Brussels, 19 June 1998 (OR.en)

COST 250/98

Memorandum of Understanding

for the implementation of a European Concerted Research Action designated as COST Action 262

"Spread Spectrum Systems and Techniques in Wireless and Wired Communications"

The Signatories to 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 document COST 400/94 "Rules and Procedures for Implementing COST Actions", the contents of which are fully known to the Signatories.

2. The main objective of the Action is to increase the knowledge of spread spectrum techniques and applications for any wireless and wired system and to propose common products and methods for a variety of possible applications. This will be achieved by the establishment of a "Forum on Spread Spectrum" systems. To this end a cooperative effort involving universities as well as telecommunication R&D establishments and industries is required.

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 ECU 25 million at 1997 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 4 years, unless the duration of the Action is modified according to the provisions of Chapter 6 of the document referred to in point 1.

COST ACTION 262

Spread Spectrum Systems and Techniques in Wireless and Wired Communications

A. BACKGROUND

Today spread spectrum is a mature technology referring to various techniques such as modulation, coding, synchronisation and acquisition methods. It refers to wired as well as wireless communications and is a very promising method for multiuser environments. The inherent advantages of these techniques is to compensate for interference and fading in wireless environments present these systems with a challenging technique for wireless applications. Although in the past spread spectrum was used for military communications, recently a number of commercial applications have attracted considerable attention, especially since 1985, from low-speed fire safety devices to high-speed LANs. All the methods of implementation of a Spread Spectrum System are used today, that is, DSSS (Direct Sequence Spread Spectrum), FHSS (Frequency Hopping Spread Spectrum) as well as hybrid techniques. Of great importance is a special method for multiple access, the CDMA (Code Division Multiple Access) method.

The first direct sequence Spread Spectrum Systems were built during the 1950s. As designers developed means for storing pseudo-random sequences and solving the synchronisation problems associated with detecting the pseudo-random carriers, the concept of asynchronous code division multiplexing on the air waves by independently operating radios was explored with these systems. Magnavox used spread spectrum techniques in their satellite communications radios developed in the 1960s. A comparison of multiple-access techniques, including FDMA, TDMA, SSMA and pulse addressing (PAMA) is given for the hard-limiting satellite repeater in 1966 at a publication of J.W. Schwartz et al and maybe it is the first open-literature use of these terms.

Several spread spectrum studies and development efforts during the late 1970s and early 1980s are notable. Among them, Hewlett-Packard developed an indoor wireless terminal communication system but did not pursue it as a commercial product. The first widespread commercial use of spread spectrum techniques was in small satellite earth stations in 1981 by Equatorial Communications Company in USA. Interim Standard 95(IS-95) was adopted by TIA in 1993, specifying the spread spectrum modulation formats and protocols for communication between a cell's base station and mobile telephone. The first CDMA cellular base station employing Qualcomm's CDMA design went into operational trials in Seattle in January 1994. Satellite networks will soon break into the forthcoming wave of personal communications. Two companies have already proposed CDMA techniques with IS-95 standard. FCC released 140MHz (1.85-1.99GHz) in 1993 for use in personal communications systems. Future cellular and personal communications services are considering CDMA as an alternative to TDMA/FDMA to increase system capacity, provide a more reliable service and provide soft handoff of cellular connection. In wireless LANs, the technology is used primarily because the first bands available for high-speed data communications were designated for spread spectrum transmission.

Ease of management, fast establishment of communication, reliability, flexibility, low weight and low cost are all important factors influencing the success of Spread Spectrum Systems.

As wireless systems are evolving towards an integrated global network, an in-depth study of these systems is increasingly under discussion based on the necessity that generic techniques, functions and devices of spread spectrum applications must be clearly defined. Wireless LANs, mobile nets, wireless optical networks, etc. must be at a high level, compatible and consistent. Other applications, such as consumer electronics (fire control, in-factory data carrier), broadcasting, can be incorporated into generic structures and concepts.

Furthermore, spread spectrum applications have also been reported for wired communications such as the use of power lines for communications purposes. Power lines are similar to fading channels when used in high frequencies, and spread spectrum has been adopted to solve this problem.

