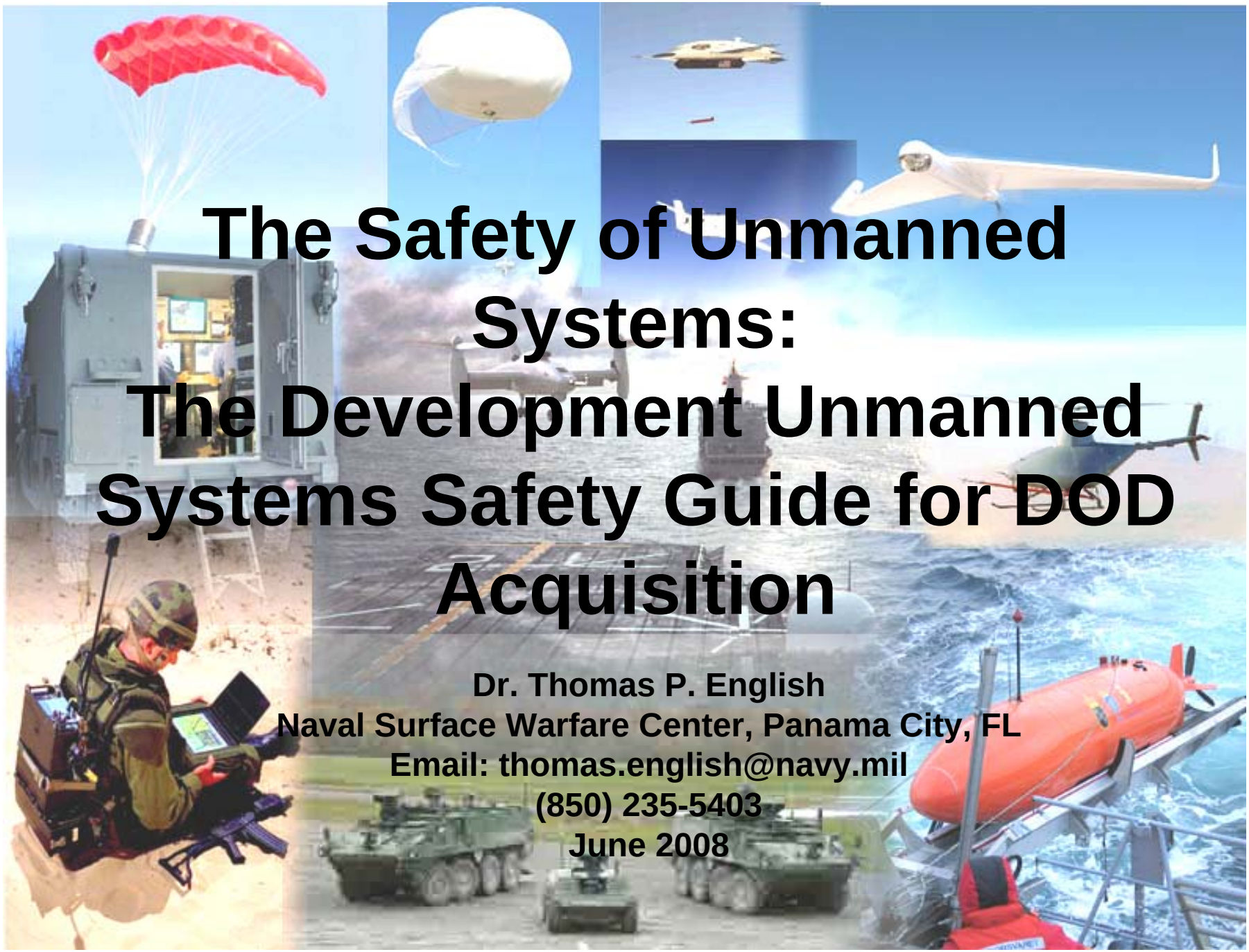

# The Safety of Unmanned Systems: The Development Unmanned Systems Safety Guide for DOD Acquisition

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**June 2008**

# Agenda

- Why Safety of UMS?
- Why UMS System Safety?
- Command and Control Issues for UMS
- Approach
- Road to Completion
- Workshop Organization
- Precept Definitions
- Working Group #3 Situational Awareness
- Summary

# Why Safety of UMSs?

MQ-1 PREDATOR WITH HELLFIRES (USAF)

