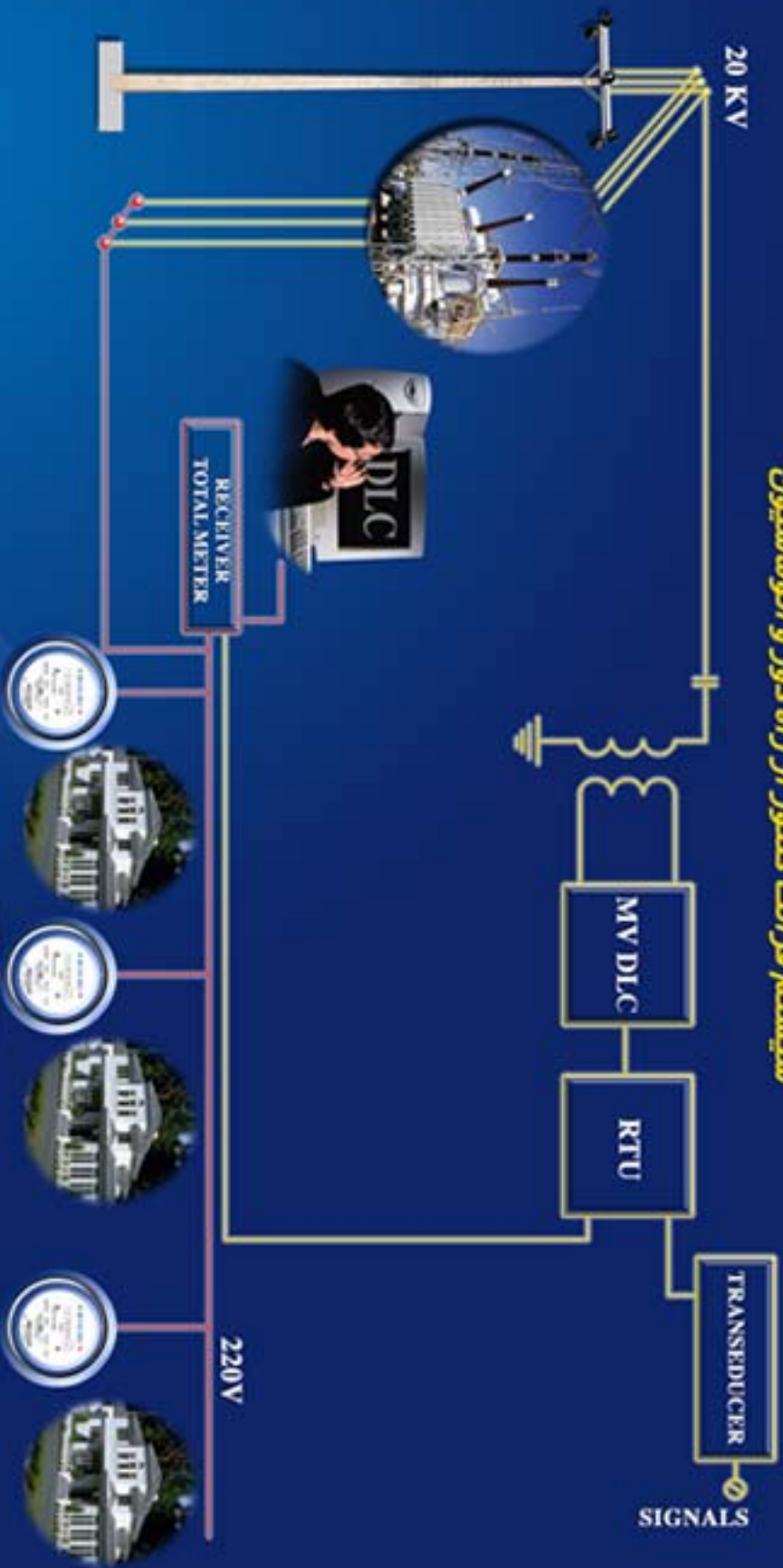


Automatic Meter Reading & Automation Systems

سیستم قرائت کنتور از راه دور و اتوماسیون



شرکت همیان فن (هفتکو)



H A M I A N F A N

Hamian Fan Automatic meter reading system

HAMAR1

This AMR system consists of one consumer side or remote transmitting electronic board plus mechanical assembly per meter, one central receiver (concentrator) per whole customers of a power distribution substation and a computer to save consumption history of customers.

