Ubiquitous Access for Computational Science and Education

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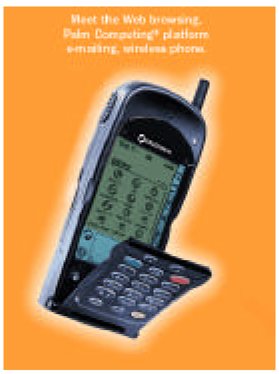
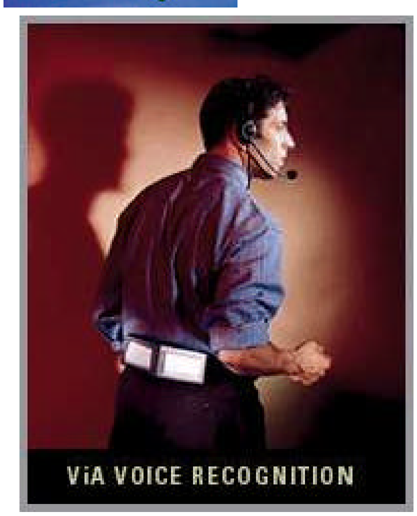
1. Introduction

Louis Turcotte produced an amazing survey (in the form of a PowerPoint presentation) of the different uses explored for small devices. Some examples are given below.





A major thrust in this area is the expected confluence of cell phone and personal digital assistant as universal wireless portable systems. As specific motivation we note the estimate that by 2005, 60 million Internet ready cell phones will be sold each year and that 65% of all Broadband Internet accesses will be via non-desktop appliances. This suggests that we can expect hand held wireless devices will play a more and more important role in areas now dominated by desktop clients. This will enable new applications and new approaches to old applications. Thus during this year we looked at ways palmtops could be used to support high performance computing and training or education applications. We have produced prototypes, which we describe and give lessons from our architecture and implementation work as well as early use of our systems.

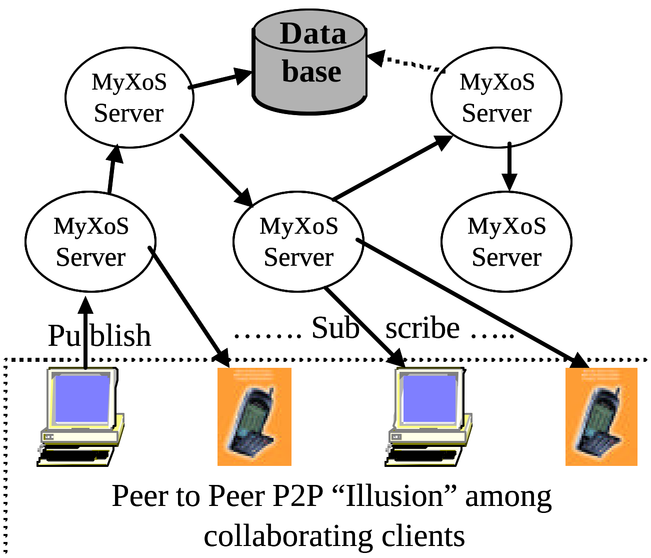
2. Base Technologies

Last year we studied in general the base technologies – especially the WAP and WML protocols and the Bluetooth hardware communication standard. [1] This year we understood more as we saw in practice what actually worked! We will learn more at the Grid on the Go workshop [2] but it appears that WAP and WML, which are optimizations of HTTP and HTML, may not make it. Currently there is a serious economic downturn in the telecommunications area and this has delayed introduction of the new infrastructure, which could broadly use WAP and WML. The deployment of data-aware (third generation) phones with integrated PDA capabilities will certainly happen. However maybe by that time we will not need WAP and WML. Rather we will prefer using the identical protocols for both desktop and non-desktop devices; this is a classic trade-off between the optimized approaches versus the clumsier but broadly understood and deployed technology. In our work we use either HTTP or conventional Java sockets to communicate with the palmtop; we sent data that was not in WML but in a format that was optimized for existing palmtop applications. So our good experience with this method suggests use of desktop communication systems for palmtops will be important.

