Summary of the scientific output of the ESoA course on Antenna project management

Involved institutions: EPFL, IMST, EADS, POLITO

Teachers: Prof. Marina Mondin (POLITO), Dr. Silvia Raffaelli (EADS), Dr. Catherine Monnin(EPFL), Dr. Marta Martinez-Vazquez (IMST), Prof. Anja Skrivervik (EPFL)

Students: 16 students from 12 different institutions: Shady Keyrouz, Arancha Dominguez Casas, Antoine Chauloux, Sébastien Clauzier, Isam Alawneh, Tomas Zvolensky, Nikolay Knyazev, Gaspard Lugrin, Deepak Singh Nagarkoti, Oluyemi Peter Falade, Shambhu Nath Jha, Maria Alberica Saporetti, Mohsen Koohestani, Anton Ivanov, Erio Gandini, Jovanche Trajkovikj.

The aim of this course was to provide the students with the required background to efficiently cope with the technical management of an antenna project. The technical key steps of a project, starting from a customer's needs, to the final antenna design and testing have been approached. The students have learnt how to clarify the requirements of a customer, make tradeoffs, look for additional information like standards, propagation channels, telecommunication theory and link budgets to establish the antenna specifications, and finally propose the best antenna system to fulfill those requirements. All this was done keeping an eye on the budget and the timeframe of the project. Topics treated included a review of antennas and systems and their characteristics, but also a review of the relevant telecommunication theory and an introduction to project management, from the industrial point of view.

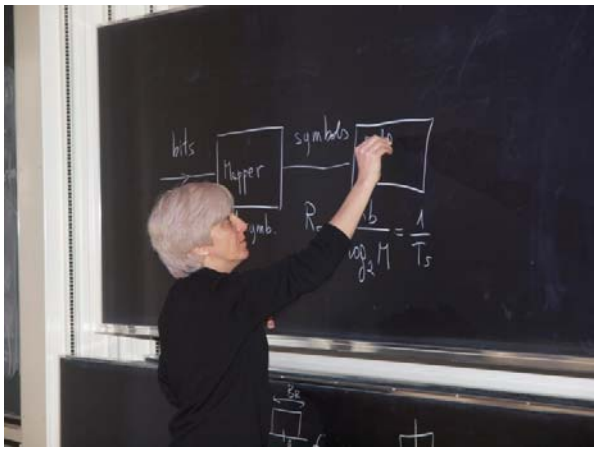
The course was aimed to PhD students and Postdocs, but was followed by two persons from industry. It consisted of theoretical classes in the morning and practical team work in the afternoon. In these practical session, each group was given an industrial antenna problem, linked for instance to wireless application in the automotive sector, or to future telecommunication platforms. The initial requirements were quite general, and the groups have during the week refined these requirements to come up with specifications and potential solutions. The groups presented their work to a panel at the end of the week.

Description of the scientific content and discussion of the event

Scope of the Course and Prerequisites:

The aim of this course is to provide the students with the required background to efficiently cope with the technical management of an antenna project. The technical key steps of a project, starting from a customer's needs, to the final antenna design and testing will be approached. The students will learn how to clarify the requirements of a customer, make tradeoffs, look for additional information like standards, propagation channels, telecommunication theory and link budgets to establish the antenna specifications, and finally propose the best antenna system to fulfill those requirements.

Outline:
- Introduction to project management.
- Antenna families
- Antenna scenarios and their implications on projects
- Telecommunications systems and their relevance to antenna projects
- Antennas: Examples from industrial projects
- Introduction to planning and testing aspects
- Practical assignments: project development



Professors Raffaelli and Mondin

Professors Martinez-Vazquez and Skrivervik

Venue

The course has been held at the EPFL, in a medium sized classroom (45 places). The practical work in the afternoons was performed in the LEMA student's lab, reserved to this aim. The students had access to computers, library (books and electronic access to all major antenna journals and proceedings), simulation tools (matlab, HFSS, CST) and usual office software. No fees have been given to the University for the Lecture Room.

