COMMITTEE T1 – TELECOMMUNICATIONS
Working Group T1E1.4 (DSL Access) **T1E1.4/2003-154**
New-Orleans, LA; May 19-23, 2003

CONTRIBUTION

TITLE: **Proposed parameters for DSM level 1-2 for SCM based systems**

SOURCE: **Metalink Broadband Access, Infineon Technologies**

PROJECT: **DSM**.

STATUS: For discussion and decision.

ABSTRACT

In this contribution we propose levels 1-2 channel identifying parameters of QAM based transmission systems for use in DSM .

NOTICE

This contribution has been prepared to assist Standards Committee T1-Telecommunications. This document is offered to the committee as a basis for discussion and is not a binding proposal. The requirements are subject to change in form and numerical value after more study. Specifically, the right to add to, or amend, the statements contained herein is reserved.

Contacts:
Amir Leshem, Metalink Broaband access, Yakun Business Park, 60972, Israel. e-mail: leshem@metalink.co.il. Tel: +972-9-9605413.

Vladimir Oksman, Infineon Technologies. Tel 732-855-9200, e-mail: Vladimir.Oksman@infineon.com

I. INTRODUCTION

In [1] we have demonstrated that SCM systems can improve the rate region in near-far scenarios even without any coordination. Coordination can obviously contribute for even better performance. In this contribution we propose parameters to be exchanged between an SCM based DSL unit and a DSM management center (SMC). The parameters include SNR, Spectral shaping parameters for both FIR and IIR based systems.

II. SNR PROFILE

In this section we propose a format for reporting SNR and power spectral densities over a list of frequencies.

1) *SCM VDSL Level 1-2 data compliance*

The SCM-based VDSL channel identification parameters should be computed (obtained) in two modes:

- *Diagnostics mode* can be invoked on-demand in order to compute diagnostics parameters accurately and exchange them reliably between the modems, even in conditions of poor SNR that would not normally allow the line to go into showtime. Diagnostics mode is not necessarily followed by steady-state. It shall not be automatically invoked during the steady-state transmission, but by the system operator.

- *Transmission mode* is when the modem is either in the initialization state, or in a steady-state transmission, as specified in T1-424-trial use part 2 [2]. This mode invokes real-time parameter analysis. Blind channel analysis methods as the ones used in the startup of T1-424-trial use part 2 can be used.

NOTE: The reason for this on-demand-computation requirement is that DSM may use this information for ongoing management and coordination of transmitted spectra. In order to realize its greatest potential, DSM may recognize and respond to changing conditions in the binder, such as modems being turned on and off, and non-stationary CPE ingress noise sources, without having to wait for the next diagnostic test.

The Level 1 and Level 2 parameters for SCM-based VDSL are listed in Table 1 and Table 2 respectively. Exact definition for those parameters are given below.

Table 1: Aggregate parameters for Level 1 DSM compatibility of SCM modems

	Diagnostics Mode	**Transmission Mode**
Line Attenuation		
Range	0 to 63 dB	0 to 63 dB
Granularity	0.1 dB	0.1 dB
Size	16 bits	16 bits
Showtime update	N/A	None
Signal Attenuation		
Range	0 to 63 dB	0 to 63 dB
Granularity	0.1 dB	0.1 dB
Size	16 bits	16 bits
Showtime update	N/A	continuous
SNR Margin		
Range	-63 to 63 dB	-63 to 63 dB
Granularity	0.1 dB	0.1 dB
Size	16 bits	16 bits
Showtime update	N/A	continuous
Attainable Bit rate		
Range	0 to 2^{16}-1	0 to 2^{16}-1
Granularity	4 kbit/sec	4 kbit/sec

