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11A. CORPORATE INFRASTRUCTURE for 5th GENERATION COMPUTERS

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JEL CLASSIFICATION
M13, M14, L14, L22, L63, L86, O14, O32

* Corporate Infrastructure For Fifth Generation Computers

In view of these trends and developments in computer electronics, super computers with 1000 to 1300 million floating point operations per second are already in use. In the 1990's the current fourth generation computers and the super computers will marry each other and lead to a "Hybrid General Purpose System". These thoughts on future computer electronics provide an adequate base to project the architecture of the generalised computer systems expected to dominate the corporate scenes in the late 1980's and early 1990's, or the pre-fifth generation environment.

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The Statistical average of the "Life Expectancy" of the world population between 1951 and 1985, works out to about 52 years. It means that in about every 52 years, there is an advancement of one human generation. In this selected bracket of 35 years, the prorated advancement of human generation is 35/52 or 0.67 generations.

In the same span of 1951 to 1985 (taking care of the emergence of super computers, and the progress towards fifth generation), the computers have recorded an advancement of 4.5 generations. Arithmetically, 0.67 generation of humans have contributed to 4.5 generations of computer upgrade, records a credit of about 6.72 computer generations (4.5 ÷ 0.67), for each unit of human generation. Should we be very proud of this achievement?

Achievement in electronic technology and computer architecture in any pace cannot serve its intended purpose, unless it is effectively and productively utilised. Also such an utilisation should bring its benefits to a broad-based world of human society. It is this society which produced, raised, cared and motivated those, who were behind these innovations.

The media for such optimum utilisation of computer technology, are the corporate sectors, covering industrial, commercial and service units. They utilise computer assistance to cut costs and time, improve human efficiency, and ensure faster implementation of laboratory models.

The human generations could, however, enjoy these benefits under optimum support from computer generations, only when the corporate sectors could produce and distribute the goods/services on a continued basis, at socially acceptable quality, and at economically justified costs. Such an achievement is possible by properly planning and attuning the corporate infrastructure, to productively utilise these modern computer development.

Paper Objective

By 1990's it is expected that a major part of the industrial and commercial designs, controls, management, research and development will be under computer control. Hence, the corporate

infrastructure should also keep pace, and tune its administration to meet the challenges of the proposed computer upgrades, towards the fifth generation. Based on these introductions, the objectives of this paper are:

— Project the architecture of the generalised computer systems expected to dominate the corporate scenes of early 1990's.

— Chart the expected corporate infrastructure which will exist to meet the computers of early 1990's.

— Critically evalute the architecture of the proposed fifth generation computer.

— Recommend an applicable remodel in the corporate infrastructure.

Thoughts on Future Computer Electronics

If we chronologically extend our thoughts and experience with computers, from its origin to its curent level, it reflects an amazing array of developments.

In the 1950's, the Scientific computers with predetermined precision/decimal accuracy with low speeds, were identified separately from the business computers, with programmably flexible precision, and high speed/high volume processors. Within the end of that decade, the printed circuit boards reduced the gap between these two breeds of computers, and generated machines which could do both of them equally well. Hence, the corporate organisations started using one central computer for both commercial jobs (like financial, personnel, materials management, etc.) and research/development work (like blending, product design, etc.). This approach integrated the engineering, scientific, cost and marketing aspects. The impact was the development of techno-commercial divisons with engineers, scientists, accountants, and psychologists working together. This generated the need for M.B.A.'s in the job market.

In an overlap period of one decades (1955-1965) the developments in tele-satellite communication system brought the analogue and digital processors together through MODEMS modulation demodulation units to convert electronic signals from intervalled digital, to continuous analogue and vice-versa). This linked the corporate organisations to their distant/international contacts and clientele. The impact was significant in airlines, hotel, and travel agency sectors. This generated global linked computer divisions needing a large number of soft-ware developments, and programme package implementation personnel.

By 1986-1987, the large-scale integrated circuits are expected to bring the current 32 bit micro-processors in one-chip version, and 64 bit micro-processors in multi-chip versions. As a result of this, the 64 bit micro-processors are expected to reach a price range of US $ 20 to 30, before the end of this decade.

The lower cost profile and faster pace of advancement in computers are attributable to the following significant contributions:

(a) Wafer-scale integrated circuits, with narrow line-widths, reduction in circuit element sizes and defect densities, and improvement in manufacturing techniques.

(b) It has been established that charges are conducted 5 times faster through circuits with Gallium arsenide substrate than in circuits with Silicon as a substrate. (It is through a different chemical technology.). These will enter widespread use.

(c) Cryogenic super conductor technology employing Josephson junction poses engineering problems. However, with or without it, the State supported and private researchers will design circuits with at least 20 times faster processing speed by mid-1990's, compared to the current level.

(d) The computer systems manufacturers could now competitively withdraw from semi-conductor manufacturing and concentrate their efforts in direct circuit designs.

(e) Last few manufacturing touches/assemblies to general purpose logic chips, with large numbers of separate circuit elements, assembled in rows (Gate Arrays) are becoming popular. These could be economically converted into most optimum logic circuits, and may become competitive by 1990's.

