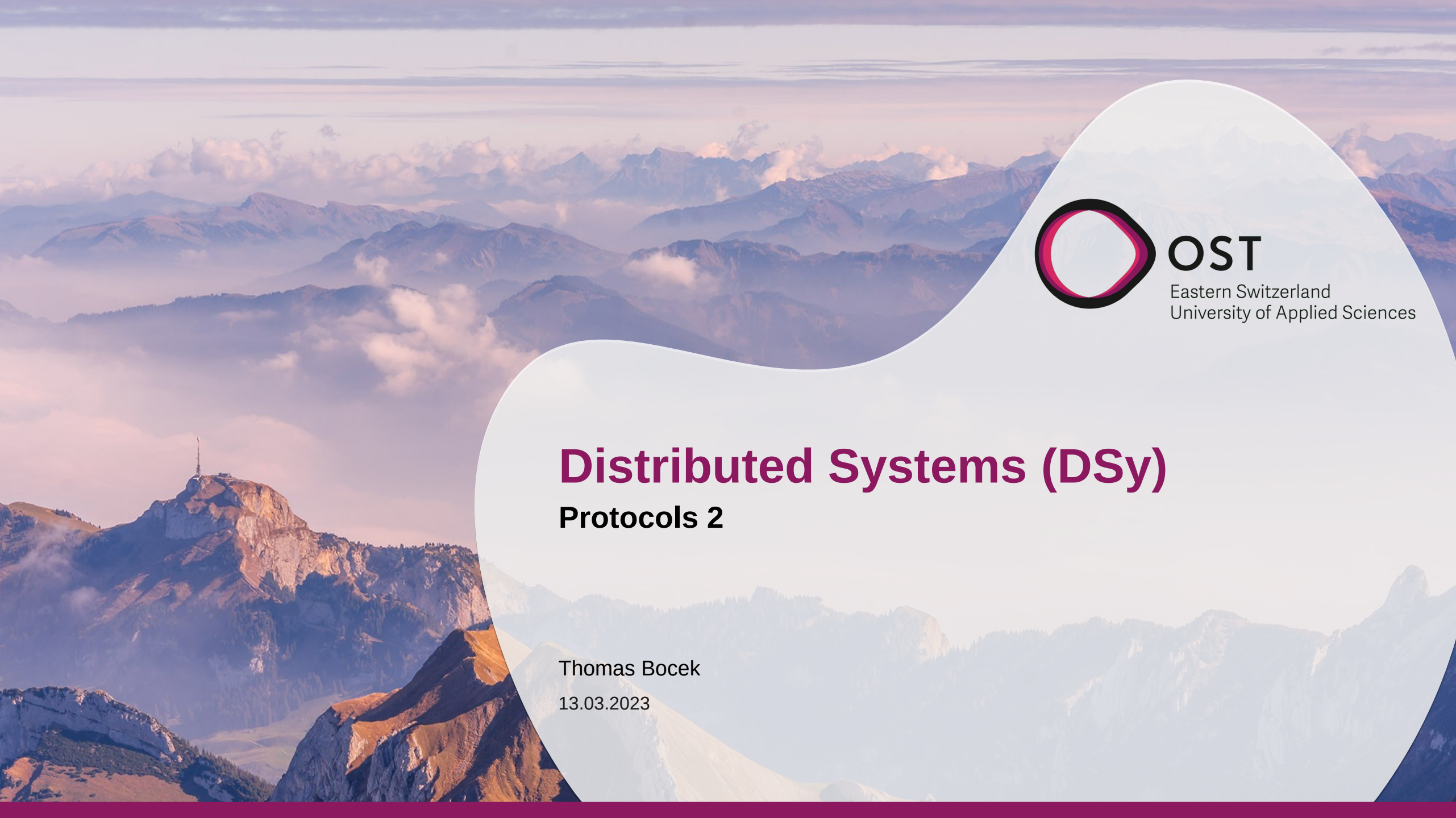

OST
Eastern Switzerland
University of Applied Sciences

Distributed Systems (DSy)

