



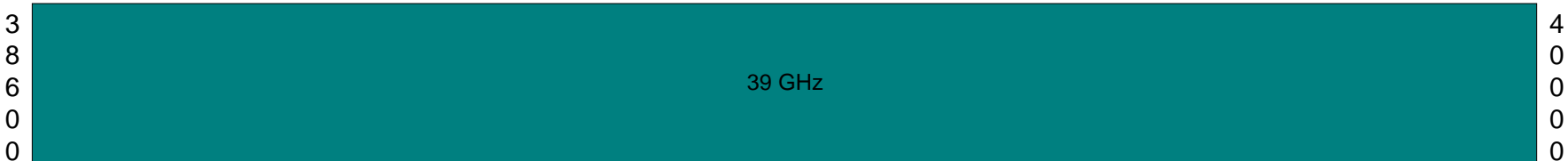
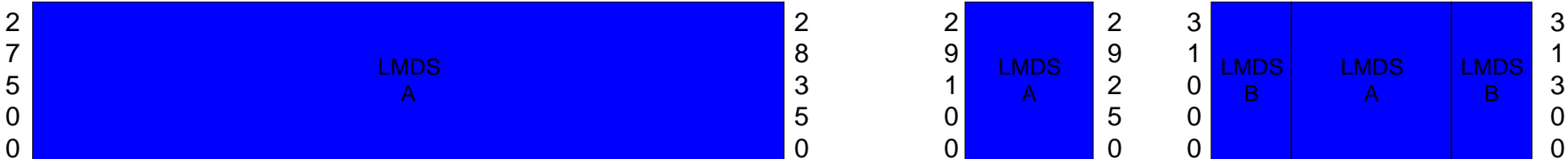
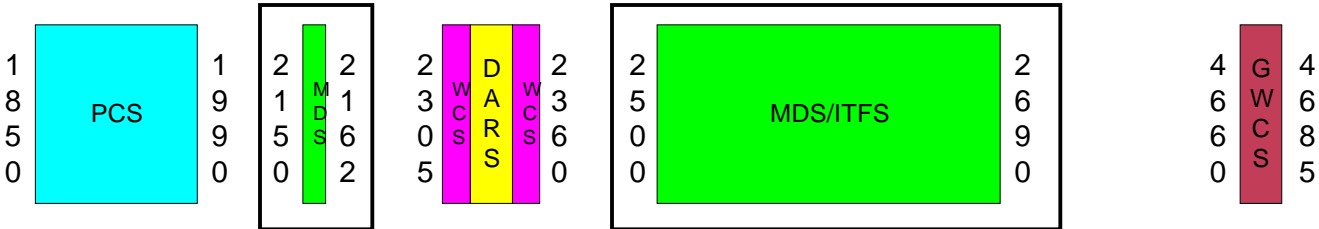
DESIGNING MMDS SYSTEMS FOR BROADBAND WIRELESS ACCESS

