WinWin Usage Scenario

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Scenario Overview

- Distributed COTS decisions
- Context: Satellite Control
- Using WinWin Negotiation and Rationale Capture Model
- Rationale capture scenario
- Rationale usage scenario
Context

Standard Satellite Control Segment Reference Architecture

Space Systems Group

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Process Satellite Commands DFD

Define Commanding Data (4) → SV Data

Commanding

Simulate TT&C Data → Command Stream

Command Stream → Process & Transmit Commands (2)

Cmd retransmission

SV State

Determine Command Performance (3)

Satellite Operator

Process Telemetry

Define Commands & Command Procedures (1)

Recommended Corrective Action

Commanding Requirements

Vehicle Command Word Structure

Mem upload

Cmd xmitted, Cmd history, Ground Status

SV State

Commanded State Change

External to Commanding

Mission Specific

SSCS Commanding

Process Activity

Ground Config.

Configure System (5)

Quality Assessed EU Measurands

Decoder state, authentication, SV state

Satellite Operator

THE AEROSPACE CORPORATION
Commanding Hardware Architecture Options

1. Max CFE (A)
   - CFE ➔ LAN HUB ➔ WS
   - Constraint Check
   - Transmission
   - Display
   - X-term

2. Max CFE (B)
   - CFE ➔ LAN HUB ➔ WS
   - Constraint Check
   - Transmission
   - Display
   - Verification

3. CFE/Server (A)
   - CFE ➔ WS
   - Constraint Check
   - Transmission
   - Display
   - Verification

4. CFE/Server (B)
   - CFE ➔ LAN HUB ➔ WS
   - Display
   - Constraint Check
   - Transmission
   - Verification

5. CFE/Server (C)
   - CFE ➔ LAN HUB ➔ WS
   - Display
   - Constraint Check
   - Transmission
   - Verification

6. WS/Server
   - WS ➔ Server
   - Constraint Check
   - Transmission
   - Display
   - Verification

7. Max WS (A)
   - CFE ➔ LAN HUB ➔ WS
   - Constraint Check
   - Transmission
   - Display
   - Cmd Plan Execution
   - Verification

8. Max WS (B)
   - CFE ➔ LAN HUB ➔ WS
   - Display
   - Cmd Plan Execution
   - Constraint Check
   - Verification
Using WinWin for SSCS Decisions

- Baseline exists for software (logical) architecture
  - Embodied in WinWin domain taxonomy
- Multiple options for physical architecture
  - Some decision drivers: performance, functionality, cost, schedule, COTS/reuse constraints
- Example scenario driven by COTS/reuse constraints
  - Rationale captured via WinWin-architecture relations and comments
- Example developed asynchronously over Internet
  - at TRW Aerospace, USC
Win Win Negotiation and Rationale Capture Model

Win Condition
Rationale
Attachments

involves

Issue
Rationale
Attachments

addresses

Agreement
Rationale
Attachments

covers

Option
Rationale
Attachments

adopts
Initial Scenario

- Customer: Air Force
- Developer: TRW
- User: Aerospace
- List of Win Conditions
- Issue: performance problem with COTS package
# Satellite Ground Stations Requirements Negotiation

<table>
<thead>
<tr>
<th>Win Conditions</th>
<th>Issue</th>
<th>Options</th>
<th>Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aerospace (User)</strong></td>
<td>Use SSCS Reference Architecture, High command rate for future systems</td>
<td>Decouple functionality</td>
<td>Achieving required speed for real-time command processing</td>
</tr>
<tr>
<td><strong>Air Force (Customer)</strong></td>
<td>Real-time command verification, Use COTS, Real-time constraint checking, IOC Schedule within 15 months, Cost ≤ $5M</td>
<td>Build Custom decoupled component</td>
<td></td>
</tr>
<tr>
<td><strong>TRW (Developer)</strong></td>
<td>Software reuse criterion</td>
<td>COTS cannot meet required performance</td>
<td>Use 2 copies of COTS package</td>
</tr>
</tbody>
</table>
Win Condition: Using COTS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not rely on the server in the event of a failure.</td>
<td>Achieved</td>
</tr>
<tr>
<td>Developed tools to prevent crashes in the event of a failure.</td>
<td>Achieved</td>
</tr>
<tr>
<td>The toolkit will be backed by a vendor, which will release updates.</td>
<td>Achieved</td>
</tr>
<tr>
<td>A user can request a new version of the software.</td>
<td>Achieved</td>
</tr>
<tr>
<td>The software will be available for download.</td>
<td>Achieved</td>
</tr>
<tr>
<td>The toolkit will be migrated to a different architecture for better performance.</td>
<td>Achieved</td>
</tr>
<tr>
<td>The toolkit will be available for download within 24 hours.</td>
<td>Achieved</td>
</tr>
</tbody>
</table>

Summary: All requirements have been met.
COCOMO Attachment

cost/schedule reduced for using COTS

cots-edcs.est

edcs.est
Issue: COTS vs. Performance

ID: TEN-ISSU-1
CREATION DATE: 07/03/96 15:05
REVISION DATE: 09/11/96 19:38
ROLE: developer
STATUS: Active
PRIORITY: Medium
STATE: Unresolved

