

National Security Sciences

Cyber Resilience and Intelligence

Carries out the science mission of advancing the resilience, security, and effectiveness of nationally critical cyber systems threatened by dynamic adversarial challenges.

Resilient Complex Systems

Focuses on the science mission of enhancing the security and resilience of complex cyber-physical systems, or systems of cyber physical systems.

1. *Cyber Physical Systems* — Focuses on critical cyber physical resilience and security for critical infrastructure that supports our national defense and intelligence agencies. A couple of key components of this group are embedded system security science and digital forensics to enable the discovery of attribution and the specific details of adversarial attacks that will inform the most effective mitigations.
2. *Energy and Control Systems Security* — Performs research and develops security and resilience science to address national critical infrastructure that drives our energy infrastructure and the supporting control systems and networks. This group also focuses on other critical infrastructure that is important to the nation's economic security such as manufacturing systems, vehicles, and buildings.
3. *Vulnerability Science* — Performs R&D in software vulnerability research, including the creation of semi-automated methods and tools to enable effective discovery of bugs, determination of the level of vulnerability of such bugs, and the development of vulnerability mitigation and exploitation techniques.

Adversary Intelligence Systems

Focuses on R&D to enhance the resilience and effectiveness of our analytic ecosystems used to capture, gather, organize, and analyze intelligence about an adversary to assist national security analysts and decision makers.

1. *Cyber Identity and Biometrics* — Performs R&D focused on detection of insider/outsider threat, development of cyber persona (e.g., using “digital exhaust”) for user identification and intent, identity science for individuals and small groups/networks of potential adversaries, and biometrics.
2. *Augmented Analyst Intelligence* — Performs R&D that will augment an analyst's accuracy, effectiveness, speed, confidence, and ability to process large amounts of multi-modal data sources via the creation of advanced data science, information visualization, augmented/virtual reality, synergistic human-machine intelligence methods, and human-computer-interface technologies.
3. *Cybersecurity Research* — Conducts R&D on artificial-intelligence- and machine-learning-driven cyber defense methods, tools, and techniques that are designed to improve the cyber analyst's ability to protect our nation's critical computer systems and networks. Operations research is an important science component to ensure effective design and deployment of

operational cyber defense tools. An integral R&D area is assurance (i.e., the level of trust and security) of the data and software systems that are deployed on such computer and network systems.

Nuclear Nonproliferation

Provides research and development to detect, characterize, and monitor foreign nuclear fuel cycle and weapons development activities, movement or diversion of special nuclear material, and nuclear explosions; develops concepts, approaches, and technologies to strengthen global security for nuclear and radiological material; engages with U.S. government agencies to enhance international nuclear security and nonproliferation regimes; and supports incident response.

Nuclear and Radiological Security

Reduces threats and risks associated with handling, storing, transporting, and processing nuclear and radiological material globally. Staff members have internationally recognized expertise in physical protection concepts and strategies, security system requirements and regulations, security culture, and risk and vulnerability assessment processes. Supports the National Nuclear Security Administration (NNSA) Office of Global Material Security by assessing, analyzing, and assisting in development of strong and sustainable security systems with partner countries.

1. *Facility and Systems Security* — Specializes in assessments and analysis of facilities, systems, and processes for security of nuclear and radiological material.
2. *Transportation Security* — Focuses on assessments and analysis of packages, systems, and processes for transport of nuclear, radiological, chemical, or biological material.
3. *Learning Sciences* — Applies expertise in nonproliferation missions and learning sciences to innovate, improve, and implement instructional methodologies that enable successful engagements with partner countries and allow decisive metrics for measuring achievement of goals.
4. *Project Planning and Logistics* — Provides project and business assistance required for tracking costs and milestones and providing reports for approximately 350 projects, including logistics support for the extensive foreign travel and partner country engagements required to fulfill ORNL's nonproliferation missions.

Safeguards and Treaty Verification

Focuses on enhancing concepts, strategies, and technologies that will strengthen the capabilities of the U.S. government and international regimes (e.g., the International Atomic Energy Agency and partner countries) to safeguard material, commodities, and technologies from proliferation and to enhance treaty verification.

1. *Strategic Commodities and Technologies* — Focuses on review and analysis of nuclear fuel cycle technologies and commodities subject to export control or high-risk property designation; provides technical input for U.S. government policy development and law enforcement, and supports U.S. efforts to enhance partner country programs for export control and high-risk property.

2. *Implementation Technologies* — Focuses on concepts, strategies, and technologies for implementing improved safeguards and nuclear material control and accountability (NMC&A) practices for domestic and international purposes; and assists the NNSA Office of Nonproliferation and Arms Control in its efforts to strengthen international regimes and partner country practices for nuclear material safeguards.
3. *Non-Destructive Analysis R&D* — Focuses on research, development, and application of non-destructive detection and analysis technologies that support material control and accounting, operational safety for material processing, and nuclear material security protocols.
4. *Verification Technologies* — Focused on research, development, and application of technologies that can support verification and/or monitoring of nuclear material in storage or transport, security of nuclear/radiological facilities, or compliance with international treaties.

