**14th ICCRTS**
**C2 and Agility**


# Applying Business Architecture Methodologies and Best Practices to Deliver Coalition Agility

**CE-009**

**Topics:**
**C2 Concepts, Theory and Policy**
**Collective Endeavours**
**C2 Approaches and Organisation**

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# Abstract

Coalition engagements and collective endeavours can be considered as a value network in which each participant is offering complementary business services. The business architecture of each of these services oriented enterprises (SOE) can be represented through five main architectural domains: business value, structure, behaviour, policy (including service level agreements) and performance. These domains can be specified using different models and modelling techniques by strategy and design, as well as operational communities of interest (COI).

The current trend towards service orientation in all industries necessitates a formal characterization of the overall business architecture model, which can then be used for the semi-automated transformation of business designs into the supporting IT solution. Military commanders demand no less: as a coalition forms and evolves, so should the underpinning command and control (C2) systems which enable them to deliver the effects needed as the mission unfolds.

This paper defines the core business domain models and their ontologies. Furthermore, state-of-the-art technologies for model-driven business transformation (MDBT) and business-driven system/service development (BDSD) are identified and described. Value network analysis (VNA) can serve as an example.

The generic business architecture model is instantiated and validated for a typical military scenario involving civil-military collaboration. Importantly, the interdependencies between value proposition and capabilities derived through collaboration among various business components and resources are demonstrated.

Finally, the paper reflects on the expected capability gains by adopting and applying such architecture.

# Problem Space

Agility in modern coalition engagements relies on the capability to manage *knowledge*, an intangible asset which involves delivering the right information to the right individuals (information superiority), but goes further in that human competence, the structure and composition of teams, enablers of the formation of trusting relationships between people and communities, and the capacity to deliver mutually beneficial collaboration and information sharing must all be managed. Knowledge management in a coalition operation truly encompasses all lines of development. It requires the synergetic alignment of information systems, business-process development, the skills and competencies of individuals, the selection and training of teams, and management of the formal and informal organisational structures which support groups and communities of interest as they continuously develop in a rapidly changing military-political scenario.

Military coalitions, as any other business, are moving towards an era of dynamic, rapidly adapting value networks, i.e. towards loosely coupled, yet complex configurations of organisations, industries, businesses and organisational units that engage in mutually beneficial relationships, able to adapt to take advantage of opportunities or to mitigate threats.

**„Value Networks are sets of roles, interactions and relationships generating economic, social or environmental value.**

**Any purposeful organization can be understood as a value network“**

**- Verna Allee**
***The Future of Knowledge, 2003***

Figure 1: Definition of a Value Network (/1/[1])

Current military doctrine makes it clear that the human – not the technology – must be the focus for network-centric operations (NCO) and that the technology is only an enabler when well matched to the business. The analysis and management of value networks emphasises the importance of human actors and addresses the human factors, for example:

- processes are not the active agents of innovation and agility in organisations, it is people who unlock the potential of systems and organisations which constitute military capabilities
- organisations must master how intangibles and relationships create value and achieve effects
- the human community in a value network should not be administered, only the right value sharing governance will motivate and enable the community to adapt and evolve to take advantage of opportunities as they arise.

Mutually beneficial collaboration undertaken to meet a coalition's mission can be considered service consumption, with each unit in the coalition consuming the services of each other. This insight defines a coalition as both a value network (see definition in Figure 1) and as a service-oriented enterprise (SOE).

While the concept of service offerings and the consumption of business services is not new, new challenges resulting from globalization and global sourcing of business functions has led to the need to orchestrate them in a flexible, agile manner. Business architecture (BA, /2/) is seen as the science and methodology of delivering coherent, dynamic and complete business designs (/3/). Using the same concepts and rigorous methodologies promises to transform the delivery of Defence capabilities and, in particular, to deliver agile coalitions able to respond to threats and evolve quickly and efficiently to opportunities in the same way that modern businesses are able to do.

For coalition SOEs there are five major domains to consider:

- organisation value
- coalition structure
- behaviour
- policy and
- performance

[1] Reference to source and further information

The effects-based approach to operations (EBAO, /4/) as shown in Figure 2 describes military actions as part of a broader approach to dealing with problems and threats faced by modern war-fighters. The diagram shows the range of domains (political, military, economic and civil) that effects can be delivered in, and how each activity potentially interacts creating complex results. In the planning phase, actions must be deduced accounting for the complex set of interactions possible.

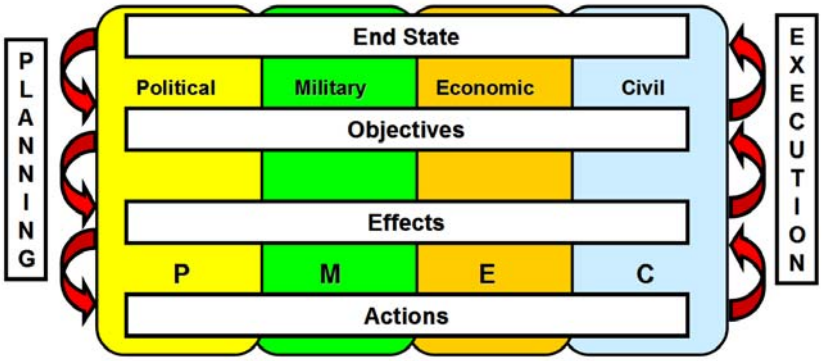


Figure 2: Effects-Based Approach to Operations

Given the complex needs of a coalition operating in this environment, we present a core business architecture for an SOE instantiated for a mission loosely based on an ISAF example. To demonstrate agility in the 'business architecture' of this coalition operation, we will describe the methods and emerging tooling used to evolve the mission objectives and integrate a new business service (task) and resources (military units) into the scenario.

# Models for Business Architecture

Business architectures can be expressed and described as models and various metadata models. The unified modelling language (UML, /5/) is particularly suited to described such models because it helps bridge between the IT-agnostic business architecture and the complementary service IT implementation. In particular:

- a business value model describes how an organisation participates within the value network, how it produces value and what constitutes the basis for strategic decisions regarding its offering portfolio and partner relationships.
- a business structure model describes how the enterprise organizes its functions. The analysis of this model helps decision making related to sourcing business activity, investments and procurements.
- a business behaviour model describes how an enterprise defines its internal operations and the behaviour of partners exposed within its ecosystem. Business services represent the externalized view of the operations of a service-oriented enterprise. The notion of policy is critical to specifying directions and guidelines (doctrine) for all aspects of the business architecture.
- a business performance model specifies the elements needed for evaluating the performance of the organisation, according to key performance indicators (KPIs) as well as specific business operations.

Information spans the five models in the core business architecture and the related information models provide the common business vocabulary used in service agreements, business rules and performance metrics and which ensures that the models are coherent. Within this framework, the JC3IEDM can be considered a subset of the coalition information model, but it is important to

note that business information embedded in the JC3IEDM solely defines the semantic meaning and does not address IT implementation specifics such as data types, lengths or multiplicities. As a result, the BA metadata models typically lack descriptive metadata (format, data type, value range, units of measure) and infrastructure metadata (e.g. resources needed to manage and control data, long-term preservation metadata) and concentrate on the following:

- provenance metadata
- who produced the data
- how it was produced
- when it was produced
- how can it be trusted
- relevance metadata
- who uses it
- what value does it have
- governance metadata
- who approves and reviews
- who has stewardship
- who can and may access it (confidentiality, licensing, rights)

Relationships are the core of any coalition network; they can be captured through the use of ontologies and expressed using the open standard based web ontology language (OWL, /6/). For example, the categories of relationships in a business architecture include the following:

| **Relationship** | **Category** |
|---|---|
| Structure | subassembly, element, component, container, attachment, hasPart, hasComponent |
| Material | madeOf, fabricatedFrom |
| Behaviour/Cause | triggers, respondsToEvent, generatesEvent, causes, indicates |
| Function | starts, stops, halts, resumes, ingests, controls, notifies |
| Ordering | successor, predecessor, next, previous |
| Spatial | above, below, between, adjacent, enclosedBy, oppositeTo, over, under, near |
| Designational | synonym, symbol, reference |
| Compliance | satisfies, fulfills, requires, complies, endorses |
| Governance | performs, performedBy, manages, managedBy, approves, approvedBy, owns, ownedBy |
| Social | ancestorOf, descendentOf, motherOf, fatherOf, childOf, friendOf, employerOf, contractorOf |

**Table 1: Relationship Categories in Ontologies**

While a business architecture of an SOE specified using open standards and tools is independent of the IT implementation (e.g. using web services and a service-oriented architecture (SOA)), such state-of-the-art IT technologies could enable the semi-automated transformation of complex coalition information services requirements into IT solutions (described in more detail in the chapter ‘Model-Driven Business Transformation’). The advantages are not just in speed of implementation, but in the agility provided to commanders to readily incorporate new coalition units into the operation as the mission unfolds or the coalition force structure changes.

