

# Dynamic Spectrum Management

*the path to Gbps DSLs/ future of copper*

*FCC*

*Via video conference*

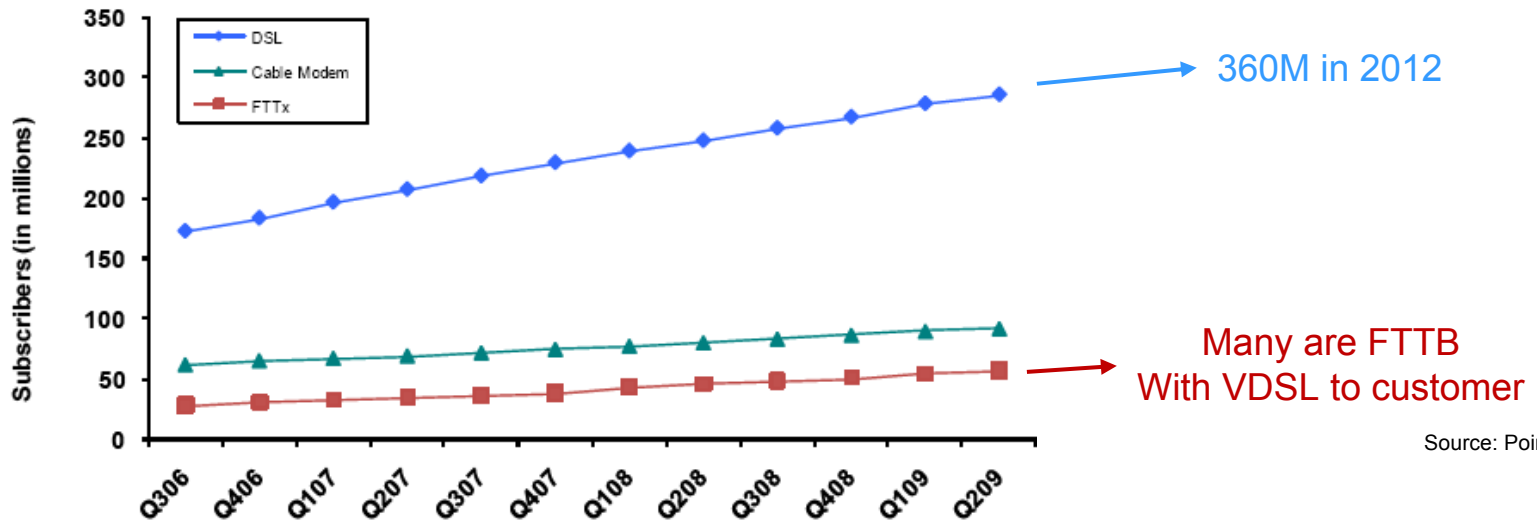
*November 19, 2009*

*John M. Cioffi*

*Prof Emeritus, Stanford U*

*Chairman and CEO, ASSIA Inc.*

# Broadband is DSL !

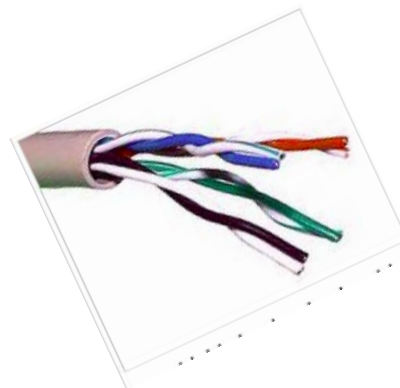


Source: Point Topic

- DSL is largest fraction (*over 70% of broadband*)
  - And growing faster (even fiber connects are VDSL)
  - **It costs a lot less**