# Why UMS System Safety?

| ***Data*** | *boolean* | ***Time*** | *boolean* | *Requirements Responsibilty* |
|---|---|---|---|---|
| RIGHT | 1 | RIGHT | 1 | Sys Eng |
| RIGHT | 1 | WRONG | 0 | Safety |
| WRONG | 0 | RIGHT | 1 | Safety |
| WRONG | 0 | WRONG | 0 | Safety |

# $C^2$ Issues for UMS

- Weapon Interaction
- Software
- Communications concepts
- Security
- Fuzing
- Unmanned Systems as systems
- Autonomy Levels
- Advances in command and control
- System of systems
- Net Centric warfare

# Unmanned Systems Leadership

- **OSD Sponsor**
  - **Mr. Mark Schaeffer, Director, Systems and Software Engineering & Chairman, DSOC ATP TF**
  - **Dr. Liz Rodriquez-Johnson, Executive Secretary, DSOC ATP TF**

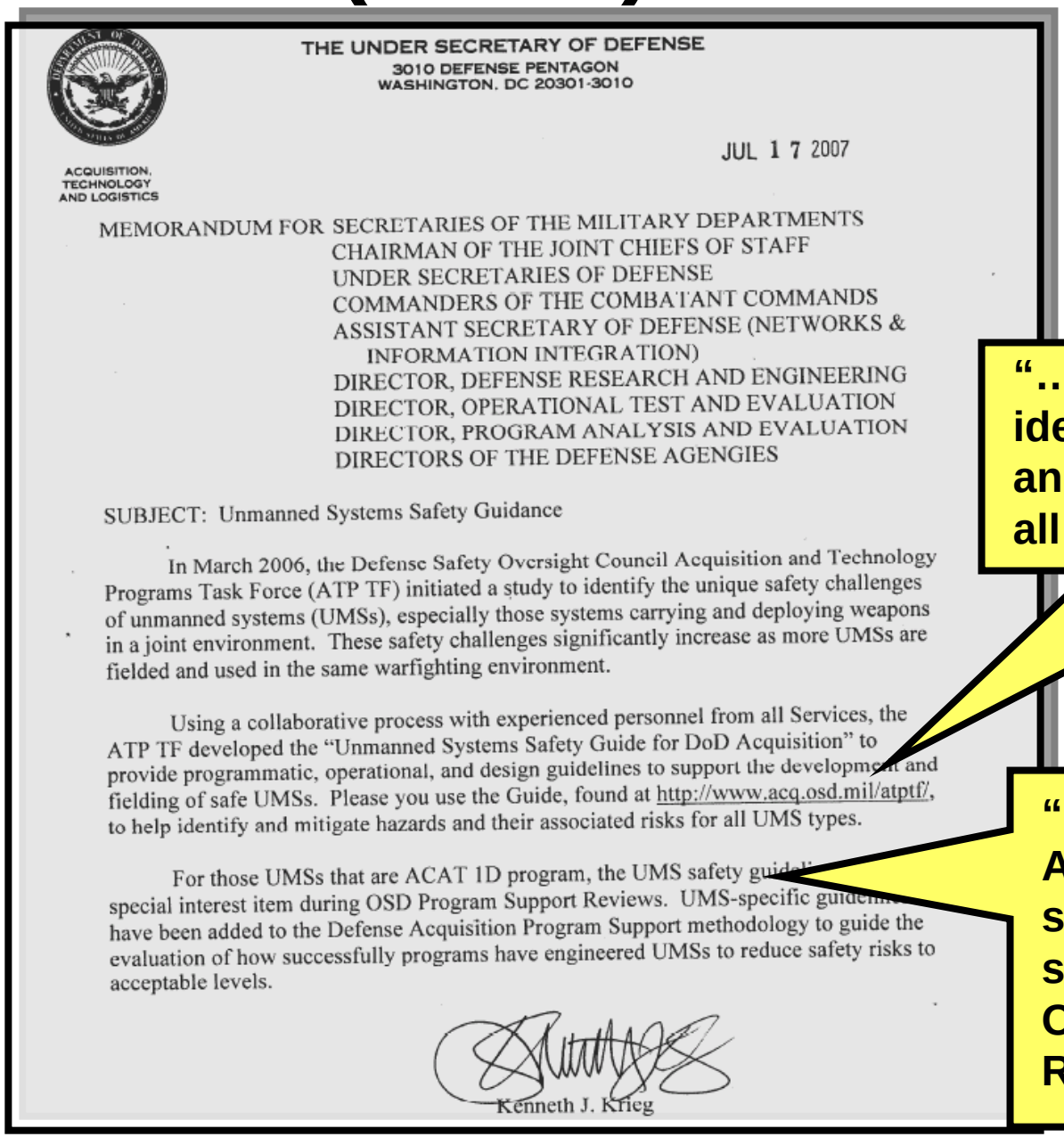
# Approach

- ✓ **Involve technical community**
  - Six Workgroups
  - Approximately 80 technical experts
  - Government, Industry, Academia
- ✓ **Maximize Community Awareness**
  - March 2006 Workshop
    - 300 attendees
  - International Systems Safety Conference (ISSC)
  - Association of Unmanned Vehicles International (AUVSI)
  - NDIA Systems Engineering Conference
- ✓ **Obtain Feedback**
  - Web Page (http://www.ih.navy.mil/unmannedsystems)
  - Tech Panels & Reviews
    - ✓ ISSC (31 July - 4 Aug 2006)
    - ✓ AUVSI (29 – 31 Aug 2006)
    - ✓ NDIA Systems Engineering (23 – 26 Oct 2006)
    - ✓ Mr. Schaeffer's Systems Engineering Forum
    - ✓ 13th ICCRTS

# Road to Completion

- ✓ **Held Three Workshops**
  - March 2006, Huntsville
  - May 2006, Crystal City
  - June 2006, Crystal City
- ✓ **Developed Safety Precepts**
  - Programmatic safety precepts (6)
  - Operational safety precepts (5)
  - Design safety precepts (19)
- ✓ **Developed more detailed design safety "best practices" (safety precept clarification tables) (ongoing)**
- ✓ **USD (AT&L) issued the Guide on 17 July 2007**

# USD (AT&L) UMS Memorandum



THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION, TECHNOLOGY AND LOGISTICS

JUL 17 2007

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
