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AD-A273 872

The Question of Standards for Digital Interactive Television

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November, 1993
CMU-RI-TR-93-23

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This research was sponsored in part by the Advanced Research Projects Agency (DOD) ARPA order 6873, under contract #MDA972-92-J-1010. The views and conclusions contained in this document are those of the author and should not be interpreted as representing the official policies, either expressed or implied, of the Advanced Research Projects Agency or the US Government.

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Abstract

Pervasive change is near. Among the central elements of this change will be digital interactive television. It is generally thought that interactive television can have a profound beneficial impact on every element of the economy from average homeowner, to small and large business, and government agency. We have the opportunity now to engage public debate on what form interactive television should take. Should it come about as a series of private, mutually incompatible, insular systems, or should it be treated like television has traditionally been treated, subject to FCC standards akin to existing NTSC and the recently agreed HDTV standards. This article attempts to provide a framework for a broad discussion of such standards.

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The Question of Standards for Digital Interactive Television

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Data blasted into homes. What will we do? In the television industry, programming is produced for distribution by networks that broadcast by way of various physical paths to standard receivers. Different industries exist for (a) receivers (e.g., RCA or Sony TVs), (b) physical paths (e.g., uplink facilities, cable operators), (c) distribution (e.g., CNN, ABC), and (d) programming (e.g., "Hollywood"). For today's video programming, standards exist in various forms that tie these industrial components to a common framework. But standards do not yet exist for "digital data" programming, whether that programming is for entertainment, information, shopping, or games.

Because digital data programming offers the opportunity for the two-way path, there is also a fifth player, the 'return feed guy.' This guy might be a quasi distribution guy, like a data server company such as Telnet, CompuServe, or Prodigy, a telephone answering group such as Telecorp, an advertiser, or, directly a programmer acting as a distribution guy as we might see with a "Macy's Channel" or a "Sega Channel."

Standards, whether official or unofficial, are essential to today's telecommunications build out. There are a variety of standards processes underway in every facet of the build out. Standards permit "quantities of exchange" to be understood. They permit the various business segments, receivers, paths, distribution, programming, and return feed, to engage in business. This is everything from the highly uniform unofficial standard like the standard "prime time" programming lengths for 30 minute and one hour shows, to highly uniform official standards like the NTSC standard for the form of broadcast video signals.

But standards serve the "engagement of business" in a broader way. They serve the consumer too. The consumer, like the businessman, has standardized quantities and a means of buying into the system. To be successful, standards must be clearly described and clearly accepted. They must fit well within technical capabilities, but necessarily permit open and evolving commerce. In digital interactive television, the subject of this paper, the standards process is just being born. Digital interactive television services are defined by the broadcast of digital data that is converted to information on the home television set. Digital interactive television services now available, such as Videotext, EON, GTE Mainstreet, Interactive Network, Starsight, TRAKKER, Videoway, X*Press, and Zing, (see Gazetteer in appendix) are completely vertical and insular.

This places a load on the consumer and other aspects of commerce to provide for an increasingly disparate array of infrastructure elements. It will not do if the consumer, for every new digital data service, has to pay for a new box on his TV, every cable operator has to pay for new forms of insertion and handling equipment, and every programmer has to bear separate production costs for each distributor. This rapidly forming tower of Babel, in essence, is perhaps the major economic problem confronting the development of interactive television. Confusion in the marketplace should be counteracted with frank discussion about how standards should be structured. It is not too early for such discussion, particularly, if, as we believe, the magnitude of commerce in this area is being severely constrained by absence of such discussion.

Let us ask about the what, where, when, and how of standards for digital interactive television. The questions that are to be discussed in this paper are broad ranging questions that ask us to think about the direct tie between a standard and the commerce it services. The first question looks for standards to copy.

I

The computer industry has a well developed standards infrastructure for digital data, why not just adopt these for the television industry?

Consider standardization in the computer industry. Similar to the television industry, the computer industry is composed of (a) user equipment (e.g., DELL computers), (b) physical paths (e.g., Prodigy, Internet), (c) distributors (e.g., Softsell, Egghead), (d) programmers (e.g., Lotus). The computer industry has put forth a large number of candidate data exchange and management standards in areas where the television industry hardly has models at all.

