

COMP5216 Assignment Project Exam Help

Week 05

Semester 2, 2020

<https://eduassistpro.github.io/>

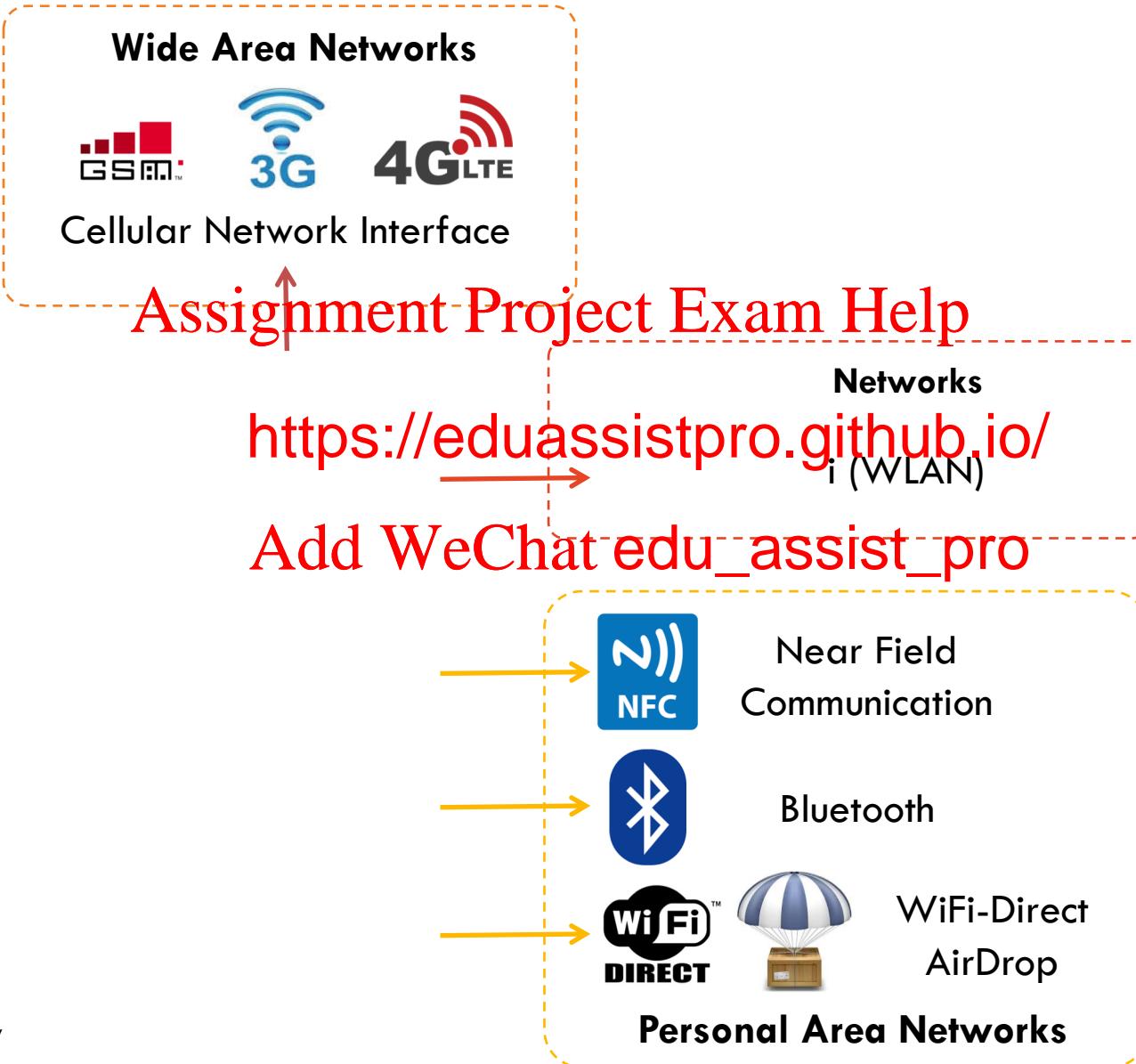
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Outline

- Overview of available networks
 - Cellular, WiFi, Bluetooth, NFC, Ad-Hoc
- What we can do as developers to optimize networking cost ?
 - Selecting the rig
 - Offloading to c <https://eduassistpro.github.io/>
 - Reduce data usage
 - Reuse data Add WeChat edu_assist_pro
- Tools for Network Debugging
 - Android Profiler
 - Wireshark

Networking Challenge



Which interface ?

Factors to consider

- **Range**
 - Location of the end hosts
 - Mobility
- **Cost**
 - For the network
 - For the consumer <https://eduassistpro.github.io/>
- **Speed**
 - Real time or delay tolerant
 - User expectations
- **Privacy and Security**
 - Public content or personal data
 - Location of the end hosts
- **Energy**
 - Smartphone energy consumption



E.g. Sharing accelerometer data from smartwatch to smartphone

- What options we have?

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Wide area networks

Wide Area Networks



Cellular Network Interface

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Wide Area Networks

Cellular Networks

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- Source: GSMA Intelligence - <https://www.gsma.com>
- Cellular network standards are governed by 3GPP - <http://www.3gpp.org>

Cellular Network Evolution – 2G

- Global System for Mobile Communications (GSM)
 - GSM is originally designed for voice.
 - Introduced **SIM** (Subscriber Identity Module).
 - Mass adoption of mobile phones started with GSM.
 - Even today GSM is the leading mobile communication technology.

