Areas of Interest

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1.1. Air Domain Technologies
- 1.1.1. Human Performance Optimization
- 1.1.2. Aerospace Medicine and Operational Health
- 1.1.3. Warfighter Survivability and Protection
- 1.1.4. Cognitive and Behavioral Sciences
- 1.1.5. Advanced Air Vehicles
- 1.1.6. Air Propulsion Systems
- 1.1.7. Aerodynamics and Flight Sciences
- 1.1.8. Hypersonics
- 1.1.9. Advanced Weapons Technologies
- 1.1.10. Energetics and Propellants
- 1.1.11. Guidance Navigation and Control
- 1.1.12. Munitions Survivability and Countermeasures
- 1.1.13. Rocket Systems
- 1.1.14. Nuclear Deterrence Technologies

1.2. Space Domain Technologies
- 1.2.1. Space Access and Orbital Systems
- 1.2.2. Spacecraft and Satellite Technologies
- 1.2.3. Space Power and Propulsion
- 1.2.4. On-Orbit Operations and Autonomy
- 1.2.5. Space Domain Awareness
- 1.2.6. Resilient and Survivable Space Architecture
- 1.2.7. Space Environment and Effects
- 1.2.8. Position, Navigation, and Timing (PNT) from and for Space
- 1.2.9. Satellite Assembly, Integration & Testing

1.3. Cyberspace/Electronic Warfare Domain Technologies
- 1.3.1. Cyber Operations and Cybersecurity
- 1.3.2. Communications and Networks
- 1.3.3. Electronic Warfare and Spectrum Operations
- 1.3.4. Quantum Technologies
- 1.3.5. Electro-Optical and Infrared Sensors
- 1.3.6. Radar and Radio Frequency Sensors
- 1.3.7. Multispectral and Hyperspectral Sensing
- 1.3.8. Signal Processing and Sensor Fusion
- 1.3.9. Quantum Sensing and Advanced Properties
- 1.3.10. Directed Energy Sensing and Countermeasures
- 1.3.11. High-Energy Laser Systems
- 1.3.12. Photonics
- 1.3.13. High-Power Electromagnetic Technologies

1.3.14. High Power Electromagnetic Effects
1.3.15. High Power Electromagnetic Applications
1.3.16. Beam Control and Adaptive Optics
1.3.17. Directed Energy Effects and Countermeasures
1.3.18. Cybersecurity for Digital Environments
1.3.19. Navigation Warfare and Counter PNT

1.4. Cross-Domain Technologies
1.4.1. Human Systems Integration
1.4.2. Human-Machine Teaming and Interfaces
1.4.3. Training and Simulation Technologies
1.4.4. Rapid Multi-Domain Integration
1.4.5. Advanced Systems Engineering
1.4.6. Integrated Vehicle Health Management
1.4.7. Power and Thermal Management
1.4.8. Advanced Materials Development
1.4.9. Additive Manufacturing
1.4.10. Materials Processing and Fabrication
1.4.11. Materials Characterization and Testing
1.4.12. Environmentally Responsive and Smart Materials
1.4.13. Microelectronics
1.4.14. Model-Based Systems Engineering, Digital Engineering, and Digital Thread
1.4.15. Advanced Simulation and Virtual Prototyping
1.4.16. Data Analytics and Artificial Intelligence
1.4.17. Additive Manufacturing Digital Integration
1.4.18. Low Cost, Size, Weight, and Performance (C-SWAP) Alternative PNT Systems for Attritable Systems
1.4.19. Modular Open Architecture approaches to Resilient PNT
1.4.20. Robotics Technologies
1.4.21. Software Systems Development
1.4.22. Physiological Operations
1.4.23. Runtime Assurance (RTA) for AI
1.4.24. Autonomy

1.5. Basic Research Technologies
1.5.1. Energetic Solid-State Physics and Mechanochemistry
1.5.2. Energy, Combustion, and Non- Equilibrium Thermodynamics
1.5.3. Aerodynamic Sciences
1.5.4. High-Speed Aerodynamics
1.5.5. Aerospace Composite Materials
1.5.6. Aerospace Structures
1.5.7. Propulsion and Power
1.5.8. Agile Science for Test and Evaluation (T&E)
1.5.9. Computational Cognition and Machine Intelligence

1.5.10. Computational Mathematics
1.5.11. Dynamical Systems and Control Theory
1.5.12. Dynamic Data and Information Processing
1.5.13. Information Assurance and Cybersecurity
1.5.14. Mathematical Optimization
1.5.15. Science of Information, Computation, Learning, and Fusion
1.5.16. Trust and Influence
1.5.17. Complex Networks
1.5.18. Cognitive and Computational Neuroscience
1.5.19. Atomic and Molecular Physics
1.5.20. Electromagnetics
1.5.21. Optoelectronics and Photonics
1.5.22. High-Energy Radiation-Matter Systems
1.5.23. Quantum Information Sciences
1.5.24. Physics of Sensing
1.5.25. Space Physics
1.5.26. Ultrashort Pulse Laser-Matter Interactions
1.5.27. Condensed Matter Physics
1.5.28. Astrodynamics

2. Definitions

2.1. Air Domain Technologies

2.1.1. Human Performance Optimization - Enhancing human capabilities and resilience across diverse operational environments through the application of scientific principles, advanced technologies, and personalized interventions. This includes, but is not limited to, physical conditioning, cognitive enhancement, stress management, and optimized human-machine interfaces techniques.

2.1.2. Aerospace Medicine and Operational Health - Advancing medical research, developing countermeasures, and implementing strategies to optimize the health, safety, and performance of personnel in demanding operational environments. This includes physiological monitoring, environmental protection, human performance enhancement, and medical support for air, space, and cyber operations.

2.1.3. Warfighter Survivability and Protection - Developing and integrating advanced technologies and strategies to protect personnel from a wide range of threats and hazards in operational environments. This includes personal protective equipment, directed energy protection, threat detection systems, casualty care, and environmental control measures applicable across various domains.

2.1.4. Cognitive and Behavioral Sciences - Understanding and leveraging human cognitive and behavioral principles to improve decision-making, enhance performance, and optimize human-system interaction in complex and

dynamic environments. This encompasses areas such as perception, attention, memory, reasoning, and social interaction.

