ReserVec: Trans-Canada Air Lines' Computerized Reservation System

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The rapid growth of the airline industry in the immediate post-World War II years overwhelmed the manual reservation systems in use at that time. Trans-Canada Air Lines addressed this problem by developing ReserVec, a very early computerized airline reservation system that was designed and manufactured in Canada. ReserVec, unlike previous automated reservation systems, was fully programmable and ran on a general-purpose computer. The technology acquired from the development of ReserVec's Gemini computer was used first in the development of the Ferranti-Packard FP-6000 multiprogrammable computer (also developed in Canada) and then in the ICL 1900/2900 series of compatible computers.

This article presents Trans-Canada Air Line's ReserVec system in the context of other automated airline reservation systems contemporary to ReserVec, including American Airline's Magnetronic Reservisor and SABRE systems.

The early 1950s was a period of tremendous growth for the airline industry in Canada and elsewhere. Although airlines were increasing fleet sizes to cope with the demands of the population, airline seats were still in short supply.[1] Trans-Canada Air Lines (TCA) operated 49 passenger planes in 1952, and 66 passenger planes by the end of 1955. Although their 1956 seating capacity of 2,600 passengers was 90 percent larger than it had been in 1951, passenger demand had increased 104 percent during the same period. By 1957, TCA was boarding 250,000 passengers per month, and demand was continuing to grow.[2,3]

Passenger aircraft in the postwar period were short-ranged. Longer flights were broken up into flight *legs*, with each leg treated as a separate flight. Airline agents booked longer flights by assembling the various flight legs. Seat availability data were typically held at regional space control centers, where flight information was noted on manual display boards. The number of personnel in the centers was limited by the sight lines to the display boards. Communication between the local ticket office and space control centers was a slow and repetitive process accomplished via teletypewriter and telephone.

Trans-Canada Air Lines' flight inventory during this period was maintained on hardboard wall charts at its Toronto and other space control centers. The wall charts, referred to as visual seat indicator boards or VSIBs, displayed a running tally of seats sold. They were maintained initially by way of multiple erasures and rewrites and later by the placement of colored disks (see Figure 1). TCA's reservations control center was connected to the remote sales offices via 29,000 miles of teletypewriter and telephone lines. By the mid-1950s the control center received 35,000 messages per day, representing three and one half to seven phone calls for each passenger boarded. By 1959 the reservations center was handling 3,500,000 transactions per month.[3-8]

Seventy-five percent of the reservations activity occurred within 10 days of the flight date, with 50 percent occurring within the last five days. For every 300 original bookings received, an average of 100 cancellations or changes took place, although passenger turnover sometimes reached 100 percent. More than half of the cancellations occurred within 48 hours of the flight time. A minimum of five manual operations was needed to complete each reservation.[4,6]

In an attempt to address the reservations problem, Trans-Canada Air Lines developed a prototype automatic reservation system as early as 1945. This system was mechanically based, but was abandoned as too ambitious for the available technical equipment.[4] In 1946, in an attempt to improve the manual reservations service, TCA experimented with giving seat allotments to local ticket offices rather than maintaining them centrally. This exercise was brief and unsuccessful.[9] Five or six years later TCA asked one of its employees in Montreal, communications engineer Lyman Richardson, to examine the airline's operations to see what could be done to improve the reservations procedures. Richardson's investigations led him to believe that a computerized reservation system was the best solution for TCA.[7,10]

A test system was prepared, and a simulation of TCA's reservations operations was performed on the University of Toronto's Ferut computer (see the articles by Hume and Williams in this issue) in the summer of 1953. The Ferut, a very early Ferranti computer manufactured in England, was programmed to store the entire TCA operational schedule and perform many operational functions in real time. Richardson believes "this was the first time that a generalized seat inventory operation was ever conducted in real-time on a general purpose computer."[5]

The 1953 Ferut simulation, however, "indicated serious limitations in the area of real-time input/output devices."[11]

The Reservisor machines: State-of-the-art reservations

In both North America and Europe reservation systems were being developed to improve reliability and response time and reduce the unit cost per reservation. To this end the Teleregister Corporation's Reservisor automated reservation system was installed in American Airlines' Boston reservations office in February 1946. The Reservisor was designed to test the processing (not the communications) phase of reservations operations, and functioned as a local seat availability system only. The basis of the Reservisor was a matrix of relays into which plugs were manually inserted to indicate whether a flight was open or closed. After a one-year trial it was found that 200 more passengers were being served daily by 20 fewer agents, although other changes may also have contributed to this increased productivity.[6,12]

In April 1949 work was started on an improved Magnetronic Reservisor for American Airlines that was to be installed in a 1,000-square-foot area at LaGuardia airport. The Magnetronic Reservisor, unlike the Boston Reservisor that served remote ticket offices, provided service to the New York-Newark-Idlewild area only. Considered the world's first fully automatic reservations device, it appears to have been the first commercial system to combine electronic processing with electronic communications.

The Magnetronic Reservisor was a magnetic-relay and vacuum-tube fixed-logic machine featuring plug-in assemblies. Design emphasis was on reliability rather than speed, and to that end twin relays were used instead of vacuum tubes wherever possible. The system was actually two machines, simultaneously working on the same input data. The machines compared signals at every stage and printed error messages if any discrepancies were detected.

