# Implementation Challenges for Responsive Space Architectures

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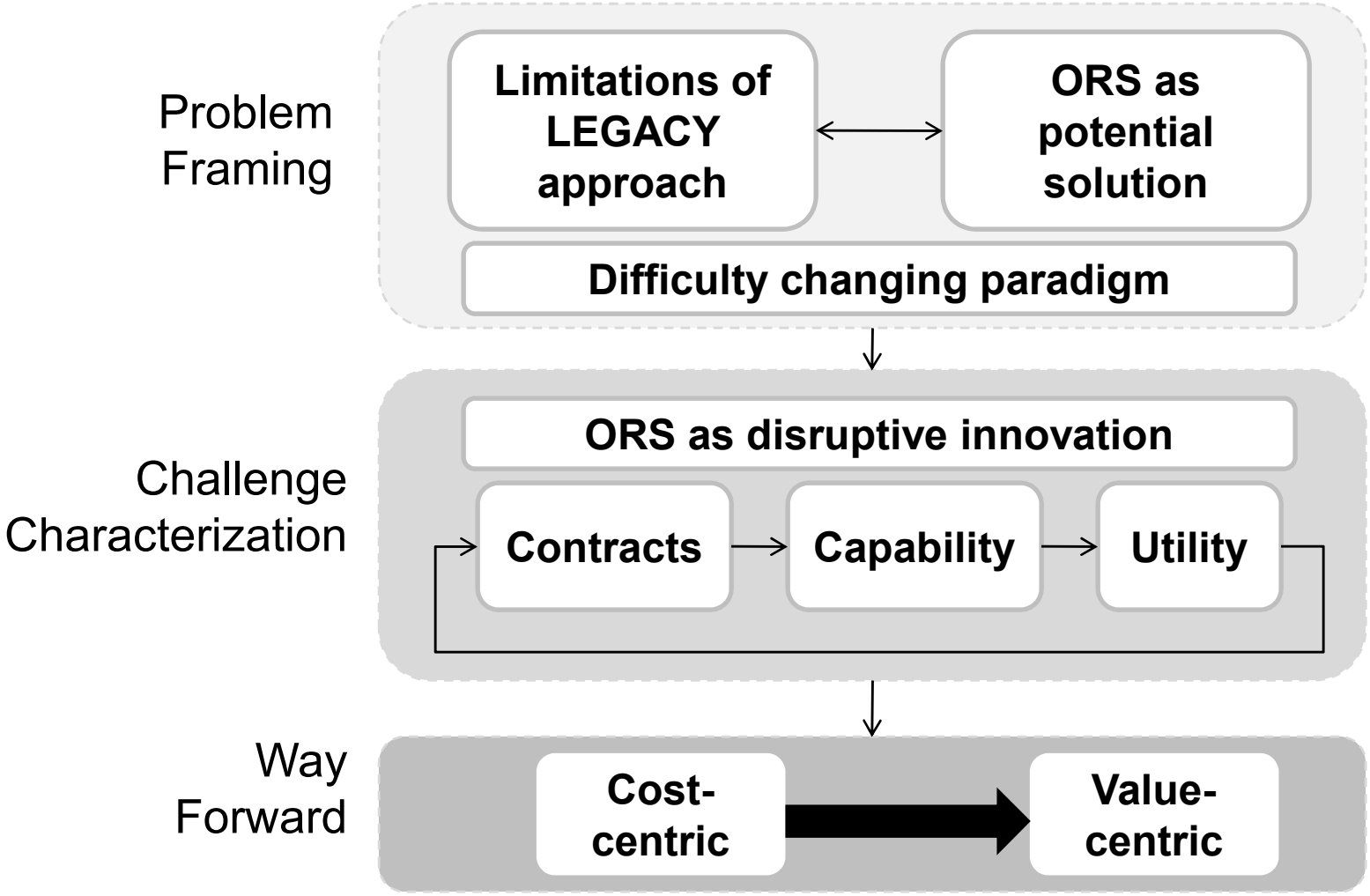
# Outline

