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TECHNICAL REPORT

TR-188
DSL Quality Suite

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Issue History

Issue Number	Approval Date	Publication Date	Issue Editor	Changes
1	November 2010		Mauro Tilocca, Telecom Italia	Original
2	26 November 2012	17 December 2012	Mauro Tilocca, Telecom Italia	Alignment of references to documents that belong to the DSL Quality Suite

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Executive Summary

TR-188 aims to specify a framework for the management of Digital Subscriber Line (DSL) quality. The objective is to obtain a common reference to allow homogeneous definition of further documents devoted to specific management aspects. The building bricks for the effective management of all the quality and stability aspects of DSL lines are described, to be used both by Vendors and Service Providers. This framework document identifies a collection of Broadband Forum documents already existing or planned, ranging from nomenclature aspects to requirements and guidelines, test plans, and best practices for Service Providers.
The reader is advised that given the nature of TR-188, the Broadband Forum documents described as being the components of the DSL Quality Suite (DQS) can be in different status: publicly available, under development within the Broadband Forum, not started. The Broadband Forum is contribution driven, hence in the latter two cases there is no commitment those documents will eventually be published.

The reader is also advised that TR-188 is subject to updates to follow the evolution of the DQS framework. Hence the latest published version possibly does not fully reflect the current status of DQS specification work within the Broadband Forum.

TR-188 is provided solely for information and does not contain any normative text. Normative text is confined to component documents of the DSL Quality Suite.

Updates for Issue 2 mainly include alignment of references to documents that belong to the DSL Quality Suite. This encompasses the publication of Issue 2 of TR-198 [12] and of the Test Plans for DSL Testing, and the reference to new documents under development.

1 Purpose and Scope

1.1 Purpose

In the light of broadband as tomorrow's universal means for communications and a multitude of other services, it is an unavoidable need to tackle the issue of DSL stability and quality by means of advanced and efficient techniques. As the penetration of broadband increases and the related service offers become more and more structured, such techniques represent a tool (or tools) of utmost importance. This is to guarantee overall service quality and performance to customers as well as consolidate broadband as a main service-enabling network platform for Service Providers.

TR-188 contains the framework for a DSL Quality Suite (DQS) intended as a collection of Broadband Forum documents focused on the management of the quality and stability of DSL lines.

The reader is advised that the components of the DSL Quality Suite (DQS) can be in different status: publicly available, under development within the Broadband Forum, not started. The Broadband Forum is contribution driven, hence in the latter two cases there is no commitment those documents will eventually be published.

1.1.1 DSL line quality and stability

Generally speaking what counts in the provision of a communication or entertainment service is the quality perceived by the customer (aka Quality of Experience) and the fact that an appropriate degree of availability and usability is guaranteed.

For bundled offers, each service component has its own characteristics and requires a particular level of QoE, availability and usability for that specific service to be acceptable. In the following considerations, the concept of usability will be left out as it is often determined by the characteristics and GUI of the PC, terminal or appliance the customer uses to access the service(s).

Service availability and quality are highly influenced by the network the service is transported through. When possible QoE and availability objectives are translated into QoS and connection availability targets at the different networking layers and apportioned among different network segments and nodes.

Following the above scheme, for broadband services delivered via a final access drop based on a DSL link it is a common practice to:

- define the concepts of DSL line stability and quality;
- identify one or more DSL parameters and elaborations of them as metrics to quantify DSL line stability and quality;

- identify targets for such metrics associated (e.g. derived empirically or "mathematically") to higher layer quality metrics and ultimately to the quality and availability levels required for the service component(s) being transported over the DSL line.

Considering the characteristics of DSL transmission it is straightforward to associate the concept of:

- DSL stability with the time the line is synchronised, with line-initialization performance monitoring parameters like Full Initialization Count and Failed Full Initialization Count, and with the associated alarm events (e.g. LOS, LOP, LPR).
- DSL quality with the error rate, with channel performance monitoring parameters like Code Violations (CV) counters and with the associated alarm and threshold crossing events.

This duality is very useful when collecting line data to monitor its status as experience teaches that trying to aggregate these aspects into one single all-purpose line metric can lead to a value that hardly links back to physical phenomena on the line.

The concepts of quality and stability can be regarded as two axes that concur to describe the status of the line. G.997.1 [17] naturally combines together these axis, as PM counters like ES, SES and UAS are triggered by root causes affecting either the quality axis (i.e. Code Violations) or the stability axis (line drops with the associated alarm indications).

