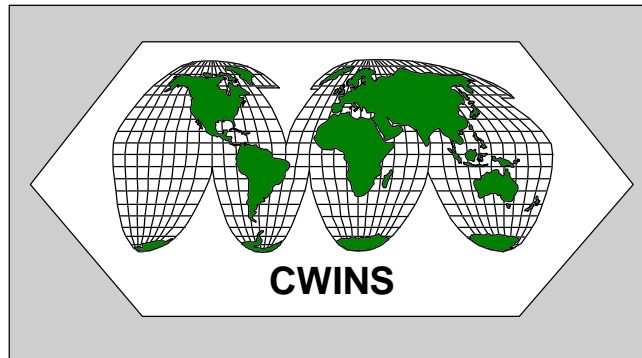


Second IEEE Workshop on Wireless LAN



Trends in Wireless LANs

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Wireless Services

- Fixed services
 - Location of the service does not change
 - Example: Inter-LAN wireless bridges, wireless local loop
- Stationary services
 - Location can be changed but the service is not provided during the motion
 - Example: Some wireless LANs
- Portable services
 - The service is provided all the time and the user is a pedestrian
 - Example: PCS services, cordless telephone
- Mobile services
 - Service is provide all the time but the device is installed in a mobile vehicle
 - Example: cellular telephone, land mobile radio

Classification of Existing Wireless Networks

Voice Driven Networks

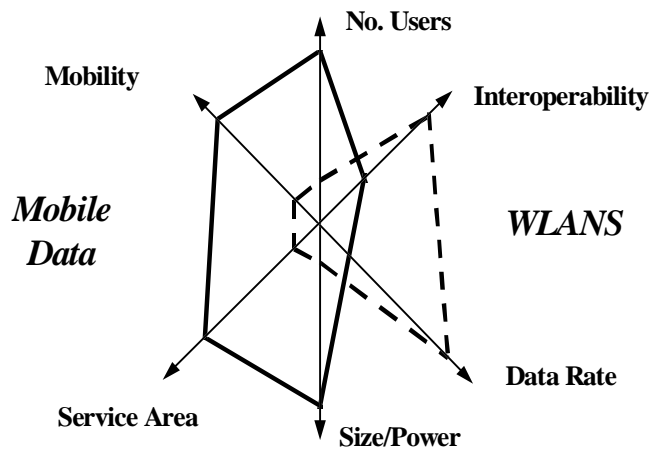
- Low power, high quality, local services (PCS, wireless PBX, telepoint)- Result of success in cordless telephone industry
- High power, low quality, wide area (Digital Cellular) -Result of demand for higher capacity for mobile radio

Data Driven Networks

- High speed local (Wireless LAN) - A new approach for local area networking
- Low speed wide area (mobile data) - Result of success in paging industry

