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通信制御向け診断・保守のための知識ベースシステム

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本論文は、通信システムのネットワーク構成コンポーネント内に、人工知能に基づくソフトウェア工学技術として、エキスパートシステム手法を導入することにより、ＣＣＭＯ（Ｃｅｎｔｅｒ　Ｃｏｎｔｒｏｌ　Ｍａｉｎｔｅｎａｎｃｅ　Ｏｆｆｉｃｅ）及びスイッチングシステム内で知的情報の並列化処理を実現することについて述べている。特にそのためのハードウェア／ソフトウェアとして先端的アーキテクチャをもつトランスピュータ／ｏｃｃａｍ言語を活用して、その実現構想を進めているところである。これにより、これまでの通信ネットワークに関する故障検出・保守技術や過密なトラフィック量の制御技術等の諸課題を効率よく解決すること及び、通信ネットワーク上で効果的に診断支援を実現することとを目指している。

A Knowledge-Base System in Center Switching Maintenance Office

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This paper describes to introduce expert systems technology in the network component of the Telecommunication systems using AI based software techniques with transputer and its own language program(OCCAM) to establish high parallel communication links between expert system in the Center Control Maintenance Office(CCMO) and switching systems.Our aim is to efficiently improve the maintenance,fault detection,manipulate the traffic congestion,and to aid in diagnosing network problem.

I . Introduction

Telecommunication networks in our century have developed different structures , in response to particular needs and seeds for potential future growth. It is become more complex systems and difficult to provide good maintenance service in a reasonable cost (Shimasaki). Some of the problems domain in Telecommunication Which are needed to investigate are Telephone Switch in the Rural area.

A Rural area now are recognizing the need for better and quicker development of their communication infrastructures.

A major handicap , and one of the reasons for this development delay is the absence of qualified local staffs. Qualified staff are usually unable to manage and maintain the critical telecommunication equipment.Those people who prefer to stay in urban centers rather than to expatriate themselves uncomfortable areas. Also, in some cases,such qualified,and consequently expensive,staffs may not be able to reach their potential in a rural area. (Bernard 85) .

A Rural Switching System (*RSS*) composed of relatively small switching systems distributed over a large geographic area.This systems can be controlled remotely from *center control maintenance office(CCMO)* which is located in urban area, figure(1) Each of these systems serves an area of low subscribers density giving rise to high Subscriber plant cost. Maintenance and administration costs are high and rising at a fast rate (Alex 81) . Expert system for this environment will offer significant savings in maintenance and administration and ultimately result in better telephone service at a reasonable cost(Michael 76).

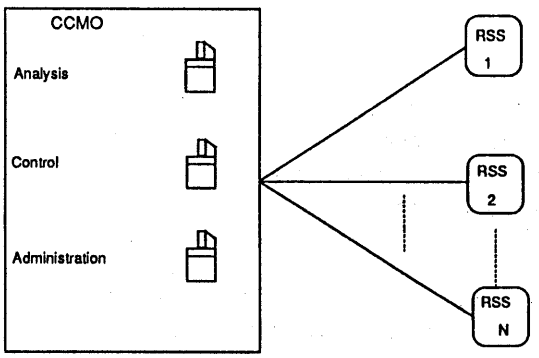

Figure 1.. Experts in CCMO

II. Center Control Maintenance Office(CCMO) background :

Center control maintenance office (CCMO) encompasses the actions of control,supervision,electronic package repairing,maintaining,and managing a telecommunication network.(see figure 2)

In order to enhance the actions described above,we need to find a solution in many problems in CCMO,some examples of our needs are follows:

(1) Need to establish Parallel mechanism links to control many switching systems at the same time in order to avoid the loses in the information messages which are sent to the center control maintenance office.

(2).To manipulate unforeseen problems,such noisy or incomplete data.

(3).To improve maintainability for diagnoses switching program to be as self_ diagnosing as possible..

(4) To supervise and control the traffic congestions, which has often occurred on the telephone network . Such traffic congestion is mainly caused by extremely large traffic terminating to specific area (*area congestion*) or specific subscribers (*subscriber congestion*) in the network . (Asaji 79)

(5). To administrate the functions these include recent change , traffic data administration, network and switch management automatic accounting(Michael) and charge bill counting.

(6). To enhance the operation test for digital electronic circuits .

