
GE-Honeywell-Bull - from GECOS to GCOS8

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GE also embarked in the process control computer business through the GE-312 that evolve later into GE-225 and into GE-265 (Dartmouth Time-Sharing System). The first direct entry of GE in the general purpose computer business was a 24-bits machine code-named Mosaic that was introduced in 1963 as GE-400. However, the upper model planned for GE-400 was hardly competitive with the just announced IBM/360.

From GECOS to GCOS8

an history of Large Systems in GE, Honeywell, NEC and Bull

a view by Jean Bellec (FEB), from the other side of the Atlantic

Part I- General Electric

General Electric was in the early 60s the largest private user of IBM computers. GE had no intent of considering electronic computers as one of its strategic segments. However a decentralized management structure allowed the hyper frequencies lab to enter the computer field through a bid for the checks sorter shop at Bank of America. (ERMA project). That was the beginning of the Computer Department established at Phoenix AZ.

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Origin of GE-600

A solution to the performance problem of the "Y" model of the GE-400 came from a project initiated outside the Computer Department, in the Military Department that had developed a computer for the US Air Force Cape Canaveral Missile Range, called M236 and installed at Eleuthera (Bahamas). That computer was a 36-bits computer due to the computation requirements of radar tracking and to the required exchange of data with IBM 7094 located at the Cape. The chief architect of the M-236 was John Couleur who will become later a technical leader of the GE Large Systems.

The debate in favor or against a M236-derived general purpose computer took more than one year and concluded finally with the victory of the M2360 project proponents in February 1963. The GE upper management was impressed by the perspective of saving the rental fees from IBM leased equipment used internally by GE (the cost of development of the new project was estimated to be offset by only one year of rentals). The other GE departments were not very impressed and were reluctant to jettison their IBM machines.

GE-625

According to the initial plan, the central processor was to be designed at Syracuse, NY and the Input-Output Controller in Phoenix, with peripheral subsystems common to the GE-400 line. The product line took the name of GE-600 initially

with two system versions with different clock values, the GE-625 and the GE-635. The software would have been developed in Phoenix with people brought from various user departments. Eventually, the processor's team migrate from Syracuse to Phoenix, while the technology team remained for a while in Syracuse.

The main innovation of GE-600 was the creation of a SMP Symmetric Multi-Processing platform, probably the first actually built in the world. While, at that time, much talk was about the reliability of a redundant system, the main advantage was different: SMP was limiting the development cost to a single design for building a line covering a range of power that would had needed probably three designs (as IBM did at that time).

In 1964, GE decided to take over Olivetti computer assets and the majority of Compagnie des Machines Bull of France. The expected value of those acquisitions was to establish an international European base for the general purpose computers. Both the GE-400 and the GE-600 were to be sold by the two European subsidiaries of General Electric.

The first GE-600 introduced in Europe was a GE-635 sold to ASEA in Sweden before the Bull-GE merger. ASEA (now part of ABB) was a General Electric licensee and used the GE-600 for scientific applications.

After jettisoning its RCA licenses, Bull was selling many GE-400 systems and started to market the GE-600 over its original market. It got a contract for the billing of Electricité de France , the largest power utility in the world, that required COBOL, while the compiler was still in its infancy in Phoenix. It required far more reliability from magnetic tapes than GE was then providing. GECOS II was an operating system that was optimizing batch processing (without an attached processor, as were at that time organized many IBM shops) and remote-batch (using Univac 1004 or GE-115 small computers as terminals). It supported multiprogramming but not very efficiently.

In 1964-1966, But obtained contracts for around a dozen of GE-600. But eventually, the EDF contract collapsed and Bull-GE froze its ordering of GE-600, waiting the solution of the technical problems that finally were sorted out in 1968. During that period, Bull-GE made studies, in conjunction with Phoenix, of a small version de GE-600, code-named Q2, that proposed a micro-programmed version of the 600. The project was cancelled when GE was no more sure of pursuing the GE-600 line.

GECOS II

The initial GE-600 systems were using GECOS-II operating system, a multiprogramming batch oriented system, based upon large (specifically IBM 7090) users requirements of that time. Thanks to the multiprogramming facilities of the OS, there was requirements for supplemental I/O converters (à la 1401) and remote batch was supported with initially Univac 1004 as terminals.

Programming Languages were:

GMAP macro assembler

FORTRAN II

COBOL 61 that was announced and "delivered" far before being qualified. in 1965

JOVIAL for an USAF contract

Files on tape and discs supported sequential and random organizations (GEFRC) and IDS was being announced.

The insufficient quality of GECOS-II associated to the poor reliability of the magnetic tapes lead, in October 1966, to as suspension of the promotion of GE-600 in the United States and of its sales by General Electric, some orders were cancelled, other delayed and the future of GE-600 was somber.

GECOS III

The operating system kernel was redesigned, adding also a time-sharing system (TSS) extending the functions of the Dartmouth Time Sharing System on the GE-265. It became GECOS III and was well accepted by existing customers. Introduced in 1968, while MULTICS was still in its infancy, no commonality was envisioned between GECOSIII and MULTICS.