This has not been all good. One example is that the physical paths in the computer industry are much more complex and disparate. Similarly, anyone who actually works with an IBM compatible PC knows the configuration nightmare that exists because standards in the area of equipment are barely operational. This configuration nightmare makes the problem of connecting a VCR to a TV look like a kindergarten exercise.

The computer industry's repeated failure in its own standardization process motivates a conclusion that the standardization process in digital interactive television should draw deeply on knowledge developed in the parallels of computerdom, but it should not be modelled after that standardization. The reasoning is simple and direct and lies in the presence of the consumer in the commercial equation. Television seeks to directly involve people who may well not tolerate the confusion of computer standards in their homes. Consequently, for instance, we believe that attempts to put such *de facto* computer network standards as "Ethernet" on cable television are doomed, not because Ethernet on cable television is not a good and fun idea for computer uses, but because it provides standardization that fails to service commerce in television.

The consumer electronics industry has a well developed standards infrastructure. Of course, this infrastructure is already adopted in the television industry. It is not digital, or, perhaps, to be fair, it is just barely digital. It is similarly just barely two-way, even counting telephony. The television industry, of which consumer electronics participates, is characterized by strong and effective standards compared to the computer industry. Function in consumer electronics is reduced in order to create simplicity that, in turn, invites standard elements. Every signal engineer is respectful of the achievement of NTSC, PAL, and the like, but he also knows how far these standards fall short in the digital data arena. In the arena of digital interactive television, we seek to increase function. An appropriate goal may be to achieve a paradigm shift in function through a few simple, standard, elements.

Proposition 1: New standards are worth considering for the new domain of digital interactive television.

II

What should be the standardized elements of digital interactive television?

Let us take the industry components in turn and address standardization that would benefit each component:

The TV Set (and the companion boxes in, on, or really near, the home). Standardizing the physical receiver certainly has obvious benefit. The equivalent has not occurred in the computer industry. In the television industry, standardization of the receiver was accomplished by standardizing the structure of the information the television receiver could receive (viz., NTSC, PAL). The analog video information structure is flat, rigid and complete. Broadband channel selection, video controls, and the like follow directly, and the television set is essentially pre-ordained. The same method is essentially being applied to high definition television. This method has been so successful that we should ask whether a similar approach would be applicable to interactive television since it, too, involves mass data distribution.

At the level of the signal that the receiver accepts, part of the standardization answer may be unfolding in the ATM (asynchronous transfer mode) computer and telephone network standard in current planning. ATM is a CCITT international standard in process [2] [3] [5]. To see why the ATM standard poses interesting ideas for interactive television standards, consider the reasoning that underlies it.

In electronics there is the technique of "broadcast" (one to anyone), "multicast" (one to a specific list), and "unicast" (one to one). Clearly the television industry has relied on broadcast. Multicast, such as is available on some cable converter boxes, most head end equipment, and many computer LANs, is not as cheap as broadcast when the audience is unconstrained. Unicast is pretty horrible for the distributor of programming, but in interactive television, it is pretty necessary for the return feed activity of buying or making a telephone call. The ATM style network has the admirable attribute that broadcast, multicast, and unicast, share a common convention known in ATM terminology as a "virtual circuit" [5]. Data in an ATM network can be moved around along a fixed path with unprecedented efficiency. No data can be stopped from making its appointed rounds.

A second highly desirable aspect of the ATM is that the data travels in data groups or packets that all have exactly the same size specified in bytes (viz., 53 byte packets or "cells"). This permits small, fast, messages and, also important, fast switching, interleaving, and routing of packets to their assigned circuits. Hardware that can count on fixed packet sizes is inherently cheaper, if only because buffering problems stay highly tractable. Also, and of utmost importance, the fixed packet size makes "constant bit rate" data streams, such as video, a very real possibility. Constant bit rate data streaming is, for all intents, impossible in Ethernet, for example.

