AFSCF PLANNING TOWARDS THE 1990's

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INTRODUCTION

The Air Force Satellite Control Facility (AFSCF) came into being over twenty years ago, and since then has evolved into a satellite support network of major national importance. The present configuration of the AFSCF includes seven Remote Tracking Stations (RTS's) situated around the globe plus a central control facility, the Satellite Test Center (STC), located in Sunnyvale, California. (See Figure 1.) Ongoing plans will provide for significant upgrades and additions to the AFSCF network. Two of these which will have a major influence on the operations of AFSCF into the 1990's are the centralization of the real-time processing capability at the STC (Data Systems Modernization) and the implementation of a Consolidated Space Operations Center (CSOC) tentatively planned to be constructed in Colorado Springs, Colorado. These two upgrades to the AFSCF are discussed (see Figure 2) in detail elsewhere in these proceedings under their respective titles.

PLANS FOR THE AFSCF FROM THE MID-1980's INTO THE 1990's

As an adjunct to the Data Systems Modernization program, plans for the late 1980's include a modernization of the Remote Tracking Stations. The goal of this effort is to bring the RTS's to a state of remote control which will fully utilize the capabilities being provided by the Data Systems Modernization (DSM) project. In particular, complete remote control of the existing Space Ground Link System (SGLS) will be addressed. Of the equipment at the RTS's, approximately seventy percent can be controlled remotely. Although much of this equipment is over ten years old, its original design included the capability for external control. The design and capacity of the DSM project will provide for remote control of this seventy percent of the RTS's. The degree to which this control will be implemented by the DSM is yet to be determined by the implementation phases of that project. The plans for a Modernized Remote Tracking Station call for completing the remotability effort by addressing both the remaining thirty percent of the RTS's and any of the seventy percent which is not implemented under the DSM effort.

Another area which is related to RTS modernization includes plans for moving to higher frequencies for ground-to-satellite commanding and telemetry. At present, there are additions being made to the RTS's to support the Telemetry, Tracking and Commanding (TT&C) of payloads on board the Space Shuttle. These additions will accommodate Time Division Multiplex (TDM) Bi-phase Modulation to be used in the S-band region of the spectrum. This equipment will have a TDM legacy into the late 1980's. The AFSCF plans call for moving to higher frequencies, probably in the K-band, coupled with a TDM technique to replace the Frequency Division Multiplex method employed in the present SGLS S-band system. Also under study for implementation in conjunction with TDM and X or K-band usage are more modern modulation techniques, such as Quadriphase Shift Keying (QPSK) to provide a more efficient use of the spectrum. The use of TDM also lends itself nicely to the employment of time-domain processing, such as convolutional encoding and Viterbi decoding techniques which yield additional link efficiencies. Movement into these higher frequency regions will require a joint and concurrent effort by both the AFSCF and the space programs which it supports. The highly successful Space Ground Link System (SGLS) developed in the 1960's provides a pattern for structuring of the coordinated development of the ground and space TT&C systems.

In the near future, there are plans to increase the complement of antennas in the AFSCF network by adding an additional antenna at the Oakhanger station and providing an antenna for vehicle checkout at Vandenberg Air Force Base. These additions are expected to provide sufficient capacity to meet the network space vehicle real-time contact loading requirements into the late 1980's and early 1990's. As discussed in the following paragraphs, architectural considerations, such as space relays and autonomous spacecraft, are expected to begin diminishing the RTS support load in the 1990's. However, the AFSCF is planning for one additional tracking station to be constructed in the late 1980's at the CSOC location. While the additional capacity provided by this station will be welcomed in the management of the load distribution, the primary reason for the CSOC RTS is to provide for survivability of satellite control functions in a crisis or natural disaster situation. Further, this station will, in all likelihood, form the kernel around which an entry point for TT&C operation performed through a space relay system can be developed.

The development of the Ground Station Link Survivability (GSLS) system currently underway within the Space Division, while not an AFSCF project, is of high interest to the AFSCF, and is receiving support from the AFSCF planning office. A transportable, mobile RTS replacement such as the one envisioned in Figure 3 would provide a substantial increase in the survivability of the AFSCF. Present planning calls for the AFSCF to be the recipient of the prototype stations developed under this effort. The prototype will be maintained in an operational state, perhaps at Vandenberg Air Force Base. Should one of the existing RTS's be destroyed, as for example the Guam station was by typhoon Pamela

in the year 1976, the GSLS prototype transportable RTS would be available for reconstitution of the station.

