Space Station Program
Program Requirements Document

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National Aeronautics and
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3.6 INFORMATION SYSTEMS

3.6.1 SPACE STATION PROGRAM INFORMATION SYSTEM

The Space Station Program information system is an end-to-end system that supports the information needs of SSP operators and users. The system is composed of many cooperating components in space and on the ground. The components include:

(1) Existing and planned SSP-controlled information systems,

(2) Existing and planned NASA-owned facilities and networks only partially dedicated to SSP support, and,

(3) Non-NASA-owned facilities dedicated to or partially dedicated to SSP support.

This diverse set of components make up a heterogeneous and geographically distributed information systems environment. A major goal is to identify interfaces that will, when implemented by the various components, present a uniform and homogeneous interface and environment to all its users. This standardization will allow for a high degree of integration and coordination.

The Space Station Program information system will function as a distributed data system and provide the information services defined herein to all SSP operators and users. Operators and users are defined as follows:

(a) "Operators" include those whose accountabilities span operating, maintaining, and managing the orbiting facilities and supporting ground systems, whether stationed on-orbit or on the ground.

(b) "Users" include those whose primary accountabilities are to use the SSP space and ground facilities to conduct the activities and processes which the SSP is designed to support (e.g., science, technology, and commercial investigations and experiments).

3.6.1.1 System Level Requirements

3.6.1.1.1 Span of Services. Defined services shall be provided to SSP operators and users throughout all phases of the Space Station life cycle. These services shall include:

(a) Transparent data communications to all applications

(b) Enabling interoperability of data systems

(c) Enabling transportability of software

(d) Command and control

(e) Operations

(f) Payload user support

(g) General data services

(h) Security and access control

3.6.1.1.2 Standards Source Hierarchy. Standards for all SSP information systems shall be based on the following prioritization of source standards:

Priority 1: International standards

Priority 2: National standards

Priority 3: Commercial (industry) standards

Priority 4: NASA-unique standards

3.6.1.1.3 Standards Documentation. Information system standards, based on the prioritization of source standards, shall be established by the SSP requirements documentation process.

3.6.1.1.4 Information Resource Management. SSP information systems shall be designed to minimize the loss of information within the systems, due to the following occurrences:

(a) Hardware failures

(b) Software failures

(c) Evolution or upgrades in technology, design, or components within the data system

3.6.1.1.5 Critical Data Flow. No critical data flow shall be limited to a path susceptible to single-point failure.

3.6.1.1.6 Information Accessibility. Within the SSP information systems, information shall be accessible by all SSP systems on a transaction or distributed processing basis.

3.6.1.1.7 Interoperability of Systems. SSP information systems shall support distributed and cooperative processing among all SSP ground and flight information systems at the data item level.

3.6.1.1.8 Software Rehosting. Applications software developed in accordance with SSP standards shall be transportable from one data system to another within the SSP without redesign or modification of source code.

3.6.1.1.9 Software Development. A standard software support environment shall be established, outside of the operational information systems environment, for the development of SSP applications software.

3.6.1.1.10 Upgrade. SSP information systems shall, with minimal impact on redesign/recertification of the remainder of a given system and with minimal disruption in services, be capable of accommodating replacement with technologically superior layers of data system hardware or software services.

3.6.1.1.11 Migration of Automated Functions. SSP information systems shall support the planned migration of automated functions from the ground to the orbiting elements.

3.6.1.2 Command and Control

3.6.1.2.1 Assembly and Orbital Operations. The SSP information system shall support command and control of SSP operator and user systems during the assembly and orbital operations phases.

3.6.1.2.2 Operator and User Interface. Applications functions within SSP information systems shall be operable via remote transactions.

3.6.1.2.3 Safe Configuration. In emergency situations, the SSP information system shall provide functions to rapidly place on-orbit systems into safe configurations.

3.6.1.2.4 Automated Commands. The SSP information system shall support the onboard storage, activation, execution, and modifications of automated command sequences, subject to manual override.

3.6.1.2.5 Resource Monitoring. The SSP information system shall provide for the measurement, monitoring, and management of all flight and ground supporting resources.

3.6.1.2.6 Transaction Filtering and Management. For user commands, the process of interpreting remote transactions for legality and for effects of the commands on the system as a whole shall be implemented. The SSP information system shall interpret remote transactions for legality and reactively monitor user commands for effects on the system as a whole, rather than monitor the commands themselves.

3.6.1.2.7 Interlocks. The SSP information system shall provide the necessary functions to effect interlocks, which are defined as the disabling of processes and transactions within an information system under system-defined rules and circumstances.

3.6.1.2.8 Override. The SSP information system shall provide the necessary functions to effect ground and crew-initiated overrides, which are defined as the initiation of alternate processes and transactions within an information system under system-defined rules and circumstances necessary to retain safety or integrity.

