Robust Ethernet

in

the First Mile

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ELASTIC NETWORKS

OUTLINE

- Ethernet Access Ideals
- The Copper Loop Environment
- The EtherLoop System
- Statistical Concentration
- Spectrum Management

EFM ACCESS IDEALS

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- **TRANSMISSION** -- LAN-like, optional statistical sharing
- **FLEXIBILITY** -- no enforced asymmetry, appn. independent
- **END-USER INSTALL** -- plug and play CPE installation
- **ERROR-FREE** -- loop errors hidden from user & network
- **SERVICE DEPLOYABLE** -- low cost/delay initial & growth
- **ONE STANDARD FOR ALL COPPER LOOPS** -- up to 21kft
- **ROBUST** -- any unloaded loop

Robust EFM

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THE COPPER LOOP ENVIRONMENT

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- **The future is fiber** (greater bandwidth, lower BER)
- **Fiber deployment is growing, new builds often include fiber from the start**
- **BUT… far more consumers are served today by twisted pair than by fiber**
- **Cost of building fiber infrastructure is significant.**
  - Example: commercial MDU market
    - A major city may have only 7 high rise buildings with fiber to each tenant
- **Copper Loop based EFM can cost effectively provide bandwidth today**

THE COPPER LOOP ENVIRONMENT

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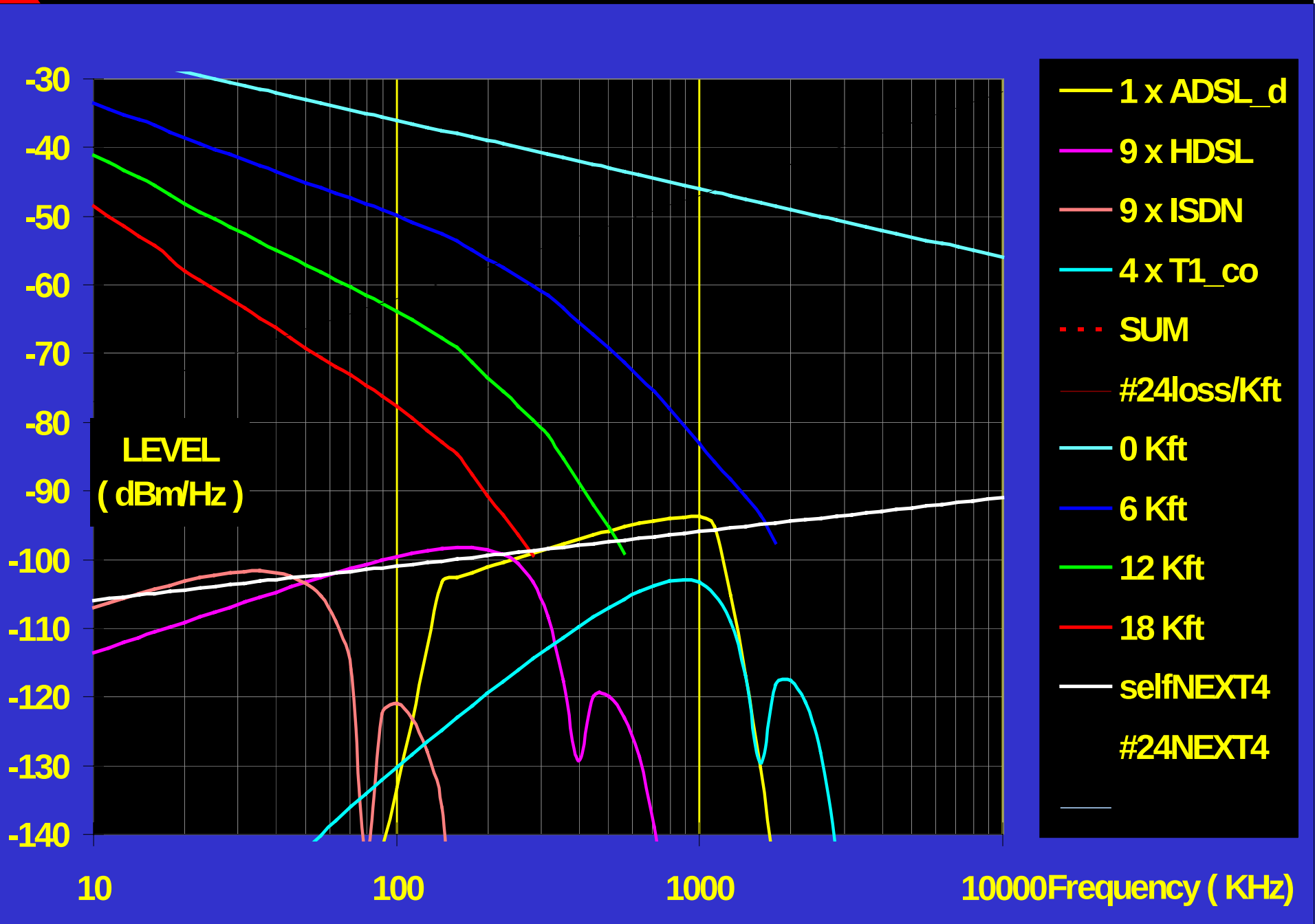
- **LOADING COILS** (must be removed)
- **BRIDGED TAPS** (easy to equalize but typically create 8 dB added loss)
- **HIGH FREQUENCY LOSS** (steep slope requires compensation)
- **INTER-PAIR CROSSTALK** (near-end crosstalk (NEXT) is key issue)
  - FROM INCUMBENT SERVICES
  - INTO INCUMBENT SERVICES
  - FROM / INTO NEW SERVICES

