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MINICOMPUTER-BASED INFORMATION SYSTEMS

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ABSTRACT

One of the key requirements for public sector management is accurate and effective generation and dissemination of information. Over the past ten years we have developed an approach to information management and distribution based on low-cost, interactive minicomputer systems programmed in a high-level language specifically designed for interactive dialogue programming [1,2]. This has been applied to a variety of industrial, commercial and medical systems, including hospital administration [1,3] and security dealing in the London Stock Exchange [4,5]. This paper describes a system recently installed based on this approach in which a small network of minicomputers is used to provide a rapid and robust dealing information service to a group of dealers in British Government Funds (gilts) and their clients. The system is particularly interesting for its provision for close man-computer interaction and for its used of mixed Teletext and Viewdata modes of information dissemination.

1. INTRODUCTION

British government funds (gilt-edged stocks or 'gilts') currently total some £60,000,000,000 nominal value and form a vital means of funding any residual budget deficit. Gilts are highly negotiable fixed-interest securities whose main characteristics are security of investment, wide range of coupon and redemption date, and a very high marketability. Each price quoted in the 'large' market stands for transactions of at least £500,000, and it is possible to deal on good prices in normal times in £5 million to £25 million. The responsibility of the professional dealer is financially heavy. He must have a full knowledge of the workings of the market and up-to-date price information, and be able to forecast the actions of other dealers and investors in the light of expected future events. Also, as computers have come to play an increasing role in the market, dealers are increasingly expected to have detailed financial comparisons of securities, both on a current and historic basis, at their fingertips.

In January 1972 we installed a minicomputer-based on-line dealing information system in the offices of a gilts broker in the London Stock Exchange. This system is on-line to the exchange floor through a radio link to its operator and provides continuously updated price/yield data on alphanumeric displays to 12 dealers locally,. This information is also made available nationally, and internationally, through a modem link from the local computer to Reuters' "Monitor" system. Five graphics terminals on the local machine give access to graphical displays of yield curves, historic price/yield changes, financial comparisons of one stock against another, and so on. All of these facilities are available to dealers at their desks during telephone conversations to clients - the ready availability of access to current and historic data on securities is an important marketing tool.

The original system used a single 20Kword PDP11/20 with 256Kword fixed-head disc and dual dectapes. In January 1977 it was extended with an 1sill floppy disc-based system keeping track of some 400 Local Government Corporation loan stocks and also maintaining a database of dealing records indexed by stock, amount, client, dealer and jobber, allowing detailed analysis of the dealing activities to be prepared as required. The opportunity was taken at the same time to write the software in a new version of the interactive programming language Basys [2], Basys II, offering enhanced modularity and the ability to call Fortran and machine code segments [6]. The new system also incorporated the latest set of techniques developed for interactive dialogue handling [7]. The enhanced system has now been in successful operation for nearly two years allowing an evaluation to be made of the performance and robustness of mini/floppy-disc-based systems.

The success of the first system and the age of the original installation allowed us to come to a decision at the end of 1977 to replace it with current technology and substantially enhance its facilities. Our experience of the 1sill, floppy discs, Basys II, and the dialogue programming system, made these four technologies an attractive base for the new system. The basic hardware/software/liveware technology used in the new system has been described in some detail in a previous publication [8] in relation to its general applications. This paper briefly describes key aspects of the new dealing information system which was installed in July/August 1978.

