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HDTV coverage of the Barcelona Olympic Games

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1. General

There was a feeling before the Games that the largest ever European HDTV broadcast was going to take place during the 1992 Summer Olympic Games in Barcelona. We now know that the operation went beyond the European dimension. In fact, it was the world's most ambitious HDTV coverage ever.

The entire broadcast operation was managed by Spain's joint venture *Barcelona 1250*. This association consisted of *RTO'92* (the Olympic host broadcaster), Radiotelevisión Española (RTVE), Retevisión and PESA. It was created with the sole purpose of covering the Summer Olympic Games using the European HDTV system. The technical facilities were mainly provided by Vision 1250, with the financial support of the European Community.

Although *Barcelona 1250* was set up in December 1991, its activity did not begin until May 1992 when an agreement was signed with Vision 1250 for coverage of the Games. The real launch of the operation did not take place until 1st July, when the budget was finally approved by Vision 1250. The total budget amounted to 12.6 MEcus.

The world's major sporting events have for many years played an important rôle in increasing public awareness of new or improved television broadcasting systems. Although HDTV cameras had been present at previous events, the 1992 Winter and Summer Olympic Games were the first at which comprehensive coverage was attempted in HDTV.

In Barcelona, for the 1992 Summer Games, European broadcasters and industry pooled their resources under the "Barcelona 1250" banner to provide over 225 hours of Olympic programming, with commentary in six languages. Over 40 HDTV cameras and their support systems were deployed, and the exercise involved over 300 production and technical staff.

Facilities were provided at nearly 700 "Eurosites" in towns and cities throughout Europe, allowing large numbers of viewers to watch the sports - and to begin to get used to HD-MAC picture quality and the 16:9 aspect ratio.

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RTO'92 was responsible for the management, logistic support and coordination of the whole operation. RTVE was charged with the planning and lay-out of the technical facilities, provision of qualified personnel and the whole engineering responsibility. Retevisión, the Spanish transmission authority, was entrusted the contribution links from the venues, the operation of the HD-MAC encoders and the planning and operation of the transmission facilities. Finally, PESA was in charge of the installation of the technical facilities (video and audio cabling, power supply, etc.) and the supply and operation of four character generators.

Over 300 production and technical staff were involved in the broadcast operation. These people were drawn from all over Europe, and in particular from the Barcelona 1250 members, RAI (Italy), Thames Television and the BBC (UK), SFP (France), DR/SVT/YLE/NRK (Scandinavia), SWF (Germany) and COM4 (Spain).

2. Production planning

A programme schedule of 235 hours 55 minutes was to be broadcast during the 16 days of the Games, that is to say an average of almost 15 hours a day. However, the control of technical quality imposed by Barcelona 1250 prevented some of the planned programmes being broadcast and, for other reasons, field hockey was not covered at all. The actual broadcast time was therefore a little less than initially expected with a total of 225 hours 45 minutes. In addition to the broadcast programmes, a substantial amount of recorded material was archived.

18 different sports in 17 venues, as well as the opening and closing ceremonies, were covered with a total of 40 cameras. Events from five venues were covered live and the sports from the rest of the venues were recorded. Live programmes accounted for some 80% of the total broadcast time. The breaks in the schedule were filled by the replay of recorded events, programme information and topical reports.

The venues linked by fibre optical circuits to the International Broadcasting Centre (IBC) were the *Estadi Olímpic*, the main venue, where the opening and closing ceremonies and the athletics competitions took place, the *Palau Sant Jordi* which was the main venue for the indoor competitions, *Piscines Picornell* for the swimming events, and

the *Palau d'Esports de Badalona*, 10.5 km from the IBC, for the basketball.

Two BTS OB vans (OB 3 and OB 5) with a total of eight cameras covered the events at the *Estadi Olímpic*, while a six-camera BTS OB van (OB 2) covered the gymnastics, handball and volleyball (finals) in the *Palau Sant Jordi*. Slow-motion vans were available for both venues. The six-camera Thomson (Ex-Camera) OB van known as *L'Orque**, installed at *Piscines Picornell* covered the swimming, synchro-swimming and water-polo. One of the cameras of this OB van was installed at the *Torre Calatrava*, a landmark of the Olympics that provided remarkable "beauty shots" widely used in the programmes.

