The True Benefit of Spectral Flexibility

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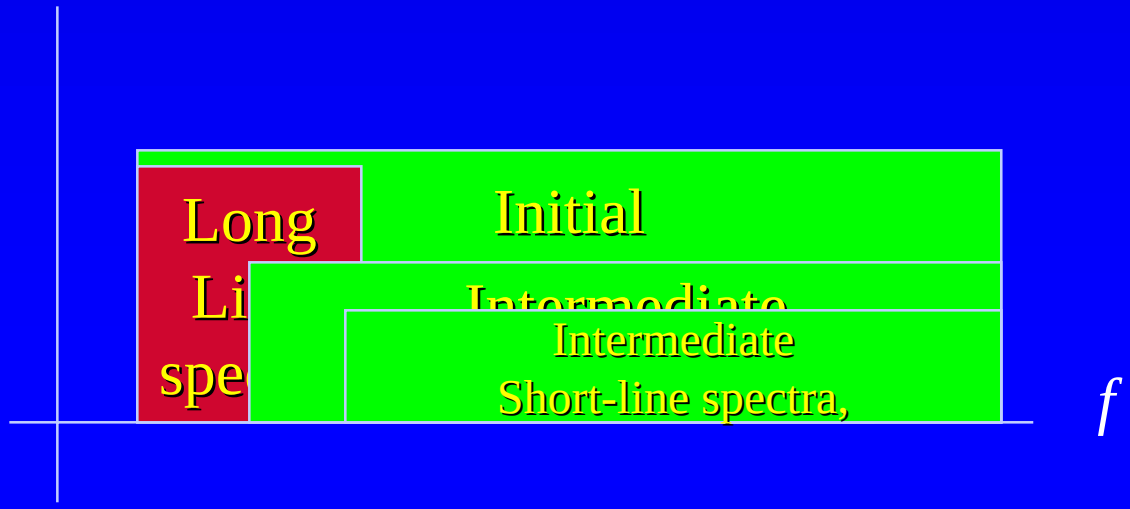
DMT modem's dynamic spectra

- Good for line itself
- ALSO good for other lines (less xtalk)
  - Especially in minimize-power mode
- Standardized option in G.dmt.bis and DMT VDSL modems
  - Politeness back-off during training
  - Bit-swapping in steady state (choose "max margin" mode for best results)
- If static spectrum choice like 998 or SHDSL is best, then DMT will converge to it, otherwise a MORE COMPATIBLE spectra is selected.
  - No DMT modem will "hog" binder as long as data rates are not set too high
- Unique Advantage of DMT – often 3x to 10x data rate

DSM ADSL basic spectrum result

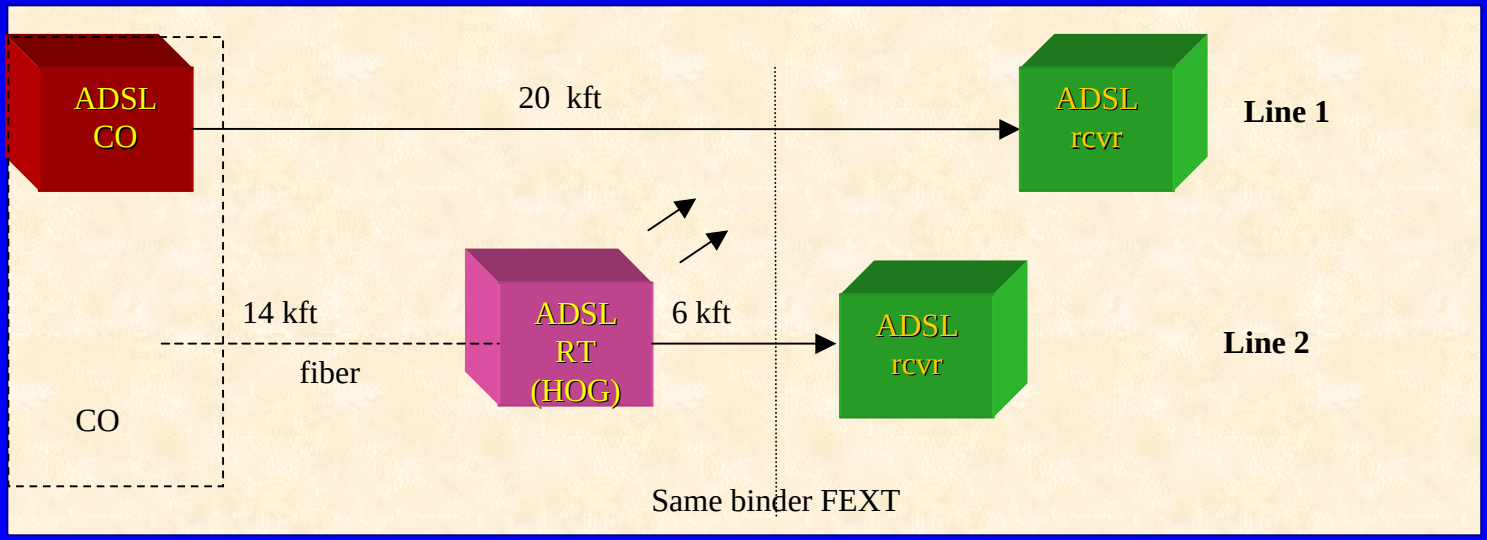
Downstream Spectra (2 lines)



