

# Commercial Spread Spectrum Background

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# Hedy Lamarr:

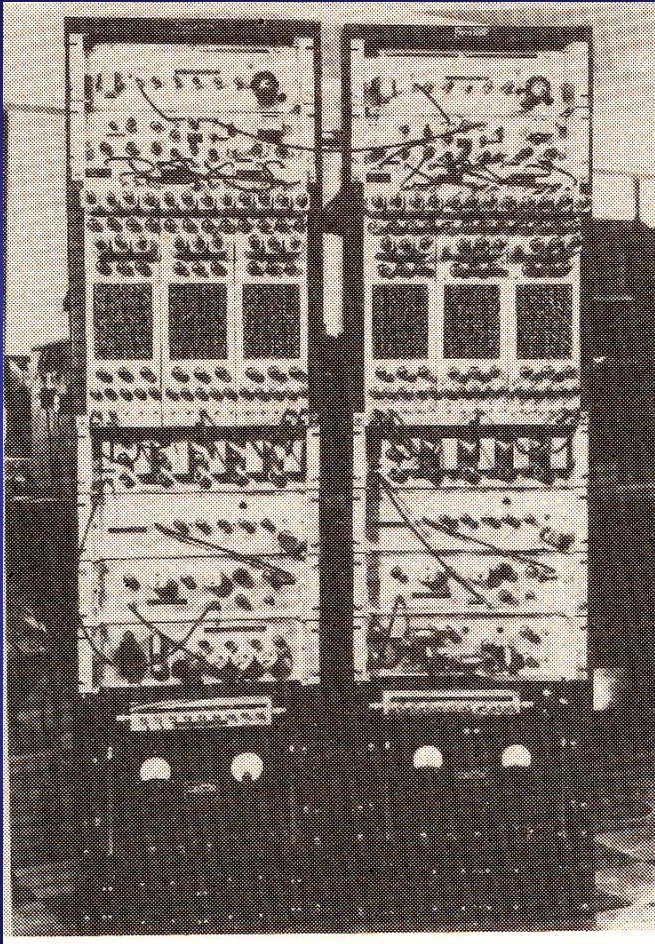
## Legendary Inventor of Spread Spectrum



- As is often reported in popular press, Hedy Lamarr was awarded an early frequency hopping spread spectrum patent during WWII
  - But invention was not reduced to practice
- Like with the computer, it is probably impossible to identify a single inventor



# 1953 MIT Lincoln Lab System



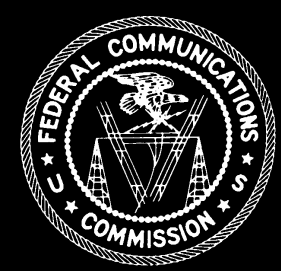
- Developed by Paul Green as a thesis project
- One of earliest PN systems
- Technology of the day limited size



# Early Literature



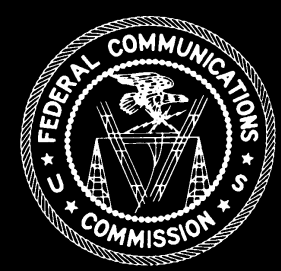
- In the 1950-1970's spread spectrum generally remained a classified technology with only occasional references in the open literature.
- My first exposure was at a classified 1972 conference
- Only "text book"-like discussion was a classified Sylvania report



# My First Real Contact



- Joining the Institute for Defense Analyses in 1975, I was assigned to studying options for communications ECCM
  - 1973 Mid East War showed an unexpected amount of communications EW
  - DoD had minimized EW threat to communications up to that point and was concerned about options to increase preparedness against “new” threat

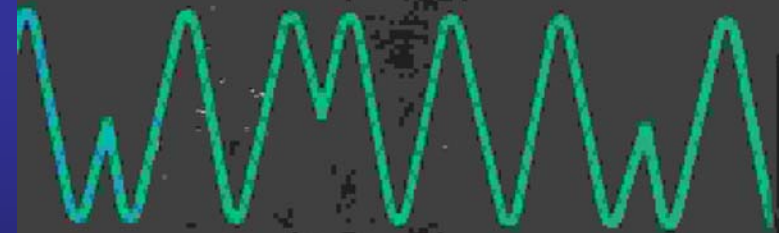


# Dixon's Book 1975



- First comprehensive, though mathematically inelegant, treatment of spread spectrum
- Introduced a generation of designers to the technology

