

# The TrustCoM

## General Virtual Organization Agreement Component

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### Abstract

The TrustCoM framework offers a paradigm for automating trust, security and contract management in dynamic VOs. In TrustCoM, contracts are the key means to steer VO collaborations and to mitigate risks inherent in integrating processes and resources across organizational boundaries. The General Virtual Organization Agreement (GVOA) is central to this concept of management through agreements. It encapsulates collaboration rules, policies and service level agreements at both the VO and member levels. The GVOA also incorporates legal aspects of the VO relationship to expedite dispute settlement. As the “rules of the game”, the GVOA states the terms of reference for a VO throughout its lifetime. We have developed a GVOA Manager as part of the VO Management component for the TrustCoM reference implementation and present here an overview of its design and usage within the framework.

### Background

One of the objectives of the UK e-science programme is to develop technologies in the scientific environment which can be transferred to application in the broader commercial world. Scientific VOs share resources in a mutually trusting environment where conflicts are mainly resolved through personal relationships. This approach to VO management does not transfer to the use of VOs in a collaborative business environment where trust management requires explicit assurances which are enforceable.

The TrustCoM framework (1) assures secure collaborative business processing in self-managed and highly dynamic virtual organisations (VOs) created on-demand. The framework builds on converging web service and grid technologies to deliver a service-oriented ICT infrastructure for SMEs and large corporations to form collaborations created in response to dynamic business opportunities.

A key feature of the TrustCoM paradigm is the use of legally enforceable contracts defined at the business level to automate the

management of a VO throughout its lifecycle as well as to promote “trustworthy” collaboration (2). Contracts are important enablers of VOs which can compensate for a lack of trust between collaborators (3). A contract can formalise in legal terms and conditions the joint expectations of the VO members and provide material guarantees to safeguard against the failure of individual members to comply.

The first significant approach to contract based service oriented service management was the design of the WSLA service level agreement (SLA) framework for web services by IBM (13), parts of which were subsequently incorporated into WS-Agreement. WSLA defined service properties and metrics for them as well as the XML readable agreement structure. A more comprehensive approach to quality of service (QoS) properties and metrics has been the OWL QoS ontology which supports QoS aware service discovery (12). WS-Agreement was able to express more complex relationships between the service consumer and service provider than WSLA, but it still did not address the legal aspects of the contract (14). In OGSA, contract management

has been focused in the area of job execution and QoS assurance. The OGSi-derived WS-Agreement protocol provides a standard syntax for specifying machine-readable SLAs to facilitate service monitoring. There are other formal and *ad hoc* approaches to electronic contracts. For example, CONOISE-G provides the Semantic Web Contracting Language (4) to represent machine readable SLAs that are enforceable by software agents. GOLD, in contrast, uses the Promela modelling language to represent in electronic forms all the basic parameters that typical business contracts comprise. The Promela representations could then be integrity checked and used in run-time monitoring of service interactions (5). These approaches imply the needs for translating contract terms, commonly the QoS terms from SLAs, to low-level technical terms that can be used to configure and monitor the VO resources.

The TrustCoM approach to legal risk analysis has been described elsewhere (17, 19), which provides the legal basis for the overall risk analysis required for partner selection (18), coalition formation (15) and the negotiation of individual SLAs (16) as parts of contracts between coalitions of self-interested parties. The TrustCoM approach to cooperation risks based upon reputation measures (20, 21) also contributes to the overall risk analysis.

In this paper, we describe the GVOA Manager component that has been developed for the Reference Implementation of the TrustCoM framework and outline the roles and usage of the TrustCoM GVOA as a generic container for VO business contracts, SLAs and access control and obligation policies. Unlike the approaches outlined above, the GVOA is based on natural language but incorporates machine readable policies (see next section). In a business environment, contracts are normally negotiated by liable persons such as managers or lawyers representing the respective partners. Therefore, it makes sense to express the GVOA in a format that is familiar to the business domain.

## 1 GVOA Overview

### 1.1 Main Functions

The GVOA is a legal contract that includes SLAs and policies that all VO members must agree to in order to participate. It specifies in legal terms and conditions the members' obligations as well as the consequent sanctions

used in determining liabilities for contractual breaches (6).

