A System-of-Systems Approach to Component Commonality

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9Th Annual NDIA Systems Engineering Conference

October 2006

Agenda

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- **Defining Commonality Requirements for FCS**
  - **The Purpose of Commonality**
  - **Commonality Definition**
  - **Commonality Requirements Allocation**
  - **Status of Commonality on FCS**
- **Considerations in Pursuing Commonality**
- **Measuring Commonality Implementation**
- **Summary**
- **Questions**

FCS System-of-Systems (SoS)

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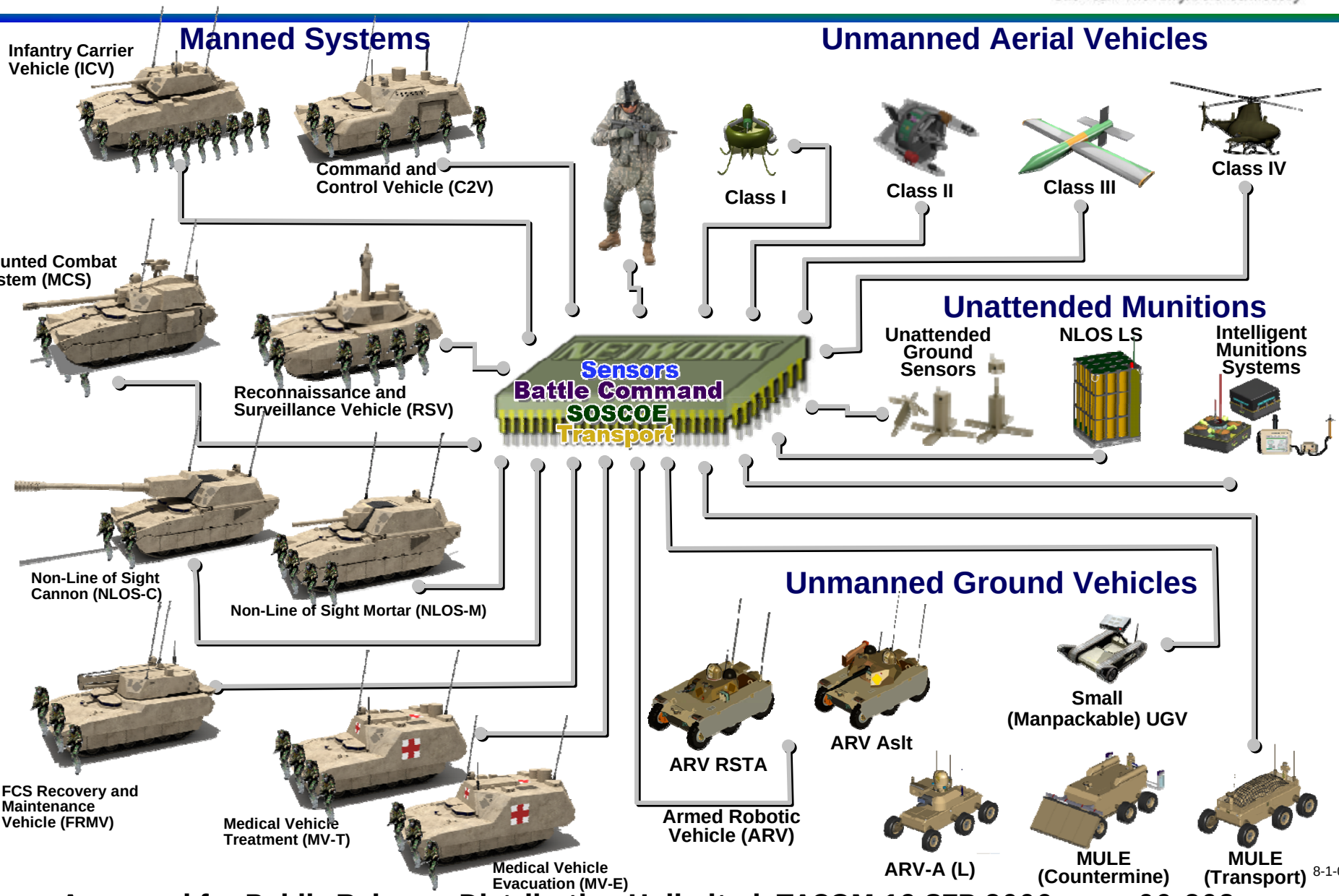

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Commonality Requirement

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The System-of-Systems shall maximize platform and component commonality within each system class to a level of 70%.