## SPREAD SPECTRUM SYSTEMS



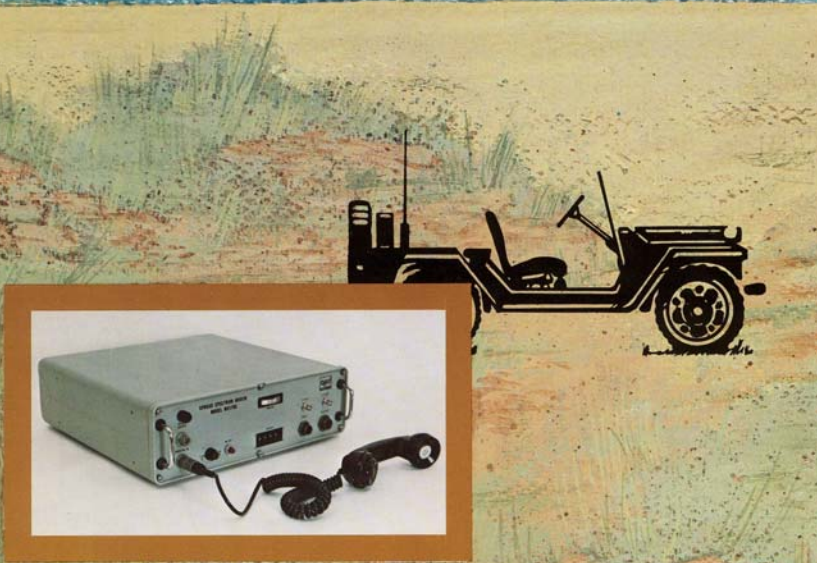
Robert C. Dixon



# Commercial Spread Spectrum c. 1979



- Magnavox produces a “civil” version of AN/ARC-50/90
- Japan MPT purchases and tests for possible civil applications
  - Concludes no practical value for civil use





# Circa 1980



## IEEE TRANSACTIONS ON COMMUNICATIONS

OCTOBER 1980 VOLUME COM-28 NUMBER 10 (ISSN 0090-6778)

A PUBLICATION OF THE IEEE COMMUNICATIONS SOCIETY



PAPERS

*Communication Theory*

A Spread Spectrum System with Frequency Hopping and Sequentially Balanced Modulation—Part II: Operation in Jamming and Multipath ..... *R. F. Mathis and R. F. Pawula* 1785

*Data Communication Systems*

Quantization Noise in Adaptive Delta Modulation Systems ..... *H. S. Lee and C. K. Un* 1794  
Priority Channel Assignment in Tandem DSI ..... *M. Schwartz, K. Mase, and D. R. Smith* 1802

- Publications became more common
- But most publications still focused on military applications
  - Possibly to justify DoD funding





# Early FCC Action



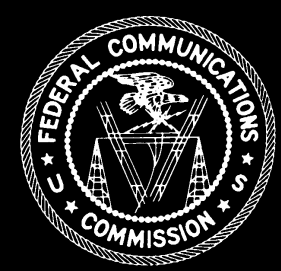
- 1980 MITRE Corp. report to study options for civil use of spread spectrum
- Available from NTIA as PB81-165284

## Potential Use of Spread Spectrum Techniques in Non-Government Applications

Walter C. Scales

Presented to  
Federal Communications Commission  
Washington, D.C.

