HDR: The Next Quantum Leap in Speed

How Linux is helping to bring High Data Rate Wireless communication to the mobile user

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ABSTRACT

The goal of anywhere, anytime, high-speed wireless communication will be reached when HDR (High Data Rate) becomes available. Although wireless communication is not new, what is new, is high-speed access. Peak speeds of 2.4 Mbps will be possible. These speeds will make multimedia applications and web surfing, heretofore limited to the desktop, available to the mobile user. This article describes how Linux is playing a critical role in aiding the development and deployment of HDR at Qualcomm, Inc.

INTRODUCTION

The age of anywhere, anytime, communication is here. The mobile user can send and receive email, buy and sell stocks, get weather reports, and surf the web. However, the speeds currently available make these tasks less than a pleasure. Speed, more often called bandwidth, is a commodity that one can never have enough of. The explosive growth of the Internet and the general desire for timely information, creates a need for more bandwidth and the efficient use of existing bandwidth. As speeds increase, the number and types of applications grow to use the available bandwidth. Multimedia is one such bandwidth demanding application. To accommodate limited bandwidth, applications are often modified for the mobile user. Technologies and specifications such as the Wireless Application Protocol (WAP) and the Wireless Markup Language (WML) are a great aid in enabling the mobile user. They mitigate some of the limitations found in the wireless environment such as diminutive displays and restricted bandwidth.

Bandwidth to the desktop computer has made huge strides in the past few years. Cable modems and DSL bring speeds that make multimedia applications reasonable. The same cannot be said for the mobile user. Despite advertisements and hype to the contrary, speeds for the mobile user with a modem and cellular phone are limited. Sending and receiving a short email is possible, but surfing web pages replete with graphics is impractical. All that will change when High Date Rate (HDR) is deployed.

HDR is a high speed, high capacity wireless Internet technology. When it is introduced, it will represent a quantum leap forward in speed. It will provide high-speed wireless Internet access to the mobile user. Speeds of 2.4 Mbps will be possible and will make web surfing and other bandwidth hungry applications heretofore limited to the desktop available to the mobile user. This article describes how Linux is playing a critical role supporting the development and deployment of HDR at Qualcomm, Inc.

WHY LINUX

Qualcomm, Inc., is a San Diego, CA. based telecommunications company. Although Qualcomm is involved in virtually all aspects of digital wireless communication, it is known to many as the publisher of

the Eudora email client and the creator of the Code Division Multiple Access (CDMA) specification. CDMA is the cornerstone of digital cellular communication in United States and many other countries.

When it came to deciding the best platform to support HDR subsystem and system level software testing, Linux was chosen for good reasons. Linux is a well-supported, fast, flexible, easy to use, reliable, open-source operating system. It is also free, but cost was not a factor. The decision was based solely on technical merit.

Telecommunications is a highly competitive, fast paced, cutting edge industry. Time to market is crucial for success. A platform that provides flexibility and ease of use were the major factors in the decision to use Linux. The choice of Linux allowed the software development and test teams to quickly implement an environment to test HDR.

The test environment consists of a wide variety of hardware and software. For subsystem level testing, there are more than 35 real-time operating system computers, 14 Windows NT systems, and 6 Linux systems. At the system level, a similar configuration is used for testing.

Like all telecommunications applications, HDR is time critical. To meet tight real-time requirements, VxWorks by Wind River Systems was chosen. To support high level testing and simulate real-world mobile users, Windows machines were used. But it is Linux that is the "glue" that holds it all together and is a key element in HDR development.

HDR AND LINUX

Linux is used in many ways to support HDR development and testing. One of the more crucial roles for Linux is to assign IP addresses to the test environment consisting of nearly 100 nodes. PCs and embedded system components installed in the system's base station are assigned addresses by several Linux DHCP servers. This allows devices to be easily added or removed to meet the dynamic needs of the test environment.

To monitor and control an embedded system, a standard RS-232 serial connection is used. However, due to the large number, an equally large number of serial interfaces is required. A terminal server (a.k.a. access server) is normally used for this purpose. However, after extensive research, no commercial terminal server was found that would allow multiple "reverse" telnet connections. To meet this requirement, off-the-shelf multi-port serial communication cards were added to the Linux machines. Using in-house developed multi-threaded software, the HDR team was able to do what no commercial product could do, allow multiple sessions to a single host. This allows several developers to simultaneously connect to the same source from multiple locations helping to make the testing process more productive.

When a software process crashes on an embedded system, hitting the hardware reset button on the board is often the only way to bring the system back to life. If the software developer is sitting next to the board, this is not a problem. However, it is more productive to allow HDR software engineers to develop and debug software from a quiet office with the embedded target residing remotely in a sometime chaotic lab environment. To solve the problem of resetting a remote system that has crashed, a small remote reset box containing electromechanical relays was interfaced to the parallel port of the Linux machines. Using a web page interface and custom software, a software developer can remotely reset any of the target computers without leaving his or her office. In addition, due to the complexity of the system and large number of embedded targets, Linux allows all targets to be reset with a single mouse click. This has been a feature that has proven to be very useful and saves a great deal of time. It also means that software developers, who choose to, may work from home and reset the hardware remotely if necessary.