# How Fast is Copper?

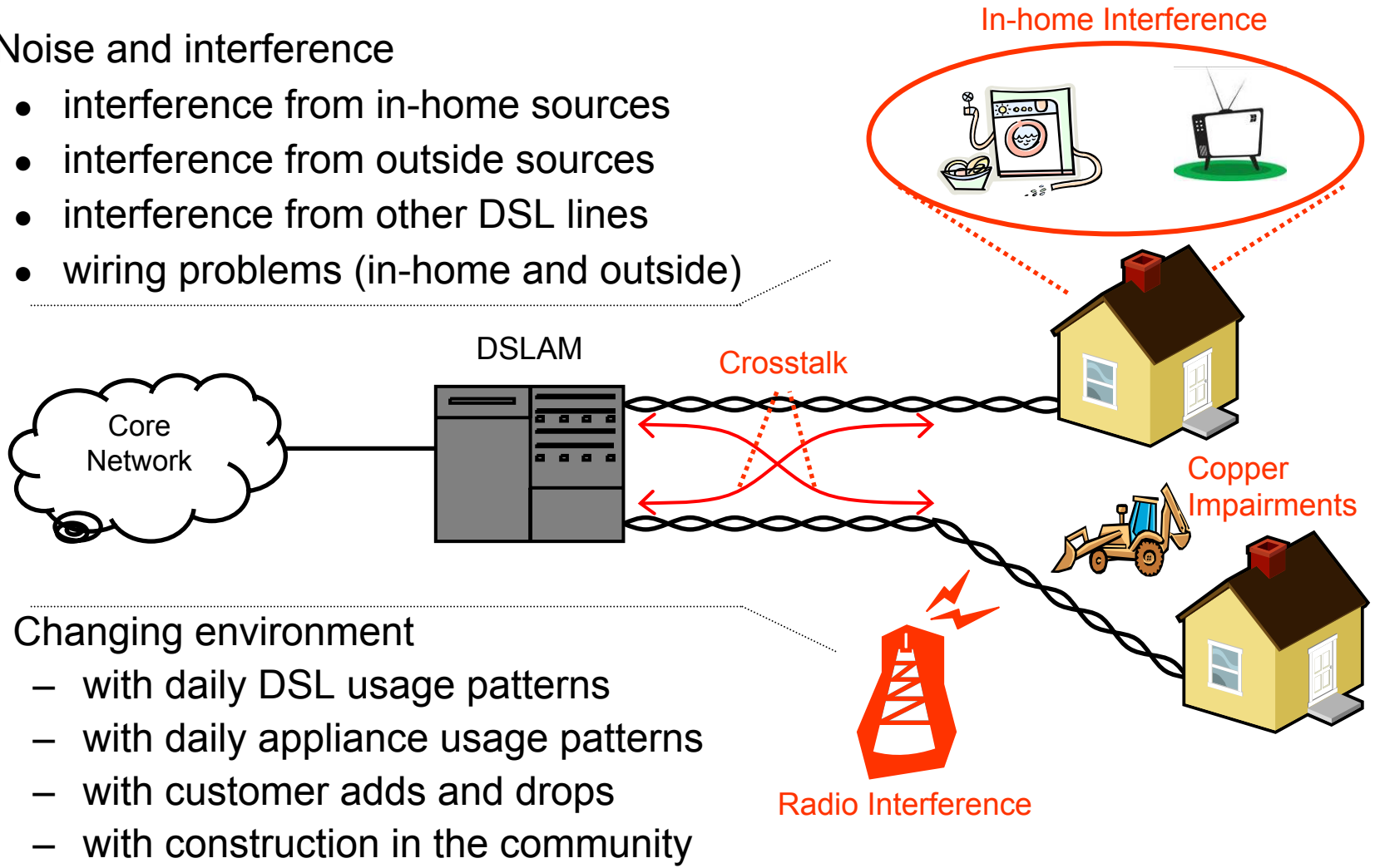
- 10 Gbase-T is 2.5 Gbps/pair
  - at 100m on category 6 twisted pair
- 150Mbps – 500Mbps DSLs demonstrated
  - 100m on category 3 twisted pair
- Ubiquitous 100Mbps to 1 Gbps DSLs?
  - *Dynamic Spectrum Management (DSM)*
    - *Soon, cheap, and energy efficient*
- ***And, a lot of signal processing***