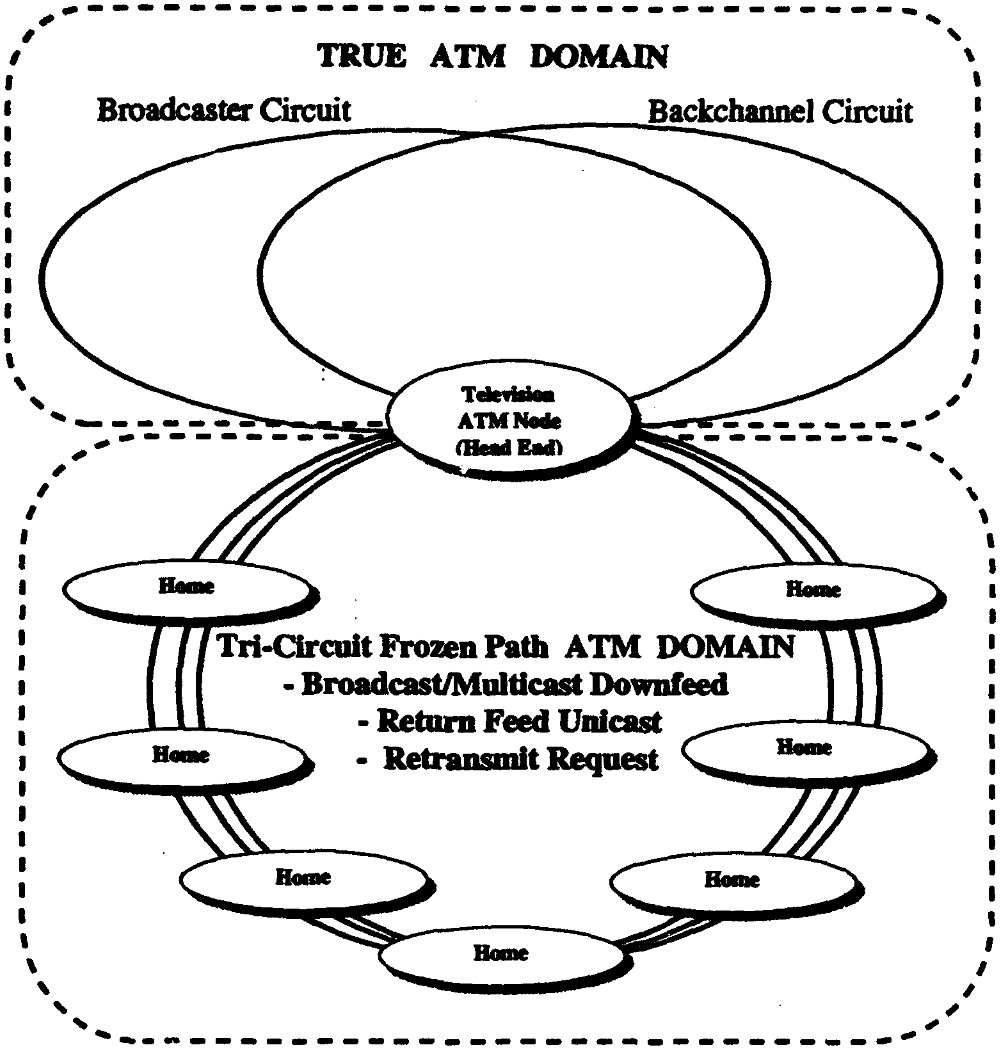
The big problem with ATM systems in television is that they assume all paths are symmetric: data rates to the home are equivalent to data rates from the home. *This is an unreasonable* assumption for much of the physical plant. More important, it is an unreasonable constraint on commerce. However, one can imagine an ATM spigot where a constant bit rate data stream of packets is made available to a local head end broadcast. True ATM "routing" is lost past this spigot, but the packet structure is retained as if this is the final path on a virtual circuit. A second ATM circuit would feed an ATM drain that would contain lower individual data rates from homes back to the distribution source or, directed at a different collection of businesses than these distributors of the broadcast information.

