

Business Drivers for Distribution Network Operators and Active Distribution Management System Developments: How Should India Embrace Best Developed Practice?

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Abstract-- The authors first present a review of typical business drivers for deregulated distribution network operators. The drivers identified are both external, including the regulator and customers and internal, involving the increasing rate of change of network development and shortages of qualified/experienced engineers.

The authors will also present a summary of recent developments in the application of Distribution Management System (DMS) development with particular reference to active network applications.

The paper's focus is on practical examples of active network management where the DMS platform has enabled the distribution network operator to improve operational flexibility, meet regulatory targets or accommodate embedded (distributed) generation while avoiding, in some cases, the network reinforcement capital expenditure normally required in such circumstances.

Further DMS developments are also described, including the integration of advanced smart meters to tightly integrated DMS and OMS applications, the use of mobile field-based technology in DMS and OMS applications and the practical use of embedded network analysis tools.

Finally, the above-mentioned issues and examples are mirrored into the Indian context. The authors look to draw a number of observations and learning points for the Indian distribution network operators in the context of best developed practice..

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INTRODUCTION

This paper describes key drivers on the 21st Century Distribution Network Operator (DNO), with particular reference to the experience of the UK DNO utilities where deregulation commenced in 1990 and has continued to evolve leading to increasing and changing pressures on the utility business.

The drivers identified include:

- The encouragement of distributed (embedded) generation as a means of achieving CO₂ reduction targets (government driver), increasing network reliability and resilience without incurring significant increases in capital and operating costs (regulator driver), reducing network capital and operating costs (shareholder driver) and reducing payments to distribution network operators (customer driver).
- Incentive-based regulation with rewards and penalties for network performance, including performance recording and reporting (regulatory driver).
- Requirements to provide substantive information to customers affected by outages/faults (regulatory, and customer driver).
- Improving average network performance together with that experienced by the "worst-served customers" (regulatory and customer driver).
- The impact of business separation, together with mergers and acquisitions, while providing a single point of contact for customer no-supply calls (regulatory and shareholder driver).

The author will outline how these drivers have both directly and indirectly led to developments in DMS/SCADA/OMS functionality and architecture.

NETWORK PERFORMANCE

Once privatised, the utilities were expected to exceed, or at least equal, the network performance recorded when operating under nationalised ownership. The regulator was able to publish the companies' system performance data (CML and CI, or SAIDI and SAIFI) annually¹. Shareholders and city investors were seen to use these data, rightly or wrongly, to gauge company performance because there is little else publicly available company performance data.

At the same time, the newly privatised utilities were looking to make operating expenditure savings wherever possible. The control room is the high cost but very important core of every distribution business; the performance of the DMS will be reflected in the recorded improvements in network performance.

The DMS must provide support for the push towards increased network performance. This includes increasing control engineer productivity, without adversely impacting operational safety, through the application of a comprehensive, user-friendly interface and architecture capable of reflecting current, and optimum, business processes. The full integration of SCADA and OMS with the DMS also brings benefits in both improving and tracking network performance.

Further regulatory influences on distribution business performance arose from the use of Guaranteed and Overall Standards of Performance.

Briefly, Overall Standards relate to macroscopic performance indicators, such as a requirement to restore supplies to 99.5% of affected customers within 18 hours (OS1). It is worth noting that the UK recently revoked all Overall Standards, as they are now considered unnecessary when compared to Guaranteed Standards and other regulatory instruments.

Guaranteed Standards (GS) of performance are customer-specific in their application. For example, GS2 requires, with some exemptions, a DNO to pay a penalty (currently £50/£100 Domestic/Non-domestic) to any customer whose supplies are not restored within 18 hours of a fault occurring.

In response, a DMS must include a means of monitoring the progress of all network incidents and their potential impact on Guaranteed Standards payments to customers. A fully integrated DMS/OMS is key to monitoring exposure to Guaranteed Standards payments.

The UK regulator has now proposed a modification to the Guaranteed Standard payments schemeⁱⁱ so that the required performance during extreme weather conditions is modified to reflect the extent of the damage inflicted on the distribution network. The proposal includes a relaxation in the penalty threshold for distribution operator performance once a “large event” or “very large event” is identified: this requires the DNO to measure that over 35% of exposed customers are affected. Again, the DMS and associated systems must provide an accurate and auditable means of measurement.

WORST-SERVED CUSTOMERS

While many customers continue to be satisfied with the quality of supply which they receive, the regulator recognised that some customers do suffer a poor quality of supply. “Worst-served” customers are often those located at remote sites supplied by tapered radial overhead networks.

