TM - S2

Call for technologies (CfT) for Evolutionary subsystems of the S2 system

1. Definitions and abbreviations used in this Call for Technologies

DVB-TM:	Technical Module of the DVB Project
TM-S2:	Ad Hoc Group of the Technical Module for the development of advanced channel coding and modulation schemes for broadband satellite services
DVB-S2 System:	EN302307 1.3.1
DVB-sx System	Evolution of the DVB-S2 system, under development according to CM1330r1 (see Annex 1). This provisional name will be used till a final decision by CM and SB
DVB-Sx subsystem:	Basic building block of the DVB-Sx system, implementing a specific functionality (e.g. FEC, Modulator, Mapper, Interleaver, ...) of the S2 building block scheme as reported in Annex 2
CfT	Call for Technologies
Proponent	Member of the DVB Project or non-Member (e.g., Company, Consortium or Institute) submitting a "Proposal" as an answer to this "Call for technologies".
Proposal	Proposed principle scheme for the implementation of an DVB-Sx Subsystem
Third party evaluators	Individual members of AGH-DVBS2 which may carry-out independent evaluations of system proposals.
Self Assessment	Self evaluation, by a Proponent, of the technical performance of its Proposal
Broadcast application	One-to-many broadband transmission (e.g. TV service)
Interactive application	One-to-one communication. The DVB-Sx system implements the forward broadband link by satellite from the operator to the users. The return channel may be implemented via RCS/RCS2 systems or other interaction systems.

2. Background

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The current goal of TM-S2 is the delivery, by end of September 2013, of a technical standard (provisionally indicated as DVB-Sx, pending final decisions by CM and SB) enabling the delivery of a significantly higher data rate (between 15% to 30%) in a given transponder bandwidth than the current DVB-S2 system (EN302307), or delivery of the same data rate at a significantly lower SNR according to the Commercial Requirements defined by DVB-CM [doc. CM-1330r1), as reported in Annex 1. This target shall be achieved **without a fundamental change to the complexity and structure of DVB-S2**, in order to guarantee a rapid and low-risk development of the specification and simple chip-set re-engineering.

The DVB-Sx system shall offer the best overall performance / cost trade-off for the core application areas already covered by S2 (in decreasing priority order):

1. consumer-oriented, broadcast applications (DTH);
2. consumer-oriented, interactive applications (forward link), including dynamic rate adaptation;
3. professional applications (DSNG, distribution of audio-visual services to terrestrial broadcast networks, Internet trunking, cable feeds, ...).

The DVB-Sx specification shall also cover newly identified applications in growing markets (including but not limited to: airborne, rail and other mobile forward links, small aperture terminals for news gathering, disaster

relief and similar ad hoc links, and VSAT forward links in regions prone to deep transient atmospheric fading).
Capability to operate at very low SNR levels is the main requirement for such new growing markets.

The specification should address all markets through a single profile while targeting core markets (as defined in CR1) with maximum efficiency gains. If necessary, modular additions to the core specification shall address new markets through a standardized framework.

To cope with wideband transponders (e.g. 250 MHz or wider), the system shall provide functionalities as required by CM1250, (for example as provided by the 1.3.1 release of EN302307).

So far, the possible candidate technologies in line with the Commercial Requirements are: a reduction of the waveform roll-off (e.g. down to 10% and/or 5%), the addition of higher order constellations (e.g. 64APSK), a better matching between constellations and FEC rates for quasi-linear and non-linear channels, the definition of finer MODCOD steps, very-low SNR modes. Other technologies in line with the Commercial Requirements are welcome.

3. Scope

This "Call for Technologies" requests proposals for DVB-Sx-subsystems, according to the S2 reference block diagram given in Annex 2, for the definition of the DVB-Sx system, in line with the Summary of draft Commercial Requirements as specified in Annex 1.

