

Full Stack Web Development

WS2020 - BSA5 Ausgewählte Kapitel



Alija Sasic, MSc.

sasic@technikum-wien.at

Smart Homes and Assistive Technologies

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Outline

1 TCP/IP

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1 TCP/IP

1.1 History

1.2 Protocol Suite

1.3 Internet Protocol

1.4 Transport Protocol

TCP/IP - History [1]

- 1969: *Advanced Research Projects Agency (ARPA)* funded a research and development project to create an experimental packet-switching network, the [ARPAnet](#).
- 1975: Operational network under the responsibility of *Defense Communications Agency (DCA)*.
- 1983: [TCP/IP](#) protocols become adopted as *Military Standards (MIL STD)* and implemented in [BSD Unix](#). The term Internet appeared as a term for the network consisting of [ARPAnet](#), [MILNET](#) and the unclassified part of the *Defense Data Network (DDN)*.
- 1985: *National Science Foundation (NSF)* creates [NSFNet](#) and connected it to the Internet.



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Internet Working Group

Request For Comments

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TCP/IP - History

- 1987: [NSF](#) creates a new, faster backbone and a three-tiered network topology.
- 1990: [ARPAnet](#) formally passes out of existence.
- 1995: [NSFNet](#) ceases its role as a primary Internet backbone network.
- Today's Internet is built by commercial providers. National network providers, called tier-one providers, and regional network providers create the infrastructure. *Internet Service Providers* ([ISPs](#)) provide local access and user services.



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ARPAnet [2]

- Named after *Advanced Research Projects Agency (ARPA)* of the *U.S. Department of Defense (DoD)*
- Results of the efforts in 1970s to develop a *network architecture* that is
 - open
 - common
 - distributed
 - decentralized
- Avoid problems resulting from typical networks of that time
 - Single point of failure (centralized)
 - Incompatibility (proprietary)



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Single point of failure [2]

Foremost design goal was establishing a *decentralized, distributed network topology*. To achieve this goal, **ARPAnet** employed a *packet-switching* technology, where each “message” is split into packets, each of which might take different routes over the network and still be reassembled and understood by the recipient.

Incompatibility [2]

To promote *interoperability*, the *Internet Working Group (INWG)* was formed to examine the issues associated with connecting heterogeneous networks in an open, uniform manner, providing an open platform for proposing, debating, and approving protocols.



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The Internet Working Group evolved into other bodies, over time [2].

- *Internet Assigned Numbers Authority (IANA)*
- *Internet Engineering Task Force (IETF)*
- *Internet Engineering Steering Group (IESG)*

Proposals for new and updates of existing protocols are provided in the form of *Requests for Comments (RFCs)*.

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Types

- *Standards (STD)*
- *Best Current Practices (BCP)*
- *For Your Information (FYI)*

Standards

- Required
- Recommended
- Elective

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- ARPANET
- Internet Working Group
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TCP/IP - Protocol Suite

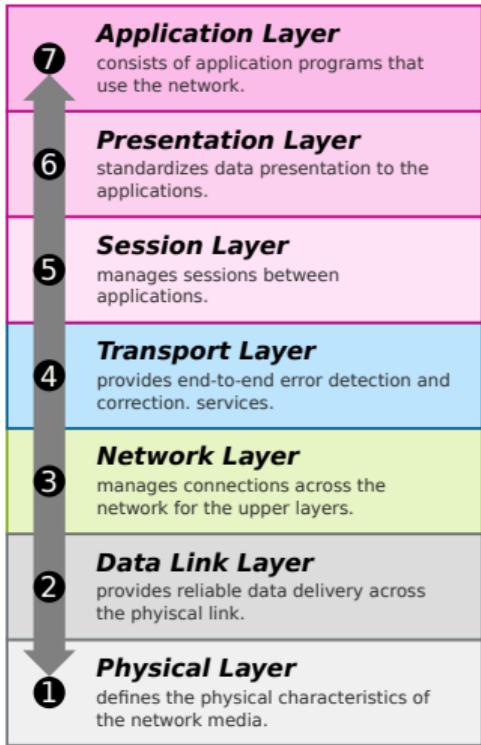


Figure 1: OSI Reference Model [1]

