9th International SpaceWire and SpaceFibre Conference 2022

Definition, Implementation and Testing of an XML-based Packet Description Language for Traffic Analysis in a SpaceWire Communication

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Outline

- Introduction:
  - SpaceWire Packet Format
  - Protocol ID and RMAP
- SpW Packet Description Language:
  - Why?
  - Format
  - SpaceART SpW Sniffer Integration
- Use-Case
- Conclusion

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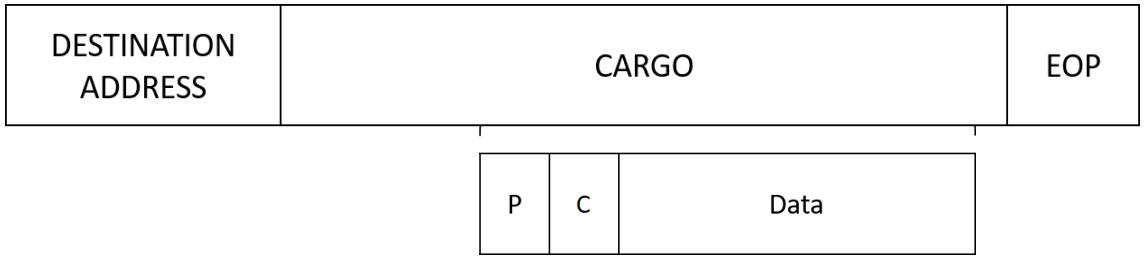
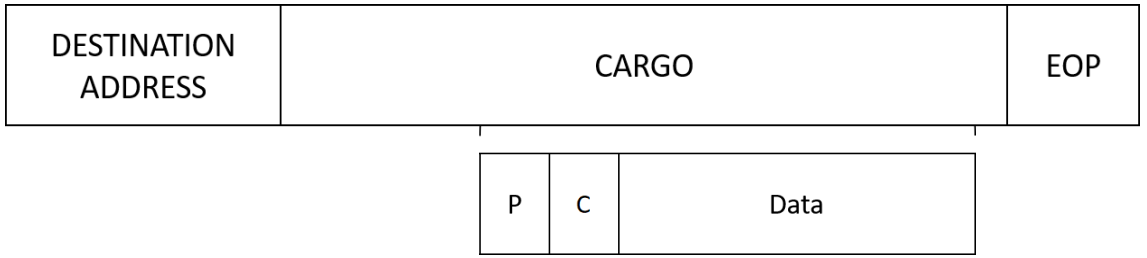
SpaceWire packet format

- SpW Packet Format
  - Destination Address
    - Logical Address
    - Path Address
  - Cargo
  - EOP



SpaceWire packet format

- SpW Packet Format
  - Destination Address
    - Logical Address
    - Path Address
  - Cargo
  - EOP
- Protocol ID
- Remote Memory Access Protocol (RMAP)
  - Write to/read from memory on a SpW Node



SpW RMAP Packets

- Write Command
  - 16 bytes header
    - Instruction byte indicates RMAP packet type
    - Memory address to write to
    - Length of data to be written
  - Data to be written
  - Verified

DESTINATION ADDRESS	PROTOCOL ID	INSTRUCTION BYTE	DESTINATION KEY
SOURCE ADDRESS	TRANSACTION ID (MS)	TRANSACTION ID (LS)	EXT. WRITE ADDRESS
WRITE ADDRESS (MS)	WRITE ADDR	WRITE ADDR	WRITE ADDRESS (LS)
DATA LENGTH (MS)	DATA LENGTH	DATA LENGTH (LS)	HEADER CRC
DATA	DATA	DATA	DATA
DATA	DATA	DATA CRC	EOP

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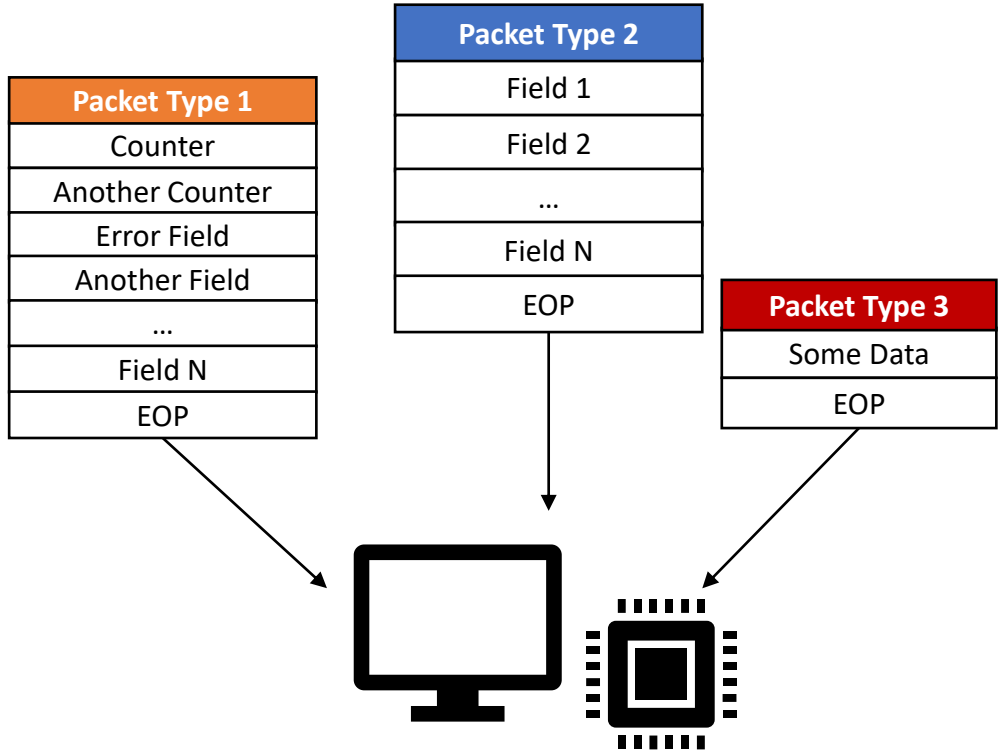
SpW Packet Description Language