- **The Problem:**
  - **What does the requirement mean … at a SoS Level?**
  - **How does the requirement apply to individual systems?**
  - **What does it mean to be "common"?**
  - **How do you measure/verify performance?**
- **This requirement interacts with other requirements for common tools, common lubricants, common batteries, commonality in communications equipment, and others.**

Need to Translate the User's Requirement into Engineering Language

Commonality Focus

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Commonality in the Factory

- Decrease production cost
  - Fewer unique tasks
  - Reduced training requirements
  - Reduced manufacturing complexity
- Streamline supply chain

Commonality in the Field

- Simplify sustainment
- Reduce sustainment
- Support multi-functionality
- Reduce personnel requirements
- Reduce training requirements

User Focus is Commonality in the Field

Why Commonality?

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- **Achieve Efficiencies in Maintainability**
  - Fewer unique installations
    - Fewer unique maintenance/repair procedures
      - Reduces training requirements
      - Requires fewer unique skills
      - Accelerates repair/replacement
- **Achieve Efficiencies in Operational Availability**
  - Less down time due to
    - Faster repair/replacement of failed components
    - Reduced spares requirements / Less dependency on the supply chain
    - Ability to swap like components between systems to meet mission needs
- **Achieve Efficiencies in Life Cycle Cost**
  - Fewer unique parts
  - Reduced spares requirements
  - Reduced training requirements

Commonality is a Key Ingredient to Meeting the FCS Program Objective to Reduce Logistics Footprint

What does it mean to be “common”?

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A part is considered “common” if the following criteria are met:

(a) The part is designated as a field-replaceable part

(b) The part is functionally required on multiple systems in a specific class

(c) The part, with the same NSN number, is equally qualified for use on all systems in a specific class without modification.

<u>Common Component</u>: A field replaceable LRU/LRM that is used in the same application on multiple systems in a system class, and has the same NSN number regardless of system application.

Establish a Common Set of Expectations

Definition of the System Classes

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For the purposes of component commonality, the systems classes are defined as follows:

Class	Systems Included	Commonality Requirement
MGV	All	Applies
MULE	MULE-T, MULE-C, ARV-A(L)	Applies
ARV	ARV-A, ARV-RSTA	Applies
SUGV	Self	Does Not Apply
Class 1 UAV	Self	Does Not Apply
Class 2 UAV	Self	Does Not Apply
Class 3 UAV	Self	Does Not Apply
Class 4 UAV	Self	Does Not Apply
T-UGS	Self	Does Not Apply
U-UGS	Self	Does Not Apply
NLOS-LS	Self	Does Not Apply
IMS	Self	Does Not Apply

Apply Commonality Where it Makes Sense

Requirement Development

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User Requirement

The System-of-Systems shall maximize platform and component commonality within each system class to a level of 70%.

System-of-Systems Design Requirement

The FCS Platforms shall use common LRUs/LRMs to allow for 70% interchangeability within the classes for each major FCS system.

System/Platform Design Requirement

The PRIME ITEM shall have 70% common and interchangeable LRUs/LRMs within each class.

