Centre for Communication Systems Research-The University of Surrey

Smart Metering System for the UK

Technologies review

Professor Rahim Tafazolli

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The UK government has mandated that every home and small business should have an electricity and gas smart meter installed by 2020. The Department of Energy and Climate Change (DECC) have instigated the Smart Metering Implementation Programme (SMIP) in order to deliver against this objective.

This report reviews the potential communications solutions for provision of an end to end smart metering system in the UK in a cost and time effective manner. It compares technical and technology solutions against the DECC targets and requirements in terms of speed of deployment, service reliability and availability, maturity of technologies and the important issue of security and understating of customer requirements.

An important issue that influences the choice of communication technology is the business and technology roadmap of the system, which initially is set to provide smart metering services, but should also be capable of providing future value added services such as smart home, smart grids, e-health etc.

The main conclusions of the study are;

No single technology can provide a complete end-to-end system

Cellular technologies are by far the more suitable option for smart metering compared to proprietary solutions. This choice is influenced by economies of scale, clear roadmap of technology for many years to come, robust end to end security and service reliability, already widely deployed networks and experience of mobile cellular operators in flexible SLA (Service Level Agreements). Also a good understanding of customers' needs is extremely important and should not be under-estimated.

The recommended smart metering solution is cellular technology complemented with small scale RF mesh networking. This provides the right balance between existing coverage capability of cellular and the ability to provide services to smart meters which could be located in hard to reach areas, such as deep indoor positions and in buildings with high penetration losses. Investigations on service availability and UK postcode coverage show that cellular systems already provide extensive coverage for a two-way smart metering system.

INTRODUCTION AND PROBLEM

Smart metering is a key enabling technology for managing energy systems more efficiently in the future and providing new information and services to consumers which reduce costs and carbon emissions[1].

The information provided helps customers in becoming energy aware and make smart decisions about energy usage and give them control over their energy cost. An interoperable smart metering system is essential in giving choice to customers in switching between energy providers as often as they wish. It will help suppliers to better understand customers and their demands. It is also an effective tool for accurate monitoring and management of distributors' networks.

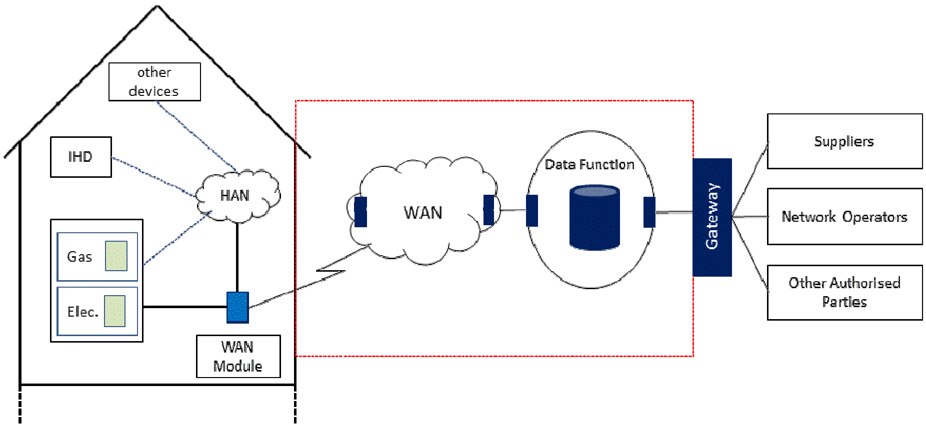
Smart metering is considered to be the foundation of Smart Grids, providing a two way link between the grid operators at one end and customers at the other. This link will allow demand response signals to be sent to the customer in order for them to choose to manage their demand in return for reduce energy rates. This also links smart metering into home automation technology. Security of user information and system are essential parts of this system. The generated data is used for controlling supply and display energy usage for a customer. It enables central collection of billing and usage data and provides economic benefit to energy producer and suppliers.

THE UK SMART METERING IMPLEMENTATION PROGRAMME

a. Government's ambition for every domestic and small business to have a smart meter (electricity and gas) by 2020.
b. Providing connectivity to these in all the different building types and geographies and achieving a first time installation success rate is the challenge.
c. Also being able to use the smart meter and communications hub to develop future new products, services and innovation (smart home, smart grid, smart cities, e-health, home security etc)

The major system elements consist of Smart Meters (SM), the Home Area Network (HAN), In-Home Display (IHD), and the Wide Area Network (WAN).

