5 Methods of implementing number portability

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The UK telecommunication network

5.1. The UK fixed telecommunication network is composed of a number of independent networks run by a range of operators. These include:

- BT;

- Mercury;

- cable operators such as NYNEX, TeleWest and Videotron; and

- Energis, COLT and MFS.

5.2. Each of the operator's networks is composed of a number of elements. Typically the main elements are:

(a) an access network which connects the customer to a switch or exchange;

(b) the exchanges themselves which route the calls;

(c) transmission links between the exchanges; and

(d) computer support systems which manage the network, its maintenance and customer support.

BT's network is the biggest in the UK. Components include nearly 7,600 local exchanges, 63 trunk exchanges and 6 international exchanges. Currently the networks of other operators are much smaller.

5.3. These networks are interconnected so that the customers directly attached to one network can talk to customers connected to another. Each customer is allocated one or more telephone numbers.

The role of telephone numbers in network design

5.4. The telephone number is not simply a customer identifier, in the manner of a bank account number or a national insurance number. Telephone numbers fit into a carefully designed numbering scheme which has been used by the telecommunication operators as the logical key to routeing calls through their networks. The numbers are structured in such a way as to identify each of the telephone exchanges that is required in order to send a call to its destination. In most telephone networks, two functions (customer identification and call routeing) are therefore performed by a single telephone number. In the BT network, as in most networks, the telephone number is also used to create a link between network and support systems such as billing, network administration and customer service.

5.5. The operator uses the dialled telephone number in order to route a call through the network. Figure 5.1 illustrates how a typical call, made from another part of the country, would be routed across the BT network to the number 01273 345678. The caller's local exchange would recognize from the first five digits that the call was for another exchange and would send the call on to its parent trunk exchange. That exchange would examine those five digits and `look up' a table which identifies these digits as being in a certain area. The exchange would then route the call on to the trunk exchange for that area. Similarly that trunk exchange would additionally examine the next two digits, identify the particular local exchange, and route the call accordingly. Finally, the local exchange would additionally consider the last four digits, identify the called party and complete the call.

5.6. In BT's network the signal and the call proceed together across the network. If the number dialled is engaged or not equipped, a Connection Not Admitted message is returned to the originating exchange and the speech and signal paths are released. The originating exchange will then act on the Connection Not Admitted message to apply the relevant indication to the caller, eg engaged or number unobtainable tones. Provided that more than 50 per cent of all calls are successful this procedure is more efficient than the alternative process of holding the call at the originating exchange, signalling to the terminating exchange and then establishing the call path if connection can be established.

5.7. The routeing shown in Figure 5.1 will change if either the caller or the called party takes its telephone service from an operator other than BT. Such calls are known as interconnect calls, since they must pass across a point of interconnection between (at least) two networks. These points of interconnection are typically located near the BT trunk exchange.

5.8. Figure 5.2 illustrates a typical call from a BT customer to a customer of another operator. Let us assume this customer's number is 01273 876543. In this case when the call reaches the terminating BT trunk exchange it recognizes the digits 87 as belonging to an exchange of an OLO rather than BT. Consequently it routes the call across the point of interconnect to the particular OLO, which then completes the call in the normal way. The only difference is that in the networks of most new operators the local and trunk exchange functions are currently integrated into one physical unit.

