

Digital Twin Consortium Introduces OMG Space Task Force Mini-Workshop

8th IEEE International Conference on Space Mission Challenges for Information Technology

OMG's Space Telecommunications Interface (STI)

Speaker: Louis Handler
Title: Computer Scientist
Organization: NASA Glenn Research Center



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Resolving Space Mission Challenges for Information Technology

OMG's Space Telecommunication Interface (STI) Submission Discussion

- Secure Network Communications (SNC WG)
- Middleware and Related Services (MARS PTF)
- OMG Meeting
- Presented by:
 - **Louis Handler**
 - **NASA Glenn Research Center**
- **Supported by Jeff Smith – Multi-Agency**
- **Collaborative Environment (MACE Fusion Center)**

This document: based on mars/2020-12-01



Agenda

- Recap of the Space Telecommunication Interface (STI) RFP
- Overview of STI submission from NASA Glenn Research Center
- Changes since March/June OMG meeting

Submission Team

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Space Telecommunication Interface RFP



- Published as OMG document mars/2019-09-21
- The objective of this RFP is to expand the PIM and PSM for the Software Radio Components Specification to support space communications.
- Seeks to address areas where existing SWRadio specification does not address key communications and platform requirements imposed by the space domain sufficiently; for example, to simplify for spacecraft resource constraints, static deployment, specialized signal processing abstraction, reliability, and availability.

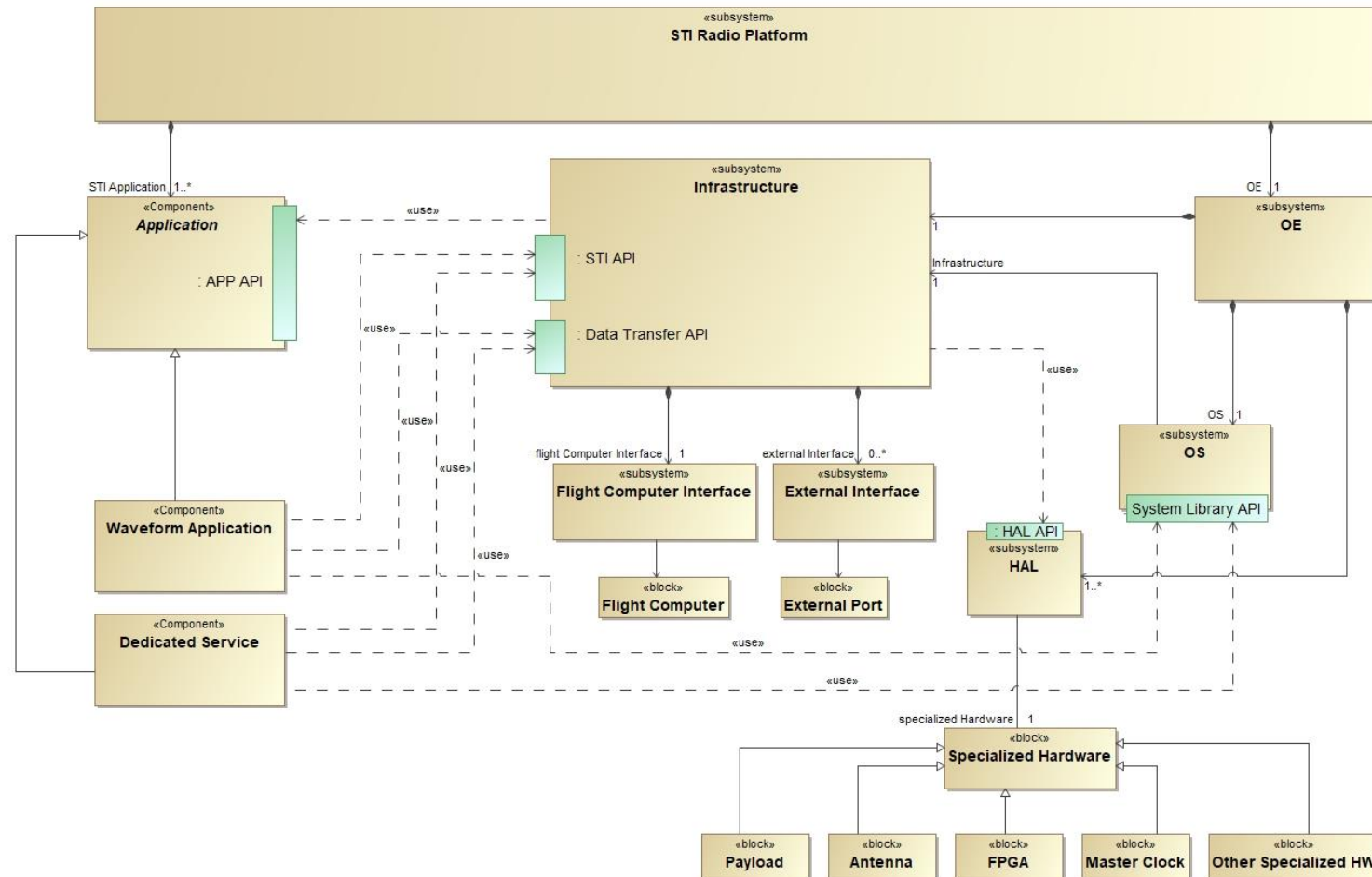
Space Telecommunication Interface (STI) Proposal



History

- A predecessor to this STI specification was developed by NASA as part of a technology demonstration of software-defined radio technology.
 - The predecessor was a “lightened” framework based on/inspired by SWRADIO (SDRP) and Software Communications Architecture Specification (SCA) and followed many of the same architectural patterns.
- NASA performed significant testing/validation on real space applications
 - Deployed and tested on the SCan Testbed on the International Space Station (2012-2019)
 - Over a decade of testing and waveform development provided lessons learned for NASA-STD-4009A, on which this proposal is based.

