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XtreemOS

Integrated Project

BUILDING AND PROMOTING A LINUX-BASED OPERATING SYSTEM TO SUPPORT VIRTUAL ORGANIZATIONS FOR NEXT GENERATION GRIDS

Demonstration scenarios and demonstration plan

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T3.4.8	XtreemFS File Replication	ZIB*

^oThis task list may not be equivalent to the list of partners contributing as authors to the deliverable

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Executive Summary

This deliverable summarizes existing XtreamOS demonstration scenarios and outlines the demonstration plan until the end of the project. We plan four to five main scenarios with applications running smoothly on XtreamOS, which will be used as first-contact demos. In addition there will be about ten other application demos and multiple more technically oriented ones; the purpose of which is to allow a more in-depth view and also serve as short tutorials on XtreamOS.

Multiple scenarios have already been successfully demonstrated at events such as the International Supercomputing Conference and project reviews. While some of these are currently being improved or reimplemented, four have already been finalized and published on the XtreamOS web pages. Rather than describing them in too much detail in this deliverable we provide references and let them speak for themselves. We also briefly describe all other scenarios that are currently undergoing development.

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Chapter 1

Introduction

The goal of demonstrating new technology is convincing potential users to buy it, try it out or provide financial or other resources for its further development, depending on the maturity of the technology and/or the planned business model. In case of the open-source XtreamOS software, we want to convince people to download it, see how it can solve their problems, and finally start using it as well as contribute to development by reporting bugs and joining development team(s).

The choice of an appropriate demonstration scenario depends, among other factors, on the audience's interests, background and technical prowess. High-level managers, end-users and anyone coming in contact with XtreamOS for the first time are most probably interested in seeing typical applications and use cases from their working field running smoothly on XtreamOS. Technical managers and system administrators, on the other hand, also need to know a bit about what is happening behind the scenes, otherwise they will not trust the technology. Demonstrations of XtreamOS thus try to satisfy both. That said, workpackage 4.4 focusses on the use-case-centred scenarios in order to ensure a favourable *first impression*. These scenarios will also be performed at trade fairs and similar events as most of the audience will be hearing about XtreamOS for the first time there. The more technical demonstrations are mostly being developed in the respective development workpackages. They will be available on the project's web pages and also be presented at some scientific conferences, where they will accompany the technical and research papers on XtreamOS.

1.1 Past and Planned Events

Since the formal start of WP4.4, there have been five demonstrations of XtreamOS at various events:

- Demonstration of the grid checkpointing service and the Wissenheim application using Object Sharing Service, both at the International Supercomputing Conference in Hamburg, Germany, June 23-26, 2009,

- Demonstration of XtreamFS at LinuxTag, Berlin, Germany, June 24-27, 2009.
- Multiple technical and application demos at the third project review meeting and the SAC meeting, both in Rennes, France, July 8-10, 2009.
- Different demonstrations to show the benefits of the XtreamOS system at the XtreamOS summit at Euro-Par 2009 in Delft, The Netherlands, August 25, 2009.
- Presentation of RBMS managing checkpoint and restart at XtreamOS Summer School in Oxford, UK, September 7-11 2009.
- Demonstration of XtreamOS as a platform for collaboration both within companies and across company borders at Poslovna Linux konferenca (Business Linux Conference) in Portorož, Slovenia, September 29, 2009.
- Supercomputing 2009 in Portland, USA November 14-20, 2009 - The consortium had several representatives including demos of XtreamOS, XtreamFS and Kerlabs demonstrating LinuxSSI. This demo showed wide-scale computing with computers and servers residing in the US and several places in Europe.

In next months we plan further demonstrations at various international events. Please refer to [3] for more details on the events.

The date, venue and format of the XtreamOS key players event is still being discussed consortium-wide. However, demonstrations are a must at such events and should focus on application-level scenarios to show the benefits of using XtreamOS.

1.2 Publicly Available Demonstrations

Perhaps even more important than the events enumerated above are the demonstrations available on the internet, which can reach the widest audience in the shortest time. We plan to publish all the demonstrations on the project's web pages in the form of video or screencast with explanation.

Furthermore, some of the open-source applications included in the XtreamOS distribution will come with everything needed by the user to replay the respective demonstration scenario on her own XtreamOS grid, including detailed instructions, sample data, links to required 3rd party software etc.