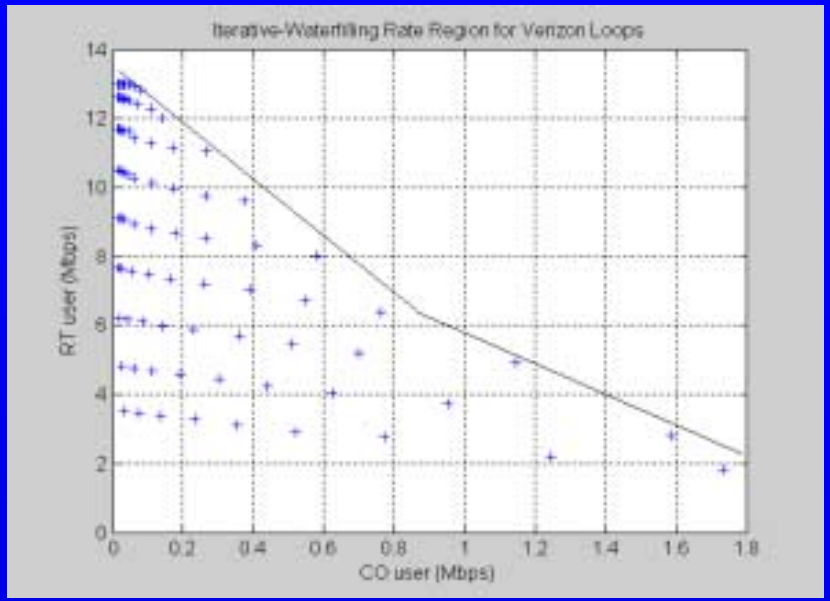
- Short line yields to long
  - No “DSL hogging”
- Enormous improvement on long line
  - At expense of reduced rate on short line
- Do so autonomously

Verizon Experimental Loop Configuration

(T1E1.4/2002-069 – "Bell Atlantic" Test Lab, Maryland)



- Hog (normal) mode
  - Short gets 9 Mbps
  - Long gets 100 kbps
- DMT DSM mode
  - Short and Long get 2 Mbps
  - 20x increase on long
  - (4,1.4), (6,.9), (8,.6)
  - Short does not attempt max



Symmetric 10Mbps Range/Rate Goals [1]

