UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
INTERNATIONAL ATOMIC ENERGY AGENCY
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
I.C.T.P., P.O. BOX 586, 34100 TRIESTE, ITALY, CABLE: CENTRATOM TRIESTE

PARTICIPANTS' REPORTS-13

ICTP - URSI - ITU/BDT WORKSHOP ON THE USE OF RADIO FOR DIGITAL COMMUNICATIONS IN DEVELOPING COUNTRIES

(17 - 28 February, 1997)

"Unplugged! The Philippine Experience in Wireless Data Networks and Technologies"

V.A.A. Ochave
Quezon City
THE PHILIPPINES

nplugged! The Philippine Experience in Wireless Data Networks and Technologies

Victorio E. A. Ochave, Jr.

lecture delivered at ICTP

February 1997

Advanced Science & Technology Institute

tline:

ntroduction

2. Philippine Projects
   -Telemetry
   - Wireless TCP/IP

3. Technology and Equipment Options

4. Issues and Design Considerations

PHILIPPINE FACTS AND FIGURES

POPULATION:	68M
GNP (real):	7%
INFLATION :	5%
POPULATION GROWTH:	2.3%

TELEPHONE DENSITY INDEX:

National Capital:	9.8
Region 2:	0.28
National Average:	**2.01 (1.0 in 1994)**

NATIONAL TELECOMM DEV'T PROGRAM (1993-2010)

HIGHLIGHTS:
a) increased access as goal
b) private-sector led growth
c) liberalization
d) intra-sectoral cross-subsidy
e) compulsory interconnection
f) local equipment manufacturing

ROLL-OUT COMMITMENTS OF LEC's

1996	1.4M
1997	2.9M
1998	1.3M
1999	329,000
2000	89,000

EXISTING INFRASTRUCTURE:

1)

	<u>No. of Players</u>
CMTS	5
IGF	9
LEC	63 priv., 4 gov't
Paging	10
Trunked Radio	10
Radiotelephone	6
Satellite/VSAT	3
Leased lines	6

2) **PCOs** 1,126 out of 1,542 municipalities served

3) **SUBSCRIBER BASE**

CMTS	500,000
PAGING	325,000
TRUNKED RADIO	18,800

Telecommunications Research and Development Program

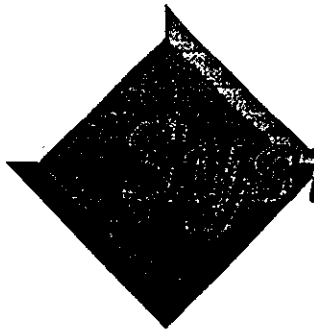
- Aims to gain knowledge (technology) and capability to develop systems and products for rural telecommunication
- Involved with the design, prototyping and pilot testing of modern transmission and switching equipment for integration to rural communications system
- Explores the development and application of wireless technologies for more convenient, efficient and faster means of transferring and receiving information

Profile

- One of the research and development institutes (RDIs) of the Department of Science and Technology
- Mandated to conduct research and development projects in the advanced fields of microelectronics and information technology
- Focuses on four major program thrusts, namely. Rural Telecommunications, Multimedia, High Level Design Automation of Integrated Circuits, and Electronic Fabrication Technology
- Provides technical services such as consultancy, product prototyping, training other support activities to industry, academe, non-government voluntary organizations, government sector

Wireless Data Network Applications

- Business/Commercial Offices
- Internet Service Providers
- Universities/Schools
- Factories/Plants/Mines
- Warehouses/Cargo Sites
- Government/Public Services
- Military/Tactical Networks



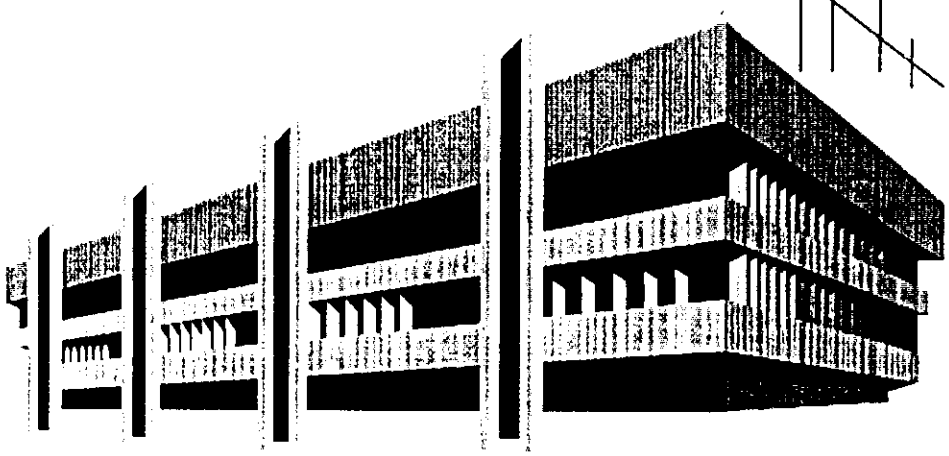
tem Engineering Projects

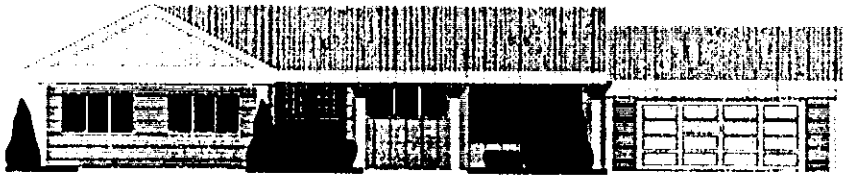
- 2.4 Ghz Spread Spectrum Network
- HF-SSB Pactor II 300 baud Link
- 19.2/56 kbps packet TCP/IP regional and provincial networks
- 4800 baud Telemetry system
- National Information Infrastructure proposal

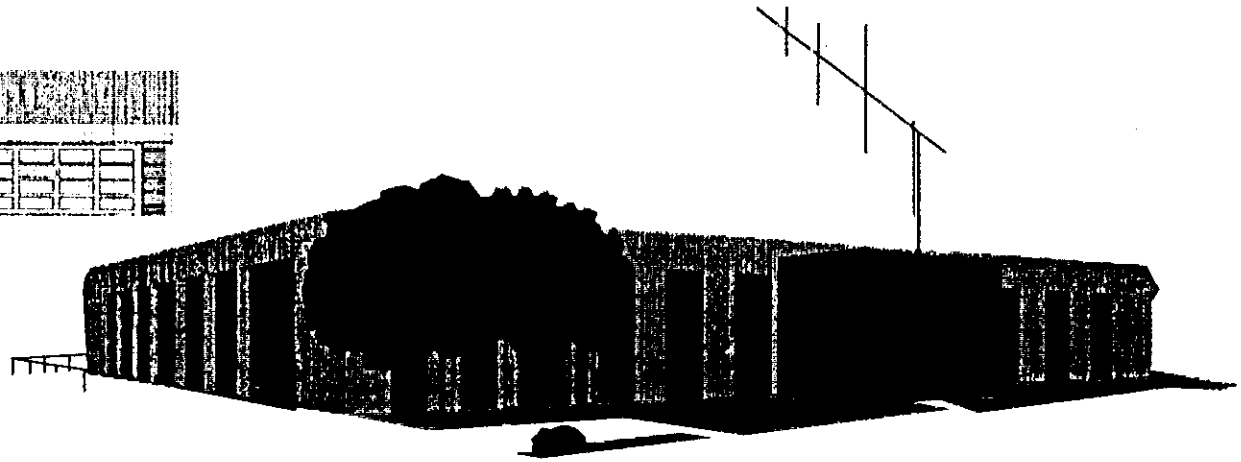
cuit Design Projects

- 1200 baud Baycom modems and TNCs
- 9.6/19.2 kbps GMSK modems
- 128 kbps FSK modem
- 1.5 Ghz Transverter RF Terminal
- UHF Data radios (5 W)
- 2 Mbps QPSK Modem
- Reed-Solomon Codec