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Source: GSMA Intelligence

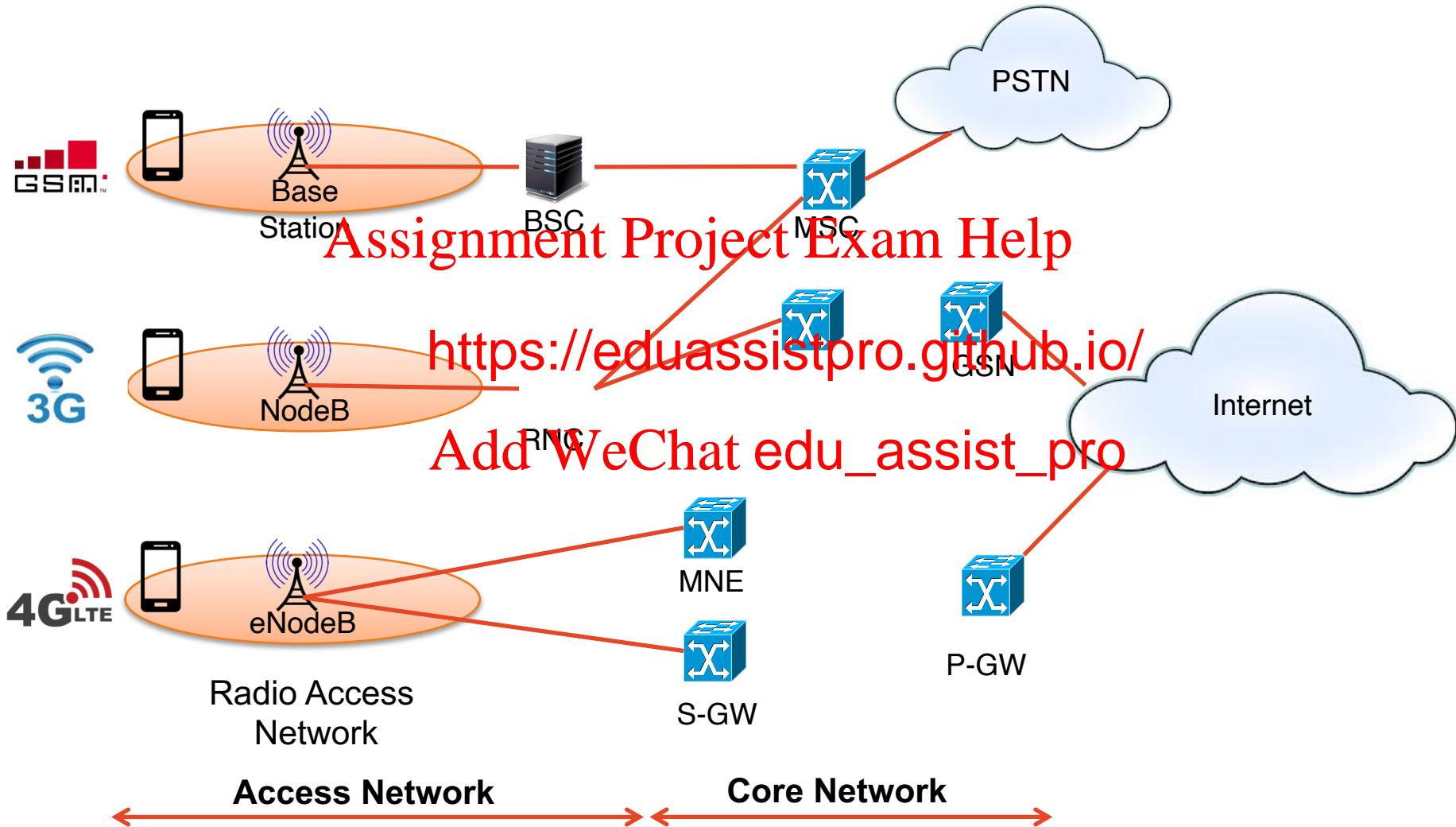
Cellular Network Evolution – 3G

- Two main variants of 3G technologies
- **UMTS** (Universal Mobile Telecommunication Service)
 - W-CDMA, TD-CDMA, and TD-SCDMA (China)
 - HSDPA, HSUPA, HSPA+ are Data specific releases.
 - HSPA+ provide
- **CDMA2000** <https://eduassistpro.github.io/>
 - In North America and South Korea
 - EVDO are Data specific releases.
 - EVDO Rev B provides data rates up to 14.7Mbits/s
- Frequency bands
 - 850, 900, 1900, 2100MHz
- Tied to mobile specific architectures and protocols.

Cellular Network Evolution – 4G

- **LTE Advanced:** 3GPP Long Term Evolution
 - <http://www.3gpp.org/technologies/keywords-acronyms/98-lte>
 - Downlink data rates up to 300Mbits/s
 - Uplink data 75Mbit/s
- E-UTRA (Evolved Access)
 - High Speed OF
- Similar frequency bands as 3G.
- All IP services including voice