GECOS III was advertised as a multidimensional system, adding to batch and remote-batch, the time-sharing and direct-access "dimensions". The architecture of GECOS III will not be significantly altered in the future versions of GCOS.

The new operating system, announced in 1967, gave the opportunity to re-launch the marketing of the 635 line and in Europe several new large orders were secured (Credito Italiano, l'Union) specially for large business applications. Bull

lost the scientific market to Control Data, Univac and IBM but succeeded to make an honorable stand in the non-scientific market.

In the US, GE succeeded to secure a large order from US Air Force for its Worldwide control & command system (WWMCCS). Some modifications to improve the security of GECOS III were developed as specials for that order, but the existence of this multi-year contract was securing the durability of the product line. A few WWMCCS systems were installed in Germany.

GE-655

The technology of the GE-635 was based on discrete transistors (Sylvania SUHL). Printed circuits were not fully used and the manufacturing cost of a system was high. A single processor system represented three large cabinets not including peripherals.

A first improvement was brought in 1967, when a new model with an integrated circuits technology was designed by the Syracuse team of GE. Its performances were better than those of the 635 and the manufacturing cost lower. It was introduced as the GE-655 at a price significantly higher than that of the 635.

GECOS-IV

GECOS-IV was a project developed in Central research Laboratory in Schenectady in 1967 under the direction of Robin Kerr. Their goal was to integrate GECOS, the work at Dartmouth and the their DESKSIDE project. GECOS-IV required a modified CPU to provide a "virtual machine" capability. It also challenged a strength of GECOS-III, its time-sharing capability.

Mark-III and General Electric Information System

In 1964, GE had helped the Dartmouth College NH to develop an interactive system for teaching programming. The hardware was a GE-200 front-ended by a communication processor developed initially for store and forward communication messages the GE Datanet-30. The terminals were AT&T Teletype 33 ASCII typewriters connected through 300 bauds Bell modems.

The Dartmouth College, perhaps inspired from MIT CTSS, had developed a special purpose operating-system including an interpretive processor of the BASIC (Beginner's All Symbolic Instruction Code) language also created for this system, christened GE-265.

General Electric started to market the BASIC service, through a special division that took over the maintenance of the Dartmouth College software. As the hardware perspective of the GE-200 was limited, the Dartmouth College accepted the GE offer of porting the DTSS (Dartmouth Time-Sharing System) to the GE-600. GE started to replace its GE-265 by GE-635 as Mark-III systems.

The hardware of Mark-III system was originally completely standard, but the software was developed and maintained independently from Phoenix. General Electric Computer Division and its affiliates (e.g., Bull General-Electric) were not entitled to license their customers with Mark-III software.

Mark-III systems main center was concentrated in Cleveland OH, but expanded with a center in Amsterdam, the Netherlands. The customers of the timesharing service were connected transparently to the computer centers.

With Mark-III, the applications were expanded to email and batch applications. Eventually, GE added to the base systems several IBM 370 computers to provide batch services without recompiling applications to the peculiarities of GE-600 code (differences in scientific operations precision in particular).

GE ISD was later instrumental in the evolution of Honeywell Large Systems by pushing Phoenix to use IBM and IBM compatible peripheral subsystems on the DPS-8 product line. GEISD had developed since the early 70s their own versions of peripheral subsystems shared between Honeywell and IBM computers and pressured Honeywell to introduce a standard facility.

After acquisition of the GE computer business by Honeywell in 1970, General Electric kept the timesharing business in an Information Services Division that is still alive. The ISD European Operation was momentarily kept inside Honeywell-Bull, but was retroceded to GE circa 1975.

Toshiba

Toshiba Corporation was a licensee of General Electric in Japan and also using the computer licenses of the GE-600. The Japanese , at the end of the 1960s, started to design their low-end version of the GE-600. They used obviously integrated circuits and designed a micro-programmed execution unit. Under the provisions of cross-licensing, Toshiba's design was later brought back in Phoenix under the ELS (entry level system) code name.

In 1973, Datamation reported, from information apparently collected from Richard Bloch that In 1969, John Haanstra, somewhat skeptical about the results of the Shangri-La task force attempted to establish as a parallel effort or as a back-up effort a project, to be done in cooperation with Toshiba that would have closed the gap between the GE-400 and the GE-600 product lines. It would have been a dual-personality machine operating in GE-400 as a 3xGE-435. The death of John Haanstra in August 1969 would have suspended the project.

[I have been unable to find a person who in Phoenix or in Bull had the knowledge of the Pi project, so I would be interesting to know more about it. For the time being, I am unable to confirm or to infirm its existence. JB]

GE APL advanced product line

Around the end of 1967, however, IBM S/360 was starting to submerge its competitors and GE had to recognized that its set of product lines covered few segments with a competitive edge.

John Haanstra (who headed several IBM technical departments) was hired by GE to design a plan to replaces current product lines by a new Advanced Product Line (APL). Forces from Paris, Milano and Phoenix started to work together on that project. The revival of the GE-600 did not materialize before 1969 and the APL did not target the still embryonic park.

GE choose a new (CML) technology for APL, what was somewhat premature .

John Haanstra left APL to head the Phoenix computer department, were he brought impulses from the APL project, such as 9-bits PSI channels, microprogrammed peripheral subsystems that improved the GECOS offering for many years to come.

