Becoming Digital: Software Technology for the Living Room

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The unsuspecting consumer has become the target of the software profession which traditionally dedicated its attention solely to the professional market. Now that a PC can be bought for the same price as a high-end television (often in the same shop), the traditional boundary between computers and consumer electronics has vanished. The availability of cheap processing power, memory, and bandwidth has created a challenging new field of digital entertainment systems, which provides employment for a growing number of software professionals, including many OOTI graduates. In this article, I discuss the main technological developments underlying the current surge in new digital consumer electronic products, more specifically those related to digital broadcasting, which is followed by a short consideration of the wide gap between technology and getting a product into the living room.

From analogue to digital

If we take television as a starting point, history started in the 1930s with the first black and white transmission. In the following sixty years, engineers have shown great ingenuity by incrementally extending the existing infrastructure to add new features, which include colour, stereo sound, and Teletext. These features all build on the basic analogue encoding of the picture where spare parts of the signal are used to encode the additional information. The Teletext information, for example, is transmitted in the period when the electron beam in the TV is temporarily turned off to move back to the beginning of the next line.

The incremental refinement of the analogue television has lead to the current situation, where every household, with only rare exceptions, has access to some 30 broadcast television channels, an up-to-date information service (Teletext), and often a VCR to play back rented movies. The only thing that seems to be missing is interesting programs.

About 10 years ago, Nicholas Negroponte, founder of the MIT Media Lab, started to announce that the existing broadcast television is doomed to be replaced by a new interactive personal medium, which makes use of the wide availability of cheap computing power, memory, and bandwidth. Instead of many channels providing content you do not want, one personal channel (‘My TV’) will provide exactly the content that you want when you want it. Furthermore, the content would not only be a linear video, but an interactive experience that moves the consumer to the tip of the couch like video games, personalised news, and discussions with co-inhabitants of the ‘global village’.

Ten years onwards, established companies and start-ups alike are fighting fiercely to get their share in this new electronic entertainment market. The immaturity of the market and the uncertainty of the long term direction manifest themselves in the quick succession of hypes (Video-on-Demand, TV-PC versus PC-TV, Web-TV), which provide a continuous stream of material for magazines like Wired.

When we concentrate on the living room environment, the attention is focused on the set-top box; a box with processing power that is on the one hand connected to the outside world, e.g., through a satellite dish, a cable, or a telephone line, and on the other hand uses the television as its output to the consumer. This

concept captures the following range of options.

- Analogue decoders for scrambled Pay-TV channels, as used by sport, movie, and other premium channels which require a specific subscription.
- Digital decoders, providing similar services as the analogue system (free channels, Pay-TV channels) plus services which use the digital signal to download an application and the telephone line for a low-bandwidth (compared to the broadcasted signal) bi-directional channel enabling, e.g., WWW browsing (like the recently introduced Web-TV).
- Video-on-demand, the embodiment of the 'My TV' concept, which uses a point-to-point connection between the service provider and the consumer, enabling a truly personal channel for receiving and controlling an incoming video but also for remote interaction with other applications (games, home shopping).

Whereas the first category is currently widely in use, the other two are still mostly vapour ware. The first digital transmission systems have been launched (e.g., Hughes' DirecTV satellite system in the U.S.) and received with enthusiasm, based on the improvement it provides on the existing television broadcasting service. On the other end of the spectrum, at the expense of huge investments in video-on-demand trials, the proof has been provided that at the moment no cost-effective solution exists for a point-to-point video connection to a service provider.

A new generation of set-top boxes is under development, building on the basis of digital broadcasting plain television, and incorporating the results of the experiments with interactive video-on-demand systems. This set-top box is based on a combination of standards which ensure easy interoperability and reuse of products.

MPEG audio & video coding

The main standardisation effort in digital video coding has taken place since 1988 under the MPEG banner, the Motion Picture Coding Experts Group. The focus of MPEG-1, and its successor MPEG-2, is an asymmetric compression scheme, which enables a cheap implementation of the decoder (in a low-cost consumer device) at the cost of extensive processing at the encoding side (e.g., in a professional studio). The MPEG-2 standard is adopted as the basis for encoding in both digital television broadcast and in digital video discs, where a compression factor of 5 is achieved without a quality loss with respect to the analogue counterpart. The next step is taken in the MPEG-4 standard (MPEG-3 has mysteriously disappeared, as happens more often in such families of standards). This standard is as object-oriented as a video coding scheme can be. First of all, the basic element for encoding is not a full screen, but rather the objects that constitute the scene, like a tree or a car, and separately the buildings that form the background. This enables the option to compose a picture at the decoder side, which can be used e.g. to adopt the picture to a particular small display (only show the centre of attention) or to add additional information for a particular large display. Furthermore, each object can have a method (to keep the terminology consistent) attached which described the procedure for decoding. This also includes the option of adding synthesized (graphical) objects.