2.1.5. Advanced Air Vehicles - Designing and developing next-generation aircraft technologies for diverse operational roles, including high-speed flight, enhanced maneuverability, stealth capabilities, and optionally manned configurations to extend operational reach and survivability.

2.1.6. Air Propulsion Systems - Innovating propulsion technologies such as turbine engines, hypersonic propulsion (scramjets, ramjets), and advanced powerplants to improve efficiency, speed, and performance of aerospace platforms

2.1.7. Aerodynamics and Flight Sciences - Conducting fundamental research in aerodynamics, flight control, stability, and aircraft performance to enable improved maneuverability, endurance, and stealth characteristics.

2.1.8. Hypersonics - Developing technologies for hypersonic flight—speeds greater than Mach 5—including materials, propulsion, guidance, and control systems to enable rapid global strike and ISR capabilities.

2.1.9. Advanced Weapons Technologies - Developing innovative kinetic and non-kinetic weapons, including smart munitions, precision-guided munitions, and novel warhead designs to increase effectiveness against evolving threats.

2.1.10. Energetics and Propellants - Researching advanced energetic materials, propellants, and explosives that provide greater performance, safety, and reduced environmental impact.

2.1.11. Guidance Navigation and Control - Developing advanced guidance and control systems for improved accuracy, maneuverability, and target discrimination in complex operational environments.

2.1.12. Munitions Survivability and Countermeasures - Enhancing munition robustness against countermeasures and hostile environments to ensure reliable performance under combat conditions.

2.1.13. Rocket Systems – Innovating and advancing rocket propulsion systems, components, and vehicle integration for various defense applications. This area includes, but is not limited to, research and development in solid, liquid, and hybrid rocket motors; advanced propellant formulations; lightweight-yet-durable structural materials; thrust vector control; and the integration of these systems into next-generation tactical missiles, and other advanced platforms.

2.1.14. Nuclear Deterrent Technologies – Developing and sustaining the advanced technologies required to ensure a safe, secure, and effective nuclear deterrent. This area includes the modernization of strategic delivery platforms both prompt and air launched, enhancing the command, control, and communications (NC3) systems for nuclear deterrence, fuzing and guidance navigation and control of delivery systems, and exploring future technologies to counter emerging threats and maintain strategic stability.

2.2. Space Domain Technologies

2.2.1. Space Access and Orbital Systems - Supporting the development of launch vehicles, space propulsion, and space maneuvering systems to ensure reliable, responsive, and cost-effective access to space.

2.2.2. Spacecraft and Satellite Technologies - Developing advanced technologies and innovative architectures for space-based assets to enhance resilience, improve performance, and expand mission capabilities. This encompasses satellite bus design, payload development, communication systems, on-orbit servicing, and other critical technologies for space operations.

2.2.3. Space Power and Propulsion - Innovating power generation (solar arrays, energy storage) and electric propulsion systems to extend satellite life and improve maneuverability and station-keeping.

2.2.4. On-Orbit Operations and Autonomy - Advancing technologies for autonomous spacecraft operations, rendezvous and proximity operations, on-orbit servicing, and debris mitigation to maintain space asset functionality.

2.2.5. Space Domain Awareness - Enhancing sensors, data processing, and analytics to detect, track, and characterize objects and closely-space objects and threats in the space environment, using hardware, algorithms, or novel techniques to collect and provide actionable information for space object information in support of space domain awareness.

2.2.6. Resilient and Survivable Space Architecture - Researching distributed satellite constellations, hardened systems, and defensive measures to ensure continuity of space operations in contested or degraded environments.

2.2.7. Space Environment and Effects - Studying space weather, radiation effects, and the orbital environment to develop mitigation strategies that protect space assets and maintain operational readiness.

2.2.8. Position, Navigation, and Timing (PNT) from and for Space - The development, deployment, and exploitation of space-based systems and technologies that enable precise geolocation, accurate time dissemination, and resilient navigation capabilities for terrestrial, airborne, maritime, and spaceborne users.

2.2.9. Satellite Assembly Integration & Testing – Advancing the processes, facilities, and technologies required for the assembly, integration, and verification of spacecraft and their subsystems. This includes developing novel techniques for integrating complex payloads, validating system performance through rigorous ground and environmental testing (e.g. thermal vacuum, vibration, acoustics) and ensuring the satellite is prepared for launch and on-orbit operations.

2.3. Cyberspace/Electronic Warfare Domain Technologies

2.3.1. Cyber Operations and Cybersecurity - Developing and implementing comprehensive strategies, technologies, and practices to secure cyberspace, protect critical assets, and enable effective cyber operations in support of national security objectives. This encompasses offensive and defensive cyber capabilities, threat intelligence, vulnerability management, and incident response.

2.3.2. Communications and Networks - Innovating next-generation, resilient, and secure communications technologies, including software-defined radios, dynamic spectrum management, and high-capacity tactical networks supporting contested environments.

2.3.3. Electronic Warfare and Spectrum Operations - Researching techniques for electromagnetic spectrum dominance, including signal processing, electronic attack and protection, and spectrum sensing.

2.3.4. Quantum Technologies - Advanced systems that leverage the principles of quantum mechanics—such as superposition and entanglement—to enable next-generation computing, communication, and sensing capabilities. Advanced algorithms designed to tackle computationally intractable problems—those too complex, slow, or resource-intensive for classical supercomputers.

2.3.5. Electro-Optical and Infrared Sensors - Developing advanced imaging and sensing systems operating across visible, infrared, and ultraviolet spectra for target detection, tracking, and identification in all-weather and contested environments.

2.3.6. Radar and Radio Frequency Sensors - Innovating radar technologies including active electronically scanned arrays (AESAs), synthetic aperture radar (SAR), and low-probability-of-intercept/low-probability-of-detection (LPI/LPD) radars to enhance detection and tracking of air, surface, and maritime targets.

2.3.7. Multispectral and Hyperspectral Sensing - Creating sensors capable of collecting data across multiple spectral bands for improved material discrimination, camouflage detection, and environmental monitoring.