Commonality Definitions Facilitate Allocation of Meaningful Requirements at Multiple Levels in the FCS Product Structure

Status of Commonality on FCS

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- **Component commonality is a contractual program requirement, specified in the ORD and Statement of Work (SOW)**
- **Commonality requirements are defined in the System-of-Systems Specification**
- **Commonality requirements are included in the Prime Item Development Specifications (PIDS) which establish the requirements baseline for each FCS system**
- **Incorporation of component commonality into the system design is required in each One Team Partner's SOW**
- **Expectations for component commonality across the SoS are clearly defined**

The FCS Program is Committed to Achieving Component Commonality Objectives

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- ✓ **Defining Commonality Requirements for FCS**
- ➢ **Considerations in Pursuing Commonality**
  - **Identifying Common Functionality**
  - **Program Set-up**
- **Measuring Commonality**
- **Summary**
- **Questions**

Considerations in Pursuing Commonality

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- **Establish commonality objectives where it makes sense, taking into consideration:**
  - System functionality
  - System performance
  - System maintenance concepts
  - Life Cycle Cost
- **The opportunity for commonality is greatest between systems that have common or similar functionality**
  - Identify common functions between multiple systems
  - Focus commonality objectives on the systems/subsystems that perform similar functions
  - Adapt definition and allocation of functions within the system architecture to facilitate the use of common components

Expectations for commonality need to be realistic

Identifying Common Functions – SoS Level

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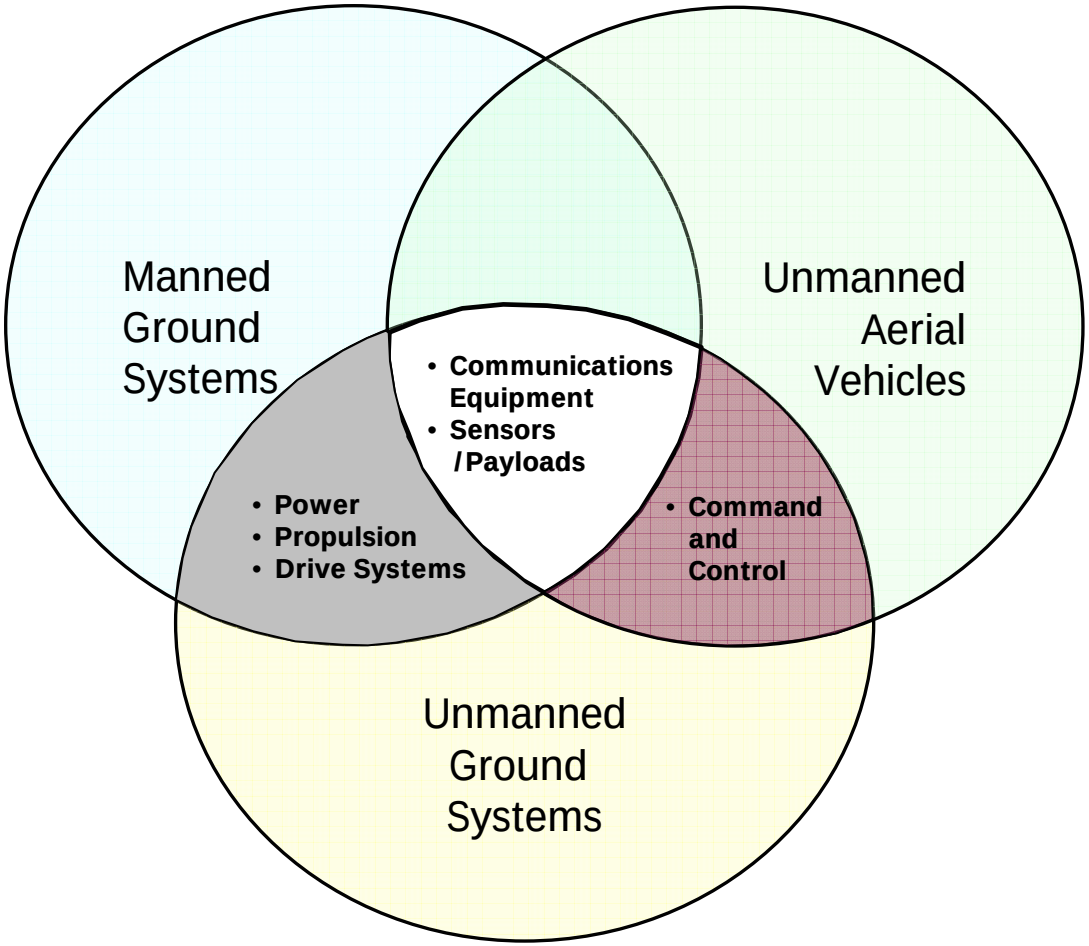
- **Identify the Systems Classes**
- **Identify common functions between systems = where it would be logical to have common components**



