

# The development of HDTV in Europe

— a tale of three cities: Dublin, Dubrovnik and Geneva

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**This article provides a short history of the search for a worldwide HDTV standard, starting with the early Japanese analogue system in the mid 1970s up to the present day ... where the EBU is recommending the use of 720p and eventually the 1080p digital standard.**

## Fog clears over San Francisco

High Definition Television is the inevitable future of television. Public expectations for quality rise over time, and are part of the process of human self-education. The more we see higher quality, the more we become accustomed to it, and the less we accept lower quality. But the journey to higher quality in Europe has been long – and its path has been difficult. Many people contributed to the long march. The story could be seen from many perspectives. This is just one of them.

News of the development in Japan of “HDTV” – sharp pictures for screens as large as 1m diagonal size – reached European ears in the EBU in the mid 1970s. In the late 1970s, a delegation from the EBU visited the NHK (The Japanese Broadcasting Corporation) research laboratory to see it for themselves. This included the author’s subsequent boss, Henri Mertens, Chief Engineer of the EBU in Brussels at that time. Henri told



**High Definition Television today – the best thing since Ice Cream, thanks to the pioneers**

me later that they were impressed, but convinced its use in Europe was “a long way off”.

EBU Members watched the SMPTE (The Society of Motion Picture and Television Engineers) set up a committee to examine HDTV and its application, in the late 1970s<sup>1</sup>. Their report concluded that HDTV would have a place principally in the cinema. EBU Members respected the SMPTE very much. If anyone would know where HDTV could be important, it should be the SMPTE, so the matter was put on one side for broadcasting in Europe for the moment. The IBA Long range Studies Report on HDTV<sup>2</sup> is an example of the EBU Members’ sentiment at the time.



HDTV in 1981. A CRT offscreen shot taken at the NHK demonstration in San Francisco in February 1981

The next milestone for us was a demonstration of the NHK analogue 1125i/30 system, organized at the SMPTE Winter Conference in February 1981 in San Francisco. The demonstration was organized by Joseph Flaherty of CBS, one of the great champions of HDTV.

The EBU’s senior technical body was its ‘Bureau of the Technical Committee’ and they were, at that time, involved in a close dialogue with the SMPTE about the parameter values for a conventional-quality digital television production standard (“4:2:2”).

The SMPTE invited the Bureau to come to San Francisco at this same time, so there could be joint discussions about this “4:2:2” format. Being in San Francisco, it was inevitable that the Bureau would see the NHK demonstration of HDTV – and be impressed by it. Bells began to ring in European heads that HDTV was moving closer to operational practice.

To illustrate European ways, Henri Mertens usually recounted that “*when the United States launches a satellite, Europe launches a committee*”. This was time for another committee too.

The EBU structure was such that research and development was part of what was called “Working Party V” Chaired by Peter Rainger, then Deputy Director of Engineering at the BBC. Under that banner came Sub Group V1, chaired by Yves Guinet from TDF in France. Sub-group V1 decided to modestly set up a “Specialist Group” to investigate HDTV, led by Charles Sandbank, then Head of BBC Research Department. It fell to Charles and his group to take the first steps towards a European policy on HDTV. The author was the Secretary of this group, V1/HDTV.

## Waters calmed

The group began its task, fired with Charles’ enthusiasm. Shortly after starting, we learned that George Waters, then Vice President of the EBU and Director General of RTE in Ireland, had invited NHK to bring their demonstration of HDTV to the next EBU General Assembly.

### 1. A Study of High Definition Television Systems

Report of the HDTV Study Group to the SMPTE Committee on New Technology, July 1979.

### 2. Walter Anderson: IBA Long range Study Report 3: High Definition Television

Independent Broadcasting Authority, January 1980.

The General Assembly was scheduled to take place in June 1982 in Killarney, Ireland. This first demonstration of HDTV in Europe looked like being (and was) a jewel in the crown for that meeting. Needless to say, V1/HDTV held a meeting at the same time in Ireland, and eagerly saw the demonstration (in the author's case, many times).

The demonstration in Ireland was more comprehensive than the one that the SMPTE had seen. NHK and CBS brought material which showed a range of natural history and sport in HDTV, and a feature documentary about Japanese culture. Delegates (or at least the author) could not believe their eyes. The outstanding beauty of a flock of pink flamingos in HDTV tore into the senses. We seemed to be looking through a window. At the end of the programme it seemed incredible to have minute credit lines which could still be read on the screen. The reality of HDTV and its potential for broadcasting was coming home to us.

## The search for a common worldwide standard

After the demonstration, The V1/HDTV group set themselves the task of endeavouring to reach agreement with all parts of the world on a single format for HDTV. The starting point was the NHK-developed 1125i/30 system<sup>3</sup> but, for Europe, a major obstacle for its use would be the difficulty of standards conversion to 25Hz – which would always be needed at least for conventional-quality television in Europe.