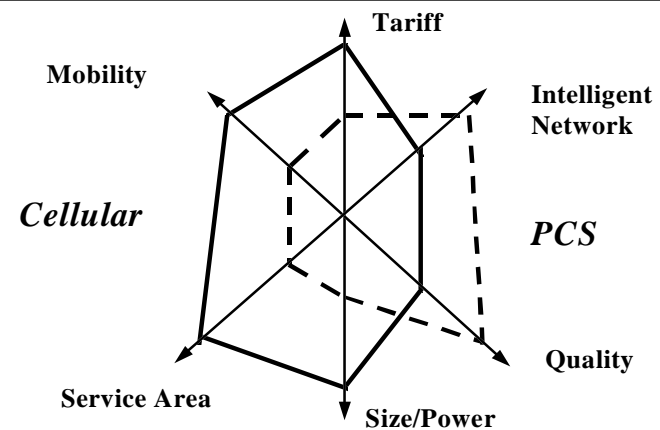
Current Wireless Network Industry

Data Services



CWINS@wpi

Voice Services



CWINS@wpi

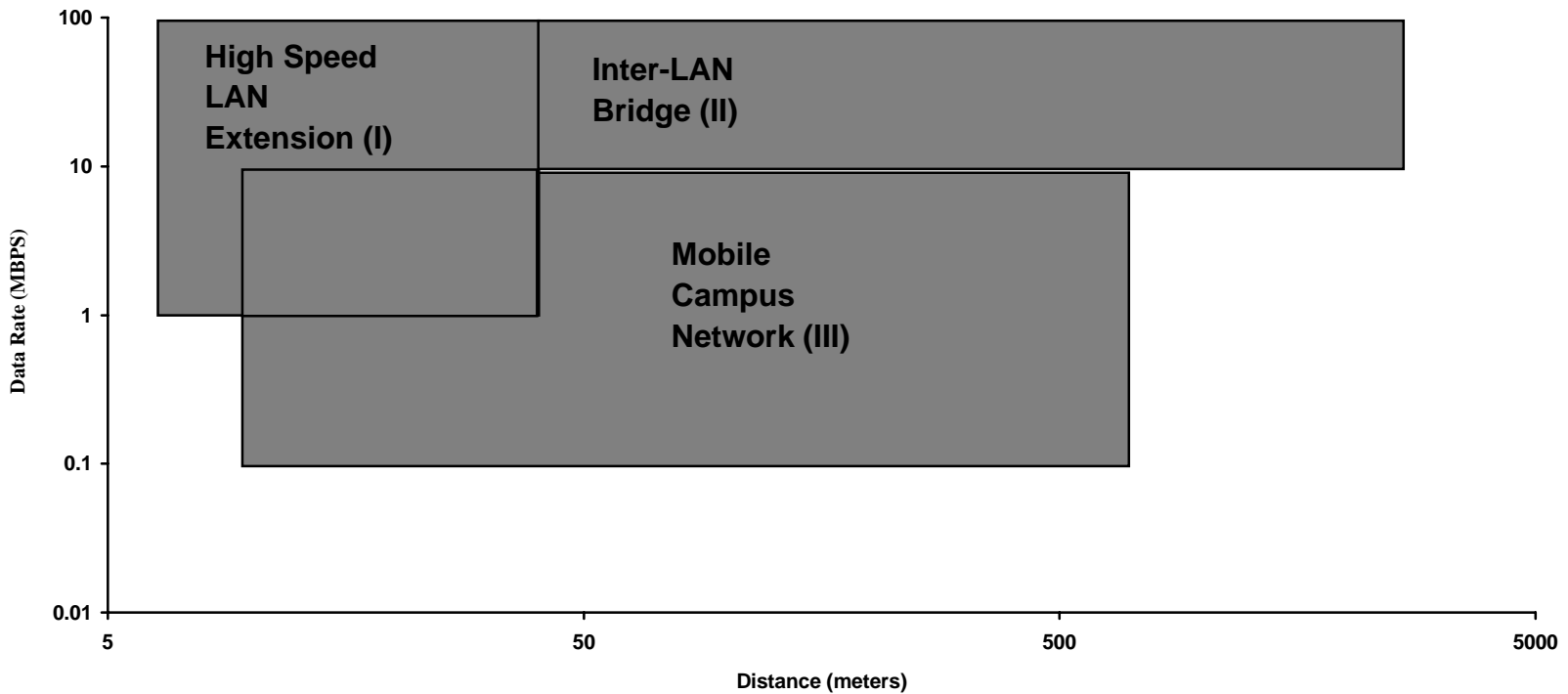
Wireless LANs

- Minimum data rate: 1Mbps (IEEE 802)
- Designed for local indoor - less than 100m
- Should interoperate with wired LANs
- Does not need large investment on infrastructure and does not collect service charges.
- Transmission technology: spread spectrum, standard radio, IR
- Examples: Roamabout, WAVELAN, Photolink, FreePort
- Standards: IEEE 802.11, HIPERLAN