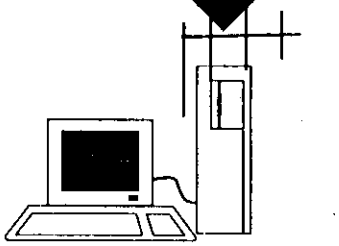
iversity
mpuses/Buildings

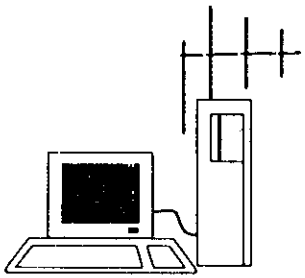


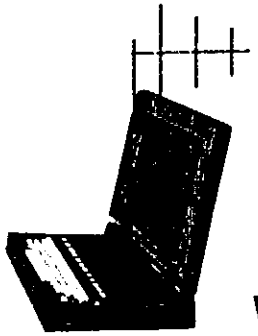




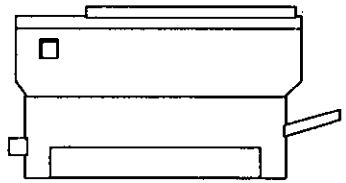
Typical Packet Network Configurations



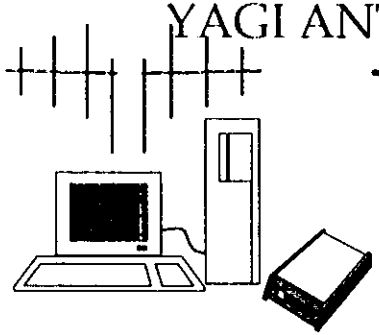




ETHERNET



56 KBPS RF MODEM
TRANSVERTER
PI2 DATA CARD
YAGI ANTENNA

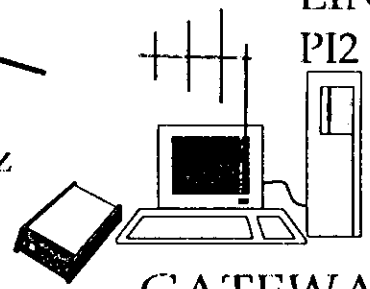


19.2kbps

400 Mhz

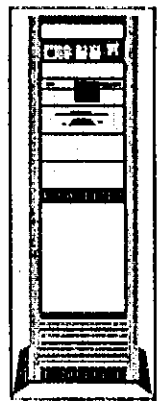
Data Engine
DE9k6/19k2 modem
D4-10 UHF 10W radio
omni or directional antenna
KA9Q NOS

56 kbps
220 Mhz



LINUX BOX w/
PI2 driver

GATEWAY

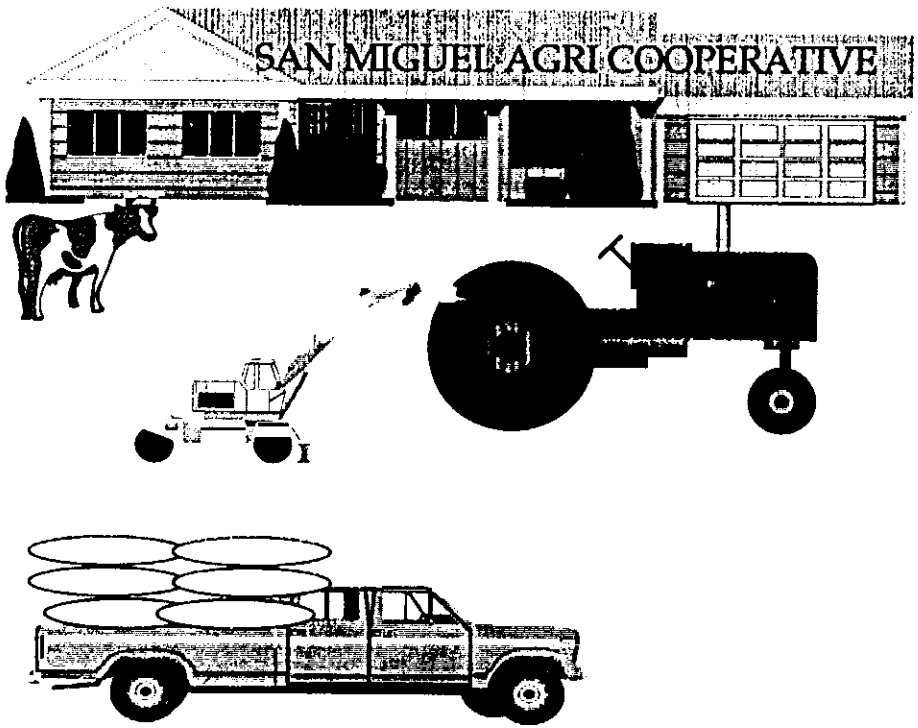


TO INTERNET

Windows 95
Ethrax Packet Driver or KA9Q NOS
Data Engine or PacketTwin (w/ 19k2 modem)
TEKK KS-1000-D19k2 5W data radio

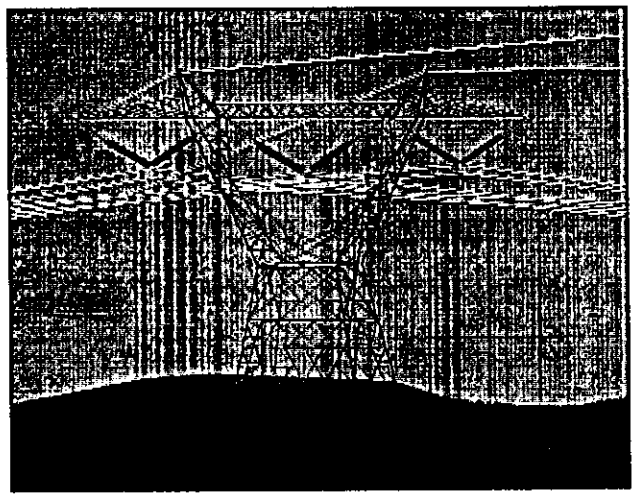
ricultural Cooperatives

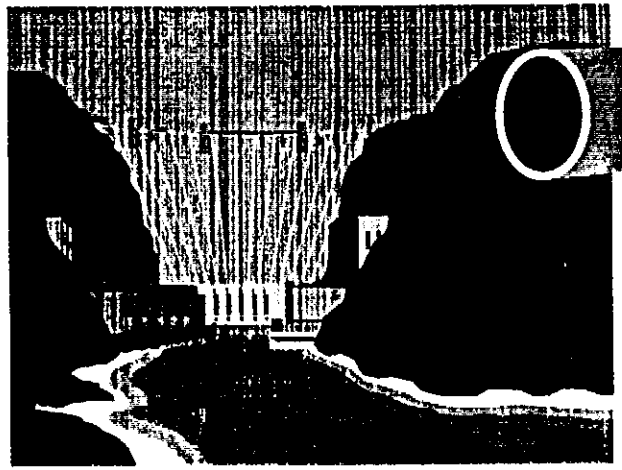
d offices - to - marketing offices networks

