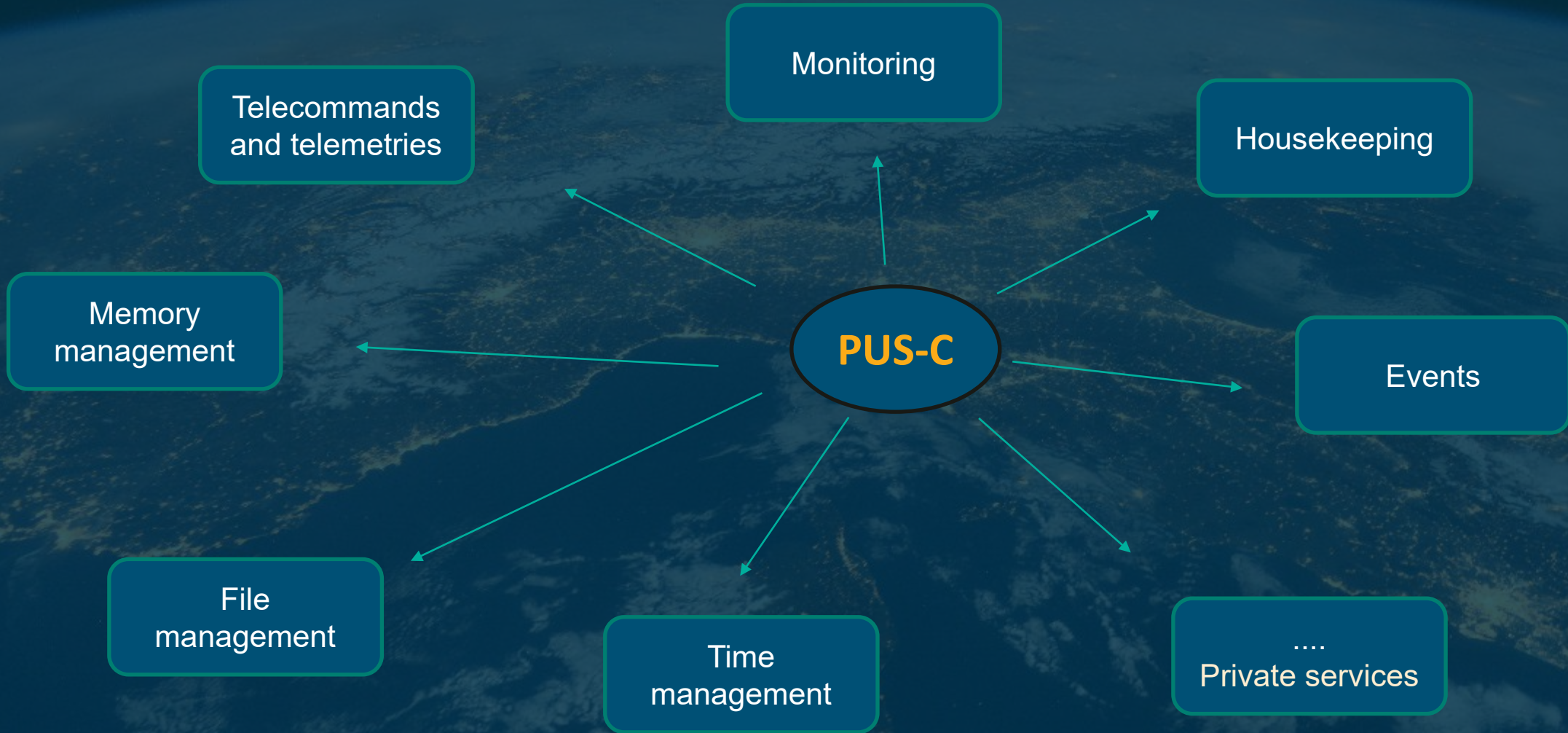