Protocols 2

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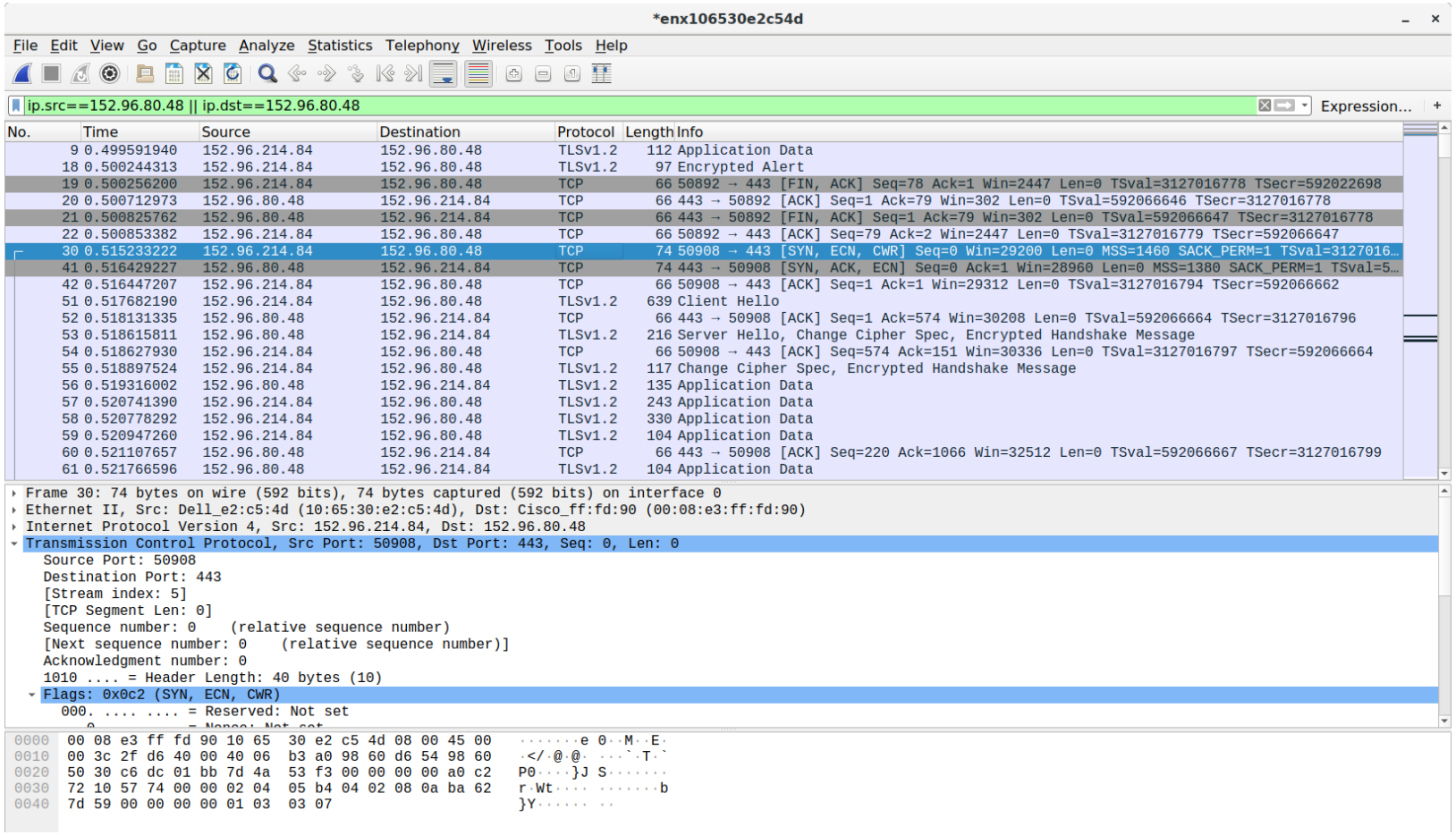
13.03.2023

Learning Goals

- Lecture 4 (Protocols, part 2)
  - How can new protocols improve latency?
  - What is an amplification attack?

