# MANAGEMENT OF ELECTRICAL POWER CONSUMPTION USING NETWORK PROCESSOR

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## Abstract

Providing electrical power in developing countries is something hard to do for many reasons that could be financial, technical and even the lack of raw materials. Therefore, the need for new technique for fairly power distribution is more attractive. From this an idea comes to make new sophisticated distributed network system which controls power consumption for the given inhibited area. The system should give a certain amount of power for each consumer .When the consumer reaches his limit the system will take an action to increase the limit if power is available or disconnect the overloaded consumer for a specified time. the present work is devoted to design a system which has an ability of controlling the power consumption by using network processor.the designed overall system is fulfilled through four distinct stages; each stage has a predefined job. The four stages communicate with each other using TCP/IP protocols suit. Therefore, a TCP/IP stack should be available at each stage.

**Keywords:** Management of Electrical Power Consumption, Monitoring of Power Consumption, Controlling of Power Consumption Using Network Processor.

# أدارة استهلاك الطاقة الكهربائية باستخدام معالج الشبكة

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## الخلاصة

إن تجهيز الطاقة الكهربائية في الدول النامية يواجهه صعوبات متعددة ، قد تكون اقتصادية أو تقنية أو نقص في المواد الأولية ، لهذا السبب ظهرت الحاجة إلى تقنية جديدة تضمن التوزيع العادل للطاقة . من هنا جاءت الفكرة إلى شبكة توزيع جديدة تضمن السيطرة على توزيع القدرة بصورة عادلة لجميع المشتركين . هذه الشبكة تعطي كمية محددة من الطاقة لكل مشترك ، وعندما يتجاوز المشترك الكمية المحددة له يجب على النظام إن يتخذ إجراء معين قد يكون إعطاء المشترك كمية اكبر من الطاقة إذا كان بالإمكان ذلك أو فصل الطاقة عن هذا المشترك فترة زمنية محددة.إن العمل الحالي مكرس لتصميم نظام له القابلية على السيطرة على استهلاك الطاقة الكهربائية باستخدام معالج الشبكة.

تم تنفيذ العمل من خلال أربع محطات ، كل محطة لها وظيفة معينة ، وتتصل المحطات فيما بينها بواسطة بروتوكول TCP/IP .

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## 1 –Introduction

The network processor industry is still at an early stage. Most of the network processors have been recently started of shipping production quantities, and only a few shipping products use network processors. Nevertheless, for developers of networking devices, network processors might be the fastest platform for the next-generation products.

Network processors provide an environment where real applications and protocols are subjected to an emulated networks consisting of resources such as links, routers and background traffic. Each of such network resources is either real or emulated. [1, 2] Network processors usually mean programmable processors that are used in network devices. Because of their programmability, they can be used in many applications, just by changing the software.

In this work, the network processor is used to control the power consumption. The work guarantees fairly power distribution to all subscription users.

The controlling of power consumption is completely limits the programmable interruption of electrical power, since the higher demand of power makes the generation systems incapable of responding to it.

## 2- System Design

The suggested system for electrical power consumption control using network processor is designed by four linked units as shown in fig (1).

In the design, the consumer is connected to the main unit (station D) via three station units (A, B, and C).

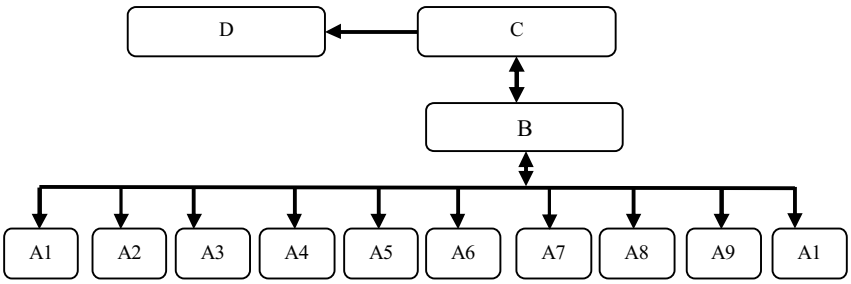



**Fig. (1) System Design**

Each consumer unit contains one A station to measure and control the current consumption, and on each power transformer there is one B station to limit the current consumption for each consumer unit (A) also to send the information back to the C station, which is placed in power station center to calculate the total power available, also there is D station to store the consumption for each consumer unit so its database station.

## 3 - System Description

The following text describes each station in fig (1) theoretically, as moving form station D to station A.

