

Operational image systems: A new opportunity

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Within the span of a few years, image processing has evolved from an esoteric, expensive technology to an indispensable tool used by modern businesses to manage the overwhelming flood of paperwork. Some of the background for this evolution and the development of the IBM system solution for image processing, ImagePlus™, are described in this paper.

Information is the lifeblood of the modern business enterprise. Whether the business is engaged in manufacturing, sales, or service, paper is by far the most prevalent medium for business communications and information retention. Despite the technology advances that have provided us with powerful workstations, high-speed communications, and ever-increasingly dense electronic data storage, it is still predominantly printed forms that are used to place orders, pay bills, dispatch shipments, initiate actions, document agreements, close deals, and record many other transactions. The alphanumeric information extracted from paper documents and entered into computer systems (usually by operators using keyboards) is known as *coded* data. The coded data can be manipulated and processed by the computer. Typically, only 1 percent of a corporation's data are coded and available for data processing.¹ The remaining 99 percent of the data are noncoded in the form of paper, microfiche, or other media.

Information is a critical resource, but reliance on paper for it is a bane to modern businesses. Process-

ing delays, lost documents, misrouted forms, retrieval delays, and storage requirements are problems that persist today with even more serious impact than in the precomputer age. Modern transaction processing systems require prompt input of data that must be transcribed from the hard copy to electronic form if the systems are to perform at peak efficiency; every minute of delay between receiving paper and entering its data into the transaction processing system has an impact on productivity. The IBM operational image system, ImagePlus™, provides solutions for these paper problems.

The ImagePlus system augments transaction processing by moving paper from the desktop to the workstation display. When paper first enters the business, its information is captured as an electronic image. From that point it is distributed, tracked, and processed electronically by the ImagePlus system in close coordination with the transaction processing system. This integration of image and transaction processing can yield significant benefits in productivity, customer service, cost effectiveness, business process quality, and competitiveness.

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Why image now?

Image processing applications have been available for over 20 years. However, the technology necessary for practical image systems was too expensive to justify production in a widespread commercial environment such as a bank or an insurance company. Several key technology breakthroughs have altered this situation dramatically in the last few years. For

The most significant technology breakthrough has been the advent of optical disk storage.

example, the price of image-capable workstations has been reduced from the \$750 000 range of the 1960s, to the \$250 000 range of the 1970s, to less than \$10 000 in 1990. In addition, the speed of data transmission through networks (both telephone and local area networks) has increased as the cost has decreased, to allow the cost-effective transmission of 50 000-character image records.

The most significant technology breakthrough, however, has been the advent of writable optical disk storage. Microfilm and microfiche provide cost-effective storage but the access is cumbersome, usability is poor, image quality is uneven, and images are not in a form suitable for computer processing. Today, magnetic DASD is a prohibitively expensive alternative for an insurance company with several million policies on file, or a bank with several million checks to capture. Optical storage provides a cost-effective replacement of warehouses filled with paper.

Businesses justify the cost of image applications in several different ways. Some use floor space savings as their paper-filled warehouses are replaced with optical disks. Others use enhanced customer service, which is obtained by displaying an image on a screen in a matter of seconds as opposed to spending minutes, hours, or even days to find a particular piece of paper in a warehouse. Still others use the increased productivity of their employees (gains of 20 to 50 percent are typically reported) as the key cost-justi-

fication method. Any or all of these methods are used today to justify the installation of an image application.

A wide variety of businesses—whether they be small, medium, or large—are potential users of image processing. Every type of business enterprise has had the experience of being buried under mountains of paper with very little knowledge of exactly where any specific piece of paper is at any given time. However, some industries are being particularly aggressive in pursuing image technology. For example, insurance, finance, public sector, and transportation service companies have immediate needs for applications that replace file cabinets. In other industries, manufacturing companies are demanding engineering drawing image capability; medical schools and hospitals are eager to install advanced medical imaging systems to handle X-rays, CAT (computerized axial tomography) scans, or NMR (nuclear magnetic resonance) scans; and scientific users are very interested in full-function visualization for their numerically intensive computing applications.² We are just beginning to scratch the surface of the many vital image applications that will stimulate new growth in industry in the 1990s and continue into the future.

