Enterprise Architecture Special Interest Group
(EA-SIG)
Collaboration Working Group
An Analysis of Collaboration in the GIG Enterprise Services

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Introduction

1 Scope

The focus of collaboration services discussed in this white paper is on applications that directly support user interaction and on the applications that monitor, manage and control these interactive services.

2 Collaboration Description

The following sections attempt to provide a description of what collaboration services are. The intent is to provide a comprehensive picture of what is meant by 'Collaboration' in the context of GES. This section attempts to describe our vision of the future of Collaboration in GES.

2.1 Collaboration Overview

As a starting point, the following general descriptions of collaboration are provided.

> *"This activity provides and controls the shared resources, capabilities, and communications that allow real-time collaborative interactions among participating group members. This environment provides synchronous collaboration capabilities; asynchronous collaboration can occur through other net-centric services and applications that are provided within the information environment." – NCOW*

Noteworthy to this description is the idea that collaboration and communications are integrally related. Another key point in the above description is that collaboration only includes real-time, synchronous, services. In this paper we have included non-real-time and asynchronous capabilities, but appreciate that these services will rely very heavily – perhaps entirely – on other services.

> *"These services allow users to work together and jointly use selected capabilities on the network—for example, chat, online meetings and work group software."– D. Meyerriecks, Net-Centric Enterprise Services*

This second definition includes the idea that there are actually many collaboration services and that users should be able to select 'a la carte' from a list.

Drawing from and embellishing on these descriptions, collaboration services are ultimately envisioned to make it very easy for groups of people to communicate together and to coordinate their activities. Collaboration services should be composed of many separate capabilities that facilitate communication. Users should be able to pick and choose from the capabilities that best support the information they are trying to communicate.

The services need to be ubiquitous enough so that all users have equal access. If there are users to whom the services are not available then communication with those users has been obstructed. It is understood that users in bandwidth constrained environments, or with specialized hardware for example, may not be able to fully utilize all services, but the services should nonetheless be available.

The services need to be as simple as possible for users to employ. Users should be presented with an intuitive interface and should not be required to understand underlying technical architecture issues. The services themselves need to be resilient enough to withstand any sort of user input without becoming unstable or unusable.

Furthermore, the services should be accessible through a programmatic service-oriented interface so they can be embedded within military applications in addition to being delivered to the user through stand-alone tools. Similarly, the collaboration services should be well integrated with other NCES services (security, discovery, etc.) to ensure that they themselves are "good citizens" within the NCES service-oriented architecture enterprise.

The services should be reliable. The services should be available whenever required with effectively no noticeable downtime. Collaboration services should be as available as commercial telephone services.

The services should provide quality experience to users.

2.2 Collaboration Services

The following sections describe a wide variety of common collaboration services and attempt to taxonomize or categorize them. The intent was to provide as comprehensive a list as possible, but it is understood that some services may have been overlooked and still others may not have even been conceived yet.

2.2.1 Definitions

First, a few definitions will help distinguish various collaboration services.

Asynchronous: Services that enable communication by users that are not concurrently accessing the service. E-mail is an example of asynchronous collaboration.

Persistent: Describes service that maintains state as time passes. The state will remain constant until acted on by a user.

Real –Time: Describes a service that provides output at (nearly) the instant of input. Desktop video teleconferencing is the classic example of a real-time service.

Synchronous: The opposite of asynchronous, this implies that users are interacting simultaneously.

Most collaboration services are either Persistent and Asynchronous or Real-Time and Synchronous.

2.2.2 Interactive Collaboration Services / Applications

Interactive Collaboration Services are those services most often associated with collaboration. These services support users directly and provide them with the support to conduct interactive collaboration. Examples of Interactive Collaboration Services include:

Presence Awareness – This provides the user with the ability to determine who is on line at a given instant in time. This awareness is sometimes restricted by a user to only include awareness of those persons of interest (e.g., "buddy lists").

Chat – This service provides the ability for multiple users to type text data onto their local device and the text can be seen by other chat session participants. Text may also be sent privately between a pair of session participants. Chat sessions may be logged for review at a later time.

> Multi-Chat – This service is a special case of the Chat Service. This provides users the ability to actively participate in multiple simultaneous chat sessions using a single interface. It provides users a way to monitor and collaborate with many simultaneous Communities of Interest (COIs).
>
> Persistent Chat / Discussion Threads – This is another special case of the Chat Service. The distinction is that chat messages posted by collaboration participants remain visible, or at least retrievable, indefinitely.
>
> Broadcast Chat– This service is a special case of Chat. This service provides certain privileged users the ability to send a chat message to multiple (usually all) chat sessions simultaneously. This type of service is generally used for announcements or alerts that apply to all, or at least many, users. The Broadcast Chat service is typically one-way. That is, a privileged user may send the chat to all of the chat sessions, but users of those sessions are typically not able to respond.
>
> Ticker – This is another special case of the Chat service. It is similar to Broadcast Chat in that it gives privileged users the ability to post messages that are visible to all logged-in users. It differs from Broadcast Chat in that the messages posted are usually displayed outside of the chat tool itself. The Ticker service is also a one-way means of communication. There is no way for users to interact with the Ticker.

Instant Messaging (IM) – Instant Messaging services combine Presence Awareness and Chat and add the ability for a user to be explicitly notified of incoming messages. By employing an IM service a user is freed from actively monitoring on-going chat activities. Instead, the service actively prompts the user whenever there is chat activity directed to that user.

Polling / Surveying - This service provides the ability for a user to request a vote from other collaboration participants. Typically, a collaboration session leader or a key decision maker will post a question to a polling service (similar to Chat), other participants will be presented with a list of possible reactions (usually 'yes' or 'no'). Individual selections may be visible to all, to a privileged few, or the service may simply return the overall result. Likewise, results may or may not be archived.

> Emoticons – This is a special case of the Polling or Surveying service. This service provides the ability for users to select specific icons that depict typical human actions (hand raising, applauding, frowning, laughing, etc.) that can be displayed to other collaboration users. This is like an unrequested response. It provides users a non-interruptive way to participate and register their reactions in real time.

Whiteboarding – This service provides a user with the ability to interactively manipulate graphical objects with other users. Users are generally provided with a rudimentary set of drawing tools (shapes, lines, text, colors, etc.) and anything one user draws on the shared whiteboard is visible to all other users. The Whiteboarding service also allows users to cut and paste into and out of the whiteboard.

