Mission Architecture

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Definitions

- "Mission architecture includes the structure of the mission, its functions, the environment in which it will exist, and the process by which it will be built and operated"
- From E. Rechtin, Systems Architecting, publ. Prentice Hall PTR, 1991

- Architecture: The concepts and rules that define the structure, semantic behavior, and relationships among the parts of a system, a plan of something to be constructed. It includes the elements (entities) that comprise the thing, the relationships among the elements, the constraints that affect those relationships, a focus on the parts of the thing, and a focus on the thing as a whole. From Shaw, et al
- Purpose: to translate user requirements into something that can be built

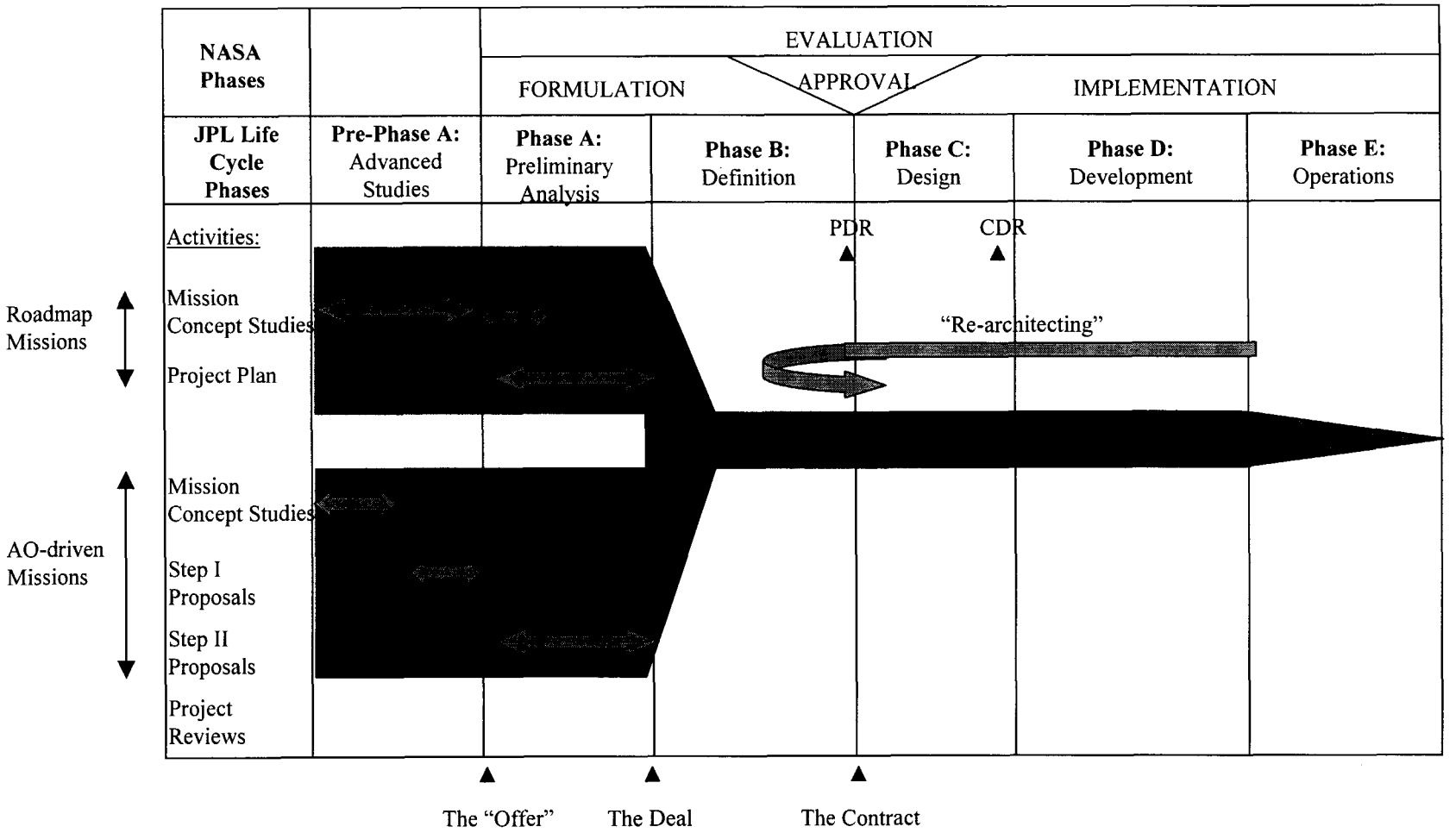
Distinction

Mission Architect	System Engineer	Project SE
Creates	Designs	Coordinates
High-level	Detailed	Requirements and I/F's
Structure	System	Across Systems

