An introduction to the concepts of the Supermarket and Retail Store Systems is presented.

Discussed are the objectives of the systems as they relate to the problems of the merchandiser and the solution to those problems in terms of specific system function and the structure chosen to implement that function. The system design philosophy pertaining to the terminals, store controllers, host processors, and specialized I/O devices is also discussed. Specific requirements of each system are described.

Overview of the Supermarket System and the Retail Store System

by P. V. McEnroe, H.T. Huth, E. A. Moore, and W. W. Morris III

Supermarket and retail store chains are often organized so that the stores belonging to a chain in a geographical area operate autonomously under the direction of an area headquarters. Thus, decision-making and administration are distributed between the area headquarters and the store management. Routine store management and administration are under the control of the store manager, whereas pricing, purchasing, inventory, warehousing, shipping, and administrative decisions that concern the enterprise as a whole are the province of the area headquarters.

The IBM Supermarket and Retail Store Systems are designed to provide data processing, merchandise-processing, and point-of-sale functions at both the headquarters level and the store level. At the store level, a variety of terminals is used for sales and checkout and for the functions associated with the processing of merchandise and the management of the store. While performing these functions, the terminals record comprehensive data on their activity. A store controller coordinates the activity of the terminals, collects data from the terminals, and performs additional specific store-level functions. It also communicates with a computer at area headquarters (the host), providing it with data collected from the terminals, receiving store-level system support and other communication from it, and, in the Retail Store System, communicating interactively with it when required.

Thus, the Supermarket and Retail Store Systems are configured in a three-level hierarchy. The host initiates the store-level systems, receives data from the stores, and can process this data for the decision-making of the headquarters management; each store in the area contains a controller subservient to the host, and each controller runs all the terminals in its store. The relative autonomy at each level of the hierarchy will be discussed in detail subsequently and in other papers.[1-3]

The functions performed by each of the systems are different and so are the benefits attainable by their respective users. In the supermarket, a significant benefit is that of checker productivity.[4] This consideration stems from the trend in the past decade of increasing operating expense due primarily to the rise of labor cost relative to productivity. The industry has already determined that the ratio of operating cost to revenue is lower for larger stores. The result has been an industry-wide trend toward larger stores. This trend also favors the introduction of an automatic system; since a store controller is needed for the Supermarket System, regardless of the number of checkout terminals, the cost per checkstand of the Supermarket System decreases as the size of the store increases.

Only recently has technology provided an adequate device to economically address the productivity requirement of the supermarket checkstand, the laser checkout scanner,[5] which contains a light source to illuminate and automatically identify each premarked item as it passes across the checkstand. In April, 1973, the supermarket industry established a unique identifier for all supermarket items made in the United States and Canada: the Universal Product Code (UPC) symbol[6] that enabled the economic use of scanners for checkout.

While the impetus for a supermarket system was checkout productivity, systems support at both store and headquarters levels was considered necessary for an adequate system. In retailing, however, the converse is true; the requirement of inventory management and store systems support was dominant in a retail store system, whereas point-of-sale productivity was less critical. A common hierarchy exists for both systems, but the constituent functions are quite disparate.

It is the purpose of this overview paper to provide some insight into the specific operating environments of these two industries, describe the common system design approach, and tell how it was modified to satisfy each industry's particular requirements.

This background is intended to prepare the reader for the other papers in this issue that deal with the Supermarket and Retail Store Systems. In our description of the systems, we discuss their aspects either separately or together, depending on whether the components are common to both systems or not.

Supermarket operating considerations

The Supermarket System provides operation at two levels: the store level and the host, or headquarters, level. After the store-level system is initiated from the host, it operates autonomously to provide checkout, to capture data on item movement, and to assist in store management functions. The host level controls many store-level systems and can process data collected by the store levels for the benefit of the chain.

In the Supermarket System, three areas of operation are addressed, "front-end," or checkstand, operation, merchandise and inventory management, and store operations. Some of the benefits of the Supermarket System compared to existing supermarket procedures are discussed.