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# Problem Framing

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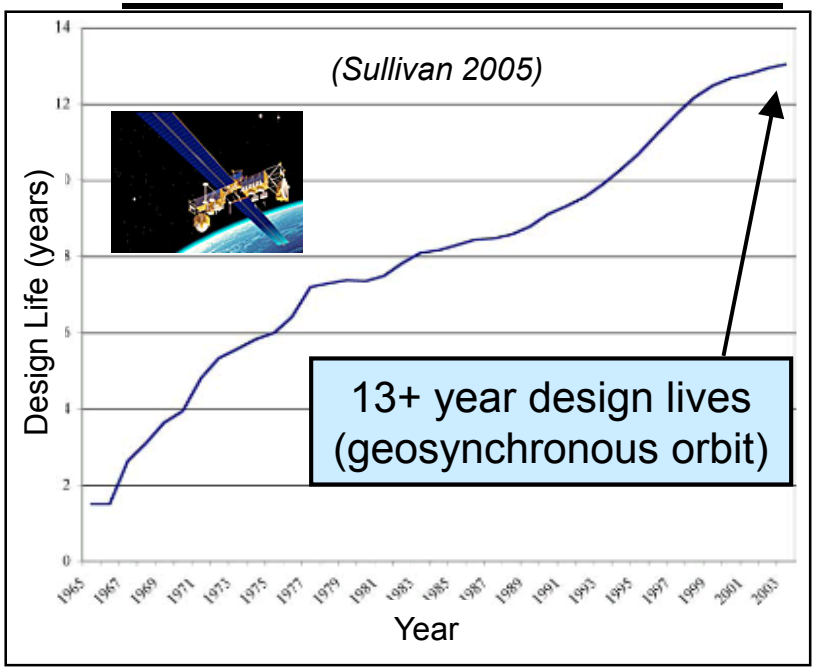
# Limitations of "Legacy" Approach

## 1960's Paradigm

- CORONA: 30-45 day missions
- 144 spacecraft launched between 1959-1972 *(Wheelon 1997)*

## Evolution to Current State




- **Inability to adapt to uncertain future requirements and environments**

*"Our spacecraft, which take 5 to 10 years to build, and then last up to 20 in a static hardware condition, will be configured to solve tomorrow's problems using yesterday's technologies."* *(Dr. Owen Brown, DARPA Program Manager, 2007)*

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# Difficulty Changing Paradigms

| **Legacy** | **Responsive** |
| --- | --- |
| • Monolithic<br>• Single spacecraft for whole mission lifetime<br>• Designed for what we **think** we will need | • Small spacecraft<br>• Several spacecraft over the lifetime of the mission<br>• Designed for what we will **actually** need; can be adapted as needed |

- Given that ORS addresses some key limitations of Legacy architectures

- Research Questions:

  1. Why is the responsive space concept struggling to gain broader acceptance in the space community?

  2. What can be done to catalyze the transition?

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# Challenge Characterization