**ISART 2000
September 6, 2000
Boulder, CO**

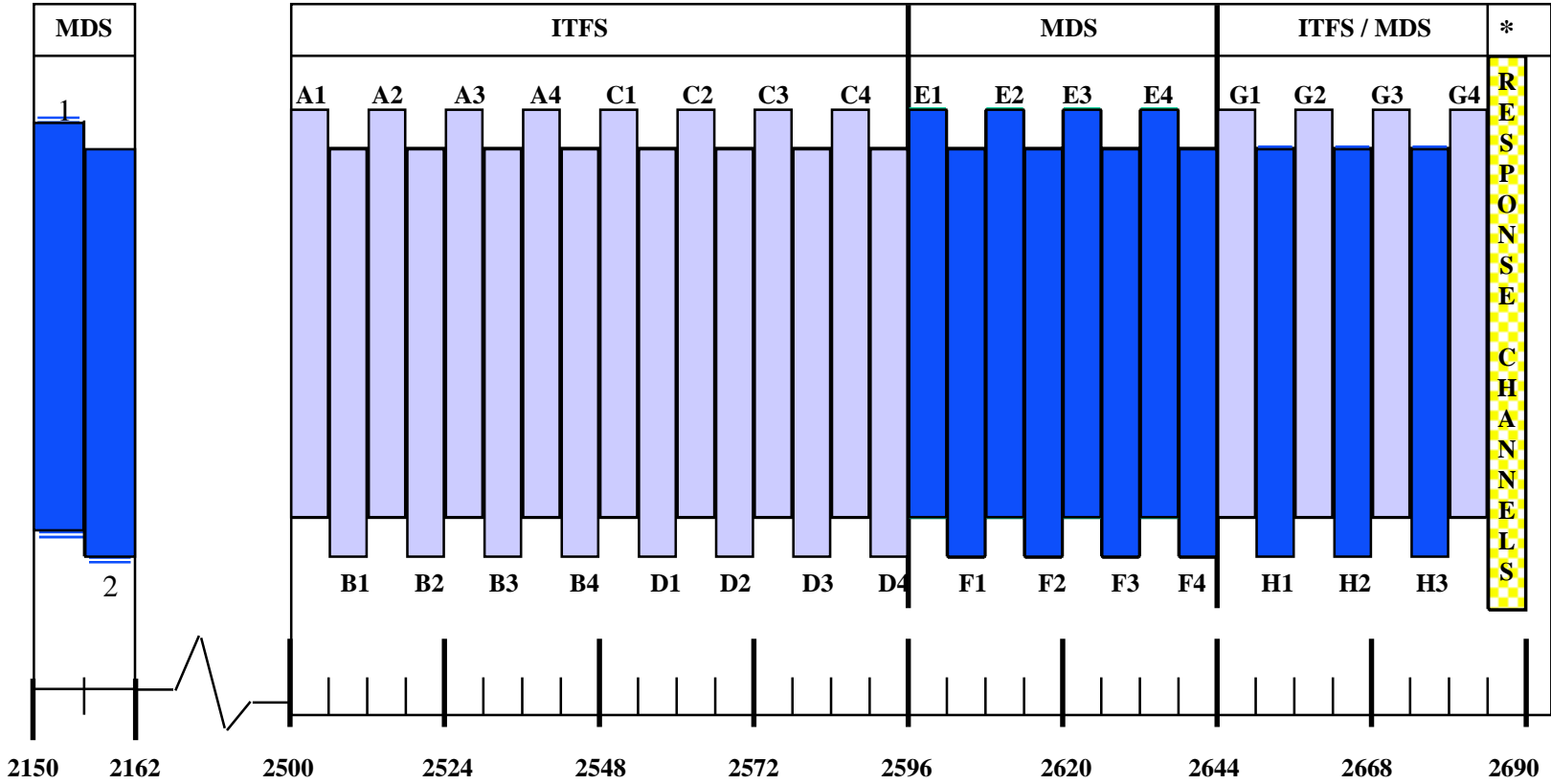
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Director – Broadband Engineering
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Fixed Wireless Access Spectrum



Wireless Cable Spectrum



A Very Brief History

- **Established as single channel video service in 1970's**
- **Added eight more channels in 1983**
- **Grew slowly as video service**
 - Capital constraints
 - Programming availability
 - Gathering critical mass of spectrum
 - DBS
- **Digital Declaratory Ruling**
 - Allowed digitally compressed transmission
 - Allowed One-Way Internet
- **Operating issues**
 - Need for additional capital
 - DBS pricing changes
- **Two-Way Order**



FCC Changes – Some Details

- **Digital Declaratory Ruling**
 - VSB and QAM modulations allowed
 - Interference criteria the same for average or peak power
- **Two Way Order**
 - Can “turn around” any channel
 - Aggregate and disaggregate
 - Channel swapping allowed
 - Interference prediction much harder