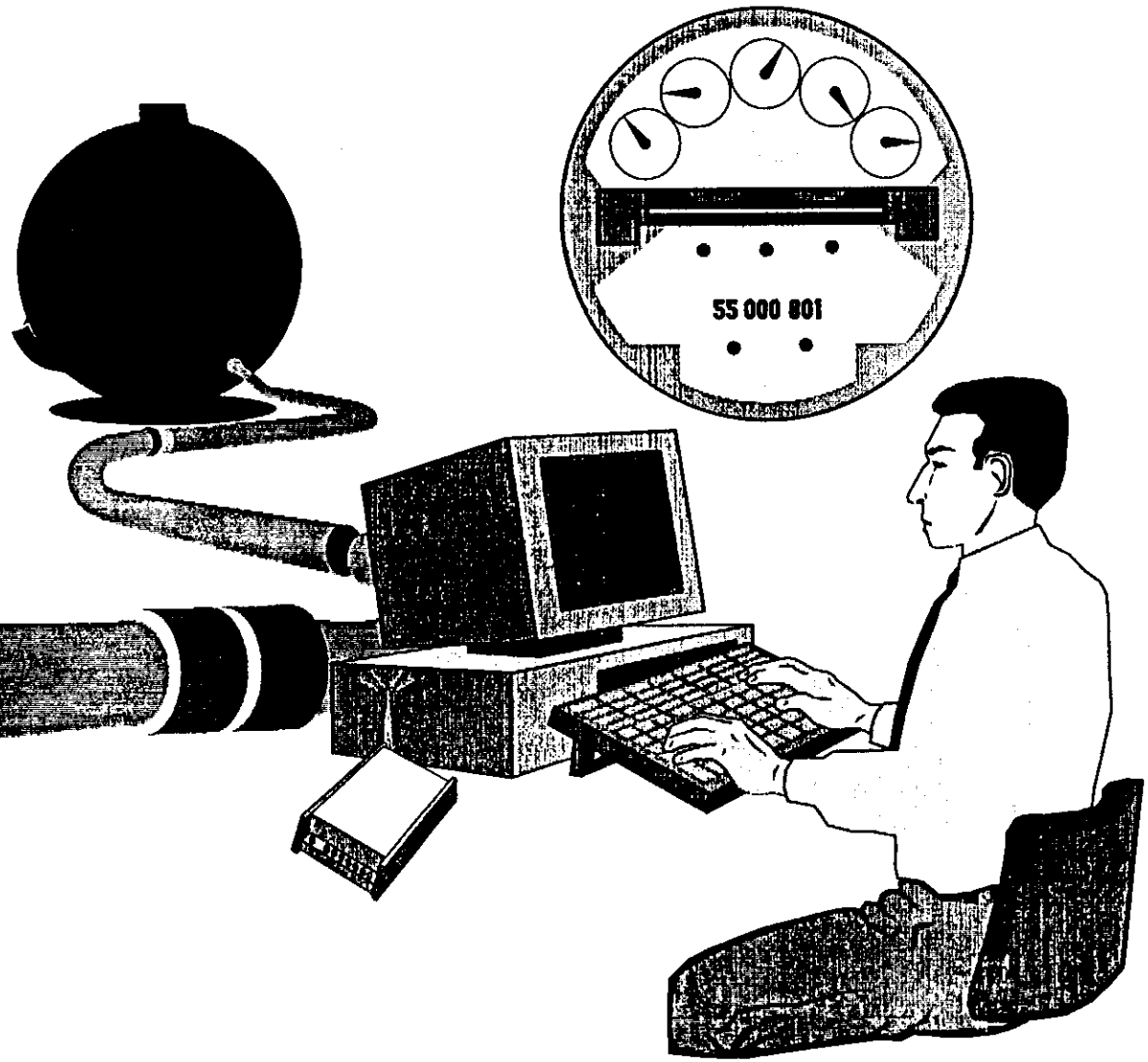


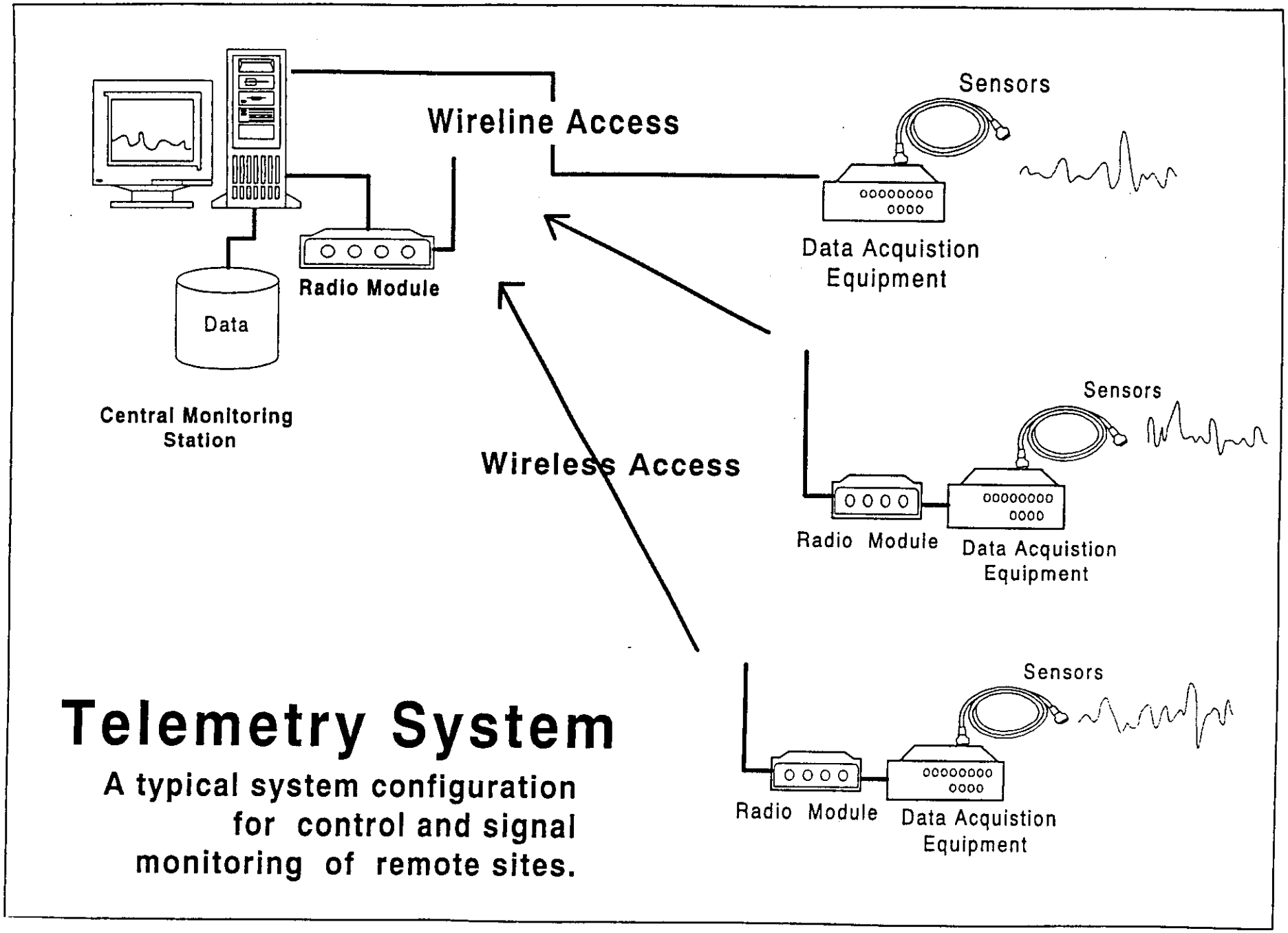
Data Acquisition/Telemetry

Wireless meter reading, SCADA, flood forecasting, etc.







