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Operations Research and Telecommunication Systems Management: A Successful Alliance

Pablo Cortés*

Ingeniería de Organización, University of Seville, C/ Camino de los Descubrimientos s/n –41092 Sevilla, Spain

Nowadays, modern telecommunication networks allow intercommunicating persons, computers, systems, enterprises, financial operations, etc. throughout the world. Such networks transport huge amounts of information that can be for leisure, training, academic, or commercial activities supporting sensitive data in many occasions. Sometimes, all this information must reach quickly its destination, but other times the encryption protocol protecting the information is a more required issue, or also the efficient use of the capacity of the network avoiding traffic jams can be mandatory.

Complex mathematical models and algorithms based on artificial intelligence techniques turn as relevant tools to deal with such difficult and sensitive problems. In this line, Operations Research (OR) arises providing a set of techniques and tools for thinking, analysing and solving, which leads to taking decisions in a structured and focused way towards efficiency and optimality. These tools include the mathematical modelling, the optimisation theory, the graph theory, or the artificial intelligence methodologies amongst others.

OR methodologies in telecommunications has been fruitful for a long time, and the modern telecommunication industry has enjoyed an enormous impetus given by the techniques that OR researchers and practitioners employ, including optimization, simulation, probability and statistics, and information theory among others. It is usual to state A.K. Erlang's original work on the performance of telephone systems as the origin of this linked collaboration. Erlang was introduced to telephone system problems by J. Jensen, chief engineer at the Copenhagen Telephone Company. In a 1917 paper Erlang proposed a formula to model telephone traffic showing that incoming calls can be characterized by the Poisson distribution. Since then, Erlang's formula has been used to estimate the necessities of lines in circuit switched telecommunication networks (that is, the traditional PSTN, Public Switched Telephone Network).

Continuing Erlang's work, E.C. Molina, as well as T.C. Fry, made significant contributions on telephone traffic theory, building an M/M/n queuing model by means of birth-and-death processes.

Additionally to the telephone traffic characterization, OR origins gave impulse to the telephony call routing efficiency. In fact, most of the routing algorithms that are used to define the operation routing tables were based on the shortest path or/and minimum spanning tree algorithms. And for a long while these algorithms were implemented with success in the industry.

During the last decade of the past century, the boom experimented by the telecommunications industry led to the development of new transmission standards, transmission media, switching modes, access protocols, etc. Since then the telecommunication industry continued growing and branching and increasing its technical complexity.

In this line, important efforts were undertaken to bring closer the operations research specialists and the telecommunication systems specialists. In fact, a same problem tackled from a narrow telecommunication perspective could lead to a infra-optimized design, and thesame problem tackled from a narrow operations research perspective could be more an adaptation of the (telecommunication) reality to a well-known OR problem than the adaptation of the OR techniques to the real problem.

So, this emerging research field forced to generate a new specialized researcher. So, researchers from other scientific fields (electrical and electronic, or telecommunication engineers) having acquired enough knowledge of OR methods were the pioneers in making significant contributions to telecommunications making use of these OR approaches (the papers of the eighties in the IEEE Journal on Selected Areas or IEEE Transactions on Networking are examples of it). In the course of time OR researchers and practitioners were entering the field and now the presence of OR people is a reality in the scientific literature, even in specialized journals such as Telecommunication Systems or the IEEE series devoted to telecommunications.

Currently, there is a wide range of research possibilities in telecommunications that can be classified according to the type of telecommunications network. For example, wire-based telecommunication systems (including interurban networks, or urban networks among others), wireless and mobile communications, satellite-based communication, etc. Other possible classification is according to the stage of operation state. For example, the planning stage that is sometimes called topological design, or the real time operation stage including traffic demand dynamic routing, communication admission control, and bandwidth allocation among other typical problems.

I would like to take advantage of this opportunity for encouraging a continuous supported research in this promising field from the OR perspective. In fact, the future of operations research in telecommunications as a thriving field is promising. The extreme complexity that telecommunications problems usually show is enormous, and thus OR will find wide gaps to make successful contributions. Furthermore, telecommunications is continuously changing, and OR researchers will have to adapt quickly to the ongoing changes in the industry and cooperate more efficiently with the technology aspects. But also OR researchers will have to make the necessary effort to reduce the gap between real life and academic problems, listening to the feedback from practitioners and real life successful experiences.

In my opinion the Journal of Telecommunications System &

***Corresponding author:** Pablo Cortés, Ingeniería de Organización, University of Seville, C/ Camino de los Descubrimientos s/n –41092 Sevilla, Spain, E-mail: pca@esi.us.es

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