Richard Green, then Director of the ATSC, the body set up to devise a US standard for terrestrial HDTV broadcasting, suggested that a worldwide (interlace) HDTV standard might use 40Hz (80 fields per second). This could then allow lower cost and higher quality standards conversion to both the 25Hz and 30Hz worlds. It would have a high “interlace factor” and the pictures would look similar in quality to progressively-scanned pictures. Standards conversion can be done easier if you convert down from a high to a lower frame rate.

The author liked this 40Hz idea very much and, if luck had been with us, there might have been a single worldwide HDTV production format based on 1125i/40. Alas, Richard was not able to convince SMPTE colleagues that moving from 30Hz to 40Hz was a justifiable thing to do. It would have meant a 25% increase in bandwidth for them, essentially for (as they might see it) no benefit.

At this point of deadlock, prompted by a proposal by BBC engineer, Richard Saunders, NHK offered to demonstrate that standards conversion from 1125i/30 to 625i/25, at transparent quality, was possible. Thus the 25Hz world could use 1125i/30 comfortably in the knowledge that there would be no major problems for conversion to 625i/25.

The HDTV motion-compensated standards converter was made by the engineers at the NHK research laboratories, and was a magnificent achievement for its time. In spite of this, many Europeans remained to be convinced of accepting the 1125i/30 format. There were still residual artefacts on the converted pictures, even with the fine standards converter, and the cost looked likely to be about one million dollars per converter – a lot of money in those days, and broadcasters thought they might need many machines each.

There thus arose within the EBU two schools of thought about HDTV production formats. The first view, shared by the RAI, Swiss TV and others was that, in spite of the standards conversion drawback, Europe's long-term interests would be best served by accepting the 1125i/30 format. The second view shared by others members, French broadcasters, Germany, the IBA in the UK and others, was that:

- accepting a 30Hz format would bring high costs and low quality;
- the 25Hz world should have a 25Hz format. It was after all, they argued, 75% of the world.

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3. In this article we use the convention of using frame rate, rather than field rate, at the end of the shorthand form of the format.

There could be no reconciling these two groups of broadcasters. Many tried, not least the valiant Charles Sandbank.

NHK had not stopped at developing the 1125i/30 system and the HDTV-SDTV field-rate standards converter; they had also developed a compression system capable of squeezing the 1125i/30 HDTV format in a satellite channel bandwidth of about 8 - 9 MHz. This was the MUSE system, which ingeniously extended the principles of interlacing to allow different spatio-temporal filtering in each of four quadrants of the picture.

MUSE was brought to Europe and was demonstrated and tested at the RAI Research Centre in Turin, Italy. NHK began HDTV broadcasting with MUSE in the mid 1980s by satellite.

European industrialists looked at this Japanese high-tech with some anxiety.

## HDTV in the ITU – the first time around

The ITU had also established a committee structure in the early 1980s to study HDTV and to try to reach agreement on a common worldwide standard. This group relied on inputs from the EBU, the SMPTE and some national administrations, so their discussions mirrored the EBU and SMPTE discussions.

Matters reached a head in 1985 and 1986 with successive deadlocked ITU meetings. The United States administration proposed to the ITU that the world should adopt the Japanese-developed 30Hz format. Perhaps out of frustration, and a lack of initial favourable response from Europe, the United States decided that governmental pressure could be the way to convince Europeans to support the 1125i/30 format. Ironically, this actually had the reverse effect to that intended. European broadcasters were annoyed and were more convinced than ever not to accept 1125i/30.

The ITU Assembly in Dubrovnik, Yugoslavia, in 1996 was one of the most acrimonious meetings in ITU history. The Eastern block countries joined in on the side of a 25Hz format and the Yugoslav Chair stopped the debate. The 30Hz world was never going to accept the expense and quality loss of a 25Hz HDTV format, and vice versa.

The author chaired many of the ITU meetings aiming to reconcile the 25Hz and 30Hz worlds. This was because his mother tongue is English, and because the EBU was essentially an organization without a position, so he could be neutral. Documents were produced, but they could only say that agreement could not be reached – attitudes had hardened too far.

After Dubrovnik, it almost seemed that everyone interested in HDTV could go home. For the moment, the ITU work was done.

But leaving Dubrovnik, a group of European administrations and manufacturers reasoned that Europe had a “narrow miss” with HDTV, and that a concerted effort was needed now to develop not only a European or 25Hz HDTV format, but an HDTV broadcast format as well, to match the technology of the Japanese MUSE system.

This was the beginnings of the Eureka project, which was in great part based on the inspired ideas of a young Philips Engineer, named Marcel Annagarn. This became the “HD-MAC” HDTV transmission system, developed in the “Eureka 95” Project. This Project deserves its own history book. Essentially, after about five years, an analogue production and hybrid analogue/digital broadcasting system was developed for a 25Hz HDTV system.

