e-Onama: Mobile High Performance Computing for Engineering Research

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ABSTRACT: *With the fast growing popularity of smartphone technology, the percentage of people accessing critical information from their handheld devices such as tablets, and e-readers, is increasing rapidly. Advanced computing devices are changing the paradigm of mobile communication. In this research paper, a solution called e-Onama is described in detail along with its applicability and future enhancement opportunities. e-Onama is an indigenously developed software solution by C-DAC which enables user to access HPC facility while on the move. This is an innovative product for addressing the needs of the open science and engineering community in HPC with ease. e-Onama has been developed for several mobile platforms like Windows, Linux and Android.*

Keywords: e-Onama, Onama, High Performance Computing (HPC), Centre for Development of Advanced Computing (C-DAC), Java Secured Channel Library (JSCH), Parallel Processing, Accelerator, Application Program Interface

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1. Introduction

Centre for Development of Advanced Computing (C-DAC) is the premier research and development organization under DietY (Department of Electronics and Information Technology), MCIT (Ministry of Communications and Information Technology), Government of India established in 1988 to explore India's supercomputing capabilities.

A High Performance Computing (HPC) cluster consists of a set of loosely or tightly connected compute nodes that work together so that in many aspects they can be viewed as a single system. The components of a cluster are usually connected to each other through fast interconnects, with each node running its own instance of an operating system. Computer clusters emerged as a result of convergence of a number of computing trends including the availability of low cost microprocessors, high speed networks, and software for high performance distributed computing. HPC clusters have a wide range of applicability in major domain areas like Climatology, Seismology, Computational Fluid Dynamics, Molecular Modelling etc.

The establishment of High Performance Computing (HPC) Systems at universities and academic institutes shall help in capacity building and act as Advanced Computational Research Centres for the engineering & scientific academic programs which shall address & catalyse the impact of high quality engineering and science education as well as high-end computational work for the research community. It will also promote research and teaching by integrating leading edge, high performance computing and visualization for the faculties, students, graduate and post graduates of the institutes and will provide solutions to many of our grand challenges which the world is facing currently.

2. ONAMA: A Quantum Leap in HPC

It is expected that, in near future, HPC will help humankind catch up with the demand of better computing requirements in all sectors that are critical. To meet this anticipated demand, C-DAC has developed an effective and versatile solution for engineering community, called Onama. This is an integrated package comprising of affordable HPC hardware, open-source tools & technologies and a well-selected set of parallel as well as serial applications, to be used across various engineering disciplines. It also contains several accelerator enabled applications that are widely used in domains such as Climatology, molecular dynamics, Computational Fluid Dynamics, bio-informatics etc. The solution provides future Technocrats/ Engineers a platform for a Quantum leap to gain an in-depth understanding of High Performance Computing (HPC). Students and Research Scholars who aspire to be HPC professionals will be able to pursue careers in advanced computing field and fulfil industry expectations.

ONAMA consists of a well selected set of parallel as well as serial applications and tools across various engineering disciplines such as computer science, mechanical, electrical, electronics civil, chemical engineering, etc. Most of the tools and applications are having user friendly interface with access to various libraries that can be used to develop programs which reduce the learning curve.

ONAMA comprises of three models, Application Installer, Application Execution Model and the Command Line Interface. Some of the screen shots of the above mentioned models are given as below:

Figure 2. Onama Installer

Several Innovative projects are being pursued by engineering undergraduates, post graduates and doctorate level students related to Onama and Parallel Computing. Affordable HPC-Onama cluster has made deep inroads in the engineering education segment. Capability and capacity building has got a major boost in terms of High Performance Computing wherein Onama is a catalytic factor.