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Communication Model

Data Encapsulation

Data Structures

Internet Protocols

Internet Protocol

Transport Protocol

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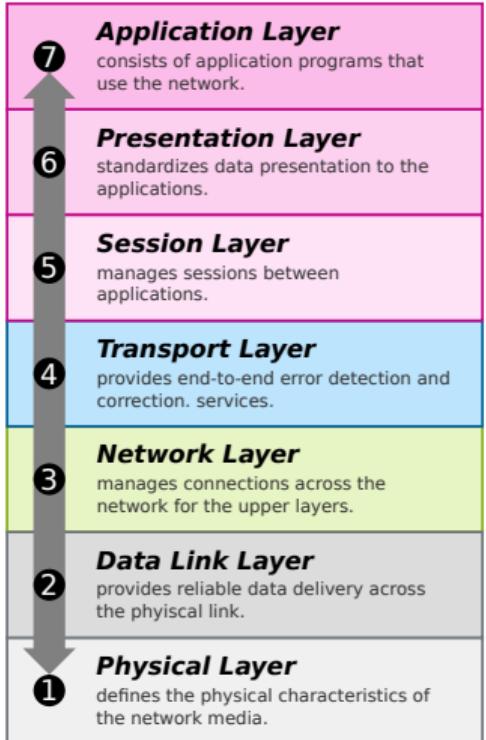


Figure 1: OSI Reference Model [1]

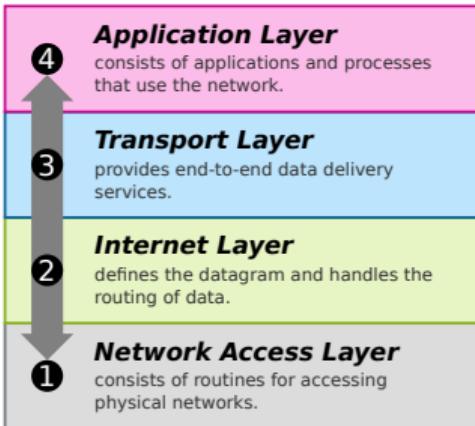


Figure 2: TCP/IP architecture [1]

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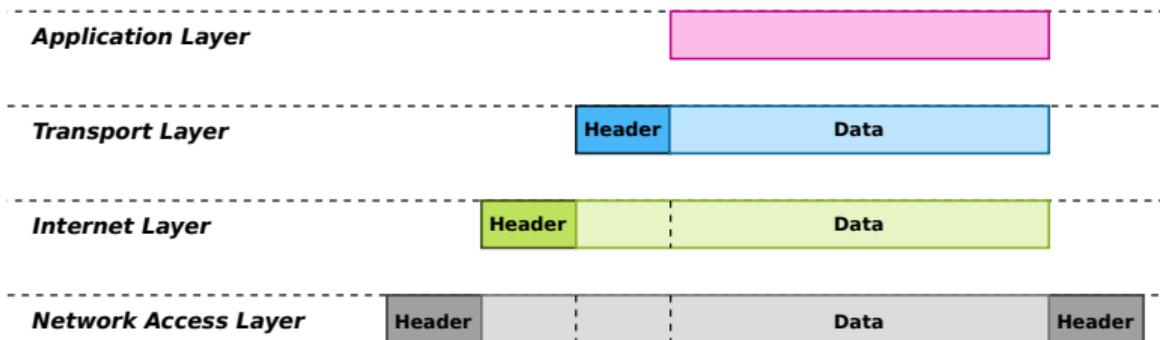


Figure 3: TCP/IP Data Encapsulation [1]



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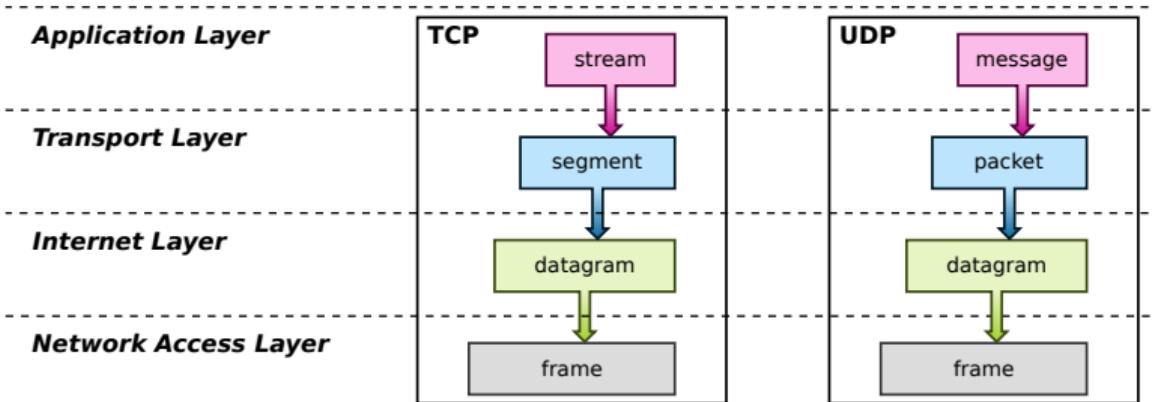


