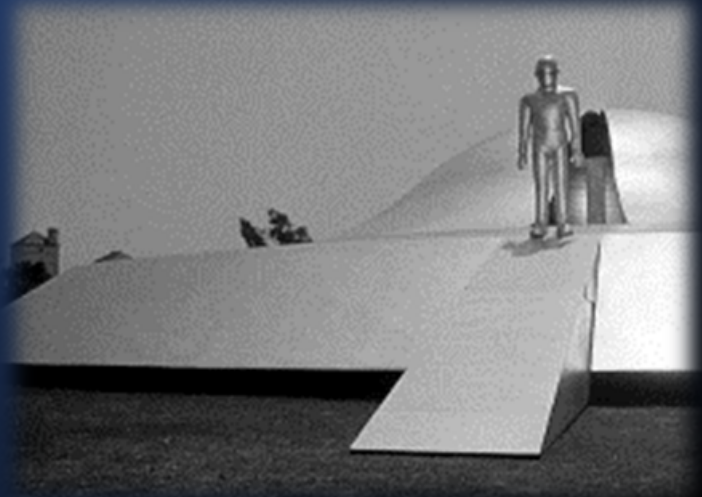
The background of the slide is a composite image of space. In the top left, a satellite orbits against a dark blue sky. In the top right, a large, bright yellow-orange planet (likely Mars) is visible, with two spacecraft streaking across the sky. In the bottom left, the Earth is shown with green continents and blue oceans, with several rockets launching from the surface. In the bottom right, the Moon is visible, with a satellite orbiting it. The central text is white and stands out against the dark background.

Challenges of Implementing Speech Control in a Spacecraft System

Only in the Movies!!



The background of the slide is a dark space-themed image. It features a view of Earth from space in the bottom left corner, showing the Americas. In the top right, there's a view of the Moon with a spacecraft on its surface. Several streaks of light, representing spacecraft trajectories, are visible in the upper right. A small satellite is in the top left.

Outline

- **Background**
 - **NASA mission roadmap**
 - **Mission control changing role for deep space missions**
- **Evolution of spacecraft control**
- **NASA Speech Recognition Investigations**
- **Challenges**
- **Development approach**
- **Recap & Final Remarks**



