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CONSORTIUM FOR SPACE MOBILITY AND ISAM CAPABILITIES

ISAM TECHNOLOGY TAXONOMY

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REVISION AND HISTORY PAGE

Revision No.	Description	Release Date
Baseline	Initial Baseline	09/12/2024
Rev A	Minor revisions for public release (e.g., updated release markings). Introduction expanded to explain hierarchical taxonomy numbering and dependency on the 2024 NASA Technology Taxonomy. Asterisks added to hierarchical taxonomy to indicate categories that are added beyond those found in the 2024 NASA Technology Taxonomy.	01/22/2025

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INTRODUCTION

The In-space Servicing, Assembly, and Manufacturing (ISAM) Technology Taxonomy is a singular point of reference created and utilized by the entire ISAM community. It spans technologies that make up all aspects of the space-based portion of the ISAM ecosystem. It will be updated based on feedback submitted by the COSMIC Research and Technology Focus Area (RT) members and adjudicated by RT subject matter experts. The ISAM Technology Taxonomy categorizes current technologies and will evolve to include anticipated innovations as ISAM technologies mature.

Hierarchical and Functional Taxonomy

The technologies in this document are organized in two ways: hierarchically and functionally. One of the goals of this overall ISAM Technology Taxonomy is to develop a repository system that is amenable to accessibility, analysis, and manipulation by computer natural language search tools to produce a resource for COSMIC users. Once the database is populated via a survey tool built from this taxonomy, the data in the inventory will be available in the form of a database that can be queried. This database is expected to become an invaluable tool for ensuring that COSMIC members remain on the cutting edge of development and innovation and to help identify partnership opportunities moving forward.

The hierarchical taxonomy follows the traditional definition of a taxonomy, as inspired by biological taxonomies: a field concerned with description, identification, nomenclature, and classification. Each technology is uniquely classified by category and sub-category. The numbering scheme used for this taxonomy is mapped directly from the 2024 NASA Technology Taxonomy; since not every category of the NASA Technology Taxonomy applies to the ISAM Technology Taxonomy, the numbering will sometimes skip in this document. This is intentional to maintain correlation with the NASA Technology Taxonomy.

The functional taxonomy captures the technologies at the system-level and/or applied capability-level. An ISAM function is defined as the application of one or more ISAM technologies to perform a specific action, task, or activity. Both the hierarchical and functional types of information are being captured to build a robust database that is usable and useful to the COSMIC community.

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HIERARCHICAL TAXONOMY (TX)

This taxonomy is modified from the [2024 NASA Technology Taxonomy](). Entries that apply to ISAM are included here. The numbering is unchanged from the NASA Technology Taxonomy to maintain correlation with that document. Additions that are not part of the NASA Technology Taxonomy are indicated with an asterisk.

TX01: Propulsion Systems

TX01.1 Chemical Space Propulsion

TX01.1.1 Integrated Systems and Ancillary Technologies (e.g. propellant transfer, etc.)
TX01.1.2 Space/Earth Storable Propellants
TX01.1.3 Cryogenic Propulsion
TX01.1.5 Hybrids
TX01.1.6 Gels
*TX01.1.10 Storable Propulsion Transfer/Refueling
*TX01.1.11 Recycling-Derived Propellant/Fuel

TX01.2 Electric Space

TX01.2.1 Integrated Systems and Ancillary Technologies
TX01.2.2 Electrostatic Propulsion
TX01.2.3 Electromagnetic Propulsion
TX01.2.4 Electrothermal Propulsion

TX01.4 Advanced Propulsion

TX01.4.3 Nuclear Thermal Propulsion
TX01.4.4 Solar Thermal Propulsion
TX01.4.7 Drag Sails
*TX01.4.8 Beamed Power Electric Propulsion
*TX01.4.9 Other Advanced Propulsion Approaches

*TX01.5 Refueling Systems

*TX01.5.1 Storage Propellant Refueling
*TX01.5.2 Cryo Propellant Refueling
*TX01.5.3 Client Prop System Design for Refueling

TX01.X Other Propulsion Systems

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TX02: Flight Computing and Avionics

