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C2 for Complex Endeavors

Hybrid Collaborative Information Environments (CIE) for enhanced Decision Support

Topics:
Cognitive & Social Issues, C2 Architecture, Collaborative Technologies for NCO

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Abstract

The implementation of effective decision support for network-enabled coalition operations is not a question of maintaining a set of isolated tools, but addresses the challenge of modelling and constantly enhancing an optimizing business process in itself. The quality of that process can be measured by its ability to sense and to respond to situations critical to the operation in order to continually improve and hasten progress to the operation's desired end state.

Agile, adaptive collaboration on the cognitive and information domain among coalition members during operation needs to be accompanied by innovative anticipation tools, which in a state-of-the-art fashion are implemented as software agents within virtual and augmented reality (VR/AR) environments.

This paper describes the technologies and core enterprise services for the implementation of hybrid CIE between human communities of interest and software agents and positions them within an architecture framework for sense & respond decision support: web-enabled ontologies, ontology-based semantic integration of real world and VR/AR, complex context and semantics sensitive event processing as well as activity and user sensitive computing. In addition, it reflects on the expected capability gains by adopting such an architecture.

Problem Space

The global trend both for running an innovative business or leading a complex operation is network-enablement in order to accommodate transformation goals as integration, innovation and business globalization. This transition in any market place is being underpinned by integration technologies, standardization of interfaces and interoperability models.

Whereas integration, as shown in the bottom layer of Figure 1, within the physical domain can be accomplished with proven techniques and products, achieving semantic interoperability in a landscape of heterogeneous platforms and applications is a different matter.

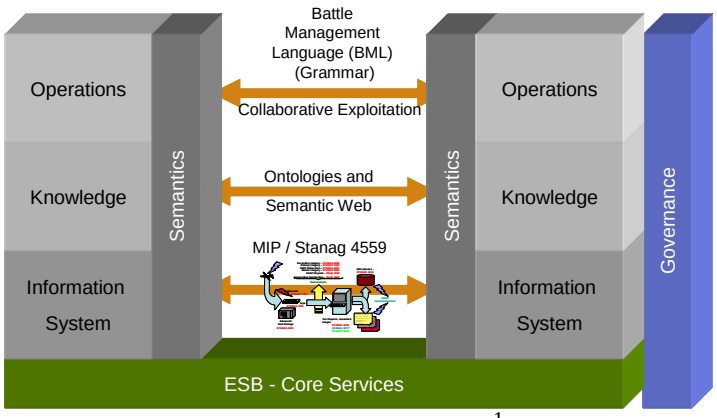

Figure 1: Layers of Interoperability[1] (e.g., /1/, /2/)

On the information layer, interoperability is basically defined via a common data dictionary or core metadata model, e.g., as described in various standardization agreements of the North Atlantic Treaty Organization (NATO) to define mutually sharable intelligence products or within the

[1] MIP – Multilateral Interoperability Programme
Stanag – Standardisation Agreement
ESB – Enterprise Service Bus

multilateral interoperability programme (MIP) to enable the exchange of data contributing to an overall operational picture.
Semantic interoperability within an ecosystem of people, systems, simulators, stimulators and robots can only be achieved by formalizing the underlying concepts through ontologies and by defining and managing business processes via a common, yet extensible control language – like Battle Management Language (BML). The collaborative exploitation of the information domain then enables enhanced, because coalition coherent, decision support as targeted e.g., in the NATO Network Enabled Capabilities Feasibility Study (NNEC FS /3/) and illustrated in Figure 2:

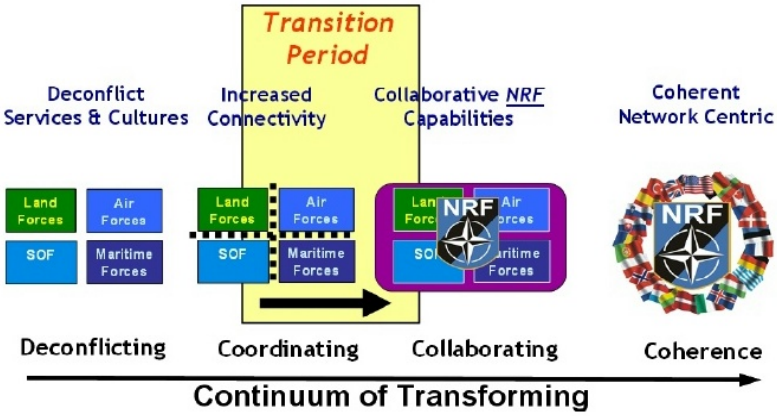

Figure 2: Roadmap of Coalition Transformation /3/

Conceptual Approach to Effects-Based Operations

One goal of the international transformation efforts is the modelling, realization and continual optimization of the command and control (C2) process for network-enabled capabilities in effect-oriented operations within a coalition environment. The Effects-Based Approach to Operations (EBAO) /4/ describes military actions as part of a broader approach to counter today's problems and threats. The different activity areas or domains as shown in Figure 3 influence each others. Intended actions have to be deducted multi-disciplinary during the planning phase and along execution; the outcomes will influence all the different domain areas.

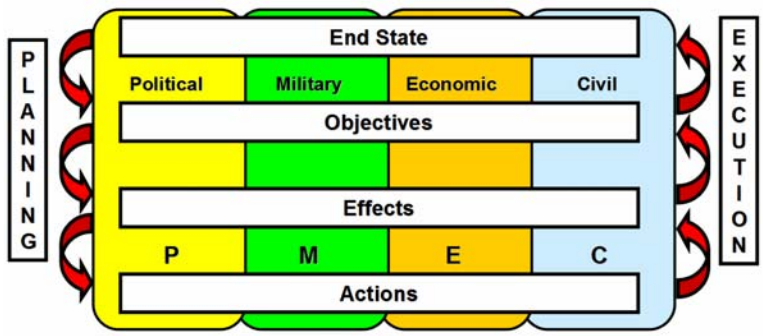

Figure 3: Effects-Based Approach to Operations

Whereas single actions planned in one domain follow a domain-specific action plan to achieve domain-related effects, complex cross-domain effects' and therefore actions' interdependencies (refer to Figure 4) have to be taken into consideration.

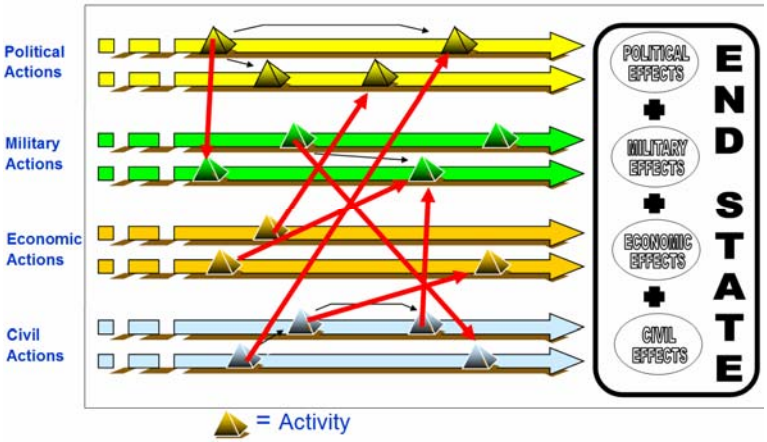

Figure 4: Interdependences between the domains

Core to the C2 process therefore is continuous collaborative decision making within the (fixed / deployable) Coalition Joint Task Forces Headquarters ((F/D)CJTF HQ), which is embedded in an inter-agency, multi-discipline responsive approach. In addition to the enablement of human collaboration, coherence in planning and command may only be achieved by partial event-driven and sense-and-response-based automation of the C2 process, especially during the decision preparation process, with analysis tools including hybrid, predictive functionalities run on a knowledge base and including virtual and simulated realities. Bracing every single decision on the principle of Network Centric Operations (NCO) complicates the decision making process, as multi-discipline and cross-domain situations have to be considered. In addition, different perspectives and perceptions of the coalition partners have to be taken into account. Figure 5 summarizes these within the C2 cycle of “observation – orientation – decision – action” (OODA).

