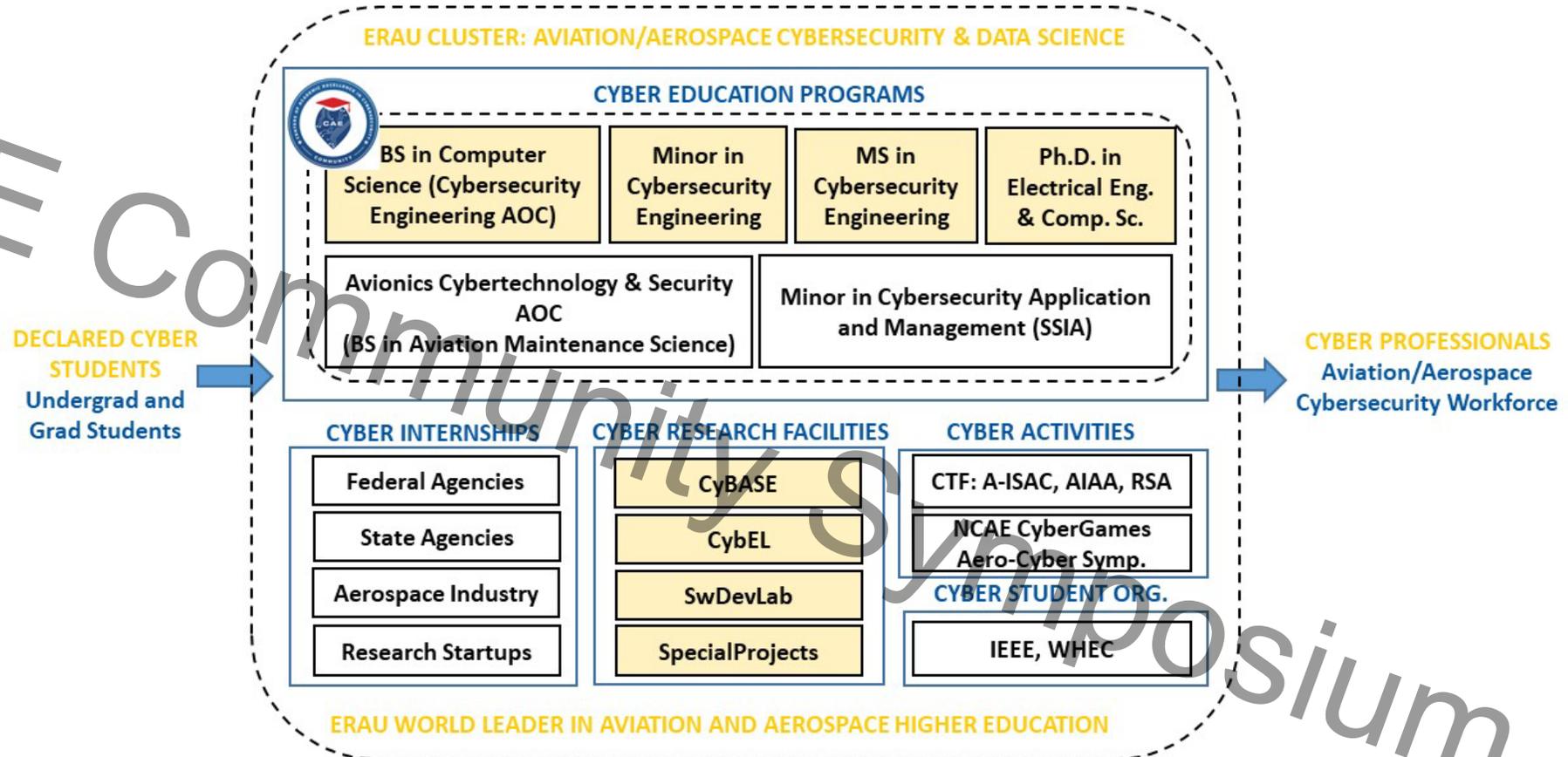# Getting Cyber Prepared for the New Space Age
Space Cybersecurity Workforce Development

CAE in Cybersecurity Community Symposium
Louisville, KY, April 16-18, 2024

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Aerospace Cybersecurity

CyBASE Cybersecurity Center

- Coordinates research activities in the field of cybersecurity and assured systems engineering across the university academic departments.

