None of these allegations bears scrutiny That they are repeated frequently, but not supported, does not make them true. In the first place, as we've explained, there will be a tremendous amount of progressive scan transmission from the first day, if for no other reason than the fact that all film-originated material (all movies and 80% of prime time programming, including most commercials) will be transmitted in progressive scan. And we expect a great many video programs to be transmitted in progressive scan also. So any claim that interlace will cause the extinction of progressive is wrong on its face We believe the industry will migrate toward more and more progressive scan transmission over time, but if we're wrong, and interlace transmission thrives, then presumably it would reflect real needs being met in the marketplace. And Schreiber's claim that including interlaced scanning will eliminate the possibility for the system to be improved over time without rendering first generation equipment useless does not bear scrutiny. We and many others have described in detail the unmatched extensibility given to the system through the use of packet headers and descriptors. This capability exists independently of any particular scanning format.

Microsoft (at 6) says that interlaced scanning and non-square pixels make the standard incompatible with computers. Microsoft (Mundie attachment at 7), along with Compaq (at 17) and CICATS (at 23), also claims that even if one computer unfriendly format is included, receiving equipment will need to perform additional conversions and decoding to enable interaction with computer applications. CICATS (at A-4) boldly estimates the aggregate cost of this conversion to consumers at $85.6 billion, by assuming $400 (!) for the cost of a quality de-interlacer, times 214 million receivers

First, an absolute statement that including interlaced scanning formats makes the standard *incompatible* with computers is wrong on its face. Combination PC/TV products exist in the market today using analog NTSC technology. Interoperability with computers would be tremendously enhanced compared to these offerings even if the standard supported interlaced transmission formats exclusively, which of course it doesn't.

Second, for the next ten to fifteen years or so, every television using a progressive scan display will need to incorporate a de-interlacer in any event if for no other reason than to receive and display NTSC transmissions during the simulcast period. Thus, at least one so-called "computer unfriendly" format is guaranteed

Third, CICATS' estimated cost of a high-quality de-interlacer is grossly inflated. The Grand Alliance has developed detailed cost estimates for a range of ATSC DTV receivers that are representative of the products a manufacturer might include in its DTV product line.[39] As part of this analysis, the Grand Alliance estimates that the incremental parts cost of a high-quality de-interlacer in 1996 is $28 to support a high-end receiver with a high-resolution 720-line progressive scan display, and $2 to support a mid-line receiver with a 480-line progressive scan display. Applying Moore's Law[40] to reflect anticipated improvements in integrated circuit technology price/performance means the high-end receiver figure will be totally negligible by 2004 when substantial market penetration occurs. Thus, these parties' claims that expensive conversions required by the presence of any interlaced scanning format will render the standard incompatible with computers are groundless.[41]

Finally, although little more needs to be said, CICATS' estimate assumes that *every* TV in America will utilize a progressive scan display and therefore need a de-interlacer. We believe that a great many receivers with progressive scan displays will be sold for a variety of reasons, however, it's likely that there will also be a market for less costly models using interlaced displays.

CICATS (at 25, 27) further claims that off-shore manufacturers were primarily responsible for the decision to include interlaced scanning, and that including interlaced

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[39]*See* Reply Comments of the Grand Alliance, Fifth NPRM, August 12, 1996, at Appendix A.
[40]Moore's Law predicts that the capabilities of integrated circuit technology will advance by a factor of two every 18 months. We use a more conservative assumption here, a factor of two every two years.
[41]Similarly, Polaroid's claim (at 2) that de-interlacing at home is either expensive or poor quality, and RPCP's contention (at 3) that interlace requires costly and complex signal processing to make text and fine-line computer graphics acceptable though still impaired to the human eye, are greatly overstated.

scanning will raise costs, making it harder for computer companies to compete against incumbent receiver manufacturers for whom the standard was tailored.

Once again, it is the Advisory Committee, and especially broadcasters, who defined the requirements for the ATSC DTV Standard, and the Advisory Committee recommendation reflects a strong and broad consensus among the parties directly involved in the provision of free over-the-air television, achieved only after years of debate on these very issues and others. Furthermore, we believe that the processing required to make these conversions will be incorporated in widely available integrated circuits at competitive prices from a variety of sources. These claims that the proposed standard puts computer companies at an unfair competitive disadvantage have no basis in fact [42]

William Schreiber (in his May 9, 1996 letter to the Commission), asserts that with the recent introduction of a progressive scan camera by Polaroid, "the last remaining argument for including an interlaced format in digital television has now been removed." Polaroid (at 2) and RPCP (at 4) make the same claim, while CICATS (at A-4) argues that this development negates the Grand Alliance's claim that an interlaced format is necessary for high-quality HDTV.[43]

While the development of this camera, based on ATSC and SMPTE parameters, is a welcome technical achievement that will help facilitate even greater use of the progressive scan formats in the ATSC DTV standard, it in no way removes the fundamental tradeoffs between

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[42]Having been misled, we believe, by detractors of the standard, CFA/MAP (at 4, 7) repeats this fallacy, saying that the inclusion of interlaced scanning effectively insulates incumbent TV receiver manufacturers from new competition. However, they also find it inconceivable that a solution cannot be found to convert interlaced to progressive and vice versa. Indeed, as shown above, they are absolutely right. Cost-effective means to perform these conversions are already in hand.