In itself, a DMS cannot easily improve the quality of supply experienced by worst served customers. However, rapid restoration of supply following a non-damage fault can often be effected within the threshold time which requires the incident to be included in SAIFI/SAIDI reporting: this can be achieved using programmed sequence switching in the DMS. For example, one UK utility has successfully used its DMS to automate over 1500 MV sequence switching schedules with significant improvements in both SAIDI and SAIFI over traditional manual post-fault restoration methods. It is also important to note that this benefit was achieved through minimal additional capital investment in DMS technology while achieving flexibility in implementation at low incremental cost. The benefits of MV automation schemes are also well described in an earlier paper presented at CIRED 2003ⁱⁱⁱ.

INCENTIVE-BASED REGULATION

In 1999 Ofgem, the UK gas and electricity regulator set the 2000 - 2005 price control for the UK distribution utilities^{iv}. This recognised that customers in general were looking for an improving quality of supply and proposed a quality of supply allowance together with a reward/penalty scheme. In order to measure by how much the quality of supply had improved, Ofgem also set strict accuracy requirements for measurement systems.

These new regulatory requirements were part of the Information and Incentives Project (IIP). There are many regulatory documents about the IIP at www.ofgem.gov.uk

For the DMS, the impact of IIP includes:

- A need to accurately maintain a database of customers together with their point of connection to the distribution network. The regulator on an annual basis independently audits accuracy; the required accuracy level is challenging: typically requiring between 90-95% accuracy in counting customers affected by network incidents. A failure to meet the required accuracy target will result in a financial penalty. This involves an annual independent audit and report to the regulator^v.
- Rapid and reliable (i.e. available 24/7) access to the customer/network database is required in order to assist with the speedy identification of network incidents, customers affected etc. (See “Provision of Substantive Information”, below).
- A financial reward/penalty scheme which creates a direct incentive for improvements in SAIDI and SAIFI. This can lead to a favourable benefit/cost ratio when the DMS incorporates a means of implementing automatic (event-triggered) sequence switching – mentioned earlier in “Worst Served Customers,” above).

PROVISION OF SUBSTANTIVE INFORMATION

Market research by the regulator and customer-representative bodies has identified that customers affected by supply failures, are at least a little less upset when provided with substantive information relating to the fault and especially its likely duration.

Substantive information is considered to represent more than an acknowledgement that a caller is affected by a particular network incident. Where possible, the caller should be given information about the likely duration of the outage and progress in restoring supplies. This requirement has resulted in further benefits for integrated DMS, OMS and call-taking systems such that the necessary accurate information quickly flows between systems. The requirement is also time-critical because customers contact the DNO almost immediately after the incident begins and continue to do so until after supply restoration.

There are examples where the regulator has required a DNO to make a compensation payment for failing to give adequate advice to a customer where that failure resulted in damage to customer's electrical apparatus. Thus, the call-taking system should guide operators through a pre-defined question/answer process and help avoid giving inappropriate or inaccurate advice. One popular call-taking application is web-based (which enables its use by other DNO staff during periods of high activity) and includes interactive wizards to guide possibly inexperienced call-takers and customers through a pre-defined set of questions to arrive at a satisfactory result.

In parallel, all customers affected by a pre-arranged outage must be given at least 48 hours notice (failure to do so results in a Guaranteed Standard payment of £20/£40 for each Domestic/Non-domestic customer). The DMS and supporting databases must track network and customer connectivity in order to maintain an auditable and up-to-date record of network events and track affected customers.

EMBEDDED/DISTRIBUTED GENERATION

Many of the world's governments have become signatories to the Kyoto Accord and have identified reductions in fossil-fired generation as a key factor in achieving CO₂ reductions.

The expectation of the industry is that the passive distribution networks will become a mixture of passive and active zones of operation and control where an active zone will assist in accommodating one or more embedded generator without expensive widespread network upgrades^{vi}. Figure 1 illustrates how one study has identified a significant benefit of active Automatic Voltage Control (AVC) over passive AVC.