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42740/1485-impact-assessment-smart-metering-implementation-p.pdf



Smart Metering System Elements

The Data Communication Company (DCC) will manage the overall SMIP eco-system sub-contracting the Data and Communications Services to the Data Services Provider and the Communications Services Provider. Smart meters require a secure two-way communications among all elements to share data about grid condition with a central communications and data management facilities.

The main engineering challenges, even though the basic architecture looks simple, are;

- 100% coverage of all premises needed – or aspired to;
- Speed of service roll out to the whole UK premises by 2020;
- Understanding of customers' needs;
- Absolute security of personal data to be assured;
- Overall network to be secure against attacks;
- Cost of Wide Area Network (WAN);
- Annual operating costs for communication between energy companies and their meters/users; and
- Solution to last minimum 15 years

Location within a building of the SM and selected technologies for WAN and HAN are fundamental consideration for installation and operation of the system and in meeting the SMIP targets.

Fast roll-out of system nationwide can be only realised if smart metering is part of an already deployed WAN infrastructure. Starting from a clean slate will, with no doubts, lead to deployment delays, patchy coverage and non-uniform service availability. It should not be underestimated the time it takes to acquire the appropriate permissions and way leaves to build new infrastructure.

The adopted technologies should have an established global market for economy of scale with no inter-operability issues in the general sense. Inter-operability is assured with standardised and agreed interfaces at all levels (service, protocols, and devices) supported by international standardisation bodies with clear road-map of evolutions for many years to come.

Another important consideration is reliability of chosen technologies. As Smart Metering has users directly involved, the chosen technologies should have been fully tested and optimised before it is offered to customers.

More importantly experience of understating customers' needs, their confidence in security/privacy and customer service cannot be underestimated. It is an extremely important need to build or to have a huge amount of experience before major roll-out.

This report is focused to large extent on review of available technologies in meeting SMIP targets and the above technical challenges in reducing the implementation risk. It starts with a review of candidate technologies for WAN and HAN. It then provides a solution and a set of recommendations to be considered for a sustainable and evolving smart metering system for the UK.

POTENTIAL TECHNOLOGY SOLUTIONS

The main system elements involved in the smart metering communications system with nationwide coverage are:

- WAN Module: A device which connects the premises via a Wide Area Network to the Data Services Provider (DSP)
- NAN: Neighbourhood Area Network which forms part of the WAN at a local level
- HAN: Home Area Network to which all meters will be connected, and connecting also to other energy consuming/producing devices
- Smart Meters: electricity, gas, later perhaps water, etc
- IHD: In-House Display, the interface for the users to the Smart Meter and HAN.
- Other HAN Devices: The availability of a low data rate link to all homes may in future permit other services e.g. smart home devices
- Data Services Provider: Providing data aggregation services for the Data Communications Company

From a radio coverage perspective, there is no single technology available today that is designed to 100% provide coverage in particularly harsh radio environments specific to smart metering. The system has to provide two-way data links for meters in difficult radio environments such as under stair cases, basements, and old and new buildings with different construction materials.

The pragmatic solution is combination of different technologies spanning WAN and NAN. To minimise deployment, operation and capital costs the coverage, where possible, should be provided by tried and tested Wide Area Network (WAN) technology. The remaining small areas, where WAN can not economically provide adequate coverage, that is mainly in harsh radio environments, appropriate and purpose-developed NAN technologies should be deployed in a seamless complementary manner between the two system elements.

