

# Comparing FH and DS Wireless LAN Technologies



# FH and DS Technology Comparison

## *Overview*

### ◆ Issue analysis

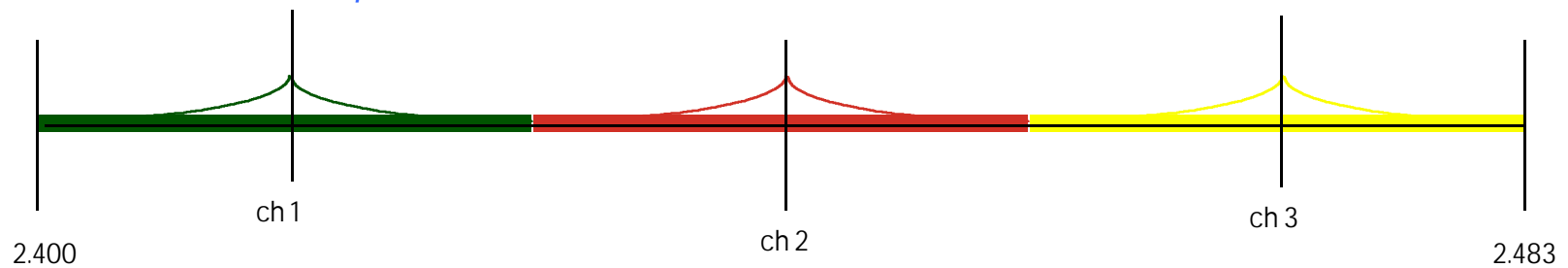
- Interference immunity
- Power management
- Scalability
- Security
- Multipath



