

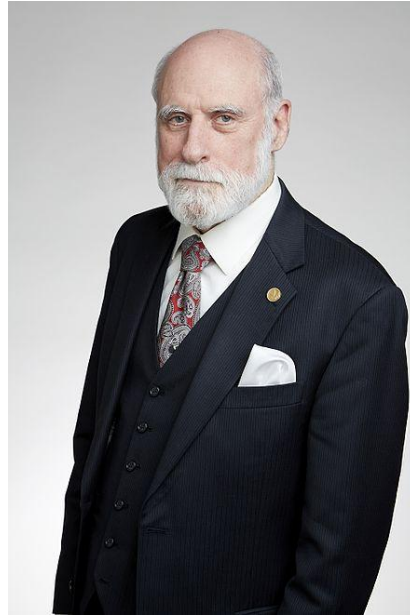
# Networking: Design Philosophy

What design choices were made in the design of the internet?

# TCP/IP



Bob Kahn



Vinton Cerf

V. Cerf and R. Kahn, "A Protocol for Packet Network Intercommunication," in *IEEE Transactions on Communications*, vol. 22, no. 5, pp. 637-648, May 1974, doi: 10.1109/TCOM.1974.1092259.



# David D. Clark

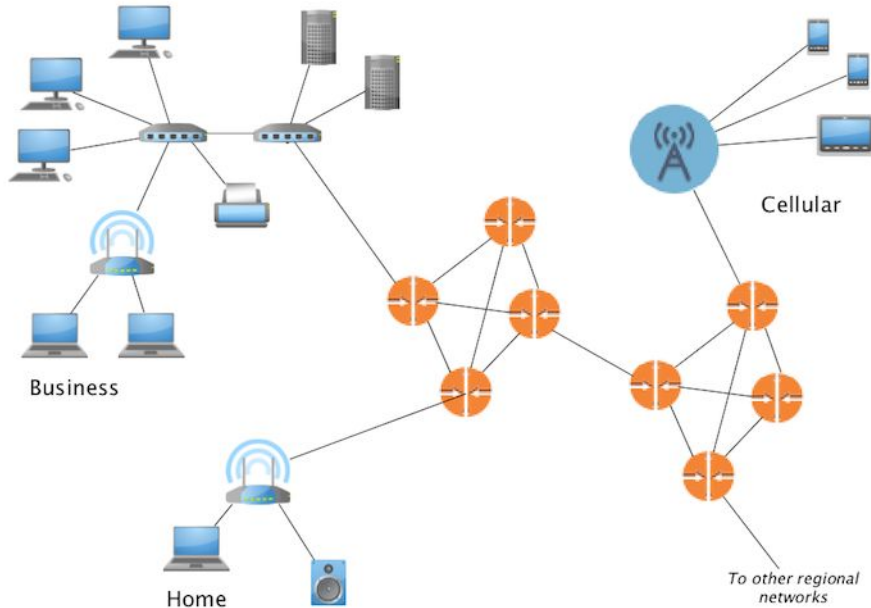


Took over TCP/IP architectural responsibility in 1983

We reject: kings, presidents, and voting.  
We believe in: rough consensus and running code.

— David D. Clark (1992)

# Fundamental Goal



Interconnect multiple networks

Shouldn't we simply connect all the users together in a unified network?

# “Secondary” Goals

1. Internet communication must continue despite loss of networks or gateways.
2. The Internet must support multiple types of communications service.
3. The Internet architecture must accommodate a variety of networks.
4. The Internet architecture must permit distributed management of its resources.
5. The Internet architecture must be cost effective
6. The Internet architecture must permit host attachment with a low level of effort.
7. The resources used in the internet architecture must be accountable.