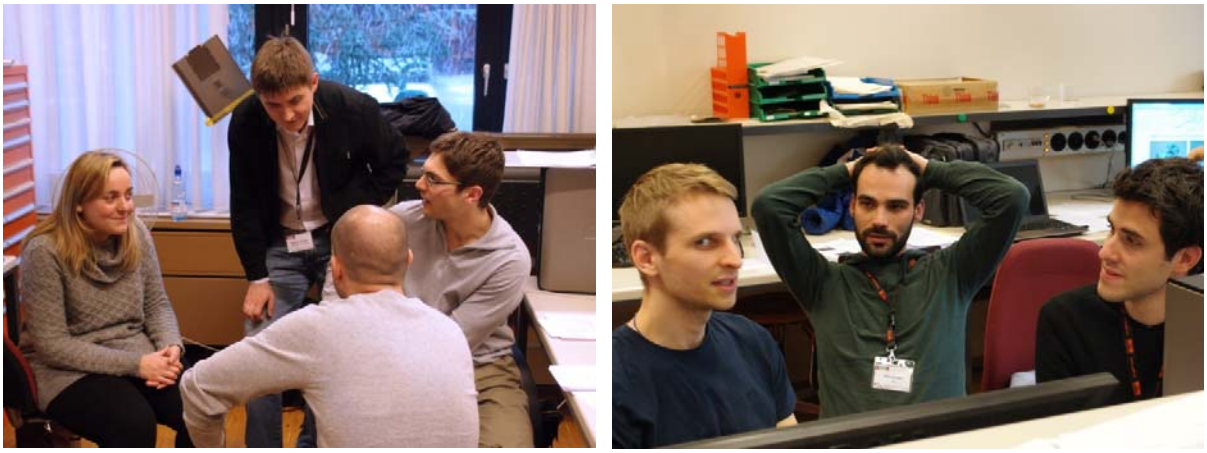


Fig. 2. Team work in the lab.

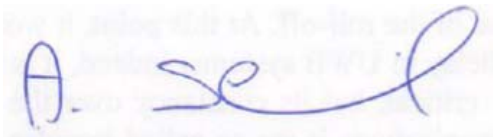
Material given to the students
All the students have been supplied with the copies of the slides presented by the speaker.

Personal project
The students, divided in teams of 4, had to apply the management principles learned. To this aim, they had to respond to a realistic tender with a proposal containing the sketch of the scientific content and all the management parts. They had to defend their proposal at the end of the week in front of a panel. The students were very enthusiastic about this project and produced excellent results. They were very committed and worked a lot of extra hours on their assignments. The list of assignments and examples are given in the appendix.

Credits, exams and their outcome
The overall number of hours and the time the students have spent on their projects is such as to justify **2 ECTS credits** for this course. A certificate of Completion has been delivered.

Evaluation of the course from the students, detected strong and weak points
The standard ESOA evaluation form, extended with an extra part for the practical project was distributed to the students; all students completed the evaluation form. The outcome is reported in Table III. After the outcome of the evaluation form and after discussion and interaction with the students, we have noticed a very high level of global satisfaction. The pertinence of the practical work was especially stressed by the students.

Lausanne, 19.03.2013



Anja Skrivervik

Appendix: Final program

Monday, 4th of February 2013: Introduction to project management

Hour	Topic	Lecturer
9:00-9:15	Course presentation	Anja Skrivervik
9:15-11:00	Introduction to Project management	Catherine Monnin
11:00-11:30	Coffee Break	
11:30- 13:00	Introduction to Project Management	Catherine Monnin
13:00-14:30	Lunch	
14:30-16:00	Distribution of Assignements, first discussions	Anja Skrivervik
16:00-16:30	Coffee Break	
16:30-18:00	Work on assignements	Anja Skrivervik

Tuesday, 5th of February 2013: Antenna Aspects

Hour	Topic	Lecturer
9:00-10:45	Antennas I : antenna families	Marta Martinez
10:45-11:15	Coffee break	
11:15-13:00	Antennas II : scenarios	Marta Martinez
13:00-14:30	Lunch	
14:30-16:00	Group work on assignments	Anja Skrivervik
16:00-16:30	Coffee Break	
16:30-18:00	Group work on assignments	Anja Skrivervik