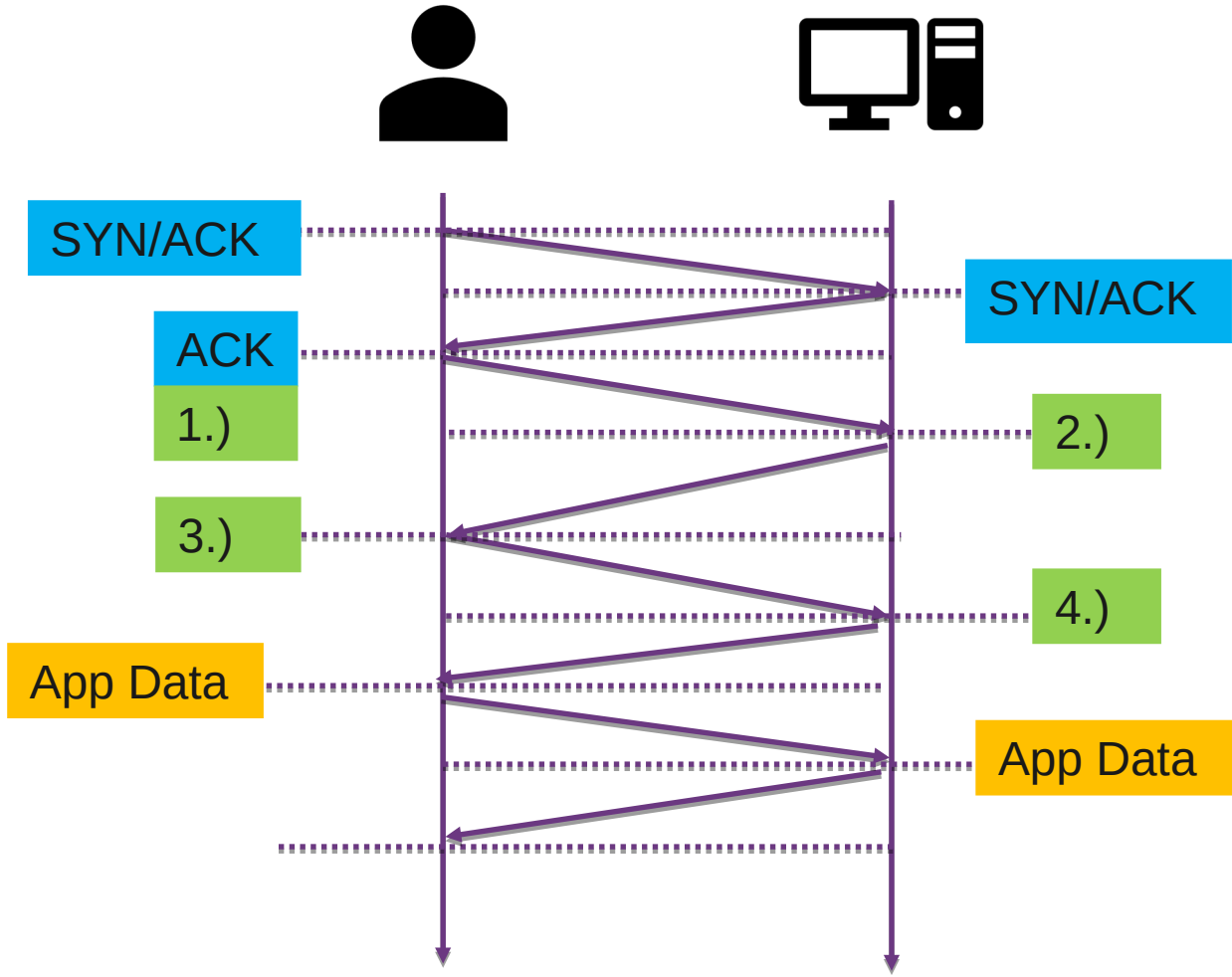
Wireshark – sometimes needed when designing protocols

- Decrypt TLS
  - `export SSLKEYLOGFILE=/tmp/keylogfile.txt`



Layer 4 – TCP + TLS

- Security: Transport Layer Security (TLS)
  1. "client hello" lists cryptographic information, TLS version, ciphers/keys
  2. "server hello" chosen cipher, the session ID, random bytes, digital certificate (checked by client), optional: "client certificate request"
  3. Key exchange using random bytes, now server and client can calc secret key
  4. "finished" message, encrypted with the secret key
  - 3 RTT to send first byte, 4RTT to receive first byte

