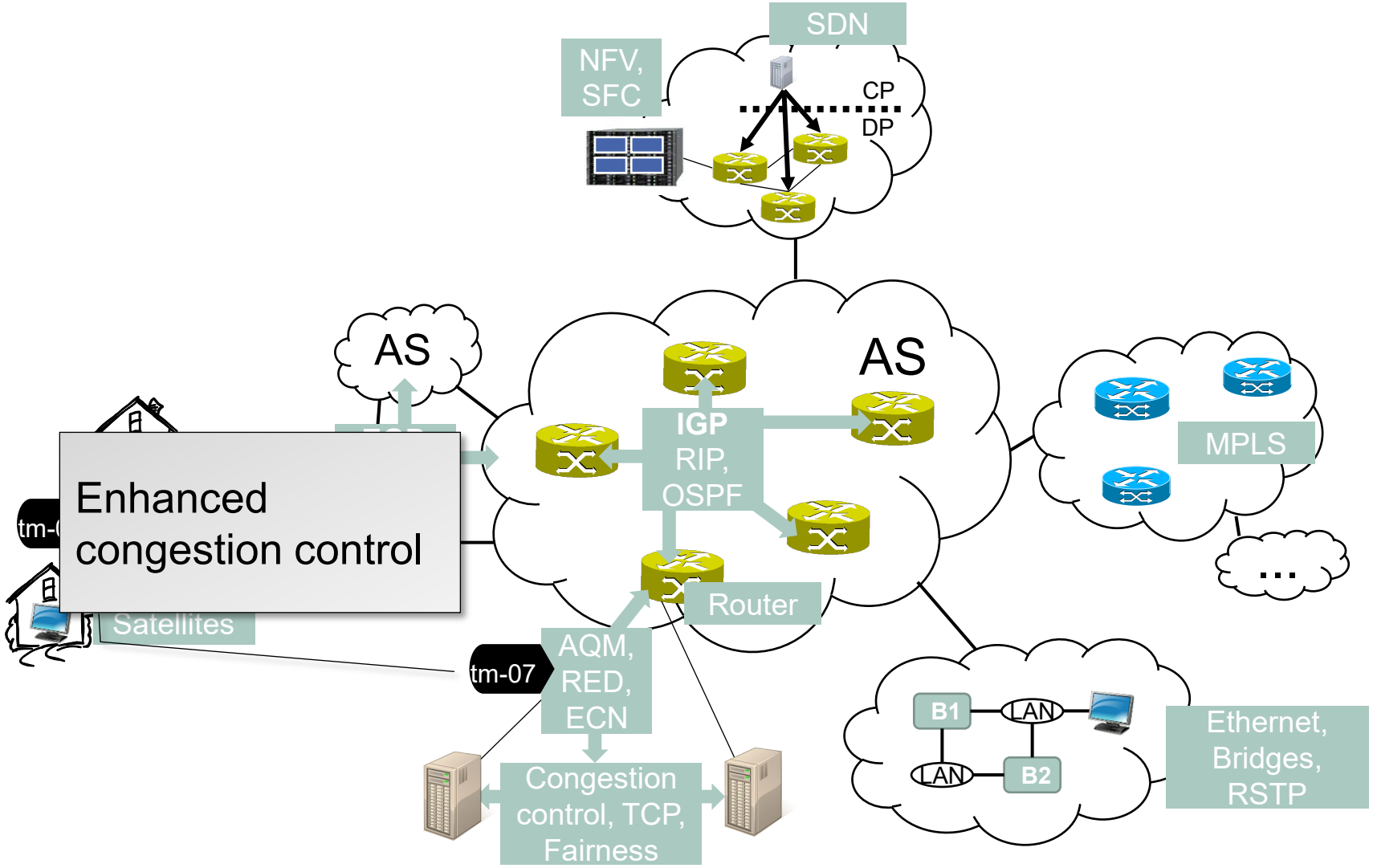
Software defined networking (SDN)
Separation of control and data plane
Network virtualization
Programmable data path




