

# System-of-Systems Platform Scoping

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# Contact Profile

## Focus and Interests:

- Carnegie Mellon Software Engineering Institute – applied research and consulting in software and system-of-systems architectures for US government and commercial organizations
- Leader in software product line research and application
- Interests: Systems of systems; enterprise architecture; platforms for reuse and ecosystem creation

## Objectives:

- Validation of the technical significance of our research problem
- Refinement of the formulation of our research problem
- Feedback on our solution direction
- Identification of potential collaborators (tight or loose relationship)



# “Product Line”

We are not developing a traditional product line

We are working in a context that involves

- “Reuse” in the form of agreement on standards, technologies, and sufficient interface definition to enable interoperability
- Scoping and governance are core activities
- Possible reuse of software and related assets (although this is incidental, not the core issue)

We see product line practices as good tools for use to create architectures in this context



# Problem

A successful system-of-systems platform must balance sufficient commonality to support economical use for interoperation...

While also providing variability and extensibility to enable innovation in system and system of systems capabilities.

These commonality/variability tradeoffs for system-of-systems platforms are frequently tacit decisions, because...

**There are no existing techniques for analyzing such decisions at the scale and degree of requirements uncertainty that characterize most systems of systems.**



# Systems of Systems (SoS)

A SoS is a distributed, collaborative system in which:

- The constituent collaborating elements are themselves systems
- The constituent systems have operational independence – each operates to achieve a useful purpose independent of its' participation in the SoS
- The constituent systems have managerial independence – each is managed and evolved, at least in part, to achieve its' own goals rather than the SoS goals

Interoperability is a primary concern of a SoS architecture



# Platforms, Platforms, Platforms

## “Platform”

- A vehicle (ship, aircraft, tank, etc.) that transports systems and provides physical services such as power and cooling [military domain]

## “Product Platform”

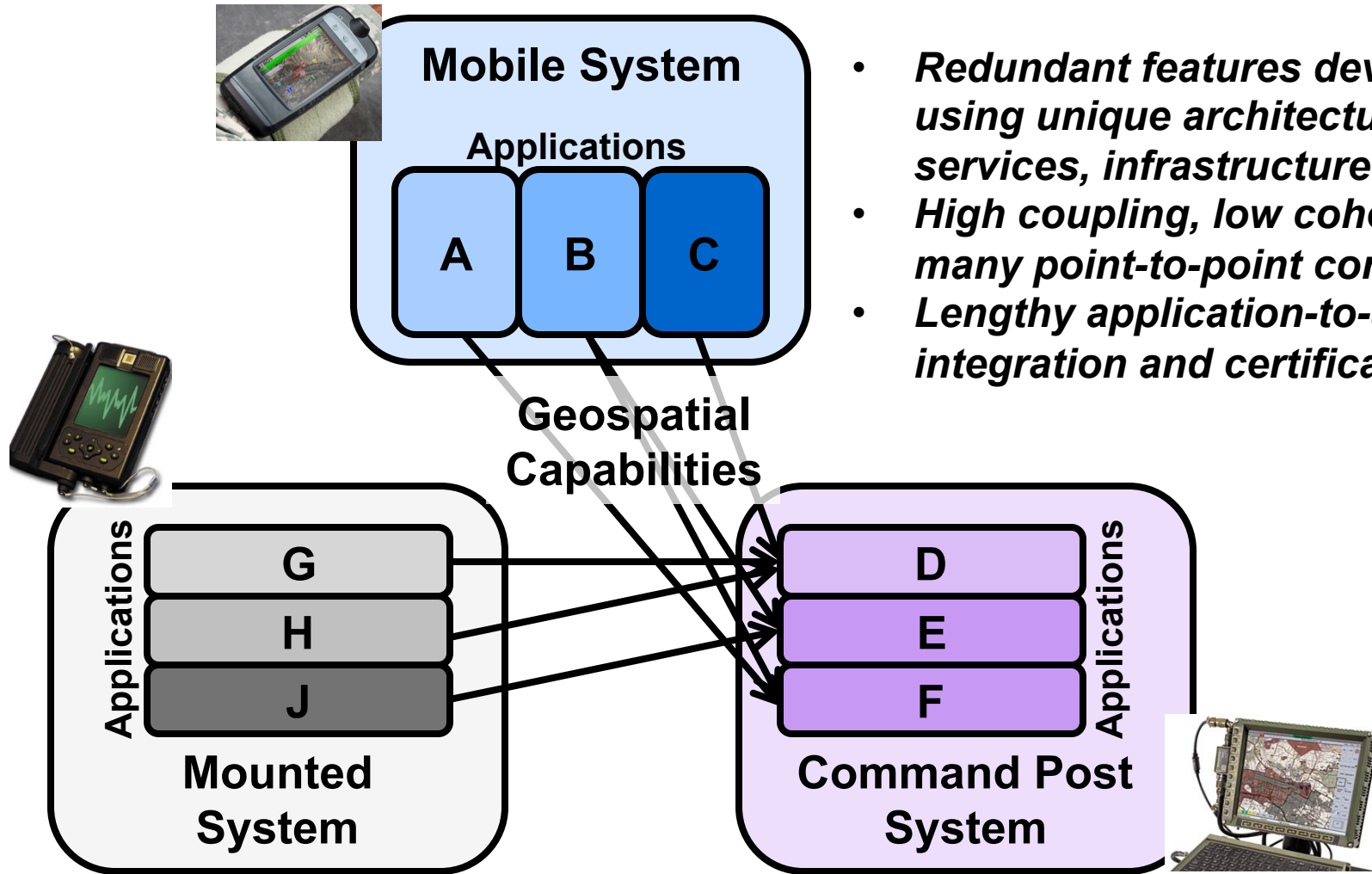
- Common elements reused across a product line or product family [Cusumano]
- See also “platform-based engineering” [Madni]
- Primary concern is reuse of software and related assets

