

Mission Systems Test Bed Project: The 21st Century Mission Control Center Environment

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The Mission Control Center System (MCCS) is an institutional resource that, from the Gemini Program through the International Space Station (ISS), has supported human space flight operations at Johnson Space Center (JSC). Under the Mission Control Center 21st Century (MCC-21) Project, the MCCS will be modified to support a broader array of space flight operations and mission classes, including flagship technology demonstrations, human precursor, robotic, and human-robotic missions. These missions include near-Earth objects, LaGrange points, lunar activities, science utilization of the ISS, as well as commercial crew and cargo missions to the ISS.

The Operations Technology Facility Mission Systems Test Bed (MSTB) Project is a Mission Operations Facility Division project implementing Information Technology (IT) infrastructure that prototypes, tests, and supports the development of key operational architecture concepts for MCC-21.

Mission Control Center System and Mission Control Center 21st Century Overview

The MCCS provides a set of functional capabilities for command, control, and support of space vehicles and their payload elements. From Gemini through the ISS—and with the strategic upgrades and the tactical equipment replacements—the MCCS has evolved to include elements that provide mission critical and mission support functions such as spacecraft command and control functions that reside in a “high security area.” These functions include: acquisition, processing, distribution, and display of telemetry downlink data; initiation of uplink and verification of command uplink data; acquisition, processing, and distribution of network, trajectory, timing, voice, video, and ancillary data; recording, storage, retrieval, distribution, and playback of selected telemetry, command, trajectory, and voice data enabling remote access and use of all of this information on displays for the flight control team.

A “moderate security” area supports: preflight production, pre-mission planning, and real-time mission re-planning; spacecraft system modeling for monitoring, evaluation, and analysis; facilities for development, integration, and testing of new functionality; resolution of flight anomalies; and remote access for use of the capabilities.

The term “high security area” refers to a physically separated environment within MCCS for functions and capabilities that, by their nature, are required to ensure the safety of MCCS-controlled spacecraft and crew. The term “moderate security area” refers to MCCS mission support functions that reside on the institutional JSC campus network.

A conceptual depiction of the new MCC-21 architecture spanning these two security areas—high and moderate—is provided in figure 1. These areas will contain the functionality described above. The MCC Operations environment in the high security area provides capabilities for the command and control of spacecraft and payload elements, spacecraft trajectory evaluation, and “safe haven” operations for ensuring safety and mission success in the event the moderate security area is unavailable. Connectivity to the spacecraft will be solely through the MCC Operations environment. A new Mission System Development Environment will be created in the moderate security area that will support the development needs of both the high and the moderate environments. The Mission Support Environment in the moderate security area provides access to the command and control functions located in MCC Operations as well as a host of mission support functions including flight production, mission planning, analysis, trajectory design, procedures development, and spacecraft system modeling.

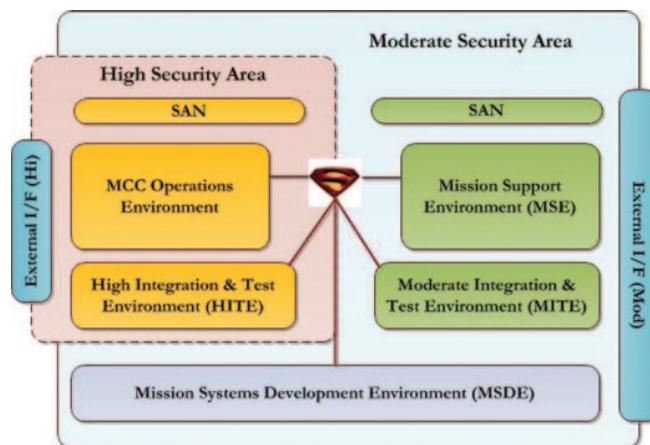


Fig. 1. Mission Control Center 21st Century conceptual high-moderate dichotomy architecture.

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Integration and test environments are provided within each security area. The high integration & test (I&T) environment and moderate I&T environment facilitate development of capabilities and migration into operations. Each I&T environment is the functional equivalent of the operations environment that they support. These environments will provide an area external to operations for integration, testing, and introduction of new technology and capabilities, assuring minimal disruption to operations, while providing staging grounds for verification of operational concepts.