TX02.1 Avionics Component Technologies

TX02.1.1 Radiation Hardened Extreme Environment Components and Implementations
TX02.1.2 Electronic Packaging and Implementations
TX02.1.3 High Performance Processors
TX02.1.4 High Performance Memories
TX02.1.5 High Performance Field Programmable Gate Arrays
TX02.1.6 Radiation Hardened ASIC Technologies
TX02.1.7 Point-of-Load Power Converters
TX02.1.8 Wireless Avionics Technologies (e.g. for RPOD)

TX02.2 Avionics Systems and Subsystems

TX02.2.1 Spacecraft Command and Data Handling Systems (C&DH)
TX02.2.4 Low-Power Embedded Computer Systems
TX02.2.5 High-Speed Onboard Interconnects and Networks
TX02.2.6 Data Acquisition Systems
TX02.2.8 Use of Advanced Commercial-off-the-Shelf (COTS) Technologies
TX02.2.9 Hardware-Enabling Secure Avionics

TX02.3 Avionics Tools, Models, and Analysis

TX02.3.1 Electronics Development Tools
TX02.3.2 Space Radiation Analysis and Modeling
TX02.3.3 Avionics Reliability and Fault-Tolerance Analysis and Modeling
TX02.3.4 Electromagnetic Environment Effects

TX02.X Other Flight Computing and Avionics

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TX03: Aerospace Power and Energy Storage

TX03.1 Power Generation and Energy Conversion

TX03.1.1 Photovoltaic Electrical Power
TX03.1.2 Heat Sources (e.g., Heat Conversion, Radioisotope)
TX03.1.3 Static Energy Conversion
TX03.1.4 Dynamic Energy Conversion
TX03.1.5 Electrical Machines (e.g., Motors, Generators, Shape-Memory Alloys and Piezoelectric Actuators)
TX03.1.6 Other Advanced Concepts for Generating/Converting Power

TX03.2 Energy Storage

TX03.2.1 Electrochemical: Batteries
TX03.2.2 Electrochemical: Fuel Cells
TX03.2.3 Advanced Concepts for Energy Storage
*TX03.2.4 Thermal Energy Storage

TX03.3 Power Management and Distribution

TX03.3.1 Management and Control
TX03.3.2 Distribution and Transmission (e.g., Cabling, Modularity, Standardization)
TX03.3.3 Electrical Power Conversion and Regulation
TX03.3.4 Advanced Electronic Parts

TX03.X Other Aerospace Power and Energy Storage

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TX04: Robotic Systems

TX04.1 Sensing and Perception

TX04.1.1 Sensing for Robotic Systems
TX04.1.2 State Estimation
TX04.1.3 Onboard Mapping and Data Analysis
TX04.1.4 Object, Event, and Activity Recognition

TX04.2 Mobility

TX04.2.1 Below-Surface Mobility
TX04.2.2 Above-Surface Mobility
TX04.2.3 Small-Body and Microgravity Mobility
TX04.2.4 Surface Mobility
TX04.2.5 Robot Navigation and Path Planning
TX04.2.6 Collaborative Mobility
*TX04.2.7 Intra-Satellite Transportation (e.g., Inchworm Robots, Small-Scale Rails)

TX04.3 Manipulation (e.g., End Effectors and Tools)

TX04.3.1 Dexterous Manipulation
TX04.3.2 Grappling Technologies
TX04.3.3 Contact Dynamics Modeling
TX04.3.4 Sample Acquisition, Handling, and Inventory Management
TX03.4.5 Manufacturing Tools

TX04.4 Human-Robot Interaction

TX04.4.1 Multi-Modal and Proximate Interaction
TX04.4.2 Distributed Collaboration and Coordination
TX04.4.3 Remote Interaction

TX04.5 Autonomous Rendezvous and Docking

TX04.5.1 Relative Navigation Sensors
TX04.5.2 Rendezvous and Docking Algorithms
TX04.5.3 Rendezvous, Proximity Operations, and Capture (RPOC) Flight & Ground Systems
TX04.5.4 Capture Sensors
TX04.5.5 Capture Mechanisms and Fixtures
TX04.5.6 Robot Control for Vehicle Capture and Berthing
TX04.5.7 Modeling, Simulation, Analysis, and Test of RPOC

