Automatic Meter Reading and Recognition System without Replacing the Existing Meter

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Abstract:
Currently, meters can be read manually, touch-read (hand-held device with a probe), Bus, Power Line, Radio, Modem, or GSM/Satellite. Existing infrastructure, cost and local regulations are the driving force behind the above mentioned choices. In the current AMR technology, the existing meter has to be replaced with new Smart/AMR meters, which is not feasible, if it is done at macro level. In this research, we consider meter reading without replacing the existing meters, standards and procedures. A system of automatic interrogating metering without the need for changing the existing system has many advantages, both to the supplier and to the consumer. It will be more economically efficient if we incorporate AMRRS for consumers to pay differing prices, based on their usage of electricity, instead of the current system in which an average or pre-rated price is used. Hence it is good to send real-time and the actual pricing to consumers along with the infrastructure feasibility and economically acceptable solution. The mentioned solutions are suitable for the upcoming cities, the old city, including residential and industrial areas and also the rural areas respectively.

Keywords: Smart meter, automatic meter reading, remote metering

1. Introduction

The aim of this research is to develop and adapt system for reading the meter automatically anywhere, anytime, without changing the existing meter.

In developed countries, AMR with RF (radio frequency) or PLC (power line carrier communication) has been widely used with the fast development of technology and national living standards improvements. However, the technology is seldom used in developing nations nowadays because the residential building styles and its network infrastructures vary. In some existing Automatic Meter Reading (AMR), the Meter design itself, has the features of an automatic meter reading, but the problem with this system is we have to replace the existing meter at each house/shop with this new AMR meter. In AMRRS method, each meter is connected to a central station via wireless sensor network. Wireless sensor network technique is used in the systematic gathering and transmission of sensed data to the end-user.

The impact of the utility meter companies includes cost-effective, trustable and disturbances free of data transfer between existing meter reading devices and the electric main station/utility control center. The reading of meter units and its management processes does not involve any human interference and are based on the wireless networks. Hence it is very flexible for utility companies to access, service and maintain this meter reading system.

2. Problem Description

- Human errors in noting the reading since they are manual
- Time consuming in doing repetitive works
- Doesn't keep track of readings to provide information when people require about how much energy they utilize
- Doesn't have regular updates of readings
- Estimated billing instead of paying for actual consumption
- Not feasible to replace Smart/AMR meter at macro level

3. Amrrs Basic Process Flow

Figure 1

First, an AMRRS device is installed along with the meter. Readings from the AMRRS device are transmitted to a reading unit through a fixed network system. The AMRRS receiver retrieves these reads to generate customer energy bills. The reads are also published to web reports on the manufacturer's web interface software and can easily be accessed online via the customer login and user name.