3.6.1.2.9 Audit or Logging. The SSP information system shall provide for the recording, for subsequent analysis or investigation, of all transactions which affect configuration or resources.

3.6.1.2.10 On-Board Operations Automation. The SSP information system shall provide an on-board automated management system to support the crew, accessible from both the ground and the SSMB, and integrated with the ground-based system.

3.6.1.3 Operations and User Support

3.6.1.3.1 Operational Interactions. The SSP information system shall be designed to minimize the need for operational interactions between operators and users.

3.6.1.3.2 User Transparency. The SSP information system shall provide users with complete end-to-end data communications transparency.

3.6.1.3.3 Telescience. The SSP information system shall support the telescience mode of operation for a distributed set of users.

3.6.1.3.4 User Service. The SSP information system shall minimize disruptions in services to users during SSMB resupply, payload exchange, and other activities which accommodate the changing set of users.

3.6.1.3.5 Data Storage. The SSP information system shall store user data only as long as necessary for the user to verify acceptance of the data, subject to a specific time limit to be established by the SSP. Acceptance of the data by a user shall be defined as user verification of data quality, quantity, completeness, and continuity, after the data have been received.

3.6.1.4 Interoperability

3.6.1.4.1 Non-SSP Facilities and Resources. SSP standards on information transfer and transactions shall not preclude the use of non-NASA communications channels and facilities, such as partner-provided tracking and data acquisition systems and user-provided space-ground or space-space links.

3.6.1.4.2 Interface to Supporting Environments. SSP standards on information transfer and transactions shall include interface to known supporting

environments, such as the Technical and Management Information System (TMIS) and the Software Support Environment (SSE), that are outside of the flight operational environment.

3.6.1.5 Facilities and Shared Resources

3.6.1.5.1 Data Paths. NASCOM and TDRSS shall be the primary services for space-ground communications and data flow.

3.6.1.5.2 Communications Format. All SSP inter-information systems data flow shall be in digital format.

3.6.1.5.3 Contingency Data Links. The SSP shall provide contingency data links to the ground to support critical telemetry, command, and voice communications in emergencies. At least one of these links shall be independent of the primary communications system.

3.6.1.5.4 TDRSS Links. SSP information system design shall be based upon the equivalent of two TDRSS single-access links allocated to SSP program elements, with one link allocated to the SSMB and the other allocated to be shared by platforms.

3.6.1.5.5 Virtual Channels. SSP information systems shall use channel or path definitions which are distinct from the physical paths.

3.6.1.5.6 Ground Communications. NASCOM shall be the primary operational ground communications resources between network control facilities and other NASA facilities. NASCOM shall provide operational interfaces to communications systems operated by partner agencies.

3.6.1.6 Data Network Requirements

3.6.1.6.1 Forms of Information. The SSP information systems networks shall provide all services defined for information in all supported forms (including data, audio, and video).

3.6.1.6.2 Network Management. The SSP information systems network shall provide network management; network failure and resource management; and data protection services and functions.

3.6.1.6.3 Government Open System Interconnection Profile (GOSIP). SSP information systems network protocols and distributed processing standards shall be designed to conform to a layered communications system architecture consistent with the International Standards Organization (ISO) Reference Model for Open System Interconnection (OSI).

3.6.1.6.4 General Purpose Resources. The SSP information system shall make general purpose flight computational services available to operators and users.

3.6.1.6.5 On-Board Data Storage. The SSP information systems shall provide TBD Gb of on-board data storage capability for operators and users.

3.6.1.6.6 Data Unit Transfers. The SSP information systems shall transfer data units between user processing facilities in a time scale compatible with user requirements.

3.6.1.6.7 Data Unit Integrity. The SSP information system shall not alter the content of user data units.

3.6.1.6.8 Data Processing. The SSP information systems network shall provide for a Level-Zero processing service to users, where Level-Zero is defined as all processing steps required to replicate the user-generated product.

3.6.1.6.9 Grades of Service. The SSP information systems network shall provide selectable grades of service for the users. Selectable parameters associated with grades of service shall include bit error rate and completeness.

3.6.1.6.10 Minimum BER. The SSP information systems network shall provide a service option for a minimum bit error rate (BER) of better than $1x10^{(-TBD)}$.

3.6.1.6.11 Data Compression. The SSP information systems network shall provide standard data compression mechanisms for users.

3.6.1.6.12 Gateways. The SSP information system network shall provide SSP-standard gateway services on the SSP network side of the gateway to external networks at designated Service Access Points (SAPs).

3.6.1.6.13 Interconnection. The SSP information systems networks shall support interconnection of external networks supporting SSP operations.

3.6.1.6.14 End-to-End Performance. The SSP information systems network shall ensure the end-to-end performance of SSP-provided standard user data communications services between SAPs on the SSP information systems services network.

