A Smart Start for Britain:

building an intelligent foundation for the nation's smart grid

Smart Metering

Response to Ofgem Prospectus (Part II)

T-Systems Limited

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T-Systems

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28th October 2010

Dear Ms Coaster,

<u>Response to Ofgem's Smart Metering Prospectus and supporting documents (Part II, 28th October deadline)</u>

We are pleased to enclose T-Systems' response to the Ofgem consultation on smart metering for 28th October. This follows our response submitted on 28th September in which we provided our response to the initial public consultation questions.

T-Systems, part of Deutsche Telekom, leads the way in delivering smart metering across Europe, with over 140 months of practical experience from 19 smart metering trials, many of which are ongoing. Along with supporting research, this experience has shaped our response to the Ofgem consultation.

In our response, we have focused on one overarching theme: *Smart metering as a pathway to the smart grid services needed to realise Britain's objective of becoming a low carbon economy.* We are convinced, based on our experience, that this will only be possible with a revised smart grid architecture. In particular, we believe that DCC's function should be able to rely on a decentralised headend infrastructure, with communication between DCC and the in-home components managed by a smart WAN/HAN module. This will deliver a number of significant benefits including:

- **Encouraging 'smarter' consumer behaviour;**
- **Delivering a scalable, enduring business and technology architecture;**
- **Enabling intelligent, timely error detection and resolution;**
- **Ensuring low-cost interoperability;**
- **Embedding effective security into the core design;**
- **Enabling future energy services.**

A revised architecture will offer the functionality needed for smart metering rollout on day one, as well as meeting the longer term requirements of the smart grid, such as the real time exchange of information and tariffs, the capability for a wide variety of central and distributed generation, and the adoption of energy efficiency services. It will also provide a simplified responsibility model and commercial framework.

We hope that you see value in our response to Ofgem's consultation, and look forward to being able to contribute further as the programme progresses. Please do not hesitate to contact me if you have any queries with regard to our submission.

Yours sincerely,

[redacted]

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1 Executive Summary

As mentioned in our previous submission T-Systems welcomes the publication of the Prospectus and its supporting documentation within the smart metering consultation. We look forward to actively participating in the process and helping define a future proof programme that can be swiftly implemented. We trust that our engagement and submissions demonstrate both our commitment to get involved and our ability to deliver value.

T-Systems provides Information and Communication Technology (ICT) systems for multinational corporations and public sector organisations in the UK, Europe and around the world. We are part of Deutsche Telekom group, one of the world's largest and most financially stable companies. Our knowledge base, which is derived from projects including replacing the entire telecoms infrastructure of Eastern Germany, makes us one of the most experienced delivery organisations in the world. Additionally, T-Systems leads the way in delivering smart metering across Europe, with over 140 months of practical experience from 19 smart metering trials, many of which remain ongoing. It is the experience and knowledge we have gained during these trials and related research activities that have shaped our approach to this Ofgem consultation.

In our September response, we identified four key themes: *Achieving behavioural change*; *Quickly agreeing a future proof design*; *Accelerating the rollout timetable*; and *Encouraging investment*. In this response we have focused on one overarching theme: *Smart metering as a pathway for smart grid services in Britain*.

Britain is committed to becoming a low carbon economy; ensuring security of energy supply; and managing its affordability for the consumer. This will be achieved by changing the fuel mix and implementing distributed generation capacity (some of which will be intermittent) as well as greater micro-generation and increasingly sophisticated demand management. Consumers will need to be encouraged to reduce and manage their energy use accordingly.

The proposed smart metering rollout will deliver remote meter reading that will provide the consumer with information relating to their energy usage. However, we question whether this information will encourage the significant behavioural changes needed to reduce consumer consumption in the longer term. T-Systems believes that longer term enduring changes in consumer behaviour will require more than a smart metering solution as contemplated in Prospectus. To achieve these goals, Britain needs smart grid functionality that enables a dynamic exchange of information and tariffs, the capability to integrate energy from virtual power plants, and the adoption of energy efficiency services. With this in mind, the smart metering rollout must offer a pathway to a sophisticated smart grid.

Delivering this vision will require end-to-end operating models, processes, information and data flows to achieve the outcomes needed. These requirements must be aligned across the target operating model, underpinning business process, technical solution and applications. This is particularly important if the overall system is to have the longevity and flexibility necessary to incorporate the innovation demanded by long-term objectives. Our response focuses upon delivery of this vision.

We have reviewed the differences between a 'traditional' smart metering architecture and an alternative that enables controlled communication to deliver smart metering today and the smart services of tomorrow, with minimum disruption and cost to consumers. The former architecture favours direct communication between a smart meter and a headend; the latter is based on a decentralised headend infrastructure, where communication between DCC and the in-home components is managed by a smart WAN/HAN module (or Smart Hub) in each home, which collects, translates and stores meter readouts. As such, the Smart Hub should be considered part of the in-home shared architecture. Instead of pushing information from the meters to the headend, as per a traditional model, it is suggested that the majority of information is pulled into DCC from the Smart Hub. The distributed architecture therefore offers future extensibility, simplified meter interoperability and communication scalability in the home, the WAN and DCC.

Figure 1 shows how the proposed alternative architecture could be illustrated (overlaid on Ofgem's view of smart metering responsibilities). This distributed architecture, governed by DCC, would be totally independent of the WAN technologies or suppliers chosen. It would encourage competition and new technologies, preventing lock-in or any distortion of the competitive landscape.

Figure 1: A distributed architecture to enable controlled, safe and scalable data management

The principles adopted in the distributed architecture are in part based on lessons learned from the telecommunications industry, where solutions have to accommodate huge volumes of data, comparable with those expected once smart metering is rolled out. We believe such an approach will enable Ofgem to realise a number of key benefits:

Encouraging 'smarter' consumer behaviour

Meeting Britain's national carbon reduction goals requires a significant change in consumer behaviour. Our trials point towards the fact that consumers require more than consumption or basic cost summaries on an In-Home Display (IHD) to achieve this. They need to truly understand what changes will deliver benefits, something that can only happen by displaying the cost of individual appliances or offering meaningful comparison (see pictures below). Further advances, such as Time of Use tariffs only deliver their real benefits when paired with an easy to understand display and home automation solution, whereby appliances can be scheduled to run at a time when cheaper tariffs are offered.

With a traditional architecture, breakdown analysis for appliances and home automation – that is, the sharing of data with programmable appliances – will only be achieved with significant supplementary investment in technology, be that a new home automation hub or control capabilities in the meter(s). Retrofitting the smart metering platform to enable real behavioural change will incur additional cost and further disruption for consumers. The current model favours intelligence in several meters, thus the complexity of the in-home network will increase

(*Where is additional information processed? Which meter owns which home automation functionality? How is it displayed?*). This will add further cost and lead to a less flexible solution.

Figures: 2, 3 and 4 show how meaningful information drives behavioural change

A Smart Hub on the other hand, lays the foundation for future home automation, providing a platform that can be programmed to offer supplier-specific applications and services and be remotely upgraded for future services, all via DCC. This is an open system that ensures total interoperability and data privacy, whilst still offering access to all in-home information. From the start, the Smart Hub in every home will give consumers a dynamic and interactive IHD, providing them with tailored information and engaging them in the management of their energy consumption. In addition, the Smart Hub guarantees consistency of information across the IHD and future displays, such as the Internet, phones and other devices. As the Smart Hub controls HAN communication, even difficult installations in tall apartment blocks and multi-household buildings are made simpler.

Delivering a scalable, enduring business and technical architecture

Traditional architecture favours a model where meter data is pushed to DCC. This means that DCC is flooded with data from millions of meters in a difficult to control manner, limiting the scalability and security of the solution. The only way to scale the platform will be the extreme overprovision of communications and processing capacity at DCC. This will add both cost and operational risk to the platform.

We propose data should primarily be pulled from the Smart Hub by DCC, allowing DCC to plan its retrieval and processing capacity. This will deliver much greater scalability at lower cost. Capacity planning both for network transmission and DCC capacity becomes much easier, thus there is no need for overprovision of resource.

Enabling intelligent timely error detection and resolution

With a data push model, detection of errors, such as missing meter readings or unusual patterns of consumption, requires sophisticated data manipulation and formal investigation at DCC. Although error rates will reduce from current levels simply by introducing digital readings, detection and correction of faulty devices still has to take place. Also, errors on the IHD, due to tariff information not being updated dynamically and thus being inconsistent with the bill or online information, may lead to distrust and confusion on the part of the consumer.

We propose that error management, including error detection, of the in-home devices should also take place in the home. Many errors, such as intermittent HAN connectivity, can be dealt with entirely by the Smart Hub, thus helping to avoid a situation where DCC becomes cluttered with erroneous data. More serious errors can be detected and subsequently communicated to DCC. With precise knowledge of the error, DCC can then initiate remote repair or callouts (which would then be dealt with much more quickly and at a lower cost).

Ensuring low-cost interoperability with a distributed architecture

In a traditional architecture, the meter sends data to DCC's headend. This means all meters, IHDs and headend solutions, and their respective interfaces, have to be tested and re-tested whenever a component is changed. Also, because specification of the eventual nationwide solution will take time, it is likely that some meters introduced prior to, or in the early stages of the programme will not interoperate with the final design and so become redundant. When it comes to designing new meters, complexity will increase if manufacturers try to differentiate their meters by adding non-standard functions.

We propose a decentralised headend using Smart Hubs. Each Smart Hub will manage translation services by unifying the format of sensory data in the home. Through remote upgrade, the Smart Hub can be made capable of communication with virtually any meter, including existing advanced meters, and also apply any required security measures introduced by the change. Because the translation is done at the home, no complex headend matching has to take place at DCC. Dependent on requirements, the Smart Hub can support a number of HAN communications technologies to support, for example, low power devices, enable communication with hard to reach meters and be ready for future, as yet unknown HAN communications methods.

Embedding effective security into the core design
Security is of paramount importance. We fully endorse the guidelines for security provided by Ofgem. Security effectiveness is a process of constant adjustment to new requirements and threats. The comparative ease, speed and effort involved in making these adjustments are the key to delivering highly secure integrated design.

Security cannot be guaranteed if it is not inherent in the design of a solution from day one. Secure designs require clear accountability and governance, as well as clear definitions of data flows. We are unsure whether a traditional architectural model provides the ability for the control and governance necessary to maintain accountability and management of security and data privacy. We fear the security solution design has been compartmentalised too early, resulting in an inability to extend it without compromising the very security it should provide. Effective governance processes and supporting technology need to drive top level architectural planning.

We propose that DCC, or some other entity, assumes a governing role within the programme, supported by an architecture that empowers it to do so effectively. As the owner of the single source of truthful data, DCC can then ensure that all data is collected in the household and held in one logical (not necessarily physical) location. This will also make it easier to manage consumer consent to third party data access, as well as protecting the integrity and security of the data. Only by empowering an entity to provide central governance, can the platform be extended securely.

Enabling future energy services
The consumer electronics and software mass market is highly innovative and new services will emerge for both home automation and smart grid applications. We are concerned that the current model will not easily facilitate the extension of the platform to accommodate these new ideas. We believe Ofgem has the chance to fundamentally change the future of smart energy in Britain to the benefit of both the consumer and the economy as a whole, by enabling rapid deployment of market led innovations and accelerating the adoption cycle.

To achieve this, Ofgem must ensure that interested suppliers and data service providers have secure access to the data necessary to develop innovative applications and services, along with an infrastructure with the required stability and capability to support them. This requires governance processes that grant secure and authenticated access to data. Governance and technology are intrinsically linked and we propose that DCC takes control of the underlying infrastructure and governance. This governance is critical to a flexible framework for IHD access and integration of future home devices and appliances further ensures the extensibility of the in-home platform. Only a governing body can ensure that consumers' interests are protected and that their data is accessed only after they have given their consent, even if it has left the household.

We see this platform at the heart of an ecosystem consisting of a growing number of businesses that deliver energy based services, home automation and potentially services from other industries – a truly competitive model. With a few modifications to the current architectural model, this programme can securely evolve into the smart grid, avoiding the need for expensive and risky restructuring, or the merging or retrofitting of data from multiple entities at a later date.

Conclusion
In summary, T-Systems fully supports Ofgem's programme and aspirations for smart metering in Britain. We believe that implementation and management of nationwide smart metering requires an advanced new infrastructure that has the potential to provide accurate bills and raise consumer awareness, and to actively encourage innovation that will empower consumers to reduce their energy consumption.

Our submission provides examples and advice from our research, trials and experience, which suggest that a significant opportunity (in the medium and longer term) could be missed if the current design and technical architecture is not revised, giving DCC the technology necessary to take greater responsibility for governance. This can be accomplished by a distributed architecture with a smart WAN/HAN module in every household. We believe grasping this opportunity could radically improve the overall economics and flexibility of the solution.

We hope to inform decisions about the smart metering architecture and contribute to the agreement of requirements and specifications that will enable a seamless transition to smart grid services and smart grid living for Britain. The differences in architecture outlined above underpin our belief in the importance of reviewing the roles and responsibilities detailed in the Prospectus, together with the supporting commercial models. We believe strongly that an end-to-end network management approach is essential in enabling a successful transition to the smart grid.

2 Response to Prospectus

The following section contains T-Systems' response to Ofgem's 'Prospectus' document, Questions 1, 2, 5, 8, 9, 10, 12, 14 and 15.

Please note that, where the content of our answers may be either repeated or provided in more detail, we have provided cross-references to other answers.

2.1 Response to Prospects Question 1

Question Text:	Do you have any comments on the proposed minimum functional requirements and arrangements for provision of the in-home display device?

T-Systems is concerned that the current set of requirements, together with the need to display information from more than one supplier, might hamper innovation and limit the potential usefulness of the display. We list below a number of areas for consideration that we believe could add value to the process of confirming minimum functional requirements for the in-home display device.

Meaningful information as part of the minimum requirements
Our responses to In-Home Display, Questions 1, 2 and 3 explain that the display of summarised energy consumption, even in pounds and pence, is not always sufficient to change consumer behaviour. Many consumers need to see the comparative cost of different devices in order to understand what they can do to reduce cost. This will become even more important with the introduction of time of use tariffs.

The quality of data available determines the extent to which it can be tailored to consumer needs, and how integrated and analysed it can be, thus the greater the volume of data incorporated and displayed, from all in-home sensors, the better. While we agree that the provision of summaries is a good first step, it is important that Ofgem places the IHD within a technical framework that can realise the benefits of future service innovations without the need to replace costly equipment.

Minimum requirements that can be shared
There are numerous technical and management challenges to be overcome if the IHD is to display comparable levels of information for both gas and electricity in a comprehensible and usable format. This holds true both for minimum specifications and more detailed requirements.

These challenges may well be exacerbated in instances where multiple suppliers to a home share the same meter. For example, Supplier 1, who was responsible for installing the meter, has effective control over the meter and therefore the presentation of information to the customer. Supplier 2 essentially becomes a subordinate 'client' to Supplier 1, obliged to negotiate all changes before they can be enacted in the meter. Ultimately this is likely to lead to each supplier wishing to install their own IHD, leading to not only stranded assets and increased cost, but also to consumer irritation.

This will encourage each of the suppliers to provide their own IHD, increasing cost both for the new piece of equipment and the communication with, and management effort from, DCC. The entire concept of shared intelligence and one simple interface to the consumer will be undermined. It is therefore of the utmost importance that the IHD is designed using open interfaces and standards that enable the highly flexible exchange and display of information, as well as the opportunity to upgrade.

Minimum requirements that encourage and accelerate innovation
If IHDs are only capable of displaying minimal information, with additional functionality subsequently defined by the first installer of a smart meter, then innovation is entirely controlled (and perhaps restricted) by that supplier.

Innovative applications and additional devices, such as monitoring units or sensors, auxiliary switches, and connectors to energy consuming/producing machines (e.g. home appliances, wind-powered generators) may not be able to use the IHD as an output device. Consumers who recognise this fact may well elect to have their IHD located out of sight, negating one of the central goals of the programme.

Figure 5: Example of a portable IHD

By its nature, the consumer electronics and software mass market is highly innovative and new services can be expected for both home automation and smart grid applications. Against the background of these innovations, the IHD represents the ideal output mechanism, seamlessly bringing together devices and applications to deliver rich, truly meaningful information to consumers. We have argued in our responses to In-Home Display Questions 1, 2 and 3, that such advanced information would benefit the consumer enormously and is much more likely to facilitate behavioural change than simple consumption summaries.

Selecting the optimal in-home architecture
T-Systems proposes that the IHD should form part of a wider open communication architecture that includes the HAN and WAN. One of the advantages of an integrated communication platform for the end-to-end data flow will be a flexible and extensible home display framework. This framework will enable any number of devices to display information from sensors within the home, as well as information supplied by suppliers and data services. However, the intelligence throughout the in-home architecture needs to be managed and controlled, not only with regards to DCC but also to ensure efficient communication within the home, and of course scalability towards future requirements.

We therefore recommend a revision to the present underlying architectural assumptions and the introduction of an in-home architecture with a remotely upgradeable control function, not just for the IHD but also for the entire in-home engagement model. Only with the right in-home architecture will the IHD provide the required control to the consumer, providing genuine value and, in doing so, driving the desired behavioural change.

The importance of having the minimum set of requirements define a framework
A list of minimum requirements is important and each requirement needs to be viewed in context of each other, like a framework within which the display of information is made possible. Please find below the list of minimum requirements that we believe should form this framework:

- Aggregation of information from various sources;
- In-home storage and processing of information;
- Display of authorised third party information chosen by the consumer;
- Supplier and data service driven formatting and presentation;
- Independence from display hardware.

We suggest that this framework would be best enabled by introducing a central processing unit into the home, a Smart Hub, with data transfer and exchange carefully controlled and governed by the consumer and, subject to their consent, DCC. In this way, DCC would be able to hold a single source of truthful consumer data whilst ensuring data governance. Furthermore a common secure interface can be provided for evolving data services from approved suppliers. Please also refer to Prospectus Question 9 and 14 for further information on the Smart Hub and governing data services within DCC. When reviewing the cost estimates for the IHD, it has to be clear where the processing of information takes place, as this capability inevitably influences the cost of the devices affected.

The importance of having a display framework that enables competition
As mentioned above, our proposal for the IHD framework and in-home architecture allows for the IHD to become a universal display concept for all suppliers and data services. We believe that suppliers will differentiate themselves by providing added value information and by supplying sensors that hook into the framework to allow home automation.

In the longer term, assuming the in-home architecture is scalable as proposed in our response, we see it providing consumers with access to an entirely new ecosystem of suppliers offering energy-based services. This will serve to inform and educate consumers, enabling them to make decisions that fundamentally change their behaviour. Again, strict governance must be provided to ensure that consumers are protected, while being offered the most suitable energy efficiency solutions and services.

Conclusion
T-Systems is concerned that the current set of minimum functional requirements for the in-home display architecture and arrangements for provision may only have a limited ability to influence consumer behaviour unless reviewed in light of a number of important considerations. We believe that the IHD should be the key interface for the smart metering platform today and for future services. We argue that, in order to achieve this, the display has to be placed within the wider open communication platform that we are proposing.

The display framework can only be made possible by a communication architecture that is broader than that indicated by the present Ofgem design. Only when opening up the in-home architecture in this way will suppliers be able to present the information necessary to encourage changes in behaviour, and the adoption of automation and energy efficiency services and solutions.

2.2 Response to Prospectus Question 2

Question Text:	Do you have any comments on our overall approach to data privacy?

Please note that this response replicates the response to Data Privacy and Security Question 1.

We have seen how data privacy concerns have threatened the success of the smart metering programme in the Netherlands. We have also seen recent cyber security warnings in the USA and of course some British publicity on this topic. As a result, T-Systems is pleased to note the clear commitment that Ofgem has made stating "*Data protection and system security are crucial issues for consumers and we will take a rigorous and systematic approach to assessing and managing these issues. This will include stringent rules and safeguards."*

We agree with Ofgem that a privacy by design approach should be at the heart of the smart metering programme. This allows the mitigation of risk in a variety of ways: minimising data collection needs; anonymising data as much as possible; agreeing data handling practices; and ensuring data privacy and security as integral parts of design, in order to help increase consumer acceptance of the platform.

We share the view that consumer confidence is a major success factor for a successful implementation of a smart metering programme. The formulated commitments and the intended privacy charter will have a critical role helping to ensure the confidence and protection of consumers' personal data and its usage only for the agreed purposes.

Security and Privacy by Design
We fully subscribe to the security and privacy philosophy set out by Peter Hustinx in his statement earlier this year:

"The EDPS believes that a more positive solution is to design and develop ICT in a way that respects privacy and data protection. It is therefore crucial that privacy and data protection are embedded within the entire life cycle of the technology, from the very early design stage, right through to their ultimate deployment, use and ultimate disposal. This is usually referred to as ***privacy by design****".*

Source:
Opinion of the European Data Protection Supervisor on Promoting Trust in the Information Society by Fostering Data Protection and Privacy 23/3/2010

However, in order to adhere to a privacy charter, the system should have built-in security from the start, so that it can execute the supporting processes in a timely and error-free manner. This requires a security protection wrapper to be built into the data flow and not be administered at different stages in the process.

From our point of view, the system privacy should be based on the following three pillars:
- The intended privacy charter as the basis for privacy in the system;
- A privacy and security framework as part of the platform architecture;
- A single data privacy authority at the single source of truthful data.

The privacy charter
A data privacy charter should explain the data privacy requirements and the respective measures and elements in the smart metering system from a consumer point of view, using consumer friendly language. The charter should also provide guidelines for the consumer segment to instil confidence in both data privacy and security.

As is already clear, consumers' personal data will be treated in accordance with the Privacy Charter. The charter will need to include all of the standard elements, such as appropriate use, monitoring, and complaints process. It is also important to have clear government guidelines on how approval can best be obtained from consumers.

The privacy and security framework
Since privacy is an integral part of the security system, security and privacy cannot be separated completely.

One of the key considerations in taking the data privacy and security by design approach is to set the scope for the end-to-end smart metering system. The end-to-end system covers all equipment, attached devices, communication links and connections from every customer through DCC to suppliers, network operators and third party service providers. This broad view of the system's scope gives the required overview to manage the risk assessment, to identify the key risk areas and to arrive at a representative payoff for the systems design guidelines at an early stage of the process. Only in this way can data privacy and security be designed into the system, as opposed to being retrofitted in a costly manner that will limit flexibility.

T-Systems therefore believes that the specification phase of the privacy and security framework should take place in interaction with the technical specification phase as early as possible in the presented timescale. This process ensures that key risks will be covered by adequate measures in the draft technical specification, to have evolved by the time specifications become available for early adopters.

We consider that an effective privacy and security framework is a central element in the success of this programme. Furthermore data privacy considerations should not be limited to capturing information that can be shared with the energy supplier, but also enabling the capture and use of information by and only for the consumer. This will give the consumer more incentive and control over their own in-home energy data and enable consumers to capture detailed information, e.g. for each room or appliance, and use it for analysis on the IHD without the worry that the information might be shared.

One data privacy authority as the entity of trust
Many years of experience delivering complex ICT solutions and highly sophisticated telecoms tariffing processes have taught us the importance of maintaining data integrity at all points within a data flow. This has very much influenced our approach to smart metering in our trials. With this in mind we believe that a traditional smart metering model and initial scope of functions will cause challenges in executing the data privacy policy. For example, T-Systems is unclear how data privacy can be assured if core master data, e.g. registration and address details or encryption details, are not controlled and managed by DCC as part of the data transfer. Data privacy may be compromised if some of the authentication or approval policy validation is only made once the data has already left the household or even worse, has been transferred to another third party that then applies the role profiles for data privacy. Numerous transfers before data privacy can be executed introduce unnecessary opportunity for error and compromise.

Also specific process requirements outside the normal data flow need to be looked at from the onset. Consumers who move home and thus leave the meters and IHD behind for the next home owner, will want all of their data wiped. With some of the requirements where the meter holds and / or feeds the IHD unit, data wiping may not be possible. The in home design needs to allow for the wiping of data when home owners change. The architecture proposed throughout the document make this possible and enables DCC to take all consumption data out of the household when the owner moves. Additional data services may be provided to the consumer, whereby the old data can still be taken to the new home for comparison or other use.

The true advantage of the Smart Hub is that much of the security and data privacy processes can take place in the household:

- Security is simplified as the Smart Hub takes the role as the front door of the household, which is securely locked allowing additional securities for the meters but this can be managed locally between the Smart Hub and meters and does not need to be executed from the central processing operation.

- Data security is given a new feature, as the levels of data detail can be managed differently. Whereas the data that is needed for billing can be passed on to the supplier and leave the household, the information about which room or appliances uses which amount of energy can be kept and processed in the Smart Hub for use by the consumer only.

In a complex infrastructure providing multi-tier services, the question of building and maintaining trust relations in the data is an important element. This clearly goes beyond security managed inside the household. Not only basic services, but also the extended services based on the primary data must be included within the data relationships. For an effective and optimised means of providing a trusted end-to-end system, it is necessary that the number of entities and devices in any single security loop is minimised. Therefore, T-Systems believes that there should be one central governing entity, responsible for monitoring and supervising the single source of truthful data, and ensuring its privacy and security (see Prospectus Question 15). We believe that this governance would also help to achieve a higher level of acceptance of the whole system by concerned consumers.

Conclusion

We fully support Ofgem's security and privacy approach. However, we would like to highlight that security and also privacy should be an inherent part of the programme's design in order to guarantee that future extensibility is not hampered by inflexible and costly privacy and security retrofitting. We therefore recommend to:

- Identify all entities of the trust chain within the smart metering system with stakeholders and have one governing entity.
- Define the end-to-end scope for a privacy and security framework with all stakeholders under consideration of well known and current security and risk guidelines,
- Ensure the establishment of this framework as early as possible within the programme in order to guarantee that security is an inherent design feature and not a retrofitted requirement.

2.3 Response to Prospectus Question 5

Question Text:	Question 5: Do you have any comments on the proposed approach to smaller non-domestic consumers (in particular on exceptions and access to data)?

Please note that this response shares certain proposals and technical concepts with the response to Non-Domestic Sector Questions 5 and 6.

Introduction
While we agree with the general principles underlying Ofgem's proposed approach, we share its concerns about potentially lost benefits relating to interoperability, smart grid and industry simplification. The freedom to implement individual solutions in the non-domestic sector will cause a heterogeneous evolution of data and communication technologies. Without strict interoperability requirements, the transition cost associated with each solution will cause a lock-in of the non-domestic customers.

In addition, we fear that without a non-discriminatory provision of access to data, the competitive market for data services operating on data centric business models will not evolve in the non-domestic sector. The complete separation of domestic and non-domestic infrastructure will eliminate the potential benefits gained through economies of scale in utilising a shared communication infrastructure. It will also negate the potential benefits of industry simplification with regards to smart grid evolution.

Proposal
T-Systems understands that limiting DCC's capability to provide services for the non-domestic market is necessary for conserving competition. In order to achieve this goal without forgoing potential benefits relating to interoperability, smart grid and industry simplification, we propose using the following approaches:

> **Ensure interoperability through a flexible, distributed architecture**
> Technical and commercial interoperability is not just a means of ensuring an efficiently operating competitive market and preventing lock-in for the domestic market, it can also be extended to the non-domestic market. Many non-domestic customers already have smart metering. Without market regulation a variety of non-interoperable smart metering solutions and services will continue to characterise the non-domestic sector. As described in our answer to Non-Domestic Sector Question 8, a Smart Hub is part of the proposed distributed smart metering architecture of DCC. Placing a Smart Hub with headend type capabilities into the customer premises would offer a high degree of flexibility and interoperability, just as it does for consumer households, without the need to replace old smart metering. Enabling switching without replacing existing hardware would also reduce the risk of stranded assets. In addition, the same flexible Smart Hub architecture that provides benefits in the home will deliver exciting opportunities in a non-domestic setting, not least innovative data services from third party service providers made possible by improved commercial interoperability.
>
> **Limit DCC's activities to provision communication and governing data services**
> Initially, we propose to limit DCC activities in the non-domestic market to the provision of communication and governing data services. If DCC's governing data services are based on an open and extensible platform, as we propose in our answer to Communications Business Model Question 1, established advanced metering service providers will initially retain the choice to build and operate internally or to procure these services from DCC. Both approaches can be utilised to build competitive data services

tailored to the non-domestic market. In the initial period, DCC would compete with other communications providers. However, in the long run, cost benefits achieved through economies of scale will provide non-domestic service providers with an incentive to opt for services provided by DCC. Over time, this should lead to widespread adoption of DCC core services as the basis for service providers in the non-domestic sector and hence increase efficiency.

Centralising data collection and distribution
We propose a centralised approach to data collection and distribution in order to bring about simplification of industry processes and a reduction in costs. A centralised approach will reduce the number of interactions between market participants by centrally collecting and distributing smart grid data. Such a data exchange organisation can be achieved by giving DCC the role of governing the single source of truthful data. Centralising data collection and distribution as part of the governing data services would enable the central coordination of smart grid related data exchange processes. In addition, interfaces for the transfer of data required for 'the calculation of use of system charges' (DCUSA 29.3.1) could be standardised in order to facilitate efficient industry processes for smart grids. Implementing a centralised approach to data collection and distribution would also support the evolution of the competitive market in the non-domestic sector. Enabling non-discriminatory access to data will lower the barrier to entry for new and innovative data service providers and hence increase competition. An increase in competition will in turn drive innovation and ensure efficient production.