Two Way Order – More details

- **Application process will be streamlined**
 - No mutual exclusivity when filed simultaneously, parties must cooperate to resolve interference
 - No FCC review of the engineering in every application (random audits)
 - Rolling one day filing window with 60 day grant
- **Very flexible use of spectrum**
 - System operator can place upstream or downstream channels on any frequency
 - Without fixed channel plan, cooperation among neighbors is important

Two Way Order – More details

- Educational transmission requirements can be fulfilled with voice, video or data
- Large data capacities can be implemented because of bandwidth available
- Propagation characteristics at 2.1 - 2.7 GHz make for very reliable paths with authorized power levels
- System designs can range from a “supercell” to a highly cellularized approach
- New modulation techniques or multiplexing techniques can be added easily
 - Procedure established for measuring compliance with existing interference standards
- Interference landscape remains difficult
 - Numerous incumbents in most areas
 - Cooperation required



New Services via Wireless Cable

- Residential High Speed Internet Access
 - **Asymmetric, shared access media**
 - **Speed verses robustness trade-offs**
- Residential Telephony
 - **IP Voice appears to be the method**
 - **A few years away?**
- Business Services
 - **High Speed Access – CIR available**
 - **Enterprise solutions – Intranets with voice**
 - **PBX trunking – bandwidth efficiency issues**



Residential

- HSA – Internet traffic
- Bundled services – voice, streaming video, safety, other utilities

