Presentation Outline

- Historical Overview
- Radio Fundamentals
- **US Developments in PCS**
- Mobile Data
- Satellite Systems
- Problems with existing schemes
- Wireless Overlay Networks
- US Government Research Initiatives

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The Vision

"People and their machine should be able to access information and communicate with each other easily and securely, in any medium or combination of media—voice, data, image, video, or multimedia—*any time*, *anywhere*, in a timely, cost-effective way"

Dr. George H. Heilmeier
IEEE Communication Mag.
October 1992

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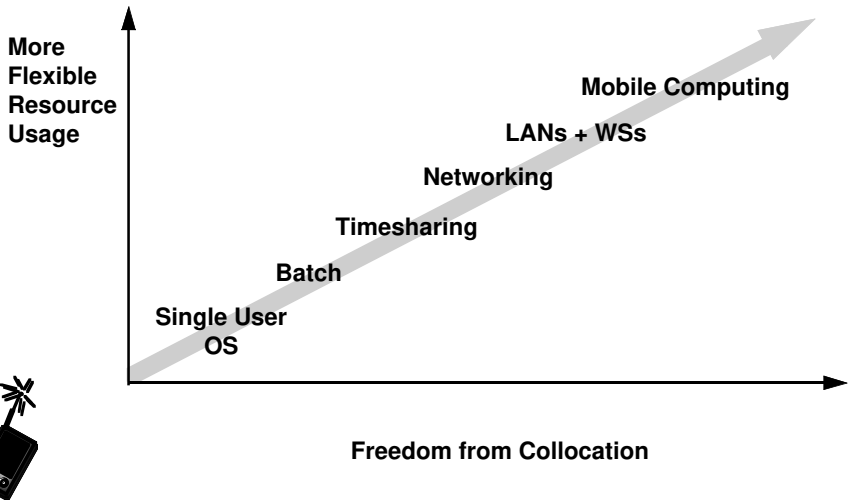
The Vision

“It is dangerous to put limits on wireless.”
Guglielmo Marconi (1932)

Natural Evolution of Computing



Presentation Outline

- Background and Motivation
- **Wireless Communications and the NII**
- Technology Overview
- Policy Issues
- Research Issues
- Research Projects

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National Information Infrastructure

"Hundreds of different networks, run by different companies and using different technologies, all connected together in a giant 'network of networks,' providing telephone and interactive digital video to almost every American."

– **Vice President Al Gore, Jr.**
Address to the ITU, 21 March 1994

"The NII will provide all Americans with the information they need, *when they need it* and *where they need it*, at an affordable cost."

– **Dr. Jack Gibbons, Presidential Science Advisor**
ARPA HPCC Symposium, 15 March 1994

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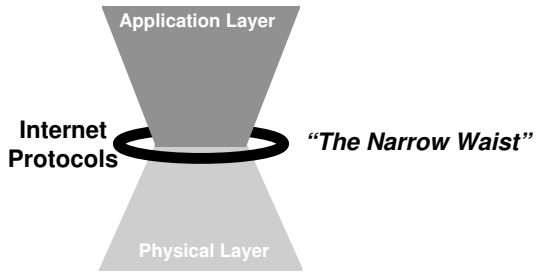
National Information Infrastructure

"What is the Internet?"

"It is the TCP/IP protocol specification."

Interoperability is the key to the information infrastructure



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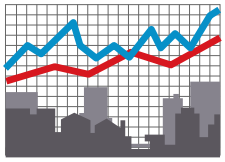
Global Information Infrastructure

"I ask you, the delegates to this conference, to set an ambitious agenda that will help all governments, in their own sovereign nations and in international cooperation to build this Global Information Infrastructure."

– **VP Gore's Address to the ITU, 21 Mar 1994**

Wireless technologies will play a major role in the developing world -- a mission and a market opportunity



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Gore's Five Principles for the NII

- **Encourage private-sector investment**
- **Promote competition**
- **Create a flexible regulatory environment that can keep pace with rapid technological and market changes**
- **Provide open access to the network for all information providers**
- **Ensure universal service**

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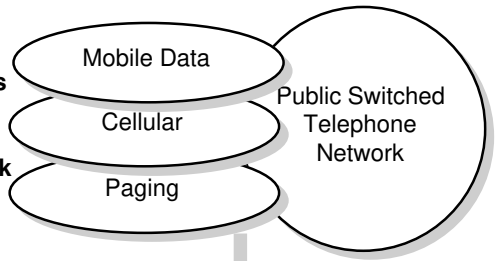
Grand Unification?

