

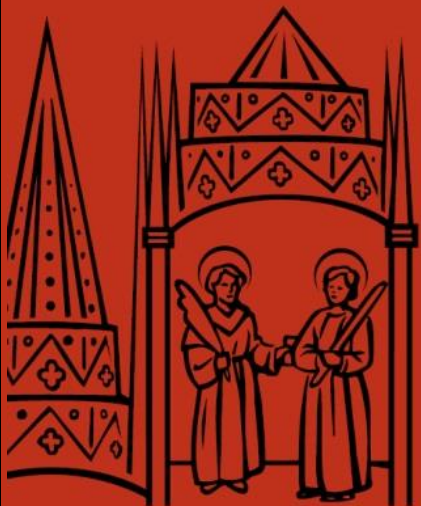
Welcome Master Programme Telecommunications Engineering

School of Engineering and Architecture

University of Bologna - Italy



ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA



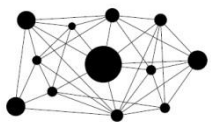
ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Multi-campus

Cesena, Forlì, Ravenna, Rimini



STUDENTS



Students

International
students

5,826

84,744
TOTAL

19,314

Students in
Cesena, Forlì,
Ravenna e
Rimini
campuses

79,833



55.9%



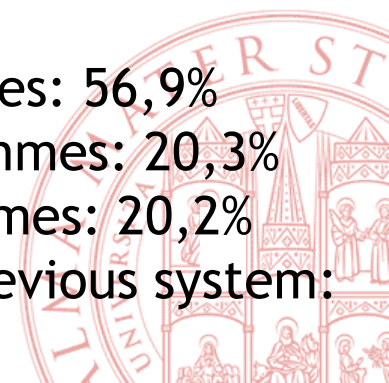
44.1%

Third cycle:

- PhD: 1481
- Specialisation Schools: 1323
- Professional Master: 1448
- Postgraduate/Lifelong learnin Programmes: 659

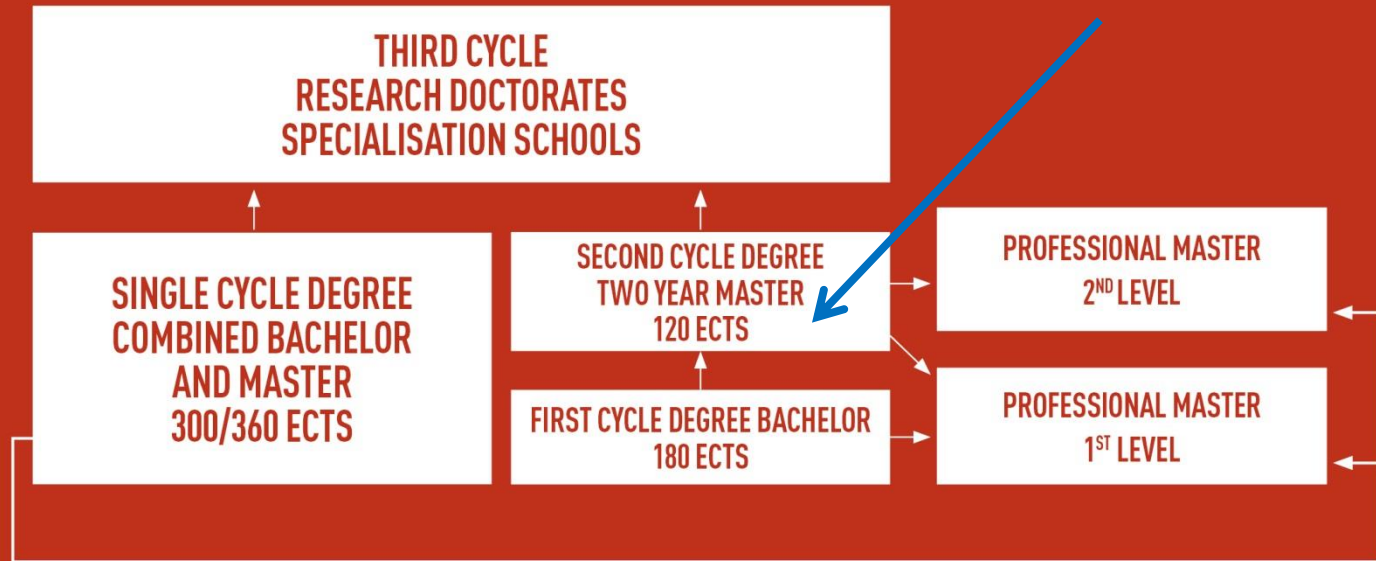
Degree Programmes:

- First cycle degree Programmes: 56,9%
- Second cycle degree Programmes: 20,3%
- Single cycle degree Programmes: 20,2%
- Degree programme under previous system: 2,6%





ITALIAN UNIVERSITY SYSTEM



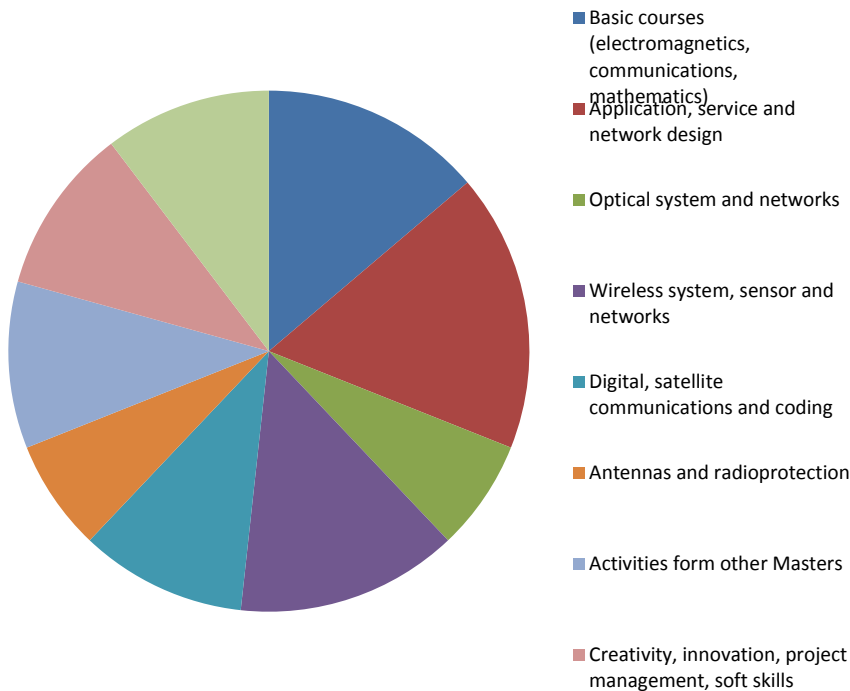
ECTS= European Credit Transfer System.

1 Credit= 25 hours student workload (classes, individual study, exams, etc.)

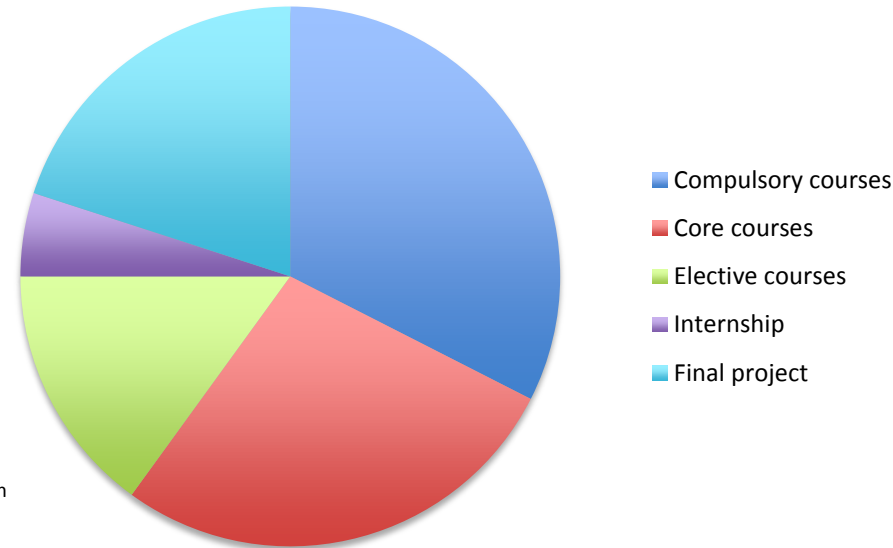


The program in a nutshell

200 CFUs offered



120 CFUs obtained



Students can build their curriculum to obtain 120 CFUs (e.g. Communications systems and devices, Communications networks and services..) following the above rules

