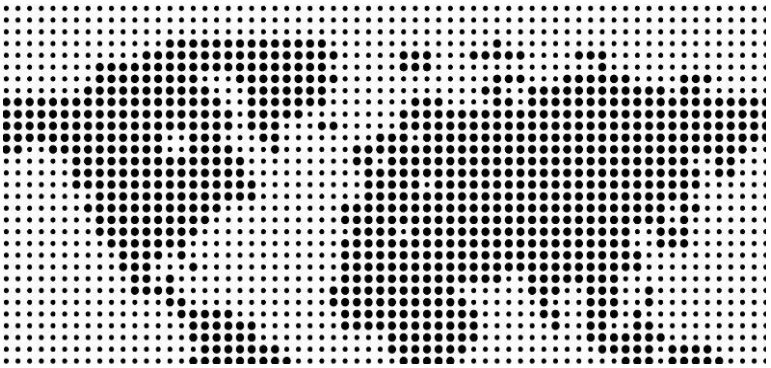
Evolution Toward A Multimode Future



Qualcomm Incorporated
December 2007

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I. Executive Summary

Societies are becoming increasingly information and communication-driven. Faster, more ubiquitous exchanges of information are achieving greater economic efficiencies and richer social interactions on a global scale.

As a result, many networks are evolving to serve diverse communication needs. These networks are increasingly interoperable and based on IP architectures. Wide area networks, with pervasive coverage in many parts of the world, are forming the basis for many multimode services. Operators leveraging fixed-mobile convergence (the trend toward offering the same services in fixed and mobile environments) are using multimode networks to offer a full suite of solutions.

More devices are integrating communication capabilities. Multi-function devices are resulting from the convergence of telecommunication, consumer electronics (CE) and computing platforms. These devices are consuming more data from a growing variety of sources, necessitating support for multimode networks.

Operator interest in and user demand for advanced data services are growing. Various service trends are leading toward a multimode wireless future in which a broad variety of services will be offered over different access technologies.

The multimode future will enable operators to bring new revenue-generating services to market with greater efficiencies and less risk; users will benefit from more choice, better value and user experience, ubiquitous access to information, and improved quality of life.

II. Network Evolution Trends

Numerous trends in the evolution of wireless and wireline technologies are leading toward a synergistic co-existence of multimode networks. One such trend is the explosive growth and popularity of wireless networks and applications. Capacity requirements continue to grow as usage increases and content becomes richer; yet availability of wireless spectrum remains limited. Networks optimized for applications with similar characteristics can deliver better user experience at a lower cost.

Operators are offering richer suites of services employing these multimode networks to minimize their costs and maximize capacity. For example, wireless networks optimized for broadcast services such as TV or radio are employing technologies like MediaFLO™, DVB-H, T-DMB, and ISDB-T. Since these networks are not designed for bi-directional unicast services or voice traffic, they are typically used in conjunction with other data and voice access technologies.

The growth of interoperable, IP-based architectures is also encouraging multimode operation. Fixed-mobile convergence is accelerating the adoption of IP-based networks. All services are transitioning to IP networks, including voice (in the form of VoIP).

With common protocols and technologies, information is more easily exchanged between networks. Hand-offs from one network to another are facilitated. Two approaches used increasingly to improve service consistency between IP-based networks are Session Initiation Protocol (SIP) and IP Multimedia Subsystem (IMS).

IMS is a framework for delivering Internet-based multimedia to mobile users over a variety of local and wide area networks. SIP is a protocol used by applications to control sessions with other participants (for example, VoIP, conference, or video telephony calls). Both SIP and IMS facilitate various aspects of communication across wireless and wired networks, and have the potential to improve multimode user experience. Another benefit of IMS is that it improves administration and billing for services across networks, and it helps stimulate service use over different networks.

As fixed and mobile networks converge, the desire of many fixed telecom, cable, and wireless operators to offer triple and quad-play services further encourages support of multiple technologies. For example, various mobile operators are looking to bundle femtocells, Wi-Fi and fixed-line access with their mobile subscriptions for complete home and mobile solutions.

Operators upgrade their networks in a phased manner as technologies evolve. These phased upgrades lead to layered, heterogeneous networks. For example, operators usually upgrade urban centers first, and then work their way outward to suburbs and rural areas when it makes economic sense to expand coverage. As a result, they often support multiple network technologies and multimode devices to span them.