- **The work of a mission or systems architect can be understood as a series of questions asked of the client, the objective being to flush out the "Don't Knows"**
- **The product of this effort is a series of different "Views" of the architecture, the objective being to illuminate it for the client**

The JPL Project Life Cycle: Project Architecture

Scope - where does Project Architecture fit in the Project Life Cycle?



There is a role for the Mission Architect, ***"Transform architecture into implementation"*** *that spans the entire Lifecycle, through at least Phase D. It may have a different level of effort and focus in each Phase.*

Mission Type Profiles

Mission Characteristics

Mission Type	AO	Assigned	Technology
Science	PI-led	Competed Science team	Limited Science
Level 1 Requirements	Established in Pre-Phase A	Established in Phase A/B	Established in Phase A/B/C
Heritage*	Medium to High	Medium	Low
Technical Maturity	Medium to High	Medium	Low to Medium
Cost Uncertainty	Low	Medium	Medium to High (capped)

*Heritage can be from a previous flight system architecture, actual hardware/software, or driven by technology assessment and validation

When do you need a new Mission Architecture?

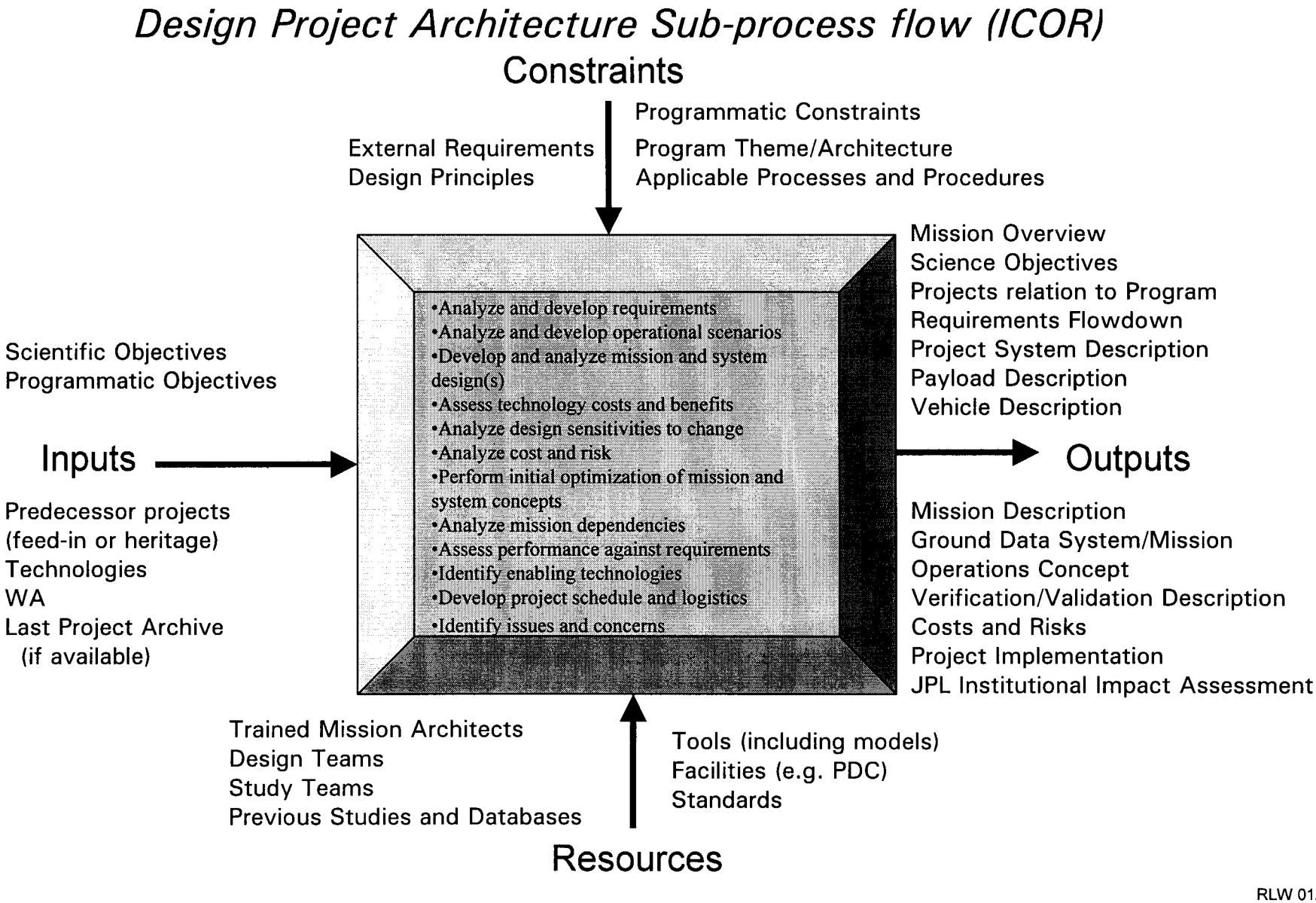
1. During pre-Phase A, and especially for the transition from Pre-Phase A -> Phase A

