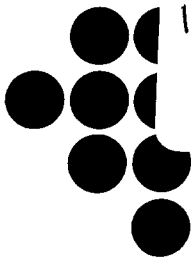

COMMUNICATIONS
FORUM

HDTV AND INDUSTRIAL POLICY:

LESSONS FOR THE 1990s

November 2, 1989

Seminar Notes

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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Robert Cohen, Economics Consultant

Lee McKnight, Postdoctoral Fellow, MIT

Lester Thurow, Dean, MIT Sloan School of Management

Antonio J. Botelho, M.I.T., Rapporteur

Lee McKnight, Post Doctoral Fellow, Center for Technology, Policy and Industrial Development, MIT, opened the session briefly introducing speakers and noting the controversial and complex nature of the topic.

The first speaker was Robert Cohen, Economics Consultant, who has recently been working on Japanese R&D activities related to HDTV. Cohen began by providing an overview of what the Japanese have done to become leaders in HDTV as well as what they are doing in relation to the coming generation of products based on HDTV research. Referring to Exhibit 1, Cohen pointed out that the Japanese have spent roughly $ 1-1.5 billion dollars over the past 25 years in the area. Most of the funds have come from the private sector, but complemented by efforts in the NHK laboratories and more recently MITI's Visual Control project.

Cohen explained that one of the reasons the Japanese have put so much effort into HDTV is the large potential market, as estimated by the Ministry of Post and Telecommunications (Exhibit 2). By the year 2,000 the annual sale will be about $ 20 billion for just HDTV television, not including a number of related spinoffs (package software, HDTV theatre). Referring to Exhibit 3, Cohen noted some of the current public programs. Over the next 5-7 years there will be about $ 2 billion put in these efforts. This compares with $ 500 million program for HDTV in Europe and a possible $ 30 million possible program in the United States under DARPA.

Next, Cohen pointed out that as part of their HDTV effort the Japanese are developing the infrastructure needed to take from what is now a satellite-based communication system to a baseband network (Exhibit 4). Recently, NTT announced that its Information Network System annual spending was rising to $ 10 billion a year. This is possibly 3-4 times what is being spent in the United States and Europe. It will make quite a difference in terms of an infrastructure for communications, computing and imaging.

Cohen went on, referring to Exhibit 5, to comment on some of the early applications of HDTV technology in Japan. Most of these initiatives will be operational by 1990 and they are usually financed by MITI or MPT. He also pointed out that the finance is quite generous, particularly when a third sector corporation, a joint venture between a public and a private company, is involved. For third sector corporations money is provided for the first three years with no interest, and half of the prime in subsequent years. Moreover, now there is much more hands on activity on the part of the financing institutions. For example, they will help in providing the support infrastructure (e.g. software development) and training.

Cohen observed that the Japanese strategy is to move from test types of HDTV on traditional sets to more real and costly HDTV in industry, to do things like design. Even American companies have started buying systems from the Japanese, e.g. Ford. HDTV can also be very helpful in automated manufacturing for high-resolution visual control.

Cohen then commented on where the Japanese, based on a MITI-sponsored Delphi study, think the HDTV technology effort is going to move in the next 20 years (Exhibit 6). They

are looking for 2,000 by 2,000 pixel screen development by the year 2,000. In relation to Exhibit 6, Cohen also pointed out that future convergence of HDTV technology creates an above average need for government financing and will increase its importance for defense and communications purposes.

Cohen then noted that among the different ways the technology is being financed, the Key Technology Center (JKTC) is a key institution. This center is financed from several sources, including special funds from the Ministry of Finance (under Government Financial Institutions) and dividends from Japan Tobacco. More recently, a special fund has been set up for the JKTC. Finance includes low interest rate loans to small and medium business as well as deferrement in pay back.

One of Cohen's concern is that response in the United States has been fairly limited. In fact, the Bush Administration has cut back on its HDTV efforts and an HDTV focused group may be dissolved. Why is it so? First, the Bush administration does not want to have anything to do with something smacking of industrial policy. Second, it appears that some people in the White House feel that there are some industries that the US should give up. The problem is that the case has not been made economically that there are certain critical links between not having a advanced semiconductor industry and not having a competitive computer industry. There is no recognition of the synergy between communications, computers and imaging and of the fact that these industries are now in a very different ball game. People are under the delusion that we should not worry, someone in a garage in Silicon Valley will come up with a new way of making semiconductors, a new way for making supercomputers. That is wrong because you can not play this game unless you have big bucks to put into the R&D. Possible consequences of not doing the R&D have much greater implications in terms of losses of jobs and losses of investment. For example, the US trade balance could be severely affected by the US failure to enter the HDTV field in a major way.

Cohen concluded that the lesson to be drawn is that the ball game is being played in a very different way, both here and in Europe. The Europeans have developed an HDTV system and have done much more to get their electronics industries going, even cutting deals with the Japanese. This is a reflection of our political inability to deal with strategic issues. Without some sort of executive leadership we are going to be out of the race within 2-3 years.

The next speaker was Lester Thurow, Dean, Sloan School of Management, MIT. For Thurow, we are facing a much more fundamental problem than just HDTV, a problem that the US has not had to deal with for the past one hundred years: How do you catch up technologically with someone who is ahead of you? Where, when and how do you make an special effort to catch up? There is no mechanism in the market that assures you that you will be able to catch up. Japan and West Germany have learned to catch up because they have had to deal with it. Here economic development was tied very closely to military power because if you did not have economic development you would have ceased to exist as a country.

Thurow said that he wished to use HDTV as a symbol to answer the questions: what do we

do if we are behind and what do we do if we are out of an industry?

He added that the first issue to be addressed is where and when, because you can not play catch up everywhere. There are a few things about which we need to have factual knowledge. First, some people have argued that HDTV is a once in a lifetime opportunity to break back into consumer electronics. It is a different enough technology that does not give you the cost disadvantage as if you were for example trying to catch up in VCRs. What makes consumer electronics so important is that it is the second largest market in the world after automobiles. If the answer is yes, this is an opportunity to break back into a very big industry, then the question is how because it is going to be expensive. Two examples. First, twenty years ago the Europeans decided that it would be unacceptable to be left out of the civilian aircraft industry. They first failed with Concorde. But they made it with the second attempt, the Airbus. It took 18 years and $ 15 billion. The lesson is that it is not a cheap enterprise and that no private company would ever put up that kind of money or wait that much time. It took the governments of Europe to work as a group, five of them.