All the publicly available demonstrations are available on the XtreamOS web page at <http://www.xtreemos.eu/demonstrations>. At the time of the submission of this deliverable the following demonstrations are available publicly:

- Wissenheim, a distributed virtual presence application,
- part I of the core scenario, showing simple VO administration and job submission,

- two XtremFS replication demonstrations.

Chapter 2

Demonstrations of XtreamOS Use Cases

As said in the introduction, the common-use-case demonstrations provide the first contact with XtreamOS for the majority of the audience. The goal is to convince them, first, that XtreamOS can solve their problems; second, that it can do so better than competing technologies. Furthermore we decided to also create simplified demonstrations from most of the applications ported to XtreamOS by workpackage 4.2. These will mainly be interesting for people working in the field of each application. The demonstrations presented in this chapter are split into two groups accordingly.

One problem with using applications for demos is that it *makes XtreamOS invisible (transparent)*. While this can be seen as a *feature* rather than a problem, we feel that we must prove that the application is in fact running on XtreamOS, which can be done in three ways:

Make XtreamOS opaque, e.g. by submitting the needed jobs manually. This is certainly not the preferred approach.

Compare it to running without XtreamOS and show how much faster it is when using multiple computational and/or storage resources from the Grid. The difference must be readily apparent or the demo must include on-line performance meters.

Show monitoring information in parallel with the demo, preferably using a map overlay to show the location of the resources being used.

The second approach may be appropriate for certain scenarios. The rest will follow the third approach, like one of the available XtreamFS demonstrations already does.

The demonstration plan for each use case is outlined below. Please see [1] for original descriptions of the applications from workpackage 4.2 and [2, 4] for updated descriptions of some of them.

2.1 Featured Use Cases and Applications

We have chosen some typical use cases of XtreamOS in various fields, ranging from a team of experts cooperating on engineering projects to entertainment to a large client-server application that only uses XtreamOS on the server side. Note that this list is not final.

2.1.1 Web Photo Archive using Cloud Infrastructure

Zmile is a web portal for photography storage and sharing that is currently being developed by ZIB and VUA. It is intended to serve a large number of users and thus requires distributed storage of the photographs and other data as well as distributed computational resources on which to run the web servers.

In the demo scenario we will show that one of the benefits of Zmile letting XtreamOS manage the distributed computational and storage resources is that the application becomes agnostic to whether it is running on physical machines or on virtual infrastructure provided from *a cloud*. Furthermore, the application is not locked to any specific infrastructure provider, which would be the case if, e.g. it would use the Amazon S3 for storage instead of XtreamFS.

Zmile will be deployed to a set of Amazon EC2 machine instances. We will show for example the amount of the available picture storage and how it increases on-the-fly as another machine from the cloud is added to the application.

2.1.2 Distributed Virtual Presence

Wissenheim is a distributed interactive 3D virtual world for edutainment and entertainment, as shown in Figure 2.1. The scene graph is transparently distributed and replicated by the Object Sharing Service (OSS) developed within WP3.4. Avatar interactions and scene graph changes are synchronized through speculative transactions provided by the OSS.

The final demo will show several users starting their Wissenheim instance through the XtreamOS xconsole. The first user starts the initial virtual world and all subsequent users automatically join this world. The final demo will also show how OSS can simplify the development of such a distributed virtual world, especially the management of the distributed game state.

where all avatars meet and chat.

2.1.3 Computer-Aided Engineering

A typical workflow in an engineering, architectural or similar working group includes each person working on an aspect of the project that matches their expertise, providing their results as input to others. As an example we will use one application (jCAE) to convert a 3D model (for example, a new model of an air-plane) to a mesh and another application that verifies a certain aspect of the design by running calculations on the mesh, as shown in Figure 2.2. Sharing data on a global file