Outline

- **Background**

- **NASA mission roadmap**

- Mission control changing role for deep space missions

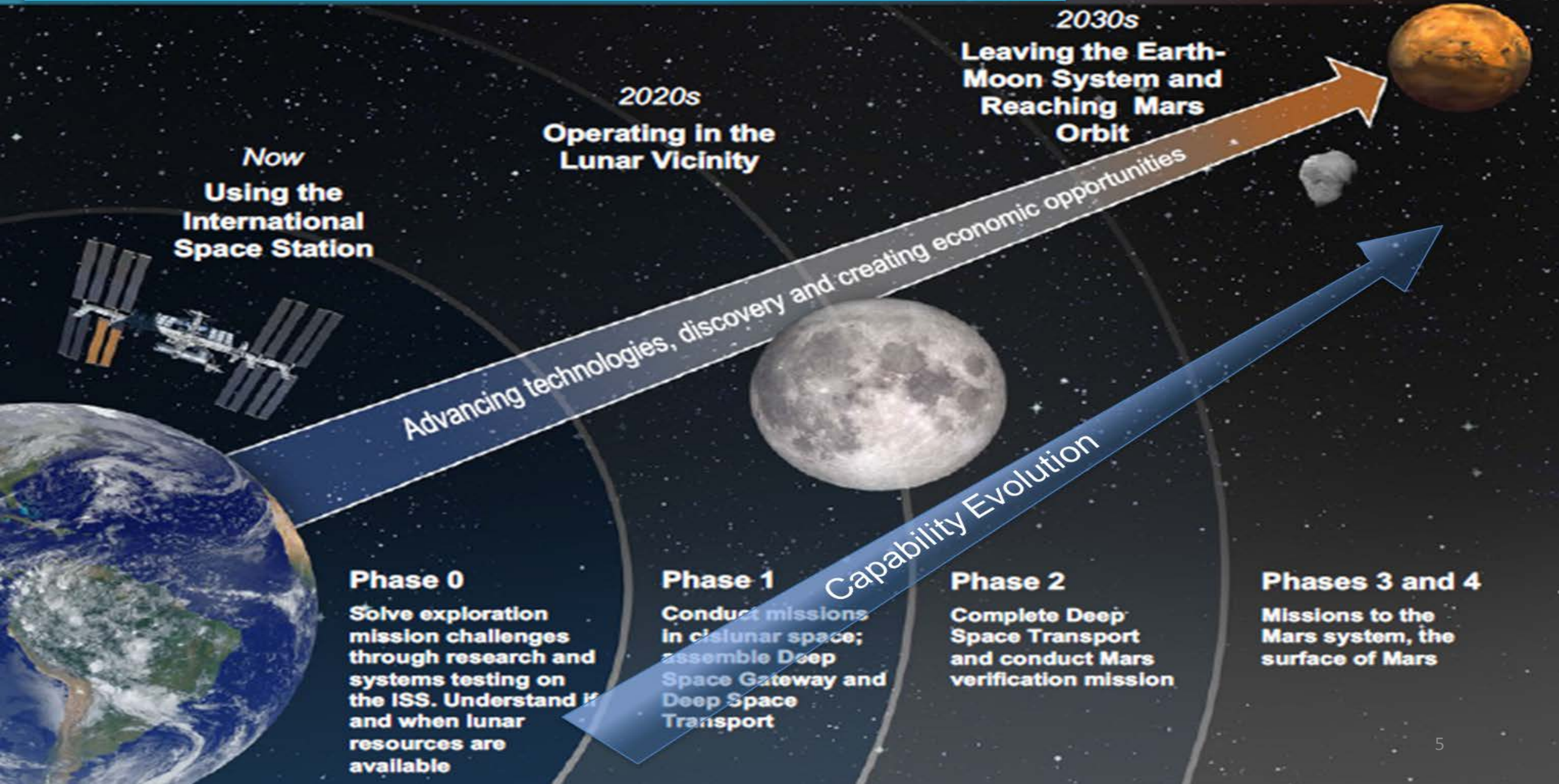
- Evolution of spacecraft control

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New Thinking--Four-Phased Approach to Mars





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Deep Space Mission Operations

Crew/Mission Control-Dependent

Crew/Vehicle-Dependent

Current

Future-Notional

On-board Mission Control



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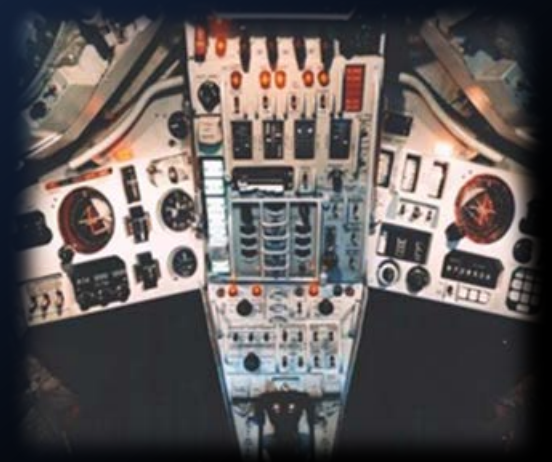


Brief History of Spacecraft Command and Control

Evolution of Spacecraft Command and Control Complexity



MERCURY



Gemini



Apollo-Command Module



Apollo-Lunar Module



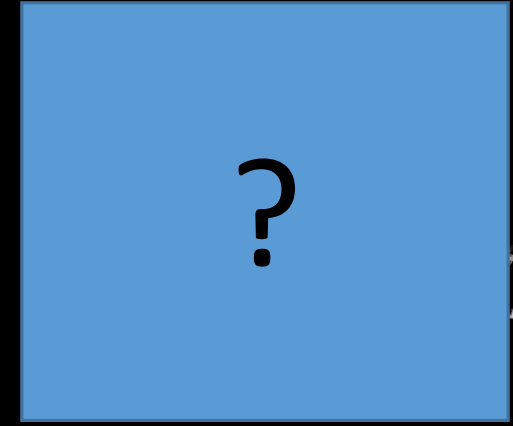
Space Shuttle



Space Station



Orion



Future Space Systems Controls



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NASA Speech Recognition Investigations - Ground

