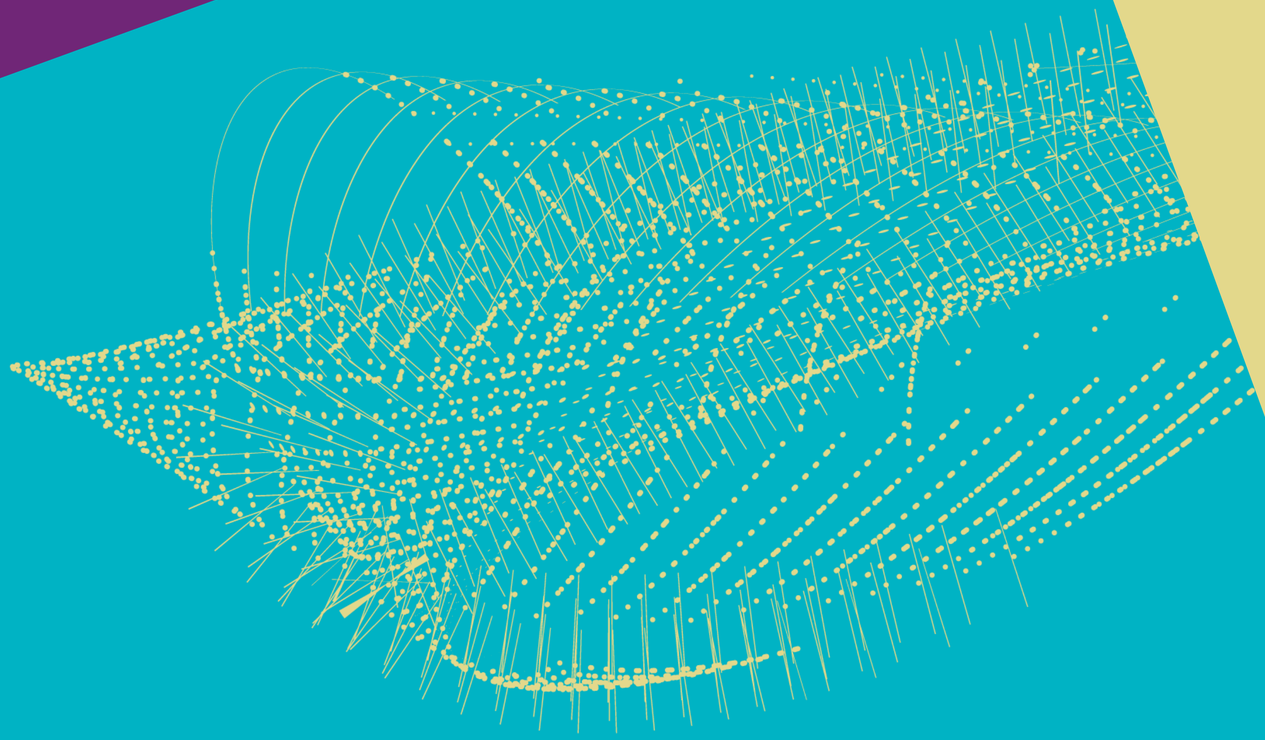
Nikhef



INTERNETWORKING AND E-INFRASTRUCTURE AT NIKHEF

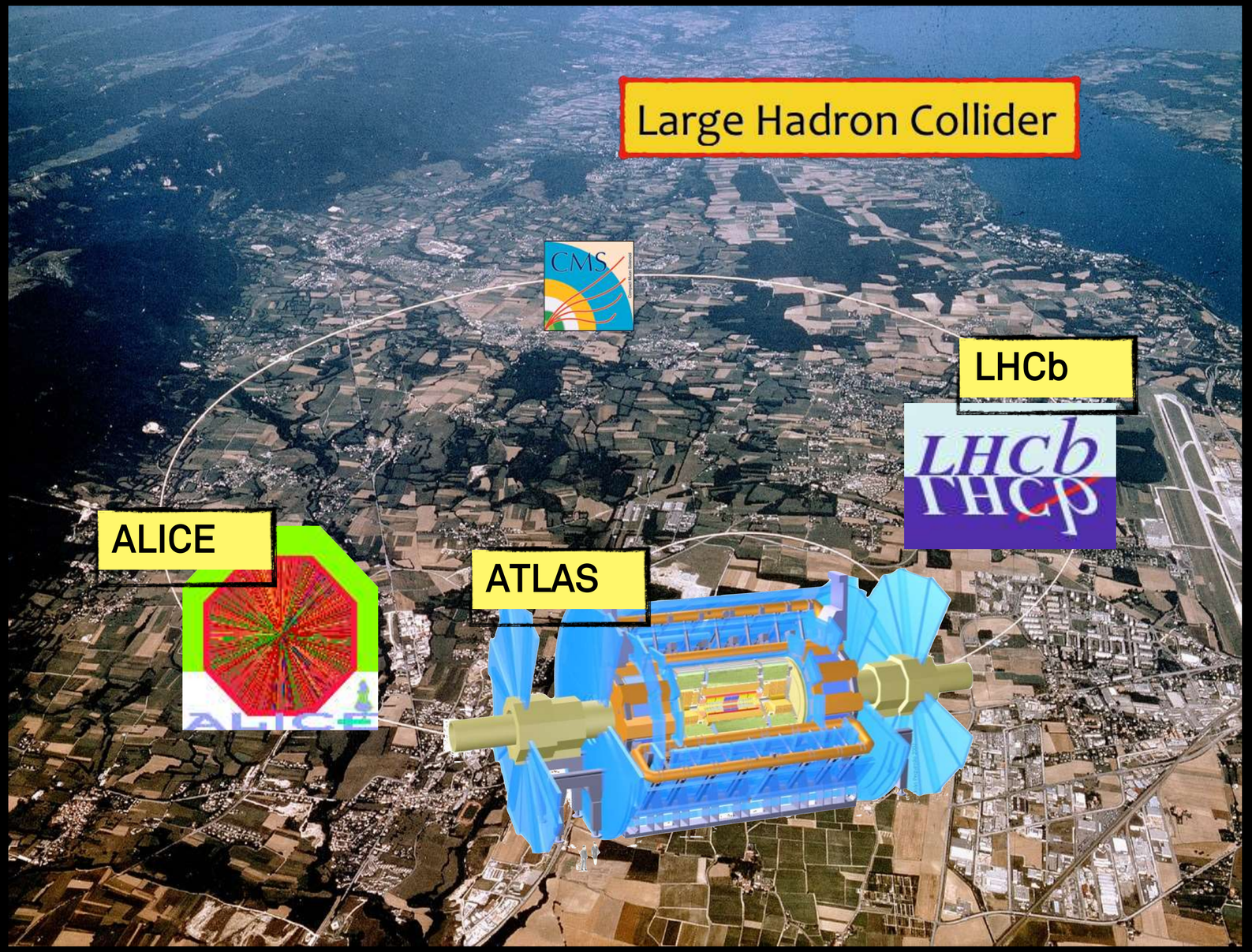
David Groep
Physics Data Processing group
September 2019