> Geo-Registered Whiteboarding – This is a special case of the Whiteboarding service in that it also provides the ability to import or paste in graphical data that includes geographical information (e.g., Lat./Long.). An example of this would be pasting an image of a target onto a map. Using a Geo-Registered Whiteboarding service the image would appear in the correct location on the map.
>
> Persistent Whiteboarding – This is a special case of the Whiteboarding Service. The distinction is that the shared whiteboard remains available indefinitely and constantly reflects the latest changes.

Application Sharing / Desktop Sharing / File Sharing – The Application Sharing service provides users with the ability to display local applications they select on other users' screens. Application Sharing also provides the ability for a user to allow another user to control the shared application. The application remains running on the sharers computer. It is just the graphical output, and potentially the user input, that is made available to others. This service can be employed to allow multiple users to update a single document interactively, or it could allow a user having trouble with an application (even their OS) to allow another remote user to have control. The purpose of the latter would be for troubleshooting, correcting or maybe just educating.

> Application Following – This is a special case of the Application Sharing service in that it does not allow other users to control the sharers application. This type of collaboration is generally used when one person is presenting information to others, such as someone giving a PowerPoint briefing.

Shared Storage - This service provides multiple users with a common place to upload and download files. This is perhaps one of the most common and basic of all collaboration services.

> Distributed Product Management – This service is similar to shared storage except that users are provided a mechanism that can automatically track changes to and provide versions of documents, code or other collaboratively developed artifacts. The service could also provide the capability for users to split documents into smaller pieces which could be separately tracked and controlled, but could ultimately be collated into a single product. This facilitates the control of large, complex documents, or code.

File Transfer – This service enables a user to transfer a file to another user or set of users.

Shared Calendars / Scheduling – This service provides a group of users with a common calendar that all may directly interact with. This service allows different users to query the availability of other users and/or resources at given dates and times. It allows leaders to provide a common schedule that all may view, and potentially manipulate, directly. A great example of a commercial application that provides this service is Microsoft Exchange.

Real-Time Multipoint Audio – This service provides users the ability to participate in audio conferences with multiple other users. This service is essentially the same as a Teleconference, except that users are able to use their computers instead of their telephones.

Real-Time Multipoint Video – This service is similar to the Real-Time Multipoint Audio service described above except that this service supports the transmission and receipt of video instead of audio. This type of video is usually from an individual camera connected to a collaboration participant's PC.

Audio Broadcast – This service provides a user the ability to send audio to many different listeners, but does not allow them the ability to be heard. This is suited for such activities as announcements or informational briefings.

Video Broadcast – Again this service is similar to the Audio Broadcast service but provides for video instead of audio. This type of video service may include standard user video from their desktop PC, but may also include surveillance cameras or full motion imagery from ISR assets.

2.2.3 Collaboration Support Services

Another potential set of services provided by the Collaboration Core Service could be a set of support services that augment or enhance the Interactive Collaboration Services. Some examples are listed below:

Gateway Service – This service could enable translation from one set of collaboration protocols to another.

> Language Translation Service – This service could be coupled with Chat, IM, or maybe even Audio services to enable collaboration amongst persons with multiple different languages.
>
> Audio to Text / Text to Audio – This service could provide users in bandwidth constrained environments, or users without audio equipment, the ability to "see" audio collaboration and to respond interactively.
>
> Protocol Gateway Service – This service could enable users with different collaborative applications, built on slightly different standards, a way to work together.

2.2.4 Collaboration Management Services

Outside of these Interactive Collaboration Services there is a requirement for a set of services that manage and control collaboration across the enterprise. These services will be grouped as Collaboration Management Services.

There are many users that require many different types of the Interactive Collaboration Services described above to support a variety of functions. The core Collaboration Service should include the capability to link those users up in the best way possible. The input to this service would be a description of the specific users - or organizations, or networks - the types of Interactive Collaboration Services that are wanted, and the schedule (including projected lifetime). The Collaboration Management Service would find the users (potentially using the Discovery Service) and would determine what types of Interactive Collaboration Services they could support (because of bandwidth, or firewall limitations or tool availability, etc.). The service might need to

appropriate Collaboration Support Services such as Protocol Gateway services, or Language Translation Services. The Collaboration Management Service would create an instantiation of a set of Interactive Collaboration Services as close to the original request as possible. This would include authorizing access for specific authenticated users. It may also include providing bandwidth reservations or allocations or requesting storage space from the Storage Service. The Collaboration Management Service would also respond to the requestor with the appropriate information to access the Interactive Collaboration Services.

Once the Collaboration Management Service had initiated a set of Interactive Collaboration Services as requested, the next time the same set of users wanted to use the tools, the Collaboration Management Service would simply re-validate the network, and the end connections (potentially making changes). Examples of these services include:

Environment Creation – This service creates virtual spaces for users to collaborate in. This involves provisioning the Interactive Collaboration Services that are requested (subject to availability). This service may request bandwidth allocations from the network, or might configure Interactive Collaboration Services to compensate for a bandwidth poor environment (by changing codecs for example). The service may also request storage space from the Storage Service. Finally, this service authorizes which authenticated users are permitted to use the virtual space.

Session Management – This service is invoked to manage and regulate synchronous collaboration sessions involving multiple users, e.g., when users attempt to access the virtual space or use specific Interactive Collaboration Services associated with the space. Sessions may be initiated, split, merged, subsetted, coordinated, monitored, audited, and archived. Sessions can be managed using a variety of control and permission policies and models and can be public or private. Session state can be persisted and restored and session histories can be stored and archived. Session Management Services interact with Security Services to ensure users are properly authenticated. This service could dynamically reconfigure Interactive Collaboration Services to accommodate for changing network conditions.

2.3 Collaboration Usage Scenarios

Collaboration services support any decision making, planning, coordination, or consultation activities involving multiple parties that are not co-located. The more multi-faceted the problem is, the more this type of technology is required. Collaboration services minimize the N^2 communication problem by providing a common focal point for information sharing.