Figure 2.1: An XtremOS edutainment scene in Wissenheim

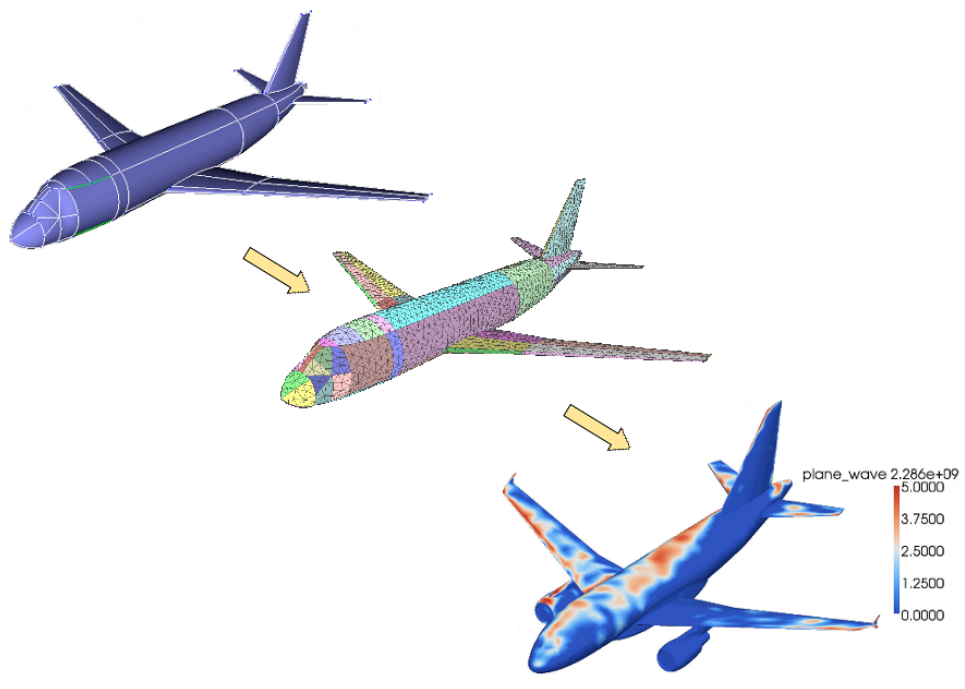


Figure 2.2: Part of a Computer-Aided Engineering Workflow

system with a strict security policy is crucial in such projects, as is using the grid computational resources to speed up the complex calculations.

2.1.4 Rule-based System Management

Rule-based System Management (RBSM) is a large-scale system management tool, providing rule-based decision making capability for the deployment and control of Grid and cloud environments (see Fig. 2.3 for an image of the main interface). We aim to show that there are many features within XtreamOS that aid management of enterprise systems. This demo will take advantage of application isolation and migration within containers, timely checkpointing and restart of applications using the XtreamOS checkpointing interface and storage of real-time monitoring data in XtreamFS.

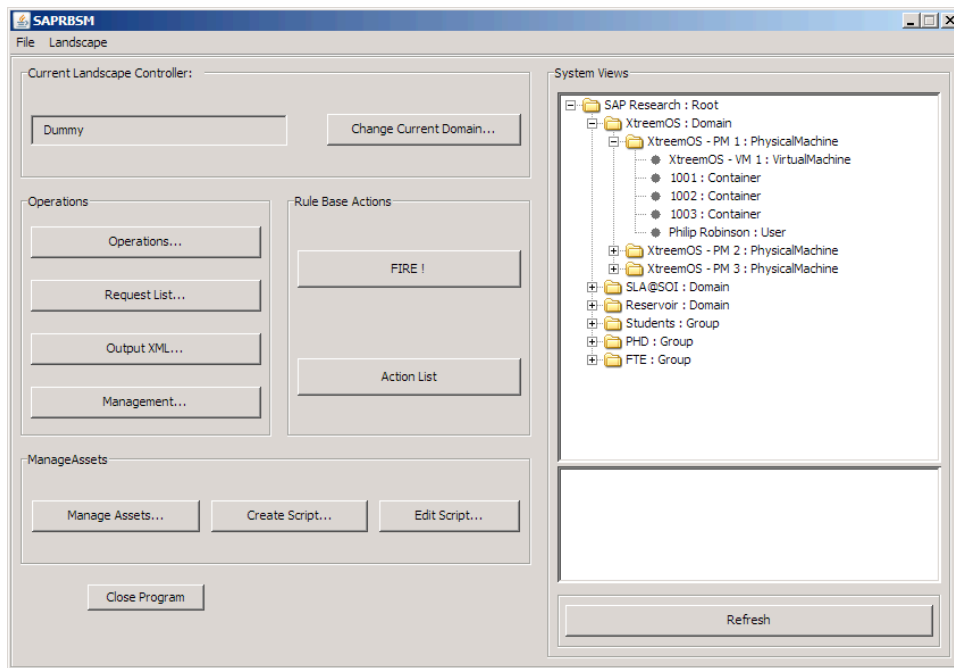


Figure 2.3: Main administrator interface for RBSM (work-in-progress)

