



MONASH
University

程序代写代做 CS编程辅导

FIT1050 Web Fundamentals



Communication and Connectivity

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Week 2

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Learning objectives

Communication Protocols

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- Understand the concept of protocols in computing
- Differentiate between different types of protocols for Internet communication
- Understand what the purpose of the web's main protocols

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Internet Connections

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- Understand the variety of connections
- Explore different issues that affect the usability of an Internet connection
- Consider how mobile connectivity affects web communication

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World Wide Web Communication Protocols

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The communication problem

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Every information-based system has an information transfer issue:



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- What medium (or media) exists between the sender and receiver?
- What transmission methods are supported by both parties?
- Are different methods required at different stages of the transmission?
- How strict should the rules be to avoid miscommunication?

Communication isn't just a computing issue

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What is a strength or weakness of these communication methods?



- **Person-to-person networks**

- Face-to-face conversation
- Phone call / postal service

- **Printed media networks**

- Newspapers / magazines / catalogues

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- **Mass broadcast electronic media**

- TV / radio

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Specific features of each method affect what can be communicated, as well as the efficiency and quality of how information is sent/received.

Communication requires standards

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- The problem of communication between separate computer networks

- Compatibility of communication hardware and software
- Compatibility of communication methods



- To operate many different services seamlessly...

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- Rules to control how communication takes place
- Clear documentation of rules
- **Solution: Standards and protocols!**

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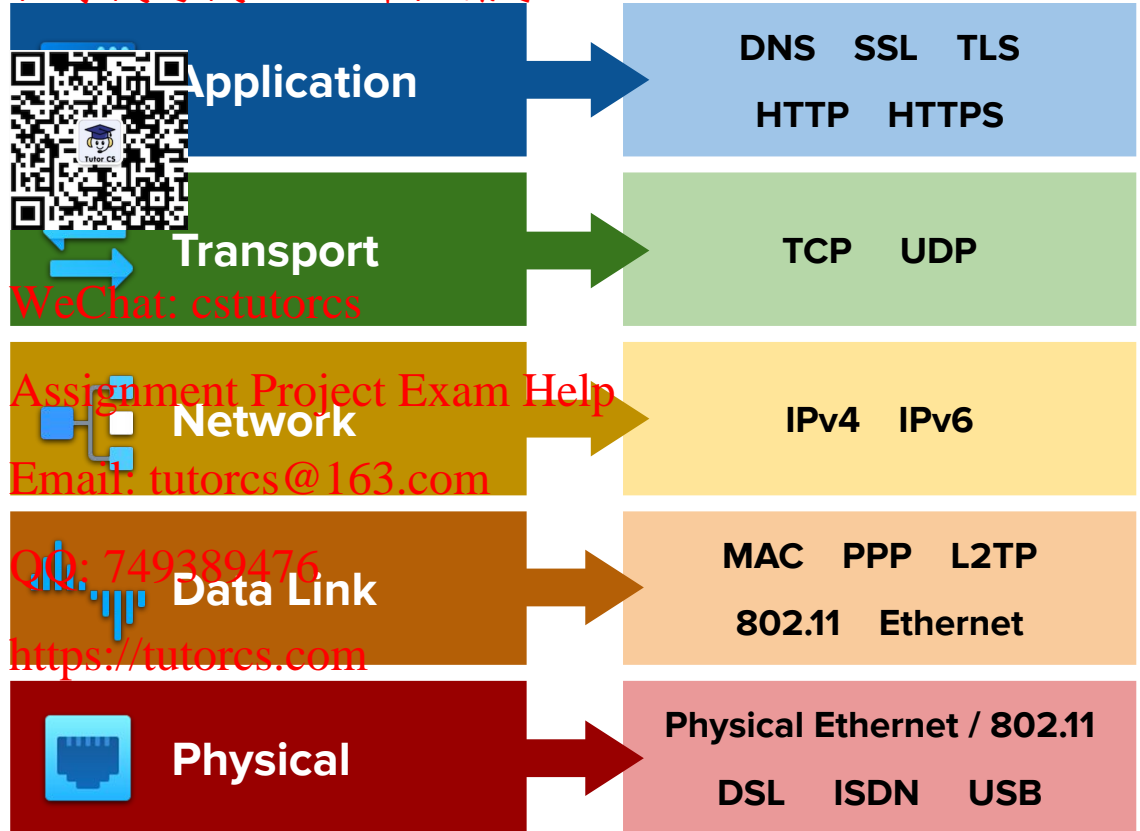
Protocols are strict, task-specific, rules. They are designed to efficiently handle a single aspect of a communication process.