Potential uses of collaboration services include, but are by no means limited to:

- E-Learning
- Medical Consultation (NOT = Telemedicine)
- Workflow Management
- Decision Making Support and History Archive
- Mission Planning
- Logistics

The following two scenarios attempt to describe how collaboration services might support the decision-making processes of a fictitious Joint Task Force (JTF)

2.3.1 Scenario 1 – Ad Hoc Community of Interest (COI) Supporting JTF Decision

There are times when a decision must be made by the JTF which would benefit greatly from the input of someone with particular subject matter expertise that is outside of the core JTF staff. In such a case, the collaboration tool

would support the ability of the JTF to quickly set up collaboration sessions with Subject Matter Experts (SMEs) from various locations.

In this scenario an ad-hoc COI is brought together in a collaboration session to facilitate a decision on a time sensitive target.

Figure 3-1 is meant to graphically depict the scenario described below.

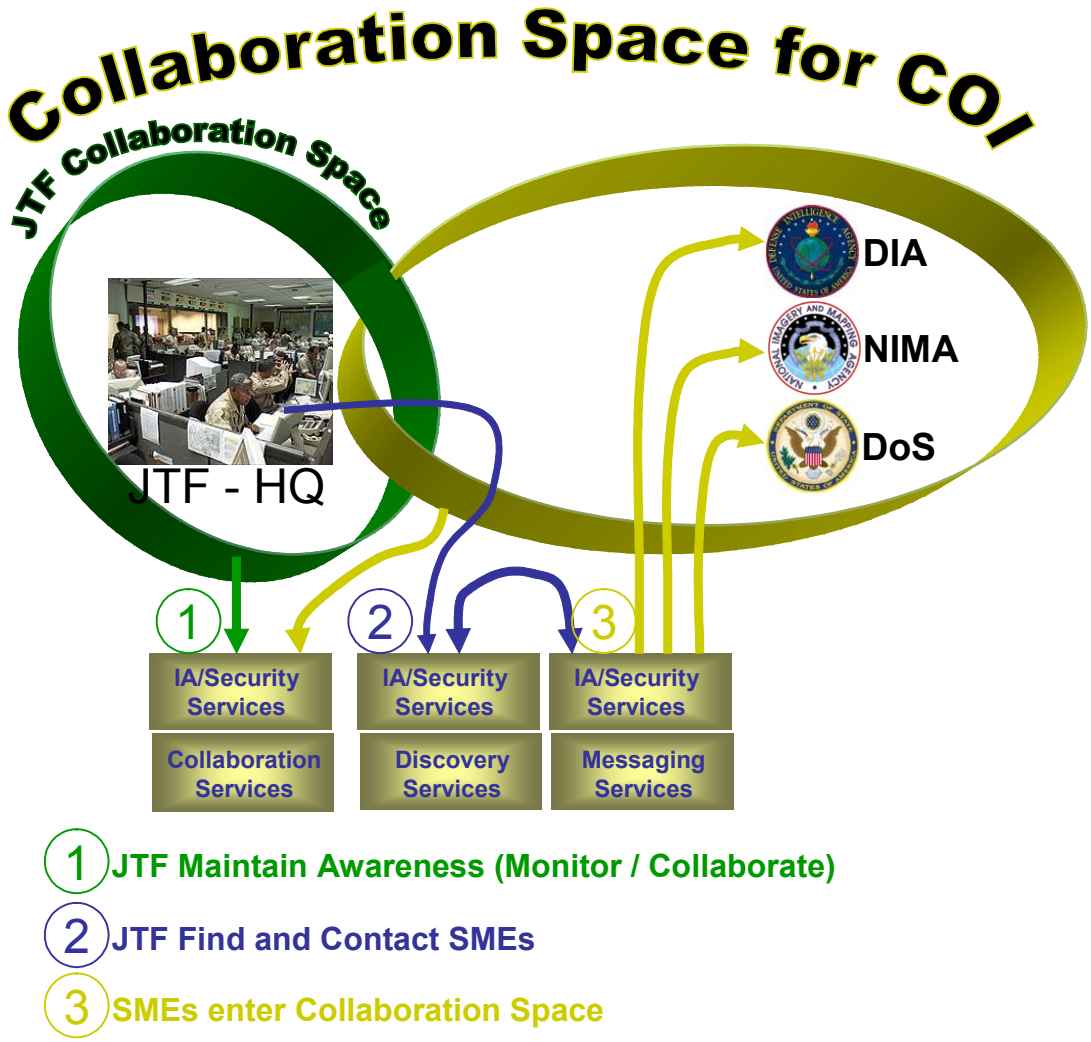

Figure 3-1 Ad Hoc COI

From Inside JOC

A core set of JTF staff continuously and actively monitors an alert service. This alert mechanism is outside the scope of the collaboration system itself. Those core staff members also continuously and actively monitor a chat window on a pre-specified collaboration session. When an alert is received that requires a course of action to be developed or decision to be made, the senior JTF staff use the collaboration system to communicate to all monitoring staff the critical information requirements for the decision and assign responsibilities for gathering said information. The senior JTF staff will also specify a time (perhaps simply ASAP), a list of required attendees and a virtual location for convening a collaboration session to facilitate the decision.

Core staff will be responsible for finding the required information or of discovering subject matter experts and notifying them of the requirement to participate in a collaboration session. The set of persons identified (maybe

some by function only at this point) that will be involved in working the particular issue will be called a Community of Interest (COI).

The Collaboration Service will provide the ability to create/initialize a collaboration space for use by the COI. This could be a simple scheduling issue involving some available pre-configured space. This step will also require configuring authorization for authenticated COI members.

At the designated time, COI members will securely authenticate themselves to the pre-specified collaboration session. The collaboration session will offer the standard collaboration services (Audio, Video, Application/Document sharing, Text Chat, Shared Whiteboard and File Transfer). The session will also likely involve shared annotation and verbal discussion of high-resolution imagery. During the session Core JTF Staff will still be required to monitor alerts and the core JTF Staff text chat session.
After the senior JTF staff has decided that COI collaboration is no longer required, the Collaboration Service will dismantle the collaboration space or return it to an availability list.

From Subject Matter Expert

It is not expected that Subject Matter Experts (SMEs) will be monitoring the same alerts that JTF staff are. Instead, SMEs will go about their daily business and only enter into collaboration sessions as explicitly requested by JTF Staff. The method used to notify the SME of a request to participate in a collaboration session will not be provided by the Collaboration Service, but will provide the SME with all of the information required to connect to the collaboration session without assistance.

