

FIXED AND MOBILE BROADBAND ACCESS TECHNOLOGIES

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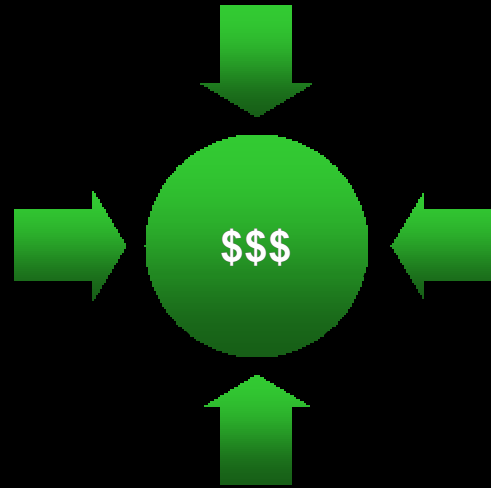
FOUR MAJOR FACTORS AFFECT BB PLATFORM ECONOMICS

Revenue-generating services

- Ability to share costs across multiple service offerings
 - Voice, Data, Video,
- Ability to reduce churn
- High market take-rate (penetration) to share fixed costs

Customer acquisition

- Customer equipment
 - Primary-line telephony, “Smart NID” or equivalent .
 - Digital video set-top boxes
- Customer installation
 - I/W Conect to “Smart NID”
 - Internet access connection of PCs or Home LAN
- Customer engineering
 - Wireless, RF engineering
 - Computer environment



Network access costs

- Installed first costs
- Costs per add
- ROWs and/or antennae sites
- Civil engineering & Construction
- Costs of concentration and backhaul
- Network engineering
- Network utilization

Operations, billing, and customer care systems

- Software support systems
- Modifications for new services/features
- Scalability

Technology is small and shrinking part of the cost.

THE FCC TECHNOLOGY COUNCIL IN 2002 ANALYZED THE STATE OF DEVELOPMENT OF VARIOUS BROADBAND PLATFORMS FOR THE *IN-HOME* CONSUMER MARKET

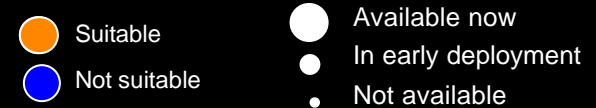


Suitable* ----- Available	Cable	DSL	VDSL or ADSL2**	FTTx	PLC	Satellite
Voice – primary line						
Voice – secondary line						
High- speed Internet						
Multi- channel video						

* Suitable refers to the technical and economic ability to deliver desired services competitively.

**Since the study was done increase in the reach of xDSL has improved the suitability.

LOW GHZ LICENSED AND UNLICENSED WIRELESS LOOKED MOST PROMISING TO COMPLEMENT CONVENTIONAL WIRED TECHNOLOGIES. ALL TECHNOLOGIES HAVE SINCE SHOWN CONTINUED IMPROVEMENT.



Suitable ----- Available	LMDS	Low GHZ licensed wireless	Un- licensed wireless	Stratos- pheric platforms	3G***
Voice – primary line					
Voice – secondary line					
High- speed Internet					
Multi- channel Video					

