

Open Space Data Link Protocol

An open source implementation of the
CCSDS TM/TC Data Link Directives

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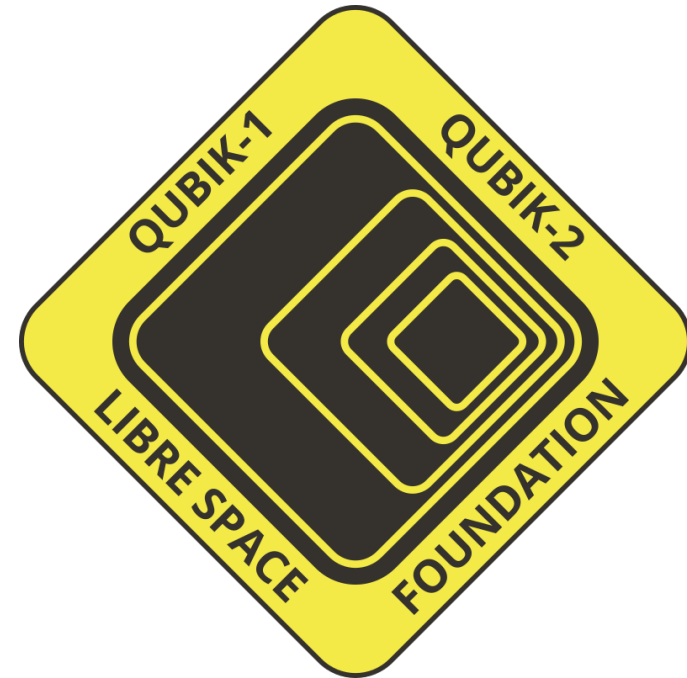


Outline

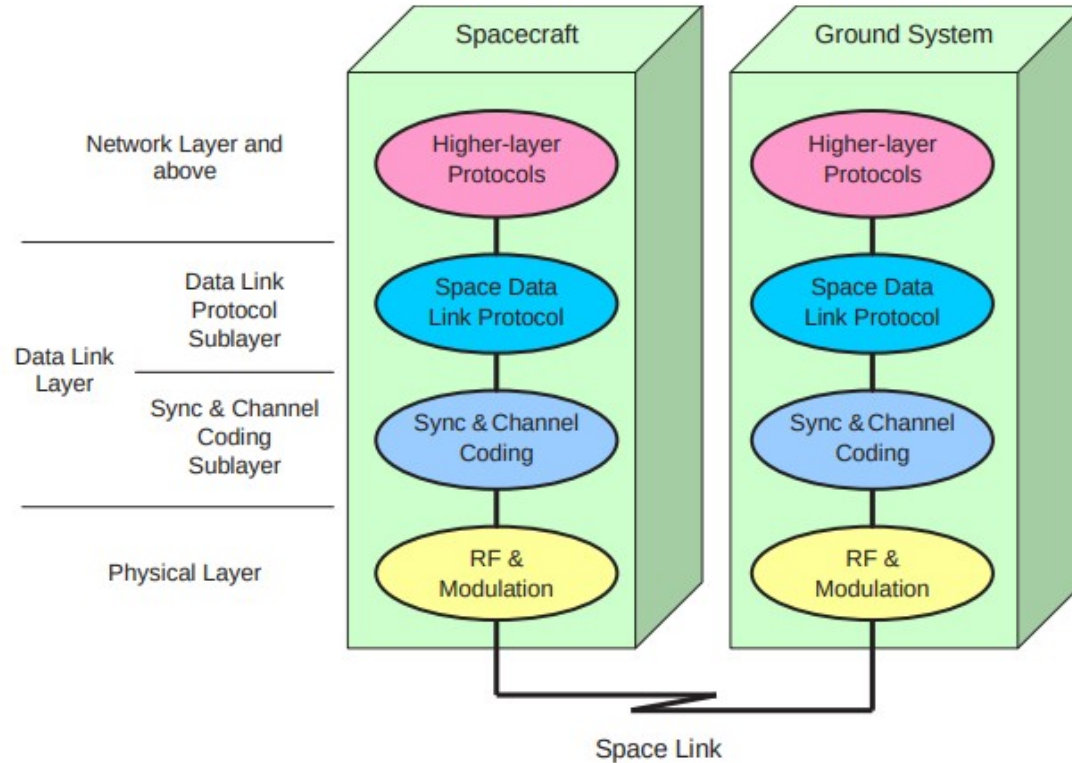
- How it started
- CCSDS TM/TC Directives
- Requirements and architectural choices
- Implementation
- Operator software
- Next steps