## 3.1-Database Station (D)

Station D is the less complex Station compared with the other three stations,

It is a computer with Microsoft SQL Server installed to record the consumption information that received from C station [3].

A sample of forwarding information to station D is shown in table (1)

**Table (1) shows sample of forwarded information to station D.**

| ID | IP Address | Current Consumption | Date and Time |
|---|---|---|---|
| 1 | 192.168.0.1 | 40 | 2007 June 26 12:00 Am |
| 2 | 192.168.0.2 | 22 | 2007 June 26 12:01 Am |
| 3 | 192.168.0.4 | 27 | 2007 June 26 12:01 Am |

The ID filed shows the number of records that has received from the C station, and the IP Address field represents the address of consumer unit (A).

Each consumer unit has unique IP address to be identified, the current consumption filed shows the value of current consumption for each consumer unit, while the date and time field show the time that the records taken.

This information stored in station D computer, so the monitoring team can know the peak consumption time also the information can be useful to know the higher consumption area and other developing purpose.

## 3.2- Main Station (C)

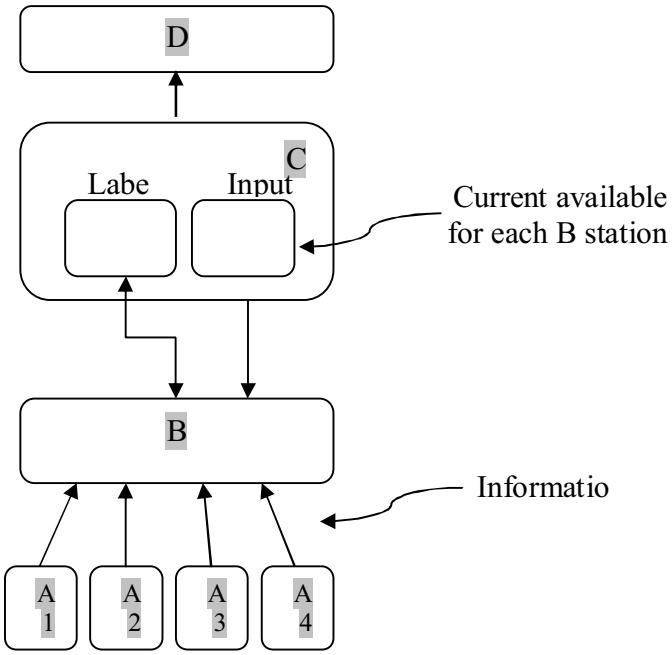
Station C is a computer containing GUI program (programmed by Visual Studio 2005). The GUI program contain labels to show the consumption information that received from B stations, also contains input boxes to enter available current for each B station as showing in fig(2) ,(there is probability to give equal current for all B stations or a special current for each one). So the GUI is used to collect the information from B stations and gives the available current to each B station, also station C sends the current consumption that is received from all B stations to the D station to store as database.

There is no limitation to use a specified operating system ,only the operating system must be produced by Microsoft and professional to support the dot net technology like Microsoft Windows 2000SP4 Pro or Microsoft Windows XP SP2 pro[4].

## 3.3- Station (B)

Station B is the most complex one compared with the other three stations .Fig (3) shows the way of connecting the network processor with station B and the other stations in the power network (station A , C and D ). Where the part in Fig.(3) encinctured by the dotted line illustrates the network processor with its necessary parts as the memory , operating system , and a special for the power network .

While, the part outside the dotted line in Fig (3) illustrates the ability of monitoring the network processor from far away. This gives an ability of monitoring stations B from any internet place. Therefore, Fig (3) shows an overall block diagram of the station, when station B is the first station in the sequence containing Network Processor.