Several COST projects are dealing with spread spectrum systems but mainly for land and satellite mobile communications. COST Actions 227 and 231 had studied in brief these systems. Also, their continuing Actions 252 and 259 cover Spread Spectrum Systems in the research areas referring to radio aspect studies. COST Action 253 studies this technique for fixed high-speed connections through satellites. In parallel, ACTS projects like MONET and SAINT make an attempt to investigate and implement these techniques, always in a mobile communications content. Other relevant projects are RAINBOW, FRAMES, WAND, SECOMS/ABATE, COST Action 248, SINUS, TSUNANMI, etc. In CODIT (RACE) a multirate DS-CDMA has been proposed. Also some COST Actions dealing with broadband communications or fibre optics as COST Action 240 or COST Action 242 or ACTS ISIS, BIDS, TOMAS may refer to relevant applications.

However, an Action concentrating on the very broad possible range of spread spectrum applications is entirely absent from the list of COST as well as ACTS projects. Such an Action can be complementary to the COST and ACTS projects referred to above, and it can support very much the future European market of these projects and the standardisation efforts currently carried out. Special cooperation is anticipated with COST Action 244 bis since spread spectrum techniques look to be very promising concerning biomedical effects on human bodies. The proposed Action will enrich cooperation between European States while maintaining and advancing expertise in the field. Of course, coordination will be maintained with the referred COST activities. Input will be provided to those projects as appropriate, to decrease the risk of overlapping. Input from completed Actions will be considered as a basis for the proposed COST Action. The proposed Action is expected to be used as a common pool of reference on any possible application and product of Spread Spectrum Systems to any interested party.

The proposal is considered appropriate for the spirit of COST Actions, which is an open and flexible framework for R&D projects in ACTS. In this way, the complementarity of COST and ACTS is confirmed. The Action requires long-term multidisciplinary efforts, a harmonisation of European and national research activities and a strong orientation to basic research. The pan-European coordination of scientific efforts will result in a clear added value to any national research and in reliable market products enforcing European penetration in the production of spread spectrum devices.

B. OBJECTIVES AND BENEFITS

The main objective of the Action is to increase the knowledge of spread spectrum techniques and applications for any wireless and wired system and to propose common products and methods for a variety of possible applications. Research will be carried out in two phases:

(i) a mid-term activity of one year focused on the thorough investigation of any spread spectrum application, a classification and registration of common features and differences. A tutorial on existing techniques and standards will be given as a result of this activity;

(ii) a longer-term activity of two years dealing with the extended analysis of integrated tools for wireless and wired communications, terrestrial and satellite, in close cooperation with many projects running in this field.

Benefits expected are:

– support of industrial competitiveness, SMEs and consumers;

– basic and applied R&D for Spread Spectrum Systems and devices;

– an integrated concept of any possible spread spectrum application;

– guidelines for integrated design and implementation of future spread spectrum networks;

– European collaboration on a field which is very prosperous for the market in the near future. In the USA such applications already exist but Europe lags behind somewhat on such products;

– technical specifications and standards for, to the extent possible, integrated products. The support of standardisation bodies from a large Community of researchers would provide further stimulations of the spread spectrum European market growth, taking into account the population needs.

C. TECHNICAL PROGRAMME

C.1. Research and Development Activities

The technical content of the Action will be specified in detail at the usual Management Committee meetings and through special meetings or workshops of the Working Groups. Researchers from universities, engineers from companies or research bodies are expected to work in close cooperation with mutual and continuous exchange of information. The mode of working will cover both extended basic research on Spread Spectrum Systems as well as proposal for applications tools. The technical content can be classified into four general Working Groups:

WG1: Channel Modelling: In this working area several sub-tasks can be addressed as:

– channel modelling through measurements or analysis at different frequency bands and for different wireless and wired applications. It is possible to design and operate a Spread Spectrum System in different frequency bands, subject to antenna size constraints, modem specifications and international/domestic radio frequency regulation. For example, L band has been as now of most interest for commercial mobile communications and the channel model used is a frequency-flat fading one. Differences between terrestrial and satellite channels as Rice or Rayleigh effects, order of spread (ms, ns), power control techniques, delay issues must be studied in depth;

