Preface

While distributed systems have been the subject for many years they continue to be a very vibrant area for intense research.

This is mainly due to the fact that they are very often heterogeneous and geographically distributed. Notably enough, technologies are and 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 our society systems. Clearly, one of the challenges for such facilitation is the identification of methods and techniques that are required in order to design, implement and maintain these geographically distributed systems in a sustainable manner.

Even though the advantages of several distributed computing paradigms such as of Web and Web 2.0, grid and cloud computing, it is only recently that their applicability into the real world of the information society has been realized. While scientists have almost exclusively used these for their own research and development purposes, there has been a clear shift to application domains that are closer to everyday life. 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 progress made with a specific reference to their design, implementation and maintenance.

The goal of the Development of Distributed Systems from Design to Application and Maintenance book is to provide such a focus for the presentation and dissemination of new research results within the aforementioned area.

THE PURPOSE OF THE BOOK

The book aims to demonstrate a network of excellence in distributed computing and by doing so to provide progress made with relevance to their design, application and maintenance. Its mission is to introduce and thus, to highlight a feasible and applicable arrangement within business and other research and development sector’s 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 distributed computing by focusing on the design, application and maintenance of such systems. The areas covered include large-scale networking and distributed systems, distributed collaborative computing, cloud computing, ubiquitous environments, wireless and real-time systems and finally, work on applying distributed computing for the specific setting of disaster management. 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:

- 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, grid and cloud computing, applicable computational technologies, distributed computing, object and service oriented architectures, web services, collaborative technologies, agent intelligence and data mining.
- 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.
- 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

Nineteen 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 possible that a chapter in one section may also address issues covered in other sections.

Section 1: Advanced Techniques and Methods for Distributed Systems

This section includes six chapters. It introduces both principles and progress made in advanced techniques and methods for distributed systems. While these stand as a state-of-the-art reference, most chapters present experimental scenarios and approaches on how these methods and techniques can be applied in the real-world. As such, they underpin future development and implementation of relevant services.

In Chapter 1 – Defining Minimum Requirements of Inter-Collaborated Nodes by Measuring the Weight of Node Interactions – authors focus on defining the minimum requirements to support the inter-cooperation between various scales, dynamically evolved Virtual Organizations (VOs). Their proposed method is able to assign a weighted value to each pair-wise path that each member (node) can select in order to locate neighbouring nodes according to their preferences. The weight of each path is be measured
by the analysis of prerequisites in order to achieve a mutually agreed interaction between nodes. The
information gathered from an interaction is then stored in a snapshot, a profile that is made available
during the discovery stage. The topology suggests that capturing inter-cooperated nodes interactions
that can be publicly available could lead to knowledge of neighbouring VO members which in turn,
could be used for facilitating a more effective resource discovery and selection decision. Work here is
applicable to grids, clouds, and inter-clouds (federated clouds).

In Chapter 2 – *Bio-Inspired Techniques for Resources State Prediction in Large Scale Distributed
Systems* – authors advance available techniques for resources state prediction in large scale distributed
systems by using bio-inspired algorithms (i.e. neural network improved by genetic algorithms). The new
approach herein consists in a new fitness function, having as a main scope the prediction error minimiza-
tion. The proposed prediction techniques are based on monitoring data, aggregated in a history database.
The experimental scenarios consider the ALICE experiment, active at CERN Institute. Compared to the
classical predicted algorithms based on average or random methods, authors obtained an improvement
considering prediction error of 73%.

In Chapter 3 – *Reliability Based Scheduling Model (RSM) for Computational Grids* – authors present
a reliability based scheduling model for the jobs on the computational grid. The model considers the
failure rate of both the software and hardware grid constituents like application demanding execution,
nodes executing the job and the network links supporting data exchange between the nodes. Job allo-
cation using the proposed scheme thus becomes a trusted one as it schedules the job based on a priori
reliability computation.

In Chapter 4 – *Performance of Wireless Sensor Networks for Different Mobile Event Path Scenarios*
– authors investigate how the sensor network performs in the case when the event moves with special
movement path. Authors compare the simulation results for four specific scenarios: when the event is
stationary, moving randomly, moving with simple 4 path and boids path. The simulation results have
shown that for the case when event is moving randomly the performance is the worst in the four scenarios.
Simulation results also show that the consumed energy of random movement is the worst among four
scenarios. The consumed energy of boids model is the lowest in four cases. This shows that the event
movement with boids model can decrease the consumed energy in the large scale WSNs.