# Technical Challenges in DSL

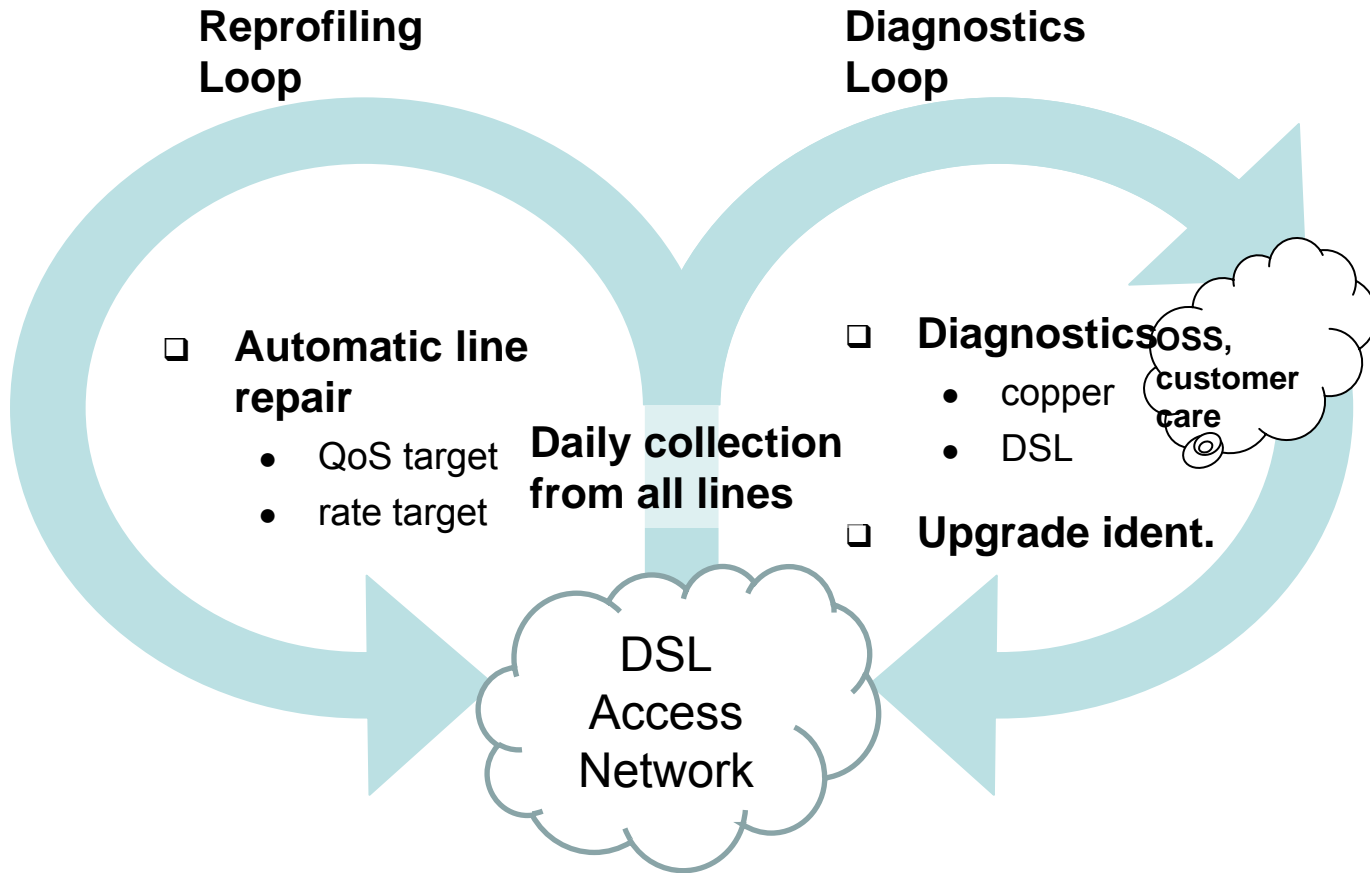
## □ Noise and interference

- interference from in-home sources
- interference from outside sources
- interference from other DSL lines
- wiring problems (in-home and outside)



