# ((Remote reading of smart gas meters

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**Abstract**

To minimiz e unaccounted natural gas in Iran, NIGC has defined several projects, among these the remote reading of smart gas metering related to organization of billing system to measure more than 13.8 million residential customers. In this project NIGC's experts designed a kind of diaphragm gas meter that encoder replaced for wheel and links. This kind of smart meter means tilt and tamper proof, temperature corrector with capabil ity of remote reading based on open source M-Bus wireless protocol.
**Keywords:** unaccounted natural gas, remote reading of smart gas metering,

## 1. Introduction

Following the increase of energy prices in world and economic value of gas exports, minimizing the amount of unaccounted Gas, accurate measuring, balance sheet of supply and demand for transmitting, distribution and consumption (figures 1-2) is a necessity. Thus supervising and management of producing and consuming for keeping balance in the network is inevitable. To create such environment, necessity of using the new methods of reading, observe and management of Household/commercial Consumption is an obvious matter. Meter reading methods have been changed from the periodic local readings to the automatic alongside the advancements of technology, as the result of the drive-by radio networks and ultimately evolved to the fixed networks.

Generally specifications of smart meters in markets, and those of the future, are in order to create a free market for both energy suppliers who attract customers by presenting rates and services, and informed customers who have the flexibility to choose from the suppliers.

Using the full potential of the new meters needs user-friendly systems compatible with newest technologies of the day to gather the needed information and provide them for the customers, company officials and the government, and also control and guide the operation genuinely.

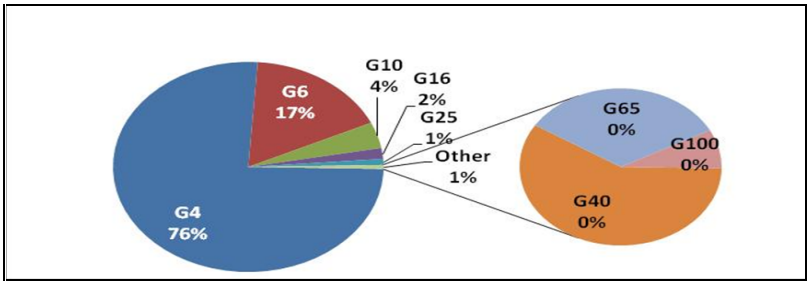


**Fig. 1:** Types and number of gas meters used for residential use

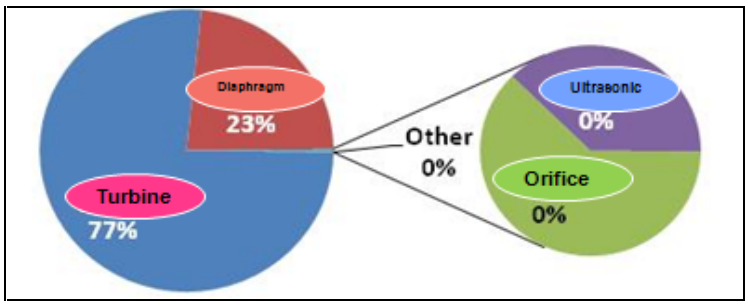


**Fig. 2**: Percentage of meter type used for major industries

## 2. Suggested methods

Overall, smart Metering that includes hardware, software, method and knowledge operates to collect and use data and information intelligently and on time (figure 3). Here, all sections are connected with each other in a two-way and instantaneous manner and each section provides necessary data and information for related sections.

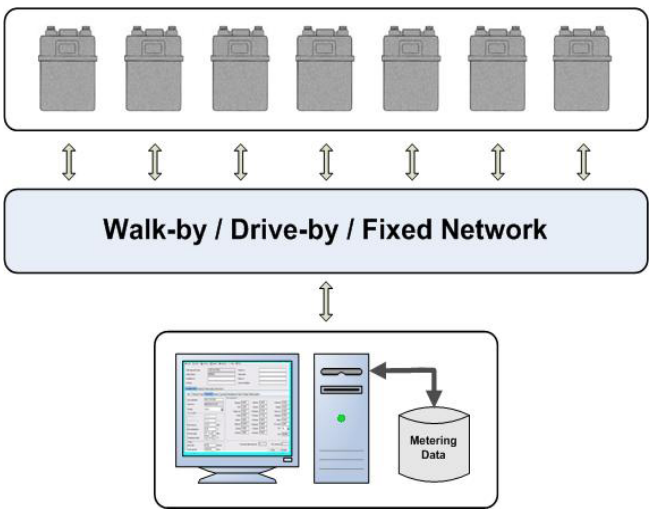


**Fig. 3**: smart metering

### 2.1. Chosen meters

Gas meters used for distant reading of Household/Commercial customers around the world, are the defragmented type with a volume counting mechanism similar to the Iran made meters, equipped with needed facilities for reading and supervising the distant consumption.