As second example, take the Japanese strategy for breaking back into the computer market. It was a very expensive and time consuming strategy that involved holding IBM's market position in place, giving all kinds of special privileges such as the Japanese Computer Leasing Company only to Japanese companies. But it took them 15 years and a large amount of money to get a competitive computer industry.

You have to think about systems of organizations and amounts of money when you break into a big industry like consumer electronics that are very different. And the technical question on HDTV is, is this the strategic moment to do it ?

The second argument is, is this a technology that if you do not have it you are going to lose a lot of other industries? Some people argue that HDTV is that kind of technology. For example, if you control the HDTV technical standards you can write it in such a way that no American computer will work with that HDTV. In this way you can point people in the direction of your own computer industry. IBM did that with software. The argument is that HDTV will allow you to do things with computers that will obviate the American advantage in software. Or this is a technology that will have a profound impact on areas that Americans still control, industrial electronics and military electronics. Or this technology will be attached to machine tools, and if you do not have the technology you will not have a competitive machine tool industry. Ultimately the question one has to ask is this a technology that the other guy can use against you in a very predatory way?

The third argument, Thurow continued, is whether this is a technology where there is an opportunity to create brand new industries that up until this day have not existed? Some people think that HDTV is such a technology. For example, HDTV could be used for increasing competitiveness in clothes retail.

Thurow said that if you think that anyone of these three arguments is valid, then you have a problem in playing catch up. The problem is that the benefits of succeeding are very widely diffused across a set of industries and a set of firms. None of these have the money,

or the interest or the capability to anteing up the big backs to get back in.
In consumer electronics the last American firm is Zenith, whose total sales are less than Matsushita's research budget.

Then the question is how to put together a system that does it? In Japan the system involves MITI and in Germany the systems tends to involve institutions like the Deutsche Bank, which has controlling interests in the top 400 German firms. In the United States we do not have the institutions.

Thurow asserted that microelectronics and Steve Jobs in a garage was a mirage. That happens once in a 1,000 years. All new industries require a lot of money, not a job for venture capitalists. Another question is can one buy this technology on the market on an equal access basis? That's the argument that you should let the Japanese spend all the money on research and then we can buy the HDTV sets and plug into our other equipment. The first issue here is: will they design standards that you know well enough in advance so that you can in fact plug your equipment into them? The second issue is: can you in fact do that? The reason IBM got interested in an industrial policy for semiconductor equipment manufacturers, is that IBM did not get equal access along with Japanese manufacturers to an advance supply of Nikon's new mask making equipment. Moreover in the US we have a set of complicated firms in terms of how do they relate with their home country, such as Sony and Honda, which have a higher implantation in the US than in Japan. Can one trust Sony to make HDTV sets for the American industry?

Thurow concluded that what worries him most is that people in Washington have not taken his three questions seriously at all. What we have is an ideological debate of should or should not the government intervene held in a very abstract world.

According to Thurow it boils down to a very simple problem: We Americans like to lie to ourselves about many issues, including that we are very pragmatic people. Nonsense. We are the original religious crusaders, and having a religious crusade is much more important than having a successful consumer electronics industry.

Thurow concluded that the key thing here, going back to where he started, is how do you play catch up and get back in. He also reminded the audience that the market mechanism nowhere says that America will catch up. Thus to play catch up here require changes in our industrial structure, changes in our institutions, and to do things in new ways. The evidence does not show that Americans have any interest in changing.

The next speaker was Lee McKnight, postdoctoral fellow, Center for Technology and Industrial Policy, MIT.

McKnight began showing how each century has had its major wave of innovation, arguing that in the 21st century telecommunications and telematics are likely to play a key role in the economy of the future.

Referring to Exhibit 7, McKnight said that in Europe specific programs are trying to

organize to make Europe competitive in these areas: RACE, ESPRIT, JESSI and EUREKA. He went on to focus his remarks on EUREKA, an industry-led program in which the European HDTV standard has been developed. McKnight explained that EUREKA works as a double network for a networked economy, which sponsors joint research among private firms, public research laboratories and universities. EUREKA's focus is on pre-competitive research, but spills over beyond it into manufacturing as well. Eureka was established 4 years ago and has already launched some 280 projects with investment totaling about $ 6-8 billion, involving both small and large firms. Referring to Exhibit 8, McKnight pointed out that there are almost 20 countries involved and its programs range from automotive safety to HDTV. Eureka effectively provides an introduction service to team up countries or firms and also acts as a marketing tool, for once a project gets the Eureka stamp it gets widely publicized. He also pointed out that the project cycle is quite fast, with action being taken in about 45 days after submission of a project proposal.

McKnight then turned to discuss standards and HDTV. He noted that standard setting is a dynamic process which involves a multiplicity of organizations. Traditionally a firm would develop a proprietary technology, which would then be passed on to a public or private standard setting body, and possibly, if successful to international harmonization or standardization. However, the world moves more rapidly these days and in addition to the traditional standard setting bodies new mechanisms have evolved such as the corporate consensus standards body (e.g., the Open Software Foundation). The X-Windows, the UNIX standard and the HDTV European standard can also be considered as standards created through a group of firms (and possibly universities and government agencies) coming together and agreeing that this would be a common basis for further R&D and new product development. At the same time all this feeds into the for example open system trend: Open Systems Interconnection and ISDN standards. Referring to Exhibits 9 and 10, McKnight pointed out that in Europe the technology has progressed from PAL and SECAM, the current television standards on through research on a number of multiplex analogue component standards for satellite broadcasting. From the mid-1980s the Japanese really picked up the pace promoting their 1125/60 HDTV standard for global standardization by the CCIR.

Referring to Exhibit 9 McKnight remarked that the Eureka project started first as a reaction to feared technological advantage the U.S. might gain through the Star Wars program. Within two years Philips, Thomson and Bosch and at the time Thorn-EMI, working together developed prototype 1250/50 HDTV equipment. The standard is now before the CCIR. In the US, as usual, there has not been a coordinated program, there are multiple competing standard proposals under consideration by the FCC and others, including the Japanese 1125/60 standard. There is rapid technological progress but at the moment no coordination mechanism for reaching consensus. There was powerful momentum behind the Sony/NHK 1125 line system, but concerns were raised that acceptance of these standards would create potentially unsurmountable barriers to American firms in many industries. A number of proposals are coming out of MIT that might help solve the current standards stalemate at an international level. Referring to Exhibit 11, McKnight suggested that one possible way out may be through flexible, open, digital smart receivers. The concept of Open Architecture Receivers was developed by

Bill Schereiber and Andy Lippman at MIT. Such an open system approach is already common in other areas such as computers. Yet the complexity of international standard setting is enormous. As shown in Exhibit 12, the number and geographical diversity of organizations involved and their mandate is quite large, including just in the US the State Department at an international level and the FCC at the domestic level.