[43]CICATS (at A-4) also states that Polaroid has introduced the world's first progressively scanned HDTV camera, the performance of which has been judged "superior to the 1080-line interlaced HDTV format in the [Advisory Committee] standard." This camera, developed by Polaroid, Philips/BTS, and MIT, though *not* the first progressive scan camera, offers performance characteristics that are greatly improved over earlier designs. CICATS' comparison of the camera to a transmission format is confusing, but assuming they mean interlaced cameras that output that format, their comparison is not based on independent, objective testing, but on the opinions of the justifiably proud developers of the new product. The marketplace will determine exactly how good this new product is for various applications.

progressive and interlaced scanning that make each of them advantageous and desirable for certain applications and under certain conditions. For example, the existence of a progressive camera does not mean that such a camera exhibits the same level of low-light sensitivity as an interlaced camera, a performance aspect that is vitally important for Electronic News Gathering (ENG) use. More fundamental to the critical issue for this transmission standard, no camera development can influence the compression related impact of interlaced scanning, which presents the compression encoder with one-half the number of pixels to compress compared to a progressive scan format of the same temporal rate and the same number of vertical lines. While interlacing causes the well-known interline flicker artifact, it must also be considered that compressing twice as many pixels in a progressive scan format would result in other compression artifacts, typically increased blockiness and noise in the picture. It is by no means established that either of these data reduction approaches (i.e., interlacing or greater data compression) is consistently preferable to the other. In fact, ATTC test results from the first round of testing clearly show that each approach offers advantages with different types of picture material. For such reasons, the Grand Alliance decided upon the inclusion of both formats, so that each content producer and broadcaster (collectively, the marketplace) could select their preferred format.

Moreover, Schreiber totally ignores the fact that the interlaced and progressive formats do *not* have the same horizontal resolution. He states "However, in the case of ATV, we are talking about coded digital systems, in which the data rate for the P and I formats are the same. In that case, the 720-line P format will have the same resolution as the 1080-line I format, as well as freedom from all interlace artifacts." Recalling that the DTV formats he is referring to are 1280 x 720 and 1920 x 1080, even if we were to agree with Schreiber that the vertical resolution is identical (and we're not convinced it is), his statements do not account for the increased horizontal resolution and resulting increase in picture quality that is provided by 1920 horizontal pixels compared to 1280.

Schreiber also claims (Vol. I at 11) that progressive scan doesn't require more channel capacity, because higher correlation permits a *doubling* of the compression ratio so that the same coded data rate is required for either scanning technique.[44] The references he attaches are not convincing, either because they proffer no such conclusion or because their results suggest different conclusions than they draw. In this case, we seem to have an existence proof that casts great doubt on his assertion. The Grand Alliance developers used every means possible within the MPEG-2 compression standard to get the best picture quality possible, and the 1080-interlaced format, presenting the encoder with 93.3 Mpixels/second (1920 x 1080 x 30 x 1.5 (a factor to reflect both luminance and chroma information)), and the 720-progressive format, presenting the encoder with 83.0 Mpixels/second (720 x 1280 x 60 x 1.5), delivered approximately equal quality, at least as judged by non-expert viewers subject to the quality limitations of the particular receivers utilized. At the maximum 19.3 Mbps payload of the transmission channel used for both formats, this means the encoder required .21 bits per pixel for the interlaced format, and .23 bits per pixel for the progressive format, i.e., the coding efficiency for progressive was about the same, or a bit less, but certainly not double that for interlaced. Indeed, if Schreiber's claim were true, we could transmit a 1080-line, 60 Hz, progressive scan format today within a 6 MHz terrestrial channel, and this tiresome debate would be over, at least for high-definition television. But we cannot, as he himself admits.[45]

One further point merits mention. Retaining the SDTV interlaced formats in the ATSC Standard is important, because they provide compatibility with the prevalent digital video products and services available today, e.g., digital DBS, MMDS, DVD, cable and telephone company-delivered services. All of these products and services rely on MPEG-2

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[44]Specifically, Schreiber (Vol. II, cover letter) claims that "[a] progressive-scan signal having the same frame rate as an interlaced signal, and the same number of lines/frame, and therefore having twice the analog bandwidth, when coded by MPEG, uses exactly the same data rate for compression."

[45]*See* Reply Comments of William Schreiber, August 6, 1996, at 5. (Such capacity could be achieved, but only for "downtown" viewers, by using a multiresolution "layered" system in which receivers recover a variable amount of data depending on the signal quality.)

Main Profile at Main Level encoding, which includes 480-line interlaced capability, but not 480-line progressive.

These debates about coding efficiencies, various coding artifacts and means to avoid them, measurable delivered resolution, and a host of other factors, have been going on for years and are likely to continue. The genius of the Grand Alliance system and the ATSC DTV Standard, is that it is inclusive. No broadcaster is obligated to use any particular format (although all 24 Hz transmission must be in progressive scan format). Rather, broadcasters will use the formats that best meet their needs. It is the marketplace, through competition and innovation, that will decide which formats are used for what purposes, and the Commission should not interfere with this process by banning interlaced transmission formats.

Several detractors of the standard, intentionally or unintentionally, continue to confuse transmission formats and display formats, e.g., BSA (at 6) says "[a]pproval of a *display* standard that permits use of interlaced technology would result in lower quality text and graphics making the product less useful and less appealing to consumers," and Microsoft (at 7, 8) says the FCC should be concerned about the quality of text and graphics *displayed* . . . the Advisory Committee proposed standard also includes a 60 Hz *display* rate, and urges the FCC to adopt a 72 Hz *display* rate. Siggraph (Attachment) urges the Commission to mandate progressive-only *displays*, saying that to allow the interlace option is tantamount to eliminating the other options for our lifetime, since a cheaper, non-compatible standard is embraced and produced first. Demos (at 2) says the Advisory Committee standard is clearly biased toward display of all formats on 60 Hz interlaced displays, and that the Commission should forbid the use of interlaced display in all new digital television receivers.

As we have explained before, the inclusion of interlaced *transmission* formats does not preclude the use of progressive scan *displays* where deemed desirable. Receiver and converter deinterlacers that offer excellent performance at reasonable cost already exist in the marketplace and others are expected very soon. Siggraph is clearly mistaken that the existence of interlaced displays will eliminate the availability of progressive displays.

Experience in both the computer and television industries proves otherwise, and numerous television manufacturers have already announced their intention to offer progressive scan displays in their initial HDTV offerings. We strongly urge the Commission to reject the proposals of Siggraph and Demos to ban the use of interlaced displays in DTV receivers.[46] Such an action would deprive manufacturers and retailers of the ability to market a broad range of useful products and would eliminate valuable options for consumers. Limiting manufacturer and consumer options would also extend the transition to digital television and delay the return of valuable spectrum.

