Advances in the IT Society, and Displays as Windows for Information

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Abstract

As the IT society reforms, we should consider the relationship between social needs, the trend of infrastructures and displays. In the IT society of the 21st century where advanced computing, large-volume memory, and high-performance networks become available, anyone can always receive the benefits of information anytime and anywhere.

According to social needs, both information and consumer services will diversify. In this paper, I would like to describe trends of displays from the viewpoint of their performance, size and technology according to client needs reflecting diversified information.

Introduction

The history of human information recording is ancient. The oldest extant recordings are the paintings that Cro-Magnon man made on the walls of a cave in southern France several tens of thousand years ago. However, the first instance of communicating recorded information dates from the time of Egyptian culture around 3,000 B.C.E. It is said that the contribution of information recording and communication made the rapid evolution of human civilization possible.

In terms of human information recognition, the greatest external information input means is our sense of sight which allows us to determine the shape of things through the medium of light. The act of seeing information which has been written down serves as a reliable input for our visual sense, enabling us to recognize and make judgments about the information. Written media evolved from walls, stone, bone, parchment, wood, papyrus, and the like, and in the 15th century, movable-type printing technology using paper as the medium was developed. The advent of the age of electronics in the 20th century brought displays upon which communicated information could be depicted. CRT displays were followed by the widespread use of flat-panel LCDs and the further development of large-format plasma displays. Now, self-illuminating organic EL (electroluminescent) displays are also beginning to make their appearance in society.

In the 21st century, the world of electronics is witnessing the further evolution of key technologies for making things such as semiconductors and magnetic memory with even greater integration and higher capacity. We are moving toward greater miniaturization and higher performance for mass storage memory elements and super-high-speed computational elements.

The increased performance and greater functionality of key technologies have enabled information such as text, images, audio and video to be digitally encoded, and with the convergence of IT and A/V, we continue to evolve toward an advanced information-oriented society in which it will be possible for anyone to decode

this digital information over high-speed networks, anywhere, anytime.

In the advanced information-oriented society, new IT industries engaged in[1)] generating information,[2)] distributing and marketing information and[3)] searching and viewing information are working hard to offer a full repertoire of services. To make such ever diversifying information visible, the display industry is striving to develop displays to meet user objectives and applications. Against this background, we will examine displays which play the role of a window that instantly links discontiguous spaces to meet the needs of society which now increasingly revolves around IT.

1. The revolution in the IT society

In our 21st century society, massive amounts of information such as economic, cultural, educational, climatic, astronomical, and medical data, are being processed using super-high-speed, high-performance computer systems and stored on servers. Over super-high-speed, broadband networks, clients are able to access needed information at any time, from any place, in any manner one desires, independent of time, distance and place.

Meanwhile, we are getting to the point where specific information such as personal and family data can be securely managed at any time, from any location, and a "ubiquitous society" is spreading to every corner of society at large. Within the home, interactive digital TVs resulting from the convergence of IT and A/V will play a major role as information platforms replacing the personal computer (**Fig. 1**) [1)]. And when one leaves home, full-function information terminals such as mobile phones and PDAs will become increasingly important. To access in-home networks from a remote location and control household appliances as well as perform safety and security checks, in-home appliances and information networks will have to be linked (become "information appliances"), and a host of new infrastructure developments such as access methods appropriate to one's purpose (**Fig. 2**) will become necessary.

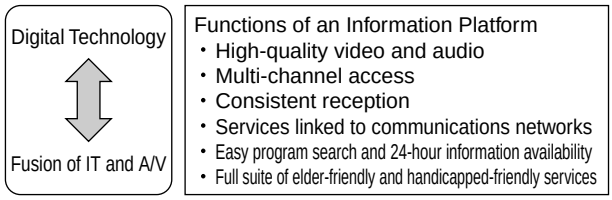


Fig. 1 The fusion of IT and AV.

