Can You SPEL BPEL?

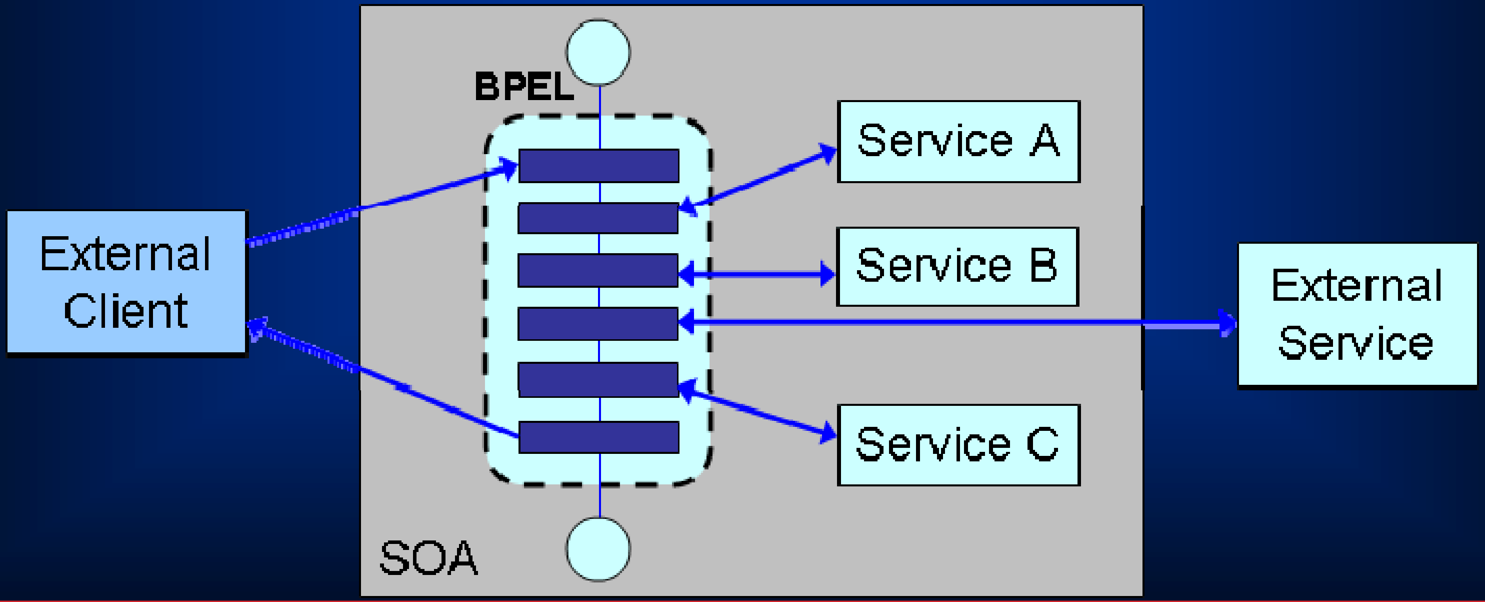
Applying Business Process Tools to Satellite Operations

Spacecraft Operational Procedures

- Most command & telemetry (C&T) systems provide some form of scripting to automate both spacecraft operations and ground system configuration.
- There are over a dozen languages to choose from (ATLAS, CCL, CECIL, CSTOL, PLUTO, STOL, TCL, etc.) and additional variation in individual installations due to ground equipment specific directives.
- Translation and validation of operations procedures can represent a major cost in acquiring a new spacecraft or changing/updating a ground system for an existing spacecraft.

