From ARPANET to a complex cyber infrastructure

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60's / 70's development of packet switching

- 1969 ARPANET based on NCP
- 1972 CYCLADES by Louis Pouzin
  - connection less, datagrams, layered structure, Transport Service (TS) in hosts

- 1972 International Packet Networking Group, INWG
- 1974 TCP article by Bob Kahn and Vint Cerf "A Protocol for Packet Network Interconnection"
- 1975 INWG consensus report, work continued in ISO and CCITT

80's birth of the Internet

- DARPA decided to continue with TCP in parallel with the ISO/CCITT standardisation efforts
- 1980 "final" TCP/IPv4 specification
- 1983 ARPANET switched to TCP/IPv4

- 1986 start of NSFNET, based on TCP/IPv4 and open for all US researchers
- 1986 NSFNET congestion collapse

Patching started

Initially, other major shortcomings received little attention

- After all, the Internet would be replaced by networks based on international standards developed in ISO and CCITT

- Wrong naming and addressing model
  - address refers to interfaces
  - Same address for the Internetwork and the network layer.

- Internet design lacked security mechanisms

- No Quality of Service

- *"On the Internet, nobody knows you're a dog"*

90's Internet wins the 'protocol war'

- ISO/CCITT results arrived too late and were much to complex
- TCP/IP code was freely available

- 1993 Mosaic browser for the WWW

- PTT networks, first X.25, later ATM, couldn't keep up with the demand

The Internet becomes the global
data communications infrastructure

Start Next Generation Internet projects

- 1997 in the USA, 1999 Japan, followed by many more

- With very little success so far, patching continues, and today, to the surprise of many, the Internet is still up and running based on the original architecture

- But for how long?

„A hardened piece of junk propagates all through the system" R.S. Barton
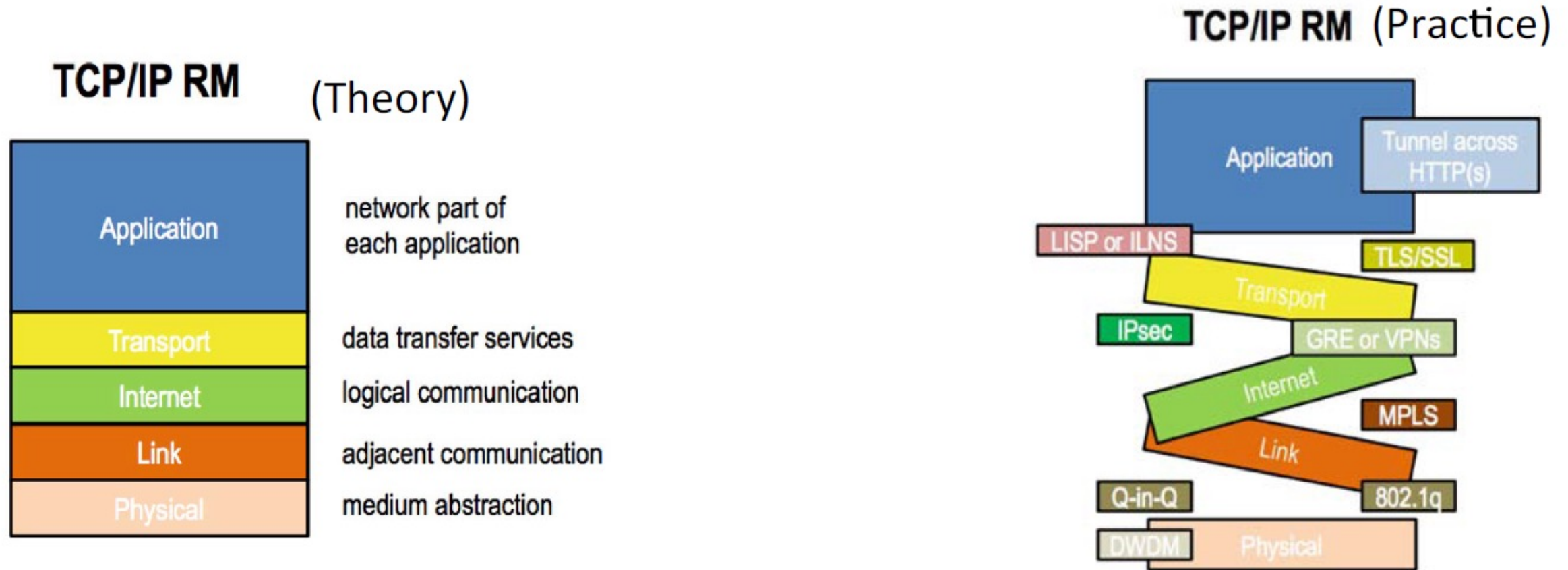
Patching results in increasing complexity

Figure 2: Internet architecture model is constantly extended to support new use cases

From ETSI Next Generation Protocols (NGP) 2019

„Program testing can be used to show the presence of bugs, but never to show their absence!" – E.W. Dijkstra

So complexity increases vulnerability

Are we in for a new Internet collapse?