Figure 3. Onama Execution Model

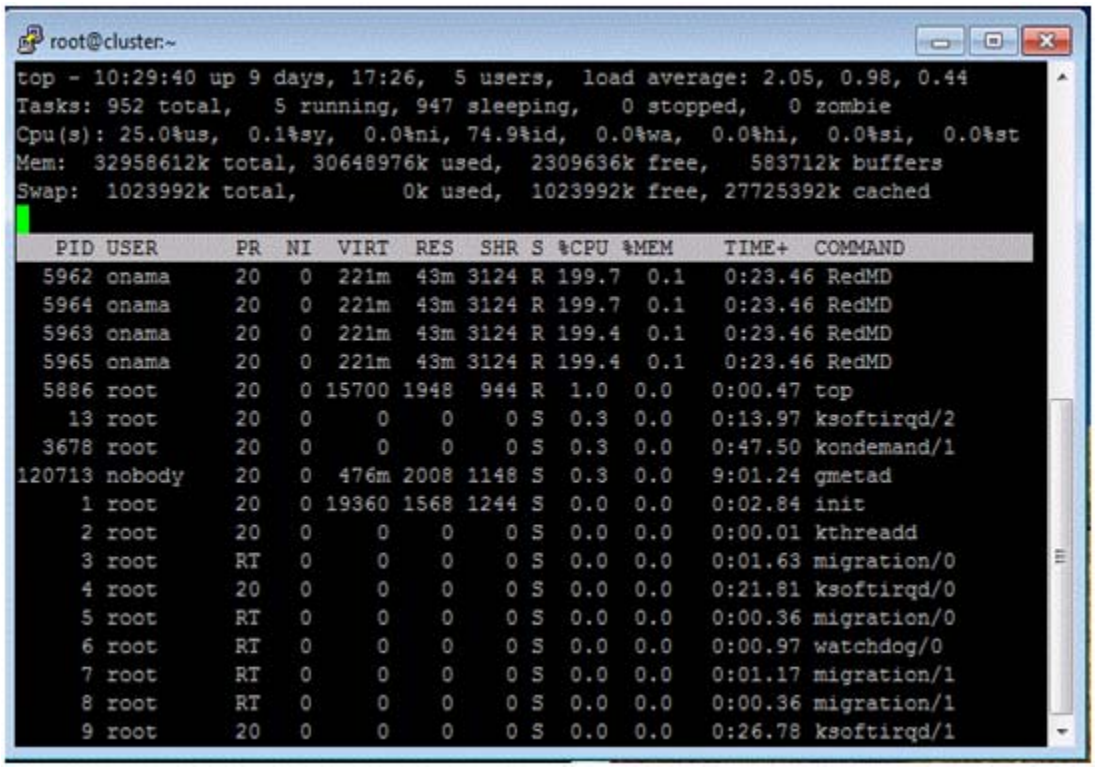

Figure 4. Parallel Execution of RedMD

Benefits:

• This program presently focuses on the engineering education community and the efforts shall culminate into the small and medium scale industry/ manufacture segment later.

• Enhanced employability in the industry by creation of HPC-ready engineers.

• Ease of access to supercomputing by the feature of an innovative approach namely e-Onama. This facility allows users to download utility on their handhelds/mobiles/tablets etc. and easily run various job on to the Supercomputing backend Onama facility via web based access.