The Call is **open for responses to DVB Members, as well as to non-members**.
Non-member proponents may attend (part of) a TM-S2 meeting to present their proposals following an invitation of the Chairman; for further consideration of such technologies for DVB-Sx, the proponents need to join DVB.

4. Deliverables, Work Plan and Procedures

As a reply to this CfT, Proponents shall define their proposed DVB-Sx-subsystems (for example including, but not limited to, narrow roll-off, higher order constellations optimized to operate on quasi-linear and non-linear channels, finer MODCOD steps, very low SNR modes, …), perform computer simulation evaluations and submit their contributions to:

the DVB Project Office by email to dvb@dvb.org

by **11 February 2013 at 23.59 CET**.

Proposals of sub-systems not included in the S2 reference block diagram are admitted, but will be retained only in case proposals within the reference block diagram are not available (or they are unsatisfactory according to commercial requirements).

Proponents shall deliver:

- Detailed description of the proposed DVB-Sx-subsystem (transmit and receive side), suitable also for third party simulation SW implementation. The described "baseline receiver implementation" shall correspond to the one used for performance self-assessment.
- Detailed self-assessed performance results of the proposed DVB-Sx sub-system, compared to the corresponding S2 sub-system, (simulations according to Annex 3, comparison and selection criteria for MODCOD families as described in Section 5 and Annex 3).
- A self-assessment that the proposed subsystems may be adapted to cope with the S2 block diagram (Annex 2) and cover the commercial requirements (see Annex 1).
- A declaration of the estimated S2 complexity increase when the proposed sub-system is added (receiver side), including a description of the complexity evaluation method adopted (see Annex 4). The DVB-Sx (receiver) complexity target should not exceed the complexity of S2 by more than

30%. More precise sub-system complexity targets may be defined only when the DVB-Sx global solution is better understood.

- A number of Declarations, as specified in Annexes 5 and 6, shall be delivered as well

Further evaluation/optimisation activities will take place in the coming months:

- Proposal evaluation and discussion
- Selection of the best subsystems candidates for the DVB-Sx "tool-kit".
- Combination of subsystems, optimisation, design of the missing elements to fulfil the functional requirements;
- Definition of the DVB-Sx "strawman specification"
- The target date for completion of this phase is around July 2013.

During the selection / optimisation process, "third party evaluators" may run simulations based on the SW tools provided by the Proponents or developed by third parties, in order to validate self-assessments and allow direct system comparisons.

In this phase, further proposals may be freely submitted and adopted, if unanimously accepted. In case unanimity may not be achieved, such new proposals will be accepted only in case of a demonstrated efficiency gain over the replies to the CfT of at least 10% (in case of family of MODCODs, using the approach described in Annex 3; in case of a single MODCOD, interpolating with a segment connecting the two nearest points of the best competing system) (Note: this is intended to offer a competitive advantage to replies to this CfT over late proposals). This procedure is applicable also to low SNR modes and high efficiency modes, not available in DVB-S2.

The following phase will cover fine-tuning and evaluations, and drafting of the final specification by end-September 2013. In this phase, the technical performance analysis will be completed by assessments over realistic satellite channel models, including carrier/sync recovery; if possible, hardware tests will be carried-out.

5. Comparison and selection criteria for MODCOD families

The performance evaluation and **selection criteria for MODCOD families** is given in Annex 3. Long (64800 bits) LDPC codes are high priority, but short (16200 bits) are also welcome; different FEC blocks are not admitted.

The selection shall be based on the simplified satellite channel model as described in Annex 3 ("hard-limiter" satellite model, without IMUX and OMUX). Results including the more complete satellite channel model (IMUX, TWTA, OMUX, and optionally phase-noise) are welcome but not used for the pre-selection.

To simplify performance comparison, the simulations for new MODCODs shall use 10% roll-off shaping filters, equally split between transmitter and receiver, and the maximum number of decoding iterations is 50. Other roll-offs may be proposed to demonstrate the overall gain of the enhanced solutions Vz S2. The reference S2 system shall use roll-off=20% and 50 iterations.

