TITLE **Description of example scenarios on ESP/2004 in SpM2**

PROJECTS SPM2, study point SP2-42

SOURCE: TNO / Rapporteur SpM2

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STATUS for Decision

ABSTRACT The description of the European Spectral Platform, as being defined in 2004, is provisionally agreed for inclusion in SpM2. Text has been proposed, but a more accurate wording is required to exclude all ambiguity, and to enable “agreed” on the text proposal. This contribution proposes refined text, derived from the available text. Revision 1 includes improvements suggested after the meeting by Andreas Thöny, Swisscom.

For resolving SP2-42 about example scenarios, text was provided on the simulation platform, known within TM6 under the working name “NESP”. The concept was provisionally agreed, but a more accurate description was required to include it in the Spectral Management document.
This contribution proposes such a (revised) text.
It was the intention that nothing of the original concept is changed

Major changes:

- The working name “NESP” has been replace by a more neutral one (we propose the name ESP/2004). Especially the “N” in NESP, referring to “new” is considered as a problem. Today, the system mix of NESP is already obsolete since ADSL2+ has not been include, while VDSL2 will cause another need for future improvement (ESP/2005 and ESP/2006, …). Therefore we observe great difficulties when ETSI TM6 decides to make the working name NESP “official”.
- The text has been reshuffled to enable a more straightforward description. In the original text the concept of area and reach boundaries was introduced in the beginning of the text, while the specification of their locations was provided not before the end of the text. This has been repaired by reshuffling.
- The text has been rephrased and augmented to avoid ambiguity. Especially the lack of a description of “attenuated cross talk” gave room for multiple interpretations, and this has to be avoided.
- All references to figures and tables are temporary phrased as [*]. This will be upgraded as soon as the text is inserted into the living list of SpM2.

The text is now considered as mature (all [*] marks are still to be replaced by figure/table numbers)

Text portions proposed for inclusion into clause 9

9 Examples of how to evaluate various scenarios

This chapter summarizes examples to show how the models in this document can be applied to perform spectral management studies.

9.1 European Spectral Platform 2004 (ESP/2004)

In 2004 several European operators created a simulation platform to support spectral management studies on e-SDSL and ADL-64. This platform comprises of several (theoretical) scenarios to cover a wide range of situations being identified in European access networks. Each scenario is a compromise between computational convenience and computational complexity of real access networks. Nevertheless, the calculated performances of xDSL systems operating under these theoretical scenarios are assumed to be indicative for the minimum performance of these systems in various European situations.
The scenarios are a combination of a technology mix (to create a noise environment), system models, topology models and loop models.

9.1.1 Technology mixtures within ESP/2004

A distinct number of technology mixtures have been identified to enable a reasonable representation of scenarios that are being deployed in various European Networks. Their names are specified in table [*].

Table[*]: Naming convention of used mixtures

Name	Description of the mix
	High penetration mixtures
HP/M	Mix includes both ADSL FDD flavors, SDSL, VDSL, HDSL CAP/2 and HDSL 2B1Q/2
HP/R	Mix includes all four ADSL (FDD and EC) flavors, SDSL, VDSL and HDSL CAP/2
	Medium penetration mixtures
MP/M	Mix includes both ADSL FDD flavors, SDSL, VDSL and HDSL 2B1Q/2
MP/P	Mix includes ADSL over POTS FDD, SDSL, VDSL and HDSL 2B1Q/2
MP/I	Mix includes ADSL over ISDN FDD, SDSL, VDSL and HDSL 2B1Q/2

The number of systems of each technology to be considered in each scenario is specified in table [*].

- For each *reference* scenario, the associated reference mix is specified in the columns labelled as “ref”.
- For each *modified* scenario, the associated modified mix is specified in the columns labelled as “mod”. The number of wire pairs occupied by the broadband systems remains the same as for the reference scenario.

By comparing the change in performance between both scenarios, the impact of replacing some “legacy” systems by systems of the new technology can be visualized. This concept is referred to as the “reference method”.

NOTE: The victim system shall not be considered among the disturbers, i.e. it shall be subtracted from the total number of disturbing systems. For two-pairs HDSL systems, only one pair shall be considered as victim, whereas the other one shall be kept among the disturbers.

