WEB Enabled Enterprise Monitor for Satellite Data Acquisition and Distributed processing workflows

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Abstract

In a large automated enterprise involving distributed operational facility an analytical insight into complete enterprise operations and infrastructure helps the managers to gain the operational intelligence thus enable them to take timely decisions to act on deficiencies and realize improvements. This requires tools for monitoring business activities, to detect situations relating to inefficiencies & threats and to identify improvement opportunities. In order to realize the tool appropriate mechanisms for capturing, processing, archiving, servicing and presenting are required. It is also important that such tools are easily accessible through thin clients. A tool called enterprise event monitoring and control (EMC) is designed to provide operational intelligence of Integrated Multi-mission Ground Segment for Earth Observation Satellites [IMGEOS] facility at National Remote sensing centre, Hyderabad. The current paper describes the design and implementation aspects of EMC system.

1 Introduction

Operational intelligence involves getting information and metrics related to inefficiencies, improvement opportunities and threats in an operational facility. This intelligence empowers the managers to take better decisions and act on the deficiencies and improve the facility. Capturing this intelligence requires tools. These tools should capture the status & utilization profiles of various computing resources and the status of each of the process as events and also special alerts for the critical events to draw immediate attention. All the information is to be archived to profile the daily and monthly behaviors of the enterprise activity in terms of load, resource utilization, and failures etc., to plan the augmentations or resizing the infrastructures or optimize the process implementations.

Designing tools to capture and monitor the events in a large automated distributed processing enterprise like Integrated Multi-mission Ground Segment for Earth Observation Satellites [IMGEOS], is a very complex and challenging task. The activities of IMGEOS are scheduling, acquisition, processing and dissemination operations pertaining to all the Indian Remote sensing satellites. The satellite ground segment processing comprises of three major functions. The first being the receiving and managing the user online requests of all Indian remote sensing satellites for data downlink and data products. These are validated, consolidated and converted to job orders in the form of downlink schedules and product generation work orders. The schedule files initiate data acquisition at the respective downlink station and result in quality assessed archives and published browse or image catalogs for online access and selection. These activities are handled by a station workflow manager (SWFM). The data product requests result in work orders for data product generation (DPG) and value added product services system and product quality check (PQC) systems. This activity is managed by data processing workflow manager (DPWFM). The qualified products from the data processing work flow are disseminated to the user in digital form through an online dissemination of media through conventional courier mode. These workflows get initiated automatically by the availability of the driving input and controlled by respective work flow manager software. Once initiated the job goes through the workflow involving various processes and processing systems to deliver the end product/service based on the dependencies on the earlier process, resources or the other external inputs.
Each input/resource availability or non-availability and the successful completion or failure is viewed as an event. Such events are to be used to show the status of ground segment operations. Every day each satellite acquires about four passes a day on local terminals and around 14/15 orbits data from polar ground stations resulting in acquisition and preprocessing of about 1000 scenes per day and on the average about 500 products are generated based on current user demands and speculations. The facility consists of around 25 servers and 15 work stations which are distributed across networks with varying level of trust. Huge number of events and meta data gets generated during the execution of the work flows which are used to display the status and performance of the facility. The systems accessible to users on public network are user ordering system and data dissemination system. These complexities call for handling heterogeneous events. The figure 1 describes the total facility block diagram.

*ADP- Ancillary data processing; *DQE- Data quality evaluation
*PRS- Problem resolution systems; *DEG- data exchange gateway
*MMPPS-Multimission payload programming system

Figure 1 IMGEOS operational facility
The number of events, timeline and the networks involved for the product/service from the various workflows has large variations requiring varying granularity, event capturing schemes and communication channels and downstream activity. Another kind of events category is related to the computing and network infrastructure. The availability utilization and status of these components help in getting the knowledge pertaining to adequacy or underutilization of the infrastructure.

In order to empower the managers with the operational intelligence it is essential to equip the facility with necessary meta data collection, capturing the parameters like operational efficiency, quality, inadequacies, infrastructure status etc and provide visualization tools providing various levels of drill down options. These tools should be deployable to desktops for wider connectivity. The managers should be enabled to take most appropriate decisions and to quickly act on these analytic insights, through manual or automated procedures.