For all of these reasons, the Commission should not attempt to relitigate the complex debate surrounding progressive versus interlaced scanning, but should adopt the consensus approach developed over the course of several years in protracted discussions of these issues within the Advisory Committee and the ATSC. The Commission should adopt the ATSC DTV Standard in its entirety, including the four interlaced scan transmission formats, and should summarily reject proposals to require all DTV receivers to incorporate progressive scan displays.

C. Square Pixels

As part of their opposition to the proposed standard, several parties strongly object to the inclusion of non-square pixels in some of the SDTV formats.

Microsoft (at 7) says that the use of non-square pixels in two of the formats is a problem that contributes toward making the Advisory Committee standard incompatible with computers. Compaq (at 17) says that requiring both pixel formats will increase the complexity and costs of consumer equipment. CICATS (at A-6) claims that converting non-square pixel material adds costs and degrades picture quality, and that this may be good news for set manufacturers, but is bad news for consumers and those who want demand for convergent products to take off. CICATS (at A-8) says it will be much less expensive in the

[46]Indeed, the computer companies whom Demos represents have long opposed government regulation of the performance or features of displays.

aggregate for broadcasters to make the conversion, and that equipment manufacturers' existing production standards may well have influenced the decision to include this enormously suboptimal feature in order to preserve the value of existing investments. RCPC (at 4) urges that all images be transmitted as square rasters, with any necessary production conversions taking place at the transmitting end, to be perfectly compatible with future display technologies such as light valve projectors and flat screens.

But as MECA explains (at 8-9), a non-square pixel SDTV format is necessary to provide backward compatibility, e.g., to enable the production of a montage digital television program where the producer chooses to include clips from old, non-square pixel NTSC programs. Consequently, to eliminate non-square pixels would restrict the creative options of future program producers and the program options of future viewers. Sony (at 3, 34) points out that the ITU-R-601 4:2:2 digital 525/625 studio origination standard was adopted almost 15 years ago, and the enormous reality of digital SDTV production -- in all 525 and 625 countries -- means that the non-square pixel SDTV format, based upon ITU-R-601 and the MPEG-2 standard, is vital to an orderly U.S. transition to digital SDTV transmission and must be maintained.

Thus, once again these complaints provide a stark example of how these commenters opposing the standard want every design decision made to maximize their narrow objectives, and seem oblivious to any impact on *television service*, or to the needs of broadcasters or any other affected industry. And even the alleged negative impacts on the narrow applications they do consider, as usual, are grossly exaggerated. No informed party in this debate believes that the inclusion of some non-square pixel formats is "enormously suboptimal," nor does it render a digital television system "incompatible" with computers.[47] And asserting that set

[47]Although he favors square pixels, Schreiber (Vol. II at 5) says square pixels are less important to the computer industry than progressive scan, and it would not be the end of the world to permit the 480 x 704 SDTV format. Carroll (at 1) says that non-square pixels should be a self-liquidating temporary measure, provided only for backward compatibility at lower performance levels. This is the case. All of the HDTV formats use square pixels exclusively, but as explained above, some of the SDTV formats include non-square pixels to provide backward compatibility with existing 525/625 television standards.

manufacturers or anyone else would benefit from adding unnecessary costs to receivers is preposterous, and more so with each repetition.

Liberty Imaging (at 2) urges the Commission to add a square-pixel version of the 704 x 480 SDTV format, i.e., 848 x 480, saying that it will be very useful for defense and other government uses. In the ATSC and Advisory Committee deliberations that eventually led to the broad industry consensus on SDTV formats, careful consideration was given to a wide variety of needs, and multiple formats were included in order to support them. Many other formats, including this one, each having some useful application, were proposed and evaluated, but ultimately not included in the consensus list. Though Liberty's suggestion is well-intentioned, we believe that these needs can be accommodated fully within the included formats. We see no compelling reason to add additional SDTV formats at this late date.

For all of these reasons, the Commission should adopt the industry consensus embodied in the ATSC DTV Standard, including the SDTV formats that contain non-square pixels.

D. Refresh Rate

The same collection of computer companies and film makers objects to the picture refresh rates included in the ATSC DTV Standard.

CICATS (at *iii*, A-11) claims that by not permitting broadcasters to transmit at rates above 60 Hz, the Advisory Committee standard guarantees that every DTV broadcast will have to be converted in computer-compatible displays. Compaq (at 18) says picture rates of 30 and 60 Hz can be upconverted for display on computer monitors, but it requires costly additional processing power and degrades picture quality. Microsoft (6) and BSA (at 6) make similar complaints about the need for higher rates. Demos (at 1-2) urges the Commission to reject the obsolete 29.97, 30, 59.94, and 60 Hz frame rates, and also recommends 72 Hz as a more natural *display* rate.[48]

[48]Once again, CICATS (at A-11) states that existing manufacturing standards may have influenced the Grand Alliance's selection. This is silly. In the first place, the Advisory Committee, not the Grand Alliance,

Once again, these complaints demonstrate a myopic focus on the narrow DTV applications of interest to these parties, showing a complete disregard for any impact of their proposals on the ability to provide high-quality television service over 6 MHz terrestrial channels. Increasing transmission frame rates from 60 Hz to 72 Hz increases the pixel rate a video coder must handle by 20%, and this cannot be done without paying the piper somewhere else.[49] In the case of the highest resolution formats, this can only show up as a degradation in quality and it is a very substantial degradation indeed. And to claim that this is pure speculation, as CICATS and others do, is nonsense. Anyone who has ever built a digital video encoder knows otherwise.