- Voice Control of Shuttle CCTV System
- EVA Retriever
- EVA Suit Control
- Advanced front end processing
- Deep Space habitat
- Aeronautics



NASA Speech Recognition Investigations- Space Shuttle Flight Demonstration



- **STS-41- Speaker-dependent**

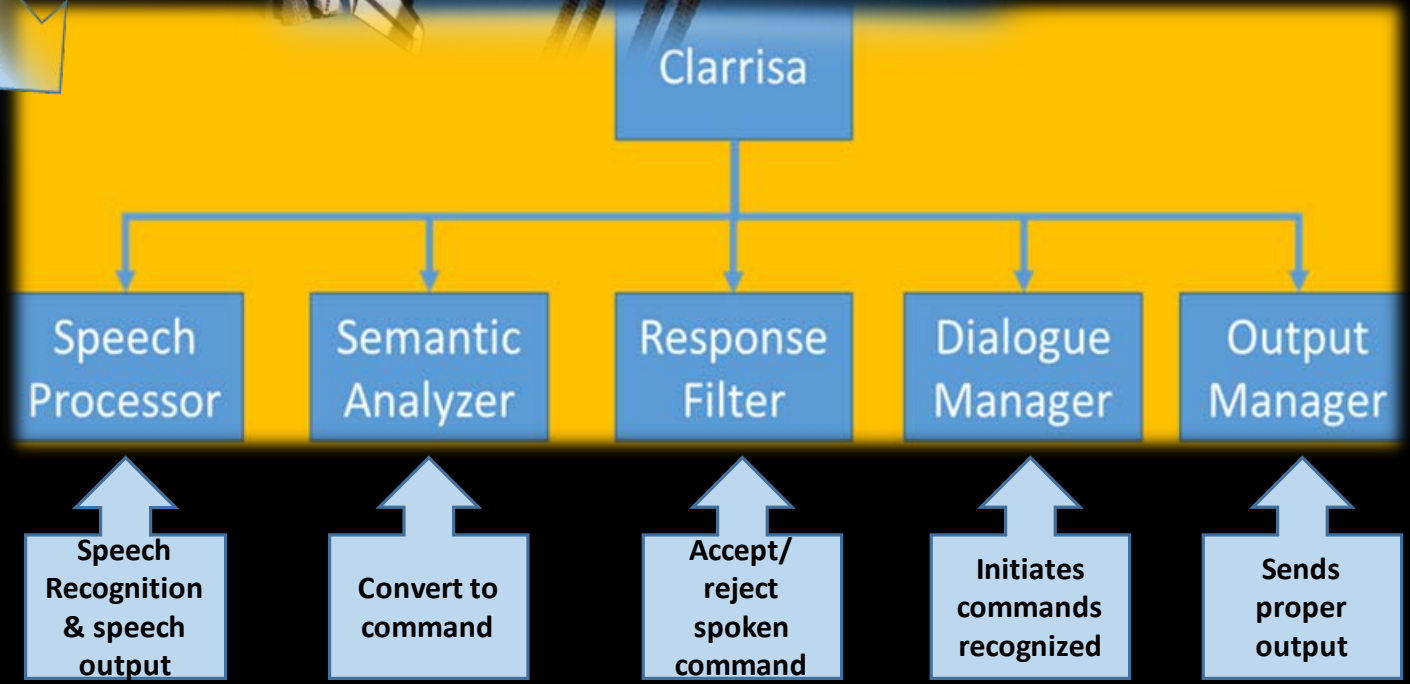
- ❓ Effects of μ -gravity of the voice
- ❓ Commanding by voice
- ❓ 10% to 30% reduction in accuracy
- ❓ On-orbit retrain capability