Digital video broadcast

The main players in the existing television market in Europe (broadcasters and consumer electronics manufacturers) have defined the Digital Video Broadcast (DVB) standard, which defines the protocol layers needed to transport MPEG-2 video and audio in combination with additional data. The advantage of this digital broadcast standard, as expressed before, is the compression rate provided by MPEG-2. This means that a delivery medium like a satellite or a cable, which currently can provide up to 30 channels, can suddenly provide 150 channels. Just wonder how long it would take to zap through all channels (if we take 10 seconds per

channel this still amounts to 25 minutes).

MHEG and Java

During the definition of DVB, the question was raised on how to include the popular Teletext-like service in the digital version. Furthermore, the need was identified to add an electronic programme guide, an on-line version that gives easy access to the programmes. After the first set of application-specific standards were defined, it became apparent that the current approach would lead to an endless series of standards for each new application. A generic application programming mechanism was to solve this problem. This has lead to the definition of MHEG-5 (yes, another family of standards where some of the intermediate numbers have dropped out), in the Multi-media and Hypermedia Expert Group. Basically, MHEG-5 is a variant of HTML which is adopted to the specific consumer/television requirements (interaction with a remote control instead of a keyboard and mouse, low-cost implementation). Following the developments of HTML, an extension of MHEG-5 is foreseen in which the Java virtual machine is used to add generic scripting facilities.

IEEE 1394

Whereas the previous standards address the interaction with the outside world, there is also the issue of the communication between devices in the home. Life would become easier for the consumer if the various devices would be able to exchange information and cooperate by themselves. Whereas currently, we are confronted by separate and inconsistent user interfaces for each device, a system approach in the home would not only relieve us of redundant actions, like installing channels for each device with a tuner, but also create a uniform user interface that can be accessed at various points in the home. Furthermore, we could reuse e.g. a CD player (or, in the near future, a DVD player) both for the audio stack and the PC, which can access the player through the network.

To enable this interaction between devices, a bus and its protocol stack are defined under the name IEEE 1394, a.k.a. FireWire, whose main feature is the possibility to transport multiple video and audio streams and its relative low cost.

When we look back at this list of main technologies for the future digital television environment, it becomes clear that the vanishing of the boundary between consumer electronics and computers is more than just a slogan. The concepts from the computer world, like NFS, HTML, and Java, have been picked up and adopted to the specific requirements of the consumer environment. This also explains the exploding demand for software expertise, which includes a wide range of topics like digital signal processing software, communication protocols, user interface management systems, and object technology.

From technology to product

Although the technology does seem to be more or less in place in the form of widely accepted standards, there is still an interesting question left, i.e., how does this translate into a mass-market product? After all, in many countries people already have a very cheap solution for watching TV that provides an adequate quality.

In Germany, the first rapid steps into digital broadcasting via satellite have already been halted because of the relative high cost of the decoder. A dead-lock situation may occur in Europe, where the broadcasters do not adopt the digital technology because of the high cost and on the other hand the cost does not drop because of the low volume of the market. On the other hand, many Asian countries are rapidly deploying digital broadcast systems, like in Singapore, Taiwan, and Hong Kong. This is also due to the fact that these countries often can start from scratch, which means that there is no existing system to compete with.

Also in this new market, the traditional rule of consumer electronics still holds. This rule states that any new type of product can enter

the market when it makes a revolutionary improvement in at least three of the following areas.

- Price.
- Power consumption.
- Convenience.
- Functionality.
- Compactness.

Whether this will be achieved depends on the cooperation of the various disciplines involved in the creation process, i.e., the various flavours in technology development (software, electronics, mechanics), user interface development, and product management.

In conclusion, having spend the last four years working together with a growing number of fellow OOTI graduates on the various aspects of a new generation of televisions, the background provided by OOTI has been important to tackle both technical and the non-technical issues. In a few years, you will be able to assess the results of OOTI every day when you turn on the TV. □

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Short News

Part-time OOTI appointments
Due to the enormous demand for people in the information technology sector, a shift in the educational background of OOTI applicants is observed; less applicants studied computing science, while more applicants have a background in physics or mechanical engineering.

At the moment a fairly stable preparatory programme is in use for applicants who need to augment their basic knowledge in computing science in order to reach the required OOTI input level. This programme takes 3 to 12 months, depending on the individual background. However, in the regular OOTI curriculum, at most six months can be spent on this preparatory work. Whenever more time is needed, this has to be done preceding the OOTI employance. For some students this poses financial problems.

In cooperation with the Stan Ackermans Institute (SAI) a new alternative has been designed for OOTI applicants who have the capacity to be admitted, but still lack necessary knowledge in computing science. In individual cases it is now possible to get a part-time appointment as OOTI for a period longer than two years. The possible combinations are such that the total amount of salary paid is the same as that paid in case of a regular two-year appointment. For instance, a possible combination is an 0.8 appointment for 2.5 years. The advantage for the OOTI in question is that he has an official status plus income right from the start, which might help to bridge financial problems. Of course, the OOTI student is supposed to work full time! □