The Internet and Sockets

Security and Networks

Eike Ritter

This Lecture

- How the Internet works.
  - Some History
  - TCP/IP
- Some useful network tools:
  - Netcat, Nmap, WireShark
- Some common attacks:
  - “The attacker controls the network”

It’s quite hard to explain what the Internet actually is.

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“The Internet is not something that you just dump something on. It's not a big truck. ***It's a series of tubes***.”

Ted Stevens, US Senator

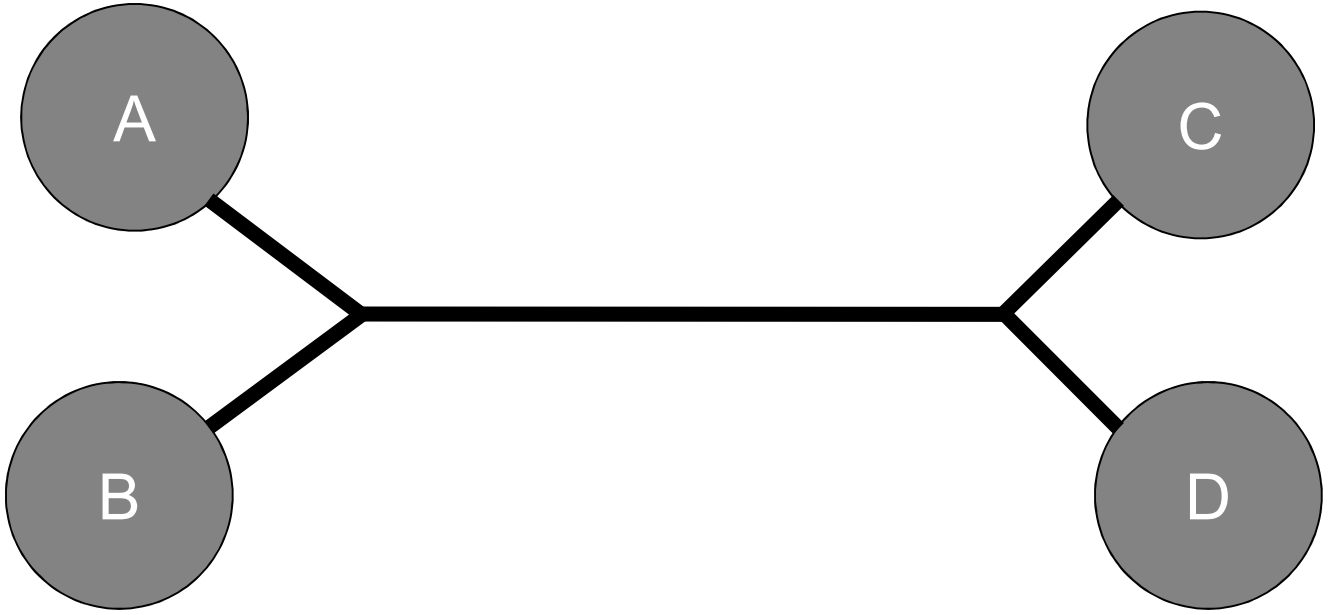
Before the Internet

- Computer Networks:
  - local networks,
  - telephone line connections,
  - leased line.

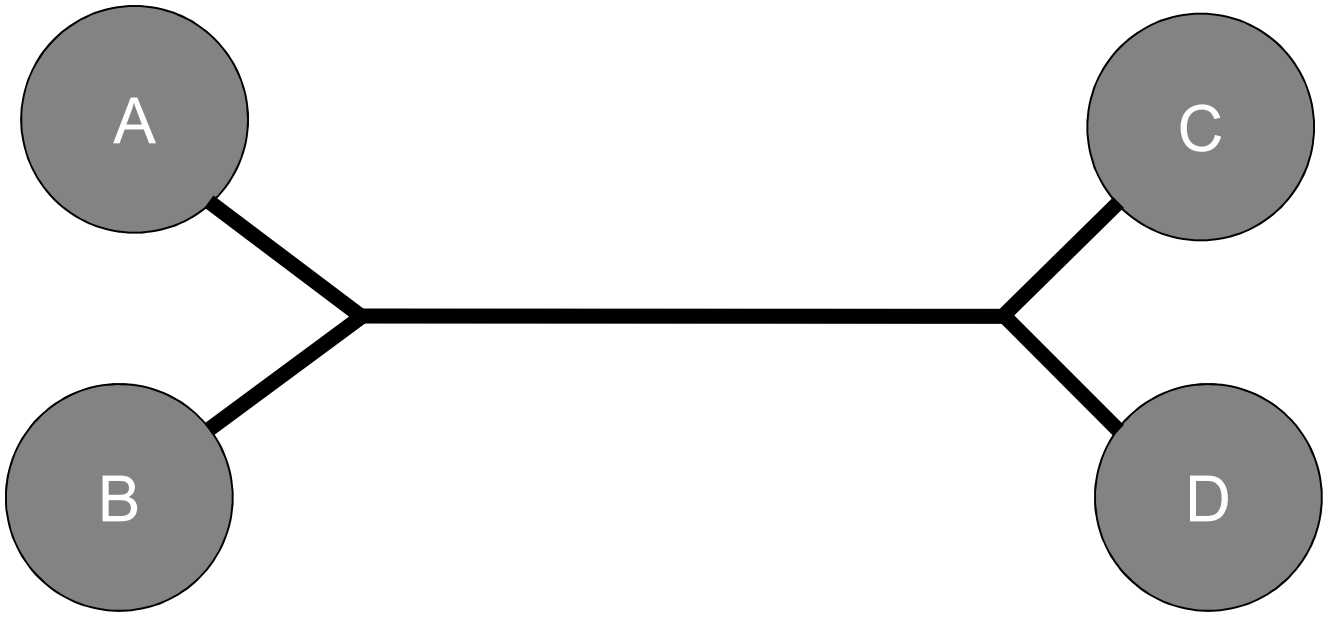
The Start 1969

- The US Defense Advanced Research Projects Agency (then ARPA now DARPA) gives research grants to universities to buy computers.
- They decide to link their computers.
- But how?