From the technical perspective, the SLAs and policies contained in the GVOA represent trust, security and contract parameters (TSC-controls). These parameters are used in configuring individual VO components and infrastructure services to constrain and monitor the VO interactions. TSC-control references are described in the GVOA in natural language as text in the GVOA body and a machine readable XML format as discrete attachments to the GVOA. These XML attachments are loaded directly into TrustCoM tools as policies (7) to facilitate the configuration and execution of the collaboration. Therefore, the GVOA can be viewed from the technical perspective as a configuration or bootstrapping document.

From the high level framework perspective, the GVOA is a vehicle to integrate legal aspects of trust, security and contract management into the technical architecture of a VO. And a main role of the TrustCoM environment is to map from a contract in natural language that can be legally binding, down to executable policies, business processes for each partner, SLAs for each service and access controls across the distributed services needed to operate the VO (8).

### 1.2 Main Processes

As "rules of the game", the creation of a VO and its evolution is substantially regulated by the GVOA. The GVOA lifecycle is thus tied to the main VO lifecycle. Figure 1 summarizes the main GVOA processes within a VO lifecycle.

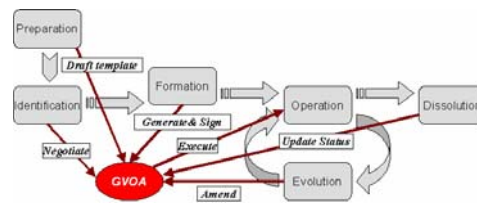


Figure 1: The GVOA Lifecycle

During the Preparation stage, individual organisations join an Enterprise Network (EN, see 7 for a description), stating what they can offer potential VOs as services with stated QoS levels and costs, and agree to participate in negotiations towards VO creation. As an Initiator prepares to form a VO, it defines the objective of the VO, the collaborative business processes required to reach the objective, and contract templates, including the GVOA, as the

starting point for negotiation. This takes place in the Identification phase, once potential VO partners who could fulfil the roles required by the collaborative business process have been identified.

The negotiation leading to the formation of a VO needs to conform to established legal processes (6). Tailoring of the GVOA template into a legally-compliant contract, in particular, demands legal expertise in the VO domain of operation, which is hard to automate. Also, many risks need to be balanced between members of the VO and the negotiation would be influenced by abstract business goals of the partners concerned. This process, again, would be hard to automate. Therefore, both human and automated processes play a part in this stage (see Section 2.2 and Figure 3).

In the Formation phase, the negotiated textual GVOA is generated and each member is obliged to sign it. Once members have agreed to be bound by it, the federation is activated and the VO launches into the Operation phase.

During the Operation phase, services configured with the TSC-controls execute to monitor the enactment of the VO business

processes. If a member's service breaches the agreed cost, time, security or quality requirements, the member will be subject to management or penalty clauses agreed in the GVOA. These could include increased monitoring to prepare for potentially legally contestable action, or the undertaking of such actions as imposing fines, or replacing VO partners. A change in the market environment may also trigger changes to the VO configuration. As there is only one operative GVOA for a VO at any one time, any changes to the VO terms and conditions must be reflected in the GVOA. As a legally enforceable document, there is an obligation to ensure that the correct version of GVOA at any specific point of the VO evolution can be made available.

Once the VO has completed its activity, the VO is dissolved and the GVOA terminated. Certain GVOA articles, such as those covering confidentiality and liabilities issues will remain in force until the final termination of the VO, which may be some years after its dissolution. This requirement reinforces the need to maintain historical records of the GVOA.