**Fig(2) Station C label and Input Box**

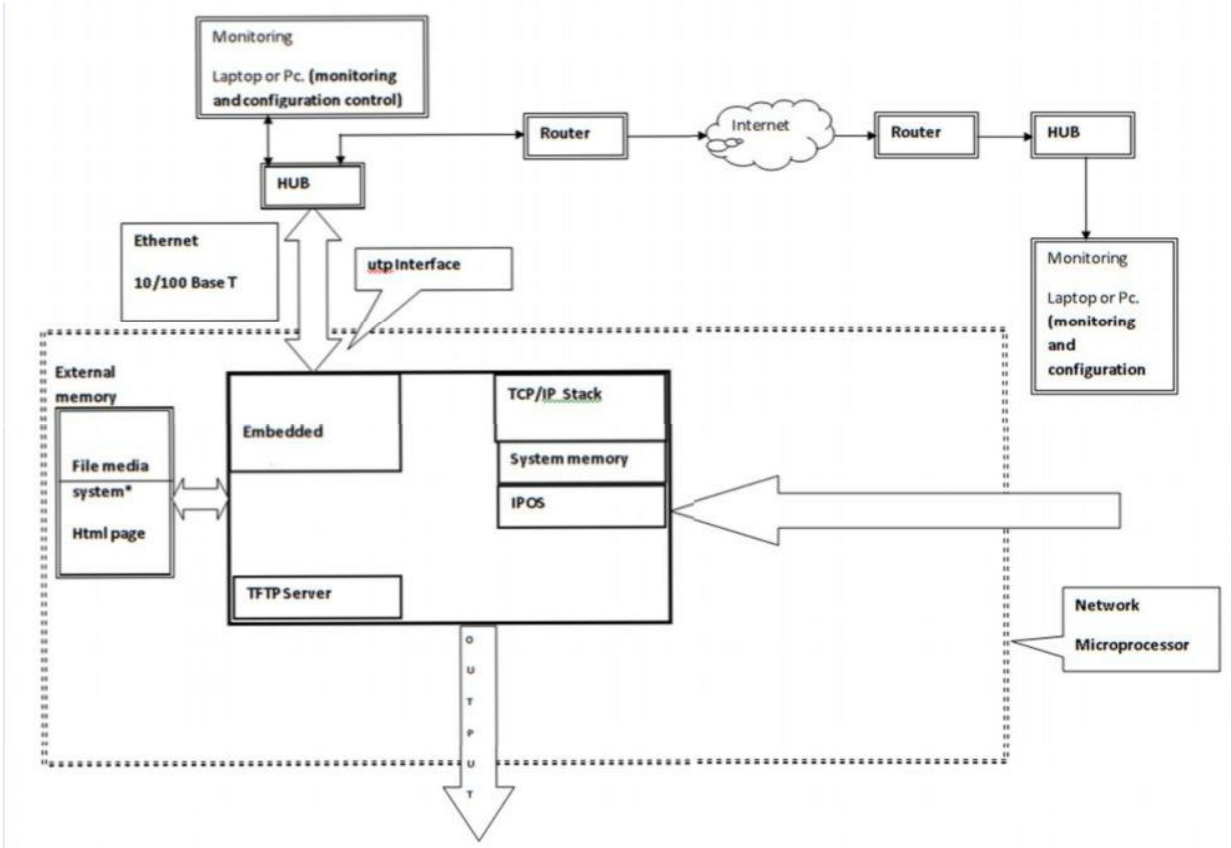



**Fig (3). Station B Layout**

The network processor is the core of the system and the decision maker; it is programmed to do the jobs without any need to human interruption. ANCI C language used to program the processor.

