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1. INTRODUCTION

The National Weather Radar Testbed (NWRT) in Norman Oklahoma is a new national asset for weather radar research (Forsyth et al 2005). It is located at the National Severe Storms Laboratory (NSSL) on the University of Oklahoma's North campus. During the spring of 2006 NSSL staff (both federal and contractor) will be relocating to the National Weather Center (NWC), located on the South campus of the University of Oklahoma. The NWRT facility will remain at the North campus site and will require the ability to operate the radar remotely from the NWC. In addition, current plans are to allow researchers from across the nation to remotely access the NWRT to support their research. To support this new remote access requirement, the Radar Control Interface (RCI) has been developed. This paper describes the features of the RCI.

2. SYSTEM OVERVIEW

The physical characteristics of the NWRT are described in the paper by Forsyth et al (2005). The RCI interacts with two major components: the Real-Time Controller (RTC) and the Environmental Processor (EP). To allow simultaneous recording of moment and time-series data, the EP has been divided into two subcomponents; one for moment processing and the other for time series recording.

In its legacy configuration, the NWRT is controlled by software running from a dedicated position. This software, referred to as the Radar Scheduler (RS) can be run inside the radar structure or at a dedicated

workstation located in the NWRT Operations Center. Only one instance of the RS can be running at a given moment. Unless the radar is being used for maintenance purposes the RS is always run at the NWRT Operations Center.

Communication between system components is done through socket connections with the RS. Both the EP and RTC components send status messages to the RS and receive data and commands from the RS. The RS must be running before all other components are started. If the RS is restarted, then all other components must be restarted as well. Modifications are planned to the RTC and EP software to eliminate these dependencies.

In our current configuration, the RCI replaces the legacy RS function. It is based on a client-server model with the RCI server communicating directly with the RTC and EP components. RCI clients interact with the RTC and EP components through the RCI server. One or more RCI clients can simultaneously communicate with the RCI server either retrieving status or sending commands to the other components. However, only one RCI client can be in control of the system at any given moment.

3. RCI SERVER

The RCI server component is a stand-alone multi-threaded Java-based application that directs all activity in the system. Once it is started, it handles all communication between users (clients) and system components. As each component is started a connection is established with the server and a new thread is started to handle communication between the server and the component. The RCI server currently runs on a Sun Ultra10 workstation but future plans are to eventually replace this with a

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Linux-based PC. Since the software is totally Java-based, no modifications will be required during the transition.

One important issue concerning remote access to the NWRT is security. In addition to the security provided by the NSSL firewall, access to the RCI server from RCI clients is controlled using a write protected host/user file residing at the RCI server. RCI clients communicate with the RCI server using a standard socket connection. When an RCI client establishes a connection to the RCI server, the RCI server extracts the user and host names from a predefined login message passed to the RCI server from the RCI client. If the user and host names are not found in the host/user file, the RCI server closes the connection with the RCI client. The contents of the host/user file are write-protected and maintained by the NWRT system administrator.

An important function of the RCI server is to handle requests from RCI clients. A request can be either a system control command or a request for information. Information can include status, logs, file lists, common data,

etc. A set of predefined messages have been developed to handle requests to and information from the RCI server. The RCI server can accommodate up to 128 separate RCI clients running simultaneously allowing multiple users to monitor the system at any given time.

Another function of the RCI server is to keep a record of all system activity. This activity includes system commands directed from RCI clients, status information, and errors. These system logs are available for viewing by RCI clients on demand. The client can specify a set of filtering criteria for a request.

4. RCI CLIENT

The RCI client is a Java-based GUI application which serves as the interface between the user and the system. It communicates only with the RCI server and can be run from any point on the network as long as a socket connection can be made to the host running the RCI server. It is functionally divided into two distinct components: control and status. A sample RCI client display window is presented in Figure 1.