# DSSS and FHSS

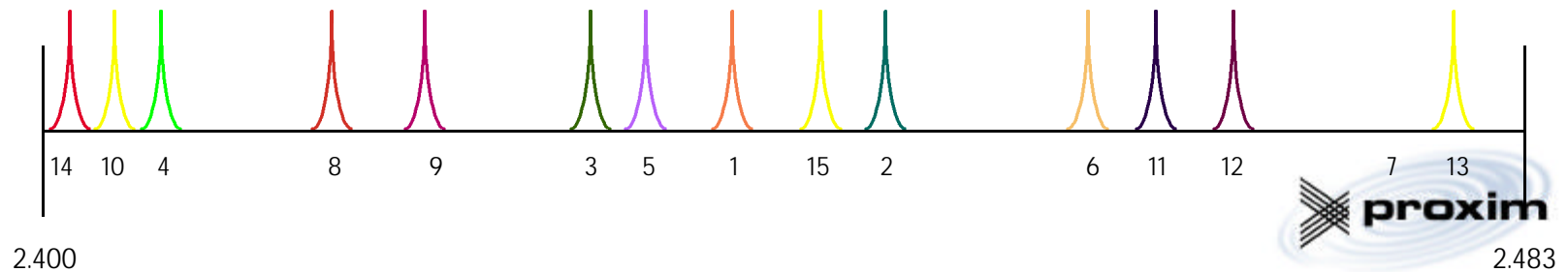
## Direct Sequence

3 Channels @ 2Mbps



## Frequency Hopping

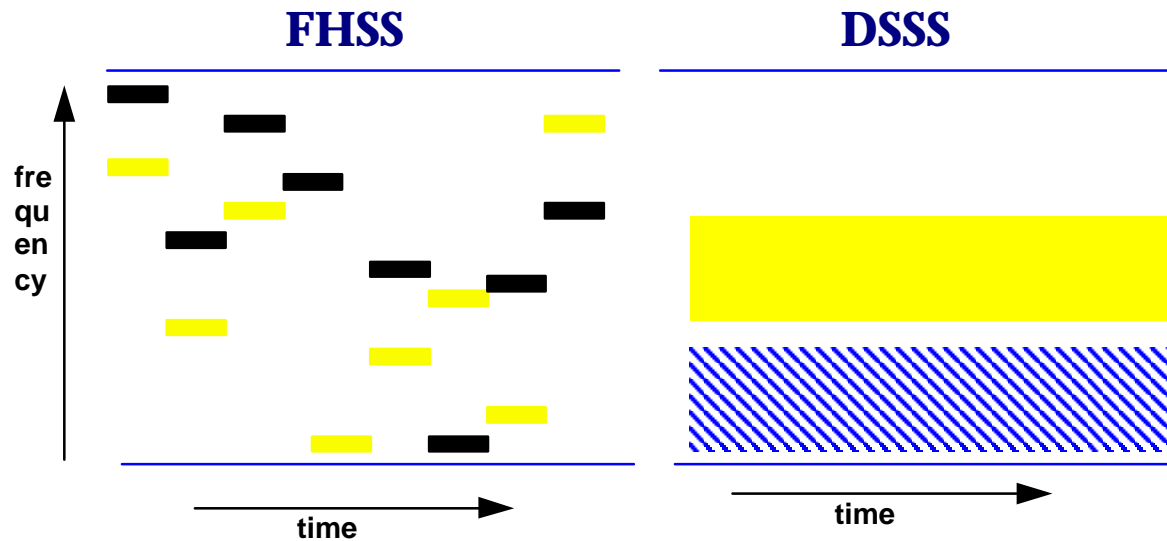
15 Channels @ 1.6Mbps



fh vs ds  
12/98 lc

# Interference Immunity

*Example using Two Non-overlapping Channels*



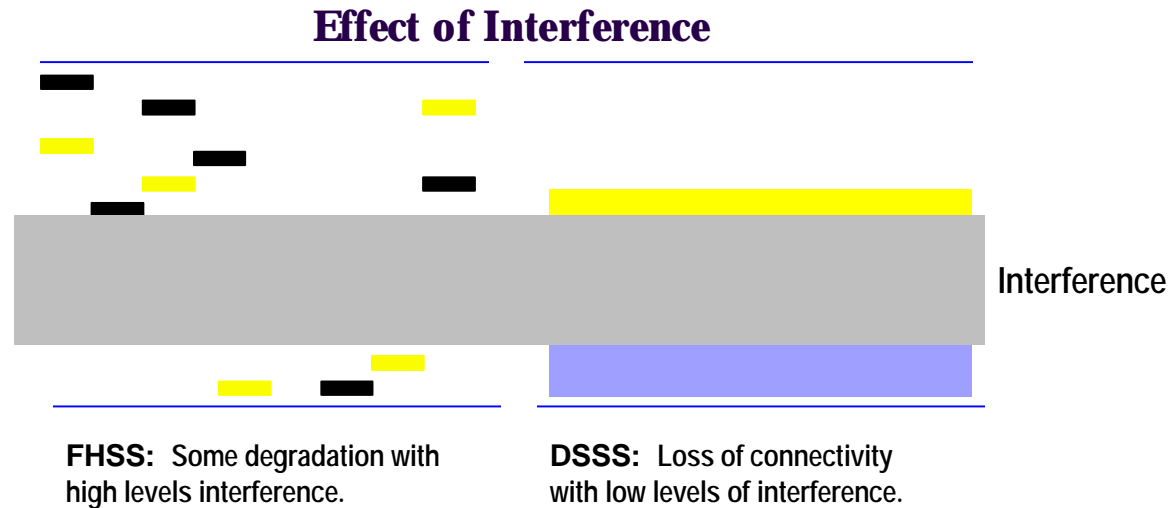
- FH hops around the band
- Uses entire band
- Higher spectral density for shorter periods of time

- DS is static
- Uses a portion of band
- Continuous lower spectral density



# Interference Immunity

## *Results with interference*



- FH performs better in two ways
- Hops around interference
- Higher power may overwhelm interference
- Transmission slowed, but not stopped

- DS performs worse
- Cannot avoid interference
- Low power cannot overpower
- Significant interference will cause loss of connectivity