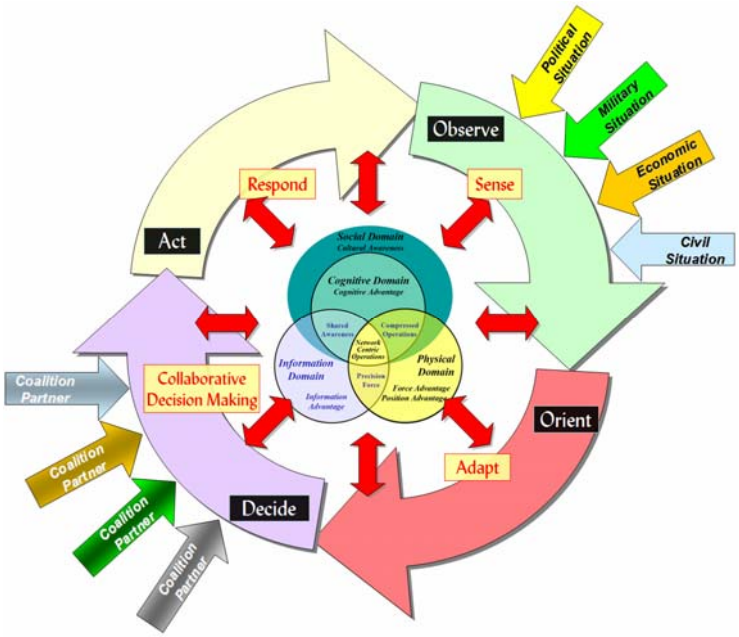

Figure 5: C2 Process in Network Centric Coalition Operations using EBAO

For the optimization of the C2 process, different reference scenarios have been defined as benchmarks in which extensive time sensitive data is provided, which in the past has not been subject to significant analysis and evaluation for adapting and optimizing operational processes, but is in principle available for such purposes - across various information and security domains and layers as well as levels of command and control.

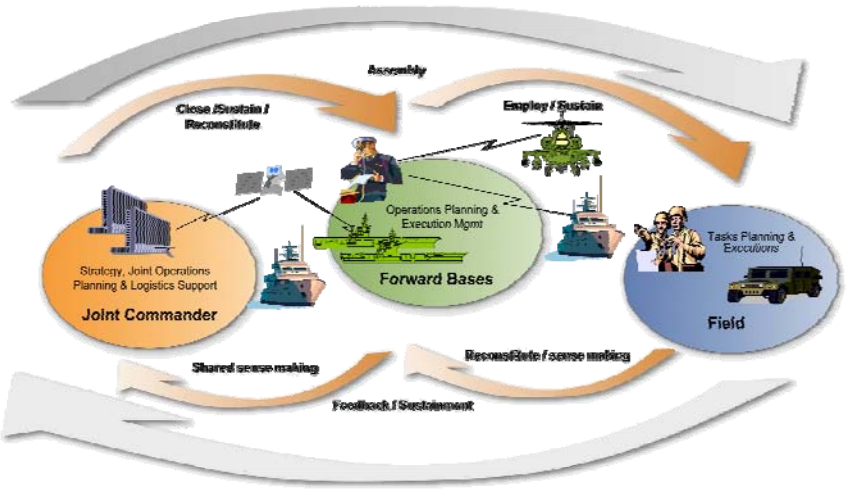

Figure 6: Knowledge Flow in the Command Chain

Implementing effective decision support in a context as of Figure 6 (geographically dispersed operations, cross-organizational networks, complex governance and C2 structure, need for process flexibility) requires deep know-ledge of the operational models for all possible missions, in other words: the specification of an overall enterprise architecture.

Reference Architecture

In the centre of an enterprise architecture (EA) as defined by Open Group and illustrated in Figure 7 stands the business strategy, i.e. the coalition's mandate – for a given scenario and situation. Therefore, there is one to be instantiated for each and every mission – ideally being underpinned by a generic architecture catalog for predefined reference scenarios like peace enforcement, stabilization or humanitarian aid.

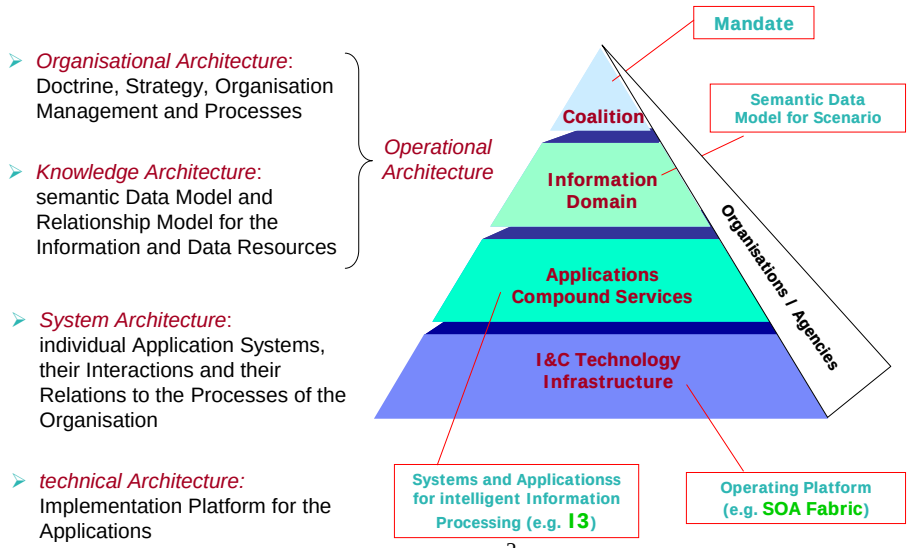

Figure 7: Enterprise Architecture Model[2] (according to Open Group, /5/)

Scenario-independent, yet evolving over time are the operational capabilities needed for any such enterprise or defense organization. The following illustration, Figure 8, defines a prototypical, widely generic component business model:

[2] I3 – Integrated Information and Intelligence
SOA – Service Oriented Architecture