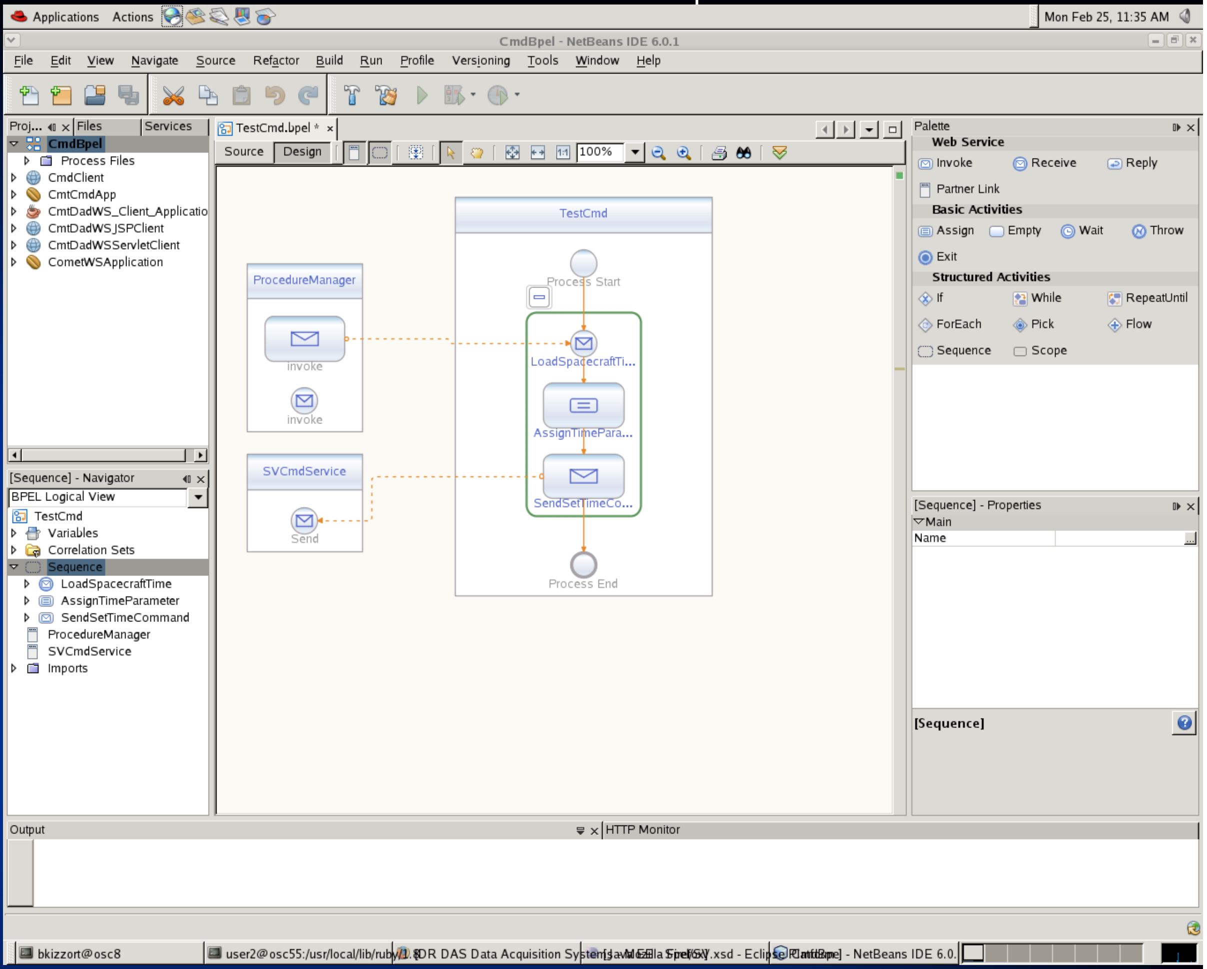
WS-BPEL

- Web Services Business Process Execution Language (WS-BPEL)
  - An orchestration language for web services that allows creation of higher level services from services defined in Web Services Description Language (WSDL)
  - XML-Based, published by OASIS in 2007 as WS-BPEL v2.0
  - Structured statements (if, while, for)
  - Parallel operations
  - Waits, event handling, fault recovery