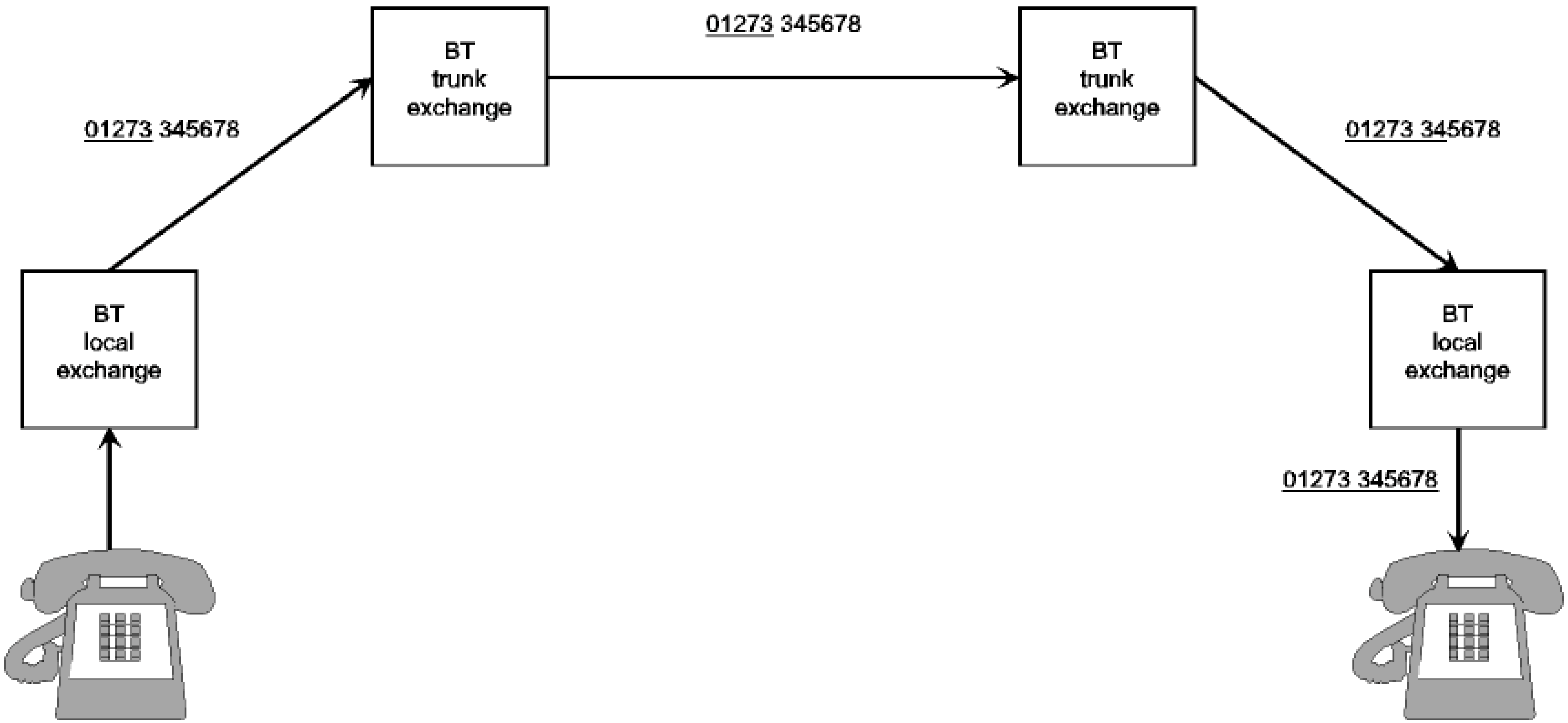
5.9. Interconnect calls necessitate a payment between the interconnecting operators. Typically it is for the operator supplying local service to the calling customer to collect the revenue for the call, and then to pass a portion of that revenue on to the other operator(s) involved in completing the call. The level of these payments will be settled by negotiation between the operators or, in the absence of agreement, following a determination by the DGT. The basic principle is that any interconnecting operator which incurs a cost in completing a call should be fully reimbursed for that cost, plus overheads, and make a reasonable rate of return. The point of interconnection is chosen by the originating operator in line with the network principles agreed between the originating and interconnecting operators.

The technical challenge of NP

5.10. NP presents technical problems to telecommunication operators. If a number has been ported then the dialled digits no longer contain all the necessary information to allow call routeing. The telephone number still correctly identifies the customer who is being called, but it no longer identifies the necessary network routeing information. In order to support NP, additional information needs to be supplied at some point during call set-up. This information must identify that the customer number is no longer identical to the network routeing number, and thus that a `number translation' needs to be performed to identify on which network, and where on that network, the customer now resides.

