APPLICATIONS OF THE DIGITAL COMPUTER IN THE IMPROVEMENT OF THE SOCIO-TECHNOLOGIOAL CONDITIONS IN A DEVELOPING ECONOMY

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ABSTRACT

This paper emphasises that there is a relation between the development of an effective computing capability and technological growth within a given developing economy. For the Nigerian economy, an attempt is made to outline some technical aspects of a few options that are likely to enhance her computing capability as well as identifying an option that is compatible with the present state of art of her technology. The implication of such an option is then examined in relation to techno-social transition within the economy.

1. INTRODUCTION

The present stage of Nigeria's development is characterised not only by an unprecedented growth rate in several sectors of the economy including educational, industrial, commercial, financial and services subsectors but paradoxically also by rapid increase in certain inputs and demands. One of such demands relates to computers and computing facilities in various sectors of the economy. An increasing recognition of the relevance of computing to national development is clearly reflected in the scale of intersectoral demand in the past decade [5] However, the high inflationary trend evidenced in the economy a few years ago as well as the strain on the foreign reserves implicit in the massive importation of computers necessitated a legislation which essentially restricted the growth of computing power in the economy. To date, the increase in computing power in most developing economies is predicated on continued importation and acquisition of computing machines and facilities. This trend need not continue. The use of a network is advocated It is stressed that this would not only de-emphasize the need for importation of computers but would help to effect an optimal utilization of existing computers and computing facilities in the economy. Recent surveys [4], [5] suggest that adequate infrastructural facilities already exist for the establishment of networks in the economy. This paper outlines a few technical requirements regarding the use of networks as well as indicating that techno-social changes are predicated on the existence of such networks.

A few factors implicit on a recent survey on computer installations in the country [4] are now outlined. These include among others:

(i) Hardware heterogeneity – narrow spectrum of different computer main frames and minis (minimal hardware incompatibility).

(ii) Zonal Concentration of computer installations (an uneven geographical distribution of computing demand).

(iii) Lack of adequate number of computer specialists (especially teleprocessing experts).

(iv) Broad spectrum *or* common software (partial software compatibility)

(v) Significant common intersectoral applications programs (partial data and

standards compatibility).

(vi) Federal government - institutions, departments, parastatals, ownership of a good percentage of installations (possibility of common organisational structure).

(vii) Intermediate communication efficiency based on telephone lines(Restricted application of microwave and satellite communication technology).

Having outlined some unique aspects of the Nigerian computing community, the merits of a few compatible network options are then examined in the light of some obvious constraints of most developing economies. These constraints dictate that any choice of network would of necessity satisfy among others, the following requirements:

- Maintainability
- Extensibility (ability to easily couple or decouple systems, softwares, etc - evolutionary structure)
- Fail soft capability (implies that failure of a device does not preclude other applications in network).
- Low cost (need for some network reliability with optimal cost/performance trade offs)

2 . FRAMEWORK FOR EXPERIMENTATION

2.1Network Options

Specifically, we shall consider the following cases:

(i) National based network (straddles the entire country).

(ii) Regional based network (straddles a state or group of states)

(iii) Local based network (straddles a town or city and its environs).

The survey data [5] precludes cases (i) and (ii). The uneven geographical spreads of computer installations as well as varying sectoral demands suggest that the use of case (i) at this stage of our economic development would be economically unjustifiable. Case (iii) appears to be attractive in some respects but connotes very high costs when viewed in relation to future potential users and the size of the country. Case (ii) therefore is the only logically attractive option at this present level of the country's development there are various implementable network topologies that could be associated with a regional based network system.

These include:

a) Centralized or star network
b) Distributed.
c) Ring.
d) Variants or hybrid of (a), (b) and (c).

For purposes of this paper, we shall restrict this discussion to a consideration of the relative merits of (a) and (b). These two cases are shown schematically in Figs. 1 and 2. In the two cases considered, there are at least three basic components, namely, the host/device, the communication interface unit and the communication subnet-work. In the centralized strategy, the central node performs both the functions of the communications network interface and network controller while for the distributed network, these two functions are shared over the communications interface units. Several channel types including telephone lines and radio links could be used to realize the path of node interconnections.

