Space Telecommunications Radio System (STRS) Definitions and Acronyms

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1.0 Introduction

1.1 Purpose

The intent of this document is to provide a common understanding of the terminology used in the following Space Telecommunications Radio System (STRS) Documents: the STRS Architecture Description, the STRS Architecture Document, the STRS Software Architecture Concepts and Analysis, and the STRS Architecture Goals/Objectives and Level 1 Requirements.

Definitions set by standards bodies such as the Institute of Electrical and Electronic Engineers (IEEE) 1900, the Object Management Group (OMG), and the Software Defined Radio (SDR) Forum will be used in the STRS documents as applicable, and the source of the definition is referenced within this document. If varying definitions exist between typical standards organizations, or if the accepted definition is not NASA or space-related, or if the definition does not exist, the STRS team derived definition is stated. Multiple definitions from different sources will be stated if they all apply to the use of the word in the STRS documents.

1.2 Scope of Document

Software defined radio is a relatively new technology area, and industry consensus on terminology is not always consistent. Confusion exists when the various organizations and standards bodies define different radio terms associated with the actual amount of reconfigurability of the radios. The purpose of this document is to provide the readers of the STRS documents the new terms and definitions that are rapidly emerging in the field of software defined radio and how they will be applied to the STRS architecture. The primary goal is to improve the understating of material presented in the reference documents.

The body of the document is presented as sections. Section 1 provides the introduction of the STRS Definitions and Acronyms, the purpose of this report, and the scope of materials contained within the definitions document. Section 2 has a list of applicable documents. Section 3 provides the definition of terms from a radio point of view. A list of acronyms is presented in Section 4.

2.0 Related Documentation

2.1 Applicable Documents

The list of applicable documents is still under development.

Document Number	Document Title
STRS–AR–00001	Space Telecommunication Radio System (STRS) Open Architecture Description
STRS–AR–00002	Space Telecommunication Radio System (STRS) Architecture Standard
STRS–RQ–00003	Space Telecommunication Radio System (STRS) Architecture Goals/Objectives and Level 1 Requirements. NASA/TM—2007-215042.
STRS–RQ–00004	Space Telecommunication Radio System (STRS) Software Architecture Concepts and Analysis. TP–214813–0.

3.0 STRS Architecture Definitions

For the STRS Architecture Document, the following terms are defined.

3.1 Adaptability

Adaptability is the ease with which a system satisfies differing system constraints and user needs (ref. 1).

3.2 Application

An application is an executable software program that may contain one or more software modules. The executable software exhibits pre-determined functionality. A primary example of an STRS application is the waveform application. An STRS application must comply with the architecture.

3.3 Application Program Interface (API)

An application program interface (API) is a formalized set of software calls and routines that can be referenced by the application program in order to access supporting system or network services (ref. 1).

3.4 Architecture

Architecture is the organizational structure of a system or component, their relationships, and the principles and guidelines governing their design and evolution over time (ref. 2).

3.5 Autonomous Operation

Autonomous operation is an implementation decision making algorithm that can be implemented on a system-level (fully autonomous) or at the sub-system-level (semi-autonomous) based on mission requirements.

3.6 Availability

Availability is the degree to which a system or component is operational and accessible when required for use (ref. 3).

3.7 Board Support Package (BSP)

A board support package (BSP) provides the hardware abstraction of the GPM module for the POSIX-compliant Operating System. It contains the boot and the generic and processor specific drivers required for the specific hardware. The BSP leverages commercial off the shelf (COTS) device drivers and other software necessary for applications to access the specific hardware.

3.8 Built-In Test (BIT)

A built-in test (BIT) is an internal test to determine whether the STRS radio and each subsystem are working properly. STRS health management uses BIT to automatically monitor the health of the system and pass any identified problem to the fault management. STRS fault management uses BIT to automatically monitor, diagnose, and isolate system problems.

3.9 Cognitive Radio

A cognitive radio is aware of its environment, internal state, and location, and automatically adjusts its operating behavior based on that information (ref. 4).

3.10 Common Platform

A common platform is a generic set of common hardware/software radio modules to meet the requirements for multiple mission types.

3.11 Component

A component is one of the parts that make up a system. A component may be hardware or software and may be subdivided into other components. Note: The terms "module," "component," and "unit" are often used interchangeably or defined to be subelements of one another in different ways depending upon the context. The relationship of these terms is not yet standardized (ref. 3).

