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CONTRIBUTION

TITLE: Draft Sections 1 and 4 proposed, Dynamic Spectrum Management

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PROJECT: T1E1-38, Spectral Compatibility Aspects for Facilities between a Central Office and the Network-to-Customer Interface (Twisted Pair Transmission System)

ABSTRACT

Attached is baseline text of the draft text for Spectrum Compatibility work item Dynamic Spectrum Management (DSM), based on the conference calls described in 2001-197R1 and the DSM-project mission document 2001-188R4. Sections 1 and 4 of contribution 2001-018, DSM Document, shall contain the proposed text.

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1. Scope, purpose, and application

1.1 Scope

This document provides dynamic spectrum management requirements and recommendations for the administration of services and technologies that use metallic subscriber loop cables. Spectrum management is the administration of the loop plant in a way that provides spectral compatibility for services and technologies that use pairs in the same cable, and is the subject of American National Standard T1.417-2001, and its subsequent re-issues. Dynamic Spectrum Management (DSM) should enhance spectrum-management value by improving reliability and increasing data rates through measurement and/or dynamic management of DSL spectral compatibility. Dynamic management incorporates parameters of the loop plant environment and loop transmission systems that are time- or situation-dependent, and which are not incorporated in the current issue of T1.417. DSL systems may provide physical-layer channel and performance information to a maintenance entity according to specifications contained within this document. This information may optionally be used by the maintenance entity and the service provider to improve service provisioning, reliability, and/or data rates. DSM informatively defines and specifies accuracies for this information to be used in a way that is consistent with existing DSL, but may allow situation-dependent (i.e., adaptive or dynamic) assignment of lines, signals, spectra, and operation of DSL modems that incorporate DSM. This document explores and defines the possibilities for spectrum management when each DSL binder situation may be individually handled rather than defining worst-case binder situations and standardizing all spectra based upon worst-case crosstalk spectra.

This document includes the following types of requirements, recommendations, and information for defined DSL systems, including:

- **Channel identification**: line- and binder-dependent characterization of signals, crosstalk, and other noises
- Formats and accuracies of this physical-layer DSL information for transfer to a maintenance entity
- Formats for optional control of situation-dependent DSL spectra and/or signals
- Algorithms for informative example calculation of channel identification at normalized accuracies for defined DSL systems.
- Algorithms for informative example specification of channel spectra and/or signals
- deployment guidelines and methods for location, isolation, and correction of DSL faults or under- or over-used binders

1.2 Purpose

The purpose of this DSM document is allow substantial improvement in data rates, reliability, and symmetry mixtures of DSL systems with respect to standardized static spectrum management in ANSI standard T1.417. To this purpose, this document defines mechanisms for optionally characterizing and possibly also controlling situation-dependent channel and crosstalk signals and spectra.

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1.3 Application

This standard is intended to be optionally applicable to DSL transmission systems and the loops upon which they operate within any given local geographic region that are maintained through one or more network maintenance entities.

4.0 General Information

Dynamic Spectrum Management (DSM) specifications in this document address methods and requisite accuracies for identification of crosstalk and line information. Such specifications also address the format for transfer of said line and crosstalk information to DSL maintenance locations possibly separate from the DSL line, as well as format for optional specification and control of DSL line spectra where permitted by the DSL line modems and allowed by the associated service operator(s). DSM considers methods for coordination, or ***spectral balancing,*** of line spectra for a common global-binder benefit and also methods for coordination of line signals, or ***DSL vectoring*****,** also for a common global-binder benefit. The use of such DSM methods on some lines may affect the performance of other lines in the loop plant; thus, these effects are to be studied and taken into account in the DSM specifications.

Two types of DSM coordination are defined:

1. *"DSM-Data" coordination* refers to the ability of a network element (DSLAM, modem, etc.) to release DSM-related information to the maintenance center.
2. *"DSM-Control" coordination* refers to the ability of the network element to accept and implement DSM-related commands from the maintenance center.