# Business Operations of ISAF Mission

The long-term goal of the International Security Assistance Force (ISAF, /7/) in Afghanistan is to build an autonomous nation based on the three pillars of society: effective legislation, jurisdiction and executive power. Figure 3 shows the distribution of coalition of forces in the different regions of Afghanistan.

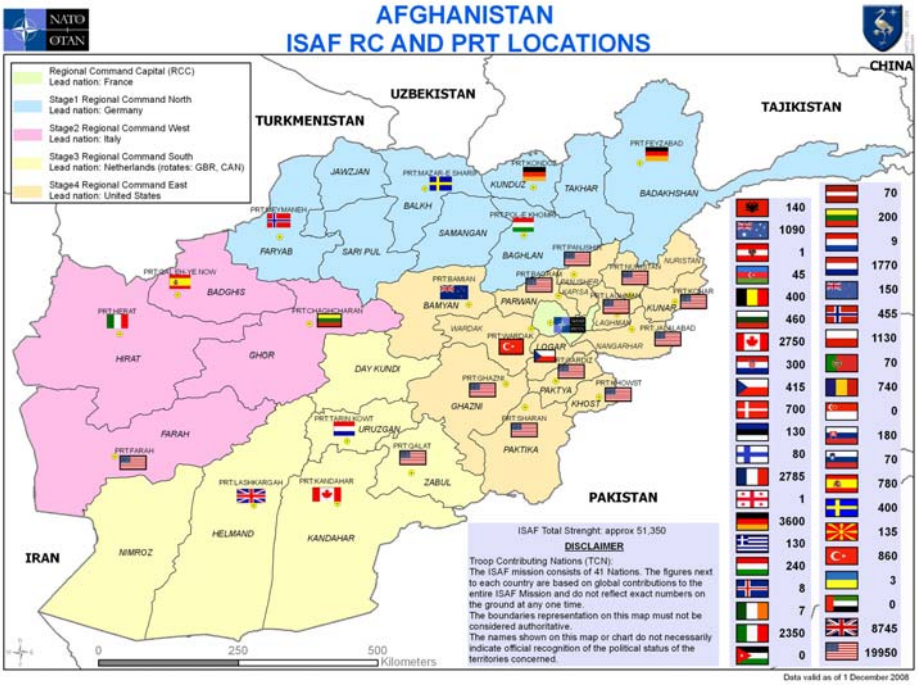


Figure 3: ISAF Coalition Topology

To help demonstrate the feasibility of the business architecture approach for coalition engagements, we have chosen the ISAF scenario and for illustration purposes, the introduction of a new mission: the implementation of a counter narcotics task and military units to execute the additional function.

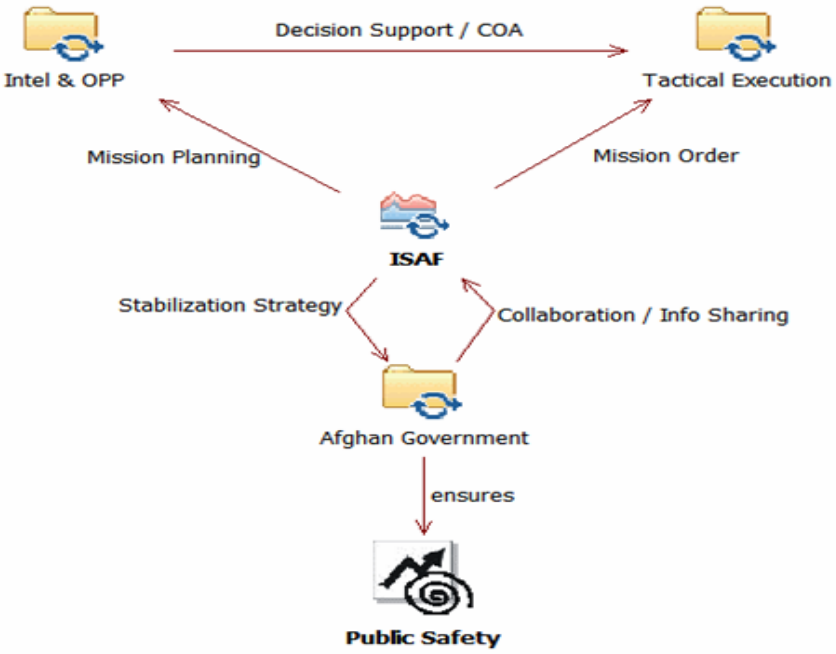


Figure 4: ISAF Mission – Nation Building[2]

[2] OPP = Operation Planning Process

In this scenario, we assume that the ISAF headquarter coordinates the flow of material, information and actions across various international and Afghan governmental and non-governmental organisations rather than acting as an autonomous organisation itself. To demonstrate the model-driven approach, we present details of the core business architecture models of an SOE including diagrams annotated with this ISAF-based example.

## Business Value Model

Whereas in most industries value is mostly measured in terms of revenue or profit, governmental and military value networks serve different purposes. Figure 5 shows the elements of value relevant to the core BA.

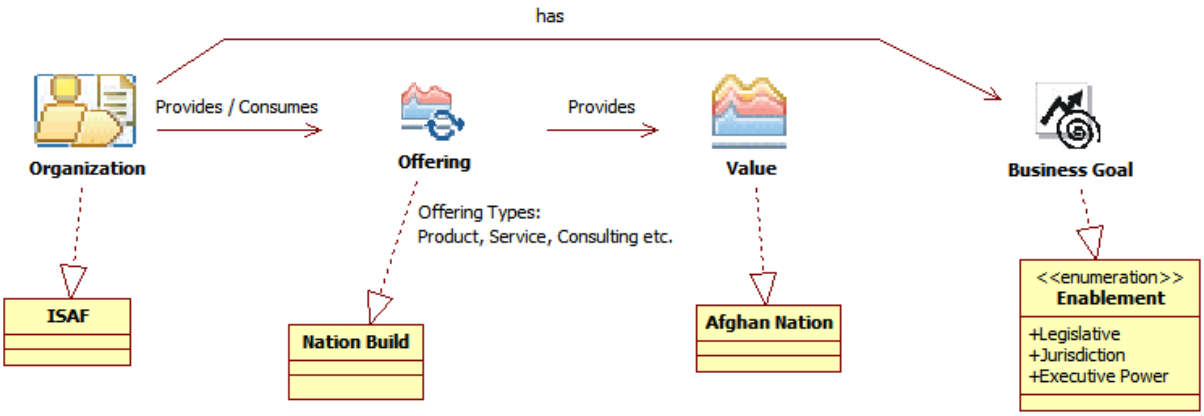


Figure 5: Business Value Model

In Figure 5, 'organisation' can be any unit in society, such as a hospital, company, municipality or federal agency. It provides value through its offerings which include products, services, intellectual property and brand-related value. In the ISAF scenario, the business goal to be achieved is the establishment of a stable society and requires business outcomes such as effective, autonomous legislation, jurisdiction and executive power of the Afghan government. To demonstrate how the model-driven approach provides commanders with flexibility and agility, a new nation-building offering, the business service 'disable drug production', will be integrated into the value network at a later stage (see chapter Scenario: Introduction of new Counter Narcotics Task ).