Proliferation Detection and Deterrence

Focuses on the R&D for detection of potential proliferation activities associated with the nuclear fuel cycle; forensics and incident response following a nuclear detonation; engineering, testing, and evaluation of systems that support the Intelligence Community (IC) and counterproliferation activities; and implementation of assessments and programs seeking to understand, assess, and/or diminish the attractiveness of special nuclear material (SNM).

1. *Material Security and Stewardship* — Focuses on supporting research, development, and applications related to identifying, minimizing, and/or addressing risks or potential threats associated with production or use of special nuclear material.
2. *Detonation Forensics and Response* — Focuses on nuclear detonation fallout prediction for support of improved capabilities in detonation characterization and forensics and provides enhanced tools to support incident response and consequence management.
3. *Process and Material Characterization* — Applies an interdisciplinary R&D approach to improve detection of nuclear fuel cycle proliferation through enhanced understanding of the impact that process operations and environmental factors may have on collected or measurable indicators.
4. *Collection Science and Engineering* — Focuses on application of scientific and engineering principles to conceptualize, design, fabricate, deploy, analyze, and validate advanced systems for collecting and measuring key indicators of proliferation.
5. *Advanced Engineering Technologies* — Applies engineering principles to design, fabricate, test, and analyze components and component/system performance that inform the IC, nonproliferation, and counter-proliferation communities.

Mission Management Software

Develops, maintains, and manages innovative software systems that support missions of the National Nuclear Security Administration (NNSA) associated with collection, analysis, and reporting of data for infrastructure and project management; strategic commodity inventory and tracking; applied data analytics for multi-component measurement and operating systems; and decision management.

1. *Enterprise Systems* — Develops software for the infrastructure and project management system used principally by NNSA offices.
2. *Systems Management* — Focuses on life-cycle development, quality assurance, testing and verification, user support, and operations for software systems.
3. *Systems and Data Analysis* — Develops software and user interfaces for systems that implement applied data management and analytics for multi-component systems used in nuclear nonproliferation mission areas.

Geospatial Science and Human Security

Interdisciplinary research and development to provide novel data and analytical technologies for human security.

Geographic Data Science

Develops sensor technologies and analytical methods, models, that collect, integrate, analyze, and derive knowledge and decision support value from spatiotemporal data.

1. *GeoAI* — Develops novel mathematical and computer science capabilities for curating, fusing, analyzing, and visualizing data sets, artificial intelligence, uncertainty quantification, data validation, privacy preservation, and anonymization techniques. Develops data bias assessment, uncertainty quantification, assurance, and privacy preservation techniques.
2. *Remote Sensing* — Develops algorithms for multimodal sensors and platforms, sensor characterization and modeling, spatial and spectral exploitation using photogrammetry, image science, and computational science approaches.
3. *Resilient Communications and Autonomous Systems* — Develops remotely operated, autonomous ground and air systems by combining expertise in embedded systems, sensors, software, aviation systems, and mechanical engineering. Develops strategies for resilient, integrated communications for edge devices.

Human Dynamics

Develops data, models, and computational approaches that utilize observation and measurement digital traces to provide insights into human activities and interactions with the environment from local to planetary scales.

1. *Built Environment Characterization* — Creates critical infrastructure data sets to characterize built environments. Conducts risk and resiliency assessment and characterization. Utilizes open-source intelligence (OSINT) to illustrate landscape features and utilizations (land cover and land use).
2. *Human Geography* — Fosters discovery of functional and complex connections between humans and their physical, cultural, and socioeconomic landscapes. Develops novel understanding of trends and patterns in settlements, migration, and generation of future population scenarios with spatial demography as a core competency.
3. *Geoinformatics Engineering* — Creates scalable computing solutions for design and development of geographic information systems with an emphasis on real-time and dynamic geocomputation, geodata integration, and software services. Provides situational awareness of

critical infrastructure for national security and performs geospatial research through advanced big data architectures, scalable computing, and data engineering.

Field Intelligence Element (FIE) Operations

Under DOE-IN authorities, serves as the ORNL focal point for all intelligence community (IC) matters. Supports national security sciences through secure IT communications, facilities, and analysis.

1. *Fuel Cycle Analysis* — Is a direct-reporting group focused on scientific and technical fuel-cycle analysis for DOE-IN and the IC.

Secure Operations

Develops, maintains, and sustains classified IT systems, facilities, and personnel security infrastructure for wide-ranging national security program activities.

1. *IT Systems* — Focuses on classified information technology expertise and platform management; maintains and protects the yellow network (HAL) for both ORNL and DOE-IN.
2. *Classified Computing/Clusters* — Combines SCI (Sensitive Compartmented Information) Security Group of four with four IT specialists for performing classified computing support in collaboration with the Lab's cluster-computing group and the Lab's IT enterprise strategy.
3. *Special Security Office (SSO)* — Focuses on physical security of the classified facility and personnel security. Expected to expand staffing to support growth in classified programs that include computing and additive manufacturing.