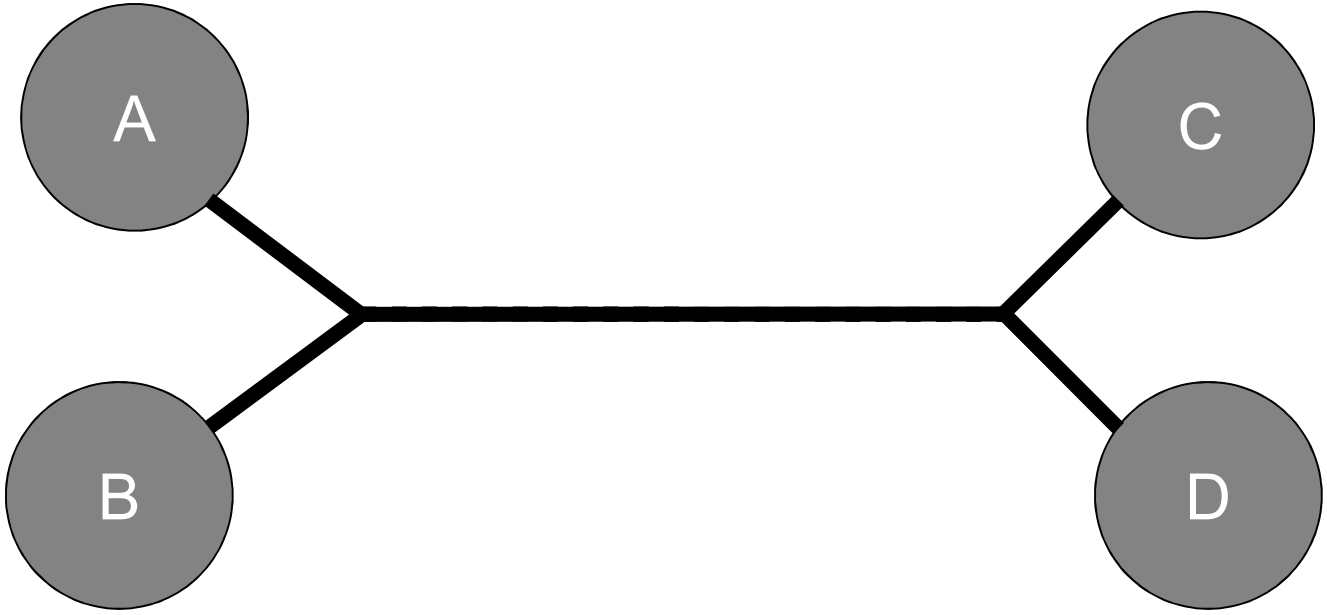
The Problem With Leased Lines



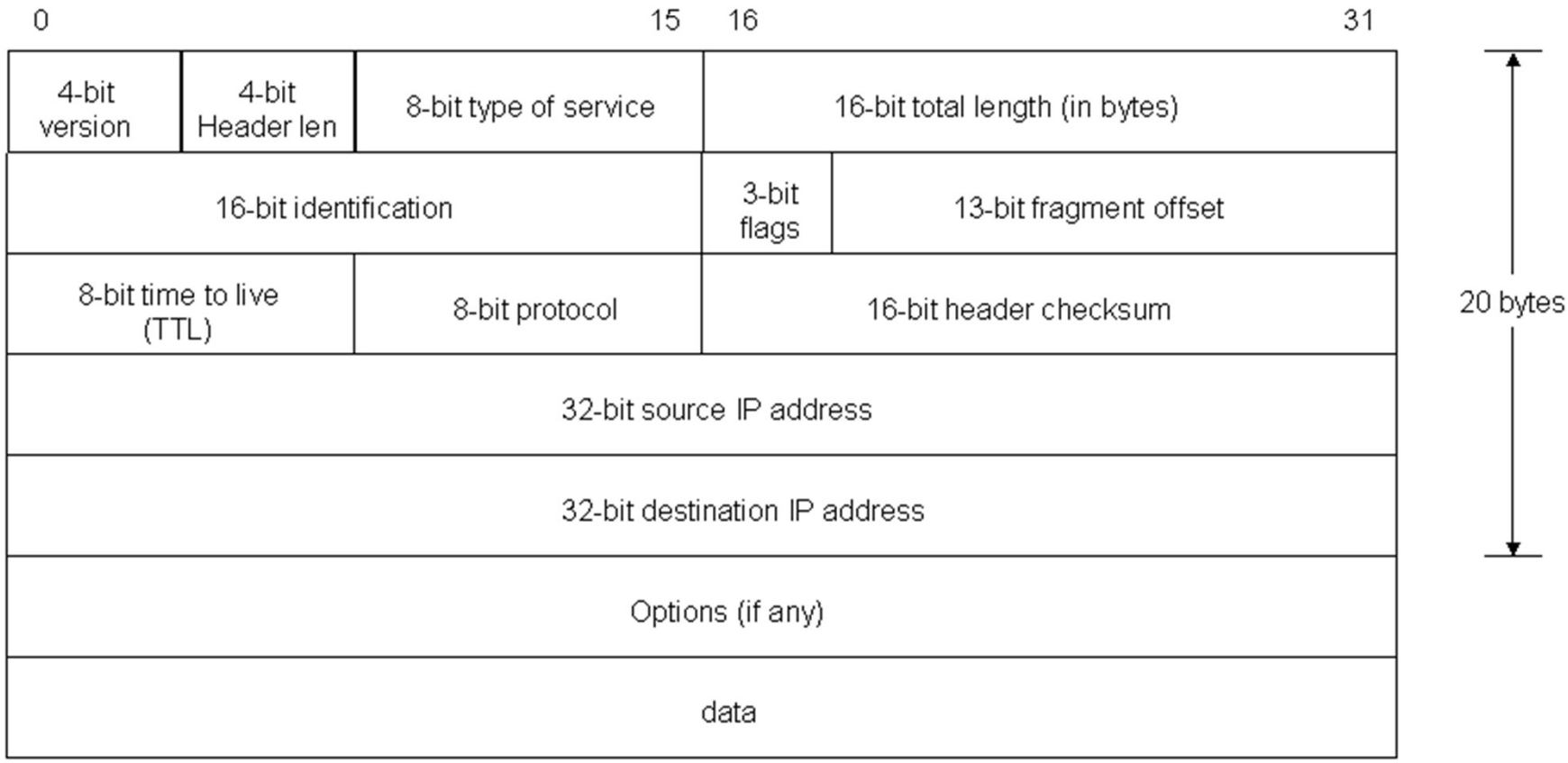
If A and D use the line, then C and B can't

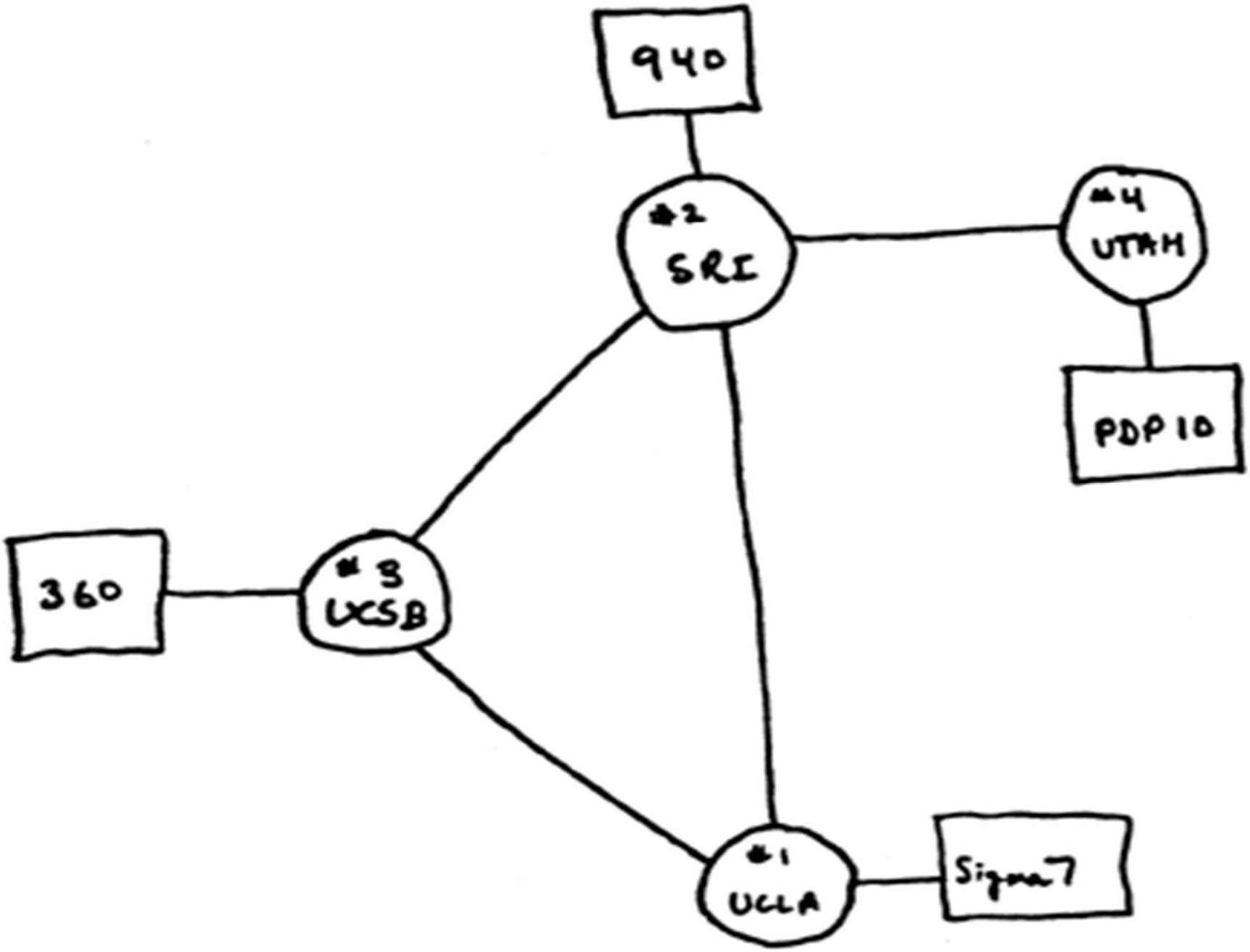


But if everyone just sends a small packet of data, they can both use the line at the same.



