RECENT ACTIVE DISTRIBUTION MANAGEMENT SYSTEM DEVELOPMENTS

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ABSTRACT

Following on from the author's paper at CIRED 2005 (The impact of government, regulator, shareholder and customer on the development of utility distribution management systems, scada and outage management systems in the 21st century), the authors summarise recent developments in the application of Distribution Management System (DMS) development with particular reference to active network applications.

The paper 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.

INTRODUCTION

The author's earlier paper[1], presented at CIRED 2005 is also referred to during this paper and is recommended as accompanying reading material.

This paper summarises some of the recent developments which have taken place at network operators control centres and which have been the result of deploying advanced DMS/OMS. Where possible, the report describes the outcome of actual implementation(s) rather than theoretical assumptions.

ACTIVE NETWORK MANAGEMENT

The barriers to entry into active network management include the circuit ratings of the Distribution infrastructure in the locus of the preferred energy collection site. Insufficient infrastructure capacity can involve substantial reinforcement costs and accompanying delays that can make an embedded generation scheme unviable.

There are three methods of optimising the network ratings:

- Examine the margins that exist in the circuit ratings - particularly the possibilities of operating with dynamic ratings
- Produce a method of limiting generation within the infrastructure ratings
- Implement both of the previously mentioned methods

Traditionally, equipment ratings have been provided as a continuous rating, a short-circuit rating and, where applicable, a cyclic rating. Seasonal ratings have also been used, for instance with overhead lines being de-rated in hot summer temperatures, and environmental ratings such as multiple cables in a trench and extended lengths of cable in ducts causing these assets to be considerably de-rated.

The measurements of load, captured through SCADA have included the flexibility to provide calculated analogues as well as directly scanned points. 'Limit management' introduces the comparison of these load analogues with the rating attribute of the appropriate equipment.

Dynamic ratings involves replacing the circuit rating figure or set of figures with a real time calculated attribute that takes into account the actual and recent power flowing through the circuit, real time ambient temperatures, calculated analogues of current running temperature, the cooling effect of higher wind speeds, to provide a rating consistent with the real time capability to dissipate heat from the circuit, and therefore provide a thermal rating that enables more flexible power throughput over a given time.

The current method ignores the fact that the higher wind speeds that provide the opportunity to generate more wind power, also act on the overhead lines and improve the thermal rating properties by refreshing the ambient air temperature and removing the heated air around the conductor on the same principle as forcing air circulation through transformer cooling tubes.

A recent application of this methodology was reported by Central Networks, UK, an E.On. company[2].

The scheme was implemented in Central Network's advanced DMS, with the expectation that "*combining output modelling with line rating enhancement could actually facilitate connection of around 30% more* [embedded] *generation*".

This scheme was awarded OFGEM's first Registered Power Zone (RPZ) status – RPZ is a mechanism established to encourage network operators to develop and demonstrate new, more cost effective ways of connecting and operating generation that will deliver specific benefits to both generators and consumers.

The use of a DMS to implement the scheme means that the mechanism can be duplicated at very low cost and effort in similar circumstances elsewhere in the network.

ACTIVE FAULT MANAGEMENT

The use of an advanced distribution management system proved itself invaluable to efficiently manage key aspects of the control centre operations during a severe outage and restoration event that took place at WPC, Perth, Western Australia.[3]

The various functions of an advanced DMS convey vital information to the control engineers that improves and streamlines decision-making, particularly when operating under pressure.

The efficient use of the embedded network analysis tools in the DMS, during the outage enabled WPC to restore safely customers as soon as possible, and reduce load only when absolutely necessary without overloading critical interconnecting feeders.

Business case summary of Advanced DMS advantages in active fault management:

- More rapid restoration of customers due to better network analysis and load forecasting,
- Potential network overloads and other similar problems were predicted and managed,
- Prevented catastrophic failure of strategic assets; this, in turn, helped WPC avoid a major unplanned outage,
- Minimised the additional disruption in a planned and controlled way,
- All affected customers kept informed of restoration progress via OMS and the OMS interface to trouble call telephone bureaux,
- Operations & senior management are kept informed of progress via embedded DMS Reporting/Information Services.

Further active fault management benefits are available through advanced DMS functionality and have been described in earlier papers[4]. The implementation of active fault management at EDF Energy on over 2000 MV circuits has resulted in a flexible, cost-effective means of achieving the strict regulatory performance requirements. Particular mention was made to the advantage of centralised, DMS-based, intelligence with remote control of MV automation devices in terms of the life-cycle costs of the solution.