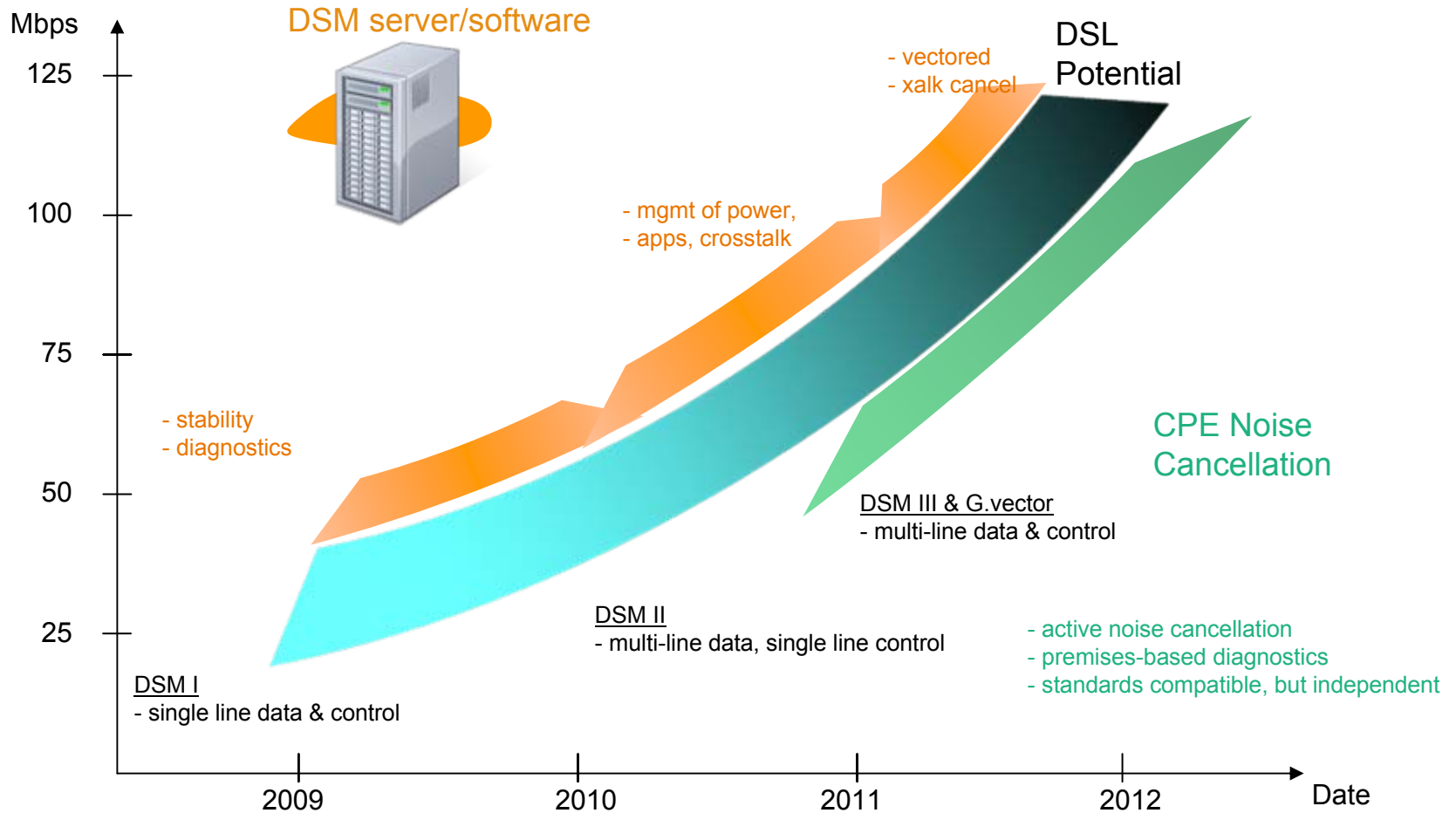
- Changing environment
  - with daily DSL usage patterns
  - with daily appliance usage patterns
  - with customer adds and drops
  - with construction in the community

# Basic DSM functions today



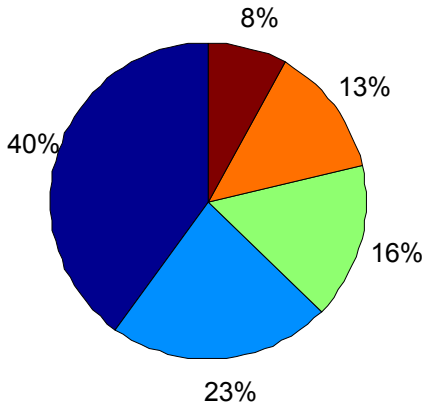
- **DSM Improves**
  - Operations cost
  - Data rate versus Length
  - Power consumption

