

# Process, Promise, Problems: Developing WiMAX as an International Standard

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# Introduction

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- Standards participation is costly
  - money (time, labor, travel, and other resources)
  - risk (possible loss of intellectual property, paying for freeriders, etc)
- Worldwide Interoperability for Microwave Access (WiMAX)--IEEE 802.16x is a cooperative effort
  - International standards development organization (IEEE)
  - Government (NIST, US) *indirect*
  - Industry alliance (WiMAX Forum)

*Premise: this wide-based global cooperation enhanced the pace and value of WiMAX standards, their international acceptance, and the ecosystem of vendors and service providers of WiMAX products and technology, and the global market for these products and services.*



# Methodology

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- WiMAX selected for study following a survey of NIST labs for cases of high impact documentary standards with NIST involvement.
- Aim was not an economic analysis but a narrative of
  - overview of the development of the WiMAX standard
  - summary of benefits and costs to the stakeholders
  - market potential in WiMAX systems and components
  - social benefits of the technology
  - impact on innovation and competitiveness.
  - challenges
- Emphasis on the benefits of NIST participation
- Methods used:
  - Focused survey of ten active participants in the IEEE 802.16 community
  - Literature review of wireless technologies and related market assessments and forecasts, and
  - Data gathering from industry analyses, news reports and articles



# Study challenges and limitations

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- Too early in commercialization process to collect quantitative impact data
- No obvious methodology to utilize
- Survey size was limited by USG rules



# “WiFi on Steroids”

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- The quest—broadband, long-range wireless mobile technology would fuse cellular telephony with internet-protocol data devices and personal computers
- WiMAX is a revolutionary communications technology that makes any desktop computer application possible wirelessly, on the road, at broadband speeds.
- WiMAX is capable of mobile data rates several times faster than current third-generation (3G) cellular speeds.
- WiMAX has the potential to ultimately allow societies to become connected internally as well as globally (narrow the Digital Gap).

