Carrier Grade Ethernet

Proposed Copper EFM PHY

Patrick Stanley, Elastic Networks, pstanley@elastic.com (678)297-3103

Co-Sponsors of This Presentation

Bob Brown, Verizon Avenue, bob.m.brown@verizon.com
Dean Hudson, Citizens Communications, dehudson@czn.com
Sherman Ackley, National Rural Telecommunications Cooperative (NRTC), sackley@nrtc.org
Robert Liethman, New South Communications, robert@newsouth.com
John Stegenga, Bass Hotels (Holiday Inn, Intercontinental, Crowne Plaza, Staybridge), john.steganga@basshotels.com
Wes Wycoff, Nortel Networks, wwycoff@nortelnetworks.com
Richard Brand, Nortel Networks, rbrand@nortelnetworks.com
Anand Injeti, ST Microelectonics, anand.injeti@st.com
Darin Kincaid, ST Microelectronics, Darin.KINCAID@st.com
David Fauser, Mitel, david_fauser@Mitel.com
Nick Yasui, Hitatchi Telecom USA, nyasui@hitel.com

Proposed PHY

Propose that the 100BaseCu PHY, as described in "Fast Robust EFM", Elastic Networks [1], be studied as a candidate for the copper based EFM, to bridge the gap from the Optical MAN to the subscriber LAN when the infrastructure does not support optical EFM options

100BaseCu IS NOT VDSL. It is a half-duplex, burst mode, frequency agile, symmetry agile, spectrally compatible access technology that builds on successfully deployed technology, and was shown in [1] to provide superior rate and reach performance compared to VDSL and ADSL.

The rest of this presentation outlines how 100BaseCu meets the 5 Criteria for successful project approval

1) Broad Market Potential

ELASTIC NETWORKS

a) Broad sets of applicability

One technology that can serve customers serviced by in-building and outside plant wiring. (See following Slides)

b) Multiple vendors and numerous users

Technology is currently being licensed and built by multiple vendors.

Equipment vendors, and Carriers have co-sponsored this proposal.

c) Balanced costs (LAN versus attached stations)

Comparable product costs to VDSL with significantly lower operational and deployment costs. Ethernet vendors and users are able to achieve an optimal cost balance between the network infrastructure components and the attached stations.

Loop Length Distributions

Contribution T1E1.4/2001-132 [2], from Telcordia Technologies, gives the following statistics from a 1990 DLC Survey of 686 DLC loops that were sampled from 126 wire centers in 5 regions:

- 10% of Loops DLC fed (had grown to 30% nationwide by 2000)
- 60.6% of DLC loops CSA compatible (length <= 12kft 26AWG)
- Assumes that DLC's built since 1990 have ~100% CSA compatibility

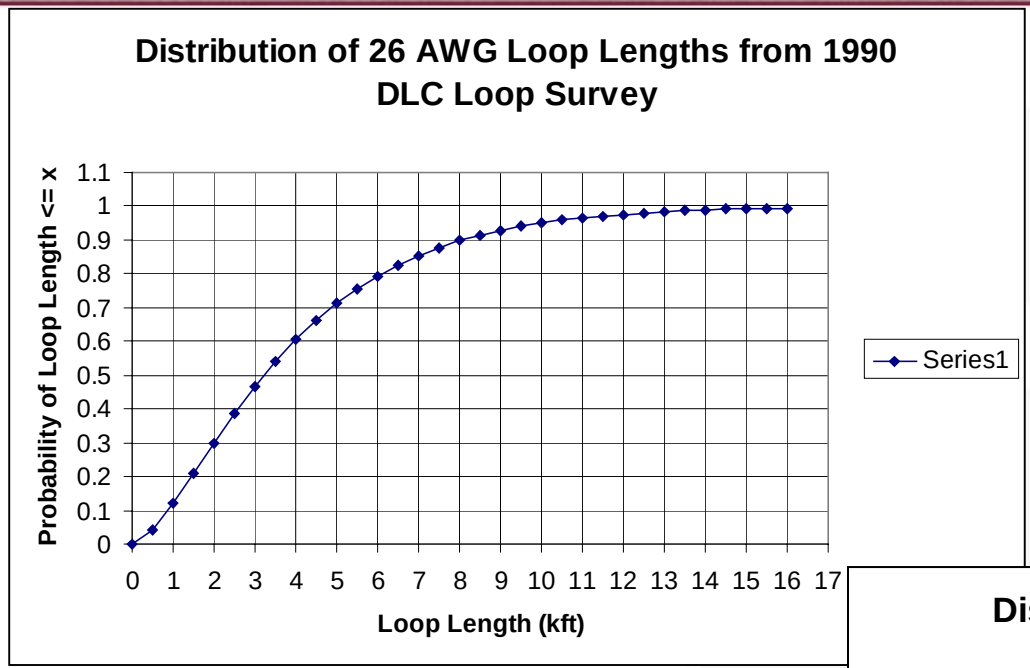
Of the CSA compatible loops:

