Common Object Interoperability Layer

Architecture Based Approach to Semantic Interoperability and Information Protection

The Common Object Interoperability Layer (COIL) is a policy or rules based data service that delivers the core capabilities described as part of the Object Management Group's (OMG) Shared Operational Picture Exchange Services (SOPES) Request for Proposal (RFP) standard scheduled for adoption in September 2010. COIL generalizes and implements these concepts in a manner that enables its application across commercial, public, military and security applications. COIL provides a programmable, distributable data service which enforces architectural models which define data and information patterns (semantics) described in UML Class diagrams. One example of such semantics are XML information exchange messages (e.g., CAP, NIEM, EDXL). COIL provides the following capabilities in relation to these semantics:

- To aggregate structured data to form community defined semantics;

- To de-aggregate data sets into structured sub-elements;

- To integrate or marshal data elements into community defined data patterns (semantics);

- To filter data based on domain values (e.g., category codes, tags, labels, ranges, other);

- To guard data based on information patterns, simple or complex, including multiple domain values and filters;

- To manage the release of information (semantics) based on their association to

  o Information exchange Requirements (IER),

  o Information Exchange Agreements (IEA),

  o Service Level Agreements (SLA), or

  o Communities of Interest (CoI);

- To marshal data to service an application program interface (API) that connects to user selected data store technologies;

- To marshal data to service an application program interface (API) that channels data to user selected distribution technologies and protocols;

- To trigger the aggregation and release of information, with or without user intervention, providing event triggered global update of information to each participant to an IER, IEA, SLA and/or CoI.

The Evolution of the Common Object Interface Layer

The Common Object Interoperability Layer (COIL) represents a fifteen year effort (Figure 1) to address interoperability issues first identified during ASMG participation on the Army Tactical Command and Control Information System (ATCCIS) Study, and later the Multilateral Interoperability Programme. Many of these interoperability issues persist to this day. COIL demonstrates that an open-standards policy based service can be implemented to enable flexible, agile and secure information sharing capability within and between agencies.

COIL was designed to enable selective sharing of information with individuals or partner agencies during coalition and multi-agency operations; while maintaining the quality and semantic integrity specified for the information. The concepts and early prototypes were developed to demonstrate the viability of ASMG's proposed interoperability and information assurance architecture solutions for the Multilateral Interoperability Programme (MIP), Army Tactical Command and Control System (ATCCIS) trials; UK MOD BOWMAN Programme and DND FELEX and EISE projects. COIL is specifically designed to address adaptability and flexibility shortfalls of current middleware implementations when applied to the dynamics of real-world operational environments. Being policy based and model driven, COIL dramatically reduces the requirement for IM/IT programmers to support the operational environment, allowing program staff to apply policies as required.
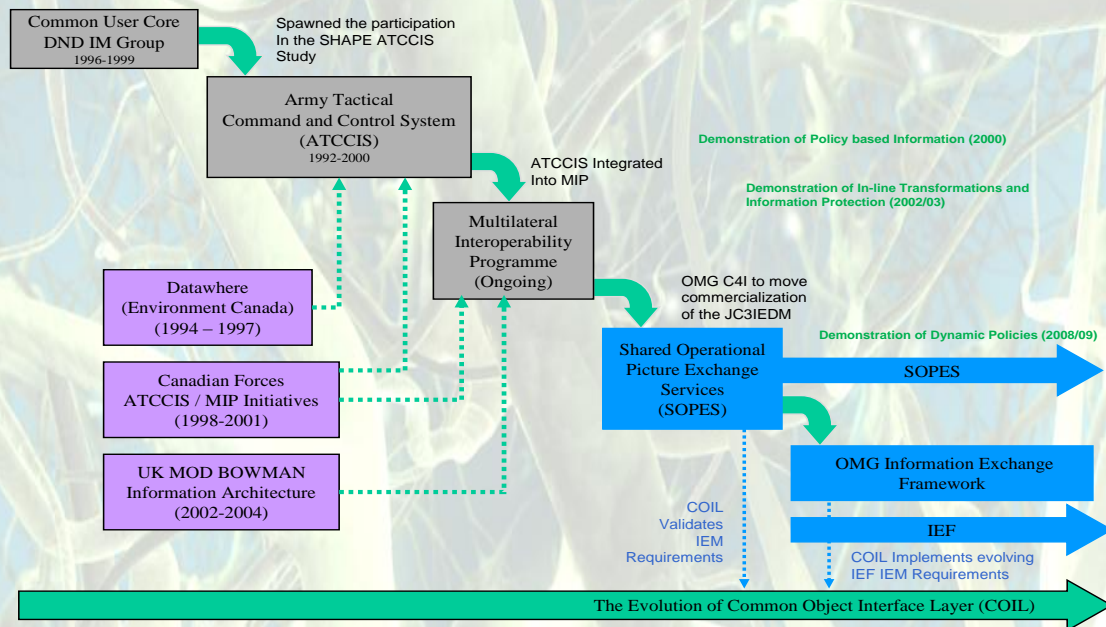
Figure 1 – Evolution of COIL