To be sure, some cost will be involved in making personal computers capable of receiving DTV broadcasts (e.g., the cost of MPEG-2 and AC-3 decoders), just as it will involve added costs to make digital televisions capable of handling information services that go beyond traditional television services. But this doesn't mean that every television should be required to bear the cost of doubling as a computer monitor, nor that the quality of terrestrial broadcast television services should be sacrificed in order to make computers that handle DTV transmissions marginally less expensive.[50,51]

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recommended the standard. Beyond that, choice of a frame rate is a tradeoff between many factors, and for the primary application of broadcast television, 60 Hz is fully adequate. And as we explained in detail in our initial comments, transmission rates need not be the same as display rates, and those applications that require a higher display rate can easily make the necessary conversions. Indeed, Hitachi America (at 4) states that 60 Hz is appropriate for the transmission standard, but actual *display* rates are not limited by the standard, and Sony (at 26) explains that any refresh rate desired can be utilized in displays, noting that they have already marketed a 28", 16:9, 72 Hz, 1920 x 1080, progressive scan computer display.

[49]As Sony points out (at 3, 26), the 60 Hz transmission rate ensures full resolution HDTV transmission through the narrow 6 MHz channel, but the critics of the 60 Hz refresh rate appear oblivious to the fundamental linear relationship between television frame rate and the bandwidth required to sustain that frame rate.

[50]Carroll (at 3) says accommodating the desires of computer companies for a higher refresh rate is a tougher problem, and suggests that computers fall back to 60 Hz when displaying broadcast signals simultaneously with computer output. Schreiber (Vol. I at 10) first says that the computer industry's preference for 72 or 75 Hz is much harder to satisfy, that upconversion at the receiver is possible but expensive, and that it's too late to make fundamental changes. In his second submission (Vol. II at 1), however, he mentions including any frame rate that is a multiple of 12 as an improvement that could be made to the system. For the reasons outlined above, we do not agree that changing the frame rate to include any multiple of 12 would be an improvement to the system, but we certainly agree that it's too late to make fundamental changes, particularly such ill-advised changes

On this issue the motion picture industry is again split. MPAA (at 7) says complaints about the 60 Hz transmission rate are unwarranted. However, the Film Makers Coalition (at 9) supports the 24 Hz refresh rate in the Advisory Committee proposal, but expresses concern regarding the 30 Hz and 60 Hz rates, fearing that broadcasters might use these rates with the 3-2 pulldown technique rather than the 24 Hz rate to transmit film.

The Film Makers should be reassured that broadcasters will always transmit motion pictures in progressive scan at a 24 Hz refresh rate. The 24 Hz rate was specifically included in the standard to take advantage of the fact that film is produced in 24 Hz and can therefore be sent at that low frame rate, yet displayed at higher rates in receivers, and the ATSC DTV Standard requires 24 Hz transmission to be progressive scan. An ATSC DTV encoder can automatically detect any material that was originally produced in film, including all movies and about 80% of all prime time television programming, and send that material using one of the 24 Hz, progressive scan formats. Broadcasters will be highly motivated to use 24 Hz progressive scan transmission for film-originated material, since it will allow them to save bandwidth which they could use to improve picture quality or to send auxiliary services.[52] The 60 Hz rate, of course, is the rate for video, not film, and it will be used to carry live video and recorded video material.

In our initial comments (at 24-25) we discussed this issue from a broadcaster and regulatory perspective, from a television receiver perspective, and from a computer perspective, showing conclusively that the refresh rates included in the ATSC Standard are not a problem. The other comments strongly reinforce our conviction that the Commission should adopt the ATSC DTV Standard without requiring any modifications to the

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[51]Thus, Demos' suggestion that the Commission regulate DTV receivers to require a 72 Hz display rate should be rejected. The Commission should not regulate the performance or features of displays, as the computer industry has long held.

[52]The 30 Hz rate, like the 24 Hz rate, is a film mode supported by the DTV standard. Television commercials are often shot in 30 Hz film. As with 24 Hz film, the system will automatically detect material originally produced in 30 Hz film and send that material using a 30 Hz progressive scan format.

transmission picture refresh rates, and that the Commission should not impose any requirements whatsoever regarding the refresh rates of displays.

E. Aspect Ratio

Some members of the motion picture industry and the coterie of computer industry complainers raise strong objections to the 16:9 aspect ratio incorporated in the proposed standard. Other members of the motion picture industry and most other parties staunchly defend 16:9.

Addressing the complaints, the Broadcasters (at 11-14) state that this flurry of dissatisfaction with the 16:9 aspect ratio comes late in the process, and reflects a disregard for the needs of the vast majority of television programming and the realities of set design. They state that 16:9 is the best choice, by far, and preferred around the world; that with screens of equal diagonal measurement 2:1 would be marginally better for the widest 20% of films, but would be worse than 16:9 for the remaining 80% of films and all other 16:9 or 4:3 television programming; and that for screens of equal height 2:1 would entail a 12.5% greater display area, which would mean 30-50% heavier TV sets with greater weight and memory adding considerable cost to receivers.

The Grand Alliance (at 25-26), Thomson (at 12-13), and Zenith (at 11-12) add that changing the aspect ratio at this late date would increase costs to manufacturers and ultimately to consumers, and that sets with wider aspect ratios would be far more expensive. Sony (at 3, 31-32) explains that an aspect ratio must accommodate original 4:3 material, vintage motion pictures, and different widescreen formats, and still make displays affordable, and that 16:9 is an excellent choice to satisfy these multiple objectives

Within the motion picture industry, MPAA (at 2, 4) supports the 16:9 aspect ratio, saying that it appears that a wider aspect ratio would represent a net loss to the public, both in

terms of the cost of digital receivers and the overall amount of original material that can be displayed without panning and scanning or "letter boxing."[53]

In contrast, the Film Makers Coalition (at *i*, 4) urges the Commission to require that broadcasters transmit all films in their original aspect ratios, and that if receiver standards are adopted, they should include a 2:1 aspect ratio. They argue (at 3, 5) that because the Advisory Committee proposal limits broadcasters to transmitting in 1.78:1 or 1.33:1, widescreen feature films (at 1.85:1 and wider) would be *unable* to be viewed in their original formats. They claim that for films wider than 1.78:1, broadcasters would be forced to cut down the images to fit in the more narrow aspect ratio, and that this panning and scanning technique fundamentally alters the dramatic impact of widescreen images. Thus, under the proposed standard, they claim (at 7) that they must either produce images based on more narrow aspect ratios or acquiesce in the destruction of their work when displayed on DTV. As an example, they discuss how many apostles might be eliminated from Da Vinci's The Last Supper if cropping were used to accommodate poor choices of aspect ratio.