SOHO/SME

- Video conferencing
- Telecommuting & Intranets
- Ecommerce

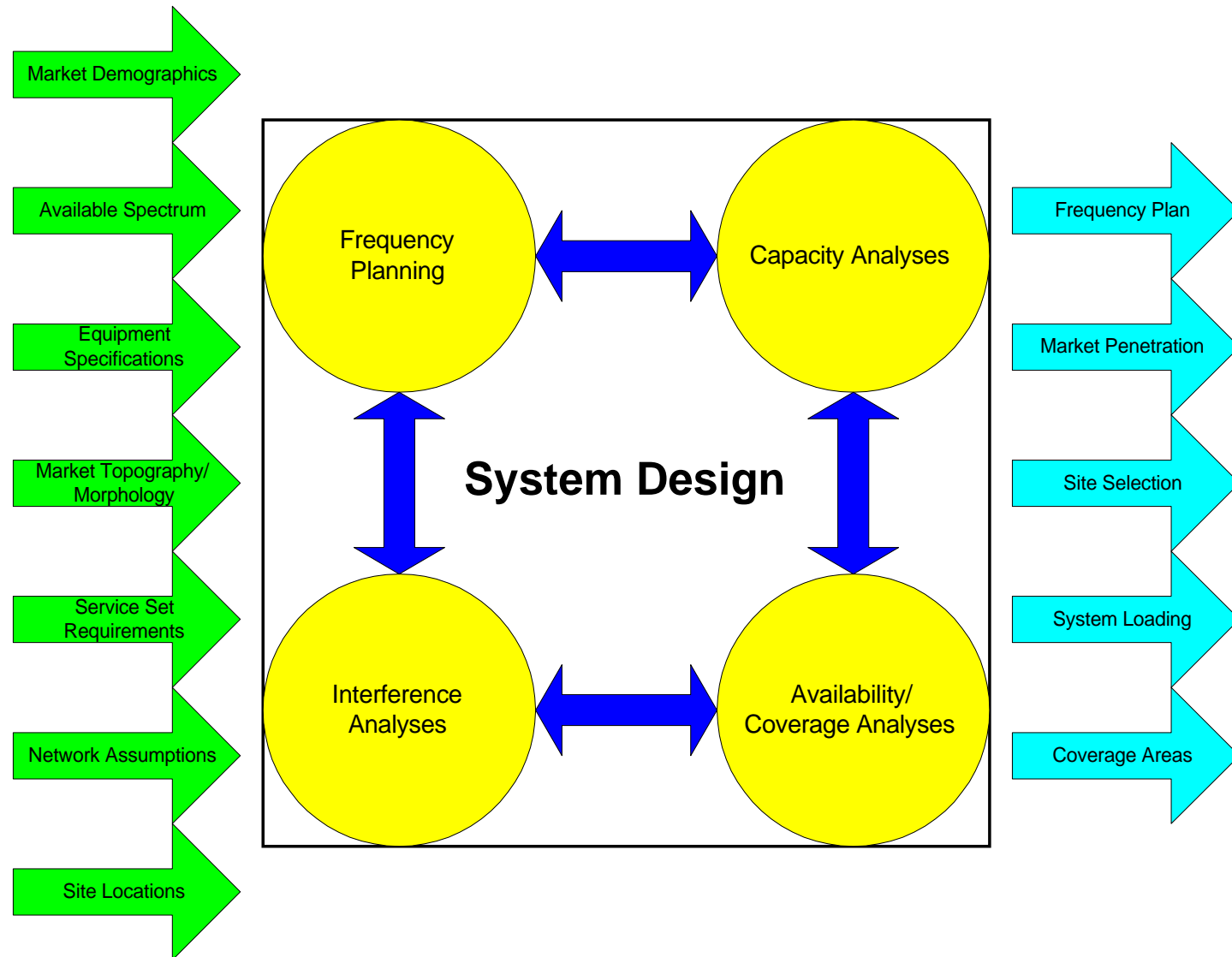
Large companies

- Enterprise solutions – SLA and QoS
- Trunking

Market Segment vs. Access Means

Market Segment	Residential	SOHO/SME	Large Enterprise
Symmetry	Asymmetric	-----	Symmetric
Commitment	Best Effort	-----	SLA/QoS
Datarate	Low	-----	High
A M C E N S S	Cable Modem		
	ADSL		
			Fiber
		DEMS/LMDS/39 GHz	
	MMDS/ITFS		

Fixed Service System Design



Fixed Service System Design

Frequency planning

- **Service set determination**
- **Demographic analysis**
- **Capacity analysis**
- **Equipment selection**
- **Preliminary site selection**
 - **Multiple data bases**
- **Coverage analysis**
 - **Terrain**
 - **Morphology**
- **Interference analyses**

Fixed Service System Design

Interference analyses

- **Downstream & upstream analyses**
- **Plane & cross-polarized**
- **Very dependent on modulation techniques & equipment selection**
- **Sectorization & antenna performance critical**
- **Limits frequency planning**

Fixed Service System Design

Coverage/Availability Analyses

- **Availability determined in %**
- **Dependent on equipment specs**
 - **Power, rx sensitivity, etc.**
- **Dependent on cell radius**
- **Dependent on topology/morphology**
- **Dependent on heights (tx & rx)**

Fixed Service System Design

Capacity Analyses

- **Service set mix dependent**
- **Network assumptions critical**
 - Loading
 - Login factor
 - Guaranteed throughput
- **Penetration desired**

