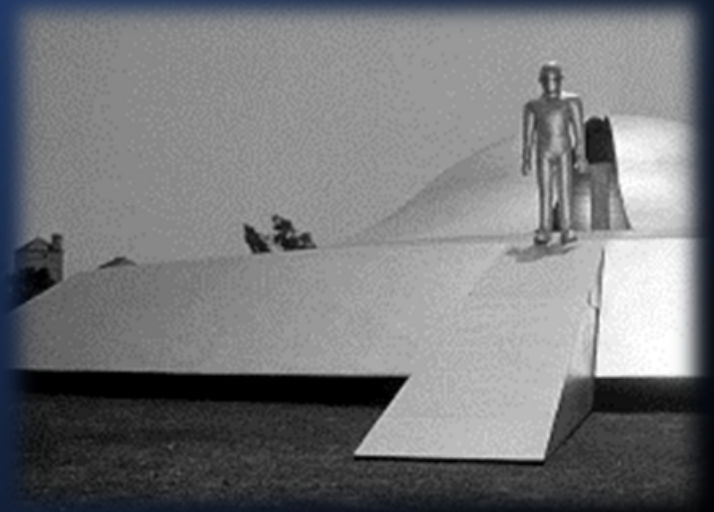
Challenges of Implementing Speech Control in a Spacecraft System

Only in the Movies!!



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**

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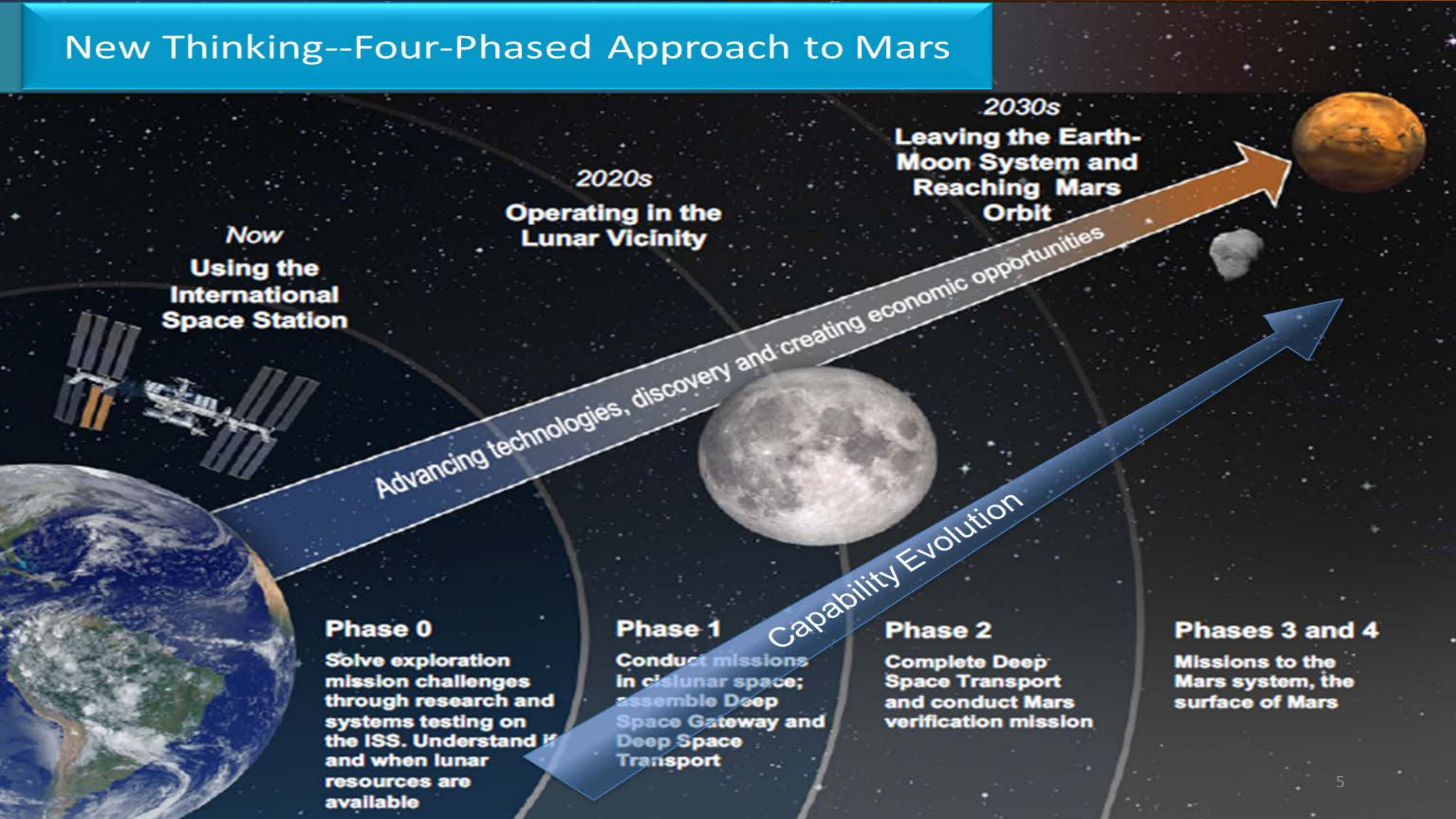
New Thinking--Four-Phased Approach to Mars