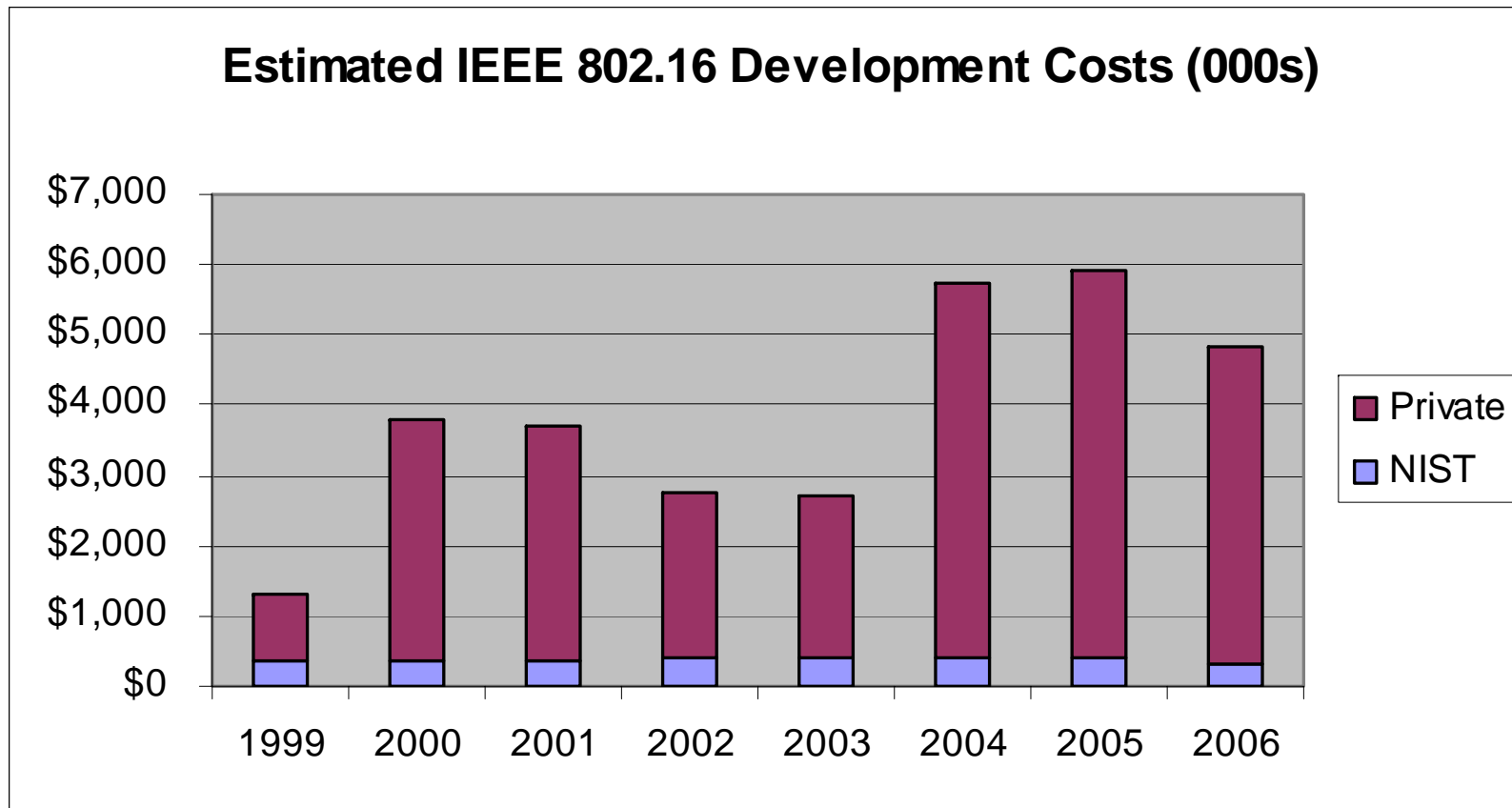


# WiMAX Development History

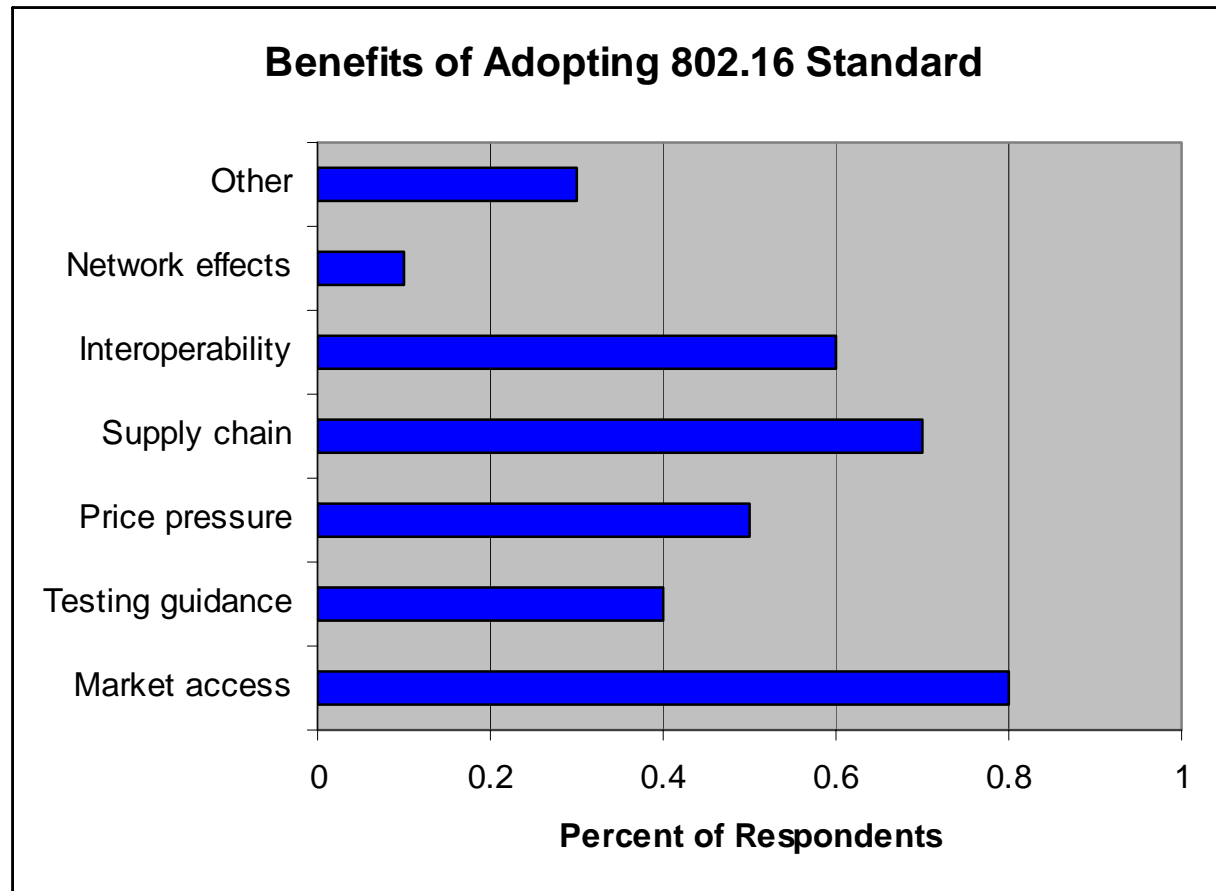
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- 1998
  - NIST interest in high-speed broadband wireless for fixed site users
  - IEEE launched 802 LAN/MAN (Local/Metropolitan Area Networks) Standards Committee.
- Within six months
  - 802.16 Working Group on Broadband Wireless Access
- 2001
  - WirelessMAN® air interface approved as IEEE Standard 802.16
  - Worldwide Interoperability for Microwave Access (WiMAX) Forum
- 2002
  - IEEE 802.16 Working Group (mobile applications)
- 2004
  - IEEE 802.16-2004 (fixed)
- 2005
  - IEEE 802.16e-2005 (mobile)
- 2007
  - WiMAX recognized by the ITU-R as an IMT-2000 technology in October