Protocol layers

Instead of one complex set of rules to cover all stages of the process, we can break down the communication process into layers.

Various technology standards within each layer interoperate to provide solutions at each layer.

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Some historical developments

Packet-switching (1961)

Transmitting data in small blocks (packets)
developed for military use to increase
network robustness



ARPANET (1969)

An early packet-switched network, and the
first to implement TCP/IP. Funded by the US
Department of Defence

Gopher (1991, example on right)

A protocol presented as an alternative to the
World Wide Web. Still operational, largely
unchanged.

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Internet Underground

This gopher space is dedicated to forgotten non-commercial Internet services, such as Gopher, Archie, WAIS, services accessed via telnet etc., along some underground activities.

Here is some information about Gopher

 [What is Gopher \(from the Floodgap.com site\)](#)

 [Updated Gopher FAQ \(from viste-family.net site\)](#)

 [About this gopher](#)

 [Secret the gopherspace](#)

 [NEW!!! Gopher Guestbook \(WARNING: port 27070\)](#)


DIY sound and text

 [Stauropygial Records \(DIY record label\)](#)

 [Evil Pop / Zloj Pop \(experimental band\)](#)

 [Ankylm \(heavy metal/alko folk band\)](#)

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Network layer: Internet Protocol (IP)

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This protocol serves 3 main functions:



1. Addressing host interfaces

- Define a standard addressing system.
- Ensuring network hardware is uniquely addressable.

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2. Fragmenting data into packets and reassembling it later

- The client and server negotiate a compatible packet size.

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3. Routing data from source to destination

- Connections are rarely direct - a route "hops" between different devices.

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Transport layer: Transmission Control Protocol (TCP)

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TCP manages data flow between at sender and receiver ends of a route while ensuring integrity for data before passing it to specific applications.



1. Negotiate and establish a working connection

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- Communicates transmission requirements between hosts.

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2. Checks for corrupt, missing or duplicate packets

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- Re-request corrupt/missing packets, discard duplicates.

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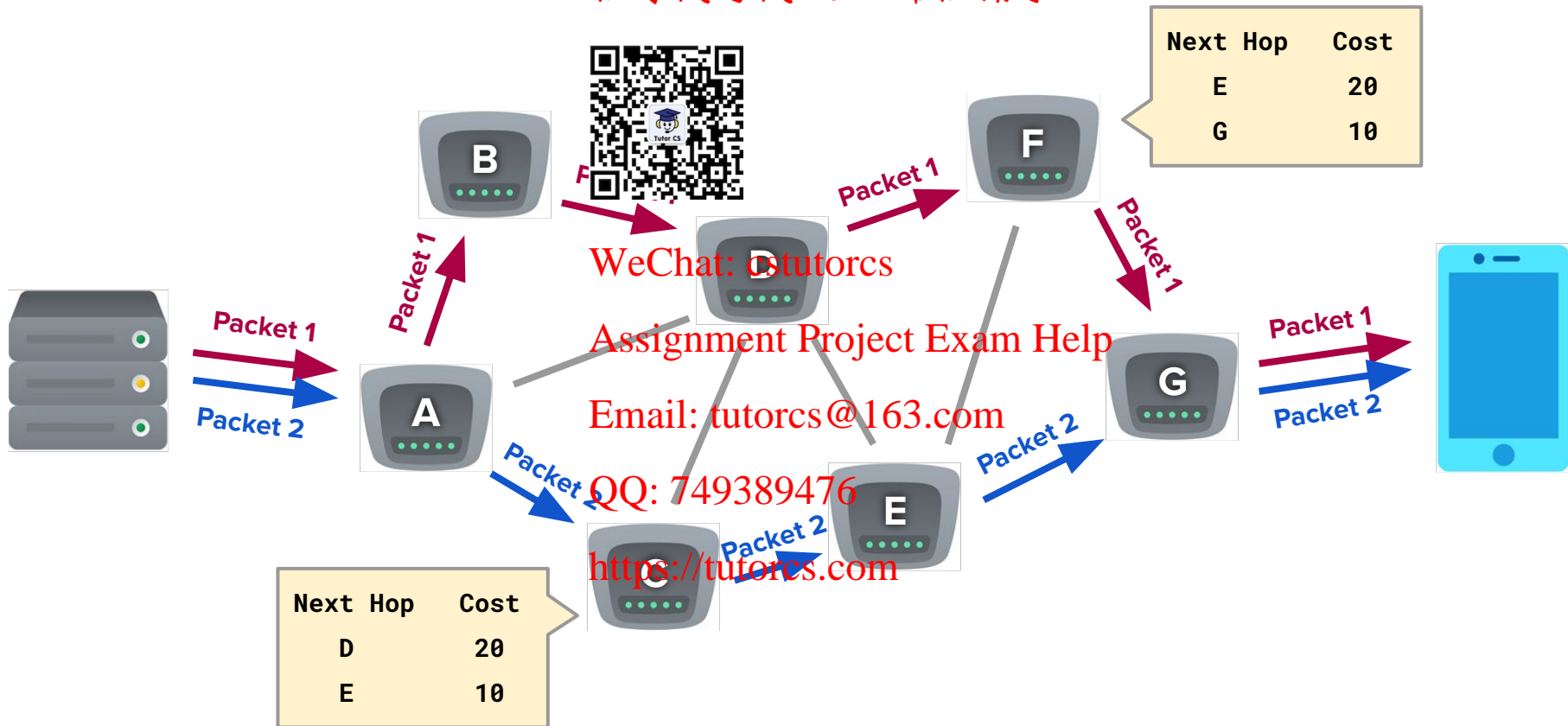
3. Detects out-of-order packets

