Paper Session I-C - Towards the Off-The-Shelf Launch

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Towards The Off-The-Shelf Launch
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Abstract

1.0 Overview

As the Space Age began in the '50's and '60's, new technologies were required to create a successful launch capability from scratch. As soon as it was possible to do so reliably, innovation became less important. As a result, commercial launches today may utilize 30 year old technology, but the price tag remains high. As long as the Cape remained the only launch site, no significant changes were required regarding launch methods and equipment. With the advent of Arianne, however, the cost of a launch became more open to price influenced competition. Today, the challenge is to create a cost-effective launch capability, while maintaining or even enhancing safety. Better quality at lower cost. Innovative use of Off-The-Shelf technologies provide one of the fastest means to this end.

2.0 Understanding Basic Issues

The typical commercial launch facility utilizes many physical direct hard lines to and from the launch pad, launch vehicle and ground support equipment. With the introduction of state-of-the-art technology, two connection complexes can be reduced to one, with hundreds of copper wires replaced by a few fiber strands. Physical switches and gauges can be replaced with computer generated images containing virtual gages, switches and the like. Changes to a control room configuration would require relatively simple changes to software. These techniques, and others like them, are increasingly used within several industries. A blend of these time-tested methods with 1990's computer technologies offers several significant advantages over current capabilities.

3.0 Utilizing Today's Technology

The capabilities of the computer industry have been dramatically improving, both in terms of vastly improved capability with drastic computer systems cost reductions. Just the last two years have seen outstanding price performance gains. With an increasing emphasis on
standards, the users of 90’s technologies will be in a strong position to challenge users of 80’s technologies.

The key is straightforward: use computer industry standards when they make sense, real-time techniques to enhance performance, and emerging visualization to enable superior operator understanding.

The developer of a 90’s based commercial launch facility could easily include the following tools to construct a formidable launch control center: seamless Real-Time capability to insure predictability of operation, multi-processing to enhance task management and redundancy, fiber-optic reflective shared memory for simplistic multi-chassis integration, POSIX compatible Unix operating system for ease of software development and o/s portability, X.11 based high resolution (1280x1024 min) 2D and 3D graphics for ease of user interface (control, monitoring, and flexible reconfiguration), intelligent I/O subsystems for cost-effective connections to GSE & launch vehicle(s), C and Ada language development for flexible software, graphics SuperWorkstations for comprehensive situational displays (range, weather, vehicle, payload), industry standard I/O slots, high speed disk I/O for data archiving, ease of hardware/software upgradability for expansion, VME Slots for custom boards, Network File System for common development common data sharing, Ethernet/FDDI for non-real-time connectability, general hardware/software modularity for ease of upgrade and fault isolation, Project Supercomputers for computer assisted launch guidance and expert systems, scalable compatible architectures to balance performance and cost per seat, RISC CPU technology for growth-oriented price/performance, with a balance of integer, floating-point, and multi-user capabilities.

In addition, all of the above should be commercially available products, allowing for the most productive use of development time to focus on software issues.

Together, the above mentioned capabilities could easily be used to upgrade sorely outdated facilities and methods.

4.0 Launch Control Facility System Overview

To become competitive in the Global Satellite Launch Market, a significant yet stable change must be made in the manner in which the Launch Control Center does its business. Obsolete equipment
must be upgraded to insure profitability, reconfigurability, validation, and safety while at the same time utilizing state-of-the-art Commercial-Off-The-Shelf products to promote outstanding real-time visualization with the fastest possible schedules.

State-Of-The-Art equipment can easily consolidate information which currently occupies the attention of many people into a form easily understood by one person, thereby significantly increasing the productivity of each individual and reducing fatigue which leads to potentially costly errors in observation or judgement.

By modularizing the hardware data acquisition, distribution, and software application components of the Control Room support systems, entire configurations can be easily modified to flexibility accommodate different launch vehicles, display needs, launch schedules, and troubleshooting needs.

By utilizing multiple system architectures, validated systems are not affected by the inclusion or removal of networked systems providing critical support for one launch but unused for another. Additionally, a launch vehicle simulator can be incorporated in place of the actual vehicle to totally check out Launch Center performance and reliability.

