



# MDA Support for Military Medical Crisis Information Systems (MMCIS)

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# The NATO Military Medical Domain

- No common NATO Electronic Health Record
  - Nations' own responsibility
    - “Push” from national EHR to NATO
  - Periodic reports about medical status
    - EPI-NATO (delayed)
- 26 NATO member nations
  - 26 different Electronic Health Records (at least: one nation may have more than one system)
  - 26 different “platforms”?
  - 26 different “standards”?
  - Maturity of systems varies
- Multinational Integrated Medical Unit (MIMU)
  - many nations in one medical treatment facility





# Types of Medical Information Systems

- Clinical Information Systems
  - Electronic Health Records (EHR)
  - Telemedicine Systems
  - Specialized Clinical Information Systems
- Logistics Information Systems
  - Transport Units Management Systems
  - C2IS (location, stretcher capacity, etc...)
  - Other systems (Blood units, Medication etc.)
- Surveillance Systems
  - Medical Intelligence
  - Epidemiology
  - +++





# Information Sources

- Medical Intelligence Reports
- NATO Medical Reports (EPI-NATO)
  - Routine Patient Consultations (deployed)
  - Medical Evacuation of Casualties
- Other sources
  - World Health Organization reports
  - Special Reports
  - News agencies?





# Standardization Activities in NATO Military Medical Services

- Committee of the Chiefs of the Military Medical Services in NATO (COMEDS)
  - NATO MedCIS WG
    - STANAG on Medical Information Systems
    - electronic Field Medical Card
  - TMED Panel
    - STANAG 2517 on Teleconsultation (approved March 2005)
  - IER (Information Exchange Requirements)
- Allied Command Transformation (ACT)
  - NATO Consultation, Command and Control Agency (NC3A)
    - MEDICS (Medical Information and Coordination System)
- Multilateral Interoperability Program (MIP)
  - L2DIEM..+++
  - C2DIEM
  - <http://www.mip-site.org>