(f) Laboratory tests in magnetic recording have demonstrated an achievement of 100,000 bits per

inch, and four times its capacity are considered possible, by mid-1990's.

(g) Commercial applications which do not need rewriting (like verified and confirmed master records), could utilise economical and faster optical recording system, now under research and development, and may become feasible in 1990's.

Pre-Fifth Generation Computer Environment

The hybrid system envisaged in the late 1980's and early 1990's will have a set of computer complex, monitored through a "supervisor" machine. Input/output file access and communication handling queue functions will be delegated to an "Interface Optimiser" unit. Direct scalar functions will be delegated to a specialised "Scalar Optimiser" unit. Vetor functions and convertible scalar to vector computations, will be handled by a specialised "Vector Optimiser" unit at 10,000 million floating point operations per second. This could be a chain of five storage processors circularly - linked by data bus for information transfer, and a control bus for process coordination.

Each storage processor will be designed to optimise their specialised functions, namely input/output, application processing (covering scalar modules/possible convertions into vectors) and specialised processor to handle vector modules. The Synchroniser Supervisory processor will link the remote supervisory facilities and time-sharing applications.

The significant feature of these will be, their link with the local area net-work communicating with user oriented mini, micro and personal computers at user locations. This future general purpose computer schematic is shown in Figure 1. This architecture is hence used as a basis to chart the expected corporate infrastructure of early 1990's.

Pre-fifth Generation Corporate Environments

The general-purpose computer-assisted organisations in late 1980's and early 1990's will have two main features in 'their' infrastructure as shown in Figure 2.

Vertical Integration: There will be five levels to optimally administer the organisation. These will be vertically integrated with clear-cut responsibilities.

Policy formulation and corporate guideline will rest on the top with President/Vice Presidents. These will be moderated, based on direct display feed-backs and summary reports from the main frame and peripherals of the general purpose computer.

Management of the organisation as per policy guidelines, will be by the department heads, administration of the operations within the frames of references/targets will be by the Managers. These two levels will be assisted by direct display feed-backs and summary reports from the main frame and peripherals of the general purpose computer. However, there will be direct downward manual inter-action at these levels.

Implementation of jobs will assume "group works" primarily to utilise the optimised directions from the computer, to effectively implement the policies and achieve or supersede the targets.

The interface for the operating work group (marketing, finance, production, research, etc.), will be their own mini/micro/personal computers communicating with, and transmitting data to the main frame. Also the main frame will provide periodic reports and directions to the work group.

The hardware will be a separate group to select/update the hardware-component at appropriate times, by proper communication and interface with external hardware specialists.

Horizontal Inter-Action: In order to keep pace with the development in computer informatics, there will be an increasing need for horizontal inter-action at implementation level.

The design sub-group, comprising systems analysts/programmers/operations research specialists will interact with external software specialists and organisations to select, test and implement techno-commercial software.

The design sub-group will interact with the work group, to plan the software to be developed internally.

The systems group along with internal orientation group and training group, will prepare the work groups to optimally and currently use the hard/software facilities. This will be through planned orientation sessions.

Under the existence of this type of organisation in the early 1990's, the fifth generation computer could enter the market with a new dimensional architecture.

The Fifth Generation Architecture

The proposed fifth generation computer architecture is shown in Figure 3. Compared to the circularly integrated general purpose computer systems in Figure 2, this exhibits an innovative and different architecture with three levels of vertical integration:

External Interface: External interface involving input/output and communications, will be dominated by logic programming techniques. These are expected to possess simple syntax and semantic, with enough expressive/descriptive leverage. This will simplify the direct user involvement and orientation, as these are expected to be derived through Horn Clause (Definite Clause) logic modules. The user logical and computational aspects will be through a fifth generation Kernel language, based on Warren's abstract Prolog machine language. This will optimise the processing, by logical conversion of scalar statements into vector, during execution. The machine is also expected to understand direct and continuous human speech with 95% accuracy from a few hundred speakers in the organisation. Graphic and pictorial information will be direct inputs.

All these are expected to be achieved by the fastest access on-line availability of about 50,000 spoken words, and about 10,000 pieces of graphic/pictorial patterns, supported by voice simulation/translation interface.

Software System: Decision–oriented software architecture is expected to dominate the fifth generation computers to a large extent. Each piece of knowledge available to suit each situation in the organisation are expected to be pooled, assembled and converted into IF, WHEN, WHILE and THEN logics, or script frames to lead the machine to select the best course or, chronology of events and decision methods, or modes to convert objects, constraints, and availability into operations research mathematical models. Starting with a pre-set knowledge, the computer is expected to become more and more intelligent through its problem-solving experience, over the passage of time.

Similarly, each piece of problem situations and logical solutions applicable to the organisation is expecpted to be converted into computer oriented interface systems and stored on-line, to decide the course of action by the machine.

The third and most innovative phase is the intelligent interface, by converting the human intelligence to select the appropriate solution for any problem, search/select/modify/apply the applicable knowledge to that problem in the right context, and accept human recommendations/suggestions, if any. These are expected to be developed, tested and proved in a general purpose computer, and then assembled/installed in a fifth generation machine.