The Magnetronic Reservisor ran 22 hours per day with the other two hours reserved for maintenance. It had a longer scheduled downtime on Saturday evenings for further maintenance. The machine was very reliable, having an unscheduled downtime of less than 0.01 percent. During its first year of operation, approximately 10 tubes per month needed to be replaced. Later the reliability improved until the Magnetronic Reservisor functioned for between two and four months without tube failures. The system had two magnetic drums locked together. The second drum was used as a backup, with the system reading from one drum and writing to both. One drum could be taken off line while the other still functioned. Each drum measured 163.8 cm wide, 76.2 cm deep, and 151.1 cm high; had a track density of 20 bits per inch; and rotated at 1,200 rpm.[12-14]

In August 1956 a larger and faster Magnetronic Reservisor was installed in the American Airlines West Side Terminal reservations office in New York City. This improved Reservisor contained 4,500 vacuum tubes and 3,000 diodes, and held 2,000 flights per day for a 31-day period on the drum. The capacity of each of the two magnetic drums was one million bits (compared with 250,000 bits on the 1952 version of the machine). Average local response time was reduced from 0.8 to 0.3 seconds, with remote transactions still taking an additional three seconds.[13]

The Reservisor reservation system worked so well that versions of it were purchased from the Teleregister Corporation by Braniff, Pan American, United, National, and Northeast airlines. Pan American's version of the Reservisor was capable of handling 3,600 inquiries per hour. In addition, a Reservisor-based hotel reservation system was built by Teleregister for the Sheraton Corporation of America, and an inventory-control system was built for the B.F. Goodrich-Hood Rubber Company plant in Watertown, Massachusetts. By 1958 Teleregister was developing airline reservation systems for TWA and Western Air Lines; railroad reservation systems for the New York Central, New Haven, and Santa Fe railroads; and savings account systems for the Howard Savings Institution of Newark, New Jersey, the Society for Savings of Hartford, Connecticut, and the Union Dime Savings Bank of New York City.[15]

By 1960 Standard Elektrik Lorenz AG of Stuttgart, Germany, had built an automated airline reservation system that was remarkably similar to Teleregister's. Standard Elektrik Lorenz also developed a car-ferry reservation system for German Railroad's ferries between Germany and Denmark. The system utilized the existing telex network, maintained 200 ship movements per day for a 62-day period on a drum memory, and used teleprinters for input and output to the central reservations office. The central processing equipment was composed of germanium diodes, germanium transistors, resistors, capacitors, and relays. Response time in the processing equipment averaged 10.5 milliseconds, but as the teleprinter characters were transmitted at a speed of 150 ms each, total transaction time was typically 20 seconds.[15]

Continued reservations efforts at TCA

Richardson of Trans-Canada Air Lines was familiar with Teleregister's system. Referring to the Magnetronic Reservisor he said,

> There was one interesting thing about that system for me — it worked. It was simple, you could tell how well it was running by the noise of the relays. You could tell whether it was busy, or not busy, or stopped.

Richardson continued studying TCA's operations with the aim of computerizing the reservation system. He enlisted the help of Josef Kates, Len Casciato, and Bob Johnston, who were associated with the Computation Centre at the University of Toronto and had worked together on the development of the UTEC computer (see the article by Williams in this issue of the *Annals*). Their initial work for TCA seems to have been as a working group for Adalia Ltd. of Montreal, which was a consulting company run by British radar pioneer Sir Robert Watson-Watt. Further details of their work for TCA are less clear. Kates, Casciato, and Johnston, working for Adalia, produced a feasibility study entitled "Preliminary Report on an Automatic Passenger Service System for Trans-Canada Airways" (unpublished). The feasibility study concluded that a general-purpose electronic computer could be used to automate the reservations process.[5]* We may assume that since Kates, Casciato, and Johnston were associated with the University of Toronto's Computation Centre, they would have worked at some level with Richardson on the 1953 TCA simulation on the Ferut computer, although the exact details are unclear. Josef Kates remembers that Trans-Canada Air Lines gave KCS, a consulting firm formed by himself, Len Casciato, and Joe Shapiro (who was also from the Computation Centre), a further project to simulate the reservation system operations on the Ferut. This may well have been the 1957 testing that Kates was referring to, as he also mentions that KCS "went on as a consultant to Ferranti, but it [the reservation system] was pretty much a Ferranti show."[16] (Ferranti was heavily involved with the 1957 Ferut tests, but as far as I can tell, not with the 1953 Ferut tests.) Len Casciato remembers, "We intended to work for TCA on the implementation and the ongoing work, but they gave the contract to somebody else."[17]

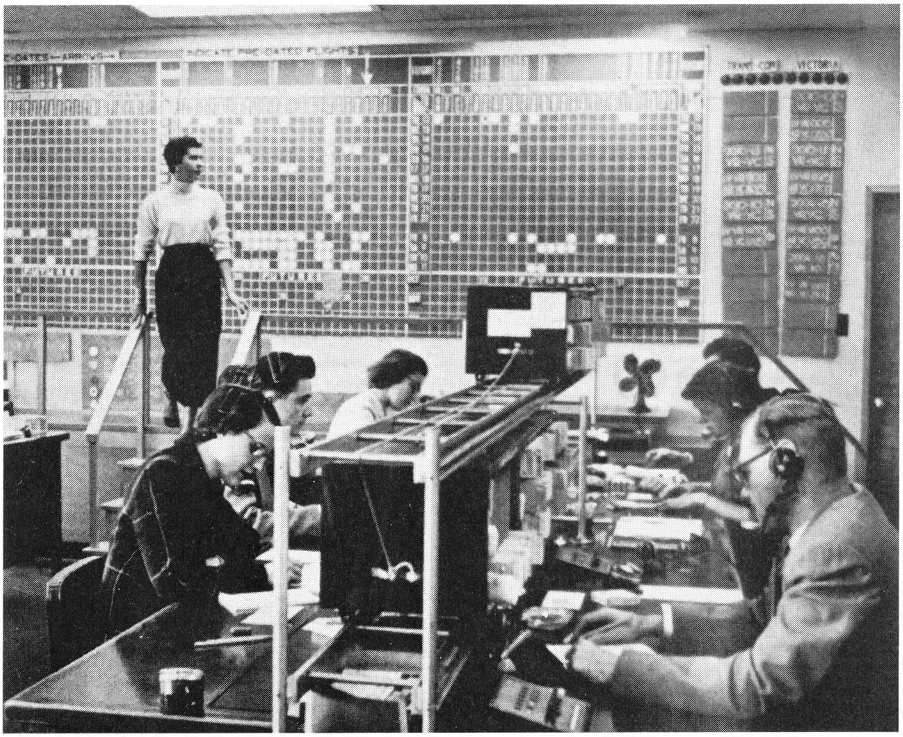

Figure 1. TCA's reservations control center, circa 1954.