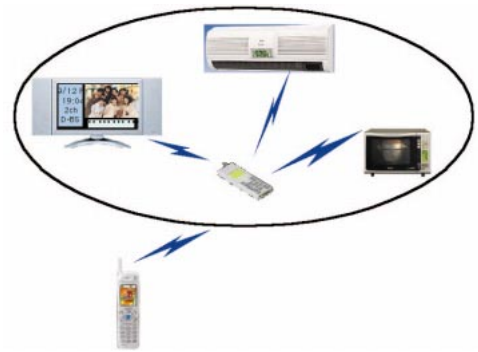


Fig. 2 The control of home electric appliances from the information terminal.

Table 1 1) The main service & needs of making information.

Major Services	Needs
Communications	Voice input with simultaneous interpretation
Electronic transactions, transportation guides, reservations	Financial organizations and merchants need net-based on-line payment capabilities for shopping, etc.
Music/video on-demand	Access when and where desired based on development of high-volume content
Positional information	Checking how crowded a restaurant is by remote video
Medical/health information	In-home diagnosis, health management
Education/learning	Continuing education, social education
Disaster prevention, public safety	Regional safety (crimes, fires) monitoring; prediction (earthquake, weather events, etc.)
Traffic systems	ITS (Intelligent Transport System) to be launched in 2003 to provide mobile information (current location, traffic volume, routes, etc.)

Next, we will explore needs of the changing IT society and corresponding trends in infrastructure technologies.

Table 2 2) The main service & needs for spreading information.

Major Services	Needs
High-speed networks	Super-high-speed, high-capacity, broadband, fiber-optic communications capable of conveying large amounts of data in two directions at once. Low-cost networks capable of delivering information in near real-time
Mobile networks	Shift to broadband capabilities to provide high-speed, high-capacity, wireless communications
Net consultants	Consultants to quickly unearth desired information from the massive amounts of information available
Storage/recognition tools	Audio/video compression technologies; voice/visual recognition technologies; memory cards

Table 3 3) The main service & needs for adopting information.

Major Services	Needs
Safety verification	Security checks on various rooms
Food, clothing and shelter information	Inventory status/stock-on-hand of food, clothing, etc.
Remote control of various home appliances	Linking home appliances to an in-home network to enable control from a personal computer or mobile phone
Interaction with domestic robots	Roving robots capable of transmitting video images to check the security status of various rooms in the home
Displays	In portable models for personal use, low power consumption and low cost. In fixed models, high resolution and reasonable portability. Transportable semi-fixed models for the home. Digital TVs designed around in-home networks. Faithful texture reproduction. Voice input/guidance.

1.1 Societal Needs

In the information-oriented society, computers are transforming their shape and entering all sorts of places, from public facilities to private homes. Such a society will allow people to reap the benefits of "anytime, anyplace, anyone" information access. The information-oriented society can be classified into 1) generating information (**Table 1**), 2) conveying (distributing) information (**Table 2**), and 3) accessing (viewing) information (**Table 3**). Societal needs exist for each classification, and they will develop and evolve through mutual interaction.

1.2 Trends in infrastructure technologies capable of responding to the needs of the IT society

Sustaining human growth and development, and maintaining safety and security will require modeling (simulating) complex systems (environment, medical, climate/weather, electronic governance, etc.). Accessing external information for this purpose begins with input systems for information in graphic, video,

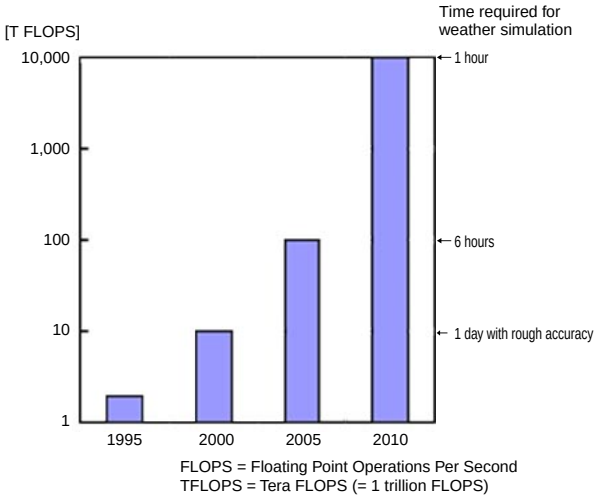


Fig. 3 The throughput of the computer.

