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US Army Research Laboratory
Human Research and Engineering Directorate
US Army Aviation and Missile Command
• Corporate Laboratory of the Army Material Command (AMC)
• Located in the Research, Development, and Engineering Command (RDECOM)
• ARL’s Six (6) Directorates:
  – Computational and Information Sciences Directorate (CISD)
  – Human Research and Engineering Directorate (HRED)
  – Sensors and Electron Devices Directorate (SEDD)
  – Survivability / Lethality Analysis Directorate (SLAD)
  – Vehicle Technology Directorate (VTD)
  – Weapons and Materials Research Directorate (WMRD)
• The Army Research Office
Core Competencies

Extramural Basic Research
- Chemistry
- Physics
- Life Sciences
- Network Science
- Environmental Sciences

Intramural Research
- Materials Sciences
- Mechanical Sciences
- Mathematics
- Computing Science

Technical Assessment & Analysis
- Ballistic Vulnerability Analysis and Assessment
- Electronic and Info Warfare Vulnerability Analysis and Assessment

Core Technical Competencies

Materials Sciences
- Structural Materials and Components
- Electronic Materials and Devices
- Photonic Materials and Devices
- Energy Materials and Components

Information Sciences
- Network Sciences
- Decision Support Sciences
- Computational Sciences
- Autonomy
- Atmospheric Sciences
- Electronic and Info Warfare Vulnerability

Ballistics and Aeromechanic Sciences
- Energetics and Propulsion Science
- Impact Physics
- Aeromechanics
- Ballistic Vulnerability

Human Sciences
- Soldier Performance
- Simulation and Training
- Human Systems Integration

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
• Distributed Autonomy
  – Human
  – Aircraft

• Interoperability
  – System-of-Systems
  – Information Detection
  – Goal Directed Control
STANAG 4586
Elements for UAS Operational Control:

• Soldier
• Aircraft
• Vehicle Module
• Common UAS Control System

*STANAG = Standardization Agreement
Interoperability is the degree of control that a Soldier has over the unmanned air vehicle, payload or both.

Within UAS operational circles five LOI levels are typically defined:

- Level 1: Indirect receipt/transmission of UAS payload data
- Level 2: Direct receipt/transmission of UAS payload data
- Level 3: Control of the UAS payload, not the flight unit
- Level 4: Control of the UAS without takeoff and landing
- Level 5: Control of the UAS with takeoff and landing
• Multiple Control Frames of Reference
• Multiple Visual Frames of Reference

Unequal control gains between aircraft payloads require Pilots to switch between two different thumb force control patterns.
• System-of-System Interoperability Requires a Human Operator Centered Design Approach Early in the Planning Stages.

• Operator workload increases over multiple frames of reference:
  – Vision
  – Control