Systems solutions

IBM has entered this growth area with solutions built from a comprehensive family of image products known as ImagePlus. Successful integration of image capability into a customer's business processes requires systems solutions in which every key element is designed to accommodate the demands of image processing. In the ImagePlus system, a true operational image application solution environment was achieved through development of critical image-related hardware and software products which, together with existing IBM products, were integrated with transaction processing applications to form an "end-to-end" image solution. (CICS [Customer Information Control System] and IMS [Information Management System] are examples of these transaction processing applications.) This complex integration task, which is done in partnership with leading-edge customers on major line-of-business applications, differentiates ImagePlus enterprise-wide solutions from discrete products that require customer integration, customization, and user application development.

All of IBM's key operating system environments offer excellent image opportunities. However, the Multi-

ple Virtual Storage/Enterprise Systems Architecture (MVS/ESA™) and Operating System/400® (OS/400®) environments were selected first to prove the technical viability and customer justification for image solutions. Once the solutions are proven, it becomes possible to build solutions for additional environments, such as Operating System/2™ (OS/2®), VM, and Advanced Interactive Executive™ (AIX®). These solutions would be developed by leveraging the technologies and the application experience gained from the initial solutions. IBM also offers the ImagePlus High Performance Transaction System (HPTS) for image enhancement of large check processing centers, and ImagePlus electronic filing cabinet for storage.

The period from mid-1987 to year-end 1989 was spent defining, developing, integrating, testing, and delivering the initial ImagePlus solutions. The first two applications were insurance policy services and bank credit card customer correspondence. These applications were initially chosen because they represent high-volume paper processes that have good payback and have long been targeted by businesses for operational improvement via image technology. These solutions were installed at USAA (see Reference 3) and Citibank (see Reference 4) during 1988 and were made available as products in 1989. During the final development stage, the products were successfully installed as complete systems solutions for a diverse set of operational image application environments for nearly 50 IBM customers worldwide. The initial set of image-enhanced applications is nearly as broad as the account set itself. However, the applications all share some basic common requirements which include folder management, work flow, and case processing.

MVS/ESA solution. The MVS/ESA solution (see Reference 3) provides a comprehensive product set from the optical back end to the image display monitor and human interface software at the front end. Also included are rich host-based image data management functions, object distribution functions, and folder management and work-flow applications that synchronize the image applications with coded-data line-of-business applications. The design point of this solution is large enterprise applications that serve thousands of users and workstations that process many thousands of transactions per day, with rapid response time, multigigabyte image document databases, and image archives in the terabyte range, and larger.

OS/400 solution. The OS/400 solution (see Reference 4) offers comparable function to the MVS/ESA solution, but in a distributed local area network (LAN) configuration. The same physical optical storage subsystem as the MVS/ESA solution attaches via the IBM 5363 processor on a token-ring LAN. This LAN is

The OS/400 image solution has a departmental focus and topology.

shared with image workstations (also common to the MVS/ESA solution), and is attached to an AS/400 application processor. The AS/400 runs the image case processing/work-flow management applications, and provides the gateway to the associated host-coded data transaction applications. The OS/400 image solution has a departmental focus and topology and a different design point than the MVS/ESA solution.

Workstation. Both previous solutions share a common Personal System/2® (PS/2®) image workstation. The workstation is designed for high performance and high resolution image processing and displays, while still functioning as a coded-data transaction terminal for host-based applications. Optional workstation features provide for scanning and image printing support. Special-purpose image accelerator hardware and high resolution landscape and portrait monitors are supported by the image workstation.

