Singularity Design Note 16

First Application Deployment

Personal Video Recorder

This Singularity Design Note summarizes our plan of record for the first real application deployment of a Singularity system. This SDN describes the application, the design decisions affecting its implementation, the target hardware environment, and the deployment scheduler.

1. Motivation

To evaluate Singularity, we must deploy real applications. We have decided to build a Personal Video Record (PVR) for the first Singularity application deployment.

The PVR application was chosen for a number of reasons:

- We can convince 50 or more users (members of the Singularity team, their families, roommates, etc.) to use the system on a regular basis.
- The application will stress the real time multi-resource scheduling system and real time garbage collector, and may stress some of the assumptions underlying the Singularity architecture.
- Users expect zero on-site system administration of a PVR and its software, beyond a choice of channels to receive and programs to record.
- A PVR application requires relatively little UI code or legacy code.

2. Implementation

Singularity systems are not fixed function devices. Singularity will be an open system from the beginning, allowing multiple applications to be reliably deployed to and executed on a shared device.

The first real application that we will build for Singularity will be a Personal Video Recorder, similar to existing products like TiVo or the PVR functions of Microsoft Media Center Edition. The PVR application is the first of many applications planned for deployment to Singularity home service appliances, but it will be the first real application and it will drive the first real deployment.

We believe that the PVR application will demonstrate the value of Singularity's unique features, including the application abstraction, the multi-resource scheduler, and the policy engine for system configuration. We are aware that existing products like TiVo have been successfully built on commodity platforms like Linux, but we believe we can demonstrate that our solution, based on Singularity, is qualitatively better.

The PVR application will display video from TV tuner to video display, record incoming video to disk, and play video back from disk. For this first deployment video will be either uncompressed or compressed used only simple compression such as YUV or delta encoding. While much greater compression is of course desirable for a cost-effective PVR appliance, it is not strictly necessary and can be added during later application releases.

The PVR application will use a program guide from the same data providers as Windows Media Center Edition. A central program guide service will periodically download data from the Windows Media Center servers and convert it into a format which can be relayed to deployed PVRs. The PVR application will support programmed video recording and pause and resume during live TV viewing.

A software update service will also be part of the first Singularity deployment, to test our approach to zero on-site administration. Our objective is to make system configuration entirely declarative and history-free. Users and administrators will set system policies, and Singularity will use the system update service will automatically manage the lifecycle of applications.

3. Hardware Target

Microsoft Research will purchase about 50 hardware systems for the PVR deployment. In selecting the hardware platform, we are attempting to maximize the platform's potential for future research beyond the initial PVR application. Ideally we should expect a 3 year deployment lifetime of the hardware for active research.

The hardware platform will consist of the AMD64 processor, the NVIDIA CK8-04 motherboard chipset, and the NVIDIA GeForce 6xxx series GPU. The CK8-04 chipset includes an on-board NIC, a SATA disk controller, a USB controller, and audio. A USB remote control will be the only human input device (HID) implemented on the hardware platform; there will be no keyboard.

By selecting exclusively NVIDIA as the chipset manufacturer of our device hardware, we realize four benefits. First, we can minimize our external dependencies and relationships. Second, we build a working relationship with a hardware vendor for future hardware/software innovations. Third, we can take advantage of NVIDIA's Unified Driver Architecture (UDA) to produce a complete family of device drivers which will be usable on new hardware for next 3-4 years. Fourth, we can simplify our future hardware purchasing story—for example, when we release Singularity to academia, we can instruct them to purchase any PC with a CK8-04 chipset.

We believe that the target hardware platform will enable many interesting options for future research. Initially we will run Singularity as a 32-bit operating system on the platform. Later, we can explore options around a 64-bit address space. While we will initially use the GeForce 6xxx as a simple frame-buffer graphics card, after the first deployments we can experiment with ways to enable the ALUs on the GeForce 6xxx GPU as additional processing units available to the OS.

4. Non Goals

The primary objective of the Singularity PVR application is test the validity of a Singularity system. Because we have pre-selected a captive target audience, the competitive choice is one of whether to use the Singularity PVR or to not use a PVR. For this first deployment, we are not competing with, for example, latest generation TiVo devices or Windows Media Center Edition devices.

Important non-goals for the first application deployment:

- Building an economically competitive device. Cost for the devices will come from the Singularity budget. When given a choice between putting development resources into hardware cost reduction or development resources into new OS features, we will choose the latter.

- Support for HDTV, digital cable, or digital satellite. In V1, the Singularity PVR will support analog cable with all channel selection occurring within the TV tuner card.

- Support for multiple tuners.

5. Deployment Schedule

Development of the PVR application will be divided into three milestones. The first two milestones are hard date driven milestones; features will be dropped as necessary to meet schedule dates. The last milestone is soft date driven milestone; the date may be dropped in order provide a functional and robust system.

5.1. Milestone 1: Basic PVR Functionality (December 31, 2004)

The priority of Milestone 1 (M1) is to implement and debug the systems level components of the PVR application.

The PVR application will display video from TV tuner to video display, record incoming video to disk, and play video back from disk. Hardware devices will include video tuner, graphics card, and disk driver.

The user interface for M1 will be minimal. Video will be either uncompressed or minimally compressed . We will use fast Serial ATA drives— multiple drives if necessary—in order to support video recording and playback without sophisticated compression. While much greater compression is desirable, it is not strictly necessary as we are do not have tight per-device fiscal constraints. No effort will be made to port any existing video codecs as the resources to do so are currently unavailable.

During M1, we will acquire a sufficient number of prototype hardware units to enable coding, debugging, and testing.

Completion date for M1 is December 31, 2004.

5.2. Milestone 2: SOSP Deadline (March 25, 2005)

The priority of M2 is the completion of two Singularity SOSP papers: a first paper on real-time, multi-resource scheduling, and a second paper on the Singularity architecture. During M2, efforts will focus on correctness, completion, and performance tuning of the system and PVR application. We also expect to add support for USB and the USB remote control.

During M2, we will acquire a sufficient number of the final "production" hardware units to enable testing and performance tuning.

Completion date for M2 is March 25, 2005, the submission deadline for SOSP 2005.

5.3. Milestone 3: Deployment to Target Sites (June 7, 2005)

The priority for M3 is deployment of the PVR appliances into the homes of deployment participants.

Key software developments in M3 will be the completion of the PVR application, completion of the TV program guide service, and completion of the system update service. Features to be added to the PVR application are the program guide, programmed video recording, pause and resume during live TV viewing, and the final GUI.

The TV program guide service will acquire program guide information from the same services used by Windows Media Center Edition, prepare the information for download to individual PVR devices, and act as the server for download.

Similar in function to Windows Update, the system update service will allow individual devices to connect and download builds of the day. Unlike Windows Update, the system update service will cover not just the OS, but all system and application components. The client side of the system update will rely heavily on the application abstraction and the policy engine to plan and realize system updates.

Early in M3, we will require the remaining production hardware units necessary for the complete application deployment. By the end of M3 these units will be deployed into the homes of individual Researchers and other deployment participants.

Completion date for M3 is June 7, 2005.

