



# Broadcasting Networks: a report from the Olympic Winter Games

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# The XX Olympic Winter Games

- ✓ Where / When :

Torino (Italy), 10<sup>th</sup>- 26<sup>th</sup> February, 2006

- ✓ The event offered the most technologically advanced coverage of any previous Olympic Games : they were the first games entirely shot in **HDTV** by the **Torino Olympic Broadcasting Organisation** (TOBO) using 400 HD cameras





# Trials

✓ Rai launched experimental transmissions of **HDTV** and **Mobile-TV**, covering the Torino area and some of the Olympic mountain sites

✓ Technologies

- ➡ HDTV (1080i/25)
- ➡ MPEG-4/AVC
- ➡ DVB-H
- ➡ DTT hierarchical modulation
  - optimal exploitation of the UHF terrestrial channel to guarantee different robustness for different services



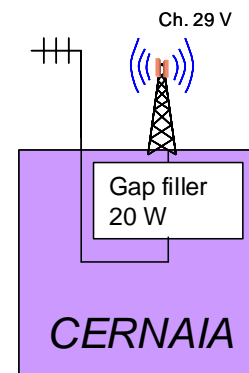
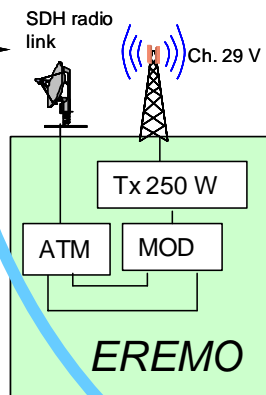
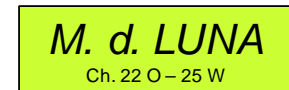
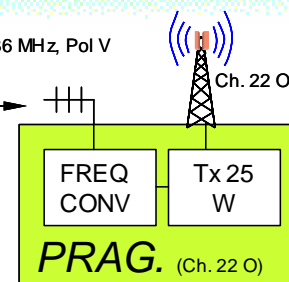
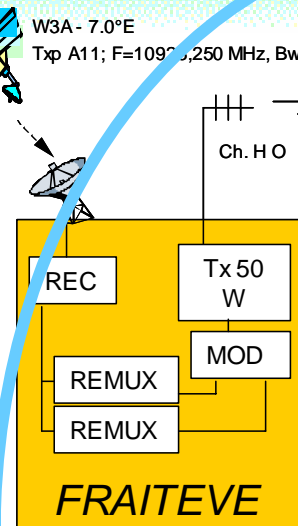
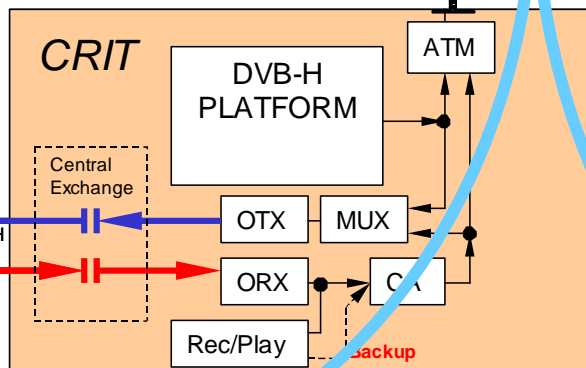
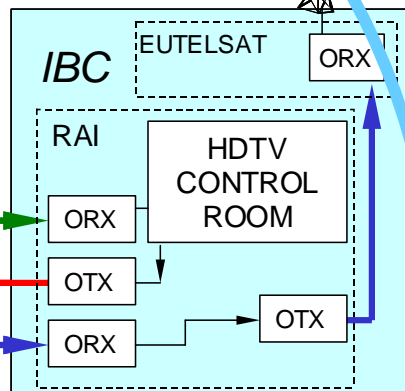
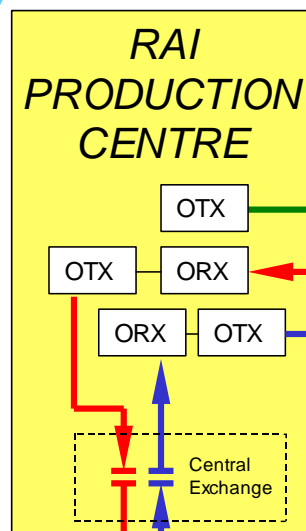
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- The map illustrates the geographical context of the Torino 2006 Winter Olympic Games. It shows the Italian Alps, the city of Torino, and the surrounding regions of Piemonte and Valle d'Aosta. The map includes the location of the Torino 2006 Winter Olympic Games, the Torino 2006 Winter Olympic Village, and the Torino 2006 Winter Olympic rings. The map is titled 'ITALIA' and 'Piemonte'.