COMMANDERS OF THE COMBATANT COMMANDS
ASSISTANT SECRETARY OF DEFENSE (NETWORKS & INFORMATION INTEGRATION)
DIRECTOR, DEFENSE RESEARCH AND ENGINEERING
DIRECTOR, OPERATIONAL TEST AND EVALUATION
DIRECTOR, PROGRAM ANALYSIS AND EVALUATION
DIRECTORS OF THE DEFENSE AGENCIES

SUBJECT: Unmanned Systems Safety Guidance

In March 2006, the Defense Safety Oversight Council Acquisition and Technology Programs Task Force (ATP TF) initiated a study to identify the unique safety challenges of unmanned systems (UMSs), especially those systems carrying and deploying weapons in a joint environment. These safety challenges significantly increase as more UMSs are fielded and used in the same warfighting environment.

Using a collaborative process with experienced personnel from all Services, the ATP TF developed the "Unmanned Systems Safety Guide for DoD Acquisition" to provide programmatic, operational, and design guidelines to support the development and fielding of safe UMSs. Please you use the Guide, found at http://www.acq.osd.mil/atptf/, to help identify and mitigate hazards and their associated risks for all UMS types.

For those UMSs that are ACAT 1D program, the UMS safety guidel[illegible] special interest item during OSD Program Support Reviews. UMS-specific guidelin[illegible] have been added to the Defense Acquisition Program Support methodology to guide the evaluation of how successfully programs have engineered UMSs to reduce safety risks to acceptable levels.

Kenneth J. Krieg

**"… use the Guide to help identify and mitigate hazards and their associated risks for all UMS types."**

**"For those UMSs that are ACAT 1D Programs, the UMS safety guidelines will be a special interest item during OSD Program Support Reviews."**

# Workshop Organization

- ✓ **Six Workgroups**
  1. **Precept Development**
  2. **Weapons Control**
  3. **Situational Awareness**
     - **Human-Machine Interface**
     - **Machine-Machine Interface**
  4. **Command and Control**
  5. **States and Modes**
  6. **Definitions/Common Taxonomy**