The planned scenario uses a pre-configured central controller hosting the RBSM administration environment to bootstrap the setup of a small XtreamOS network, consisting of the deployment of virtual machine images and the management interfaces required to allow control through RBSM, with monitoring information being stored in a repository on an XtreamFS share. RBSM will then be used to deploy a set of test applications, both directly, and through the use of containers, and demonstrate the usage of the checkpointing and migration functionality to show the potential real-world use case for these features.

2.1.5 Mobile Video Sharing with On-Demand Transcoding

One of the most interesting “resources” shared by a mobile device could be the local photos and videos captured with the device. Also, as demonstrated in the past, one interesting application case of the Grid access from a mobile device is the possibility of transcoding video files, in order to be able to reproduce them even if the original codecs are not supported on the mobile device. Mixing both ideas, we have designed a scenario where a user captures a video with its mobile device and mark it for “on-demand sharing” (so that it will be uploaded to the XtremFS as soon as someone tries to access it); then, a different user will try to access this video file using the GPlayer application, that will automatically transcode the video file accessed (the video captured by the other user in this case, that will be stored in a format not supported by the second user’s terminal) before playing it.

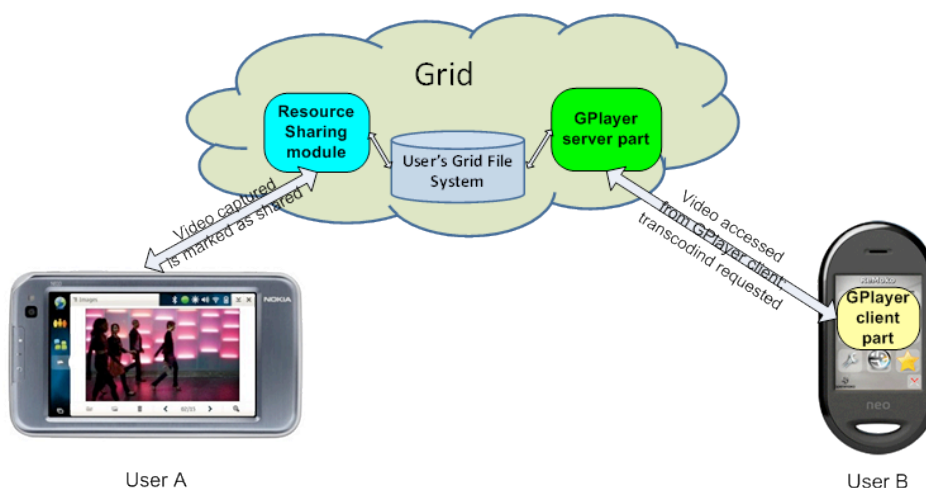


Figure 2.4: Scenario for Mobile Video Sharing with On-Demand Transcoding

2.2 Other Use Cases from Workpackage 4.2

We conclude this Chapter by the current list of applications from workpackage 4.2 that have not been selected into the group of featured use cases but are useful for demonstrating that XtremOS supports a wide range of applications. They will also be interesting to people working in respective fields. The prospective list of such use cases is given below.

SpecWeb2005 demo will show that this web server benchmarking framework has been successfully ported to run on top of XtremOS and is able to take advantage of this distributed operating system. Indeed, XtremOS offers to the SPECweb2005 benchmark a wide range of functionalities. Concretely,

it is suitable to be used as an advanced and dynamic testing platform. With the communication between the aforesaid application and the AEM component of XtremOS (through XATI API) we are able to reserve the needed resources to execute all the components of the application in question. In addition, we make use of a monitoring GUI with the aim of controlling the whole life cycle execution of the application.

