Preface

Distributed systems and technologies have been the subject of intense research for many years. Clearly, this is not a new subject, yet it continues to be very vibrant. This is mainly due to the fact that many concerns have been encountered, as most of the technologies are very often heterogeneous and geographically distributed. Notably enough, technologies are in fact meant to be used by several communities of users, which are also geographically distributed. Hence, the ability to make technologies interoperable remains a crucial factor for the development of several types of society systems. Clearly, one of the challenges for such facilitation is that of technologies integration, which aims to provide seamless and flexible access to multiple autonomous, distributed, and heterogeneous resources.

On the other hand, the volume of data being currently created and digitized is growing at an unprecedented rate. The efficient and effective mining of useful information from high volume data sets is becoming an increasing scientific challenge: what is currently known as the “big data” challenge.

While a wealth of data processing techniques have been proposed, traditionally these algorithms can only be deployed on single computers utilizing limited computing resources for data processing. Thus, the combination of large dataset size, geographic distribution of users and resources, and computationally intensive analysis results in complex and stringent performance demands that, until recently, have not been satisfied by any existing computational and data management infrastructure. However, a rapid development of novel distributed computing paradigms have been emerged including but not limited to peer-to-peer (P2P), service oriented, Grid and Cloud computing and other, next generation technologies. These computing paradigms can utilize various resources over the Internet for solving data and computationally intensive problems in an efficient way. Implementation of data processing algorithms and systems in high-performance distributed computing environments is thus becoming crucial to ensure system scalability as data continues to grow inexorably in size and complexity.

Even though the advantages of these types of evolutionary research are continually acknowledged, it is only recently that the need to appreciate its applicability into the real world of the information society has been realized. During the last decade, scientists have almost exclusively used these for their own research and development purposes, but lately the focus is clearly shifting to more interdisciplinary application domains that are closer to everyday life. These can provide people from different organizations and locations with the opportunity for resource (hardware, instrumentation, software, application, and data) level integration as a means to help assist diverse disciplines’ progression.

In turn, these distributed systems’ integration pushes typical application developments and involves application areas in Web dynamic data integration such as resource, process and workflow integration, and management for science-to-science, science-to-business, business-to-business, business-to-customer, or customer-to-customer integration. Hence, these paradigms have an increased focus on the integration
of distributed systems, resources, and technologies, which are available within and across various collaborative communities or organizations. As such, the size and complexity of integrating and applying cutting-edge distributed technologies are enormous and thus, there is a particular need to acknowledge research undertaken as a means to broaden the applicability and scope of the current body of knowledge in the area.

The maturation of the field, together with these new issues raised by the continuous and diversified challenges in the underlying technology and application domains, require a central focus in the area. The goal of the Technology Integration Advancements in Distributed Systems and Computing book is to provide such a focus for the presentation and dissemination of new research results about the development and integration of applicable distributed systems and technologies.

THE PURPOSE OF THE BOOK

The book aims to demonstrate a network of excellence in effectively and efficiently integrating distributed related resources using a variety of advanced computational methods and technologies. Its mission is to introduce, and thus, to highlight a feasible and applicable arrangement within business and other organizational e-infrastructures.

It also deepens its focus by highlighting strengths, weaknesses, opportunities, and threats when these are deployed within a real-world organizational setting. Contributions in this book pay particular attention to presenting topics that are diverse in scale and complexity, as well as written by and for a technical minded audience.

More importantly, the goal of the book is to prompt and foster further development for best practices in identifying opportunities and thus, it provides an excellent source for future applicable directions and technology innovative adoptions in the society.

WHO SHOULD READ THIS BOOK?

The content of the book offers state-of-the-art information and references for research work undertaken in the challenging area of advanced integration technologies and distributed computing including resource discovery and scheduling; service oriented architectures; Web and Grid services; high performance data processing and high performance computing middleware and architectures. With this in mind, the book offers an excellent source for the technical audience and the computer science minded scholar. Thus, the book should be of particular interest for the following people.

First, it is of interest to researchers and doctoral students who are fully engaging in the area of distributed computing, distributed data technologies, and integration technologies. The book should be also a very useful reference for all researchers and doctoral students working in the broader fields of high performance computing, applicable computational technologies, distributed computing, service oriented architectures, Web services, collaborative technologies, agent intelligence, and data mining.

