Command and Control Technologies Corporation

- CCT is under contract to the Mid-Atlantic Regional Spaceport to build, install, & validate the WFF Pad 0A Universal Ground Control System.

- Command and Control Technologies Corporation (CCT) is a Florida based small business specializing in decision focused situation awareness and automation for space, defense, and security Applications.
Background

The Virginia Commercial Space Flight Authority (VCSFA) is developing a new launch pad to support mid-class, liquid oxygen (LO2)/kerosene (RP-1) fueled launch vehicles
  – NASA Wallops Flight Facility (WFF) Launch Pad 0A
  – Planned Completion: April 2012
  – Multi-use launch facility

Orbital Sciences Corp will be the 1st user of the new launch complex, flying the newly developed Antares launch system in support ISS cargo and resupply
  – Orbital is a key stakeholder and is substantially contributing to the technical requirements/features of the pad.

A key feature of the new launch complex is a Universal Control System (UGFCS).
  – Provides automated remote control and monitoring of all pad systems
  – Reconfigurable/Extensible for vehicle and mission specific requirements
UGFCS Scope Summary

- Remote control and monitoring of pad systems
  - Automatic fill/drain of liquid and gas commodities
    - LO2, RP-1, GHe, GN2, LN2
  - Automatic sequencing of Deluge Systems
  - Supervisory control of Vehicle & Payload Env Control Sys (ECS)
  - Supervisory control of Vehicle Transporter/Erector (TEL)

- Operator situation awareness:
  - Systems Health & Status, Caution & Warning, Alerts/Advisories.
  - Mode Control: Automated and Manual operation

- Time synchronization/correlation and Control

- Historical data archive and data reduction services

- Integrated interactive pad simulation

- Remote web based NRT pad monitoring

- Capable of operating stand alone or in concert with launch vehicle command and control
  - Includes extensible features to support vehicle specific Conops
FCS Architecture Overview

• Software architecture based on COTS Command and Control Toolkit™ C² Framework
  – Orbital selected same framework for vehicle launch ops command and control
  – COTS T-Zero Sequencer provides Timeline management
• COTS servers and workstations interconnected via standard network communications
• COTS distributed industrial I/O for GSE and Vehicle interfaces
  – PROFINET Industrial Ethernet Ground Control Network
  – Gateways to other protocols
    • EtherNet/IP
    • ModBus
• Fault Tolerant / Redundancy / Bumpless Failover
  – Software, Servers, Workstations, Networks, Critical I/O
  – Significantly leverages COTS redundancy technology
• Development limited to UGFCS specific adaptations
Integrated Launch/Fluid Ops

- ECS / Deluge
- Fluid/Gas GSE
- Special Test Equipment
- Electrical GSE
- Transporter / Erector
- Electrical GSE
- Ground Control Network

Vehicle / Mount

- Range
- Ground Control Network
Launch Site Control Zones

- RP1 Storage
- LN2 Storage
- LO2 Storage
- GHe Storage
- GN2 Storage
- Deluge
- TEL
- ECS
- RP1 Pad
- LO2 Pad
- GHe/LN2 Pad
- Launch Mount
- STE
- FCS Control Server
- Ground Control Net
- Display Net
- To LCC & Pad Support Facility
FCS Controller Locations

To LCC & Pad Support Facility

- RP1 Storage
- ECS
- Deluge
- RP1 Pad
- GHe/LN2 Pad
- Mount
- STE
- GHe/GN2 Storage
- LO2 Storage
- FCS Control Server
- Ground Control Net
- Display Net
- TEL
- LN2 Storage

BASIN 3
BASIN 2
POND 2
POND 3
Information Processing Concept

End-Item Control is Modal: Autonomous or Human In-The-Loop

Decision Makers Can Drill Down To System/Subsystem Details as Required

Nominal Situation Awareness Abstracts Details & Provides Priority Focus on State, Events, & Constraints

Distributed End-Items

End-Item Interfaces
- Range
- Vehicle & Vehicle GSE
- Pad Facility
- Environmental Control System
- Fluid / Gas GSE
- Water Deluge
- Transporter / Erector

Role Players
- Vehicle Operator
- Ground Safety
- FCS Operator
- Sustainer / Maintainer
- Observer

Decisions

Situation Awareness

FCS

Ops Process Control

Visualization & Advisory

System / Subsystem Control & Monitoring

C² Services

Communications

Command / Control

Data
FCS Modes and States

Pre-Mission Operations
- Configuration
- Maintenance
- Development
- Logon
- Power Up

Operation Execution
- Safe
  - Op-Safe (Standby)
  - Fail-Safe

Auto-Sequence
- Fill
- Drain
- Launch
- Abort

Manual
- Interlock Disabled
- Abort Fail

Simulation Execution
- Test
  - Hardware Emulation
  - Train

Post-Mission Operations
- Analyze
- Archive
- Logoff
- Power Down

Transition to Safe Mode
- Startup/Shutdown
- Failure
- Operator Initiated Emergency Safe
- Operator Initiated Hold/Standby
- End of Sequence

Power On

Startup

Shutdown
BACKUP
Sample Screenshots

LO2 Display

ECS Display

RP1 Display

TEL Gripper Arm Display
TEL Gripper Arm Testing

TEL Hydraulics Testing
Deluge Testing

FCS Controller
OCCS Workstation

FCS Utility Workstation

FCS Workstation