

02-146 ExParte FCC WTB

**Cisco Systems, Inc.
May 16, 2003**

- **Demand Drivers**
- **Deployment Model**
- **TDD & FDD**
- **Licensing & Coordination**
- **ATPC**
- **Technical Rules**

Demand Drivers

Demand Drivers: Network Growth

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Network Connectivity Upgrade/Expansion

Rapid, competitive, flexible deployment

Gigabit Ethernet Port Growth:

7.1m in 2002

12.1m in 2003

20.6m in 2004

10 Gig Ethernet Port Growth

5k in 2002

30k in 2003

110k in 2004

Growth in Distribution to Core, LAN to MAN

Demand Drivers: Storage Area Networking

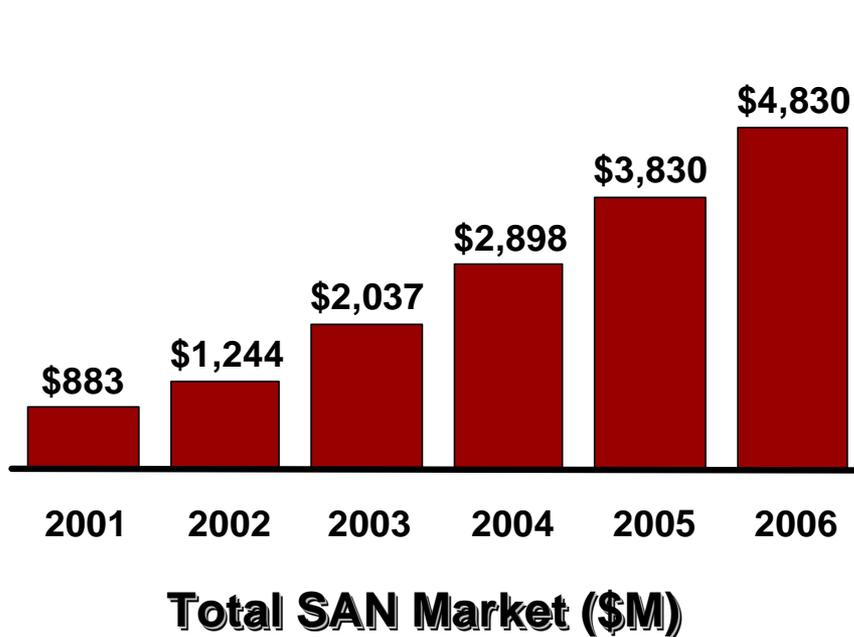
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Remote Disk Storage

50% of CIOs identified Storage Needs

Disk drive capacity ~60% per year

Price per GB falls 35-40% per year



Sources: Gartner/Dataquest, IDC

Target Market Segments	Transmission Speeds
* Suitable for Small to Mid Size Work Groups * Deployed as Stand Alone or SAN Edge Devices	1Gbit/sec
* Suitable for Data Centers and Mid Size to Large Enterprises * Deployed as SAN Edge to Core	2Gbit/sec
* Suitable for Large Enterprises and Data Center * Deployed as SAN Core Backbone	10 Gbit/sec

Sources: Variety of Industry Sources

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Demand Drivers: How Cisco Sees the Market

- **Fundamental Needs:**
 - Gigabit speed**
 - Flexibility**
 - Speed of deployment**
 - Cost**
- **Enterprise, outdoor bridging market is \$250-\$300m in 2003. Licensed bridging is bigger.**
- **Requirements in *selling* wireless bridging to the Enterprise directly or through SPs:**
 - Sales Cycle**
 - Number Customer Sales Calls**
 - Customer Satisfaction**

Demand Drivers: Wireless Bridging Customer Needs

- **Why use: Cost effective, rapidly deployable alternative or complement to leased lines or fiber trenching**

- **Customer requirements**

Reliable bandwidth – as bridging is moved further into the core of enterprise networks, the requirements for reliability and bandwidth increase.

