VOICE, VIDEO AND BROADBAND: THE CHANGING COMPETITIVE LANDSCAPE AND ITS IMPACT ON CONSUMERS

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Panel III: Wireless Technologies

Henry J. "Hank" Kafka

Vice President-Architecture, AT&T

I. Introduction

Swift technological evolution and persistent innovation have characterized wireless broadband services. First-generation analog wireless technologies facilitated the widespread adoption of mobile voice services. Second-generation digital mobile wireless technologies enabled both voice and data applications, leading to a diversity of handsets, increased security, and higher service quality experiences, thus further accelerating the widespread adoption of wireless communication services. As the underlying wireless technologies continued to evolve, they supported more robust broadband data services and applications, in addition to mobile voice communications services. In recent years, new wireless technologies have been introduced that focus on both fixed and mobile broadband data services.

AT&T has deployed a range of these technologies for both fixed and mobile wireless broadband access. These technologies are already competing with wireline broadband services, and they will continue to support ever higher speeds and more advanced services. AT&T is today the leading provider of wireless services, and has deployed Wi-Fi, satellite and WiMAX-enabled wireless broad services in various areas throughout the country. Indeed, the last three

years, the company has invested more than $18 billion to increase the scope and capabilities of its wireless network, focusing on widespread voice and data coverage, high-speed data connectivity, and service flexibility, reliability and quality.

II. GSM Technology Evolution, from 2G to 4G

- **Prelude: 0G – 1G – Mobile Radio Telephones to AMPS.** Wireless technology evolution is described in terms of "generations," or "G" for short. Predating the first generation of widespread analog cellular telephone systems in the 1980s were "Mobile Radio Telephone Services." These were the bulky car, truck and briefcase phones that operated on radio frequencies ancillary to the public switched telephone network, and marked the first steps in the wireless evolutionary path, or "0G." True first-generation (1G) cell phone standards were widely introduced in the 1980s. These were analog signal-based systems, such as the Advanced Mobile Phone System ("AMPS") developed by Bell Labs in the United States. While digital signaling was used to connect radio towers to the telephone networks, call signaling was analog and modulated to frequencies of 150 MHz and higher. Thus, separate frequencies were required for each conversation, necessitating the use of enormous bandwidth. Second-Generation (2G) cellular telephone systems are, by contrast, fully digital. With digital calling systems, voice data can be compressed and multiplexed much more effectively, ensuring in turn a more efficient use of spectrum bandwidth.
- **2G – Global System for Mobile Communications (GSM).** The fully digital GSM technology family is the world's most popular wireless phone technology standard and is one of the fastest growing communications technologies of all time. Six hundred carriers in 200 countries serve more than 2.8 billion subscribers with this technology.

Roaming agreements among these carriers allow GSM customers to use their phone when traveling in most countries around the world. The standard is constantly evolving, and new releases are backward-compatible with the original second generation GSM phones.

Mobile phones connect to the GSM cellular network by searching for cells in the immediate vicinity. The coverage area of each cell varies. In a macro cell, the base station antenna is installed on a high mast or building; in a micro cell, used chiefly in urban areas, the antenna height is lower than average roof-top level. A cell coverage depends on a variety of factors, including antenna height, antenna gain, and propagation conditions. Cell user's subscription and other information is stored on a Subscriber Identity Module (SIM), a detachable smart card that enables users to retain information after switching handsets. GPRS (General Packet Radio Service) is the first level of data service on GSM. This packet-based service utilizes the GSM Radio Access Network, combined with a core network dedicated to data. With average speeds of about 35 kbps, GPRS allows nationwide text and email service and basic WAP (Wireless Application Protocol) Internet browsing. GPRS is used for many text messaging PDAs, including Blackberry, Treo, and others.

- **2.5G – Enhanced Data Rates for GSM Evolution (EDGE).** EDGE service provides further enhancements in data capability over the GSM network. EDGE allows both increased data transmission rates and improved data transmission reliability. EDGE was introduced into GSM networks beginning in 2003. With typical speeds of 75 to 135 kbps, advanced mobile services like video and music clips, full picture & video messaging, high-speed color Internet access, and email on the move are possible.

EDGE is especially important to business users, as it permits mobile access to corporate applications at speeds far in excess of dial-up. EDGE Evolution architecture further improves EDGE enhancements by reducing latencies and increasing signal quality. AT&T's EDGE network includes 45,000 cell sites and is the largest high-speed wireless data network in the U.S., covering more than 290 million people in over 13,000 cities and along 40,000 highway miles.

