EVOLUTION OF THE DOD GLOBAL SPACE TEST CAPABILITY

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ABSTRACT

This paper is an overview of progress toward a more formalized military space test range capability. It reviews the motivation for a space test function, relates history which has led to the contemporary space test operation, scopes existing space test pursuits and projects a direction for future activity. Its intent is to baseline the status of the current space test program and to present one vision for its future evolution.

BACKGROUND

Space-based assets have been employed as a part of the global U.S. military strategy since the late 1950s. Initially, each deployment was a unique test operation. All were effectively research and development (R&D) "proof of concept" systems. Over time, space technology and space vehicle operations matured. The perception of satellites as experimental devices gave way to a recognition of their military utility, first as augmentation to support forces and later as force multiplier assets. Space-based navigation, meteorological, communications and surveillance systems became an accepted adjunct to traditional land, sea and air force elements. The decision to apply resources in space as an integral component of the U.S. military evolved strongly in the 1970s. When it became evident that spacecraft operations must become "routine" to traditional warfighting support, space force objectives of "Force Enhancement," "Space Control," "Force Application" and "Space Support" were established in U.S. Air Force policy in 1980. A commitment was made with the establishment of Air Force Space Command (AFSPACECOM) in 1982 to move proven spacecraft systems from a "continuous test and evaluation" mode of orbital operations to a phase where routine mission functions could be executed by an operating command with non-engineer, military personnel. Subsequently, Strategic Defense Initiative Organization (SDIO) Delta 180, Delta 181 and Delta 183 space test experiences reemphasized the need for shortened timelines to safely implement increasingly-complex, on-orbit spacecraft tests. Additionally, support to traditional ground, sea, and air test operations in geographically diverse situations (i.e., remote ground regions, over-the-horizon locations, broad ocean areas) became of interest. This implied use of spaceborne assets as a means for establishing a capable, cost-effective test and evaluation (T&E) capability. The need was for an independent space safety analysis and certification function as well as for a space T&E range. That dictated that an agency be designated with responsibility for the establishment and management of a "global space test capability." An execution agent with extensive knowledge of in-space test and spacecraft operations as well as an appreciation of the broad set of test capabilities possessed by the U.S. military T&E community was recommended to being this ambitious program to fruition.

RECENT HISTORY

Clearly, the need for an identified central agent responsible for global test and evaluation has its roots in the maturation of spacecraft systems applications. Spacecraft use has evolved from primarily an RDT&E support tool to the employment of operational spacecraft as one element of the U.S. warfighting capability. The practicality of spacecraft systems use in this application was proven in Operation Desert Storm. Integration of two initiating themes (Figure 1) have led to designation of the Consolidated Space Test Center (CSTC) as the lead DoD agency for generation of a global test capability. Within the U.S. Air Force, Air Force Systems Command's "cradle to grave" responsibility for space systems development, operation and support has given way to a "normalization of space" initiative to transition the operational side of space systems command structure responsibilities in a manner traditional to that for other Air Force weapon systems. This was a specific objective in the formation of AFSPACECOM further logistically supported by the Air Force Logistics Command. Within DoD, budgetary considerations have driven a recognition of the need for consolidation of the application of test assets of the Major Range Test Facility Base (MRTFB) with those of other T&E resources. Although modem-era, global-scale test execution implies the use of space-based assets, space test operations need not be confined to an investigation of space system developments. This recognition, coupled with the emergence of a requirement for an independent, worldwide space test support function, has led to Office of the Secretary of Defense (OSD) sponsorship of a tri-service cooperative to field a Global Range Capability (GRANCAP). Under GRANCAP, all DoD T&E activity requiring interfaces with space-based assets will be managed under a single umbrella organization. The execution agent will organize resources drawn from the set of traditional range facilities to service any agency requiring use of space-based test assets or planning to conduct tests in space. Figure 2 overviews the GRANCAP concept. The Air Force has been designated executive agent for GRANCAP by OSD. Individual projects are to be executed by the Army, Navy and Air Force. The CSTC (by virtue of its 30-year history of successful execution of space test programs) has been selected to manage Air Force implementation of GRANCAP.

CURRENT SPACE-RELATED TEST ACTIVITY

The present scope of the space-related T&E effort concerns achievement of GRANCAP near-term objectives and the reorientation of traditional spacecraft development and space experiment support functions to operate effectively in the GRANCAP T&E environment.

The immediate interest of the OSD-sponsored, tri-service GRANCAP acquisition program is activation of a core set of capabilities with the ability to plan and conduct DoD space-related tests through integrated, coordinated multi-range support. Primary interest in new capability is to provide for the initial upgrade and integration of current range systems for early IOC and to support T&E requirements projected for the next five years. To that end, key projects are underway. The Initial Space Safety System will establish and develop a safety function capable of positive control for global range testing. Its development is the responsibility of the USAF Space Systems Division. The Interrange Internet System will establish a capability to transfer data between DoD ranges during real-time experimentation. Its design is the responsibility of the USA Electronic Proving Ground. The Interrange Scheduling System will provide the ability to coordinate, schedule and utilize existing multiple DoD range resources. Its implementation is the responsibility of the USN Pacific Missile Test Center. Figure 3 illustrates key aspects of the projects. Successful consummation of the three initiatives will yield the infrastructure necessary to meld MRTFB and other range system assets into a “virtual” test range resource which, on demand, is capable of configuring itself to meet user global-scale test objectives. That is, the implemented GRANCAP will not assume ownership of the participating range assets. It will provide the mechanisms, interfaces and procedures to temporarily link capabilities resident on existing ranges in order to accomplish global-scale test objectives.

