A DISTRIBUTED AND INTEGRATED INVENTORY MANAGEMENT CAPABILITY FOR NETWORK MANAGEMENT SYSTEMS

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Abstract: Network management of geographically diverse undersea cable systems with assets assembled from a variety of suppliers poses special challenges. Accurate enterprise wide inventory information for Field Replaceable Units (FRU) is necessary for optimal asset management. To keep cable systems operating efficiently, it is critical that accurate inventory of provisioned and spare equipment be kept current. This paper discusses an approach whereby FRU inventory information may be managed with minimal user involvement for the entire undersea cable system.

1. OVERVIEW

TEMS (TE SubCom Element Management System) and TEMS-NMS (TE SubCom Network Management System) are software based products to support undersea cable Network Management System (NMS) functionality at the Element Management Layer (EML) and Network Management Layer (NML). The EML and NML functions are defined by the ITU Telecommunications Management Network (TMN) model [1]. These mature

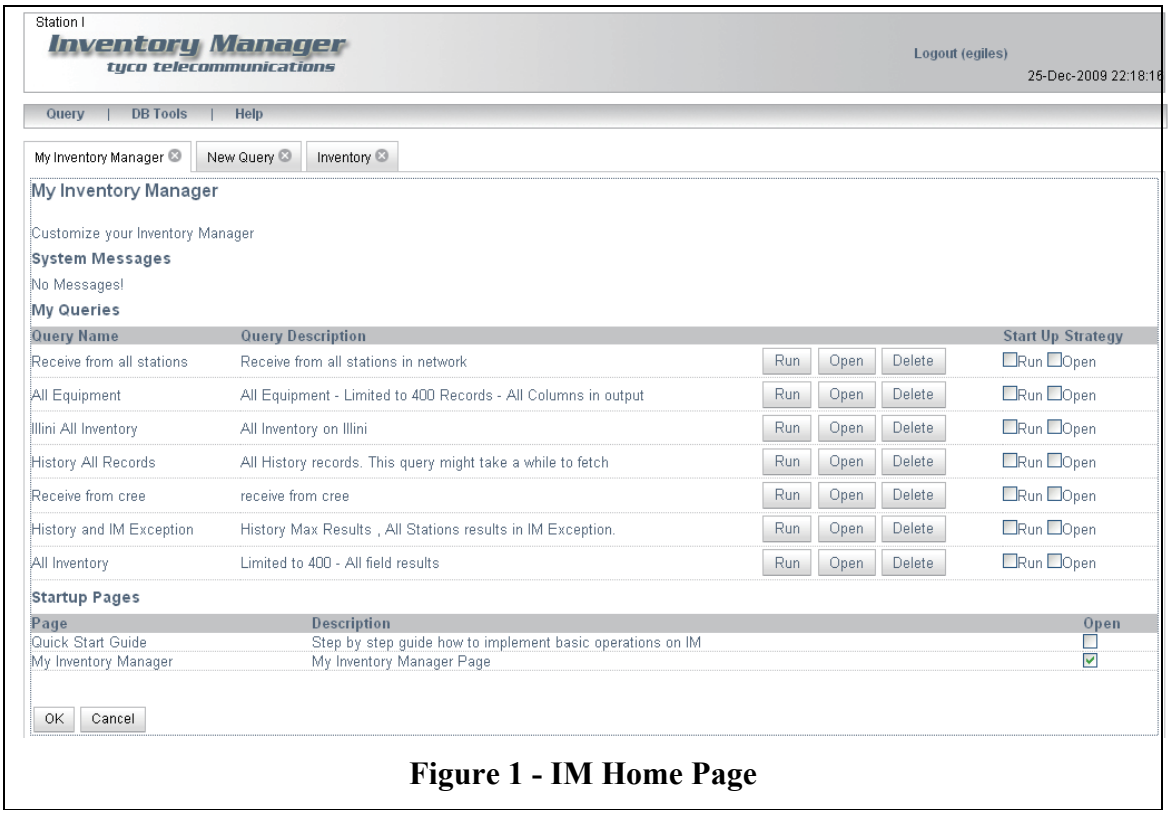

Figure 1 - IM Home Page

products continue to be enhanced to support new Network Elements (NEs) as well as providing customer value added features such as the "Distributed and Integrated Inventory Management (IM)" capability. IM enhances the fulfillment of the Configuration Management (CM) category and provides reporting capabilities to support asset management as defined by TMN.

A FRU is a piece of equipment in the cable system. To be managed, an instance of a FRU must have a unique serial number. Examples of FRUs include circuit packs, shelves, filler packs, fans, documentation, desks, chairs, etc.

IM is a tracking system for records of inventory units for any FRU that are supplied to, provisioned in, and sent out of a cable station or depot associated with a cable system. IM is a web application that runs in every cable station and relies on the existing functions of the EML and NML to retrieve and store inventory information of equipment in the cable station. IM tracks equipment identification information such as serial number, manufacturing info, and so on, and also equipment life cycle information such as in-service hours, active or spare state, repair history, current location. Current and historical inventory information of the equipment is made available to users through a user friendly web interface that can be run inside or remote to the cable system. Through the web interface users are allowed to execute local or system wide queries, and create reports of the records that can be printed or exported to well known data formats.