Identifying Common Functions – System Level

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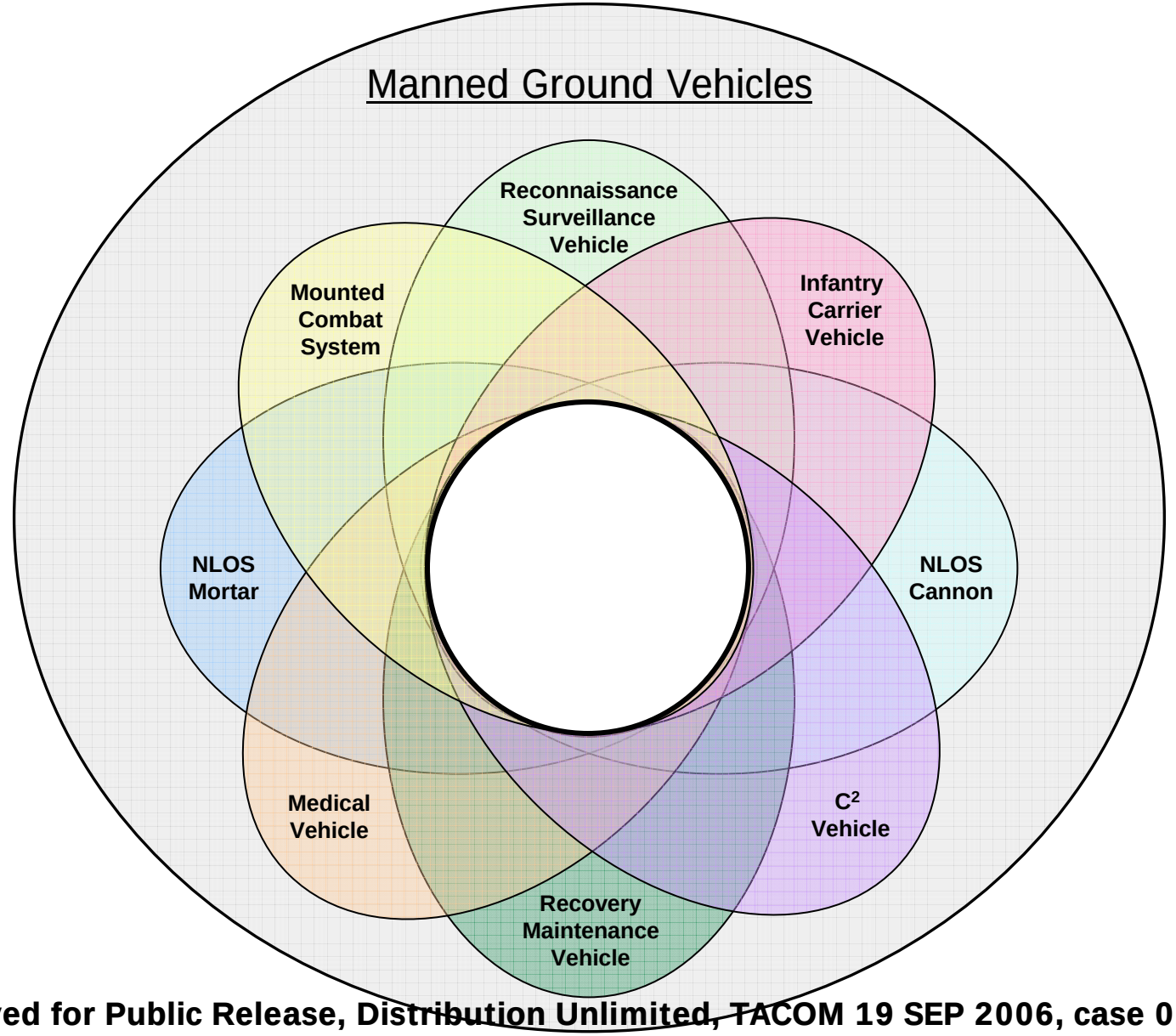