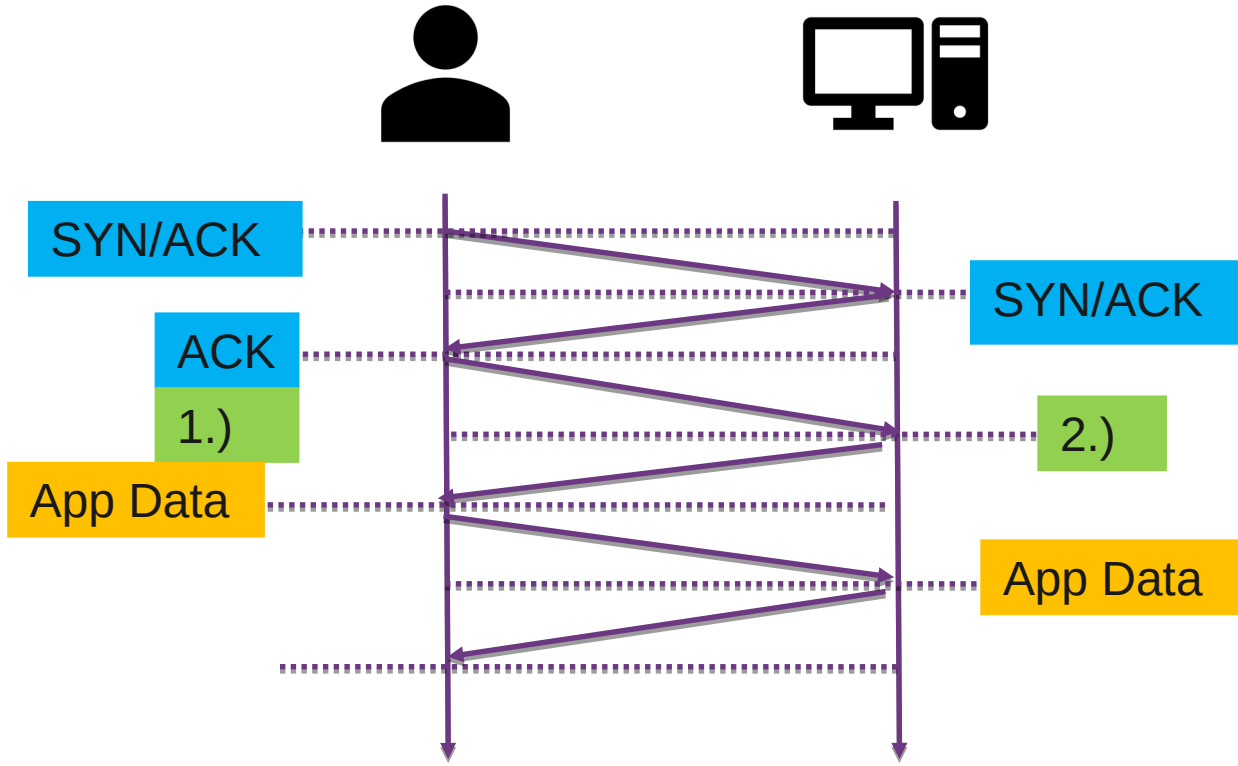


https://www.ibm.com/support/knowledgecenter/en/SSFKSJ_8.0.0/com.ibm.mq.sec.doc/q009930_.htm

```
PING sydney.edu.au (129.78.5.8) 56(84) bytes of data.
64 bytes from scilearn.sydney.edu.au (129.78.5.8): icmp_seq=1 ttl=233 time=307 ms
64 bytes from scilearn.sydney.edu.au (129.78.5.8): icmp_seq=2 ttl=233 time=305 ms
64 bytes from scilearn.sydney.edu.au (129.78.5.8): icmp_seq=3 ttl=233 time=305 ms
```