- **STS-78- Speaker –independent**

- ❓ Same objectives as STS-41
- ❓ Commercial adaptive system
- ❓ Confidence check
- ❓ Macro-commanding



NASA Speech Recognition Investigations- ISS Flight Demonstration

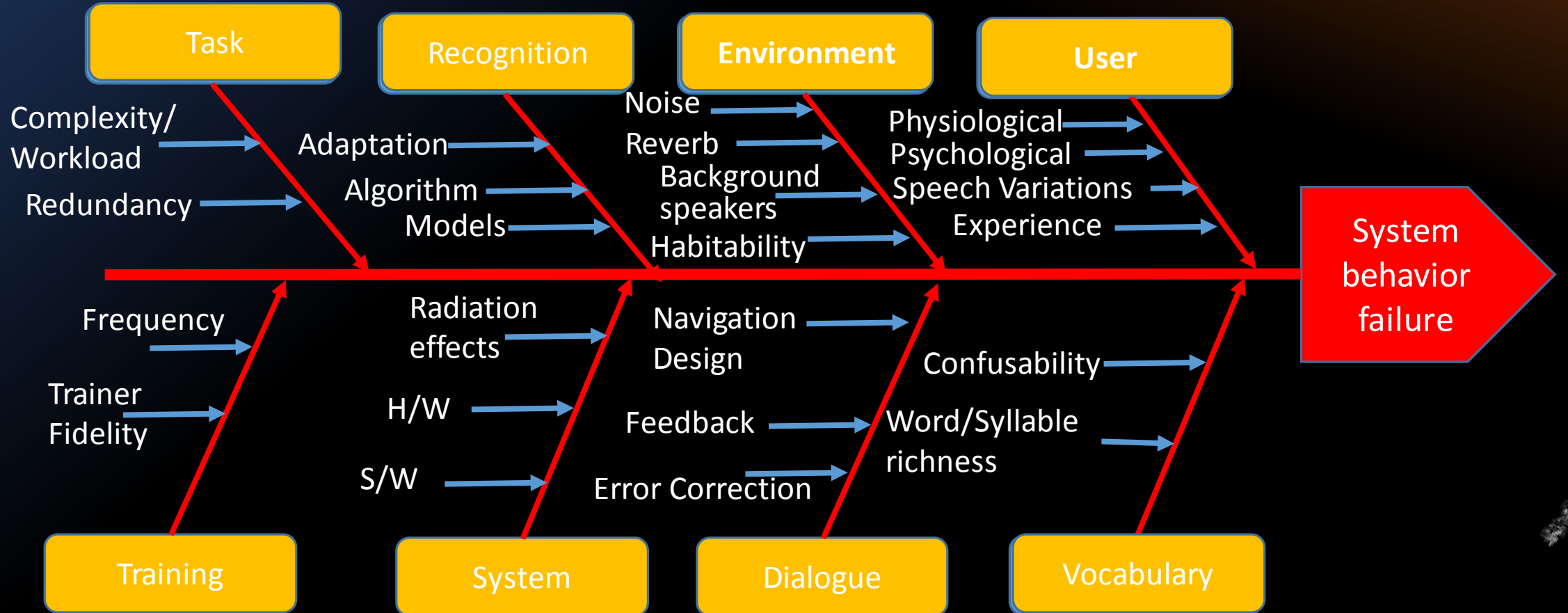




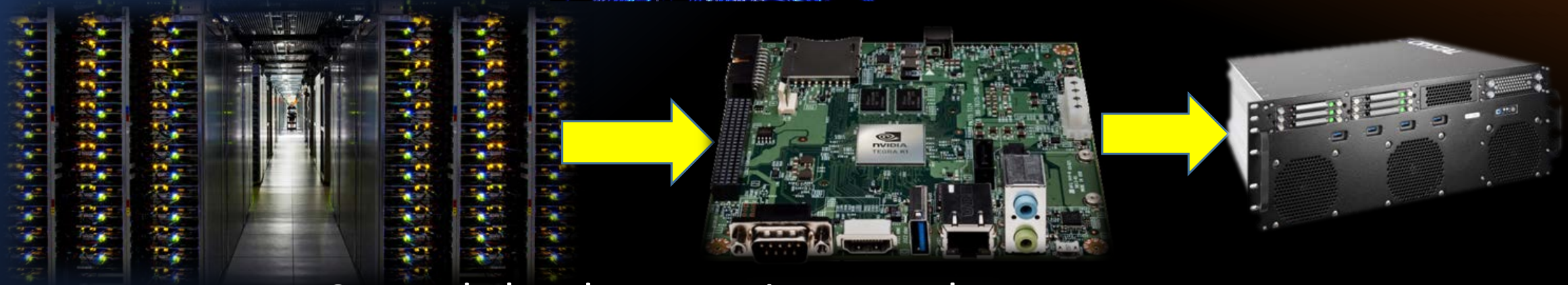
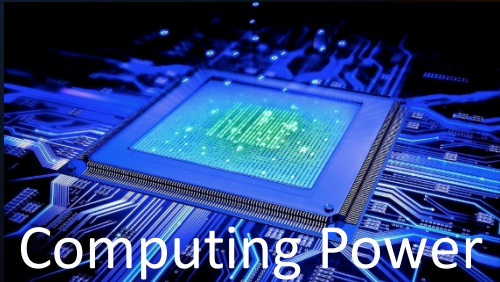
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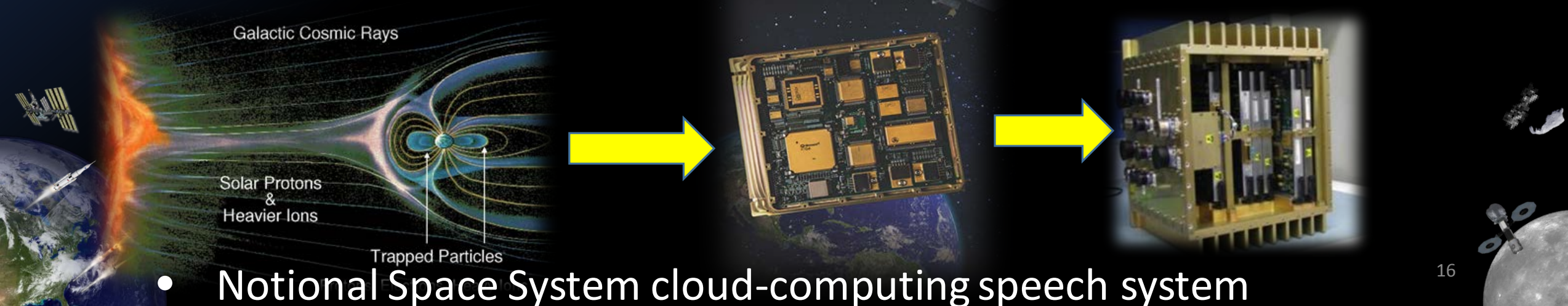