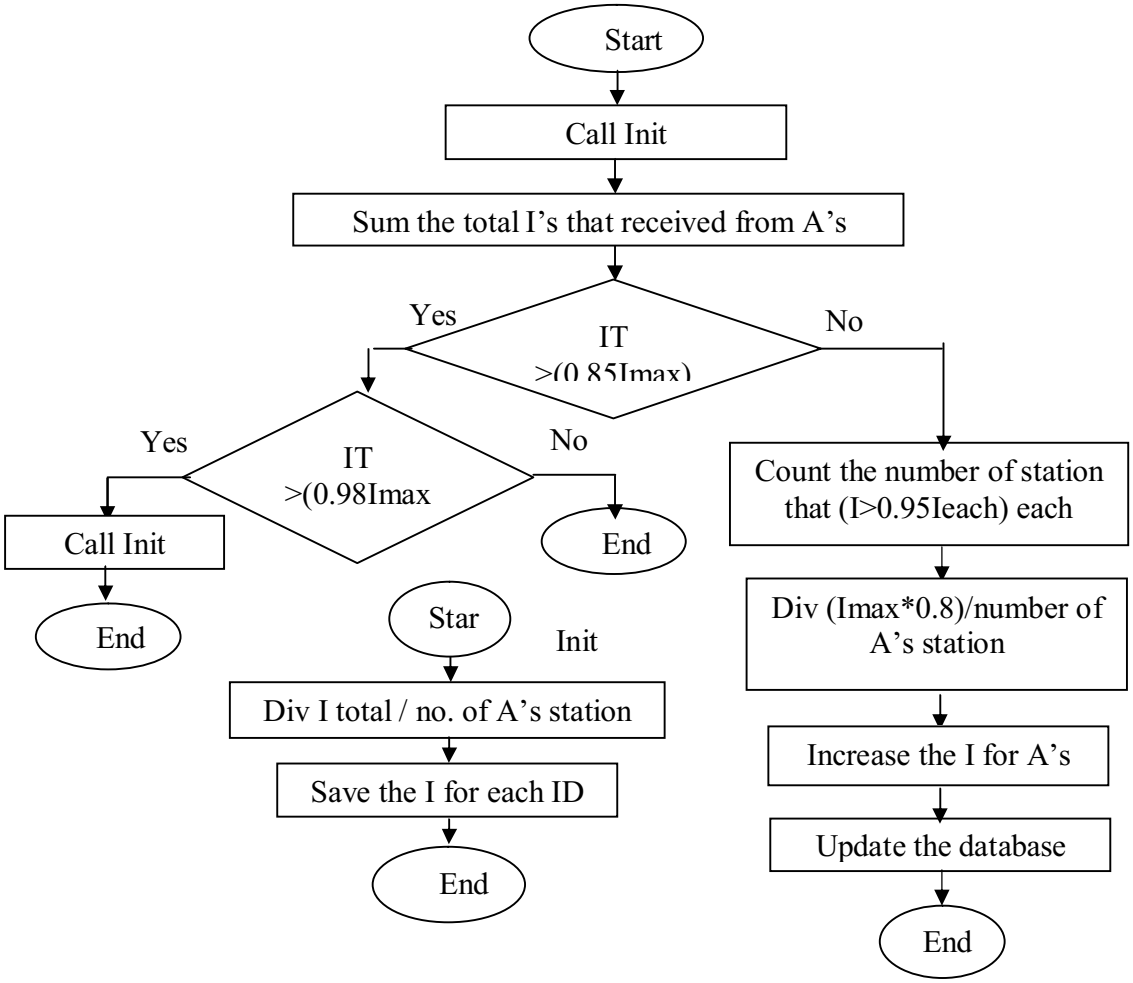
At the start , station B needs to know his clients (consumer unit A), the addition of clients to the station is done by login to the station and adding the IP Address for each client , so that three web pages are made in station B network processor:

1. Login page (for security access).
2. Add clients page (for add clients).
3. Set credential page (for changing the username and password of the station).

Also station B needs to know the station C IP Address, to send the consumption value and takes the available current.

After adding clients to station B and identify station C IP address, station B will immediately communicate with station C to know the available current for it.

When the station know the available current it will divide this current by the number of consumer unit (A) and send this value for consumer unit connected. Station B is programmed by the algorithm shown in fig (4).




**Fig(4).Station B program algorithm.**

The program uses the following features in the processor:

1- Embedded Web Server

The processor has a built in Web Server (Embedded Web Server) the server provides WebPages hosting (htm or html) format; administrator can access the station from anywhere in the local network by the station IP address (each B station has an IP address). There are three WebPages made for login and for adding clients and for setting the username and password.

2- Common Gateway Interface (CGI)

Common Gateway Interface is one method by which a web server can obtain data from (or send data to) databases, documents, and other programs, and presents that data to viewers via the web. More simply, a CGI is a program intended to be run on the web.

## 3.4- Consumer Unit Station (A)

The location of station A,[6] is in each consumer unit (i.e. House) , which is mounted beside the circuit breaker; station A also contains a network processor with interface circuit to read the value of the current consumption to send it to station B that is connected with it.

Station A also contains alarm system (buzzer) to alarm the user when the consumption reaches the given value. When the consumption reaches the given value for a given time, station A will automatically cutoff the power for this user. After the limited time station A will automatically reconnect the user.

## 4. Security of the System

The system contains security for the transmitted information between stations A and B, B and C .The security used in the system depends on the signature, the packet transmitted between the stations contains secure signature, so that the sending station puts the secure signature on the packet and the receiving station checks the signature if it does not match the station it will drop that packet.

The system does not depend on the encryption of the information between the stations because it's a very complicated work since everyday there are new algorithms for encryption and decryption of the information.

The amount of given time is between two and three minutes to give enough time to the user to limit his consumption and turn off some devices.

## 5. Installation and Operation

This text is usually devoted to tackles the actual implementation of controlling the power consumption using network processor prototype.

The implementation of network processor for power consumption control as shown in fig (5) passes through the following practical installation and setting steps for the stations D to A:

## 5.1-Station D Installation and Setting

Station D usually contains the following parts for power control process:

1-Microsoft Windows Server 2003 Enterprise Edition.

