

Wireless Broadband Internet

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Outline: Wireless Broadband Futures

- ❑ Wireless Broadband Internet
- ❑ 3G *and* WiFi: Complements & Substitutes
- ❑ WiFi business models
- ~~❑ Regulatory Policy Issues~~

"Wireless Internet Access: 3G vs. WiFi?," with Lee McKnight

"Software Radio: Implications for Wireless Services, Industry Structure, and Public Policy," with Sharon Gillett and Fuencisla Merino

<http://itc.mit.edu>

Wireless Broadband Internet Future

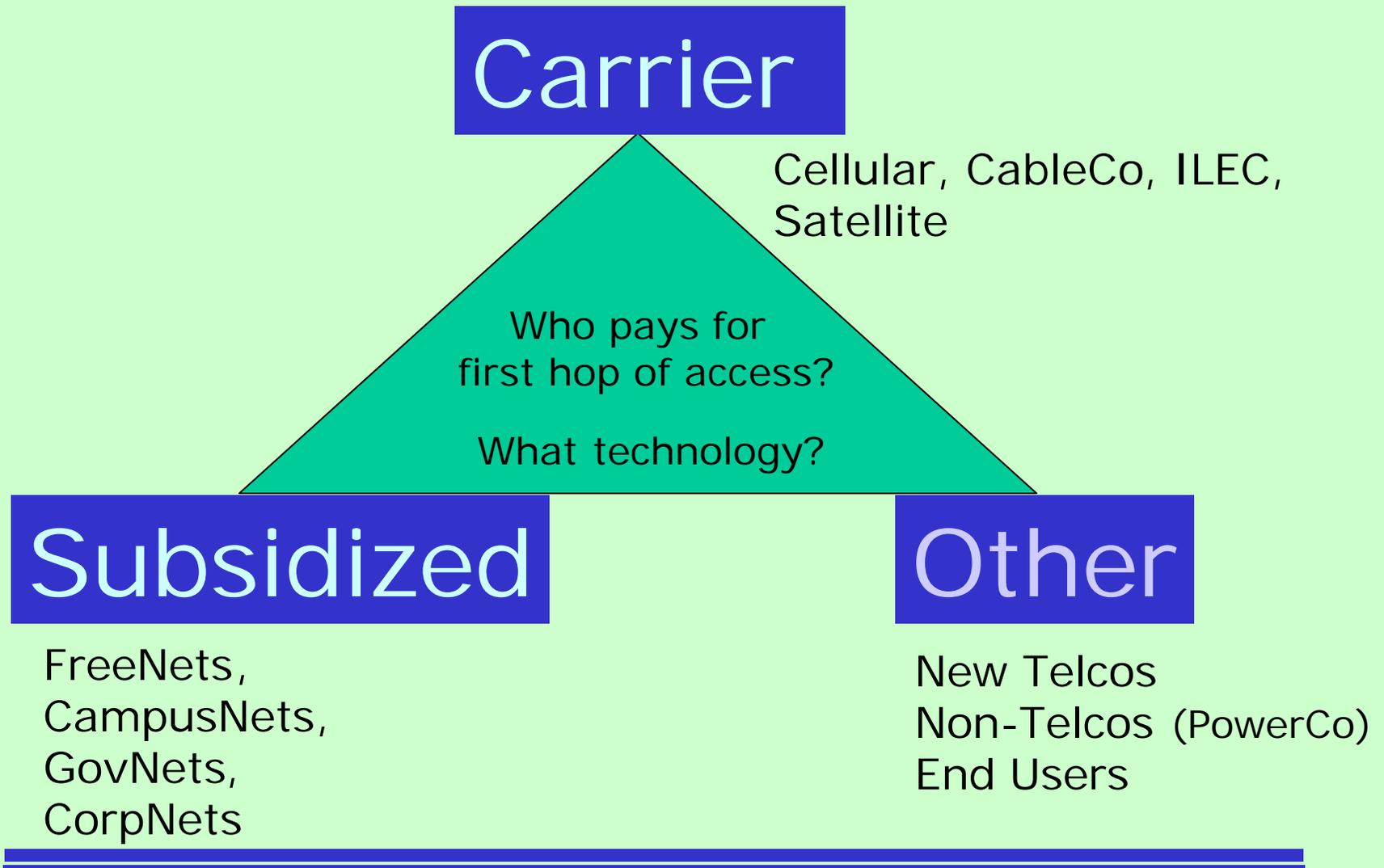
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Vision of Future

- Ubiquitous/pervasive computing
 - Chips in everything → unaware, automatic
 - Networked → wireless
- Wireless/wireline integration
 - Always on, anywhere accessible multimedia applications

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- Heterogeneous technology environment
 - Lots of wireless technology/networks
 - Continuing innovation & overlapping legacy networks
 - Interoperability/interfaces focus, not uniform standardization
 - Multiprotocol support necessary (e.g., SDR)
- Complex industry environment
 - Mix of firm types, dynamic competitive environment
 - Convergence, liberalization, competition, & globalization

Who will build the wireless infrastructure?