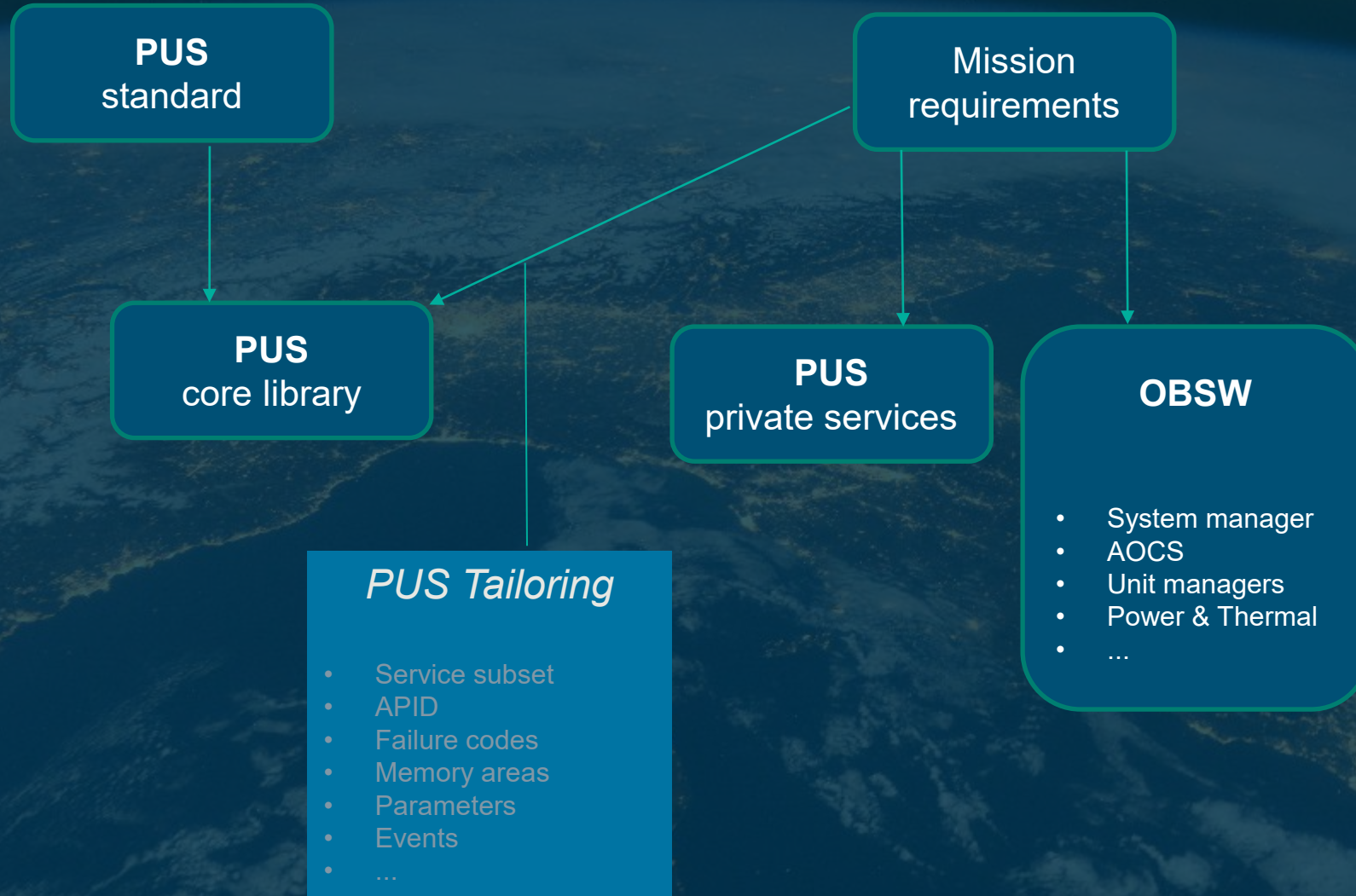