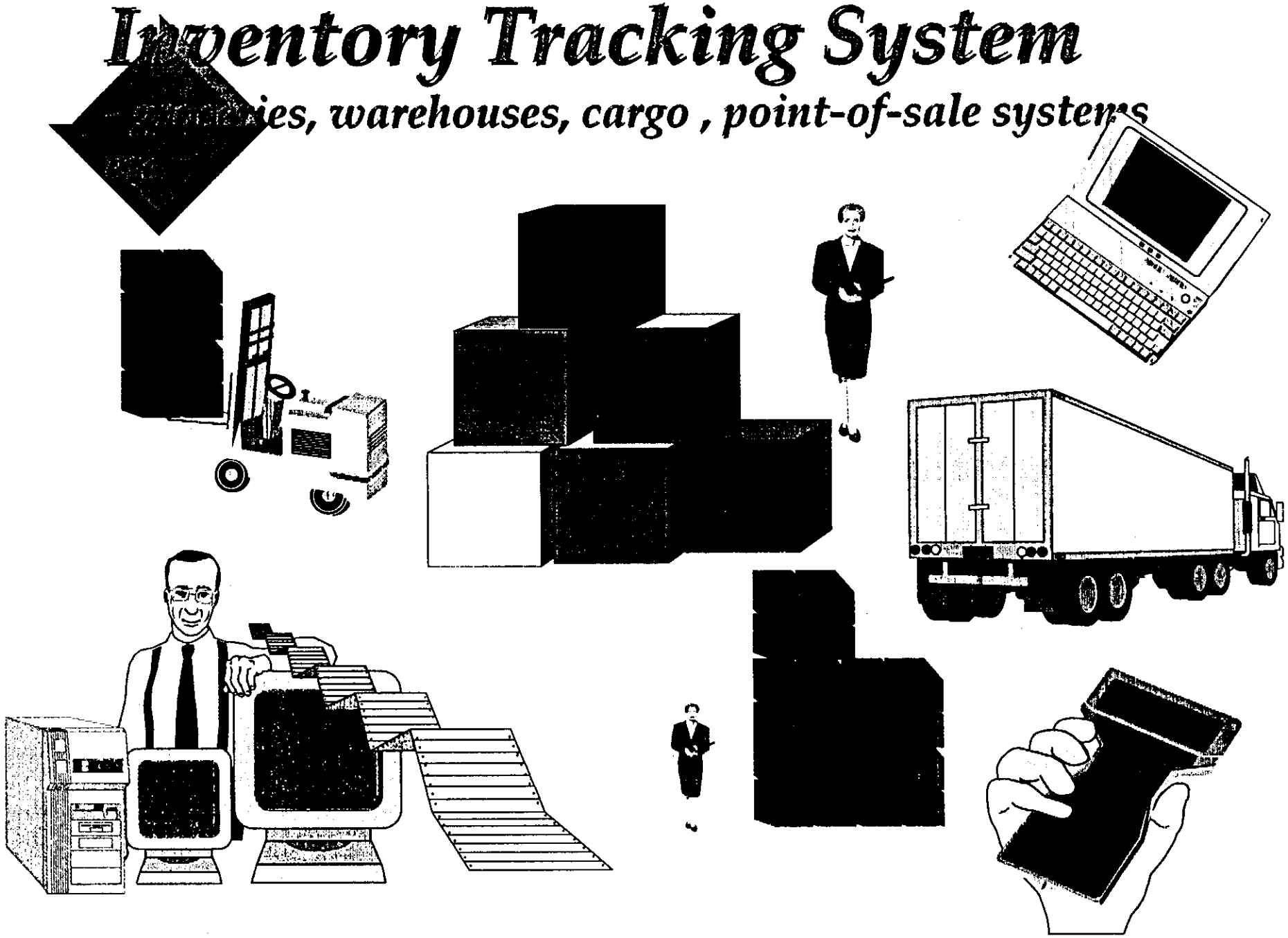


Telemetry System

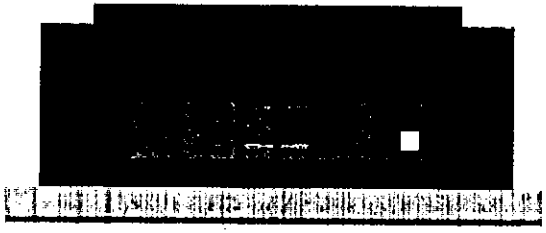
A typical system configuration for control and signal monitoring of remote sites.

Inventory Tracking System

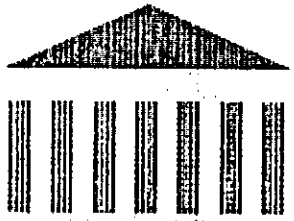
...ies, warehouses, cargo , point-of-sale systems