The claims that widescreen feature films would be *unable* to be viewed in their original aspect ratio, and that film makers must either use narrower aspect ratios or acquiesce in the destruction of their work, are simply wrong. Beginning with the first movie transmitted over DTV, films can be shown in any aspect ratio desired by the movie owner by using letterboxing in the film-to-video transfer process.[54] With 16:9 (1.78:1) widescreen receivers (the deeply embedded worldwide standard), this would require minimal black bands (4% of the screen height) for the 80% of movies that are produced with a 1.85:1 aspect ratio, and larger black bands (25% of the screen height) for the 20% of movies produced with a 2.4:1 aspect ratio.

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[53]Universal Studios (at 2) endorses the MPAA comments with respect to the proper aspect ratio.

[54]Schreiber (Vol. I at 10) states that a 2:1 aspect ratio is much too wide for much material that is used today, and that aspect ratios wider than 16:9 can be accommodated by the letterbox method. Carroll (at 3) says aspect ratio is not such a big issue, discussing windowing options that can be used to show video on squarish PCs.

Indeed, after making all of these complaints, the Film Makers Coalition (at 6, fn. 8) casually mentions the letterboxing solution in a footnote

Furthermore, until someone invents a receiver that changes its physical shape on demand, the only way to show *all* films in their original aspect ratio is to use letterboxing. However, this is strictly a matter for film owners and broadcasters to work out between themselves. If a film maker insists that his or her widescreen film be shown in its original aspect ratio, he or she can insist upon letterboxing rather than panning and scanning in any agreement reached concerning DTV broadcasts of that material. There is no valid reason for the Commission to interfere in such private negotiations.[55,56]

Primes generally echoes the comments of the Film Makers Coalition, but further argues that 1.33:1 material is generally comparatively low resolution television, so it isn't as much of a problem to have side curtains and lower resolution on such material, and therefore, the aspect ratio should be weighted toward the wider media because wide material needs to be magnified and fill the screen and squarer NTSC material simply does not. But as the Broadcasters articulated in the comment noted above, Primes' proposal for a wider aspect ratio would be marginally better for the widest 20% of films, but would be worse for the remaining 80% of films and for all 16:9 HDTV and all 16:9 or 4:3 SDTV video programs. This is one more example where a complaint about the standard reflects a desire to satisfy one particular point of view without due regard for other important needs. The Advisory Committee's recommendation, by contrast, must and does provide a balanced solution to meet a wide variety of needs In addition, the ATSC DTV Implementation Subcommittee is in the

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[55]The Film Makers Coalition (at 7) argues that a government requirement that film images be forced into an artificial aspect ratio is inconsistent with the Telecom Act and other important principles. Of course, no one is proposing anything of the sort. Film makers can produce in any aspect ratio they desire and can insist that their work be shown in its original aspect ratio, if they wish, by using letterboxing.

[56]The Film Makers Coalition (at 6) also claims there is no flexibility in the standard -- present or future -- with respect to the aspect ratio. Once again, this is simply not true. Letter boxing provides complete flexibility from day one; and for the future, the ATSC DTV Standard would permit new aspect ratios to be incorporated by defining new packet identification headers in the transport system, however, such additions could not be made lightly, because of backward compatibility problems. *See* EIA/ATV Comments at 15

process of reviewing areas such as this to determine if Recommended Practices are warranted. We have invited cinematographers to participate in this activity, and are hopeful that they will offer their knowledge and perspective.

Compaq (at 18) and CICATS (at 25) argue that specifying only two aspect ratios is unnecessarily restrictive and ill-considered, and that the proposed standard is incompatible with motion pictures and will perpetuate their adulteration.[57] CICATS (at 26) states "Because many films have wider picture aspect ratios than the two prescribed by the ACATS standard, presentation on DTV of many films . . . would require amputation of part of the filmed image -- losing as much as 45% of the image of a widescreen movie on a 4:3 screen and resulting in viewer confusion and impairment of artistic quality. . . . Such adulteration of one of our country's most vital art forms should be avoided." (footnotes omitted)

In the first place, the ATSC DTV Standard emphasizes the widescreen 16:9 aspect ratio, and uses it exclusively for all of the HDTV formats. (One of the primary reasons for including a 4:3 aspect ratio for SDTV formats is compatibility with 4:3 computer displays!) The availability of 16:9 aspect ratio formats alleviates the problem tremendously and is a substantial improvement over today's single choice of 4:3.

It is, in fact, the CICATS proposal that would wreak havoc with artistic considerations. If a wide variety of aspect ratios were transmitted without any established default transmission standard aspect ratio, each television receiver manufacturer would probably handle them differently: some would letterbox, some would "auto pan-and-scan" and some would crop arbitrarily. The result of the CICATS proposal would be complete loss of artistic control by the creative community. As CICATS notes in its Technical Details exhibit (at 4), "[w]hen these constraints are removed, then any aspect ratio image

[57]Again, we find it remarkably inconsistent that Compaq and CICATS would vehemently criticize the proposed standard for supporting too many video formats and at the same time criticize it for supporting too few aspect ratios.

can be sent through the channel. It would then be up to the receiver to display what it can by either pan-and-scan or letterboxing, or a combination of the two."[58]