The basketball events were covered by the six-camera Thomson OB van *L'Epaulard* in the *Palau d'Esports de Badalona*, linked to the IBC by a 140-Mbit/s optical fibre circuit.

Two character generators were assigned to the main venues and another one was used on a time-shared basis by *L'Orque* and *L'Epaulard* OB vans.

The events that took place in the *Palau d'Esports de Barcelona*, close to the IBC (gymnastics, handball and volleyball) were covered with the three cameras of the Thomson (Ex-Camera) *Baleine Bleue* OB van installed in the IBC premises. A new camera was added to this coverage when the Thomson two camera *Le Rorqual* OB van finished its recording mission, and the second one was assigned to the studio.

Four OB vans were dedicated to mobile functions at various venues to record sports events. The RTVE van, equipped with three BTS cameras, covered football and tennis, a Thomson camera on board a helicopter recorded panoramic shots and the yachting and marathon competitions, a BTS two-camera OB van (OB 4) covered the equestrian events, and for judo, canoeing, fencing and cycling the one-camera *Baleineau* and the two camera *Le Rorqual* Thomson OB vans were used.

The simplified diagram of *Fig. 1* shows the interconnections and locations of the different technical facilities in the IBC as well as the mobile equipment.

* Thomson has "baptised" its HDTV vans with the names of whales: *L'Orque* and *L'Epaulard* (orc, or killer whale), *Baleineau* (whale-calf), *Rorqual* (fin-back whale), *Baleine bleu* (blue whale), *Le Cachalot* (sperm whale).

3. Technical facilities

Taking into account the venues linked by optical fibres to the IBC, the recording and editing requirements and the available technical facilities, it was decided to dedicate the various OB vans to well-defined functions although some degree of flexibility was allowed.

The IBC, located in the Barcelona Trade Fair Area, was mainly occupied by RTO'92 and the rights-holding World Broadcasters. The HDTV facilities had to be installed outdoors in three different areas of the IBC grounds. Some space was nonetheless available in the IBC building for the

HDTV studio and the off-tube commentary booths. Equipment which was not housed in OB vans or containers, as well as the offices, was installed in mobile cabins.

The BTS master control unit (MCU), housed in a container, the power generators and four OB vans were installed in one of these areas. The Ex-Camera (Thomson) OB vans *Baleine Bleue* and *Le Cachalot* had as their main functions recording and editing the broadcast programme in digital form. As mentioned earlier, the first van was also used for the production of live programmes from the nearby *Palau d'Esports de Barcelona*; it also handled the studio camera.

