SUCCESS STORY

SKYGUIDE MONITORS AIR SURVEILLANCE RADARS IN 4D

« It was through the power of a prototype demonstration that I was able to convince my managers of the performance of a 4D solution; especially since it offers numerous advantages, such as an integrated SQL database, a comprehensive and intuitive development environment, openness through plug-ins and components, and simplicity of maintenance. »

Jean-Rémi Dunand
Expert radar data analyst at skyguide

Control tower of Geneva (Cointrin) airport.

Jean-Rémi Dunand, radar data analyst at skyguide, the Swiss air traffic control agency and air navigation services provider, used the 4D environment to develop a quality monitoring application for the air traffic surveillance system. Here's how it happened…

Switzerland is a mountainous country where access can be a tricky affair for aircraft approaching an airport. It's also a crossing point for one of Europe's most dense and complex airspaces for en-route aircraft. This situation requires a particularly reliable and high-precision radar surveillance network. To ensure high-quality monitoring of the equipment, in connection with the skyguide maintenance services, Jean-Rémi Dunand developed a comprehensive monitoring and radar data processing system in a 4D environment. *"Its purpose, he explains, is to detect the slightest performance degradation of the surveillance system before it has an operational impact and creates trouble for the air traffic controller."*

This system – called SCQUAM, which stands for Surveillance Chain Quality Monitoring – has more than proven its worth and today interests the developer's European colleagues, illustrating the long genesis of an innovative approach… initiated back in 2001.

The genesis of innovation

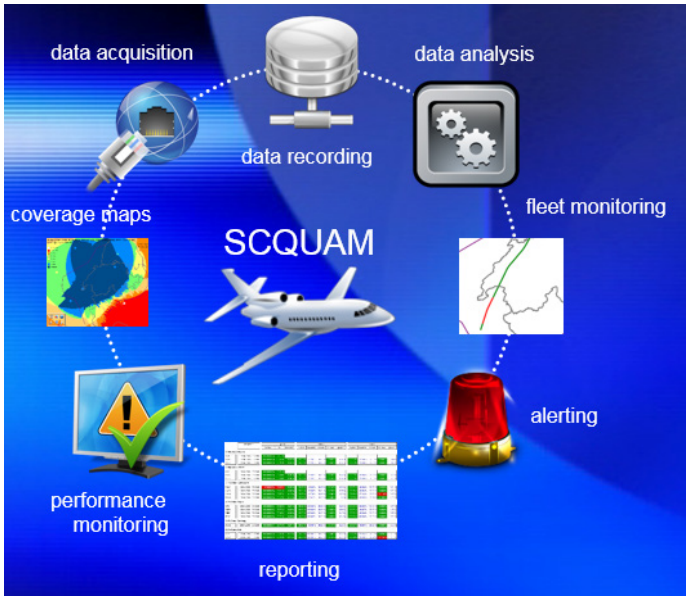
« *When I arrived at skyguide in 2001*, says Jean-Rémi Dunand, *the air traffic control agency tasked me with monitoring the quality of the radars. It became apparent that analyzing their operation once or twice a month, or even once a week, is not sufficient to ensure aviation safety. We also concluded that it was necessary to automate the entire quality measurement process in real time, from data acquisition through to its analysis, as well as the display of results and alerts to the engineering and maintenance teams.* »

At the time, most European control agencies export acquired data to Excel spreadsheets, which they use to publish graphs. Dissatisfied with this slow and cumbersome method, and having already worked with 4D in a previous position, Jean-Rémi Dunand immediately sees the advantages to be gained from using this database environment. So he begins to develop a very simple application on his PC, which can produce graphs and other reports.

Revealing unsuspected problems…

This first "prototype" sparks the interest of his colleagues responsible for radar maintenance. They then discover operational problems for radars that they had not previously suspected; for example, dating errors, or the instability of certain parameters, due in particular to variations in atmospheric pressure. These problems, while not actually jeopardizing aviation safety, still needed to be remedied.

"The main parameters we have to monitor on a radar are the quality of the detection of aircraft in controlled airspace, the accuracy of aircraft positions and paths (trajectories) provided to controllers, and the identification of false tracks which may be due, for example, to reflections made by a crane installed near a radar", explains the developer. After this initial critical success, he then continues to enhance his prototype progressively over the course of nearly two more years following user requests.



From radar monitoring to surveillance chain monitoring

The information supplied by the prototype proves its worth, and in 2003 skyguide decides to create a project for transforming this prototype into a continuous quality monitoring system for aeronautical surveillance radars. This system must feed data to an interface in the control room allowing the technical supervisor to directly monitor quality.

Throughout this long period of development, the scope of the application evolves from Radar Quality Monitoring (RQM) to Surveillance Chain Quality Monitoring (SCQUAM) going far beyond the original framework of radars. This system must then process the data, not only from the sixteen radars located in Switzerland, but also data from multi-radar tracker equipment and aircraft transponders.