- Contributes to the research and product development while collaborating with industry as well as the scientific community.

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University Offerings Status
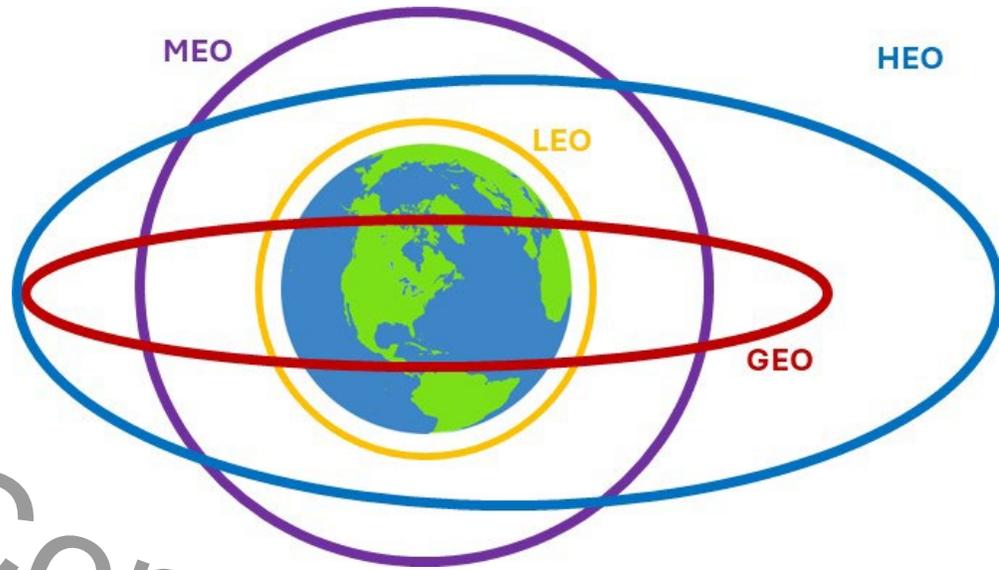
- New space age: missions outside of Low Earth Orbit.
  - Rocket launches became almost common.
  - Need for cyber protection increases.

- State-of-the-art instruction in rocket and satellite technologies, advanced life support, autonomous systems for outer space exploration.
  - Formal instruction in cybersecurity for space missions falls behind.

- ERAU response:
  - Research agenda in space cybersecurity technology and analysis.
 - Proposed Space Systems Cybersecurity course.

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Commercial and Military Space Operations

- Communication:
  - Assured by GEO satellites (approx. 580 in orbit) with civil and military operations.

- Navigation:
  - GPS satellites (32 satellite in orbit) provide PNT services.