Towards a PUS component-based execution platform

The PUS standard specifies on-board services for ground stations to operate the spacecraft. It is big and complex.



The challenge



opus: the PUS specification and tailoring tool

List of available PUS services and corresponding TM/TC packets

Service detailed specification

Project-specific configurable data

The screenshot shows the 'PUS-C Population Tool' interface. On the left, a tree view lists service capabilities, with 'EXT[129] Reaction wheels management' selected. The central pane shows the detailed specification for this service, including its name, ID (129), and a description of its responsibilities. On the right, a table lists 'Reference data values' such as 'ABSOLUTE-ADDRESS', 'ABSOLUTE-TIME', and 'ACTIVITY-PERSISTENCY-STATUS'.

opus tailoring process



The screenshot shows the 'PUS-ASN1-GEN' application window. It has a menu bar with 'Configuration', 'Tools', and 'Help'. Below the menu bar are several configuration fields:

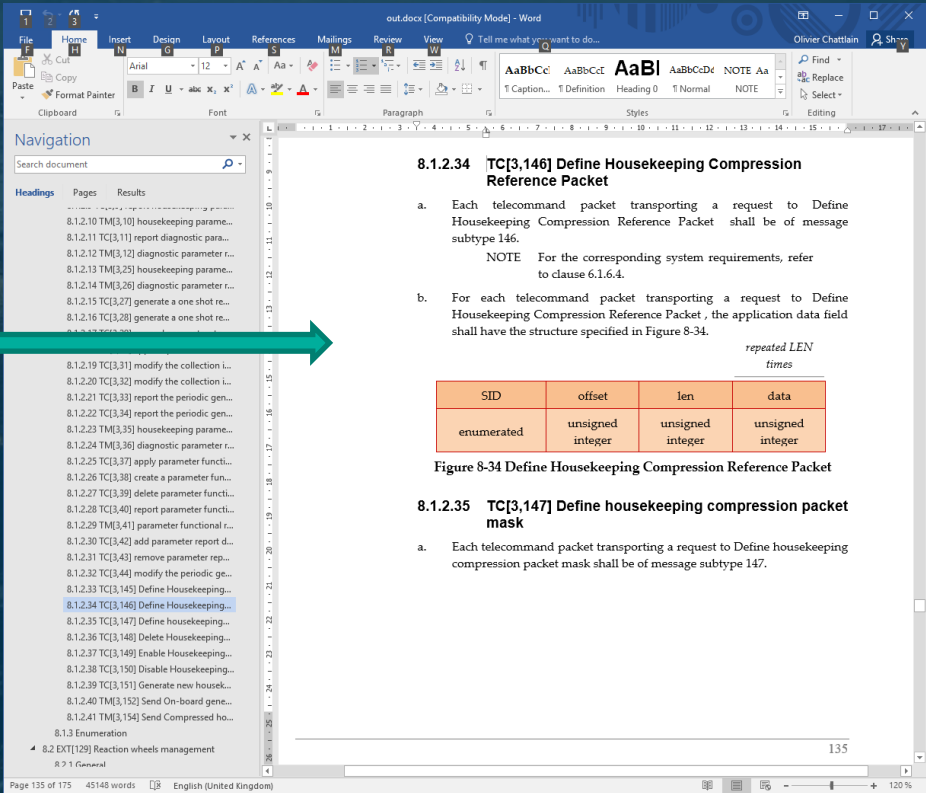
- Data source: Local PostgreSQL [ODBC]
- ASN.1/ACN implicit knowledge provider: Implicit Knowledge Provider
- Output directory: C:\PUSDocGenWorkingDirectory\GeneratedASN1ACN
- Capability types: A tree view with the following items:
 - ST[01] request verification
 - Acceptance and reporting subservice
 - Routing and reporting subservice
 - Execution reporting subservice
 - ST[02] device access
 - Device access subservice
 - capability to distribute on/off device commands (TC[2.1])
 - capability to distribute register load commands (TC[2.2])
 - capability to distribute register dump commands (TC[2.5] and TM[2.6])
 - capability to distribute CPDU commands (TC[2.4])
 - capability to distribute physical device commands (TC[2.7])
 - capability to acquire data from physical devices (TC[2.8] and TM[2.9])
 - capability to distribute logical device commands (TC[2.10])
 - capability to acquire data from logical devices (TC[2.11] and TM[2.12])
 - Group(at least one of capability to distribute on/off device commands, capability to distribute regi
 - ST[03] housekeeping
 - Housekeeping reporting subservice
 - Diagnostic reporting subservice
 - Parameter functional reporting configuration subservice
 - ST[04] parameter statistics reporting
 - ST[05] event reporting

At the bottom of the window is a large 'Generate' button. A red arrow points from a text box on the right to this button.

