Operations and maintenance centre — delivering network services

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Network management, administration and maintenance activities have developed dramatically since the introduction of digital exchanges, with their ever-increasing capabilities for remote interrogation and control. The operations and maintenance centre (OMC) was born to exploit the exchange capabilities and fulfil the need for fast and efficient centralised administration and maintenance facilities. This paper describes and traces the development of the OMC, outlines its key role and achievements in the delivery of network services in pace with on-going requirements, and investigates the technical challenges being addressed as part of its evolutionary design.

1. Introduction

The operations and maintenance centre (OMC) has been a key component in BT's network management portfolio for over ten years and is at the heart of the network modernisation programme. It is a centralised operations and maintenance support system providing powerful facilities for the management of both local and trunk switched networks. OMC systems are deployed in nine special-purpose computer centres throughout the UK and are operated by users at ten command centres called network operations units (NOUs). Each OMC provides a single-point interface between its users (e.g. exchange maintenance staff and administrators), external systems (e.g. CSS, NTMS, CallMinder and the IN) and the PSTN network digital exchanges within its catchment area.

As well as providing ever more efficient and fast mechanisms for network administration and maintenance, the continued development of the OMC is key to enabling the reliable provision of new services and products in the shortest possible time-scales. The ability to link to various external systems, and the automation of those links where possible, are key enablers in this (see Fig 1).

Thus the OMC plays an essential part in providing BT's customers with easy service provision or modification, and ensures the subsequent reliability of those services. Within BT the OMC provides an extremely efficient means of network management on a day-to-day basis, and assists in the fast deployment of new services and features developed by other major BT development programmes.

The business benefits outlined above are possible because of the in-built capabilities of the system and the business processes used to implement frequent upgrades. These attributes may be simply expressed in terms of power, quality and flexibility, as shown in Fig 2.

The power of the OMC lies in its exploitation of advanced technology and cutting edge software, together with the provision of extensive, fast relational-database storage and communications facilities. The quality of the system is maintained by applying stringent security requirements and by ensuring reliability through fallback provision and thorough testing of all new and modified processes. The flexibility of the OMC results from its modular design and the business processes used to control and implement all upgrades. The design is such that most changes can be data driven, while careful business planning, release control, and a 'fast-track' process for urgent changes ensure that all business requirements are met in a timely manner.

2. Delivering interface capabilities

The OMC provides a single point interface between digital exchanges of the network, external systems and users that enables service provision and network management. In addition to over 24 types of OMC user, there are currently 14 external systems which utilise the facilities provided by the OMC. Figure 3 shows some of these systems in relation to the OMC.

A major benefit of the OMC is that it provides simplified and consistent 'service perspective' facilities for its users and external systems, while performing complex 'network view' control-and-monitoring functions via man/machine language (MML) communications with the digital exchanges and switches. Complex communications,

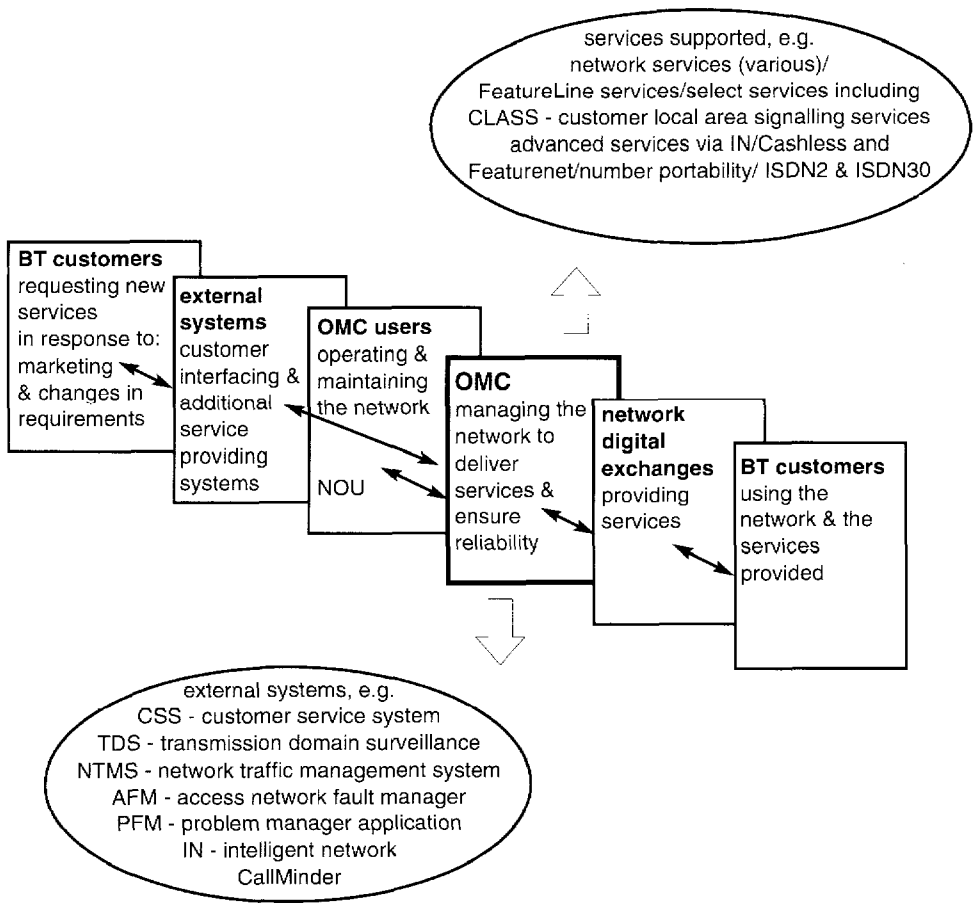

Fig 1 The OMC — delivering network services.