The above "quick tour" of the solutions illustrates the complexity and breadth of separate products required to produce an image solution. Figure 1 provides an inventory of the product set required for these two initial solutions. Notice that a number of common components in the workstation and storage subsystems are utilized in the two solutions.

This wide array of components required the involvement of many IBM sites. Figure 2 shows the locations currently involved in providing these products. Combining products from all these sites with components from several major vendors and business partners to develop comprehensive image systems solutions has been an exciting challenge.

Image directions

Today's solutions are the first generation of practical solutions with broad applicability. Since image applications have finally become affordable and are utilized in the operational environment after more than two decades of technical evolution, one could ask, where is image going? How will image solutions evolve? How rapidly will they impact business processes on a broad scale? We believe the evolution and impact of image in the 1990s will be rapid and dramatic. Image applications will be in the forefront of strategic information system (IS) investments throughout the decade. The following sections provide a brief glimpse of possible near-term directions for image, from several different points of view.

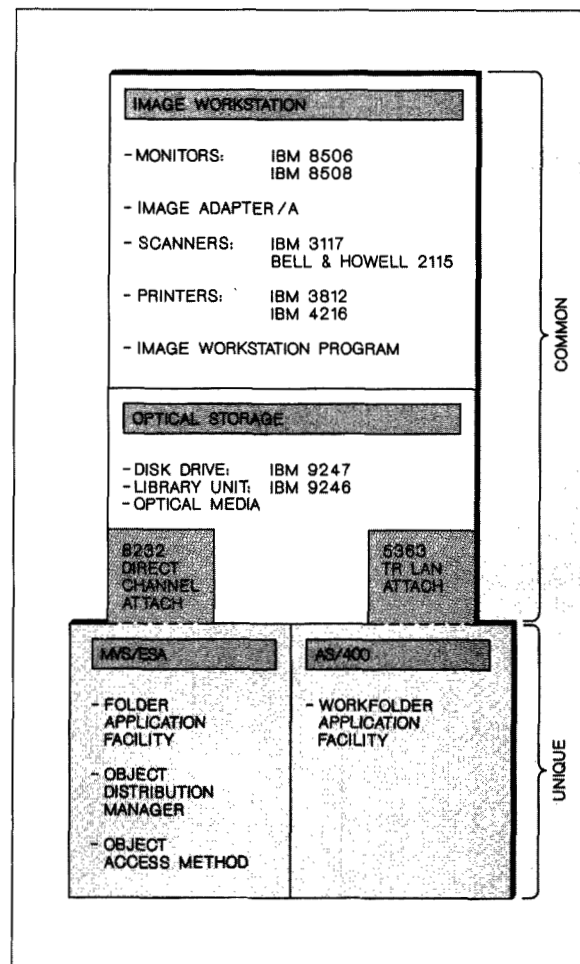
Technology view. The key technologies for image growth are workstation power, communication bandwidth, magnetic DASD, and optical storage. All of these technology areas made rapid advancements in the late 1980s that made operational image feasible. The best news for the future of image is that all of these areas have very exciting prospects for the 1990s!

Workstations. The evolution of the IBM PS/2 is providing increased compute power, memory and storage capacity, display resolution, and software and data management. There is also increased function and support for peripheral attachments and special-purpose adapters to provide a significant improvement to the overall price vs performance tradeoffs. Image performance can be envisioned as becoming comparable to today's high performance coded-data applications. Since all of these facets of the workstation improve the image storage and display characteristics directly available to the user, the image application capability of the 1990s workstation will be limited by imagination, not by technology.

Communications. Image networks will benefit and become more widespread in use because of the improvements in communication technology. The high volume of data required will be transmitted via the modem communication facilities. Fiber optic LANs at 100 megabit bandwidth, ISDN (Integrated Systems Digital Network), and fiber backbone networks are all designed to deliver large objects in high volumes in ever faster and more affordable ways.