A legal "digital interactive television receiver" in this sense would be able to accept ATM packets at a specified rate, would be unicast and multicast ready (viz., can filter by address if requested), and would be able to produce ATM packets at a specified rate that is very possibly different, and smaller, than the rate required for reception. Rates, or speeds, matter a lot to the consumer side of the standards equation since different electronics are required to service faster data rates. Current ATMs (STS-3) achieve speeds of 155 million bits per second. In simple terms, one ATM path could hold about 1000 TRAKKER-style digital interactive television networks, about 10,000 Videotext networks, and about 8 of the most data-aggressive networks we have seen. *Any combination is possible on one ATM. Yet, one ATM path would allocate* approximately 4 satellite channels.

The ATM television node is the node at the downlink head end. This implies a broadcast of ATM packets because negotiated bit rates between an ATM television node and each television receiver(s) could become too expensive. Of great concern in broadcast is the protection of data integrity. The virtual circuit notion is now violated because the receipt is from one ATM circuit, and the return feed is sent to another ATM circuit. There is no universal "handshake" that determines if the data received by or sent from the TV has not been corrupted. The technique to fix this would be a third class of ATM circuit with different circuits defined between the ATM television node and each television receiver; this is, again, an extremely expensive proposition. The error correction issues here are profound. The only safe solution, in/out data rate symmetry with unicast transmission, is probably too expensive and will inhibit commerce.

One possible solution to this problem is straightforward. This is a messaging protocol in a third ATM circuit defined between the ATM television node and all television receivers it services. It characterizes the high bandwidth downstream data and watches the low bandwidth upstream, or return feed, data for "too much *transmission* error." *Broadcast error causes a* "catch up" interleave transmission of old with new data. As a general principle, this says that if bandwidth is asymmetric, error correction needs to be averaged. Properly tuned, this type of system could conceivably only rarely fail while keeping television receiver electronics capable of inexpensive but high performance.

The basic ATM idea is illustrated below by tying a true ATM domain to a Television ATM domain through a Television ATM node: It should be emphasized that the broadband coax/fiber that already exists in most cable plants will service all three ATM circuits in the drawing. Circuits are not the same as wires but they do define different paths or tunable channels (in the case of broadband). The circuits are shown as closed paths for visual clarity, but they need not be closed:



Proposition 2: Standard, fixed size, packets of digital information should be defined for broadcast, multicast, and unicast activity in digital interactive television. Standard "sharing" with the telephone and computer industry is possible.

There are non-technical reports of AT&T ATM network tests in cable television test markets including Viacom's Castro Valley and Time Warner Cable's Full Service Network in Orlando [1], although there appear to be no published details in the technical literature.

Physical Paths. The question of standardizing the physical path is probably moot right now. Ideally, the consumer would have exactly one electrical socket through which all power and communications would flow into the house and into and out of appliances in the house. Looking just at an average home's bills, it is clear that the power company investment per household far exceeds the telephone investment per household that usually exceeds the cable investment per household. This suggests that if we were to seek standards at the wire level, we would look at the power cord and define data standards associated with data communication to and from, and data isolation within, the household. The only wiring existing in homes that is shielded for high frequency transmission is cable. Imagine that every home had a "Home ATM Node" that provided for a separation of internal home data traffic and externally routed data traffic. Who could afford to provide that node? Who could, by existing regulation, get away with the standardization? The power companies?

But, forget that. Attend to reality. Ignore standardizing path except within telephone, cable, and power. Within these domains we have pretty solid physical-path-level standardization already. This includes radio, microcellular radio, microwave, and the like. The FCC understands this problem, and we can leave this to them. After all, they took proper action with EON (see Gazetteer in appendix) that tried, but failed, to get exclusive access to public bandwidth.

Proposition 3: No physical path standards are required in digital interactive television that are not already conceptualized for other purposes.

Distribution. *In the television industry, the major distributors are the television networks.* Television networks were historically broadcasters that had to obtain individual FCC licenses to broadcast on a wavelength.

Later, there was a separation between the "television broadcaster" -- the guy who had the antenna tower and the FCC license, and the "television network" -- the guy that distributed the programming to the broadcasters and later the cable companies. In this sense, the "television broadcaster" of today is not in distribution as much as he is in the physical path business. Indeed, the advent of cable and many channels has brought a redefinition of the television network that more cleanly distinguishes the distributor from the road he uses.