How it started

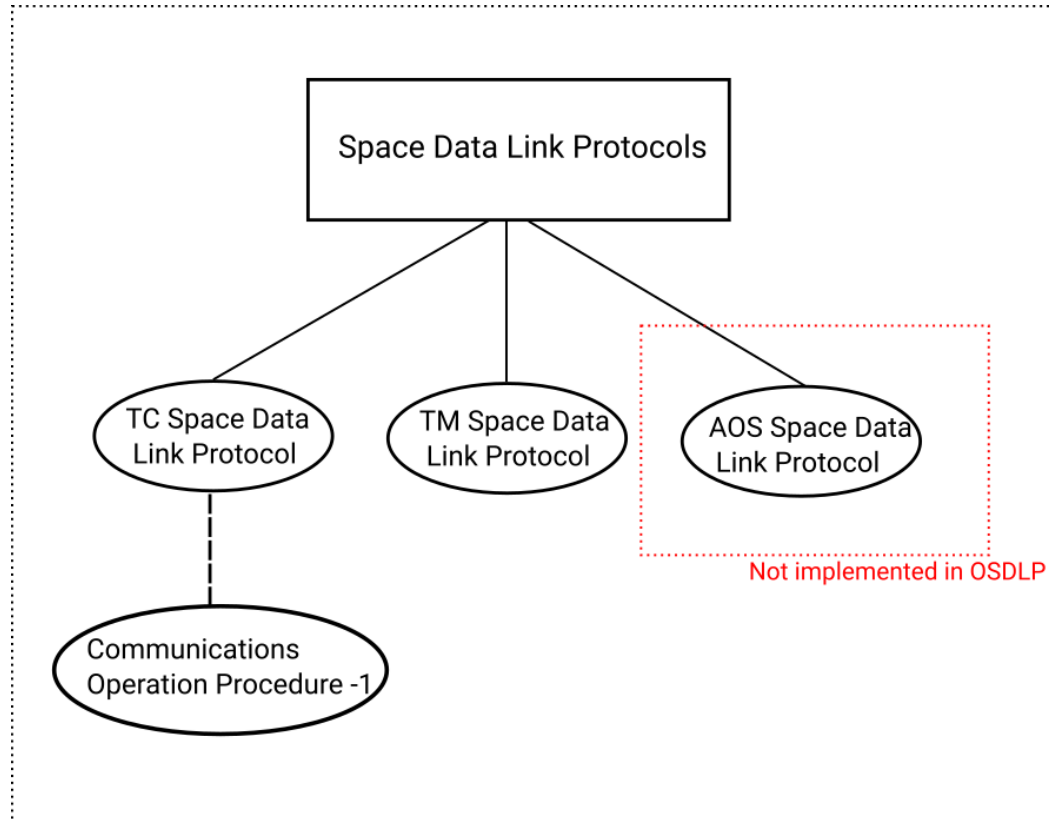
- In need of a MAC layer protocol for QUBIKs
- CCSDS Directives a perfect fit
- No available open source implementation for embedded devices
- Let's do it ourselves!