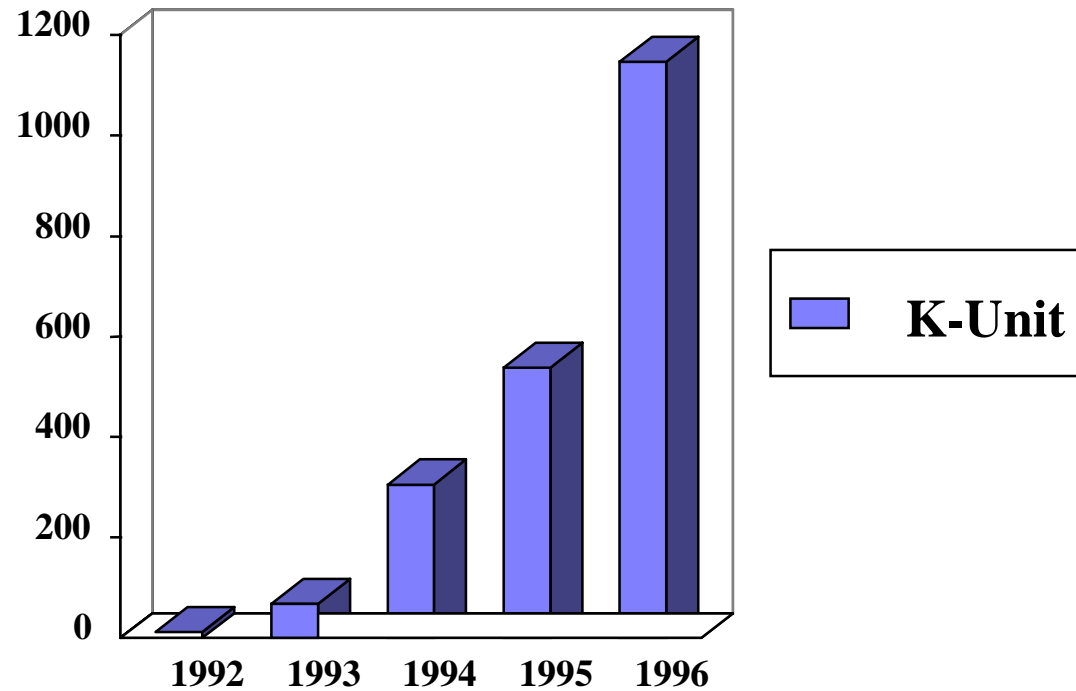
Wireless LAN Applications

- LAN extension: hospitals, factory floors, branch offices, offices with wiring difficulties
- Inter-LAN bridges: Cross-building point-to-point connection, high speed distance access.
- Adhoc networking: conference registrations, campaign headquarters, military camps
- Nomadic access: lap-top to printer access
- Infopad: fusion of computer and communication in ship boards, research labs
- Campus area networks (CAN): wireless class rooms, wireless Internet access
- Body LAN: for soldiers in the battlefield

Coverage and data rates for three classes of wireless LAN applications



Wireless LAN Market



Wireless LAN Technologies

Technique	DF/IR	DB/IR	RF	DS/SS	FH/SS
Data Rate	1 - 4 Mbps	10 - 155 Mbps	5 - 10 Mbps	2 - 20 Mbps	1 - 3 Mbps
Mobility	Stationary/Mobile	Stationary w/LOS	Stationary/Mobile	Stationary/Mobile	Mobile
Range	50 - 200 ft	100 ft	40 - 130 ft	100 - 800 ft	100 - 300 ft
Freq./wavelength	800 - 900 nm	800 - 900 nm	18 GHz, ISM	ISM bands	ISM bands
Modulation	OOK	OOK	FSK/QPSK	QPSK	GFSK
Access Method	CSMA	CSMA	Res. ALOHA, CSMA	CSMA	CSMA
Manufacturer	Spectrix	InfraLAN (token ring) JOLT (pt-to-pt)	Motorola - Altair	DEC AiroNet WaveLAN (mesh) Persoft Solectek Proxim Windata WiLAN	Proxim RDC Xircom

IEEE 802.11 and ISM bands

- Media Access Protocol (MAC) for both peer-to-peer and centralized topologies
- Uses 2.4 MHz ISM bands
- Supports DSSS (BPSK and QPSK), FHSS (GFSK), and DFIR (OOK)
- Data rates are 1 and 2 Mbps for DSSS and FHSS, 1Mbpsfor DFIR
- For DSSS the band is divided in two groups:
 - Group I centralized at: 2412, 2442, and 2472 MHz
 - Group II centralized at: 2427, and 2457 MHz
- For FHSS three patterns of 22 hops out of 79 available I MHz bands with GFSK. Minimum hop rate is 2,5 hops/second
- Provide interoperability among all stations

ETSI Res-10: HIPERLAN

- MAC for both peer-to-peer and centralized networks
- Uses 5.25-5.3 GHz and 17.1-17.3 GHz
- Uses GMSK modulation with DFE
- Data rates are 10-20 Mbps
- The maximum range is 50m
- Supports asynchronous data as well as isochronous voice