2.3.8. Signal Processing and Sensor Fusion - Advancing algorithms and architectures to integrate data from multiple sensor types for enhanced target recognition, situational awareness, and reduced false alarms.

2.3.9. Quantum Sensing and Advanced Properties - Exploring emerging quantum technologies and photonic devices to achieve breakthroughs in sensitivity, resolution, and sensor miniaturization.

2.3.10. Directed Energy Sensing and Countermeasures - Developing sensors that detect and characterize directed energy threats and support electronic warfare and self-protection systems.

2.3.11. High-Energy Laser Systems - Developing scalable, high-power laser technologies for precision engagement of air, ground, and space targets. This includes solid-state lasers, fiber lasers, and beam control systems for weaponization.

2.3.12. Photonics – Leveraging the science of light to develop and transition advanced capabilities in sensing, quantum information science, and directed energy for integrated Intelligence, Surveillance, and Reconnaissance (ISR), and spectrum warfare operations.

2.3.13. High-Power Electromagnetic Technologies - Researching high power microwave sources, pulse power, antenna, pulse compression, and distributed systems as well as particle beams to disable, disrupt, or destroy enemy threats to bases, UAS, electronic systems, communications, and sensors without kinetic effects. It also includes required modeling and simulation for the technologies.

2.3.14. High Power Electromagnetic Effects – Researching effects of High Power Electromagnetics to include High Power Microwaves (HPM) and particle beams. This includes physics level phenomenology as well as system testing in an anechoic chamber or a test range and everything in between. It also includes development and maintenance of all the required modeling and simulation to properly evaluate the effects.

2.3.15. High Power Electromagnetic Applications – Focuses on the end-to-end development and delivery of integrated High-Power Electromagnetic (HPEM) systems. It encompasses all engineering necessary for the complete project life cycle. The work includes the design, build, and integration of individual subsystems, which are then assembled into the final system. This process culminates in comprehensive field testing, operational analysis, and the eventual deployment of the technology.

2.3.16. Beam Control and Adaptive Optics - Innovating advanced beam steering, adaptive optics, and atmospheric compensation techniques to maintain laser beam quality and accuracy over long distances and through turbulent environments.

2.3.17. Directed Energy Effects and Countermeasures - Studying the physical and operational effects of directed energy weapons on targets and associated collateral effects and developing defensive measures against hostile directed energy threats.

2.3.18. Cybersecurity for Digital Environments - Protecting digital assets, infrastructure, and information from cyber threats through the development and implementation of advanced security measures and resilient architectures. This encompasses threat detection, vulnerability assessment, intrusion prevention, and incident response to ensure the confidentiality, integrity, and availability of critical systems.

2.3.19. Navigation Warfare and Counter PNT - Research and development efforts focused on both disrupting adversary PNT systems and protecting friendly forces from similar attacks, ensuring mission success in GPS-denied or degraded environments. This involves developing both offensive and defensive technologies and strategies related to PNT.

2.4. Cross-Domain Technologies

2.4.1. Human Systems Integration - Integrating human capabilities, limitations, and preferences into the design, development, and evaluation of systems to optimize human-machine interaction, improve usability, and enhance overall system effectiveness. This encompasses human factors engineering, user interface design, workload assessment, and cognitive support to ensure safe, efficient, and intuitive operation.

2.4.2. Human-Machine Teaming and Interfaces - Developing technologies to improve interaction between humans and AI-enabled systems, optimizing performance across diverse operational environments and enhancing decision-making, mission planning, and situational awareness.

2.4.3. Training and Simulation Technologies - Developing and deploying innovative training methodologies and simulation tools to enhance individual and team proficiency, improve operational readiness, and facilitate effective mission rehearsal across a spectrum of operational scenarios. This includes virtual reality, augmented reality, serious gaming, and adaptive learning systems.

2.4.4. Rapid Multi-Domain Integration - Rapid Multi-Domain Integration involves seamlessly combining technologies and capabilities from the air, space, cyber, electronic warfare, and ground domains. Its core purpose is to develop interoperable and networked systems that significantly enhance the operational effectiveness of joint and coalition forces. This integration aims to create a unified and synchronized approach across all domains to achieve mission objectives.

2.4.5. Advanced Systems Engineering - Applying holistic and innovative systems engineering approaches to design, develop, integrate, and test complex systems and architectures, ensuring seamless interoperability, optimal performance, and cost-effective solutions across the entire lifecycle. This encompasses requirements engineering, architecture development, modeling and simulation, and verification and validation.

2.4.6. Integrated Vehicle Health Management - Creating systems for real-time monitoring and diagnostics of aerospace platforms to enhance safety, readiness, and maintainability.

2.4.7. Power and Thermal Management - Advancing technologies for efficient power generation, storage, distribution, and thermal dissipation across multiple platforms and operational scenarios. This encompasses innovations in energy harvesting, power electronics, battery technology, advanced cooling systems, and thermal interface materials to enable high-performance systems in demanding environments.

2.4.8. Advanced Materials Development - Creating novel materials with enhanced properties tailored for diverse applications, including but not limited to aerospace structures, electronic components, and protective coatings. These materials may include high-temperature ceramics, lightweight composites, metamaterials, multifunctional materials, and bio-

inspired materials. Focus is on improving performance characteristics, durability, and resilience in extreme and contested environments.

2.4.9. Additive Manufacturing - Innovating and maturing additive manufacturing techniques for on-demand production of complex geometries, customized parts, and multi-material components. This encompasses advancements in materials, processes, modeling, and quality control to enable rapid prototyping, distributed manufacturing, and agile sustainment solutions across various domains.

2.4.10. Materials Processing and Fabrication - Developing and optimizing advanced processing and fabrication techniques for creating materials and components with tailored properties and microstructures. This includes methods such as nanomanufacturing, advanced joining, surface engineering, and coatings to enhance performance, reliability, and longevity in a wide range of applications.

2.4.11. Materials Characterization and Testing - Using experimental and computational techniques to understand the structure, properties, and performance of materials under relevant operational conditions, enabling the development of advanced aerospace systems.