Cellular Networks

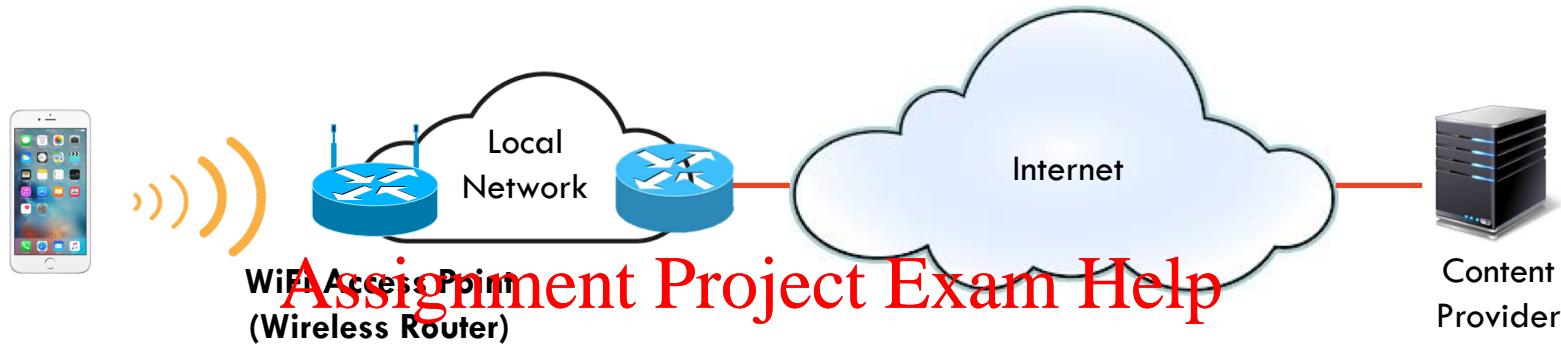


Frequency Usage



- Licensed band - Cellular networks
- Unlicensed band - WiFi, Bluetooth, Zigbee, Microwave, etc.

Local Area Network - WiFi



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Minimum
Infrastructure

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deployment

heap alternative to
cellular networks

- Current smartphones select WiFi over Cellular for data access by default.

Local Area Networks - WiFi

- WiFi hotspots are everywhere !
 - In Australia - Telstra, Manly Ferry, Westfield, etc.
 - **433 million hotspots worldwide by 2020.**

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WiFi – IEEE 802.11

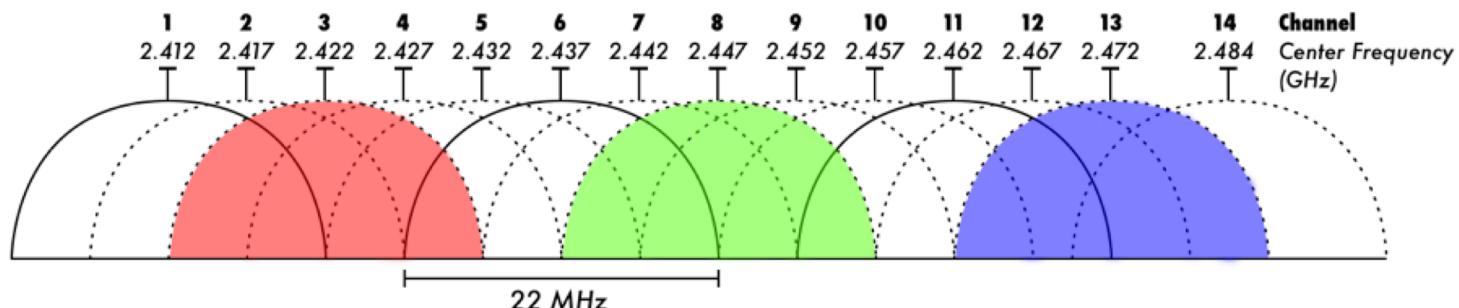
IEEE 802.11 Standards

- First version is released in 1997.
- Often called invented at CSIRO, Australia.
- Wi-Fi Alliance (non-profit) formed in 1999.
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https://eduassistpro.github.io/
- Medium Access
 - CSMA/CA- carrier sense multiple access with collision avoidance (recall: Ethernet use CSMA/CD)
- Does not support global mobility
 - 5G heterogeneous networking supports seamless integration with WiFi hotspots.

<http://www.ieee802.org/11/>

WiFi

- ISM(industrial, scientific and medical) frequencies.
- **2.4GHz Band**
 - IEEE 802.11b, 802.11g, 802.11n
 - Range \approx 70m
 - 11/14 channels (non overlapping)
 - Very crowded frequency
 - May suffer interference over, etc.
<https://eduassistpro.github.io/>
- **5.8GHz Band**
 - IEEE 802.11a, 802.11n, 802.11ac
 - Range lower than 2.4GHz \approx 35m
 - 23 channels (non overlapping)



WiFi

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Can be
exploited for
many
innovative
apps