The process of connecting to the session will employ secure authentication so that the JTF can be certain that they have the correct person and no one else.

The SME will enter the collaboration session, provide what assistance they can and ultimately disconnect from the session.

2.3.2 Scenario 2 – Real-Time Monitoring of Multiple Simultaneous Collaboration Sessions

There will be times during crisis operations when a single system operator is involved in multiple simultaneous COIs, supporting multiple, separate decision processes. This situation will be handled in a similar manner as Ad Hoc COIs, but will likely rely on more asynchronous means of collaboration. This is because a user will only be able to operate one set of audio video equipment at a time.

Figure 3-2 is meant to graphically depict the scenario described below.

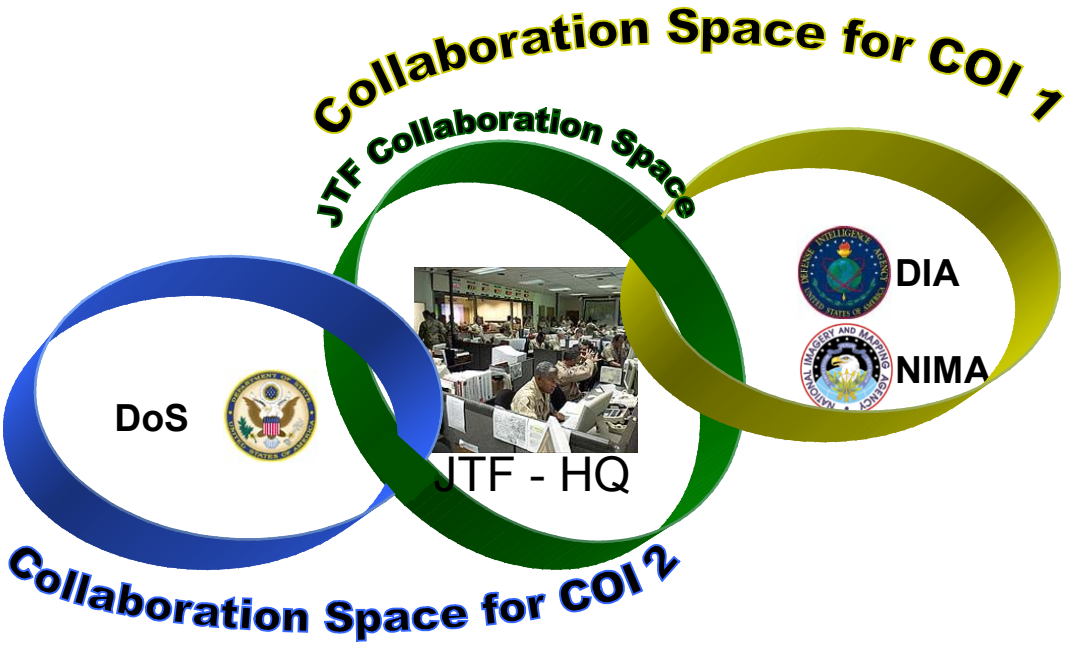

Figure 3-2 Multiple Concurrent Collaboration Sessions

From Inside JOC

As noted in the Ad Hoc COI Scenario, core JTF staff will be required to monitor alerts and a specific chat session at all times. There may be cases where JTF staff members are already participating in a collaboration session when a new alert, relating to an entirely new situation is received. In this case, the senior JTF staff will again communicate critical information requirements and collaboration session parameters (time, virtual place) to core JTF (just as before). The main difference between the two situations is that actual collaboration sessions may be forced to rely on more asynchronous means. Specifically, persistent text chat and data conferencing will facilitate the ability of different parties to enter a particular collaboration space at different times and leave whatever information is required. As other users enter the space, they should be able to see previously posted documents, text chat and whiteboard annotations. Real-time collaboration applications like audio conferencing may also be used, but there may not be a time when all parties are present.

From Subject Matter Expert

In the case that a SME is participating in a collaboration session when they receive a request to enter another, unrelated, session, the SME will behave similarly to JTF staff. The SME will be forced to rely on more asynchronous forms of collaboration like persistent chat and data conferencing.

3 Collaboration Technology

This section will address the state of collaboration as it exists today; commercially, in the standards bodies and as employed by DoD. This section attempts to describe where we are today.

3.1 Collaboration Standards

3.1.1 XMPP

"The eXtensible Messaging and Presence Protocol (XMPP) is an IETF standard for server-to-server IM interoperability and presence awareness."[1]

3.1.2 SIMPLE

"SIMPLE is an add-on to the Session Initiation Protocol (SIP) that some industry insiders predict will be the basis for a new Instant Messaging and Presence Protocol (IMPP). SIMPLE stands for SIP for Instant Messaging and Presence Leveraging Extensions. SIP was originally developed for voice over IP (VoIP), but has since incorporated support for Web conferencing, live video, and other media. SIMPLE is backed by Microsoft, IBM, Sun, Novell, and other industry leaders."[2]

3.1.3 HTTP(S)

"HTTP (HyperText Transfer Protocol) is the set of rules for transferring files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web. As soon as a Web user opens their Web browser, the user is indirectly making use of HTTP. HTTP is an application protocol that runs on top of the TCP/IP suite of protocols (the foundation protocols for the Internet)."[3]

"HTTPS (HyperText Transfer Protocol over Secure Socket Layer, or HTTP over SSL) is a Web protocol developed by Netscape and built into its browser that encrypts and decrypts user page requests as well as the pages that are returned by the Web server. HTTPS is really just the use of Netscape's Secure Socket Layer (SSL) as a sublayer under its regular HTTP application layering. (HTTPS uses port 443 instead of HTTP port 80 in its interactions with the lower layer, TCP/IP.) SSL uses a 40-bit key size for the RC4 stream encryption algorithm, which is considered an adequate degree of encryption for commercial exchange."[4]

3.1.4 XML

"XML (Extensible Markup Language) is a flexible way to create common information formats and share both the format and the data on the World Wide Web, intranets, and elsewhere. For example, computer makers might agree on a standard or common way to describe the information about a computer product (processor speed, memory size, and so forth) and then describe the product information format with XML. Such a standard way of describing data would enable a user to send an intelligent agent (a program) to each computer maker's Web site, gather data, and then make a valid comparison. XML can be used by any individual or group of individuals or companies that wants to share information in a consistent way.