The television network now focuses on providing a coherent message to the consumer. There are the four "national networks," CBS, NBC, ABC, and Fox that package generic programming regardless of path. Then there are a large number of custom networks, such as CNN, that package specialized programming. The basic elements of the packaging include the network name, a statement of what kind of programming it packages, and who it sells to. Sometimes it sells to advertisers (e.g., the national networks). Sometimes it sells to cable operators (e.g., basic cable). Sometimes it sells directly to consumers (e.g., HBO, QVC).

It is useful to ask why "packagers of programming" exist at all. From a simplistic point of view, there should be programmers and path. A packager that only has a name, a class of product he packages, and a sales strategy, is not very much by way of substance. Should packagers be "standardized"? The answer is that they service a real need or they would not continue to exist and flourish. They should be considered for digital interactive television, but the current infrastructure blocks their growth. Indeed, it is the packager and distributor that data standardization must continue to support and it is the packager and distributor, the channel, of digital interactive television that data standardization is *least ready to support.* If there is a problem anywhere in the standardization picture, it is here.

In terms of specific standardization objectives, the problem is in *the software systems on the television receivers (cable boxes, or whatever).* This implies standardization in *operating systems*, if you will. Nearly anything will work for a head end. Interactive television networks can freely engage in commerce, if the operating systems on the receivers have certain agreed on properties. We believe a repetition of the MS-DOS/WINDOWS/OS-2 and Unix debacles are unwarranted on the home television. The interactive television software providers listed in the Gazetteer (appendix) are all producing vertical, insular, operating systems for interactive television. Can't we talk about it first this time?

There *should* be a basis for a standard. Interactive television implies a feedback loop encompassing the interactive service and a person or "user." The user must be provided with a means to communicate his wishes to the service, and the service must be provided with a means to respond and to present new information. In an interactive television service, the television's screen and speakers fulfill the latter need.

Because the physical display is given in the form of a television receiver, the problem of standardizing a "display device" has a restricted domain. Video standards for television specify a rectangular viewing area with a specific aspect ratio, a raster scan with a specific number of lines, a specific gamut of colors, and a specific time course.

All existing and proposed standards for television are well suited to a "frame buffer" -- an array of memory cells, each of whose contents dictate the color (or a component of the color) displayed at exactly one position in the raster (i.e., the color of one "pixel"). A complete frame buffer standard would specify: color model, screen layout in terms of how pixels are arranged on the raster, how many there are, how they are numbered, and memory layout providing a mapping from locations in the memory array to pixel positions and color components. Sub-topics include number of bits per pixel, interleaved color versus color planes, and color lookup tables versus direct color. Once specified as a *reference* frame buffer, the box maker (e.g., SEGA, RCA, Panasonic, HP, Scientific Atlanta) can implement the reference for interactive services meant to operate generically on any box or television receiver.

Besides a physical reference frame buffer, there are several layers of software components that are candidates for standardization.

There is a *driver* or software component of the operating system that mediates access to the frame buffer. This driver does not fulfill the traditional role of hiding details of an idiosyncratic display device because only a handful of display devices are possible due to television regulations.

In the spirit of the reference frame buffer, there can be software-library graphics routines and system calls for primitives that perform various graphical operations (e.g., stroking lines and curves, filling shaded polygons, drawing text). Basic "graphical user interface" objects would provide library routines and managed resources that establish a framework for universally "scripting" user and service interactions.

Graphical user interface design principles could be standardized. It is interesting to note that the computer industry has focused its attempts on standardizing the higher levels, while allowing chaos to reign at the lowest levels. Software systems such as "Microsoft Windows" or "X Windows" attempt to shield applications from the details of the hardware. This is exactly the wrong approach for interactive television. In the world of Microsoft Windows, there is an overwhelming number of different frame buffer standards, and an application can not be tailored to one without sacrificing its ability to perform on another. In the world of interactive television, only a handful of display types exist given by official standards like NTSC, PAL, and HDTV. We expect authoring for interactive television to be done on personal computers and workstations. A reference frame buffer greatly simplifies the task of insuring titles that will play on all television receivers.

