GUROBI OPTIMIZATION

Maximizing Radio Resource Flexibility and Resilience

Inmarsat boosted efficiency by 40% while improving resource utilization and end customer satisfaction.

inmarsat

Inmarsat has led the way in global mobile satellite communications for over 40 years. They solve the toughest connectivity challenges of their customers, anywhere in the world. Working with a global network of partners, they have all satellite communication needs covered – today and far into the future.

Industry: Telecommunications
Location: Europe
Use Cases: Resource
Website: www.inmarsat.com

Results

- Identified satellite beams with underperforming bandwidth bundles and optimized and reconfigured them to increase utilization efficiency
- An increase in efficiency of 20 to 40% in the most congested geographical areas
- Significant improvement in resources utilization and end-customer satisfaction

As the world leader in global, mobile satellite communications, Inmarsat customers include governments and aid agencies, as well as the maritime, aviation, agriculture, and mining industries among others.

Rapid growth in demand for their services prompted Inmarsat to seek an optimization partner, to ensure their satellites remain operating at peak capacity. Inmarsat turned to Gurobi Alliance Partner Smith Institute for help. Smith Institute's expertise in algorithm design and mathematical optimization—combined with their particular knowledge of the complexities of radio communications spectrum management—made them an attractive choice.

Addressing Massive Complexities

Smith Institute worked with Inmarsat to construct and benchmark an optimized series of algorithms that maximize spare capacity responsively and minimize unmet demand—enhancing the customer experience and protecting Inmarsat's bottom line.

Smith Institute worked closely with Inmarsat's radio resources management team to understand fully the current operating methods and the challenges they faced. Once they had gained a good grounding in the specifics of Inmarsat's operations, they set about creating a model of the existing system against which they would be able to benchmark new methodologies. This would ensure they could prove the value of any proposed solution.

With an agreed model of the existing radio resource management system in place, the Smith Institute team was able to begin to break down the end-to-end system into its constituent parts—looking in-depth at which mathematical techniques might be applied to enhance their flexibility and resilience.

Effective radio resource management for satellite communications must address multiple complexities:

- How the specific capabilities of each device communicating with

Partner Spotlight

Smith institute

The Smith Institute's vision is to bring the boundless potential of mathematical ingenuity to the everyday world. From improving the performance of railways to meeting Carbon Zero targets, forecasting crop growth to verifying radio spectrum auctions, they tackle clients' critical and complex problems with bespoke solutions.

Learn more at www.smithinst.co.uk

> **“ Gurobi is ideally suited for this project, with its ability to handle complex real-world constraints and outcomes.”**
>
> **Dr. Robert Leese**
> *Chief Technical Officer, Smith Institute*

the satellite network are affected by a complex interplay of factors—including symbol rates, modulation options, error checking and correction, energy consumption, and atmospheric conditions.

- Each of Inmarsat’s satellites needs to be able to offer a set of characteristics that will allow the smoothest experience possible for all devices requesting its services under the prevailing conditions.
- At the same time, they also need to have the flexibility to adjust those characteristics if conditions or capabilities change.
- In addition, the operation of Inmarsat’s service needs to be in compliance with its legal, regulatory, and contractual obligations.

To manage this complexity, Smith Institute took a two-stage approach. First, they constructed a genetic algorithm programmed to assemble and analyze a set of likely transmission scenarios. From here, they could determine a combination of traffic carriers favorable to meet anticipated demand in the prevailing conditions.

Computer Artists Impression of the Inmarsat-3 spacecraft

These optimal traffic carrier combinations could then be fed into the second stage algorithm, which creates the bandwidth bundles best suited to meet current, recognized demand. To create these bandwidth bundles, this second-stage algorithm, processed by Gurobi Optimizer, matches selected symbol rates to appropriate modulation and error correction options—as determined by the capabilities of the devices currently transmitting to the satellites and the prevailing atmospheric conditions.

Finally, the Gurobi Optimizer processes the algorithm again to assign these bandwidth bundles to the specific devices, so that all devices get the optimal connection experience given their characteristics, the overall traffic, the prevailing conditions as they affect each device, and Inmarsat’s service obligations.

Gurobi Delivers the Boost of Solving Speed and Power Inmarsat Needed

Even when the model is expertly crafted, solving the complex real-world mathematical model Smith Institute created for Inmarsat’s radio resources management problem is only feasible with specialist software. Smith Institute has found that the Gurobi Optimizer is consistently the right tool for robust, high-powered optimization at speed, and it was ideally suited to processing their radio resource management model, with its multitude of constraints and possible outcomes.

The solution is expected to allow Inmarsat to identify satellite beams with underperforming bandwidth bundles and optimize and reconfigure these to increase utilization efficiency. Initial results suggest that this will allow an increase in efficiency of 20 to 40% in the most congested geographical areas. Considering the scarcity of satellite resources, this represents a significant improvement in resource utilization and end-customer satisfaction.