Identifying Common Functions – System Level

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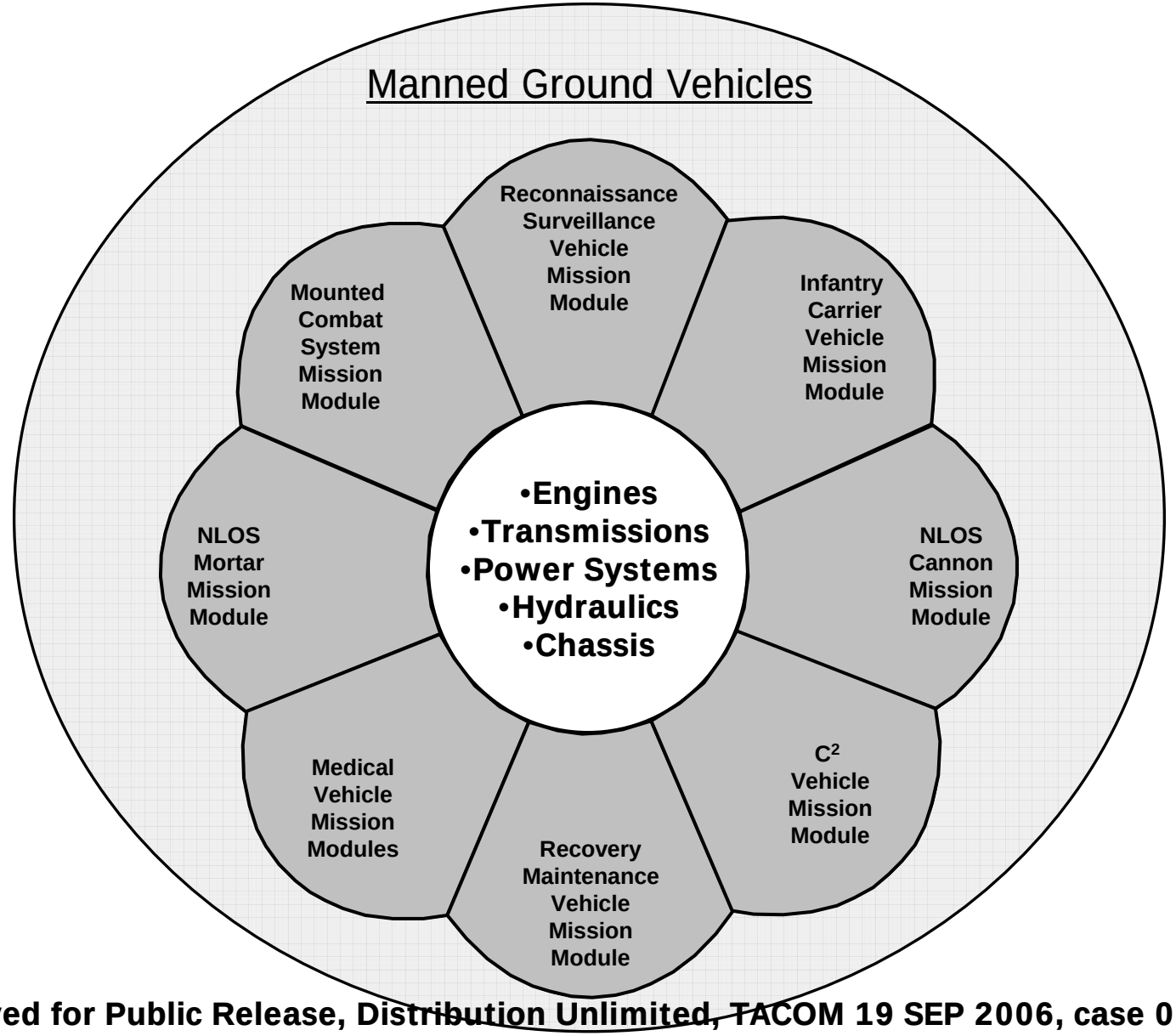