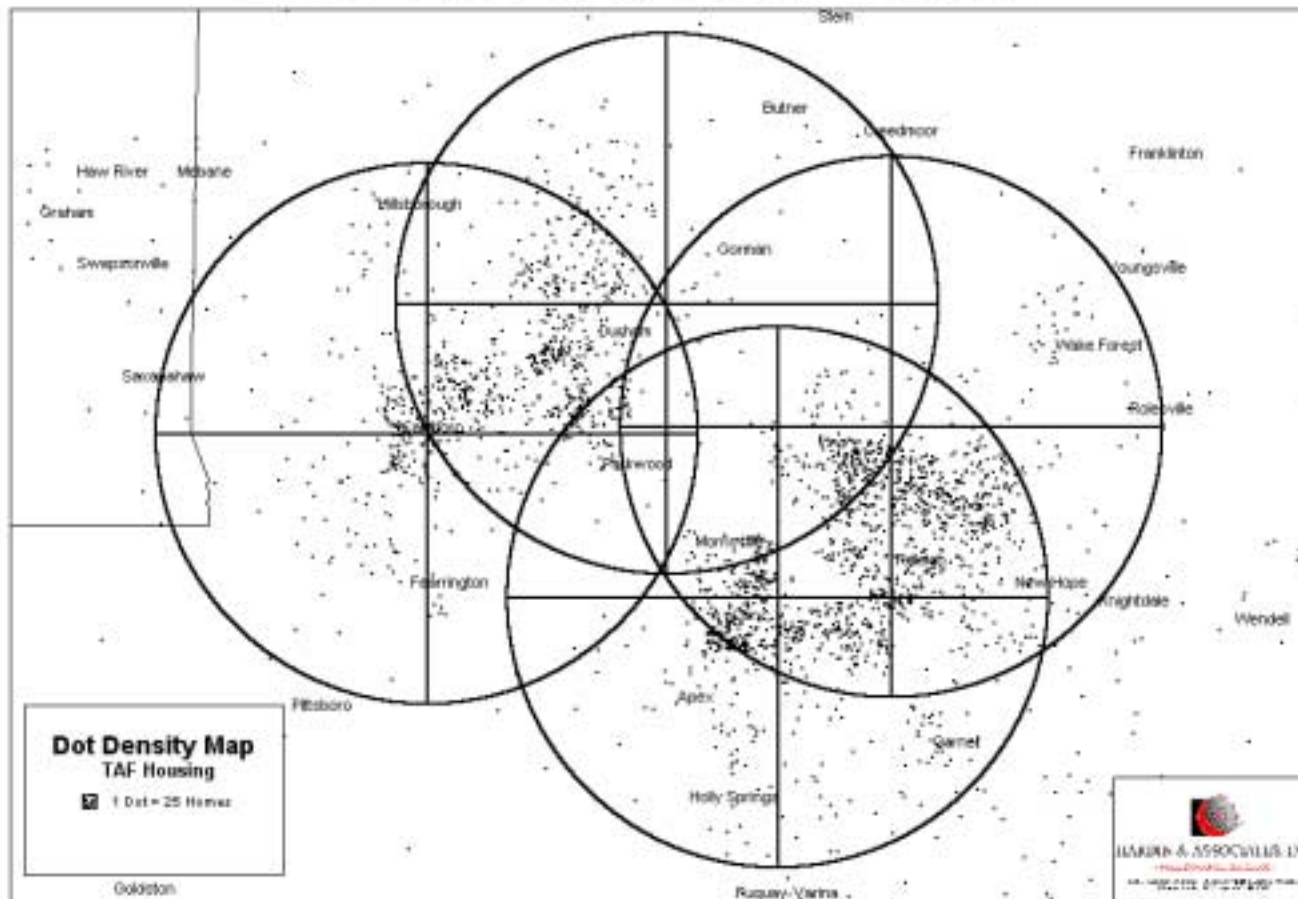
Case Study - Raleigh, N.C.

- Look at a typical design
- Concentrate on coverage and self interference
- Design assumptions -