COIL Capability

ASMG's COIL toolkit (Figure 2) provides for the use of a model (UML class Diagrams) within a Model Driven Architecture (MDA) process to specify information sharing policies for:

- **Contracts**, models of agreements to share information (Semantic) amongst two or more community members.

- **Semantics**, models of data patterns that govern the aggregation of data elements into meaningful information elements as defined by two or more community members.

- **Filters**, which constrain the inclusion or exclusion of data elements during the preparation of a semantic (semantically complete information element, data set or message).

- **Guards**, which restrict (block) the release of data sets conforming to the specified data patterns, excluding its release on all the contracts.

- **Guard Releases,** which explicitly release instances of a data set conforming to a Guard on a specific contract;.

- **Wrappers**, models elements which explicitly tie the data elements to tables in an underlying data store (or database).

- **Transformations,** which alter the structure of data elements to conform to data-store or community requirements;

These policies govern the operation of the Common Operational Interoperability Layer Runtime Environment. The Tool environment's model driven process ties the runtime policies back to the legislative, policy and regulatory situation requirements for the community. This provides significant improvements in the flexibility, agility and sustainability in the engineering of Information Systems and Information Assurance solutions.

The COIL runtime is a software service that ingests the specified policies and enforces the policies in a transparent manner and auditable by community stakeholders; differing from many software solutions that encode the rules, making difficult to assess their adherence (validation, verification and certification) to requirements and the impact (cost, time resources) of legislative, policy and regulatory changes. COIL policy specifications are captured in architecture documentation, retaining institutional knowledge, directly reflected in the operational requirement, and are directly auditable by stakeholders.

The COIL runtime also provides an interface to a policy management service, through which an organization or community can dynamically adapt specified aspects of the policies to reflect dynamics of the real-world. Provision of, and access to this interface is controlled through user, organization or community security protocols. The interface can be configured to provide central control of all instances of COIL or locally managed; again under organization or community specification.

COIL was architected to address the challenges of organizations needing to participate and share information in multi-agency operations in dynamic real-world environments (emergency, crisis, major events and military operations), or loosely-coupled business partnerships. **The policy development process and toolkit elements record the details of an organizations' information environment in a manner consistent with new regulatory requirements and the needs of decision makers. This vital Institutional/Corporate knowledge is frequently ethereal and difficult to uncover.**

The greatest challenge to most interoperability efforts and is the stakeholders' ability to understand and resolve the practical aspects of operational need and the restrictions of legislation and regulation. COIL tackles this challenge directly, by:

1. Explicit specification of policies and traceability from legislation to operation.
2. Directly supporting the documentation of business/operational policies (rules) governing the sharing of information;
3. Automating transformation of architecture models (describing business rules in human readable form) to software-executable and software-enforceable rules.
4. Aligning information exchange with operational procedures, organizations and operational nodes.
5. Using commercial off the shelf tools that integrate with architecture repositories to retain institutional knowledge/memory, and provide decision and analytical tools related to enablement of business and operational policies and rules.
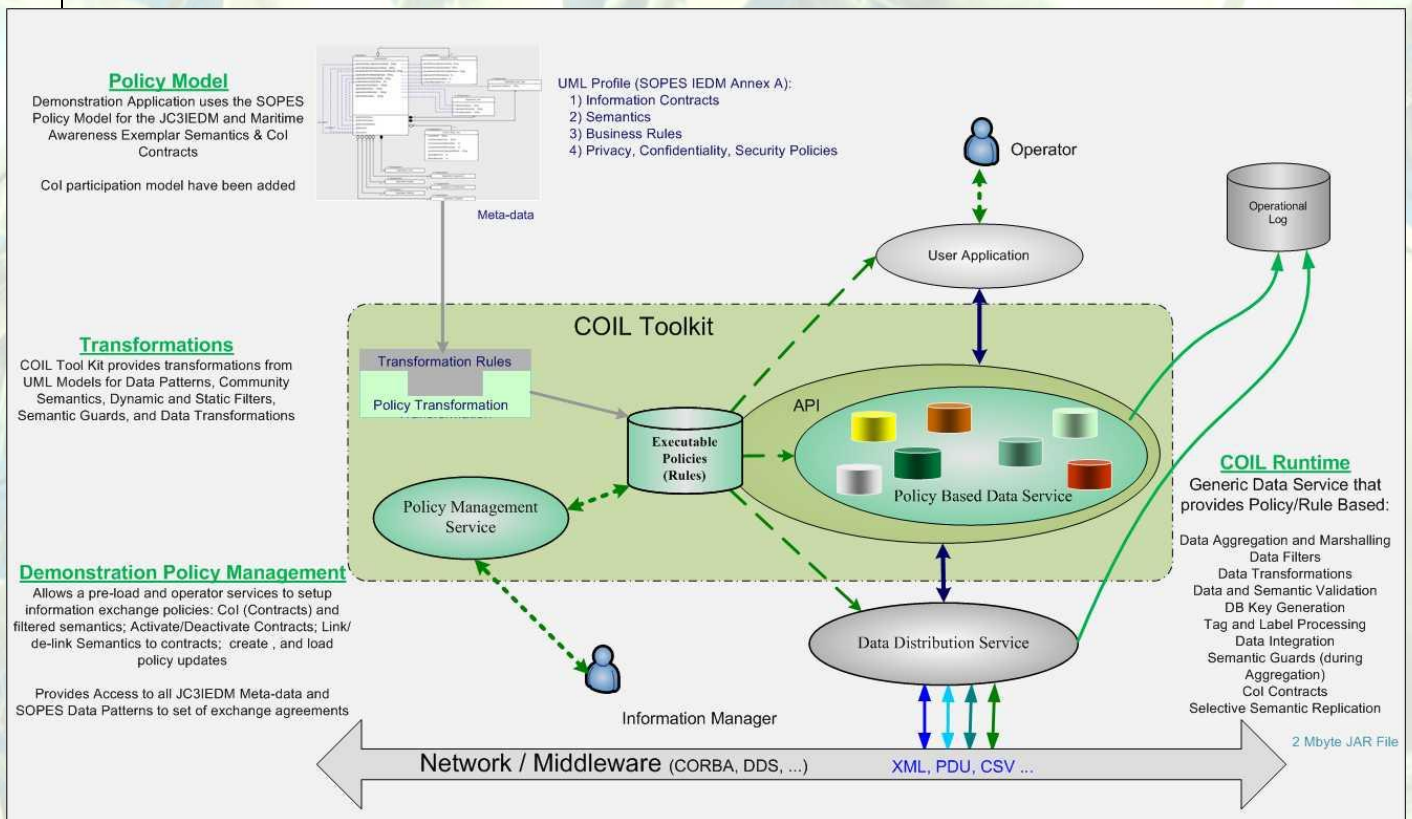
Operational Requirement Overview