IP PACKET HEADER

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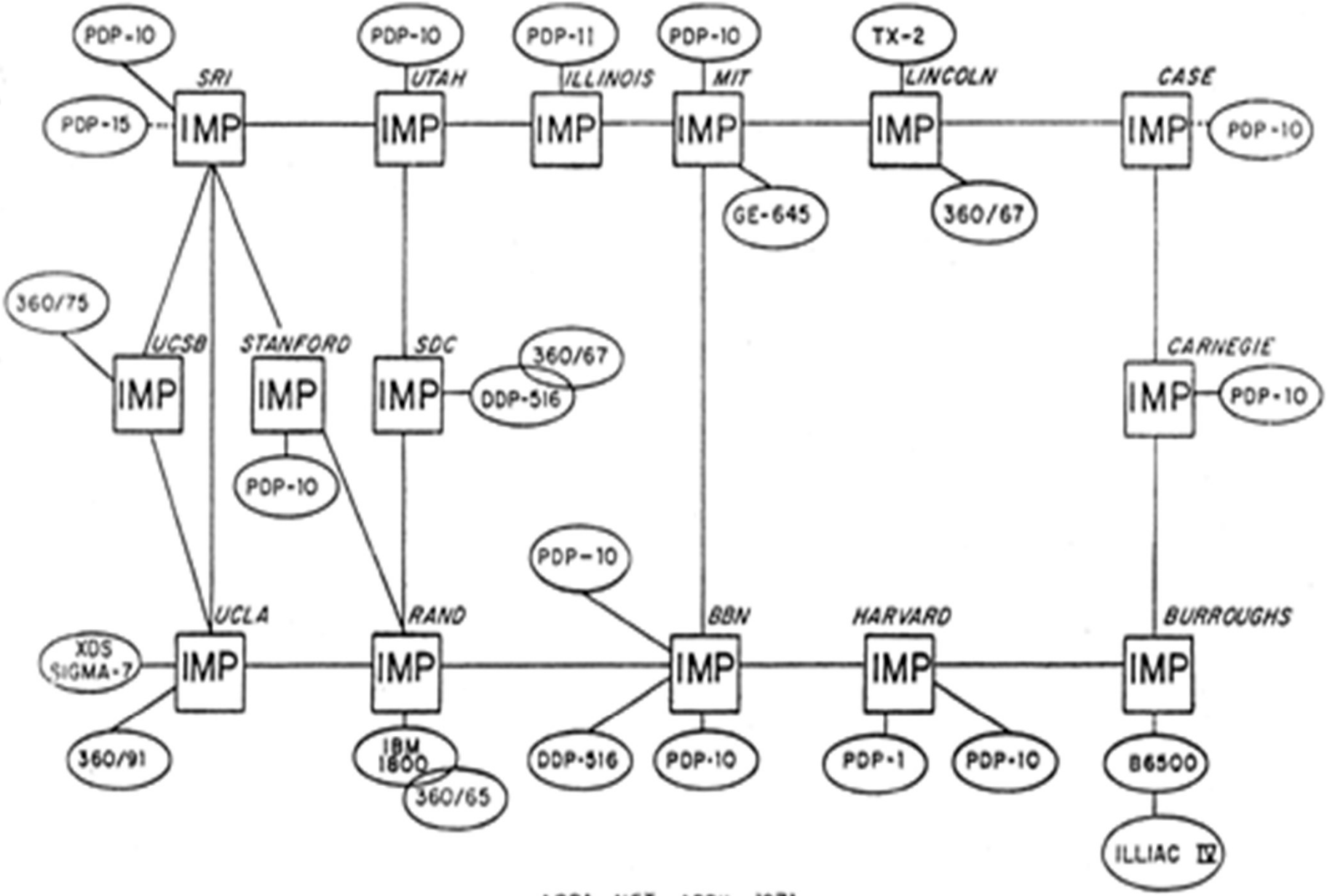
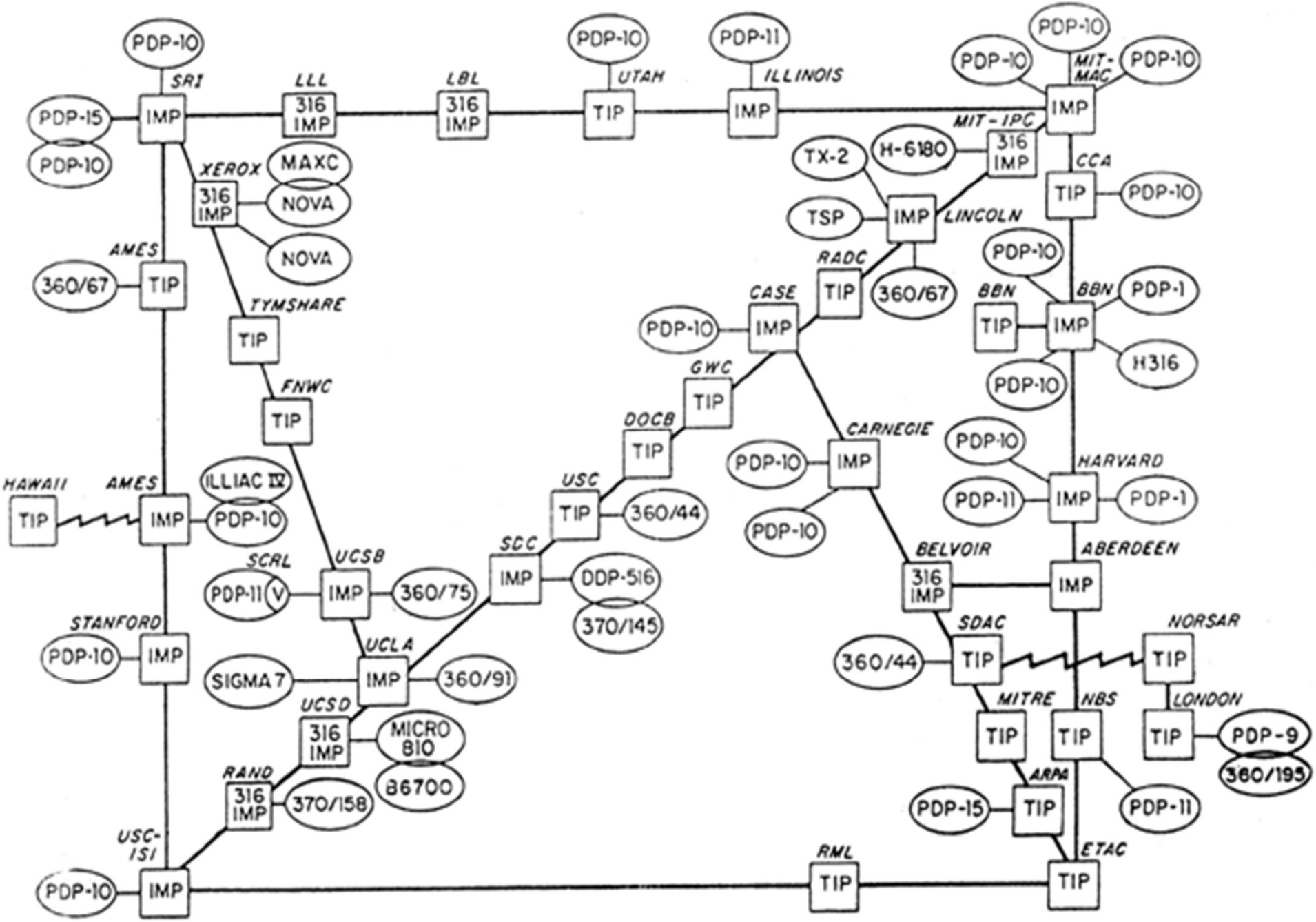
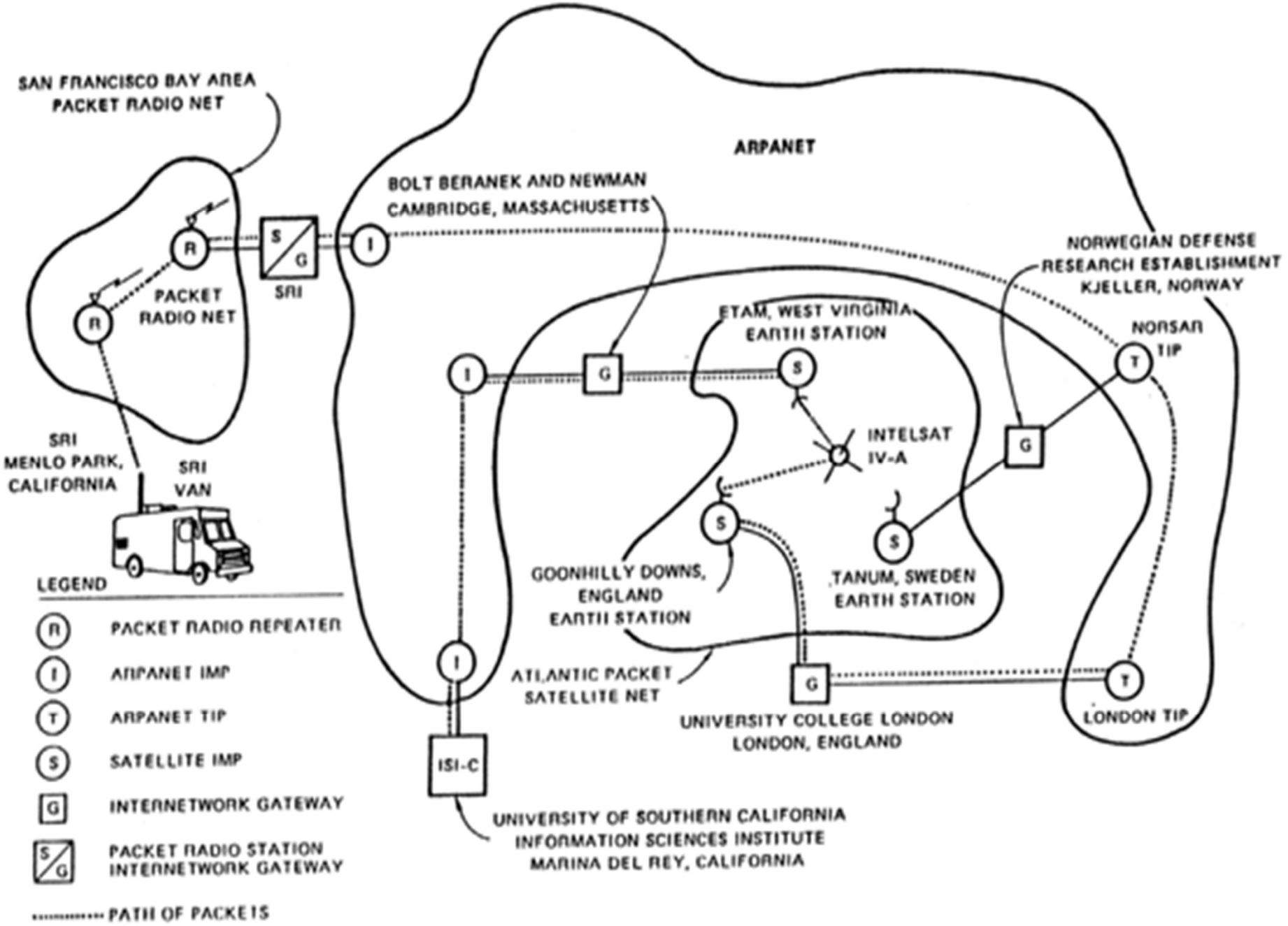