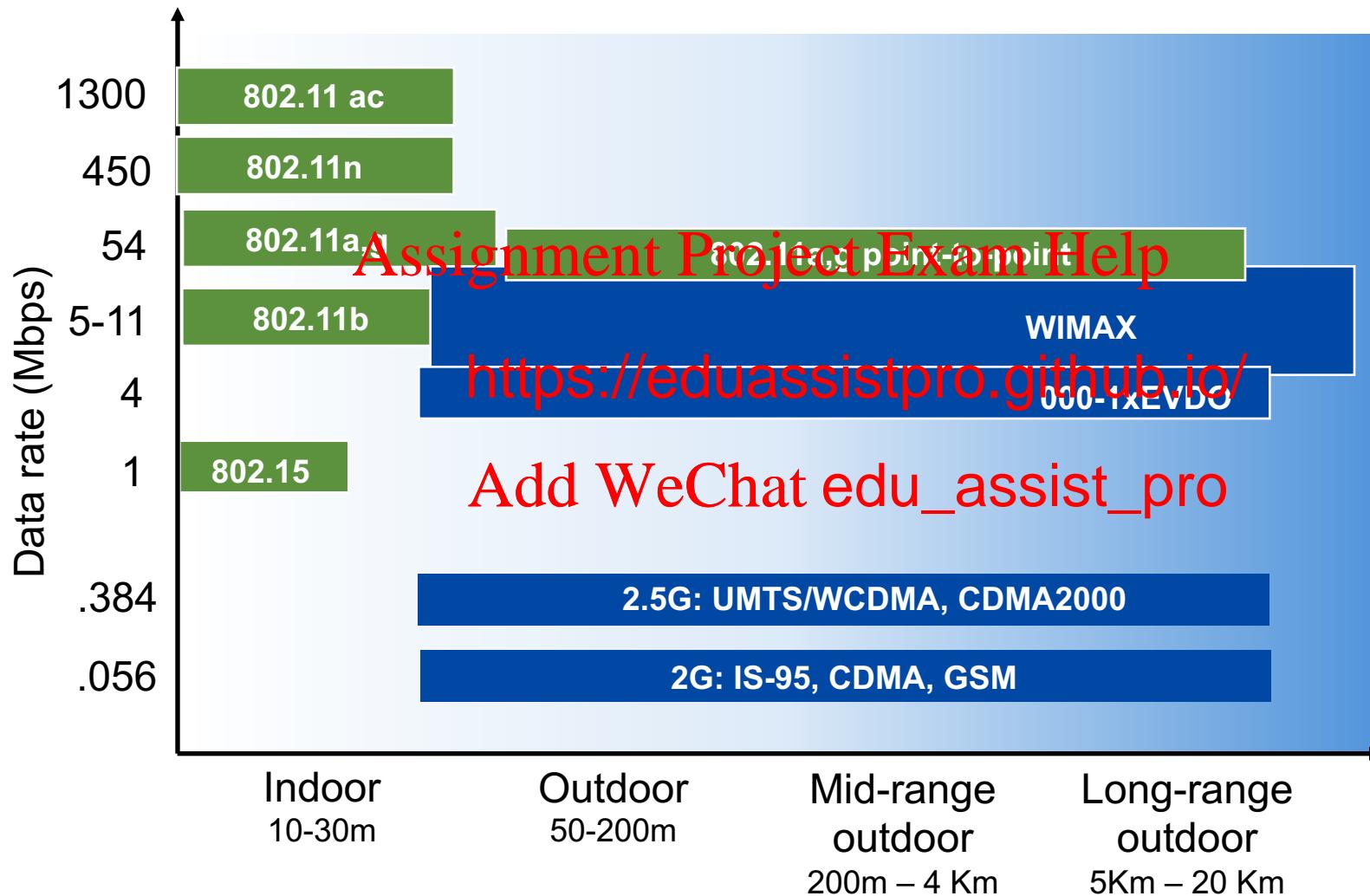
WiFi

- Most of the smartphones supports IEEE 802.11 a/b/g/n/ac

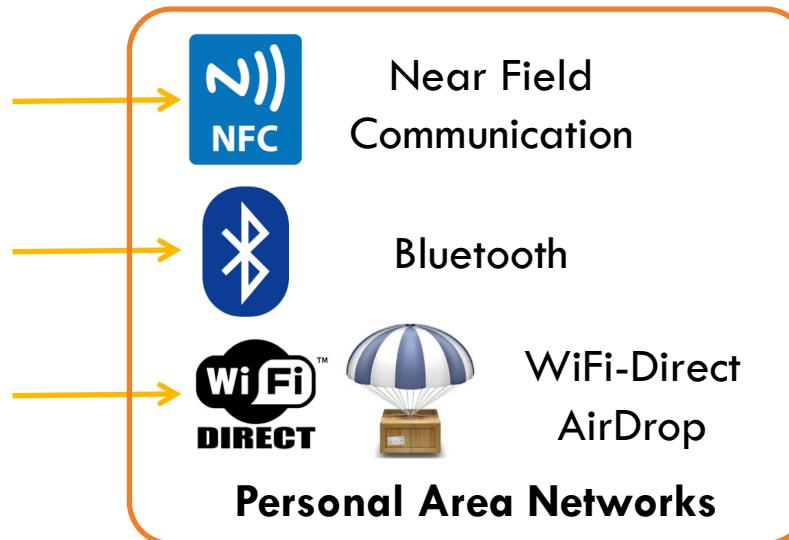
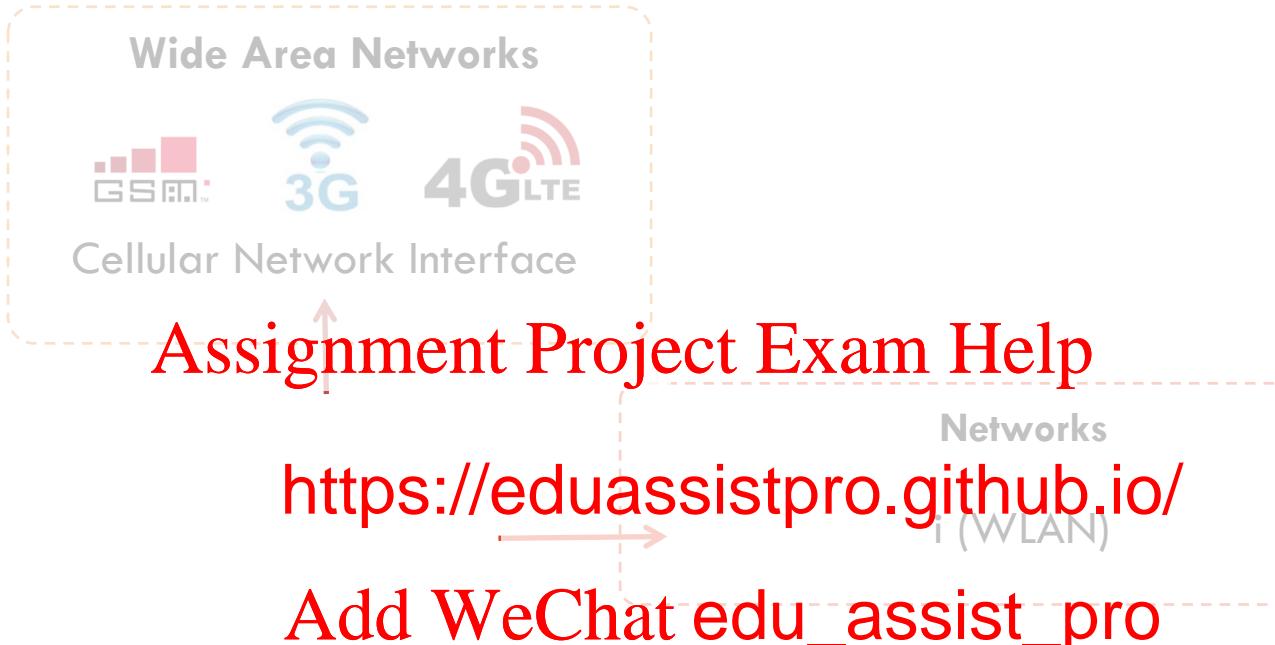
IEEE 802.11	Released date	Frequency band (GHz)	Bandwidth (MHz)	Max Speed (Mbits/s)	Range (m)
a	1999/2012	2.4/5.8	20	54	35
b				11	35
g				54	38
n	2009	2.4/5.8	1.4/20/40/80/ 160	50 96/200/4 33/866	70
ac	2013	5.8	20/40/80/ 160	96/200/4 33/866	35