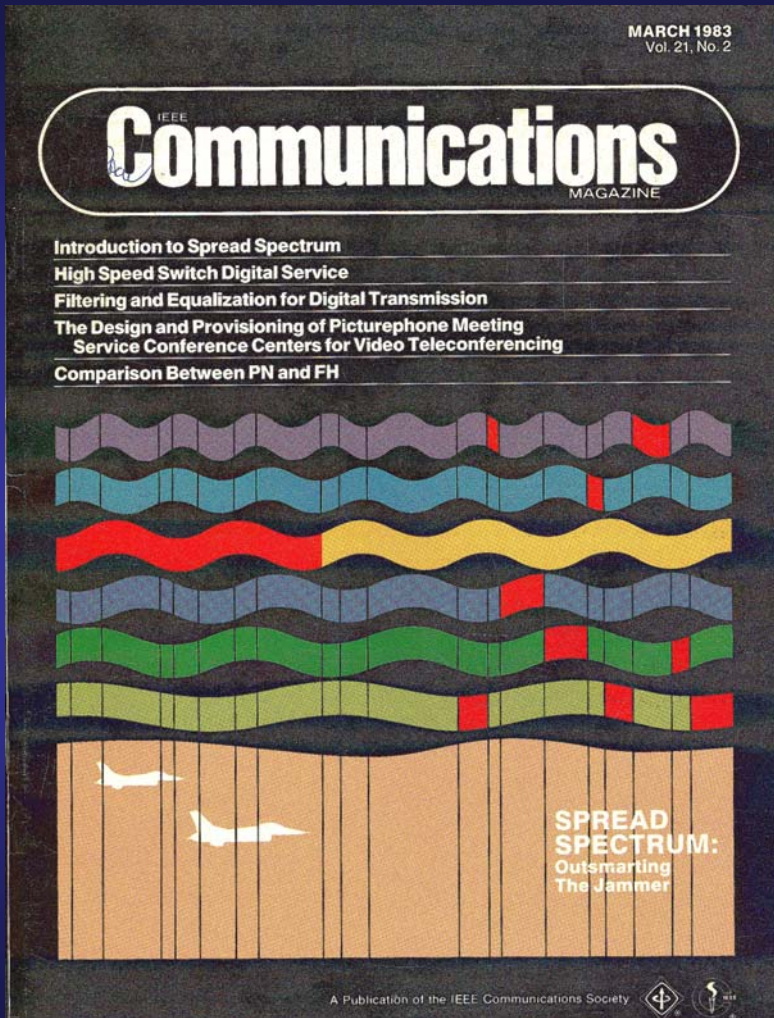
The  
Telecommunications  
Act of 1934



- 1981 2 initiatives begun:
  - Docket 81-413 – General use
  - Docket 81-414 – Amateur radio use
- While H-P was supportive, most industry opposed
- IEEE IT Society filed support



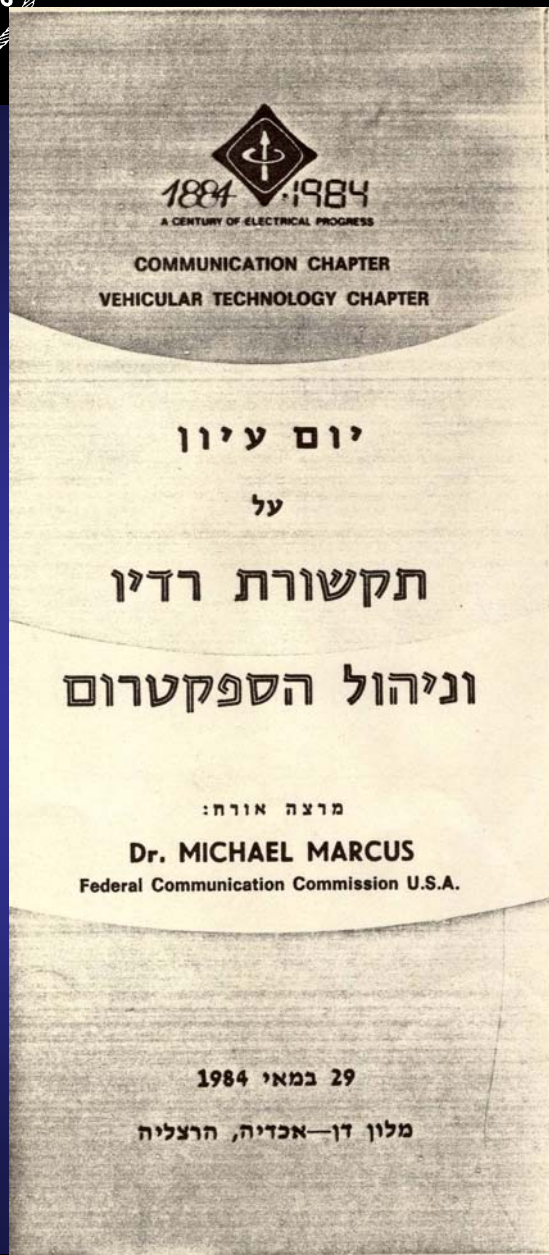
# 1983



- While publications still focused on military use
- FCC issued new proposals focusing on ISM bands as a “proving ground” for spread spectrum in civil use



# 1984



- While interest in the US was minimal, others were interested



Before the  
 Federal Communications Commission  
 Washington, D. C. 20554

FCC 85-245  
 35747

In the Matter of )  
 )  
 )  
 Authorization of spread spectrum and other ) GEN DOCKET NO. 81-413  
 wideband emissions not presently provided )  
 for in the FCC Rules and Regulations. )

FIRST REPORT AND ORDER

Adopted: May 9, 1985

Released: May 24, 1985

By the Commission:

INTRODUCTION AND SUMMARY

1. Spread spectrum modulation is a wideband modulation which was originally developed for military applications but which has several interesting civil applications 1/. This technology has been implicitly forbidden by the FCC rules with a few limited exceptions. On June 30, 1981, the Commission adopted a Notice of Inquiry ("Inquiry") 2/ in this proceeding seeking comments on a rule structure that would permit civil use of this technology 3/.