McKnight concluded that if standards can be used to control and create new industries this suggests that the U.S. has to rethink the way it sets standards, how quickly it does so and how it coordinates that with other industrial or research initiatives. McKnight proposed an Eureka-like structure supported by private industry to facilitate R&D and technology support mechanisms, a potential Corporation for Advanced Technology. The proposal as it stands does not require government leadership. Conceptually one could imagine a small office like Eureka to facilitate risk sharing and information sharing in a range of technologies, including HDTV. The proposal does not address where will the money come from. In fact, the revenues needed for the program are not so great, as in the case of Eureka where the stamp of approval is the largest benefit. The greatest advantage of this proposal is that it would just create a small office to take the lead to help industry coordinate its efforts.

The first question in the ensuing question and answer period asked where is the need for cooperation most pressing, in R&D or deployment? Thurow answer was that there is a striking difference between the way America, the Japanese and Germany spend their R&D money. The US spends 70 percent on new products and 30 percent on new processes; the Japanese just the opposite; and the Germans come down in the middle. The US used to spend correctly but things have changed in the last 20 years, so inventing a new product doe not necessarily do you any good. You have to manufacture. All the major new consumer electronics products were not invented by the Japanese. Thus the old distinction between process and product investment does not hold any more and that is part of the problem with HDTV. The problem is not to be able to invent it but make it cheaper. The US government only does serious research in health. Research is not something firms will do without the right incentives. With the end of the cold war the US has to move away from military research and needs new institutions. We cannot continue to rely on DARPA and DOD alone.

Cohen replied that there have been U.S. industrial policy efforts to deal with industries when we knew it was going to take a lot of investment. Part of the problem is that the economics profession dropped any discussion of how we really dealt with industrial development, especially with government playing a central role. The development of RCA is a good case as well as MIT's development of automated machinery with the sponsorship of the Air Force. The US has set up many of the institutional models which were then copied by the Japanese. He argued that it is necessary to get things to market at the right price. Thurow added that the major catch up effort in the post war period was the space program.

The next question asked which area should the US target, if we consider that the area of communications and consumer electronics is already lost. Thurow replied that in the world

economy you play a cooperative and competitive game simultaneously. There is a whole set of cooperative things that the US still has to do with the Europeans and the Japanese. But at the same time one wishes the US to generate a world class standard of living. There is certainly some industries that the US will be behind in, but given the size of its population the US cannot afford to be behind in very much and still generate a world class standard of living. He added that it is his belief that electronics is too big for the US to lose and he also does not see any other sector out there big enough to replace it.

The following comment questioned how will the US do the catch up, in particular if the US goes towards a government-led strategy how to avoid excessive bureaucratization and conversely if the US goes towards an industry-led strategy how to avoid penetration by foreign industry in an open economy. Thurow's answer was that the public and private distinction is a false one, in other countries the distinction is not so clear. He suggested that in the US the direction to take is to create an industry-led industrial policy which government supports rather than the other way around. That is why there is a need to change the US banking legislation to allow the creation of combines like the Deutsche Bank.

Cohen added part of the answer to the catch up strategy is that from where Japanese started that they were clearly focusing on where higher value added was going to be created. The question is not to decide which industries to drop but what sort of opportunities you lose down the road. The Japanese have systematically identified where are the real high value opportunities and how do you need to restructure the Japanese economy to provide the capital investment and educational changes to get there. Thus the issue is how will the US be able to assure that individual firms will organize for identifying these high value added opportunities.

Thurow added that what is efficient for an individual firm has to do with how the government organizes the incentives for the area. For example the US is falling behind in electronic banking whereas in France the government has taken the responsibility to establish the necessary network to speed up the diffusion of electronic banking. In the US you cannot do that because it requires a degree of organization which is lacking in the system.

McKnight commented that a Corporation for Advanced Technology could do much of the facilitation and coordination effort. A second element of the catch up strategy should be a pilot project similar to Japan's Hi Vision community program. The Japanese program aims to provide experience and feedback to Japanese industry. If the US goes in the direction of the open architecture receiver, it is not likely to succeed without large pilot projects involving many cities and providing mechanisms for the various concerned industries, producers and users, to collaborate.

Cohen remarked that the US already has a number of national institutions analogous to the Deutsche Bank, in educational loans, in housing, in agriculture. Why not use this national mechanism? The semiconductor commission is proposing such mechanisms, in the American way. Thurow commented that most of the financial mechanisms mentioned are in deep financial trouble. Cohen replied that the model can be used and well managed.

The next question asked for comments on proprietary systems and on the emergence of three economic blocs in the future as regards HDTV future development.

McKnight answered that open does not mean non-proprietary. You can have an open system and open standard to which someone may have ownership rights. MS-DOS is a case in point. The standard setting process and open architecture development is complex and in HDTV the main efforts have been to block the Japanese standard. It is not clear at this point who owns the patent rights over the modified version of the Japanese standard which allows for compression for broadcasting and cable transmission.

Cohen added that up until now it was assumed that you could set up your own standard to protect your industry. But now with the move towards deregulation and global communications it is much more difficult to control these areas. Now the Japanese have an HDTV-type monitor with a production cost less than $ 1,000 and within a couple of years they could easily put together a combined HDTV plus HDTV/VCR. And there is nothing to stop a cable company to sign an agreement with Japanese companies to send special movies to these sets. The possibility for commercializing HDTV in a different way means the formal standards bodies may have nothing to do with commercial success.

The next comment built upon Cohen's remark about the importance of software and stated that the US may have a natural lead and aptitude for software development, the things that will run on HDTV. Does control of the HDTV hardware really control that activity or should the US put its energy into information products.

McKnight's reply was that Sony's strategy is an integrated hardware and software strategy, to avoid the early problems they had with the lack of software availability on Betamax. It shows that you can still use standards as a key lever to your success in hardware.

Thurow added that it depends on the hardware producer strategy. Apple could have blocked people from writing software for its computers. The software guy is at the mercy of the hardware guy. It is also mistaken to think that the Us has some natural innate comparative advantage in software. In fact, our competitors have a strategy to wrestle this industry from the U.S. as they had a strategy with Airbus. For example, the new European television protocols explicitly say that sixty percent of the programming has to come from Europe. This is the beginning of a strategy for pushing down the monopoly of the US in the entertainment industry.