As depicted in Figure 1 and Figure 2, a *DSL maintenance center* performing DSM-Data coordination may optionally accept line and crosstalk information in a specified format across an interface *DSM-D*. The DSL spectrum maintenance center (SMC) can process the information received and provide such processed data results for the use of DSL service providers according to specified criteria and format at interface *DSM-S*. The DSL maintenance center performing DSM-Control coordination can also dynamically specify downstream and upstream DSL line spectra recommendations across an interface *DSM-C*, that is, implement *spectrum balancing.* The DSL modems at line termination and network termination may share line information in a specified format across interface *DSL. Vectored DSL* systems can also allow *DSM-C* to provide joint specification of multiple DSL line signals in the downstream direction of the *DSL* interface, while also allowing specification of methods to coordinate DSL receivers in the upstream direction of the DSL interface. It is recognized that DSM data may be transmitted through interfaces that are specified by other standards groups or the DSL forum. However, the format and nature of the data is pertinent to the DSL line and therefore the purview of T1E1.4, specifically the existing spectrum-management project.

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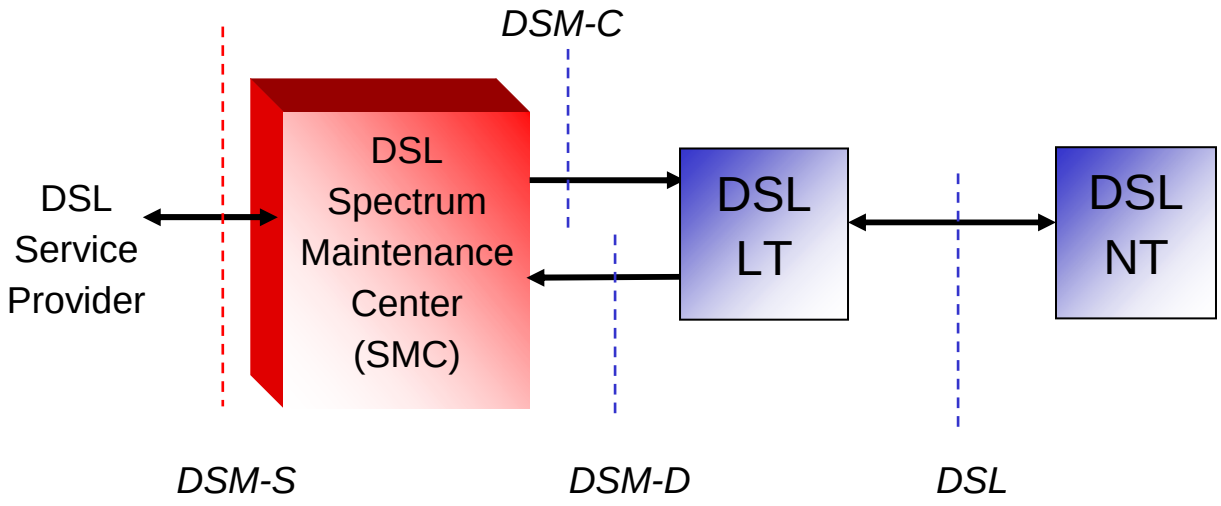


Figure 1 – DSM Reference Diagram

Figure 2 illustrates functionality of DSM for 3 levels of coordination, presumed to occur increasingly in time as one progresses vertically down in the diagram.

- *Level 0* coordination is no coordination, which occurs when service providers either do not have DSM-capable equipment or elect to disable any such DSM function intentionally.
- *Level 1 DSM-Data* coordination implies that spectral data is provided to the network maintenance center.
- *Level 1 DSM-Control* coordination implies that certain recommendations or corrective procedures for time-invariant transmission parameters are made to/by DSL service providers in order to improve or maintain the quality of DSL service to all customers.
- *Level 2 DSM-Data* coordination implies that time-domain line measurements are provided.
- *Level 2 DSM-Control* coordination considers the possibility of time-varying physical layer signals being controlled by a single service provider and being coordinated to improve DSL data rates, reliability, and/or range for all customers.

A single binder may see a combination of uses of any or all levels, depending upon service-provider preferences. Each service provider may elect to operate at different levels, depending on specific deployment issues.

For brevity of notation, *DSM-Data* and *DSM-Control* coordination levels can be denoted as "*Level x/y*", where *x* denotes the level of DSM-Data coordination and *y* the level of DSM-Control coordination.