STI System Architecture Overview



System Architecture



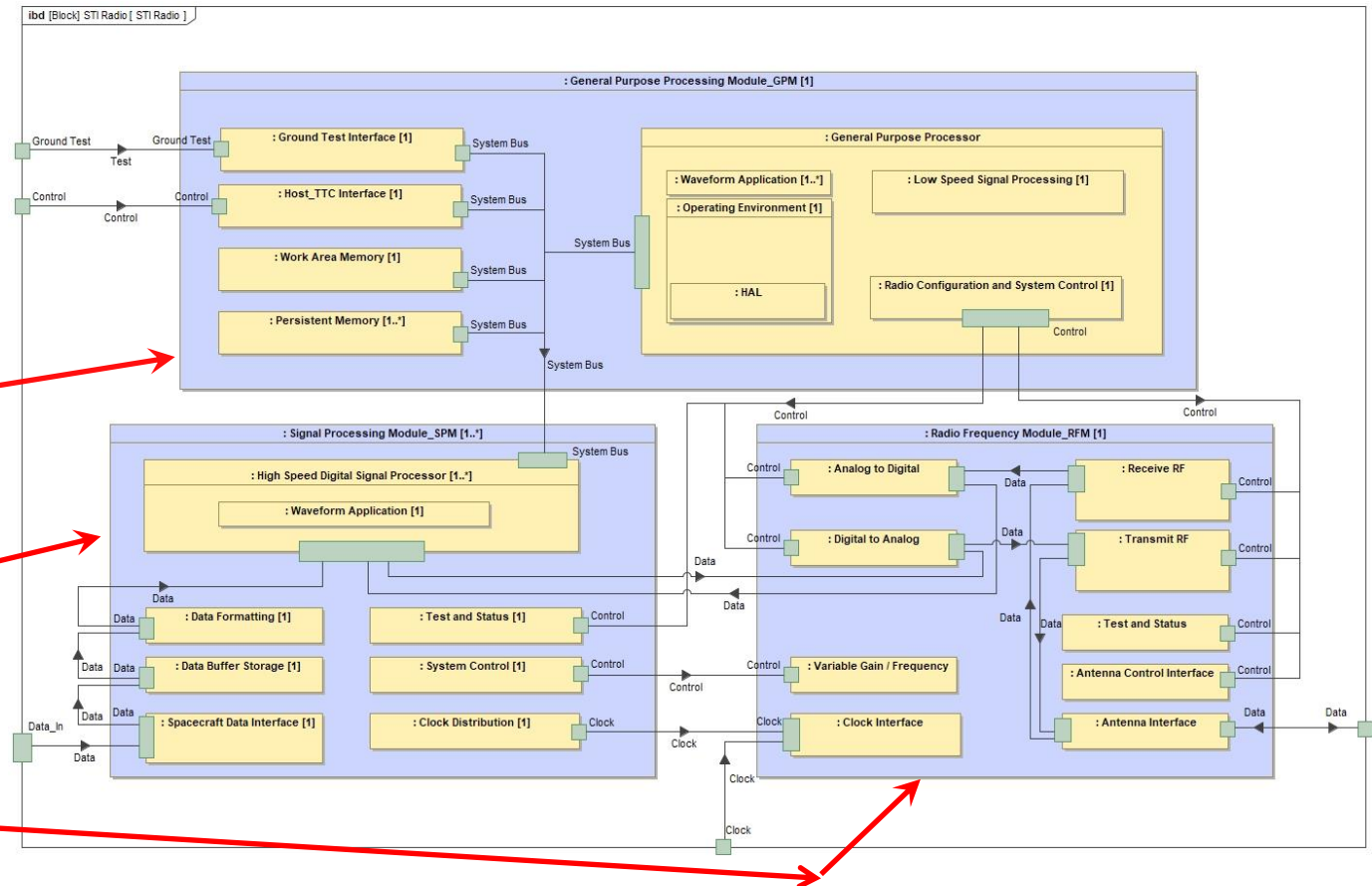
- STI defines the various roles and responsibilities of the stakeholders
 - Defined roles and integration points allows for more parallel development efforts, vendor independence
- Emphasis of standard is different for different system roles
 - Focus on a specific software interface (i.e. API) to ensure portability
 - Focus on documentation of system capabilities rather than prescribing a specific set
- This approach allows some component re-use while still allowing the overall system to be tailored to the specific deployment environment and requirements

STI Overview – Hardware Architecture



STI defines fundamental blocks of a generic SDR platform

- General Processing Module (GPM) hosts the control plane
- Signal Processing Module (SPM) hosts the data plane
- Radio Frequency Module (RFM) provides the radio interface



