



PROPOSAL FOR A NEW COST ACTION

"Packet-Oriented Service Delivery via Satellite"

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France

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Memorandum of Understanding
for the Implementation of a European Concerted
Research Action designated as

COST Action 272

“Packet-Oriented Service Delivery via Satellite”

The Signatories of this Memorandum of Understanding, declaring their common intention to participate in the Concerted Action referred to above and described in the Technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of the document COST 400/94 Rev. “Rules and Procedures for Implementing COST Actions”, the contents of which the Signatories are fully aware of.
2. The main objectives of the action are to contribute to the identification of key requirements, analysis, performance comparison, architectural design and protocol specification of future packet-oriented satellite communication systems, with a clear focus on Internet-type system concepts, applications and protocols/techniques on the various layers.
3. The overall cost of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at 3.2 Million € in 2000 prices.
4. The Memorandum of Understanding will take effect on being signed by at least five Signatories.
5. The Memorandum of Understanding will remain in force for a period of four years, unless the duration of the Action is modified according to the provisions of Chapter 6 of the document referred to in Point 1 above.

COST Action 272

“Packet-Oriented Service Delivery via Satellite”

A. General Background

Telecommunication networks are moving towards an all-IP environment with unified protocols in both access and core networks. Moreover, the distinction between mobile and fixed environment is becoming less and less evident. The demand for broadband, multimedia-type type of services over the few next years will continue to grow and in time it is expected to compete with voice services not only in the traffic volume but also in the share of the service providers' revenue.

Increased competition among numerous service providers and the need to differentiate themselves in the marketplace is resulting in the necessity to reduce the network cost, increase the overall efficiency, and introduce new broadband multimedia applications. It is believed that these goals can be best met by the integration of services, and their provision through the network based on a single transport mode.

Satellite communications are currently not keeping pace with the development witnessed in terrestrial networks, however in an all-IP environment they could easily facilitate early deployment of the service to many users currently out of the reach of communication services. Deployment of such an all-IP environment in the satellite segment, however, requires examination/study of suitability of the existing protocols and algorithms, and implementation of the required modifications/adaptations or even development of more efficient algorithms taking into account peculiarities of satellite systems.

With the demise and/or the continued financial problems of some current narrowband non-GEO constellations, understandably there has been some discouragement in the satellite telecommunications community. Such systems find it difficult to compete with globally deployed terrestrial mobile networks. On the other hand, there is a real demand for broadband applications coming from the market, and the deployment of the future satellite systems has to be driven by these new requirements, especially in areas and scenarios where terrestrial networks are not so well established or suited. Moreover, lessons learned during the last decade also push more interest again towards the appeal of GEO systems with their inherent broadcast and multicast features, may it be provision of regional or “nearly global” service, achieved by respective solutions ranging from one stand-alone GEO satellite over a regional GEO cluster to interconnected GEOs forming a simple ring or mesh network.

In the non-GEO area, recently significant amount of the research work has been devoted to the implementation of the optical intersatellite links (ISLs) and to all-optical switching on-board of the satellite. The transition from electronic to optical technology will especially lead to an increase of channel capacity and to extremely fast processing and forwarding of information in a future space backbone.

Satellite communications are expected to play an important role in such competitive environment, driven by some recent technological advances which enabled (i) the implementation of efficient intersatellite links for the traffic interconnection in the satellite

segment, (ii) onboard processing capabilities aiming to improve dynamic resource utilisation and flexibility, and (iii) multiple spot beam coverage to optimise bandwidth efficiency. Based on these advances, broadband satellite networks will represent an attractive solution to provide two way connectivity direct to the end user and to furnish new services such as high speed internet access and private network solutions. Furthermore, satellite networks are best suited to satisfy the increasing demand for the broadcast and multicast type of services with additional advantage of providing global accessibility.

