Net-Centric Information and Knowledge Management and Dissemination for Data-to-Decision C2 Applications using Intelligent Agents and Service-Oriented Architectures

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

MCG - Mission Command Gateway and C2 Object Library for Coalition Operations

Developer team includes
C2D, VFSD, Drexel U., Soar Tech., CSI, Raytheon, IHMC, SAIC, L3, DAC, OSU

Presented by Dr. Israel Mayk
Israel.Mayk@us.army.mil
D2D IMD(XX) to the Edge

Per Operation
>1000 Orders
>100000 Reports
**FREE TEXT MESSAGE** | **REDCON ALERT**
---|---
Check Fire ** | Situation Report (SITREP) **
Call for Fire ** | Field Orders 2 ***
Observer Mission Updates¹ | Operations Plan ***
On-Call Fire Command | Fragmentary Order (FRAGO) ***
Message to Observer¹ | Warning Order (WARNO) ***
Fire SPT COORD Measures | Minefield Laying
End of Mission/Surveillance * | Overlay **
Sequent Adjust | MOPP Alert
Observer Readiness Report | MEDEVAC Report **
Airborne Fire Mission | Logistics Report *
Spot Report * | Personnel Report
Engagement Report * | Supply Point Status
Contact Report * | Task Management
Land Route Report * | LOG Task Order
Obstacle Report | LOG Call for Support **
Bridge Report * | LOG Task Status **
Position Report * | LOG Task Sync
NBC 1 Report ** | Execution Matrix
NBC 4 Report¹ | Mayday/911 *
D2D IM&D Message Threads
(2011 Experiments)

WARNO(4IBCT|1, 2, 3)
OPORD(4IBCT|1)
FRAGO(4IBCT|1, 2, ...)

WARNO(1-44IN|1, 2, 3)
OPORD(1-44IN|1)
FRAGO(1-44IN|1, 2, ...)

WARN(B CO|1, 2, 3)
OPORD(B CO|1)
FRAGO(B CO|1, 2, ...)
Vertical and Horizontal IM&D

Echelon n+1

- Unit A1 Order
- Unit A Order

Echelon n

- Unit A.1 Order
- Unit A1 Order
- Unit A1.1 Order
- Unit A2 Order
- Unit A2.1 Order
- Unit A2.2 Order

Echelon n-1

- Unit A1.1 Order
- Unit A1.2 Order
- Unit A1.3 Order
- Unit A2.1 Order
- Unit A2.2 Order
**7 BfSB (ME)**

T1: Prepare for tactical operation.

P1: Support 7DIV concept of the operation.

T2: Conduct reconnaissance and counter-reconnaissance fwd of TAA ANZIO and ST. LO along Axes GREEN, BLUE and YELLOW.

P2: Eliminate enemy recon's ability to disrupt 7ID's offensive actions along those axes.

T3: Conduct route recon of AXIS BLUE to CHURCH PASS (high ground North of Monticello).

P3: Provide updated information on route conditions and activities and ensure trafficability along AXIS BLUE.

T4: Conduct aerial reconnaissance of OBJs KESTREL, HAWK and LION.

P4: Inform CDRs of enemy disposition, composition, and route status.

T5: Conduct aerial reconnaissance of AIR AXIS RED.

P5: Inform commanders of 4IBCT and 7CAB of enemy disposition, composition, and possible ADA ambush sites.

---

**5FBCT (OBJ Kestrel and Lion)**

T1: Prepare for Tactical Operation.

P1: Support 7DIV concept of the operation.

T2: Coordinate with 7BfSB for AXIS GREEN and OBJs KESTRAL and LION reconnaissance and counter reconnaissance.

P2: Shape the operational environment.

---

**7 BfSB (ME)**

T1: Prepare for tactical operation.

P1: Support 7DIV concept of the operation.

T2: Conduct reconnaissance and counter-reconnaissance fwd of TAA ANZIO and ST. LO along Axes GREEN, BLUE and YELLOW.

P2: Eliminate enemy recon's ability to disrupt 7ID's offensive actions along those axes.

T3: Conduct route recon of AXIS BLUE to CHURCH PASS (high ground North of Monticello).

P3: Provide updated information on route conditions and activities and ensure trafficability along AXIS BLUE.

T4: Conduct aerial reconnaissance of OBJs KESTREL, HAWK and LION.