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TX04.6 Robotics Integration

TX04.6.1 Modularity, Commonality, and Interfaces
TX04.6.2 Modeling and Simulation for Robots
TX04.6.3 Robot Software
*TX04.6.4 Multi-Robot Collaborative Autonomy

TX04.X Other Robotic Systems

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TX05: Communications, Navigation, and Orbital Debris Tracking and Characterization Systems

TX05.1 Optical Communications

TX05.1.1 Detector Development
TX05.1.2 Large Apertures
TX05.1.3 Lasers
TX05.1.4 Pointing, Acquisition, and Tracking Techniques and Technologies
TX05.1.5 Atmospheric Mitigation
TX05.1.6 Optimetrics
TX05.1.7 Innovative Signal Modulations

TX05.2 Radio Frequency

TX05.2.1 Spectrum Efficiency
TX05.2.2 Power Efficiency
TX05.2.3 Atmospheric Characterization and Mitigation
TX05.2.4 Flight and Ground Systems
TX05.2.5 Launch and Reentry Communications
TX05.2.6 Innovative Antennas
TX05.2.7 Innovative RF Technologies

TX05.3 Internetworking

TX05.3.1 Disruption-Tolerant Networking
TX05.3.2 Adaptive Network Topology
TX05.3.3 Information Assurance (e.g., Cybersecurity, Encryption)
TX05.3.4 Integrated Network Management

TX05.4 Network-Provided Position, Navigation, and Timing

TX05.4.1 Timekeeping and Time Distribution
TX05.4.2 Revolutionary Position, Navigation, and Timing Technologies

TX05.5 Revolutionary Communications Technologies

TX05.5.1 Cognitive Networking
TX05.5.2 Quantum Communications
TX05.5.3 Hybrid Radio and Optical Technologies

TX05.6 Networking and Ground-Based Orbital Debris Tracking and Management

TX05.6.1 Orbital Debris Tracking
TX05.6.2 Orbital Debris Characterization

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TX05.6.3 Orbital Debris Mitigation
TX05.6.4 Orbital Debris Monitoring Software Platforms

TX05.7 Acoustic Communication

*TX05.7.1 Sonar
*TX05.7.2 Acoustic Sensors
*TX05.7.3 Active and Passive Sensors (e.g., Geophones and Seismic Receivers)

TX05.X Other Communications, Navigation, and Orbital Debris Tracking and Characterization Systems

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TX06: Human Health, Life Support, and Habitation Systems

TX06.1 Environmental Control and Life Support Systems (ECLSS)

TX06.1.1 Atmosphere Revitalization
TX06.1.2 Water Recovery and Management
TX06.1.3 Waste Management
TX06.1.4 Habitation Systems
TX06.1.5 ECLSS Modeling and Simulation Tools
*TX06.1.6 Biological (Grown) Life Support

TX06.2 Extravehicular Activity Systems

TX06.2.1 Pressure Garment
TX06.2.2 Portable Life Support System
TX06.2.3 Informatics and Decision Support Systems

TX06.3 Human Health and Performance

TX06.3.1 Medical Diagnosis and Prognosis
TX06.3.2 Prevention and Countermeasures
TX06.3.3 Behavioral Health and Performance
TX06.3.4 Contactless and Wearable Human Health and Performance Monitoring
TX06.3.5 Food Production, Processing, and Preservation
TX06.3.6 Long-Duration Health
TX06.3.7 System Transformative Health and Performance Concepts
TX06.3.8 Decompression Sickness Mitigation

TX06.4 Environmental Monitoring, Safety, and Emergency Response

TX06.4.1 Air, Water, Microbial, and Acoustic Sensors
TX06.4.2 Fire Detection, Suppression, and Recovery
TX06.4.3 Protective Clothing and Breathing
TX06.4.4 Remediation

TX06.5 Radiation

TX06.5.1 Radiation Transport and Risk Modeling
TX06.5.2 Radiation Mitigation and Biological Countermeasures
TX06.5.3 Protection Systems
TX06.5.4 Space Weather Prediction
TX06.5.5 Monitoring Technology

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TX06.6 Human Systems

TX06.6.1 Human Factors Engineering
TX06.6.2 Training
TX06.6.3 Habitability and Environment
TX06.6.4 Operations Effectiveness
TX06.6.5 Integrated Systems Safety
TX06.6.6 Maintainability and Supportability

