The Ideal Collaborative Environment

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What immediately springs to mind when discussing cross-organizational electronic collaboration are the capabilities of today's collaboration tools: e-mail, bulletin boards, chat sessions, and virtual rooms. However, today's tools provide only a framework for the ideal environment. This paper builds on current collaboration capabilities to describe the Intelligence Community Collaboration Forum's vision for the ideal collaboration environment and the challenges in achieving it.

The Intelligence Community Collaborative Operations Network (ICON) Program Office was established in December 1998 to facilitate collaboration and the free flow of information across the intelligence community (IC). As its main starting point, the ICON Program Office initiated an IC collaboration forum in March 1999 to identify collaboration programs and systems within the IC and Department of Defense (DoD) and to achieve a consensus on common goals. During its first year, more than 150 IC members attended the forum. Its membership included representatives from the majority of intelligence agencies as well as the DoD. This paper highlights key findings of forum sessions from its inception to the present, defines common terms, and describes today's electronic collaboration capabilities, and the ideal collaboration environment for the future.

Current Collaboration Capabilities

At the forum outset, participants discovered a need for a common framework of collaboration terms. Basic terms such as "collaboration" and "interoperability" held different meanings for participants depending upon their organizational background. This section defines key terms.

Collaboration is "the process of shared creation: two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own [1]." The following list defines levels of collaboration:

- Level 1: At a basic level, individuals operate independently and interact to accommodate their own specific needs passing documents back and forth and sharing information, but not as part of a working group or team [2].
- Level 2: At the next level, a group of individuals exchange information as part of a community of interest, but not to achieve a common goal [2].
- Level 3: At the highest level, collaborators operate as a team to achieve a common purpose by working together and gaining new insights [2].

Asynchronous collaboration allows data (e.g., a message) to be sent as soon as it is ready, regardless of whether recipients are ready to receive it. Asynchronous collaboration includes e-mail with attachments, threaded discussion databases, bulletin boards, and persistent electronic "rooms" where members can store and access common documents and files at their convenience. Table 1 lists asynchronous collaboration capabilities. Asynchronous collaboration capabilities emphasize support for collaboration levels one and two.

Bulletin Board: central electronic repository that allows users to post information for members to share.

E-mail: a network service that allows users to send, create, receive, view, store, and forward messages.

People Locator: ability to find other user's userids to send e-mail.

Group Calendars: ability to share calendar information between different users.

Threaded Discussions: asynchronous postings to which people can link responses.

Virtual Persistent Workspace (Virtual Room): a permanent, networked environment where a group of users share expertise and contribute to solving problems via virtual teaming activities.

Table 1: *Asynchronous Collaboration Capabilities*

Synchronous collaboration manages (synchronizes) the sending and receiving of dynamic text, audio, and video, such that only a single user can dominate a discussion at a time. However, a group of users can work together to share ideas in real-time. This mode of collaboration is also referred to as "real-time collaboration." It supports collaboration at the highest level and includes text-based chat sessions, electronic whiteboards, awareness knowledge, and live audio/video conferencing.

Audio/video conferencing: audio/video session where users are able to see and hear each other electronically on a desktop computer.

Audio: real time aural information from a microphone to a speaker.

Video: real-time visual information from a camera.

Awareness: mechanisms that allow users to know who is on-line.

Chat: real-time sharing of text data (i.e., real-time e-mail; "instant" messages).

Shared applications: ability to view and control an application on another's desktop.

Virtual Teams: individuals forming and acting as a team by means of electronic collaboration tools or information services to accomplish a mutual goal, regardless of location.

Whiteboard: shared drawing board analogous to a "chalk board" that may be blank or display an image that a group of users can individually mark up and review in real-time.

Table 2: *Synchronous Collaboration Capabilities*

Point-to-point and multi-point communication are the two modes of communication provided for synchronous collaboration. Collaboration tools that feature point-to-point communications require each computer system to handle all of its communication with other computer systems involved in a synchronous collaboration session. Point-to-point tools are effective only for a small group of users because communication bandwidth can rapidly become saturated as more users join a session. Collaboration tools that feature multi-point communication are applicable for small and large groups of users, since they provide server capabilities that manage bandwidth and facilitate communications between user platforms.

The International Telecommunications Union has defined several communications standards used by collaboration tools for both multi-point and point-to-point communications. H.323: defines audio and video conferencing protocol for networks based on the Internet protocol (IP). T.120 provides standards for data-conferencing capabilities, including application

sharing, electronic whiteboard, chat, and file transfer functions.