Proposition 4: The standardized television signal provides a good opportunity to standardize display and sound for digital interactive television.

As stated, sound can be treated similarly to display since sound is standardized in the television signal. However, printers for television sets introduce complexity. But this complexity exists in a problem domain for interactive television called "capability management." The next section provides a short overview of the concept.

Capability Management. A standardized interactive television receiver should support a multitude of different information services with the same absolute uniformity as television receivers today support a multitude of different television programs. These services should be further grouped by channel or network. Since information services are software, it follows that the interactive television standard must specify a standard environment -- or operating system -- in which that software is executed.

We believe in a modern, multi-tasking operating system, but by modern, we do not mean overweight. The most central capabilities management problem is the allocation of resources of local memory to individual interactive television services. Allocation must support types of local memory including "working storage," "long term, message, storage," "ultimate or you-must-never-lose-this, storage," and "removable memory (e.g., floppy)." The TV display and user input devices must also be allocated as owned resources. Different user-generated events may be owned by different services. To include the printer and other possibly non-standard devices, there should be a means to determine their presence and to allocate them as interactive service resources. Finally, many interactive services use signal lights, alerts, and alarms. Every receiver should support a few basic, resource allocated, instances of these.

Interprocess communication protocols can provide restricted data sharing inside the box, and basic return feed protocols can be universal in order to establish interprocess communication back to the head end.

Capability management, as a central thrust for standardization, provides for many opportunities. Here are some more: It can ensure that no service can perform a credit card transaction without the cardholder's explicit permission. It can allow a "Civil Defense" service to sound an alarm in the middle of the night -- perhaps because of an impending flood -- while denying that capability to another service. It can enforce contracts between service providers so that service networks can be insured for ownership protection that "A" may be a client of service "X", but service "B" may not.

Capability management can guarantee that the user sees the message "out of memory," at no time other than the instant when he tries to subscribe to a new interactive service, request a new piece of information, or otherwise invoke a new network or new network service. It would not do if interactive television "crashed."

Proposition 5: Basic data manipulation capabilities should be standardized in digital interactive television.

Programming. The standards th t exist for television video programming are dictated both by statute and convention. We suspect that attention needs to be paid to standards for digital interactive television. This should permit programmers to know what will, and will not be, allowed. For example, if we allow "premium" programming that may be pornographic, violent, or explicit, should programming be *uniformly rated* so as to allow parental (or other) access control to programming through a standard receiver?

The digital interactive TV is capable of accepting or gaining access to graphic pictorial and full motion digital video information that may not be desirable. Catalogues may be available that may offend some people, and there may be the desire to restrict access to different family members. The argument made by HBO and other premium channels that people pay extra to see the stuff that is otherwise not seeable, and therefore the network has the right to broadcast it, may need to be better structured. Central database systems accessible through home television provide access opportunities essentially uncontrolled by any responsible 'publication' editor. A purchase may have to occur in certain allowed ways to certain classes of material or an authorized person may have to be capable of blocking the display of certain information if a key enabler, e.g., a password, is not present. For example, keywords like "no violence" and "no gambling" could be selected with confidence by a parent. It is useful to point out that the copyright holders, the programmers, *should* want this blocking standardized and present on all interactive TVs so they can maintain the most freedom of expression. The buyer has the right to what he purchases in the privacy of his own home only if he can be held responsible because he can easily make it *un*available to a child. This does not require the nationally renowned "encryption chip," we think, just some conscientious standard words regarding the capacity of the interactive TV to limit viewing by distribution channel. In this regard, this is much like universal product labelling in food packaging.

Proposition 6: There should be universal product labelling for digital interactive television that enables home screening for content.

Obviously, with impulse buying on the TV a desirable possibility, should there be standards that govern the clarity of the buy? For example, if someone buys something, should there be a clear message that requires a notification and second acceptance, and should it be possible to "unbuy" something within a few minutes of a buy?