Ease of use and deployment – must be as simple to manage as a leased line with support for a single day install and a deployment period that is far shorter than leased lines

- **Existing customer examples**

Fortune 500 customer in San Francisco expanded to a location across the street. No tie lines were available and there was a moratorium on trenching in the city. Unlicensed wireless was used to connect the two locations.

Hospital system in a major US city with multiple hospital sites. Utilized wireless bridging as a redundant link between sites.

Demand Drivers: Domestic Fiber Hotels

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- **There are about 8000 fiber hotels (POPs) today**
- **Business proximity¹**
 - 750k business buildings in US with >20 employees**
 - Only ~5% of these buildings have fiber connections today**
 - ~75% of these buildings are within 1 mile of a Fiber Hotel**
- **Fiber trenching has declined due to economic and Municipal conditions**
- **The opportunity is to bring these buildings online with fiber-like capacity using millimeter-wave wireless**

This is the “Hub and Spoke” deployment

¹Source: RHK

Deployment Model

Basic Hub and Spoke Deployment Model

- **Single Service Provider deployment:**
 - Acquires roof rights for all 70/80 GHz links on Fiber Hotel**
 - Responsible for link performance and availability**
 - Likely deploys radios from a single vendor**
 - Has sophisticated radio planning and deployment departments; can readily resolve installation and commissioning difficulties**
 - **Enterprise deployment**
 - Enterprise customer owns and installs link from spoke to hub**
 - Installation and commissioning costs must be kept low**
 - Customer not typically equipped to resolve co-location interference problems**
 - Hub location has many radios, independently managed, from multiple vendors**
- Multi-SP deployments share this characteristic**

Hub and Spoke Deployment Objectives

- **Objective is to bring the benefits of fiber to customers**
 - With fiber, customers can upgrade to higher-rate services as their needs grow**
 - With fiber there is the perception, if not reality, of no practical bandwidth limitations**
 - These features equate to investment protection for the future**
- **70/80 GHz wireless must offer the same benefits**
 - Wireless services must be capable of scaling to 10+Gbps rates**
 - As links are upgraded in capacity, there will be a mixture of different radios on the hub's roof—this should be enabled by the FCC's rules**
- **Technical rules must support/promote both deployment models**
 - Market will decide preferred model(s)**
 - Industry/customers win when barriers to deployment are removed**

On the Use of TDD & FDD in 70/80 GHz Paired Spectrum

Benefit of Dual-Band FDD Architecture: Easy Capacity Upgrades to 10+Gbps

- **Generally accepted in the industry that 71-76 and 81-86 GHz bands will be required for 10+Gbps, full duplex capacity**
- **Initial deployments using TDD or single-band FDD virtually guarantee transmitter co-location issues as capacity upgrades occur**
 - Nearby, planned upgrade of full-band 10Gbps transmitter would be operating in the same band as victim receiver**
 - In this scenario, path coordinator would predict harmful interference and not permit capacity upgrade**
- **Dual-band FDD radios do not have this problem**

Licensing and Coordination

- **Traditional Approaches**

Geographic auctions are not appropriate in this case because they would unnecessarily constrain deployment and usage

Although Site Licensing is the most appropriate model for RF purposes, the large number of sites or links would create an administrative burden during the initial application process as well as renewals or changes

The current the path coordination process requires manual coordination between the FCC and IRAC

ULS Staff indicated 35 day average processing time for private, fixed, point-to-point ULS applications (45 days for common carrier)

- **Blanket Licensing with Path Coordination**

First link authorized by traditional site-by-site licensing.

Coordination completed in advance, with conditional operation permitted until application approval (based on Part 101)

Coordination will be based upon GPS coordinates. Vertical coordination could be based on AGL utilizing the same side of a building or from a GPS-calculated roof height, with a floor count

Upon grant of license, licensee could operate additional paths based upon coordination and notification of the Commission (could be done by Path Coordinator)

Equipment upgrades would require re-coordination, with Commission notification.