FIGURE 5.1

Call routeing on the BT network

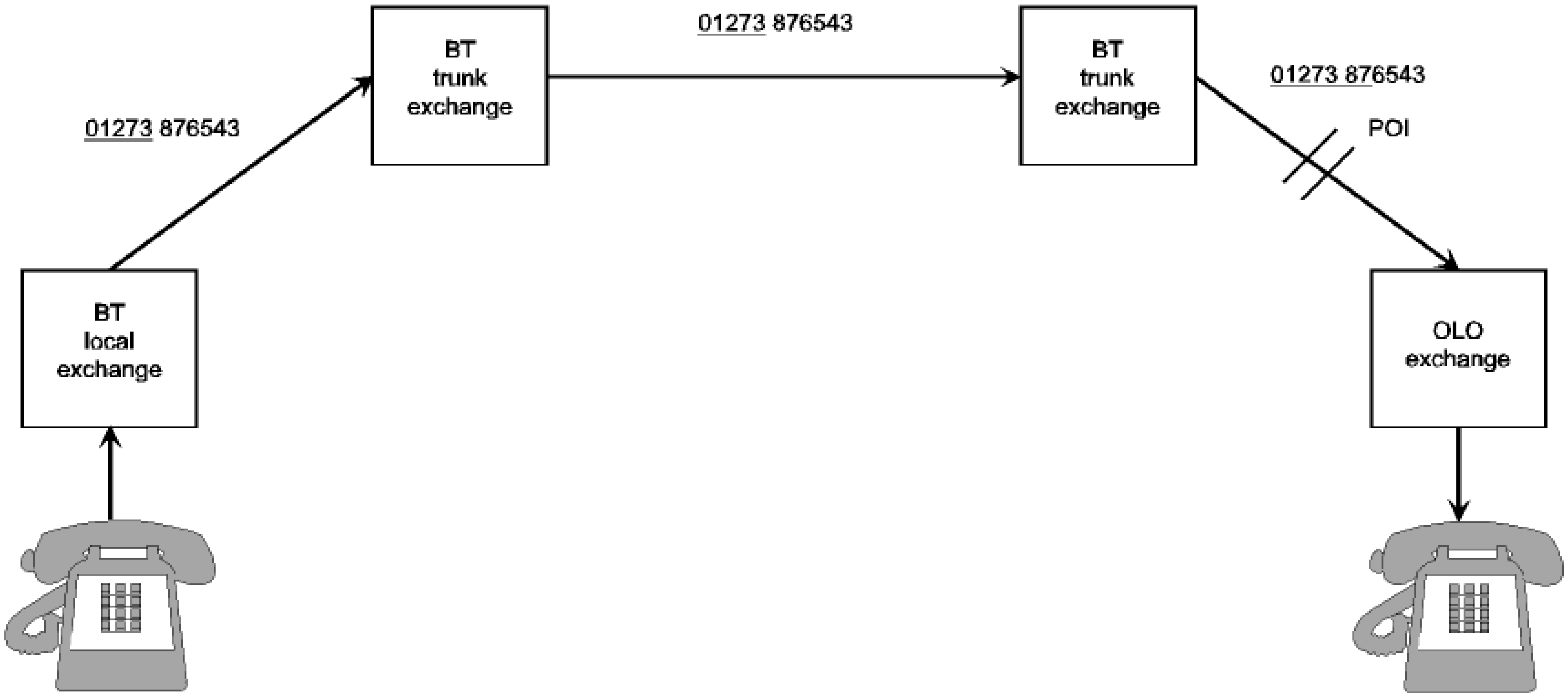


Source: BT.

Note: The underlined digits are those 'active' at each point of the call set-up.

FIGURE 5.2

Routeing of interconnect calls



Source: BT.

Notes:
1. The underlined digits are those 'active' at each point of the call set-up.
2. POI = point of interconnection.

5.11. We understand that in principle this information can be supplied, and such number translation performed, at various points during the call set-up phase. These two operations may be performed at the originating local exchange, at one of the trunk exchanges used for long-distance calls, or at the destination local exchange. Each of these cases gives rise to different technical challenges and introduces different cost elements to the network. In particular, technical solutions vary in their balance between fixed costs: costs which arise when a subscriber ports a number and thus vary with the extent of porting; and costs which are incurred by calls to all numbers, whether or not they are ported. The ability to perform the two operations at various locations depends on the technology used in the network. (Currently the BT network used for the basic switched telephone service is capable of performing number translations only at the destination local exchange. As a result, one of the key issues arising from the introduction of NP is to identify the migration path between technical solutions for NP which takes account of the complex interactions between demand, fixed costs and variable costs.)