Second, the book should be useful to academics and mainly postgraduate students engaging in research informed teaching and/or learning in the aforementioned emerging technologies fields. The view here is that the book can serve as a good reference offering a solid understanding of the integration and distributed computing subject area.
Third, the book is a great resource for professionals including computing specialists, practitioners, managers, and consultants who may be interested in identifying ways and thus, applying a number of well defined and/or applicable cutting edge techniques and processes within the aforementioned domain areas.

BOOK ORGANIZATION AND OVERVIEW

Twenty-one self-contained chapters, each authored by experts in the area, are included in this book. The book is organized into three sections according to the thematic topic of each chapter. Having said that, it is quite possible that a chapter in one section may also address issues covered in other sections.

Section 1: Advanced Integration Methods and Services

This section includes six chapters. It introduces both principles and advancements in various integration technologies, methods, and services for delivering high quality of service in several environments that are supported from Web Services, peer-to-peer, service oriented, and Grid architectures. While these stand as a state-of-the-art reference, some chapters present scenarios and approaches on how these methods and techniques could be further improved. As such, they underpin future development and implementation of relevant services.

In Chapter 1 – Web Services in Distributed Information Systems: Availability, Performance and Composition – authors focus on Web services technology and discusses related technical issues including availability, performance and composition. It also introduces Grid, agents, and Semantic Web technologies that can work together with Web services to serve different business goals.

In Chapter 2 – Towards a more Scalable Schema Matching: A Novel Approach – authors are interested in studying scalable matching problem. They survey the approaches and tools of large scale matching, when a large number of schemas/ontologies and attributes are involved. They attempt to cover a variety of techniques for schema matching, and as such, they propose a scalable schema matching methodology that deals with the creation of a hybrid approach combining these techniques. Their architecture includes a pre-matching approach based on XML schemas decomposition and as shown by their experiments, the proposed methodology has been evaluated and implementing in a PLASMA (Platform for LArge Scale MAtrching) prototype.

In Chapter 3 – Load Balancing to Increase the Consistency of Replicas in Data Grids – authors discuss that data grids are current solutions to the needs of large scale systems. In such systems, advantages are possible only by using the replication technique. In order to guarantee replica set reliability, it is necessary to have high coherence. This fact, however, penalizes performance. In this chapter, the authors propose studying balancing influence on replica quality. For this reason, a service of hybrid consistency management is developed, which combines the pessimistic and optimistic approaches and is extended by a load balancing service to improve service quality. This service is articulated on a hierarchical model with two levels.

In Chapter 4 – MaGate: An Interoperable, Decentralized and Modular High-level Grid Scheduler – authors present the design and architecture of a decentralized grid scheduler, named MaGate, which is developed within the SmartGRID project and focuses on Grid scheduler interoperation. The MaGate scheduler is modular structured, and emphasizes the functionality, procedure and policy of delegating local unsuited jobs to appropriate remote MaGates within the same grid system. In addition, a specific
swarm intelligence solution is employed as a critical complementary service for MaGate to maintain an optimized peer-to-peer overlay that supports efficient resource discovery. Finally, several experiments on communities of different scale, and under various scenarios are offered.

In Chapter 5 – Towards a Quality of Service Framework for Peer-to-Peer Applications – authors discuss that the potential of the Peer-to-Peer (P2P) concept for designing the next-generation of real-world distributed applications can be realized only if a comprehensive framework quantifying the performance related aspects of all classes of P2P applications is available. In this chapter, authors propose an early Quality of Service (QoS) framework covering various classes of P2P applications; content distribution, distributed computing and communication and collaboration. Early results from the prototype implementation of the Peer Enterprises framework (a cross-organizational P2P collaborative application) are used as a basis for formulation of the QoS parameters. The individual performance measures, which comprise the QoS framework, are also discussed in detail along with some thoughts on how these can be complied with.

In Chapter 6 – A Study on the Effect of Application and Resource Characteristics on the QoS in Service Provisioning Environments – authors deal with the problem of quality provisioning in business service-oriented environments by examining the resource selection process as an initial matching of the provided to the demanded Quality of Service (QoS). The chapter realistically centres upon modeling a data mining application and simple PC nodes in order to study how they affect response times. It moves on, by proving the existence of these specific relations and maps them using simple artificial neural networks so as to be able to wrap them in a single mechanism for resource selection based on customer QoS requirements and real time provider QoS capabilities.