TX06.X Other Human Health, Life Support, and Habitation Systems

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TX07: Exploration Destination Systems

TX07.1 In-Situ Resource Utilization

TX07.1.1 Destination Reconnaissance and Resource Assessment
TX07.1.2 Resource Acquisition, Isolation, and Preparation
TX07.1.3 Resource Processing for Production of Mission Consumables (e.g. Structural, Fuels, etc.)
TX07.1.4 Resource Processing for Production of Manufacturing, Construction, and Energy Storage

TX07.2 Mission

TX07.2.1 Logistics Management
TX07.2.2 In-Situ Manufacturing, Maintenance, and Repair
TX07.2.3 Surface Construction and Assembly
TX07.2.4 Microgravity Construction and Assembly
TX07.2.5 Particulate Contamination Prevention and Mitigation

TX07.3 Mission Operations and Safety

TX07.3.1 Mission Planning and Design
TX07.3.2 Integrated Flight Operations Systems
TX07.3.3 Training
TX07.3.4 Integrated Risk Assessment Tools
TX07.3.5 Planetary Protection

TX07.X Other Exploration

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TX08: Sensors and Instruments

TX08.1 Remote Sensing Instruments and Sensors

TX08.1.1 Detectors and Focal Planes
TX08.1.2 Electronics
TX08.1.3 Optical Components
TX08.1.4 Microwave, Millimeter Waves, and Submillimeter Waves
TX08.1.5 Lasers and Laser-Based Sensors
TX08.1.6 Cryogenic/Thermal Systems
*TX08.1.7 Hyperspectral Imaging
*TX08.1.8 Ultra-Wideband Sensors

TX08.3 In-Situ Instruments and Sensors

TX08.3.1 Field and Particle Detectors
TX08.3.2 Atomic and Molecular Species Assessment
TX08.3.3 Sample Handling
TX08.3.4 Environment Sensors
TX08.3.5 Electromagnetic Wave-Based Sensors
TX08.3.6 Extreme Environments Related to Critical System Health Management
*TX08.3.7 Haptic Sensors

TX08.X Other Sensors and Instruments

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TX09: Entry, Descent, and Landing for Manufactured Material Return

TX09.1 Aero-assist and Atmospheric Entry

TX09.1.1 Thermal Protection Systems
TX09.1.2 Hypersonic Decelerators
TX09.1.3 Passive Reentry Systems for SmallSats

TX09.2 Descent

TX09.2.1 Aerodynamic Decelerators
TX09.2.2 Supersonic Retropropulsion

TX09.3 Landing

TX09.3.1 Touchdown Systems
TX09.3.2 Propulsion Systems for Landing

TX09.4 Vehicle Systems

TX09.4.2 Separation and Reusable Docking Systems

TX09.5 Flight Mechanics and GN&C for Entry, Descent, and Landing

TX09.5.3 EDL Control Systems
TX09.5.4 EDL Hazard Detection

TX09.X Other Entry, Descent, and Landing

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TX10: Autonomous Systems

TX10.1 Situational and Self-Awareness Technologies

TX10.1.1 Sensing and Perception for Autonomous Systems
TX10.1.2 State Estimation and Monitoring
TX10.1.3 Knowledge and Model Building
TX10.1.4 Hazard Assessment
TX10.1.5 Event and Trend Identification
TX10.1.6 Anomaly Detection

TX10.2 Reasoning and Acting

TX10.2.3 Path Planning
TX10.2.4 Execution and Control
TX10.2.5 Fault Diagnosis and Prognosis
TX10.2.6 Fault Response
TX10.2.7 Learning and Adaption
*TX10.2.8 Edge Computing

TX10.3 Collaboration and Interaction

TX10.3.1 Joint Knowledge and Understanding
TX10.3.2 Behavior and Intent Prediction
TX10.3.3 Goal and Task Negotiation
TX10.3.4 Operational Trust Building

TX10.4 Engineering and Integrity

TX10.4.1 Verification and Validation of Autonomous Systems
TX10.4.3 Operational Assurance of Autonomous Systems
TX10.4.4 Modeling and Simulation of Autonomous Systems
TX10.4.5 Architecture and Design of Autonomous Systems