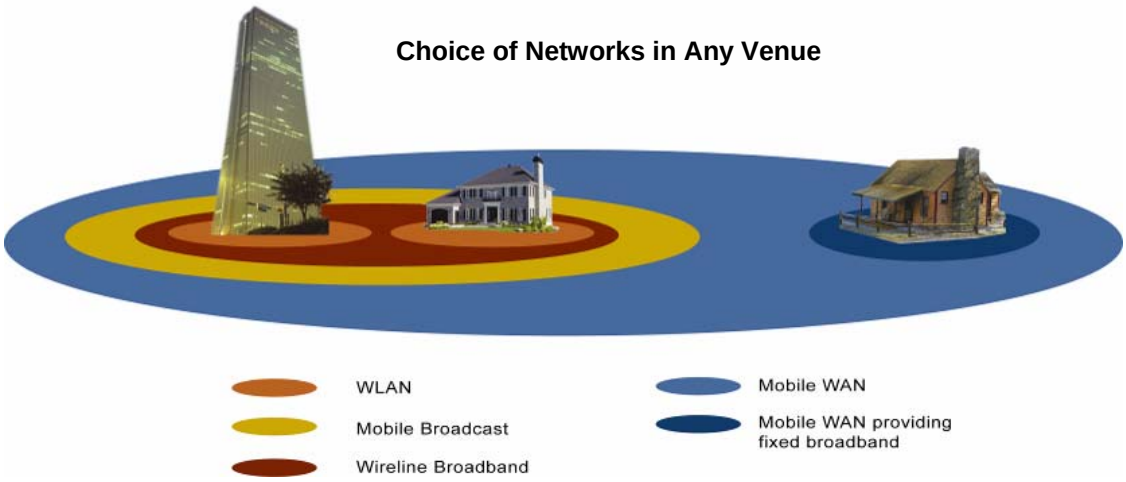

Figure 1. Choice of Networks

Wireless WANs will continue to provide the most complete coverage and increasingly be the network of choice for anytime, anywhere services. They will be augmented by islands of coverage with other technologies, including higher-performance evolutions of 3G. In recognition of these trends, Qualcomm continues to develop higher-performing technologies while ensuring backward compatibility, and support for many different networks with each solution.

III. Device Evolution Trends

As portable devices are evolving, they are being used for a growing variety of applications. Several factors related to this evolution are increasing the number of access technologies used for timely exchange of information and content.

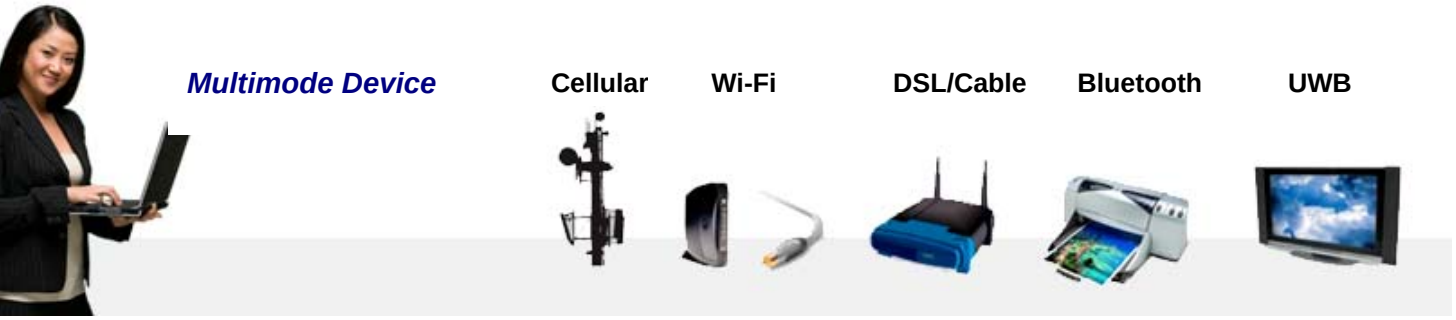

Figure 2. Device Evolution Trends for Multimode Devices

More devices are integrating communication capabilities, and many are supporting multiple technologies. Simply creating and storing content is no longer enough. As network performance improves, it often becomes more convenient to transfer content wirelessly than to wait until a device is docked. For example, mobile devices intended to provide high speed wide area data transfer support EV-DO, HSDPA, or HSUPA in addition to Wi-Fi.

Convergence of telecommunication, CE and computing platforms is leading not only to new classes of devices but also resulting in cross-pollination of functionality between existing devices. As devices become more feature-rich, they often consume information from a wider variety of sources and communicate over several different networks. For example, new classes of devices like ultra-mobile PCs (UMPCs) provide multiple communication options. Devices intended for location-based services typically offer GPS support.