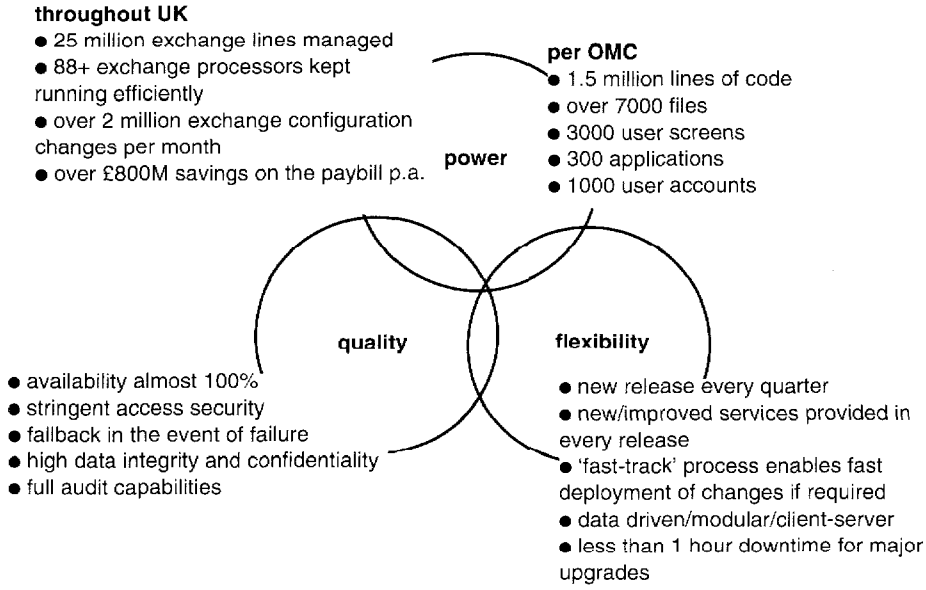

Fig 2 OMC attributes and statistics.

processing and data management functions are performed by the OMC in order to fulfil this role.

Translation processes are necessary to convert between the various exchange MMLs and the users' service views (these being independent of the exchange types and releases). The translation processes are complemented by extensive distribution and scheduling facilities. By this means the multiple interactions necessary, for example, to provide a customer with a new service such as CallMinder, can be performed 'behind the scenes' after only one initiating request from the customer service system (CSS)

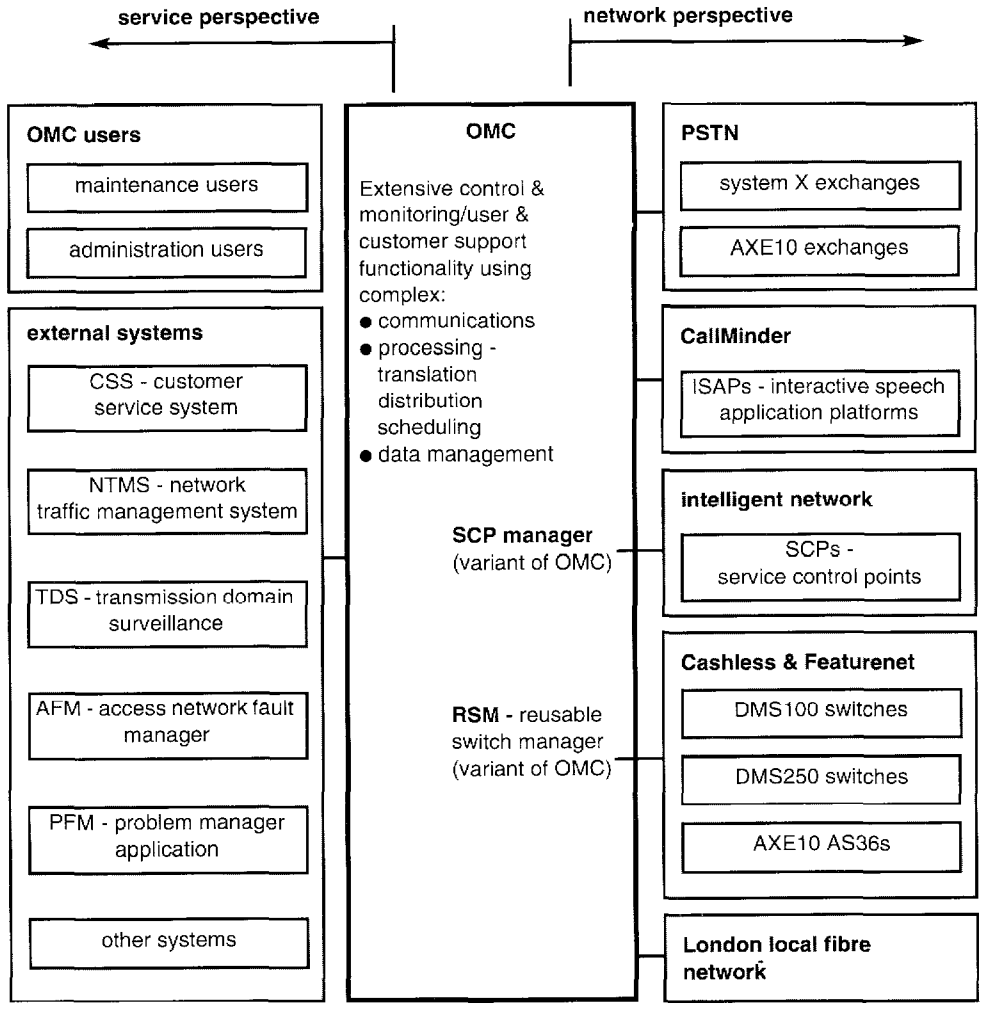

Fig 3 OMC interfaces.

or an OMC user. Requests can also be processed in batches and at off-peak periods to further improve efficiency. The operational efficiencies provided by the above interfacing functions alone repay investment in the OMC many times over.