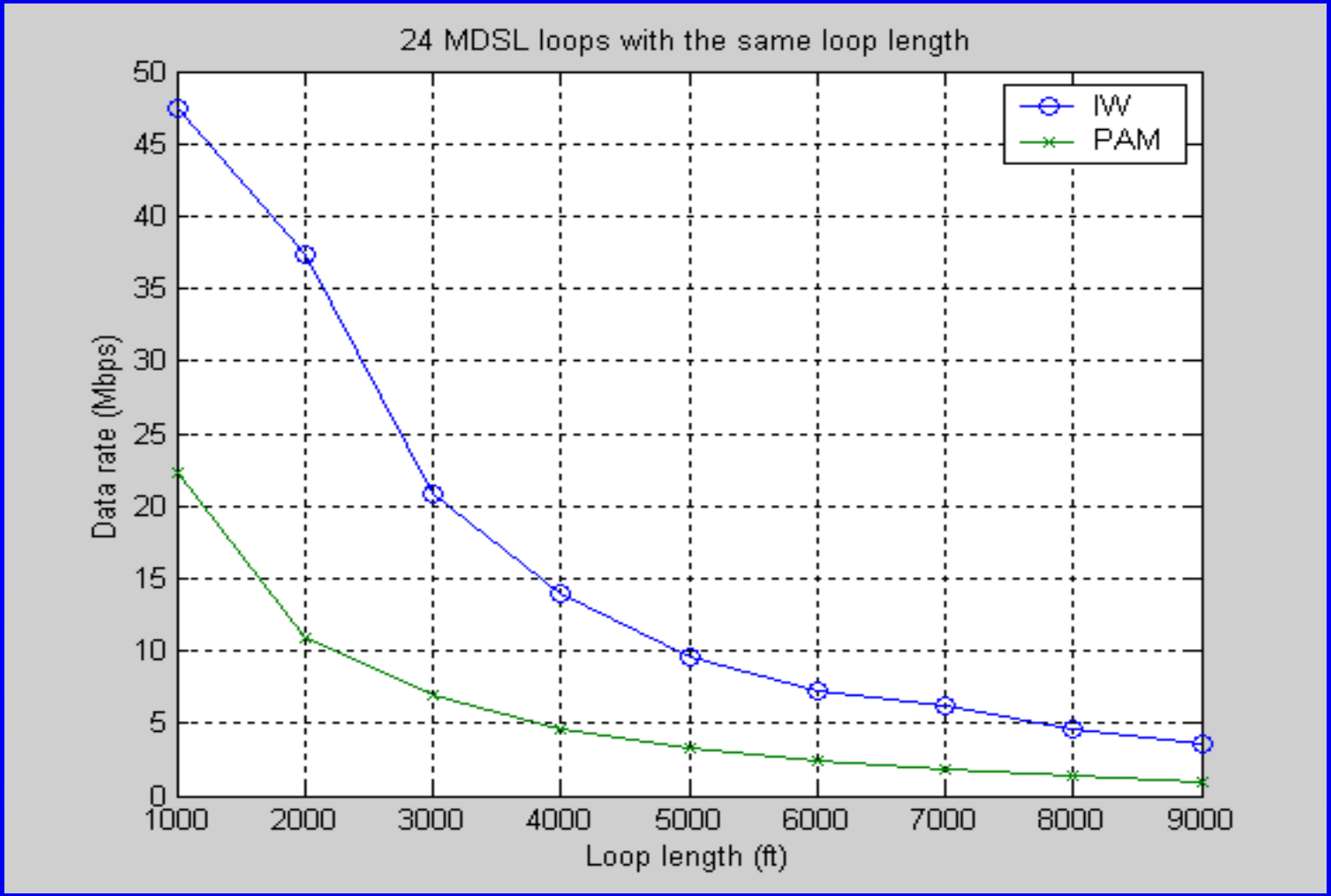
Table 1 – 10 MDSL objectives and goals (from [1])				
Aggregate bit rate (sym payload)	Number of twisted pairs	Average bit rate per pair	Objective loop length	Desired loop length
10 Mb/s	1	10 Mb/s	2.5 kft	>3.5 kft
10 Mb/s	2	5 Mb/s	4 kft	>5 kft
10 Mb/s	3	3.33 Mb/s	5.5 kft	>6.5 kft
10 Mb/s	4	2.5 Mb/s	7 kft	>8 kft
10 Mb/s	5	2 Mb/s	8 kft	>9 kft
4 Mb/s	4	1 Mb/s	12 kft	>12 kft
2 Mb/s	4	512 kb/s	15 kft	>15 kft

For EFM ?

Iterative Water-filling (IW) with Dynamic Spectrum Management:

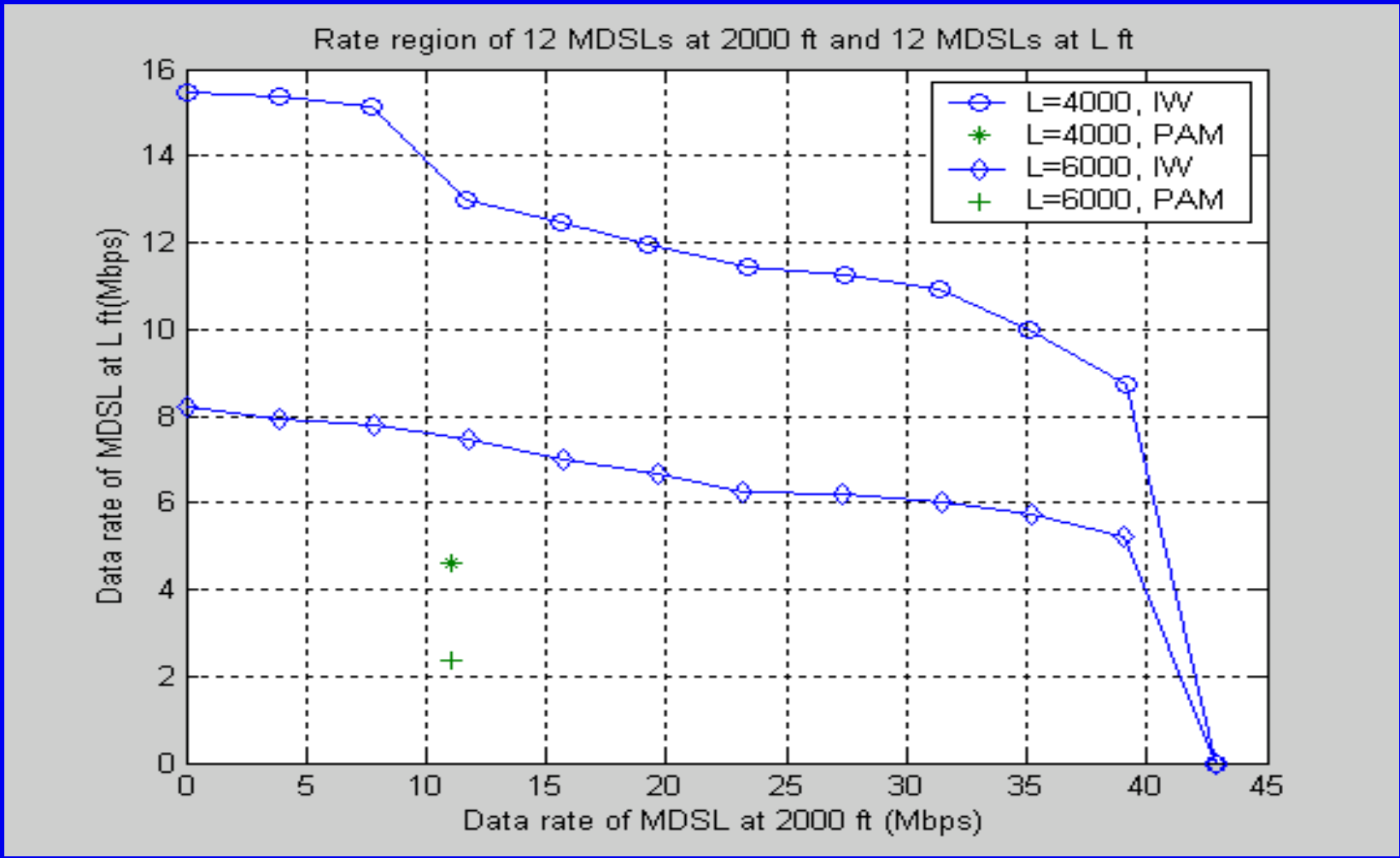
- Allows Mixture of Asymmetric and Symmetric services with no performance loss
  - I.e., mix ADSL with 10 MDSL – no spectrum problems
- Even when existing ADSL is at CO and EFM (10 MDSL) is at remote terminal, and both are in same binder
- Next few slides show some results