Governing data services (GDS)
T-Systems proposes that scope of DCC should include all services and raw data storage necessary for DCC to act as the single source of truthful data. With this master data, DCC and the smart metering solution can safely evolve towards the smart grid avoiding any costly, and risky restructuring or having to merge or retrofit data from several entities at a later stage.

Governing data services include:

- *Translation services;*
- *Scheduled data retrieval;*
- *Meter registration;*
- *Supplier switching;*
- *Policy enforcement;*
- *Security.*

Conclusion
T-Systems believes that use of DCC communication and governing services should be optional for the non-domestic sector in the initial phase of the programme. However, we believe this approach could prove ultimately inefficient when moving towards the smart grid; collecting and distributing smart grid data. In order to ensure an efficient market evolution in the non-domestic sector we thereby propose:

- Initial optional use of DCC with encouragement to suppliers to the non-domestic sector to develop data services using advanced metering solutions and data (from domestic and non-domestic sectors) available from DCC's single source of truthful data;
- Ensure interoperability through the implementation of the Smart Hub and a distributed headend architecture which will enable a cost free transition to using DCC;
- Mandating a centralised approach to smart grid data collection and distribution by DCC when the smart grid and its associated services are ready to take Britain to the next level of energy efficiency.

By adopting our proposed architectural changes and using the Smart Hub as the entry point to controlled communication for meter data based on a flexible data services model, substantial industry improvements can be realised in the midterm. The Smart Hub would ensure general service interoperability in the non-domestic market. Making the use of DCC optional, but opening its framework to interested advanced metering service providers, will encourage cost efficient service provision and foster innovation in the non-domestic market. Eventually this could lead to synergies between data services created for the non-domestic market and the consumer market. Mandating a centralised approach to the collection and distribution of smart grid related data will increase efficiency and enable a centrally coordinated smart grid evolution.

In summary, implementing the three concepts proposed by T-Systems: interoperability; governance; and having a single source of truthful data, would allow the smart metering programme to conserve the competitive market in the non-domestic sector, whilst allowing it to evolve into a rapidly growing and more efficient market led organisation. Ultimately, this approach for the non-domestic sector could lead to a reinvention of advanced metering solutions based on a nationwide, flexible, and open, smart infrastructure.

2.4 Response to Prospectus Question 8

Question Text:	Do you have any comments on the proposals that energy suppliers should be responsible for purchasing, installing and, where appropriate, maintaining all customer premises equipment?

Please note that this response replicates the response provided to Regulatory and Commercial Framework Question 5.

Introduction
We agree with Ofgem that energy suppliers should be responsible for installing and maintaining all equipment at consumer premises. However, we believe that it is essential to assign responsibilities to devices according to flow of data as opposed to assigning responsibilities on a first come first serve bases. Responsibility for the flow of data determines:

- The specification of physical devices to be installed in the home (meters, IHD and HAN/WAN module and any future devices);
- Procurement and management of each device, including error identification and management.

In our September response to Prospectus Question 19 (see Appendix 10.1), we explained in detail why we believe there is a need to define an end-to-end solution based on the flow of data. The underlying architecture of the end-to-end solution determines the ability of the different parties to execute control over this data flow. We would like to build on this argument here by describing our proposed architecture and the implications this would have regarding the respective roles and responsibilities of the suppliers.

The case of the HAN/WAN module
Our experience in 19 smart grid trials has led us to favour an architecture with a single source of truthful data, which is housed by one overarching entity. This architecture is independent of WAN or HAN technologies, or service providers. The central body, potentially DCC, owns the transfer of data between the meters and IHD(s) in the home, including the ‘single source of truth’. Please note that the single source of truth does not have to be physically located in one place but does have to be controlled as one logical place. In the architecture favoured by T-Systems, this would mean some of the consumption data can stay in the household and be used by the consumer. Higher levels of data aggregation may be made available for relevant and required data services, or not shared at all.

We found that some of the governing data processing can be done more effectively in the home in order to increase scalability and interoperability. The architecture is based on a distributed technical platform, requiring a physical shared device in the house (the Smart Hub) and the governing and central equipment housed at DCC. Although present in every home as well as centrally, the platform is one integrated infrastructure, enabling effective security, efficient analysis and control of communication.

We propose that DCC does not just procure the relevant governing data services but takes on the responsibility of the governance (thus ensuring it is impartial). Since it owns the central technical platform, DCC has to also own the distributed component, i.e. the Smart Hub in the home. (We propose this entity also be the WAN/HAN module since it has gateway functionality and actually enables multiple HAN and WAN technologies). Installation and maintenance would remain the responsibility of the suppliers. This proposition is in line with the view brought forward by the DCG working group.

Responsibilities Summary

The table below provides a summary overview of the ownership of physical infrastructure and services associated with our proposed architecture, as well as the responsibility for ensuring availability of each unit (i.e. installation and maintenance), and for data transfer.

Physical unit	Ownership	Responsibility for ensuring availability (2)	Responsibility for ensuring data transfer
IHD	*Lead Supplier (& other supplier(s))*	*Lead Supplier (& other supplier(s))*	*DCC*
HAN/WAN module (1)	*DCC (3)*	*Lead supplier (& if change in suppliers the electricity meter supplier)*	*DCC*
Gas Meter	*Supplier (8)*	*Supplier*	*DCC*
Electricity Meter	*Supplier (8)*	*Supplier*	*DCC*
Other meters and Sensors	*N/A*	*Supplier*	*DCC*

Service	Ownership	Responsibility for ensuring availability (2)	Responsibility for ensuring data transfer
WAN	*WAN service provider (4)*	*WAN service provider*	*DCC*
HAN(s)	*N/A (shared medium)*	*N/A*	*DCC (7)*
Governing Services (5) inc. fault/error identification and tracking (6)	*DCC*	*DCC*	*DCC*

The following underlying assumptions were made for the table above:

(1) The HAN/WAN module is a smart device (in this response it is referred to as the Smart Hub) that controls and manages communication within the household and also between the household and DCC. As mentioned above, optimisation of the frequency and timing of data transfer, and selection of aggregation levels for data transfer, thus data privacy, are desirable. This is not possible without a controlling device in the home that can be managed remotely, and this control function has to be given to a governing, empowered and trusted party which we propose is DCC.

(2) Availability of the in-home devices and networks relies on installation and maintenance of the technology. It is assumed that this is done by the responsible parties. However, DCC would know where maintenance and, in most cases, what kind of maintenance would be required, and could therefore engage suppliers in a cost effective manner.

(3) We propose that DCC owns the Smart Hub and therefore cost should be shared amongst platform users as for central DCC functions. T-Systems' recommendation is to distribute the cost as part of the service charge for meter readings. Note that while cost is introduced to increase the capabilities of the WAN module, less intelligence is required in the smart meters and other HAN devices. Capabilities for security, communication with DCC and processing requirements for IHD and other industry processes do not have to be redundantly present within each meter, thus reducing the cost of meter production. We expect further in-home cost reductions to stem from the less complex information model that comes with the Smart Hub, i.e. IHD fed by one as opposed to several devices. Using the Smart Hub as a central point of communication within the HAN enables the coexistence of several HAN technologies to cater for complex in-home setups. Again, this also reduces cost in such setups. Please note that we propose that the consumer contact for the Smart Hub remains with the respective suppliers. The Smart Hub is able to constantly monitor the health of the in-home architecture and devices, and will therefore be able to provide real time information via DCC to suppliers and they then inform and manage the consumer and their expectations.

(4) DCC procures the WAN service from one or many WAN service providers. The providers are responsible for making the WAN available. The quality and operation of the WAN service will be the WAN service providers' responsibility but not the data transfer or health of any devices used for data transfer, which is managed by DCC and its distributed infrastructure.

(5) Smart grid services can be sourced from large or niche suppliers as the smart grid ecosystem evolves. DCC will procure those data services and manage them on the basis of the governing data services that are part of the licenced DCC. Again the data quality and appropriate data transfer would be monitored and managed by DCC, thus offering a full, end-to-end service to suppliers.

(6) Error identification and tracking in a central error log can be done by DCC, which controls communication between the in-home sensors and IHD as it has the opportunity to analyse and, in many cases, correct errors remotely via the Smart Hub. On-site visits would be the responsibility of the supplier. Call out requests and requirements would already be understood prior to the home visit as a result of an in-home analysis performed by the Smart Hub, inevitably reducing maintenance costs and improving the consumer experience. T-Systems proposal generally agrees with the proposition of a central error log brought forward by the DCG groups.

(7) The Smart Hub much increases the flexibility of the in-home architecture. As every device in the home only has to communicate with one other device – the Smart Hub – multiple HAN technologies can be deployed for communication. For example: if one type of communication is insufficient to cover a complex home installation (thick walls combined with radio interference for instance), secondary communications modules can be installed in the Smart Hub to enable communication to an individual HAN device. Furthermore additional software can be offered to manage challenging HAN technologies

such as Power Line Communication (PLC). Inbuilt error correction and error resolution routines are available to manage the communication in homes that are difficult to reach (see Appendix 10.2). It is also important that, via the Smart Hub, the drain on battery-powered communications, e.g. in devices that are not connected to the electricity network, can be minimised. This will inevitably extend battery life, reduce the need for replacement and avoid disruption to the supplier and consumer.

(8) As a result of points mentioned in point 3 and 7, we believe that the cost benefit analysis for a Smart Hub model should take into account reduced cost for less complex meters, IHD and future devices, as well as the less tangible cost reduction that results from the reduced overall in-home architecture complexity and cost of WAN communication.

2.5 Response to Prospectus Question 9

Question Number:	Do you have any comments on the proposal that the scope of activities of the central data and communications function should be limited initially to those functions that are essential for the effective transfer of smart metering data, such as data access and scheduled data retrieval?

Introduction
We agree that the initial scope of DCC should be limited to achieving effective transfer of smart metering data, but we reason that, as pointed out in the DCG working groups, effective transfer of smart metering data requires registration and policy enforcement. We further believe that these data services should not be procured but be inherent to DCC.

The required scope for DCC to operate effectively
We believe that the proposed scope of activities of DCC and its central data and communications functions should be limited initially to the following:

- DCC should be the governing body for controlled communication and data transfer;
- DCC should own the critical services required to govern and control the end-to-end data flow; and have the ability to procure competitively any additional data services;
- DCC should be the authority for the design of the overarching communications architecture and for ensuring that the underlying communication platform and data transfer remains stable and accurate.

T-Systems proposes that DCC should act as the single, independent point of accountability for the end-to-end flow of data and one single source of truthful data, which enables providing data access and management of scheduled retrieval. However only by empowering DCC into this position and providing the necessary registration and policy details can this role be executed in an efficient and accountable manner.

We are building on the argument from our September response where we explain why data integrity between the meter and the energy supplier, and back to the consumer, should be viewed in the context of one end-to-end data flow, driven from one *centrally accountable, single source of truthful data (as outlined in answer to Prospectus Question 8)*. In order to understand this, it is necessary to depart from the physical view of the end-to-end value chain and consider the underlying logical data model. Whereas the physical view shows physical entities and locations, such as meters, homes, DCC data centres and supplier data centres, the logical view shows the flow of data between functional blocks throughout the value chain with the single source of truth at its centre. The figure below summarises these two views:

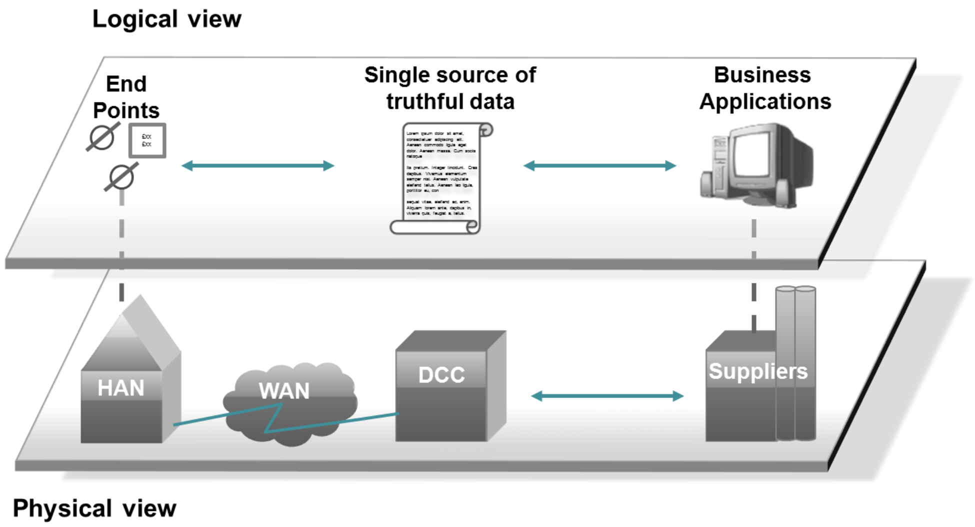


Figure 6: Logical vs. Physical system views

The logical view then leads us to a fundamental design principle whereby the 'single source of truthful data' acts as the central point between the many end points on both the left and the right side of the diagram. By contrast, the current Ofgem approach does not clearly specify a single source of truthful data, or how it should provide a simple, effective connection between data flows. Rather, the current design appears to allow a multitude of rigid connections to a multitude of end points, with varying degrees of control over data. These rigid connections introduce unnecessary complexity for the process of management and associated unclear accountabilities. We believe that this model limits scalability, introduces potential legal challenges that could cause significant delays to the smart metering programme. These legal challenges would occur as DCC's operation, especially error identification and tracking but also guiding future innovation, would be difficult without visibility and control over the entire end-to-end data flow.

> **The single source of truthful data**
>
> *The single source of truth or truthful data is a term used to refer to the practice of structuring information models and associated schemata, such that every data element is stored exactly once and no more. In a network of computational entities or systems such as that proposed to support smart metering, the sharing of data is inevitable. Changes to and transfer of data has to be carefully managed in order to prevent data corruption and inconsistencies. If in doubt, there has to be one point of reference that is guaranteed to provide the 'true data'. The location of this true data is referred to as the 'single source of truth'*

Although certain elements of the present approach may appear more attractive to industry (e.g. meter requirements and specifications might compel manufacturers to increase the smartness in their meters), it will nevertheless limit the ability of ICT data service providers to propose high quality, end-to-end technical solutions and therefore the scalable secure infrastructure necessary for the more dynamic management processes and increased volumes of data services that we anticipate within a smart grid environment. As a result, the opportunity to deliver innovation and service improvement to consumers and the energy sector will be curtailed, as will the richness of communication between the energy suppliers and their consumers.

We are concerned that without a single governing body with the technology that enables control over the end-to-end data flow the following risks are introduced:

Accountability is critically limited if consumer master data is kept in a decentralised fashion with suppliers or data services: in case of multiple supplier switches, data changes would involve a complex process of updates across different storage locations. The defaulting of any commercial entity would likely result in the loss of critical data or the start of data inconsistencies. Unclear conflict resolution between parties for the exchange of critical data may lead to further legal complications.

Security is manageable while the data transfer is limited to remote meter reading, but becomes increasingly complex as new data services, such as home automation and smart grid services become a reality. Without an accountable governing body, the management of security will become complex, hamper innovation and hinder competition.

Interoperability of data services is likely to be hampered, especially with regard to future services, where there is as yet no clearly defined trusted source of data made available to those future service providers. As a result, requirements for smart grid services are not yet defined. A decentralised, complex network of information will most likely require an equally complex and costly system modification to enable the many new smart grid service. This in turn endangers security, and what we fear will lead to a slowdown in innovation.

Development of competitive data services is hindered by the lack of a clear interface for available data, or by a rigid interface with limited flexibility, thus risking lock-in. This will make it difficult to both retrieve data, and clearly identify which data service is authorised for access by a particular consumer. The ensuing complexities will significantly increase the barriers for entry into this new market, as well as slowing down any progress or innovation.

Future Innovation is limited by the lack of accountability, complex interoperability and security. Only a clearly defined, controlled communication platform with common interfaces (for data as well as management) will be easily extended with as yet unknown requirements.

DCC to own the governing data services and procure additional data services

With the risks outlined above, we propose that the initial scope of DCC should make governance and raw data storage not a separately procured data service but include governing services and raw data storage into the core processes to enable a single source of truthful data. This would also encourage evolution towards the smart grid without risky restructuring or costly merging/retrofit of data from several entities at a later stage.

Third party approved data services

Subject to the correct access and data privacy controls being in place, DCC could support a supplier-enabled market of third party data services. For example:

Customer information services, including services to help consumers to find the appropriate tariff and/or the supplier for their consumption pattern.

Dynamic demand response, including companies to help define automation rules for controlling the energy consumption of their grid-connected appliances.

Prepayment, including prepayment providers outside DCC offering prepayment with different top-up methods such as mobile phones or payment cards.

Appliance 'Health' Insurance. Active monitoring of in-home heating system and appliances such as washing machines and dish washers. Sensors in these devices could regularly inform the service supplier of device efficiency status.

Please note that a degree of regulation of this new market will be needed, and energy suppliers may wish to adopt a leading role in this market.

In our view this means that DCC should own and be responsible for:

- Encryption and basic translation services;
- Scheduled and un-scheduled data retrieval;
- Meter registration;
- Supplier switching;
- Policy enforcement;
- End-to-end error identification, tracking and management.

Figure 7 below shows our view of the minimum scope of DCC whereby the governing data services (GDS) form part of DCC core functionality, and other data services can be procured and supplied as by third party approved data service providers.

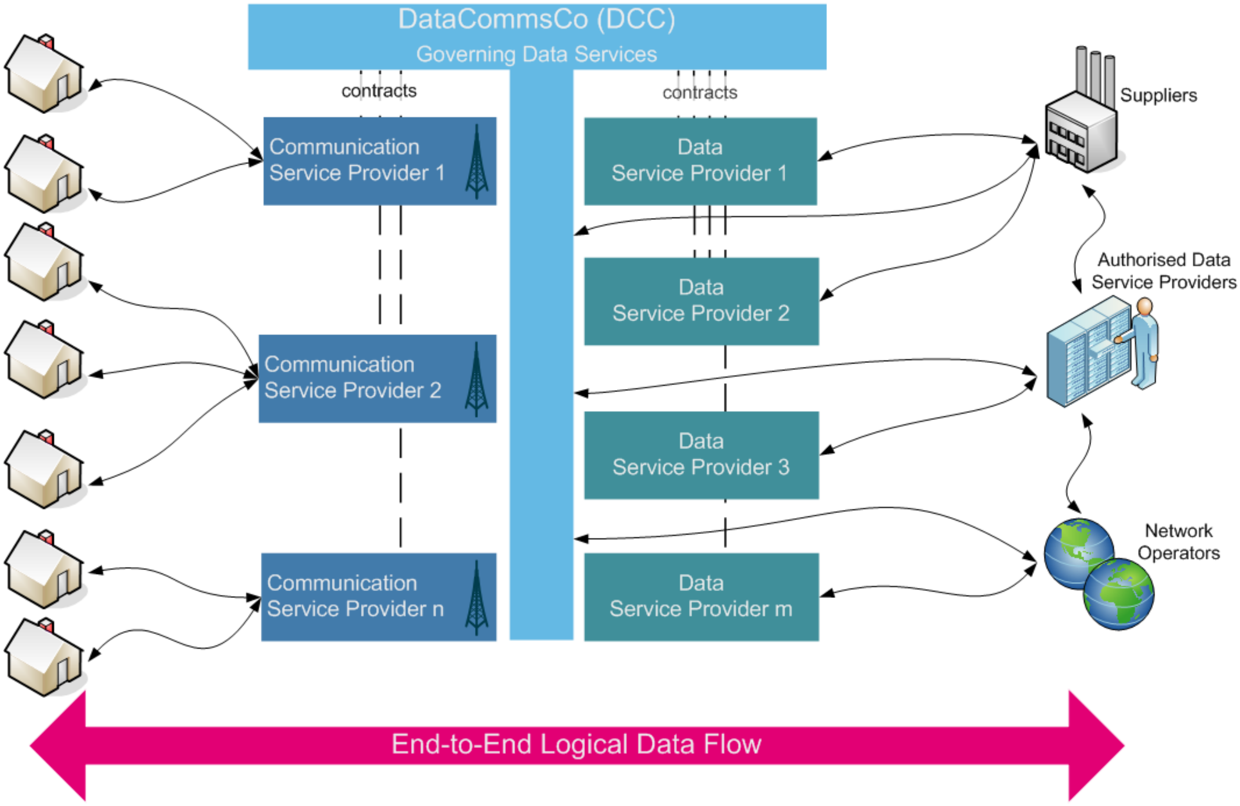


Figure 7: T-Systems' view of minimum DCC scope

We agree with Ofgem's proposal that DCC should act as a contracting body, procuring and managing contracts with WAN and data service providers, however we suggest that an exception should be made with regards to the governing set of data services that are at the 'heart' of the end-to-end data flow. This is because the function and continuity of the solution can only be guaranteed if the GDS is an integral part of DCC. Under these circumstances it will be possible to:

- Avoid legal conflicts that could cripple the entire operation for remote meter reading before it can even evolve into a smart grid;
- Empower DCC with technical and operational experience necessary to function as a design authority and develop a future-proof design;
- Establish a central point of technical accountability to guide any error resolution process;
- Establish a central point of technical accountability to guide the many new data services that will grow in the evolving smart energy market;
- Provide a trusted party to instil stakeholder confidence and ensure any concerns are effectively addressed and managed.

Conclusion

The empowerment of DCC to be the platform's single governing body with responsibility for the GDS and the architectural design of the platform will ensure that all interested data service providers have secure access to relevant data that will allow them to develop applications for the consumer or for other authorised purposes. We see DCC as the heart of an ecosystem consisting of a growing number of businesses that deliver energy based services and home automation.

In summary, including the GSD into DCC as a core function will deliver the following benefits:

- Improved technical interoperability (by simplifying the interfaces between data service providers) and thus the speed with which solutions can be developed and brought to a competitive market;
- Simplification of industry processes (by reducing the complexity of raw data processing and applying of authorisation profiles);
- Effective encryption of data in the home and secure transmission to DCC, thus reducing the security processes that need to be applied to meet the necessary and constantly changing security requirements.
- Facilitation of the smart grid (by retaining the technical knowledge and infrastructure operating experience essential to smart grid evolution with multiple independent suppliers).

2.6 Response to Prospectus Question 10

Question Text:	Do you have any comments on the proposal to establish DCC as a procurement and contract management entity that will procure communications and data services competitively?

Introduction

T-Systems fully supports the decision to establish DCC as a licensed entity which provides an independent contracting body that encourages fair competitive procurement and certainty to all stakeholders. However, as Robert Hull, Managing Director, Commercial, Ofgem E-Serve pointed out in his presentation on the 29th September 2010, there is a key question concerning "*the extent to which DCC's role goes beyond data carriage into data management and provides a mechanism to streamline energy industry processes".*

As described in our answer to the previous question, we share Ofgem's view that DCC should act as a contracting body, procuring and managing contracts with WAN and data service providers, since this provides benefits with regards to cost effectiveness in procurement and flexibility in service provision. However, we suggest that an exception should be made with regards to the governing data services (GDS) that are the 'heart' of the end-to-end data flow.

With the increase in scope through GDS, the new scope of DCC can be summarised in the two diagrams below:

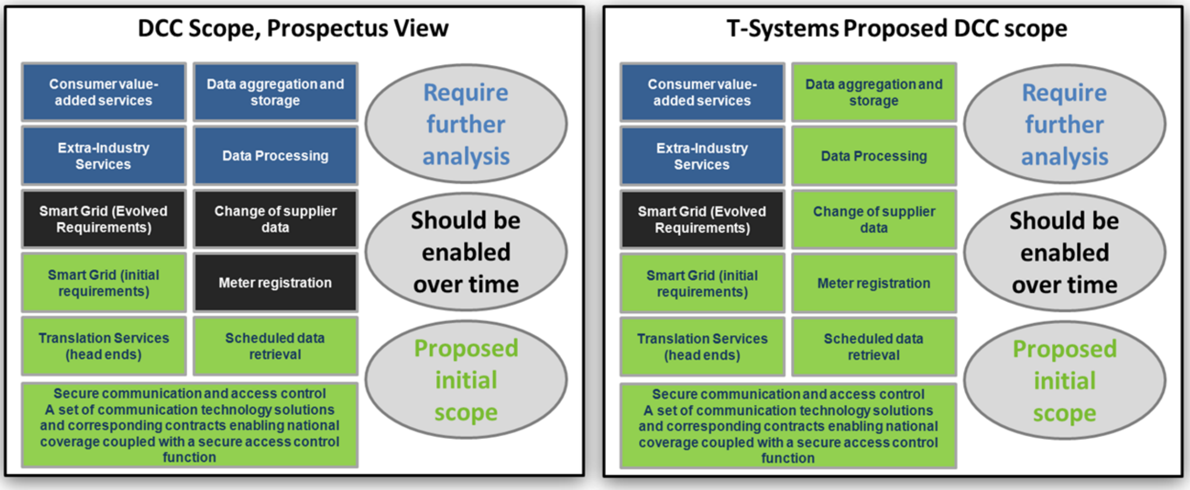


Figure 8: Alternative scope for DCC

We strongly believe the increase in scope will ensure that the future development of the smart metering architecture is guaranteed to be impartial and will allow a risk-free evolution towards the smart grid. A definition of GDS, an explanation of our underlying central principle (the need for a 'single source of truthful data'), and a fuller description of the benefits of this approach have been provided in our answer to Prospectus Question 9, and are therefore not repeated here. We will however focus on procurement and contract management activities for data services in the future that we believe should be managed by DCC, focusing on two key criteria, firstly encouraging innovation and quality of data service, and secondly ensuring value for money of data services.

Encouraging innovation and quality of data services
T-Systems believes that with firm governance and one single source of truthful data, the foundation for competitive procurement of data services from many established large and niche players is created . The benefits of a central, informed and empowered DCC for data service providers would be seen as follows:

- Accountability for the end-to-end communication remains outside the scope of data service providers;
- Reduction of complexity and thus confidence that data service can be built on a stable, extensible architecture of data transfer. This will reduce the risks for data service providers when developing of new solutions;
- Standardised interfaces and interaction among all participants
- Privacy and trust levels are increased through a centralised security and data storage that is being overseen by DCC;
- Confidence in the quality of data provided by a single source of truthful data. And, hence data that has no errors introduced through multiple transfers amongst third parties that can negatively effect the service provider;
- Confidence in the foundation on which future services can be built without having to negotiate with multiple parties. This also encourages investment by third parties in bringing innovative solutions to the market.

Ensuring value for money
With DCC acting as a single service provider to the industry, procurement and contract management for communication and advanced data services would lead to strong competition. A clearly presented, well understood set of governing services would deliver two significant benefits over other options:

- Accountability for error;
- A level playing field for all contending providers through the clear set of functional requirements.

By also making DCC's governing data services available to third parties (via a secure framework), any additional DCC data services would be forced to compete against the private sector. We believe this will not only drive competitive pricing but also innovation, without risking the integrity or stability of the communication and data infrastructure for the smart grid.

The anticipated role of the design authority within DCC would ensure that DCC will keep an end-to-end view of the data flow and vision, ensuring that innovation is not stifled by single cost saving measures or overpowering procurement deals. With this in mind, T-Systems strongly believes in competition. Please note competition does not require precluding an IT supplier who is providing more than one data service.

Conclusion
We propose that Ofgem consider increasing the scope of DCC to include core governing data services (GDS) that elevate it to a position of clear accountability and leadership for the entire smart metering infrastructure. GDS will provide the minimum set of services necessary to lead the smart metering evolution as well as to procure communication and data services cheaply and competently.

Finally, the establishment of a well-defined interface for data services, as provided by GDS, will allow not only other non-governing DCC data services to be established, but will encourage and ease interoperability for a wide range of third party appliances and data services in a secure manner.

2.7 Response to Prospectus Question 12

Question Text:	Does the proposal that suppliers of smaller non-domestic customers should not be obliged to use DCC services but may elect to use them cause any substantive problems?

Introduction
T-Systems agrees with Ofgem's proposed approach that the use of DCC data services should be optional for suppliers to non-domestic customers. We especially appreciate Ofgem's concerns regarding unfair competition if DCC were to offer energy management and efficiency services in the non-domestic market. We do however believe that, in the long-term, the underlying communication infrastructure that will be created on the back of smart metering cannot be a competitive service, and in its simple form would also not be a significant differentiator or aspect of innovation. It is this communication and governance of data that we believe should be available only through DCC, building a single source of truthful energy data for the nation and assuring the security and stability essential in such a critical infrastructure.

A single source of truthful data – domestic and non-domestic
Smart grid evolution requires the knowledge of consumption data as well as energy generation data. Suppliers and network operators use this data to plan their capacity and manage their distribution networks respectively. This data can be provided in one of two ways, either decentralised (where market participants share the data bilaterally) or centralised (where a central entity collects and distributes the data).