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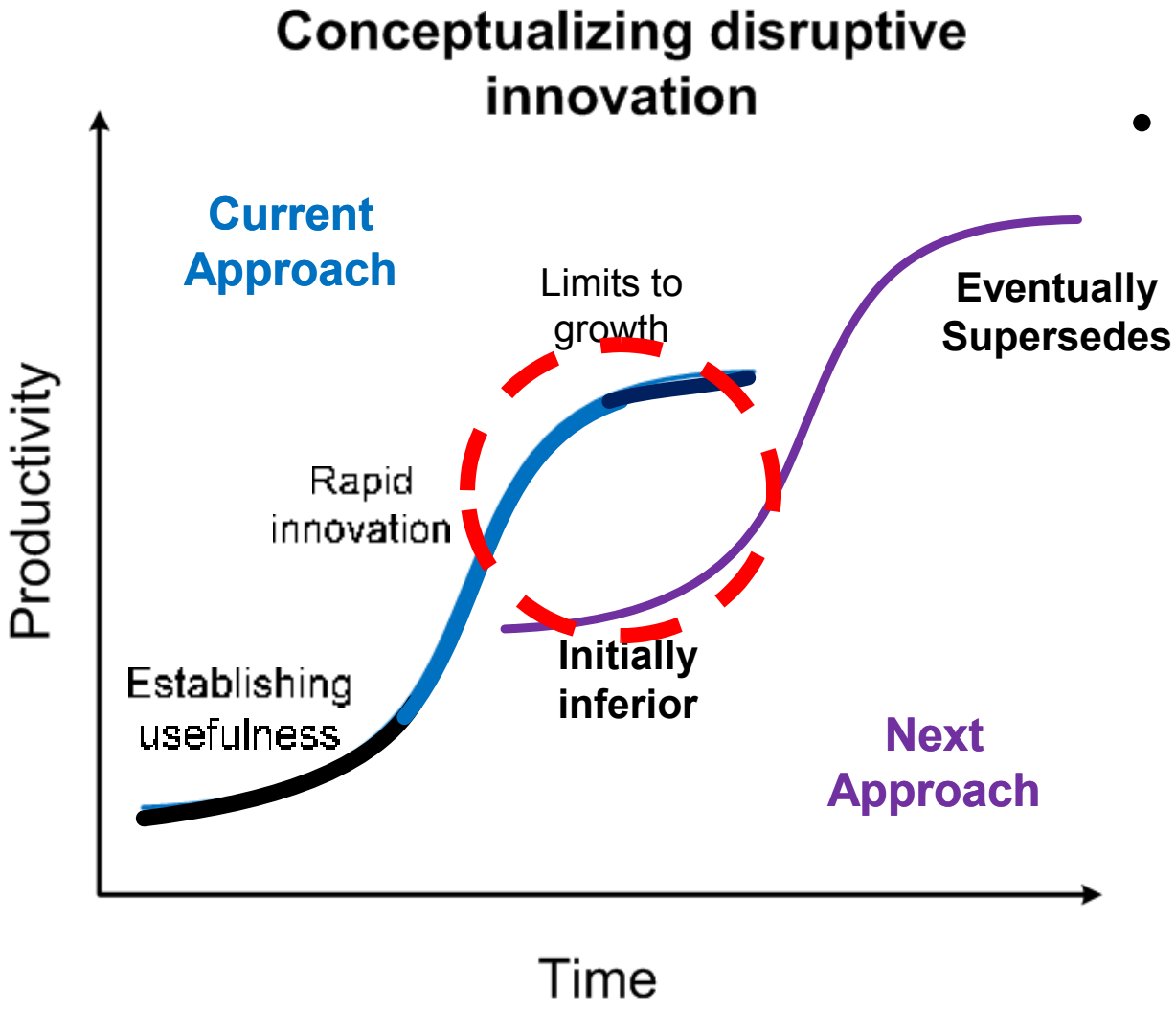
# ORS as Disruptive Innovation




- 18 Challenges
  - Generating enabling technologies (7)
  - Overcoming institutional inertia (6)
  - Demonstrating utility (5)

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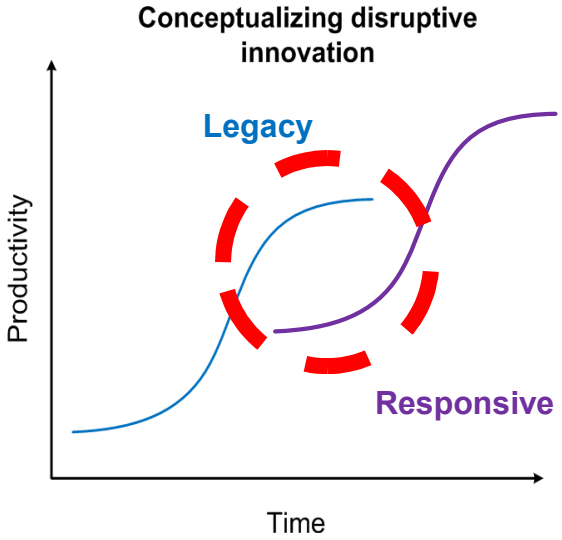
# Transition Challenges: Inertia




- **The Contractors**
  - An inability for established firms to accommodate "Disruptive Innovation"
  - Economic stake of satellite contractors in the status quo
- **The Customer**
  - Government system program offices have become entrenched in an incremental evolutionary philosophy
  - The "back-to-basics" approach of DoD acquisitions
- **The Market**
  - Lack of corrective "market" mechanisms in the DoD enterprise

*"We have to overcome ourselves in order to put this program into place and allow it to be successful,"* (Hartman, C4ISR March 2009)