The input/output problems encountered during the 1953 tests on the Ferut computer had been addressed by 1957, when TCA allocated $75,000 to construct six prototype "transactor" terminals along with other necessary equipment and to run more tests on the Ferut. Teletypewriter I/O had been used during the 1953 Ferut simulation, but Richardson had since determined that the teletypewriter keyboard was neither reliable nor fast enough for this operation. He noted that sales agents took paper-and-pencil notes while gathering details of a reservations transaction from a customer. He designed a card that the agents could mark (instead of taking notes) while speaking with a customer and then insert into a transactor terminal. The card was marked by connecting labeled pairs of small circles with a penciled line. The transactor terminals were designed to detect the presence or absence of these lines as input, and to make an appropriate punch in the edge of the card as output. The construction of the prototype transactors, along with related equipment, was carried out by Ferranti-Packard Electric Ltd. of Toronto.[10] The associated distribution system used "transistors and solid-state devices entirely and is built with plug-in units that can be readily changed."[7,10,11,16-18]

For testing in 1957, six transactor terminals were hardwired into a local distributor and then connected via telephone line and a computer coupler to the Ferut. TCA's board of directors came from Montreal to attend a demonstration of the test system, performed at the University of Toronto. Also in attendance at the demonstration was the president of Canadian National Telegraphs, as this company maintained Trans-Canada Air Lines' teletypewriter equipment and lines. A full range of reservations operations was tested, including queries, the booking of reservations, cancellations, multiple-leg routing, and limited sale. As a result of the demonstration, TCA authorized the design of a complete computerized reservation system.[10,11,15]

In 1959 TCA placed a two-million-dollar order with Ferranti-Packard for the field and communications equipment needed for the reservation system; this represented all of the system's equipment except for the central computer. The bulk of this order was for 350 transactor terminals, to be placed in TCA's sales offices. No doubt in reference to the Magnetronic Reservisor's agent set, the transactor terminal was held up as an "improvement on other booking systems that require punch key operation."[19] Later in the same year, Ferranti-Packard was awarded the contract for

* The bibliography of the Vardalas/National Museum of Science and Technology "Computer History Project" gives the unpublished feasibility study a date of 1955, but the text of the Computer History Project seems to indicate that the study was completed before the 1953 Ferut simulation. Len Casciato, in a 1992 interview, remembers the feasibility study as taking place "in the very last part of 1953," and Josef Kates (also in a 1992 interview) remembers the study taking place in late 1953 or starting in the spring of 1954, which, in either case, would be after the 1953 Ferut simulation.

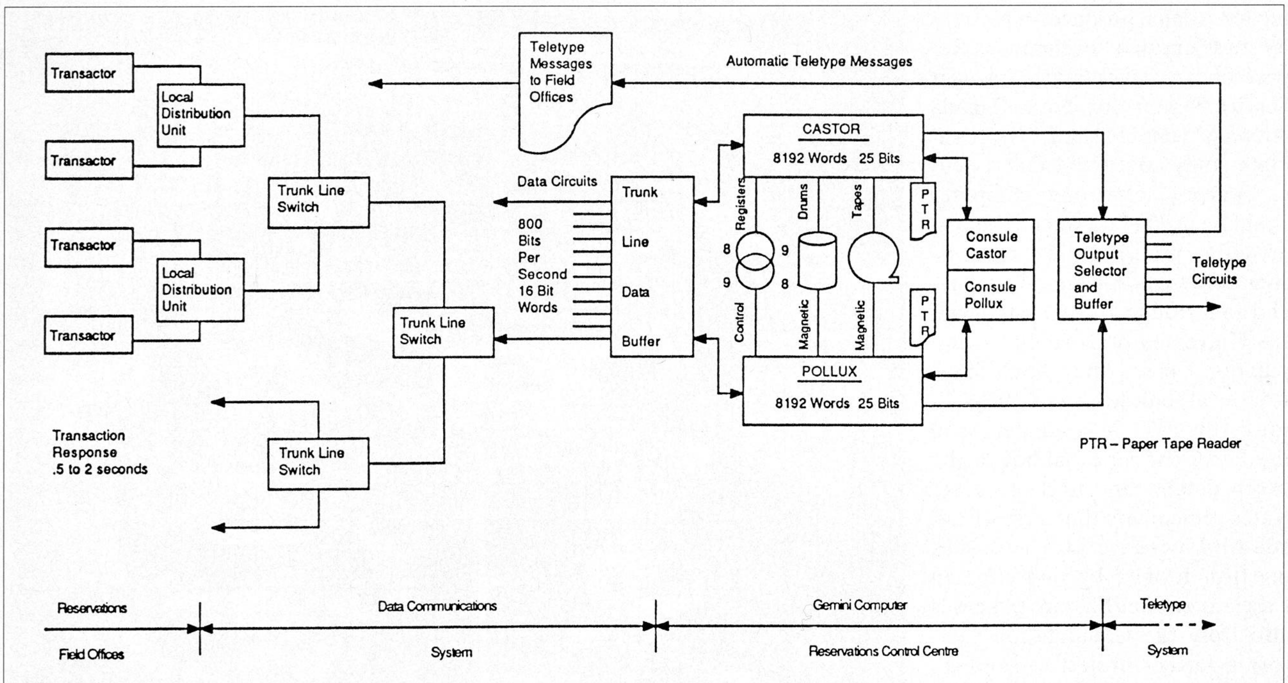

Figure 2. Schematic representation of the ReserVec system (diagram courtesy of Lyman Richardson and John Vardalas).

