FAQ

Project Samuel – Grid Data and Measurement System (GDMS)

1. What exactly is Project Samuel?

Project Samuel was the code name for Reactive's demonstrator project with National Grid and SSE. The purpose of the project was to demonstrate Reactive's Grid Data Measurement System (GDMS) working in the field. The project started in April 2014 and ended successfully in March 2016. Ofgem funded project Samuel under its Networks Innovation Allowance (NIA) fund.

2. What is GDMS?

GDMS stands for Grid Data and Measurement System. GDMS is a broadcast communications and measurement technology invented and patented by Reactive Technologies that uses the frequency of the electricity network to transport data through it.

GDMS is a unique communications technology that allows connected devices to share information and enables remote control and measurement of power producing and consuming assets across electricity networks.

It has a range of potential applications including communicating with assets connected to the electricity network, and measuring and controlling their energy consumption or generation. It will lead to a wealth of insightful operational data from electrical assets and highly increase access to DSR programmes e.g. by residential customers.

3. In simple terms, how exactly does GDMS work?

Connected devices send and receive data across the electricity network through minute and subtle changes made to the grid frequency by modulating the power consumption of transmitting devices. These 'on' and 'off' or frequency

changes create a unique code. Receivers, embedded in the plugs of devices, such as freezers, hot water tanks and air conditioning equipment, are programmed to detect these frequency changes. Receiving devices then identify and decode the messages, which automatically tell the device to carry out a particular instruction, for example, to tell the device to take action such as turn down or turn off according to a schedule, or based on grid frequency changes.

GDMS allows for faster, automated responses from assets so they can be used for higher value, system-critical, load-balancing services like frequency response and also can yield valuable insights into the behavior of assets connected to networks.

4. So what's the bigger picture here? Why is Project Samuel considered to be such a major technological breakthrough?

Reactive Technologies successfully transmitted and received data through the entire UK electricity network during Project Samuel. Data has been proven to travel along electricity lines before, but only over very short distances (i.e. through an office building) as digital messages have been unable to cross the air gap in network transformers without the costly addition of repeater units on each transformer. This limitation makes such technologies financially prohibitive and consequently technologies such as Power Line Communications have been limited to localised applications. As far as Reactive and National Grid are aware, Reactive's successful demonstration of GDMS technology is the first time data messages have been successfully sent through an entire national grid network (transmission and distribution grids), making it **a world first.**

Having proved that nationwide communications can be achieved using the UK's existing electricity network, it will be possible in the future to communicate with any receiver device, regardless of its physical location. GDMS offers new ways

of communicating with devices that are plugged in anywhere to the electricity network independent of the internet or mobile telecommunications networks.

5. What's the main new benefit GDMS brings to providing DSR services?
GDMS is a broadcast technology that can communicate with any receiver device plugged into the electricity network. This means that by using GDMS, connected devices can receive specific and regular instructions about how to participate in DSR services remotely and at scale. The needs of electricity networks change over time, therefore the specifications of DSR services change over time. GDMS enables more sophisticated control by ensuring that assets enrolled in DSR services can be kept up to date with specific network needs. GDMS can update the parameters against which an asset should respond, for example what time of day, or what level of frequency should trigger a response. Without GDMS, each individual asset would need to be configured manually or via an internet connection and interface which is not always available. GDMS can communicate information to millions of devices in one go and can also communicate with specific groups of assets i.e. assets in one area of the country, to enable localized responses.

6. What is 'system frequency' and how is it being used in this project?
"System frequency" is the frequency of the electricity network. The frequency of the electricity network is maintained within a band of 50Hz at all times. This is done by maintaining a balance between supply of and demand for electricity on a second by second basis. The company responsible for ensuring that supply and demand are always balanced in the UK is National Grid. If supply and demand are not balanced at all times, the frequency of the system starts to move away from 50Hz. When the frequency moves outside of the safe band above and below 50Hz the system becomes unstable and could trigger automatic shut-downs in parts of the network leading to black-outs.

7. Why not just use the internet or existing telecoms network?

GDMS is a communications system specifically designed for use in electricity networks and offers features that cannot be provided by existing communications technologies. GDMS can be used to remotely verify if an asset or assets are connected to an electricity network by requesting a specific response to a message. If the asset or assets respond, they will create a unique pattern in the frequency of the network which the GDMS system can interpret. There is no other way to remotely verify the status of electrical assets that do not have individual controls systems, which includes most residential and commercial assets and a good number of industrial assets too. GDMS receiver devices measure frequency therefore can enable assets to participate in frequency based services which neither the internet nor existing telecoms communications technologies can offer. In addition, GDMS messages can travel to wherever power travels, therefore it benefits from extensive coverage using existing, secure infrastructure (the electricity network). This coverage is wide (corner to corner of the country) but also deep – messages reach all the way to individual assets at the end of the electricity line.

