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Challenges in Computational Solid Earth System science in the frame of CYCLOPS project

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The Solid Earth system is an immensely complex system, involving processes and interactions on a wide range of space- and time-scales. To understand and predict the evolution of the Solid Earth system mainly in the frame of seismology, is one of the greatest challenges of modern science, with success likely to bring enormous societal benefits.

Computational solid Earth science is an active and growing field spanning seismology, geophysics, geodynamics and indeed all of the solid Earth sciences. Computational science works together with real-world data from experiments and seismological and geodynamical observations, to build an understanding of past, present, and future Earth

system structure. As data become more complex, and as modelling and simulations become more realistic, the computational burden is growing faster than the growth of available computing power.

High-performance computing, along with the wealth of new observational data, is revolutionizing our ability to simulate the Solid Earth systems with computer models that link the different components of the system together. In this presentation we demonstrate potential grid application on a (1) the Geoenvironmetal (Seismological) Sensors Network (GeSSN), (2) on the daily analysis of seismological data and (3) on the estimation of Centroid Seismic Moment Tensor.

A GeoEnvironmental (Seismological) Sensor Network comprises an array of sensor nodes and a communications system which allows their data to reach a server. The sensor nodes gather data autonomously and a data network is usually used to pass data to one or more base stations, which forward it to a Sensor Network Server (SNS). Some systems send commands to the nodes in order to fetch the data, while others allow the nodes to send data out autonomously. GeoEnvironmental Seismological Sensor Networks represent a new way to sense and understand the geoenvironment, which have a huge potential in many areas of the earth sciences. Although it is the development of technology that has enabled this new style of monitoring, it is Solid Earth system and environmental scientists with their understanding of geo environmental processes that need to play a vital role in guiding this exciting revolution.

Quarterly earthquake seismic data files are collected from stations over South Aegean and stored at GSL and INRH-CTRC. A great amount of data is generated monthly. Under traditional approaches, a researcher, that wants to use this massive data set, needs to download data from a server and uses his own computer to process it. A cluster approach provides both the data as well as the computational power to process this data. Cluster also makes it possible perform performance optimizations. Earthquake seismic data are mirrored on cluster's storage facilities automatically from all the stations. Data is stored on storage elements in files and made available through the File Catalogue Service. The cluster oriented data management provides the ability to built different applications that can use high volume datasets in a similar way. Today, four main applications has already built and run in the discussed cluster :

a) Quick estimation of earthquake's parameters: 200sec after receiving a trigger signal, a preliminary automatic solution is calculated

b) Experimental real time estimation of earthquake's magnitude using wavelets

c) Dynamic map interface that displayed the estimated locations (automatic and manual) of the earthquakes using the Google Maps API

d) The Centroid Seismic Moment Tensor application obtain the Centroid and the Seismic Moment Tensor of a given earthquake, which are the main features to characterize the source of an earthquake. It is an inversion based approach which uses a 3D grid of discrete points in space to cover a given area around the earthquake location.

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