7.4 USER PROFILE BASED PRODUCT DISTRIBUTION IN THE WSR-88D OPEN SYSTEMS RADAR PRODUCT GENERATOR (ORPG)

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1. INTRODUCTION

The Open Systems Radar Product Generator (ORPG) for the WSR-88D (NEXRAD) is currently under development at NSSL as part of the NWS project of NEXRAD Product Improvement (Saffle and Johnson, 1997). A significant component of the ORPG is the Radar Product Distribution. The WSR-88D RPG distributes radar products generated by the RPG to various external users through leased as well as dial-in lines. The communication protocol used is the X.25/PVC. The WSR-88D system requirements also define the product distribution procedures for a set of user classes.

The ORPG must meet the current RPG system requirements by providing the product distribution services for all current WSR-88D users. It must also have the potential to serve future new users such as the AWIPS and other advanced weather forecasting systems. The current procedures may need to be extended and new procedures may need to be implemented. Other communication services other than analog telephone lines and protocols other than X.25 may need to be supported.

In order to protect the ORPG from technology obsolescence and dependencies upon vendor specific hardware equipment, commercial-off-the-shelf (COTS) communication hardware is used in the ORPG. Modularized software design supports scalability, extensibility and a high level of independence on the hardware platform.

In the following we discuss some of the design concepts and new features of the ORPG Product Distribution.

2. COMMUNICATION ISSUES

The current WSR-88D users receive products through leased or dial telecommunication lines. The current RPG has a built-in VME Communication Subsystem (VMECS) providing support for the X.25 protocol used over the narrow band communication links. The VMECS consists of hardware and firmware communication components resident in the RPG computer which supplies the protocol management for the data link and network layer protocols.

The ORPG must have appropriate communication equipment for supporting product distribution. Instead of using a proprietary built-in communication subsystem, the ORPG uses COTS communication equipment. Currently available equipment include stand-alone communication servers, which can be accessed through a Local Area Network (LAN), and communication cards, which can be connected to an ORPG computer through a system bus. Using COTS communication equipment will be cost-effective and provide desired extensibility and protection against hardware obsolescence. When new communication services (for example ISDN), protocols, and hardware become available, new communication equipment can be acquired for replacing existing ones or adding to the ORPG for extending its capacity. Refer to Zahrai, et al. (1997) for a description of the ORPG architecture.

In the ORPG design, the choices of the product distribution communication services, protocols, and equipment are kept open. The ORPG is designed to be able to support any communication equipment that implements the required services and protocols. The development effort needed for adding support for a new piece of communication equipment or a new protocol is minimized and does not require ORPG-specific knowledge. For example, support for users on the LAN and the INTERNET can be easily implemented. Additionally, different communication equipment can be used simultaneously in a single ORPG system.

The OSF and ISL are currently investigating the technical solutions of reusing the existing RPG narrow band communication equipment. The ORPG will be able to use these equipment when they are isolated from the Concurrent computer system.

3. SOFTWARE DESIGN

The ORPG uses a highly modularized, layered software architecture as described by Jain, et al. (1997). The ORPG

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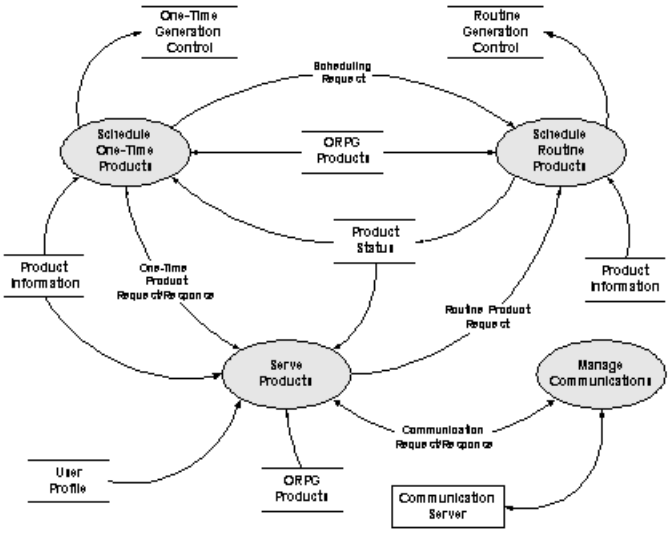

Figure 1. Product Distribution Data Flow Diagram.

product distribution part is partitioned into four tasks as depicted in Figure 1. In the data flow diagram of Figure 1, each bubble is implemented through a task.

