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Digital Remoting for Air Traffic Control in Terminal Areas

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The U. S. Federal Aviation Administration (FAA) and Sperry Univac Defense Systems Division St. Paul, Minn., are currently involved in a radar digitizing and data remoting project which is expected to lead to methods for economical expansion of terminal area radar service. The project consists of adding two capabilities to an upgraded Automated Radar Terminal System (ARTS IIIA). The first capability is the digitizing of primary and secondary radar and the remoting of the target reports to an ARTS IIIA Data Processing System (DPS). Second is the remoting of ATC data from the ARTS !IIA facility to other air traffic control towers in the terminal area (hereafter called "remote towers" for ease of discussion). The project is scheduled to undergo evaluation at Tampa, Florida, USA, in the latter part of 1978 with results available in early 1979.

The geographical extent of the project is depicted in Figure 1 with approximate distances shown between participating facilities. Information flow of the radar data on the communication circuits is in one direction (from radar site to the ARTS IIIA). Target reports, alarm conditions, and weather messages are sent from the Tampa and Sarasota radars to the Tampa ARTS IIIA DPS. Information flow is in both directions on the remote tower circuits. Digital display data flows toward the remote towers with keyboard messages returning back from the remote towers to the central site. The ARTS IIIA DPS at Tampa performs the aircraft tracking and data block association, formats all display outputs (including those for the remote towers), interpretes and acts on all appropriate keyboard messages from each display position, collects and records selected flight data, and automatically accommodates system reconfiguration to a backup mode in event of either a system element (hardware) failure or a requirement to isolate a portion of the system for off-line utilization.

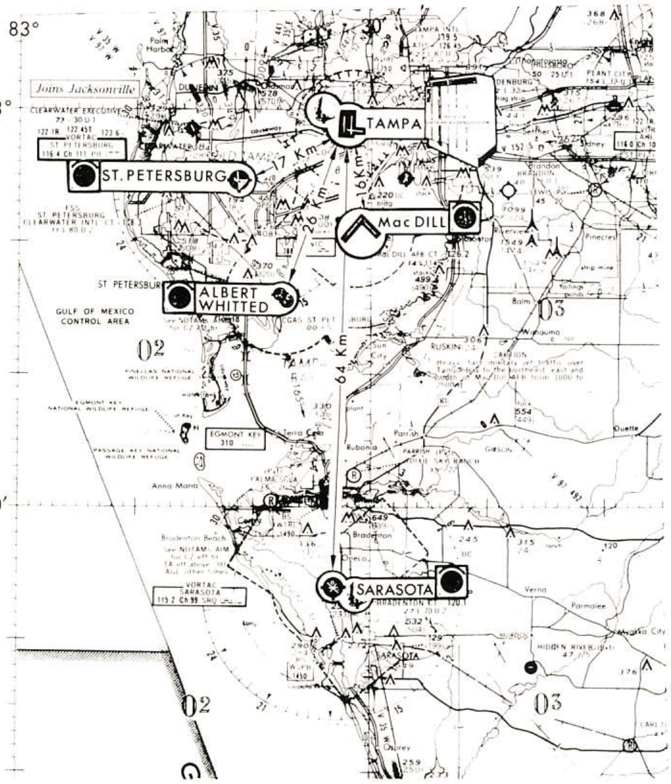

Figure 1. Digital Remoting at the Tampa, Florida (USA) TRACON

Figure 2 represents a pictorial diagram of the complete system. At the Tampa and Sarasota radar sites are Sensor Receiver and Processor (SRAP) units. They digitize the primary and secondary target reports and format the reports for transmission over 4800 bits per second circuits. For evaluation purposes, one of the Tampa SRAP units is installed at the indicator site (TRACON equipment room) and operates in a "local" mode. In this mode, the unit outputs its information (target report, weather, etc.) via a 30-bit parallel interface directly to an I/O channel on the ARTS IIIA DPS. For this local operation, broadband primary and secondary radar videos must be available at the DPS site.

The Tampa TRACON will have two ARTS III display consoles that have been modified for vector generation (all digital) operation. They will use a combination of vectors and alpha-numerics to present a digital map, weather, and aircraft track data developed from the Satasota SRAP target reports. These consoles will be used by controllers working traffic in the Sarasota sectors. The