The goals prevent any form of constraint

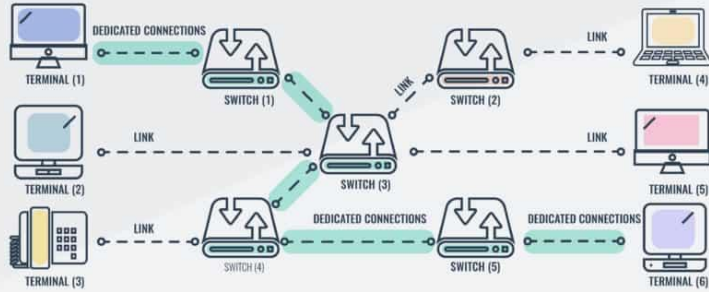
Security? Performance? Quality of Service?  
Complexity? Difficulty to implement services?

The network relies on best-effort delivery

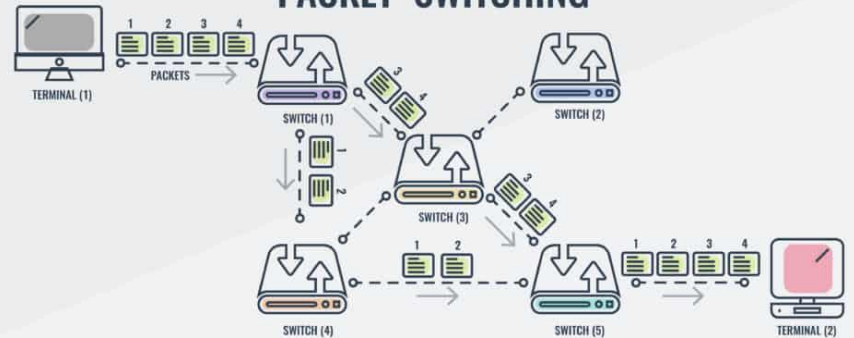
Is this desirable if our host is malicious?

# Packet and Circuit Switching

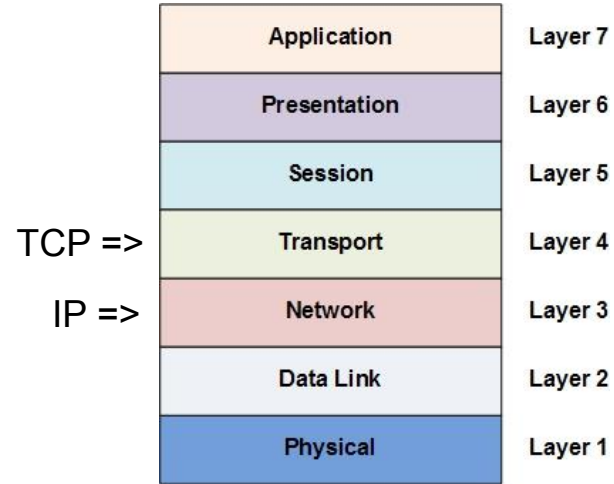
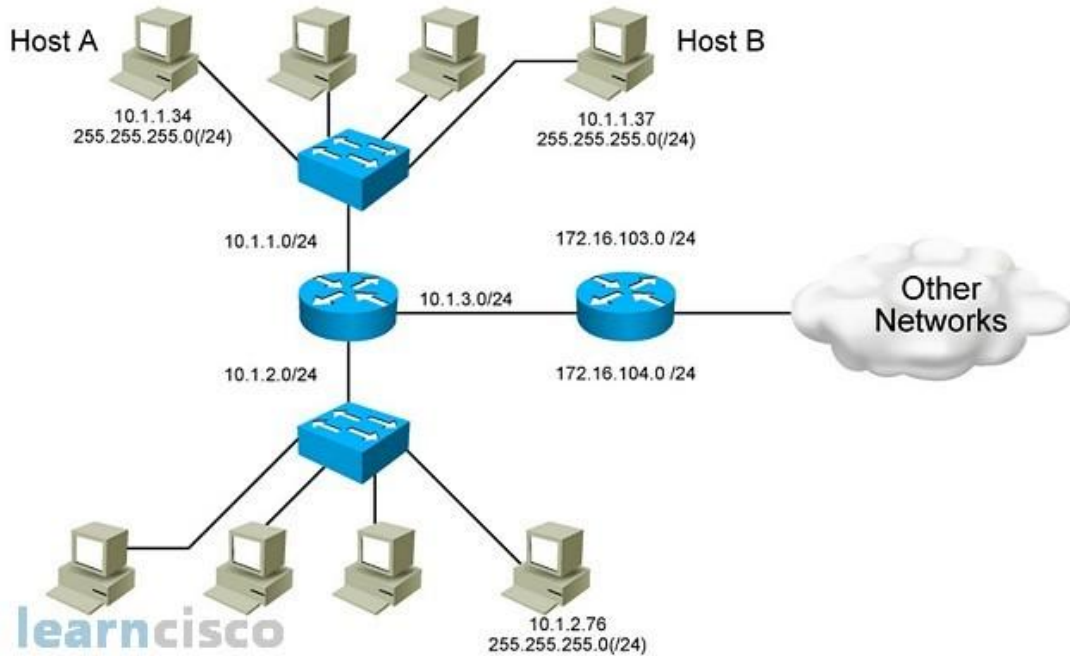
## CIRCUIT SWITCHING



