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Future Trends for ETR Range Control

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Introduction

Operations at the Eastern Test Range require coordination of instrumentation systems located at many widely separated locations. The workload of the ETR has changed from its original mission of supporting aerodynamic launches to support of ballistic launches and now faces an era of orbital support tasks. This paper discusses the plans for Range Control during the coming era. The observations contained herein represent one school of thought of the many groups that are studying the ETR workload of the present and near future.

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Operations at the Eastern Test Range require management of instrumentation systems at many widely separated locations. Instrumentation sites are located on the mainland USA, extend downrange to Africa and include aircraft and instrumentation ships. Instrumentation must be closely coordinated during an ETR launch or orbital support mission. Range Safety and the range user require command control capability for mainland and downrange instrumentation. Real time telemetry and tracking data are required for decision making. Range Scheduling requires real time instrumentation status. Central Control and its new addition at the Cape, the Range Control Center (RCC), are the focal points for performing and coordinating these activities.

In the past, ETR operations have been characterized by providing support for single live launches both manned and unmanned. Planning and administration of the operation has been based on a single major operation or program being supported at a given time. Planning was based on the assumption that all range instrumentation could be made available for the single test at the requested time. Commitments were firmly established in a document known as the Operational Directive (OD) for the test. Operating personnel had the necessary time and could follow well established procedures for preparation and checkout of the range instrumentation committed to the test. The test operation had a marked beginning, a limited duration and a marked end. During the period of support the OD was rigidly adhered to and no other program would be scheduled for major support. At the conclusion of a given test the range, after suitable preparation, could be made ready for a different program.

With the advent of the nation's manned and orbital programs, the support requirements changed in several ways. While the number of live launches became fewer, the complexity of support tests has increased. Orbital manned missions require preparation and support for longer periods. Certain satellite programs require intermittent and continuing support during the periods in which manned missions and live launches are in progress. Some of these impose requirements for tracking support from vehicles whose beacons may no longer be active. Some programs require variable launch azimuths and variable flight plans dependent upon other events in the mission. This results in the range user requirement for freedom in calling up instrumentation support.

The ETR is thus presented with requirements for simultaneous support of multiple programs from several locations and with a limited amount of time to prepare and check out equipment for certain support requirements.

DOD orbital programs are currently requiring the support of world wide tracking stations. The Network Controllers and their technical support team require a control center for coordinating the global tracking network and launch preparatory tests.

A review of the changing nature of the ETR workload leads to the following conclusions:

1. Multiple simultaneous operations demand a strong central control of scheduling. The scheduling officer will require an instantaneous knowledge of operating status and of commitments. Range Scheduling and scheduling changes must be done in real time. Tools must be provided for rapid evaluation of range user conflicting instrumentation requirements and for real time resolution of schedule conflicts. The range will require flexibility in scheduling its instrumentation for test support. This implies that during long duration missions the range should be free to divert its instrumentation for support of other user requirements.

2. Redundant instrumentation should not be committed to a test. This instrumentation should be kept available for call-up in support of short term range users.

3. Equipment checkout procedures must be revised and shortened to provide reduced instrumentation turn-around time.

4. Tracking support requires accurate ephemerides, the ability to update orbital parameters from newly acquired tracking data and the ability to calculate and transmit to the tracking sites accurate pointing angles.

5. In the command control area, greater emphasis will be placed on steerable antennas. Telemetry systems will deal with reduced signal-to-noise ratios.

6. Reliable communications, voice, data and teletype are required and must be capable of rapid reconfiguration to accommodate changing mission support objectives as a given test proceeds. The Network Controllers and their technical support team will rely more heavily on automatically updated displays which summarize instrumentation status and assist the Controller and Launch Superintendent of Range Operations (SRO) in evaluating the impact of equipment outages. A greater need will exist for a display of orbital parameters and for the occurrence of key mission events which will be detected by remote telemetry and relayed to the Network Controllers.

7. Range Safety will be working with bigger boosters. Impact in the launch area will be more damaging. The Range Safety Officer (RSO) requires more information for his decisions. He must now know in addition to launch vehicle Impact Point (IP) the astronaut IP. How large is the debris area if the mission must be aborted during the early launch phase? Greater emphasis will be placed on electronic displays so that attention is not diverted by a multiplexity of mechanical plotting boards. Improved sensors yielding greater accuracy and better information on missile attitude are needed.