Of paramount importance is the requirement for safety. By utilizing a design concept which blends multiple complex individual components into a single yet cohesive functional unit by virtue of elegant simplicity, the total safety picture is drastically enhanced.

Commercial-Off-The-Shelf equipment is available with broad price ranges and outstanding performance which means virtually all computational and display systems can be obtained from a single American vendor which provides binary compatibility across the Control Room Complex while yet utilizing Industry Standards such RISC, VME, 2D and 3D Graphics, TCP/IP, FDDI, multi-processing, reflective shared memory across systems, POSIX compatible Unix with Real-Time Extensions, X-Windows and Motif, validated Ada and high-resolution operator displays with simultaneous NTSC video network output. This provides superior implementation schedules, reduced training needs, effortless integration, and simplistic redundancy.
Combined with the adaptability of many 2D and 3D graphics applications, Artificial Intelligence applications, and the like, the software engineering required is significantly simplified.

Implementation of such a system could be done in parallel with existing equipment to effectively validate the concept with zero risk, and in a quicker time-frame than one would normally expect for such a project. Due to the flexibility of the concept, this design could also be simplistically modified to communicate with other launch sites, even those with drastically different launch vehicles.

5.0 Future Expansion

A modular approach also allows for relatively easy expansion of a launch system into related areas of interest.

The first is a post-transport checkout facility. As launch vehicles are shipped across the US to the Cape, components may become loosened. It would be relatively easy to utilize the same checkout hardware/software employed on the pad, but used while the vehicle is still attached to the transport vehicle. Many components could be verified and replaced prior to placement on the pad, with obvious time and cost savings.

The second is flexibility of configuration. Instead of running hard lines to a bunker area and wiring up new switches, lights, and strip charts for slight changes in vehicle configuration, virtual visual switches and such are easily added to the hardware/software repertoire of capability. In fact, the same hardware could be connected to many different types of launch vehicles on the same pad, with the flexibility to adjust designed into the coordinating software.

Third, it becomes simple to network this kind of capability to flexibly control many different pads from a central point, or to even send relevant information across country to remote monitoring sites. This fact could even allow for a real-time monitoring facility near a major tourist attraction to better acquaint people about space technologies.
6.0 Implementation Methods

Traditionally, long program cycles of three to five years and beyond have been utilized to develop the technologies used today. However, in the realm of commercial ventures, this approach must be avoided lest by the time the capability is developed the companies which would use it are no longer in the business of launching payloads.

A more streamlined approach to generate compartmentalized online capabilities (which can be painlessly introduced to insure safety) needs to be implemented. This means that the appropriate experts in the use of today's technology need to be engaged in a development phase to use that technology in as rapid a manner as possible, with research into various enhancements (such as expert systems) to be phased in once the basic foundational structure is in place. This is not R&D, but rather D&R. The tools are here today. They just need to be used with a view towards a quality oriented, competitive, launch capability.
Basic Technology Shift

Junction Complex 1000+ Hard Wires

Physical Connections, Difficult Reconfigurability

Telemetry

Vehicle

GSE

Junction Complex

Virtual Controls

Few Fiber Strands

Subsystem

I/O

Virtual Controls

Physical Controls

Hardware/Software Integration, Simplistic Reconfiguration
Control Room Overview

from launch pad (up to 25Km)
1000 DP x 32 bits ea
X 120HZ sample rate =
480KB/sec used with a
6.5MB capacity =
~ 10% utilization of
SCRAMNet bandwidth

Application Processors

Engineering Team
(6 teams each with
2 systems - 12 systems
total not shown)

Data Replay and
Troubleshooting
System

Communication Link

Remote Monitoring Reception

Remote Monitoring Stations

Guest Monitoring Stations

Remote Monitoring Transmission
(Uni-Directional)

Archival and Retrieval System

magnetic disk

optical disk

CEM 08/02/90 1500
Launch Pad Overview

VMIC I/O subsystem with NASA-supplied demodulator card

Launch Pad troubleshooting/application backup system

Vehicle Signal Generator

Note: Systems shown are triply redundant

- - represents 3 redundant links of the ScramNet fiber optic interprocessor link from Systran Corporation