- IEEE 802.11ad (60GHz) is coming...!**
 - Supports ~7Gbps data rate
 - But, requires line-of-sight → Point-to-Point connections

Summary – WiFi vs Cellular



Personal Area Networks



Personal Area Networks (1) Bluetooth



- IEEE 802.15.1 - now maintained by Bluetooth SIG¹
- ISM band - 2.4GHz

¹<https://www.bluetooth.com>

Bluetooth

- Bluetooth device in discoverable mode transmits the following info on demand:
 - Device name, Device class, List of services, Some Technical information (e.g: device features, manufacturer, Bluetooth specification)
- Traditional pairing:
 - Needs user interaction <https://eduassistpro.github.io/>
 - If not, PINs are
- **Secure Simple Pairing (SSP)**
 - Since Bluetooth v2.1
 - Works without user interaction.
 - Use other technologies such as NFC to bootstrap the authentication.
- Establish a shared secret key and if both devices store the same key, they are paired after that.

Bluetooth

- Infrastructure-less network → self-organized
- Time Division Multiple (TDM) access with random channel hopping 625 ns timeslot.
- 40 channels with <https://eduassistpro.github.io/> and 3 advertising channels.
- Master – Slave approach
 - Up to 8 slave devices
 - Up to 255 parked devices (not actively transmitting data)

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Bluetooth v5

- Bluetooth v5
 - **2x Speed, 4x Range, 8x Data** and less interference
 - Only available in new hardware iPhone 8, iPhone X, Galaxy S8
 - https://3pl46c46ctx02p7rzdsqg21-wpengine.netdna-ssl.com/wp-content/uploads/2019/03/Bluetooth_5-FINAL.pdf
 - 3 PHY Layers to select

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- LE Coded S=8
 - Higher range
 - Low speed
- LE Coded S=2
 - Low range
 - Higher speed

Personal Area Networks (2) NFC

- Range≈4cm of each other.
- ISM band - 13.56MHz

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Data rates > 106-424 kbps

<https://eduassistpro.github.io/>

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standardization
SMA, NFC Forum¹

- NFC is based on **RFID** (Radio Frequency IDentification)
 - Use magnetic field induction in close proximity

¹<http://nfc-forum.org>

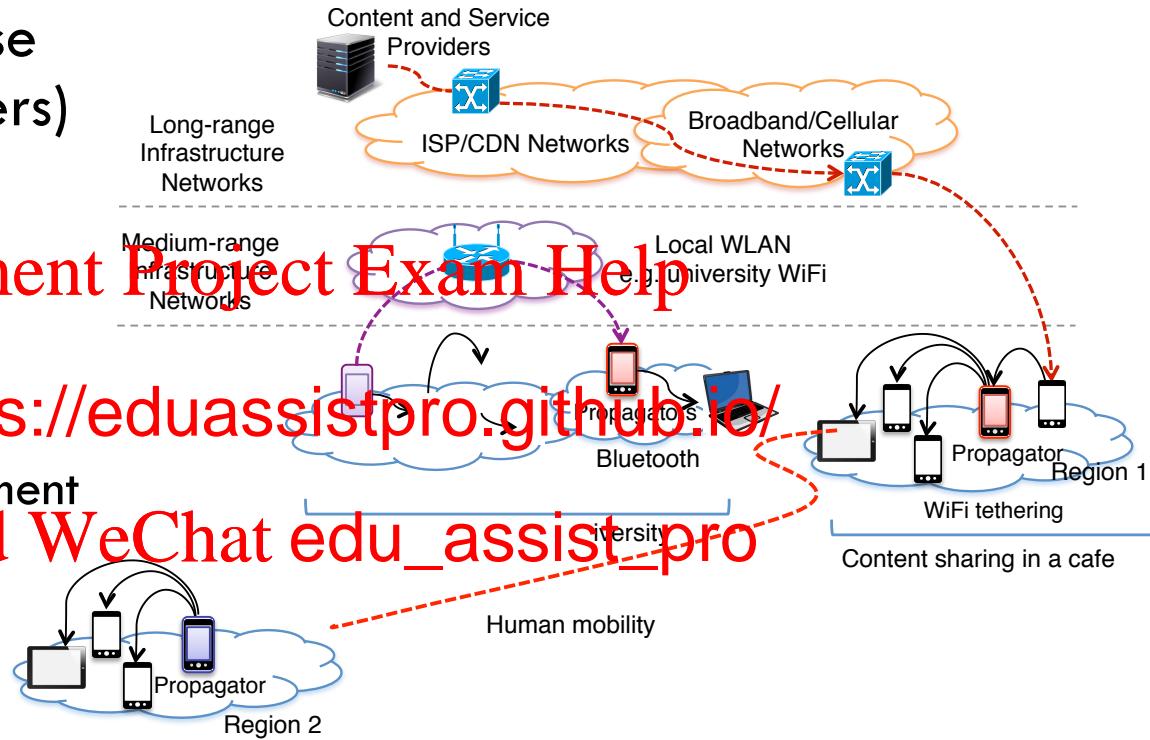
Personal Area Networks (3) WiFi Variants