Magnetic storage. The significant difference in data retrieval performance between magnetic and optical DASD assures that magnetic media will have a key

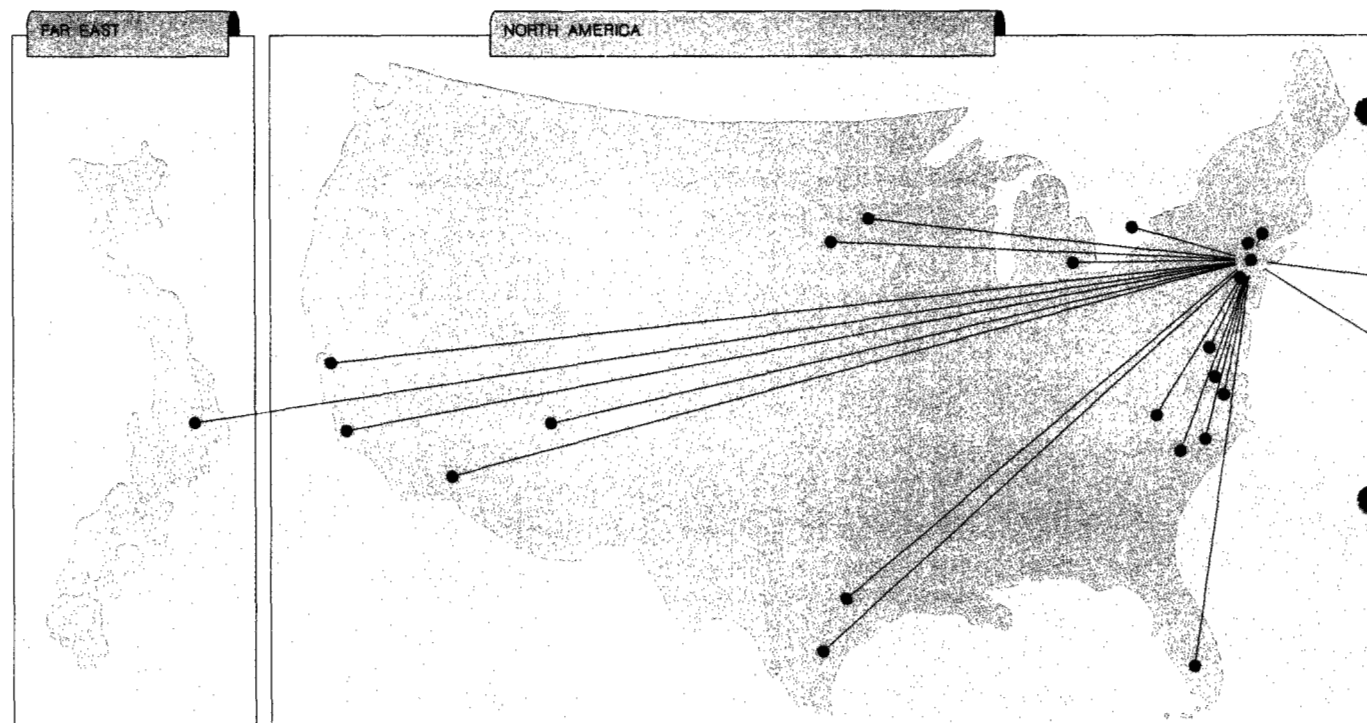
Figure 1 Common and unique MVS/ESA and AS/400 components



role in the image storage hierarchy of the 1990s. Rapid improvements in capacity and price for magnetic storage, both at the host and the workstation, are perceived to continue into the foreseeable future. This will allow for large sets of image documents to be on magnetic DASD, thus allowing high-performance image applications to be unconstrained by relatively slower optical retrieval times.

Optical storage. Today's optical drives and libraries will be viewed in retrospect as the RAMAC® era of optical: first generation in performance, capacity, and versatility. Major advancements in performance and capacity are expected soon and we expect this trend to continue through the 1990s. Read/write optical media are beginning to appear, and the soft-

Figure 2 IBM locations involved in ImagePlus system



ware to exploit these media in ways akin to magnetic disk storage is in the development stage.