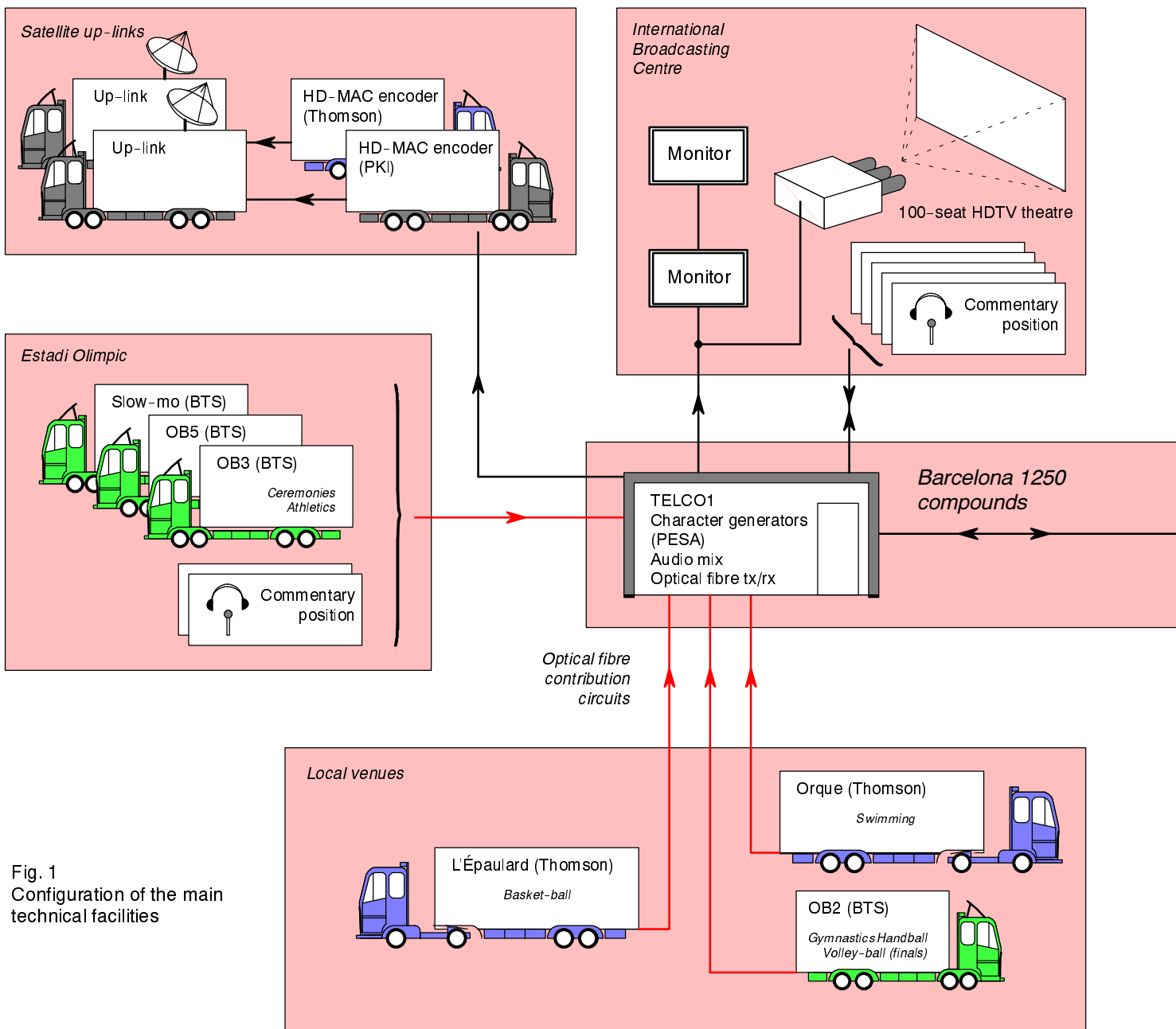


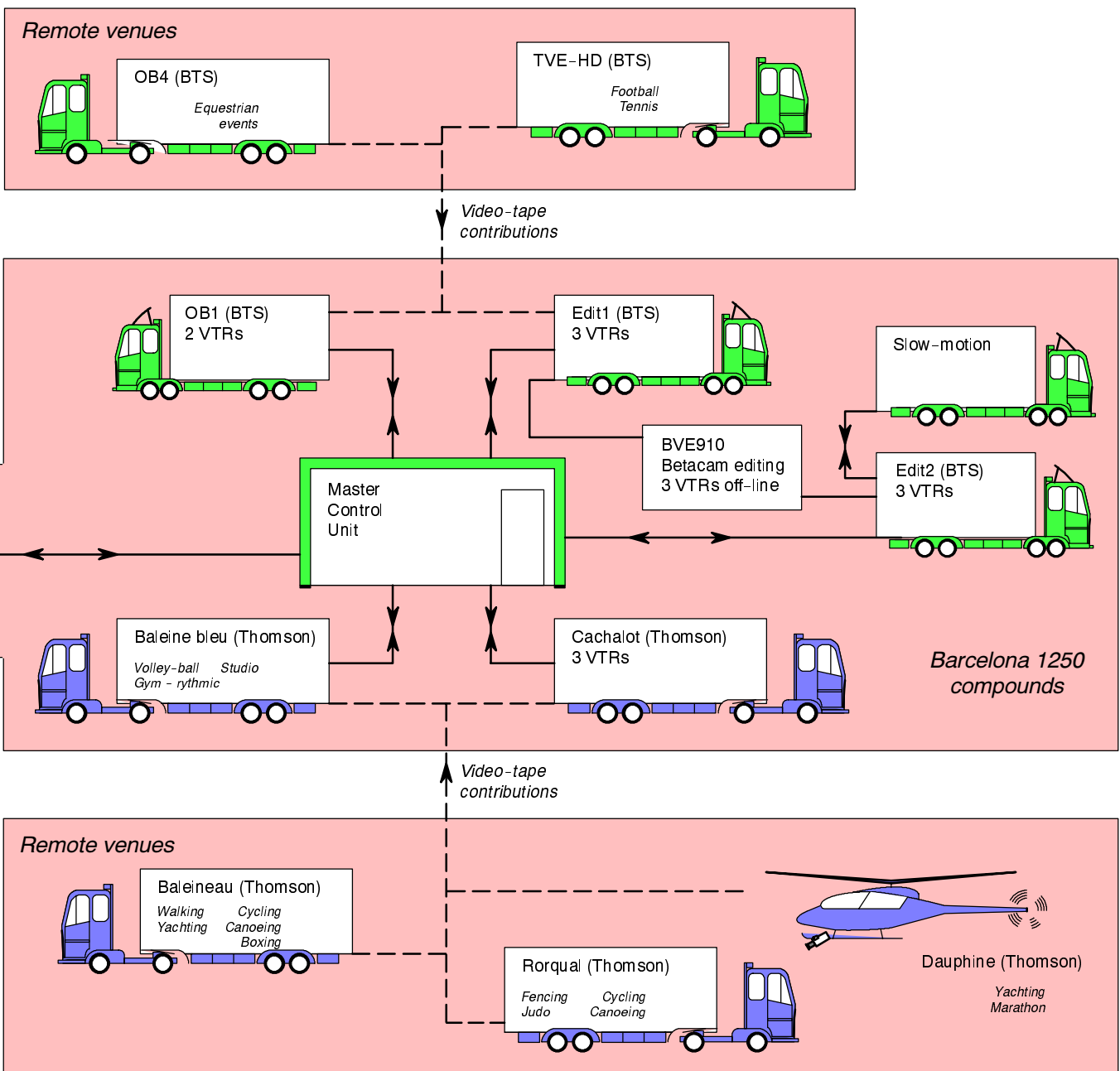
Fig. 1 Configuration of the main technical facilities

The BTS OB van 1 and the OB edit unit 1 recorded and edited the signals from the venues in analogue form. In a separate area, linked by optical fibre circuits to the MCU area, the BTS OB Edit 2 and slow-motion unit 3 edited the tapes recorded in analogue format.

Next to the MCU area, in IBC Pavilion 2, a 50 m² studio with auxiliary services was implemented together with five off-tube commentators' positions equipped with standard commentator units, HDTV monitors, 625-line television receivers connected to the RTO cable network and com-

mentary information system (CIS) terminals. The CIS was an innovative data-base developed for the Barcelona Olympic Games. It consists of a monitor with a touch-sensitive screen and options that included start lists, summaries, statistics, records and biographies.

The MCU received un-synchronized signals from the four venues linked to the MCU by optical fibres. They were incorporated into the programme via the MCU synchronizers. Additional inputs were the synchronized signals from the OB vans located at the IBC and from the character