3.1 Manage Communication

"Manage Communication" is implemented as task "comm_manager". This task provides communication services for the ORPG product distribution function by interfacing with the communication server or implementing the communication protocols. It provides the following services:

- Building a connection to a remote user;
- Terminating a connection;
- Sending and receiving user messages;
- Monitoring line status.

The user requests services by sending request messages to comm_manager. In responding to the requests, comm_manager sends response messages to the user. comm_manager is the only ORPG task that is communication equipment and protocol dependent. A different version of comm_manager may need to be developed to support a different protocol and different communication hardware.

comm_manager provides services through an Application Programing Interface (API) that is independent of any particular communication service, protocol or hardware. Thus the remaining parts of the ORPG product distribution are fully isolated from any communication specific characteristics. Multiple, heterogeneous communication devices and protocols can be supported simultaneously, in which case multiple instances of comm_manager may be executed. This makes the ORPG product distribution capacity extensible. For example, when there is a need for servicing additional users or a communication service of higher bandwidth becomes available, the ORPG capacity can be extended by adding new equipment and running an appropriate comm_manager for the new lines.

comm_manager does not implement any ORPG product distribution specific procedures. The developer of this task does not need to have knowledge about ORPG products, procedures and messages.

3.2 Serve Products

"Serve Products" is implemented as task "p_server" which implements ORPG product distribution procedures. An instance of p_server may serve multiple users. Multiple instances of p_server, however, can be initiated for each user providing additional robustness. When one p_server instance fails, only users that are served by that instance will be affected.

p_server performs the following tasks for each user:

- Builds and maintains the link connection to the user.
- Performs the user authentication procedure.
- Distributes alert messages and alert products to the user.
- Receives the product and alert requests from the user and distributes ORPG products to the user.
- Checks product distribution permissions.
- Sends General Status Messages, product lists, request response messages, background maps, annotation data and other messages to the user.
- Reports user and connection status to the ORPG control and HCI (Human Computer Interface).
- Performs Narrow Band load shedding when congestion conditions are detected on the distribution queue.
- Processes RCM (Radar Coded Message) distribution.
- Performs disconnection procedures.

Upon receiving a product request, for one-time or routine products, p_server passes the request to the respective one-time and the routine product schedulers for product generation scheduling.

Product distribution control and user profile information are read from data stores "Product Information" and "User Profiles" as depicted in Figure 1. Data in these stores can be dynamically updated by the HCI. For example, new users can be added to the ORPG while it is in operation.

3.3 Schedule Routine Products

ORPG task ps_routine implements "Schedule Routine Products". It performs two functions, maintaining a real time product information source and controlling routine

product generation according to all user requests and the directions from the ORPG operator through the Human/Computer Interface (HCI).

ps_routine monitors the product generation messages and other messages sent by the algorithm/product tasks and updates the product information stored in the "Product Status" data store which will be used by other ORPG tasks such as the product server, the HCI, and the archive manager. The product information contains a list of all ORPG products, their current scheduling status, and their generation history.

ps_routine controls product generation for all products that use the real-time radar data flow. In order to perform this task, ps_routine maintains a product generation table which is updated based on the current user requests, weather mode, default generation list and ORPG system load condition.

ps_routine reads product generation control information from the "Product Information" data store. This information includes the default product generation table (which is weather mode dependent), the product dependence table, and the product generation load shed priority table. Data in "Product Information" can be dynamically updated by the HCI. For example, new products can be added to the ORPG while it is running in operational mode.

ps_routine is the single task in ORPG that can directly control the product generation with real-time data stream.