## Business Structure Model

Illustrated in Figure 6, the architecture of complex enterprises, which offer business services to multiple internal and external consumers, are best described in the form of business components, i.e. logical groupings of tasks executed within the enterprise.

Figure 6 describes a strategic capability that can be derived through collaboration amongst various business components. The model can be canonically extended to support a variety of analyses, including for example, creating an understanding of the work distribution within the enterprise, visualization of the IT application coverage of business components, or the generation of a business component heat map showing surfeits and shortfalls in capability across the enterprise. The IBM Component Business Model (CBM) comprises tools and method guidance to create a roadmap for business transformation within the value network (/8/).

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ISAF = International Security Assistance Force
COA = Course of Action

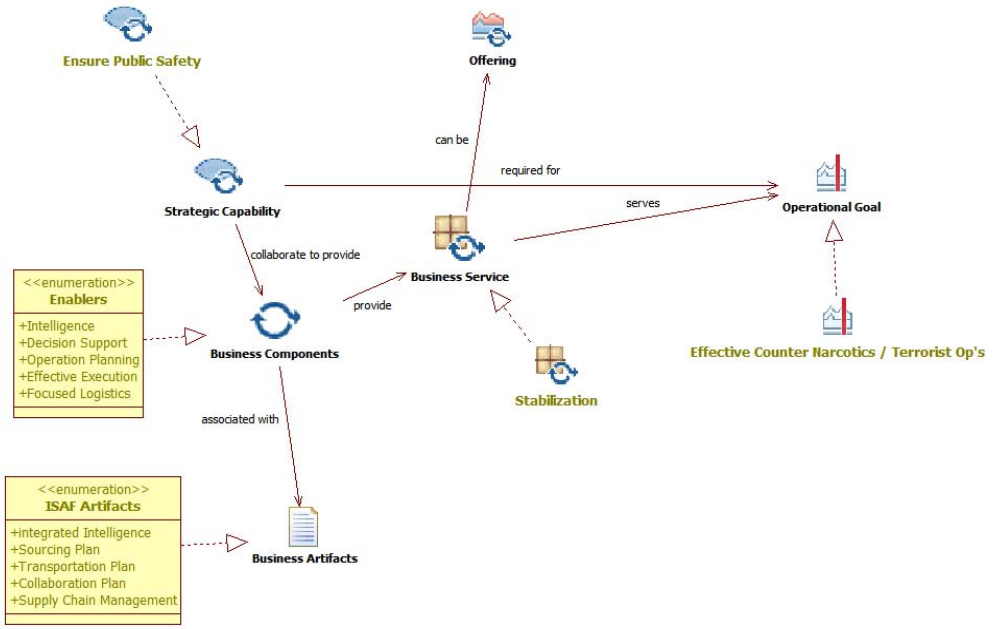


Figure 6: Business Structure Model

A business artefact is an entity whose purpose is to track progress toward a specific operational goal within the business and which deals with the purpose, the service requests and the resource administration requests of any business component.

The notion of 'coalition componentization' promotes the concept that work performed within a business component can be offered as a business service, enabling a tight relationship between components and business services which work together to achieve the operational goal. A strategic capability is the offering of a core business service by only one or very few components in the governed value network.

## Business Behaviour Model

In the context of a service-oriented coalition value network, business services provide the foundation for the business behaviour model, which describes business operations as viewed from within and outside of the enterprise.

A business service – not a web service – has two aspects: its business specification and its service operation model (see Figure 7). The specification of a business service describes, from a business perspective, what the service provides, how it is consumed, how its performance is measured and how it is managed. The service agreement represents the realization of a business specification that is acceptable to both service provider and consumer. The service operation model (described in Figure 8) shows how a service function within an offered service can be realized. The model allows the service provider to communicate the description of service operations to the service implementer as well as the service consumer.

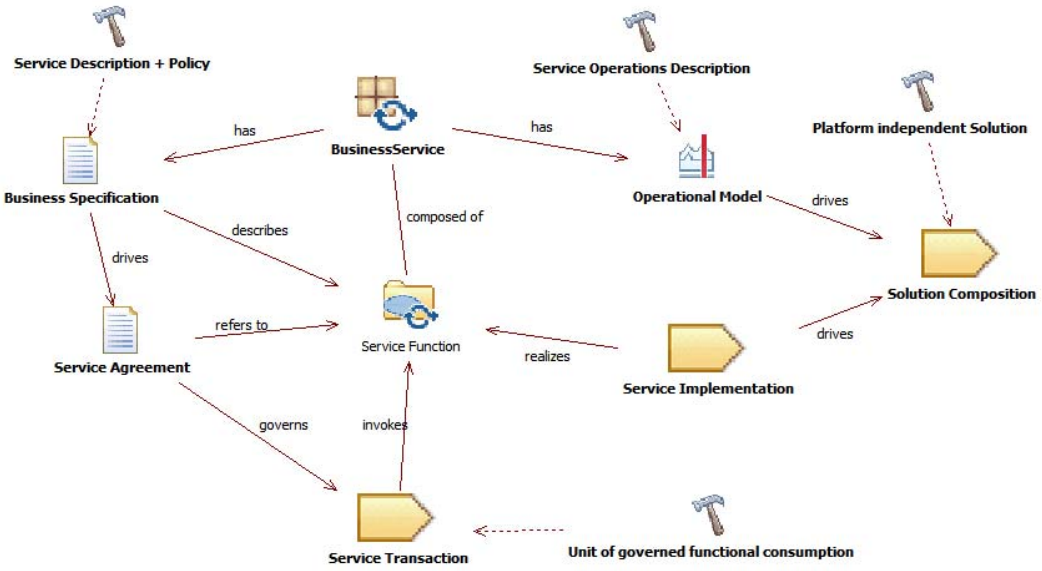


Figure 7: Business Service Model

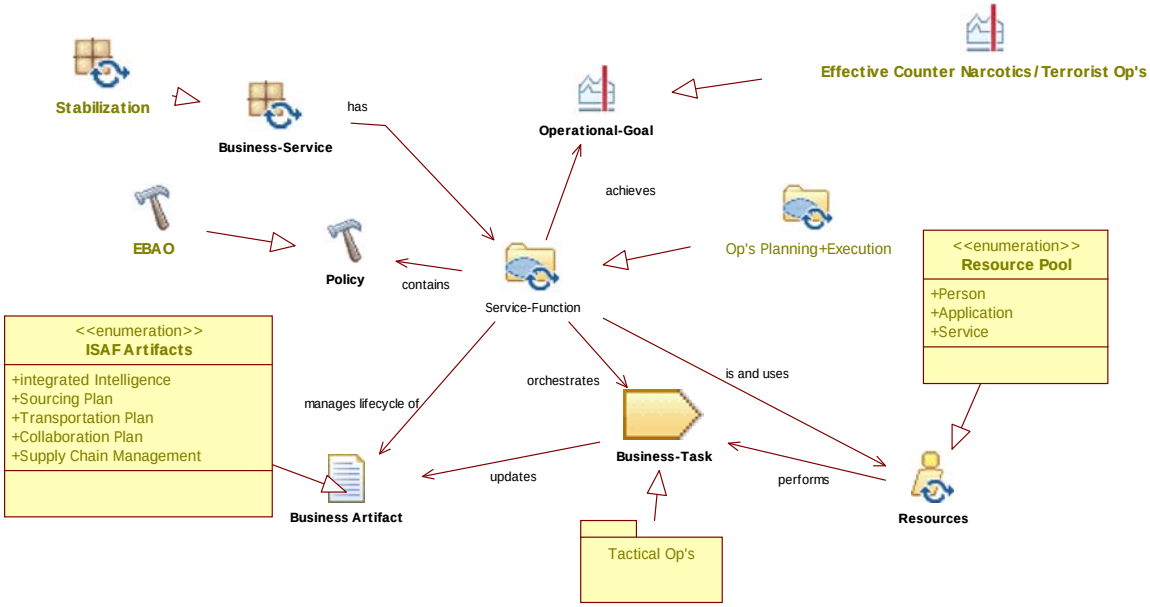


Figure 8: Service Operation Model

Based on a top-level business artefact, which for a coalition could be the mission's mandate, any particular operation can be created as a graph of business tasks and as a set of repositories through which the artefact flows during its life-cycle. Business tasks consume resources to achieve the operational goals sought, and resources called 'performance managers' are associated to ensure that commitments are adequately satisfied. Service functions are the externally visible part of the operation of each component. Whenever a service function is complex, as in the ISAF operation planning and execution, the service operation model can be built up from components using two mechanisms: business service choreography and process orchestration. The first describes coalition behaviour in the SOE as a sequence of commitments between one or more service providers and consumers throughout the lifecycle of a service transaction. In contrast, process orchestration describes behaviour as a sequence of business tasks performed by people, applications and services from partners. Figure 9 provides a high-level overview of the service choreography of our example ISAF mission.