Use case	SNR range	C_{SAT}/N_{min}	C_{SAT}/N_{max}	Number of MODCOD steps	Priority
DTH & VSAT	mid	5	12	20	1
Professional & VSAT	high	12	24	22	2
VSAT & Mobile	low	-3	5	12	2
VSAT & Mobile	Very low	-10	-3	5	2

Note 1: 5 to 8 spare MODCODs are for overlapping regions. Proposals will be compared for solutions having the number of MODCOD as given in the table for the various SNR regions

Note 2: Evenly distributed steps in each SNR range is a good design characteristic, which may be part of the evaluation process

Note 3: in case of multi-carrier operation, the table above shall be modified replacing C_{Sat} with $C_{Allocated}$= C_{Sat}-OBO (in phase 1, AWGN channel is adopted, thus OBO has no meaning, while in phase 2 the optimum OBO shall be used).
For MODCOD family selection, highest priority shall be given to the mid-SNR range.
The hypothetical family including the S2 MODCODs plus intermediate new MODCODs shall be the preferred family (in case such a proposal is available), although totally new MODCOD families shall be selected in case of an average capacity gain (Vz the previous hypothetical family) exceeding 6%.

For the high and low SNR ranges available in S2, the solution shall be primarily searched within the extensions of the modes available in S2, but further optimised families may be preferred in case of an additional capacity gain exceeding 6%.
Proposals targeting efficiencies larger than 4.5 bit/s/Hz (not available in S2), shall make reference, in terms of performance comparison, to S2 32APSK code-rate 9/10 at the same symbol rate, and should target to reach 1 dB maximum degradation from the modulation-constrained Shannon limit (AWGN)
Proposals targeting very low SNR modes (<-3 dB, not available in S2), shall make reference, in terms of performance comparison, to S2 QPSK with repetitions, and should target to reach 1 dB maximum degradation from the modulation-constrained Shannon limit (AWGN).

Specific MODCOD families may be proposed for **quasi-linear channels**, provided that an additional efficiency gain exceeding 6% is achieved over the family adopted for the non-linear channel.
Note: in terms of PL-Header overhead, the inclusion of a “linear PROFILE” does not imply additional losses, since “linear PROFILE” and “nonlinear PROFILE” never coexist on the same transponder/MUX.

The final set of MODCODs will be the union of the best groups in all SNR ranges.

ANNEX 1

Enhancement of the DVB-S2 Standard
Summary of draft Commercial Requirements
as developed by CM-BSS

Use Cases for an enhanced DVB-S2 Standard

While defining the commercial requirements the CM-BSS group decided that the new specification shall address the current DVB-S2 core markets including Direct-To-Home broadcast but also shall address newly defined applications in market segments such as airborne, rail, disaster relief, etc.

Direct-To-Home

Several DVB-members expressed the commercial need to benefit from the 20-30% throughput gain that would be possible with an evolutionary enhancement (eg. adding additional MODCODs and tighter roll-offs) already in the 2015-2016 time frame. The respective use case is the anticipated launch of 4K (QFHD) television services in Ku-/Ka-band that will use HEVC encoding. In this context it may be desirable to eventually use fragments of smaller blocks of capacity on two or three DTH transponders and bond them into one logical stream (see CR7).

Applications requiring low SNR links

The request to incorporate Low SNR links applications in the commercial requirements has been supported by several DVB member companies.

Already today several proprietary systems offer the ability to close links with SNRs well below those supported by the existing DVB-S2 standard. These are designed to serve markets such as airborne (business jets), small portable terminals for journalists and other professionals, and interference limited systems – e.g. to comply with regulations on adjacent satellite interference.

In addition to these existing applications, it is expected that explosive growth will occur in the civil aviation internet access market in the next 2 to 3 years, particularly as new satellite systems come in to use offering Ka-band coverage on a global basis.

