# Second IFIP Workshop on Intelligent Vehicle Dependability & Security

**June 23 – 26, 2022**


**Workshop Chair**

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Prof. Cristina Nita-Rotaru, NEU
Dr. Wilfried Steiner, TTTech, Vienna


https://www.dependability.org/wg10.4/ivds/index.html

# IVDS Summer 22 Workshop Overview

Workshop Focus: How to Survive Cyber Attacks on Safety-Critical Functions of Intelligent Vehicles

Goal: Discuss design solutions, quantitative cyber-survivability measures, and verification and validation with regard to impact on AV safety.

Specific Topics & Issues[1,2]

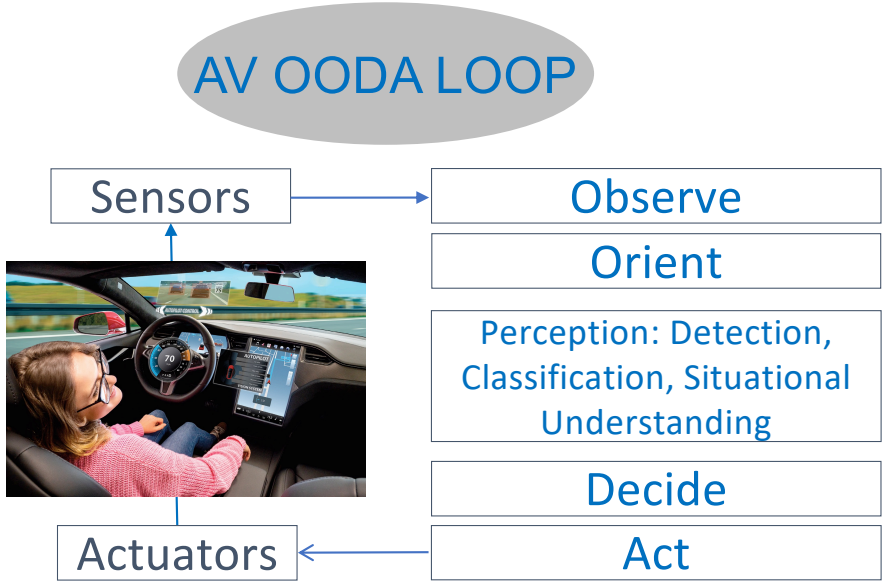
- Maturity of techniques: Theoretical analysis, modeling, simulation, lab experiments, component and system test & verification, penetration testing, real-world test runs, etc.
- Gaps in capability of techniques and current research in filling those gaps
- Industry use and awareness of existing techniques
- Integration of techniques to provide a holistic safety argument
- Novel system architecture and design solutions for cyber survivability

Desired Outcome: A set of specific actions, both short term and long term, to achieve the IVDS project's vision, mission and goals.

1. Physical attacks such as stickers on stop signs, dirty road patches, or poisoning of training data are outside the scope of cyber-related attacks.
2. Deficiencies of AI/ML are also not the focus of this workshop.