the construction of the reservation system's computer as well. The project engineer for the system was D.K. Ritchie, and the principal designer was Fred Longstaff. Although other computer manufacturers were considered (including IBM), Ferranti was awarded the contracts because of its knowledge and experience with the test systems.[10,20,21] A contemporary news article noted, "the general-purpose computer system is the first such system to be awarded for Canadian design and manufacture."[22]

The system was designed to handle 60,000 transactions per day. The computer, which was called the Gemini, could process 10 typical reservations transactions per second. The Gemini was designed as a general-purpose computer to offer maximum flexibility and future expansibility for the reservation system. The transactor terminal's design stressed versatility for the same reasons. The Gemini was Canada's first commercially built transistorized computer.[5-7,23,24]

KCS Data Control Ltd. of Toronto developed the system design for the Gemini system, but seems to have lost the bid for a later programming contract to H.S. Gellman and Company Ltd. of Toronto. The programming for Gemini was tested on Ferranti-Packard's Pegasus computer at their Toronto plant.[4,17,25,26] Richardson estimated that

> The complete set of operational programs for the system, including the assembler and all off-line functions, consists of about 25,000 instructions and constants. With the many modifications that were introduced during the period of implementation and adjustment, it is estimated that about 100,000 instructions were written.[11]

Late in 1960, Trans-Canada Air Lines held a contest among its employees to name the new reservation system. The name "ReserVec" (from *Reser*vations *E*lectrically *C*ontrolled) submitted by Lethbridge passenger office manager Harry J. Simper won the $100 prize.[7] At this time TCA was handling 3,500,000 transactions to fly 250,000 passengers per month. ReserVec was expected to effect a 60 percent reduction in human transactions.[20]

ReserVec's field equipment was installed and maintained by Canadian National Telegraphs with installation commencing April 11, 1961. Installation of the computer began in August 1961. On October 16, 1961, the ReserVec system was turned on for Toronto and all stations to the West Coast, northern Ontario, and Chicago. The Montreal and Ottawa areas were added two days later on October 18, and all remaining stations on November 1. A simulation program was run on the Gemini computer to allow field offices to gain experience with the system before it was used with the public. Initial statistics on the use of the system were also gathered at this time. System testing was completed August 1, 1962, and the ReserVec system, including 330 transactor terminals, 100 local distributor units, 10,000 miles of dedicated telephone circuits, and the Gemini computer in Toronto, commenced full-scale operation on January 24, 1963, serving more than 60 cities spread over 39,000 miles of air routes. The total cost of the ReserVec system was $4,000,000.[7,11,27-29]

With the implementation of ReserVec, Trans-Canada Air Lines was able to release 8,000 miles of full-time teletypewriter circuits and 4,000 miles of telephone circuits that were no longer needed. The Gemini computer, connected directly to the teletypewriter system, was able to send messages to the sales offices automatically. The operating staff at the reservations control center was reduced from 230 to 90. ReserVec, at this time, was processing 80,000 to 100,000 transactions per day (some of them for training and demonstration purposes only), with approximately 10 percent of those transactions being processed during its peak hour.[10,11]

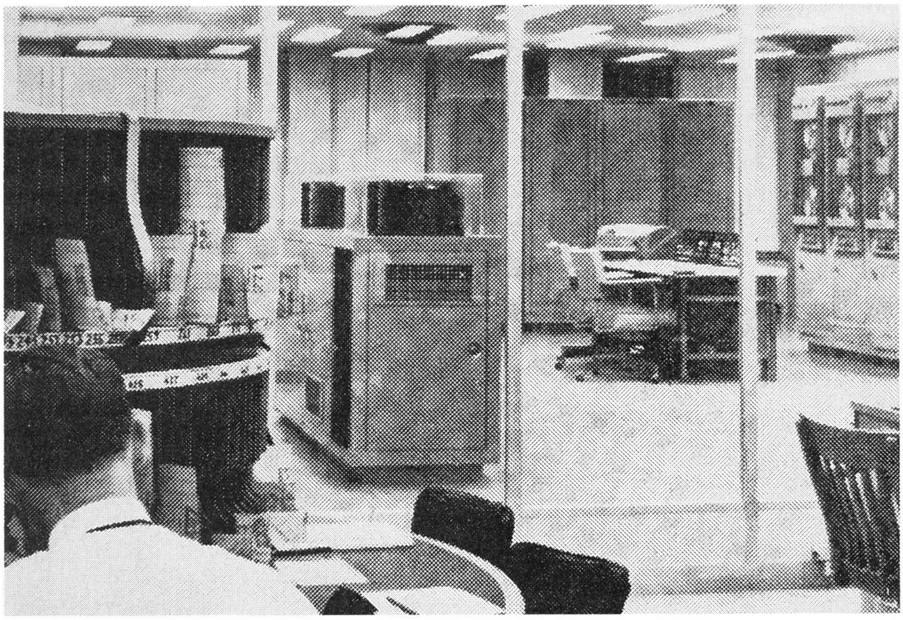

Figure 3. ReserVec central registry, circa 1961 (part of the manual reservations center is visible in the foreground). The cabinets in the left background (only the tops are visible) housed the Gemini computers. In the center are two of the shared magnetic-drum units. On the right are the dual control consoles facing the magnetic-tape drives, and in the background are the trunk-line data units.

The ReserVec system

The ReserVec system comprised the central registry, the remote reservations offices, and the communications systems that connected the two.

The central registry, located in Toronto, contained the twin computers, their shared memory systems, trunk-line data buffers (sometimes referred to as computer couplers), paper-tape readers, and teletypewriters. The reservations offices contained the transactor reservations terminals, local distributors (which connected the transactors to the communications system), and teletypewriters. The data communications system connected the reservations offices to the central registry via voice-quality data circuits (telephone lines). A teletypewriter communications system also linked the reservations offices to the central registry. Figure 2 is a schematic representation of the ReserVec system.

Central registry. The Gemini computer consisted of two identical computers running identical software. Known individually as Castor and Pollux (after the twin stars in the constellation of Gemini), the two computers shared the operational load of the ReserVec system. Each of the computers was housed in a separate cabinet, had its own arithmetic unit, program control unit, core memory, and paper-tape reader. The two computers shared drum and magnetic-tape memory. Figure 3 shows the central registry.