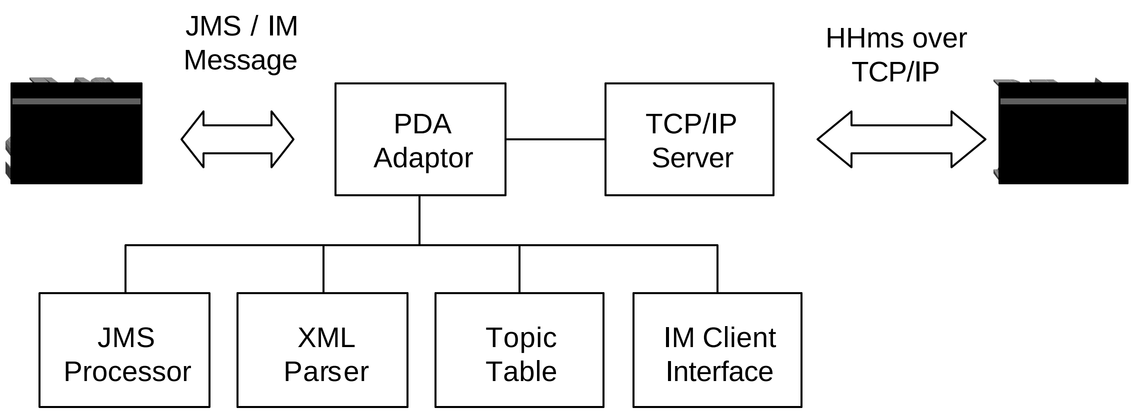
The new Bluetooth standard will enable pervasive short distance wireless links. However Bluetooth is not yet available for many devices and we do not have the necessary access points deployed. Bluetooth supports different power levels but the attractive low power option has very short range (a few meters). Thus it does not seem easy to deploy within a largish area like a research department. Rather the standard here is the 802.11b standard which is high-bandwidth (11 megabits per second), good range (100 meters) and a commodity item – you can purchase at Amazon.com. Thus we expect this protocol to be used in “department” applications such as classrooms or computer centers. We understand deployment of 802.11 and other wireless infrastructure is subject to serious security concerns in DoD and this needs further research. 802.11 interfaces are quite expensive (a significant fraction of cost of a PDA) and it is not clear what will be the low cost high bandwidth winner. An early use of Bluetooth is expected to be in naturally small environments such as enabling communication between your laptop, PDA and cell phone. In the wide area, we can use infrastructure like Palm.Net or digital cell phones for wireless communication – currently in the 14.4 kbaud bandwidth range. One will presumably always see a hybrid environment; high performance wireless in local areas with a geographically broader and slower infrastructure.

The situation may be moving slower and in somewhat different and more conservative technical directions than we expected. Nevertheless the revolution will happen and we should see the construction of handheld accessible web sites by a broader community. We should move away from the current “closed garden” approach typified by Palm.Net where the wireless web sites are high quality but proprietary.

3. Architecture of Collaborative Handheld devices



We have studied the best way to integrate palmtop devices into our Garnet collaboration system. Garnet is built around the notion of a publish/subscribe message service shown in figure to the left, which keeps the state of shared objects consistent between the collaborating clients. As explained in another report [3], we exchange information about the shared object but render it separately for each client. This is implemented using an adaptor sitting between the palmtops and the Garnet collaboration system. The adaptor looks like a conventional desktop client to the message service (currently JMS the Java Message service). It then uses a special lightweight protocol HHMS (HandHeld Message Service) to communicate with the palmtop. HHMS could take a very different form for each type of palmtop.