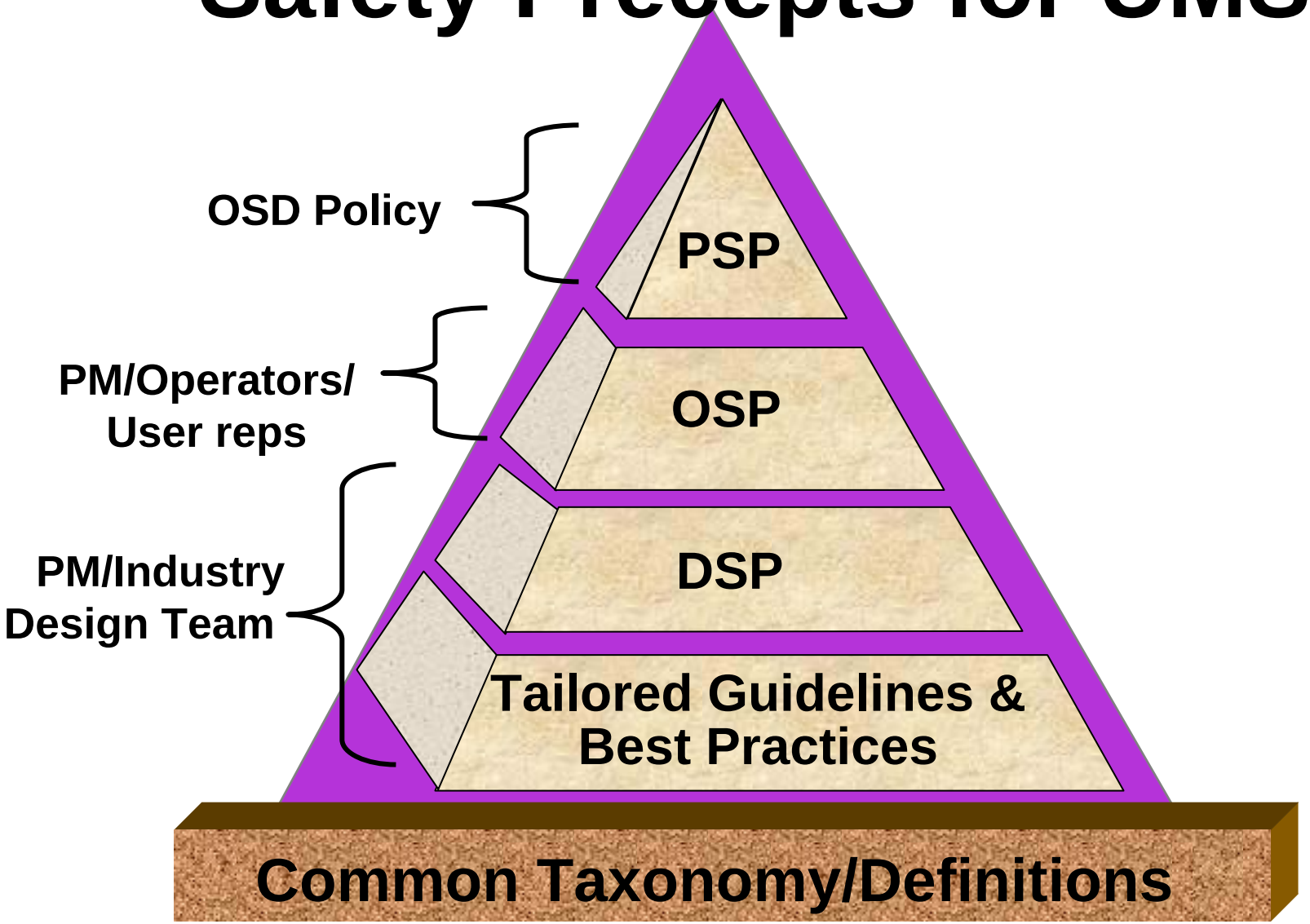
# UMS Safety Precept Definitions

**Programmatic Safety Precept (PSP)** = Program management principles & guidance that will help ensure safety is adequately addressed throughout the lifecycle process. (6)

**Operational Safety Precept (OSP)** = A safety precept directed specifically at system operation. Operational rules that must be adhered to during system operation. These safety precepts may generate the need for Design Safety Precepts. (5)

**Design Safety Precept (DSP)** = General design guidance intended to facilitate safety of the system and minimize hazards. Safety design precepts are intended to influence, but not dictate, specific design solutions. (19)

