

# Wireless or Radio, Fixed or Mobile: Some Observations

Donald C. Cox

Harald Trap Friis Professor of Engineering  
Stanford University

# Early Wireless was Spark Telegraphy

Spark:

- A form of Spread Spectrum (CDMA)
- BUT, the receiver did NOT have the despreading code!

# Wireless in Early Days (turn of century +)

- Covered long distances and over difficult terrain
- Fixed:
  - Trans oceanic
  - Trans continental
- Mobile:
  - Ship to ship
  - Ship to shore
- Early Fixed Wireless Telegraphy
  - was replaced with copper wire
- Early Mobile Wireless Telegraphy
  - moved higher in frequency

## Early to Mid Century

- Wireless became an Antique word
- Wireless became known as RADIO and later Microwaves
- Radio advances transmitted Audio and later Video

## Radio Uses Included:

- Broadcast
  - AM, FM and later TV
  - Both to Fixed and Mobile
- Radio Communications
  - Mobile “Two Way” to cars, ships and airplanes
  - Still some fixed long distances over difficult terrain (HF and later “Tropo Scatter”)
- “High” Bandwidth Transmission
  - Point-to-point microwave “relay”
  - Satellite “relay” (later)

## 1970s and 1980s

- Economical “High” Bandwidth “Wire” Transmission Technologies Appeared
  - Coaxial Cable
  - Glass Fiber
- Demand for Transmission Bandwidth Soared
  - Long Distance Telephony proliferated
  - Video Networks proliferated
- “High” Bandwidth Radio was Expensive
  - Limited spectrum availability required sophisticated (expensive) technology

# Disaster Struck Radio in the U.S. in Early to Mid 1980s

- Fixed Radio Transmission Technologies were Replaced Rapidly by “Wire” Technologies
  - Trans oceanic radio → Glass fiber (HF and Satellite)
  - Trans continental radio → Glass fiber (Microwave point-to-point & Satellite)
  - Broadcast TV → Cable TV and videotape
  - Broadcast Radio → tape
- Fiber was for Everything
  - Fiber to the  
Business                      Home                      Curb                      ...
  - Hybrid fiber — Coax
  - ...

## Mid 1980s in the U.S. Radio was dead!! (Fixed Radio)

- BUT:
  - Cellular had been deployed
  - Cordless telephones had appeared
  - Paging had evolved to messaging
  - Europe was “Alive” with GSM activity
  - Japan was pursuing digital cellular and cordless
- BUT:
  - McKinsey said these were NOTHING
    - Maybe 1 Million Cellular Subscribers by 2000!!



## Late 1980s

- Cellular had exceeded 1 million subscribers in the U.S.
- Cordless telephones were everywhere
- Paging/Messaging had expanded

Note: These applications are MOBILE or Tetherless!!  
The Replaced applications are Fixed

# 1980s Mobile and Tetherless Applications

- Used “Old” Radio Techniques!
  - Single channel per carrier (SCPC)
  - Frequency Modulation (FM)
- Provided access to Fixed Communications Networks
- Used Sophisticated Channel Control
  - Frequency Reuse
  - Multiple Access
  - Interference Control
  - Handoff (for cellular)
- Moved to higher frequencies for more system bandwidth

## Early 1990s

- Radio became an Antique word
- Radio became known as **WIRELESS!!**

## Mid 1990s to Now

- Cellular/High Tier PCS subscriber growth still explosive
- Cordless telephones everywhere
- Paging/Messaging ubiquitous
- Wide area Wireless Data is of little significance
- Wireless LANS are of little significance

# Now

- Wireless is the “Rage”
- Wireless is for everything
- Everyone is “on the Bandwagon” (like fiber in the 1980s)
- Wireless to the:
  - car
  - handset
  - business
  - home
- Wireless for:
  - voice
  - messages
  - “data”
  - video
  - control
  - . . .
  - mobile
  - tetherless
  - fixed
- For bandwidths:
  - low
  - medium
  - high

## Wireless Communications Systems, Technologies, Services

<b>Present Importance</b>	<b>Application</b>	<b>Systems/Technologies/Services</b>
↑	M	Cellular Radio/High-Tier PCS (voice)
↓	M	Cellular Radio/High-Tier PCS (messaging)
↑	T	Cordless Telephone (voice)
↓	T	Cordless Data Phone (data)
↑	M	Paging (messaging)
→	M	Wide Area Data Systems (data)
→	T	Wireless LANS (data)
→	M	Low-tier PCS (voice & messaging)
↓	M	Satellite Mobile Systems (voice/data)
↓	F	Fixed Wireless Loops (voice band)
↓	T	Home Wireless (home/RF/Blue Tooth to internet)
↓	F	Fixed Wideband Wireless Access (LMDS, MMDS, i.e. voice and data)

M = Mobile

T = Tetherless

F = Fixed

## Some Observations

- Techie Community likes fixed wireless
  - Without mobility many sophisticated signal processing techniques work well
- Data Community sees wireless as an opportunity for growth
- Telco and Cable “bypassers” see fixed wireless as a “cheap” and “quick” alternative to copper and fiber

# What Does History Suggest About This “Zoo” of Wireless Applications??

- Fixed Radio is often cheaper
  - For startup
  - For difficult terrain
- “Wire” Technologies usually “win”
  - For large bandwidth Non-Mobile continuing needs
- Mobile Voice is a “Killer Application” for Wireless
- Mobile Messaging has significant usefulness
- Mobile Data has limited niche applications



## Projections for Wireless Communications Systems, Technologies, Services

<b>Present Importance</b>	<b>Application</b>	<b>Systems/Technologies/Services</b>	<b>Future Importance</b>
↑	M	Cellular Radio/High-Tier PCS (voice)	↑
↓	M	Cellular Radio/High-Tier PCS (messaging)	↑
↑	T	Cordless Telephone (voice)	↑→
↓	T	Cordless Data Phone (data)	↑→
↑	M	Paging (messaging)	↑→
→	M	Wide Area Data Systems (data)	→
→	T	Wireless LANS (data)	→
→	M	Low-tier PCS (voice & messaging)	↑→
↓	M	Satellite Mobile Systems (voice/data)	↓→
↓	F	Fixed Wireless Loops (voice band)	↓→
↓	T	Home Wireless (home/RF/Blue Tooth to internet)	↓→
↓	F	Fixed Wideband Wireless Access (LMDS, MMDS, i.e. voice and data)	↓→

M = Mobile

T = Tetherless

F = Fixed

Mobility is Wireless

Wireless is Difficult

Is Wireless Mobility