Wednesday, 6th of February 2013: Telecommunication aspects

Hour	Topic	Lecturer
9:00-10:45	Introduction to telecommunication theory I	Marina Mondin

10:45-11:15	Coffee break	
11:15-13:00	Introduction to telecommunication theory II	Marina Mondin
13:00-14:30	Lunch	
14:30-16:00	Group work on assignments	Anja Skrivervik
16:00-16:30	Coffee Break	
16:30-18:00	Group work on assignments	Anja Skrivervik

Thursday, 7th of February 2013: Industrial aspects

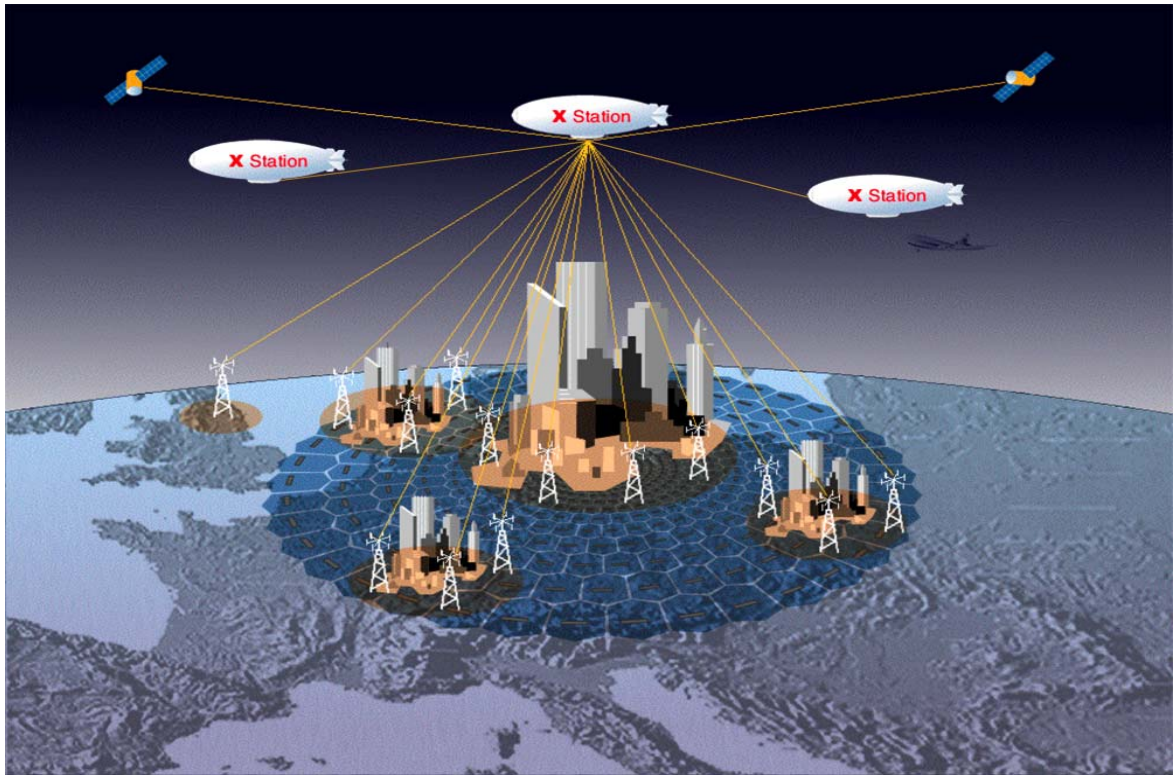
Hour	**Topic**	**Lecturer**
9:00-10:45	Introduction to antenna projects and their management	Silvia Raffaelli
10:45-11:15	Coffee break	
11:15-13:00	examples of industrial antenna projects	Silvia Raffaelli
13:00-14:30	Lunch	
14:30-16:00	Group work on assignments	Anja Skrivervik
16:00-16:30	Coffee Break	
16:30-18:00	Group work on assignments	Anja Skrivervik