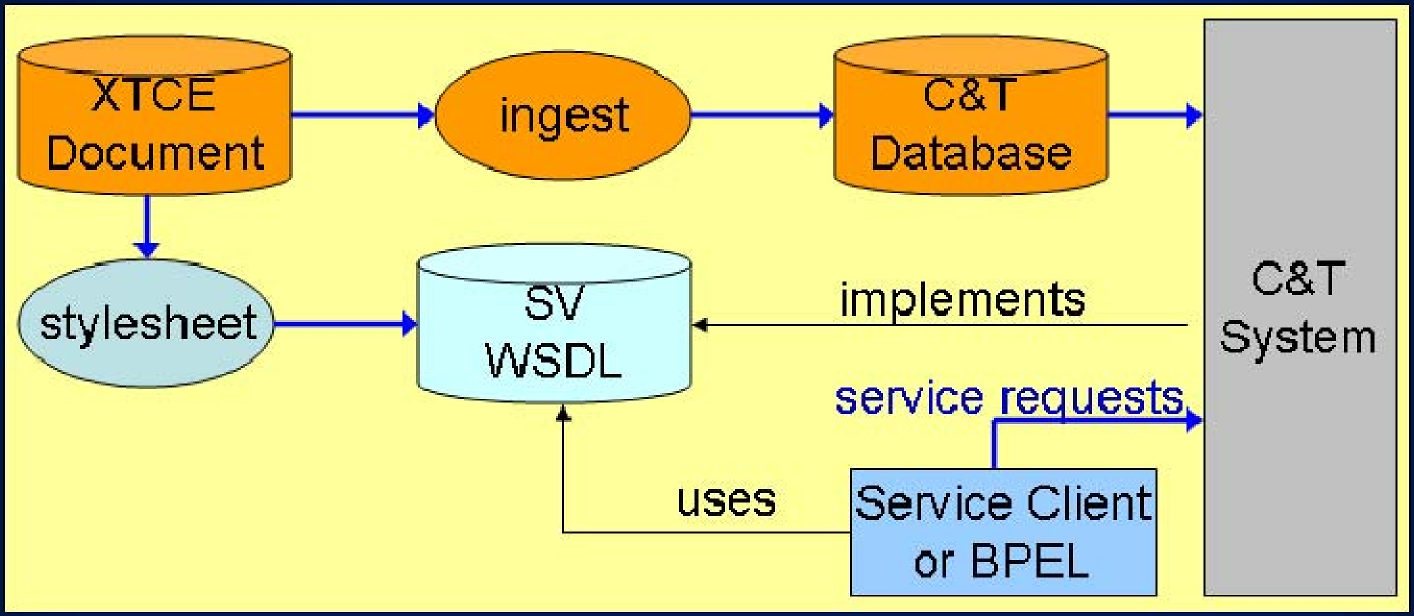
WS-BPEL is well-supported

- Execution engines & development tools:
  - ActiveBPEL®
  - NetBeans®
  - Oracle / BEA
  - IBM Websphere®
  - Eclipse WebTools
- Features:
  - Simulation
  - Debugging
  - Visual Execution
- Model-Driven Architecture:
  - Rational Rose®
  - MagicDraw®



