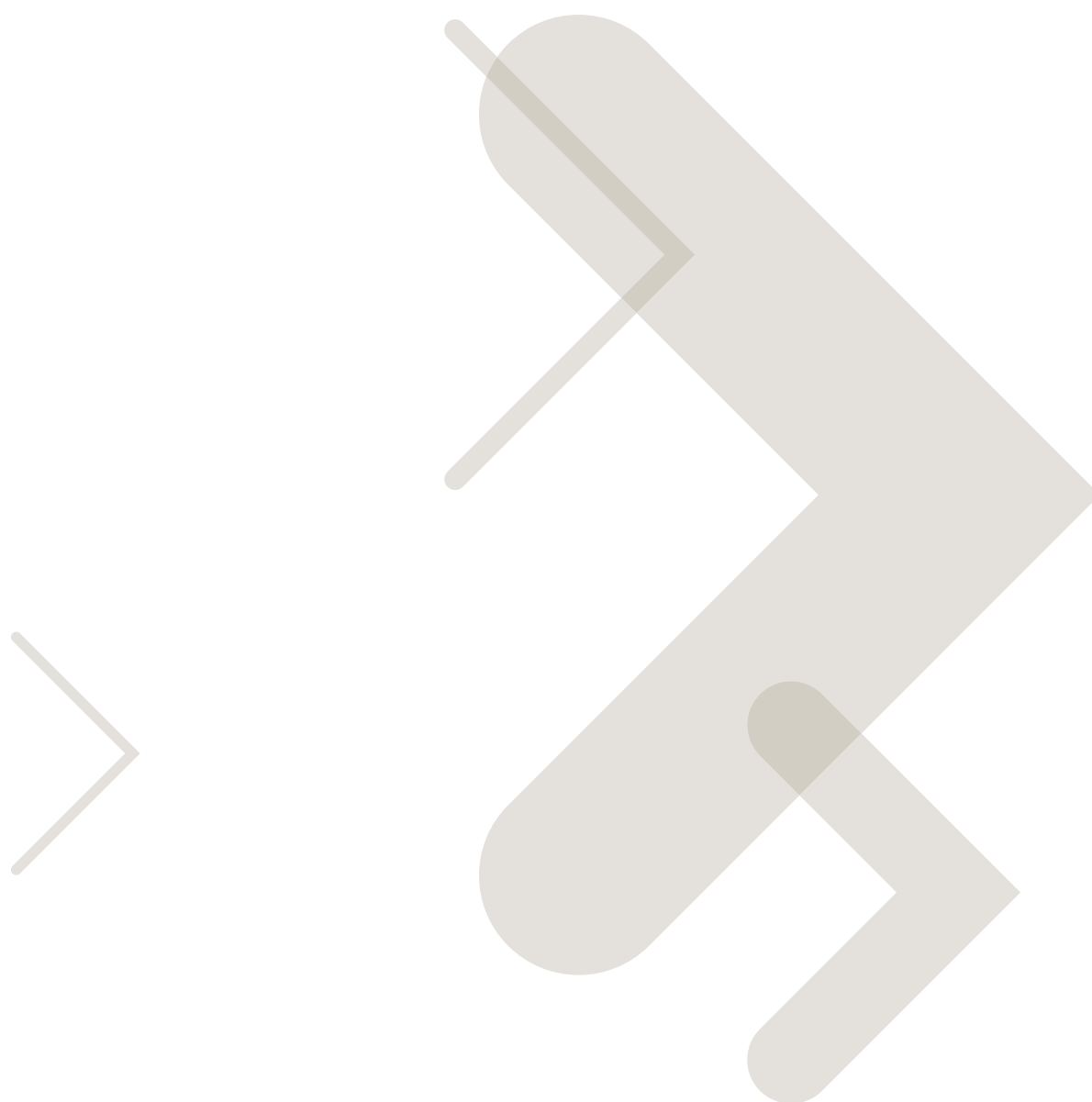





# Driving 4G: WiMAX & LTE





**WiMAX and LTE are well positioned to drive the global evolution towards pervasive wireless broadband communications with market acceptance, rich ecosystems, and promising economies of scale.**