WIDE AREA NETWORK TECHNOLOGY OPTIONS

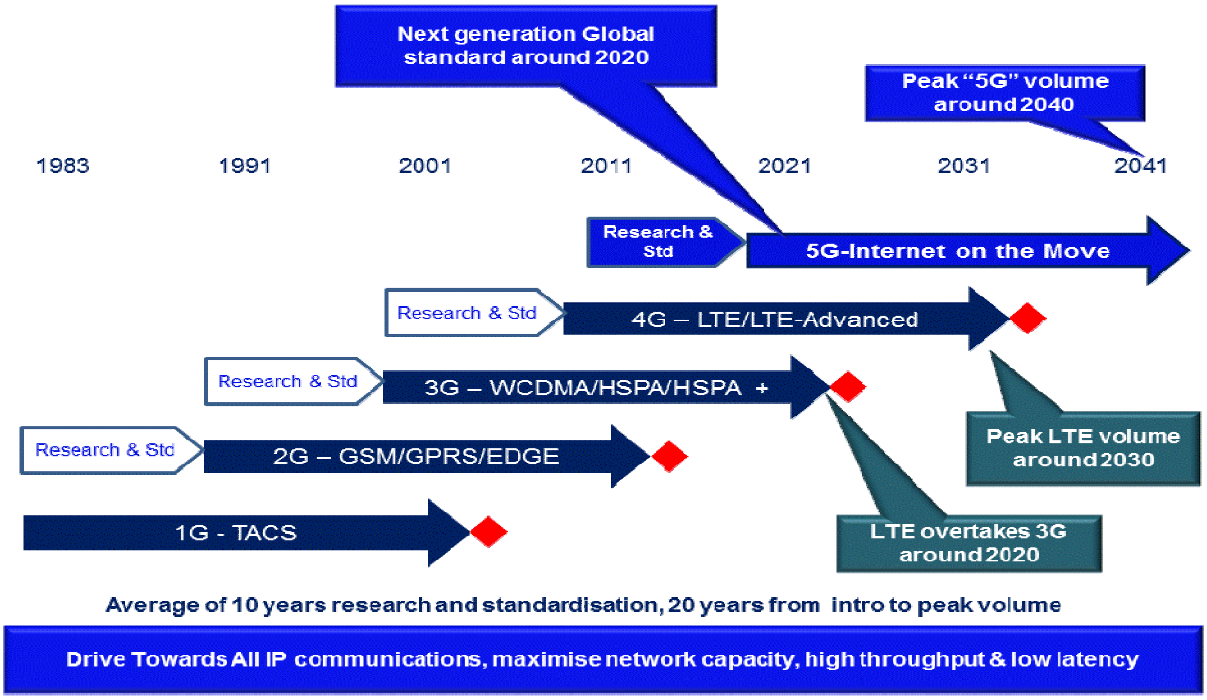
There are many technology candidates for wide area networking. The options range from standard cellular mobile technologies 2G/3G/4G[2] to proprietary technologies such as RF Mesh Networking[3], Long Range Radio[4] and satellite networks. Other wired technology candidates are ADSL and PLC[5] (Power-Line Communications).

[2] http://www.3gpp.org/specifications
[3] Akyildiz, I.F., Wang, X. and Wang, W., Wireless Mesh Networks: A Survey,

Proprietary solutions such as Long range radio, PLC, RF mesh, and even satellite networks suffer from low economies of scale and lack of industry support for their evolution in support of new services and applications. An important point for consideration is the ease of future integration of smart metering system with mobile devices which is easily facilitated with cellular systems, whereas it is costly and not supported with proprietary WAN solutions. Satellite networks are good for remote connectivity but do not have sufficient link budgets to be available in built up areas. Wide Area Mesh networks suffer from capacity as the number of nodes increases leading to uncontrollable delays and instability in system performance.

Cellular Technology

Cellular technologies are continuously evolving with higher speed capabilities, rich data services capability and with vast existing coverage footprint.



Evolution of Cellular standards

Computer Networks Journal (Elsevier), March 2005

[4] http://smartreach.com/meeting-the-challenge/

[5] Power Line Communications, "Theory and Applications for narrowband and Broadband Communications over Power Lines", Hendrik C. Ferreira, Lutz Lampe, John Newbury, Theo G. Swart, Wiley, ISBN 978-0-470-74030-9

LONG RANGE RADIO

There are some candidate technologies based on Long Range Radio4,6 and proprietary solutions at 412MHz. The main justification is better radio propagation for penetration into buildings to reach smart meters compared with the higher frequencies. Travelling of long distances brings about other issues such as reduced frequency re-use, containing interference and hence lower area capacity specially when the system matures and new added services are available. Other important issue is the form factor for smart meters which require larger antennas compared with higher frequencies. From building penetration losses perspective, as will be shown later, there is no significant differences between this frequency and that at 900MHz. Also, with proprietary networks they don't enjoy the ongoing investment or have the established and growing developer community of say cellular networks. Adoption of LRR for the UK smart metering system would not be recommended.