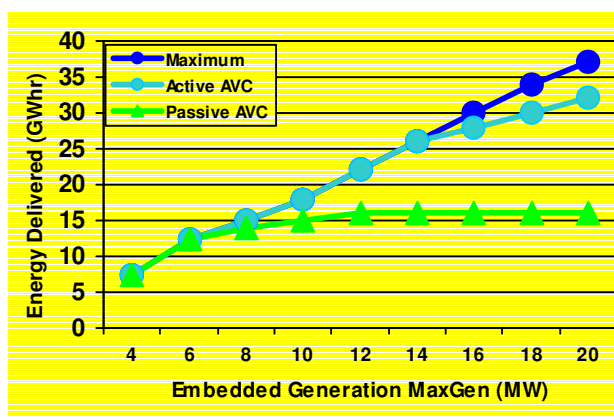


FIGURE 1: The potential benefit of an advanced DMS – active AVC

It is the author's experience that a DMS for active distribution networks will likely include the following features:

- Advanced, automatic control functionality. Automation must be fully integrated with SCADA and OMS so that any abnormal network configurations can be reflected in the control sequence(s).
- Access to embedded network analysis routines. This will include event, or user initiated, partial, or total, analysis such that the analysis results can be used to trigger changes in network operating conditions, e.g. adjusting the basic voltage setting at a 33/11kV substation in response to changes in local embedded generation output (Active AVC).
- Network splitting to reduce fault level supported by automatic DMS restoration functionality can enable a DNO to accommodate additional embedded generation without incurring the capital costs associated with replacing potentially over-stressed switchgear^{vii}. The need to incorporate measurements taken from a number of network locations and make sometimes complex calculations, means that automatic fault level monitoring and control will be more effective if implemented in an advanced DMS rather than in a stand-alone application.
- Provide supplementary safety logic. For example prohibit manual switching at sites where the fault level is calculated to be above or close to switchgear ratings.

CHANGES TO BUSINESS STRUCTURE

Privatisation and subsequent regulatory pressures have resulted in both business separation and mergers.

Naturally, business mergers are sought in the light of economies of scale although the UK regulator has imposed a “cost of merger” on utilities equivalent to a one-off reduction in revenue of £32 Million spread over 5 years. This cost saving must be achieved by the new distribution business before any additional shareholder returns are gained.

The result of the mergers and acquisition activities is that the DMS needs to be capable of changing to reflect the new business structure. However, it is important that this flexibility must not be at the expense of either performance or availability. Many UK DNOs have selected a DMS which offers a flexible architecture, with a system designed to support multiple control room locations, even across Wide Area Networks (WANs) and also support a distributed and disparate SCADA architecture. Critical DMS success factors include:

- Flexible DMS client/server architecture
- Flexible SCADA architecture
- Multiple SCADA protocol support
- Ability to integrate with other, possibly multiple, legacy business systems, including data historian, CIS and asset management system.

One typical issue encountered in a distribution business merger is the presence of multiple legacy SCADA systems including multiple SCADA protocols. For example, GE Energy’s ENMAC* DMS can accommodate numerous legacy SCADA protocols at each Front End Processor (FEP) enabling the combined business to continue to operate legacy SCADA systems without any impact on the control/operational user interface.

Meanwhile, the regulator has also promoted business separation, such that areas of distribution businesses where competition may be encouraged are created as separate organisations, operating at arms length from the others, or even required to be divested.

Again DMS flexibility is paramount as the distribution business changes through regulatory controls. DMS architecture must be able to change to reflect organic or growth through acquisition.

