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Title:

What do You Mean, Radio?

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Motorola, Inc.
7 May 1991

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What do You Mean, Radio?

What is "LAN speed?"

Radio is NOT a "broadcast" medium

Protocols and Transparency

Reuse ("cellular") considerations

High data rates (10 to 100 Mbps)

Range trade-offs

Radio systems HAVE emerged as a product

Licensed vs Unlicensed operation

Frequency bands and their tradeoffs

Presented by
Thomas A. Freeburg
Motorola, Inc.
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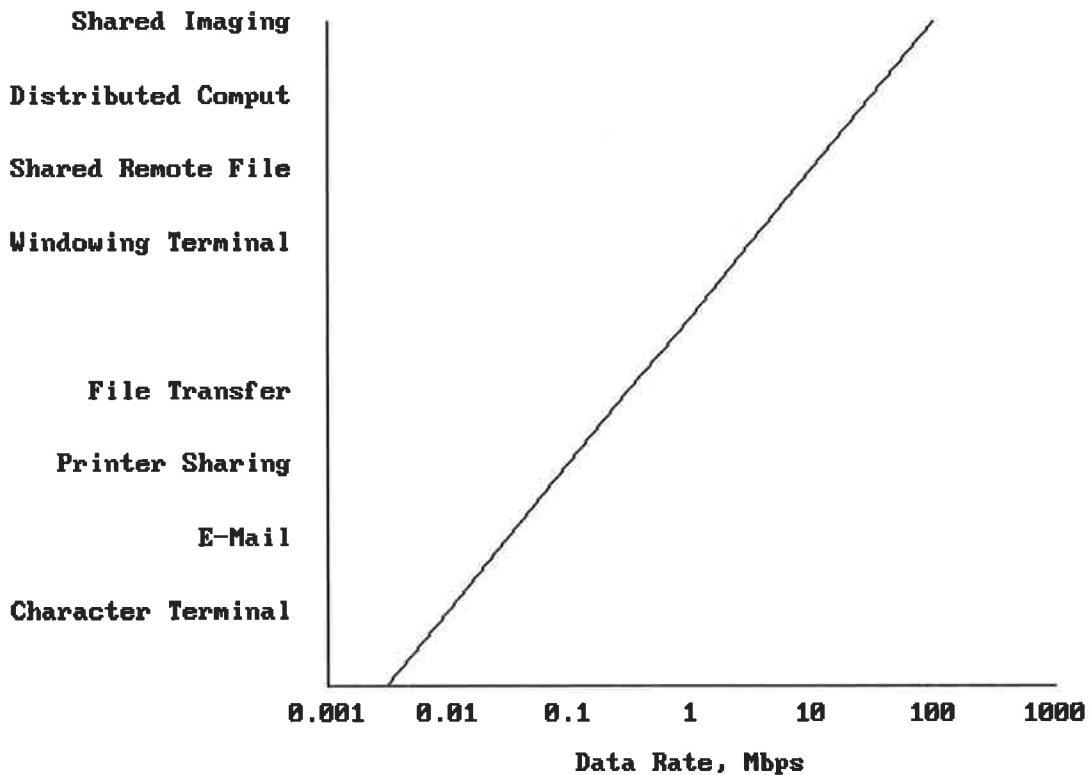*Radio Telephone Systems Group*

