



*Mobile Broadband. Everywhere.*

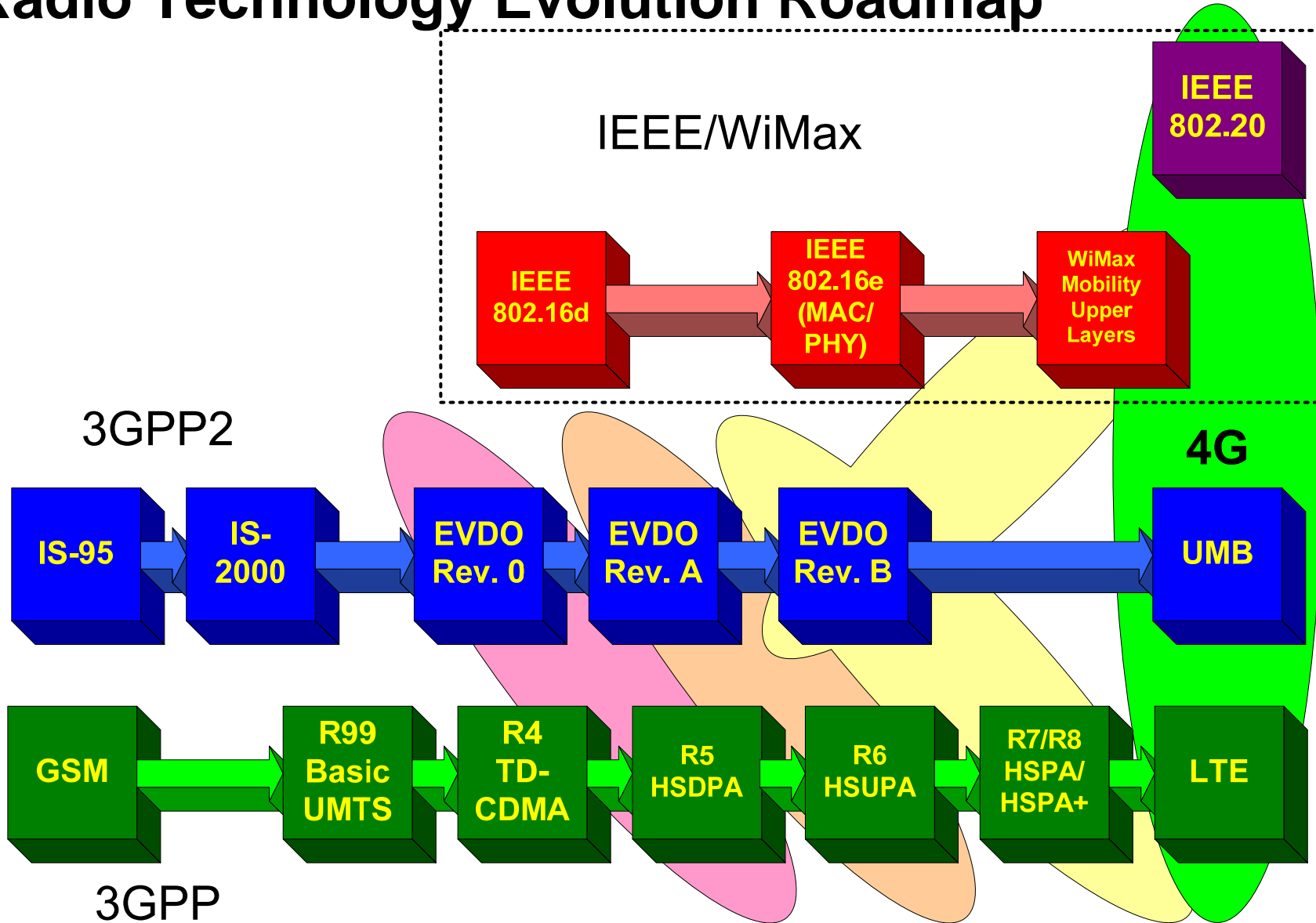
# Evolution toward 4G Mobile Wireless Networks