2- SQL Server 2005 Enterprise Edition.

After the SQL Server is installed the main database file is created. The name of the main database is master and the name of table is User_Consumption.

This table contains the following records as shown in Fig. (6)

1- IP address
2- Amount of Current
3- Date and Time
4- Notes

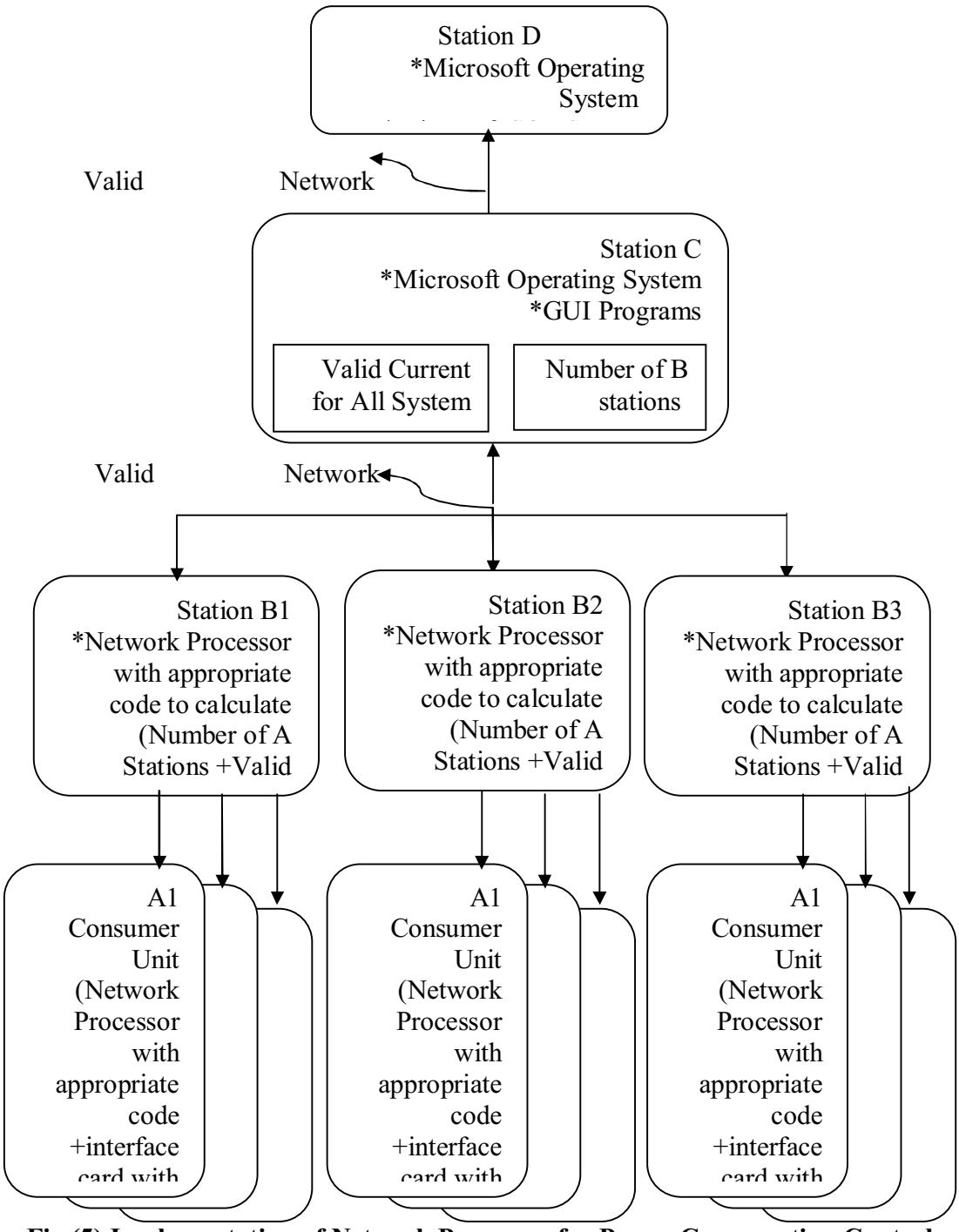



**Fig (5) Implementation of Network Processor for Power Consumption Control**

## 5.2-Station C Installation and Setting

The operating system for station C is the Windows XPSP2 (Service Pack 2) which used with a program contains GUI (Graphical User Interface) programmed by Visual Studio 2005 to help the station administrator to manage the station smoothly as given in Fig. (7), The Add Station button is used to add B station, after adding all B stations, the administrator can select any station that entered previously and enter the total current available and the number of B stations as shown boxes of fig(7).