When the OMC is required to make a new service available to customers, it is often only necessary to add or modify a translation component, the distribution and scheduling being reusable together with all the other background administration and security facilities of the OMC. Thus implementation costs, including associated user re-training, are kept to a minimum. Variants of the OMC such as the service control point (SCP) manager and reusable switch manager (RSM) [1] are further examples of the reuse of OMC components, as described later.

2.1 *Network perspective interfaces*

The OMC system supports the two major types of digital local exchange (DLE) in the UK core telephone network — System X [2, 3] and AXE10. All System X exchange variants, the AXE10 trunk (AS36), and two types of NorTel switch (DMS100 and DMS250), are also supported. The OMC also provides the following support.

- CallMinder — this is a call-answering service (formerly called NBCAS) which allows the diversion of calls when lines are busy and provides a message-taking facility via interactive speech application platforms (ISAPs) connected to trunk exchanges throughout the UK. The ISAPs are under OMC control. The OMC is required to configure both the ISAP and the exchange in order to provide the CallMinder service for a customer.

- IN — the intelligent network is an overlay configurable network above the existing network, designed to enable fast deployment of new customer services. It moves services and features, that would otherwise be provided on PSTN digital switches, on to a separate real-time computer system called the service control point (SCP). The OMC SCP manager governs deployment of new services on the SCP.

- Cashless and FeatureNet — these systems employ a variant of the OMC to manage the digital switches they use to route appropriate calls from within these overlay networks on the PSTN.

- LLFN — the London local fibre network offers to key BT customers in the London area flexible services over pre-provided optical fibre. A planned LLFN-OMC integration involves merging LLFN software on to an OMC to improve performance of the network and to enable LLFN functionality to be made available nation-wide when installed as part of a future OMC build.

2.2 *Service perspective interfaces*

The following external systems use OMC functionality for service provision and to remotely control and monitor the UK network.

- CSS — the customer service system handles customer requests for services and requires access to the OMC to implement these services in the exchanges. Currently, 70% of these transactions are automatically processed by the OMC, with a further 20% planned to be automated within the next two years. Because of the importance of the CSS-OMC link, the multi-protocol router network (MPRN) and other resilience measures have been employed to ensure its maximum availability for the automated transactions.

- NTMS — the network traffic management system is a centralised network traffic control system, based at Oswestry. The NTMS can issue a set of high-level control instructions for any number of selected PSTN exchanges in order to, for example, prevent congestion on a part of the network. It uses an automatic link with the OMC to effect these controls quickly and efficiently.

Further external systems include:

- TDS — transmission domain surveillance system,

- PMA — problem management application,

- AFM — access network fault manager.

3. Delivering solutions — system evolution

A key aspect of the success of the OMC is that it has consistently delivered solutions to meet the needs of BT's networks. The following sections demonstrate this aspect in the history, present developments of the OMC, and describe the mechanisms by which these solutions continue to be delivered in line with ever-increasing demands on technology and time-scales.

3.1 *Hardware and software evolution*

Early developments of the OMC resulted in the installation of the first 'OMC2', operating on a DEC VAX VMS platform, in 1985. It has since been continually upgraded to satisfy the need for additional processing power, to improve performance and to support the ever-increasing variety and power of digital exchanges and other external systems. Table 1 summarises the main functionality associated with each OMC2 software build from 1992 to the present day.

Table 1 Software of OMC2 software builds.

Build	Description	Date
K1	OMC2/CSS interface Tariff group charging	2/92
K2	AXE10 phase 3C	6/92
L	Migration of OMC2 SRS to the Unix platform	1/93
M	OMC2 support for FAN, maintenance reorganisation for network administration improvement plan, support for National Code Change [4]	4/93
N	Upgrade to VMS 5.5 and front-end processor replacement	7/93
O	Support for Billings 90s (elapsed time charging) Support for CLASS network services OMC security enhancements	11/93
P	OMC2-NTMS interface AXE10-DXE4 DN re-parenting	4/94
Q	OMC2 support for CLASS services Support for NBCAS Support for centrex working on System X	8/94
R	Billing 90s Phase 2 (account code services) OMC2-CSS interface enhancement Enhancement of IN services support	12/94
S	Support for ISDN DSS1 services Migration of CSS-OMC2 links to MPRN Provision of comms gateway for Cashless, FeatureNet	2/95
T	Phase 2 for FeatureLine on System X and enhancements to CLASS network services	5/95
U	Feature interworking (introduced to support marketing of network services)	8/95
V	Number portability development	
W	FeatureLine on AXE10 OMC-CSS link improvements	11/95 3/96
X	ETSI(DSS1) SCP manager phase 1	7/96

The OMC currently operates on DEC VAX computers running the VMS 5.5 operating system. They interface with a Unix Data Server (UDS) comprising a Sequent processor and hosting an Oracle database. Front-end processors (FEPs) handle external communications to the exchanges, external systems, user terminals and printers. These stand-alone processors are connected to the main VAX processors via an ethernet.