In the Implementation of AMR/AMI Systems, meters hold the major part of the investments for guaranteeing the long termed contracts (15 years) and by securing the suitable practical facilities for company's needs, they provide the Proper operating condition from the investments.
Relevant considerations with the choosing the meters in part 5 are summarized below:

1. Accuracy, quality and Durability of the mechanical part of the meter
2. Matching the mechanical counting with the electronic counting or electronic measurement

3. Meter functional capabilities like Tilt proofing, Tamper proofing and the ability to transmit the data using the Frequency of 870-868 MHz
4. Saving the data in One-hour time spans
5. Equipped with local port for meter reading

### 2.2. Existing structures

In the provincial gas companies, Subscribers system is the only practical system that needs the meter data. In the current system the meter reading process is done by periodic and 45 to 60 days visits of the reading agent to the meter installed location (figures 4-5). Under the current conditions, distant reading of the gas subscribed users can be provided with mobile and fixed network structures. Which are described below:

**Fig. 4**: Measuring the gas consumption of the residential consumers

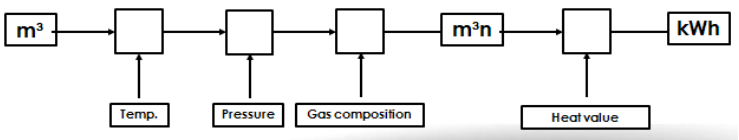


**Fig. 5**: Measuring the gas consumption of the industries

#### 2.2.1. Mobile network structure

In this structure (figure 6) by adding short ranged Communication Module to the meters using Frequency of 870-868 MHz and installing the similar module on the PDA or car, the distant meter reading can be done by the Walk-by and drive-by methods.
Although using this method can decrease the meter reading period from 45 days to a month, not changing the very Foundation of the meter reading and consumption supervising, and lack of the flexibility of the central practical computers, can redo the advantages.

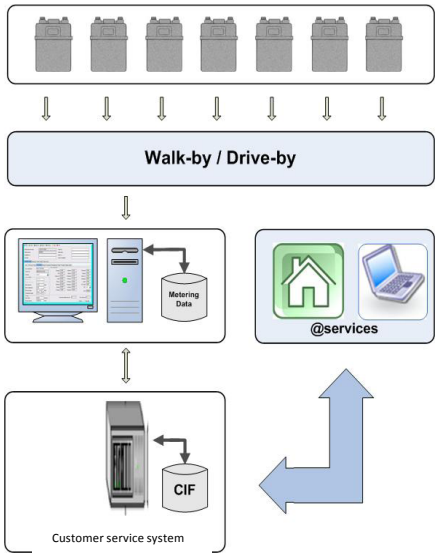


**Fig. 6**: mobile network

### 2.2.2. Fixed network structure

In this structure (figure 7) by adding short ranged Communication Module to the meters using Frequency of 870-868 MHz or long ranged one, and installing fixed collectors to the covered areas, meter reading can be done without reading agents and in a daily basis. And by using the new system's facilities, the gas consumption bills can be sent in organized periods and specific dates.

In this structure, subscribers can see the Precautions and consumption diagrams online, in addition to the Billing Information Inquiry.

Due to the geographical distribution and density of subscribers in country, the usage of both methods in achieving the ultimate goal of distant meter reading is possible, and a combination of both structures can provide the economical coverage in a city or an area. Also mobile network structure can be upgraded to the fixed network structure in case of an increased density.