After a new attempt by GE to redefine a new product line (in a 4 months meeting named Shangri-La in summer of 1969), the GE management finally decided in April 1970 to sell its Computer Department. Honeywell was the buyer of all the assets (including Phoenix as well as the European subsidiaries)

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Part II-the Honeywell years

The Honeywell take-over of the GE computer business (1970)

The General Electric management was somewhat disappointed by the Shangri-La results. The US was facing an economic down-turn for the early 70s. The big spending of the US Government in cold war nuclear submarine and weapons and in space was reaching an end. Many GE businesses had a perspective of requiring big investments, such

as large jet engines for the 747 generation. The business plan presented by its Computer Division required at least three years of high R&D spending and the return on investment from this effort was remote and somewhat uncertain.

As Honeywell, desiring to expand its market, expressed to GE its interest to merge their interest, GE accepted immediately. GE conserved its timesharing business, but let incorporate all its Computer Division inside Honeywell. Honeywell management, prior the merger, was unsatisfied with the proposals prepared by its engineering and planning staff and was very pleased to find in the wedding basket the work on the Shangri-La project that becomes the Honeywell NPL project.

However, the sales network of Honeywell in North America was by far superior in terms of aggressively and marketing savvy to the GE sales representatives, probably too used to just collect the customer requirements and to transmit them to Phoenix. The Honeywell sales representatives could not wait for NPL and had nothing to offer in the upper range than the GE-600. As a consequence, the GE-655 was renamed the Honeywell H-6000; it was re-priced by the introduction of entry models and was boosted by the connection of Honeywell disks peripherals, inspired by IBM technology and had over the GE models the advantage of really working !

The beginning of a Japanese connection (1969-1972)

In the mid 60s, the Ministry of Industrial Trade and Industry of Japan has setup a national objective to help large electrical keiretsu to be competitive in digital electronics, including computers. Some genuine technology was developed, such as parametrons in Nippon Electric Company, a switching technology similar to magnetic cores. But, MITI estimated that Japanese companies had to start by joint ventures with foreign companies to catch up.

American Companies except IBM and Burroughs accepted to enter agreements with the MITI allocated counterparts to gain distribution rights and access to a Japanese market that was almost impossible to access, because trade restrictions as well as language. IBM Japan started a third source of manufacturing in Japan for the S/360. However, IBM was the targets of clones manufacturers such as Hitachi and Fujitsu. Eventually, Mitsubishi joined that fray and NEC was also a participant in NTT DIPS project to develop IBM clone machines.

However, NEC main target was to be Honeywell that recently developed successful IBM1401 competitors and NEC bought licensing for manufacturing, continuation and derivative engineering for the H-200 product line from Honeywell. The target assigned to Toshiba was General Electric. Toshiba owned already many licenses from GE in other areas and it was a natural candidate for collaborating with GE in the computer field. The GE-600, more modern and corresponding better to the Japanese manufacturing market was accordingly licensed to Toshiba.

Some software products (PL/1 compiler and prototype of GCOS8) were developed by Toshiba and reacquired by Honeywell before being incorporated within the GCOS development. Actually, the design of Toshiba PL/1 was itself a derivative of the NPL technology.

In the late 60s, MITI attempted successfully to regroup the subsidized efforts of the Japanese companies. Some companies, such as Toshiba retreated from the general purpose computers. A MITI engineered regrouping of NEC and Toshiba was established as NECTIS (Nec-Toshiba Information System) that became the owner of GE-Honeywell large system licenses and eventually transferred them to NEC.

Honeywell 6000 (1970)

The take-over of General Electric by Honeywell implied small modifications in naming the existing products. The Large Systems were re-christened Honeywell 6000, and the word GECOS was abbreviated in GCOS (Generalized Comprehensive Operating System).

The main model was the H-6080. With its cache (2K words) , the performances of 6080 reach 1 Mips. It was downgraded marketing models were the 6070, 6050, 6060, 6040, and 6030.

The peripheral devices offering was revisited and adopted the NPL peripherals developed by Honeywell, (NDM400 as DSU190B, NDM500 as DSU191)

For main memory, the MOS technology (chips 1K, 1.2µs) was introduced to replace magnetic core. The range of main memory capacity extended from 60K to 256K words.

The IOP Input-Output processor used the PSI interface to replace the old CPI Common Peripheral interface channels.

EIS the extended instruction set (1969-1971)

One of the deficiency of the H-6000, by comparison with the IBM S/370, was the performances in the execution of instructions frequently used in business data processing operations, such as decimal computations and variable length data transfers in memory. The GE-600 executed those instructions via iterations implying branches.

The analysis of that performance problem lead to the proposal of a specialized unit that would interpret a new set of variable length instructions. The EIS was originally implemented in its own cabinet. It supported both the BCD and the ASCII character set as well as decimal arithmetics.

The Honeywell 6000 was sold in two sets of models: the odd-numbered 6030, 6050, 6070 were the non-EIS models, while the even-models incorporate the EIS-unit.