2.2 Network Characteristics

The Centralized network is characterized by:

Simplified overall control - The complexity of overall control problem is greatly simplified. All communication functions of message routing, speed of

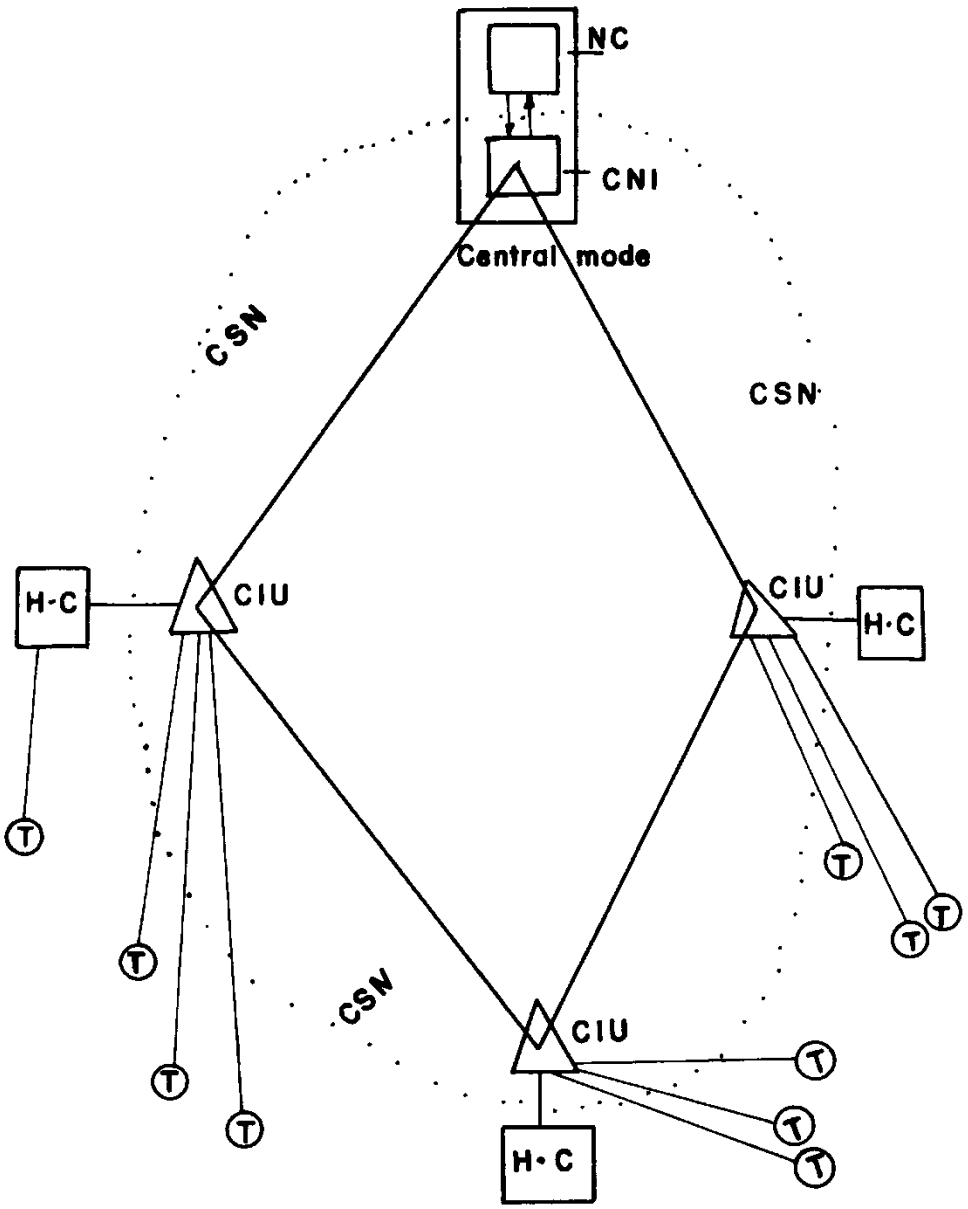

Fig.1. centralized or star network

T = user terminal

CIU = control inter face unit

Csu = communications sub network

H.C = host computer