ARPA NET, APRIL 1971

ARPA NETWORK, LOGICAL MAP, SEPTEMBER 1973




SAN FRANCISCO BAY AREA
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KJELLER, NORWAY
PACKET
RADIO NET
SRI
ETAM, WEST VIRGINIA
EARTH STATION
NORSAR
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SATELLITE NET
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INFORMATION SCIENCES INSTITUTE
MARINA DEL REY, CALIFORNIA
LEGEND
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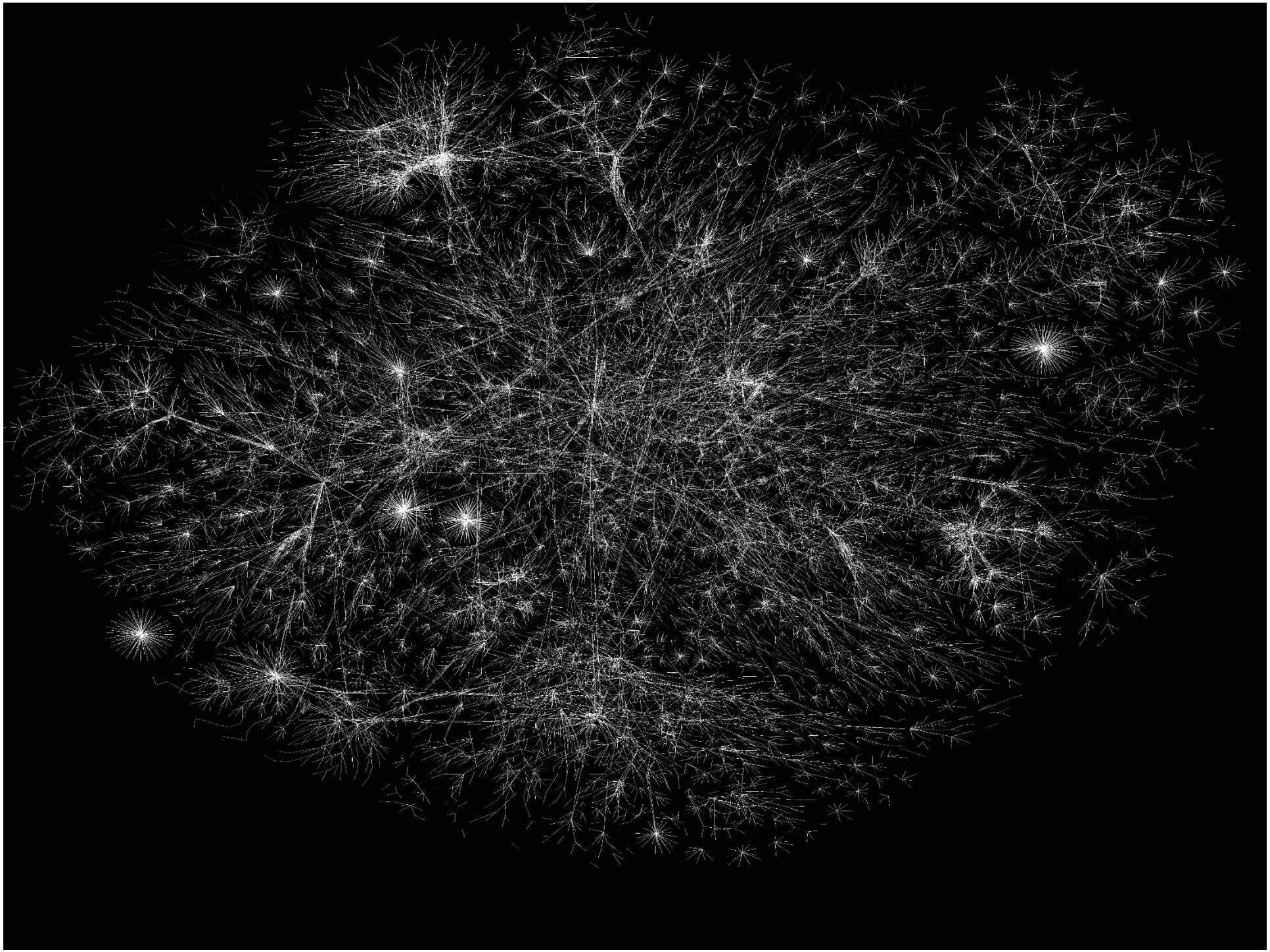
INTERNETWORK GATEWAY
PATH OF PACKETS



http://submarine-cable-map-2015.telegeography.com

traceroute

BT and Vodafone among telecoms companies passing details to GCHQ

Fears of customer backlash over breach of privacy as firms give GCHQ unlimited access to their undersea cables

The document identified for the first time which telecoms companies are working with GCHQ's "special source" team. It gives top secret codenames for each firm, with BT ("Remedy"), Verizon Business ("Dacron"), and Vodafone Cable ("Gerontic"). The other firms include Global Crossing ("Pinnage"), Level 3 ("Little"), Viatel ("Vitreous") and Interoute ("Streetcar"). The companies refused to comment on any specifics relating to Tempora, but several noted they were obliged to comply with UK and EU law.

http://www.theguardian.com/business/2013/aug/02/telecoms-bt-vodafone-cables-gchq

Transmission Control Protocol

- 1974: daily traffic more than 3 million packets a day. Many are getting lost.
- TCP is a protocol than runs on top on IP, if an IP packet gets lost. It requests that it is resent.
- TCP/IP becomes allows Inter network connections.