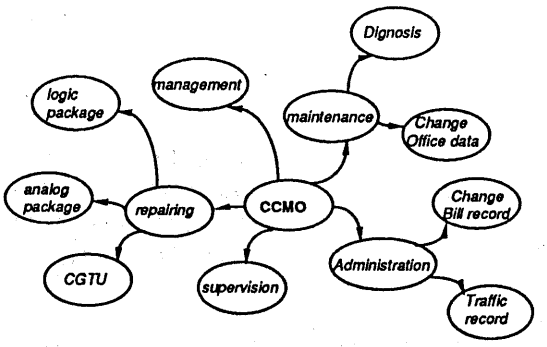

Figure 2. The actions in CCMO

III . EXPERT SYSTEM COMPROMISE THE PROBLEMS

In order to maintain high_quality service, it is necessary to keep pace with changing technology in Telecommunication environment,these techniques covered are knowledge_based or "Expert" systems. This expert systems technology represents an appropriate set of tools for capturing the knowledge needed to define requirements for CCMO (Fox 88) .

An expert system is a rule_based AI application program for doing a task which requires expertise or better classified as a problem_solving software that embodies specialized knowledge in a narrow task domain (Charniak 85) .

This area of AI has concentrated on the construction of high_performance programs in specialized professional domain , which consist of knowledge about a particular domain, understanding of domain problems and skill at solving some of these problems (Hayes 83) .It can help achieve to solve the problems by improving the maintenance for switching system from center control switching maintenance(*CCMO*) as problems domain in our Expert system, and to control using monitoring results to make changes in the network to maintain or increase performance, control actions may include rerouting,diagnosis,and repairing .

In the past decade ,much progress has been made in the development of practical expert systems for telecommunication,some of this experts listed in the table below

Table..... Expert system for switch maintenance , Diagnosis , and Repairing

System	Company	Description
ACE	AT&T Bell	Automated Cable Expertise_Inter cable trouble reports (Vickers 86)
ESTA	AT&T Bell	Expert System for trouble Analyzes trunk outage code (Khan 87)
SMART	Bell Comm.	Switching Maintenance and Repair Tool. (Sutter 86)
MAD	Bell_North.	Maintenance Advisor DMS family of switches (Bult 87)
COMPASS	GTE Lab.	Central Office maintenance for GTE No.2 EAX switch (Prerau 85)
NEMESYS	GTE Lab.	Maintenance for GTE5 . EAX switching system (Macleich 86)

IV. A KNOWLEDGE REPRESENTATION

The knowledge representation techniques involve routines for manipulating specialized data structures to make intelligent inferences .

There are several knowledge representation in the expert system application for e.g. Logic Model(Robinson 84) ,Frame Model (Minsky 75), Procedural Model (Kochan 83) , and Production Model (Brownston 85) Etc. .

These models have been developed to solve different problems ..Also use a procedural language model for representing the knowledge with procedural properties .In this Expert its better to represent the knowledge partly in a production model and partly in a procedural programming model.We use model_based methods design descriptions,such as the structure and behavior descriptions. to represent knowledge for electronic package repairing in the repairing part for *CCMO* (Davis 83),(Naseem 88).Structural interconnectivity is represented by various pointers stored in *Frame models* whereas behavior is expressed in procedural programming model .In the circuit domain, the behavior of each component is modeled as a set of constraints,for example ,in analyzing analog circuits the Cells represent circuit voltages and currents,the values are numbers,and the constraints are mathematical equations.In digital circuits, the Cell represent logic levels, the values are 0 and 1,and the constraints are Boolean equation(De Kleer 87).In a production properties we can simulation the production model by other language such C or OCCAM language to represent the knowledge for switching system's diagnosis(RSS) . The reason for this we used in our design transputer based and its own language program *OCCAM* to establish parallel communication links between expert system and Rural Switching Systems *RSS* ,and between the expert system components for parallel Inference implementation,this programming also allowed to invoke the user defined function written in the programming language C or Pascal or other stander languages.In our design we use OCCAM programming language as a harness to link modules written in the select languages (INMOS 88).

V . EXPERT SYSTEM ARCHITECTURE.

This section describe an expert system architecture used in the center control maintenance. Figure 3. shows this architecture.In the following , we describe each component in this figure .