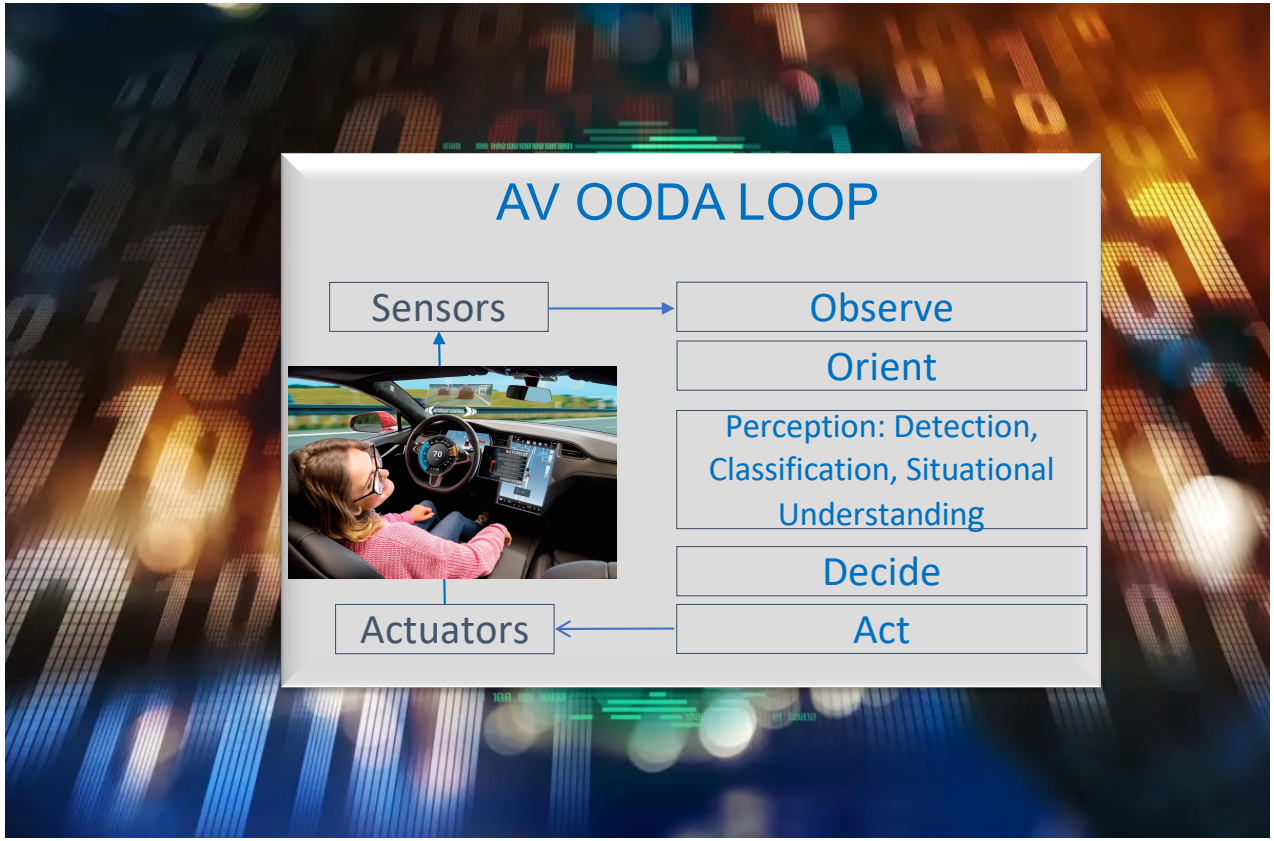
# Workshop Scope

- Sensors (Observe): Electro-Optical, Infrared, Radar, GPS, MEMS, Vehicle subsystems (Engine/Brakes/etc) performance, health & status sensors
- Algorithms (Orient & Decide): Catch-all for all the Feedback Control System Functions, incl. sensor processing and correlation, situational awareness, decision making, collision avoidance, etc.
- Actuators (Act): Commands to Engine, Brakes, Steering
- Processors: CPUs, GPUs, Software
- Communication: Links to other cars and Traffic Signaling Systems
- Driver Inputs: for L0 – L3 AVs