Domain Name Servers (DNS)

- Remembering IP address is to hard.
- So people associate names with addresses.

  e.g. news.bbc.com → 212.58.226.141
- A hierarchy of servers list handle requests
- The route for most of Europe is RIPE based in Amsterdam.

Ports

- To allow multiple connections TCP uses “ports”
- A TCP “Socket” connection is defined by:

(destination IP, destination port, source IP, source port)

- The destination port normally depends on the service: WWW runs on port 80, ssh on port 22, dns on 53…
- The source port is normally chosen at random.

Netcat

Netcat is a tool to make Internet connections.

Syntax varies between OS.

- listen on 1337: `nc –l 1337`
- connect to machine 127.0.0.1 on port 1337: `nc 127.0.0.1 1337`

Nc demo

Nmap: http://nmap.org/

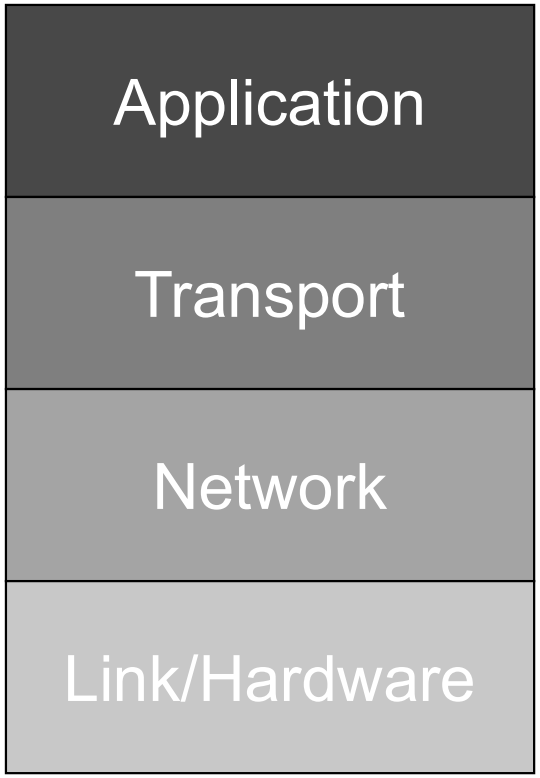
- Check if 1000 most common ports are open:
  - `nmap 127.0.0.01`
- Additionally send messages to ports to find out what the service is:
  - `nmap -A 127.0.0.01`
- Scan all ports
  - `nmap -p- 127.0.0.01`

Nmap demo

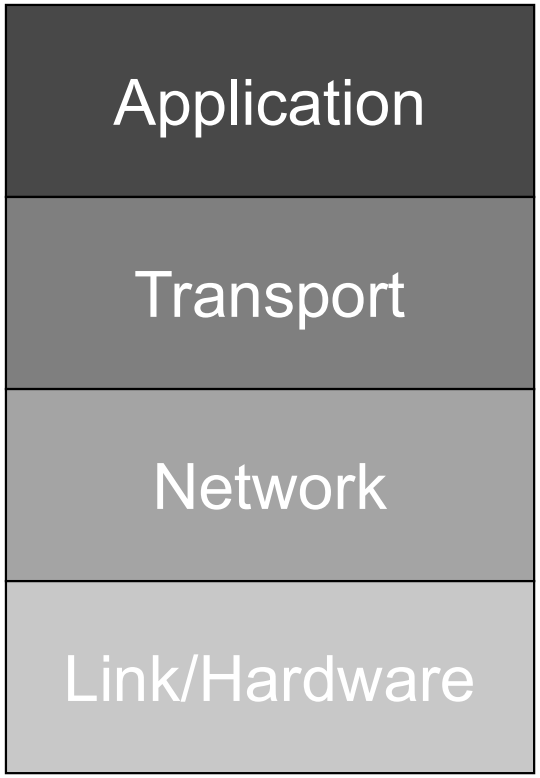
The Internet Protocol Stack

Internet communication uses a stack of protocols.

Each protocol uses the protocol below it to sent data.



The Stack, Most of the Time:



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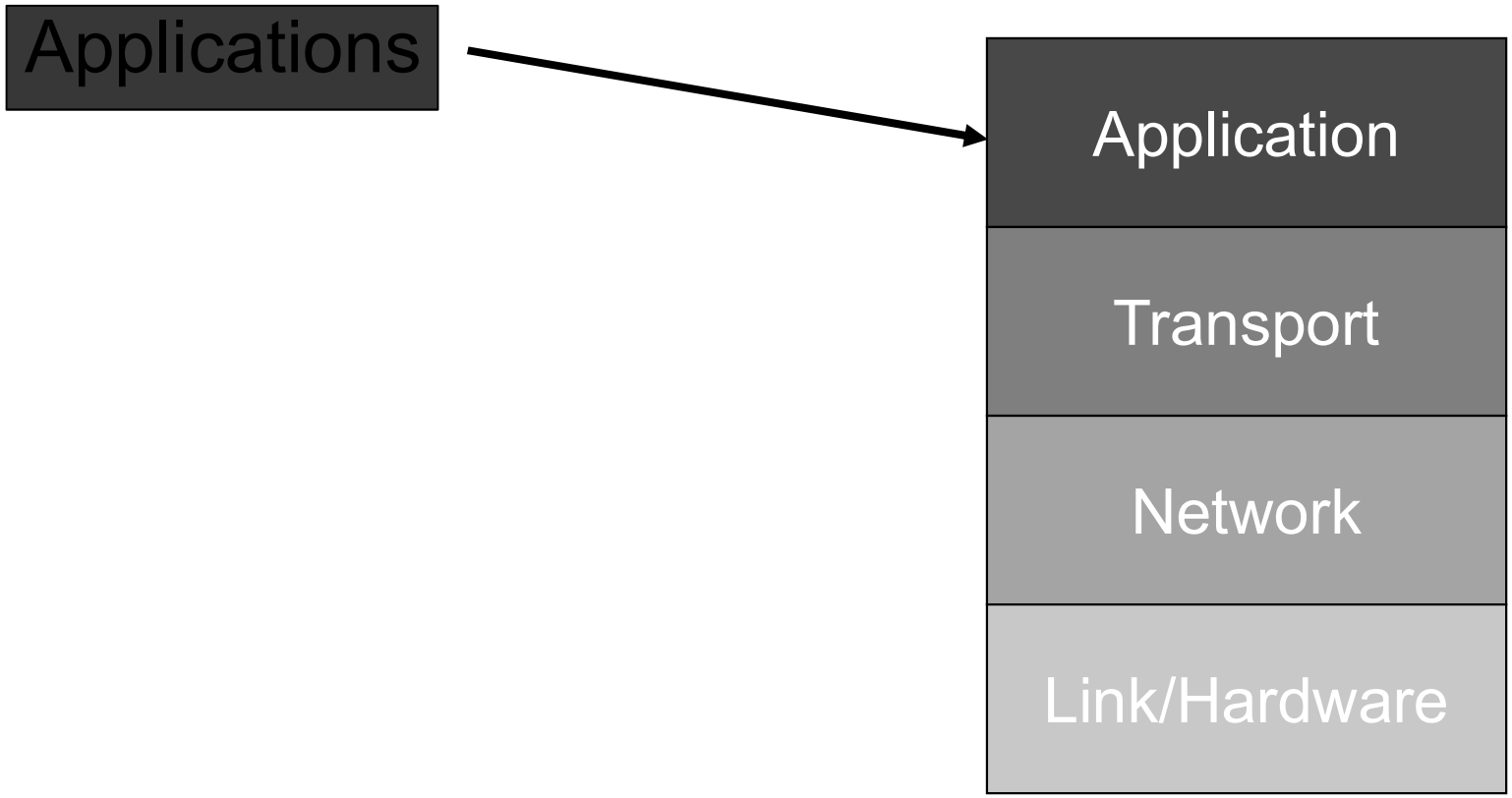