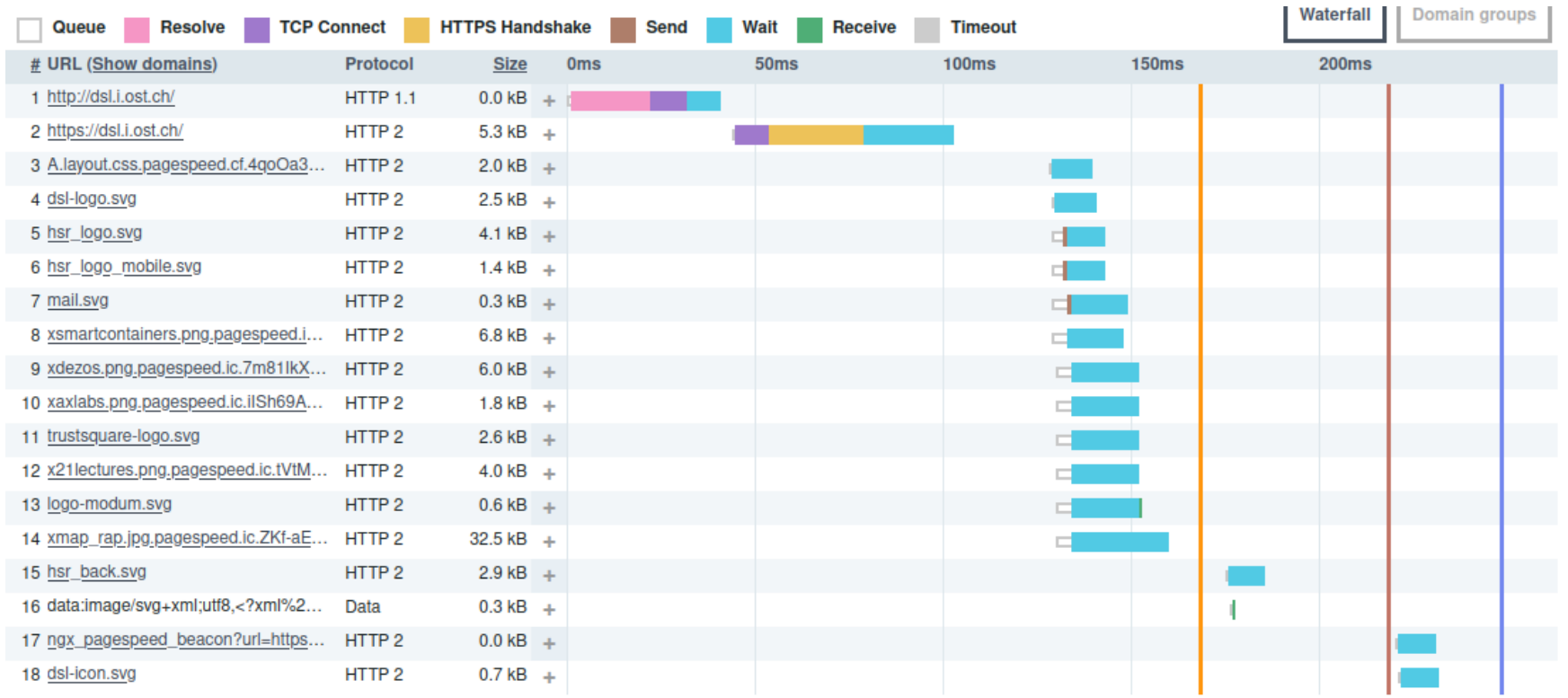
Layer 4 – TCP + TLS

- TCP + TLS handshake:
  - 1RTT - Ping to Australia: 329ms
  - 3RTT = 987ms! No data sent yet
- TLS 1.3, finished Aug 2018
  - 1 RTT instead of 2
    - 1.) Client Hello, Key Share
    - 2.) Server Hello, key Share, Verify Certificate, Finished
  - 0 RTT possible, for previous connections, loosing perfect forward secrecy
  - 95% of browsers used already support it