TX10.5 Other Autonomous Systems

*TX10.5.1 Vision and Virtual/Augmented Reality Avionics

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TX11: Software, Modeling, and Simulation

TX11.1 Software Development, Engineering, and Integrity

TX11.1.4 Operational Assurance
TX11.1.6 Real-Time Software

TX11.2 Modeling

TX11.2.1 Software Modeling and Model Checking
TX11.2.2 Integrated Hardware and Software Modeling
TX11.2.3 Human-System Performance Modeling
TX11.2.4 Science Modeling

TX11.3 Simulation

TX11.3.1 Distributed Simulation
TX11.3.2 Integrated System Lifecycle Simulation
TX11.3.3 Model-Based Systems Engineering (MBSE)
TX11.3.4 Simulation-Based Training and Decision Support Systems
TX11.3.5 Exascale Simulation
TX11.3.6 Uncertainty Quantification and Nondeterministic Simulation Methods
TX11.3.7 Multiscale, Multiphysics, and Multifidelity Simulation

TX11.4 Information Processing

TX11.4.1 Science, Engineering, and Mission Data Lifecycle
TX11.4.2 Intelligent Data Understanding
TX11.4.3 Semantic Technologies
TX11.4.4 Collaborative Science and Engineering
TX11.4.5 Cyber Infrastructure
TX11.4.6 Cyber Security
TX11.4.7 Digital Assistant
TX11.4.8 Edge Computing in Simulation Environment

TX11.5 Mission Architecture, Systems Analysis, and Concept Development

TX11.5.1 Tools and Methodologies for Defining Mission Architectures or Mission Design
TX11.5.2 Tools and Methodologies for Performing Systems Analysis
TX11.5.3 Tools and Methodologies for Vehicle or Concept Definition Activities

TX11.6 Ground Computing

TX11.6.1 Exascale Supercomputers

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TX11.6.2 Automated Exascale Software Development Toolset

TX11.6.3 Exascale Supercomputer File System

TX11.6.4 Quantum Computers

TX11.6.5 Public Cloud Supercomputers

TX11.6.6 Cognitive Computers

TX11.6.7 High-Performance Data Analytics Platform

TX11.6.8 Cloud Computing

TX11.X Other Software, Modeling, Simulation, and Information Processing

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TX12: Materials, Structures, Mechanical Systems, and Manufacturing

TX12.1 Materials

TX12.1.1 Lightweight Structural Materials
TX12.1.2 Computational Materials
TX12.1.3 Flexible Material Systems
TX12.1.4 Materials for Extreme Environments
TX12.1.5 Coatings
TX12.1.6 Materials for Electrical Power Generation, Energy Storage, Power Distribution, and Electrical Machines (e.g., Ionic Liquids)
TX12.1.7 Special Materials
TX12.1.8 Smart Materials

*TX12.2 Assembly Processes and Methods for Structures

TX12.2.1 Lightweight Concepts and Architected Materials
TX12.2.2 Design and Certification Methods
TX12.2.3 Reliability and Sustainment
TX12.2.4 Tests, Tools, and Methods
TX12.2.5 Innovative and Multifunctional Concepts

TX12.3 Mechanical Systems

TX12.3.1 Deployables, Docking, and Interfaces
TX12.3.2 Electromechanical, Mechanical, and Micromechanisms
TX12.3.6 Mechanical Drive Systems
TX12.3.7 Mechanism-Life-Extension Systems
TX12.3.8 Docking and Berthing Mechanisms and Fixtures

TX12.4 Manufacturing

TX12.4.1 Manufacturing Processes (e.g., Joining, Multi-Material, Biological, Mining, and Welding)
TX12.4.2 Digital Transformation Technologies for Manufacturing
TX12.4.3 Electronics and Optics Manufacturing
TX12.4.4 Sustainable Manufacturing and Recycling
TX12.4.5 Nondestructive Evaluation and Sensors
TX12.4.6 Recycle, Reuse, and Repurpose Processes
TX12.4.7 Additive Manufacturing
*TX12.4.8 Automated and High-Throughput Material Testing
*TX12.4.9 Raw Material Inventory Management and Automated Resupply