# Trials' architecture

## Generation

### Torino



### Mountain sites

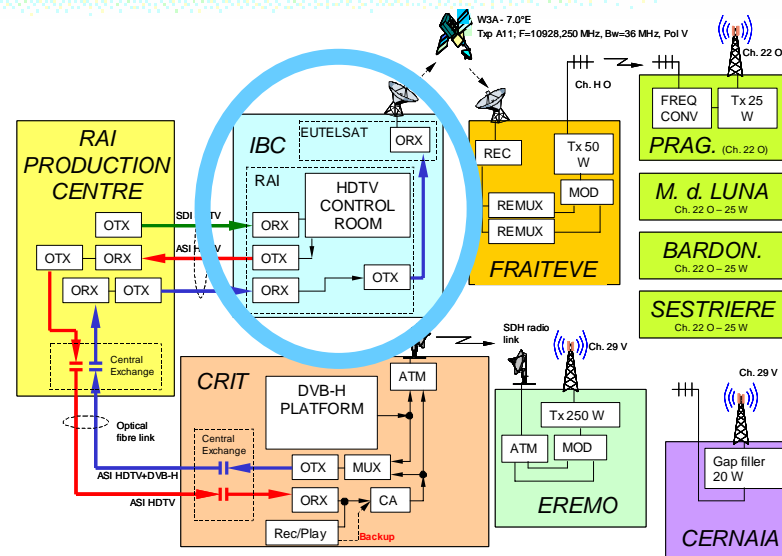
## Broadcasting

### Torino



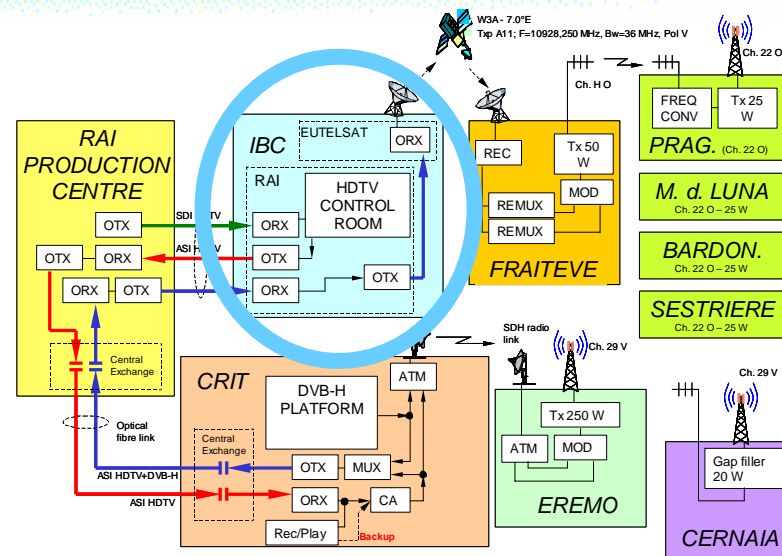
# HDTV Control Room (IBC) - 1

- ✓ **Switching** of the Video and Audio signals received from TOBO
- ✓ **Journalists comments**, when available from RAI Production Centre, can be added to the international audio
- ✓ **Encoding** of the video and audio signals in MPEG-4/AVC at 14.5 Mb/s and Dolby AC3, respectively
- ✓ The encoded bit-stream was routed via **optical fibre link** to the RAI Research Centre (CRIT) for CA encryption, multiplexing and transmission



# HDTV Control Room (IBC) - 2

- ✓ **Recording** of the A/V signals for re-broadcasting during periods of the day when no live events were available