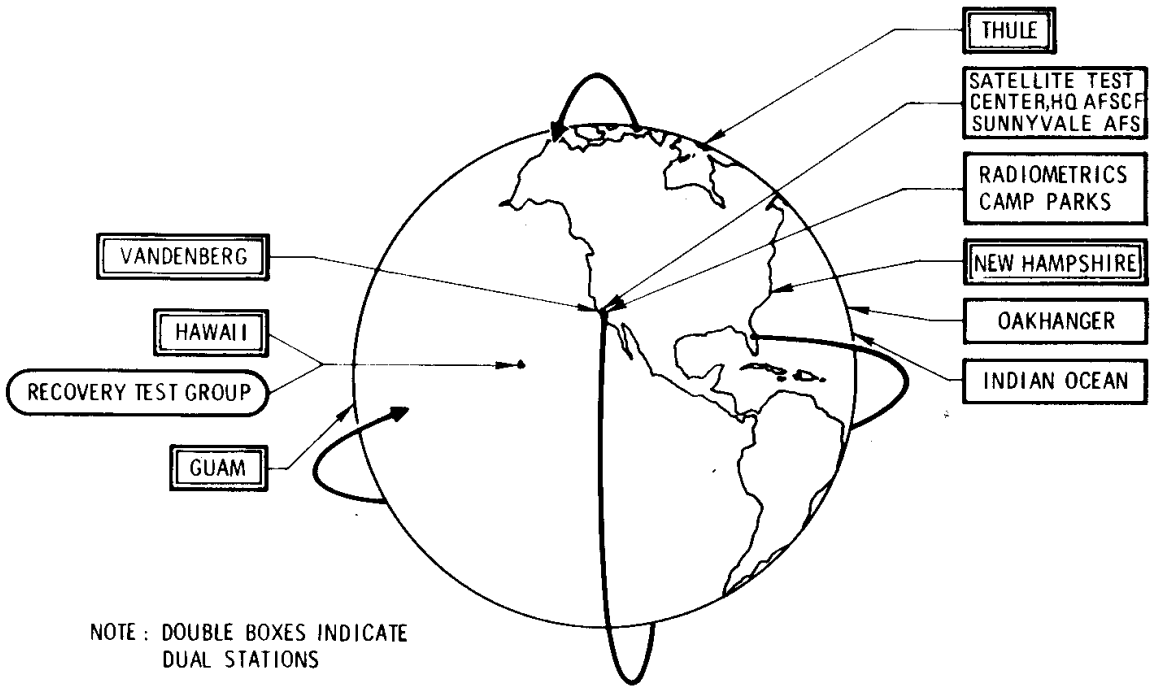
Beyond the present plans for modernization of the Remote Tracking Stations, currently ongoing studies are addressing the appropriate architecture for a space relay capability for the AFSCF. One such study, the Satellite Control System (SCS) study performed under contract for the Space Division, was completed earlier this year. This study proposes a five-satellite constellation in Geosynchronous Orbit providing a generalized dedicated space relay for a substantial portion of the projected DoD satellite missions of the late 1980's and early 1990's. (See Figure 4.) More recently, an internal AFSCF/SD CX Generalized Space Relay Study has been examining the potential for an architecture provided by add-on relay packages to existing and planned host satellites. (See Figure 5.) An AFSCF satellite relay for support of DoD satellite programs is needed to provide for increased survivability not achievable with a ground network, improved duration.of visibility with low and medium altitude satellites, improved higher rate data delivery directly to users from increasingly sophisticated satellite-borne sensor systems and reduced dependency on overseas ground stations. Such a DoD satellite control system relay satellite contemplates using satellite-to-satellite links protected against terrestrial interference by oxygen absorpotion in the 60 GHz region or, alternatively, narrow-beam lasers. Users and the AFSCF could receive and transmit data between the relay satellites and earth terminals in the K-band region using a multi-beam satellite antenna for downlink distribution.

In parallel with the planning towards a general space relay capability for satellite control, an effort is underway throughout the Space Division to move in the direction of constructing satellites which will be more autonomous. The primary attribute of an autonomous satellite will be its ability to survive for a six-month period with no satellite control contact. In addition to the survivability achieved through autonomy, a significantly reduced workload on the ground satellite control facilities could be achieved. This provides an attractive cost offset for the efforts directed toward achieving autonomy. The general areas which must receive attention in order to provide for autonomous six-month operations are: position determination, fault recognition and isolation, and redundant equipment substitution on board the spacecraft with no assistance from the ground support network.