POWER LINE COMMUNICATION TECHNOLOGY

Power line communications, are not suitable due to many technical reasons such as:

Low frequency PLC: This method works by modifying the normal 60-cycle sine wave of the alternating current on the electrical wires. The pulse is added when the voltage passes zero on the alternating current. It has been argued that this type of system is safe because of the low frequencies. However, there are reports of sensitive people having much trouble with this type of system even a dozen feet away from any electrical line or household wire. This is probably because of the "dirty power" which turns the wires into unintentional antennas[7].

- Medium-frequency PLC: This technology adds to the electrical lines a signal that is similar to the "dirty power" created on the wires by electronic equipment (computers, televisions, etc.). The method has been used in the past to bring AM radio to remote areas of Germany, Switzerland and the Soviet Union. Listeners could simply pick up the signals radiating off high-tension power lines in the area, using an ordinary AM radio. Switzerland transmitted several stations on the same power line, using frequencies from 175 kHz to 340 kHz. Some meters also use this method to transmit data to the utility. They tend to use frequencies in the 50 kHz to 100 kHz range. These signals do not travel far and can be blocked by transformers, so this method is mostly used in areas where several homes share a transformer.
- Broadband PLC: It transmits high-frequency waves over the power line, usually in the 1 to 30 megahertz range. This gives a much higher transmission capacity than the low- and medium-frequency methods. The system has been contested by amateur radio groups and short-wave radio broadcasters as the power lines act as giant antennas and interfere with their radios. The British industry group Electromagnetic Compatibility Industry Association (EMCIA) has also protested, contending the radiation from the power lines interferes with telephone systems, especially DSL/ADSL internet services.

- Dirty electricity on the household wires: When electrical signals travel on an electrical wire, it will radiate as an antenna. Wires that are intended to carry communication

[6] https://www.airwavesolutions.co.uk/home/
[7] www.eiwellspring.org

signals are usually twisted or shielded, as is done with telephone cables, computer networks and cable TV. This greatly limits the radiation from the wires. Household electrical wiring was never intended to be used for communication signals, so it is not twisted or shielded and therefore radiates more readily than telephone lines carrying DSL, computer network lines and cable TV connections. The telecommunications industry is well aware of this phenomenon, and is making sure that the frequencies used to transmit on the electrical wiring are chosen so they do not interfere with broadcast transmitters. The British Broadcasting Corporation (BBC) has early on studied the issue:

. . . there is the difficulty for radio-system users that the signals PLT [Power Line Telecommunication] injects do not simply travel from point to point along the wiring, they also escape as radiated emissions (emphasis in original)[8].

WIRELESS MESH NETWORKING[9]

When n identical randomly located nodes, each capable of transmitting at W bits per second and using a fixed range, form a wireless mesh network, the throughput $\gamma(n)$ by each node for a randomly chosen destination is $\boldsymbol{\theta}\left(\frac{W}{\sqrt{nLogn}}\right)$ bits per second under a non-interference protocol.

If the nodes are optimally placed in a disk of unit area, traffic patterns are optimally assigned, and each transmission's range is optimally chosen, the *bit–distance* product that can be transported by the network per second is $\boldsymbol{\theta}\left(W\sqrt{An}\right)$bit-meters per second. Thus even under optimal circumstances, the throughput is only $\boldsymbol{\theta}\left(\frac{W}{\sqrt{n}}\right)$ bits per second for each node. Similar results also hold under an alternate physical model where a required signal-to-interference ratio is specified for successful receptions.

Fundamentally, it is the need for every node all over the domain to share whatever portion of the channel it is utilizing with nodes in its local neighbourhood that is the reason for the constriction in capacity.

Splitting the channel into several sub-channels does not change any of the results.

Implication to note: the throughput furnished to each node diminishes to zero as the number of nodes/hops is increased. Acceptable performance from wireless mesh networking is only achievable in small network scales i.e, smaller numbers of nodes featuring connections mostly with nearby neighbours.
Stand-alone wireless-mesh network is not a viable solution for WAN due to instability in capacity and excessive delay caused by uncontrollable interference.

[8] BBC White Paper 099 by Jonathan Stott, November 2004.