What role did the Netherlands play

- We had a slow start, but caught up in the 80's

- Government actively stimulated developments and took a pragmatic approach toward ISO/OSI as the future goal.

- The Dutch PTT was supportive too, using the research community as launching customer for new services

80's in the Netherlands

- 1982 CWI starts EUnet with central node at CWI

- 1984 start SURF project, initially EARN, DECNET and X.25

- 1986 RARE, now GEANT, starts with secretariat at Nikhef

- 1986 delegation of .nl to CWI, 1988 connected status to open Internet

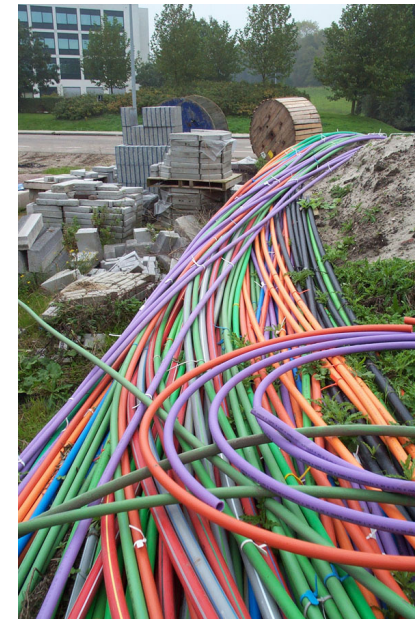- 1989 NLnet starts Internet service provision

90's in the Netherlands

- SURFnet moves from IP over X.25, via IP over ATM to native IP

- 1992 first European native IP backbone

- 1992

- 1993

- 1999

Pictures by Yuri Demchenko

# 00's hybrid networking

- 2001 2.5 Gbps Lambda

- iGrid 2002 in Amsterdam, showcase of 10 Gbps optical networking

Paradigm shift

- OptIPuter and DAS3/StarPlane were Powerful Distributed Cyberinfrastructures to Support Data-Intensive Scientific Research and Collaboration in a 'LambdaGrid' world

- Isolated from the global Internet, targeting trusted communities

- Innovation focus on middleware and applications

- Internet shortcomings became less of a concern
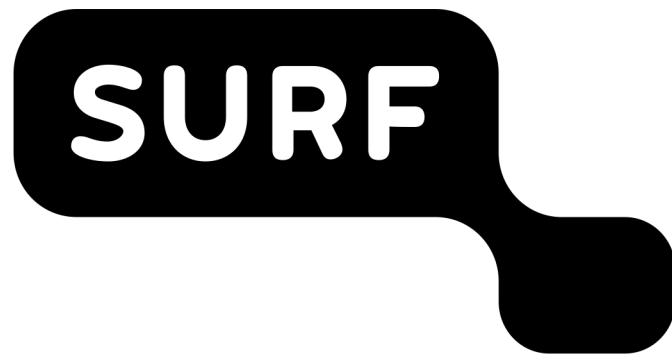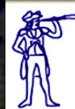
The COOK Report on Internet Protocol
Technology, Economics, and Policy

BUILDING A NATIONAL KNOWLEDGE INFRASTRUCTURE:

HOW DUTCH PRAGMATISM IMPLEMENTS NATIONAL POLICY
TO NOURISH A 21ST CENTURY ECONOMY

10's All IP networking, Clouds, Data

- Cybersecurity is becoming an increasing problem, the number of incidents is increasing and the attacks are becoming more sophisticated

- Dependence on PTTs has moved to dependence on the Big Five

- Increasing government regulation

20's Still challenges ahead

- The Internet has become an indispensable infrastructure

- But is still based on the original Internet architecture, which clearly is no longer fit for purpose and which is now largely controlled by a few big commercial stakeholders

- Public values such as accessibility, security, transparency and sustainability need more attention

- Dutch government declared Cybersecurity 'Chefsache' and published a Cybersecurity Strategy 2022-2028

So let's move on!

- data sharing in an open and democratic playing field

- Security, Stability and Transparency in inter-network Communication

*i*Grid 2005 San Diego

Thank you