CASE STUDY

Space COTS Approach for New Launcher and Capsule

CURTISS-WRIGHT

DEFENSE SOLUTIONS

Challenge

- New launcher and manned capsule needed system with high reliability
- Limited budget for developmental flights
- Wanted flexibility in system design to account for late changes

Solution

- Procured most cost effective system that met mission design verification objectives
- Use a proto-qualification strategy to ensure design requirements are met
- COTS has flexibility to more easily adapt to spec changes

Results

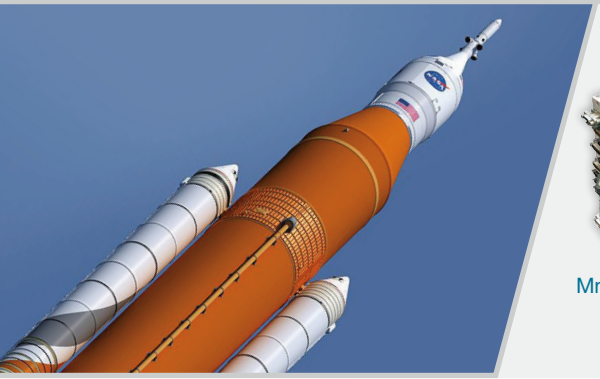
- Fixed price contract delivered required equipment
- Successfully operated 100% error free throughout all the environmental testing
- System able to quickly and efficiently meet changes

Challenge

NASA needed to develop a space launch system and a manned capsule to replace its previous vehicles and to meet future plans for deep space exploration, including plans to land people on Mars. The Space Launch System (SLS) is planned to be the most powerful ever built while the Orion spacecraft is being designed to carry astronauts to explore the moon, asteroids, Mars as well as ferry crew and supplies to the International Space Station (ISS).

As with any new vehicle, a majority of the operational performance is unverified until data can be gathered from test flights. The challenge with such a launch system is flights are also extremely expensive with the data gathered being very important to the mission success – thus the Developmental Flight Instrumentation (DFI) performance is critical. The environmental conditions are extreme and thus a system must be highly rugged.

However, the limited budget meant a custom engineered solution would be too expensive. What was needed was a DFI system capable of gathering the required data but within the limits of a tight fixed budget available for the developmental flight testing campaign. System flexibility was also a concern to ensure any system could account for late changes in data capture.



MnACQ-200

CDAU

12-port
Network Switch

Solution

The solution was to choose a commercial off-the-shelf system (COTS) from Curtiss-Wright that had been proven in harsh environmental conditions and had a track record of reliable operation. The tactic was to procure the most cost effective COTS system that came close to mission design verification objectives and institute a Proto-qualification Environmental Stress Screening (ESS) program as well as ESS Acceptance Testing rather than selecting a fully space qualified system. By trading risk against cost, significant savings could be achieved with only a manageable increase in risk that too much data may become unusable for a period of time. This risk may be too high for systems where failure could result in mission failure or loss of life.

The qualification process was designed to ensure reliability requirements are met so that sufficient confidence is obtained in the system. A sample number of representative systems was used to demonstrate the feasibility of the delivered systems. Tests included vibration, long duration burn in, thermal cycling, thermal vacuum, EMI, and shock.

Curtiss-Wright did have to develop new processes to test the systems. This was in fact the most difficult part of the system requirements – being able to design and implement tests to effectively prove the systems would operate error free throughout all environments. These included the TTC CDAU variant for the launcher and the MnACQ-2000 stackable networked data acquisition units and Ethernet Switches for use in the capsule.

Some minor modification to the SLS CDAUs were required to meet the enhanced ruggedness requirements including a modification to the base plate and internal connectors to meet the severe vibrations. Customization of the MnACQ and Network Switch power supplies was also undertaken to ensure the system could cope with the expected doses of radiation.

Results

A COTS system was selected that met all the requirements without the high custom system development costs. In total, the delivered system includes eight TTC CDAUs and nine MnACQ-2000 stackable networked encoding units for the capsule that were connected using two 12-port Ethernet switches. Figure one shows an overview of the systems. The SLS CDAU system DFI data is telemetered for capture on the ground. All of the Orion networked DFI system data is recorded in the capsule, in addition health and status packets and a subset of the DFI data is transmitted to the Ground System during the test flight. The DFI System also has the flexibility to more easily meet any future specification changes such as the desire to add more instrumentation.

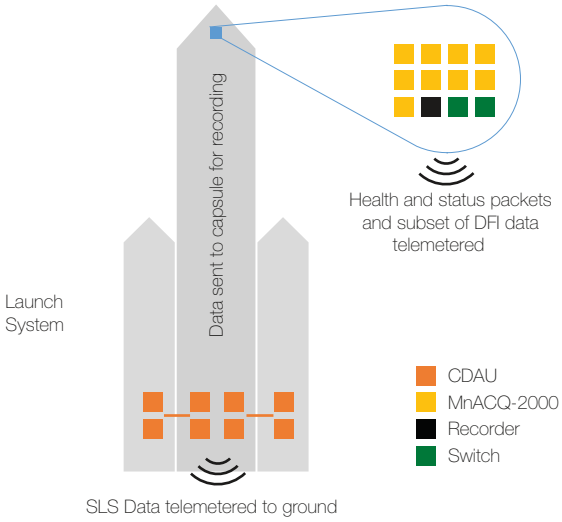


Figure 1: Systems Overview

At the time of writing, all but one of the MnACQs have successfully operated 100% error free within the nominal range throughout all the environmental testing. The system facilitates the gathering of crucial data that includes accelerometer, thermocouple, voltage, current, strain gage, pressure, potentiometer, discrete, bi-level and video. This data will help validate the launcher and capsule designs. An important factor, in this and many other space applications, is the pressure to keep costs low. There is more competition now in this sector which was until recently the preserve of a few large government agencies. Thus perhaps the greatest result then is the fact that a system was obtained that cost-effectively meets the challenges. The anticipated first launch date of the new launcher and capsule is in 2019.

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