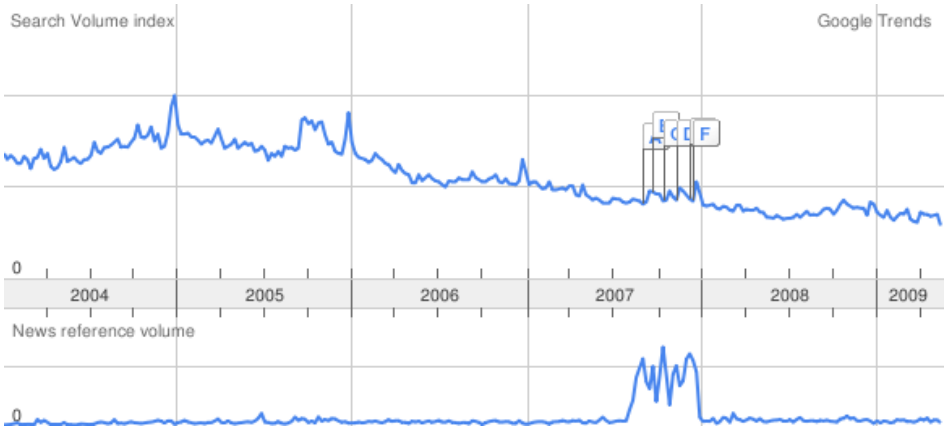
Foreword

Peer-to-Peer (P2P) and Grid computing share many common technological challenges: (i) both involve accessing and interacting with distributed resources, such as computational servers, data storage facilities, scientific instruments (such as wireless sensor networks involved in telemetry, to large scale instruments such as telescopes or radio interferometers); (ii) both involve aspects of resource discovery – whereas Grid systems have generally utilized known registry services, the discovery mechanisms in P2P systems are more diverse in nature, ranging from the use of hash tables, to the use of gossiping and flooding protocols. It is also useful to note that both Grid computing and P2P also suffer from similar concerns – such as the absence of suitable business models in deployment, aspects of efficiency and security. Efficiency issues can be of multiple (and in some instances of conflicting) types: energy, cost, and utilization being the more representative examples. Economic models that attempt to compare the impact of these considerations have also been significantly explored in both the P2P and Grid computing communities, although translation of some of this work to wide scale use is still lacking. It is also useful to note that whereas Grid computing has seen a recent decline in interest, P2P systems have continued to demonstrate an enduring interest and a growing user community. Although not a definitive measure, Google Trends provides one graphical representation of this phenomenon, indicating a surge in interest in mid 2007 in P2P systems, which coincided with an increase in video and audio use of P2P tools (such as emergence of Skype and YouTube), along with the growth in social networking (based on data from a study by Cisco systems (Barnett & Sumits, 2008)). Another survey conducted by Sandvine Networks (P2P On, 2008)over the July-September 2008 period, involving 16 million individuals in 18 countries with broadband access, indicates a similar trend, with applications such as video streaming, gaming, VoIP and social networking increasing traffic by almost 50% per subscriber.

Trend 1. Search Volume Index for the term "Grid Computing"

Trend 2. Search Volume Index for the term "P2P" – the scale on the y-axis in this graph is different from that in the Trend 1 graph – and should not be directly compared. It is primarily intended to demonstrate the overall trend over time for a particular search term use (in Google).