Each OMC is tailored to meet the requirements of individual installations. This is achieved via the VAX hardware options of processor power, peripherals, cluster architecture and communication interfaces. Plans are in place to upgrade to an Alpha platform in the near future,

increasing processing capacity even further to meet operational needs.

System software

OMC application software is predominantly written in the 'C' programming language and makes full use of sophisticated facilities inherent in the VAX/VMS operating system. System administration software is predominantly written in DEC/VAX DCL programming language. Database services are provided by the VAX utilities and layered products such as the ORACLE relational database management system on the UDS. Front-end software (FES) provides on-screen menus and forms for the OMC users who manage the network.

Upgrades and reuse of OMC software

The OMC is a full client/server system which is data driven such that most upgrades to the interfaces and facilities it is required to deliver can be implemented with considerable efficiency and reliability. A component-based software architecture has been implemented whereby previously discrete files have been combined into functional components that can be assembled as required for a particular application. This development has enabled the reuse of OMC system components for applications apart from the PSTN. Examples of where the OMC2 is or has been used as the basis for cost-effective development within related BT programmes include the following.

- SCP manager — this is used to control intelligent network (IN) services in response to IN service requests fed to it. The SCP manager reuses OMC functionality but uses TCP/IP LAN connections rather than the FEP.

- RSM — the reusable switch manager (RSM) utilises code from OMC2 build S in a stripped-down form and interfaces with three new types of switch, the NorTel DMS100 and DMS250, and the Ericsson AXE10 AS36 variant. RSM control of these switch types has enabled provision of the Cashless and FeatureNet services.

- LLFN-OMC integration — the integration of LLFN functionality on to an OMC will give the LLFN manager platform a standardised upgrade path for future enhancements.

- TNS — the transmission network surveillance (TNS) system was a very early reuse of the OMC and has had many components rewritten over time. The system monitors all the problems with transmission equipment in the network.

3.2 The OMC enhancement process

The speed of change sweeping the UK telecommunications market makes it impossible to give a definitive statement of requirements over a long period. The requirements up to a year ahead can be mapped out with a fairly solid baseline, enhanced with smaller developments as and when the business decides that these can be accommodated. Beyond a year, some business needs can be determined, but the growth in risk and uncertainty runs parallel to the explosive growth in competition and the increasingly rapid introduction of new and converging technologies.

Planning and delivering new releases

The OMC2 programme usually has four releases under way at any one time. Each release is typically eight months from its definition to national roll-out completion, with a new release every ten to twelve weeks!

The OMC programme has a three-year quality plan and budget (QPB) which provides the approval envelope for development, support and infrastructure. This QPB identifies major programmes of work for the OMC each year, for example, Billing 90s, Intelligent Network, Corniche, FeatureLine and CLASS. The enhancements on the programme are driven by facility requests (FRs) which specify the business opportunity or problem. These are reviewed frequently via a prioritised workstack, and all high priority FRs are referenced by a client requirements definition (CRD) for the release.

When the requested enhancements are agreed, the associated FRs are specified and designed. These, often complex, changes are carefully engineered and tested before an operational pilot can commence. To ensure BT's operations continue without any adverse impact, two in-service pilots are undertaken of each new release. If both are successful, then national roll-out commences.

Upgrade performance and continuing service provision

A key measurement of success in the provision of new OMC functionality is that the software releases have consistently been delivered to the time agreed. Service target statistics are also regularly produced to ensure performance standards are met, with additional statistics produced following each major release (see Fig 4).

Mechanisms exist to address problems quickly and efficiently. Each problem is given a unique reference number and is owned by a support engineer. A fix can be delivered to all sites by an emergency release procedure or, if that is not immediately possible, helpdesks are advised of a 'workaround' or a mandatory notice is issued.

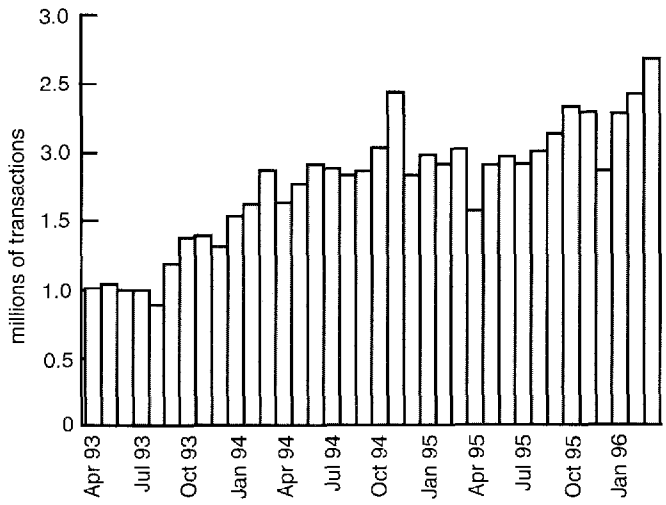

Fig 4 National OMC transactions volumes (April 1993 — March 1996).

The whole OMC programme is complemented by a support organisation to ensure effective resolution of in-service problems should they arise. This cover is provided 24 hours a day, every day of the year.

Improving the OMC infrastructure

The main emphasis of the OMC programme has been to deliver new functionality as quickly as possible to meet essential business needs. Aggressive delivery schedules have been used to meet this need, placing demands on the development, operational and user communities which they have continually met.

Since it is also important to address improving processes, working practices and the underlying quality of the core delivered products and services which comprise the OMC infrastructure, an 'OMC2 Improvement Programme' has been implemented. This is an ongoing programme of work which proactively addresses areas which cause pressure in either the development or operational areas.

Fast track

To further add flexibility to the OMC programme a small enhancements process is run called 'fast-track'. This aims at introducing new functionality on the OMC in 30, 60 or 90 days from requirement to delivery.