These three aspects of software system are expected to function in coordination on the following basis:

Computer draws inferences about any given situation and generates questions, if any, to the users. These will be answerable in Yes/No or by providing some information. These answers will be integrated with the problem solving/knowledge bases, and computer will take decisions.

The inferences will be presented to the user with logical reasoning behind the solutions, underlying insights and sensible advices/recommendations, if any.

The knowledge gained and problem–solving techniques after each situation, if new, will be stored in a buffer file. These could be added to the knowledge base, problem–solving and inference modules, if the user wishes so.

Hardware: The hardware is expected to be synchronised with the software system through a knowledge-base unit, problem-solving and inference unit, and an intelligent interface unit. Each of these will have appropriate sub-units and mutually high-speed interaction, to optimise the functions of each unit.

These three units in the main frame will be supported by a very large integrated architecture to handle scalar functions, optimally convert them into vector functions wherever possible, and optimise input/output functions. All these warrant a different approach to corporate infrastructure to utilise the fifth generation capabilities.

Proposed Corporate Infrastrcture for Fifth Generation

Faster decision-intensive organisations (airlines, hotels, consumer goods industries, energy alternate units, etc.), will divert to fifth generation computers on their arrival, to improve their business prospects and create a super image. Based on appropriate feasibility, these could be through in-house installation, time-sharing, machine time hiring, or tele/satellite communication links with a central fifth generation computer centre.

Along with the fifth generation computer, it is also expected that adequate safety/security features will be available in the market to keep the confidentiality of the knowledge base, problem solving, and intelligent inferences of each corporate unit.

To meet these new dimensions, the corporate infrastructure in the early 1990's as in Figure 2 will be inadequate, because of their restrictions to vertical integration and horizontal interaction. The proposed design is shown in Figure 4.

Professor Johru Moto-Oka, who chaired the research and study committees that preceded the actual formation of the "Institute for New Generation Computer Technology (ICOT)" in Japan, stated that they chose to try and envisage an ideal society for that decade (1990's) and then design information systems/computers that would help to realize that ideal.

The fifth generation corporate infrastructure model proposed by me in Figure 4 is expected to meet the needs of the society in 1990's and meet their challenges/ideals through a hexa-fold approach

Maintenance of Hierarchy and Machine Interface: The proposed corporate infrastructure in Figure 4, is a circularly integrated version of the structure in Figure 2. This maintains the administrative links from President down to the implementation level, except the whole team will be an action team, rather than a decision team.

The policy and management aspects will be translated and integrated into the knowledge, problem solving and inference modules of the fifth generation software. The Work, Training and Systems Group will utilise an integrated, shared fifth generation micro, mini, personal computers, besides the Systems Group designing/updating the software for the fifth generation main frame. This is expected to aid easy organisation transfer from a general purpose to a fifth generation environment in 1990's.

Circular Integration: The personal link between any two levels in the heirarchy is expected to intensify because of the feed-back and direct questions from the fifth generation knowledge, problem-solving and inference modules.

There will be direct responses from the Vice-Presidents (in consultation with the President) and Department Heads, to the fifth generation computer queries related to knowledge, problem-solving and inferences. Responses to these will aid direct and quick updating of policies and management styles of the organisation down to the managers and work groups. This will circularly and informally integrate the Managers and Work Group with the top level, namely the President. This is shown by a circle connecting these levels, in Figure 4.

Problem/Solution Orientation: Both in the Work and Training Groups an additional staff-set up is provided to understand/analyse the problems, generate inferences, document them, and aid training on a continued basis for current and new staff members. This is to synchronise the implementation environment with the fifth generation capabilities.

Knowledge/Intelligence Orientation: In the systems group, an additional staff-set up to develop and update the knowledge-based management is provided. This is to work in coordination with the design and orientation group and update the knowledge base, problem-solving and inference modules.

Integrated Intelligence Interface: The current knowledge-bank and problem solving/inference modules will be analysed and innovated continuously by an "Intelligent inference group" attached to the Department Head of the Management Systems (MIS).

Through their research and development activities, they will innovate new dimensional and intelligent approaches to meet the challenges of the organisational needs. The equipment group in hardware, the knowledge management, and intelli-

gent inference group in MIS will form "Intelligent inference and man-machine interface shell", as shown in Figure 4.

Mutual Training: Horizontally interacting training group in Figure 2, is modified into a mutually interacting "Training Shell" in Figure 4. The Training and Systems groups will jointly conduct training programmes to the work group members towards the optimum utilisation of fifth generation capabilities. Periodically the Training and Work groups will jointly conduct training programmes to the Systems group to update 'their thoughts and approaches in building the knowledge, problem solving and inference modules'

Summary

Arithmetically each level of human generation contributes to computers by 6.72 generations upgrading. But this effort could pay back to the human society, only by tuning the corporate infrastructure to utilise these computer innovations optimally.

Hence, the objective of this paper is to analyse the fifth generation developments and propose a new corporate infrastructure to meet the expected challenges.

The future computer electronics works towards drastic cost reduction and process-speed optimisation. Hence the pre-fifth generation computer environment in late 1980's and early 1990's will be dominated by a circularly integrated general-purpose computer network. The Pre-fifth generation organisation will have the characteristics of vertical integration in the hierarchial administration, and horizontal interaction at implementation levels.