Current L0-L2+ Functions + Future L3-L5 capabilities

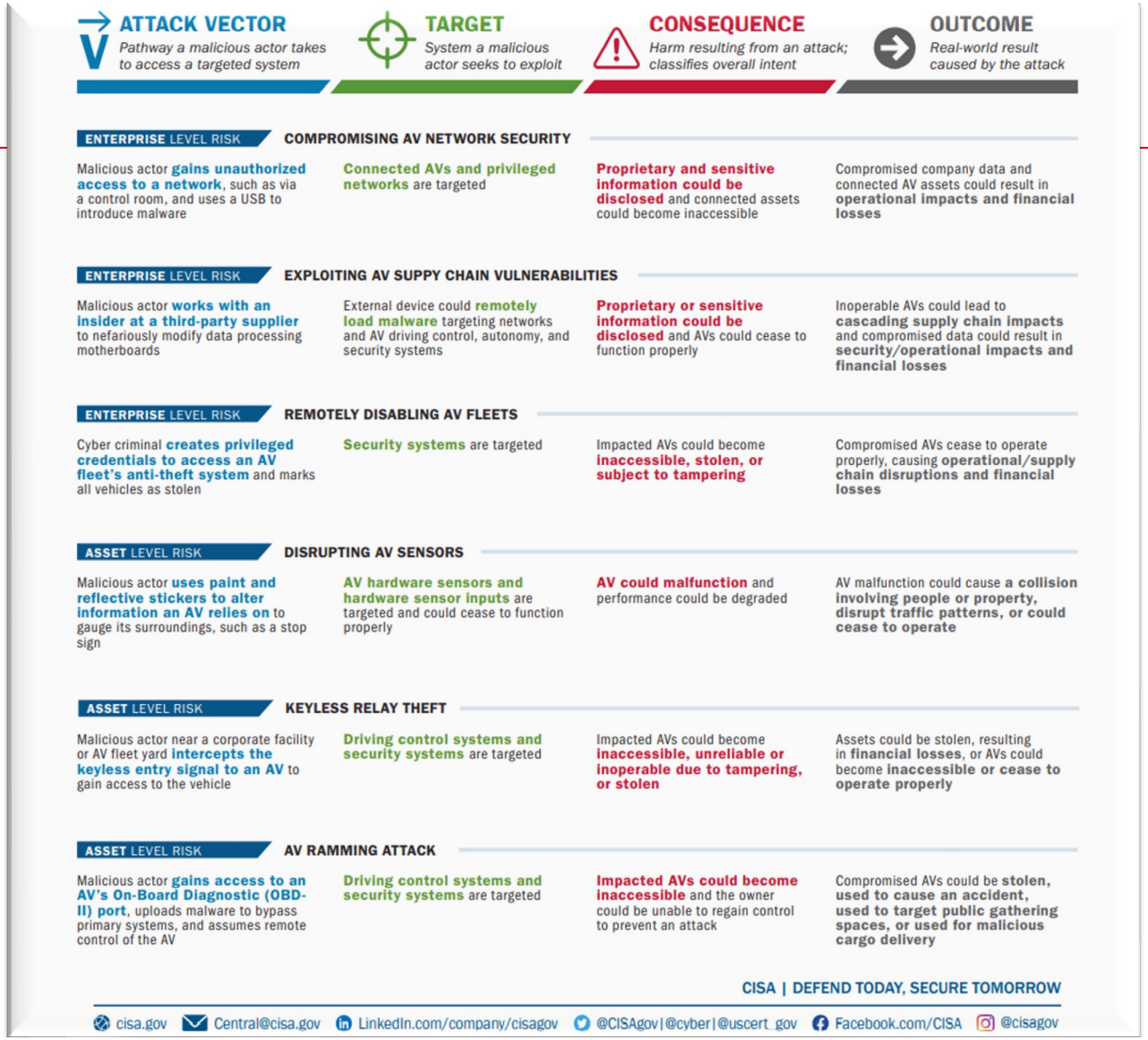
# AV Ecosystem Immersed in Digital Sea




AV sensors, actuators, computations, comms are subject to continual cyber attacks

# Cybersecurity and Infrastructure Security Agency (CISA) Autonomous Vehicle Cyber-Attack Taxonomy (AV|CAT)

WG.10.4



| ATTACK VECTOR<br>*Pathway a malicious actor takes to access a targeted system* | TARGET<br>*System a malicious actor seeks to exploit* | CONSEQUENCE<br>*Harm resulting from an attack; classifies overall intent* | OUTCOME<br>*Real-world result caused by the attack* |
|---|---|---|---|
| **ENTERPRISE LEVEL RISK** — **COMPROMISING AV NETWORK SECURITY** | | | |
| Malicious actor **gains unauthorized access to a network**, such as via a control room, and uses a USB to introduce malware | **Connected AVs and privileged networks** are targeted | **Proprietary and sensitive information could be disclosed** and connected assets could become inaccessible | Compromised company data and connected AV assets could result in **operational impacts and financial losses** |
| **ENTERPRISE LEVEL RISK** — **EXPLOITING AV SUPPY CHAIN VULNERABILITIES** | | | |
| Malicious actor **works with an insider at a third-party supplier** to nefariously modify data processing motherboards | External device could **remotely load malware** targeting networks and AV driving control, autonomy, and security systems | **Proprietary or sensitive information could be disclosed** and AVs could cease to function properly | Inoperable AVs could lead to **cascading supply chain impacts** and compromised data could result in **security/operational impacts and financial losses** |
| **ENTERPRISE LEVEL RISK** — **REMOTELY DISABLING AV FLEETS** | | | |
| Cyber criminal **creates privileged credentials to access an AV fleet's anti-theft system** and marks all vehicles as stolen | **Security systems** are targeted | Impacted AVs could become **inaccessible, stolen, or subject to tampering** | Compromised AVs cease to operate properly, causing **operational/supply chain disruptions and financial losses** |
| **ASSET LEVEL RISK** — **DISRUPTING AV SENSORS** | | | |
| Malicious actor **uses paint and reflective stickers to alter information an AV relies on** to gauge its surroundings, such as a stop sign | **AV hardware sensors and hardware sensor inputs** are targeted and could cease to function properly | **AV could malfunction** and performance could be degraded | AV malfunction could cause **a collision involving people or property, disrupt traffic patterns, or could cease to operate** |
| **ASSET LEVEL RISK** — **KEYLESS RELAY THEFT** | | | |
| Malicious actor near a corporate facility or AV fleet yard **intercepts the keyless entry signal to an AV** to gain access to the vehicle | **Driving control systems and security systems** are targeted | Impacted AVs could become **inaccessible, unreliable or inoperable due to tampering, or stolen** | Assets could be stolen, resulting in **financial losses**, or AVs could become **inaccessible or cease to operate properly** |
| **ASSET LEVEL RISK** — **AV RAMMING ATTACK** | | | |
| Malicious actor **gains access to an AV's On-Board Diagnostic (OBD-II) port**, uploads malware to bypass primary systems, and assumes remote control of the AV | **Driving control systems and security systems** are targeted | **Impacted AVs could become inaccessible** and the owner could be unable to regain control to prevent an attack | Compromised AVs could be **stolen, used to cause an accident, used to target public gathering spaces, or used for malicious cargo delivery** |