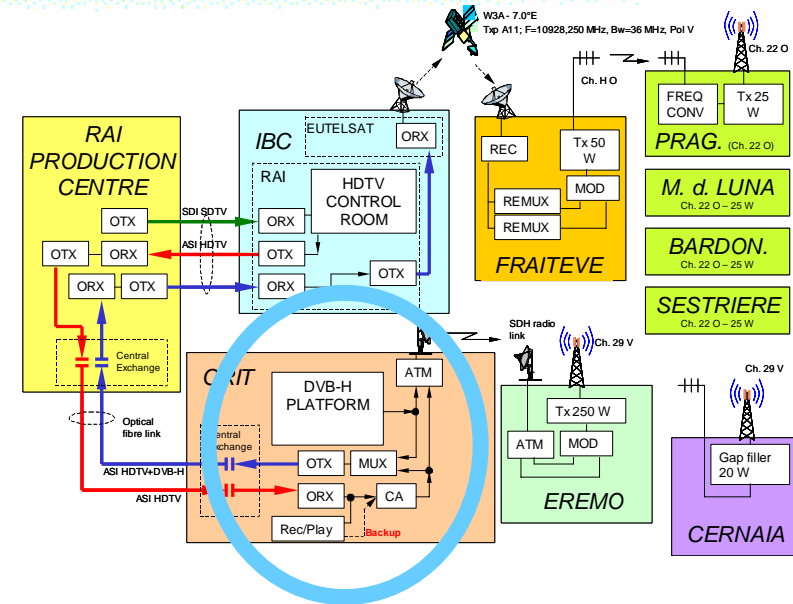


- ✓ The technical infrastructure worked properly 24/7 for the whole Olympics period



# DVB-H Platform (CRIT)

- ✓ **7 TV channels**, of which 6 available on DTT plus an ad-hoc channel (Rai Mobile), generated in the Torino Production Centre
- ✓ **6 radio channels**, belonging to the Rai's free-to-air offer
- ✓ TV channels encoded in H.263 (video @250kbps)
- ✓ Radio channels encoded using AAC format (@64kbps)
- ✓ Electronic Services Guide (ESG) generation and signal encryption

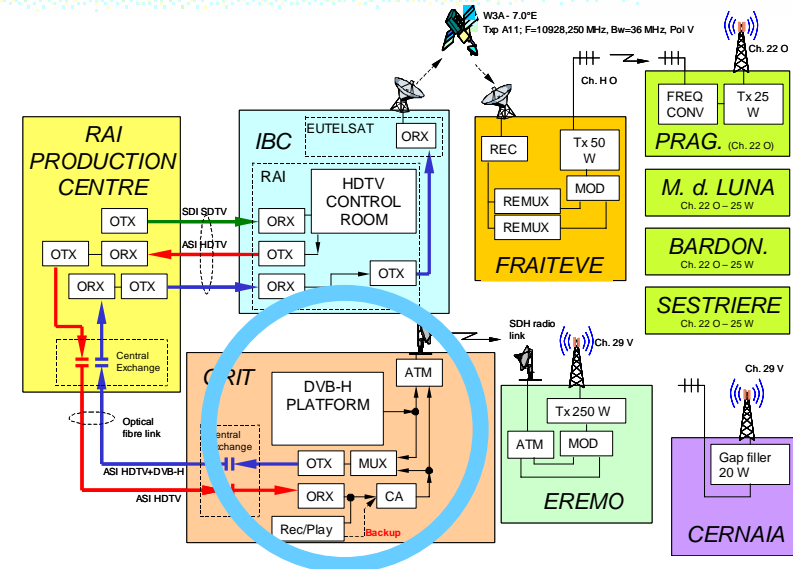






# Encryption and multiplexing (CRIT)

- ✓ The encoded HD signal was encrypted to prevent unauthorized usage
- ✓ The DVB-H and HDTV streams were multiplexed together for satellite transmission