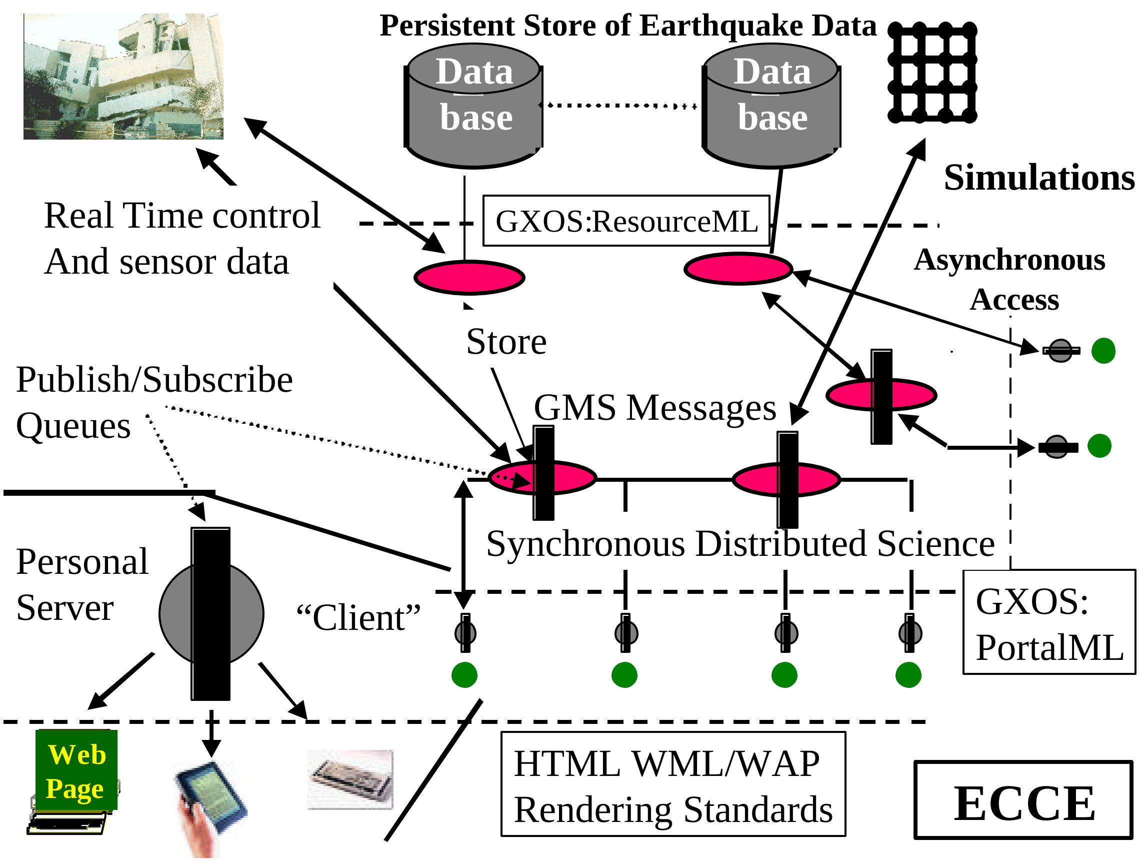
For our initial experiments, we are using the Compaq iPAQ with an 802.11 wireless connection to an access point connected to our local intranet. Here we use Java sockets connecting "personalJava" on the iPAQ to the adaptor. The Palm 7 connection will on the other hand use HTTP over the much slower Palm.Net service.

Analogously the intermediate adaptor can simplify a shared export XML files such as HTML or SVG so they can be handled by the less powerful palmtop. For instance, the Batik SVG viewer we are using does not currently run on the palmtop. In our design, Batik runs on the adaptor and transmits a simple file to the palmtop, which it can display. The figure above illustrates some other possible adaptor services including parsing complex XML messages.

Our Garnet collaboration system supports shared display, instant messenger (from the open source http://www.jabber.org site), text chat and shared SVG and HTML files. We discuss this further in section 5.