- Career opportunities: a telecommunication engineer is able to design, implement and manage telecommunication devices, systems, networks and services, as well as covering positions not directly related to telecommunications (e.g. management)

First Year

57 credits	
First Semester	Second Semester
Electromagnetic Propagation for Wireless Systems M B9 F. Fuschini/G. Tartarini	Information Theory and Coding M B6 G. E. Corazza/A. Vanelli Coralli
Communic. Systems: Theory and Measurements M B9 O. Andrisano	Antennas for Wireless Systems M B6 D. Masotti
Network Design M B6 C. Raffaelli	Optical Fiber Systems M B6 G. Tartarini
Mathematical Methods M C6 M. Ferri / N. Arcozzi	Radio Networks M B6 R. Verdone
choose 12 credits (type B)	Multimedia Services and Applications M B6 D. Tarchi
choose 6 credits from Tab. C-1	
choose 3 credits	Creativity and Innovation M F3 G. E. Corazza Project Management and Soft Skills M F3 R. Verdone

Second Year

63 credits	
First Semester	Second Semester
<p>Optical Circuits and Networks M B6 P. Bassi / C. Raffaelli</p> <p>Mobile Radio Systems M B6 R. Verdone</p> <p>Wireless Sensor Networks M B6 C. Buratti</p> <p>Digital Receiver Design and Optimization M B6 G.E. Corazza/A. Vanelli Coralli</p> <p>Satellite Communication and Navigation Systems M B6 A. Vanelli Coralli</p> <p>Choose 18 credits from this Tab. B-2</p>	<p>Radioprotection and Spectrum Management M B6 M. Barbiroli</p> <p>Wireless Systems Laboratory M B6 A. Bazzi</p> <p>Circuit Design for Wireless Systems M B6 A. Lipparini</p> <p>Antennas for Wireless Systems M B6 D. Masotti</p> <p>Optical Fiber Systems M B6 G. Tartarini</p> <p>Radio Networks M B6 R. Verdone</p> <p>Multimedia Services and Applications M B6 D. Tarchi</p>
<p>Trends in Communications M F3</p>	
<p>Choose 6 credits from Tab. F-2</p>	
<p>Any course D (12 credits) – see Tab. D-2</p>	
<p>Final Project M E24</p>	

Course types

- B: core TLC
 - ING-INF/02, ING-INF/03
- C: TLC-related disciplines
 - ING-INF/01, ING-INF/05, MAT...
- F: labs and interdisciplinary courses (P/F)
- D: elective courses – any type



C

Resources Optimization M C6
 Hardware and Software design of
 embedded systems M C6
 Digital Systems M C6
 Elements of Stat and Signal Proc
 M C6
 Principles, Models and Applications
 for Distributed Systems M C6
 Opti Models and Algorithms M C6

CFUs to choose

Year 1

6 CFUs

B

Antennas for Wireless Systems M B6
 Optical Fiber Systems M B6
 Radio Networks M B6
 Multimedia Services and Appl M B6
 Optical Circuits and Networks M B6
 Mobile Radio Systems M B6
 Wireless Sensor Networks M B6
 Digital Receiver Design and Opt M B6
 Satellite Comm and Navigation Syst M B6
 Radioprotection and Spectrum Mngm M B6
 Wireless Systems Laboratory M B6
 Circuit Design for Wireless Systems M B6

12 CFUs

18 CFUs

12 CFUs

D

Any exam from table B
 Any exam from table C
 Any exam from table F
Any exam !

Year 2

6 CFUs

3 CFUs

F

Creativity and Innovation M F3
 Project Mngm and Soft Skills M F3
 Prot. and Arch. for Space Networks M F3
 Software Development M F3
 Laboratory of Networking M F3
 Laboratorio di software per le tLC T-A F3
 Lab of High Freq Electr Circ Des M – F3
Laboratorio di reti T F3 (to be approved)
 Progetto di sistemi in fibra ottica T – F3
 Internship in ICT F6

How to make your choice: type B

- Former study plans (type B):
 - CN2S (Communications Networks Systems and Services)
 - CD2S (Communication Devices Signals and Systems)
- Different mixes are interesting as well depending on different objectives
- The study plan is now organized with enhanced flexibility to meet your motivation and interest (see also second year)

Radio Networks M B6

R. Verdone

Multimedia Services and Applications M B6

D. Tarchi

Antennas for Wireless Systems M B6

D. Masotti

Optical Fiber Systems M B6

G. Tartarini

e.g.

Antennas for Wireless Systems M B6

D. Masotti

Radio Networks M B6

R. Verdone

1st year choices - Type B – core courses

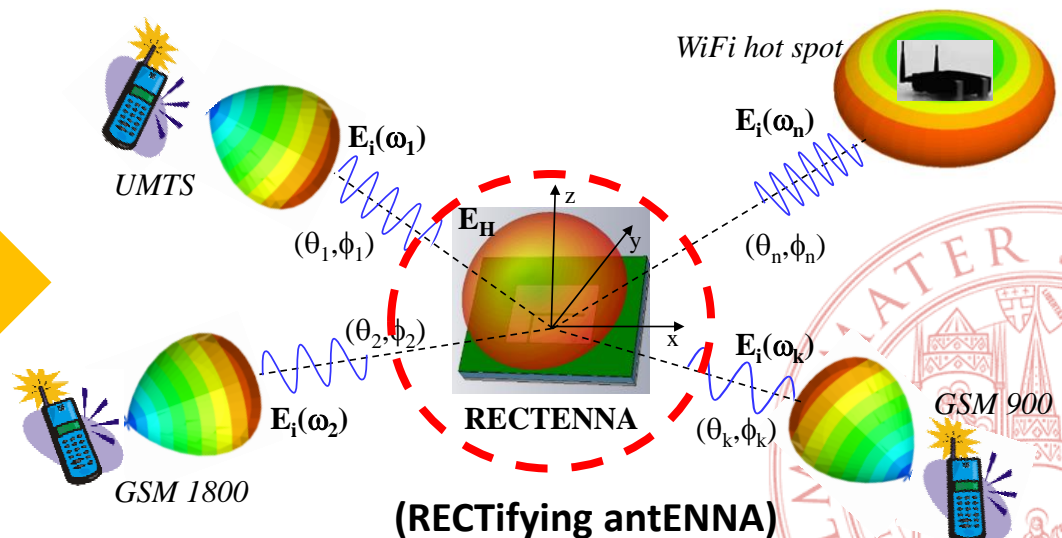
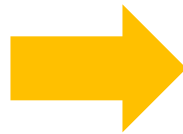
57 credits	
First Semester	Second Semester
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<p>Communic. Systems: Theory and Measurements M B9 O. Andrisano</p>	<p>Antennas for Wireless Systems M B6 D. Masotti</p>
<p>Network Design M B6 C. Raffaelli</p>	<p>Optical Fiber Systems M B6 G. Tartarini</p>
<p>Mathematical Methods M C6 M. Ferri / N. Arcozzi</p>	<p>Radio Networks M B6 R. Verdone</p>
<p>choose 12 credits</p>	<p>Multimedia Services and Applications M B6 D. Tarchi</p>
<p>choose 6 credits from Tab. C-1</p>	<p>Creativity and Innovation M F3 G. E. Corazza</p>
<p>choose 3 credits</p>	<p>Project Management and Soft Skills M F3 R. Verdone</p>

Antennas for Wireless Systems M

(D. Masotti) B6

- ◆ Main antennas (wire, patch) operating principles and design
- ◆ Antennas array (multiple antennas combination) theory
- ◆ Antennas exploitation in modern **5G-IoT** applications:

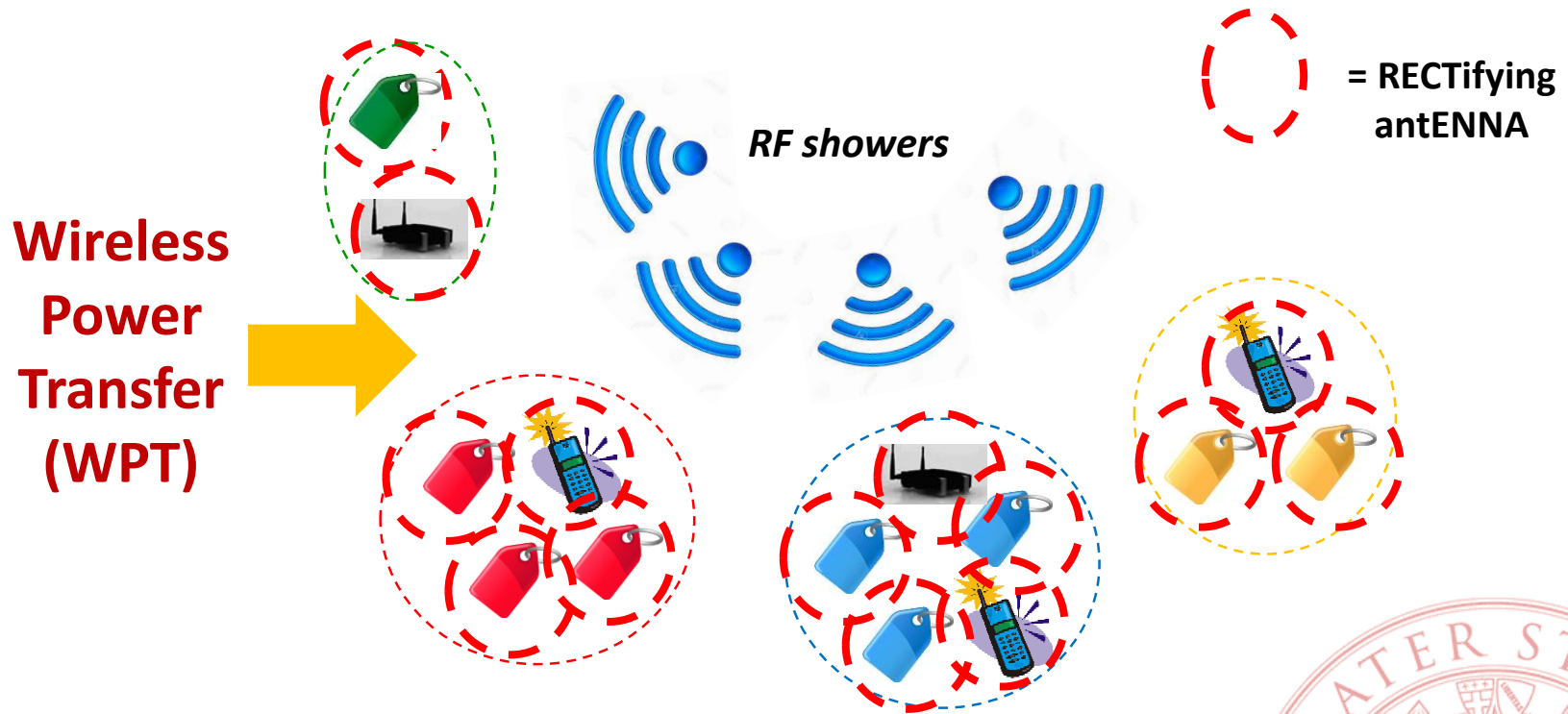
**RF energy
harvesting**



Antennas for Wireless Systems M

(D. Masotti) B6

- ◆ Antenna exploitation in modern **5G-IoT** applications:






























- ◆ Laboratory: Electromagnetic design of cell-phone multi-band antenna and single-band rectenna

Multimedia Services and Applications



Multimedia Services and Applications

	Image	Video	Audio
Representation	 	     	
Transmission		     	 
Service		     	  

Optical Fiber Systems

Learning Outcomes of the Course

- Knowledge of the operation of the building blocks of optical transmission systems, aimed to their basic design in different realistic scenarios.



Treated Topics

1. Transmission and Processing of Optical Signals

- Optical fiber: main characteristics
- Optical Transmitters and Receivers
- Optical Components for Telecommunications and Sensors

2. Laboratory activities with optical systems and devices

- Lasers, optical modulators, photodiodes, couplers, circulators, WDM couplers/splitters
- Optical Spectrum Analyzer
- Three-port Vector Network Analyzer
- Vector Signal Analyzer (9 kHz-6 GHz, Analysis band 31.25 MHz)
- Vector Signal Generator (9 kHz-6 GHz, Modulation band 120 MHz)
- ...

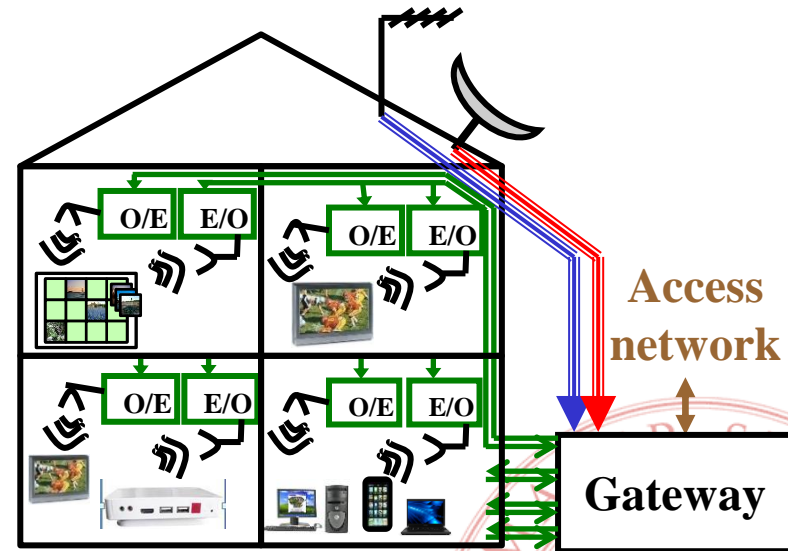
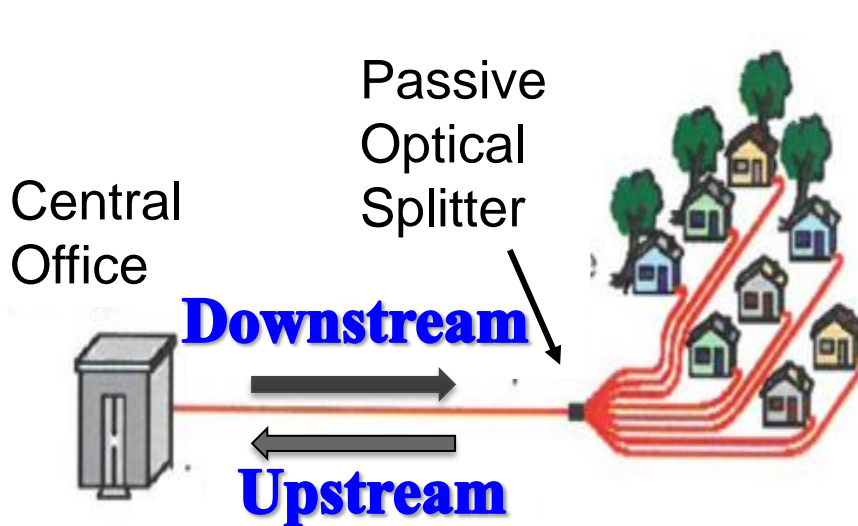