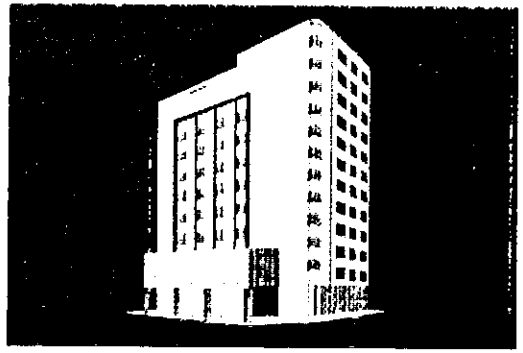
Government Offices



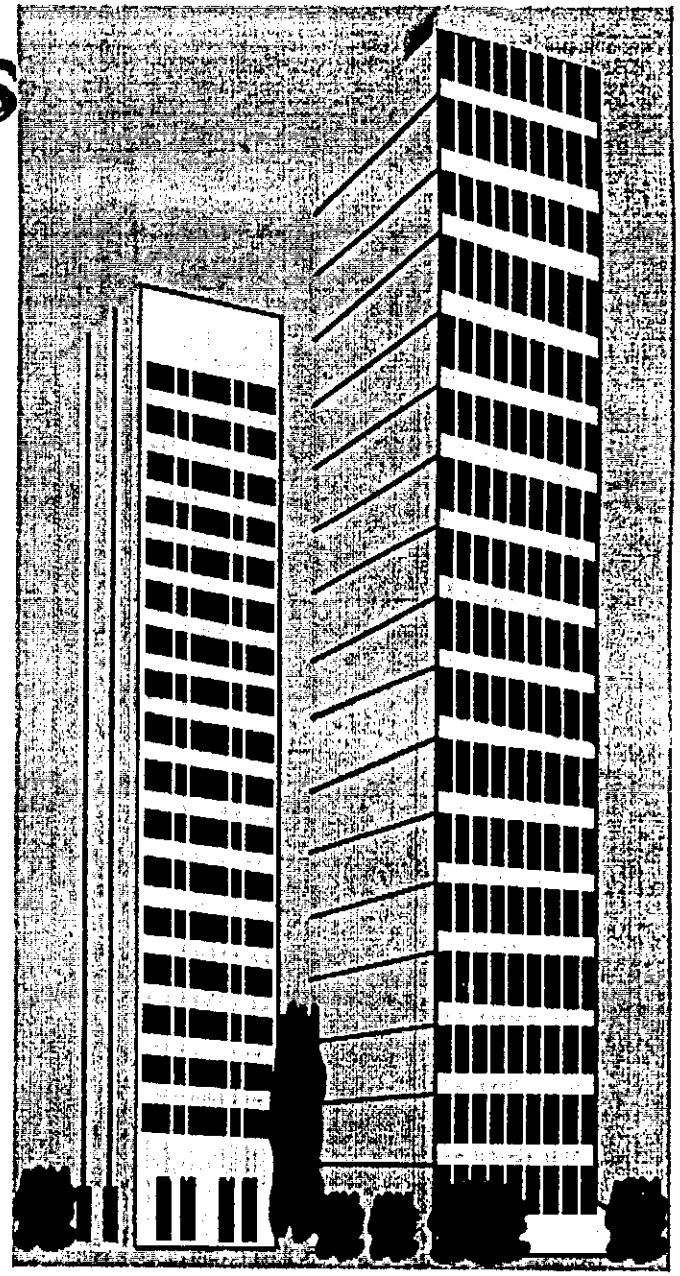
LTO DISTRICT OFFICE



CONGRESS



GSIS , SSS , BIR DISTR. OFFICES

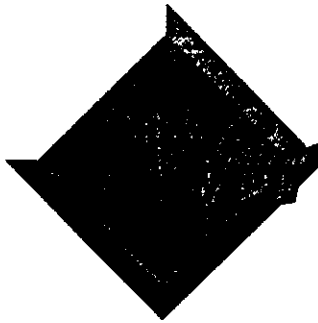


Technology and Equipment Options

- Medium- to High-Speed Packet Radio
- Cellular Data
  - cellular digital packet data
  - circuit-switched cellular data
- Spread-Spectrum
  - frequency-hopping
  - direct-sequence
- Infrared

Private Packet Radio Network

- packetized data consisting of TCP/IP info encapsulated by AX.25 headers and transmitted using CSMA/CD protocol.
- provides point-to-multipoint, point-to-point, and peer-to-peer connectivities.
- 9600 baud, 19.2 kbps, up to 56 kbps
- optimum for short, bursty data
  (messaging, telemetry, POS, database queries, fleet dispatch, Internet email, telnet , ftp etc.)
- bandlimited; requires freq. license

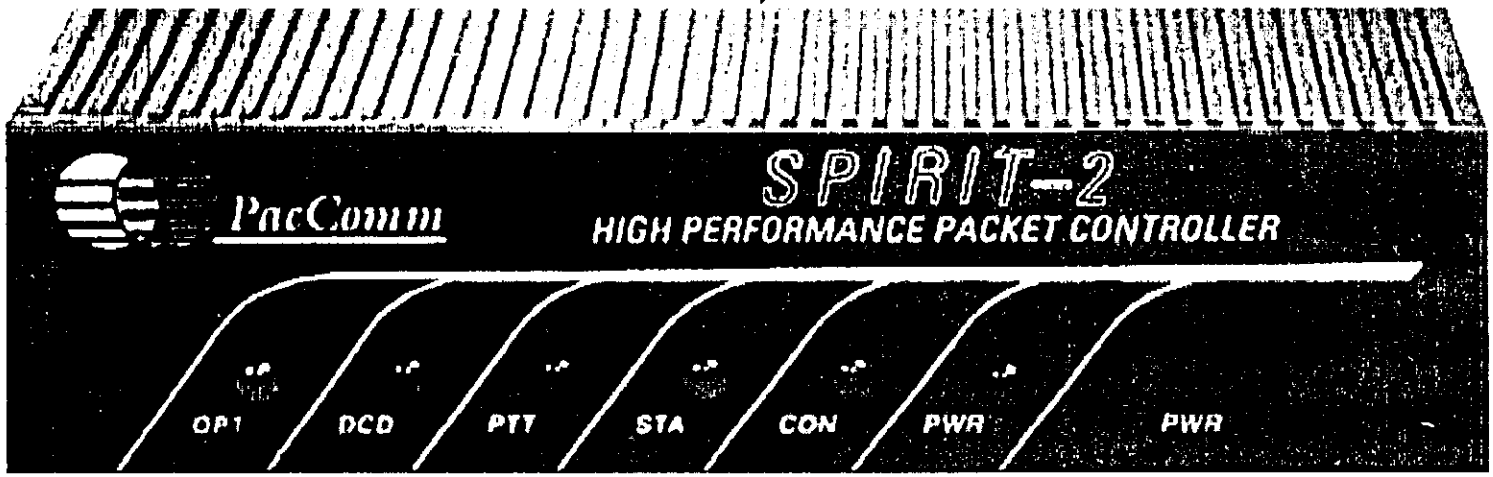


eless LAN Technologies

	Advantage	Disadvantage
Licensed Narrowband Radio (Packet)	❖ cheaper, guaranteed user-access ❖ larger coverage depending on RF power (~ 40 km.)	✦ Requires individual license for each network location ✦ lower data rates (9.6 - 56 kbps) ✦ bandlimited ✦ prone to interference

Private Packet Radio Network

- **Terminal Node Controller** - data interface that handles packet assembly/disassembly, error detection and correction, radio control. RS-232 interface connection to PC; 9k6 - 19k2 modems avail.

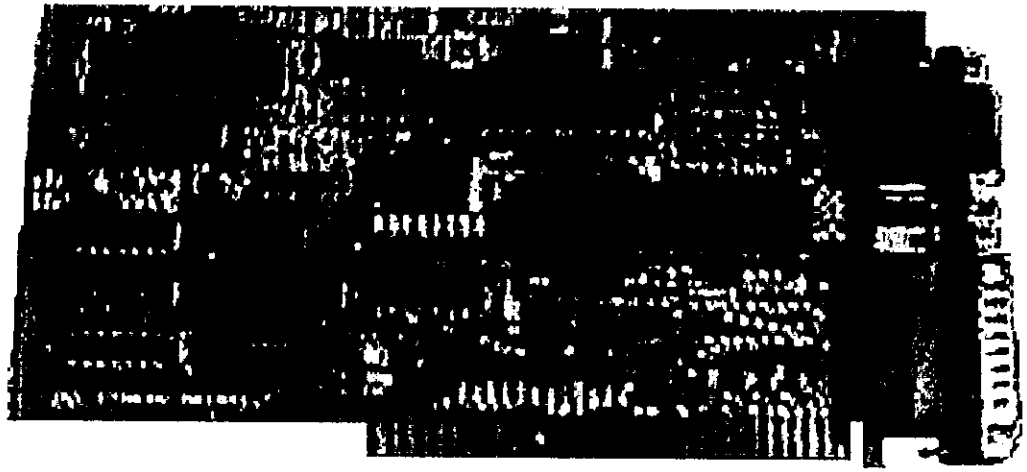


Kantronics Data Engine, Paccom SPIRIT-2, etc. ~ U$ 400.00

http://www.kantronics.com, http://www.paccomm.com

...vate Packet Radio

PC Bus Interface Cards - provide the same function as TNC's, but uses PC bus slots (ISA) instead of serial links; DMA access capable; DOS/Linux drivers available; RS-232/RS-422 if to modem; 9k6 to 128 kbps.