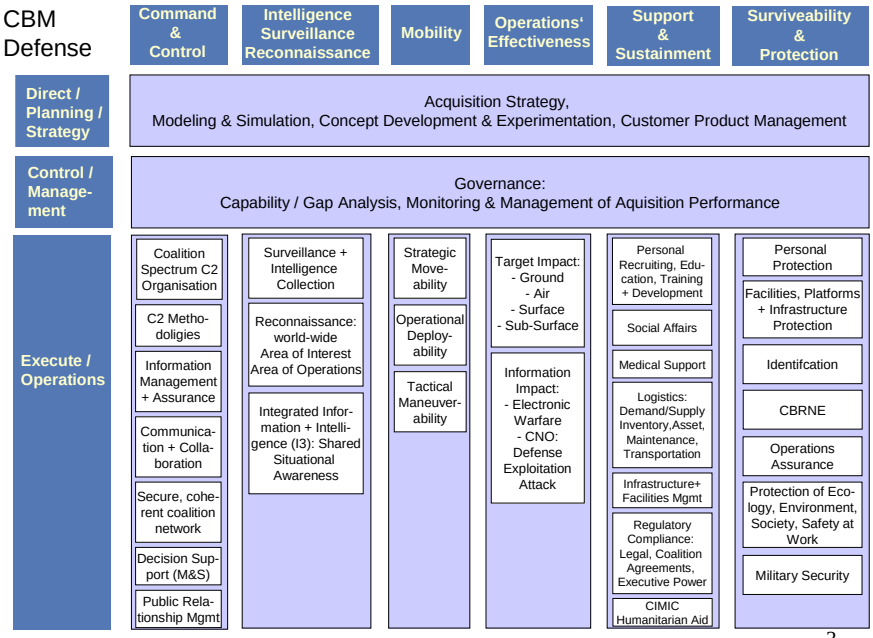

Figure 8: Capabilities Matrix and Component Business Model[3]

The roadmap to the development of such coalition coherent capabilities is underpinned by several architectural concepts and methodologies to be applied on top of basic network enablement by the core services of an enterprise service bus (ESB) as defined in Figure 9:

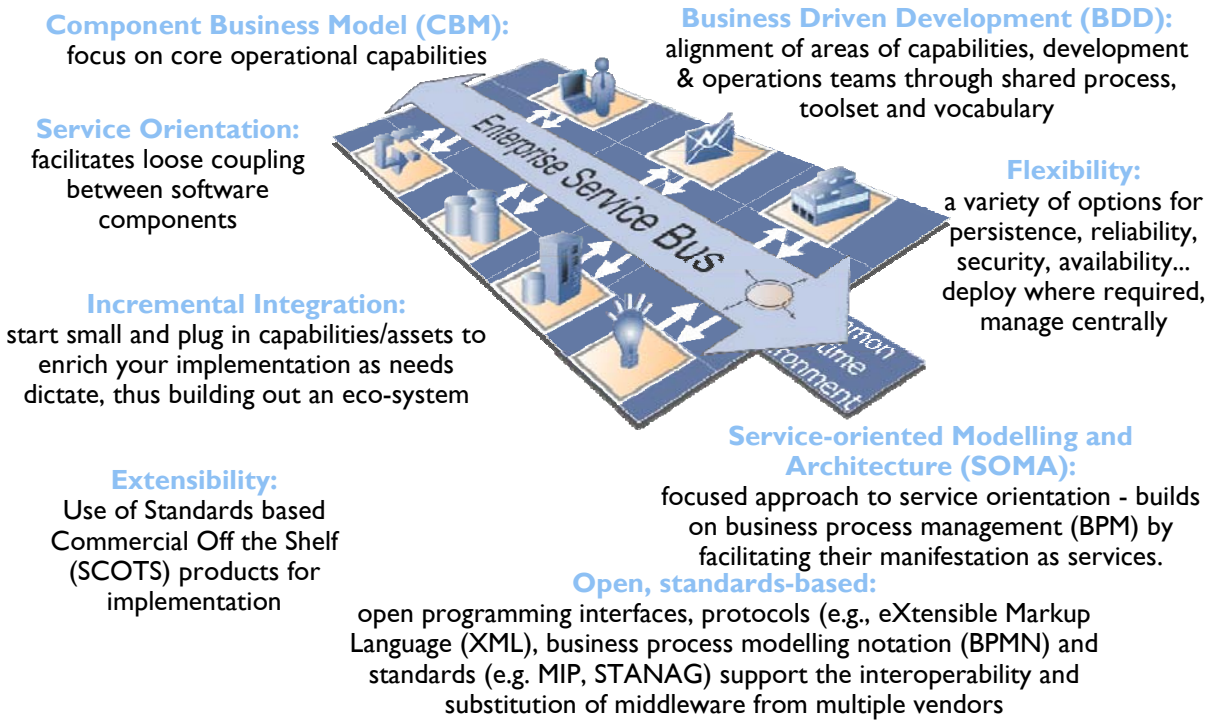

Figure 9: Network-Enabled Capabilities (NEC) Architecture Building Blocks

The core component of an EA and its catalogue for a vast scenario landscape are the generic models to define:

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

- organizational structure
- meta data structure
- processes & process flows
- service provisioning and orchestration
- systems' and services' performance and behaviour
- regulatory environment
- risk management and governance procedures.

For each mission these models need to be instantiated and maintained as well as optimized during operation – the underpinning governance model is shown in Figure 10:

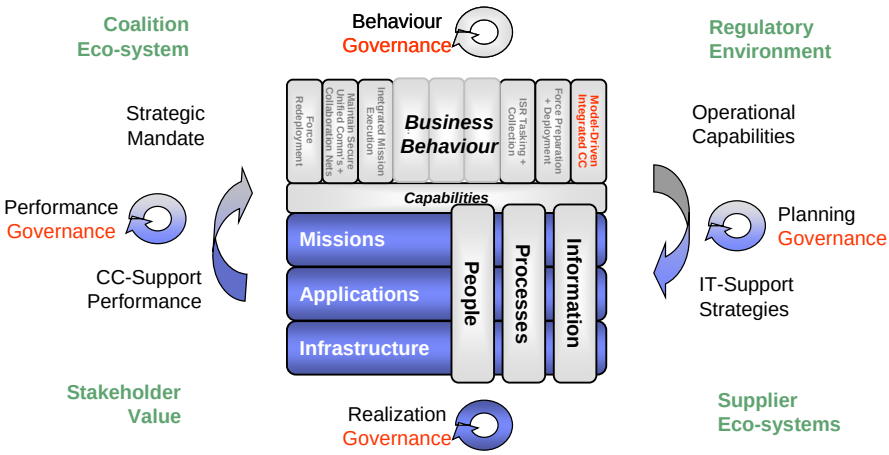

Figure 10: Model-Driven Life Cycle Management

The refinement of the generic models is subject of the transition to NEC and needs to follow the specifics of national transformation strategy aligned with the model-driven approach of Figure 11:

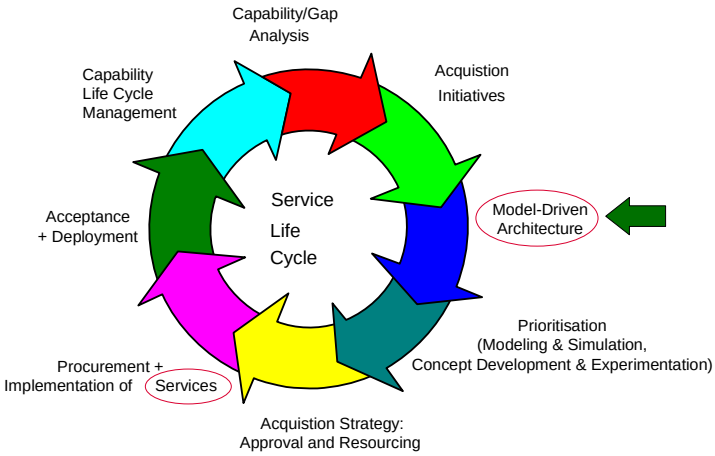

Figure 11: Service Life Cycle Management

This reference architecture framework builds on the concepts and standards of model-driven architecture and development (MDA/MDD) /6/ as defined by the Object Management Group and highlighted in the illustration above. It is supported by standard-based commercial of the shelf (SCOTS) products usable to implement the state of the art methodologies and technologies described in the following chapter as reusable business services (highlighted in Figure 11).

