NEXTAR: Small Satellite Bus Based on SpaceWire Deterministic Implementation

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What SpaceWire provides for small satellites are:

- Traditional On-board Computers
- Small size, light weight
- Modularity

SAR probe
Optical probe
NEXTAR – the Earth Observation model

**ASNARO (Advanced Satellite with New system Architecture for Observation)**

- The first model with NEXTAR bus

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
<td>Mission</td>
<td>Pan / Multi (6-bands)</td>
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<tr>
<td>- Optical sensor</td>
<td>GSD : &lt; 0.5m/2m (Pan/Multi)</td>
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<tr>
<td>- Data transmission</td>
<td>Swath: 10km X-band, 16QAM, ~ 800Mbps</td>
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<tr>
<td>Pointing</td>
<td>Coverage: +/- 45deg x +/-45deg (cross x along track)</td>
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<td></td>
<td>Agility: 1deg / sec (average)</td>
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<tr>
<td>Launch</td>
<td>compatible with major launchers</td>
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<tr>
<td>Orbit</td>
<td>SSO ~ 500km altitude</td>
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<tr>
<td>Mass</td>
<td>Bus 295 kg (incl. 45kg fuel)</td>
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<td></td>
<td>Mission 200 kg</td>
</tr>
<tr>
<td></td>
<td>&lt;TOTAL&gt; 495 kg</td>
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<tr>
<td>Power</td>
<td>Generation : &gt; 1300 W (EOL)</td>
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<tr>
<td></td>
<td>Payload : 400 W</td>
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<tr>
<td>Dimension</td>
<td>2.5 x 3.5 x 3.2m (in orbit)</td>
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</table>
Determinism Implementation exploiting SpW/RMAP

Determinism required for NEXTAR bus
- Every data must be delivered and collected on time.
- Re-transmission and ACK/NACK transaction are required.
- Shortening system test schedule without reducing reliability
- Integration with legacy interface
  - CAN, UART, MIL-STD-1553B, etc.

Inherent capability in SpW/RMAP
- RMAP
  - CRC, Status field, transaction sequence
- SpaceWire
  - EOP and EEP

Deterministic character is formalized in draft specification of SpaceWire-D.
Protocol Layer for Scheduling and Assured Transmission

Documents established by JAXA and NEC

- Telemetry/Command Design Criteria / SMCP
- Annex for each project

- SpaceWire Network Design Criteria

Reference Protocol Stack

User Application

PTP

PnP

Segmentation/Blocking

Retry/Redundancy

Protocol ID / RMAP (ECSS-E-ST-50-51C/52C)

Scheduling

SpaceWire (ECSS-E-ST-50-12C)

Results of Analysis for the SpW-D Draft Specification
Takahiro Yamada (JAXA/ISAS)
18 October 2010
Fifteenth SpaceWire WG Meeting
Deterministic Implementation for NEXTAR (1/3)

Scheduling

- One second comprises 64 time slots.
  - Each time slot corresponds to SpaceWire Time-Code.

- RMAP is used for all transactions.
- Latency is defined as the maximum delay time of an RMAP reply.

Multiple transaction in one time slot is realized within the limitation of latency definition
  - No modification is required on SpaceWire/RMAP.
Communication Services

- **Implicit services**
  - Re-transmission
  - Re-transmission through alternative paths

- **Explicit services**
  - Distribution Services
  - Collection Services
    - Polling for additional telemetry collection and command delivery request

- Guaranteed transactions with ACK/NACK are implemented on RMAP.
Services are distinguished through addresses

- Exploiting RMAP inherent characteristics for Plug & Play capability

Undefined Area is available for Configuration Information (ex) QoS lookup table, etc.

[Internal Register usage example]
- GPO/GPI register for functional check
- LED control for GSE
- SpaceWire Logical Address
- IP revision
- Buffer memory map information
- etc.
Road map of NEXTAR

Standards & Development

**SDS-1**

- **Space Cube 2**
- Joint collaboration study with JAXA/ISAS
- 64bit MPU
- Burst SRAM
- SpaceWire
- On-orbit demonstration (~100kg)

2008~2009

**NEC standard bus (NEXTAR)**

- JAXA/ISAS small satellite series
- METI advanced small satellite

(300kg~500kg)

2011

**NEC standard bus (NEXTAR)**

- Micro Satellites

(30kg~50kg)

2013~