The fact that all these technologies are developing rapidly makes image one of the most promising IS industry growth areas of the immediate future.

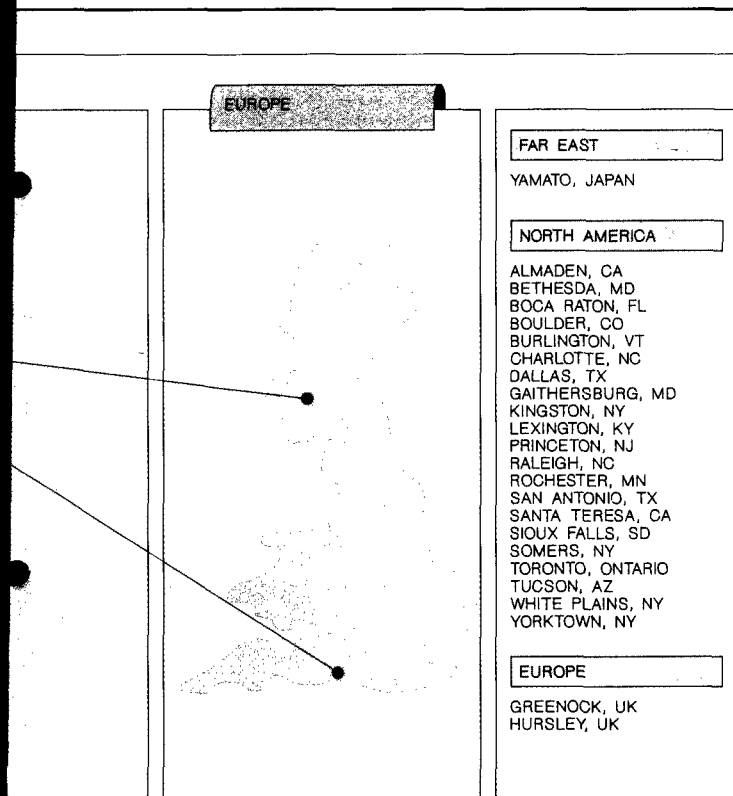
Solution view. The first two announced platforms address folder-based applications for bilevel commercial paper, the image of which is not to be altered. Expansion of these solutions to address a range of applications is an obvious next step. This can be facilitated via a rich assortment of application program interfaces (APIs) and a published image architecture. Taking these solutions into other operating system environments such as OS/2, VM, and AIX represents a broad set of additional opportunities. Extending beyond commercial paper into gray scale, color, large technical images, and animated computer-generated images for visualization can all be done in an evolutionary way using the basic image tools and data management subsystems now being developed. We fully expect to see image solutions grow in all the above environments in the early 1990s.

Integration view. To fully address the daily operational needs of the modern knowledge worker, image solutions must become much more fully integrated with other technical tools in the worker's toolkit. Key items among these integration challenges of the immediate future follow.

Facsimile, or FAX. This form of image must be recognizable as both an input and output medium to operational image systems. FAX is now a ubiquitous means of image communications worldwide and must be fully accommodated to provide an effective integrated solution.

Voice. In key industries such as insurance and financial services, voice records must be stored and retrieved the same as image objects in order to support transactions and maintain complete information archives.

Office applications. Full integration of image with professional office applications is a strong requirement, both in operational image applications and in more casual "electronic file cabinet" environments.



OCR. Optical character recognition (OCR) is a natural extension of operational image systems. The recognition of specific fields on a document is required to index a document. Converting to coded data with high accuracy from many fields on a form will allow elimination of much expensive key data entry, providing significant new justification for image systems.