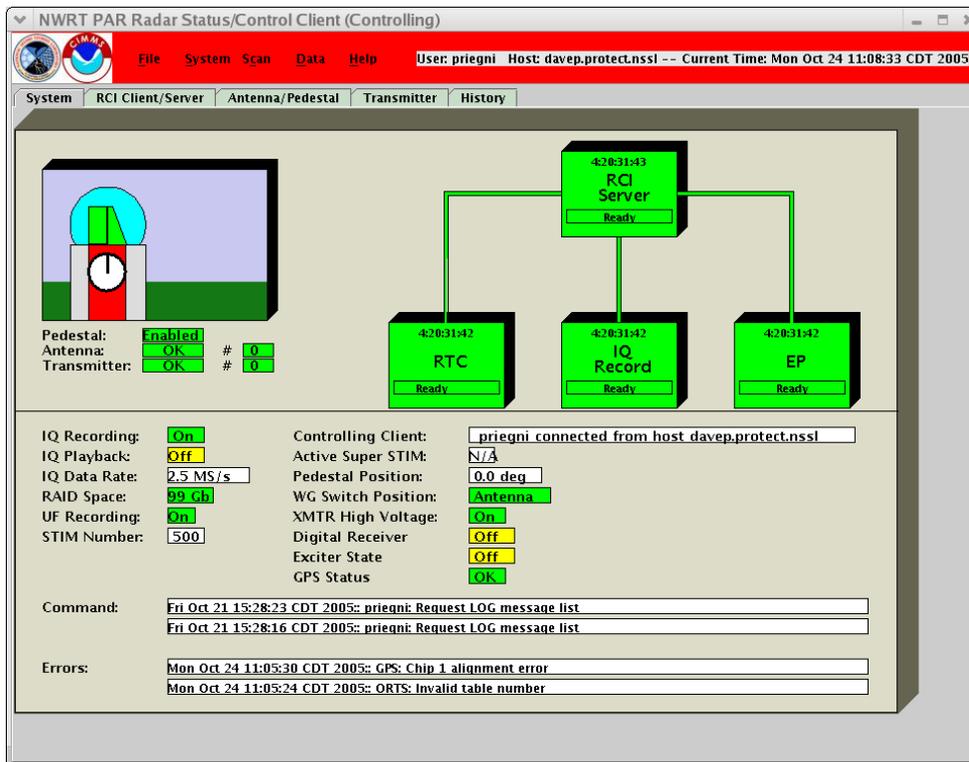


Figure 1: Sample RCI Client Display (System tabbed window view)

4.1 RCI Client Control

The control component of the RCI client consists of a set of dropdown menus located near the top of the RCI client display window. The dropdown menus are grouped as follows: File, System, Scan, Data, and Help.

The File menu item contains selections to download data contained in files from the server to other NWRT components. For instance, to be able start a data collection scan, one must first download a file, called a Super Stimulus, to the RTC and EP components. A Super Stimulus file contains information needed to perform one or more volume scans (i.e., PRF, beam direction, pulses). Other file types that can be accessed include calibration, radiation inhibit sectors, and data playback files. An Exit selection is provided to terminate the client.

The System menu item contains selections to request/release system control and startup/shutdown system components. It also contains selections to control the transmitter.

The Scan menu item contains selections to control scan processing (start, stop), control the pedestal (stop, position, stow), and stop the transmitter from radiating.

The Data menu item contains selections to control time series (I/Q) and moment data recording.

The Help menu item provides information on the operation of the system.

To begin a typical data collection operation, one would first select a Super Stimulus file from the File menu, enable the pedestal (currently done using a physical keyed switch in the Operations Center), activate the transmitter from the System menu, and then start the scan by selecting the scan start selection from the Scan menu.

Most of the menu selections are active only after the user requests and is granted control by the RCI server. Otherwise, they are inactive (desensitized). When an RCI client is controlling, no other RCI client can

send control commands to the RCI server until control is released by the controlling RCI client. A control override is provided in the event a non-controlling RCI client needs to take control from a controlling RCI client. However, in order to override another RCI client the user will need override authority (which is determined by the RCI server using information contained in the host/user file). The title of the RCI client window indicates whether it is controlling or non-controlling (also if the client is controlling, all control selections will be sensitized)

4.2 RCI Client Status

The status component of the RCI client is always active. A group of tabbed windows are used to organize status information into related groups. Each tabbed window contains a specific collection of status items. Currently, the main tab groups are: System, RCI Client/Server, Antenna/Pedestal, Transmitter, and History.

The System tabbed window provides a composite view of the NWRT system. This is the view that an operator will normally want to display. It shows the state of each NWRT component and the most important status information from the RTC and EP components. It also shows the active Super Stimulus and the user who is in control (if there is a controlling client). A graphical representation of the radar facility is displayed in the upper left portion of the window indicating the pedestal position, whether the pedestal interlock is enabled, the state of the transmitter/high voltage, and whether there are antenna, transmitter or pedestal alarms active. It also displays the two most recent log messages and the two most recent RTC or EP error messages. If the EP or RTC components are down, all associated status items are tagged as "not available".