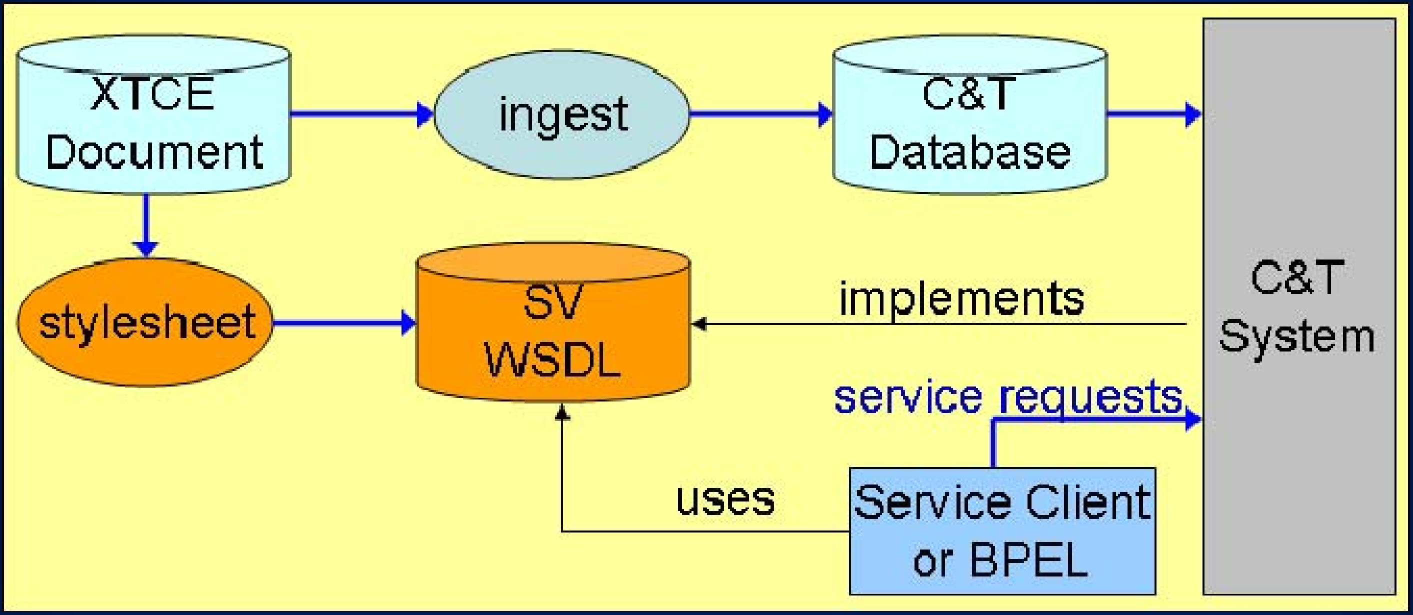
XTCE – an OMG & CCSDS specification

- The XML Telemetry and Command Exchange (XTCE) specification provides a way to define command and telemetry formats and processing for C&T systems.



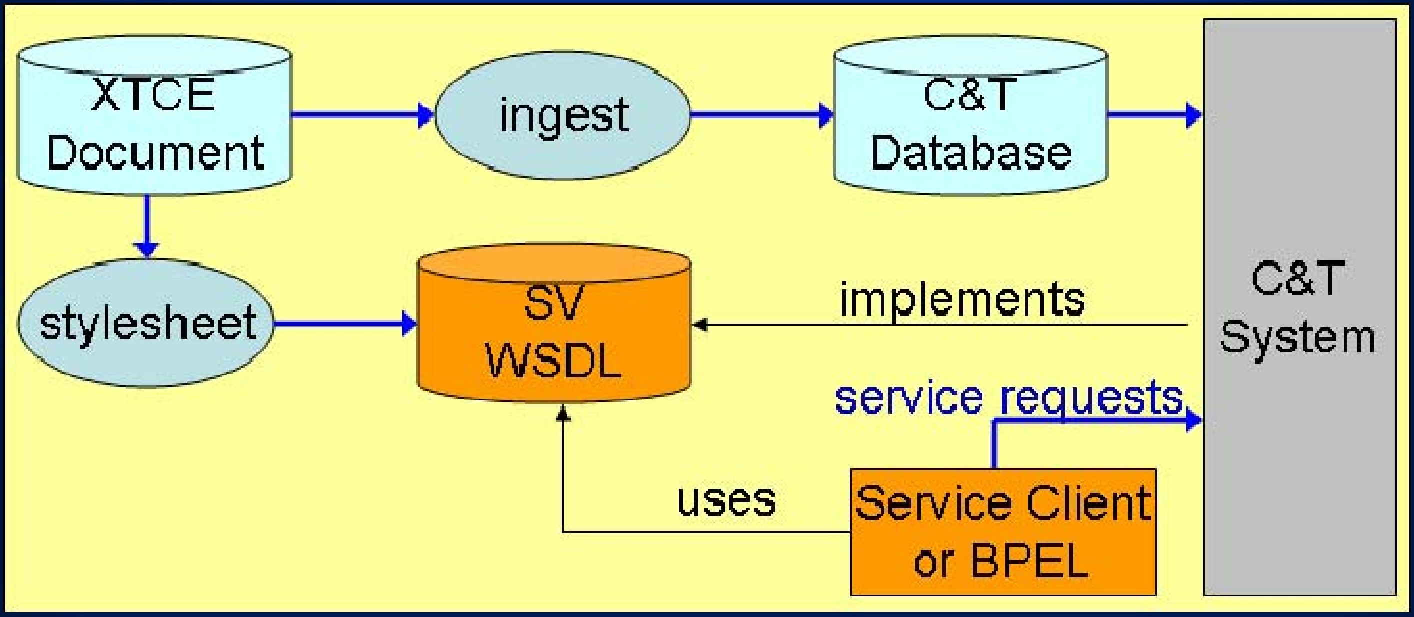
XML Stylesheet Language (XSL)

- An XTCE spacecraft document could be translated via a standard XSL style sheet into a spacecraft-specific Web Services Definition Language (WSDL) document.
- A published style sheet would provide consistent definition of service interfaces for spacecraft control given the same XTCE document.