3.12 Conventional or Legacy Radio

A conventional or legacy radio is a non-programmable radio designed for one fixed configuration for producing a single waveform at a specified frequency. The radio may have limited options for tuning, data rate, etc. or may even carry multiple types of data, but is incapable of adapting to new waveforms.

3.13 Data Publisher

Data publisher is the software component that transmits data to one or more subscribers. In the STRS architecture, it may be implemented by waveforms and parts of the STRS infrastructure.

3.14 Data Subscriber

Data subscriber is the software component that receives data from the data publisher. In the STRS architecture, it may be implemented by waveforms and parts of the STRS infrastructure.

3.15 Device

A hardware device is a physical entity that is capable of performing a function. A software device is a software abstraction of a hardware device(s). A STRS device is a software device that is part of the STRS Infrastructure having a well defined and portable API which may use the HAL to read, write, and control hardware devices.

3.16 Evolvability

Evolvability is the ease with which a system or component can be modified to take advantage of new software or hardware technologies (ref. 1).

3.17 External Interface

An external interface consists of software and/or hardware that enable signals to be transported to and/or from a radio. Examples include interfaces to/from the flight computer, power, data sources/sinks, and antenna.

3.18 Fault Management

Fault management is the set of functions that detect, isolate, and correct malfunctions within the system or provide notifications.

3.19 Firmware Developer Interface (FDI)

A firmware developer interface (FDI) is the interface that abstracts the waveform application running on the FPGA from devices external to the FPGA.

3.20 Flexibility

Flexibility is the ease with which a system or component can be modified for use in applications or environments other than those for which it was specifically designed (ref. 3).

3.21 Flight Computer

The flight computer is a separate computer connected to the STRS radio that is used to monitor and control the STRS radio. It may contain the watchdog timer for the STRS radio.

3.22 General-purpose Processing Module (GPM)

A general-purpose processing module (GPM) is a hardware module used for general purpose processing that contains the STRS OE. The GPM consists of the general purpose processor, appropriate memory both volatile and non-volatile, system bus, the spacecraft (or host) telemetry, tracking and command (TT&C) interface, ground support telemetry and test interface, and the components to support the radio configuration.

3.23 Guidelines

Guidelines are nonbinding statements intended to guide the broader and longer-term aspects of the STRS Architecture.

3.24 Hardware Abstraction Layer (HAL)

The hardware abstraction layer (HAL) is the library of functions that provides a platform independent view of the specialized hardware by abstracting the physical hardware interfaces. The HAL implements any software or firmware that is directly dependent on the underlying hardware. The HAL is the part of the operating environment (OE) that the STRS Infrastructure uses to access hardware.

3.25 Hardware Interface Description (HID)

The hardware interface description (HID) describes physical and electrical interfaces, hardware performance, capability, capacity, size, weight, and power requirements.

3.26 Health Management

Health management is the capability of monitoring the health and performance of a system, subsystem, device or process. Health management invokes fault management when corrective action is needed.

3.27 Hierarchical Structure

Hierarchical structure characterizes a system in which components are contained by other components and/or provide services to the next higher level components. Hierarchical structure is a key attribute of an open architecture that enables system description, design, development, installation, operation, upgrades, and maintenance to be performed at a given layer or layers. This type of structure allows each layer to be modified without affecting the other layers.

3.28 Interoperability

(1) The ability of a system to work with or use the parts or equipment of another system (ref. 5).
(2) The capability of different radio systems or radio networks to communicate and exchange information with each other. Dissimilar systems or networks may achieve interoperability by changing their operating parameters to a common compatible format or operating through a bridge that translates between incompatible formats. An alternate definition is to determine and adapt all radio parameters required for broadest communication compatibility across all target networks (ref. 4).

3.29 Maintainability

Maintainability is the ease with which a software system or component can be modified to correct faults, improve performance, or other attributes, or adapt to a changed environment (ref. 3).

3.30 Method

Method is the implementation of an operation. It specifies the algorithm or procedure associated with an operation (ref. 6).

3.31 Module

Module is a self-contained hardware or software component that interacts with a larger system. A software module (program module) performs specific tasks within a software system (ref. 7). A hardware module is a physical grouping of devices capable of implementing specific functions.