P4: Inform CDRs of enemy disposition, composition, and route status.

T5: Conduct aerial reconnaissance of AIR AXIS RED.

P5: Inform commanders of 4IBCT and 7CAB of enemy disposition, composition, and possible ADA ambush sites.

---

**7HBCT (-)**

T1: Prepare for Tactical Operation.

P1: Support 7DIV concept of the operation.

T2: Coordinate with 7BfSB for AXIS YELLOW and OBJ BADGER reconnaissance and counter reconnaissance.

P2: Shape the operational environment.

---

**2MECH (UK) (OBJ Badger)**

T1: Prepare for Tactical Operation (ART 7.5).

P1: Support 7DIV concept of the operation.

T2: Coordinate with 7BfSB for AXIS BLUE and OBJ BADGER reconnaissance and counter reconnaissance.

P2: Shape the operational environment.

---

**4IBCT (MN) (OBJ Tiger)**

T1: Prepare for Tactical Operation.

P1: Support 7DIV concept of the operation.

T2: Coordinate with 7BfSB for Air Axis and LZ reconnaissance and counter reconnaissance.

P2: Shape the operational environment.

---

**3MECH (AS) (OBJ Hawk)**

T1: Prepare for Tactical Operation.

P1: Support 7DIV concept of the operation.

T2: Coordinate with 7BfSB for AXIS BLUE and OBJ HAWK reconnaissance and counter reconnaissance.

P2: Shape the operational environment.

---

**7DIV Key Tasks:**

- Defeat Attican forces at OBJ HAWK (CORTEZ).
- Seize the HITE DAM intact at OBJ KESTREL.
- Destroy enemy long range fires and coordinate for joint fires destruction of those assets immediately adjacent to the division AO.
- Secure bridge crossing sites throughout AO. Conduct concurrent Stability Operations.
- Prepare for follow-on operations.
Multi-Role / Multi-National Staff & Agent Collaboration

1-44 4IBCT(US)

2-44 4IBCT(US)
COMBAT ORDERS FLOWCHART

ORDER ISSUED TO YOU

I. SITUATION
   A. Enemy Forces
   B. Friendly Forces
      1. Higher
         (a.) Mission
         (b.) Intent
      2. Adjacent
      3. Supporting
   C. Attach/Detach

II. MISSION

III. EXECUTION
   A. Cmdr's Intent
   B. Concept of the Op
      (a.) Scheme of Maneuver
      (b.) Fire Support Plan
   C. Tasks
   D. Coordinating Instructions

IV. ADMIN/LOGISTICS

V. COMMAND/SIGNAL

ORDER YOU ISSUE

I. SITUATION
   A. Enemy Forces
   B. Friendly Forces
      1. Higher
         (a.) Mission
         (b.) Intent
      2. Adjacent
      3. Supporting
   C. Attach/Detach

II. MISSION

III. EXECUTION
   A. Cmdr's Intent
   B. Concept of the Op
      (a.) Scheme of Maneuver
      (b.) Fire Support Plan
   C. Tasks
   D. Coordinating Instructions

IV. ADMIN/LOGISTICS

V. COMMAND/SIGNAL

MDMP
TLP
SMEAC
METT-TC
OAKOC
ASCOPE
PMESII-PT

B0326 COMBAT ORDERS I,
USMC, Basic Officer Course
Integrating/ Synchronizing the Art of MDMP and Science of IMDP

1. Receipt of MSN
   - WARNO1(n+1)
   - WARNO2(n+1)
   - WARNO3(n+1)
   - OPLAN(n+1)
   - OPORD(n+1)
   - FRAGO1(n+1)
   - FRAGO2(n+1)
   - FRAGO3(n+1)

2. MSN Analysis
   - WARNO1(n)
   - WARNO2(n)
   - WARNO3(n)

3. COA Development
   - Or Own Perceived Msn

4. COA Analysis

5. COA Comparison

6. COA Approval
   - WARNO3(n)
   - OPLAN(n)
   - OPORD(n)
   - FRAGO1(n)
   - FRAGO2(n)
   - FRAGO3(n)

7. Orders Production
   - OPLAN(n)
   - OPORD(n)
   - FRAGO1(n)
   - FRAGO2(n)
   - FRAGO3(n)

Or Own Perceived Msn
Collaborative planning is the real-time interaction among commanders and staffs at two or more echelons developing plans for a single operation.
D2D Essential Ingredients(a)