- Use WiFi networking interface: Range and Data rates are similar to WiFi.
- **WiFi-Direct**
 - Activates Software AP within the device
 - Specifications are administered by WiFi Alliance¹
- **AirDrop** by App
- **WiFi-Tethering** (<https://eduassistpro.github.io/>)
 - Some network operators block WiFi
 - Can only connect up to 8-9 devices

¹<http://www.wi-fi.org/discover-wi-fi/wi-fi-direct>

Ad-Hoc Networking

- No Infrastructure (base stations, routers, servers)
- Devices organize themselves
- Device to device communication
 - E.g. disaster management



Ad-Hoc Networking - Android

- Network Service Discovery (NSD) API to discover available services/devices nearby
- WiFi P2P API to setup wireless connections

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- Devices that support:
 - Printers, Webcams<https://eduassistpro.github.io/>
- Allows fast data transfer within a network
 - Low latency
 - No bandwidth cost
 - Useful in range of P2P applications
 - E.g. chatting, file sharing and multi-player games
- <https://developer.android.com/training/connect-devices-wirelessly/>

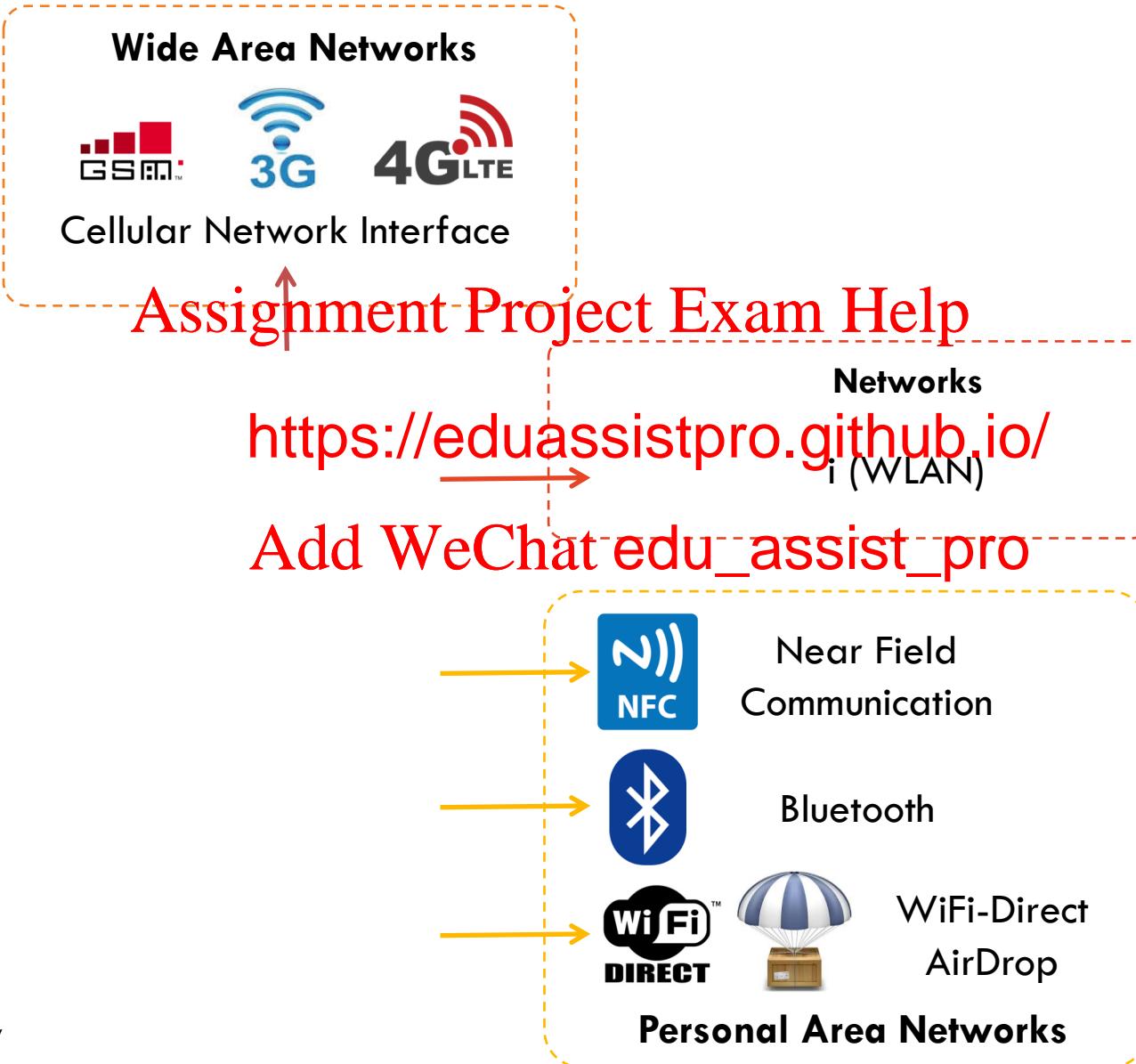
NSD

- Rely on DNS-based Service Discovery (**DNS_SD**) protocol
 - Allows your app to request services by specifying;
 - A type of service, and
 - The name of a device instance that provides the desired type of service
- What is DNS (Domain Name System) ?
 - Map between hostnames (e.g. www.google.com) and its IP address
 - For Internet there is <https://eduassistpro.github.io/>
- Multicast DNS is distributed (no central authority)
 - Hostnames ending with .local
 - All devices in the same sub-net creates a directory of service exchanging IP multicast messages
 - i.e. NSD will not work if multicast traffic is blocked on the local network
- DNS-SD extends Multicast-DNS including service information
- You can register your service name at;
 - <https://www.iana.org/form/ports-services>

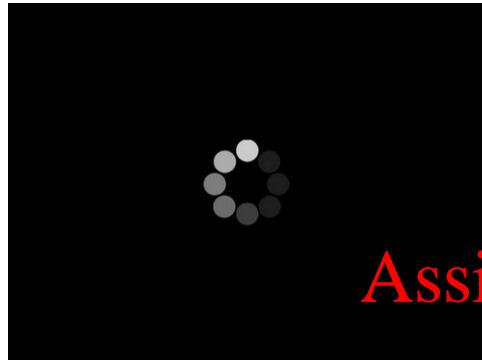
WiFi P2P

- Allows apps to connect nearby device without a network or hotspot support
 - <https://developer.android.com/training/connect-devices-wirelessly/wifi-direct>
- Provides WPA2 encryption
- Steps:
 - 1. Ask for the correct permissions.
 - 2. Set-up a broadcast
 - 3. Peer Discovery & <https://eduassistpro.github.io/>
 - 4. Connect to a peer
- WiFi P2P can also be used to discover services nearby
 - Recall NSD requires devices to be on the same WiFi network
- A higher level API for adhoc connections combining WiFi and Bluetooth –
NearBy API
 - <https://developers.google.com/nearby/connections/android/discover-devices>

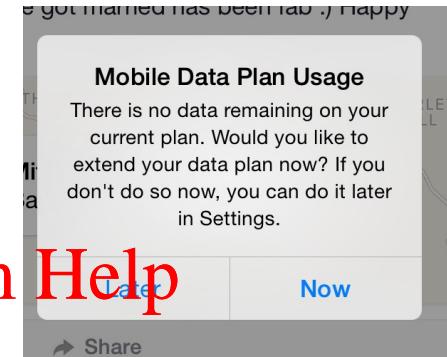
Networking Challenge



What to avoid ?



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Best P <https://eduassistpro.github.io/> Working