TX12.5 Structural Dynamics

TX12.5.4 Test, Tools, and Methods

TX12.X Other Manufacturing, Materials, and Structures

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TX14: Thermal Management Systems

TX14.1 Cryogenic Systems

TX14.1.1 In-Space Propellant Storage and Utilization
TX14.1.3 Thermal Conditioning for Sensors, Instruments, and High-Efficiency Electric Motors
TX14.1.5 Cryogenic Analysis, Safety, and Storage

TX14.2 Thermal Control Components and Systems

TX14.2.1 Heat Acquisition
TX14.2.2 Heat Transport
TX14.2.3 Heat Rejection and Storage
TX14.2.4 Insulation and Interfaces
TX14.2.6 Heating Systems
TX14.2.8 Measurement and Control

TX14.X Other Thermal Management Systems

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TX17: Guidance, Navigation, and Control

TX17.1 Guidance and Targeting Algorithms

TX17.1.1 Guidance Algorithms
TX17.1.2 Targeting Algorithms
*TX17.1.3 Onboard Navigation Algorithms

TX17.2 Navigation Technologies

TX17.2.3 Navigation Sensors
TX17.2.4 Relative Navigation Aids
TX17.2.5 RPO, and Capture Sensor Processing and Processors

TX17.3 Control Technologies

TX17.3.1 Onboard Maneuvering, Pointing, Stabilization, and Flight Control Algorithms
TX17.3.2 Dynamics Analysis, Modeling, and Simulation Tools
TX17.3.3 Ground-Based Maneuvering, Pointing, Stabilization, and Flight Control Algorithms
TX17.3.4 Control Force and Torque Actuators
TX17.3.5 GN&C Actuators for 6DOF Spacecraft Control During RPOC

TX17.4 Attitude Estimation Technologies

TX17.4.1 Onboard Attitude and Attitude Rate Estimation Algorithms
TX17.4.2 Ground-Based Attitude Determination and Reconstruction Algorithm Development
TX17.4.3 Attitude Estimation Sensors

TX17.5 GN&C Systems Engineering Technologies

TX17.5.1 GN&C System Architectures, Requirements, and Specifications
TX17.5.2 GN&C Fault Management, Fault Tolerance, and Autonomy
TX17.5.3 GN&C Verification and Validation Tools and Techniques
TX17.5.5 Vehicle Flight Dynamics and Mission Design Tools and Techniques
TX17.5.7 End-to-End Modeling and Simulation of GN&C Systems

*TX17.6 Technologies for Spacecraft Trajectory Generation, Management, and Optimization

*TX17.6.1 Strategic Management of Space Vehicles
*TX17.6.2 Tactical Management of Space Vehicles

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TX17.X Other Guidance, Navigation, and Control

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FUNCTIONAL TAXONOMY (FN)

FN01: ISAM Crosscutting

FN01.1: Avionics, Communications, and Navigation

FN01.2: Design and Analysis for ISAM

FN01.3: RPO Sensing and Algorithms

FN01.4: Capture, Docking, and Mating

FN01.5: Automation and Autonomy

FN01.6: Power Generation, Storage, and Distribution

FN01.7: In-Space Propulsion

FN01.8: Spacecraft and Debris Tracking

FN01.9: In-Space Verification and Validation

FN01.10: Station-Keeping and Formation Flying

FN01.11: Robotic Manipulation

FN02: Servicing

FN02.1: System Health Inspection

FN02.2: Free-Flyer Inspection

FN02.3: Modular Component Replacement and Augmentation

FN02.4: Fluid Transfer

FN02.5: Fluid Mass Gauging

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FN03: Assembly

FN03.1: Structural Disassembly/Reassembly

FN03.2: Surface Mobility and Logistics

FN03.3: Orbital Mobility and Logistics

FN03.4: Joining Methods

FN03.5: Connecting Prefabricated Modules

FN03.6: Deploy or Inflate Structures

FN03.7: Spacecraft Reconfiguration

FN03.8: Outfitting

FN04: Manufacturing

FN04.1: Additive Manufacturing

FN04.2: Subtractive Manufacturing

FN04.3: Forming, Casting, and Molding

FN04.4: Recycling, Reuse, and Repurpose

FN04.5: ISRU Material Sourcing

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FN04.8: Microgravity-Enabled Material Fabrication

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