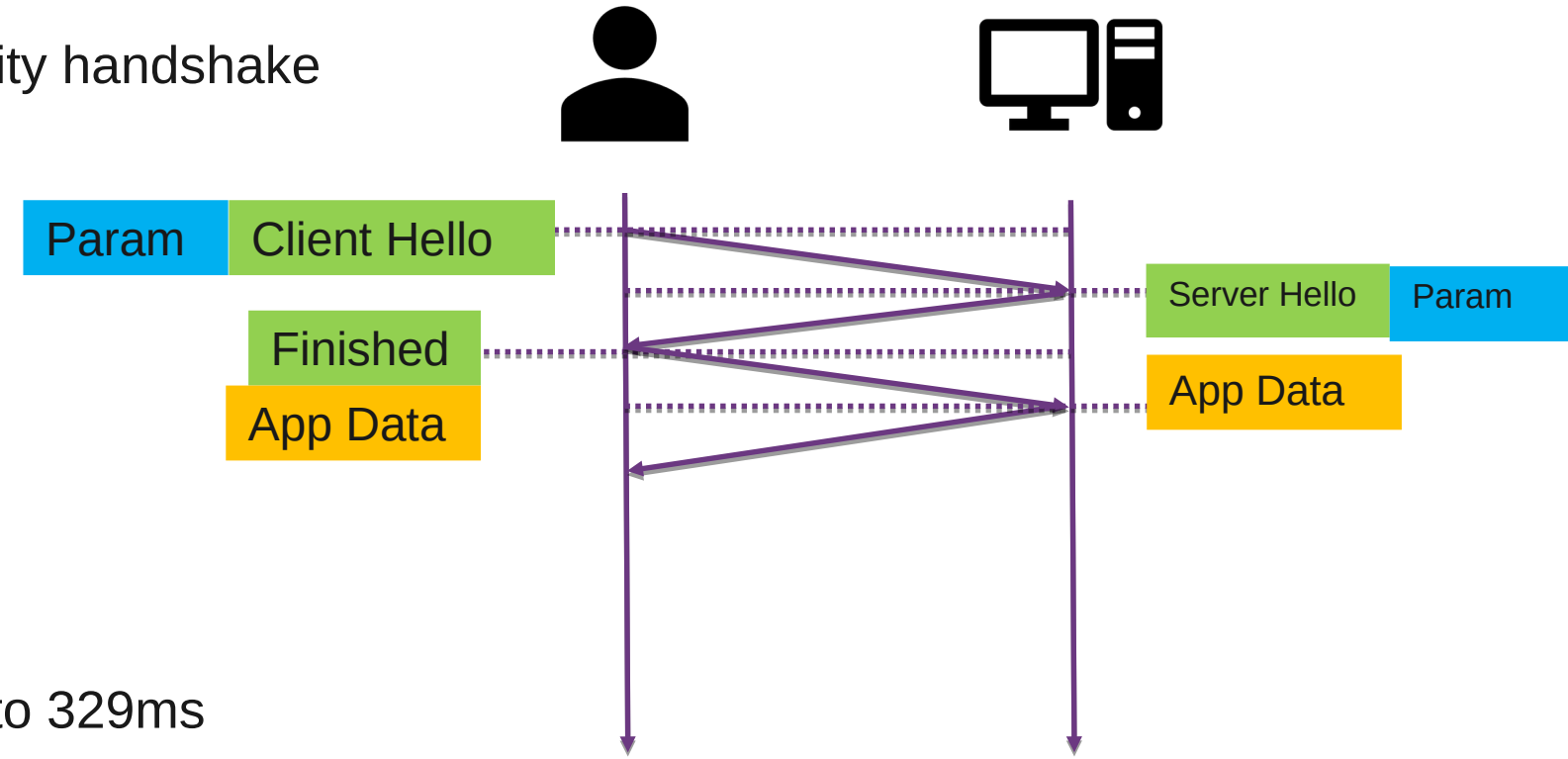
Layer 4 – TCP + TLS

- Website Speed Test [link]
  - Resolve → DNS, TCP Connect → TCP Handshake, HTTPS Handshake → TLS/SSL



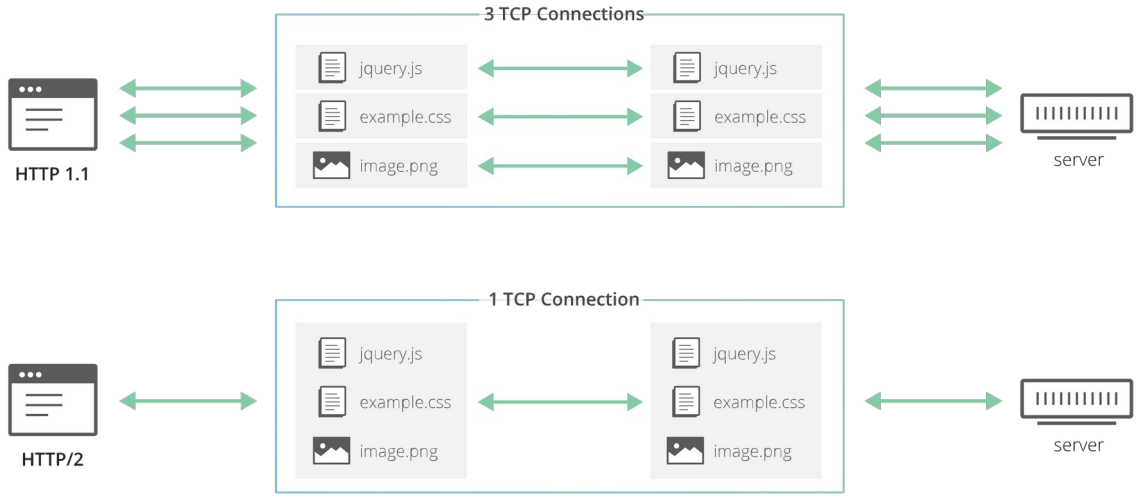
QUIC / HTTP3

- QUIC: 1RTT connection + security handshake
  - For known connections: 0RTT
  - Built in security
  - “Google's 'QUIC' TCP alternative slow to excite anyone outside Google” [link] (9%, 25%, 75%)
    - Facebook
    - Cloudflare, state of HTTP
- Example Australia: from 987ms to 329ms