A major challenge to ongoing spacecraft T&E activity is the use of the Air Force Satellite Control Network (AFSCN) operational asset base to accomplish effective GRANCAP-type functions. The traditional DoD spacecraft T&E asset base represented by the AFSCN is now controlled by AFSPACECOM. Within the AFSCN, T&E interests have been recognized by retention of the CSTC as a tenant at the Onizuka Air Force Base (OAFB), California network control node. At Onizuka, the CSTC retains access to AFSCN fixed-site assets for GRANCAP and other test support purposes. It conducts spacecraft test operations from Test Support Complexes (TSCs). Consistent with the GRANCAP concept, it augments basic AFSCN services by use of its dedicated transportable assets to effect geographically-unconstrained test operations. The resultant test support configuration revises past spacecraft test operations philosophy to emphasize the two historical perspectives which led to CSTC designation as the lead T&E agency for space. Operations and RDT&E functions are separated while support of space-based experimentation and DoD spacecraft development is continued. Flexible T&E services are provided on a global scale as envisioned by GRANCAP. As suggested by Figure 4, current space test operations apply the modern T&E philosophy to assist a variety of customers including the Air Force Phillips Laboratory, the SDIO, the Space Test Program (STP), the spacecraft system program offices (SPOs) and the AFSPACECOM. Nonmilitary customers are supported as well. For example, launch and early orbit assistance has been provided for NASA interplanetary missions (e.g., COBE, Galileo, Magellan, Ulysses), NOAA spacecraft (TIROS and GOES) and foreign space operations (e.g., the German Deutscher Fernmeldesatellit and English Skynet deployments).

CSTC support to the recently-completed Relay Mirror Experiment (RNIE) (Figure 5) and the Combined Release and Radiation Effects Satellite (CRRES) deployment (Figure 6) illustrates the GRANCAP philosophy. Multiagency objectives were achieved through application of multirange assets to accomplish global-scale test coverage. GRANCAP-type space safety, scheduling and data transfer functions were accomplished. CSTC Transportable assets were employed to meet experiment-specific test support configuration requirements.

The RME was an SDIO program to test atmospheric effects on LASER beams, and to demonstrate the feasibility of relaying laser energy from a ground source. A LASER beam in Hawaii was directed at the RME spacecraft, and a mirror on the spacecraft relayed it to a ground target and scoring system, also in Hawaii. To carry out this experimental program, a transportable facility for spacecraft commanding and telemetry retrieval had to be located in Hawaii to permit local control of the spacecraft during LASER firings. Secure communications were established between the Remote Operations Control Center and the CSTC. CSTC Orbital Safety personnel performed prelaunch analyses of the LASER to assure there was no hazard to passing aircraft and Hawaiian residents. These actions were an early exercise of GRANCAP principles.

CRRES is designed gather data on the near-earth space environment, particularly ionospheric irregularities. Conducted jointly by the Air Force Space Test Program and by NASA Marshall Space Flight Center, it posed a number of challenges. 20,000 telemetry points were displayed simultaneously on 20 workstations at CSTC and on a network linking several remote sites. Cannisters deployed by the CRRES spacecraft released chemicals to facilitate study of ionized particle behavior. Safety analyses were needed to assure that there was virtually no chance for the cannisters to collide with other spacecraft or for the chemicals to contaminate any of them. Again, a transportable command and telemetry system was required for spacecraft tests at the factory, and weather imagery from the Defense Meteorological Satellite System was needed during orbital tests. The newly activated test support organization met these complex needs by providing safety expertise and by coordinating and interlinking existing assets belonging to several agencies, exemplifying the GRANCAP approach to RDT&E in space.

THE FUTURE

The opportunities for future application and payoff of a DoD Global Space Test Capability are many but, realization of the potential implicit in the GRANCAP concept will require cooperation, dedication, resource commitment and perseverance on the part of the T&E community. A major challenge facing the initiative will be to find an effective T&E path that provides the highest leverage for technology development and operational programs support in the current era of constrained DoD budgets. The MRTFB Range Commander's Council can be employed in this pursuit as a mechanism to assist the integration of space test with more traditional MRTFB functions. The CSTC must implement a technical, engineering-intensive approach to space test mission execution which will rely on time share of AFSCN operational resources. It must also catalyze the application of space-based assets across the broad class of development objectives supported by the DoD T&E community. It must lead development of a multirange interface infrastructure to activate a global-scale test range capability based on use of space-based test assets.

The strategy for meeting the challenge of the future will be to maintain and expand existing CSTC and other ranges capabilities as melded together by the core asset set provided through the GRANCAP acquisition. The projects for initial safety, scheduling and internetting capabilities must be completed, demonstrated, matured and deployed at other DoD ranges. Given that basic set of integrating services for the T&E community, the required fully interactive infrastructure to support MRTFB-wide data processing needs and a broad class of unique T&E requirements for rapid analysis of test data can be pursued. Technology initiatives funded through the OSD-sponsored Centralized Test and Evaluation Investment Program (CTEIP) will be used to augment the basic GRANCAP structure. Figure 7 shows some of the planned technology development activities specifically directed toward expanding space-related or space-based T&E support capabilities. Extension and integration of test range capabilities to encompass other military test suppose objectives (such as the conduct of large, multiple-range test support operations as well as remote site and over-the-horizon testing) can then follow through a fully-developed GRANCAP.

The National Aerospace Plane (NASP) test support scenario of Figure 8 represents a future T&E mission requiring global-scale test asset coverage by an integrated set of range facilities. Suborbital flight test operations require application and coordination of range system assets across the continental U.S. Transatmospheric and orbital tests will require world-wide expansion of this suppose complex. To help assure an economical transition of support for atmospheric testing to orbital trials, CSTC assisted in the formulation of preliminary test plans for atmospheric flight. Safety analysis and in-flight monitoring aids (e.g., collision avoidance software) as well as navigational software to predict trajectories for transatmospheric maneuvers will be required. The vehicle will possess unprecedented agility for space vehicle operations and will cover large volumes in space. Since this will be a manned vehicle, the need is seen for continuous communication, accurate, real-time, time and space position information (TSPI) and assured telemetry reception over all flight phases.

