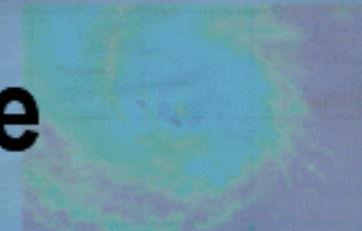# 2004 Ground Systems Architectures Workshop

Raytheon (NPOESS) Perspective on Software Architecture

Breakout Session 10A
Architecture-Centric Evolution and Evaluation (ACE2) of Software-Intensive Systems

30 Mar 04

**Jim Boegman
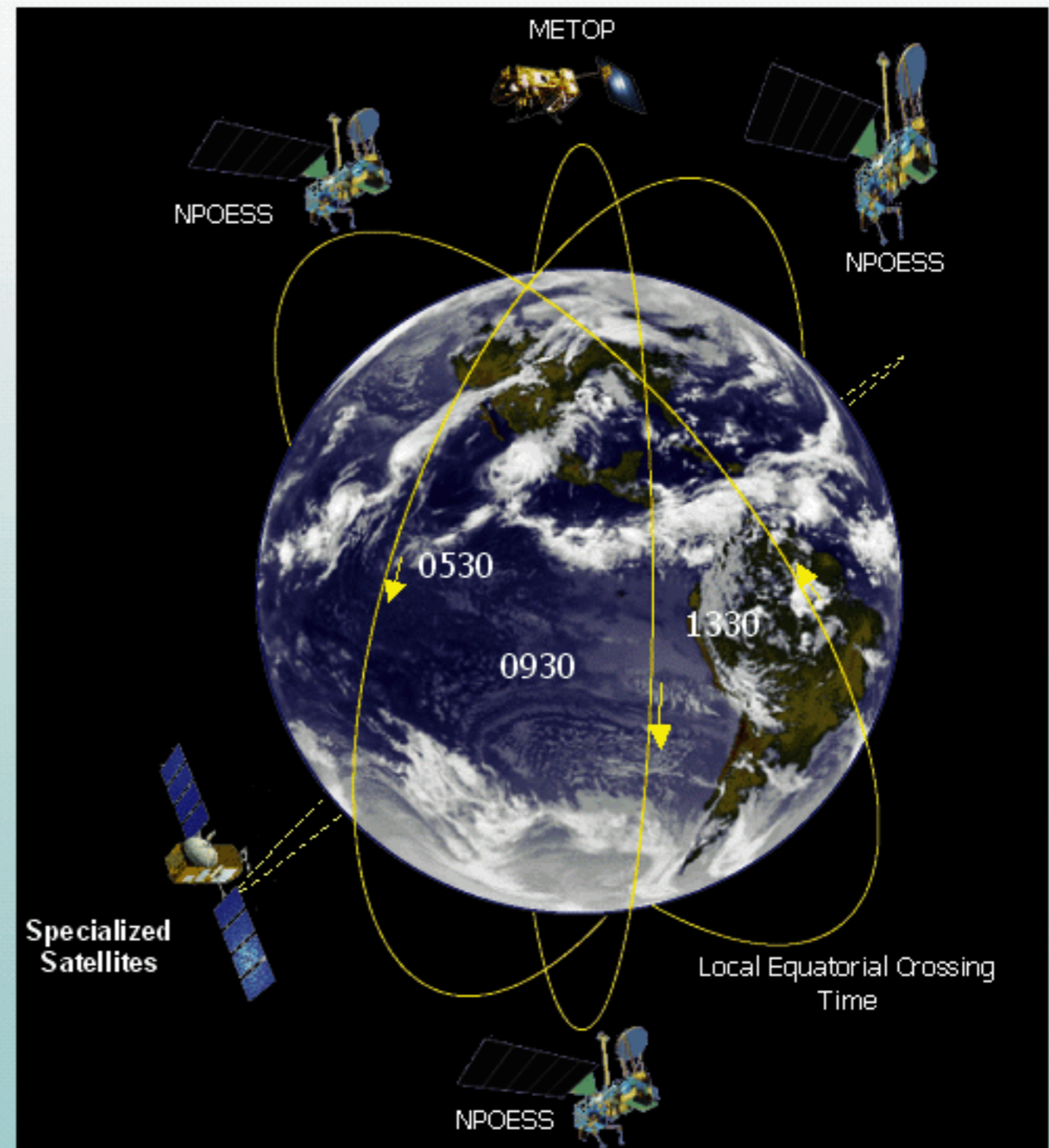SO-CLG SW Technical Lead