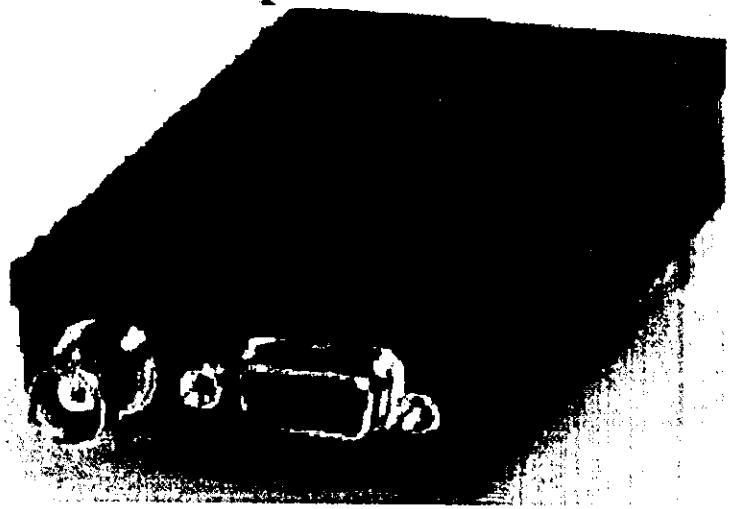


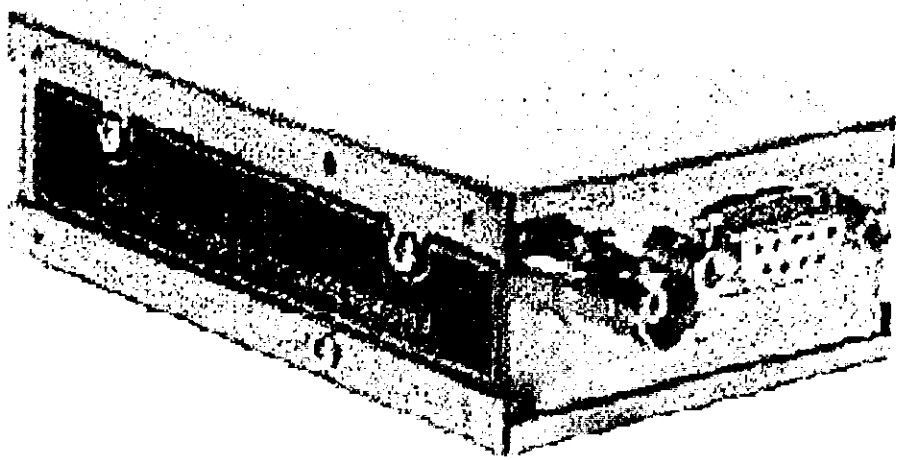
Gracilis PacketTwin, Ottawa PI2 cards ~U$130 - 230

http://www.paccomm.com, http://hydra.carleton.ca

Packet Data Radios

- Narrowband Direct FM radios; commercial voice radios are unusable.
- direct FSK modulator, wideband IF, linear phase characteristics, fast TX/RX switching, 2W-5W RF output.





TEKK Data Radios KS-900/KS1000 ~U$100 - $120
AZDEN PCS-9600D ~U$800.00

Packet Modem Cards

- use GMSK or DFSK modulation (G3RUH)
- 9600 baud -> 25 khz BW
- 19.2 kbps -> 30 khz BW
- typically used as daughter boards on PacketTwin ISA cards or on TNCs.
- Kantronics DE9k6/19k2 or Paccomm MC-NB96 (~ U$110 - $150.00)

Network Operating System/PC-Based IP Routers

(http://www2.miyazaki-mic.ac.jp/johan/jnos40/)

- shareware KA9Q and derivatives (NOS, JNOS,TNOS etc.) exist for various platforms (DOS, Linux, Windows)
- multitasking, PC-based IP routing software that encapsulates TCP data with AX25 headers for radio transmission.
- supports telnet, ftp,slip,ppp, smtp, pop, nntp, web servers, RIP, ping, traceroute etc.

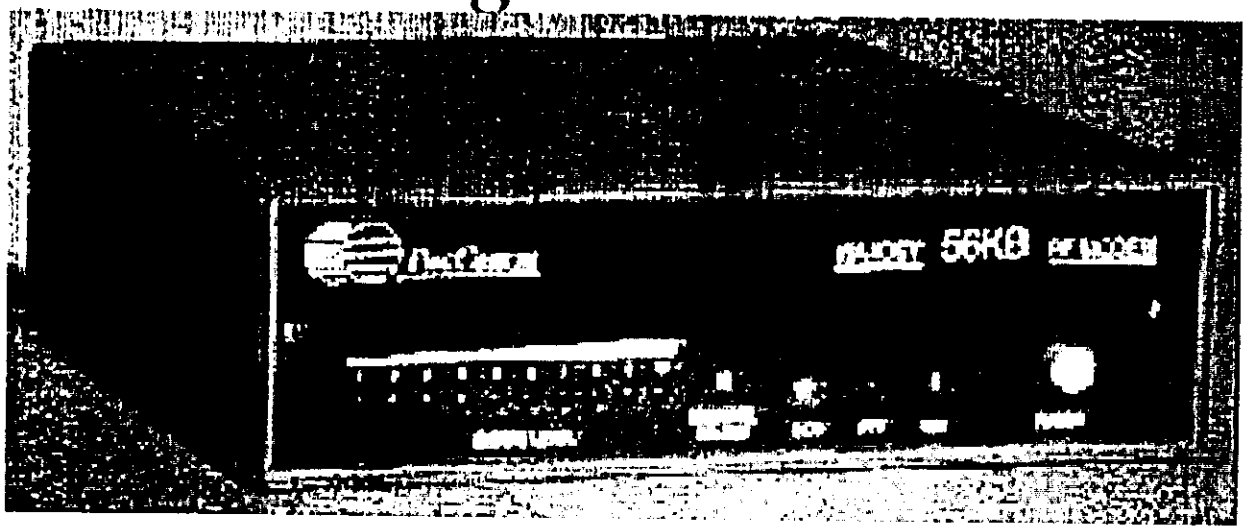
cket Softwave

- Packet drivers that support various interface cards (PI2, PacketTwin, RS-232) exist.
- There are also drivers that provide an Ethernet interface to Winsock applications while converting packets to RS-232 format for TNCs. This enables the use of graphical Web browsers over radio at 19.2 kbps .

kbps RF MSK Modem

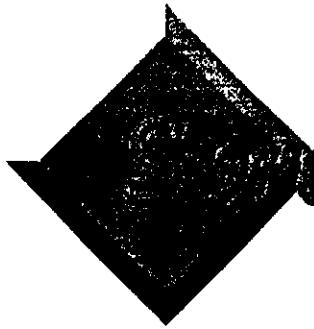
- *28-30 Mhz RF output, with 70 khz bandwidth at 56 kbps; U$350.00*

- *requires a transverter to convert output to 220 Mhz or 400 Mhz; best for point-to-point trunk/bridge links.*