Checkstand benefits of increased productivity achievable by using scanners are discussed by Antonelli[7] and Metz and Savir.[1] Scanning also allows increased accuracy of price-recording on item checkout. The code (UPC if marked by the manufacturer, or store-assigned code otherwise) is typically a unique, 12-digit item identification number, marked both in decimal characters and in a bar-coded form that can be read by an optical scanner.[6] All the codes in the supermarket's inventory are maintained at the controller in a file of price description records that contain both the prices and alphabetic descriptions of the items. The code of an item is invariant even though its price may vary among stores. Prices are marked on the shelf but not necessarily on the merchandise since the system reads the code of an item at the checkstand, retrieves its price and description, and displays that information to the shopper, while also printing it on his receipt tape. A significant benefit in store operations lies in the potential of a reduction in price-marking since it is anticipated that items will mostly be coded by the manufacturer prior to shipment to the store.

Cash and funds control may be improved. The checker can use the keyboard to enter the type of tender—check, cash, coupons, or food stamps—and if authorization is required, the shopper's account number. Automatic check authorization may reduce losses significantly. The store controller can facilitate rapid and accurate reconciliation of tender.

On the other hand, at headquarters, the system provides item-movement data so that the user can implement optimal inventory policies and shelf allocation procedures whose effects may be reduction of both back-room inventory and stockouts, or shortages (which not only reduce sales but also disappoint shoppers), increased turnover because of more efficient shelf allocation, and the reduction in ordering cost as a consequence of the adoption of automatic reordering procedures. Furthermore, the user can analyze the effectiveness of advertising, the performance of new items, and the performance of similar items by different vendors. He can also study store needs as a function of the store location within the chain and the overall effect of his price management program.

Retail store operating considerations

In the retail store environment, point-of-sale operation, merchandise processing, and store operations are also addressed, but with different emphasis. Differences between the retail store and the supermarket environments principally relate to the point-of-sale function, item labels or tickets, the functions of merchandise processing, and the system flexibility necessary to accommodate fluctuation in the load and mix of these functions. Berk, Dunbar, and Hobson[2] cover this topic comprehensively.

In the traditional department store, a salesclerk assists the shopper in selecting his purchases, and the typical shopper buys only one or two items per purchase. However, the retail clerk is faced with a multitude of options at the point of sale. These options include such transaction types as discount, C.O.D., layaway, partial payment, multiple charge plans, etc. He may be a temporary employee, unfamiliar with the store's procedures, who needs to be quickly trained and guided through many types of sales transactions. System design considerations that address these difficulties are discussed by Antonelli.[7] (On the other hand, the checkout process of the mass merchandiser has much in common with that of the supermarket.)

Throughout the industry, each retailer tickets merchandise in the manner that best suits his own environment. Some vendors attach their own price and brand name tickets to their merchandise prior to shipping to a retailer. Some retailers use central receiving centers where the merchandise is marked and then sent to the stores. Often, ticket-making and attaching is done at the store of sale. The retail sales ticket contains a great deal more information than that required in a supermarket identification system. This information contains such data as stockkeeping unit number, buying division, selling division, class, size, and price. However, there is much variability both in size and content of retail tickets. The Retail Store System consequently contains the capability of making and reading a variety of tickets.

The magnetic hand-held scanner, or wand, is normally a more accurate and faster data entry device than the keyboard when many characters of data are to be entered.[7] The Retail Store System includes point-of-sale terminals with magnetic wands and magnetic ticket units.

The functions of merchandise processing are related to the activities of the ordering, receiving, and internal movement of merchandise. Individual stores tend to adopt their own style and format in the recording and data processing of such activities. To reflect this individuality, provision is made for the user to write his own programs to execute these functions by the store controller should he so desire.

Considerable fluctuation is to be expected, by season and by time of day, in the load and mix of sales and the various merchandise-processing functions. Consequently, provision is made for generation of a flexible, store-level system, designed to cope with a particular load and mix. Reference 2 discusses this variability and the techniques of the generation of a flexible system.