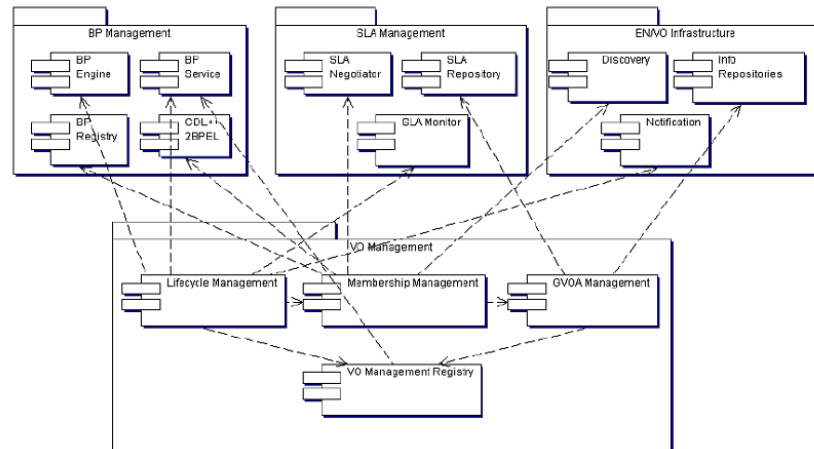


Figure 2: VO Management Sub-system Overview (7)

## 2 The Implementation

The previous section reviewed the main roles and usage of the GVOA in TrustCoM. In this section, we describe the GVOA implementation that supports these specifications.

### 2.1 As Part of the VOM Architecture

The GVOA component is part of the VO Management (VOM) sub-system (Figure 2). The VOM plays a central role in the overall

organization and enactment of VOs within an EN. It is responsible for defining and storing BPMs, VO details and policies, managing VO membership, coordinating the VO interactions and triggering VO lifecycle changes. The GVOA Manager supports the VOM by providing GVOA-specific services, which include:

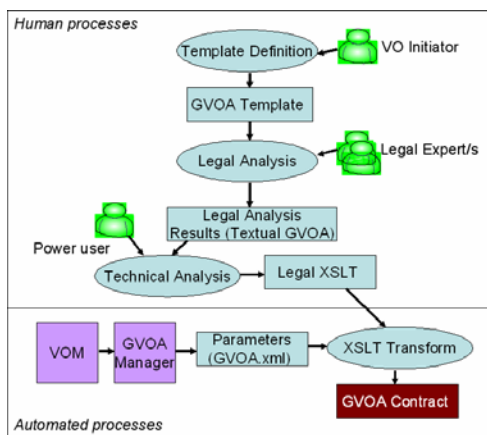
- hosting the GVOA for each VO;
- managing the creation and evolution of the GVOA for a VO as membership changes

and as new policies are defined for new roles; and

- maintaining a repository of GVOAs for VOs within the EN.

## 2.2 GVOA Design Overview

As there are significant human input to the definition and negotiation of the textual GVOA, it is clear that the GVOA processes cannot be fully automated. Although the US military has largely automated the creation of simple procurement contracts (22), the legal system is based around judicial opinion, and expert opinion, so any attempt to fully automate the process of contract formation will fall foul of the legal establishment (23). The TrustCoM approach is to base contract negotiation on templates that are manually created and analysed prior to their usage within automated processes (see the Preparation phase of section 1.2 above). This design enables part automation of the contract management processes.



**Figure 3:** Integration of Human Processes

Figure 3 gives an overview of using a handcrafted XSL stylesheet to accommodate human input into the generation of the textual GVOA contract. The XSL stylesheet can be amended by a non-programmer at various stages of the GVOA lifecycle and applied to a core set of GVOA parameters captured in an XML document by automated VOM processes to derive the legally-compliant textual GVOA.

Following this approach, we identified three main parts for the GVOA component:

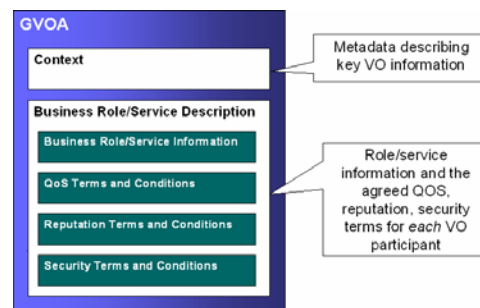
- the GVOA XML template;
- the GVOA Manager; and
- the GVOA Repository.