We use power grids as communication media to carry consumption information from the network customers to the central station easing installation and eliminating the need for the cooperation of third parties.

System updates consumption data for any customer every 15 minutes and stores received data in general and customer specific files.

Computers in the central stations save consumer data while performing statistical operations on the collected data to create customer specific and network specific statistical inferences.

Parameters such as average consumption, peak consumption and other parameters of interest can be calculated for selected customers or the whole network.

An AMR System benefits

An AMR system has many benefits to the power distribution companies including but not limited to:

- Reduction of man power expenses
- Possibility of multiple tariffs
- Reduction of electric energy loss or theft
- Possibility of service for other meters and utilities (gas, water)
- Elimination of human made errors in data transfers from meters to billing centers
- Online and real time information on distribution of energy as a function of time and location

Methods of AMR Implementation and benefits of the DLC method

An AMR system can be built around different technologies. Some of the most important are listed below.

- RF Method 1: Fixed local antennas in the central stations and high power transmitters in each meter site
- RF method2: Mobile local antennas in local stations and low power transmitters in each meter site
- Public switched Telephone lines

- DLC

The first method suffers from the following problems:

- No guaranteed RF path between T/R
- Needs user cooperation for antenna and transmitter maintenance
- Needs central antennas relocation with new constructions in the region
- High power consumption of transmitters.
- High cost of transmitters
- Need to bandwidth procurement

The second method suffers from the following problems

- Need for point by point survey by the mobile personnel
- Low data collection rate due to above

Problems of the 3rd (telephone line) method

- Need for PTT Cooperation (AMR is not going to disturb normal PTT customer calls)
- Restriction of data collection to specific times of day due to that same reason
- Low sampling rate of meter readings due to the time restrictions
- Difficulty of necessary tariff implementations due to sampling rates.

DLC is a superior method to implement AMR

We believe that DLC or distribution line carrier is much better to implement AMR. In this method we use already installed power lines to communicate to the meter. Here are some main points

- DLC uses a private network owned by the power companies themselves. There is no need to cooperate with third parties be it PTT or RF bandwidth vendors
- High meter sample rate due to elimination of the time scheduling restrictions
- Low power consumption
- Easy installation- no need to connect antennas, transmitters and telephone lines
- IEC recommended. IEC61334 has allocated the 9-95 KHz band to the power companies. They can use this bandwidth for their communication purposes.

HAMAMR1 System Architecture

This system consists of a transmitter per subscriber, a receiver in the power substation and a computer to process the consumer and network information.

Transmitter Architecture

The transmitter housed inside the meter structure includes the following parts

- An opto-coupler to transform mechanical meter's disk rotations to electrical pulses. In case of digital meters this part can be bypassed and pulse output of the meter can be directly fed to the following section
- An electronic board counting the pulses, converting counts to kilowatt-hours and storing the consumption data in the local nonvolatile memories. The memories can hold consumption data in case of power cut outs.
- A transmitter section to send the consumption data on the power lines

Transmitter features

- The transmitter can be installed in mechanical meters' housing, converting them to digital meters while at the same time upgrading them to smart remote units which can communicate with the central station via power lines.
- The transmitter can be installed alongside with digital meters adding remote reading capability to these units.
- Unique codes for meters. A meter is unambiguously identified in a large network, no matter from which substation it is fed.
- System can be used in highly populated residential areas with high concentration of adjacent electricity meters as well as rural areas. No loading of the transmission medium in transmission frequency band
- Low power consumption of the electronics. light burden on the power generation capacity
- Robust design to achieve unsupervised operation of remote unites for long time.