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# Power Management

## *FH and DS Technology Differences*

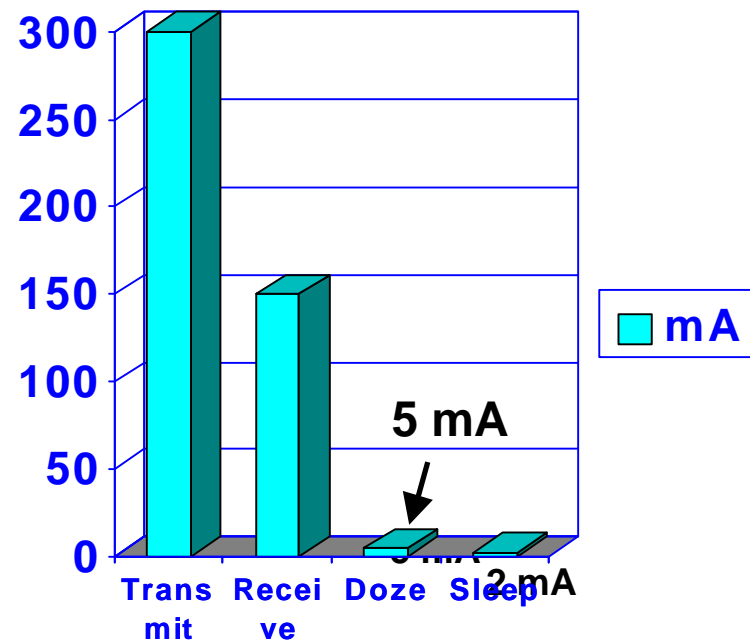
- ◆ FH-based designs can use nonlinear power amplifiers
- ◆ Nonlinear power amplifiers are much more power efficient
- ◆ DS transmitters must use very linear power amplifiers for the receiver to properly interpret the signals
- ◆ Linear power amplifiers have much higher power draw



# Power Management

## *RangeLAN2 Marathon™*

- ◆ A highly-tuned algorithm that delivers the lowest power consumption on the market
- ◆ Doze mode - a unique Proxim advantage
  - When not receiving or transmitting, radio is in doze mode
  - An average between receive and sleep
  - No latency in returning to transmit or receive mode