XML is 'extensible' because, unlike HTML, the markup symbols are unlimited and self-defining. XML is actually a simpler and easier-to-use subset of the Standard Generalized Markup Language (SGML), the standard for how to create a document structure. It is expected that HTML and XML will be used together in many Web applications. XML markup, for example, may appear within an HTML page. "[5]

3.1.5 SOAP

"SOAP (Simple Object Access Protocol) is a way for a program running in one kind of operating system (such as Windows 2000) to communicate with a program in the same or another kind of an operating system (such as Linux) by using the World Wide Web's HyperText Transfer Protocol (HTTP) and its Extensible Markup Language (XML) as the mechanisms for information exchange. Since Web protocols are installed and available for use by all major operating system platforms, HTTP and XML provide an already at-hand solution to the problem of how programs running under different operating systems in a network can communicate with each other. SOAP specifies exactly how to encode an HTTP header and an XML file so that a program in one computer can call a program in another computer and pass it information. It also specifies how the called program can return a response." [6]

3.1.6 T.120

"The International Telecommunications Union (ITU) T.120 standard is made up of a suite of communication and application protocols developed and approved by the international computer and telecommunications industries. Using these protocols, developers can create compatible products and services for real-time, multipoint data connections and conferencing. With T.120-based programs, multiple users can participate in conferencing sessions over different types of networks and connections."[7]

3.1.7 H.323

"H.323 is a standard approved by the International Telecommunication Union (ITU) in 1996 to promote compatibility in videoconference transmissions over IP networks. H.323 was originally promoted as a way to provide consistency in audio, video and data packet transmissions in the event that a local area network (LAN) did not provide guaranteed service quality (QoS). Although it was doubtful at first whether manufacturers would adopt H.323, it is now considered to be the standard for interoperability in audio, video and data transmissions as well as Internet phone and voice-over-IP (VoIP) because it addresses call control and management for both point-to-point and multipoint conferences as well as gateway administration of media traffic, bandwidth and user participation."[8]

3.1.8 SIP

"The Session Initiation Protocol (SIP) is an Internet Engineering Task Force (IETF) standard protocol for initiating an interactive user session that involves multimedia elements such as video, voice, chat, gaming, and virtual reality."[9]

3.1.9 H.320

H.320 is a "Suite of ITU-T standard specifications for videoconferencing over circuit-switched media such as ISDN, fractional T-1, and switched-56 lines." [10]

A matrix that maps these various standards and protocols to the interactive collaboration services they support is provided below.

		Chat						Polling / Surveying		Whiteboarding			App Sharing						Audio / Video			
	Presence Awareness	Chat	Multi-Chat	Persistant Chat	Broadcast Chat	Ticker	Instant Messaging	Polling / Surveying	Emotion	Whiteboarding	Geo-Registered Whiteboarding	Persistent Whiteboarding	App Sharing	App Following	Shared Storage	Distributed Product Management	File Transfer	Shared Calendars	Real-Time Multipoint Audio	Real-Time Multipoint Video	Broadcast Audio	Broadcast Video
XMPP		X	X				X															
SIMPLE		X	X				X															
HTTP(S)		X	X	X	X	X									X	X						
XML																						
SOAP																						
T.120										X	X		X									
H.323																			X	X	X	X
H.320																			X	X	X	X

Figure 4-1 Protocol Support for Collaboration Services

3.1.10 Emerging Standards

Technology does not stand still there are many ongoing efforts to modify existing standards, or to create new standards entirely. For example, the Internet Engineering Task Force (IETF) has over 100 current drafts related to collaboration. For more information see: http://www.ietf.org/1id-abstracts.html. There are also other standards bodies including the International Telecommunication Union (ITU) and World Wide Web Consortium (W3C) for example.

3.2 Collaboration Products

All of the interactive collaboration services and protocols described in the preceding sections exist, and to varying degrees are used within DoD, today. A list of the specific products that support these services and protocols would be quite extensive. The work of identifying and categorizing these products could be a potential recommendation for work to pursue in the near term. Ideally, products could also be tested in a laboratory environment to determine degree standards compliance, performance and any specialized feature sets that distinguish the product.

What is lacking in the market place are tools that fit into the collaboration support services and collaboration management services described above. Perhaps the most pressing need would be for tools that fit into the latter category. The current state of the industry does not offer much by way of managing and controlling, much less integrating, the various tools and products out there.

From a longer-term perspective, the main issue with the collaboration marketplace today is that products currently available are predominantly in the form of stand-alone, self-contained tools that do not incorporate the service-oriented architecture concepts that are inherent in the NCES vision. These products also do not use services provided by the other NCES core service areas, nor are they readily adaptable to do so. The key long-term challenge in the NCES Collaboration Services area will be to cultivate a product marketplace that supports and adheres to NCES service-oriented architecture concepts.

3.3 Collaboration in DoD

DoD currently employs many collaboration services. Some are simply commercial products while others were developed exclusively for the government. The pre-eminent collaboration "tool" today is the Defense Collaboration Tool Suite (DCTS). As its' name implies this is actually a suite of many tools supporting many services. In an effort to promote interoperability DoD has designed DCTS to use open standards and has mandated that other collaboration tools employed in DoD must interoperate with DCTS. The process of testing the degree to which a particular collaboration tool complies with DCTS is called "Certification".

Table 4-1 describes some of the key criteria DoD currently uses to certify collaboration tools.

