

WIRELESS TELECOMMUNICATIONS

WHERE ARE WE TODAY-- WHERE WILL WE BE TOMORROW?

Harold Sobol

The University of Texas at Arlington, (Retired)

**1999 ATP National Meeting
U.S. Department of Commerce
San Jose, CA November 15, 1999**

1

Wireless Telecommunications

Topics

- **Introduction**
- **Access Technologies**
- **Mobile and Fixed Wireless Access Today**
- **Mobile and Fixed Wireless Access in the Future**
- **Technology Challenges**
- **Conclusions**

2

Introduction

- **Evolution of modern wireless access**

- **Mobile Phone Service**

- “*telephone service for people on the move*”

- **1946 -1970’s** : Various versions, low subscriber capacity
 - **1980’s**: 1G Cellular; AMPS, 800MHz, analog, voice
 - **1990’s**: 2G; digital, 3 access stds; paging, data overlays
Europe, 1 access std, growth/service exceeds US
 - **Mid 90’s**: PCS, 1.9 GHz, increase subscriber capacity
 - **1999**: 3G Plan, IMT-2000
 - **1999**: Iridium introduced and enters Chapter 11

3

Introduction -- continued

- **Evolution of modern wireless access**

- **Fixed Wireless Access (FWA)**

- “*The wireless local loop (WLL) and other applications*”

- Growth of internet and multimedia leads to new demands for fixed high speed access
 - POTS twisted pair unable to meet high speed requirements
 - FWA is an alternative for high speed access
 - Telecom 96 opens opportunities for FWA
 - Low infrastructure cost and rapid deployment are FWA drivers
 - DBS digital TV confirms utility of satellite for FWA

4

Introduction -- continued

- **The future of wireless access**
 - **An integral part of future multimedia public and private telecom networks**
 - **Significant contributor to meeting the 4 “Anys” of telecom**
 - *Anywhere* - Broad coverage
 - *Anything* - Multimedia
 - *Anytime* - High reliability
 - *Anybody* - Affordable universal service

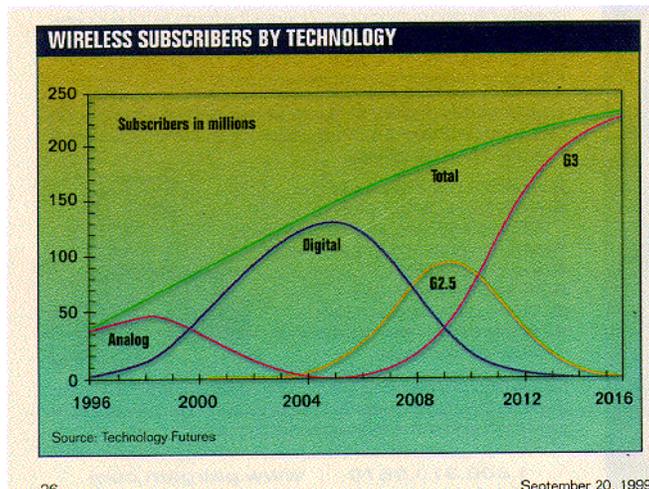
5

Access Technologies

<i>Technology</i>	<i>Service Provider</i>
• Twisted pair <ul style="list-style-type: none">– POTS– Digital subscriber line; xDSL	Local exchange carrier
• Fiber to the subscriber <ul style="list-style-type: none">– FTTC, FTTH	Cable company, LEC, IXC
• Hybrid Fiber Coax	Cable company
• Wireless <ul style="list-style-type: none">– Mobile; Terrestrial and Satellite– Fixed; Terrestrial and Satellite	Mobile & satellite carriers, CLECs, IXC, private

