QUEST for Human Exploration of the Solar System

GSAW99
NASA/JSC/Lynn R. Vernon
Why are we Here?

- Present a vision of the Ground and Space architecture to support the Human exploration of space.
- Develop Partners for future development
- Gather/Exchange Information about Lessons Learned
- Technology Information exchange
**QUEST Vision for Exploration of Space**

Earth Based Operations

Planetary Based Operations

Operations Vehicle Based

Control Center Constellation

Planetary Constellation

Interstellar Constellation

- MCC
- ISS
- JSC
- KSC
- JPL
- MSFC
- GSFC
- Ames
- EARTH
- MOON
- MARS
- JUPITER
- PARTNERSHIP
- COST
- AUTONOMY OF MISSION VEHICLE
- GROUND OPERATIONS TEAM
The Vision for Exploration of Space

- Acknowledges
  - Funding for the future will continue to be tighter and more competitive
  - NASA’s commitment to having human presence on Mars
    - Research and Development must connect to Enterprise missions and goals
  - The blurring of boundaries between robotics and human exploration
  - Information Sharing is a MUST
- Requires all of NASA’s expertise
  - Information sharing between centers in support of each others programs
  - Lessons learned from robotics missions applied to human presence
Forward the Vision for Exploration of Space

- Revolutionary progressive steps
  - Earth based
    - Uniting NASA through its incredible Control Centers
  - Planetary (Mars/Lunar)
    - Increased information sharing required
    - Collaboration is essential between robotics, Human and Mission to Planet Earth program’s for mutual benefits
- Interstellar
  - Where we all want to go in the future
Strategic Baseline 2005
Control Center Constellation
Programs Supported: Shuttle, station, lunar return startup, assembly complete, increasing shuttle rate

Functionality Needed:
• Integrated & Interactive space operations information sharing
• Vehicles through control centers operate as if on same network <system constellation>
• Enhanced system archive - virtual functionality checkpoints
• Automated end-to-end scheduling and configuration of vehicle to ground interfaces

• C&C automation
  • Merge planning & cmd&cntl through collaborative “mission management” environment
  • Ground manages plan, crew/vehicle execute
  • Minimum ground intervention for execution
  • Virtual reality C&C display and simulation

Process improvements
• Integrated/Collaborative Flight Design, Productions, reconfiguration, planning & exec

Strategic Baseline 2010
Planetary Constellation
Programs Supported: shuttle, station, lunar return, Mars

Increased autonomy of Planetary Based Operations

Functionality Needed:
• In Situ C&C operations
• In Situ control center assets,
• Ping, cmd and cntl integrated at vehicle or constellation level
• Ground configures and manages tools and applications remotely
• Information returned for system and mission evaluation
• Robotics

Open-distributed operations
• Data path from vehicle to ground users independent from control center
• Open-distributed control center, control center tracks activities and provides services to distributed

Emersive Communications
• Virtual crew-family communication & emersive communications for crew ground operations planning

Process/Operations
• System development through intelligent synthesis
• Automated test and verification

Strategic Baseline 2015
Interstellar Constellation

Increased autonomy of Vehicle Based Operations
Programs Supported: shuttle, station, lunar (multi-vehicle), Mars (multi-vehicle), Interstellar

Functionality Needed

• Autonomous vehicle, C&C onboard
  • Strategic planning on ground, tactical planning on vehicle.
  • Vehicle plans and performs system maintenance, vehicle participates in planning
  • Ground roles are mission objectives & priorities and vehicle engineering support
  • Vehicle and ground system operate as team members, coordinate resources as required

Process/Operations
• Verbal/conversational system interface
• Integrated training, verification and cmd system for SW loads

Distributed Operations
• Distributed and integrated operations for science/payload operations, vehicle engineering support and non-critical operations

Process/Operations
• System development through intelligent synthesis
• Automated test and verification

Open-distributed operations
• Data path from vehicle to ground users independent from control center
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Emersive Communications
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Process/Operations
• System development through intelligent synthesis
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What have we done?

- Developed and growing Partnerships:
  - UCSD, Moorhouse, UHCL - Tech Transfer, NASA University Tech. & Research
  - Development of Mars Operations Concept, NAVY Helo project, NASA Engineering

- New Technology cooperation
  - Xylan, Veda Systems, STK, Heroix Robomon

- Initiated QUEST
What is QUEST?

- QUEST (Qualification and Utilization of Electronic System Technology) for Space Exploration initiative
- A civil servant lab environment where new technologies for command, control and planning can be tested and integrated prior to migration into the operational environment
- Develops Core Competencies in the civil servant work force for developing future architectures and evaluating CSOC proposed architectures (IOA)
What is **QUEST**?

- Allows for revolutionary advances in Space Exploration operations instead of evolutionary advance
  - Back to NASA’s Core Mission
- Global Systems Engineering instead of local Systems Engineering
  - Not Business as Usual
  - Can not live in an isolated world of “not invented here”
  - Must explore policies to bridge the gap between research and operations
Challenge

- NASA
  - Inter. and Intra. Agency development of partnerships and collaboration

- Universities
  - Develop new technologies and systems engineering skills in support of future space operations

- Industry
  - Assist/Lead in the development of new technologies and standards in partnership with NASA

- Other Agencies
  - Develop partnerships and collaboration with NASA on Lessons Learned and common goals
Attachments

Technologies to support the QUEST for Space Exploration
Strategic Baseline 2005
Control Center Constellation

Programs Supported: Shuttle, station, lunar return startup, increasing shuttle rate

Technologies Needed:
- Information vs. Data sharing
- Enhanced network prioritization and routing of data vs. information vs. command
- Increased Bandwidth communication
- Distributed, yet integrated information storing
- Enhanced connectivity and switching between Control Centers and vehicles
- Alternative security methods to allow constellation, while ensuring integrity of constellation
- Enhanced communication standards to allow vehicle to act like a node on the Control Center Constellation
- Data priority scheme to ensure RT execution data requirements are met

Strategic Baseline 2010
Planetary Constellation

Increased autonomy of Planetary Based Operations
Programs Supported: shuttle, station, lunar return, Mars

Technologies Needed:
- Nanotechnology for computer systems
- Increased Stellar Bandwidth communication
- Distributed, yet integrated information storing
- Enhanced stellar connectivity and switching
- Alternative security methods to allow planetary constellation, while ensuring integrity of planetary constellation
- Enhanced communication standards to allow vehicle to act like a node on the Control Center Constellation
- Lightweight and portable telepresence equipment
- Conversational voice recognition by computer systems
- Power generation and storage
- Organic hardware systems
- Regenerative components (logical first-step: “breedable” memory)

Strategic Baseline 2015
Interstellar Constellation

Increased autonomy of Vehicle Based Operations
Programs Supported: shuttle, station, lunar (multi-vehicle), Mars (multi-vehicle), Interstellar

Technologies Needed:
- Quantum technology for computer systems
- Quantum pair technology for communication
- Bioelectonics
- Increased interstellar Bandwidth communication
- Enhanced interstellar connectivity and switching
- Lightweight and portable telepresence equipment
- Alternative energy sources and types