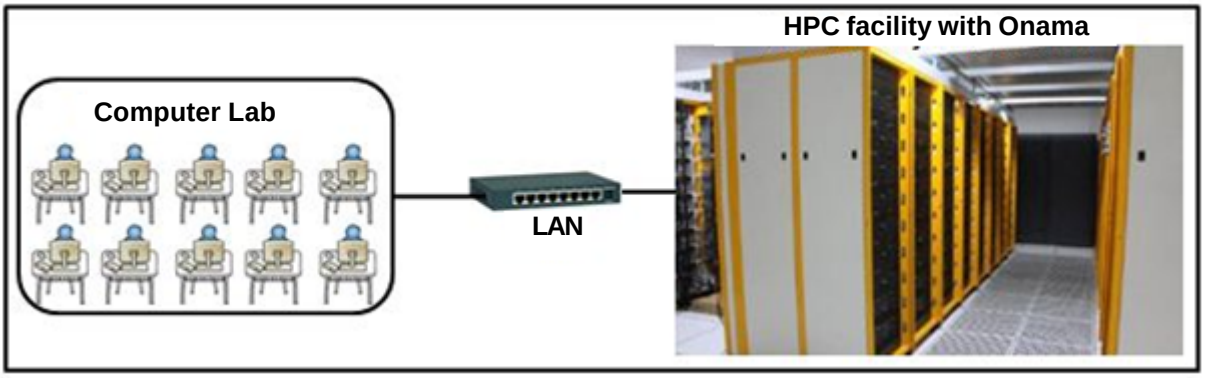

Figure 5. Onama Overview

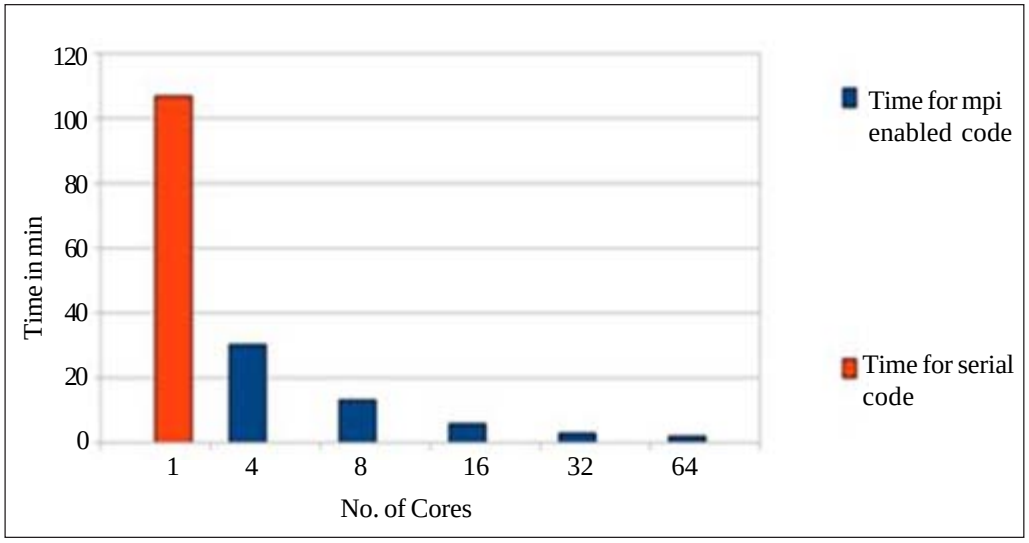

Figure 6. MPI HmmervsHmmer

3. e-Onama: HPC at the fingertips

After the success of Onama, and from the experience and user feedback, there was a thought for making the solution mobile. Onama requires the user to be in some network for connecting to the High Performance Computing Cluster for execution of jobs which was uncomfortable/ difficult to several researchers who are mostly on the move. This seeded the thought of making the solution mobile. Thus e-Onama was developed.

e-Onama is basically Onama on your handheld devices like smartphones, tablets etc. Regardless of the geographic location where the HPC server is situated, user canrun their jobs onto the cluster with the help of their handhelds. A similar kind of

graphical user interface (as that of earlier version of Onama) has been developed for e-Onama also for various mobile platforms. The user interface developed is light weight for the devices to afford.

One of the exciting features of e-Onama is Parallel Computing in your hand. The jobs are submitted using handheld devices to the HPC facility where the actual parallel processing takes place. This is accomplished using various parallel programming techniques like MPI (a specification for the developers and users of message passing libraries.), OpenMP (An Application Program Interface that may be used to explicitly direct multi-threaded, shared memory parallelism)etc., Some of the parallel applications included in e-Onama are RedMD, MPQC, TOWHEE, GERRIS, TYPHON, etc.,

Figure 6 shows comparison of results exhibited by serial code (Hmmer) and parallel code (MPI-Hmmer).

The job will be submitted from the handheld device which in turn submitted to the cluster through mobile internet/Wi-Fi/ any other wireless network. The Job will be executedon the HPC facility at the backend and the result can be viewed on handheld.