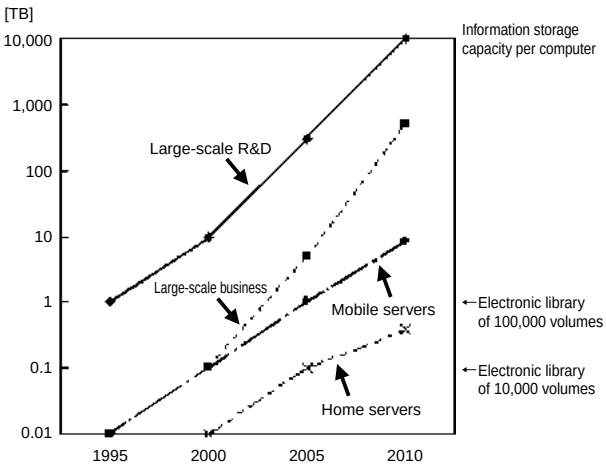


Fig. 4 The memory storage for the server.

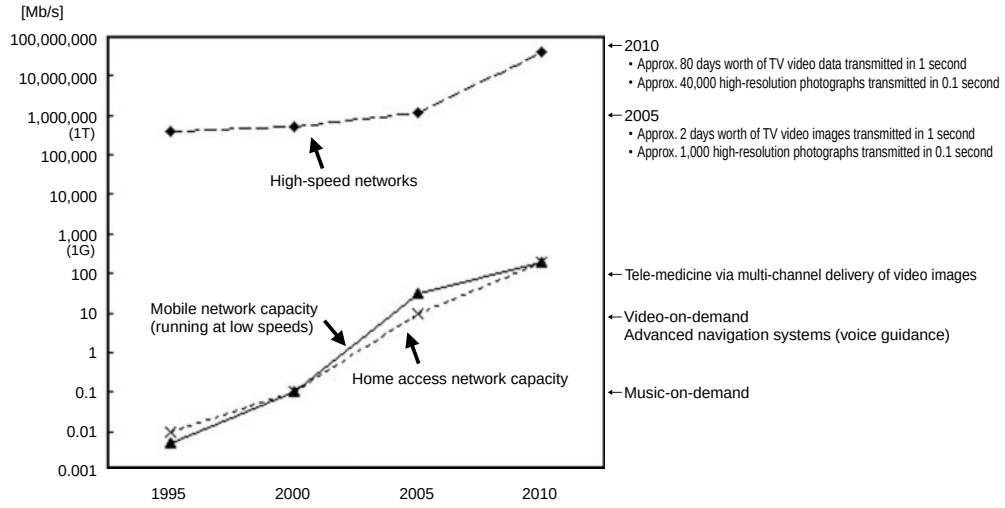


Fig. 5 The network capacity.

and text forms. And the rapid evolution of high-speed computing capable of processing large amounts of information quickly will also become critically important, as will high-capacity storage, high-speed networks, user-friendly data terminals, and displays that serve as windows for the information[2]. We can look to predictions for the evolution of computer throughput (**Fig. 3**), server storage capacity (**Fig. 4**), and network capacity (**Fig. 5**) as infrastructure trends that can serve as yardsticks for the IT society.[3]

These predictions indicate that the amount of computer-processed information will increase at an accelerating pace. IT infrastructure performance, including processing capabilities, storage capacity, and network capacity, is expected to evolve to a level two or three orders of magnitude higher than year 2000 levels in 2010.

2. Trends in display diversification

Vast amounts of information (economic, cultural, educational, weather, astronomical, medical data, etc.) processed by super-high-speed, high-performance computer systems will be stored on servers. Clients will be able to access required information via super-high-speed, broadband network services from any location, at any time, in any manner desired, independent of time, distance and location. This relationship is shown in **Fig. 6**. In the remainder of this paper, we will examine displays which provide a means of visually rendering diverse information, and which will serve as a window instantly linking discontiguous spaces.