## 2.3 The GVOA XML Template

An XML template is used to encapsulate the core GVOA parameters for VOs operating within the TrustCoM framework. Conceptually, the GVOA XML structure (Figure 4) comprises two main sections (9):

- Context – represents meta-data describing the VO, eg. name, objectives, validity period, membership etc. This information maps to the main business and legal terms and conditions of a VO.
- Business Role/Service Description – represents specific information on each business role defined in the collaboration definition, including information/references to the service provided by the role, the agreed terms and access policies. This information defines the technical configuration and operational constraints of the required VO infrastructure.

As mentioned above, the GVOA XML will be generated by the GVOA Manager using data derived from other VOM processes, eg. membership management.



**Figure 4:** The GVOA XML Structure

## 2.4 The GVOA Manager

The GVOA Manager is an interface to the GVOA repository (see next section) and exposes operations for the VOM to manage GVOAs for VOs operating within the EN.

In the current Reference Implementation, SAP's VOM Toolkit (10) is used as the VO Manager software. The application is built on Java JSP and Axis web service technologies supported by third party components such as Tomcat, Juddi and MySQL. The VOM Toolkit comprises three separate software editions. Each offers user interfaces and functionalities tailored to support the three key VO roles: Host, Initiator and Member.

The VOM Host software provides the infrastructure to connect the various VOM software editions and supports common VOM services. As one of these services, the GVOA

Manager has been deployed on this platform (Figure 5). The interface is implemented as a doc/wrapped style java web service and currently provides 14 operations (Figure 6) for the VOM to create or retrieve a GVOA, amend VO roles, add and update TSC-controls, etc.

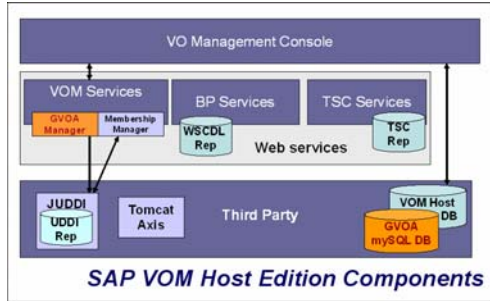


Figure 5: GVOA Manager Deployment

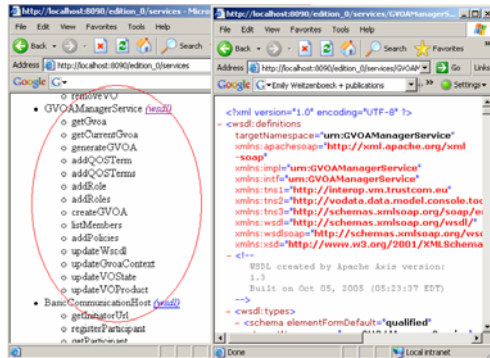


Figure 6: A Snapshot of the GVOA Manager Web Service

## 2.5 The GVOA Repository

The GVOA repository provides backend database support to the GVOA Manager. Figure 7 gives the database schema of the repository. The schema provides temporal support for the GVOA XML and XSL templates as well as artifacts for TSC configurations. Attributes which have already been replicated into the GVOA XML, such as the individual QoS Terms and VO Context, will be overwritten as fresh data is loaded. Storing a snapshot of the current GVOA in relational format facilitates the GVOA creation and re-creation processes.

When a GVOA parameter is updated, only the relevant piece/s of data in the database table need updating without having to perform many expensive XML manipulations. The design is also more flexible than alternatives as the GVOA XML template and textural GVOA contract can be generated on demand when a snapshot is complete, rather than by default.

## 3. Create GVOA Example

To illustrate the application of the GVOA Manager component, we present a concrete example based on the createGVOA operation (Figure 8). The operation is invoked by the VOM Initiator when the VO is ready to go into the Operation phase. (In the current TrustCoM framework, negotiation is handled by the VO Manager and restricted to a single round of offer-acceptance [see 6].) The createGVOA operation involves the GVOA Manager interacting with different VOM components to extract, transform and load the data to the GVOA repository. The process completes with the textual GVOA legal contract together with the SLAs/policies being written to the VOM Host.