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What can we (developers) do ?

Do you really need this data ? Yes

1. Select the right content for the device, the user and adapt dynamically
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2. Offloading cell networks
<https://eduassistpro.github.io/>
3. Reduce the amount of data
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4. Reuse the data as much as possible
 - Secure networking [Week 6]
 - Energy efficient networking [Week 8]

(1) Selecting the right content

- User expectation dependent on context;
 - Users' activity, e.g. running or sitting in the living room.
 - Time of the day.

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- Request approp

<https://eduassistpro.github.io/>

- Examples for bad practices?

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(1) Adapting to the conditions

- Check before downloading/uploading
 - User activity
 - Connected network type
 - Available network bandwidth
 - Location
 - Time of the day <https://eduassistpro.github.io/>
- Slow connection → Add WeChat `edu_assist_pro`
 - Download to `n_media`
- DASH Video Players (Dynamic Adaptive Streaming over HTTPS)
 - E.g. YouTube – Varying video quality according to the available network bandwidth

(2) Offloading

- **Reactive offloading**
 - Offload to another network when it is available.
 - Cellular to WiFi, WiFi to Bluetooth, Bluetooth to USB

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- 55% of global children will be added to WiFi by 2020.

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(2) Offloading

- All most all current smartphones automatically prioritise WiFi networks over Cellular (3G/4G) networks

Benefits of WiFi Offloading Project Exam Help

- Faster connection speed)
<https://eduassistpro.github.io/>
- Lower cost
- Lesser battery drain Add WeChat edu_assist_pro
- Overall improved quality of user experience
- Reduces cellular network capacity issues

(2) Offloading - Reactive

- To automatically connect to WiFi, the available WiFi network has to be **in the previously connected list of networks**.
- **Reactive WiFi Offloading practices**
 - Wait until the download is complete; transfer;
 - Large files <https://eduassistpro.github.io/>
 - Delay tolerant content, e.g. softwares.
- Push notifications to the user to connect to WiFi after a timeout)
- Scan the available WiFi networks and offer the user option to switch to WiFi

(2) Offloading - Predictive

- **Predict** near future WiFi availability and **delay** the transmission.
- Only works for **non-real time content** (delay-tolerant content)
 - Social networking content.
 - Software update
 - Environmental monitoring
- **Predict** future demand and effect **add** the content when the user is connected to WiFi.
 - News
 - YouTube, Facebook videos