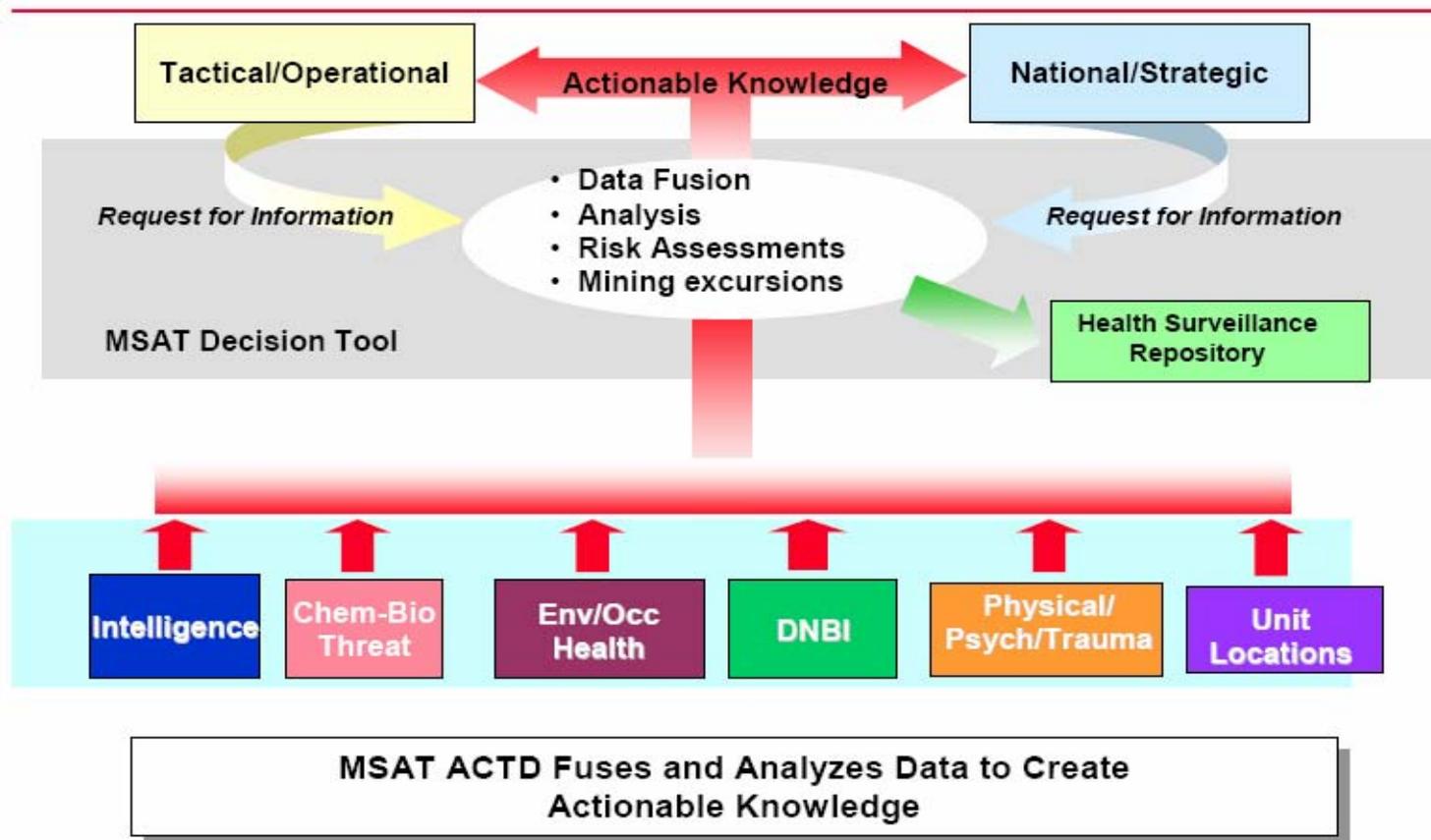
# Medical Crisis Management

- Three priorities given from COMEDS
  - Patient Tracking
  - Medical Situational Awareness
  - Medical Surveillance
- Allied Joint Medical Support Doctrine (AJP-4.10a)
  - Reliable, secure and effective communications and information systems are critical to operational success and the effective employment and control of CIS resources are command responsibilities. (§1155)
  - Medical Information and Coordination System (MEDICS) must have the capability to interface with the corresponding logistics and operational data management systems included in the Logistics Functional Area Service (LOGFAS) and TOPFAS.(§1156)
  - Automation technology embodies computer automation hardware and software capabilities, fundamental to medical support across the progressive spectrum of evacuation, treatment, record-keeping, surveillance, and the full range of staff functions, including information and data exchange through electronic mail linkages. This domain is critical for medical linkage into information management systems and medical interactions at theatre and subordinate command levels (§1159)





# Example: Medical Situational Awareness



From: *Medical Situational Awareness in Theater*  
<https://fhp.osd.mil/msat/index.jsp>





## Challenges to Optimal Multinational Cooperation (AJP-4.10a §2006)

- Differences in force capabilities and operating procedures impose limitations on a multinational force's ability to operate effectively. Among the risks that may need to be addressed are deficiencies in interoperability, such as differences in operating procedures, technical incompatibilities and lack of standardisation. In fact:
  - A. Procedural and tactical differences present the force with situations where different units from different services or nations may not be able to work effectively together.
  - B. Language barriers present communications difficulties that may result in differences in interpretation of the mission or assigned tasks; and may be intensified by limitations in the range of communications technologies available. In addition, the ability to communicate between patient and medical staff is a key element in medical care.
  - C. Lack of standardisation and interoperability can cause technical difficulties.
  - D. Inability to exchange information, intelligence, technical data, or communications can result from incompatibilities and national security concerns.
  - E. Medical cooperation can be degraded because of concerns about other Nations' capability and the lack of common medical standards of care.
  - F. Professional relationships vary between nations, for example nurses in some nations have greater independence, autonomy and status than in others.
  - G. National laws may prevent some health professionals (eg Nurse Anaesthetists) working in another nation's MTF.
  - H. Significant differences between medical command structures of participating nations.
  - I. Legal barriers to drug, medical materiel (eg defibrillators) and blood use, for example drugs may not be licensed for use by some participating nations.





# Summary: MMCIS Concerns

## ■ 'ilities

- Functionality
- Quality
- Reliability
- Scalability
- Flexibility
- Viability

## ■ INTEROPERABILITY

- NATO Operations
- Peace Keeping Operations
- Civilian – Military – Cooperation (CIMIC)





# Problem Statement

- How can MDA support and improve Military Medical Crisis Information Systems?
  - Information interoperability
    - Syntactic
    - Semantic
    - Process
  - Information quality
    - Timeliness
    - Accuracy
  - Modeling
    - Testing
    - Validation
    - Effectiveness