2.4.12. Environmentally Responsive and Smart Materials - Developing materials that adapt to their environment or provide sensing and self-healing capabilities to enhance system resilience and functionality.

2.4.13. Microelectronics – The science and technology of designing, fabricating, and applying micro-scale electronics components and integrated circuits to enable the powerful computation, miniaturization, and advanced functionality essential for modern defense, communication, and aerospace systems.

2.4.14. Model-Based Systems Engineering, Digital Engineering and Digital Thread, Advanced Simulation and Virtual Prototyping - Creating and utilizing comprehensive digital representations of systems and their lifecycles to enable improved design, analysis, verification, and validation. This encompasses digital twins, virtual prototypes, and simulation environments to optimize performance, reduce costs, and accelerate development timelines.

2.4.15. Advanced Simulation and Virtual Prototyping – Employing digital models and computer-aided engineering (CAE) to simulate, test, and analyze product performance under real-world conditions prior to physical creation.

2.4.16. Data Analytics and Artificial Intelligence - Developing and applying advanced algorithms, machine learning techniques, and data-driven approaches to extract actionable insights from complex datasets and enable intelligent decision-making. This encompasses predictive analytics, pattern recognition, anomaly detection, and automated reasoning to improve situational awareness, optimize operations, and enhance system performance.

2.4.17. Additive Manufacturing Digital Integration - Integrating additive manufacturing processes with digital design, simulation, and analysis tools to enable closed-loop optimization, enhanced design freedom, and improved part quality. This encompasses generative design, topology optimization, process simulation, and in-situ monitoring to maximize the benefits of additive manufacturing.

2.4.18. Low C-SWAP Alternative PNT Systems for Attritable Systems – Developing affordable and expendable PNT solutions to ensure resilient navigation and timing capabilities for unmanned, potentially disposable aircraft in GPS-denied environments prioritizing C-SWAP requirements

2.4.19. Modular Open Architecture approaches to Resilient PNT - Developing flexible and adaptable PNT systems that use standardized interfaces, enabling rapid integration of new technologies and algorithms to maintain reliable navigation and timing in contested environments. This modularity facilitates quicker upgrades and responses to emerging threats against GPS.

2.4.20. Robotics Technologies – Developing and integrating autonomous and semi-autonomous robotic systems for a wide range of defense applications. This would include advancements in ground, air, and space robotics for tasks such as logistics, maintenance, inspection, repair, automated manufacturing, and potentially augmenting human teams in hazardous environments.

2.4.21. Software Systems Development – Developing and implementing advanced, secure, and resilient software systems to enable and enhance mission capabilities across all domains. This includes the application of modern software development methodologies like DevSecOps, the creation of modular and open architecture systems for rapid capability integration, ensuring cybersecurity is built into the software lifecycle, and developing software for artificial intelligence, machine learning and autonomous systems.

2.4.22. Physiological Operations - Systems and technologies that exploit human cognition to influence, disrupt, and usurp adversary decision-making and behavior. This includes but is not limited to actions to affect the will, awareness, and understanding of adversaries while protecting friendly information, optimization of Operations in the Information Environment through planning and tradecraft, and decision-making processes to achieve an information advantage across the competition continuum.

2.4.23. Runtime Assurance (RTA) for AI - Developing safety frameworks that monitor an autonomous system’s behavior in real-time to ensure it stays within predefined operational boundaries. If the AI proposes an unsafe action or encounters an unpredictable scenario, the RT system “intervenes” by switching control to a simpler, trusted backup controller to prevent a collision or failure.

2.4.24. Autonomy for Airborne Platforms - Develop the ability of uncrewed aerial systems to navigate, make decisions, and execute missions with minimal or no human intervention. By leveraging advanced sensors, artificial intelligence, and sophisticated flight algorithms, these platforms can dynamically adapt to changing environments and avoid obstacles in real-time. This capability exists on a spectrum, ranging from basic automated waypoint tracking to fully independent operations where the aircraft manages its entire flight profile from takeoff to landing.

2.5. Basic Research Technologies

2.5.1. Energetic Solid-State Physics and Mechanochemistry - The objective of this portfolio is to understand critical chemical and physical behaviors in solid-state energy systems that arise due to compositional complexity under far-from-equilibrium conditions for game-changing advancements in critical DoD expeditionary systems. Research supported by the portfolio will build the foundational scientific knowledge to understand chemistry and reaction dynamics in heterogenous solid materials, causal pathways for energy release in mechanochemically-stimulated systems, energy localization and the interplay between continuum-level phenomena and molecular evolution, and the implications of shock dynamics on local state property and chemical behaviors. Solutions will necessarily arise from combined efforts utilizing empirical, numerical, and theoretical treatments to interrogate these uncertainties. Basic science advances supported by this portfolio will transition scientific discoveries that will inform the development of the next generation of Department of the Air Force (DAF) solid-state energy systems with a focus on improved energy and power density, operational reliability, ruggedized response to insult, effect-based optimization, and understanding system behavior as a function of age and operating conditions.

2.5.2. Energy, Combustion and Non-Equilibrium Thermodynamics – The majority of Air and Space Forces' system functions rely on the chemical energy stored in energetic molecules, converted into relevant forms, such as momentum through the combustion for propulsion and electricity from the electrochemical process for information processing, system control, direct energy weapon etc. The program supports efforts to explore, understand, describe, simulate/model, and manipulate/control key underlying physical and chemical phenomena/processes in energy supply and conversion, fostering innovative/ unconventional thinking, leading to game-changing capabilities as well as helping with current urgent needs for Air and Space Forces.

2.5.3. Aerodynamic Sciences - Supports basic research of fundamental flowfield physics across a range of conditions. Greater understanding of the fundamentals of the flowfield physics is crucial for exploitation into air

vehicle performance gains relevant to the U.S. Air Force (USAF). The portfolio is interested in aerodynamic flowfields arising in both internal and external configurations and extending over a wide range of Reynolds numbers. The portfolio seeks to emphasizes the characterization, modeling, prediction, and control of flow instabilities, turbulent flows, and aerodynamic fluid-structure/material interactions. A focus on the understanding of the fundamental flow physics, the dynamics and control of aerodynamic shear flows, and interactions of these flows with rigid and flexible surfaces in motion is motivated by an interest in developing physics based predictive models and innovative control concepts for these flows.