The administrator can now push the start button to send the available current to selected B station and start listen to it.

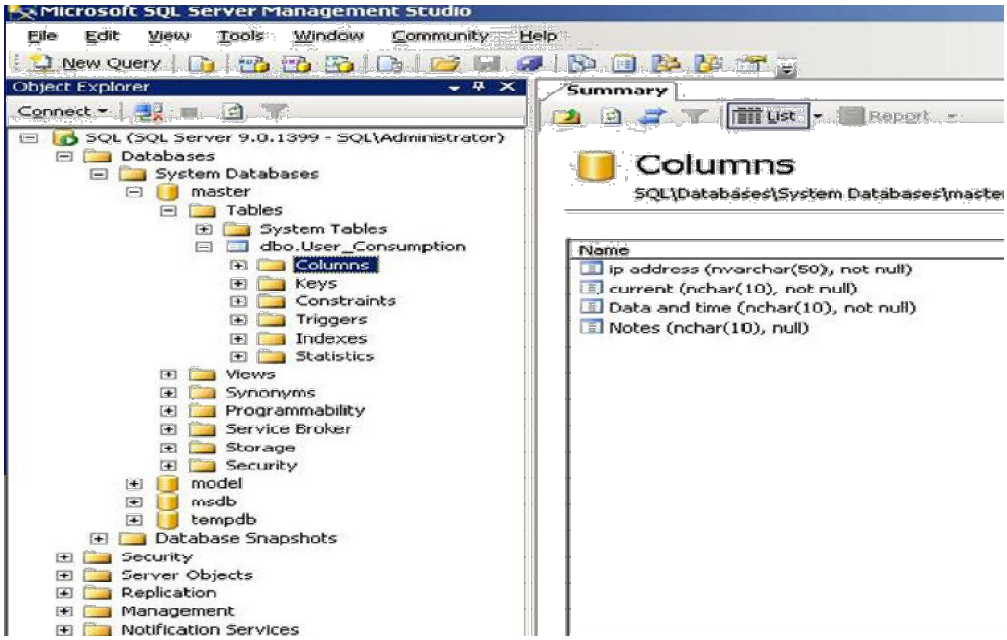
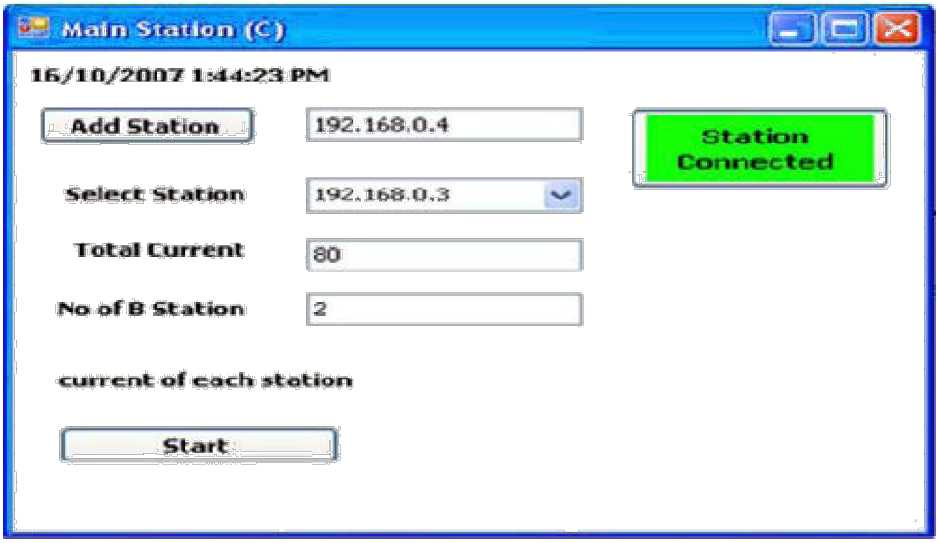



**Fig (6), The Tables of Database File.**




**Fig(7), The GUI Administration Program.**

## 5.3-Station B Installation and Setting

The main part in station B is the network processor, the processor is programmed with an appropriate code to work as explained by the block diagram shown in fig (4)[5].
The webpage is designed to add or delete users (Consumer unit), also to change the username and password of the station.