Primes (at 7-8) states that deep within MPEG-2 there is a mechanism for viewers to watch panned and scanned versions of programs, and urges that this code be disabled, saying the public should not be given the choice to eliminate part of the picture.[59] Once again, this seems to be a request for the government to intervene *a priori* in negotiations between content owners and content deliverers. Such panned and scanned versions of programs will not exist unless the licenses granted by owners give broadcasters the right to show films in this format. This is a matter for film owners and broadcasters to resolve by themselves, but viewers should certainly not be deprived of the capability to choose if film makers agree to make choices available

Given the great, genuine concern that film makers rightfully feel for maintaining the artistic integrity of their creations, we can't help but express again our puzzlement that some of them do not adamantly demand that any DTV standard *at least* ensure the availability of full HDTV resolution from day one of the transition to digital television. For the first time in history, HDTV offers them the ability to deliver to viewers in the home pictures with resolution comparable to that available in movie theaters. And although most ATSC members are not film makers, we would expect that conveying the full resolution of a picture would be at least as important as maintaining its full spatial extent in terms of preserving artistic integrity. Isn't it at least as important to see a tear in Jesus' eye as to see all twelve apostles?

We believe that the logical extension of the Film Makers' aspect ratio arguments to picture resolution would have them ask the Commission to impose a requirement that all movies be delivered in their full original *resolution*, i.e., in HDTV. While we would not endorse such a policy, we are amazed that some of them have chosen to embrace the

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[58]Primes (at 7) also advocates not specifying an aspect ratio, but as explained above, we believe his recommendation would mean far *less* artistic control over the content consumers ultimately view.
[59]Note that this MPEG provision is solely for the purpose of displaying a 16:9 picture on a 4:3 screen.

unproven CICATS counterproposal -- a proposal that does not incorporate HDTV at all in the baseline FCC standard, but only promises HDTV in future enhancement layers if market demand develops and if doubtful, untested technical claims bear fruit. These members of the film industry seem to be swatting at the aspect ratio gnat, while swallowing the resolution camel!

For all of these reasons, we urge the Commission to adopt the ATSC DTV Standard, including the aspect ratios recommended by the Advisory Committee.[60]

F. Need for a Data Broadcast Standard

As noted previously, several parties, including Intel (at 3), CICATS (at 17, A-12), and Compaq (at 21), express the need to ensure that the ATSC DTV Standard can deliver computer data, including executable code, but they intend to pursue this in appropriate industry groups and state that this work needn't postpone action to adopt a standard.[61]

In our initial comments we described the effort it has begun within ATSC to define a data broadcast standard, including our efforts to involve more members of the computer industry in this activity. Indeed, since that time, this ATSC working group, chaired by Intel, has held its first meeting and begun this important work to develop a supplement to the ATSC DTV Standard.[62] While Intel does not support portions of the ATSC Standard, they have show significant leadership by committing to work with the television industry on

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[60]As Appendix B to these reply comments, we provide the Commission with Mark Schubin's very informative paper, "Searching for the Perfect Aspect Ratio" regarding the debate over the appropriate aspect ratio for advanced television displays. Although his paper focuses on the aspect ratio for *displays*, the historical information he includes and the analysis he provides give useful insight into the debate on the proper transmission format aspect ratio as well. His paper finds that there is no clear evidence of an aesthetic or physiological reason to choose any one display aspect ratio over another, and after noting several advantages of the 16:9 ratio, including the fact that it has been chosen and is in use around the world, he concludes that his research has found no compelling reason to change any existing choice of aspect ratio.

[61]Demos (at 8) also urges the Commission to refer the transport portion of the standard to a competent committee for additional work to provide error-free data delivery, while Hitachi America (at 7) highlights the flexibility provided by the ATSC DTV Standard for defining data services different than video services.

[62]As we made clear in our initial comments, this type of supplemental standard need not be part of the basic DTV standard adopted by the Commission.

development of new standards and services. We are hopeful that other members of the computer industry will participate in this exciting area of development."

G. Interoperability with Other Delivery Media

In our initial comments we noted the significant investments and contributions of the cable industry throughout the Advisory Committee process to ensure the suitability of the standard for carriage over cable systems, saying that as a result we believe that as voluntary standards activities continue in the cable industry, and for other video delivery systems, it is likely that many elements of the terrestrial ATV standard will also be incorporated in emerging standards in these industries. We further stated our belief that such voluntary standards will promote the early availability of digital television, including HDTV, over all of these other media as well as terrestrial broadcasts, without causing undue burdens on cable operators or other providers.[63]

The Broadcasters (at *iii*, 2, 24-32) take a different view, urging the Commission to take all steps necessary to ensure that the cable industry adopts the ATSC DTV Standard, or achieves maximum commonality with it, saying that in addition to adopting the terrestrial broadcast standard, other measures may be necessary to bolster consumer confidence that the sets they buy will be compatible with cable and other video transmission technologies. The Broadcasters describe in some detail the benefits they see flowing from intermedia compatibility forged by a common standard. They prefer a regulatory alternative whereby the Commission would require cable systems and other video distribution systems to adopt the DTV standard, but say that the next best, but far less preferable, alternative would be to require intermediate levels of commonality. They advocate specific requirements for various scenarios that will occur during and after the transition to DTV, and urge the Commission to

[63]The Grand Alliance (at 27) argues further that the ability of these other competitive delivery media to introduce compelling new technologies without FCC review and approval will continue to provide pressure to ensure that universal broadcast television service implements the technology required to remain responsive to consumer needs.

adopt firm principles in this proceeding, but work out the details in a separate proceeding, so that expeditious licensing of DTV channels is not further delayed.

ABSOC (at 3) notes the importance that standards adopted for ATV and for other delivery media, including cable, satellite, and telecommunications networks, include a maximum degree of commonality, to ensure both interoperability and acceptable levels of cost to consumers and service providers. Similarly, Schreiber (Vol. II at 3) says the standard should discourage the proliferation of noncompliant receivers for cable, DBS and niche markets. Receivers for any new TV service should be usable for all new TV services.