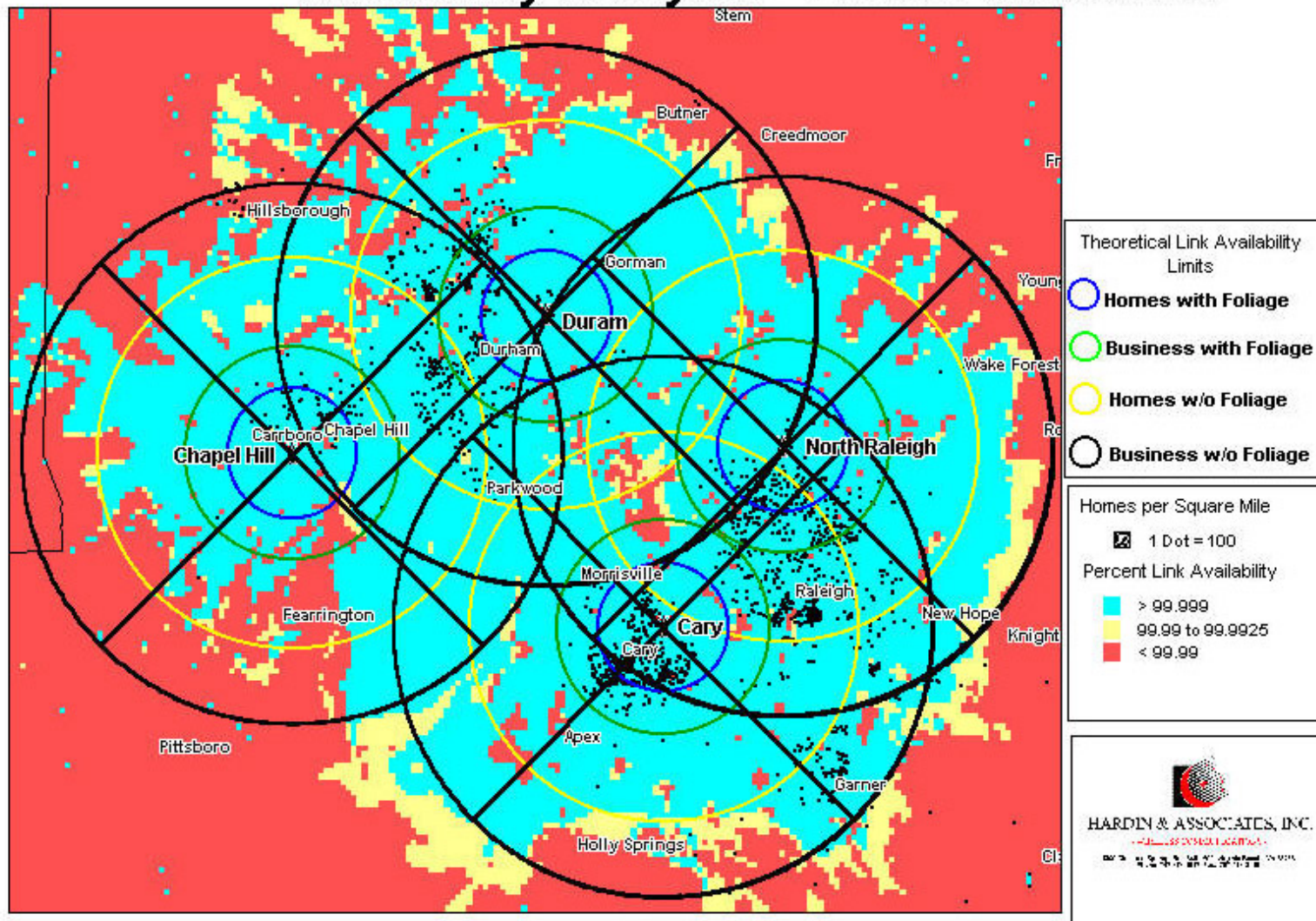
	<u>Down</u>	<u>Up</u>
Bandwidth available	80 MHz	80 MHz
Equipment bandwidth	2 MHz	0.2 MHz
Filter roll off	15%	15%
Throttled data rate	1.54 Mbps	256 Kbps
Max mod density	64 QAM	4 QAM (QPSK)
Overhead (FEC, etc.)	20%	20%
Network loading	80%	80%
Login (usage) factor	20%	20%
Typical file size	16 Kbytes	1.6 Kbytes
Transfer time	1 sec	1 sec
Penetration target	80%	
No telephony		