2.5.4. High-Speed Aerodynamics - The flow field around a high-speed vehicle strongly influences its size, weight, lift, drag and heating loads. Therefore, research in this area is critical to the USAF and U.S. Space Force's interesst in rapid global and regional response and space operations. This portfolio aims to lay the scientific foundation, through discovery, characterization, prediction and understanding of critical phenomena, for game-changing advancements in our understanding of high-speed, high-temperature non-equilibrium flows around flying vehicles. External and internal transitional and turbulent wall-bounded flows are critical to the cadre of problems studied. Such understanding is a pre-requisite to making hypersonic flight routine.

2.5.5. Aerospace Composite Materials - Supports basic research in the design, processing, and characterization of novel composite materials to enable transformative enhancement in their performance through understanding of the chemistry, physics, and mechanics in heterogeneously structured materials. Such materials are aimed to significantly impact the structural design of future USAF and USSF platforms including airframes, space vehicles, satellites, and a multitude of load-bearing systems. Key scientific areas supported by the program include: collective phenomena in heterogeneous materials, interface science, composite age and cycle evolution, dynamic process effects on properties, and information theory for design tools for composite materials.

2.5.6. Aerospace Structures - The goals of this research program are to integrate newly emerging classes of aerospace structures and materials, novel functional material systems or devices, programmable meta-architectures, intelligent subsystems, stimuli responsive surfaces, structural dynamics, and their combinations into load-carrying and/or multifunctional structures to achieve unprecedented USAF and USSF system performance. The program seeks to establish fundamental understanding required to revolutionize functionality of new aerospace structures and materials to enable futuristic concepts of structural design.

2.5.7. Propulsion and Power - Seeks to expand knowledge discovery to enable enhanced maneuver and power capabilities across the aerospace domain.

In tandem, this portfolio seeks to pioneer new approaches and research innovations to dramatically accelerate the underlying rate of discovery.

2.5.8. Agile Science for Test and Evaluation (T&E) - Supports basic research inventing and innovating revolutionary capabilities responsive to the Air Force and Space Force T&E community. Crossing scientific frontiers necessitates enhancing and pioneering test and measurement capabilities. The program sponsors basic research in areas enabling metrology and facilitating correct and comprehensive interpretation of test information. Agile science of test and evaluation leads to improving the ability to analyze and model operational environments, pursue science discoveries, and accelerate research & acquisition. The Air Force Office of Scientific Research (AFOSR) T&E program encompasses three (3) broadly-defined, overlapping thrust areas: Autonomy, Hypersonics, and Cyber & Microelectronics. The Program is closely aligned with other AFOSR science areas advancing experimental methodologies and merging scientific disciplines.

2.5.9. Computational Cognition and Machine Intelligence - Supports radical basic research aimed at transformatively advancing the mathematical and computational foundations of machine intelligence and human-machine alignment. Systems with varying degrees of autonomy in the USAF and USSF face resource-limited, adversarial, uncertain, and highly dynamic conditions in missions requiring time-critical decision-making. To ensure system integrity against algorithmic subversion, an ideal machine component should provably ensure system robustness by providing real-time, falsifiable recommendations that fully communicate its degree of uncertainty.

2.5.10. Computational Mathematics - Seeks to develop innovative mathematical methods and fast, reliable and scalable algorithms aimed at making radical advances in computational science and large-scale engineering and design. Research in computational mathematics underpins the fundamental understanding of complex physical phenomena and leads to predictive simulation capabilities that are crucial to the design and control of future USAF and USSF systems, and their lifetime expectancy. Proposals to this program should focus on fundamental scientific and mathematical innovations and should have the potential to address some of the most important computational challenges in science and engineering. Additionally, it is desirable to frame the basic research ideas in the context of applications relevant to the USAF and USSF, which can serve simultaneously to focus the research and to provide avenues for transition of basic research outcomes into practice. Applications of current Air Force and Space Force interest include, but are not limited to, quantum physics and quantum information systems, plasma dynamics, turbulence (e.g., in fluids, combustion, plasma), lasers and directed energy, aero-thermo-

dynamics, information science, data analysis (including machine learning), and material and structural sciences.

2.5.11. Dynamical Systems and Control Theory - Emphasizes the interplay of open dynamical systems and control theories, with the aim of developing innovative synergistic strategies for the design and analysis of controlled systems that enable radically enhanced capabilities, including performance and operational efficiency for future USAF and USSF systems. Only high-risk, and high-impact basic research on the mathematics of analysis and control theory for complex dynamical systems will be considered. Proposals should focus on the fundamental science and mathematics, while having relevance to future Air Force and Space Force systems and operations.

2.5.12. Dynamic Data and Information Processing - Seeks mathematical concepts that dynamically incorporate additional data, whether measured or from models, into an executing application to coordinate dynamic measurement collections, model refinements, and system awareness. Examples include dynamic data driven applications systems (DDDAS), physics-enhanced machine learning (PEML), and physics-based and human-derived information fusion (PHIF). Key developments should harness the use of first-principle models towards real, simulated, or augmented signals, data, and information processing to obtain substantial comparative improvements over existing methods. The portfolio encourages multidisciplinary research, especially synergistic and systematic collaborations between domain researchers in engineering, mathematics, computer sciences for multiresolution systems modeling, diagnostics, and analytics.

2.5.13. Information Assurance and Cybersecurity - Securing cyberspace, i.e. defending against and preventing cyber-attacks are not new challenges but these have become increasingly pressing in the light of technological advancements. Software and protocols are continuously becoming more complex to meet application demands. More flexible computing environments, such as distributed systems, demand new ways of thinking how to ensure secure end-to-end functionalities, even though components are only known to be individually secure. The emergence of nanoscale devices and quantum information processing and communication also portends new technological challenges for cybersecurity. By the same token, these new technologies potentially offer unparalleled security solutions to the existing or future problems.