Factors affecting robust speech recognition application in space



Factors affecting robust speech recognition in space- Cont'd



- Ground cloud-computing speech system



- Notional Space System cloud-computing speech system



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- **Development Approach**

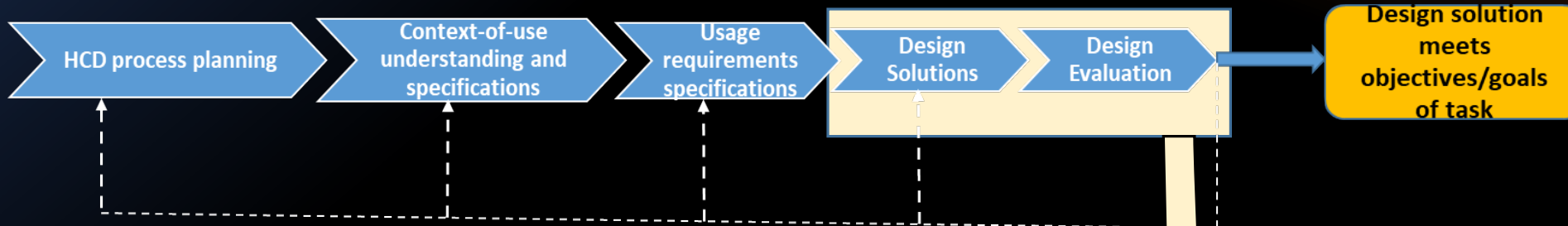
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Development Approach