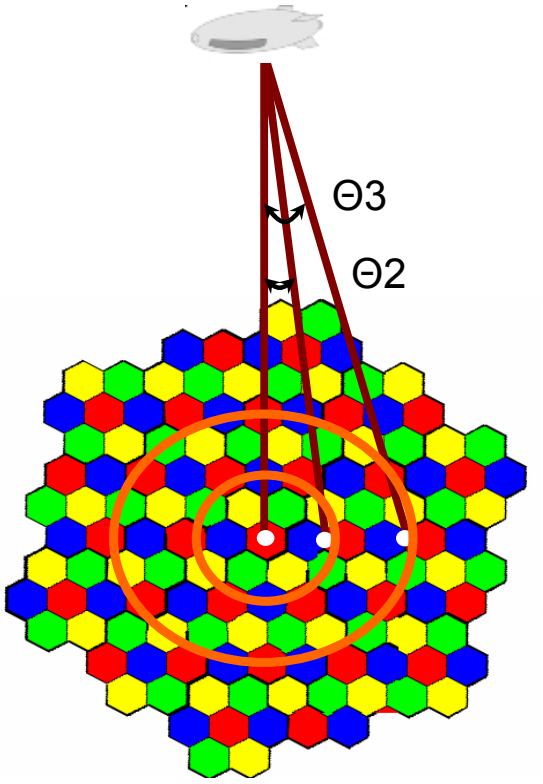
Friday, 8th of February 2013: Presentations, Discussions and Wrap up

Hour	**Topic**	**Lecturer**
9:00-10:45	Planning aspects	Anja Skrivervik
10:45-11:15	Coffee break	
11:15-13:00	Presentations of group work, grading of projects	Anja Skrivervik
13:00-14:30	Lunch	
14:30-16:00	Final discussions and course assessments	Anja Skrivervik
16:00-16:30	Coffee Break	

Appendix 2: example of project for team work

Base station antenna for a cellular system located on a High Altitude Platform.





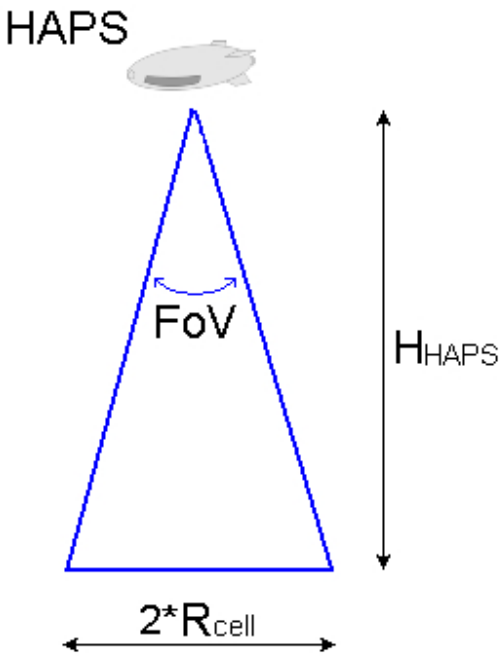
Example of a cellular network with a 4 frequency re-use scheme.

We want to develop a cellular network using bases stations located on High Altitude Platforms (HAPs).

Plan the antenna design for the base station antenna located on the HAP, knowing that :

Frequency	27.5 - 31.3 GHz
Bandwidth	3.8 GHz (=13%)
HAPs Antenna Gain	19 dB (TBC from link budget)
H_{HAPs}	21 Km
FoV	13,6
Rcell	2.5 Km

A demonstration breadboard should be delivered and characterized by the end of the project.



The maximum budget allocated for this design phase is 60 k€.

Indications : the planning should include :

- A first estimation on how many cells can realistically be covered by one HAP station, considering a 4 frequency re-use scheme and a 7 frequency re-use scheme
- An estimation of the link budget
- The antenna specifications
- Antenna architecture candidates that might fulfill the specification
- A first assessment of those architectures
- A time plan, with milestones
- A test plan
- A sketch for a cost (what points it should include, not how much it will really cost)