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Deep Space Mission Operations

Crew/Mission Control-Dependent

Crew/Vehicle-Dependent

On-board Mission Control

Current

Future-Notional

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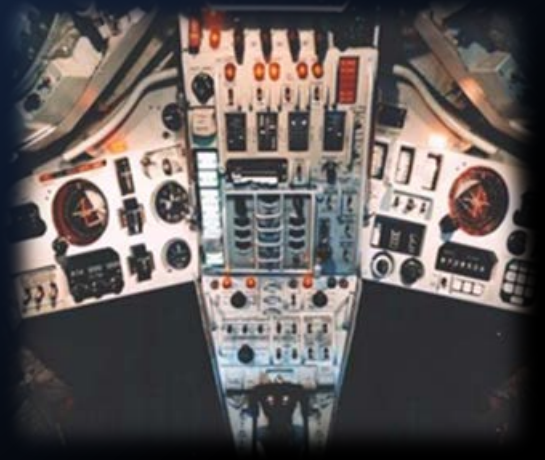
Brief History of Spacecraft Command and Control

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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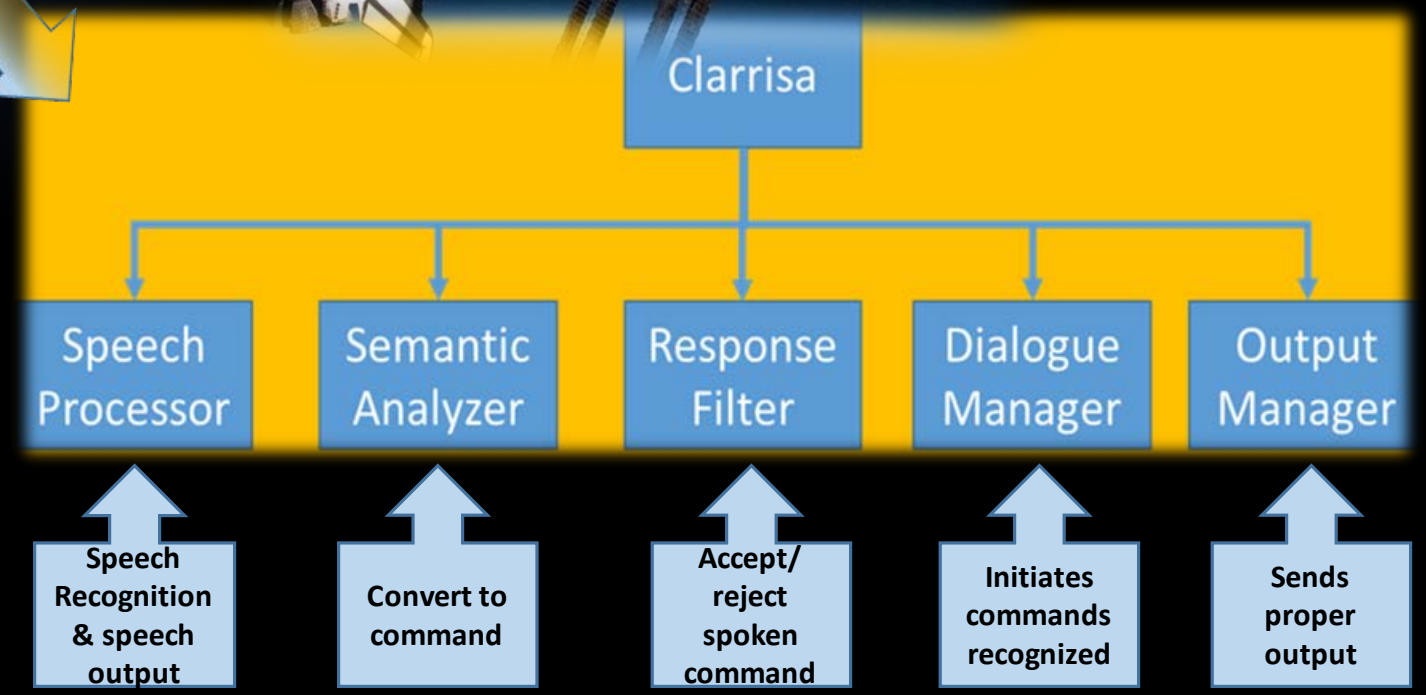
NASA Speech Recognition Investigations- Ground