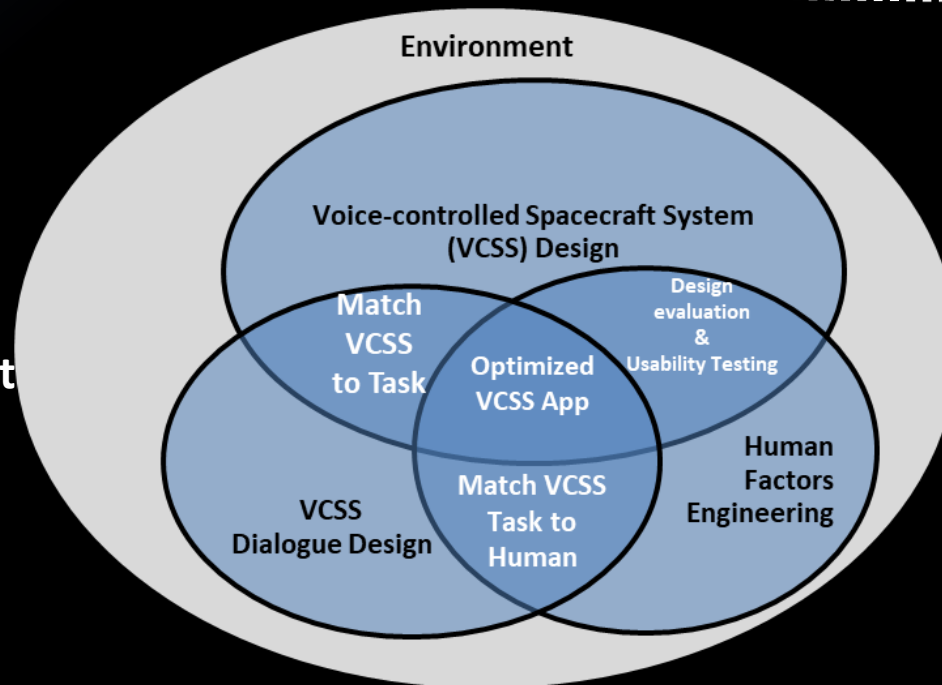
NASA Life-Cycle Phases	Approval for Formulation		Approval for Implementation			
Project Life-Cycle Phases	Pre-Phase A: Concept Studies	Phase A: Concept & Technology Development	Phase B: Preliminary Design & Technology Completion	Phase C: Final Design & Fabrication	Phase D: System Assembly, Integration & Test, Launch & checkout	
Human Spaceflight Project Life-Cycle Reviews		SRR SDR	PDR	CDR	SIR	Legend SRR-System Requirements Review SDR-System Definition Review PDR-Preliminary Design Review CDR-Critical Design Review SIR-System Integration Review