The logo of the Series 60

Honeywell Series 66 (1973-1974)

After the rather deceptive and painful development of the NPL (New Product Line), Honeywell decided in 1973 to combine the introduction of the NPL small and medium systems with a re-launching of the H-6000 large system as Level 66. The Level 66 models were delivered in 1975.

Using basically the 6080 design, the 6680 reached 1.2 Mips. The level 66 systems used main memory with 4Kbits chips. The EMM (Extended Memory Management) allowed an extension of the main memory size to 4 "quadrants" of 256K words.

For the Large Systems Department, the introduction of Series 66 was essentially cosmetic: price changes, packaging rules' changes. The plans called for "unification" of software, to allow a customer to migrate easily between Levels. The challenge was extremely difficult between Level 64 and Level 66 that differ by word and byte size, by encoding of commercial data (EBCDIC vs. BCD and ASCII), by the design of the operating system (availability of threading, of removable discs media in the Level 64 and not in Level 66). Happily, there was practically no customers who attempting to climb the upgrade path set up in 1973.

However, this Unification effort was more successful in some software areas. Large Systems GCOS adopted UFAS as an indexed sequential data access method to complement IDS. IDS evolved into IDS-II that introduced subschemas and some program/data independence.

Later-around 1977-, the models of Level 66 were renamed 66/DPS (Distributed Processing System); there has been 66/DPS05, 66/DPS1, 66/DPS2, 66/DPS3, 66/DPS4 et 66/DPS5. Again, this renaming was a marketing positioning to changes price and image. The DPS wording corresponded to a pre-announcement of Distributed System Architecture, still in its infancy.

Migration of the H-200 large systems through the CM-200 (1974)

Honeywell marketing strategy was primarily to exploit its park and protect it from the competition. After the termination of the level 64 high end project in 1973, it was proposed to "emulate" the H-200 programs by packaging a refurbished H-3200 processing unit on a H-6040 as an asymmetrical multiprocessing system. The performances could not sensibly exceed the original H-200 system's and the logistics costs due to delay of the refurbishing contribute to the lack of success of that program.

The last MULTICS system, the 6180 and the series 68. (1973-1976)

May be, because the headquarters of Honeywell Computer Division were located in the Boston area, the image of MULTICS was more appealing to Honeywellers than to Phoenixians.

Honeywell decided to re-launch MULTICS with a reimplemented 645 on the base of the H-6000 technology, that was announced late in 1973 as the Honeywell 6180 (delivered in 1974), later reintroduced as Level 68. This model was initially offered as a standard model and announced world-wide.

Honeywell boosts its software effort on MULTICS by completing its 30 engineer's team in Cambridge with a team of around the same size in Phoenix. The Cambridge team worked with MIT in basic operating system, while the Phoenix team concentrated on running GCOS as a subsystem under MULTICS, on languages (FORTRAN, Basic) and on some business applications.

In 1972-73, The plans were to base the evolution of GCOS and MULTICS on a common hardware base and on a MULTICS software nucleus. Those plans were dropped with the introduction of NSA (see hereunder).

However the merger of CII and Honeywell-Bull in France opened a significant opportunity to deliver MULTICS systems that appealed more to large French users (engineering and scientific labs). Several 66/80 were delivered to those customers in 1978

NSA the new system architecture(1973-current)

The migration towards MULTICS was not received with an unanimous enthusiasm in the GCOS community. MULTICS had an experimental university connotation that did not fit well with the conservative spirit of the Phoenix people. The scientific orientation of this OS did not pleased more the European marketing people in Honeywell-Bull. The plan for bringing all the GCOS applications within MULTICS was likely to be delayed and would miss the end of 1973 milestone.

The GE-600 and GE-645 processor architect, John Couleur, proposed in February 1973 a complete departure from existing plans. John Couleur estimated that the complexity of the MULTICS interior decor would definitively plague the performances of such a machine. He was also convinced that the MULTICS architecture based on segments and rings was not flexible enough for long range computing that required capabilities on much smaller objects than the MULTICS segments. The "Trojan horse" syndrome and the "capabilities machines" were, at that time, a hot subject in conferences and publications.

John Couleur also estimated that the New System Architecture could be retrofitted to the series 66 processors in current production. This assumption lead to the Management approval of the new plans, in spite of the objections from the Multicians.

There was not a complete software view behind those architecture concepts and the NSA were introduced into the software in several waves between 1975 and 1985, without never reaching the initial goals. The performance objections

to the MULTICS design were real and lead eventually to the RISC mood of the 90s. NSA was also a CISC machine and the number of circuits was very close to that needed for the MULTICS compatible machine.

The 6XXX (1969-1973)

The Level 66 suffered from a lack of performance in front of the top IBM 370. The most powerful model the 66/80 was painfully reaching the equivalent of 1 IBM Mip (that is the 370/158). To compete with the IBM 370/168, both logical improvements and a new technology would be needed.

The expected technology was a resurrection of the CML technology and the introduction of a hybrid circuits technology known inside the Honeywell community as micro-packaging.

Among the objectives of the 6XXX design was the capability to run the object programs and the GCOS 64 operating system. A hybrid machine capable to operate on 32/36 bits words and in 8/9-bits bytes was envisioned.

State of the art logic design features like cache, translation look-aside tables for address computations were part of the 6XXX design.