State of the Art Technologies for Hybrid Collaboration

Digital Communities (DC)

Historically, people living in proximity have formed communities to achieve common goals by building a sense of belonging, nodding social ties and perform collaboration, knowledge and resource sharing. Technology has impacted these human communities by increasing their scope, expanding their capabilities and organizational complexity. Global digital communities leveraging the world-wide web (WWW) and new tools for collaboration and interaction break the tie to geography and become vital to globally integrated and virtual enterprises such as coalition forces. Digital communities in conjunction with Web 2.0 technologies and SCOTS tools enable collective intelligence. Already widely adopted in the commercial world (commerce, e.g., ebay and software development, e.g., Rational Jazz), civil public sector (education, e.g., Wikipedia) and social domain (playing, e.g., World of Warcraft and socializing, e.g., XING), these technologies are mature enough to be incorporated in the decision making C2 processes as well.

Human and software agents' behaviour patters can be correlated by interpretive collaboration models and be aligned using situation-sensitive negotiation policies and rules, see Figure 12.

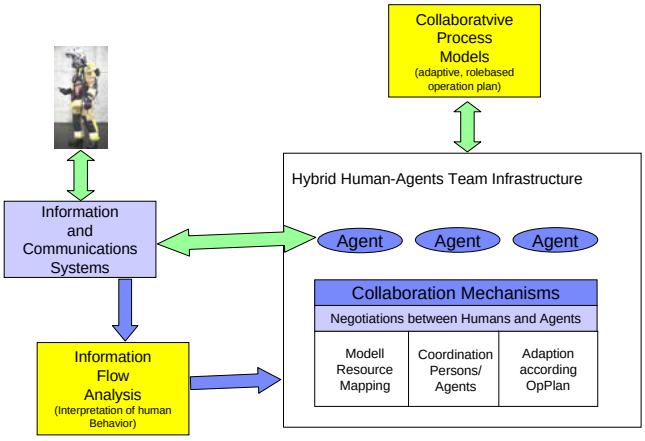

Figure 12: Model-based Mission Sensitive Adaptive Collaboration

This way, huge investments in command and control information systems (CCIS), modelling and simulation (M&S) decision support tools and platform simulators as well as system stimulators of the coalition partners can be leveraged on the foundation of a coherent operational architecture and process model and a common, open standards-based infrastructure base. Entities – whether people, agents or web services – are integrated into the collaboration process using a common representation model, thus making the concrete instantiation transparent to the process.

Business Integrity

The dynamics of disaggregated value nets, compounded by increasing regulations and characterized by data explosion, require a new approach to manage business integrity. An integrated framework for managing business integrity is especially critical for delivery of the full promise of service-oriented architecture (SOA) and information on demand (IoD) in globalized ecosystems.

Business integrity links fundamental issues of high-level business policy to practical, operational matters of processes, data and IT – as illustrated in Figure 13:

- basis for defining "doing the right thing" – Policy Integrity:

- policies include business practices, government regulations, ethical policies and negotiated contracts of business conduct with partners
- needs well-defined policies that can be translated to be measurable and actionable
- doing things in the right way – Process Integrity
- process integrity ensures actions follow intended paths and applicable policy
- needs regular and complete monitoring and management of appropriate metrics
- having the right basis for doing things – Information Integrity
- information integrity ensures correct and consistent information with appropriate access control
- needs information management that properly and completely represents the core business entities.

Governing policies, process models and core data entities today are typically defined and managed in only loose alignment – SCOTS tooling is available, but needs to be incorporated in a holistic view giving proper consideration to the interdependencies of these three integrity dimensions:

- Business Rules & Process Formalization Standards:
- Semantics of Business Vocabulary and Business Rules (SBVR)
- Business Process Modelling Notation (BPMN)
- Business Process Definition Metamodel (BPDM)
- Extensible Business Reporting Language (XBRL)
- Rules Automation Tools (e.g., Complex Event Processing)
- Business Process and Performance Management
- Operational Risk Quantification & Management Framework
- Master Information Management
- Information Provenance Management.

Figure 13: Levels of Business Integrity

Structured representations of regulations and procedures are emerging and facilitate policy automation, e.g., Estrella /7/ is a framework (compare Figure 14) to standardize and automate the capture of legal information (such as tax legislations) through an XML-based Legal Knowledge Interchange Framework and Language (LKIFL):

Figure 14: Regulation Sharing within Estrella Ecosystem

High-level policies, expressed as formal rules, link to entity-driven process models which are mapped to SOA solutions where monitoring assures processes are followed and information is managed according to policies; Figure 15 illustrates this:

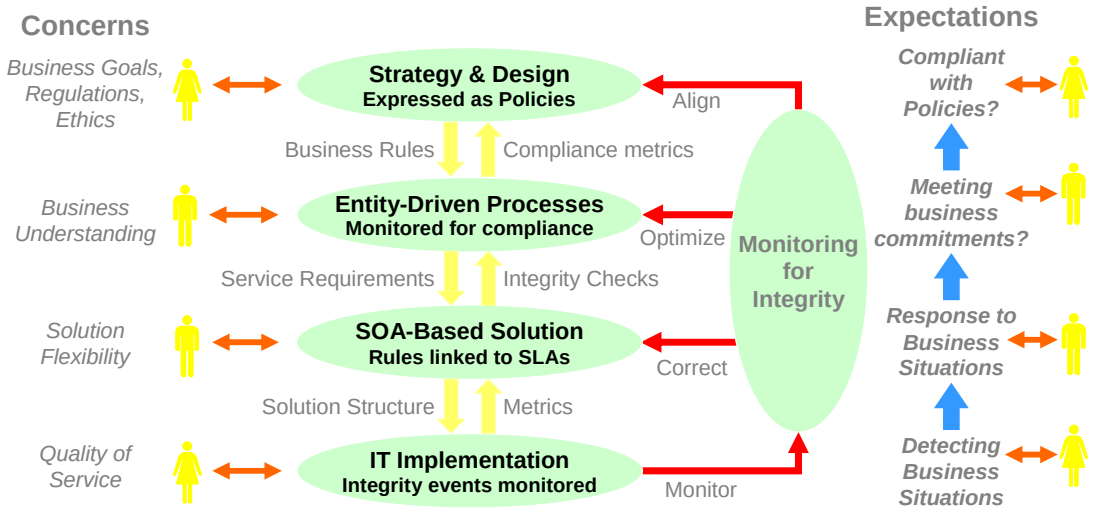

Figure 15: Model-Driven Business Transformation (MDBT)[4] – maps to Defense CBM

Enterprise Service Bus (ESB)

Virtualization

What has been a transaction monitor and manager in silo systems in the past, according to Gartner™ is an ESB in a network-enabled ecosystem. An ESB is a flexible connectivity and exchange infrastructure for the integration of application and services. It is used to reduce the number, size and complexity of interfaces needed for this integration. An ESB cares intelligently for the:

- Matching and control of messages between communication partners
- Conversion of transport protocol between requestor and provider
- Transformation of message formats between communication partners while maintaining the semantics
- Dissemination and distribution of critical information and events to relevant resources, services and consumers.