Optical Fiber Systems

Treated Topics

3. Basic Analysis/Design of practical Optical Systems

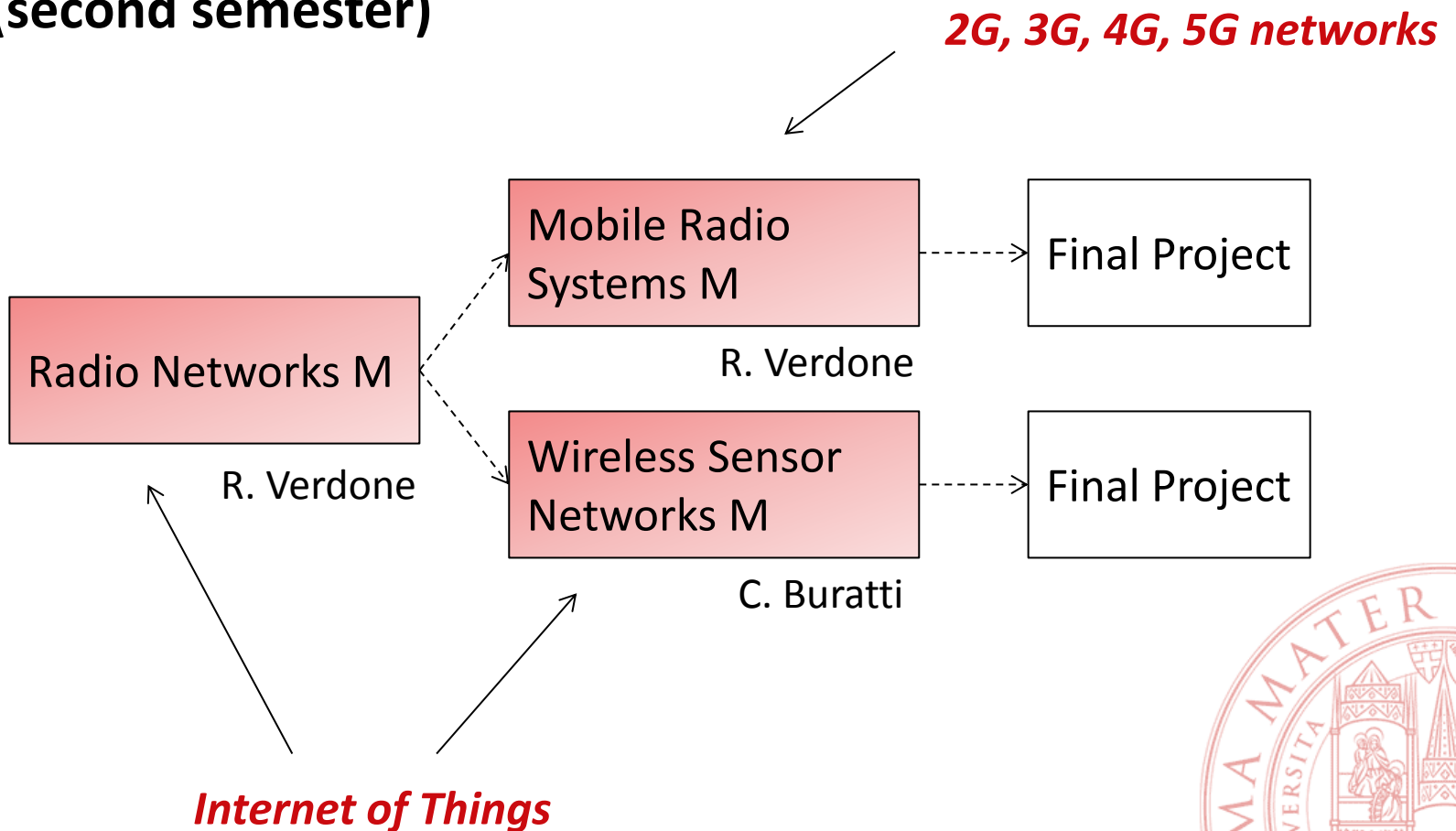
- WDM High Speed connections
- Metro Area and Access Networks
- In-Building Scenarios



Courses by Radio Networks Group

**First Year
(second semester)**

Second Year



Radio Networks M

- Foundations
- System-Level View



Radio Networks M

- System-Level View



Is it a transmitter? A receiver?

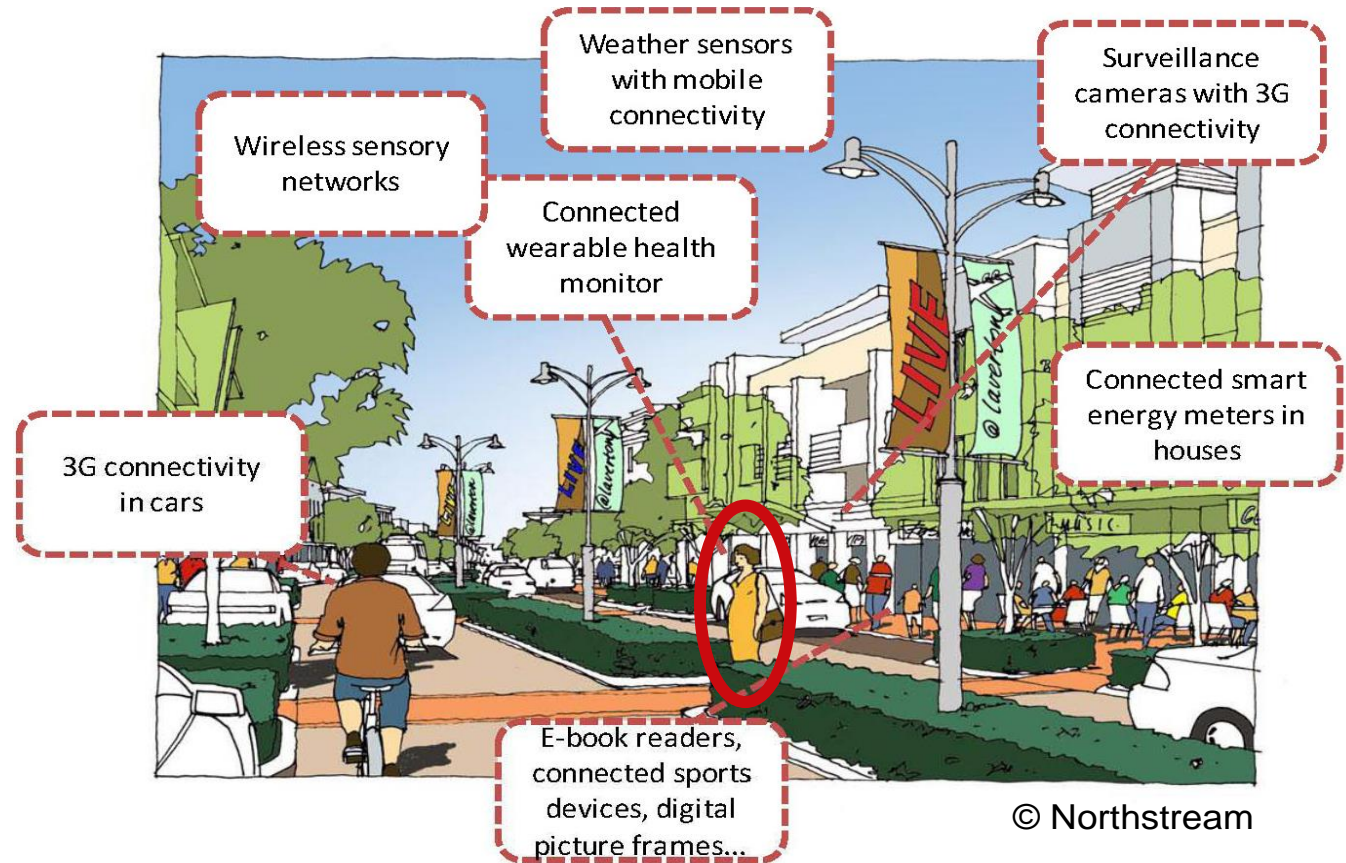
Is it an amplifier? A filter?

Or an antenna?



Radio Networks M

- System-Level View



Mobile Radio Systems M

- Evolution from 2G onwards
- System-Level View



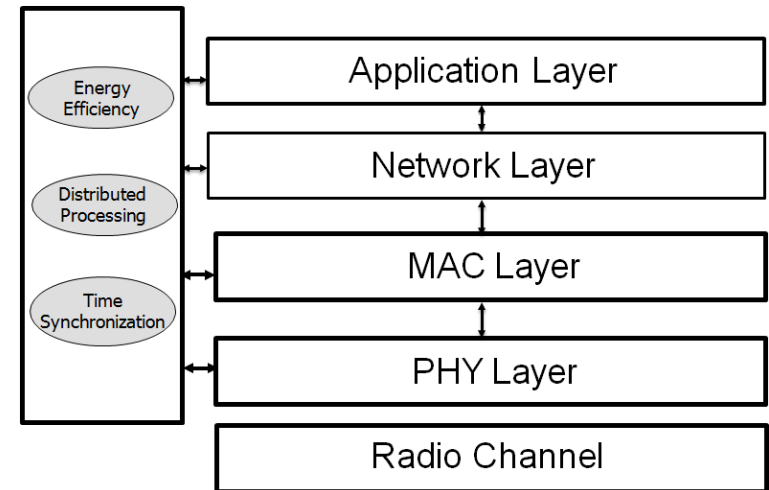
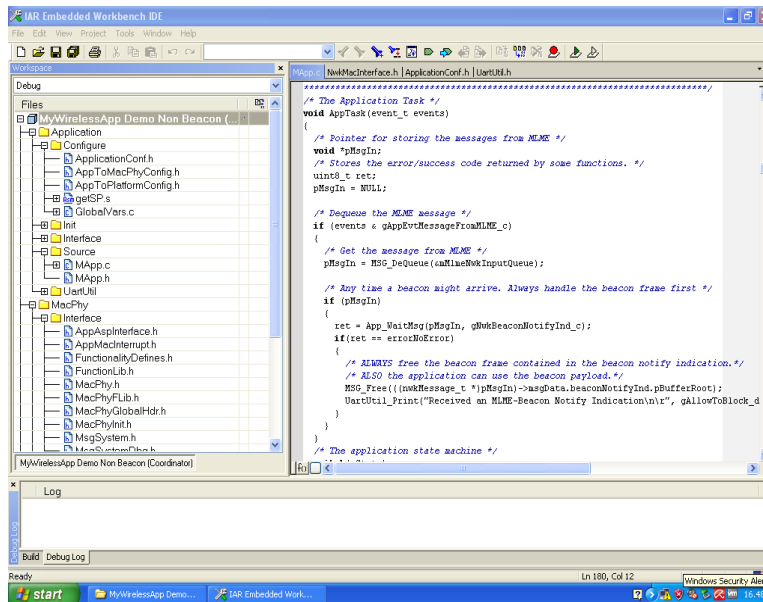
Wireless Sensor Networks M