Table [*] : Reference mixtures and modified mixtures with the new technology for the five scenarios

Mix / System	HP/M		HP/R		MP/M		MP/P		MP/I	
	Ref.	Mod.	Ref.	Mod.	Ref.	Mod.	Ref.	Mod.	Ref.	Mod.
SDSL 1024 kb/s	5	5	16	16	4	4	4	4	4	4
SDSL 2048 kb/s	10	10	16	16	5	5	5	5	5	5
HDSL 2B1Q/2	3×2	2×2	-	-	1×2	0×2	1×2	1×2	1×2	1×2
HDSL CAP/2	2×2	2×2	3×2	3×2	-	-	-	-	-	-
ADSL over POTS FDD	75	68	63	55	18	16	25	20	-	-
ADSL over ISDN FDD	25	22	96	84	7	6	-	-	25	20
ADSL over POTS EC	-	-	21	19	-	-	-	-	-	-
ADSL over ISDN EC	-	-	32	29	-	-	-	-	-	-
VDSL (FTTEx)	12 [1)]	12 [1)]	25 [2)]	25 [2)]	5 [1)]	5 [1)]	5 [1)]	5 [1)]	5 [3)]	5 [3)]
New system under study	0	12	0	25	0	5	0	5	0	5
ISDN/2B1Q (alone)	50	53	97	103	14	15	14	14	0	0
ISDN/2B1Q (same pair)	25 [4)]	22	53 [4)]	48 [4)]	7 [4)]	6 [4)]	0	0	0	0
ISDN/4B3T (alone)	0	0	0	0	0	0	0	0	14	19
ISDN/4B3T (same pair)	0	0	0	0	0	0	0	0	30 [5)]	30 [5)]
Pairs in total for BB	137	137	275	275	41	41	41	41	41	41
Pairs in total for BB and ISDN	187	190	372	378	55	56	55	55	55	60

1) VDSL (FTTEx) P2 M2 with US0, ETSI main plan (997) or optional regional band plan (998)
2) VDSL (FTTEx) P2 M2 with US0, ETSI main plan (997) only
3) VDSL (FTTEx) P1 M1 without US0, ETSI main plan (998) only
4) These ISDN/2B1Q systems share the same pair with ADSL over ISDN systems
5) These ISDN/4B3T systems share the same pair with ADSL or VDSL over ISDN systems

Note 1: When VDSL is considered as disturbing system for the other systems it is not necessary to specify its band plan. When making simulations on VDSL performance instead, a homogeneous VDSL environment and the band plan indicated in the explanations of Table [*] should be considered.
Note 2: The modified mixtures depend on the type of system under study. In this example the modified mixtures where determined for studies of ADL-64 and E-SDSL.

9.1.2 System models within ESP/2004

Table [*] specifies transmitter signal models for each system being part of the mix. Power back-off or power cut-back shall be taken into account for all the systems for which it is mandatory in the relevant specification. Concerning VDSL UPBO, use the reference PSD for Noise D (see VDSL [*]) in high penetration scenarios (using HP/M and HP/R) and the one for Noise E in medium penetration scenarios (using MP/P, MP/I and MP/M).
Table [*] specifies receiver performance models for each system being part of the mix.

Table [*] Transmitter signal models

Name	***Transmitter signal model***
SDSL 1024 kb/s	SDSL transmitter model, as specified in clause 4.6 for 1024 kb/s
SDSL 2048 kb/s	SDSL transmitter model, as specified in clause 4.6 for 2048 kb/s
HDSL 2B1Q/2	HDSL transmitter model, as specified in clause 4.4 (use" default" model)
HDSL CAP/2	HDSL transmitter model, as specified in clause 4.5
ADSL over POTS FDD	ADSL transmitter model, as specified in clause 4.8 (*see NOTE 1*)
ADSL over ISDN FDD	ADSL transmitter model, as specified in clause 4.10 (*see NOTE 1*)
ADSL over POTS EC	ADSL transmitter model, as specified in clause 4.7
ADSL over ISDN EC	ADSL transmitter model, as specified in clause 4.9
VDSL (FTTEx)	(*see NOTE 2*)
ISDN/2B1Q	ISDN transmitter model, as specified in clause 4.2
ISDN/4B3T	ISDN transmitter model, as specified in clause 4.3

NOTE1: Use the ADSL adjacent FDD template when ADSL is considered a disturber (in the noise), but use the ADSL guardband FDD template when ADSL is considered a victim

NOTE2: PSD Templates are defined in the VDSL standard [*]