Figure 4: TCP/IP Data Structures [1]

TCP/IP - Protocol Suite



Application Layer Protocols

DHCP, DNS, FTP, NTP, POP, HTTP, RTP, SIP, SMTP, SSH, Telnet, TLS/SSL

Transport Layer Protocols

TCP, UDP, DCCP

Internet Layer Protocols

IP (IPv4, IPv6), ICMP, ICMPv6, IGMP, IPsec

Network Interface Layer Protocols

ARP, NDP, OSPF, PPP, MAC (Ethernet, Wi-Fi, DSL, ISDN, FDDI)

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Internet Protocol (IP)

The current version IPv4 is defined in [RFC 791](#). Characteristics

- Connectionless
- Unreliable
- Media Independent

Functions

- Defining the datagram, the basic unit of transmission in the Internet
- Defining the Internet addressing scheme
- Moving data between the Network Access and the Transport Layer
- Routing datagrams to remote hosts
- Performing fragmentation and re-assembly

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Internet Protocol (IP)

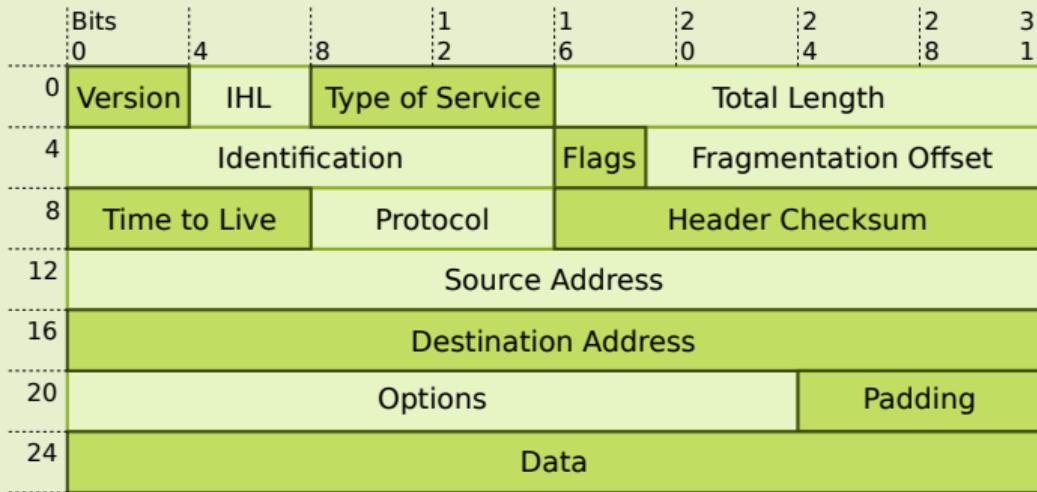


Figure 5: IP [1]