NPOESS C3S IPT**

Tri-agency Effort to Leverage and Combine Environmental Satellite Activities
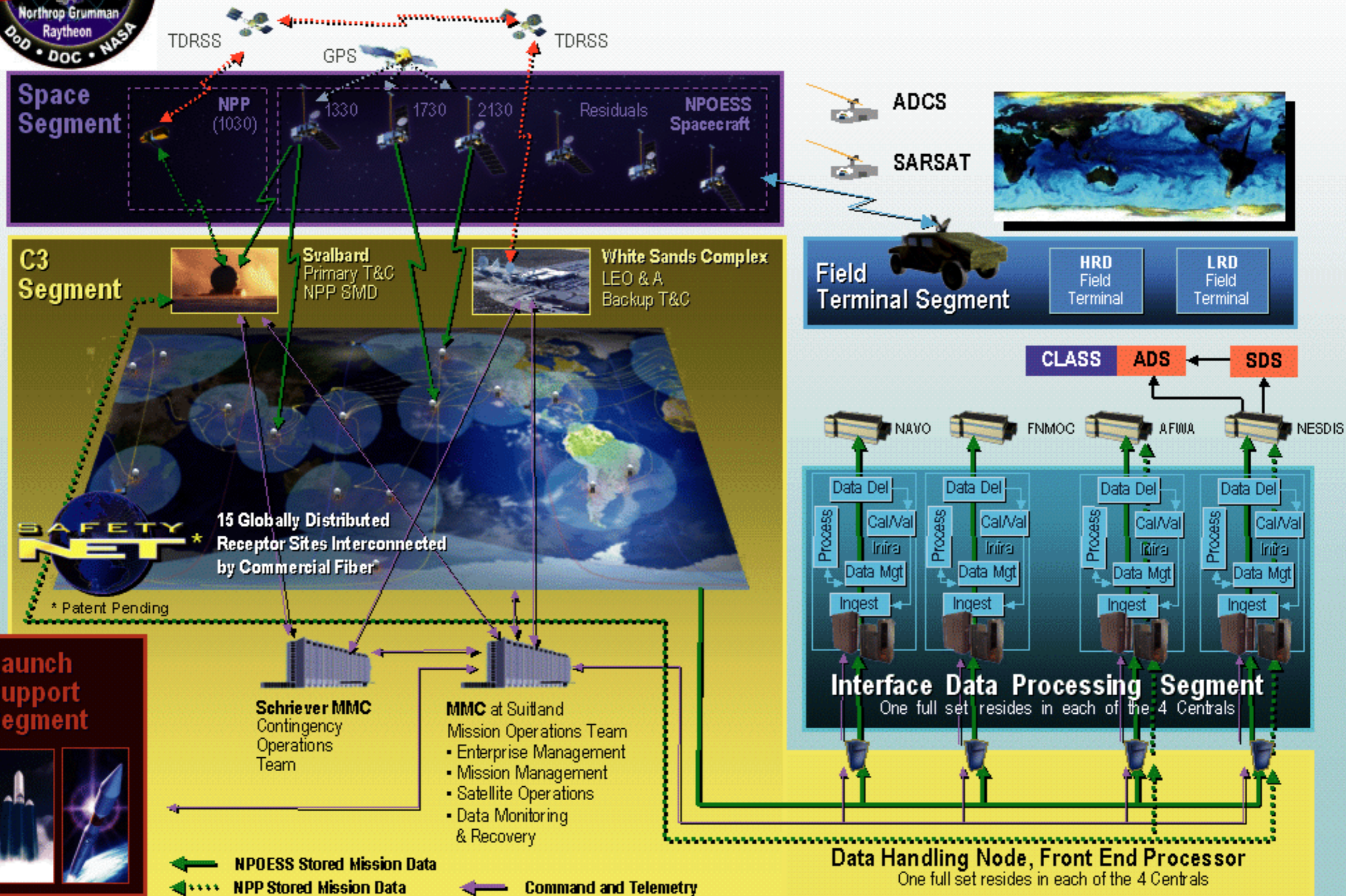
Mission

- Provide a national, operational, polar-orbiting remote-sensing capability

- Achieve National Performance Review (NPR) savings by converging DoD and NOAA satellite programs