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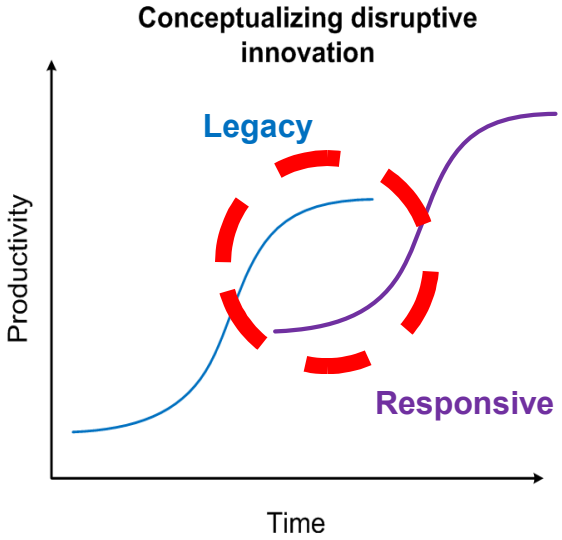
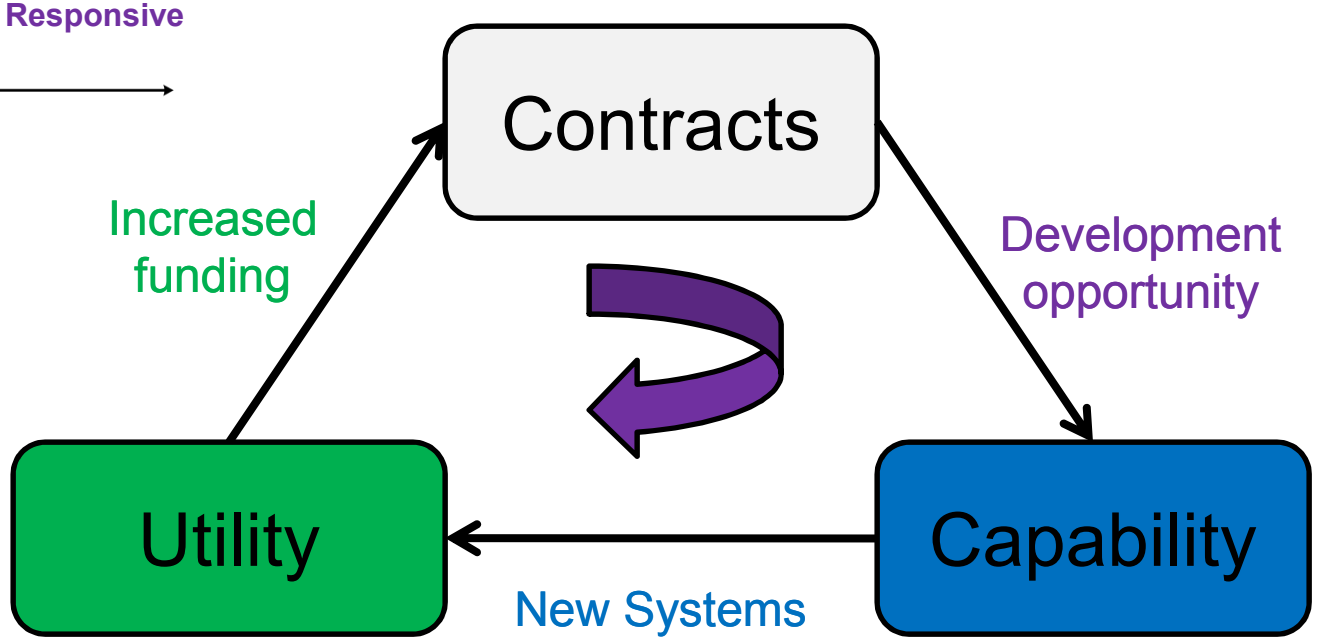
# Transition Challenges: Utility




> *"Culturally, DoD hasn't determined that small satellites can have a whole lot of utility, […] So we're going to struggle with that until we can actually produce something the [combatant commands] can use."* (Van Sant, C4ISR)