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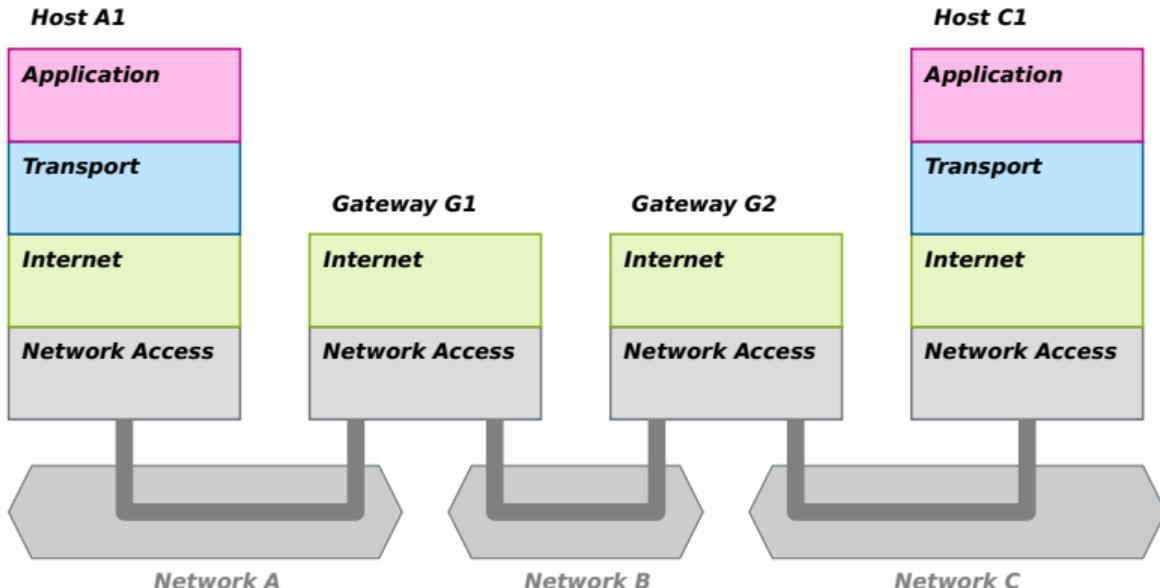


Figure 6: TCP/IP Routing through gateways [1]



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TCP/IP - Transport Protocol

User Datagram Protocol (UDP)

The current version of UDP is defined in [RFC 768](#).

Characteristics

- Connectionless
- Unreliable
- Minimal overhead

Functions

- Delivering data to the correct application process



Figure 7: UDP [1]



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Connection Establishment

TCP/IP - Transport Protocol



Transmission Control Protocol (TCP)

The current version of TCP is defined in [RFC 793](#).

Characteristics

- Connection-oriented
- Reliable
- Byte-stream

Functions

- Delivering data to the correct application process
- Retransmission of lost data
- In-order delivery
- Congestion control and avoidance
- Data integrity

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Transmission Control Protocol (TCP)

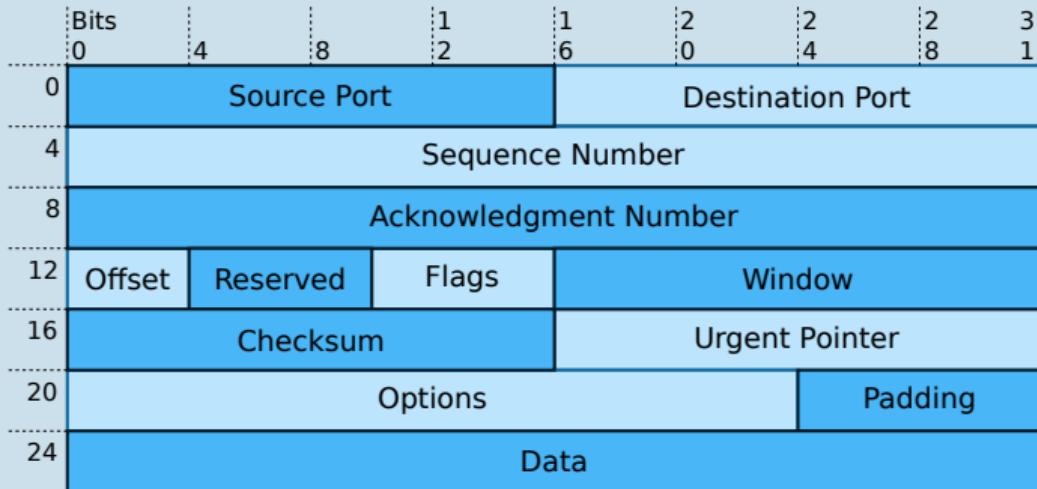


Figure 8: TCP [1]