However, the low urgency of binary compatibility with Level 64 did not justify the complexity of the machine. Also Honeywell Marketing had given up the competition with IBM in the scientific area and in high-end transaction oriented systems. Finally, the 6XXX project was discontinued and the team was set a less ambitious project code-named Med.-6.

66/85 Med.-6

After the termination of the 6XXX project, Large systems Management decided to reuse the 6XXX technology for a less ambitious project targeted to the main stream of GCOS customers. This project was named Med-6 and was announced under the 66/85 name.

The technology was to be CML water-cooled micro packaging developed by Honeywell SSED department, in close relation with the laboratories in Phoenix.

The Med-6 was designed to use a new IOC, the first architectural departure from the original GE-600. It was to be microprogrammed, reducing the individual logic of the channels to data buffers.

The IOC design was used later by NEC in systems to be re-imported by Honeywell in the DPS-90.

Honeywell DPS-8

In 1979, following the IBM introduction of its E series (4300 series) that include a significant price reduction. Honeywell wished to revamp completely its computer lines. Existing systems prices were cut at the IBM level and the marketing image was comforted in emphasizing the communications facilities. All systems were calling Distributed Processing System (DPS). The large systems were named DPS-8 and delivered 2Q80.

The main model was the DPS-8/70 quoted at 1.7 Mips; it had a cache of 8K words .The other models were DPS8/52, 8/46. Models 8/44, 8/20 were derived from the ELS Entry Level System(0.55 Mips)

New price cuts were made later by creating new models named DPS-8/x5

GCOS-8

In 1978, GCOS-3 was renamed GCOS-8. The GCOS-III maintenance (bug corrections) was discontinued only in sep87. The initial release(SR1000) of GCOS-8 offered few enhancements but supporting GCOS-III programs . However, the new name was an incentive to customers to migrate to a NSA-capable new processor. In fact, from a user point of view, the usage of BCD code was discouraged and it was made clear to them that new applications have to be ASCII. That decision created a market either by specializing one machine for BCD or by creating service bureaus to serve old BCD applications.

The first NSA-version of GCOS was implementing on a base acquired from Toshiba that has started its own development of a new version of the operating system. The heterogeneity of the initial implementation lead to the lack of a single programming model "environment" inside GCOS-8. The GCOS-III's environment coexisted (for ever?) with the DMIV-TP's (derived from Toshiba's development) and the new Time Sharing's environment (that matched closer the initial goals of NSA). Note that the Toshiba code and programmers had been eventually acquired by NEC developing ACOS-6 in parallel with GCOS-8.

The majority of Large Systems users, at that time, were running business applications (in batch and in transaction environments) and the prime programming language became COBOL-74, supplanting COBOL-68 (limited at BCD support)

The Large Systems Front-End Processors (1964-1994)

Remote Batch and the Datanet-30.

The GE-600 customers were desiring to keep their inputs (cards) and their outputs (paper) in their own premises and save trips to the computer center. So, GE decided to use the Univac 1004 small computer as a remote batch terminal. The remote batch terminal was connected through 1200 and 2400 bauds telephone lines to a front-end computer produced by GE, the Datanet-30.

Later, the Univac 1004 was replaced in the GE offer by stripped down GE-115 produced in Italy with Bull-General Electric peripherals.

The Datanet-30 was connected to the IOC through a standard CPI interface.

There was a project for a high end Datanet, called Datanet-500 that was discontinued early.

The DN-30 was replaced in 1974 by a more modern special purpose computer called Datanet-355. Instead of being attached through a standard channel (PSI channel), a new Direct memory interface was designed (the IOC received a DIA Direct Interface Adapter) supposedly for better performances. The DN-355 added a direct terminal protocol allowing a short-message direct communication between the VIP display terminal or the Teletypewriter and application programs. The GRTS-355 had now two modes of operation: the remote batch line-oriented mode and the direct access character mode A new software product called NPS (Network Processor Software) replaced partially the GRTS and added the management of queues of messages. NPS supported also a

remote minicomputer RNP based on H-516, that acted essentially as a terminal concentrator.

The DN-355 was replaced by a cheaper minicomputer (Honeywell-516) model that runs a port of Datanet-355 software.

Honeywell Series-16 minicomputers and their Level-6 successors (alias DPS-6, a.k.a. Mini-6) were used as remote batch and terminal concentrators from 1975 to the late 80's.

In the late 70s, Honeywell and CII-Honeywell Bull had designed a new communications architecture, called DSA For Distributed Systems Architecture, an ancestor of ISO communication layered architecture. The main support of DSA was a Front-End Processor (FEP), common to the DPS-7 and DPS-8 product lines, and called Datanet, as its pre-DSA predecessors. It was based on an Honeywell Level 6 (a.k.a. DPS-6) minicomputer connected to the DPS-8 through the existing DIA. The Datanet software (DNS Datanet Network Software) was developed in Louveciennes by Honeywell Bull networking unit. It differs slightly from the free standing network computers and from the Datanet for DPS-7 by the need to support pre-DSA networks for GCOS8 and to deal with DIA peculiarities. The front-end for GCOS8 was called Datanet-8 in the U.S.