Pick the PUS services you need, give your project specific data (APID, Failure codes...), and press the button



The tools generate documents with a layout that is identical to the original PUS-C standard



opus to TASTE models (TM/TC definitions in ASN.1)



Telecommand (SEQUENCE) ASN.1 ACN							
Finally instantiate the Telecommand type							
No	Field	Comment	Present	Type	Constraint	Min Bits	Max Bits
1	packet-version		always	NULL	N.A.	3	3
2	packet-type		always	NULL	N.A.	1	1
3	secondary-hdr		always	NULL	N.A.	1	1
4	dest-apid	Possible values: • ground (2047) • flight (2046)	always	APID	N.A.	11	11
5	sequence-flags		always	NULL	N.A.	2	2
6	packet-seq-count		always	SEQ-COUNT-OR-NAME	N.A.	14	14
7	packet-data-len		always	NULL	N.A.	16	16
8	secondary-header		always	Telecommand-secondary-header	N.A.	35	35
9	packet-data		always	TCs	N.A.	22	397

TCs (CHOICE) ASN.1 ACN							
Create the full list of TCs used in my project							
No	ACN Parameters	Type					
1	tc-type	TYPE-ID					
2	tc-subtype	TYPE-ID					
No	Field	Comment	Present	Type	Constraint	Min Bits	Max Bits
1	tc2-4		tc-type=2 AND tc-subtype=4	TC-2-4	N.A.	22	397

TC-2-4 (SEQUENCE-OF) ASN.1 ACN						
instantiate the TC-2-4 for my project						
No	Field	Comment	Type	Constraint	Min Length (bits)	Max Length (bits)
1	Length	Special field used by ACN indicating the number of items.	unsigned int	(SIZE(1 .. max-Cpdu-Cmds))	1	1
2	Item #1		CPDU-Cmd	N.A.	21	198
...						
3	Item #2		CPDU-Cmd	N.A.	21	198

