Exsys Case Study

Satellite Diagnostics – Anomaly Identification and Resolution Multi-Mission Advanced Ground Intelligent Control

US Air Force - Space and Missile Systems Center

Satellite ground control systems are expensive to develop, acquire, maintain and modify. Part of the problem is the lack of a standard base architecture, which results in a number of unique systems with high development and maintenance costs. The concept of the Multi-Mission Advanced Ground Intelligent Control (MAGIC) was to address these shortcomings. Exsys® Knowledge Automation Expert System Software was used to develop the expert system portion of the MAGIC project.

The objective of the MAGIC program was to develop the architecture for the next generation of satellite ground stations. The MAGIC architecture is flexible enough to be used for any existing or future satellite family. It provides a ground station architecture that manages multiple missions, easily adapts to new missions, and decreases acquisition costs while enhancing operational capabilities and improving operator effectiveness.

The loss of manpower (due to cut backs and retirement) required better tools for satellite anomaly identification and resolution. The research and prototyping program was sponsored by the Network System Program Office of the USAF Space and Missile Systems Center (SMC/CW) as a path-finding effort in support of the USAF Command and Control System Upgrade Program.

The first phase of MAGIC focuses on real-time telemetry display, telemetry storage, and post-pass analysis. The MAGIC Phase I system receives telemetry from up to 6 satellites simultaneously, processes the telemetry, and provides a graphical real-time display of the data, along with extensive analysis and reporting tools. The real-time user interface provides a display of the data as it is being received from the satellites. The system provides a list of events that the operator should respond to and the status of every subsystem in the satellite. The Exsys expert system is used to identify and prioritize the events to which the operator should respond. It also graphs telemetry, and displays current values.

The complex satellite data is decrypted by the front end (Nighthawk), which provides EU conversion, time tagging, and storage of the raw data. The EU converted data is sent to the user interface and the expert system for analysis, and to a database for long-term storage.

The master control program (MCP) is the central controlling and distribution thread in the system. It gathers information from the front end, and then distributes it to the expert system and database. The expert system processes are started and provided with their initialization information, and the front-end interface (SDDF) is started. During execution, the MCP updates the internal data structures, which are forwarded to the user and to expert system, which receives updated data values at approximately 20-second intervals.

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The expert system is run in forward chaining for maximum rule processing speed. The expert system generates the events that are displayed. It also generates the subsystem status for display on the screen. It receives telemetry data from the MCP and sends events and subsystem status through a connection to the MCP, which then passes the data on to the user.

After the expert system processes the data sent by the MCP, it generates all of the events to be displayed on the screen. Upon completion of the satellite pass, the expert system and the user interface processes are terminated, the final values are sent to the database, and the user is allowed to setup a new satellite pass.

The MAGIC Phase I system was installed at Space Operations Complex at Falcon AFB in an operational room that controls the communications satellites for the Air Force. Despite its complex architecture, the MAGIC Phase I system was developed in only 7 months.

For more details on the MAGIC system see:

American Institute of Aeronautics and Astronautics, AIAA-95-3716
AIAA Space Programs and Technologies Conference
“Multimission Advanced Ground Intelligent Control”, Lt Col. Nancy Crowley, USAF