Back in the ITU, the storm of Dubrovnik had passed after about two or three years. Many of the most dogmatic voices no longer took part. In 1990, the author was asked to Chair Working Party 11A, which was charged with HDTV matters.

## HDTV in the ITU – the second time around with Rec. 709

Scared by the Dubrovnik experiences, the author began the task of trying to move toward a meaningful ITU specification for HDTV. This was to become a new version of ITU-R Recommendation 709. Getting there involved many personal discussions. The core idea was to base a Recommendation around a progressively-scanned format with two frame rates, 1080p/50 and 60. Everyone seemed to understand that the future of HDTV should lie with this progressively-scanned format. The concept was to define the format in the digital domain with a common image format, 1080 by 1920, for both the 50Hz and 60Hz versions.

A delicate matter for a time was the inclusion of an interlace version of the 1080 format, which was important because it was in actual practical use. At that time, it was the reality of HDTV. The problem was that the ITU had, some years earlier, produced a “definition” of HDTV which stated that, compared to conventional television, HDTV had to offer “improved motion”. Strictly speaking, an interlace format, unless using a much higher frame rate, did not do so. Conventional definition television is already 50Hz and 60Hz interlaced. The only way to comply with the ITU definition of HDTV was to move to progressive scanning. The 1080i/50 and 60 formats were not, according to the letter of the law, true “High Definition Television”.

The argument used – to convince sceptical Europeans to agree to include interlace scanning in the Recommendation – was that the use of interlace scanning was an intermediate format that would only last a few years. They did agree to include it in the Recommendation. There was now the prospect of a Recommendation which had, on the downside, two field rates and two frame rates, but was on the other hand a combination of the “common image format” and a “common data rate”, which would help agile production and reception equipment to be made which could handle both rates. Junji Kumada from NHK, who was a founding father of HDTV in Japan, agreed to prepare the new version of draft ITU Recommendation 709, which he did, producing one of the most important documents in HDTV.

Two year’s later, after discussions at NAB between the author and various film-makers, Robert Hopkins from Sony Pictures agreed to prepare an additional part of the next version of Recommendation 709 to allow the 24 and 25 progressive formats, because of their convenience for television drama and some movie-making. This created the version of Rec. 709 essentially in its present form. The author is honoured to have been associated with this.

All of these steps were achieved by a “softly softly” negotiation approach, drawing on the hard lessons of the original standardization approach – they required no special talent, but a lot of leg work.

## HDTV from 709 to the progressive present

Since that time, High Definition Television broadcasting began in the United States and Australia, to add to the HDTV services begun in Japan in the 1980s.

For many years in Europe however, for broadcasters, High Definition Television was not taken up. HDTV displays seemed too expensive to be affordable by Mr and Mrs Joe European Public, and probably too bulky to be attractive for Mrs Public. The situation changed with the oncoming wave of flat-panel displays, which are much more attractive furniture than CRTs, can readily be made to display HDTV pictures and, with massive worldwide sales, can be bought at low cost.

The good news in the late 1990s was that HDTV seemed now possible in Europe, but the less good news was that Europe



**The first demonstration of HDTV broadcasting by satellite using advanced video compression in 2004**



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had to bite the bullet and look again at HDTV formats. The new displays were all progressively scanned. All camera pictures begin life in progressive form and now end life at the display in progressive format. The EBU set about analysing the situation. In this new solid-state world, the EBU was not able to find advantages in maintaining interlace scanning. Its recommendation<sup>4</sup> is that HDTV broadcasting should use progressive scanning – 720p in the short term, and probably 1080p in the long term.

The 720p format – a practical quality match to 1080i with the benefit of progressive scanning – was the ingenious idea of many individuals, too numerous to mention, but among them was William Schreiber of MIT. Much of our information in Europe about the system, and progressive scanning in general, came from Antoon Uyttendaele from Disney/ABC in the United States. They should write a book about their work.

We need not be sad about leaving the grand old lady: *interlacing*. She was invented in the 1930s as a simple and effective bandwidth-reduction tool that was a great match to electron-beam scanning, both in cameras and displays. But after seventy years, it would be surprising if there were not better tools to do the same thing. Today we can make content-adaptive compression systems which do not leave a footprint on the signal. The transition will take time, and will not be immediate, not least because of legacy installations, legacy products, and because getting your mind around three-dimensional spatio-temporal spectra, in order to understand the benefits of avoiding interlacing, is not simple.

But finally, if the author had to say who he thinks invented HDTV, he would probably suggest that most laurels go to Dr Fujio from the NHK Research laboratory in Japan. It was the work of a genius, and of a charming man, and Dr Fujio's legacy will live for many decades to come.



**The author wonders how to explain to his wife what he has just bought**

4. David Wood: High Definition for Europe: A Progressive Approach  
EBU Technical Review No , September 2005.