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# Presentation

Palazzi registers all the lessons via Zoom

One can also find material of reference (will not be updated overtime though): <https://www.math.unipd.it/~cpalazzi/WNMA.html>

Everything else is on Moodle. The program is as follows:

* Introduction, wireless systems, protocols architecture, issues and measures
* Physical Layer (fundamentals and mobility effects)
* Data Link Layer (fundamentals on duplexing, TDMA, FDMA, CDMA)
* Network Layer (addressing/routing with device mobility)
* Transport Layer (Reliable communication and mobility impact on TCP)
* Application Layer (Geolocalized services, DTN, smart applications, distributed sensing, crowd computing, intelligent transportation system,…)
* Wireless Network Architectures: management and challenges
* WLAN, Infrastructure and Hot-Spot Networks
* Wireless Mesh Networks (WMN)
* Sensor Networks (Sensor Networks)
* Mobile Ad Hoc Networks (MANETs)
* Vehicular Ad-Hoc Networks (VANETs)
* Flying (Drone) Ad-Hoc Networks (FANETs)
* Satellite systems, challenged networks
* Consumer market technology; main standards; advanced issues:
* IEEE 802.11b/g/a/e/n/s/p
* IEEE 802.15.1 (Bluetooth)
* IEEE 802.15.4 (ZigBee)
* RFID
* Services:
* Location-based services
* Client/Server and alternative service paradigms
* Wireless Internet
* Pervasive wireless communication systems
* Other fields where Wireless Networks apply: existing and visionary services

The project can be on whatever scenario for the exam, will be any kind of project.

* Practical implementation or study of course-related scenarios
* Performance evaluation of protocols in wireless scenarios
* Development of applications for mobile environments (e.g., videogames or other applications for smartphones)

The specs for the project are as follows:

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Descrizione generata automaticamente

4 pages are enough, but students find them too short for the report for the project. We will discuss with the professor, and we both have to agree on that (via a meeting or I don’t know). It may be much related to Networking but also something completely different.

One can create a big project to satisfy both Mobile Programming and Multimedia and this course; this is also a chance.

The project has this kind of evaluation criteria:

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Descrizione generata automaticamente

This is class on:

* Design, analysis, and implementation of protocols and algorithms in (mobile) wireless network systems and their implication in the design of popular/innovative mobile applications

This does not cover:

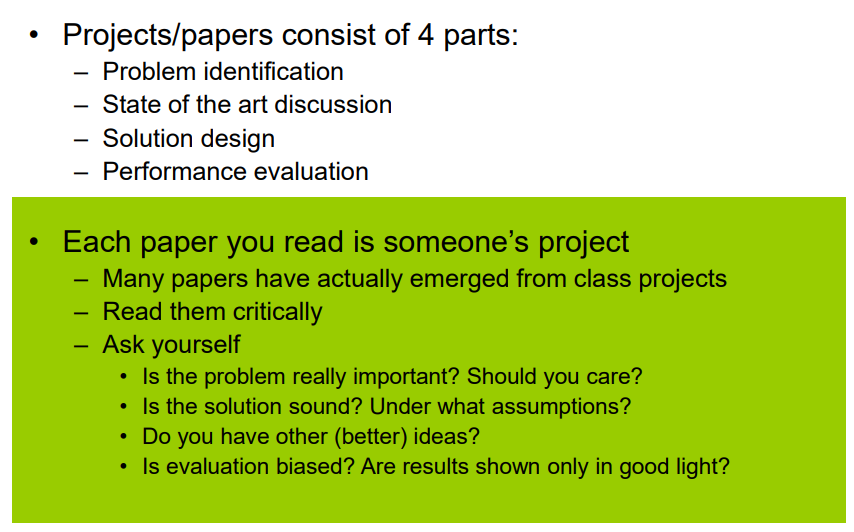
* Modulation schemes, transmitter/Receiver design, signal processing and antenna design, source coding / channel coding, privacy / Security

The project can be done in pairs (strongly suggested, 2/3 people per team)

The exam is oral, not written, which is an oral examination. Then the project can be delayed and decided to a term even after the examination. The teacher is flexible on this.

We are supposed to read papers to explore and further dive on a particular topic, to absorb concepts, for ourselves and to rationalize different ideas and different solutions. Via the intranet of UniPD inside the Department, we can freely access our specific papers.

General criteria on how to write the papers:



It’s important to discuss ideas and thoughts with the professor, mainly on an area and direction and find new solutions for more problems.  
Also:

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Descrizione generata automaticamente

Immagine che contiene testo, schermata, Carattere, documento

Descrizione generata automaticamente

# Mobile communications and Wireless Systems

In the history of communication, the main thing is transmitting data, no matter the channel. Now device penetration goes between 80% to over 115/120% all over the continents. Connection has overtime become ubiquitous, reaching billions of users and devices worldwide.