2.5.14. Mathematical Optimization - The program goal is to develop novel theory, algorithms, and software for the many classes of Mathematical Optimization problems that arise in support of decision, design, and allocation problems confronting the USAF and USSF. Areas of interest include resource allotment, planning, logistics, interdiction, engineering design, resiliency, and scheduling. Problems can be deterministic in that

input parameters and objectives are known with certainty or can have data uncertainty that is addressed using such methods as stochastic programming and robust optimization. The research, while of fundamental importance to such problems, can also profoundly impact related areas of study, including the operation of autonomous vehicles and the effectiveness of machine learning.

2.5.15. Science of Information, Computation, Learning, and Fusion - The USAF and USSF collect vast amounts of data through various modes at various times in order to extract and derive needed “information” from these large and heterogeneous (mixed types) data sets. Some data, such as those collected from magnetometers, register limited information content which is more identifiable at the sensor level but beyond human’s sensory reception. Other types of data, such as video cameras or text reports, possess more semantic information that is closer to human cognition and understanding. Nevertheless, these are instances of disparate data which encapsulate different types of “information” pertained to, perhaps, the same event(s) captured by different modalities through sensing and collection.

2.5.16. Trust and Influence - Funds interdisciplinary high risk, transformative basic research that (1) elucidates the social and cognitive principles and processes surrounding the establishment, maintenance, and repair of trust between and among humans and intelligent agents, machines, algorithms, and/or other emergent technologies, with particular interest in situations where these concepts apply to heterogeneous, distributed teams or teaming constellations (i.e. teams of teams); and (2) advances the science of social influence to enhance understanding of how the phenomena and/or associated processes shape or affect human beliefs, perceptions, attitudes, and/or behaviors. The program encourages multidisciplinary and transdisciplinary approaches, which may include contributions from sociology, anthropology, computer and information science, psychology, cognitive science, linguistics, mathematics, economics, computational social science, and other social or behavioral sciences, among other disciplines. It further encourages research designs that utilize laboratory studies, modeling, and/or field research intended to develop novel, transformative theories, frameworks, or evaluative measures. Projects that aim to successfully consider the interplay of trust and influence in any of the contexts described below are welcomed.

2.5.17. Complex Networks - Complex networks are pervasive in military, commercial, and civilian operations. Complex networks consist of a graph (directed or undirected) together with a set of attributes. These attributes can include scalar or multi-dimensional weights on the edges or nodes of the graph, topological characteristics of the graph, flows over the graph, and processes that define the dynamics of the graph. Complex networks cut across many scientific disciplines (e.g., mathematics, computer

science, engineering, socio-economics, etc.) and many application domains (e.g., communications, sensing, information systems, transportation, etc.). Networks fundamentally describe the structural aspects of interactions between individual agents. Networks can be extremely large and can have multiple characteristic scales. They can be static or dynamic. They can be physical or virtual. Networks can consist of multiple heterogeneous subnetworks (i.e., a network- of-networks), with explicit and implicit interdependencies. For example, transportation networks are intimately coupled to computer and electrical-power networks. Thus, the failure of a critical node or arc in one network can trigger failures in another, which can create a cascade event with catastrophic consequences. All of these characteristics of networks can make the analysis, understanding, and utilization of networks difficult and computationally prohibitive.

2.5.18. Cognitive and Computational Neuroscience - The Cognitive and Computational Neuroscience program funds high-risk, high-potential basic research that uses experimental and computational modeling techniques from systems neuroscience, cognitive neuroscience, computational/theoretical neuroscience, cellular and molecular neuroscience, cognitive science, and cognitive psychology to understand the neural mechanisms responsible for perception, cognition, and behavior/motor control. The program also supports brain-inspired algorithm and hardware development provided these are grounded in neurobiology and are useful for testing proposed neuroscience theories and/or enabling novel capabilities in computing, artificial intelligence, or autonomous systems.

2.5.19. Atomic and Molecular Physics - Encompasses fundamental experimental and theoretical Atomic and Molecular Physics research that is primarily focused on studies of cold and ultra-cold quantum gases, precision measurement, matter-wave optics, and non-equilibrium quantum dynamics. These research areas support technological advances in application areas of interest to the USAF and USSF, including precision navigation, timekeeping, remote sensing, metrology, and novel materials for the USAF and USSF needs in the future.

2.5.20. Electromagnetics - Supports basic research (modeling/simulation) in linear/nonlinear Electromagnetics together with research in the general area of signal processing.

2.5.21. Optoelectronics and Photonics - Optoelectronic and photonic devices support a critical array of current and future Air and Space Force capabilities. Applications include high-capacity communications, secure networking, and advanced optical signal processing and computation. These applications require components capable of recording, reading, and changing data at extremely high speeds while maintaining low power, low weight, and a small footprint suitable for airborne and space platforms. The

portfolio advances the understanding of optoelectronics and photonics by exploring fundamental concepts, particularly focusing on how light and matter interact at the nanoscale and the quantum nature of light.

2.5.22. High-Energy Radiation-Matter Systems - Seeks to provide revolutionary advances in the fundamental understanding of the physicals processes involved, and our ability to control and exploit, the interaction of electromagnetic energy and matter. This portfolio seeks to find novel experimental, theoretical, and computational approaches to the nonlinear, multi-scale, and multi-physics scenarios where the kinetic, potential, and electromagnetic field energy are of comparable order. Examples including the opportunity to provide useful work for a variety of applications, including directed energy weapons, high-energy density physics, sensors and radars/lidars, electronic and electro-optical warfare, and novel compact accelerators as well as an improved ability to operate and exploit a range of extreme environment and conditions. High-energy lasers, high-power electromagnetism, pulsed power, plasma physics, nuclear physics, regimes of atomic pressure, radiation damage, and high-energy density EM-matter interactions, including biological interactions, are all of interest to this portfolio.

2.5.23. Quantum Information Sciences - Encompasses experimental and theoretical basic research to significantly advance the fundamental understanding, control, and exploitation of non-classical phenomena for the analysis, collection, processing, storage, dissemination and protection of information. Emphasis is on key fundamental research areas that underpin multiple quantum information science and technology areas for novel Air and Space Forces capabilities well beyond what is possible with classical systems.