Program Setup

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- **Commonality objectives integrated early in the development effort**
  - Program goals and objectives
  - Identification of the system functionality and performance
  - Definition of the product structure
- **Commonality is more than a requirements issue**
  - Concept of Operations
    - Commonality needs to be driven by user goals and objectives
  - Business Management
    - Commonality objectives need to be part of the program business model
  - Supplier Management
    - Suppliers need to be contractually obligated and incentivized to achieve commonality objectives

Commonality Needs to be Built Into the Basic Foundations of a Program

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Compliance with Commonality Requirements

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- **Early attempts on FCS to define an methodology for determining compliance with the commonality requirements looked at statistical analysis**
  - Resulted from many different interpretations of what it meant to be common and how it applied to the FCS systems
  - Lacked relevance - difficult to relate back to desired design characteristics and performance
- **Establishment of the commonality definitions facilitated discussions on how to count common versus unique LRUs/LRMs**
  - Perceived as a more tangible assessment of compliance
  - Directly related to the system design
  - Discussed as Approach 1 on the next chart
- **Consideration of commonality as a SoS requirement being addressed in a system design/development environment leads to the proposal of Approach 2**
  - Potential for more realistic expectations
  - Allows for consistent assessment between system and SoS perspectives

Commonality Approaches are Still Evolving

Measuring Commonality – Approach 1

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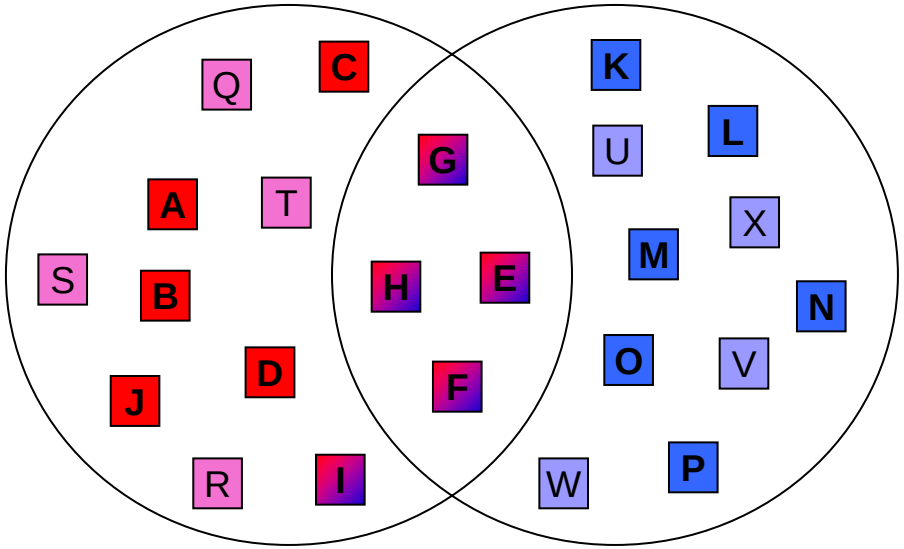
$$\text{Commonality Requirement } (C_R) = \frac{\text{Total Number of LRUs/LRMs that should be common}}{\text{Total Number of LRUs/LRMs}}$$

$$\text{Commonality Performance } (C_P) = \frac{\text{Total Number of LRUs/LRMs that are common}}{\text{Total Number of LRUs/LRMs}}$$



- Each box is a part
- Bold indicates a part that has been designated as an LRU/LRM
- ■ Indicates an LRU/LRM that should be common
- Of the LRUs/LRMs that should be common, only the ones in the intersection actually are common

System 1
14 Parts
10 LRUs/LRMs (Bold)
5 LRUs/LRMs should be common
4 LRUs/LRMs are common

C_R = 5/10 = 50 %
C_P = 4/10 = 40 %

System of Systems
24 Parts
16 LRUs/LRMs (Bold)
5 LRUs/LRMs should be common
4 LRUs/LRMs are common

C_R = 5/16 = 31 %
C_P = 4/16 = 25 %

System 2
14 Parts
10 LRUs/LRMs (Bold)
4 LRUs/LRMs should be common
4 LRUs/LRMs are common