Additional Sources of Information on High-Speed Packet Networks

- *http://www.tapr.org/tapr/html/pkthome.html*
- *http://hydra.carleton.ca*
- *http://www.mindspring.com/~bobm/grapes/grapes.html*



ead Spectrum Technology

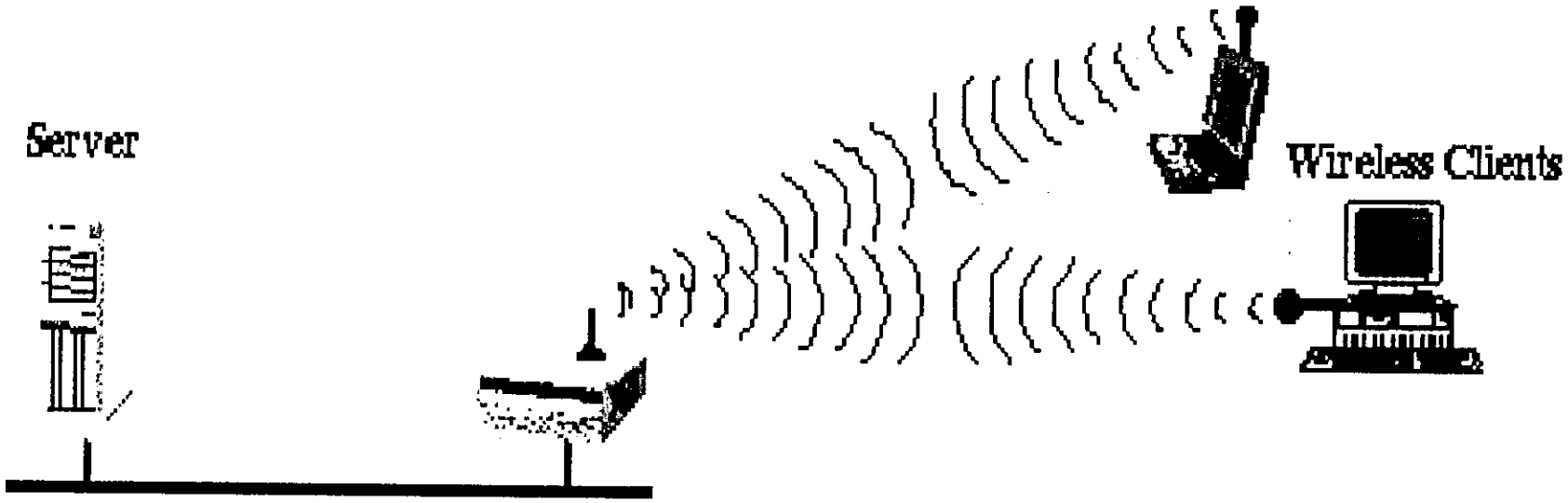
- Wideband RF modulation developed by U.S. military for use in reliable, secure, mission-critical systems.
- trades **bandwidth** for **security and reliability.**
- uses the **Industrial, Scientific, and Medical bands**:
  902-928 Mhz, 2400 - 2483.5 Mhz, 5725-5850 Mhz.
- **Standards**: IEEE 802.11, ETSI 300 328, HIPERLAN
- users are multiplexed in time using the Ethernet protocol CSMA/CA.
- Raw bit rates of 64 kbps to 2 Mbps, with throughputs of 600-800 kbps.
- Maximum RF output power of 1 watt (Max. ERP = 4W); no license needed.

Advantages of Spread Spectrum

- interference immunity
- effective rejection of multipath signals (DS)
- low interference emission
- high data rates (64 kbps to 2 Mbps)
- no license requirement
- very easy to install
- robust, error-free digital pathways.
- inherent security