[9] Piyush Gupta, *Student Member, IEEE,* and P. R. Kumar, *Fellow, IEEE, "The Capacity of Wireless Networks", IEEE TRANSACTIONS ON INFORMATION THEORY, VOL. 46, NO. 2, MARCH 2000*

WAN Technologies Comparison

The table below shows a quick comparison between WAN candidate technologies.

3G	2G (GPRS)	Long-Range Radio	Mesh WAN	PLC WAN	
2,000	40		9.6-100+	Several to 100+	Data rate (kbps)
<1s	~1s		1-60s	<1s	Delay
YES	YES	No	No	No	Global standard
YES	YES	No	No	No	End-to-end tested Security
YES	YES	No	No	• No • Very difficult	QoS mechanism
Yes-mix of services Evolution to 4G, 5G	Yes-mix of service Evolution to 3G	No	No	No	Service evolution capability
Easy to integrate with mobile phones/devices	Easy to integrate with mobile phones/devices	difficult	difficult	difficult	Integrated services
• YES (revert to SMS) • Proven interference management	• YES (revert to SMS) • Proven interference management	No	• No • Uncontrollable interference	• No • Interference at high voltage transformers and interference to other devices and services specially low frequency broadcast service	Robustness
Fast	Fast	slow	slow	slow	Nation-wide Deployment timescale
3G	2G (GPRS)	Long-Range Radio	Mesh WAN	PLC WAN	

The cellular standards are the main contender technology for WAN. The WAN element of smart metering should start with GPRS, supported in 2G, and evolve to 3G, 4G and 5G when commercially viable and when more capacity and richer services are needed to be supported in the smart metering system. Mesh networking is an appropriate complementary technology to Cellular system only when deployed in small scale for environments where cellular coverage is limited by building penetration losses.

NEIGHBOURHOOD AREA NETWORK TECHNOLOGY OPTIONS

Unlike WAN, the available wireless technologies for NAN are IEEE standards such as 802.11x family and ZigBee[10] (based on IEEE 802.15.4)[11] standard. For wired-technologies the options are PLC or ADSL.

For the reasons mentioned above it can be concluded that PLC is not a viable solution for HAN from economic, interference and technology evolutions in support of future services points of view. The IEEE802.11x standards are not suitable for low power smart metering and are generally cannot provide the expected stable QoS (Quality of Service) due to the wide spread deployment of WiFi. Additionally the customer privacy cannot be guaranteed without excessive modifications to IEEE standards.

ZigBee provides higher layer protocol stacks to complete the IEEE 802.15.4 lower layers of the Physical Layer and Media Access Control (MAC). The IEEE standard 802.15.4 is specified for low-rate Wireless Personal Area networks (WPANs). The higher layer protocol stacks provided by ZigBee consists of network layer, application layer, ZigBee device objects (ZDOs) and manufacturer-defined application objects.

In addition to the two higher layers to the underlying structure, the most significant improvement is the introduction of ZDOs. These are responsible for a number of tasks, which include keeping of device roles, management of requests to join a network, device discovery and security.

The ZigBee nodes can go to sleep for a long time, hence average power consumption is very low, resulting in long battery life. ZigBee nodes can go from sleep to active mode in less than 30ms so the latency can be low in responding to messages.

They operate in master-slave relationship between devices in a house hold (slave node) and smart meter (master node). ZigBee is an all-IP solution and supports IPv4 and v6 wireless mesh-networking at 868MHz (in Europe), 915MHz (in the USA and Australia) and 2.4GHz in most countries in the world.

Low power-usage and operation in 868MHz allow longer battery life and longer range. Data transmission rates vary from 20 kbps in the 868 MHz frequency band to 250 kbps in the 2.4 GHz frequency band. The ZigBee network layer natively supports star, tree and mesh networking topologies. Every network must have one coordinator device (master), tasked with its creation, the control of its parameters and basic maintenance. Within star networks, the coordinator must be the central node. Both trees and meshes allows the use of ZigBee routers to extend communication at the network level providing topology flexibility that can be adapted to different local environments making it an ideal NAN solution for smart metering system in the UK .

[10] http://www.zigbee.org/Standards/Downloads.aspx

[11] http://standards.ieee.org/getieee802/download/802.15.4-2003.pdf.

WHAT IS THE BEST APPROACH?