- Design of a Wireless Sensor Network
- Implementation of a Wireless Sensor Network



Wireless Sensor Networks M

- Full Protocols Stack Addressed
- Implementation on Real Devices



Project Management and Soft Skills M (3 credits)

- ability to apply knowledge of math, science, and engineering
- ability to design and conduct experiments, analyse/interpret data
- ability to design a system, component, or process to meet req.s
- **ability to function within multi-disciplinary contexts**
- **ability to identify, formulate, and solve engineering problems**
- **understanding of professional ethical responsibility**
- **ability to communicate effectively**
- **ability to assess the impact of solutions in a societal context**
- **ability to engage in life-long learning**
- **knowledge of contemporary issues**
- **ability to use the techniques, skills, and modern engineering tools**



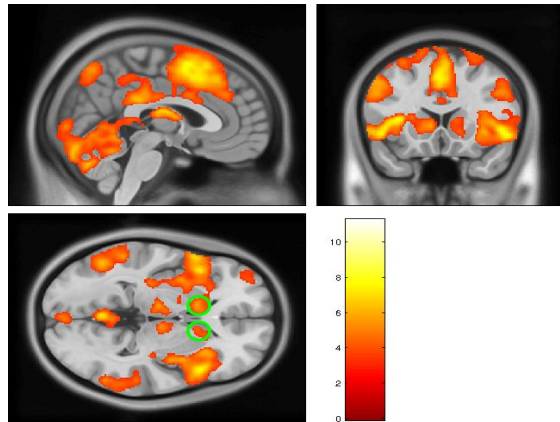
1st year choices - Type F

57 credits	
First Semester	Second Semester
<p>Electromagnetic Propagation for Wireless Systems M B9 F. Fuschini/G. Tartarini</p>	<p>Information Theory and Coding M B6 G. E. Corazza/A. Vanelli Coralli</p>
<p>Communic. Systems: Theory and Measurements M B9 O. Andrisano</p>	<p>Antennas for Wireless Systems M B6 D. Masotti</p>
<p>Network Design M B6 C. Raffaelli</p>	<p>Optical Fiber Systems M B6 G. Tartarini</p>
<p>Mathematical Methods M C6 M. Ferri / N. Arcozzi</p>	<p>Radio Networks M B6 R. Verdone</p>
<p>choose 12 credits</p>	<p>Multimedia Services and Applications M B6 D. Tarchi</p>
<p>choose 6 credits from Tab. C-1</p>	<p>Creativity and Innovation M F3 G. E. Corazza</p>
<p>choose 3 credits</p>	<p>Project Management and Soft Skills M F3 R. Verdone</p>

Creativity and Innovation (F, 3 CFU)



- ◆ Creativity is necessary to the dignity of human beings



Global Challenge Insight Report



The Future of Jobs

Employment, Skills and
Workforce Strategy for the
Fourth Industrial Revolution

January 2016

- ◆ DIMAI: Modelling of the creative thinking process
- ◆ Idea generation rate: 10/h
- ◆ Application to start-up companies



1st year choices – Type C

57 credits	
First Semester	Second Semester
Electromagnetic Propagation for Wireless Systems M B9 F. Fuschini/G. Tartarini	Information Theory and Coding M B6 G. E. Corazza/A. Vanelli Coralli
Communic. Systems: Theory and Measurements M B9 O. Andrisano	Antennas for Wireless Systems M B6 D. Masotti
Network Design M B6 C. Raffaelli	Optical Fiber Systems M B6 G. Tartarini
Mathematical Methods M C6 M. Ferri / N. Arcozzi	Radio Networks M B6 R. Verdone
choose 12 credits	Multimedia Services and Applications M B6 D. Tarchi
choose 3 credits	Creativity and Innovation M F3 G. E. Corazza Project Management and Soft Skills M F3 R. Verdone
	choose 6 credits from Tab. C-1



Digital Systems M

- Course themes: combinatorial networks, asynchronous logical networks, synchronous logical networks
- Basic VHDL language elements
- Modern digital systems design using Xilinx Vivado FPGA design system
- The course is preparatory for more advanced design techniques based on high level languages

At the end of the course the student will be able to implement medium complexity logical devices

Exams consist first of a written test (about 2 hours) : if passed an oral exam takes place

Before a student can attend the exam a VHDL project must be implemented (design and test) . The project must be proposed by the student and accepted by the teacher

Principles Models and Applications for Distributed Systems

- **Learning outcomes**

Knowledge related to the technologies needed for management and usage of computer networks and distributed systems.

- **Course contents**

1. Basic elements of the hardware and software architecture of a network node.
2. Communication of network applications: methods and tools
3. Network security



Principles Models and Applications for Distributed Systems

Lab. activity

- Introduction to Java programming language
- Communication problems

Seminars

- The role of software in TLC
- Cloud computing
- Network virtualization
- Mobile devices and applications security
-



2nd year choices – core courses B

63 credits	
First Semester	Second Semester
<p>Optical Circuits and Networks M B6 P. Bassi / C. Raffaelli</p>	<p>Radioprotection and Spectrum Management M B6 M. Barbiroli</p>
<p>Mobile Radio Systems M B6 R. Verdone</p>	<p>Wireless Systems Laboratory M B6 A. Bazzi</p>
<p>Wireless Sensor Networks M B6 C. Buratti</p>	<p>Circuit Design for Wireless Systems M B6 A. Lipparini</p>
<p>Digital Receiver Design and Optimization M B6 G.E. Corazza/A. Vanelli Coralli</p>	<p>Antennas for Wireless Systems M B6 D. Masotti</p>
<p>Satellite Communication and Navigation Systems M B6 A. Vanelli Coralli</p>	<p>Optical Fiber Systems M B6 G. Tartarini</p>
<p>Choose 18 credits from this Tab. B-2</p>	<p>Radio Networks M B6 R. Verdone</p>
	<p>Multimedia Services and Applications M B6 D. Tarchi</p>
<p>Trends in Communications M F3</p>	
<p>Choose 6 credits from Tab. F-2</p>	
<p>Any course D (12 credits) – see Tab. D-2</p>	
<p>Final Project M E24</p>	

Wireless Systems Laboratory M B6

(Second Year, Second Semester)

Prof. A. Bazzi

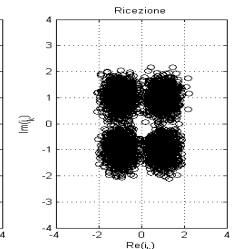
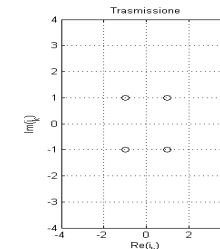
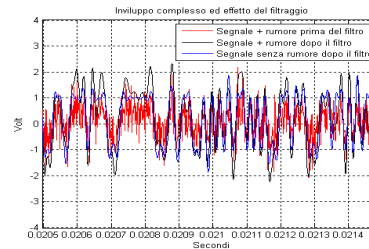
*Related courses in the first year: **Communic. Systems: Theory and Measurements***

Laboratory Activities ~80%

Content: design and performance evaluation of wireless systems through...

...Simulations...

Tools: Matlab, Simulink, ...