Figure 1: Transmitter board and the IR mounting assembly



figure2: Remote unit inside a conventional mechanical meter. The IR mounting module can be seen in the front side of the picture, to the left

What kind of information are transmitted from the transmitter to the receiver

- Area ID: presently assigned 4 bit nimble to resolve for similar numbers in the case of adjacent regions cross talk. More bits are

tagged in the receiver based on the receive stations unique code to generate a nationwide unique code for every meter.

- Meter ID: 10 bits to cover 1000 consumers per substation.
- Aggregate consumption: 10 bits to transmit up to 100kwh consumption with .1 kwh resolution. Central software keeps track of the consumption records and corrects for consumption fall over once consumption exceeds 100kwh
- More bits to protect the transmitted data against transmission errors. Total number of bits sums up to 40 bits.

Receiver Architecture

The receiver includes the following parts

- Analog front end to filter out unwanted signals and bring the received signal to a level suitable for digital manipulations
- Digital section to decide on received bits and recover the customer information
- Three phase power supply
- Computer interface to transmit customer data to the computer for further processing

Receiver features

- Large capacity. More than 1000 customers can be supported by the receiver hardware and software.
- Robust design to achieve unsupervised operation of remote units for long time.
- Receiver can detect and store position of customers on different phases of the supply network. Using this side information a better balance of power distribution between different phases can be achieved.
- Receiver includes memory to save temporary consumer data in case of power cut outs
- More customers can be added up to the system's capacity. No change in the receive side need to be made. New customers are automatically detected by the system and added to the data base. Thus the AMR system can be started with as many customers as needed at present and grow up in future as new customers are added in

A photo of the receiver follows



Figure 3: Sample central (concentrator unit)



figure4: central unit connected to computer

What kind of information are transmitted from the receiver to the computer

- Meter and area ID received from the transmitter
- Aggregate consumption data received from the transmitter
- Locally generated time stamp for any transmit to receive connection
- Locally generated phase stamp for any customer

System Network

Network includes the customers, central station and the protocols governing data transfer between the two sides.

Network Protocols

Having one receiver and many transmitters one should decide how to manage data delivery from the transmitters to the receiver. Here are some methods alongside with their pros and cons

- Polling. The central station asks remote stations to send data. No remote side starts data transmission unless so asked by the central station. This method necessitates two sided connection and T/R inside the meter adding to the complexity and cost of the system. Once the cost accepted this method is a good candidate to make large networks.
- One sided synchronous where all meters are synchronous and each meter sends data in specified intervals. In this method time should be kept to fraction of a second. This method is not practical with reasonable prices.
- Asynchronous connection, each meter enters the network randomly. This method is reasonable in AMR applications and does not have drawbacks of the two methods.

Network size

- Network population size depends on the bit rate, number of bits per transmission, number of transmission intervals per hour and the connection protocol.
- Due to the random nature of transmission initiation a success rate should also be considered for every connection trial.
- considering 150bps, 15 minutes between transmission intervals, forty bits per transmission, and 90% success rate, system covers 177 customers
- With those same parameters, 80% success rate system covers 377 customers. Failure rate is 4% in two successive connections. More than 96% are read in 30 minutes

Network Physical size

By network physical size we mean how far on the average customers can be from the central station.

Network physical size depends on the quality and loading of the network which translates into the signal attenuation on the network

Network capacity on the other hand depends on the injected signal level and sensitivity of the receiver. This parameter is limited by the relevant standards.

Sensitivity means how weak a received signal can be and still be interpreted correctly by the receiver. This parameter itself depends on the network (noise) quality, receiver design parameters and error correction mechanisms built into the receiver.

Our system has 1mv sensitivity and an average 5 volt injection capability on the power lines.

Based on average power grid properties this system supports 500 meters between transmitter and central station.

Software

System Software is a user friendly one developed by our company which can execute different operations on the received data to produce meaningful and easily interpretable outputs to the operator's convenience. Some of the features and operations of the software and the overall system follows.