## PACKET SWITCHING



# IP

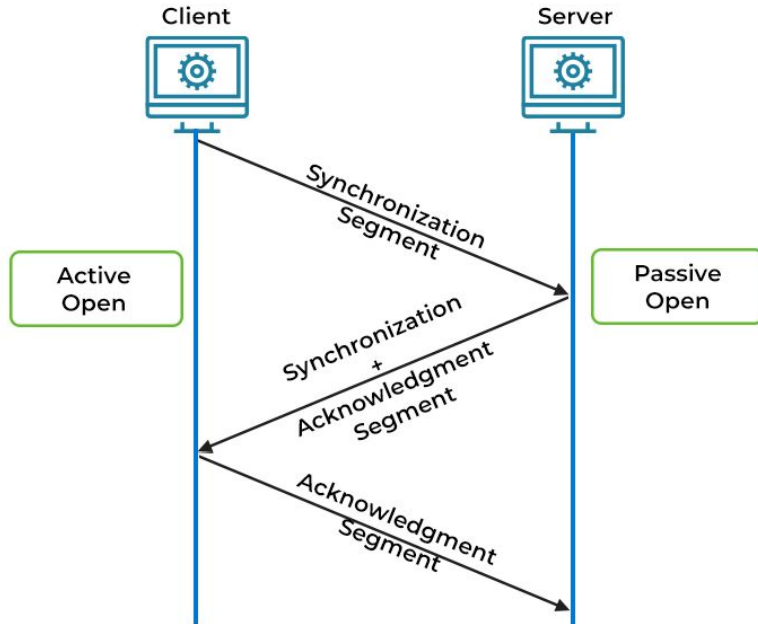


Originally TCP and IP were not split

# TCP



## FUNCTIONING OF TRANSMISSION CONTROL PROTOCOL (TCP)



A stream which is:

- Reliable
- Ordered
- Error-checked

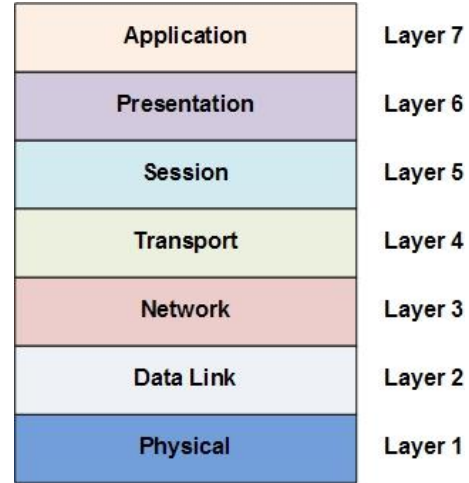
Flow control is based on bytes

What about:

- Throughput?
- Latency?
- Security?
- ...

