Innovative Approach to an ICT Infrastructure supporting Smart Grids and Smart Metering for Municipal Electricity Undertakings

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Introduction

Power utilities across the world have recognised that a key enabler for the successful implementation of their Smart Grid and Smart Metering projects is gaining a higher level of intelligence and information from the power network, something which can only be achieved through the massive growth in the use of ICT systems and services.

The most flexible platform for the delivery of such services, (as well as the existing requirements for Operational Telephony and general business communications), is undoubtedly a fibre optic based core network.

Deploying fibre deeper into the network and closer to the customer has many advantages. However, adopting such a strategy comes with a significant price tag; for many regional and national utilities the necessary capital investment and subsequent operational costs of creating this ICT environment are huge and any business cases to support it are at best challenging and at worst non viable. This situation can be exacerbated for utilities with smaller geographic footprints where economies of scale do not contribute positively to their commercial models.

This paper outlines an innovative approach that was considered in a project conducted by Mott MacDonald in 2008, where we designed a solution to create a single national fibre network specifically for the power utility industry based upon existing utility owned fibre. Although the solution was not implemented in this form, the initial planning exercise in association with the level of utility company engagement and co-operation that was achieved does provide insight into one way in which utilities could potentially achieve mutual benefit through a more collaborative approach to a common issue. In a territory such as South Africa it may well merit further investigation.

Background

Historically, many utilities have built their own in-house Operational Telecommunications (Op-Tel) networks and created extensive operation and maintenance support teams to manage them. This behaviour has been driven by a number of factors:

- Prior to the creation of competing fixed telecom network operators, the utility had little choice because incumbent, government owned telecom authorities would not invest to meet the needs of utility companies
- Utility companies are by the nature of their business operation highly risk averse, and by keeping services in-house they can control the reliability, availability and dependability of the communications services that support the Critical National Infrastructure (CNI). This view is sometimes articulated when one discusses the issue of securing managed or outsourced services with utility companies; there is often common feedback that such an approach is difficult to adopt as 'only the power industry really understands its needs'
- Some of the telecommunications services required by the utilities have to maintain very demanding performance attributes and characteristics (particularly for Tele-Protection services). The Public Telecommunications Operators (PTOs) do not always provide such services, or such stringent Service Level Agreements (SLAs) required for these services within their standard product portfolio. As such, utilities are then offered 'bespoke' services by the PTO, which in many cases are more expensive than self provision.
- Due to concerns over national security, there is a growing view that transferring service delivery risk to third party service providers, regardless of the SLAs, contractual arrangements or punitive measures agreed between parties is inappropriate when operating and managing CNI.
- A power utility is under external pressure from Regulators and Legislators to drive improvements in performance, safety and ultimately value for money for consumers. By building, operating and maintaining their own in-house networks, utilities provide a level of commercial, contractual and technical stability that underpins their business operation. For example, any new technology implementations and upgrades can be based upon the utilities operational needs in a controlled, timely and budgeted manner, whereas a PTO may demand the upgrade or change to a technology platform used by the utility to suit its own business strategy, regardless on the impact to the utility.

For many utilities building, operating and maintaining in-house Op-Tel networks is an important element in supporting their ongoing corporate responsibility and accountability.

This is also true for the multi-national utilities. In 2011, Mott MacDonald conducted an Operational Telecommunications benchmark study which compared a group of utilities from the USA, Europe, Africa and the Middle East. It was found that utilities which have a more global footprint (i.e. those with operations in more than one country) operate in a similar way to any global enterprise. Core business functions are centralised across the group, such as finance, human resources, purchasing and even IT and corporate communications. However, Operation Telecoms is in general delivered locally through in-house networks managed by in-house teams.

The Challenges of In-House Service Delivery

Building, operating and maintaining an in-house Op-Tel network is not without its challenges and complications. This paper does not include a definitive list of these challenges but it does touch on a few key areas.

Firstly, it is expensive to build and maintain a dedicated network, and unlike a PTO there is a limited customer base to spread the cost with no immediate or significant revenue stream to recover the capital expense. Additionally, even budgeting for relatively small upgrades or network extensions can become more complex due to the way in which the local Regulatory authority views how the costs are dealt with.