-----  
 1/ The spreading or dilution of the energy in spread spectrum systems over a wide bandwidth results in several possible advantages: short range overlays on other emissions, resistance to interference from other emissions, and low detectability. While it is not anticipated that spread spectrum will replace other types of modulations in general, the unique characteristics of spread spectrum offer important options for the communications system designer.

2/ 87 FCC 2d 876

3/ A companion Notice of Proposed Rulemaking was adopted in Docket 81-414 proposing use of spread spectrum in the Amateur Radio Service and has been implemented, in part, in a Report and Order we are adopting today.

# 1985



- May 9, 1985 FCC adopts spread spectrum rules in ISM bands
- Same basic rules until 2002
  - 1 W limit
  - PN or FH
  - Almost any application



incorporated July  
 1985



# “First Light”



- In 1988 the first real commercial spread spectrum product appeared – a LAN
- Second product was Gambatte MIDI LAN
  - Limited production
  - Very popular with top rock musicians!
  - Derivative system still used in nuclear power plants

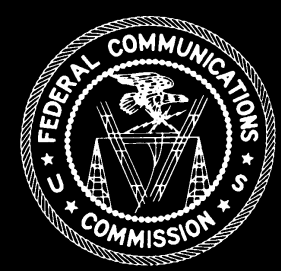


# “Second Light”



- Gambatte MIDI LAN
  - Limited production but very popular with top rock musicians!
  - Derivative system still used in nuclear power plants