Criterion	Description	Applicable Standard (or Reference Implementation) for DOD Collaboration	Required For Certification
Coexistence	Client shall coexist with DCTS environment	DODD 4630.5 (COE Level 5 Compliance)	Yes
Collaborator Status	Locate any collaborator	HTTP, XML, SOAP, via published API	Yes
Conference Discovery	Locate any ITU compliant conference (e.g., meeting) on any server	HTTP, XML, SOAP, via published API	Yes
Virtual Space Discovery	Locate any persistent space (e.g., room) on any server	HTTP, XML, SOAP, via published API	Yes
Text conference	Text chat with any person	• Reference Conferencing clients • Reference published API	Yes
Virtual Space Access	Launch an application with default data to enter any “accessible” persistent space (e.g., room) on any server	None – Done by demonstration with reference	Yes
Conference Join	Launch an application with default data to join any “accessible” conference (e.g., meeting) on any server	• H.323 (Audio/Video) • T.120 (Data)	Yes
Application Sharing	Demonstrate ability to share applications	ITU T.128	Yes
Whiteboard	Demonstrate ability to annotate still images	ITU T.126	Yes
Audio	Demonstrate ability to share audio	ITU H.323/G.711	Yes
Video	Demonstrate ability to share video	ITU H.323/H.261	Yes
File transfer	Import/export documents between meetings and rooms	ITU T.127 FTP, http & XML	Yes
Authentication, Encryption, Lockdown	Provide appropriate security mechanisms (e.g., to get permission to connect to DOD networks) and not interfere with other collaboration components	Authentication by password or certificate (PKI), Encryption by SSL or VPN; workstations & servers locked down according to type accreditation requirements	Yes
Usability	Product shall not substantially degrade collaboration Usability, stability, or performance,		Yes
Directory Services	Gain access to “public restricted” collaboration resources through global directory services on participating networks	LDAP V3	Future

Table 4-1 DoD Collaboration Certification Matrix

4 Collaboration Challenges and Issues

With the vision for collaboration discussed in Section 3, and the current state of technology addressed in Section 4, we can begin to describe the challenges as we move forward.

4.1 Interoperability

4.1.1 Dependencies

Collaboration services rely heavily on many of the other proposed Core Enterprise Services. The design of specific collaboration services will depend on the specific implementations of the other core services. Any obstacles in the deployment of these other services will directly impact the ability to deploy collaboration services.

Storage – Collaboration services will rely on storage services to provide the persistence of virtual environments. Any collaboration service that provides the ability for users to come and go at various times while maintaining a common view will require the storage service.

Messaging – All of the Instant Messaging collaboration services will rely on the Core Messaging Service.

Mediation – The collaboration support services will rely on the Mediation service to translate collaboration traffic between various protocols and natural languages.

Discovery – Collaboration services will rely on the Discovery service to allow end users to find one another and to initiate communications.

Information Security – Collaboration services will rely on the Information Security service to securely authenticate users and to protect collaboration traffic and stored information.

Directory Services – Collaboration services will use Directory Services for awareness, presence, identification, location, and for general information.

4.1.2 Protocols

In order to enable end-to-end communication between virtually any combinations of end-points, collaboration services need to be engineered to use common open protocols.

Nevertheless, despite this there are a number of known issues (and some issues yet undiscovered) with current protocols. For example, given the current state of the standard and the real-world nature of existing networks, the following issues have been observed with certain protocols:

1. Firewall traversal: Call transfer with some protocols often fails to work through firewalls and NATs.
2. Telephone number schema: Non standard telephone number schema often causes incompatibility.
3. Device registration: Some services do not handle failed registration correctly and a flurry of retries can bring down the service.
4. Digest authentication: inoperability is caused by vendors using different authentication methods.

Application vs User interface to core collaboration services

4.2 Network Support

Perhaps the most significant challenge facing the implementation of collaboration services is Quality of Service (QoS) assurance in the network. Packet switched, Internet Protocol (IP) networks such as the SIPRNet, NIPRNet and Internet were not designed to support real-time interactive collaboration traffic. These networks introduce varying degrees of delay, packet loss and packet jitter to packets that traverse them. These effects are extremely detrimental to the end user experience. In order to provide the user with

a positive experience with collaboration services, these network issues need to be addressed possibly through filtering layers targeted for specific network limitations and specific edge device limitations.

For any given interactive collaboration service a set of metrics could be developed which specify optimal and minimum tolerable levels for bandwidth, delay, packet loss and jitter. For any set of end-points these metrics would represent guidelines for the filtering layers.

4.3 Security

A highly collaborative environment imposes additional demands and places additional stresses on the security capabilities within the environment. Information can be shared more easily in a collaborative environment and the identification/authentication, access control, and logging/audit capabilities must be designed to be strong enough and pervasive enough to manage and enforce security within such a sharing-rich environment. In addition, collaboration suggests a need for new approaches to discretionary access control, wherein users being invited to a collaboration session who do not have permission to view the data within the session may temporarily be granted permission during the course of the session at the discretion of the inviter. This is comparable to the sharing of data on a "need to know" basis within the non-computer world, but requires controls to ensure that data does not "leak" out of the session and persist without permission. Access control will be further complicated as information is shared across DoD and civilian/multi-national barriers and additional laws and restrictions come into play.

Securing data types has always posed a number of challenges. Some data types may be more sensitive than others, therefore data types must bear a classification system that must be respected when accessed by different user and group types. The establishment of a security model that encompasses both classification sets (user/groups and data types) is essential to securing the collaboration environment's content. This security model will drive the controlling directory design, and is more than likely the most important element in setting up a collaboration effort under a required security model.

Historically, most data classifications have only been user and group I.D.s associated with the file itself, a rather crude, yet effective securing methodology. There have also been limits to the number of classifications that can be associated with a given data resource. This has always presented a number of design challenges to those tasked with creating the security model for a collaboration effort. Once established, modifying the security design at a later date becomes very cumbersome. So it is best to create a security model with a great deal of forethought and careful consideration of the system requirements, the ongoing maintenance requirements, and possible future extensions of the collaboration services.

An issue that has made some forms of collaboration impractical in practice in certain contexts is the proliferation of firewalls and communication port restrictions. A number of collaboration capabilities currently require communication on specific ports or ranges of ports that are not typically open in firewalls. It is unclear to what extent firewalls will be prevalent in the target network environment, which includes the SIPRNET as well as intelligence community, coalition, and non-military agency networks. As we cross from military networks into these other network domains, the issue of developing more capable domain transfer services (e.g., guards) becomes relevant in enabling at least some forms of collaboration across network/security domains. With regard to the port/firewall issues, it will behoove collaboration capability implementers to minimize the number of ports needed and standardize them to reduce administrative barriers to collaboration.

4.4 Scalability

The implementation of collaboration services must support the ability of any GIG user to collaborate with any other GIG user or users. This implies that the collaboration services must be global in scale.

Collaboration for the War Fighter

Collaboration scaling does not exclusively depend upon the underlying system's ability to meet user communications and application access demands. Current systems can be acquired with the ability to support concurrent loads of thousands of active users. Most collaboration efforts begin to loose efficiency

when more than a few (let's say 8-10 as a preliminary estimate) active participants attempt to collaborate. (See the following Management and Control section for more details.) Information workers can be overwhelmed by the onslaught of too much data. Therefore collaboration scaling must be accompanied by a matching consideration of data filtering. Data mining and knowledge management are not usually thought of in terms of system scalability. But in the context of collaboration services, data presentation and filtering is a key concern to assist overall system scaling.