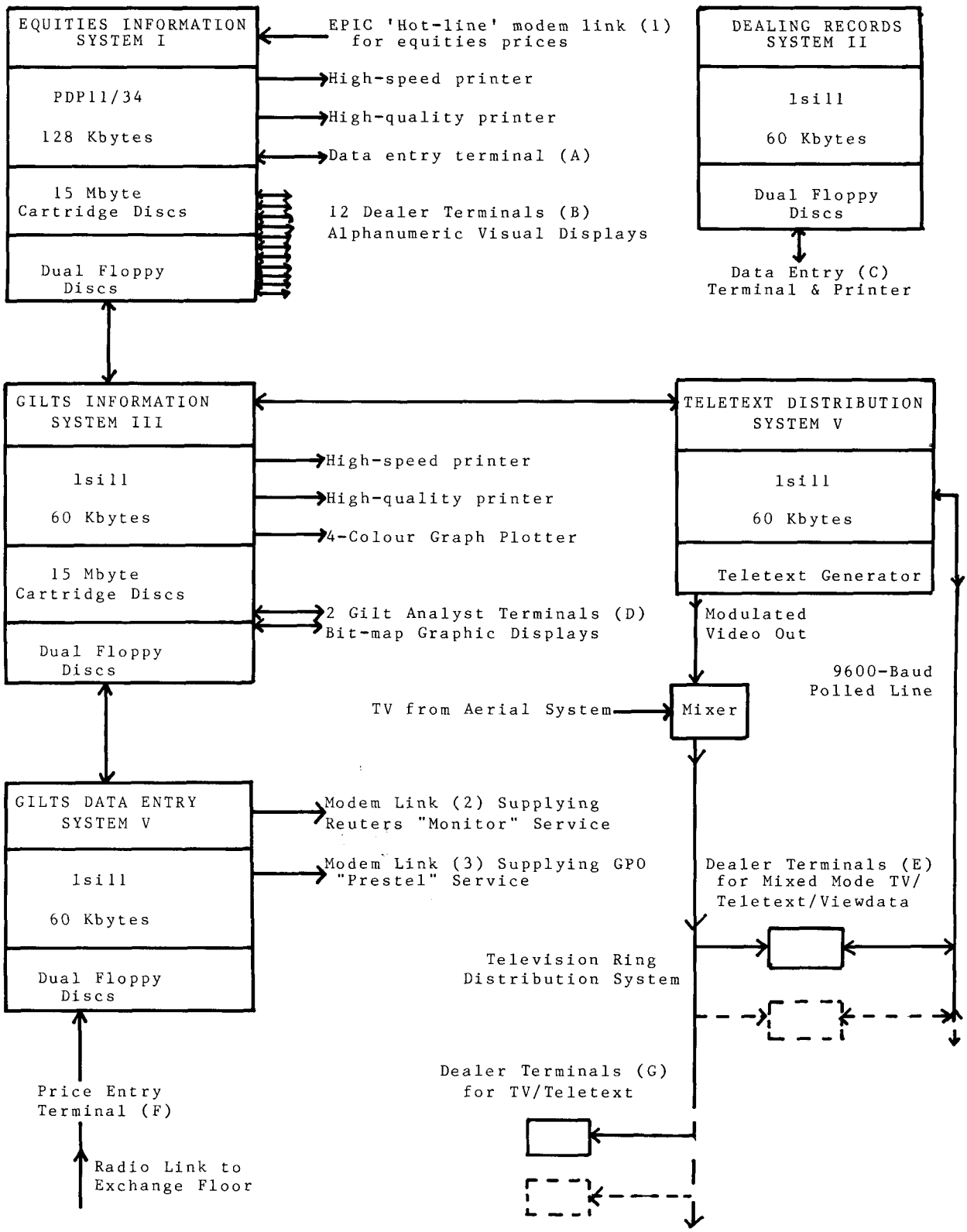

Figure 1 Distributed Dealing Information and Records Systems

2. DESIGN CONSIDERATIONS

Figure 1 is a block diagram of the main elements of the new system. It includes 5 PDP11 computers, 4 used as major self-contained systems including backing store, and 1 used solely as a display controller (System IV). The primary services provided by each sub-system are:

SYSTEM I: Equities Information System: provides rapid access to a database of studies of particular companies by the broker's analysts. It also acceses on-line price information on equities through the EPIC 'hot-line' link (1) to the central London Stock Exchange computer. This system uses conventional hardware technology, a PDP11/34 with cartridge discs and alphanumeric visual display terminals (B). It is shown here for completeness since access to its database is available to the rest of the system.

SYSTEM II: Dealing Records System: is the configuration briefly described above for keeping a database of gilts dealing information. It is completely self-contained for security reasons but can act as a backup processor should one of the others go down.

SYSTEM III: Gilts Information System: provides rapid access to, and manipulation of, current and historic data on gilts and other fixed interest securities. The sole task of this system is the management of a specialized financial database. It has attached 2 interactive graphics terminals (D) using 360 by 720 point bit-map displays for alphanumeric and graphic data presentation. These are used by two senior dealers for analytical purposes, modelling the term structure of interest rates through 'yield-curves', etc. Video outputs from these terminals allow interesting results to be made available to other dealers. A four-colour graphic plotter on this system allows hard-copy to be produced of such graphic output. Both this system and SYSTEM I have document preparation facilties producing camera-ready copy on high-quality 'daisy-wheel' printers so that analytic reports may be produced and disseminated to clients.