The fifth generation architecture with its innovative techniques will be tuned to accept keyed, voice, picture inputs and process towards decision and action guidelines, using knowledge based management, problem solving, and inference modules. The machine is also expected to become more intelligent with the passage of time. The proposed fifth generation organisation structure is hence designed with the maintenance of 1990's hierarchies and machine interfaces; circularly integrated policy and management work flow; intensified problem-solution and knowledge intelligence orientation; integrated intelligent human-machine interface; and a mutual training set up.

These are expected to achieve the objects of fifth generation computer designs, and disperse its benefits optimally to the society in 1990's.

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Figures on the following pages

FIGURE – 1

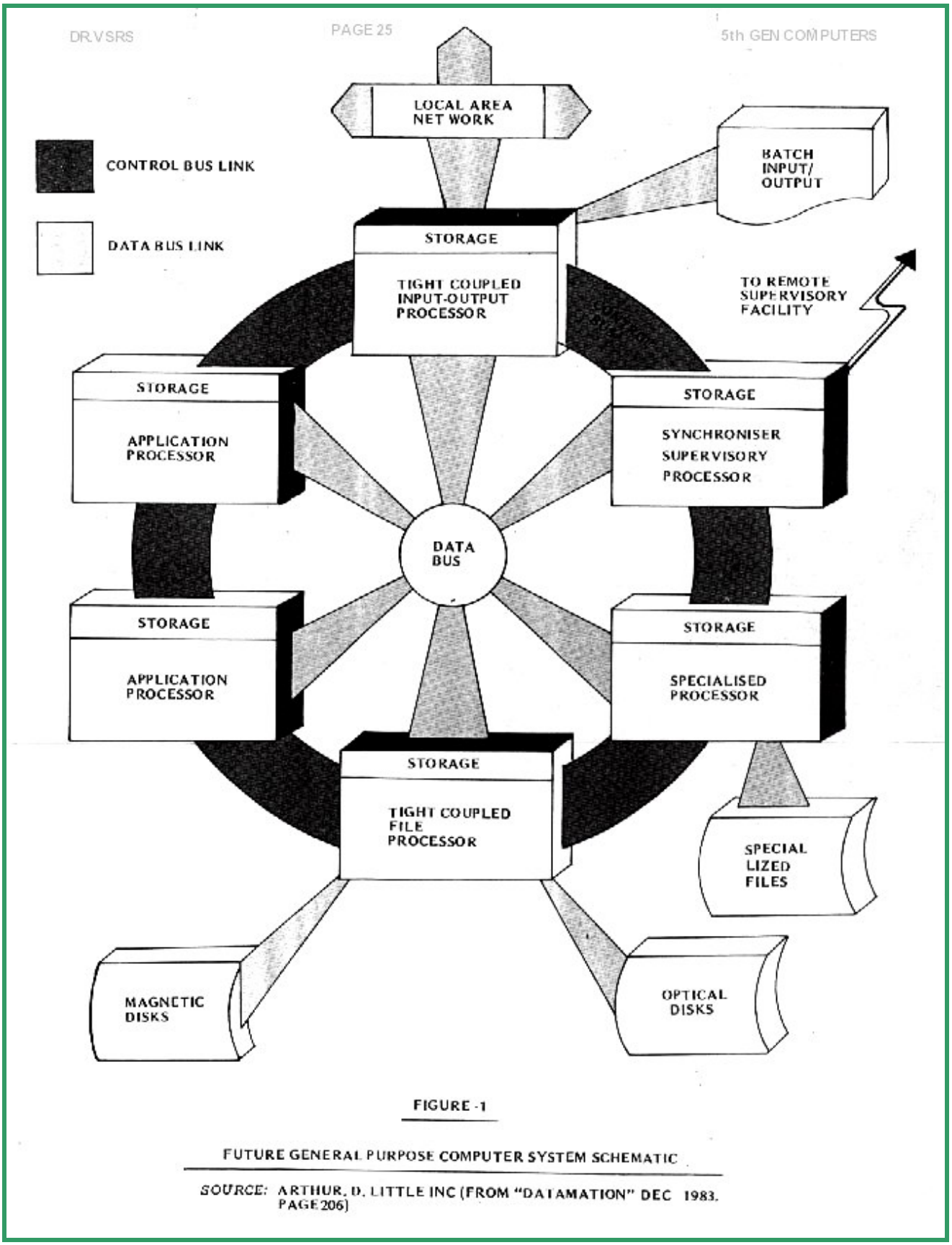


FIGURE -1

FUTURE GENERAL PURPOSE COMPUTER SYSTEM SCHEMATIC

SOURCE: ARTHUR, D. LITTLE INC (FROM "DATAMATION" DEC 1983. PAGE 206)