RECEIVED LEVEL + RECEIVER MARGIN VS. CROSSTALK LEVEL



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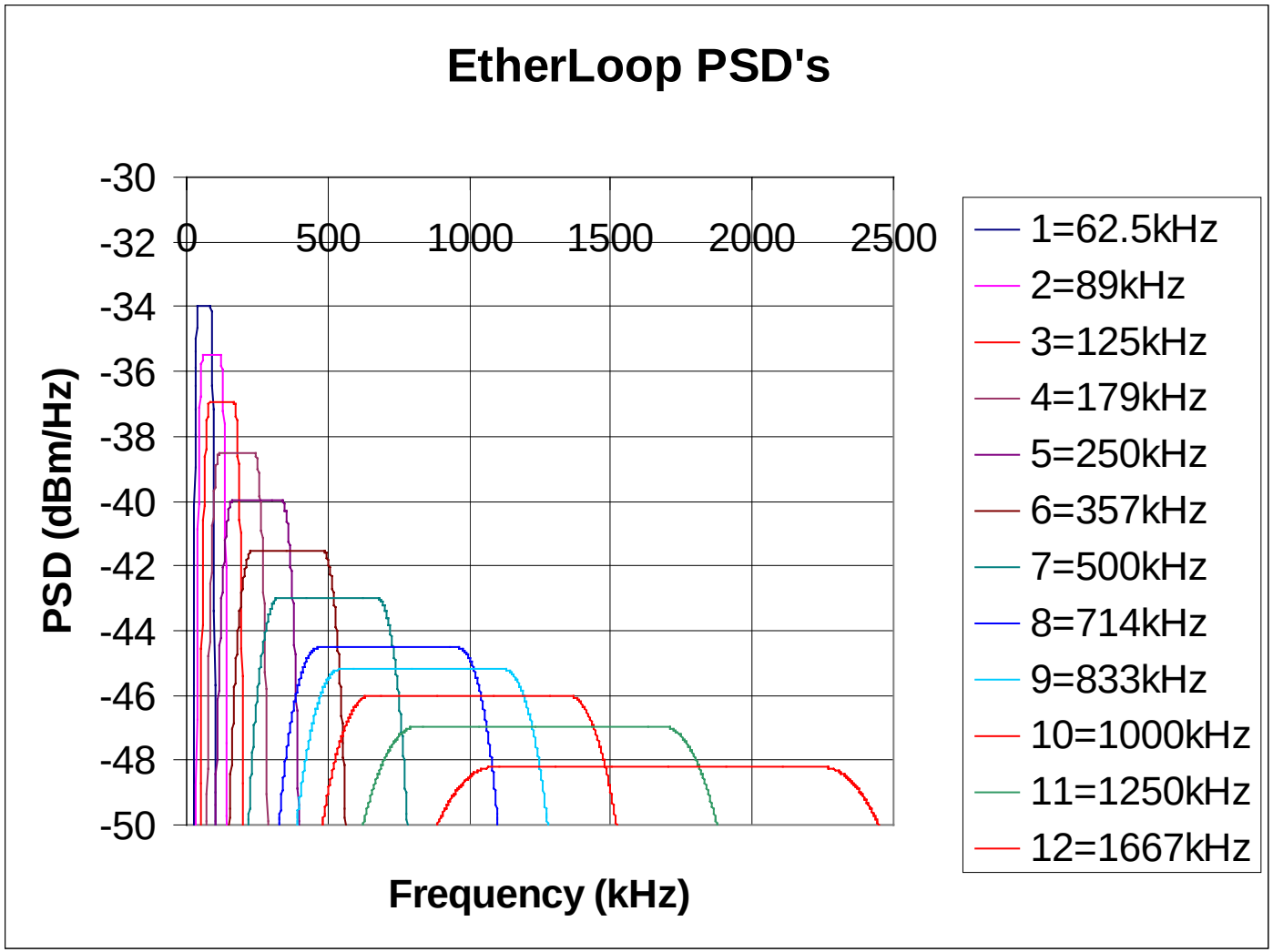
ETHERLOOP ™