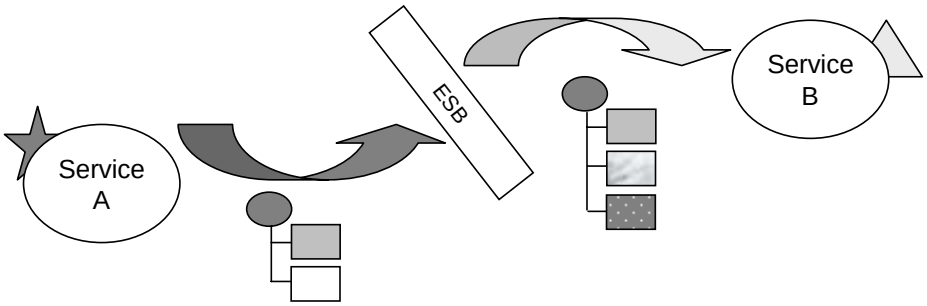

Figure 16: Functional Spectrum of an SCOTS ESB

[4] SOA – Service-oriented Architecture
SLA – Service Level Agreement
IT – Information Technology

These inherent core ESB services, shown in Figure 16 can be used to configure intelligent hybrid CIE based on the following component model of Figure 17:

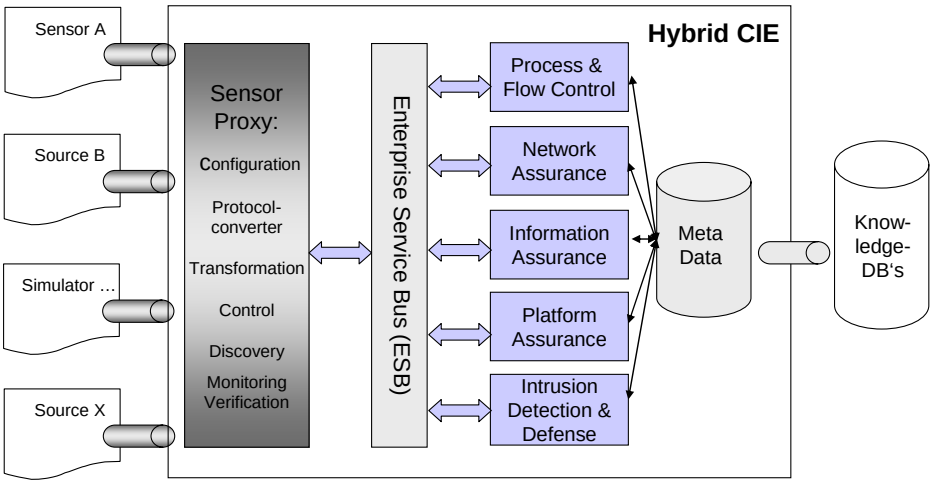

Figure 17: Semantics- and Model-Driven ESB Configuration for Hybrid CIE

Event-Driven Applications

An event-driven application (EDA) can be defined as one that executes 'when-then' rules /8/, like: 'WHEN reality deviates significantly from model/expectation THEN respond'. The human brain is trained to ignore most sensory data it receives, and pays attention only when the unexpected happens in a process. This type of control system behaviour needs to be introduced into EDAs: continual operational control (monitoring) and the capability of instantaneous mode change. There are at least four disciplines necessary to consider for EDA:

- Business Intelligence (BI)
- Loose-coupling Enterprise Application Integration (EAI)
- Continuous operation
- Timely response to exceptional situations.

The last topic in this list is addressed by Complex Event Processing (CEP), a technology based on the IBM research asset Active Middleware Technologies (AMiT, /9/) and designed to detect complex situations that involve a context-sensitive composition of messages and events and trigger actions and information annotation and augmentation. It can enrich the mediation services of an ESB by introducing state and thus by analyzing the messages and monitor predefined relationships between them in the flow. CEP uses so-called event-processing agents (Figure 18), which statefully integrate messages from sensors, monitoring instances, polling data bases and web services to asynchronously generate messages to (multiple) responders.

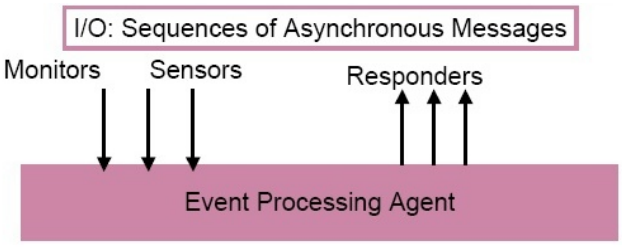

Figure 18:: Event Processing Agents (EPA): asynchronous composition of messages

An event-driven application thus becomes a layered network of event-processing agents.

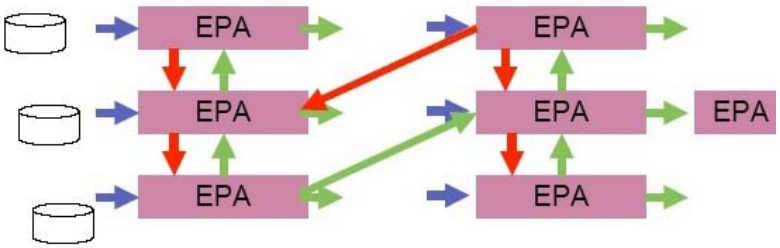

Figure 19:. Message flow between EPAs

The blue arrows in Figure 19 indicate message sequences from sensors. The green arrows indicate message sequences to responders or other EPAs in the same or higher layer, the red ones newly generated when-then rules from EPA or user console.

CEP in the context of model-driven hybrid CIE for the support of coalition engagements can be used to ensure operations' integrity by taken into account both the operational architecture of the mission and a quantifying risk and threat model to recognize and act upon critical situations (Figure 20):

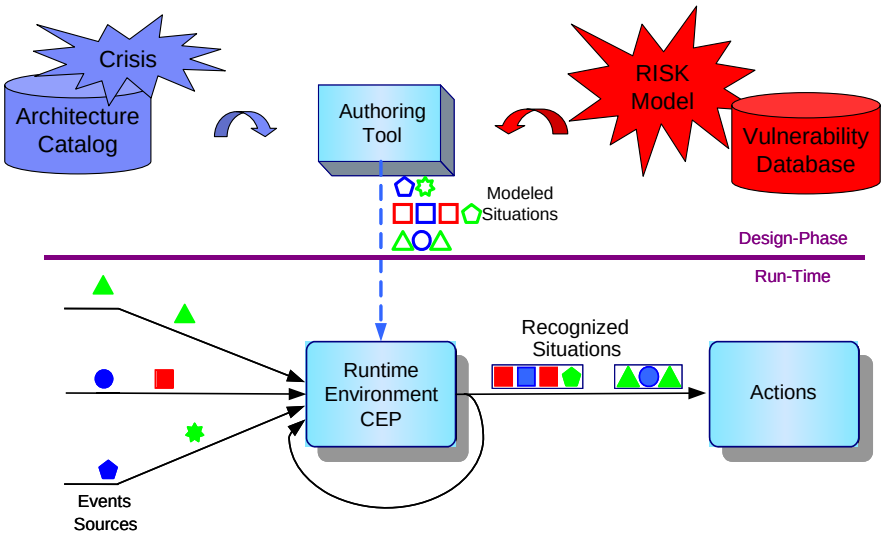

Figure 20: CEP[5] for Operations' Integrity

Existing models plus an authoring tool for model-driven development comprise CEP.
CEP is necessary, but not sufficient to allow for mode-change detection in an ecosystem's behaviour, the results of other research lines must be incorporated, too:

- Filtering of messages upfront
- Finite state machines for monitoring
- Time and size windows
- Fuzzy match making: learning by example
- Fuzzy matching: natural languages
- Statistical operations
- Regular expressions
- Spatial operators.

