Desktop grids: Connecting everyone to science

Today’s personal computers are powerful but, most of the time, a large proportion of their computational power is left unused. A desktop grid takes this unused capacity, no matter what its location, and puts it to work solving scientific problems. With over 1 billion desktop computers in use, desktop grids can offer a low cost, readily available computing resource for scientists while allowing citizens across the world to contribute to scientific research. Together with grids and supercomputers, desktop grids can be a useful complement to the e-Infrastructure landscape.

What is a desktop grid?

Desktop grids fall into two categories - local and volunteer. While local desktop grids are comprised mainly of a set of computers at one location, a business or institute for example, the resources in a volunteer desktop grid are provided by citizens all over the world.

Today researchers are using desktop grids to simulate protein folding (Folding@home), find ways to provide clean water (IBM’s World Community Grid), and model climate change (Climateprediction.net). Scientific problems that can be split up into small tasks and sent to different computers for computation are perfect for solving with desktop grids. These projects farm out tasks to computers located across the globe which send the results back to scientists once they are complete.

David Anderson, BOINC director – “BOINC is being used by over 50 volunteer computing projects, doing research in everything from quantum mechanics to cosmology. About 430,000 PCs from all over the world, many of them equipped with GPUs, participate in these projects. Together they supply about 6 PetaFLOPS of computing power.”

A large majority of volunteer computing projects are based on open source software called BOINC. BOINC allows scientists to plug their own projects into the software, so volunteers can easily download and run applications on their computer. The BOINC client, used by the volunteers, can be configured to run only when the PC is not in use, often as a screensaver, or to run at the lowest priority while the PC is in use. Other desktop grid middlewares include XtremWeb, developed by INRIA/CNRS, which is mainly used to manage computations on desktop computers within an organisation.

LHC@home 2.0 aims to bring the world’s largest particle accelerator into your home. The platform – an extension of the already successful LHC@home – allows volunteers to connect to CERN-based research projects simply by donating their extra computing power. The project Test4Theory, for example, simulates high-energy particle collisions which scientists can compare to real-life collisions, such as those occurring in the Large Hadron Collider (LHC).

“My dream is to be able to establish a ‘virtual LHC’, which would require being able to generate 40 million events per second, as much as the real LHC, running at full steam,” says Peter Skands, the lead scientist behind Test4Theory. “We estimate that it would take somewhere between 10,000 and 100,000 connected computers to achieve this, a combined amount of computing power that we have only faintly begun to imagine, since we started working with LHC@home 2.0. With the enthusiasm we have seen in the public so far, there definitely appears to be awesome possibilities for what we can do with this platform.”
Today increasing numbers of people are using their desktop or laptop computers to make a contribution to scientific research. This is thanks to projects such as BOINC (Berkeley Open Infrastructure for Network Computing), a volunteer computing platform that harnesses the power of millions of computers around the globe to solve complex problems in fields such as climate change, medicine, and astrophysics.

Enhancing other e-infrastructures

Desktop grids are just one of a number of ways in which researchers can access computing capacity. They can provide a useful complement to the other facilities in the e-infrastructure landscape. While supercomputers are able to solve a wide variety of complex computational problems they are expensive and are limited to a relatively small number of researchers. Cluster-based grids can provide a cheaper solution for more researchers, but for a more limited set of applications. Assuming the computers making up a desktop grid are already paid for, they can open up computational research to more scientists at an even lower cost.

Making it green: Desktop grids are often touted as a ‘green solution’ as they use computing resources already in existence. However, in reality, determining whether a desktop grid is green, or not, is complex. How volunteers choose to donate their computing time plays a big part in this – adding on a CPU load to a machine running at a low capacity doesn’t cost much energy, but using a computer that would otherwise be switched off does. Even the country a machine is running in can make a real difference. Connecting a computer in a hot country such as Dubai to a desktop grid is likely to use more energy, as the machine needs to be kept cool.

Desktop computing challenges

Desktop grids can provide a variety of different benefits, however their use raises a number of challenges. A Desktop Grids for eScience Road Map produced by the DEGISCO project in July 2011 took a closer look at some of the following issues:

- **Supporting a desktop grid:** Aside from having to develop applications that can run across a number of heterogeneous systems, the distributed nature of a desktop grid poses unique problems. As volunteers provide the resources, it is difficult to test and fix applications.
- **Making it green:** Desktop grids are often touted as a ‘green solution’ as they use computing resources already in existence. However, in reality, determining whether a desktop grid is green, or not, is complex. How volunteers choose to donate their computing time plays a big part in this – adding on a CPU load to a machine running at a low capacity doesn’t cost much energy, but using a computer that would otherwise be switched off does. Even the country a machine is running in can make a real difference. Connecting a computer in a hot country such as Dubai to a desktop grid is likely to use more energy, as the machine needs to be kept cool.