24 MDSLs in same binder (same length)



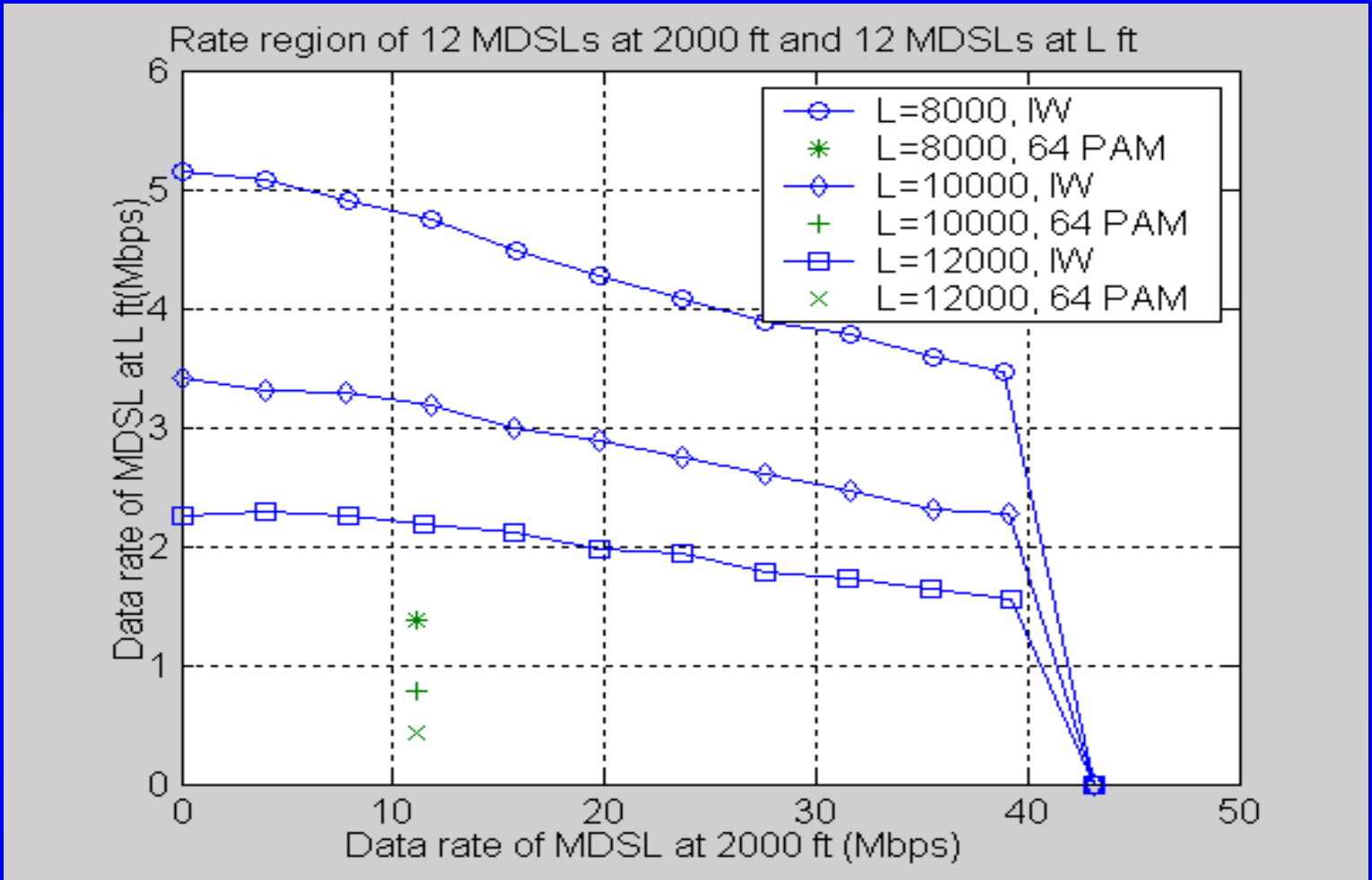
- NO coordination whatsoever

MDSLs of varying lengths mixed



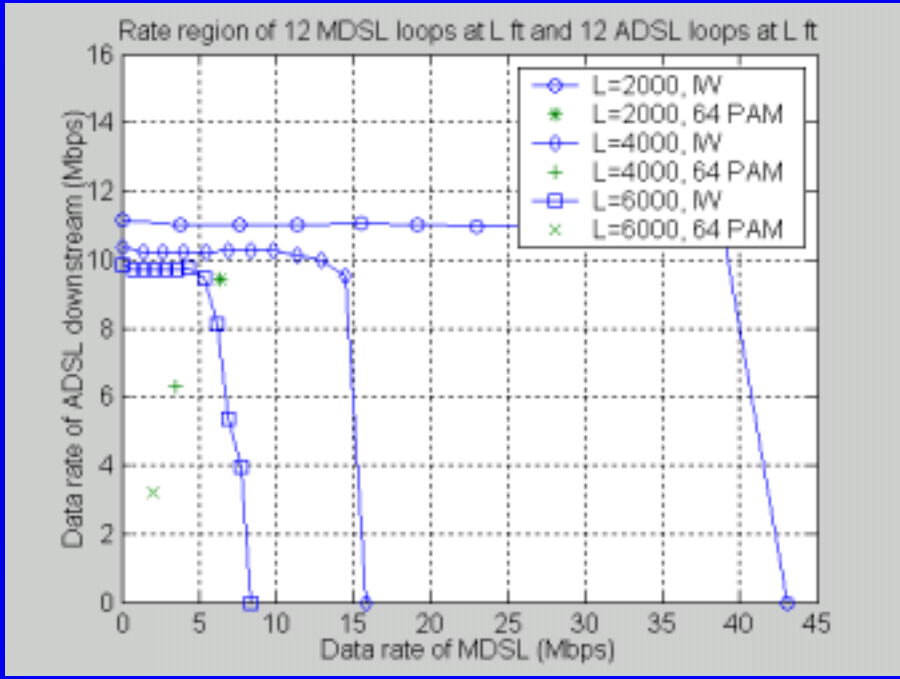
- Improvement grows from 2x range of 64PAM on previous slide to 4x here

