Mission Evaluation Room Concept of Operations Evolution: Successful Merging of Technologies and Techniques

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The International Space Station (ISS) Mission Evaluation Room (MER) is a flight control facility used by Engineering Directorate personnel in support of ISS vehicle operations and science projects. The facility is staffed with engineers who possess in-depth knowledge of each of the ISS systems, and they provide real-time engineering support to the Mission Operations Directorate staff in the Flight Control Room.

Following the final space shuttle flight, the demand for real-time ISS MER support will decrease due to the absence of shuttle visits to the ISS. This will enable the ISS MER to transition to a lower-cost, remote, distributed support posture—i.e., a remote MER—while maintaining "essential support" such that the risk to crew and the ISS are not increased.

The existing ISS MER, shown in figure 1, will be abandoned by engineering personnel in a planned, stepwise fashion. Once the operation of the remote MER concept has had sufficient operational experience, the MER room will be repurposed for other customers. A new approach for providing MER personnel access to the voice, video, and data systems from remote locations would be required to accommodate this transition. Note, however, that the MER tool set—including the MCC Automation System tool set—will not be affected, thereby preserving the investment already made in the staff's training. The additional requirements were for secure remote access from office or off-site, and the need to use the training investment in the current tool set and its support environment.

The challenge was met; all associated risks were successfully managed. Specifically, the risk challenge was centered on the production of a service that cannot be interrupted, but that cannot be continued without significant changes to the Concept of Operations (Con Ops) currently being implemented. It required that new, different, and disruptive technologies be incorporated into the system, while incorporating the current, trained, skilled cadre of operations staff into a sufficiently familiar environment to avoid undue "learning curve" risk.

NASA selected an existing prototype of a virtualized MCC, called Mission Control Center Experimental (MCCx).

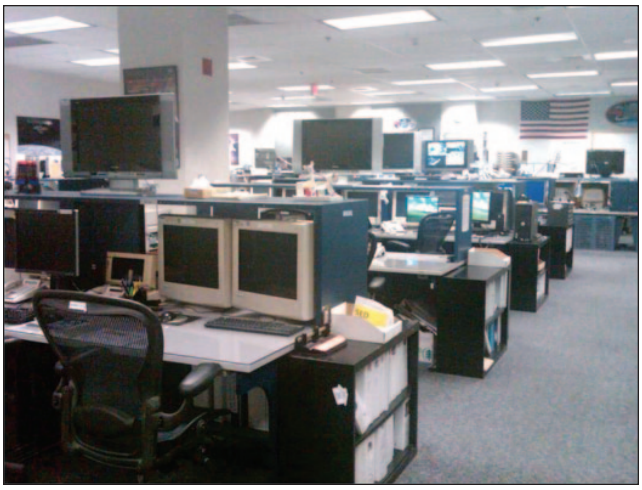

Fig.1. *International Space Station Mission Evaluation Room facility.*

This prototype used existing MER tools and the trained MER personnel. The solution was Internet Protocol (IP) based, and already had secure operations and remote access available. By combining the available Johnson Space Center (JSC) IP Television (IPTV) system for the monitoring of video and audio signals over IP, and a prototype Voice over IP (VoIP) system recently integrated by the Mission Operations Directorate, the combined data, voice, and video services could now all leverage existing IP infrastructure. This approach is referred to as "Everything Over Internet Protocol" and simplifies the deployments of these services to remote locations.

The confluence of activities, technologies, and requirements used to transition the MER operations defines a prescriptive methodology that can be repeated in the future within NASA and industry. Recall, the challenge is that production of an ongoing service cannot be interrupted, but yet it cannot be continued as configured without change. This is a "soft" technology called operations research— commonly referred to as Knowledge Capture in the Knowledge Management arena.

In project scenarios like this, the search for detailed requirements begins, and quickly mires down. The push to define the requirements usually consumes the team. Not so here. Since this transition of the MER to remote

operations was a partnership between the MER and the Mission Operations Facilities Division of the Mission Operations Directorate, that pitfall was avoided by directing the team energy on what was available as a system to interface to the MCC. This resulted in the definition of very high level "Mission Support Requirements," as shown in figure 2.

System Driver	Definition of Driver	Measure of Driver
Performance	Provide a usable system that is responsive and provides optimized utilization of hardware for the stakeholders	For remote access primary measurements of performance are responsiveness, throughput and utilization from the controlled portion of the system architecture
Scalability	Provide ability to expand utilization of provided services which may involve increasing the number of simultaneous users, increasing the volume of data, increasing the number of services provided, or increasing the number of remote access points	Scalability is defined as the maximum number of simultaneous users, maximum amount of simultaneous transmitted data, and the maximum number and location of remote connections.
Availability	Provide a system that meets the up-time needs of the stakeholders to support their operations concept	Measured using industry standard uptime metrics
Usability	Provide the users with the remote collaborative environment by enabling the operations scenario	Stakeholder demonstrations with feedback in regards to the ease of use of system, and refinement on system design when necessary
Security	Provide the infrastructure to allow for one-way push of data from a high security environment	IT security local to MOFD and FDOC will analyze intrusion detection, and implement designs that will allow for mitigations in the event of an intrusion

Fig. 2. *System performance requirements.*

To provide secure display information using ISS real-time data to remote locations, secure two-way voice loops to remote locations, and standard definition video channels to remote locations, the team developed and followed a process that defines the methodology for any system that must change while still in motion. First, a return on investment must be completed that indicates, to the first order of approximation, the goals and performance trades were made quantifiably, and show positive, or at least non-negative, return on investment. Second, tools are maintained in place to preserve the training and associated "sunk cost" of the current staff. Third, recognition of the impacts of a radical change in Con Ops (such as remote operations) on both the system and staff performance must be made. Fourth, to the extent practical, use commercial off-the-shelf products; there is no penalty in project time and money for switching if insurmountable problems are encountered. Fifth, leverage the prototype systems available to minimize risk to the total project, filling the commercial off-the-shelf gap. Sixth, run the new system with the current staff parallel to the old system prior to "lights out" on the old system as a risk control.

The demonstration of return-on-investment benefits of a Con Ops modification—employing prototype systems in an integrated fashion to build a new system—results in a Con Ops/system that is cost effective and risk bounded, and is completed in a relatively short time span. When repeated for future facility transitions, this Knowledge Capture will benefit not only JSC, but any critical real-time operation requiring seamless transition.