FIGURE –2

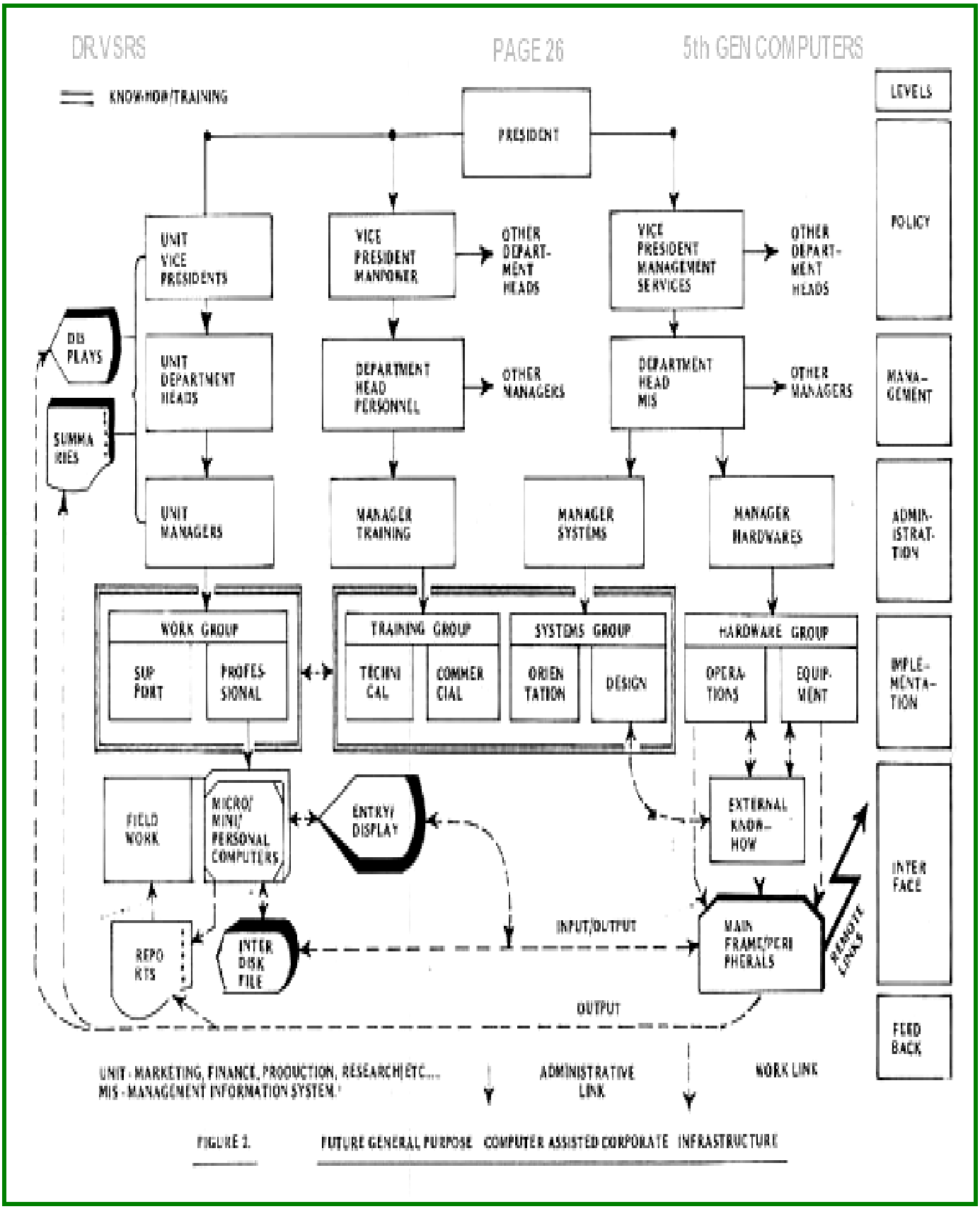


FIGURE 2. FUTURE GENERAL PURPOSE COMPUTER ASSISTED CORPORATE INFRASTRUCTURE

FIGURE – 3

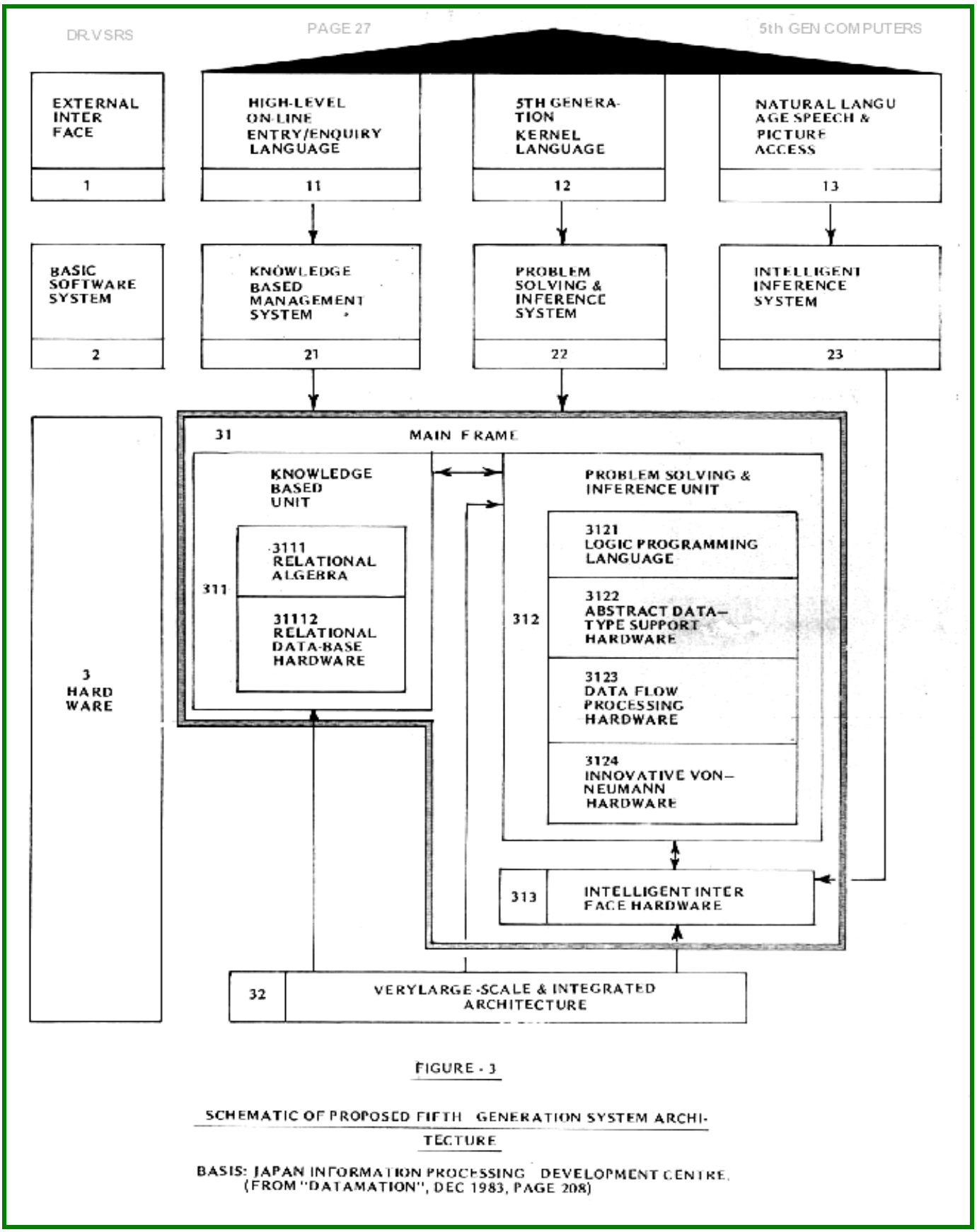


FIGURE - 3

SCHEMATIC OF PROPOSED FIFTH GENERATION SYSTEM ARCHI-TECTURE

BASIS: JAPAN INFORMATION PROCESSING DEVELOPMENT CENTRE. (FROM "DATAMATION", DEC 1983, PAGE 208)

