Today's Technical Control Center

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Abstract

As the flight test community moves into the 21st century, the ever increasing demand for higher telemetry data rates and the need to transport additional data types is becoming the challenge of every flight test range. The evolution of the flight test range has grown from low telemetry data rates and a few 2400 baud tracking sources into high-speed telemetry, GPS based tracking, networking, digital video, and more. Recognizing the need to change the way data is managed has resulted in an effort to redefine the work centers at the Air Force Flight Test Center (AFFTC) at Edwards AFB. The Technical Control Center (TCC) within the Ridley Mission Control Center at Edwards AFB is currently being relocated with the intent of achieving tomorrow's vision, while supporting the missions of today. One major goal of this redefinition is the elimination of as much analog transmission equipment as possible in favor of digital transmission. The new digital range requires management of data and allocation of that management in different ways than the past. Moving to an all-digital range has advantages that are just now being realized.

This paper outlines the current and future design, configuration, maintenance, and operation of the TCC and touches on how some of the other range functions are impacted. In addition, the challenges and benefits of implementing the next generation in range communications will be discussed.

Keywords

Range Communications, Technical Control Center, Asynchronous Transfer Mode (ATM)

Introduction

The function of the Technical Control Center (TCC) has historically been the hub for range communications between all mission control facilities, remote ranges, and range sensors. Although the role of the TCC will likely remain, the operational methodology is undergoing a tremendous shift. The past has been filled with a large number of systems operating in point-to-point modes with distributed network operations and management. The new system being implemented at the Range at the Air Force Flight Test Center (AFFTC), Edwards Air Force Base (AFB), is offering a dramatic change to the distributed nature of network management on the Range. The new concept allows the TCC to serve as network managers in the more traditional sense, allowing the provisioning, connection, disconnection, maintenance, and troubleshooting from a central location. This paper addresses some of the old technologies and processes along with the new technologies and processes and the benefits of the new system.

Past Operations

The TCC at the AFFTC Range has many functions; paramount is the responsibility for managing communications links between mission control facilities, range sensors, and remote ranges. Currently, there are nearly 30 distinct systems that must be managed separately. These systems carry mission critical information for range operations including:

- Telemetry
- Voice
- Video
- Time Space Position Information (TSPI)
  - Radar
  - Global Positioning System (GPS)
  - FAA Air Surveillance Radar
- Network
- Flight Termination Command and Control
- Uplink
- Remote System Command and Control

Over the past several decades, the communications systems at Edwards have grown as point solutions, each adding another patch to the quilt. Several systems are required for backbone services, several systems required for access to the backbones, and separate and unique systems for switching the various types of data. Requirements have increased to the point where more patches must be added to the quilt, or a completely new system could be added to meet the requirements that will satisfy both near and long term needs.

As an example, consider the early digital transmission of telemetry at medium bit rates (< 6 Megabit per second [Mbps]). These streams were transported over DS-2 (6.312 Mbps) smart multiplexers. These data rates were supported over analog microwave links with a 10 to 12 Megahertz bandwidth. For transport around the range, the DS-2s are multiplexed up to DS-3 (44.736) data rates. Later generations of the smart multiplexer supported transmission directly at the DS-3 rates. The current configuration of data communications at Edwards supports the DS-3 smart multiplexers, the DS-2 smart multiplexers, DS-2 to DS-3 multiplexers, and DS-3 transmission systems.

In addition, with the architecture supported, nearly all telemetry streams must be transmitted from the tracking site to the Mission Control Center (MCC) to the final destination. Typical configuration at the MCC is to demultiplex the telemetry stream to the lowest rate and patch to the transmission system to the final destination. This system is very hardware-intensive and requires much personnel interaction at several locations.

New Range Communications System

The Range at the AFFTC is implementing a new system. An overview of the system is provided here, more detail is provided in the referenced papers.