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# Way Forward

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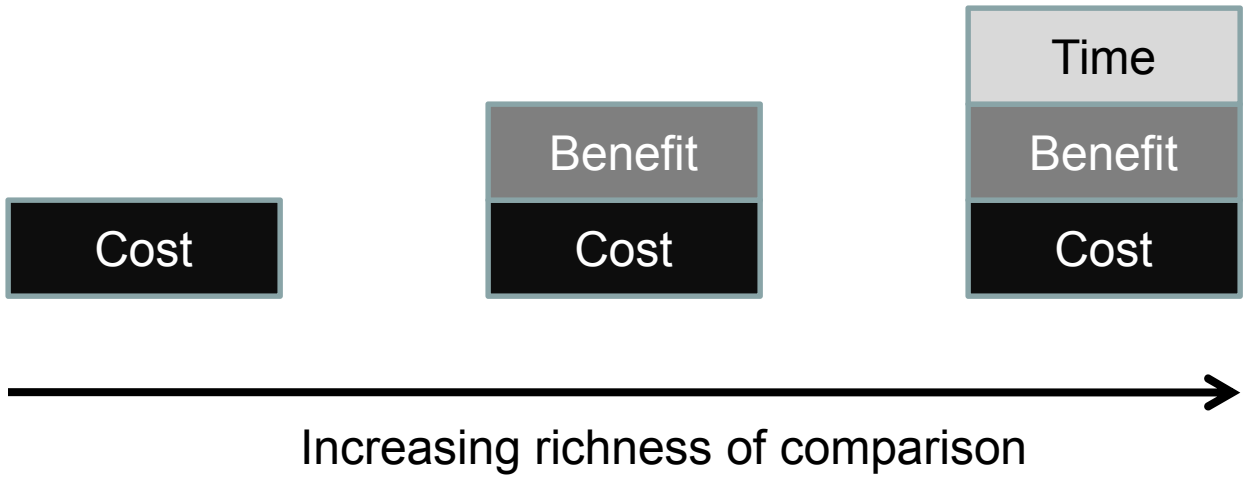
# Broaden Analysis Scope to Enable "Fair" Comparison

- **Challenge:** Legacy and Responsive Architectures have different strengths and weaknesses. Traditional evaluation methodologies do not internalize full set of Responsive attributes.

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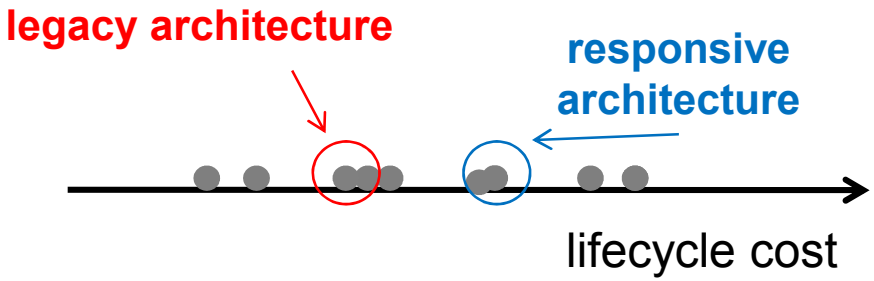
# Cost Comparison

Cost-based comparisons are only good differentiators among similar architectures

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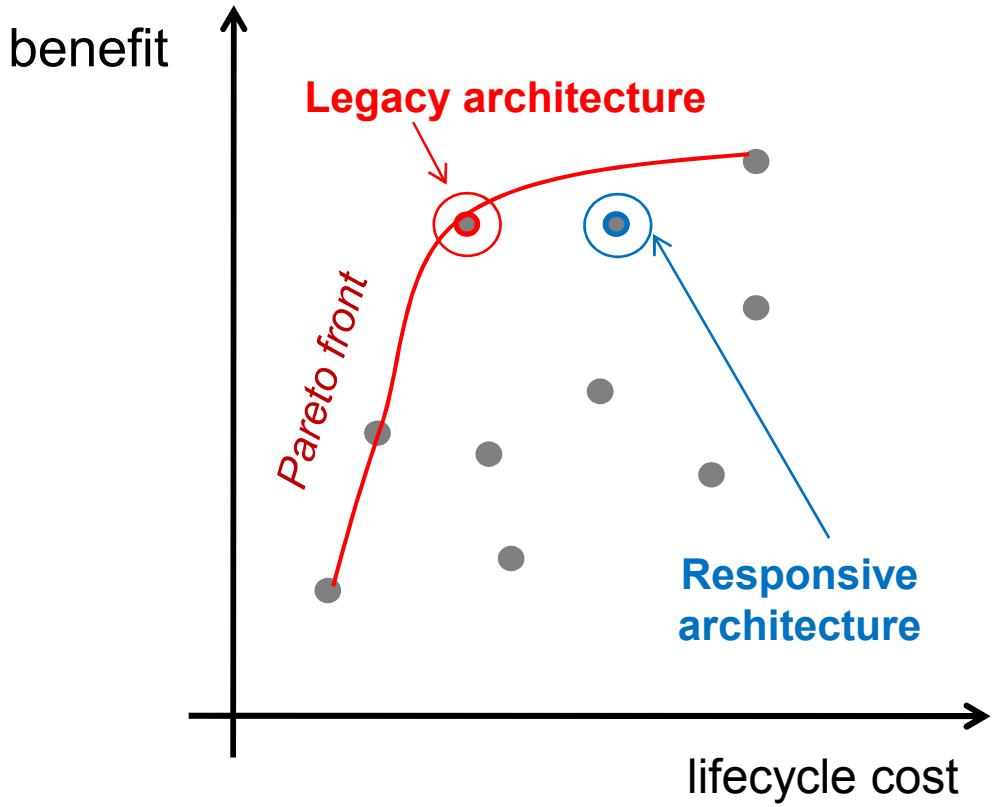
# Cost and Benefit Comparison