The following is an example of how networks are created to penetrate the whole environment for communication, made for measuring data and send other things. We want to run data making a good compromise between performance and effectiveness, depending on the scenarios listed above. In this case, delays can matter and speed of transmitting specific data:

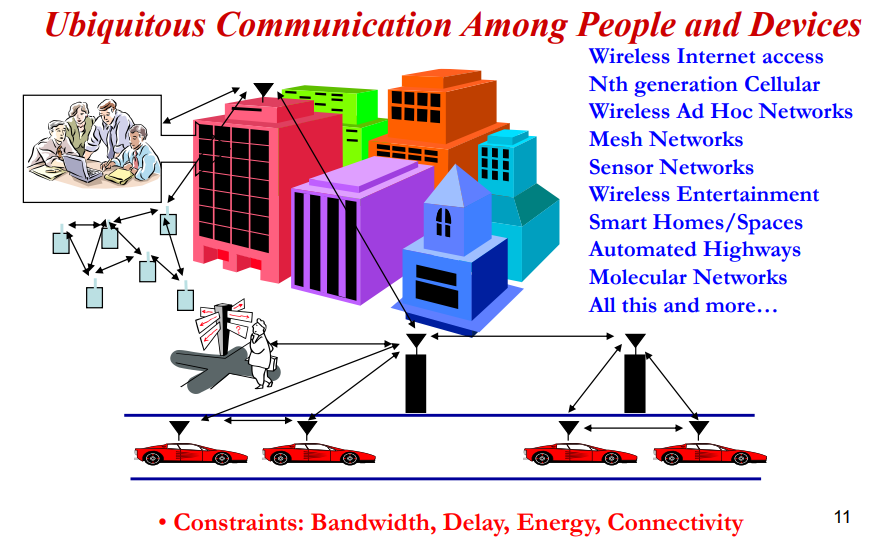
Immagine che contiene testo, schermata, Carattere, diagramma

Descrizione generata automaticamente

The largest part of mobile data consumption is taken up by video data, may it be streaming, VoD (Video on Demand) and other video formats, possibly even HD/UHD, AR/VR. Following we may find social networking, software downloads and updates, etc.

Communication can be functional, but sometimes delays and errors can happen; for example, the Iridium network where we must consider satellites delays, handoffs/handovers and moving time, switching, etc. Back then, this network very much failed in give constant latency or even the Tsunami Warning System, which failed to feedback any warning communication causing many deaths.

Wireless is growing to use between multiple scenarios at the same time, where interactivity compensates the bandwidth use (differentiating this way the different types of Web, i.e. Web 2.0/3.0 or even Web Squared, where the devices themselves transmit data to the power of 2, constantly exchanging and sending data). To summarize:



Wireless channels are a difficult and capacity-limited (with respect to the wired counterpart) broadcast communications medium. Traffic patterns, user locations, and network conditions are constantly changing, because applications are heterogeneous with hard constraints that must be met by the network. Energy and delay constraints *change design principles* across all layers of the protocol stack.

Below the general multimedia requirements (where BER stands for Bit Error Rate):

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Descrizione generata automaticamente

A few considerations:

* For data we don’t care about content transmission of every single packet, but in the total time of having the whole thing downloaded, without losing packets. We send out data with protocols that decide how to burst data
* On the other side, games, voice (VoIP) are pretty much requiring applications, where locally we have the application, but constant packets are sent and generate traffic to control and hold and we need to be having something continuous
* In the case of video, either streaming or prerecorded data, we need to burst huge data and have bigger packets to make the experience seamless to the final user

In computer networks design, we have layers, as something called the *crosslayer design*, based on constraints of transmission between delay, rate and energy, causing the loss of packets. It’s advisable to focus “on your layer” when creating a network application, without having something universal but functional (without sacrificing exploitation of more possibilities).

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Descrizione generata automaticamente

What we essentially mean is creating something carefully, having each layer naturally interact with others, without “crossing borders” unsafely, but *propagated*.

Let’s introduce the Current Wireless Systems, crafting something like:

* Cellular Systems, where geographic regions are divide into cells, crafting areas to reuse spatially frequencies/timeslots/codes between cells and coordinating handoffs via control functions. We also must consider cell size (shrinking it means increasing capacity but also networking burden) and conflicting technology between cells, to keep the service alive.
  + Data is bursty, having 3G widening the data pipe (with both voice and data), while 4G and 5G more focused on data (higher bandwidth, reliability, lower latency)

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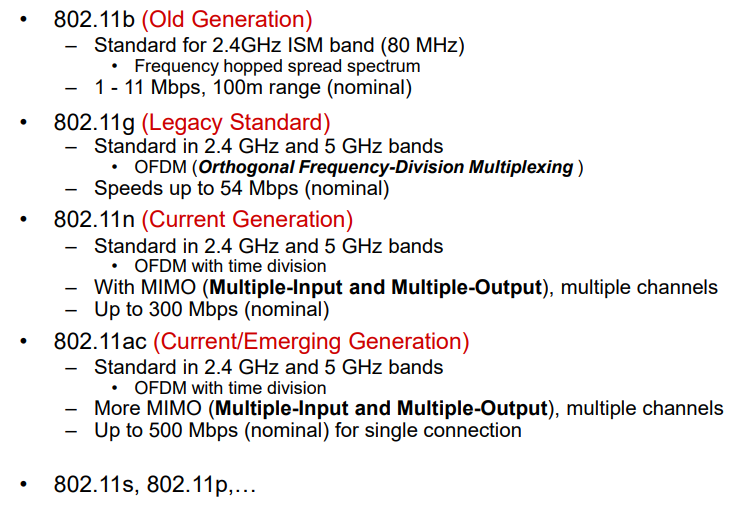
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* Wireless Local Area Networks (LANs), which connect local computers (between a 100m. range), breaking data into packets and sharing channel access randomly. This backbone provides best-effort service, dividing packets into smaller ones; this can be a problem in overhead, retransmitting again older packets, but causing less loss (better to lose, i.e. a size of 1000, 5 packets of 200 rather than 1000 “big” one; this implies that the BER is higher on higher packets).
  + Wirelessly we’re not using the full bandwidth, because “we always waste time on something else”, may it be voice, data consumed, packets, etc.

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Descrizione generata automaticamente

Just to give a quick overview of WLAN Standards (make a different summary of sort):



* Wireless Mesh Network
* Satellite Systems
* Bluetooth
* RFID
* D2D