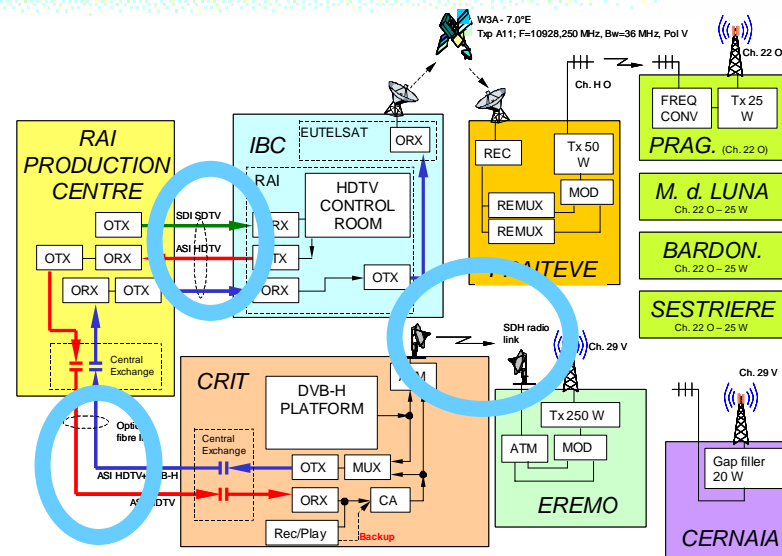


- ✎ PSI/SI tables for HDTV satellite Set Top Box reception
- ✎ PSI/SI tables, hidden in “ghost PIDs”, for the terrestrial modulator of the mountain sites and reception by terrestrial Set Top Boxes
  - In the “Fraiteve” site, re-multiplexers separated the HDTV and DVB-H transport streams and included the correct PSI/SI tables, hidden in the satellite stream

# Transport network - 1

## ✓ Optical fibre links for ASI signals in urban area

- ☞ Compressed HDTV @ 14.5 Mbit/s
- ☞ Multiplex compressed HDTV + DVB-H
- ☞ Dedicated links
- ☞ Routing diversity, equipment redundancy



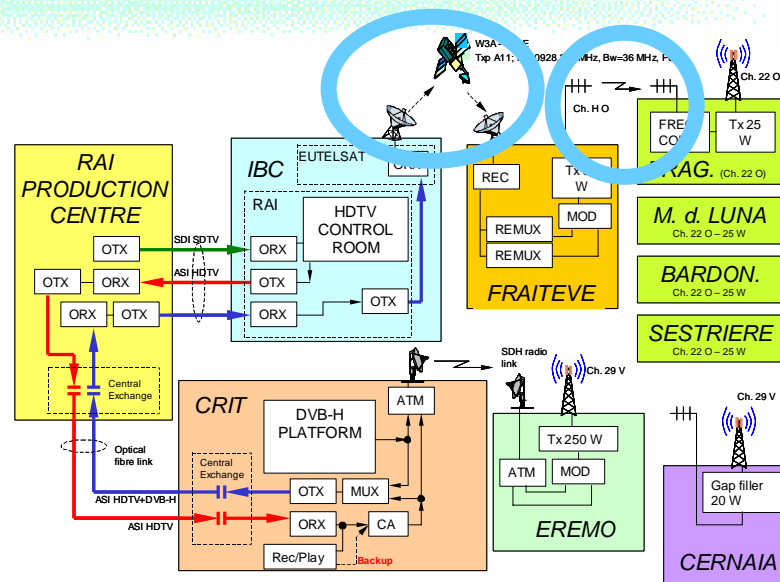
## ✓ SDH radio link to the “Eremo” Broadcasting Centre

- ☞ ATM technology: allowed to transport the two multiplexes on a single DS3 container (45 Mbit/s)

# Transport network - 2

## ✓ Satellite link

- ➡ to feed the DTT modulator and transmitter of the mountain sites
- ➡ Eutelsat W3A – 7.0°E
- ➡ DVB-S, QPSK 1/2,  $\approx 26$  Msymb/s, Bw = 36 MHz
- ➡ Receiving dish  $\varnothing = 1$  m



## ✓ OFDM link (VHF channel H)

- ➡ to feed the 4 DTT repeaters in the mountain sites
  - frequency conversion of the received signal from channel H to channel 22