- Jack Terry invented EtherLoop in 1996 while at Nortel
- Led to a spin out, Elastic Networks
- ETHERnet in the local LOOP (EtherLoop™) combines Ethernet with DSL
- 2 Patents issued, several pending
- Rate adaptive, burst mode
- 10Mbps maximum rate, 21kft maximum reach
- Spectrum Manager Feature ensures spectral compatibility, while maintaining maximum bandwidth

ETHERLOOP ™ PSD's



ETHERLOOP ™ ”SPEEDS”

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- The Data Rate is determined by Modulation Level and Center Frequency

- QPSK (QAM4) 2 bits/symbol

- QAM16 4 bits/symbol:

  1 Msymb/sec * 4bits/symb = 4Mbps

  1.67 Msymb/sec * 4bits/symb = 6.67Mbps

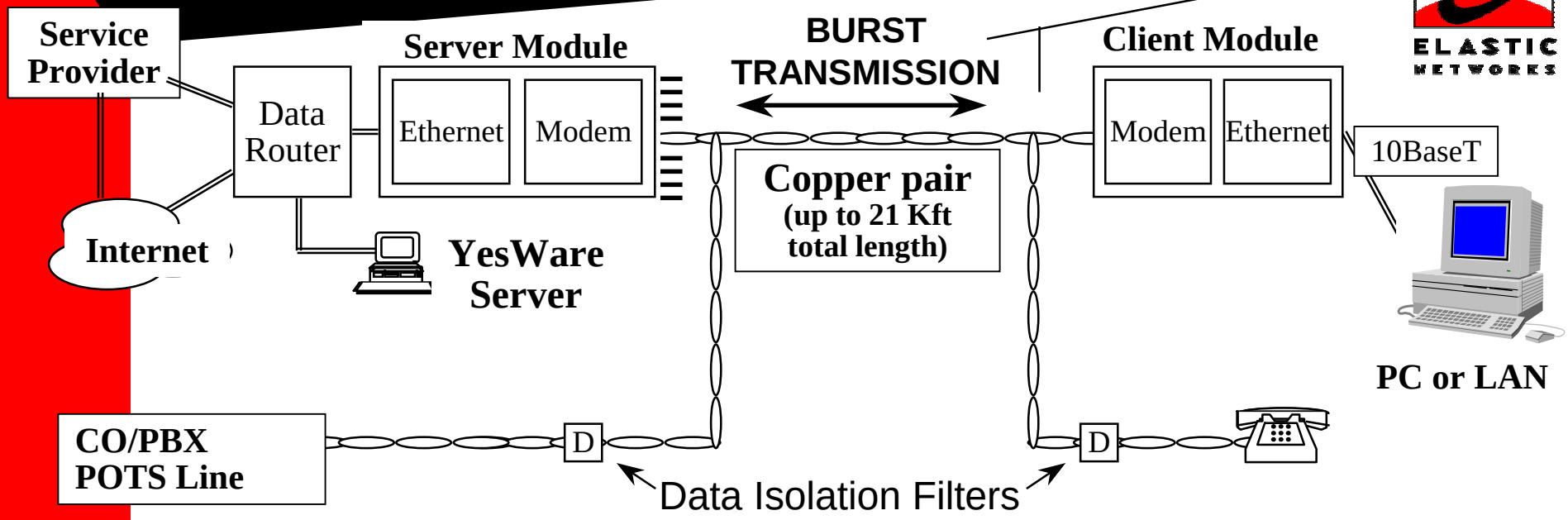
- QAM64 6 bits/symbol:

  1.67 Msymb/sec * 6bits/symb = 10Mbps

Ethernet - EtherLoop ™ Synergy

10BaseT Ethernet	Elastic Networks' *Etherloop ™*
10BaseT - Short Loops	unloaded OP/MDU Loops
<---- Single Spectrum, "half-duplex" ---->	
<---- Statistical "Burst" Transmission ---->	
Collision / retransmission protocol (CSMA-CD)	Collision avoidance loop protocol
<---- Error Correction by re-transmission ---->	
<---- Flexible Transmission Symmetry ---->	
<---- Self-adjusting Traffic (TCP-IP protocol) ---->	
10 Mb/s transmission rate	Adaptive, according to loop & traffic, up to 10 Mb/s

THE ETHERLOOP ™ SYSTEM



- **half-duplex burst transmission**
- **statistically shared central Etherloop modem possible**
- **data bridging**
- **traffic management, test & analysis via data path (special Etherloop "type" field, local or via Internet)**
- **splitterless**