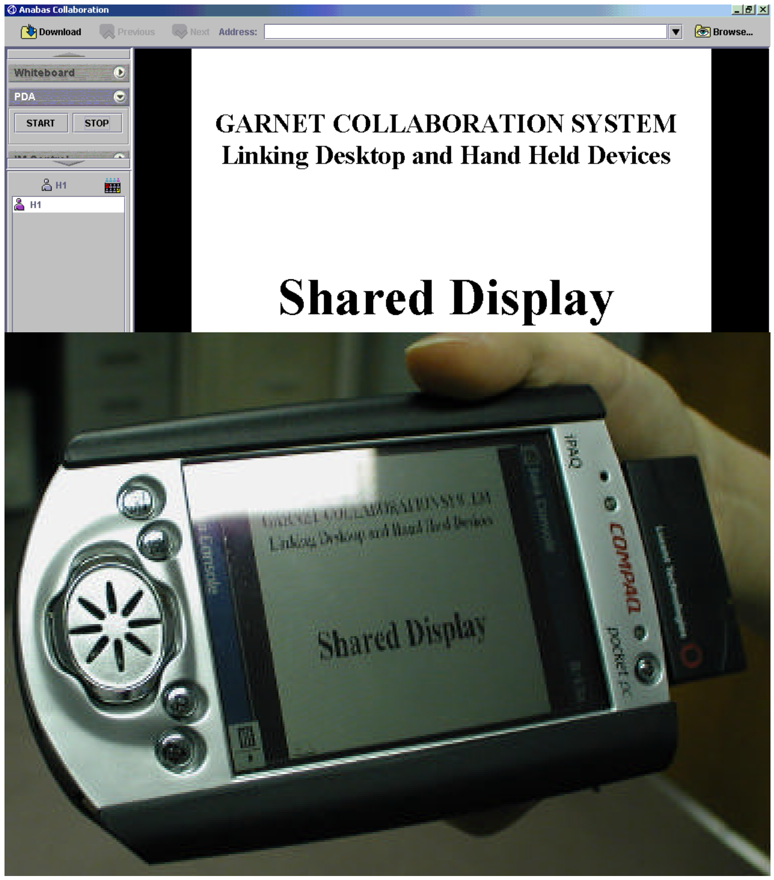
4. Applications of Collaborative Handheld Devices

Consider the ways palmtops can be included in collaborative sessions such as those involved in training. Students can get quizzes, web-page summaries (thumbnail images) and home works on their palmtops while watching the full curricula on a large high quality display in the lecture hall. The notes can be taken on these small devices and related to lecture both through the thumbnail image and the timing information carried in the JMS events. The hand held notes and recorded lecture material (the recording is performed automatically in ECCE) can be integrated later at the student's convenience to provide an archive that contains all the information in a form that is indistinguishable from the alternative of using conventional laptops or desktops as student interfaces.



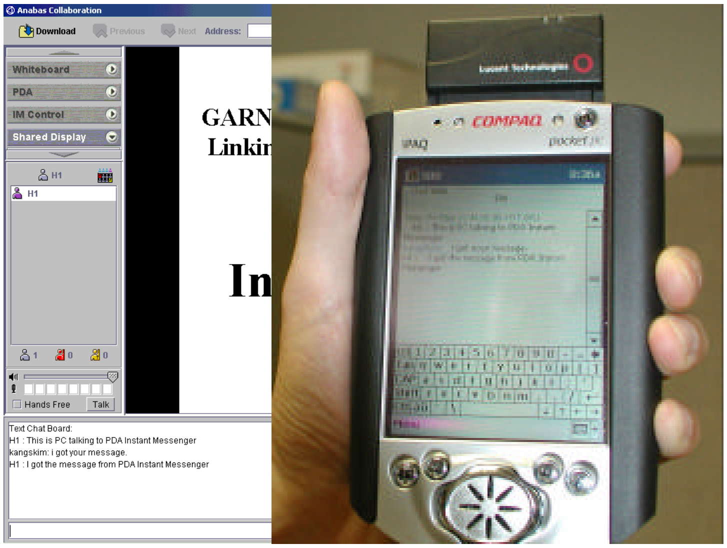
In the figure above, we sketch an architecture to support realtime interpretation of earthquake events using our ECCE environment and both conventional and handheld devices. The realtime nature of such scenarios enhances the value of handheld devices as it allows experts to be brought into a discussion or planning session wherever they happen to be.