Initially, the Datanet was essentially supporting existing terminals (the VIP and IBM 3270 families) to the transaction processing and file sharing applications. Then, it supported remote batch and terminal concentration from DSA DPS-6 systems. In parallel, DSA was modified to comply with the then (and yet) emerging ISO standards and renamed ISO-DSA. New applications such as FTP (file transfer) between DPS-8 systems were developed. The architectural differences between the DPS-8 and the 32-bits machines (including DPS-7) made heterogeneous FTP of limited use.

In 1982, large customers had a need to interconnect DPS-8 and other systems for exchanging high volume of data. Particularly it was the case for the connection to Data Storage machines, such as Masstor and StorageTek powered at that time by IBM-architecture engines. The connection was made via a NSC (now a division of StorageTek) Hyperchannel with NSC providing also the software.

In 1985, Bull delivered an extension to the DNS software called "Janus" that allowed a SNA gateway to IBM mainframes. The main usage of Janus was to allow a common park of terminals (SNA or VIP) to access, somewhat transparently) IBM and GCOS mainframes. It was also used to transfer files between those systems.

In 1990, DNS was extended to support larger front-ends processors (multiprocessor PRX-A DPS-6 models). The Credito Italiano system was so supporting simultaneously more than 15 000 terminals on a GCOS-8 system.

In 1985+, to face the eventual phase-out of the DPS-6, Bull developed a brand new product called "MainWay". It supported TCP-IP as well as ISO protocols. WAN and LAN were equally supported and, for LAN, added high speed FDDI fiber-optic links to Ethernet. The heart of MainWay was a high-end HUB (of 3COM origin) on which was connected the NSV hardware running a recoded DNS software. The re-use of DNS allowed the compatibility with the Datanet. As its UNIX Bull contemporaries, the NSV computer used the Motorola microprocessor MC68000. The MainWay HUB is connected to the DPS-8 through a new single-board FCP-8 adapter and a FDDI link.

XDS CP6 software on DPS-8

In 1974, Xerox Data Systems decided to abandon its line of general purpose computers bought in the late 60s from Scientific Data Systems, and to concentrate on office products. Honeywell decided to buy the park of customers (essentially scientific timesharing users). However the perspective of migration to GCOS was not greeted by enthusiasm by the customers and was menacing a write-off of the park. XDS developers, located in Los Angeles, proposed to port the existing Xerox operating system to the DPS8 hardware. Architecture differences between XDS and DPS-8 were immense: the XDS machine was a 32-bits machine. However the existing customers were using exclusively high level language programming and did not use any tricks in data input-output processing.

The Los Angeles team was used to modern programming techniques (PL/6 was a PL/1 like implementation language developed for the project) and the conversion program succeeded without cost overrun.

While the actual migration of XDS users to DPS-8 was not significant from a business point of view (two dozens? of systems in Canada and in the US, two? in Northern Europe), this program did not hurt the Honeywell finances.

Somewhat curiously, CII-Honeywell Bull dismisses this program when planning the conversion of IRIS80 users in 1977. The IRIS 80 was a derivative of the original SDS-7 system and the XDS system was a close cousin of SIRIS-8. Independently from the "job security" motivation of all engineering teams, the desire of minimum dependence from Honeywell by the CII-Honeywell Bull management prompted the decision to unify the CII product lines within the DPS-7 instead of the DPS-8.

DPS88 (Orion)

After the 66/85 failure, Honeywell decided to reserve its CML technology for high end systems. It started the development of the Orion project, introduced as DPS-88. Noise considerations as well as reliability constraints lead to maintain water cooling that finally had been mastered in Phoenix. The SSED provided TAB chips were assembled in relatively large substrates.

The DPS-88 logic was based on extensive performance analysis of GCOS programs as well as competition. The processor ended being quite sophisticated and uses cache, instruction prediction units The performances were about four times those of the DPS8/70. It was announced in 1982.

The DPS-88 was sold to existing customers that were finally able to have a machine almost on par with IBM systems. It was delivered as DPS88/81 (single processor) and DPS88/82 (dual processor).

Unhappily, a big problem came from a cost-reduction program that replaced gold with copper for the substrates' wires. An electro-migration phenomenon occurred after several months of usage leading eventually to replacement of the majority of DPS-88s by DPS-90s.

DPS-8000 (RPM)

The RPM project is the only case of simultaneous developments of two Large Systems processors. It was started when the Med-6 project was orienting towards a much more expensive machine than originally planned, more precisely when the choice of realizing a redundant system with two interlocked processors was made. It was considered impossible to deliver an entry system with no redundancy, not even auto-controlled circuits. The water-cooled CML technology of Med-6 was an additional cost constraint for offering a medium-system computer competing with IBM 4341. So, a more conventional design , based on TTL technology code named RPM (for reliability, ???, maintainability) was proposed and implemented to complement the Orion offer. RPM borrowed many features from the DPS-8 processors and cost savings came essentially of the use of larger scale integration.

DPS-8000 was introduced in 1987 as a single and dual processor. Models 83 (tri) and 84 (quad) were announced one year later

Transaction Oriented Systems

GCOS-3 did not integrate the concept of transactional applications. Under GCOS-3, a TPS Transaction Processing Subsystem was implemented that consisted to spawn a job when a transaction command was recognized by the TPS monitor. This solution had comprehensive functionalities but was not competitive in front of the emerging CICS from IBM.