Response Time

1 Mbps -----------------------------> 10 Mbps

Floppy ---------------------------->Hard Disk

File Transfer ------------------->Shared File

Closure ---------------------------->Interactive

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Required Network Data Rates

Shared Imaging

Distributed Comput

Shared Remote File

Windowing Terminal

File Transfer

Printer Sharing

E-Mail

Character Terminal

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      0.001    0.01    0.1     1     10    100   1000
                      Data Rate, Mbps
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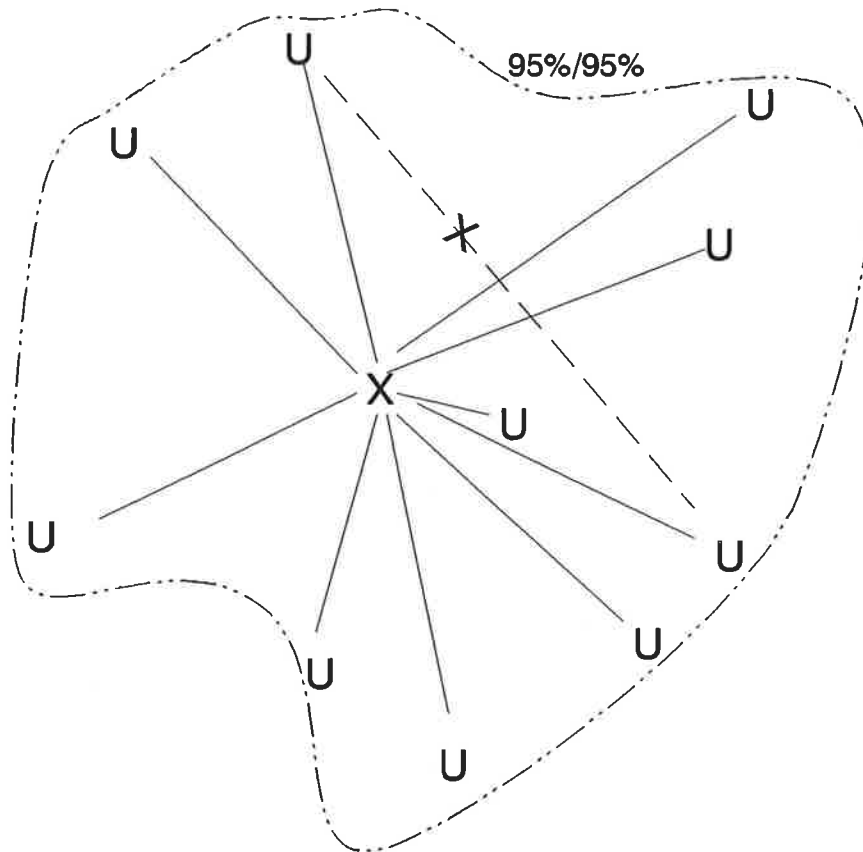**MOTOROLA, INC.**
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Radio is NOT a Broadcast Medium

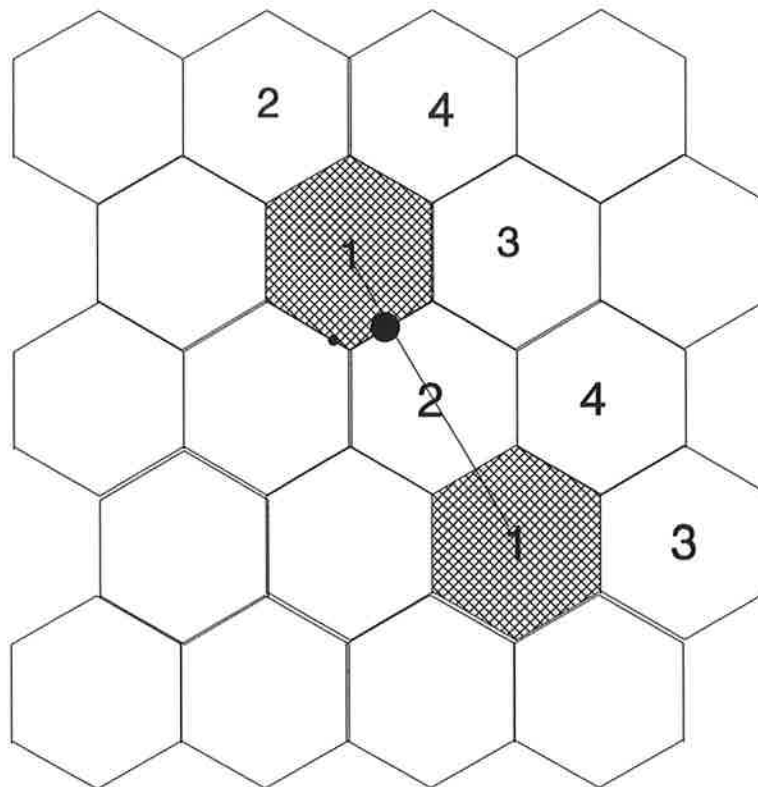**MOTOROLA, INC.**
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7-Cell
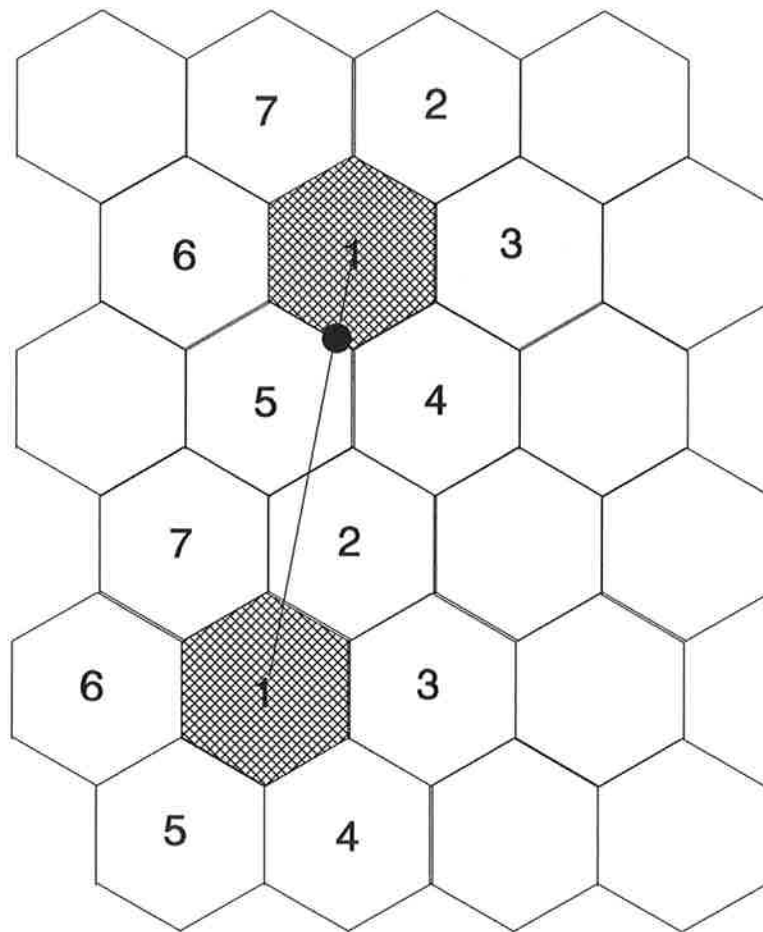
$$C/I = 20 \log 5$$
$$= 14 \text{ dB}$$