4.5 Management and Control

Limitations of traditional applications are encountered when used to support collaborative data manipulation. Most, if not all, current computer applications for manipulation of data are single-user centric. A word processor or spreadsheet application is designed around the concept of a single user manipulating a single file. While multiple files may be opened simultaneously, only one file is actually manipulated at a time in the current scheme of applications use. The first user to open a file with edit permissions, effectively eliminates the edit permissions for any following users, until the file is returned to the file system and the permissions are reset.

This inherent applications characteristic causes multiple concerns when being used in a true collaborative fashion. Few, if any, productivity applications can, without some form of over-riding file management and control layer, manage the complexities of multiple users attempting to edit the same file. Of course, this "limitation" is also seen in physical collaboration efforts. It is easy to envision the chaos of four or five people simultaneously trying to create or edit the same drawing on a whiteboard. The role of the moderator, or, in simpler terms, the control point/final authority for change control and/or data merging must exist in any collaboration effort, regardless if the collaboration effort is physical or virtual.

Unfortunately, the notion of communication collaboration carries an inherent many to many, "full duplex," design concept and is therefore perceived to be much more flexible and, in many ways, easier to manage. Take the example of a teleconference call as our reference point. As long as a certain courtesy is maintained (one participant talking at a time, etc.) some sensible order of information delivery and comment can result. This appears to resemble the one user/one data source at one time restraint of data manipulation applications.

Effective collaboration efforts are founded on an orderly exchange of data types between collaborators with at least a tacit understanding of the proper rules of conduct. Most of our collaboration efforts focus on the systems aspects of collaboration, and ignore the time and effort that should be spent on developing effective collaborators through training in proper collaborative processes.

4.6 CONOPS

The concept of operations for a collaboration environment must include a wide range of definitions and procedures. These definitions range from user and data types to roles and responsibilities of the creators, maintainers, and closers of collaborative efforts. An inherent aspect of the CONOPS must include the methods for establishing and authenticating the identity of the approved collaborators and the relationships between collaboration team members and the security model for the data that is central to the collaboration effort. When the collaboration team is comprised of multiple partner types, security of content and control of data access by team member (group) role or individual (user) role becomes a key design consideration.

The CONOPS should include, as a minimum, the following elements:

THE DEFINITION OF COLLABORATION SERVICES SYSTEM(S)

- SCOPE
- INCLUSIONS
- LIMITATIONS

THE COLLABORATION SYSTEM

5 Recommendations

5.1 Long-Term Vision

It is anticipated that the current model of collaboration, in which the various collaboration capabilities are provided by stand-alone, self-contained collaboration-specific tools, will continue within DoD and industry in the near term. In the longer term, we envision that collaboration product capabilities will become more aligned with NCES service-oriented architecture concepts. In this envisioned environment, the key collaboration services are provided as true services on the network. Such services will be accessible directly by the user via a web browser or through a web-based collaboration-specific tool, but they will also be accessible programmatically as network services so that they can be embedded within military and commercial applications.

This will foster a new class of *collaboration-enabled* applications that will provide domain-specific functionality (e.g., intelligence, planning, situational awareness, logistics) and embed collaboration capabilities within them to allow multiple users to collaborate on the application data and views simultaneously. Collaboration-specific tools and collaboration-enabled applications will share the same network-accessible services, all based on current or emerging standards (or, where necessary, interim NCES-developed interfaces in the absence of consensus standards), and will thus be broadly interoperable.

Collaboration-enabled applications will offer a new form of application sharing distinct from the current conventional approach (exemplified by NetMeeting) that broadcasts screen images from a single user's workstation to the workstations of multiple other users without persisting the application data for shared access during the session or subsequently. In this new style of application sharing, called *information-centric*, the applications dynamically share their information objects via a conferencing or publish-subscribe server. The information shared and viewed by the applications may include data from multiple

application servers, and the shared data is persisted and available to all collaborators during and after the session.

The architecture of this envisioned future collaboration environment is depicted conceptually in Figure 5-1. This figure shows the two different kinds of applications – collaboration-specific and collaboration-enabled – both accessing a hierarchy of collaboration services. In addition, the collaboration-enabled applications access domain-specific application services to provide collaborative functionality to the users within those domains. Both sets of applications and the underlying collaboration services exploit the other core enterprise services (discovery, collaboration, mediation, etc.) as appropriate.

A new class of collaboration-enabled applications must also be synchronized with a new class of collaboration-savvy users. While many collaboration modes exist in current efforts throughout commercial and government decision making, a new class of applications matched to a new mindset of applications use will unlock the full potential of next generation collaboration systems. This potential will only be unlocked by targeted collaboration use training and re-examining current decision-making processes.