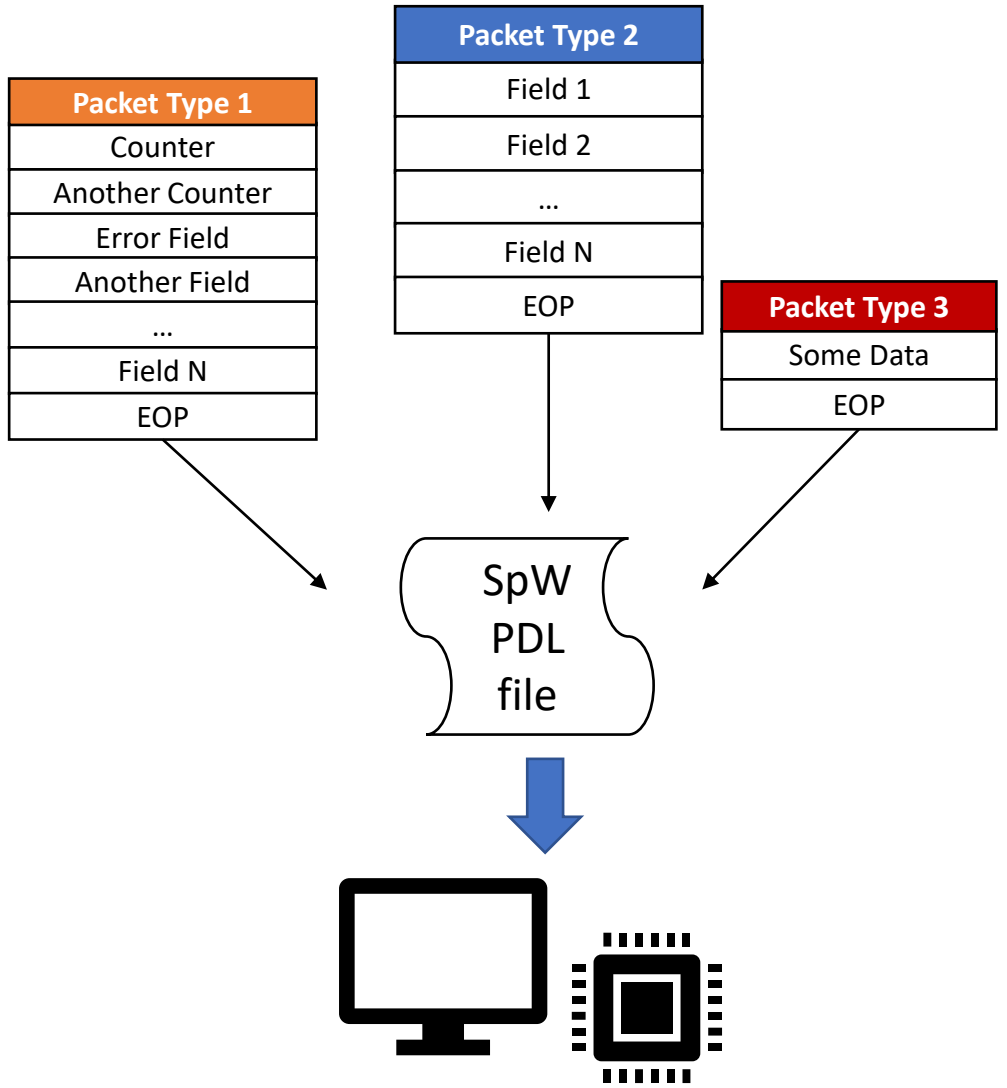
- SpW Packet are well-structured and flexible
- SpW-based missions use unique packet formats
- Precisely tailored for each mission
- Need for the development of special-purpose SpW packet manager for processing/generating SpW data
- Easy for machines, tedious for humans especially with several large packets



SpW Packet Management directly on SW/HW

SpW Packet Description Language

- SpW Packet Description Language (SpW PDL)
- XML-Based description for enhancing automatic generation/parsing of SpW Traffic
- eXtensible Markup Language
  - Both machines- and human-readable
  - Supported by most programming languages (JAVA, C/C++, Python)
- Description SpW Packet structure
- Simplify human interaction
- Easy and flexible packet description



SpW PDL – Format

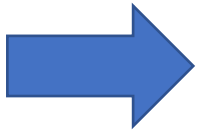
- XML-based
- Address
  - Logical
  - Path
- Payload
  - Fields
- Can be used by multiple applications
- XML parser supported by most languages

```
<spw_pdl>
    <spw_packet name="generic_spw_packet">
»   »   <address>
»   »   »   <logical_address>
»   »   »   »   238
»   »   »   </logical_address>
»   »   </address>
»   »   <payload>
»   »   »   <field size="32" name="packet_counter" />
»   »   »   <field size="8" name="1_byte_field" numOccurs="4" />
            <field size="16" name="2_bytes_field" numOccurs="2" />
            <field size="32" name="4_bytes_field" numOccurs="2" />
»   »   »   <field size="8" numOccurs="100" name="dataarray" />
            <spareByte numOccurs="20"/>
            <EOP/>
»   »   </payload>
    </spw_packet>
</spw_pdl>
```

SpW PDL – Format

```
<spw_pdl>
    <spw_packet name="generic_spw_packet">
        <address>
            <logical_address>
                238
            </logical_address>
        </address>
        <payload>
            <field size="32" name="packet_counter"> 25 </field>
            <field size="8" name="1_byte_field" numOccurs="4">
                255
            </field>
            <field size="16" name="2_bytes_field" numOccurs="2">
                256
            </field>
            <field size="32" name="4_bytes_field" numOccurs="2">
                65536
            </field>


            <EOP/>
        </payload>
    </spw_packet>
</spw_pdl>
```



Generic SpW Packet
0xEE
0x00
0x00
0x00
0x19
0xFF
…
0x01
0x00
…
0x01
0x00
0x00
…
EOP