# Overall Goals

- MDA as standard architecture methodology for Military Medical Crisis Information Systems (in NATO)?
  - Standard models
  - Standard profile
- Interoperability conformance checking at Model-Level
- Ad-Hoc information exchange





# Why Model Driven Architecture?

- Interoperability is key
  - MDA is centered around interoperability
- MDA is flexible
  - Platform independent (PIM vs. PSM)
    - 26+ different information systems (26 NATO member nations)
  - Tool support
  - “Open Content”
  - Adaptable (changes can be made – proposals to OMG)
- MDA is industry-oriented
  - Not-for-profit industry consortium with a common goal
- UML/MOF/CWM
  - Well-established
  - Well-known
  - Available





## What features of MDA can be utilized?

- Design By Contract (DBC)
  - Object Constraint Language
- Action Semantics
- UML Profiling
- Model-level Testing and Validation
- Design Patterns
- Common Warehouse Meta-model (CWM)
- xUML





# Design By Contract (DBC)

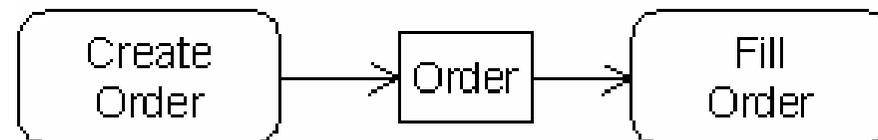
- UML Object Constraint Language (OCL)
  - Pre-conditions
  - Post-conditions
  - Invariants
- Interoperability
  - Syntactic
  - Semantic
- Quality Assurance
  - System testing





# Action Semantic

- For executable modeling and simulation
- For full code and test generation
- Not standardized!
- Example



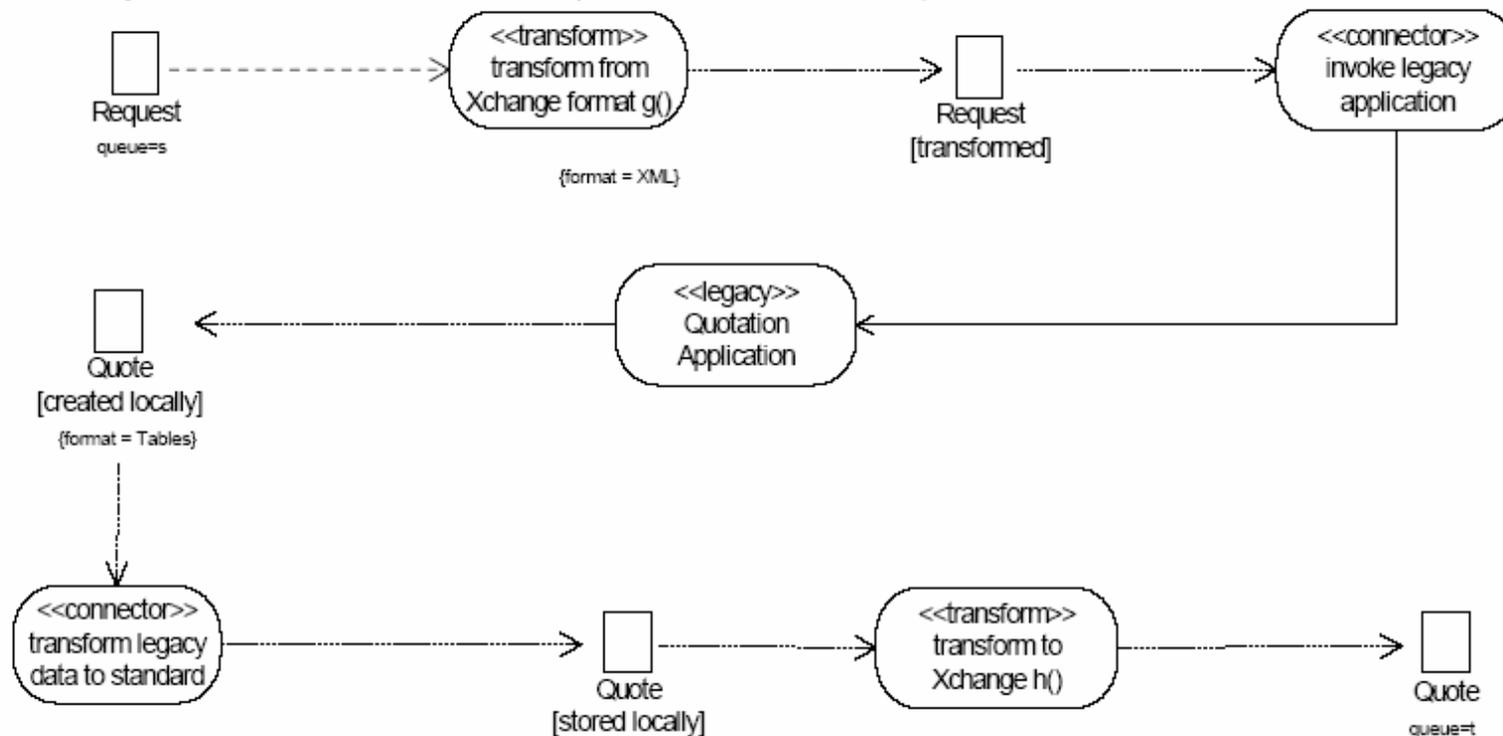
Journal of Object Technology:  
[http://www.jot.fm/issues/issue\\_2003\\_07/column3](http://www.jot.fm/issues/issue_2003_07/column3)