In 2006, SCQUAM becomes operational in client/server mode. In 2009, it gains followers in France where Jean-Rémi Dunand installed it to monitor 50 radars at the request of the Air Navigation Services Directorate in Toulouse.

Ready-to-use information for air traffic controllers

Each SCQUAM system consists of a Linux machine and a Windows machine. The first delivers real-time capture and recording of radar / tracker flows as well as the processing of this data. It sends the results to the second machine hosting the SCQUAM server that users connect to from their PCs.

Running in a 4D v15.2 environment since 2015, SCQUAM allows skyguide to prove the conformity of its equipment with the technical specifications included in certain European regulations, including EC1207 (and the ESASSP: EUROCONTROL Specification for ATM Surveillance System Performance) and EC262. It provides the air traffic management system with a flow of ready-to-use information for engineers and technicians, in the form of tables, graphs and visibility maps.

«Thanks to 4D and the possibility of developing complex algorithms in an external plug-in, affirms Jean-Rémi Dunand, *we were the first in Europe to provide air traffic controllers with high-resolution (25 m x 25 m) visibility maps, significantly more accurate than previous maps with a scale of several kilometers, which is fundamental for a mountainous country like Switzerland.* »

The benefits of a monitoring solution in a 4D environment

• The application identified and triggered the correction of various dating problems in the data, which were reduced to only one case every three months. This level of quality is indispensable in a real-time system that ignores data that is too old (by several seconds).

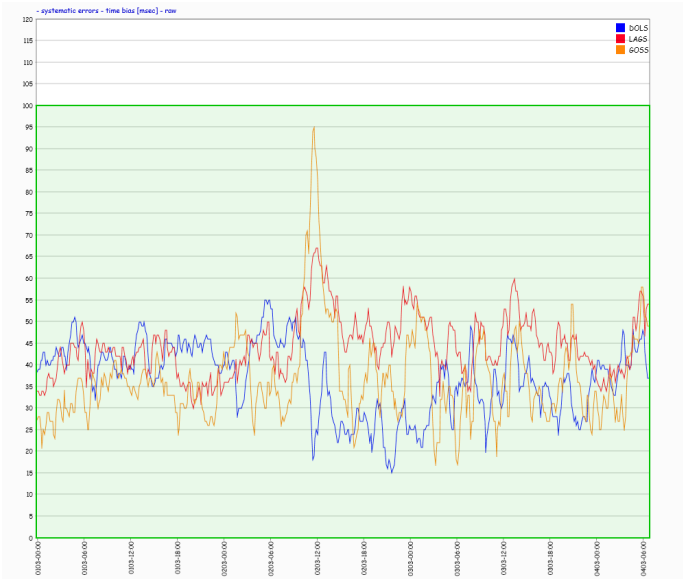
• The monitoring tool highlights possible degradations of the system in real time: e.g., an increase of transmission delays, a decrease in probability of detection, a degradation of accuracy, an increase of false tracks, the misalignment of a radar in relation to the north, identification of aircraft whose transponders do not have the expected behavior, etc.

• It allows the graphical comparison of the quality of networks in order to detect problems immediately and contact the Swiss or foreign network maintenance teams in order to address them.

• Automatic generation of monthly reports (4D Write) serves as proof of conformity of radar equipment quality with European regulatory requirements.

• Technological advantage: while most other air traffic control agencies perform ad hoc analysis on a case-by-case basis, SCQUAM carries out automated analysis, every hour. Results are immediately available and can be visualized in tables or graphs. The system includes many more features and measures far more performance indicators than the usual practice. Its strong connection to the radar analysis software (SASS-C) provided by EUROCONTROL offers the advantage of incorporating everything into a single tool.

• EUROCONTROL acknowledges SCQUAM as a powerful tool that Jean-Rémi Dunand is regularly requested to present at European meetings, and whose results are utilized during technical discussions.



Time bias estimation of three radars using multi-radar tracker equipment.