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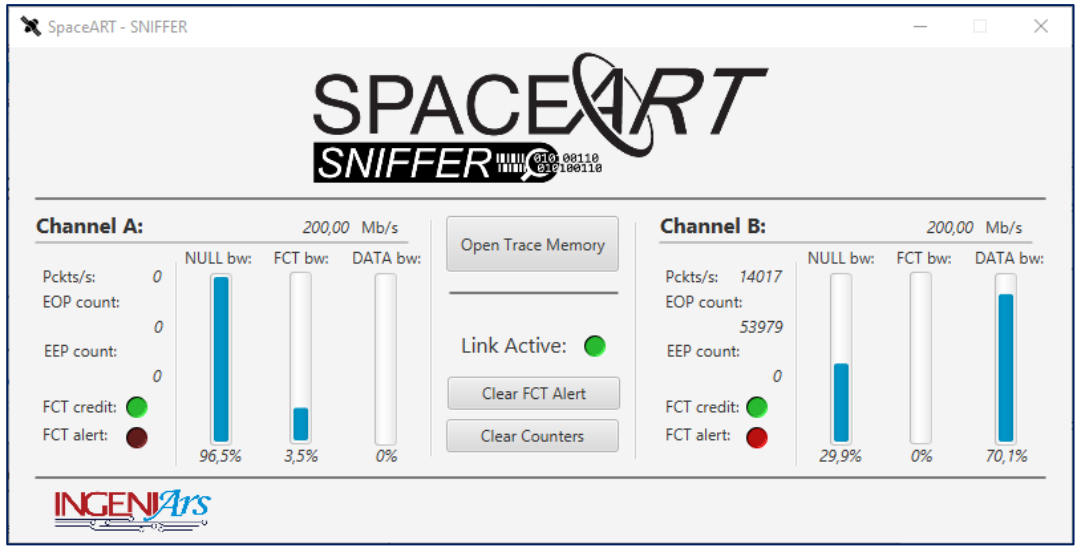
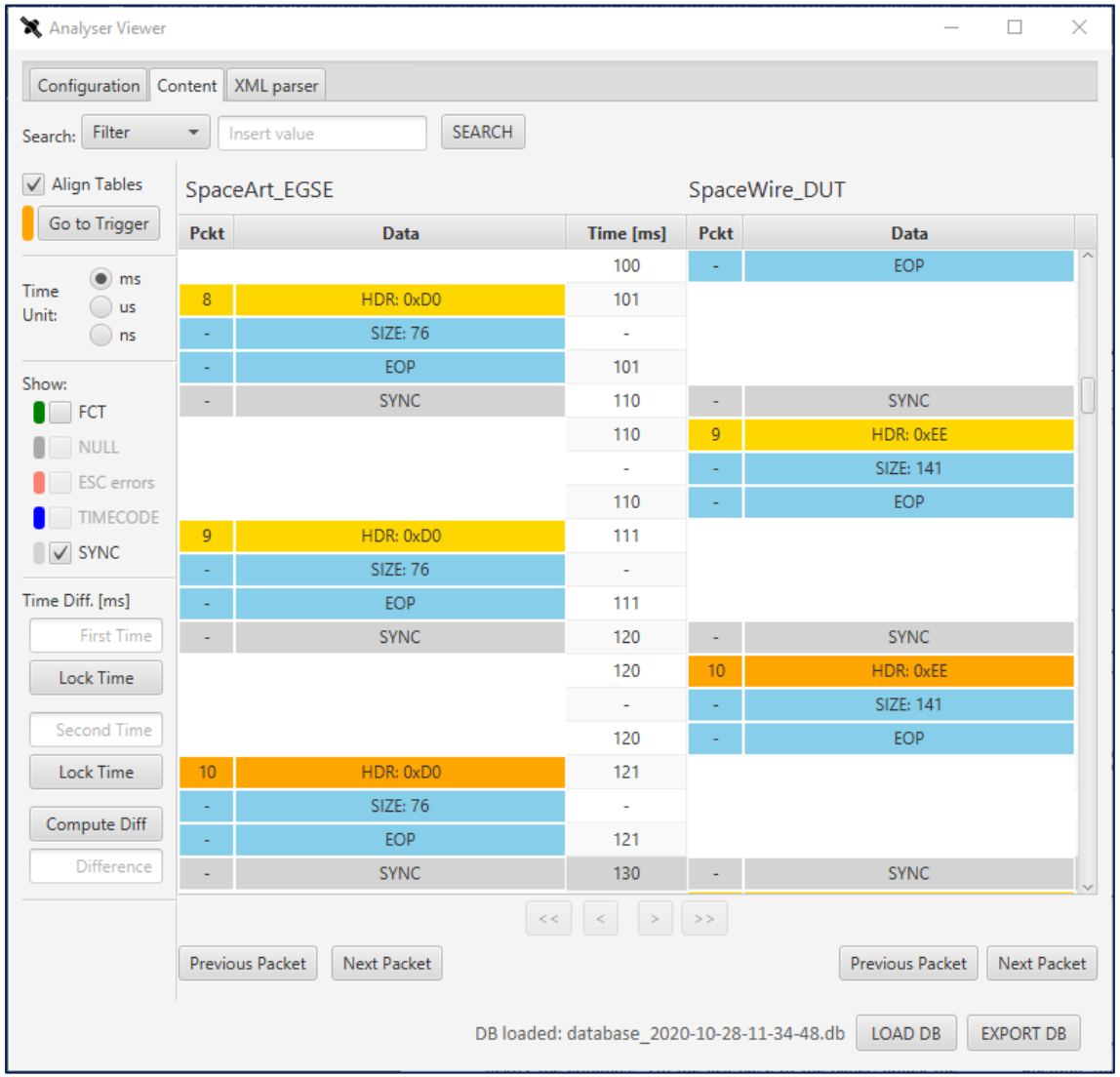
SpW SpaceART Sniffer

- SpW Link Analyser
- 2 SpW Interfaces
- Ethernet connection to Host-PC
- Graphical User Interface (GUI)
- SpW packets analysis
- SpW character level analysis
- Real-Time traffic analysis



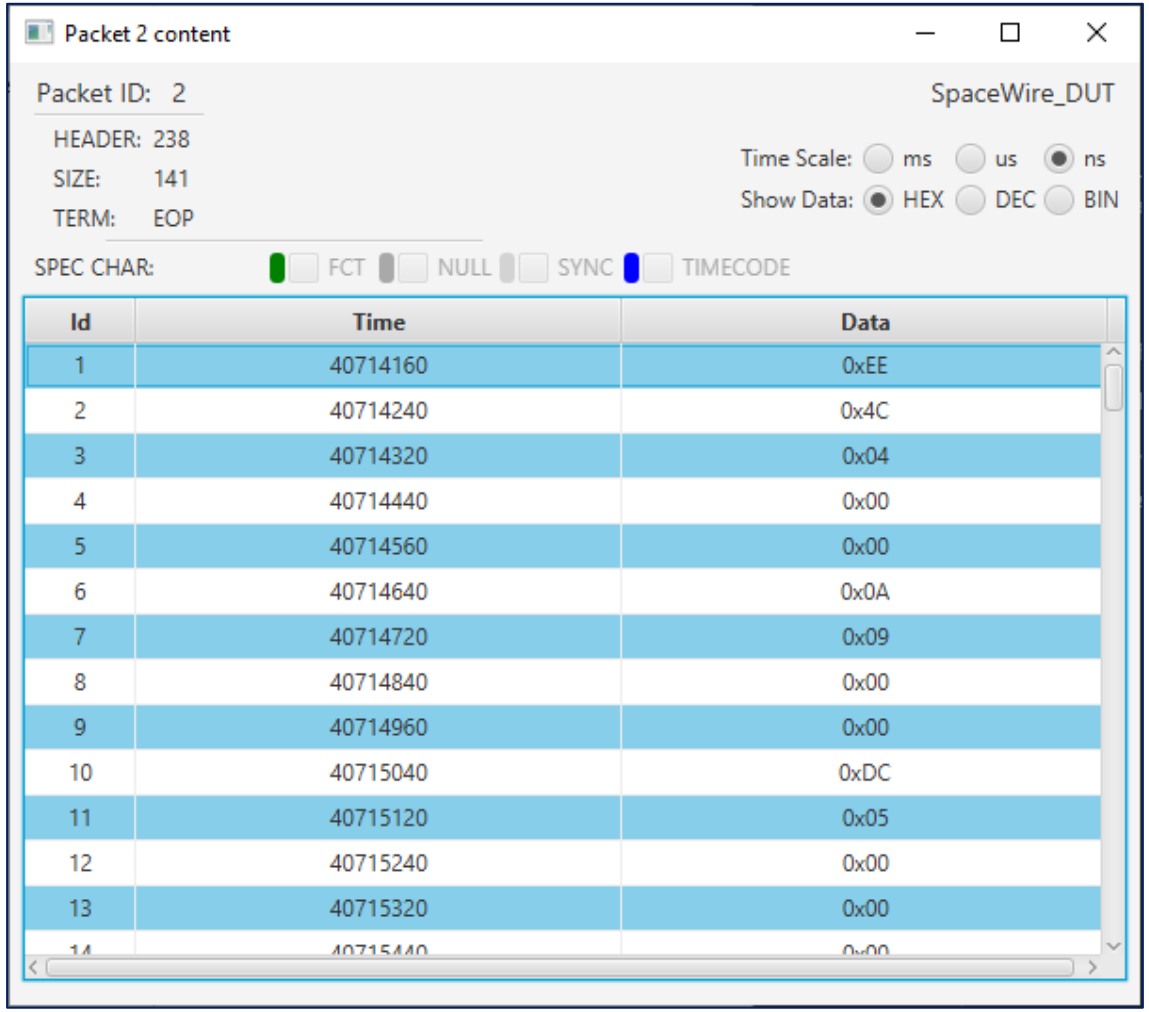
SpW SpaceART Sniffer – Data Analysis

- Database file
- Packet visualization
- Trigger
- Time visualization
- Time synchronization