Increasingly, organizations are seeking to collaborate in the development information services that deliver interoperability collaboration and outcomes. This requires organizations to expose information holdings to selected partners, within coalition and multi-agency operations, while providing adequate protections for sensitive, private, confidential or legally significant information. Information systems, applications and services are expected to rapidly adapt to changes in operational environment. The operational need for information is increasingly subject to change based on intent, context (e.g., stage of the operation), severity of the event, multiplicity of related events, broadening of events focus, location changes, participation, adjustments of partners or participating agencies roles and responsibilities, and threats or risks escalation.

COIL provides organizations with the ability to adapt information exchange policies to the situation, while assuring that information security, protection and privacy policies continue to be enforced. To provide this capability COIL can segregate and expose the operational policies, allowing designated operators (as authorized by the community) to modify selected elements of the contract – while providing full retention and audit-ability of the policy decisions taken. Conversely, traditional development practices coupled with the migration to commercial-off-the-shelf (COTS) systems and out-sourced development have resulted in a steady loss of institutional or corporate knowledge resulting in:

1. Rigid and brittle and systems interfaces that are difficult and expensive to change;
2. Repetitive reverse engineering and re-engineering efforts to extricate corporate information and business rules from application environments;
3. Increasing percentages of IM/IT budgets going to maintenance and life-cycle costs;
4. The proliferation of personal applications to address perceived shortfall(s) system capability;
5. Inability to adapt to changing business requirements;
6. Inability to process sensitive information (classified or private) in a manner that satisfies regulators; and
7. Inability to address increasing regulatory, auditing and accreditation requirements.

The Benefits of the COIL Development Method

The COIL Policy Development Method (PDM) provides stakeholders with a systematic approach to specifying information exchange requirements, delivering information interoperability and improving information quality for decision makers. The approach aligns to enterprise and system architecture practices, and applied MDA transforms to convert policy models into an executable form that are enforced at runtime.

The methods align to widely used architectural frameworks (Figures 3), to provide:

- o Improved portability,
- o Improved flexibility and agility,
- o Improved reusability,
- o Improved Audit-ability,
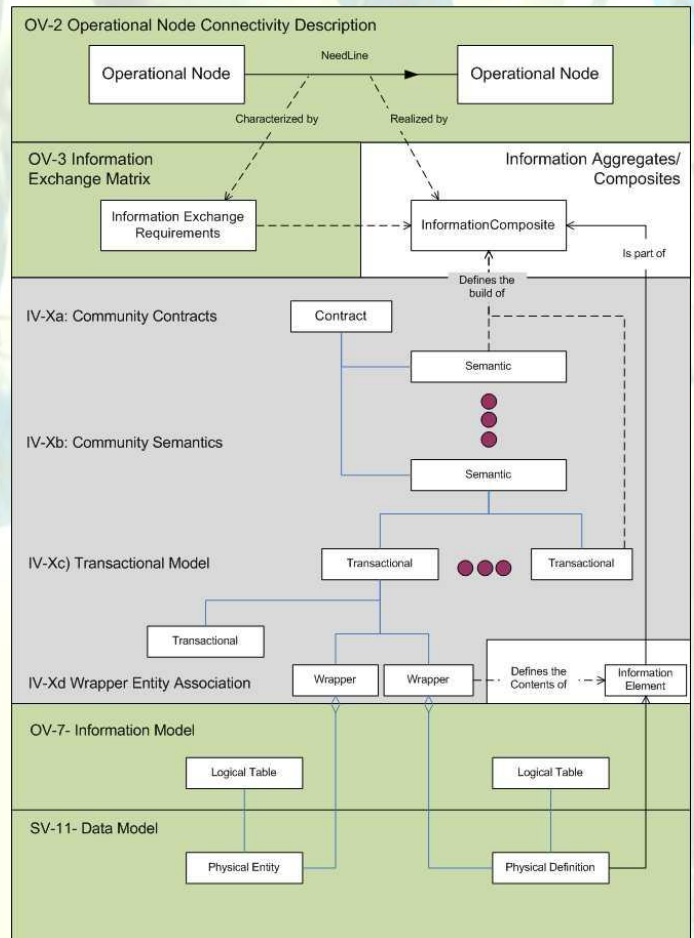- o Improved documentation,