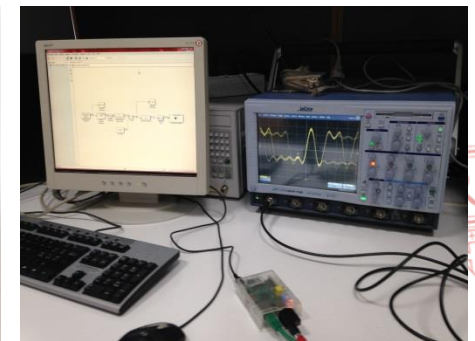


...and Measurements

Hardware: Raspberry Pi, Oscilloscopes,...



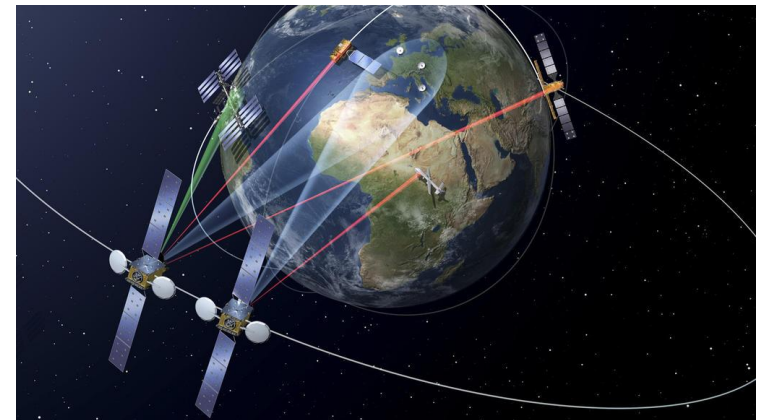
<http://www.simulinkdefinedradio.com>



More info: see the Unibo web page / write to alessandro.bazzi@unibo.it

Satellite Communications and Navigation Systems M B6

- ◆ Satellite Communications and Navigation systems are an integral part of modern and future communication systems:
 - GPS / Galileo
 - Direct TV broadcasting
 - Internet (broadband) access
 - Backhauling of 3G/4G/5G systems
- ◆ SatCom and SatNav
 - common background with wireless communication systems
 - specific challenges due to the space component (propagation, coverage, mobility, etc) and to the system architecture (ground/space/user segments)
- ◆ Instructor: Prof. Alessandro Vanelli-Coralli
- ◆ Related course
 - Protocols and architectures for space networks



Optical Circuits and Networks

- ◆ Instructors:
 - Prof Paolo Bassi
 - Prof Carla Raffaelli
- ◆ The course will introduce to:
Programmable Optical Networks
covering topics from:
Technology and Optical circuit design (1st module)
to **Network analysis and design (2nd module)**



Course contents will then illustrate

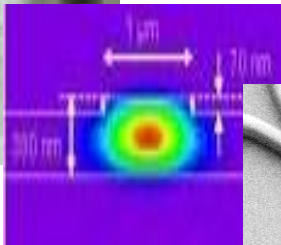
materials



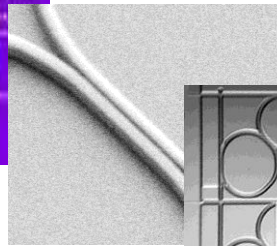
technology



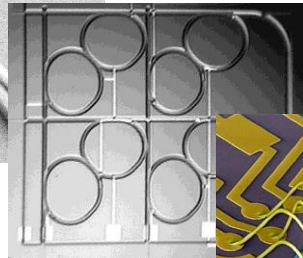
waveguides



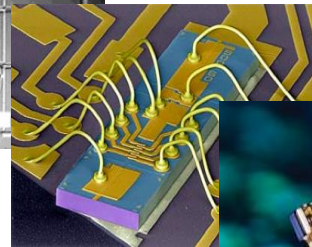
devices



circuits



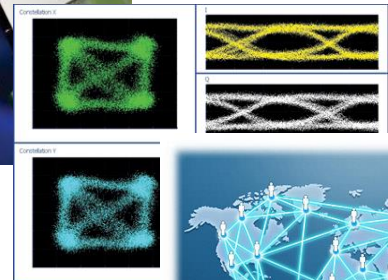
modules



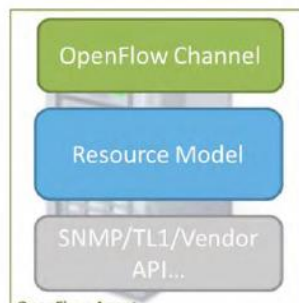
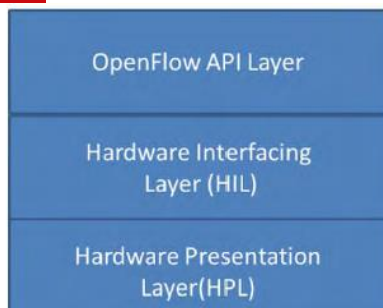
packaging



systems



network



Mobile Radio Systems M

- Evolution from 2G onwards
- System-Level View



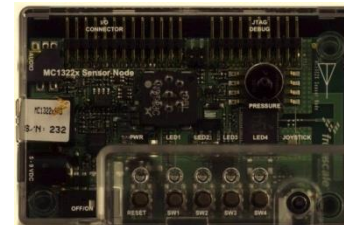
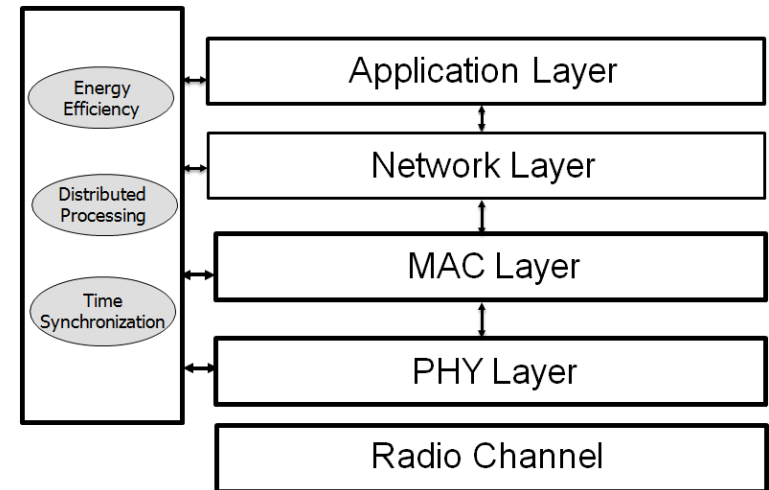
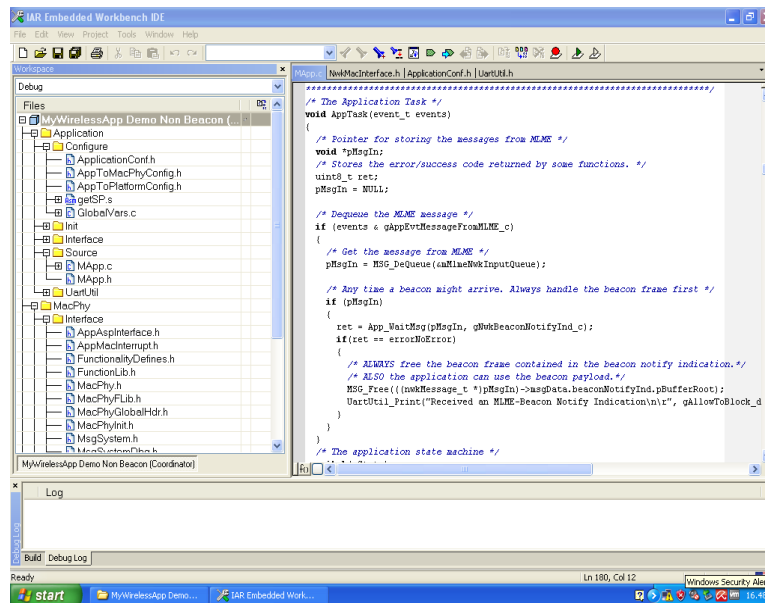
Wireless Sensor Networks M

- Design of a Wireless Sensor Network
- Implementation of a Wireless Sensor Network