STI Software Operating Environment Model

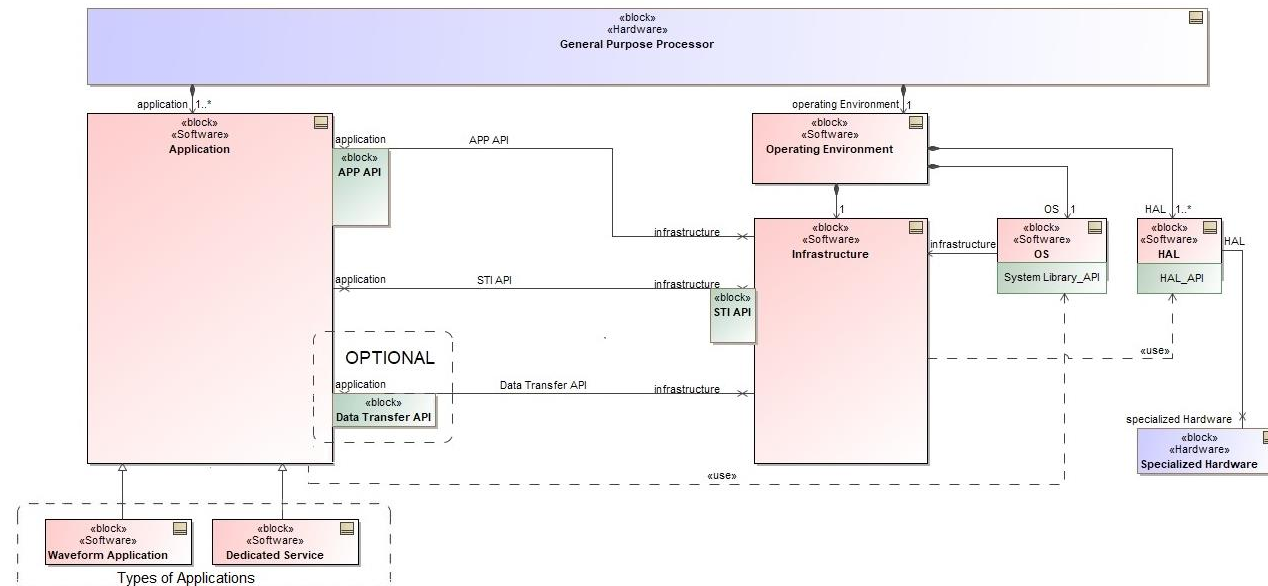


Proposal prescribes specific API requirements for items between the STI Infrastructure and waveform/application services layers

- Allows portability of software elements between different OE implementations

Proposal prescribes documentation requirements for layers below the STI Infrastructure

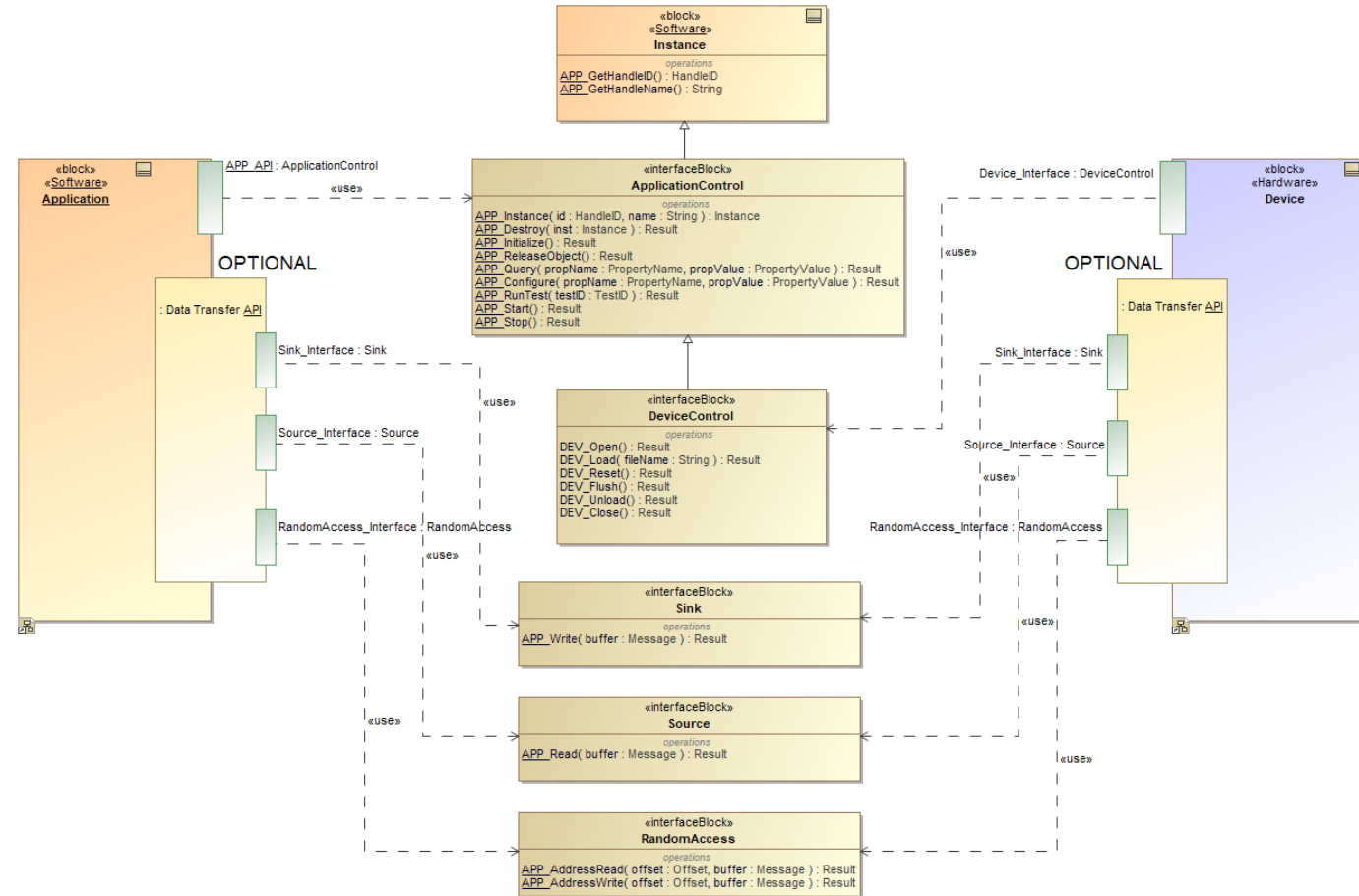
- Specialized hardware and hardware system limitations/capabilities defined in vendor-supplied documentation.