In Chapter 5 – *The Development of a Parallel Ray Launching Algorithm for Wireless Network Plan-
ing* – authors focus on the development of a parallel ray launching algorithm based on an intelligent ray
launching algorithm (IRLA). Simulations are implemented, and evaluated performance has shown that
the parallelization has greatly shortened the running time. Moreover, the COST231 Munich scenario has
been adopted to verify algorithm behavior in real world environment, and observed results have shown
a 5 times increased speedup upon a 16-processor cluster. In addition, the parallelization algorithm can
be easily extended to larger scenarios with sufficient physical resources.

In Chapter 6 – *Soft-Checkpointing Based Hybrid Synchronous Checkpointing Protocol for Mobile
Distributed Systems* – authors propose a hybrid checkpointing algorithm, wherein an all-process coordi-
nated checkpoint is taken after the execution of minimum-process coordinated checkpointing algorithm
for a fixed number of times. In coordinated checkpointing, if a single process fails to take its checkpoint,
all the checkpointing effort goes waste, because each process has to abort its tentative checkpoint. In
order to take the tentative checkpoint, an MH (Mobile Host) needs to transfer large checkpoint data to
its local MSS over wireless channels. Hence, the loss of checkpointing effort may be exceedingly high.
Therefore, authors propose that in the first phase, all concerned MHs will take soft checkpoint only. Soft
checkpoint is similar to mutable checkpoint, which is stored on the memory of MH only. In this case, if
some process fails to take checkpoint in the first phase, then MHs need to abort their soft checkpoints only. The effort of taking a soft checkpoint is negligibly small as compared to the tentative one. In the minimum-process coordinated checkpointing algorithm, an effort has been made to minimize the number of useless checkpoints and blocking of processes using probabilistic approach.

**Section 2: State-of-the-Art Distributed Systems Applications**

This section includes seven chapters. The content of this section is particularly valuable to those whose interest resides within the application area of distributed systems advances.

In Chapter 7 – *Distributed Adaptive Windowed Stream Join Processing* – authors present an adaptive framework for processing a window-based multi-way join query over distributed data streams. The framework integrates distributed plan modification and distributed plan migration within the same scope by using a building block called the node operator set (NOS). An NOS is housed in each node that participates in the join execution, and specifies the set of atomic operations to be performed locally at the host node to execute its share of the global execution plan. Experiments confirm the effectiveness of the developed adaptive framework on reducing the join execution cost and indicate a small additional adaptation-overhead for distributing the NOS update.

In Chapter 8 – *A Failure Detection System for Large Scale Distributed Systems* – authors present a failure detection system based on adaptive, decentralized failure detectors. The system is developed as an independent substrate, working asynchronously and independent of the application flow. It uses a hierarchical protocol, creating a clustering mechanism that ensures a dynamic configuration and traffic optimization. It also uses a gossip strategy for failure detection at local level in order to minimize detection time and remove wrong suspicions. Authors present results showing that the system scales with the number of monitored resources, while still considering the QoS requirements of both applications and resources.

In Chapter 9 – *Integrating Production Automation Expert Knowledge across Engineering Domains* – authors introduce the Engineering Knowledge Base (EKB), a Semantic-Web-based framework, which supports the efficient integration of information originating from different expert domains without a complete common data schema. Authors evaluate the proposed approach with data from real-world use cases from the production automation domain on data exchange between tools and model checking across tools. Major results are that the EKB framework supports stronger semantic mapping mechanisms than a common repository and is more efficient if data definitions evolve frequently.

In Chapter 10 – *Lightweight Editing of Distributed Ubiquitous Environments: The CollaborationBus Aqua Editor* – authors present the CollaborationBus Aqua editor, a sophisticated, yet lightweight editor for configuring ubiquitous environments in groups. The CollaborationBus Aqua editor simplifies the configuration and offers advanced concepts for sharing and browsing configurations among users.

In Chapter 11 – *Guaranteeing Correctness for Collaboration on Documents Using an Optimal Locking Protocol* – authors present a novel collaborative technique for documents which is based on transactions, schedulers, conflicts, and locks. It is not meant to replace existing techniques; rather, it can be used in specific situations where a strict form of concurrency control is required. While their approach is highly formal - with an emphasis on proving desirable properties such as guaranteed correctness - the work is part of a project which aims to fully implement the technique.