– coding, equalization, interleaving at various data rates and for various media transmission (wireless, fibres, power lines, ...). The Spread Spectrum Systems have been classified by their architecture and modulation concepts. The most commonly employed spread spectrum modulation schemes are:

  * Direct-Sequence Spread-Spectrum (DS-SS) including CDMA
  * Frequency-Hopping (FH) including Slow-Frequency-Hopping (SFH)
  * CDMA and Fast-Frequency-Hopping (FFH) systems
  * Carrier Sense Multiple Access (CSMA) spread spectrum
  * Time Hopping (TH)
  * Chirp
  * Hybrid spread spectrum methods.

An appropriate coding technique must be checked and applied to any application. For example, for satellite mobile communications there are proposals for using GEO, MEO, LEO systems and LEOs are considered to be based on CDMA mainly.

WG2: Network Aspects: The cost effective and optimal structure of a network in order to exchange voice, video or data is a very important option. Simulation techniques will play a very important role in support of these problems. Two sub-tasks are considered, namely:

– Existing and new network configurations, channel allocation.

  Definition of parameters needed for planning, network optimisation algorithms by minimising interference. Development of a systematic prototype (software) tool for network planning capable of coping with the various network and environment situations. Any possible configuration is under investigation, that is terrestrial, satellite networks, LANs, energy supply networks, TV broadcasting or general consumer applications. Special features will be pointed out. For example, wireless optical networks which are sensitive to shadowing and covering usually suffer to some extent from blind corners, so we must instal passive/active reflectors. Since IR signals do not penetrate walls, these systems provide a considerable degree of privacy and adjacent cells need not use different frequencies.

– Spectrum efficiency, protocols for high and low data rates. The efficiency of CDMA or hybrid CDMA techniques is exemplified in the capacity of the analog AMPS standard cellular system in Los Angeles, which is about 500 000 customers and may theoretically be increased to between 5 and 10 million customers by the use of CDMA or combined TDMA without using any new spectrum. At all events, spectrum efficiency depends on the type of technology employed, the services offered and the usage demands made on the system.

The ease of implementation of new services and especially multimedia applications will be examined thoroughly. Protocols for the specific transmission channel (wireless, fibre, ...) will be proposed.

WG3: Components

The main points of investigation are:

– Receivers/modems and synchronisation techniques
– Macro and micro diversity techniques
– Intelligent antenna structures
– Biomedical effects.

For DSSS systems of great importance is the implementation of receiver. Three architectures are generally used: (a) the post-demodulator correlator receiver, (b) pre-demodulation despreading receiver, and (c) the post-detection correlation technique. A pulse-shaping filter is also used. For coherent detection, three types of synchronisation are necessary, for carrier recovery, bit timing recovery and pseudonoise synchronisers.

For the FHSS systems (or fast FHSS) time recovery, code acquisition and code tracking control is needed. Another point of interest is the power control for CDMA as well as the sectorisation of antennas and orthogonal coding.

The progress in electronics must be tightly followed, since new equipment concepts are made possible by the revolutionary semiconductor chip products.

WG4: Standards

Several concepts have been developed for personal communications, such as hybrid CDMA/ISMA, CDMA/OFDM, multirate CDMA, etc. Two digital standards are at present in place in the USA and they are incompatible with each other. The third standard, broadband CDMA, has many advantages over narrowband CDMA and TDMA (6-10 times the capacity of TDMA, 3 times the capacity of narrowband CDMA, needs less power, supports higher quality voice, ...).

Bodies dealing with standards as EIA (IS-95) or IEEE 802.11 committee (spread spectrum CSMA standards), ANSI, ITU will be accessed by this Working Group.

It is necessary to support standardisation efforts to facilitate the introduction of spread spectrum products into the European and national markets.

Of great importance are:

- A general interface standard for spread spectrum applications, at least a limited number of interfaces for wired and wireless applications.

- A standard recommended system architecture for these new access technologies.

The fear is that, without uniform standards for equipment and software, future networks will be unable to work with each other.

Standardisation must be based on user needs and be shifted from a single standard to sophisticated standards. The future of the standards process will be more a reflection of the market place needs of the customers and less of the specific desires of the operator.