With the growing demand for a rapid response to requests for network management solutions [5], the OMC fast-track process makes it possible to implement new self-contained developments quickly and cost-effectively over the whole network without sacrificing the traditional high quality of engineering. This process represents a radical approach to the development and integration of network management solutions. It exploits best practices from OSS experience while allowing a rapid applications development approach to significantly reduce the time taken to deliver solutions to the market.

When an OMC fast-track RFC is approved it is because it will realise commercial benefits for BT's network operations, or a significant business advantage is to be gained by implementing the development on an in-service release. The process features a non-disruptive software life cycle commensurate with the small, but critical amount of development undertaken. Although the functionality is delivered quickly, it is important that the released software is not of a lower quality than the mainstream released software. The processes associated with the development, testing, integration and installation of BT's normal high quality of software are therefore maintained throughout the process.

A fast-track development is targeted at a mainstream OMC release but can be delivered earlier, on top of one or more in-service releases. This approach allows the OMC to treat the development as an in-service patch fix, using the infrastructure and procedures which already exist. After a fast track development is delivered to the field it is incorporated into the next mainstream release to avoid rolling it out as a separate delivery.

OMC fast-track achievements to date include the following developments:

- enhanced pure mode — whereby exchange MML can be sent to a large number of exchanges automatically,
- resources out of service (OOS) analysis — required to investigate how much equipment goes out of service each day and whether it is back in service the following day,
- improved retrieval routines for test and diagnostic procedures on digital exchanges,
- assistance in the roll-out of the CallMinder service in London via an automatic customer check,
- improved AXE10 facilities, including automatic line testing.

4. Delivering new services

With the constantly changing telecommunications market-place, the OMC needs to provide facilities appropriate to ensuring that market needs are met in the following key areas:

- customer choice — BT must be able to offer best value for money, strong brand image and the ability to provide requisite products at the required time,
- flexibility — BT must be able to respond to the increasing pace of change if it is not to miss opportunities for competitive advantage,

- quality of service — the service that customers receive from telecommunications suppliers is a key differentiator; BT quality targets require that systems support delivery against commitments, on time, every time, with all that implies for data quality and issue escalation.

Major project areas currently concerned with the delivery of services to customers include:

- CSS-OMC link — increasing automatic functionality,
- ISDN,
- CLASS,
- FeatureLine,
- intelligent network developments,
- regulatory work — for example, addressing Oftel requirements for number portability.

4.1 CSS-OMC link

CSS is the primary interface with customers for order entry and service provision, which in turn passes these on to the OMC to implement the service changes requested.

The OMC is continually evolving to provide more automated transactions for CSS. A fully-automated CSS-OMC link is being implemented in phases. Since the physical CSS-OMC link was established in 1992, developments have continued to increase its scope and functionality so that within two years the link is planned to provide automatic handling of approximately 90% of all transactions. Automatic transactions (current or planned) include:

- line provision and cessation, and start/stop of orders for single lines and PBX,
- provision of line-based features,
- temporary and restore out of service (TOS and ROS) for billing purposes,
- provision of ISDN2 and ISDN30 services,
- the provision of select services, e.g. call diversion, call barring, three party call facilities, CLASS facilities,
- addition and removal of lines for FeatureLine business groups,
- the provision of advanced services, e.g. account code and CallMinder,
- handling of customer supplied data, e.g. a call diversion number,
- support for payphones.

The scope of the CSS-OMC link is also expanding to include facilities such as:

- new network intelligence infrastructure programme — the CSS/OMC interface is to be enhanced to allow the provision of new IN services, such as Account Code, in greatly reduced time-scales,
- tactical billing OCB — this permits outgoing call barring (OCB) on those lines where payment is overdue while allowing the customer to retain incoming calls (this tactical approach increases the likelihood of retaining customers when the account is settled),
- support for new technology — this will provide automated provisioning on new network systems such as TPON, AVMUX, FAN, LA30, 1-per-customer radio and HDSL,
- advanced PSTN services — this is aimed at the business market and allows regional directory numbers (DNs) to be retained or allocated for businesses outside a region,
- feature interworking — this provides support for the marketing of network services packages containing CallMinder, call waiting, call diversion and call sign (formerly DRN) services,
- elapsed time charging,
- call management information (CMI) — this provides customers with reports on the performance of calls, such as the proportion of successful/unsuccessful calls, reasons for failure, time to answer incoming calls and most commonly dialled numbers.

4.2 OMC and ISDN services

The OMC has always played a key role in the setting up and management of ISDN services (both ISDN2 144 kbit/s via 2-wire links, and ISDN30 2 Mbit/s links via screen cable or optical fibre) for customers on the main network. These ISDN services are currently being aligned with the European Telecommunications Standards Institute (ETSI) Digital Signalling System 1 (DSS1) with the result that additional areas of OMC support are being provided. These include:

- test and diagnosis of faults — the OMC allows the initiation of line tests and the provision of subsequent fault diagnosis for all services including ISDN; additionally, a warning message is provided if the specified test will result in disruption of the customer service (tests include error-rate checking, line-controller testing for ISDN30, and cable-pair identification tone for ISDN2),

- collated fault reporting — the OMC collects fault reports relating to the ISDN services and makes them available in various presentations,
- provision and reservation of ISDN2 and ISDN30 — supported via manual or auto-allocation of equipment numbers,
- adding, altering and ceasing services — the OMC allows a new ISDN service to be allocated and an existing ISDN service to be modified or removed,
- additional supplementary services for ISDN2 including D-channel packet handling and maintenance closed-user groups.