SpW SpaceART Sniffer – Data Analysis

- Packet content
- Character level
- Time between characters
- Presence of special characters
- Single data value



Id	Time	Data
1	40714160	0xEE
2	40714240	0x4C
3	40714320	0x04
4	40714440	0x00
5	40714560	0x00
6	40714640	0x0A
7	40714720	0x09
8	40714840	0x00
9	40714960	0x00
10	40715040	0xDC
11	40715120	0x05
12	40715240	0x00
13	40715320	0x00
14	40715440	0x00

SpW PDL – SpaceART Sniffer Integration

```
<spw pdl>
    <spw packet name="Packet_Type1">
        <address>
            <logical address>206</logical address>
            <logical address>207</logical address>
            <logical address>208</logical address>
        </address>
        <payload>
            <field size="16">FIRST_16BIT_FIELD</field>
            <field maxValue="2" minValue="0" size="16">16BIT_FIELD_MAX2</field>
            <field maxValue="12000000" minValue="400" size="32">32BIT_FIELD</field>
            <spareByte/>
            <field size="8" numOccurs="28">ARRAY_OF_DATA</field>
            <spareByte numOccurs="37"/>
            <field size="8">CHECKSUM</field>
            <EOP/>
        </payload>
    </spw packet>

    <spw packet name="Packet_Type2">
        <address>
            <logical address>222</logical address>
            <logical address>238</logical address>
            <logical address>254</logical address>
        </address>
        <payload size="141">
            <EOP/>
        </payload>
    </spw packet>

    <spw packet name="Packet_Type3" size="16">
        <address>
            <logical address> 100</logical address>
        </address>
        <payload>
            <spareByte />
            <EOP />
        </payload>
    </spw packet>

</spw pdl>
```

SpW PDL – SpaceART Sniffer Integration

```
<spw pdl>
    <spw packet name="Packet_Type1">
        <address>
            <logical address>206</logical address>
            <logical address>207</logical address>
            <logical address>208</logical address>
        </address>
        <payload>
            <field size="16">FIRST_16BIT_FIELD</field>
            <field maxValue="2" minValue="0" size="16">16BIT_FIELD_MAX2</field>
            <field maxValue="12000000" minValue="400" size="32">32BIT_FIELD</field>
            <spareByte/>
            <field size="8" numOccurs="28">ARRAY_OF_DATA</field>
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            <EOP/>
        </payload>
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        <address>
            <logical address>222</logical address>
            <logical address>238</logical address>
            <logical address>254</logical address>
        </address>
        <payload size="141">
            <EOP/>
        </payload>
    </spw packet>

    <spw packet name="Packet_Type3" size="16">
        <address>
            <logical address> 100</logical address>
        </address>
        <payload>
            <spareByte />
            <EOP />
        </payload>
    </spw packet>

</spw pdl>
```