TCP =>

IP =>





# Focus on Safety



RYAN SINGEL SECURITY FEB 25, 2008 10:37 AM

## Pakistan's Accidental YouTube Re-Routing Exposes Trust Flaw in Net

A Pakistan ISP that was ordered to censor YouTube accidentally managed to take down the video site around the world for several hours Sunday. The Pakistani government ordered ISPs to censor YouTube to prevent Pakistanis from seeing a trailer to an anti-Islamic film by Dutch politician Geert Wilders. YouTube has since removed the clip for violating its terms of service, but a screenshot [...]

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Common issue: Path hijacking

Trust is only mentioned twice in the paper, it now plays an important role

Should we change anything?

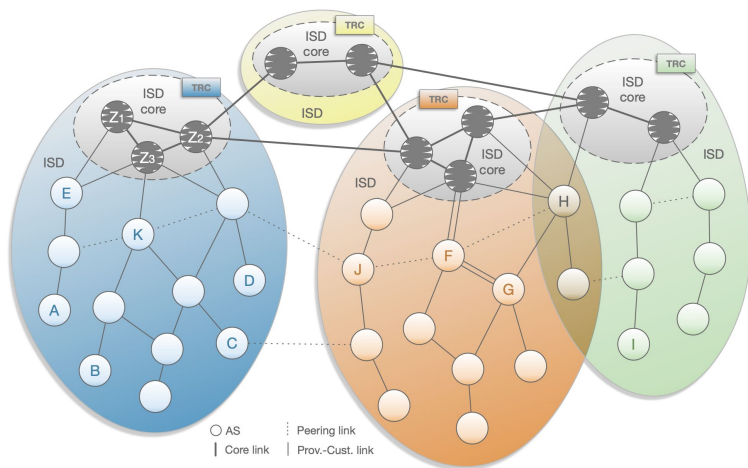
How can we change it?



# SCION: A Secure Internet Architecture

Different objectives:

- Availability in the presence of distributed adversaries
- Transparency and Control
- Efficiency, Scalability, and Extensibility
- Support for Global but Heterogeneous Trust
- Deployability



To learn more: <https://scion-architecture.net/>

Technical Documentation: <https://scion-architecture.net/pdf/SCION-book.pdf>

# Is the design too simple? QUIC

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Security with TLS had to be built on top of TCP

Should security be on top of TCP or should it be integrated into transport layer?

HTTPS is required by most browsers

# Arguments for end-to-end

- So many threats at many layers
  - Making the network super reliable does not address all the threats
  - Application will need to make checks anyway
- Lower layer need not provide perfect reliability
  - They need to provide some because of retries.
  - Trade off between reliability and performance.
- Where to put early checks and retries
  - Application: simplifies the network; increase overall cost;
  - Network: more efficient (hop-by-hop basis); some applications don't want this; doesn't know details so can't do it efficiently
- Where to put encryption
  - If network do the encryption, it must be trusted.
  - The data passed through the network are vulnerable.
  - Authenticity must still be checked by the application.
- Low level system don't need to provide certain functionality because application may not exactly need that and end up implementing their own anyway.

# Arguments against end-to-end

- Today's network is very fast. Does the overhead really matter?
- Prototyping time; Minimizing time to market
  - Reusing off-the-shelf module save us time.
  - Especially, the functionalities nowadays are pretty common.
- We now see PaaS (platform as a service) that provides all the building blocks for modern applications: e.g. Firebase
  - User authentication, database, etc.
  - Realtime socket
  - Security rules
- Making your own solution is very expensive and prone to bugs.
- The right question is: to what extent should the network should provide such functionality
  - Statistics of failure

## Some more scenarios require different focus.

- Internet of things; sensors; and Cloud computing
- Google Stadia; gaming over the internet
- CDN; and static sites
- High Frequency Trading; Fairness
- Internet in rural areas; energy concerns