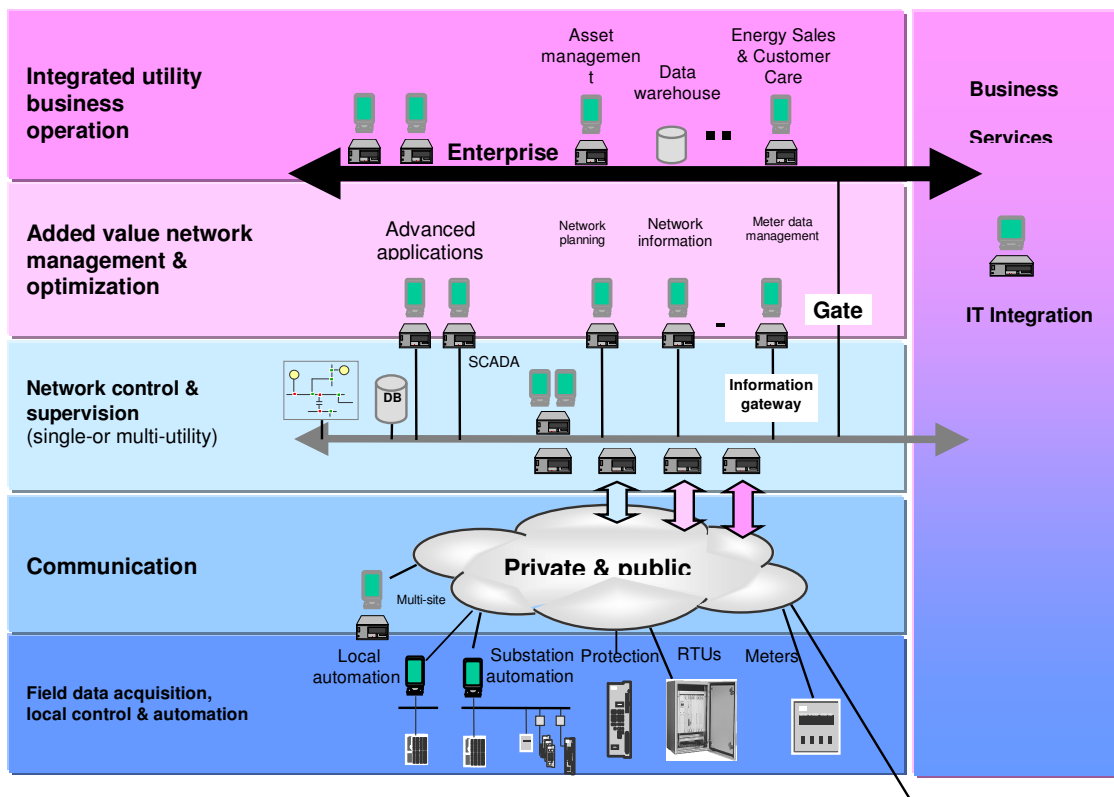
THE INDIAN DIMENSION

Taking the DMS/OMS/SCADA functionality described above, the authors’ propose that the following will be of most importance in Indian network businesses:

- Recent legislation, including the Electricity Act provide for open access by generators to transmission and distribution networks which may help reduce local network overload situations, if the DMS provides adequate load management technologies. Elsewhere, the networks are often subject to energy supply situations that require selective, yet cost-effective, load shedding. These load management schemes must take account of rota/rotational plans and critical customers, e.g. hospitals, to ensure that utilities can meet regulatory requirements, both now and in the future.
- Considering Distribution Automation (DA), an advanced DMS solution is typically the quickest and most cost-efficient means of implementing a solution. In the authors’ experience an MV feeder fault normally requires up to twenty-four hours to repair the fault and restore supplies to customers supplied by the faulted cable, and up to three hours to restore supplies to customers supplied by other cables on the same MV circuit – because of manual switching. While DA cannot reduce the repair time involved, it can bring dramatic reductions to the switching and isolation times with the three hour manual switching duration cut to less than three to five minutes through the addition of a small amount of remote-controlled MV switchgear with low-cost, possibly GSM, communications facilities. The regulatory rewards for this investment are now available in many territories, including India.
By making use of an advanced DMS, the implementation of DA can be accelerated at lowest cost, providing a solution where the DA intelligence, IT support and operational expertise can remain at the control centre, leaving the remote-controlled devices and simple communications infrastructure in the field.
- The DMS should also provide enhanced enterprise-wide service support through easy and low-cost integration with other enterprise systems, including, but not limited to, Geographic Information Systems, Customer Information Systems and Asset Management/Maintenance Systems.
- Further regulatory rewards are often available for those utilities that can best manage their large group of field operators. This can be enhanced through the use of a DMS with Mobile functionality. The immediate benefits

noted in this application include quicker planned and unplanned outage management because the communication between control room/dispatcher and field operator is significantly accelerated.

The diagram included below shows how an advanced DMS may be integrated with other enterprise systems:



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EDUCATION:

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EXPERIENCE:

David is a Subject Matter Expert for GE with responsibilities for advising on product development in the utility arena. Prior to joining GE, David was a Principal Engineer at OFGEM, formerly OFFER, the UK gas and electricity regulator (1991-2000). In this position, David advised the Director General on technical matters relating to the regulation of the electricity industry. During his time at OFGEM, David participated in Price Control Reviews of Transmission and Distribution businesses in England, Wales, Scotland and Northern Ireland and represented the regulator at national committees, including NETA and the Distribution Code Review Panel. David attended a secondment to BC Hydro, Canada, (1993-1994) where he participated in a strategic study of an enterprise-wide Geographic Information System for the organisation. David's earlier career was spent in a number of senior engineering positions and roles at Southern Electricity Board and Eastern Electricity, before, during and after privatisation.

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Chandan is new with GE, having joined in August 2006. His earlier roles were with Reliance Industries Limited, PT Polyprima Jakarta, Honeywell Automation and Reliance Energy Limited. With Honeywell, Chandan was the Industry Business Manager for Power. With Reliance Energy, Chandan was the Project Manager for SCADA-DMS-GIS implementation projects for the cities of New Delhi and Mumbai.

A regular speaker at the automation seminars in the domain of Power Generation, Transmission and Distribution, Chandan also has to his credit a number of strategic papers on this subject.

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