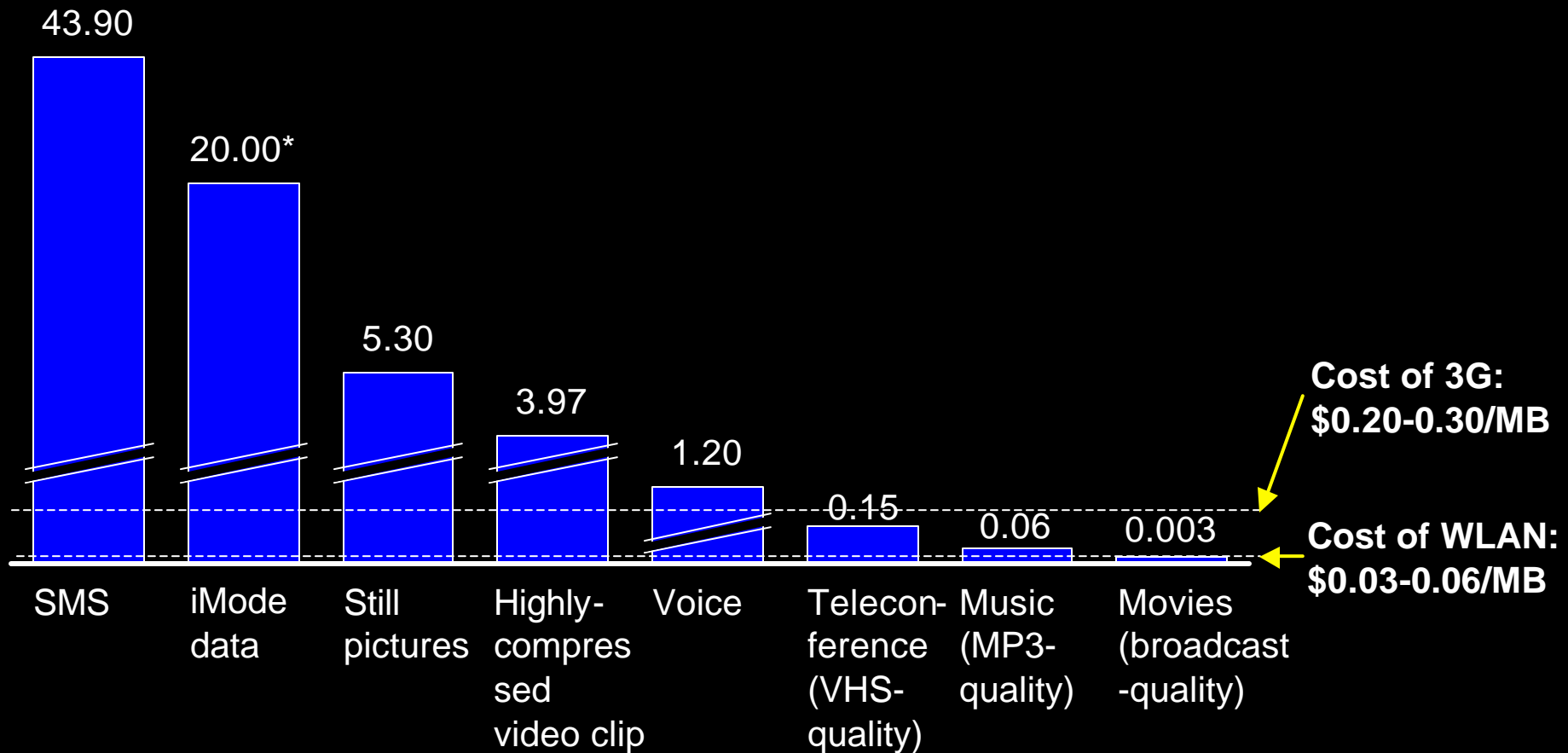
* Suitable refers to the technical and economic ability to deliver desired services competitively.

** Low GHZ refers to portable and fixed wireless systems using licensed frequency below 4 GHz (e.g. WiMax)

***Study addressed fixed broadband access to homes, not solutions for mobility.

WIFI IS FAR MORE COST EFFECTIVE THAN 3G IN HOT SPOTS BUT DOES NOT SUPPORT MOBILITY AND WIDE AREA NETWORKING...

Projected consumer willingness to pay
\$ per Mbyte



IDEAL DESIGN SPECS FOR A WIRELESS BROADBAND NETWORK

General requirements for WBB network

1. Support of apps with no change to apps, devices, protocols or content
2. High spectral efficiency with a high number of users
3. Ability to use existing IP standards-based architectures
4. Low latency (<50 ms) to support 2 interactive real time apps
5. Support of end-to-end QoS for tiered services for revenue maximization
6. Support of subscriber identification through standard IP policies
7. Toll quality voice and 'instant on' voice services
8. Native multi-cast for bandwidth efficiency and streaming applications
9. High end-to-end security



Additional requirements for mobile broadband

1. Predictable high capacity **mobile** QoS throughout a WAN serving area
2. Compatible with CPE (form factor, power requirements, . . .)