Licensing and Coordination with USG

- **Coordination Time between USG & commercial use**

Comsearch filing supports 50-60 day best case coordination with FAS/IRAC, although there is no worst case limit. The lack of transparency into the process makes business planning impossible.

We support a Trusted Path Coordinator, which the NTIA supported in their reply comments but with reservations that this requirement would limit the number of coordinators.

NTIA agrees Government/Commercial coordination is a 'critical factor'. Continuation of the current process could lead to 'significant burdens' and 'unacceptable delays'

- **Cisco proposes:**

- 1) All USG assignments, excluding classified, should be entered in the database used by accredited "Commercial Path Coordinators".

- 2) All USG assignments, including classified, should be entered in the database used by authorized "Trusted Path Coordinators".

- 3) Commercial Path Coordinators can query the database maintained by the Trusted Path Coordinator for a yes/no answer.

Licensing and Coordination: Satellite & RAS

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- **Fixed Satellite Service**

USwww future commercial satellite priority over previously licensed terrestrial service will preclude commercial and SP use.

Full extent of USG satellite usage and plans based on Uswww.

- **Radio Astronomy Service**

The record does not support NAS claim for enlargement of existing RAS coordination zones.

We concur with NAS on web site coordination for commercial deployments within existing coordination zones.

To minimize interference and maintain the restriction zones current size, we propose banning:

- Analog modulation**
- Unscrambled digital data**

Licensing and Coordination

- **No Unlicensed use in band**

Creates unacceptable uncertainty for Enterprise or SP use of OC-192 equivalent

Discovering, identifying and notifying an Unlicensed interferer is time prohibitive based on the negative business impact

- **No Channelization**

As depicted by our simulations, channelization of the band is not required to achieve a high density of deployment within a geography

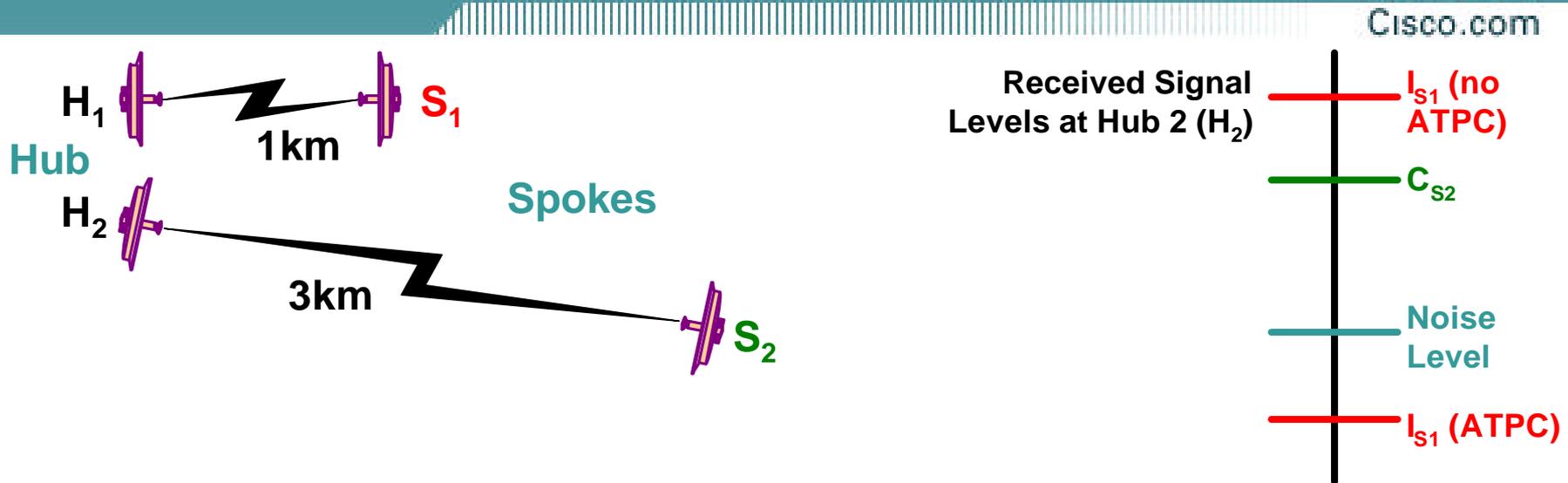
Channelization will erode the multi-Gigabit data speed potential of this band, and reduce commercial interest