The work of the NICC

5.12. In order to identify this optimum migration path, OFTEL submitted a functional specification for NP to the NICC in February 1994 (see paragraph 3.42). The NICC is an industry forum comprising operators and equipment manufacturers which was established by the DGT to advise him on technical matters. The DGT asked the NICC to identify both a short-term solution which could be introduced as soon as possible, and a long-term solution embracing standardized interfaces and the possible use of shared IN resources.

5.13. The NICC established a Number Portability Task Group to work on the DGT's specification. To date this task group has considered only the short-term solution, for which it issued a draft High Level Service Description in June 1994. This solution, which is called `data decode', was accepted by OFTEL and has since been trialled by BT and some of the cable companies. BT told us that it will be available for commercial service from the end of 1995.

5.14. The data decode solution essentially determines the information to support portability that should be passed between operators. It relies on an exchange within the donor operator's network inserting a prefix of the format 5xxxxx before the dialled number. This prefix has two purposes. The digit 5 indicates to the donor operator that the subsequent dialled number has been ported. The digits xxxxx then identify the precise exchange to which it has been ported. The recipient operator can then decode this information in order to complete the call in two stages. First it must use the 5xxxxx code to route the call to the right exchange. The exchange must then process the original number in local look-up tables so as to connect the call to the particular customer.

5.15. The NICC solution does not prescribe the way in which each operator inserts the 5xxxxx prefix. There are several options, each of which is compatible with the data decode solution. As far as BT is concerned, however, to avoid a fundamental change in network routeing procedures it is necessary to identify ported numbers at the destination local exchange where information about the called party resides. This can be done in either of two ways. In the first option, which is known as `tromboning', the physical call path is established as far as the destination local exchange before it is recognized that the called number has been ported. In the second option, which is known as `call drop-back', the call is set up to the donor network's destination local exchange as before. If the number is ported, the 5xxxxx prefix is signalled back to the trunk exchange, which then releases the connection to the local exchange and sets up the call using a more direct path. For all operators there is also the possibility of keeping the information on ported numbers in databases located outside the switch infrastructure. Such solutions are termed IN solutions.

5.16. Before describing these three solutions in more detail, it is worth noting that a more primitive technical solution is also available. BT could use its existing `remote call forwarding' service, which is available (at additional cost) to BT subscribers wishing to have incoming calls forwarded to another BT number, to implement NP. Indeed, the early discussions between BT and Videotron were based on a call forwarding solution. However, call forwarding has a number of limitations which make it less attractive than the data decode solution. As a consequence, and given that data decode is now technically available, the call forwarding solution is no longer being actively pursued by any of the operators.

Tromboning

5.17. In the tromboning solution the recognition of a ported number and insertion of the 5xxxxx prefix is carried out at the donor operator's terminating local exchange (ie the exchange to which the called party was connected before porting the number). This exchange then reroutes the call to its new destination. In the case of a hierarchical network infrastructure such as BT's, most calls need to be routed to the trunk exchange before being handed over to the recipient operator. For calls which have been routed in from the trunk exchange in the first place there is thus a doubling back or tromboning, creating an additional loop in the call path (see Figure 5.3[1]) which exists for the duration of the call.

5.18. The tromboning solution therefore has the effect of requiring additional capacity for most calls to ported numbers. The necessary additional resources are of three types:

- switch processing required to set up the call;

- switch capacity required for the duration of the call; and

- transmission capacity required for the duration of the call.

5.19. Whether additional capacity is required under the tromboning solution depends on the type of call made. There are three main types of call in BT's network:

(a) own exchange calls;

(b) adjacent exchange calls; and

(c) trunk exchange calls.

Figure 5.4 shows for all three types the impact of a customer switching operator with and without NP under the tromboning solution. It indicates that, while NP creates a requirement for additional transmission and switching capacity for adjacent exchange and trunk calls, only additional switching capacity is required for own exchange calls (see paragraph 6.18 for the breakdown between the three types of call). Capacity need is relieved by the fact that the ported customer makes no use of BT's access network for outgoing calls.

5.20. The tromboning situation results from the hierarchical nature of the BT network. Historically BT operated a network with four hierarchical levels. Now, following modernization, it operates at two levels. The tromboning phenomenon is less likely to affect operators other than BT in the short term, because they either have interconnection at their local exchanges or have integrated trunk/local exchanges, so the implementation of data decode on their systems will not result in the tromboning of calls. In the longer term this situation may change if operators which currently have integrated exchanges move to two tiers of exchanges. It should also be noted that Mercury's network incorporates some two-tier exchange hierarchy and may therefore have to perform tromboning of calls if it is involved in the porting of individual numbers to other operators.