**Motorola's committed focus and investment uniquely position us to bring both market-leading WiMAX and LTE solutions to the global marketplace. Availability and regulations of spectrum, paired with time-to-market business objectives will likely determine operators' selection of WiMAX and LTE. Operators will reap first-mover benefits of market share and speed-to-revenue by taking advantage of their access to broadband spectrum holdings to penetrate the wireless broadband market early.**

#### *WiMAX & LTE*

- » *The two principal mobile broadband platforms for the next decade*
- » *Extensive development communities for networks, devices & applications*
- » *Field tested and market proven services*
- » *Enable new revenue generating applications previously reserved to fixed line broadband*
- » *Economies of scale leading to steep cost declines*
- » *Built on IP foundations; integrating mobile broadband with IP networking*
- » *Utilizing OFDM air interface, next generation base station design & advanced antennas*
- » *Operating in licensed spectrum and addressing globally available bands*

#### **Demand for bandwidth**

The rapidly growing demand for affordable bandwidth in fixed and mobile services is driving the industry to deliver high performing, cost effective wireless broadband platforms that can be deployed in the varied spectral allocations worldwide.

#### **Key technology enablers**

Wireless technology platforms addressing the growing demand for bandwidth will share key technology enablers including OFDM air interface, advanced antenna techniques including MIMO and beamforming, flat all IP architectures, and common IP core.

#### **WiMAX & LTE**

Leveraging the key technology enablers for next generation wireless broadband, the industry has demonstrated strong support for 802.16e-2005 and LTE to provide solutions applicable to a broad set of global operator segments with varying spectrum holdings.

| <b>WiMAX &amp; LTE Applications Meeting the Needs for:</b> |  |
|--|--|
| <b>Fixed, Nomadic, Mobile</b>                              |  |
| Fixed  | Fixed broadband service analogous to DSL or cable without the wires              |
| Nomadic  | Hotspot coverage for un-tethered, localized connections                          |
| Mobile   | Combining broadband with the freedom and roaming of cellular                     |
| <b>Voice, Data, Video</b>                                  |  |
| Voice  | Carrier-class voice services using VoIP  |
| Data   | Multi-megabit broadband data services  |
| Video  | On-demand and broadcast video services   |
| Gaming   | Online, multi-player, latency sensitive gaming applications                      |
| Personal Broadband   | Interactive, personalized rich media applications delivered "on-the-go"          |
| <b>Enterprise, Residential, Underserved</b>                |  |
| Enterprise   | End-to-end QoS offering quality assurances for enterprise connectivity           |
| Residential  | Home broadband data and voice bundles  |
| Underserved  | Eliminating digital divide in underserved areas; supporting economic development |
| Campus   | Airports, universities, office campus coverage                                   |
| Special Events   | Special events connectivity for media, participants, fans                        |
| Wholesale  | Leased network services to ISPs  |
| Safety & Security  | Advanced public safety monitoring, remote surveillance, roadway safety           |

### Scale Economies

Industry forecasts demonstrate strong market adoption rates for both WiMAX 802.16e-2005 and LTE leading to the necessary volumes for driving scale economies. Within a decade, it is anticipated that the majority share of wireless networks will be shared between the WiMAX and LTE technology platforms.

### Device Proliferation

Both WiMAX 802.16e-2005 and LTE will benefit from rich ecosystems of devices spurred by the standards based designs, open IPR environments, commitments from chipset manufacturers, large communities of developers, and interest from consumer electronics manufacturers. Both WiMAX and LTE are anticipated to surpass the critical volumes required to drive down device costs. While initially both WiMAX and LTE devices will be driven by multimodal platforms, as the networks become pervasive, single mode devices will further drive cost points lower. WiMAX today is additionally benefited by the commitments of major chipset manufacturers, driving a large, embedded base of WiMAX enabled devices.

### Performance

WiMAX 802.16e with migration to 802.16m will share similar performance capabilities with LTE as both technologies exploit similar wireless and IP design techniques to approach the maximum spectral efficiencies defined by Shannon's Law (approximately 6 bits per hertz). With 802.16e operators can deliver upwards of 3.5 bits per hertz today (35 Mbps per sector for a 10 MHz channel) while 802.16m and LTE will advance that to over 5.0 bits per Hertz (greater than 100 Mbps per sector for a 20 MHz channel) as has been already demonstrated in a number of field tests.