Some usage scenarios require high-speed data transfers over short distances with limited mobility. Many devices support Wi-Fi or PAN technologies like Bluetooth® and UWB for these transfers. Operators can also use femtocells as a low cost, high-performance WAN solution to increase indoor coverage for existing voice and data services, and to provide a basis for next-generation converged services.

Data requirements are increasing with each device generation; multiple communication options are often supported to provide maximum performance or coverage in a variety of scenarios. Continuous advances in hardware integration are leading to devices with more processing power, storage, memory, and higher resolution displays. Vendors are accommodating larger file transfers with permutations of short-range high-speed options (such as USB, UWB, Bluetooth, and Wi-Fi) and long-range high-mobility options like 3G and its evolution.

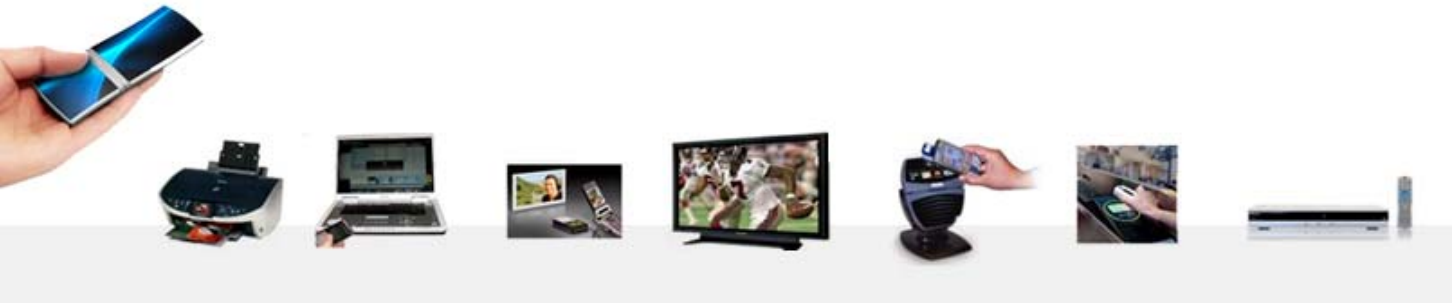

Figure 3. Device Evolution Trends

3G mobile phones and derivatives are evolving into CE and computing platforms of the future. Volumes are significant and functionality is growing in all tiers. Phones equipped with multiple interfaces are becoming personal information gateways, progressively integrating more features from other classes of devices. Users are able to print pictures, play movies on flat screen TV's, access their bank accounts, or make micro payments with stored-value cards.

Qualcomm is supporting this vision by developing power-efficient chipsets that integrate a growing array of functionality, provide significantly more processing power for applications, and natively support many different access technologies. For example, Qualcomm's Snapdragon™ platform provides a 1 GHz processor for diverse uses including gaming and portable entertainment devices, and pocket computers. Snapdragon supports a broad array of mobile broadband options, including EV-DO, HSDPA/HSUPA, broadcast TV and multimedia, Wi-Fi, and Bluetooth.

IV. Service Evolution Trends

Operators are eagerly investigating new services while cautiously investing in multimode networks to deliver them economically. Significant rewards await those who can successfully capitalize on key drivers of future consumption:

- Services that are available anytime, anywhere
- Consistently good user experience combined with ease of use
- Flexible options that enable cost/performance trade-off

Figure 4. Internet Applications

In a mobile setting, users have a natural desire to enjoy many of the same wired Internet applications with which they are already familiar. Some of these services include full-track music download, streaming music and video, mobile TV, and multiplayer gaming. Many operators are bringing wireline applications to the wireless environment to provide more ubiquitous access. Incremental, rich, data-intensive services usually require additional capacity. Operators often offer these new services over multimode networks to maximize capacity and ensure high-quality user experience.

Operators desiring to deliver excellent service quality often employ a multimode approach, because some of these services benefit from higher data rates while others require low latency. For example, some technologies provide excellent QoS (Quality of Service) and low latencies required for VoIP and many streaming applications. However, service continuity also suggests that the same applications be made available on multiple technologies, as not all technologies are available everywhere. Although data rates may be lower on “fallback” networks, operators can optimize applications to maintain acceptable experience.

Another factor increasing data consumption and driving operators to support multiple networks is the trend of users generating their own content and wanting to share it with others. This “social networking” phenomenon is typified by services like YouTube™ and MySpace™, where users capture home-made videos and then upload them to websites for others to view and exchange. The increased traffic is best accommodated by WAN technologies like EV-DO Rev. A and HSUPA, which provide ubiquitous coverage and greater uplink capacity.