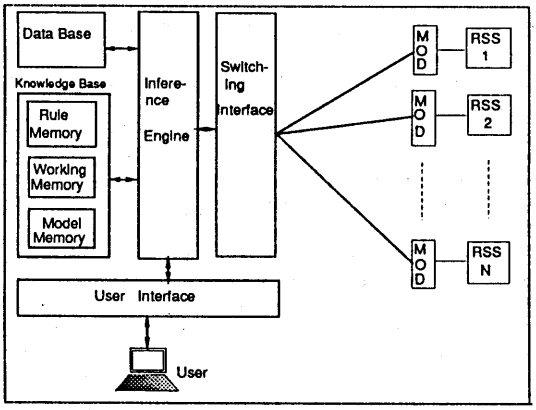

Figure 3. Expert System prototype for CCMO

A. A KNOWLEDGE BASE

A knowledge base comprising facts as well as problem_solving rule and consists of three memories Rule memory , work memory,and model memory,as fellow:

1. Rule Memory

This memory contain a set of production rules in the Production model and composed a set of IF _ THEN rule called productions.The left_hand side(LHS) of the rule is the condition part which describes the data configuration for which the rule is a propriate.The right_hand side(RHS) is the action part of the rule which gives instructions for changing the data configuration.(Brownston 85),(Zhang 88).

This rules represent compution relationships among facts.IF _ THEN rules used as input and uses forward and backward chaining to draw inferences from these rules in light of available data . An example of a rule is the following .

IF Line circuit LC0 indicated fault ,
AND Line circuit LC1 indicated fault ,
AND Line circuit LC2 indicated fault ,
AND Line circuit LC3 indicated fault ,
AND no fault indicated in Codec circuit .

THEN Line circuit switch (LSW) is implicated as the source of failure .

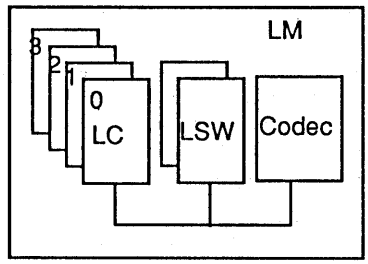

Figure 3.a Line Module (LM) in switching system

This example of the rules for Subscriber Module problems (LC is the Line circuit of subscriber) .

The IF part of the rule is known as premise , which is a logical combination of functions operating on facts .The THEN part of the rule is known as the action , which is a sequence of functions with such side effects as asserting a value for a fact or initiating a user interaction(Symonds 86).

2.Working Memory

The working memory stores the current state of knowledge during the problem _ solving process by holding symbols that represent facts about the domain and the problem solver's strategies and goals. The contents of working memory is compared with premise part of the rules , and matching rules to become candidates for execution(Takahashi 88) .

3.Model Memory

In the repairing section for CCMO we used models (Structure and behavior) to represent knowledge of fault in the electronic package devices.This models are using simulation rules and inference rules to capture the knowledge of behavior, and functional organization to describe the knowledge of structure , see figure 4.

Simulation rules that represent flow of electricity(digital behavior),and Inference rules representing flow of inference(conclusion we can make about the device),(Davis 84).

The components of electronic devices have been represented using *Frames*.

A *frame* is a data structure that includes declarative and procedural information redefined internal relations .

The structural is represented by various pointers stored in Frames. In case of behavior is represented in procedural rules. The reason for this because the model_based representation of digital electronic device is more compact than a production rule_based

representation.

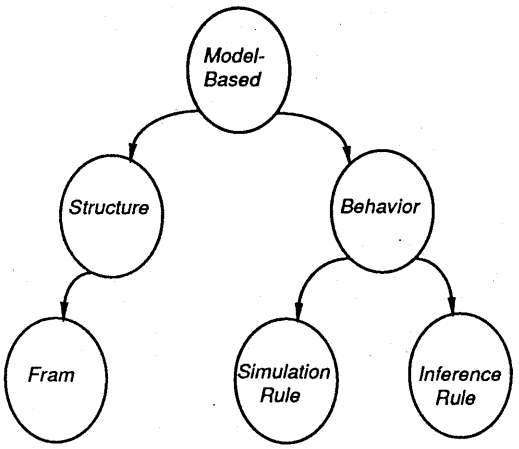

Figure 4. Represantation in Model_ Based

B. DATABASE : Database comprise many memories , for e.g. command , parameters , alarm , trouble history memory , as well as Data management and Data collection . The data used in the process of inference are store in the database .figure 5 .