The centralised approach is preferable since it reduces the number of interactions between market participants, thereby simplifying industry processes and minimising overheads. In addition, interfaces for transfer of data required for 'the calculation of use of system charges' (DCUSA 29.3.1) should be standardised in order to facilitate efficient industry processes for the smart grid.

We propose that DCC be used as the governing body to collect, secure and distribute the data appropriately, as required for 'the calculation of use of system charges' (DCUSA 29.3.1). This means using DCC for smart grid operation across both domestic and non-domestic participants and requires that the interfaces provided by DCC are specified.

A new competitive market of services for supplier of smaller non-domestic customers
Regarding the future development of DCC and their data services (beyond core governance), we believe DCC should not compete against ICT suppliers offering energy management and efficiency services to suppliers of smaller non- domestic customers. On the contrary, given that DCC will provide an intelligent communication infrastructure and governing data services, building upon this with specialised solutions could be an attractive business opportunity for ICT suppliers. Competition and innovation will be encouraged as the focus moves from core communication services, where little differentiation is possible, to unique solutions and high value services.

We believe an entirely new market of energy consumption consultancy services could rapidly grow out of having anonymised, statistical consumption data aggregated in one single source of truth. In the non-domestic sector, these services should be available to suppliers and customers directly, independent of anything offered by DCC to the domestic market.

T-Systems is confident that suppliers to non-domestic participants could significantly benefit from using core communication and governing services from DCC and leveraging innovations on the domestic market without feeling dependent or restricted by the function of DCC. Seizing this potential is dependent upon technical interoperability with services provided by DCC in the domestic market. This will be achieved by building the smart metering infrastructure on open standards with specified interfaces that allow the integration of existing non-domestic smart metering into the domestic market platform. In our answer to Regulatory and Commercial Framework Question 15, we proposed to introduce a smart WAN module or Smart Hub, a device capable of easily integrating existing advanced meters into the smart metering infrastructure. As a consequence, smaller suppliers can integrate their non-domestic customers, and their outdated smart meters, without transition costs and will be able to focus on value-added services that deliver innovation for the smart grid.

Conclusion
We agree that suppliers of smaller non-domestic customers should not be obliged to use DCC services for data services. However we do believe that full separation of non-domestic and domestic consumption data would provoke the evolution of a decentralised exchange for data related to grid management and thus a difficult to manage smart grid. Hence, without the initial obligation for suppliers of smaller non-domestic customers to also utilise DCC for collection and distribution of data related to the management of the smart grid, benefits related to the simplification of industry processes and innovation would be lost.

In the long run, suppliers to non-domestic customers need to be obliged to use DCC’s communication and governance infrastructure to transfer and collect all meter data. The transition to using this DCC service can be made easy with a smart metering infrastructure that offers a simple interface via a Smart Hub. This would not only reduce problems for smaller suppliers but allow them to compete more effectively as they can focus on energy solutions and services that are specialised, without having to invest in the underlying communication infrastructure required.

2.8 Response to Prospectus Question 14

Question Text:	Have we identified all the wider impacts of smart metering on the energy sector?

While we note that Ofgem has created a set of functional requirements that will enable the remote collection of meter data and enable the consumer to view their energy consumption on a display in their home, we do not see the wider vision of this approach.

Ofgem has the chance to fundamentally change the future of smart energy in Britain by putting in place a flexible and extensible framework for the exchange of information between the home, data services and the energy sector. We believe that if Ofgem adopts the correct approach, this framework will facilitate the development of a new competitive industry based on energy services.

As outlined in the previous answers, T-Systems strongly believes that success of the solution depends on the architectural design and governance for smart metering. This requires security and scalability to be part of the design foundation that grows with increasing data and traffic volumes, adjusting seamlessly to new requirements. With the smart grid comes the potential for many new energy services that could improve today’s and tomorrow’s energy behaviour and lifestyles. Even other sectors such as healthcare, care for the elderly and home security, may have to be catered for as they look to leverage the existing infrastructure of the smart grid. As a result the smart metering solution has to be build in light of those increasing demands and complexities. We are concerned that these wider implications on the energy sector and other sectors may not have been fully incorporated when requesting feedback to the Prospectus and other RFIs that have been issued recently.

Deciding on the right end-to-end architecture

As outlined in our answers to previous sections, a traditional architecture for smart metering favours a model where all meters communicate directly with DCC. This means that DCC is flooded with data from millions of meters in a difficult to control manner. Further meters and other sensory devices could increase this complexity. This approach is limited in its scalability and security. The only way to scale this architecture would be with extreme overprovision of communications and processing capacity at DCC. This adds both cost and operational risk to the platform and this implication has not been given sufficient attention in the Prospectus.

We propose data should be primarily pulled from a Smart Hub in the home by DCC, and much of the data processing should be handled in the home. In addition to the inclusion of a Smart Hub, this will require a rethinking of minimum specifications across all in-home devices. The benefits of in-home data processing include not only reducing pressure on the network and central processing body (and thus costs), but also improving security and providing more data security options. Even better management of some of the less mature HAN technologies is possible. This delivers much greater scalability at lower cost and less risk of failure and error as capacity planning both for network transmission and DCC capacity becomes much easier. (Please also see Appendix 10.2)

Deciding on the right governance for data services

Security and data privacy cannot be guaranteed if it is not inherent in the design of the solution from day one. Secure designs require clear accountability and governance, as well as clear definitions of data flows. We are uncertain whether a traditional architectural model implied by Ofgem provides the ability for the control and governance required for clear accountability and management of security and data privacy. We fear that a traditional architecture and model has led to compartmentalising the security solution design too early, building processes around it that cannot be extended without compromising security. We believe that effective governance processes and supporting technology need to drive top level architectural planning or this will limit the potential of smart metering and thus the ability of the energy sector to evolve and innovate.

We propose that DCC becomes the governing entity of the programme supported by an architecture that empowers DCC to do so effectively. This will require a revision of the architectural assumptions currently evident in the Prospectus. DCC would then become the owner of the single source of truthful data, ensuring data is collected, processed and distributed in the most efficient and appropriate way, controlling data transfer along the entire value chain. This will also make it easier to manage consumer consent to third party data access, as well as protecting the integrity and security of the data. The platform can only be extended securely by empowering and enabling one entity with responsibility for governance.

Enabling future energy services

The consumer electronics and software mass market is highly innovative and new services will emerge for both home automation and smart grid applications. This is to be welcomed and will positively influence the energy sector. We are however concerned that without the required reliable and stable architecture and governance the innovation may not be possible. We believe that Ofgem has the chance to fundamentally change the future of smart energy in Britain to the benefit of both the consumer and the economy as a whole, by enabling rapid deployment of market led innovations and accelerating the adoption cycle.

To achieve this, Ofgem has to ensure that all interested suppliers and innovative data service providers have secure access to the relevant data to develop applications and services, and an infrastructure that has the required stability and capability to support their services. This can be achieved through governing data services providing secure and authenticated access to data and the empowerment of DCC to be the governing body of a reliable platform.

Conclusion - an end-to-end framework for the energy sector
We would urge Ofgem to consider our proposals in specifying a flexible, future proof smart metering platform that benefits the energy sector and consumers alike. While the current specifications are likely to deliver a system capable of remote meter reading and simplifying the switching processes, it will be too limited to allow for a significant extension of transaction volumes and processing of information future services would require. This would be a missed opportunity for Britain with negative impact on the evolution of the country's energy sector.

We believe that Ofgem needs to consider a smart metering solution that is open and extensible for a new world of future energy and other services. DCC will have to be equipped with the governing processes and technology to manage the many interested parties and data requirements. This will be a big responsibility that cannot be taken lightly and will require a stable technical foundation that is easy to execute and govern from the beginning.

2.9 Response to Prospectus Question 15

Question Text:	Is there anything further we need to be doing in terms of our ensuring the security of the smart metering system?

Please note that this response shares certain proposals and technical concepts with the response to Data Privacy and Security Question 5.

Introduction
The Home Secretary succinctly summarised the issue when she pointed out that *"It's (cybercrime) a threat to government, it's a threat to businesses and indeed to personal security. We have identified this as a new and growing threat in the UK and you just have to look at the figures – in fact 51% of the malicious software threats that have ever been identified were in 2009."*

T-Systems is in agreement with Ofgem on the adoption of a security by design approach, and the plan to collaborate with different security and stakeholder groups in reaching an appropriate and practicable level of security.

Security Concept
According to a recent study from PriceWaterhouseCoopers, 92% of large companies experienced a security incident in 2009. We agree with the idea of the risk assessment and believe that security should be evaluated over all components of the system and realised as an iterative process, in a top-down design, within the security by design approach, based on an integral and holistic security conception. Among others, integral parts of this security concept should include:

- Definitions of the security goals for the system and its components;
- An analysis of the threats and risks at different stages; and
- Definitions of measures and mechanisms (e.g. security mechanisms, security hardware, unique IDs within the system) to prevent the system from those threats.

Overall, the security concept should deal with the whole system as well as with every single type of component. In this way it can help to ensure that all security aspects are taken into consideration and that only strong security mechanisms are used.

Security platform

In addition to Ofgem's proposals we would like to highlight that in order to ensure that security becomes an inherent part in the design of the programme, the platform architecture has to be considered as a whole. We propose that the platform should include:

A single source of truthful data.

The single source of truthful data should be the guardian of smart metering data, managing consumer consent and data aggregation for suppliers and third party data services should take place here. This way it can be ensured that data is only passed once a consumer has granted access and that any data passed to third parties contains the minimum necessary detail. Since all data is held at this point, future services, such as smart grid data processing can be securely realised without requiring data from other sources. We believe that a single source of truthful data could also simplify incident monitoring, auditing processes and system security as a whole.

The security within this system should be based on a central key management and a public key infrastructure, with a central certification authority provided by a trust centre.

An impartial governing body such as DCC

The governing body is required to house the single source of truthful data and guarantee its integrity. This governing body has to oversee the platforms future extensions and ensure they comply and expand on the platforms security by design.

A smart gateway in the home

A gateway equipped with a hardware security module will simplify the in-home security platform and reduce cost of other HAN devices that require less sophisticated security as a result. It will reduce the complexity of managing authentication for several meters (and future devices) directly from DCC and thus reduce the probability of handling errors. We propose that, within its role as the central smart device in the home, the Smart Hub also acts as the WAN/HAN Module. The Smart Hub can perform initial data aggregation across data collected from HAN devices. Remote upgradeability allows for future security updates to continuously protect the platform and it reduces the overhead by only having to remotely upgrade one instead of several devices. A single gateway also increases security by reducing the number of points of HAN entry to one. This also allows for easier integration of further HAN devices from a security point of view.

T-Systems security credentials

In 1988, T-Systems set up a new division to evaluate products and systems for payment systems. In 1991 we were officially accredited by the banks in Germany (Zentraler Kreditausschuss). At the same time, it was officially accredited by the German government (Federal Office for Information Security, BSI) to perform evaluations according to the European security evaluation criteria ITSEC. T-Systems is also accredited for the Common Criteria first being published in the late nineties. Our lab is well known for its expertise in hardware and software security. Organizations such as VISA International, MasterCard and the Payment Card Industry (PCI) accredited and recommend T-Systems to their customers.

Recent successes include the planning, building and operating of the entire security system for an electronic road user charging system in Germany. T-Systems elaborated the security concept for the system, developed the Key-Management System and specified all security components including the "security control centre". Furthermore, T-Systems developed, implemented and delivers the smart cards operating for the charging system based on the its own smart card operating system TCOS.

Conclusion
We at T-Systems believe that only a security by design approach will fulfil the security challenges of the smart metering programme. An approach where security is only applied to the various components of the platform without taking an end-to-end view may result in an inflexible solution that will be costly and slow to extend.

We hope that the DCG working group will review the present smart metering architecture and compare it to the proposal for a distributed platform that uses a Smart Hub as an intelligent WAN Module with integrated security gateway. This will make the implementation of appropriate security and risk mitigation counter measures easier. The Smart Hub then also becomes a useful tool for the consumer who wants to develop the HAN further towards convenient and cost-efficient energy consumption.

As the smart metering infrastructure evolves, the underling security architecture must evolve in line with it. This will require flexible security architecture comprising the following:

- The Smart Hub as a secure home gateway with an integrated hardware security module; and
- A single source of truthful data at DCC as the accountable body responsible for meter registration.

We believe that building a security architecture on this basis will lead to a solution with the necessary flexibility. Such an alternative architecture would be both highly secure and future proof.

3 Response to Communications Business Model

The following section contains T-Systems' response to Ofgem's 'Communications Business Model' document, Questions 1, 2, 3, 4, 5, 6 and 8.

Please note that, where the content of our answers may be either repeated or provided in more detail, we have provided cross-references to other answers.

3.1 Response to Communications Business Model Question 1

Question Text:	Do you agree that access control to secure centrally-coordinated communications, translation services and scheduled data retrieval are essential as part of the initial scope of DCC?

Please note that this response shares certain proposals and technical concepts with the response to Prospectus Question 9.

Introduction

We agree with Ofgem that access control to secure communication, scheduled data retrieval and translational services should be part of the initial scope of DCC. However, we believe that Ofgem should examine more closely how this is done, in order to maximise interoperability and future extensibility of the solution. In particular we recommend a review of the following design features:

- The **Scalability of communication and of DCC** data services with regards to the number of meters that send information to DCC, and the redundancies introduced when several meters send information from the same home.
- **Interoperability** is a concern when many different types of meters and IHDs have to communicate with one central entity that manages a single source of truthful data. Given the growing range of meter types and manufacturers as well as future types of meters, such as water and micro generation metering, keeping track of interoperability with several different headends centrally will be increasingly complicated.
- **Future extensibility** may suffer as a result of the interoperability and scalability concerns. If limited to one centralised rigid headend to translate all data, then complexity may become a challenge in itself. In this event, optimisation and flexible timing of data transfers would be difficult since limited control is imposed until DCC receives the data.
- **Security management** becomes increasingly complex with an increasing number of smart meters and other devices in the home. Potentially, the headend solution has to be able to manage encryption and meter authentication when receiving data; this could mean that data leaves the home

Headend

The headend describes functionality that receives the stream of meter data signals and performs low-level error correction on them before making the data available for other systems to request, or pushing it out to other systems. Headends are likely to require specific adaptations for each meter type, as well as be communications technology specific, if this is proprietary to the metering system.

The headend is typically at a central physical location, however in our proposed architecture, communications are not proprietary and meter translation services can be performed in the home, also making data available for in-home processing and display.

without authentication; the decryption may also be difficult at the headend and data analysis is further delayed.

- **Error management** of the actual in-home equipment is one of the most frequent types of errors. Algorithms have to be run on data received at DCC to identify meters that are no longer behaving correctly. When those faults are detected, it will be difficult to pinpoint the source of the fault, whether HAN communication or meter.
- **Cost and power concerns** arise from introducing additional computing capability into the meters. Not only is this capability somewhat redundant, given that all meters in the home require a similar kind of intelligence, but battery powered meters (such as gas and potentially water) will require more frequent battery replacement to support the duplicated computational needs in each meter.
- **The meter installation and registration process** may require manual matching of meter IDs to address details and suppliers during the installation process. This introduces opportunity for manual errors from installation engineers or other parties.

Agreeing a right distribution of smartness

In T-Systems view, the functionality of translation services should be distributed between the home and DCC's governing data services (GDS) in order to address the concerns above. In our response to Prospectus Question 14, we introduced the Smart Hub concept. We believe that this Smart Hub, located at the interface between HAN and WAN should be responsible for managing in-home devices and collecting sensory information from the meters on site, prior to WAN communication in a unified format. In order to collect data from the Smart Hub, DCC's GDS initiates communication on a regular basis, to retrieve metering (and other) information in standard format.

- **Scalability** benefits are realised through the reversal of data transfer initiation (i.e. the pulling data from the household instead of waiting for data to be pushed from the meter[•]). This allows DCC to retrieve data from homes sequentially, as opposed to being flooded by incoming meter data. The concept also addresses scalability by reducing the number of connections necessary for each home to one, even if further meters are added in future. In addition, information exchange with the IHD is added into a dynamic communication model.
- **Interoperability** is managed by unifying the format of sensory data in the Smart Hub. Based on a remotely upgradeable platform, the Smart Hub can be updated to understand the communication with virtually any meter capable of communication, including existing advanced meters. Because the translation is done at the home, no complex headend matching has to take place at DCC. Dependent on requirements, the Smart Hub can support a number of HAN communications technologies, supporting low power devices, communication with hard to reach meters, and even be ready for future HAN communications methods.
- **Future extensibility** is ensured by building the Smart Hub on an upgradeable platform. Future processing requirements, future home sensors and further meters can all be made compatible with the Smart Hub easily and at low cost. In this way, new functionality can be incrementally introduced and activated when it is required.
- **Security management** is simplified, with the Smart Hub acting as the junction between home security and DCC security requirements. The Smart Hub authenticates HAN devices and establishes encrypted communication. Information is processed at the Smart Hub and encrypted again prior to WAN communication with DCC (where the data is then stored). In reducing the complexity of security management (and as a result the likelihood of human error), the overall security of the system is increased. Scalability of the security system is also enhanced.
- **Error management** can be addressed in the Smart Hub by including diagnostics for the HAN devices. This will allow the Smart Hub to identify problems with HAN

[•] Please note that any handshake has to be two-way, hence the WAN requirement for each transaction remains but overall volume of transactions will be reduced significantly.

communications and meters, and even enable remote repairs. Simple errors, such as intermittent HAN reachability, can be dealt with entirely by the Smart Hub (see Appendix 10.2). In the case of more complex errors, the Smart Hub can simply convey any errors it has identified at the point of data retrieval by DCC, allowing DCC based error resolution to take the correct action. Last gasp errors are also more likely to be identified by the Smart Hub and can be dealt with without the need for more complex solutions in each meter. There is still the potential for emergency messages to be sent from the Smart Hub to DCC. However, Smart Hub based error management reduces the need for services callouts, as well as increasing the ability to pinpoint the error source, thereby enabling the correct response and reducing the cost of repair.

- **Cost and power concerns** are reduced, since the Smart Hub will perform most processing tasks leading to less complex and lower cost meters. In addition to lower processing requirements, a central Hub can insure communication across HAN devices operating different communications technologies. Battery powered meters that can thus communicate with low power communications technologies, while IHD and other devices can use high bandwidth and longer range technologies.
- **The meter installation process** can be simplified through the Smart Hub security management features. Based on a unique hardware security ID, the Smart Hub's identity cannot be falsified. Building on this hardware security, the Smart Hub supports encryption and different authentication methods to ensure the authenticity and integrity of both itself and connected devices. Thus identification of the consumer premises and authentication of new meters, as well as meter registration, can be handled 'zero touch' during the physical meter installation. No manual, error-prone process is required for activation by the installation engineer or another party.

Conclusion

We agree with Ofgem that communication, scheduled data retrieval and translational services should be part of the initial scope of DCC. However, this is based on the assumption that the system architecture controls communication across the end-to-end data flow, and that it is not the meter that drives communication to a rigid headend communication receiver.

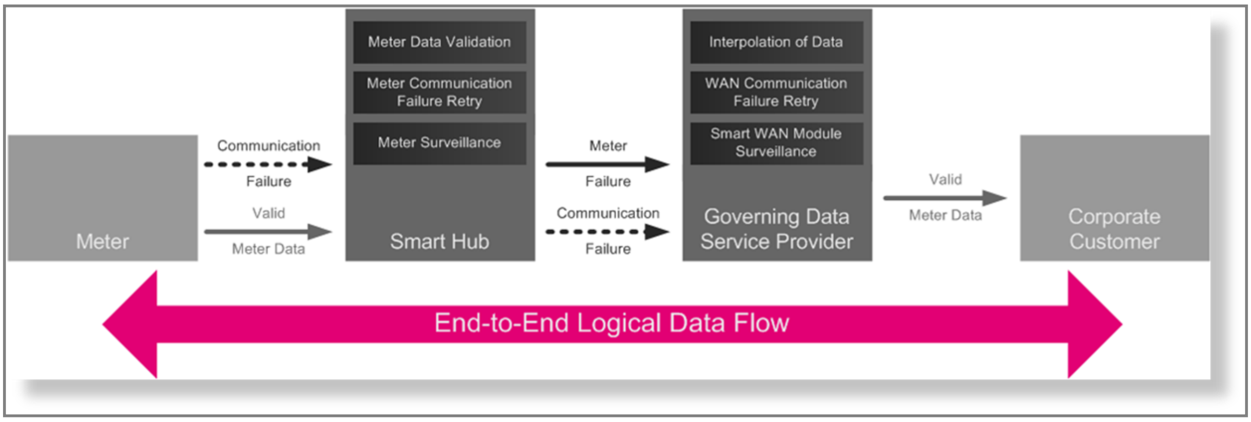


Figure 9: Error Management with Smart Hub

Initial translational tasks and authorisation take place in the home and therefore reduce risks to data confidentiality, interoperability, future extensibility and cost, as well as security and error management. We suggest that scalability of the smart metering platform will be greatly increased by deploying a distributed platform, similar to a decentralised headend arrangement (placing a headend into each home), which allows for a data pull as opposed to a push model.

3.2 Response to Communications Business Model Question 2

Question Text:	Do you agree that meter registration should be included within DCC's scope and, if so, when?

Introduction
T-Systems believes that meter registration should be centralised within the initial scope of DCC in order for a scalable and secure smart metering solution to exist. However, in addition to the question of centralisation, our reasoning also addresses how it can be achieved in a secure and scalable manner.

Centralised or decentralised?
There are two options for meter registration; centralised within one entity or decentralised and distributed among multiple entities.

With regard to efficiency, the centralised approach is superior as it reduces the number of interactions between communication partners. For example, if a consumer switches supplier, their data must be updated. If stored centrally, this update takes place only once. If storage is decentralised, it is likely that the updated data will need to be transferred between multiple databases, increasing time and cost and potentially causing delays that will impact consumer satisfaction.

Centralised meter registration represents a single source of truthful data, which leads to simplification of industry processes and the avoidance of inefficiency, by reducing the number of potential data sources.

From a security perspective, centralised meter registration enables central access control, which requires fewer resources for security management than the decentralised storage. If meter registration data is stored in different places controlled by different entities, inconsistencies could occur due to redundant versions of the same data. While synchronisation could solve this issue, it would incur additional cost.

In summary, centralising the storage of meter registration data is the preferred alternative, offering the following benefits:

- Improved efficiency;
- Consumer experience safeguarded;
- Simplified industry processes;
- Reduced cost.

Within or outside DCC?
On the basis that meter registration is best done centrally, the next decision is whether the entity responsible for registration is within DCC's scope or outside of it.

Meter registration data is required for several critical functions within the smart metering system, notably access control, switching suppliers and scheduled data retrieval. Every time one of these functions is required, DCC must access meter registration data. And given the frequency with which these functions will be required, ease of access to registration data will be critical, as will minimising the cost of access.

Ensuring that meter registration is within the scope of DCC will deliver the following benefits:

- Quick, efficient access to meter registration data;
- Clear accountability for execution of data confidentiality;
- Reduced cost.

Distributed or centralised headend functionality?
Assuming that the responsibility for meter registration is in DCC, this does not mean that physically it has to be executed in a central data centre. As outlined in Communication Business Model Question 1, data governance can be executed in a distributed fashion, thereby optimising and improving security and efficiency even further.

Conclusion
T-Systems believes that centralised meter registration, within the scope of DCC, will provide a reliable basis for building efficient smart metering services. As already outlined in the previous question, it will also enable an architectural model with many additional advantages that radically outweigh those from a traditional architecture.

In our answer to the next question we discuss further services that we believe should also be considered as part of DCC's scope. These services further build on the foundation of meter registration data services as part of DCC, as reasoned in this answer.

3.3 Response to Communications Business Model Question 3

Question Text:	Should data processing, aggregation and storage be included in DCC's scope and, if so, when?

Please note that this response shares certain proposals and technical concepts with the response to Prospectus Question 9.

Introduction
T-Systems believes that some data processing, aggregation and storage should be included within the scope of DCC from the outset. We see this capability as being central to the effective operation of the smart metering infrastructure and the achievement of Ofgem's objectives. The previous two answers clarified how DCC can operate a flexible and extensible communications platform for remote meter reading. In contrast to Ofgem however, we believe that the initial scope of DCC cannot be limited to the transfer of large volumes of smart metering data, without a minimum of features required to ensure confidentiality and security to consumers and also to enable a seamless future evolution of the platform.

In our September response we argued that, in order to understand the requirements for the smart metering solution, it is necessary to depart from the physical view of the end-to-end value chain and consider the underlying logical data model. Whereas the physical view shows physical entities and locations, such as meters, homes, DCC data centres and supplier data centres, the logical view shows the flow of data between functional blocks throughout the value chain. The figure below summarises these two views.

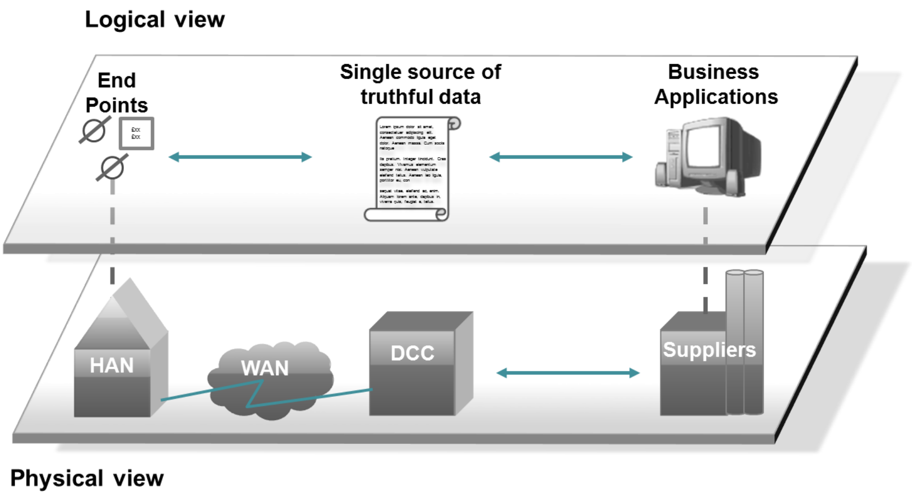


Figure 10: Logical vs. Physical system views

Risks of a traditional architecture model and initial scope
The logical view highlights the need to introduce a single source of truthful data into the platform's data flows, to act as a mediator to the many end points on both the left and the right side of the diagram. Without a mediating or governing entity to control the data flow, the architecture is likely to be subject to a growing number of risks in the following areas:

- **Accountability** is critically limited if consumer master data is kept in a decentralised fashion at suppliers or data services. In the case of multiple supplier switches, data would have to be located at several locations and data changes would involve a complex process of updates across those different storage locations. The application of confidentiality instructions and authentication checks would be delayed, risking legal challenges resulting from difficulties in tracing and assigning responsibility for errors. Furthermore, should any commercial entity fail to fulfil their role, it would likely result in the loss of critical data or the start of data inconsistencies. Unclear conflict resolution between parties for the exchange of critical data may further lead to legal complications.

- **Security** would remain manageable while the data transfer is limited to remote meter reading, but would become increasingly complex as new data services, like home automation and grid services, become reality. Without an accountable central body, the management of security will become complex, hampering innovation and hindering competition.
- **Interoperability** of data services would be hampered, particularly in future services, where there is no clearly defined source of information. Requirements for grid services for example are not yet defined. A decentralised, complex network of information will most likely require an equally complex and costly system modification to enable the new grid service. This will in turn endanger security and lead to a slowdown in innovation.
- **Development of competitive data services** will be hampered by the lack of a clear interface for available data or a rigid interface with limited flexibility, thus risking lock-in. This will make it difficult to retrieve data, or clearly identify which data service is authorised for access by a particular consumer. The resulting complexities will raise the barrier for market entry, as well as slowing down any progress or innovation.
- **Future Innovation** will be limited by the lack of accountability, interoperability and security. Only a clearly defined communication platform with clear interfaces (to data as well as management) will be capable of easily extending to incorporate as yet unknown requirements.

Third party approved data services

Subject to the correct access and data privacy controls being in place, DCC could support a supplier-enabled market of third party data services. For example:

Customer information services, including services to help consumers to find the appropriate tariff and/or the supplier for their consumption pattern.

Dynamic demand response, including companies to help define automation rules for controlling the energy consumption of their grid-connected appliances.

Prepayment, including prepayment providers outside DCC offering prepayment with different top-up methods such as mobile phones or payment cards.

Appliance 'Health' Insurance. Active monitoring of in-home heating system and appliances such as washing machines and dish washers. Sensors in these devices could regularly inform the service supplier of device efficiency status.

Please note that a degree of regulation of this new market will be needed, and energy suppliers may wish to adopt a leading role in this market.

Proposed minimum scope of DCC

1. DCC to be the governing body for controlled communication and data transfer;
2. DCC to own the critical services required to govern and control the end-to-end data flow;
3. DCC to ensure there is a single source of truthful data for all supporting data services solutions that are to be procured as part of DCC or supported by third parties;
4. DCC to be the authority for the design and ensuring the underlying communication platform and data transfer remain stable and accurate.