Cohen disagreed by saying that there are advantages for the US software industry given the visual nature of the culture and larger experience with computers. The problem is that we know very little about the economics of these knowledge-based industries and how do you maintain advantage. The commercial market for software has been barely tapped. Some people like George Gilder who would argue that is where to go. The problem is that he is assuming that the infrastructure is going to be there. This is certainly an area in which the U.S. has an advantage.

The next question asked if once a standard emerges and you enter a more commodity-type

market or a special market develops is there any strategy for a player that starts behind either for jumping on the commodity curve or providing special products.

Cohen answer was that there is a clear use for HDTV in hospitals, schools and in the defense system as a strategy. Current government expenses can be used to drive the early part of the industry. There could also be financial help for the auto industry to start adopting HDTV. The US has technology in these areas that certainly outclasses the Japanese. Some of the US-made flat panel displays are far ahead than anything coming from Japanese leaders. Similarly the US digital processing and compression technologies are still quite advanced.

The next question about world competition was addressed to Thurow. Are we really dealing with business as usual? Can the US really meet their sources of power given by what appears to be a total vacuum of power of the US in these matters? Will the US be able to develop a countervailing organizational power to the Japanese and German challenges.

Thurow answer was that there is no evidence that the Japanese cheat, but rather that they play the game very shrewdly. The US has to do the same. The problem is that the US protects the dying industries while the Japanese protect the leading industries. The game is different for the US because there was this postwar period which was an anomaly in which the US was ahead in everything. The way to go in HDTV is to have demonstration projects and use creativity, because we have no industry except Zenith.

Cohen commented in relation to the Japanese different way of operation that given US anti-trust regulations it is not likely that IBM could
do things that Fujitsu does in bidding in Japan. The US has to understand that the Japanese think different and interpret rules differently.

The last question asked what would be the forum to discuss a national HDTV strategy in practical terms and who would be the players. Thurow argued that there is a need for a strong Executive leadership, it is not something that can be done alone by Congress. The problem is that the Bush administration is coming down to say that the US has no problem and there is no such a thing as designing an American solution. Cohen then added that the solution is to get the President to see the problem.

PREVIOUS JAPANESE PROGRAMS FOR HDTV:
TOTAL SPENDING 1964-1989

NHK HDTV R&D	20 Billion Yen	$133 Million
Private Corporations	100-200 Billion Yen	$.67 - $1.33 Billion
MITI Visual Control Systems Project 1981-85	15.7 Billion Yen	$105 Million
Total	136-236 Billion Yen	$.9- $1.57 Billion

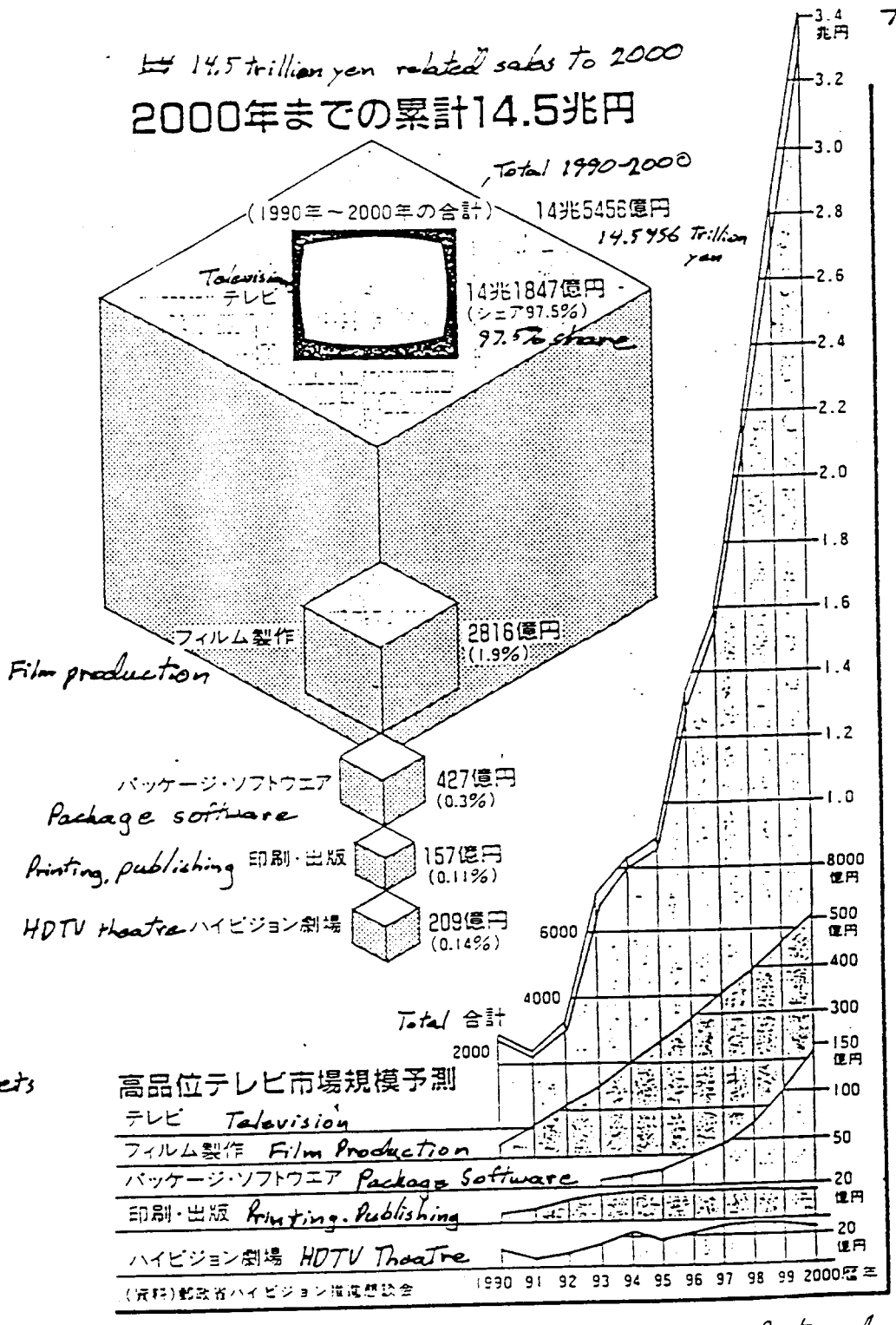
Exchange Rate U.S. Dollar equals 150 Yen