- Remote sensing:
  - Environment, weather, agriculture, military.
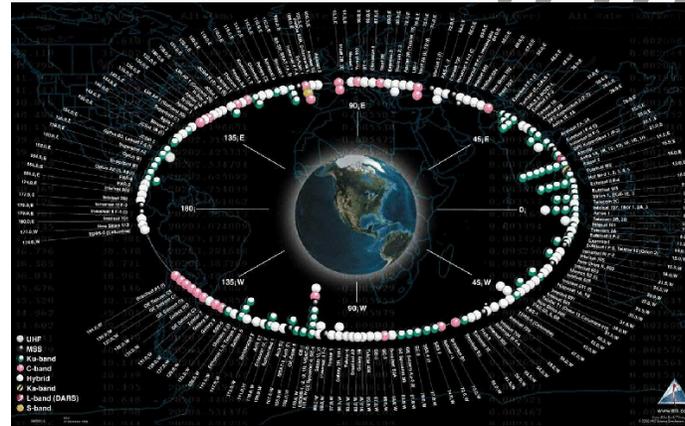
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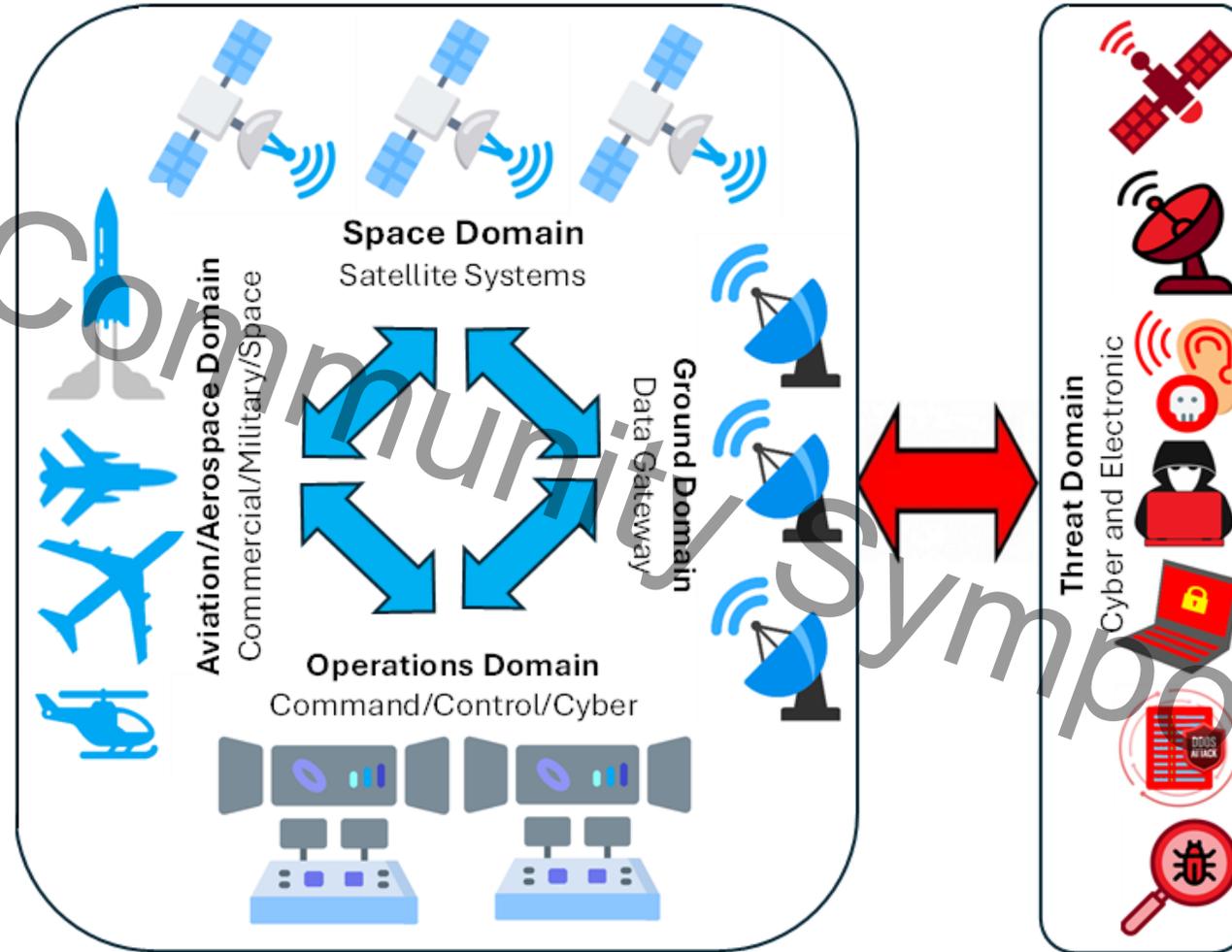
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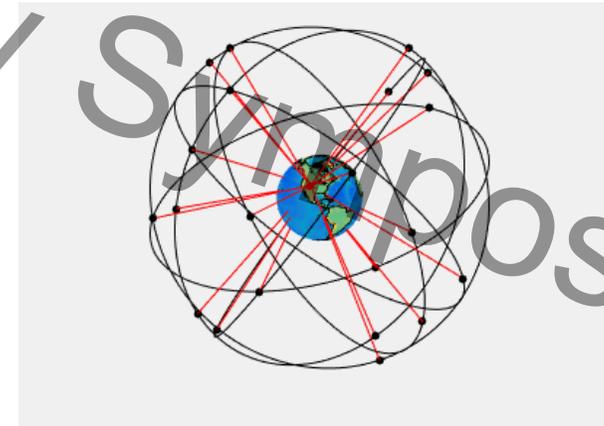
Aerospace Cybersecurity