Finally, low SNR working could promote new markets for VSAT terminals, where today availabilities in higher frequency bands would be unacceptable. This is already the case with Ka-band in the tropics; however the same phenomenon would be apparent in all regions for proposed new systems in Q/V-band. By allowing ACSM (Adaptive Coding, *Spreading* and Modulation) to operate down to at least E_s/N_0 of -9.5 dB, it is possible to keep the terminal logged into the network during fast, deep rain fades.

Above applications have been considered in the requirements outlined in CR2 and CR4.

Draft Commercial Requirements

The following commercial requirements for an evolutionary enhancement of the DVB-S2 standard have been agreed by the CM-BSS group:

CR0: Satellite operators, broadcasters and manufacturers require a technical standard for higher efficiencies without a fundamental change to the complexity and structure of DVB-S2.

CR1: The specification shall focus on both the application list currently addressed by DVB-S2 for the core markets (Direct-To-Home, broadcast distribution, contribution, VSAT outbound and high speed IP links) and for newly identified applications in growing markets (including but not limited to: airborne, rail and other mobile forward links, small aperture terminals for news gathering, disaster relief and similar ad hoc links, and VSAT forward links in regions prone to deep transient atmospheric fading).

CR2: The specification shall focus on Es/No ranges necessary to address the markets of interest. The specification should address all markets through a single profile while targeting core markets (as defined in CR1) with maximum efficiency gains. If necessary, modular additions to the core specification shall address new markets through a standardized framework. The Es/No range is extended in the higher range reflecting the availability of higher powered and spot-beam satellites (such as video and IP trunk links achieving Es/No of >22 dB). The lower Es/No range is required to maintain links during deep fades seen in mobile and high

frequency systems (such as in VSAT systems). The specification should be harmonized with the lower Es/No range and ACSM described in the DVB-RCS2 guidelines.

CR3: The specification shall bring an efficiency gain over the existing DVB-S2 standard averaging at least at 15% and where possible shall implement 25%-30% on individual measuring points, reflecting a significant commercial interest of the ecosystem in the satellite industry.

CR4: The system shall maximize spectral efficiency (measured in bits/sec/Hz) at all operating points across the channel conditions and shall maximize link robustness. The specification shall take into account the use of multiple spot beam systems.

CR5: The specification shall comply with the wideband transponder requirements as outlined in document CM1250 (except the requirement of being backwards compatible to DVB-S2 (EN 302307 v.1.2.1).

CR6: The specification of the modulation techniques shall be compatible with other common or recently defined satellite related items such as wideband, ACM, Uplink power control, RF Carrier ID, RF pre-distortion etc.