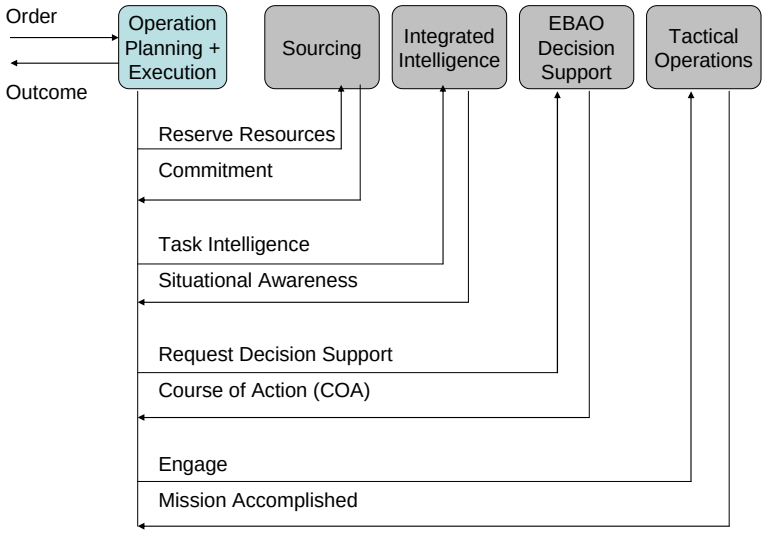


Figure 9: ISAF Service Choreography

Creating the model begins with identifying the logic of the business flow at the highest level and as a sequence of business tasks. The model is then iteratively refined down to a level where each business task is identical to service component or composite business service; then no further decomposition is required.

## Business Performance Model

Coalitions define performance goals to meet their mission and to guide execution of the plan. Key performance indicators (KPIs) can be used to define and measure progress toward goals and to represent quantifiable measurable objectives, agreed to beforehand, that reflect the critical success factors of an engagement. As shown in Figure 10, the model elements useful in performance analysis include business goals, operational goals, KPIs and other metrics, business service, service functions and the business artefacts. The turn-around time (TAT) serves purely as an example of a measurable objective, other significant metrics might include: number of casualties, material consumption, environmental impact and proxies for civil perception.

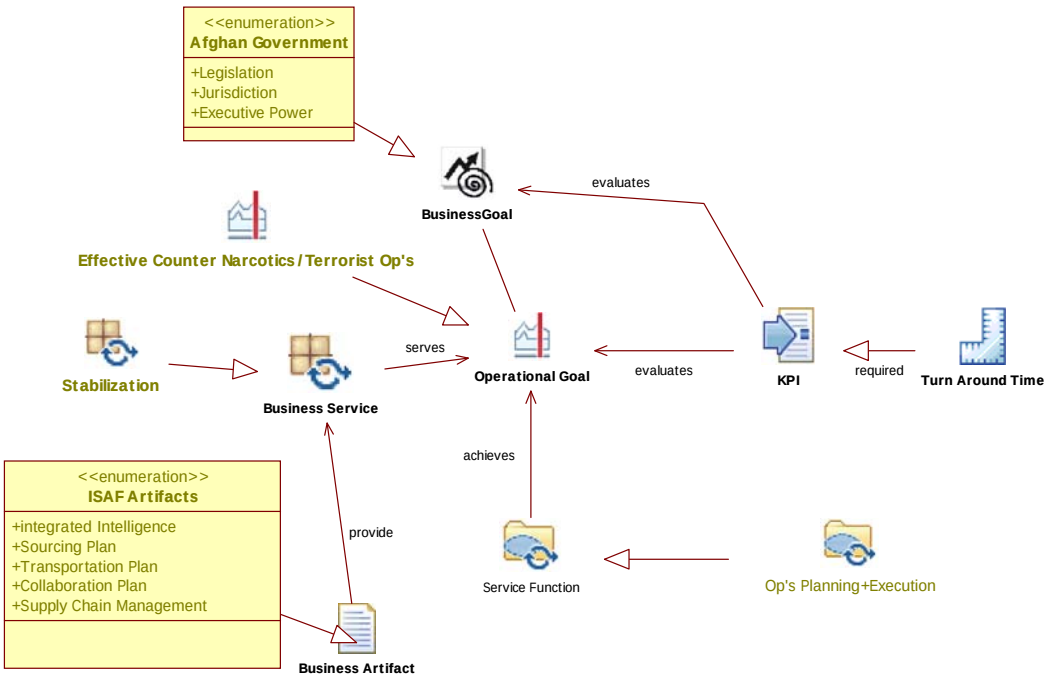


Figure 10: Business Performance Modelling

Methodologically, the steps to develop a commitment model should include:

- identification of business goals
- identification of artefacts representing metrics, situations, decisions and actions; artefacts, relationships and attributes derived from goal specification
- definition of business performance managers (BPMs); human agents, automated software agents, business process agents etc.
- definition and implementation of services for the BPMs.

# Model-Driven Development and Optimization

Aside from the value that rigorous modelling of an ecosystem of consumers and providers of services within an SOE brings through enhanced understanding of the enterprise, the approach opens the door to semi-automated transformation of business design into IT solutions for the entire value network. The primary benefit is not just the accuracy afforded in this transformation, but is the agility it brings to commanders.

No longer are command structures and formations hamstrung by the IT architectures they have inherited: agile development of systems, which support the structures that commanders need, has become a reality.

## Model-Driven Business Transformation

Model-Driven Business Transformation (MDBT) links strategic business objectives to IT implementation through multi-layered modelling, algorithmic transformation of models from the business to IT levels, and code generation from the models to a platform-specific IT implementation. Figure 11 shows the layers of the four different model categories: strategy, operation, execution and implementation, and their interdependencies within an SOA-based implementation.

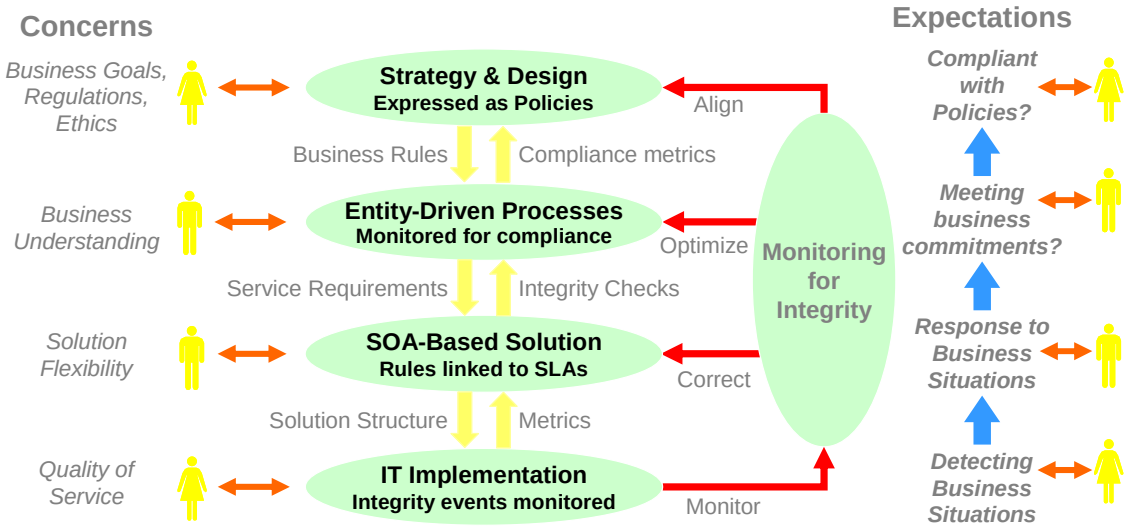


Figure 11: Model-Driven Business Transformation (MDBT)

Modelling starts with business design and operational analysis to define the core business rules and policies. Policies can be found and are implemented in outward-facing service definitions such as service agreements, information models and performance metrics haven been derived from business needs (operational plans), corporate-level guidance (military doctrine) and from external laws (strategic guidance) and regulations. Based on the Object Management Group

(OMG) Business Motivation Model (BMM, /9/), policies govern the value network by specifying design aspects other than information and operational models.