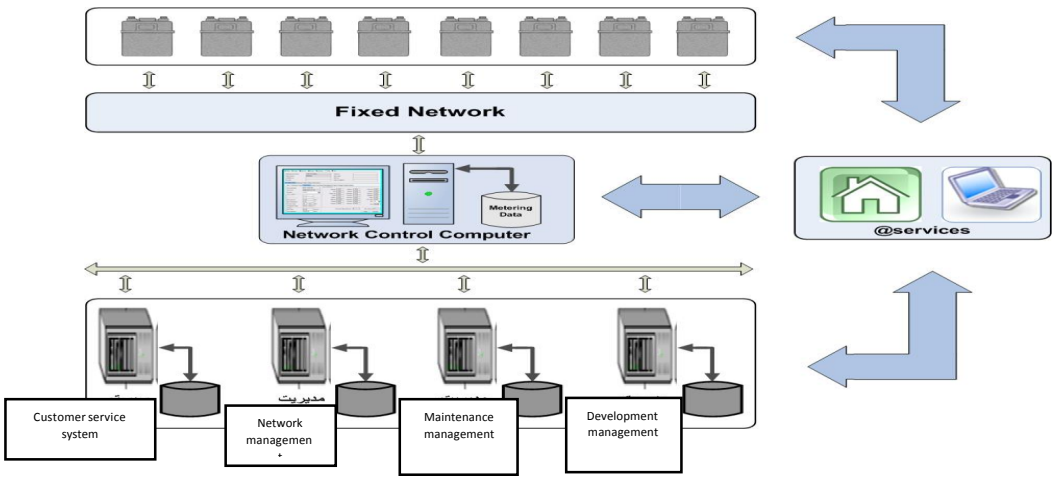


**Fig 7**: fixed network

### 2.3. Standards of the smart metering

1. Meter standard IGS-M-IN-101
2. meter index and it's ability to convert the volume of gas with temperature
3. Local port with standard IEC 62056-21 : 2002
4. meter communication protocol and Wireless M-bus DC According to the EN 13757 Standard
5. Explosion-proof capability of the meter with standard ATTEX Frequency band 868-870 MHz

### 2.4. Communication platform

meters of water, electricity and gas are installed in the subscriber's private and platforms like electricity cables, VPN, MPLS, phone lines and cell phones and Wireless communications (RF) (figure 8). A combination of these platforms can also be used in the distant reading's network architecture. They can be used as a platform with the in-touch ability foe establishing a connection between the meter and the outside of the subscriber's private. Communication platform can be one layered and two layered. In two layered platforms data can be transmitted from meter to a fixed or mobile antenna through Frequency band 870-868 MHz (figure 9) and in the one layered platforms, it will be sent directly from meter to the NCC's location.

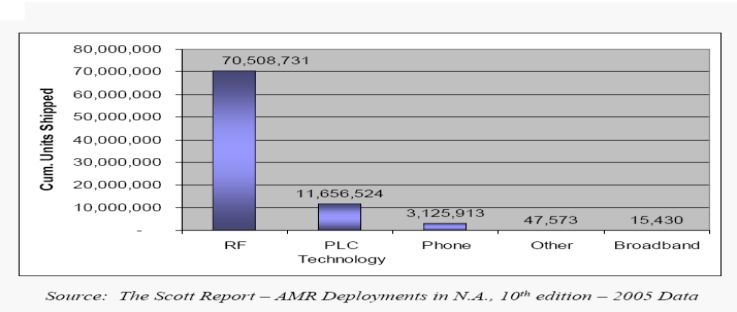


**Fig. 8**: AMR/AMI technologies

### 2.4.1. The use of radio channels

Although usage of the radio communications is simply accessible, but in industrial, Science and medical applications (ISM), using this option is limited by rules of the Frequency allocation and utilization of radio channels, matching International Telecommunications Union standards (ITU), and In line with the proper utilization of space within a frequency channel of communication and avoiding the Overlap between radio channels. Incorrect Frequency planning in this case are observed by the competent authority

Studies conducted by the COGNSYT Institute about the rate of utilization of communication media in AMR/AMI technologies in water, electricity and gas companies in the northern America, which are published as "The Scott report", show that from 85 million meters equipped with distant reading facilities, 70 million of them are equipped with Radio communication (RF), 11 million with PLC technology and 3 million with fixed phone lines and other communication areas does not have a significant role in AMR/AMT technology.