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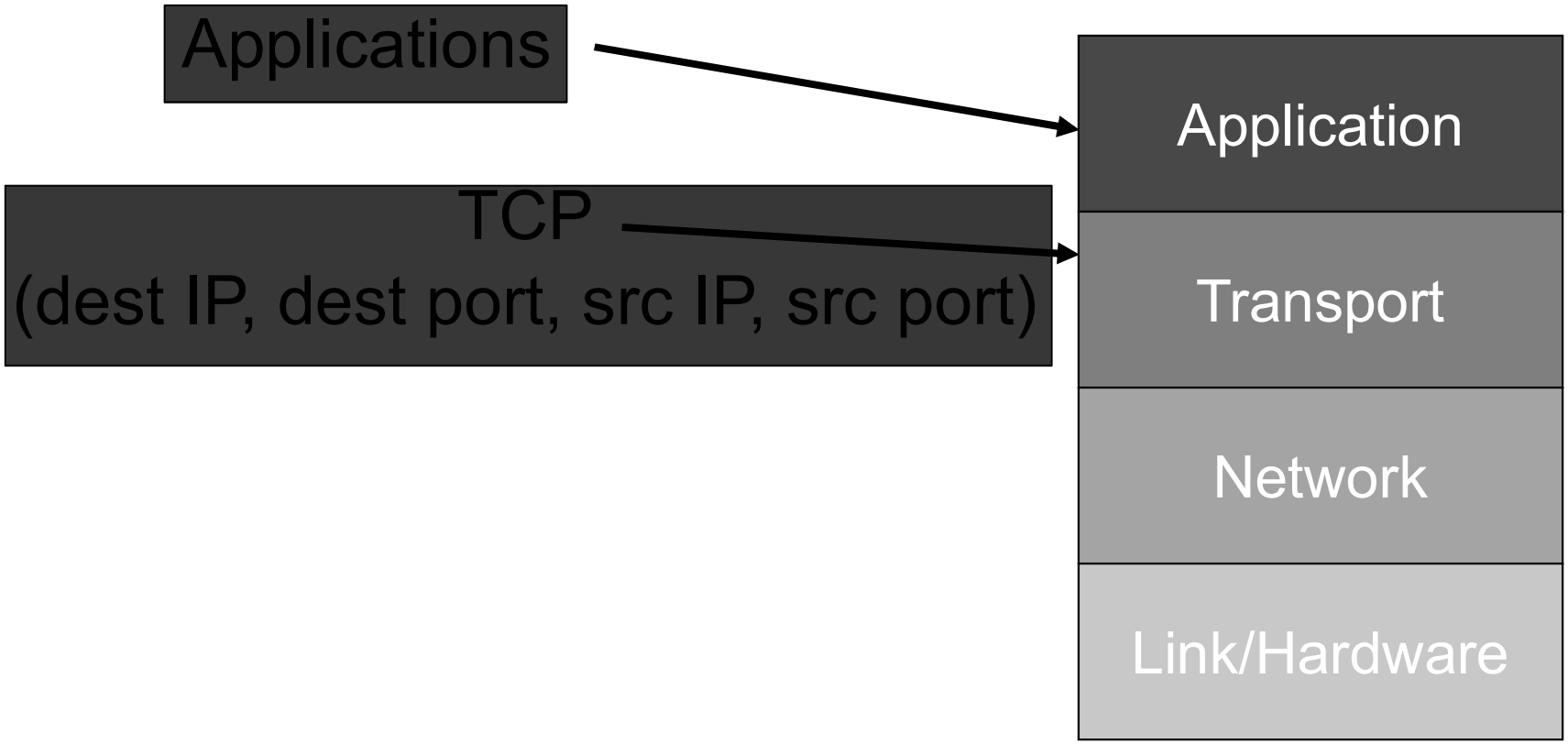

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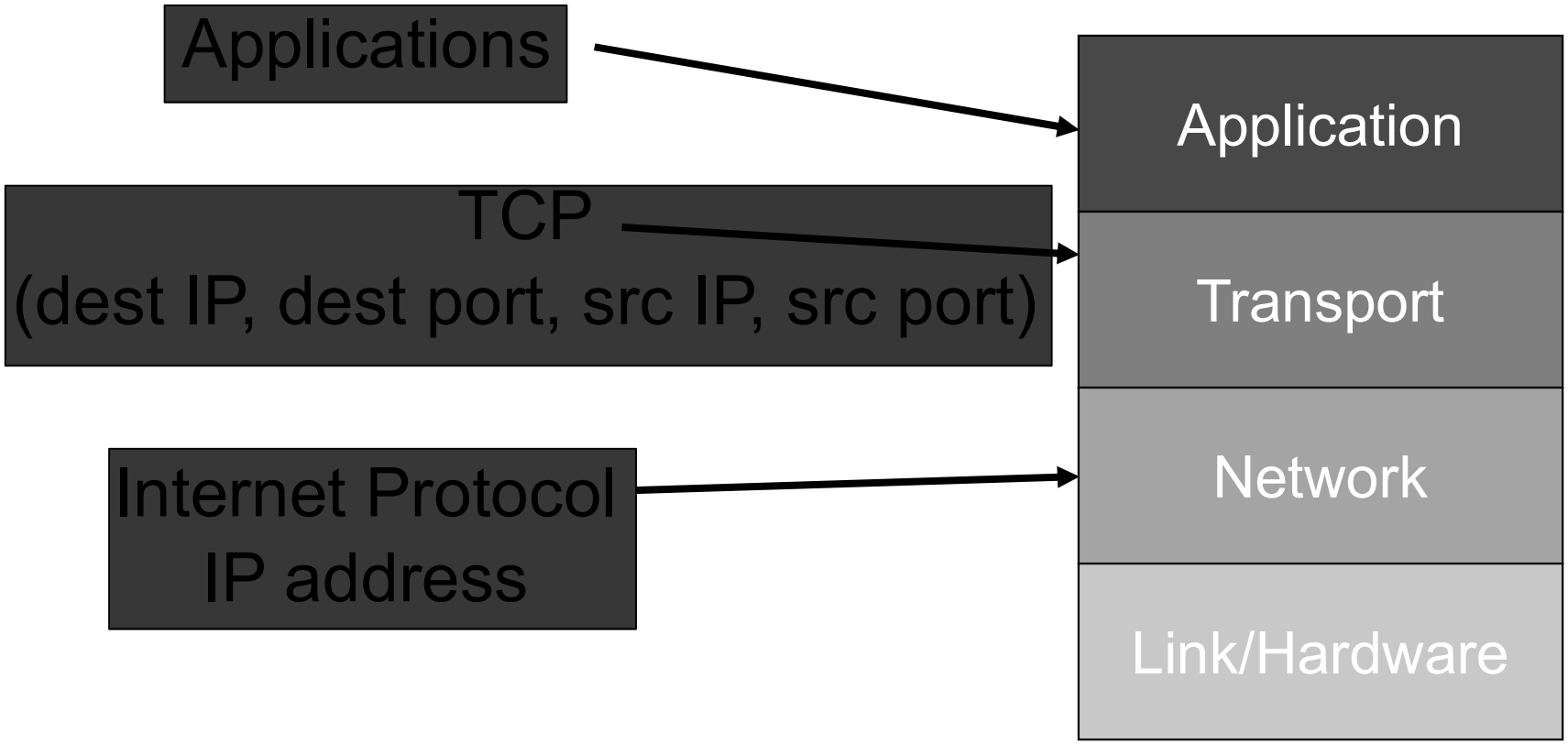