The application of policies in coalition context leads to the rules of engagement, which need to be described with highly structured, discrete and atomic statements – expressed in terms of the mission specific vocabulary. This concept of using structured English to express policies in a practicable and enforceable manner as rules is standardized by the BMM and the OMG Semantics of Business Vocabulary and Rules (SBVR, /10/). Rules within the coalition's business architecture are about strategic requirements, not tactical execution. They specify modalities about what is necessary, possible, impossible, obligated, permitted or prohibited. Table 2 lists the key modalities defined in SBVR as well as an example for each.

| | **Modality Type** | **Example in SBVR Structured English *)** |
|---|---|---|
| Structural | Necessity | **An** order **always** *has* **exactly one** commander |
| | Possibility | **It is possible that an** COA *has* **more than one** order |
| | Impossibility | **An** order **never** *includes* **another** order |
| Behavioural | Obligation | **Each** order **must** *be processed* **within** the set execution time |
| | Permission | **A** frigate **may** *pursue* **a** pirate vessel |
| | Prohibition | **A** commander **must not** *change* **the** political Rules of Engagement (RoE) |
| *) SBVR keywords are given in **boldface**, terms (names for objects) are underlined and verbs (names for relationships) are in *italic*. | | |

**Table 2: Types of Business Rules expressed in SBVR modalities**

These atomic statements can be transformed to complex rules by the use of logical connectors that link the clauses built from relationships in the information model. Both artefact-centric operation modelling and the rules of engagement (RoE) derived business rules model are used in operational analysis to determine

- what needs to be monitored:
- events
- metrics
- situations
- actions
- which business services need to be provided – preferable integrated applications in a SOA
- which human interactions are needed
- role model
- use cases
- data views

Eclipse (/11/) builds the open-source and open-standard foundation for available end-to-end tooling support for this SOE SOA life cycle. MDBT incorporates the analysis of business performance as described in Figure 10 and therefore goes beyond other SOA assembly frameworks (/12/) considering only activity-based process models. In research (/13/), IBM has developed an e2e SBVR prototype (/14/) compliant with the OMG Model Driven Architecture (MDA, /15/) standard (as shown in Figure 12):

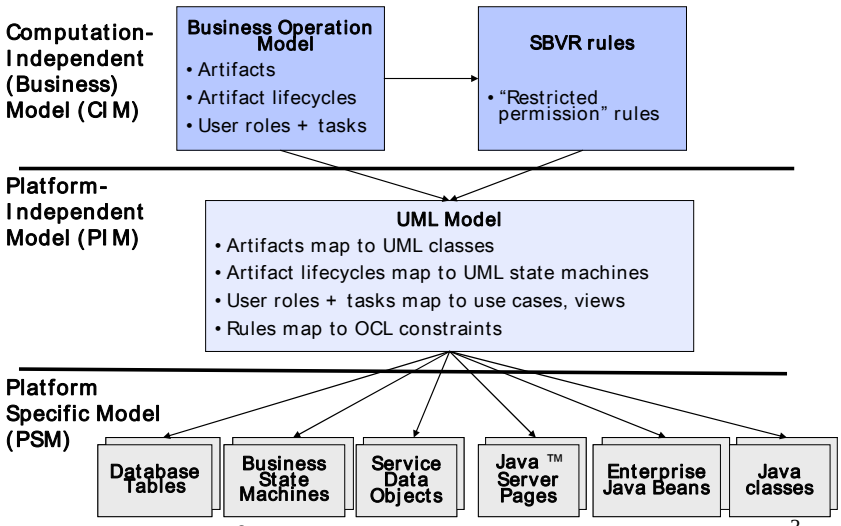


Figure 12: Artefact-centric Business Modelling and SBVR[3]

# Value Network Analysis

Value network analysis (VNA, /1/) supports a whole-system understanding on how people, process and technology work together to create both social and economic value. It is a methodology for understanding, using, visualizing and optimizing internal and external business value networks and complex ecosystems (/16/). The visualizing graphs are part of the ontology defining the business architecture.

Coalitions as SOEs are about creating service value in a network context. As pointed out in the chapter Model-Driven Business Transformation, information and communication technologies (ICT) play a crucial transformative role in coordinating and delivering service value and managing its complexity. Figure 13 shows the principal coalition service value network and its generic actors (/17/).

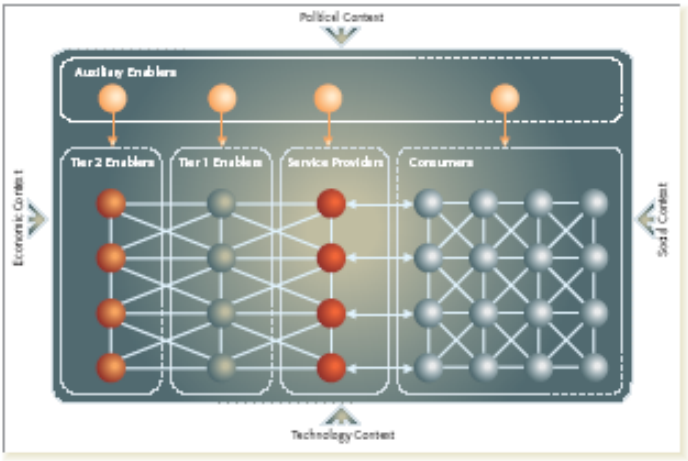


Figure 13: Conceptual Model of Service-Value Networks

The value of a service increases along the value chain from a tier 2 enabler through to final consumer. The KPIs and metrics taken from the business performance model (Figure 10) are used to quantify the value generated in the different nodes of the value network and provide a mechanism for driving optimization.

[3] UML = Unified Modelling Language
OCL = Object Constraint Language

# BEAM: Framework for Business Ecosystem Analysis & Modelling

Business ecosystem analysis and modelling (BEAM, /18/) is a research framework to design an optimized network of interconnected business entities.

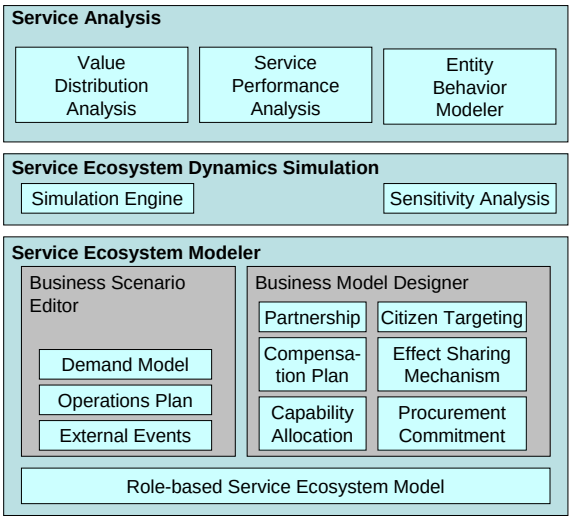


Figure 14: Beam System Architecture for Coalition Engagements

Figure 14 illustrates the proposed system architecture to benefit from the integration of methods from value network modelling, game theory analysis and multi-agent systems (MAS).