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- Re-sequences data packets before passing to an application.

TCP/IP packet switching with routing tables

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TCP vs UDP (User Datagram Protocol)

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Transport Control Protocol

Detects and re-requests lost packets.

Assigns packet sequence and corrects order.

Data errors handled during communication.

Requires resources to manage data transport.

Used where data integrity is critical.



User Datagram Protocol

Does not validate successful packet arrival.

Sends packets as a continuous stream.

Data errors are handled by the application.

Minimal resources use for data transport.

Used where data is needed in quickly.

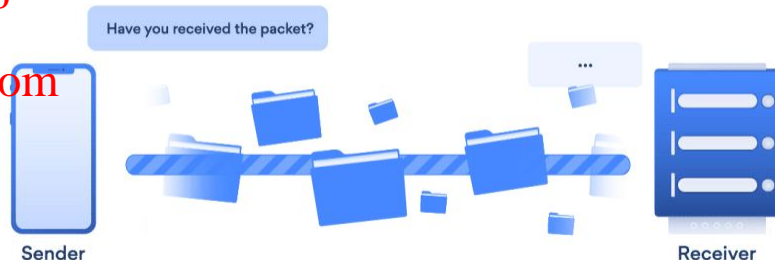
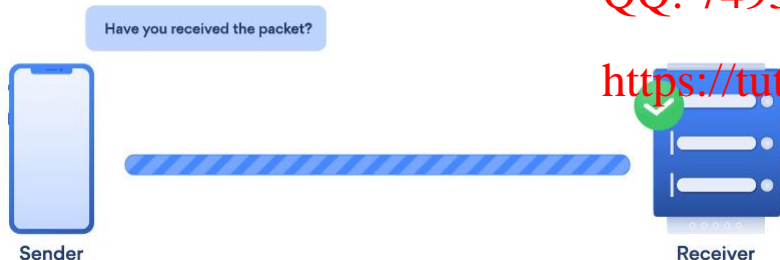
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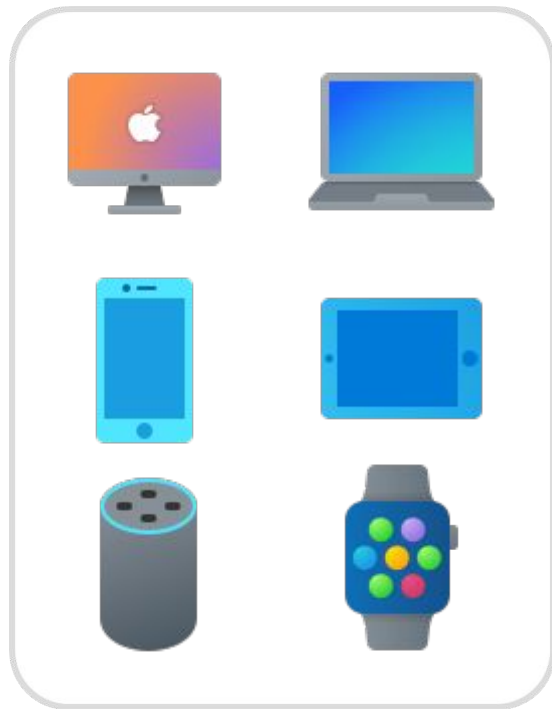
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Review: Client-server model of computing

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Last week we considered how **web clients** request resources from **web servers**.