- Efficient and user friendly software
- Received signals are time stamped in the receiver. Based on these time stamps and proper software operations system can support different tariffs as prescribed by the power companies
- Position of customers on different phases of the distribution network can be determined. Using this side information a better balance of power distribution between different phases can be achieved. There is a separate column in some of the software outputs which displays phase position for any customer.
- More customers can be added up to the system's capacity. No change in the receive side need to be made. New customers are automatically detected by the system and added to the data base. Thus the AMR system can be started with as many customers as needed at present and grow up in future as new customers are added in
- User friendly software in the base station facilitates extraction of user specific and network specific averages and graphs.

- Sample software window of a small four customer network is depicted below. The present version supports five columns for each customer including last aggregate consumption, last update time, last update date, single phase customer's phase situation and the present update status

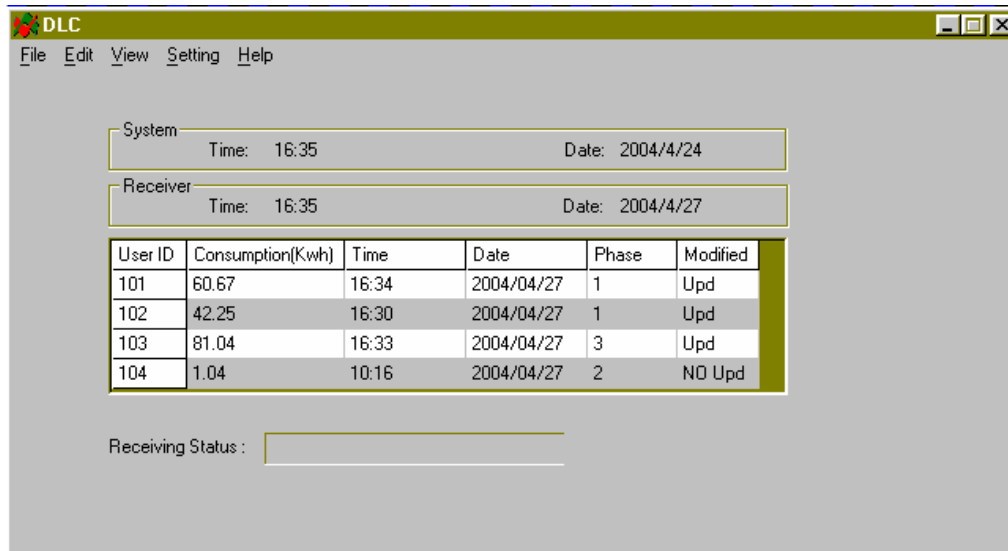


Figure 5: consumers' group window. Aggregate consumption of any customer is displayed simultaneously with the last update time

- Another window presents consumption status and once desired consumption history of any specific customer. Data display can be in the form of a table or graph