SYSTEM IV: Teletext Distribution System: is essentially a display processor for SYSTEM III. It uses the new techniques of teletext and viewdata to communicate information to dealers through extended colour TV receivers. The rationale for this system is discussed in section 2.2.

SYSTEM V: Gilts Data Entry System: provides a basic price/yield information service for gilts. This system has been kept deliberately as a compact, self-contained system that operates independently of the other sub-systems primarily to ensure continuity of service with no interference from other activities and a very high degree of backup. The broker involved is a prime supplier of on-line market data on gilts to outside information services and it is vital that these cannot be disrupted. The small floppy-disc-based system is adequate to cope with this service and communicates through modem links to the Reuters "Monitor" service (2) and the GPO "Prestel" service (3); it is similarly linked to SYSTEM III internally. This system is also able to provide a basic price/yield on-line dealing information service as an emergency backup to all dealers. This 'backup' was used for 6 weeks during system installation as the main service, proving that the small system could carry the key workload. It will be noted that the SYSTEM V configuration is available on each of SYSTEMS I through III, and thus there are 3 backup processors for the main service. This level of backup is not essential but it does allow great flexibility in maintaining services during any form of system failure - the overall system is designed to be robust.

2.1 Why a Distributed System ?

One key design decision was to go for multiple, distributed processors rather than a single central system. Some of the reasons will be apparent in the discussion above but it is worth clarifying them since "centralized versus distributed" is a key issue nowadays [8]. The main design considerations were:

(1) Reliability - the rationale for multiply backing up SYSTEM V has already been discussed. Provided the system operation is properly organized (readily changed patch panels for system inter-connection - programs for database transfer - etc.), a distributed system of this type with multiple similar configurations, each having a high degree of autonomy, can offer an extremely robust service with minimum degradation under a wide variety of conditions of hardware failure.

(2) Continuing Development - the same features that lead to robustness of service also lead to ease of continuing development, an important requirement for all such highly interactive systems [1,7] since man-machine symbiosis develops and the users' needs change with their growing experience of the system. The capability for ease of continuing development without disruption to established services must be seen as a key design requirement. The extreme modularity and high de-coupling between modules of this system design makes field modification very simple in relation to the complexity of the overall system.

(3) Continuing Replacement - computing technology is changing so rapidly that systems are necessarily obsolescent at installation. Even before this system was installed a variety of enhanced processors, backing stores and terminals became available. The overall design as a set of functional modules makes it possible to replace sub-systems at relatively low-cost on a continuing basis. Since the hardware released consists of self-contained computer systems it may be used for less demanding activities elsewhere, e.g. word-processing.

None of these advantages is automatically available from a distributed system. They have to be achieved through an overall system design that takes them as prime objectives and is somewhat different in approach to that for main-frame installations.

2.2 Why Teletext and Viewdata ?

Another major decision in the new system design was the choice of information dissemination technology. We had previously used a special-purpose MOS character memory with TV video output to run an 8-channel TV price/yield information distribution system to dealers, together with some storage-tube graphics terminals for interactive, analytical work. In the new system we decided as a major innovation to distribute price/yield information using teletext [9] technology for the main part, and viewdata [10] technology where interactive access was also required. This allowed the dealer terminal to be a standard colour television set incorporating a teletext decoder and giving access to BBC and ITV programs, BBC and ITV teletext (Ceefax and Oracle), as well as our own information services. Since the use of these terminals placed no load whatsoever on the central processor it was possible to offer the indefinite extension of this service - the dealing floor is currently cabled for 70 such sets.

The teletext specification [9] calls for 24 lines of 40 characters to be displayed on the screen of a conventional colour TV receiver. The character set consists essentially of the 7-bit ASCII characters together with escape codes setting the foreground and background each to be one of 6 colours, black or white. Escape codes also allow an elementary 'graphics' character set to be mixed in which gives control of a 3 by 2 cell of dots in each character position (i.e. an overall 'bit-map' of 72 lines by 80 columns) - this is quite effective for bar-charts.