Other components within the VOM system (see Figure 2) are responsible for the configuration, monitoring and enforcement of the policies defined in the GVOA. For example, the executable versions of policies are loaded into the policy subsystem where they will execute when the security, SLA or BPM subsystems raise the specified trigger events. Events are communicated to the appropriate components through a subscription based notification service. A detailed description of the enforcement process is beyond the scope of this paper but a discussion of the TrustCoM SLA enforcement process is given in 11.

## 4. Conclusions

The management of dynamic commercial VOs is the key research issue for TrustCoM. In contrast to academic grids, TrustCoM seeks to provide a secure environment where collaboration risks are managed through legally enforceable contracts expressed in business terms. We have highlighted how the GVOA is used to introduce a legally enforceable framework to bring non-technical elements into the TrustCoM technical architecture. The GVOA could accommodate both qualitative and quantitative clauses, such as confidentiality and QoS terms respectively. We have also described the design and usage of the GVOA component. The main innovation of the GVOA is to provide a generic vehicle to capture and refine legally enforceable contractual terms and conditions into deployable processes that monitor and enforce them. Although some work remains to resolve data provenance, contract signing protocol, processes to support GVOA modification during VO evolution, we feel that the work will be of interest to anyone

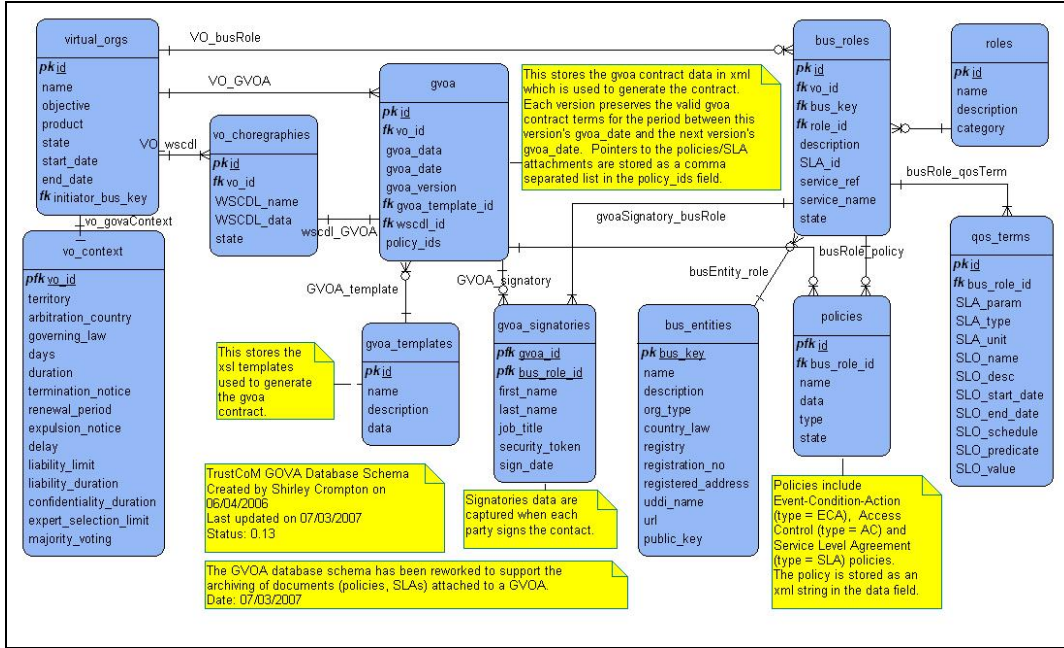


Figure 7: Database Schema for the GVOA Repository

working with VO management technologies.

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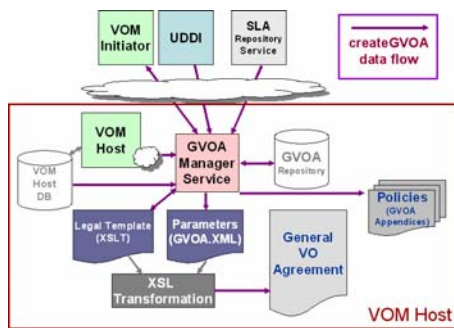


Figure 8: The createGVOA operation

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