The Gemini's word length was 25 bits, including sign and parity bit. The capacity of the magnetic-store random-access memory was initially set at 4,096 words for each computer. This was doubled to 8,192 words before implementation when the airline added first-class sections to its flights. Each class looked like a separate flight to the reservation system; hence twice as many flights now needed to be handled by the system.[10] The clock cycle time was 28 microseconds. Negative numbers were stored in twos complement form. The add time was 56 μs, multiplication time 220 μs, unconditional transfer 28 μs, and conditional transfer 140 to 170 μs.[6,8]

Arithmetic unit. The arithmetic unit in each of the twin computers contained two groups of eight single-word registers. Registers 0 through 7 were magnetostriction delay-line accumulators used as index or accumulator registers.[6] Registers 8 and 9 formed the communications bridge between the two computers, coordinating the sharing of drum memory, and 10 through 15 were special-purpose registers used for input, output, and console control.

External memory. The external memory, shared by both computers, consisted of five magnetic-drum units and six magnetic-tape units.[11] The tape store included the "current store" or "master inventory" (MINT), which contained the entire TCA flight schedule for the next 360 days. The MINT recorded all reservations and cancellations for these flights, the cancellations being held to indicate the amount of flight turnover. A "reservations statistical store" (RESST) was also kept on magnetic tape. All of a flight's records were moved to RESST after the completion of the flight, for later statistical analysis.[30,31]

Drum memory, referred to as "critical store," contained complete inventory for the next 10 days' flights and for flights approaching capacity. Transaction details of active passenger records for the current day's flights were stored in an area called the "immediate detail store" or "immediate departure detail." A "space indicator table" containing the available seat count for each flight leg and date held in the MINT was also maintained in drum memory.[30-32]

The immediate detail store grouped the day's reservations records by flight number and destinations within the flight. Each record contained the passenger initials, boarding conditions (local, reconfirm, or connection), and booking office identity, and indicated whether the passenger held additional reservations. This information was used by local reservations offices on the day of the flight for match, reconfirm, and tally operations.[30]

If one computer was operating on a particular drum-memory location — that is, a particular flight number in the critical store — the other computer was locked out of that memory location until the first machine was finished. This was accomplished through a communications link between the computers via registers 8 and 9. If Castor was accessing drum memory location *n*, register 8 of Castor and register 9 of Pollux contained *n*.[5]

The critical store units were vertically mounted air-bearing magnetic drums manufactured by Ferranti-Packard in Toronto. Four drums were used in day-to-day operations, with a fifth drum maintained as a "spinning spare." The drums were divided into 32 tracks along their length with eight sectors per track. Each sector contained 128 25-bit words, giving a total of 32,768 addressable words per drum. Revolution time was 32 ms and average access time was 17 ms.[5,6,11]

Gemini, upon receiving a reservations transaction, would determine whether the flight in question resided on drum or magnetic-tape store. If a booking was received for a flight that was not in drum store, Gemini wrote the transaction to the "pending store" tape, where it was held until master inventory was updated. Presumably, the space indicator table in drum memory was first consulted to determine if such a transaction could be accepted, and the table was adjusted appropriately if the transaction was accepted.[6,31]

"Updating" was the process whereby transactions were transferred from the pending store tape to the master inventory tape. The frequency of updating was determined by operating conditions, but it sometimes occurred as often as every two hours. One of the twin computers was taken off line from active service to perform this task. As the computers had considerable excess capacity, little or no operational difference was detected by the reservations offices when only one computer was on line. The complete updating process took between 45 and 90 minutes. A 60-second pause in reservations service occurred when the updating computer was brought back on line.[31]

Input system. The Gemini received its input from eight trunk-line data buffers (computer couplers) and two paper-tape readers. The trunk-line data buffers were the interface between the Gemini computers and the communications system trunk lines from the reservations offices. The buffers terminated the telephone trunk-line circuits, and each buffer could store a complete transactor message in a nickel delay-line memory. The buffers accepted an incoming message from a trunk, assembled one 13-bit character at a time, performed parity checking, and checked the total number of words in the message (which had to be 24) before telling the Gemini that a transaction was waiting. The first available computer then took the transaction. The reverse operation was carried out when the computers sent messages back to the trunks, as well as making a check that the transmission had been received correctly.[6,24]

Trunk-line switches/trunk distributors. The trunk-line switches (sometimes called trunk distributors) allowed many different operating points to share a common trunk line, and ensured that only one transactor and one local distributor were connected to a trunk-line data buffer at a time. As well, the trunk-line switches could select one of several alternative routes. When a communications trunk was idle — that is, no cards were inserted into transactors — the trunk-line switch rested in the "through" position. Upon subsequent insertion of a transactor card into a transactor, the local distributor for that particular transactor transmitted a signal causing the necessary trunk distributors to switch to provide a circuit to the computers. The circuit was held until the originating transactor received the computer's reply, usually less than two seconds.[6,24]

Standard voice-channel trunks (telephone lines) were used for long-distance data transmission. This afforded considerable backup facilities as other available telephone lines could quickly be put into service if a trunk were to fail.

Transactor.* The transactor was the remote I/O terminal to the Gemini computers and had no user controls. A ticket agent made pencil marks on an input card indicating the type of transaction desired (sell, query, cancel, etc.) and the particular details pertaining to that transaction. The agent then inserted the card into a slot in the top of the transactor, which initiated operation. The transactor clamped the card, read the marked information, and transmitted it to the central computer. The card was held pending the computer's reply, which consisted of small semicircular notches punched into the card's right-hand edge. The transactor then released the card to the waiting ticket agent.