Requirements for IM were generated based on analysis of specific customer needs and include the following:

- Track and manage enterprise wide FRUs (i.e., within and across cable stations, Return and Repair (R&R) locations, and depots)
- Manage current and historical information for thousands of installed and spared FRUs
- Automatically discover FRU inventory data and operation state for equipment managed by TEMS.
- Manage any equipment that is not automatically discovered (non-TE SubCom equipment) by allowing input of their information manually
- Perform FRU lifecycle management based on FRU location, operational state, R&R operation, and repair status.
- Report exporting to comma-separated values (CSV) files
- Secure user accessibility via web browser technologies (see Figure 1)
- The ability to have new types of FRUs defined by users
- User configurable queries with scoping at a cable station or cable system
- Automatic and user initiated state changes and FRU record modification
- The ability to add, modify, and delete inventory records of non-discoverable FRUs
- Log events affecting changes to inventory records
- User annotation of inventory records with notes
- Auto user logoff after periods of inactivity

2. IM ARCHITECTURE

IM is a standalone web application that is built upon a secure and reliable Linux® based platform [1]. Assets from industry proven, open source technologies such as

[1] Deployment on other platforms, such as Microsoft Windows™ is also possible.

MySQL AB®, GlassFish™, Enterprise JavaBeanstm (EJBtm), etc. with user accessibility via a web browser such as Firefox is employed. A Graphical User Interface (GUI) leveraging web-based technologies tends to leverage typical user experiences, thus minimizing learning and training curves as well as application deployment. For example, menus, behaviors, toolbars, etc. should be familiar to most internet users.

Each TEMS server typically co-located with its managed NEs in a cable station also hosts the IM server applications and database. As such, no additional computer hardware is required. The IM applications support:

- User access, based on URL addressing
- User authentication based on a unique login and password pair including support for user roles
- Inter and intra cable station database queries and updates including state transitions representing the transmittal of a FRU from one site to another
- Auto-discovery of TEMS managed NEs including appropriate state changes (such as a pack pull)
- FRU data importation with audits via industry standard spreadsheet compliant data sets[2]
- Inter cable station database communications and user access via the embedded TEMS Data Communications Network (DCN) which uses on and off cable facilities
- Managed data to include serial number, warranty end date, hours in service, firmware version, etc.

In this architecture, a user may log into and be authenticated by any TEMS server with access to any IM database in the network. This approach optimizes on and off cable DCN usage, thus maximizing IM application performance.

3. DATABASE POPULATION AND PROVISIONING

Customer requirements and expectations dictate that the NMS applications must support both high reliability as well as high availability. In addition customers desire systems that require minimal maintenance efforts, especially in the areas of database maintenance and management. These expectations are verified by TE SubCom Global Technical Support Center (GTSC) interactions with cable station and NOC personnel. The combination of FRU auto-discovery and FRU data importation from the Commissioning and Acceptance (C&A) Bill Of Materials (BOM) fulfilment process is intended to electronically populate and provision all appropriate FRU pedigree data Minimal user web actions are required to populate any “missing” FRU data or customer provided FRUs (e.g. furniture or third party equipment not provided by TE SubCom).

4. FRU INVENTORY AT SUPPLY DEPOTS AND REMOTE LOCATIONS

A supply depot is associated with a cable station but it may be at a remote location, that is not physically co-located with a station or NOC, Therefore a depot only manages spare equipment (that is equipment in the “Spare” state (see section 5)). Since a remote depot does not have an active TEMS, IM is configured such that the cable station physically closest to the remote depot is allocated to be the supporting server. This approach encourages minimization of repair time since under most conditions, cable station spare equipment should be located at the closest physical depot.

[2] These files are typically generated by the Installation, Commissioning and Acceptance Teams in fulfilling BOM delivery.

5. HOW FRU LIFE CYCLE/STATE MANAGEMENT WORKS

A FRU will be in one and only one of seven possible states at any time (see Figure 2 for the state model). State changes must be initiated by a user for FRUs not managed (i.e. discovered) by TEMS. FRUs managed by TEMS, may have their state changes detected and reported by TEMS (e.g. insertion/removal of a discoverable FRU) or by user interaction.

FRU records may transition through the following seven states.

- New: A new inventory record is created to begin the tracking and management of the FRU (i.e. piece of equipment).
- Provisioned: Indicates that the FRU has been inventoried and is provisioned for service.
- Spare: Designates that the FRU has been allocated to the local spare pool.
- On-site: A transitional state where the FRU is in the station, but has not yet been provisioned for service or allocated as a spare.
- R&R: The FRU has been sent out for repair.
- Off-site: The FRU is not available in the station for use in the network or as an available spare but has not been shipped out for repair. Equipment could reside in a depot.
- Retired: The FRU is no longer in the network inventory.