2. At any stage in the project life cycle when the major structural elements of your mission have been changed substantially, e.g.

- Program context
- Science Requirements
- Mission Objectives
- Funding
- Payload
- Spacecraft bus
- Launch Vehicle
- Technology Availability (Technology Readiness Levels)
- Trajectory
- End-to-end Data Flow
- Verification & Validation Plan
- Operations Plan
- Partners

3. Architecting continues at some level at all stages in the mission

Design Project Architecture Sub-process flow (ICOR)



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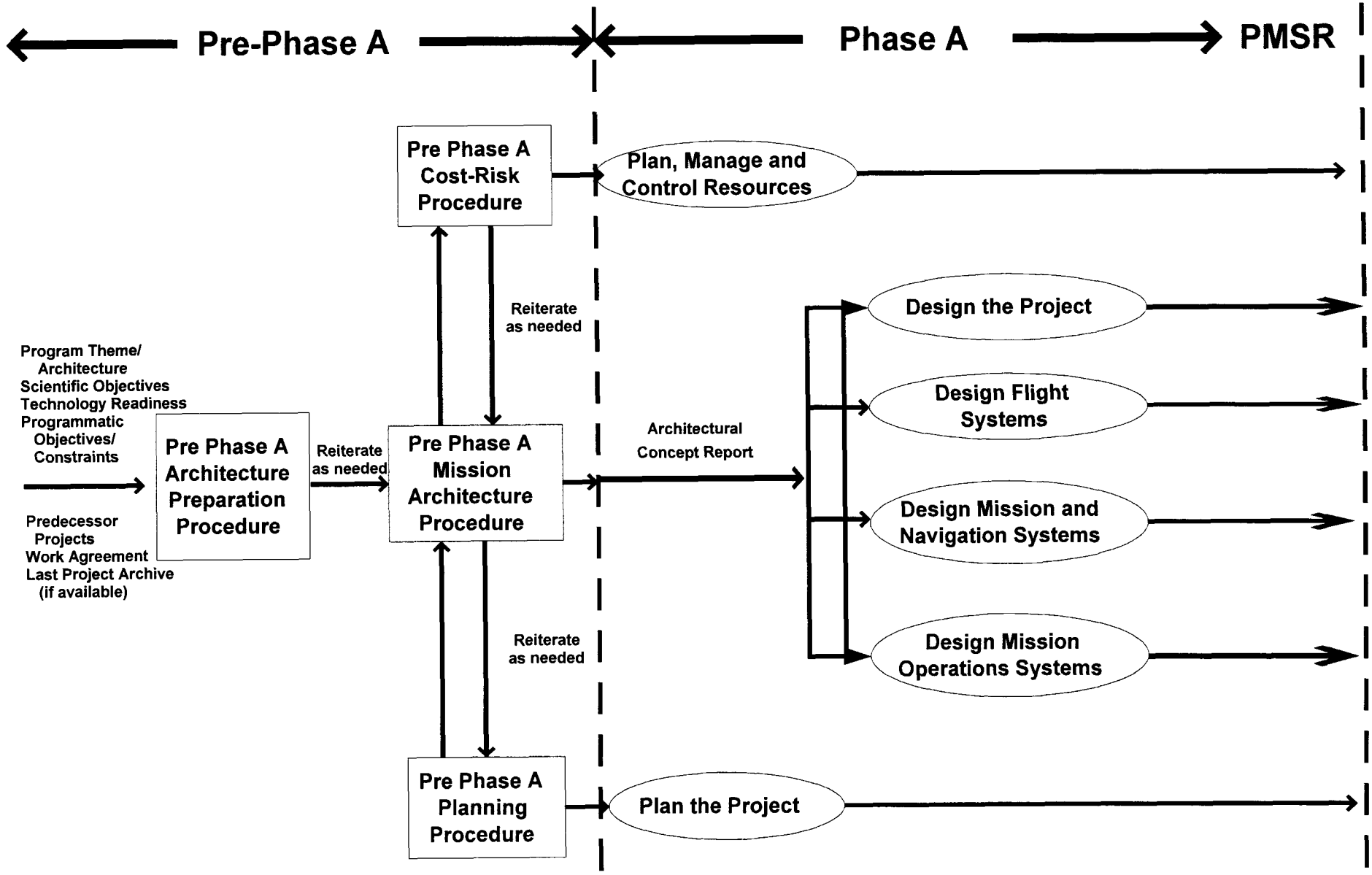
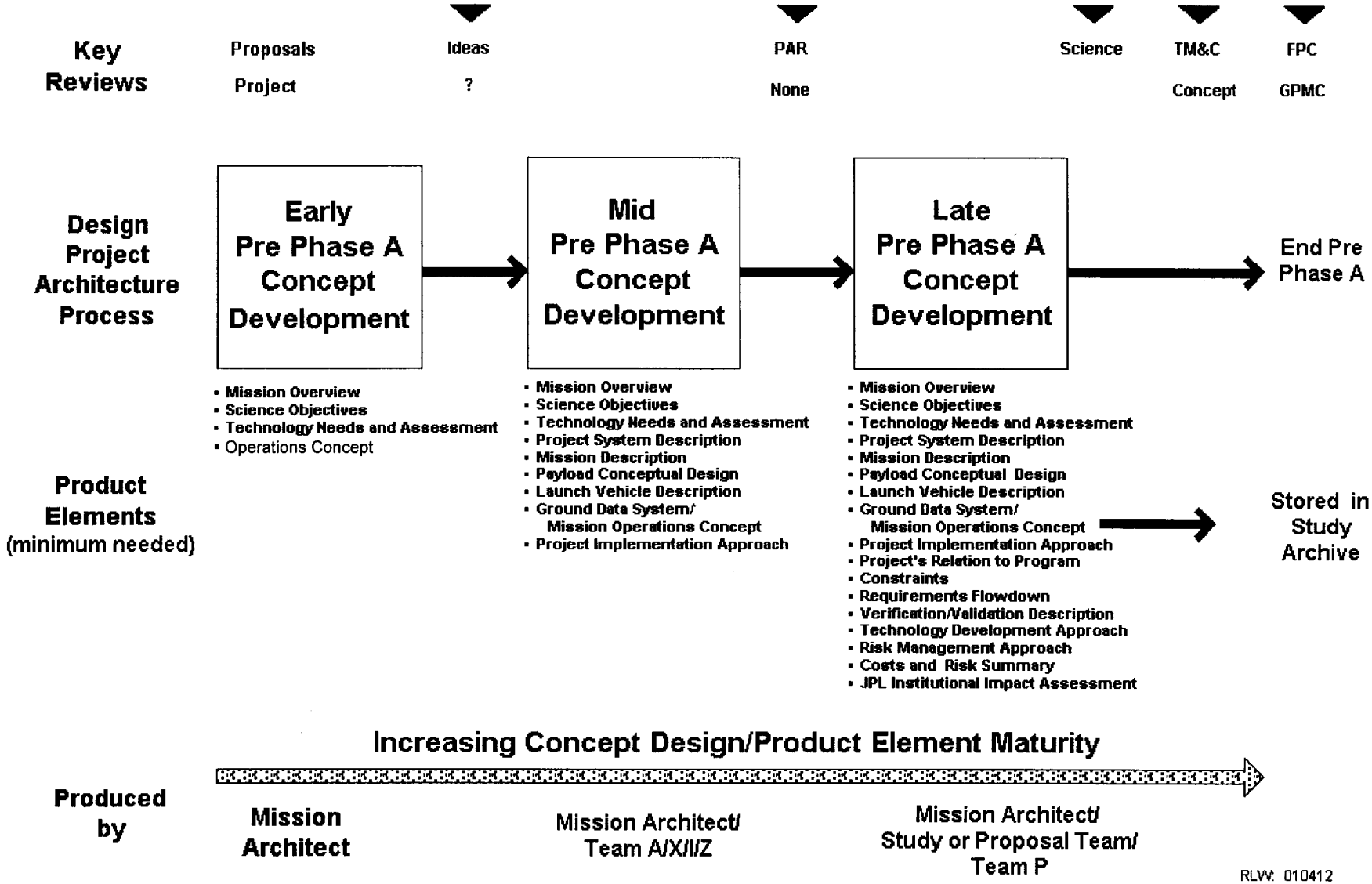
Design Project Architecture