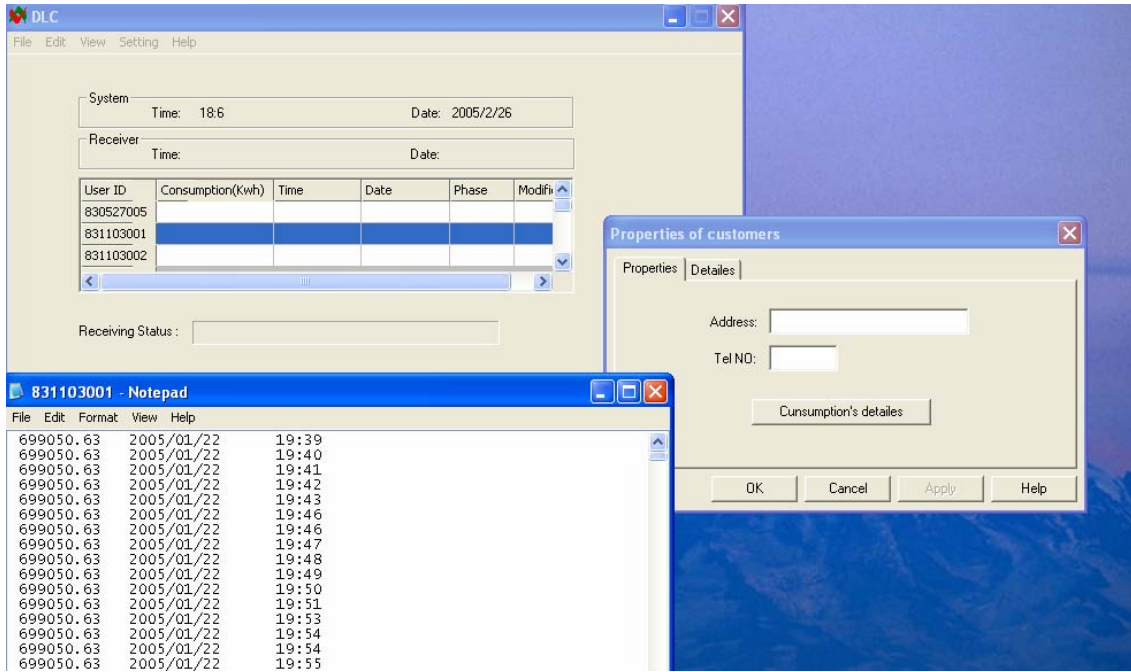


Figure 6: 3 windows displayed. Consumers' group window. desired consumer's contact information window and desired customer's consumption history.

- Once desired, Selected consumer' record can be displayed in graphs

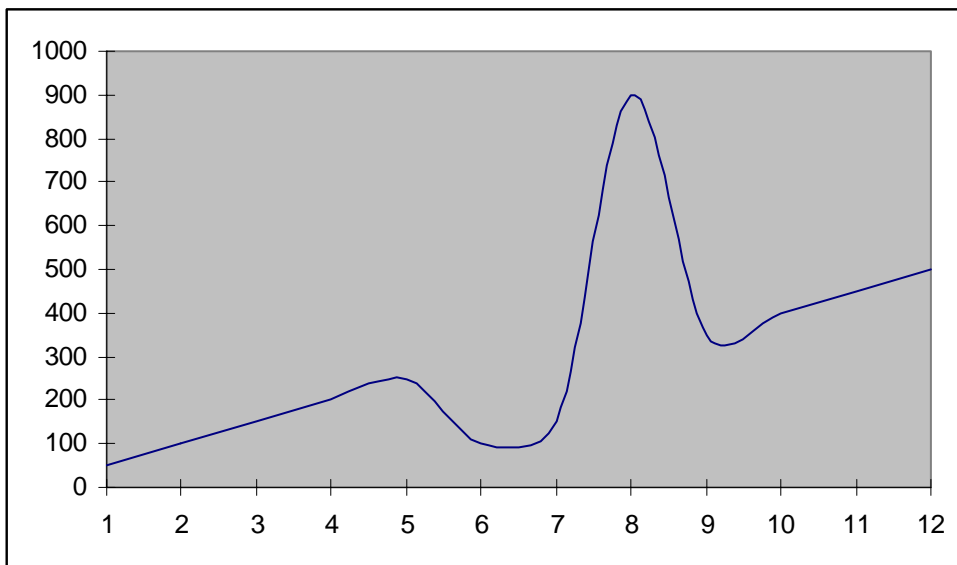


Figure 7: sample consumption record of a hypothetical selected customer. Consumption in kwh vs. time in weeks