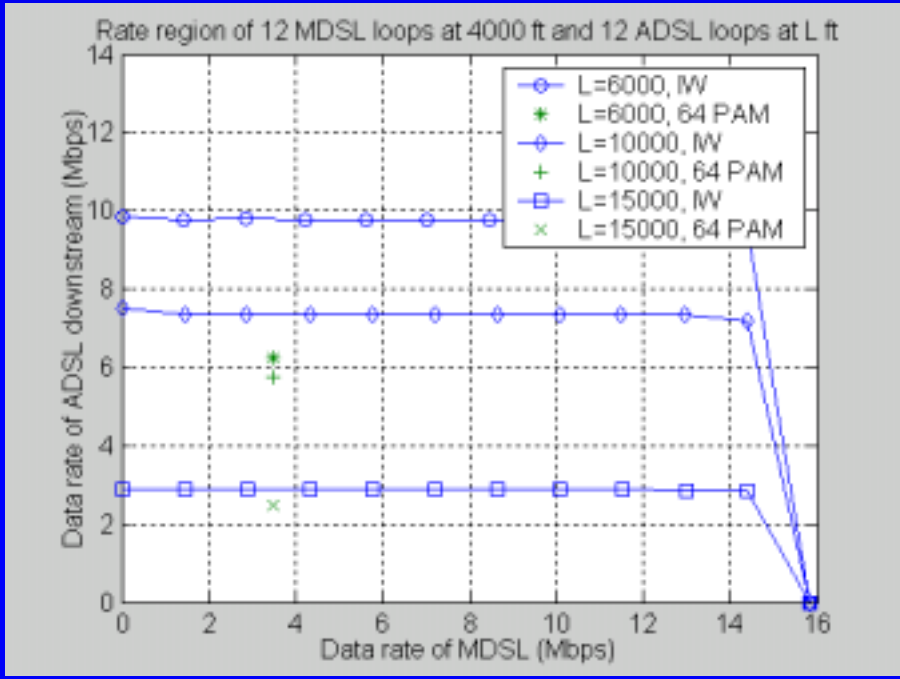
MDSL's of varying length



- Long lengths have less advantage, but still significant (nearly 3x data rate here)