6

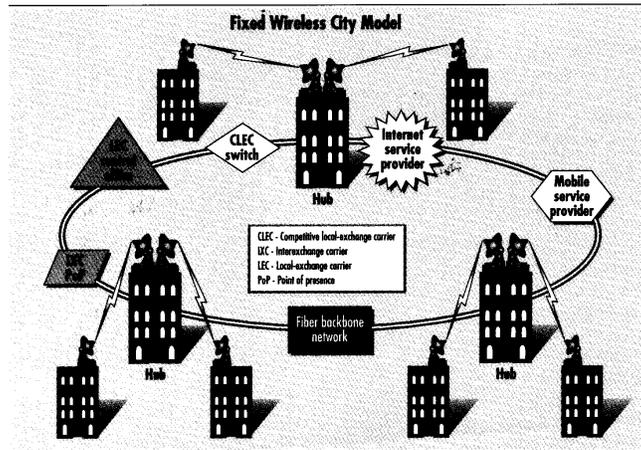
US Mobile Wireless Access Today



Mobile Wireless Access Today

- **Subscriber Status**
 - 0.8 and 1.9GHz digital will outnumber analog in 2000
 - Total subscribers today (80M) about same as internet
- **Technical Status of 2G**
 - CDMA (IS-95), TDMA (IS-136) and GSM access technologies used
 - Data service limited to 20KB/s
 - Limited ability for 911 location
 - Some nationwide roaming
 - Plan to introduce 2.5G prior to 3G
- **Manufacturers**
 - Motorola, Lucent, Nortel, Qualcomm, Ericsson, Nokia, etc
- **Service Providers**
 - Wireline carriers, AT&T, Sprint, Nextel, Block C-F carriers, etc

Fixed Wireless Access



9

Fixed Wireless Access Today

- **Subscriber Status**
 - Primarily business service at this time
 - Service business in 2000 estimated at \$1B
- **Applications**
 - Private networks, link SOHO to ISPs and corporate networks, extension of public networks, CLEC access
- **Technical Status**
 - Usually a fiber infrastructure to hubs or nodes and short FWA link
 - Competition: xDSL, HFC, Fiber; satellite
 - Architecture: Point-to-Point (PP), Point-to- Multipoint (PMP)
 - Frequency Bands: 2 - 40 GHz
 - Future , fixed version of mobile
- **Manufacturers**
 - Adaptive Broadband, Alcatel, Bosch, DMC, Ericsson, Harris, Helioss, Lucent, Newbridge, Nortel, P-Com, etc
- **Service Providers**
 - ART, MCI, Nextlink, Sprint, Teligent, WinStar,etc

10

Fixed Wireless Access Today

- *Point-to-Point*
 - 24 GHz ,
 - 1.5 - 45 MB/s
 - Primarily business subscribers, bundled local/LD service
 - 39 GHz
 - 1.5 - 155 MB/s, ATM
 - Auction scheduled for next summer
 - Fourteen paired 50MHz blocks in 172 Economic areas
 - Incumbent systems remain in service
 - Business subscribers

11

Fixed Wireless Access Today

- *Point-to-Multipoint*
 - 2 GHz MMDS
 - Originally simplex (wireless cable) for TV
 - Significant interest to carriers (LECs, CLECs, IXC) for duplex broadband multimedia to businesses and later residential
 - Licenses issued
 - AT&T 27MB/s test system
 - 24 GHz, PMP version of PP system
 - 30 GHz LMDS,
 - Broadest bandwidth assignments, 1150MHz
 - 1.5 -45 MB/s data rates
 - Auctions held, systems activated shortly, 986 Licenses
 - Primarily business users

12

Future Mobile Wireless Access

- *Requirements*
 - Seamless operation with fixed networks
 - Higher speed capability for internet and advanced digital services
 - Improved location accuracy, voice quality, security
 - Multi tasking
- *Applications*
 - High speed internet services Email
 - Mobile computing Video teleconferencing
 - Global roaming Tracking and ID
- *3G Features*
 - w-CDMA, 5MHz channel
 - 384KB/s operation for mobile and 2MB/s fixed(microcells)
 - Designed for IP service , data channel always on
 - Packet switched data and circuit switched voice
 - Dedicated pilots for downstream/upstream power control and for smart antennas
 - Synchronous and asynchronous base stations

15

Future Mobile Wireless Access

- *Requirements for 4G and higher*
 - Higher data rates, approach 2MB/s for mobile
 - New frequency bands
 - Higher spectral efficiencies
 - Packet switched voice
- *General*
 - Satellite mobile service will be a component of 3G and future G's
 - Wireless phone population will exceed wired in 2004
 - Mobile wireless access will replace POTS as primary voice service and will also provide most data services excluding high speed entertainment