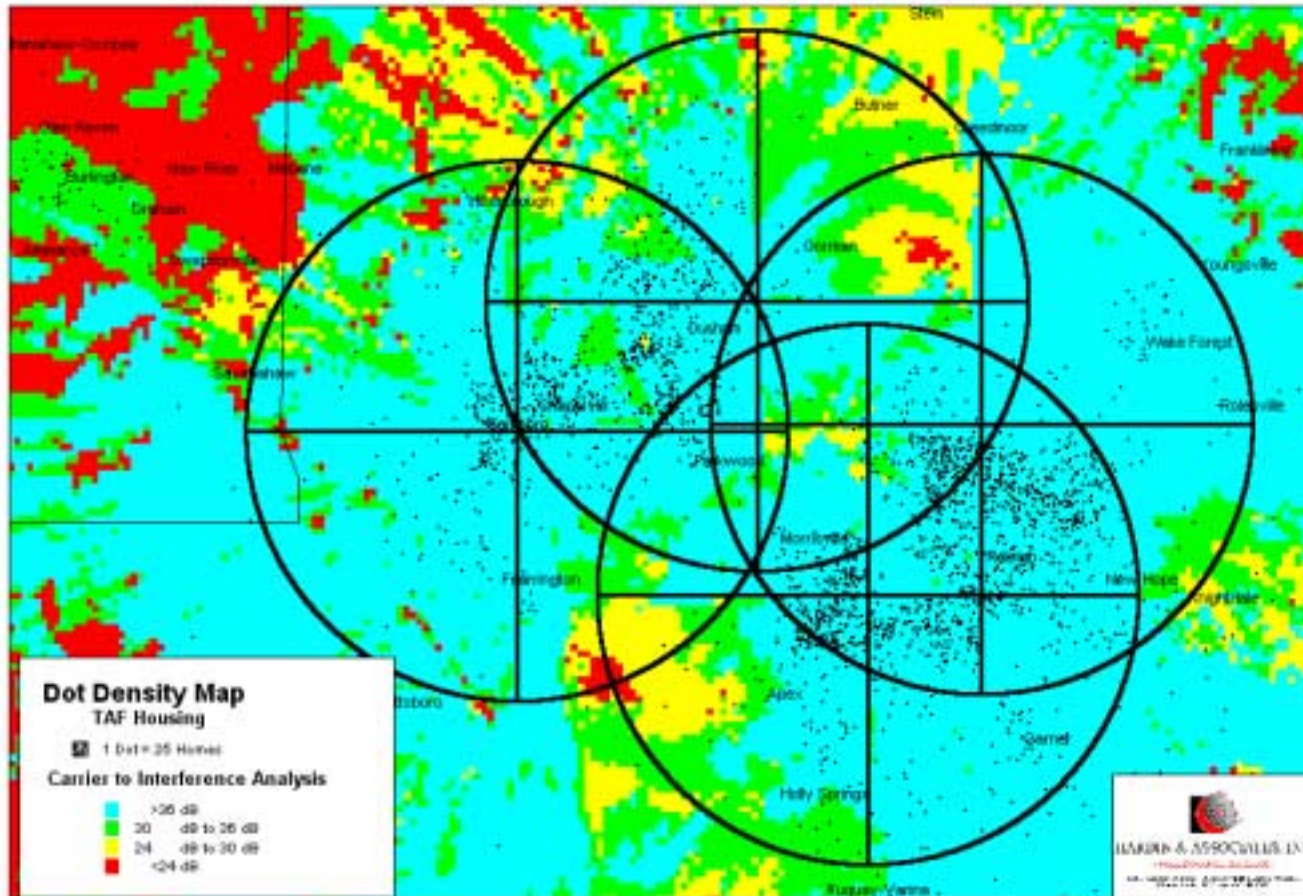
MDS Two Way Node Layout



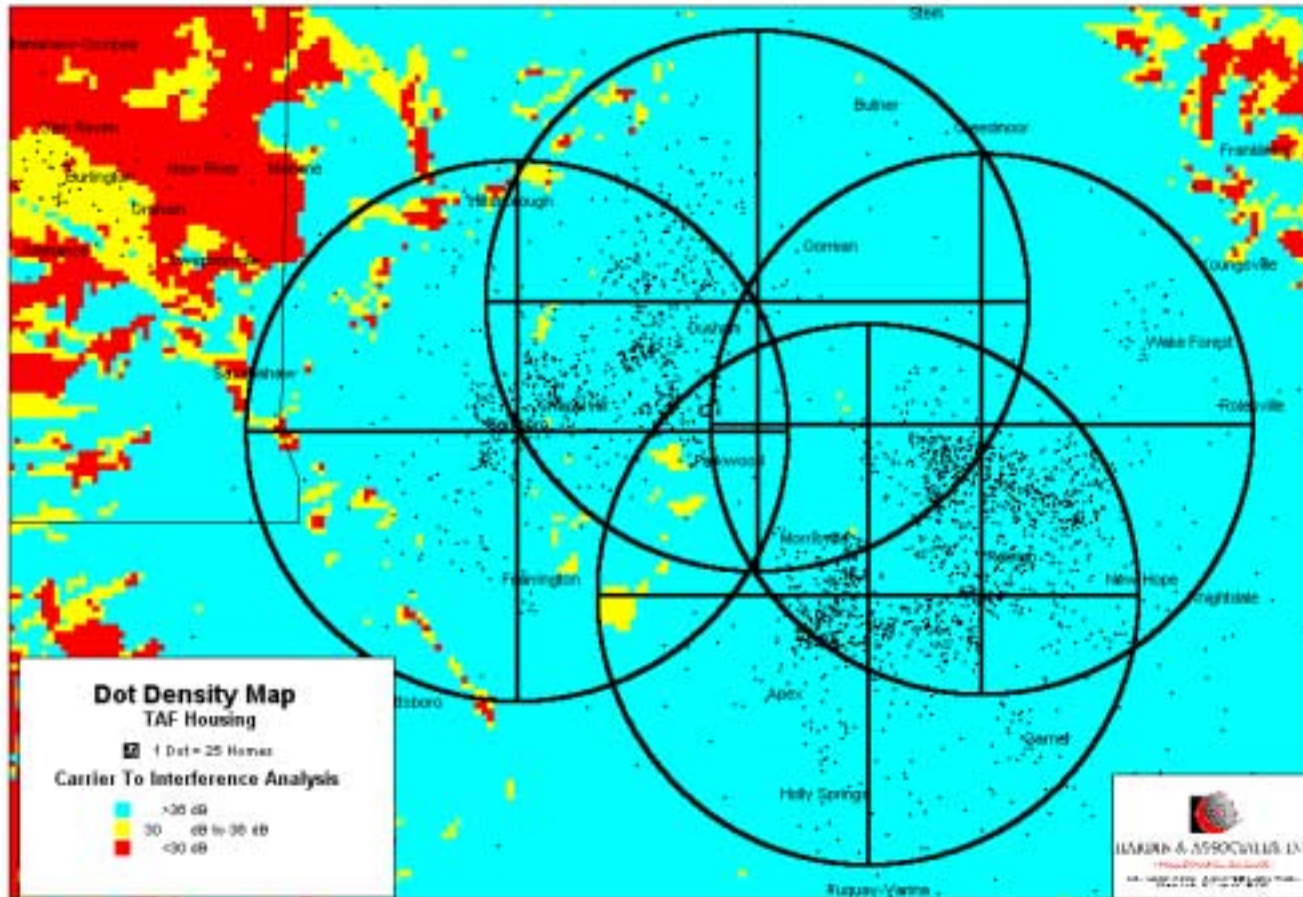
Avalability Analysis - Line of Site Areas



MDS Two Way Node Layout



MDS Two Way Node Layout



Coverage by each node

	Total Households	TAF Households
N1A	86,069	19,485
N1B	58,542	8,697
N1C	30,304	6,316
N1D	21,081	5,329
N2A	10,748	1,362
N2B	77,135	12,886
N2C	75,735	19,856
N2D	16,956	1,682
N3A	7,930	482
N3B	30,909	7,475
N3C	53,726	12,421
N3D	35,606	5,425
N4A	72,020	14,608
N4B	9,489	2,050
N4C	10,319	2,532
N4D	14,067	2,603

Frequency Plan