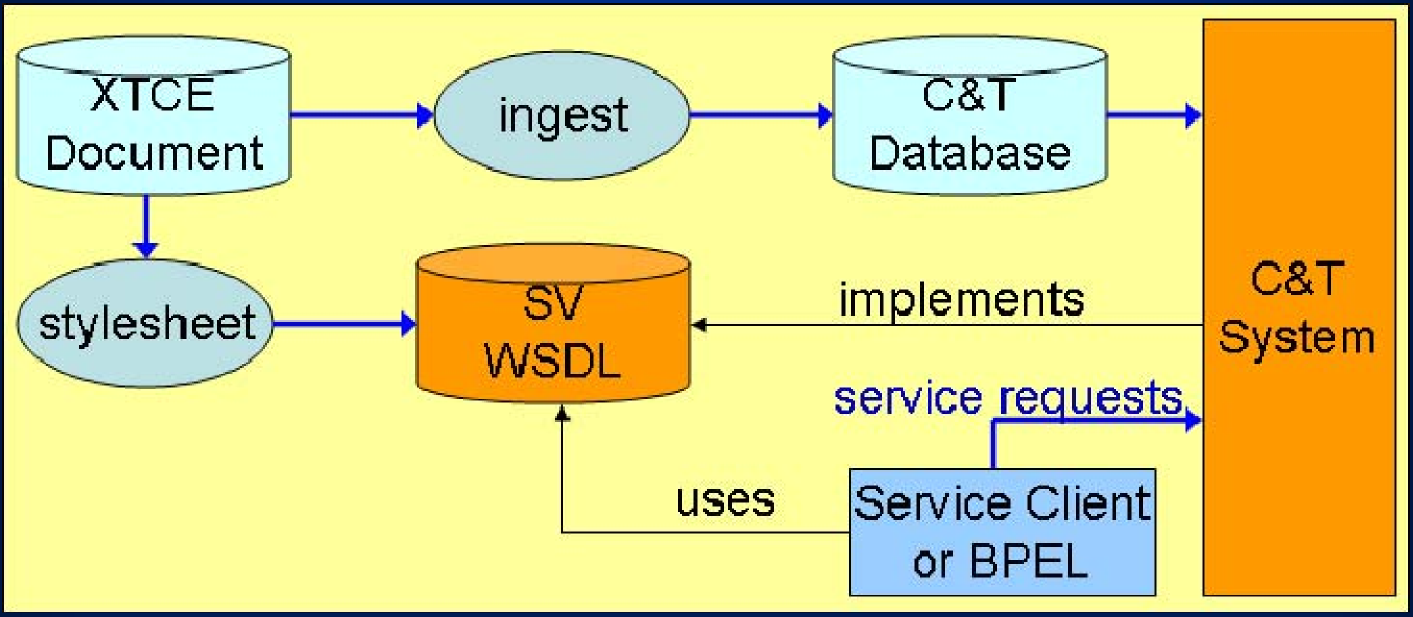
Spacecraft Process Execution Language (SPEL)

- A WS-BPEL/SPEL tool uses the WSDL to edit operations procedures and insure valid commands and parameters are used in the procedure.
- SPEL execution results in service requests to the C&T system to request telemetry and transmit commands.



Tool Support for WSDL is Good

- Development tools provide code generation to help implement the WSDL service interfaces for the C&T system.



Performance

- Latency added by Web Services is more variable than with local scripting and about an order of magnitude slower
- What we found:

Measurement	WS-BPEL (Glassfish)	Python
Command Latency	18 ms	3 ms
Telemetry Value Request	13 ms	<1 ms
Command Rate With Receipt Verification	108 cpm	118 cpm
Command Rate Open Loop	2571 cpm 43 cps	16364 cpm 273 cps

Summary

- Latency and execution time for WS-BPEL procedures are reasonable as a human-in-the-loop view or human-in-the loop replacement.
  - Sequential command transmission is not significant compared to a typical command counter telemetry response.
- Translation to and from native scripting languages to support higher performance is possible.
- Tools are drag-and-drop, but good ease of use would require some domain-specific enhancements. Building command requests in XML in the NetBeans BPEL-mapper is awkward compared to a language sensitive editor for text scripts
- There may be some database / script versioning experience in space that is applicable to WS-BPEL.

References

- “Goals for the BPEL4WS Specification”, http://xml.coverpages.org/
- WS-BPEL v 2.0 http://www.oasis-open.org/
- WSDL Specification, http://www.w3.org/TR/wsdl
- XTCE Specification, http://www.omg.org/technology/documents/formal/xtce.htm or http://public.ccsds.org/publications/archive/06-11-06.xml
- XSL Specification, http://www.w3.org/TR/xsl/