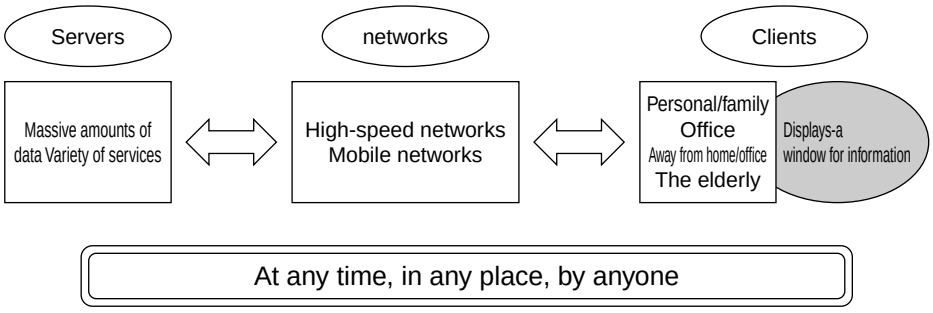
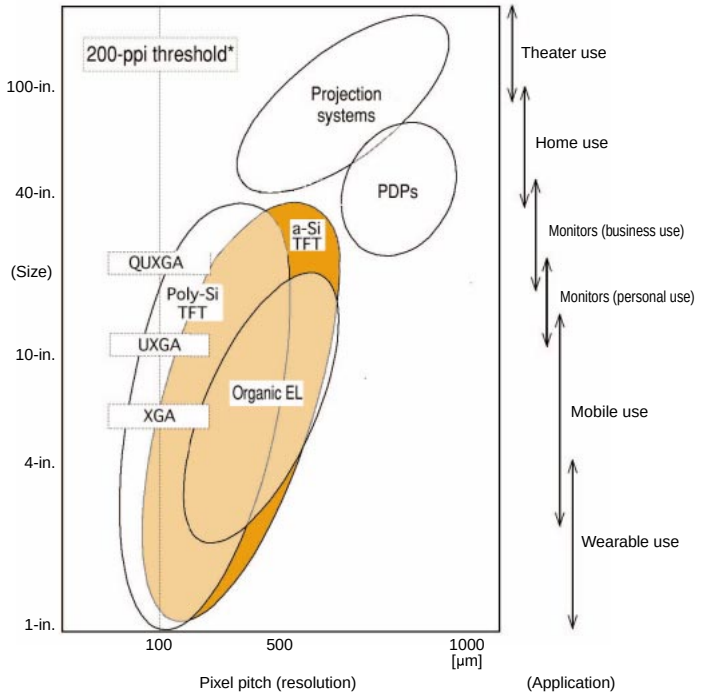


Fig. 6 The relation of the server, the network and the client.

Display development for the advanced information-oriented society must be responsive to user objectives and applications in order to meet the needs of a society which increasingly revolves around IT.
1) For home use, advanced displays will enable several members of the family to view, for example, the details of various services on a large screen or digital HDTV and high-resolution images with faithfully reproduced textures. In addition, compatibility with interactive communications will enable such displays to play a major role as information platforms replacing personal computers.
2) For business use, lower costs take priority, but demand for high-resolution capabilities are also high.
3) For personal use, displays will not only serve as conventional PC monitors, but will also be used to display photographs as well as DVD and digital TV images that demand high resolution and fast response rates. In addition, to accommodate the continuing increase in the elderly population, displays must be especially easy on the eyes, easy to operate, and capable of rendering text clearly in large font sizes.
4) For mobile use, display power consumption, resolution, size and cost are determined by their intended use, and competition between traditional LCDs and self-illuminated organic EL displays will become intense. In addition, to reduce panel frame and IC chip mounting area, "intelligent" panels are expected to be based on a poly-Si TFT design, and on CG-Silicon TFT, a further evolution of the same architecture.[5] For wearable use, direct-view models such as wristwatch designs will also appear in addition to the goggles style.