# DSM Unlocks xDSL Potential

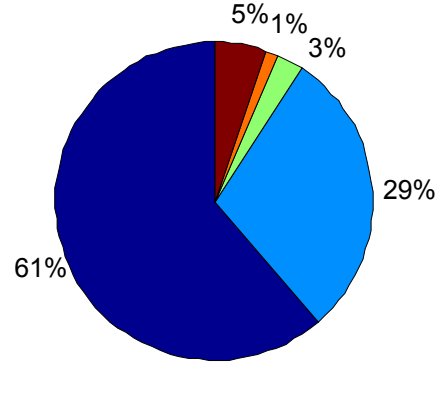


# DSM Level 1 Example (23M+ today)

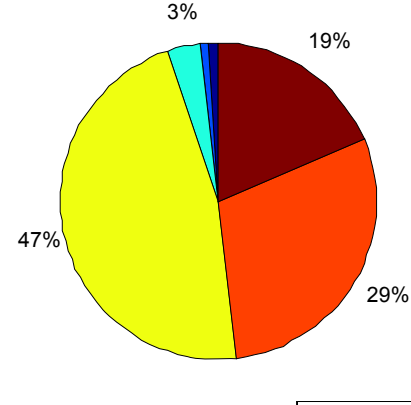
Stability Before DSM



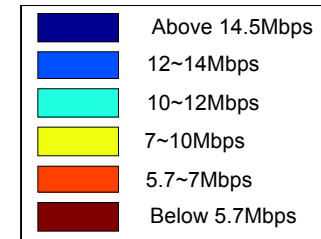
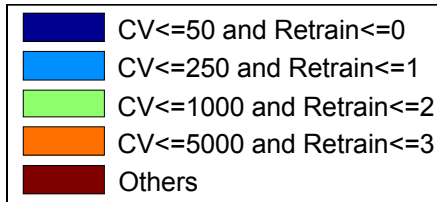
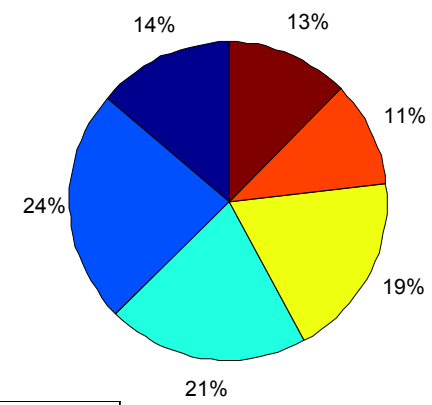
Stability After DSM