Table [*] Receiver performance models

Name	***Receiver performance model***
SDSL	SDSL receiver model, as specified in clause 6.3
HDSL 2B1Q/2	HDSL receiver model, as specified in clause 6.1
HDSL CAP/2	HDSL receiver model, as specified in clause 6.2
ADSL over POTS FDD	ADSL receiver model, as specified in clause 6.5
ADSL over ISDN FDD	ADSL receiver model, as specified in clause 6.7
ADSL over POTS EC	ADSL receiver model, as specified in clause 6.4
ADSL over ISDN EC	ADSL receiver model, as specified in clause 6.6
VDSL (FTTEx)	*See NOTE 1*
ISDN/2B1Q	*See NOTE 1*
ISDN/4B3T	*See NOTE 1*

NOTE1 : The evaluation of the performance of this victim system is no part of ESP/2004

9.1.3 Topology models within ESP/2004

The scenario assumes that an uninterrupted homogeneous cable, without branches, interconnects the victim system under study. In addition, it assumes that the network topology can be represented by a simple (point-to-point) two-node topology model (see clause 8.3.1).
This is of course an over-simplification of real access networks, and therefore the way systems are disturbing each other is refined (a) according to the way NT systems are distributed along the cable, and (b) to what distance NT systems are separated from their LT counterpart.

Refinements of disturbance

For the first refinement, two different topologies are defined:

- **Distributed topology**. Here it is assumed that the NT ports of a cable (or bundle or binder group) are distributed along the loop, and that a single cable is capable of providing access to customers at both near and far distances from the exchange.
- **Virtually co-located topology**. Here it is assumed that the NT ports of a cable (or bundle or binder group) are virtually co-located, and that a single cable can only provide access to near locations or to far locations. Different cables are then needed to connect customers at both locations.

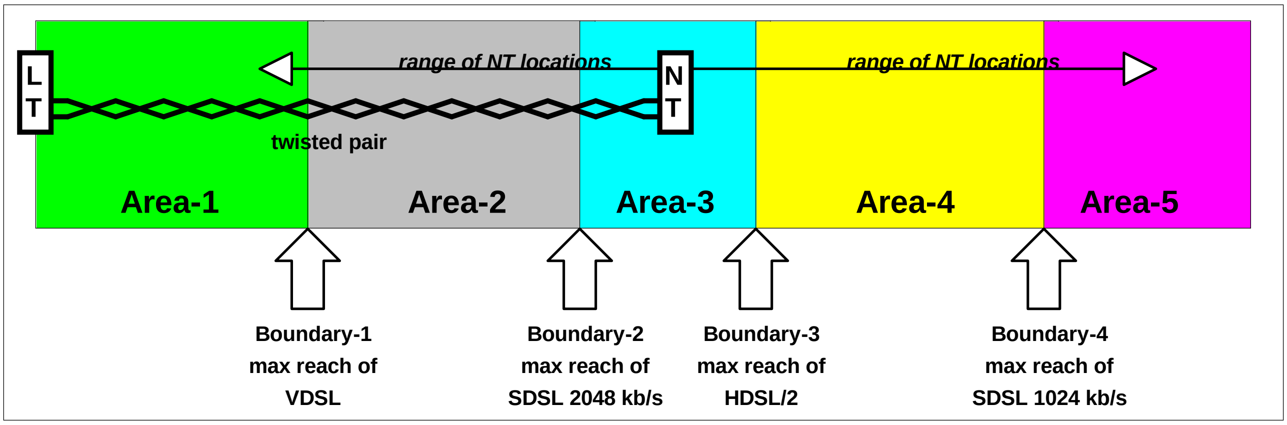
In either case, the LT disturbers are co-located with the LT victim. To compensate for the fact that some NT disturbers are not always at the same location as the NT victim system, the cross talk of these disturbers is attenuated first.
Attenuated cross talk means within this context the following: Assume that no disturber resides beyond the victim NT. If *L* is the distance between an investigated NT victim and a group of co-located NT disturbers, then calculate the cross talk of these disturbers (NEXT & FEXT) at the location of these disturbers as if no other disturber does exist. In the following step, attenuate this noise level by the loss

of a loop with length *L.* Repeat this for each group of co-located NT disturbers, and subsequently add the powers of all these cross talk components to evaluate the cross talk level at the location of the victims.

For the second refinement, the reach limits of the involved systems are accounting for the disturbance of such a system. This means that a system will not be deployed beyond its reach limits, and that the composition of the disturber mix changes when the loop length exceeds certain reach boundaries.
To simplify this refinement, only five reach boundaries are distinguished, and the involved systems are all classified according to these boundaries. This is summarized in table [*], and illustrated in figure [*].