ETHERLOOP ™ ARCHITECTURE

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DATA TRANSPORT

- FORMATTING
  - ETHERNET FRAMES CONCATENATED INTO HDLC BURSTS
- ERROR MITIGATION
  - RETRANSMISSION, SPECTRAL ADAPTATION
- SPECTRAL ADAPTATION
  - PER DIRECTION, CONTINUOUS
  - BASED ON ERROR RATE, SIGNAL TO NOISE RATIO
- DIRECTIONAL MULTIPLEXING

ETHERLOOP ™ ARCHITECTURE (Part 2)

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- DIRECTIONAL MULTIPLEXING
  - ~~SINGLE BAND, FULL-DUPLEX~~
    - ~~NEXT-LIMITED~~
  - ~~FREQUENCY DIVISION~~
    - ~~CONSTRAINS TRAFFIC SYMMETRY~~
    - ~~HIGH BAND LIMITS REACH~~
  - TIME DIVISION
    - BURST TRANSMISSION ✓

ETHERLOOP ™ ARCHITECTURE (Part 3)

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BURST TRANSMISSION

- TRAFFIC DRIVEN DIRECTIONAL FLEXIBILITY
  - JUST LIKE ETHERNET
- “QUIET” INTERVALS BETWEEN DATA BURSTS
  - LOWER MEAN PSD IN MULTI-PAIR CABLE
  - PERMITS NOISE/CROSSTALK ASSESSMENT
- NO SYNCHRONIZATION TO LOOSE / REGAIN
  - PERMITS VERY RAPID SPECTRAL ADAPTATION
- ENABLES **STATISTICAL CONCENTRATION**

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STATISTICAL CONCENTRATION

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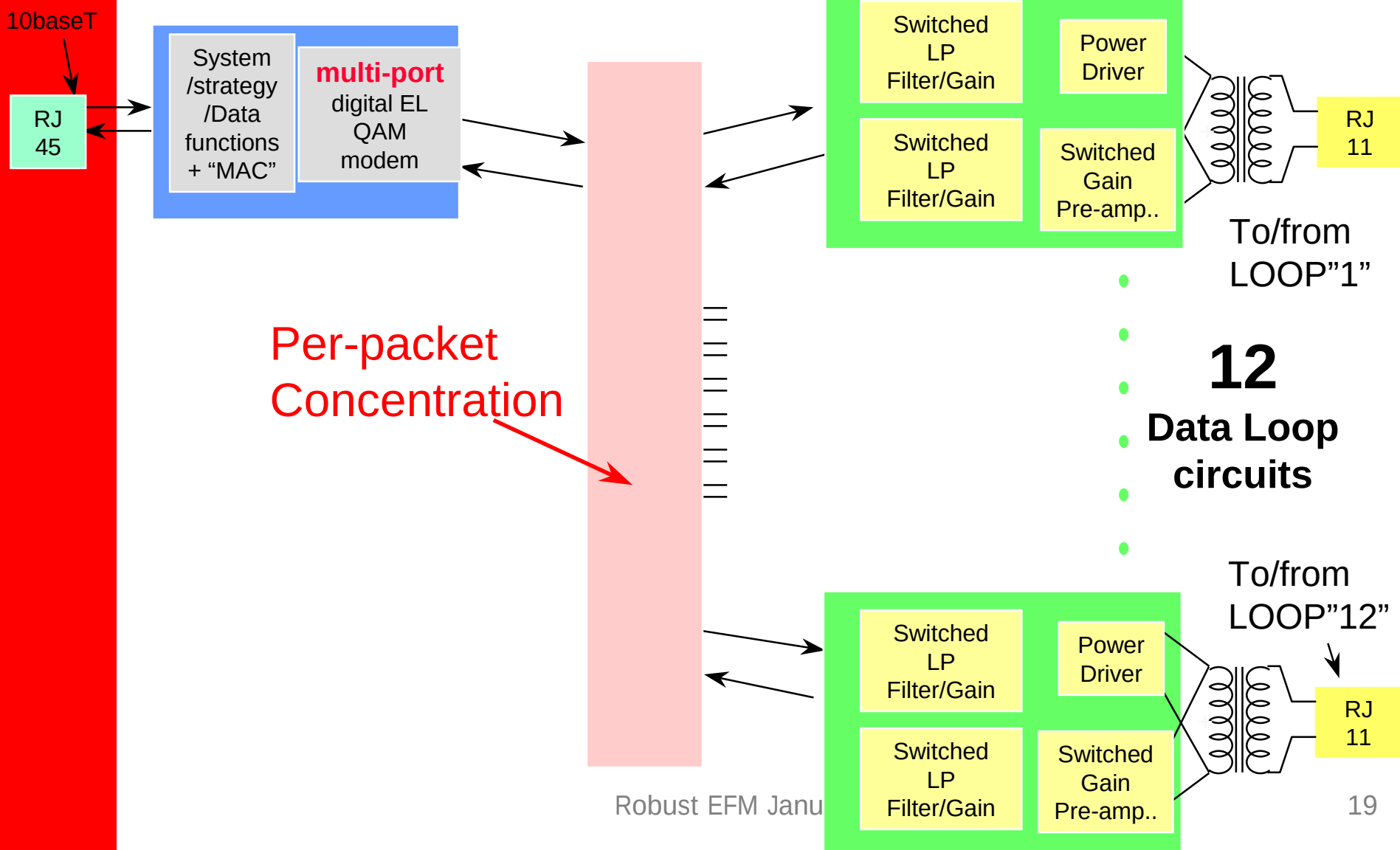
- "CENTRAL" ***ETHERLOOP*** "MODEM" SHARED ACROSS MULTIPLE LOOPS
  - ECONOMICS
    - FEWER MODEMS
  - POWER SAVINGS
  - HIGHER DENSITIES
  - SAVES A STAGE IN DATA SWITCHING