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# Mission Assurance

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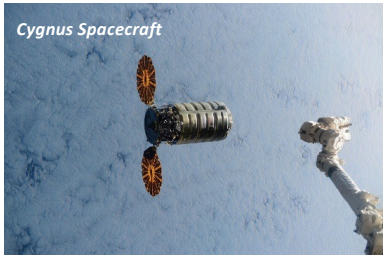


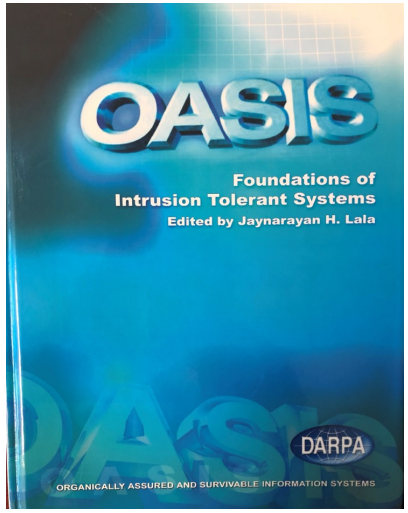


DRAPER

ITS Intrusion Tolerant Systems

Self- Regenerative Systems

OASIS




DARPA




Raytheon Missiles & Defense


DARPA

# New Paradigms for Cyber Defense

10 February 2003


**Dr. Jaynarayan Lala**

**Program Manager**

**Information Processing Technology Office**

INFORMATION PROCESSING TECHNOLOGY OFFICE

# Self Regenerative Systems (SRS): The Fourth Generation

**Prevent Intrusions**
(Access Controls, Cryptography, Trusted Computing Base)

Trusted Computing Base


Access Control & Physical Security


Cryptography


Multiple Security Levels

**1st Generation: Protection**

**But intrusions will occur**

**Detect Intrusions, Limit Damage**
(Firewalls, Intrusion Detection Systems, Virtual Private Networks, PKI)


Firewalls


Boundary Controllers


Intrusion Detection Systems


VPNs


PKI

**2nd Generation: Detection**

**But some attacks will succeed**

**Tolerate Attacks**
(Redundancy, Diversity, Deception, Wrappers, Proof-Carrying Code, Proactive Secret Sharing)


Intrusion Tolerance


Big Board View of Attacks Real-Time Situation Awareness & Response


Graceful Degradation


Hardened Operating System

**3rd Generation: Tolerance**

**So the system must reconstitute**

**Restore System**
(Diagnosis, Learning, Reconfiguration, S/W Rejuvenation, Natural Immunity, Reflection)


Self-Aware


Diagnosis


Learning


Reconfiguration


Reflection

**4th Generation: Regeneration**

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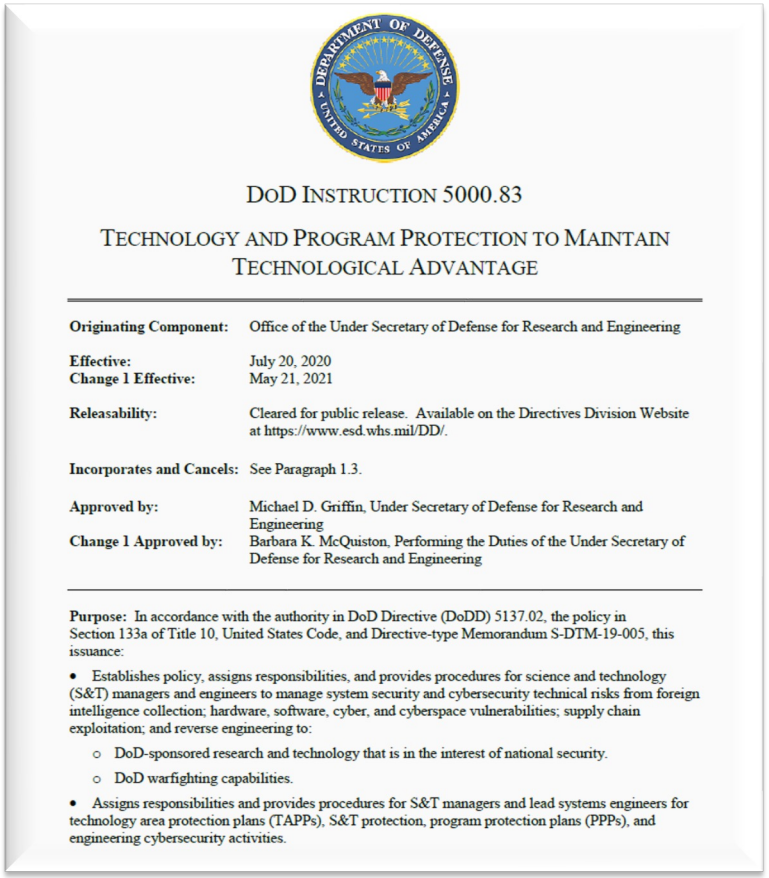
# DoD Policy: Make Systems Cyber Survivable

1.2. POLICY.
….
c. Programs will employ system security engineering methods and practices, including cybersecurity, cyber resilience, and **cyber survivability** in design, test, manufacture, and sustainment.

Such methods and practices will **ensure that systems function as intended**, mitigating risks associated with known and exploitable vulnerabilities to provide a level of assurance commensurate with technology, program, system, and mission objectives.