Nikhef – experiments at CERN

ATLAS
- *Higgs physics*
- Beyond the standard model

LHCb
- *rare decays*
- matter vs anti-matter

Alice
- *quark-gluon plasma*
- matter phase transitions



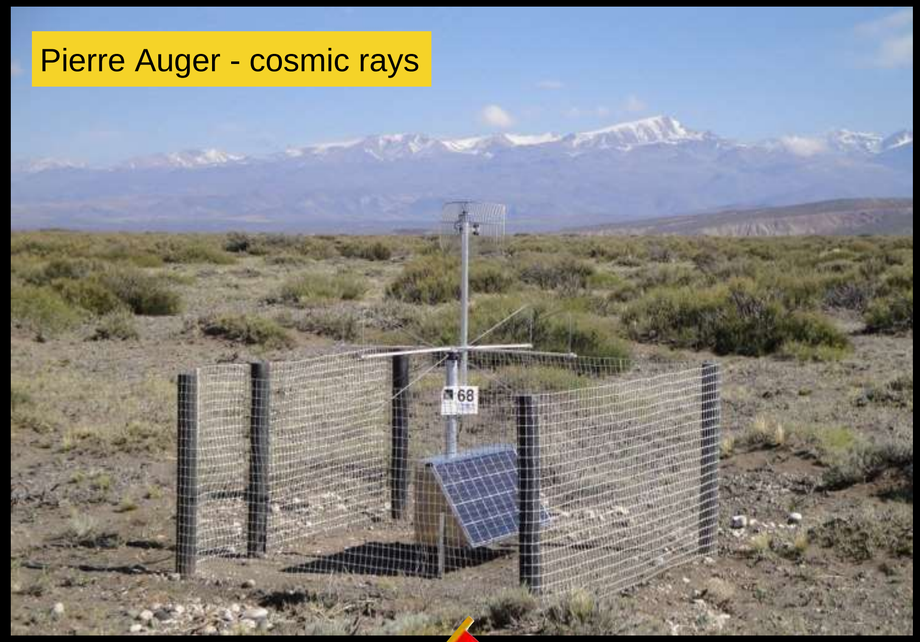
Nikhef – astroparticle physics

KM3NET
- neutrino telescope

Virgo/LIGO
- **gravitational waves**

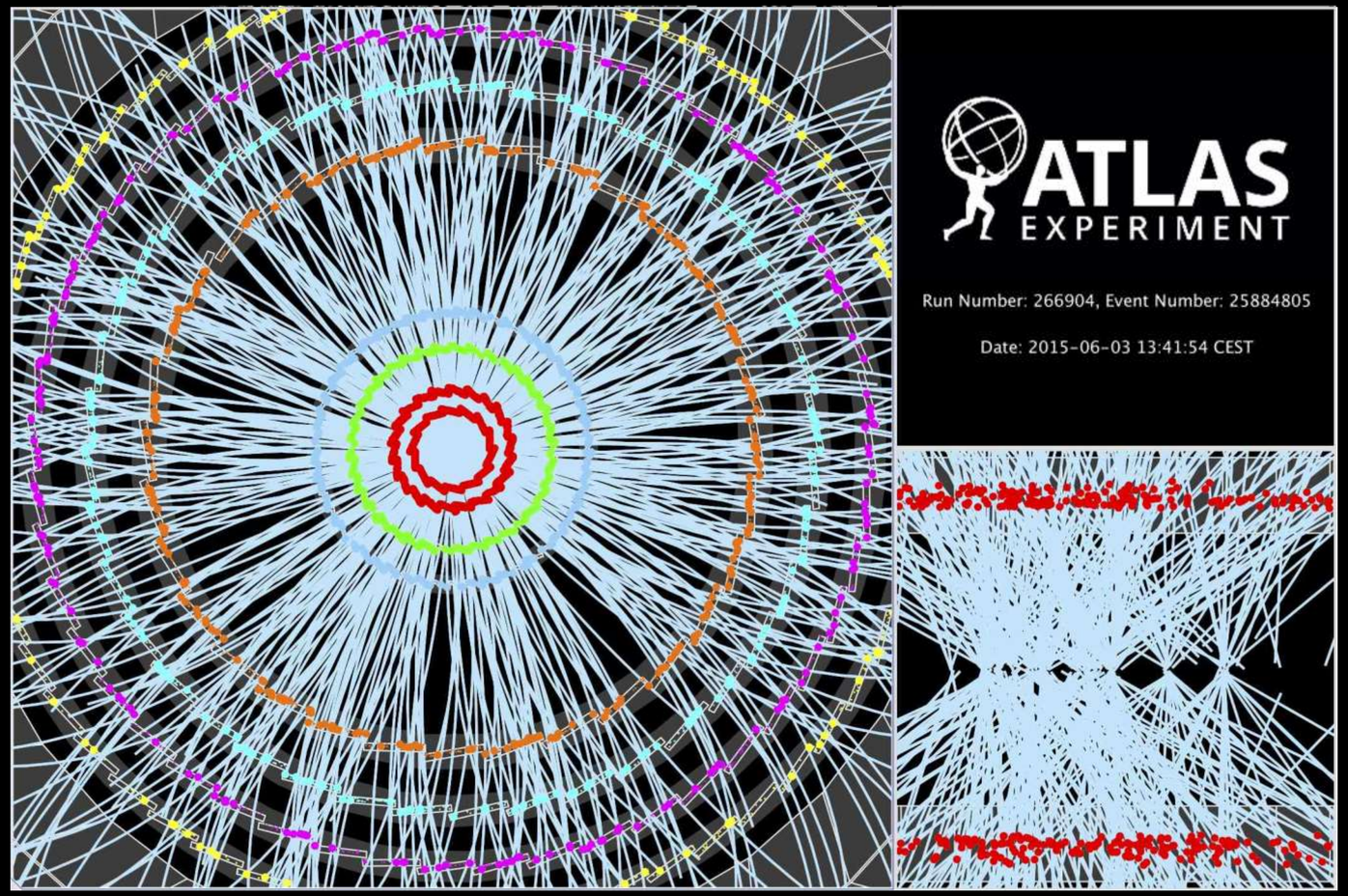
Auger
- ultra-high energy cosmic rays

Xenon
- search for dark matter



Computing on data: 40 million per second

~ 10 seconds to a compute a single event at ATLAS for 'jets' containing ~30 colllisions



Display of a proton-proton collision event recorded by ATLAS on 3 June 2015, with the first LHC stable beams at a collision energy of 13 TeV

Event processing time: v19.0.1.1 as per Jovan Mitrevski and 2015 J. Phys.: Conf. Ser. 664 072034 (CHEP2015)

Nikhef

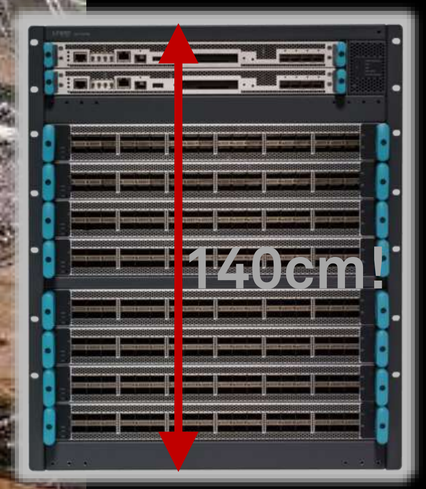
Network: from 9600bps to 1.2Tbps

4 cm

1990

~ 50 PiB/year data
from CERN to WLCG

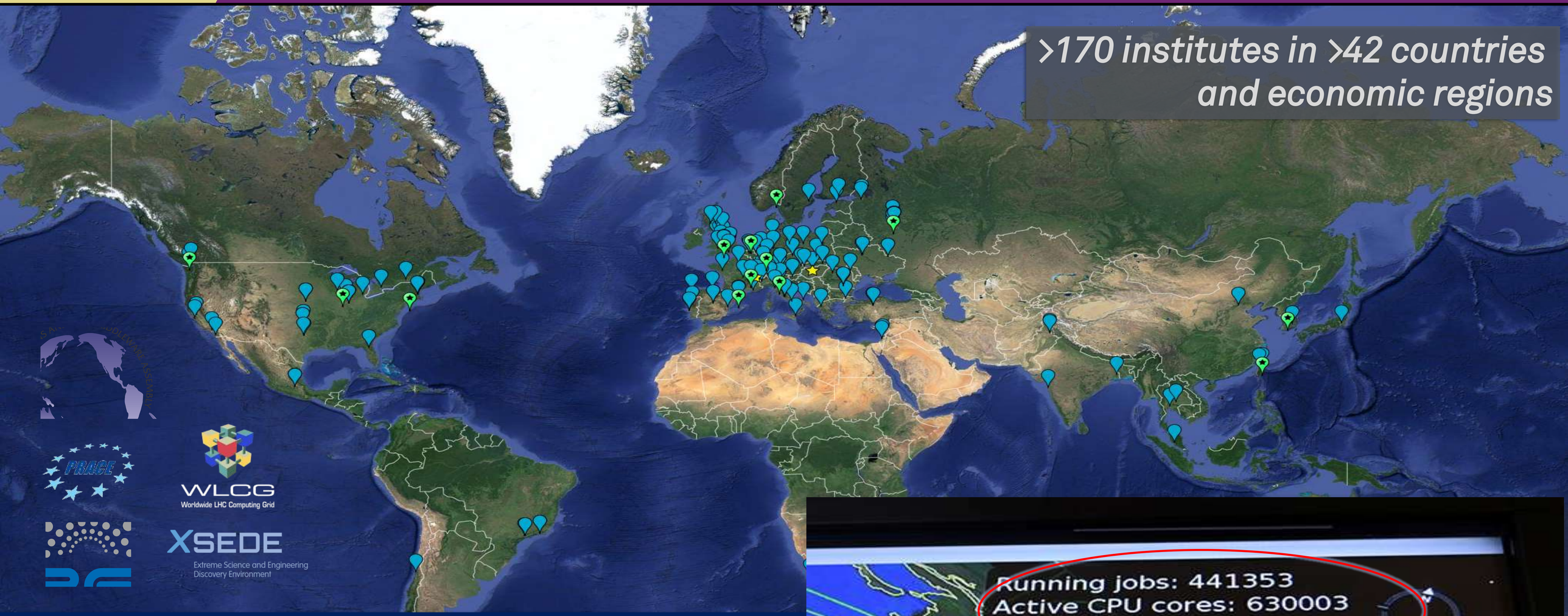
2019



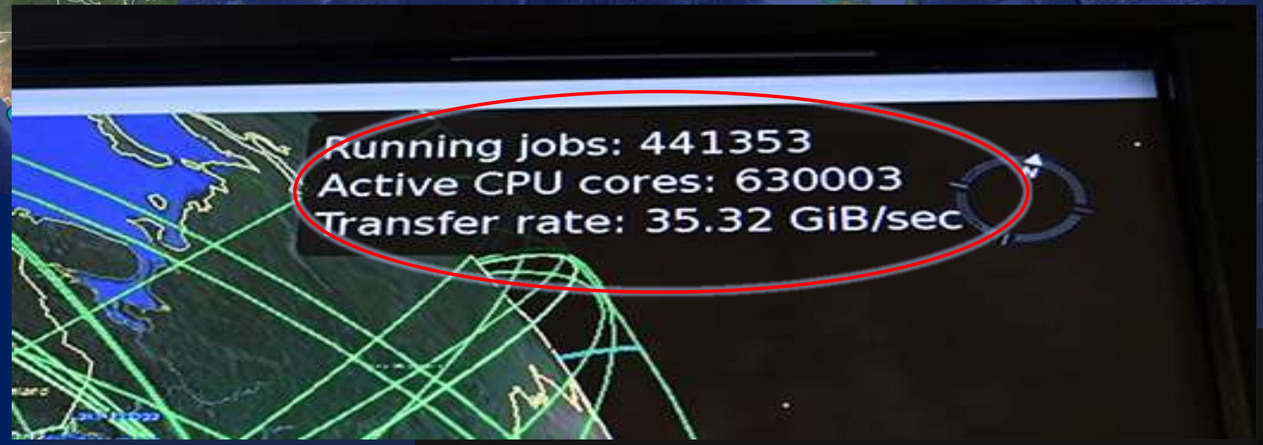
top-left: Hayes smart PSTN modem, 1200–9600bps
bottom-right: Juniper QFX10k16, up to 28.8Tbps