Figure 4 has shown the sample ecosystem associated with hosted business-to-business (B2B) transaction services that facilitate purposeful and effect-oriented collaboration. Typical decision support frameworks assume that the strategic outcome can be defined independently of the reactions of other players in the network. At nearly all levels of the decision process, however, interaction among players is significant. The BEAM framework therefore considers the interconnections and interdependencies of the participating entities and adopts game-theoretic techniques for the design of business architecture models in a service ecosystem. They are complemented by the computational methods used in the context of MAS loosely coupled networks of problem-solver entities (agents) that work together to find answers to problems that are beyond the individual capabilities or knowledge of any single entity. MAS typically have the following key characteristics – all of which apply to modern coalition engagements:

- each agent has incomplete capabilities to solve a problem
- there is no global system control
- data is decentralized
- computation is asynchronous.

Specific new challenges arise in agile service ecosystems:

- allowance for evolution of and duplication in roles over the service life cycle
- methods for systematic study of interactions among many business entities
- validation of ecosystem model and assumptions.

| Class | Concept | Properties |
|---|---|---|
| Resource | Such elements as monetary, human capacity, machine, software and power that can be consumed in the execution of business activities or invested to realize a service | Owner<br>Unit cost |

| Activity | A task that uses resources | Resource consumption |
|---|---|---|
| Decision | The selection of a course of action among variations such as expected outcome and capability allocation | Objective<br>Decision variable set<br>Constraint set<br>Related decision variable |
| Metric | Performance indicator of a business object (activity, business entity or service ecosystem | Business object<br>Value |
| Role | A set of connected activities and decisions in a service ecosystem | Activity list<br>Decision list<br>Metrics list |
| Business Entity | A general term used for enterprises, business units and regulators | Goals (e.g. risk attitude)<br>Demographic properties (e.g. size and location) |
| Business Model | The roles and relationships of an organisation as defined in the business architecture | Partnership<br>Decision-making structure<br>Decision-making mechanism |

**Table 3: Service Ecosystem Model Elements**

Mathematical models allow for the calculation of value metrics for each entity in the value chain (Figure 15). The framework is complete and available to be verified with further case studies, e.g. the capture of interactions between coalition decision makers.

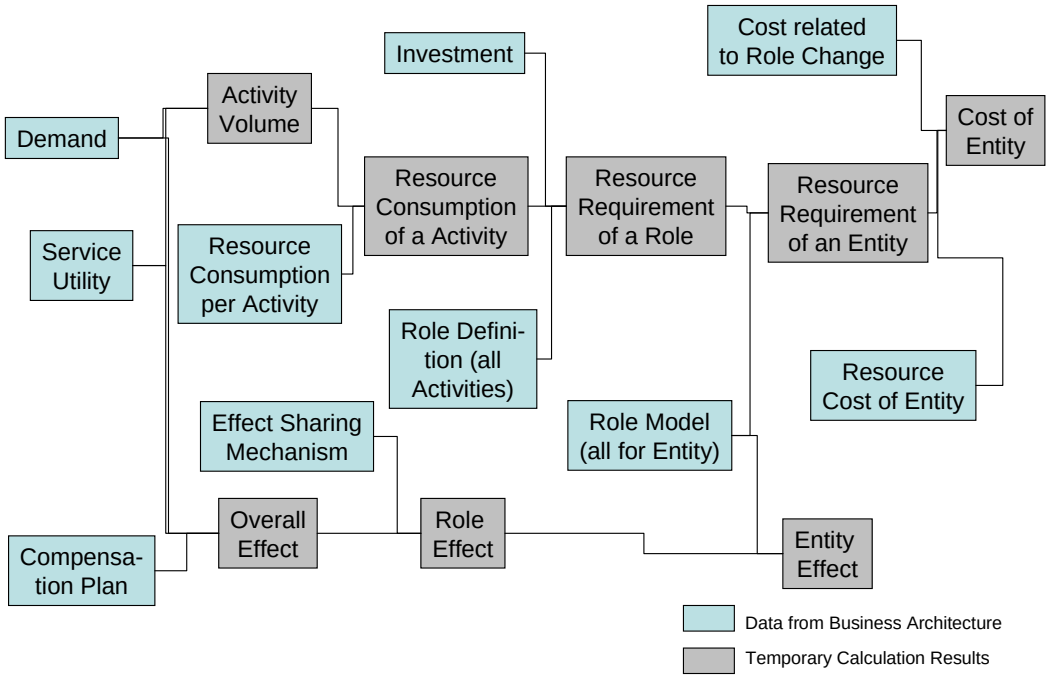


Figure 15: Value Distribution Calculation

# Scenario: Introduction of new Counter Narcotics Task

In our example, counter narcotics operational capabilities are the foundation for the ISAF business goal as defined in Figure 5. To demonstrate the concept of agile service orchestration, we want to introduce the new business service ‘disable drug production (DDP)’ to the defined business architecture in a methodology-based, rigorous manner and sketch out a possible SOA service implementation based on a specific counter narcotics ontology.

## Establishing the business service goal

ISAF, as shown in Figure 5, strives for the establishment of an autonomic nation Afghanistan with a stable balance of legislation, jurisdiction and executive power. One prerequisite to achieve the mission strategic business goal is the abatement of the still flourishing drug trade in rural areas of the country. Therefore, as its name indicates, DDP's business goal is to disable drug production in order to harm that trade and stabilise the country.

## Identifying new service opportunities

DDP can be seen as an SOE in itself having the same type of business architecture and the opportunity to be designed and implemented using MDBT and through a Service-Oriented Modelling and Architecture (SOMA) approach. In particular, by lowering the center of gravity from the mission's strategic to the operational level, the human operator, not an entire organisation, becomes the focal point in the center of the SOE. A few roles are defined by the business service goal.

Role A in the DDP business component is responsible for background intelligence over wide areas of interest (strategic intelligence) in Afghanistan. The function results in country and area reports published regularly to a broad community thus adding to the background body of knowledge about the infrastructure in the areas (preparation of the battlespace).

Role B utilises primary imagery intelligence and references previous reports and secondary imagery from various sources in order to generate updated assessments to be disseminated through the value network.

Role C receives real-time freetext reports from operators collecting information – some of which is key to the DDP business objective and performs ontology-based text mining and recommends suitable tasking.

## Evaluate Partnerships

DDP as a model-driven business intelligence exploitation service clearly depends on the effective ISAF value network. Based on existing information and operation standards such as NATO standardization agreements (STANAGs), the intelligence exploitation service must address the following knowledge sharing challenges:

- How do we perform knowledge management throughout the network?
- How do we collect data relevant for timely decision making from heterogeneous sources?
- How do we avoid information overload?
- Who are the right people to analyse the information?
- Do we trust the information?
- How do we achieve regulatory and legal compliance?
- How do we aggregate, correlate and fuse information pieces?
- How do we achieve procedural and semantic interoperability?
- How do we present knowledge for effective decision making?

## Setting operational Goals

Timely decision making to run an effective military operation is often prohibited by systems developed as stovepipes. These stovepipes are the result of legacy systems implemented through project-based acquisitions and problem-specific applications implemented in proprietary manner. The lack of interoperability is reflected on all levels:

- network integration – systems which cannot be connected
- data exchange standards – applications which cannot use each others data
- semantic interoperability – transferred information is meaningless to the other system
- process coherence – systems and organisations cannot operate with each other

A standard based intelligence dissemination architecture is key to a solution to provide users with seamless information accesses across organisational layers; it consists of at least of the following set building blocks:

- Meta Data Model & Management
- Catalogue for Intelligence Products
- Geographically disperse Service Catalogue & Storage
- Heterogeneous Networks
- Multiple Security Domains.

## Business Artefacts

The solution is underpinned by the following interoperability framework (Figure 16, /19/) that is open standards-based and complies with the SOA 'Data as a Service' concept.

Interoperability builds on the core integration, communication and collaboration services of the enterprise service bus (ESB). In this design, the ESB is used to connect service and information providers and consumers while hiding their underpinning technical implementation.