- Incorporate new technologies from NASA

- Encourage International Cooperation

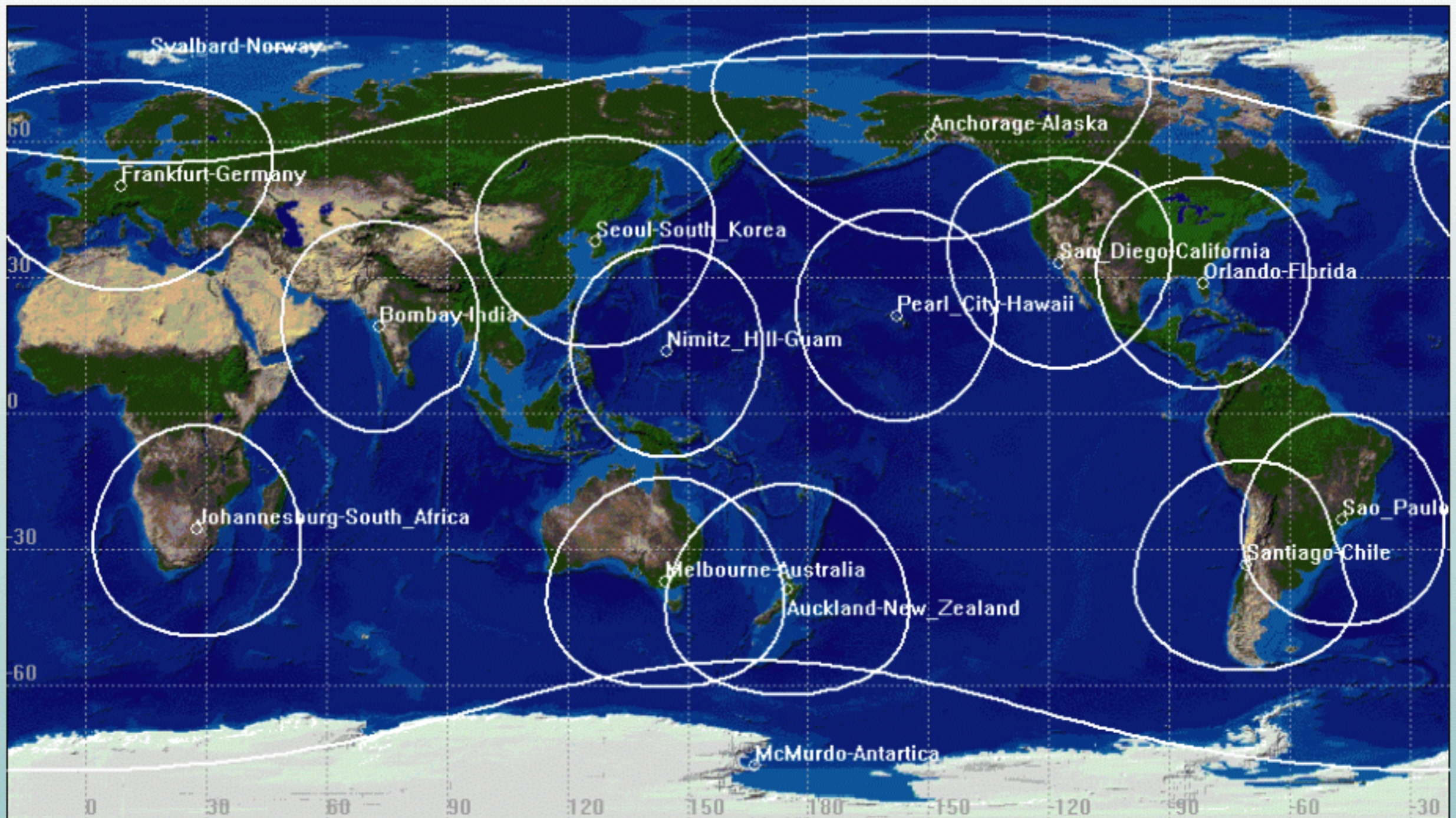**Saves as Much as $1.3 Billion from the Cost of Previously Planned Separate Developments**