- **Defer Mobile allocation**

Would present new, potentially intractable coordination challenges

On the Need for ATPC in 70/80 GHz Spectrum

How ATPC Helps Mitigate Interference During Rain



- ATPC helps on the “uplink” (Spoke to Hub direction)
- When it rains, link 2 (being longer) is impaired much more than link 1, exacerbating the near-far problem (example rain loss »15 dB/km at 40mm/hour precipitation rate)
- With ATPC, spoke transmitter on shorter link powers up less during rain
- The more the S₁ transmitter lowers its power using ATPC, the greater the probability link 2 (as well as other subsequent paths) can be coordinated
- The greater the EIRP of S₁, the more ATPC dynamic range is needed

Proposed Technical Rules (Joint Reply Comments Agreements)

Proposed Technical Rules

From Joint Reply Comments filed by Cisco, Bridgewater, Ceragon, Endwave, LOEA, Stratex:

- **Dual-band FDD**

71-76 and 81-86 designated as paired spectrum

Given radio transmits in one band and receives in the other

- **ATPC**

Received signal level lower than required C/N + 10dB unless transmitter has reduced its power to minimum

Required only for radios with EIRP > 23dBW

Dynamic range (dB) = EIRP_{dBW} - 23

- **EIRP**

Maximum is 55dBW when antenna gain is ³50dBi

Maximum (dBW) = 55 - 2(50 - G) when antenna gain is <50dBi

Proposed Technical Rules (cont.)

- **Power spectral density is $\leq 150\text{mW}$ per 100MHz**
- **Antenna radiation pattern envelope (RPE)**
 - 1.2° minimum HPBW**
 - 43 dBi minimum gain**
 - Refer to Joint reply comments for co-pol and cross-pol sidelobe and backlobe levels**
- **Linear polarization**

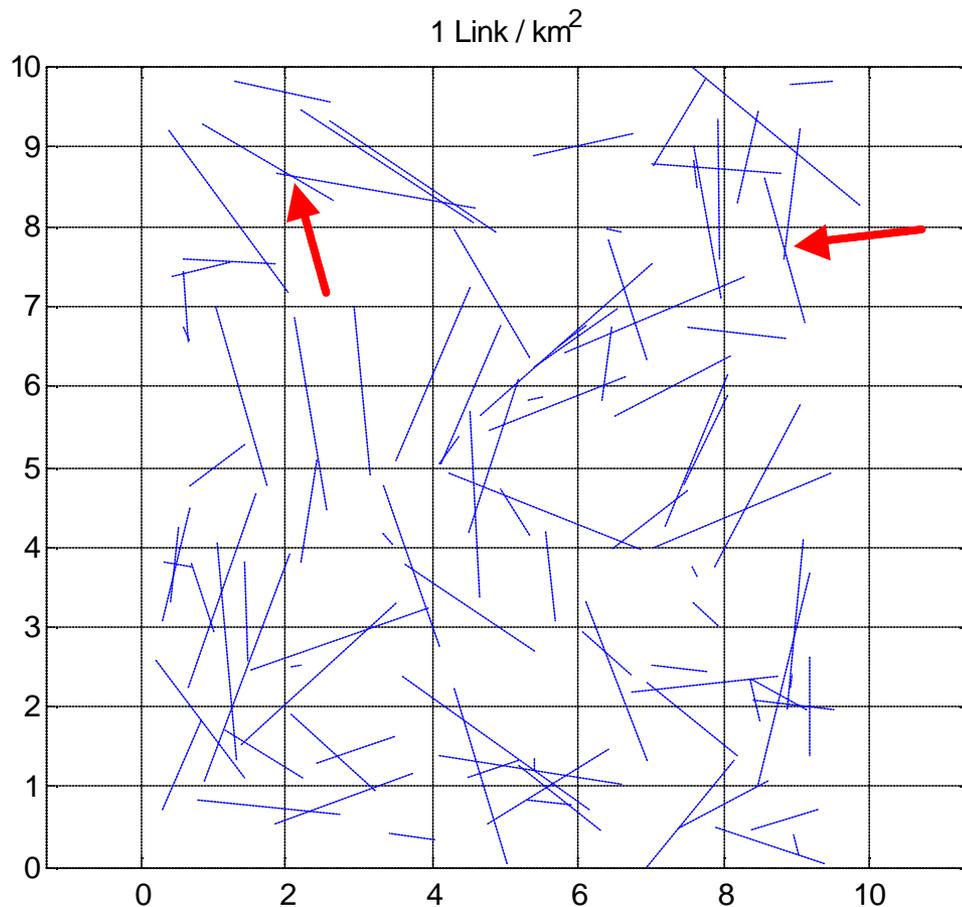
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EMPOWERING THE
INTERNET GENERATION

