Case Study - Norweb/United Utilities

The system described here is a power outage monitoring system installed at United Utilities (formerly Norweb) in Manchester, with additional client software being installed at various regional offices and depots. The customer provides electricity supply to the north west of England and had a requirement to reduce the amount of *customer minutes lost* (CML) due to power outages. The electricity watchdog in the UK had introduced penalties for those regional electricity distribution companies that were not improving the figures associated with customers being off supply.

It was decided that the best way of reducing this amount of time was to increase the speed at which the electricity board was informed of faults in the first instance. Previously, in rural areas, it was often a call from a customer reporting a loss of supply that prompted an investigation into a fault. This call could be received some time after the actual fault had occurred, especially when faults occurred during the night, leading to unnecessarily long periods without power. The system installed by NHDS, known as the PODS system (power outage disturbance sensors), utilised several thousand POD sensors installed in domestic customer's premises. These sensors are connected to a customers mains supply, usually via a domestic 3-pin socket, and also are connected to the customers phone line. When any loss or restoration of power (permanent or momentary) is detected, or voltages exceeding predefined limits detected, the POD units call the host system using a toll free phone number (so that the customer is not paying for the call) and report their status. The host system can then report such faults and also determine if a fault is confirmed or not by examining data from other POD sensors on the same high voltage (HV) circuit. This is to detect the situation where a customer unplugs a sensor temporarily or has a localised power loss, e.g. a circuit breaker tripping.

Using this system United Utilities were able to reduce the amount of time it took to restore faults by an average of about 10 to 20 minutes in rural areas.

The host system was also used to generate reports of *customer minutes lost* data for examination by the watchdog as proof that they were taking action to reduce the CML and *time to restoration* figures.

As the system was first installed, it was decided that other facilities could be added to the system and United Utilities commissioned a series of custom software packages and modifications to the standard software to enhance the system. These included a report generation client terminal that would generate a variety of reports specifically tailored to the customer, a relay control terminal that would control a series of external indicators so that problems could be flagged up in a busy control room without having to examine computer screens or listen to audible indicators and a custom client terminal that would look at data from multiple POD sensors to aid in pinpointing where a fault might lie on the distribution network (the standard client terminal would report which sensors had reported faults, but the custom one would report which area of the distribution network had a problem and aid in pinpointing the exact location of the fault).

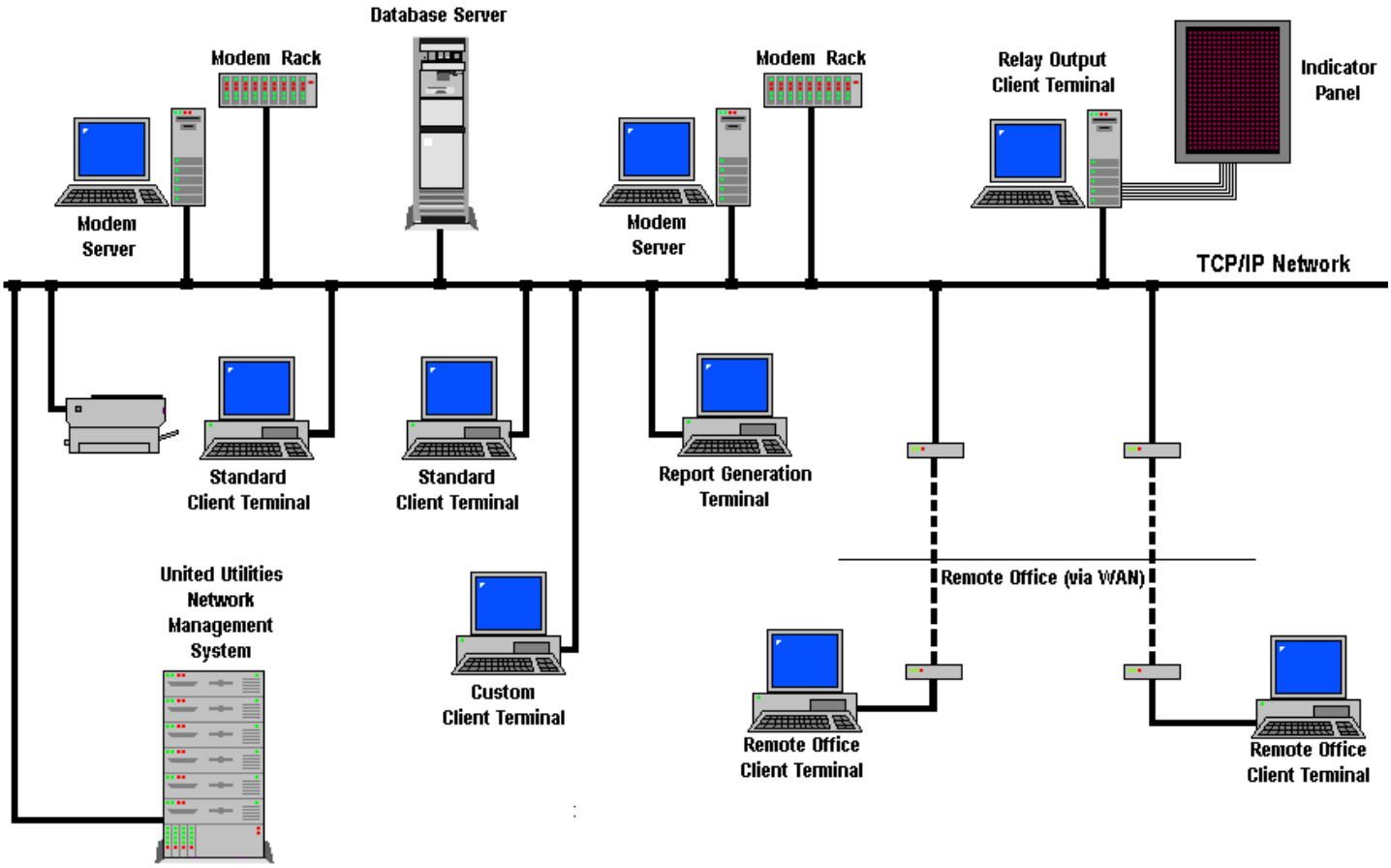
At a later stage, the system was modified again to interface to the network management system (NMS), which controlled and monitored the actual electricity supply network and also the TroubleCall system, which placed automated messages on the customer fault reporting phone lines informing callers that a fault was known about and being dealt with without operators having to be involved. Initially this interface was through file exchange, but this was eventually facilitated by SQL queries being run on the system database by the customers network management system and also the customers own report generation software run on individual terminals.