[5] CEP – Complex Event Processing

Unstructured Information Management Architecture (UIMA)

The Unstructured Information Management Architecture (UIMA) framework, originally developed by IBM and now being standardized by the Organization for the Advancement of Structured Information Standards (OASIS), is an open, industrial-strength, scalable and extensible platform for building analytic applications or search solutions that process text or other unstructured information to find the latent meaning, relationships and relevant facts buried within. It enables developers to build analytic modules and to compose analytic applications from multiple analytic providers, encouraging collaboration and facilitating value extraction for unstructured information.

Open source analytics modules from OpenNLP and General Architecture for Text Engineering (GATE) team at the University of Sheffield can run within the UIMA framework. In addition, many vendors, including IBM, have developed or are developing UIMA-compliant modules, which for intelligence and decision support would typically have the following structure (Figure 21):

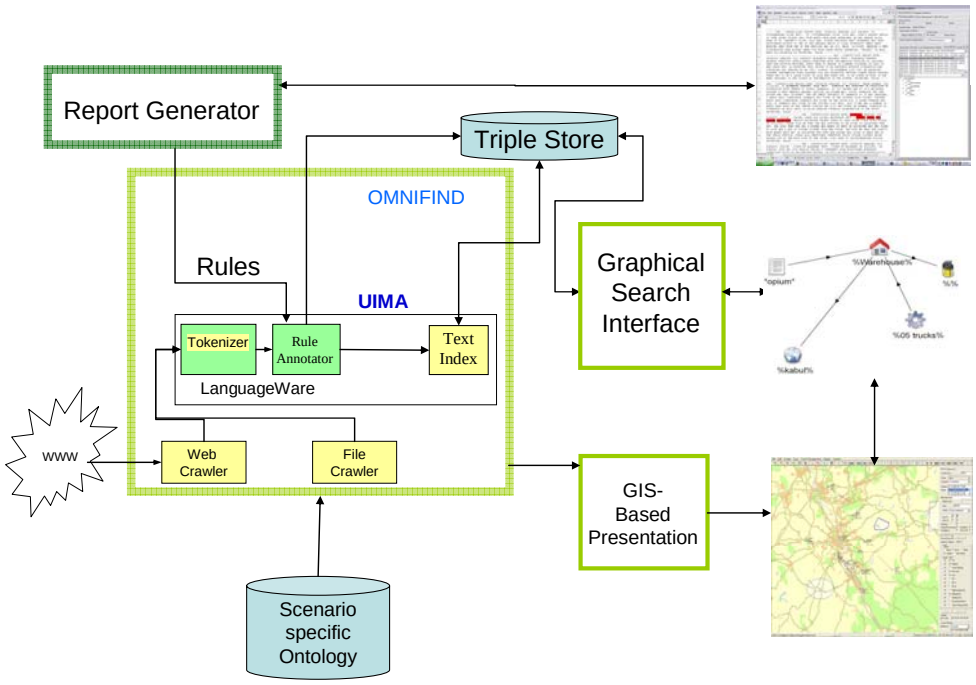

Figure 21: UIMA compliant Entity Analytics Module

Core components are:

- a crawler for various data sources including file systems, databases and internet
- problemspace specific ontologies to achieve semantic understanding of natural language
- text analysis and text mining capabilities as core services
- services for the formalization of natural language (e.g., BML) to enhance interoperability of hybrid service providers
- managers for the geo-spatial context of both structured and unstructured information
- graphical search interfaces to reduce ambiguity in search requests and
- the powerful 2D/3D graphical visualization of search results for timely situation awareness.

Ongoing Research

IBM Research /10/ uses the term ‘continual optimization of business operations and processes’ to refer to the application of a broad set of methods and tools (partly still under development), such as mathematical optimization and special purpose heuristics as well as predictive analysis on combinations of real-time and historical data to update operations plans and assist (collaborative)

decision making, that can be communicated in (near) real time for the purpose of reaching operations' objectives.
In the following a description of the most relevant emerging technologies to increase decision making capability is given.

Collaborative User Experience (CUE)

Activity Centric Computing (ACC)

The concept behind ACC simply is to organize collaborative work around the activities and their goals, not around the tools in use. Innovative collaboration tools bring together all related work and collaborations into a common view for the user, thus supporting complex collaboration needs more effectively by being outcome-driven.
An activity as a unit of work is the collection of all relationships which emerge between people, the materials they work on, their communications and all the processes they need to achieve a common goal, for example to create a situational background picture for operation planning purposes.
IBM research has developed an internally used ACC tool in 2005, which initially supports the sharing of six types of objects: messages, chat transcripts, files, tasks, web links and email. Complex tasks can be structured through sub-activities. Activities and objects have simple metadata attached to them: description, due date and individual tags. Keyword tagging allows for finding related resources across activities. This research product has evolved to an enterprise product: Activity Explorer as part of IBM Workplace Collaboration Suite (WCS) 2.6 /11/. Basically, the application creates an activity dashboard requiring only a web browser and email capacity on the client side. Related research to be integrated in the future includes:

- Social bookmarking (e.g., share and tag bookmarks, private bookmarks for sensitive content, feeds)
- Temporal views on activities (calendar views on meetings, resources and feeds)
- Email activity management (email message correlation with activities shared with sender, activity order based on correlation of names)
- Project management (work activities anchored to project plan, reporting out function, email communication with external participants).

Collaborative Reasoning

The 'Collaborative Reasoning' project focuses on supporting groups in collecting, understanding and reasoning about incoming or historical information prior to decision making and acting. The project will explore user experiences and underlying computational systems in the areas of:

- Collaborative modelling and hypothesis generation
- Collaborative ontology creation and refinement
- Use of models and ontologies as the basis for collaboration, attention management and data collection.

In addition, results shall be used to ensure the future integrity of various NCO domains.

Unified Activity Management (UAM)

As part of the associated Unified Activity Management (UAM) /12/ project, new models for collaborative business applications are developed and shaped into business activity patterns, which by combining single tools with team-work and formal business processes are of increasing value to individuals, teams and the overall enterprise. Business activities thereby undergo early integra-

tion into the development and optimization of business processes and harmonize business operation (Figure 22).

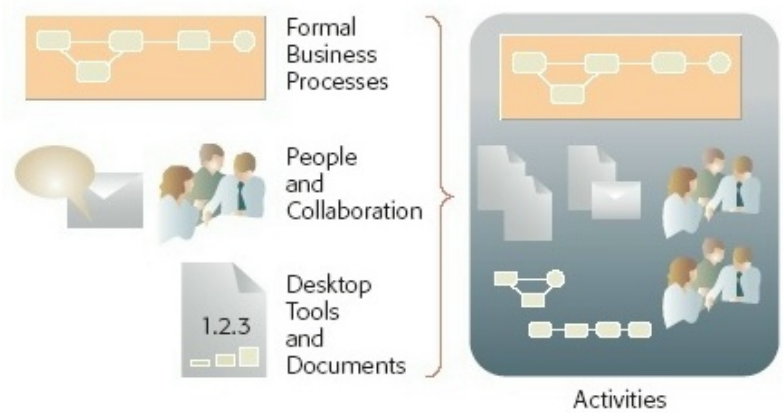

Figure 22: Evolution of business computing

An activity pattern is an activity structure that is suitable for reuse by creating instances to guide the work. ACC brings together disparate computing systems and tools by creating linkages among activity structures and their associated resources; activity management is the use of an activity-centred computing system to manage all the digital elements in a model of collaborative business work. In the context of hypertext and the world-wide web, UAM is defining an explicit ontology for activities, which allows the derivation of activity structures either from patterns or by the users themselves. As web-based technologies will mature, UAM will allow for the discovery and optimization of best practices.