Common system design

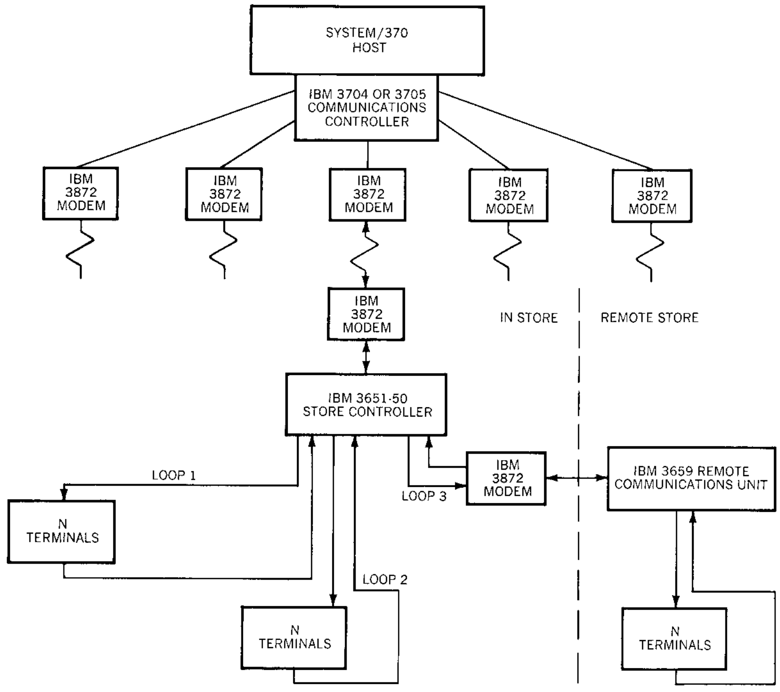
The basic diagrams for the Retail Store and Supermarket Systems offered in the United States and Canada are shown in Figures 1 and 2, respectively. Both systems are designed with three levels of hierarchy—the host processor, the store controller, and the terminals. The controller and terminals perform specific functions appropriate to their level in the store hierarchy; these functions are discussed later.

host

The host processor can be a System/370 model having dynamic address translation supported by OS/VS or DOS/VS. The System/370 operates with binary synchronous communication (BSC) and/or synchronous data link control (SDLC)[8] through a communications controller that is connected to the controllers of all the stores under that host by telephone lines carrying signals at 2400 or 4800 bits per second[9] (see Figures 1 and 2). Different communications devices and signal rates may be used in systems outside the United States and Canada according to local usage. We will not discuss these differences in this paper.

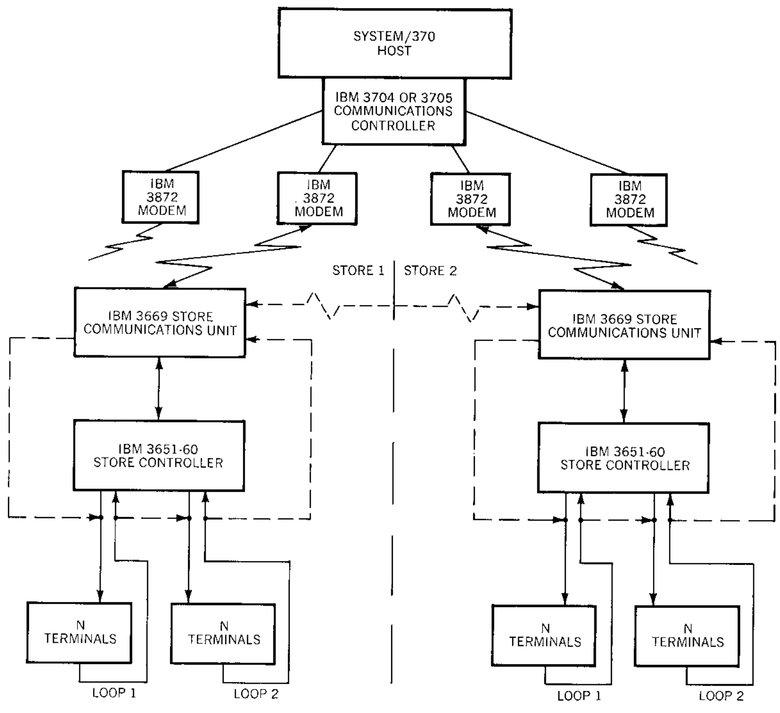
Each store can remain autonomous and yet be serviced by the host; for example, the labor scheduling of a supermarket would be done at the host, central retail credit files are held at the host, and the location of expensive inventory (big-ticket items) is recorded in the host files. These files may be accessed by inquiry from a store controller.

