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# High Performance Computations for Decision Support in Critical Situations: Introduction to the Third Workshop on Urgent Computing

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## Abstract

This paper is the preface to the Third Workshop on Urgent Computing. The Urgent Computing workshops have been traditionally embedded in frame of International Conference of Computational Science (ICCS) since 2012. They are aimed to develop a dialogue on the present and future of research and applications associated with the large-scale computations for decision support in critical situations. The key workshop topics in 2014 are: methods and principles of urgent computing, middleware, platforms and infrastructures, simulation-based decision support for complex systems control, interactive visualization and virtual reality for decision support in emergency situations, domain-area applications to emergency situations, including natural and man-made disasters, e.g. transportation problems, epidemics, criminal acts, etc.

*Keywords:* urgent computing, early warning system, emergency computations, decision support, large-scale computations

Complex, large-scale, collaborative simulations are becoming more and more crucial for decision making in critical situations like floods, earthquakes, wildfires, terroristic attacks, epidemics, pandemics, instabilities in financial markets and similar. At the same time recent advances in experimental techniques such as detectors, sensors, and scanners have opened up new vistas for real-time initial data collection and aggregation in many levels of details. The complete cascade from the individual components to the fully integrated multi-science systems crosses many orders of magnitude in temporal and spatial scales. These principles change the approach to decision support into data-driven simulations, exploration and the selection of the appropriate scenarios. The ultimate challenge is to not only make the simulation processes in different scales, but also provide their mutual coupling across scales in the overall system together with the real-time data assimilation into computational models [1]. Thus, it leads to four types of inhomogeneity in decision support computation problems due to:

- diversity of computational scenarios used for the exploration and decision support in critical situation, in respect to the features of its evolution;

- composition of the various simulation models and the software for different computational platforms and resources;
- irregularity, uncertainties and incompleteness of the input data;

Additionally, the amount of computations which is required for the early recognition of the critical situations and for the decision support while expecting the critical situation is rather different. Jointly, it gave birth to Urgent Computing (UC) – a new area of computer science addressing algorithms, methods and tools enabling prioritized, immediate and effective access to large compute and storage systems (computers, grids, clouds) for such emergency computations which require clever decision making. UC is being considered as computational services (or resources) since data services work together in distributed computational environment to help decision makers create an optimal behavior scenario within a strict time limit.

UC is the basic technology for the Early Warning Systems (EWS) which are traditionally targeted for the disaster prediction and prevention in a lot of areas (e.g. environmental science, epidemiology, telecommunications, etc.). Generally the UC-solutions were mainly domain-specified [2]. However the development of domain-neutral middleware [3] demands deeper studies in several computer science areas such as the methods and algorithms of providing immediate access to large scale compute and storage facilities, data placement, resource management and optimization for urgent computing, solutions enabling collaboration, SLA and policies [4]. Inspired by these researches, the recent UC is the general technology to design EWS for decision support in critical situations comprising complex technical, environmental and social systems. It provides wider consideration of UC as the body of the system bases (including middleware for UC and EWS), scalable methods, algorithms and domain-specific software for the forecast and exploration of critical situations, techniques for decision support of the user-end in case of emergency (including visualization and virtual reality), and the applications stipulated by real-world customers.

The Urgent Computing workshop has become an integral part of International Conference of Computational Science (ICCS) starting 2012. It aims to develop a dialogue on the present and future of research and applications associated with the large-scale computations for decision support in critical situations. The key workshop topics in 2014 are: methods and the principles of UC, UC middleware: platforms and infrastructures, simulation-based decision support for complex systems, interactive visualization for decision support in emergency situations, domain-area applications to emergency situations, including natural and man-made disasters. This workshop combines several papers devoted to infrastructural aspects of UC, including resource scheduling and the use of mobile devices, since the papers are about possible applications of UC in a wide set of domain areas. These applications include: marine rescue operations, flood prevention, transportation problems (including evacuation) and the shipping in severe weather conditions.

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