Additional benefits of the PODS system were that United Utilities were able to produce evidence when dealing with complaints from customers about quality of supply (voltages being too high or low at times, or spurious power outages occurring too frequently) and would install sensors at locations where complaints had been received to help in identifying and correcting such problems. The information gathered by the PODS system was also used in determining the schedule of when to cut trees close to overhead cables, as a report generated by the system could identify likely instances of nearby trees knocking against the lines and causing frequent yet short momentary power outages.

System Description

In brief, the system is comprised of a central database server holding the system database and there are two terminals acting as modem servers receiving calls from the POD sensors in the field. There were then 16 client terminals situated at a variety of geographical locations within the Norweb area. These consisted of the standard host terminal for those people who required full status information, the custom terminal for other positions which required details on where faults actually were, most of which were configured to just show the faults pertaining to particular areas. One client terminal was linked, via relay output cards to an indicator board in the electricity supply control room and the remaining terminals were report generation terminals, which were used on demand to produce statistical reports for internal use and for use with the watchdog authority.

The diagram below shows the main elements of the PODS system for United Utilities.



The individual elements of this system are as follows:

- **Database Server** — This is the heart of the system where all the status and historical data is stored. This was originally a low cost Sybase Server running on a Windows 98 desktop PC but was later changed to an Oracle 9 database management system running on a Windows 2000 server PC. The reason for the change was to maintain database standards with the rest of the organisation.
- **Modem Servers** — The system contains 2 modem servers to receive the calls from the POD sensors. Each server consists of the standard host terminal software installed on a Windows 2000 server PC mounted in a rack in one of the customer's server rooms controlling a rack of modems (attached via TCP/IP). There can be up to 16 modems on each server.
  Although these terminals are not used with permanent monitors or keyboards, as they are unmanned, they can be used as standard client terminals if desired.
- **Modem Racks** — The modem racks contain up to 16 modems each and are 19" rack-mounted units that are connected to the modem servers via the local area network.
- **Standard Client Terminals** — The standard client terminal software is used to provide system status and the viewing of historical event data. Some terminals are configured to view the entire system, but others are only associated with particular regions and their data is filtered accordingly.
- **Custom Client Terminals** — The custom client terminal is a software package specifically written for United Utilities that presents status information in specific ways. Its main purpose is to report HV network faults and their most likely places of occurrence as determined by status reports from individual POD sensors. Again, these terminals are used by some to show the overall system status and by other users to show only the status for those areas of interest to the user.
- **Relay Output Client Terminal** — This is a special version of the client terminal which is equipped with relay output control cards that are used to control a number of external indicators (flashing lamps and message displays). These indicators are programmed to be activated when faults are detected in specific areas or when system faults are detected (modem loss, server being offline, etc.). Relay control is now built into the standard NHDS host terminal.
- **Report Generation Terminal** — This terminal was developed specifically for the customer. The standard host terminal is capable of compiling a variety of reports, but for this system the customer had specific requirements to produce statistical reports of particular formats, both for internal use and for use by the external watchdog authority.

- **Remote Office Client Terminals** — The remote office client terminals consist of either the standard or custom client software but are installed at remote locations, connected to the system database via the customers own WAN (wide area network). The interface to the system database and the network architecture ensured that these terminals did not have significant performance disadvantages over locally connected clients.
- **Network Management System** — The customers own network management system (NMS), used to control and monitor the entire electricity distribution for the region, interfaces to the PODS system so that it can treat POD sensors in the same way as it treats its larger SCADA remote terminal units installed at primary substations. The PODS are treated as just another input and are transparent to the users of this system, so users of the NMS can benefit from the information gathered by the PODS system without referring to a second software package or having to interpret that information in a different manner.
  At first the interface between the NMS and the PODS system was made by means of file exchange, where the PODS system would periodically create files containing the current status of each PODS sensor or spreadsheets of historical event. Eventually, however, the NMS was modified to read the information directly from the PODS system database.

United Utilities are now developing their own clients in-house, with assistance from NHDS, by interfacing directly to the system database. This allows them to use their own in-house expertise to design their own system resources.