HNI = communication network interface

NC = network controller

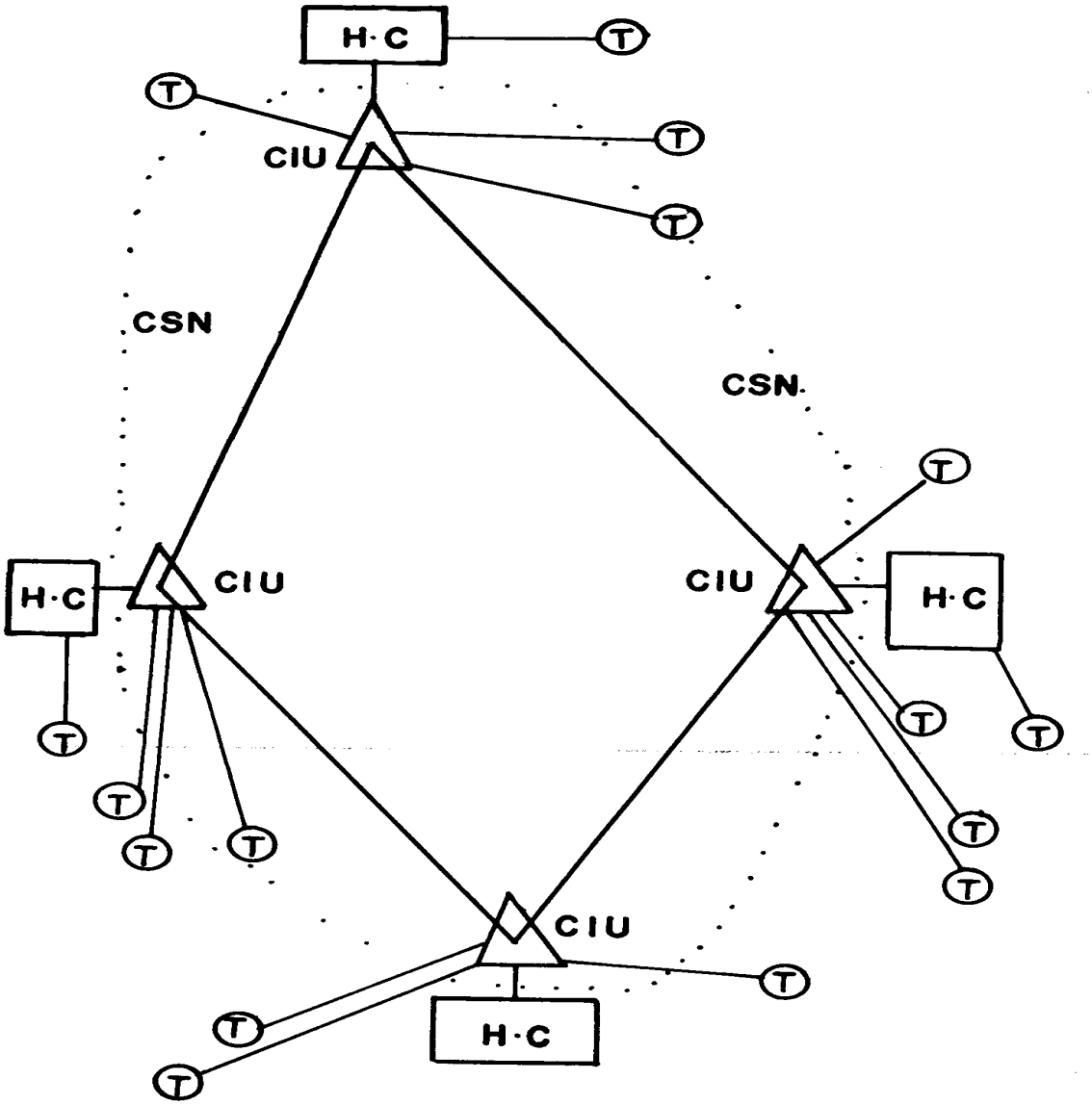

Fig. 2 distributed network

conversion, code/protocol conversion, error checking as well as job scheduling and allocation of host resources to users are performed and monitored from a common location. This is particularly attractive when considered in the light of the inadequacy of specialized staff in many developing economies.