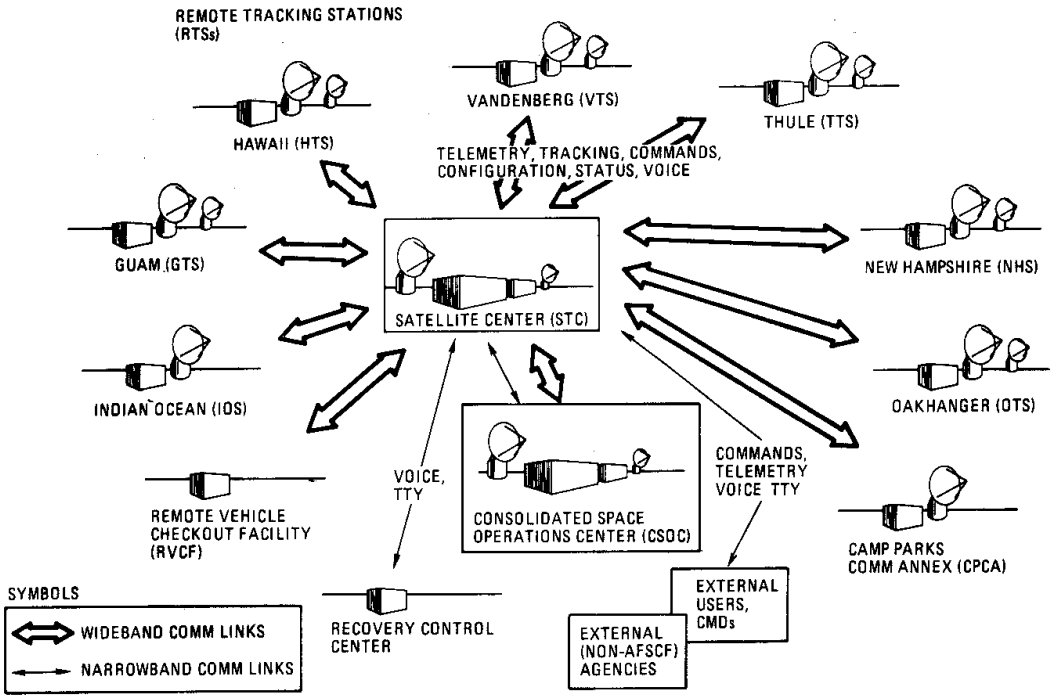
SUMMARY AND CONCLUSION

With the emergence of a space relay capability for satellite control, coupled with increasing satellite autonomy, the AFSCF plans to enter the 1990's with a posture which will accommodate a much reduced dependence on the present overseas Remote Tracking Stations. Closing of these stations could follow as soon as their support loads and the needs for their services are replaced by the above methods.

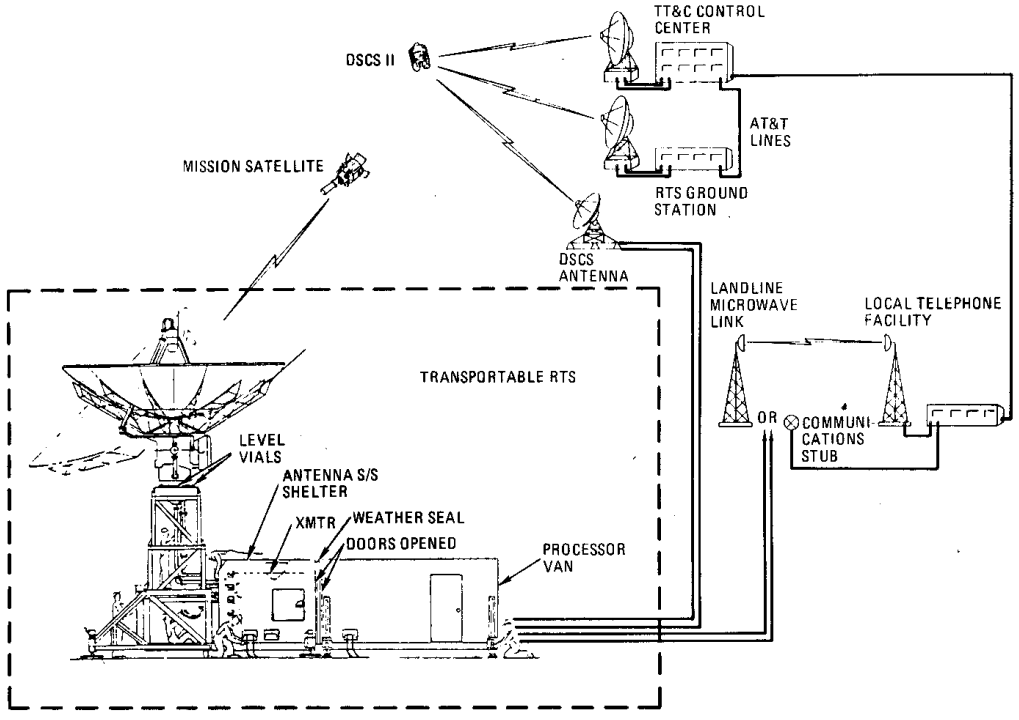
The AFSCF will then be consolidated completely on United States soil with the major facilities located within the continental United States. While autonomy on board the satellites will reduce the contact time required for satellite control, the use of space relays will have greatly increased the potential period of coverage. With these new directions, operating costs will be lower while service to users and survivability should be enhanced.