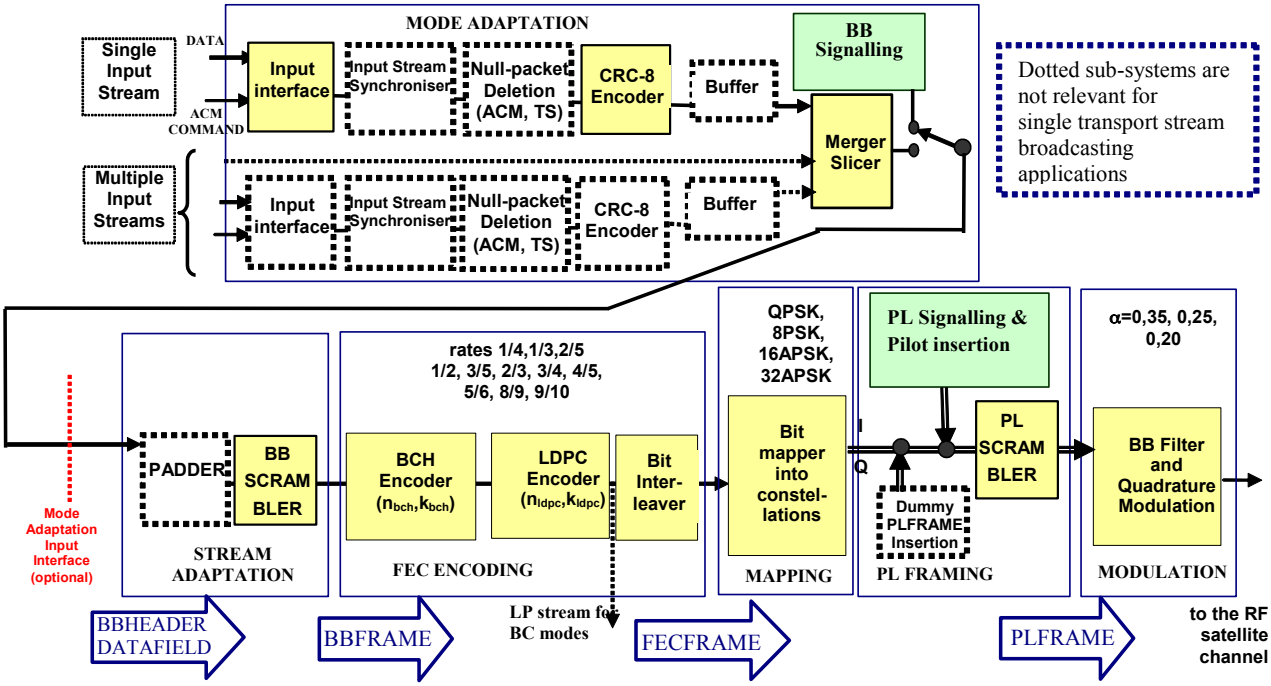
CR7: Assuming a multiple tuner front-end in the receiver the specification shall allow for the logical bonding of satellite transponders.

CR8: The specification shall allow for better diagnostic capabilities (of link performance including accurate estimation of signal to noise ratio).

CR9: The specification shall take advantage, where possible, of the difference in linear and non-linear operations, reflecting the commercial advantages in differentiating applications like video distribution and video contribution of satellite signals.

CR10: The specification shall be a short track development and shall be available at the latest by end of September 2013 in order for DVB no to lose the aspect of a widely adopted and successful standardization in the satellite market.

ANNEX 2
Reference S2 System block diagram



ANNEX 3
System performance evaluation

The Proponent shall perform the self-assessment of the proposed DVB-Sx sub-system performance by computer simulations, using the following models:

1) For single carrier per transponder operations:
   a. In the first phase: hard limiter TWTA characteristics as in Figure 1 plus AWGN
   b. In the second phase: relevant channel models as described in [1] for the application services using single carrier per transponder operations
2) For multi-carrier per transponder operations:
   a. In the first phase: AWGN only
   b. In the second phase: relevant channel models as described in [1]for the application services using multi-carrier per transponder operations

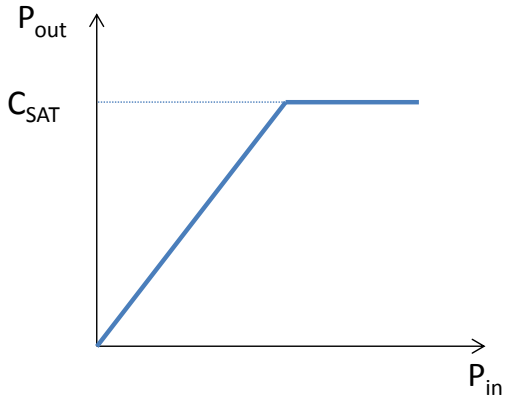


Figure 1: Hard-limiter TWTA model

The performance shall be compared with the corresponding S2 sub-system.

For the first phase, the proponent shall deliver:

- Single-carrier per transponder:
  - Spectral efficiency η (useful bit/s/Hz computed over the reference bandwidth B_{REF}) versus C_{SAT}/N curves for the proposed algorithm (for FER down to 10^{-5}) when the system parameters of the relevant channel models are optimized (IBO, symbol rate, roll-off…).
- Multi-carrier per transponder:
  - Spectral efficiency η (useful bit/s/Hz computed over the reference bandwidth B_{REF}) versus C/N curves for the proposed algorithm (for FER down to 10^{-5}) when the system parameters of the relevant channel models are optimized (symbol rate, roll-off…).