- **3G – Universal Mobile Telecommunications System (UMTS).** UMTS, which supports much higher data transfer rates than previous technology iterations, is the leading 3G technology choice today, offering potential worldwide coverage. It uses Wideband Code Division Multiple Access (W-CDMA) spread-spectrum mobile air interface, in connection with existing GSM infrastructures, to achieve higher speeds. 3G enables typical speeds of 220 to 320 kbps. This permits, by way of example, workgroup collaboration, vertical-specific devices (an x-ray viewer, for example), video and music on-demand, digital TV and radio, and home or business security video monitoring. AT&T's 3G service footprint includes more than 200 major metropolitan areas.
- **3.5G – High Speed Packet Access (HSPA).** HSPA is a further enhancement of UTMS capability. Two capabilities associated with HSPA--High Speed Downlink Packet Access (HSDPA) and High Speed Uplink Packet Access (HSUPA)--increase bandwidth utilization efficiencies provided by UMTS, resulting in decreased system latency, and improved voice and data system capacity. It is anticipated that future releases will increase peak throughput through more advanced modulation technologies and the use of multiple transmit antennas.

HSPA is not a stand-alone access technology different from UMTS-WCDMA, but is rather the result of the successive introduction of advanced features in the UMTS WCDMA standard, making use of the core capabilities of the WCDMA system. The key capabilities associated with HSPA are an optimized shared downlink channel capable of reaching instantaneous transfer rates of 14.4 Mbps, and the possibility of reaching uplink transfer rates of 5.76 Mbps. In addition, HSPA data users and circuit switched voice users can share the same radio channel.

- **3.9G – Long Term Evolution (LTE).** LTE is a new radio interface being developed as the next evolutionary step in the GSM family of wireless technology standards. Along with this new radio interface, a corresponding network architecture called SAE, or System Architecture Evolution, is also being developed. LTE development goals include (1) evolution towards a pure packet-only system; (2) higher data rates (target peak data rates of 100 Mbps downlink and 50 Mbps uplink); (3) higher spectral efficiencies, and flexible channel bandwidths; (4) higher quality-of-service, always-on experience, and lower latency; and (5) a simpler and more efficient network architecture.

  The SAE/LTE architecture is relatively flat. It has fewer nodes, no circuit-switched domain, no single point-of-failure, and load-sharing and traffic re-distribution capabilities. It is tailored to deliver broadband and real-time packet-switched services. These technologies further enable simpler end user receiver devices, as well improvements in system capacity and user experience. In addition to being well designed to carry high speed data services, LTE is also well designed for low bit-rate real-time streaming services such as VoIP. Subject, of course, to further

specifications development, current estimates indicate that general commercial availability of LTE infrastructure and devices should occur in the 2010 to 2012 time frame.

- **4G – IMT Advanced.** The International Telecommunications Union (ITU), through its Radio communication Sector (ITU-R), is in the process of establishing a definition of 4G wireless systems. The system requirements should be established next year, and it is anticipated that standards will be complete in the 2010-2011 timeframe. As with 3G, 4G will be defined in stages and will describe a family of evolving technology systems. The initial vision for the 4G system called for a new radio access interface that could handled a wide range of supported data rates according to economic and service demands in multi-user environments, with peak data rates of up to 100 Mbps for high-mobility applications and 1 Gbps for low-mobility / local applications.

III. Wi-Fi and WiMAX

Wireless Fidelity (Wi-Fi) operates in the license-exempt spectrum. It is a local area network (LAN) technology originally designed to add mobility to wired LANs and is based on IEEE standard 802.11. Worldwide Interoperability for Microwave Access (WiMAX) is a broadband wireless technology that enables wireless data in both fixed and mobile environments. It is based on the IEEE 802.16e standard. The WiMax Forum, which developed and defined "WiMAX," described it as a "standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL." The bandwidth and reach of WiMAX make it suitable for a range of applications including providing high-speed data and telecommunications service, providing Internet connectivity

diversity, connecting WiFi hotspots with each other and to other parts of the Internet, and providing mobile connectivity. WiMAX has recently been accepted as an IMT-2000 (3G) standard by the ITU, though much work remains to be done in terms of establishing a fully interoperable multi-vendor ecosystem.

Wi-Fi Applications. Wi-Fi is effectively deployed in residential (chiefly in-home networking applications), enterprise, large and small venue "hot spots" and metropolitan environments ("Metro Wi-Fi") settings. AT&T offers access to the nation's largest Wi-Fi network, providing or enabling Wi-Fi access at more than 57,000 locations in more than 85 countries. In addition, AT&T has partnered with municipalities for wide area public Internet access, as well as government and public safety functions through the deployment of municipal WiFi networks. Our first such deployment occurred in Riverside, California, and we have partnered with St. Louis and San Antonio to provide Wi-Fi services in the future.

A typical Metro Wi-Fi agreement calls for a provider to deploy its equipment on city light poles and fixtures throughout the coverage area. The provider typically maintains the network and handles customer service. This architecture is designed to enable widespread broadband access, including nomadic access, with minimal direct investment for the municipality. Metro Wi-Fi business models combine advertising based revenue for free, basic broadband service, Wi-Fi subscription options for higher levels of service, and revenues from enterprise service offerings using the wireless network. In turn, municipalities potentially benefit in a number of ways, including city use of the services, business development and retention, and increased tourism. In general, the municipal WiFi networks that AT&T has been involved in have succeeded in technical respects, although logistical issues, chiefly in terms of base station power, have posed challenges.