3.6.1.7 Video and Audio

3.6.1.7.1 Bidirectional Transfer of Video. SSP information systems shall support the bidirectional transfer of video within the SS, between selected orbiting elements, and between the orbiting elements and the ground.

3.6.1.7.2 Video and Audio Handling. SSP information systems shall develop an integrated approach to video and audio data handling which accommodates the needs of multiple classes of operators and users.

3.6.1.7.3 Video Transmission. SSP information systems shall provide selectable resolution and frame rate options for video transmission between the orbiting elements and the ground in support of a variety of applications, including user experimentation, distribution to public information channels, and teleconferencing.

3.6.1.7.4 Transfer of Audio. SSP information systems shall support the transfer of full duplex audio within the manned orbiting elements, between manned orbiting elements, and between manned orbiting elements and the ground.

3.6.1.7.5 Synchronization. SSP information systems shall have the capability to synchronize audio and video.

3.6.1.7.6 Compression. SSP information systems shall implement data compression techniques for video and audio to maximize communications efficiency and to minimize undesirable interaction with other operators and users accessing shared facilities.

3.6.1.7.7 End-to-End Performance. TBD.

3.6.1.7.8 Minimum BER. The SSP information systems network shall provide a minimum BER of TBD for video and a minimum BER of TBD for audio.

3.6.1.8 Ancillary Data

3.6.1.8.1 Engineering Data. The SSP shall provide long-term archiving, cataloging, retrieval, and distribution of engineering data associated with the on-orbit SSP elements.

3.6.1.8.2 Operations Logs and Histories. The SSP shall maintain operations logs and histories which document all major activities, including those activated by ground users, flight crew, and automated systems.

3.6.1.8.3 Ancillary Data. SSP information systems shall provide ancillary data to operators and users with a timeliness that supports operator and user data processing requirements. The ancillary data to be provided shall include:

(a) Orbital position

(b) Attitude references

(c) Capabilities to compute pointing references in real time for payloads that view phenomena external to the SSP.

(d) Universal Coordination Time (UTC) standard time references, transmitted to operators/users with a minimum resolution of one millisecond.

(e) A range of TBD standard frequency references.

3.6.1.9 Security and Access Control

3.6.1.9.1 Threat Analysis. A threat and vulnerability analysis shall be completed and periodically updated for the SSP information system. Security and access control guidelines, based on the threat analysis, shall be derived. All privacy and security mechanisms implemented within the SSP information systems shall bee commensurate with these guidelines.

3.6.1.9.2 Data Protection. SSP information systems shall protect the transmission of data critical to the health and safety of the flight elements of the SSP, commensurate with the threat analysis guidelines.

3.6.1.9.3 Access, Tampering and Privacy. The SSP information systems and networks shall provide information privacy, access, and tamper protection services for all forms of information (computer, voice, video).

3.6.1.9.4 Data Encryption. SSP information systems shall provide standard encryption mechanisms (algorithms, instructions, etc.) to users; however, SSP information systems shall not provide a data encryption service for users. Users may implement private encryption mechanisms internal to their application data sets.

3.6.1.10 SSP Information Systems Development Requirements

3.6.1.10.1 Operator/User Requirements Document. An "Operator/User Requirements Document" will be completed. It shall contain and validate the information-gathering and processing service requirements of the diverse SSP operator and user community.

3.6.1.10.2 Operator/User Services Specification. An "Operator/User Services Specification" document will be completed. It shall specify the data handling services, standards, and user interfaces in response to the requirements document above.

3.6.1.10.3 Operator/Users Guide. An "Operator/Users Guide" will be completed prior to the operational phase. It shall provide user/operator instructions and training material for all services available and in use at any given time in the program life cycle.

3.6.1.10.4 Architecture and Standards. The SSP shall define a top-level SSP information system architecture which includes the allocation of derived requirements. The SSP shall select, document, and enforce all required and necessary information systems and data transmission standards.

3.6.1.10.5 Design Testbed. The SSP shall provide an SSP information system testbed capability early in the design phase and shall maintain this capability throughout the lifetime of the SSP. Users and non-SSP elements shall provide testbed elements to complement those of SSP.

3.6.1.10.6 Training. The SSP shall provide capabilities to train operators and users in the use of SSP information system services in preparation for operational activities.

3.6.2 SOFTWARE SUPPORT ENVIRONMENT (SSE)

The SSP shall provide a common SSP-funded Software Support Environment (SSE) for the development of all SSP-funded operational software. Operational software is that which interfaces in real time with on-orbit elements or supporting information systems, and software which supports the certification of that software.

The SSE shall provide the tools and standards necessary for all phases and activities involved in software development including management, requirements, design, development, integration, test and maintenance.

3.6.2.1 SSE System Configuration

3.6.2.1.1 SSE Functions. The SSE shall provide for the development, local configuration management, test, integration, and sustaining engineering of all SSP operational flight and ground software.