STI Application Software Interface Structure



- Proposes a SW Interface structure similar to existing SDR standards (NASA STRS, SWRADIO, SCA)
- Software written for these other environments should be usable without extensive rewrites or refactoring



Compliance Points (from RFP section 6.5.2)



- 1) Standard interfaces for control, management and status retrieval of the subsystems.
 - Provided in section 10.6 of proposal (STI API); Subsystem lookup APIs defined in 10.6.1.2, various control and management APIs defined in 10.6.2.
- 2) Control interfaces with functionality to control the synchronization of subsystems.
 - Specialized device control in section 10.6.3, Generic Messaging, Event Publish/Subscribe, Logging, Time sync APIs defined in sections 10.6.4 – 10.6.8
- 3) Interfaces that allow setting and querying parameters defined in the hardware abstraction of subsystem elements.
 - PropertySet interfaces defined in section 10.6.2.3
- 4) Application interfaces and related metadata defined separately for each subsystem.
 - Application interfaces defined in section 10.5 (Application and Device Control Interface)
 - Proposal dictates that each subsystem/instance has separate objects in memory, separate properties and property definitions

RFP Items Not Fully Addressed in Proposal



Networking (RFP section 6.5.3)

- STI is primarily defining a system architecture and control plane and is agnostic to the physical layer
 - Any type of underlying network routing/structure could be accommodated while still complying with the architecture
 - Scheduling, intermittent connectivity can all be handled via applications/waveforms running in the environment

Security (RFP section 6.5.4)

- A security manager is part of the overall architecture but the specific role is not defined in the PIM
 - Different SDR deployments have different security requirements
- Architecture allows each waveform to be executed in a “secure enclave”
 - Transparent to applications without changing the general system architecture

Current/Future Items Not Directly Addressed in Proposal



Optical Communications et al

- STI defines a system architecture and control plane and is agnostic to the data plane
 - Any type of underlying telecommunications hardware could be accommodated while still complying with the architecture
 - Standard proven to help in creation of optical and hybrid comms immensely; minimal or no changes needed when porting

Use of CORBA

- CORBA is discouraged for space implementations, due to SWaP considerations
 - The PSM information provided is for space implementations
 - However, the PIM allows an IDL to be compiled and used
 - Real Time CORBA was not available for testing

Summary



- The STI proposal is based on a proven and deployed predecessor
 - Addresses the needs of real space SDR deployments
 - Clear upgrade path for existing software/hardware investments
- Uses an architecture similar to existing SDRP/SCA specifications
 - STI upgrades/updates these concepts/paradigms to SysML
 - Simplified for Space Domain where relevant
- Addresses main compliance points from the STI RFP

Submissions



- Space Telecommunications Interface (STI) Request For Proposal (RFP) approved by AB 9/26/19. [mars/19-09-21](#)
- Submission approved at December 2020 OMG meeting with the following documents:
 - Inventory file: <https://www.omg.org/cgi-bin/doc?mars/2020-11-02>
 - XML: <https://www.omg.org/cgi-bin/doc?mars/2020-11-07>
 - Images (SVG): <https://www.omg.org/cgi-bin/doc?mars/2020-11-08>
 - Document: <https://www.omg.org/cgi-bin/doc?mars/2020-11-01>