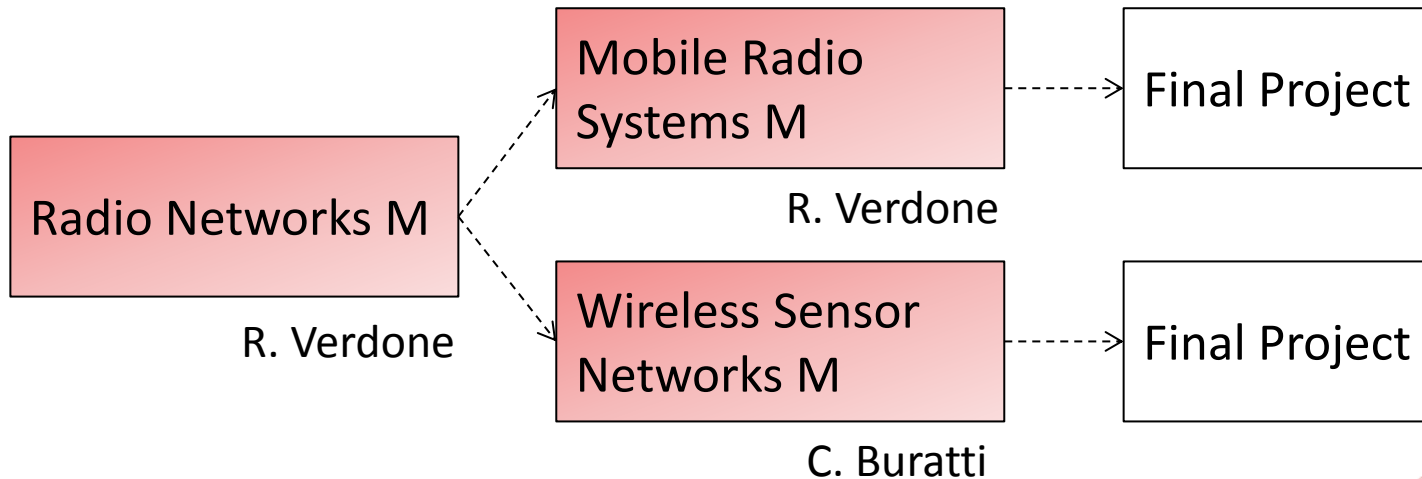
Wireless Sensor Networks M

- Full Protocols Stack Addressed
- Implementation on Real Devices



Courses by Radio Networks Group

To subscribe to our info channel please send an email to
radionetworks@robertoverdone.org



2nd year choices Table F-2 – Labs – P/F

(choose 6 CFUs)

Prot. and Arch. for Space Networks M F3

C. Caini

Software Development M F3

O. Andrisano

Laboratory of Networking M F3

W. Cerroni

**Laboratorio di software
per le telecomunicazioni T-A F3**

A. Vanelli Coralli

Creativity and Innovation M F3

G. E. Corazza

Project Management and Soft Skills M F3

R. Verdone

**Laboratory of High Frequency
Electronic Circuit Design M – F3**

C. Florian

Laboratorio di reti T F3

W. Cerroni

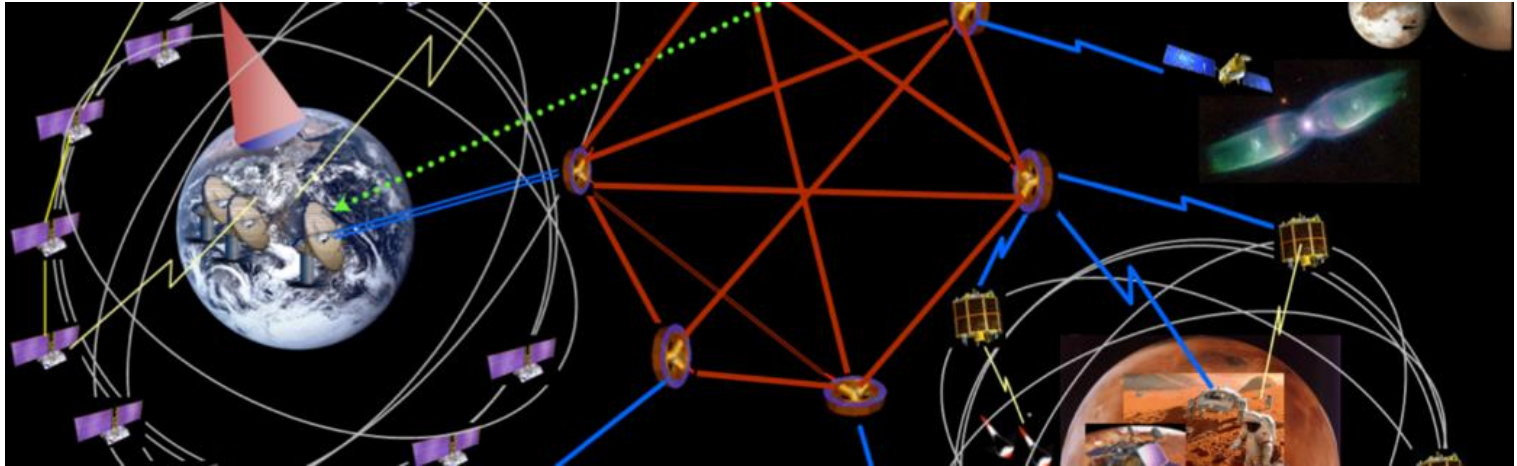
Progetto di sistemi in fibra ottica T – F3

G. Tartarini

Internship in ICT M - F6



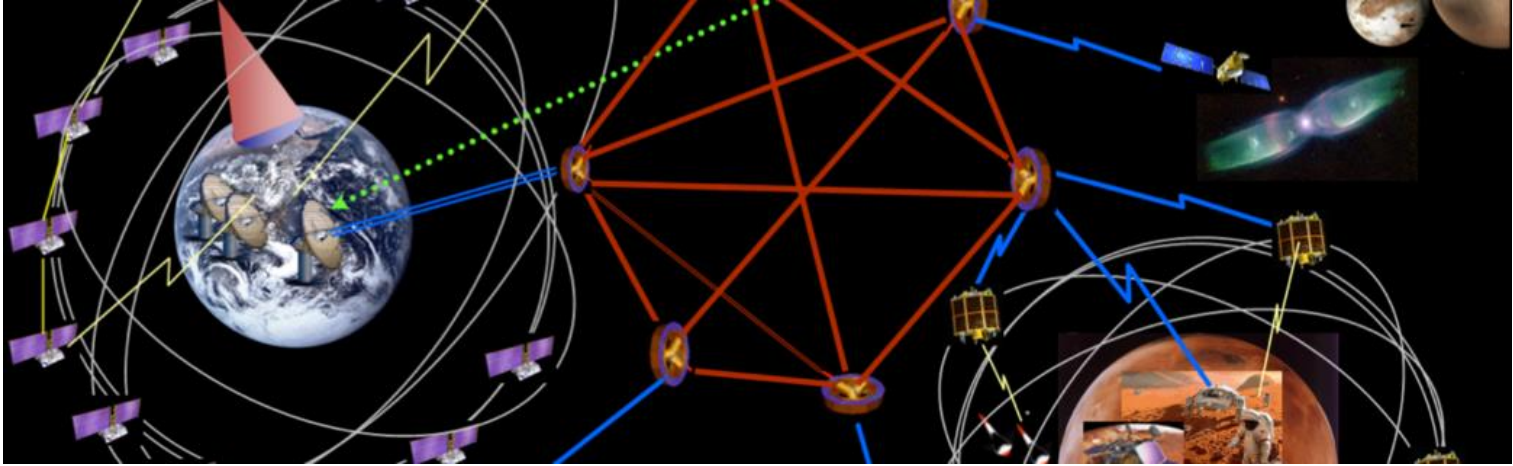
Protocols and architectures for space networks



- ◆ Prof. Carlo Caini
- ◆ F3 (30 hours, of which 15 Theory, 15 Lab)
- ◆ First semester 2nd year
- ◆ Pass/fail exam
- ◆ Basic background on TCP/IP networking required
- ◆ Complements “Satellite Communication and Navigation Systems” (Prof. A. Vanelli Coralli, in parallel)



Protocols and architectures for space networks



- ◆ June 21, 2016: New Solar System Internet Technology Debuts on the International Space Station
 - This month, NASA took a major step toward creating a Solar System Internet by establishing operational Delay/Disruption Tolerant Networking (DTN) service on the International Space Station.
 - The DTN service will help automate and improve data availability for space station experimenters and will result in more efficient bandwidth utilization and more data return.



