

*THE VALUE OF PERFORMANCE.*  
***NORTHROP GRUMMAN***

# **STEM and Systems Engineering: A Continual Need and Natural Fit**

**Presented at GSAW 2018**

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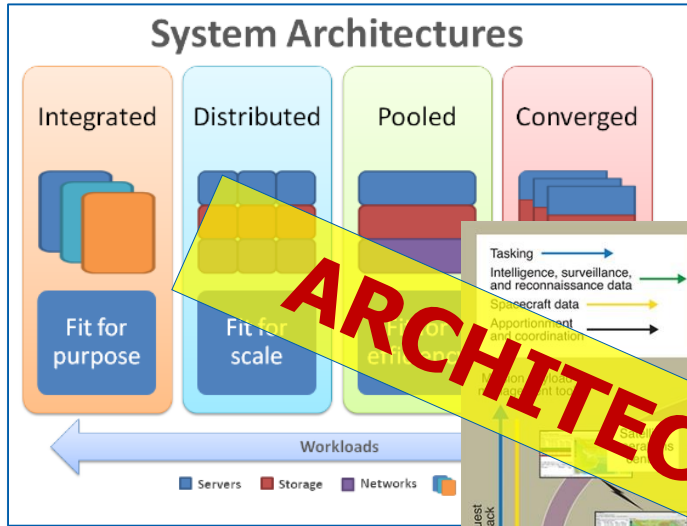
- We have been using the “STEM/STEAM” moniker for more than a decade to the point where it may be acoustically indiscernible from a parent saying “eat your vegetables” at the dinner table.
- As a technical society dedicated to the advancement of the art and science of systems engineering, INCOSE is deeply wedded to the continued push for students to pursue STEM-centric educations.
- The purpose of this presentation is to present the value of STEM from a Systems Engineering perspective within the context of Ground Systems and a focus of STEM capability at the customer level.

- System/Architecture complexity transcends domain, discipline, social, and technical interfaces
- Lack of STEM skills make for poor customer requirements and invalid products
- Strong Operator STEM skills enable operators and maintainers to contribute to system and architecture evolution
- Need for STEM skills to understand narrative stories
- Need for STEM skills to make/understand policy

**Regardless of location in the lifecycle, strong STEM skills have value to SE**

**Strong STEM skills are a critical enabler to the resilient enterprise**

# Complexity is the Driver



The challenge, of course, is that most real-world systems are, in fact, complex... Systems Engineers soon learn that Mother Nature is not malevolent – but is very unforgiving.<sup>1</sup>

**ARCHITECTURAL COMPLEXITY**

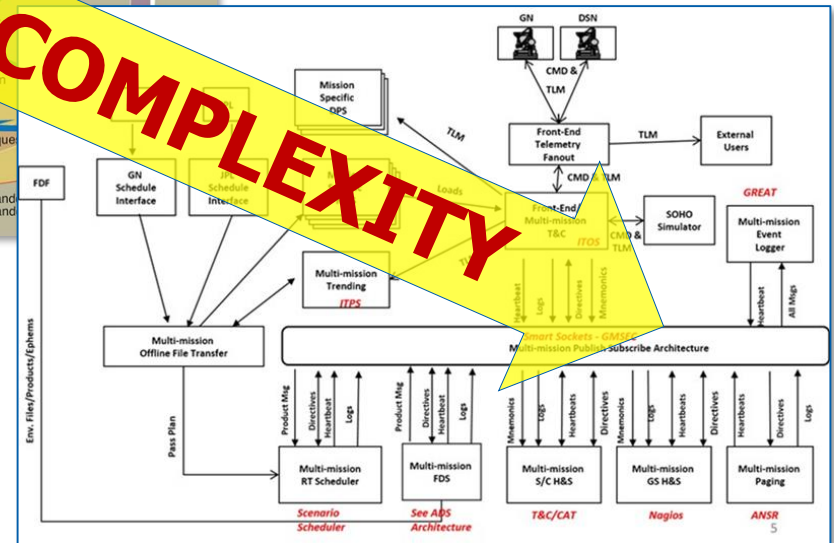
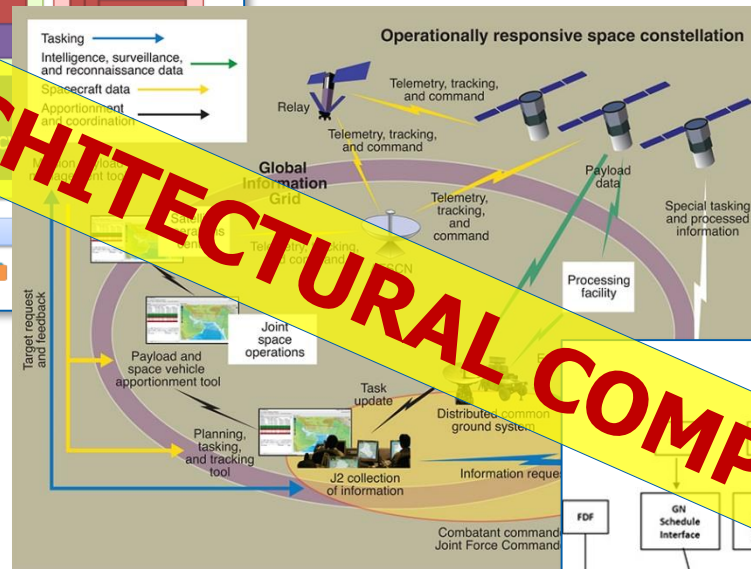


Image Sources: <http://www.themetisfiles.com/2013/01/the-four-types-of-system-architectures/>  
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<https://www.emergentspace.com/wp-content/uploads/Engineering2.png>

# SE vs. STEM Role



Customers



Developers



Maintainers



Operators

## System Evaluation

System Operation  
Capability Needs  
ConOps  
Validation

Requirements  
Architecture  
Design  
Integration  
Verification

Field & Depot  
Maintenance

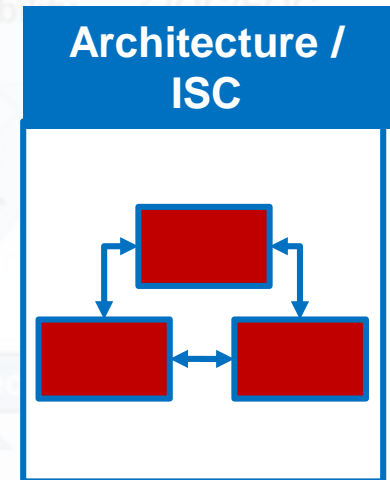
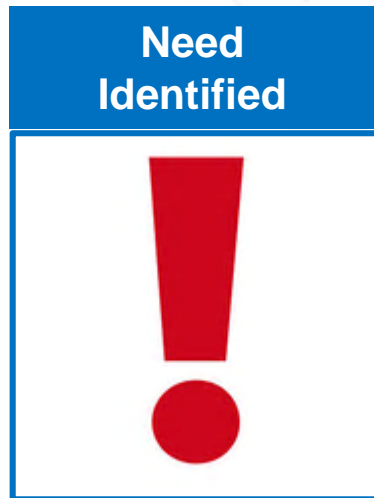
System Operation

Less-obvious  
STEM Need

Obvious STEM Need

Regardless of location in the lifecycle, strong STEM skills have value to SE

# Customer STEM in SE & Architecture



**S**

Understand the possibilities and constraints

**T**

Understand existing systems, tools, and technologies

**E**

Understand the options for system modification/enhancement

**M**

Understand the risk and value propositions

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