HDTV

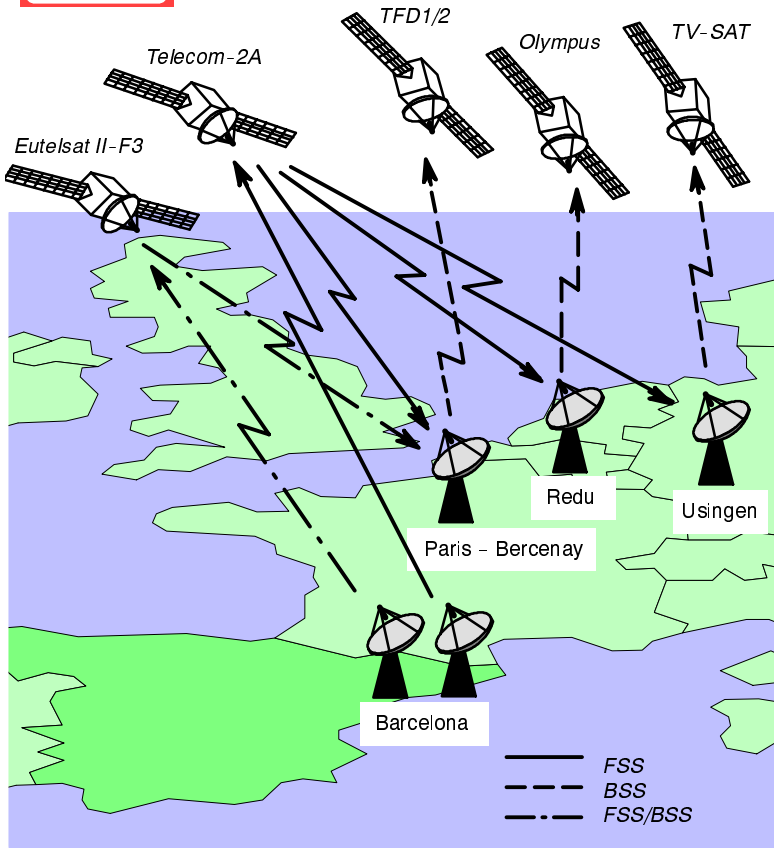


Figure 2
Satellite links

generator. The MCU could handle two different programmes and had two additional outputs, one for recorded programmes and the second to feed the HDTV monitors installed at the IBC. A down-converter at the MCU was used to convert the HDTV signals into 625-line PAL for distribution through the cable system.

The fibre optics equipment (Telco 1), character generator and systems for the control of international and commentary sounds were installed in a cabin. Additional cabins for the Barcelona

Table 1
Satellite HDTV parameters

	TDF 1/2	OLYMPUS	TV-SAT	TELECOM 2A	EUTELSAT II F3
Channel number	17	24	18	3	33
Centre frequency	12.033	12.168	12.054	12.600	11.596
Bandwidth (MHz)	27	27	27	36	30
Deviation (MHz/V)	13.5	13.5	13.5	22	16
Energy dispersal (MHz _{p-p})	0.60	0.60	0.60	2.0	1.0
Polarization	RHCP	LHCP	LHCP	Vertical	Horizontal
Orbital position	19° W	19° W	19° W	8° W	16° E

1250, Vision 1250, Thomson and BTS offices completed the installations in the MCU compound. A separate area was reserved for the transmission and encoding facilities. These comprised two transportable transmitting earth stations, the PKI and Thomson HD-MAC encoders, and a cabin housing the optical fibre terminals, digital codecs and monitoring facilities.

4. Satellite links

As the Spanish satellite Hispasat was not operational in time for the Olympic Games, the only BSS satellites available to cover Europe were TDF 1/2, TV-SAT and Olympus, however none of these could be up-linked from Spain. Therefore, two satellite hops were needed and as an intermediate link, transponder 33 (36 MHz, Superbeam, 52 dBW EIRP) of Eutelsat II-F3 was chosen.

A Retevisión earth station transmitted the signals originated in Barcelona via Eutelsat to the BSS satellite up-link earth stations at Paris-Bercenay (France), Usingen (Germany) and Redu (Belgium). After considering several back-up alternatives, Barcelona 1250 decided, in close contact with the Eureka Support Group, to use transponder 3 of the Telecom 2A satellite together with a France Telecom transportable earth station. In fact, owing to the sound configuration adopted for the opening and closing ceremonies, the Telecom 2A path became the main link for TDF 1/2 and TV-SAT, while Eutelsat II-F3, besides feeding Olympus, assured coverage of continental Spain and Portugal. However, the northern part of Spain, including Madrid, was covered with TDF 1/2. Although the drift of Olympus resulted in severe pointing losses, channel 24 was used to cover Italy with satisfactory results.



BTS camera covering the tennis competition



Retevisión up-link earth station and Thomson HD-MAC encoder van



BTS camera at the Estadi Olímpic

Barcelona 1250



Inside the Master Control Unit



The choice of the HD-MAC transmission parameters, particularly the FM deviation, was a matter of some concern. The value of 16 MHz/V, which was compatible with the existing HD-MAC receivers, was adopted after the test transmission carried out a few hours before the first scheduled programme. The standard value of deviation on FSS satellites, 22 MHz/V, was maintained for Telecom 2A.

Fig. 2 shows the satellite links and transmission parameters. FSS/BSS means the hybrid parameters adopted for Eutelsat II-FS. Table 1 shows the transmission parameters and satellite characteristics. The performance of HD-MAC with different FM transmission parameters was very good.