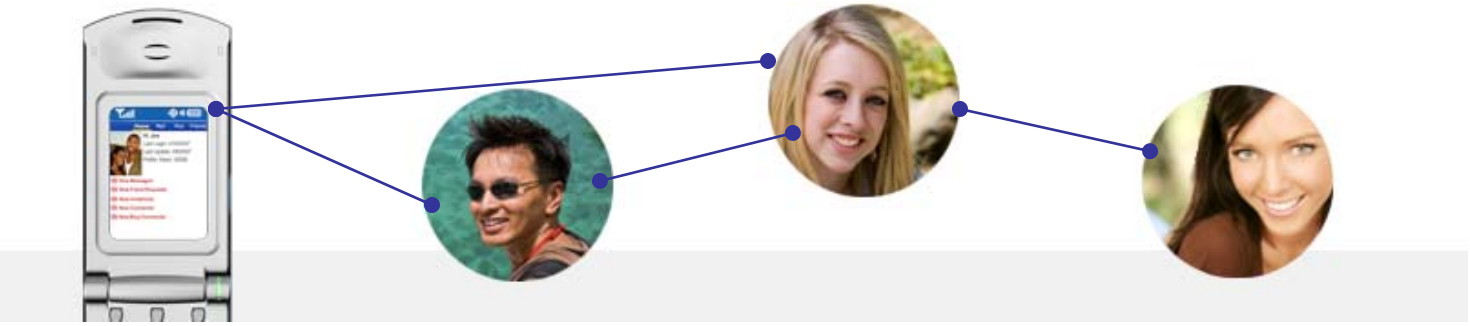

Figure 5. Social Networking

Yet another interesting trend encouraging the growth of multimode services is operators’ desires to create value by combining synergistic applications that utilize different radios. For example, many are starting to provide distinctive new offerings such as location-based services combined with mapping or browsing, TV combined with voice services, and streaming radio combined with music selection and interactive response.

Figure 6. Location-based Services

Operators are evolving services that are becoming an integral part of people's lives, allowing them to communicate, be entertained, and get information, wherever and whenever they want. To enable this vision, Qualcomm is providing a complete platform and software development environment that is tightly integrated with its comprehensive multimode chipset solutions. Qualcomm provides many tools that simplify the development of applications that can be ported to numerous devices and work with many different networks. This enables developers to implement applications quickly in a multimode environment and enjoy a time-to-market advantage.

V. End-to-end Multimode Solutions

"End-to-end multimode solution" refers to a systemic approach in which all pieces work together from beginning to end to provide seamless user experience—from multimode networks, and to network-based operator services to devices and end-user applications. End-to-end multimode solutions are usually achieved by collaboration between different vendor and operator solutions adhering to common standards and approaches. Various vendors intimately familiar with both network and device designs can provide added value in implementations of multimode solutions.

For example, Qualcomm designs ASICs for base stations, multimode device chipsets and modules, and accompanying software to manage multimode operation. Qualcomm also actively contributes to the definition of various wireless technology and interoperability standards. Furthermore, Qualcomm gains insight into multimode applications from providing support to numerous application developers. The company's solutions reflect a systems-approach to multimode platforms. Partner products that integrate these solutions provide thoroughly-tested interoperability across multiple technologies from device to network.

Significant R&D is required to bring new technologies to market, presenting a barrier to entry for many companies. To enable leading edge solutions in the marketplace, Qualcomm develops prototype reference boards, software and chipsets that 1) can facilitate base station and device designs, and 2) reduce interoperability testing times. By utilizing these components and technologies, vendors can reduce their development costs and quickly commercialize new multimode solutions.

VI. A Vision of the Multimode Future

Key trends prevalent in the evolution of networks, devices, and services predict that we are transitioning toward an increasingly multimode world. In this world, users will be able to access virtually any service anytime and anywhere. They will also be able to enjoy a consistency of experience across devices and user interfaces.