Each line of a TV video signal may be used to encode one line of 40 teletext characters (plus some run-in and identification characters). There are some 16 lines available in each frame of a UK TV signal that are essentially unused because they correspond to the fly-back period. Using all of these to carry encoded teletext allows us to transmit a 'magazine' of 50 teletext 'pages' in a 1.333 second cycle. Users access a particular page by setting up its number on a keyboard at their sets. When the decoder recognizes this page number in the header of a transmitted page it displays it on the set. Thus users have access to any one of our fifty pages of information with less than 1 second average waiting time. They can also switch to normal TV channels, internal CCTV and videotape, and BBC and ITV teletext (which has a rather longer cycle time because magazines of some 150 pages are transmitted using only 2 TV lines per frame). We are also able to insert news flashes as 'boxed inserts' into the TV picture being watched as a general alerting facility.

The teletext distribution system has the advantage that the dealer terminals (G) place no load on the computer - the frames sent out cyclically are kept in main memory buffers and updated as necessary but no interaction with the users occurs. The 12 specialist gilts dealers do have a need for direct interaction with the computer to request information that it is not possible to pre-prepare and present in our 50 teletext pages. These dealers have enhanced teletext terminals (E) consisting again of colour TV receivers but with the additional facility of communicating directly with the computer through a polled serial line in 'viewdata' mode. These dealers still obtain most of their information through the teletext system so that the load placed on the computer through the interactive communication is reasonbly small although very important.

The sets used by the dealers currently are Sony portables with 8" screens, an appropriate size for the fairly low viewing distances involved - special anti-flicker circuits are used to prevent visual disturbance which is normally a problem with the use of TV sets as data displays. The separate CCS decoders used have a number of special facilities including computer over-ride of TV and teletext selection and sound levels on a selective basis. This allows them to be used to carry both visual and audio announcements to individual dealers or groups of dealers. The use of the sets with viewdata facilities giving interactive access to the computers is transparent to the dealers since the same keyboard is used to communicate with the computer as for inputting teletext page numbers - the context allows the destination of the keyboard request to be determined.

2.3 Software Design

All systems except IV are programmed in the mixed-code, segmented, multi-user system described in Ref.6 (SYSTEM IV is downline loaded from III with a small machine-code monitor specific to its tasks). The operating system used is an un-modified version of DEC's RT11 (allowing standard device and file handlers to be used for the backing stores), under which runs a multi-user version of Basys II. Basys itself is a language specifically designed for highly interactive business applications. It has long integer arithmetic for accounting and a family of powerful string-processing commands for dialogue programming. Basys II code is partially encoded and interpreted giving both very compact programs and also the capability of interactive programming.

A major feature of Basys II allowing rapid program development is the extreme modularity brought about by a system of functional 'segments' that may be programs in Basys, Fortran or Assembler, data areas, device drivers, etc. Segments may be freely loaded or unloaded at run-time allowing systems to be dynamically configured for different purposes. The procedure call in Basys II passes parameters by value or by reference and these are automatically converted by the intepreter into a form suitable for the called segement, whether Basys, Fortran or Assembler. All but the main job segments are shareable so that in a multi-user, or multi-task, environment many sub-systems may be standard shared segments, the database manager, yield calculator, applications library, etc.

Basys II segments are scheduled on a round-robin time-sharing basis and may be multi-threaded. Fortran and assembler segments are scheduled on a transaction-processing basis. The availability of Fortran and assembly code is important for those (small) sections of an application that have to run at high speed. The segments generated being dynamically loadable and shareable allows them to be

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used to form a 'virtual machine' for all tasks running on the system - Basys II systems are readily and rapidly customizable. Special attention has been paid to making program development of the compiled segments as simple as that as the interpreted ones - for example, run-time errors in Fortran segments report back to the Basys II interpreter both the nature and the Fortran source line giving rise to the error. Since the error is most often caused by the parameters passed this usually enables the problem to be identified and resolved interactively without further compilation.

3 CONCLUSIONS

The system briefly described in this paper gives a recent case history for the exploitation of distributed mini/micro systems with close man-computer interaction through colour and graphic terminals, and information dissemination through teletext, high-quality document preparation and communication links to other services, as described and advocated for general business use in Ref.8. It exemplifies the potential of such systems to act as specialist information processing and database systems for both private and public sectors - such systems give us the highly effective information transfer technology necessary to the institutions of our modern society.

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