4.3 OMC and CLASS

Customer local area signalling services (CLASS) are a range of advanced network services made possible through the development of calling line identity (CLI) facilities. CLASS forms part of the 'Select Services' marketing programme, as shown in Fig 5, and is expected to contribute significantly to BT's revenue.

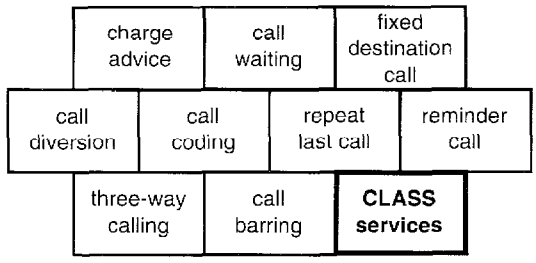

Fig 5 BT's Select Services.

By taking advantage of the ability to record CLI information, CLASS takes Select Services a step further. Customers are provided greater control over their telephone contacts — helping them to meet the requirements of a competitive business world. CLASS services are listed in Table 2.

Table 2 CLASS services.

CRN	call return
CAD	caller display
CIW	calling line identity withheld
ACR	anonymous call rejection
COT	customer originated trace
RBWF	ring back when free
RBWFI	ring back when free inhibit
PDN	presentation delivery number
DRN	call sign (formerly distinctive ringing)

The OMC plays a central role in the provision of CLASS services by providing the platform through which these services are configured on the network. Implementation of CLASS services can be achieved via manual, automatic, and bulk-driven interfaces.

The OMC also collects statistics identifying equipment and DNs capable of supporting CLI, together with an indication of spare capacity. This information is obtained from an OMC database for System X, and from the exchanges for AXE10. OMC-collected statistics can also be used to identify which DNs have specified CLASS services.

Since the initial implementation of CLASS services, development within the OMC is focused on increasing the consistency of System X and AXE10 service levels, and on providing an expanded customer base for CLASS services across other line types and interfaces. Beginning with build X, for example, CLASS services will become available to FeatureLine customers on System X exchanges.

4.4 OMC and FeatureLine services

FeatureLine is the BT product name for centrex facilities offered to small-to-medium business customers. FeatureLine provides services directly via digital exchanges, ensuring that users have access to state-of-the-art technology with each OMC upgrade. The product is supported on all System X and AXE10 exchanges, offering customers easy entry to private branch exchange (PBX) functionality without the up-front costs of a PBX switch.

FeatureLine offers a service package similar to that available on a conventional PBX, allowing up to 60 lines to be grouped together to form a cohesive business group (BG). The contributing lines in the group — or extensions — can include up to ten multi-line groups or PBX lines. All lines share a common numbering plan.

Customers within a BG can call each other by dialling a two-digit number from any other extension within the group. Each extension is also provided with a full DN which can be used to call the extension directly, from within or outside the group.

FeatureLine customers are also offered a wide menu of service options, including private network numbering, hunt-group working, and much more.

A private network numbering plan, for example, facilitates calls across a customer's BGs located across any System X exchange. Under this plan, customers dial an 'inter-site access code' — usually 8 — followed by the two-digit 'site code' of the required BG and then the extension number (see Fig 6). Calls between BGs can still be made via the public switched telephone network (PSTN) by first dialling 9 — the PSTN access code.

The OMC operates as a central point for FeatureLine development, installation and product support. The installation office (ISO) duty provides CSS with the facilities to install and support FeatureLine services. As each line is added to a FeatureLine group, all the existing

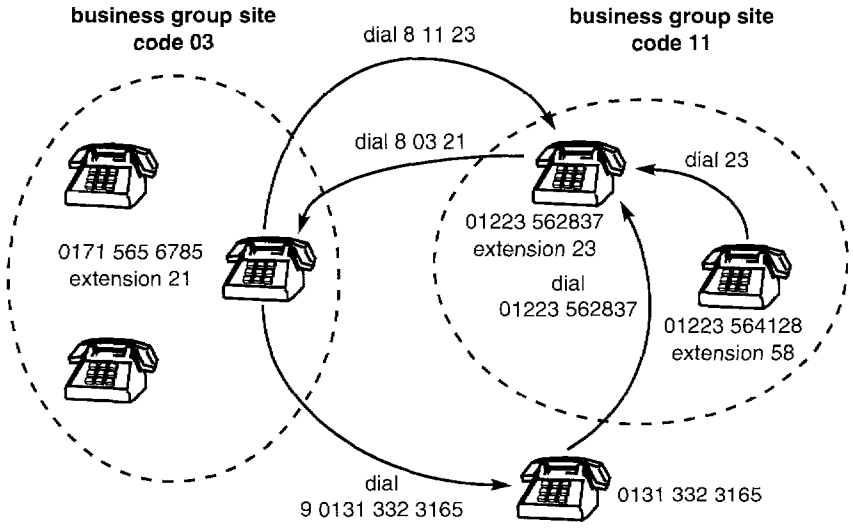

Fig 6 FeatureLine private network numbering facilities.

facilities are removed and the selected package and options applied. The OMC also provides support for feature changes for DNs and extensions, separately for individuals, BGs, and hunt groups.

Ongoing plans call for continued OMC involvement in design, implementation and testing.

4.5 OMC and IN advanced services

The intelligent network (IN) fulfils the requirement to implement any new service quickly and cost-effectively, over the whole network, without detracting from the operation of the existing network. The contributions to IN developments of the OMC and the SCP Manager, which re-uses OMC functionality, have been and continue to be extensive.