MOBILE WORKFORCE MANAGEMENT

A further recent advanced DMS development was part of a collaborative effort between Western Power Distribution, Yambay** and GE Energy using mobile PDA technologies with ENMAC*[5].

The primary objective of the DMS/Mobile scheme was to reduce the duration of faults through improving and speeding communications between control room and field staff. In addition, there was also a further improvement in the accuracy of reporting outage durations, which is subject to an annual regulatory audit.

The initial implementation enables automatic confirmation of switching operations and times from the PDA direct to the integrated DMS/OMS. This eases a sometimes significant "dispatcher bottleneck" meaning that field staff do not have to wait to speak to a control engineer to confirm operations or to receive instructions. At the same time, control engineers can better maintain attention on important details because they do not have to break off from one task to respond to field staff that are engaged in another task.

The Requirements of the system were identified as:

- Simple to use – both in the field and at control centres.
- Provide a replacement for the paper copies of switching programmes that had been used in the field.
- Provide Field Staff with an exact copy of the switching schedule / job viewed by a Control Engineer via the DMS.
- Enable Field Staff to update ENMAC* Switching Schedules / Jobs without engaging with a Control Engineer

The first implementation of the ENMAC/Mobile system was commissioned during 2005/06 and is reported in WPD's IFI project report[6]. This report shows that project benefits outweigh project costs and indicates that the project had been completed with 850 field units commissioned in less than 12 months.

One very important feature of the mobile technology implementation is the use of "push technology" to ensure that any message will be delivered even when communications are unreliable, e.g. when a mobile device is taken inside an underground substation. The system provides real-time status reporting on queuing and delivery or non-delivery of messages and these are incorporated in the DMS to ensure that the safety critical nature of the field and control engineer's work is not compromised.

DMS SMART METER INTERFACE

The increasing use of smart meter technology for revenue metering in Europe and elsewhere provides a further opportunity to extend the 'reach' of DMS and OMS.

Before smart metering can be integrated with DMS/OMS, it is important to differentiate between different 'types' of smart meters. In this paper, we assume that the smart meter system will provide the following functionality as a minimum:

- Full, reliable, and low-cost two-way communications between network operator and each smart meter. E.g. typical DMS-meter message/command can be completed within ~20 seconds,
- 'Last Gasp' power failure signalling from smart meter to OMS. N.B: This naturally requires a fault/interruption tolerant meter and communications infrastructure,
- On-board load-break switch/contactor to provide selectable whole or partial load disconnection,
- Reporting of Import (demand) and, separately, Export (on-site generation or microgeneration),
- Reporting of terminal voltages, either by exception or on demand.

Other characteristics of advanced smart metering systems includes remote programmability of metering communications network and meter; remote firmware upgrade of meters and supporting modules; support for gas and water metering, where applicable; support for customer information devices: typically hand held devices and/or internet information services.

The smart meter system functionality described above can help facilitate the following Advanced DMS/OMS functions:

- Increased 'visibility' of network loading, voltages and power flows. This can be used to update DMS network models with loading and voltage details. Advanced DMS functionality mentioned in the author's earlier paper included active network voltage control to better accommodate embedded generation – the ability to monitor received volts at customers meter terminals will provide clear confirmation that such a scheme continues to meet statutory voltage requirements.
- Near-immediate outage notification, which can reduce the requirement to provide telephone call centre services – provided that customers are aware of this functionality and do not continue to phone in as before.
- Selective load management to assist network operators as they cope with short-term imbalances between supply and demand in the most cost-effective manner.

There is a useful public domain review of the potential benefits of smart metering for network operators, which was conducted as part of OFGEM's review of Domestic Metering Innovation[7]. A more-detailed review and revision of the benefits ascribed by OFGEM (referred to as 'heroic assumptions' by OFGEM) to the features listed above shows clearly that, for many network operators and for some large customer groups, a smart meter implementation could achieve payback for network operators in very short timescales.

SUMMARY

The advances described in this paper illustrate that the selection of an advanced DMS can facilitate further advanced network management developments, each of which are capable of delivering significant business benefits to network operators. The future business environment for network operators will continue to present challenges similar to those already identified here and elsewhere, including staff attrition and the impact of supply-side demands for more embedded, renewable generation; the selection of an advanced DMS can help meet these challenges.

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* Trademarks of General Electric Company.

** www.yambay.com, Australia.