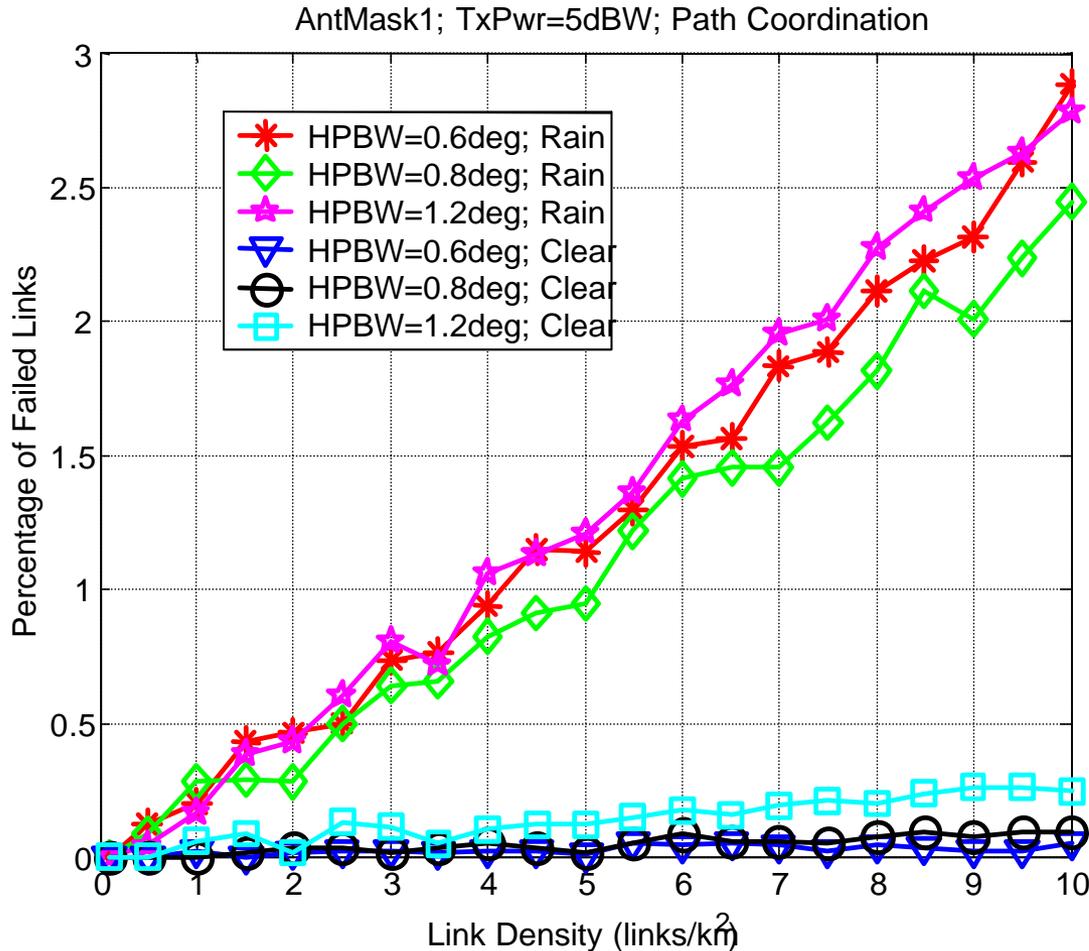
Background Material

Random Deployment Simulation Method



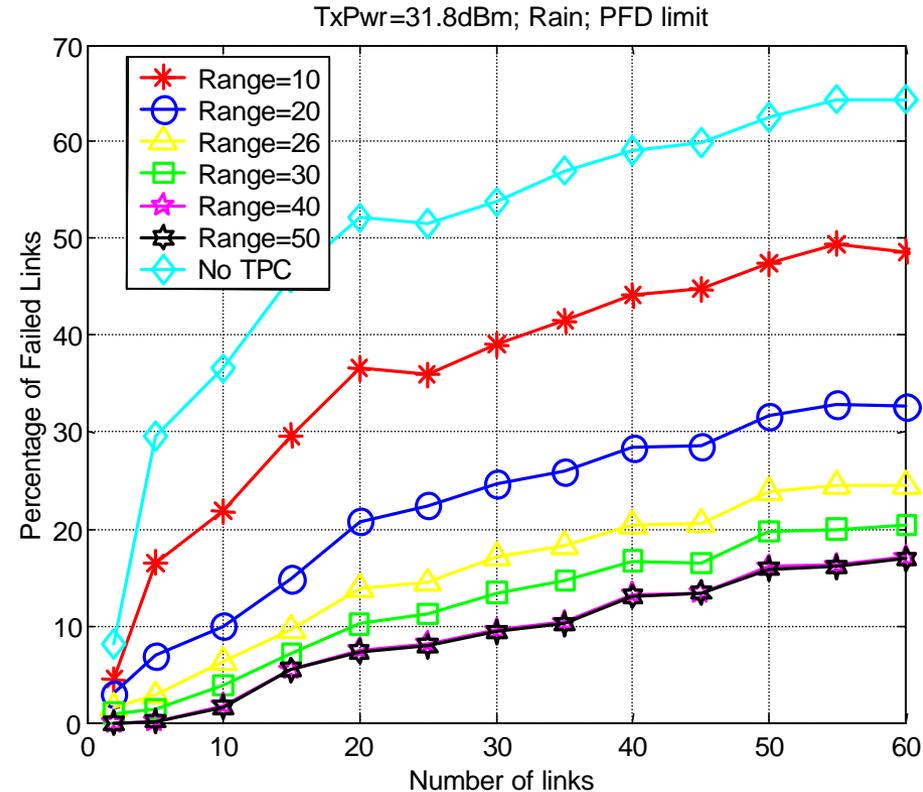
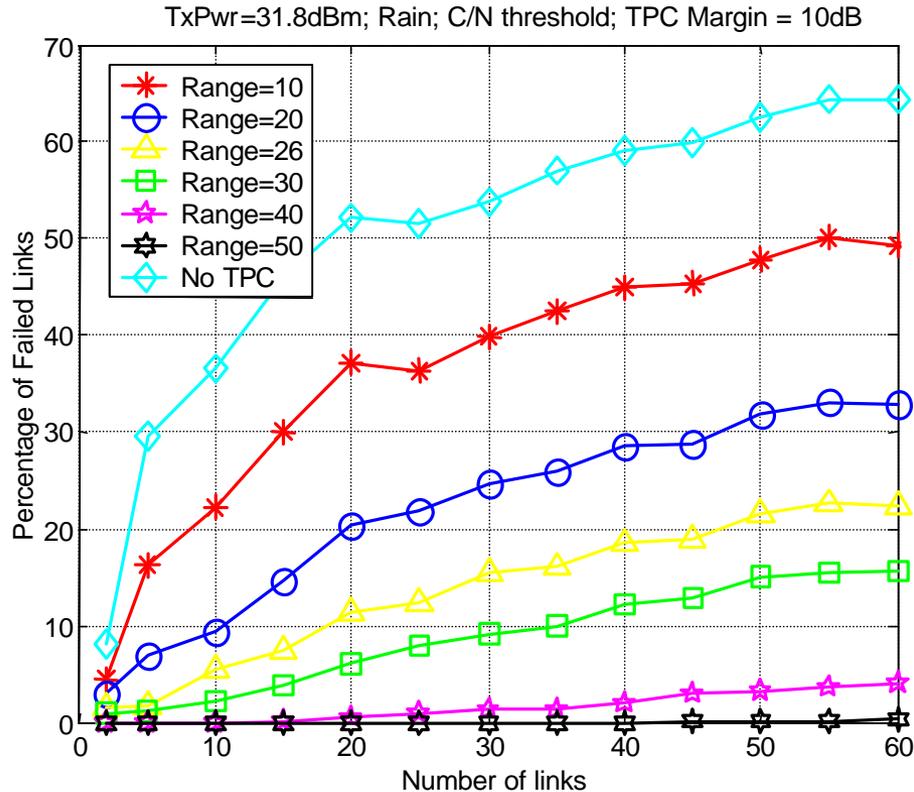
- This study simulated a square region 10 km by 10 km (roughly the size of San Francisco).
- The figure shows 100 links distributed over the 100 sq km area.
- The potential points of interference are when the end of one link shows up near the middle of the path for another link. Some of those points are shown as arrows in the figure.
- In this example the maximum length was approximately 2.5 km.