FROM TECHNOLOGY AND BUSINESS POINT OF VIEW

There are only two primary WAN options available for smart metering, the second-generation (2G) and third-generation (3G) cellular standards. Most cellular point-to-point Smart Metering infrastructures today are part of Global System for Mobile Communications (GSM) networks and use the General Packet Radio Service (GPRS) data service, a low-cost 2G solution. GPRS provides the best starting point for the WAN segment of the smart metering solution and if commercially viable should also look to use the new higher speed services available from EDGE, (Enhanced Data Rates for GSM Evolution), or 3G technology. This will allow the infrastructure to take advantage of the opportunities of additional revenue-generating services such as value added services. Other benefits of cellular technologies are listed below.

Value of Cellular technologies to Smart metering System	
Real-time Communications	Average latency in order of milliseconds
Large Coverage	>98% U.K. population is covered
Standard Based	Backed by 3GPP and 3GPP2 bodies
Affordable Cost	Connectivity cost decreasing continuously
High Scalability	5 billion + connections worldwide
Reliability and Security	Used in government and finance sectors

Wireless mesh networks enjoy distributed functionalities and control and designed for cost-effective networking solutions to a specific and "limited" area such as home or battlefields where there is no specific infrastructure available. The main disadvantages of wireless mesh networks for large area coverage is lack of fast response to changes in network topologies and hence resulting in unpredictable service availability, capacity and quality of service. Currently there is not any large scale deployed wireless mesh network for commercial use. Theoretically capacity in "large" wireless mesh network deceases roughly as a square root of number of hops/links[12] making it unreliable for wide area networking. This instability in capacity leads to

[12] Piyush Gupta, *Student Member, IEEE,* and P. R. Kumar, *Fellow, IEEE, "The Capacity of Wireless Networks"*, IEEE TRANSACTIONS ON INFORMATION THEORY, VOL. 46, NO. 2, MARCH 2000

unbounded delay in the network. Wireless mesh network technologies are only suitable to fill in spots in extremely difficult radio environments in a complementary fashion to wide area cellular systems.

Stand-alone wireless-mesh network is not a viable solution for WAN+HAN due to instability in capacity, excessive delay caused by uncontrollable interference

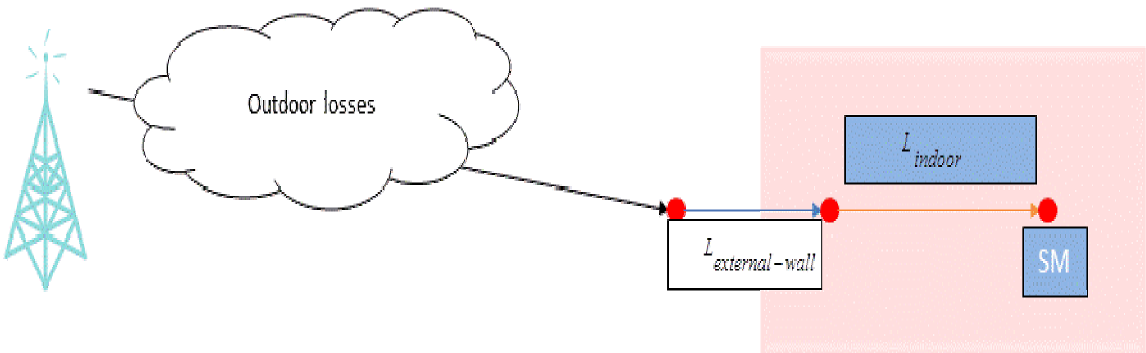
From Radio Coverage Point of View

Radio coverage to smart meters which are sometimes located in challenging radio environments in conjunction with needing to meet the DECC target of close to 100% population coverage is an essential consideration. In definition of the coverage, it is assumed as smart meter (currently known as population) coverage rather than land coverage.

Here we evaluate through a link-budget-analysis of “land coverage” availability of cellular systems and compare that with existing “population coverage” provided by such systems as well as coverage of proprietary Long-Range Radio solutions at 412MHz. For cellular system 2G technology at 900MHz is considered taking into account smart metering specific radio environments.

The question here is whether a single technology alone can meet the population coverage target set by DECC cost effectively. If not, what possible pragmatic solution is out there to deliver this target as well as another important target set by the DECC which is all home in the UK should have smart metering by 2020.

