



**at&t**

# Wireless Technology Innovation at AT&T

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# Where Does Innovation Come About?

- Edge/Devices – most visible to the user
- But this is not worth much without innovation in the network:
  - RAN
  - Transport
  - Core and routing
  - OSS/BSS – billing, performance monitoring, maintenance, SON
  - Network based application environment/APIs
- Business models
- End to End Architecture development – investigations that cover multiple components of the architecture

**Innovation at the Edge is critically dependent  
on innovation in the Network**

# How Does Innovation Come About?

- Internal R&D, Analysis, Architecture Development, Operations
  - Experience from operational problem solving
  - Analysis and simulation, identification and assessment of new or improved techniques
  - Unique perception afforded by end-to-end visibility
  - Internal technical innovation processes and tools
- Partnerships with Universities
- Standards participation
- Partnerships with network and edge vendors – unique needs drive innovative products, solutions, and services – 3<sup>rd</sup> party partnerships are crucial

**More than 6,000 patents issued in the last ten years.  
Average of three new patents *every single business day***

# Innovation Through Standardization

- Pace of technology change => invention in standards processes
  - This is no longer the standardization of completely developed technologies
  - Technology is designed as part of the standardization process
  - Individual participants have further opportunity to innovate
- Industry interaction leads to new ideas
- Membership and active participation in over 50 organizations – including SDOs (Standards Development Organizations) and industry forums
- AT&T has leadership positions in over 60 committees, sub-committees, boards, etc.

# 3GPP Evolution of Wireless Networks

BSC: Base Station Controller  
 BTS: Base Transceiver Station  
 HLR: Home Location Register  
 GERAN: GSM EDGE Radio Access Network  
 GGSN: Gateway GPRS Support Network  
 LTE: Long Term Evolution  
 MSC: Mobile Switching Center  
 RNC: Radio network Controller  
 SGSN: Serving GPRS Support Network  
 UTRAN: Universal Terrestrial Radio Access Network

SIM

2G

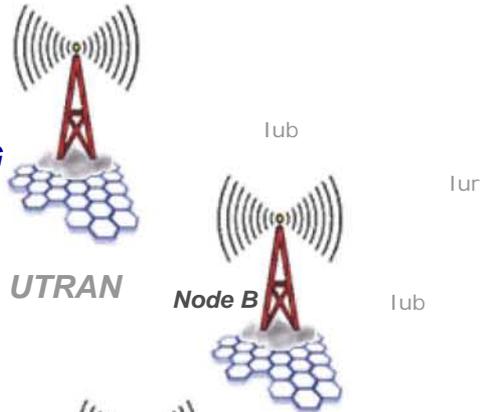


A

Gb

USIM

3G



Iu-cs

Iur

Iu-ps

Iu-ps

S1-MME

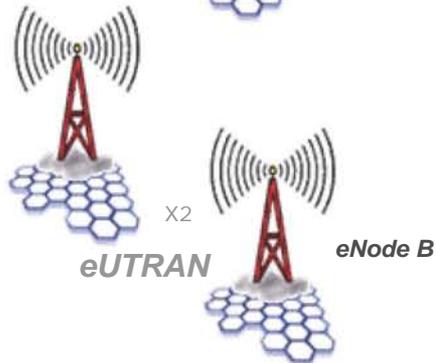
S1-MME

S1-u

S1-u

USIM/ISIM

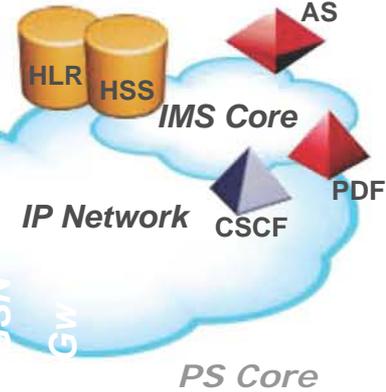
LTE



CS Core



D



# The Need to Innovate in the Network

- Over the last 3 years, wireless data usage in AT&T's network has increased nearly 5000%. Mobile internet use is becoming part of our daily lives.
- The acceleration in data usage shows no signs of slowing – rapid changes needed in technology, network planning, and network deployment
  - Radio system evolution (GSM/EDGE to UMTS/HSPA, now moving to LTE)
  - Radio system planning, deployment issues – e.g. SON
  - Radio speed increases must be matched by increases in backhaul capability
- Management of capacity, throughput and users on the network is critical to high user perceived quality, to service public safety needs, etc.
- It is not just speed but quality, the balancing of many needs in an end-to-end architecture.
- Spectrum management is also critically important
  - Increased spectral efficiency
  - Interference mitigation
  - Bandwidth management
  - Spectrum refarming - Multi-technology, multi-band operation

**All of these elements are interrelated in a complex way and must be carefully planned and managed.**

# Application: Ten years ago many common devices were in their infancy...

Analog cell phones were still widely used, 2G underway



Casio's new digital camera featured 1024 x 768 resolution

The most prevalent internet connection was a 56kbps dial-up modem



The Powerbook G3 had a 300Mhz processor, zip drive and a 5.0 GB hard drive.