Call drop-back

5.21. Call drop-back is an enhancement of the tromboning solution. As with tromboning the recognition of ported numbers and insertion of the 5xxxxx prefix is carried out at the donor operator's terminating local exchange. However, during the call set-up phase the signalling system passes this information back to the trunk exchange so that the call path to the recipient operator can be established directly from the trunk exchange. The donor operator's terminating local exchange then takes no further part in the call.

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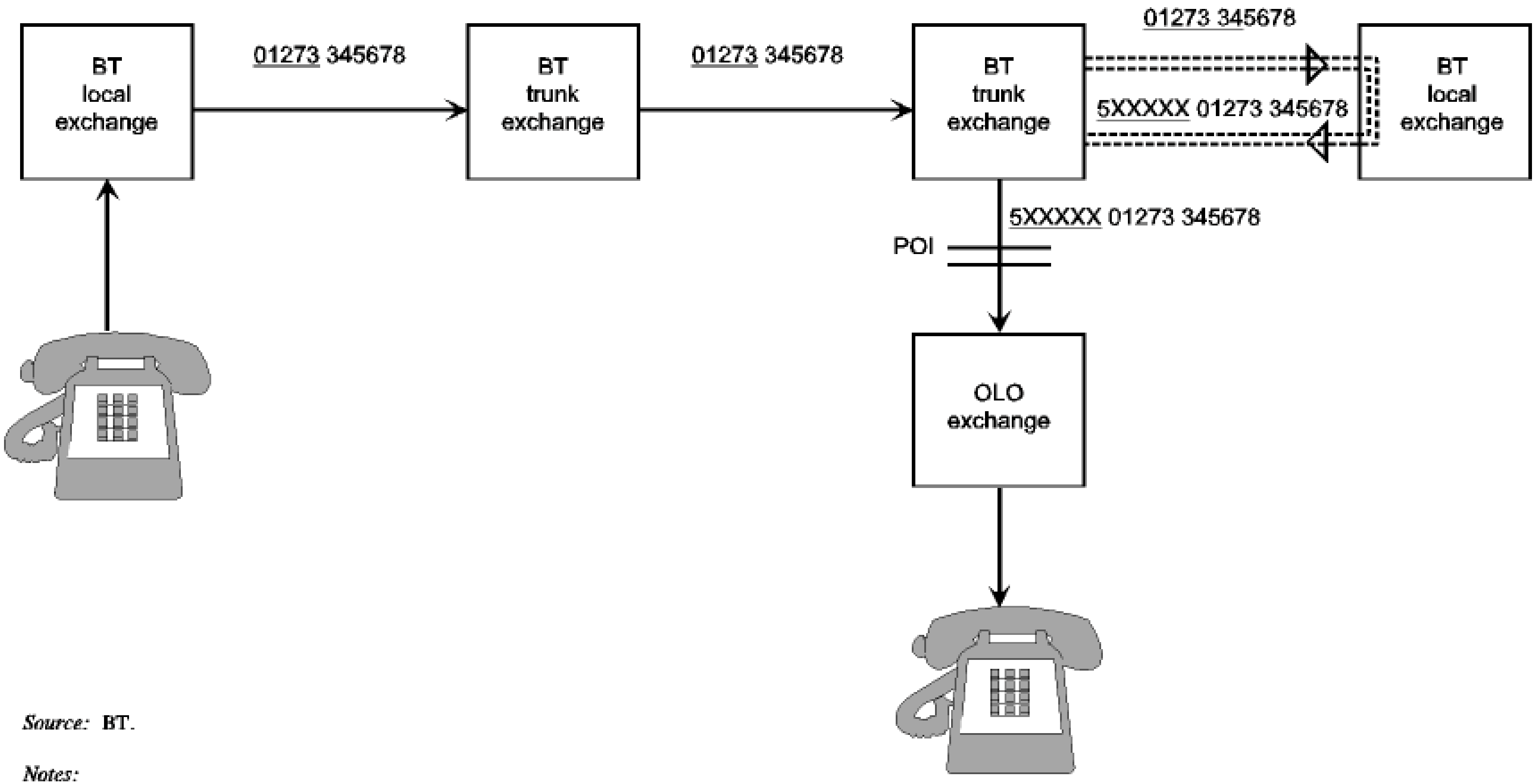
[1]Porting from the BT network is used for illustrative purposes; numbers might also be ported from other operators to BT.