- 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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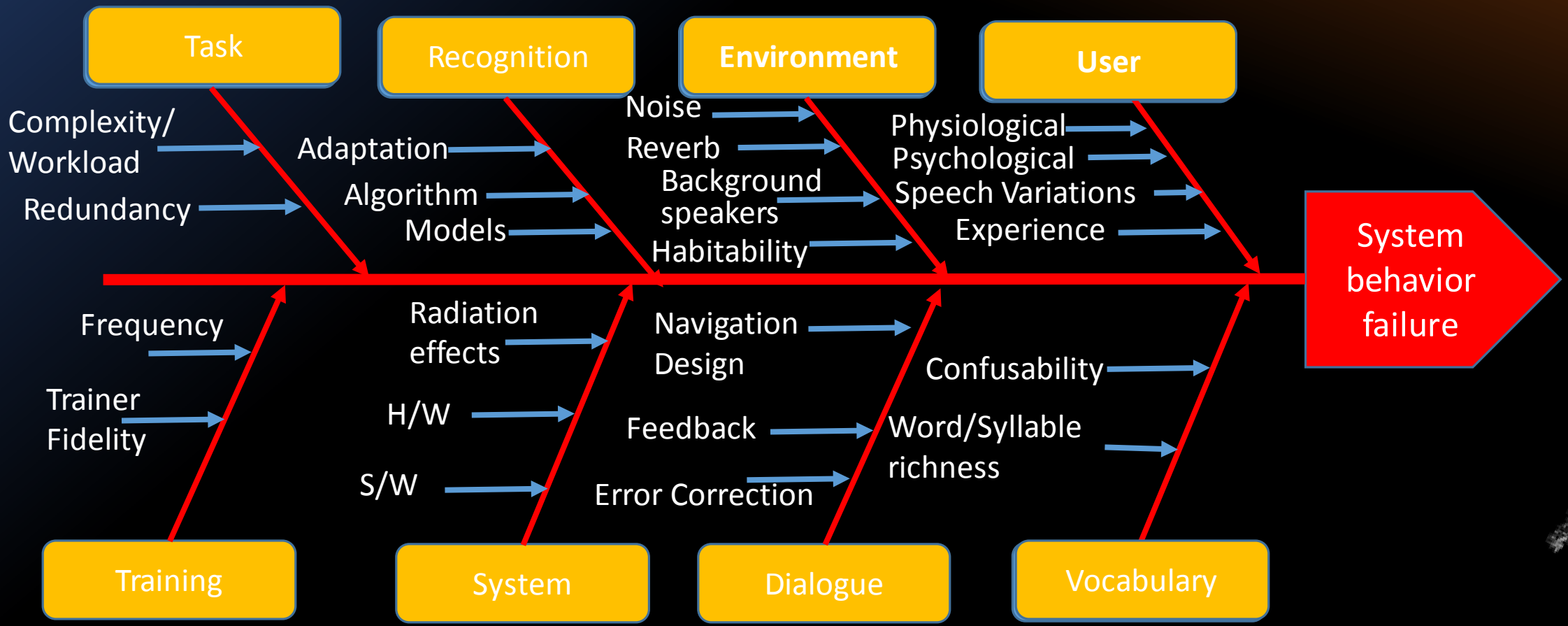
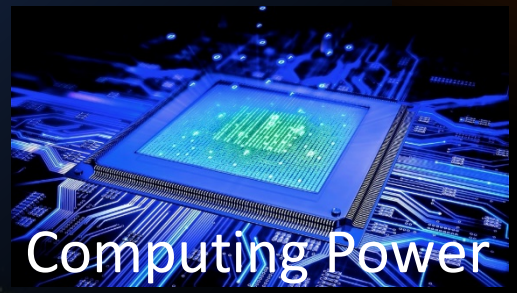
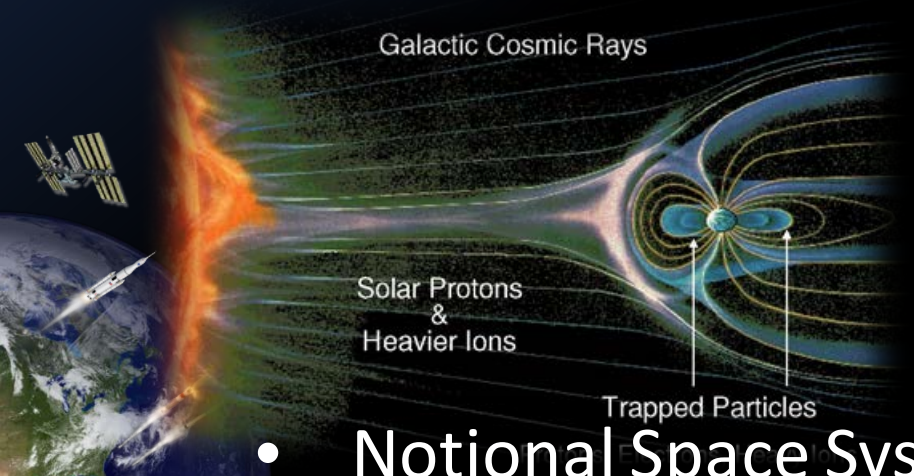
Factors affecting robust speech recognition application in space