Wi-Fi was still in its infancy



Stacked hard drives afforded computer users ample space to store files.

The Walkman combined the ability to listen to tapes and the radio on-the-go.



The first commercial bluetooth products began coming out only in 1998.

Sony released their concept flat-screen model TV in 1998.



DVDs were beginning to overtake VHS tapes but many families began purchasing dual-mode players.



GPS products were still in their infancy.

# ...all of which are now incorporated into one device

The devices operate on the new AT&T 3G network



The iPhone features a 2.0 megapixel camera

The 3G network has maximum download speeds of 7.2 Mbps



The iPhone and Bold automatically connect to the nearest WiFi station



Roughly 360 albums can be held on the iPhone



The iPhone uses a 667MHz processor, more than double top 1998 processing speeds



With a 16 GB capacity, there is roughly triple the hard drive space than most desktops in 1998



Bluetooth is now ubiquitous in cell phones and is present in some vehicles

The incorporation of widescreen multi-touch displays

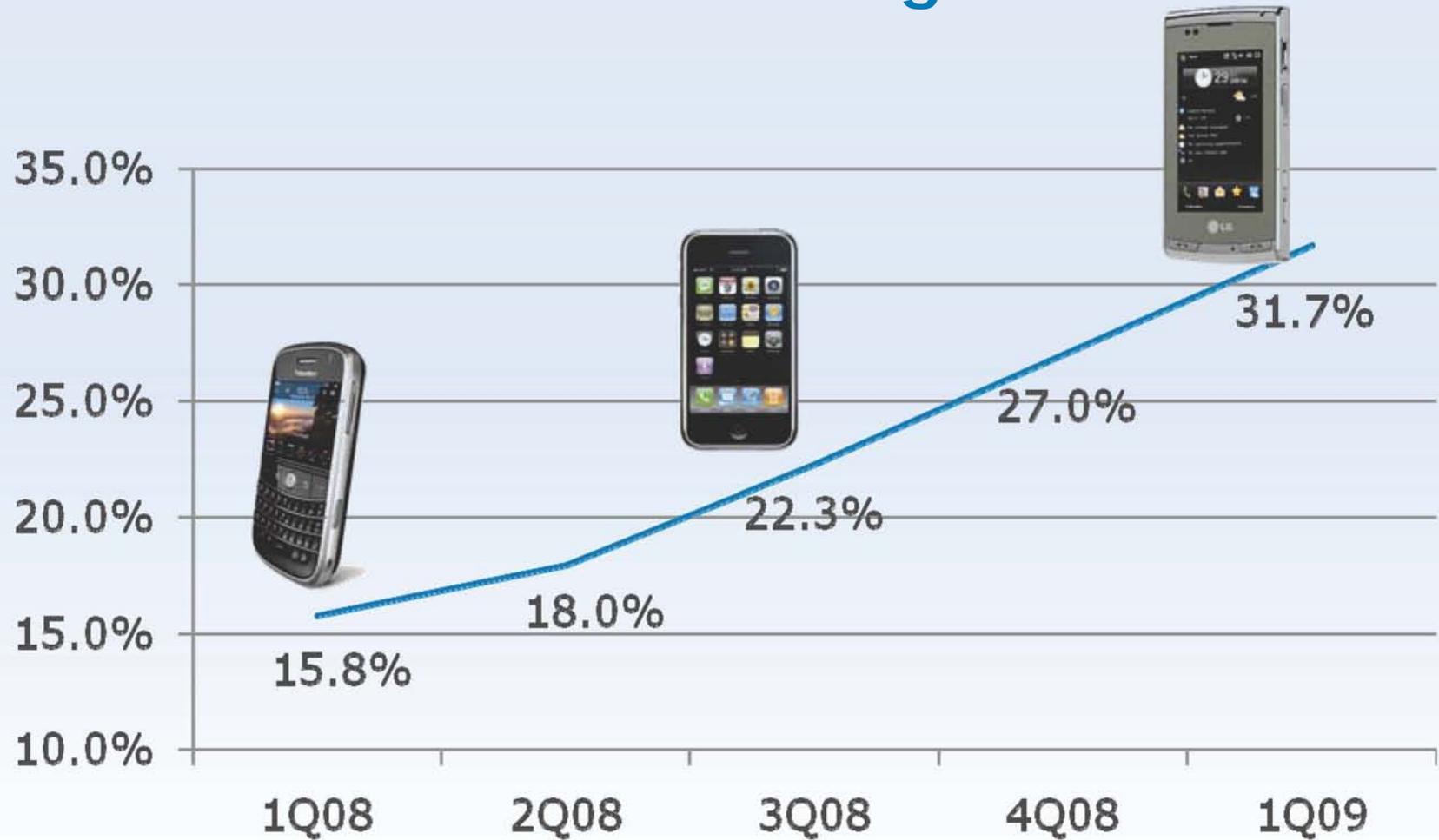


YouTube, along with multiple forms of video, can be viewed on the iPhone



The new devices can overlay satellite images onto the users coordinates

# AT&T Consumers with Integrated Devices



# New Generation of Connected Devices

## Netbooks & MIDs

- Mini Computing
- Customer Experience
- Instant On/All Day Battery



## Picture Frame

- Push photos to Grandma
- No setup required
- Sync with Digital Camera



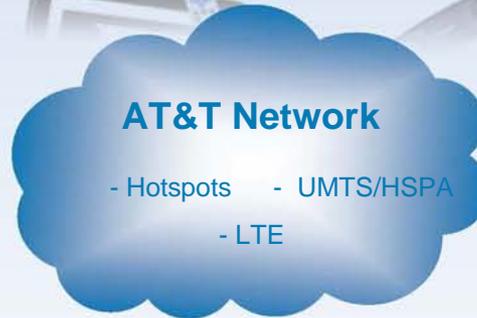
## eReader

- Access to Books, Newspapers, Mag.
- Simple out of the box experience
- Subscription Opportunities/Rev



## Cars and Telematics

- Diagnostics & Safety
- Real Time Traffic
- Web Content
- Rear Entertainment



## PNDs

- Real Time Traffic