C.2. Technical visits and workshops

The scientific results of the Action should be presented at annual workshops and at a final workshop open to all interested parties. A WWW site will be organised for widespread dissemination of the outputs of the Action. Technical workshops as well as scientific conferences are foreseen since the Action is oriented both to basic research and application work. Close cooperation with relevant international conferences (i.e. ISSSTA) will be attempted.

Technical visits like short-term missions (STM) will be scheduled according to the COST rules to research institutions or companies. A special committee will be agreed from the members of the MC to manage the technical visits.

C.3. Final report

Annual reports will be prepared and presented to the chairpersons' meeting of the TCT in June every year.

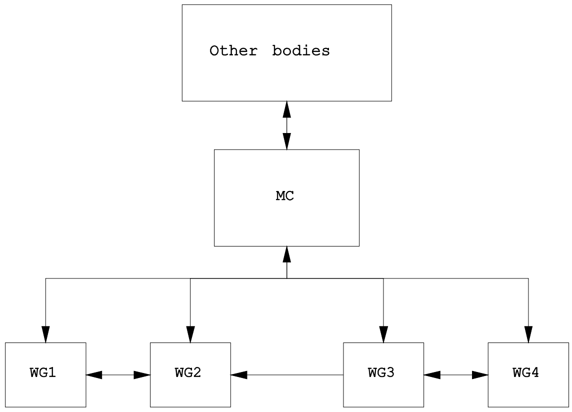
The final results will be published as a book and an on-line database manual to offer a reference manual of up-to-date information on Spread Spectrum Systems and services. The structure of the final report will be studied in depth in order to be a really friendly and useful manual for people with different levels of knowledge on Spread Spectrum Systems. The chairperson will be responsible for this activity.

D. ORGANISATION AND TIMETABLE

D.1. Organisation, management and responsibilities

The activities described above will rely on close cooperation of the members of the Working Groups focusing their efforts on specific tasks and sub-tasks. Management Committee meetings will take place 2-3 times per year, to assess results and to specify future work. Working Group meetings, seminars and workshops will be organised when needed. The Management Committee, in concertation with the COST Telecommunications Secretariat, will ensure efficient contacts with other relevant COST Actions. Delegates of the signatories are expected to actively contribute to meetings, to take responsibility for specific items of the Action and to contribute to establishing liaisons with other projects.

The work will be split into four groups and there will be a person responsible for each group (figure 1). The Management Committee will elect a Chairperson and Vice-Chairperson and will be responsible for the interactions with other European or international bodies, as well as with projects, institutions, visits to laboratories, etc.



D.2. Timetable

The duration of the proposed Action is four years. The first year will be devoted to the investigation of existing applications and their classifications while the three other years will result in guidelines for common standards and products of spread spectrum tools. A bar chart is attached indicating the related expected results.

E. ECONOMIC DIMENSION

Estimated number of signatories (on the basis of the expressed interest): 12 countries

Cost per signatory per year:

1 person/year: Engineer, Researcher	ECU 100 000
1 person/year: Technician	ECU 60 000
2 persons/year: PhD, Student, Secretary	ECU 60 000
Equipment and material costs	
Travel	ECU 20 000
Total per signatory per year	ECU 240 000

Economic dimension:

Total over 4 years for all signatories (240 x 4 x 12)	
+ 10% overhead for running/operational costs	ECU 12 672 000
Total cost to national funds	ECU 12 672 000
EU overhead (over 4 years) (75 000 x 4) KECU	ECU 300 000
Economic dimension:	ECU 25 644 000

TIMETABLE

Task / Year	1	2	3	4
1: Channel modelling	Hybrid access schemes		Specifications for common interfaces	
		Channel modelling, propagation measures		
		Interface, power control, near-far		
2: Network aspects	Different architectures Common services Level of integration			
	Spectrum of management, protocols			
		Simulation management tools		
3: Components	Receivers, level of integration			
		Diversity antennas		
	Coding, interleaving, synchronisation			
			Prototype terminal	
			Booklet, on-line manual	
4: Standards	Existing standards	Generic interface recommendation		

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