The accessing of station B done is by writing the station IP address in the internet explorer ,the login windows will appear , after inserting the username and password for the station, the main webpage will appear as in fig(8),the worker now can add or delete clients by clicking Set Clients link shown in fig(9), or changing the username and password of the station by clicking the Set Credential link as shown in fig(10)[6].

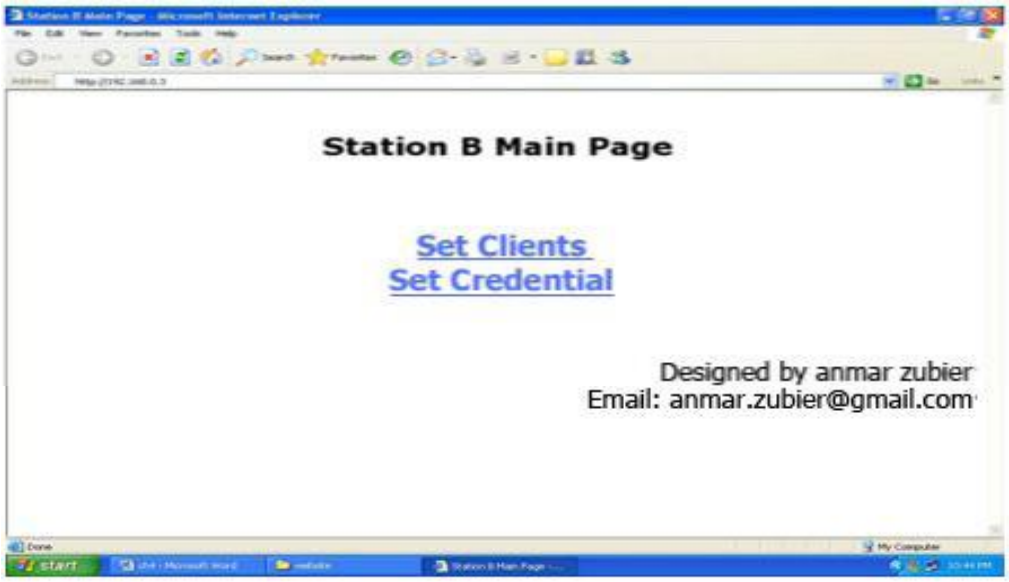



**Fig (8), Station B Main Page.**

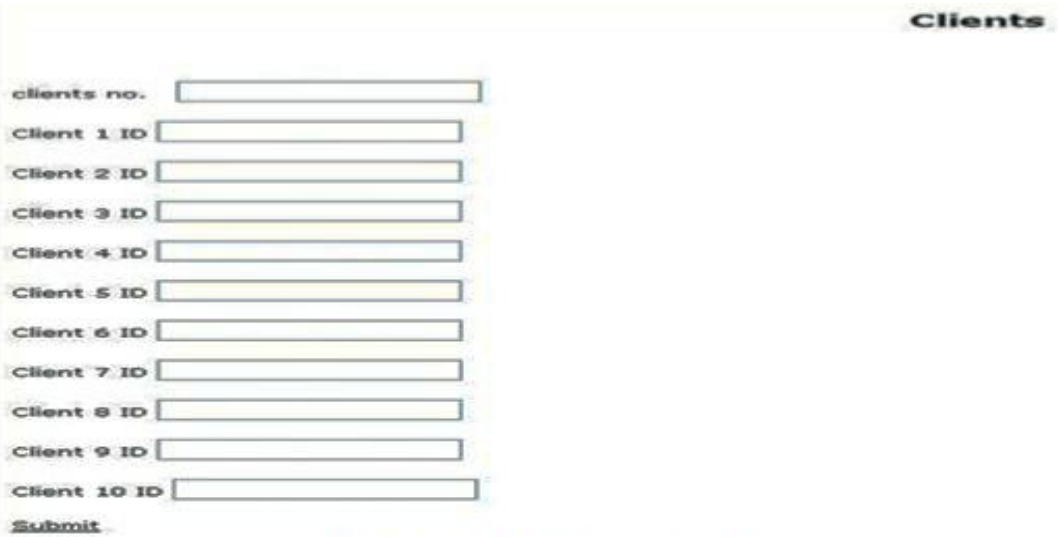



Fig (9), Add or Delete Clients page.

