SWITCHING TO THE FUTURE OF RANGE COMMUNICATIONS AT EDWARDS AFB

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ABSTRACT

The Edwards Digital Switch (EDS) provides mission critical voice and time-space-position information (TSPI) communication switching capability to the Edwards Test Range. The present system has been in operation for about 10 years. The core of this system is based on widely used commercial-off-the-shelf (COTS) time-slot interchange switches that were designed for a 40-year service life. The application layers of the system, comprising the command/control elements and the communications and user interfaces, were custom developed by the prime contractor to satisfy the performance requirements of the Air Force Flight Test Center (AFFTC).

Problems with the current system include difficulty in obtaining replacement items for equipment developed by the prime contractor and higher than expected failure rates for this equipment. Based on experience, the service life for the equipment developed by the prime contractor appears to be about 15 years. Another problem is that lower cost packet switches are taking market share from the more traditional time-slot interchange switches. This factor tends to accelerate the obsolescence of the existing COTS equipment.

Solutions are being investigated to update or replace the EDS. One solution is to reuse the existing COTS core equipment and replace the present application layers, preferably with COTS. Another solution is to replace the entire system with COTS or vendor-modified COTS hardware and software.

INTRODUCTION

The first step in establishing a plan for improvement & modernization of the Edwards Digital Switch (EDS) is in knowing where we are and what we have now. This will allow us to establish the current operational baseline switching capability. We must also assess any known shortfalls with the current switch and identify future operational requirements. Then we can seek alternative solutions for achieving the desired future switching capability.

BASELINE SWITCHING CAPABILITY

The EDS provides advanced voice networking capabilities to the Edwards Test Range and consists of six groups of configuration items:

1. System-level controls and monitoring are centralized in the control and display subsystem (CDS). Workstations provide subsystem-level control and monitoring.

2. The central switching subsystem (CSS), as the primary interface with the range environment, provides system connectivity to radios, telephone circuits, and communications links to other facilities. It integrates the EDS with links to the control room switching subsystems (CRSS). Each CRSS connects individual user stations within a mission control room (MCR) or other localized area.

3. The user equipment element consists of a subscriber terminal unit (STU), channel expander, and interface panels for headsets, foot switches, and speakers.

4. The remote radio control unit optimizes usage of available frequencies, allowing control of tunable radios from the CDS.

5. The site selection unit facilitates the handover of voice communications between receiver sites when a long-range test is monitored.

6. The system architecture is based on a central system-level control element, a central switch, multiple subsystem-level control elements, multiple subsystem switches, and end-equipment items that are interconnected through the switch network.

The EDS combines multiple voice communications applications in a single system. The system has been expanded to integrate voice and data switching. Its major function is support of multiparty-networked voice communications within MCRs and between other test participants. Other voice functions are an intercom capability including direct access (hot line) and indirect access (dial-up), subscriber loop connections to the base-level telephone exchange, and the public switched network system. Digital interfaces allow integration of cipher text data and TSPI data switching functions.

Systems based on the EDS design have also been installed by the Air Force at Eglin AFB and by the Navy at China Lake.

The EDS acquisition and development project began in 1985. A multiyear, fixed-price requirements-type contract was awarded in April 1989 for a system based on T-1 signaling and using major components already in wide use within the public switched telephone network.

Some components within the system are COTS items while the contractor developed many units, along with much of the integration software. The Air Force opted not to purchase the data rights for those items, which remains proprietary with the contractor.

The system has been in operation since 1994. In October 1996, a sole-source contract was awarded to the developing contractor for further enhancements and sustainment. Since the installation of the original CSS, and three CRSS the entire system has been expanded to include seven control rooms at the Ridley Mission Control Center and four at the Birk Flight Test Facility. The entire system has been upgraded for Y2K compliance.

Recent reviews indicate that the primary user interface is becoming more prone to failure and replacement parts are increasingly more difficult to procure. The core system components continue to operate with little or no problem.

CURRENT SYSTEM ELEMENTS and ARCHITECTURE

The EDS includes features to meet the security requirements of numerous Special Access Required programs. Each switching subsystem consists of two separated and isolated switches, a RED switch and a BLACK switch. Although both use the same switching technology, extensive shielding and filtering and the use of fiber-optic trunks substantially reduces emissions from the RED switch elements. This RED/BLACK separation is extended to the user position. The need to compartmentalize programs with critical security requirements is met by the hierarchical switching architecture. The system is partitioned into elements. Switching for each of these elements is performed by the CRSS assigned to the element. Although the CSS accomplishes interfaces to external circuits, such as radios, and interconnection with other MCR, sensitive communications can be contained within a specific MCR.