COMP Superscalar will run the **hmmpfam**, a protein sequence analysis application, exploiting the XtremOS AEM features to reserve resources for the execution and submit and control jobs. COMPSs also will make use of XtremFS to store the intermediate files of the application, as well as the necessary classes, binaries and scripts.

openTurns is an **open** source initiative to **Treat uncertainties, risks, and statistics**. Running an OpenTURNS study often consists of running thousands or millions of independent calculations from which a global consolidated answer is gathered. In the demo these calculations will be launched on the grid formed by all connected XtremOS nodes belonging to the same dedicated VO. OpenTURNS will submit jobs transparently through XtremOS Job Manager with a minimum modification to OpenTURNS framework.

Zephyr is a multidomain multigrid preconditioned conjugate gradient solver applied to academic 2D Navier-Stokes driven cavity problem or 2D Burgers viscous transport equation. It is often used to benchmark HPC hardware in serial or distributed MPI version. Serial Zephyr will be used in a demonstration of XtremOS checkpoint/restart, where we will checkpoint and kill the calculation while in progress, then restart it and achieve the expected results. The MPI version will be shown running on a set of machines running the PC-flavor of XtremOS.

Secured Remote Computing application will be used to remotely pilot one Zephyr calculation from another node. An XtremFS partition visible to both processes will be used as the secure shared media via which the piloting orders will be conveyed.

MAESTRO was designed to reproduce the footprint of Moderato, a radiographic modeling code that combines a Monte-Carlo and a straight-line attenuation model. Moderato can simulate the behaviour of each photon by tracing their route from the light source up to the impact reached on the inspected object or on the argentic film. The combined result of thousands of these impacts gives a global image as would be obtained on a photographic film during actual radiographic inspection. MAESTRO will demonstrate how such simulations behave when launched and monitored using the job manager of XtremOS.

MaxDB Replayer demo will demonstrate a business application running on top of XtremFS demonstrating the capabilities of this distributed file system. In a typical multi-tier business solution the great majority of file operations is transactional relying on a central database. In practical business scenarios, end-user applications access this database via the middleware WEB Application Server. For MaxDB Replayer application we recorded IO access traces that MaxDB database generates while supporting a real-life business application. Then, the IO load that was captured in the traces is applied to XtremFS by replaying the traces over XtremFS. Replying the traces, especially when they are concurrently replayed from several nodes, generates a considerable amount of IO to the data files (called MaxDB volumes) and effectively simulates distributed landscape of a business application.

Enterprise Document Indexing and Searching : TREX is a SAP application that is used as an indexing and enterprise search distributed engine. At the index construction stage the engine reads a large amount of input documents from a filesystem and writes the resulting index to the filesystem. Thus the index construction stage imposes a significant read and write load to the underlying filesystem. At the TREX use case we will use XtremFS filesystem to store the input documents and the resulting index files that TREX produces. Thus we will demonstrate the scalability, high availability and performance advantages that XtremFS provides for TREX search engine at its index construction stage.

Mobile Instant Messaging is a Grid-adaptation of the well-known Pidgin application for instant messaging. Not needing to create a Grid-application from scratch (as it would be needed with a web-based solution instead of native XtremOS-MD), we have modified the Pidgin application to make it Grid-aware, being able to store the settings and conversation logs in XtremFS so that they can be accessed from every device.

Galeb is an open-source function fitting utility with a command-line interface. It is already included in the XtremOS distribution. We will add instructions for the typical use-case of providing the input data on an XtremFS volume and submitting a parallel Galeb job to the grid.

Chapter 3

Technical Demonstrations of XtremOS Features

Once the demonstrations described above catch someone's attention, she will possibly want to explore XtremOS in more depth and learn about some of the technicalities behind it. We have thus created a *core* scenario that encompasses most of the typical administration tasks and presents the user interface of XtremOS, and the Xterior scenario will show an alternative, SAGA-based GUI used to interact with XtremOS. On the other hand we also have multiple scenarios explaining particularly interesting features that are hard to present with the use cases from workpackage 4.2. All technical scenarios can also be viewed as short XtremOS tutorials.

3.1 Core Scenario

The core scenario was developed to include the typical administration tasks in a running XtremOS grid. It involves two actors – a grid administrator working on node `core.xlab.si` and a user working on his computer `client.xlab.si`. The core node also acts as a resource, and the grid contains another resource node `resource.xlab.si`.