2.5.24. Physics of Sensing - Investigates the fundamental physical principles governing the remote detection and characterization of objects. Moving beyond incremental improvements, the program discovers revolutionary sensing concepts that offer transformative gains in accuracy, sensitivity, and scalability. While research primarily targets imaging and non-imaging sensors across the electromagnetic spectrum, the portfolio also explores alternative modalities complementary to electromagnetic measurements. Key areas include aligning sensor performance with the underlying physics of electronic and optoelectronic devices, adaptive optics, and novel multimodal sensing for ground-, air-, and space-based platforms. Research within this portfolio is inherently multidisciplinary, bridging theoretical modeling, computational discovery, and experimental validation. Scientific themes include defining the physical and information-theoretical limits of information acquisition; understanding radiation propagation through stochastic or heterogeneous media; and the multiscale physics of radiation-matter interactions to define the fundamental limits of information preservation and sensor robustness. A significant objective is

developing physics-rooted models to characterize objects from unresolved or degraded signals. By prioritizing new physics, the program enables novel tracking and identification capabilities with vastly reduced size, weight, power, and cost in contested or degraded environments. This portfolio prioritizes fundamental exploratory research. It does not support device prototyping or incremental enhancements of current state-of-the-art techniques. While artificial intelligence and machine learning techniques may be utilized as tools to achieve research objectives, they are not a primary research goal of this portfolio.

2.5.25. Space Physics - Supports basic research on the solar-terrestrial environment extending from the Sun through Earth's magnetosphere and radiation belts to the mesosphere and lower thermosphere region. This geospace system is subject to solar radiation, particles, and eruptive events, variable interplanetary magnetic fields, and cosmic rays. Perturbations to the system can disrupt the detection and tracking of aircraft, missiles, satellites, and other targets; distort communications and navigation signals; interfere with global command, control, and surveillance operations; and negatively impact the performance and longevity of USAF and USSF space assets.

2.5.26. Ultrashort Pulse Laser-Matter Interactions - Focused on one of the most fundamental process in nature, the interaction of light with the basic constituents of matter. The objective of the program is to explore and understand the broad range of physical phenomena accessible via the interaction of ultrashort pulse (USP) laser with matter in order to further capabilities of interest to the USAF and USSF, including directed energy, remote sensing, communications, diagnostics, and materials processing. The portfolio explores research opportunities accessible by means of the three (3) key distinctive features of USP laser pulses: high peak power, large spectral bandwidth and ultrashort temporal duration.

2.5.27. Condensed Matter Physics - The Condensed Matter Physics program seeks to investigate fundamental physics of condensed matter, which can ultimately be exploited for unprecedented performance in both classical and quantum applications. The central goal is to discover new quantum phases and phase transitions, as well as to understand new physical phenomena-, specifically, extraordinary macroscopic physical properties in solid state materials. These quantum materials can host combinations of multiple phenomena or a plethora of quasi-particles, exhibit distinctive functionalities, and be engineered to create new platforms for disruptive capabilities for USAF and USSF, ranging from sensing and communications to computation.

2.5.28. Astrodynamics - This program seeks to provide revolutionary advances in the fundamental understanding of the physical processes that impact the motion and control of both natural and artificial objects moving in the gravity fields associated with the Earth/Moon/Sun system. Allied questions

of precision navigation and timing, logistics, and sensing associated with maneuvering spacecraft also inform this portfolio, especially where they impact our understanding of dynamics associated with current and future USSF missions.

3.0 Mission Organization Alignment

AREAS OF INTEREST (AOI)														
Mission Organization	**1.1 Air Domain Technologies**	**1.1.1 Human Performance Optimization**	**1.1.2 Aerospace medicine and Operational Health**	**1.1.3 Warfighter Survivability and Protection**	**1.1.4 Cognitive and Behavioral Sciences**	**1.1.5 Advanced Air Vehicles**	**1.1.6 Air Propulsion Systems**	**1.1.7 Aerodynamics and Flight Sciences**	**1.1.8 Hypersonics**	**1.1.9 Advanced Weapons Technologies**	**1.1.10 Energetics and Propellants**	**1.1.11 Guidance Navigation and Control**	**1.1.12 Munitions Survivability and Countermeasures**	**1.1.13 Rocket Systems**	**1.1.14 Nuclear Deterrence Technologies**
Air Warfare (AFRL/RA)	X					X	X		X	X				X	
Foundational Technologies (AFRL/RE)															
Information & Spectrum Warfare (AFRL/RF)	X			X					X	X		X		X	X
Space Warfare (AFRL/RJ)	X	X							X	X	X	X	X	X	X
Digital Capabilities (AFRL/IZ)															
711th Human Performance Wing (711HPW)		X	X	X	X			X							
Technology Transition (AFRL/RR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Systems Technology Office (AFRL/STO)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Mission Organization	**1.2 Space Domain Technologies**	**1.2.1 Space Access and Orbital Systems**	**1.2.2 Spacecraft and Satellite Technologies**	**1.2.3 Space Power and Propulsion**	**1.2.4 On-Orbit Operations and Autonomy**	**1.2.5 Space Domain Awareness**	**1.2.6 Resilient and Survivable Space Architecture**	**1.2.7 Space Environment and Effects**	**1.2.8 Position, Navigation, and Timing (PNT) from and for Space**	**1.2.9 Satellite Assembly, Integration & Testing**
Air Warfare (AFRL/RA)										
Foundational Technologies (AFRL/RE)										
Information & Spectrum Warfare (AFRL/RF)		X	X			X	X	X	X	X
Space Warfare (AFRL/RJ)	X	X	X	X	X	X	X	X	X	X
Digital Capabilities (AFRL/IZ)										
711th Human Performance Wing (711HPW)										
Technology Transition (AFRL/RR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Systems Technology Office (AFRL/STO)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