Globally distributed in EGI & WLCG

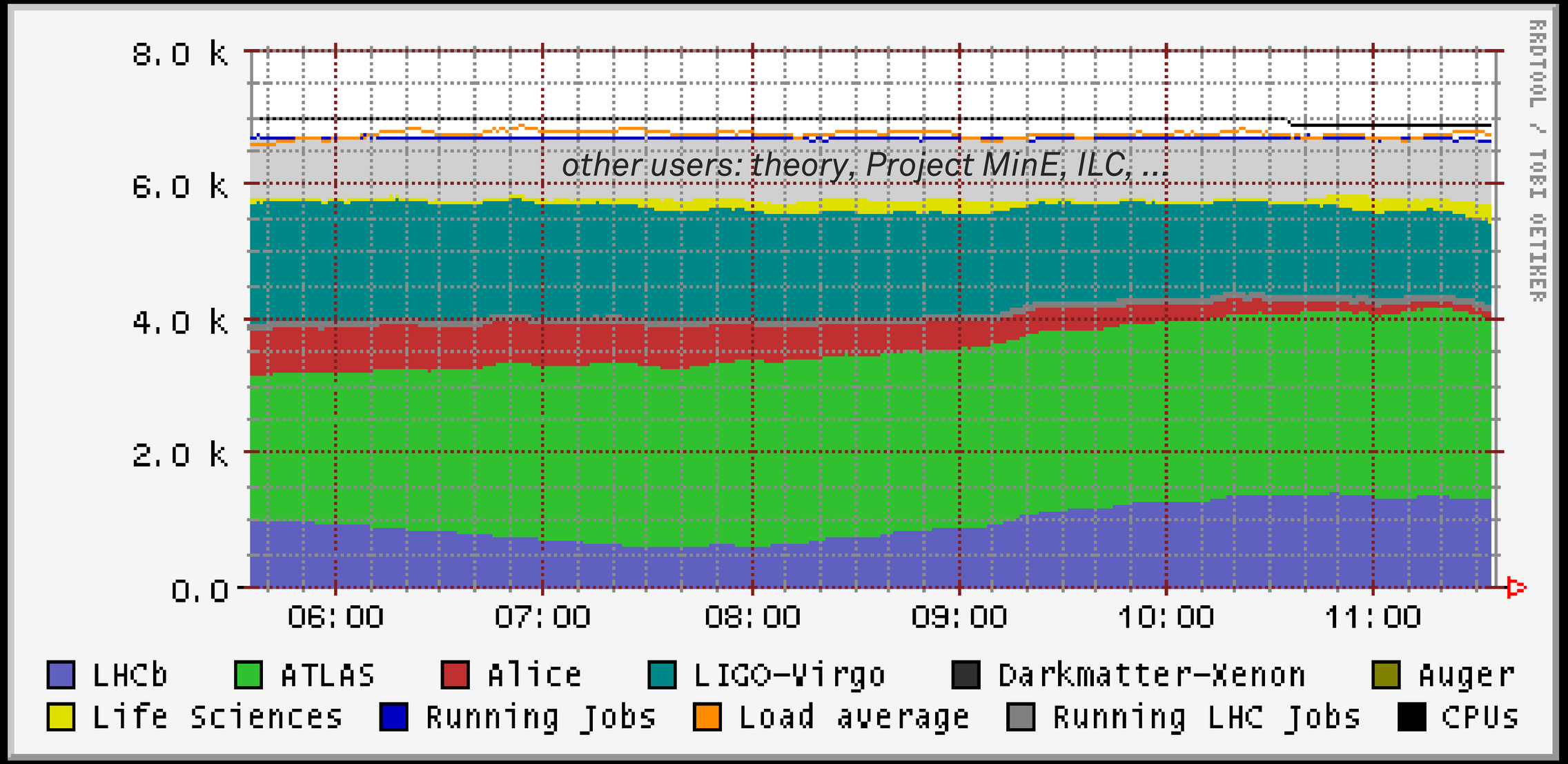
>170 institutes in >42 countries and economic regions



- *Computing* *~ 1,000,000 cores*
- *On-line disks* *> 310 PB*
- *Archival* *> 390 PB*

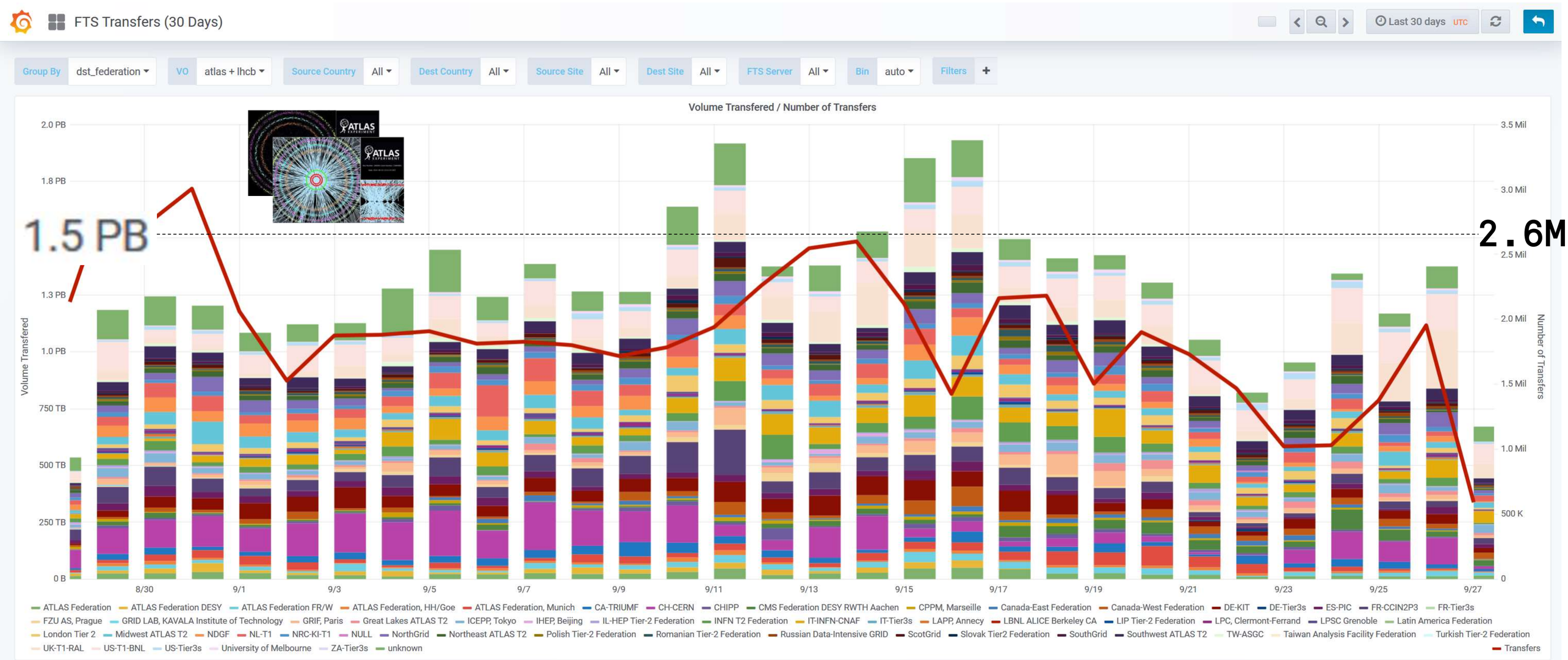


e-Infrastructure: Nikhef and SURF



Nikhef Data Processing Facility, HTCompute platform utilisation, 4 September 2019

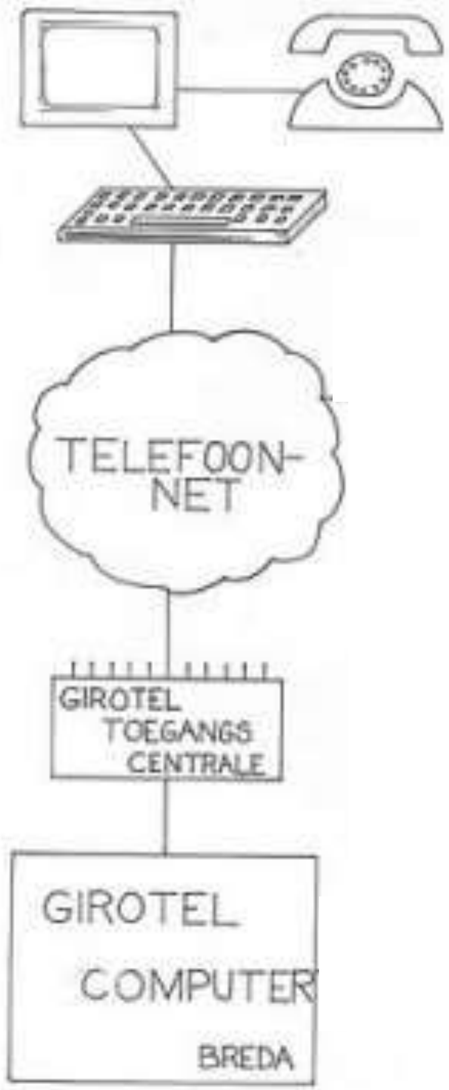
Distributing data via the network



source: https://monit-grafana.cern.ch/d/000000420/fts-transfers-30-day on September 27, 2018