The following picture shows an end-to-end radio link that a signal has to travel in different environment and suffer from different fading and losses in delivering a reliable two-way smart metering system.



End to End Propagation losses in Smart Metering System

The total end-to-end path-loss:

$$L_{total} = L_{outdoor} + L_{exterior-Wall} + L_{indoor}$$

For $L_{outdoor}$ COST 231 model[13] is used

For Building Penetration loss (BPL) of $L_{exterior-Wall} + L_{indoor}$, several sources are used[14] [15] [16]

Transmitter Parameters		Downlink		
		BS	Units	
Transmitter RF Peak Output Power	Ptx	20.0	W	max power (GSM 900 BTS Class 5| GSM 05.05 Mobile Power Class 4)
as above in dBm	PdB	43.0	dBm	= 10*log Ptx
Combiner+Cable+Connector Losses	Lcc	-3.0	dB	
Tx Antenna Gain	Gtx	16.0	dBi	
Equivalent Isotropic Radiated Power	EIRP	56.0	dBm	= PdB + Gtx - BL-Lcc
Receiver Parameters		Smart Meter	Units	
Receiver Sensivity	Rx_c	-105.0	dBm	2dB & 4dB better than GSM 5.05 reflects equipment development
Rx Antenna Gain	Grx	0.0	dBi	
Diversity Gain	DG	0.0	dB	
Required Isotropic Power	Prx	-105.0	dBm	Rx+Lcc-Grx-DG+BL
Maximum Allowed Path Loss	PLmax	161.0		= Tx EIRP - Prx
Link Loss Calculations		D/L	Units	
Interference Degradation Margin	IDM	2.0	dB	SM location with good planning result in negiligible interefrence
Static/Fast Fade Margin	FFM	6.0	dB	Required as Meter Stationary TU5 & Red-M Report "Smart Metering RF Study D.2 (.1, .2, .3, .4, .5), Suggested 3 to 6 dB - Red-M Report "Smart Metering RF Study" for DECC-June 2012
Building Penetration Loss	BPL	12.0	dB	O2 Trial at BRE - suggesting 12dB mean, Building Penetration Loss at 900MHz
Shadowing Fade Margin	SFM(L50)	8.0	dB	L50
Coverage Target	Cov	90.0	%	Ofcom Technical Parameter
Shadowing Fade Margin	SFM(L90)	10.2	dB	L90
Total Planning Uncertaintity	U(L90)	30.2	dB	= IDM + FFM + BPL + SFM(L90)
Allowable Propagation Loss(L90)		130.8	dBm	= Plmax - U(90)
Planning Level (L90)	**Lev**	**-74.8**	**dBm**	**= EIRP - PL (90)**
Target coverage threshold		**-75.0**	dBm	**Assuming 5km range, Typical urban area**

Link Budget planning for cellular based Smart metering System

It is important to note that, even with high Building Penetration Loss (BPL) of 12dBs, it is possible to provide good coverage in difficult urban indoor smart meters.

However, in rare harsh indoor environments that is typical to some UK buildings which are made of indoor material with high losses and with meters placed in "deep indoor" locations there is no significant difference between 900MHz and 412MHz (433MHz, assuming it is close enough) performance[17]. According to Tables 8 and 9, Page 17 of this reference the indoor loss (L_c) between 433MHz (close enough to 412MHz) and 869MHz (close enough to 900MHz) is 3dBs for purpose built flats and 5.5dBs for non-flat buildings.

The proposed model in this report is a good model providing an extremely close match with the measurements and the model. In this model, the indoor loss (L_c) is a frequency dependent parameter.

[13] http://www.lx.it.pt/cost231/final_report.htm

[14] Smart Meter RF Surveys, Final report, 8th June 2012, Dr Bachir Belloul, Red-M

[15] Propagation losses into and within buildings in the 800, 900,1800, 2100 and 2600 MHz bands Survey for Ofcom, Real Wireless, 19th July 2012

[16] BRE indoor measurement campaign by Telefonica/O2, 2013

[17] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/136124/smart-meters-rf-surveys-final-report.pdf

However, the above link budget is for 90% area availability (land coverage) which translates into 92.7%[18] of population coverage in all environment categories.