This is inherently tied to the concept of DSL availability, also embedded in the UAS counters themselves:

- DSL availability requires that the link is sufficiently stable, e.g. number of resynchronisations per day acceptable, and has sufficient quality, e.g. average and instantaneous BER acceptable, with regard to carried service components.

This attribute can be very useful, on the other hand, when it comes to diagnosing a line and deciding on corrective actions. It can be beneficial to simply refer to qualitative categories that bring together the stability and quality status. As a simple example one can define a line as:

- Bad: DSL link is mostly unavailable or transmission suffers from high degradation
- Poor: DSL link is sometimes unavailable or suffers from little degradation (associated to noticeable impact to customer QoE)
- Good: DSL link is available and (almost) error free (with service experience as good as defined in TR-126 [6])
- Unknown: not enough data to determine actual status

The assessment of DSL line availability is key as this is a necessary (though not sufficient) condition for the service to be available. Then on top of DSL availability, other parameters (e.g. current and attainable bitrate, delay, time statistic of the noise margin, etc.) can be considered to assess the line's suitability to carry current service components, to be resilient to increases to DSL penetration in the binder and in support service changes/upgrades.

As said above, the stability and quality of the line can be quantified by the elaboration of certain DSL parameters but clearly they need to be tightly linked to information related to carried services, to operators specific practices, customer self-care input and other relevant data.

In the context above the concept of **DSL Quality Management** (DQM) is introduced as the abstract **capability of pro-active and efficient control of the quality and stability** of broadband lines.

By definition, the scope of DQM fully resides within the DSL domain but this is only a working hypothesis that allows the boundaries of the DSL Quality Suite as a structured Broadband Forum project to be identified.

As clearly stated above the ultimate objective is service and all its attributes that combine to form the customer perception which in turn answers to the inherent *"pay-for-value"* commitment that is behind any service offer.

Under this perspective DSL quality and stability, as the key objective of DQM, have to be always regarded as a contribution to the overall service perception and have to be treated, in Network Operation and Maintenance processes, in strict coordination with all other influencing parameters and metrics.

1.2 Scope

The aim of the DQS is to identify the building blocks (reference features and tools, equipment and system requirements, network strategies and practices) to be used by vendors and Service Providers to develop solutions that enable pro-active and efficient maintenance of broadband lines and services. Furthermore the explicit definition of requirements for such solutions can be used by operators as a reference for tenders and system validation. Finally, some guidelines for Service Providers, coming from suggested profiles and best practices are conceived as a useful part to complete this Suite.

The DQS scope mainly takes into account ADSL, ADSL2, ADSL2plus and VDSL2 technologies and focuses on DSL parameters and metrics to guarantee and ameliorate the quality and availability of the "physical layer service" over a copper pair.

Nevertheless, as discussed in the previous section, DQM techniques have to be considered part of more complex processes encompassing different segments of the whole network connection and have to be applied in coordination with techniques associated to higher layers.

Finally, DQM techniques need to be driven by the service components actually being delivered over a specific DSL line. As far as the types of services, not only IPTV is taken into consideration but all the components of today's triple-play offers (e.g. HSI, VoIP, IPTV) are dealt with either alone or bundled onto the DSL line.

The list of documents below describes the components that contribute to the DSL Quality Suite as a structured project. This list can change in time depending on the actual course of the works

within the involved Working Group(s) and each version of this framework document identifies the status of the DQS components as a published TR or an ongoing/planned Broadband Forum WT/PD.

For completeness TR-188 can also point to documents from other Standards Developing Organizations (SDOs).

2 References and Terminology

2.1 Conventions

This Technical Report is solely informative and therefore does not contain any normative text. There are no conventions relating to requirements. Normative text is confined to component documents of the DSL Quality Suite.

2.2 References

The following references are of relevance to this Technical Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Technical Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.

A list of currently valid Broadband Forum Technical Reports is published at www.broadband-forum.org.