The CSTC will continue as the key military element responsible for maturation of the DoD Global Space Test Capability. It will provide the forum for multi-agency participation in GRANCAP evolution. It will operate to advise all DoD agencies as to the status, benefits and potential of space-related assets relative to their experimental and/or developmental T&E objectives. Its Space Test Range Office will analyze T&E requirements imposed by future space test missions, will budget and acquire T&E resources, and will function as a clearinghouse to facilitate experimenters use of space-related T&E assets. The CSTC posture will be one of facilitating the processes of technology transition and systems acquisition through its space-related T&E services. Its primary customer base will be the DoD R&D as well as system acquisition communities for which it will operate a laboratory in space. It will have particular responsibility for space test operations (e.g., in association with Air Force Laboratories and the SDIO) with emphasis on RDT&E in the space environment. It will also seek out and explore new opportunities for space-based T&E support of other military systems R&D (e.g., cruise missiles, aircraft) for the national defense. It will support the military systems implementation process as a DT&E and/or IOT&E resource manager contributing to SPO turnover of developed systems for operational use. The CSTC will also continue its role as the designated DoD agency for interfacing military space-related test assets in support of non-DoD space experiments such as those conducted by other U.S. government agencies, U.S. commercial interests and foreign entities.

Continued testing incorporating use of space-based assets is assured. Traditional activities will endure and, given the vision of GRANCAP, new ones will be added. At issue is the nature and extent of the class of operations which will be addressed. At the CSTC, traditional functions will continue to provide uninterrupted service for evolutionary systems developments associated with the contemporary customer base. Incremental capabilities will be added to meet known requirements imposed by ever more complex space experiments. The evolutionary implementation of the GRANCAP T&E umbrella will catalyze a push for integration of USAF space test activities with the T&E functions of the MRTFB ranges, the USN World Range and the USA Space Systems Test Bed concept. In the extended T&E arena so defined, the likely trend in requirements for military systems acquisition support will be toward more complex investigations which aid tactical systems development and require multi-mission applications of space-based T&E assets. Collateral areas will address maturation of the traditional military T&E system through activation of interfaces with the National Test Facility, NASA research centers and private enterprise initiatives. This will require broadening of traditional operational interfaces to accommodate an expanding customer base and potentially may encompass many U.S. commercial as well as additional foreign test support operations.

CONCLUSION

Military space systems have reached maturity with the application of operational satellite constellations in support of U.S. warfighting forces. Their demonstrated success as a force multiplier in Operation Desert Storm will likely intensify future U.S. military dependency on space-based assets given the programmed reduction of DoD resources through 1995. Test operations in space and space-based test assets must evolve to support this increased space emphasis. The GRANCAP T&E structure is under development and the CSTC resource is active to meet that need. As the operator of a laboratory in space, the CSTC stands ready to assist the R&D community in the determination of cost-effective directions for future program development and test. As manager of the GRANCAP acquisition, the CSTC will also advocate availability of effective T&E resources which, when properly applied, can guarantee space as well as other fielded systems will execute their assigned mission upon deployment. The CSTC-supported global Space Test Range capability will be a prominent feature of the modern DoD system development and implementation process. It will function to assist technology transition from the R&D community to the systems acquisition establishment. It will act to aid systems activation conveyance of proven development concepts from design organizations to operational elements.

