**Framework:**

This thesis is part of the partnership between NOS and IST within the scope of the M.Sc. Master on Communications Engineering and Data Science (CoDaS) that is a data science program with application in the Telecommunications sector.

Mobile Telecommunication Network has evolved radically over the last 4 decades. The complexity of managing those networks increased dramatically by supporting several types of technologies, services and traffic demand higher than ever. The effort to manage the networks is exponentially increasing to an order of degree that it is essential to introduce Machine Learning algorithms able to adapt to changes and evolve over time to achieve automation of network planning and optimization tasks.

Network capacity management is a critical task in the assurance of quality of experience provided by the Mobile Network Operator (MNO). The engineering teams monitor the network to ensure that network capacity is adequate for the traffic overtime. However, the diversity of services requirements and the customer mobility makes the capacity management increasingly difficult to perform.

**Objective:**

Evolve the operator network capacity management to Machine Learning based processes. It is expected to obtain algorithms capable of modeling network traffic, predicting the areas where it will be necessary to act and, based on engineering rules, prescribing the necessary changes. The system should work with multi variable inputs, be robust to outliers and able to find seasonal effects.

**Framework:**

The network resource consumption is essentially determined by data services, which have a volume much higher than the requested by voice services. In this way, the capacity management is mainly defined in terms of the minimum quality of experience of the data services.

Although the NOS mobile network is made up of 2G, 3G, 4G, and 5G technologies, when customers use data services, they are sent with priority to the technologies with higher capacity, that is, 4G and 5G technologies. The capacity management is therefore more critical in 4G and 5G technologies.

The work will focus on technologies:

* 4G (4 bands: 800, 1800, 2100 and 2600 MHz)
* 5G (2 bands: 700 and 3500 MHz)

The quality of the data service offered by a mobile network operator essentially depends on the customer's installed capacity and radio conditions. The terminal category is another factor that affects the service, as it defines which technologies are supported and the number of bands that can be aggregated.

The system will have several network Key Performance Indicators (KPI) as input variables, such as the number of users, the average user throughput, cell modulation ratios, average signal strength and timing advance of the traffic to model the cell environment. The prescribed actions will be based on the network configuration and engineering rules that will be defined.

**Expected result:**

At the end of the work, it is intended to obtain:

1. Weekly classification of cells/sectors of the network in the “Green”, “Yellow” and Red” categories according to the Quality of Experience (QoE), for actual status and forecasting at 3 months and 6 months.

2. Output a list with the QoE classification per cell/sector and Root Cause Analysis (RCA) labels such as “Capacity”, “Poor Coverage”, “Interference”, etc.

3. For capacity problems prescribe the list of capacity increase and remove actions according to predefined engineering rules.