NPOESS Architecture
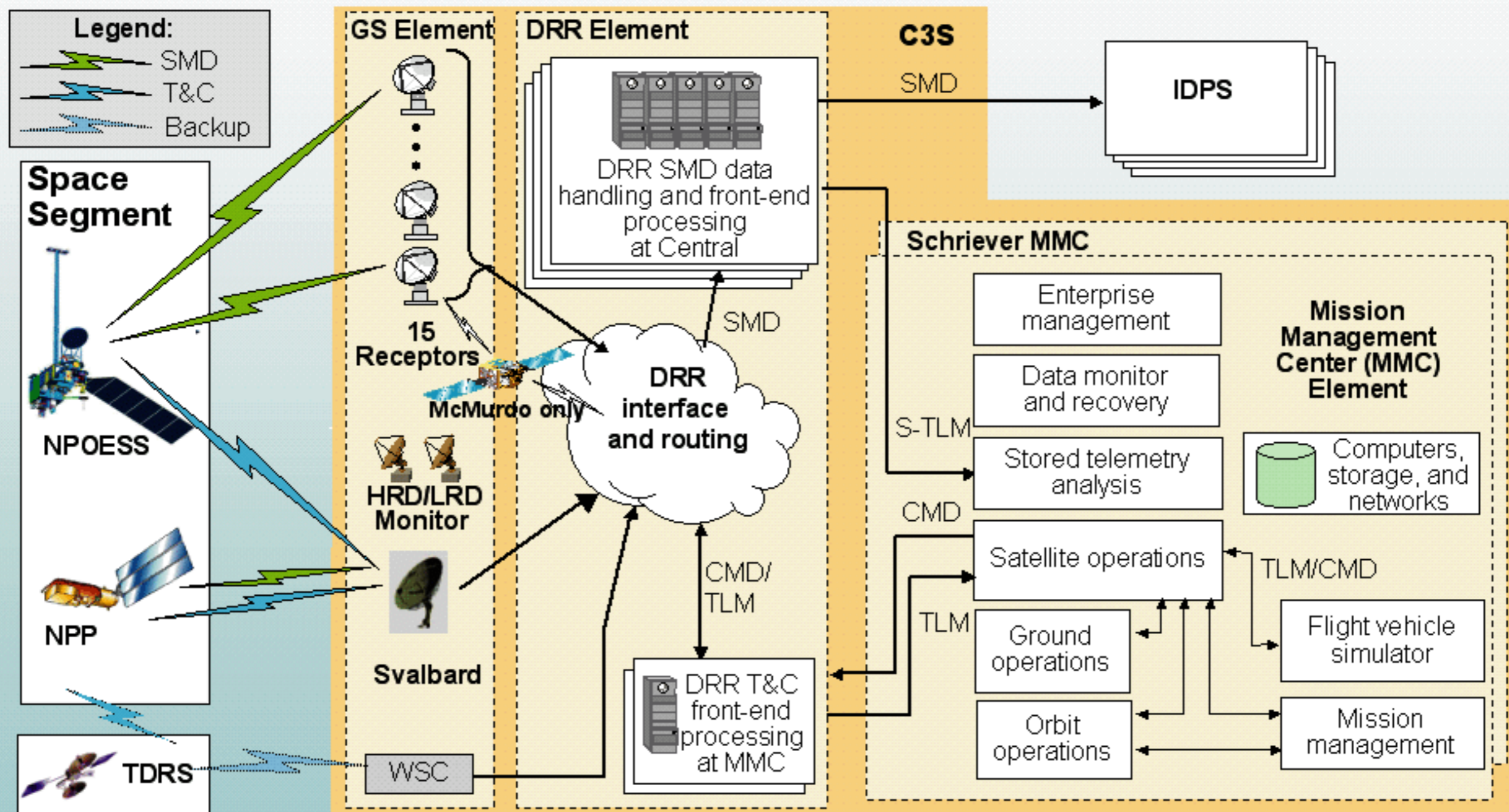

Space Segment
- TDRSS
- GPS
- TDRSS
- NPP (1030)
- 1330
- 1730
- 2130
- Residuals
- NPOESS Spacecraft
- ADCS
- SARSAT

C3 Segment
- Svalbard — Primary T&C, NPP SMD
- White Sands Complex — LEO & A, Backup T&C

SAFETY NET *
15 Globally Distributed Receptor Sites Interconnected by Commercial Fiber

* Patent Pending

Field Terminal Segment
- HRD Field Terminal
- LRD Field Terminal

CLASS | ADS | SDS

Launch Support Segment

Schriever MMC
Contingency Operations Team

MMC at Suitland
Mission Operations Team
- Enterprise Management
- Mission Management
- Satellite Operations
- Data Monitoring & Recovery

NAVO | FNMOC | AFWA | NESDIS

- Data Del
- Process
- Cal/Val
- Infra
- Data Mgt
- Ingest

Interface Data Processing Segment
One full set resides in each of the 4 Centrals

Data Handling Node, Front End Processor
One full set resides in each of the 4 Centrals

Legend:
- ➡ NPOESS Stored Mission Data
- ◀···· NPP Stored Mission Data
- ➡ Command and Telemetry