1985, at your home in the Netherlands …

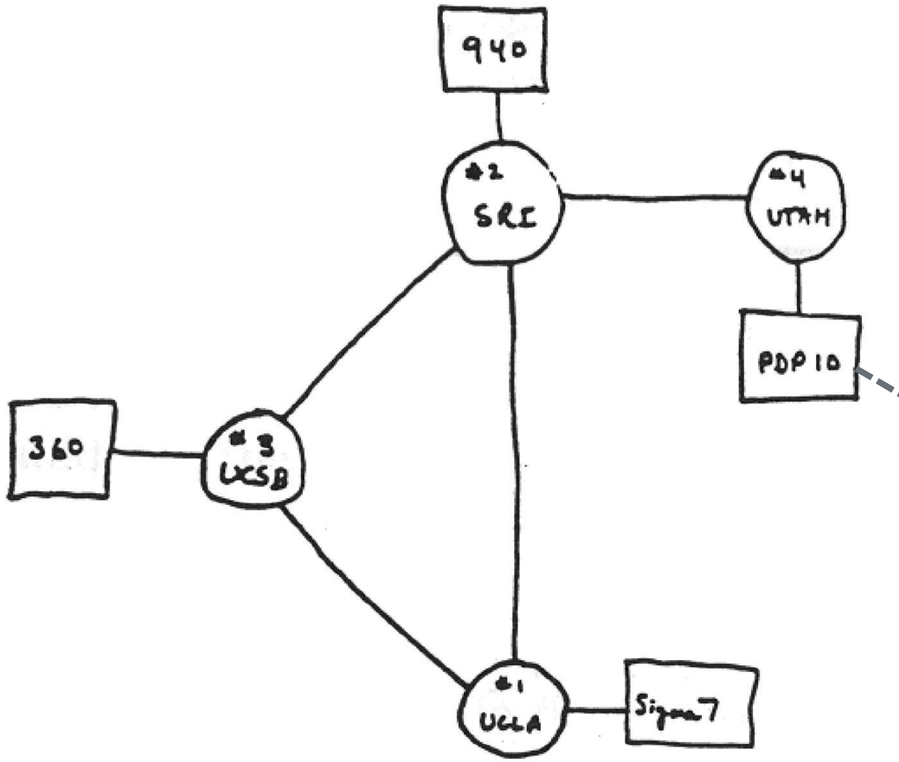
September 1985: Girotel



Humble beginnings: a direct circuit link from your MSX modem to the IBM system in Breda

images: “Blauw bloed”, https://anekdotes.blauw-bloed.nl/2009/09/09/

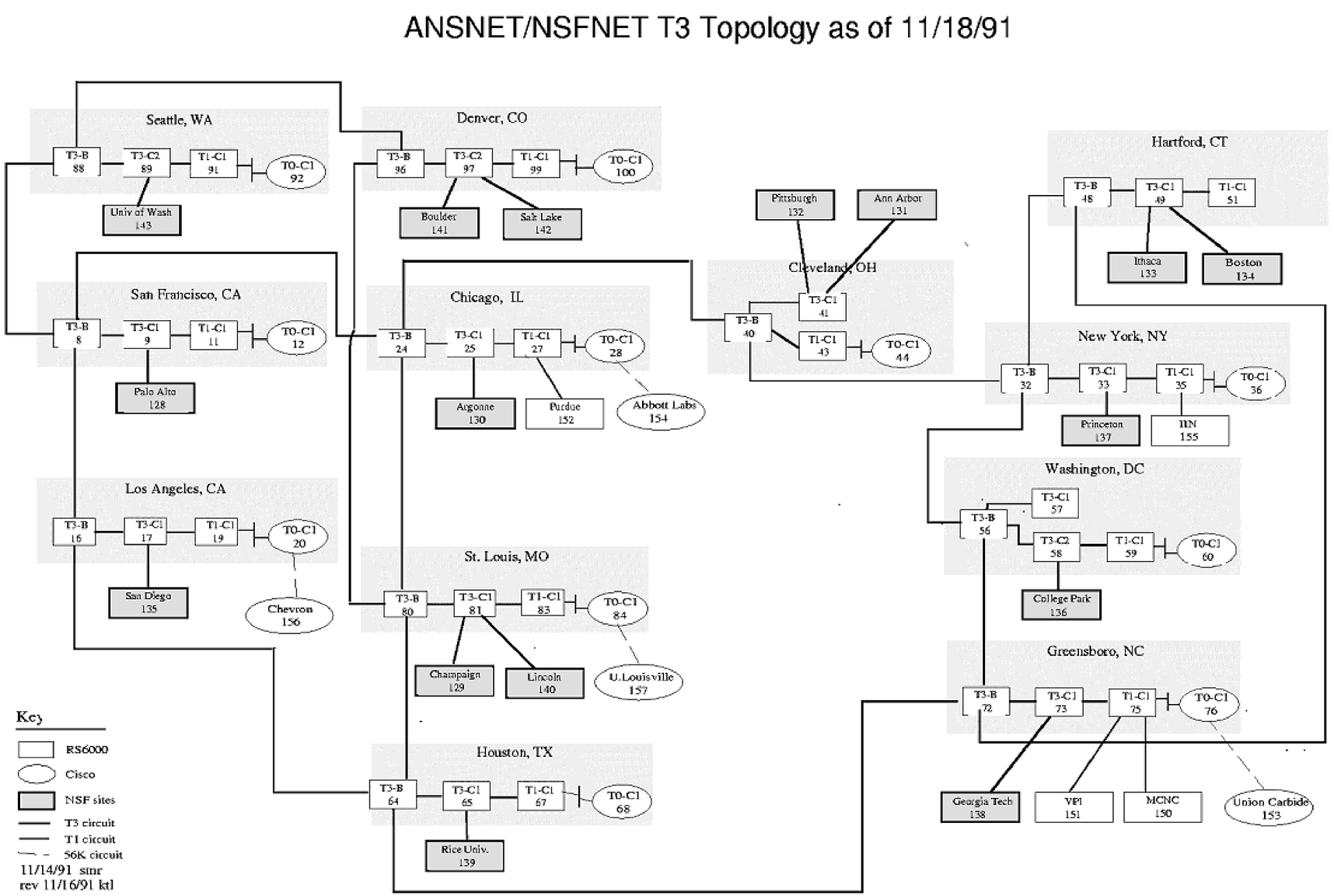
Paradigm change: packet vs circuit-switched

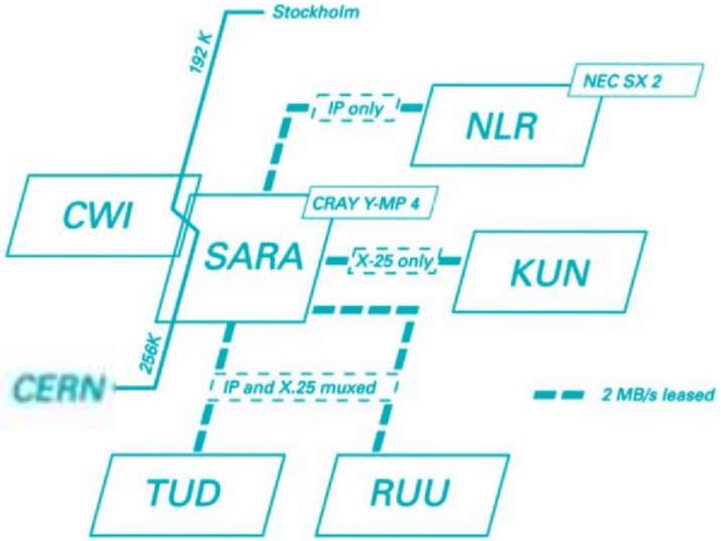


‘Ye olde compatibilitye’

Image source: Alex McKenzie and "*Casting the Net*", page 56. See https://personalpages.manchester.ac.uk/staff/m.dodge/cybergeography/atlas/arpanet2.gif ; acoustocoupler: Wikimedia

Early internet, and SURFnet in NL





See https://personalpages.manchester.ac.uk/staff/m.dodge/cybergeography/atlas/historical.html for more historic maps

SURFnet 2, 1990

From remote access to collaboration

https:// /Welcome.html

Welcome to my ho

This page features, or should feature, r

The Web offers much, in:

The Netherlands, Eur

There are several other interesting plac

NOS-'Teletekst' (received an hono

WWW Virtual Library (via CERN)

De Digitale Stad (the Digital City)