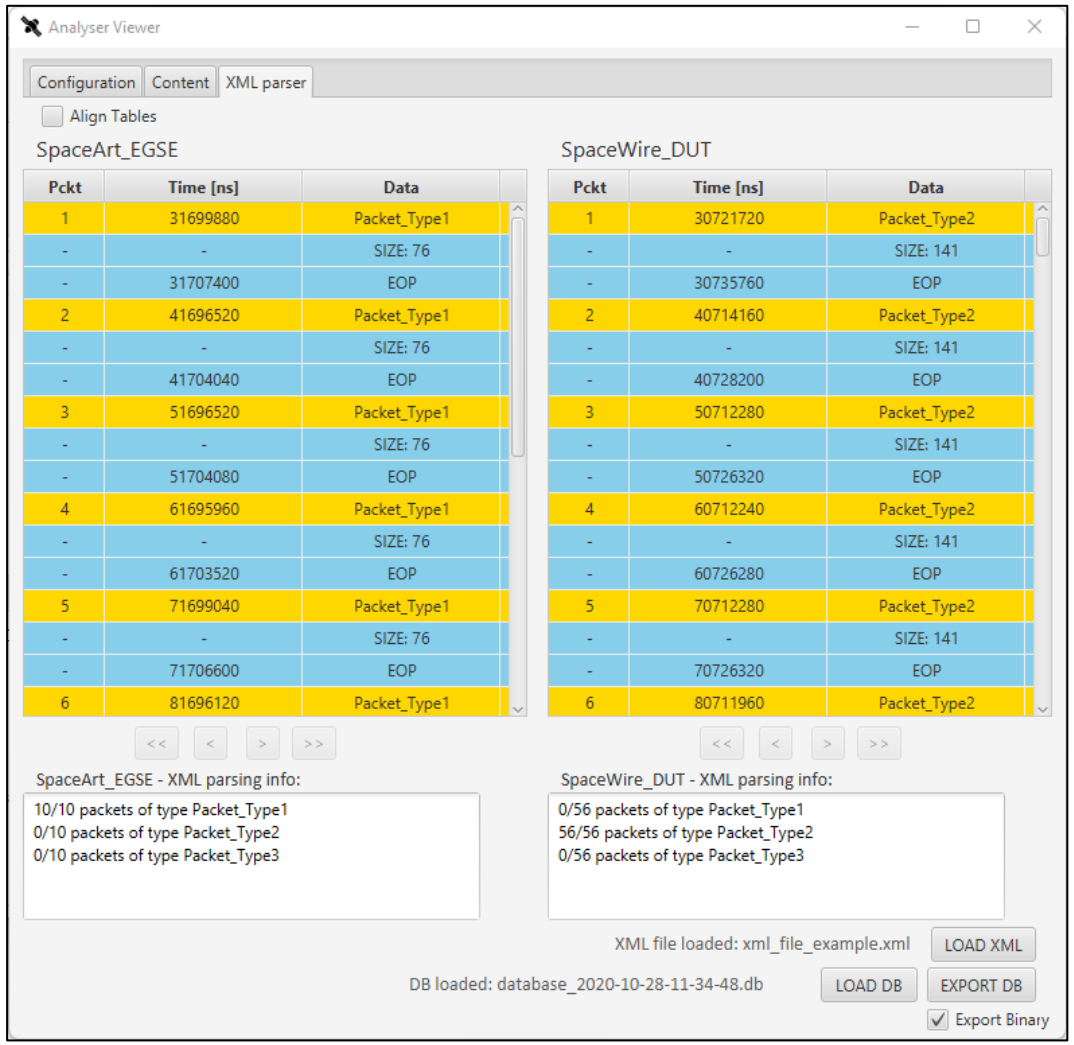

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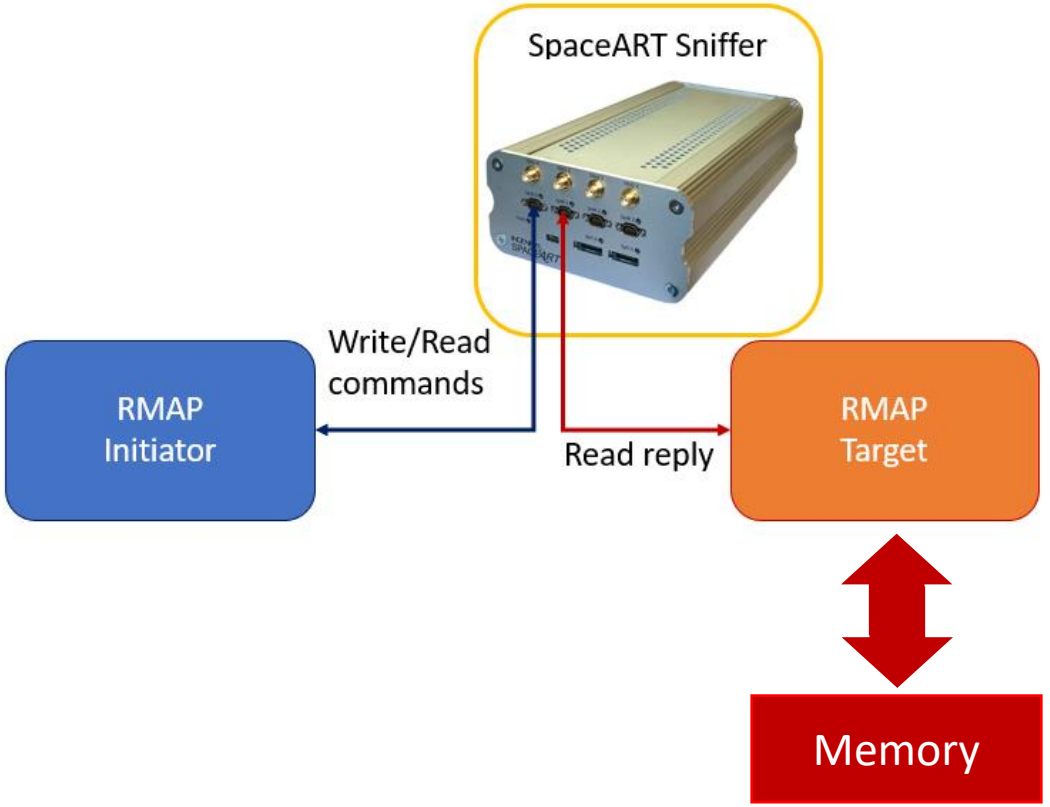
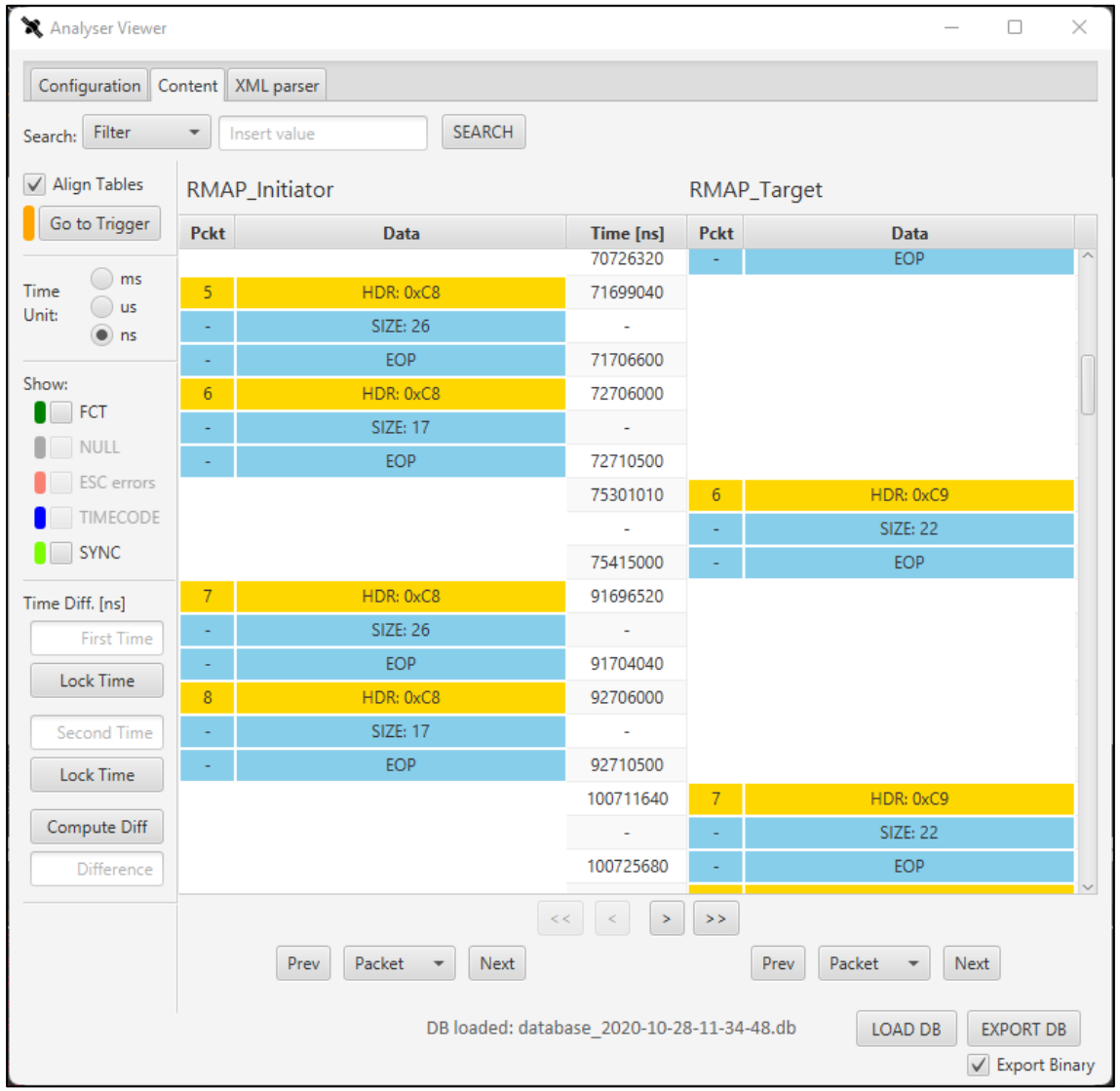
Test Case

- RMAP Communication
- RMAP Initiator sends a set of Write requests, each followed by a Read requests
- No replies for Write requests
- Dummy packets inbetween RMAP packets
- Data traffic analysed through SpaceART Sniffer (SpW PDL)



Test Results

- Sniffer nominal data parser
- Write and Read packet can be recognized
- Read replies can be recognized on the other side