SafetyNet – The Key to Low Data Latency and High Data Availability

SafetyNet -- 15 globally distributed SMD receptors linked to the centrals via commercial fiber – enables low data latency and high data availability
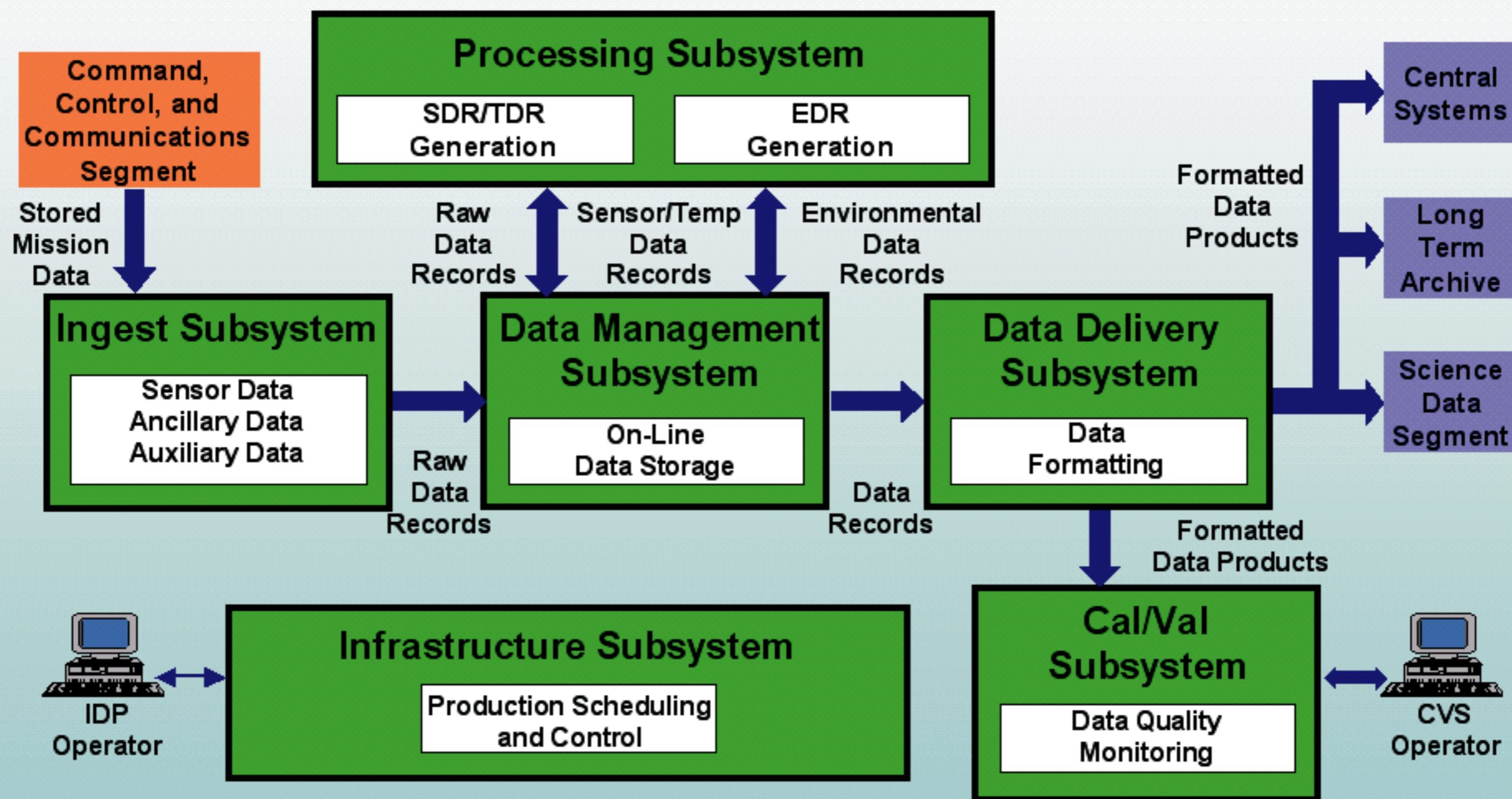
Command, Control, and Communications (C3) Segment Design

Legend:
- SMD
- T&C
- Backup

Space Segment
- NPOESS
- NPP
- TDRS

GS Element
- 15 Receptors
- HRD/LRD Monitor
- Svalbard
- McMurdo only
- WSC

DRR Element
- DRR SMD data handling and front-end processing at Central
- DRR interface and routing
- DRR T&C front-end processing at MMC

C3S
- SMD → IDPS
- SMD
- CMD/TLM

Schriever MMC
- Enterprise management
- Data monitor and recovery
- Stored telemetry analysis
- Satellite operations
- Ground operations
- Orbit operations
- S-TLM
- CMD
- TLM

Mission Management Center (MMC) Element
- Computers, storage, and networks
- Flight vehicle simulator
- Mission management
- TLM/CMD

Low-cost, reliable, and timely data delivery with flexibility to accommodate system growth and technology insertion

Interface Data Processing Segment (IDPS) Functional Diagram

NPOESS — Northrop Grumman Raytheon — DoD • DOC • NASA

Command, Control, and Communications Segment

Stored Mission Data

Processing Subsystem

- SDR/TDR Generation
- EDR Generation

Raw Data Records

Sensor/Temp Data Records

Environmental Data Records

Ingest Subsystem

- Sensor Data
- Ancillary Data
- Auxiliary Data

Raw Data Records

Data Management Subsystem

- On-Line Data Storage

Data Records

Data Delivery Subsystem

- Data Formatting

Formatted Data Products

- Central Systems
- Long Term Archive
- Science Data Segment

Formatted Data Products

Infrastructure Subsystem

- Production Scheduling and Control

IDP Operator

Cal/Val Subsystem

- Data Quality Monitoring

CVS Operator

Architecture Definitions

"The structure or structures of the system, which comprise software elements, the externally visible

properties of those elements, and the relationships among them."