Figure 1 Retail Store System



N = NUMBER OF TERMINALS THAT CAN BE ATTACHED TO A LOOP

Figure 2 Supermarket System



DASHED LINES INDICATE CONNECTIONS USED DURING STORE BACK-UP OPERATION
N = NUMBER OF TERMINALS THAT CAN BE ATTACHED TO A LOOP

The controller is the focal point for store operations. It collects data from the terminals and host, directs inquiries to its own or host processor files, and directs responses to these inquiries to the terminal originating the inquiry.

controller

Communication between the controller and terminals is on a store loop. Messages traverse the loop in batches of catenated messages initiated by the controller periodically. The batch is initially composed of a header character, a sequence of all the output messages ready to be sent to the terminals on the loop (each message with its terminal identification), a poll character, and a long sequence of blank characters. As the batch traverses the loop, each message passing through every terminal, terminals receiving messages can selectively read them from the batch by their identification. Terminals that are ready to send messages do so by recognizing the first blank character of the sequence after the poll character, modifying it so that it is no longer blank, and then inserting the messages in place of subsequent blank characters. Thus, when the batch returns to the controller, messages sent by the terminals will be catenated behind the poll character in the order of their sending terminals. Each such cycle is called a polling cycle.

The retail controller supports up to three loops, two of which may encompass remote stores; the supermarket controller normally supports only two local loops, although in *back-up* mode a third remote loop is also supported. As pointed out earlier, the supermarket terminal requires access to the price description record file of the controller for checkout. Whenever a controller fails, the loops in that store reconfigure to a third (remote) loop supported by a controller in a different designated supermarket ("sister store"). An operator in the failed store switches the store communications unit to the back-up mode and dials the sister store. The controller in the sister store automatically answers the call, recognizes the request for back-up, and proceeds to support the terminals in the failed store as if it were the controller of those terminals while it continues to support the checkout operations of its own terminals (Figure 2).[3] The back-up mode therefore affects two stores, the one containing the failed controller and the one supporting the failed controller. The back-up relationship may, but need not, be reciprocal.

Figure 1 shows a retail controller with three loops attached, two local and the third remote. The number of terminals that should be attached to a loop is a function of the expected traffic and desired service time required for the terminals on that loop.[1,2] The maximum number for the Supermarket System's two loops is 12 terminals per loop (24 on the remote loop in back-up), and for the Retail Store System's three loops, it could be as high as 64 terminals per loop. The second and third loops of a retail system can be used to control terminals in remote stores through the remote communications unit. Each remote loop can further be configured in segments to support no more than three remote stores through a remote communications unit at each location.

host/controller communication

The store systems are supported by the IBM Subsystem Support Services, programs that are executed at the host, providing system initialization and maintenance functions for the store controllers assigned to the host. Examples include configuration to their individual operating environments, specification of the number of terminals connected to each controller, terminal configuration, etc.

The subsystem support services use the user's specification to select options that define the operations of each terminal, giving it appropriate tax tables, modulo check procedures, operator number, sales receipt options, passwords, etc. It also allocates space for the user's files. After the system initialization information is transmitted with the user's files to the controller, the store system operates independently of the subsystem support services.

