



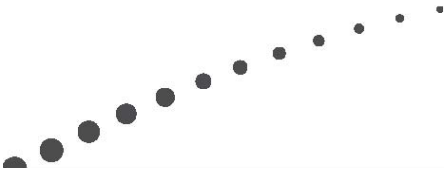
The “Nirvana Phone”

Concept Specification & Draft Reference Architecture

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INTRODUCTION

This document describes the requirements and architecture for the “nirvana phone”, a concept that would allow the SmartPhone to be used as a full screen computing desktop alternative. Topics covered include:

- “Nirvana Phone” Concept Overview
- Example Use Case Scenarios
- “Nirvana Phone” Architecture
 - Basic Implementation
 - Implementation with the OKL4 Microvisor
 - Alternative Architectures
- Device Requirements
- Features / Functions

THE NIRVANA PHONE

CONCEPT OVERVIEW

As SmartPhones continue to become more capable, fast networks become more pervasive, and virtual desktops like Citrix XenDesktop go mainstream, it is becoming increasingly possible to use a SmartPhone to perform tasks previously limited to laptops and desktops. Desktop virtualization is a concept that delivers a complete Windows desktop experience as an on-demand service to any user, anywhere.

A *virtualized* desktop is stored on a central server or blade PC in the data center, instead of on the local client device. When users work from their local client device, all of the programs, applications, processes, and data are kept and run centrally in the data center. This enables users to access their desktops on any capable device, such as a traditional desktop computer, laptop, thin client, or SmartPhone. The following illustrates the concept of desktop virtualization:

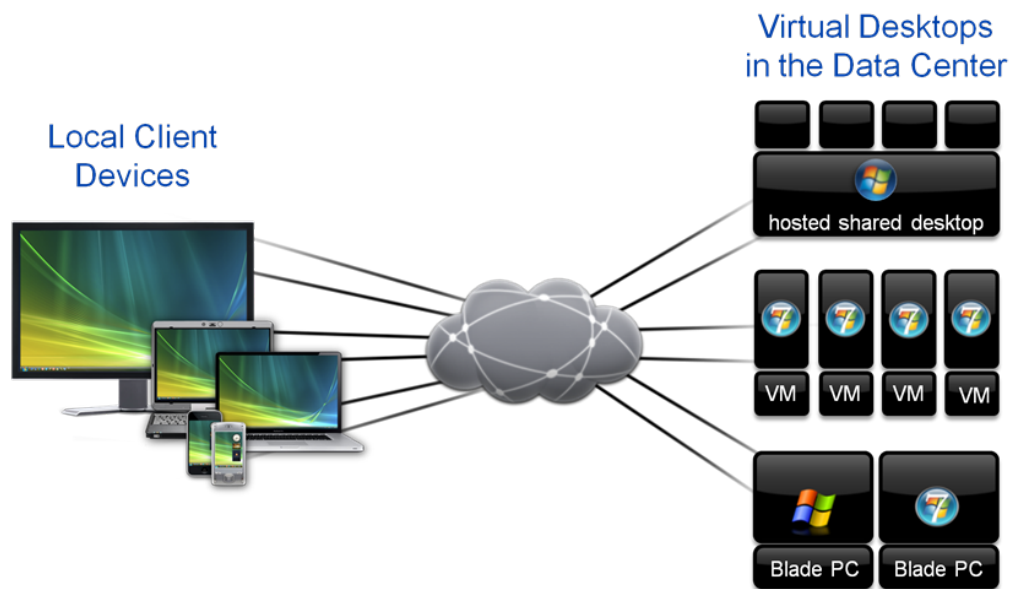


Figure 1: Virtual Desktops

The “nirvana phone” concept allows a user to use their small form factor device when on the move or in the office to access business applications and data.

The objective of the “nirvana phone” is to enable a user to more fully leverage their SmartPhone as their primary computing device, and enable the connection to common larger form factor peripherals such as full screen monitors, mice, and keyboards. When the “nirvana phone” is connected to such peripherals, the use cases are extended from normal mobile applications to the enhanced use of full desktop and larger resolution applications.