DCC to be the governing body for controlled smart meter communication
We believe that DCC should act as the single, independent point of accountability for the end-to-end data flow. Only by empowering DCC with this role can the security and quality of data, including efficient error management, be assured. This approach reflects scope option 3 described by the DCG (please refer to the document 'DCC Scope Options – Information Request'). Future development of the architecture will remain impartial, protecting against market distortion. Please note that control of communication is independent of both WAN technology and service provider.

DCC to own the governing data services
We propose the initial scope of DCC should include all governing services and raw data storage necessary for DCC to act as the single source of truthful data. With this core set of services, or governing data services (GDS), DCC and the smart metering solution can evolve towards the smart grid, avoiding any risky and expensive restructuring and the need to merge or retrofit data from multiple entities at a later date. GDS should include the following:

- Encryption and translation services;
- Scheduled data retrieval;
- Meter registration;
- Supplier switching;
- Policy enforcement;
- Error identification and tracing.

The question of what data storage and processing facilities should be included in DCC can now be addressed based on the requirements for operating this core set of governing services.

- **Storing master data.** Maintaining the single source of truthful data encompasses storing master data including meter registration (as described in the document 'DCC Scope Options – Information Request') in a central location within DCC. This will increase the accountability and security of the solution. As discussed in the previous answer and pointed out in the DCG Subgroup, master data is required for meter registration, policy enforcement and supplier switching. Adding a master data repository at a later stage would require complex and expensive restructuring cost, aside from the security implications of storing consumer data in a distributed fashion.

- **Storing transactional data.** GDS should store transactional data, including meter readings, to enable aggregation, data recovery and future services. The smart metering system, particularly within our proposed architecture, will ensure that these data will always either be correct, or, having been identified as in some way erroneous, not be recorded in the first place.

- **Data aggregation.** This is needed for any applications that require consumption data in an abstracted form. For instance, smart grid applications will require an energy consumption matrix in order to engineer the network and suppliers will require it to plan demand. Other future services could use anonymised consumption data to analyse energy consumption behaviour in order to help reduce expenditure. If the transactional data set is distributed among different suppliers, catering for the future requirements of grid applications, for example, becomes difficult and costly to implement. Storing data securely in GDS provides an extensible interface to available data.

- **Data recovery.** Historic consumption data and tariffs should be stored within the HAN in order to display energy costs to the consumer. Tariff information is merely passed through from the supplier and not duplicated anywhere. Historic and tariff information together enables consumers to compare energy costs and make decisions that might alter their energy consumption. Since data loss through technical failure is always a risk, data recovery mechanisms should be provided in order to avoid consumer dissatisfaction. If suppliers were to provide data recovery instead, they would have to bear additional costs and the complexity of recovery, particularly in cases of recent supplier switching, would be increased. We therefore recommend transactional data storage in the GDS.

DCC to be the authority for the design
The role of design authority for smart metering and future initiatives is a challenging one. Unless a reliable and stable communication infrastructure is at the forefront of all thinking, innovation and evolution may distort the fundamental features of the architecture. No other party has the future of the infrastructure at heart as much as the end-to-end data transmission and control function, especially if embedded into a regulated, licensed and independent operation.

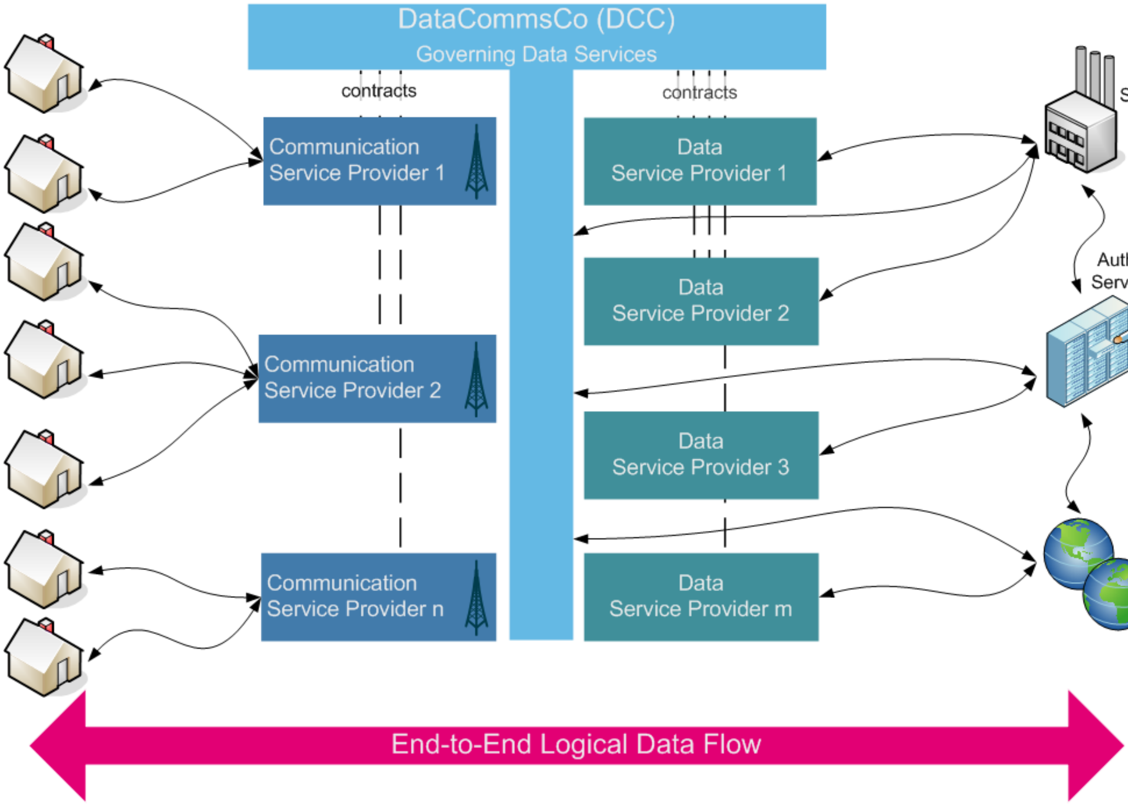


Figure 11: T Systems' view of minimum DCC scope

Conclusion - DCC as the core of an extensible smart metering infrastructure
Through GDS and the empowerment of DCC to be the platform's governing body, all interested data service providers will have secure access to the data necessary to develop applications for consumers or other authorised purposes.

We share the view expressed in the DCG working group that DCC is responsible for the overall technology strategy and see DCC at the heart of a growing ecosystem of businesses that deliver energy based services and home automation. In order to empower DCC to become the programme's leading body, we propose that data storage, aggregation and some processing be present within DCC at an early stage. With a core set of governing data services, DCC and the smart metering solution can evolve quickly towards the smart grid, avoiding any risky and expensive restructuring and the need to merge or retrofit data from multiple entities at a later date.

3.4 Response to Communications Business Model Question 4

Question Text:	Do any measures need to be put in place to facilitate rollout in the period before DCC service availability and the transition to provision of services by DCC, for example requiring DCC to take on communications contracts meeting certain pre-defined criteria?

Introduction
At T-Systems we believe that the staged rollout along with the transition to DCC services are a source of concern for energy suppliers and ICT service providers.

The main reasons for this concern are as follows:

- Technical interoperability, and hence sustainability of investments by energy suppliers and ICT service providers;
- Extent of investment necessary for a temporary solution;
- Possible disappointment for consumers who receive a temporary, potentially incomplete experience that may not meet their expectations and could drive negative perception of their supplier;
- Long-term vision and thus business cases for smart grid, related to how much reliance can be placed on the data generated and quality of the supporting architecture.

Ofgem's desire to facilitate the rollout in the period before DCC services are available is appreciated, but the real concern remains that early rollout decisions could jeopardise the quality of the design and the stability of its foundation. A robust foundation and validated end-to-end design is needed for a successful solution that will not only deliver remote meter readings but also smart grid services. We believe it is possible to reduce the risks in the period before DCC services and potentially make elements of DCC services available early in the process.

As outlined in our September response, DCC could be launched sooner by tendering for DCC and WAN service providers earlier than is currently planned. However, this recommendation is based on the assumption and requirement that a confirmed end-to-end design is ready before any procurement process starts. The following activities are suggested:

- **Clarification of the role and detailed scope of DCC:** The remit of DCC needs to be clearly laid out in parallel with the completion of the technical specifications (Phase 1). As reasoned in the previous answers, the end-to-end architectural design for control of all data communication cannot be seen independently of the smart metering system in the household, and cannot be efficiently executed without some governance in DCC. This therefore has to be well thought through and agreed before any detailed specification can be confirmed or any early rollout activities can start. Depending on the underlying architecture, requirements and specifications, there may be the possibility for early communication contracts and temporary on-demand services, meeting the pre-defined criteria of the future DCC.

  We feel that the clarity of the end-to-end architectural design and the completeness of specifications will increase the level of certainty for suppliers and organisations applying as potential DCC and data services candidates.

  Please note that, as mentioned above, the remit and scope of DCC depends largely on the underlying architecture of the end-to-end data flow. If Ofgem wants to provision any early communications contract or encourage any temporary data services before DCC is in place, all specifications will have to be confirmed. It is highly recommended that trials are carried out to test the different architectural models for the end-to-end data flow before any specifications are communicated for procurement.

- **Provision of interim services:** Once DCC scope is clear, the provision of interim data services and communication contracts would be possible.

  T-Systems recommends that on-demand services are requested from ICT suppliers and that these are required to meet the same technical specifications as the functionality to be provided by DCC's initial scope at go-live.

  On-demand services would enable suppliers to conduct early rollout without the need for investment in expensive ICT infrastructures or contracts. Market distortion could also be avoided by ensuring both small and large suppliers are able to take advantage of central services.

- **Bring forward the launch of DCC:** As outlined in our response in September, we believe that tendering for DCC could start as soon as completed technical specifications are available, and could end shortly after implementation of regulatory changes required for DCC. This could potentially accelerate the programme from Autumn 2013 to Spring 2013, whilst also providing more time for the tendering process.

- **Transferring registration data and registration processes to DCC:** In parallel with DCC's go-live, we believe that controlled communication and security of data requires a set of master data information. This requirement has also been pointed out by the DCG working group. In order to prevent duplication and confusion, there needs to be one single source of data which, if part of DCC, could simplify many industry processes, including registration, switching, encryption and security. We recommend that these services are included in DCC at the first go live. (Please refer to the response to Question 1 in this section for further details.)

Conclusion

We believe that Ofgem can facilitate the rollout in the period before DCC service availability and the transition to DCC when services are available. That said, the main focus for both activities should not override the most important objective, which is ensuring a robust, secure and flexible underlying architectural design for smart metering and the smart grid. It remains a concern that the urgency attached to early rollout and pre-DCC services could weaken the long-term solution because of the inability to test the stability of the solution for the smart grid and any later adjustments.

3.5 Response to Communications Business Model Question 5

Question Text:	Do you agree that the licensable activity for DCC should cover procurement and management of contracts for the provision of central services for the communication and management of smart metering data?

Please note that this response shares certain proposals and technical concepts with the response to Prospectus Question 10.

Introduction

Summarising the information provided in the Communications Business Model, there were a number of options considered for DCC.

Ofgem went through a process of considering each of the possible options for DCC. These were:

Option (A) DCC as a full service provider: This would involve a single step in which a licence would be granted to DCC as a full service requirements provider, following a competitive licence application process. The licence would set out service obligations and regulated revenue. Under this option the applicant for the DCC licence could be either a single entity or a consortium of data and communication service providers.

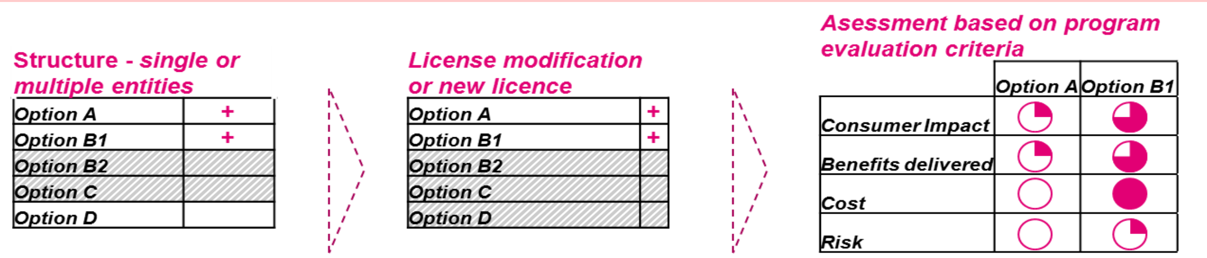
Option (B) DCC as a procurement and contract management entity: This would involve a two-stage approach, as follows: (i) DCC would be established as a procurement and contract management entity; and (ii) DCC would procure, on a competitive basis, a number of service providers that would together deliver the full scope of the data and communications services required. DCC would be prohibited from also acting as a service provider. There are two variants to this approach:

> *Option (B1) A licence would be granted to DCC following a competitive licence application process.*
> *Option (B2) The licence of an existing licensee would be modified to require the licensee to establish a separate entity to undertake the procurement and contract management activities. Under this approach, procurement and contract management would not be a new licensable activity.*

Option (C) Licences would be granted following a competitive licence application process to separate data and communications companies.

Option (D) Licences would be granted to a single data company and separate regional communications companies to enhance competition in the provision ofcommunication services.

We understand that, based on Ofgem's decision making process summarised in the diagram below, Ofgem's options A and B1 are the most appropriate, and Ofgem currently favours *grant[ing] a licence, following a competitive licence application process, to DCC as a procurement and contract management entity (Option B1). A key role for this entity would be to run competitive tenders to procure a number of service providers, which would together deliver the full scope of the data and communications services required.*



We believe that there will be five steps involved in the process of granting the new license to DCC. These are:

- Defining the scope of new licensable activity;
- Development of DCC Licence;
- Development of the Smart Energy Code;
- Development of licence application regulations;
- Competitive licence application process.

We understand that Ofgem's current thinking is that the new licensable activity would *'broadly cover the procurement and management of contracts for the provision of central services for the communication and data management of smart metering data'.*

Whilst we share Ofgem's view that DCC should be an independent, regulated entity, we believe that limiting DCC's licensable activity scope to procurement and contract management for all data services will have a negative impact on:

- Customer experience;
- Technical interoperability (by establishing a multitude of interfaces between data service providers);
- Simplification of industry processes (by adding complexity with distributed accountability);
- Facilitation of smart grids (by outsourcing the technical knowledge and experience of operating the infrastructure essential to smart grid evolution).

Establishing a DCC that can assist the long-term goals

T-Systems believes it is possible to overcome these risks. Instead of having to choose between either a full service DCC or a procurement operation, we suggest that a hybrid model is considered as Option (E). This has already been outlined in the previous answers to Communication Business Model Question 3.

This Option (E) would include only the minimum scope necessary for a DCC, which should be:

1. DCC to be the governing body for controlled communication and data transfer;
2. DCC to own the critical services required to govern and control the end-to-end data flow;
3. DCC to ensure there is a single source of truthful data for all supporting data services solutions that are to be procured as part of DCC or supported by third parties;
4. DCC to be the authority for design and ensuring the underlying communication platform and data transfer remain stable and accurate.

These functions are described in greater detail in the response to Question 3 of this section.

Comparing the business options

We propose the initial scope of DCC should include governing services and raw data storage necessary for DCC to act as the single source of truthful data. With this core set of services, DCC and the smart metering solution can evolve towards the smart grid without being influenced by other motivations that later lead to costly and risky restructuring or having to merge or retrofit data from several entities at a later stage. Whilst we will continue to refer to these activities as the governing data services (GDS), the regulated licence and procurement function would of course remain in DCC.

We refer to this as option (E) and the figure below shows how this compares to the other options previously identified by Ofgem and evaluated against the criteria for consumer impact, benefits delivered, risk and cost.

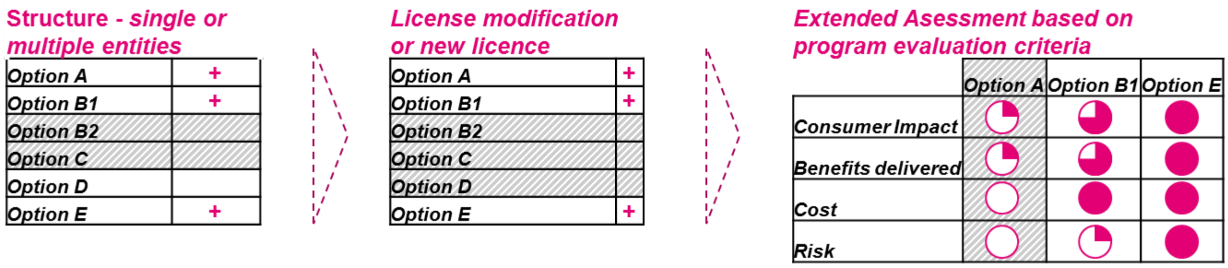


Figure 11: Assessment of alternative DCC options

We agree with Ofgem's proposal that DCC should act as a contracting body, procuring and managing contracts with WAN Service Providers and also data service providers. However, as explained above an exception should be made with regards to GDS, which represent the 'heart' of the end-to-end data flow and ensure the control and security of data transfer required for a smart grid of the scale expected in Britain.

In practise, this means the GDS would be operated by DCC. Being an integral part of DCC will provide assurance of the function and continuity of the core communication platform, in addition to:

- Avoiding legal conflicts that could cripple the entire operation for remote meter reading before it can evolve into a smart grid;
- Empowering DCC with the technical and operational experience necessary to function as a design authority and develop a future-proof design;
- Establishing a central point of technical accountability to guide the many new data services that will grow in the new smart energy market;
- Assuming the role of trusted party to instil stakeholder confidence and ensure any concerns are effectively addressed and managed.

Conclusion

We propose that Ofgem consider increasing the scope of the licensed procurement and contracting entity that forms DCC to include governing data services. This would elevate DCC to a position of clear accountability and leadership for the entire smart metering infrastructure and its evolution (proposed Option E).

The governing data services (GDS) would provide the minimum set of services necessary for the technical platform to become flexible, extensible and secure. It is these attributes that will allow the communication platform to evolve towards and beyond the smart grid, and competitive and meaningful procurement to take place. A DCC operating GDS would have the technical and design expertise to lead the smart metering evolution, as well providing the interoperability essential to consistently procure the most innovative, cost competitive data services. Some of these may become part of DCC in the future but many will also be supported and remain part of the external ecosystem. This will then assist a competitive third party data service landscape to form in a secure fashion. This is further explored in T-Systems' response to the next question.

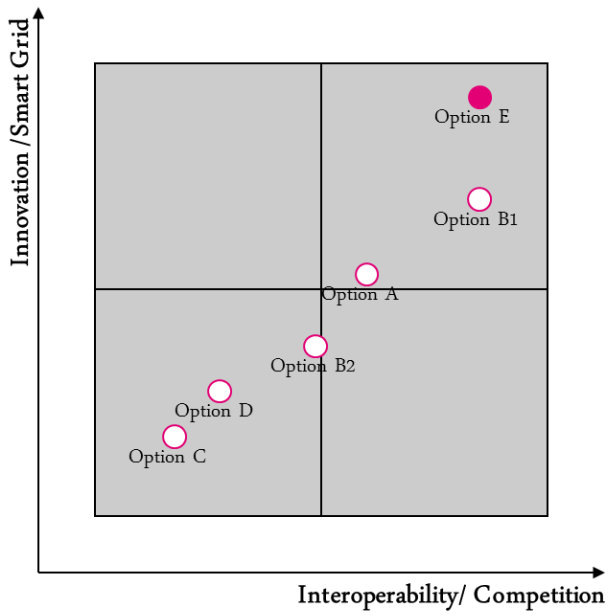


Figure 12: Output of DCC assessment

3.6 Response to Communications Business Model Question 6

Question Text:	Do you consider that DCC should be an independent company from energy suppliers and/or other users of its services and, if so, how should this be defined?

Introduction
The context for this question is the section in the Communication Business Model document that states: *Demonstration of independence of DCC from its service providers. Any party controlling the prospective licensee or controlled by it would be ineligible to bid to provide services to DCC. We will further consider whether or not DCC needs to be fully independent from suppliers or other service users and welcome views on this issue*.

This response therefore assesses the three elements of the question, as follows:

1. Regarding independence from existing energy suppliers;
2. Regarding independence from other service users; and
3. Addressing the technical needs of the programme and why it is that DCC will need to have a wider scope than just a procurement authority.

Independence from existing energy suppliers
The risks associated with DCC being attached to an existing energy supplier are that it may distort competition in the energy market, both commercially and in terms of future innovation:

- The company concerned may gain insight into the energy usage patterns of its competitor's customers;
- It would be able to undercut its rival's prices;
- It would gain an ongoing product/service innovation advantage over its customers by being able to introduce DCC services that perfectly dovetailed with the consumer services being offered by its parent company;
- It may shape the development of the services without a broader vision that might evolve over time.

The scope of the DCC license may limit these risks, as would insisting that any existing energy supplier that wished to bid for the license, do so via an independent subsidiary.

There are various examples of how such independence can work very effectively in the market; the road user charging system in Germany is one such example. It operates a new system for collecting a distance-based road toll for heavy commercial vehicles on federal motorways in Germany. This system was developed and installed by a joint venture, of which Deutsche Telekom is a key member, on behalf of the German Federal Ministry of Transport, Building and Urban Development. They own and manage the design authority but procure GPRS services from multiple providers and additional data services from various providers, including T-Systems. The independence of the joint venture means that although Deutsche Telekom is a key stakeholder, T-Systems has to tender competitively for those services.

Independence from other services users
The risks associated with DCC being attached to any other services user today and in the future are the same as for existing energy suppliers above. Again there is danger of distortion to the market and the future design of the information grid. Discussions about the future of a smart communication network have already linked healthcare, security, white goods and e-

mobility as extensions to its scope. These services users may also be inappropriate for the DCC licence entity.

As a result we feel that DCC should look at service providers that excel in data services, IT and communication and invite them to tender for the regulated and independent entity with governance and procurement responsibilities.

Energy suppliers and services users could however still participate in this market by selling their services to DCC as it increases in scope, or to other services users as the functionality covers other industries. This may be particularly interesting to suppliers as it provides an opportunity to expand their consumer relationships and services portfolio.

A technical foundation to build upon
The decision regarding the degree of independence and who may bid for the DCC license also depends on the scope of DCC. T-Systems believes that DCC needs to retain the ability to execute a governing function, which in itself can be seen as data services (see also answers to Commercial Business Model Questions 1, 3 and 5). In this respect, T-Systems does not share Ofgem's view on the scope and role of DCC. We believe that limiting DCC to an independent procurement and contract management body poses a substantial threat to the overall programme objectives.

We believe that separation of the governance process, such as registration and authentication of data, applying approval concepts and security updates, from DCC will pose the following risks:

- Limited capability to implement industry simplification as the overall concept for controlled communication is not the underlying foundation to build on;
- Difficulty in applying and executing clear accountability across the many parties;
- Increased management of changes introduced by all the different parties and thus significantly more administration;
- Integration of governance in DCC and constantly monitoring performance;
- Reduced consumer trust in the smart metering infrastructure because of the reactive nature of management;
- Limited capability to adopt industry innovation quickly and seamlessly.

As described in answers to previous questions, we believe these risks may be mitigated by extending DCC's scope to include the operation of the governing data services (GDS). We propose that DCC operates GDS and then procures all communication services and any further data services externally.

Procuring all communication and extended data services ensures that DCC can flexibly acquire the 'best value for money' solutions available in the marketplace. Operating the critical core of the smart metering infrastructure will ensure the required technical expertise for supporting communication and data service procurement activities.

In addition, a DCC owned GDS would guarantee retention of the capability to manage industrial change and foster innovation of the smart metering infrastructure. Operating GDS would also ensure that DCC is capable of managing error identification processes and providing advisory and support services to service users.

Separating the provision of GDS from other data services would lead to the development of secure, standardised and specified interfaces to GDS and its data. These interfaces will be used by service providers contracted by DCC, while also enabling the secure development of a competitive third party data service market. This non-discriminatory access to GDS will ensure the development of a competitive market for data services and ultimately lead to the following benefits:

- Efficient operation of security and scalability of services offered by DCC;
- Innovation in data services for the consumers, energy suppliers and other future services users, opening the market to many new entrants and niche players;
- Best price and competition for a wide range of data services, WAN technologies and suppliers;
- Increased consumer choice, experience and ultimately consumer acceptance.

Conclusion
For obvious competition reasons, DCC should be an independent company from energy suppliers and/or other users of its services. This should be managed via the competitive tendering for the DCC license and the scope of the license itself.

Ofgem has outlined its belief that a strict separation of DCC and service providers is necessary. While T-Systems broadly agrees with the need to separate DCC and service providers, we believe that core governing data services (GDS) need to be operated by DCC itself, in order to elevate it to a position of accountability and leadership for the continuously evolving smart metering platform.

We propose that a licence be granted to DCC that includes a procurement and contract management entity with GDS. DCC would then procure, on a competitive basis, a number of service providers for the WAN and for data services, reviewing their ongoing and new services regularly.

3.7 Response to Communications Business Model Question 8

Question Text:	Do you have any comments on the proposed approach to cost recovery and incentivisation for DCC?

Introduction
We agree with Ofgem that DCC is a regulated monopoly and that its profits should also be regulated. We support the proposed ten-year license and believe that this will provide the necessary long-term view for investment in Britain. However we feel that the current cost recovery and incentivisation approach is overly prescriptive and does not facilitate the innovation needed for the development of the smart grid and new services provided by new entrants. DCC must be seen to be both capable of delivering a workable solution from day one, and visionary in its ability to foster confidence in the system as it develops towards the smart grid. A poorly equipped DCC in these terms, despite the best approaches to cost recovery and incentivisation, will fail because businesses will be discouraged or otherwise restricted from participating in the market.

We believe that the current incentivisation and cost recovery approach considers only the short-term costs to suppliers and their consumers, without considering the longer term benefits of smart grid evolution and the provision of additional services. The proposed approach is based on an architectural model that delivers remote meter reading, and potentially some demand side management, but does not incentivise the management of the data flow that will enable diverse and innovative smart grid services and solutions in the future.

We recommend that Ofgem considers a cost benefit analysis for alternative end-to-end architectural options, possibly in a workshop format, inviting the different ICT suppliers that favour these options. (Our response to Prospectus Question 19 in the September submission covered this topic in more detail. Please see Appendix 10.1.)

Understanding the underlying architecture

While the ten-year license concept will be invaluable in helping the ICT and other business sectors to quantify business opportunities and make long-term investment plans for Britain, uncertainty with regards to the end-to-end architecture design and the ability to control the underlying communication of data, makes an adequate assessment impossible.

A traditional smart metering architecture and approach consisting of a simple WAN communication device, multiple smart meters, and contracted data service provision, would substantially increase procurement and contract management risks for all applicants interested in operating DCC. We believe that accountability for errors and the possible inability to scale or add automation in the home could lead to legal challenges, potentially even bringing the evolution of the system to a standstill. As discussed in several of our answers to the Communications Business Model, a traditional smart metering architecture will have a negative impact on the potential to offer advanced services by DCC or other third party service providers. Hence, implementing a traditional architecture concept as the foundation of the end-to-end smart metering system would potentially discourage many businesses from investing and consequently limit the degree of innovation and business opportunities in the smart energy sector in Britain.

T-Systems is concerned to see Ofgem's request for information for the cost-benefit analysis of DCC in parallel to this consultation process. Whilst ICT suppliers can now provide their respective costings for DCC data services, depending on the different possible scope, the questions do not give the option to provide costs for the different underlying end-to-end architectures.

The architecture option proposed by T-Systems (see responses to Commercial Business Model Questions 1 and 3) would overcome some of the issues we see arising from a traditional approach by distributing costs differently along the value chain. Only by comparing the different architectural models in their entirety, rather than the cost of the devices, physical location or responsible party, can the true cost savings be identified.

Conclusion

We believe that only our proposed architecture can provide businesses interested in operating DCC with increased certainty concerning the ten-year operation period, and also reduce the communication volume and the smartness in each of the in-home devices, thus reducing overall cost. This would not be apparent if viewing DCC's cost benefit analysis in isolation.

In addition our proposed architecture and approach would reduce the overall programme risks and foster innovation on advanced data service provision and home automation. Finally, we believe that ensuring a central provision of governing services at the heart of DCC, utilising standardised open interfaces, will open the market to a faster evolution of competitive smart grid services, which also is not captured unless a cost-benefit analysis, cost recovery and incentivisation model is carried out in light of the underlying end-to-end architecture. We recommend that Ofgem considers a cost-benefit analysis for the different end-to-end architectural options, possibly in a workshop format, inviting the different ICT suppliers that favour these options.

4 Response to Consumer Protection

The following section contains T-Systems' response to Ofgem's 'Consumer Protection' document, Question 5.

Please note that, where the content of our answers may be either repeated or provided in more detail, we have provided cross-references to other answers.

4.1 Response to Consumer Protection Question 5

Question Text:	Do you agree that consumers should be able to obtain consumption information free of charge at a useful level of detail and format? How could this be achieved in practice?

Please note that this response shares certain proposals and technical concepts with the response to In-Home Display Questions 1 and 6.