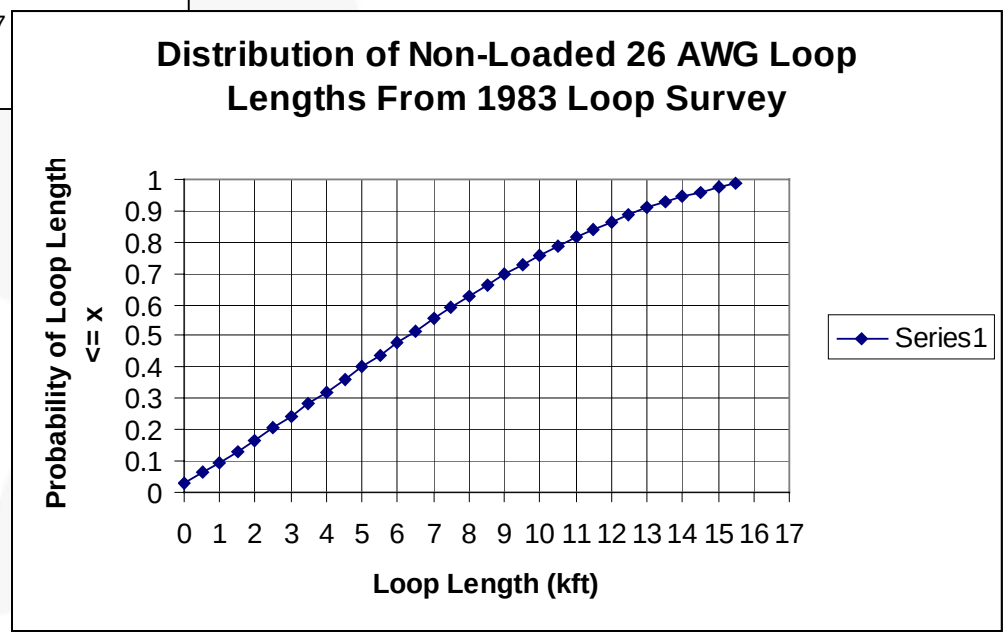
	Avg	90%	75%	Median	25%
Loop Length (ft) from RT to TU-R	3808	7824	5304	3263	1940

Contribution T1E1.4/2000-219R1 [3], from Telcordia Technologies, gives the Following statistics from a 1983 Survey of business and residential loops in 5 Of 7 regions in the United States. Of non-loaded loops:

	Avg	90%	75%	Median	25%
Loop Length (ft) from CO to TU-R		13000	10000	6500	3000

Loop Length Distribution Graphs





Addressable Market, CO & DLC

Loop Reach for MINIMAL CONNECTION, based on simulated cases found in [1] :

- FSAN998 Compliant VDSL Band Plans: 3000 ft
- Draft Trial Use Standard Compliant VDSL/ADSL Band Plans: 12000 ft
- Fast Robust EFM (Carrier Grade Ethernet) Band Plan: 20000 ft

DLC Market Addressed:

- FSAN998 Compliant VDSL Band Plans: 41%
- Draft Trial Use Standard Compliant VDSL/ADSL Band Plans: 85%
- Fast Robust EFM (Carrier Grade Ethernet) Band Plan: >99%

CO Market Addressed:

- FSAN998 Compliant VDSL Band Plans: 24%
- Draft Trial Use Standard Compliant VDSL/ADSL Band Plans: 86%
- Fast Robust EFM (Carrier Grade Ethernet) Band Plan: >99%

Total OSP Market Addressed:

- FSAN998 Compliant VDSL Band Plans: 29%
- Draft Trial Use Standard Compliant VDSL/ADSL Band Plans: 86%
- Fast Robust EFM (Carrier Grade Ethernet) Band Plan: >99%