The new system introduces new technology to communications as the backbone system. The Range at Edwards served as a beta trial site of the Cellworx Service Transport Node (STN) for ADC Telecommunications. The Cellworx product provides an Asynchronous Transfer Mode (ATM)/ Synchronous Optical Network (SONET) hybrid solution that allows for much more efficient use of bandwidth. Access to the backbone is currently through ADC Kentrox ATM Access Concentrators (AAC).

The beta trial was composed of four Cellworx nodes with six AACs attached at various points around the network. The beta trial proved to be successful to the point where the AFFTC Range has purchased the system and is in the process of bringing it into operations. The system is expected to have 5 or 6 Cellworx nodes and between 20 and 30 AACs connected for user access. Figure 1 shows the configuration of the system during the beta trial.

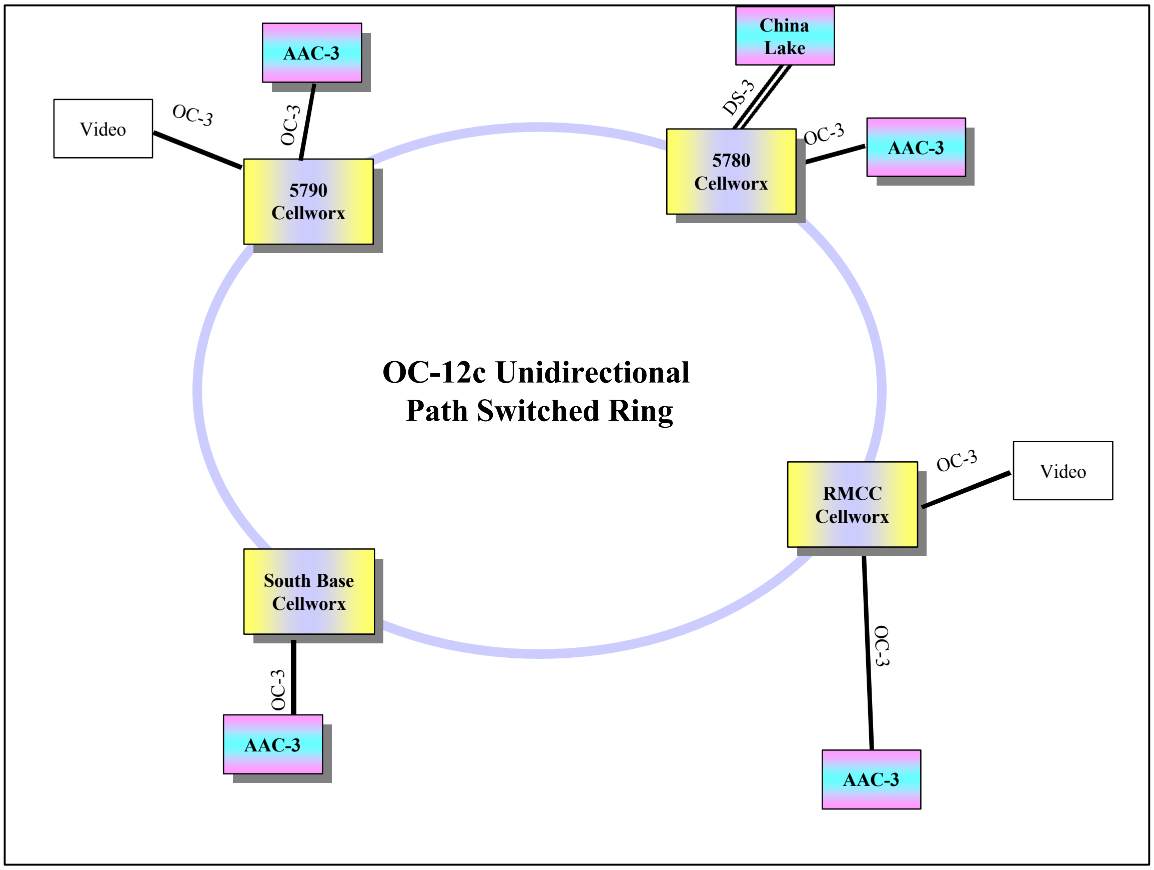

Figure 1 - Beta Trial System Configuration

Future Operations

Operations of the TCC are about to undergo a tremendous shift in capability and in operational support. The shift can be seen in four areas:

- Communications architecture shift
- Network management
- System scheduling
- Merging of transmission and switching capability

The insertion of new technology provides a marked increase in responsiveness, flexibility, and efficiency.