- Points of Interest
- Web Search



## Cameras

- Backup Photos to Internet
- Limitless Memory Card
- Send Photos to Digital Photo Frame



## Media Player

- Movie Player
- Photos
- Music



## Monitoring/Tracking

- Medical Applications
- Security
- Home/Business monitoring
- Child Track/Find Fido

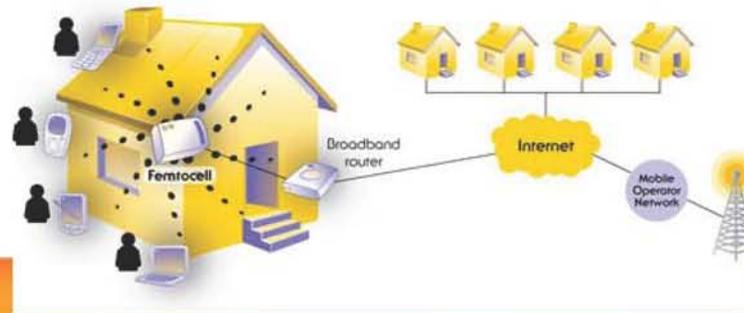


## Gaming Devices

- Multiplayer Games
- Game Downloads
- Social Networking
- Browsing

# Near Term Network Innovations

- **Adding 3G Capacity.** In 2008 and 2009 to date, high-quality 850 MHz spectrum has been deployed in more than half of AT&T's 3G network footprint to improve overall coverage and in-building reception, with additional markets planned for later in the year. Deploying 2100 new cell sites.
- **Evolution of 3G.** AT&T is beginning to deploy the next step in HSPA with a peak speed of 7.2 Mbps.
- **More Bandwidth to Cell Sites.** Adding fiber-optic connectivity and additional capacity to thousands of cell sites across the country this year, expanding the critical connections that deliver traffic from a cell site into the global IP backbone network. These upgrades will support the higher mobile broadband speeds enabled by both HSPA 7.2 and LTE.
- **Preparing for LTE Deployment.** Trials in 2010 with widespread deployment in 2011.
- **Wi-Fi Integration.** Many AT&T smartphones will be able to switch seamlessly between 3G and Wi-Fi connectivity. AT&T has the nation's largest Wi-Fi network – more than 20,000 hotspots, including locations in all 50 states, 90,000 hotspots globally and AT&T also can create permanent or temporary extended Wi-Fi zones in areas with high 3G network use, like a grouping of hotels or a festival.
- **MicroCells.** Customer trials leading toward general availability of AT&T 3G MicroCell offerings, which utilize femtocells to enhance in-building wireless coverage.