Introduction
T-Systems welcomes the proposal that the consumer should, free of charge, be provided with consumption data that contains a useful level of detail. This will help to ensure that the consumer is fully engaged in the smart metering programme, which is a key condition for the programme's success. We also concur with Ofgem's proposals that the main avenue for information should be the IHD. However, we would draw attention to the argument that we put forward in our response to In-home Display Question 1, highlighting that consumption information alone is not sufficient to encourage changes in consumer behaviour.

Meaningful information without additional cost to the consumer
A consumer has to be able to understand which appliances generate cost and what they have to do to reduce this cost. This will become even more important with the introduction of time of use tariffs. Meaningful information can only be made available to the consumer by integrating information from additional in-home sensors into the IHD. While we agree that the provision of summaries is a good first step, we believe that Ofgem has to carefully consider how meaningful interaction with the consumer can take place via the IHD without the costly need for frequent WAN side information exchange (such as tariff updates, DCC side processing, etc). We also believe that it is important that Ofgem places the IHD into a technical framework that will allow the concept to benefit from future service innovations without the costly replacement of equipment.

We would propose that an effective HAN framework with a Smart Hub enables much of processing in the home without adding additional WAN cost. Energy efficiency services offered to consumers at later stages should be self funding for the consumer and chosen on this basis, thus not hampering consumer interest in meaningful energy information.

Proprietary designs will hamper innovation and add cost
Initially, electricity and gas meters will be installed and their readings displayed on the IHD. If IHDs are only required to display minimum information, and any additional functionality is dictated by the first installer of a smart meter, then innovation is effectively controlled (and perhaps restricted) by that supplier. As a result, innovative applications and additional devices, such as monitoring units or other sensors, auxiliary switches, connectors to home appliances or energy-generating machines may not be able to use the IHD as an output device. There is a risk therefore that suppliers may choose to each install a value added IHD in the consumers home, in order to be able to differentiate, thus increasing the risk of stranded assets which

indirectly will add the costs along the value chain and ultimately increase the cost burdens on the consumer.

We recommend that by introducing open standards for IHDs and enabling energy efficiency services through a well integrated and easy to adopt smart metering architecture, differentiation will soon move to the features that make energy efficiency and savings easy. These features and services can in most cases be remotely managed, thus reduce the temptation to differentiate merely via a new IHD that appears more attractive than another.

The solution is one of choosing the right in-home architecture
T-Systems proposes that the IHD should form part of the wider in-home architecture built on open standards. One of the advantages of this will be a flexible and future proof home display framework. This framework will contain multiple display devices showing a range of information from mandatory and optional sensors, as well as (subject to the users opt-in) information supplied by suppliers and other data services.

In our answers to In-Home Display Question 7, and Communications Business Model Question 1, we discuss how concentrating the in-home intelligence in a Smart Hub model will increase the smart metering system's flexibility by separating computational intelligence from the metering (and display) functionality. The Smart Hub becomes a central point where all metering data (and all future system data) is collected. Supplier information, such as tariffs can also be made available via DCC and stored in the Smart Hub.

The Smart Hub's extensible software platform concept allows for virtually any computation of information for time of use tariffs, as well as a range of options to display this information on the IHD. We argue that as the central device inside the HAN, the Smart Hub should be a largely autonomous unit that can drive this interactive output on the IHD, even for more complex applications, without the need to use constant WAN side processing or information.

Future additions to the platform, such as sensors that enable pinpointing or remote controlling of energy-hungry devices (home automation), could be integrated into the Smart Hub via remote software upgrade, displayed and interactively controlled via the existing IHD.

The display framework creates a competitive landscape
As mentioned above, our proposal for the IHD framework allows for the IHD to become a universal display concept for all suppliers and data services. We believe that initially, suppliers will be able to differentiate by their ability to provide added value information and by supplying sensors that tie into the framework to allow in-home automation. In the longer term, we see the display framework as the consumer-facing end of an ecosystem consisting of a number of businesses that deliver energy based services. We believe that enabling this type of energy service will eventually contribute to carrying the cost required to continually evolve the smart metering platform, turning energy savings into a new source of growth for the economy as a whole.

Conclusion
T-Systems welcomes the proposal that the consumer should be provided with meaningful consumption data free of charge. We believe that the IHD should be the key interface for consumers to access their consumption data and other future services. We argue that, in order to achieve sustainable change of consumer behaviour, the display should be placed within the end-to-end smart metering architecture that we are proposing throughout this response. In the short-term, with the right smart metering architecture much of the IHD interaction with the consumer can take place autonomously within the home, requiring little extra WAN communications or DCC activity. In the longer term, a competitive service industry would be able to form, offering a host of new energy saving and home management services to consumers. We believe that this industry will eventually carry some of programme's investment costs, as well as providing a lasting benefit for the economy and for consumers.

5 Response to In-Home Display

The following section contains T-Systems' response to Ofgem's 'In-Home Display' document, Questions 1, 2, 3, 4, 5, 6, 7 and 8.

Please note that the answers in this section have content that is repeated, in less detail, in Prospectus Question 1.

5.1 Response to In-Home Display Question 1

Question Text:	We welcome views on the level of accuracy which can be achieved and which customers would expect, in particular in relation to consumption in pounds and pence.

T-Systems is confident that the level of display accuracy that can be achieved with a smart metering system as outlined by Ofgem in the Prospectus will be sufficient to meet Ofgem's requirements. Nevertheless, we question if this information is what the consumer would hope for and whether it will be sufficient to change consumer behaviour in the long-term.

Display accuracy
The basic functionality required by Ofgem for the IHD is the provision of summarised values in pounds and pence. The accuracy of these values will depend on how often the display is updated, and on either the accuracy of manual input of tariff information, or the smart meter's ability to receive tariff information from suppliers via DCC.

Information that will affect behaviour
During our smart metering trials in continental Europe, we found that a single value summarising consumption within a home, be it in pounds and pence or otherwise, is of limited use. Such a summary does not assist the majority of consumers in understanding how their money is being spent, or in identifying faulty or energy-hungry devices in their home. Hence, understanding the cost of using individual devices and, as a result, understanding how to change behaviour is left to the consumer.

Measuring the power drain of individual appliances used in the home is the first step in prioritising what could be used less, or what should be turned off when not in use. Commonly available plug-in power meters can be used for this purpose. These devices are plugged into any electrical power socket, between the power supply and the appliance to be measured, and include a built-in display to clearly show the amount of power that the appliance consumes. For example, using a plug-in power meter to measure the energy used in a washing machine cycle can show the difference between using a hot wash and a cool wash.

Complexity of presentation
Ofgem has already highlighted that displaying the actual cost of usage is critically important, and after-market plug-in power meters are often limited in that the cost of the energy consumed depends on the unit prices input by the user, and on the time the appliance is used. As a result, plug-in power meters help to analyse energy in detail, but require some additional arithmetic work in order to build up an overall picture. This is not as straightforward as measuring the momentary power consumption of an appliance: a kettle consuming 2kW for 20 minutes a day costs less than a fridge consuming 35W for 24 hours every day.

This shows that the power meter by itself is unlikely to change consumer behaviour, because the information it provides does not help the consumer without further analysis. What is required, in order to enable changes in consumer behaviour, is the ability to combine sensory information from multiple appliances and systems, and process it for display on the IHD in such a way that it can be easily understood by the consumer (see pictures 13, 14 and 15).

Figures 13,14 and 15 show how meaningful information drives behavioural change

Ideally, the display should tell the consumer that their fridge is faulty and thus consumes an extra £50 worth of energy per year, or that leaving the TV running all day will cost an extra £40 a year (figures are example only).

A central hub of information to facilitate behavioural change

We propose that, in order to influence significant behavioural change, the smart metering system requires more than meter consumption information. It requires smart analysis of information from several sources and eventually automation. The sort of automation that allows a consumer to programme their appliances, via the IHD, to be activated and deactivated at certain times of day that correspond with the time-of-use tariffs they've negotiated with their suppliers.

We agree with Ofgem that the first steps towards automation will be the display of consumption information, but we believe that the foundation for expanding the platform in the future should be set correctly in order to avoid disruptive and costly changes. We therefore argue that information should be stored centrally in the HAN, independent of its origin. This might include metered values, values from sub-meters, information supplied by smart appliances, as well as tariffs and pricing information providing more than actual consumption in pounds and pence.

In our responses to In-Home Display Question 7 and Regulatory Framework Question 15, we highlight the advantages associated with using a Smart Hub as the central point within the HAN network. We propose that the IHD be fed by the Smart Hub, based on an extensible display framework that can be remotely updated to display virtually any information on the IHD in any format. For example, providing cost information or displaying tariff information customised by currency or language are applications that can easily be implemented. In-home automation services and the display of data obtained via smart grids can be displayed without the need to roll out additional devices or swap out the IHD for a new version. Supplier-branded IHD applications are possible, even if a different supplier originally installed the meters.

Conclusion

In our trials, we have found that the key to behavioural change is to provide the consumer with meaningful information that will help them identify the steps necessary to reduce their bills and therefore save energy. We must therefore question whether a consumption summary, even showing values in pounds and pence, will allow a consumer to identify their old fridge or their faulty TV as the power-hungry culprit causing costly energy wastage in their home. Consumers will only change their behaviour if they can see the reasons for changing and the benefits they'll gain in doing so.

While we agree that the first step in this process is the establishment of smart metering and the installation of IHDs in homes, we believe that Ofgem needs to go further. In order to process more complex information from additional in-home sensors, the IHD must be part of an open, intelligent system such as a HAN, with a Smart Hub that interprets and helps automate energy saving behaviour. Only the central processing unit of such a system will be able to integrate and process the information from several sources, including historical and new tariffs, so that it can be available and displayed in an easily understandable fashion. Moreover, when combined with a configurable Smart Hub, we believe the IHD could become the energy management centre in the home of the future, without significant new investment or the rollout of new devices across Britain.

5.2 Response to In-Home Display Question 2

Question Text:	We welcome evidence on whether information on carbon dioxide emissions is a useful indicator in encouraging behaviour change, and if so, how it might be best represented to consumers.

Displaying carbon dioxide emissions and their effects may well have the potential to change consumers' behaviour, if provided in addition to the monetary IHD display. However, T-Systems does not have any direct evidence of this from any of its current or past smart metering trials.

Data derived from the IPCC Guidelines for National Greenhouse Gas Inventories could be used to derive carbon dioxide emissions in tonnes/kWh, which could of course be presented on the IHD in tonnes/kWh. Innovative ways of showing this can be developed for the IHD.

This question highlights the necessity to design a flexible and open architecture that enables consumers to select applications that suit their needs and display those results on an IHD.

In order to process more complex information from further sensors, the IHD has to be part of an open, intelligent platform such as a HAN with a Smart Hub. Only the central processing unit of such a platform will be able to integrate and process the information from several sources, so that it can be displayed in an easily understandable fashion. Moreover, if associated with a configurable Smart Hub, the IHD could become the future proof energy management centre of the future home.

5.3 Response to In-Home Display Question 3

Question Text:	We welcome views on the issues with establishing the settings for ambient feedback.

T-Systems is committed not only to the evolution of highly effective smart metering solutions, but also to their positive impact on consumers and the environment in which they are used. While we welcome the idea of ambient feedback, our findings relating to its actual affect on behaviour are inconclusive.

Ambient feedback
T-Systems has commissioned market research covering this and other topics as part of our smart metering trials. Among other valuable insights, the research has shown how consumers might react to ambient feedback from their IHDs. Specifically, it highlighted that customers would welcome some means of understanding how their energy usage deviated from what

might be considered normal for a household of their size.

The approach could be incorporated into the home many different ways, not just a coloured light on an IHD. For example, an illuminated, colour-changing fabric was demonstrated at the Fourth Irish Human Computer Interaction Conference. The developers of the fabric argued that simple ambient feedback, integrated into the surroundings as the colour of a home textile, may provide a powerful motivator in better raising awareness of electricity consumption.

Of course, a difficulty associated with this approach is correctly profiling the household, in order to correctly measure and display usage compared to the 'average'. The same profiling would also need to consider average climate values and seasonal effects.

Open framework for any form of feedback
As in our answer to Question 2 above, we highlight the need to design an inherently flexible and open architecture for the smart metering system. We believe that such an architecture will allow for any form of output device, including forms of ambient feedback and energy efficiency services, potentially as part of a competitive market.

5.4 Response to In-Home Display Question 4

Question Text:	Do you think that there is a case for a supply licence obligation around the need for appropriately designed IHDs to be provided to customers with special requirements, and/or for best practice to be identified and shared once suppliers start to roll out IHDs?

T-Systems fully supports the case for a supply licence obligation to offer Universal Accessibility IHDs to customers with special requirements. Best practice could be shared by suppliers and proactively learned via usability tests, discussions with specialist organisations and perhaps even a smart metering IHD trial focused specifically on this subject.

In its responses to In-Home Display Questions 1 and 7, T-Systems has highlighted the benefit of technically decoupling the IHD from any specific supplier's smart meter. In general, the standalone IHD at the consumer's site must rely on secure and reliable data either provided instantly or calculated by the basic set of applications such as:

- Pricing information provided by suppliers;
- Officially published emission factors of CO_2 depending on the energy mix;
- Historical data of meters (in the event that the previous meter has been changed out for any reason);
- Information from additional meters that may be installed at a later date, such as heat or water meters;
- Data logged from 'advanced' electronic meters, such as those in use in the non-domestic sector.

For a variety of reasons, including that of Universal Accessibility, none of this information should have to be manually input and for security and liability reasons should originate from one principal source at the consumer's home.

A Smart Hub would monitor and control the meters, store the readout for access from DCC via the WAN and send whatever information is needed to the standalone IHD. Furthermore, as explained in the responses to other questions in this section, it could connect to other devices, enabling the system to be highly usable for customers with special needs without making any changes except to the type of IHD required.

5.5 Response to In-Home Display Question 5

Question Text:	We welcome evidence on whether portability of IHDs has a significant impact on consumer behavioural change.

As a result of over 140 months of cumulative experience from 19 smart metering and smart grid trials, T-Systems has developed the view that substantial and sustained impact on consumers' behaviour will only be achieved by providing a smart metering system that is flexible enough to meet their individual needs.

Our largest trial, in Friedrichshafen, Germany, has been ongoing since late 2007 and has not only provided us with technology breakthroughs but also generated useful independent market research data. T-Systems is trialing a number of different IHDs, some of which are portable. Wider smart metering trials have shown that customers are (at least in the early stages of a trial) very keen to locate those appliances that use the most power in the home. It is logical therefore, that a portable IHD that can be carried around the house will assist in helping consumers to understand their energy consumption (see Figure 16).

T-Systems and Technische Werke Friedrichshafen commissioned independent market research in September 2009, 18 months into the trial of smart metering in Friedrichshafen, Germany. Some of the reported comments from consumers highlight their appreciation of tailored information, confirming how helpful a portable IHD could be:

"As a result of tracking our usage we have installed a switchable socket. The TV, VCR, etc are no longer on standby when not in use"

"A freezer stood in the basement and we had another smaller one upstairs, we now bring our food up from the basement and have turned off the little 'energy guzzler' upstairs"

An open and flexible architecture, with a central store for data and applications, would even allow the remote observation of energy consumption, although this would be reliant on DCC implementing smart hub capabilities and suppliers providing user authorisation for such a service.

We believe the portable IHD should therefore be decoupled technically from any specific supplier's smart meter and, for the purposes of auditing the individual usage characteristics of electrical devices, be capable of a minimum set of applications explained in the response to In-Home Display Question 7.

Figure 16: Example of a portable IHD

The consumer electronics and software mass market is by its nature highly innovative and new services will emerge for home automation and smart grid applications. From day one of the programme and into the future, devices and innovative applications will be able to come together seamlessly, using the IHD as an output device. We have argued in our answers to Questions 1, 2 and 3 that such advanced information and functionality would provide significant benefits to the consumer and is much more likely to encourage the desired behavioural change.

5.6 Response to In-Home Display Question 6

Question Text:	Do you agree with the proposed minimum functional requirements for the IHD?

Please note that this response shares certain proposals and technical concepts with the response to Prospectus Question 1.

T-Systems is concerned that the current set of requirements, together with the requirement to display information from more than one supplier, will hamper innovation and reduce the usefulness of the display.

The importance of meaningful information
We have explained in our responses to In-Home Display Questions 1, 2 and 3, that the display of summarised energy consumption, even in pounds and pence, will not be sufficient to change consumer behaviour. Consumers must be able to see the comparative cost of different devices and understand what they can do to reduce this cost. This will become even more important with the introduction of time-of-use tariffs.

This more advanced information can only be made available to the consumer through the integration of data from additional in-home sensors into the display. While we agree that the provision of summaries is a good first step, it is important that Ofgem place the IHD within a technical framework that can realise the benefits of future service innovations without the need to replace costly equipment.

Choosing the right in-home architecture
T-Systems proposes that the IHD should form part of wider open platform architecture. One of the advantages of such a platform will be a flexible and extensible home display framework. This framework will enable any number of devices displaying information from sensors within the home, as well as information supplied by suppliers and data services.

Figure 17: GlucoTel service using smart metering architecture

The right platform architecture and open design of the IHD makes as yet unknown functions possible in the future. Such innovations will encourage greater engagement with the consumer, further encouraging a positive change in behaviour.

In our smart city trial in Germany, the smart metering architecture has been extended beyond energy to benefit the community in other innovative ways. Working with our partner, BodyTel Europe GmbH, and with expert medical support, we have developed GlucoTel, a service for diabetics. GlucoTel lets patients stay in the comfort of their own homes, while still having critical personal data monitored remotely in case of emergencies. Other supporting facilities, including an IHD diary, have also been enabled. The service also offers the inclusion of other means of communication such as mobile phones and the Internet (see Figure 17).

The minimum set of requirements
In T-Systems' view, the minimum set of requirements should define the framework within which display of information is made possible:

- Aggregation of information from various sources;
- In-home storage and processing of information;
- Display of authorised third party information chosen by the consumer;
- Supplier and data service driven formatting and presentation;
- Independence from display hardware.

We suggest that this framework would be best enabled by combining a central processing unit in the home (the Smart Hub) with a governing data services provider at DCC; the latter delivering a common interface of core services to any authorised suppliers. We discuss the Smart Hub in detail in our answer to Prospectus Question 14, and the governing data services (GDS) concept in our answer to Prospectus Question 9.

The display framework creates a competitive landscape
As mentioned above, our proposal of the IHD framework allows for the IHD to become a universal display concept for all suppliers and data services. Initially, we believe that suppliers will differentiate themselves by providing added value information and by supplying sensors that hook into the framework to allow home automation.

In the longer term, we see the display framework as the consumer-facing end of an ecosystem consisting of a growing number of businesses competitively delivering a range of energy-based services.

Conclusion
T-Systems is concerned that the current set of specifications will lead to limited success in encouraging and supporting long-term behavioural change among consumers. We believe that the IHD should be the key interface for the smart metering platform today and for future services. To achieve this, the display should be placed within the wider open architecture platform that we are proposing.

The display framework made possible by this architecture will enable the presentation of virtually any information and enable the IHD to become the consumer front end of a new competitive landscape of energy based services.

5.7 Response to In-Home Display Question 7

Question Text:	Do you have any views or evidence relating to whether innovation could be hampered by requiring all displays to be capable of displaying the minimum information set for both fuels?

T-Systems has already proven interoperability with 57 meters for water, electricity, gas, hot water and a number of dual-fuel hybrids. T-Systems proposes that innovation can only be enabled if the technical solution includes a standalone display coupled with a Smart Hub with some processing power and storage capabilities. In this respect, T-Systems would argue that the Ofgem minimum set of requirements, paired with the need to display more than one supplier's set of information, is likely to hamper innovation and reduce the usefulness of the display.

Minimum specifications lead to proprietary designs that cannot be shared
There are a number of technical and management challenges that have to be overcome if the IHD is to display comparable levels of information, in a comprehensible and usable format, for both fuels, independent of whether this is for the minimum information set or more.

These challenges may well be exacerbated in the event that one supplier is a 'client' on the hosting IHD of another. The latter can update information and eventually enhance its visualisation easily, whilst the 'client' supplier is obliged to negotiate all changes with the host.

Proprietary designs and minimum specifications will hamper innovation
Initially, electricity and gas meters will be installed and their readings displayed on the IHD. If IHDs are only required to display minimum information, and any additional functionality is dictated by the first installer of a smart meter, then innovation is effectively controlled (and perhaps restricted) by that supplier. As a result, innovative applications and additional devices, such as monitoring units or other sensors, auxiliary switches, connectors to home appliances or energy-generating machines may not be able to use the IHD as an output device.

The solution is one of choosing the right in-home architecture
T-Systems would propose re-phrasing the question: *Which in-home smart metering architecture concept would enable the IHD to become a flexible, expandable and future proof display platform for all suppliers and future services*?

That is to say that basic functional requirements should address more than only the most basic display content. The real question is what should an IHD be capable of and what kind of applications running on the smart meter, or elsewhere, can use it as a 'smart' output or, if a touch-screen is available, even as an input device.

Standalone should be taken literally. An IHD should therefore be physically separate from any specific supplier's smart meter. In general, the standalone IHD at the consumer's site must rely on secure and reliable data, provided either instantly or calculated by the basic set of applications, none of which should be manually input and, for security and liability reasons, should originate from one principal source in the consumer's home.

A central, in-home device will provide an open, extensible platform
T-Systems recommends that information and applications are stored (and if required, processed) on a single Smart Hub within each household. The Smart Hub, comprising enhanced hardware and software, should be the principal hosting device in the HAN.

A Smart Hub would monitor and control the meters, store the readout for access from the WAN and send whatever information is needed to the standalone In-Home Display. Furthermore, as explained in the responses to other questions in this section, it could connect to other devices and hosts, as well as home automation applications or smart grids. The resulting open HAN architecture and meter abstraction will create commercial benefits and aid the simplification of industry processes.

Conclusion
T-Systems agrees with the underlying point within Question 7, that providing the IHD with data from two or more separate devices managed by two or more separate companies will lead to many problems. And these will get worse once in-home automation and further services start to emerge.

We believe that the IHD should be the central point of interaction and information for the home, enabling both today's energy services and those of the future. We argue that the Smart Hub would introduce an extensible central information and processing unit to the HAN that can supply the IHD with virtually any information, tailored to consumer needs, supplier needs and any other involved party. Moreover, the Smart Hub naturally evolves the IHD concept to any device capable of securely interfacing with it: phones, computers and ambient devices as well as software applications. The IHD could support a competitive, flexible and future proof market, based on well-understood open standards.

5.8 Response to In-Home Display Question 8

Question Text:	Do you agree with the proposals covering the roles of and obligations on suppliers in relation to the IHD?

As explained in our answer to Question 7, T-Systems recommends integrating the in-home architecture into a wider, more flexible framework. This would enable a dynamic exchange of information between all in-home devices and sensors, and allow for the retrieval of relevant information from energy suppliers via DCC.

In order to realise this open system, we propose the following obligations on lead suppliers in relation to the IHD:

- Independence of any proprietary protocol between a gas or electricity meter;
- Details of the IHD interface (e.g. pixel graphics or objects to render) and the level of 'smartness' of the underlying hardware/software;
- Openness to future applications.

In the architectural model proposed by T-Systems, each household would have a Smart Hub that is owned by DCC and that provides all necessary information for the consumer to analyse their energy usage. The Smart Hub will be able, depending on how it has been programmed by the consumer, to display relevant information and potentially exchange data with other automation tools and appliances in the home. As such, the IHD is not a self-operating device but part of an open system of devices and information.

The IHD is therefore critical to every installation. It should be an open system that gives each gas and electricity supplier the same configurable features, rather than providing an unfair competitive advantage to the supplier who installed it.

Being part of an open system, there is less risk of hard-coded functions within the IHD becoming redundant over time. This will not only minimise the risk of outdated devices and stranded assets, but also eliminate the need for suppliers to provide a second IHD in addition to one already installed.

6 Response to Non-Domestic Sector

The following section contains T-Systems' response to Ofgem's 'Non-Domestic Sector' document, Questions 4, 5, 6, 8 and 9.

Please note that, where the content of our answers may be either repeated or provided in more detail, we have provided cross-references to other answers.

6.1 Response to Non-Domestic Sector Question 4

Question Text:	Do you agree with the proposed approach that use of DCC should be optional for non-domestic participants in the sector?

Please note that this response shares certain proposals and technical concepts with the response to Prospectus Question 12.

Introduction
T-Systems agrees with Ofgem's proposed approach that the use of DCC should initially be optional for non-domestic participants. We also appreciate Ofgem's concerns regarding unfair competition if DCC was to offer energy management and efficiency services in the non-domestic market. However, we are conscious of the need to have a single view of the smart grid and this will require information from the non-domestic sector. Without this holistic picture of energy consumption, any smart grid services and solutions will remain limited.

One single source of truthful data for energy consumption
Smart grid evolution requires the knowledge of consumption data as well as energy generation data. Suppliers and network operators use this data to plan their capacity and manage their distribution networks. This data can be provided in one of two ways, either decentralised (where market participants share the data bilaterally) or centralised (where a central entity collects and distributes the data).

The centralised approach is preferable since it reduces the number of interactions between market participants, thereby simplifying industry processes and minimising overheads and data inconsistencies. In addition, interfaces for transfer of data required for "the calculation of use of system charges" (DCUSA 29.3.1) should be standardised in order to facilitate efficient industry processes for smart grids.

Smart grid services for the non-domestic sector
However, regarding the future development of DCC, we believe that it does not need to compete against independent ICT suppliers offering energy management and efficiency services in the non-domestic sector. We propose that DCC be used as the single source of truthful data, for the collection and distribution of data required for "the calculation of use of system charges" (DCUSA 29.3.1). This means using DCC for smart grid operation across both domestic and non-domestic participants, and requires that the interfaces provided by DCC be specified accordingly. DCC can have a view of the grid and supply critical data to suppliers but does not need to offer any specialised services to non-domestic consumers. DCC can focus exclusively on the secure and efficient management and aggregation of consumption data.

Of course DCC could competitively procure smart grid data services over time, including those for non-domestic customers, and offer them centrally. Or it could continue to focus on smart metering and add smart grid services to domestic consumers only, leaving the non-domestic smart grid services market as before.

We feel that, in addition to optimising the effectiveness of smart grid services by having a single source of truthful data, having this source managed by a regulated entity will level the playing field in the non-domestic market. Smaller ICT suppliers will be given the opportunity to differentiate themselves with niche and specialised solutions, without having to develop their own costly and secure communication and data management infrastructure.

Making it easy to integrate non-domestic smart meters
T-Systems believes that non-domestic participants could benefit from innovations in the domestic market. Clearly, seizing this potential is dependent upon technical interoperability with services provided by DCC in the domestic market. We strongly support Ofgem's focus on open standards and specified interfaces, which we feel will allow the integration of existing non-domestic smart meters into the domestic market platform.

In our demand side management trials in the non-domestic sector, we have used the Smart Hub, which is usually placed in the household, to facilitate the integration of older non-domestic smart meters into the smart grid. This has proven highly successful because the Smart Hub can adapt and supply much of the intelligence needed to meet smart metering communication specifications.

Conclusion
While we agree that use of DCC services should be optional for non-domestic participants, we propose setting up technical specifications, such as the use of a Smart Hub, to ease the integration of existing meters in the non-domestic sector. A migration path should be established to enable the market to benefit from one single source of truthful data and realise new opportunities for innovative energy management and efficiency services.

6.2 Response to Non-Domestic Sector Question 5

Question Text:	If use of DCC is not mandated for non-domestic customers, do you agree with the proposed approach as to how it offers its services and the controls around such offers?

Please note that this response shares certain proposals and technical concepts with the response to Prospectus Question 5.

Introduction
While we agree with the general principles underlying Ofgem's proposed approach, we share its concerns about potentially lost benefits relating to interoperability, smart grid and industry simplification. The freedom to implement individual solutions could give way to a heterogeneous evolution of data and communication technologies. Without strict interoperability requirements, the resulting high switching cost associated with each solution could therefore cause lock-in (or rather a lock-out) of non-domestic customers.

In addition, without a non-discriminatory provision of access to data, the competitive market for data services operating on data centric business models could be stifled in the non-domestic sector.

Separating the domestic and non-domestic infrastructures risks eliminating the potential benefits of economies of scale gained by utilising a shared communication infrastructure. It could also negate the potential benefits of industry simplification with regards to smart grid evolution.