For various industries, on top of the ESB interoperability foundation, standards for the controlled, formatted data exchange between applications already exist. In the case of the military intelligence communities, NATO STANAG 4545 is used to share image intelligence products (documents and imagery). Medical imagery utilises similar standards optimized for their enterprise requirements.

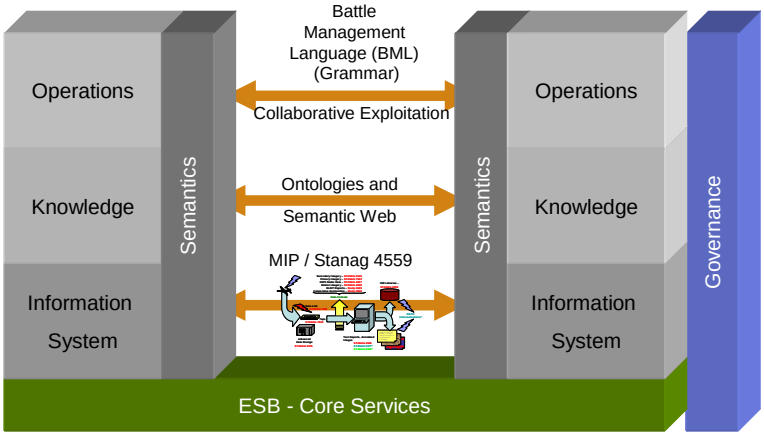


Figure 16: Layers of Semantic Interoperability

Knowledge can be shared by introducing theme-specific ontologies and semantic search capabilities building on the unstructured information management architecture (UIMA, /20/). Figure 17 shows the structural model of UIMA as used in DDP.

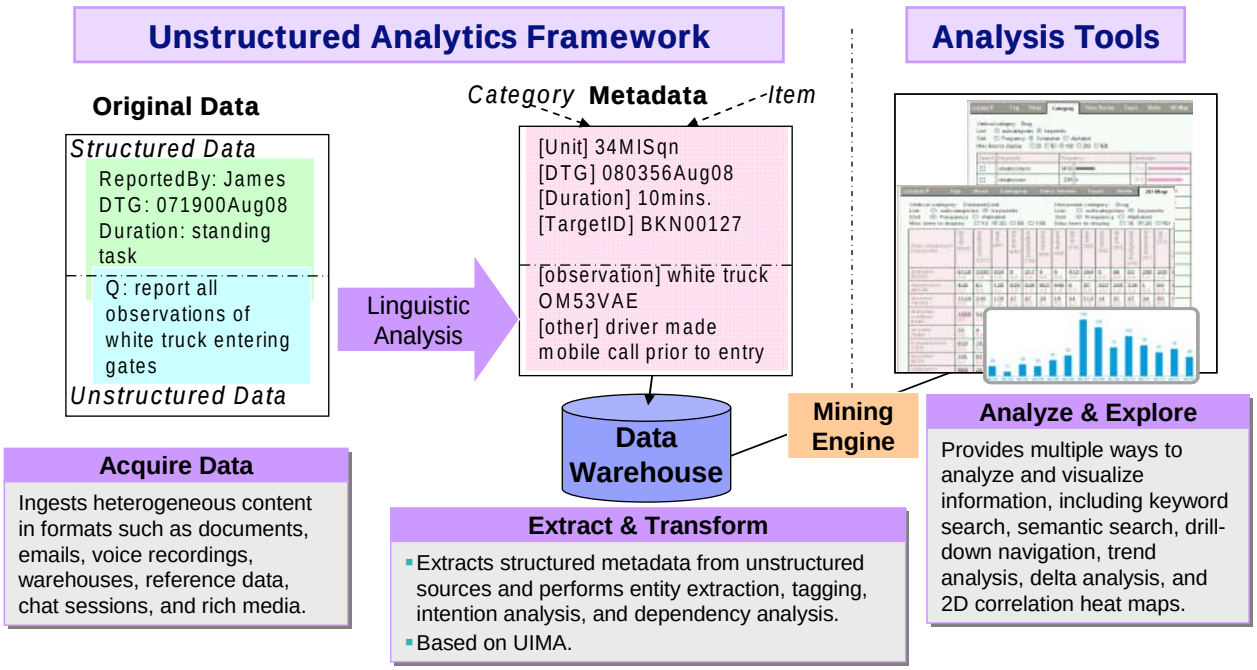


Figure 17: Principle of UIMA

While this provides context-specific information management, dynamic orchestration and collaborative processes can be added. A good example is the ontology-based order and reporting language known as Coalition Battle Management Language (C-BML, /21/). Such business process execution languages (BPEL) allow for business intelligence exploitation and business value creation at the network-enabled operational level.

## Service Operations

From an analyst's point of view there is a defined set of use cases and capabilities needed:

- collection/ingestion of intelligence data
- enrichment/augmentation of metadata
- semantic/ontology-based search
- collaborative exploitation by human experts and IT services
- intuitive presentation of knowledge, e.g. geographical information system (GIS) based
- publication of business intelligence objects.

This calls for the following major architecture building blocks:

- role-based, multimodal portal as unified access point
- collaboration suite as common services available to all users
- semantic search engine
- centralized identity and access management
- geographically dispersed, virtualized content & storage management
- multi-layered security manager
- enterprise service bus as information and service broker.

## Resources and IT Services

A DDP SOA solution includes services for:

- **Data Ingestion**
  these are performed within the broker of the ESB and will be based on the respective

meta-data models defined by the data source – whether a sensor of some type, a database or an internet-based feed, such as a news ticker. Separate ingestion services are implemented for different input modal modes:

- input through an offline medium, such as a CD: portal-based services for the administrator to post the content onto an ESB message queue
- online feed based on published XML schema: predefined ESB message queue
- federated via an application adapter: when information is requested from an external source, it will be exposed directly as a web service to be discovered and mediated by the ESB.

- **Data Dissemination**
  is based on the core capabilities of the ESB and can accommodate any of the underpinning philosophies:
  - push / pull
  - publish / subscribe
  - post (no named recipient)

- **Analysis**
  these services basically perform annotations and meta-data augmentation of the ingested data in order to generate higher value insight. Using the core capabilities of UIMA and the collaboration suite they are instantiated around the following disciplines:
  - **Indexing**
    as part of natural language processing
  - **Triple Store**
    relationship establishment between recognized business entities and objects
  - **Ontology-Based Enrichment**
    using inference models
  - **Free Tagging**
    by experts – to be re-fed into the analysis process for further insight harvesting.

- **Exploitation**
  is performed both by collaboration (discussing insight between experts) and by using the analysis services as 'tagging" to further enhance knowledge and by using ontology-guided reporting and graphical search services and is enabled by knowledge visualization in an OGC (open GIS consortium, /22/) compliant manner. An industry-specific, yet standardized icon set is integrated into the presentation services, e.g. the NATO APP6(A) set of tactical symbols.

- **Optimization**
  is continuously performed by the analysis of newly added tags and deduction of additional triples to enrich the knowledge base.

# Anticipated Capability Benefits

In our DDP case study we have introduced a few prototypical artefacts:

- an information integration and dissemination framework
- a semantic interoperability model
- the deployability of a business service, DDP, as a network-enabled capability (NEC).

These are the foundation for the technical transformation methodology to overcome today's problems in diverse collectives such as ISAF. The main lesson in support of coalitions opera-

tions, e.g. the British operations TELIC and HERRICK, was that they were dominated by systems developed as `stovepipes'. Rather than integrating the systems that British Forces were trained on when they deployed together, the problem was solved by a separate procurement of a NATO information systems – not solving the stovepipe issue but making one more. These stovepipes are the result of legacy systems implemented through bounded 'project-based acquisition' focused on a particular environmental priority, or, urgent operational requirement, implemented with a view to addressing the current imperative. For example, in Afghanistan, a number of legacy and more recent imagery systems are unable to deliver information beyond their primary customer. While data standards are mature, offering the potential for systems to exchange data, relatively little integration has occurred. As a result, the Defence community is unable to share intelligence effectively, or to exploit even a small portion of information collected. Our case study around DDP sketches out the answer to this problem, without the necessity for a series of planned acquisitions delivering a new system to integrate the existing systems, i.e. using a 'bigger' stovepipe to integrate a series of stovepipes.