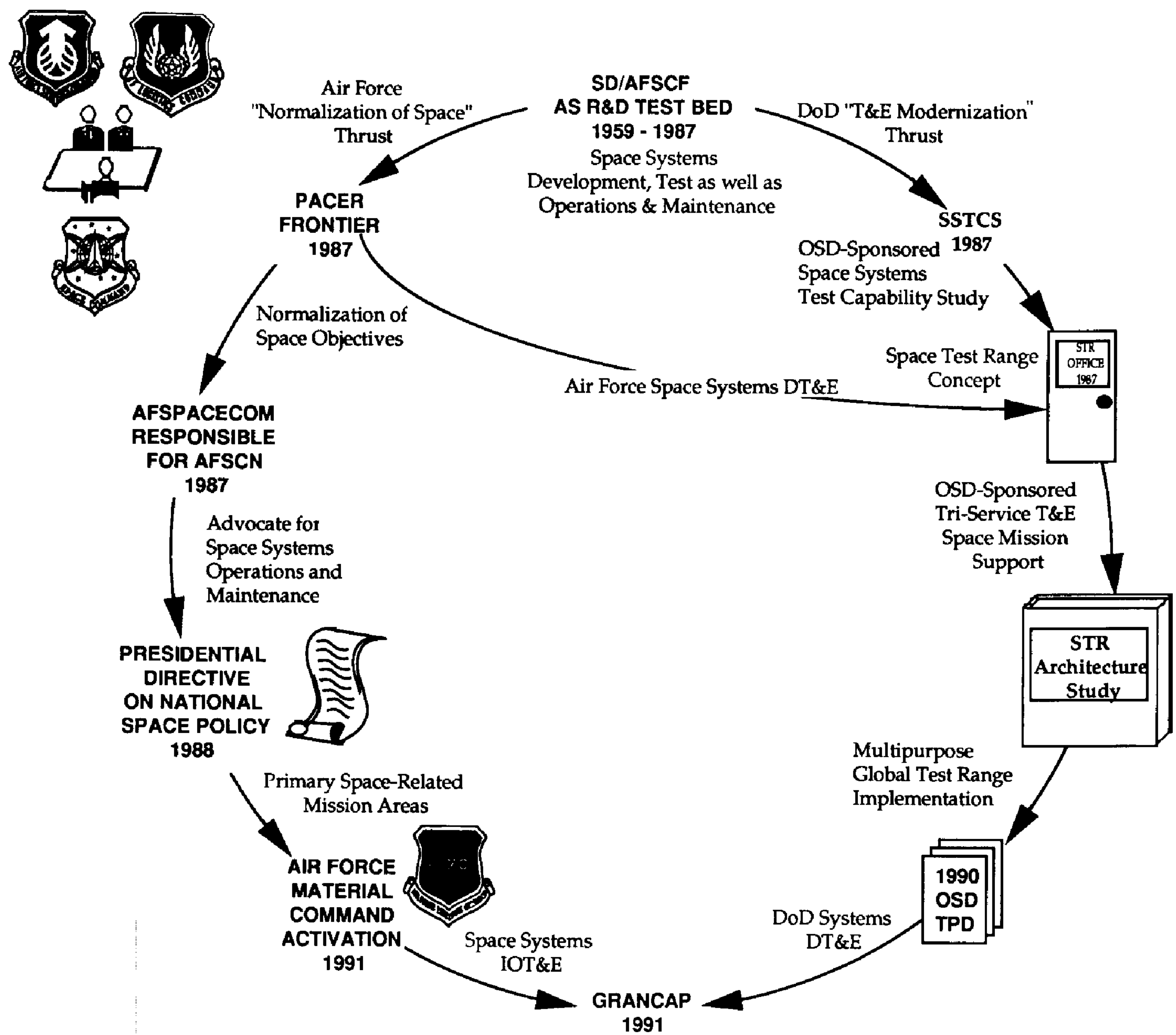


Figure 1 - Genesis of the Global Range Capability Concept

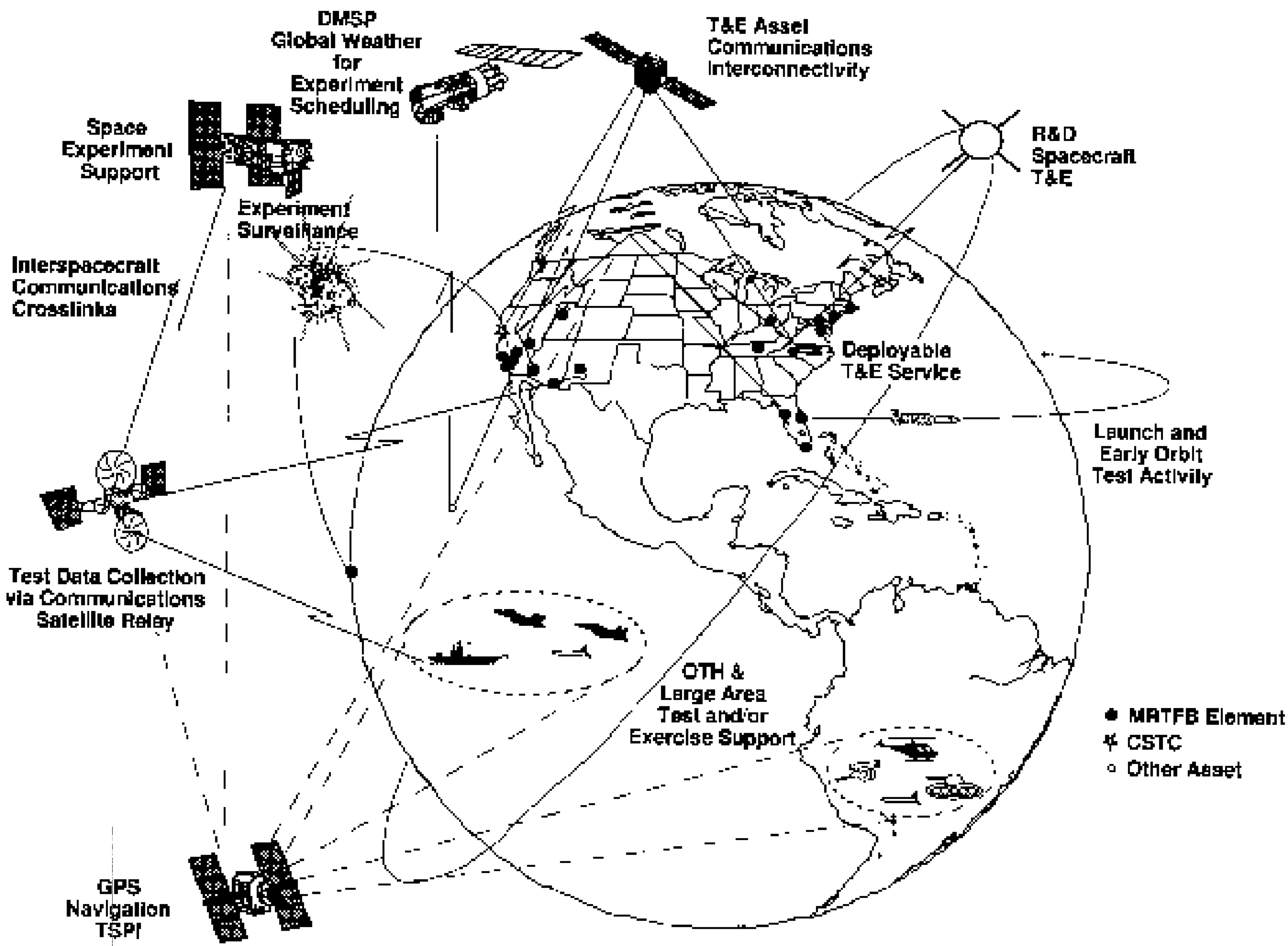