4. Amrrs Architecture
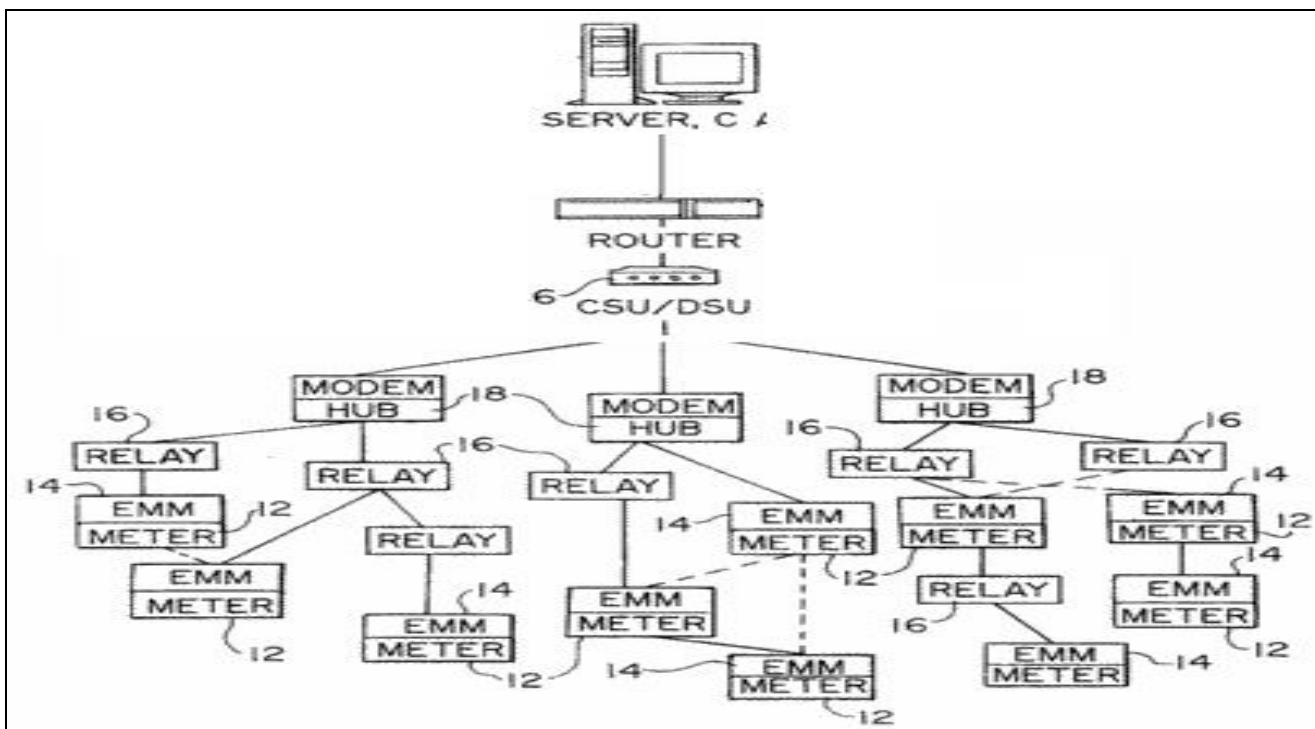
Figure 2

A meter reading system, preferably includes an entity mediate modem (EMM), an ethernet hub and a data collection system. The EMM interacts with one or more utility meters with the same communication format of the utility meter so that the utility meter does not require modification. The EMM receives meter data from the utility meter and converts to a wi-fi communication format. The wi-fi formatted data, is then transferred to the hub. The hub, then translates the wi-fi data into a radio signal communication format. Then, it is transferred via router to decode to the digital data to the data collection system for use by the utility as desired, e.g. energy billing, tracing, control, etc.