The RCI Client/Server tabbed window provides information about RCI clients and the RCI server. An icon pushbutton object is displayed for each active RCI client. Non-controlling RCI clients are displayed in blue and the controlling RCI client is displayed in red. The icon used for the local RCI client is different from the icon used for all other RCI

clients. The user and host names of each client can be obtained by moving the cursor over its associated pushbutton object. If a user wants to send a text message to another user they can select the icon pushbutton associated with that user, fill out a simple form, and then select a button to send the message.

The Antenna/Pedestal tabbed window contains status information pertaining to the pedestal and antenna. This information is received regularly by the RCI server from the RTC component and sent to RCI clients on request. If the RTC component is down then all status items are tagged as “not available”. Selections are provided to command specific antenna tests (controlling RCI client only) and display the results of completed tests (all RCI clients). A sample antenna test report display is presented in Figure 2.

The Transmitter tabbed window contains general transmitter status and individual transmitter fault status information. As with the Antenna/Pedestal window, it contains information sent to the RCI server from the

RTC component. If the RTC component is down then all status items are tagged as “not available”.

The History tabbed window displays system log information. The logs are presented in reverse chronological order (latest message at the top of the display list) and tagged by type (status, command and error) and component (RCI, RTC and EP). Filter switches are provided for the user to select a combination of type and component. In addition, the user can enter a text string so that only messages containing the string are displayed. A sample RCI History window display is presented in Figure 3.

As long as the client is running, status requests are automatically sent by RCI clients to the RCI server in 2 second intervals. The RCI server sends a status message back and the RCI status display objects are refreshed. If the RCI client doesn't receive status back in a preset amount of time, the connection with the RCI server is terminated and an attempt is made to reconnect with the RCI server.

The screenshot shows a window titled "ORTS Antenna Test Report Summary". The window has a menu bar with "File" and "Help". Below the menu bar are two circular logos and the text "Power Supply Data Bus Check: Tue Oct 18 13:43:54 CDT 2005". The main content area contains a table with the following columns: BIT, BUS, CAL, COR, MAGIC, VOLT, Test Point, Register, Min Value, Max Value, Incl/Excl, Error Word, Description, and Fault Result. The table lists 15 test points, each with a register value of 346, a min value of 329, and a max value of 363. All tests are marked as "Inclusive" and have an error word of 2000-2013. The descriptions are TAM A4 (Expander), TAM A5 (Expander), TAM A6 (Expander), TAM A7 (A/D Converter), TAM A8 (Expander), TAM A9 (Expander), TAM A10 (Expander), TAM A4 (Expander), TAM A5 (Expander), TAM A6 (Expander), TAM A7 (A/D Converter), TAM A8 (Expander), TAM A9 (Expander), and TAM A10 (Expander). The fault results are "see flowchart Pages 5A-556 .. 559" for test points 2031, 2047, 2079, 2127, 2143, 2191, 2223, 2239, 2271, 2319, 2367, 2415, 2959, and 2991, and "see flowchart Pages 5A-560 .. 563" for test points 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013.

BIT	BUS	CAL	COR	MAGIC	VOLT	Test Point	Register	Min Value	Max Value	Incl/Excl	Error Word	Description	Fault Result
						2031	346	329	363	Inclusive	2000	TAM A4 (Expander)	see flowchart Pages 5A-556 .. 559
						2047	346	329	363	Inclusive	2001	TAM A5 (Expander)	see flowchart Pages 5A-556 .. 559
						2079	346	329	363	Inclusive	2002	TAM A6 (Expander)	see flowchart Pages 5A-556 .. 559
						2127	346	329	363	Inclusive	2003	TAM A7 (A/D Converter)	see flowchart Pages 5A-556 .. 559
						2143	346	329	363	Inclusive	2004	TAM A8 (Expander)	see flowchart Pages 5A-556 .. 559
						2191	346	329	363	Inclusive	2005	TAM A9 (Expander)	see flowchart Pages 5A-556 .. 559
						2223	346	329	363	Inclusive	2006	TAM A10 (Expander)	see flowchart Pages 5A-556 .. 559
						2239	346	329	363	Inclusive	2007	TAM A4 (Expander)	see flowchart Pages 5A-560 .. 563
						2271	346	329	363	Inclusive	2008	TAM A5 (Expander)	see flowchart Pages 5A-560 .. 563
						2319	346	329	363	Inclusive	2009	TAM A6 (Expander)	see flowchart Pages 5A-560 .. 563
						2367	346	329	363	Inclusive	2010	TAM A7 (A/D Converter)	see flowchart Pages 5A-560 .. 563
						2415	346	329	363	Inclusive	2011	TAM A8 (Expander)	see flowchart Pages 5A-560 .. 563
						2959	346	329	363	Inclusive	2012	TAM A9 (Expander)	see flowchart Pages 5A-560 .. 563
						2991	346	329	363	Inclusive	2013	TAM A10 (Expander)	see flowchart Pages 5A-560 .. 563

Figure 2: Sample RCI Client Antenna Power Supply Data Bus Check Test Report Display.