In contrast to the Broadcasters, most manufacturers favor relying on market forces, but note the benefits that rapid adoption of the ATSC terrestrial broadcast standard would provide for encouraging compatibility with other delivery media. For example, MECA (at 10-11) states that market forces will provide an incentive to non-broadcast industries to support the ATV Standard if it is promptly adopted, and urges the Commission to act rapidly before proprietary technologies become entrenched, while Dolby (at 4) argues that a strong FCC mandate for the ATSC DTV Standard would promote interoperability with other media.

The Grand Alliance (at *iii*, 26-27), Thomson (at 14), and MPAA (at 8) echo the view that as voluntary standards efforts continue for other video delivery media, it is likely that many elements of the terrestrial ATV standard will be incorporated in emerging standards in these industries. Zenith (at 13) and Thomson (at 14) state that the ATSC DTV Standard should provide the core of these other standards. General Instrument (at 8) notes that the ATSC standard is highly interoperable with non-broadcast transmission media without limiting the flexibility of those media. While 8 VSB modulation was selected for broadcast television, satellite systems employing the same digital audio and video compression will use QPSK, while cable TV is deploying 64 QAM and eventually 256 QAM. In this way, manufacturers can take advantage of maximum commonality of components without sacrificing the special benefits of different transmission media.

Zenith (at 13) states "[i]n light of the fact that approximately 60 percent of all television viewing in cable TV homes is of broadcast television stations, it is vital that the Commission assure that cable transmission and other video delivery methods are compatible with the broadcast DTV standard, i.e., that cable signals are compatible with ATSC-compliant receivers, based on known standards. Zenith adds that in the case of modulation, cable compatibility will be assured as consumer electronics manufacturers introduce cable-compatible DTV receivers that operate with both ATSC terrestrial 8-VSB and ATSC high-data-rate 16-VSB signals, and by Commission requirements that DTV signals on cable are to be "passed through" to the DTV receiver in ATSC-compliant 8-VSB or 16-VSB form. Ultimately, Zenith believes, receivers and converters that perform both VSB and QAM demodulation may be feasible, but the cable industry needs to agree upon a single QAM approach.

EIA/ATV (at 16-17) argues persuasively that the rapid implementation of the broadcast ATV standard will create momentum that should facilitate the resolution of many technical issues without Commission intervention, and that DTV implementation should not be delayed pending resolution of all of the nettlesome cable interoperability issues. Once the ATSC DTV Standard is adopted and several additional minor steps have been taken, EIA/ATV believes that marketplace forces and the voluntary standards-setting process will foster resolution of the remaining issues.

Commenters in the cable industry oppose applying the standard to cable or other video delivery media. NCTA (at 12, Owen appendix at ¶38) argues strongly that the Commission need not become involved in assuring compatibility between digital broadcast standards and digital standards for cable and other delivery media. NCTA argues that while the standard may *work* on cable and other media, there is no reason to believe it is optimal for the public, the vast majority of whom receive video by means other than terrestrial broadcast.

TCI (at 3) states that imposition of the ATSC standard would be especially ill-advised for non-broadcast multi-channel video program distributors (MVPDs), and that TCI and other

MVPDs have invested billions of dollars in state-of-the-art digital technologies that would be undermined by a government-imposed digital broadcast standard. TCI (at 20) notes that even if different transmission standards are employed by broadcasters and cable, if all new digital receivers can receive both broadcast and cable digital transmissions, or if subscribers can use set-top boxes to receive cable transmissions, consumers need not be concerned about being stranded, noting that CableLabs has patented a hybrid VSB-QAM demodulator that could be built into digital TV receivers for an incremental cost of approximately $15.

Similarly, Pacific Telesis (at 1) opposes any extension of the "Grand Alliance" DTV standards or application of any required transmission standards to new video technologies such as MMDS.

In light of all of these comments and the complicated issues surrounding compatibility with cable and other delivery media, we agree with those parties who believe that the best possible course for the Commission is to promote the resolution of these compatibility concerns by swiftly adopting the ATSC DTV Standard for terrestrial broadcast service.[64]

VII. The Commission Should Not Impose Receiver Requirements

The Broadcasters (at *iii-iv*, 32) urge the Commission to adopt receiver standards as are necessary to ensure that consumers can choose equipment that matches at the receiving end the performance levels the standard promises at the transmitting end. They state that sets must receive all formats and reject interference, and must live up to the performance capabilities of the Grand Alliance prototype system, and that the Commission has the authority to impose such requirements. Island Broadcasting (at 3) urges the Commission to require

[64]TelQuest (at 4-5) disagrees that the ATSC standard is suitably interoperable with other video delivery systems, and urges the Commission not to mandate a modulation scheme for terrestrial broadcast service, but let the industry develop a single modulation scheme other than VSB. The Commission should reject this suggestion. As explained by General Instrument in the passage quoted above, different modulation schemes are appropriate for different applications. The VSB modulation scheme was incorporated in the Advisory Committee's recommendation because it best met the needs for terrestrial broadcast service. There is no reason to think that "the industry" should, could or would adopt a single modulation scheme for all video delivery media.

receiver designs that will maximize protection to adjacent NTSC channels from DTV channels.

A. The Commission Need Not Adopt an All-Format Receiver Requirement

In our initial comments, noting the significant amount of HDTV programming that broadcasters intend to provide, we stated that it would be foolhardy for any manufacturer to offer digital sets in the marketplace that go dark for any programming, much less a substantial amount of broadcast programming. Consequently, we said, digital receivers will have all-format reception capability with or without any government mandate to do so.