*Indicates the type and size of panels at a resolution of 200 ppi (126 μm pitch)

	Resolution H x RGB x V	Panel size for 200 ppi
QUXGA	3200 x RGB x 2400	20-inch
UXGA	1600 x RGB x 1200	10-inch
XGA	1024 x RGB x 768	6.4-inch

Fig. 7 The relation with the panel size, the pixel pitch and the use.

Fig. 7 is a chart showing concepts for the future of various FPD technologies in terms of display size, pixel pitch (resolution), and application. High-performance TFT panels with integrated peripheral circuitry such as driver logic hold out promise for both small- and large-format high-resolution displays. Embedding peripheral logic functions within the panel to create an integrated unit is being pursued to boost TFT performance, improve reliability, and stabilize fabrication processes. Many manufacturers are engaged in a fierce battle to develop the high-performance TFT panels targeting the next generation of flat-panel displays, in particular, Sharp Corporation and Semiconductor Energy Laboratory Co., Ltd. with their joint development of CG-Silicon TFT panels.

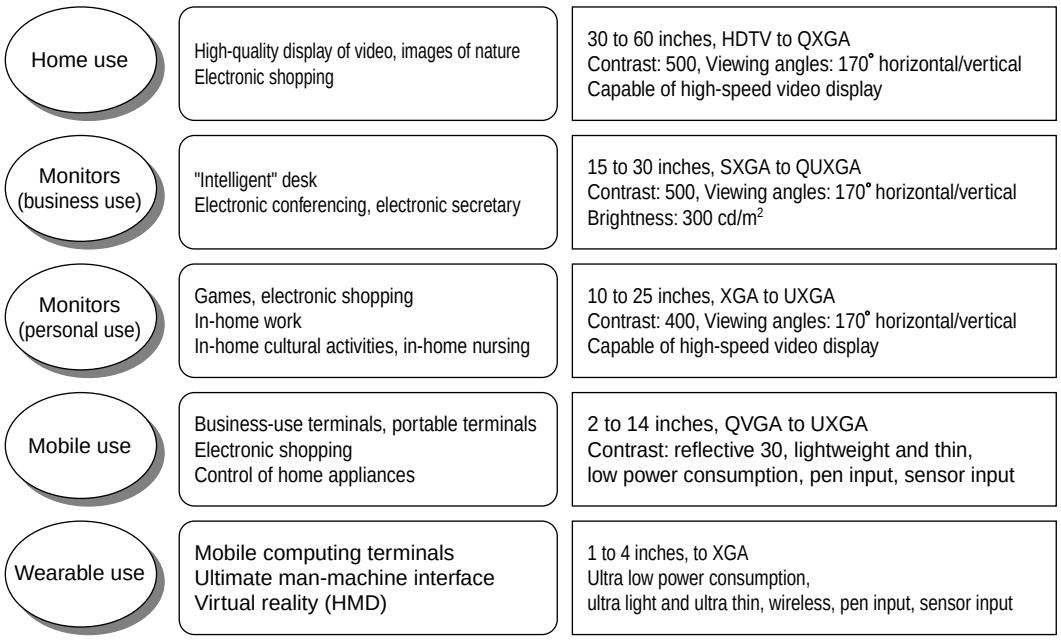


Fig. 8 Uses and demand characteristics of the future displays.

Fig. 8 shows the characteristics demanded by various display applications. **Table 4** is a compilation of display quality levels and merchantability. From **Figs. 7** and **8**, we can look forward to the appearance of the following new display products based on the expansion and enhancement of information networks.

1) In large formats, new displays equipped with new interactive digital functions that will serve as information platforms viewable by large numbers of people such as displays for home use and in videoconferencing.

2) In small- and medium-formats, in addition to conventional business and game applications, new categories of products for use in data display, image viewing, remote control, etc., that will be enhanced with electronic-shopping and home-appliance-control functions.

3) In wearable terminal devices that can be worn on the body, hit products that will be the successor to mobile phones will serve as the ultimate man-machine interface.

These new products are predicted to engender new markets for displays.

The following facts are clear from **Table 4**. Large-format panels require high display quality including high resolution and video compatibility, and small to medium formats for portable use demand convenience and merchantability such as low power consumption and light weight.