The administrator starts with explaining the web-based XtremFS and Scalaris status pages. The user then shows his XtremFS home volume and copies some files from his local home directory to XtremFS. He explains a simple job `hello` that he would like to submit. However, he cannot use the job submission GUI because he is not a member of any VO yet, and thus has no user certificate. He asks to join the `demo-vo` using the VOlife web interface. The administrator approves his request and also adds him to a group and role within this VO. The user downloads the certificate that proves his VO membership. He can now submit the job (see Figure 3.1) and show the output.

The second part of the scenario shows resource selection, resource management, and job monitoring. In contrast to the first part it employs the Linux-like

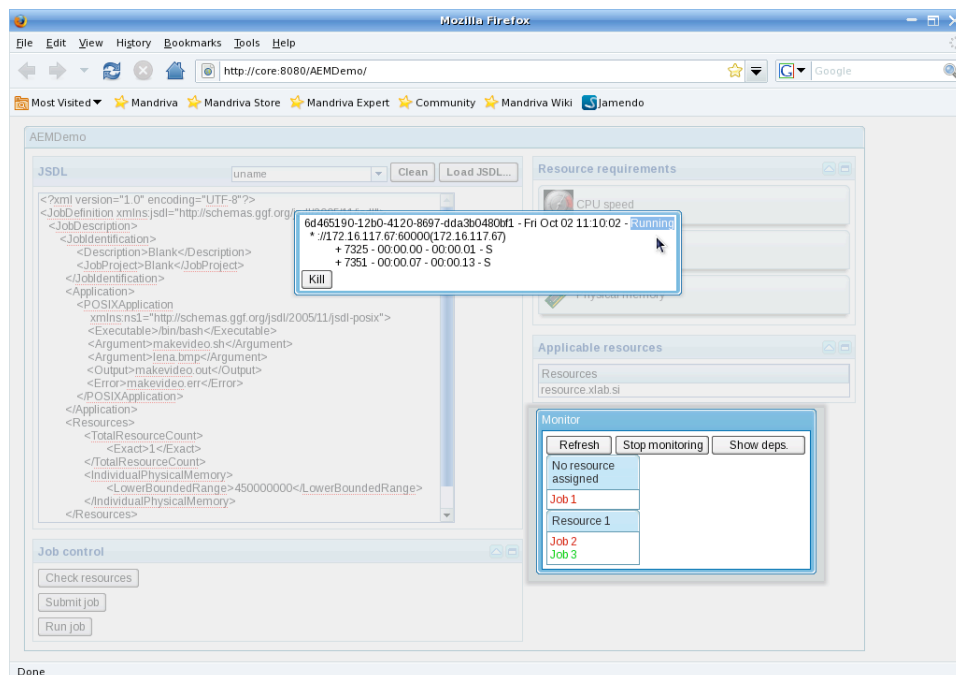


Figure 3.1: Submitting and monitoring XtreamOS jobs using a web-based GUI

command-line interface of XtreamOS. The user would in this case like to submit a longer running job that also requires more memory. He first checks whether any existing resources are available with the required amount of memory. None are, so he decides to offer his own computer as a resource to his VO, taking on the role of resource management. The required administration steps on his part as well as on the VO administrator's part are shown. Once the resource is added, the job is run and then monitored using both the standard `ps` tool as well as the XtreamOS version `xps`.

3.2 Xterior

Xterior is a SAGA-based application that provides a GUI to the typical Grid operations such as usage of global file systems, submitting and monitoring jobs etc. We will demonstrate how Xterior can be used as an alternative interface for XtreamOS.

3.3 Virtual Nodes

Virtual Nodes allow one to replicate a Java-based service for fault-tolerance. This demonstration scenario presents a fault-tolerant POP3 server based on the virtual

nodes framework. The open-source POP3-capable Java Email Server (JES)¹ was modified to fit the virtual nodes requirements, which took one person week of programming effort. A non-modified POP3 e-mail client is used to show that the replication is completely transparent to the client. For more details please see [5].