Section 2: State-of-the-Art Middleware Technologies and Architectures

This section includes seven chapters. The content of this section is particularly valuable to those whose interest resides within the area of high performance computational technologies and architectures. While it stands as a state-of-the-art reference it also provides forthcoming real-world advances in the area.

In Chapter 7 – The Crystal Ball in HPC Has Never Been More Exciting, nor More Important – authors detail that foresight in High Performance Computing (HPC) is not merely a question of when Petaflop, or Exa- applications will be available. A much deeper view is fundamental for understanding the accompanying driving forces, both presently and in the future, and for making important choices based on the most relevant criteria. In this chapter, authors propose a brief review of the history of HPC since the foundation of SOS and of the impact of the major trends and possible disruptions envisioned for the next five years.

In Chapter 8 – On The Path to Exascale – authors refer to that there is considerable interest in achieving a 1000 fold increase in supercomputing power in the next decade, but the challenges are formidable. This chapter discusses some of the driving science and security applications that require Exascale computing (a million, trillion operations per second). The chapter summarizes ongoing research aimed at overcoming these hurdles. Topics of interest are architecture aware and scalable algorithms, system simulation, 3D integration, new approaches to system-directed resilience, and new benchmarks.

In Chapter 9 – Application Performance on the Tri-Lab Linux Capacity Cluster (TLCC) – authors discuss that in a recent acquisition by DOE/NNSA several large capacity computing clusters called TLCC have been installed at the DOE labs: SNL, LANL, and LLNL. TLCC architecture with ccNUMA, multi-socket, multi-core nodes, and InfiniBand interconnect, is representative of the trend in High Performance
Computing (HPC) architectures. This chapter examines application performance on TLCC contrasting them with Red Storm/Cray XT4. Micro-benchmarks and performance analysis tools help understand the causes for the observed performance differences. Control of processor and memory affinity on TLCC with the NUMACTL utility is shown to result in significant performance gains. While previous studies have investigated impact of affinity control mostly in the context of small SMP systems, the focus in this chapter is on highly parallel Message Passing Interface (MPI) applications.

In Chapter 10 – Abstractions and Middleware for Petascale Computing and Beyond – authors describe that as high-performance computing moves to the petascale and beyond, a number of algorithmic and software challenges need to be addressed. Authors review the main performance-limiting factors in today’s High Performance Computing (HPC) software and outline a possible new programming paradigm to address them. The proposed paradigm is based on abstract parallel data structures and operations that encapsulate much of the complexity of an application, but still make communication overhead explicit. Finally, the chapter outlines the structure and functionality of such a middleware and demonstrates its feasibility on the example of the parallel particle-mesh library (PPM).

In Chapter 11 – A Simulator for Large-scale Parallel Computer Architectures – authors explain that efficient design of hardware and software for large-scale parallel execution requires detailed understanding of the interactions between the application, computer, and network. Authors have developed a macro-scale simulator (SST/macro) that permits the coarse-grained study of distributed-memory applications. In the present work, applications using the Message Passing Interface (MPI) are simulated; however, the simulator is designed to allow inclusion of other programming models. Authors describe the design of the simulator, provide performance results, and present studies showing how application performance is affected by machine characteristics.

In Chapter 12 – The Red Storm Architecture and Early Experiences with Multi-Core Processors – authors explain that the Red Storm architecture, which was conceived by Sandia National Laboratories and implemented by Cray, Inc., has become the basis for most successful line of commercial supercomputers in history. In this chapter, authors describe the fundamental characteristics of the architecture and its implementation that have enabled this success, even through successive generations of hardware and software.

In Chapter 13 – The Sicilian Grid Infrastructure for High Performance Computing – authors discuss that the conjugation of High Performance Computing (HPC) and Grid paradigm with applications based on commercial software is one among the major challenges of today e-Infrastructures. Several research communities from either industry or academia need to run high parallel applications based on licensed software over hundreds of CPU cores; a satisfactory fulfillment of such requests is one of the keys for the penetration of this computing paradigm into the industry world and sustainability of Grid infrastructures. This problem has been tackled in the context of the PI2S2 project that created a regional e-Infrastructure in Sicily, the first in Italy over a regional area. Moreover, it shows the results of some relevant use cases belonging to Computer Fluid-Dynamics (Fluent, OpenFOAM), Chemistry (GAMESS), Astro-Physics (Flash), and Bio-Informatics (ClustalW).