(2) Offloading - Predictive

- Regular behavioural patterns of users
 - Users have regular weekly patterns, e.g. 9:00am -5:00pm work hours.
- Long-tail content popularity
 - 10% of content
 - <https://eduassistpro.github.io/>
- User and location targeted content
 - Location based advertisement distribution
 - User targeted content, e.g. Facebook videos

(3) Reduce Data

- Download only essentials
- Don't upload everything collected

Data Compression Assignment Project Exam Help

- Specially for text files less than 1 MB [JavaScript, CSS, .txt](https://eduassistpro.github.io/compression.js)
- The compression and decompression should be supported by the end-points.
 - Common algorithms - GZIP, DEFLATE

(3) Reduce Data - Image compression

- Trade size and color
 - More colors → larger size

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<https://eduassistpro.github.io/>

- Adjust quality to around 75
 - Significantly smaller image size for insignificant visual difference
- **WebP** provides better compression than JPEG and PNG
 - <https://developers.google.com/speed/webp/>
 - WebP lossless images are 26% smaller compared to PNGs

(3) Reduce Data - Image compression

- Use WebP whenever possible
- If not, use;
 - PNG – if image needs transparency or image is simple in color and structure **Assignment Project Exam Help**
 - JPG – if image is complex

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Same color better compression with PNG

(3) Reduce Data - Other forms of data reductions

- **Minification** of JS, CSS and HTML
 - Remove unnecessary characters
 - JS – e.g. UglifyJS [<https://github.com/mishoo/UglifyJS2>]
 - CSS – e.g. CSSNano [<https://github.com/ben-eb/cssnano>]
 - HTML – HTMLMinifier [<https://github.com/kangax/html-minifier>]
 - General minification
 - Compress: GZIP <https://eduassistpro.github.io/>
 - Offline compression using Zopfli or
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- **Serialization**
 - JSON, XML are serialization methods, but bulky and slow
 - Use customized structure to minimize data
 - FlatBuffers - an efficient cross platform serialization library
 - <https://google.github.io/flatbuffers/>

(3) Reduce Data - Data Compression

- Samsung Max App (Previously Opera Max)

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(4) Reuse Data

- Design the app and the communication protocol to reuse data, if you control both the client and the server.
 - **Static content** – Cache until updated
 - **Dynamic content** – Cache until expires

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- For web-content, <https://eduassistpro.github.io/> number of flexible ~~Add WeChat edu_assist_pro~~ parameters.
- <https://developers.google.com/web/fundamentals/performance/optimizing-content-efficiency/http-caching>

(4) Reuse Data - HTTP Caching

- HTTP Header cache-control directives:
 - **no-store**- can not cache the content
 - **no-cache**- can not use unless checking server
 - **public**- can be cached for all users
 - **private**- can be cached for only one user
 - **max-age**- maximum time in seconds that the cached content can be used
 - **ETag** – use to check saved version at the client is still valid

(4) Reuse Data - Cache Replacement Policies

- Storage is not unlimited, **not possible to cache everything...!**
- Memory cache vs Disk cache
- Use the most suitable cache replacement policy for the app.
 - FIFO - First In First Out
 - Largest Evict
 - **LRU - Least Rec**
 - **LFU - Least Freq** <https://eduassistpro.github.io/>
- Android Caching support [Add WeChat edu_assist_pro](#)
 - <https://developer.android.com/reference/android/net/http/HttpResponseCache>
 - <https://developer.android.com/reference/android/util/LruCache>
 - <https://developer.android.com/topic/performance/graphics/cache-bitmap>
- Image caching/loading libraries
 - Glide - <https://github.com/bumptech/glide>
 - Picasso - <http://square.github.io/picasso/>

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To <https://eduassistpro.github.io/>

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Android Profiler

- Available from Android Studio 3.0
 - **View > Tool Windows > Android Profiler**
- Great tool to ensure efficient/in-efficient usage of resources of your app **Assignment Project Exam Help**
 - CPU Profiler
 - Memory Profile <https://eduassistpro.github.io/>
 - **Network Profiler**
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- Enable Advanced Profiling
 - **Run > Edit Configurations > Profiling > Enable advanced profiling**

Android Profiler

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<https://eduassistpro.github.io/>

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Clicking here opens Network Profiler

Network Profiler

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Network Profiler

- Click on the network timeline to open Network Profiler
- **Connection view**
 - List both sent and received files including the size, type, status, etc.
- **Assignment Project Exam Help**
- **Thread view**
 - Display activities
- Currently supports ~~HttpURLConnection~~ ~~OkHttp~~ libraries
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- Can not profile other application traffic to answer questions like;
 - What happened to all of my data?
 - Why my battery drains so fast?
 - Is my data safe?

Wireshark for passive network measurements

- Wireshark Packet Sniffer
 - Download - <https://www.wireshark.org>

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<https://eduassistpro.github.io/>

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Resources

- Android Developer Documentation
 - <https://developer.android.com/guide/topics/connectivity/>
- Computer Network Fundamentals
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 - **Computer Networks** *8th Edition, Jim Kurose, Keith Ross* <https://eduassistpro.github.io/>
- Mobile networking best practice
 - **AT&T Video Optimizer Best Practices**
 - <https://developer.att.com/video-optimizer/docs/best-practices>

What's Next?

- Assignment 2 released today.
- Media access tutorial today, which provides the basis for Assignment Project Exam Help
- Project Proposa <https://eduassistpro.github.io/>
- Submit a PDF via Canvas by the Add WeChat edu_assist_pro
- Next week
 - Mobile Privacy and Security