3.4 Checkpointing

The XtremOS grid checkpointing architecture (XtremGCP), which is capable of checkpointing and recovering jobs running on heterogeneous grid nodes (LinuxSSI and LinuxXOS for PCs), will be updated in the third release of XtremOS. The final grid checkpointing demo in 2010 will show checkpointing and restart of a text-based application running on two heterogeneous grid nodes. The demo will present the new implementation of the coordinated and uncoordinated checkpointing protocol. Additionally, the demo will show the handling of in-transit messages between heterogeneous checkpointer by a new channel flushing protocol integrated into the coordinated checkpointing protocol.

3.5 XtremFS

The XtremFS development team have provided multiple demos of XtremFS, two of which we chose to publish on the XtremOS web pages (see Figure 3.2, or <http://www.xtreemos.eu/demonstrations> for the full video). In the first one they demonstrate the XtremFS replication and failover with an unmodified MPlayer. They play a regular movie file stored on two XtremFS OSDs (Object Storage Devices). As one OSD is disconnected, the user only senses a short pause (depending on the size of MPlayer buffer) before the XtremFS client transparently switches to another replica. The second demonstration shows how new replicas are created and how the on-demand replication strategy works.

¹<http://www.ericdaugherty.com/java/mailserver/>

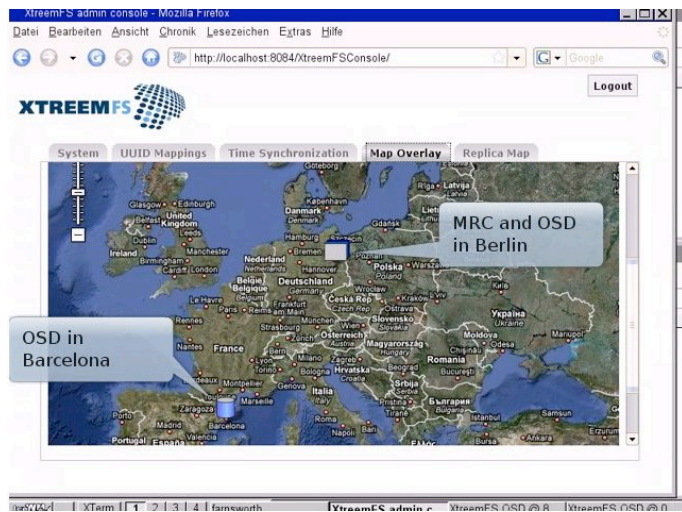
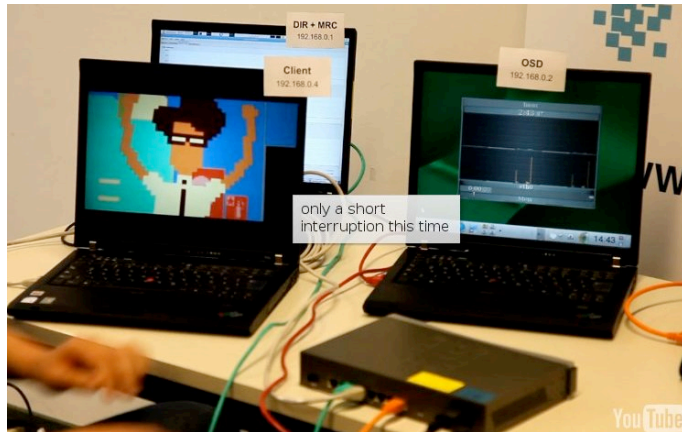


Figure 3.2: Playing a video with two replicas on XtremFS within the first scenario (left) and monitoring a geographically distributed XtremFS configuration used within the second scenario (right)

Chapter 4

Conclusion

XtreemOS has already been demonstrated live multiple times. Most of these demonstrations focussed on technical aspects, such as typical administrative tasks and particularly interesting individual components. In the final phases of the project, however, we will demonstrate commonly used applications from various domains running smoothly on an integrated XtreemOS system. In particular, we plan to emphasize the following *featured* use cases:

- Web photo archive using cloud infrastructure,
- Distributed virtual presence application,
- Computer-aided engineering with collaboration among experts,
- Rule-based system management and
- Mobile video sharing with on-demand transcoding.

These demonstrations will probably represent the first contact with XtreemOS for the public. We believe that the wide set of domains covered by these use cases has the potential to spark interest with most of the audience. All of these use cases will demonstrate the main benefit of XtreemOS, that is the ability to exploit distributed systems for various applications in a collaborative environment. In other words, the goal is to show *what* can be achieved with XtreemOS. Technically, of course, everything that is doable with XtreemOS is also possible without it, so we will be showing that with XtreemOS it runs smoother and with less effort than with other grid software and other competing solutions.

