SpaceWire Plug-n-Play and CCSDS SOIS: How do they fit together?

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CCSDS SOIS Background

- CCSDS Spacecraft On-board Interface Standards (SOIS) is a Work Group (WG) that has defined the services for 2 of the 3 defined layers defined by SOIS (documented in a series of CCSDS Red Books)
  - Subnetwork and the application support layer has service definitions
  - Transport layer has no services defined
- The Subnetwork SOIS defined services are requirements that feed into the SpaceWire (SpW) WG to steer its focus
  - e.g., SpW-Real Time (RT) is an effort to implement the Quality of Services (QoS) defined in the SOIS Green book
- SOIS Plug-n-Play (PnP) services defined by SOIS include device discovery (at the subnetwork layer) and services at the application support layer
  - Device Enumeration
  - Device Virtualization
  - Etc.
AFRL ORS Background

• Air Force Research Lab (AFRL) office of Operational Responsive Space (ORS) has been working on implementing their approach for PnP and have defined an architecture
  – implemented on PnPSat – demonstration not to be launched

• Some portions of their implementation approach may be useful to SOIS application support services
  – specifically Device Description, i.e., eXtensible Transducer Electronic Datasheet (XTEDS)
Current CCSDS SOIS Work

• Service Red Books for Sub network WG are complete and
• WG is now focused on defining PnP architecture models for the application support layer
• These architectures are based upon defining a device description for on-board components, i.e., an Interface Control Document (ICD)
• There are two choices being considered for device description
  – IEEE 1451 - Transducer Electronic Datasheet (TEDS) and
  – eXtensible Transducer Electronic Datasheet (XTEDS)
AFRL ORS-CCSDS SOIS Collaboration

• AFRL has made XTEDS public release (as of April 2009) and has presented their PnP concept to the SOIS WG in April 2009
  – IEEE 1451 TEDS was also presented & demonstrated

• AFRL ORS has requested that CCSDS SOIS take the lead to standardize XTEDS

• XTEDS developer (Ramon Krosley, Design Net Inc.) has been made available by AFRL to work with SOIS WG to understand and evaluate XTEDS
What is XTEDS

• An XML Schema for describing certain aspects of on-board interfaces
  – Interfaces – software or hardware
    • Some location info
    • Messages (outgoing, incoming (cmds), and combos)
    • Variable in those messages (i.e. “parameters”)
    • User defined flags (Qualifier)
  
• Stored on device

• Very small and simple
NASA/GSFC Goal for PnP

• Provide ability to develop avionics architecture that allow utility spacecraft component made by different vendors to communicate seamlessly with an application
  – Implementations and architectures can be independent between entities (because of ITAR, etc.) but can communicate with same components

• Reuse of software device drivers
How SpaceWire fits in

• Data Link layer protocols need to support device discovery algorithms for PnP
• SpaceWire currently has no formal mechanism to perform device discovery
• SpaceWire device discover mechanism would also have to support the ability to read the device description (probably XTEDS) from the component
  – Device description stored in non-volatile memory in component
SpaceWire PnP Status

- An Experimental packet based protocol using Protocol Identifier was developed and implemented by AFRL (for PnPSat) and NASA (in lab)
- ESA has experimented with RMAP using features in Atmel 8X router to perform device discovery
- JAXA (Takahiro Yamada) proposed using Remote Memory Access Protocol (RMAP) as a standard method for performing network management like Simple Network Management Protocol (SNMP) is used to control and monitor a Management Information Base (MIB)
  - this method should be pursued as the mechanism for device discovery
  - also provides ability to standardize the configuration space
- AFRL would like to keep asynchronous message notification feature (from router) that is in the packet based experimental protocol
  - when link on router becomes detached send a message to subscribers
SOIS and SpW WG Collaboration

• SOIS needs the SpW WG to define it’s mechanism for device discovery
  – Recommend using RMAP and defining a MIB
• SOIS needs to study/prototype XTEDS and work with AFRL to modify XTEDS to meet SOIS requirements (in process)
  – SOIS requirements will be defined by use cases (see backup)
• SOIS also needs to work with XML Telemetry Command Exchange (XTCE) WG (see backup) so that XTEDS can be automatically translated to XTCE (for ground segment)
End.
Thank you
Backup