## “Industry Platform” or “SoS Platform”

- Provides services to an open set of systems that need to interact to form a system of systems [Cusumano, Klein *et al*]
- General-purpose services, such as directory and authentication
- Domain-specific services, such as geospatial information processing for a command and control system of systems.
- Primary concerns:
  - Support for interoperation among the systems using the platform
  - Reduce the cost and time needed to develop or modify systems for the system of systems
  - Enable modular substitution of constituent systems in the system of systems
- May enable ecosystem creation



# Example – No SoS Platform (Current Solution)

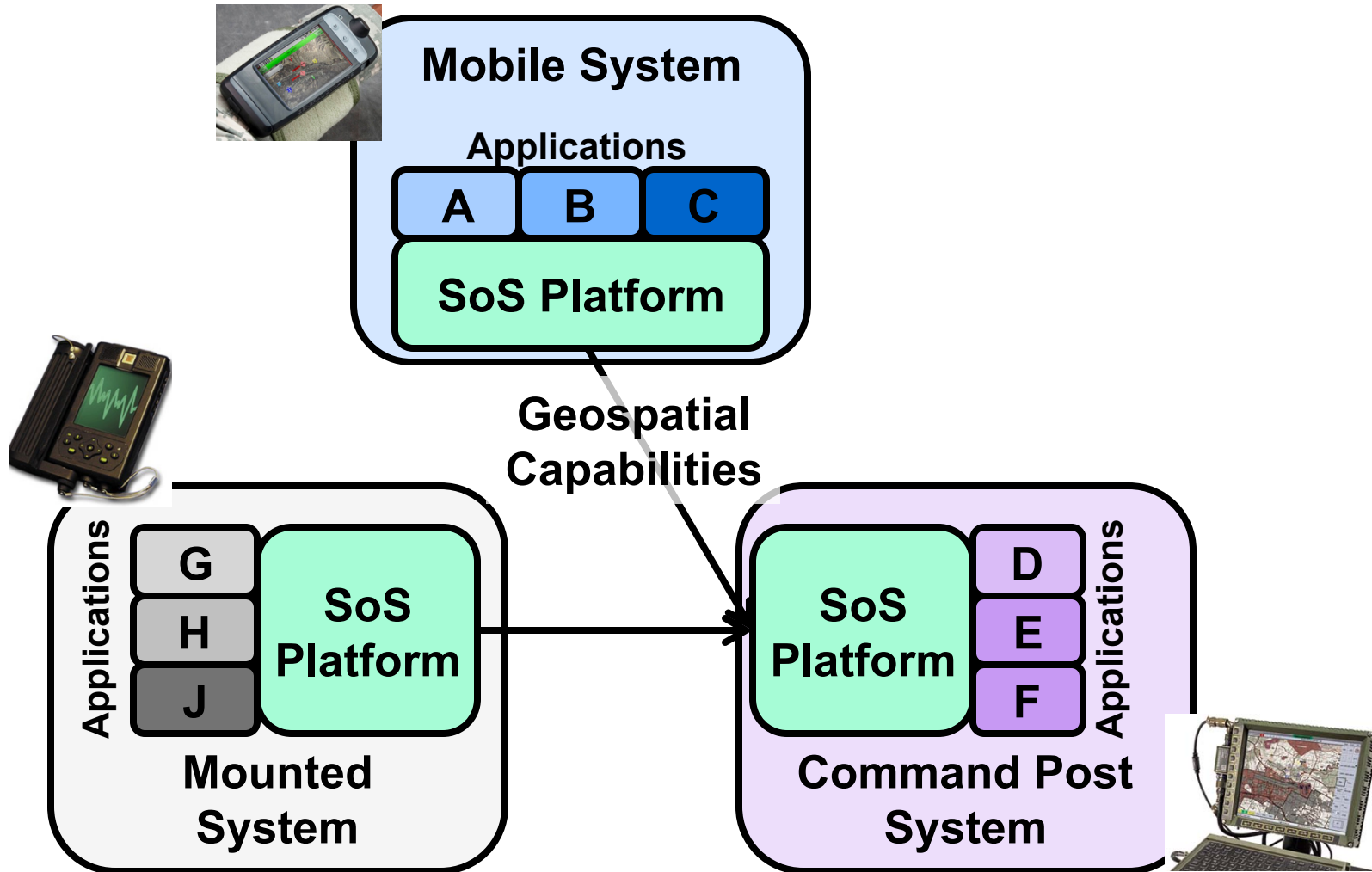


- *Redundant features developed, using unique architectures, data services, infrastructure*
- *High coupling, low cohesion – many point-to-point connections*
- *Lengthy application-to-application integration and certification*





# Example – Using an SoS Platform



# Why is this interesting?

## Scoping and System Independence

### Scoping:

- Sources of uncertainty:
  - Long time from definition to deployment
  - Long-lived SoS
  - Managerial independence of constituent systems – divergence in technology and architecture approaches
- Scale
  - Large numbers of architecture elements and relations
  - Automated tooling is usually necessary

### System Independence

- Why should a system join a system of systems?
- Why should a system use a system-of-systems platform?
- Related to ultra-large-scale systems – incentives and governance are necessary



# Discussion

How can we describe the problem better?

Does anyone have experience solving this problem? Are there existing case studies that we can use to shape our solution?

We are planning to use real options modeling to select platform features.

- What is the state of the practice in economic modeling of architecture decisions?
- What is the state of the practice using real options modeling in product line contexts?