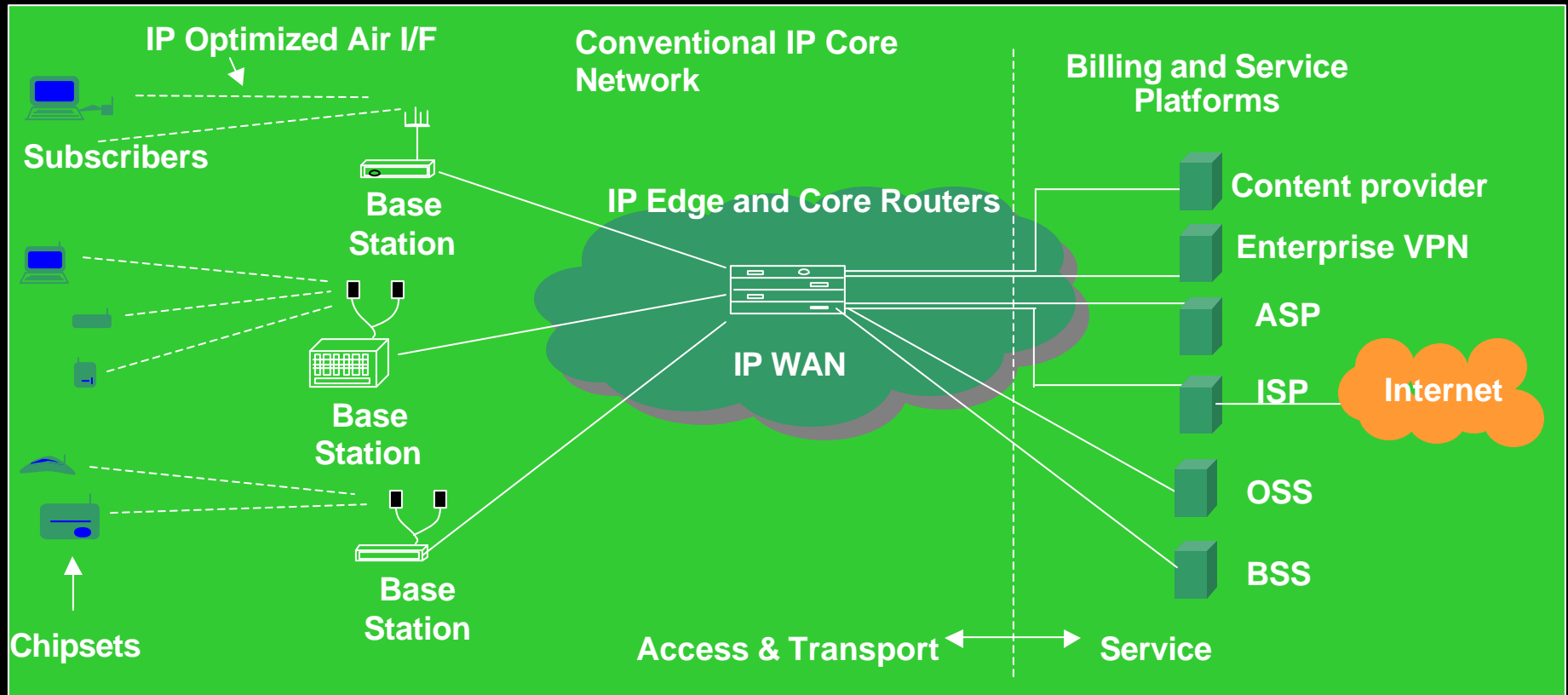


Additional requirements for fixed/nomadic wireless

1. Predictable high capacity QoS throughout a WAN serving area
2. Competitive with DSL and Cable in costs and performance

- New technologies are vying to meet these requirements but no technology currently provides an ideal solution
- WiFi today meets performance requirements but does not provide for mobility and wide area coverage
- Cellular data offers today provide mobility and ubiquity but not "Ethernet like" performance

THE EMERGING WIRELESS BB TECHNOLOGIES OFFER THE BENEFITS OF AN “IP FRIENDLY” ARCHITECTURE



Advantages

- Simple extension of IP networks - seamless internetworking
- Increased spectral efficiency
- Effective capex deployment
 - CPE and installation
 - Base stations and sites
 - Backhaul and core network