Figure 2 - Global Range Capability Scenario

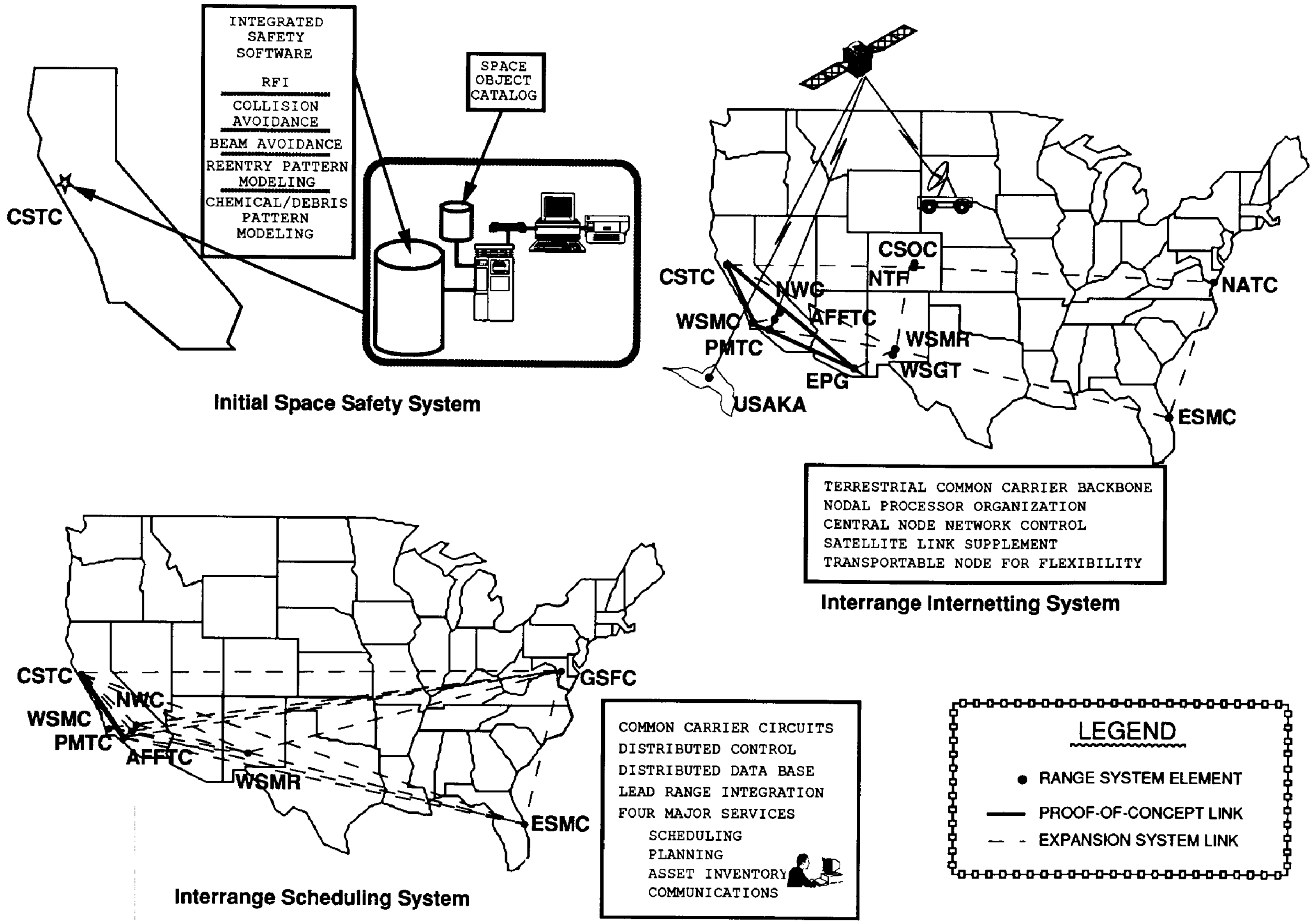
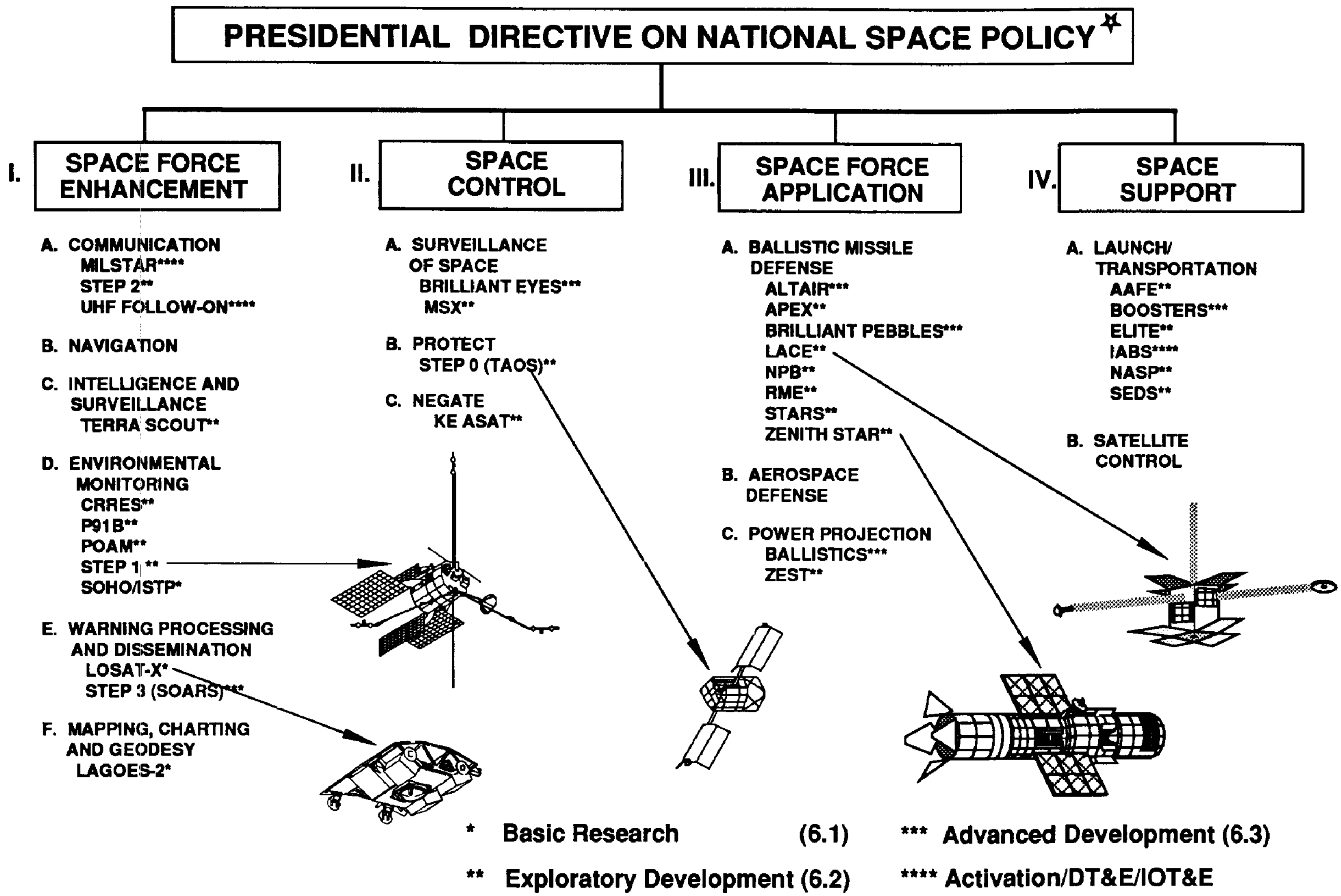