The following is an illustration of the “nirvana phone” concept:



Figure 2: “Nirvana Phone” Connectivity Illustration

KEY FUNCTIONAL AREAS OF FOCUS

There are several capabilities in today’s SmartPhones that need to be developed to realize the vision of the “nirvana phone”. These include:

- **Video-out** – A few SmartPhones have video-out to support a large external monitor, but the resolution is limited in some cases and usually focused on media output to television-type monitors with NTCS or PAL resolution. A “nirvana phone” implementation should focus on compatibility with common computer monitors and projectors and the common resolutions and physical connectors associated with these devices. Enhanced graphic drivers are also required to support the attached monitors as an extended graphics space, and not just a mirror or replacement of the device’s native screen.
- **Audio** – Existing capabilities that connect SmartPhones to external audio devices like headsets or powered speakers would be utilized.
- **Keyboard and Mouse** – To allow a user to be fully immersed into “nirvana phone” use, more than “just a bigger screen” is required. The user must also be able to leverage full-sized input peripheral devices such as mice and keyboards. Bluetooth capability including connection to industry standard Bluetooth keyboard and mouse is required. Optionally a “nirvana phone” docking station could be provided to allow connection to a standard USB keyboard and mouse.
- **Citrix Receiver** – Client software that allows the user to securely access corporate applications, desktops, and data from their mobile device and output this data to either the device’s local screen or video-out to an external monitor
- **Docking Station (Optional)** – An associated docking station would allow docking a “nirvana phone” to be docked and provide instant connectivity to power, video, and other peripherals.

EXAMPLE USE CASE SCENARIOS

Use cases for the “nirvana phone” include the following two high level examples:

- **Mobility and Flexibility** – Many users want to travel lighter and have the flexibility to leave their laptop at home on trips all together. It’s their personal choice if and when to use a “nirvana phone”. For example:
 - A traveling salesperson may want to travel light and use their “nirvana phone” to connect to a projector to deliver a sales pitch, allowing them to leave their laptop at home.
 - A mobile employee can connect their “nirvana phone” in Internet cafes in the airport and the flat screen TV in their hotel room to get a full desktop use environment.
 - An employee that wants to “Bring their Own Device” (BYOD) to the workplace. The “nirvana phone” enables employees to utilize their own device safely on a public 3G network that is isolated from the corporate network.
- **Cost Control** – Companies are looking for cost reduction methods and may decide to increase the ROI on the SmartPhones they have bought for their employees by leveraging them as “nirvana phones” to replace laptops or desktop systems and eliminate the maintenance associated with laptops and desktops. For example:
 - A company decides that the cost of purchasing and supporting a full laptop for each of their employees is too high, and adopts a policy of only supplying defined job roles with a “nirvana phone” as a laptop alternative.
 - A service company decides to save money by eliminating laptops equipped with aircards in their service vans and replace them with “nirvana phones” that connect to a simple LCD screen and a Bluetooth mouse and keyboard to leverage the data network already paid for on the smart phones, lowering their total cost of ownership (TCO).
 - A hospital provides “nirvana phone” hotspots throughout the hospital to which employees can connect their nirvana phone. This allows them to experience a desktop-like connection to hospital and patient data throughout a hospital at a lower cost of only a monitor, mouse, and keyboard for each hotspot.
 - A company sets up “nirvana phone” capable office hoteling that allows users to connect their nirvana phone to full-size peripherals (monitor, mouse, and keyboard) in any available cube environment and get an office desktop-like experience.

SOLUTION REQUIREMENTS

NIRVANA PHONE – NATIVE DESIGN

A native “nirvana phone” design requires that peripheral drivers for each of the key functional areas would need to be developed for each device platform, and in some cases for the specific device. The Citrix Receiver and the drivers would run in the context of the device’s native OS. Although this design may seem simpler, it does not scale well across multiple platforms. Designs that leverage a mobile hypervisor could prove to be more effective.

The following illustrates the basics of the native design:

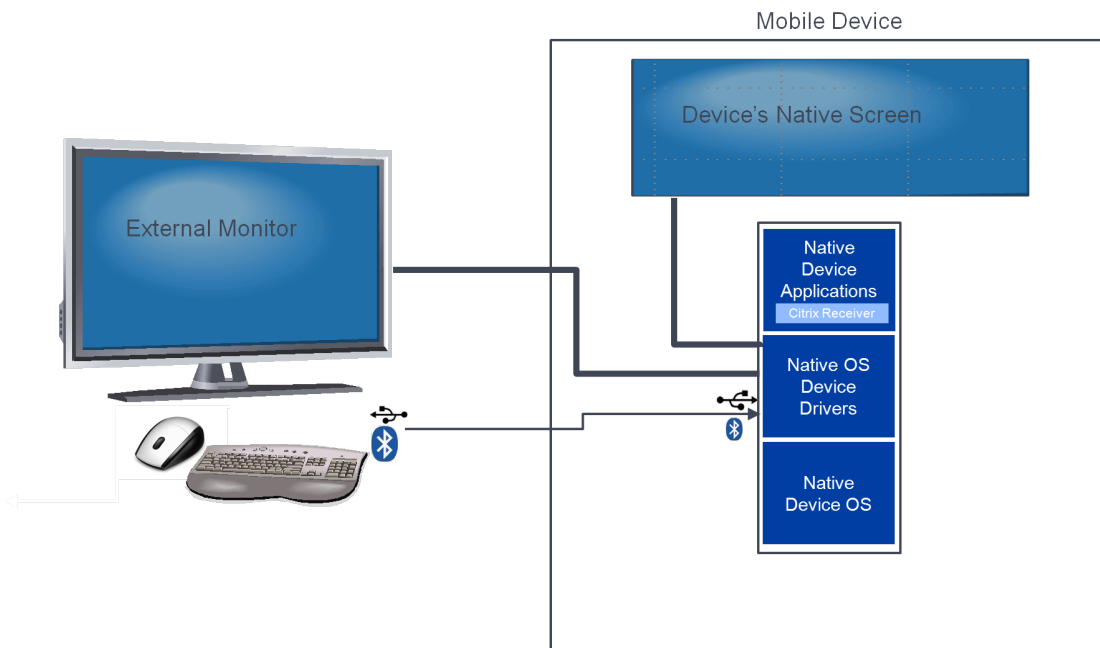


Figure 3: Nirvana Phone – Native Design

NIRVANA PHONE – MOBILE HYPERVISOR REQUIREMENTS

Mobile hypervisors, such as the OKL4 Microvisor from Open Kernel Labs, can be used to enhance the “nirvana phone” native design by allowing the core architecture to be used across multiple mobile device platforms. Mobile hypervisors can abstract the majority of the “nirvana phone” functionality into a secure cell, and then allow that cell to run in conjunction with a device’s native operating system (OS). The native OS only needs to know that the “nirvana phone” functionality exists in a secure cell on the device and how to start that functionality when requested. The cell handles the driver integration, services, and all of the “nirvana phone” operations independent of the native OS, regardless of the OS type.

The OKL4 Microvisor enables a secure, isolated environment for the Citrix Receiver technology and the device driver software that enables the external devices. Benefits of an OKL4 Microvisor-based implementation include:

- **Improved Security** – Using OKL4 prevents the native device OS environment from accessing the information flowing between Citrix Receiver and corporate IT assets. This remains true even if the security of the native OS environment has been breached.
- **Reduced Development Effort** – Where the native OS design approach requires OS-specific device drivers for each of the external devices (display monitor, keyboard, and mouse), a single OKL4 native device driver for each device type can be reused with several different SmartPhone OSes. The savings offered by SmartPhone OS-independent device driver implementation are realized not only during initial development but during ongoing maintenance as well.

- Device Sharing Flexibility** - When the “nirvana phone” is docked, in addition to the use of Citrix Receiver, the user can still use the phone as a phone. At a minimum the phone needs to present a UI on the monitor and through the mouse/keyboard/microphone/speakers. In other words, the Citrix Receiver and the “nirvana phone” OS share those devices.

By virtualizing shared devices and providing the ability to apply policies on how sharing is implemented, the OKL4 Microvisor offers a very flexible framework for device sharing. This flexibility allows the "nirvana phone" user to run native SmartPhone OS applications and at the same time access enterprise applications from a memory efficient and secure OKL4 cell.

Although the Citrix Receiver runs in isolation from the native device OS, a “launcher” application on the native OS initiates its execution. As illustrated in the following figure, the Citrix Receiver is running in an OKL4 Microvisor secure cell.