# DTT Broadcasting

## ✓ Hierarchical modulation

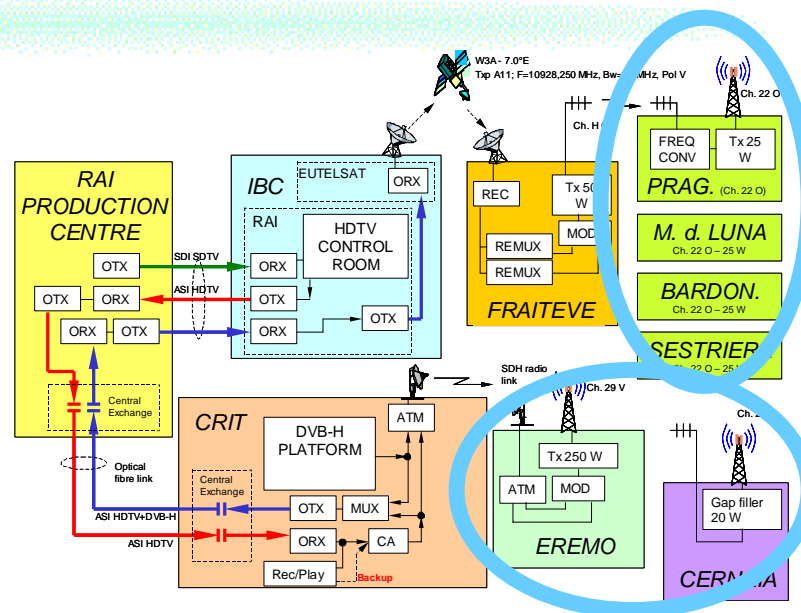
- ➡ QPSK  $\frac{1}{2}$  in 64QAM  $\frac{3}{4}$ ,  $\alpha=2$ , Guard Interval  $\frac{1}{8}$ , FFT 8k)
- ➡ HDTV @ 14.5 Mbit/s, DVB-H @ 5.3 Mbit/s

## ✓ Torino (Channel 29)

- ➡ Main transmitter: 4 kW ERP
- ➡ Gap filler (20 W)
  - to improve the indoor/outdoor reception in downtown (dense urban area)

## ✓ Mountain sites (Channel 22)

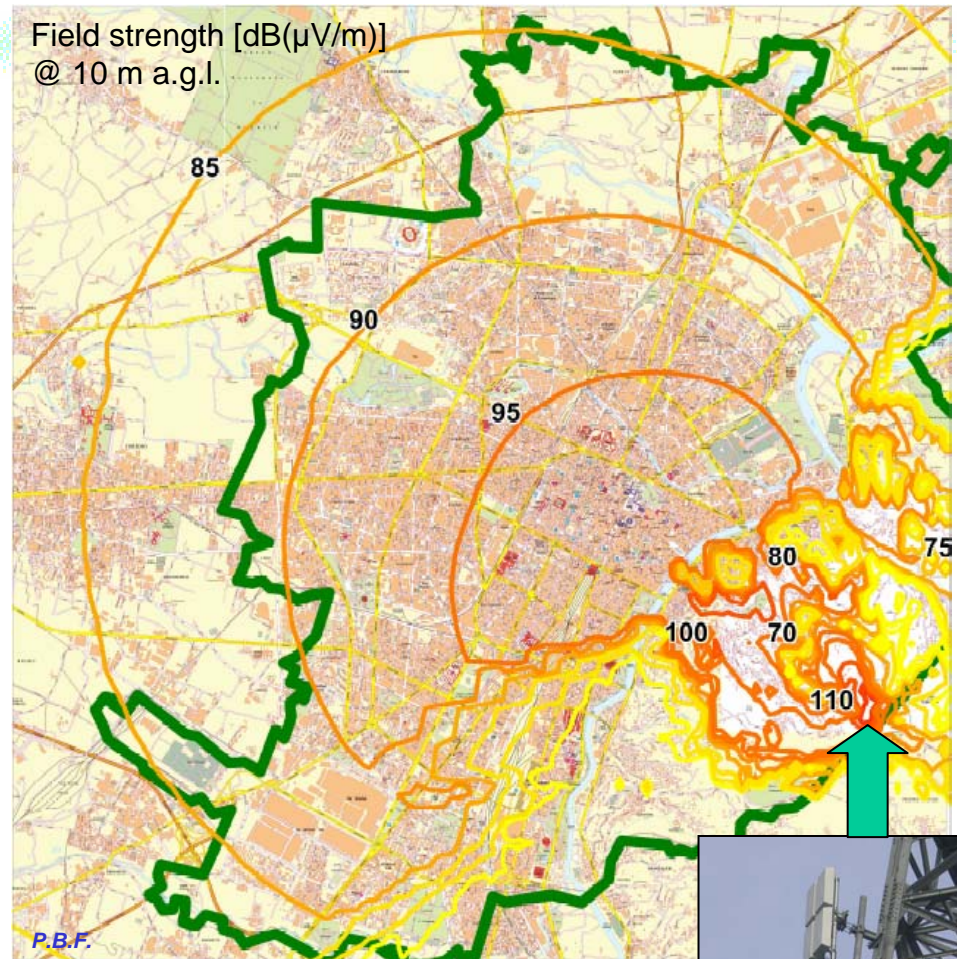
- ➡ 4 transmitters (25 W) operating on the same channel in non-overlapping areas
  - covering the sites of Sestriere, Bardonecchia, Pragelato, Monti della Luna