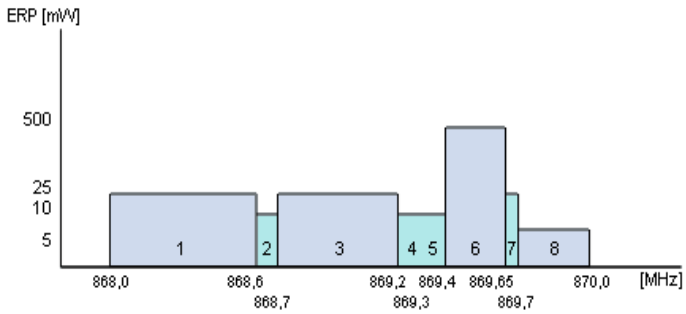


**Fig. 9**: Minor channels of ISM band

### 2.4.2 Antenna for meter

Meander Line-, Tapered Slot- and Patch antennas were studied. Meander Line antenna is suggested by makers of transceivers for 850 and 900 MHz bands. The polarization of Tapered Slot antenna is vertical and benefit for metering point. The proposed antenna is simulated by using HFSS software. The simulated gain is 1.3 dBi. The co-polar and cross-polar radiation patterns in horizontal and vertical planes at frequency 868 MHz are plotted in Fig. 10. These parameters were measured in KNTU Lab. (K.N.Toosi University of Technology, Tehran, Iran).

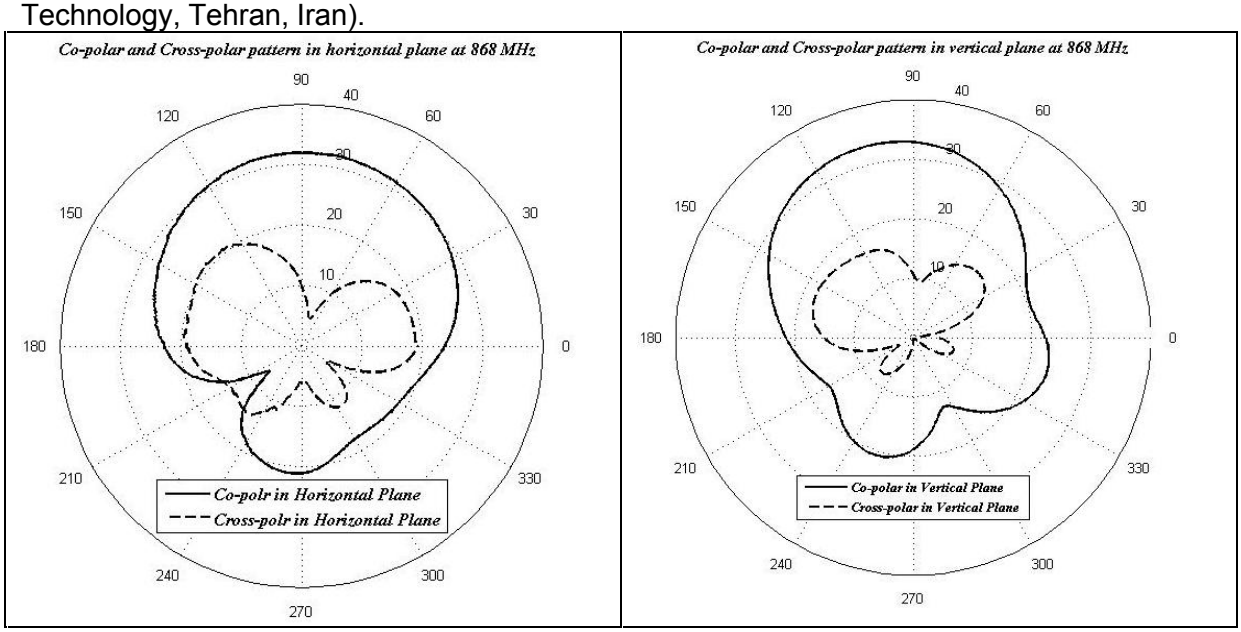


Fig. 10: Measured Co- and Cross-Polar radiation pattern in a) horizontal and b) vertical planes.

The Patch antenna is simulated by using HFSS and the simulated gain is 4 dBi. This type of antenna has a vertical polarized and directional radiation pattern and is ideal for external use. Figure 11 shows the measurement setup of proposed antenna in KNTU Laboratory.