Document	Title	Source	Year
[1] ATIS-0600007	*DSM Technical Report*	ATIS	2007
[2] TR-100	*ADSL2/ADSL2plus Performance Test Plan*	BBF	2007
[3] TR-105 Issue 2	*ADSL2/ADSL2plus Functionality Test Plan*	BBF	2011
[4] TR-114	*VDSL2 Performance Test Plan*	BBF	2009
[5] TR-115 Issue 2	*VDSL2 Functionality Test Plan*	BBF	2012
[6] TR-126	*Triple-Play Services Quality of Experience (QoE) Requirements*	BBF	2006
[7] TR-138	*Accuracy Tests for Test Parameters*	BBF	2009
[8] TR-160	*IPTV Performance Monitoring*	BBF	2010
[9] TR-165	*Vector of Profiles*	BBF	2009
[10] TR-176	*ADSL2Plus Configuration Parameters for IPTV*	BBF	2008
[11] TR-197	*DQS: DSL Quality Management techniques and nomenclature*	BBF	2012
[12] TR-198 Issue 2	*DQS: DQM systems functional architecture and requirements*	BBF	2012
[13] TR-252 Issue 2	*xDSL Protocol-Independent Management Model*	BBF	2012
[14] TR-260 Issue 2	*DCF functional and performance Test Plan*	BBF	2012
[15] PD-277	*DQS: Energy Efficiency in DQM*	BBF	
[16] WT-286	*Testing of Metallic Line Testing (MELT) functionality on xDSL Ports*	BBF	WIP
[17] G.997.1	*Physical layer management for digital subscriber line (DSL) transceivers*	ITU-T	2009
[18] G.996.2	*Line Testing for Digital Subscriber lines (DSL)*	ITU-T	2009

2.3 Abbreviations

This Technical Report uses the following abbreviations:

BBF	Broadband Forum
DCF	Data Collection Function
DLM	Dynamic Line Management
DQM	DSL Quality Management
DQM-ME	DSL Quality Management - Management Entity
DQS	DSL Quality Suite
DSL	Digital Subscriber Line
DSM	Dynamic Spectrum Management
DSLAM	Digital Subscriber Line Access Multiplexer
EM	Element Manager
HSI	High-Speed Internet
IP	Internet Protocol
IPTV	IP Television
MD	Marketing Draft
MR	Marketing Report
N/B	Northbound
NMS	Network Management System
ONU	Optical Network Unit
PCF	Profile Configuration Function
PD	Proposed Draft
S/B	Southbound
SDO	Standards Development Organization
TR	Technical Report
VoP	Vector of Profiles
WIP	Work in Progress
WG	Working Group
WT	Working Text
VoIP	Voice over IP

3 Technical Report Impact

3.1 Energy Efficiency

TR-188 has impact on Energy Efficiency in that some of the DSL Quality Suite components have. More details are given in specific DQS components.

3.2 IPv6

TR-188 has no impact on IPv6.

3.3 Security

TR-188 has no impact on security.

3.4 Privacy

TR-188 has no impact on privacy.

4 Introduction

Historically DSL standardisation has been quite focused on transceivers requirements and their ability to deliver increasing bitrates along with link features often tailored to that purpose. This is a natural consequence of operators and vendors aim of deploying broadband services maximising coverage and speed.

After the take up and growth phase, the issue of DSL quality and stability has become more and more important with:

- the increase of copper based broadband penetration;
- the introduction multi-play service offers with stricter QoE requirements;
- the need to consistently and reliably sustain the revenue stream generated by the copper infrastructure and services and also to allow a smoother transition paths towards fiber based deployments.

The DQS is a structured framework of standards to guide the international community in the development and exploitation of network equipment and systems specifically designed to apply sophisticated and scalable DQM techniques.

This section describes the DQS structure in terms of its components and their mutual relationship. A component is a published TR or a Working Text/Proposed Draft that is being or can be developed by the relevant Technical WG(s) of the Broadband Forum.

In the following heading structure and sections text, documents labelled as:

- TR or MR, have already been published by the Broadband Forum
- WT, PD or MD, have already been initiated and are under development by the Broadband Forum and, as such, are only available to Broadband Forum members.

When no tag is associated to a document or area of work it means that no drafting has been started though that area is recognised as relevant within the DQS framework.

Each component, though with different degrees of importance, contributes to the overall DQS framework as part of a specific category.

Following a logical order the identified DQS categories are as follows:

- the **management techniques and nomenclature** category relates to definitions which clarify the use of terminology and acronyms related to DQM and the description of the techniques and parameters to enhance DSL quality and stability.
- the **requirements** category addresses the features and capabilities needed on the equipment and/or management systems to effectively implement the management techniques for DSL quality and stability.

- the **configuration** category deals with the line profiles suggested for specific services or specific DSL technologies when addressing the trade-off between quality/stability and other link characteristics such as bitrate, delay, etc.
- the **best practices** category depicts currently adopted Network Operation practices.