"The funda-mental organization of a system, embodied in its compon-ents, their relationships

to each other and the environment, and the principles governing its design and evolution."

"The set of significant decisions about the organization of a software system, the selection of the structural elements and their interfaces by which the system is composed, together with their behavior as specified in the collaborations among those elements, the

composition of these structural and behavioral elements into progressively larger subsystems, and the architectural style that guides this organization---these elements and their interfaces, their collaborations, and their composition."

"The structure of the comp-onents of a program / system, their interrelation-ships, and principles and guidelines

governing their design and evolution over time."

No Universal Definition of "Architecture"

Architecture & Requirements

Architecture   Design   Implementation
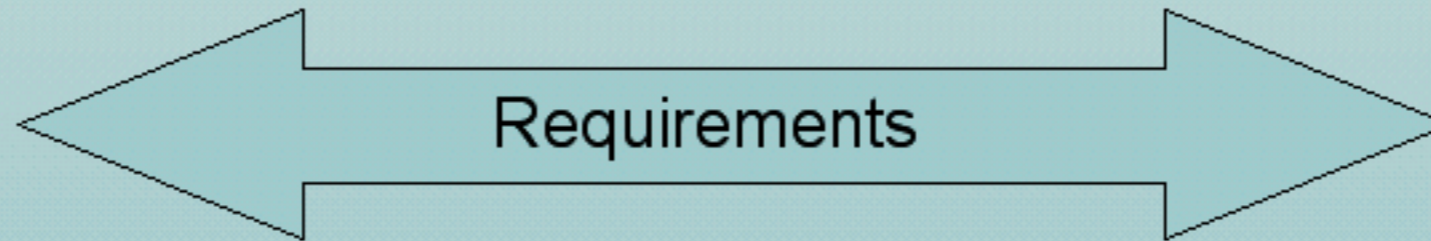
Requirements

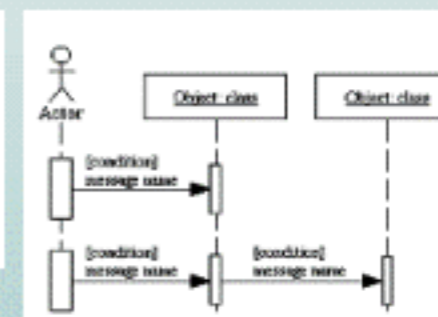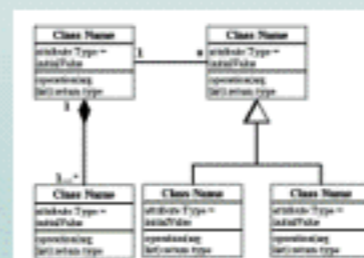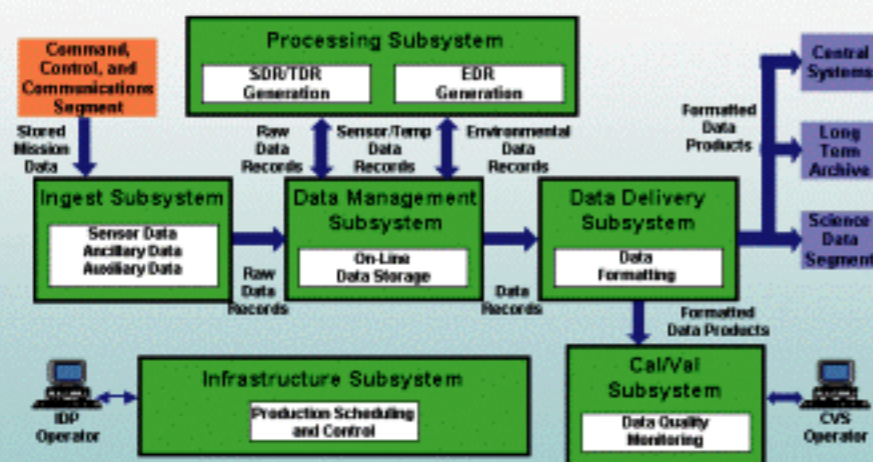## Spectrum from Architecture to Implementation Requirements Describe the Spectrum