ne Common SS Equipment

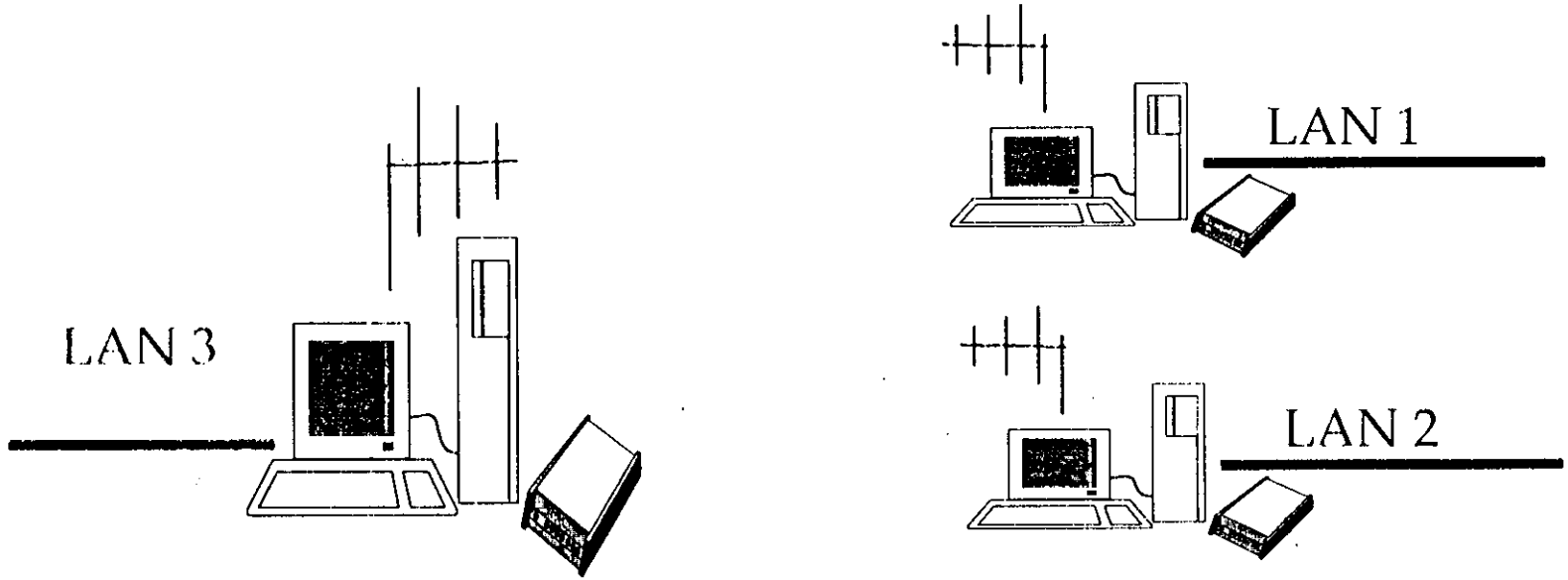
Access Points/Client Cards



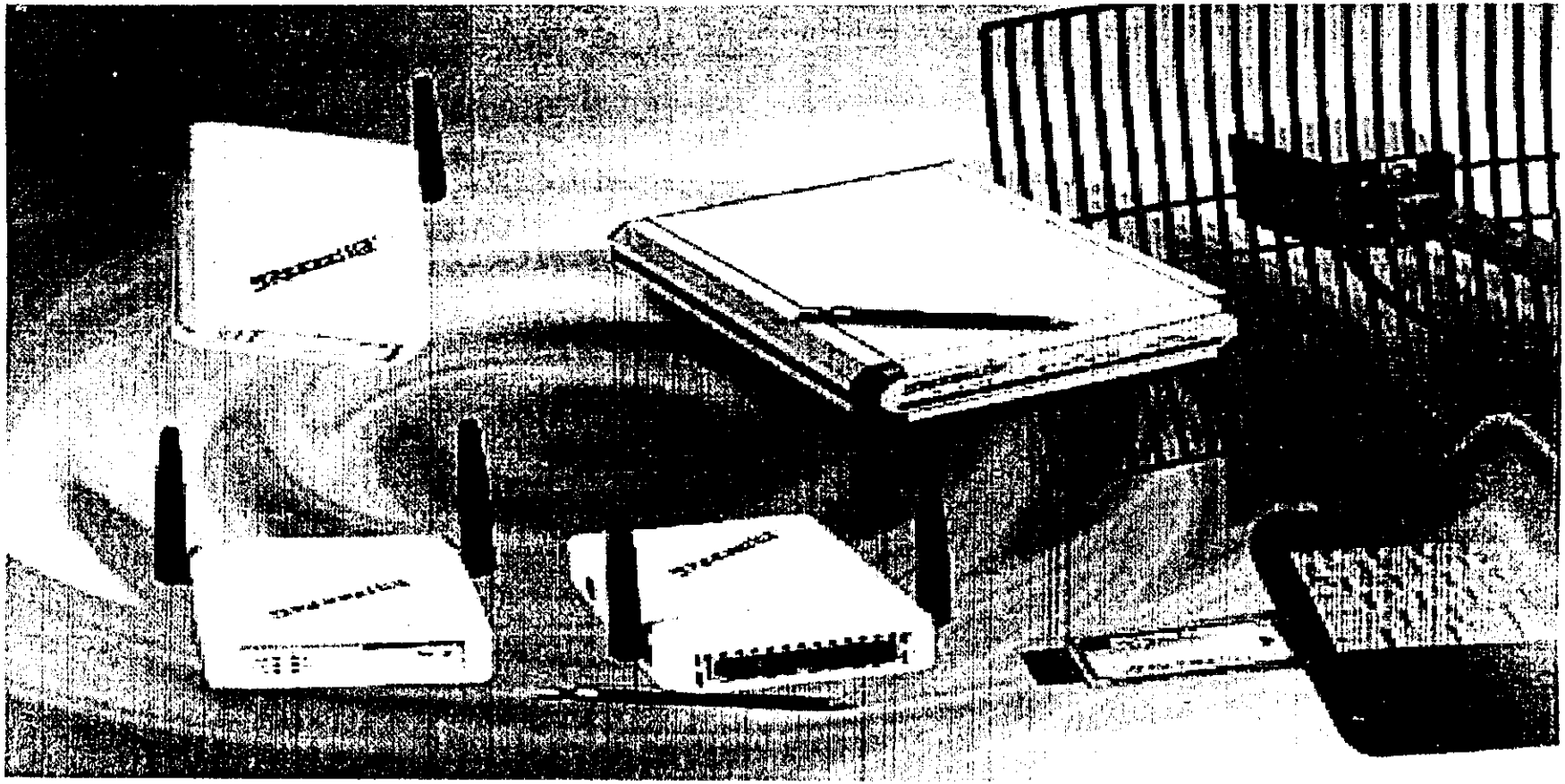
Aironet, Wavelan , Breezecom Client Adapters (ISA, PCMCIA,10BaseT);
150 m to 500m indoors/500m to 5 km outdoors; 215 kbps to 2 Mbps; U$500 - $1000
Access Points: ~U$1300.00

dges/Routers

link, KarlNet, TAL, Aironet, Proxim, or , for a router,
any PC with IP routing software will do .



10 to 50 km. distance; 64 kbps to 2 Mbps; RS-422/RS-232/EIA-530/
Ethernet interfaces or standalone; U$2000 - $3500.00



Other Sources of Information on SS Technology

http://wavelan.com, http://wolfe.net/~nts/aironet/airtop.html,
http://www.wolfe.net/~nts/cylink/cytop.html,
http://www.tetherless.com, http://www.proxim.com,
http://www.datalife.gtem.com

Wireless Network Design Issues

- **Path Attenuation**
  - absorption
  - diffraction
  - free-space path loss
  - shadowing
  - "slow fading"

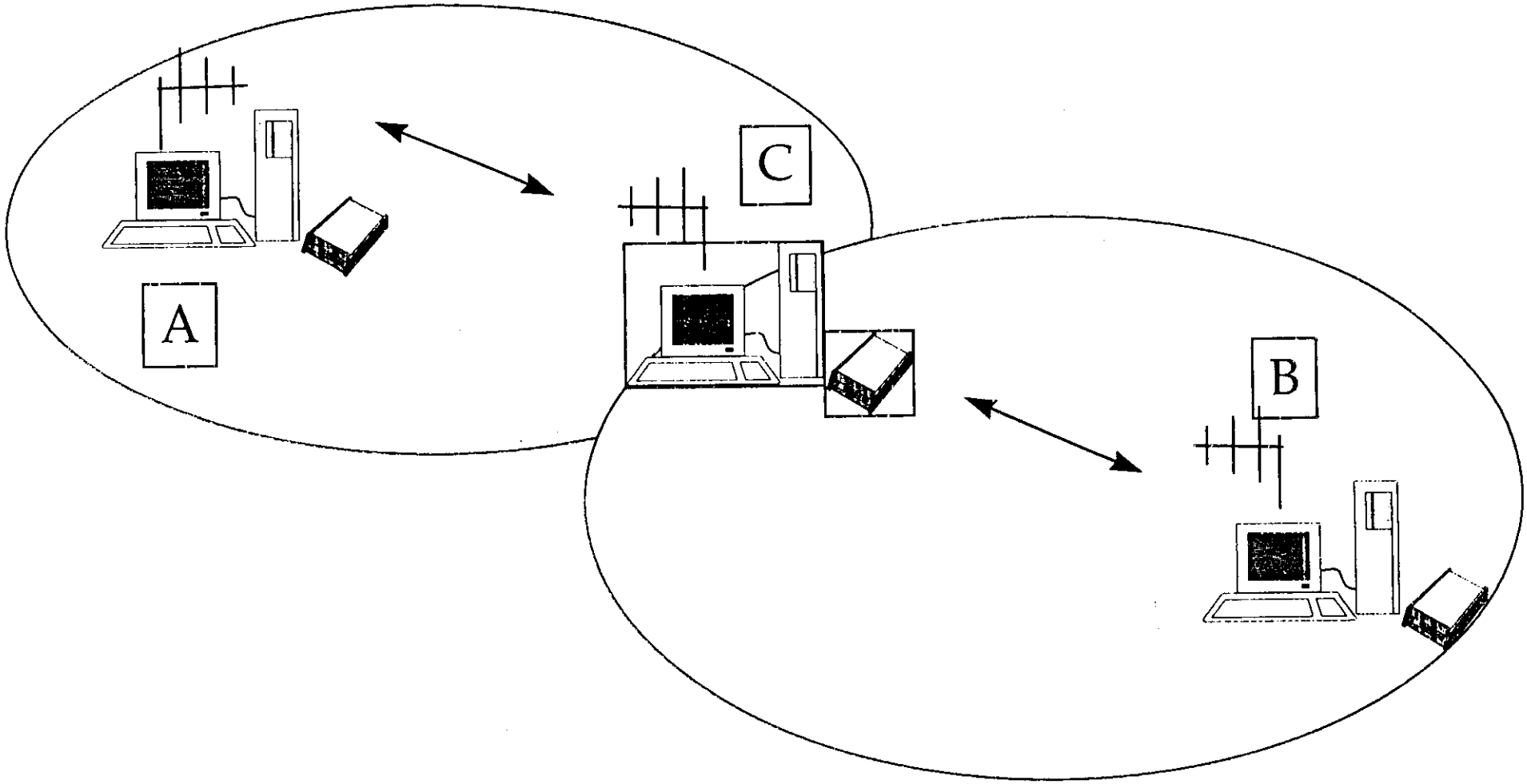
Wireless LAN Customer Considerations

- Range/Coverage
- Throughput
- Reliability
- Integrity/Security
- Interoperability with Wired Network
- Interference and Coexistence
- Simplicity/Ease of Installation
- Cost
- Health Risks/Safety of Emissions

Countermeasures

- Error-correcting access protocol
- Frequency Planning and Management
- Proper Antenna Engineering
- Use of Bi-directional Amplifiers

"Hidden" Transmitter Syndrome



Challenges in Wireless Networking (cont.)

- **Reflection and Multipath**
  - delay spread
  - fast fading
  - doppler shifts

BER of 10^{-2} are typical in a wireless channel; the radio channel limits a system design to B/W efficient, but less robust coding and modulation schemes.