Fractionated Spacecraft Workshop

Vision & Objectives

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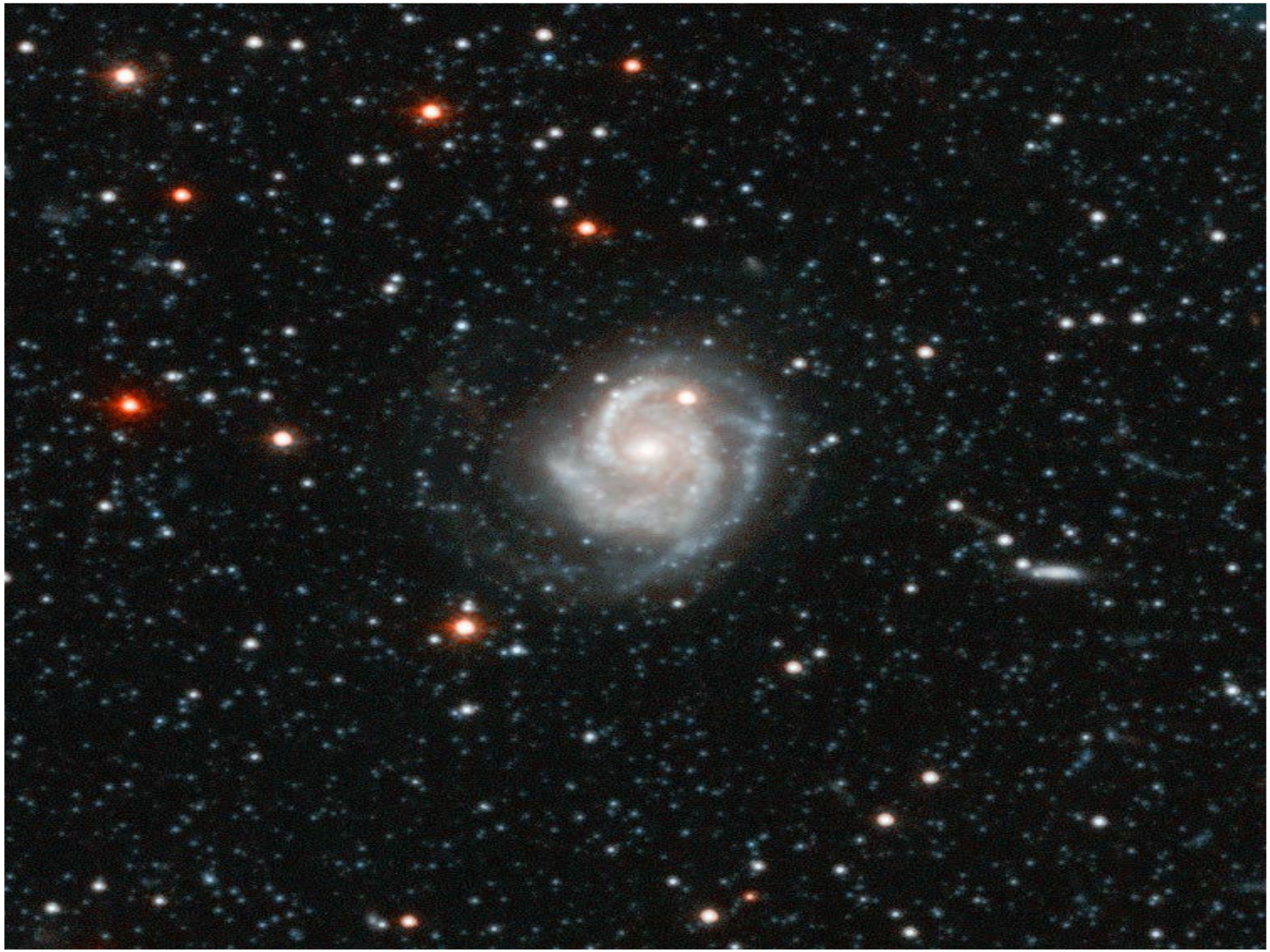
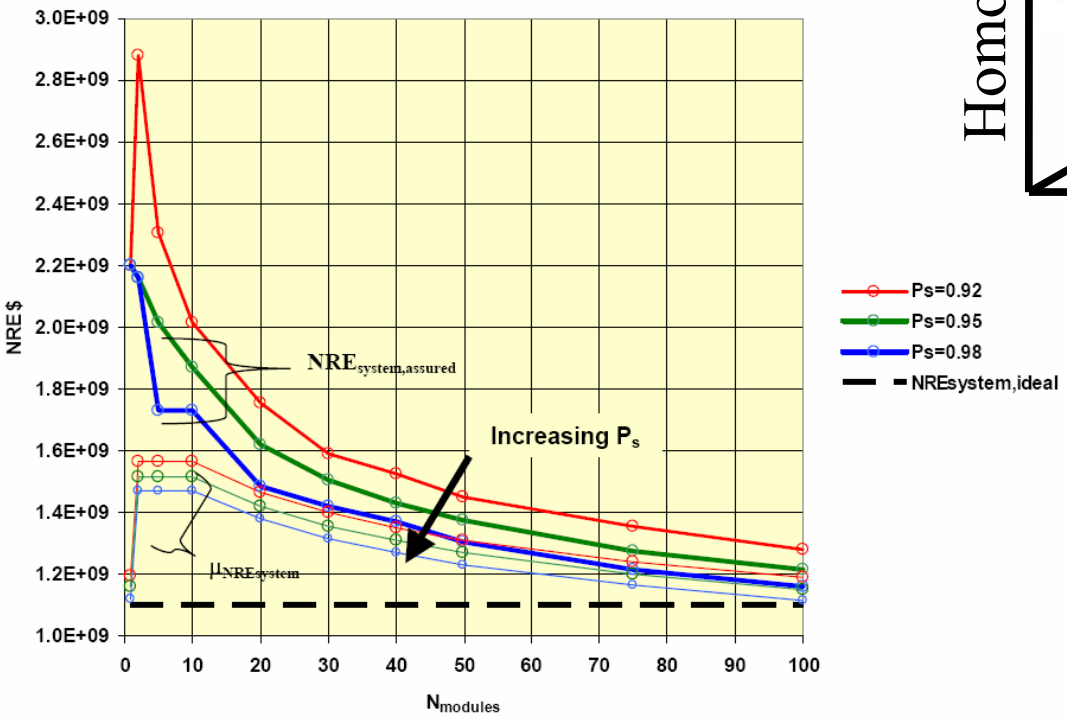
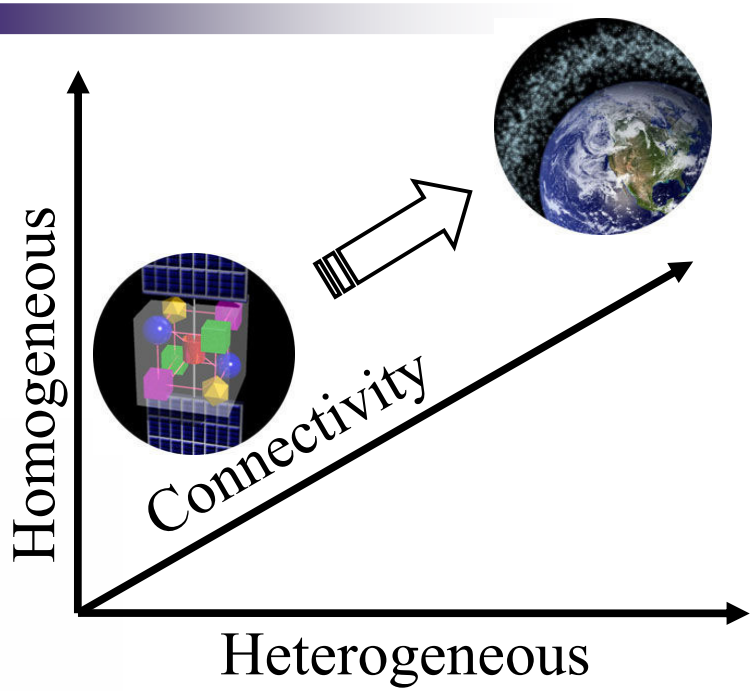