The Apache web server residing on each of the Linux systems is invaluable. Both static and dynamic pages provide software developers the means to monitor, control, and coordinate testing.

After software components are released, they are distributed to clients for testing using the ftp server on Linux. Sufficient disk space is available for many versions of the software to remain on-line. Changing to a new version is as simple as changing a soft link to point to the current version.

At the subsystem level, HDR messages are sent over an Ethernet network rather than over the air. This has the great advantage of simplifying the test environment, since sending packets over the air adds unnecessary complexity (i.e., fading, multi-path, noise etc.) to the testing environment. Transmitting messages over Ethernet allows HDR messages to be examined by monitoring network traffic. Linux serves as an excellent network sniffer. The standard `tcpdump` command is adequate for most diagnosis. For more complex searches and analysis of network traffic: `ngrep`, `xipdump`, `tcptrace` and `xplot` are used. The plethora of powerful networking tools available made our choice of Linux a wise one.

HDR WEB CAM

HDR should not be confused with other wireless technologies such as Bluetooth, that is limited to approximately 10 meters, or wireless LAN devices, which provide local network access up to 100 meters. HDR provides the same mobility as that enjoyed by cellular phone users. Access to the Internet will be possible virtually everywhere that digital cellular service is provided.

Figure 1 shows just how mobile you can get. This demo may be the world's first portable web cam. Since HDR supports high-speed transmissions, multimedia applications such as this web cam are possible. It consists of a network video camera (AXIS 2100, see Linux Journal #77, page 102) connected to a prototype HDR wireless modem (a.k.a. access terminal). The internals of the access terminal will be made into an ASIC (Application Specific Integrated Circuit). It can then be incorporated into almost any device. In fact, it will be possible to integrate the wireless modem in the camera. Other products include PCMCIA size wireless modems that can be inserted into a laptop.

WHAT IS HDR

The telecommunications industry categorizes products and services by generation. Analog cellular phones, developed over a decade ago, are considered first generation (1G) products. Second generation (2G) products are digital cellular phones currently in widespread domestic use and growing rapidly worldwide. HDR falls under the third generation (3G) umbrella. It is a spectrally efficient 1.25 MHz cellular Personal Communications System (PCS) Code Division Multiple Access system. It provides wide-area high-speed packet data connectivity for both fixed and mobile terminals.

To optimize throughput and make best use of available bandwidth, HDR is an asynchronous system. It sends and receives at different speeds. Those with cable modems are familiar with this mode of operation. For example, a cable modem's download speed from the Internet to the user is fast, typically measured in Mbps. The upload speed from the user back to the Internet is lower. HDR is similar to cable modems in that the download (Forward Link) speed to the user is higher than the upload (Reverse Link) speed. The HDR forward link is capable of operating at speeds from 38.4 to 2,457 Kbps. The reverse link speed varies from 9.6 to 307.2 Kbps.

To further optimize use of system resources, HDR supports a "dormant mode". An access terminal is said to be dormant when there is no communication in the forward or reverse link for a specified period. When this occurs, some, but not all, system resources are deallocated. When data needs to be transmitted, the connection is quickly reestablished. From a human standpoint, it will be instantaneous.

HDR shares another characteristic with cable modems; users share the available bandwidth. If there is only one user to a cable modem neighborhood, all available bandwidth is provided to that single user. As more users begin to use the system, speeds are reduced. However, other factors unique to the wireless world come into play. For example, the signal strength of the mobile terminal is an important factor. A complex scheduling algorithm is used to optimize throughput and assure a high performance network.

CONCLUSION

HDR brings speeds to the mobile user that were heretofore unavailable, impractical, or too expensive. While HDR will make bandwidth intensive applications possible, it would be naïve to think that HDR is the final solution. Mobile users want to do everything with their mobile systems that they do from their desktop systems. And like the desktop user, mobile users have an insatiable appetite for bandwidth. One can provide sufficient bandwidth for a particular application, but as new applications are developed, they will place additional requirements on bandwidth. Fortunately, HDR and the underlying CDMA system upon which it is built will support expansion.

This is an exciting time to be alive. A time when many of the predictions of science fiction writers are coming true. Arthur C. Clarke, the Farther of Satellite Communication and famed author of the book *2001: A Space Odyssey*, said, "*Any sufficiently advanced technology is indistinguishable from magic*". I think the same can be said of both HDR and Linux.

RESOURCES

Qualcomm, Inc. HDR Home Page: http://www.qualcomm.com/hdr/
AXIS, Inc. Video Network camera: http://axis.com

Richard Parry works as a software engineer at Qualcomm, Inc. and is currently working on the HDR project. He spends much of his time surfing the web looking for a life. He is a licensed amateur radio operator, callsign W9IF. When possible, he plays racquetball, skis, and scuba dives. He can be reached at rparry@qualcomm.com or visit his home page at http://w9if.net.

FIGURE 1

Prototype HDR Wireless Modem and Network Camera