Simulation Results for Random Deployments with Different Antenna Beamwidths



- This slide shows the results when the links are deployed using 0.6°, 0.8°, and 1.2° HPBWs with directivities of 50, 47, and 44 dBi respectively.
- Wider beamwidths lead to shorter ranges and lower ATPC dynamic ranges; narrower beamwidths result in higher ATPC dynamic ranges, which reduces interference.
- Overall the performance for the three different beamwidths is very similar, indicating that the maximum EIRP and required ATPC dynamic range is balanced.

ATPC Performance as a Function of Dynamic Range



- **C/N threshold performs much better than PFD limit as the ATPC dynamic range increases**

Power Flux Density Calculation

- From Joint Reply comments, maximum PFD = 100pW/cm² (corresponds to 10Gbps link)

8PSK, 8dB NF, 1 foot dish antenna, 10dB margin

Parameter	Base	Better BER	Higher Rate
Bandwidth (MHz)	5000	5000	5000
NF (dB)	8	8	8
Antenna dish size (in)	12	12	12
Beamwidth (deg)	1.2	1.2	1.2
Power Control Margin (dB)	10	10	10
Required C/N	18.0	21.0	24.0
Power Flux Density (pW/cm ²)	100	200	400

- Conclusion:**

Performance is similar to C/N-based approach for agreed-upon ATPC dynamic range

However, little margin for future growth in linkrates (and consequent C/N required)

Hub and Spoke Interference

- **TDD radios**

 - **Transmit and receive in the same band**

 - **Will interfere with FDD receivers operating in that band (both single-band and dual-band FDD receivers)**

 - **Will also interfere with other TDD radios from a different vendor**

- **Single-band FDD radios**

 - **Defined as frequency division duplexed with transmit and receive bands both within 71-76GHz (or 81-86GHz)**

 - **Nearby transmitters will interfere with dual-band FDD radio**

 - **Without industry agreement on channelization plan, single-band FDD transmitters may interfere with nearby single-band FDD receivers**

- **Dual-band FDD radios**

 - **Defined as frequency division duplexed with transmitter in 71-76GHz band and receiver in 81-86GHz band (or vice versa)**

 - **Nearby transmitters do not interfere with receivers as long as all [hub] outbound transmitters use the same band (assured by path coordinator)**