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# Scalability

## Direct Sequence



- Clients can only roam between APs on the same channel

## Frequency Hopping



- Clients can roam between APs on different channels

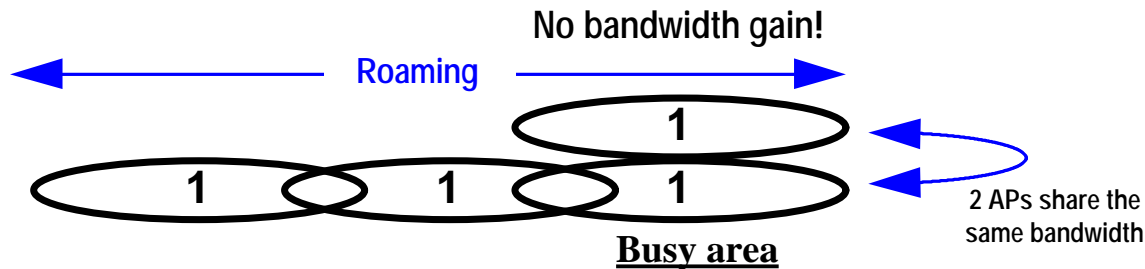




# Scalability

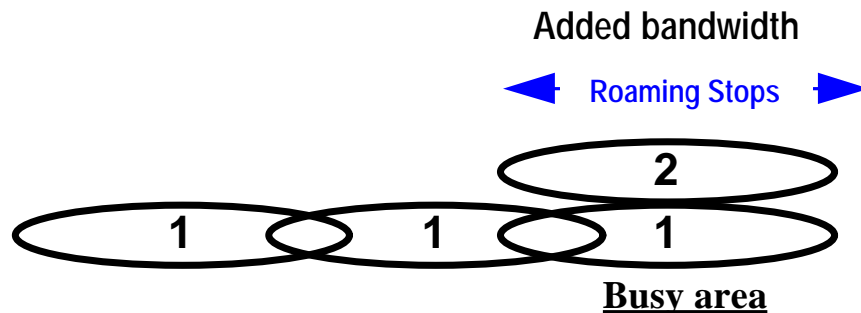
## Why DS systems don't scale

### Add an AP on the same channel



- No additional bandwidth gain

### Add an AP on a different channel

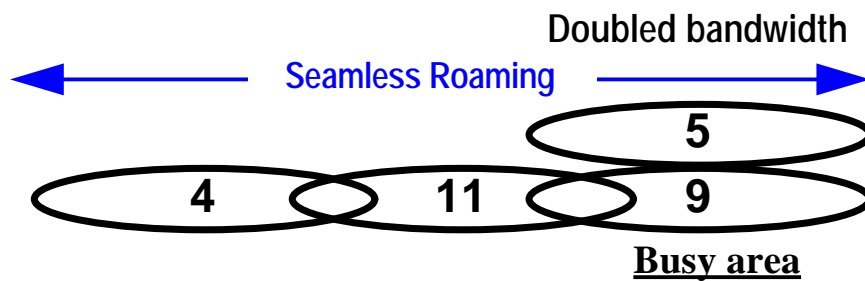


- Clients must be specially configured for each channel



# Scalability

*Why FH systems do scale*



- Add an additional AP in the busy area
- Clients can roam between APs without special configuration

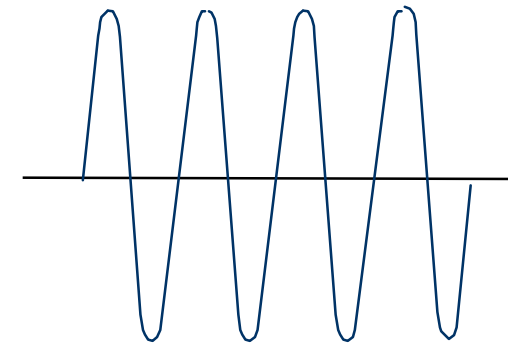
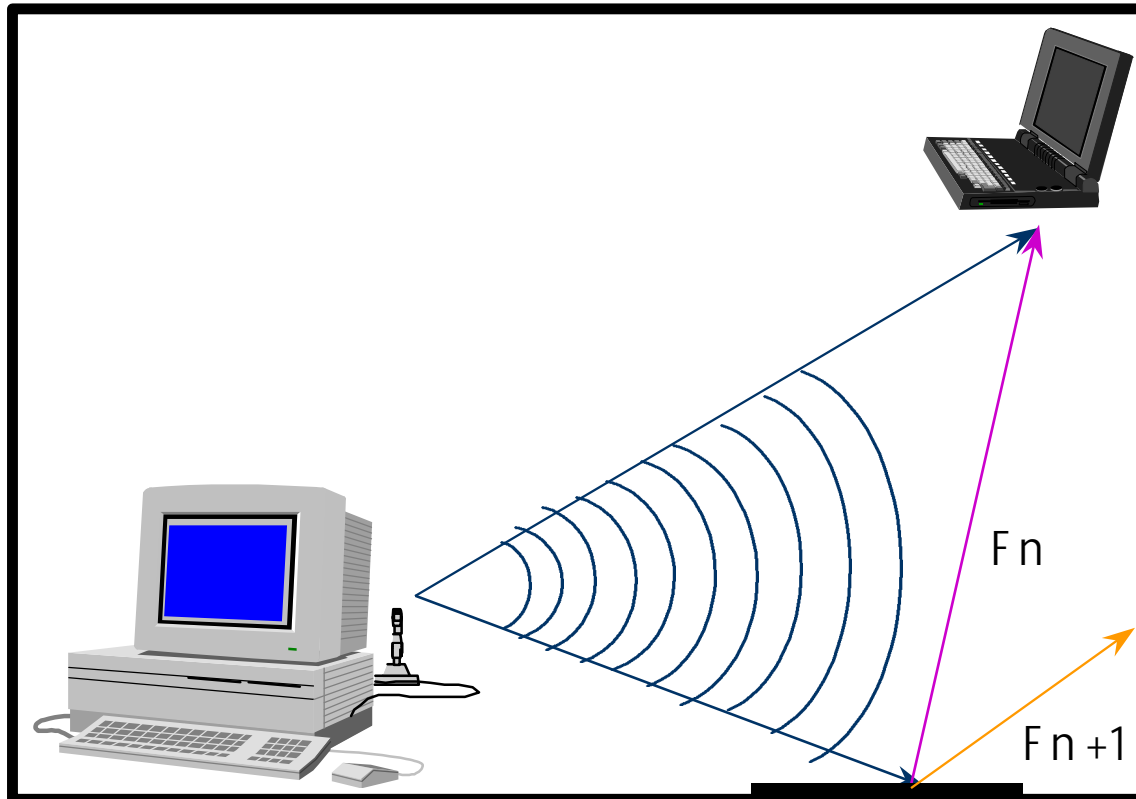