B. Objectives and Benefits

The main objective of the Action is to contribute to the identification of key requirements, analysis, performance comparison, architectural design and protocol specification of future packet-oriented satellite communication systems, with a clear focus on Internet-type system concepts, applications and protocols/techniques on the various layers.

In order to guarantee maximum benefit and flexibility, the Action must first of all assess the interesting satellite-specific market segments and potential at an early stage and come up with a clearly focussed set of reference scenarios (global/regional, GEO/non-GEO, broadcast/multicast/interactive, QoS/best-effort, all-IP/hybrid, ...) as a basis for further R&D work that goes into the details of technical solutions. However, ongoing research will always have to monitor and evaluate ongoing activities in both the wireline and the (terrestrial) wireless Internet world and be open to required changes of the once identified working basis in the rapidly changing communications world. Such monitoring should cover newly deployed systems (like first and upgraded return channel systems) as well as more basic R&D work in both parallel COST, IST, and ESA programmes.

Many future (Internet or Internet-like) applications, especially those requiring a broadband communication channel, could significantly benefit from

- (i) quick deployment over the satellite segment;
- (ii) the possibility to provide multicast/broadcast type of services on a global scale;
- (iii) the opportunity to dynamically set up coverage of short-term events, virtual private networks, etc.

Moreover, there are some chances for the European research organisations and satellite industry to catch up or even take the global lead in some mid-term and/or long-term key research and technology fields, as for instance operation of constellation networks, optical networking for non-GEO systems, etc., which seem to be most severely (but probably only temporarily) affected by recent failures of some systems or the impression of current stagnation in others.

It should also be a clear commitment within the COST framework to provide a basis for carrying on such longer-term research which may prove to be of strategic importance (again) in some years time ahead.

The envisaged duration of four years is considered appropriate for such kind of systematic future-oriented research, yet with the required broad scope, and can give room for activities that would not be possible within projects in the IST or similar programmes, also as they are typically much more focussed and tailored to very specific aspects/systems. Moreover, the COST framework has in the past clearly demonstrated that it provides an ideal forum for harmonisation of national research activities, thanks to its inherent bottom-up approach, which is especially essential for Europe to keep pace in hot-topic and/or strategic areas.

Additional benefits of setting up the proposed research activities within the COST framework are expected because of the need to perform multidisciplinary research in various areas such as traffic characterisation and modelling, satellite communications, optical communications, optical switching, etc. Namely, the COST framework seems to be the most suitable platform to bring together people and organisations with different expertise, which could in future, when the research work reaches a more mature phase which could lead to well defined outcomes, form a basis for a successful consortia within the IST programme. Taking into account the recent direction of the development in satellite communications, the proposed satellite specific COST Action could besides for the satellite communications people prove especially interesting for people working in the areas of optical links and optical switching. These areas are expected to provide satellite communications with the essential technologies required for the future provision of broadband communications in the space segment. This Action proposes to identify the impact of optical processing from the networking standpoint. For these purposes, a liaison with COST 267 will be set up.

Other currently ongoing or planned COST Actions as well as EC funded projects (e.g., IST projects) have been examined in order to avoid overlap and possibly use synergies. On the COST track, the proposed Action intends to bring together all European research activities in the satellite domain, in this sense being unique. However, in the light of ever-increasing cross-relevance of research topics, the follow-on of COST 255 and the ongoing COST 257, COST 259 and COST 263 Actions as well as their potential follow-on Actions are identified as candidates for close liaisons. Current IST projects considered as valuable candidates for liaisons are BRAHMS, HeliNET, SUITED, and VIRTUOUS.

The proposed work can be regarded as a reasonable and somewhat natural continuation of the COST 227/252 line, which has over the last years already identified the “satellite IP“ scenario as a promising one, considered to require a considerable amount of longer term research activity. Corresponding work on key issues has been started during the second half of COST 252. Moreover, valuable input is considered also to come from the parallel COST 253 Action, where some initial research has been performed in the areas of traffic characterisation and routing in ISL networks . Thus it seems natural to “merge” these two former satellite Actions under the banner of “Internet over Satellite”.