Changes Since the March 2020 OMG Meeting

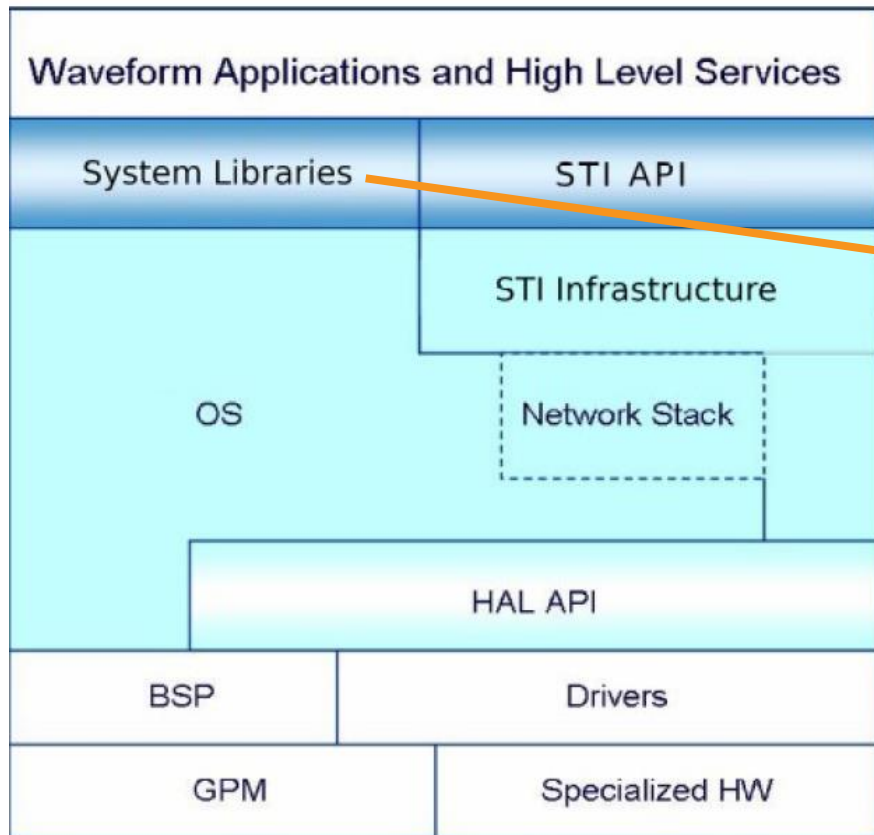


- Fixed error in Table 49 (method name Stop was shown as Initialize)
- Made a few minor editorial changes for grammar and clarity
 - Fixed misspelled words, repeated words, spacing, a vs an, etc.
 - Moved table numbers and labels above the tables rather than below
- Made a few minor obfuscations in section numbers due to copying from one format to another (these will be fixed)
- Updated figure 9, STI Layer Cake Model (see next slide)

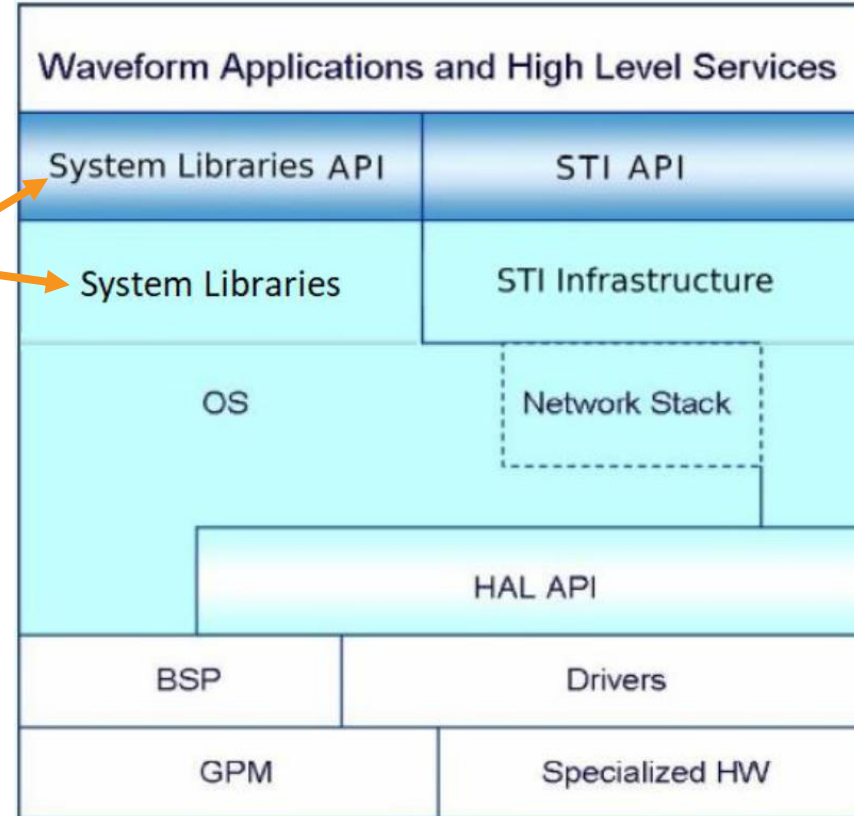
Changes to Figure 9: Software Execution Model



Before:



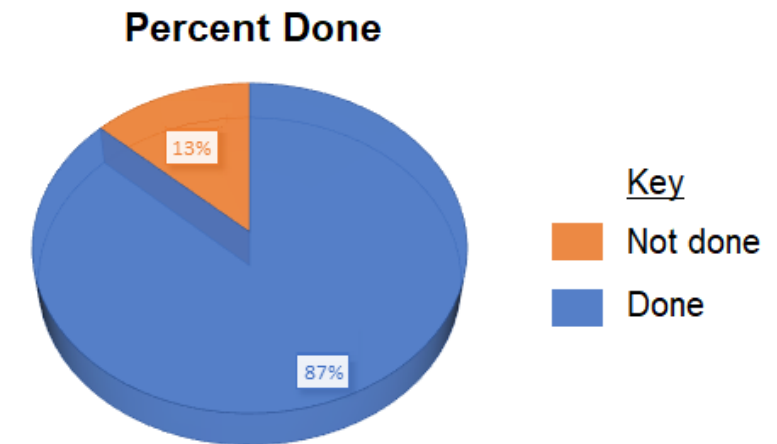
After:



Changes Since the June 2020 OMG Meeting



- Responded directly to 99 out of 114 OMG AB reviewers' comments
 - Some of the others are addressed in the PSM
- Added Section 0 to describe how STI 1.0 addresses the “shall” statements in the RFP
- Clarified nominal portions and corrected grammar errors
- Made diagrams more consistent
 - Eliminated figures that did not explain issues of importance
 - Updated figures to conform to SysML
- Corrected errors also found in proofreading
- Increased formality and combined requirements with corresponding tables