Figure 3 - GRANCAP Acquisition Program Elements (Notional)



✡ Presidential Approval of Revised National Space Policy on January 5, 1988

Figure 4 - Representative Test Mission Operations

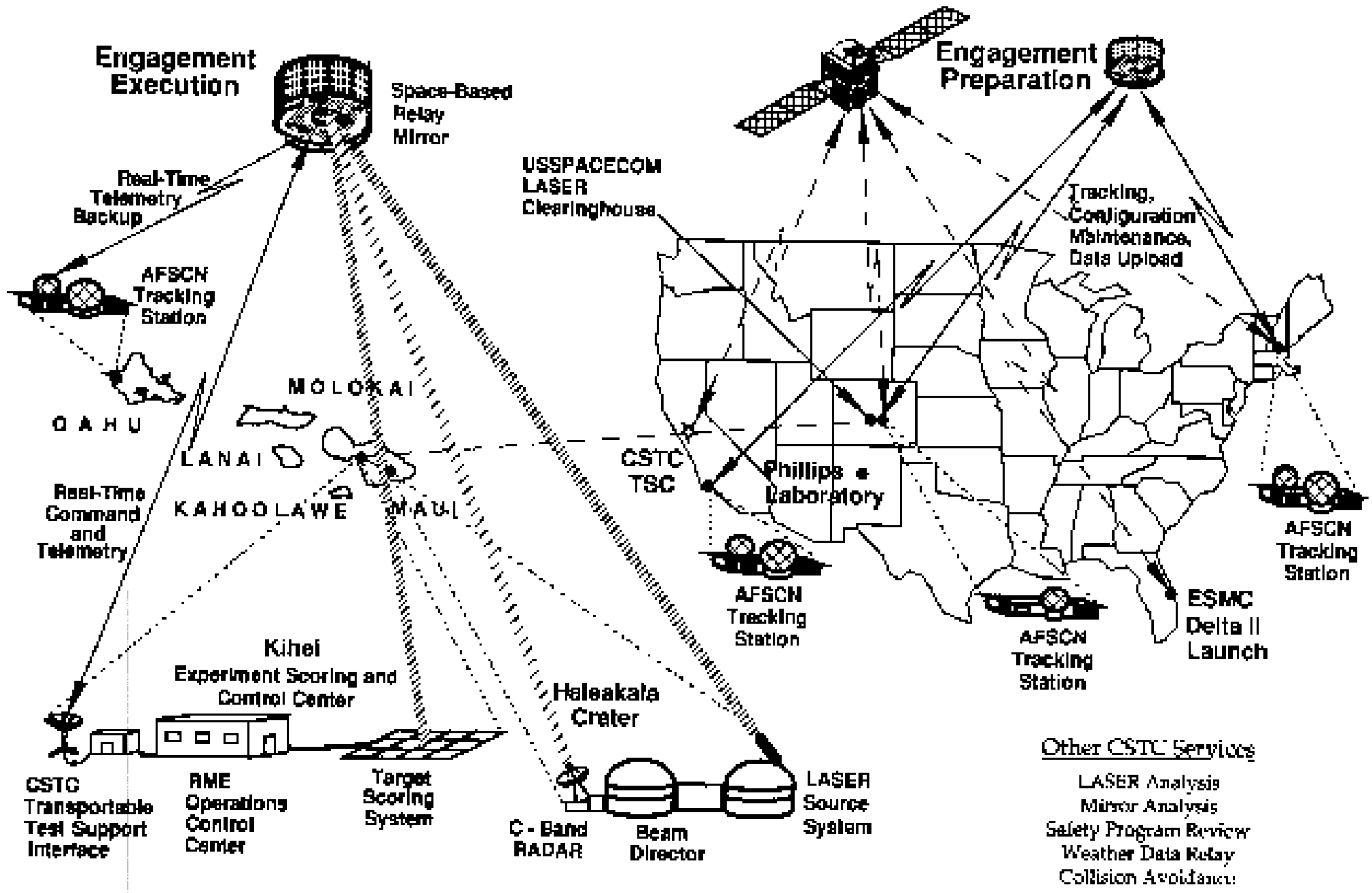


Figure 5 - RME Support Overview

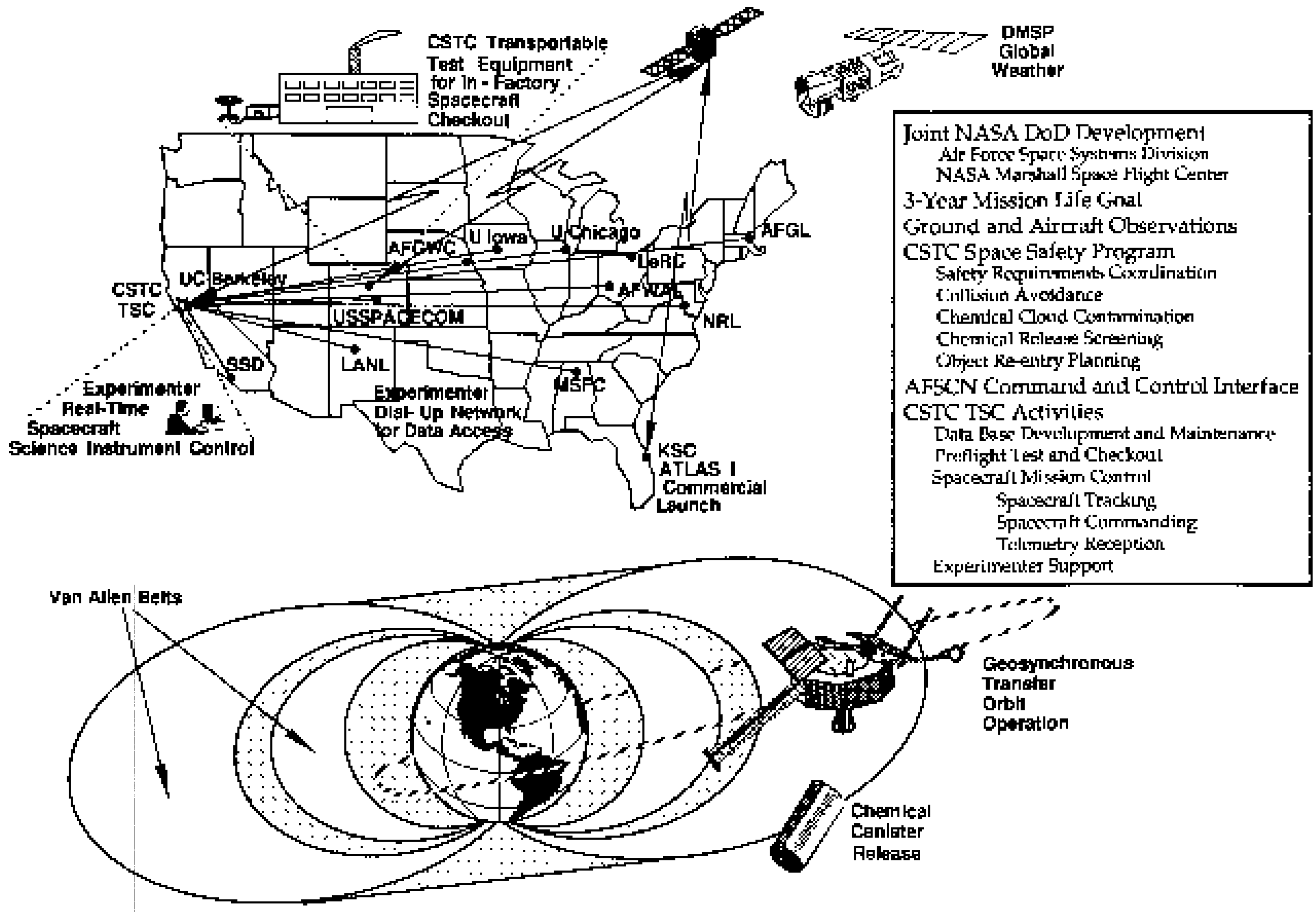


Figure 6 - CRRES Experiment Support Overview