5. Communication Network
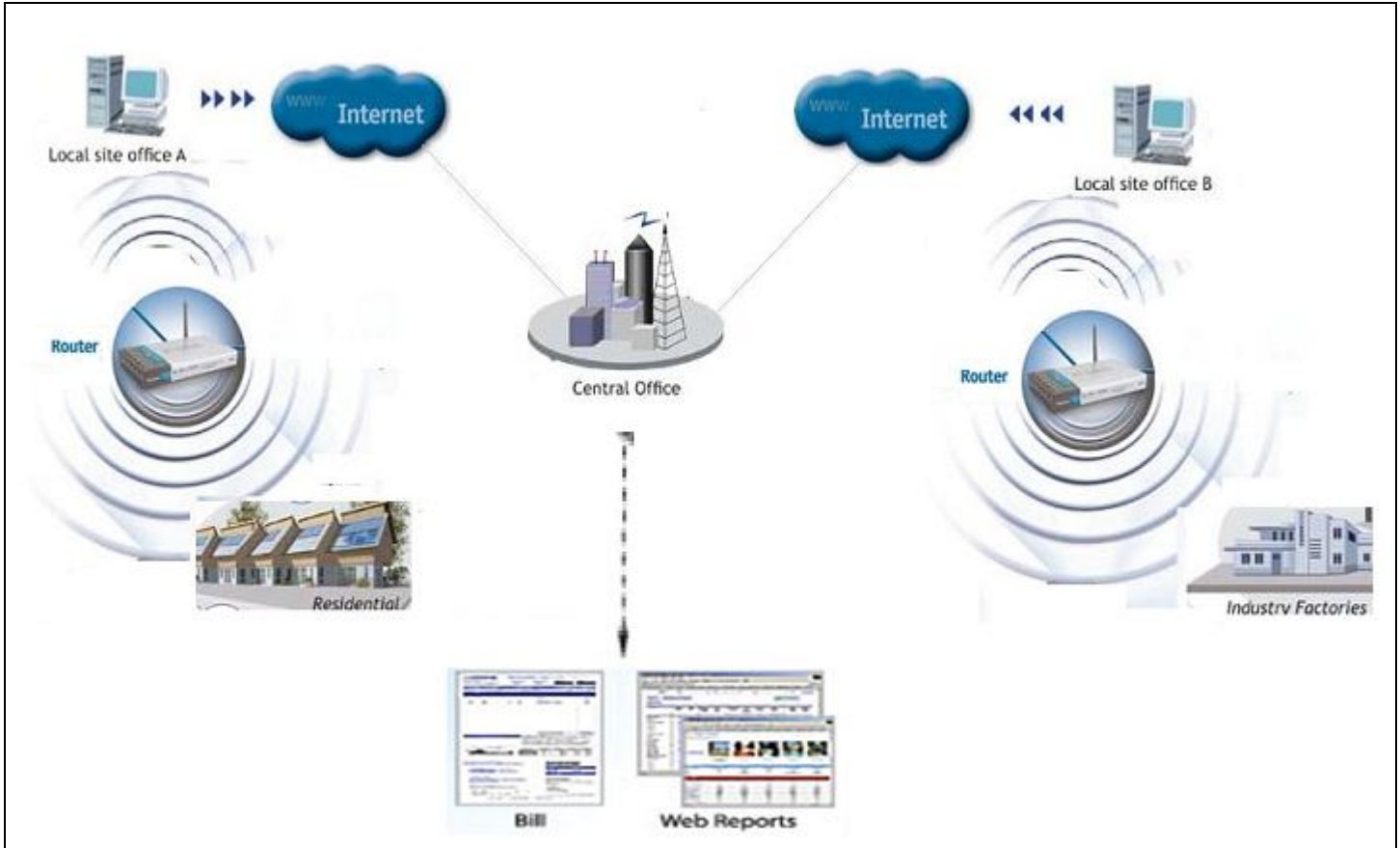
Figure 3

The data collection system need, only recognize one communication format rather than attempting to accommodate numerous message formats such as wires, coaxial cable, optical fiber, or radio frequency. Hence it is the Wi-Fi activated network with the WPA security. The network does not support public Internet access. It is a private and secure network that is operated as an enterprise network. Every node in the wireless mesh network infrastructure is authenticated to the network before it is allowed to participate in the mesh. All wireless traffic is encrypted on each wireless hop through the system.*WiFi Protected Access* (WPA) is a step up from WEP and is now part of the 802.11i wireless network security protocol. It uses the temporal key integrity protocol (TKIP) encryption. As with WEP, WPA security involves signing on with a password, use WPA or 128-bit WEP technology, though some still use the vulnerable WEP approach.

6. Constraints and Assumptions
Connections must be set up in such a way to provide high data transfer and to avoid intruders to the software application.

7. Failure Mode Effect Analysis

No.	REVISION	DATE	PREP	APPROVE	OCCURRENCE		INFLUENCE		DETECTION			CRITICALITY		
1	ORIGINAL				100%	5	CRITICAL	5	ALMOST NONE	5		OCCURRENCE		
					VERY FREQUENTLY	4	VERY GREAT	4	SAMPLE SOFT	4		INFLUENCE	70-125	=S
					FREQUENTLY	3	GREAT	3	SAMPLE HARD	3	X	DETECTION	30-69	=A
					OCCASIONALLY	2	LITTLE	2	100%SOFT	2		CRITICALITY	10-29	=B
					ALMOST NEVER	1	aLMOST NONE	1	100%HARD	1			1-9	=C