- Riverside, CA – Phase I was launched in the third quarter year. The system involves 71 meshed access points with a coverage area of 3 square miles. Signal tests indicate that the system is performing well on the 2.4 GHz spectrum. It also includes a 4.9 GHz overlay for public safety (fire and police) use that is working well.

- San Antonio, TX – Covers downtown San Antonio, including major tourist areas such as the Alamo, the Riverwalk/River Center and the Convention Center. A 4.9 GHz Public Safety trial is a part of the overall 18 month pilot trial.

- St. Louis, MO – Targeted to 1 square mile where the city has suitable mounting assets with 24x7 power. Will cover St. Louis Arch & Park, the Convention Center, and Stadium.

WiMAX Applications. AT&T continues aggressively to explore the use of fixed wireless solutions such as WiMAX as a complement or enhancement to DSL service and/or other broadband services. The company has a number of WiMAX trials underway.

- Pahrump, NV – This is a consumer market trial in the licensed WCS band, using pre-WiMAX technology. The trial reaches over 1,300 households, which are able to achieve the equivalent of DSL data rates. Customer surveys show that the vast majority of customers had no problems with setting up their equipment and establishing an Internet connection, and were likely to refer the service to a friend.

- Anchorage, Fairbanks and Juneau, AK – These cities are part of statewide initiative to expand the reach of broadband Internet services throughout Alaska by

using WiMAX technology. This deployment, in conjunction with satellite video services, will enable AT&T to offer a product that competes with "triple play" voice, video, and data services offered by the local exchange carriers and cable companies in these areas. The company offers tiered pricing plans with speeds of up to 2 Mbps. Current plans are to deploy 25 tower sites in Anchorage.

These trials have to date been successful and have largely validated the technologies, but a number of challenges remain. Most notably, AT&T has been targeting areas for fixed-use WiMAX deployment where it has not been economically feasible to deploy DSL facilities. Yet, many of the same economic hurdles related to subscriber density and the significant costs of facilities build-out are present with wireless deployments. In addition, AT&T's WiMAX deployments use the Wireless Communications Service (WCS) 2.5 GHz band. While this has not been a problem in Alaska, the FCC has yet to finalize out-of-band emissions limitation standards; thus, technologies are not yet available to fully capitalize on deployments within this band.

The Alaska WiMAX deployment is AT&T's first experience with this new and evolving technology. The "Wave 2" version of WiMAX needed to meet service performance requirements has only recently been finalized and is in the process of completing certification testing. Fully certified equipment will not be available with the baseline network services until 3Q2008. Nevertheless, WiMAX, at this early stage, is showing promise for fixed broadband applications.

IV. Wireless Broadband Deployment: A Snapshot

Empirical data show that wireless broadband systems are today being adopted in customer markets as substantial competitive alternatives to cable modems and DSL, and data trends indicate that they will become increasingly formidable alternatives in the future. In June of this year the FTC's Staff Report on Broadband Competition Policy concluded that there is evidence on a national scale that: (1) consumer demand for broadband is growing quickly; (2) access speeds are increasing; (3) prices (particularly speed-adjusted or quality adjusted prices) are falling; and (4) new entrants, deploying Wi-Fi, WiMAX, and other broadband technologies, are poised to challenge the incumbent cable and telephone companies.[1]

According to the most recent report released from the FCC, based on statistics gathered from providers during the second half of 2006, wireless and satellite providers have more than 25% of all broadband subscribers in the United States.[2] Indeed, the FCC report indicates that from December 2005 to December 2006 mobile wireless high-speed subscribership grew nationwide by more than 600%, nearly doubling from 11 million to 21.9 million in the second half of 2006 alone.[3] New wireless subscribers made up 62% of the total growth in high speed lines during the second half of 2006.[4] A substantial number of consumers now have access to high-speed service from satellite technologies, as well as other wireless technologies, such as Wi-Fi, WiMAX and 3G cellular services.[5] As of November 5, 2007, there were 63,654 Wi-Fi hot spots in the United States, three times the number in the second, third and fourth countries in

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1 Broadband Connectivity Competition Policy, FTC Staff Report (June 2007) at 156.

2 High-Speed Services for Internet Access: Status as of December 31, 2006, Industry Analysis and Technology Division, Wireline Competition Bureau (Oct. 2007) at Table 1, Chart 2

3 Report Shows Substantial Growth in Wireless Broadband (CTIA Press Release, Nov. 1 2007).

4 *Id.*

5 FTC Report at 102

the international Wi-Fi "Top Ten" (the UK, France and Germany) and four times the number in fifth-place South Korea,[6] an increase of over a third since the FTC's June 2007 Report.[7]

[6] http://jiwire.com/search-hotspot-locations.htm (last visited Nov. 7, 2007).

[7] FTC Report at 102, finding "over 40,000 hot spots across the country."