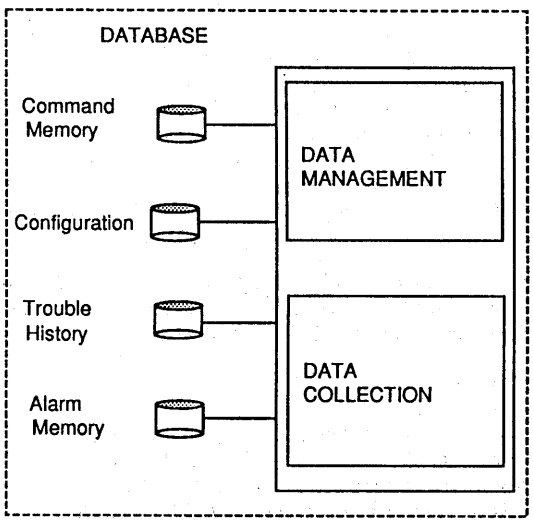

Figure 5 ..Database of Expert System for CCMO

C. USER INTERFACE

The user interface assists interactions between users and the system , and allows the users to monitor and interrogate the reasoning process of the system.

D. INFERENCE ENGINE

Inference engine is a program which determines how to apply knowledge contained in a knowledge base to current facts and premises described in working memory in order to infer new data (Robert 88) .
The rule -base reasoning systems are either forward chaining (evidence directed) or backward chaining (goal directed) . In forward chaining systems reasoning begins with evidence of hand attempting to reach a hypothesis by testing the validity of IF conditions against known facts to produce conclusions from the THEN clauses . Backward chaining systems hypothesize a solution and attempt to prove it by satisfying the solution 's IF conditions (Macleish 86) .
In the Center Control Maintenance Office *CCMO* need to control many Rural Switching System *RSS* in the same time , this required to built parallel inference machines to achieve high performance then infer the rules at high speed .
Also required to built high level parallel languages to express parallelism such parallel C language and OCCAM to handle heavy computation , data interpretation and communication .

VI.TRANSPUTER IMPLEMENT FOR PARALLEL INFERENCE MECHANISM

The transputer provides a direct implementation for parallel inference machines by increasing the amount of processing , memory , communications and concurrency within the same architecture (INMOS).
The parallelism offered by multiprocessor systems , built from transputer . The transputer is capable of providing both SIMD and MIMD type processing and which can be used for the realization of a range of reasoning processing (Morrow 88) . See figure 4

1. TRANSPUTER ARCHITECTURE

Transputer is a microcomputer with its own local memory and with links for connecting one transputer to another transputer .
The transputer architecture defines a family of programmable VLSI components . The transputer product family is a single chip containing processor , memory , and communication links which provide

point to point connection between transputer. And each transputer product contains special circuitry and interfaces adapting it to a particular use . Transputer can be used in a single processor system or in networks to build high performance concurrent systems .

2 . PROGRAMMING

The parallel construct is unique to *OCCAM* . It provides a straight forwarded way of writing programs which directly reflects the concurrency inherent in real systems . *OCCAM* can be used as a harness to link modules written in the selected languages ,for example we can represent the Rules in the knowledge base in *C* language or other languages and process this rules in the transputer driving by *OCCAM* programming language (Joachim 87) .OCCAM can be used to program an individual transputer or to program a network of transputer . When OCCAM is used to program an individual transputer, the transputer shares its time between the concurrent processes and channel communication is implemented by moving data within the memory . When OCCAM is used to program a network of transputer each transputer executes the process allocated to it .

3 . COMMUNICATION

The key concept is that communication is synchronized and unbuffered . If a channel is used for input in one process , and output in another , communication takes place when both processes are ready , the value to be output is copied from the outputting process to the inputting process , and the inputting and outputting processes then proceed see figure 6 . A link between two transputer is implemented by connecting a link interface . This requires a simple protocol , each signal line carries data and control information .

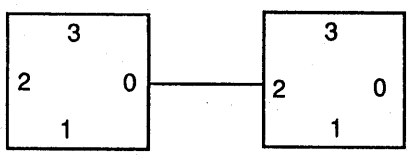

Figure 6. Two linked transputers

```
CHAN OF INT Link :
PLACE PAR
   PROCESSOR 0
      PLACE Link AT Linkout0 :
      WHILE TRUE
         SEQ
            Link ! message

   PROCESSOR 1
      PLACE Link AT Linkin2 :
      WHILE TRUE
         SEQ
            Link ? message
```

VII. NETWORK DESIGN

The design are composed on three stages.In first stage of the component consist groups of IMS C004 crossbar switch , to establish high speed communication links between Rural switching systems *RSS* and Expert system .IMS C004 is a transparent programmable link switch designed to provide a full crossbar switch between 32 link inputs and 32 link outputs. The IMS C004 can switch links running at either the standard speed of 10 Mbits/sec or at the high speed of 20 Mbit/sec .This group act as multiplexing and Demultiplexing the channels from/to RSS.