Figure 3 – Aligned to DODAF/MODAF/NAF

- o Improved productivity,
- o Reduced development time; and
- o Greater retention of corporate knowledge;

COIL Tool Kit Features

- The COIL policy Development Methods use MDA to:
  - o Promote rapid discovery, assessment and deployment of information exchange capabilities ;
  - o Promote rapid deployment of community policies within the framework of a life-cycle methodology (Figure 4);
  - o Promote the application of communities of interest within the governance of an exchange contract ;
  - o Enable the application of inline transformations, guards and filters during the data aggregation process.
  - o Enable direct traceability to legislation, policy and operating procedures support governance regimes and regulatory reporting.
- Domain filters and semantic guards enable enhanced levels of information assurance and quality of service (QoS);
- Integrated semantic guards and domain filters enhance security, caveat separation and privacy.
- The application of a standard UML profile for information exchange within an Architecture Framework:
  - o Promotes a shared understanding of information sharing requirements for stakeholders, users and developers.
  - o Promotes consistency in the specification of community semantics.
  - o Promotes the ability to validate semantic and data consistency during operations.

Figure 4 – Notional Policy Life-cycle

- Semantic and data validation on inbound and outbound information promotes improved community wide data quality;
- Exposure of information assurance policies promotes increase trust by users and stakeholders.
- The API facilitates the integration with a variety of data distribution and middleware services (e.g., DDS, SOA, Web Services, etc,) integration;
- The API facilitates integration with client applications and middleware solutions.
- The API facilitates the simultaneous use of XML, Protocol Data Units (PDU), data objects and messaging interfaces.
- Open Architecture promotes portability across heterogeneous operating systems and data environments.
- Policy based data services enables:
  - o Dynamic adaptation of operational characteristic to meet changing operational requirements
  - o Adaptive community of interest (CoI) stand-up and tear-down; and
  - o Event Driven Global Update for community information;
  - o Evolutionary development of interoperability capability;
- Event driven global update for CoIs promotes improved situational awareness, collaboration and decision support.
- Policy based services provide the flexibility and agility needed to adapt information services to dynamic real world events and operational context;
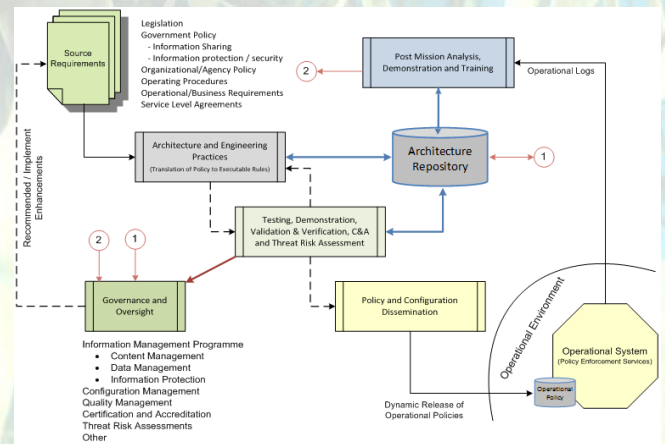
COIL is adaptable to many information sharing technologies and operational domains, including: C4ISR, Crisis Response and Management Organizations, Police Operations; Fire Department Operations; Government Operations; Distributed or Loosely-coupled Business Operations, Health Services (Electric Health Records); Insurance and Financial Services; and Other.

REFERENCES AND LINKS

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