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4-Cell

$$C/I = 20 \log 3$$
$$= 9.5 \text{ dB}$$

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4-Cell Sectorized
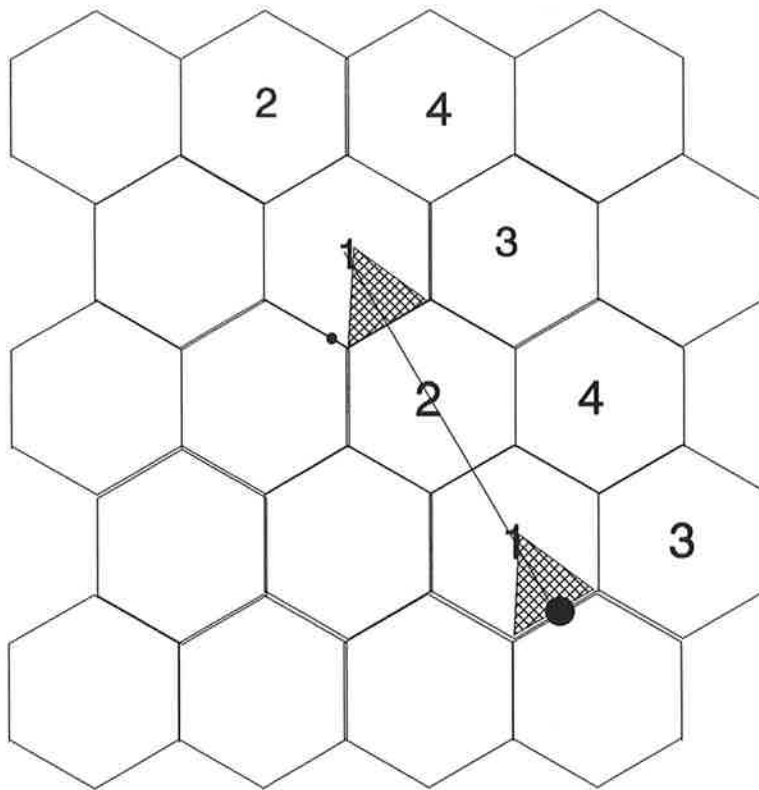
$$C/I = 20 \log 5$$
$$= 14 \text{ dB}$$

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The "Ideal" Range

Typical LAN Size of 8 to 12 —
Design for 32 max

200 square feet per person

Required Range = Sqrt (200 x 32 / 3.14)
= 45 feet

Must Penetrate Office Walls

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Uses of Wireless Networking

Room

Meeting

Work-Group   } "Enterprise"

Backbone

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Radio Systems **HAVE** Emerged as a Product!