Secondly, utilities adopt a slower rate of communications technology change than PTOs. One may expect this to be advantageous to utilities, as once a technology is deployed it will remain 'fit-for-purpose' for perhaps 20+ years. However, in reality the technology market (dominated by PTOs) is driven by innovation and development, leaving utilities with ageing and in some cases unsupportable infrastructure. The issue is compounded by the complexities associated with the deployment and particularly the interfacing of new communications devices with the existing power engineering assets. Arranging network outages (both communications network and power network) to support these implementations is disruptive to the business operation and can take years to complete.

This results in utilities finding it hard to integrate new technology easily. As a consequence, this has created a 'mesh of technologies' in many utilities, where network requirements have developed organically and new networks have been overlaid on older networks.

An additional challenge concerns the resource pool. Utilities worldwide are affected by an ageing workforce and diminishing skills base. It is relatively easy to recruit technicians and graduate engineers, however once the utility has invested the time and money in training and up-skilling these employees, staff retention can become a problem with more financially lucrative roles available outside the industry. Again, this is particularly true in the ICT environment were graduate recruits are likely to be less incentivised to work on what they perceive as legacy networks (TDM based technology), when the whole communications market is focussed on IP.

Telecommunications services are an important enabler for the safe and efficient operation of a utility (and without doubt their importance in performing this function will grow within the context of Smart Grid and Smart Metering) these services do not constitute 'core business' to a power utility. As a consequence, there will always be pressure from the business to drive down cost and maximise efficiency of the telecommunications department - especially in an unbundled and competitive environment. This invariably means reduced investment in equipment and resources.

Many utilities then are faced with a dilemma. How do they find a solution to telecommunications service delivery that:

- Meets the demanding performance standards of Op-Tel;
- Supports the security requirements for CNI;
- Is scalable to support growth and capacity cost effectively;

- And can embrace new technology with the scale to make it cost effective?

The Co-Operative Op-Tel Network

One possible answer may be to create a co-operative Op-Tel network, a ubiquitous fibre based communications platform that would be owned and operated by a group of utility companies. The co-operative network would be designed and built to deliver dedicated Op-Tel and B2B services to the industry, with the option to generate additional revenue through leasing spare capacity and services to the general market place. The platform could be used to support multi-disciplinary utilities (electricity, gas, water etc.) layered across the end-to-end value chain (generation, transmission, distribution and supply). Ultimately the platform could provide the basis for an integrated Smart Grid in its widest context, driving efficiencies and performance not just within each utility (today's Smart Grid focus) but in a truly customer centric manner linking traditional, renewable, bulk and distributed generation, storage, transmission, distribution, supply and the consumer.

In 2008, Mott MacDonald was engaged by a client to develop such a scheme. While the project did not come to fruition in this form, the experience provides a valuable insight into what could be achieved, identifying some of the key activities and challenges involved in creating such a scheme, including assessing the overall scheme viability, design concept and architecture, the commercial framework options, the operating environment (including necessary Service Level Agreements) and potential operational models. A brief outline of the case study is documented here to provide context.

Case Study

A national Transmission System Operator (TSO) was considering its Op-Tel strategy for the next 15 to 20 years. As part of that strategy, there were some key drivers for change which it wished to consider:

- A urgent requirement to replace the ageing telecommunications assets and platforms, some of which were unsupported by the vendor community due to their age
- An urgent requirement to upgrade and in some areas replace the ageing fibre infrastructure
- The impact of the migration from TDM to IP services (considering both the effect of implementing and the effect of not implementing IP services for Op-Tel)
- Reviewing the likely future requirements for Smart Grid and Smart Metering and how these new services could be accommodated into their network
- The sourcing strategy for the Op-Tel services – should they build an in-house solution or outsource the network to a PTO.

A fundamental decision taken by the TSO was that regardless of both the current and future services it required, the most flexible platform for delivering them was over a fibre based infrastructure. The immediate challenge therefore was how to implement a 'refreshed' national fibre network with the minimum disruption to their existing operation.