Today:
Overlay Networks with limited connectivity thru telephone network



Future:

Universal Mobile Telecommunications Systems (UMTS)
European RACE program: Pan-European Standards
Low cost pocket communicator for speech & medium data services
at home, office, and outdoors

Future Public-Land-Mobile Telecommunications Systems (FPLMTS)
CCIR: World-Wide Standards

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Beyond Voice: Wireless Applications

Besides 20,000,000 cellular telephone users …

- **Public safety, law enforcement, emergency medical teams, disaster response, military ops**
- **Intelligent Vehicle Highway Systems, transportation, mapping, location finding**
- **Smart buildings: people and item tracking, energy management**
- **Where tethering is too restrictive, e.g., repair in hostile, hard to reach places**

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Proposed Cellular Standards

Parameter	AMPS	IS-54	GSM	QCDMA	RCDMA
Proposer	Current Standard	Interum Digital	Euro Standard	Qualcomm	Rockwell
Radio Access Method	FDMA	TDMA/ FDMA	TDMA/ FDMA	CDMA/ FDMA	CDMA
RF Channel Size	30 Khz	30 Khz	200 Khz	1.25 Mhz	40 Mhz
Channel Rate	—	48 Kbps	271 Kbps	10, 32 Kbps	20-40 Kbps
Voice Channels per RF Channel	1	3	8	20-60 per sector	126
Duplex Voice Channel Size	60 Khz	20 Khz	50 Khz	—	—
Voice Bit Rate	—	8 Kbps	13 Kbps	8-32 Kbps	16 Kbps
Handset Xmit Pwr mW max/avg	600 600	3000 200	1000 125	200 6	100 1
Max Cell Radius	> 32 Km	> 32 Km	32 Km	2.5 Km	450 m

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Proposed Cellular Standards

Parameter	CT	CT2Plu	UD-PCS	DECT
Proposer	Current Cordless	Cordless 2nd Gen	Bellcore	Ericsson 3rd Gen, In building
Radio Access Method	N-FM	TDMA/ FDMA	TDMA/ FDMA	TDMA/ FDMA
RF Channel Size	20 Khz	100 Khz	700 Khz	1.7 Mhz
Channel Rate	—	72 Kbps	514 Kbps	1.1 Mbps
Voice Channels per RF Channel	1	1	10	12
Duplex Voice Channel Size	40 Khz	100 Khz	70 Khz	144 Khz
Voice Bit Rate	—	32 Kbps	32 Kbps	32 Kbps
Handset Xmit Pwr mW max/avg	< 10	10 5	100 10	250 10
Max Cell Radius	100 m	100 m	500 m	500 m

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PCS Proposals

Proposal	Mobility	Supporters
CDMA (IS-95)	High	Qualcomm, AT&T, Motorola, ALPS, GSIC, Samsung, Sony, US West, Sprint Bell Atlantic, Time Warner
DCS1800	High	Pac Bell, Nokia, MCI, Siemens, Kycom
IS-54	High	AT&T, McCaw
Omnipoint	High/Low	Omnipoint, Rockwell
WACS	Low	Bellcore, Motorola, Panasonic, US West, Sprint, Bell Atlantic, Time Warner
DECT	Low	Ericsson
PHP	Low	NEC, Panasonic, Hitachi, Toshiba, PCSI
5 MHz CDMA	Low	Interdigital, Oki

- Standards bodies currently favoring WACS and CDMA
- But pressure for worldwide interconnectivity - 87 operators provide 51 countries with GSM
- DECT/GSM interconnectivity being studied in Europe
- Desire for products that work in licensed and unlicensed bands

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Latest Developments in PCS

- March 1995 A and B auctions
- Three major players
  - PCS PrimeCo
    - » AirTouch, US West, Bell Atlantic, NYNEX Mobile
    - » Qualcomm CDMA chosen as the technology
  - Sprint Telecommunications Venture (STV)
    - » CDMA technology chosen
    - » Vendors may include Qualcomm,. NorTel, Motorola, AT&T
  - AT&T Wireless
    - » Digital TDMA most likely technology choice
- Other players
  - PacBell, Bell South have chosen GSM technology

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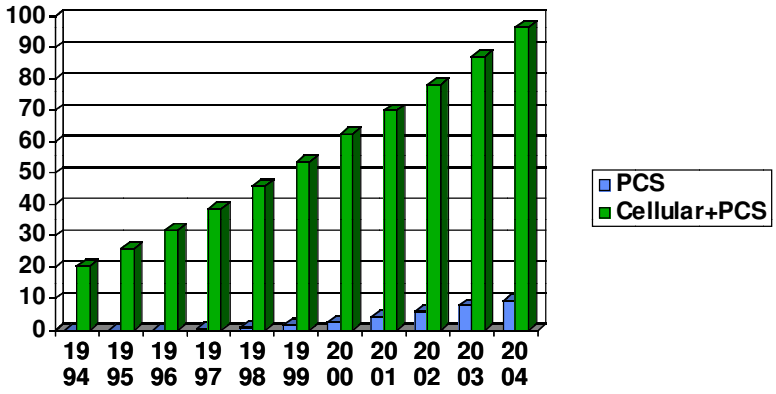
Yankee Group Forecast



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