NASA Project Life-cycle Phases

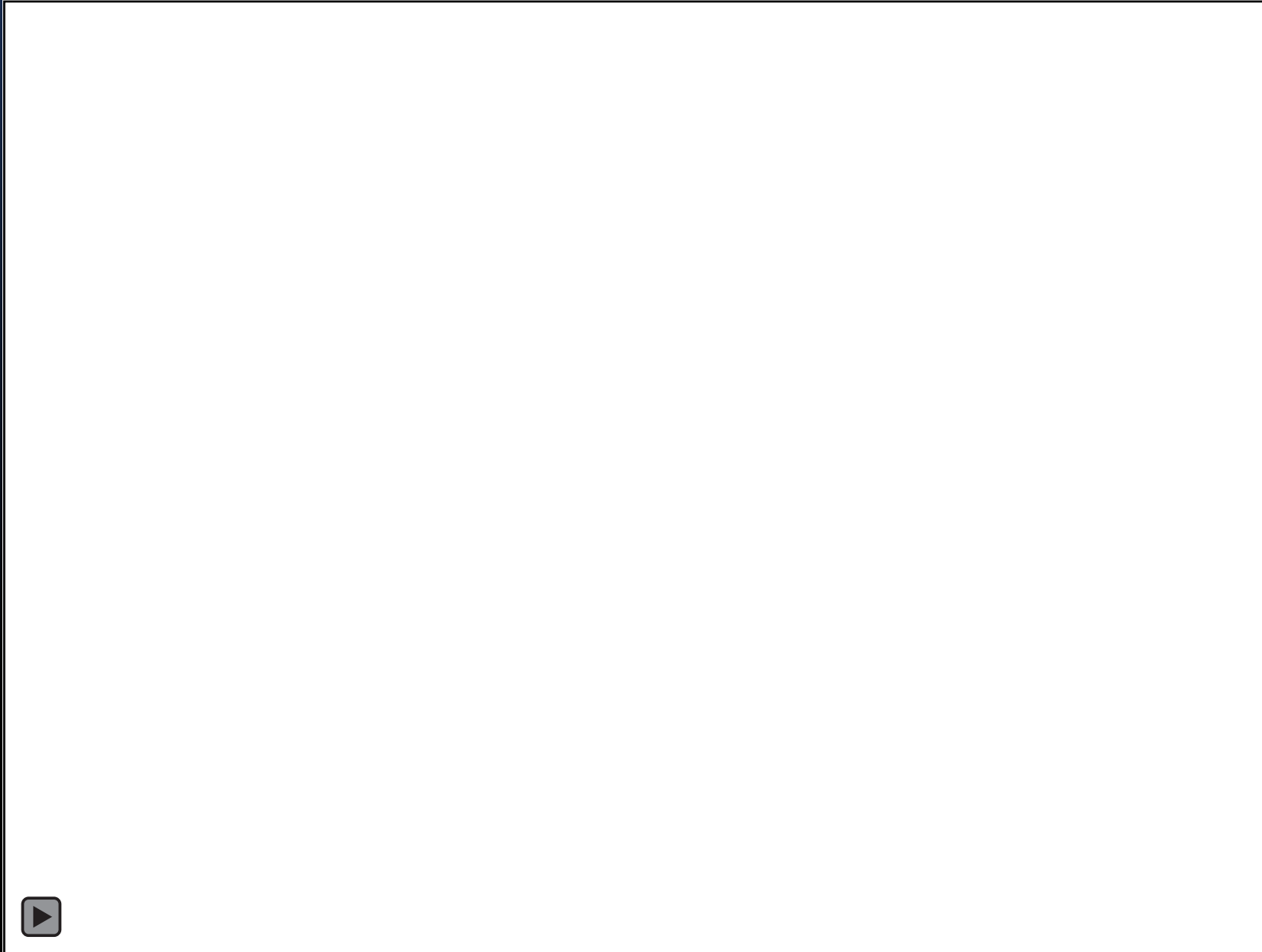
Human-Centered Design (HCD) Process



Key Development Activities



Will speech control ever be this good?



The background of the slide is a dark space scene. In the top left, a small satellite orbits against a blue sky. In the top right, a large, bright yellow-orange sphere, likely the Sun or a planet, is partially visible. In the bottom left, a view of Earth from space shows the Americas. In the bottom right, a satellite orbits the Moon. Several streaks of light, representing rockets or spacecraft, are visible in the upper right quadrant.

Recap & Final Remarks

- Deep space mission system complexity will need better system HCI
- Speech recognition for command and control is a viable option for future missions-extra help to a small crew on a complex spacecraft/habitat,
- Importance of **trust** in the system-Reliable, robust, and understandable



Questions?