1SC2391 – Restoring telecommunications after a natural disaster

Instructors: Raul De Lacerda
Department: DOMINANTE - SYSTÈMES COMMUNICANTS ET OBJETS CONNECTÉS
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 40
On-site hours (HPE): 27,00

Description

The project "Restoring Wireless Communications Infrastructure after Natural Disaster" is one of the 3 Integration projects that conclude Thematic Sequence 2 (ST2) SCOC : Communicating Systems and Connected Objects. It sheds concrete light on the implementation of a wireless communication network after the passage of a hurricane. The implementation of a resilient solution takes into account the geographical and human factors of the island.

"Relief operations are based on a fast communication network to be implemented"

This topic deals with the real case of a natural disaster taking place on the island of Saint Martin. Located in the Caribbean, this island, like those surrounding it, is subject to numerous hurricanes from mid-May to the end of November. These hurricanes, of varying strength, can be powerful enough to destroy all installations linked to the communication network. This was the case with Hurricane Irma in 2017. This is the framework within which we will place ourselves. The entire wireless communications infrastructure on the island was wiped out by the hurricane. Your job is to study the characteristics of the island and to propose a solution in order to set up a resilient telecommunications network throughout the island for long-term use.

The dimensioning of the network will have to take into account the distribution of populations on the island to ensure a service adapted to the main areas of demographic concentration. The quality of communications is an essential factor in ensuring 4G coverage for all users. Your solution will have to include the dimensioning of a hertzian link between the network of the island of Saint Martin and the neighbouring island (spared by the hurricane) which is connected to the mainland by means of an optical fibre. Your study should be based on realistic data. It will use simple propagation models seen in the specific course of the thematic sequence. The use of

simulation software to check the quality of radio coverage and the relevance of the distribution of base stations is one option among others to argue your architectural choices.

"The realization of your mission will take into account the time dimension".

Several milestones essential to your project will be defined:
(i) It is necessary to propose the characteristics of the emergency communication network to be set up. This solution must ensure coverage of the island's two airports and the capitals Marigot and Philipsburg. This solution must be set up within 12 hours after the passage of the hurricane in order to organize rescue operations on the island. The key word is "emergency".
(ii) The second solution is to propose an intermediate network providing radio coverage for the entire population of the island. The capacity of the network is a parameter to be taken into account in the sizing of the proposed solution. All solutions must be costed and justified.
(iii) The proposed solutions must support backhall links between cells. This is essential for the operation of the communication network.
(iv) It is necessary to provide a microwave link with the neighbouring island in order to maintain contact with the rest of the world. This link must support the capacity of the entire island of Saint Martin.
(v) The sustainable solution must be resilient and economically viable. The partner of this EI is Nokia. It will provide you with the various technological solutions in its catalogue. The energy supply of your solutions is your responsibility. Nokia has solar solutions that you should take into account.

The subject thus proposed is intended to put you in the position of the technical sales engineer who has to size a wireless communication network according to the geographical location of transmitters and users, the antennas used or the nature of the propagation model used. Depending on the propagation model chosen, you will need to readjust your solution and its impact on resilience and cost. Depending on the choice of propagation model, you can negotiate the final cost of your solution. Your strategy is to quantify the different options according to the coverage-resilience-cost trade-off. You will have two Nokia experts who will accompany you throughout the week to evaluate your proposals and guide your choices towards a concrete solution.

Quarter number
ST2

Prerequisites (in terms of CS courses)
None

Syllabus

Day 1

(i) Problem identification and analysis of technological solutions proposed by Nokia.

(ii) Identification of the island context and formulation of a coverage proposal for the airports on the island of Saint Martin and the capitals Marigot and Philipsburg.

(iii) An initial costing is expected by the end of the day (4 p.m.) for a first deliverable: 5 slides describing the problem and the first coverage solution for the emergency services.

Day 2

(i) Identification of the needs of each zone of the island to size the capacities of each node of the network.

(ii) Assessing radio frequency signal levels to test radio coverage according to the propagation model used and the geographical positions of the nodes of the proposed network. Validation of the calculation assumptions via simulation software. A discussion with a Nokia expert should be scheduled at the end of the day to explain your strategy.

(iii) Coverage and capacity; a balance to be found

Day 3 morning

(i) Sizing of the capacities of the different nodes of the network

(ii) dimensioning of the radio-relay system with the neighboring island

Day 3 afternoon and Day 4 morning

(i) Preparation of an assessment of the solution to be presented to Nokia experts at the end of day 3.

(ii) The morning of Day 4 should allow you to refine your final presentation.

Day 5

Your oral presentations are ready. Auditions will take place in the morning in front of Nokia-Sacaly experts and prizes will be distributed.

Class components (lecture, labs, etc.)

This course "**Restoring Wireless Communications Infrastructure after Natural Disaster**" is a **Problem-Solving** learning activity. It allows students to confront a concrete telecommunication problem. The student must work in teams to carry out a mission that the group must present and argue according to technical and economic criteria. The teaching is programmed over a "blocked" week. During the week, students work in groups of 5 to 6 students, supervised by a team composed of experts from Nokia and teacher-researchers from CentraleSupelec. The communication with the management team is horizontal and requests are taken care of throughout the week.

Progress points will be made on a daily basis.

Grading

The evaluation will take into account: individual attendance, involvement in group work, relevance of technical-economic choices, oral presentations and discussions with experts (questions/answers).

Course support, bibliography

«Antennas and Propagation for Wireless Communication Systems», Simon R. Saunders, Alejandro Aragón-Zavala

Resources

Teaching team :
A. Wautier (PR, CS, L2S),
S. Hoteit (MCF, CS, L2S),
R. de Lacerda (MCF, CS, L2S)

Experts from Nokia-Saclay :
E. Preira
S. Chabbouh

Taille de l'effectif : 30 à 35
Outils logiciels : CloudRf

Learning outcomes covered on the course

At the end of the course, students will be able to :

- Understand the stakes of the implementation of a telecommunication network for exceptional situations
- Selecting network components based on the technical characteristics imposed by a customer
- Building a technical argument and fine-tuning a commercial offer
- Prioritize the constraints of a modeling problem
- Establish technical reasoning on the basis of complex and different kinds of parameters
- Build a solution from a simple model and propose alternatives based on more complex models
- To take a critical look at a solution and justify its limits
- Presenting a problem-solving approach in a well-argued manner

Description of the skills acquired at the end of the course

C1 Analyze, design, and build complex systems with scientific, technological, human, and economic components
C4 Have a sense of value creation for his company and his customers
C7 Know how to convince
C8 Lead a project, a team