- Low failsoft communication capability. - This is a disadvantage.
- Simpler maintenance.
- Compatibility - The broad spectrum of similar hardware's and software make the problem of system and data compatibility minimal.
- The problem of communication protocol is much easier - Communication mainly based on elephone lines.

i)Subvoice grade lines (0 - 150 bits/sec.)

ii) Voice grade lines (300 – 9600 bits/sec).

iii) Broad band (over 10,000 bits/sec).

The distributed network 1S characterized
by:

- High communications failsoft capability.
- High modularity.
- Complex and costly communication network interface.
- Compatibility problem more difficult to handle.
- More complex control problem.
- Communication based mainly on micro- wave transmission - switched packets [1]and related technologies.

The indicated characteristics suggest that no one single network configuration could cater for all the limitations as well as the requirements of a developing economy. However, it would be apparent that a centralized network topology would be ideal for Nigeria.

2.3 Application Modes of the Network

The varied natures of the application requirements in various sectors of the economy dictate that the network should be able to support the following
application modes:

i. Remote job entry.
ii. Remote batch processing.
iii. Interactive applications.
iv. Dynamic file access/transfer.
v. Load sharing.

By employing one or more of the above application modes, it would be possible to avail computing power via the network in any sector and geographical location straddled by the network.

3.POTENTIAL ROLE OF COMPUTING POWER IN SOME MAJOR SECTORS OF THE ECONOMY.

In this section, the potential role and impact of computing power is examined relative to the services, educational, commercial and financial, transport and industrial subsectors of the Nigerian economy.

3.1 Services subsector.

One important area in this sector where computers could play a vital role is in the health care delivery services. The health care service is characterized
among others, by inadequate number of personnel and infrastructural facilities to cope with the ever increasing demand. This discussion would be necessarily restricted to the potential use of computers for electrocardiography, diagnosis and patient monitoring.

A computerized electrocardiograph system essentially involves the automation of the manual procedures, measurement of various ECG (Electrocardiogram) wave form parameters and the selection of an interpretation by applying empirical decision rules developed by those who designed and wrote the computer programs. comparative results indicate that there is (80 - 90)%
agreement between computerized electro-cardiogram analysis and the analysis by cardiologists. Computer cardiogram analysis could however be performed in less than 1/3 the time required by cardiologists. Moreover, the computer method offers less cost per unit cardio-
graph for the patient than the manually

interpreted ones. The use of computers by cardiologists would therefore enhance their productivity and this could equally help to improve clinical outcomes.

As regards computer diagnosis, developments in computer science and decision theory have made it possible to produce programs that can accept clinical data and effectively supplement or sometimes supplant the doctor's intellectual inputs to suggest tests, diagnosis or treatments. These programs which could be combined with a data bank that stores medical records and accepts results of laboratory tests and diagnostic procedures directly from a mini-computer that control laboratory equipment could be of much value in a developing economy with insufficient number of doctors. However, the present state of art of computing in the country precludes the immediate possibility of applying computer diagnosis. It could become a technically viable addition to the national health care delivery system in the future.

The monitoring of physiological variables in intensive care units is one area where computers can help improve clinical outcomes. The computer could automatically sample the many physiological variables from a patient by means of a transducer attached to the patient. Other data such as medical orders, progress notes and laboratory test results could be manually keyed to terminals by teChnicians, doctors or nurses. The computerized patient monitoring system then measures the patient's physiological state and checks for trends and variables outside acceptable limits and may warn the intensive care unit staff to intervene before a problem attains a crisis point. Computing power could thus contribute to the enhancement of the nation’s health or it's wealth when measured in human terms.

Water resources management and planning is an area of the services sector that has evidenced suboptioamal performance. The near chaotic water situation in some large cities of Nigeria does suggest the weakness of conventional projections and estimates on water consumption and demand patterns. A plausible solution approach lies in the formulation of mathematical models for water resources management and conservation. The suboptimal performance of this subsector partially derives from the lack of models for the demand pattern and this of course assumes the non-existence of models for intra urban population dynamics and the related impact of water demand. As a consequence, the resources in this subsector are continually overstretched. However, the planning, management and conservation of water resources in a given city could be modelled and a dynamic solution to the various possible mathematical formulations could be obtained by computer methods. An optimal trade-off between the resources and demand parameters could be found which would offer an effective solution to the water problem of a large city. A solution to the water problem would inevitably enhance performance in these establishments and institutions in various sectors in which water constitutes a basic input.