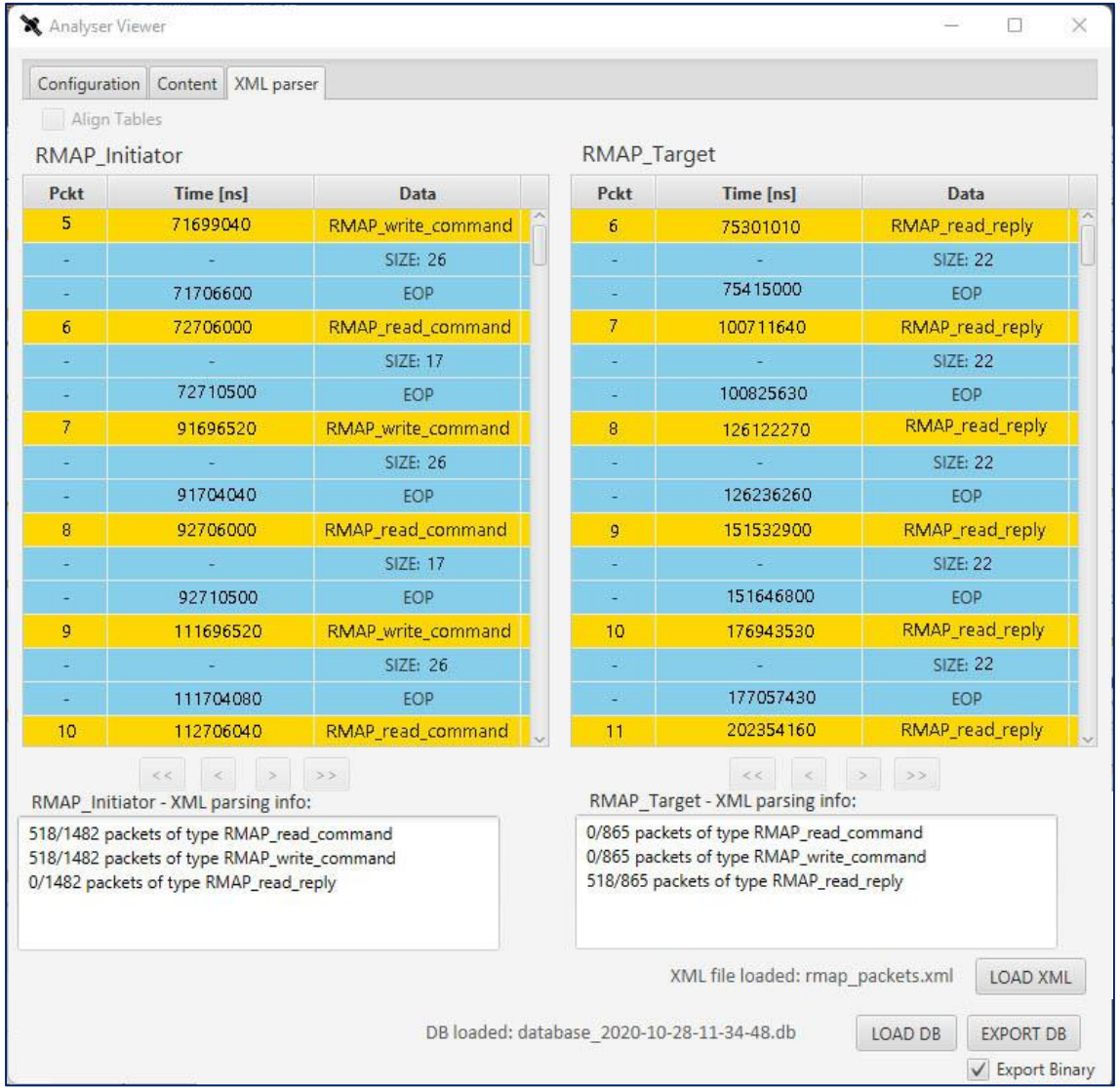


Test Results - SpW PDL for RMAP packets

```
<spw_pdl>
    <spw_packet name="RMAP_read_command">
        <address>
            <logical_address> 200 </logical_address>
        </address>
        <protocol_id> 01 </protocol_id>
        <payload>
            <field size="8" name="config_byte"> 76 </field>
            <field size="8" name="destination_key"> 00 </field>
            <field size="8" name="src_logical_addr"> 201 </field>
            <field size="16" name="transaction_id"> 01 </field>
            <field size="8" name="extended_addr"> 00 </field>
            <field size="32" name="read_address"> 00 </field>
            <field size="24" name="data_length"> 08 </field>
            <field size="8" name="header_crc"> 205 </field>
            <EOP/>
        </payload>
    </spw_packet>
</spw_pdl>
```

Test Results – RMAP packets

- Identifies the RMAP packets
- Shows their occurrence in the traffic
- Shows statistics about the packets
- The data inspection is simplified



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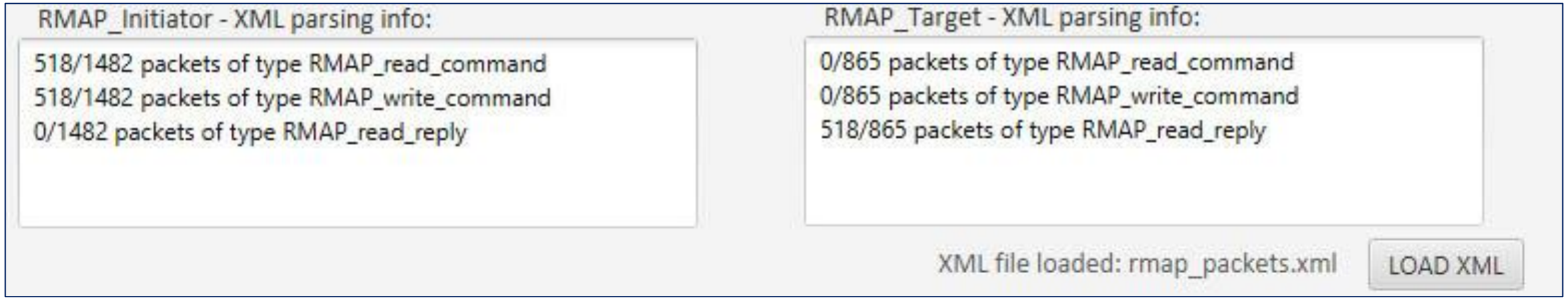