Different Access Technologies
SDN
NFV, SFC
CP
DP
AS
AS
AS
EGP, BGP
IGP
RIP, OSPF
Router
MPLS
...
tm-06
DSL, Satellites
Ethernet, Bridges, Spanning Tree
B1
LAN
LAN
B2
Ethernet & Co.
tm-06


SDN
NFV, SFC
CP
DP
AS
AS
AS
EGP, BGP
IGP
RIP, OSPF
MPLS
DSL, Satellites
Router
...
Congestion control, TCP, Fairness
tm-07
TCP congestion control in depth



Enhanced congestion control

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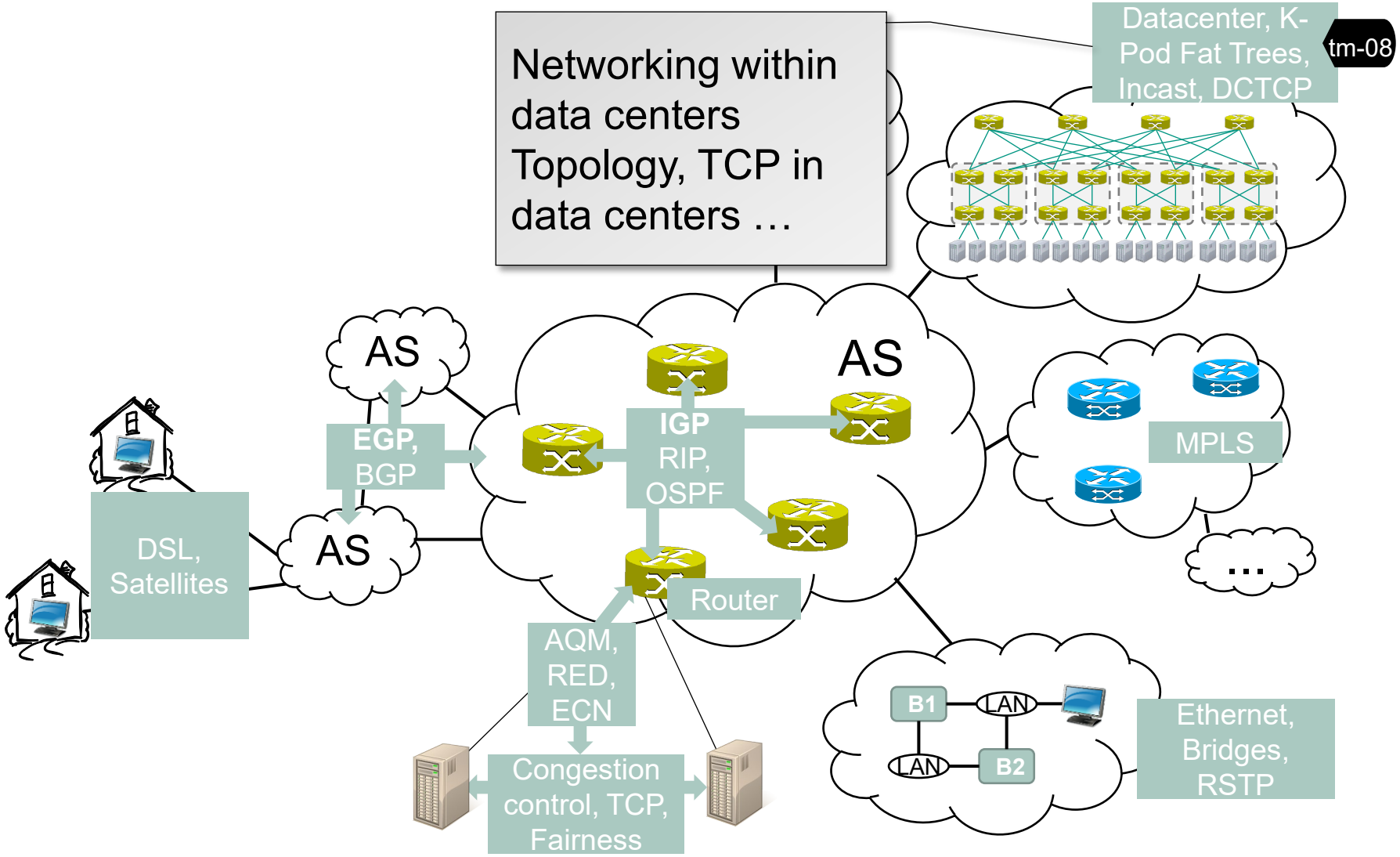