The IN forms an overlay infrastructure above the existing network that intercepts and interprets calls for advanced services and instructs the main network in their implementation. Concentrating the control of advanced services in the overlay network provides for ease of implementation and maintenance. For the most part the main network continues with its normal operations but provides the new services under intelligent control from the IN overlay.

The basis of IN operations lies in the separation of the logic of a service from the switching system (see Fig 7). IN moves the services and features running on a digital switch and places them in a separate, real-time computer system called a service control point (SCP). In the IN environment, the switch asks the SCP what treatment to give a call, and the SCP provides instructions on what is to be done, for example, to re-route the call or play an announcement. This moves the intelligence out of the exchanges, speeding up and reducing the cost of providing new services.

The digital switches have required considerable phased-in modification to allow communication with the SCPs. A switch with the capability of communicating with the SCPs is called a service switching point (SSP). SSP capability now resides within each of BT's digital main switching units (DMSUs).

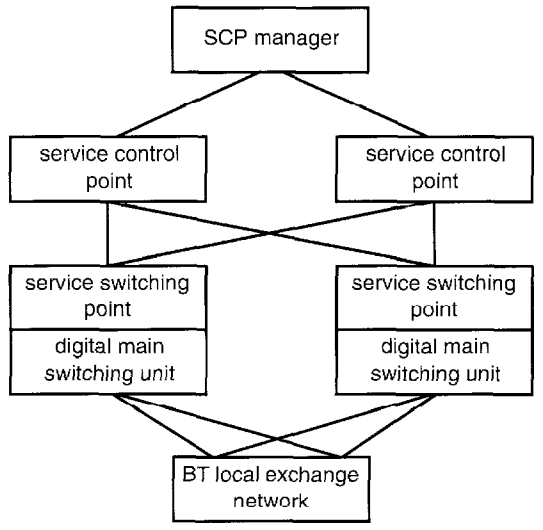

Fig 7 IN components.

The OMC and IN developments

Early groundwork for the IN included OMC-related developments in two areas which are not strictly IN services.

- The CallMinder service — this utilises an early 'intelligent peripheral' the ISAP, the development of which set the groundwork for a hardware platform that is reusable with different functionality, the SCP. Continuing ISAP development extends support to packages containing CallMinder in combination with

previously incompatible switch-based services such as call waiting and call diversion. Future transfer of call control to the IN's SCPs, will support the national launch of a full portfolio of feature interworking packages.

- The advanced PSTN (A/PSTN) — this allows businesses to maintain a local point of contact for their customers. The customer dials the local number and is re-routed, via ordinary digital exchange facilities, on to the digital derived services network (DDSN) for handling. The implementation of A/PSTN involved the configuration of BT's digital exchanges for call re-routeing and also allows re-routeing to the DMSUs with SSP capability.

The OMC SCP manager

The SCP manager is deployed as an application reusing OMC functionality and provides a platform for further support of IN services. The SCP manager supports the centralised administration of customer service data and holds a master copy of all service application data. As data is received by the SCP manager, it is posted down to each SCP, ensuring integrity across the network and preventing inconsistencies.

The SCP manager governs the deployment of new services on the SCPs, initially supporting the national roll-out of a new 'account codes' service. With this service, the customer dials an outgoing number, then enters a billing code which appears on an itemised bill along with the listed call. This allows, for example, a solicitor's office to apply outgoing phone charges to individual accounts, or a household to identify calls made by individual family members.

Associated with the SCP manager is the fast-track National Activity Management System (NAMS) which manually interfaces with CSS to extract orders, populate a bulk order interface file, and transfer this data on to the SCP manager. In future, customer data transfers will rely increasingly on automatic CSS-SCP manager links.

4.6 OMC and number portability

With the 'opening-up' of the telecommunications market, business and domestic users have been provided with a much greater choice of supplier. This development has led to an Oftel requirement that customers should be able to transfer between network operators, and retain their existing telephone number(s). BT has responded swiftly to this demand by introducing number portability, a facility allowing customers this option when transferring to an 'other licensed operator' (OLO) operating in the same locality, and to continue using that number if they return to BT. It also permits customers who transfer from an OLO service to BT to use their existing OLO telephone numbers. This allows for greater flexibility in the transfer of telephone numbers between operators, and has other advantages, including:

- the provision of a sound platform for winning new customers from OLOs, enabling the new service to be set up quickly and efficiently,
- the ability to retain a presence at an ex-BT customer's site allowing the customer to transfer back to BT with minimum disruption,
- presenting the customer with the appearance of a seamless interface between BT and OLOs when transferring service.

Further planned developments of number portability include the automatic provision of 'managed migration' via the CSS, and enabling transfers for multi-line customers and single-line PBX DNs.

5. Delivering improved support — real-time processing

Maintenance support facilities provided by the OMC contribute significantly to the efficient running of the network and consequently to customer satisfaction. Developments in this area involve real-time interactions and processing to speed the resolution of faults by streamlining fault analysis, work assignment and problem resolution [6]. Examples are:

- real-time alarm ToolKit,
- black-spot analysis tool.

5.1 Real-time alarm ToolKit

The real-time alarm ToolKit was developed to provide increased operational support for maintenance personnel using the reusable switch manager (RSM) to monitoring FeatureNet. Two fast track RFCs were implemented to provide this real-time alarm system, and following its success on the RSM and FeatureNet, an extension of its use to all OMCs is under way.