Value-centric perspective enables unified evaluation of technically diverse system concepts

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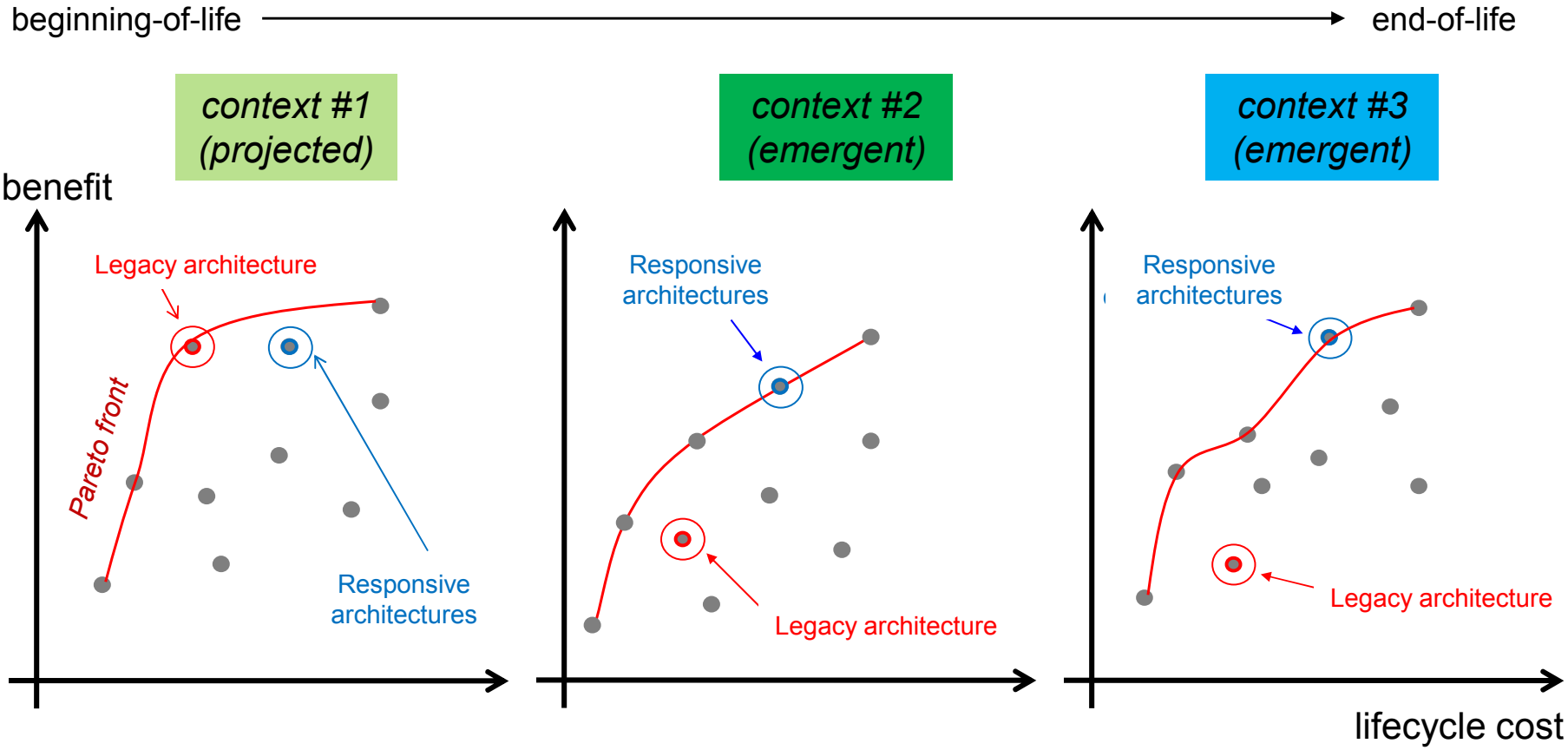
# Cost, Benefit & Time Comparison