⇨ For the first phase, the reference bandwidth shall be set to B_{REF}=Rs(1+roll_off) and equal to the bandwidth of the DVB-S2 carrier to which the DVB-Sx carrier is compared to (in general the two carriers might have different symbol rates due to different roll-offs).

For the second phase, the proponent shall deliver, for both the single-carrier and multi-carrier case:

- Spectral efficiency η (useful bit/s/Hz computed over the reference bandwidth B_{REF}) versus C_{SAT}/N curves for the proposed algorithm (for FER down to 10^{-5}) when the system parameters of the relevant channel models are optimized (IBO, symbol rate, roll-off…). To be noted that in multi-carrier case the transponder is assumed to be filled with uniform bandwidth carriers as described in the relevant sections of [1].

⇨ For the second phase the reference bandwidth B_{REF} shall be set to the – 3dB bandwidth of the OMUX filter for the case under test within the different scenarios of [1] (for the most typical 36 MHz OMUX, it corresponds to 38 MHz while for the larger transponder bandwidths this value shall be scaled according to the scaling formula outlined in [1]) .

Note: as indicated in section 5, for new MODCOD proposals, roll-off=10% shall be simulated versus S2 at roll-off=20%

Regardless the phase and the transponder mode, to achieve a sufficient statistic precision, at least 25 frame errors shall be simulated at FER=10^{-5}

C_{SAT} is the on-board TWTA CW saturated power, C is the carrier power, Rs the carrier symbol rate, N the noise power integrated over the reference bandwidth B_{REF} and FER the FEC codeword frame error rate.

Additional curves may be delivered (e.g. hardware test, satellite test), if available.

Comparing modcods that are close in performance can only be done correctly if they exhibit either the same spectral efficiency or the same carrier-to-noise threshold.
In case modcods are compared with different spectral efficiencies AND different CSAT/N thresholds, it is clear that they cannot be compared.
Therefore, the approach is not to compare individual modcods, but rather modcod groups. This way, we can avoid comparison for a specific C_{SAT}/N (which can be beneficial to one modcod). Instead we compare over a range of C_{SAT}/N's.

In detail, the performance comparison follows the steps outlined below:

- A candidate group of modcods is compared to the DVB-S2 benchmark (or to another proposed group of MODCODs) in a given SNR range.
- Comparison is made by averaging over a certain SNR range
- The overall efficiency gain is computed as follows:

$$\eta_{gain} = (1/N_{gran}) \ \Sigma_i \ [\eta_{NEW} (C_{SAT}/N_{min} + i\ SNR_{step}) / \eta_{S2} (C_{SAT}/N_{min} + i\ SNR_{step})]$$

Where $\eta_{NEW} (C_{SAT}/N)$ and $\eta_{S2} (C_{SAT}/N)$ denote the efficiency of the best modcod with a threshold lower than C_{SAT}/N, for the new scheme and the DVB-S2 scheme, respectively.
The proposal is to have a resolution of SNR_{step} =0.01dB.

The proponent shall also clearly states which a-priori knowledge of the transponder characteristics he assumes for the proposed sub-systems.

In case sub-systems are proposed which imply either a functional improvement or an improvement of the performance of corollary schemes (like, for example, the overhead signalling schemes), the functional/performance advantage of these schemes with respect to the legacy DVB-S2 specifications shall be duly justified within the scenarios and/or the channel models described in [1].

Simulation of low FER around 10^{-7}-10^{-8} with a sufficient statistics (eg. 25 erroneous frames) may become very critical in terms of simulation time. Therefore replies to the CfT may limit to FER=10^{-5}, while simulations at FER around 10^{-7} may be deferred to the following evaluation phase.