## Technology Comparative

|                                | WiMAX 802.16e  | WiMAX 802.16m  | LTE  |
|--------------------------------|--|--|--|
| Network Equipment Availability | 2007   | 2010   | 2009   |
| Handset Availability           | 2008   | 2011   | 2010   |
| Standard Body                  | IEEE & WiMAX Forum   | IEEE & WiMAX Forum   | 3GPP   |
| Spectrum band Plan             | TDD  | TDD, FDD   | FDD  |
| Frequency*                     | 2300, 2500, 3300<br>3500, 3700                               | Under 6 GHz TBD  | 700, 850, 900, 1800<br>1900, 2100, 2500                      |
| Channel Bandwidth              | 3.5, 5, 7, 8.75, 10 MHz                                      | Scalable bandwidth 5 – 20 MHz<br>TBD                         | 1.4, 1.6, 3.5, 10, 15, 20 MHz                                |
| Channel Throughput             | ~3.5 Mbps / Hz downlink<br>35 Mbps, 1 Sector, 10 MHz channel | ~5.0 Mbps / Hz downlink<br>50 Mbps, 1 Sector, 10 MHz channel | ~5.0 Mbps / Hz downlink<br>50 Mbps, 1 Sector, 10 MHz channel |
| Spectrum Type                  |  | Licensed   |  |
| Radio Technology DL            |  | Scalable OFDMA   |  |
| Radio Technology UL            |  | Scalable OFDMA   |  |
| Antennas                       |  | MIMO & Advanced Antenna Techniques                           |  |
| Core Technology                |  | Flat, All IP   |  |
| Application Layer              |  | IMS  |  |
| IPR                            |  | More distributed than existing 3GPP & 3GPP2 networks         |  |
| Application                    |  | VoIP, Data, Video  |  |
| Terminal Variety               |  | Fixed CPE, Mobile handsets, Data Cards, Consumer Electronics |  |
| User Plane Latency             | <20 ms   | <5 ms  | <5 ms  |
| Control Plane Latency          | <100 ms  | <100 ms  | <100 ms  |

\* WiMAX Forum Certification Profiles currently specified for 2300, 2500, and 3500 MHz.

### Enhanced Flat IP Architecture

Both WiMAX and LTE benefit from a simple, peer-to-peer network architecture that features flat, all IP-based design. The architecture significantly reduces the complexity of the network, offers the benefit of faster handovers, provides the foundation for versatile service delivery, and offers freedom in network scalability.

### Smart Antenna Techniques

Both WiMAX and LTE take advantage of revolutionary multi-antenna techniques such as MIMO and beamforming at the base station and end-user device to dramatically improve the communications link. This enhances the most demanding application scenarios including heavily obstructed propagation environments, high interference levels, and high speed mobility service.

### Inter-Technology Operations

WiMAX 802.16e-2005 and LTE will interoperate with existing wireless technologies, offering handovers across access platforms including Wi-Fi, GSM and CDMA. These technologies are additionally being developed to serve media mobility across various fixed line and wireless access technologies. Multi-mode / multi-band handheld devices combined with system support for inter-technology handovers will allow operators to benefit from the deployment scale of today's cellular and Wi-Fi installations and to deliver services over the best-fit network anywhere, anytime.