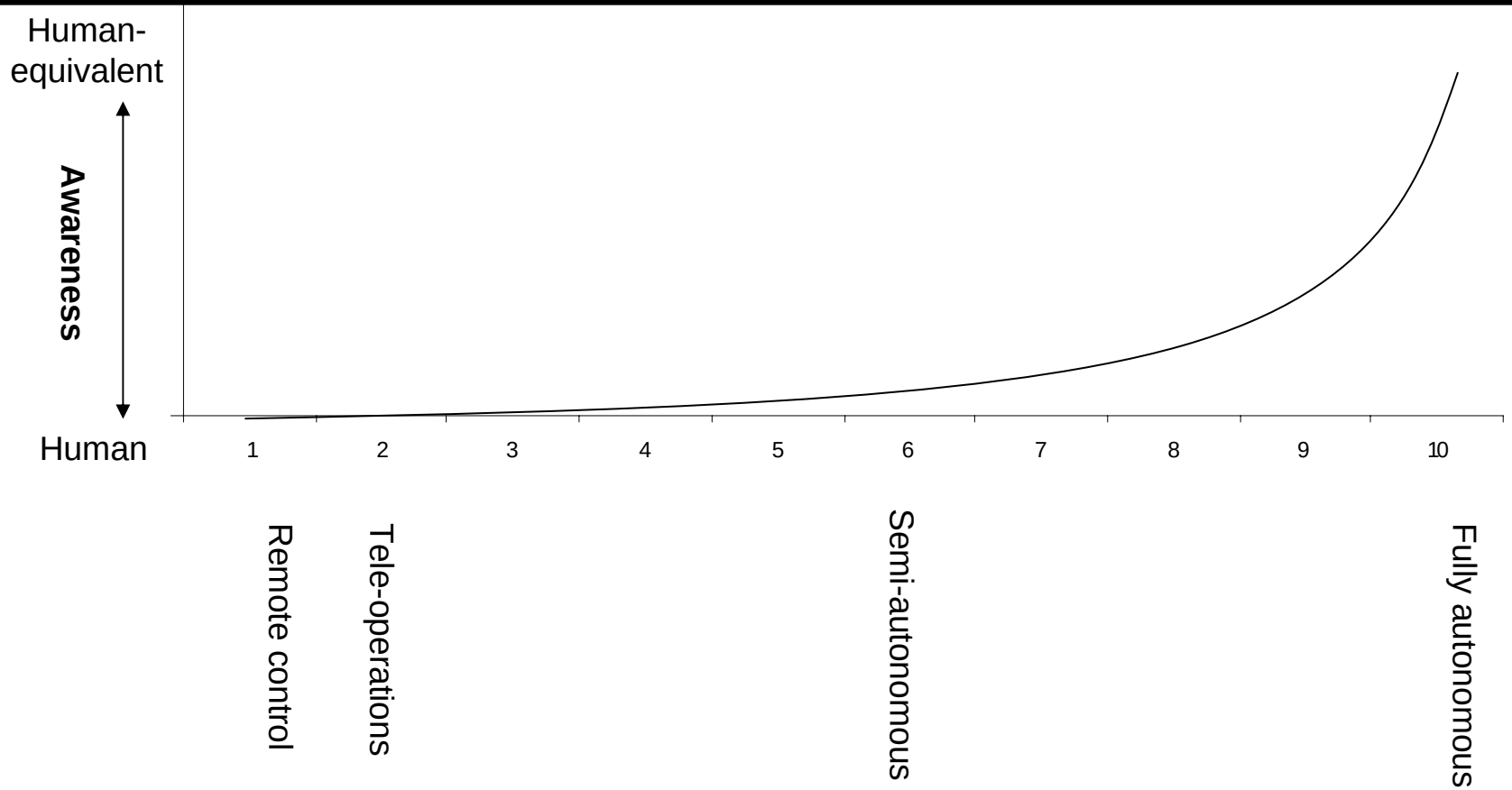
# Safety Precepts for UMS




**Provide PMs, designers, and systems safety managers with appropriate safety guidelines and best practices, while maintaining PM's flexibility**