History of Wireless LANs

- Diffused Infrared - 1979 (IBM Rueschlikon Labs - Switzerland)
- Spread Spectrum using SAW Devices - 1980 (HP Labs - California)
- Wireless modems - early 1980's (Data Radio)
- ISM bands for commercial spread spectrum applications - 1985
- IEEE 802.11 for Wireless LAN standards - 1990
- Announcement of wireless LAN products - 1990
- Formation of WINForum - 1992
- ETSI and HIPERLAN in Europe - 1992
- Release of 2.4, 5.2 and 17.1-17.3GHz bands in EC - 1993
- PCS licensed and unlicensed bands for PCS - 1993
- 1996:

Frequency Bands

- Walkie talkie plus voice band modems: around 150MHz
- ISM bands for the spread spectrum technology: .9, 2.4 and 5.7 GHz
- Optical wireless: above 300 GHz (not concerned by FCC)
- Licensed and unlicensed PCS bands: 1.8-2.2 GHz.
- Emerging bands for mobile broadband: 5, 17, 22, 38, 60 GHz

Note: The higher the frequency, the wider the band. Also the higher the frequency the more complex the electronic and the smaller the coverage.

Organization involved in WLAN

- IEEE 802.11 - ISM bands using DSSS/FHSS/DFIR
- ETSI Res-10 - HIPERLAN in 5 and 17GHz
- WINForum - unlicensed bands for PCS
- WLI - Interoperability
- Wireless ATM Forum - wireless access standard
- WAND - wireless ATM network demonstrator
- AWACS - ATM Wireless Access Communication System
- UMTS - 2Mbps packet switch service
- MBS - 2-156 Mbps
- WLNA - marketing alliance
- WLRL - research alliance

Characteristics of the Information Packets

Real time voice packets (Isochronous Transmission)

- Can not tolerate delays in the order of 100 msec
- Can tolerate packet loss in the order of 1%
- Have relatively uniform connection times (3-20 Min)
- Have large information size for each access
- Arrive periodically with an average rate of 50%

Bursty data packets (Asynchronous Transmission)

- Can tolerate delays
- Can not tolerate packet loss and high error rates
- Have relatively wide connection times
- Have small average information size for each access
- Arrive in bursts

Real Time Video Packets (Isochronous Transmission)

- Can not tolerate delays in the order of 100 msec
- Can not tolerate packet loss
- Have variety of connection times
- Have information size for each access
- Arrives continuously with variable rate.

Two Classes of Networks

- Connection-base : evolved from applications with isochronous transmission
- Connection-less : evolved from applications with asynchronous transmission

Connection-Less Networks

- Example: Ethernet, Token Ring, 100 Base-T, FDDI
- Low QOS - no control over latency and instantaneous through put (RSVP by Cisco, FT-2 by BBN provide acceptable QOS)
- Low cost cards already available in most workstations
- More expensive switches
- Supported data rate: from 10-650Mbps
- Suitable for VBR operation in wireless environment

Connection-Oriented Networks

- Example: ATM
- High QOS - control over latency and instantaneous throughput
- Expensive cards not widely available
- Less expensive switches because they are used for other purposes as well
- Supports data rates up to 622Mbps
- Difficult to implement a bandwidth efficient VBR operation in wireless environment

Implication on Wireline/Wireless Networks

- In wireline networks we prefer integration to avoid two sets of wiring and two sets of switches.
- In the wireless we may assign two separate bands for isochronous and asynchronous transmissions. This implies separation in the air and integration in the wires.

Direction of the Future: Integration

- Specification: multi-rate, multi-power, and multi-media
- Users: portable phones, pen-pads, note-books, and workstations.
- Added features: universal operation, wideband capabilities

Two Approaches

- Evolutionary Approach: Software Radio
- Revolutionary Approach: A New System

Desirable Multi-Media Applications

- Image and data file sharing
- Video-conferencing
- On-demand video
- Distance control

Requirement for Multi-Media Networking

- Diversity in data rate (Animation 2.5Mbps, Full-video 27.7Mbps)
- Synchronization between the image and the voice
- Potential for broadcast
- Large storage capability (Single color image 5Mbytes, 10 min Animation/Video 100-200Mbytes)
- User interface design (how to combine applications in one screen)

Wireless Specific Requirements

- Availability of widebands in reasonable frequencies
- Enforcing synchronization in mobility management
- Terminal size and power consumption
- Dynamic bandwidth allocation for VBR

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