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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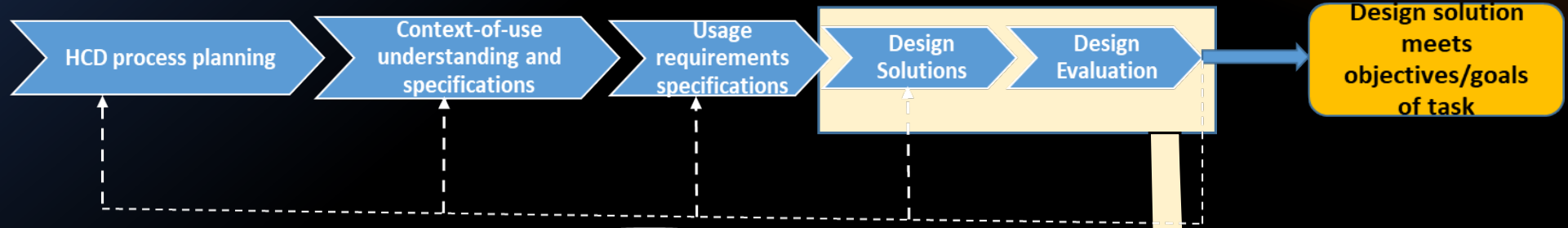
Development Approach

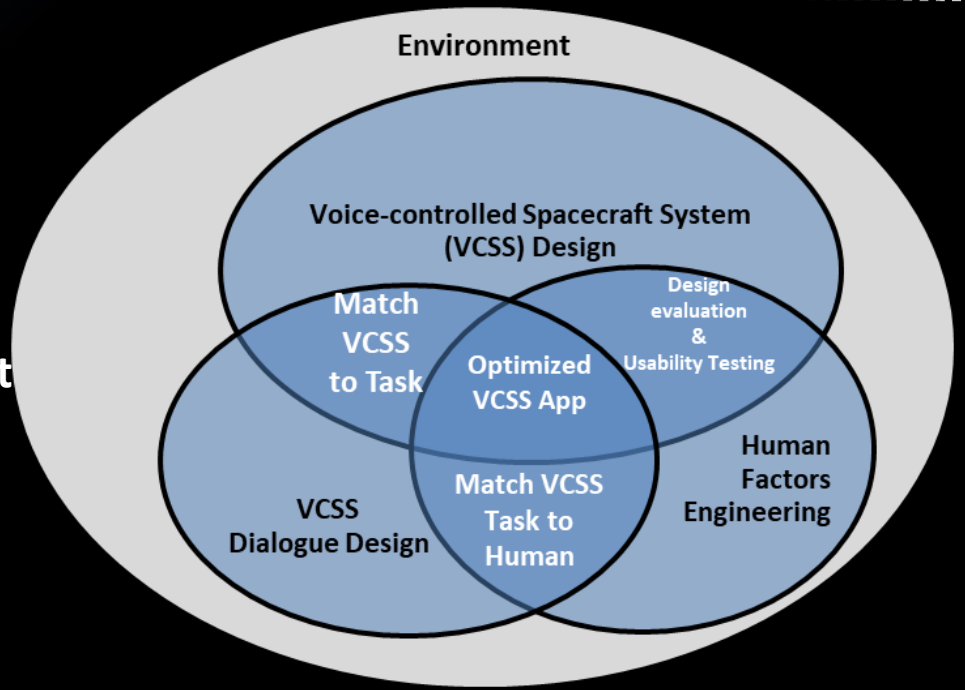
NASA Project Life-cycle Phases

NASA Life-Cycle Phases	Formulation (Approval for Formulation)		Implementation (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

Human-Centered Design (HCD) Process



Key Development Activities



Will speech control ever be this good?

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?