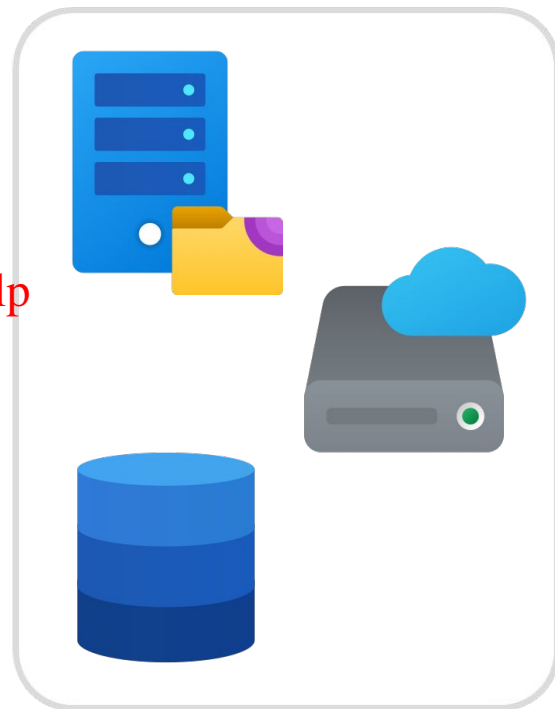


I am a...
Do you understand me?
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I can accept...

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Hello, I am here for you.
I also understand you.
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Sending you data...



HTTP: Hypertext Transfer Protocol

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HTTP provides communications rules for both requests and responses.



The client sends a request containing:

- Request metadata, including a URL
- Optional encoded data

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The server sends a response including:

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- Request metadata, including a status code

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- The requested data, usually in the form of an HTML document

HTTP communication headers

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Client Request

```
:authority: en.m.wikipedia.org
:method: GET
:path: /static/images/mobile/copyright/wikipedia-en.png
:scheme: https
accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.9
accept-encoding: gzip, deflate, br
accept-language: en-US,en;q=0.9
cache-control: no-cache
cookie: WMF-Last-Access-Global=31-Jan-2020;
      GeoIP=AU:VIC:Clayton:-37.91:145.13:v4;
      WMF-Last-Access=31-Jan-2020
user-agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64)
          AppleWebKit/537.36 (KHTML, like Gecko)
          Chrome/79.0.3945.130 Safari/537.36
```



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Server Response

```
accept-ranges: bytes
access-control-allow-origin: *
cache-control: max-age=31536000
content-length: 10361
content-type: image/png
date: Fri, 31 Jan 2020 01:40:01 GMT
expires: Mon, 25 Jan 2021 02:09:45 GMT
last-modified: Mon, 04 Dec 2017 19:10:13 GMT
server: ATS/8.0.5
status: 200
```



HTTP authentication

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HTTP does provide basic authentication (login) features via the request URL.



<http://username:password@www.example.com/restricted/>

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However, this method is **not recommended** (at least on its own)

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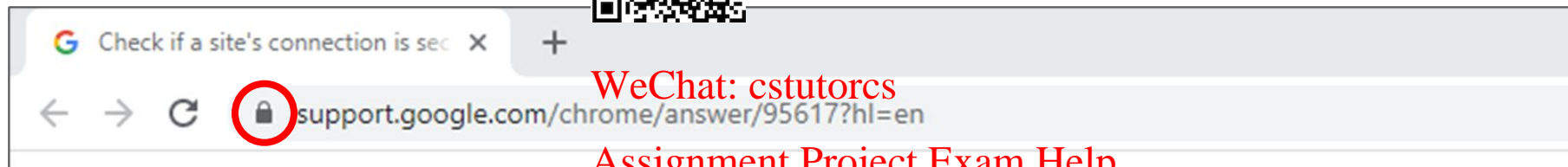
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- Using plain HTTP the request URL is visible in transit.
- On the client, the credentials are visible in the browser's address bar.
- On the client, the credentials are stored in the browser's history.
- At the server, the credentials will be logged in plaintext.
- At the server, there is no default mechanism for preventing brute-forcing.