FIGURE 5.3

Call path with tromboning solution



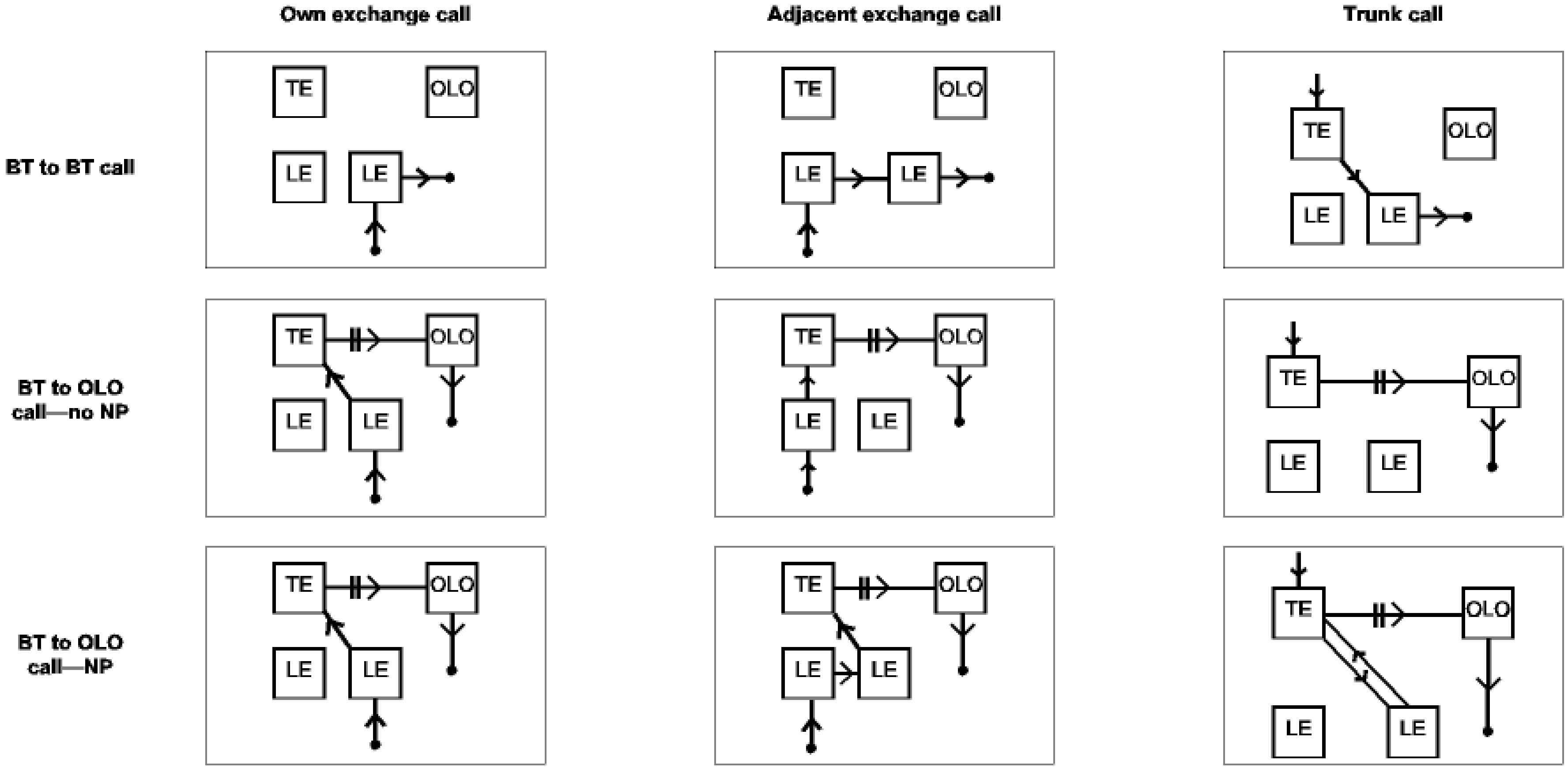
Source: BT.