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Licensed or No?

NEED FOR COORDINATION

The need for coordination is an accepted fact among out-of-building systems, and a similar understanding must exist for in-building systems. Microcellular regions provide a spectrally responsible means for transferring high-bandwidth data, but like traditional cellular regions, require a certain degree of coordination to prevent interference.

Coordination promises that a user will always have access to an interference-free communication channel. Without it, there is the possibility of a disruption to service if, for example, a new user begins operating a WIN system next door to an existing user. The actual probability of such a disruption occurring is low, but will grow as WIN systems become commonplace. Now is the time to decide on a suitable strategy for coordination.

MARKET DEMANDS

Closely related to the issue of coordination is licensing. The type of license assigned to WIN systems, along with the licensing system selected, will have a large impact on the public acceptance of WIN technology. In order for a wireless LAN to successfully compete against traditional cable-bound LANs, it must be immediately deliverable to the end-user. Customers, distributors, and Value Added Resellers (VARs) are unwilling to wait for an operating license to be granted, before they can legally use, sell, or install a wireless LAN. All items in a LAN are off-the-shelf, implying immediate delivery from local distributors or VARs; therefore a suitable licensing system must be developed to meet these expectations. Traditional LANs don't impose a licensing delay, and neither must a wireless LAN.

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It's Important to Prioritize

	Payback	Development Cost	Product Cost
Reuse	10,000	3	5
Protocol	10	2	3
Modulation	1	3	10

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900 Mhz

Unlicensed Only (ISM)
=>very vulnerable to interference
Ranges on the order of several hundreds of feet ;
good wall penetration
=>low user densities
Spread-Spectrum
26 Mhz Available
=>2 Mbps or so at reasonable spread ratios

1.8 GHz

"Virgin" as far as data goes
Ranges on the order of a couple hundred feet;
good wall penetration
=>low user densities
DECT in Europe
Unlicensed (but limited to this service only)
Raw 1.1 Mbps; max data 256 to 600 Kbps
Apples's request to the FCC
Unlicensed; interference potential unknown
10 Mbps or higher
Spectrum Availability could be years away

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2.4 GHz

Unlicensed Only (ISM)
=>very vulnerable to interference
Ranges on the order of a hundred feet ;
good wall penetration
=>low user densities
Spread-Spectrum
45 to 80 Mhz Available
=>10 Mbps or so at reasonable spread ratios

5.4 GHz

Unlicensed Only (ISM)
=>very vulnerable to interference
Ranges on the order of a hundred feet ;
moderate wall penetration
=>moderate user densities
Spread-Spectrum
45 to 80 Mhz Available
=>10 Mbps or so at reasonable spread ratios

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18 GHZ

Licensed
Range on the order of 50 feet
Wall penetration good inside; poor outside
    =>high user density
100 MHz available today
15 Mbps today; => 100 Mbps

24 GHz

Unlicensed Only (ISM)
    =>very vulnerable to interference
Range on the order of 50 feet
Wall penetration good inside; poor outside
    =>high user density
Spread-Spectrum
45 to 80 Mhz Available
    =>10 Mbps or so at reasonable spread ratios

60 GHz

"Virgin"
Ranges limited to Line-of-Sight
No wall penetration
    =>"Backbone" use only

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Diffused IR

No Wall Penetration
Ranges on the order of 50 feet
Moderate bit rates (1 Mbps?)

Very-Short-Range Diffused IR

No Wall Penetration
Ranges on the order of 10 feet
Bit rates up to 10 Mbps

Point-to-Point IR

No Wall Penetration
Ranges on the order of 200 feet; line-of-sight only
Bit rates up to 10 (toward 100) Mbps