Besides the HD-MAC transmissions, digital techniques based on Eureka 256 codecs were implemented for different purposes. Retevisión established a 70-Mbit/s radio link between Barcelona and Seville to feed, as an alternative, the fifty HDTV receivers installed in several pavilions of the Expo 92. Transmission at 45 Mbit/s via transponder 46 (36 MHz, Widebeam, 43.6 dBW EIRP) of Eutelsat II F3 made it possible to feed two reception points in the Canary Islands. The 45

Mbit/s signals were also received in Barcelona, Madrid, Seville and Rome. In France, the 45 Mbit/s signals were decoded and re-coded in D2-MAC for distribution by France Telecom.

5. Sound configurations

In addition to the international sound, it was agreed to transmit commentary sound in five languages: German, Spanish, French, English and Italian. Two HD-MAC encoders were available, one provided by PKI and the other by Thomson, and it was also decided to use them on alternate days, one of them for transmission and the other for back-up.

As the system capacity allowed only six monophonic audio channels or one stereo sound and four mono channels, it was necessary to disregard the stereo option during coverage of the sports events. However it was decided that stereo was necessary to appreciate fully the musical content of the opening and closing ceremonies. A configuration was adopted for the transmission of these ceremonies in which the two encoders were used simultaneously, each one fed with stereo international sound and commentary sounds in Spanish, French and English plus Italian in the PKI encoder and German in the Thomson encoder. This configuration decreased the flexibility of the system and the back-up possibilities in those particular transmissions.

In Fig. 3 the configurations for the sports events and for the opening and closing ceremonies are shown. Stereo sound is of course an important feature of the HD-MAC system, but the decision to give priority to the back-up possibilities proved to be correct. The use of stereo sound with half-bandwidth (7.5 kHz) was also considered but this would not have been suitable for some receivers.

6. On-screen text and graphics

The coverage of the Summer Olympic Games featured, for the first time in the world, on-screen text and graphics in full-screen HDTV. The equipment was developed and delivered by the PESA company to meet the requirements of Barcelona 1250. PESA is a member of the Eureka 95 Spanish consortium. It recently joined Vision 1250 and, as mentioned earlier, was one the partners of Barcelona 1250.

The design was based on the up-grading of the company's well known 525/625 INFINIT charac-

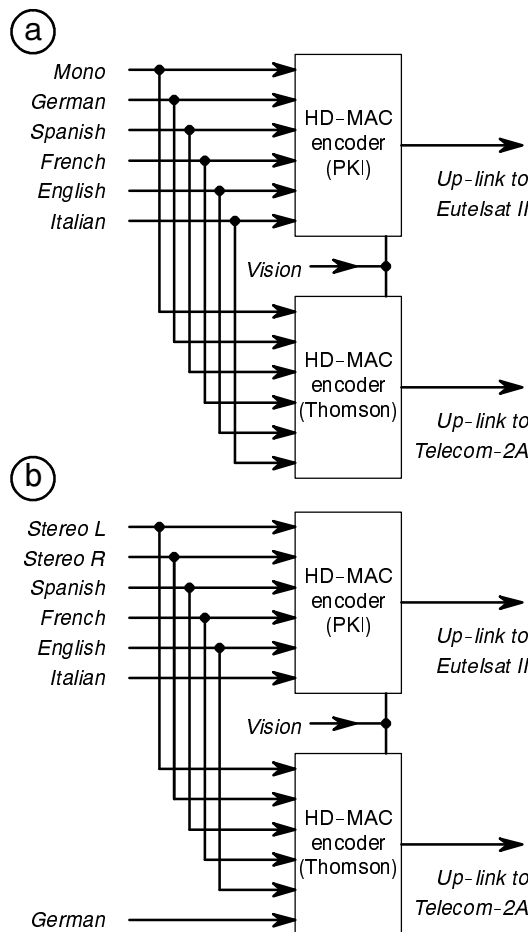


Figure 3
Sound configurations
a) Sports events
b) Opening and closing ceremonies

ter generator. The main jobs were redesigning the video input/output and the frame buffer boards as well as adapting the software. The HDTV character generator had to be connected to the IBM token ring network for the sport results, but the software was only suitable for the protocol of conventional character generators. It was decided to use a portable personal computer (PC) and develop a special programme to solve this interface problem.