No.			
PROCESS / PROCESS NAME	input	Fault input	Processing
MAN	No	No	No
MACHINE	Yes	Yes	Yes
FAILURE MODE	No transmission	False input	Input validation
POTENTIAL CAUSE OF THE FAILURES	WIFI not accessible	Some malpractice	DR conversion
CONSEQUENCES 1 (INFLUENCE)	No input	Intruders	Improper input
CONSEQUENCES 2			
OCCURRENCE (RATING)	1		2
INFLUENCE	1		2
DETECTION	1		1
CRITICALITY	C		C
IMMEDIATE PROCESS (PREVENTATIVE MEASURES)	Narrow band wireless LAN	WEP	temporal key integrity protocol encryption
DESIGN			
FACILITIES			
CONTROLS			
DOWNSTREAM PROCESS (PREVENTATIVE MEASURES)	Wi-Fi hand-held receiver	Send auto email	Noise clearing
DESIGN			
FACILITIES			
CONTROLS			
JUDGE			
ADDITIONAL PREVENTATIVE MEASURES	Send auto email	Process latest data	Normalizing
WHO			
WHEN			

Relocation	Yes	No	Irrespective data	False Input	Other energy usage	3	2	1	C	Change address approval			Auto re-indexing of input	
Intruders	Yes	No	Hacking	No Security	Fault Data	0	0	0	C	WPA enabled access point		WPA enabled setting		Data comparison
Recognition	No	Yes	DR and RD conversion	Meter rotating Input	Consume recognition time	3	2	2	B	Segmenting		Individual DR and RD conversion		Color Inverter
Web application		Website inaccessible	Hosting server crash	User lose interest	2	2	1	C	Redirection		Improve load balancing servers			
		Slow loading pages	Huge no. of inputs	Page ignorance	2	2	2	B	compression		Data stored locally			Back end process

		Broken hyperlinks	Negligence in Maintenance	Does not show up	1	1	1	C	Regular Maintenance		Auto check for broken links			Fail-over servers	
		Page not displayed	Unsupported browser	Page inaccessible	3	1	1	C	Redirect to update version						

Table 1

8. Benefits

The system provides dozens of benefits to customers that are a bit less tangible in terms of dollars and cents. These include more rapid resolution of disputed bills, fewer errors, improved response to outages, reduction in theft losses, improved security through elimination of intrusions by meter readers and access with customer-provided keys to indoor meters, off-cycle meter reading, customer-selectable billing and payment dates, and others.

9. Conclusion

This technique is one of the most reliable and easily applicable in mesh network systems. The utilization of AMRRS is the advanced technology for accurate measurements and theft control and is very helpful to achieve the objective in security operation of the power system. It will send accurate readings to a computerized billing system up to five times a day and will largely eliminate the need for estimated bills. Since it is an automated system, it eliminates the need for meter reading personnel to visit customer properties. It also provides the customers with an online application that lets property owners view and manage their consumption on a daily, weekly, monthly, and yearly basis. Automating the meter reading capabilities to increase billing accuracy and provide customers with the tools they need to better manage their usage. AMRRS recommends an immediate network installation followed by a staged meter implementation based on anticipated benefits and costs.

10. References

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APPENDIX

SUPPORTIVE DOCUMENT
- The article "Better System Needed for Meter Reading" published by asia one news on 30th July 2008 and the viewers comments has revealed the problems that customers encounter and the necessity of coming out with a new system
- The studies from the Center for Strategic and International Studies (CSIS) has discussed about the possibility of connecting external devices for network.
- Straits Times reported on Electricity bills went up about 21per cent on 1st Oct 2008.
- Straits Times reported on many household that are not coping well with their electricity bills.
- The article published by Cisco Wireless Networking division for All Wireless Article explains about the security concerns about wireless data transmission using WEP technology
- The American National Standards Institute (ANSI) standard that describes a protocol used for two-way communications with an electricity meter.