# Security

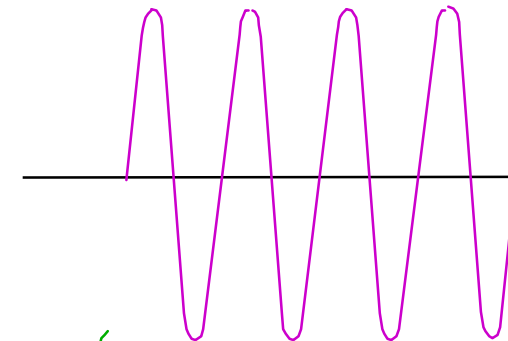
- ◆ Spread spectrum systems are inherently secure
  - DS and FH are both spreading technologies
  - Designed to be difficult to crack over the air
- ◆ Watch for vendor implementation differences
  - 802.11 mandates WEP
    - 40 bit encryption and authentication
    - Difficult, complex to integrate
    - No DS vendor has successfully integrated



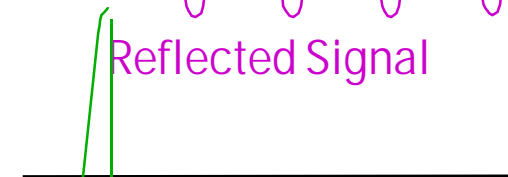
# Multipath and Coverage Holes



Direct Signal



Reflected Signal



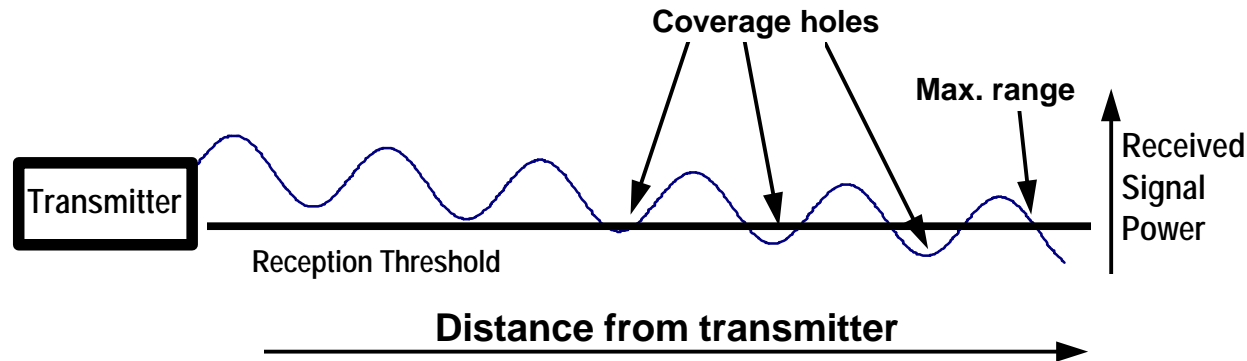
Total Signal



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Multipath nulls - direct and reflected signals sum to produce a signal below the receiver reception threshold causing coverage holes.