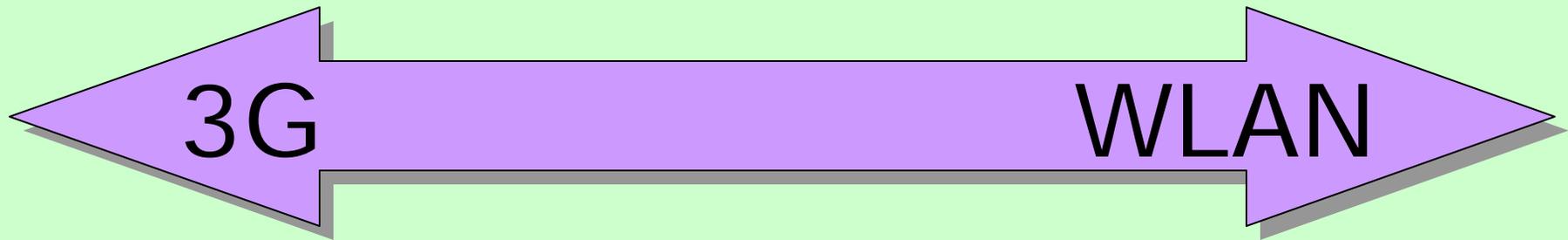


Lots of Wireless Technology

- All along the RF spectrum
 - Microwave
 - Satellite (geosync, LEO)
 - MMDS, LMDS
 - Cellular 3G
 - WLANs (*e.g.*, WiFi)
 - Free Space Optics, UWB, etc.
- Lots of complementary technology
 - Smart antennas, software radio, multi-user information theory, ad hoc networking, etc.
- Licensed and Unlicensed (shared) spectrum use models

focus on these two
to highlight implications
for industry structure

Wireless Industry structure?



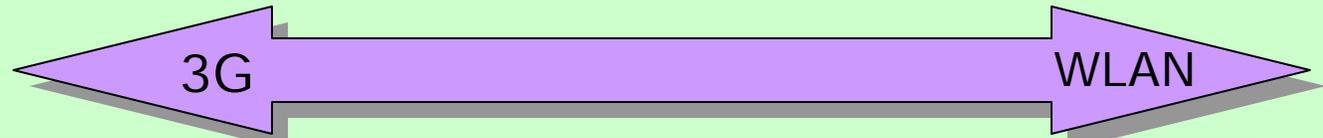
- ❑ Traditional Carrier Model
- ❑ Top Down
- ❑ Vertically Integrated
- ❑ Centralized Control

Service Provider Model
Network-centric
(Bell system redux?)

- ❑ Accommodates Alternative Players
- ❑ Bottom Up
- ❑ Less Vertically Integrated
- ❑ Distributed Control

End-user Equipment Model
Edge-centric
(Internet vision)

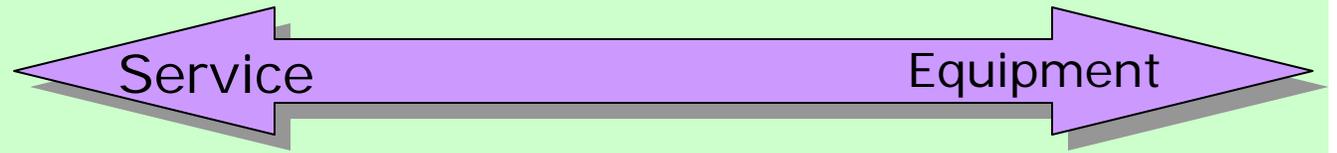
Substitutes or Complements? WLANs Disruptive technology?