The proponent shall demonstrate that the PRBS generator used within its own simulation programme has sufficient random properties to meet the long simulation time requirements of the self-assessments.

As for the channel model, the proponent shall use the SW code developed by the Channel Model Group [2]

[1] DVB-SX Channel Models, TM-S2 Channel Model Group, document TM-S20xxx
[2] DVB-S2 Channel Model simulation SW – User Manual

ANNEX 4
COMPLEXITY EVALUATION

Each Proponent shall self-evaluate the complexity of its proposal DVB-Sx-subsystem (receiver side mandatory, transmission side optional). **The receiver complexity shall be evaluated on the specific decoding algorithm, which was used to obtain the simulation results** as a reply to this CfT (e.g. computation precision, number of decoding iterations, interleaving depth...).

Each Proponent shall provide a detailed description of the adopted complexity evaluation method

In case the simulation SW optimisation (to achieve high running speed) requires the use of solutions which are not in line with the hardware implementation, the Proponent shall describe such discrepancies and certify the reliability of the simulated performance and of the complexity self-assessment

An example of possible complexity evaluation method for the FEC decoder may be found in DVB-S2 CfT (DVB-S2 017-Rev4)

ANNEX 5
DECLARATIONS

PROPONENT COMPANY: .....
PROPOSAL N. (TO BE DEFINED BY THE EVALUATOR) .....

Intellectual Property Rights (see Annex 6)

Self assessment of suitability to cover technical and functional requirements for the application areas

The Proponent declares to have analysed the Commercial Requirements in Annex 1, and derived the technical and functional requirements for the three **core application areas**: consumer-oriented broadcast applications; consumer-oriented interactive applications (forward link), including dynamic rate adaptation;; professional applications.

The proponent declares:

☐ that the proposed subsystems are suitable building blocks to cover the three aforementioned core application areas

Explanations: *.....(two pages minimum*)

The Proponent declares to have analysed the Commercial Requirements in Annex 1, and derived the technical and functional requirements for the **emerging application areas**, including but not limited to: airborne, rail and other mobile forward links, small aperture terminals for news gathering, disaster relief and similar ad hoc links, and VSAT forward links in regions prone to deep transient atmospheric fading

The proponent declares:

☐ that the proposed subsystems are suitable building blocks to cover the …….. (please specify which one) application area(s)

Explanations: *.....(two pages minimum*)

Authorised Signature of the Proponent Company: .....

Name: ..... Title: .....
Date:.....

ANNEX 6 IPR

1. Proponents are requested to provide the following information:

DVB fosters the formation of voluntary licensing programmes.

DVB intends to begin its fostering process early in the work of the DVB-Sx specification. It is contemplated that a meeting will be held of lawyers and licensing specialists of contributors on the fringes of a future DVB meeting in 2013. Please indicate whether you would like to be notified about this meeting by the Legal Director DVB, eltzroth@dvb.org, and to receive further information on the pooling effort.

If so, please indicate the name and email address of your representative to this pooling discussion meeting.

/_/ The proponent agrees to be notified of the initial meeting of the DVB pool fostering process.

_____
(name of IPR specialist)

_____
(email address)

Note: the meeting is intended for DVB participants that have a well-founded belief that they may hold IPRs essential to the DVB-Sx specification, including in the form of patents and patent applications.

The Legal Director DVB will call an initial meeting to occur alongside a meeting of the DVB-Sx subgroup. The agenda of this first meeting would identify tasks and set a schedule for the work of this pool planning group. The ambition would be to announce a pool shortly after the technical work on DVB-Sx is completed. The pool would be comprised initially of holders of issued patents and would grow as further patents are granted.

2. At times DVB members join with non-members in a common response to a Call for Technologies. It is responsibility of the DVB member proponent to ensure that that these non-member contributors confirm that they are bound to the IPR rules of the DVB Project. Contact the Legal Director DVB, eltzroth@dvb.org, for the form of the statement to be completed by each non-member contributor.