VU Campus Informatie Systeem

SURFNET and NLnet

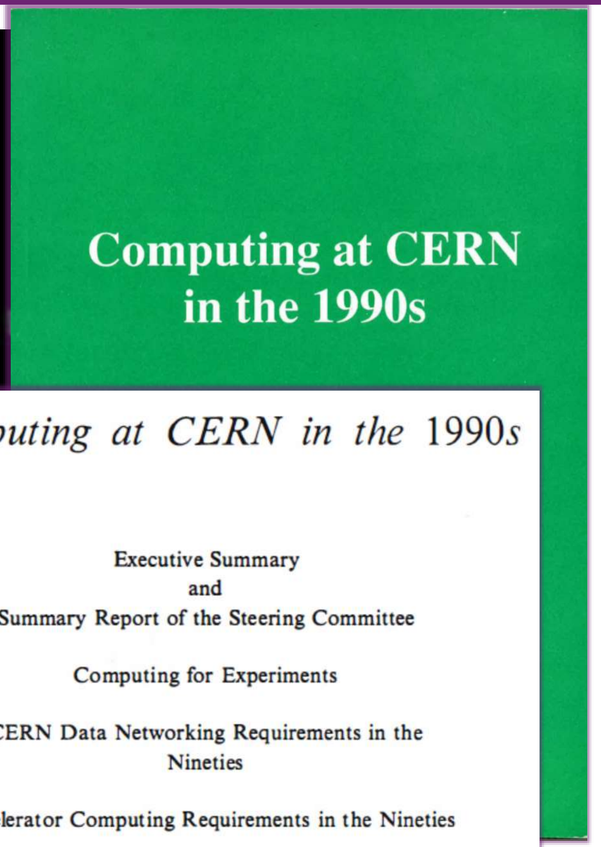
Meteorological satelite pictures (vi

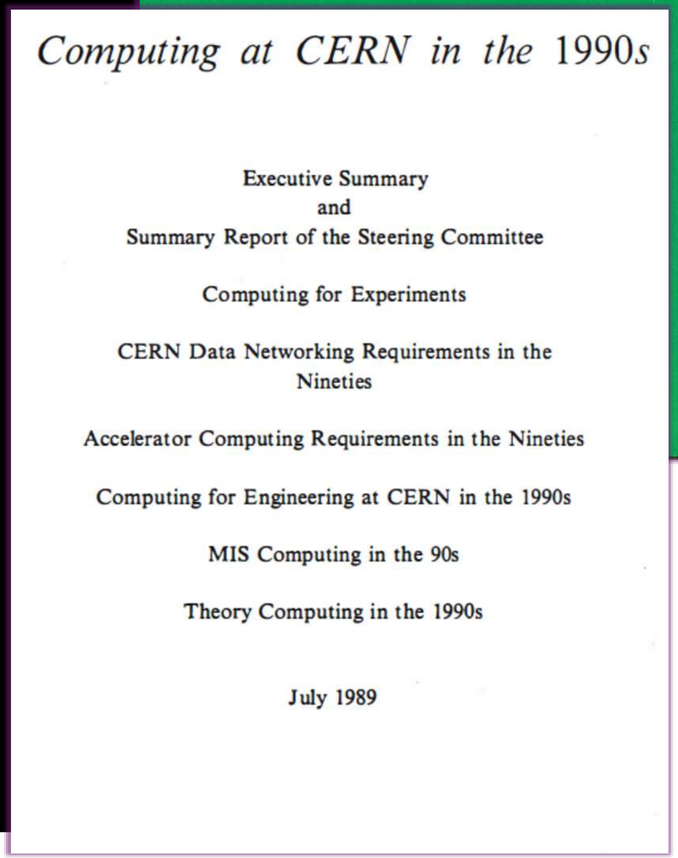
I work at NIKHEF, a research institute l

A short summary of the daily news (in

What about my homepage at NIKHEF?

```
WWW - World Wide Web at NIKHEF

  Help [1]     About this program, and the World-Wide Web

  NIKHEF [2]   NIKHEF information

  CERN [3]     CERN Information, ftp access to file server asis01.cern.ch

  HEP [5]      High Energy Physics

  WWW [6]      The home page of WWW on info.cern.ch

  NETFIND [7]  World Wide User Lookup of email addresses

      [End]

1-7, Quit, or Help: 2
```




Computing at CERN in the 1990s

Executive Summary
and
Summary Report of the Steering Committee

Computing for Experiments

CERN Data Networking Requirements in the Nineties

Accelerator Computing Requirements in the Nineties

Computing for Engineering at CERN in the 1990s

MIS Computing in the 90s

Theory Computing in the 1990s

July 1989

Sources:
nic.nikhef.nl (Feb 1992),
trivia.nat.vu.nl:8000 (Nov 1993), and
cds.cern.ch/record/206085/

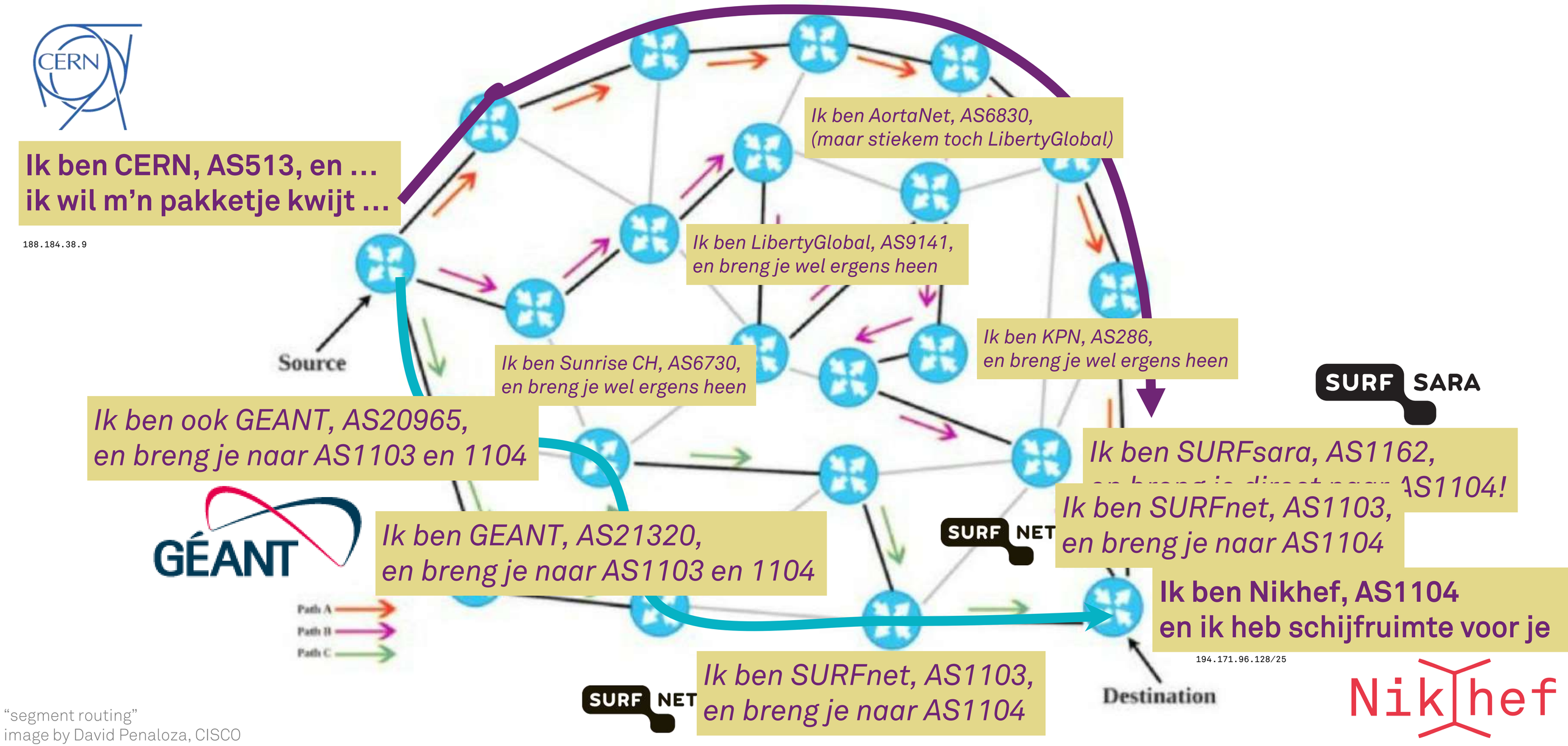
how would *you* get to CERN?

Traceroute measurement to linuxsoft.cern.ch (multihomed)

General Information | Probes | Map | TraceMON | IPmap (beta) | Results

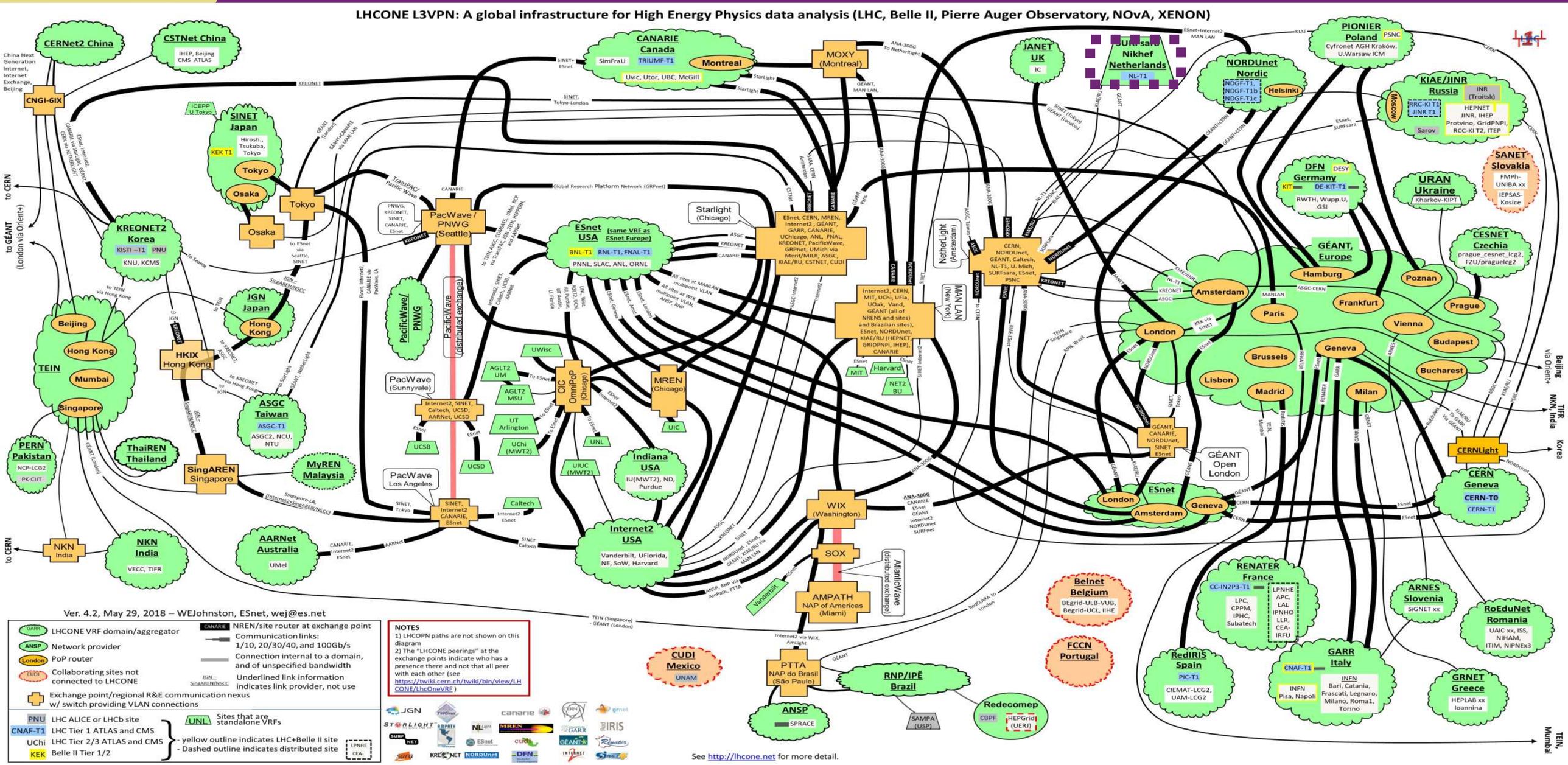
Data: TraceMON IPmap
from RIPE NCC Atlas
atlas.ripe.net
measurement 9249079