Genesis of Fractionation

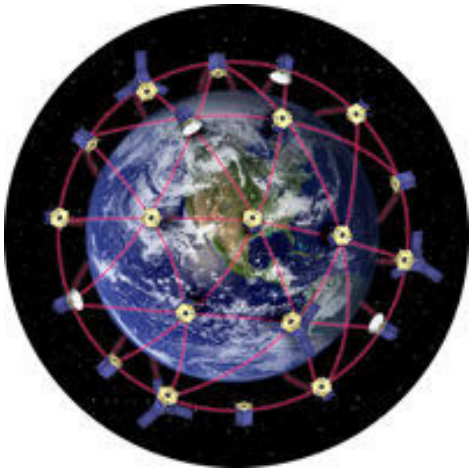
- Wireless bus
- Reducing launch risk
- Pixie dust



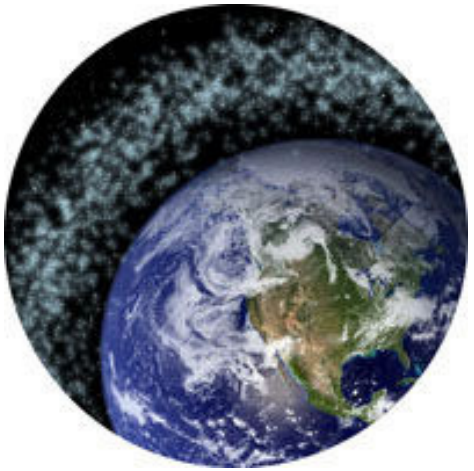


Vision for Fractionated Systems

Component Fractionation



Global Fractionated Infrastructure



Pixie Dust

- This is not TechSat-21
  - Aperture synthesis may be enabled, but not raison d'être
- DARPA demo may not be the "optimal" fractionated spacecraft
  - LEO vs. GEO
  - Fully heterogeneous vs. mixed
  - Single payload vs. multiple payloads
- Objective is instead to develop hard technologies and processes

Fractionation - A Panacea?

- Per Pete Rustan (AW&ST op-ed, 9/5/2005), biggest problems facing space industry:
  - Overly detailed and inflexible requirements
  - Inflexible budgets
  - Requirements creep
  - Poor management of subcontractors
  - Uncertainty about new electronic components
  - New spacecraft for each set of requirements
  - Forgetting about ground services
- Fractionated systems are an architectural response to each of these!

Logic of Fractionation

- Space systems are developed and operate under uncertainty:
  - Technical uncertainty
  - Environmental uncertainty
  - Launch risk
  - Demand uncertainty
  - Requirements uncertainty
  - Funding risk
- Traditional approach to coping with uncertainty:
  - Margins
  - Redundancy
- Fractionated systems offer architectural approach to uncertainty:
  - Flexibility
  - Diversification of risk
  - Spatial distribution

Net Value Proposition

VALUE

- Capability
  - Incremental Deployment
  - Graceful Deterioration
- Flexibility
- Diversification
- Distribution