Transform UML to SysML

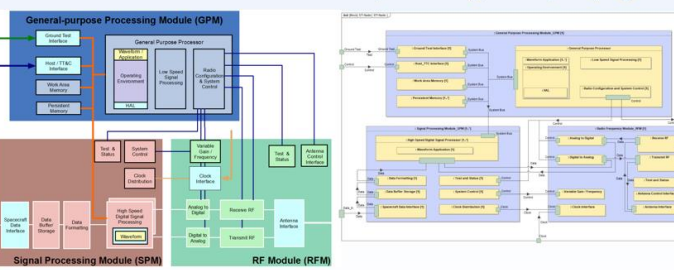


Changes to Figure 3: Notional STI Hardware Architecture

Before:

After:

(Deleted figure 2 specifying color)

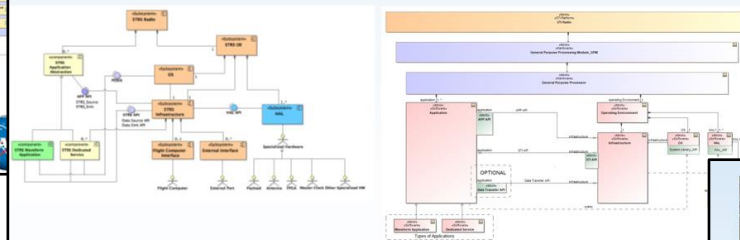


Changes to Figure 10: Layered Structure

Before:

After:

(Became figure 7)



National Aeronautics and Space Administration

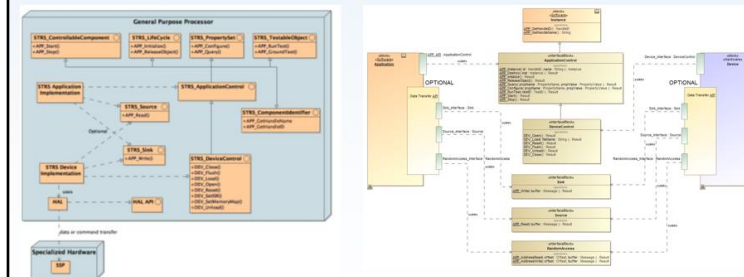


Changes to Figure 14: Application and Device Structure

Before:

After:

(Became figure 9)