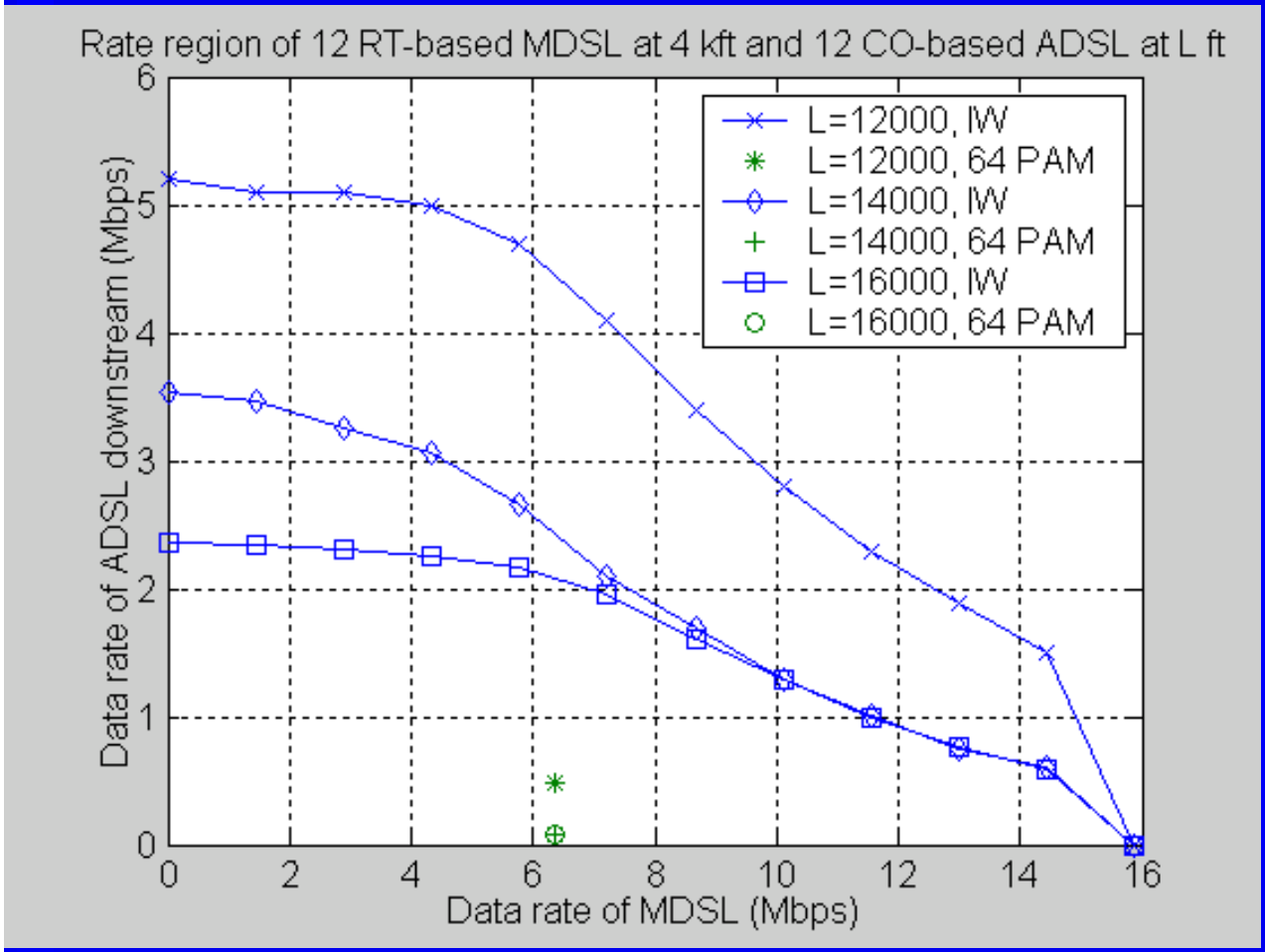
MDSL with ADSL present

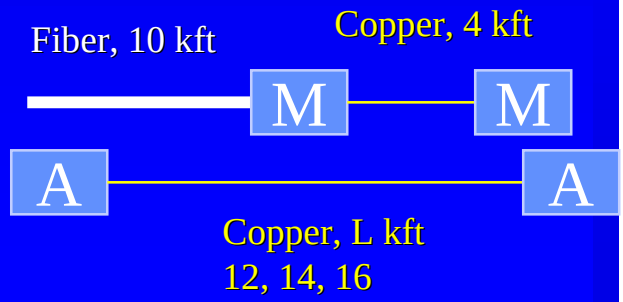




- ADSL basically unaffected by IW MDSL –
  - 64 PAM and rate-adaptive ADSL are not very compatible (both are hurt)