Dnstrm Rates Before DSM

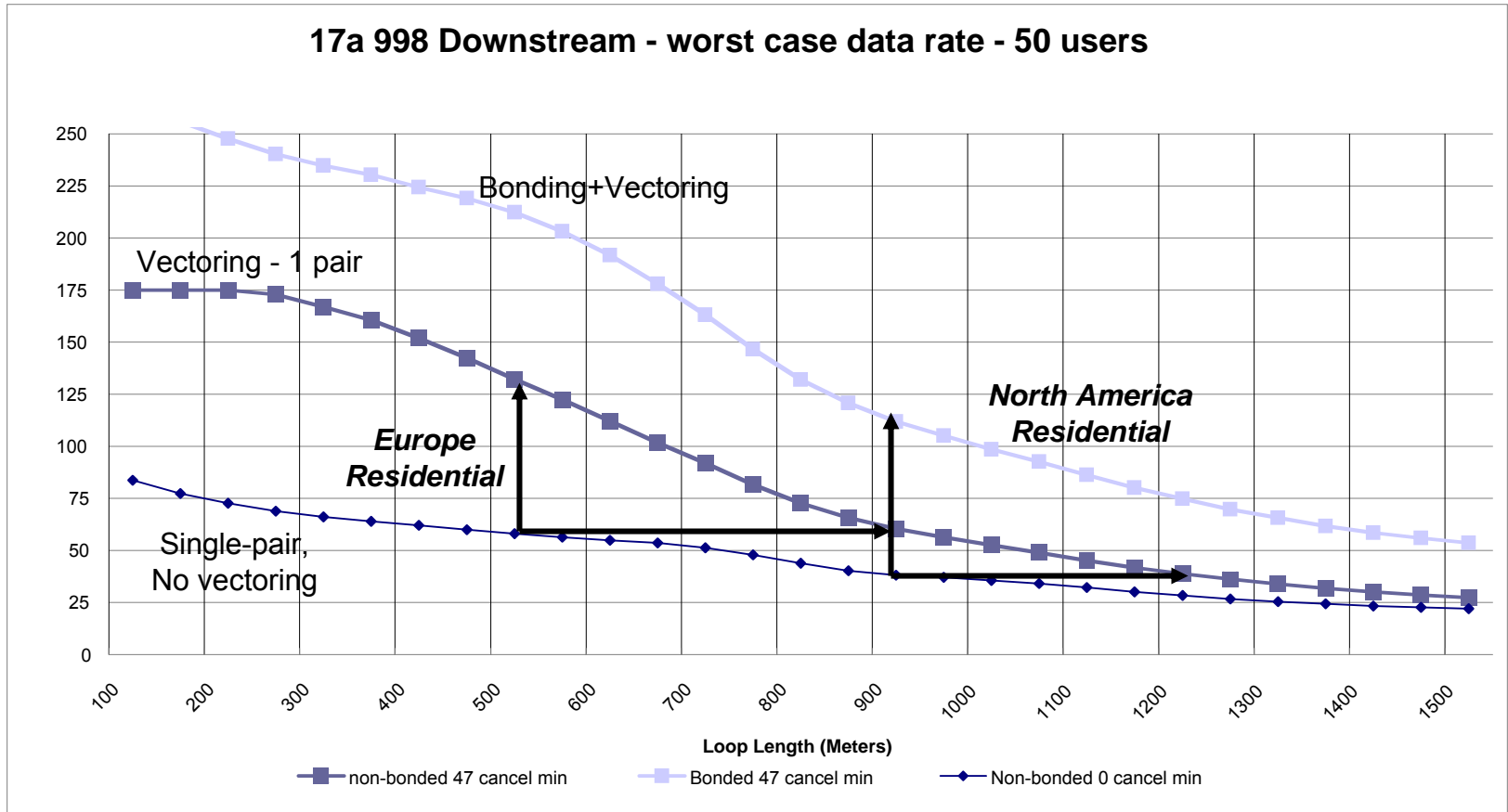


Dnstrm Rates After DSM



- DSM Level 1 is deployed on
  - 17M lines in USA
    - Will approach 30M by YE2010
  - 6M DSLs in Europe
    - Will exceed 15M by YE2010