BGP, and Policy Based Routing



"segment routing"
image by David Penaloza, CISCO

‘LHC Open Network Environment’



From the 80's to today

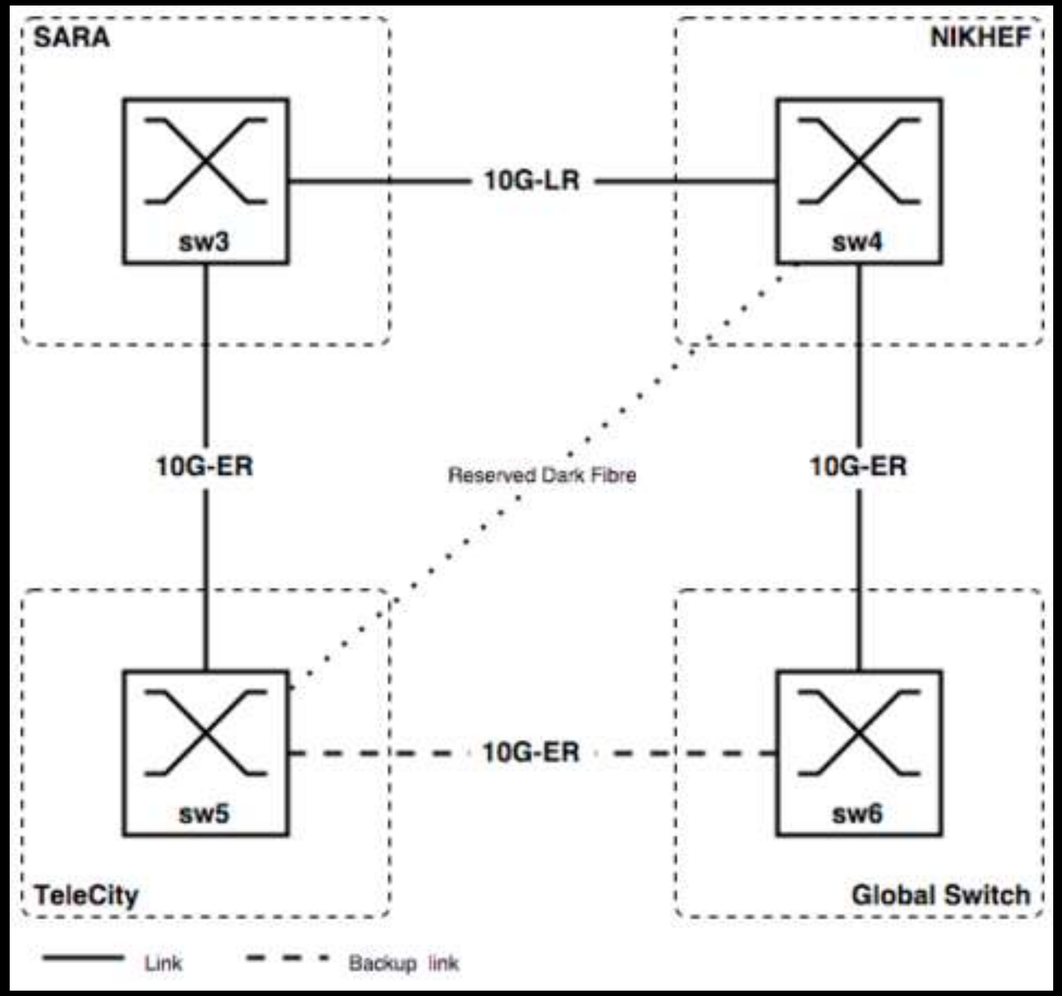
this is how H1.40 could have looked ...
it is actually the Nikhef-K computer room
on the Oosterringdijk

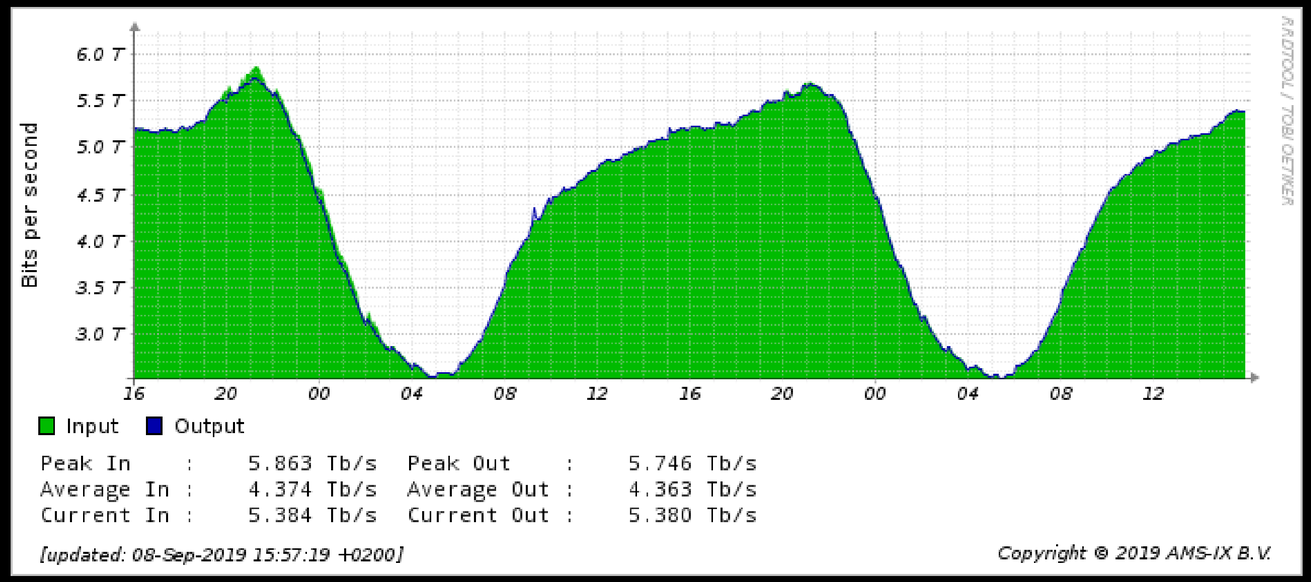
IBR LAN @Nikhef: the first exchange

1996, Nikhef H1.40

the yellow Ethernet cable is the WCW local area loop for the International Backbone Router (IBR-LAN)

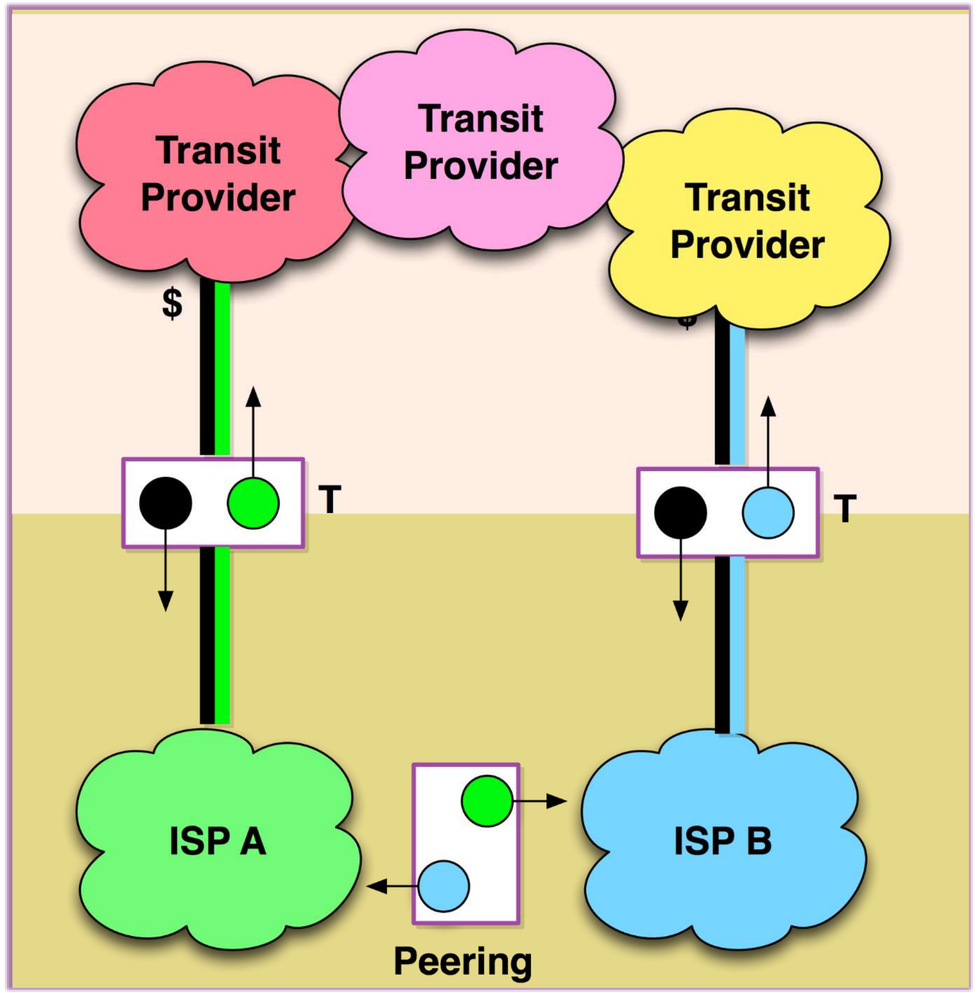
AMS-IX in ~2002, and traffic today





traffic graph: aggregate AMS-IX NL traffic on Sept 9, 2019
about 20% of the AMS-IX traffic is at Nikhef, out of 16 locations total
source: https://stats.ams-ix.net/