Nominal Data Analysis

- Packet content
- Character level
- Time between characters
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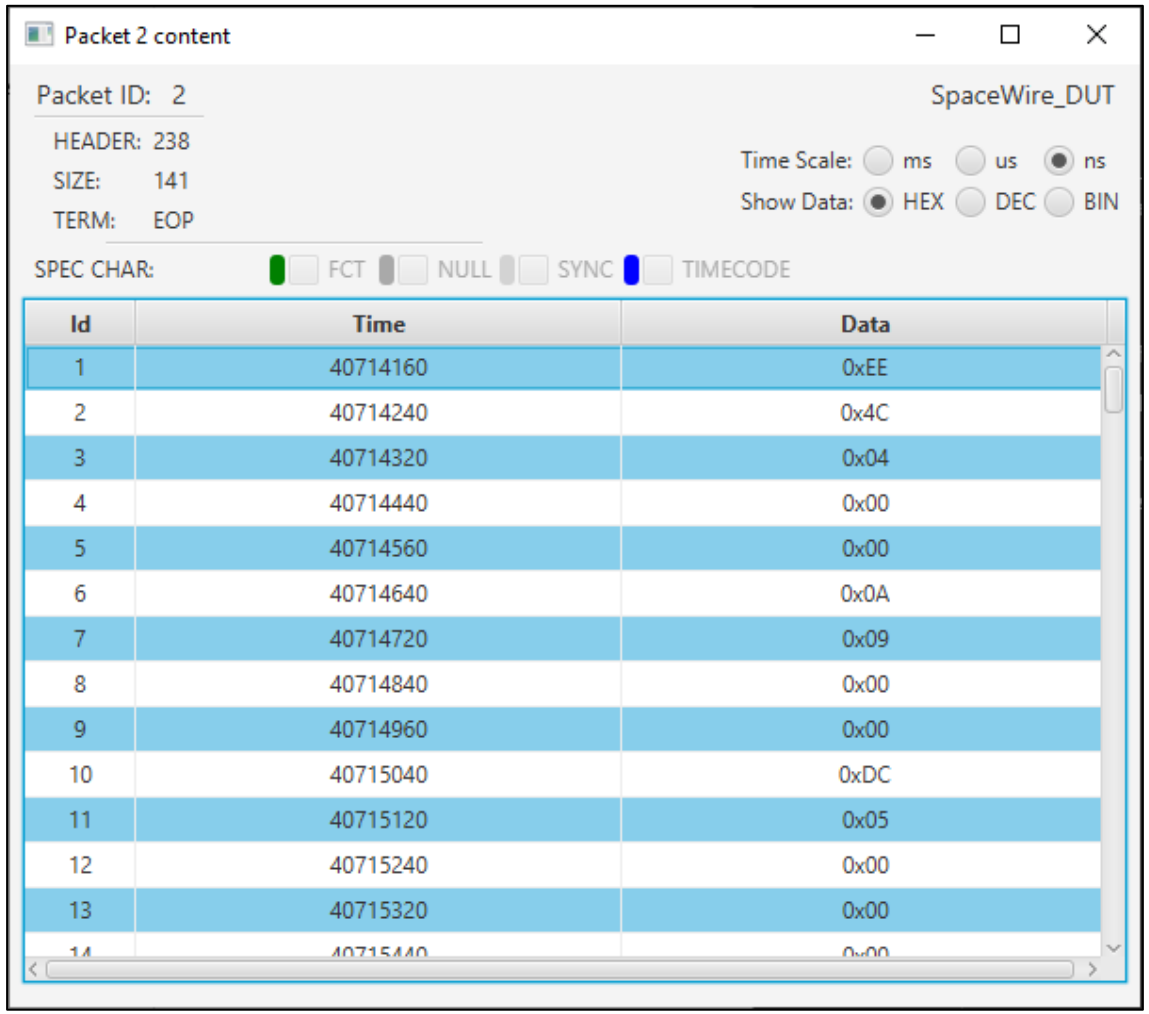
- Single data value



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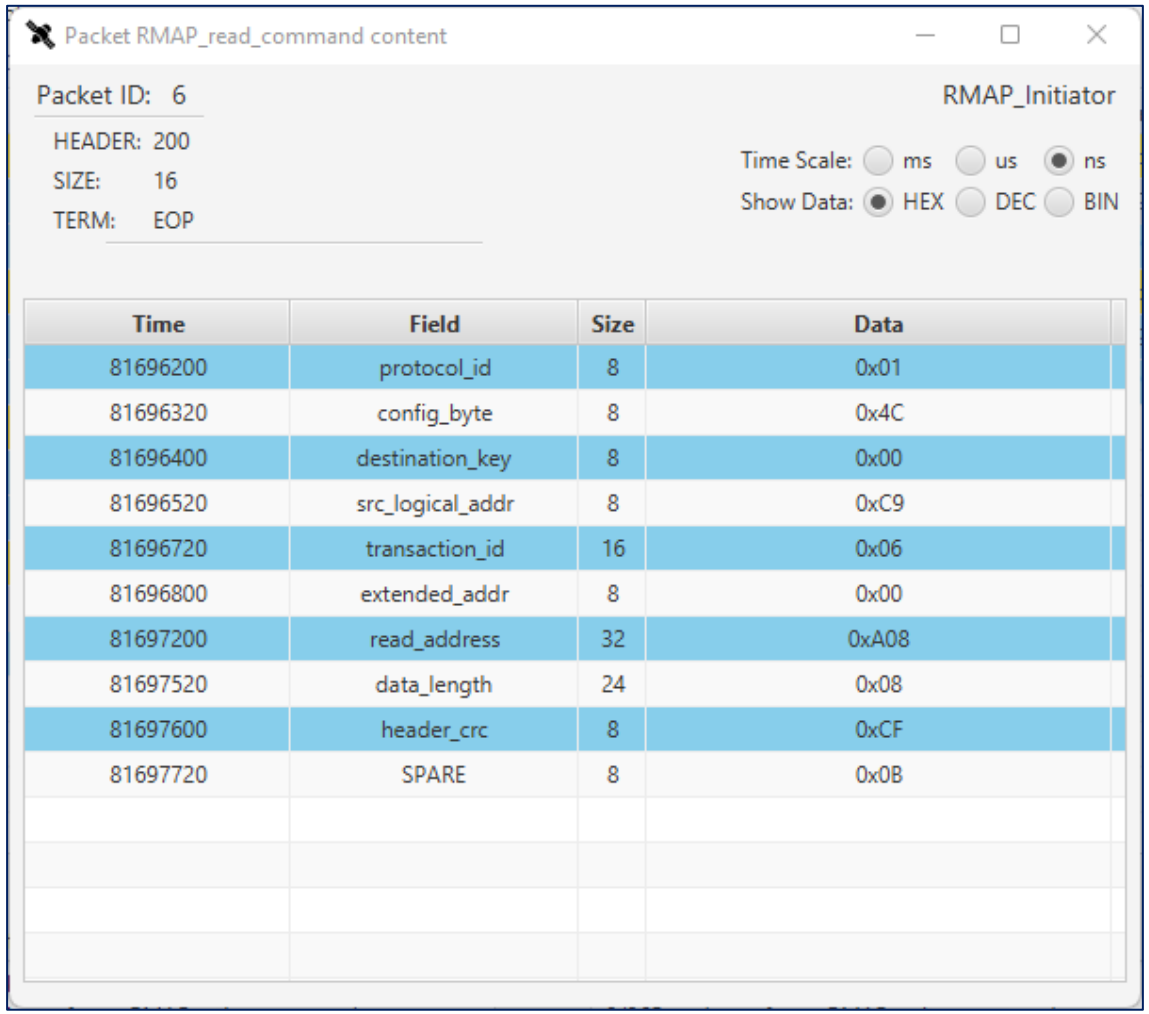
8	40714840	0x00
9	40714960	0x00
10	40715040	0xDC
11	40715120	0x05
12	40715240	0x00
13	40715320	0x00
14	40715440	0x00

Test Results – RMAP packets content

- Data organized as in SpW PDL
- Data bytes are grouped and named as indicated by the user
- More readable
- Inspect packet content is easier



Time	Field	Size	Data
81696200	protocol_id	8	0x01
81696320	config_byte	8	0x4C
81696400	destination_key	8	0x00
81696520	src_logical_addr	8	0xC9
81696720	transaction_id	16	0x06
81696800	extended_addr	8	0x00
81697200	read_address	32	0xA08
81697520	data_length	24	0x08
81697600	header_crc	8	0xCF
81697720	SPARE	8	0x0B

