Geoffrey C. Fox

I received a Ph.D. in Theoretical Physics from Cambridge University **and** I am now professor of Computer Science, Informatics, and Physics at Indiana University. I am also director of the Community Grids Laboratory of the Pervasive Technology Laboratories at Indiana University. I previously held positions at Caltech, Syracuse University and Florida State University. At Caltech I was Professor of Physics, and at times I was executive officer (department chair) for physics, Dean for Educational Computing and Vice Provost for computing. Since 1983 I have led major computational or computer science research projects. I have published over 500 papers in physics and computer science and been a major contributor to six books. I have worked in a variety of applied computer science fields with work on theoretical, experimental and computational physics evolving into contributions to parallel computing and now to Grid systems. En passant, I worked with many different application scientists, on symbolic manipulation with Stephen Wolfram and on Complex Systems as part of CNS (Computation and Neural Systems) option at Caltech of which I was co-founder. I have started two small companies and I'm actively involved in one of them Anabas at the present. Anabas is a California Company that builds collaborative frameworks but it is a very small and not so healthy company.

I am interested in important projects with a compelling application motivation that exploit my expertise. My current group (termed Community Grids Lab or CGL) has three Research Associates, two software engineers and 18 PhD candidates. My "not directly research" activities include substantial work in the Global Grid Forum where I am on the steering group and co-chair of two research groups (Grid Computing Environments and Semantic Grid). I am a member of the technical advisory board for both the UK e-Science core program and its OMII Open Middleware Infrastructure Institute. I have been the editor since its inception 17 years ago of the journal Concurrency and Computation: Practice and Experience. Its 2005 volume is scheduled for 1850 pages in 15 issues. I work with minority institutions including Jackson State University and the American Indian Tribal Colleges; my most useful contribution here is teaching many online classes from 1997-2005.

Publications and presentations can be found at http://grids.ucs.indiana.edu/ptliupages/ and http://www.infomall.org. I describe my recent work below.

HPJava parallel Java language and mpiJava binding of MPI to Java:
http://www.hpjava.org This open source project was completed in April 2003 and current work consists of software maintenance in response to user input. . There have been over two thousand downloads so far of the mpiJava system which allows development of portable Java programs that can be executed efficiently on important distributed-memory parallel computers. The HPJava Development Kit release includes a translator (i.e. compiler) for a syntactic extension of Java with support for Fortran-like multidimensional arrays and HPF-like distributed arrays. The lack of these has been an obstacle to uptake of Java for scientific computing. The release package also includes standard libraries for

operating on the new data structures. This software has been very succesful in education but Java has not been popular for mainstream scientific computing.

Grid Architecture: I have done substantial work trying to clarify the issues involved in using Web Services in Grids and how one should build containers and service stacks that will properly scale. This research is used in several of the projects below. The papers http://grids.ucs.indiana.edu/ptliupages/publications/GapAnalysis30June03v2.pdf http://grids.ucs.indiana.edu/ptliupages/publications/RS-CGL-ColorOnlineSubmission-Dec2004.pdf and http://grids.ucs.indiana.edu/ptliupages/publications/WebServiceGrids.pdf describe some of this work.

Grid Portal Technology: http://www.collab-ogce.org.This OGCE (Open Grid Computing Environment) activity builds on earlier Web and Grid portal projects and is centered on developing the architecture and support tools for the user interfaces to Grids. This collaboration of six major organizations is led by my research group CGL and is the major such Grid portal activity in the nation. The OGCE is funded by the NSF National Middleware Initiative. Current work is focusing on providing support for computational Grid portals using the new Web Service standard WSRP and the Java standard JSR168 for portlets. The adoption of these technologies will allow OGCE technology to be widely incorporated in a variety of portal systems. Major OGCE deployment activities currently underway include the development of NSF TeraGrid user and system portals. CGL was also part of the team, lead by the University of Minnesota, that was awarded a 2004 NSF ITR project to develop a collaborative computational chemistry Grid, VLab. CGL will develop portals and Web Service infrastructure for this project.