Data Rate, CO & DLC

Loop Reach for 10Mbps, based on full binder self disturber case [1] :

- FSAN998 Compliant VDSL Band Plans: 4500 ft
- Draft Trial Use Standard Compliant VDSL/ADSL Band Plans: 4500 ft
- Fast Robust EFM (Carrier Grade Ethernet) Band Plan: 11000 ft

DLC Market Addressed:

- FSAN998 Compliant VDSL Band Plans: 57%
- Draft Trial Use Standard Compliant VDSL/ADSL Band Plans: 57%
- Fast Robust EFM (Carrier Grade Ethernet) Band Plan: 84%

CO Market Addressed:

- FSAN998 Compliant VDSL Band Plans: 36%
- Draft Trial Use Standard Compliant VDSL/ADSL Band Plans: 36%
- Fast Robust EFM (Carrier Grade Ethernet) Band Plan: 82%

Total OSP Market Addressed:

- FSAN998 Compliant VDSL Band Plans: 42%
- Draft Trial Use Standard Compliant VDSL/ADSL Band Plans: 42%
- Fast Robust EFM (Carrier Grade Ethernet) Band Plan: 83%

Copper Bridge for Optical MAN

ELASTIC NETWORKS

FTTuser:

- YANKEE Group estimates 5-7% of buildings served by fiber

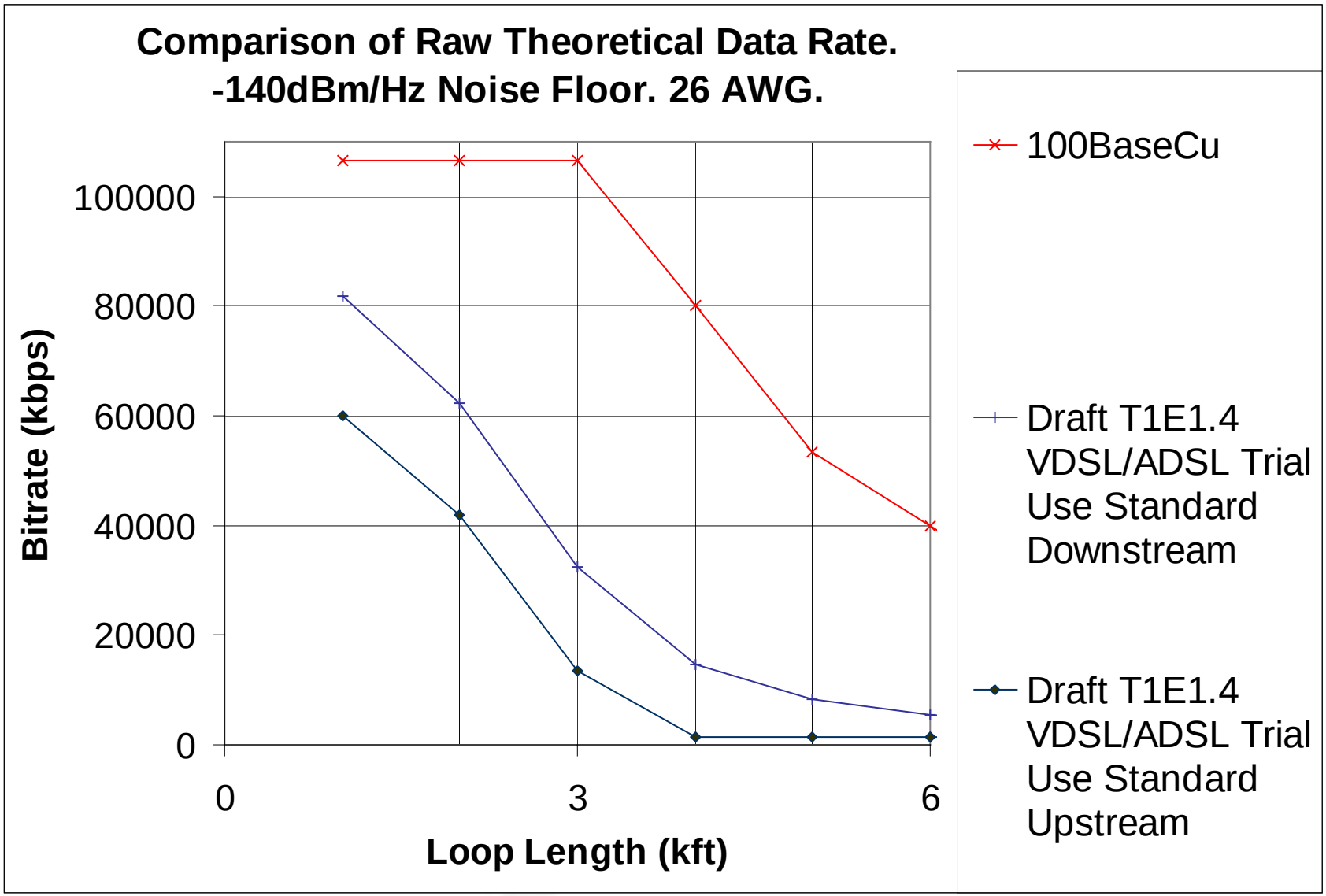
Even with FTTB, need bridge In Building:

- Even by 2003, approximately 60% of in building market will require use of unstructured Cat 3 wiring to reach tenants

Buildings that could be reached by copper bridge from optical MAN:

- Chicago: 42%-67% of buildings within 1-5 miles of fiber
- LA: 40%-73% of buildings within 1-5 miles of fiber

Higher Data Rates on Short Loops



2) Compatibility

a) Conformance with 802 Overview and Architecture

- As a supplement to IEEE Std 802.3, the proposed project will remain in conformance with the 802 Overview and Architecture.

b) Conformance with 802.1D, 802.1Q, 802.1p

- As a supplement to IEEE Std 802.3, the proposed project will remain in conformance with 802.1D, 802.1Q and 802.1f, though extensions to these standards may be proposed as additional work items.

c) Compatible managed object definitions

- As a supplement to IEEE Std 802.3, the proposed project will follow the existing format and structure of 802.3 MIB definitions.

3) Economic Feasibility

a) Known cost factors, reliable data.

- Products based on EtherLoop are being manufactured and sold internationally today. Costs have been established and are based on data from multiple manufacturers.

b) Reasonable cost for performance.

- EtherLoop shares the same cost advantages of Ethernet as compared to ATM technologies.

c) Consideration of installation costs.

- EtherLoop is extremely tolerant to variances in the copper plant. It automatically adjusts it operating parameters to optimize performance for a given loop, greatly reducing costs of installation for the service provider

4) Distinct Identity

a) Substantially different from other IEEE 802 standards.

- There is no existing 802 standard or approved project appropriate for wire line access over the vast majority of outside plant and in building wiring, using the Ethernet access protocol and frame format, with the exception of certain combinations of operating speed and media defined in various supplements to IEEE Std 802.3. This project will expand that set to include all non-loaded copper used for wireline voice service today.

b) One unique solution per problem (not two solutions to a problem).

- This PHY would provide a single solution for all non-loaded copper used for wireline voice service today.

c) Easy for the document reader to select the relevant specification.

- The proposed project will be formatted as a supplement to IEEE Std 802.3, making it easy for the document reader to select the EFM specification. Ethernet over CAT 3 copper is the distinction.

5) Technical Feasibility

a) Demonstrated system feasibility.

- 100BaseCu builds on the base technology of EtherLoop, which been deployed in hundreds of thousands of loops in multiple countries. Has 3 years of successful deployment history.

b) Proven technology, reasonable testing.

- 100BaseCu builds on the base technology of EtherLoop, which has been validated by Telcordia. It is fully compliant with the T1.417 standard for spectral compatibility. It has been tested in the lab in fully filled binder groups and the presence of multiple interferers. (See following slides for simulated vs. measured performance)

c) Confidence in reliability.