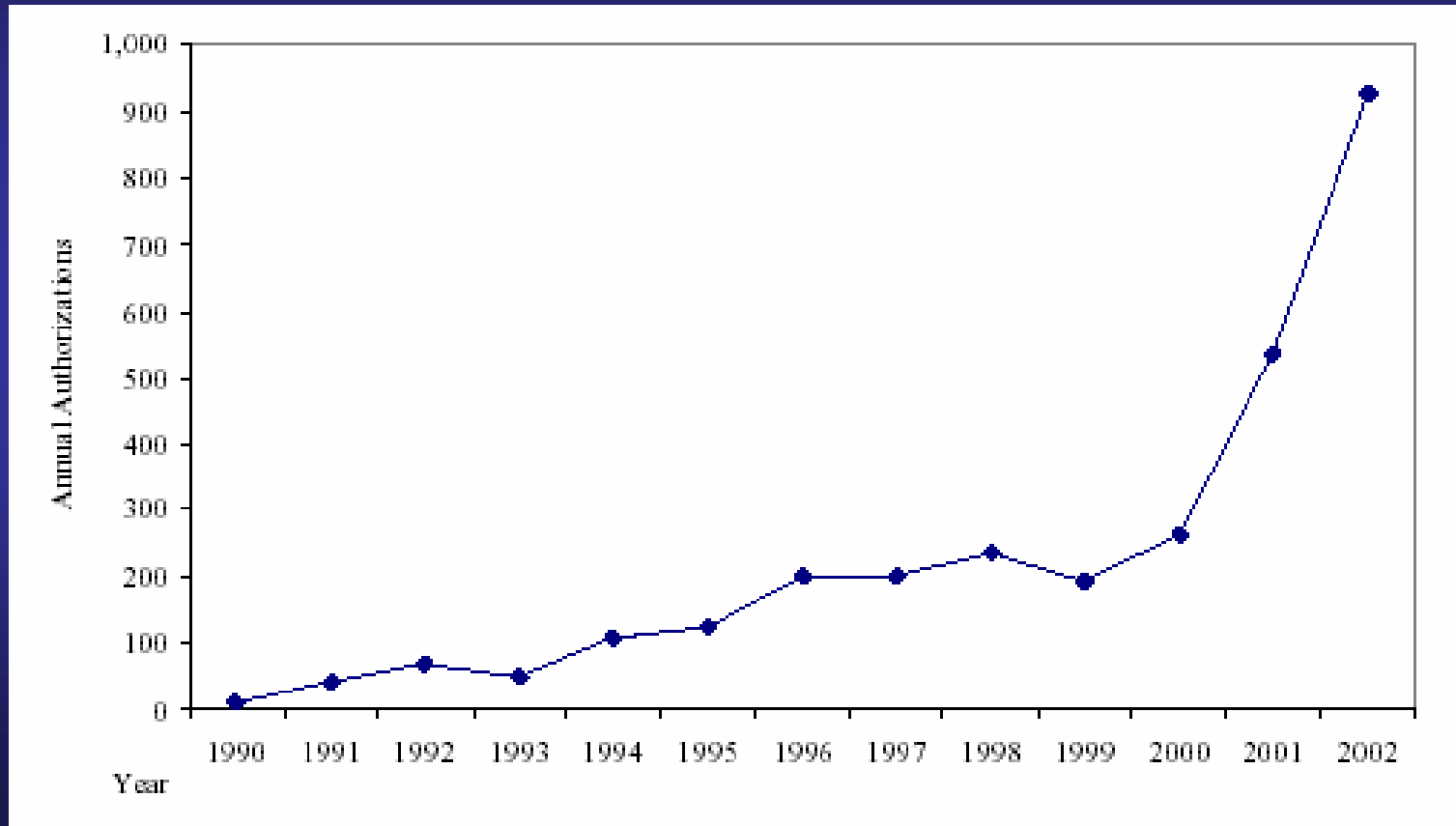




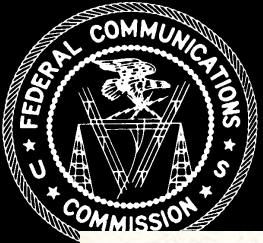
# Equipment Trends



- After slow start, equipment authorizations has had exponential growth







# 1991



## SPREAD SPECTRUM

**Potential Commercial  
Applications  
Myth or Reality?**

**21 - 23 May 1991  
Le Chateau Montebello,  
Montebello, Quebec, Canada**

## WORKSHOP NOTES

in cooperation with:

Institute of Electrical & Electronics Engineers (IEEE), Ottawa Section  
Ottawa Carleton Research Institute (OCRI)  
Telecommunications Research Institute of Ontario (TRIO)  
Alberta Telecommunications Research Centre (ATRC)  
Department of Communications

- “Myth or Reality”
- Many key players went to Quebec woods to discuss the future of spread spectrum



# 1992



## Spread Spectrum Scene

*The PCS, Wireless Network and CDMA Monthly News Magazine*

Volume 1,  
Number 7  
October, 1992

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Single Copy Price \$3.00

Special Issue on New Spread Spectrum, LAN and PCN Products



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### The Future of Wireless LANs and PCNs

Some of the latest wireless products for LANs and PCNs are pictured here. Do these products indicate the future direction of Spread Spectrum applications?

Are we about to enter the era of the PDA (Personal Digital Assistant, or Appliance)? Or are these sleek new products just more misguided marketing ideas that represent sidetracks to the direction of progress in this business? This month's editorial discusses these and other important issues for Spread Spectrum's future.

see EDITORIAL page 2



**Are We Ready For This? More New Products Inside Spread Spectrum Scene**

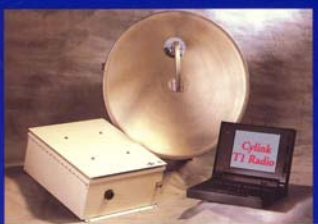
- LANs discussed
- Available products focused on cordless phones and PDA-like systems



# Non-LAN Systems



## AirLink™



### AirLink T1 Specifications

#### General

- System Replaces wire in a T1 system
- T1 interface DSX-1, (ANSI T1.102-1987)
- Line Code Bipolar AMI or B8ZS
- Format Clear channel
- Mounting Pole mounted for maximum range
- Bit Error Rate Better than 10<sup>-10</sup> unfaded
- Optional Access Unit Switchover, AC power, Order Wire

#### Maintenance Features

- Software control Local & remote status & control; non-volatile memory
- Features Internal test generator; HW & SW version identification; Receive level and quality; Bit error & errored seconds count; Alarm log; Local and remote loopback; Software controlled DSX-1 line equalization
- Maintenance port RS-232 DTE interface
- Control RF Power Level, PN code
- Order Wire 2-wire modular phone jack
- Connectors 41-pin weatherproof; N-type female antenna

#### General Radio

- C-band 5.725-5.850 GHz
- Modulation type Spread spectrum; MSK; Time Division Duplex
- Spreading code Direct Sequence, 32 bit code
- Frequency 5.7875 GHz, 95 MHz bandwidth (1 dB)
- RF Channels 1
- Output Power Software set, 100 mW max
- System Gain 100 dB
- Receiver Sensitivity -80 dBm @ BER=10<sup>-6</sup>
- Impedance 50 Ohms

#### Power Consumption

- AirLink T1 50 Watts
- Direct power -36 to -72 Vdc @ 1 A
- Fusing (source) 2 Amp at -48V

#### Environmental

- Enclosure Weather proof (NEMA 4)
- Operating Temp -30 to +60 degrees Celsius (-22 to +140 deg. F)

- Unlicensed point-to-point was unexpected but permitted by liberal rules
- Undersold traditional Part 101 systems
- Popular in cellular industry for quick installation without paperwork





# Hedy is Still Remembered!