COST

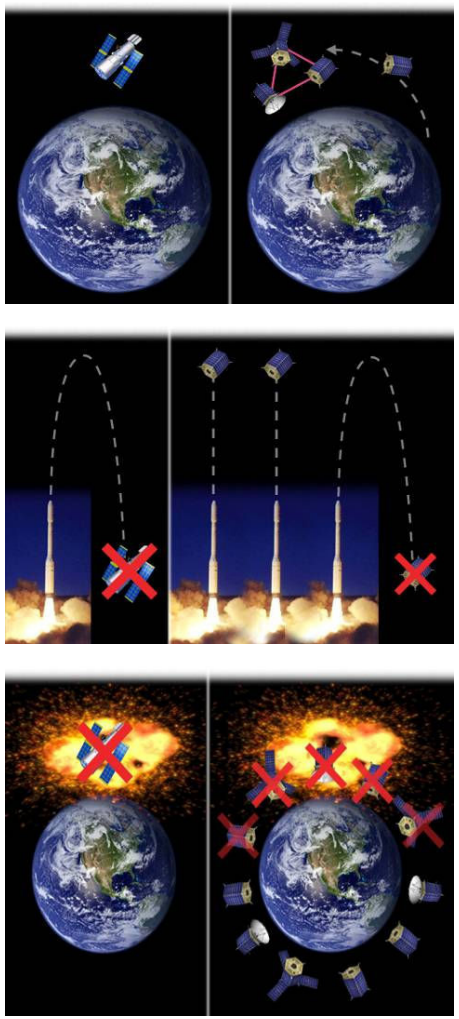
- Baseline Mass
- Fractionation Overhead
- Learning Curve
- Payload Isolation
- Industry Process Changes

NEW PARADIGMS

- Very Large Spacecraft
- Enabling Small Launch Vehicles
- Payload Security
- Industry Competition

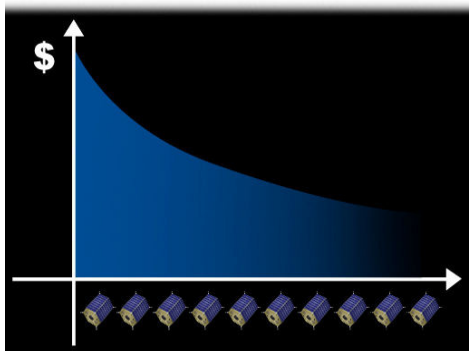
Value Sources

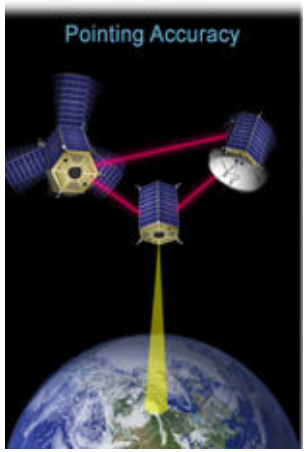
- **Capability:** Similar to that of monolithic spacecraft with analogous payload, except:
  - Incremental Deployment
  - Graceful Deterioration
- **Flexibility:** Options to add modules, remove modules, replace modules, or reconfigure spacecraft architecture throughout development and operational life.
- **Diversification:** Decorrelation of failure probabilities across components leads to lower variance of lifecycle cost and value streams; target spreading.
- **Distribution:** Spatial distribution of spacecraft modules reduces undesirable interactions and leads to reduced system fragility.



Cost Sources

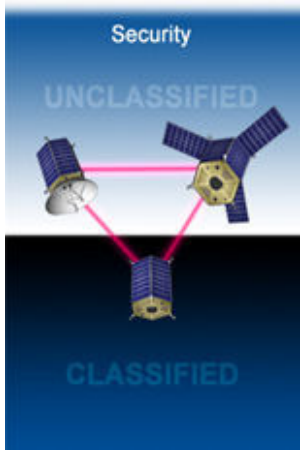
- **Baseline Mass:** Comparable to monolithic spacecraft for given capability level.
- **Fractionation Overhead:** Fractionated spacecraft incurs mass penalties due to overhead of replicating some structurural and thermal control elements, plus addition of transcievers and inter-module interfaces.
- **Learning Curve:** Production learning effects from duplication of infrastructure modules either in a given spacecraft or across multiple spacecraft.
- **Payload Isolation:** Pointing accuracy and resultant ADCS requirement isolated to payload module only yielding to mass saving.
- **Industry Process Changes:** Commoditization, non-traditional participants, rapid design-build-fly, systems engineering processes.