Software Development

- ◆ **Prof. Oreste Andrisano**
- ◆ The following categories where your work can be included are listed below:
 - a) SW for programmable systems and devices - measurement activity**
 - b) SW for simulation of TLC systems and networks with special emphasis on mobile applications**
 - c) SW for smart networks (smart lighting, infomobility, localization...) and possible measurement activities**
 - d) SW for Big Data over sensor networks: acquisition, data processing and information reconstruction**



Software Development: different options

section a)

- ◆ SW for signal analysis in a digital transmission scenario
- ◆ PC controlled (baseband and passband modulations)
- ◆ - SW to analyse spectra of signals and disturbance

section b)

- ◆ SW for information processing in a vehicular network scenario
- ◆ SW for simulating the physical layer in a vehicular network based on Visible Light Communication (5G oriented)

section c)

- ◆ SW for integration of energy harvesting with sensor networks
- ◆ SW for programming devices for smart lighting
- ◆ SW for feedback system in a smart lighting environment

section d)

- ◆ SW for simulating the random positions of nodes in a WSN
- ◆ SW for simulating and evaluating information reconstruction in crowd-sensing
- ◆ SW for simulating uncertainties in multidimensional random sampling
- ◆ SW for big data oriented data bases



Software development: activity plan

◆ The activities will be planned

- vis-a-vis with the professor,
- no lectures in the room

◆ HOW to WORK:

- After your declaration of interest, we will fix a meeting to define
- and plan your activity.
- You are free to work in small groups (I will check your proposal).

◆ Assessment method

- The exam is done as follows.
The student presents
 1. A report on the activity carried out
 2. an electronic support containing all files that are necessary to the correctly execute the codeThe examination consists of a discussion on the activity, as well as on a demo of the software developed.

◆ link:

<http://www.engineeringarchitecture.unibo.it/en/programmes/course-unit-catalogue/course-unit/2016/391936>



Laboratory of Networking M F3

- ◆ 2nd year, elective, 3 CFUs, type F
- ◆ Practical perspective on advanced networking aspects
- ◆ Topics:
 - IP routing protocols: RIP, OSPF, BGP, MPLS
 - Quality of Service in IP networks
 - Emerging networking technologies: Software-Defined Networking (SDN), Network Function Virtualization (NFV)
- ◆ Lectures + laboratory sessions
 - open-source software tools
 - commercial networking equipment
- ◆ Requirements: basic networking backgrounds
 - Ethernet, VLANs, TCP/IP
 - Practical experience is a plus



Laboratorio di Reti di TLC T (3 CFU)

- ◆ Laboratorio di Reti di TLC T can be given in English (II semester/I YEAR)
- ◆ Network interface configuration, proxy ARP, DHCP server
- ◆ Ethernet switch management and virtual LAN (VLAN) configuration
- ◆ IP packet forwarding, tools for firewall and NAT implementation
- ◆ Basics of network security issues and IPsec-based VPN set-up

HIGHLY RECOMMENDED TO STUDENTS INTERESTED IN PRATICAL LABS
(not coming from UNIBO 3-year program)



Internship in ICT M F6

Internship for Final Project

To increase visibility of career opportunities

- ◆ 1 CFU = 25 hours
- ◆ Internship for ICT M 6 CFU
 - 150 hours, 1 month
- ◆ Erasmus placement support for Internship abroad
- ◆ Internship for final project M 12 CFU
 - 300 hours, 2 months

TAB. E-2 (choose 24 cfu)		
Learning activity - Attività formativa	TAF	CFU
Final Project M-A	E	24
Final Project M-B	E	12
Internship for final project M	E	12

Schedule for study plans and course choices

- First intake: October 17 – November 18 (2016)
- Second intake: February 13 – March 10 (2017)



The aim of the Master program

- Prepare Engineers with a strong competence in the Telecommunications area
- Here are some practical suggestions.....



How to be successful

- Take notes during class
- Ask question when teacher invite you to do (raising your hand)
- Study material before next class
- Contact Professors or tutors for explanation soon in case of unclear material
- Do carefully assigned tasks
- Be on time at classes and exams



Interactions with Instructors

- Take advantage of receiving hours
- Contact Professors or tutors for an appointment at the end of the class or by e-mail
 - Be sharp with appointment
 - When tutors fix you appointment you must go at the appointment
 - Don't wait the last few days before the exam
- Tutor are also available for this task
 - All courses 1 semester/1 year have one (new!)
 - Looking forward to having your feedback



Exams

- Three periods for exams:
 - January/February
 - June/July
 - September
- 6 calls are commonly offered
 - Choose one and tackle it with the best preparation you can
 - Not overlapping with classes



Personal study plan

- In case for any reason (courses C, D, ..., international mobility) you need to propose something different in your personal study plan you have to contact immediately the study plan commission of the programme
- Prof. Marina Barbiroli
marina.barbiroli@unibo.it
- In case you fix an appointment you must respect carefully day and time of the appointment



The questionnaire

- You will be invited to fill a questionnaire at the end of each course
- The questionnaire is highly important for many aspects and especially to improve the course
- Be careful and responsible about this task
- Your answers to the questionnaire report your final perception of everything related to the course
- Do not wait for the questionnaire to alert the Professor about critical aspects



DEI's international Desk: assignments

Dr. Giulio Ascari

- Residence permit support
- Advice on study plans, international mobility, internships etc...
- Interface with headquarters' offices

Giulio Ascari

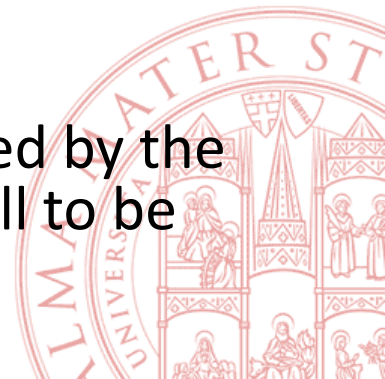
Second floor – new building

giulio.ascari@unibo.it – 051 20 93 648



International Mobility

- Overseas: “Call for applications” now open – application deadline: November 3
- Info meetings (Belmeloro): October 18 (Canada and California), October 21 (USA)
- Erasmus +: “Call for applications” to be opened in December/January
 - Courses or final project preparation
- Fellowships of the School of Engineering for Final project preparation (2 calls: May and October)
- Additional fellowships for periods abroad awarded by the telecommunications Engineering Programme (call to be scheduled)



Contacts

Course venue: Alma Mater Studiorum – Università di Bologna

Department of Electrical and Information Engineering

Viale del Risorgimento, 2 – 40136 Bologna

Contacts and useful website: Giulio Ascari – Students Advisor

giulio.ascari@unibo.it - +39 051 20 93 648

Program website: <http://unibo.it/TelecommunicationsEngineering>

City of Bologna: <http://www.bolognawelcome.com/en/>



Table C (choose 6 CFUs)

Optimization Models and Algorithms M C6

D. Vigo

Resources Optimization M C6

D. Vigo

**Hardware and Software design of
embedded systems M C6**

L. Benini

Digital Systems M C6

G. Neri

**Elements of Statistics and Signal Processing
M C6**

R. Rovatti

**Principles, Models and Applications
for Distributed Systems M C6**

M. Boari

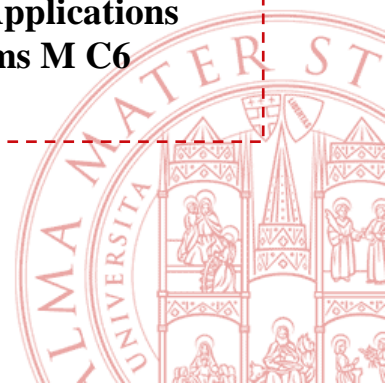


Table D – any discipline (choose 12 CFUs)

	Any exam from table F-2
	Any exam from table B-2
	Any exam from table C-1
Numerical Methods M – 6 CFU	
Computer Architectures M – 6 CFU G. Neri	
Elettronica delle telecomunicazioni M-A – 6 CFU A. Santarelli	
Statistics, Algorithms and Systems for Big Data processing M– 12 CFU R. Rovatti	
Metodi numerici per l'ingegneria M – 6 CFU F. Sgallari	



Table F-2 – Labs – P/F (choose 6 CFUs)

Prot. and Arch. for Space Networks M F3

C. Caini

Software Development M F3

O. Andrisano

Laboratory of Networking M F3

W. Cerroni

**Laboratorio di software
per le telecomunicazioni T-A F3**

A. Vanelli Coralli

Creativity and Innovation M F3

G. E. Corazza

Project Management and Soft Skills M F3

R. Verdone

**Laboratory of High Frequency
Electronic Circuit Design M – F3**

C. Florian

Laboratorio di reti T F3

W. Cerroni

Progetto di sistemi in fibra ottica T – F3

G. Tartarini

Internship in ICT M - F6