These can be summarized into improvements in both hardware and in operating procedures.

The new Range Control Center currently being implemented by the ETR is one facet of the approach of solving some of the complex problems of range control. The RCC will provide Range Scheduling and Range Operations with real time information on the status of range instrumentation It is linked by audio pairs to all ETR sites and to other ranges and tracking sites via the ETR Communications Center. These provide communications for voice and data signals. Wide band pairs provide circuits for wide band telemetry and video signals.

Each major operating area within the RCC is provided with front wall displays visible from all operating consoles. Typical of these displays are those of the Network Operations area shown in Fig. 1. The display on the left gives the status of range and network instrumentation. Mainland sites and downrange sites connected to the submarine cable will provide direct inputs to the status displays. These will make use of the new Range Instrumentation Control System (RICS) which is a digital communications system employing error correction and error detection coding. The center screen is computer driven and can display IP or vehicle Present Position in XY, XH or YH coordinates for ETR launches and in XY coordinates for orbiting vehicles. The background geography can be appropriately scaled, for example, to show only the Cape Kennedy area during the launch phase.

Details of the network status display are shown in Fig. 2. This board lists all major ETR instrumentation such as radar, telemetry, command, computer and communications equipment. These are arranged in vertical columns and are posted against the station instrumentation site. A green upward pointing arrow designates an "AOK" or "GO" condition. A red downward pointing arrow designates a "CNY" or "NO/GO" condition. The instrumentation designator, for example, 0.18, is illuminated when this radar is committed to support a test. ETR instrumentation occupies the left two-thirds of this display. The right portion of the display lists the DOD and NASA tracking sites that are committed to an orbital mission. The major instrumentation of each tracking site is posted, for example, Vandenberg radar, telemetry and command, computer and Glotrac. Committed test support, "GO" or "NO/GO" condition are indicated as described for ETR instrumentation. The top quarter of the board displays test number, booster and network count, Greenwich Mean Time, and the status of the count - "Hold" or "Counting". The status of the network tracking stations will be received by the Network Controllers and posted from their console positions in the Network Control Center.

ETR instrumentation status will be posted automatically from messages received over RICS or manually by an Instrumentation Operations Coordinator (IOC). The SRO and Range Control Officer (RCO) and the Network Director will thus be provided with the information they need for decision making. The Range Scheduling branch in Central Control is also provided with an ETR instrumentation status display for use in scheduling subsequent test support.

Fig. 3 shows the three main operations areas of the RCC. The front wall displays are visible from all consoles in each area. Console positions are available for the Range Operations, for Project and Program Management representatives, for the Network Controllers and for ETR top management. One area is devoted to global and satellite operations. TV cameras will pick up the front wall displays and remote these to consoles in other areas.

In conclusion, the changing nature of the workload of the ETR from support of single ballistic missile launches to simultaneous support of multiple orbiting vehicles and in the near future to support of manned lunar and outer space programs will require a change in range operating practices. Among these changes will be flexibility in scheduling to assist in resolving instrumentation conflicts, a departure from rigid ODs, greater reliance on computers for scheduling, and a streamlining of range operating procedures to provide the range with reduced turnaround time. The range user will benefit from this by having available to him an Air Force test range that can optimize its support to the varied requirements of range users' programs.