MULTI-PORT ETHERLOOP - FIXED CONCENTRATION



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The ETHERLOOP ™ SYSTEM

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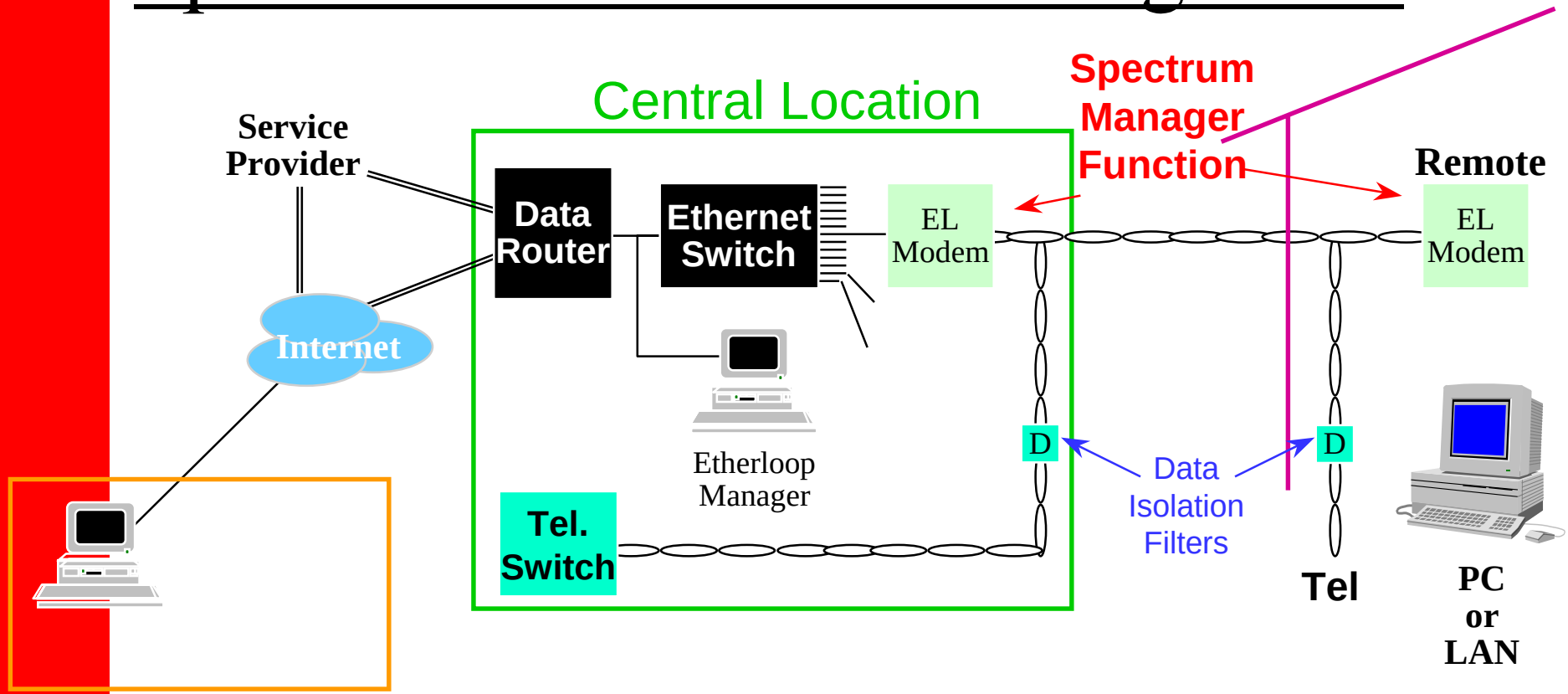
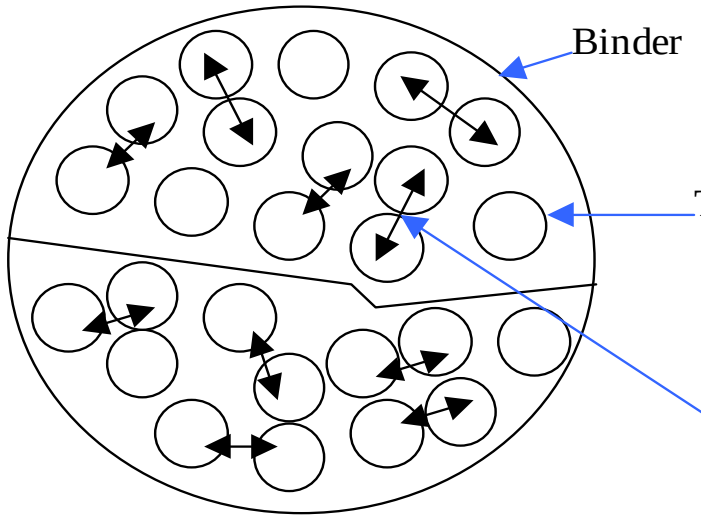
Spectrum & Services Management