Notes:

1. The underlined digits are those 'active' at each point of the call set-up.
2. The call path marked ----- is the additional conveyance compared with the direct routeing. Additional converyance applies only to calls to ported numbers.
3. POI = point of interconnection.

FIGURE 5.4

Additional capacity requirements for tromboning NP



Source: MMC.

Notes: TE = Trunk exchange. LE = Local exchange. || = Point of interconnection.

5.22. Call drop-back leads to a significant reduction in the need for additional conveyance of trunk calls but it makes little difference to the capacity requirements for own exchange and adjacent exchange calls (see Figure 5.5).

5.23. The appropriate specification for call drop-back, although available within BT's system, has not yet been implemented in BT's switch software. BT told us that it expected to be able to implement drop-back from November 1997.

5.24. Implementing call drop-back will increase costs through the design, testing and installation of additional switch software (see Chapter 6).

Intelligent networks

5.25. The distinguishing feature of IN solutions is that the information on routeing for ported numbers is held on a separate database. This database is consulted at some point during the call set-up phase and supplies the network switches with the information necessary to route the call to its destination. IN would not completely separate the number from the switches. However, it would allow the 5xxxxx code to be inserted earlier than the terminating exchange. Calls to non-ported numbers would be routed exactly as described earlier.

5.26. Strictly speaking this is a necessary but not sufficient description of IN. It is in fact possible to use number translation databases which are located separately from the switch without designing a full IN architecture. Nonetheless, it is common parlance to refer to any such logically separate database solution as an IN solution. We also adopt this terminology.

5.27. With the IN solution, it is only possible to determine whether a number is ported after making reference to the IN database. This means that a database has to be looked up for some calls to non-ported numbers as well as calls to ported numbers. The IN solution is therefore fundamentally different from the tromboning and drop-back rerouteing solutions in that it introduces additional signalling and database look-up for calls to numbers which have not been ported.

5.28. Reference to the IN database could be made at various different points during the call set-up. The main options are as follows:

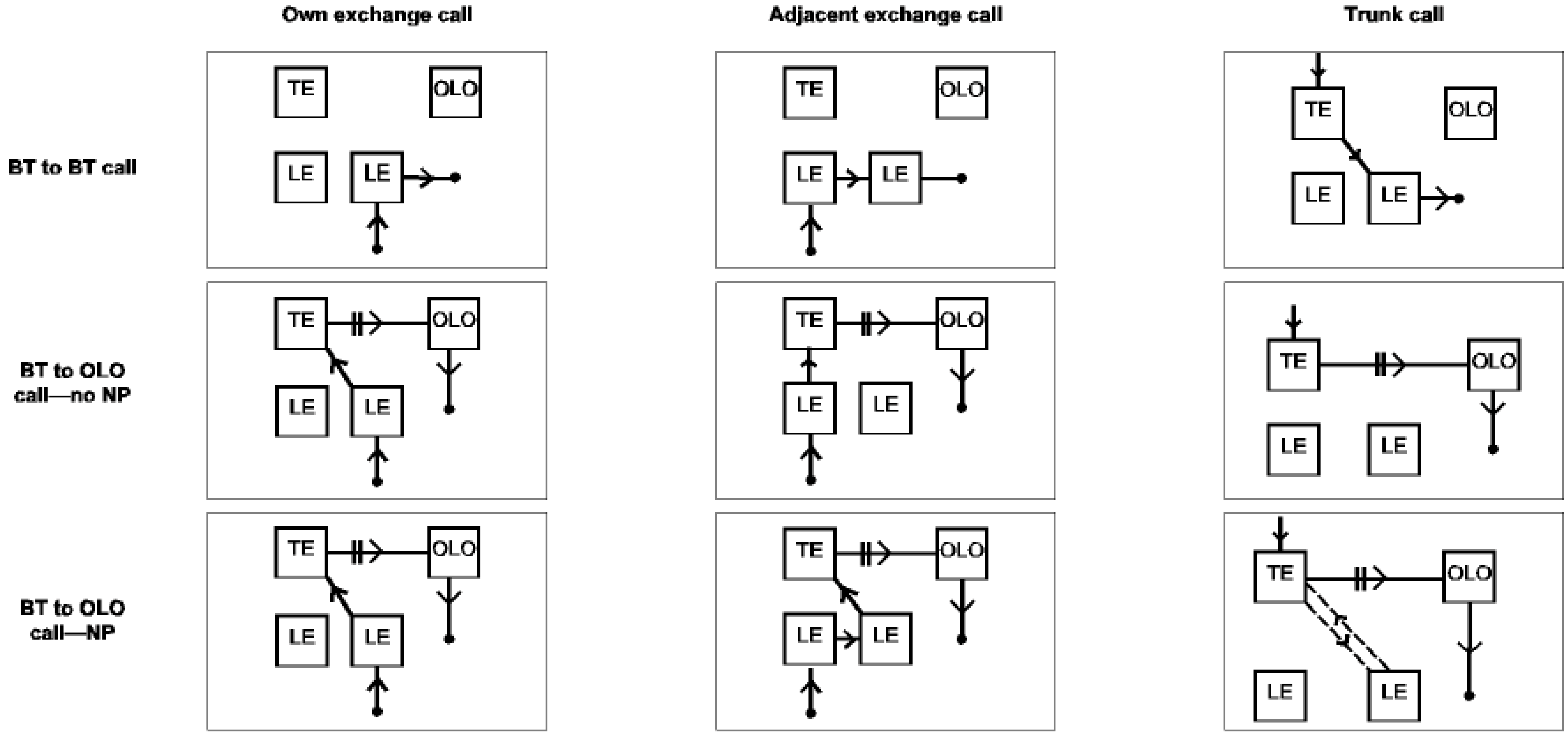
(a) The database reference could be made at the donor network's terminating local exchange. This solution would minimize the number of `wasted' database look-ups (ie those of non-ported numbers), since the terminating local exchange would only consult the IN database if it were in an area where portability was active. However, the variable costs of providing NP would remain high and the capital costs would be increased.