Technical applications. A broad set of applications require large drawings, color images, or complex gray-scale images to be contained in the same folder as bilevel images and to be displayed on the same workstations. Medical patient folders containing X-rays, pharmacy records, and admission sheets are an example of such an application; engineering release folders holding E-size blueprints together with specification sheets and assembly process sheets are another.

Volume printing. Printing images in high volume must be achieved on all points addressable (APA) printers to meet demands of many applications. Image printing must be intermixed with coded data printing with minimal degradation of print speed.

Enterprise view. Several early customers of ImagePlus have identified a vision of the "image-enhanced enterprise," in which all key line-of-business applications are enhanced by the use of image technology. Key to that vision is the ability of image systems to exchange information using a common architecture (see Reference 5). To a bank or insurance company, this would be a critical step in consolidating their customer services and providing on-line access to all coded and image customer data through a common system. The cost savings and competitive advantage of this level of integration are significant in several major industries. Figure 3 is a representative configuration for an insurance company. This system may easily be modified to support other industries and applications.

In manufacturing firms, integration of image with engineering graphics and coded data systems also has excellent justification. Image-based electronic data interchange is viable in a manufacturing enterprise, which includes communications with vendors, customers, and product servicers.

Knowledge worker view. Lastly, competing for the desktop of the knowledge worker of the 1990s will require providing a rich menu of high-performance tools, utilizing visual and voice image services. The emerging major requirements will include image manipulation, rich work-flow applications, rapid retrieval mechanisms, and strong aids to search folders and files. Advances in human factors will evolve as new applications are used in the workstation. Automatic delivery of all necessary information to the knowledge-worker's desktop will be the key to tomorrow's solutions (Figure 4).

Challenges

ImagePlus provides image solutions for today's operational paper problems. But there are numerous challenges to be addressed in the future as image is implemented across the workplace and more sophisticated and esoteric applications are developed. Some areas presenting challenges follow.

Human factors. Working with image documents is different from working with the paper originals. Improvements are needed in support of large image documents to enable quick browsing and to locate areas of interest. Enhancement techniques are necessary to clarify images of smudged, damaged, or otherwise illegible documents. Support is required for viewing and comparing multiple pages and annotating images with text, image, or audio.