# DTT Broadcasting: main transmitter

- ✓ New array of transmitting antennas has been put into operation at the Torino Broadcasting Centre

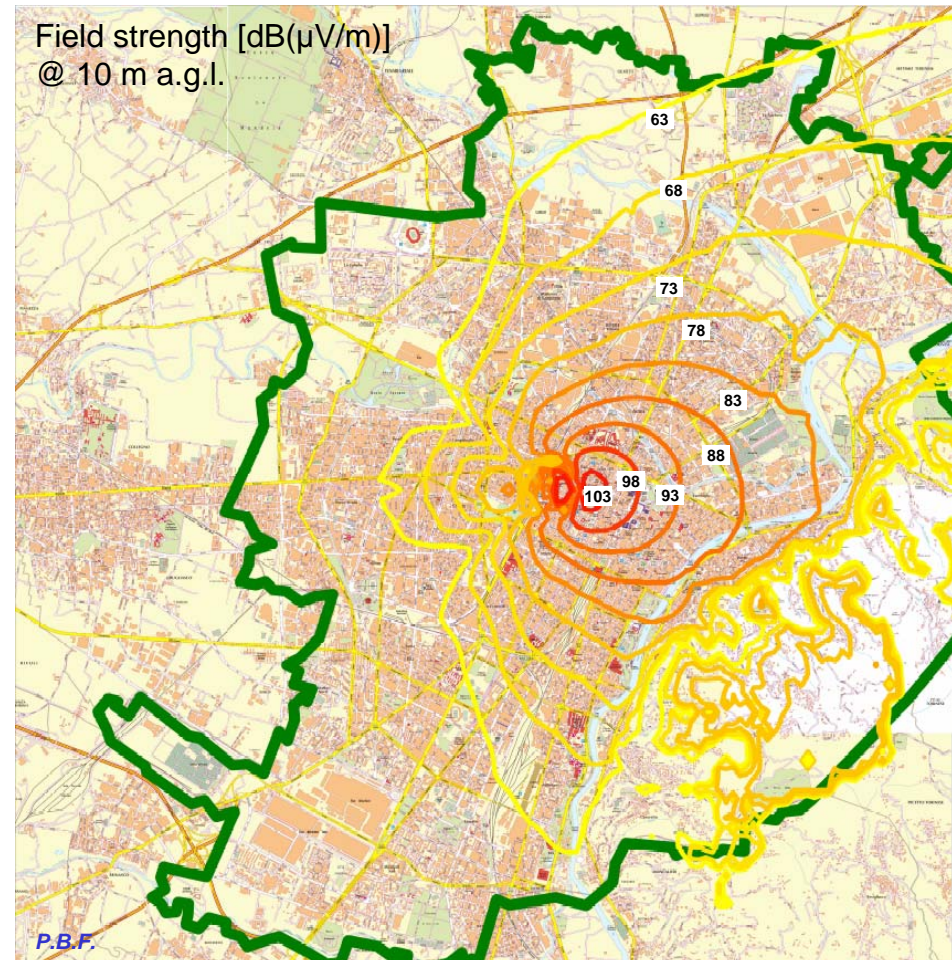
☞ The radiation pattern was limited in the horizontal plane and tilted towards the centre of the city in order to achieve good coverage for DVB-H mobile/indoor reception