Size	16 bits	16 bits
Showtime update	N/A	continuous

Table 2: Parameters for Level 2 DSM compatibility of SCM modems

	Diagnostics Mode	**Transmission Mode**
Frequency range parameters		
Band number	8 bits	8 bits
Basis resolution $\Delta f = d_0 + d_1 / d_2$ (kHz)	d_0 8bits, d_1 4bits, d_2 4bits $d_1 < d_2$	d_0 8bits, d_1 4bits, d_2 4bits $d_1 < d_2$
Minimal frequency ($n_{min} \times k\Delta f$ kHz)	16 bits	16 bits
Maximal frequency ($n_{max} \times k\Delta f$ kHz)	16 bits	16 bits
Frequency index k (Frequency bin width = $k \times \Delta f$ kHz)	8 bits	8bits
Channel response: $H(f)$		
Range	(Scale)*(2^{-15} to 1), linear complex, Scale is 2^{-15} to 2	(Scale)*(2^{-15} to 1), linear complex, Scale is 2^{-15} to 2
Granularity	Scale	Scale
Size	Single 16 bit scale + 2x16 bit per bin	Single 16 bit scale + 2x16 bit per bin
Filters removal	Best effort	Best effort
Measurement period	1 second	1 second
Showtime update	N/A	Continuous
Echo transfer function (optional) $H_{echo}(f)$		
Range	(Scale)*(2^{-15} to 1), linear complex, Scale is 2^{-15} to 2	-102.2 to 0 dB
Granularity	Scale	0.1 dB
Size	Single 16 bit scale + 2x16 bit per bin	Single 16 bit scale + 2x16 bit per bin
Filters removal	Best effort	Best effort
Measurement period	TBD seconds, RMS value	TBD seconds, RMS value
Showtime update	N/A	N/A
Transmit signal PSD: $P_{tx}(f)$		
Range	-120 to -30 dBm/Hz	-120 to -30 dBm/Hz
Granularity	0.25 dBm/Hz	0.25 dBm/Hz
Size	10 bits per bin	10 bits per bin
AFE removal	Best effort	Best effort

Measurement period	TBD seconds, RMS value	TBD seconds, RMS value
Showtime update	N/A	continuous
Received signal PSD: $P_{rs}(f)$		
Range	-140 to -20 dBm/Hz	-140 to -20 dBm/Hz
Granularity	0.25 dBm/Hz	0.25 dBm/Hz
Size	10 bits per bin	10 bits per bin
AFE removal	Best effort	Best effort
Measurement period	TBD seconds, RMS value	TBD seconds, RMS value
Showtime update	N/A	TBD
SNR*(f)*		
Range	-31 to 63 dB	-31 to -63 dB
Granularity	0.5 dB	0.5 dB
Size	8 bits per bin	8 bits per bin
Measurement period	1 second	1 second
Showtime update	N/A	continuous

a) Frequency range parameters

The particular frequency *f* use for parameter specification is expressed using the number of frequency bins *n*:

$$n = round\left(\frac{f}{k\Delta f}\right)$$

b) H(n) Definition

The channel insertion-loss function *H(n)* that is further described in Section 5 of this report, is represented in linear format by a *scale* factor and a normalized complex number *a(n)+j*b(n),* where *n* is the bin number $n_{min} < n < n_{max}$. The scale factor is coded as a 16-bit unsigned integer. Both *a(n)* and *b(n)* are coded as a 16-bit 2's complement signed integers. The value of *H(n)* is defined as $H(n) = (scale/2^{15})*(a(n)+j*b(n))/2^{15}$. In order to maximize precision, the s*cale* factor should be chosen such that $max(|a(n)|, |b(n)|)$ over all *n* is equal to $2^{15}-1$.

An *H(n)* value of $a(n)=b(n)=-2^{15}$ indicates that the attenuation is outside the range to be represented.

c) Transmit PSD $P_{tx}(n)$

Transmit PSD values $P_{tx}(n)$ is the value of the receive power spectral density at frequency bin $n \times k\Delta f$. It is calculated using the values of PSD level and transmit filter poles and zeros specified in section 8 T1.424-Trail use. Additionally, directly read filter coefficient may be used in the same format.

d) Received signal PSD $P_{rs}(n)$

The received signal PSD $P_{\mathrm{rs}}(n)$ is the value of the power spectral density at frequency $n \times k\Delta f$. It shall be computed as:

$$P_{rs}(n) = P_{tx}(n) - |H(n)|^2$$

e) SNR Definition

The signal-to-noise ratio *SNR(n)* for a particular frequency bin is a real value that represents the ratio between the received signal power and the received noise power in the frequency range of the bin *n*. The signal-to-noise ratio *SNR(n)* per bin is measured during data transmission, averaged over a 1 second periods. The measurement is updated on request.