Crosstalk Issues for xDSL

- Transmitted energy from adjacent pairs may be coupled

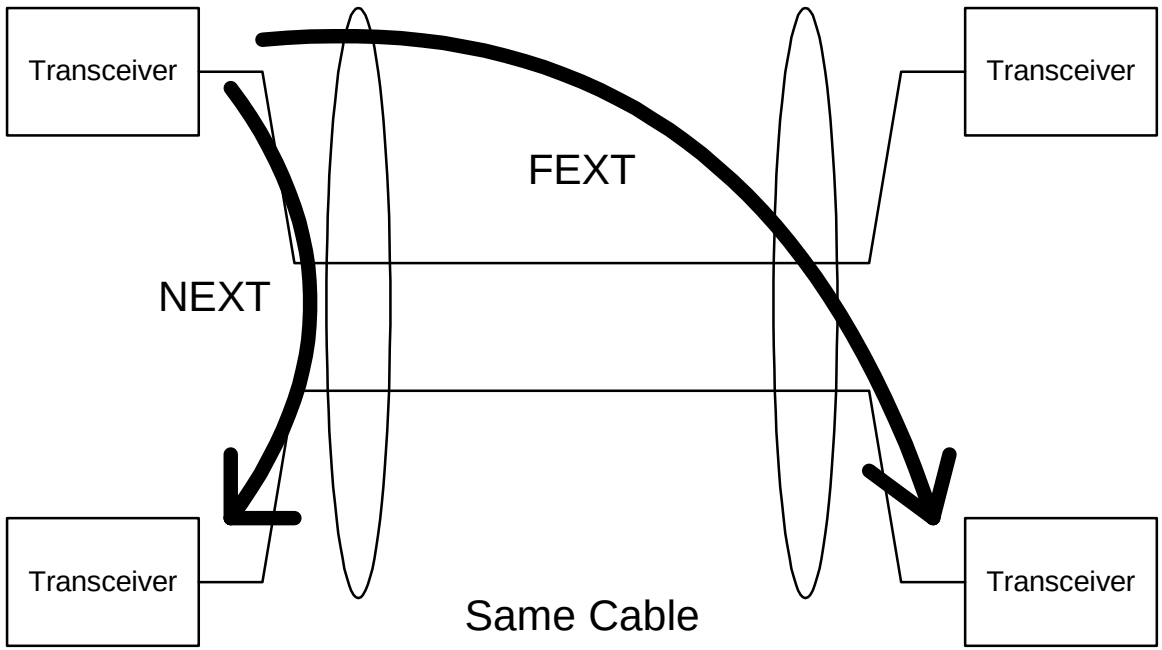


Sample 25-pair binder with 12/13 pair “sub-units”.