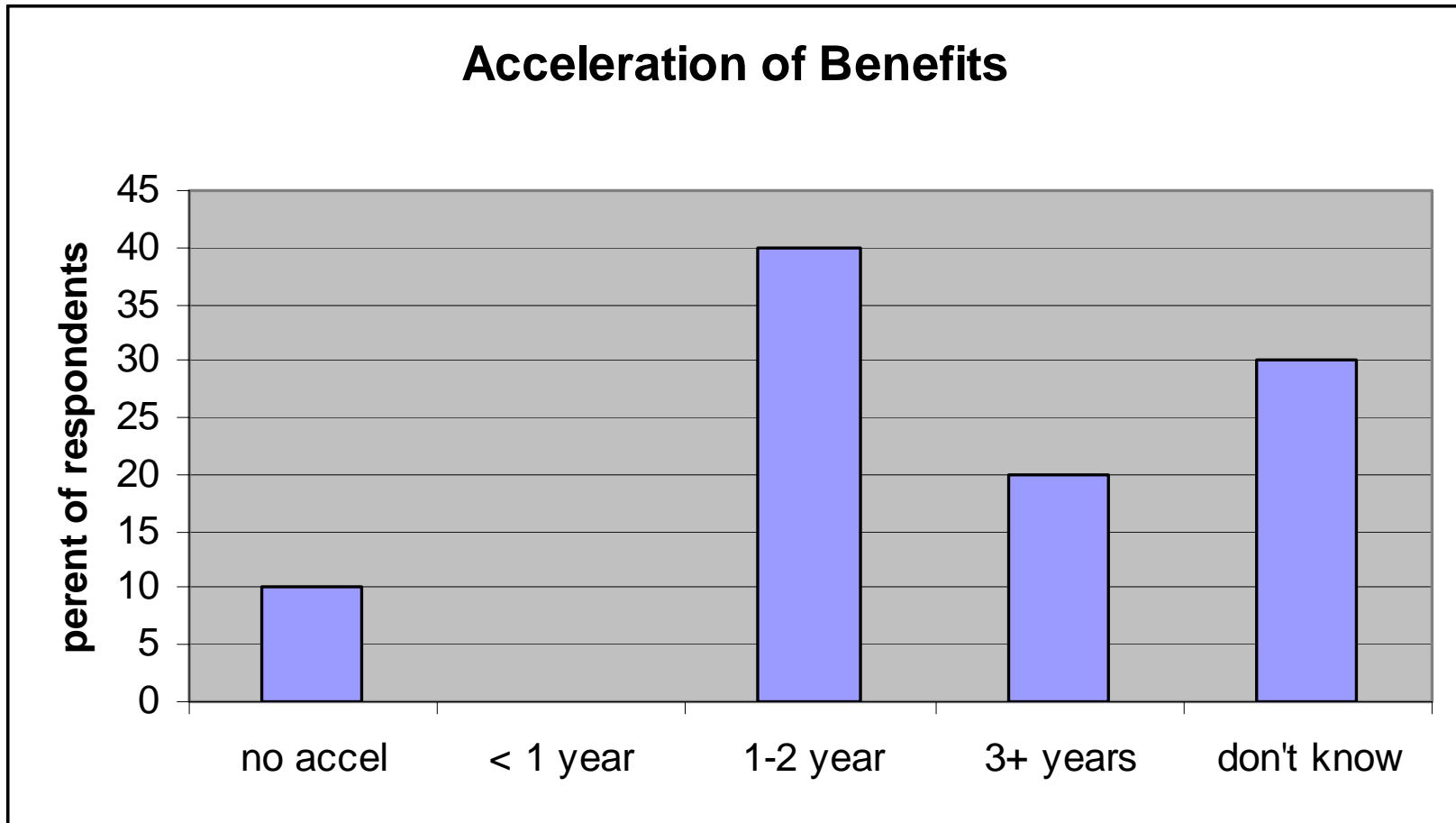
# IEEE 802.16 Development Costs



# Survey Results of the Benefits of Adopting the 802.16 Standard



## Estimated Acceleration of Benefits Due to 802.16



# Stakeholders Affected by Benefit/Cost Savings

Type of Benefit or Cost Saving	NTS Operators	Incumbes	Vendor	SDO's/S SO's	Government	Gov/Bus	Public
802.16 standards accelerates WIMAX development and adoption	√		√	√	√	√	√
Standards participation increases ROI	√		√				
Fixed WIMAX enables "last mile" connectivity and service	√	√			√	√	√
Fixed WIMAX is efficient in backhaul operations	√	√	√		√	√	√
Fixed WIMAX covers more area than WiFi at lower capital cost per user	√		√		√		
Mobile WIMAX enables efficient applications for SCADA, security, other municipal operations	√		√		√	√	
Mobile WIMAX integrates 3G/4G phone with high bandwidth data	√		√	√	√	√	√

# Stakeholders Affected by Benefit/Cost Savings

Type of Benefit or Cost Saving	Operators	Incumbent	Vendor	SDO's/SSO's	Government	Gov/Bus	Public
WIMAX systems increase competition and improve quality, availability, and affordability	√		√	√	√	√	√
Creative business models create stronger services (bundling)	√				√	√	√
Hybrid systems utilize legacy hardware, software	√	√	√				
Variety reduction leads to economies of scale	√		√				
Lower system integration costs due to content of standards	√		√	√	√		
Supplier alliances benefits small business	√		√				

# Stakeholders Affected by Costs and Risks

Type of Benefit or Cost Saving	Operators	Incumbents	Vendor	SDO's/SSO's	Government	Users--Gov/Bus	Users--Public
"Real world" effects restrict WIMAX potential (range, bandwidth, QoS)	√		√	√	√	√	√
Business models not tested; revenue, profit may not meet projections	√	√			√		
ARPU may not be sufficient for good ROI	√				√		
Chipset power consumption difficult to solve	√		√	√		√	√
Competition threatens operators of legacy systems	√	√		√	√		
Available spectra may be limited or costly	√	√			√		



# Social/Public Benefits

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- Reduced costs to governments and enterprises
  - surveillance, public safety, inventory and fleet tracking and management, and educational services, etc.
  - Case: Allegany County, Maryland, US