Most of the commercially available enterprise monitors predominantly address the monitoring of the resource status of the IT infrastructure and are not easily configurable for organization specific business process workflow monitoring. Hence it is planned to develop an EMC tool to meet the specific requirements of multi-mission ground segment processing facility. This tool is intended to provide operational intelligence through an event-centric approach to information delivery. It also ensures that there are no constraints imposed on the enterprise processing and the data movements to operate this tool.

The current paper describes the design and implementation aspects of EMC system which involves a server hosting the EMC application and browser based monitoring clients installable on any PC and a centralized node locked interactive client service layer reads the event repository and provides the visualization at default level and additional drill downs and historic event visualization based on demand. It enables to view the status as per the processing workflows by sequencing and integrating the events related to an activity. Presentation layer provides the necessary query options and the visualizations of the results.

2 Architecture

EMC is designed based on innovative hybrid architecture for event monitoring with message based communication model to capture, integrate, archive and notify the events of the enterprise and presenting the data for passive and interactive visualization through rich graphical interface accessible through web browser. The asynchronous mode is not used as the latency requirement is only for near real time monitoring, and ground segment systems are built with required contingencies to handle the critical driving event non-occurrence as per the timeline. EMC uses the layers of an event driven architecture but uses traditional pull based request/response model with synchronous communication. The EMC application comprises of five components namely event collection, event preprocessing, event archival and query processing and presentation. (Figure 2).

![Figure 2 EMC components](image)
3 Design

3.1 Events capture and processing

The tasks involved are the identification of events, the granularity, format, criticality flagging, capturing mechanism and the communication channel for the event message transfer to the server. The events captured are heterogeneous in nature. All the events are reported through autonomous messages [2]. It involves simple event processing and stream event processing [1]. The simple events are archived in the repository after processing and the visualization of these events is through options on the front end. These events are related to process completion and trigger file availability for the process initiation and resource utilization. The stream events are streamed to the subscribed process in addition to the archival in the repository and these events are termed critical events and displayed on all EMC clients. The events flagged as critical are related to resource non-availability resulting in possible stoppage of the workflow. The event capturing is loosely coupled with processing nodes. There are four types of events and the event capturing mechanism is also different. The first type of events are from the nodes internal to the network and are captured using Message Agents that are deployed to each of the node. These agents are tightly coupled with the event processor on the server. The event processor listens to the event on the event channel and archives after processing. In case of critical events the processed event message is directly sent to the event dispatcher and also notified to the concerned responder.

Second type of events are from distributed networks and captured through the messages generated by the processes and posted on to a sharable storage hence are decoupled from the server [2]. These messages are received through a customized secured data exchange gateway [4].

The third type of events are associated with the resource status and are captured by establishing a secured remote session with the node on the local network using Java secured shell.

The fourth type of events are related to data product generation. The data product generation happens on a set of functional nodes starting from data product generation to quality verification and media writing, which are called as work centres and managed by a work flow manager. At the end of the chain the product is dispatched from this facility. The events are generated at very frequent interval and posting the status at that this frequency is not required immediately. These events are fetched from production database at predefined intervals and provided to event processor for drill down views by the user/manager.

The communication channel used are TCP/IP, shared file systems and JDBC drivers based on the application deployed to fetch the event/message data. The figure 3 below shows the various modes of event capturing used in the enterprise. All these events and messages provide data to the event processor.
3.2 Repository
The repository contains the event database updated by the event processor and also the production status received periodically from the workflow managers. In addition it contain static database which will have information about the destinations of the external service actions. This data will be used for interactive drill down menus and to analyze the trends for continual improvement of the system.

![Figure 4 Event Repository]

3.3 Service layer
EMC extends two levels of service layers [figure 5]. One is on the internal network where it provides web service and the map service. The other service layer is the e-mail service where the critical events and error messages are posted for email dispatch to the remote subscribers for notification.

