

## Chapter 3

# Desktop Grids

### From Volunteer Distributed Computing to High Throughput Computing Production Platforms

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#### ABSTRACT

*Desktop Grids, literally Grids made of Desktop Computers, are very popular in the context of “Volunteer Computing” for large scale “Distributed Computing” projects like SETI@home and Folding@home. They are very appealing, as “Internet Computing” platforms for scientific projects seeking a huge amount of computational resources for massive high throughput computing, like the EGEE project in Europe. Companies are also interested of using cheap computing solutions that does not add extra hardware and cost of ownership. A very recent argument for Desktop Grids is their ecological impact: by scavenging unused CPU cycles without increasing excessively the power consumption, they reduce the waste of electricity. This book chapter presents the background of Desktop Grid, their principles and essential mechanisms, the evolution of their architectures, their applications and the research tools associated with this technology.*

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## ORIGINS AND PRINCIPLES

Nowadays, Desktop Grids are very popular and are among the largest distributed systems in the world: the BOINC platform is used to run over 60 Internet Computing projects and scale up to 4 millions of participants. To arrive at this outstanding result, theoretical and experimental projects and researches have investigated on how to take advantage of idle CPU's and derived the principles the of Desktop Grids.

### Origins of Desktop Grids

The very first paper discussing a Desktop Grid like system (Shoch & Hupp, 1982) presented the Worm programs and several key ideas that are currently investigated in autonomous computing (self replication, migration, distributed coordination, etc). Several projects preceded the very popular SETI@home. One of the first application of Desktop Grids was cracking RSA keys. Another early system, in 1997, gave the name of “distributed computing” used sometimes for Desktop Grids: distributed.net. The aim of this project was finding prime numbers using the Mersenne algorithm. The folding@home project was one of the first project with SETI@home to gather thousands of participants in the first years of 2000. At that time folding@home used the COSM technology. The growing popularity of Desktop Grids has raised a significant interest in the industry. Companies like Entropia (Chien, Calder, Elbert, Bhatia, 2003), United Device<sup>1</sup>, Platform<sup>2</sup>, Mesh Technologies<sup>3</sup> and Data Synapse have proposed Desktop Grid middleware. Performance demanding users are interested by these platforms, considering their cost-performance ratio which is even lower than the one of clusters. As a mark of success, several Desktop Grid platforms are daily used in production by large companies in the domains of pharmacology, petroleum, aerospace, etc.

The origin of Desktop Grids came from the association of several key concepts: 1) cycle stealing, 2) computing over several administration domains and 3) the Master-Worker computing paradigm.

Desktop Grids inherit the principle of aggregating inexpensive, often already in place, resources, from past research in cycle stealing. Roughly speaking, cycle stealing consists of using the CPU's cycles of other computers. This concept is particularly relevant when the target computers are idle. Mutka and al. demonstrated in 1987 that the CPU's of workstations are mostly unused (M. W. Mutka & Livny, 1987), opening the opportunity for high demanding users to scavenge these cycles for their applications. Due to its high attractiveness, cycle stealing has been studied in many research projects like Condor (Litzkow, Livny, Mutka, 1988), Glunix (Ghormley, Petrou, Rodrigues, Vahdat, Anderson, 1998) and Mosix (Barak, Guday, 1993), to cite a few. In addition to the development of these computing environments, a lot of research has focused on theoretical aspects of cycle stealing (Bhatt, Chung, Leighton, Rosenberg, 1997).

Early cycle stealing systems were bounded to the limits of a single administration domain. To harness more resources, techniques were proposed to cross the boundaries of administration domains. A first approach was proposed by Web Computing projects such as Jet (Pedroso, Silva, Silva, 1997), Charlotte (Baratloo, Karaul, Kedem, Wyckoff, 1996), Javeline (P. Cappello et al., 1997), Bayanihan (Sarmiento & Hirano, 1999), SuperWeb (Alexandrov, Ibel, Schauser, Scheiman, 1997), ParaWeb (Brecht, Sandhu, Shan, Talbot, 1996) and PopCorn (Camiel, London, Nisan, Regev, 1997). These projects have emerged with Java, taking benefit of the virtual machine properties: high portability across heterogeneous hardware and OS, large diffusion of virtual machine in Web browsers and a strong security model associated with bytecode execution. Performance and functionality limitations are some of the fundamental

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