In Chapter 12 – *Collaboration Support for Activity Management in a Personal Cloud Environment* – authors describe a framework supporting the development of open collaboration environments which
integrate heterogeneous business services. The framework facilitates the user cooperation in the execution of shared activities by offering a workspace awareness support which abstracts from the business services employed to operate. The management of the workspaces of the user’s collaborations is based on the functions offered by the Collaborative Task Manager (CTM), which offers a lightweight and flexible model for handling more or less complex collaborations. The CTM is integrated with business services in a loosely coupled way which supports the management of parallel workspaces for accessing the user’s collaboration contexts, their objects, and the related awareness information.

In Chapter 13 – Matrixes of Weighing and Catastrophes – authors propose the use of a multi-criteria technique, namely the Matrixes Of Weighing (MOW) for the handling of catastrophes, in particular the pre-catastrophe and post-catastrophe phases, where a series of problems are usually handled which solution leads to a choice, which could be done by using multi-criteria techniques. The objective of this investigation is to present the MOW with multiplicative factors, and showing their application in the pre-catastrophe phase, when choosing possible shelters and in the post-catastrophe phase, by aiding to hierarchies which infrastructures to be recovered after a catastrophe.

**Section 3: High-End Design Concepts for Future Distributed Systems**

This section includes six chapters. This section goes beyond and builds upon current theory and practice, providing cutting edge and visionary real-world directions on how distributed computing technologies are and could be used in the near future to the benefit of various settings.

In Chapter 14 – Resource Management in Real Time Distributed System with Security Constraints: A Review – authors provide a widespread survey of research work reported in RTDS. This review covers the work done in the field of resource management, load balancing, deadlock and security. Authors also present the challenges involved in tackling these issues and prompt future directions in these areas.

In Chapter 15 – A Meta-Design Model for Creative Distributed Collaborative Design – authors acknowledge that collaboration in creating software systems becomes more complex and frequent among multidisciplinary teams. The challenge is to bridge the communication gaps among stakeholders with diverse cultural and professional backgrounds. Authors also argue that future uses and issues cannot be completely anticipated at design time and developers must provide open-ended software environments that can be evolved and tailored in opportunistic ways to tackle co-evolution of users and systems. With this in mind, authors propose a conceptual meta-design model, the Hive-Mind Space (HMS) model to support multidisciplinary design teams’ collaboration and to foster their situated innovation. The model provides localized habitable environments for diverse stakeholders and tools for them to tailor the system, allowing the co-evolution of systems and practices. Two concrete case studies demonstrate the implementation of the HMS model and provide a possible solution to overcome the complex, evolving, and emerging nature of the collaborative design.

In Chapter 16 – Adaptable Information Provisioning in Collaborative Networks: An Object Modeling Framework and System Approach – authors argue that the widespread of knowledge across a network can be used as an effective vehicle to promote trust within the network, successfully resolve conflicts, and build a prospering collaboration climate. With this in mind, authors present an extensible information modeling framework and also further complementary concepts that are designed to enable such an active provisioning service. Furthermore, a high-level architecture for a system that offers the targeted information provisioning service is described.
In Chapter 17 – Design and Implementation of Hybrid Time (HT) Group Communication Protocol for Homogeneous Broadcast Groups – authors were concerned with the number of messages sent within a group of multiple peer network. Herein, authors take advantage of the linear time (LT) and physical time (PT) protocols since the message length is O(n) for the number n of peers. Authors discuss a hybrid time group communication (HT) protocol to reduce the number of messages unnecessarily ordered by taking advantage of the linear time and physical time. They evaluate the HT protocol in terms of the number of unnecessarily ordered messages compared with the PT and LT protocols. Authors show the number of unnecessarily ordered messages can be reduced in the HT protocol compared with the LT and PT protocols.

In Chapter 18 – Information Communication Technology and a Systemic Disaster Management System Model – authors present some aspects of the communication processes within a Systemic Disaster Management System (SDMS) model. Authors are focused on that ICT should not be used in isolation but it should be seen as part of the whole system for managing disaster risk. Further research is needed in order to illustrate the full application of the ICT within the context of the developed model.

In Chapter 19 – A Next Generation Technology Victim Location and Low Level Assessment Framework for Occupational Disasters caused by Natural Hazards – authors discuss the use of an exemplar occupational disaster scenario in which advanced ICT utilization could present emergency managers with some collective computational intelligence in order to prioritize their decision making. To achieve this, authors adapt concepts and practices from various next generation technologies including ad-hoc mobile networks, Web 2.0, wireless sensors, crowd sourcing, and situated computing. On the implementation side, they developed a data mashup map, which highlights the criticality of victims at a location of interest. Authors also present the service architecture in the form of data and process flows, its implementation, and some simulation results.

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