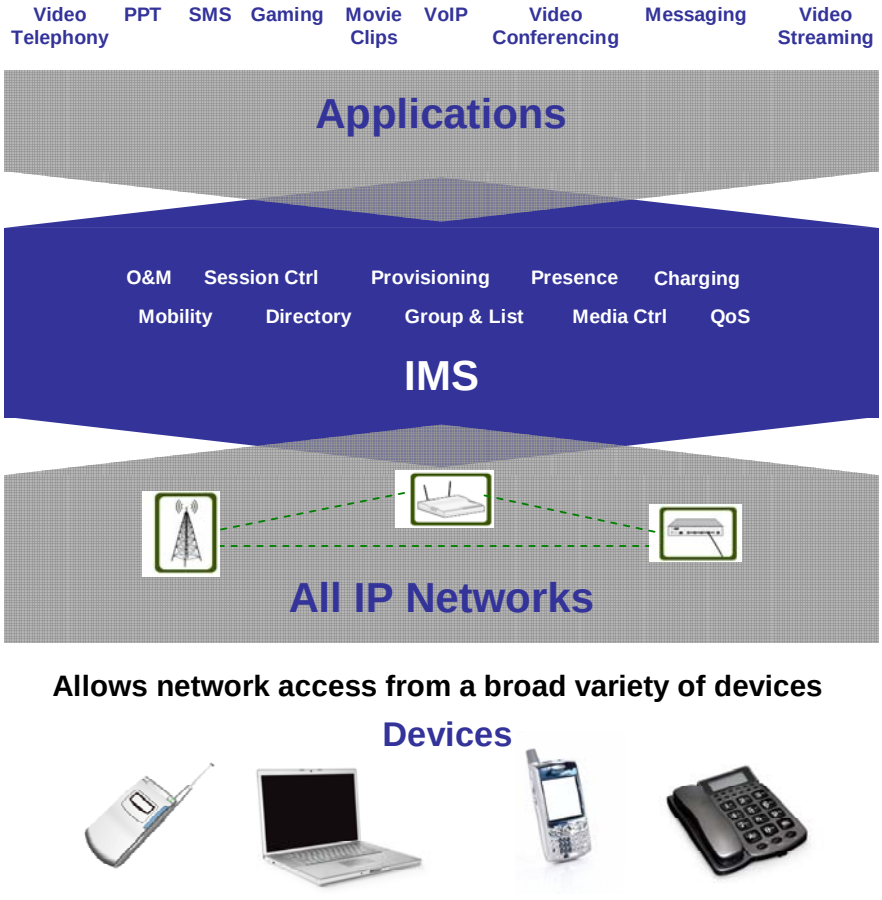

Figure 7. Multimode World

A variety of network technologies exist today and many will persist for the foreseeable future. As a general rule, all of these technologies are designed with a specific usage scenario in mind. Operators will continue to deploy a mix of different technologies. Wide-area network technologies are, and will continue to be, the foundation of ubiquitous services as they offer most complete coverage and serve the largest number of users. WAN coverage will be overlaid with smaller islands of other network technologies which will augment WAN services. Broadcast networks will also supplement WANs, providing blanket coverage for delivery of compelling mobile television, music, and other datacast streams.

In this converged world, wireline and wireless operators will pursue growing opportunities to deliver rich IP-based voice and data services to consumers. They will court subscribers with rich suites of service offerings delivered over a variety of technologies. Owing to their ubiquitous coverage, WAN-based services will begin to appear in all facets of people's lives. Subscribers, in turn, will have even more choices than they do today. They will effectively live in a world of layered networks and service offerings. They will be able to choose, for example, between wireline broadband, fixed wireless services when at home, and various forms of WLAN and mobile broadband while on the move.

In each case, they will select the network that provides them the desired speed, responsiveness, coverage, reliability, and roaming to suit their needs at the right price point.

Devices will be configurable and contain profiles to transition users unobtrusively from one network to another; conditions prompting a hand-off might include application requirements, user-experience and cost considerations.

Multimode devices that can access the same services over different networks will provide better "anytime, anywhere" access. Multimode devices will also be beneficial to service continuity as some technologies will have limited network coverage, or in some cases, limited in-building penetration.

Greater interoperability between networks will assure a more seamless user experience during transitions. The pervasiveness of IP-based networks, QoS support, IMS, and web-based applications will facilitate user migration across both wireless and wireline networks, while also maintaining performance.

Leveraging synergies between different networks with diverse services and multimode devices will present many benefits for both consumers and operators. Operators will be able to deliver new, differentiated, high-ARPU services to both consumers and businesses. They will improve their ability to attract new subscribers while reducing churn. Delivering services across multimode networks will also reduce their risk and help realize cost savings.

Subscribers, in turn, will be able to seamlessly enjoy services and obtain better value through expanded choices. The broad array of services and more ubiquitous access will provide improved quality of life; relevant information will be more readily available when it is needed. Users will also be more productive; the same applications with consistent interfaces will be available on a various devices, and a multitude of applications will be available on the same device almost anywhere.