Integrated Technologies providing Integrated Capabilities
(Information/Knowledge Management by TITAN)

- Enemy Equipment
- Observe/Observer
- Products Drive Capabilities Integration
- High Payoff/Value Target
- Actors Drive Technologies Integration
- Decide/Decider

Integrated Technologies providing Integrated Capabilities
(Information/Knowledge Management by TITAN)
Supporting Full Spectrum of Contexts and Contents

(Information/Knowledge Management by TITAN)

Diagram showing relationships between different elements:
- Situation, $S_u$
- Mission, $M_m$
- Ext. Source
- Content
- Context

Arrows indicating flow and relationships between these elements.
C. Enemy Forces

BPF cells have been conducting reconnaissance in AO Tiger to determine 4IBCT locations, dispositions, and readiness levels. BPF is expected to conduct limited harassment attacks using mortars and snipers to test 4IBCT defense and reaction capabilities. BPF will likely attempt to pass 4IBCT vehicle checkpoints to test procedures and assess vulnerabilities.

D. Friendly Forces

1. Higher Headquarters' Mission and Intent

A. Higher Headquarters Two Levels Up

1. Mission

2. Commander's Intent

B. Higher Headquarters

1. Mission
MCG Agent based Architecture
MCG Support (MGS) Services

- **Data Product Support (DPS)**
- **Alert & Warning Support (AWS)**
- **Workflow Orchestration Support (WOS)**
- **Product Dissemination Support (PDS)**
- **Initialization & Execution Support (IES)**
- **MultiMedia Support (MMS)**
- **Reference Book Support (RBS)**
- **Smart Filtering Support (SFS)**
- **Export/Import Support (EIS)**
- **MCG Agents**
  - negotiate resources
  - support interoperability among services

MCG Services support Web Service Standards and utilize POR Infrastructure
Provides a relevant environment/venue to assess emerging technologies in a C4ISR System-of-Systems (SoS) configuration to enable a Network Centric environment IOT reduce and mitigate risk for FCS Concepts, Future Force capabilities, and accelerate technology insertion into the Current Force in support of the Army Brigade Combat Team Modernization Plan and the Future Force

- An **R&D Program of Record** chartered by the CG, RDECOM and the Army Acquisition Executive
- Conducts **integrated Live, Virtual, and Constructive** technology demonstrations
- Provides technology maturity **evaluation and assessment services** to R&D and POR’s
- Employs a **state-of-the-art instrumentation, data collection & reduction** (IDC&R) tool suite that supports the quantification of vertical and horizontal SoS & Network Centric Warfare activities
- Employs **SoS Engineering and Integration** methods that promote **rapid SoS reconfiguration and enable repeatable assessments**
- A proven **Technology Transition Venue**

Approved for public release; distribution is unlimited.
## Trial Run Daily Battle Rhythm

<table>
<thead>
<tr>
<th>Time</th>
<th>Technical</th>
<th>Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0800</td>
<td>Systems Preparation</td>
<td>Morning Brief (0800)</td>
</tr>
<tr>
<td>0830</td>
<td>Systems Ready</td>
<td>Issue Order</td>
</tr>
<tr>
<td>0930</td>
<td>Technical Support</td>
<td>Trial Run 1 (0830-1200)</td>
</tr>
<tr>
<td>1200</td>
<td>Systems Re-set</td>
<td>Operations Re-set</td>
</tr>
<tr>
<td>1300</td>
<td>Systems Ready</td>
<td>Trial Run 2 (1300-1630)</td>
</tr>
<tr>
<td>1430</td>
<td>Technical Support</td>
<td></td>
</tr>
<tr>
<td>1600</td>
<td>Data Harvesting</td>
<td></td>
</tr>
<tr>
<td>1700</td>
<td>System Shutdown</td>
<td>AAR</td>
</tr>
</tbody>
</table>
Technology Demonstrated