3.4 Schedule One-time Products

Task ps_onetime implements "Schedule One-Time Products". Upon receiving a one-time distribution product request, p_server passes the request to ps_onetime for product scheduling. ps_onetime is responsible for providing the requested product by conducting the following steps. It first searches for the product in the current product storage. If the requested product is not found in the product storage, ps_onetime determines whether it should be generated using the real-time data flow or the play-back data. If the real-time data flow is used, it sends a message to ps_routine for generation scheduling. If the play-back data is used, ps_onetime activates appropriate product generation tasks to accomplish the job.

ps_onetime sends a message to p_server in response to every requested one-time distribution product. The message contains the product information, if it is generated successfully and ready for shipping, or a failure response if the product did not exist and could not be generated.

ps_onetime reads scheduling and generation information from "Product Status" data store for products generated by the real-time data flow. It reads product generation control information from the "Product Information" data store which can be dynamically updated by the ORPG operator (through HCI).

4. USER PROFILE BASED PROCEDURE

The current RPG services product users in terms of their classes. Users of each class receive their unique subset of the RPG product distribution services. Five distinct user classes are defined. They are

- Class 1: Associated PUPs (FAA ARTCCs).
- Class 2: Non-associated PUPs.
- Class 3: Principal User External Systems (PUES).
- Class 4: Other Users.
- Class 5: NWS GDSSs/RFCs.

Special procedures and rules are defined for each class user. These rules are implemented in the RPG software and are inconvenient to modify.

A user profile based product distribution control approach is adopted in the ORPG design to replace the user class based approach in the current RPG. In the ORPG, each product user accesses selected ORPG product distribution services specified in the user's user profile.

A user profile specifies whether each of the following services are granted for the user:

- Max connect time override privilege;
- APUP status is available from the user;
- RPGOP privilege;
- Alert services (Alert and alert product distribution);
- Communication load shed;
- General status message distribution;
- Map distribution;
- Product generation list distribution;
- Product distribution list distribution;
- RCM distribution;
- Disconnection after distribution completion;
- Messages with different source identification addresses on a dedicated line are allowed;
- The user receives a Alert Adaptation Parameters message upon connection if the user does not use alerts;
- Immediate disconnection instead of waiting for distribution completion of the current product.

A user profile also contains the following tables:

- The distribution permission table;
- The map table;
- The default distribution table.

"The distribution permission table" lists all products that can be requested by the user for routine and/or one-time distribution for each weather mode. "The map table" specifies the maps that will be transmitted to the user upon connection. "The default distribution table" defines a set of products that will be automatically distributed to the user after connection.

A user profile also defines the maximum connection time for the user, the maximum number of products the user can request for routine distribution, and the users name, ID and password.

In the ORPG, each dedicated line has a pre-defined user profile. For dial users, each user must have a specific user profile associated with the users ID.

Although there are no predefined user classes in ORPG, the user profile based product distribution control approach provides full support for the current RPG product users. This is accomplished by creating special user profiles that emulate the legacy user classes.

User profiles are stored in ORPG adaptation data base and can be modified while ORPG is in operation. New users can be added and existing user profiles can be modified through the HCI. An updated user profile will become effective at the next time the user is connected to ORPG.

The user profile based product distribution control approach provides flexibility to meet potential future ORPG product users' requirements.

5. SUMMARY

The product distribution part of the ORPG is described in this report. One of our major goals in the design is to isolate the communication part of the software such that heterogeneous COTS communication equipment can be used in ORPG. This is accomplished by introducing the comm_manager task. Support for new communication services and protocols can be added to the ORPG in the future without modifying most parts of the ORPG Product Distribution software.

The ORPG adopts a user profile based product distribution control scheme instead of the legacy user class based approach. Allowing full product distribution service control on individual user basis, this provides extended product user service configurability.

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