- Once desired aggregate consumption record of the network can be displayed
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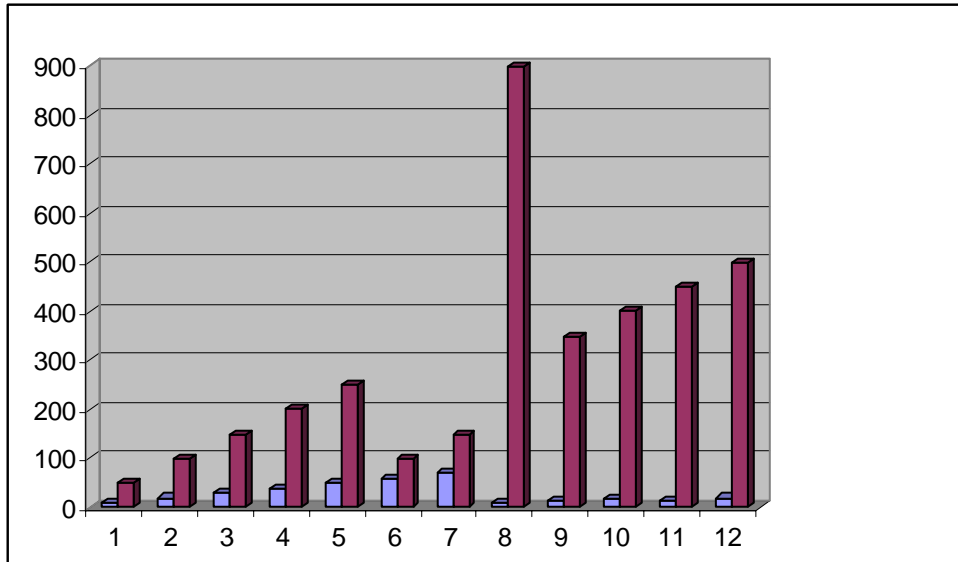


fig7: consumption record (red columns) and number of customers for each consumption range (blue columns) versus time in weeks for a hypothetical small network

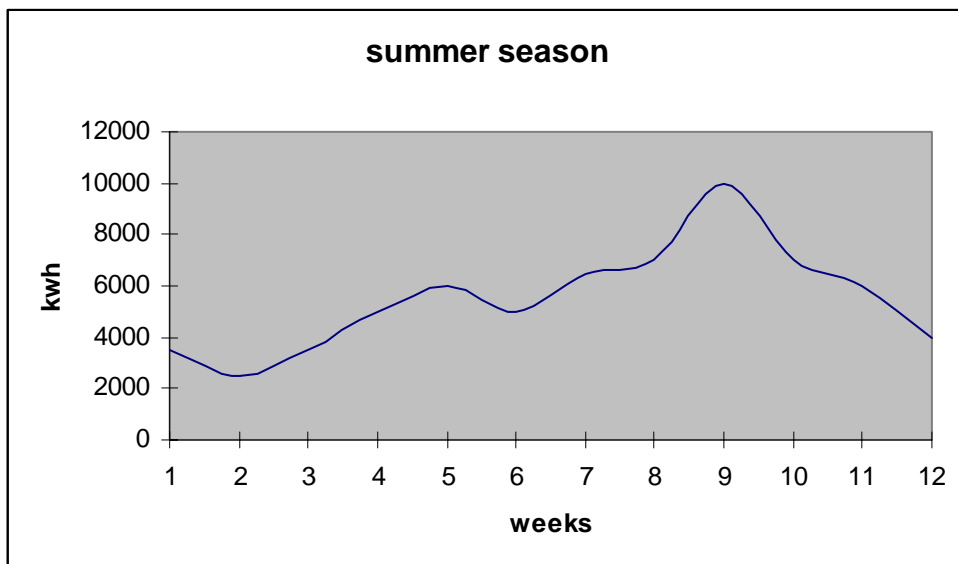


fig8, small hypothetical network's aggregate consumption versus time in weeks

Technical specifications

Electrical

Line voltage	220 volt nominal
Line voltage tolerance	+/- 80 volt
Line frequency	50 Hz- 60 Hz
Power consumption	approximately 1 watt for the transmitter board
Method of electronic reading	optical reading of disk rotation
Line coupling	capacitive
Signal voltage amplitude	complies with cenelec en500656

Mechanical

Tr . Board dimensions	default: 10* 10 cm. can be tailored to meters inside size
Central	20*21.2*15.7 cm

Environment

Ambient temp.	Up to 65 degrees
Indoor – out door	out door for remote (transmitter) and indoor For the central

Network

Number of consumers	355 for 90% success rate and 15 minutes interval
Meter ID	unique code up to 16 million meters
ID assignment	in factory (for new meters) or on site
Consumption record updates	default: every 15 minutes

Records and outputs

User records	specific user consumption record vs. time User phase position on the network
Group records	record of the selected network consumption vs. time Network outages vs. time