Proposal

T-Systems understands that limiting DCC's capability to provide services for the non-domestic market is necessary for conserving competition. In order to achieve this goal without forgoing potential benefits relating to interoperability, smart grid and industry simplification, we propose using the following approaches:

> **Ensure interoperability through a flexible, distributed architecture**
>
> Technical and commercial interoperability is not just a means of ensuring an efficiently operating competitive market and preventing lock-in for the domestic market, it can also be extended to the non-domestic market. Many non-domestic customers already have smart metering. Without market regulation a variety of non-interoperable smart metering solutions and services will continue to characterise the non-domestic sector. As described in our answer to Non-Domestic Sector Question 8, a Smart Hub is part of the proposed distributed smart metering architecture of DCC. Placing a Smart Hub with headend type capabilities into the customer premises would offer a high degree of flexibility and interoperability, just as it does for consumer households, without the need to replace old smart metering. Enabling switching without replacing existing hardware would also reduce the risk of stranded assets. In addition, the same flexible Smart Hub architecture that provides benefits in the home will deliver exciting opportunities in a non-domestic setting, not least innovative data services from third party service providers made possible by improved commercial interoperability.
>
> **Limit DCC's activities to provision communication and governing data services**
>
> Initially, we propose to limit DCC activities in the non-domestic market to the provision of communication and governing data services. If DCC's governing data services are based on an open and extensible platform, as we propose in our answer to Communications Business Model Question 1, established advanced metering service providers will initially retain the choice to build and operate internally or to procure these services from DCC. Both approaches can be utilised to build competitive data services tailored to the non-domestic market. In the initial period, DCC would compete with other communications providers. However, in the long run, cost benefits achieved through economies of scale will provide non-domestic service providers with an incentive to opt for services provided by DCC. Over time, this should lead to widespread adoption of DCC core services as the basis for service providers in the non-domestic sector and hence increase efficiency.

Making the use of DCC optional, but opening its framework to interested advanced metering service providers, may encourage the advanced metering industry to develop data services for non-domestic users for the new platform. Eventually this could lead to synergies between data services created for the non-domestic market and the consumer market.

Conclusion

T-Systems believes that making the use of DCC services optional in the initial phases of the programme is the right approach to service provision in the non-domestic sector. In order to ensure an efficient market evolution in the non-domestic sector, T-Systems proposes:

- Optional use of DCC initially, but encouragement of data services based on advanced metering solutions for the non-domestic market;
- Ensuring interoperability through the implementation of the proposed distributed architecture, including the Smart Hub.

Implementing these two approaches would allow the smart metering programme to preserve the competitive market in the non-domestic sector, while allowing it to migrate onto the new platform. Ultimately, the combined GDS and Smart Hub approach could lead to a reinvention of the advanced metering solutions of the non-domestic sector, based on the flexible, open in-home and DCC infrastructure.

6.3 Response to Non-Domestic Sector Question 6

Question Text:	To what extent does our proposed approach to the use of DCC for non-domestic customers present any significant potential limitations for smart grids?

Please note that this response shares certain proposals and technical concepts with the response to Prospectus Question 5.

Introduction
We fully understand Ofgem's reasoning for not obliging non-domestic suppliers or meter service providers to use DCC's communication services. However, we are concerned that such an approach will introduce substantial complexity in the realisation of Britain's long-term smart grid vision.

As recognised in DCUSA, two sets of data are essential for facilitating the evolution of smart grids: 1) current transactional data for the calculation of 'Use of System Charges', and 2) historical data for operation, design and planning of Distribution Systems. This incorporates knowledge of consumption data as well as energy generation data. Suppliers and network operators use this data to plan capacity and manage distribution networks respectively. The exchange of this data can be managed in one of two ways:

- Either decentralised (where market participants share the data bilaterally;
- Or centralised (where a central entity collects and distributes the data).

T-Systems believe strongly that a centralised approach will offer the most substantial benefits, whilst avoiding potential limitations for smart grids.

The risks of a decentralised approach
Current obligations only mandate the realisation of bilateral data exchange, without a specification of data format or interface, as illustrated in Figure 18 below. These obligations, without the requirement to utilise DCC's communication services, are likely to result in a complex network of bilateral exchanges consisting of a variety of data formats, interfaces and data storage points.

Furthermore, this organisation of data exchange requires participants to operate redundant interfaces and IT processes, causing additional operational costs that will likely be passed on to customers.

Finally, given that, in such an industry organisation, DCC only controls the interfaces related to its own services, its ability to positively influence market organisation and support the evolution of smart grid will be extremely limited.

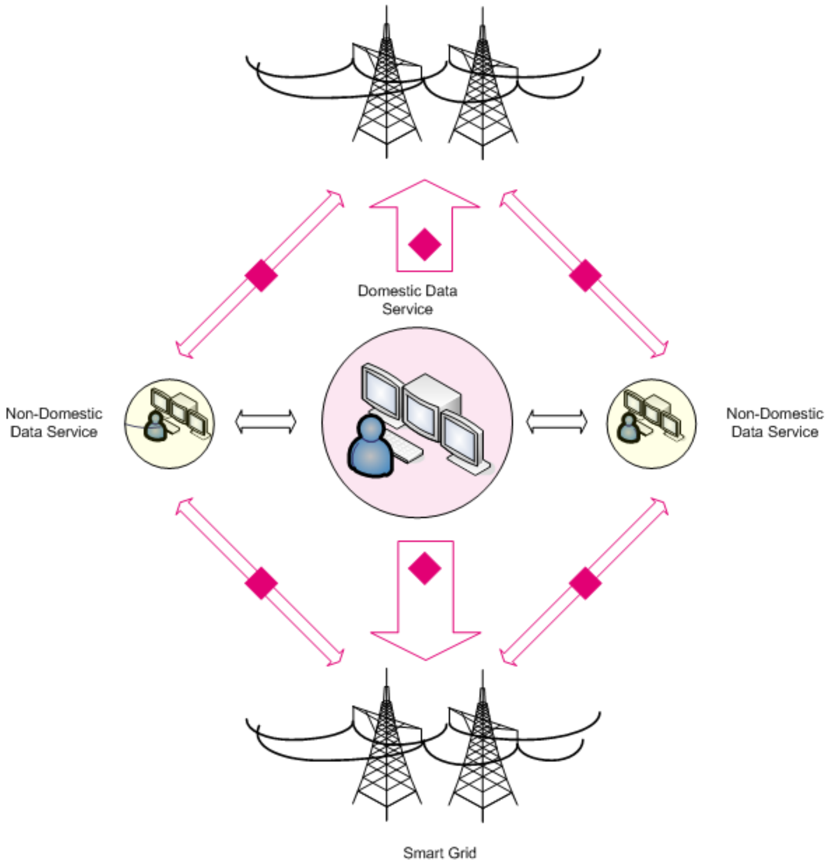


Figure 18: The complexity of a decentralised approach

The benefits of a centralised approach

T-Systems proposes a centralised approach to data collection and distribution in order to achieve industry process simplification and a reduction in cost. The centralised approach, as shown in Figure 19 below, will reduce the number of interactions between market participants by centrally collecting and distributing data.

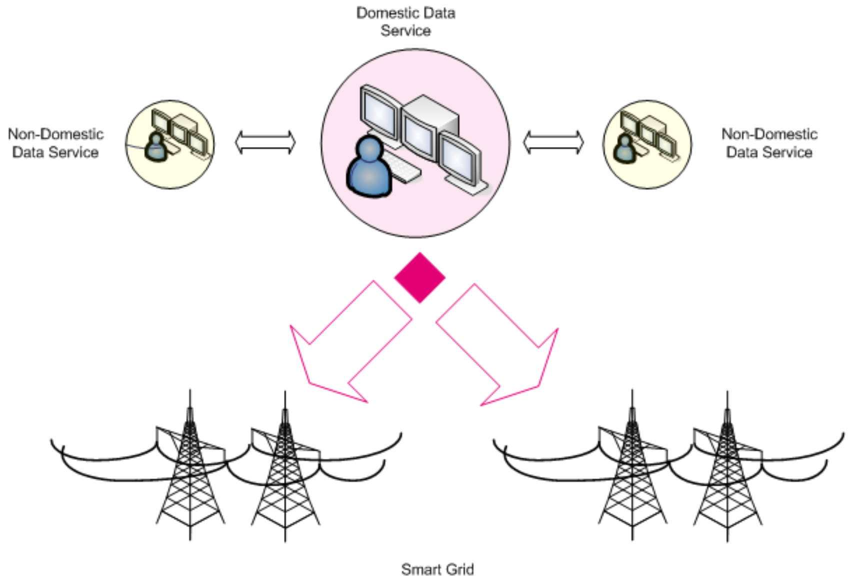


Figure 19: Proposal for a simplified, centralised approach

A centralised data exchange organisation can be achieved by mandating that DCC act as central data collector and distributor. Centralising this function within GDS would enable the standardisation of a smart grid related data exchange processes. In addition, interfaces for the transfer of data required for “the calculation of use of system charges” (DCUSA 29.3.1) could be standardised in order to facilitate efficient industry processes for smart grids.

Implementing a centralised approach to data collection and distribution would also support the evolution of the competitive market in the non-domestic sector. In our response to Question 5, we discuss various means of migrating existing advanced metering systems onto the new platform. Enabling non-discriminatory access to the data reduces the barrier to entry for new and innovative data service providers and hence increases competition. Such an increase in competition will in turn drive innovation.

Conclusion
T-Systems recommends that DCC be used, with its role as GDS, as the single source of truth that collects and distributes consumption data relevant for smart grid control. We believe that the evolution of smart metering towards the smart grid will only be possible if DCC has access to all such data, particularly where it may be critical to future extensibility.

This question highlights the importance of choosing the right architecture for the smart metering programme. Among many other data requirements, non-domestic consumption data has to be taken into account for the smart grid. DCC and the architecture of the programme as a whole must be able to account for this. T-Systems is confident that only by taking an end-to-end view of the architecture will it be possible to build a system that is sufficiently open and extensible to meet such requirements.

6.4 Response to Non-Domestic Sector Question 8

Question Text:	How can interoperability best be secured in the smaller non-domestic sector?

Introduction
We agree with Ofgem that ensuring interoperability is a vital component in engaging the non-domestic market. While Ofgem should aim not to mandate policies that will damage the existing market for advanced metering or add cost burden to the non-domestic market, it has to consider that metering data from the non-domestic market is vital for the smart grid. We therefore propose that interoperability should be combined with a robust, extensible smart metering platform in order to provide the advanced metering industry with a natural migration path leading to more powerful and lower cost solutions. If this migration path holds commercial benefits for the industry, migration should happen naturally and without any distorting effect on the market.

Ensure interoperability through the Smart Hub architecture
In our answer to Communications Business Model Question 1, we argue that the functionality of (headend) translation services should be distributed between the home and DCC data centre, by deploying a Smart Hub in the home. We believe that this Smart Hub, located at the interface between the HAN and WAN interface (i.e. the WAN module) should be responsible for managing IHDs and collecting sensory information from the meters on-site, prior to WAN communication, in a unified format. We propose that the Smart Hub be remotely upgradeable, giving it the ability to communicate with current and future meters, as long as they are enabled to send data. Using this infrastructure, any advanced meter becomes interoperable with the smart metering platform if and when this is required.

Provide an extensible platform for data services via DCC's GDS
We argue in our answer to Question 4 that DCC's GDS services should ensure that all interested data service providers are provided access to the data necessary to develop applications for the consumer or for other authorised purposes. It follows that GDS provide a secure service development interface for the advanced metering industry, to enable the development of new offerings using the smart metering platform and their existing meter infrastructure. In addition to the non-domestic market, the advanced metering industry can bring to bear its experience to develop home automation and energy saving services for the consumer market using the same infrastructure.

Conclusion – a natural migration path for the non-domestic market
We argue that migrating the non-domestic market, without distorting an existing industry, can be achieved by providing a platform that is open and extensible and that allows advanced metering businesses to develop new services for this platform. The Smart Hub concept allows easy integration of existing advanced meters, and GDS provides the extensible backend that third party services can utilise to build services. Economies of scale should ensure that GDS is more cost effective than proprietary advanced metering communications with their own headend solutions, adding a cost pressure on the migration path. Finally, given the much larger market penetration of the smart metering platform, advanced metering businesses should be compelled to offer their services through this new platform.

6.5 Response to Non-Domestic Sector Question 9

Question Text:	What steps are needed to ensure that customers can access their data, and should the level of data provision and the means through which it is provided to individual customers or premises be a matter for contract between the customer and the supplier or should minimum requirements be put in place?

Please note that this response shares certain proposals and technical concepts with the response to Prospectus Question 5.

Introduction
T-Systems does not believe that minimum user requirements covering the needs of the non-domestic sector are feasible. It is nevertheless important that non-domestic customers retain the ability to access their consumption data and distribute or utilise it as they see fit. At the very least, this will be necessary to avoid customers being 'locked-in' due to non-transferable consumption data.

Provision of access to data
In our answer to Question 8, we have outlined our views with regards to how the non-domestic market could migrate onto the smart metering platform. While we suggest no timescales for this to happen, our proposed framework does provide solutions to the question of data access:

> **Flexible display framework**: We have argued in our answer to In-Home Display Question 7, that the Smart Hub concept can provide a remotely customisable means of powering a wide range of display devices. The extensibility of the concept could also allow for non-domestic advanced metering data service providers to customise a display with information that is relevant to non-domestic customers. While the information and the display would together form a competitive market offering, they would be enabled by the Smart Hub and DCC's GDS.

Historic data storage: The Smart Hub and GDS are capable of storing historical data, which can be retrieved via the display or by authorised suppliers or data service providers.

Conclusion

While we agree that a standardisation of user interface requirements is not feasible in the non-domestic sector, we do believe that a standardised framework for storage and display of data should be provided.

Only the establishment of non-discriminatory access to data, via mandated industry standards, will ensure that customers in the non-domestic sector are protected from any inability to transfer historical data and the resulting lock-in. In addition, standardised accessibility to stored data records is a prerequisite for competition in the data services market.

7 Response to Regulatory and Commercial Framework

The following section contains T-Systems' response to Ofgem's 'Regulatory and Commercial Framework' document, Questions 3, 5, 9, 12, 14 and 15.

Please note that, where the content of our answers may be either repeated or provided in more detail, we have provided cross-references to other answers.

7.1 Response to Regulatory and Commercial Framework Question 3

Question Text:	Do you have any comments on the indicative table of contents for the Smart Energy Code as set out in Appendix 3?

Please find below our comments to a selection of the items from your Appendix 3.

Item 10 - Meter access control and access authentication
This item suggests that DCC should manage access control to meter functionality and usage data. We argue in our response to Communications Business Model Question 15, that a Smart Hub could reduce management overhead by providing a secure interface to all HAN components on an abstracted level. In other words, a Smart Hub would store consumption data and provide information from all meters to DCC in the form of procedure calls. Security, authentication and access control between the Smart Hub and the meters could be managed independently from WAN communication security. Operating the Smart Hub would enable the central coordination of access control and access authentication on meter functionality and consumption data for the HAN. Central coordination would further facilitate a simplified and more secure approach to switching or relocation processes (e.g. initiating a remote reset of a smart metering system after a customer moved out). This approach would result in a less complex, and therefore more secure, solution.

Item 11, 12 - Gateways, commands and data transfer to meters
As proposed for item 10, these processes would be simplified with a Smart Hub providing an abstracted interface to installed meters. Such an interface would ensure interoperability across different meter manufacturers, meters provided by early movers, and existing non-domestic meter systems. This would be achieved by providing a unified, well-known interface on the WAN side, while providing an individualised (driver like) model on the HAN side to communicate with the meters. Additional meters could be made compatible with the system by means of a remote firmware update to the WAN module. Future features such as remote commands and error detection could also be provided by the Smart Hub as they become available on the meters. Handling error detection on this level would also facilitate much more detailed error information, leading to lower repair costs.

Item 14 - Responsibilities of suppliers
This item suggests that suppliers would have responsibility for the WAN module. T-Systems proposes that a smart WAN module (Smart Hub) should technically be part of DCC. However, the responsibility for installing and maintaining the Smart Hub could be shared among suppliers or be part of DCC, as long its function is specified and controlled by DCC.

Item 17 - Security and business continuity
The security of all communications networks involved in the smart metering system (encompassing HAN, WAN and data services) is best achieved by ensuring that all devices on the network are authenticated and communicate in a secure, encrypted manner. In our September response and its response to Communications Business Model Question 3, T-Systems highlighted the security advantages of adopting an end-to-end security approach whilst designing the system architecture. In-home security management should take place in the Smart Hub and only authenticated entities should communicate with it. DCC security management should oversee the security of communication between Smart Hubs and DCC's governing data services (GDS), between GDS and additional data service providers and between all data services, third parties and suppliers.

As further explained in our answer to Question 5 below, the selection of underlying architecture will have immediate implications on roles, responsibilities and cost distribution throughout the value chain. We therefore believe it is in Ofgem's interest to reflect on the relative benefits of the different architectures, before proceeding with roles, responsibilities or cost benefit analysis.

7.2 Response to Regulatory and Commercial Framework Question 5

Question Text:	Do you agree with the proposals concerning the roles and obligations of suppliers in relation to the WAN communications module?

Please note that this response replicates the response provided to Prospectus Question 8.

Introduction
We agree with Ofgem that energy suppliers should be responsible for installing and maintaining all equipment at consumer premises. However, we believe that it is essential to assign responsibilities to devices according to flow of data as opposed to assigning responsibilities on a first come first serve bases. Responsibility for the flow of data determines:

- The specification of physical devices to be installed in the home (meters, IHD and HAN/WAN module and any future devices);
- Procurement and management of each device, including error identification and management.

In our September response to Prospectus Question 19 (see Appendix 10.1), we explained in detail why we believe there is a need to define an end-to-end solution based on the flow of data. The underlying architecture of the end-to-end solution determines the ability of the different parties to execute control over this data flow. We would like to build on this argument here by describing our proposed architecture and the implications this would have regarding the respective roles and responsibilities of the suppliers.

The case of the HAN/WAN module
Our experience in 19 smart grid trials has led us to favour an architecture with a single source of truthful data, which is housed by one overarching entity. This architecture is independent of WAN or HAN technologies, or service providers. The central body, potentially DCC, owns the transfer of data between the meters and IHD(s) in the home, including the 'single source of truth'. Please note that the single source of truth does not have to be physically located in one place but does have to be controlled as one logical place. In the architecture favoured by T-Systems, this would mean some of the consumption data can stay in the household and be used by the consumer. Higher levels of data aggregation may be made available for relevant and required data services, or not shared at all.

We found that some of the governing data processing can be done more effectively in the home in order to increase scalability and interoperability. The architecture is based on a distributed technical platform, requiring a physical shared device in the house (the Smart Hub) and the governing and central equipment housed at DCC. Although present in every home as well as centrally, the platform is one integrated infrastructure, enabling effective security, efficient analysis and control of communication.

We propose that DCC does not just procure the relevant governing data services but takes on the responsibility of the governance (thus ensuring it is impartial). Since it owns the central technical platform, DCC has to also own the distributed component, i.e. the Smart Hub in the home. (We propose this entity also be the WAN/HAN module since it has gateway functionality and actually enables multiple HAN and WAN technologies). Installation and maintenance would remain the responsibility of the suppliers. This proposition is in line with the view brought forward by the DCG working group.

Responsibilities Summary

The table below provides a summary overview of the ownership of physical infrastructure and services associated with our proposed architecture, as well as the responsibility for ensuring availability of each unit (i.e. installation and maintenance), and for data transfer.

Physical unit	Ownership	Responsibility for ensuring availability (2)	Responsibility for ensuring data transfer
IHD	*Lead Supplier (& other supplier(s))*	*Lead Supplier (& other supplier(s))*	*DCC*
HAN/WAN module (1)	*DCC (3)*	*Lead supplier (& if change in suppliers the electricity meter supplier)*	*DCC*
Gas Meter	*Supplier (8)*	*Supplier*	*DCC*
Electricity Meter	*Supplier (8)*	*Supplier*	*DCC*
Other meters and Sensors	*N/A*	*Supplier*	*DCC*

Service	Ownership	Responsibility for ensuring availability (2)	Responsibility for ensuring data transfer
WAN	*WAN service provider (4)*	*WAN service provider*	*DCC*
HAN(s)	*N/A (shared medium)*	*N/A*	*DCC (7)*
Governing Services (5) inc. fault/error identification and tracking (6)	*DCC*	*DCC*	*DCC*

The following underlying assumptions were made:

(1) The HAN/WAN module is a smart device (in this response it is referred to as the Smart Hub) that controls and manages communication within the household and also between the household and DCC. As mentioned above, optimisation of the frequency and timing of data transfer, and selection of aggregation levels for data transfer, thus data privacy, are desirable. This is not possible without a controlling device in the home that can be managed remotely, and this control function has to be given to a governing, empowered and trusted party which we propose is DCC.

(2) Availability of the in-home devices and networks relies on installation and maintenance of the technology. It is assumed that this is done by the responsible parties. However, DCC would know where maintenance and, in most cases, what kind of maintenance would be required, and could therefore engage suppliers in a cost effective manner.

(3) We propose that DCC owns the Smart Hub and therefore cost should be shared amongst platform users as for central DCC functions. T-Systems' recommendation is to distribute the cost as part of the service charge for meter readings. Note that while cost is introduced to increase the capabilities of the WAN module, less intelligence is required in the smart meters and other HAN devices. Capabilities for security, communication with DCC and processing requirements for IHD and other industry processes do not have to be redundantly present within each meter, thus reducing the cost of meter production. We expect further in-home cost reductions to stem from the less complex information model that comes with the Smart Hub, i.e. IHD fed by one as opposed to several devices. Using the Smart Hub as a central point of communication within the HAN enables the coexistence of several HAN technologies to cater for complex in-home setups. Again, this also reduces cost in such setups. Please note that we propose that the consumer contact for the Smart Hub remains with the respective suppliers. The Smart Hub is able to constantly monitor the health of the in-home architecture and devices, and will therefore be able to provide real time information via DCC to suppliers and they then inform and manage the consumer and their expectations.

(4) DCC procures the WAN service from one or many WAN service providers. The providers are responsible for making the WAN available. The quality and operation of the WAN service will be the WAN service providers' responsibility but not the data transfer or health of any devices used for data transfer, which is managed by DCC and its distributed infrastructure.

(5) Smart grid services can be sourced from large or niche suppliers as the smart grid ecosystem evolves. DCC will procure those data services and manage them on the basis of the governing data services that are part of the licenced DCC. Again the data quality and appropriate data transfer would be monitored and managed by DCC, thus offering a full, end-to-end service to suppliers.

(6) Error identification and tracking in a central error log can be done by DCC, which controls communication between the in-home sensors and IHD as it has the opportunity to analyse and, in many cases, correct errors remotely via the Smart Hub. On-site visits would be the responsibility of the supplier. Call out requests and requirements would already be understood prior to the home visit as a result of an in-home analysis performed by the Smart Hub, inevitably reducing maintenance costs and improving the consumer experience. T-Systems proposal generally agrees with the proposition of a central error log brought forward by the DCG groups.

(7) The Smart Hub much increases the flexibility of the in-home architecture. As every device in the home only has to communicate with one other device – the Smart Hub – multiple HAN technologies can be deployed for communication. For example: if one type of communication is insufficient to cover a complex home installation (thick walls combined with radio interference for instance), secondary communications modules can be installed in the Smart Hub to enable communication to an individual HAN device. Furthermore additional software can be offered to manage challenging HAN technologies such as Power Line Communication (PLC). Inbuilt error correction and error resolution routines are available to manage the communication in homes that are difficult to reach (see Appendix 10.2). It is also important that, via the Smart Hub, the drain on battery-powered communications, e.g. in devices that are not connected to the electricity network, can be minimised. This will inevitably extend battery life, reduce the need for replacement and avoid disruption to the supplier and consumer.

(8) As a result of points mentioned in point 3 and 7, we believe that the cost benefit analysis for a Smart Hub model should take into account reduced cost for less complex meters, IHD and future devices, as well as the less tangible cost reduction that results from the reduced overall in-home architecture complexity and cost of WAN communication.

7.3 Response to Regulatory and Commercial Framework Question 9

Question Text:	What is needed to help ensure commercial interoperability?

Introduction
T-Systems fully supports Ofgem's stance on commercial interoperability, to achieve Ofgem's goals, however, care will need to be taken to ensure that smart meter specifications will sufficiently detailed and robust so as to safeguard against long-term meter interoperability concerns. We propose this because, if meters and IHDs, and software installed on them, are used by meter manufacturers and suppliers as a means of competitive differentiation, this could cause unwanted contractual complexities during the handover, as well inconsistencies in consumer experience. There are several aspects to commercial interoperability; it cannot be seen in isolation. These interdependent aspects of interoperability and how they can best be managed are described in more detail below.

Commercial interoperability
In our response to Regulatory and Commercial Framework Question 15, T-Systems described the concept of a Smart Hub – a remotely upgradeable in the home that acts as a central point of intelligence for communication and data collection – along with its advantages. As part of DCC managed infrastructure, this Smart Hub would enables the concentration of intelligence required in the HAN infrastructure. As a result, the meters would not be required to contain all supplier specific software, reducing duplication of software in multiple meters and thus also reducing the complexity of any required commercial agreements for meter ownership and maintenance. Supplier specific configuration in the Smart Hub could simply be configured at the point of the switch, using an agreed procedure.

Technical meter interoperability
For good reason, Ofgem is concerned about smart meter interoperability in several areas of the programme. Early movers are likely to install non-compliant meters, and non-domestic customers have been operating advanced meters for several years.

However, interoperability of the smart metering system is also a concern after steady state is achieved and devices are developed further. Regression testing will be required for any changes to ensure interoperability is maintained. This is particularly challenging when all devices and interfaces are changing at the same time.

T-Systems' Smart Hub concept manages and mitigates almost all interoperability concerns by providing one common interface on the WAN side. Any meter capable of communicating the required information could be integrated into the system simply by providing a translation of data inside the Smart Hub. Essentially, each meter could have a corresponding 'driver' that ensures interoperability with the Smart Hub. However, regardless of the installed meter, the communication on the WAN side of the home would always be identical. Smart Hub upgradeability would ensure that any future meter could be integrated into the system.

Management interoperability
In relation to Ofgem's concern about asset responsibilities, T-Systems suggests that DCC will need to be provided with relevant meter registration data during a supplier switch. As explained in our response to Communications Business Model Question 1, we believe that registration services should fall within the remit of DCC from the outset. Ofgem's concern would be addressed by this approach, particularly if Ofgem considers asset management (IHD, Smart Hub, etc) to be part of the registration process. Much of this progress could be automated,

without requiring manual interaction, as a result of the architecture proposed throughout this document.

T-Systems also proposes that all decisions relating to data provided by in-home devices (meters, etc) are made centrally, executing decisions approved by the consumer. DCC's governing data services (GDS) function should offer clearly defined interfaces for all meter data, master data, and transactional data. We believe the existence of such a body will be necessary to ensure there are no inconsistencies between meter features, and that any resulting variations in customer experience are avoided.

Communications before DCC becomes operational
The main concern in the pre-DCC phase is where a smart meter reading may be taking place via a supplier's intermediate data service. This data service may be subject to commercial agreements between a supplier and a communications provider, and may be based on a proprietary set of advanced meter features that is inconsistent with the minimum requirements. Even if the meters are technically interoperable, and the commercial agreement with the communications provider can be modified, the meter may require configuration (potentially on site), in order to transmit necessary data to the new supplier. If a supplier has deployed a meter beyond minimum specifications (for example to create competitive advantage), these advanced services will no longer be available to the new supplier unless a translation service is deployed.

We state in our September response that, in order to reduce concerns relating to a lack of interoperability, DCC's launch should take place as soon as possible. Our proposed architecture and features described for the Smart Hub can further mitigate many of the risks outlined for the interim phase.

Conclusion
Commercial interoperability concerns will be reduced and Ofgems' longer-term programme goals will be more achievable if a Smart Hub is placed at the centre of the in-home architecture. The Smart Hub will reduce the degree of complexity necessary inside the smart meters themselves and alleviate the legal complexity necessary to achieve technical and commercial interoperability.

At the same time, the Smart Hub will provide a configurable and updatable interface to suppliers, enabling them to differentiate their services to consumers, for example via extensions and the IHD. This therefore also offers the foundation for commercial interoperability at the data services end of the value chain, creating the opportunity for a rapidly evolving new ecosystem for energy services.

7.4 Response to Regulatory and Commercial Framework Question 12

Question Text:	What evolution do you expect in the development of innovative time-of-use tariffs? Are there any barriers to their introduction that need to be addressed?

Introduction
We share Ofgem's view that the introduction of the smart metering system will facilitate a wider introduction such as adoption of time-of-use tariffs. In our view, the introduction of complex tariffs will have an impact on the overall smart metering system architecture.

In our response to In-Home Display Question 1 we explained why the display of summary consumption information, be it in pounds and pence or otherwise, will not easily facilitate behavioural change. The consumer requires additional information to understand which device is consuming power in order to change behaviour. This becomes even more relevant with time-of-use tariffs. The practise of scheduling devices to run on low cost energy will quickly become redundant if the consumer doesn't know which devices could and should best be scheduled so as to save money.

Computation and display of helpful information will require the IHD to be fed from several sources: consumption data from the meter, tariff information from the supplier via DCC (or by manual input) and any further sensory input (e.g. to determine individual device consumption).

Aggregation and presentation have to be enabled via several distributed devices in the HAN: the IHD, the meters and the WAN module. Some devices may be battery powered, reducing their capability to process information. Depending on the complexity of the time-of-use tariff and frequency of change, this may require frequent updates. Continuous (real-time) calculation may need to takes place at the consumer premises.

