Ph.D. Position in Optimization of Scheduled Maintenance Operations for Complex Industrial Systems

Background

This PHD project will be held at CentraleSupélec – Paris-Saclay University, in the department of Industrial Engineering (http://www.lgi.centralesupelec.fr) of CentraleSupélec. It will be hosted by the team Safety and Risk (http://www.lgi.centralesupelec.fr/en/node/167) and the industrial chair Risk and Resilience of Complex Systems (RRSC). This chair is funded by 3 major actors of the French industry: EDF (Power supply provider), Orange (Telecom) and SNCF (Railway).
The chair has two main missions: to ensure a level of scientific excellence and to promote the transfer of knowledge and technology. The objective for the partners is to share common concerns, contribute to the development of pooled models and exchange on use cases. The chair is based on a team of 3 experienced permanent staff and several PHD students.

The main topics covered are risk analysis and optimizing the resilience of complex systems. The three lines of work identified are:

1. Modeling systems of systems and interdependencies for risk management and resilience between several operators.
2. Modeling and optimizing maintenance phases to reduce their impact on intra- and inter-operator service continuity.
3. The development of a common platform of models and methods and the implementation of sensitivity studies.

The present PHD project is in line 2. The candidate will take benefits of an exceptional environment, both from the academic side and the industrial one, being in contact with internationally recognized researchers and key stakeholders in the industry.

Industrial and scientific issues

Preventive maintenance programs are a critical topic for operators of complex systems as they can adversely affect customer safety and their satisfaction in the short to medium term. The challenge is to make optimal decisions that do not harm the safety of users of the systems while preserving maximum continuity of service over a given horizon. At the scale of a complex system or a system of systems, the development of a maintenance program is not a simple task and its optimality can only be evaluated through dedicated analysis tools and simulation methods.

The industrial partners of chair RRSC agree on the fact that a significant number of scheduled maintenance decisions are certainly not made in an optimal way, because they are not based on a clear methodology nor appropriate quantification tools. The gain obtained from preventive maintenance operations must be evaluated and improved through methodological work of analysis, modeling and simulation addressing the following issues:

a. Modeling and analysis of inter-dependencies between several subsystems which all contribute to the continuity of service of the whole.

b. Joint modeling and optimization of preventive maintenance and the functional chain by routing production/traffic/users dynamically according to preventive maintenance actions and scheduled shutdown of certain sub-systems (servers, tracks, sorting lines luggage,…).
c. Correct sizing of redundancy: optimal use and/or questioning of the existence of hardware redundancies to ensure service continuity during rerouting.
d. Joint optimization of condition-based maintenance and asset renewal activities. Strengthening cross-functionality in asset management to avoid isolation between business management and production management.

These issues will be addressed at the scale of a complex system and the scale of a system of systems, taking advantage of the multi-partner aspect of the chair.

Use case

The use cases will be extracted from the following application frameworks proposed by the partners:

- Complex systems:
  - SNCF mobile infrastructure and equipment.
- System of systems:
  - Orange telecom network infrastructure and EDF electricity network.
  - SNCF network infrastructure, Orange telecom network and EDF electricity network.

Work planning

- 0 – 6 months: bibliographic study and precise definition of use cases
- 6 – 24 months: methodological developments addressing the issues mentioned above and developed from the analysis of use cases. Development of general methodologies applicable to different use cases.
- 24 – 36 months: development of decision support tools and promotion of research work.

Your profile

- The applicants should hold a diploma/M.Sc. degree in Engineering and Applied Science (Industrial Engineering, Mechanical Engineering, Applied Mathematics, etc.)
- Excellent academic records, solid mathematical background and computer programming skills
- Good communication skills, fluency in spoken and academic written English and the willingness to fully commit yourself as part of an international team
- French language is a plus, but not mandatory.

Application

Deadline: September 20th, 2020

Documents: send a **CV** and **your bachelor's and a master's transcripts** to Dr. Yiping Fang (yiping.fang@centralesupelec.fr) and Professor Anne Barros (anne.barros@centralesupelec.fr)

The PHD project is expected to start as soon as possible.

For further information please contact Dr. Yiping Fang (yiping.fang@centralesupelec.fr) and Professor Anne Barros (anne.barros@centralesupelec.fr)