A FRU may only move from one state to another based on the defined state model. The state model mimics existing FRU asset management processes employed in undersea cable systems. State model rules are simple and strictly enforced by IM. This simple approach, requiring minimal operator input, supports and encourages compliance to the inventory management process. State changes are recorded as historical events in the FRU inventory records.

A key capability of IM is its interaction with TEMS. For TEMS managed NEs, their associated FRUs may automatically change state to/from “Provisioned” and “On-Site”; thereby enabling accurate tracking of FRUs that are provisioned and managed by TEMS. All other state changes occur as a result of any one of nine of the following user actions.

- Provision Unit Spare, or On-site state
- Allocate As Spare
- Un-allocate to On-Site
- Un-allocate to Off-Site
- Ship Item
- Receive Item
- Ship for R&R
- Replace Unit
- Retire Unit

6. CONCLUSION

In this paper we have identified customer needs and requirements related to FRU inventory management. The paper also

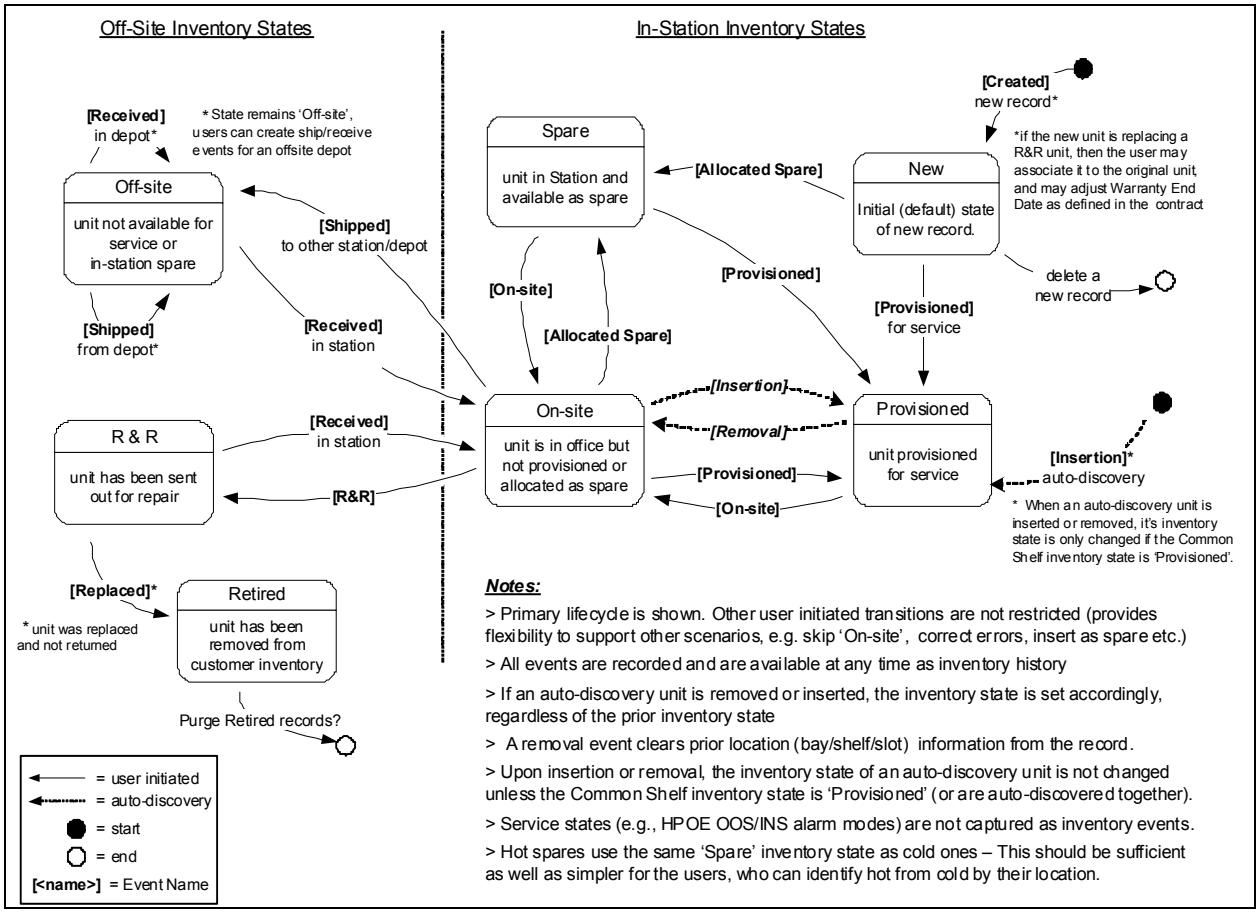

Figure 2 – IM State Management

describes TE SubCom's implementation of a distributed system that fulfills these needs.

7. REFERENCES

[1] ITU-T Recommendation M.3010, "Principles for a Telecommunications Management Network", October 1992