and private direct peering



Network Data Centres and Housing

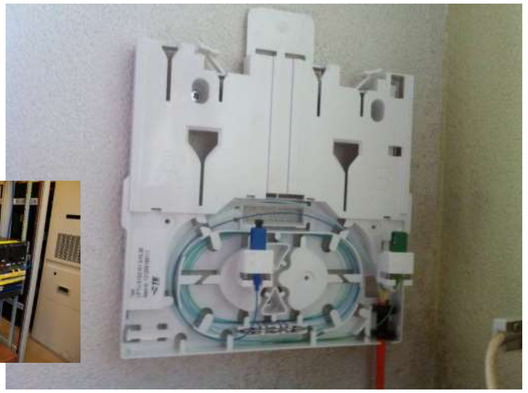
- the more ISPs are located together, the easier private peerings become
- parties ‘pay their own way’ to the housing location, and have their own equipment – so it’s not ‘free’
- peerings can be settlement-free or paid
- *model takes traffic away from IX-es*

PeeringDB

For a quick summary on peering, see e.g. http://drpeering.net/core/ch4-Internet-Peering.html

100 Gbps and up … beyond the LHC!

Thuis ‘FttH’
~0.1 – 1 Gbps BX
single strand SC

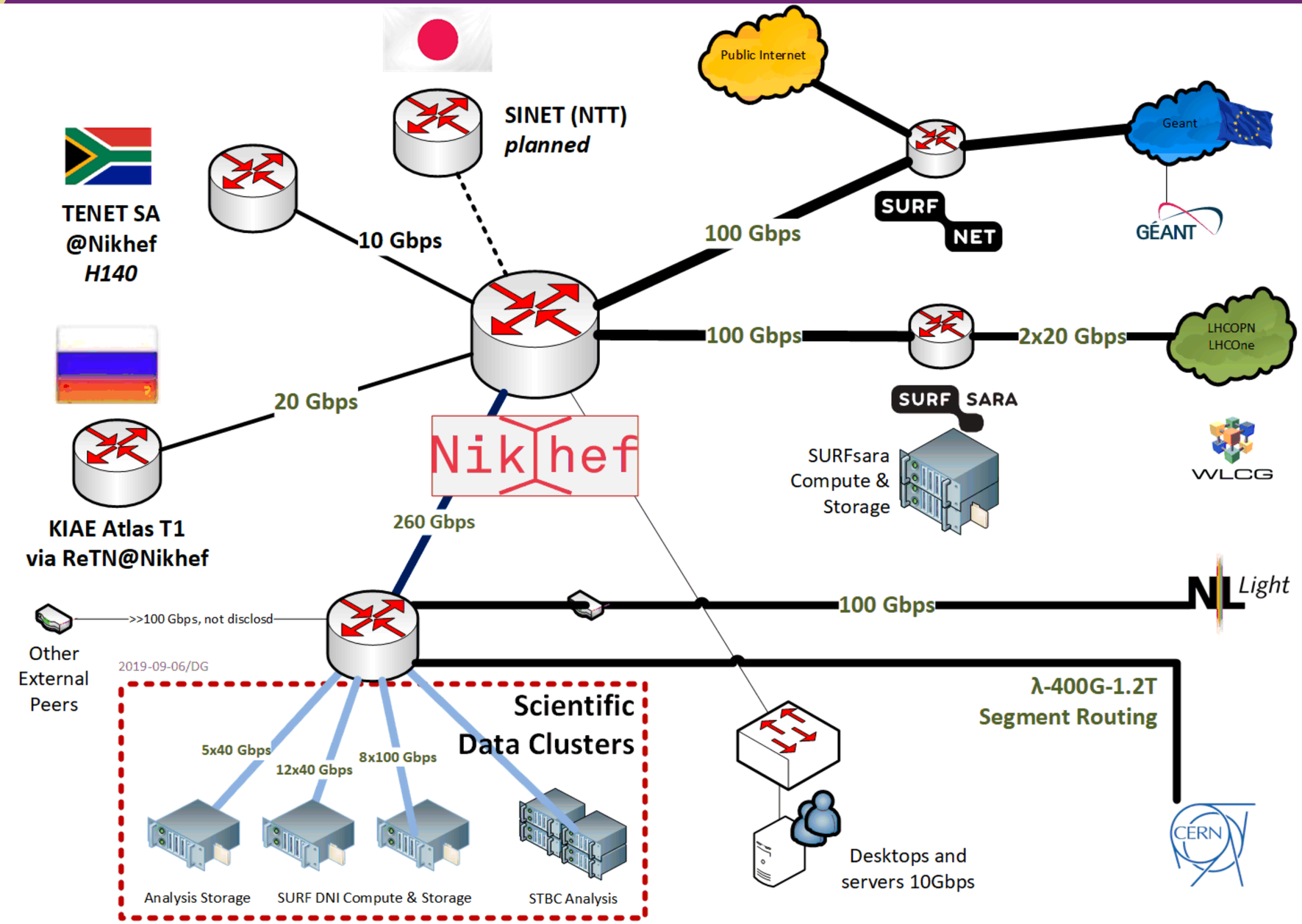


vergelijk:
VDSL BR straatkast
voor als je nog
op xDSL koper zit
0.02-0.2 Gbps

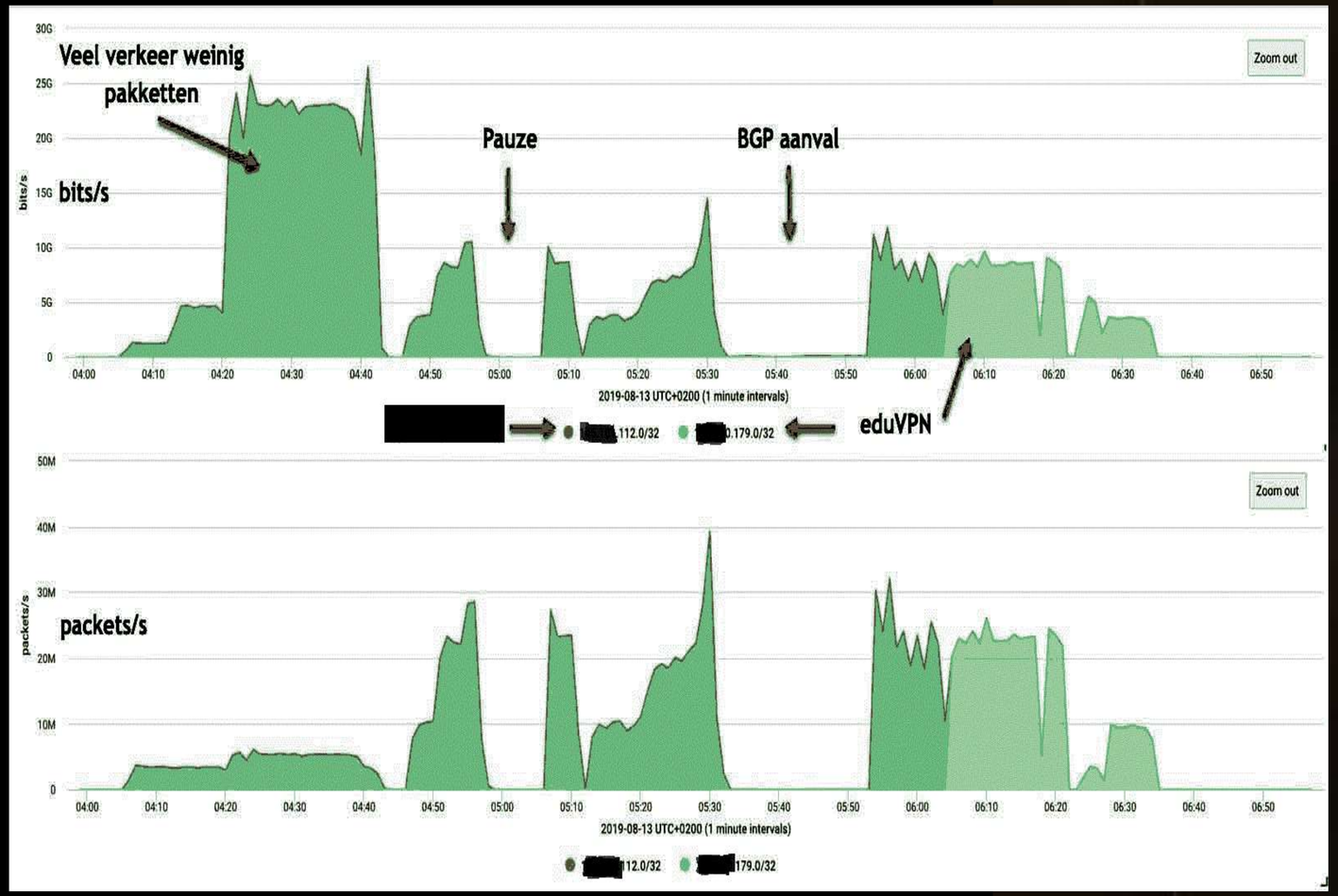
Nikhef
Data Processing
Facility

330 Gbps – 1200 Gbps

Direct peering infra for ‘big data’