16

Future Fixed Wireless Access

- **Requirements**
 - Interface with high speed optical network hubs that are moving closer to the subscriber
 - Subscriber data rate of 1 - 2 GB/s
 - ATM and IP systems
 - Tiered QoS , very high availability and reliability
 - Interface with LANs and xDSL for within building distribution
- **Applications**
 - High speed internet services
 - Remote interconnect to corporate networks
 - Residential entertainment
 - SOHO and medium size businesses

17

Network Architectures for FWA

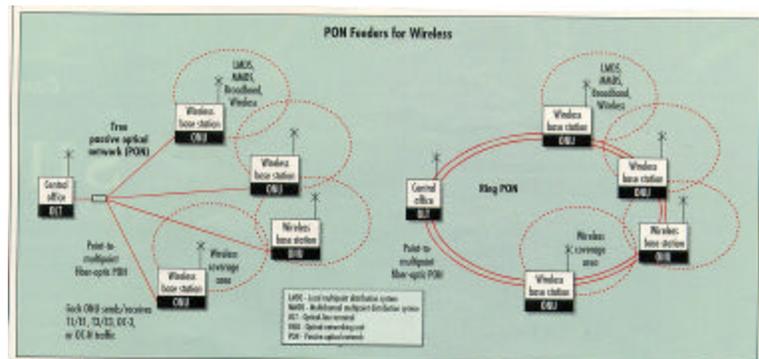


Fig. 4. A PON can aggregate traffic from the wireless base stations back to the CO. Wireless base stations deliver broadband services in a surrounding area that is typically 5 km.

18

Millimeter wave - optical interface

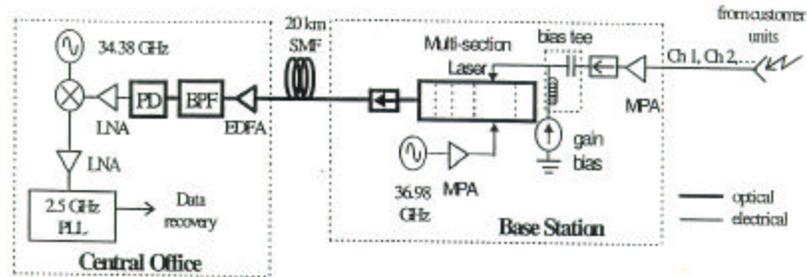


Fig. 1 Experimental set-up for upstream multi-channel data transmission incorporating a MSL with hybrid mode-lock

19

Future Fixed Wireless Access

- **Technical Requirements**
 - Cost competitive with HFC and direct fiber
 - PP service for business subscribers
 - PMP and mesh networks in dense urban residential areas
 - Higher carrier frequencies (60/95GHz) and greater band width allocations
 - Initially, PP; 38GHz, 622MB/s using 512 QAM
PMP; 38GHz, 155MB/s using 64QAM
 - Two layer distribution
 - Unlicensed 5 GHz band (UNII) for 20MB/s service, follows European HIPERLAN service
 - Use of TDD and FDD transmission

20

Technology Challenges

- **Advances in DSP, coding, antennas, devices, and access technologies to meet power, size, cost and complexity constraints of portable units**
- **Achievement of high spectra density with high M-Ary modulation in interference dominated environment**
- **Introduction of improved modulation systems for more robust performance with interference**
- **Interference countermeasures**
- **Propagation issues in dense environments**
- **Propagation into buildings**
- **Smart antennas and wide bandwidth tunable antennas**
- **Health issues**

21

Technology Challenges

- **High bandwidth, high linearity components**
- **Application of DSP techniques for direct conversion receivers and direct launch transmitters**
- **Retuning versus broadband design**
- **Application of the software defined radios in future networks**
- **High efficiency subscriber units**
- **Development and application of MMICs**
- **Security through codes and subscriber biological identification**

22

Conclusions

- **Wireless is a huge global business today and has the promise to be even bigger in the future**
- **Wireless access addresses the model for future telecommunications to subscribers**
- **Wireless access has specific advantages in the fixed environment, but to be a big winner the performance and cost must be competitive with other access technologies**
- **Wireless access should be the POTS of tomorrow**
- **Satellite systems which were not addressed because of time limitations will be a component of the future wireless access picture**