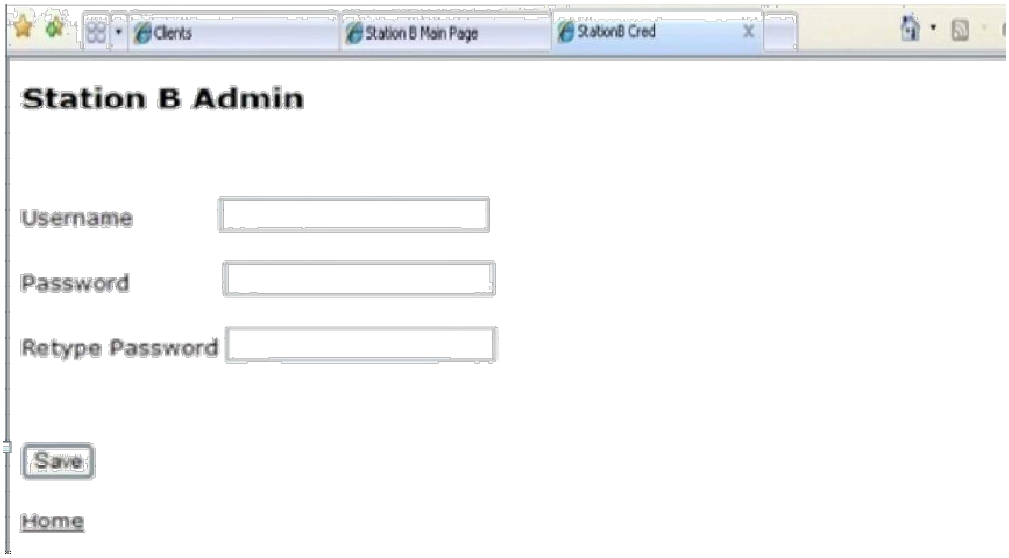



**Fig (10), Station B Login Page.**

## 5.4-Station A Installation and Setting

The main part of station A also is the network processor[6], the processor is programmed with an appropriate code to work.

The processor will be placed in each consumer unit with interface circuit to read the current consumption and send it to station B, also each consumer unit (station A) receives its available consumption value form station B.

**Table (2) Devices Used by Each Consumer in Testing the System**

| | Device Name | Current consumption(A) |
|---|---|---|
| 1 | Split | 12 |
| 2 | Heater | 15 |
| 3 | TV + satellite receiver | 1 |
| 4 | Lights | 2 |
| 5 | Washer | 3 |
| 6 | Computer | 2 |
| 7 | Freezer | 2 |
| 8 | Others | 2 |

## 6. System Testing and Results

The system was tested three times with two consumer units each supplied by 50A in the first test, 30A in the second test and 10A in the last test. Each mode was tested for 24 hours.

The operation of the electrical equipments used by the consumers was assumed to be a random function to select the value of the current consumption for each time. The random function was programmed to select the current value in the range from 0A to 39A. The value 39A was taken as the full load value of the current consumption of the devices that can be found in each house, as explained in Table (2).

## 7. Testing Modes

### 1: 50A Mode (First Consumer Unit)

Station C supplies 50A as a total current and the result for the first consumer unit was:

1- Number of Current Interruptions = 0 times for 24H
2- Average of current consumptions = 10.80A

The average of current consumptions = total value of current consumption in 24 H / no. of reads operation
No. of reads operation = 1 per 32 second
Then:
24 *60*60 = 86400 seconds in 24H
86400 / 32 = 2700 read per 24 H

### 2: 50A Mode (Second Consumer Unit)

Station C given 50A as a total current and the result for the second consumer unit is:

1- Number of Current Interruptions = 0 times for 24H
2- Average of current consumptions = 11.40 A

### 3: 30A Mode (First Consumer Unit)

Station C given 30A as a total current and the result for the first consumer unit is:

1- Number of Current Interruptions = 9 times for 24H
2- Average of current consumptions = 7.13 A

### 4: 30A Mode (Second Consumer Unit)

Station C given 30A as a total current and the result for the second consumer unit is:

1- Number of Current Interruptions = 7 times for 24H
2- Average of current consumptions = 6.76 A

### 5: 10A Mode (First Consumer Unit)

Station C given 10A as a total current and the result for the first consumer unit is:

1- Number of Current Interruptions = 17 times for 24H
2- Average of current consumptions = 8.3 A

### 6: 10A Mode (Second Consumer Unit)

Station C given 10A as a total current and the result for second consumer unit is:

1- Number of Current Interruptions = 15 times for 24H

2- Average of current consumptions = 7.3 A

## 8. Conclusion:

In this paper, the application of the network processor in the limitation and control of current consumption by the users was successfully tested for two clients with three current values.

Another improvement point in this field the application of network processor in power management field achieves a justice distribution of the power between the consumers.

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