Figure 3 A typical insurance application

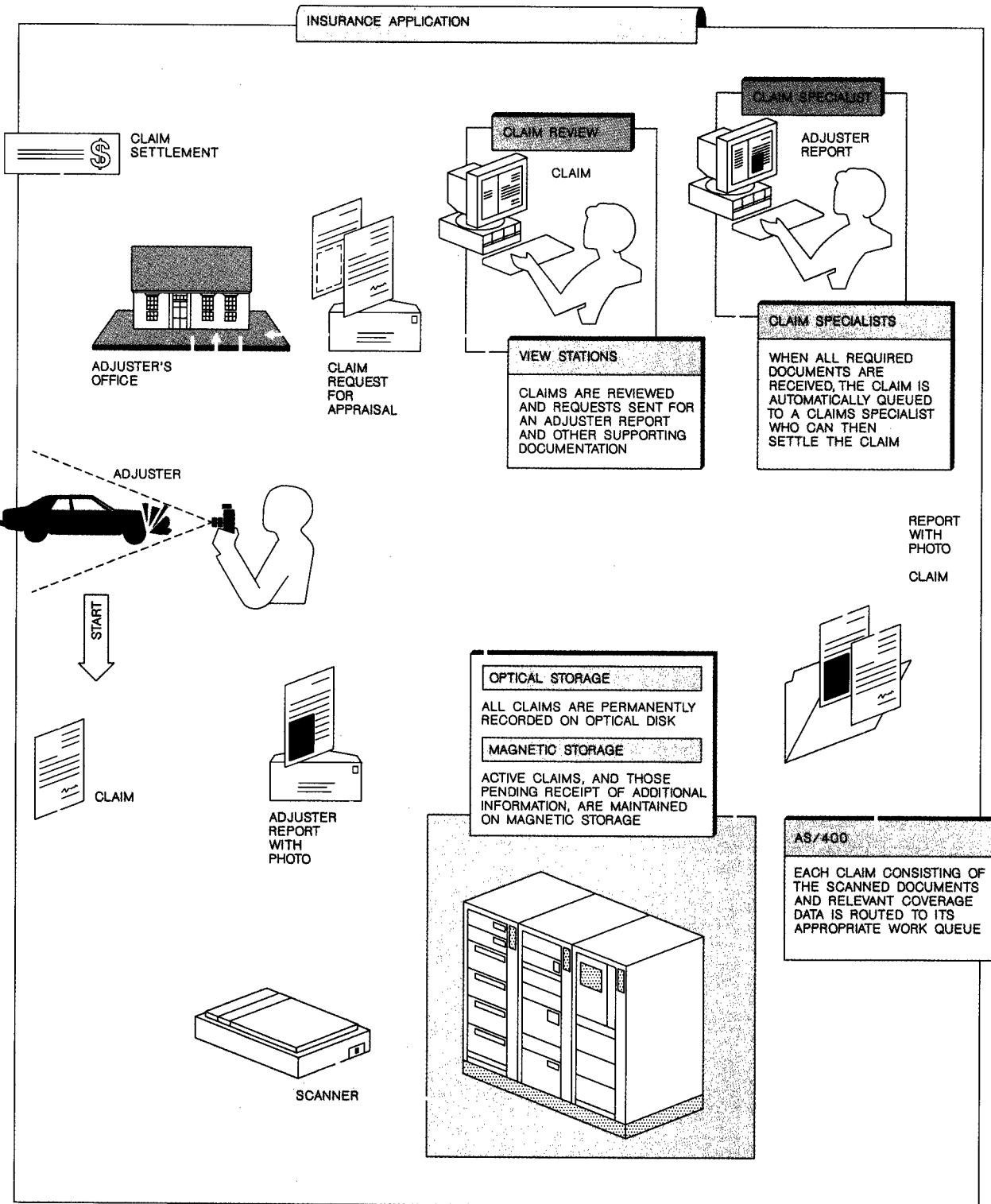
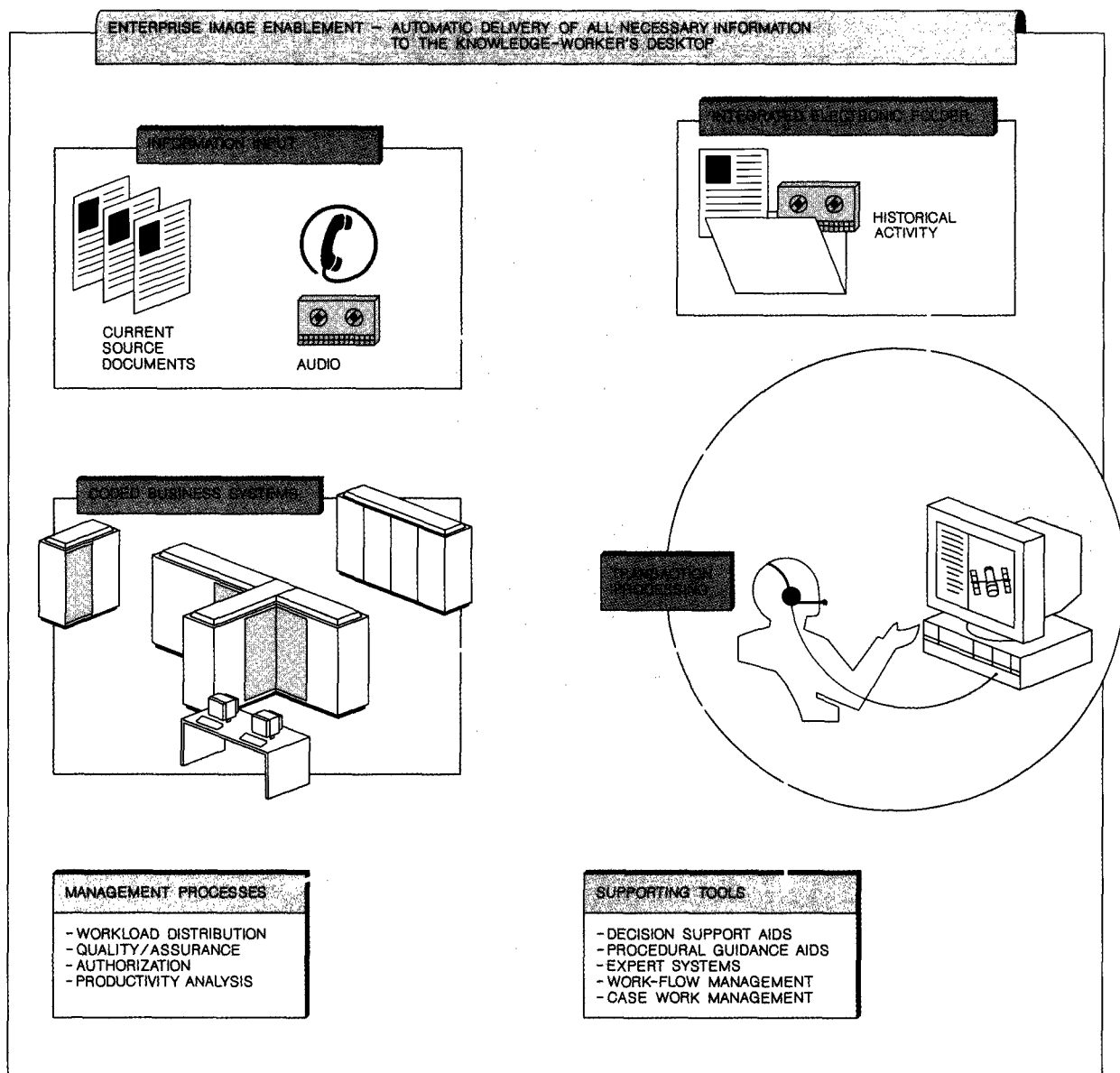