5. Examples of Collaborative Handheld Shared Applications

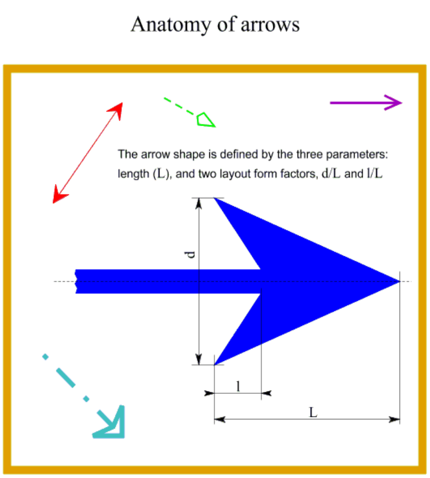


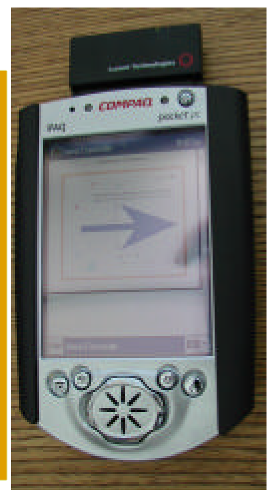
The figure to the left shows a screen shot of both a desktop and a handheld display sharing a PowerPoint slide using the shared display mechanism. The adaptor runs the basic desktop shared display code and the framebuffer is extracted, resized and sent to the iPAQ with a simple interface code. We will add interactive options to choose the iPAQ image size from the handheld – here the rescaling will be done on the adaptor server.

Here we note that the latest release of VNC (public domain shared display) for Palmtops shown on the left is quite impressive – it is fast and includes server side resizing for reducing the shared display size. We have not examined this in detail to see the division of work between server and client. We feel that our dedicated shared display code has several advantages over using VNC (which is how Tango did shared display). One important feature is that our shared display code uses exactly the same JMS event bus as all other applications. This allows a clean architecture with a single archiving and fault tolerance service.



Here we illustrate another adaptor function. The Jabber.org instant messenger in the iPAQ is linked with the desktop chat room.