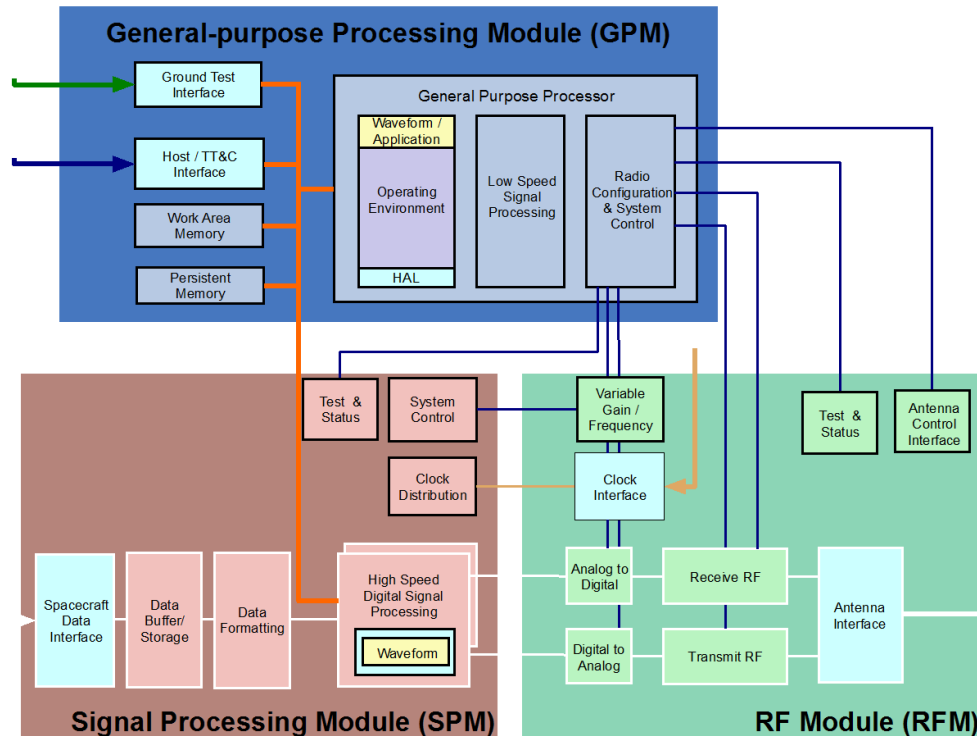


National Aeronautics and Space Administration

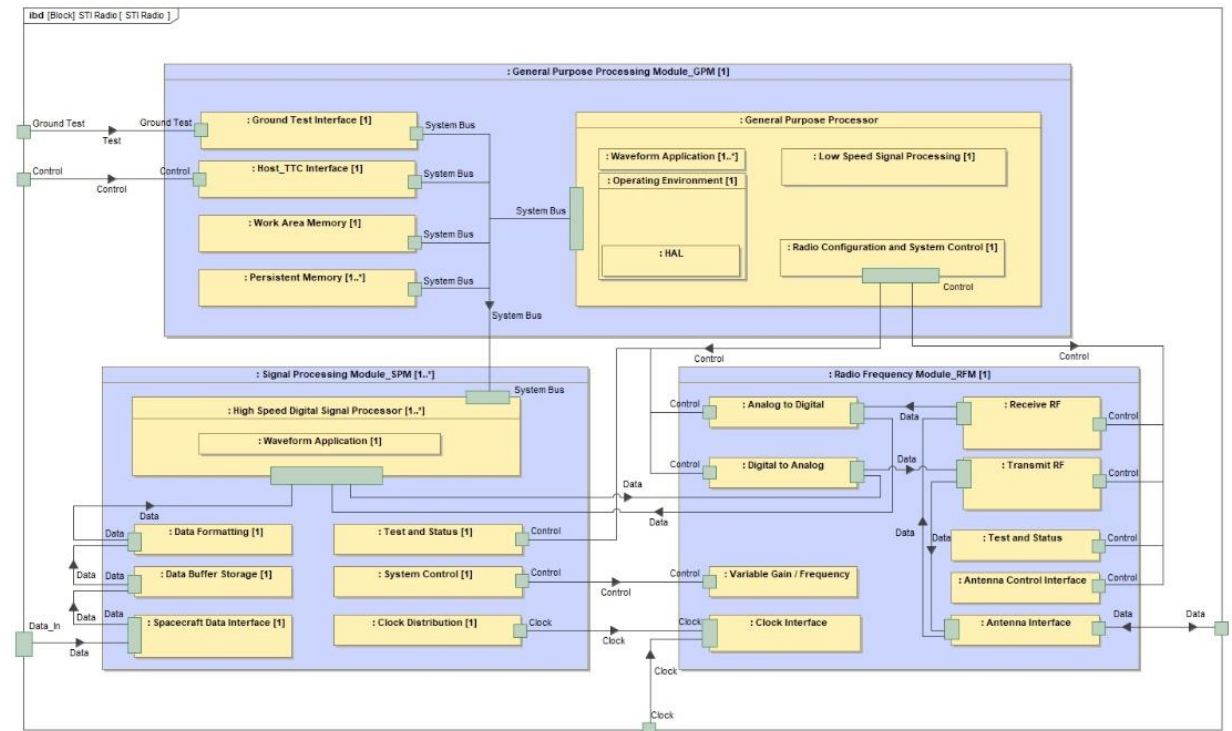
Changes to Figure 3: Notional STI Hardware Architecture



Before:

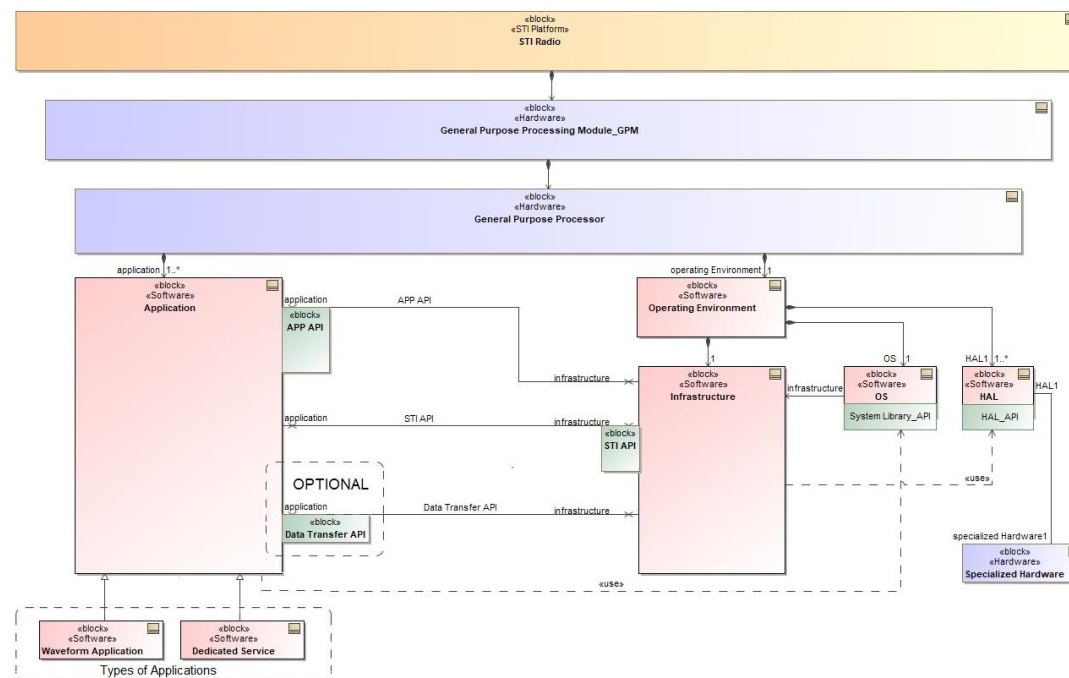


After: (Deleted figure 2 specifying colors)