Commonly Used Collaboration Tools

- *Collaborative Virtual Workstation* (CVW): This is a software prototype developed by MITRE that supports a collaborative environment optimized for supporting persistent, geographically dispersed virtual rooms. CVW provides chat, audio/video conferencing, application sharing, electronic whiteboarding, and multi-point communications. At the time this paper was written, MITRE was looking for a vendor who would assume responsibility for managing and improving the software [4].
- *Information Workspace* (IWS): General Dynamic developed IWS as a Web-based, collaboration environment featuring virtual rooms, audio/video conferencing, chat, electronic whiteboarding, and application sharing with multipoint communications.
- *Microsoft NetMeeting*: A Microsoft product that supports point-to-point communications for its audio/video conferencing, chat, application sharing, and electronic whiteboarding.
- *IBM Lotus Sametime:* A Lotus product that interfaces with most Web browsers and provides audio/video conferencing, chat, application sharing, electronic whiteboarding, and awareness with multipoint communications. Considered by Giga to be the leading collaboration tool [5].

The Ideal Collaboration Environment

While e-mail, bulletin boards, chat sessions, and virtual rooms are powerful features to enable cross-organizational electronic collaboration, they are only initial capabilities.

This section builds on existing collaboration capabilities to describe the forum participants' vision of the ideal collaboration environment. The capabilities are not described in any particular order because participants considered each one critical for the ideal environment.

Following each capability, the author discusses technical challenges to overcome before it can become a reality.

Capability No. 1: Rapidly find the right people with the right expertise.

To enable collaboration, users are able to quickly identify, locate, and contact specific staff or subject-matter experts from community organizations, academia, and industry; they are provided with detailed information such as the contact's full name, job title, organization, phone number(s), pager number(s), address(es), levels of access, and areas of expertise. For example, the collaboration system could display a menu that enables users to select from technical subject-matter areas such as telecommunications, data warehouses, parallel processing, and enterprise portals to find experts from industry, academia, DoD, or another IC organization, along with sufficient contact information. A user could also search for names with only partial information. For instance, if a user knew part of the last name, "Bran," and that he was located at the Pentagon, the collaboration system could perform a partial name-string search for all Army personnel at the Pentagon and return a list of possible matches.

Challenges

The real challenge is being able to identify and locate experienced personnel and subject-matter experts from external organizations since each employs staff with particular areas of expertise. To achieve this capability, it is necessary to link each organization's directory through a mechanism like a meta-directory. Today's collaboration tools rely on the directory services provided by the network or third-party vendor products. The schema can often be tailored to provide additional information about staff. For example IBM provides directory services for Lotus Sametime through Domino, another Lotus product. However, because most commercial products are not interoperable, organizations need to consider using either the same directory service products, or defining point-to-point customer interfaces that interconnect the directories.

There is another challenge: Collaboration tools need open Java ports to exchange data using communication protocols such as User Datagram Protocol (UDP). Because firewall systems have difficulty filtering UDP, especially for malicious code and new viruses, organizations may not be willing to open these ports for collaboration.

Currently, two standards compete to support directory service protocols: Lightweight Directory Access Protocol (LDAP) and X.500. The protocol standards are not compatible, although custom interfaces can be developed to exchange packets between the various commercial products used by different organizations. Vendors have begun developing software to implement meta-directory mechanisms, generally using LDAP as the preferred standard. However, they are only in the preliminary stages of developing the required capabilities.

A number of vendors united recently to establish a directory services standards consortium, the Directory Interoperability Forum, to achieve the vision for unified, cross-organizational, open standard directory services. Its membership includes IBM, Lotus, Novell, Oracle, Cisco, Sun-Netscape, Citrix, and Unisys [6].

Capability No. 2: Quickly organize and conduct virtual teams and meetings.

This capability builds on capability No. 1 by organizing key personnel and subject-matter experts from around the world into virtual teams as soon as the need arises, coordinating and conducting ad hoc and formal virtual meetings using electronic collaboration tools. The collaboration system could provide a set of virtual conference rooms to conduct a desktop teleconferencing session at any time of day. Virtual conference rooms could be scheduled so that sessions could be conducted at an appointed time. During the session, the collaboration system could project team member images talking and sitting around a conference room table – just as if the session was being held in a video teleconference room – even though each desktop teleconferencing user was remotely located.

Of critical concern is the ability to contact an individual in another organization when a crisis occurs. Lotus' Sametime and AOL's Instant Messenger provide a feature that will instantly notify on-line users that "John Doe" wants to talk to them If he/she is not on-line, Lotus Sametime will phone the individ-

ual and/or page him/her to obtain a timely response. This should be a standard feature in collaboration tools.