Data rates listed in Figure 2 are for example only.

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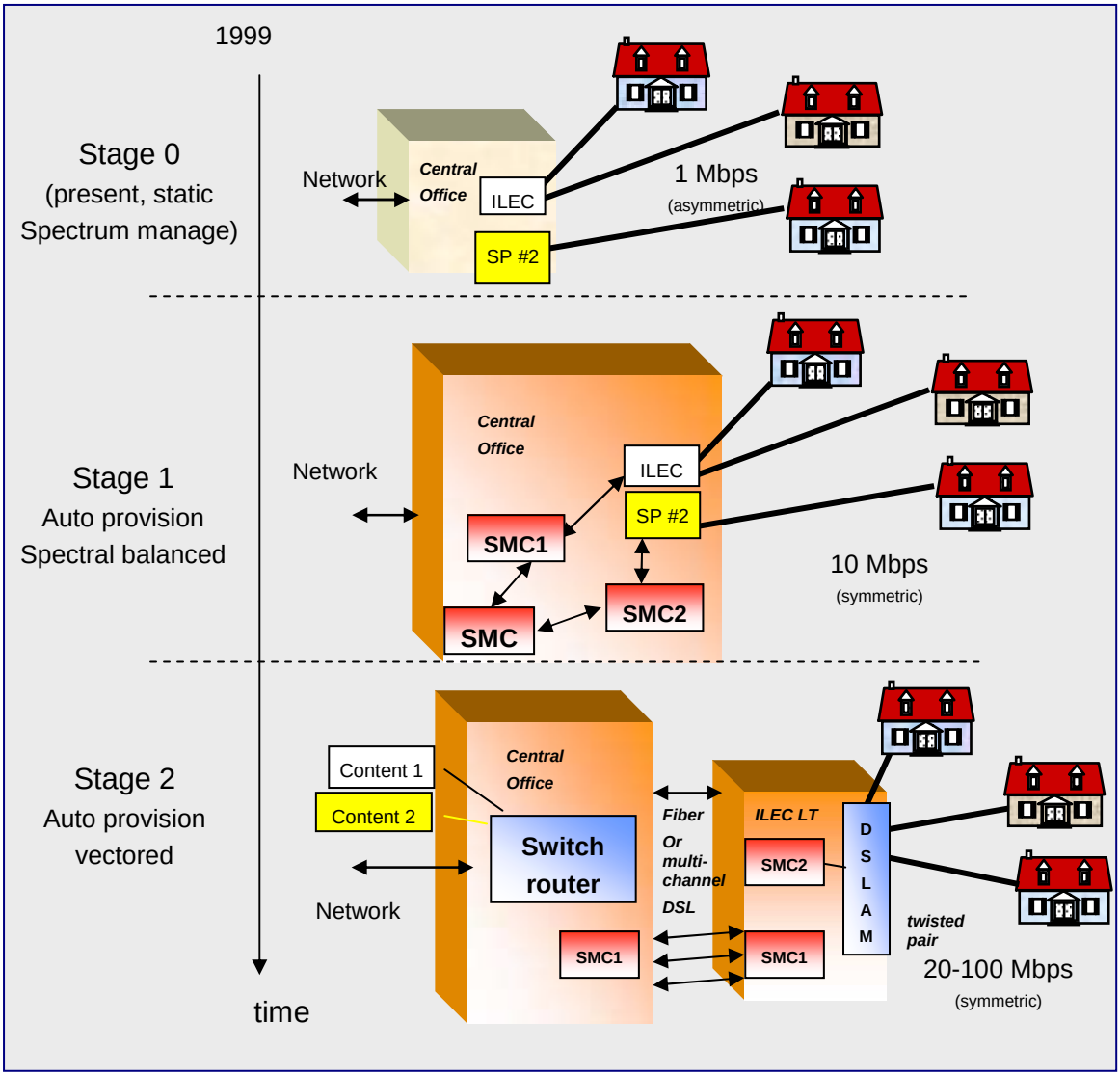


Figure 2 – DSM Functional Diagram and Timeline

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