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# Outline

- 4G radio technology evolution roadmap
- Impact of 4G mobile broadband advances
  - End users
  - Enterprises
  - Wireless service providers
- Major trends in mobile broadband services
  - Fixed/Mobile convergence
  - New deployment models
  - Multi-mode (multi-radio technology) devices
  - Integration of services and applications
- Smooth evolution of All-IP applications and services from 3G to 4G

# Radio Technology Evolution Roadmap



Roughly Equal End User Experience

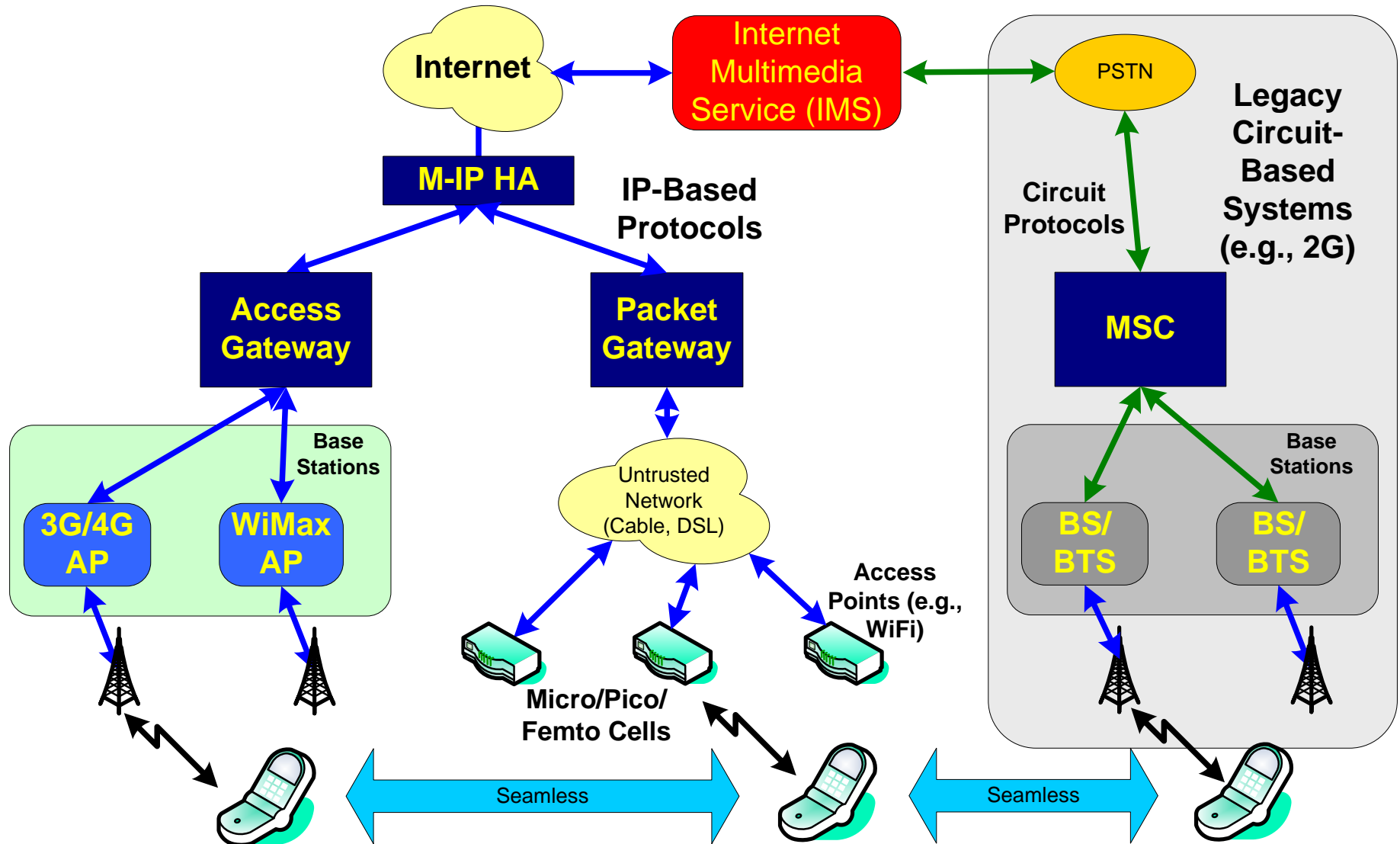
# Mobile Broadband Radio Technology Trends