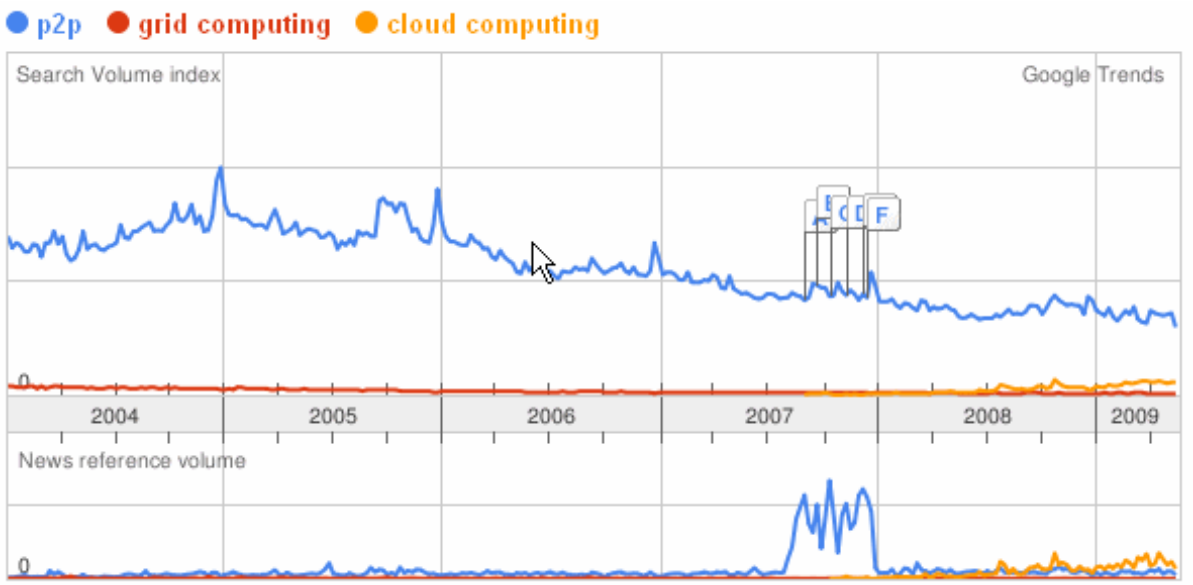


Perhaps, the most interesting trend is seen when we compare the terms P2P, Grid Computing and Cloud Computing – as demonstrated in the graph in Trend 3. Here, it is useful to note that interest in P2P surpasses that in Cloud and Grid computing, and that interest in Cloud computing is only begging to emerge since mid 2008.

Secure access and data privacy remain important challenges for practical deployment of both Grid and P2P systems. The lawsuit against the P2P site "Pirate Bay" (similar to Napster many years ago, but based on Torrent technology) demonstrates that legal sharing of content, and subsequent adoption of these practices by the P2P community remain important challenges. The shutting down of Napster did however lead to positive outcomes, for instance the emergence of legal sharing systems such as KaZaA. Such issues have also limited the adoption of Grid computing in industry, primarily due to data confidentiality and privacy concerns (which remain valid in many Cloud computing deployments available today). Investigating aspects of trust within external providers, and ensuring that these providers will not violate their advertised Service Level Agreements remain barriers that limit use of outsourced ("third party") computational resources in Grid systems.

Given this context, this handbook is timely, as it brings together a collection of articles that address many of the significant challenges that remain in better use of P2P and Grid computing systems. The five sections: (i) fundamental themes; (ii) efficiency; (iii) scalability and robustness; (iv) security and (v) applications, all provide useful surveys and a discussion of possible future directions. Articles in each of the above sections also cover description of particular research projects that are attempting to overcome current technological or usage challenges. The "fundamentals" section covers the use of P2P and Grid technologies in mobile and pervasive devices, mechanisms to support service discovery and network management issues. Some of the articles in this section provide useful introductory material for those new to P2P and Grid technologies – especially the overlap in their features and possible integration. Section 2 on "efficiency" contains articles addressing optimisation strategies related to various aspects of systems management, such as adaptive discovery of data, incentive mechanisms, indexing and resource co-allocation. It is useful to see open research issues and trends being discussed by the authors, in areas such as advanced reservation and the deployment of multi-site applications, driven by a survey of developments over the last decade. Section 3 covers issues related to scalability and service level management, through the use of redundancy or replication (for instance). One particular article, for instance, focuses on the financial risk associated with resource unavailability or failure, with a further

Trend 3. Comparison between term search on "P2P", "Grid Computing" and "Cloud Computing" via the Google search engine



discussion about how Service Level Agreements (and contracts) can be developed to reduce investment risk in this context. When a single resource provider must participate in multiple applications, often it is necessary to support more than one electronic contract – thereby leading to potential conflicts between them. Mechanisms to allow automated verification and conflict detection are therefore essential to enable more efficient use of P2P and Grid computing infrastructure. This aspect is also explored in this section. Section 4 considers various aspects of security in P2P and Grid systems, considering both issues of trust management and identity-based cryptography. Section 5 concludes the book with examples of a number of applications, ranging from Video on Demand (with large multimedia data transfer requirements) to wireless sensor networks (consisting of devices with limited power/energy capability using radio communication with low data transfer requirements, which must operate in a more unstable environment). Hence, a range of different applications have been presented

With the emergence of recent interest in Cloud computing (which, interestingly, encompasses both P2P and Grid technologies), the extensive coverage provided in this handbook will provide useful background material.

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