Pre Phase A --> Phase A Interfaces

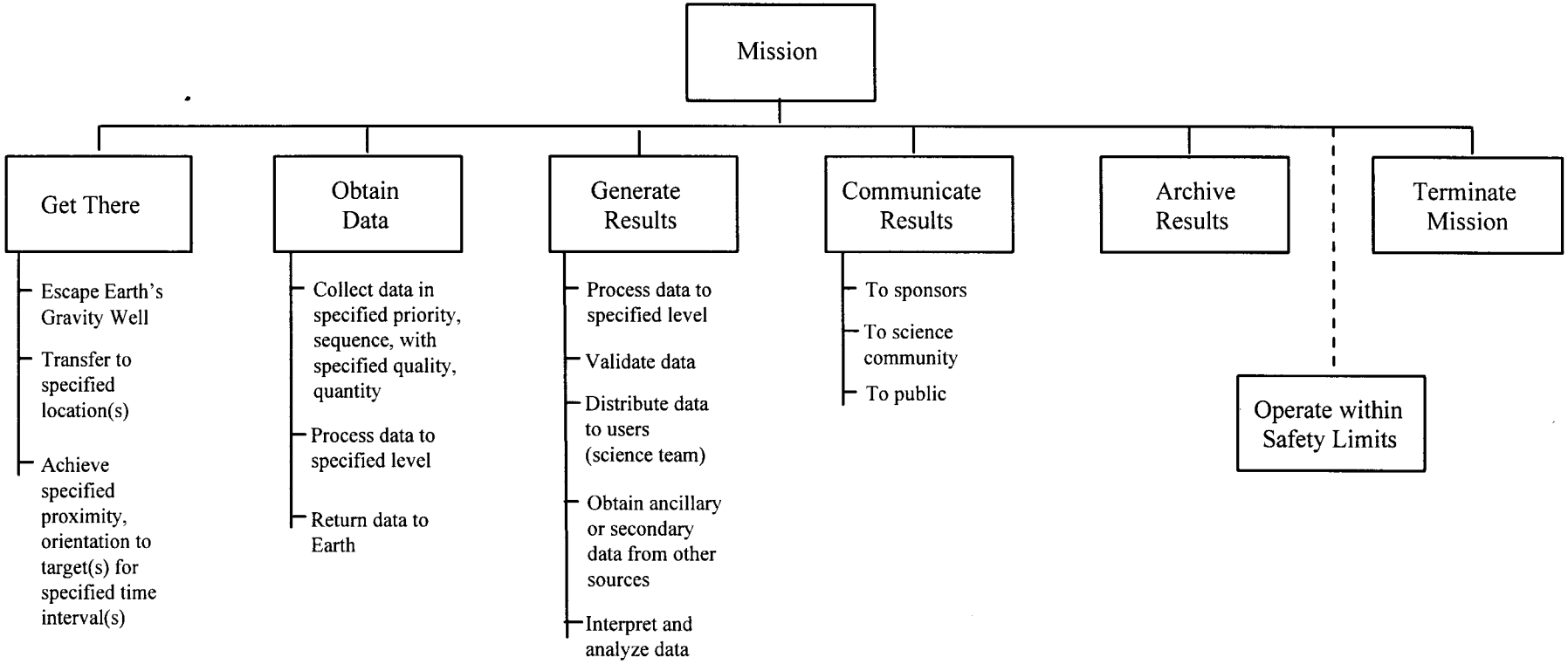


Design Project Architecture Process

Process Overview



Functional Decomposition of a NASA Space Mission Architecture



Applicable to:

Flybys
Orbiters (Earth and Planetary)
In situ missions
Constellations
Heliocentric observers
Sample return missions
Occultation experiments

[At level 1 this decomposition also applies to ground-based or airborne Earth-bound investigations]

Describes what the system is intended to do

Elements of Pre Phase A Mission Architecture

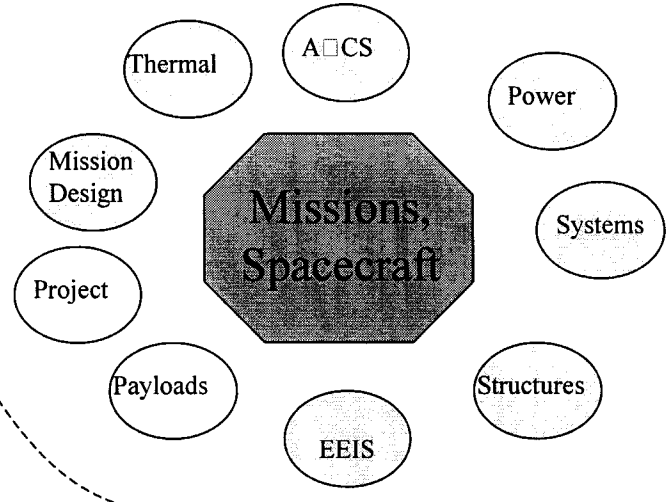
- **Mission Overview**
- **Science Objectives**
- **Quad Chart**
- **Technology Needs and Assessment**
- **Project's Relation to Program**
- **Mission Requirements**
- **Project System Description**
  - Key Drivers (hardware & software)
  - Redundancy
  - Fault Protection Concept (hardware & software)
  - Architecture
  - Software Architecture
  - System Trades
  - Flight System Mass Breakdown (w. margins)
  - Flight System Power Breakdown (w. margins)
  - End-to-End Information System Concept
  - Data Return Budget and Margins
  - Design Principles Exceptions
  - System Margin Summary: mass, power, cost, performance
- **Mission Description**
  - Environmental Conditions
  - Key Drivers
  - Mission Trades
  - Orbit and Trajectory (w. margins)
  - Navigation Concept
  - Launch Vehicle: Packaging, Mass and Margin; Stowed Configuration; Launch Strategy
- **Payload Conceptual Design**
  - Payload Configuration Diagram (s), Stowed and Deployed
  - Block Diagram
  - Heritage (hardware & software)
  - Mass (w. contingency)
  - Power (w. contingency)
  - Size (w. contingency)
  - Data Rates
  - Pointing Characteristics
  - Thermal Characteristics
  - Software Description
  - Technology Maturity Matrix
- **Flight System Descriptions (bus, lander, etc.)**