EIA/ATV (at 18-19) argues that nowhere in its final report did the Advisory Committee Technical Subgroup advocate an all-format requirement, that the FCC lacks authority to impose such a requirement, and that it is unnecessary in any event, because the marketplace will ensure a robust market for digital receivers and converters capable of receiving all DTV formats. MECA (at 11-12) similarly argues that with a transmission standard in place, a receiver standard is not required, and that market forces will ensure that receivers support all formats. They see a fundamental difference in that broadcasters specifically asked the Commission to adopt a standard, but manufacturers did not. Zenith (at 4) and Thomson (at 15) say a requirement is unnecessary, while General Instrument (at 4, fn. 2) argues that receiver requirements can and should be left to the marketplace. The Grand Alliance (at *iii*, 28) says all-format capability will be offered without any government mandate to do so, and the Commission need not and should not impose such a requirement.

Hitachi America (at 8-9) believes that the capability is essential and that all consumer electronics manufacturers will recognize this and act accordingly, but if not, the FCC may need to take steps. Tektronix (at 4) supports such a requirement, i.e., that all DTV receivers and set-top boxes be required to provide picture and sound from any of the DTV formats, arguing that it will do no harm.

ITI (at 3) urges the Commission to adopt a requirement that all DTV receivers receive, but not display, all formats. However, Intel (at 9, fn. 5) opposes a requirement that

only all-format receivers be used, saying "If a computer equipped with a TV tuner were considered a receiver, which Intel believes is not the case, the Commission would be doing a great disservice to the computer user by first selecting several formats not suitable for computer display and then forcing the consumer to buy an expensive device that attempts to correct the problem."

After reviewing these comments we remain convinced that manufacturers will be amply motivated by marketplace forces to provide all-format reception capability, with or without any government mandate to do so

B. The Commission Should Not Impose Other Receiver Requirements

In addition to the Broadcasters, AFCCE (at 2) supports further requirements on ATV receivers, including minimum requirements for such characteristics as noise figures, equalizer range, and adjacent channel signal immunity, among others, so that the planning factors on which channel allotments are based will result in the best possible service to the public. Carroll (at 7-8) says there is no reason to tolerate bad receiver design for an instant.

MCEA (at *i*, 5) urges the Commission to avoid establishing performance standards for receivers, and MECA (at 12) says there clearly is no need for such requirements. Tektronix (at 4) argues that quality standards should be the subject of voluntary industry standards. The Grand Alliance (at 28) states that if it is determined that any minimum performance levels need to be established for DTV receivers, they should be the subject of voluntary industry standards, just as they have been with the current analog system for many years.

In our initial comments (at *iii*, 29) we explained that the ATSC Implementation Subcommittee, consisting of broadcasters, receiver manufacturers, and others, is examining the need for such requirements related to the reception performance of receivers, and that if they are deemed necessary, we will work with the Consumer Electronics Manufacturers Association to develop such standards, but that such considerations need not and must not delay the adoption of a standard, whether such standards are voluntary or become the subject

of FCC regulations.[65] Considering all of the comments, we remain convinced that this is the best course to pursue. Accordingly, we urge the Commission not to adopt any performance standards for receivers at this time.

Regarding other potential receiver requirements, Siggraph urges the Commission to adopt progressive scan as the one acceptable method of *display*. Microsoft (at 7-8) asks the Commission to require that text and graphics *displayed* on a DTV meet the requirements for text and graphics currently in use for computers, and to incorporate a 72 Hz *display* rate, yet CICATS (at 22) says it does not want the Commission to mandate *display* standards. And Demos (at 2) (the architect of the CICATS counterproposal) urges the FCC to forbid the use of interlaced displays in all new digital television receivers. Intel (at 9) opposes all receiver requirements beyond those necessary to prevent cross-interference between equipment, and PCUBE (at 4) urges the Commission not to mandate any receiver requirements.

With respect to displays, we strongly urge the Commission not to impose any requirements whatsoever, a position that the computer industry has held for many years. Any such requirements would interfere unnecessarily with the competitive market for receivers and would deprive consumers of valuable options and increase prices.

VIII. Rapid Adoption of the Standard Will Promote International Trade

In our initial comments we highlighted the efforts within the Advisory Committee to promote international compatibility of the standard, and stressed the benefits of promoting use of the standard around the world, concluding that the most important thing the Commission could do to facilitate international compatibility and promote export opportunities is to adopt

[65]Thomson (at 15) and Zenith (at 15) endorse this position, but they believe that any such standards should definitely be voluntary.

the ATSC DTV Standard as rapidly as possible.[66] The other comments on this topic strongly support these conclusions.

NTIA (at 1-2) explains that "[a]doption of a digital transmission standard promises to spur the American economy in terms of manufacturing, trade, technological development and international investment -- including job growth," and "will provide U.S. industry an opportunity to regain a larger share of the world's consumer electronics market." NTIA (at 2-3) also describes the growing momentum of DVB, and the likely negative impact if the U.S. government delays or forgoes adoption of the standard, saying "[t]he Commission must act rapidly to ensure that American industry and consumers are able to fully capitalize on the years of hard work that have gone into the development of a new advanced television system. If we fail to act now, the window of opportunity may be closed by the success of competing foreign standards."

OSTP (at 1-3) calls attention to the ever-diminishing "window of opportunity" for the U.S. to define a worldwide standard, describes the threat that inaction will leave the field to DVB, and gives a powerful recitation of the global economic benefits that will flow to the U.S. by prompt adoption of the standard, but will be drawn away by foreign competitors if the Commission fails to act rapidly.

The Broadcasters (at 7), Thomson (at 16), Zenith (at 15-16), and the Grand Alliance (at *iv*, 29-30) all echo the view that the most important thing the Commission can do to promote international trade is to adopt the ATSC DTV Standard as swiftly as possible. Philips (at *v*, 16) sees America on the brink of relinquishing its lead to international competitors, and asks whether the U.S. will become an exporter of DTV and its spin-off technologies, or become an importer of an inferior foreign standard. Philips (at *v-vi*) and Thomson (at 2) stress the importance of adopting a standard for preserving and creating jobs

[66]We also described recent changes in the charter of ATSC to facilitate our ability to promote the adoption and use of the ATSC DTV Standard in other countries, noting that our efforts encounter the obvious obstacle that the standard has not yet been adopted for terrestrial television in the United States.