The above list does not preclude the addition of further categories as deemed necessary.

The DQS structure contained in TR-188 represents a main guideline, nevertheless it is not intended as a mandatory document, instead it serves as a tool to describe and manage the DQS from a high level perspective and its versions will be adapted to follow the evolution of its components.

5 DSL Quality Suite components

This section describes the components of the DSL Quality Suite taking into account the structure and categories outlined in Section 4. This is done bearing in mind that the DQS aims to provide a structured standardization framework to address DQM issues both in the domain of marketplace solutions and for network operation purposes. More specifically for each of the DQS categories and each of the identified components, its relevance in the DQM problem area is explained.

5.1 Management techniques and nomenclature components

These documents aim to provide the international community with a unified nomenclature about the techniques and strategies available to address DSL stability and quality issues. They define a common language to refer to parameters, functionalities and typical network practices in the above problem space.

Such an 'alphabet' is a fundamental prerequisite for the specification of requirements for systems enabling effective Network Operation strategies.

Furthermore the components under this section are developed in a way that their content is easily understandable by less expert readers.

5.1.1 TR-197 "DQS: DSL Quality Management techniques and nomenclature"

A number of different schemes and acronyms can be found in the literature (e.g. DSM, DLM) for defining the techniques and strategies for monitoring and assuring DSL stability and quality. Sometimes these names and conceptual approaches are also used by commercial products or within the operational work-flows of access networks.

The purpose of TR-197 [11] is to define a common nomenclature and a unified framework to describe functionalities, tools, techniques and strategies that are already available or under study for the support of DSL Quality Management. Such unified taxonomy of DQM "enablers" represents a very useful toolkit for DQM-enabled solutions design and for network provisioning and assurance strategies.

In building such a taxonomy the focus is put on the issues and problems to be solved rather than the implemented algorithms. Furthermore the energy efficiency impact of each technique is described.

5.1.2 PD-277 "DQS: Energy Efficiency in DQM"

The purpose of PD-277 [15] is to provide a description of DSL Management configuration parameters, data parameters, techniques and other appropriate methods in order to support energy saving techniques in DSL network and CPE equipment. It also addresses validation of the parameters at the management interfaces to Network Elements and CPE to verify the ability of the systems to support energy saving configurations.

5.2 Requirements components

This section refers to documents that specify requirements for systems to be ready for supporting DSL Quality Management. Historically, few specific DQM architectural, functional/performance

and interface requirements have been standardised and adopted by the industry. This has resulted in very diversified support, with a lack of features and capabilities needed to deploy sophisticated and scalable DQM techniques.

5.2.1 TR-198 "DQS: DQM systems functional architecture and requirements"

A management network architecture enabling DSL Quality Management is composed of different systems that, broadly speaking, need to:

- collect relevant information related to DSL line behaviour,
- analyze line parameters,
- modify the DSL profile, on a line or bundle basis, to improve line stability and/or performances.

The systems involved in the DQM architecture are both broadband equipment (DSLAMs, ONUs, etc.) and management systems (e.g. EM or NMS). Current standards specify features and requirements for DSL transceivers, equipment and related management systems but there does not exist a self-consistent specification which defines the capabilities supported by the overall network architecture (management systems and network of equipment) to enable DQM within Network Operation practices. The functional and system requirements specified have to be seen as a whole set applicable to the abstract DQM-entity without any mandatory specification(s) about their apportionment onto each of the involved network resources.

TR-198 [12] provides an architecture that identifies the key functions of a DQM system and the external functions on which it depends and to which it delivers its output. The requirements for each functional block are given. Interfaces between the functional blocks and between the functional blocks and the external functions are identified. Existing standards that are relevant to these interfaces are indicated and the need for new standardized interfaces identified. Requirements on the interfaces are listed.

TR-198 [12] encompasses:

- definition of the functional architecture of a DQM system
- high level description of the interfaces of a DQM system
- functional and performance requirements for the N/B interface of the Data Collection Function
- requirements for the S/B interface for the Data Collection Function
- specification of the performance requirements for the DQM-ME of a Network Element
- functional requirements for the N/B interface of the Profile Configuration Function (PCF)
- high level description and requirements of other functions within a DQM system

5.2.2 Gap analysis about DSL parameters collection needs

A system implementing DSL Quality Management relies on the capability to assess the DSL line behavior, identify its noise environment and impairments that could limit maximum achievable performances.