C_R = 4/10 = 40 %
C_P = 4/10 = 40 %

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Measuring Commonality – Approach 2

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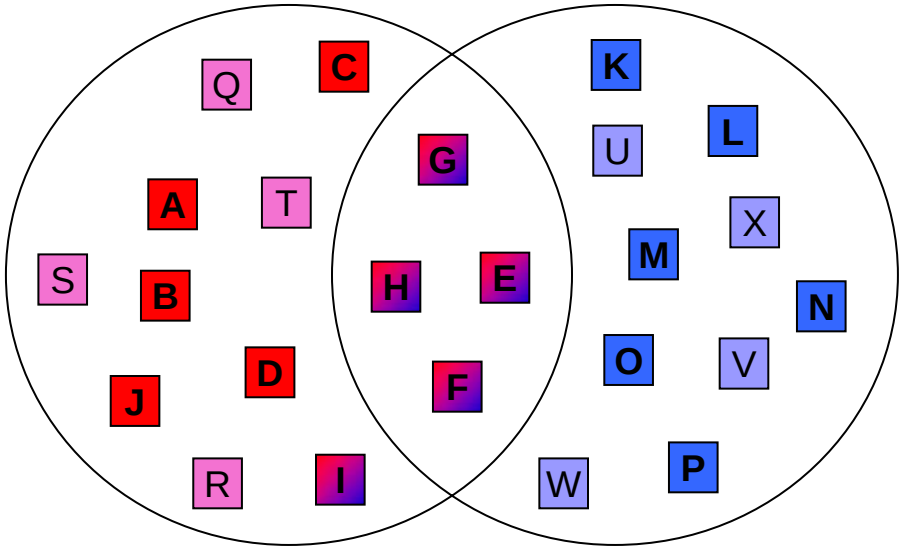
$$\text{Commonality Potential } (C_p) = \frac{\text{Total Number of LRUs/LRMs that } \textbf{could} \text{ be common}}{\text{Total Number of LRUs/LRMs}}$$

$$\text{Commonality Ratio } (C_r) = \frac{\text{Total Number of LRUs/LRMs that are common}}{\text{Total Number of LRUs/LRMs that } \textbf{could} \text{ be common}}$$



- Each box is a part
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- ■ Indicates an LRU/LRM that should be common
- Of the LRUs/LRMs that should be common, only the ones in the intersection actually are common

System 1
14 Parts
10 LRUs/LRMs (Bold)
5 LRUs/LRMs could be common
4 LRUs/LRMs are common

C_p = 5/10 = .5
C_r = 4/5 = .8

System of Systems
24 Parts
16 LRUs/LRMs (Bold)
5 LRUs/LRMs could be common
4 LRUs/LRMs are common

C_p = 5/16 = .3
C_r = 4/5 = .8

System 2
14 Parts
10 LRUs/LRMs (Bold)
4 LRUs/LRMs could be common
4 LRUs/LRMs are common

C_p = 4/10 = .4
C_r = 4/4 = 1

Measurement Observations

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- **Approach 1**
  - Percentages, as a definition of the level of commonality to be exhibited by a system to be designed, do not translate well into design requirements
  - Percentages, as an assessment of performance or compliance, can be misleading
- **Approach 2**
  - A measure of “Commonality Potential”, based on the evaluation of common functions in a conceptual design, can provide more realistic expectations for a specific development effort
  - A “Commonality Ratio” provides an assessment of commonality that is more consistent across multiple systems in a SoS environment

Assessment Approach Needs to be Developed Concurrently with Definitions and Requirements

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Summary

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- **FCS is actively working to meet the program commonality objectives**
- **The FCS program SoS approach to commonality is based upon:**
  - A clear definition of Commonality
    - What is Commonality?
    - What is the purpose of Commonality on a specific program?
    - How are Commonality criteria applied to the system architecture?
  - Commonality objectives included in the initial formulation of a program
  - Commonality objectives synchronized with the system architecture and conceptual design
- **Measures of achievement of commonality objectives are being developed using the same definitions and expectations that established the commonality requirements**

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