The vision proposed by Mott MacDonald was to create a national fibre network through a combination of TSO and DSO fibre. The fibre network would be designed on a core and access network basis. The core network would be primarily formed from existing TSO fibre, and the access networks created primarily from existing DSO fibre. The scheme leveraged the fact that the DSO primary substations were located adjacent to the TSO substations. Additional fibre would be installed (either underground or OPGW or fibre wrap on the DSO network) to support the closure of rings for enhanced network resilience on both the core and access layers.

Challenges to Implementation

Without doubt the most difficult challenge is opening the initial discussion and generating the interest between the various utilities. Lessons learned from the case study showed that from the outset it was important that discussions were led by a 'neutral' party. This ranged from the initial presentation of the concept to each interested utility, through to the later design stages. This provided all parties concerned with a 'level playing field' and was a way of successfully managing the competing interests that surfaced during discussions. By establishing this 'neutral' buffer between the various utilities, concerns over confidentiality and commercial sensitivities can be more simply addressed. The process also illustrated that not every utility had to be interested or convinced from day one. Within the geography considered within the case study there was a national TSO and fourteen DSOs. Four of the DSOs were initially ambivalent about the scheme. However, as the momentum built they decided to actively participate in discussions.

In such a scheme, it has to be recognised that not all utilities will be equal participants, either in how much fibre they contribute, or in the services that they lease back. However, the platform has to be capable of delivering compatibility between all participants. The starting point for this is to recognise that the initial platform will support multiple technologies and solutions for multiple OpTel services and such solutions are readily available in the market today. Linked to this is ensuring that there is a fair and equitable commercial arrangement put in place which benefits all concerned parties.

Assessing the Overall Scheme Viability

Creating a co-operative network can have a large impact on time and resources. It is therefore important to be able to assess the overall validity of the scheme quickly so that a decision can be made on whether to proceed or not. This can be achieved through some initial preliminary design activity which in essence will identify whether there are indeed enough assets to share (i.e. fibre, spare capacity etc), what future roll-out and refurbishment plans each utility has (in the case study, roll-out and refurbishment of OPGW plans for a three year period were considered) and the scale (and hence estimated cost) of any new build required to support the scheme. An example of such a design if provided in Figure 1.

Design Concept and Architecture

As described earlier, the core design concept is to create a fibre network based upon a highly resilient core network connected to regional or local access rings. The core network is mainly provisioned through the TSO fibre and the access rings provided by the DSO companies fibre. The interface point between the core and access layers in essence relies upon the proximity of the DSO primary substations to the TSO substations providing an effective point of present.

For the TSO, the design benefits can include identification of alternative routes between TSO substations (using routes created through the DSO networks)thereby providing either greater resilience, or creating alternative routes for maintenance / fibre replacement works, or providing future network extensions

