The Pervasive Collaborative Computing Environment– *"Supporting Collaboration on Day-to-Day Work Processes"*

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Summary

Many of the tools currently available for collaboration focus on heavy-weight applications such as videoconferencing tools. While these are important, there is a more basic need for collaboration tools that support connecting people to work together on an ad hoc or continuous basis. Tools that support the day-to-day connectivity and underlying needs of a group of collaborators are important for providing light-weight, non-intrusive, and flexible ways to stay in touch and work together. Towards this goal we are developing a Pervasive Collaborative Computing Environment (PCCE) within which participants can rendezvous and interact with each other.

To enable collaboration on the daily tasks involved in scientific research, collaborative frameworks should provide lightweight and ubiquitous components that support a wide variety of interaction modes. We are developing the PCCE to provide a persistent space within which participants can locate each other, exchange synchronous and asynchronous messages, share documents and applications, share workflow, and hold videoconferences. The PCCE will also provide integrated tools to support shared computing and task control and monitoring.

Scientific collaborations are organized to accomplish a wide variety of tasks within a wide range of organizational structure and formality. Within this domain, we find highly structured environments (e.g., the production analysis phase of high-energy physics experiments) and informal, spontaneous collaborations (e.g., co-authoring, cooperative software development, and instrument "debugging" efforts). The present lack of an integrated set of software tools to facilitate the broad range of scientific collaborative interactions discourages the formation of effective collaborative teams.

Many of today's scientific collaboratory tools such as videoconferencing tools are highly interactive and only support formal meetings. Although videoconferencing is an important part of a collaborative environment, much of the work of scientific collaboration requires more informal and asynchronous mechanisms. Collaborators also need light-weight and flexible ways to stay in touch. When collaborations are world-wide and often extend beyond normal working hours or have limited satellite operations, asynchronous communication becomes critical.

Collaborators currently revert to email and telephone because present software lacks asynchronous, ad hoc communication mechanisms. However, email messages are often delivered out of sequence and responses from collaborators can become disorganized. Also, the typical scientist now receives so much email during the course of a day that it is generally ignored during periods of concentrated work.

In addition to communications, collaborations need tools that enhance their ability to manage shared scientific computations. Computing activities, including shared program development and debugging and 24x7 data analysis operations, have become a central feature of modern scientific research efforts. These efforts are increasingly collaborative, involving individuals and institutions at locations distributed all over the globe. Grids are becoming the primary environment within which distributed users share computing tasks, analyses, and visualization results. The grid brings security requirements and opportunities for the development of collaborative tools that interact with computations.

The underlying core component of the PCCE system is the PCCE server. The PCCE server is the initial login point for all users entering the collaboration. This server keeps track of the set of users authorized to join the collaboration and the set of users currently in the collaboration. It provides the directory services and the base connectivity to allow collaborators to see who is in the environment and contact each other. This server is enhanced with Java servlets to facilitate its use in a web-based environment. For example, the lightweight servlet processes coordinate login, authentication, and tool-launch information for an HTTP session. In addition, since software state is maintained on the central server, users are provided with persistence from session to session or from site to site.

Another core component of the PCCE is text-based messaging provided by an IRC server and client. Normally the IRC protocol is implemented using unsecured connections and simple clear text password authentication of participants. We have written our own client and enhanced the IRC to provide encrypted SSL connections that allow for PKI and username/password authentication. We have also added the ability to have persistent channels to provide rendezvous locations for particular interest groups.

Within collaborations that support large computing efforts, there is a clear need for collaborative computational workflow management tools. There is an immediate need for tool sets that facilitate the basic shared monitoring, control and scheduling operations found in most collaborations' computing activities. Presently the operational activities associated with computing remain outside of the collaborative mainstream and are thus difficult or impossible to share in any effective way. We are building web-based tools that allow shared control of grid-based computing activities and workflow.

We are working closely with the Reliable and Secure Group Communication Project, the Distributed Security Architectures Project, and the Scalable and Secure Peer-to-Peer Information Sharing Tool Project to leverage development efforts across the projects. We are also working with several science projects in high energy and nuclear physics interested in using the PCCE tools including: the LHC Atlas and CMS collaborations, the D0 collaboration, the CDF collaboration, and the Global Accelerator Network. We are also working with NERSC support personnel.

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