HTTPS - Hypertext Transfer Protocol Secure

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HTTPS extends HTTP by encrypting **data in transit** using **Transport Layer Security** (TLS, newer) or **Secure Sockets** (SSL, older).



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The initial DNS request to resolve the domain is unencrypted, but afterwards:


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- The client and server negotiate and exchange security keys.
- Any URL requests that occur during the session are encrypted.
- Request and response data are both encrypted for the session duration.

What do you think? Is this page safe?

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To help protect your account we regularly look for early signs of potentially fraudulent activity.



We want to make sure you're the owner of this account

We didn't recognise a device or location that was recently used to log in, so we'd like to confirm your identity.

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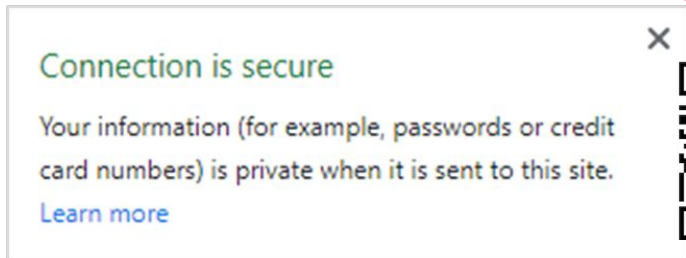
Login from **unknown device**, Romania

December 7 2017 - 08:33:52 PM

Sign-in to Verify Your Account

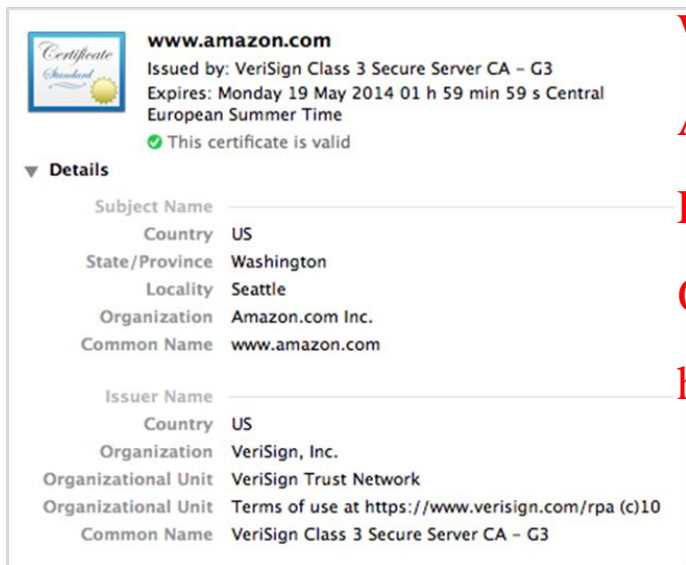
SSL certificate types

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**Domain
Validation**

Client-server traffic is encrypted.
(e.g. personal portfolio)



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**Organisation
Validation**

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Client-server traffic is encrypted.
Identity of the organisation is checked.
(e.g. online store)

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**Extended
Validation**

Client-server traffic is encrypted.
Identity of the organisation is checked.
Organisation passes background check.
(e.g. bank)

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Internet Connections

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Connection links - many technologies

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- **Analog telephone** PSTN (Public Switched Telephone Network)
- **Digital telephone** ISDN (Integrated Services Digital Network)
- **Digital data lines** ADSL (Asynchronous Digital Subscriber Line)
- **Cable Internet** HFC (Hybrid Fibre-Coaxial)
- **Fibre Fixed Line** Fibre To The... Node / Gurb / Basement / Home
- **Mobile Internet** Mobile networks (2G GPRS, 3G HSPA, 4G LTE, 5G NR)
- **Wireless Networks** Wi-Fi local networks (802.11 A, B, G, N, AC, AX)
- **Fixed wireless** Long-range wireless networks (WiMAX, 4G, 5G)
- **Satellite Internet** One-way + terrestrial, two-way satellite