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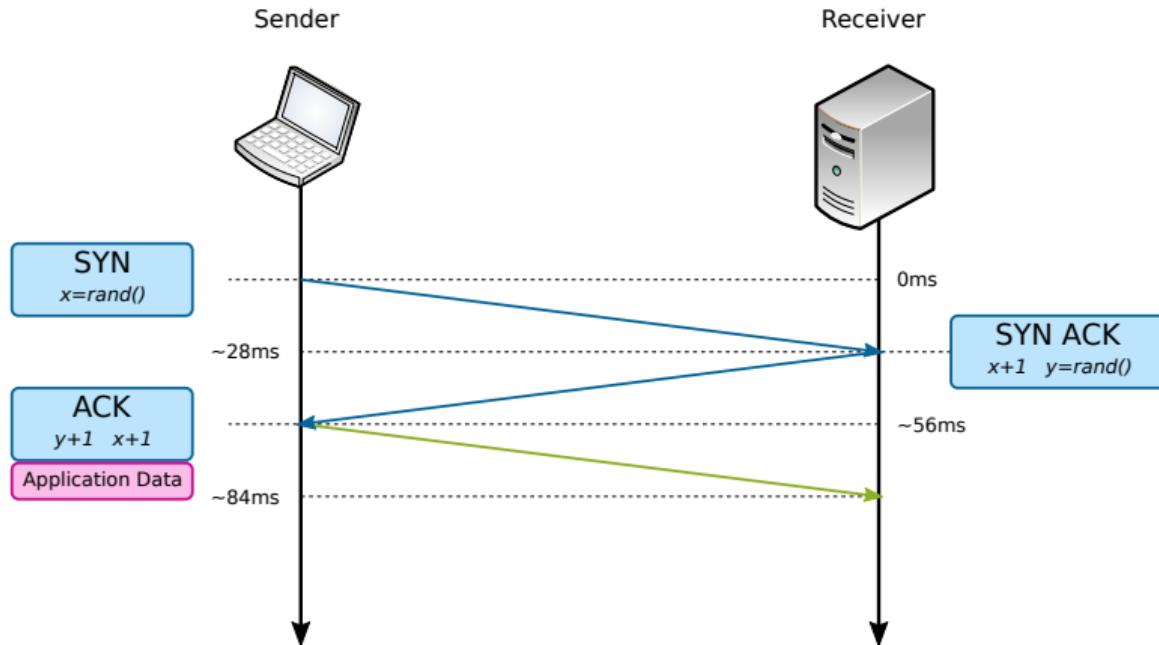


Figure 9: TCP Three-Way Handshake [1]



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Acronyms |

- ARP Address Resolution Protocol
- ARPA Advanced Research Projects Agency
- ARPAnet Advanced Research Projects Agency Network
- BCP Best Current Practices
- BSD Berkley Software Distribution
- DCA Defense Communications Agency
- DCCP Datagram Congestion Control Protocol
- DDN Defense Data Network
- DHCP Dynamic Host Configuration Protocol



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Acronyms

References

Acronyms II

DNS Domain Name System

DoD Department of Defense

DSL Digital Subscriber Line

FDDI Fiber Distributed Data Interface

FTP File Transfer Protocol

FYI For Your Information

HTTP Hypertext Transfer Protocol

IANA Internet Assigned Numbers Authority

ICMP Internet Control Message Protocol

Acronyms III

IESG Internet Engineering Steering Group

IETF Internet Engineering Task Force

IGMP Internet Group Management Protocol

INWG Internet Working Group

IP Internet Protocol

IPsec Internet Protocol Security

ISDN Integrated Services Digital Network

ISP Internet Service Provider

MAC Media Access Control

Acronyms IV

MILNET Military Network

MIL STD Military Standards

NDP Neighbor Discovery Protocol

NSF National Science Foundation

NSFNet National Science Foundation Network

NTP Network Time Protocol

OSPF Open Shortest Path First

POP Post Office Protocol

PPP Point-to-Point Protocol



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Acronyms

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Acronyms V

RFC Request for Comments

RTP Real-Time Transport Protocol

SIP Session Initiation Protocol

SMTP Simple Mail Transfer Protocol

SSH Secure Shell

SSL Secure Socket Layer

STD Standards

TCP Transmission Control Protocol



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Acronyms

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Acronyms VI

TCP/IP Transmission Control Protocol/Internet Protocol, Internet protocol suite

TLS Transport Layer Security

UDP User Datagram Protocol

U.S. United States

Wi-Fi Wireless Fidelity



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Acronyms

References

References I

- [1] C. Hunt, *TCP/IP Network Administration*, 3rd ed. Sebastopol, CA: O'Reilly Media, Inc., 4 2002. [Online]. Available:
<http://shop.oreilly.com/product/9780596002978.do>
- [2] L. Shklar and R. Rosen, *Web Application Architecture*, 2nd ed. West Sussex, England: John Wiley & Sons Ltd., 4 2009. [Online]. Available:
<https://www.wiley.com/en-us/Web+Application+Architecture%3A+Principles%2C+Protocols+and+Practices%2C+2nd+Edition-p-9780470518601>



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References