In addition, other kinds of service-oriented tariff schemes, or operations requiring computational capacities, might evolve over time. We believe that uncertainty relating to the required technical capacity, and the distribution of computational entries and responsibilities within the current approach pose a barrier to both the function and the evolution of the smart metering system.

Proposal
Given the uncertainty regarding future requirements, we suggest ensuring that the smart metering system architecture is sufficiently flexible and upgradeable.

In our answers to In-Home Display Question 7 and Regulatory Framework Question 15, we discuss how concentrating the in-home intelligence in a Smart Hub model will increase the smart metering system's flexibility by separating computational intelligence from the metering (and display) functionality. The Smart Hub becomes a central point where all metering data (and all future system data) is collected. Supplier side information can also be retrieved via DCC.

The Smart Hub's extensible and upgradeable software platform concept allows for virtually any computation of information for dynamic tariffs, as well as for an informative display of this information on the IHD. Future additions to the platform, such as sensors that enable pinpointing or remote controlling of energy-hungry devices (home automation), could be integrated into the Smart Hub via remote software upgrade, and then displayed and interactively controlled via the existing IHD.

Conclusion
At present, the complexity and technical requirements of future tariffs are uncertain. Designing a smart metering system with the current limitations on technical flexibility could create significant barriers to the evolution of complex tariffs. In order to avoid the risk of incurring substantial costs for device replacement (e.g. meter, IHD), the smart metering system must be sufficiently flexible.

T-Systems' proposed Smart Hub concept will mitigate the concerns of current and future services, and pave the way towards the smart grid and home automation.
With this in mind, we would like to stress the importance of conducting a comparative investigation into the relative flexibility and future proof nature of the various smart metering architecture models.

7.5 Response to Regulatory and Commercial Framework Question 14

Question Text:	What arrangements would need to be put in place to ensure that customers located on independent networks have access to the same benefits of smart metering as all other customers?

As described in Communication Business Model Question 1, we propose that meter registration should be included in the initial scope of DCC and that use of this meter registration service should be mandated for all domestic customers, independent of the type of associated network operator.

The combination of clear technical specifications proposed in the Smart Energy Code and the utilisation of a central meter registration service will then ensure reliable technical interoperability between suppliers. Mandating such a process and service for IDNOs will guarantee that their customers can also switch freely between suppliers.

Conclusion
A mandated, centralised approach to meter registration is essential in order to ensure that all customers can benefit equally from the introduction of smart metering, including the ability to switch readily between suppliers. In addition, harmonising processes and procedures around meter registration will avoid the need for complex, costly and error prone interfaces between IDNO and DNO registration services.

7.6 Response to Regulatory and Commercial Framework Question 15

Question Text:	Are there any other industry processes that will be affected by smart metering and which the programme needs to take into account?

Ofgem has highlighted the key role smart metering could play in the transformation of the energy industry through its ability to simplify the existing myriad of processes that have evolved over time including, for example, the need to switch supplier quickly and easily.

T-Systems proposes that the most certain way of achieving these Ofgem goals will be to rollout smart metering within an overarching architectural design that ensures an end-to-end logical flow of data, associated with a ‘single source of truthful data’. We believe smart metering will not only deliver remote meter reading, but also become the extendable foundation for the smart grid and supporting services. Management of the many new services relying on data from smart metering will therefore have to be simplified. More information about the benefits of a reliable architecture for smart metering and management of a single source of truth has been described fully in answer to Prospectus Question 9.

8 Response to Data Privacy and Security

The following section contains T-Systems' response to Ofgem's 'Data Privacy and Security' document, Questions I, 2 and 5.

Please note that, where the content of our answers may be either repeated or provided in more detail, we have provided cross-references to other answers.

8.1 Response to Data Privacy and Security Question 1

Question Text:	Do you have any comments on our overall approach to data privacy?

Please note that this response replicates the response to Prospectus Question 2.

We have seen how data privacy concerns have threatened the success of the smart metering programme in the Netherlands. We have also seen recent cyber security warnings in the USA and of course some British publicity on this topic. As a result, T-Systems is pleased to note the clear commitment that Ofgem has made stating "*Data protection and system security are crucial issues for consumers and we will take a rigorous and systematic approach to assessing and managing these issues. This will include stringent rules and safeguards.*"

Security and Privacy by Design
We fully subscribe to the security and privacy philosophy set out by Peter Hustinx in his statement earlier this year:

*"The EDPS believes that a more positive solution is to design and develop ICT in a way that respects privacy and data protection. It is therefore crucial that privacy and data protection are embedded within the entire life cycle of the technology, from the very early design stage, right through to their ultimate deployment, use and ultimate disposal. This is usually referred to as **privacy by design**".*

Source:
Opinion of the European Data Protection Supervisor on Promoting Trust in the Information Society by Fostering Data Protection and Privacy 23/3/2010

We agree with Ofgem that a privacy by design approach should be at the heart of the smart metering programme. This allows the mitigation of risk in a variety of ways: minimising data collection needs; anonymising data as much as possible; agreeing data handling practices; and ensuring data privacy and security as integral parts of design, in order to help increase consumer acceptance of the platform.

We share the view that consumer confidence is a major success factor for a successful implementation of a smart metering programme. The formulated commitments and the intended privacy charter will have a critical role helping to ensure the confidence and protection of consumers' personal data and its usage only for the agreed purposes.

However, in order to adhere to a privacy charter, the system should have built-in security from the start, so that it can execute the supporting processes in a timely and error-free manner. This requires a security protection wrapper to be built into the data flow and not be administered at different stages in the process.

From our point of view, the system privacy should be based on the following three pillars:

- The intended privacy charter as the basis for privacy in the system;
- A privacy and security framework as part of the platform architecture;
- A single data privacy authority at the single source of truthful data.

The privacy charter
A data privacy charter should explain the data privacy requirements and the respective measures and elements in the smart metering system from a consumer point of view, using consumer friendly language. The charter should also provide guidelines for the consumer segment to instil confidence in both data privacy and security.

As is already clear, consumers' personal data will be treated in accordance with the Privacy Charter. The charter will need to include all of the standard elements, such as appropriate use, monitoring, and complaints process. It is also important to have clear government guidelines on how approval can best be obtained from consumers.

The privacy and security framework
Since privacy is an integral part of the security system, security and privacy cannot be separated completely.

One of the key considerations in taking the data privacy and security by design approach is to set the scope for the end-to-end smart metering system. The end-to-end system covers all equipment, attached devices, communication links and connections from every customer through DCC to suppliers, network operators and third party service providers. This broad view of the system's scope gives the required overview to manage the risk assessment, to identify the key risk areas and to arrive at a representative payoff for the systems design guidelines at an early stage of the process. Only in this way can data privacy and security be designed into the system, as opposed to being retrofitted in a costly manner that will limit flexibility.

T-Systems therefore believes that the specification phase of the privacy and security framework should take place in interaction with the technical specification phase as early as possible in the presented timescale. This process ensures that key risks will be covered by adequate measures in the draft technical specification, to have evolved by the time specifications become available for early adopters.

We consider that an effective privacy and security framework is a central element in the success of this programme. Furthermore data privacy considerations should not be limited to capturing information that can be shared with the energy supplier, but also enabling the capture and use of information by and only for the consumer. This will give the consumer more incentive and control over their own in-home energy data and enable consumers to capture detailed information, e.g. for each room or appliance, and use it for analysis on the IHD without the worry that the information might be shared.

One data privacy authority as the entity of trust
Many years of experience delivering complex ICT solutions and highly sophisticated telecoms tariffing processes have taught us the importance of maintaining data integrity at all points within a data flow. This has very much influenced our approach to smart metering in our trials. With this in mind we believe that a traditional smart metering model and initial scope of functions will cause challenges in executing the data privacy policy. For example, T-Systems is unclear how data privacy can be assured if core master data, e.g. registration and address details or encryption details, are not controlled and managed by DCC as part of the data transfer. Data privacy may be compromised if some of the authentication or approval policy validation is only made once the data has already left the household or even worse, has been transferred to another third party that then applies the role profiles for data privacy. Numerous transfers before data privacy can be executed introduce unnecessary opportunity for error and compromise.

Also specific process requirements outside the normal data flow need to be looked at from the onset. Consumers who move home and thus leave the meters and IHD behind for the next home owner, will want all of their data wiped. With some of the requirements where the meter holds and / or feeds the IHD unit, data wiping may not be possible. The in home design needs to allow for the wiping of data when home owners change. The architecture proposed throughout the document make this possible and enables DCC to take all consumption data out of the household when the owner moves. Additional data services may be provided to the consumer, whereby the old data can still be taken to the new home for comparison or other use.

The true advantage of the Smart Hub is that much of the security and data privacy processes can take place in the household:

- Security is simplified as the Smart Hub takes the role as the front door of the household, which is securely locked allowing additional securities for the meters but this can be managed locally between the Smart Hub and meters and does not need to be executed from the central processing operation.

- Data security is given a new feature, as the levels of data detail can be managed differently. Whereas the data that is needed for billing can be passed on to the supplier and leave the household, the information about which room or appliances uses which amount of energy can be kept and processed in the Smart Hub for use by the consumer only.

In a complex infrastructure providing multi-tier services, the question of building and maintaining trust relations in the data is an important element. This clearly goes beyond security managed inside the household. Not only basic services, but also the extended services based on the primary data must be included within the data relationships. For an effective and optimised means of providing a trusted end-to-end system, it is necessary that the number of entities and devices in any single security loop is minimised. Therefore, T-Systems believes that there should be one central governing entity, responsible for monitoring and supervising the single source of truthful data, and ensuring its privacy and security (see Data Privacy and Security Question 5). We believe that this governance would also help to achieve a higher level of acceptance of the whole system by concerned consumers.

Conclusion

We fully support Ofgem's security and privacy approach. However, we would like to highlight that security and also privacy should be an inherent part of the programme's design in order to guarantee that future extensibility is not hampered by inflexible and costly privacy and security retrofitting. We therefore recommend to:

- Identify all entities of the trust chain within the smart metering system with stakeholders and have one governing entity.
- Define the end-to-end scope for a privacy and security framework with all stakeholders under consideration of well known and current security and risk guidelines,
- Ensure the establishment of this framework as early as possible within the programme in order to guarantee that security is an inherent design feature and not a retrofitted requirement.

8.2 Response to Data Privacy and Security Question 2

Question Text:	We seek views from stakeholders on what level of data aggregation and frequency of access to smart metering data is necessary in order for industry to fulfil regulated duties.

Introduction
As described in Ofgem's Data Privacy and Security document, smart meters enable a much more detailed level of energy consumption capture than was achievable previously. This makes possible the detailed profiling of customers based on their habits and lifestyle. In order to prevent exploitation of this fact, appropriate safeguards need to be established.

Level of data aggregation
Data aggregation and the access to this data not only affect security, but also transfer volumes. We believe that for aggregation to take place, data should be packaged at a central location in the home before it is transferred and merged with a nationwide single source of truthful data, and passed on to other parties, e.g. suppliers, as requested by the consumer.

Since a central data service and security entity would also be responsible for the data regulation, we believe that this kind of entity could be responsible for the following:

- Helping to simplify the data exchange between customer and the supplier;
- Simplifying security, incident monitoring and auditing processes; and
- Making it easier to ensure a high level of security, based on the established security framework.

The time for data exchange and the amount of data could be negotiated in a later stage and be defined in service level agreements.

We think that, in addition to DCC that govern and protect the management of data communication, every households' HAN should be secured by a gateway. We propose that this gateway function is best adopted by the Smart Hub, which divides the smart metering communication process into the HAN as a local 'household device network' and the WAN as a national 'smart metering network'. The gateway approach equipped with more 'intelligence' in the gateway and less "intelligence" in the connected devices would have many advantages in comparison to an architecture where DCC has to communicate with each device individually:

- The security gateway would help to introduce new mechanisms to protect the customer from profiling. Among others, the aggregation of intermediate values within the different tariffs, the aggregation of a higher number of households, and the anonymisation of the data are possibilities to protect the privacy of the consumers.
- Since not every electric device like a washing machine or a coffee maker would be accessible from outside, the Smart Hub would simplify security updates within the global smart metering network without interfering with the consumers activities within the HAN.
- In view of the fact that an up to date gateway would provide up to data security within the WAN, from the security perspective, older or non-updateable devices could also be managed within the household device network, avoiding security threats for the whole system.
- The gateway would also simplify and secure the integration of new devices into the network. Since those devices would not be able to access the WAN on their own, they would pose less risk for the system.

- To prevent the household from denial of service attacks from the WAN, the gateway could act as a secure data filter and could block unauthorised access into the HAN. To prevent the WAN from inner denial of service attacks (for example from a high number of manipulated devices in different households or HANs), the gateway could function as a data collector or a switch to stop the attacking device.
- Since the Smart Hub would allow the integration of older and cheaper devices, it would further raise the acceptance of the smart metering system.

Conclusion
Since T-Systems believes that only a high level of privacy and security can increase and strengthen the acceptance of this solution, we propose that the security service should be an integral function of the underlying architecture, as it would be in the proposed distributed platform with the Smart Hub. Trusted governing processes can then be enforced by DCC and enable DCC to be effective in the management of the approved data exchange within the system.

8.3 Response to Data Privacy and Security Question 5

Question Text:	Do you agree with our approach for ensuring the end-to-end smart metering system is appropriately secure?

Please note that this response shares certain proposals and technical concepts with the response to Prospectus Question 15.

Introduction
The Home Secretary succinctly summarised the issue when she pointed out that *"It's (cybercrime) a threat to government, it's a threat to businesses and indeed to personal security. We have identified this as a new and growing threat in the UK and you just have to look at the figures – in fact 51% of the malicious software threats that have ever been identified were in 2009."*

T-Systems is in agreement with Ofgem on the adoption of a security by design approach, and the plan to collaborate with different security and stakeholder groups in reaching an appropriate and practicable level of security.

Security Concept
According to a recent study from PriceWaterhouseCoopers, 92% of large companies experienced a security incident in 2009. We agree with the idea of the risk assessment and believe that security should be evaluated over all components of the system and realised as an iterative process, in a top-down design, within the security by design approach, based on an integral and holistic security conception. Among others, integral parts of this security concept should include:

- Definitions of the security goals for the system and its components;
- An analysis of the threats and risks at different stages; and
- Definitions of measures and mechanisms (e.g. security mechanisms, security hardware, unique IDs within the system) to prevent the system from those threats.

Overall, the security concept should deal with the whole system as well as with every single type of component. In this way it can help to ensure that all security aspects are taken into consideration and that only strong security mechanisms are used.

Security platform

In addition to Ofgem's proposals we would like to highlight that in order to ensure that security becomes an inherent part in the design of the programme, the platform architecture has to be considered as a whole. We propose that the platform should include:

A single source of truthful data.
The single source of truthful data should be the guardian of smart metering data, managing consumer consent and data aggregation for suppliers and third party data services should take place here. This way it can be ensured that data is only passed once a consumer has granted access and that any data passed to third parties contains the minimum necessary detail. Since all data is held at this point, future services, such as smart grid data processing can be securely realised without requiring data from other sources. We believe that a single source of truthful data could also simplify incident monitoring, auditing processes and system security as a whole.

The security within this system should be based on a central key management and a public key infrastructure, with a central certification authority provided by a trust centre.

An impartial governing body such as DCC
The governing body is required to house the single source of truthful data and guarantee its integrity. This governing body has to oversee the platforms future extensions and ensure they comply and expand on the platforms security by design.

A smart gateway in the home
A gateway equipped with a hardware security module will simplify the in-home security platform and reduce cost of other HAN devices that require less sophisticated security as a result. It will reduce the complexity of managing authentication for several meters (and future devices) directly from DCC and thus reduce the probability of handling errors. We propose that, within its role as the central smart device in the home, the Smart Hub also acts as the WAN/HAN Module. The Smart Hub can perform initial data aggregation across data collected from HAN devices. Remote upgradeability allows for future security updates to continuously protect the platform and it reduces the overhead by only having to remotely upgrade one instead of several devices. A single gateway also increases security by reducing the number of points of HAN entry to one. This also allows for easier integration of further HAN devices from a security point of view.

T-Systems security credentials
In 1988, T-Systems set up a new division to evaluate products and systems for payment systems. In 1991 we were officially accredited by the banks in Germany (Zentraler Kreditausschuss). At the same time, it was officially accredited by the German government (Federal Office for Information Security, BSI) to perform evaluations according to the European security evaluation criteria ITSEC. T-Systems is also accredited for the Common Criteria first being published in the late nineties. Our lab is well known for its expertise in hardware and software security. Organizations such as VISA International, MasterCard and the Payment Card Industry (PCI) accredited and recommend T-Systems to their customers.

Recent successes include the planning, building and operating of the entire security system for an electronic road user charging system in Germany. T-Systems elaborated the security concept for the system, developed the Key-Management System and specified all security components including the "security control centre". Furthermore, T-Systems developed, implemented and delivers the smart cards operating for the charging system based on the its own smart card operating system TCOS.

Conclusion
We at T-Systems believe that only a security by design approach will fulfil the security-challenges of the smart metering programme. An approach where security is only applied to the various components of the platform without taking an end-to-end view may result in an inflexible solution that will be costly and slow to extend.

We hope that the DCG working group will review the present smart metering architecture and compare it to the proposal for a distributed platform that uses a Smart Hub as an intelligent WAN Module with integrated security gateway. This will make the implementation of appropriate security and risk mitigation counter measures easier. The Smart Hub then also becomes a useful tool for the consumer who wants to develop the HAN further towards convenient and cost-efficient energy consumption.

As the smart metering infrastructure evolves, the underling security architecture must evolve in line with it. This will require flexible security architecture comprising the following:

- The Smart Hub as a secure home gateway with an integrated hardware security module; and
- A single source of truthful data at DCC as the accountable body responsible for meter registration.

We believe that building a security architecture on this basis will lead to a solution with the necessary flexibility. Such an alternative architecture would be both highly secure and future proof.

9 Glossary of terms

The following list contains words and terms we have used in our answers that may not be immediately familiar to all readers of this submission. We have avoided repeating any of the terms from Ofgem's Prospectus and supporting documents.

Term	**Definition**
Distributed platform or architecture	Distributed platform or architecture denotes a platform whose hardware and software components are not physically in one location. Although physically distributed, the platform's components function as one unit.
DNO	Distribution Network Operators regulated under the Utilities Act 2000. These companies have a statutory duty to connect and supply electricity to customers in their area.
EEBus	EEBus describes the use of existing communication standards, norms and products in order to increase energy efficiency by facilitating the exchange between applications and services.
End points	The final destination/s within an end-to-end process or system
End-to-end	The description given to a process or system that extends fully between end points.
Governing Data Service (GDS)	Subset of all core governance processes and raw data storage necessary for DCC to act as the single source of truthful data.
Headend	The headend describes functionality that receives the stream of meter data signals and performs low-level error correction on them before making the data available for other systems to request, or pushing it out to other systems. Headends are likely to require specific adaptations for each meter type, as well as be communications technology specific, if this is proprietary to the metering system.
ICT	Information and Communications Technology
IDNO	Independent Distribution Network Operators. IDNOs own and operate electricity distribution networks, typically as extensions to the existing distribution network, for example to serve a new housing estate.
Infrastructure	Infrastructure denotes a platform as well as its policies and guiding bodies. The Smart Metering infrastructure includes things like privacy charter, smart energy code as well as governing bodies and processes.

Locked in	The state in which a device or technology may be limited in its ability to interact or interoperate with other devices or technologies.
Platform	Platform describes the hardware architecture as well as the software framework (including application frameworks) underlying our smart metering proposals. Platform excludes things like privacy charter and smart energy code.
Single source of truth	The single source of truth or truthful data refers to the one location or point of reference that guarantees to be the source 'true data'.
Smart Hub	The Smart Hub is a device in the home that acts as mediator or communications hub, controlling the data flow between external entities (e.g. energy suppliers, third parties) and other devices within the home (e.g. utility meters, smart appliances). It also operates as the WAN and HAN module.
Traditional Architecture	The traditional architecture is characterised by a meter centric approach to smart metering. It incorporates 1 to many smart meters that individually collect and distribute smart metering data. Each meter separately provides data for IHD visualisation and push data via a WAN-modem to a headend system and data management software. Management of a potential HAN is distributed among the participating devices.

10 Appendices

10.1 Prospectus Question 19, September 28th submission

We have included this answer in the appendices for reference, as it is referred to in several of our answers in this submission.

Question:	The proposed timeline set out for agreement of the technical specifications is very dependent on industry expertise. Do you think that the technical specifications can be agreed more quickly than the plan currently assumes and, if so, how?

At T-Systems, we share Ofgem's desire to speed up the agreement of technical specifications and appreciate the dependence on industry expertise. Much time will need to be spent in order to fully understand the many different technical options and evaluate their respective advantages and disadvantages before decisions can be made. This will be particularly difficult given the different industry and technical experts and their differing views, concerns, priorities and motives. Reviewing and rationalising such a significant volume of input will inevitably be the most time consuming activity in this phase.

The presentation approach
In the interest of simplifying the process, we suggest incorporating a presentation approach into the Ofgem specification design process, as illustrated in Figure 1 below.

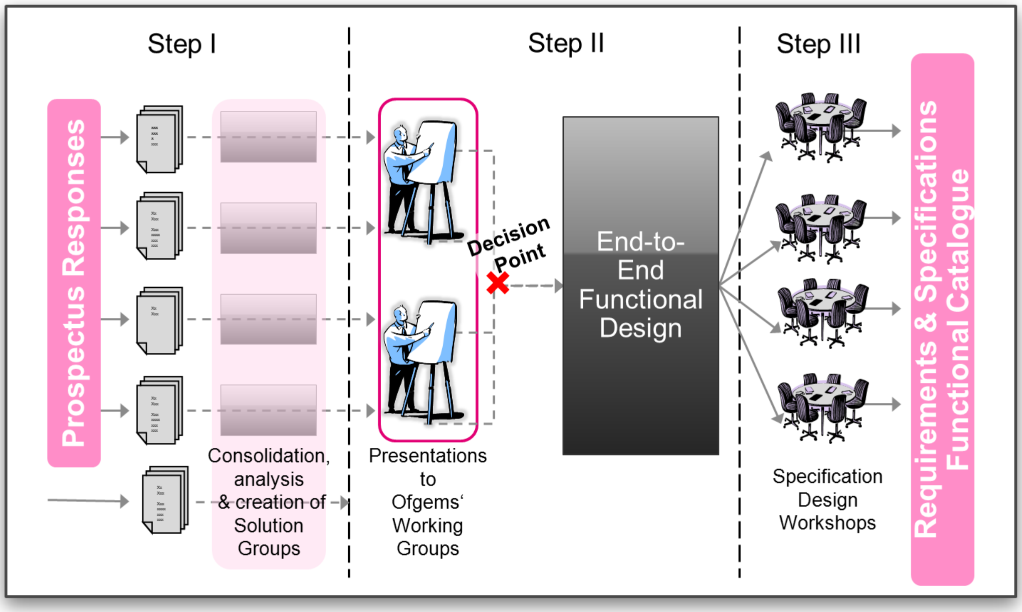


Figure 1: Proposed specification design process

In T-Systems' view, there are a small number of significantly different solution options, each varying in the distribution and degree of smartness along the value chain. Ofgem could use the prospectus responses to identify experts with a full understanding of the different data flows within the smart metering system, invite these individuals to lead 'solution groups' and task them with developing detailed presentations on each of the different solution options. There would also be the opportunity for other parties to form alternative solution groups to investigate additional models.

Subsequently, within a month, each solution group would be invited to present their findings to a panel of experts, chaired by Ofgem. Clearly defined scoring mechanisms with predefined criteria would then be applied, leading to the selection of a single optimal solution.

Once this is done, the third step would be the agreement of a technical specification. Given the now shared understanding of the overall solution, this could take place in parallel work streams without any conflicting design agenda, and without jeopardising the end-to-end integrity of the architecture.

We believe that adopting this approach could deliver agreed, documented technical specifications as early as Spring 2011.

T-Systems has extensive experience in advising large organisations on the evaluation of different ICT solutions, including working with the German government on projects to define new protocols and standards for online processes. We have found that open workshops and discussions with large numbers of stakeholders and advisors take longer than a structured presentation approach, in which different experts or expert groups are given the opportunity to explain their preferred approaches and then invite discussion.

We would welcome the opportunity to discuss this approach (and potentially other methods of accelerating the design specification process) with Ofgem. We believe Ofgem has already undertaken several specification activities and we would also like to better understand its preferred decision making process, in order that we might make additional suggestions. Irrespective of the manner in which the decision making process is structured, we emphasise the importance of rapidly establishing an escalation process and clear accountability for decisions made.

10.2 Smart metering and the Home Area Network white paper

Please note that the white paper follows overleaf

Smart metering and the Home Area Network
White paper

T-Systems Limited

Version 1.1
Date 1/10/10
Status Final

Contents

Executive summary

By October 2010, Deutsche Telekom had accumulated over 140 months of smart metering trials. The advantages and disadvantages of the different approaches used in these trials have been collected and are summarised in this paper. Some experiences, particularly with Home Area Network (HAN) technology, may help inform the decision-making process prior to large-scale rollout in Britain.

The concept favoured by T-Systems and referred to in this document is based on a decentralised headend infrastructure, in which communication between the Governing Data Services Centre (GDSC, similar to the UK DCC) and the in-home components is optimised through the 'smartness' placed in the WAN/HAN module. This approach effectively transforms the WAN/HAN module into a 'Smart Hub'.

It means that instead of pushing information from the meters to the headend, GDSC can pull information from the Smart Hub. Typically, this information will already have been analysed, aggregated and, in many cases, processed. The Smart Hub also helps overcome many of the challenges traditionally associated with the smart metering installation process.

T-Systems' proposed architectural design for smart metering provides a stable, secure and extensible foundation for smart grid services. This document, however, focuses exclusively on the benefits associated with HAN set-up and management.

Experiences from selected projects within our trials

Trials at T-City, Friedrichshafen

- Approximately 700 small and large households plus ~50 apartment blocks to date;
- Meters owned and operated by municipal utilities;
- Using Ethernet and HomePlug Powerline 1.0 for the HAN;
- Electricity meter Interfaces RS485/IEC1107;
- Gas and water meter Interfaces EN13737-MBUS;
- Using ADSL (~75%) and VDSL (~25%) WAN interfaces, most of them owned by the residents;
- Some remote locations have rate-reduced DSL (128kBit/s Upstream);
- Smart Hub usually located in the basement next to the electricity meter using a HomePlug Powerline connection to the residents DSL Router/Modem;
- Started end of 2007, operational since Q1/2008.

Meter reading is done based on EN13757 standards for gas and water and OBIS/EN62056-21 for electricity meters. The meters support complex metering (power quality monitoring: harmonics, cos Phi, voltage drops) and two-tier time-of-use (ToU) tariffs.

The HAN consists of more than 60% HomePlug Powerline installations (IP-based). Power line communication (PLC) takes place between the DSL router (ADSL and VDSL) and Smart Hub. The Smart Hub is usually located close by, and with a wired connection to, the electricity meters. The meter connection is bidirectional, allowing adjustment of time/date in the meter and optional tariff-switching (ToU model).

Smart metering: The HAN design

Smart metering faces particular challenges in large buildings (e.g. apartment blocks) and buildings with many meters. For consumers on all floors to receive an advanced meter infrastructure (AMI) signal from a meter in the basement, the signal requires support from various technologies and stakeholders. The proposed Smart Hub architecture helps to facilitate this by offering a single point to reach within the building, rather than multiple individual devices. This reduces effort on the part of the GDSC in trying to retrieve data from the households, as shown in Figure 1 on the following page. Diagnostics within the Smart Hub also provide support, to both GDSC and consumers, in identifying communication problems that might arise.

