IOT BASED SMART WATER METER FOR CITY DISTRIBUTION MANAGEMENT

Dr. Ragini Shukla, Dept. of Information Technology

Dr. C.V. Raman University, Bilaspur

ABSTRACT- This paper proposed scheme reduces overheads on Utilities in handling meter reading and billing for water distribution in metropolitan and large urban conglomerates.The smart metering approach proposed differs from existing commercial methodologies by making use of low cost IoT hardware and smartphone app.This scheme permits both Meter Reader as well as individual domestic / industrial consumers to use regular smartphones to perform meter reading and update to utility's portal / database for billing and payment.

KEYWORDS- IoT, AMR, customer relations and billing, smartphone, water distribution system, Municipal Utilities.

INTRODUCTION- The world is increasingly looking forward to new technologies to improve quality of life as well as reduce impact of human activities and consumption on environment.Thi paper describes a novel Smart meter implementation architecture that permits both online and offline methods especially for areas with poor / unreliable cellular network coverage. Water Utilities have traditionally looked at managing water distribution. Which was as a sensitive task with basic human approach. which sometimes result in uneconomically high cost of water management[1] and skewed cost-sharing arrangements among different categories of society. The main revenue for water utilities have been through Billing for consumption. This paper proposes implementation of smart water distribution metering approach suited to the countries with limited development in infrastructure and growing populations and little expansions to urban habitat. Availability of clean water and its increasing demand from urbanizationand population growth in cities.Thus, the cost of management of water transmission, storage, treatment, distribution and billing for consumption are serious issues in underdeveloped and developing countries.

SMART METERING AND CRBMS-

A. CRBMs FOR WATER DISTRIBUTION

Municipal Water Supply utilities implement CRBMs[2] to improve revenues, to improve operations and maintenance, to cut down on non-revenue water costs including leakages, losses, unmetered discharges, etc[3][4][5].Dynamic and real-time updates to CRBMs help in reduction of billing periods. Real time update of metering data to CRBMs call for optimized infrastructure and methodologies in bringing remote meter data to Utility Office through a secure, reliable, cost-effective approach.3- or 2-month billing cycle to 1-month cycle. improve response to customer complaints, help respond faster to incidents such as pipeline leakages and breakdowns[6], achieve re-organization of water traffic in case of unforeseen disruptions[7], etc.

B. AUTOMATED METERING AND SMART METERS

Traditionally, Smart Water meters uses electronics interface to the Consumption Register module on the Water-meters to capture information such as Consumption, Register Tamper (Tamper-proof Flag Status), unique ID of meter, etc. Smart metering has been looked upon as Automated Meter Reading (AMR) to cater to Billing requirements of the Utility.Alternate techniques of AMR rely on the use of handheld radio orvehicle mounted radio (RF Transceivers) that poll the water meters for consumption and meter integrity data.These meters are fundamentally Water-meters with an ON/OFF Solenoid Valve and Electronic module that records consumption as well as reads Pre-paid Card (serial EPROM/ Smartcard /RFID Card) as well as drives the Valve OPEN or CLOSE.One commercial implementation of Meter Reading comprises AMR modules on each water-meter communicating by RF to a Data Concentrator Unit (DCU) that accumulates data from up to 16 to 32 Meters.

THE SMART METERING SYSTEM

SMART-METER PROTOTYPE WITH EXTERNAL EIM- The tamper-flag is fundamentally a combination of spring-loaded switch that detects forceful detachment of pick-off from the water-meter, and a secondary sensing by Hall-effect device to detect presence / shift of strong external magnetic field in the meter vicinity.Tampering by use of an external magnet typically causes locking of pulse output signal stream from meter register.The EIM has two tamper Flags, one corresponding to Register-tamper (cut-off of pulse signal) due to forceful mechanical tampering and the other corresponding to Tamper signal from Hall-effect based sensor that senses a strong