With the directions towards

- (i) packet-oriented operation and correspondingly re-designed service offerings and technical solutions,
- (ii) ever-growing broadband demand with all its implications (higher frequency bands, even better resource utilisation, etc.), and
- (iii) ever-increasing importance of value for both users and providers (in terms of flexibility, transparency, adaptability, ... of services, algorithms, system architecture, hardware options, ...),

the proposed Action extends the scope of the current satellite COST Actions.

Some of the expected outcomes of the proposed COST Action are:

- Identification of technologies supporting IP over satellites and enabling new services and QoS guarantees;
- Study of suitability to implement IP switching in the sky;
- Adaptation of protocols and algorithms initially developed for the fixed and mobile terrestrial networks, to make them suitable for the use in satellite segment;
- Development of new algorithms, designed deliberately for the satellite segment;
- Evaluation of the suitability of using various optical technologies in the space segment;

Another objective relates to the dissemination of ongoing research work and results obtained in the course of the Action. The dissemination plan foresees the organisation of a Mid-Term and a Final Seminar as two key elements. These events are targeted to the wider European satellite R&D community, and the major objective is to offer potential benefit from the Actions's results to people, organisations and companies which are not directly involved in the Action's work. In the context of the Seminars, a kind of proceedings or report would be issued in paper and/or electronic form.

In addition, a systematic submission of papers to relevant journals and conferences is fostered as a strong element for dissemination of results to a wider audience. Due to the typically shorter turn-around, especially the presentation of papers at conferences will open valuable evaluation opportunities in terms of feedback and discussions from/with colleagues outside the Action. The target list of international journals identified as particularly relevant comprises (but is not limited to) the *International Journal of Satellite Communications*, *Space Communications and Broadcasting*, *Telecommunication Systems*, *IEEE Transactions on Communications*, *IEEE/ACM Transactions on Networking*, *IEEE JSAC (regular and wireless series)*, *IEEE Communications Magazine*, *IEEE Internet Computing*. Relevant conferences include *IEEE Globecom*, *IEEE ICC*, *IEEE Infocom*, *IEEE VTC*, *AIAA ICSSC*, and *ECSC*, including specific European and/or world-wide audiences, respectively.

As a complement to focused technical topic papers from single authors or work-groups out of the Action, it is envisaged to systematically place publications identified as "Action papers" (more of review and overview type) in order to bring the Action's work as such to a broad public attention. For all "open" publications, it should be a key requirement to clearly identify the satellite's specific role, environment, challenges, strengths and opportunities which is especially important (but often not trivial or obvious) in the Internet environment. Besides standardisation activities, such conference publications are obviously a second opportunity to bring in the satellite specific interests and opportunities also to the attention of the terrestrial (wireless and wireline) communications R&D community and finally as a complementary element into the future (Internet) communications infrastructure.

In parallel to the mentioned special events, paper submissions and presentations, *permanent* external visibility of the Action will be mainly provided by a web server, which will host basic information as the MoU, participants and contacts lists, and MC meeting information. Moreover, Seminar reports and Temporary/Technical Documents will be provided for download. Extending prior established practice from COST 253, also open software developed in the frame of the Action will be made available for download.

Relevant evaluation results of the Action (including non-formal public feedback of high importance) will be taken into consideration in updating the dissemination plan during the course of the Action.

The proposed Action also aims at setting up a link with standardisation bodies and provide them with results (e.g., IETF for all issues related to the role of satellite in reference to Internet/multicast; ETSI for standardisation of proposed protocols), and in the longer term the research performed is expected to provide a solid basis for forming a potential consortium in future EC Framework Programmes.

C. Scientific and Technical Programme

This section describes the contents of the studies to be performed within the organisational framework of Section D.