  - Configuration Diagram (s), Stowed and Deployed
  - Subsystem Concepts & Block Diagrams
  - Heritage (hardware & software)
  - Mass (w. contingency)
  - Power (w. contingency)
  - Size
  - Downlink/Uplink Rates
  - Pointing Capability
  - Thermal Capability
  - Software Description
  - Technology Maturity Matrix
- **Mission Operations Concept**
  - Concept Description
  - Key Drivers
  - Operations Scenario
  - Flight/Ground Interface
  - Overview of Mission-Critical Scenarios
  - Ground Data System
  - DSN Support or Other Ground Stations
  - Software Description
  - Data Archive Concept
  - Technology Maturity Matrix
- **Project implementation Approach**
  - WBS, WBS Dictionary
  - Implementation Approach (who does what)
  - Project Organization Chart
  - JPL Workforce Estimates
  - Project Schedule
  - Planetary Protection Strategy
  - Launch Approval Strategy
  - Outreach & Commercialization Plan
- **Constraints**
- **Requirements Flowdown/Mission Traceability Matrix**
  - Science -> Mission -> System
  - Requirements and Constraints Compliance Matrix (L1 requirements, HQ, programmatic, institutional)
- **Verification/Validation Description**
  - ATLO
  - Environmental Qualification
  - Mission V&V
  - Software
  - Fault Protection
- **Technology Development Approach**
  - –T echnology List
  - –T echnology Readiness Levels (TRL's)
  - –Key Technology Descriptions
  - –T echnology Development Milestones
- **Risk ManagementApproach**
  - Risk Assessment and Mitigation Strategy and Risk Rating
  - Risk List
- **Costs and Risk Summary**
  - Cost-Risk Estimates by Phase and WBS (w. reserves)
  - Schedule Risk (w. reserves and critical path identified)
  - Design-to-Cost-Risk Trades
- **JPL Institutional Impact Assessment**
  - Workforce Needs
  - Facilities
  - DSN Usage
  - Budget
  - –% Prob ability of Proceeding to Implementation