3.6.2.1.2 Replication. The SSE shall be capable of being replicated in geographically distributed facilities, as required by the SSP and its users.

3.6.2.1.3 Functions and Tools. The SSE shall provide the following functions and tools for the life cycle creation and management of operational Space Station software:

(a) SSE execution management;

(b) distributed communications;

(c) data base management;

(d) configuration access control;

(e) user interface support and management;

(f) project management;

(g) configuration management;

(h) safety, reliability, and quality assurance;

(i) document processing;

(j) office automation;

(k) software production through the life cycle phases of requirements, development, design, code, test, integration, maintenance, and sustaining;

(l) data reconfiguration; and

(m) user training.

3.6.2.1.4 Hardware Configurations. The SSE shall support a range of hardware configurations.

3.6.2.1.5 Connecting Network. The SSE shall use TMIS to provide the connecting network among SSE facilities.

3.6.2.2 SSE Interfaces

3.6.2.2.1 Software Production and Integration Facilities. The Software Production and Integration Facilities shall use the SSE, and provide interfaces with the SSE Development Facility operational systems to support the prelaunch development and checkout of installed operational software, and to support the transfer of software updates during the operational phase.

3.6.2.2.2 Communications Interfaces. The SSE Development Facility shall provide additional communications interfaces to allow the distributed software facilities to intercommunicate and to be accessed using the SSP information systems network upon its availability.

3.6.2.2.3 Partner Interfaces. The SSE shall provide interfaces with partner facilities.

3.6.2.3 SSE Accommodation of its Users

3.6.2.3.1 Design and Implementation. SSE design and implementation shall be driven by requirements of its users, based on the needs of the SSE user community.

3.6.2.3.2 User-Developed Software. Subsets of the SSE shall be provided to its users who develop software to be used in conjunction with Space Station, at the users request and expense. This shall include, at a minimum, SSE users funded by other NASA offices and the partners, subject to limitations of technology transfer agreements.

3.6.2.3.3 Training. The SSE shall provide training to users of the SSE, and shall be capable of providing assistance upon request in the development of non-operational software.

3.6.2.3.4 Software Library. The SSE shall provide a software library for the exchange of software among SSE users and facilities.

3.6.2.3.5 SSE Development Facility. The SSE Development Facility shall provide assistance to the Software Production Facilities and Software Integration Facilities for installation, configuration, maintenance, and problem reporting.

3.6.2.3.6 Non-Operational Software. The SSE shall be capable of supporting users in the development of non-operational software.

3.6.3 TECHNICAL AND MANAGEMENT INFORMATION SYSTEM (TMIS)

The SSP Technical and Management Information System (TMIS) is a collection of ADP systems and services supporting SSP Program and Project Office personnel with management and technical functions associated with program management, analysis, and configuration management. TMIS is a distributed information system which houses all SSP programmatic baselines and information. TMIS provides information access services to institutions, contractors, and organizations outside the program and project offices.

3.6.3.1 Purpose. TMIS shall provide common standards, methodologies, and processes within the SSP for the business of controlling and managing the development of the Space Station.

3.6.3.2 Scope. TMIS direct services shall be limited to Space Station Program and Project Offices under the management of the Associate Administrator of Space Station and the Space Station Program Director, and gateways and interfaces services to supporting NASA institutions, contractors, and partners.

3.6.3.3 Interfaces. The TMIS shall provide network services and standards, and information content standards, for the SSP.

3.6.3.4 Standards Documentation. These standards shall be documented in a TMIS Interface Requirements Document, which shall provide all the specifications necessary for institutions and organizations external to the direct support of TMIS to access and provide approved information to and from TMIS databases.

3.6.3.5 Information Resource Management. The design and standards of TMIS shall provide all necessary Information Resource Management functions for the Space Station Program and satisfy the intent of OMB Circular 130 concerning Information Resources Management (IRM).

3.6.3.6 Information Loss. The TMIS shall, through its evolution of functions and functional capabilities and systems, preclude the loss of information at all times and within tolerances and conditions as specified in TMIS requirements.

3.6.3.7 Development. TMIS development shall involve a hierarchical process of network and connectivity standards and implementation; tool and ADP standards and implementation; information and database standards and implementation; and organizational management and controls.

3.6.3.8 TMIS Users. All TMIS processes and functions shall be designed to user-provided requirements.

3.6.3.9 TMIS Functions and Standards. TMIS functions and standards shall be developed incrementally and commensurate with programmatic needs and budget constraints.

3.6.3.10 Standards and Functional Capabilities. The incrementally growing baseline of all TMIS standards and functional capabilities shall be documented, reviewed, and baselined through the same process used to control SSP systems. TMIS shall maintain its own documentation hierarchy within that process.