# UML Profiling

- “Stereotypes” and “Tagged Values”
  - HL7 RIM elements as Stereotypes?
- MOF extension?
- Example: EAI Profile (March 2004)





# Model-level Testing and Validation

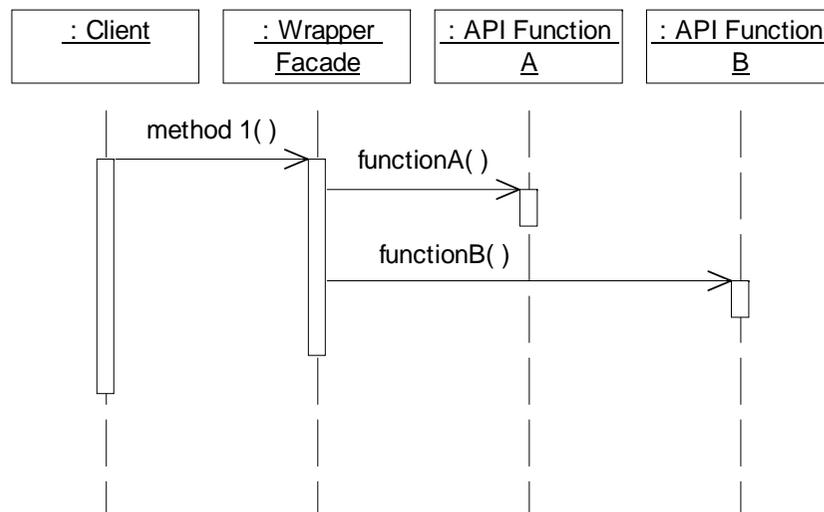
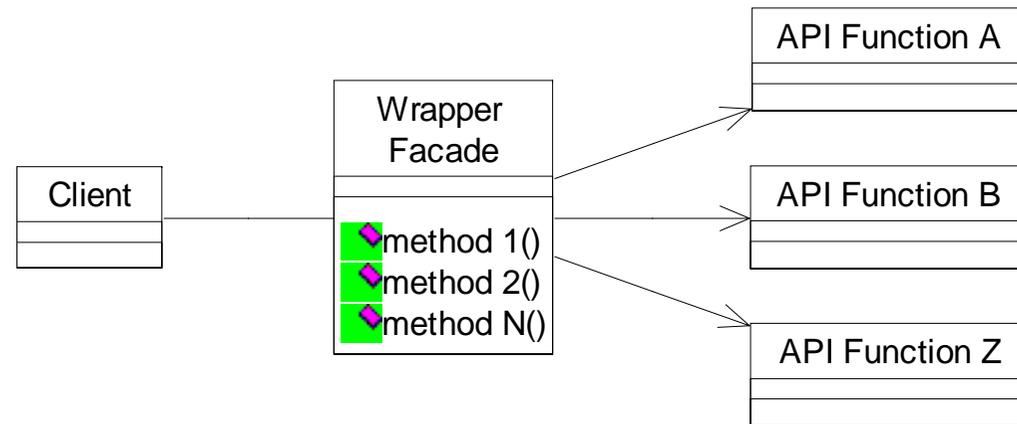
- Activity diagram
- Sequence / Interaction diagrams
- Collaboration diagrams
- UML 2.0 Testing Profile
  - suitable for MMCIS?