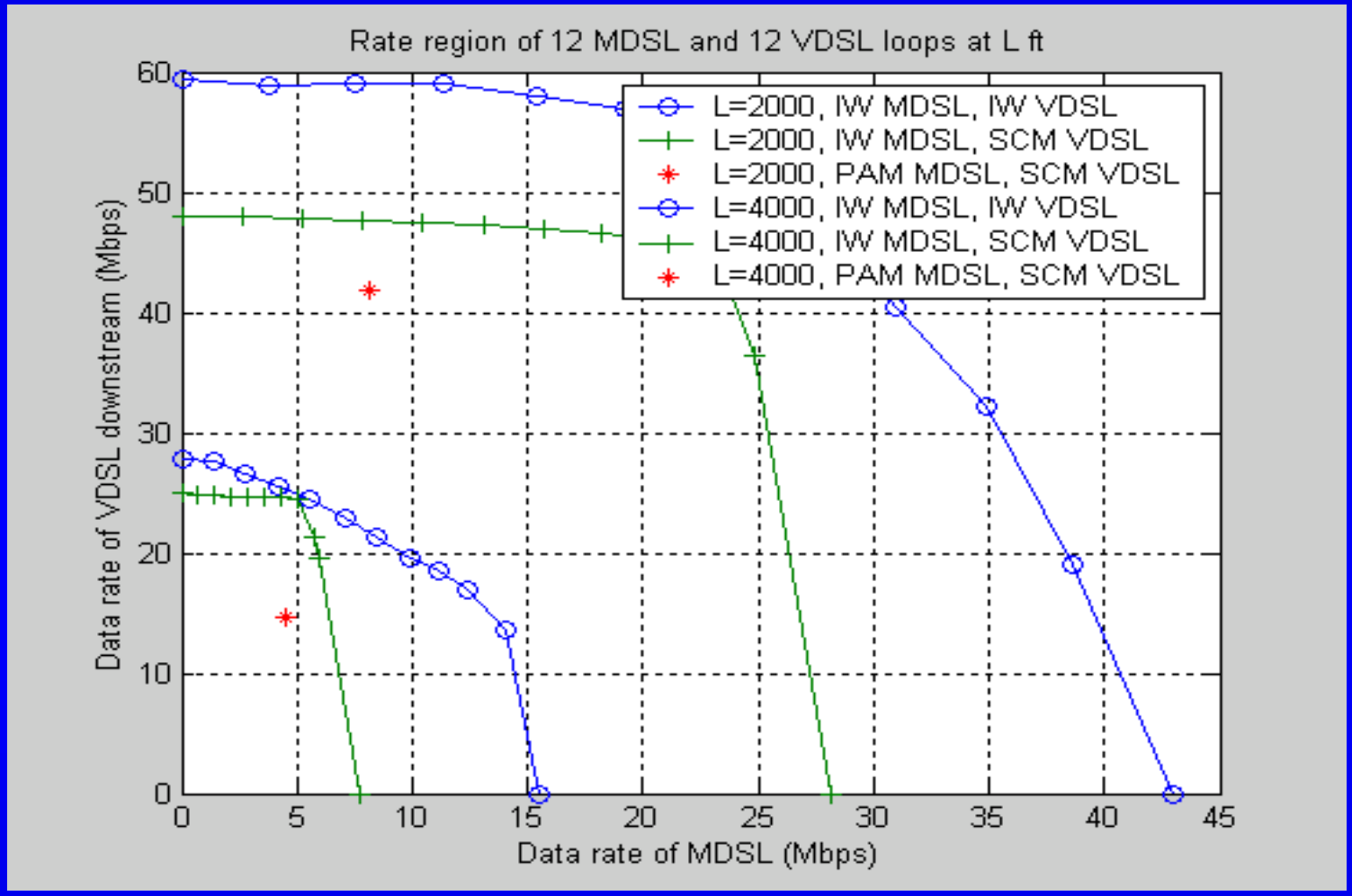
ADSL at CO, MDSL at RT





- Cabinet is 10 kft from CO – last 2 to 6 kft in same binder
- ADSL at CO “swamped” by 64 PAM
- ADSL at CO largely unaffected by IW

MDSL and VDSL



- Only IW methods are compatible with VDSL

Table Revisited (extra column)

Table 2 – Augmentation of Table 1 with IW results					
Aggregate bit rate (sym payload)	# of twisted pairs	Average bit rate per pair	Objective loop length	Desired loop length	**IW Result**
10 Mb/s	1	10 Mb/s	2.5 kft	>3.5 kft	**5 kft**
10 Mb/s	2	5 Mb/s	4 kft	>5 kft	**8 kft**
10 Mb/s	3	3.33 Mb/s	5.5 kft	>6.5 kft	**9 kft**
10 Mb/s	4	2.5 Mb/s	7 kft	>8 kft	**10 kft**
10 Mb/s	5	2 Mb/s	8 kft	>9 kft	achieved
4 Mb/s	4	1 Mb/s	12 kft	>12 kft	achieved
2 Mb/s	4	512 kb/s	15 kft	>15 kft	achieved

- Allows mixture of ADSL and MDSL
- Rate regions do reduce in size

Conclusion

- IW DMT Never does worse than static spectra
- All 10 Mbps goals exceeded by IW
  - And much higher rates enabled also
- Allows ADSL
  - Even from CO (when MDSL is at RT)
- Allows/enables VDSL
- Overwhelming advantage with flexible spectra

Motions

- Add the following Objective Statement for IEEE 802.3ah Copper Track:
- PHY option for single-pair non-loaded voice grade copper distance >= 1600m and speed >= 10 Mbps full duplex
- Add the following criteria for Copper Objectives:
- Include flexible spectra as a criteria for IEEE 802.3ah Copper Objectives