This layer consists of the Business Logic and the Messaging component for making the events available to the Presentation Layer. The Business Logic comprises of various modules which read the processed events database and formats it as required by the Presentation Layer. The Messaging Component then makes this data available to the Presentation Layer. This layer also consists of Geo Server which is responsible for providing Map interface to the Presentation Layer to display the ground trace being acquired. BlazeDS is used as the server based Java remoting technology to interface with the Presentation Layer.

The visualization is provided in two modes. One is default display of the major event status with an update at predefined intervals based on the archived events and the second level is demand based services based on the selection on the front end. This layer will host the appropriate business logic for processing the queries.

![Figure 5 Service layer]
3.4 Presentation layer

Presentation layer gives the visualization options to the user as real time event flow, critical event posting and demand based queries. The User Interface (UI) Component is based on RIA technologies using FLEX framework which is responsible for communication with the backend modules for data and presenting it for effective visualizations. The UI component comprises of progress or statistics or history views which actually leads to analytical data giving holistic view of the enterprise. The AMF interface facilitates less data movement which in turn leads to lower network consumption. There are also various data fetching routines which make the data available from production chain database to the Event processor for various statistical drill down views from macro to micro levels.

The challenge of enterprise visualization comprises of identifying the amount of information, grouping of information, sequence of information translated into a dynamic Graphical user interface. The domain knowledge of satellite ground processing and the operational experience is transformed into the design of the visualization space so that the visual components are intuitive. Keeping things clear and concise at the same time being highly responsive in achieving the action.

The events received by Event manager are used to present views for different levels of management for taking appropriate action. The Information on the enterprise gets dynamically updated to view End to end monitoring of a satellite pass with default granularity at Event level including the quick look of the actual data being acquired and on-demand at Process level information for each pass. On-demand history passes information with a provision to filter passes based on criteria like mission, sensor, channel etc. On error: error summary (pass, process, reason etc.), Generation of email information file and pushing it to email server, Pass summary at the end of pass, etc.

The various levels of information visualization are

- System level - system health, performance, throughput
- Operational level - operational flow for normal and emergency operations
- Product level - individual product level quality and status in the production chain

4 Implementation

The figure 6 shows various components of the EMC. The web browser is the client for visualization and the Modest Maps Flex API is used for interactive maps. The web server provides the service through BlazeDS. The business logic is extended through servlets, plain Java objects and database access objects. Jdbc driver is used to connect to event repository. Events are captured through agents, through direct system calls, through production data base using JDBC connectivity. The messages from other network are received through common storage, the communication to the users external to the networks is through email.

5 Deployment

The application is deployed on a Linux based 2-CPU blade server connected to SAN storage for the interfaces and the production network. It is a truly multi-mission application which has more than 40 clients. It interacts with more than 25 systems for events, generates more than 20 views. Provides interacting reporting tool to generate reports based on user need.
6 Results

This work has resulted in a unique event-driven application which has exploited the state of art technology for providing web enabled single window GUI for complete enterprise monitoring. The user interface shows holistic views, drill down features to navigate from macro level to micro level details and remote monitoring of the Enterprise. The model is scalable to add more workflows, views and reports.

**Level’0’Chain Monitoring Visualization**
- Centralized Monitoring of the Enterprise Operations
- Events logging for problem analysis and reporting
- Quick Look Data View along with area being covered on Map
- Process Level monitoring of all scheduled passes
- Data Quality visualization
- Pass Countdown of all scheduled orbits
- Statistical reports
- Status reports
- Problem reports

**Data Processing Chains Monitoring Visualization**
- Production chain visualization
- Tracking of product status
- Drill down feature up to product level
- Monitoring of priority Products
- Status Reports
  - Work Center wise
  - Mission wise
  - Product type wise
- Reports for statistical Analysis.

*Figure 6 EMC deployment diagram*
7 Conclusion and future work

Enterprise Monitor and control application is scalable to add more processing systems and add more number of drills down views based on user requirement using events and messages of standard format. The current model handles events synchronously it is planned to make change in the architecture to handle PUB/SUB model and handling the events asynchronously enabling real time monitoring of the events.

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9 References

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