AIR FORCE SATELLITE CONTROL FACILITY
1980 CONFIGURATION
Figure 1



AFSCF NETWORK CONFIGURATION PLANNED FOR 1985
Figure 2



CONCEPTUAL DEPLOYMENT OF A TRANSPORTABLE/MOBILE RTS INTO THE AFSCF NETWORK
Figure 3

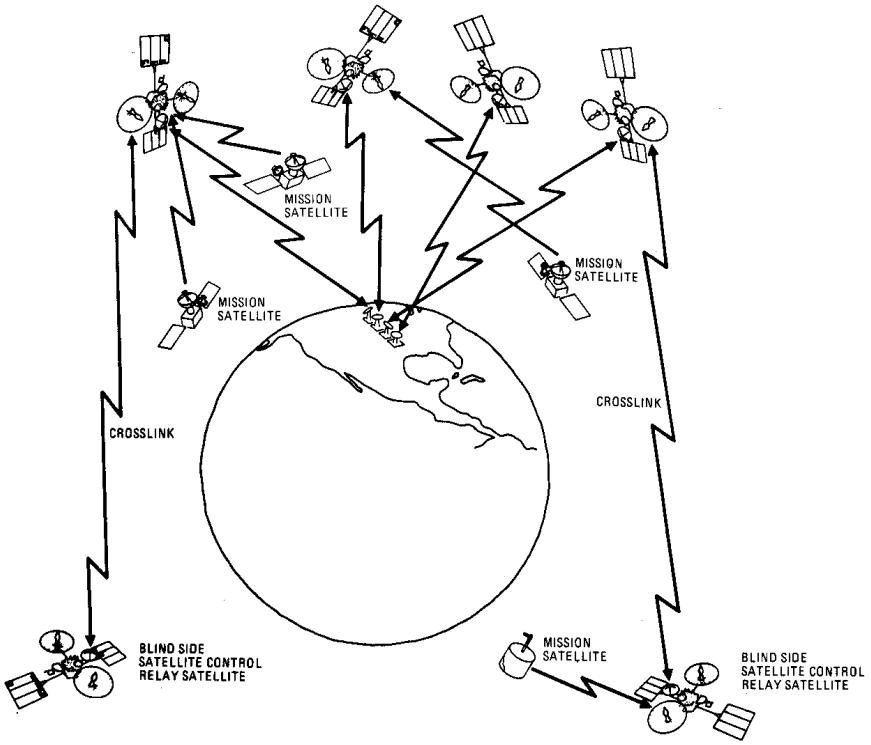
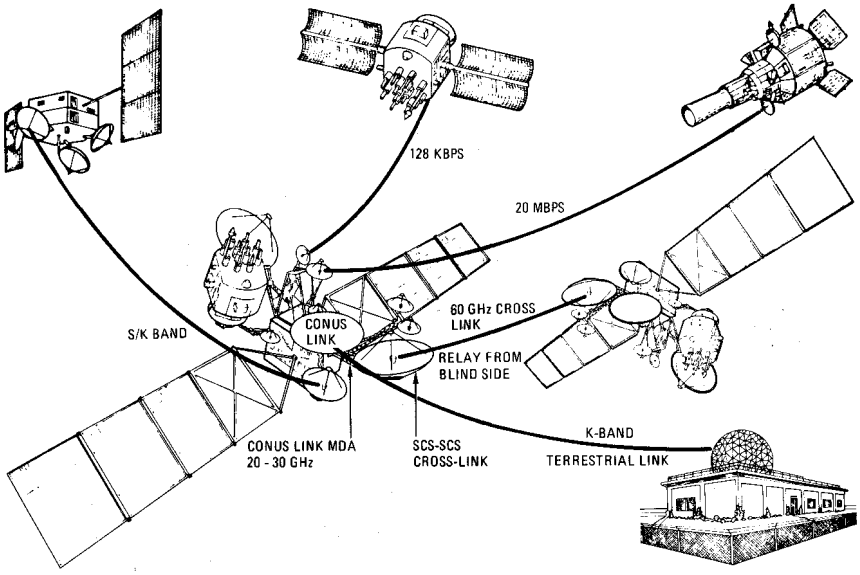


ILLUSTRATION OF DEDICATED SATELLITE CONTROL SATELLITE SYSTEM INCLUDING CROSSLINKING
Figure 4



CONCEPTUAL "ADD ON" SATELLITE CONTROL PACKAGE ON A GPS HOST SATELLITE
Figure 5