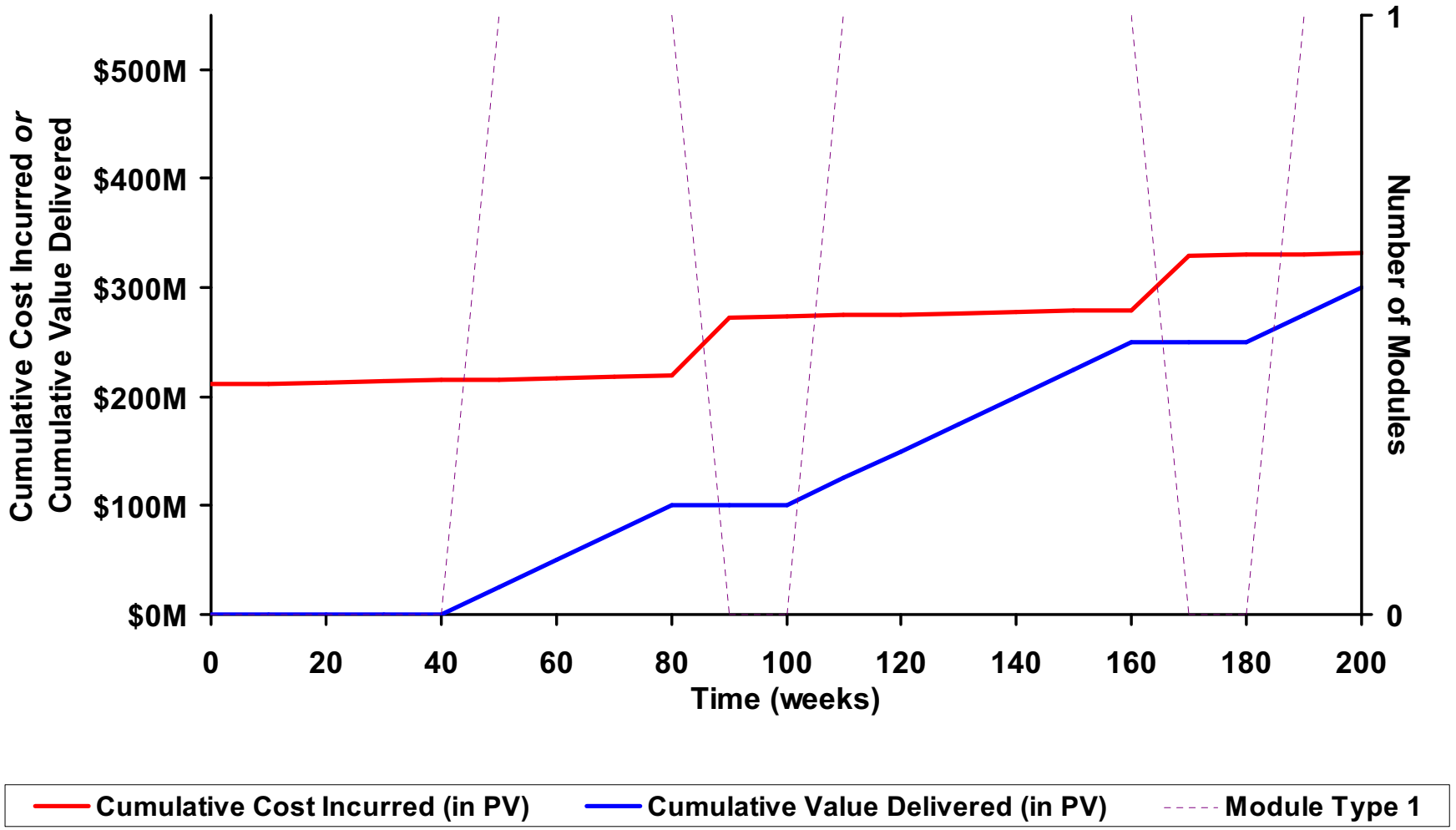


New Paradigms

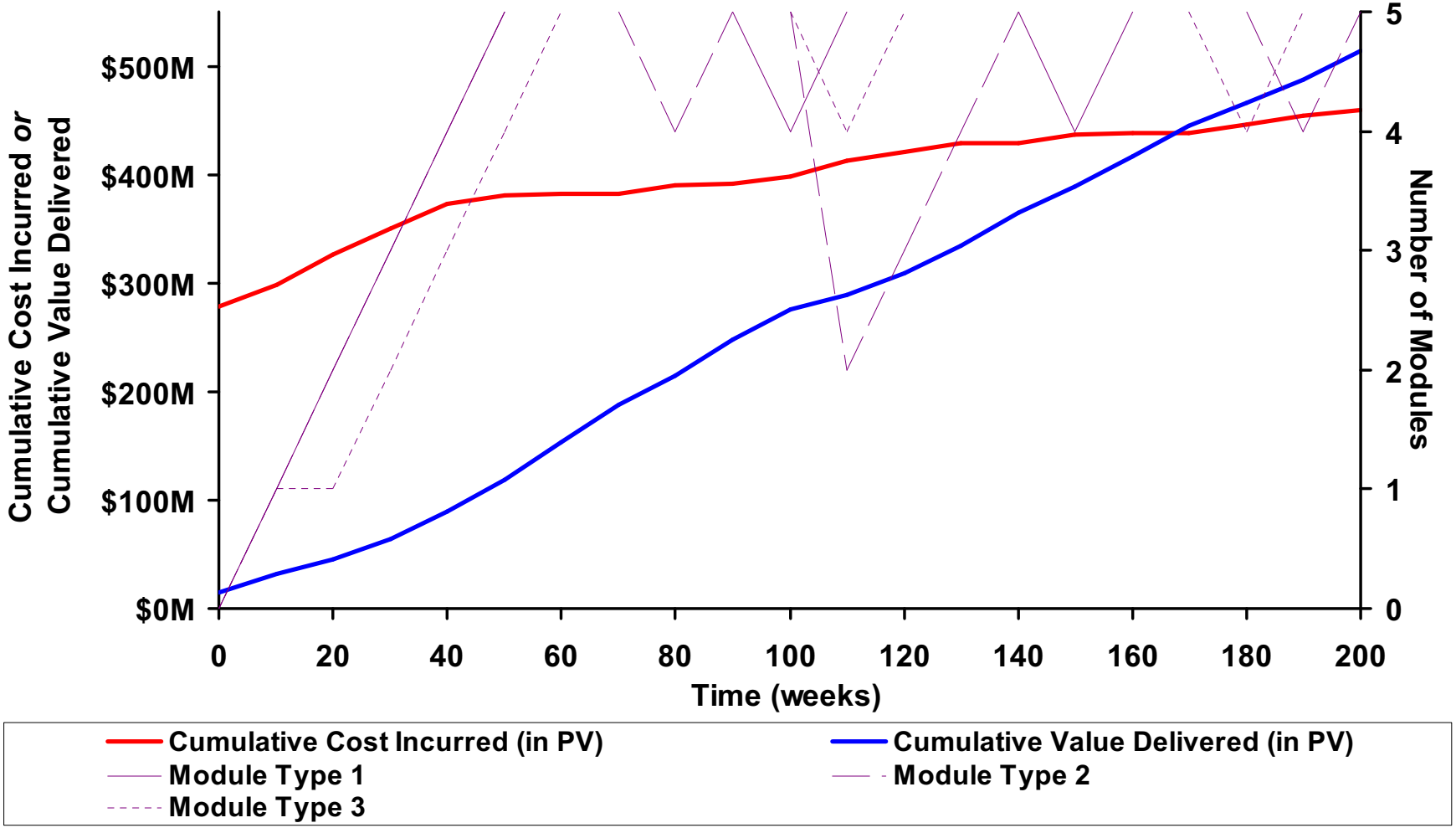
- **Very Large Spacecraft:** Enabling "virtual spacecraft" in excess of current launch vehicle capacity without on-orbit construction.
- **Enabling Small Launch Vehicles:** Provide small payloads in volume (economies of scale) for tactical responsive launch vehicles.
- **Payload Security:** Physical separation of payload allows separation of classified from unclassified spacecraft development efforts.
- **Industry Competition:** Structural changes to the space industry permitting participation by smaller players and competition on value.