Two lights were located on the exterior of the transactor case, one green and one red. The green light was illuminated under normal operation; the red light flashed if transmission problems occurred or shone steadily if data errors were detected. The complete transaction cycle took a minimum of 910 ms, with a response time of up to 2 seconds during busy periods.[11]

The transactor unit was 16 inches long, 13 inches wide, and 10.5 inches high. It weighed 55 pounds and was enclosed in a two-tone gray fiberglass casing. It was usually mounted under a counter or desk, with only the card lip protruding above the desk top, in such a way that one transactor could be shared by four agents — a typical agent telephone conversation was 300 seconds, while the transactor was used for only two or three seconds. The cost of each transactor was about $3,000. Figure 4 shows a desk-mounted transactor.[4,6,11,25]

When a card was inserted into the transactor, two microswitches were actuated via small levers. One of the switches was used to determine if the card had reached the bottom of the slot. Similarly, a microswitch was used to detect the presence or absence of a punch in the first reply

* Many of the technical details in this section were published in 1959, approximately two years before the ReserVec system was fully installed. The transactor terminal in its final form may therefore have differed slightly from these specifications.

punch position at the top right-hand corner of the card. This punch indicated that the card's transaction — for example, "sell" — had already been completed. Such a transaction was, thus, prevented from inadvertently being processed twice.[6]

The transactor card was logically divided into a matrix of 285 positions arranged in 15 rows and 19 columns. The card was read by measuring the level of electrical resistance at each of the matrix positions, indicating the presence or absence of a pencil mark. A pencil mark was registered, even if it went only halfway across the electrode area.[6,10,33]


Figure 4. Desk-mounted transactor terminal.

The 285 matrix positions were sensed simultaneously and stored in an internal memory in the transactor — this storage allowed the central computer to automatically request retransmission of the information should transmission errors be detected. Fourteen additional hardwired bits were added, giving a total of 299 bits of data that were then transmitted to the local distributor. Thirteen of the added hardwired bits uniquely identified the transactor terminal to the rest of the system. These 13 bits were set via plug positions inside each transactor. The 14th bit indicated the presence or absence of a reply punch in the upper right-hand corner of the transactor card, sensed via a microswitch.[33]

The computer's reply to a transaction was edge-punched into the transactor card via 12 punches, giving 4,096 reply possibilities.

Local distributor. Local distributors served as concentrators for the control and distribution of messages going between the transactors and the computer. Up to 25 transactor terminals could be connected to a single local distributor.

The reply from the computer came in the form of two identical words received in sequence followed by one blank word. Each word consisted of 13 bits: 12 bits to operate the reply punches, and one bit to set the indicator light on the transactor. The local distributor tested the parity of the reply and matched the first word against the second. If the reply was received correctly, the distributor caused the reply punches in the transactor to be triggered, punching the computer's reply in the edge of the waiting transactor card. If the reply was not received properly, it would be resent a given number of times before timing out and causing the transactor's red indicator light to illuminate. The transmission rate was 800 bits per second.[6,11,23]

Transactor cards. The transactor card was standard punch-card stock, 7.5 × 3.5 inches. Cards were printed such that a single card format could be used for several different types of transactions. Thirteen different types of cards were used initially, two of which were reserved for central registry use.[34]

Only the right-hand portion of the card was scanned by the transactor. The approximately 5 × 3-inch scanning area was preprinted with pairs of small circles identifying any of the 285 matrix positions that might have been needed for the transaction at hand (see Figure 5 on the next page). Typically, 18 positions would need to be marked per transaction.[23,35]

The red indicator light on the transactor was illuminated if card errors were detected by the computer. Such errors included requesting seats on a flight that didn't exist, attempting to execute certain transactions with the same card twice (such as "cancel" or "sell"), and attempting an operation without marking all of the necessary information on the card. The computer was programmed to check the flight number, boarding date, and flight leg for space, but did not determine if a requested flight connection was actually feasible. Thus, an agent error in selecting a connecting flight would not be detected by the system.[29,32]

Figure 5 shows a ReserVec reservations card from 1961. To make a reservation with this card, the ticket agent wrote, in the left two inches of the card, the passenger's name, telephone number, and so on. This information remained local to the booking office and was not communicated to the computer.

The sales agent indicated the type of transaction to be sent to the computer by selecting from the INSTRUCTIONS field at the top of the scanned portion of the card. A typical reservation might involve selecting QUERY, followed by selecting SELL. Both of these transactions could be accomplished using the single card twice, as long as the transactions were attempted in the aforementioned sequence.

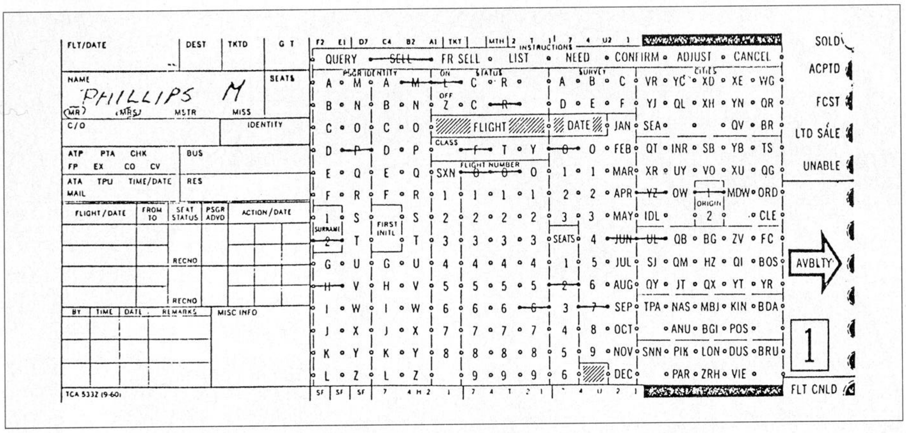

Figure 5. A reservations card (reduced in size).