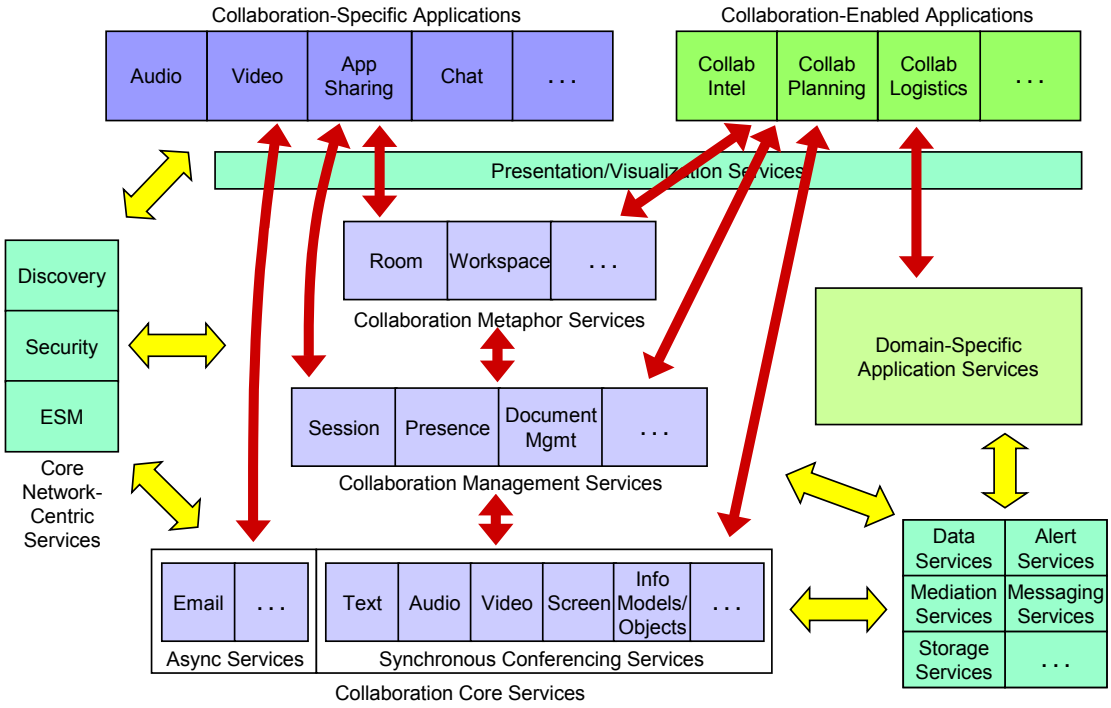

Figure 5-1. Envisioned Future Collaboration Architecture

In this envisioned collaboration environment, the collaboration services are divided into three categories:

- Collaboration Metaphor Services – Services that provide high-level capabilities to the user offer specific contexts, structures, processes, and rules for guiding collaboration in terms of real-world or common computing metaphors that are familiar to users. Such metaphors provide means for users to meet and to persist, navigate, and share information. These can include but are not limited to building/floor/room metaphors, workspace metaphors, and immersive 3D environments.
- Collaboration Management Services – Services for establishing, finding, managing, and persisting collaborative sessions, conferences, and interactions. These services include session management services, presence awareness services, document management services, and so on.

- Collaboration Core Services – Services that provide the core synchronous and asynchronous collaborative capabilities. The *Conferencing Services* provide low-level services for conducting conferences to share various types of information in synchronous collaboration sessions. Many of these capabilities are supported by current commercial conferencing servers, and such servers may be extended in the future to support additional kinds of conferencing. The Conferencing Services enable conferencing involving a variety of information, including text, audio, video, application screens, annotations, and information models/objects. The Asynchronous Services provide low-level support for asynchronous sharing information via, for example, e-mail, discussion groups, calendar sharing, and document transfer.

5.2 Immediate - Today

Continue focus on standards and interoperability

Gather lessons learned and "best practices" for effective use of collaborative solutions

Identify and categorize the capabilities of current technologies

Identify significant technological "holes"

Begin to organize, and develop infrastructure, to support large, complex systems engineering process.

Begin the process of educating users to collaboration benefits to their everyday tasks.

5.3 Short Term – Next 5 to 10 years

Define Collaboration Services

Identify and define in detail interfaces w/ other core services

Establish a method for identifying and accessing subject matter specialists throughout the enterprise

Promote development of integrated management tools

Begin engineering QoS support in network

Develop CONOPS (integrated w/ other core services)

Engineer/Define security infrastructure/architecture

Continue to institutionalize organizations that will define future of GES

Leverage early adopters of collaboration services to disseminate collaboration culture throughout user community

Integrate collaboration as a mainstream component of decision making and execution processes.

Appendix A - Terms

Ad-Hoc COI – an operational COI that forms in response to immediate events. Ad-hoc COIs come into existence to address an issues and disband once that issue have been resolved.

Application Schema – An application schema provides the formal description of the data structure and content required by one or more information communities. --- set of conceptual schema for data required by one or more applications.

COI – Community of Interest.

DCP – Distributed Computing Platform

F**eature** – abstraction of a real world phenomenon or attribute of a system

Federation – an IT configuration where organizations and systems collaborate without a single management framework.

GML – Geographic Markup Language

Information Community - a collection of people (a government agency or group of agencies, a profession, a group of researchers in the same discipline, corporate partners cooperating on a project, etc.) who, at least part of the time, share a common digital geographic information language and common spatial feature definitions.

Interface – named set of operations that characterize the behavior of an entity

Jurisdiction - an administrative entity with a single management authority that can establish standard policies, procedures, and technologies. All systems within a jurisdiction are subject to this management framework.

Metadata – data about data.

OGC – Open GIS Consortium

Ontology – the working model of entities and interactions in some particular domain of knowledge or practices, such as electronic commerce or "the activity of planning." A set of concepts - such as things, events, and relations - that are specified in some way (such as specific natural language) in order to create an agreed-upon vocabulary for exchanging information In artificial intelligence (**AI**), an ontology is, according to Tom Gruber, an AI specialist at Stanford University, "the specification of conceptualizations, used to help programs and humans share knowledge." . One or more taxonomies can be developed for the ontology and taxonomies can be used as part of the ontology model.

Operation – specification of a transformation or query that an object may be called to execute. Also, a virtual enterprise established to achieve some real world goal (e.g., Operation Iraqi Freedom) – see Ad Hoc COI

Operational COI - a collection of individuals, organizations, and systems with similar business and information needs. Operational COIs operate across Jurisdictions and Federations and in fact are the primary reason for their existence. Operational COIs develop their own operating conventions addressing such issues as information models, policies, and practices.

Service – distinct part of functionality that is provided by an entity through interfaces accessible over the GIG network.

Taxonomy – the science of classification according to a pre-determined system, with the resulting catalog used to provide a conceptual framework for discussion, analysis, or information retrieval. In theory, the development of a good taxonomy takes into account the importance of separating elements of a group (taxon) into subgroups (taxa) that are mutually exclusive, unambiguous, and taken together, include all possibilities. In practice, a good taxonomy should be simple, easy to remember, and easy to use. However most real world entities and concepts can be viewed as belonging to multiple taxonomies, based on the

operational context in which they are referenced. For example, a main battle tank is both a vehicle and a weapon system. It can also be a shelter, cargo, asset, target, etc. in other operational contexts and thus taxonomies.

Viewpoint – form of abstraction achieved using a selected set of architectural concepts and operational contexts with associated structuring/representation rules, in order to focus on particular concerns within a system development, acquisition, or virtual enterprise context.

Appendix B - References

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