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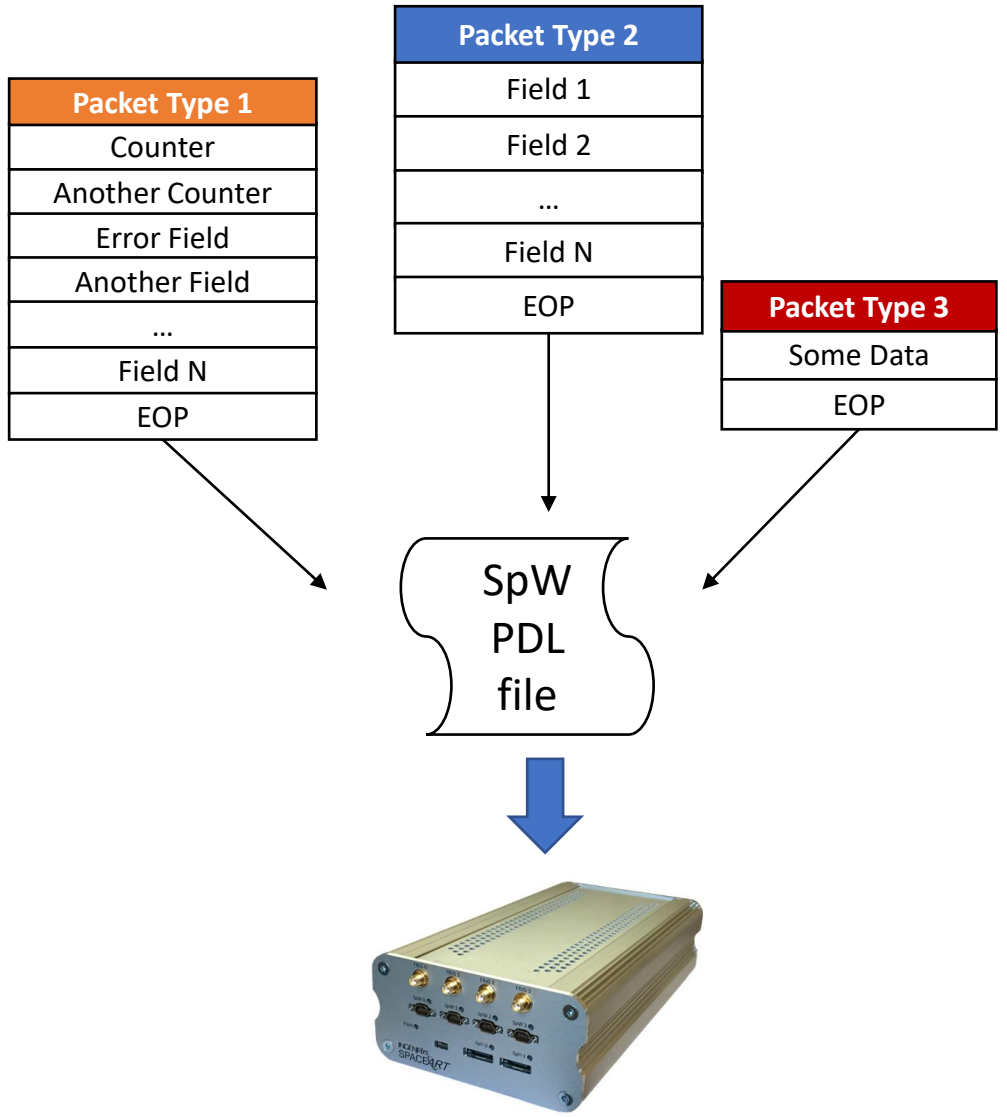
  - XML flexibility
  - Human- and Machine-Readable
- SpaceART SpW Sniffer Integration
- Enhance user-friendly SpW data inspection



Conclusion

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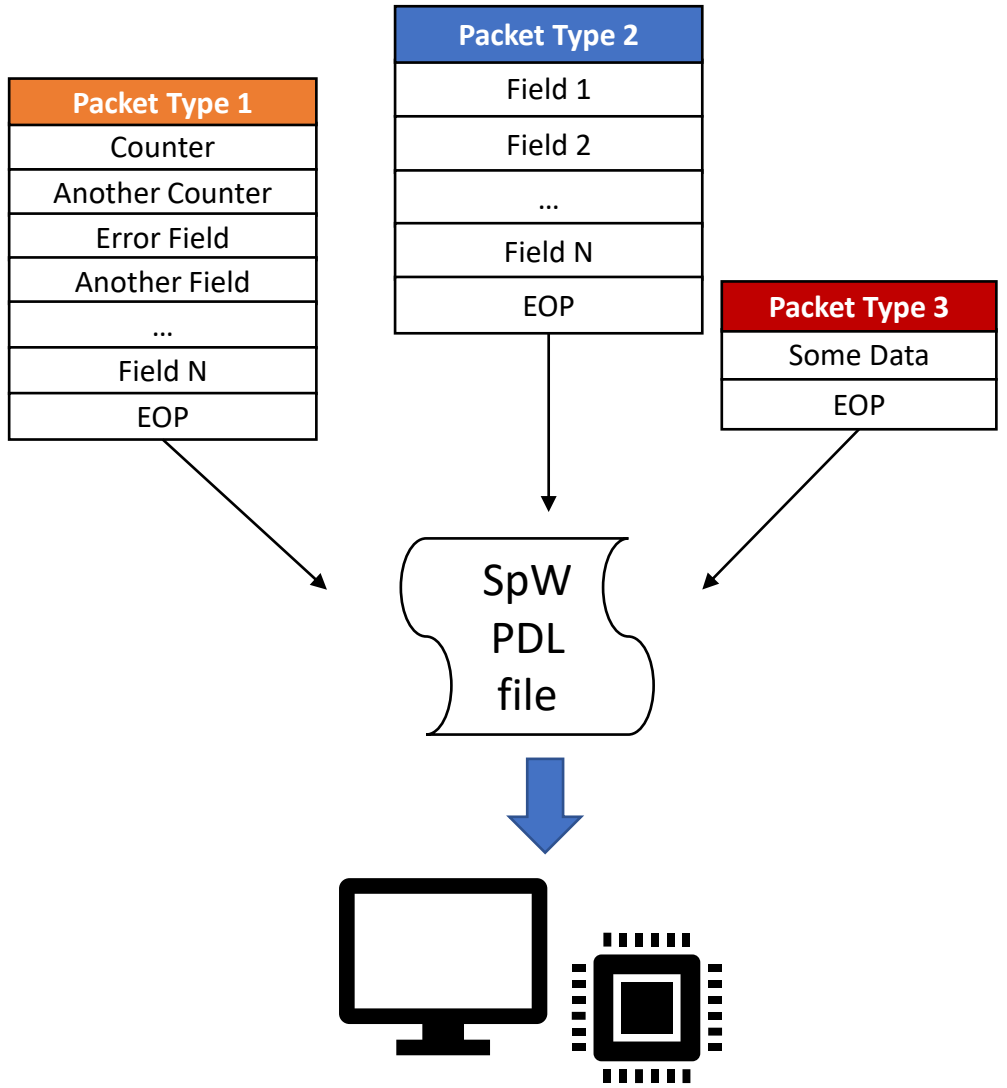
  - XML flexibility
  - Human- and Machine-Readable
- SpaceART SpW Sniffer Integration
- Enhance user-friendly SpW data inspection
- Suitable for SpW-based applications



Thank You

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