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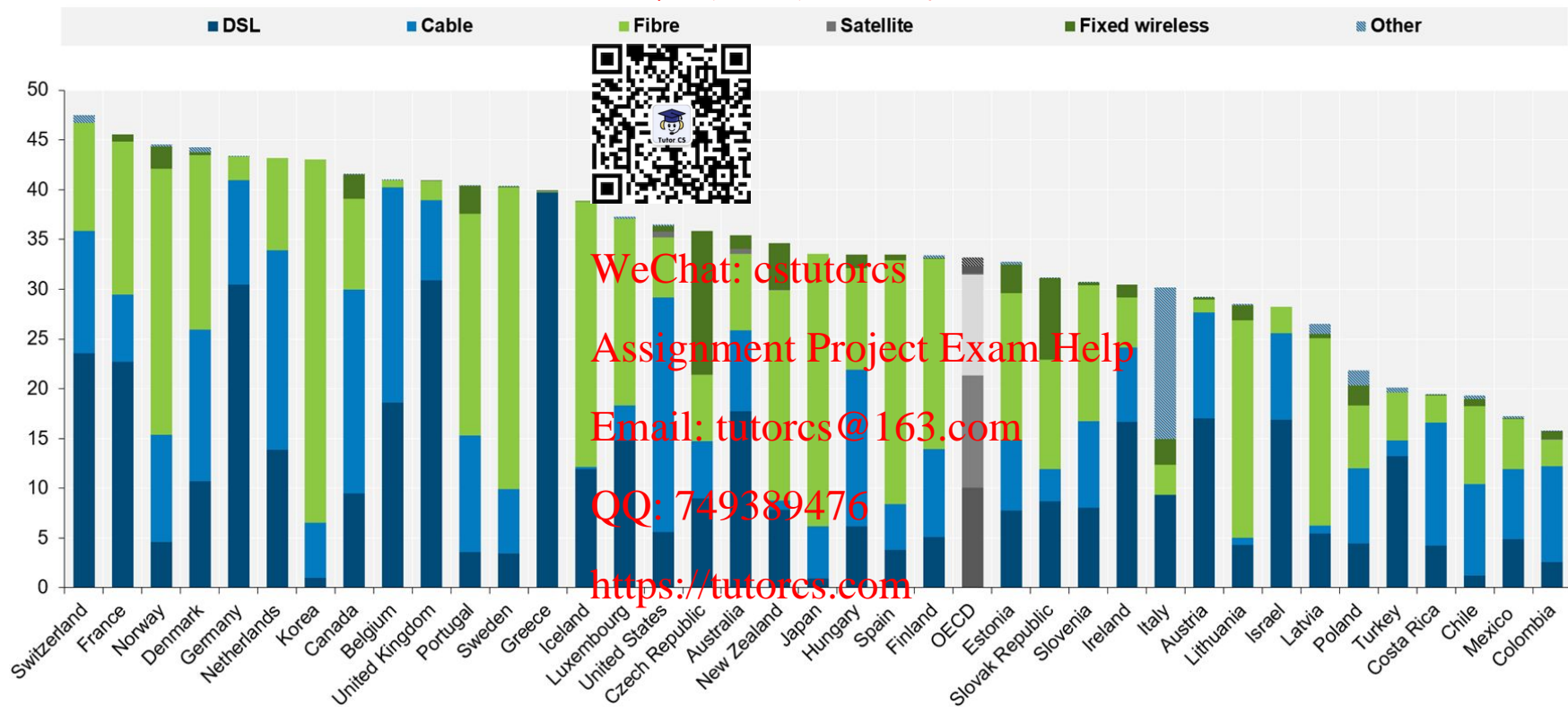
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Fixed broadband per 100 inhabitants (Dec 2020)

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Connection links - design issues

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- **Link capacity**

- Legal definition of "broadband" can vary by country



- **Variability in bandwidth capacity**

- Symmetrical and asymmetrical capacities

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- **Performance**

- May not match theoretical or advertised capacity

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- **The "digital divide"**

- Affordability and regional availability
- Other governmental and societal issues

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Response times

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Main factors influence perceived response times:



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- **Bandwidth** - the rate at which you can send/receive data
 - Influenced by client network connection
 - Influenced by server capacity and network connection
- **Latency** - the time taken for data to get from Point A to Point B
 - May also be a result of processing delay at the server
- **"Stutter" or "Jank"** - perceived by the user
 - Usually caused by processing delay at the client end

New technologies increase bandwidth and decrease latency

Bandwidth

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Technology	Capability	Typical Speeds	Notes
ADSL	8 Mbit/s	6 Mbit/s	Varies by distance
ADSL2+	24 Mbit/s	15 Mbit/s	Varies by distance
Cable	250 Mbit/s	< 100 Mbit/s	Shared bandwidth
Fibre	1 Gbit/s	~25-100 Mbit/s	Assuming FTTP
Satellite	1 Gbit/s	< 25 Mbit/s	Line-of-sight
2G GSM	0.3 Mbit/s	~ 60 kbit/s	Rarely used
3G UMTS	42 Mbit/s	~ 8 Mbit/s	Highly variable
4G LTE	300 Gbit/s	~ 30 Mbit/s	Highly variable
5G NR	20 Gbit/s	~ 200 Mbit/s	Highly variable