Key success factors

- Viable Business Case
- Market Traction
- Low enough upfront and variable capex

SUMMARY OF MAJOR WIRELESS BROADBAND TECHNOLOGIES

<u>Technology</u>	<u>Vendor Support</u>	<u>Service Providers</u>	<u>Uses & Market Position</u>
WCDMA HSDPA	<ul style="list-style-type: none"> • 3G UMTS Ecosystem 	<ul style="list-style-type: none"> • Vodafone • Cingular trial • NTT-DoCoMo • Many others planned 	<ul style="list-style-type: none"> • Wireless Data Applications • Planned evolution of WCDMA for • High speed down, limited uplink • Cellular WCDMA carriers
CDMA2000/ EVDO/EVDV	<ul style="list-style-type: none"> • Qualcomm Ecosystem 	<ul style="list-style-type: none"> • Verizon • KDDI • China Unicom • Many others planned 	<ul style="list-style-type: none"> • Wireless Data Applications • Planned evolution of CDMA 2000 • High speed down, limited uplink • Cellular CDMA 2000 carriers
UMTS/TDD	<ul style="list-style-type: none"> • IPWireless • UTStarcomm 	<ul style="list-style-type: none"> • Woosh (NZ) • PCCW (UK) • Airdata (Germany) ... 	<ul style="list-style-type: none"> • Wireless Data • VoIP (but QOS?), limited mobility • Primarily niche attackers
WiMax	<ul style="list-style-type: none"> • Intel and Wimax Forum 	<ul style="list-style-type: none"> • KD (pre WiMax) • BT Trial • FT Trial • Others planned 	<ul style="list-style-type: none"> • Wireless IP – voice and data • DSL alternative initially • Future Mobility (different platform?) • Fixed line players needing mobility
WiFi Mesh	<ul style="list-style-type: none"> • Tropos • Mesh Networks • Nortel • Cisco 	<ul style="list-style-type: none"> • City of Chasqua, MN • Q-Wqre, Taipei • Philadelphia • Others 	<ul style="list-style-type: none"> • Wide area WiFi (Internet access) • VoIP in future; nomadic • Exploit WiFi client installed base • Partnerships with municipalities
FLASH-OFDM	<ul style="list-style-type: none"> • FLASH OFDM • Siemens 	<ul style="list-style-type: none"> • Nextel (Raleigh) • T-Mobile (Holland) • Telstra (Australia) • Vodafone Japan 	<ul style="list-style-type: none"> • Wireless IP – voice and data • High performance IP complement for cellular operators

3G DEPLOYMENT HAS STARTED AROUND THE WORLD. AND MANY OPERATORS ARE ALSO TESTING NEW NETWORK TECHNOLOGIES (EXAMPLES – NOT EXHAUSTIVE)

Transmission Technology

Europe

North America

Asia Pacific

UMTS-TDD



Flash-OFDM



WiMax (IEEE 802.16, 802.16a, 802.16e)



MCSB



i-Burst



WiFi Timeline Indicates Substantive Deployment Took >5 Yrs; Cellular, DSL, Cable Modem Followed Similar Time Lines