The real-time alarm ToolKit displays switch-originated FeatureNet alarms at the network operations unit (NOU). The system is provided via a PC which has access to the host RSM, and offers the following features:

- a single log-on at the PC provides direct access to the RSM and all appropriate exchanges,
- real-time alarms are listed in a scrolling window (the alarm bar) colour-coded based on priority — alarms can be expanded to give full report details,

- users can mark individual reports as 'assigned' and 'unassigned', allowing all other users to monitor current report assignments across a group of exchanges,

- new alarm information, task assignments, and clear reports are reflected back to all active PCs as they are created, in real time.

Within each RSM session, multiple windows can be opened in an enhanced transparent mode display (as shown in Fig 8). Individual screens and windows can be cut, pasted, and printed. All activity within the real-time alarm ToolKit provides direct commands to the exchange itself, bypassing forms and menus.

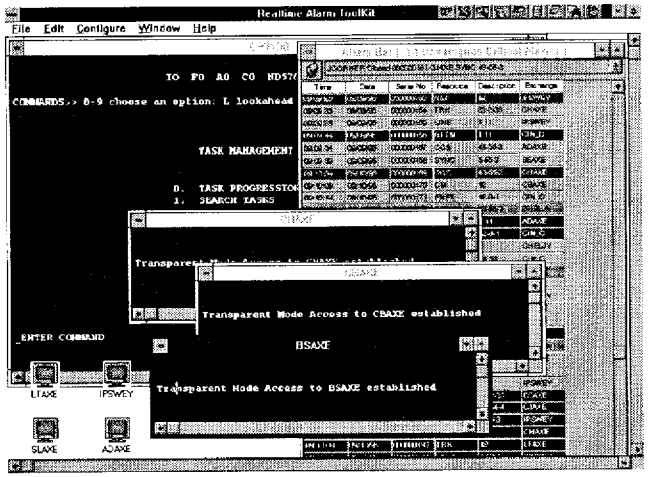

Fig 8 Real-time alarm ToolKit.

Through a single log-on, each user is assigned an individual profile of exchanges for which alarms are displayed. Users can add and delete exchanges from their list.

The alarm bar

As each user logs on, the system displays the last 1000 records for the exchanges being monitored on the alarm bar. New alarms are added to the bottom of this listing, in real time, as they are generated.

The alarms listed in this window are colour-coded as to severity — critical, major, or minor. Colour coding further defines the alarms as they are assigned and un-assigned, through use of shading. Colours are fully configurable by individual PC users, as are the fonts used. Users can also individually set whether an alarm bell will sound as new alarms are added, separately for critical, major, and minor alarms, or when the status of an alarm changes. Users also decide individually whether to show alarms assigned to users other than themselves.

The future in real time

The real-time alarm ToolKit, developed expressly for RSM FeatureNet alarms, is now being considered for use with OMC core PSTN alarms and the Cashless overlay network. The prototype software has provided a baseline understanding of requirements and features, opening the door to future benefits in BT operations and service provision:

- reduced response time,

- easily co-ordinated exchange information,

- greatly facilitated workload assignment and monitoring.

The expectation is to simplify fault analysis and consolidate work across exchanges, helping to set the groundwork for servicing projected customer levels — further strengthening BT's position in an increasingly competitive business environment.

5.2 *Black-spot analysis tool*

Another PC-based tool being developed for use with the OMC is the black-spot analysis tool (BAT). This powerful tool uses standard Microsoft packages such as Access and Visual Basic to enable automatic analysis of fault trends and the presentation of results in a wide variety of formats. Threshold levels can be set to filter unwanted information.

6. Conclusions

The OMC is a key component in BT's ongoing network development. This paper has shown how, from its early days when it 'unlocked' the potential within the then new digital exchanges for centralised management and maintenance, it has been continually upgraded to provide a most powerful and flexible tool with ever-increasing capabilities applicable both within and beyond the confines of the PSTN. The technical challenges for the future are numerous as the competition to supply more and more customer services within ever shorter time frames becomes increasingly intense. However, the OMC system, the development team, and the development processes in place to support enhancements continue to prove themselves capable for the challenge.

Since the OMC provides such a good foundation for further development it can look forward to a long life as it is used to achieve the following objectives:

- to advance BT's market position by beating the competition on services,
- to be a prime key in down-streaming Breakout,
- to automate more processes and thereby increase BT's productivity,
- to provide a reusable chassis to reduce the number of systems engineered,
- to evolve the core network towards intelligent networks.

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Andrew Dawson-Maddocks joined BT in Liverpool in 1981 as an apprentice and on successful completion of his apprenticeship in 1984 concentrated on exchange maintenance. In 1989 he graduated from Essex University, achieving a BSc in Electronic Engineering, specialising in computers, microprocessors and VLSI design. With this, he moved to BT Laboratories and joined the OMC development unit, initially involved in VV&T. In 1991 he moved into the senior technical design role on the OMC.

After returning from secondment with the intelligent network design team, in 1992 he was appointed project manager of OMC. Since 1994 he has had the programme management responsibilities for all of BT's switch management systems developments.

David Cooper joined BT in 1981 after receiving a BSc and PhD in Physics from Liverpool University. He initially worked in the design and fabrication of single mode optical fibres. This was followed by several years working on the design and fabrication of semiconductor junction lasers and optical amplifiers. He was involved in the transfer of this technology to the joint venture with DuPont (now HP). Since 1982, he has been leading teams of software engineers developing network management software for BT's network. He currently leads a unit working on the OMC software controlling BT's switches, fault localisation and testing of transmission systems.

Colin Scobie joined BT Fulcrum Communications in 1981, working on materials requirements planning and production control systems. In 1987, he moved to Ipswich to join a project implementing network management systems for the Government telephone network.

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