However, communication between the controller and the host can be reestablished in order, for example, for the host to update a price description record at the controller, for a message to be sent from the host to a store terminal through the controller, for summaries of item movement or transaction log data (see next two sections) to be transmitted from the controller to the host, for the host to update check authorization files at the controller if they are maintained there or for the controller to request and receive credit authorization from the host, for the host to transmit data to be used for printing tickets, etc. Some of these examples are applicable to the Supermarket System, others to the Retail Store System, and some to both systems. In the Retail Store System, interactive communication may be established in which store-level functions are actually executed at the host by some user's application programs.

Design criteria specific to the Supermarket System

supermarket terminal

Supermarket point-of-sale terminals replace conventional cash registers in the Supermarket System. The checker has the option of scanning code symbols, keying item codes, or keying prices into the system. Using UPC code, the terminal retrieves the item's price and description from the controller and prints them on the shopper's receipt with the terminal station printer. A display panel with alphanumeric capability is provided so that the shopper can read a description of the item as well as the price.

The supermarket can choose the item descriptor and load it into the system. Besides the shopper's receipt, a three-station alphanumeric printer provides a journal tape containing a summary of the transaction and an insert station so that checks may be inserted and endorsed. A cash drawer is also provided. Appropriate operator guidance is employed using the display.[7]

The terminal maintains a full set of totals by transaction and a grand total, checks data entered for validity, and controls guidance information. The checkout scanner, when used, is attached to the terminal. Special features for the terminal provide for the attachment of ancillary equipment such as scales, coin dispensers, and stamp dispensers.

The supermarket terminal station can be installed as an integrated unit containing a keyboard, printer, cash drawer, and a display or in a distributed configuration with these units detached. In the distributed configuration, all units are packaged under separate covers and are connected by cables, thus allowing flexibility in checkstand design.

Dickson and Soderstrom[5] describe the design and operation of the laser scanner. Antonelli[7] discusses checkstand design suited to realize the potential productivity of a scanner. Metz and Savir[1] show the relationship between the parameters of scanning procedures and total system performance.

The scanner contains a moving beam of light that is reflected back through a window in the checkstand when an item is moved over it. The diffuse reflectance from the surface of the item is transformed to electrical signals whose modulation is monitored. When this modulation is consistent with a bar-coded label, the signals are decoded to the numeric code. The decoding process is discussed by Savir and Laurer,[6] who show that through the use of parity, modulus checking, and multiple scans on a single item pass, most scanning errors are detected before the code is sent to the controller, permitting rescan of the item, when this occurs, without delay.

The terminal sends the code to the controller as a message in a polling cycle and receives the price and description of the item in a message from the controller in a subsequent polling cycle. The price and description are displayed and printed at the terminal. The price may be modified at the controller by rules for determining the price of a single item when multiple pricing or mix-and-match pricing is used. The item movement is recorded at the controller. A system of buffers at the terminal permits overlap of the processing of items.[1]

Items may also be checked by scanning or keying of the price if either the code is not used or the price in the price-description record is to be overridden.

Design criteria specific to the Retail Store System

retail store terminals

Several terminals are designed to meet the specific requirements of the Retail Store System. These terminals are the retail store terminal with an optional magnetic wand to capture data from magnetic-encoded tickets, the ticket unit, and the display station.

The retail store point-of-sale terminal contains a keyboard, printer, and cash drawer similar to, but not identical with, those of the supermarket point-of-sale terminal. Separate displays and guidance panels are provided; whereas the nature of guidance of the supermarket terminal is a display of the appropriate error code on the occurrence of an abnormal event, guidance in the Retail Store System is normally the indication of the correct sequence of operator's actions. This indication is made on a separate panel upon which the appropriate message is illuminated. Entry of sequences of many characters of input is facilitated by magnetically encoded tickets scanned by a hand-held scanner, or wand. Entry of such data using a wand is both faster and less prone to error than when entered by using the keyboard.

The ticket unit encodes and prints magnetic tickets from stock in lengths of one, two, or three inches. It also reads batches of two-inch tickets from a cartridge.