# WORK GROUP #3
# Situational Awareness

# Challenge - Addressing the Spectrum

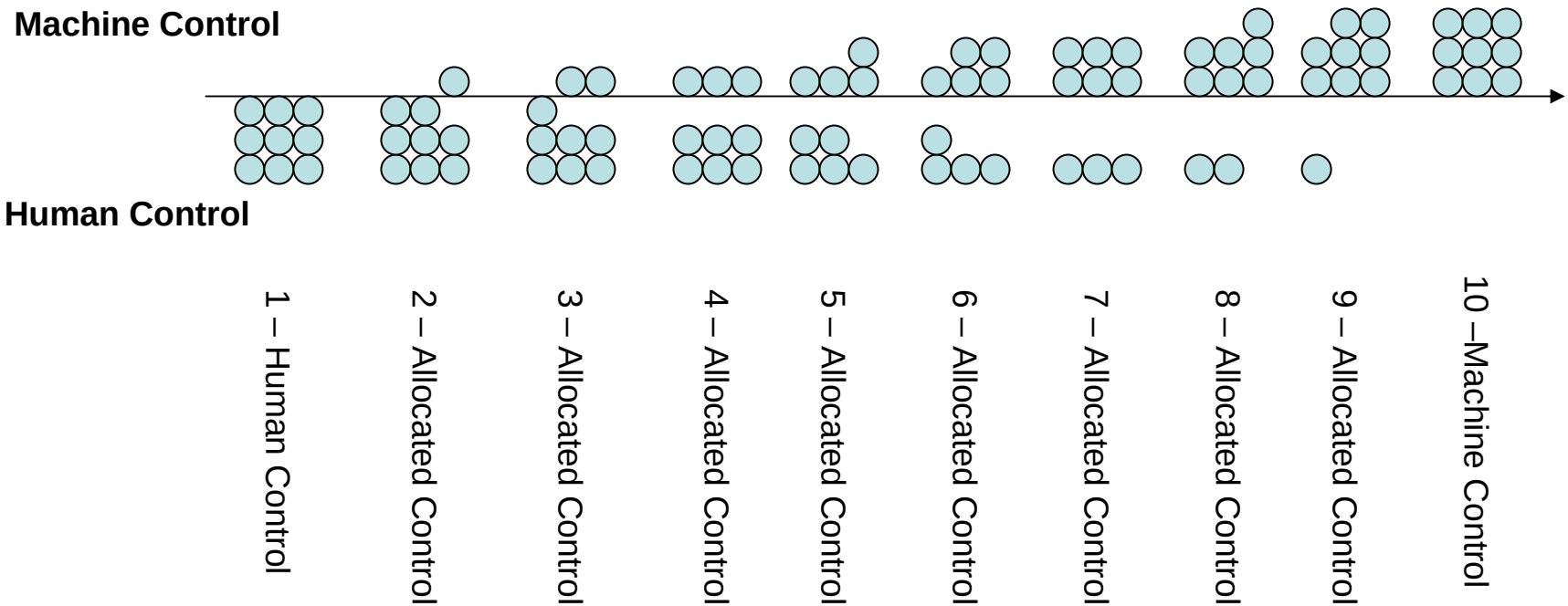


# Spectrum of Autonomy Linked to SA

Denotes individual safety-critical actions for which adequate SA must be defined.
i.e. arm the machine gun, steer to avoid obstructions, discriminate target, …

Position shows whether machine or human must have this SA.

Human SA requires Performance Measurement Criteria to evaluate.
Machine SA requires an original characterization since it is not currently defined.



# Design Safety Precept #3

**DSP-3**: **The unmanned system shall be designed to provide information, intelligence, and method of control ($I^2C$) to support safe operations.**

Definitions:

- **Information**: Knowledge or data necessary for the safe operation of a UMS; obtained from the process of recognizing and interpreting data in the environment, memory and recall of facts, and/or communication.
- **Intelligence**: The capacity of a UMS to acquire, comprehend, and apply information.
- **Method of control**: The means or manner in which an operator interacts, influences, or directs an unmanned system; a function of three non-exclusive system attributes:
  - **Mode of control**
  - **Level of authority**
  - **Level of control**

# Definitions (cont):

- **Mode of control**: The means by which a UMS receives instructions governing its actions and feeds back information.
  - Remote control
  - Tele-operation
  - Semi-autonomous
  - Fully autonomous