The methodology entails a system approach where trade-offs are explored in a systematic way. In particular, special emphasis is given to the balance between on-board processing complexity and flexibility as this is an important issue for both the investment and the operation and maintenance of the satellite. Also, it has an impact on the design of the terminals and the cost of the service delivered to the end user.

Area 1: Access network aspects

Objectives:

- To identify and quantify the tradeoffs among terminal performance, complexity and cost.
- To identify adequate transmission and link techniques for Internet type traffic flows.

Terminal and propagation

The terminal and propagation aspects covered are:

- The design of efficient receivers with low consumption for mobile terminals.
- The design of low cost reconfigurable terminals.
- The determination of most appropriate transmission schemes according to the service constraints.
- The modelisation of the power requirements for CDMA techniques.

Multiple access and link layer

The transmission of packets for best effort services is a research field to be investigated. The following points are addressed:

- The comparison of the performance and tradeoffs existing between emerging standards and legacy schemes.
- The elaboration of jitter-free access schemes for multimedia traffic in the Ka-band.
- The assessment of algorithms, methodologies and internal signalling protocols for the control of dynamic resource allocation for Internet-type traffic.

Area 2: Space segment aspects

Objectives:

- To identify and quantify the tradeoffs of among performance, consumption and economical cost of on-board processing.
- To identify the scenarios for a future transition from electrical to optical on-board processing.

Routing

The current challenge of routing for satellite networks is the provision of Quality of Service (QoS) routing. QoS routing in its most general form is a complex optimisation problem.

Devising QoS routing encompasses the following studies:

- The performance of on-board distributed/decentralised routing with an emphasis on the required computing power, signalling load and convergence time.
- The signalling required to support these routing algorithms.
- The identification/study of approaches mixing both connectionless and connection-oriented service provision and their impact on the routing and switching operations.
- The identification of the impact of optical processing on routing aspects with migration scenarios from optical circuit switching to full optical packet switching.

Transport

The transport activities in the Action cover both the design of new protocols as well as the use of existing transport schemes as a means of tunnelling other protocols. The following key topics are identified:

- The extension of existing terrestrial or the elaboration of new transport protocols for fault-tolerant services such as video on demand.
- The study of an evolutionary approach to multicast by layering IP over existing MPEG-2 and DVB standards.

Area 3: User and service provider aspects

Objectives:

- To identify suitable models integrating Internet services and worldwide communication.
- To identify the tradeoffs between complexity and effectiveness for supporting QoS in multi-network environments using different media or networking technologies.
- To implementation of secured communication in multicast environments with an emphasis on IPsec.

Applications and QoS

In this field the action intends to set-up a close relation with COST 257 action and its possible following action with the aim to review the traffic models developed there and adapt them for the need of our studies. Having this in mind a special attention will be paid to:

- The characterisation of services.
- The elaboration of traffic models integrating market studies.
- The customisation of existing models for the need of study in satellite systems.
- The impact of these models on dimensioning studies.

Furthermore, an emphasis will be centred around Quality of Service issues, both on the implementation/evaluation of an architecture to support QoS and the performance evaluation of services relying on QoS. The key topics to be covered are:

- The study of the techniques for defining and supporting QoS at different layers of a protocol stack.
- The inter-operability of existing QoS architectures in the Internet (IntServ, DiffServ) and in ATM.
- The study of an IP telephony architecture for satellite networks as a first application of a QoS capable IP satellite backbone.

Security

In a tight connection with QoS aspects certain security issues will need to be addressed both the implementation of basic security services and higher level components. Also specific security requirements need to be addressed such as for the provision of e-commerce, m-commerce, tele-banking, etc. The successful implementation of such applications will rely on a satisfactory security system. Satellite environment has its own security challenges, where eavesdropping and active intrusion is much easier than in the terrestrial fixed or mobile networks because of the wider broadcast nature of satellites.