SOURCES: NHK: Letter to author, June 14, 1989;
Private Corporations: Mark Eaton, "Japanese High Definition Systems: Research, Development, Deployment," Microelectronics and Computer Corporation, MCC International Liaison Office, Austin, Texas, August 22, 1989
MITI: Conversations with MITI Officials in Tokyo, May 1989

EXHIBIT I

14.5

Trillion ¥



Projected HDTV markets

Source: Ministry of Posts and Telecommunications, HDTV promotion committee

High Vision Forum

JAPANESE PROGRAMS FOR HDTV: TOTAL SPENDING

(in millions of dollars)

	Sponsor	Years for Program	Companies Involved	Total Budget (Yen Billions)	($Millions
Giant Electronics Project	Key Tech	1988-94	15	13	$88.3
High Vision City Program	MPT	1989-92	14 cities	14.4	$96
High Vision Communities	MITI	1989-92	10-20 cities		($50+)
Hi-Vision Promotion Center	MITI	1988-92(?)		2.7	18
Flat Panel Displays	Key Tech	1988-1994	12	30	$200
Rear Projection	Key Tech	1988-	3	3.9	26
Broadcasting Satellite-3	NHK-linked	FY 1985&86		3.6	24
High Definition Television Engineering Corporation	Key Tech	1989-1993	4	3.9	$26
HDTV Satellites	NHK-linked	1989-1991		84	$560
HDTV Satellite Corporation	NHK-linked	1991-1997		107.25	$715
Hi-Vision Communications	MITI	1989-	69		
Regional Hi-Vision System Communications	MPT	1989-	31		
Nihon Hi-Vision: Lease Hi-Vision Software	MPT	1989-	40		
High-Level Image Technology Research Laboratories	Key Tech	1989-1992	3	12	75
Graphics Communications Technologies, Ltd.		1989-1992		4.5	30

TOTAL HDTV FUNDING IN JAPAN :1985-1997: 279.25 Billion Yen or $1.9 Billion

JAPANESE COMMUNICATIONS AND COMPUTING INITIATIVES RELATED TO HDTV: ANNUAL SPENDING

(in billions of dollars)

Information Network System	$ 8.57
Teletopia	10.71
Intelligent Manufacturing System (MITI-10 years)	.33
Information Technology Research	.30
New Communications Protocols	.21
Total spending	$ 20.12 Billion

EXHIBIT 4

EXAMPLES OF THE USES OF HIGH VISION TECHNOLOGY
CONSIDERED FOR INCLUSION IN THE HIGH VISION CITIES PROGRAM

Example	Location	Type of HDTV	Years Available	Expected Cost
Outdoor Theatre	Drive Ins	400 Inch	1990-95	Y 2.5 billion
Outdoor Theatre Billboard Advertising	Side Walls of Buildings	400 Inch	1990-95	Y 2.5 billion
Indoor Theatre	Movies	400 Inch Rear Projection	1989	Y 250 million to Y 500 million
Indoor Minitheatre	Department stores Hotels	100 Inch Rear Projection	end 1988	Y 80 million to Y 240 million
Indoor Minitheatre	Restaurants Coffee Shops	100 Inch Rear Projection	end 1988	Y 80 million to Y 240 million
Street Bulletin Board	Parks, Lots Streets	100 Inch Rear Projection	1990-95	Y 30 million to Y 70 million
Moveable Bulletin Board	On cars for advertisements	100 Inch Rear Projection	1989	Y 40 million to Y 100 million
Broadcasting Conference System	Offices, Factories	Two 50 Inch	1990	Y 13 million to Y 220 million
Broadcasting Conference System	Universities, Training courses	Two 50 Inch	1990	Y 13 million to Y 220 million
Satellite Broadcasting	Consumer Home Use	40 Inch MUSE Receiver	1990	Y 3 million to Y 20 million
Ground Broadcasting	Consumer Home Use	40 Inch MUSE Receiver	1990	Y 3 million to Y 20 million
High Vision Database	Libraries Art Museums Hospitals/ Health Centers University Research Institutes Government Offices Fire Stations City Halls Showrooms Railroad Stations	50 Inch	1988	Y 80 million to Y 140 million

FUTURE TECHNOLOGY DEVELOPMENT IN JAPAN THAT IS RELATED TO HIGH DEFINITION SYSTEMS
RESULTS OF A DELPHI STUDY COVERING THE PERIOD, 1987-2015

Area to be Developed	Medium-High Degree of Importance	Time of Realization	Constraints on Realization		Need for Government Funding
			Economic	Technology	
Widespread Use of HDTV With 1,125 Scanning Lines	86%	1993-1998	76%	7%	15%
Practical Use of Color Image Panels with a Resolution of the Order of 1000 by 1000 Pixels for Use in Portable TVs	36%	1993-1998	43%	52%	21%
Practical Use of Displays that Can be Read like Print on Paper	88%	1994-2004	14%	77%	24%
Practical Use of Color Video Display Panels with a Resolution of at Least 2000 by 2000 Pixels	93%	1992-1998	32%	62%	24%
Widespread Use of Flat Color TV Screen Size of at Least 20 Inches	90%	1994-2001	45%	48%	18%
Development of Three-Dimensional TV that Can be Viewed Without Special Glasses	59%	1995-2005	18%	74%	20%
Development of Technology to Distinguish Complex Two-Dimensional Patterns at a Speed and on a Par With Humans	94%	1997-2008	4%	94%	39%
Widespread Use of Communications Systems for Retrieval of Still or Motion Video Information from Electronic Libraries Through Broadband Communications Lines	94%	1996-2005	84%	8%	29%
Communications Links to Enhance Links Between Headquarters and Branch Offices Using Entire Wall Surfaces as Displays	48%	1993-2001	73%	16%	17%
Widespread Use of Electronic Systems for all Office Activities, Including Storage, Retrieval, Editing and Preparation of Documents and Statistics	97%	1992-1998	70%	8%	13%

Note: Percentage Scores Represent the Opinion of Respondents Considering the Area Important for Development

EXHIBIT 6

EUROPEAN HDTV/HIGH RESOLUTION SYSTEMS-RELATED INDUSTRIAL POLICY PROJECTS

RACE

Research on Advanced Communications for Europe

Broadband communication technologies.