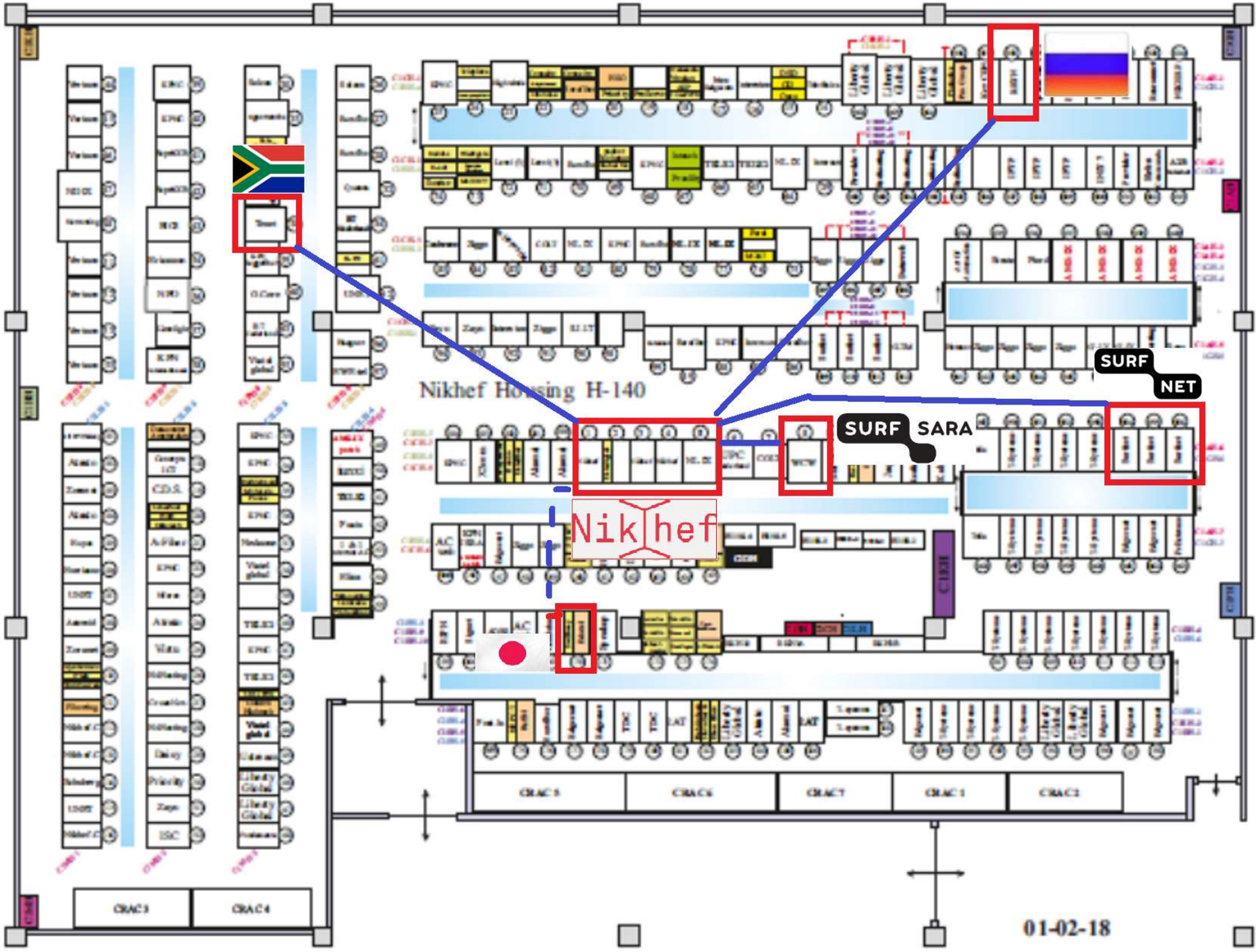


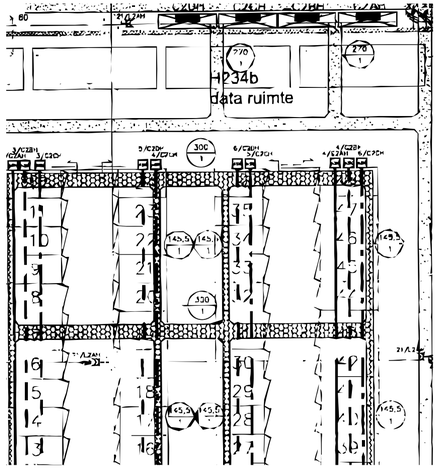
Our science data looks akin to a DDoS



evaluating resilience to cyberattack – *in a cooperative way*

Touching the networks





Some quick housing facts

~180 networks, 33 carriers

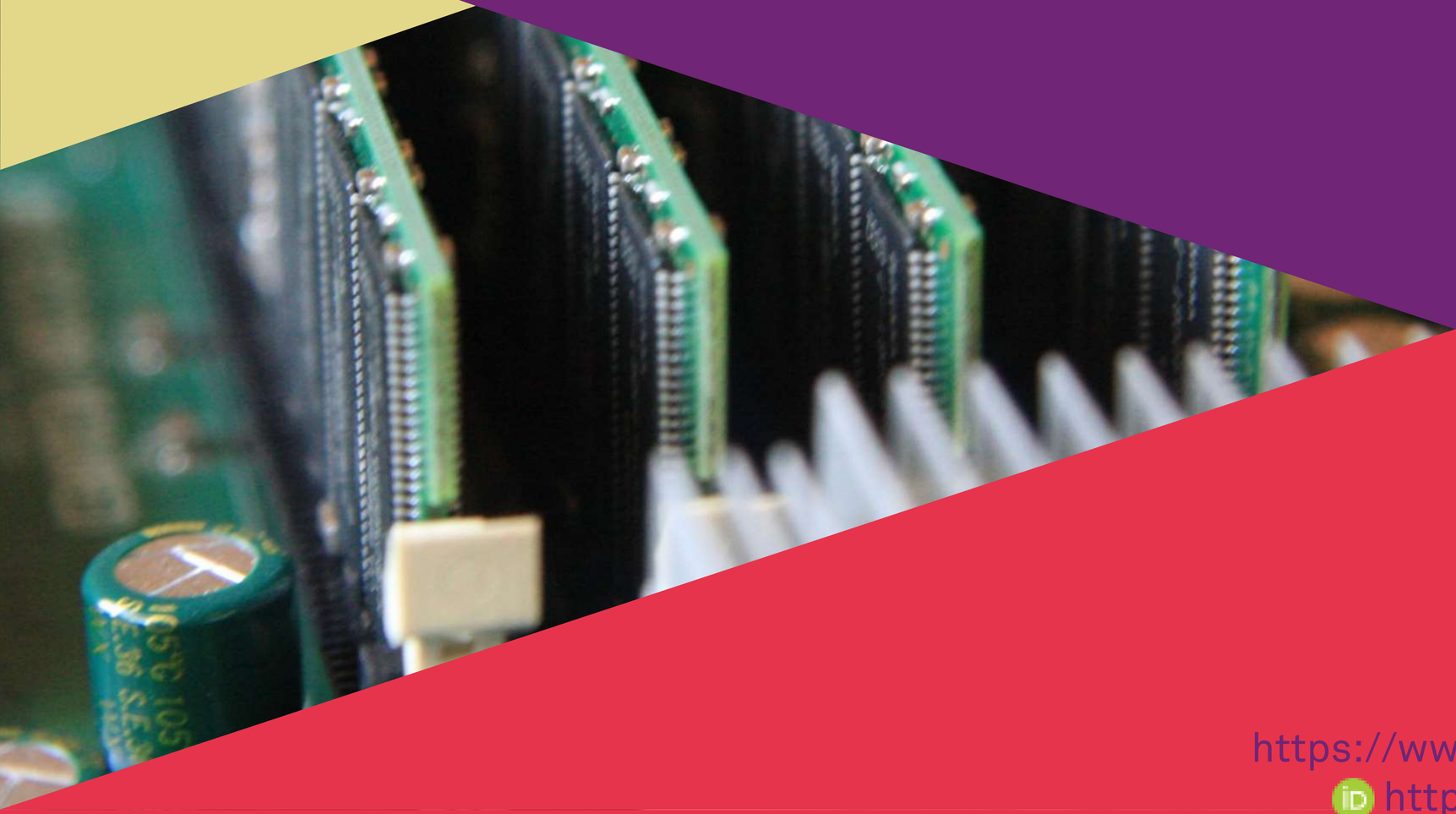
2.5 MW redundant power, A+B feed

Data Processing Facility (400 kW)
high-power ~9kW/rack, 24 C

Housing facility ~4kW/rack, ~18 C

many energy optimization methods ...

~21% additional power needed for cooling
surplus heat (3500 GJoule/yr, ~112 kW-yr)
linked to student housing via an STES



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