Chapter 1.7
Computational Grids:
An Introduction to Potential Biomedical Uses and Future Prospects in Oncology; Neuro-Oncology Applications as a Model for Cancer Sub-Specialties

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ABSTRACT

A network of interconnected computers, or "computational grids," can facilitate the ability of users to complete complex computational tasks that would be virtually impossible with a single computer. By leveraging the computational strength of grids, individual users can efficiently disseminate, exchange, and retrieve information as easily as if it were stored locally. As the authors found in this study, the possibilities computational grids present for highly specialized medical fields such as neuro-oncology are limitless. By harnessing the power of grids, neuro-oncologists can link to sophisticated interactive medical images around the world, perform complicated statistical analyses, create larger collaborative research projects, and improve delivery of care to patients around the globe. Thus, utilization of grid computing modules will inevitably lead to marked improvements in clinicians' ability to detect, manage, and prevent complications associated with brain tumors.

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BACKGROUND

Computational grids are networks of interconnected computers that are linked in a manner that enables users to carry out very large or complicated computational tasks that could not be performed on a single computer or a small group of computers alone. By linking thousands of computers via high-speed networks, grid systems enable thousands of interconnected computers (or "computer farms") to be accessed on demand to meet the varying needs of many users (Hernandez, Blanquer, Solomonides, Breton & Legre, 2006). This pooling of computational resources in grids facilitates the ability to share and aggregate computational capabilities and thus allows greater efficiency in performing tasks. In perspective, each grid serves dozens to hundreds of independent user communities with each user community consisting of hundreds or thousands of users. Table 1 provides an overview of a sample computational grid implemented to deal with national public health concerns. Similar grids have been proposed in fields ranging from ecology and economics to business management and industrial engineering (Hernandez, Blanquer, Solomonides, Breton & Legre, 2006), (Ahmed, Lenz, Liu, Robinson & Ghafoor, 2008). By distributing the workload among large numbers of computers, users are able to speed up response times for many applications (Toffler & Toffler, 2007), (Breton, Blanquer Hernandez, Legre & Solomonides, 2006). Three primary forms of grids currently have widespread use and reflect the preferences and needs of the users:

a. **Computational grids:** using computing power from multiple linked computers to enable users to solve complex computational problems.
b. **Data grids:** harnessing the strength of interconnected computers to enable the exchange of data among users, primarily those engaged in data mining and decision support. Data grids do not share computing power as computational grids do.
c. **Collaborative grids:** harnessing the power of computational grids to enable users to cooperatively conduct and monitor ongoing collaborative projects.

Given the rapid dissemination of information in the Internet era, many researchers in business, academia, and other spheres of society have become increasingly dependent upon the ever-expanding amount of computational and electronic data available (Ahmed, Lenz, Liu, Robinson & Ghafoor, 2008), (The University of Washington School of Public Health's Center for Public Health Informatics, n.d.). Accessing grid systems can provide shared resources that transcend geographic boundaries and thus improve their productivity as researchers (Hernandez, Blanquer, Solomonides, Breton & Legre, 2006), (Goble, 2001). Although primarily used in business and academic applications in the past, grid technology has increasingly become useful in healthcare in a variety of ways, including genetic linkage analysis, determination of protein structures, molecular sequence analysis, data mining, and biomedical image processing, to name a few (Table 1) (Hernandez, Blanquer, Solomonides, Breton & Legre, 2006), (Toffler & Toffler, 2007), (Weiss, 2001). The pooling of computers allows individual users to disseminate, exchange, and retrieve information as easily as if it were stored locally (Goble, 2001), (Camarasu, Benoit-Cattin, Montagnat, & Racceanu, 2008), (Swedlow, Goldberg, Brauner & Sorger, 2003). Instructive scenarios on how grids can be used in biomedical experiments are described in Table 2.

The "excess computing power" (Toffler & Toffler, 2007) that grids offer has emerged as a platform to address the computational, storage, and information management requirements of large-scale biomedical applications (Ahmed, Lenz, Liu, Robinson & Ghafoor, 2008), (Weiss, 2001), (Ammen & Versweyveld, 1998), (Scotch, Yip & Cheung, 2008), (Zou, Miller, & Schmidt-

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