ESPRIT

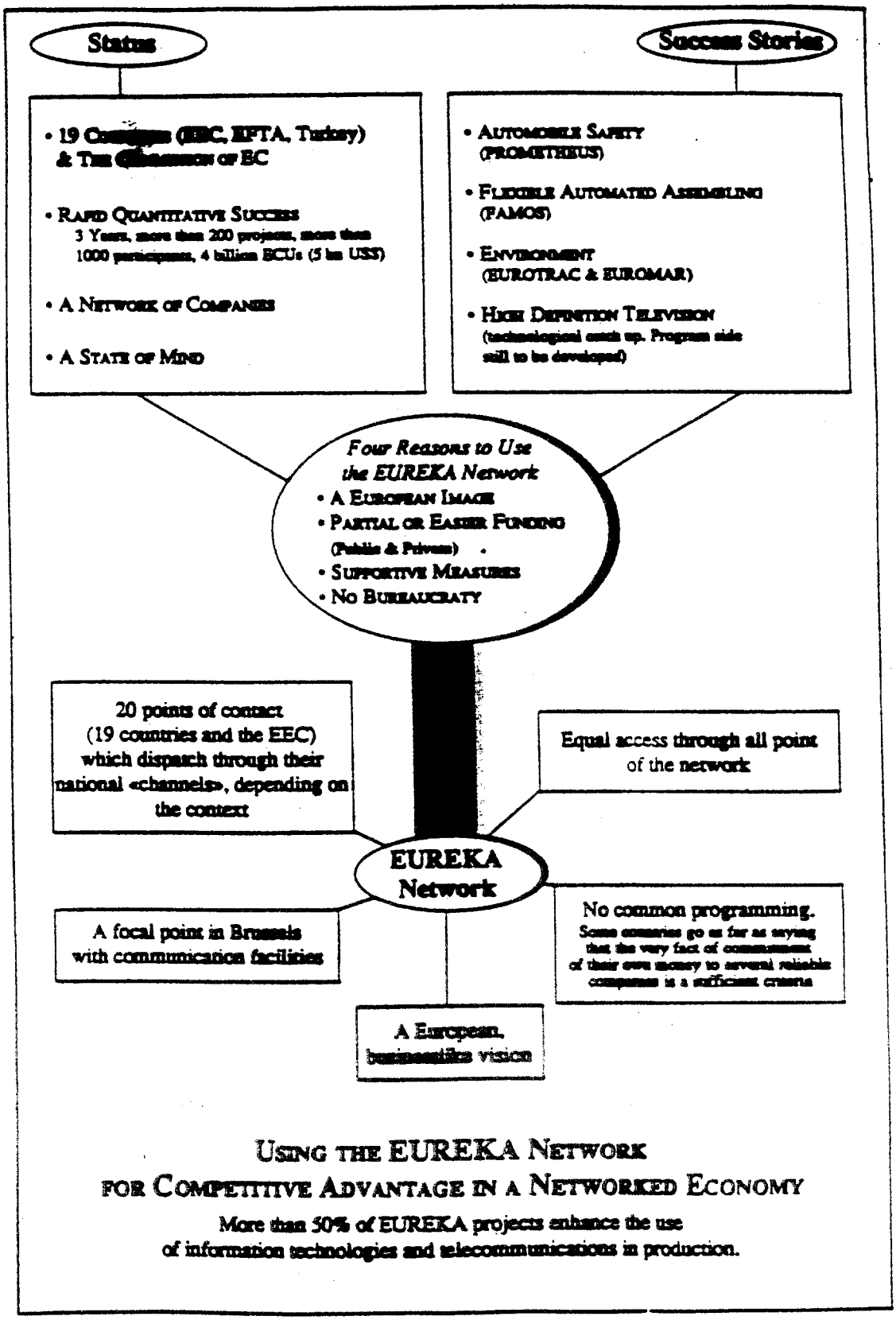
European Strategic Program for Research on Information Technologies

Digital signal processing, etc.

EUREKA

Advanced Technology (non-industry-specific, but including Eureka-95, the Philips/Thomson/Bosch 1250/50 standards alliance)

EXHIBIT 7



Using the EUREKA Network for Competitive Advantage in a Networked Economy

More than 50% of EUREKA projects enhance the use of information technologies and telecommunications in production.