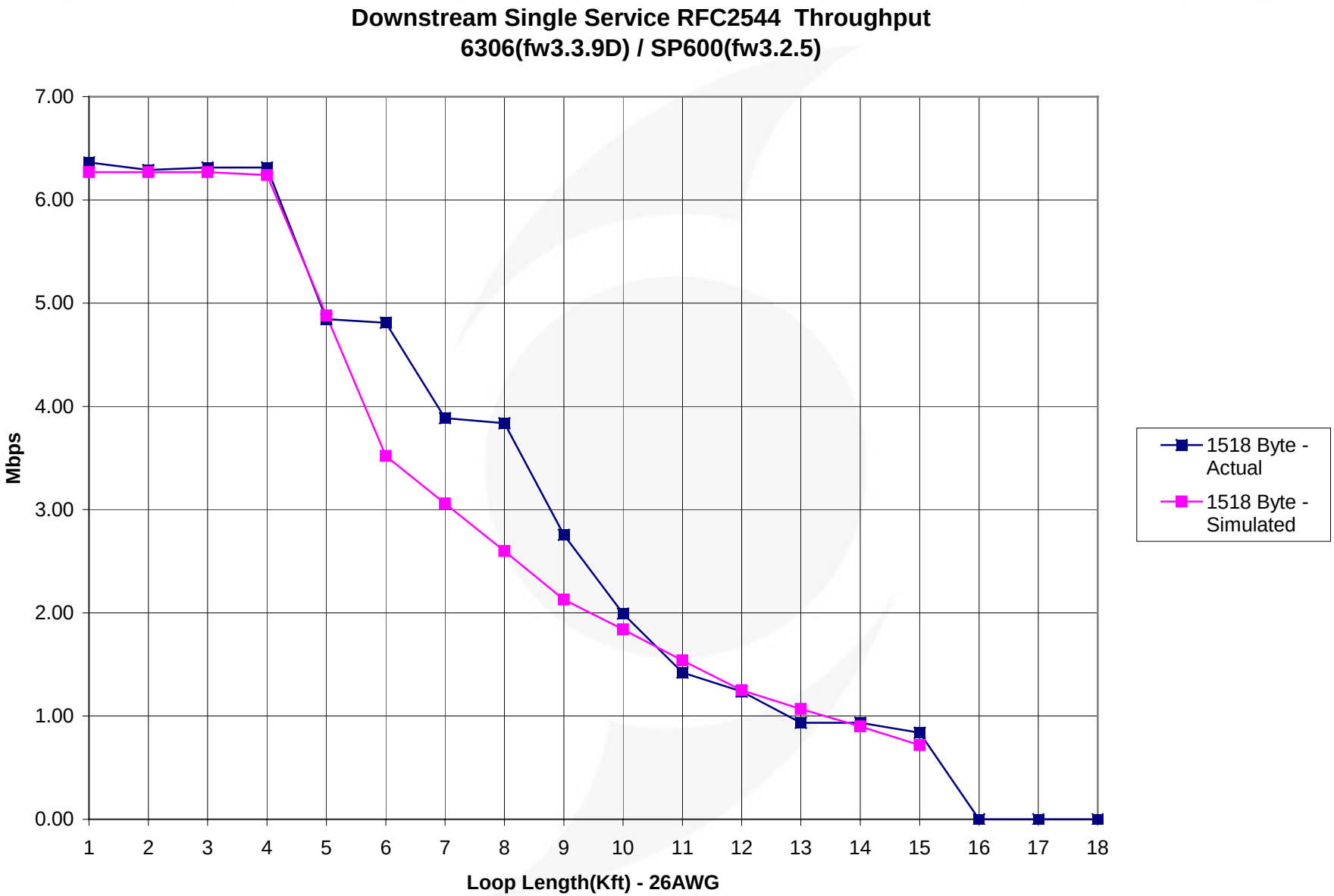
- 100BaseCu builds on the base technology of EtherLoop, which has been widely deployed by over 70 phone companies who have validated it's reliability in the field.