Challenges

The most conspicuous challenges relate to providing sufficient communications connectivity across all organizations, quality of service, and trusted security mechanisms to support virtual meetings. Unless the same collaboration tools are used by each organization, conducting virtual meetings with attendees from various organizations is simply not possible today. Further, many organizations do not provide the necessary transmission speed, reliability, and communications bandwidth necessary to avoid problems with spotty audio quality or choppy video. Users want phone quality audio and smooth video.

Many vendors are unable to supply details on how many concurrent audio/video conferencing and chat sessions can occur simultaneously, and how many users it would take to significantly degrade performance. These are significant questions concerning service quality. More businesses are engaging in cross-organization virtual meetings through information provider (IP)-based networks – and industry is pushing the envelope. Vendors will be forced to define more efficient data compression algorithms for convergent networks where data, voice, and video are carried over the same transport mechanism, whether they are wireless, optical, coaxial, or some entirely new innovation.

Forum participants said that as information exchanges with foreign personnel and academic experts increase, the need for language translation tools will become more prominent. Commercial speech-recognition translation modes include speech-to-text, text-to-text, and text-to-speech. However, commercial tools – no matter what their level of sophistication – have not achieved direct speech-to-speech translations. Vendors such as Lernout and Hauspie [7] offer a suite of tools that can be combined to translate from speech-to-speech using the incremental steps. The tools can be integrated with the leading commercial collaboration tools. But language translation tools have a long way to go before they achieve highly accurate translations for all languages and dialects.

Capability No. 3: Enable cross-organizational collaboration to support the business lifecycle.

This capability gives interagency and internal staff the ability to brainstorm together, exchange insights, and develop products electronically according to business workflows that unify related work activities to enhance the timeliness of product delivery. For instance, the collaboration system would include a workflow tool that automatically tracked the status of an intelligence product developed by several organizations through its origination, revision, approval, release, and final dissemination.

Challenges

Modern vendor group-ware/workflow tools can be readily adapted to coordinate well-defined business processes such as logistics, proposal development, and retail services. However, these tools are not easily adapted for highly complex activities and business rules such as those represented by the community's business life cycle.

In addition, the lack of interoperability across available tools poses another viable concern when individual organizations come to rely on different tools. Industry will have to develop more sophisticated workflow tools than currently available. The tools will also need to include expert system capabilities to implement the community's business rules in the workflows.

Meanwhile, collaboration tools that enable personnel from different organizations to develop a joint product raise new questions: Who becomes the product originator? Who owns it? Who is responsible for updating and maintaining it? The answers to these questions are critical to determining where it should be stored, how it should be stored, when it should be archived, who should be able to review it, who can access it, how data conflicts should be resolved, and who should update it. Organizations need to develop common rules of engagement for procedures on handling information management and configuration management issues related to joint products.

Capability No. 4: Build, find, and exchange information across organizational boundaries.

Forum participants described an environment that uses rapid, intelligent search tools across organizational servers to find information that looks for keywords within their required context, pruning the search space to provide a few relevant matches. The collaboration system would allow users to use or define the context of a keyword or phrase. For example, a search for White House news could apply specific search criteria such as public newscasts about the president, vice president, first lady, first family, and White House staff.

Challenges

There are three major challenges: more powerful search and retrieval tools; immediate access to information; and mechanisms that effectively link cross-organizational products, databases, and information. Current search and retrieval tools typically provide hundreds of meaningless keyword matches, often too many to review. Companies are beginning to develop "intelligent" search tools that use clustering mechanisms to select matches from documents then show paragraphs (rather than partial sentences) where a match occurred. Keyword/context searches are more difficult and require a knowledge base association with keywords. Associative databases are being investigated as one means of improving search routines for keyword/context matches.

Immediate access to information, especially as it grows beyond terrabytes, will remain a significant challenge. Several mechanisms are in use to speed information access: networking caching technologies and storage area networks (SANs). Companies such as Akami and Inktomi provide network caches composed of hardware and software to store web pages and other information for rapid retrieval. SANs employ a high-speed network (via fibre channel) that interconnects storage devices enabling users to share devices through network servers. These are just the beginning of innovations as network technologies experience vast performance improvements, and network appliances provide more sophisticated services.

To consolidate and display information, metadata models are employed to interconnect cross-organizational servers, databases, products and information of different organizations. But metadata models do not resolve data inconsistencies and conflicting data, nor fuse information from different sources. As time progresses and metadata modeling approaches are more mature, best practices will exist for developing models that take care of data inconsistencies and conflicts, present the information in an understandable format, and employ expert knowledge to fuse information to improve reporting accuracy.

