Investigating the Role of Handheld devices in the accomplishment of Grid-Enabled Analysis Environment

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Abstract. We investigate the role of handheld devices as a potential platform to be used in the Grid Enabled Analysis Environment (GAE) by porting desktop PC-based analysis software to run on Pocket PC's and other handhelds. This will enable them to be used for the analysis of data from the Compact Muon Solenoid (CMS), which goes online in 2006 at the European Organization for Nuclear Research (CERN). The environment currently comprises client software that runs on the Pocket PC providing interactive analysis features on the device and a remote data server named Clarens, which functions as a portal to the Grid, and ensures secure and authenticated access to the CMS data.

1 Introduction

The CMS (Compact Muon Solenoid) [1] at CERN, going online in 2006, will use the Grid to store the gigabytes of data it will generate each minute. This data can only be analyzed by rendering it in the form of 2D and 3D diagrams to enable scientists to derive conclusions about events taking place in the CMS. Our research aims to harness the technology of handheld devices to analyze this event data stored on servers connected to the Grid.

This paper describes an analysis environment that has been built by porting popular desktop PC-based physics analysis software including the Java Analysis Studio (JAS) [2] and the WWW Interactive Remote Event Display (WIRED) [3] for the PersonalJava environment on the PocketPC with WinCE 3.1. A portal to the Grid is provided by the Clarens server [4] developed at the California Institute of Technology (Caltech). Clarens also provides the Globus Security Infrastructure (GSI)-based [5] authentication features. Either wireless or wired network connections to the Pocket PC are possible by use of an appropriate 802.11b compatible plug-in card.

2 Related Work

Currently there are no physics analysis applications available for the PocketPC and handheld devices. The main obstacles in this field include the slow and unreliable nature of wireless connections, and the slow speed (typically 200 to 400 Mhz), limited RAM and small amount of permanent storage (usually 32 MB) of the handhelds.

However, a large number of desktop-based applications for analysis of physics data are available. These include JAS, WIRED, ROOT, GEANT and IGUANA. JAS, developed at the Stanford Linear Accelerator (SLAC), is used mainly for the analysis of 1D and 2D histogram data from particle accelerators. It can fit mathematical functions to the data histogram and display various statistics related to the data.

WIRED, developed at CERN and SLAC, is used for rendering event data and subcomponent geometry information from particle accelerator experiments. The file format used by WIRED is HepRep, which represents event data using XML.

Finally ROOT (developed at CERN) [6] is an important tool for us because of its special format ROOT files, containing data objects in a highly efficient, quickly accessible hierarchical structure.

3. Integration Architecture of the Analysis Environment with the Grid

The analysis environment is integrated with the Grid environment through a Grid-enabled portal developed at Caltech, named Clarens. Clarens is basically a remote data server, acting as a portal to the Grid. It provides secure access to data files through a GSI-based security protocol. Any users wishing to access the data need to authenticate themselves with Clarens before accessing any services on it. Once logged in, users can access various services using XML-RPC.

We are now in the process of implementing own Java-based version of Clarens which can integrate more effectively in this architecture. The Java based Clarens (JClarens) will use a peer-to-peer platform for load-sharing and fault tolerance, and will thus provide better performance over the unreliable wireless connections.

4. JASOnPDA

JASOnPDA is the main PocketPC based application that has been developed so far. This software communicates as a client with Clarens server, which enables it to fetch histogram data as ROOT files from the server, and manipulate and render it on the Pocket PC by use of the stylus. Users can also view statistics and fit functions against the histograms.

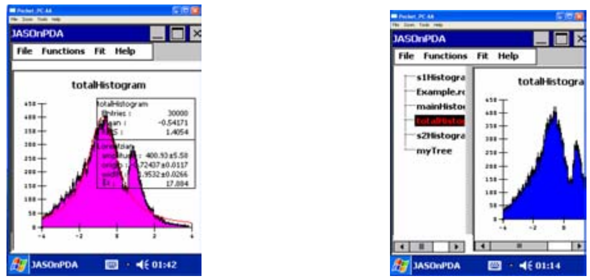

Fig. 1. A snapshot of JASOnPDA running on a PDA taken through the Remote Display Control Host, showing its features of histogram plotting, function fitting, and statistics calculation

The most important issue that had to be resolved was that of the incompatibility of some critical classes with PersonalJava on Wince. Firstly, the classes from FreeHEP [7] for analysis of ROOT files, known as RootIO, used dynamic proxies, which are unavailable in PersonalJava. As a result, we wrote entirely our own code for carrying out RootIO. Secondly, the encryption/ decryption features needed for authentication with Clarens were also incompatible. To solve this issue, cryptography classes from BouncyCastle [8] were used. These classes allowed us to make our application "Grid-enabled"; able to access the Grid with Clarens providing the necessary security mechanisms.

The first iteration of this application was not, however, up to the required standards of performance. The speed of the application was enhanced by optimizing the parsing of the ROOT file to fully utilize the indexed structure of ROOT files and using backend threads to speed up the tree structure display and populate hash tables with data from the histogram objects.

5. WiredOnPDA

WiredOnPDA is a reduced version of Wired using Personal Java as the VM on WinCE. The basic interfacing of the application with Clarens is carried out using the same method as JASOnPDA. The HepRep2 XML is parsed using the Piccolo parser, which has been found to be the fastest SAX parser available so far. The parsed data is used to extract the "drawables" stored in the HepRep2 files, which are then displayed on the screen. Transformations and projections on the drawables can also be applied on the event displays.

The issue of incompatibility with Personal Java was resolved by replacing the incompatible code in WIRED3 classes with code from the older versions of WIRED (WIRED1). This especially included the code for displaying the drawables, which was based initially on Java2D. We replaced this code with the Graphics classes of Java 1.1, which gave surprisingly good results in displaying the drawables.

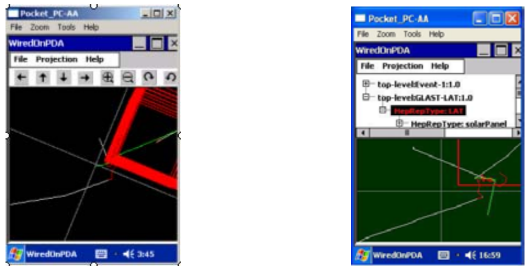

Fig. 2. A view of WiredOnPDA displaying an event from a HepRep2 file. The buttons on top allow users to translate, rotate or scale the diagram

6. Selection/Evaluation of Tools and Technologies for Handhelds

An important problem was to find out a suitable JVM for running our Java applications on the PocketPCs. After evaluating several technologies such as IBM Device Developer, SuperWaba, Savaje, and MIDP, we finally opted for Personal Java Runtime Environment by Insignia Jeode [9], which supported Java 1.1.6 as well as several security and collection classes from Java 2.

7. Conclusion

Already our current work proves that resource-constrained devices such as the Pocket PC can be integrated with the Grid, and can play a vital role in the realization of the idea of a Grid-Enabled Analysis Environment (GAE). The completion of this project will prove to be a milestone towards the attainment of a level of maturity in Pocket PC based applications, that has only be seen in desktop applications so far.

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