Entity Analytics

IBM Entity Analytic Solutions (EAS) /13/ deal with the analysis of heterogeneous information in distributed sources to provide insight within an information domain. Available are tools to perform the following tasks:

- global name analyis, scoring and recognition in the semantic context of a name reference encyclopedia
- identity resolution: who is who?
- clarification of the issue: who knows who? (identifying relationships and networks)
- complying to existing privacy regulations and necessity for source protection (anonymity of all but wanted entities).

These technologies need to perform core services in any information and intelligence on demand solution within a cross-agency, cross-government and civil-military data sharing environment and therefore are part of the IT foundation for collaborative coalition decision making.
Under development are ready-to-use ontology-based solutions for given tasks, e.g., law enforcement.

Figure 23 shows an example of a result of a social network analysis and its graphical presentation.

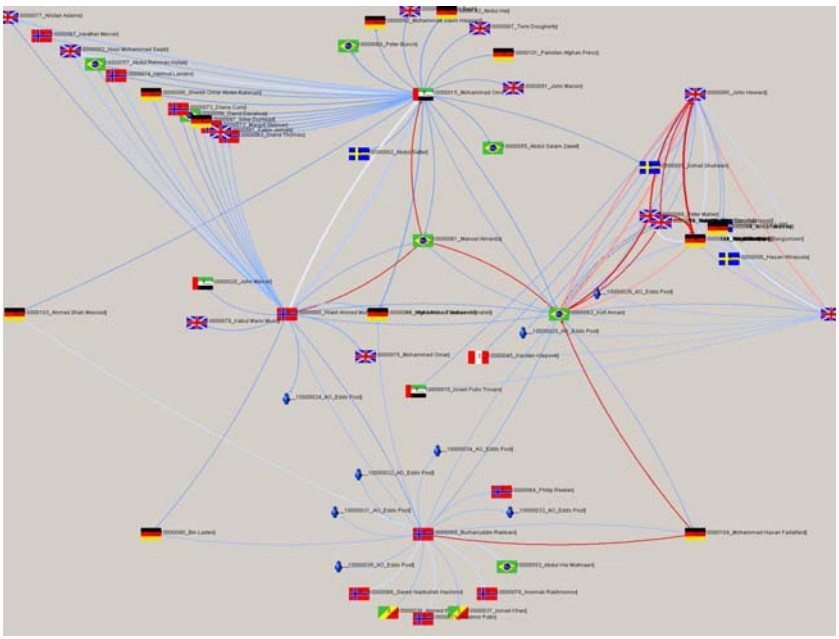

Figure 23: Social Network Analysis Example

Multi-Layer-Security Service-oriented Architecture (MLS-SOA)

The need to share information across the cognitive and social domain of a coalition poses new challenges for information assurance, which needs to be guaranteed across security domain boundaries. IBM is enhancing the core enterprise security services in her service oriented architecture (SOA) foundation to become data-centric by implementing three levels of security governance (Figure 24):

- read-protection through data encryption sensitive and according to classification
- write-protection and prevention of data manipulation through application of strong means for authentication – both for verification and identification of entities in the network
- data dissemination control through trust-able third party guards performing re-classification and encryption services.

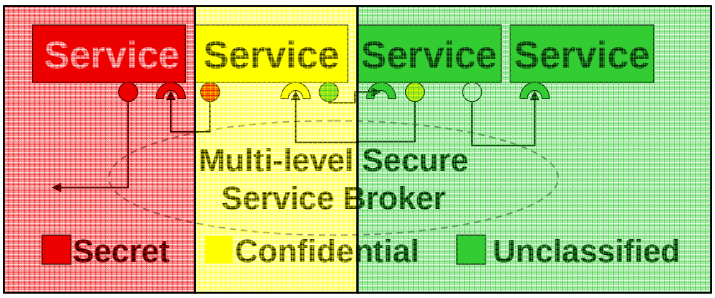

Figure 24: Service Oriented Assurance

Whereas such MLS Broker would have advantages like late binding, implementing it with high assurance seams to proof very difficult and expensive. Research and development therefore concentrates on a distributed implementation over multiple zones with high-assurance guards and minimal assurance for single-level brokers.

Innovative Operations Research (OR)

OR is driven by think tanks within IBM on demand Innovation Services (ODIS, /14/, /15/), the business optimization and analytics micropractice in particular. They apply cutting edge models,

algorithms, software and expertise to solve complex optimization problems. Special focus lies on but is not restricted to:

Large Scale Optimization

This group delivers the robust capabilities to look across a complex global enterprise with varied products, partners, demands and capabilities to determine the optimal operation to improve business results. In the new on demand environment, large-scale optimization as an analytical tool will enable continuous business transformation by determining optimal and timely solutions to complex business problems. The IBM research team has already deployed optimization solutions already for various organizations, for example with complex transport logistics.

Data Mining for Business Intelligence

The Data Analytics Research (DAR) project develops tools and techniques that help organizations to manage risk, to protect themselves from fraud and to more effectively handle their operational relationships. Assets include a variety of knowledge discovery and data mining applications and solutions to produce business intelligence. In an interdisciplinary approach, techniques from artificial intelligence, statistics, pattern recognition and information theory are incorporated. One project seems to have special potential for coalition planning and decision making: web-based automated market intelligence. In the area of unstructured information mining, the DAR has focused on solutions that embed fast algorithms for document matching and clustering, which allow for the structuring and semantic understanding of the information domain.

Resource Allocation under Uncertainty

These services apply novel concepts and methodologies to transform core business processes and to increase the overall efficiency of resource allocation in uncertain environments. The speciality combines analytic methods like optimization theory, statistical modelling, risk management and financial valuation with a collection of IBM developed mathematical models, algorithms and software implementations. Sample offerings include:

- predictive modelling and stochastic optimization for process improvement
- performance tracking and monitoring through real-time prediction of key quality metrics
- ‘ABS-2’ is a software solution that is used to model the allocation of scarce resources. It can be effectively used to forecast service demands associated with delivery windows.

Modelling and Simulation

Stochastic modelling and simulation techniques can be used to predict the performance of complex engineering and information systems that are characterized by uncertainty. These methods provide means of comparing alternative designs or operating policies, as well as performing “what-if” analyses for existing systems. A formal mathematical model mimics the system of interest and the behaviour over time is being simulated using computer power. Analysis is performed afterwards using statistical methods.

Combinatorial Optimization & Scheduling

Advanced optimization techniques are applicable to customer unique problems in manufacturing, transportation, distribution tasks re-sulting in optimized schedulers.

Active Integration

This research initiative intends to provide technology to allow organizations to become "sense and respond" ones. The technology will enable analytic processing to proceed concurrently with operational processing of data with timely feedback to the primary operational system. Active integration is real-time constrained integration of otherwise independent operational processing.

Business Architecture

This work stream provides tools and techniques for analyzing and modelling all aspects of individual or collectively networked organizations. Examples include nets of organizational capabilities, resource access, process and work flow, formal and informal or social organization networks, and the links between them. Understanding the organization through multiple views and from various angles is critical to effective transformation of complex business systems – a business architecture~~s~~ helps to achieve~~s~~ this transparency.