The issues go far deeper. Several companies have already explored something called a "commercial ambush." This is advertising that is structured to ambush the first tuning of the set or set top to show up on a completely unwanted basis. With any form of return feed capability, the possibility of "big brother" is there. An intelligent TV, even with very little intelligence, can represent a flood of homeowner information to the even slightly cagey marketer, con-artist, or criminally minded. It is usually possible for the TV receiver to know when such "big brother" activity, whether potential or actual, is being invoked. One suggestion, that could have merit, would be a blue LED standard for a blue light that indicates external surveillance potential in an interaction.

It should be recognized that any commercial on TV has a "blue light" potential since buying patterns can be inferred. Infomercials, that seek buys immediately, or QVC home shopping, would have the blue light on all the time. But let us assume this kind of "indirect surveillance" will not cause a blue light. Only direct surveillance. Digital interactive television has the potential, indeed the probability, of blue light activity that cannot otherwise be noticed. If the blue light is on while someone is simply perusing a shopping guide, it would mean the perusal, not the buys, are being monitored. If the blue light comes on after the impulse buy and at the time of notification and second acceptance, the person knows the buy itself is surveiled (as it must be, a tautology, of course).

Proposition 7: There should be universal alerting for digital interactive television that indicates return feed buys and surveillance.

Other aspects of programming standards for interactive television have to do with the interactive controls themselves. It is interesting how IR remote control units have come to be. RCA Laboratories (now Sarnoff Laboratories, Princeton, NJ) published a specification that was widely copied. There has been obvious utility in standardization in this area. In further support, we have published the source code and electronic schematics for an IR remote that will handle most TVs, VCRs, and Cable boxes, and made our data and programs available on the Internet [4]. We used "pre-trained" commercially available remotes to train our own remote to several hundred devices. This stuff is "copylefted," so if you modify it, Carnegie Mellon University owns it and you must make your modifications available in source form for putting on the net for the next guy. This depends on the *honor system* not the legal system. We urge a look at the specification language for remote control signals. Perhaps TV set receivers could be programmable in a similar specification language in order to promote interoperability between remotes and interactive television sets (or set top boxes, etc.)

III

What standardized elements of digital interactive television should be official?

Aside from unofficial standards, there are two kinds of "official" standard. One is by statute and another by industry group mandate. Let us combine a summary of the points made with a discussion of coercion for the common good (viz., the good of open commerce).

The standardization of the TV set (box, etc.) seems to reasonably be achieved by the same mechanism currently available: standardize the data stream into (and now out of) the TV set. The data handling capabilities of NTSC are not useful. We suggested that a possible standardization would follow the ATM networks currently being built out internationally for telephony. Special ATM television nodes and certain special provisions for highly asymmetric data broadcast into homes would bring costs down and retain the roles played by cable operators. ATM technology is standardized and available from many companies. It is approximately the correct bandwidth and, with ATM television nodes, could be in the right price range for home use.

Standardization of physical pathways, transceiver protocols, materials, and the like, is pretty much orthogonal to issues in standardization of digital interactive television. There will be multiple competing physical pathways or pathway sharing. The pathway providers should not, in general, object to the need for standardizing the interactive data stream at least as it appears entering into and leaving from their paths.

The issue of standardization for distribution is much less clear. Right now all interactive television services are vertical and insular. We would even include in this list videotext because it places such presumptive constraint on what the data can do. It is a bad sign if the interactive networks are building their own boxes, their own remote controls, etc., as they appear to be doing. We suggested that an operating system requirement specification on the receiver would come close to solving this problem. Obviously, though, it would be a bad idea to have a national or international standard operating system for digital interactive television services. Perhaps we can borrow from the NTSC, or, simply, video, standards process. Is it possible to control the operating system by specifying the content of the signal? Perhaps we should look at structuring what can appear in the ATM packets that will service interactive television. This is not unlike how the NTSC standard places tacit requirements on television construction.

The final aspect of standards is in the programming arena. This is perhaps an arena where the FCC should be involved in a way comparable to its involvement with broadcasters on matters of limiting pornography, violence, gambling, intrusion, and the like.

IV

What to do about all this?

Data is soon to blast into homes in utter chaos. Those who possess relevant knowledge should write. Those who can publish what is written, should publish it. More widespread public dialog should begin. This should not be left solely to engineering groups, news reporters, or large corporate interests. Television is soon to be a new agent, living and practically breathing, in the home.