Technology	UMTS, CDMA-2000, etc.	WiFi (802.11b), etc.
Bandwidth	Low (~100s Kbps)	High (~10s Mbps)
Coverage	Ubiquitous (Km)	Local (100m)
Deploy Cost	High (~\$50k)	Low (~\$1k)
Spectrum	Licensed	Unlicensed
Services	Voice adding data	Data adding voice
Retail infrastructure	Yes, service model in place	No, need to add

3G status: most carriers implementing 2.5G with plans for 3G

WiFi: rapid growth, still small installed base; Competitive value chain



Example?	Telecom Services	Computer
Business model?	<i>Invest in capacity and lease access to consumers for monthly subscription service</i>	<i>Sell boxes to consumers who replace when become obsolete</i>
Where's network intelligence?	Network	Edge devices
Where's network CAPEX?	Service provider	End-user
Innovation adoption process?	Centralized	Decentralized
Who controls services?	Service provider	Customers
Regulatory?	Utility regulation	Unregulated, Certification, Industry Standards

— Different industry economics, institutional/regulatory history

3G v. WiFi?

- Complements, yes
 - 3G/WiFi integration
 - Hotspots for value-added services (multimedia)
 - Easier migration to 3G (GPRS+WLAN instead of W-CDMA)
 - Spectrum efficiency/re-use (e.g., within buildings)
 - Wireline/Wireless integration
 - Alternative technologies for last hop access

- Substitutes, yes
 - Last mile competition? (3G instead of DSL)
 - Wireline entry into wireless? (ILEC or overbuilder using WiFi)
 - Equipment replaces service provider bus model?
 - Is future of ICT more like computer industry or like telecom?

WiFi Business Models

- ❑ Enterprise and Home WLANs
- ❑ Community Nets (Freenets, CampusNets, GovNets, MuniNets)

Equipment

-
- ❑ Cellular/WLAN integration
 - “Raisins in the muffin”
 - Extend coverage/capacity (within buildings)
 - ❑ PWLAN Service Providers (Boingo, Wayport)
 - Aggregators (Boingo) “\$895 hot spot in a box”
 - Hot spot providers
 - ❑ Wireline broadband extension
 - ILEC entry into wireless? (Residential resale of wireless)
 - Wireless Fixed Local Loop
 - ❑ Wireless ISPs for rural/suburban areas

Service provider

Cellular/WLAN integration

It's happening...

- ❑ Avaya/Proxim/Motorola: WiFi/Cellular roaming
- ❑ Nokia: WiFi/GPRS integration
- ❑ Cometa Networks: JV of AT&T, IBM, Intel to provide wholesale wireless broadband
- ❑ T-Mobile: Starbucks, etc. hotspot services
- ❑ Nextel: iDEN and private WiFi for customers
- ❑ Verizon & Sprint focus on 1XRTT for now
- ❑ Lots of others: VoIP integration, security, Wireless IP switching, etc.

Drivers...

- ❑ Different technologies to fill product space
 - Ubiquity: 3G (or, 2.5G)
 - Bandwidth: WiFi Hot Spots
- ❑ Cellular provider advantage
 - Already have retail/service model
 - Drive to bundle services, increase ARPU
 - If not, risk of cannibalization

Impact WiFi on Wireline Providers (no resale)

- Home WLAN complementary good to wireline broadband.
 - Increase demand for wireline BB (sell more? raise price?)
 - Operating cost impact?
 - Transport costs/congestion increase
 - Customer service costs increase
- WiFi for wireless fixed loop
 - Share/extend wireline DSL
 - Differentiated service: lower price (quality) for shared fixed access
 - Platform for mobile entry by wireline (competition with cellular?)
- WiFi by competitor is substitute to wireline broadband
 - Cellular, new carrier, or end-users
 - Best defense may be strong offense

Impact WiFi on Wireline Providers (w/ resale)

□ Revenue up/down?

- No revenue sharing (“Freenets”) → theft of service
 - (But may educate customers about BB)
- Revenue sharing
 - Cannibalization of existing wireline or incremental subscribers?
 - Incremental roaming customer demand
 - (What is sharing model? How is billing/metering managed?)

□ Costs up/down?

- Equipment costs: customer pays for WiFi
- Traffic costs: usage up per fixed line
- Customer service costs: who responsible for?

□ Strategic implications for carrier of encouraging WiFi

- Does wireline want to compete with cellular?
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Impact of WiFi-like Technologies

- ❑ Broadband penetration enhanced
- ❑ Expanded service options: unlock potential of Internet
- ❑ Increased broadband and/or wireless competition
 - Lower entry barriers
 - More technology options
 - Facilitate new business models/architectures
 - CommunityNets (end-user subsidized)
 - NextGen Wireless Carriers, Wireless/wireline convergence & competition
 - Ad hoc network alternatives, etc.
 - Equipment, not service
 - Viral growth
 - Convergence

Slides Not Used

Back-up

Regulatory Policy and Wireless

1. Spectrum policy
2. Universal service
3. Competition Policy
4. Infrastructure/Technology Policy
5. Everything else: Privacy, Security, etc.