User Interface Technologies

UIT /16/ centers on the emerging and future interfaces that support human-computer interaction. UIT research focuses on the enabling technologies that help computers 'hear' (speech and speaker recognition and verification), 'see' (face, gesture, gaze and hand-writing recognition and object identification and tracking), 'speak' (speech synthesis, facial synthesis) and 'sense' (affect recognition, sensor technologies), and to understand and combine these in multimodal ways.
The latest outcome of this work are advanced, two-way 'speech-to-speech' translators, commonly named "Multilingual Automatic Speech Translator" (MASTOR), which especially improve the communication between English and Iraqi Arabic speakers, but provide for the addition of further languages.

Ethnographically Informed Design

Ethnographic research yields insight into individuals' everyday experiences, enabling organizations to develop and deploy useful technologies and organizational practices to achieve operational goals. It occurs in the context of a populations' work and life, allowing researchers to more fully comprehend a range of influences on behaviour (human factors). The ethnographic approach is a structured analysis of people's activities which includes observing how they interact with tools, services and products, and how they make decisions and get things done. Ethnographic analysis enables the creation of representations of everyday experiences that pave the way for designing effective organizational practices and for leveraging current technology investments by understanding the human, social and cultural dimensions of work and life.

Project References

To encourage further readings, we state just a few references for adoption and usage of some of the available and emerging technologies for enhanced decision support listed above:

- **Coalition Warrior Interoperability Demonstration (CWID 2007)**
  is a message broker based ESB including a web services repository has proven itself as managing communication infrastructure to leverage service orientation in a network-centric environment. In addition, first adaptors to legacy systems and semantic metadata models (e.g., MIP) have been developed.
- **Translingual Automatic Language Exploitation System (TALES)**
  IBM Translingual Automatic Language Exploitation System is an international news monitoring solution designed to address the exponential growth of broadcast information. Monitoring is done via a search interface that allows an English speaker to search foreign

language content in the English language. It is UIMA-based and –compliant and currently available for modern standard Arabic, Iraqi Arabic, Mandarin Chinese, Englisch and Spanish. /17/

- **Realtime(RT)-CEP**-Proof-of-Concept
  CEP isin principle real-time capable; restricted only by missing yet determinism in RT Linux and RT Java. In IBM laboratory conditions a simulation of an air interception operation has been successfully conducted /18/
- **Interim Strategic-Tactical Imagery Dissemination Architecture (IS-TIDA)**
  IBM proposed a model-driven information dissemination and knowledge management solution (as sketched out in Figure 21) for the Interim Strategic-Tactical Image Intelligence Dissemination Architecture of the UK MoD including MIP-support, C-BML-extensions and STANAG compliance.
- **Danish Ministry of Finance (MoF)**
  Denmark adopted the transformation model as of Figure 15 to reinvent and re-engineer the operations of the MoF.
- **IBM-in-Second-Life (SL)**
  IBM maintains own SL data centres and runs theme related applications, e.g., Lotus Building, SOA Hub or a technology briefing centre. In addition, Sears and Circuit City may serve as IBM references for SL applications. /19/

Anticipated Capability Benefits

In conjunction the described technologies promise capability benefits in the following categories (compared to Figure 8) – this list does not claim to be complete:

- **C2-Organization:**
  dynamically assembled teams and digital communities can provide more flexibility in the command structure and thus make the organization more agile.
- **C2-Methodologies:**
  by being policy-driven, the methodologies will become more declarative, flexible and manageable during operation planning and while the operation enfolds.
- **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.
- **ISR:**
  social network analysis and collaborative business insight will allow for better exploitation of ISR capabilities.
- **Sustainment:**
  the capability to perform immersive training with innovative technologies is only one benefit to be mentioned.
- **Protection:**
  entity analytics for identification, CEP for CBRNE[6] risk detection and counter measure initiation are only exemplary use cases of innovative technologies.

Summary

The technologies around socio-semantic computing have created a shift to a demand-driven self-serving culture among users, expecting to find content easily and complete tasks on their own. Independent of an organization's mandate, transition is more about people rather than products or services.

[6] chemical – biological – radioactive – nuclear - explosive

In the space of the internet this trend is manifested by the vast emergance and rising importance of user-generated and user-maintained content within the web. To make that content accessibly for relevant communities and provide for effective navigation becomes the growing challenge for web design. Collaborative capabilities are influencing search using an information architecture and metadata models (ontologies).

This paper has described the state-of-the-art technologies also covering the aspect, that usability of IT – human factors – is about designing for human limitations of cognition and perception. Therefore, M&S needs to be performed more in virtual and augmented reality, personas being the simulation objects to collaborative with people – including the soft factors of persuaion, emotion and trust.

Semantic modelling of military organizations and operations makes the adoption of these technologies for coalition engagements possible.

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A.3 Abbreviations

2D/3D	Two-/three-Dimensional
ACC	Activity Centric Computing
API	Application Programming Interface
BDD	Business Driven Development
BI	Business Intelligence
BML	Battle Management Language
BPDM	Business Process Definition Metamodel
BPEL4WS	Business Process Execution Language for Web Services
BPM	Business Process Management
BPMN	Business Process Modelling Notification
C2	Command and Control
C4ISTAR	Communication, Collaboration, Command, Control, Intelligence, Surveillance, Target Acquisition and Reconnaissance
CBM	Component Business Model
CBRNE	Chemical, Biological, Radioactive, Nuclear, Explosive
CC	Command and Control
CCIS	Command and Control Information System
CCRP	Command & Control Research Program
CEP	Complex Event Processing
CIE	Collaborative Information Environment
CIMIC	Civil Military Collaboration
CJTF	Coalition Joint Task Force
CNO	Computer Network Operations
CUE	Collaborative User Experience

CWID	Coalition Warrior Interoperability Demo
DAR	Data Analytics Research
DC	Digital Community
DCJTF	Deployable Coalition Joint Task Force
EA	Enterprise Architecture
EAI	Enterprise Application Integration
EBAO	Effects-Based Approach to Operations
EDA	Event-Driven Application
EPA	Event Processing Agent
ESB	Enterprise Service Bus
GIG	Global Information Grid
HQ	Headquarter
http	Hypertext Transport Protocol
I3	Integrated Information and Intelligence
ICCRTS	International Command & Control Research and Technology Symposium
IoD	Information on demand
ISR	Intelligence, Surveillance and Reconnaissance
IS-TIDA	Interim Strategic-Tactical Image Intelligence Dissemination Architecture
IT	Information Technology
LKIF	Legal Knowledge Interchange Framework
M&S	Modelling and Simulation
MASTOR	Multilingual Automatic Speech Translator
MDA	Model-Driven Architecture
MDBT	Model-Driven Business Transformation
MDD	Model-Driven Development
MIP	Multilateral Interoperability Programme
MoD	Ministry of Defense
MoF	Ministry of Finance
NATO	North Atlantic Treaty Organization
NEC	Network Enabled Capabilities
NRF	NATO Response Force
OASIS	Organization for the Advancement of Structured Information Standards
ODIS	on demand Innovation Services
OR	Operations Research
SBVR	Semantics of Business Vocabulary and Business Rules
SCOTS	Standard-Based Commercial of the Shelf
SL	Second Life
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
	Service Oriented Access Protocol
SOF	Special Operations Forces
SOMA	Service Oriented Modelling and Architecture
Stanag	NATO Standardization Agreement
TALES	Translingual Automatic Language Exploitation System
UAM	Unified Activity Management
UIMA	Unstructured Information Management Architecture
UIT	User Interface Technologies
WWW	World-wide Web
XBRL	eXtensible Business Reporting Language
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 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 NCO and the evolution of the supporting GIG (global information grid). She has joined the IBM Defence team more twenty-five years ago, after achieving her Masters Degree in Mathematics in 1981.

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