The following issues will be addressed:

- Security threats to multicast over satellites such as satellite access control, multicast network elements and user data privacy and integrity.
- Security-key distribution architectures over satellites especially for very large number of users.
- Adaptation of the IPsec standard to wireless and multicast communications.

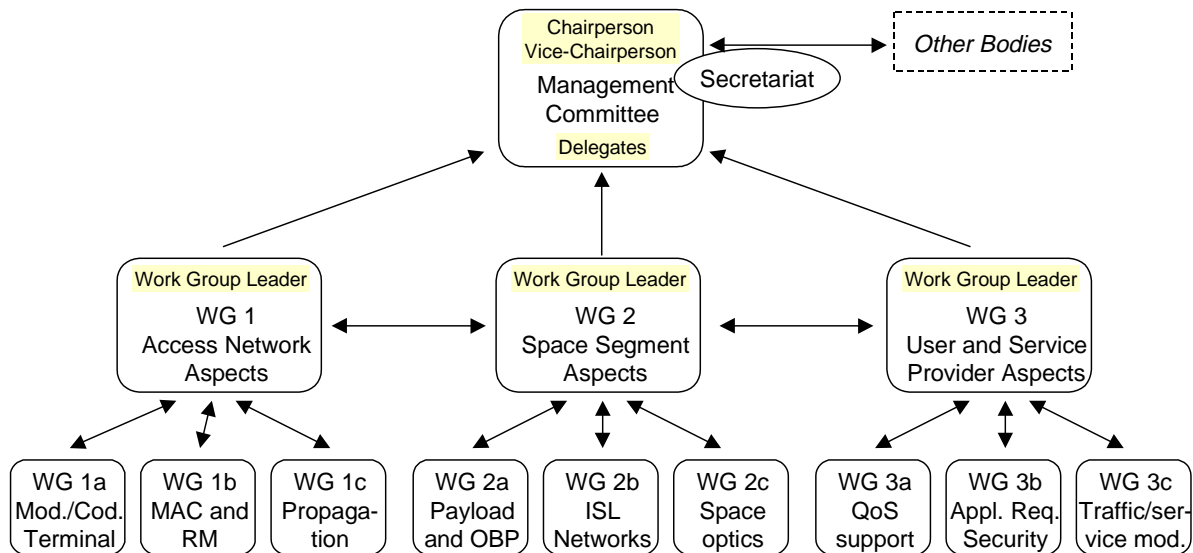
D. Organisation and Timetable

D.1 Organisation, Management and Responsibilities

The previously outlined work will in principle be organised in three working groups, each being potentially more or less subdivided into sub-groups on demand; a likely subdivision from a current perspective is indicated here but is definitely subject to reconsideration upon start of the Action.

- WG 1 : Access network aspects
 - a) Modulation and coding techniques; terminal design
 - b) MAC and resource allocation techniques
 - c) Propagation aspects
- WG 2 : Space segment aspects
 - a) Payload and on-board processing issues for both GEO and LEO
 - b) Core/backbone network issues for ISL-based LEO
 - c) Optics in space segment
- WG 3 : User and service provider aspects
 - a) QoS support
 - b) Application requirements and security
 - c) Traffic modelling and user/service profiles

The following diagram illustrates the whole organisational framework of the Action.



It is evident due to the organisation in the Working Groups (including the subgroups) that some of the earlier identified topics exclusively fit into one of them whereas others cover aspects that are relevant and feed into two or more. Therefore, in any case close co-ordination is inevitable. However, organising the Work Groups along (sub-)system aspects or segments of the value-chain rather than along (OSI) layers or research areas should clearly push a more focussed work toward feasible system solutions, especially on the “internet-over-satellite” path, and is thus expected to enhance the exploitation of Action results for other projects and industry, as well as more closely feed into standardisation efforts.

Each WG is co-ordinated by an elected work group leader who is also responsible for the exchange and co-operation with other groups and the whole Management Committee, in order to achieve convergence in the results of both the Working Groups and the whole Action.