Basis for Understandability
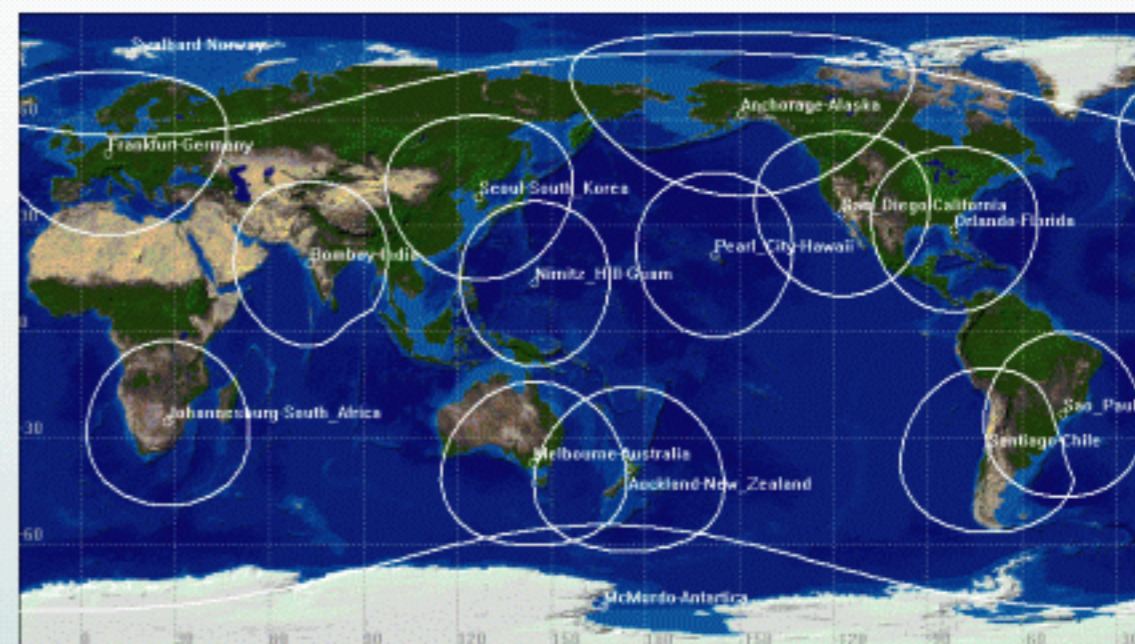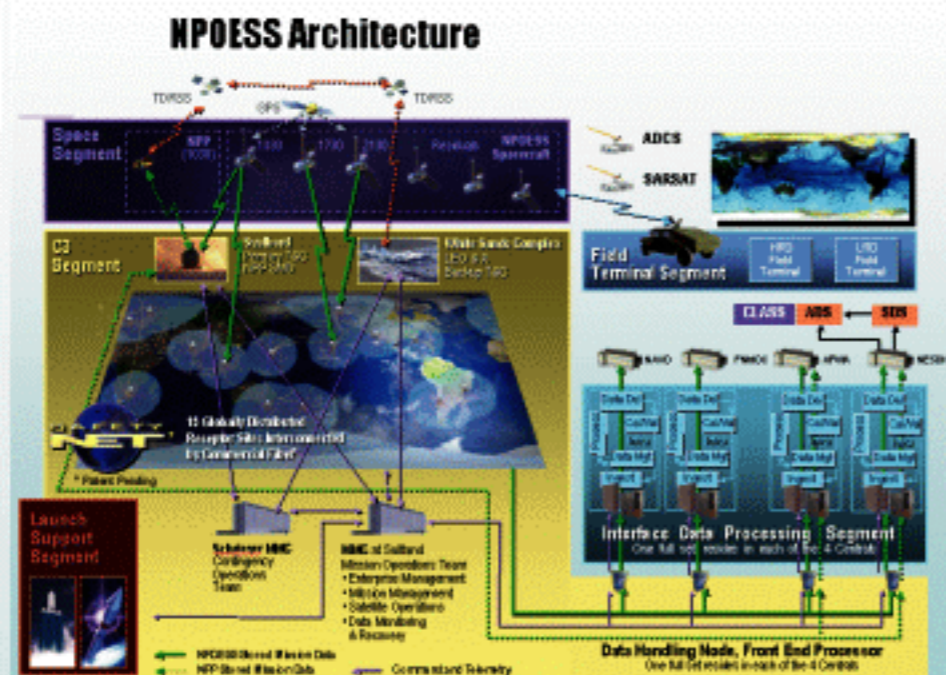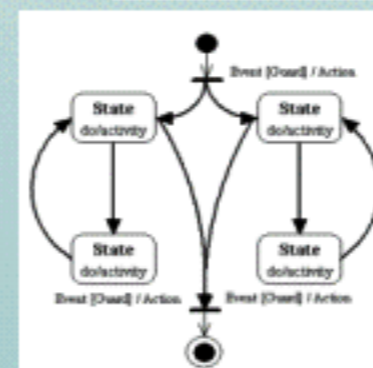
Different Views of the Architecture Enable Comprehension at the Appropriate Level of Detail