NETWORK SUPPORT AREA DISPLAYS

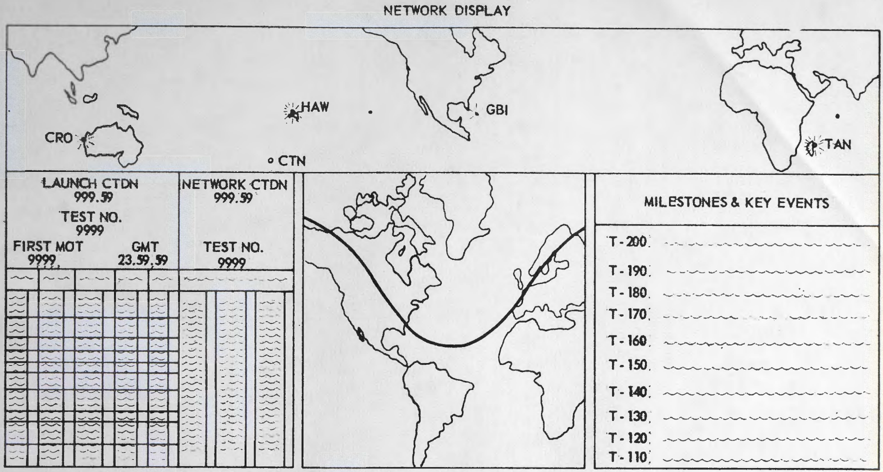


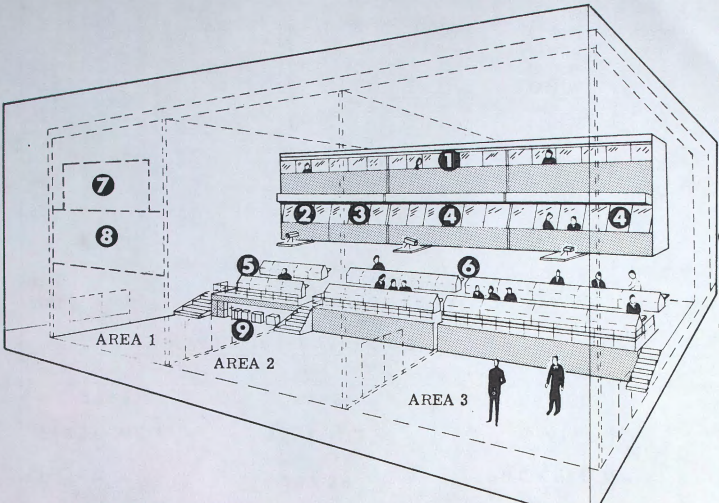
Fig. 1

NETWORK SUPPORT AREA STATUS DISPLAY

LAUNCH COUNTDOWN			NET COUNTDOWN	
HOLD	999.59	PROCEED	999.59	
			HOLD	PROCEED
FIRST MOT.	TEST NO.	GMT	TEST NO.	
9999	9999	23.59.59	9999	

STA	RADAR		TLM	CMD	COMPUT	COMM	NETWORK TRACKING STATIONS		
MNLD	1.16 ▼▲	AZSA ▼▲	TEL 2 ▼▲	PRI ▼▲	3600 ▼▲	SCBL ▼▲	ATL ▼▲	HAW ▼	PTP ▼▲
	0.18	MIST	TEL 3	SBY	3600	COMM	GLO	RDR	RDR
	19.18	GLO	TEL 4	EMG	GSFC	TTY	COM	TLM	TLM
				EMG	GSFC	FP-V	BDA	COM	COM
					GSFC	FP-T	RDR	CMD	PMR
STA 3	3.16		TEL	PRI		COMM	TLM	BS	COM
	3.18			SBY	4101	TTY	GLO	RDR	CPU
STA 4	GLO	MIST				COMM	COM	TLM	PTM
STA 5	5.16			PRI		COMM	CMD	COM	RDR
				SBY		TTY	CRO	VAN	TLM
STA 7	7.18	GLO	TEL	PRI	4101	COMM	RDR	RDR	COM
				SBY		TTY	TLM	TLM	SNI
STA 91	91.18	GLO	TEL	PRI	4101	COMM	COM	COM	RDR
				SBY		TTY	CMD	CPU	TLM
STA 12	12.18	12.16	TEL	CMD	1206	COMM	JI	GLO	COM
STA 13	13.16	GLO	TEL	CMD	1206	COMM	RDR	YUM	WHS
STA 40	40.43			CMD	1206	COMM	TLM	GLO	RDR
GAS	C-BD	L-BD	TEL		1206	COMM	COM	NEL	COM
	X-BD					COMM		GLO	
GVT	C-BD	L-BD	TEL	CMD	1206	COMM			
	UHF					COMM			

Fig. 2



1. VISITORS' AREA
2. COMMAND POST
3. SATELLITE OPERATIONS CENTER
4. RANGE OPS AREA
5. NETWORK CONTROL CENTER
6. PROJECT AND PROGRAM MGT
7. NETWORK DISPLAY MAP (AREA 1)
8. DISPLAYS (AREA 1, 2 AND 3)
9. TELETYPE

RANGE CONTROL CENTER

Fig. 3