Another important task carried out by PESA was the transfer to HDTV of all the graphic information collected by RTO'92 for conventional television. The flags, sports logos and other symbols were up-converted with no horizontal distortion. Some 200 flags, in two different sizes, 32 logos and 100 symbols were created. More than 50 different background elements (truncated ellipses) were up-converted by software with horizontal distortion and finally some 1000 chart templates

A Thomson camera taking "beauty shots" from the Torre Calatrava

Barcelona 1250

One of 6 Thomson cameras covering swimming events at the Piscines Picornell

were manually created, on the basis of the corresponding 625-line screens, to show the results of the different competitions.

In some sports (tennis, football, basketball etc.) the character generator was not connected to the IBM token ring. In these cases it was used as an autonomous unit and the operator had to select a suitable screen and enter the scores. A PC programme was designed for this application. The conventional television timing signals were used for HDTV, directly in the Thomson equipment and up-converted in the BTS equipment.

7. Conclusions

The immediate post-Games feeling was that the overall quality of the HD-MAC transmissions had been better, and more consistent, during the 16 days of the Games than in previous demonstrations. This view has to be confirmed when the relevant EBU Groups analyze the quality reports that have been sent to Barcelona 1250 and evaluate the recorded signals that have been collected by several EBU Members and Barcelona 1250.

Nearly 700 viewing sites were installed all over Europe using equipment supplied by the European manufacturers Philips, Thomson, Nokia and Seleco. In a meeting of the Eurosites Group held in Barcelona a few days before the beginning of the Games it was agreed that any technical prob-

lems observed in the sites during the transmissions would be reported to Barcelona 1250. Apparently the problems, if any, were not worth reporting. However, the failure of a fibre optical circuit prevented the transmission of the international sound at the beginning of the opening ceremony.

In the period just before the Games, or while they were under way, Barcelona hosted three other meetings related to HDTV: the Eureka Advisory Board, the HDMAGIC/T Group and the Eureka 95 Directorate. The participants had the opportunity to get first-hand information about the preparations or visit the HDTV facilities in operation. In the framework of Vision 1250, the main suppliers of the HDTV equipment were BTS and Thomson. It is well known that the two manufacturers have developed their products based on different approaches, but this was not an obstacle to the great success of the operation which ran smoothly and was practically fault-free. European HDTV has proved its technical viability and is now ready for a new operational phase.

The unprecedented success of the HDTV coverage of the Summer Olympic Games shows what can be achieved when broadcasters, equipment manufacturers, satellite and telecommunication operators and European organizations work together in close cooperation in a well-defined and ambitious European project.

Manolo Romero studied telecommunications engineering at Madrid University and joined Spanish Television in 1965 where he held a number of engineering posts. He has been involved with EBU television coverage of every series of Olympic Games since the Mexico Games in 1968. In 1982 he headed the host broadcaster operations for the World Football Cup in Spain and in 1984 was responsible with ABC for international operations at the Summer Olympic Games in Los Angeles.

Since 1985 Mr. Romero has been Head of EBU Sports Operations. From 1988 to 1992 he was Director of RTO '92, the host broadcasting organization for the Olympic Games in Barcelona and in this capacity he was Managing Director of Barcelona 1250 which covered the Games in HDTV. Mr. Romero is now Executive Vice-President of the Atlanta Committee for the Olympic Games, in charge of broadcasting operations for the 1996 Olympics; he is also responsible for EBU Sports International, the company set up by the EBU to perform the tasks of host broadcaster for the 1994 World Football Cup in the USA.

Mr. Romero is a consultant to the Radio and Television Commission of the International Olympic Committee.

Eduardo Gavilán took his doctorate in Telecommunication Engineering at the University of Madrid and received his Master of Science degree in Electronic Engineering at Stanford University (California).

Mr. Gavilán was Vice-Chairman of the EBU Technical Committee for 14 years and Director of Engineering at RTVE. He is now Chairman of the Technical Committee of Organización de Televisión Iberoamericana (OTI) and Director of International Relations for Technical Affairs at RTVE.

During the Summer Olympic Games he was the Director for External Relations for Barcelona 1250.