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Glossary

ATM - asynchronous transfer mode. Literally this means that data is streamed *so fast* that it can be streamed in packets without strict adherence to regular, synchronous, timing of a given packet stream. This terminology comes from telephony where such packets are nevertheless 'resynchronized' for audible playback at the receiver. ATM networks are gaining widespread acceptance in telephony and computerdom.

Digital Interactive Television. Television services that are *distinguished* from traditional video services because they are digital. This categorization excludes new digital video services such as MPEG II compression standards for video. Rather it focuses on non-video (all but video-camera based) productions, entertainment, and information services.

Ethernet. Ethernet is a local area network protocol in which packets of variable size are unicast to named receivers. Ethernet is not suitable to broadcast or to continuous rate data feed. At 10 million bits per second it is 15 times slower than an ATM network.

FCC - Federal Communications Commission. Washington, D.C. The regulator for open air, and certain regionally exclusive wire/fiber, use of electromagnetic spectrum.

Interprocess communication. In any software operating system in which several programs can execute at once, there may be a facility called interprocess communication. This facility enables separately running programs to send messages directly to each other.

Multitasking operating system. In computerdom, an **operating system** is a computer software system that provides basic control of a computer and its attachments. A **multitasking** operating system provides certain accepted methods for permitting multiple tasks (or processes, or programs) to execute on the computer as if in parallel. Technically speaking, the interactive television can probably get away without *true* multitasking if capability management is tightly enough controlled, but in practice, the task schedulers of multitasking operating systems provide the desired flexibility and robustness.

Abridged Digital Interactive Television Gazetteer

Since there is really no current literature, I give a listing of companies from which information may possibly be obtained. The list is necessarily incomplete. Nearly every existing video network has some interactive activities underway. Nearly every hardware provider of televisions or set top boxes has, or has a group working on or providing hardware into interactive television. Nearly every major copyright owner (e.g., Time-Warner) has networks and titles in test or deployment.

The lists below contain companies and organizations with a particular digital interactive television focus.

Interactive Television Networks

ACTV, NY NY.
EON, Inc. Reston, VA.
ICTV, Santa Clara, CA.
GTE Mainstreet, GTE Inc.
Interactive Network, Inc., Mountain View, CA.
NTN Entertainment Network, Carlsbad, CA.
NU Media, Alexandria, VA.
ONTV, Television Computer, Inc., Pittsburgh, PA.
SEGA Channel, Sega, Inc., San Francisco, CA.
Starsight Telecast, Freemont, CA.
TRAKKER Interactive Services, United Video, Inc. Tulsa, OK.
TV Guide ON SCREEN, Englewood, CO.
Videotext, widely available worldwide owned by Video Broadcasters.
Videoway, Videotron, Inc., Toronto Canada
X*Press Information Services, Inc., Englewood, CO.
Your Choice TV, Bethesda, MD.
Zing Systems, Englewood, CO.

Interactive Television Software Providers

Electronic System Products, Roswell, GA.
First Person, Inc., Palo Alto, CA.
General Magic, Mountain View, CA.
Kaleida Labs, Inc. Moutain View, CA.
Microsoft Corporation, Inc. Bellvue, WA.
Microware Systems, Corp. Des Moines, IW.
Probita, Boulder, CO.
Scala Computer Television, Inc. Reston, VA.

Television Industry Trade Organizations impacting Interactive Television

CableLabs (Cable Television Laboratories)
Louisville, CO (effective January 17, 1994)

CATA (Cable Telecommunications Association)
Fairfax, VA

CCITT (International Consultative Committee for Telephone and Telegraph)
Geneva, Switzerland

ECSA (Exchange Carriers Standards Association)
Washington DC

EIA (Electronic Industries Association)
Washington, DC

IEEE (Institute of Electrical and Electronic Engineers)
Piscataway, NJ

NAB (National Association of Broadcasters)
Washington DC

NCTA (National Cable Television Association)
Washington DC

SCTE (Society of Cable Television Engineers)
Exton, PA

SMPTE (Society of Motion Picture and Television Engineers)
White Plains, NY