AREAS OF INTEREST (AOI)															
Mission Organization	**1.3 Cyberspace/Electronic Warfare Domain Technologies**	**1.3.1 Cyber Operations and Cybersecurity**	**1.3.2 Communications and Networks**	**1.3.3 Electronic Warfare and Spectrum Operations**	**1.3.4 Quantum Technologies**	**1.3.5 Electro-Optical and Infrared Sensors**	**1.3.6 Radar and Radio Frequency Sensors**	**1.3.7 Multispectral and Hyperspectral Sensing**	**1.3.8 Signal Processing and Sensor Fusion**	**1.3.9 Quantum Sensing and Advanced Properties**	**1.3.10 Directed Energy Sensing and Countermeasures**	**1.3.11 High-Energy Laser Systems**	**1.3.12 Photonics**	**1.3.13 High-Power Electromagnetic Technologies**	**1.3.14 High-Power Electromagnetic Effects**
Air Warfare (AFRL/RA)															
Foundational Technologies (AFRL/RE)															
Information & Spectrum Warfare (AFRL/RF)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Space Warfare (AFRL/RJ)	X	X	X	X	X	X	X	X	X	X	X				
Digital Capabilities (AFRL/IZ)		X													
711th Human Performance Wing (711HPW)															
Technology Transition (AFRL/RR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Systems Technology Office (AFRL/STO)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Mission Organization	**1.3.15 High-Power Electromagnetic Applications**	**1.3.16 Beam Control and Adaptive Optics**	**1.3.17 Directed Energy Effects and Countermeasures**	**1.3.18 Cybersecurity for Digital Environments**	**1.3.19 Navigation Warfare and Counter PNT**
Air Warfare (AFRL/RA)					
Foundational Technologies (AFRL/RE)					
Information & Spectrum Warfare (AFRL/RF)	X	X	X	X	X
Space Warfare (AFRL/RJ)				X	X
Digital Capabilities (AFRL/IZ)				X	
711th Human Performance Wing (711HPW)					
Technology Transition (AFRL/RR)	N/A	N/A	N/A	N/A	N/A
Systems Technology Office (AFRL/STO)	N/A	N/A	N/A	N/A	N/A

AREAS OF INTEREST (AOI)															
Mission Organization	**1.4 Cross-Domain Technologies**	**1.4.1 Human Systems Integration**	**1.4.2 Human-Machine Teaming and Interfaces**	**1.4.3 Training and Simulation Technologies**	**1.4.4 Rapid Multi-Domain Integration**	**1.4.5 Advanced Systems Engineering**	**1.4.6 Integrated Vehicle Health Management**	**1.4.7 Power and Thermal Management**	**1.4.8 Advanced Materials Development**	**1.4.9 Additive Manufacturing**	**1.4.10 Materials Processing and Fabrication**	**1.4.11 Materials Characterization and Testing**	**1.4.12 Environmentally Responsive and Smart Materials**	**1.4.13 Microelectronics**	**1.4.14 Model-Based Systems Engineering, Digital Engineering and Digital Thread**
Air Warfare (AFRL/RA)				X	X	X		X		X	X				X
Foundational Technologies (AFRL/RE)	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Information & Spectrum Warfare (AFRL/RF)	X	X	X	X	X	X	X				X			X	X
Space Warfare (AFRL/RJ)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Digital Capabilities (AFRL/IZ)	X				X										
711th Human Performance Wing (711HPW)		X	X												
Technology Transition (AFRL/RR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Systems Technology Office (AFRL/STO)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Mission Organization	**1.4.20 Robotics Technologies**	**1.4.21 Software Systems Development**	**1.4.22 Physiological Operations**	**1.4.23 Runtime Assurance (RTA) for AI**	**1.4.24 Autonomy**
Air Warfare (AFRL/RA)		X			
Foundational Technologies (AFRL/RE)	X				X
Information & Spectrum Warfare (AFRL/RF)		X	X	X	X
Space Warfare (AFRL/RJ)	X	X		X	X
Digital Capabilities (AFRL/IZ)					
711th Human Performance Wing (711HPW)	X		X		
Technology Transition (AFRL/RR)	N/A	N/A	N/A	N/A	N/A
Systems Technology Office (AFRL/STO)	N/A	N/A	N/A	N/A	N/A

AREAS OF INTEREST (AOI)															
Mission Organization	**1.5 Basic Research Technologies**	**1.5.1 Energetic Solid-State Physics and Mechanochemistry**	**1.5.2 Energy, Combustion, and Non-Equilibrium Thermodynamics**	**1.5.3 Aerodynamic Sciences**	**1.5.4 High-Speed Aerodynamics**	**1.5.5 Aerospace Composite Materials**	**1.5.6 Aerospace Structures**	**1.5.7 Propulsion and Power**	**1.5.8 Agile Science for Test and Evaluation (T&E)**	**1.5.9 Computational Cognition and Machine Intelligence**	**1.5.10 Computational Mathematics**	**1.5.11 Dynamical Systems and Control Theory**	**1.5.12 Dynamic Data and Information Processing**	**1.5.13 Information Assurance and Cybersecurity**	**1.5.14 Mathematical Optimization**
Air Warfare (AFRL/RA)			X	X	X			X			X		X		X
Foundational Technologies (AFRL/RE)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Information & Spectrum Warfare (AFRL/RF)									X	X	X		X	X	X
Space Warfare (AFRL/RJ)	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Digital Capabilities (AFRL/IZ)														X	
711th Human Performance Wing (711HPW)										X					
Technology Transition (AFRL/RR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Systems Technology Office (AFRL/STO)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Mission Organization	**1.5.20 Electromagnetics**	**1.5.21 Optoelectronics and Photonics**	**1.5.22 High-Energy Radiation-Matter Systems**	**1.5.23 Quantum Information Sciences**	**1.5.24 Physics of Sensing**	**1.5.25 Space Physics**	**1.5.26 Ultrashort Pulse Laser-Matter Interactions**	**1.5.27 Condensed Matter Physics**	**1.5.28 Astrodynamics**
Air Warfare (AFRL/RA)									
Foundational Technologies (AFRL/RE)	X	X	X	X	X	X	X	X	X
Information & Spectrum Warfare (AFRL/RF)	X	X		X	X			X	
Space Warfare (AFRL/RJ)	X		X	X	X	X			X
Digital Capabilities (AFRL/IZ)									
711th Human Performance Wing (711HPW)									
Technology Transition (AFRL/RR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Systems Technology Office (AFRL/STO)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A