CASE STUDY

Graph-Based Network Topology Analysis for Telecommunication Operators

Management and technology consultancy Sopra Steria developed an Intelligent Network Analysis (INA) tool with cross-site data management for a major telco provider using Neo4j and graph algorithms.

BY THE NUMBERS

3M nodes

18M relationships

INDUSTRY

Telecommunications

USE CASE

Intelligent Network Analysis

GOAL

Centralized network analysis tool for real-time, multi-site impact and root cause analysis.

CHALLENGE

High complexity of dependencies: about 800 billion possible network configurations, time-consuming analyses, digital representation of the network did not match the actual state of the network

SOLUTION

Holistic visualization of the actual state of the network topology and Intelligent graph analytics for analyses and simulations

RESULTS

- Cost-optimized planning thanks to better data integrity and quality
- Significant time and cost savings in network analysis and monitoring
- Future-proof data platform for business decisions

The Company

Sopra Steria, a leading European technology company with recognized expertise in consulting, digital services, and software development, helps its clients drive digital transformation and achieve tangible and sustainable results. With 47,000 employees in around 30 countries, Sopra Steria offers comprehensive end-to-end solutions that make businesses and government agencies more competitive and efficient. Its clients include the leading telecommunications operators in Europe.

The Challenge

The pressure to innovate and cut costs is enormous in telecommunications. Providers are driving the nationwide 5G network rollout in Germany, improving network coverage and laying many kilometers of fiber optic cable. They also have to continuously adapt their network during ongoing operations. Every day, an operator records more than 1,000 changes that affect the network on a large scale, which is no easy challenge due to the complexity involved.

A typical network of a mobile operator in Germany consists of about 30,000 routers, 50,000 microwave links, and 80,000 endpoints in the German telecommunications network. But that is only the lowest physical layer. More service layers are built on top of this, which together form several million connections that make up the actual network function. Changing the network topology (for example, through 5G network expansion) is complex.
Network operators have professional tools and processes for controlled adaptation, but these tools are designed for a planned state, not the current state of the network. In addition, topological dependencies cannot be adequately identified based on work orders. "Such preliminary checks were time-consuming and too inaccurate," explains Andreas Lattoch, Principal Engineer at Sopra Steria. "The testing has to include the network topology, and for complex routing changes we need a dry run or simulation." The real network, in all its complexity, could only be replicated in the lab to a limited extent.

The Solution

The team set out to develop Intelligent Network Analysis (INA) with Neo4j. Along with the Python framework NetworkX, the Neo4j graph database is the core of the new solution.

"The number of use cases is huge. Starting from the actual state of the network, we can now plan in a capacity and runtime-oriented way, as well as in a cost- and time-optimized way. Building a microwave link or optical fiber is very expensive, and it takes months to implement in the best case. Complex construction projects take several years. Before making such a large investment, we have to carefully weigh all alternatives (cost, time, benefit)."

Andreas Lattoch, Principal Engineer
Sopra Steria

When all the data was imported into Neo4j, it was assembled into a graph that now comprises approximately 3 million nodes, which are connected by 18 million relationships. With the help of Neo4j Graph Data Science, the complex network can be monitored holistically and in real time. INA relies on some of the graph algorithms in Neo4j Graph Data Science, including shortest-path, which calculates the fastest connection between two nodes.

In terms of graph analytics, two approaches are key in the area of risk analysis. Root cause analysis allows the network operator to quickly identify the central node of a failure directly in the application. If a router fails, network operators can immediately see how this affects the entire topology. Impact analysis can be used to simulate various scenarios. For example, a network engineer uses the INA system to assess how changes in the network topology will affect the network (e.g., How will traffic be distributed in the network if capacity is increased at node points? What happens if a fiber link fails?) New links can be inserted into INA using Weighted Shortest Path and assigned a bandwidth to determine traffic routing. If engineers want to take a part of the network offline for construction, they can immediately see which part is affected at each node and edge.

Such what-if analyses provide a data-informed basis for decision-making. "The number of use cases is huge," says Lattoch. "Based on the current state of the network, we can now plan in a capacity- and runtime-oriented way, as well as in a cost- and time-optimized way. Just building a microwave link or optical fiber is very expensive, and it takes months to implement in the best case. Complex construction projects take several years. Before making such a large investment, we need to carefully weigh all alternatives (cost, time, benefit)."

The Results

The telco service provider's processes are even more cost-optimized now and a team of experts has documented immense time savings. Complex queries that previously took up to a week and required a lot of manual effort can be executed and attractively visualized within seconds with INA. Experts are able to plan more precisely, search the various dimensions of the graph more efficiently, and determine, among other things, which connections lead to effective quality improvements for the network. This contributes to higher customer satisfaction.

The system provides network experts with instant insight into the entire network as well as events, their causes, and consequences. "The potential of graph technology is far from exhausted for us," says Lattoch. "We are still at the very beginning with INA. The results of the project are use case agnostic, so they can be further developed not only in the telco sector, but across industries for business consulting."