Simulation of EtherLoop vs. Measured Data

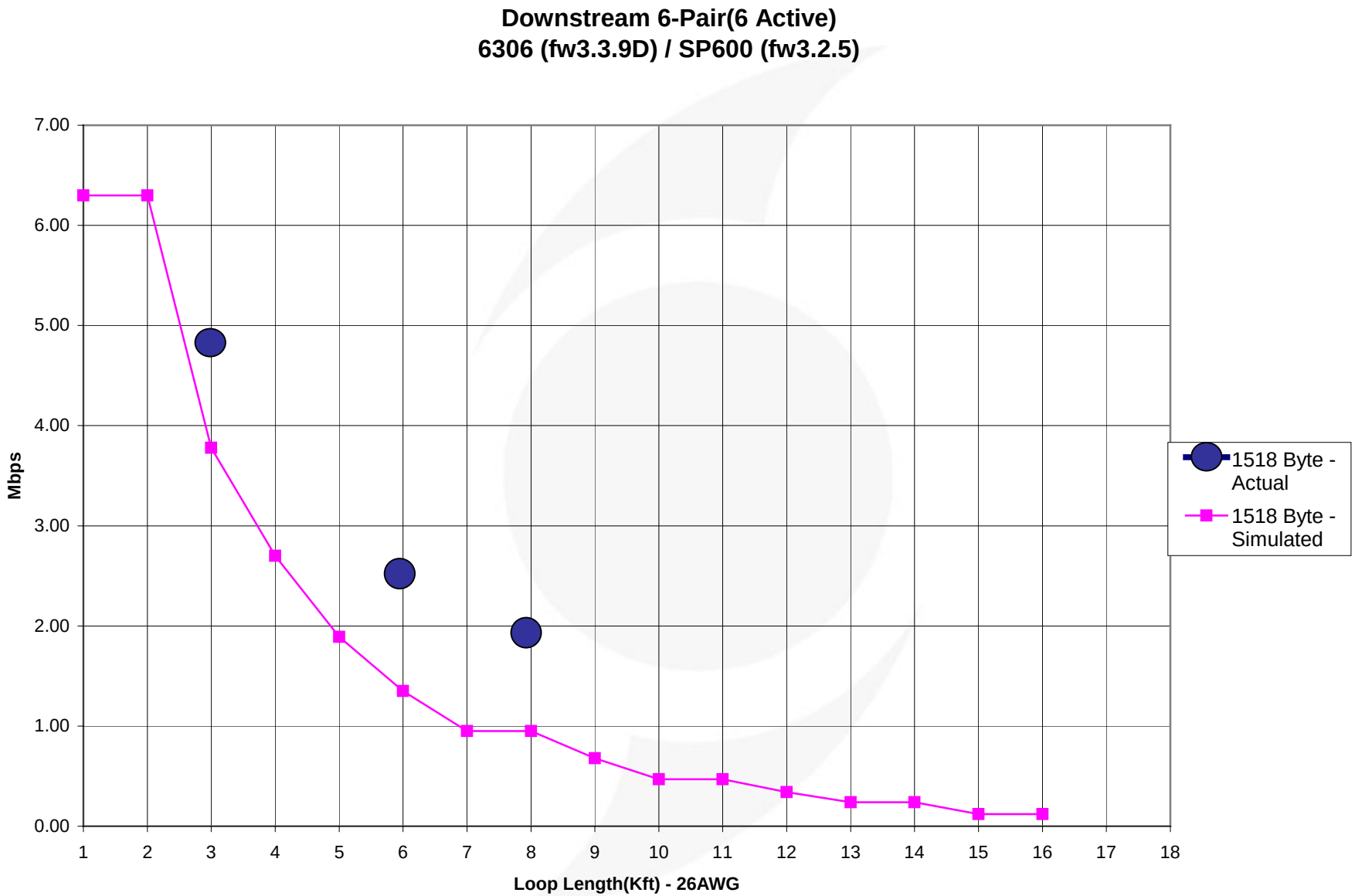
EtherLoop simulations performed in January 1998, prior to availability of 6.67 Mbps product, and prior to full characterization testing of 4Mbps product. Test results performed on Consultronics Loop simulator for single loop test, and in real copper binders for multi-disturber tests.

Based on this track record, high degree of confidence that similar agreement will be met with 100BaseCu

Single Loop Case, No Disturbers



5 Disturber Case (Characterization Continues)



Proposal

Propose that long reach, non-VDSL, PHYs, such as 100BaseCu, be included in the study of EFM for copper, in order to address a broader market potential, offering service beyond 3500ft, and to offer higher data rates on all loop lengths.

References

[1] “Fast Robust EFM,” Elastic Networks, IEEE 802.3 EFM Study Group, Plenary, March 2001

[2] “Statistical Variables for Evaluating Compatibility of Remote Deployments ,” Telcordia Technologies, pursuant to work supported by BellSouth, SBC, and Verizon, T1E1.4/2001-132, May 2001

[3] “2B1Q SDSL Crosstalk: Mixed Bit Rates and Numbers of Disturbers ,” Telcordia Technologies, pursuant to work supported by BellSouth and SBC, T1E1.4/2000-219R1, November 2000