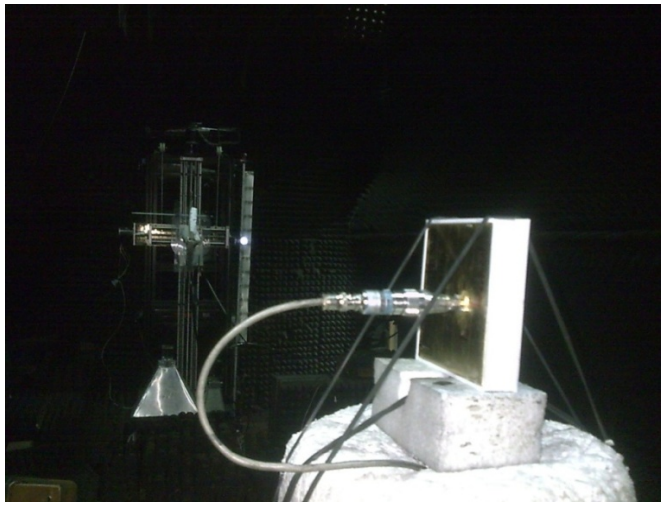

Fig. 11: Measurement setup of Proposed Antenna for metering.

The co-polar and cross-polar radiation patterns in horizontal and vertical planes at frequency 868 MHz are plotted in Fig. 12.

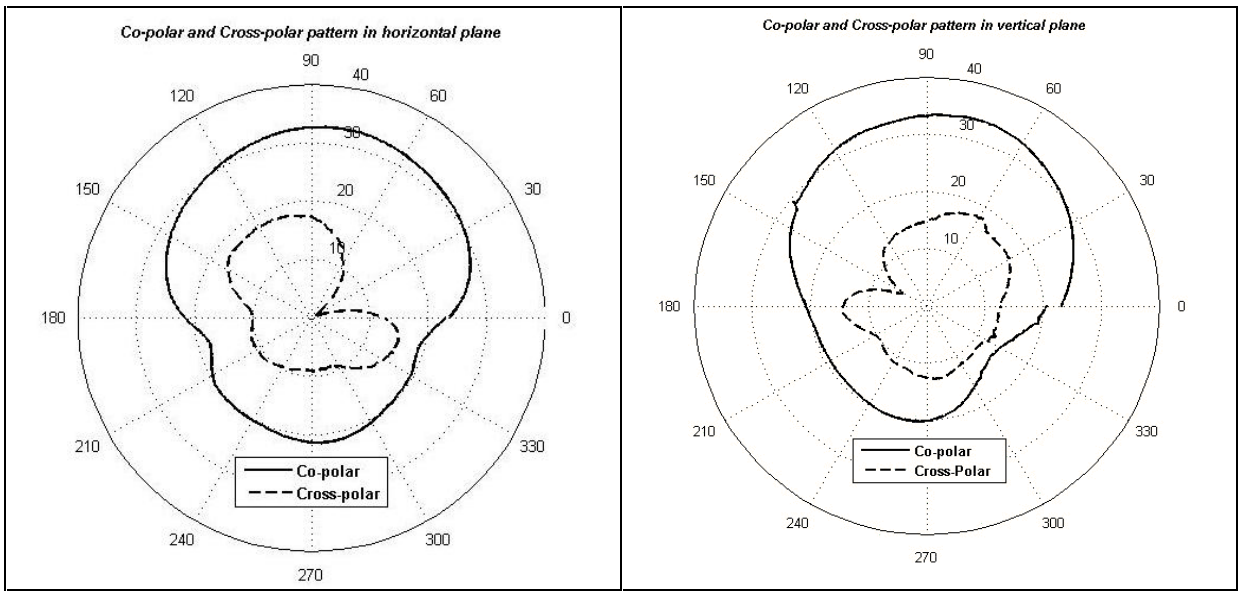


Fig. 12: Measured Co- and Cross-Polar radiation pattern in a) horizontal and b) vertical planes.

However, Tapered Slot- and Patch antennas have better radiation performance than Meander Line antenna.

### 2.4.3 Antenna for Data Collection (DC)

The half-wave dipole antenna simulated by using HFSS (High Frequency Structure Simulator) software is shown in Figure 13. The antenna has an Omni-directional radiation

pattern and is useful for Data Collector application. The input impedance is 50 ohm and VSWR (Voltage Standing Wave Ratio) is better than 1.5:1. Peak gain is about 1.6 dBi.

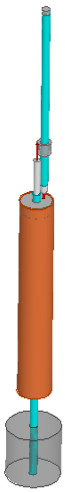

Fig. 13: half-wave dipole antenna Structure in HFSS for data collector.

Figures 14 (a) and (b) show the measured Co- and Cross-Polar radiation pattern of dipole antenna at frequency 868 MHz in horizontal and vertical planes.