3.32 Open Architecture

An open architecture is one whose functions, interfaces, components, and/or design rules are defined and published.

3.33 Open Source or Open Source Software (OSS)

Open source or open source software (OSS) is any computer software distributed under a license which allows users to change and share the software freely. Open source software is required to have its source code freely available and end-users have the right to modify and redistribute the software to others. (ref. 8).

3.34 Open Standards

Standards that are widely used, consensus based, published and maintained by recognized industry standards organizations (ref. 2).

3.35 Open System

An open system is one with specified, publicly maintained, and readily available standards (ref. 9).

3.36 Over the Air Programming (OTAP)

Over the air programming (OTAP) is a method of providing software updates by means of a communication channel realized by the STRS radio itself.

3.37 Platform

A platform is a combination of hardware and software components capable of executing software applications. A STRS platform must include the STRS OE which executes STRS services and waveform applications.

3.38 Portability

Portability is the ease with which a system application or service can be transferred from one hardware or software environment to another (ref. 3).

3.39 Portable Operating System Interface (POSIX)

Portable operating system interface (POSIX) refers to a family of IEEE standards 1003.n which describes the fundamental operating system services and functions necessary to provide a UNIX-like kernel interface to applications. POSIX is not an operating system but assures guaranteed programming interfaces available to the application programmer.

3.40 Quality of Service (QoS)

Quality of service (QoS) for networks is an industry-wide set of standards and mechanisms for ensuring high-quality performance for critical applications. The goal of QoS is to provide preferential delivery service for the applications that need it by ensuring sufficient bandwidth, controlling latency and jitter, and reducing data loss (ref. 10).

3.41 Queue

A queue is a list in which items are appended to the last position in the list and retrieved from the first position in the list; that is, the next item to be retrieved is the item that has been in the list for the longest time (ref. 3).

3.42 Radio Frequency (RF) Module (RFM)

The radio frequency module (RFM) performs the conversion to and from carrier frequencies and provides the signal processing module with baseband or IF signals and the transmission and reception equipment with RF signals. RFM associated components may include filters, RF switches, diplexers, low noise amplifiers (LNAs), power amplifiers, and analog to digital (and vice-versa) converters. This module handles the interfaces that control the final stage of transmission or first stage of reception of the wireless signals, including antennas.

3.43 Real-Time Operating System (RTOS)

Real-time operating system (RTOS) is an operating system that guarantees a certain capability within a specified time constraint.

3.44 Reconfigurability

Reconfigurability is the ability to modify functionality of a radio by changing the operational parameters without requiring a software update.

3.45 Reconfigurable Radio

A reconfigurable radio is a radio whose functionality can be changed either through manual reconfiguration of radio modules or can be changed under software control. Software reconfiguration control of such radios may involve any element of the radio-communication network. Software defined radios are a subset of reconfigurable radios (ref. 4).

3.46 Reconfigurable Transceiver (RT)

A reconfigurable transceiver (RT) is a radio with limited processing and selectable remote reconfiguration (e.g., filter parameters and modulations).

3.47 Reconfiguration

Reconfiguration is the act of modifying the functionality of a radio by changing the operational parameters without updating the software.

3.48 Reentrant

A reentrant function is one that can be entered before completion of a prior execution of that same function and execute correctly (ref. 11). A function that is reentrant is automatically thread-safe, but not necessarily the reverse.

3.49 Reliability

Reliability is the ability of a system or component to perform a required function under stated conditions for a specified period of time (ref. 3).

3.50 Reprogrammability

Reprogrammability is the ability to modify functionality of a radio by changing the operational software or firmware either wholly or partially.

3.51 Reusability

Reusability is the degree to which a software module or other work product can be used in more than one computing program or software system (ref. 3).

3.52 Scalability

Scalability is the degree to which components or functions in an implementation can be sized in systematic proportions for varying capacities (ref. 3).

3.53 Selectable

Selectable is the ability to choose from a range of choices. For example, a selectable parameter may be modified to change system characteristics at runtime.

3.54 Services

Services are software programs that provide functionality available for use by other applications.