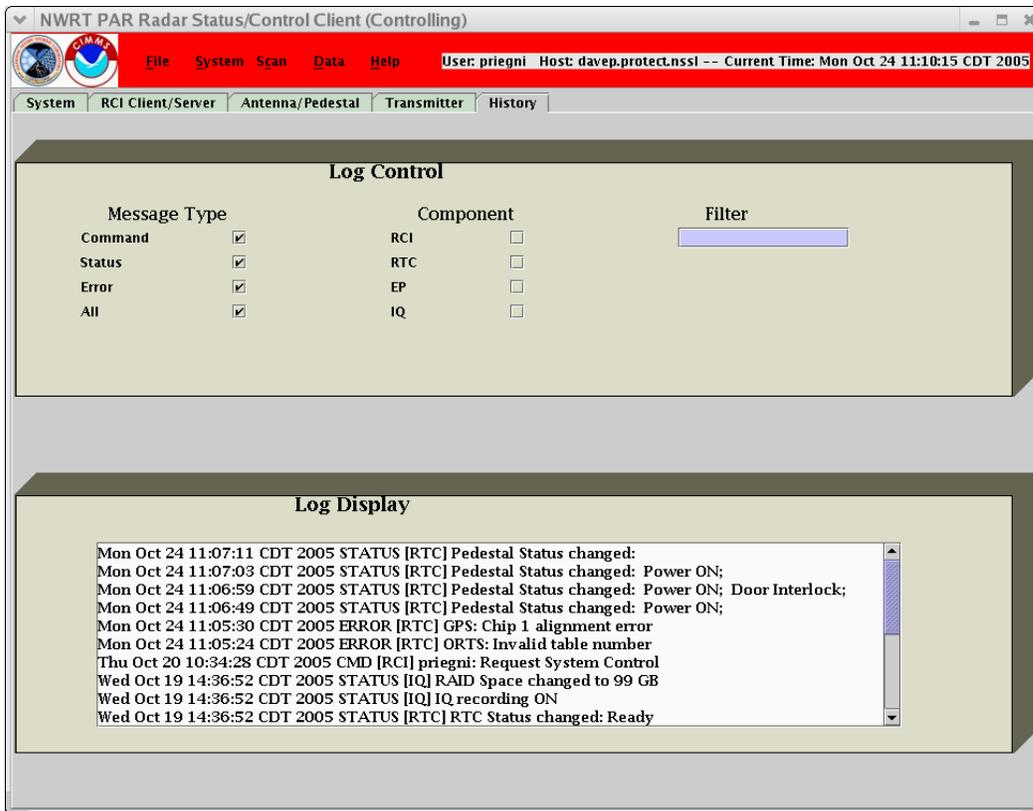


Figure 3: Sample RCI Client History Window Display

5. SUMMARY

A new software package, called the Radar Control Interface (RCI), has been developed for the National Weather Radar Testbed (NWRP). With the impending move of NSSL staff to the new National Weather Center (NWC) and the physical location of the radar at the current NSSL site, remote control capability is required to support the move. The RCI has been designed to allow multiple users to monitor, and a single user to control, the radar from remote locations. Security features have been implemented to restrict user and host access and allowing a single user to control the system at a given point in time. Not only does this design allow remote control from the NWC, it also allows researchers from outside the Norman community to operate the radar. Future enhancements include a moment display window, calendar type scheduler, and an expanded logging capability to capture user generated information during data collection.

6. ACKNOWLEDGEMENTS

This paper was prepared by David Priegnitz and Douglas Forsyth with funding provided by NOAA/Office of Oceanic and Atmospheric Research under NOAA-University of Oklahoma Cooperative Agreement #NA17RJ1227, U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the authors and do not necessarily reflect the views of NOAA or the U.S. Department of Commerce.

7. REFERENCES

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