# DTT Broadcasting: gap-filler

- ✓ Installed on top of the “Cernaia” Rai Palace in the centre of the city
  - ☞ antenna height of 75 meters above ground level
  - ☞ the radiation pattern was oriented in order to improve the coverage of the city centre and to avoid interferences with the antennas of existing community receiving installations







# HDTV Viewing Points - 1

- ✓ 15 locations in Torino (main railway station, Rai premises, media centre, university, Casa Italia, tourist offices, hotels)
- ✓ 11 Tourist offices in the mountain sites
- ✓ Equipped with terrestrial or satellite receiving installation, HD Set-Top-Boxes and 42" 50" HD-Ready plasma display



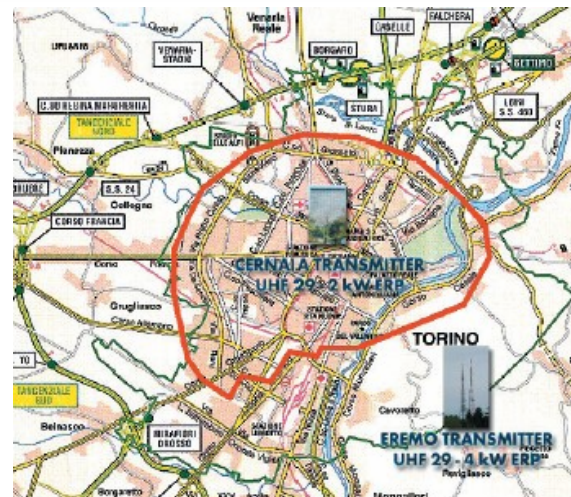
## HDTV Viewing Points - 2

- ✓ Posters and leaflets explained the scope and the details of the trial
- ✓ Two conference rooms have been equipped at CRIT premises for an audience of about 70 persons, and used for demonstrations
- ✓ The initiative has been greatly appreciated both by technical and general viewers, and people have expressed approval and appreciation for the outstanding quality of the video/audio signals



# DVB-H mobile reception - 1

- ✓ Extensive measurement campaigns in the Torino area
  - ➡ more than 3250 measurement points
  - ➡ with hierarchical or regular modulation
- ✓ Evaluation of the **indoor coverage** of the DVB-H signal in the more severe reception condition, i.e. **at ground floor**
  - ➡ Hand-held terminal, integrated antenna





# DVB-H mobile reception - 2

- ✓ The results confirm that, in the zone where the field strength (10 m a.g.l.) was greater than 95 dB( $\mu$ V/m), the reception of the DVB-H signal was quite good also at ground floor

☞ average location probability of about 85%, as predicted by theory

- ✓ With a field strength of 100 dB( $\mu$ V/m), an average location probability of 95 % can be achieved





## DVB-H mobile reception - 3

- ✓ About 50 Nokia 7710 receiving terminals were distributed and, for some users, viewing habits and usage data were monitored
  - ☞ service and program name, viewing time, action type
- ✓ The Log Files with daily usage information were sent from the terminals to the Logging Server via GPRS connection
- ✓ The trial is still going on and the inclusion of a wider set of users, with higher statistical significance, is planned

- ✓ The trials were an important opportunity for Rai to test on the field the most recent DVB/MPEG technologies, and to provide the viewers with exciting HDTV and Mobile-TV demonstrative services
- ✓ As far as we know, HDTV, MPEG-4/AVC and DVB-T technologies have been used together for the first time
- ✓ Even if MPEG-4/AVC coding technology is not yet completely mature, nevertheless it has proved to be suitable for HDTV encoding and transmission over DVB channels





# Acknowledgements

- ✓ The author wishes to thank all the colleagues of Rai who contributed to the success of the event
- ✓ The trials have been possible thanks to the following technological partners:
  - ☞ ADB for the HDTV set-top boxes
  - ☞ CVE for HDTV studio and optical fibre equipment
  - ☞ Eutelsat for the satellite link
  - ☞ Panasonic for the HD Ready Plasma Display Panels
  - ☞ ST Microelectronics for the decoding chipset
  - ☞ Tandberg for the HDTV encoder