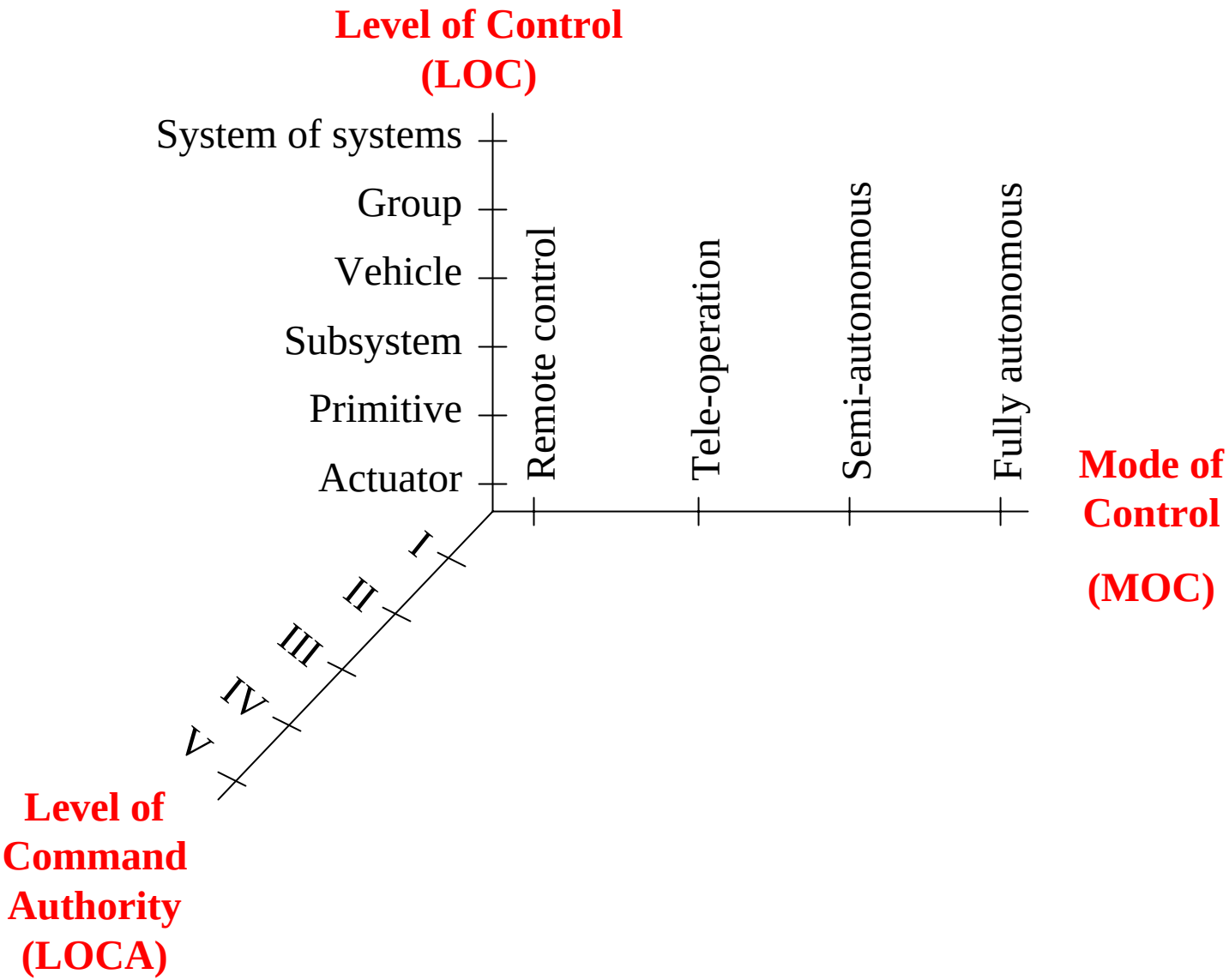
Definitions (cont):

- **Level of command authority**: The degree to which an entity is invested with the power to access the control and functions of a UMS.
  - Level I – Reception and transmission of secondary imagery or data
  - Level II - Reception of imagery or data directly from the UMS
  - Level III - Control of the UMS payload
  - Level IV - Full control of the UMS excluding deployment and recovery
  - Level V – Full control of the UMS including deployment and recovery

# Definitions (cont):

- **Level of control**: Locus at which a controlling entity interacts, influences, or directs a UMS(s).
  - Actuator
  - Primitive
  - Subsystem
  - Vehicle
  - Group of vehicles
  - System of systems

# UMS Command and Control Elements




Questions and Comments