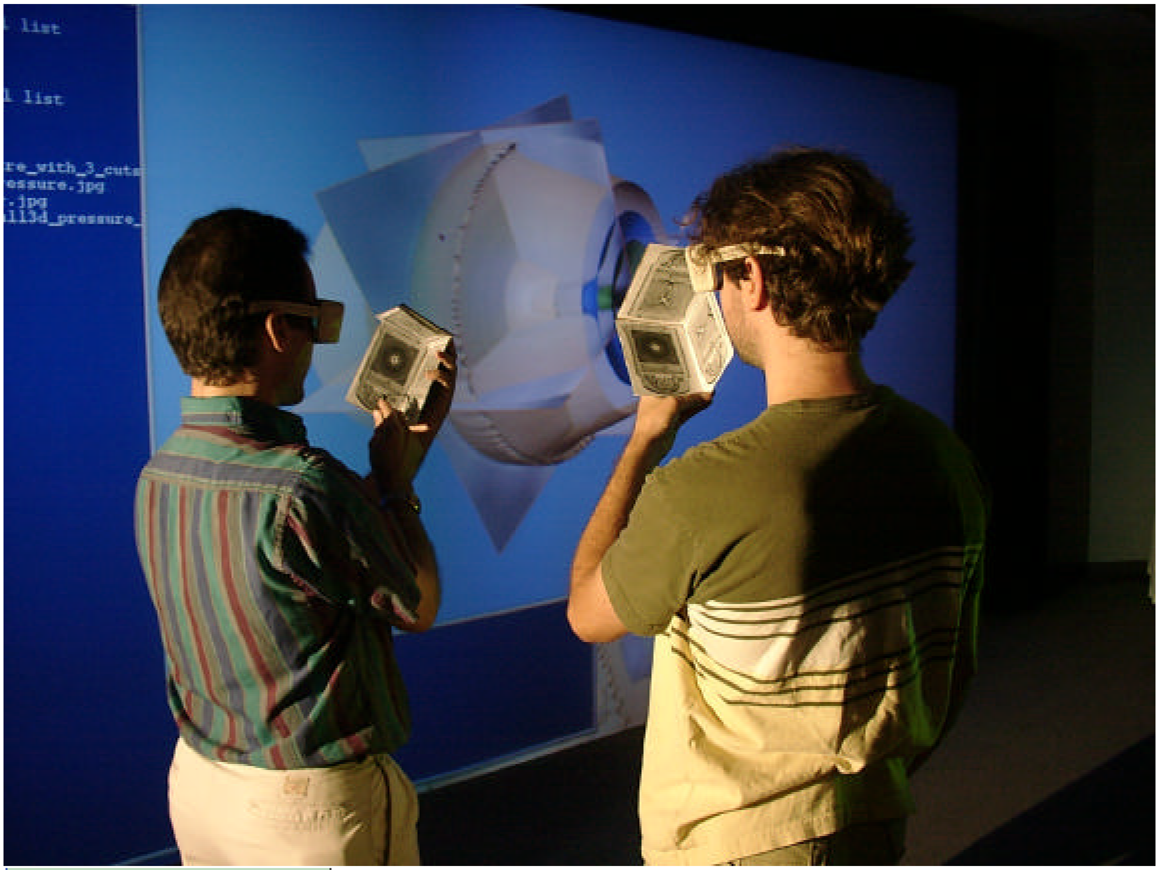


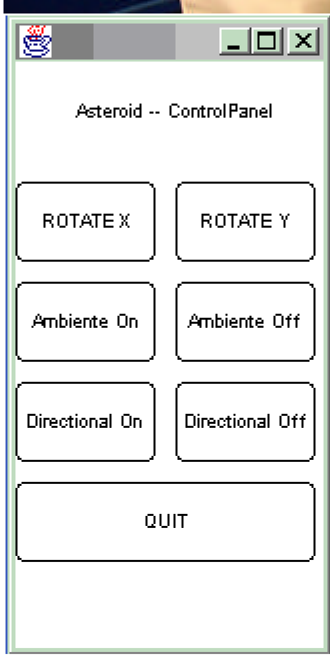


Here we illustrate shared SVG between desktop and handheld device. As PowerPoint and Adobe Illustrator can be exported to SVG, this allows us powerful shared export capability for important authoring styles. SVG is natural for all 2D vector graphics as in the simplest scientific visualization and whiteboards.

6 Collaborative Visualization with Handheld Control

As another example, we designed with the FSU visualization group a demonstration of wireless palmtops controlling high-resolution displays – this produces a much more powerful personal interface than the conventional untethered mouse and keyboard interface. By interfacing palmtops using an adaptor to a portal like Gateway from FSU, we can support job submission and status monitoring from HPC systems.