Section 3: High Performance Distributed Systems and Applications

This section includes eight chapters. This section goes beyond and builds upon current theory and practice, providing cutting edge and visionary real-world directions on how distributed computing and integration technologies are and could be used in the near future to the benefit of various settings.
In Chapter 14 – Credential Management Enforcement and Secure Data Storage in gLite – authors describe new security solutions for Grid middleware, and specifically faces the issues related to the management of users’ and servers’ credentials, together with storing and secure data transmission in the Grid. The work is built on Grid Security Infrastructure (GSI) and it provides new capabilities (i.e. smart card Grid access, and strong security file storage XML-based) to be used on top of different Grid middleware, with a low level of changes. This work presented in this chapter is currently implemented on gLite and accomplishes the access to Grid resources in a uniform and transparent way.

In Chapter 15 – A Grid-Aware Emergency Response Model (G-AERM) for Disaster Management – authors concern with the emergency management community that is working towards developments associated with the reduction of losses in lives, property, and the environment caused by natural disasters. With this in mind, the chapter goes on to propose the Grid-Aware Emergency Response Model (G-AERM) and describe on how to make the best of functionality offered by emerging ICT to support intelligence in decision making towards a more effective and efficient emergency response management.

In Chapter 16 – A Mathematical Analysis of a Disaster Management Data-Grid Push Service – authors refer to that several obstacles arise in the design and implementation of data Grid services. In this chapter, authors are particularly interested in a notable obstacle, namely how to keep service consumers informed of relevant changes about data committed in multiple and distributed service provider levels, and most importantly, when these changes can affect others well-being. With this in mind, the chapter - via the use of relevant case scenarios – describes in detail the service architecture, as well as its mathematical analysis for keeping interested stakeholders informed automatically about relevant and critical data changes.

In Chapter 17 – Service and Management Oriented Traffic Information Grid – authors presents a real-time, dynamic information services provision for travelers and traffic managers by using Grid technology. The system provides travelers with services of optimized route scheme, bus arrival prediction based on real-time route status, and route status forecast. For traffic managers, the system can provide vehicle tracing, traffic monitoring, history data analysis, and decision making on traffic control strategy. In this regard, the chapter explores key research such as large multi-source traffic data integration, route status forecast, and optimum dynamic travel scheme implementation based on massive GPS data.

In Chapter 18 – Mining Environmental Data in the ADMIRE Project Using New Advanced Methods and Tools – authors present the EU funded project Advanced Data Mining and Integration Research for Europe (ADMIRE), that is about designing new methods and tools for comfortable mining and integration of large, distributed data sets. The authors present a set of experimental environmental scenarios, and the application of ADMIRE technology in these scenarios. The scenarios try to predict meteorological and hydrological phenomena which currently cannot or are not predicted by using data mining of distributed data sets from several providers in Slovakia.

In Chapter 19 – Collaborative e-Learning and ICT Tools to Develop SME Managers: An Italian Case – authors focus on face-to-face and classroom-based development courses that is problematic for time-poor SME managers. Authors describe that collaborative learning, especially as represented by an action learning approach, would seem ideal for SME managers. But can collaborative learning be adopted as a blanket approach in the case of SME managers? Or should we first take into account what the contextual influences on learning, networking, and collaboration are?

In Chapter 20 – Sketch Based Video Annotation and Organization System in Distributed Teaching Environment – authors explain that as the use of instructional video is becoming a key component of e-learning, there is an increasing need for a distributed system that supports collaborative video an-
notation and organization. In this chapter, the authors construct a distributed environment on the top of NaradaBrokering to support collaborative operations on video material when users are located in different places. Finally, an informal user study was conducted and results show that the system improves the efficiency of video organizing and viewing and enhances user’s participating into the design process with good user experience.

In Chapter 21 – OBIRE: Ontology Based Bibliographic Information Retrieval in P2P Networks – authors discuss that it has been widely recognized that bibliographic information plays an increasingly important role for scientific research. The chapter presents Ontology Based Bibliographic Information Retrieval (OBIRE) that is an ontology based Peer-to-Peer (P2P) network for bibliographic information retrieval. OBIRE is evaluated from the aspects of precision and recall, and experimental results show the effectiveness of OBIRE in bibliographic information retrieval.

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