Options: [ ]

Name: Available technology will not meet required performance

If TEN uses the COTS package from ASTI, to implement the architecture described in Commanding Hardware Architecture Option 2, then performance is not sufficient to support the desired real-time constraint checking and command verification.
Option 1

- Have COTS Vendor Decouple Functionality
  - Put Command Plan Execution, Verification on Server processor
- COTS Vendor: I need to analyze my legacy-code product
  - To determine effort required for decoupling
- Software understanding tools applied
  - Decoupling would require additional 9 months, $600K
  - Incompatible with IOC date
Aerospace-Option-1

**Body:** Decouple COTS package for the commanding functionality

**Status:** Rejected

**Rationale:** Requires 9 months, $600K; incompatible with IOC schedule

**Taxonomy:** Performance, COTS, cost, schedule

**Attachment:** option-arch-1

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**Id:** option-arch-1

**Body:** Graph

---

**Performance Drivers**

- DataRate:
- Platform:
- Init-Delay:

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**Cost Drivers**

- Input
  - SLOC:
- Output
  - SCHE: 9 months
  - COST: 600K

---

**LAN-HUB**

- **c1**
  - Constraint Check Transmission, Verification

- **c2**
  - Command Interface

- **c3**
  - Command Execution

- **c4**
Option 1: Decouple Functionality

**Rationale:**
This option was rejected when ASTI indicated they needed 9 months and $600K to decouple their COTS package.

**Comment:**
Aerospace 07/03/96 13:49

**Request:**
Request that COTS vendor (ASTI) decouple functionality
Option 1 and Associated Architecture

<table>
<thead>
<tr>
<th>Option ID</th>
<th>Name</th>
<th>CREATION DATE</th>
<th>REVISION DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option</td>
<td></td>
<td>06/28/2010 10:22</td>
<td>02/21/2007 17:58</td>
</tr>
</tbody>
</table>

- Request that CORI vendors (ASTD) decouple functionality

4. CFE/Server (B)

CTE

Constraint Check
Transmission
Verification

LAW-HUB

Command Interface

WS

Server

Command Plan Execution
Option Summary

- Option 1 - Have COTS vendor decouple functionality
  - Rejected: Requires 9 months, 600k; incompatible with IOC schedule

- Option 2 - Build custom decoupled components
  - Rejected: Requires 22 months, $2M; incompatible with cost, IOC schedule

- Option 3 - Use 2 copies of COTS package on 2 processors; some additional glue code required
  - Adopted: performance model verifies feasibility

☐ Rationale for rejections, adoptions captured
**Agreement: Using 2 copies of COTS**

<table>
<thead>
<tr>
<th>Name</th>
<th>Achieving required speed for real-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Options:</td>
<td>Body</td>
</tr>
</tbody>
</table>

We will use 2 copies of the COTS software on the processors to achieve the required speed.

<table>
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<tr>
<th>Name</th>
<th>Achieving required speed for real-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Options:</td>
<td>Vote</td>
</tr>
</tbody>
</table>

Policy: Please vote by April 1, 1997

<table>
<thead>
<tr>
<th>Vote:</th>
<th>Concur</th>
</tr>
</thead>
</table>

Aerospace: Concur

State: In Progress
Rationale Usage Scenarios

1. Same project; crisis 2 years after delivery
2. Same project; crisis avoidance 1 year after delivery
3. Different project; 1 year later
1. Same Project: Crisis Response

- Different customer and developer representatives
- No memory of original options, decisions
- Crisis 2 years after delivery
  - Duplicated COTS package causing miscommunication
  - 6 months available to fix problem
  - Proposed solution: Decouple COTS
- Search previous WinWin options with COTS, schedule, performance domain taxonomy elements
  - Find the proposed solution option infeasible since the previous rejection rationale indicates that it takes 9 months to decouple COTS
2. Same Project: Crisis Avoidance

- Different customer and developer representatives
- System engineer identifies miscommunication problem
- New requirement: fix Year-2000 problems in SGS
- Based on the new requirement, Customer can provide additional 15 months, $800K for the project
  - Year-2000 problems Estimated effort: $100K, 5 months
- Search previous WinWin options with cost, schedule, performance Domain Taxonomy elements
  - Find the option “custom decoupled components” not feasible with 22 months schedule and $2M in rationale
  - Find the option “COTS decoupling” feasible with 9 months and $600K in rationale
3. Different Project: 1 Year Later

- Different customer organization, developer division
- Similar workload parameters and architecture options
  - Also need IOC in 15 months
- COTS vendor has convinced customer that COTS product can do anything
  - Customer pressing for decoupled COTS option
- System engineer searches related projects having WinWin options with COTS, performance & schedule
  Domain Taxonomy elements
  - Assuming consistent domain taxonomies, no subsequent COTS fix
  - Find option for "COTS decoupling" with rationale justifying the option as infeasible (9 more months)