Figure 4 Knowledge-worker's desktop



Performance. The performance of today's ImagePlus systems with an image retrieval time of 5 to 30 seconds is favorably contrasted to paper retrieval times measured in hours or days. However, coded transactions are frequently characterized by sub-second response times, and users will want the image system to perform similarly so as not to unduly impact productivity. The requirement for perform-

ance improvement must be reflected in all the elements of the systems—storage, applications, communications, and workstations—if the end user is to benefit.

Availability. Images must be available to all enterprise personnel, not just the primary users. Whereas coded data exist in many forms and can usually be

exchanged between users by processing the data through the appropriate transforms, image is a data type that is supported by few of the existing workstations and printers. Affordable upgrades or replacement equipment must be developed to enable universal image support.

Advanced functions. Beyond bilevel image is gray-scale and color imaging. Advances in memory, monitors, scanners, storage, communications, and compression and enhancement techniques are necessary to make the price of these systems competitive with today's bilevel systems.

Advanced applications. Sophisticated imaging systems are used today in advanced application areas such as medicine, engineering, geology, meteorology, visualization, criminal investigation, and machine vision. But there are many applications yet to be addressed, such as recognition of handwriting, placing libraries and museums on line, and facial recognition.

Summary

Image technology captures information from paper and transforms it into an electronic file that can be stored, distributed, displayed, printed, and manipulated by modern data processing equipment and software. However, the size and complexity of images demands that nearly every element of the computer system be enhanced if optimum performance, cost, and usability are to be realized. The IBM ImagePlus system provides a solid foundation of systems solutions engineered to support both today's "paper replacement" production applications and the sophisticated applications of tomorrow.

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