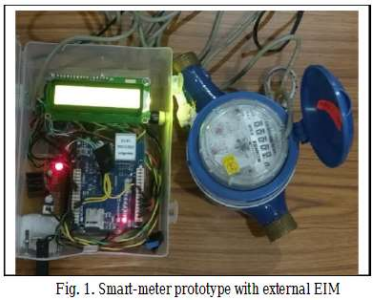
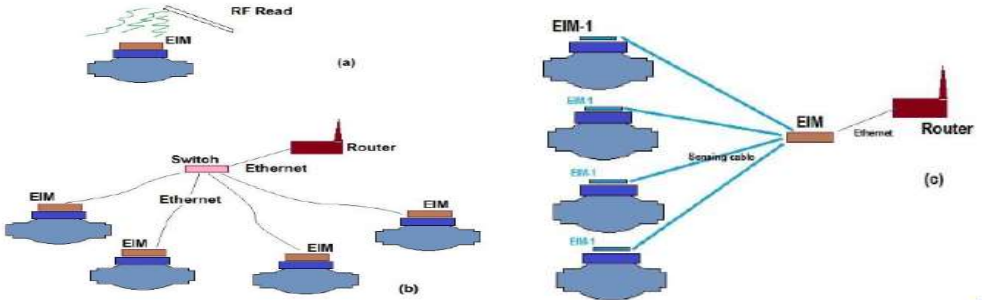


Fig. 1. Smart-meter prototype with external EIM

external magnetic field (due to use of an external magnet).

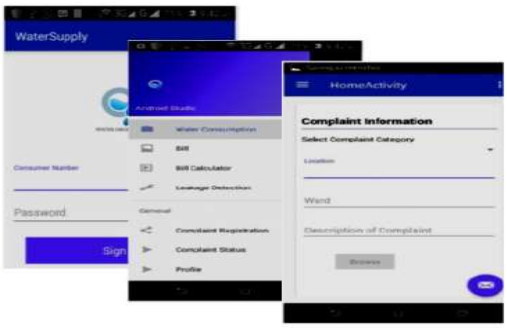
SMART METERING ARCHITECTURE-The proposed Smart-Meter system architecture for water distribution operations and CRBM comprises of following different options.

a) Meters with EIM transmitting data to Smartphone (over Wi-Fi or Bluetooth)-The smartphone Metering App is responsible for sending query to poll the meter reading information including date-time stamped consumption, tamper flag and meter ID.This type of system isonly recommended for standalone Bulk Water meters used for large consumption metering or distribution branch pipeline flow monitoring.
b) Meters with EIM connecting over Ethernet to Router. Regular Routers for GSM/3G/4G or Optic-fibre could be used for connectivityto Utility over Internet.No separate expensive Data Concentrator module required.



c) Meter EIMsvariant that interface to multiple Meters No separate expensive Data Concentrator module required.Meter EIMs of this type would be wired to communicate digital serial data over two wires. In this approach a smartphone App is not essential for metering operations.

SMARTPHONE APP FOR METERING AND DIAGNOSTICS-The Smart Meter reading and diagnostics application has been developed using Android SDK and Java.The smartphone App permits update of meter consumption record to the CRBM after secure login access to the CRBM, view consumption records pertaining to previous Billing cycle, etc Fig.3.shows screenshots from the developed smartphone App.The App permits access to CRBM record on Monthly consumption for the Registered Meter to help reveal consumption trends of the individual user.It is prepared as a multiple screen application that permits user to configure and tag the associated Water-meter with the Consumer ID and Address details at the CRBM system.This data may help consumer to assess losses, over-limit consumption, etc.