- An open-system / Government open-source Managed-objects
  Intelligent Agents and Web Services enabling automation in support of Mission Command Data-to-Decisions threads
- Highly modular scalable heterogeneous intelligent agents Frameworks
- Harmonized C2 products with common contexts and domain objects to reduce user workload, human errors and duplication of effort among collaborating users and services
- Enabled integrated Army-wide, Joint, Inter-Government, Inter-agency and Coalition interoperability using shareable data and shareable services.
- Reduced time from receipt of higher HQ OPORDs to transmission of own HQ OPORDs.
- Common intelligent seamless information management and dissemination to the tactical edge
- Improved support to data filtering, fusion and transformation (FFT)
- Improved situation awareness, assessments and understanding.
Provided the means to create, initialize, collaborate and issue plans and orders for execution vertically and horizontally across units IAW task organization:

7DIV → 4IBCT → 1-44IN BN & 2-44IN BN

Provided the means to visualize, filter, aggregate and share information with Current Force ABCS environment (JCR and CPOF) for execution monitoring at all live C2 locations.
Demonstrated maturity of advanced concepts and SW implementations at TRL 6 using realistic operational settings.

Observed users in charge using SW in an operational context.

Obtained performance measures using a realistic communications infrastructure to include JTRD(SRW) and Satellite.

Enabled opportunity of assessments of integration with other advanced technologies involved in Data-to-Decision applications:

- C2MINC/3G
- CERBERUS
- EBAL
- Biometrics
- TUGS
- UAS
C2 Managed Object Library (C2MOL) for Net-Centric Information and Knowledge Management and Dissemination including Data-to-Decision C2 Applications using Intelligent Agents and Service-Oriented Architectures

PRESENTED BY DR. ISRAEL MAYK
Israel.Mayk@us.army.mil
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
The C2MOL is a consolidation of contributed ideas from participating C2 applications developers.

Reduce duplication of effort by creating the synergism essential to develop a SW library of coherent, consistent and comprehensive SW Objects in Java and C++

Harmonized to comply with existing message, display, database standards and Application Program Interfaces (APIs) extensible to compatible interim non-standard specifications that are required to support new capabilities.
C2MOL Objectives

- High quality, open source message parsers
- Extensible ontology, translation framework
- Reusable in the context of Army, Joint and Coalition applications
• Software systems need to process common message formats to operate in a modern networked environment
  
  – Time, effort, and money are wasted when multiple contractors each duplicate the work of interfacing with these common formats
  
  – A well documented, open source implementation could quickly pay for itself
  
  – Reduce integration difficulties stemming from incompatible implementations
• There will always be new message formats
  – No one schema can meet the needs of all stakeholders
  – No one schema can anticipate all future requirements

• Many message formats represent common objects
  – Position/spot reports, graphical control features, imagery, etc
  – Parsers should share code and simplify translation of these common objects
C2MOL Goals

• Build and publish message parsers
  – Popular message formats that lack good software support
  – Popular programming languages
• Good documentation exists for most widely used message formats
  – Embed this documentation and make it easily available to developers
• Rigorous test suite
C2MOL Goals (cont’d)

• Define mappings between objects in two or more common message formats

• Develop extensible framework to translate parsed messages from one format to another leveraging the ontology mappings
  – Exploit transitive properties to minimize duplicated effort

• Follow an open governance model
  – Make it easy for 3rd parties to add support for additional message formats
• TITAN was an Army Technology Objective 4 Year program focused on information management and dissemination for command and control

• Leverage intelligent agent and web service technologies

• Focus on interoperability
  – Existing programs of record
  – Other research systems
  – Joint and coalition systems
• Ten contractors building agents and services
• Common set of object bindings
  – Message parsing and validation
  – Enforce business rules
  – Shared application objects
• Eliminated large amounts of duplicated effort
• Improved integration between components
• Need to interact with many different message formats and APIs
  – prdC2, JVMF, CoT, JC3IEDM, MIP, etc
• Developed several translation components
  – Difficulty sharing code
• Messages that were translated multiple times often lost data
  – Representation mismatches
    • IED vs. Boobytrap vs. IED explosion ‘event’ vs. Landmine…
  – Message provenance
    • Sender (person/time/system), free text comments
Conclusions

• C2MOL has the potential for significant cost savings by
  – eliminating large amounts of duplicated effort
    • Development costs
    • Testing and integration costs
  • C2MOL will enable R&D by enabling coexistence of existing, evolving and non-standard objects.
  • C2MOL was successfully implemented in the TITAN ATO and is scalable to many more C2 Standards and developers similar to other Open Source efforts