WiFi Development

1995–2000

2000

2002

2005

1. Orientation phase;
Competing standards

2. Driving standardization

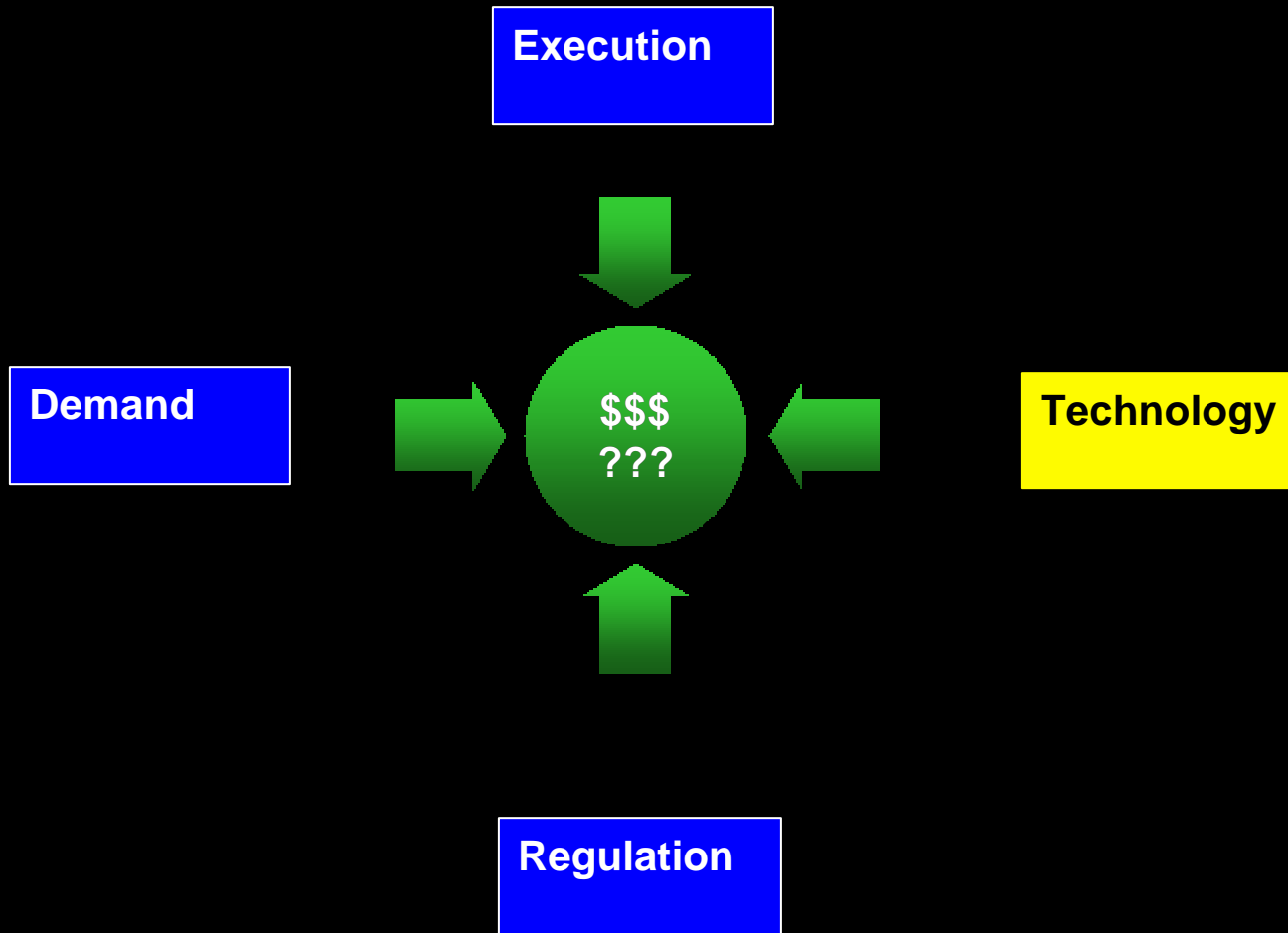
3. Building ecosystem

- Bell Labs and other develop early WLANs (Orinoo)
- WiFi 802.11 standard released 1997 by IEEE, Lucent and 3Com first vendors to support WiFi standard with chipset
- Major vendors found specification lacking
- Home RF group founded 03/98 to promote SWAP (Shared Wireless Access Protocol) with major players like HP, IBM, Microsoft, Motorola, Intel
- WiFi Alliance founded in fall 1999 to promote certification and interoperability

- Major vendors promote WiFi (e.g., Intel sponsors 802.11 via Developer Conference in 08/2000)
- Standard chipsets readily available
- Test scripts developed and agreed upon
- Certification lab operations
- Product certification begins in earnest.
- Interoperability demonstrations

- WiFi deployment takes off
- WiFi PC/MIA cards readily available
- Many vendors of WiFi base stations
- European regulators changes rules to allow commercial deployment of WiFi networks
- WiFi enterprise and home networks deployed
- WiFi Hot Spots spread
- Intel builds WiFi into Centrino platform

TECHNICAL RISK IS ONE OF FOUR MAJOR UNCERTAINTIES AFFECTING INDUSTRY OUTLOOK



SUBSTANTIVE TECHNICAL BARRIERS MUST BE HURDLED FOR BROADBAND WIRELESS TECHNOLOGIES TO TAKE OFF

Description

Potential impact

Coverage Coverage Coverage

- Ability to adequately cover footprint in real world of foliage, roof clutter, etc. unknown
- 80% of capex may be needed to get last 20% of coverage

- Increased capex
- Increased cost of customer qualification and acquisition
- Decreased Market Share

Inside/outside

- Ability or not of signal to penetrate buildings possibly necessitating outside antennae and connection to inside wiring

- Increased costs of customer equipment
- Increased costs of customer provisioning (truck rolls)

Client costs

- Cost of client H/W and S/W in client system
- Costs of connecting to customer's devices (PC or LAN, telephone inside wiring)

- Increased cost of customer equipment until volume achieved

Vendor support

- Ability of vendor to support large scale deployment, systems integration, operation systems support

- Inability to get needed systems integration and installation and operations systems support

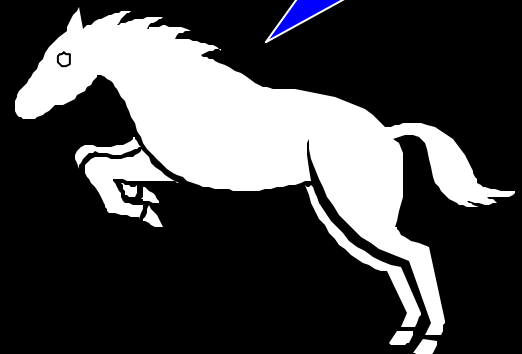
Spectrum

- Ability to acquire adequate spectrum at right frequency, right type (TDD or FDD), and right amount for cost effective deployment

- Cost of acquiring spectrum
- Time to market delay

*For technologies that make it in the market,
engineers are always overly optimistic on
how successful they will be w/in 2 years
and
always underestimate the impact of their
successes (< 1 in 5) over a decade!!!*

Thanks !



Is there is a Pony in
there somewhere!