HOW TO ACHIEVE THE DECC COVERAGE TARGET

To achieve the population or postcode coverage target set by DECC. Based on existing coverage of cellular networks in the UK there are several options available to achieve this target:

1-Increase in the number of base stations

At the time of writing this report, encouraging news was received that the UK Chancellor of the Exchequer announcement[19] that the Government would invest up to £150m towards the capital expenditure costs of improving mobile coverage in what has become known as the Mobile Infrastructure Project (MIP).

2- Infrastructure sharing

Some operators are moving towards infrastructure sharing as in EE (Everything Everywhere) and O2 and Vodafone (called Beacon). Such infrastructure sharing is expected to increase population coverage by another 5% to 6% in addition to current[20] >92.7% making it 97.7% to 98.7% making it maximum of <2% short of the DECC target.

3- Use of RF Mesh Network

The remaining <2% coverage can be effectively provided by use of small scale mesh networks.

[18] http://www.mobiles.co.uk/coverage.html
[19] http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-marketreports/cmr12/telecoms-networks/uk-5.20and5.21
[20] http://www.mobiles.co.uk/coverage.html

Conclusion and Recommendations

It is clear that no single technology currently available that would satisfy all the engineering and business challenges associated with a smart metering system that meets the ambition of nationwide coverage and within the timeframe of 2020 as set by the DECC.

2G connections are expected to begin declining for mobile communications starting from 2014[21].Making available more GPRS capacity for smart metering which is expected to grow by a factor 20 in the next 10 years (2011-2021)[22].

Cellular operators have built up extensive experience and know-how in providing Quality of Service (QoS), Quality of Experience (QoE) and Service Level Agreement (SLA) with customers and with businesses. They have vast experience in understanding of the needs of customers in terms of communication and service range, security, reliability of service and billing. Equally important is experience of SLA in B2B making them ideal in leveraging on their experience in establishing SLAs with utility companies.

The cellular systems provide a combination of tested and proven technologies that have support of international standardisation to overcome potential inter-operability issues, have economy of scale with existing eco-system in place and with embedded in-design security and quality of service mechanisms. The cellular systems are already widely available and in service.

In the UK, GPRS currently provides service[23] to more than 98% of population. Providing service to machines which could be in extreme radio environment is not cost-effectively as a stand-alone network. The remaining few percentage coverage should be provided by RF Mesh network technology which can integrate and inter-operate with cellular system and provide similar carrier-grade security and reliability as in cellular network.

Stand-alone cellular network is not a viable solution for WAN +HAN from radio coverage point of view

Best solution for WAN is Hybrid of Cellular and “limited” Wireless Mesh Network

There is no one size fits all

- Cellular plus wireless mesh is the best solution
- Best investment choice for Great Britain for many years to come
- Natural investment and resource support for cellular

[21] Wireless Intelligence, Jul ’12
[22] Analysis Mason, May ’12
[23] http://business.bt.com/business-mobile/mobile/coverage-checker/

- Natural development community for mobile: Leading to great value add services in future
- Benefit of global scale with cellular technology: Continuously driving down component cost
- Global standard: minimising inter-operability at all level
- Cellular operators: understand customers better, bring in more than 27 years of experience dealing with customers and businesses
- Security, information privacy, quality of service and experience offered to customers is unique in mobile cellular business

ABOUT THE AUTHOR

Professor Rahim Tafazolli

www.ee.surrey.ac.uk/ccsr/

He is the Director of the Centre for Communications Systems Research (CCSR) and 5G Innovation Centre (5GIC), Faculty of Engineering and Physical Sciences, The University of Surrey in the UK.

He has published more than 500 research papers in refereed journals, international conferences and as invited speaker.

He is the editor of two books on "Technologies for Wireless Future" published by Wiley's Vol.1 in 2004 and Vol.2 2006.

He is currently chairman of EU Net!Works Technology Platform Expert Group, board member of the UK Future Internet Strategy Group (UK-FISG).

He was the lead academic on IoT UK Strategic Research, Development and Innovation Agenda, a study jointly sponsored by TSB and RCUK (EPSRC, AHRC and ESRC).

Recently, his team, he actively contributed to the Machine Type Communication to 3GPP RAN1 Technical Report (TR36.888).

He was appointed as Fellow of WWRF (Wireless World Research Forum) in April 2011, in recognition of his personal contribution to the wireless world. As well as heading one of Europe's leading research groups.