- The amount of coupling varies from pair-to-pair, and from cable-to-cable

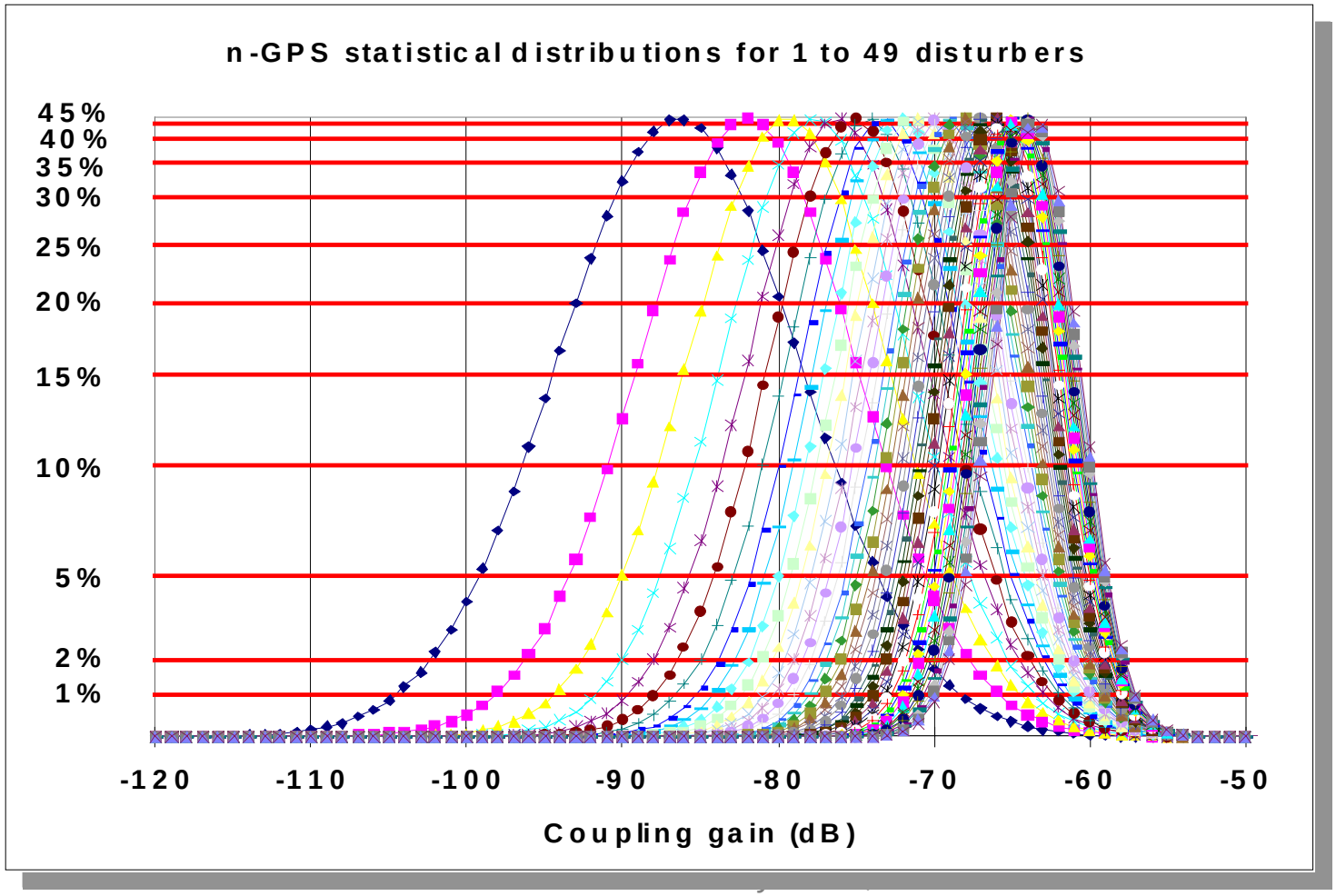
Crosstalk Issues for xDSL (Part 2)

- Definition of Near End Crosstalk (NEXT) and Far End Crosstalk (FEXT)



Crosstalk Issues for xDSL (Part 3)