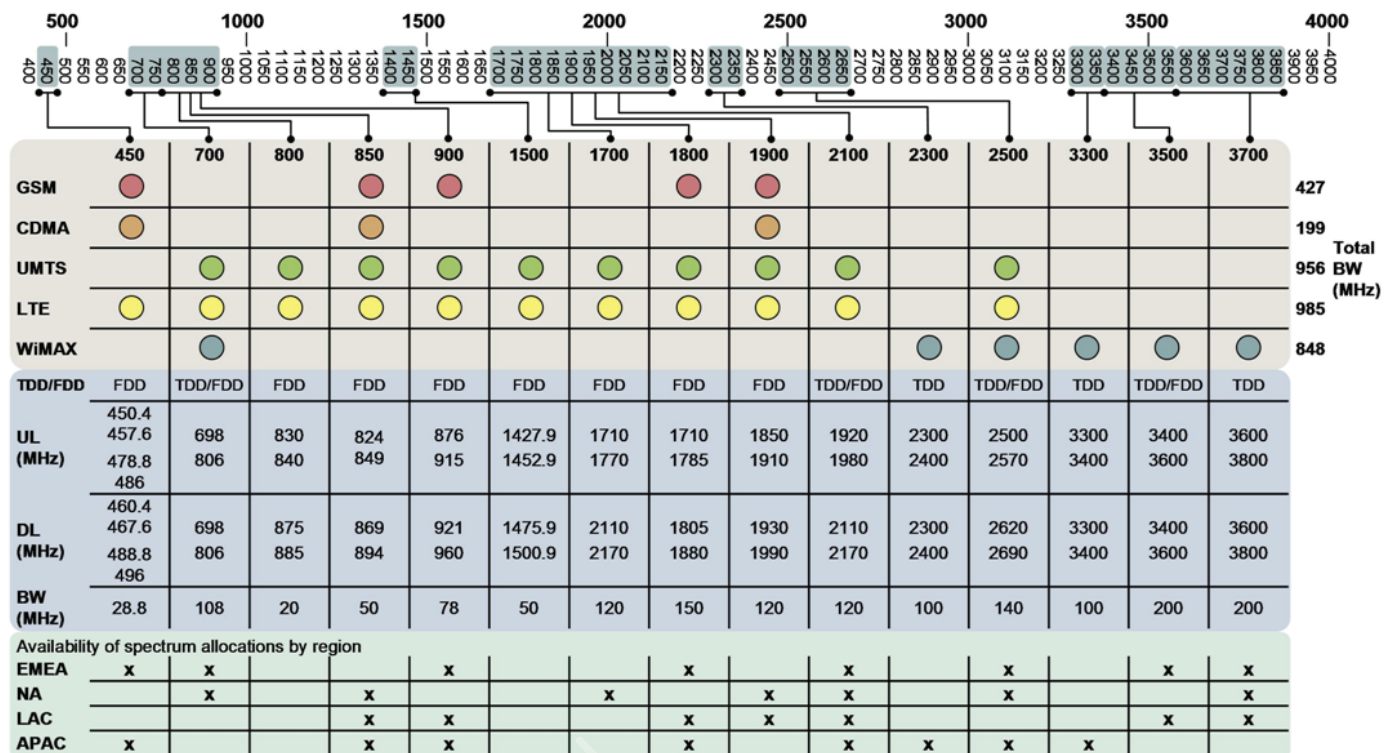
### TDD & FDD

WiMAX 802.16e-2005 is currently specified to operate with TDD operations while LTE is being specified for FDD operations. While both technology platforms can be implemented to address both TDD and FDD, current vendor implementations based on requirements expressed by global operators are focusing WiMAX on TDD and LTE on FDD. Regulation of an operator's spectral holdings as TDD or FDD will be a key decision factor on the operator's technology selection.

### Operating Spectrum

While LTE bands of operation are still to be finalized, it is likely that LTE will be considered for those spectrum bands available today to GSM, CDMA and UMTS. To date, the WiMAX Forum has defined profiles for 802.16e platforms operating in 2300, 2500, 3300, 3500 and 3700 MHz bands. These WiMAX bands are largely underutilized, licensed spectrum allocations available globally. Both WiMAX and LTE have available a significant amount of spectral real estate (LTE may have access to 985 MHz of spectrum while WiMAX 802.16e-2005 today has access to 848 MHz of spectrum) meeting the industry needs for allowing a broad pool of operators to deliver broadband services to a large number of users.

## Global Wireless Spectrum Allocations



1. An FDD variant of WiMAX 802.16e-2005 under consideration by the industry for 700 MHz deployment
2. 2500 MHz band in Europe under regulatory assignment and likely to include both TDD and FDD allocations

**Time to Market**

WiMAX 802.16e-2005 has a two year head start over LTE. The availability of WiMAX solutions in the market today provide operators a distinct time to market advantage for deploying high capacity wireless broadband networks. Operators with appropriate spectrum holdings seeking a time to market advantage for deploying new, differentiated services will consider WiMAX as their technology platform of choice.