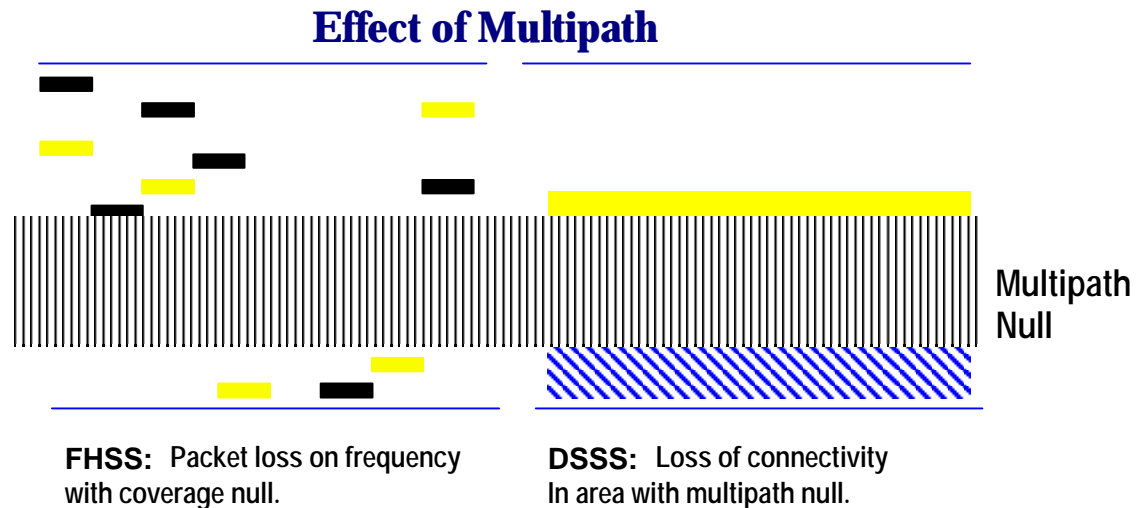
# Multipath and Coverage Holes



- ◆ Multipath nulls exist at all frequencies at *different* ranges
- ◆ Two ways to avoid impact of multipath nulls
  - Change frequency
  - Change position



# Multipath and Coverage Holes



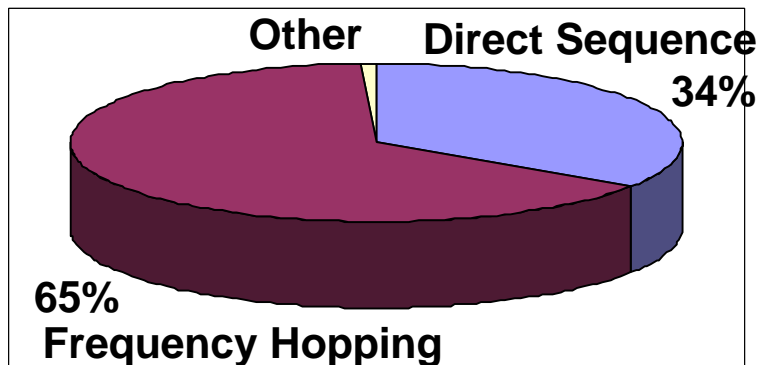
- FH systems are not multipath prone
- Hops to a different frequency where there isn't a null
- Doesn't require changing position
- DS is multipath prone
- Frequency static
- Cannot move to a different frequency
- Not practical to change position to alleviate



# Marketplace Technology Adoption

## *The trend*

Worldwide Wireless LAN  
NIC Shipments by  
Transmission Technology, 1997\*



\*Source: International Data  
Corporation, 1998

### ◆ Market Share Leader

### ◆ Technology Leader

- Smallest and lightest, lowest power consumption radio
- De facto standard for Windows CE

### ◆ Price Leader

- Only technology to break \$200 adapter barrier

### ◆ Basis for new wireless standards

- Bluetooth
- HomeRF
- WPAN



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# Marketplace Technology Adoption

*The momentum*

## Frequency Hopping

- ◆ AMP
- ◆ Aironet
- ◆ Bay Networks
- ◆ BreezeCOM
- ◆ Citadel
- ◆ Cruise
- ◆ Data General
- ◆ Fujitsu
- ◆ Hand Held Products
- ◆ Hewlett-Packard
- ◆ IBM
- ◆ IDWare
- ◆ Intermec
- ◆ Kansai
- ◆ Kinetic
- ◆ LXE
- ◆ Mitsubishi
- ◆ Monarch
- ◆ Motorola
- ◆ NEC
- ◆ Percon
- ◆ Proxim
- ◆ Raytheon
- ◆ Sharp
- ◆ Symbol
- ◆ Teklogix
- ◆ Telos
- ◆ WaveAccess

**Seven radio vendors**

## Direct Sequence

- ◆ Aironet
- ◆ Bay Networks
- ◆ Lucent
- ◆ Symbol

**Two radio vendors**



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