The Management Committee will elect a Chair- and Vice-Chairperson who essentially share the responsibilities for both

- the internal scientific and organisational co-ordination of the whole Action, and
- the contact and interactions with EC and other European and international institutions, projects and standardisation bodies.

It is foreseen that the Action will establish and foster liaisons with the following projects and organisations, where the information flow should be typically bi-directional:

- *COST framework:* Actions 255, 257, 259, 263, 267 and/or respective (potential) follow-on Actions;
- *IST projects:* BRAHMS, HeliNET, SUITED, VIRTUOUS;
- *Standardisation bodies:* ETSI TC SES / STF 126 and follow-on; WG S-UMTS;
- *Other organisations:* ESTEC “Ad-Hoc Group” AHG dealing with issues related to service requirements for broadband satellite applications.

The Management Committee may upon request or obvious benefit arrange and co-ordinate technical workshops and seminars, staff exchanges, specific interaction between participating institutions on dedicated joint topics, and especially use the STSMs as efficient tool to speed up the development of some particular technical matter.

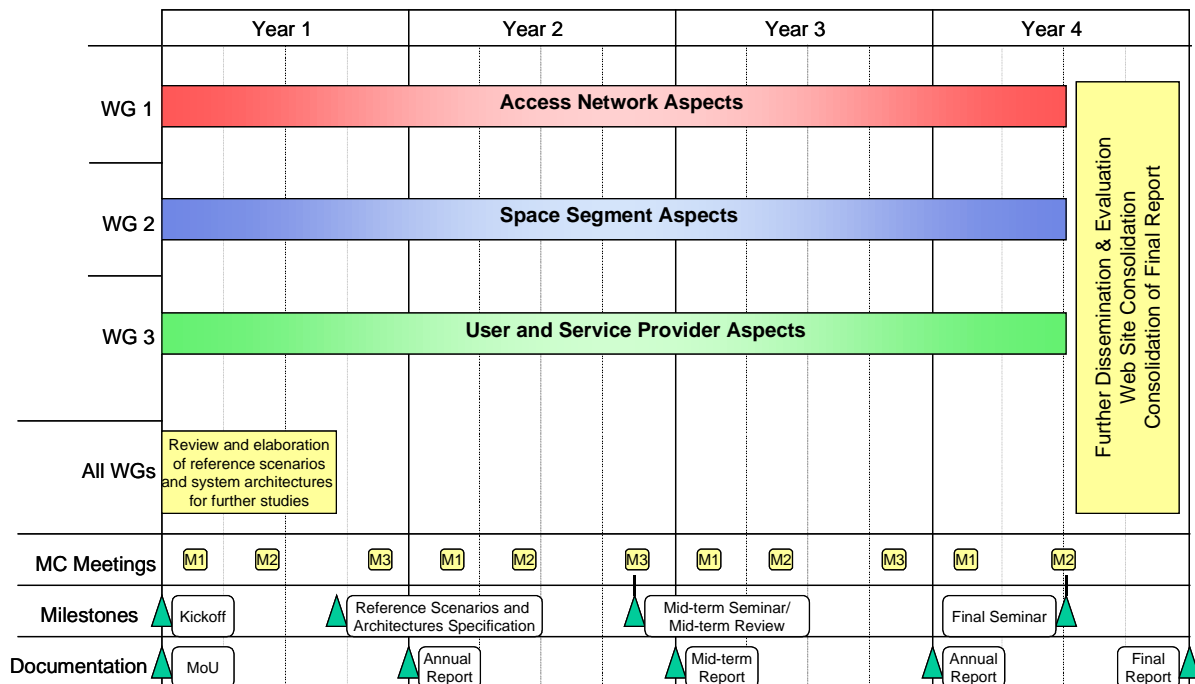
Delegates representing Signatories in the Management Committee are expected to

- attend and actively contribute to MCMs and workshops, according to the objectives and milestones of the Action;
- take responsibilities for specific action items within the MC on demand;
- act as contact persons and rapporteurs for their respective national research groups;
- achieve working liaisons between the Action and other related COST Actions, IST projects, etc., according to the recommendations of the TIST.