Table [*]: System classification according to the boundaries in figure [*]

System class	System examples	Deployment practice
1	VDSL	*VDSL will not be deployed beyond area 1 limits*
2	SDSL, 2048 kb/s	*2048 kb/s SDSL will not be deployed beyond area 2 limits.*
3	HDSL/2	*Two-pair HDSL will not be deployed beyond area 3 limits, (except for "virtually co-located topologies" where the use of a regenerator is assumed to extent the reach).*
4	SDSL, 1024 kb/s	*1024 kb/s SDSL will not be deployed beyond area 4 limits. (except for "virtually co-located topologies" where the use of a regenerator is assumed to extent the reach).*
5	ADSL ISDN (SDSL, 512 kb/s)	*All these systems in the mix will be deployment up to area 5. (except for the "distributed topologies", that do not include 512 kb/s SDSL systems)*



Figure[*]: Concept of reach areas in ESP/2004, and associated boundaries

<u>**Boundary locations of the disturbers**</u>
The location of each boundary between two areas in figure [*] is scenario dependent, and is specified in table [*]. Not all combinations of system mixtures and topology models are required for the ESP/2004 scenarios, and therefore table [*] is restricted to those combinations.
These boundary values are assumed to be a fair reach estimation of the associated victim system, under the stress conditions of that particular scenario.

Table [*]: Location of boundaries within the scenarios in ESP/2004

Area limit / Scenario	**Boundary 1** (Area-1 to –2)	**Boundary 2** (Area-2 to –3)	**Boundary 3** (Area-3 to –4)	**Boundary 4** (Area-4 to –5)
HP/M (distributed)	1500 m	2405 m	2614 m	3459 m
HP/R (co-located)	1500 m	2113 m	2487 m	3154 m
MP/P (co-located)	1500 m	2794 m	2975 m	3995 m
MP/P (distributed)	1500 m	2794 m	2977 m	4112 m
MP/I (distributed)	1500 m	2861 m	3036 m	4267 m
MP/M (distributed)	1500 m	2802 m	2985 m	3957 m

NOTE The estimations have been carried out in a certain order, and all these systems operated with at least 6 dB of noise margin. First a system was considered that has the shortest reach in the given scenario. Next the system was considered that has the second shortest range in the same scenario, and so on. In addition, the following simplifications have been applied:
(a) Boundary 1 is fixed to 1500m. (*This is the right-hand boundary of area 1, representing the maximum deployment distance of VDSL*.)
(b) In scenarios where both HDSL.2B1Q/2 and HDSL.CAP/2 systems are present, boundary 3 represents the shortest reach of the two.

<u>Handling disturbers in "distributed" topologies</u>

Table [*] summarizes how to deal with the various disturbers in distributed topologies.

- ***Cross talk from area 1 systems***: If a victim system is deployed beyond area 1, assume that VDSL is terminated at boundary 1 and disturbs the victim system by attenuated cross talk.
- ***Cross talk from area 2 systems***: If a victim system is deployed beyond area 2, assume that SDSL 2048 kb/s is terminated at boundary 2 and disturbs the victim system by attenuated cross talk.
- ***Cross talk from area 3 systems***: If a victim system is deployed beyond area 3, assume that HDSL is terminated at boundary 3 and disturbs the victim system by attenuated cross talk.
- ***Cross talk from area 4 systems***: If a victim system is deployed beyond area 4, assume that SDSL 1024 kb/s is regenerated and neglect the effect of the additional cross talk by the repeaters somewhere between the LT and NT. However, the cross talk that is generated by the SDSL 1024kb/s system at the end of the line should be taken into account.

Table [*]: Summary of the disturbers to be considered in a distributed topology

Disturbers when victim NT is in				
Area 1	**Area 2**	**Area 3**	**Area 4**	**Area 5**
VDSL	X-1	X-1	X-1	X-1
SDSL-2048	SDSL-2048	X-2	X-2	X-2
HDSL	HDSL	HDSL	X-3	X-3
SDSL-1024	SDSL-1024	SDSL-1024	SDSL-1024	Reg. SDSL-1024
ADSL	ADSL	ADSL	ADSL	ADSL
ISDN	ISDN	ISDN	ISDN	ISDN

- X-n means attenuated crosstalk from area-"n"
- Reg. SDSL-1024 means regenerated-SDSL 1024 kb/s systems

Handling disturbers in "virtually co-located" topologies
Table [*] summarizes how to deal with the various disturbers in virtually co-located topologies.