The user has to first login through the handheld with a valid username, password and hostname/IP Address registered on the cluster.

The screenshot will look like this:

Figure 7. e-Onama on handheld device

Once the user is logged onto the server, he is presented with the Onama Execution model (as mentioned above). The user is given full flexibility of executing the applications listed in the Onama execution model. Once the required application is selected and the '*run*' command is given, the execution model sends the appropriate command to the server. The application will be executed actually at the backend HPC facility thus giving very less load to the handheld device. The user can addshell scripts, edit application parameters etc., as per the requirements and resubmit through the handheld.The light weight nature enables the applications to be executed in a smooth manner.

e-Onama has been developed for several platforms like Windows, Linux etc., The HPC facility at the backend is based on Linux. Regardless of the platform in the handheld device, the application shall be run on the HPC facility and result viewed on the handheld. e-Onama is developed in JAVA hence it can be run on any platform. The aspect ratio of e-Onama will be automatically adjusted depending upon the target device.

4. Handheld to HPC Connectivity using Java

The solution is fully developed in Java since Java has several advantages compared to other programming languages. The

programs that are developed in Java are simple, object-oriented, architecture-neutral, portable and dynamic. The reason for selecting Java for developing this application is its coding portability between various platforms which is the main objective of e-Onama.

The connectivity between the handheld device and the High Performance Computing facility is achieved by using Java Secured Channel Library (Jsch). Jsch allows users to connect to an sshd server and use port forwarding, X11 forwarding, file transfer, etc.