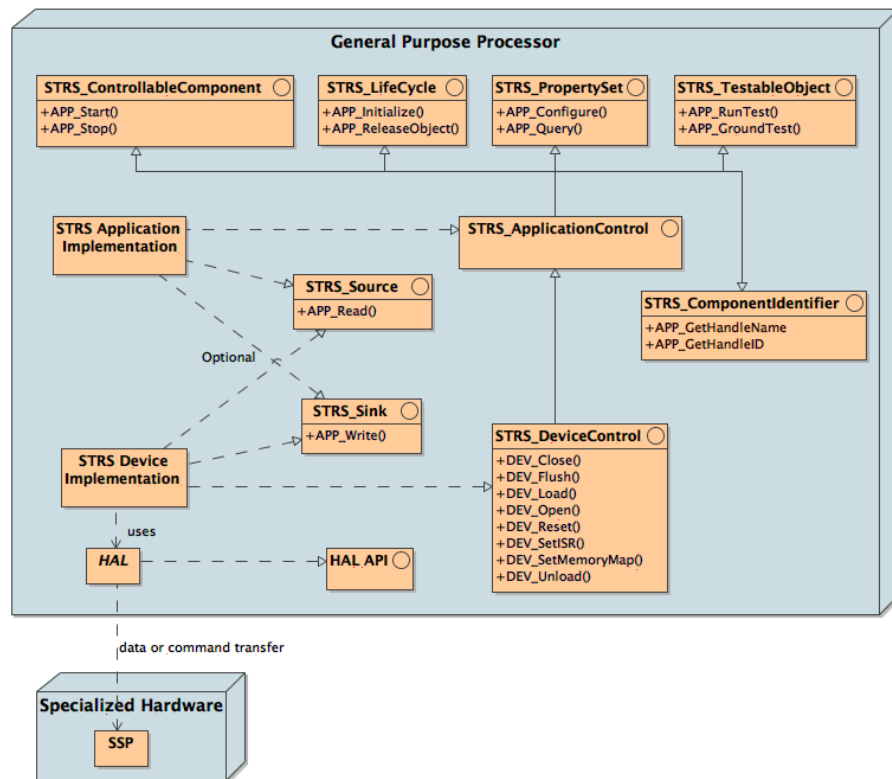
After: (Became figure 7)



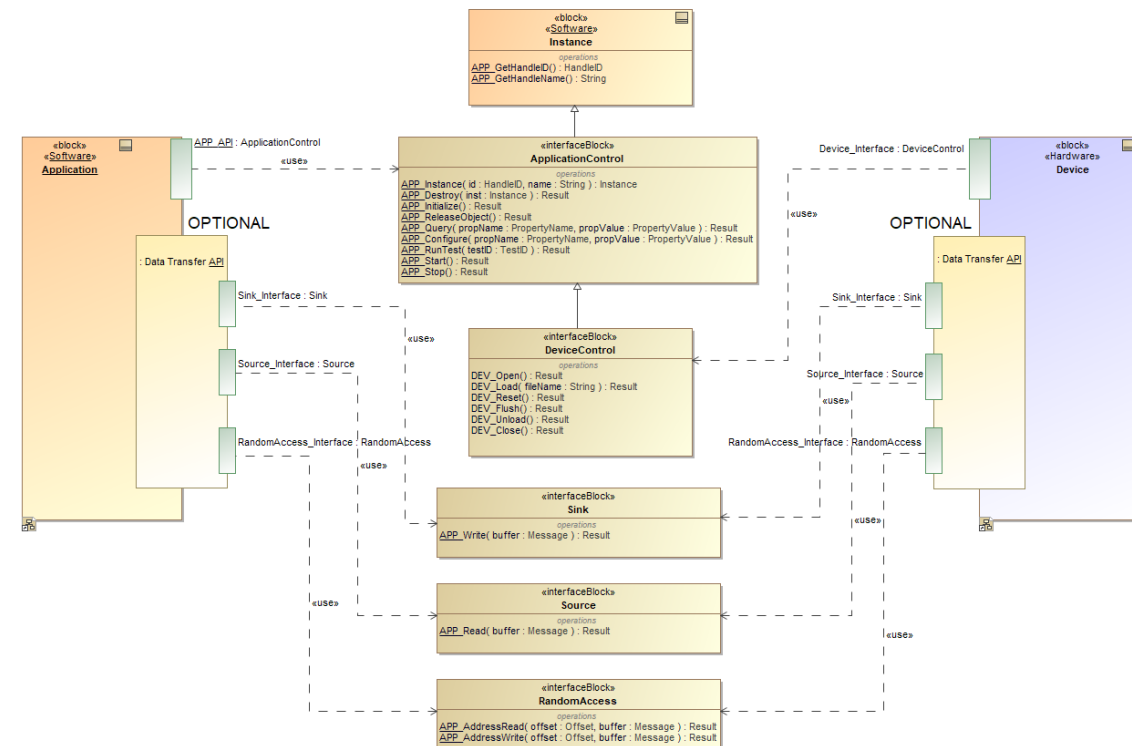
Changes to Figure 14: Application and Device Structure



Before:



After: (Became figure 9)



Current Status



- Finalization Task Force (FTF) was established to review STI beta spec
- Comments to FTF closed on June 15, 2021, for current beta spec
- FTF expected to resolve 9 actions over next 6 months to finalize beta spec to be approved for publishing in Dec 2021
- Comments can still be made for revisions that a future Revision Task Force will address – website: <https://issues.omg.org/issues/task-forces/STI>
- More information can be found at:
 - **Beta Spec available now for review & comments:** <https://www.omg.org/spec/STI/About-STI/>
 - **Blog:** <https://pub.omg.org/>
 - **Public Release Announcement - New Object Management Group Specification Enables Open Software-Defined Radios for Space/Navigation Communications**
Spec reduces life-cycle costs for space and ground platforms - March 9, 2021
<https://www.omg.org/news/releases/pr2021/03-09-21.htm>

STI Questions and Answers



Questions and Answers