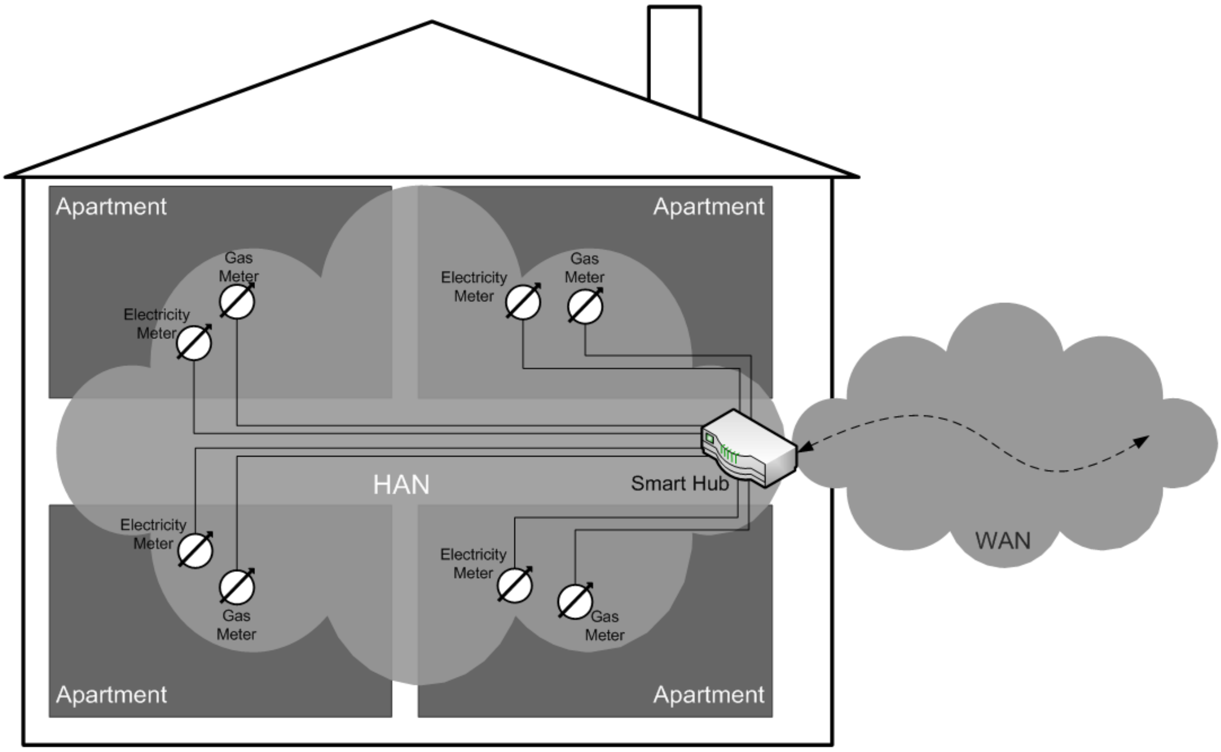


Figure 1: Smart Hub in a multi-tenant building

T-Systems' first trials in Friedrichshafen were run in typical family homes. Because an existing WAN connection (ADSL and VDSL routers, owned by the residents) was used, there was no fixed communication cost per building. Within the trials it made economic sense to share a copper-based WAN connection between residential gateways, especially when there were only one or two meters per building.

In the last two years, many electricity meters have been rolled out with EN62056-21/DLMS/IEC1107 interfaces. In several trials, the Smart Hub connects to these meters using a wired RS485 interface. Because the RS485 is a bus interface, it allows connection of up to 31 separate wired meters to the Smart Hub. This means that the costs for installation, hardware and lines could be divided by the number of meters connected.

In many ways, using a wired bus connection has proven to be an effective approach, particularly when the meters are located close together (in the basement). For instance, it allows protection of the communication by keeping the wires in a sealed enclosure, and the meters can receive tariff-switching commands over the wired connection. However, the disadvantage of putting a GDSC-operated Smart Hub in an enclosure sealed by the utility, is that the enclosure has then to be opened and re-sealed by authorised utility service personnel. It was concluded that the meter interface should be wireless and encrypted.

The alternative used later was encrypted wireless MBUS communication with simple, unidirectional meters (gas, electricity and water). These meters transmit their current energy readings on a regular basis to the Smart Hub, which includes a data mirror per meter to facilitate reading of the latest data without querying the meter directly. If the meter doesn't deliver the current power or volume flow values directly, the Smart Hub is able to derive them from the latest energy/volume readings and hold them in the data mirror.

Significant work was invested to find the right HAN interfaces for different infrastructures, from single-family houses to large buildings. Many of the challenges faced and solutions found are described in this document.

Laboratory tests: ZigBee for metering

Our first laboratory tests with ZigBee for smart metering were done in 2007. Experience from our 2007 laboratory tests concluded that several improvements are required to ZigBee Metering (2.4Ghz) technology before it can be used for smart metering.

- The 2.4GHz PHY (10mW EIRP, allowed for ZigBee in-home) limits the (un-meshed) distance between coordinator and node to five meters (with one wall) or 10-15m (line of sight).
- Only non-battery powered meters (Electricity Meters) can be used as FFDs (Full Functional Devices, “mesh routers”). Battery powered meters like Heat Cost Allocators, Water Meters and Gas Meters can be used as RFD (Reduced Function Devices, “endpoints”), but the topology is usually different: The battery operated meters are located in the flat were they would be ideal for mesh networking to increase the range of the network. The electricity meters, located in the basement, have a remote position not well suited for relaying.
- Because at that time there was no Smart Energy Profile (SEP) available, too much initial configuration had to be done (including shared AES-Secret, PAN-ID, and channel selection). Manual configuration is an obstacle to scalability.
- No support from meter manufacturers for 802.15.4 PHY or ZigBee in most parts of Europe (except UK).
- No seamless migration to IPv6 (this was later achieved with 6lowPAN).
- Missing data models and profiles for smart metering. Discussions are ongoing relating to “tunnelling” or “mapping” between established metering standards (e.g. DLMS/COSEM, ANSI) and newer SOA data models. The SEP defines “Simple” and “Complex” metering profiles, which require mapping of meter data to SEP data fields and re-mapping to DLMS/COSEM for the Smart Hub.

The conclusion in 2007 was to abandon ZigBee/2.4GHz and move to EN13757-4 based Meter Reading for the trials in Germany.

Sub-metering: Apartment blocks

- This project within our trials runs in 64 apartments distributed over two buildings;
- A HomePlug 1.0 infrastructure with Shared-Keys established between basement (central WAN connection point) and Smart Hub in the apartment;
- One Smart Hub located in each apartment sits in the sub-distribution cabinet;
- A dedicated metering ADSL connection and DSL router in basement was used for all apartments;
- Sub-metering of water and heat-cost allocators (approx. 300 meters in this installation);
- Started early 2008, fully operational since April 2008, billing by housing provider since end of 2009.

Meter reading in these premises is based on a proprietary 868MHz SRD Protocol. The HAN consists of 100% HomePlug Powerline installations. The PLC (Powerline Communication) takes place between Smart Hubs in the apartments and a DSL router in the basement.

The data from proprietary sub-meters is translated to DLMS/COSEM by the Smart Hub. The work to be done in this trial included a firmware upgrade and configuration upgrade of the Smart Hubs to support the proprietary sub-meters. No hardware change was necessary thanks to the flexible radio module concept.

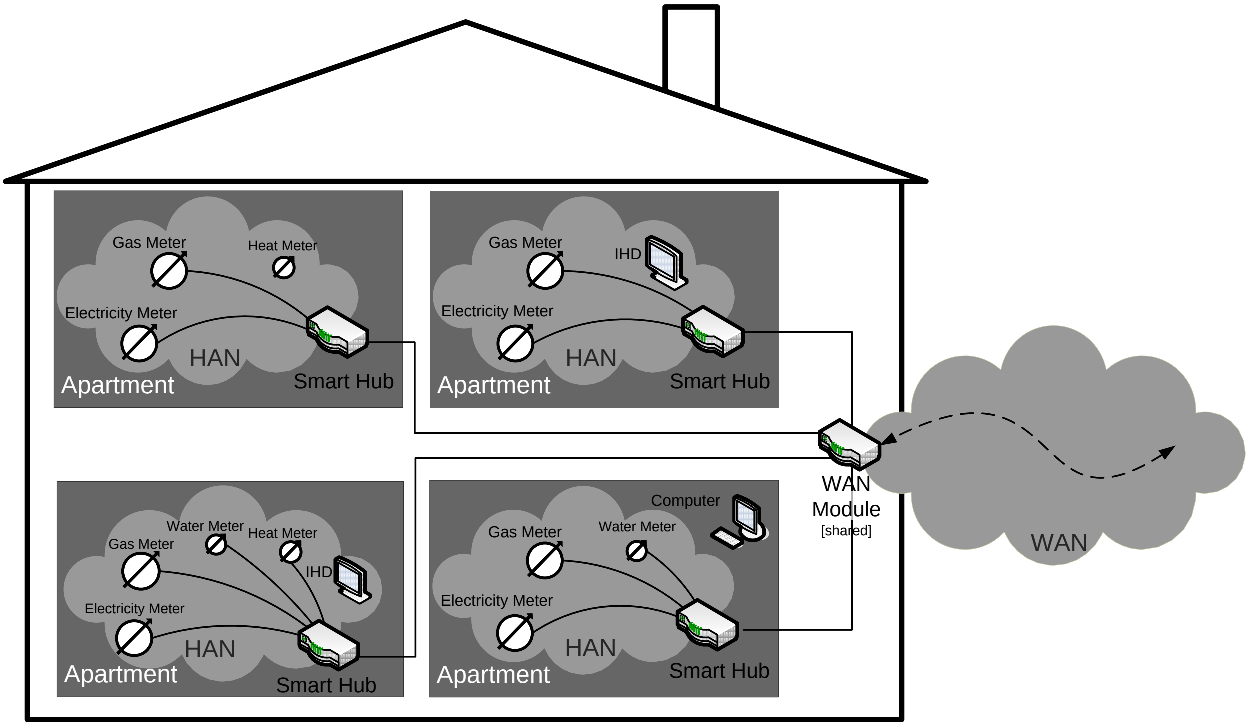


Figure 2: Sub-metering in an apartment block

T-Entertain: HomePlug AV experience

Several thousand installations, each with a HomePlug AV based HAN, supporting T-Entertain products for IP-based audio and video streaming over in-home PLC.

T-Systems used the installations in Friedrichshafen to verify the parallel operation of HomePlug AV for Internet TV streaming and HomePlug Turbo for meter reading using the same PLC. We learned that meter readings and IP-TV were not degraded where different HomePlug standards are in use.

Simple electricity metering with GPRS

As a proof-point especially for GPRS (the WAN technology that the Smart Hub would connect to) the following conditions were established:

- A single national utility company;
- GPRS WAN connection in a dedicated VPN;
- The Smart Hub located next to electricity meter.

This project, which started in 2010 and remains ongoing, focuses on GPRS/VPN connectivity. To date no significant challenges have been experienced. The aggregation feature in the Smart Hubs is extensively used to reduce WAN traffic, which has a direct effect on costs.

Smart Hub: Application layer data translation

There are many existing National and European Metering Standards and Interfaces. Currently the Smart Hub maps the different Meter Protocol Data Models to the DLMS/COSEM Object Model. To avoid tunnelling of meter protocols to GDSC, we prefer an XML encapsulation of the meter data, the advantage being that it is a universally-understood data description on the WAN interface. The XML interface can be extended to support other data/object models (e.g. CIM, SEP).

The Smart Hub translates data formats/object IDs and data point IDs between HAN (meter/appliance interface) and WAN (XML formatted), using a remotely configurable mapping table. This allows new data points and measurement values to be configured in the Smart Hub. It also allows interoperability between different meter protocols (e.g. EN13757-MBUS, EN62056/IEC1107, SEP).

The Smart Hub currently being used in trials supports ~60 different meters and many HAN technologies. Please also see Figure 3 for more details.

Because it is impossible to foresee when a universal HAN standard will covers 90% of home devices, T-Systems chose the translation approach, which is aligned to ISO/IEC 18012-1 (Home Electronic System - guidelines for product interoperability).

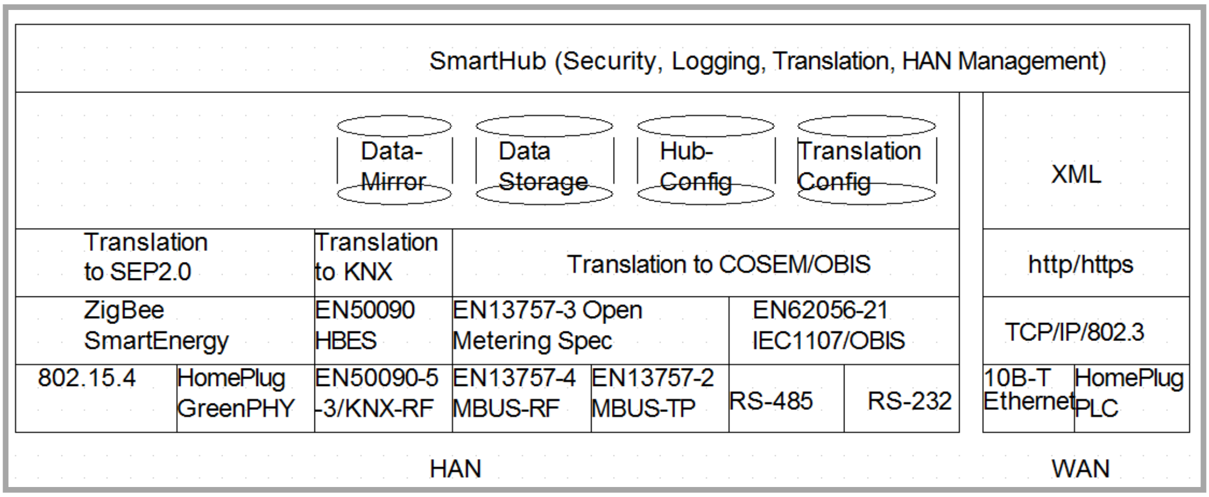


Figure 3: Smart Hub Structure

HAN media technology comparison

As outlined before, the information provided in this section is based on our experiences from trials at T-City, Friedrichshafen.

IEEE802.15.4 (and ZigBee)

ZigBee uses the IEEE802.15.4 PHY+MAC layer. Most implementations use the 2.4GHz physical layer. In contrast to the United States, in-home communication for ZigBee/802.15.4 devices is limited to 10mW EIRP (US: 100mW) in most European countries. The 2.4GHz ISM band is also used by WLAN, Bluetooth, microwaves, wireless USB and is therefore heavily populated.

The radiation conditions in the 868MHz band are better (especially through walls), allowing for a communications distance of between 10 and 30 meters in buildings, including between storeys. There is an 868MHz PHY (with different modulations) for the European 802.15.4 implementation but the trade-off is that there is only one channel, which is limited to 20kbps data rate.

ZigBee mesh networking in the meter/Smart Hub interface is not a short-term solution for in-home communication because a critical mass of installed non-battery operated devices/nodes must first be available.

EN13757-4 (used by KNX RF/wMBUS/OMS/NTA8130/DSMR)

An 868MHz PHY (EN13757-4, wireless MBUS in Germany) was preferred because of better radiation conditions where walls or ceilings need to be penetrated. The 868MHz band (CEPT/ERC Recommendation 70-03, Annex 1 g1), which is reserved for short-range devices, allows up to 25mW EIRP and increases the distance by a factor of three to five times, compared to 2.4GHz/10mW transmission (recommended by the SEP1.0 profile).

There are several modes (S, T and a new C) in the EN13757-4 standard. T Mode (frequent transmit) was used in nearly all trials for gas, water and some electricity meters (eHZ with wireless-MBUS module). T Mode allows battery-operated devices (unidirectional) to run for more than 10 years while still transmitting in intervals of 30 seconds or less.

Mode S uses a different frequency, but is compatible with KNX RF (EN50090 Home Automation Standard for appliance control) on the radio layer. Mode S was seen only in some heat-cost allocators.

Only some of the electricity meters used in trials had bidirectional communication, but all used proprietary bidirectional protocols. The first Open Metering Specification (OMS) conformant meters are currently arriving and are being used in trials. They feature several advantages, including their compliance with the EN1373 standard, AES128 encryption and a mapping specification to OBIS/COSEM IDs.

The next OMS specification release defines support for Appliance control.

HomePlug (1.0Turbo and AV)

HomePlug is an in-home broadband power line technology that has been in use since 2002. It was used in the first AMR trials and proved to be a good choice for in-home IP communication. HomePlug 1.0 (and Turbo) used the 4.3 to 21MHz frequency band with an 84 Carrier OFDM Modulation. HomePlug GreenPHY and AV use frequencies up to 30MHz and output power is regulated by EN55022. The output power for transmission is programmable (and remotely manageable) and individual carriers are notched to avoid interference with HAM radio frequencies. Broadband PLC is different from CENELEC PLC (<100kHz Band) to the substation especially with the data rates and frequency bands used.

The reliable communication distance is around 100-200m. The number of nodes on the power line is not limited, but the number of nodes per network depends on the version of HomePlug (v1.0: 16 nodes, Turbo: 32 nodes).

In trials, the network comprised of two to four nodes (DSL router, Smart Hub, one or two PCs). In apartment blocks with one Smart Hub per apartment or floor, the ability to accommodate 31 floors/apartments per network (each network has one WAN connection) is usually sufficient.

Currently the Smart Hub uses HomePlug 1.0 Turbo, with data rates of 5-85Mbps in apartment blocks. The full operating power demand for HomePlug 1.0 Turbo communication is 1.5W.

Instead of using an external (consumer technology) Wall-Plug adapter, the Smart Hub integrates a modular HomePlug PHY for the following reasons:

- Uses internal interface for PLC diagnostics and management (i.e. key management, spectral shaping) which is not secure or not possible with external Plugs.
- Application can determine times for HomePlug communication to save power and best transmission conditions. This is important because PLC is intermittent and unreliable.
- There is no unsecured Ethernet cable between Smart Hub and HomePlug bridge.
- No additional procurement risks and costs for separate component.
- Superior lifetime in contrast to consumer HomePlug products.
- No additional space and installation time for power outlet needed.
- Lower cost than two separate devices.
- Allows star network-topologies to be built (this is not possible with consumer products).
- Allows logical networks to be built within other HomePlug networks.

A new IEEE P1901 compatible PHY (HomePlug GreenPHY or HomePlugGP) has also been developed. Data rates are between 1MBps (minimum) and 3.8Mbps (peak), but the power demand is much lower. For further information, see:
http://www.homeplug.org/tech/whitepapers/HomePlug_GreenPHY_Overview.pdf

Like Ethernet and Wi-Fi, HomePlug can transport IPv4 and IPv6 payload, which is an advantage for the future migration path to an all-IP HAN. Together with ZigBee, HomePlug (GP) is a favourite media MAC/PHY for the HAN and the Smart Energy Programme.

In most trials, HomePlug Powerline is used as a medium-distance HAN “backbone” in the premises, connecting the basement with the apartments. Wireless Short Range Technologies are used for the shorter distances spanning one or two rooms.

IEEE802.3 Twisted Pair Ethernet

Twisted Pair Ethernet was used in approx. 25% of the trials in single-family homes, to connect the Smart Hub to the DSL modem/router. This is often the case when the DSL modem sits in the basement next to the electricity meters.

Advantages:

- No shared medium is used, giving additional privacy protection;
- For distances less than 10m a patch-cable is often the simplest/cheapest network connection.

Disadvantage:

- Reduced user acceptance if wire is visible or has to cross walls/ceilings.

Wi-Fi

Although WLANs were not used in the trials, they were identified as a good candidate for HAN technology.

Advantages:

- IEEE802.11(b/g) wireless networks are widely used for consumer HANs. Infrastructure is already available in many residential premises.
- High bandwidth (>10MBit/s).
-

Disadvantages:

- The indoor communication distance is 15-30m (with walls);
- Using the resident's WLAN infrastructure to fulfil a metering service contract may raise legal problems;
- Configuration of the Smart Hub to use customers' router requires configuration of the residential router or Smart Hub (SSID, WPA-Keys). Plug-and-play installation is required to make Wi-Fi a successful HAN technology; this is available with WLAN routers supporting WPS (Wi-Fi protected setup).

Please see the table below for a summary of the information provided above:

HAN Technology	Shared Medium	Gross data rates	IP based	RX-On Power	Reliable-Inhouse-Range	Nodes on Medium
802.15.4 2.4GHz/10mW not meshed	Yes	250kbps	No	0.1W	<10m	>100
802.15.4 868MHz/10mW	Yes	20kbps	No	0.1W	30m	>100
Wi-Fi	Yes	2-54Mbps	Yes	0.4W	<15m	>100
HomePlug 1.0T	Yes	2-85Mbps	Yes	1.5W	150m	<32
10Base-T	No	100Mbps	Yes	0.1W	100m	2
HomePlug GP	Yes	3.8Mbps	Yes	0.3W*	150m*	>100
EN13757-4	Yes	16-32kbps	No	0.1W	30m	>100

Table 1: HAN media technology comparison

Future proofing HAN technology

Flexible HAN Media (Meter/Appliance) Interface

The meter communication interface (between meter and Smart Hub) may change with future standardisation in Europe. It may become the same HAN interface as for the IHD, programmable thermostat and appliance control.

To avoid ’stranded‘ investments, a transition from EN62056-21/IE1107, DLMS/COSEM, EN13757 to (ZigBee) SEP 1.0, 1.x and 2.0 should be supported. The Smart Hub hardware interface is modular and can be wireless (802.15.4 2.4GHz, 802.15.4 868MHz, wireless MBUS/OMS, EN13757-4, KNX RF) and wired (EN13757-2/MBUS, RS485 and RS232).

Smart Energy Profile

SEP does not define a specific metering protocol (like EN62056, ANSI, etc.). While native SEP meters (simple or complex metering application profile) are not used, the Smart Hub provides alternative meter interfaces.

For native meters, the metering data from the simple and complex metering profile can either be translated into the DLMS/COSEM or the CIM data model, and stored in the data mirror or the historic data memory. Transfer to GDSC is done via request of XML documents.

Security

Protection of residents’ privacy, secure storage and the transmission of personal data (e.g. historic power consumption) is a key requirement. This means that data transmission on all interfaces and data storage has to be secured.

MAC Layer Encryption

All shared media HAN interfaces (wireless, power line) must be encrypted. It is the experts’ view that, for the next 20 years, a 128bit symmetrical AES encryption for home appliance control and meter data protection will be sufficient. This is critical, because hardware accelerators for encryption cannot be updated remotely.

Some HANs already implement MAC layer security:

- OMS/EN13757 wireless MBUS meter interface: AES128;
- ZigBee SEP with AES128;
- HomePlug 1.0: DES+;
- HomePlug GP: AES128;
- HomePlug AV: AES128;
- WLAN: WPA/WPA2 (with AES128), WPS.

Wireless interfaces are generally preferred, as Ethernet LAN and wired meter interfaces are usually not encrypted, e.g. Wired MBUS (EN13757), RS232 RS485.

Secure data storage in Smart Hub
The Smart Hub can store (log) data for more than 100 meters. Historic data is stored in flash memory, thus preventing data loss in case of longer mains outages. Historic (stored) data is encrypted with individual keys.

Intermediate storage ("data mirror") of consumption data from battery operated meters (e.g. gas and water) allows In-home Displays (IHDs) to read consumption data from the Smart Hub (via the HAN) instead of using a direct meter read. The advantage being that the RF receiver in the battery-operated meter need not be always active, making a battery lifetime in excess of 10 years possible.

Secure management interface
The secure management interface allows operation, administration and maintenance of the Smart Hub and managed HAN components. This includes:

- Security updates for the Smart Hub;
- Protocol updates to support new features;
- Meter protocol updates;
- Appliance firmware updates through HAN interface (potentially);
- Change of keys and credentials for meters and residents;
- Change asset identification for installation, replacement, removal of assets (e.g. meters);
- Change of network configuration parameters;
- Diagnostic commands to analyse the HAN;
- For bidirectional meter interface: gas-valve switching, electricity meter load-switching (remote connection and disconnection).

Chain of trust enables trusted services to the customer premises
The Smart Hub is installed by trusted service personnel, establishing the initial link between a Smart Hub and a specific location (premises) and HAN (including meter). This creates a chain of trust between GDSC and HAN, in which all interfaces are secured by state-of-the-art encryption and authentication technologies. WAN communication uses public key cryptography (TLS) and meter communication is secured with symmetrical encryption (128Bit). This enables services between the consumer premises and GDSC, which require trusted, secured and confidential communication. This not only includes metering (for protection of personal data), but also online payment (see Prepayment appendix) and Ambient Assisted Living (AAL).

Summary
This section explains the benefits of the Smart Hub HAN approach:
- A chain of trust is created between Governing Data Services Centre (GDSC) and the HAN;
- Provides a solution for different HAN infrastructures without new wires (e.g. PLC, Wireless, Wired);
- Supports (but does not enforce) different HANs for metering, appliance control and IHDs'
- Smart Hub collects, translates and stores meter readouts;
- Data mirror for battery-operated meters;
- Allows interoperability between meters without waiting for a universal standard;
- Allows new HAN standards (SEP 1.x, 2.x) to be used;
- Supports remote management and diagnostics of HAN network (HomePlug-based and wireless);

- One version of Smart Hub integrates a HomePlug Broadband Powerline interface (uses state-of-the-art OFDM Modulation);
- Manageable PLC interface can be adapted to local requirements (spectral shaping of PLC carriers);
- Low energy consumption of Smart Hub;
- Scalable communications architecture (client/server model, no push);
- Open, IP and XML-based interfaces for WAN connection;
- Modular Meter Radio Interface (IEEE802.15.4 2.4GHz, 868MHz, EN13757-4);
- Modular WAN interface for media independent WAN connectivity;
- Secured firmware upgrade (e.g. to upgrade SEP Requirements);
- Secured configuration upgrade (e.g. provisioning, move-in/move-out);
- Secured event/diagnostics interface (for HAN and meter failure analysis, tamper detection);
- Secure certificate-based PKI Infrastructure;
- Multi-utility support (electricity, gas, water, heat and sub-metering);
- Bidirectional meter communication to support prepayment schemes (valve switch, set power limit).

Media agnostic WAN interface

The Smart Hub uses TLS security (https) to the GDSC headend, using a minimum AES128 bit symmetrical encryption. The authentication of the Smart Hub is done with a X.509 certificate.

Our trials show that, of the several available WAN technologies, each has benefits and disadvantages, dependant on the local conditions. On balance, there is no strong preference for one technology.

The WAN modem/router may be internal or external to the Smart Hub - the modular WAN interface allows either. With an external router, the resident's DSL/cable modem connection can be used.

Because of the large number of networked nodes (Hubs) that will potentially be statically connected to the GDSC, there could be a shortage of IPv4 addresses. There must therefore be a migration path on the WAN interface from IPv4 to IPv6 protocol and customers' routers should be IPv6 ready on the WAN side.

The following list explains the advantages and disadvantages found in the trials:

GPRS

GPRS was used in trials where no other WAN access was available. GPRS was also used as an alternative to demonstrate usage of a VPN for metering. Using GPRS in basements was difficult because of poor signal strengths. However, positioning of the antenna in an elevated position gave better results, and this could be achieved either by using long antenna cables, or by bridging the distance between Smart Hub and GPRS Modem (Bridge) using an IP Technology (e.g. Ethernet or Broadband Powerline) connection.

Advantages

- GPRS has the advantage that the Smart Hub is part of a VPN and has no direct connection to the public Internet;
- GPRS is available in locations were other (wired) WAN connections are not.

Disadvantages

- For frequent meter readings (more often than daily) the amount of data traffic on the air interface can be problematic;
- The RSSI level is low in basements and in buildings with thick walls, leading to poor reliability of data connections;
- Bandwidth is limited (especially for buildings with several meters).

ADSL, VDSL connections to the home

DSL is widely available and has been used in Germany in many trials. The Smart Hub allows the use of an external DSL modem/router to communicate with GDSC. Especially in apartment blocks, the DSL connection is superior to GPRS because of the higher bandwidth, higher reliability in basements or buildings with thick walls. A dedicated building IP connection for metering and other services based on DSL or Cable Modem is preferable, since it can be shared by all apartments through one router. This was implemented in all larger multi-apartment installations.

Some trials use direct PPPoE connections through the residential routers. The advantage with this is direct access to all Smart Hub services/ports without using a configured router. PPPoE has to be passed through the router and the PoP must support more than one active PPPoE connection per line. Another advantage is that data volume accounting for metering is not billed to the resident.

Advantages

- Dedicated line to building (no shared medium);
- Widely available;
- High bandwidth allows line-sharing by several Smart Hubs;
- Line diagnostics to premises by communications provider.

Disadvantage

- Higher fixed cost for service if dedicated DSL connection for metering/smart energy has to be installed (residential DSL connection cannot be used in a single-family house).

Cable Modem connection

One of T-Systems' trials, implemented with a partner company, used cable modems. In the trial, the Smart Hub retrieved a private WAN IP address via DHCP and became part of a VPN. The assignment of the IP address and Smart Hub DHCP registration was achieved using its unique 6-byte DeviceID. The cable modem used had previously been installed by the local ISP. There was no additional fixed cost for the Smart Hub WAN connection.

Glossary

COSEM	“Companion Specification for Energy Metering” sets the rules, based on existing standards, for data exchange with energy meters.
GDSC	Governing Data Services Centre
DLMS	Device Language Message Specification. A generalised concept for abstract modelling of communication entities.
HAN	Home Area Network for communication, to which meters, appliances, IHDs, residential gateways and Smart Hub are attached.
IHD	In-Home Display. This shows the status of appliances, consumed energy, active tariff, warning or informational messages and should allow user input to control appliances or select choices for home energy management.
OMS	Open Metering Specification (in alignment with TC294). EN13757 based meter reading and device control (bidirectional).
SEP	(ZigBee) Smart Energy Profile. A specification by the ZigBee Alliance that describes the data structures for communication with smart meters, smart appliances and IHDs over the ZigBee protocol stack. Latest non-draft version is 1.1. SEP 2.0 draft is in discussion.
Smart Hub	Device that connects the HAN to the WAN. The Smart Hub collects, translates and stores meter data. It can also collect, translate and store appliance status and send messages over the HAN to appliances and IHDs.
ToU	Time-of-use. Time of day/weekend when different tariffs/prices apply.
WAN	Wide Area Network. The WAN connection is made by modems (DSL modem, GPRS/UMTS Modem, cable modem) together with residential routers.