3.55 Signal Processing Module (SPM)

The signal processing module (SPM) contains the implementations of the signal processing used to handle the transformation of received digitally-formatted signals into data packets and/or the conversion of data packets into digitally-formatted signals to be transmitted. Also included is the spacecraft data interface. Components include application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), digital signal processors (DSPs), memory, and connection fabric or bus.

3.56 Software Defined Radio (SDR)

Software defined radio (SDR) is a radio in which some or all of the physical layer functions are implemented in software and/or firmware.

3.57 Software Defined Radio Architecture

A software defined radio architecture is a comprehensive, consistent set of functions, components, and design rules according to which radio communications systems may be organized, designed, constructed, deployed, operated and evolved over time. A useful architecture partitions functions and components such that a) functions are assigned to components clearly and b) physical interfaces among components correspond to logical interfaces among functions (ref. 12).

3.58 Software Radio

A software radio is an extension of a software defined radio with more functionality implemented in general purpose processors as opposed to ASIC's and FPGAs. A software radio implements communications functions primarily through software in conjunction with minimal hardware. Software radios are the ideal software defined radio in which digitization occurs at the antenna (ref. 4).

3.59 Space Telecommunications Radio System (STRS)

Space telecommunications radio system (STRS) is the name of the project that defines and maintains the SDR architecture for NASA.

3.60 Specialized Hardware

Specialized hardware is hardware that may be initialized or controlled using software. STRS specialized hardware is initialized and controlled using the HAL. The Specialized hardware permits certain algorithms or functions to be optimized in hardware. Specialized hardware can include: field programmable gate array (FPGA), digital signal processor (DSP), and application specific integrated circuit (ASIC).

3.61 STRS Command Source

The STRS command source abstracts the command functionality usually found in the interface to the flight computer.

3.62 STRS Infrastructure

The STRS infrastructure is that part of the STRS operating environment which configures and controls STRS waveforms and services as well as specialized hardware via the HAL. Additional functionality may be required for radio robustness and mission dependent requirements.

3.63 STRS Operating Environment (OE)

The STRS operating environment (OE) is the portion of the STRS radio that contains the STRS Infrastructure, the POSIX conformant RTOS, the HAL, and optional middleware software.

3.64 STRS Radio

A STRS radio is a software defined radio compliant with the STRS architecture standard, running one or more waveforms**.**

3.65 System

System is a collection of components organized to accomplish a specific function or a set of functions (ref. 3).

3.66 System Architecture

System architecture is an abstract description of the entities of a system, and the relationship between the entities (ref. 13).

3.67 Thread-safe

A function is thread-safe if it works correctly during simultaneous execution by multiple threads. A function that is reentrant is automatically thread-safe, but not necessarily the reverse.

3.68 Upgradeability

Upgradeability is the ease with which a system or component can be modified or replaced to take advantage of new software or hardware technologies (technology insertion) with minimal changes to the rest of the system.

3.69 Usability

Usability is the ease with which a user can learn to operate, prepare inputs for, and interpret outputs of a system or component (ref. 3).

3.70 Use Case (UC)

Use cases (UCs) capture the requirements of a system by describing how the system should interact with the users or other systems (the actors) to achieve specific goals.

3.71 Watchdog Timer (WDT)

A watchdog timer (WDT) is software and/or hardware that monitors the health of a system and, if a problem is detected, takes the appropriate action to restore the system back to health.

3.72 Waveform

A waveform is the set of transformations applied to information (e.g., voice or data) that is transmitted over the air and the corresponding set of transformations to convert received signals back to their information contents (ref. 4).
Traditionally, a waveform was simply an electromagnetic signal whose amplitude varies with time.

3.73 Waveform Application

A waveform application is the code that implements all the functions and algorithms necessary to realize a waveform. The waveform application can be distributed among various processing elements, including specialized hardware (e.g., FPGA/DSPs). In STRS, if the waveform application requires run-time support for functions that it cannot provide directly, it must use the STRS APIs in the infrastructure to access the desired functions whether provided by the infrastructure directly or by other waveforms or services.