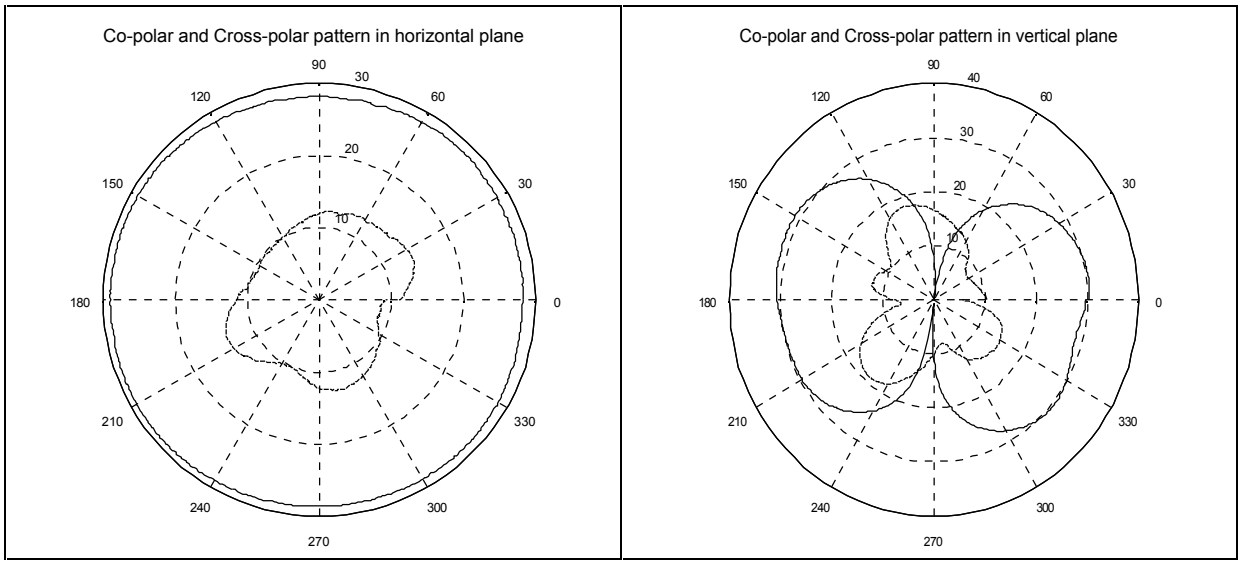


Fig. 14: Measured co- and cross-Polar radiation pattern in a) horizontal and b) vertical planes.

### 2.5 Network control center (N.C.C)

All of the data with RF communication platforms are sent to Network control center (N.C.C) and are organized and kept in a typical data base such as SQL (figure 15). By using these data, it is possible to extract several applications and give services and data to the variety of

inside and outside of the company, like government. Its main usage in the gas company is the Invoice production and consumption behavior of subscribers.

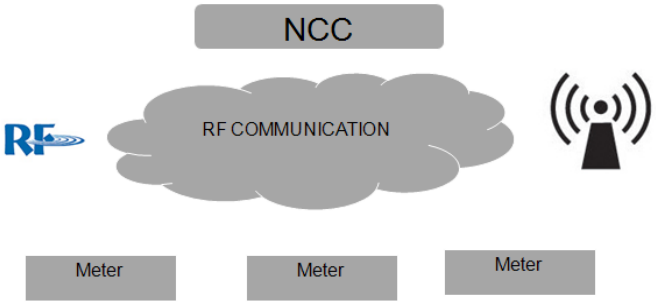


**Fig. 15**: NCC

## 3 Conclusion

According to the experiences of gas companies around the world in Implementation and operation of the AMR/AMI systems, which are comparable to the activities of the provincial gas companies by the number of subscribers and geographic area, With regard to the possibilities and limitations stated in the text, Radio communications (RF) between minor subscribers and collectors, between collectors and the network control center mostly GSM/GPRS (if not available, fixed phone lines, VPN and MPIS) will be used. For major subscribers, communication between Measurement equipment and the network control center, with the features in the major subscriber's site, GSM, GPRS and fixed phone lines will be used. Due to the geographical distribution and density of subscribers in country, the usage of both methods in achieving the ultimate goal of distant counter reading is possible, and a combination of both structures can provide the economical coverage in a city or an area. Also mobile network structure can be upgraded to the fixed network structure in case of an increased density.

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