Positioning Navigation Timing

- Aviation: FMS, ADS-B.
- Space: launch vehicle tracking, surveillance accuracy.
- Survey and mapping: GIS.
- Energy: power grid management, resource exploration.
- Maritime: guidance and control, fleet tracking, waterway navigation.
- Weapons: terrain guidance, target location, cruise missiles.
- Special operations: navigation, precise timing.
- Search and rescue: combat survivor, emergency locator.
- Agriculture: fleet maintenance, livestock training.
- Land transportation: ITS, just-in-time inventory, real-time routing.
- Comm and network: secure comm, cellular integration, emergency.
- Recreation: hiking, boating, trip planning.
- Public health ad safety: firefighting, emergency vehicle tracking, accident location, stolen vehicle location.

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Threat Environment

Threat Domain
Cyber and Electronic

- Conservative, slow-changing, security, many times, an after-thought.
- Space systems: are they protected because not too many access them?
  - Niche domain, proprietary systems, large cost.

- Generic attack types:
  - Space-based external attack: rogue satellites.
  - Ground-based external attack: rogue ground station.
  - Industrial control systems attack: on ground systems.
  - Insider threat: ground station and WAN network.
  - External cyber attack: towards users.

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Threat Mitigation

- Data: encryption, confidentiality, integrity.

- Software: secure coding, threat modeling, crypto signatures.

- Hardware: segregation of critical and non-critical systems.

- IDS: ML-based anomaly detection.

- Crypto: authenticated encryption.

- Data links: comm protocols, multiple paths uplink.

- Ground: perimeter, network endpoint, software, data.

- Prevention: requirements, governance, risk management, supply chain, threat modeling.

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Research Agenda

- EECS Ph.D. Dissertations (with cybersecurity research topic).
  - AI/ML-enabled spaceflight and cyber defense analysis, in progress.
  - Machine Learning and Artificial Intelligence Methods for Cybersecurity Data within the Aviation Ecosystem, 2022.
  - Hardware Security for Wireless Communications Systems using Antenna-based Radio Frequency Fingerprint Engineering, 2022.

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Space Systems Cybersecurity Course Topics

- Overview of space systems architecture and operations.
- Stakeholder identification and potential cybersecurity impact.
- Difference between IT cybersecurity and space OT cybersecurity.
- Space systems threat actors and their motivations.
- Space systems attack surface and attack vectors.
  - Attacks on data links, comm signals, ground stations,
  - Space-based and ground-based attack types.
  - Industrial control systems attack types.
  - Insider threats on space systems assets.
  - Space systems supply chains and related threats.
- Space systems cyber events risk likelihood and consequences.
- Current space systems policy guidance and standards.

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Ahead...
Research and Education

- Current environment and issues:
  - Cybersecurity as a discipline grows faster and more complex every day.
  - Availability of SDR, open-source software for radio tech, COTS components.
  - Availability of live traffic data and large datasets.
  - Communication attacks such as jamming, spoofing, and message injection may become common once they start to be profitable from an economic perspective.
  - Some cases of jamming (GPS) have closed-down airports for several minutes.

- Way forward:
  - Bring awareness of aerospace cybersecurity.
  - Invest/increase aerospace cybersecurity educational programs.
  - Update course offerings with latest state-of-the-art knowledge.