The goal of running applications smoothly implies that XtreemOS must be transparent. However, in addition to the *what* aspect a significant portion of the audience may be interested in *how* XtreemOS features work. Some use cases will show the monitoring interface of XtreemOS within the demonstration scenario, from which some of the "back-stage" will be visible. In addition, we have decided to produce technical demonstrations focusing on the features of XtreemOS that

are particularly interesting from technical or scientific point of view and those that cannot be smoothly included into the above use cases.

Altogether the planned scenarios will provide an interested viewer some insight into all major components of XtreamOS. Table 4.1 shows the relation between scenarios and XtreamOS components. Note that some components contain many interesting features, so two scenarios using the same components are not necessarily similar at all. The intention is not fitting scenarios to components, which would inevitably produce less interesting demonstrations with unnatural use-cases, but rather to steer the viewer interested in certain parts of XtreamOS towards the scenarios related to it.

We target scientific and business events on one hand and the internet audience on the other. At various events the amount of content is limited, thus only the above mentioned featured use cases will be shown there. The online audience, however, will be offered to select from those, complemented by demonstrations with other applications that are being ported to XtreamOS in workpackage 4.2 and advanced versions of technical demonstrations. Both catching the initial interest and providing more in-depth coverage is essential in order to motivate users to download and try out XtreamOS, thus both kinds of demonstrations will be offered on the web. Currently the demonstrations web page is consistent with other sections of the official XtreamOS web site, although we will consider using a more eye-catching design.

So far we have implemented multiple technically-oriented scenarios, the distributed virtual presence demo and some of the smaller use cases. All have been successfully demonstrated multiple times, although the scenarios and presentation of most should be improved before showing them at the most important events or publishing online. However, one of the featured use-case scenarios and three technical demonstrations have already been finalized and published on the web (see Section 1.2 for details).

Table 4.1: Planned XtreamOS demonstrations and XtreamOS components they use. \checkmark / \checkmark denotes focus on this component or its heavy use, \checkmark denotes less heavy use, and \circ optional use of the component. The published scenarios are shown in **bold**.

Scenario \ component	VO resource administration	and job sub-mission and monitoring	dynamic resource allocation	checkpointing and restart	virtual nodes	distributed servers	security	OSS	XtreamFS	LinuxSSI and KDFS	XtreamOS MD
Web photo archive											
Distributed virtual presence		\checkmark						\checkmark / \checkmark	\checkmark / \checkmark		
Computer-aided engineering		\checkmark	\checkmark	\circ			\checkmark	\checkmark / \checkmark	\checkmark	\circ	
Rule-based system management	\checkmark / \checkmark		\checkmark	\checkmark			\checkmark		\checkmark		
Mobile video sharing with on-demand transcoding		\checkmark					\checkmark		\checkmark		\checkmark / \checkmark
SpecWeb2005		\checkmark / \checkmark	\checkmark / \checkmark	\checkmark					\checkmark		
COMP Superscalar with hmpfam		\checkmark	\checkmark						\checkmark		
openTURNS		\checkmark	\checkmark								
Zephyr		\checkmark	\checkmark	\checkmark					\checkmark	\circ	
Secure remote computing		\checkmark					\checkmark		\checkmark		
MAESTRO simulating Moderato		\checkmark							\checkmark		
MaxDB replayer		\checkmark							\checkmark / \checkmark		
Enterprise document indexing and searching									\checkmark / \checkmark		
Mobile instant messaging							\checkmark		\checkmark		\checkmark / \checkmark
Galeb		\checkmark	\checkmark						\checkmark	\circ	
Core scenario part I	\checkmark / \checkmark	\checkmark / \checkmark					\checkmark		\checkmark		
Core scenario part II	\checkmark / \checkmark	\checkmark / \checkmark	\checkmark / \checkmark				\checkmark		\checkmark		
Xterior		\checkmark							\checkmark		
Virtual nodes					\checkmark / \checkmark						
Checkpointing				\checkmark / \checkmark							
XtreamFS									\checkmark / \checkmark	\checkmark	

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