Spectrum Policy

- Allocate additional spectrum for commercial applications
 - Licensed & Unlicensed
 - Auctions, but not as general revenue tax
- Focus on market-based spectrum allocation/assignment
 - Flexible licensing rules: let private sector choose how to use spectrum and when to redeploy to other uses
 - Allow overlay and underlay (*e.g.*, UWB) rights
 - Allow market trading of rights
- Reform certification rules to allow spectrum agile devices and smart wireless devices

Universal service

- ❑ Wireless extends options for coverage
 - WISPs for low-cost rural/urban access
- ❑ Wireless Broadband redefines
 - Who should contribute?
 - What services should be eligible?
 - Who/what should be subsidized?
- ❑ Not just a wireless issue, but *Digital Divide* more generally.

Competition Policy

- ❑ Facilitate/encourage local WiFi networking...
 - CampusNets, GovNets, CommunityNets, BusNets, etc.
 - Local econ development/community building initiatives
 - How? Info sharing & technical assistance, promote interconnection, demand aggregation for backhaul costs, financing, etc.
- ❑ Local Service Providers licensed/allowed
 - Building, Campus, Community
- ❑ Impact on wireline/mobile carriers?
 - Expanded WiFi expands market/demand
 - Increased competition facilitates deregulation
 - Public investment should not crowd out private

Infrastructure/Technology Policy

- Support international/industry standardization
 - Avoid dictating technology choices
- Streamlined equipment certification rules
 - Mirror international rules for scope/scale economies
- Wireless-network friendly zoning
 - Antenna siting (*e.g.*, access to roofs, rules for sharing power/wireline outside structure, etc.)
 - Line-of-sight & rights-of-way access protection

Everything else: Privacy, Security, etc.

- Privacy and Consumer Protection
 - Location aware wireless services pose new threats
- Security
 - Emergency services (location rules?)
 - Primary phone service (power required?)
- mCommerce Business Rules and Regulation
- etc.

Status 3G

- Cellular upgrading networks to add data services
 - 2.5G (GPRS/1XRTT) → 30-130kbps, not 2Mbps of 3G
 - MB/Message pricing → value-added service
 - Coverage still being expanded

	2G	2.5G	3G
AT&T	TDMA	GSM/GPRS/EDGE	W-CDMA
Cingular	TDMA/GSM	GSM/GPRS/EDGE	W-CDMA
Nextel	iDEN	advanced iDEN	
Sprint	CDMA	cdma 1XRTT	cdma2000
T-Mobile	GSM	GPRS	W-CDMA
Verizon	CDMA	cdma 1XRTT	cdma2000

Status of WiFi: leading WLAN technology

WiFi Sales	2000	2001	2002e
Shipments – Home use	0.4	2.6	5.2
Shipments – Business use	2.6	7.0	10.8
Sales	\$0.8B	\$1.8B	\$2.0B

Growth rapid,
still small

Source: Cahners In-Stat, June 2002

Wireless Ethernet Compatibility Alliance (WECA) estimates \$5B by 2005

WiFi Value Chain: Globally competitive → rapid price declines...

Chips	Intel, Agere, Philips, TI, Atheros, etc.
Equipment	IBM, Proxim, Dell, Motorola, etc.
Software	Microsoft, VeriSign, TeleSym, etc.
Service Providers	T-Mobile, British Telecom, Wayport, Boingo, Cingular

Need Multiple Wireless Networks

- Bandwidth
 - Control: <10Kbps (monitoring, signaling)
 - Real-time communications: < 100Kbps (telephone)
 - Broadband: 10-100S Mbps (streaming video)
- Distance
 - Pico (digital jewelry)
 - LAN
 - WAN

WiFi Challenges

- Standardization: 802.11b, a, g, ...
 - Need multi-mode chipsets for compatibility. (802.11a/b soon.)
- Other technologies
 - UWB, 3G, Bluetooth, ?? ... WLAN only one approach
 - Power requirements (Battery)... general wireless BB problem
- CAPEX to fund build-out. (only 8k hotspots today)
- Second mile costs (WiFi connects to wireline)
- Software -- middleware and application support
 - Security ... not a WLAN-unique problem
 - Mobility & network management (*e.g., Roaming*)
 - QoS
 - Service provisioning (authentication, billing)
- Spectrum policy: Licensed vs. Unlicensed, Congestion management