- ***Cross talk from area 1 systems***: If a victim system is deployed beyond area 1, assume that a disturbing VDSL is terminated at boundary 1 and disturbs the victim system by attenuated cross talk. (NOTE The concept of "virtual co-location" conflicts with the concept of attenuated VDSL cross talk up to area 5, but the impact of such cross talk becomes ignorable beyond some distance.)
- ***Cross talk from area 2 systems***: If a victim system is deployed beyond area 2, convert the disturbing SDSL 2048 kb/s into an SDSL system with lower bitrate. For victims deployed in area 3 or 4, this bitrate equals 1024 kb/s. For victims deployed in area 5, this bitrate equals 512 kb/s.
- ***Cross talk from area 3 systems***: If a victim system is deployed beyond area 3, assume that HDSL is regenerated and neglect the effect of the additional cross talk by the repeaters in the middle of the line. However, the cross talk that is generated by the HDSL system at the end of the line should be taken into account.
- ***Cross talk from area 4 systems***: If a victim system is deployed beyond area 4, assume that a disturbing SDSL 1024 kb/s is regenerated and neglect the effect of the additional cross talk by the repeaters in the middle of the line. However, the cross talk that is generated by the SDSL 1024kb/s systems at the end of the line should be taken into account.

Table [*]: Summary of the disturbers to be considered in a virtually co-located topology

Disturbers when victim NT is in				
Area 1	**Area 2**	**Area 3**	**Area 4**	**Area 5**
VDSL	X-1	X-1	X-1	X-1
SDSL-2048	SDSL-2048	SDSL-1024	SDSL-1024	SDSL-512
HDSL	HDSL	HDSL	Reg-HDSL	Reg-HDSL
SDSL-1024	SDSL-1024	SDSL-1024	SDSL-1024	SDSL-512
ADSL	ADSL	ADSL	ADSL	ADSL
ISDN	ISDN	ISDN	ISDN	ISDN

- Reg-HDSL means regenerated-HDSL 2 pairs systems
- SDSL-512 means a 512 kb/s SDSL system (or lower if that rate will not work either)
- X-n means attenuated crosstalk from area-"n"

9.1.4 Loop models within ESP/2004

The models for transmission and cross talk are specified in table [*]. For the sake of simplicity, all effects related to the impedance for both the insertion loss and the crosstalk calculations are ignored. The impedance of 135 Ohm is selected for all the systems, even if this is not correct for such systems like e.g. those belonging to the ADSL family.

Transmission	Two-port model See VDSL [1]	TP100	The TP100 cable model described in Annex A of ETSI VDSL[1] is chosen. Bridge taps are assumed to be absent, and the characteristics of all cable sections in a cascade are assumed to be equal per unit length.
	Reference Impedance	R_N = 135Ω	The impact of the levels of signals, as a function of the termination impedance, is ignored for computational convenience. For calculating signal loss, assume that source and load impedance are R_N= 135Ω, for each xDSL system under study.
Crosstalk	Cumulation See clause 8.3.2		The FSAN sum for cross talk cumulation, as specified in clause 8.3.2.1, applies for cumulating the power levels of M individual disturbers into the power level of an equivalent disturber.
	Coupling See clause 8.3.3.	K_{xn_dB} = –50 dB K_{xf_dB} = –45 dB f_0 = 1 MHz L_0 = 1 km	The basic models for equivalent NEXT and FEXT diagram for two-node topologies, as specified in clause 8.3.3.1, applies for modeling the equivalent cross talk coupling.
	Injection See clause 8.3.4	$H_{xi} \equiv 1$	The impact on the levels of cross talk noise, as a function of the termination impedance, is ignored for computational convenience (equivalent to $H_{xi} \equiv 1$)

Table [*]: The involved models and associated parameters to account for various cable characteristics.

9.1.5 Scenarios within ESP/2004

To carry out a spectral management study for a “new system” under ESP/2004, the six scenarios in table [*] are to be evaluated according to the reference method. This means that the change in performance is to be evaluated for each broadband system in the mix of each scenario, when the mix changes from the “reference mix” to the “modified mix” (as specified before in table [*]).
In addition, the following applies

- All the systems shall have at least 6 dB of noise margin.
- The frequency resolution to be used in the simulations shall be 4.3125 kHz or smaller.
- A flat level of -140 dBm/Hz representative of background noise shall be added to the overall cross talk noise.

Scenario	Mix	Topology
1	HP/M	distributed
2	HP/R	co-located
3	MP/P	co-located
4	MP/P	distributed
5	MP/I	distributed
6	MP/M	distributed

Table [*]: The combination of mixtures and topologies that form the scenarios of ESP/2004

End of literal text proposals