FIGURE – 4

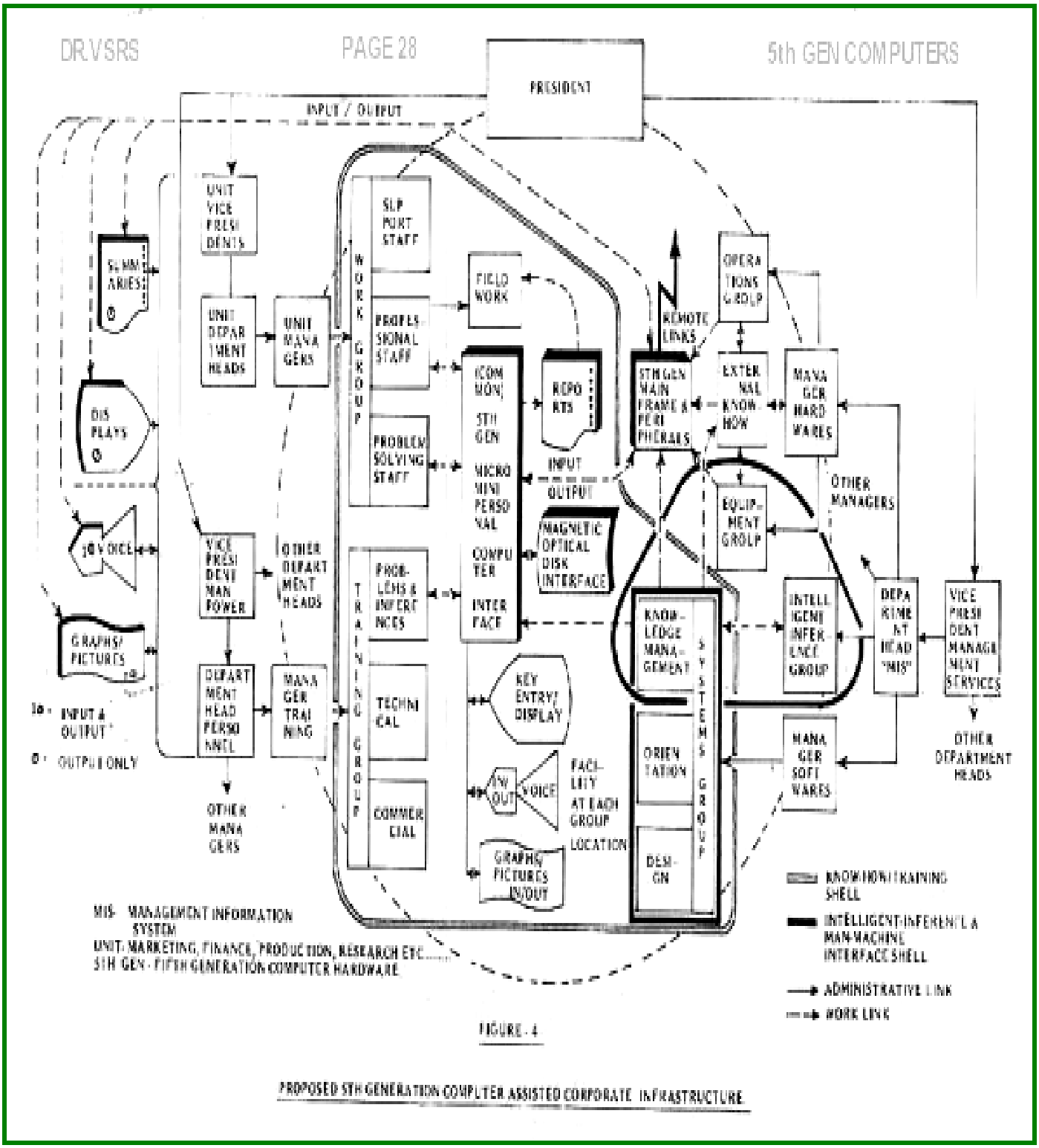


FIGURE - 4

PROPOSED 5TH GENERATION COMPUTER ASSISTED CORPORATE INFRASTRUCTURE

POST PUBLICATION APPRAISAL

5th GENERATION COMPUTER - CORPORATE INFRASTRUCTURE

INFERENCES AND SUPPORT (Published in 1985 - Realised in 1990s)

From the advent of computerised information processing technique in 1900s, the computing electronic technology as well as the information storage / retrieval methodology have advanced in an accelerated pace.

UPTO 4th GENERATION (HORIZONTAL INTEGRATION).

Infrastructure : Co-ordinate with 1 external Hardware Group. Recruit, train and maintain 4 Group of personnel in-house. Live with 5 limitations.

EXTERNAL HARDWARE GROUP : Design, develop and supply a pre-set machine configurations / combinations, and provide the necessary maintenance and support. INTERNAL SYSTEMS GROUP : Study the user needs, prepare flow diagrams, divide into individual program modules, provide process assurance controls, data backup and data reload methodologies. SOFTWARE GROUP : Study the Systems specifications, prepare logic processing diagrams, code individual program using pre-set language syntax / limitations, test, implement and provide modification support, as and when the need arises. OPERATIONS GROUP : Receive the Input information from the work divisions, process them through punch cards or entry type writer screens. Sort, collate, process the data using the assigned Software Modules / Programs, print reports, cross check the control totals to ensure the accuracy of processing and deliver the Output reports to the information user groups. USER GROUP : Receive information in the form of reports. Review and take appropriate actions / decisions.

LIMITATIONS. TIME DELAY : A sizeable time delay between submitting the input information and getting the output reports. This is a minimum and mandatory time to receive, process, ensure accuracy and deliver. LINKS : Limited links and on-line information sharing facility between computers and personnel. Physical movement of information through hard copies. KNOWLEDGE PROCESSING : Exclusive domain of each group. The hardwares do not have any capability to store the knowledge and guide any Group. EXPERIENCE GAINING : Limited to the memory and retrieval capability of each. group, from the stored hard copy reports. The hardwares are not designed to self-store, analyse and provide valuable feedback. MULTI MEDIA : Limitations in processing Animation, Image, Video, Voice, and a range of on-line select facility for the User Group.

THE 5th GENERATION INFRASTRUCTURE - 1990s (VERTICAL INTEGRATION)