The display station contains a keyboard, a 1920-character alphanumeric display, and an optional printer. It is used as a terminal for merchandise processing and as a control unit for the ticket unit.

The normal mode of operation of the retail terminal is on-line with the controller. However, the terminal can operate in a stand-alone mode similar to an electronic cash register operation if for any reason the controller or loop is inoperative.

The basic functions of the retail terminal are classified as sales support and administrative support. Sales support is directly related to the sales transaction taking place at the terminal. Administrative functions lend support to the sales function but are not directly related to a specific sales transaction.[2] Sales support functions include sales transactions and transaction logging, credit authorization, price look-up, and point-of-sale totaling.

The price look-up function allows the item price to be stored in the controller. This operation is similar to that described in the Supermarket System. The request for data can be entered by wanding or keying.

For data entry, the display station together with the printer can be used to produce purchase orders, to retrieve purchase orders that were created earlier at the host processor, to check in merchandise received, and to permit receiving personnel to enter data related to receiving transactions. The display station can be used to execute user-written application programs at the store controller, to direct inquiries to host files, or to be in an interactive mode with the host.

The format, content, and sequence of tickets can be generated either by the host or by the store controller executing a user-written application program. A display station initiates the printing of tickets by enabling (setting up for operation) the ticket unit and calling the ticket data.

The ticket unit can make from one to 4095 identical tickets. There are three sizes of tickets in eight separate formats: one-inch self-adhering labels and two- or three-inch tags. All tickets are one-inch wide. Each batch of tickets can be identified clearly with an extra ticket, referred to as a batch identification ticket, containing instructions for the merchandise markers. Operator intervention is limited in normal situations to performing ticket setup and loading and unloading of encoded tickets. Thus the speed of operation and number of tickets produced is not operator-dependent because the operator of the ticket unit is not required to set up the machine each time the information changes on tickets.

During normal operations of the Retail Store System, data is collected from terminals and stored on the controller's files. Data from the terminals is stored on the transaction log. Data from display stations, ticket units, and the host processor is stored in other designated files. For example, a message from a display station could be identified as a purchase order to be stored on the purchase-order file, and a message from the host processor could be stored on a report file.

Summary

The Retail Store and Supermarket Systems are designed to assist in performing the tasks of store operations, in particular, sales, ordering, and ticket-making. They are also designed to solve the problems and perform the tasks of the area headquarters management with the user's programs using data collected from store operation for inventory control, labor scheduling, traffic management, store shelf allocation, sales promotion assessment, and item profitability evaluation, among others.

The Retail Store and Supermarket Systems are structured in a hierarchy of three levels. At the lowest level are the terminals used by store personnel for sales and other store functions. These terminals are controlled and supported by a controller located in the store. This controller, with controllers from other stores of the enterprise, is linked to a host computer at the area headquarters.

Within the systems, the store-level operation is designed to be autonomous. Components within the store-level system require neither data processing personnel nor programming by the user at the store for their operation.

Each system contains contingency capability against failure of the controller—the Supermarket System shares the controller of another store and the retail point-of-sale terminals can operate off-line in stand-alone mode.

Checkout in the Supermarket System can be more productive and accurate than conventional checkout using cash registers, largely because of a laser scanner. A scanner can be used, of course, only if the information required at checkout is in scannable form. Appropriate encodation is by means of the Universal Product Code. During checkout, item-movement data are collected for management data processing. Some of the other potential benefits of the Supermarket System that have been mentioned are savings due to reduction of price marking, remarking, misrings, stockouts, and excess of inventory, and savings due to improved control of cash, funds, and check authorization.

In addition to point-of-sale terminals, the Retail Store System contains display stations and ticket units to accommodate comprehensive merchandise processing. The retail point-of-sale terminal can also be more productive than the cash register because of more accurate and faster data entry achievable by its magnetic wand entry device and its operator guidance features. This terminal also collects item data for management data processing.

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