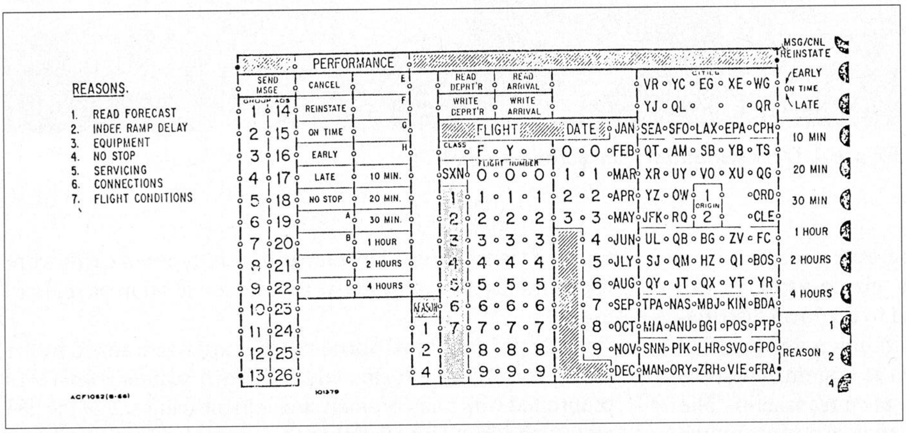

Figure 6. A flight performance card (reduced in size).

Three markings were used to identify the passenger — the first two letters of the surname plus the first initial. The SURNAME area in the first column was used to indicate which of the two letters marked represented the first letter of the passenger's surname. If the surname was, for example, Phillips, then the operator would mark both "H" and "P," and the "2" would be marked to indicate that the second of the two letters, "P," was to be taken as the first letter of the surname.

When the sales agent was finished marking off the necessary information, the card was inserted into the transactor terminal and the computer punched its reply into the right-hand edge. SOLD indicated that a SELL transaction was accepted as requested. The ACPTD position was used in reply to wait-listing requests and indicated that the central registry had accepted the wait-list transaction. FCST was punched only on the day of the flight and indicated that a "forecast" on that particular flight affecting its arrival or departure existed. Another card could then be inserted into the transactor by the agent to obtain the details of the forecast. LTD SALE, when punched, meant that fewer seats were available than requested. UNABLE indicated that no seats were available on the flight requested. AVBLTY (availability) was associated with the next six punch positions, which referred to the requested flight, two flights earlier, and three flights later. If any of the six positions was punched, the computer was indicating that there was no space on the requested flight section. If the position directly opposite the AVBLTY arrow was punched, the system was indicating that an extra section with adequate space had been added to the requested flight. Punching of any of the other five positions indicated that the earlier or later flights had space. In this event, the ticket agent could place the punched reservations card over a special "form of availability" chart, lining up the AVBLTY arrow on the card with the listing on the chart of the flight requested. The flight number showing through the punched position in the edge of the card gave the number of the flight that had space. The 12th punch position, FLT CNLD, communicated that the requested flight was canceled from inventory.[35]

The flight performance card (Figure 6) was used either to inform the computer as to the current status of a flight (e.g., "one hour late due to flight conditions") or to read that same information from the system. As up to 25 percent of requests to reservations agents were for arrival and departure information, this card, like the reservations card, was used frequently.

Thirteen different types of transactor cards, capable of a total of 47 different operational functions, were in use as of July 1962. Additional cards and operating functions were no doubt added over the lifetime of the ReserVec system.

Other contemporary reservation systems

By 1958 Univac had developed an airline reservation system to run on its general-purpose UNIVAC File Computer. Input/output was via "ticket agent sets" that contained a small viewing screen and a limited set of keys. The system performed one to one and a half transactions per second (compared with ReserVec's 10 transactions per second) and had a one-second local and 10-second remote response time (compared with ReserVec's maximum two-second response time). Northwest Airlines seems to have installed one of these UNIVAC systems in 1959.[36]

Intelex Systems Incorporated, an associate of International Telephone and Telegraph Corporation, had developed a special-purpose Intelex Airline Reservation Computer by 1960. The reservation computer could be configured with magnetic-core memory of 2,000 to 10,000

Table 1. Comparison of the Reservisor, ReserVec, and SABRE reservation systems.

	Reservisor (1956 version)	ReserVec (Gemini)	SABRE (IBM 7090)
Fully operational	Aug. 1956	Jan. 24, 1963	Dec. 1964
Construction	Vacuum tube, relay, diode	Transistor	Transistor
Logic	Hardwired	Programmable	Programmable
Internal memory	Relay	8K (25-bit) words, each computer	64K (36-bit) words, each computer
External memory	2 drums	5 drums, 6 tape units	6 drums, 16 disk units
Number of I/O devices	161 agent sets	330 transactors	More than 1,000 agent terminals
Response time	3.33 seconds	910 milliseconds to 2 seconds	Less than 3 seconds
Transaction volume	600/hour	80,000-100,000/day	26,000/day
Computer timings (in microseconds)			
Clock speed		28	2.18
Add		56	4.36
Multiply		220	4.36 to 30.52
Unconditional transfer		28	2.18
Conditional transfer		140 to 170	2.18 to 4.36

10-bit words. This compares with ReserVec's 16,384 words of core memory equally divided between its two computers. External memory on the Intelex computer consisted of a magnetic drum and magnetic tape. Drum capacity was 12,800 words, with a maximum access time of 20 ms. By comparison, each ReserVec drum contained 32,768 25-bit words and had an average access time of 17 ms. Thus, the Intelex Airline Reservation Computer had more core memory than ReserVec's Gemini, but less storage per drum. The two systems had similar drum access time, while the Gemini's published add time was at the fast end of the Intelex add time range. The main difference between the two systems was that the Gemini was a general-purpose computer, while the Intelex machine was designed specifically for seat reservation applications.

Martin H. Weik's "A Third Survey of Domestic Electronic Digital Computing Systems" (1961) indicates that two Intelex Airline Reservation Computers were on order at that time but gives no further details.[37]

While TCA's ReserVec was under development, work was under way on American Airlines' SABRE reservation system, built by IBM. The reservations problem was first discussed between IBM and American Airlines in 1953. By June 1954 IBM had prepared a draft proposal for such a system, with a joint study between the two corporations taking place between 1954 and 1958. IBM applied experience gained from the SAGE defense system to build the SABRE. Formally begun in 1957, the SABRE reservation system became fully operational in December 1964, nearly two years after ReserVec[38] (see Table 1).

