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## Collaborating the peer-to-peer way

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Most online collaboration applications are Web server-based. In other words, there is always a host system to which all collaborators must log in and all shared data must be uploaded.

In this hierarchical topology, the centralized host shares the data, relays and mediates the interaction between all participating members in real-time or off-line. Most Web server implementations require a browser and plug-in to start and join conferences while others require sizable software to be installed locally. The entire infrastructure depends on the service provided by the host. Should this provider be absent, nothing will work.

An alternate approach gaining popularity is using peer-to-peer (P2P) connections to construct a collaboration network on the fly. In a pure P2P topology, computers are managed independent of one another and have equal rights for initiating communication, sharing resources and validating users.

During the collaboration, there is no dominating controller. Every collaborator is a server as well as a client. The TCP/IP-based socket or distributed component object model (DCOM) can



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be used to build P2P communication channels between computers and construct the collaboration network. Two or more users can construct a network as long as they have the P2P software and are connected to the network, either local or Internet. There are

The basic semantic of P2P collaboration is straightforward. The application (a conference room) must be started on one computer with a document

loaded as the intended content for collaboration. The user on this computer informs others of this conference by providing its location. Other parties will then start the P2P application and initiate the join sequence with the given conference location. Since it's a peer-to-peer connection, channels are constructed between all participating conference members and destructed one by one as each leaves the conference.

Once the connection is established, the intended content for collaboration will be distributed and displayed on all participating computers. This content can be a "whiteboard," a raster image, a normal document, a 3-D object, a streamed voice or live video.

When the collaboration adjourns, the content displayed on other collaborators' computers will be removed as the application terminates. Only one conference record is saved with the original on the disk of the content owner. With no unnecessary duplicates, version conflicts are avoided.

Without a control server to manage and dispatch shared data, P2P collaboration requires a sophisticated mechanism to synchronize every display of all participating members. Depending on collaboration features implemented, the application must ensure that everybody is "on the same page at the same time."

When the view changes by pan, zoom and rotation or when mark-ups are made, the result of all user actions must be properly transmitted to and updated on every display accurately and instantaneously. In fact, multiple conferences can be collaborated with multiple users through the same P2P network simultaneously. With a smart semaphore scheme, all participating members can

act synchronously instead of requiring a control token to limit one user action at a time.

Just like in a normal conference room, every participant can write notes and see notes written by others. For raster images, such as digital photos, pixel data are transmitted and user markups can be overlaid. For vector data, such as architectural or mechanical drawings, supported formats will be transmitted.

Most Web server collaboration tools do not address 3-D data for collaboration in the technical field. High-end P2P solutions support complicated computer-aided design data, such as 3-D models of various types, with capabilities of dynamic view manipulations and section cuttings in real-time during the collaboration.

Since there is no data upload or duplication to a public server or other participating collaborators, a P2P model implemented in this fashion greatly reduces security risks.

Pure peer-to-peer models allowing anyone to construct a collaboration network on the fly any time and anyplace for multiple conferences without dependency on other services are fast becoming viable alternatives to Web server conferencing solutions.

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