CCSDS TM/TC Directives

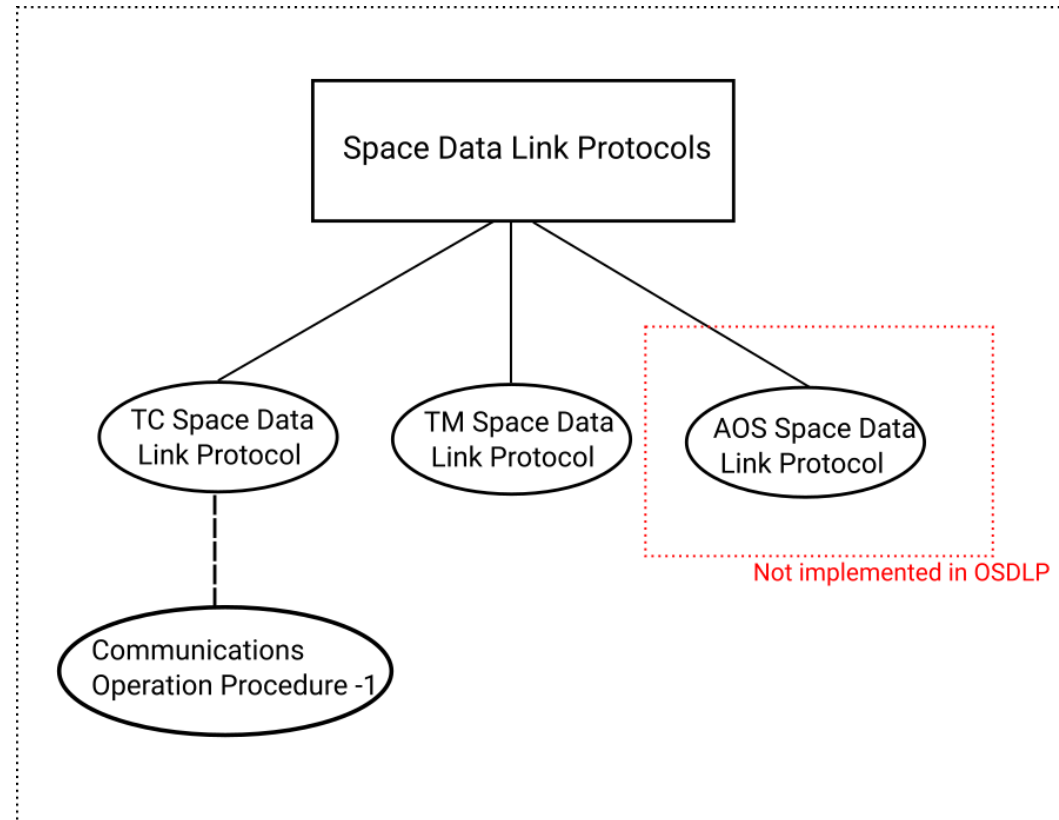


CCSDS TM/TC Directives



CCSDS TM/TC Directives - Features

- Segmentation and blocking of packets
- Channel sharing
- Different QoS per channel user
- Automatic Repeat Request and flow control defined in COP-1
- Feedback channel (CLCW)
- Optional security protocol
- Advanced Orbiting Systems (AOS) protocol extends the TM SDLP



CCSDS TM/TC Directives – Channel sharing

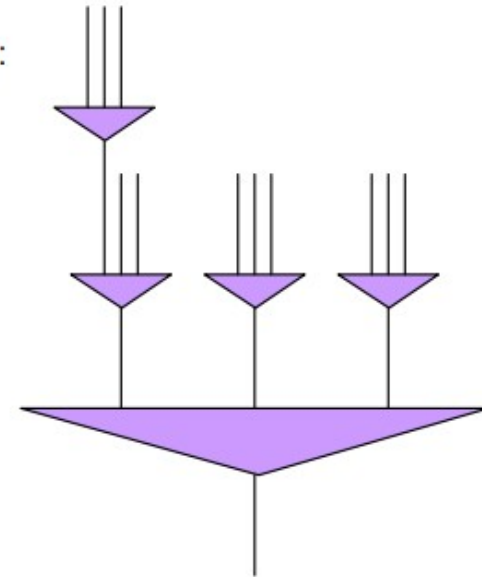
- Channel segmentation in Virtual Channels
- Different priority per VC
- Different QoS per VC
- Further segmentation of VC into Multiplexer Access Points (MAP) for TC only