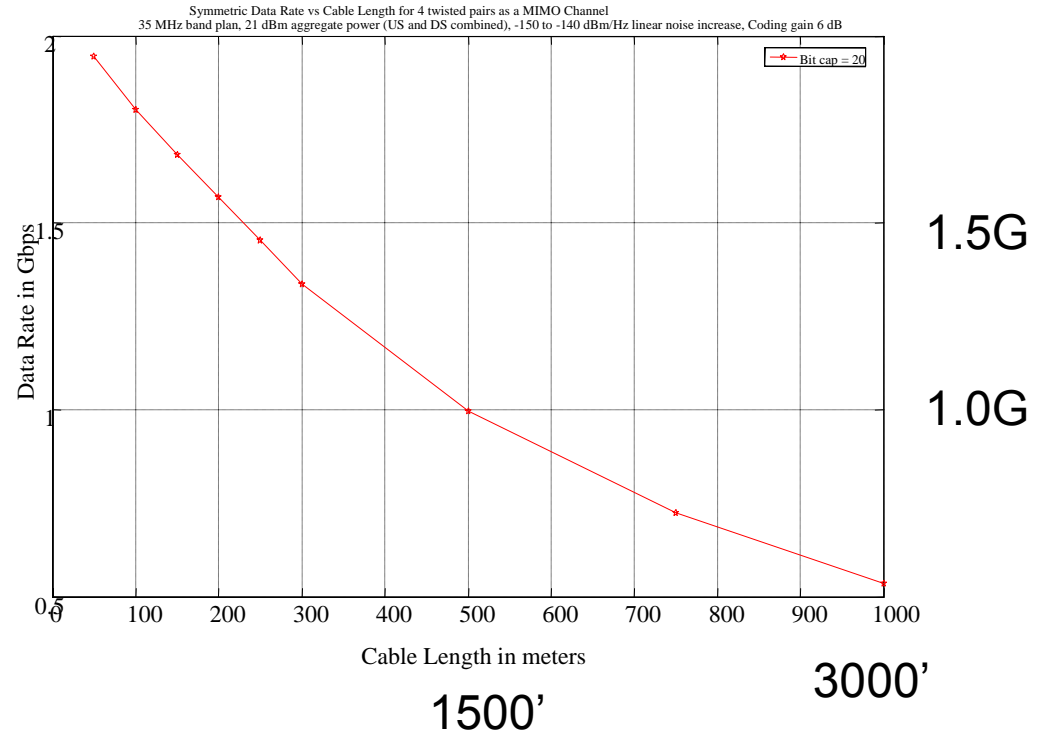
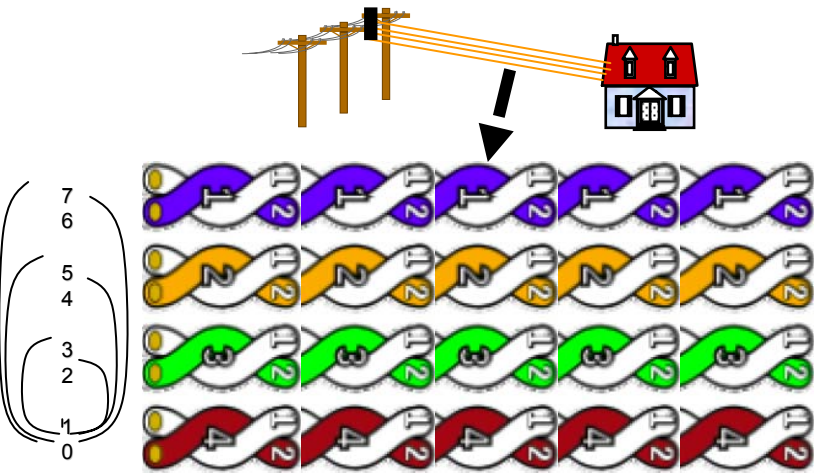
# Level 3 DSM: ITU G.993.5 VDSL2+



- 100-pair Telco cable, 4x25-pair binders (NIPP-NAI model)
- Does not include Telco cross-box, so gains may be larger!



# Bonding “GDSL” – 4-pair drop



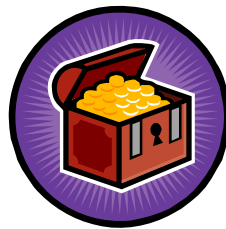
- Up to 7 channels
- 30MHz

# The DSM Opportunity

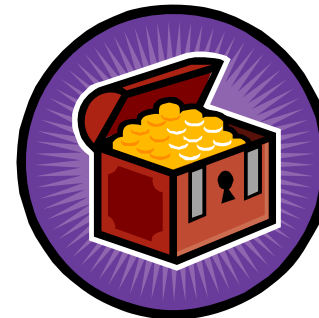
- Dynamic Spectrum Management (DSM)
  - Path to 100+ Mbps VDSLs and/or ADSL2+
    - DSM Level 1 – line stability in use now worldwide
    - DSM Level 2 – politeness (higher speeds, lower power) - beginning
    - DSM Level 3 – “G.vector” – 100+ Mbps VDSLs
      - Bonding of multiple lines, etc.
- DSL is global wire-line revenue growth vehicle
  - Major opportunity for new services triple/quadruple play
  - Video (IPTV, video-phone, You Tube)
  - Dual-Wifi (and/or Femto-cells) fed by DSL



Level 1  
1\$/line-mo



Level 2  
3\$/line-mo



Level 3  
> 10\$/line-mo