- Rapid radio technology advances
  - OFDM
  - MIMO
  - Low-cost/low-power implementations of extremely complex radio designs
- Rich eco-system of radio technologies
  - Wide-area (macro) cellular systems
  - In-building micro/pico/femto cells for enhanced coverage
  - Fixed/Mobile Convergence (FMC)
  - 802.11x, WiMax, GSM/EDGE/UMTS, LTE, cdma2000 1xRTT/EV-DO/UMB, IMT-Advanced

# Results of Radio Technology Advances

- Greater need for seamless integration of many radio technologies
- Multi-mode (multiple radio technology) devices
  - Consistent services/experience to end user
  - Seamless handoff between technologies
- Common application service architecture
- Common evolved radio access network architecture for multiple technologies (for carriers/service providers)

# All-IP Mobile Wireless Broadband Networks



# 4G Builds on 3G Radio Access Technology Services and Capabilities

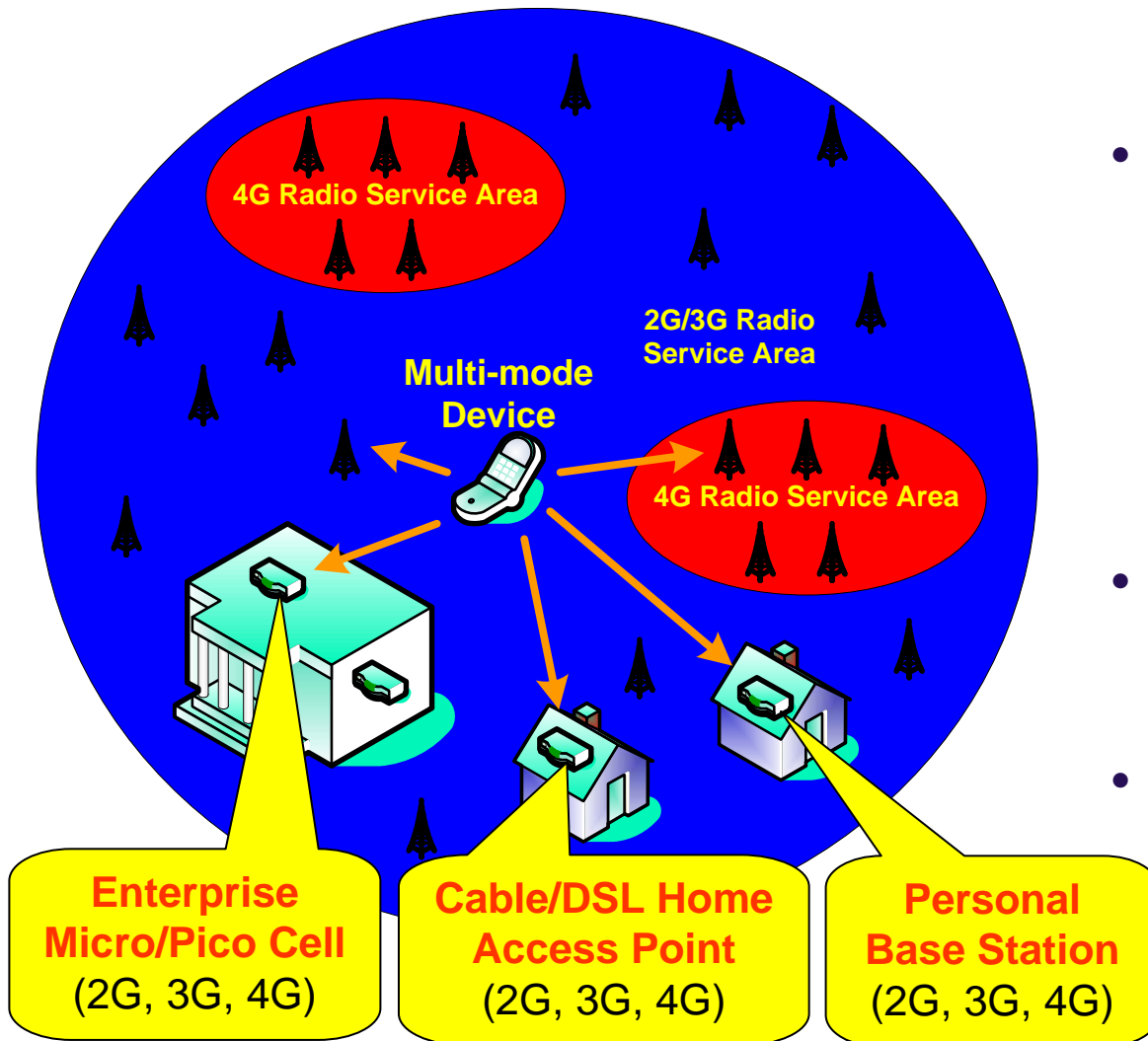
- All-IP services and radio access network implementations
- IP Multimedia Services (IMS)
  - VoIP and Push-to-Talk
  - Common service architecture for all fixed and radio technologies
  - SIP
- Multiple service support and QoS capabilities
- Mobility capabilities
  - Seamless handoff
  - Integrated roaming
- Security
- OA&M architectures