The significance of the MSTB Project is the risk and cost reductions for the MCC-21 Project through prototypes of the secure network and computation architectures, security and information assurance policies, and technical management of the IT infrastructure, culminating in a tested “secure network, systems architecture, and operations concept.” The prototyping in the MSTB will provide in-depth understanding of the MCC-21 IT systems and refines the MCC-21 Systems Architecture and Operations Concept.

Given a tested MCC-21 Operations Concept, this then evolves the critical security policy configuration and deployment in a cross-domain environment (mission critical/high and moderate), with integrated secure network and computation architectures, into the MCC-21 environment, thus defining the cross-domain virtualization architecture for new secure local area network configurations, and its effect on system behavior, redundancy, and backup system capability. Utilization of the Operations Technology Facility and its state-of-the-art equipment, such as Nexus 7000, FortiGate, Blade Centers, and Storage, as an integrated platform for prototyping of a “MCCS Data Center” and secure network, are planned. As the MSTB Project

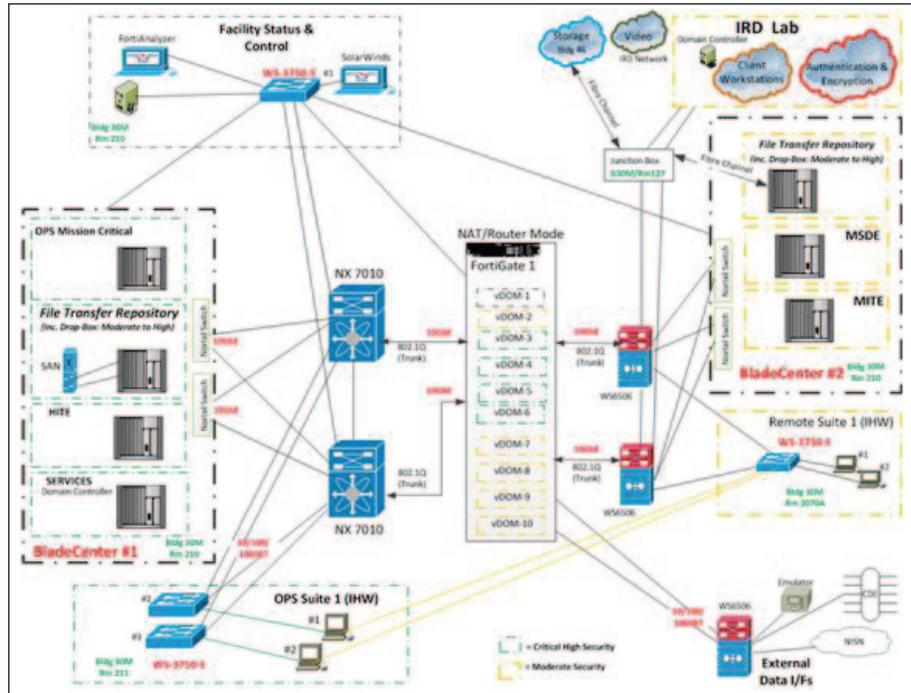


Fig. 2. Mission systems test bed high-moderate dichotomy architecture.

evolves, additional equipment and software—guided by the functional requirements—will be added. Test case results and trade studies on these new technologies for potential infusion into the MCCS will be conducted here.

Figure 2 shows an intermediate stage of the MSTB as it is today. This depiction illustrates both the high critical environment and moderate support environment, as well as the “Sentinel” security gateway.

The MSTB is the showcase prototype and evaluation environment for the continued evolution and proving grounds for MCC-21 operational concepts. Given the rapidity of IT technology evolution, especially in the commercial commodity areas, the MSTB is a necessary part of the operational MCC-21 infrastructure that assures lower risk to operations, even when new, disruptive technologies are infused. Additionally, future architectures for the MCC-21 can be examined, refined, and enhanced—all with minimal risk and cost to critical mission and space operations.