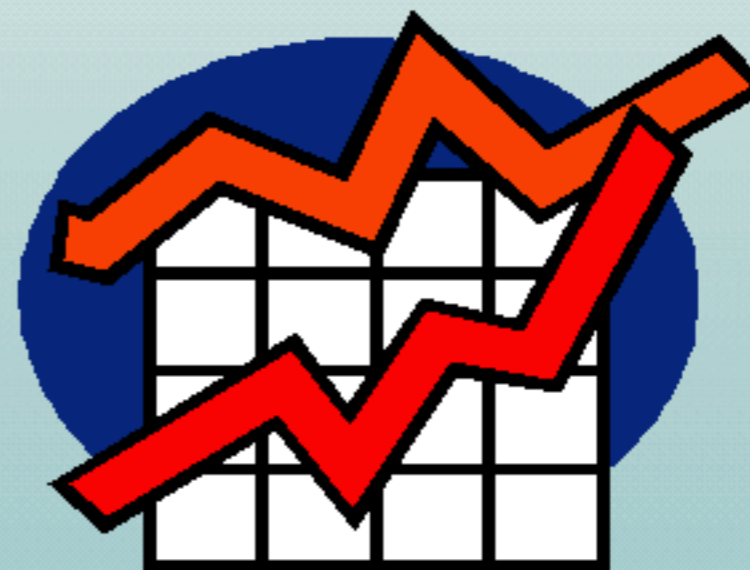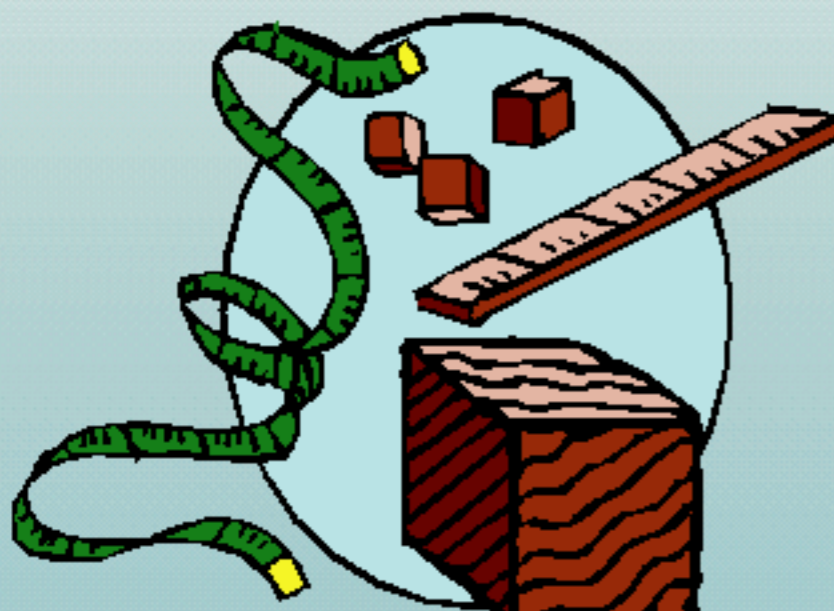# Basis for Assessing Maintainability / Extensibility
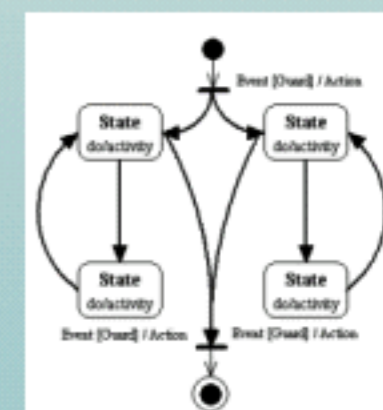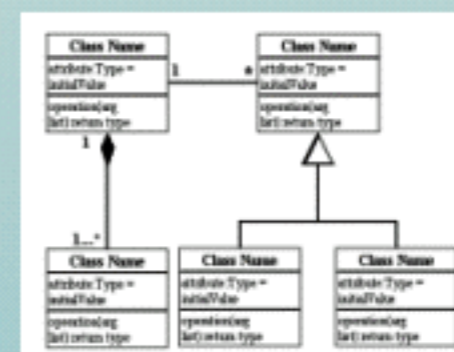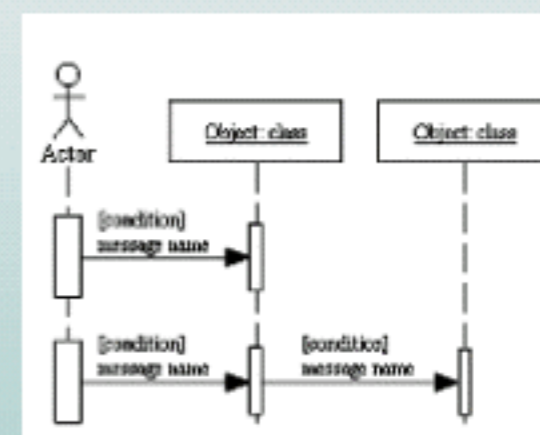
Architecture Alone Does Not Provide the Detail Needed to Assess Cost / Schedule Impacts

Basis for Assessing Executability

Architecture and Models Cannot Accurately Measure Performance / Reliability

Questions