Large users, specially in Europe, requested that a CICS-like system be implemented on GCOS. A first version called TDS was implemented in 1973, in BCD mode. It was followed by DM-IV TP that employed the ASCII mode.

The NSA architecture was well suited for a transaction oriented system. However, the hardware design was not backed by a uniform programming model. DM-IV TP was reimplemented using a subset of NSA under the form of TP-8. TSS used NSA under different system conventions.

While several different transaction systems were able to run under GCOS-8, a single TP system and its associated data base were not, for a while, able to use simultaneously several processors. That restriction was removed in TP-8, a little prior IBM CICS/VS.

New data Base Approaches.

One of the new developments in data base area in Honeywell Large systems took place on a somewhat exotic customer project. It was due to perform spare parts' management for the Iranian Imperial Air Force. Eventually, this project was used as the base of a generalized Data Dictionary.

In the late 70s, it became obvious that the hope Honeywell had in the standardization of Codasyl data base management did not concretize and that IBM initiated work on relational data bases would rather invade the computer industry. Honeywell started a big effort to cap IDS and UFAS with a relational layer.

In parallel, several customers express an interest for the Teradata solution of for their large data warehouses. Teradata offered a complete data retrieval system with an SQL interface. The Teradata solution would have eventually lead to a phase-out of the mainframe, by moving to a client-server solution linking directly the workstation to the data base server.

Since the late 70s, IBM offered an automated solution to tape storage by providing cartridge tape libraries. After a preliminary approach based on Masstor cloning of the IBM libraries, Honeywell selected the much more reliable solution proposed by StorageTek of Louisville CO.

Change in the I/O Strategy.

In 1979, Honeywell gathered task forces to do a reappraisal of the computer business of the 80s. This effort was called the Zeus project (nothing to do with the late 80s NEC processor). Engineering and Marketing recognized a definitive failure to compete with IBM in new Large Systems. Honeywell and Honeywell-Bull, more reluctantly, consider that their large business relies on the park of existing customers, and that even those customers were also IBM customers.

As a development cost saving, Honeywell decided to sell its magnetic peripheral plant to Control Data under the form of a joint venture named Magnetic Peripherals Inc. that regrouped the CDC and Honeywell plants in Minneapolis MN and Oklahoma City OK, under CDC management. Honeywell and Honeywell-Bull became minority shareholders of MPI.

During that period, IBM was putting a lot of efforts to dominate the storage market, adding fonctionnalités in their subsystems to counteract the offering of cloners. Honeywell Large Systems users, that were also IBM customers, require from Honeywell equivalent functions.

The hypothesis of connecting IBM subsystems started to materialize. On the IBM side, the penetration of the Amdahl and Hitachi processors become significant and Honeywell ceased to be perceived as a competitor. IBM ended to propose cooperative developments to attach IBM newest channels and peripheral subsystems to Honeywell large systems.

A first approach was that a new IOC design, code named Dipper, designed for the RPM system was extended to support the IBM FIPS channel.

Part III- NEC and Bull

Nippon Electric had developed many DPS-8 compatible models, since 1973, under the ACOS-6 operating system. ACOS-6 was based upon the code licensed from Honeywell GCOS-3. This initial version evolved to support some the NSA features, somewhat independently from Phoenix, while NEC continued to have access to Honeywell software technology. One of the reasons from divergence between ACOS-6 and GCOS-8 was that NEC attempted, somewhat successfully, to keep synergy between ACOS-4 (the 32-bits operating system, inherited also from Honeywell-Bull) and ACOS-6. High end systems of the two lines had identical technology, they had the same peripheral and a close gross design (system controller structures, caches...). NEC privileged ACOS-4 over ACOS-6 and started to implement new architectural and technological features on the 32-bits machines. One of the advantage for the ACOS-6 systems was that they rely on mature and well-debugged technology.

DPS90: Ajax (1982-1985)

In 1980, NEC announced in Japan the S/1000 that outperformed the IBM 3090. It was based on air-cooled packaging technology.

General Electric Information Services was on the market to replace its aging Level-66 systems (running Mark-III). The DPS-88 proposed by Honeywell had lower performances than the IBM machines and GE was hesitant vis-à-vis the technical problems of Orion. After the announcement of the S/1000, they started to negotiate with NEC the acquisition of S/1000 for the Mk-III central system.

When the news of a GE contract leaked in the press, some other customers were also interested, but as they were GCOS users, they cannot have GCOS running on NEC hardware without Honeywell participation.

Honeywell entered in negotiation with NEC to market the S/1000 central system with GCOS-8 and Honeywell supplied subsystems world wide. The contract was finalized in 1984. A parallel agreement extended the scope to Bull territories.

The competition between the overlapping DPS-88 and DPS-90 ended with the replacement of a large number of technology-plagued DPS-88 by DPS-90 by the manufacturer.