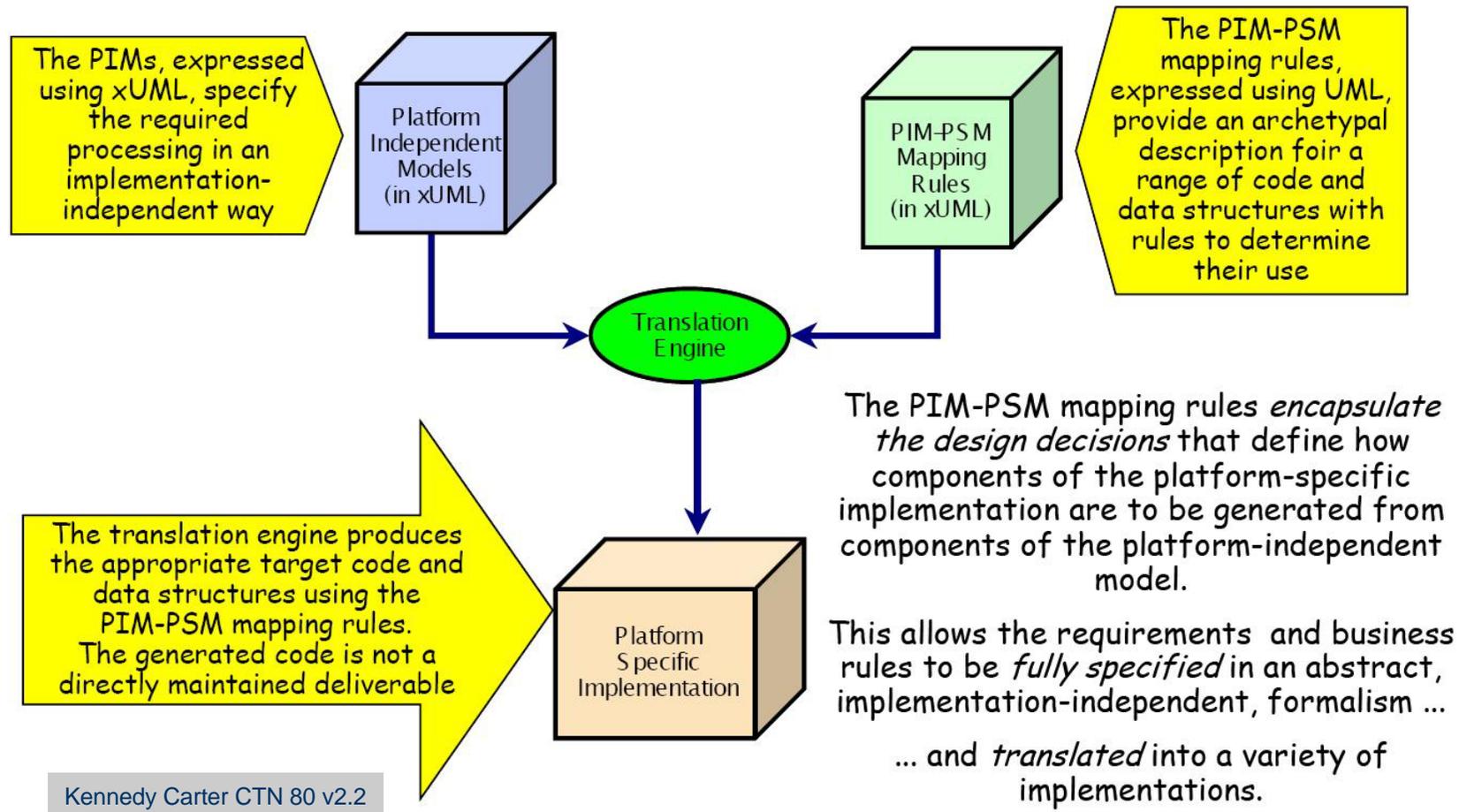
# Design Patterns

- Architectural Styles supported by tools
- Example: Wrapper Facade





# Executable UML (xUML)





# How can this be achieved?

## ■ Projects

- European projects
  - LinkCare (eTEN)
- National projects
  - Military Medical Projects
- PhD

## ■ Standardization

- NATO MedCIS
- Multilateral Interoperability Program (MIP)
- National representatives in standardization bodies





# (preliminary) Publication Plan

- “Problems with today’s Multinational medical situational awareness systems – an ICT perspective”
- “MDA as a tool to increase Levels of Interoperability in MMCIS”
- “UML profile for MMCIS”
- “Model-level testing of interoperability between MMCISs”
- “Experience from using MDA in MMCIS development – executable UML”
- “Ad hoc MMCIS – vision or reality”