Communications Architecture Shift

In the past, nearly all communication lines were hubbed in the TCC and switched somewhere in the MCC. The star architecture, with the MCC at the center, required that data from one point in the star to another be transmitted via point-to-point links to/from the MCC and switched between the points. The data was then subject to failures and configuration problems at many points in the circuit path. In the star configuration, no possibility exists for redundant links.

Using the Cellworx provides a ring network architecture that provides the capability to create a virtual mesh architecture allowing the operators to accept data at one point in the network and deposit it at only the required location(s). The need for intermediate circuit termination and switching is greatly reduced.

Network Management

Most of the transmission equipment currently in use at the AFFTC range requires front panel control and management. The Cellworx and AAC system will allow for remote in-band management and out-of-band backup management capability. With the new system, the responsibility of troubleshooting and maintenance of Range communications is reduced to fewer personnel, reducing the cost of range operations.

In the same telemetry example used above, the efficiency, hardware requirements, and personnel interaction are greatly reduced. With a pre-wired system, a system operator can perform the configuration of the data stream, from input to output, from a central location via software command.

System Scheduling

System scheduling is impacted in an interesting way. No longer is the system bound by traditional channel limitations. Instead, there is a definite trade-off of channel capacity and number of channels. In the ATM system, bandwidth can be dynamically allocated to application based on need. Missions (real-time, simulated, or constructive) are allocated bandwidth and channel resources; the system can support the mission until either of the resources are expended. As the system grows, the number of ports may grow; however, the bandwidth on the backbone will not. As missions are completed, their bandwidth can be reallocated to other missions using either the same or different ports.

For efficient use of the network resources, the scheduling system must adapt to the capabilities provided. To continue under the same paradigm, the network will not operate at peak efficiency. As part of the network, there will be a portion of the network that is allocated to permanent applications, such as voice trunk lines, tracking support, and situational awareness applications for general applications and range safety.

Merging of Transmission and Switching

The new range communications system at the AFFTC introduces new technology into the range application. One of the benefits includes the ability to perform much of the switching that is currently performed in dedicated data switches (i.e., Voice, TSPI, Video, Telemetry) directly within the transmission system.

As the system matures, the experience gained over time will determine the extent that the embedded switching capability will be used in the transmission system. It is expected that all switching in the MCCs will be performed using dedicated switches. However, using the dedicated switches to perform trunking between facilities will be greatly reduced in favor of broadcasting data directly from the transmission backbone.

Conclusion

The introduction of modern communications technology into the test and evaluation range impacts more than the operations of a particular system. In the case of the ATM/SONET hybrid system being installed at the AFFTC Range, whole work centers are being redefined. Systems that have been thought as being completely separate in the past are now being melded to provide a very efficient comprehensive capability.

As a result of these shifts, many range functions will be impacted. Resource management of all systems must become more coordinated to take full advantage of the technology. Range resource managers must have a better understanding of the capabilities to become more efficient. An example is trunk bandwidth between bases. Instead of dedicated bandwidth for each mission or type of mission (real-time or modeling and simulation), the bandwidth can be shared. However, the impact is that the bandwidth must be scheduled. Modeling and simulation efforts now must schedule the test times and share the resources. In the past, modeling and simulation efforts did not necessarily schedule their efforts.

Tremendous cost savings can be achieved if the processes are able to adapt to the new technology. The longstanding methods and mind sets of dedicated resources for each mission regardless of cost must be replaced with emphasis on large cost savings through sharing of resources with the risk of schedule deconfliction impacts.

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