- XTEDS Use Cases
- XTEDS vs. XTCE
XTEDS Use Cases

Jonathan Wilmot
Device Normalization

• Run Time
  – For each class of device, star tracker, rate sensor, ...
    • On system initialization, on board software reads device data parameters from device
    • Uses data parameters to convert data into standard normalized values for run time algorithms
  – Allows devices of the same class to be substituted with true run-time PnP

• Compile Time
  – For each class of device, star tracker, rate sensor, ...
    • Development tools read system configuration file that references device data parameter file
    • Tools use data parameters to autocode conversion algorithms and compile link into software load
  – Allows devices of the same class to be substituted during development time with minimal schedule impact
Command & Telemetry

• Control center databases can be generated with XTEDs data
• Run Time
  – Device is queried and data sent to the control center
  – Tools use data parameters auto update control center database
  – Supports true run-time PnP of devices for commands and telemetry
• Compile Time
  – Development tools read system configuration file that references device data parameter files
  – Tools use data parameters auto update control center database
  – Allows devices to be substituted during development time with minimal schedule impact
• **Note that Command & Telemetry also applies to consoles and displays for crewed systems**
XTCE vs XTEDS

Brief Intro, features, criticisms

Kevin Rice Sept 09
What is XTCE

• CCSDS and OMG Standard
• Describes aspects of telemetry stream necessary for ground segment decommutation
• Describes aspects of command stream necessary for ground segment commutation (of cmds)
• XML Schema
• Format neutral (generalized: CCSDS, or major/minor frames, etc...)
• Specific focus for CCSDS missions is on:
  – Describing packet format (headers) and time stamps and packet body
  – Describing individual parameters in the packet body and how to convert them on the ground to a data type ready for further processing
    • Assume NO meta data in the data, you get bits – the ground needs additional info to successfully process
  – Describing additional aspects of TLM parameters common on the ground segment side
    • Limits, etc...
  – Describing how a command, it's associated packet and arguments go together
  – Describes how a user argument turns into a command packet item
  – Describe how additional items are in the command packet that the user does not usually see (checksum, etc...)
  – Describe command aspects such validity, priority, side effects and so forth unique to commanding
• Intended to be used as an EXCHANGE mechanism
  – Not replace native formats but map native formats to XTCE for common use among mission team members
  – Or larger community
  – Communities must agree on “how they do things”, otherwise some % of info loss
XTCE Criticisms

• Very large schema
  – Many use cases captured as industry common practice
  – Most institutions only need subset
    • Many vendors tied to specific institutions
  – Large feature set scares implementers
    • Most institutions used to how they do things only
    • Little appreciation for variances in greater industry
    • (but often some unique feature to them missing as it’s not common practice, results in criticism)

• Some syntax choices may be overly complicated
  – Certain items require additional implementation beyond parsing the XML and reading the info
  – Drives up cost

• Potential for large files size scares some

• Annotation incomplete in Schema itself
  – But we now have the CCSDS Magenta Book Core Ref. Guide

• Ambiguous in places
  – Certain items appear to allow constructions that do not make sense

• Due to large size, less industry commonality than one would think, need for reports to constrain usage by community makes it harder to adopt
What is XTEDS

• An XML Schema for describing certain aspects of onboard interfaces
  – Interfaces – software or hardware
    • Some location info
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XTEDS Criticism

- No documentation
- Variable construction is ambiguous
  - Not clear which combination of attributes and elements is legal, many to choose from
- Does not completely describe what’s on the “wire”
  - No bit or byte order
  - Does a poor job of describing relationship of wire bits to receiving side’s data type
    - A int32 count with a Curve is a float to the receiver after processing
    - Have to derive that depending which features are set
- Message construct high-level, may be too minimal
  - Assuming variables are packed, one after the other
  - Can’t describe gaps or addressing if needed
  - No way to specifically call out a header for example, messages cannot refer another, only variables
- No time based data types
- Describes Interface, it’s messages and what’s in them to a point
  - No behavior
  - Which Message means off?
- Generally, may simply be missing items that should be there for a broader user base