# 4G Differences vs. 3G

- Optimized for new spectrum allocations
  - 20 MHz+ blocks bandwidth
  - May be Time Division Duplexed (TDD) or Frequency Division Duplexed (FDD)
- Emphasis on advanced antenna technologies
  - Multiple transmit/received antennas (MIMO) in mobile and base station
  - Spatial Division Multiple Access (SDMA)
- Enhanced performance
  - Especially, very high peak data rates
  - Total capacity of system (from the wide bandwidth and antenna advances)

# Transition from 3G to 4G Radio Technologies

- Initial deployments will be in islands
  - Pragmatic limitations
  - Cost precludes 100% build-out
  - Radio technology churn
- Integration of access and service delivery
  - Legacy => 3G => 4G radio technologies
  - Seamless handoff
  - Common core network services (All-IP, IMS)
  - Multi-mode devices (multiple radios)
- Spectrum expansion
  - Can't displace legacy and 3G technologies
  - Wide bandwidth blocks
- 4G may require major upgrades to cell sites for advanced antenna technologies (e.g., MIMO)



# Long Term Benefits of 4G

- End users
  - Same rich multi-media services as 3G (VoIP, Push-to-Talk, Video Conferencing, On-Demand content access, etc.)
  - Smooth migration and continued ubiquitous service availability
  - Faster, richer experience
  - Ultimately, lower cost for better experience matching broadband expectations
- Enterprises
  - All-IP, multimedia services, securely delivered across all environments (fixed, 3G, 4G, etc.)
  - Ultimately, lower cost for an experience matching the Internet/Intranet experience with full mobility
- Service providers
  - Lower CAPEX/OPEX
  - Access to new, wide-bandwidth spectrum blocks to greatly enhance total capacity available

# Summary

- Mobile broadband wireless systems quickly maturing
  - VoIP, Multimedia Services (IMS)
  - SIP
  - QoS capabilities
- Applications and services work today
  - “3G” radio technologies (EV-DO, UMTS HSUPA, etc.)
- Key enablers for the success of mobile broadband services
  - All-IP services
  - Integrated services across all environments (fixed, mobile, all technologies)
  - Multi-mode devices
  - Seamless handoff of the link layer across radio technologies
- 4G technologies **will not**:
  - Fundamentally change the types of applications that can be supported vs. 3G
- 4G technologies **will**:
  - Enhance the peak data rates and total capacity using new, wideband (20 MHz+) spectrum
  - Enhance the ability to do more sophisticated radio deployments (OFDM, antenna technologies such as MIMO, etc.)
  - Improve the long term economics of ubiquitous mobile broadband internet service