In addition, GDMS provides a communications channel for assets or devices that may not benefit from having internet access. For example, some remote geographic locations may have no, or limited or unreliable internet connectivity, but they will be connected to the grid. Extending the internet to these locations could prove prohibitively expensive and may not provide the reliable communications infrastructure required to operate services such as DSR. Some buildings and homes may have poor internet access, bandwidth issues or weak mobile network coverage. Signals may have to pass through several physical barriers before reaching an internet modem. In contrast, electricity supply to assets tends to be extremely reliable. By using the electricity network as the communications channel, GDMS provides an alternative, secure communications channel for greater numbers of assets, without having to spend money on ensuring they are internet enabled.

8. Is communicating via the existing electricity network more cost effective?

GDMS does not require any new communications infrastructure to be built so for places with no internet connection it is more cost effective and enables a means of communication where none existed before. GDMS offers a cost effective way to enroll assets into DSR programmes whether internet connected or not.

9. You say this is a 'world first' and that competitors have been trying to achieve this breakthrough for some time. What challenges have you overcome?

Sending and receiving data through local electricity networks, ie, a single building, is known as Power Line Communications (PLC). These technologies are limited in range and cannot propagate a signal through transformers or over long distances. The successful demonstration of GDMS is understood to be a world first in sending data through an entire electricity network over long distances and through transformers to all corners of the grid.

10. In terms of customers, who stands to benefit from Project Samuel?

There are many applications of GDMS, which is a communications and measurement technology; a few examples are described here:

DSR has traditionally been targeted at major energy users from the commercial and industrial sectors. GDMS could open up the domestic DSR market, allowing consumers to participate in these schemes and create new revenue streams.

GDMS can be used to measure the power generation or consumption profile of assets connected to the electricity network, eg, a solar or wind farm. Owners of generation assets, Transmission System Operators (TSO) and Distribution Network Operators (DNO) could all benefit from having greater visibility of how their grid assets behave on the network thanks to real-time data provided by GDMS.

GDMS will give electricity network operators greater insight into the behaviour of electrically connected assets that either generate, consume or store electricity. The data provided by GDMS will provide a clearer picture of how electricity is generated and consumed at the distribution network level. Such information is essential for operators tasked with balancing electricity networks which are becoming increasingly complex with the increased variety of assets connected to them such as distributed and intermittent generators like solar along with electric vehicles and batteries.

GDMS can generate data that will provide insights into the behaviour of complex energy networks and smart grids, creating intelligence that can be invested in further innovation, and in developing new social and business models that drive the digital revolution and energy transformation already underway.

GDMS will also allow network operators to reduce costs and pass savings on to electricity consumers by improving the accuracy of forecasting models and the purchase of energy reserves.

Consumers will benefit from GDMS as Transmission and Network Operators reduce costs and improve reliability and security on the networks.

11. Will you be offering the service directly to customers or through partnership arrangements?

We expect to build relationships with a range of stakeholders such as independent generators, Transmission System Operators, Distribution Network Operators, energy suppliers and utility companies, along with electricity consumers and prosumers to bring the technology to market.

12. Do you have any timescales for when you expect the service to be commercially available?

There are many applications of GDMS and some of those are closer to commercialisation than others. For example, we expect to be able to offer residential DSR services using GDMS technology in a few years' time.

13. Can you give me examples of 'demand-side loads'?

"Demand-side loads" are any devices that consume electricity such as fridges, air conditioning equipment, pumps or electric cars.

14. What sort of data could be transmitted through the grid?

The data that could be sent through the grid would be messages that instruct and asset to do something or request information from the asset. For example, a message could instruct an asset to do something (eg, turn up by 10% for 20 minutes at a certain time of day).

15. What is significant about the timing of this announcement? Do you have any statistics to support this project?

The National Infrastructure Commission estimates that Smart Power technologies, which includes technologies like GDMS, could save the consumer £8bn by 2030[1]

National Grid spent over £1bn on balancing the electricity system in the UK last year and estimates that this could double in the next five years to £2bn[2]. Traditionally these balancing services have been provided from power stations on the supply side of the electricity system. Earlier this year, National Grid announced that it would like to procure up to 50% of its balancing services from the demand side by 2020[3] marking a dramatic change in how the energy system will be managed in the future.