The basic EDS switching units are AT&T Digital Access and Cross Connect Switches (DACS II). They are time division digital switches that connect to the external network through T-1 ports. Internally, each T-1 frame is broken into its 24 individual DS-0 channels, which are recombined into a T-1 frame at the destination port. A wide variety of switching modes can be configured for each DS-0 channel under dynamic external control. The DACS II is available in 160 and 320 DiGroup sizes. Each size can be procured with zero DiGroup and populated to maximum size with modules that support two full duplex T-1 ports (Dual DiGroups).

The EDS, shown in figure 1, contains a central core of control and switching equipment. This central core consists of the CDS, the CSS, and the power distribution subsystem

(PDS). The EDS capabilities can be expanded modularly. At the AFFTC, the module of expansion is the MCR. An MCR contains CRSS and a number of user equipment sets.

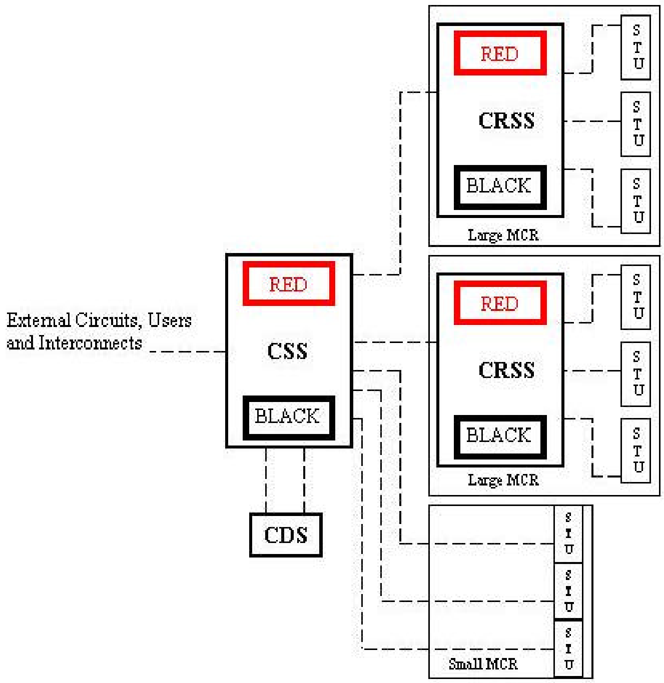

Figure 1. EDS Architecture

Operation of the EDS is controlled and monitored from the CDS. The CDS consists of dual redundant network control computers and two operator workstations. There are also provisions for remote operator workstations.

The contractor produced the CDS applications software. This software, in addition to making and breaking all connections, configures all interfaces and continuously runs diagnostics on off-line system elements.

The CSS provides the major interface between the EDS and external circuits, interconnects users in multiple MCRs, and serves as the entry switch for users located outside of an MCR. The CSS contains two 320-line DACS II frames each with a capacity of 7,680 voice circuits. A separate frame is used for the RED and the BLACK section. Neither frame is fully populated, but each can be expanded to its full capacity with readily available modules.

Each CRSS contains two 160-line DACS II frames, partitioned into RED and BLACK sections. This smaller size easily accommodates the various MCR sizes.

The primary user interface was developed around a STU with capabilities to provide the user with access to BLACK/RED voice channels. The following channel configurations are in use: 9/9, 15/3, and 18/0. To provide even greater channel capacity, station channel expanders (SCE) are also available in the 9/9 and 18/0 channel configurations. Up to three SCEs can be attached to each STU to make a maximum configuration of 72 channels. A variety of user interface panels are available to customize the user position. Each STU contains output and volume controls for two-user headsets. The headsets with accompanying hand switches are plugged into a Type I Remote Headset Interface Panel. Foot switches are available if preferred. The position can be expanded to accommodate four personnel using the Type II Remote Headset Interface Panel that includes a separate pair of volume controls as well as headset jacks. For positions where a loudspeaker is preferred, it can be interfaced via the STU speaker panel.

Two EDS auxiliary units improve the management of ground-air radio assets, the remote radio control unit (RRCU) and the site selection unit. They operate together to increase the capability of the EDS operators to control the radios and ease the support of extended flights.