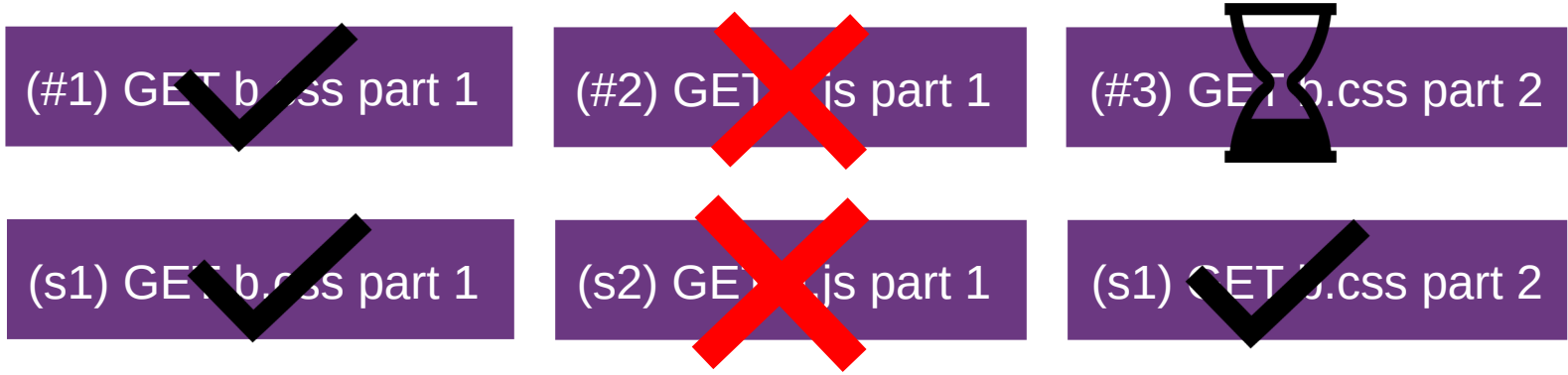


QUIC / HTTP3

- Multiplexing in HTTP/2
  - HTTP/1 → HTTP/2
- HTTP/2: Head-of-line blocking
  - One packet loss, TCP needs to be ordered
  - QUIC can multiplex requests: one stream does not affect others
- HTTP/3 is great, but…
  - NAT → SYN, ACK, FIN, conntrack knows when connection ends, not with QUIC, timeouts, new entries, many entries
  - HTTP header compression, referencing previous headers
  - Many TCP optimizations

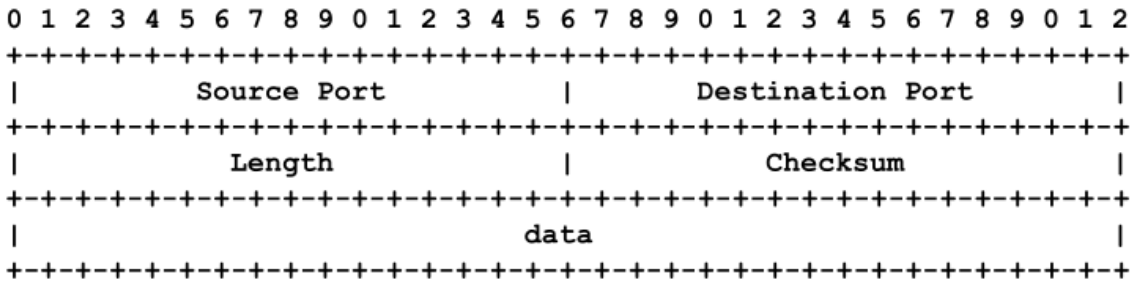


source: https://blog.cloudflare.com/the-road-to-quic/



Layer 4 - Transport

- User Datagram Protocol (UDP)
  - UDP is used for DNS, streaming audio and video
  - Simple connectionless communication model
  - No guarantee
    - Delivery
    - Ordering
    - Duplicate protection



- SCTP (Stream Control Transmission Protocol)
  - Message-based
  - Allows data to be divided into multiple streams
  - Syn cookies - SCTP uses a four-way handshake with a signed cookie.
  - Multi-homing multiple IP addresses of endpoints
  - Not widely used: “ We have been deploying SCTP in several applications now, and encountered significant problem with SCTP support in various home routers. ”
    - E.g., OpenWRT – not enabled by default
    - E.g., UFW - Uncomplicated Firewall – not supported
  - SCTP used by WebRTC, but tunneled over UDP

UDP example

- UDP Server (Java)

```
import java.net.*;

class Server
{
    public static void main(String args[]) throws
Exception
    {
        DatagramSocket serverSocket = new
DatagramSocket(8081);
        byte[] receiveData = new byte[1024];
        while(true)
        {
            DatagramPacket receivePacket = new
DatagramPacket(receiveData, receiveData.length);
            serverSocket.receive(receivePacket);
            String s = new
String( receivePacket.getData());
            System.out.println("Message Received: " +
s);
        }
    }
}
```

- UDP Client (golang)

```
package main

import (
     "net"
)

func main() {
     srv, _ :=
net.ResolveUDPAddr("udp","127.0.0.1:8081")
     local, _ := net.ResolveUDPAddr("udp",
"127.0.0.1:0")
     conn, _ := net.DialUDP("udp", local, srv)
     defer conn.Close()
     conn.Write([]byte("5Anybody there?"))
}
```