EXHIBIT 8

50 Hz. ADVANCED TELEVISION STANDARDS (PAL/SECAM COMPATIBLE SYSTEMS?)

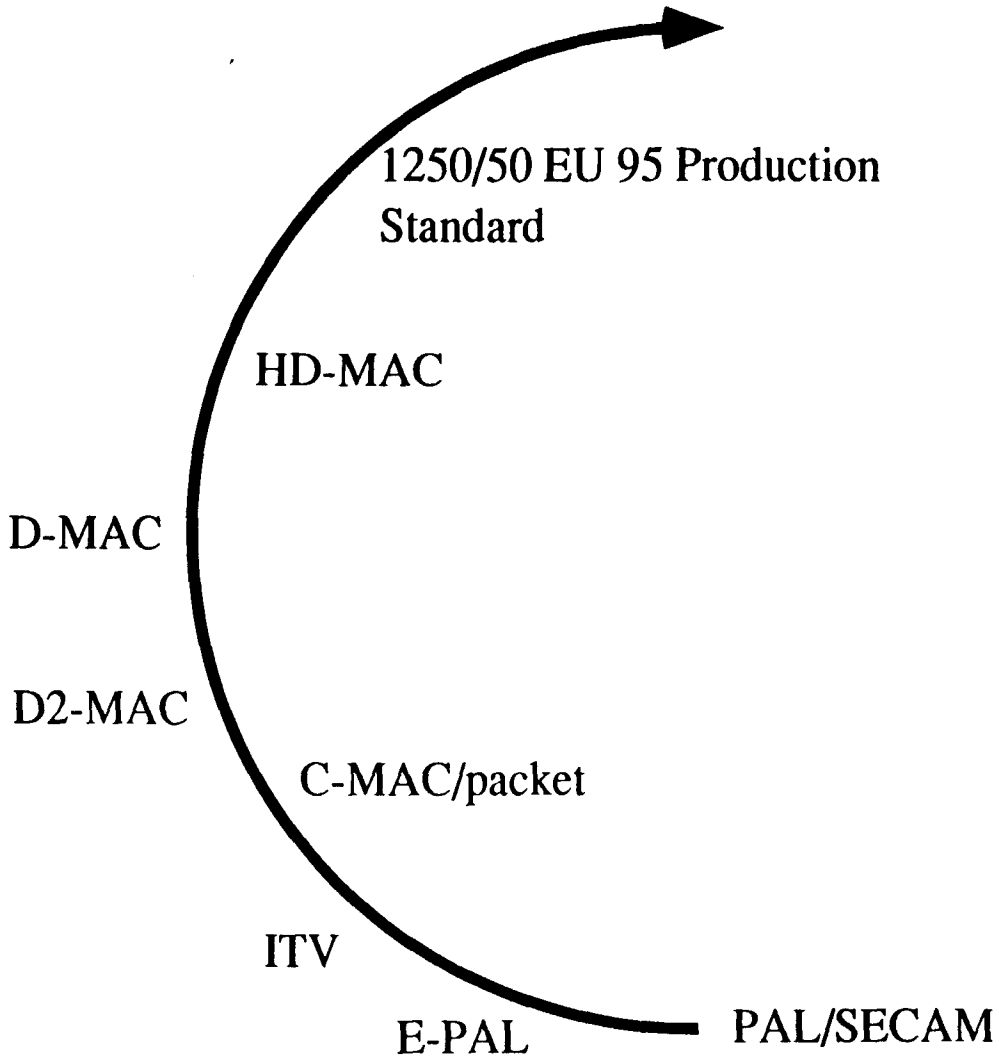
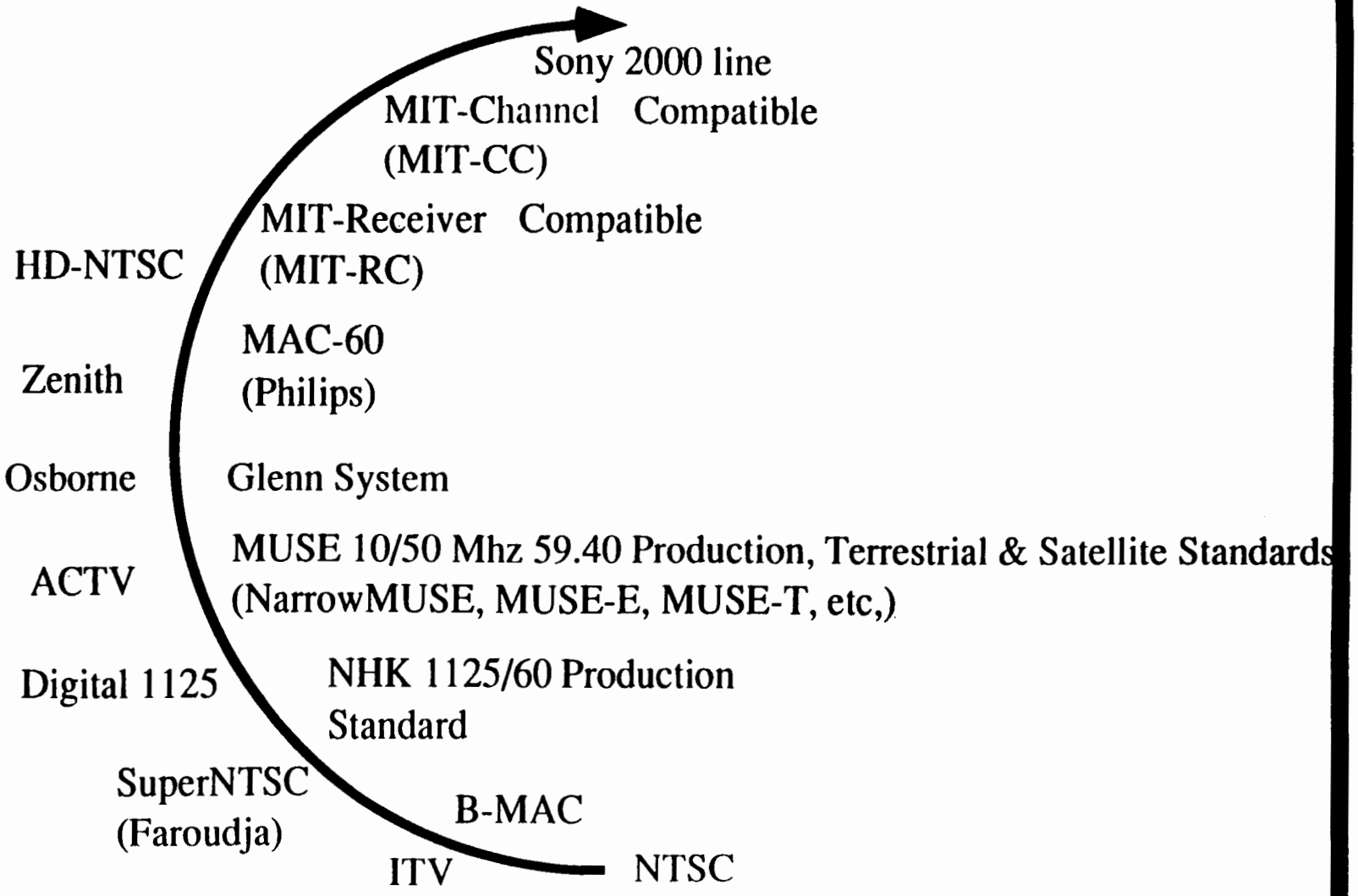


EXHIBIT 9

59.94/60 Hz. ADVANCED TELEVISION STANDARDS (NTSC COMPATIBLE & NONCOMPATIBLE)