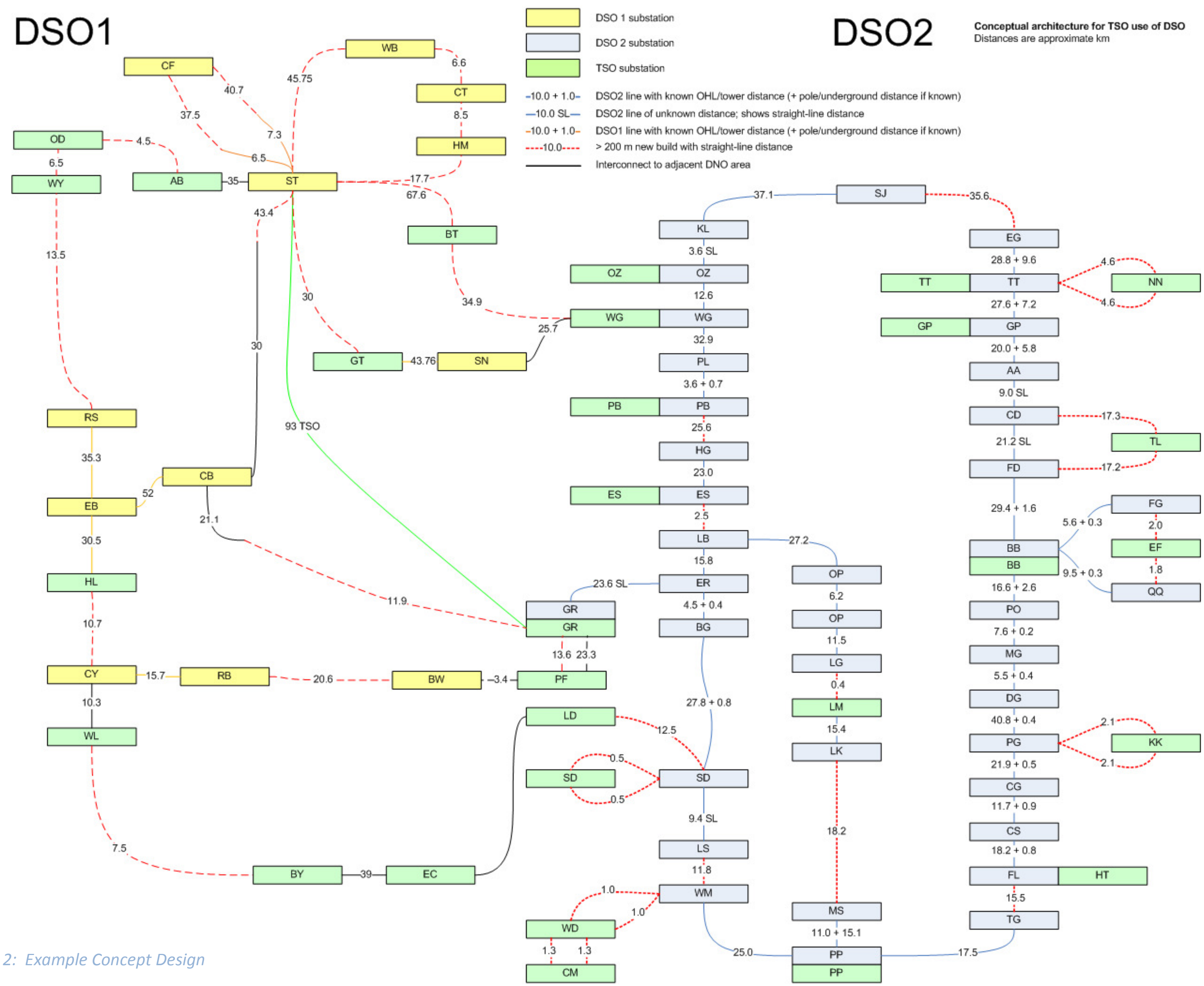

Figure 2: Example Concept Design

more cost effectively. Although in most cases these routes will not be the most direct (shortest) path between TSO substations, they are often more than suitable for telecommunications services.

For the DSOs the design benefits can be more significant. Firstly, there is likely to be much less fibre installed within a DSO region. Where fibre does exist, it may only be connectivity between small groups of primary substations. Often these clusters of fibre network are islanded from each other, and consequently across the DSO region not all the primary substations are connected to a single network. Through careful use of available TSO fibre and much reduced new build fibre, these clusters can often be connected creating a more resilient DSO network. Furthermore, (based upon suitable TSO fibre routes for access) it can be possible to extend fibre deeper into the DSO network. Within the case study, we also identified areas where adjacent DSOs benefitted from interconnecting and sharing fibre along the geographic boundaries.

The Commercial Framework Options

The key commercial benefit to the op-operative network is cost sharing. The increased customer base (multi-utility), and theoretically the reduced length of fibre routing across the network reduces unit support costs through economies of scale.

There are two key areas of shared cost. Firstly the shared cap-ex for infrastructure costs, which could be for new build or investment into the scheme by providing spare fibre capacity. Secondly the shared service management or lease costs (op-ex) from leasing capacity from the scheme.

There are many options available for cost sharing and these will depend on the specific circumstances of the co-operative network that is achieved (see Figure 2).

Of course, one option of the model is to create a new utility telecommunications business, created as a joint venture between all the utilities, to build operate and maintain the network.