The apparent inadequacy of energy inputs as regards electricity supply has been a cause of concern in several sectors of the economy. The growing Nigerian economy has been experiencing an explosive demand for electricity for the past decade. It is natural to expect that there is a basic need for effective planning to forecast the future load and demand on the national electric network. It has to be admitted [6] that the National Electric Power Authority (NEPA) does produce on an annual basis, a forecast of electric load covering a period of ten years in the future as well as a five year forecast to aid generation planning and financial forecasting. The following Table 1 (6] portrays the level of demand on NEPA over the given time period while Table 2 [7] indicates the nature of efforts being made by NEPA to contain the growing demands.

	31st march1973	31st march 1980	Increases%
Generation Capacity mw	500	2,000	300
Energy Generating GWH	2,211	6,434	191
Energy Sales GWH	1,752	6,733	227
Maximum Demand MW	407	1,181	190
Number of Consumers	338,313	964,984	185

Table 1: Generating and Demand Statistics

Power station	Out put
Afam iv	450 MW
Sapelle	300 MW
Shiroro	600 MW
jebba	540 MW

Table2: new power stations under construction.

The above Tables suggest that NEPA is aware of its basic problem and there is a genuine effort to contain the problem. The exceptionally high increase in the number of consumers and power demand given in Table 1 and the efforts on the part of NEPA reflected in Table 2 cannot offer an effective solution on the long term. It is imperative that the planning strategies of NEPA need serious re-examination if its effectiveness to the growth of the economy is to be enhanced and if its public image is to be improved especially in the future. There is a strong need for extensive use of numerical models to handle NEPA's planning and projections. Computer methods would therefore not only aid the enhancing of NEPA's planning capability but would help eliminate the delays inherent in its Bills, distribution departments.

3.2 Commercial and Financial Subsector.

Part of the stagnation which is found in this subsector, especially in the banking institutions stems from delays involved in the handling of large volumes of information and transactions by manual or semi-mechanical based operations and procedures. Several routine manual based operations and file handlings could be very conveniently handled by the computer. This would not only greatly improve the throughput in this sector but also influence the quality of its output. A good number of establishments and institutions in the commercial and financial sectors are becoming computerized in the country. It is hoped that the trend would continue and this would later produce a net spill-over effect on the entire economy that would result in higher productivity per unit time.

3.3 Transport Subsector

The role of computers in some areas of the transport subsector has recently gained acceptance in the country. The improved schedulling and cargo handling operations of the N.P.A. (Nigerian Ports Authority)in some of the Nigerian ports and the improved reservation mechanism in use in the Nigerian Airways all bear testimony to

the significance of the use of computing power in optimizing economic throughput in this sector of the economy.

3.4 Industrial Subsector

The potential impact of the application of computer techniques to the problems of growing industries is partly examined in relation to developing economies and is discussed in OKEKE [5] .

3.5 Educational Subsector.

It would be structurally and economically unfeasible for many developing nations to invest entirely in original research and so the possible contribution of original research within such economies would be minimal. However, since there is a need to develop technical awareness and thus establish a technological base, the developing nations need to emphasize at the present on technical adaptations. To do this, a developing nation needs to develop the ability to analyse the concepts embodied in borrowed techniques and processes and the reformulation of such concepts in terms compatible with their environment. For adaptation of designs of sophisticated techniques, the computer would not
Only be an invaluable tool but would be the only feasible option when viewed in relation to the fact of infrastructural and structural deficiencies of
the developing countries. Computer simulations would make it possible to predict the result of different
design decisions while the actual experiments could only be used to validate the resulting predictions. Computer based research has therefore a strong cost-saving implication and should be a 'sine qua non' for a developing economy that aspires for technological transition into a modern economy.

4. CONCLUSION

The constraints of a developing economy dictate that a central network topology would be an effective answer to the demand for computing power in the Nigerian economy. The increasing acceptance of computing power in the commercial, financial and some areas of the transport subsectors reflects a growing recognition of the role of computing power in enhancing the throughput and effecting techno-social changes in these sectors. Several areas in the services, educational and industrial subsectors of the economy now embody growing technological imperatives and the desire for greater quantification and precise measurements. The introduction of computing *power* in the economy via a network would reinforce this trend.

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