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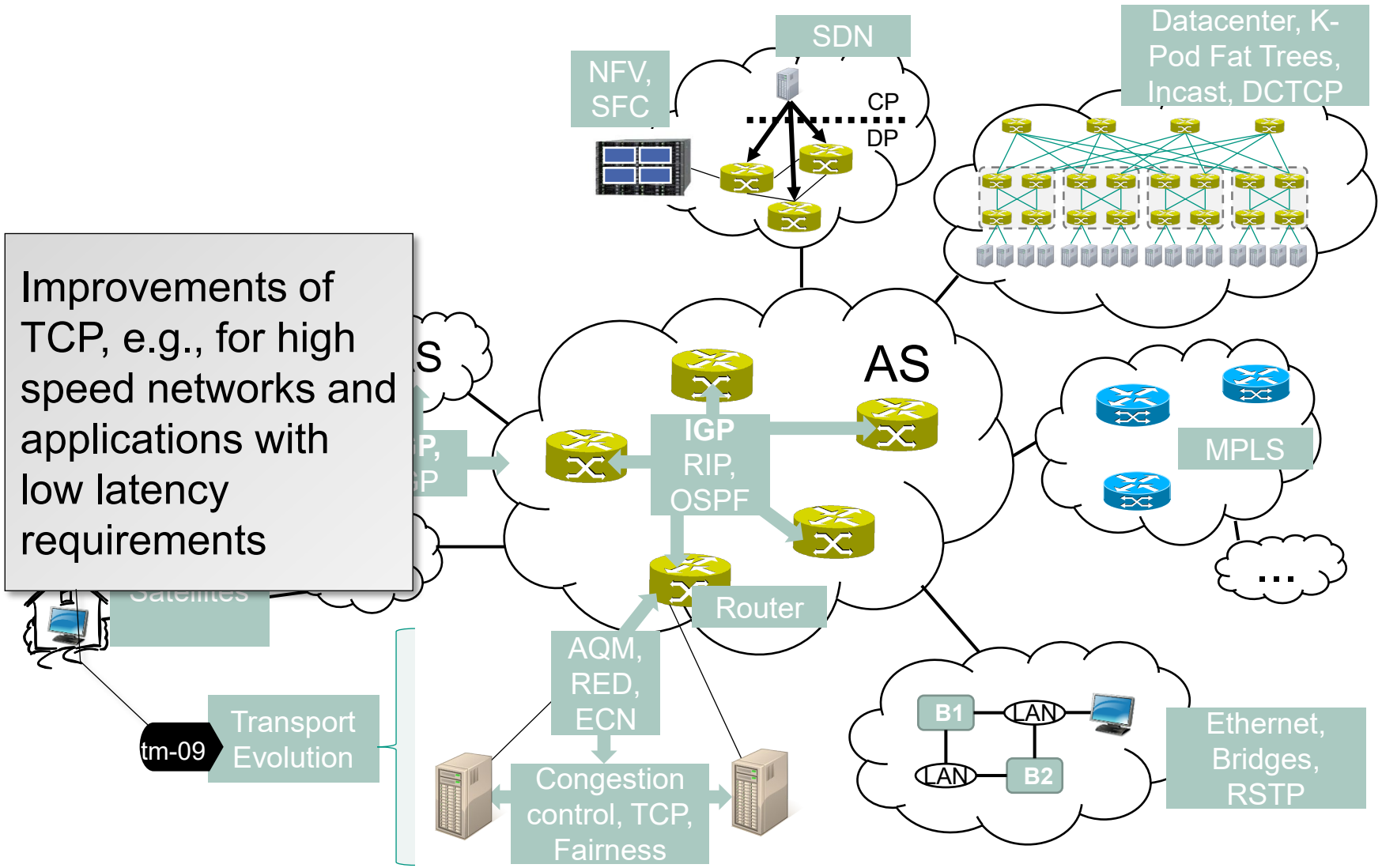

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Lecture Telematics