# Evolving AT&T's Network – All IP

Content Provider

## Portable

- **Largest U.S. Wi-Fi network** more than 21,000 hot spots domestically and 80,000 worldwide (roaming)
- Leveraging Wi-Fi to provide the best user experience



## Metro Ethernet

- **IP Access at the Edge** – seamless local access to support converged products and applications.



## Mobile

- **3G broadband deployed** to over 350 U.S. markets, including all top 100 cities
- Deployment of nation's first HSUPA-enabled mobility network
- **Evolving to LTE**

Content Provider

Aggregation Router

## Fixed

- **>14 million fixed broadband connections**
- Rich suite of IP services for business
- Ethernet Services (fiber and copper-based)
- **AT&T U-verse platform to reach 30 million living units** by end of 2010 (FTTH, FTTN)

## Backbone/Core

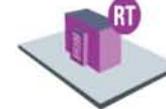
- **Premiere OC-768 Core Network** – 40 Gigabit per second ultra long haul network capable of providing intelligent dynamic content transportation and managed Quality of Service.
- **Content Hosting, Storage & Management** – expanding capabilities by deploying facilities at key locations to enhance content accessibility and speed,
- **Cache Capabilities** – network assets and capabilities will enhance the customer experience through expanded caching functionality.

## Telco Wired HSIA Architectures

All Copper Loop Based DSL



RT Based DSL



FTTN



FTTP



# Evolving the Core: AT&T Services Over IP Strategy: Layered Architecture

Integrated Service Delivery Environment



AT&T IMS Infrastructure Provides Advanced Services in a Uniform Environment

AT&T Converged Services Infrastructure

**IMS Core**  
**Global IP/MPLS Network**  
**Border Elements and Gateways**

All Access Technologies



Any End Device

# A Few Examples of the Innovations at AT&T

## AT&T Innovations or Substantial Contributions

- Key patents in Space-Time Coding, MIMO and OFDM
- Advanced Receiver definition, simulation and standardization for improved performance
- Enhancements to voice coding for improved voice quality – worked through standards
- MIMO antenna investigations and driving improvements with vendors and in the standards
- Higher Order Modulation for increased throughput
- Bandwidth aggregation for higher throughput
- Network based vocoder rate adaptation control for increased capacity

# A Few Examples of the Innovations at AT&T

## AT&T Innovations or Substantial Contributions

- New activation/provisioning scenarios and methods
- Emerging devices development partnerships and testing – driving a new market
- Developed radiated performance metrics and test procedures for devices – reverberation chambers
- Partnered with a small company on uplink transmit diversity for higher uplink data rates
- Drove much of the development of 3G femtocells, first to deploy 3G femtocells in the US
  - Driving standardization in the Femto Forum and 3GPP
  - Location validation for proper E911 routing
  - Voice compression on the uplink

# A Few Examples of the Innovations at AT&T

## AT&T Innovations or Substantial Contributions

- Partnered with device vendors to improve battery life and efficiency
- Audio noise cancellation techniques in wireless devices for improved audio quality
- Development methods to support TTY for the hearing impaired community
- Drove intelligent roaming concepts and methods
  - Done initially for ANSI-136
  - Extended to GSM and later 3GPP technologies
- Driving requirements and solutions in LTE and LTE-Advanced
- Early deployment of IMS networks for both mobile and wireline networks – unique services and network integration
- Cellular/WiFi/GPS based integrated dispatch, planning and routing system

# A Few Examples of the Innovations at AT&T

## AT&T Innovations or Substantial Contributions

- Drove the development of distributed base station architectures to improve performance and electrical power consumption.
- Developed unique co-siting solutions to enable 2G and 3G base stations to share existing coax cables on towers
- The need to simplify and integrate network planning - SON
- First US carrier to deploy
  - Blackberry
  - Palm
  - Windows Mobile
  - iPhone

# A Few Examples of the Innovations at AT&T

## AT&T Innovations or Substantial Contributions

- WMM-SA
  - Developed a new protocol that fused reservation and CSMA protocols with a QoS overlay - provides a deterministic QoS mechanism in WiFi
  - Patented by AT&T, and then contributed the patent to IEEE 802.11, now part of the IEEE 802.11e QoS standard
  - With the increase in multimedia and voice use in carrier based WiFi environments, such QoS capabilities are becoming increasingly important
- Hotspot deployment and cellular/WiFi integration
  - Partnership developed with Wayport (later became part of AT&T)
  - Developed centralized control methodology to reduce cost and speed deployment
  - Developed integrated software client for laptops
  - Partnered with device manufacturers for integrated client in handhelds
  - Developed method of authentication for non-browser devices (cameras, Eye-Fi, etc.)
- Muni-WiFi (3 cities deployed)
- VoIP over WiFi deployment
- White spaces