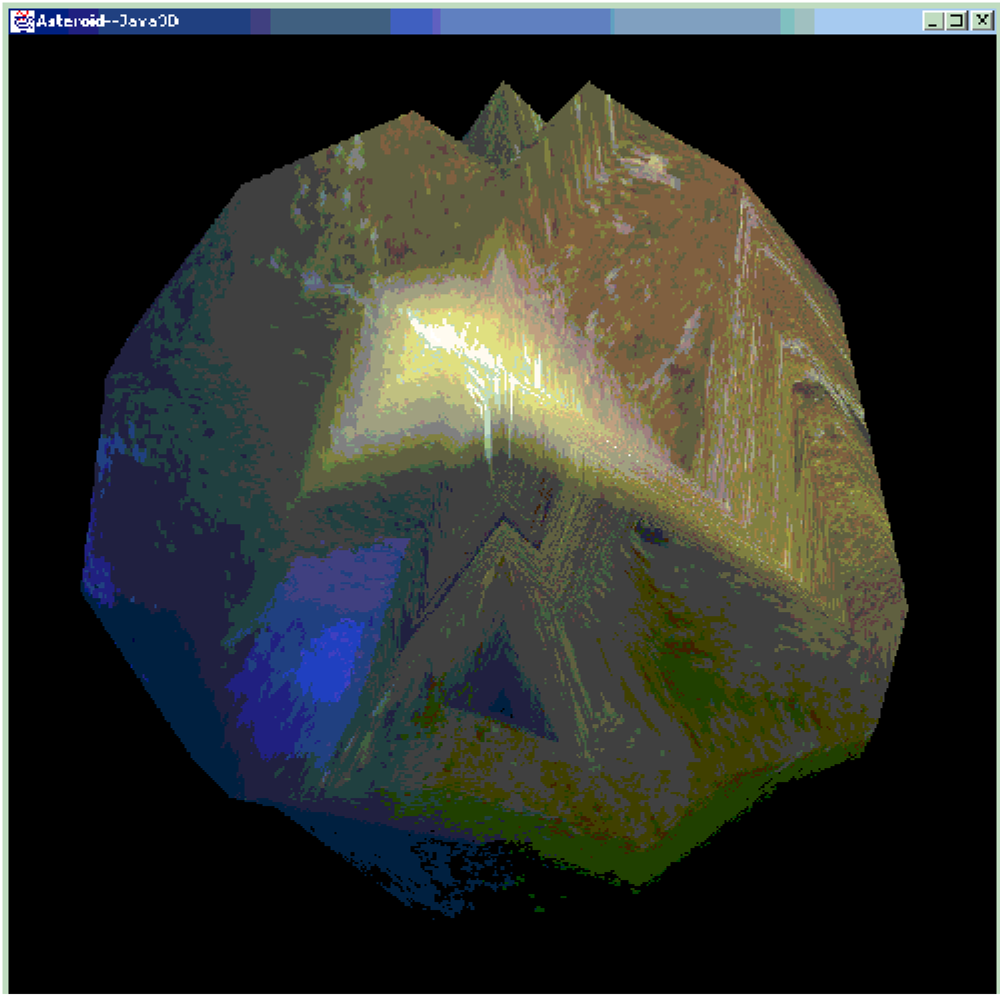




Above we show of a sketch of how this could look with a controller made from 3 handheld devices – one for each of the two dimensional slices of the 3D object displayed on the large screen.

As a simpler prototype we built a simple Java handheld controller communicating with a Java3D rendered image on the FSU PowerWall shown on the next page. To the left we show the PDA control panel.

Here we show the 3D image manipulated by our prototype



References

1. David E. Bernholdt, Sangyoon Oh, Konrad Olszewski, Geoffrey C. Fox, "Tools for Handheld Supercomputing: an Assessment of the Wireless Application Protocol (WAP)", *ERDC Technical Report May 2000*, http://www.new-npac.org/users/fox/documents/wapmay00/wap-assessment.html
2. Grid on the Go Workshop May 2001, http://www.ncsa.uiuc.edu/gog/
3. Geoffrey C. Fox, "Architecture and Implementation of a Collaborative Computing and Education Portal", ERDC Technical report May 2001.