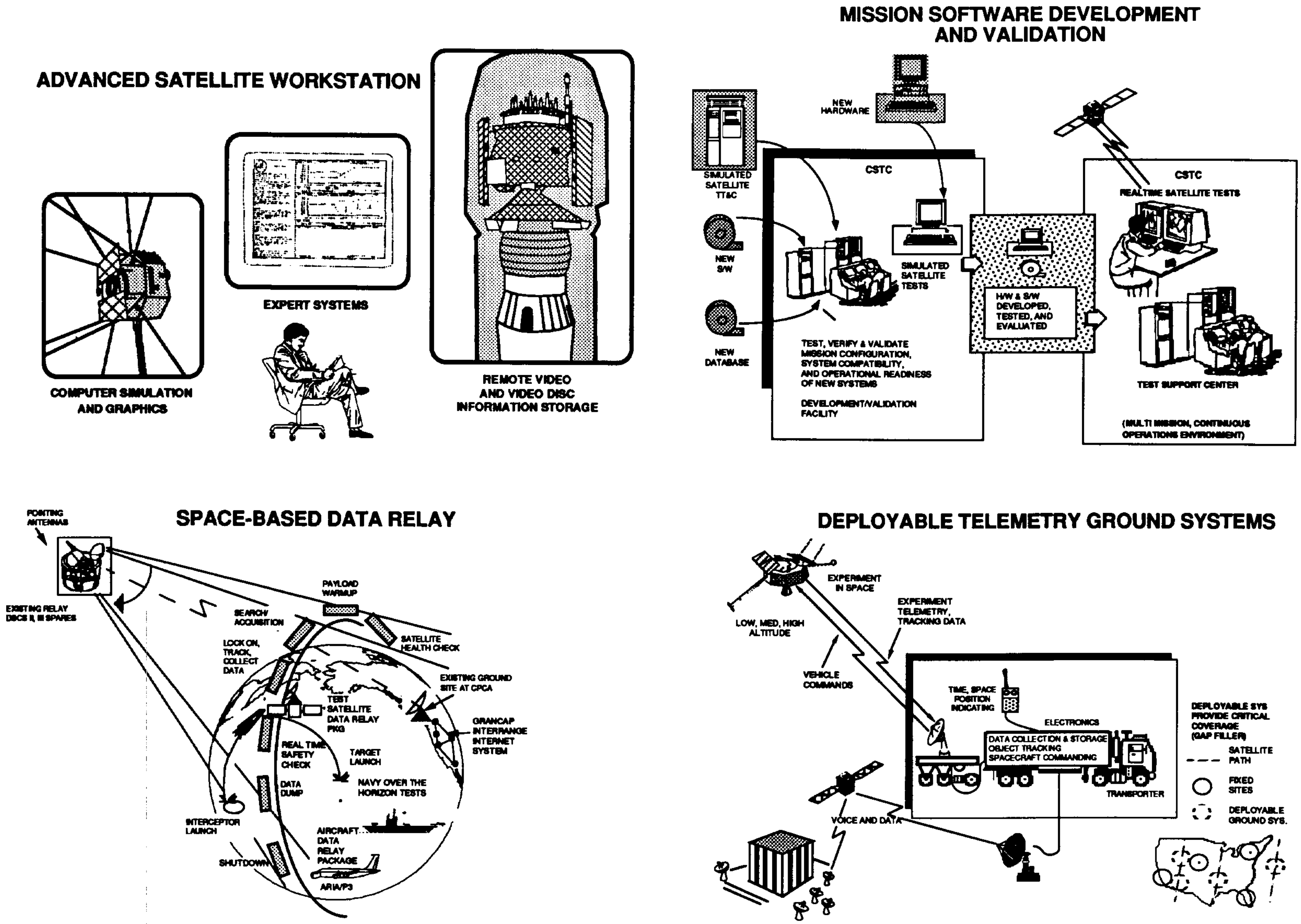


Figure 7 - Currently-Active Technology Development Interests

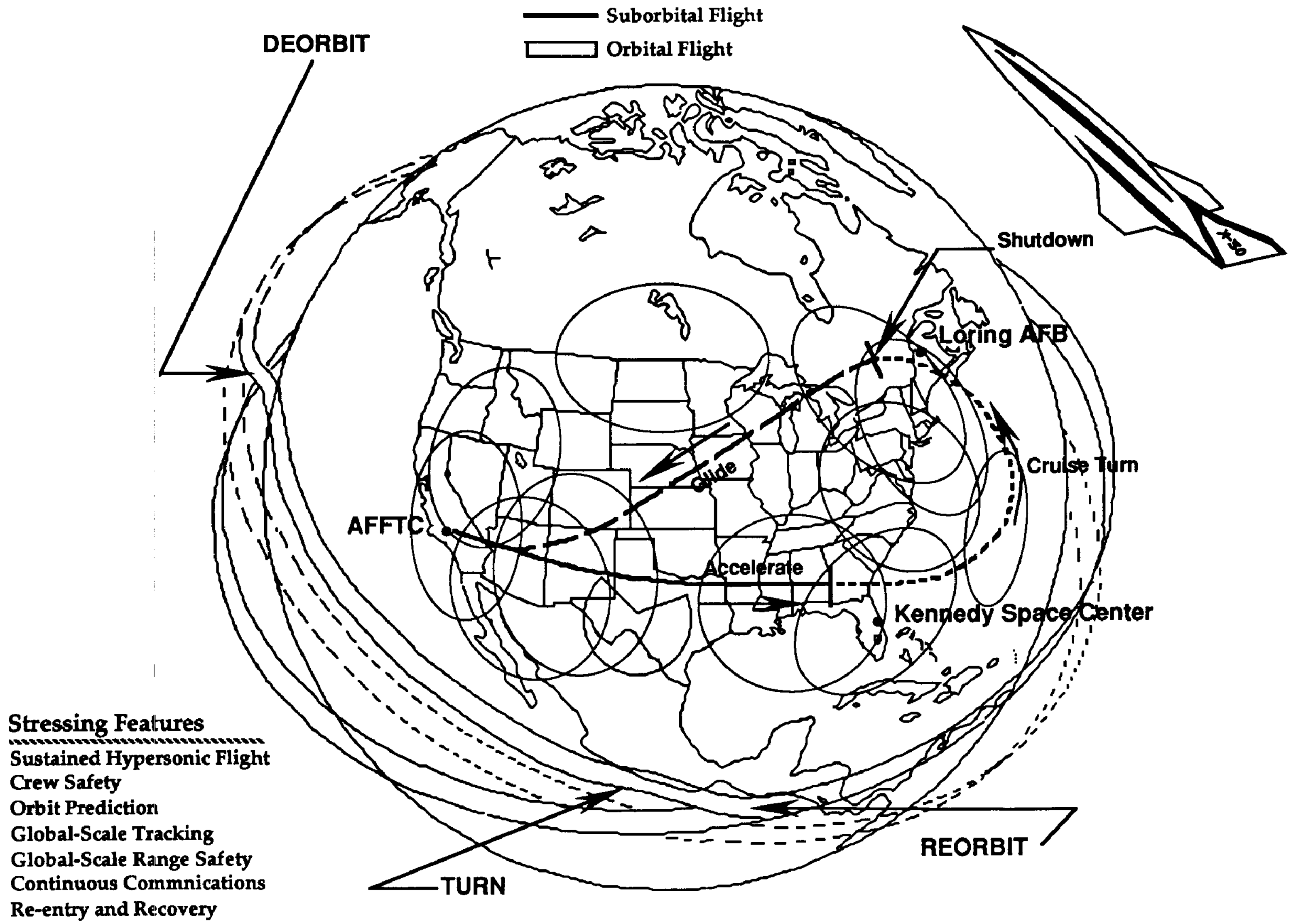


Figure 8 - NASP Test Operations Support Scenario