Analyzing ORS *vis-à-vis* "Legacy" requires modeling value delivery over entire design life (i.e., **changing contexts**)

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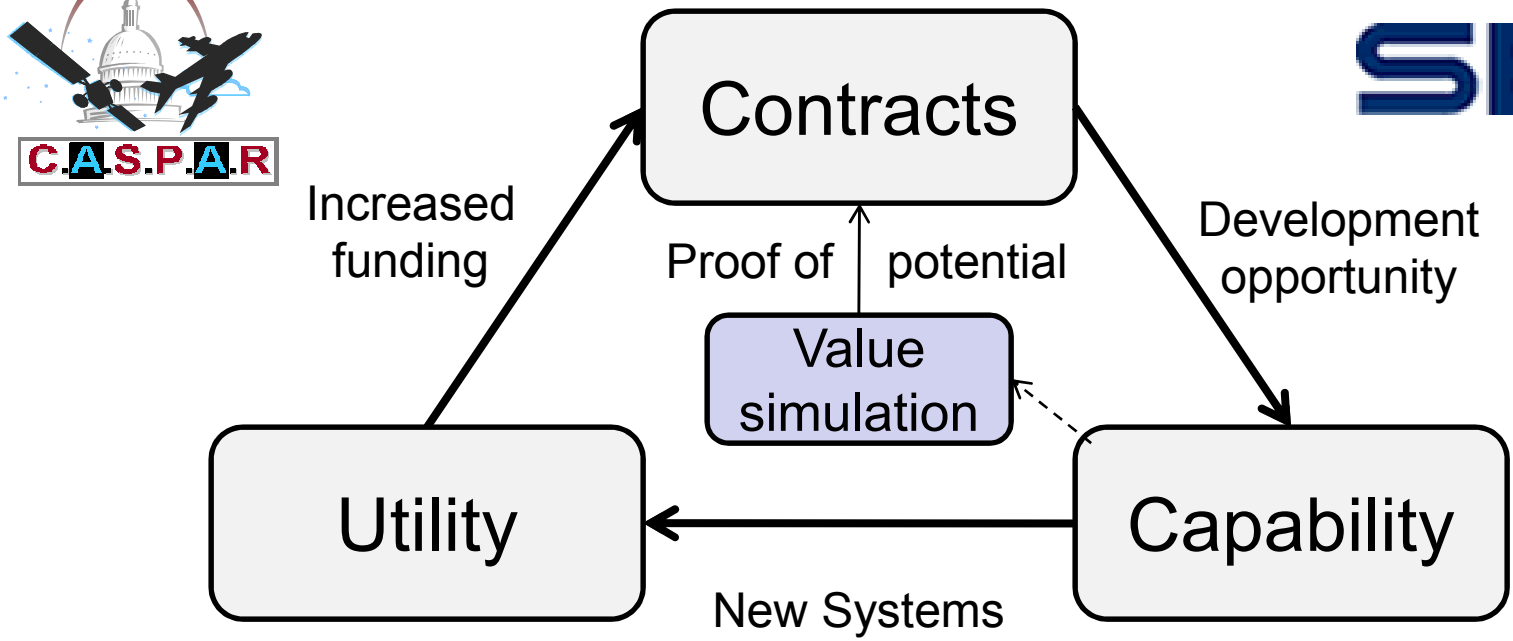
# Ongoing Work

**Market Dynamics**

**Valuation Techniques**




*CASPAR and SEAri are actively working to integrate economic, political, managerial and technical analyses to address these deeply interdisciplinary questions.*

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