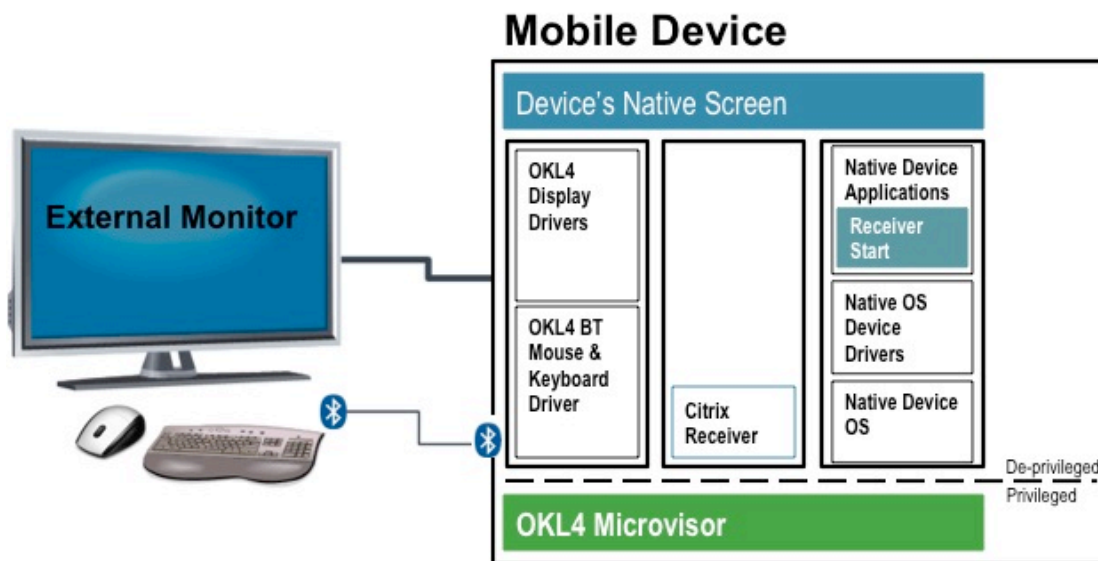


Figure 4: Nirvana Phone Device– OKL4 Design (Docked)

DEVICE REQUIREMENTS

Following is a brief list of the device requirements:

Video Output – Must include HDMI, VGA, USB, or other industry standard monitor format. Also, the emerging wireless video standard(s) should be supported. Note that NTSC or PAL are insufficient, based on the screen resolution requirement.

Screen Resolution – Minimum resolution 800 x 600. A *virtual graphics driver (VGD)* running on the nirvana phone extends the usable graphics display space to a Virtual Graphic Display area, separate from the device’s native display.

Keyboard / Mouse Connectivity – Connectivity to the external input devices is provided via Bluetooth or USB.

Minimum requirement:

- Bluetooth 2.0+ with full HID support
- USB 2.0+ with Host (not Slave only) support

Network Connectivity

- 802.11 D or higher
- Cellular 3G or higher

Operating System Support – Candidates include Android, other Linux distributions, Windows Phone, BlackBerry, and Symbian.

Performance metrics – *Video latency thresholds and other performance metrics to be determined.*

Minimum Recommended CPU Class – ARM 1136 @ 528 MHz

Minimum Recommended Memory

- ROM: 256 MB
- RAM: 192 MB

Docking Station Connectivity (Optional) – Features include video, two USB ports and AC power charging.

NIRVANA PHONE – ALTERNATIVE ARCHITECTURES

There are also alternative architectures that can achieve the same desired result of a “nirvana phone” connecting to a full-sized display monitor to improve the device usability while stationary. These alternatives can include wireless connections between the “nirvana phone” and the display, which can be an attractive alternative. However, it also means that a matching or compatible hardware device is embedded or attached to the display. These alternative architectures will be documented in a separate specification.

CONCLUSION

This document outlines core requirements for a “nirvana phone” SmartPhone, including accelerated implementation in partnership with Citrix strategic partner, Open Kernel Labs. SmartPhone providers that develop a device which meets these requirements will achieve a new level of functionality and desirability (by users and IT) that is unmatched in the current marketplace.

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About Open Kernel Labs

Open Kernel Labs, Inc. is the global leader in virtualization software for mobile devices, consumer electronics, and embedded systems. Backed by the largest, independent team of microkernel developers, OKL4 is deployed on more than 500 million mobile phones worldwide. Device OEMs, mobile network operators, and semiconductor suppliers depend on OK Labs to deliver high performance solutions that decrease BOM cost, reduce complexity, and speed time-to-market