1125/60 & 1250/50 'COMPATIBILITY' THROUGH OPEN VIDEO ARCHITECTURE

OPEN VIDEO ARCHITECTURE SMART RECEIVERS

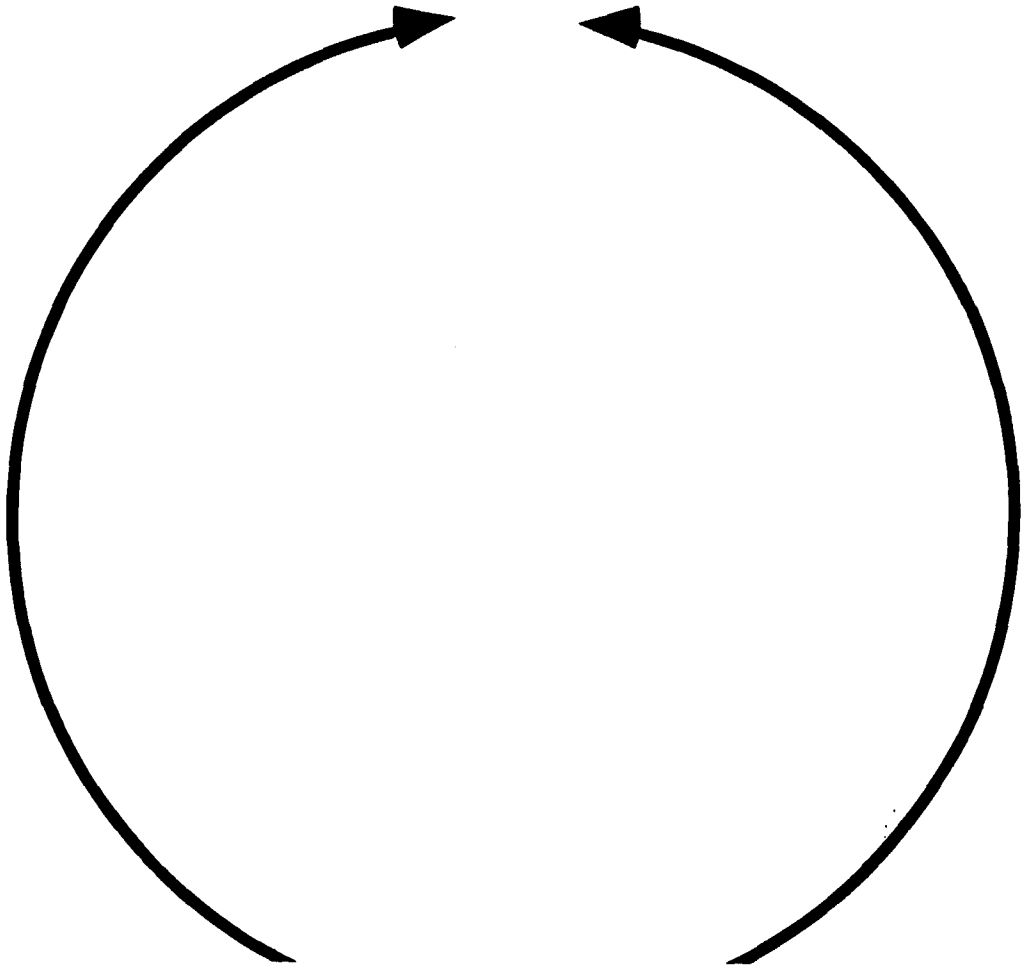


EXHIBIT II

HDTV STANDARDS INSTITUTION

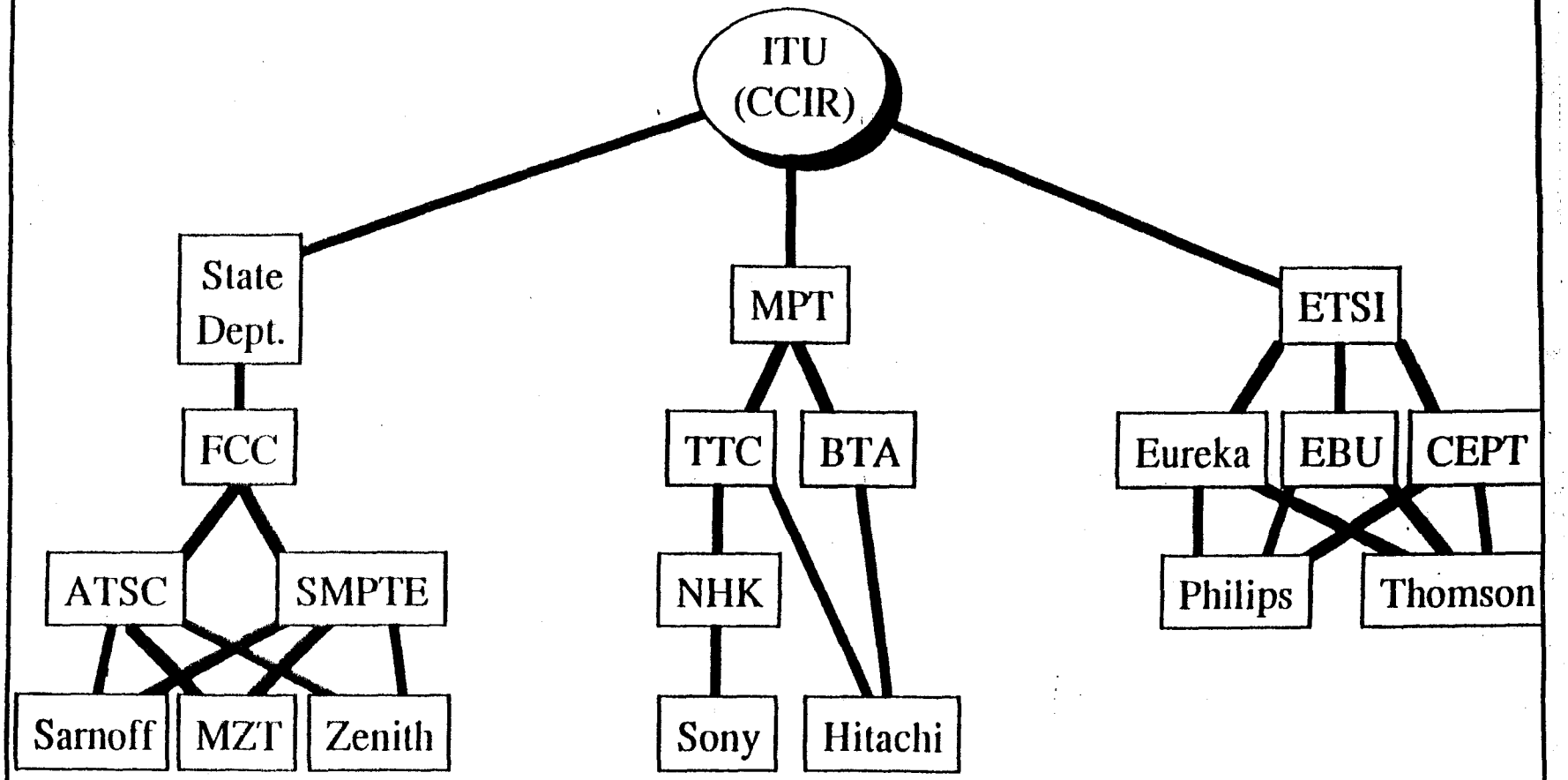


EXHIBIT 12