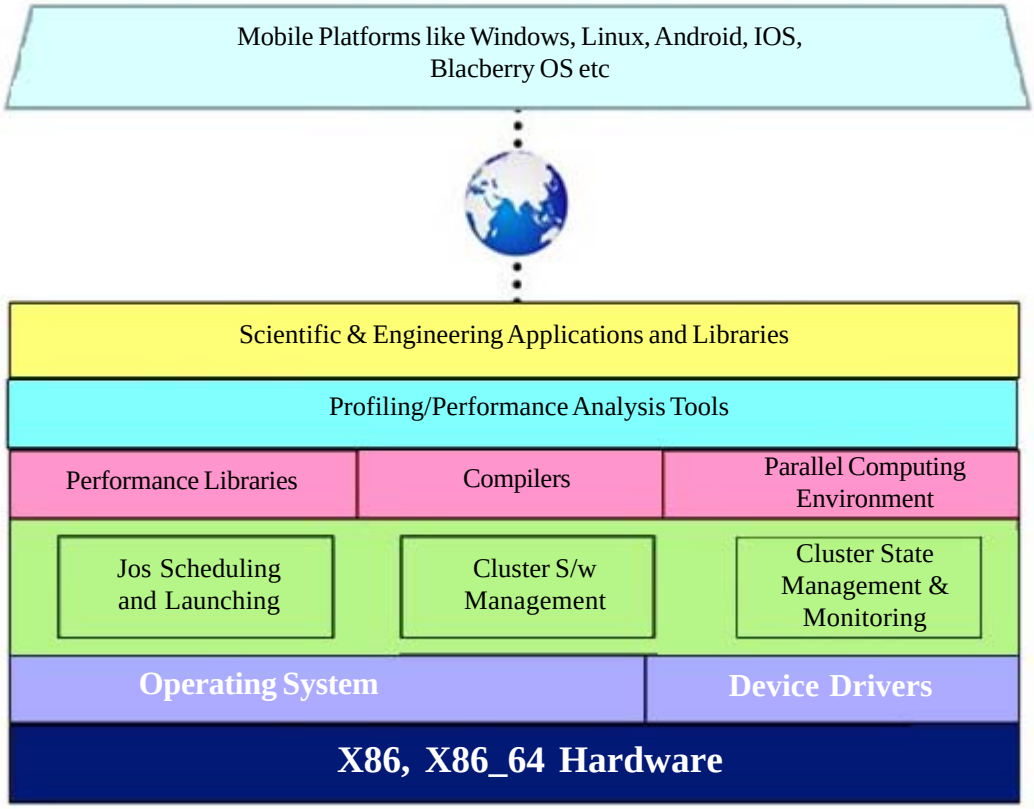

Figure 8. e-Onama Architecture

First Jsch shall establish a session between the handheld and the HPC facility. Then parameters like username, password, port number, IP/hostnameis provided by the user and after validation of the credentials a secure channel is established using ssh protocol. Secure Shell (SSH) is a cryptographic network protocol for secure data communication, remote shell services or command execution and other secure network services between two networked computers that connects, via a secure channel over an insecure network. Once the channel has been established, the commands will be executed in the server.

After executing the command in the server, the GUI response of the application will be displayed using X11 forwarding in the handheld device. X11 forwarding is the process of forwarding the windows of a remotely started X application to a client desktop.

Once the user views the output, one will have the flexibility to change any of the input parameters through the handheld for comparing the outputs.

5. e-Onama Design

• **Configuring Integrated Development Environment**: eOnama software development includes two Integrated Development Environment (IDE), netbeans7.1 and IntelliJ IDEA 12.1.4. These IDEs provide the developer, comprehensive facilities and flexibility for development. Development on Android platform requires an IDE with ADT plugin and SDK along with running XServer in the background.

• **Android emulator:** The Android SDK includes a virtual device as a mobile emulator. It helps to develop an android application without use of a physical device.

• **e-Onama layout design:** e-Onama application has an Activity file and a XML file for the designing purpose. The activity contains the actual java code and XML file contains the portion of code for design.

Figure 9. e-Onama connectivity model

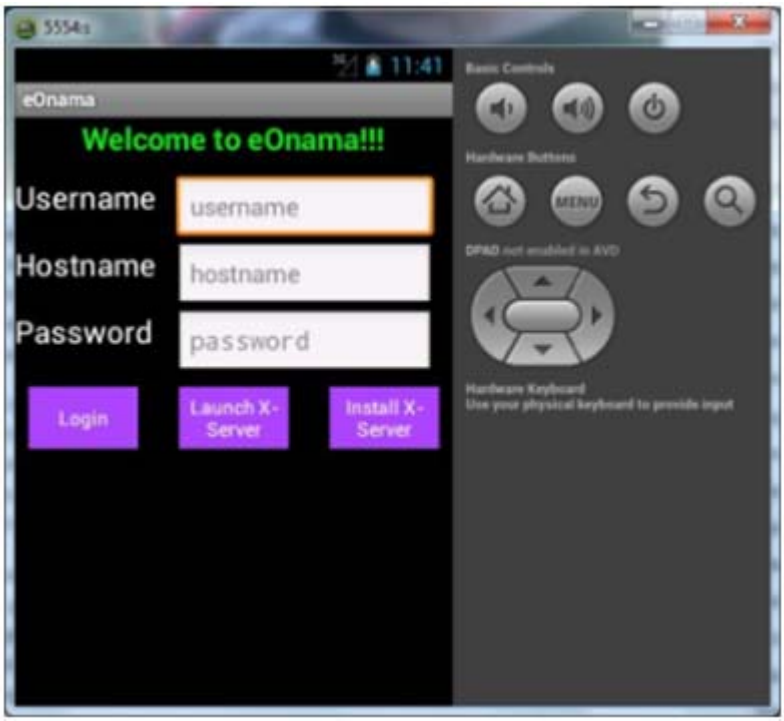

Figure 10. Android Emulator

6. Technical Challenges

• **Latency:** As the application is creating a SSH connection from target device to remote Linux server, latency is a major issue.

• **Forwarding GUI from server to client machine:** Xserver is used to import the application GUI from remote machine (linux server) to the mobile device (client machine). The challenge is in the launching of XServer and execution of e-Onama application simultaneously.