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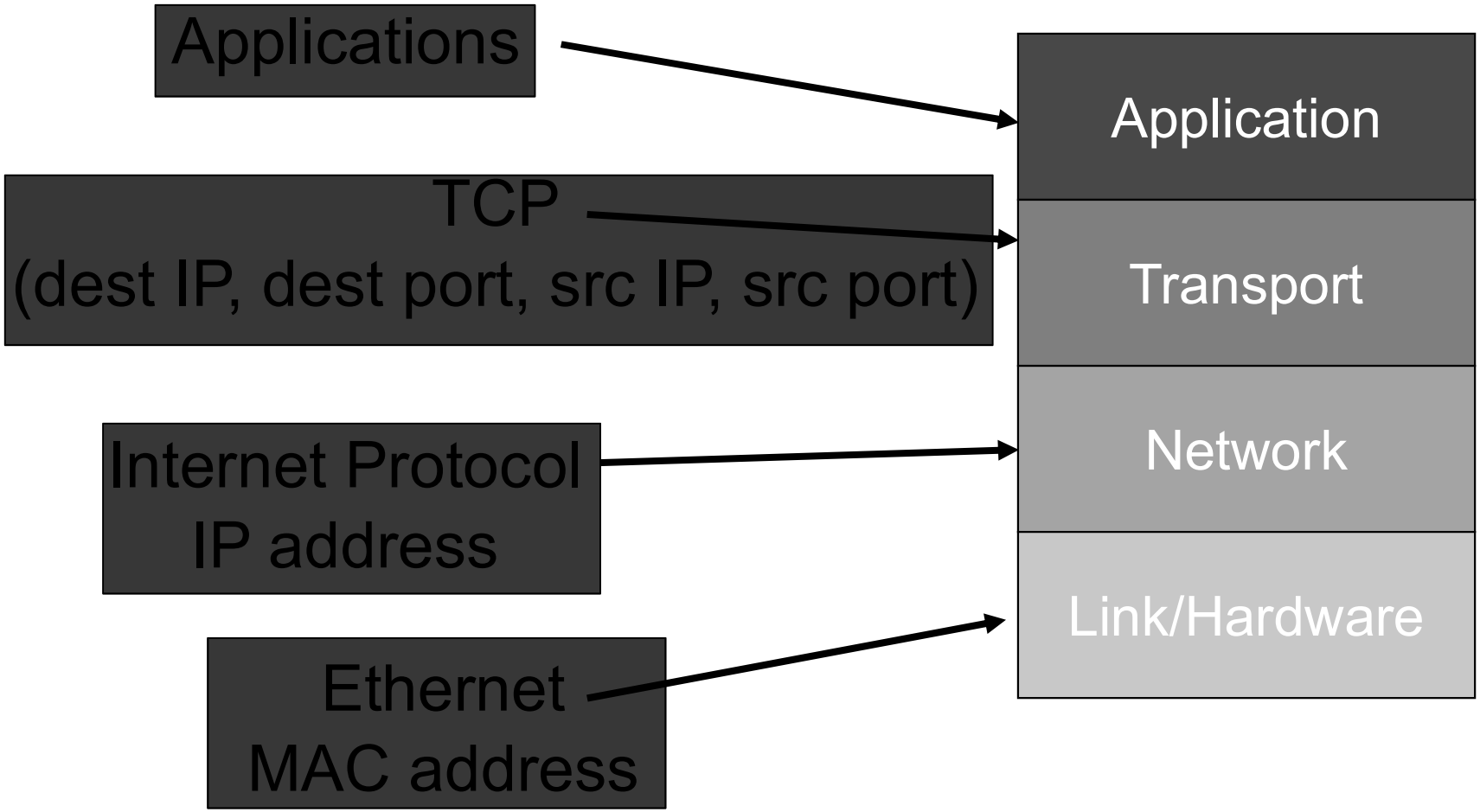


MAC and IP Addresses

- Every machine has a unique MAC address (media access control) e.g. 48:d7:05:d6:7a:51.
- Every computer on the Internet has an IP address, e.g., 147.188.193.15.
- NAT address 10.*.*.* 7 & 192.168.*.* are not unique local addresses.

DHCP & ARP

Dynamic Host Configuration Protocol:

- Assigns an IP address to a new machine (MAC address). Not stored long term.

Address Resolution Protocol (ARP)

- Lets router find out which IP address is being used by which machine.

ARP spoofing lets one machine steal the IP address of another on the same network.

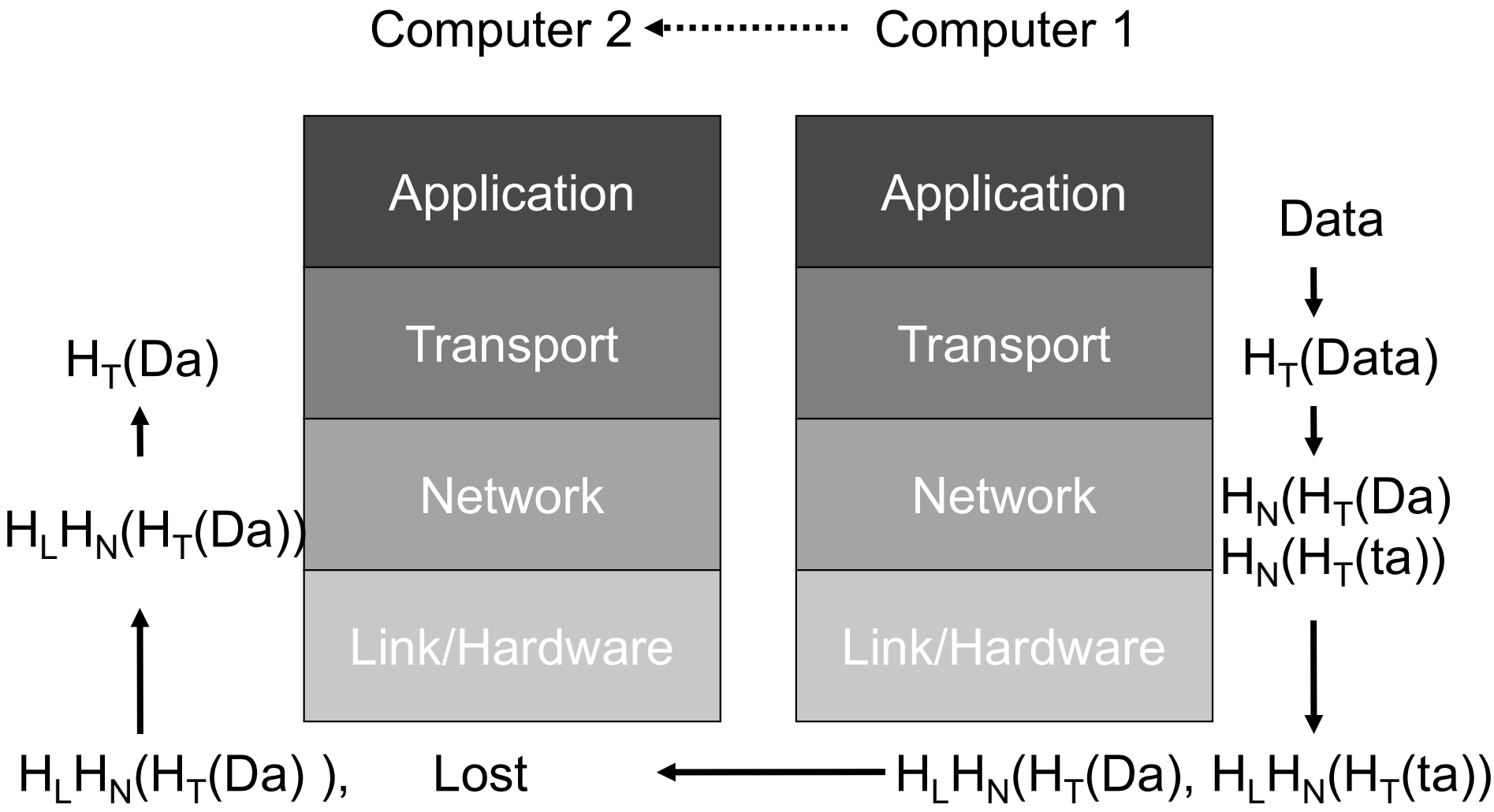
WireShark www.wireshark.org

A network protocol analyzer: It records all Internet traffic, so it can then be viewed and analysed.