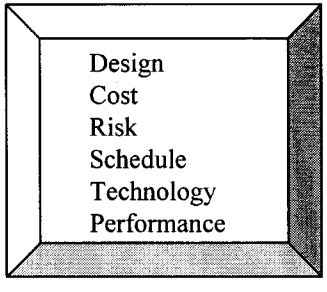
Guidelines:	• Pre-Phase A – Phase A: *1 or more Viewgraphs for each element*

JPL Project Design Teams

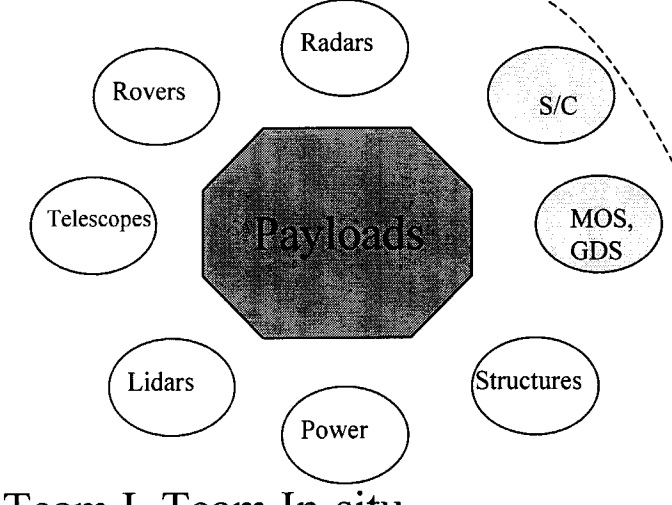
Formulation Phase Support Team, Pre-project Teams

Team X, Team A NPDT

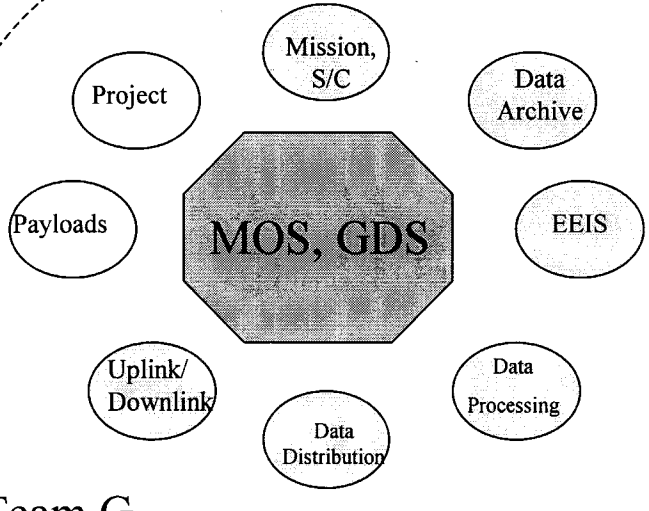




Products



Team I, Team In-situ NPDT



Team G Virtual Mission Ops

Integrated Simulation and Modeling

Project Trades Model for Mars '09 Lander