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[1] https://www.gov.uk/government/publications/smart-power-a-national-infrastructure-commission-report

[2] http://utilityweek.co.uk/news/Balancing-costs-could-double-to-%C2%A32bn-within-five-years-report/1257062#.V5H5_jWxmDb

[3] http://theenergyst.com/national-grid-launches-major-demand-side-response-push/

The Association for Decentralised Energy estimates that the industrial, commercial and public sectors could contribute 9.8GW of flexibility to the UK energy system which would deliver substantial benefits to those sectors and wider UK energy system.[4]

If the UK deployed 4GW of user-led DSR through the Capacity Market, the Association for Decentralised Energy estimates this would avoid the need for 50 new open cycle gas turbine power plants delivering a net saving to consumers of £600m by 2020 and £2.3bn by 2035[5].

16. We're hearing a lot about shrinking capacity margins. If rolled out on a larger scale, could this project help 'keep the lights on' in the UK?

GDMS can help to keep the lights on in the UK as it can help to increase the amount of DSR or flexible demand available to the electricity system. Flexible demand can be used to respond to emergency situations such as an unexpected trip from a power station or clouds rolling over a solar panel resulting in a sudden drop in the supply of electricity. Flexible demand can also be used to reduce peak demand on the system. This is particularly important on cold still days in winter when demand could be higher than the available supply from power stations, the riskiest time for black-outs.

17. Security will obviously play a significant part in the success of this project. What steps has Reactive taken to ensure the data remains secure?

GDMS is a broadcast technology, which means that it does not know (or broadcast) any private user details, just very high level service descriptors (e.g. water heaters in the south west of the country). Trusted encryption techniques can be used to ensure data security.

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[4] http://www.theade.co.uk/medialibrary/2016/07/19/e0bd71e7/Flexibility%20on%20demand%20full%20report.pdf

[5] http://www.theade.co.uk/medialibrary/2016/07/19/e0bd71e7/Flexibility%20on%20demand%20full%20report.pdf

18. What sort of new services are you expecting GDMS to unlock?
GDMS will allow the residential sector and other hard-to-reach assets and sectors to participate in demand response programmes. This is because GDMS is a low-cost solution for communicating with assets plugged in to the electricity network. Without GDMS, assets need an internet or cellular connection and an individual meter which can be financially prohibitive for smaller assets. Once GDMS enables these assets to be communicated with remotely through the electricity network, new services will need to be developed to reward their participation. Currently balancing services are designed to enable the industrial, commercial and public sectors to participate.

19. National Grid has commented: "We're in the midst of an energy revolution with a shift to demand side response, an exponential rise in renewables and the uptake of new technology," What is Reactive's view on this?
The energy sector is undergoing a fundamental transformation. Two thirds of existing generating capacity is due to shut down by 2030 (Smart Power report) – the majority of this being coal, gas and nuclear. While new gas and nuclear plants are forecasted to come online in that time frame, wind and solar are due to fill much of this gap to support the UK's binding decarbonisation targets. This is significant because in order to reach the same output, the electricity-generating network will be made up of many smaller generators.

These generators will have a less flexible supply profile as you cannot turn wind and solar up or down in the same way you can with coal or gas.

Also the system will have less elasticity, or inertia, to absorb shocks to it. This creates a significant challenge for the system operator, National Grid, when tasked with maintaining the balance of supply and demand on a second-by-second basis.

Duncan Burt, Head of Operate the System at National Grid announced National Grid would procure over 50% of its balancing services from the demand side by 2030, underlying the shift to rely on the demand side to keep the system in balance.

These dynamics create an urgent need for sophisticated forecasting; measurement and communications technologies to ensure the lights stay on. This is at the heart of what Reactive does.

The energy sector has relied on mechanical and electrical engineering to meet its technical needs. Now it is time for change. RT brings sophisticated communications engineering to the energy space offering radically different solutions that can address these critical issues.

Another critical issue facing the energy sector is that the capacity margin, the difference between available generating capacity and forecasted demand, is at a low level. Last year alone there was a net reduction of generation capacity in the UK of 4.4GW, the great majority of that being coal fired power stations. Measures are urgently needed to help to reduce the levels of peak demand on the system particularly during winter months. This supports the need for a dramatic increase in demand side management and demand flexibility.
http://media.nationalgrid.com/press-releases/uk-press-releases/corporate-news/future-energy-scenarios-2016/

20. What's the next step for Reactive Technologies?

Reactive is now focusing on building further partnerships with interested corporate partners to bring the technology to market in the UK and overseas with parties such as distributed generators, network operators and energy suppliers along with electricity consumers and prosumers.