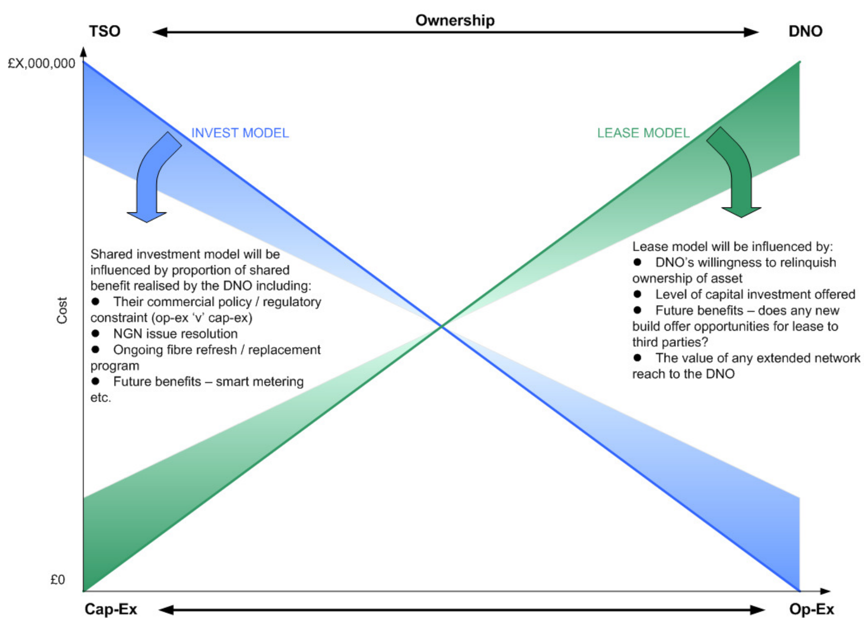

Figure 2: Commercial Framework Options

Operating Environment

In addition to the asset sharing required to create the physical co-operative network, a suitable operational and maintenance environment has to be created. Again, many options exist and these will be determined by the specific solution created, however sharing of technical resources between utilities may prove beneficial.

Issues to be addressed in creating such an environment are operating standards acceptable to all utilities, and importantly service level agreements between utilities (particularly in the event of incidents, faults and outages).

As identified within the commercial framework options, some of these issues may be more easily addressed if a utility telecommunications organisation is created to support the co-operative network. Transferring technical staff from the utility to the new organisation focussed on telecommunications may be an attractive option to the utilities companies and staff alike.

Benefits of the Co-Operative Scheme

The primary benefit of the scheme is the creation of a purpose built, bespoke network that caters specifically for utility requirements with the cost for the build, operation and maintenance shared proportionately across the utilities that utilise the network.

The performance, topology and capability of the co-operative network perfectly reflects utility requirements, offering a fibre based flexible platform supported by other technologies within the DSO partners for delivering today's telecommunications services and indeed a basis for next generation communications services including supporting Smart Metering and Smart Grid.

Additionally, the co-operative model has all the advantages of an in-house solution, but is in effect an 'in-community' solution. This addresses concerns over security and risk associated with CNI and should be attractive to legislators and regulators alike.

From a resource perspective, in the case of major faults there is potentially access to a wider resource pool from across multiple utilities (staff sharing opportunities as well as infrastructure).

Summary

The co-operative Op-Tel network is an innovative solution created by the co-operation and sharing of existing and new communications assets between utilities. In the context of South Africa, this would consist of collaboration between the Municipalities and National Transmission Operator to create a ubiquitous communications platform. The process to create such an environment will not be easy, but the idea it may well be worth considering. As with many countries, South African utilities are all faced with business challenges associated with creating cost efficiencies whilst at the same time having to support new initiatives such as Smart Grid and Smart Metering. The Op-Tel network underpins all of these current and future services, and a co-operative network has the opportunity to meet the demanding requirements of the utility operation and provides a level of future proofing whilst reducing the overall investment and cost exposure of an individual utility. In essence, a solution where the achieved outcome 'is greater than the sum of its parts'.