The C2 Workstation and Data Replication over Disadvantaged Tactical Communication Links

Presentation held at the NATO RTO-IST Taskgroup 12 Workshop on September 11th & 12th in Quebec, Canada

TNO Physics and Electronics Laboratory,
Irv. F.N. Driesenaar
Driesenaar@fel.tno.nl
**Title:** The C2 Workstation and Data Replication over Disadvantaged Tactical Communication Links

**Author:** TNO Physics and Electronics Laboratory

**Abstract:**

Approved for public release, distribution unlimited.

**Security Classification:**

- Report: Unclassified
- Abstract: Unclassified
- This page: Unclassified
Part 1. Introduction

Structure of this Presentation:

• Part 1. Introduction
• Part 2. The Problem Domain
• Part 3. The C2 Workstation (C2WS)
• Part 4. Conclusions and Recommendations
Part 2. The Problem Domain for this Presentation

**How to:**
- Collaborative working
- Selective data distribution
- (Re-)Synchronisation
- Stand alone operation
- Security

**Despite:**
- Limited bandwidth
- Limited reach
- Frequent disconnects
- Latency
- Out of order delivery
- Missing data packages
- Corrupt data packages
- Dynamic topology
Part 3. The C2 Workstation (C2WS)
C2WS Physical Environment

C2WS System Architecture Context Diagram

UNCLASSIFIED – APPROVED FOR PUBLIC RELEASE
C2WS Evolution

C2WS Design Decisions I - Workstation

• Local data store (client or server!)
  Each workstation is a replication node!
• Overlays to group information
• Publish/Subscribe on a per Overlay basis
  – no servers, no single point of failure
  – Catalog of available information
• Parallel synchronisation and processing of (out of order) messages
C2WS Design Decisions II - Data Distribution I

• Supports Overlay Concept
• Publish/Subscribe – COTS product
• C2WS messages
  – unit of data distribution
  – can be processed ‘out of order’
  – can be distributed with different QoS setttings (future)
  – can be encrypted and signed (future)
  – portable data (XML) -> C2XML
  – ‘(delta) object completeness’
C2WS Design Decisions III - Data Distribution II

• Synchronization
  – For subscribed Overlays:
    • Active Information and/or
    • Historic Information (time period)
    • Configurable data loggers/synchronization servers
  – Heartbeat

• Multi-master replication with loose consistency & convergence
Collaborative work on a shared Overlay

- Last update wins
  - Version numbers on object-attribute values
  - Conflict resolution on a per attribute basis only.

- Data conflict
  - Normal (foreign key, transactional) integrity is not enforced in favor of availability.
  - Left to end users after synchronizing
  - Replication mechanism only provides convergence

- Differing view - different overlay
  - Within an Overlay, data will most likely be contributory than conflicting
# C2WS versus ATCCIS/MIP DEM

<table>
<thead>
<tr>
<th>ATCCIS</th>
<th>C2WS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database replication</td>
<td>Info bus</td>
</tr>
<tr>
<td>Contracting</td>
<td>Publish/subscribe per overlay</td>
</tr>
<tr>
<td>Contracts (predefined)</td>
<td>Overlays (flexible)</td>
</tr>
<tr>
<td>Relational</td>
<td>Object oriented</td>
</tr>
<tr>
<td>Proprietary PDU syntax</td>
<td>XML</td>
</tr>
<tr>
<td>Fixed QoS</td>
<td>COTS MOM</td>
</tr>
<tr>
<td>LC2IEDM</td>
<td>C3I info model</td>
</tr>
<tr>
<td>Ownership</td>
<td>Update anywhere; access control lists/ last wins</td>
</tr>
<tr>
<td>Database table changes</td>
<td>Object( change)s</td>
</tr>
<tr>
<td>Full bulk synchronization</td>
<td>Synchronization options</td>
</tr>
<tr>
<td>Increments after full bulk</td>
<td>Concurrent synchronization &amp; regular data exchange</td>
</tr>
</tbody>
</table>
Part 4. Conclusions & Recommendations

• C2WS principles
  – Data organized in Overlays
  – Update anywhere, collaborative work
  – Use Publish-Subscribe paradigm

• Challenges:
  – Proof of the pudding...
  – How to use Overlays?
  – vehicle level and down?
  – Combine security & publish-subscribe?
Conclusions & Recommendations

• Recommendations
  – Contact TNO and/or C2 Support Centre
  – Join MIP/Seawg
  – Take care
Questions?