sensor	datation	global			mode A					mode C				
		availab.	PD	ovf codes	overall	validated	correct	inc. valid.	garbled	overall	validated	correct	inc. valid.	garbled
	28.11.2015 - 14:00:00	100.00000	89.28 %											
	28.11.2015 - 14:00:00	100.00000	99.90 %	0.11 %	99.80 %	99.93 %	99.80 %	0.11 %	0.01 %	99.91 %	99.91 %	99.91 %	0.00 %	0.06 %
	28.11.2015 - 14:00:00	100.00000	99.71 %	0.11 %	99.83 %	99.95 %	99.83 %	0.11 %	0.02 %	99.94 %	99.94 %	99.95 %	0.00 %	0.06 %
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	28.11.2015 - 14:00:00	100.00000	99.81 %	0.01 %	99.89 %	99.93 %	99.89 %	0.01 %	0.00 %	99.88 %	99.88 %	99.88 %	0.00 %	0.06 %
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	28.11.2015 - 14:00:00	100.00000	99.74 %	0.01 %	99.92 %	99.95 %	99.92 %	0.01 %	0.05 %	99.91 %	99.91 %	99.91 %	0.00 %	0.00 %
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	28.11.2015 - 14:00:00	100.00000	98.14 %	0.00 %	100.00 %	100.00 %	100.00 %	0.00 %	0.95 %	99.84 %	99.84 %	99.84 %	0.00 %	1.28 %
	28.11.2015 - 14:00:00	100.00000	98.41 %	0.00 %	99.99 %	100.00 %	99.99 %	0.00 %	0.33 %	99.99 %	99.99 %	100.00 %	0.00 %	1.11 %
	28.11.2015 - 14:00:00	100.00000	99.29 %	0.00 %	99.98 %	99.99 %	99.98 %	0.00 %	0.15 %	100.00 %	100.00 %	100.00 %	0.00 %	0.47 %
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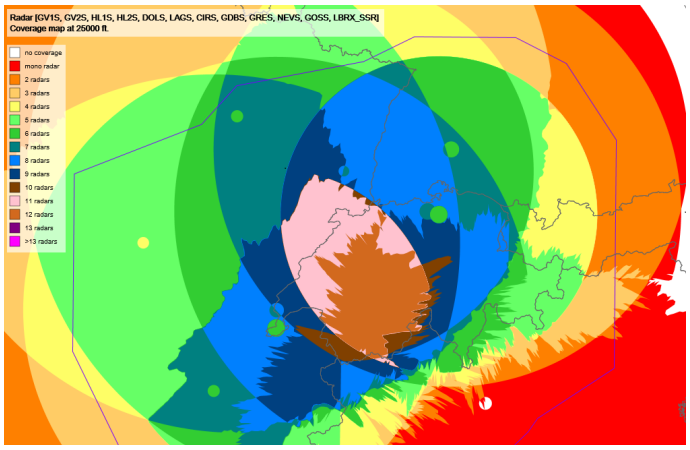
	28.11.2015 - 14:00:00	99.96690	99.68 %	0.01 %	99.98 %	100.00 %	99.98 %	0.01 %	0.93 %	99.99 %	99.99 %	100.00 %	0.00 %	1.20 %
	28.11.2015 - 14:00:00	100.00000	99.96 %	0.00 %	99.98 %	100.00 %	99.98 %	0.00 %	0.12 %	99.99 %	99.99 %	99.99 %	0.00 %	0.07 %
	28.11.2015 - 14:00:00	100.00000	97.69 %	0.00 %	99.76 %	99.77 %	99.98 %	0.00 %	0.00 %	99.77 %	99.77 %	99.78 %	0.00 %	0.00 %
	28.11.2015 - 14:00:00	100.00000	99.59 %	0.01 %	99.96 %	100.00 %	99.96 %	0.01 %	0.00 %	99.99 %	99.99 %	100.00 %	0.00 %	0.00 %
	28.11.2015 - 14:00:00	99.98580	98.60 %	0.01 %	99.65 %	99.67 %	99.98 %	0.01 %	0.00 %	99.57 %	99.57 %	99.58 %	0.00 %	0.00 %

Summary table for the quality of aircraft detection by all radars. Values in red are those where the radar exceeds the recommendations, which does not necessarily indicate there is a problem! The role of Jean-Rémi Dunand consists in analyzing each value in red, finding the explanation for it and assessing whether it could have an operational impact (in which case the radar will be disconnected from the operational chain until a return to normal), and, where appropriate, initiating corrective actions.



Simulation of multi-radar coverage excluding the radars of the Southern Alps, to simulate, for example, the impact of a case of radar failure while maintenance is in progress on a radar. If this occurs, SCQUAM shows that it would be necessary to increase separation distances between planes in the red zone.

About AJAR

AJAR is the official 4D Distributor for Switzerland since 1993. Their main customers are IT companies that develop innovative solutions. The applications based on 4D technology cover numerous sectors (finance, health, press, etc.).

Maurice Inzirillo
maurice.inzirillo@ajar.ch
www.ajar.ch

About 4D

A global leader in business software development solutions for over 30 years, 4D provides integrated platforms that simplify and speed up the development and deployment of Web, mobile, desktop, and client-server business applications. 4D solutions and development tools are used in more than 70 countries, count millions of end users and over 10,000 Independent Software Vendors (ISVs). 4D is located in France, USA, Germany, Japon, Australia, etc.

Rolande Courté
rolande.courte@4d.com
www.4d.com

About skyguide

Swiss air traffic control agency and air navigation services provider, skyguide has 1500 employees with over 560 civil and military air traffic controllers. Over 300 engineers, technicians and IT experts are responsible for the development and maintenance of its complex technical installations and facilities.

The Safety Management System (SMS) is an integral part of skyguide's management process, leading it to identify, assess and manage potential risks systematically, whether at the human, procedural or technical level.

Number of IFR flights controlled in 2015: 1.2 million

Jean-Rémi Dunand
jean-remi.dunand@skyguide.ch
www.skyguide.ch/fr