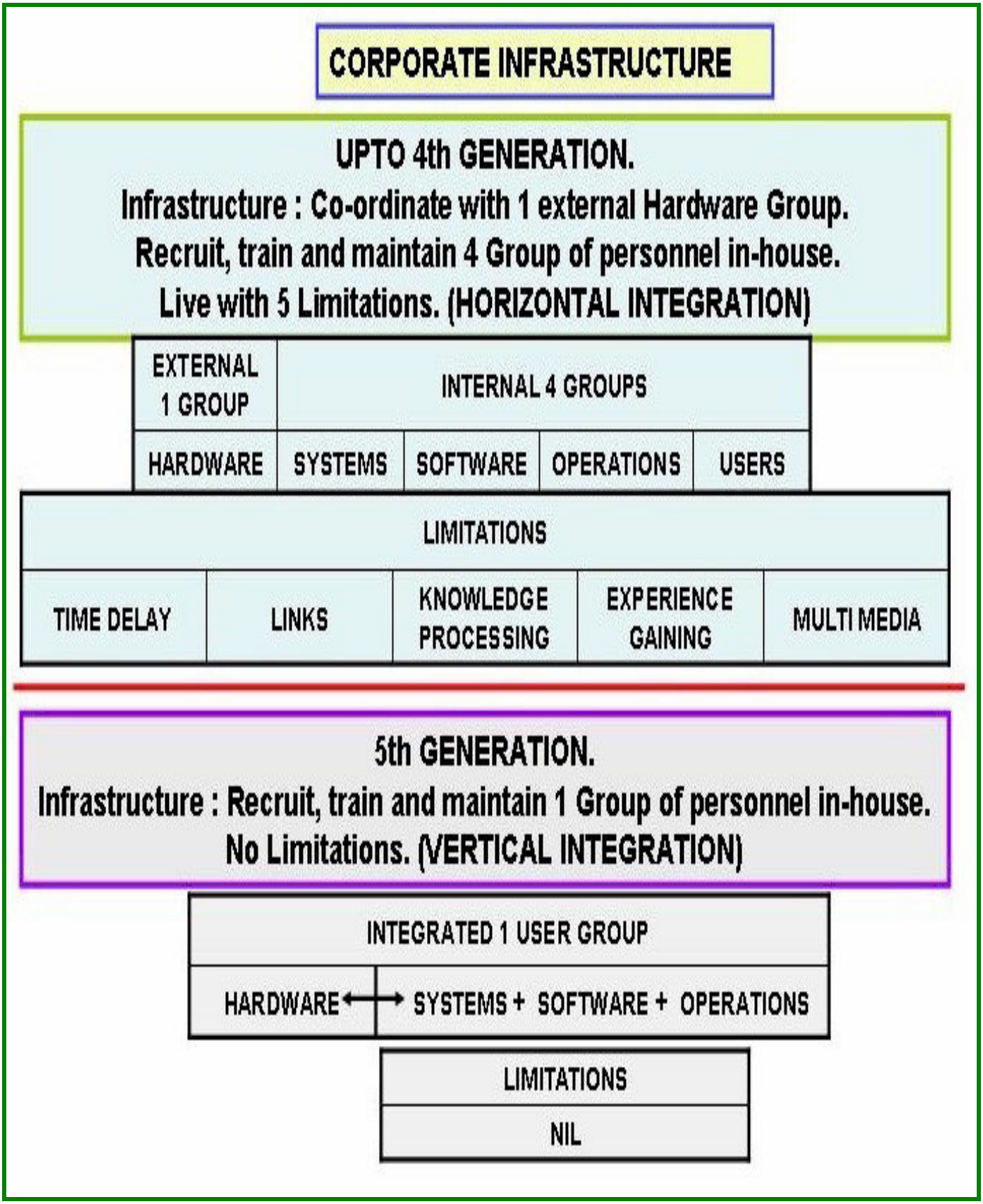
Recruit, train, periodically update and maintain 1 Group of in-house personnel. No limitations.

INTERNAL USER GROUP (Integrated with) EXTERNAL HARDWARE GROUP : Decide the requirement and chooses the required hardware. Can buy different machines, parts and components and assemble / modify to suit their needs. INTERNAL SYSTEMS GROUP : Choose the required system needs on-line and the necessary program modules are generated by the computer. On-line edit, backup and data reload options are provided, for the user to choose and integrate with the generated program modules. SOFTWARE GROUP : Embedded softwares as per the specification of the Systems selected. On-line selection of the softwres to suit specific requirement. Develop own softwres on a select and fit basis from an open-ended and plug and play software generators. OPERATIONS GROUP : Input own data/parameters, process and get the Output in screens or on hard copies. Also send and receive information from other remote users.

ACTUAL 5th GENERATION INFRASTRUCTURE IN 1990s

REALISATION. All Hardwares with different performance, process speeds, and design choices are made available by different manufacturers. The User Groups configure, select, assemble, utilise and perform in-house repairs/fault fixing. Use Visual platforms (Kernel Language). Hyper Texts, Data base generators. Import or cut /opy and paste facility for program modules. Spread sheets, Word Processing, Web Browsers etc.. Each user input their own data, sort, collate and Output on screen, other media or on hard copy printers.

LIMITATIONS. TIME DELAY : Brought to Nil or to a considerable minimum, through Network links, Internet browsing. LINKS : Any number of linked nodes to a server. On-line information entry, retrieval and exchange. KNOWLEDGE PROCESSING : Computer suggested on-line corrections and edits like spelling checks, punctuation and grammar. EXPERIENCE GAINING : Experience gained by the computer for each user is available on-line, like suggestion for date, time, frequently used data, help screens and experience guidance help request as specifically set by the user. MULTI MEDIA : Image processing in different formats. Unlimited on line audio, video, voice processing, image processing in different formats, colour graphics etc..


CORPORATE INFRASTRUCTURE
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Infrastructure : Co-ordinate with 1 external Hardware Group.
Recruit, train and maintain 4 Group of personnel in-house.
Live with 5 Limitations. (HORIZONTAL INTEGRATION)
EXTERNAL 1 GROUP
INTERNAL 4 GROUPS
HARDWARE
SYSTEMS
SOFTWARE
OPERATIONS
USERS
LIMITATIONS
TIME DELAY
LINKS
KNOWLEDGE PROCESSING
EXPERIENCE GAINING
MULTI MEDIA
5th GENERATION.
Infrastructure : Recruit, train and maintain 1 Group of personnel in-house.
No Limitations. (VERTICAL INTEGRATION)
INTEGRATED 1 USER GROUP
HARDWARE
SYSTEMS + SOFTWARE + OPERATIONS
LIMITATIONS
NIL

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