Table 4 Performance of needs.

	Quality level of display						Merchantability			
	Viewing Angle	Resolution	Response	Relative Brightness	Contrast	Grayscale	Depth	Power Consumption	Size (diag. inches)	Narrow Frame
Home use	HDTV~QXGA	◎	◎	◎	◎	◎	◎	○	30 to 60	○
Monitor (business use)	SXGA~QUXGA	◎	◎	◎	◎	◎	◎	○	15 to 30	○
Monitor (personal use)	XGA~UXGA	◎	◎	◎	◎	◎	◎	○	10 to 25	◎
Mobile use	QVGA~UXGA	○	◎	○	◎	○	◎	◎	2 to 14	◎
Wearable use	~XGA	○	◎	○	◎	○	◎	◎	1 to 4	◎

3. Trends in panel technology

Poly-Si and CG-Silicon TFT technologies that can be used for both LCD panels and organic EL displays are expected to yield higher display resolutions, integration of functional circuit logic, and narrower frames. Boosting the drive capabilities of the system-on-glass will require as yet unrealized breakthroughs in technology and mounting techniques, including improved crystallinity, improved insulating layer/semiconductor boundary characteristics (better reliability and mobility), improved fine-line pattern forming technologies on large-format motherboards, and lowering interconnect resistance.

In mobile and wearable applications which demand super-low power consumption, reflective-type LCD panels which are readable even under direct sunlight have distinct advantages, and significant improvements are appearing on the horizon.

For self-illuminating displays, active programs to develop new organic EL materials are underway, and significant improvements in material-linked service life and color purity can be anticipated. And because the need for filters and polarizers is eliminated, lower production costs can be expected, but further development of technologies to improve resolution is still necessary.

To accommodate diversifying information services and to increase their convenience as a window for information, work on next-generation displays cannot stop at merely the display section. It will also be important to integrate control logic and interface circuitry as well as provide on-board memory and sensors, and to pursue greater compactness, higher functionality and lower costs.

By 2010, next-generation displays can be expected to meet these standards:[3)]
1) LCD system displays with resolutions of 400 dpi and processing speeds of 100 MHz.
2) Highly supple (flexible), impact-resistant displays with excellent performance in the mobile environment.
3) Power consumption for semiconductors of less than 1/200th of current levels, and for LCD modules, less than 1/100th that of current levels. Power-saving designs and high-performance batteries will mean mobile terminals which will require recharging only once a month.

Conclusions

For the advanced information-oriented society of the 21st century, massive amounts of information will lie hidden like an underground energy source, and clients will be able to quickly select and retrieve desired information from this huge store of data. The desired information will be shown on displays, and these displays will serve as windows for information and communications that instantly link discontiguous spaces.

To best match the situation in which they are being used, displays will be required to have quality levels and merchantability appropriate for personal, mobile, or home use, indoors or out.

In particular, for compact displays for use in mobile phones and other mobile devices, not only there is competition among different types of LCD panels in terms of power consumption, functionality and performance, but organic EL displays are also becoming competitive for this application. Further improvements in performance are anticipated from the application of poly-Si and its spin-off, CG-Silicon TFTs, which can be used in both LCD and organic EL displays.

To develop basic platform technologies for energy-efficient fabrication processes and high-performance TFT displays, a number of prominent Japanese LCD panel manufacturers have established the Advanced LCD Technologies Development Center Co., Ltd. (ALTEDEC) as a joint venture[4]. Its mission is to conduct basic research in preparation for the advent of the next generation of IT.

The recording and dissemination of information has made a major contribution to the evolution of human civilization. Thanks to the revolution in IT, information dissemination will become possible simultaneously to an extent unprecedented in human history, providing the advanced information-oriented society of the 21st century with the potential to evolve into a borderless, global civilization. Displays will play a key role as windows for the information that fuels the advance of civilization. Further development is still required before paper can be replaced as a recording medium, but as displays become increasingly intelligent, we can look forward to their developing into an even larger industry than they are today.

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