Excellent for debugging protocols and network problems

See also tcpdump, which writes packets directly to disk.

Using the Stack to Send Data



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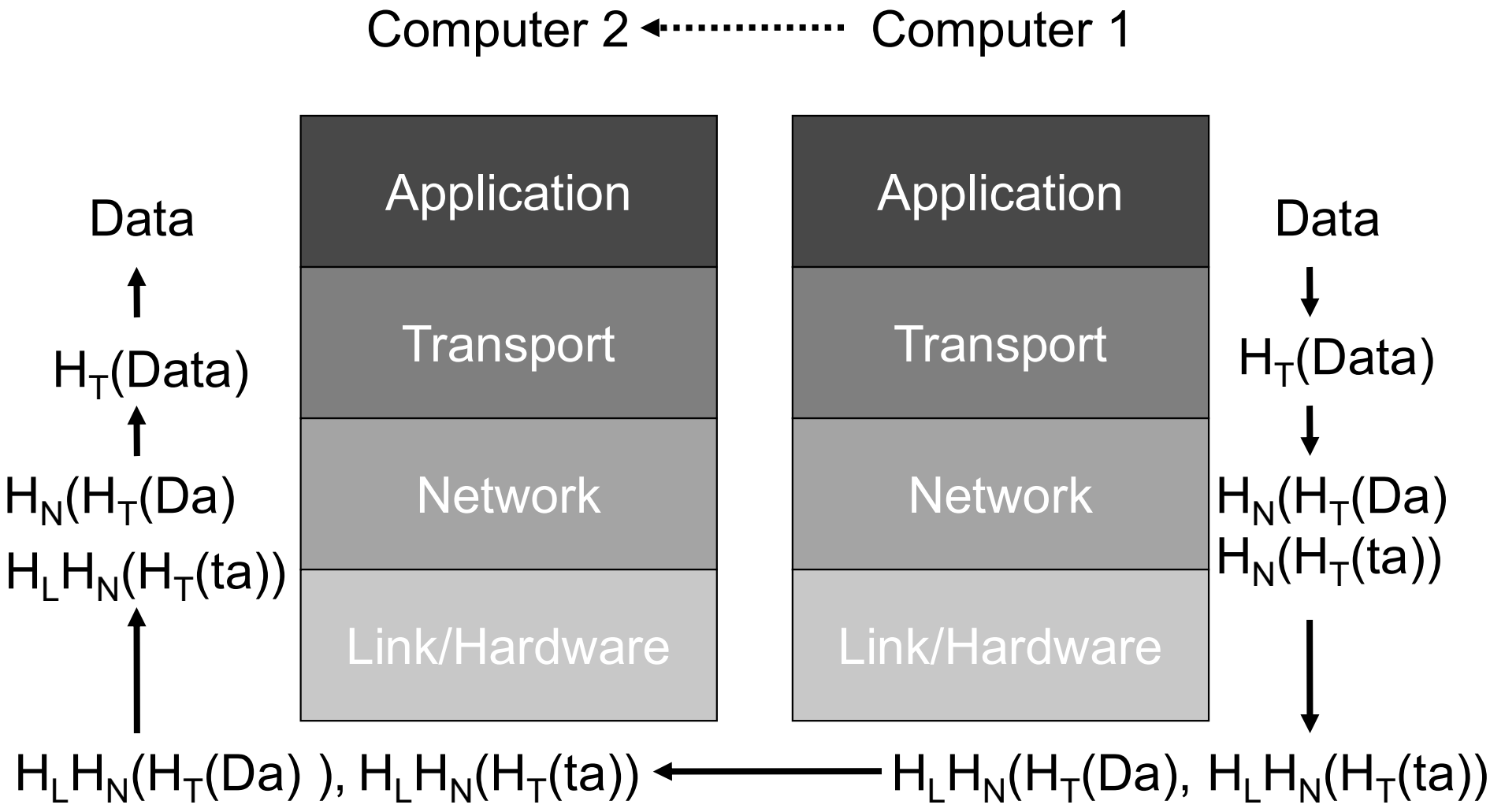
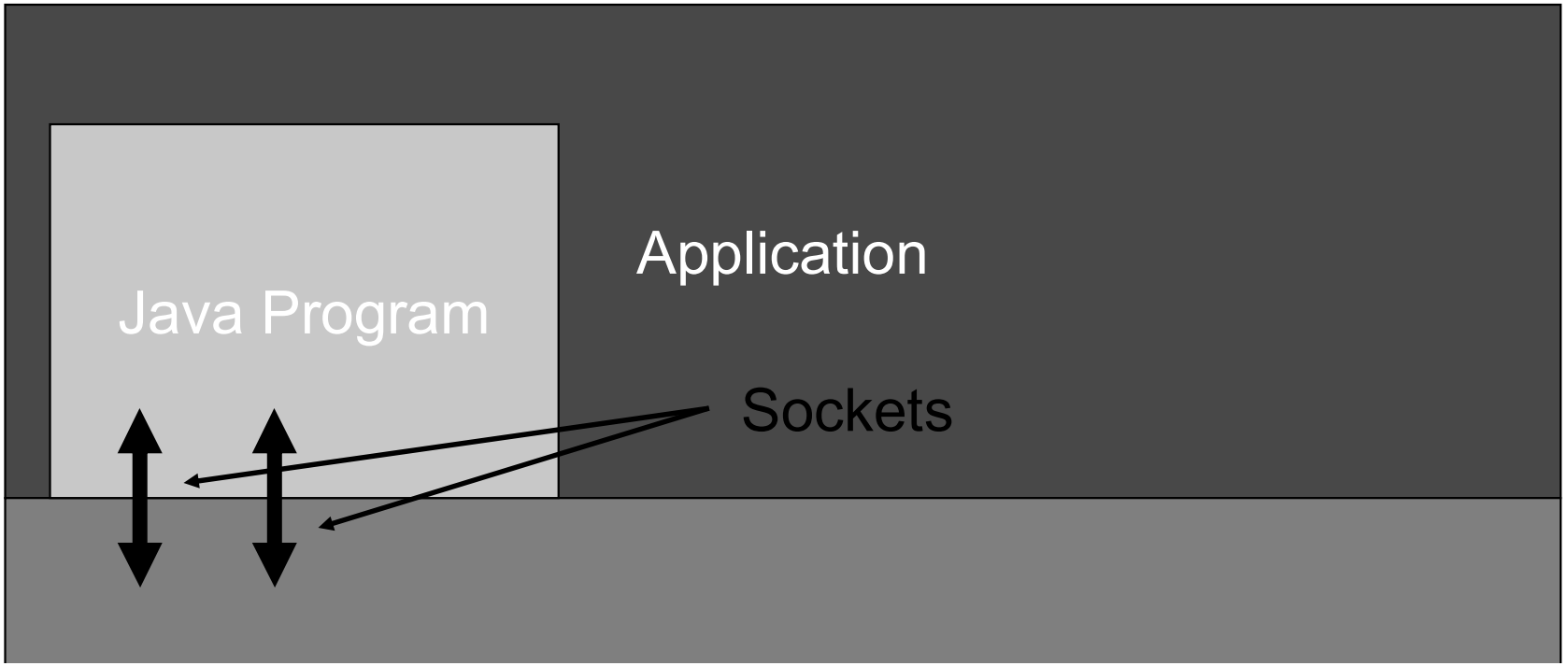


Wireshark demo

nc

Our View of the Stack in Java



Java Sockets demo

“The Attack Owns The Network”

The Internet was not designed with security in mind.

Traffic may be monitored or altered.

All good security products assume that the attacker has complete control over the network (but can’t break encryption)

This Lecture

- How the Internet works.
  - Some History
  - TCP/IP
- Some useful network tools:
  - Nmap, WireShark
- “The attacker controls the network”