DPS9000: Titan (1985-1987)

The 1984 distribution agreement between NEC and Honeywell and Groupe Bull included a statement of intent for a \$1000 follow-on. This model, code-named Titan inside Honeywell, was primarily designed for the Honeywell (and Bull) market. The investment made by customers in the DPS-88 cooling system and the Swedish noise standards lead NEC to water-cooling for this machine. The technology of S/2000 was coming from the NEC ACOS4 S/1500 and from the SX-2 supercomputer announced in 1985.

The Honeywell system was named DPS9000.

Groupe Bull takes over of Honeywell computer business (1985)

Around 1984, Honeywell was starting to reconsider its commitment to the computer market. It was completely absent from the microcomputers that started to submerge dedicated office computers and minicomputers. It was almost non-existent in the technology market, having consecrated all its efforts in VLSI towards high speed CML at the expense of CMOS. The synergy between the Control Business Operations and the Computer business was very low, at a time where minicomputers were replaced by the flock of microprocessors derived from the Intel 4004 and Motorola 6500.

It was not obvious for Honeywell to find a candidate for acquiring its computer business. The last big merger was the limited success Unisys affair, where the combined business of Burroughs and Univac was significantly lower than the sum of their pre-merger business.

The only candidates were NEC and Groupe Bull. NEC was not enthusiastic to buy Honeywell. They consider themselves unable to take-over the management of the company, they did not see that Honeywell could become a long term profitable company and prefer to acquire a minority position. Honeywell management was more successful to get the Groupe Bull money. Bull had not developed any development capability on the DPS-8. A large part of the margin of Bull was coming from the GCOS-8 park, where Bull had almost no R&D expenses and where the price erosion started by IBM cloners was not altering the captive GCOS customers. In fact, Bull could not abandon the responsibility of GCOS-8 to a competitor, without menacing the core of its business. At that time, in France Japan was considered as the Evil Empire wishing to take over all the "fleurons" (jewels) of the French electronics and the Bull management had no difficulty to convince its State shareholder to buy in the Honeywell business to avoid a Nippon take-over. the mood in the mid 80s was that buying companies was extremely easy, thanks to leverage buy-outs practices that allow to pay the acquired company by selling a part of its assets.

Finally, Bull accepted to pay Honeywell in cash and NEC took a 18% share in Honeywell-Bull, Inc.

The main asset acquired by Bull was, in fact, the Large Systems establishment. However, the headquarters of Honeywell-Bull stayed in Billerica MA and H-B started grandiose developments, hiring engineers and managers from fledging US minicomputers companies.

After 4 years of Boston directed management, the Phoenix establishment was more and more controlled by Paris. The Planning, Marketing and Engineering reported independently to Paris. Under the French rule, the manufacturing facilities remaining in Phoenix were transferred in Brighton, MA. The hardware engineering became closely integrated with Les Clayes and seriously reduced. Les Clayes participate to the RPM-II project and later to the Jupiter project. A big emphasis was ported on Software Engineering productivity. Eventually, in 1994 the Black Canyon establishment was partially closed to take in account the reduction in Phoenix personnel.

Sales concentrate on very large accounts, the first level of maintenance in Northern America was sold to Wang Laboratories.

RPM-II (1988-1993)

The RPM-II was designed in Phoenix on the base of the Bull CMOS Auriga technology and reuse several components of the DPS7000 French design. The RPM-II implementation trailed the French design by 24 months instead of the 9 months originally planned. Contrarily to the Japanese, neither the French nor the Phoenixians were yet experimented to derivative a 36-bits design from a 32-bits design. Also the announcements made that the RPM-II would be the last system designed in Phoenix did not improve the morale of engineers.

RPM-II was introduced as an entry point of the DPS9000 product line.

DPS9000/900: Zeus (1988-1992)

NEC was reluctant to develop a new member of the ACOS6 product line. However, the success of the DPS-90 leads Honeywell-Bull to request an "umbrella" for the DPS-9000 systems. In fact, some of the industry expectations for a main frame market evolving towards a distributed network of medium size computers did not materialize for reasons of operation cost and the perspective of open systems. Some customers did even return to centralizing their main frame operations and request more powerful computer.

NEC accepted to satisfy these needs by launching a new system, code-named Zeus and also marketed in Japan under the name of NEC ACOS S/3900. The system used a technology integration level significantly higher than the S/2000. The central processor was composed of a single large board. Each substrate was huge and quite expensive. Happily, the reliability was high and the support costs remain affordable.

Jupiter (1995-1997)

After the finalization of the Auriga 2 project, that regrouped 4 DPS-7 processors on a single board to build a computer with up to 24 processors, and after the failure of supplying NEC with a XSA version of Auriga 2, the Les Clayes design team was becoming idle and was proposed to build a DPS-9000 version of the Auriga 2 system. This project was code-named Jupiter.

Formally announced in April 97, Jupiter was christened DPS-9000/700 with a maximum 8xSMP configuration at 45 Mips per processor.

The processor chip of Jupiter is one of the most integrated of its time, it includes 7.3 million transistors

Although NEC initially planned to phase out their ACOS 6 systems, some of their customers were still reluctant to move out of ACOS 6 either towards UNIX or to ACOS 4. So, NEC wished to endorse the Jupiter project for the Japanese market and received their first system in 4Q96.

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