The component business model (CBM) of coalition operations is defined by the following capability matrix (Figure 18).

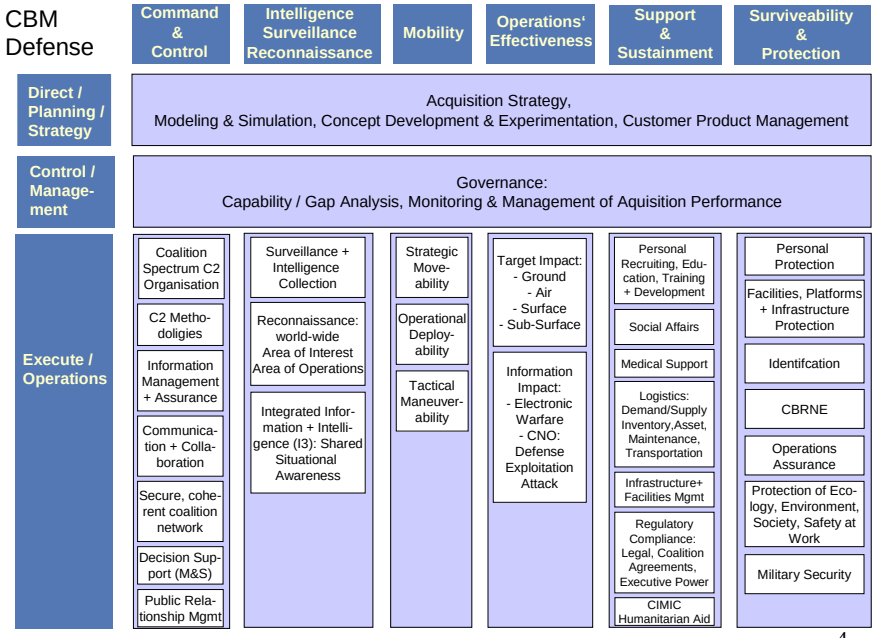


Figure 18: Capabilities Matrix and Component Business Model[4]

Applying the core BA models to ISAF and introducing integrated business services using the methodology laid out for DDP promise capability benefits in the following categories (compared to Figure 18) – this list does not claim to be complete:

- **C2-Organisation:**
  knowledge about the interactions and dependencies of the decision makers can provide more flexibility in the command structure and thus make the organisation more agile.
- **C2-Methodologies:**
  by being policy-driven, the methodologies will become more declarative, flexible and

[4] CBM = Component Business Model
CNO = Computer Network Operations
M&S = Modelling and Simulation
CIMIC = Civil – Military - Collaboration
CBRNE = chemical/biological/radioactive/nuclear/explosive

manageable during operation planning and while the operation unfolds. The transformation of policies into enforceable business rules allows for more transparency and assurance.

- **C2-Support:**
  based on integrated intelligence exploiting hybrid data sources, commanders will be given higher quality and more timely shared situational awareness to enable more predictive and effective operations planning and execution.
- **Intelligence-Surveillance-Reconnaissance (ISR):**
  complex analysis tools such as social network analysis, complex event processing and collaborative business insight will allow for better exploitation of ISR capabilities.
- **Sustainment:**
  the capability to perform immersive training with innovative technologies is one of the benefits identified.
- **Protection:**
  the incorporation of risk management policies and fraud models into the business architecture can lead to earlier risk detection and counter measure initiation.

# Summary

Integrating business services across organisational boundaries still remains a challenge due to lack of standards in many areas including service message formats, service nomenclature and service interfaces. The role of industry standard organisations and governmental agencies in developing relevant standards for business architecture is becoming more and more important as the need for semantic interoperability and process control languages (structured English) rises.

In this paper we have elaborated on the state of the art technologies for business architecture and model-driven architecture and development of SOA solutions to implement seamless business services in a service value network, including VNA, game theory and multi-agent simulation systems. The benefits to military coalitions of such an approach is more rapid implementation of IT systems to support the complex organisations typically found in coalition operation. But perhaps most importantly, model-driven architectures provide commanders with the opportunity to evolve command and control systems as the mission evolves, to respond quickly to new threats, or to rapidly assimilate new forces as they are declared to the operation.

In conclusion, we have demonstrated the potential for capability gains and improvements by adopting the BA methodology for business design and optimization. We recommend further case studies on the adoption of these methods and technologies to manage especially the human factors in agile coalition ecosystems and empower commanders to effectively lead agile operations.

# A. Appendices

## A.1 Figures



## A.2 Tables



## A.3 References

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## A.3 Abbreviations

| | |
|---|---|
| B2B | Business-to-Business |
| BA | Business Architecture |
| BDSD | Business Driven Service Development |
| BEAM | Business Ecosystem Analysis and Modelling |
| BML | Battle Management Language |
| BMM | Business Motivation Model |
| BPM | Business Process Manager |
| C2 | Command and Control |
| C4ISTAR | Communication, Collaboration, Command, Control, Intelligence, Surveillance, Target Acquisition and Reconnaissance |
| CBM | Component Business Model |
| C-BML | Coalition Battle Management Language |
| CBRNE | Chemical, Biological, Radioactive, Nuclear, Explosive |
| CCRP | Command & Control Research Program |
| CD | Compact Disc |
| CE | Collective Endeavour |
| CIMIC | Civil Military Collaboration |
| CNO | Computer Network Operations |
| COA | Course of Action |
| COI | Community of Interest |
| CTO | Chief Technology Officer |
| DDPS | Disable Drug Production Site |
| e2e | end-to-end |
| EBAO | Effects-Based Approach to Operations |
| ESB | Enterprise Service Bus |
| EU | European Union |
| GIS | Graphical Information System |
| ICCRTS | International Command & Control Research and Technology Symposium |
| ICT | Information and Communication Technology |
| ISAF | International Security Assistance Force |
| ISR | Intelligence, Surveillance and Reconnaissance |
| IT | Information Technology |
| JC3IEDM | Joint Command, Control and Communication Information Exchange Data Model |
| KPI | Key Performance Indicator |
| M&S | Modelling and Simulation |
| MAS | Multi-Agent System |
| MDA | Model-Driven Architecture |

| | |
|---|---|
| MDBT | Model-Driven Business Transformation |
| MDD | Model-Driven Development |
| MoD | Ministry of Defence |
| NATO | North Atlantic Treaty Organisation |
| NCO | Network Centric Operations |
| NEC | Network Enabled Capabilities |
| OCL | Object Constraint Language |
| OGC | Open GIS Consortium |
| OMG | Object Management Group |
| OWL | Web Ontology Language |
| RoE | Rules of Engagement |
| SBVR | Semantics of Business Vocabulary and Business Rules |
| SME | Subject Matter Expert |
| SOA | Service Oriented Architecture |
| SOE | Service Oriented Enterprise |
| SOMA | Service Oriented Modelling and Architecture |
| STANAG | NATO Standardization Agreement |
| TAT | Turn Around Time |
| UIMA | Unstructured Information Management Architecture |
| UML | Unified Modelling Language |
| VNA | Value Network Analysis |
| XML | eXtensible Markup Language |

## A.4 About the Authors

**Margarete** is a member of the IBM technical leadership team and executive IT specialist and technical leader and chief architect for the Government Industry in Europe, nourished by her experience as technical consultant for the German MoD and Armed Forces regarding the business transformation towards network-centric operations (NCO) and the effects-based approach to operatons (EBAO). She has joined the IBM Defence team more twenty-five years ago, after achieving her Masters Degree in Mathematics in 1981.

**Mike** has a twenty years experience in the Royal Air Force, during which he gained Masters Degrees in both Engineering and Defence Management. In active service he contributed to the development of Joint C2 capabilities and intelligence production and as well having had an appointment in the MOD Equipment Capability Customer where he played a significant role in shaping the UK MOD's concept of network-enabled capability (NEC). Joining IBM in 2006 as a Defence subject matter expert (SME), he has contributed to aligning C4ISTAR requirements with capability development within IBM.