Capability No. 5: Deliver the right information to the right people as soon as it is available.

Participants described a "smart product delivery" capability that profiles users to deliver targeted information considered relevant to their areas of interest even if it is not specifically requested. In addition, the information is provided as soon as it is received in the required user format that is compatible with his or her local applications. For example, a user asks to be notified when the London Stock Exchange drops to a certain level and to be provided with a list of companies affected. The collaboration system could respond with a list of firms that the user's profile indicated would be of interest such as major banking institutions and large, high technology firms. Additionally, the information could be provided in a preferred format such as Word Perfect or Microsoft Word.

Challenges

Existing digital library tools can filter information from news broadcasts and other information sources to alert users as soon as a keyword match occurs. As mentioned earlier though, these tools present the same retrieval challenges – search tools provide hundreds of matches to sort to find a meaningful match. This capability builds on the powerful search and retrieval features described with capability No. 4. In addition, unless a user requests specific information, it is highly unlikely that the tools will be able to find related useful items.

Vendors have already developed knowledge discovery for marketing purposes. These tools automatically use attributes such as a consumer's demographics and use of product X to determine whether he or she might be interested in a product Y, and subsequently send him or her product Y information. Again cross-organizational communications connectivity is required here so that products can be automatically disseminated to users.

Because applications vary, it is important to provide the product in required format. Many desktop publishing tools generate files in other tools' formats, but this is not universally true. Directory service vendors are considering adding user profiles in the directory service products, so that product files will be generated automatically in the format required by a user's application.

Capability No. 6: Provide and maintain sufficient security.

Security systems need to be proactive: denying unauthorized access, detecting and disabling intrusions before damage or compromise occurs, and protecting systems from malicious code and viruses. An advanced security system such as biometric recognition could be used here to reduce the potential for unauthorized access, or a system monitor that identified suspicious system behavior based on a user profile. Here a user logging onto the system at midnight on a Friday would raise a red flag if the user's typical work schedule for the past year has been weekdays from 7 a.m. to 5 p.m.

Challenges

Since commercial tools that provide information security services (e.g., virus checkers, firewalls, and intrusion detection systems) are immature, there are protection gaps:

- An ability to eavesdrop on individual conversations via unauthorized, remote access of desktop system microphones.
- The ability for imposters to send deceptive messages and data or to participate in a collaboration session without discovery.
- A difficulty handling excessive denial-of-service actions, causing the system to crash.
- The inability to detect and protect from intrusions that exploit operating system weaknesses.
- A difficulty detecting malicious code and new viruses that enter through message attachments and other means.
- A difficulty detecting spoofing.

The introduction of Public Key Infrastructure for public and private certificates to access organizational applications, systems, devices, and data is a starting point for resolving some of these problems. But collaboration tools will need to be modified to take advantage of them. Industry is also improving biometric recognition and encryption mechanisms, but firewall services are inadequate, seriously lagging behind the ingenuity of hackers to create new damaging viruses and malicious code.

Capability No. 7: Employ technology and community standards.

The need for industry standards and commercial standards-based products is seen as the single most important factor for enabling application and data interoperability. But where industry standards are lacking, organizations need to define their own standards. The ideal collaboration environment provides services using standards-based products.

Challenges

Due to their immaturity, it will be several years before vendors understand what features collaboration tools require, including defining common physical standards, more sophisticated displays and user interface, security, metadirectories, and service quality. In the meantime, it is important to concentrate on monitoring vendor consortia developments in the standards arena and to procure commercial products that feature widespread marketplace acceptance and show potential as open standards. For a more detailed discussion on challenges for open standards, refer to [8].

Conclusion

Both non-technical issues and electronic collaboration tools must be considered since increasing the information flow dramatically increases the potential for error. For example, the IC

has typically operated in a need-to-know environment whereas the Internet provides openness and public access. What is the delicate balance between these opposing operating modes?

Collaborators are also responsible for assessing the expertise of information from others before basing conclusions on new information sources. This trust poses a challenge for virtual teams whose members are remote and unknown: how to develop trust among unknown staff to support developing joint products? Furthermore, the IC has traditionally rewarded individuals for independent product development. What reward structure would motivate individual staff to cooperate with team members across the intelligence community? Hall conducted a study on collaboration in the community that uncovered barriers to collaboration and discussed such concerns [9].

Yet as these technical and non-technical issues are addressed to achieve the ideal collaboration environment, users will forget what it was like to collaborate simply by phone, video teleconference centers, and physical meeting rooms. ◆

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"*As a rule, software systems do not work well until they have been used, and have failed repeatedly, in real applications.*"

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About the Author

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