ASSESSMENT OF WATER CONSUMPTION AND LOSSES-Analyses of these yielded information on water loss, enabled steps to be taken for improving water conservation measures, etc.A preliminary assessment on water loss evaluation and conservation was undertaken on a small section of water distribution network at the Institute campus. The water loss on account of various factors such as pipeline joint leakages underground, faulty water-meters, defective faucets and water-taps, overflow water loss due to aged / broken float-valves, dripping losses through garden water hoses, etc.within the small community.Data Analytics at the CRBM would provide information such as consumption patterns for each type of consumers, identify and evaluate changes in these patterns, look for trends in consumer demands, verify consumption data for suspect consumers and conduct audit to identify avoidable leakages, pipeline pilferages and breaks, etc.

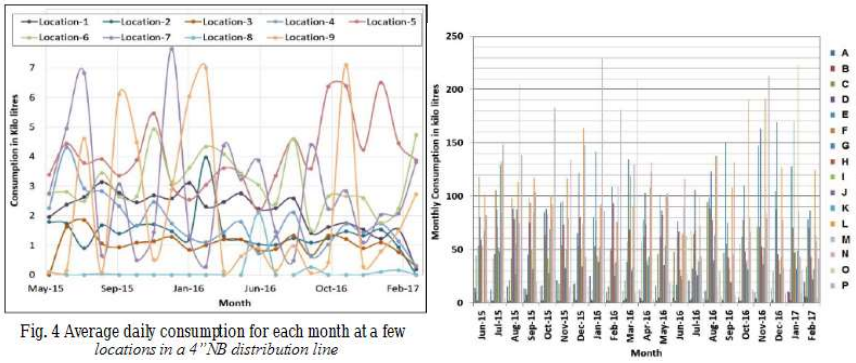


Fig. 4 Average daily consumption for each month at a few *locations in a 4"NB distribution line*

CONCLUSION-A novel system for implementing an economic and reliable smart water distribution metering using IoT based hardware and smartphone App is discussed. The features of prototype system and the benefits are discussed. The novel approach overcomes disadvantages in certain smart-meter systems such as tampering in pre-paid water-meters that often go undetected due to standalone nature of pre-paid meters; tampering or unauthorized Top-Up updates to pre-paid meter smartcards using hacking software, etc. The proposed architecture also overcomes connectivity issues typically seen in DCU architectures when DCUs are installed near Meter banks in basements or areas with poor / unreliable cellular signal strengths. The work is being extended to cover a range of Distribution metering and Unaccounted for Water issues faced by utilities while giving direct and intangible gains to the consumers in the changing smart infrastructure scenario in urban areas.

REFRENCES-

[1] M. J. Mudumbe and A. M. Abu-Mahfouz, "Smart water meter system for user-centric consumption measurement," in *Proceeding - 2015 IEEE International Conference on Industrial Informatics, INDIN 2015*, 2015.

[2] M. Baka and M. Aziz, "Implementing a novel IT Governance Framework - A case study the Abu Dhabi Water & Electricity Authority," in *2010 2nd International Conference on Engineering System Management and Applications, ICESMA 2010*, 2010.

[3] A. Knobloch, N. Guth, and P. Klingel, "Automated water balance calculation for water distribution systems," in *Procedia Engineering*, 2014.

[4] J. Sirkiä, T. Laakso, S. Ahopelto, O. Ylijoki, J. Porras, and R. Vahala, "Data utilization at finnish water and wastewater utilities: Current practices vs. state of the art," *Util. Policy*, 2017.

[5] J. Wang, R. Cardell-Oliver, and W. Liu, "Discovering routine behaviours in smart water meter data," in *2015 IEEE 10th International Conference on Intelligent Sensors, Sensor Networks and Information Processing, ISSNIP 2015*, 2015.

[6] T. C. Britton, R. A. Stewart, and K. R. O'Halloran, "Smart metering: Enabler for rapid and effective post meter leakage identification and water loss

management," *J. Clean. Prod.*, 2013.

[7] P. F. Boulos, L. B. Jacobsen, J. E. Heath, and S. Kamojjala, "Real-time modeling of water distribution systems: A case study," *Journal - American Water Works Association*. 2014.