When citizens become scientists

When Einstein@Home discovered a new pulsar its discovery wasn’t credited to astronomers, but to its volunteers – Daniel Gebhardt, from Mainz, Germany, and husband-and-wife team Chris and Helen Colvin from radio pulsars in observations from the Arecibo Observatory in Puerto Rico. The new pulsar, discovered in October 2010 and named PSR J2007+4722, was the first deep-space discovery by Einstein@Home. Since then a further seven pulsars have been discovered by Einstein@Home volunteers, showing how donating your computer can make a real difference.
Managing a desktop grid

Unlike supercomputers or cluster-based grids, desktop grids have an extra component that needs to be managed – their volunteers. Using volunteers to donate computing time forms the basis of all volunteer desktop grids, and can create positive links between citizens and science.

Francois Grey, Citizen Cyberscience Centre

“In my view, the most revolutionary aspect of volunteer computing is the public participation. Far from being passive, many participants turn volunteer computing into a serious hobby. Some contribute to debugging the software, others help newcomers in the forums, still others set up teams and events to encourage more participation. I predict that ultimately, this will lead to public involvement in setting the agenda for the research that is carried out using public resources. Just as has already happened for journalism on the web, the distinction between amateur and professional will start to blur.”

The first step - recruiting volunteers - needn’t be a difficult one. When the project LHC@home began, its creators thought it would attract no interest. However one thousand people downloaded the application in the first 24 hours with no publicity effort at all. Often volunteers are interested in the area of science they are contributing towards such as searching for new drugs or ways to generate clean water. AlmereGrid has taken recruitment one step further, by setting up a ‘city grid’ intended to reach out to volunteers that may not be traditionally interested in donating computing time. AlmereGrid has partnered with local and national companies across Almere in the Netherlands to disseminate information on volunteer computing and get more people interested in the topic.

While projects do not need to pay volunteers to use computing resources, they do need to keep volunteers informed. To ensure volunteers’ interest is sustained over a project’s lifetime they should be provided with feedback and information on how the project’s research is progressing.

Fundraising through science

The Charity Engine has ambitions to be a worldwide computer. Launching in summer 2011, Charity Engine will provide volunteers’ computing time to a collection of hand-chosen projects and raise money for charities at the same time. By joining Charity Engine, its volunteers will also have the chance to win a cash prize of up to a million dollars, every few weeks.

Charity Engine raises funds for its associated charities, as well for its prize draws, by selling volunteers’ computing time in bulk to science and industry. Its volunteers are not asked to support any particular science project they simply agree to let Charity Engine send ethical work to their PCs.

“Our volunteers are joining to make computer-generated charity donations and prize draw entries, they might not actually care about the science,” says Mark McAndrew, founder of Charity Engine. “But that’s fine, because all that idle, wasted computing power will make Charity Engine the ultimate supercomputer - and we love the science.”

For more information:

AlmereGrid: www.almeregrid.nl
BOINC: http://boinc.berkeley.edu
Charity Engine: www.charity-engine.org
Citizen Cyberscience Centre: www.citizencyberscience.net
DEGISCO: www.degisco.eu
EDGI: www.edgi-project.eu
Einstein@Home: http://einstein.phys.uwm.edu
e-IRG: www.e-irg.eu
IDGF: www.desktopgridfederation.org
LHC@home: http://lhcatome.web.cern.ch
Malariacontrol.net: www.malariacontrol.net
XtremWeb: www.xtremweb.net
EGI: www.egi.eu
iSGTW: www.isgtw.org
e-ScienceTalk: www.e-sciencetalk.org

Glossary

CPU: Central Processing Unit; a microprocessor (a processor on an integrated circuit) inside a computer that can execute computer programs.

GPU: Graphics Processing Unit; a device that renders graphics for a computer. GPUs have a highly parallel structure that makes them more effective than general-purpose CPUs for some complex processing tasks.

Quality of service: the ability to guarantee a certain level of performance.