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Appendix—Acronyms and Abbreviations

Abbreviation	Definition
ADC	Analog to Digital Converter
AEP	Application Environment Profile
AGC	Automatic Gain Control
API	Application Program Interface
ASIC	Application Specific Integrated Circuit
BIT	Built-In Test
BSP	Board Support Package
C++	Computer programming language
C&DH	Command and Data Handling
CAD	Computer Aided Drafting
CCSDS	Consultative Committee for Space Data Systems
CF	Core Framework
CFD	Concepts and Functions Document
CFG	Configuration
CMOS	Complementary Metal-Oxide Semiconductor
COMSEC	Communication Security
CORBA	Common Object Request Broker Architecture
COTS	Commercial Off the Shelf
CPU	Central Processing Unit
DAC	Digital to Analog Converter
DoD	Department of Defense
DSP	Digital Signal Processor
ECL	Emitter Coupled Logic
EEPROM	Electrically Erasable Programmable Read-Only Memory
FDI	Firmware Developer Interface
FIFO	First In, First Out
FPGA	Field Programmable Gate Array
GPIO	General Purpose Input Output
GPM	General-purpose Processing Module
GPP	General Purpose Processor
GPS	Global Positioning System
HAL	Hardware Abstraction Layer
HH	Hours
HID	Hardware Interface Description
HQ	NASA Headquarters
HW	Hardware
I/O	Input/Output

ICD	Interface Control Document
ID	Identification, Identifier
IDE	Integrated Development Environment
IDL	Interface Definition Language
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IF	Intermediate Frequency
INFOSEC	Information Security
IP	Internet Protocol
ISO	International Standards Organization
ITAR	International Traffic in Arms Regulations
Java	Computer Programming Language
JTeL	JTRS Technical Laboratory
JTRS	Joint Tactical Radio System
LLC	Logical Link Control
LNA	Low Noise Amplifier
LRU	Logical Replaceable Units
MAC	Medium Access Control, a sublayer of the OSI Data Link Layer
MDA	Model Driven Architecture
MIPS	Millions of Instructions Per Second
MLS	Multi-Level Security
MM	Minutes
MMU	Memory Management Unit
N/A	Not Applicable
NM	Network Module
NRZ	Non-Return to Zero
NSL	Near Strike Lightning
OE	Operating Environment
OM	Optical Module
OMG	Object Management Group
OO	Object-Oriented
ORB	Object Request Broker
OS	Operating System
OSI	Open System Interconnection
OSS	Open Source Software
OTAP	Over-the-air Programming
PIM	Platform-Independent Model
PN	Pseudo random Noise
POR	Power On Reset
POSIX	Portable Operating System Interface
PROM	Programmable Read-Only Memory

PSE51	Real-time Controller System Profile, defined in IEEE Std 1003.13
PSE52	Real-time Controller System Profile, defined in IEEE Std 1003.13
PSE53	Real-time Controller System Profile, defined in IEEE Std 1003.13
PSM	Platform-Specific Model
QoS	Quality of Service
RAM	Random Access Memory
ROM	Read-Only Memory
RPN	Reverse Polish Notation
RF	Radio Frequency
RFM	Radio Frequency Module
RT	Reconfigurable Transceiver
RTOS	Real-Time Operating System
SBU	Sensitive But Unclassified
SCA	Software Communications Architecture
SCDS	Space Communication and Data System
SDR	Software Defined Radio
SEC	Security Module
SEU	Single Event Upset
SPM	Signal Processing Module
SRAM	Static Random Access Memory
SRD	Support and Rationale Document (for the SCA)
STRS	Space Telecommunications Radio System
SW	Software
SWG	Space Working Group
TBD	To Be Determined
TBR	To Be Reviewed
TCP	Transmission Control Protocol
TMR	Triple Mode Redundancy
TRANSEC	Transmission Security
TT&C	Telemetry, Tracking and Command
TTL	Transistor-Transistor Logic
UC	Use Case
UML	Unified Modeling Language
UNIX	Computer operating system developed by AT&T Bell Laboratories.
WDT	Watchdog Timer
WF	Waveform
XML	Extensible Markup Language
XSL	Extensible Stylesheet Language
XSLT	Extensible Stylesheet Language Transformation

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14. ABSTRACT
Software-defined radio is a relatively new technology area, and industry consensus on terminology is not always consistent. Confusion exists when the various organizations and standards bodies define different radio terms associated with the actual amount of reconfigurability of the radios. The Space Telecommunications Radio System (STRS) Definitions and Acronyms Document provides the readers of the STRS documents a common understanding of the terminology used and how they will be applied to the STRS architecture.

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