The most important means for providing permanently updated external visibility of the Action is planned through the web server, where also the Temporary Documents will be available for download. Dissemination to a wider audience is mainly achieved through two open Seminars being not limited to Signatories of the MoU (where the Mid-Term Seminar also serves as a major Review Milestone), as well as the participation of MC members to various international conferences. Another possibility to disseminate results is the organisation of some Management Committee Meetings as a parallel session to some national/international conferences.

D.2 Timetable

A timetable for the whole Action, including meetings/events, ongoing documentation, and key activities/milestones, is presented in the following.



E. Economic Dimension and Costs

E.1 Overall Economic Dimension

Basically, several Signatories of both COST 252 and COST 253 Actions (11 and 10 Signatories, respectively, in total), who have participated in the preparation of this MoU and/or have otherwise indicated their interest, can be considered as likely candidates to sign this MoU. The anticipated number of 10 Signatories to this MoU is based on the declared/expected interest of the following countries:

Belgium	France	Germany	Greece
Italy	Norway	Portugal	Slovenia
Spain	United Kingdom		

Currently, in addition the following countries are considered to potentially sign up the MoU:

Austria	Czech Republic	Hungary	Ireland
Poland	Switzerland		

The overall economic dimension of the complete Action is assessed based on the estimated total work effort spent as follows:

Contribution (in person-years PM) per Signatory per year:

$$\frac{1}{2} \text{ PY scientist} + 2 \times \frac{1}{2} \text{ PY student} = \mathbf{80\,000\ \text{€}}$$

Assuming 10 Signatories and 4 years duration, the total economic dimension amounts to

$$4 \times 10 \times 80\,000\ \text{€} = \mathbf{3.2\ \text{Million\ € / Action,}}$$

and the resulting average economic dimension of the Action per year is **800 000 € / year.**

No specific equipment has to be purchased for the Action, expecting that all participants will dispose of general purpose computer equipment.

Any departure from the assumed number of participating countries will change the overall cost accordingly.

E.2 Draft Calculation of Financing from COST Budget

	Costs	Comment
(a) Travel expenses and daily allowance for Delegates to MCMs		
Travel expenses per MCM	$10 \times 1.5 \times 600 \text{ €} = 9\,000 \text{ €}$	10 Signatories; 1.5 Deleg. per Sign. per MCM in the average; 3 days per MCM (incl. travelling)
Daily allowance per MCM	$10 \times 1.5 \times 3 \times 120 \text{ €} = 5\,400 \text{ €}$	
Sub-total per MCM	$9\,000 \text{ €} + 5\,400 \text{ €} = 14\,400 \text{ €}$	
Sum (a)	$11 \times 14\,400 \text{ €} = 158\,400 \text{ €}$	11 MCMs / 4 years according to timetable
Average per year (a)	39 600 €	
(b) Operating and running costs		
Seminar organisation (including proceedings public.)	$2 \times 3\,000 \text{ €} = 6\,000 \text{ €}$	2 seminars (mid-term and final); 1 invited speaker per seminar
Invited speakers	$2 \times 1\,000 \text{ €} = 2\,000 \text{ €}$	
Short term scientific missions	$4 \times 6 \times 1\,500 \text{ €} = 36\,000 \text{ €}$	6 missions per year; 4 years
Secretariat (including overhead)	$4 \times 14\,000 \text{ €} = 56\,000 \text{ €}$	
Sum (b)	100 000 €	
Average per year (b)	25 000 €	
Total costs		
Sum (a) + (b)	258 400 €	
Average per year (a) + (b)	64 400 €	

In summary, the estimated COST financing share with respect to the economic dimension is roughly 8%.

Annex A

List of contributors to the preparation of the MoU

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