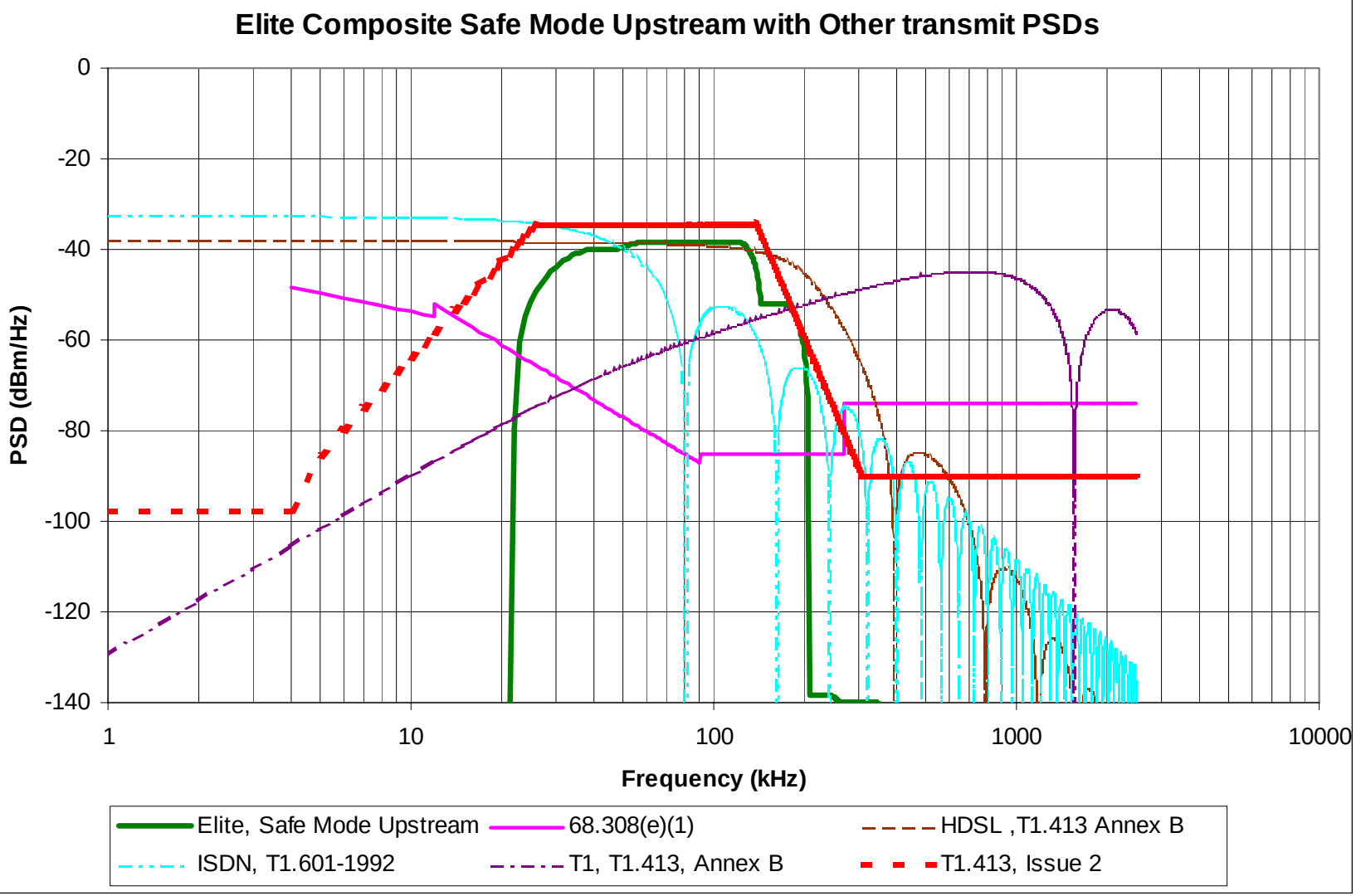
- Statistical View of NEXT, Far Left Curve is for 1 Disturber, Far Right Curve is for 49 Disturbers



SM Standard

- **Spectrum Management Standards Activity**
  - Goal of the standard is to allow compliant systems to be deployed in unbundled loop environment without significantly degrading other services in the binder
  - The Default Letter Ballot on the Draft Proposed American National Standard (dpANS) Spectrum Management Std was closed, and the final draft issued at the Nov 2000 T1E1.4 meeting. Standard expected to be published end of Jan 2001.
- **Two Methods of Demonstrating Spectral Compatibility**
  - The standard states that a service is spectrally compatible if it either:
    - A) fits within the PSD mask of one of the 9 defined classes, or
    - B) is demonstrated by analysis, using “Method B”, to cause interference with the same or less impact than from the defined classes
- **Conformance Critera for Burst Mode (STS) Systems**
  - At the Feb 2000 meeting, the Short Term Stationary (STS) - burst mode-conformance criteria, based on contributions by Elastic Networks and others, was moved to the AGREED status. STS systems that meet these criteria, and one of the PSD tests listed above, are spectrally compatible with the basis systems
- **EN modems conform to the dpANS Spectrum Management Standard**
- **Elastic Appointed to NRIC V, Focus Group 3**
  - Federal Advisory Committee, with a 2 year Charter
  - 15 companies in Focus Group advise FCC on Spectral Compatibility issues

Part 68 needs updating



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ELASTIC NETWORKS

Robust Ethernet in the First Mile
HIGHLIGHTS

- A fully compliant extension of Ethernet
- LAN-like traffic characteristics
- no traffic asymmetry constraints
- end-user plug & surf, no PC reconfiguration
- spectrally compatible in unbundled loop
- economic, low power, compact
- robust to offer bandwidth where fiber is not avail.
- Rate adaptive up to 21kft

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