The RRCU controls the tuning frequency at remote sites based upon instructions entered by the operator at the CDS console. It also reports error status to the CDS operator if the radio does not accept the information. The unit can interface to either GRC-171 (UHF) or GRC-211 (VHF) radios.

NETWORKED COMMUNICATIONS

The EDS permits the creation of large networks, which allow communities of common interest to communicate throughout a test mission. The construction of common networks for multiple missions is eased by the capability to combine networks into a master network without losing the identity of the individual networks. In this manner, complex operational networks can be assembled and stored in advance to support test missions.

The CSS has provision for 192 two-wire interfaces. Each simulates a standard telephone set to the local exchange. Any of these interfaces can be connected to one or several STUs. Using the STU keypad, the user connected to a two-wire interface has the complete equivalent of a standard telephone set integrated into the user position.

DIGITAL CONNECTIONS

Since the EDS is a digital network, it is easily configured to transmit encrypted voice and voice-rate digital data. It provides a system-level solution to the problem of distributing classified communications in a secure, straightforward manner. Although originally designed to interface voice data in analog form, the EDS provides for direct T-1 interfaces. These allow intermixed voice and data from other ranges to enter the EDS and be switched to a final output without separating the multiplex out in channel banks.

Voice can be switched directly to STUs or radios, encrypted data directed to decryption equipment, and digital data such as inter-range TSPI can be routed as required.

CURRENT SHORTFALLS

The use of off-the-shelf hardware and software components for the EDS was a key performance parameter that was intended to eliminate problems encountered in maintaining a previous generation system. The requirements for the EDS were based upon increased capacity, security, and the use of standard as opposed to proprietary implementation. These concerns were stressed when developing the EDS. However, when the CDS, along with its interfaces, was developed we have found ourselves still in a proprietary dilemma.

When developed, the CDS was thought to have a service life of 20-30 years. However, based on experience to date, this was an overoptimistic estimate. Now with technology emerging at an accelerated rate it is difficult to maintain these components. Industry is producing and developing next generation equipment and rapidly decreasing production of replacement parts for currently developed systems.

Similar issues exist for support of the AT&T DACS II switches. The intended service life for these units was 40 years. We believe this to be a credible estimate. However, at some point in time these units will undoubtedly require service. Will that support be available in the next 10 to 15 years?

Of equal concern is the current functionality of the system. The system currently installed has a large amount of excess capacity and was designed with expansion in mind. Will this excess capacity be required to meet the requirements of our customers in the future?

The EDS was designed to support voice and TSPI data within the same switching fabric well into the 21^{st} century. However, It is becoming increasingly evident that within 5-8 years the system, or portions of it, will become unsupportable.

Additionally, we need to continue to work toward having a flexible system that is designed to comply with open system standards.

FUTURE FLIGHT TEST NEEDS

Some of the projected changes that may impact future switching capabilities:

- The trend away from the single large mission control room paradigm. The availability of affordable gigabit-terabit/second fiber-optic carrier systems has created an opportunity for a paradigm shift to “virtual” mission control rooms, in which the mission team members may be geographically dispersed.

- The trend toward merging different data streams (such as voice, video, and data) so that individual data types are transparent to the common carrier systems.
- The trend toward supplying gigabit/second data streams directly to the desktop.

Some of the design features embodied in the current system should to be reexamined:

- The need for a stand-alone voice switch to satisfy our “unique” voice networking requirements.
- The need to continue to support many different network connection types. Some of the more esoteric connection types, which were developed specifically for air traffic control within the R-2508 restricted airspace, were never actually used.
- The need to continue to switch low rate TSPI data streams through the voice switch? Perhaps this could be better accomplished by another mechanism?
- Should we combine voice with video switching?

ALTERNATIVES

The alternatives described below were determined by the need to modernize all or part of the existing system.

1. Replace the CDS and the STUs and retain the DACS II equipment. The advantage is the potential to lower the initial investment cost by retaining the DACS IIs. The disadvantages include the difficulty interfacing new with retained equipment, future support for the DACS IIs, and the likelihood of ending up with another situation in which we are the only customer for a proprietary product offered by a single vendor.

2. Replace the entire system. Advantages include a fresh start with a solution designed to fit our long-term modernization plans and lower life cycle cost. The disadvantage is higher initial investment cost.

CONCLUSION

Our recommendations are to (1) investigate various options for implementing the desired modernization alternatives; (2) determine the best course of action in anticipation of modernizing, upgrading, or replacing the current system; and (3) pursue an ongoing dialogue on the subject with industry, the academic community, and with other government agencies.

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