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Latency

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Type of connection

- Wired connections typically have lower latency than wireless
- New technology typically has lower latency than older equivalents



Connection distance

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- Physically longer distances require more time to transmit
- Longer distances require usually more “hops” between servers

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Connection quality

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- Transmission errors result re-routing over longer routes
- Transmission errors require data to be re-sent

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Response time expectations

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0.1 seconds or less

- Feels like it was caused by not the computer.
- Essential to support the feel of direct manipulation.



Approximately 1 second

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- Users can sense a delay, and thus know the computer is generating the outcome but they still feel in control.

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10 seconds or longer

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- Users feel at the mercy of the computer and wish it was faster.
- After 10 seconds, they start thinking about other things

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Test it yourself!

The developer tools in Google Chrome (and other browsers) includes a network panel that can visualise site loading performance:

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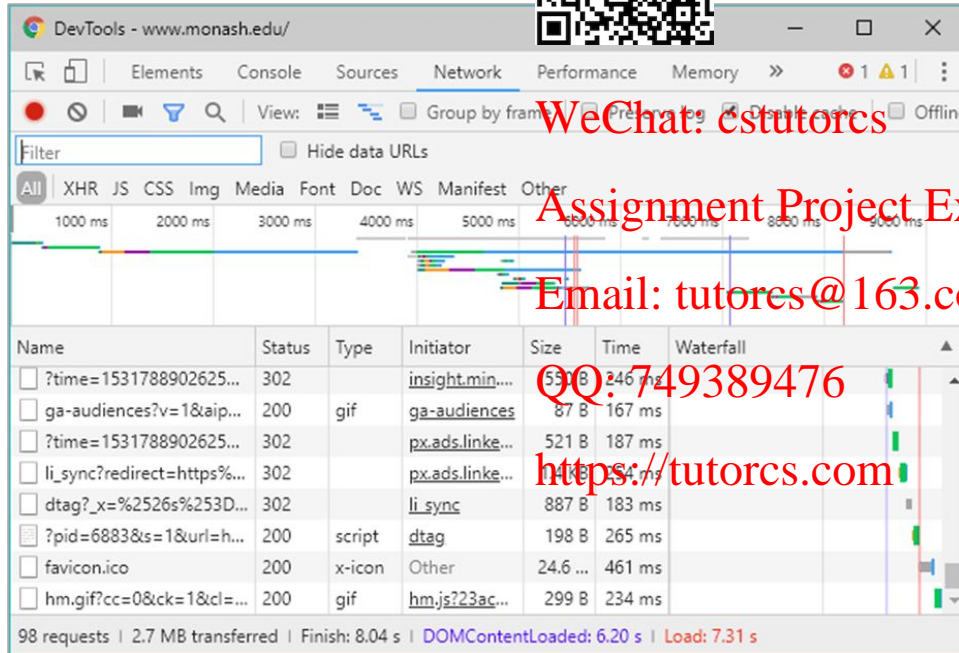
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Settings