"…. Joint Capabilities Integration and Development System (JCIDS) Manual, updated February 12, 2015, implements a robust **cyber survivability requirement** within the **mandatory system survivability Key Performance Parameter (KPP)**. This new requirement will enhance system resilience in a cyber-contested environment or after exposure to cyber threats."

- DoD Program Manager's Guidebook for Integrating the Cybersecurity Risk Management Framework (RMF) into the System Acquisition Lifecycle, September 2015



DoD INSTRUCTION 5000.83

TECHNOLOGY AND PROGRAM PROTECTION TO MAINTAIN TECHNOLOGICAL ADVANTAGE

| | |
|---|---|
| **Originating Component:** | Office of the Under Secretary of Defense for Research and Engineering |
| **Effective:** | July 20, 2020 |
| **Change 1 Effective:** | May 21, 2021 |
| **Releasability:** | Cleared for public release. Available on the Directives Division Website at https://www.esd.whs.mil/DD/. |
| **Incorporates and Cancels:** | See Paragraph 1.3. |
| **Approved by:** | Michael D. Griffin, Under Secretary of Defense for Research and Engineering |
| **Change 1 Approved by:** | Barbara K. McQuiston, Performing the Duties of the Under Secretary of Defense for Research and Engineering |

**Purpose:** In accordance with the authority in DoD Directive (DoDD) 5137.02, the policy in Section 133a of Title 10, United States Code, and Directive-type Memorandum S-DTM-19-005, this issuance:

- Establishes policy, assigns responsibilities, and provides procedures for science and technology (S&T) managers and engineers to manage system security and cybersecurity technical risks from foreign intelligence collection; hardware, software, cyber, and cyberspace vulnerabilities; supply chain exploitation; and reverse engineering to:
  - DoD-sponsored research and technology that is in the interest of national security.
  - DoD warfighting capabilities.
- Assigns responsibilities and provides procedures for S&T managers and lead systems engineers for technology area protection plans (TAPPs), S&T protection, program protection plans (PPPs), and engineering cybersecurity activities.

**Cyber Survivability is a new Key Performance Parameter (KPP) for weapons systems**

# Agenda Overview

https://www.dependability.org/wg10.4/ivds/ivds2022/program.html