G.997.1 [17] already provides a comprehensive set of DSL parameters. Other initiatives among different standardization bodies are now in place in order to enhance the available diagnostic

features on DSL lines (e.g. G.996.2 [18], TR-160 [8], ATIS-0600007 [1] and other work in regional bodies).

The purpose of this component is to:

- identify relevant parameters that allow an optimal diagnosis of DSL lines,
- identify gaps in available performance monitoring parameters and features currently specified in the standards and propose new capabilities,
- guide and stimulate the standardization of those parameters that are essential, or desirable, for DSL Quality Management but not yet included in DSL standards.

The Broadband Forum efforts with respect to performing this gap analysis as part of the DQS are for further study.

5.2.3 Testing framework for DQM-ready systems

This component is conceived as a collection of pointers to specific test procedures or dedicated test plans focused on the verification of DQM related features and capabilities.

One set of this collection contains the test configurations and procedures, defined in some Broadband Forum Test Plans, dealing with the validation of the functionality and performance of equipment directly related to DSL quality and stability. As an example pointers to tests under impulsive noise and other types of line threats are appropriate for inclusion in such components. The following Broadband Forum Test Plans specify Test Cases for the verification of functionalities and performances of DSLAMs and CPEs which are relevant for a DQM-ready system:

- TR-100 - ADSL2/ADSL2plus Performance Test Plan [2]
- TR-105 - ADSL2/ADSL2plus Functionality Test Plan [3]
- TR-114 - VDSL2 Performance Test Plan [4]
- TR-115 - VDSL2 Functionality Test Plan [5]
- TR-138 - Accuracy Tests for Test Parameters [7]

For all these TRs, an Issue 2 has been published or is under development along with WT-286 - Testing of Metallic Line Testing (MELT) functionality on xDSL Ports [16].

Tests for the verification of system level features that enable DQM strategies are also part of this component.
More specifically TR-260 [14] specifies functional and performance tests for the Data Collection Function defined in TR-198 [12] and is aimed to help the verification and maturing of DCF implementations.

5.3 Profiles configuration guidelines components

These components contain the principles, methods and recommended values for DSL configuration profiles.

It is known as not viable to adopt a “one-fits-all” approach in the physical layer configuration. Hence it is mostly useful to define guidelines for choosing parameters values for different DSL

flavours (ADSL2plus, VDSL2, etc), type of offered service (HSI, VoIP, IPTV or a mix of them) or for specific copper pair conditions (length and observed types of impairments).

The Broadband Forum efforts with respect to developing profiles configuration guidelines in support to DQM strategies as part of the DQS are for further study.

5.3.1 TR-176 - ADSL2Plus Configuration Parameters for IPTV

As stated in TR-176 [10], this Broadband Forum Technical Report "… contains generic ADSL2plus configuration parameter settings for use in the deployment of IPTV over ADSL2plus. Included are ranges of deployed parameter values derived from the experiences of service providers and vendors who have already tested, trialed and/or deployed IPTV over ADSL2plus and hence represent current industry practice. In addition, specific recommendations are made for a baseline set of parameters supporting IPTV. …"

5.3.2 TR-165 - Vector of Profiles (VoP)

As stated in TR-165 [9], "this Working Text addresses the need for greater flexibility in setting DSL profiles by defining a vector of profiles. The DSL configuration parameters are divided into independent, but technically related, sets of parameters. Each parameter set defines a profile. The profiles are referenced from a vector of indices, each index identifying a unique profile. This allows a large number of profiles to be used without having to store huge quantities of profile data. The Vector of Profiles is a key enabler to DSL Quality Management. It is also expected to help Network Operators in the implementation of efficient and cost-effective Network Operation processes such as Network Creation, Service Delivery, Service Assurance and Troubleshooting."

5.3.3 TR-252 - xDSL Protocol-Independent Management Model

Evolutions of the Vector of Profiles specifications are developed under Broadband Forum TR-252 [13], which encompasses DSL configuration based on a VoP and other object model aspects (e.g. Performance Monitoring, alarms).

5.4 Best practices components

These components describe best practices in the use of DQM as a stability tool to optimize single-play and multi-play services over copper lines.

Use cases, experiences and suggestions are presented in these components.

The Broadband Forum efforts with respect to describing DQM best practices as part of the DQS are for further study.

End of Broadband Forum Technical Report TR-188