The signal-to-noise ratio *SNR(n)* is represented as an 8-bit unsigned integer, where *n* is the frequency bin index $n_{\min},\ldots,n_{\max}$. The value of *SNR(n)* is defined in dB. An *SNR(n)* value of 255 indicates that measured SNR is outside the range to be represented.

f) Line Attenuation Definition

The line attenuation (LATN) is the difference in dB between the power received at the near-end and that transmitted from the far-end over at the particular bin , i.e., the channel insertion-loss function ***H(n)*** averaged over all the relevant frequency range . LATN is defined as:

$$LATN(dB) = 10*\log\frac{\sum_{n=n_{\min}}^{n_{\max}} \left|H(nk\Delta f)\right|^2}{\left(n_{\max}-n_{\min}\right)k\Delta f}.$$

The loop attenuation is calculated during initialization, and is updated during data transmission. An LATN value of 1023 indicates that the attenuation is outside the range to be represented.

g) Signal Attenuation Definition

The signal attenuation is the difference in dB between the power received at the near-end and that transmitted from the far-end, over the used frequency band. Received signal power in dBm is the integral over the bandwidth of the signal received at a given frequency band. The measurement is updated during (re-)initialization and data transmission.

The attenuation SATN shall be represented as an 8-bit unsigned integer, with the value of SATN defined in dB. An SATN value of 1023 indicates that the attenuation is outside the range to be represented.

h) SNR Margin Definition

The signal-to-noise ratio margin is the amount of increased received noise power (in dB) relative to the noise power that the receive PMD function is designed to tolerate and still meet all the the target BERs over all the latency paths (at the line rate in use at the instant of measurement), accounting for all coding (e.g. trellis coding, RS FEC) gains included in the design at a bit error rate of *1e-7*.

The signal-to-noise ratio margin is measured by the receiver during initialization and showtime and may be updated both autonomously and on request. The signal-to-noise ratio margin shall be represented as an 11-bit 2's complement signed integer, with the value of SNRM defined in dB. An SNRM value of -1024 indicates that the signal-to-noise ratio margin is outside the range to be represented.

i) Attainable Bit Rate Definition

The attainable net data rate is the maximum net data rate (summed over all bearer channels) that the receive PMS-TC and PMD functions are designed to support and still meet the PMS-TC and PMD bearer configuration boundaries (e.g., latency, BER, margin) , accounting for all available coding (e.g. trellis coding, RS FEC) gains included in the design, and accounting for the loop characteristics at the instant of measurement, under the following conditions:

- Single bearer and single latency operation;
- Noise Margin (NMRG) to equal or be above the SNR Target Margin;
- BER not to exceed the highest BER configured for one (or more) of the latency paths;
- Latency not to exceed the highest latency configured for one (or more) of the latency paths;
- Accounting for all coding gains available (e.g., trellis coding, RS FEC) within latency bound;
- Accounting for the loop characteristics at the instant of measurement.

The attainable net data is calculated during the showtime. The attainable net data rate shall be represented as a 32-bit unsigned integer, with the value in bit/s. ATTNDR is represented with an accuracy of 4 kbit/s.

REFERENCES

[1] A. Leshem. Dynamic FDM and Dynamic Power Back-Off for QAM based VDSL. T1E1.4 contribution 2003/049. Newport Beach, CA, 2003.
[2] V. Oksman (ed.). VDSL trial use standard, part II. T1-424-trial use.
[3] J. Salz. “Optimum mean square decision feedback equalization”. BSTJ, Vol. 52, No. 8. pp. 1341-1373. October 1973.
[4] J. Cioffi. “SNR computation using DFE”. T1E1.4 contribution.