- Potential for reduced cost to residents/individuals through bundled high-speed internet voice and data services for multiple devices
- Narrowing the Digital Divide
  - US large urban/rural areas
  - Global connectivity



# Innovation and Competitiveness

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- Standards have dynamic impact on innovation (hamper, hinder)
- Survey respondents (8/10) report that 802.16 enhances innovation
- WiMAX ecosystem created with hundreds of manufacturers/vendors/service providers and new services



# Challenges

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- **Business Plans/Revenue Models**
  - US municipalities scaling back in wireless projects
  - Investors concerns about return on investment
- **Real-World Performance**
  - Range, speed up to promise?
- **Standards competition**
  - Path to 4G



# Conclusions 1

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- WiMAX developed via a fast hybrid process
  - Government, SDO, Industry as partners
  - Significant benefits as a result
- WiMAX impact already being felt world-wide
  - Ecosystem of devices, applications
  - Many regional and national networks operating or planned
- Potential for WiMAX as a transformational technology in mobile broadband, 4G—but challenges remain
- Economic impact analysis needs methods, data



# Conclusions 2

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- Standards partnership adds value
  - NIST participation viewed as significantly helpful
  - SDO participation pooled technical expertise
  - International participation (28 countries)
  - Consortium involvement for fast conformity/assessment
- Government participation is cost effective
  - NIST costs <10% of total standard development
  - Accelerated standard adoption increases ROI
- International standards competition should benefit 4G technology



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# Technology comparison; Wi-Fi and WiMAX

	Wi-Fi	WiMAX
Standard	IEEE 802.11b,g	IEEE 802.16_
Range	~300 m (PAN, LAN)	~50 km (MAN)
Modulation Scheme	DSSS with CCK, OFDM	OFDM
Rate	Up to 54 Mbps (2.4 GHz)	Up to 110 Mbps (3.5 GHz)
Spectrum	2.4 GHz (unlicensed)	2-66 GHz (licensed)
Security	Optional WEP, WPA, WPA2	Mandatory 3DES, AES