• **Aspect ratio & resolution:** Android usually runs on several mobile platforms, with different screen sizes and resolution. The application should be configured and compiled in such a way so that it can be compatible with all the devices running with Android operating System. Besides that, e-Onama includes a lot of heavy weight components such as long drop down lists, so it is a major challenge to display the GUI with all components in the target device.

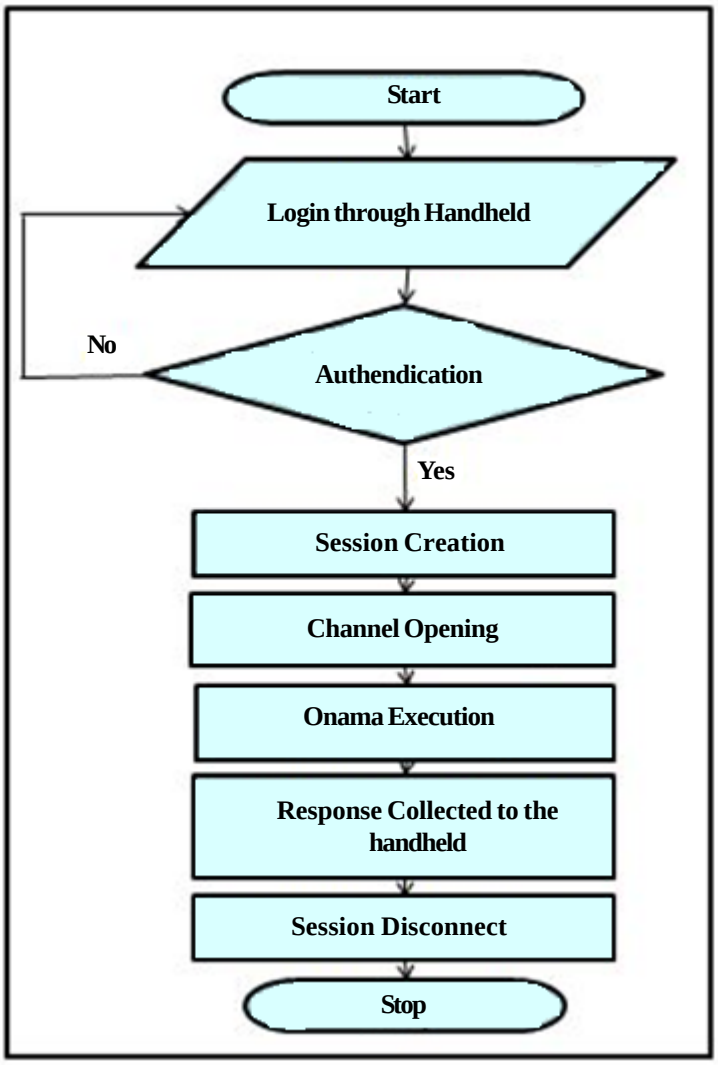

Figure 11. e-Onama Flowchart

7. Application areas for e-Onama

There can be numerous opportunities for e-Onama in the field of Scientific and Engineering areas. e-Onama can be used in many scientific areas like climatology, Siesmology, Oceanography etc., where the scientific processed data from the HPC facility can be viewed in a real time manner. This technology can be very much handy for many top level scientists who are in charge of several multi-domain areas. Another application similar to e-Onama can be developed for the health care sector where the

doctors can access the data of the patient's state in a critical point of timecontinuously from any location.

8. Conclusion and Future Work

A conventional HPC environment in which numerous amount of parallel processing is involved contains large hardware like compute nodes, interconnects, LAN/WAN and finally the user workstations. By introducing e-Onama, we are trying to eliminate the last component i.e the user workstations. This not only gives user the flexibility of High Performance Computing on one's fingertips but also gives a mental satisfaction of working on one's handheld device in the comfort of one'senvironment.Work is being done for launching of XServer along with e-Onama. Currently, e-Onama has been developed for handhelds with platforms like Windows and Linux & Android. Developments for various platforms like, Blackberry OS, Apple IOS etc., which are contemporary Operating Systems in the handheld devices is anon-going effort.

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