CPDU-Cmd (SEQUENCE) ASN.1							
No	Field	Comment	Present	Type	Constraint	Min Bits	Max Bits

```

PacketTypes.asn1* (PUS-C/ccsds @ MyProject) [master] - Qt Creator
File Edit Build Debug Analyze Tools Window Help
Projects
TimeWindow.asn1
service-02
LogicalDevice.acn
PhysicalDevice.acn
PhysicalDevice.asn1
PUS-2-1.acn
PUS-2-1.asn1
PUS-2-10.acn
PUS-2-10.asn1
PUS-2-11.acn
PUS-2-11.asn1
PUS-2-12.acn
PUS-2-12.asn1
PUS-2-2.acn
PUS-2-2.asn1
PUS-2-4.acn
PUS-2-4.asn1
PUS-2-5.acn
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PacketTypes.asn1*
Parameter.asn1
Request.asn1
TC-Packet.acn
TC-Packet.asn1
TM-Packet.asn1
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opus to TASTE (2) - components

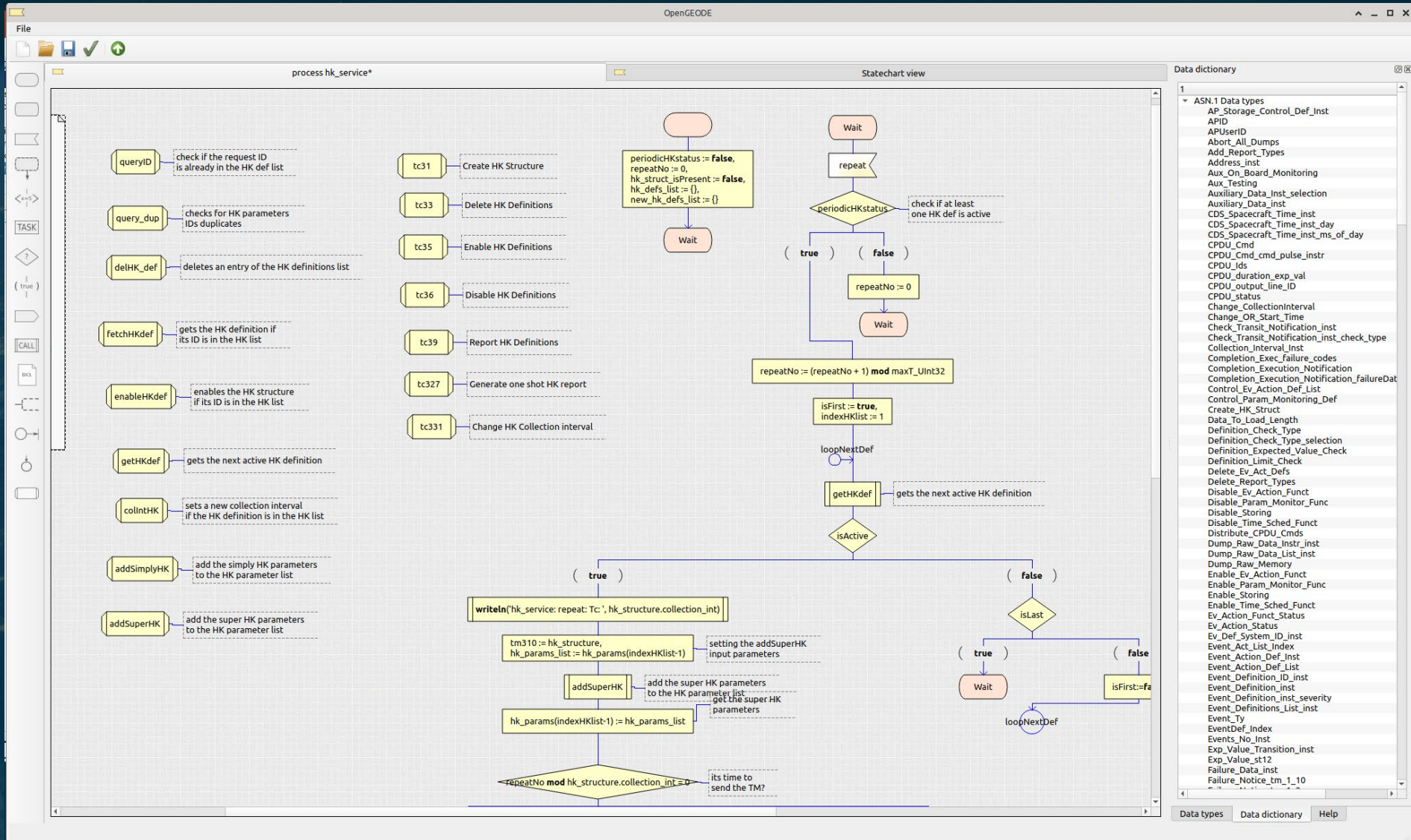


The screenshot shows the Qt Creator IDE with the following components:

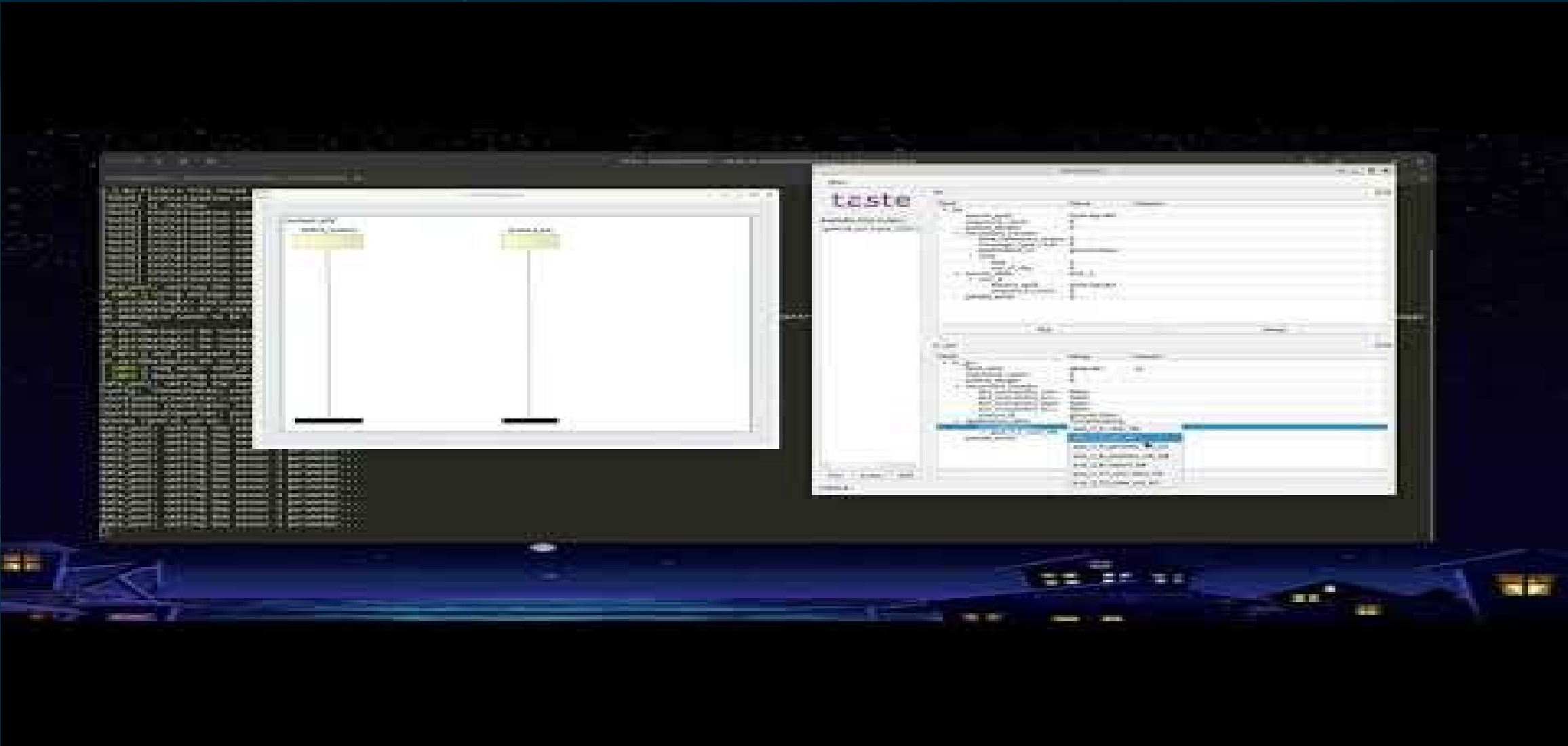
- Editor:** Contains ASN.1 code for 'interfaceview.xml'. The code defines types for TC, TM, and TC-Secondary-Header. A red circle highlights the 'Import Component' dialog box.
- Import Component Dialog:** A list of services to import, with 'Housekeeping Service' selected. Other services include Memory Management Service, Onboard Monitoring Service, Parameter Management Service, and Event Report.
- Diagram:** A UML-like diagram showing 'Platform Software' and 'Ground Segment' components. 'Platform Software' contains 'Hous...' and 'Platform Software'. 'Ground Segment' contains 'ground GUI' and 'processTC'. Arrows labeled 'tm' and 'tc' indicate data flow between the components.



Example: the Housekeeping service



Demo of the housekeeping service



Status and conclusion

- The PUS Execution Platform is work in progress
- The proof of concept includes only a few PUS services:
 - Housekeeping,
 - Monitoring,
 - Event-Actions
- **opus** will be integrated in taste by 2024 and allow:
 - Easy creation of new PUS services
 - Guided tailoring for PUS data
 - Automatic generation of TM/TC encoders for flight code
 - Automatic generation of a mission-tailored PUS library (including private services)

Questions?

1. Quick introduction to TASTE
2. Demo
3. The SAVOIR Onboard Software Reference Architecture (OSRA) and TASTE foundations
4. Modelling and working with a PUS-C execution platform