## Wireless Evolution Roadmap

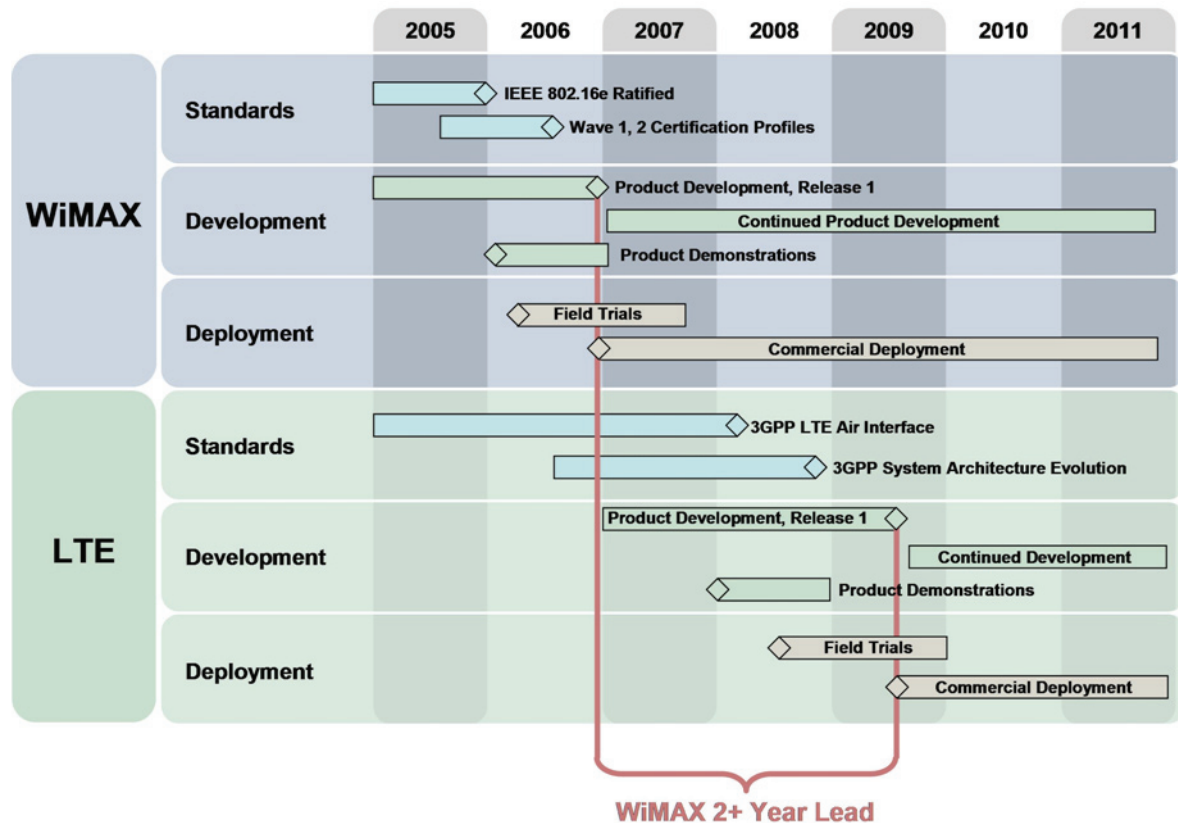
### Analog Cellular

- 1983**
  - AMPS - First commercial operation of AMPS (AT&T's Illinois Bell, Chicago)
  - 1983 - Motorola DynaTAC 8000X - world's first commercial portable cell phone
- 1985**
  - TACS system (AMPS based) in commercial operation in the UK

### Digital Cellular

|              | 1992       | 1994                | 1996 | 1998                | 2000              | 2002 | 2004                 | 2006                 | 2008 | 2010          |
|--------------|------------|---------------------|------|---------------------|-------------------|------|----------------------|----------------------|------|---------------|
| <b>3GPP</b>  | GSM (1992) |                     |      |                     | UMTS (2001)       |      | HSDPA (2005)         | HSUPA (2007)         |      | LTE           |
| <b>3GPP2</b> |            | CDMA - IS95A (1994) |      | CDMA - 1xRTT (1998) |                   |      | DO (2004)            | DO Rev A (2006)      |      | UMB           |
| <b>IEEE</b>  |            |                     |      |                     | 802.11 b/g (1999) |      | 802.16d WiMAX (2005) | 802.16e WiMAX (2006) |      | 802.16m WiMAX |