Lifecycle Cost-Benefit (Monolithic)

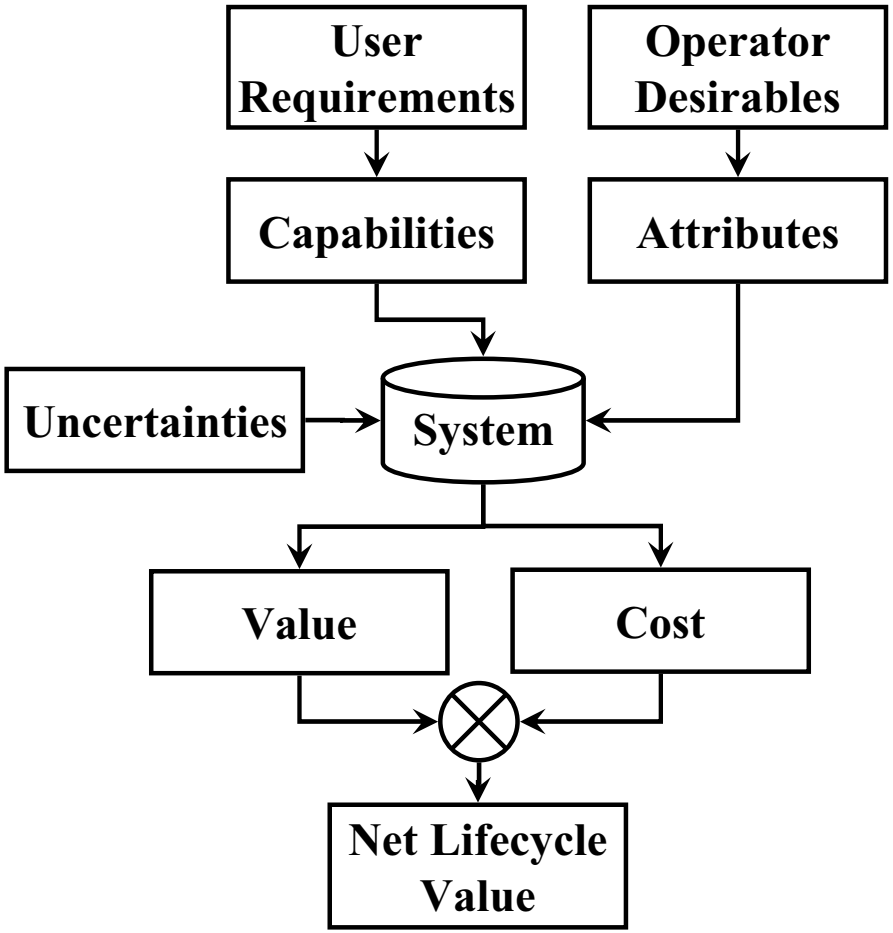


Lifecycle Cost-Benefit (Fractionated)

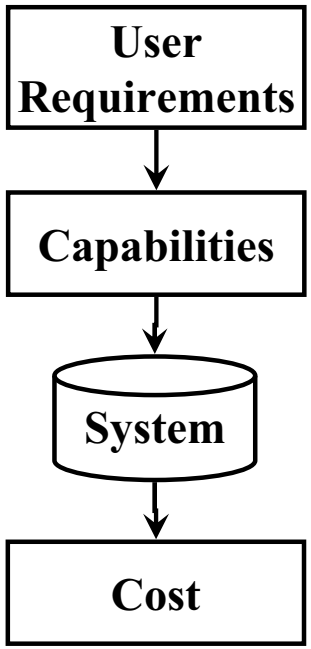


Value-Centric Acquisition

VALUE-CENTRIC



COST-CENTRIC



Workshop Structure & Objectives

- Does the concept make sense?
- Is it technologically feasible?
- What process/industry changes are needed?
- Overview of tradespace for each of the technology "pillars" – i.e., the major enablers.
- Feedback from industry to DARPA on what technologies make sense.
- Feedback from industry to DARPA on demo mission concepts and scope.
- Opportunity for industry to air ideas and form symbiotic relationships.