MAP Channels (TC-SDLP only, Optional):
Identified by MAP ID

Virtual Channels (VC):
Identified by VCID

Master Channels (MC):
Identified by $MCID = TFVN + SCID$

Physical Channel:
Identified by Physical Channel Name



Requirements and architectural choices

What we required:

- A library in C/C++
- Low memory footprint
- User in control of memory utilization

What we decided:

- “Platform independent” OSDLP library
- User will provide and manage all data structures
- Use “weak” gcc attribute for user implemented functions

```
299
300⊖/**
301  * Dequeues an item from the sent queue
302  * @param the queue_item to hold the item
303  * @param the scid
304  * @param the vcid
305  * @return 0 or positive value for success, negative value otherwise
306  */
307  __attribute__((weak))
308  int
309  osdlp_tc_sent_queue_dequeue(struct queue_item *, uint16_t, uint16_t);
310
311⊖/**
312  * Returns if the sent queue is empty
313  * @param the scid
314  * @param the vcid
315  */
316  __attribute__((weak))
317  bool
318  osdlp_tc_sent_queue_empty(uint16_t, uint16_t);
319
320⊖/**
321  * Clears the sent queue
322  * @param the scid
323  * @param the vcid
324  * @return 0 or positive value for success, negative value otherwise
325  */
326  __attribute__((weak))
327  int
328  osdlp_tc_sent_queue_clear(uint16_t, uint16_t);
```


Implementation - OSDLP

- (Almost) all features of the Directives implemented in OSDLP
- TC, TM and COP in separate files
- User implements and manages the queues holding packets
- Requires more developer effort but gives greater control
- User also implements timers and locking wherever needed
- Unit tests for testing a number of scenarios

Implementation – Space Packet Protocol

- Space Packet Protocol added as a contribution to OSDLP
- SPP is a network layer protocol
- Suitable for ground-to-space, space-to-ground, space-to-space or on-board communication links

Operator Software

- osdlp-operator
- C++ CLI application
- Used for initialization, virtual channel selection TC transmission and TM reception
- Uses UDP ports to receive and convey packets to the RF frontend
- Configuration through libconfig library

```
==> Insert VCID
0 | Management
2 | Request TM
3 | Experiment
0

VCID 0 selected
==> Insert initialization option :
0 | Return to VCID selection menu.
1 | Initiate with CLCW (Just wait until a packet arrives)
2 | Initiate no CLCW (Don't expect anything. Begin TX)
3 | Initiate with Set V(R) (Sends a command. Good for ping)
4 | Initiate with Unlock. (Another command. Also good for ping)

2

==> Choose MAP
0 | Return to VCID selection menu.
1 | Change periodic telemetry attributes
2 | Request periodic telemetry attributes
3 | Kill switch
4 | Deploy antenna
s | [osdlp] Set new V(S) (Local frame sequence number)
t | [osdlp] Terminate local osdlp service (Reset)
r | [osdlp] Resume
```

Next Steps

- Refactor code and improve usability
- Write documentation
- More testing
- Implement AOS features
- Implement Space Data Link Security option (SDLS)

References

- Space Data Link Protocols – Summary of concept and rationale (CCSDS 130.2-G) <https://public.ccsds.org/Pubs/130x2g3.pdf>
- TC Space Data Link Protocol (CCSDS 232.0-B) <https://public.ccsds.org/Pubs/232x0b4.pdf>
- TM Space Data Link Protocol (CCSDS 132.0-B) <https://public.ccsds.org/Pubs/132x0b3.pdf>
- Communications Operation Procedure–1 (CCSDS 232.1-B) <https://public.ccsds.org/Pubs/232x1b2e2c1.pdf>
- Space Packet Protocol (CCSDS 133.0-B) <https://public.ccsds.org/Pubs/133x0b2e1.pdf>
- oslp library <https://gitlab.com/librespacefoundation/osdlp>
- osdlp-operator <https://gitlab.com/librespacefoundation/osdlp-operator>



Questions?