- nc –u localhost 8081

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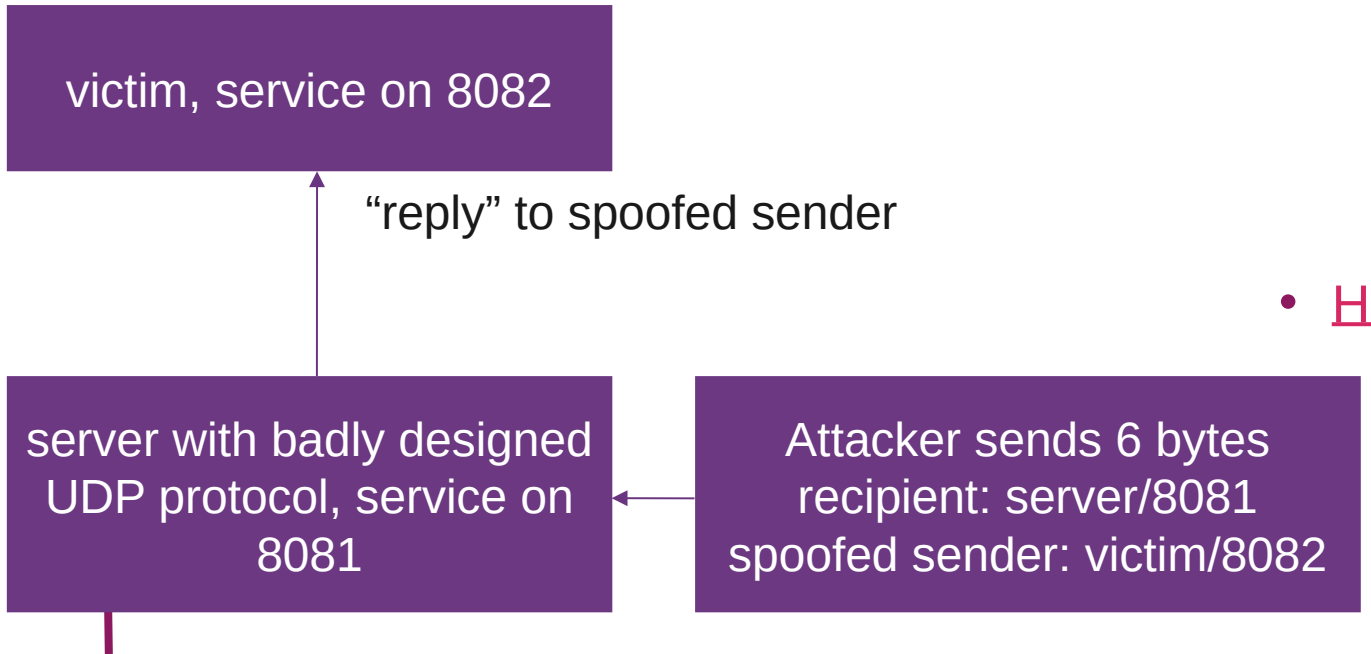
Layer 4 - Transport

- DDoS Amplification Attacks
  - Request 10 bytes, reply 100 bytes → factor 10
- Local demo with server-ra/victim, and hping3
  - hping3 --udp IP -p 8081 -E test.tmp -d 6 -s 8082 -c 1



- Attacker in go/Java/node/c#
  - You need to spoof UDP packets, typically not supported in those languages
  - Go: `func DialUDP(network string, laddr, raddr *UDPAddr) (*UDPConn, error)`
    - laddr: we need to set here the victims IP/port
    - But go tries to bind to that
    - Not yours: “bind: cannot assign requested address”
- Hping3: Pen test tool

hping3 is a command-line oriented IP, TCP, UDP, ICMP and RAW-IP packet assembler

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Comparison – Transport Layer

TCP *

- Transport layer
- Connection oriented
- Reliable transfer
- Streams
- Guaranteed order
- Widely used – HTTP/1, HTTP/2
- Flow and congestion control
- Heavyweight
- Header size is 20 bytes
- Error checking and recovery

UDP *

- Transport layer
- Connection less
- Unreliable transfer
- Messages
- Unordered
- Widely used – DNS, HTTP/3
- No flow, congestion
- Lightweight
- Header size is 8 bytes
- Error checking, no recovery

SCTP *

- Transport layer
- Connection oriented
- Reliable transfer
- Messages
- User can choose
- WebRTC
- Flow and congestion control
- Heavyweight
- Common header is 12 bytes
- Error checking and recovery

(QUIC) *

- Transport layer*
- Connection oriented
- Reliable transfer
- Multistream
- Guaranteed order
- HTTP/3
- Flow and congestion
- Heavyweight*
- Long: 17, short: 13* (no sec) - 1200
- Integrity check