SERVO (Solid Earth Research Virtual Observatory) Grid: http://www-aig.jpl.nasa.gov/public/dus/quakesim/ .This NASA funded activity provides the Cyberinfrastructure supporting earthquake science with both data and simulation components running on large parallel machines. It is a collaboration involving 5 universities (Davis is one of these) and is led by the Jet Propulsion Laboratory with CGL responsible for the system architecture and Grid portal and services. It was deployed for use in research and education in spring 2004 and the first tutorial on it was offered in July 2004 at an international meeting in Beijing. This meeting involved a group of earthquake scientists coordinated by the Asia Pacific Economic Cooperation. A major next step iSERVO involves expansion of our Grid to sites in Australia, China and Japan and we just submitted a proposal for this. SERVO's initial funding, to develop and deploy the core Grid and portal technology and support an initial set of earthquake simulation and modeling applications was funded by the NASA Computational Technologies (CT) program. SERVO's current funding comes through NASA's Advanced Information Systems Technology (AIST) program. Current activities build on the core application management technologies to build more sophisticated integration tools for numerous codes and data sources.

NaradaBrokering Grid Messaging System: http://www.naradabrokering.org. This core Grid middleware is being actively developed and provides a software overlay network supporting high performance reliable communication between multiple Grid and Web

services and their clients. We have extensively benchmarked the system showing that a single broker can support hundreds of simultaneous clients. We have linked NaradaBrokering to the peer-to-peer model supporting both JXTA and an enhanced version of the well known file transfer system BitTorrent. We have also prototyped a Web Services reliable messaging version of GridFTP. Recent enhancements include the use of NaradaBrokering to support Web Services and substantial additional funding has been obtained from the United Kingdom to deploy our software as core Grid infrastructure supporting reliable messaging and notification services. The latter includes support of the new specifications WS-Eventing and WS-Notification linked to the original Java Message Service. We have added two professional software engineers to our team to lead the transition from NaradaBrokering as a promising prototype to it being robust infrastructure to support multiple Grid and peer-to-peer projects.

GlobalMMCS Service-based Collaboration Environment:
http://www.globalmmcs.org. This was made available for initial user evaluation in May 2004 with the initial release supporting audio-video conferencing with interoperation between H323, Access Grid and RealPlayer subsystems. It is also features an innovative shared screen capture suitable for dynamic displays such movies. The user interface supports the portlet architecture. Recent work has improved the performance of the system and supported both handheld and Macintosh clients for upload and download. All communication in GlobalMMCS uses NaradaBrokering allowing it reliable transport without the need for hardware multi-cast. All capabilities from session control to media manipulation such as audio and video mixing are architected as services communicating with a TCP or UDP based publish-subscribe paradigm. We have made substantial progress with two new technologies. Firstly a powerful archiving system built in to NaradaBrokering that will enable VCR like capabilities on real-time streams; secondly a video annotation tool aimed at the digital entertainment and e-Sports applications.

These major projects are complemented by two smaller research activities
Carousel Grid Interface to Mobile clients: This project developed a proxy architecture and uses NaradaBrokering to link cell-phones to Grid systems. Work in this period has focused on improving performance and providing fault tolerant high performance SOAP compliant communication between Grid services and cell phone clients. We also have demonstrated multi-point video conferencing linking cell phones with traditional Polycom and Access Grid clients. See
http://grids.ucs.indiana.edu/ptliupages/projects/carousel and work of PhD students Sangmi Lee (graduated), Kangseok Kim and Sangyoon Oh on
http://grids.ucs.indiana.edu/ptliupages/publications)

Message-based User Interfaces: This has shown how to adapt the well known MVC (Model View Control) to use explicit messaging to link the model and view components of an application. This gives an elegant linkage of traditional desktop applications with Web services. It should allow easier support of applications on both Windows and Linux clients. This novel M-MVC (Message based MVC) architecture is being used both in our mobile client research and to develop a valuable collaborative visualization tool for the Department of Energy Nuclear Fusion Grid. This is PhD work of Syracuse students

Xiaohong Qiu (graduated 2005 with thesis http://grids.ucs.indiana.edu/~xqiu/dissertation.html) and Minjun Wang (see his papers on http://grids.ucs.indiana.edu/ptliupages/publications)