SABRE was a larger system than ReserVec, supporting more than 1,000 terminals (compared with ReserVec's initial 330) from two IBM 7090 computers located at Briarcliff Manor, north of New York City. The computers were connected to six high-speed IBM 1998 magnetic drums of SAGE design, and 16 IBM 1301 disk storage units. Unlike ReserVec, where most of the hardware was developed specifically for the system, most of SABRE's hardware components already existed within IBM. The SABRE's 7090s initially contained 32K of 36-bit words of internal memory but this was increased to 64K words in 1963 (ReserVec's Gemini computers contained 8K words of core memory each). Total capacity of the external drum memory in SABRE was 7.4 million characters, compared with ReserVec's five magnetic drums that had a combined capacity of approximately 4.1 million characters.

SABRE's disk storage units had a total capacity of approximately 800 million characters, which cannot be compared with the external storage of ReserVec, which was on magnetic tape. SABRE's seat availability information was kept on drum and the passenger details on disk; thus both forms of external memory were accessed during a transaction. This is in contrast with ReserVec, where only drum store was accessed during a transaction. The SABRE reservation system maintained more extensive passenger details than ReserVec, including full passenger names, telephone numbers, special meal requirements, and hotel and automobile reservation information, none of which was stored within the ReserVec system.[38]

One of SABRE's 7090 computers typically handled the real-time reservations data processing, while the other computer ran the batch jobs and was available to take over the real-time functions if necessary. This is somewhat similar to the functioning of ReserVec, where one of the Gemini computers was taken off line to perform the batch updating.[38]

Ticketing agents accessed SABRE via "agent terminals" that consisted of an IBM I/O Selectric typewriter; a "director console" that was used by the ticket agents to enter the flight date, number of seats required, and other information via push buttons; and an "air information device" (AID). A specially punched card containing information about all flights between the origin and destination cities in question was inserted by the sales agent into the AID. A specific flight was then selected by pressing row and column buttons adjacent to the punched card. The I/O Selectric typewriter typed the computer's output messages at approximately 15 characters per second. Twenty-six thousand transactions were handled daily by SABRE with a response time of less than three seconds. By way of comparison, ReserVec was handling 80,000 to 100,000 transactions per day at installation, with a maximum response time of two seconds.[38]

In 1963 another IBM-based airline reservation system was being installed for Pan American World Airways — referred to as Panamac. Panamac used the IBM 9080 Teleprocessing system and served 114 cities on six continents from its computing center in New York. In Canada, Toronto, Montreal, and Vancouver were connected to Panamac.[29]

ReserVec's performance and legacy

Trans-Canada Air Lines' ReserVec system could essentially only make and count reservations. The passenger name could be stored only as three characters, and manual records needed to be kept to record the passenger details that the computer didn't store. TCA had no way of connecting the computer's reservations records with their manually stored records. A new system, known as Pioneer, was developed to store these passenger details, to eliminate Air Canada's massive manual records, and thus to improve reservations efficiency without yet replacing ReserVec. (TCA became Air Canada on January 1, 1965.) Pioneer ran on Burroughs D-82 communications computers that were originally designed for the American military. It stored full passenger name, phone numbers, point of contact, special meal requirements, waiting-list information, itinerary, and other passenger data that were already available in American Airlines' SABRE system. The Pioneer system was, however, a local system, and was installed in Air Canada's Montreal and Toronto stations only, since these cities accounted for most of the airline's volume. Other centers continued to maintain passenger details manually.[10,21,39]

Trans-Canada Air Lines' ReserVec system was used for nine years, with an average downtime of only 120 seconds per year. Although it was initially designed to handle 60,000 transactions per day, it accommodated more than three times that number at the end of its operating life, without any major modifications, and with only a slight (3.5 percent) increase in its total number of transactor terminals. ReserVec (later known as ReserVec I) was replaced by ReserVec II (a UNIVAC-based system with cathode-ray-tube and keyboard terminals) at the end of 1970.[5,7]

The experience gained by Ferranti-Packard in the development of the Gemini computer had a significant influence on its FP-6000 computer, which was completed in 1963, and was the first multiprogrammable computer developed in Canada (see the article by Vardalas in this issue). The logic-circuit design of the FP-6000 was "essentially carried over in total" from the Gemini, with the Gemini being "the essential ingredient in the design of the FP-6000 system."[8] Only five FP-6000 computers were actually produced by Ferranti-Packard. One was sold to the Federal Reserve Bank in New York, another to the Toronto Stock Exchange, a third to the Saskatchewan Power Corporation, the fourth to the Defence Research Establishment in Dartmouth, Nova Scotia, and the last to Ferranti Edinburgh (an aviation-oriented subsidiary of Ferranti Ltd.).[40]

At about the same time, the British government was consolidating the British computer industry in an effort to increase its competitiveness. Ferranti Ltd., the English owner of Ferranti-Packard Ltd., had their computer division purchased by ICT (International Computers and Tabulators Ltd.), which later became ICL (International Computers Ltd.). Shortly afterward, Ferranti Ltd. sold ICL all rights to the Canadian Ferranti-Packard FP-6000 computer. ICL's 1900 and 2900 series of computers were based on the design of the FP-6000 (the original FP-6000 became the ICL 1904). The ICL 1900 and 2900 series of computers still exist, and their development can be traced back to the Gemini computer, designed and built by Ferranti-Packard in Canada for Trans-Canada Air Lines' ReserVec I passenger reservation system.[41] ■

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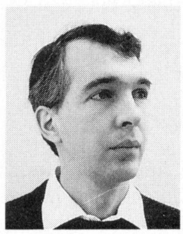

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