In the second stage the network is a rectangular array of 3 x 16 transputer (figure 8), each of which is a T414 with no external support chips . The memory for each transputer is limited to the 2 kbytes of on-chip, but we can increase the capacity of the memory for each transputer with 256 kbytes of fast external RAM In third stage is IMS C004 crossbar to establish parallel communication links between second stage and knowledge base.Each IMS C004 in the system design is controlled from an IMS T212 16 _ bit transputer via the configuration links(configLinkIn,configlinkOut). In this two channels are place on each IMS C004 link in opposite directions ,the protocol tokens for this channels could be implemented using Hoar's CSP(Hoare 78) as follow:

Protocol tokens are prefixed by ct. for IMSC004 to (configlinkIn=C.in) and eta. for exchange tokens from (configlinkOut=C.out) (INMOS 89).

```
C = c.in ? token
  → case
token= ct.input.output          (SET.IN.OUT)
token= ct.link                  (SET.LINK)
token= ct.enquire               (ENQUIRE)
token= ct.disconnect.output     (DISCO.OUTPUT)
token= ct.disconnect.link       (DISCONNE.LINK)
token= ct.reset          (RESET)
token= ct.setup                 C
```

```
        esac
CONTROLLER= C.out ? token
                  →case
token=eta.act          (C.out?any,any→
                              CONTROLLER)
token=eta.req.         (DEAL.WITH.REQ)
token=eta.rel.         (SET.LINK.OR.SEND.NEW.
                        RELEASE
esac
```

VIII . EXAMPLE

The following example illustrates the use of concurrency in the exploitation of the multitransputers . The expert system receive the message from one of the Rural switching systems ,Repairing center,or user ,see figure 7 for example the message received from RSS ,to analysis message routine therefore involves:

1.establish communication link between RSS and the transputer group.

2.identify the message received such trouble,traffic,or charge bill.

3.classify the trouble in one of the module(CC,SPM,MM,LM,etc.)

4.in the same time expert will send message to the user.

5.establish communication link between transputer and knowledge -base.

6.infer the rules which are related to the message received.

7.execute the rules this include change data in the data base or send command to RSS and knows the user about the kind of the trouble.

---- MESSAGE ----

(LC 1 _ LOCKOUT)
(LC 2 _ LOCKOUT)
(LC 3 _ LOCKOUT)

----END OF MESSAGE ----

The expert system will interpret this message to program and store in the work memory and will begin to matching this information with the rules memory in the knowledge base , selection and execution the rules Which are satisfied by current contents of working memory Infer the rules and send message to the display terminal or user.

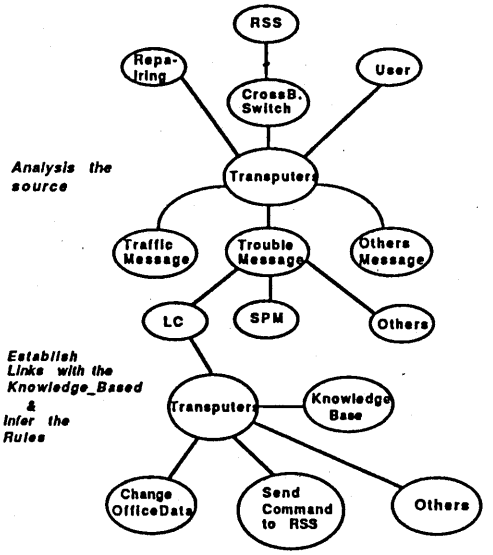

Figure 7. ...An Example of the Expert System's Diagnosis for the line circuit (LC)in RSS

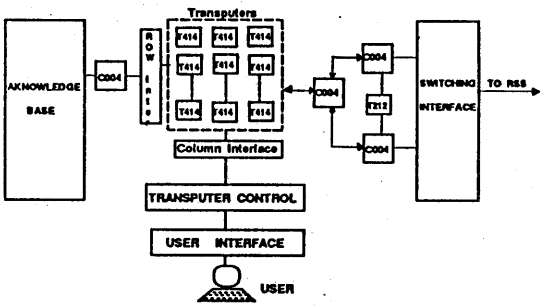

Figure 8.—The internal archiecture for Expert System in CCMO

IX. CONCLUSIONS

Today's networks are becoming more complex ,we need better operations, administration and maintenance tools at their disposal.

This expert can help achieve to solve the problems by improving the maintenance for switching system from center control switching maintenance(*CCMO*) , and maintenance in a packet_ switching network.

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