## WiMAX 802.16e & LTE Roadmap



**Need for Capacity**

Wireless operators who have WiMAX appropriate spectrum holdings and are anticipating significant demand growth in data services in one to three years that challenge the capacity and economics of their current systems will consider WiMAX to satisfy their bandwidth growth at lower cost per bit served. Wireless operators projecting sufficient capacity to address near term forecasted data consumption growth may elect to wait for the availability of market ready LTE solutions. New entrants without legacy wireless networks who have access to WiMAX spectrum will benefit in entering the market early with WiMAX to deliver differentiated wireless service with a favorable cost structure, capturing market share and speeding time-to-revenue.

**Global Leader in OFDM**

Motorola led the industry in recognizing the potential of WiMAX to transform markets. Through early development investments and being a chief contributor in scribing the global standard, Motorola has paved the way for bringing OFDM technologies to the world.

**Driving the Standards**

The WiMAX and LTE System Architectures are being developed by Senior Architects with technical expertise across GSM, iDEN, WLAN and CDMA technologies. These teams have been highly involved with the IEEE, 3GPP, 3GPP2 Standards Forums contributing significantly to the technical standards. Motorola is the number one contributor to the LTE RAN standards leveraging deep technical expertise and experience with OFDM radio technologies.

**Design Efficiencies**

The extensive design and development capabilities from bringing to market an end-to-end WiMAX portfolio offers Motorola tremendous efficiencies in realizing best-in-industry LTE solutions. At Motorola, the WiMAX and LTE development organizations are one team working in close collaboration to bring both WiMAX and LTE to market quickly and with a high focus on quality. Motorola is leveraging upwards of 80% of its WiMAX development efforts to develop a best-in-class LTE platform that will meet early trials and commercial deployments.

**End-to-End**

Motorola is committed to delivering the promise of true Personal Media Experiences. Motorola has organized its business units and roadmaps to deliver end-to-end WiMAX & LTE solutions spanning core, video headend, service delivery, infrastructure, backhaul, devices, chipsets, operations & management, and a comprehensive services portfolio. With a view on the full scope of operator deployment needs, Motorola partners with operators to develop an optimal business model tailored to their market profile and service goals with focus on speed-to-revenue.

**Quality**

Motorola has placed a tremendous focus on bringing the highest quality WiMAX 802.16e-2005 and LTE solutions to market. WiMAX and LTE quality is governed by Motorola Networks Quality Standards and an established Quality Review Board comprised of experts across multiple technologies. Motorola employs a system test plan developed and executed by Motorola's SEI Level 5 Test organization, responsible for iDEN, WLAN and CDMA testing.



### **Early to Market Advantage**

Service providers around the world will benefit by taking advantage of their access to broadband spectrum holdings to penetrate the wireless broadband market early. With WiMAX 802.16e-2005 commercially available today, early-to-market WiMAX service providers will be positioned to reap first-mover benefits.

Early-to-market service providers will have the opportunity to maximize their share of subscribers. In many cases, high-spend residential and enterprise users are early adopters, providing access to potentially lucrative market segments.

Early-to-market service providers will be capable of delivering differentiated services at a substantially more favorable cost structure than wireline or previous cellular technologies have afforded.

Their new networks will have access to a growing wave of devices enabled with mobile broadband silicon, which paired with innovative new applications, offers the opportunity to deliver attractive services that realize new revenue streams.

A distinct advantage of the WiMAX 802.16e-2005 technology standard is its ability to deliver powerful connections across fixed, nomadic and mobile applications. Operators can consider a strategy of utilizing WiMAX to deliver a fixed and nomadic offering at the onset of their service launch to speed time-to-revenue. The flexible, software definable radios incorporated into Motorola's wi4 WiMAX equipment allows for simple software updates to enable full mobility application - giving operator's the confidence to deliver fixed, nomadic applications today and to evolve into fully mobile applications as their offerings strategy and market requirements demand the capability.



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