Resource type filters

Waterfall

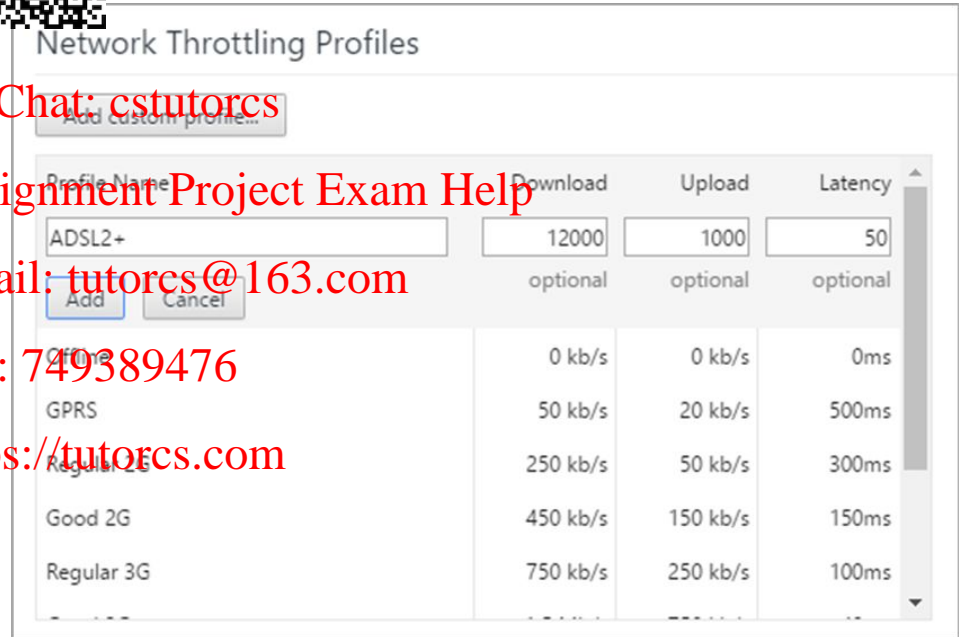
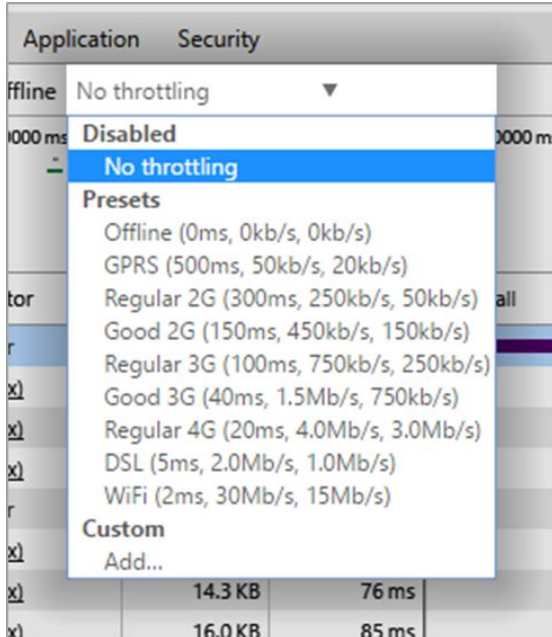
Network log

Summary

Simulating bandwidth and latency

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The **network** panel in Chrome allows includes an option to artificially throttle loading of resources from any server.



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Transfer time is more than download time

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Name	×	Headers	Preview	Response	Cookies	Timing
www.news.com.au						
home.css?m=15607411..						
jquery.js?m=155835665						
home-top-concat-min.j..						
rampart.js						
utag.sync.js						
adblock.js						
21140324cc257298758..						
46a289d151e7f9c81139						
mobile-useragent-info.j..						
echo.min.js?m=150171..						
jquery-migrate.min.js?...						
analytics-idp2.js?m=15..						
utag.js						
widgets.js?ver=2011111						
pending.js?m=1408998..						
neverending.js?m=1349						
home-bottom-concat-...						
iframe-async-loader.js?..						
vip-analytics.js?m=1411						
masterbar.js?m=14890..						
masterbar-tracks.js?m=..						
161 / 314 requests 2.3 ME						

Queued at 0		
Started at 5.16 ms		
Resource Scheduling		TIME
Queueing		5.16 ms
Connection Start		TIME
Stalled	WeChat: cstutorcs	0.97 ms
DNS Lookup		40.56 ms
Initial connection	Assignment Project Exam Help	36.32 ms
SSL		16.81 ms
Request/Response	Email: tutorcs@163.com	TIME
Request sent		0.23 ms
Waiting (TTFB)	QQ: 749389476	566.80 ms
Content Download		198.16 ms
Explanation	https://tutorcs.com	849.13 ms

Minimising bandwidth and latency

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Optimise to transmit less data and reduce time spent waiting for data.



- Remove unnecessary files
- Prefer single files over many files
- Author media at appropriate dimensions
- Choose efficient file formats and encoding
- Compression - both file-based and HTTP compression
- Selectively pre-load or lazy-load content
- Use servers located closer to users

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But what if your users are located in different countries around the world?

Content delivery networks

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Next week

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- Learn the basics of HTML
- Understand the importance of Web Standards



Reminders

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Participation Milestone 1 assessment takes place this week during lab class.

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Lab attendance is required to complete this task and earn full marks.

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If you are unable to attend your lab session, contact your tutor as soon as possible!

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Special consideration will be available if you have a legitimate reason with appropriate documentation.