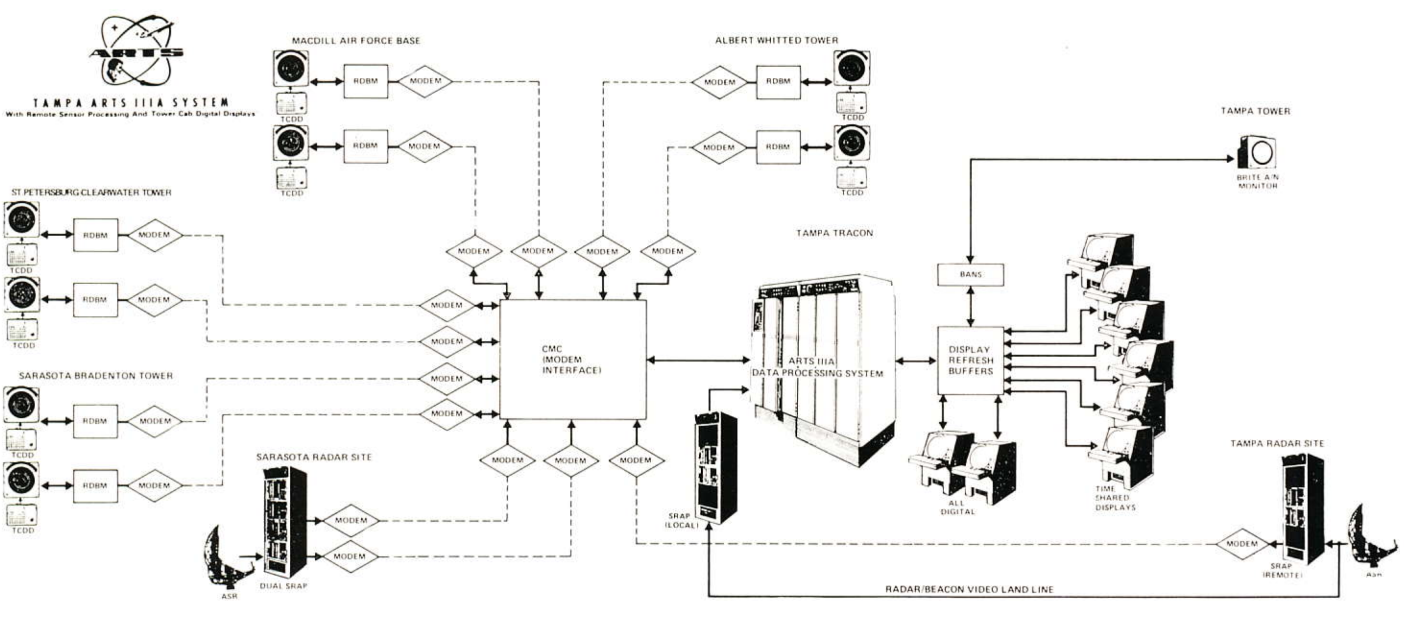

Figure 2. System Block Diagram

six remaining ARTS (time-shared) displays will present the Tampa radar videos and associated digital data blocks.

A most obvious and impressive piece of new equipment used in the project is the Tower Cab Digital Display (TCDD). These units were designed and built by the Magnavox Company under subcontract to Sperry Univac. As shown in Figure 2, the TCDD's will be located at each of the four remote towers and will display the information forwarded by the ARTS IIIA. The TCDD is a digital stroke writing display with a character repertoire of the upper case alpha, 10 numeric, and 19 special characters. It has a digital mapping capability, a circle generator for computer controlled range rings, and target trail represented by history dots (up to five per track). The unit has been designed for use in the very high ambient light conditions of the control tower cab. Character quality is considerably better than that available on the TV raster type BRITE equipment used in the Tampa tower cab and many other U.S. control towers. Data block formats as well as keyboard/trackball entries will be identical to those of the vector generator displays used in the Tampa TRACON IIIA.

As shown in Figure 2, each TCDD is connected to one Remote Display Buffer Memory (RBDM). The RBDM, which includes a microprocessor, is a new device developed specifically for the remote tower application. It receives the TCDD display update data from the DPS and manages the data in a 4K display refresh memory. It also performs preliminary data entry processing and controls transmission of this information back to the DPS. Data transmission verification is accomplished through the use of cyclical redundancy codes for each message. A full duplex 4800 bit per second data circuit is used for two-way communication. The RDBM includes self-contained diagnostics and digital test patterns for checking and aligning the TCDD's.

Each dotted line of Figure 2 represents a 4800 bit per second data circuit and each terminates at the DPS into the Communication Multiplexer and Controller (CMC). The CMC is also a new microprocessor based unit that contains various modem adapters and a multiplexer to interface the data circuits with the DPS. The CMC can accomodate sufficient adapters for 32 circuits and has extensive built-in diagnostic test features for maintenance and fault isolation.

Of course, the final Tampa system will have all of the new features currently being implemented into the other major terminals in the U.S. under a separate contract.

Total system processing capacity will be 600 tracked aircraft, generally alloting 300 each to the two sensors. Each sensor will have dual SRAP capability and dual circuits for increased reliability. Each radar data circuit is capable of carrying 470 target reports per scan. The twin circuits provide ample overload protection and reduce the delay in the reports reaching the DPS. Each remote tower has the capacity for 80 tracks which could be increased by using a 9600 bit per second data circuit. Dual CMC's, RDBM's, and TCDD's are used in the system to increase system reliability. The DPS is also sized to have one extra computing element and one extra memory module for system reliability. In the event of a DPS element failure, the system will automatically recover (within 10 seconds) to a capability matching the inventory of available elements. Critical system data (tracks, flight plans, sector configuration, etc.) is constantly recorded on a disk subsystem for use in such a recovery.

This FAA project is another major step forward in the evolutionary growth to a full digital terminal operation. Expected benefits of these new tools are: wider use of available radar information, fewer siting restrictions for terminal radars, improved ATC coordination between IFR rooms and remote towers, and of course, lower communication costs due to the substitution of digital telephone lines for the more expensive radio microwave links (RML) now used to transmit radar information. ■