(b) The database reference could be made at the donor network's terminating trunk exchange. This solution would increase the need for database look-ups, but would remove the additional conveyance of calls to ported numbers. The number of database look-ups would increase because all inbound calls through the trunk exchange would have to consult the database for routeing information. Furthermore, local calls which previously did not use the trunk exchange would now need to be routed to it in order to consult the database. Once this has been done, however, calls to ported numbers could be routed directly to their destination without involving the donor network's local exchange.

(c) The database reference could be made at the originating local exchange. This solution would require all calls in the network to consult an IN database holding data on all numbers which were potentially portable. As far as NP is concerned there would be little advantage in doing this: the only benefit might be that the originating operator would be able to determine the correct terminating operator, and might therefore be able to avoid using a third party in the delivery of the call. Reference to the IN database at the original local exchange could, however, improve the efficiency of other services (eg number mobility, personal numbering) and would be a way of implementing non-geographic (eg 0800) portability.

FIGURE 5.5

Additional capacity requirements for call drop-back NP



Source: MMC.

Note: TE = Trunk exchange. LE = Local exchange. || = Point of interconnection. —— = Path established for duration of call. - - - = Path established for call set-up only.

Under *(b)* and *(c)* the terminating local exchange would still need a record that a number had been ported in order refer `own exchange' calls to the IN database. This would also provide a fall-back solution should there be any problems with IN.

5.29. IN solutions could co-exist with data decode. In this case, the IN database look-up would simply return the dialled number, plus the 5xxxxx prefix if the dialled number had been ported. The switch could then route the call in exactly the same way as for other data decode solutions. In this way it would be possible for any network operator to introduce IN solutions to NP without affecting other operators which might continue to use drop-back or tromboning solutions.

5.30. As noted in paragraph 5.28, an IN solution would require that in areas where NP was implemented all calls, rather than just calls to ported numbers, would have to consult the IN database. This might be an expensive overhead. One way round this problem would be to use a hybrid of the call drop-back and IN solutions. This might involve the originating local exchange holding the call while it sent an interrogating signal to the donor local exchange. If this interrogation indicated that the number had been ported the originating exchange would then consult the IN database, otherwise it would establish the call in the normal way.

5.31. While it is probable that all operators will incorporate some IN architecture within their networks in the next few years, it seems likely that exchanges will continue to undertake a degree of analysis of most traffic, with IN databases triggered only for services which require it, such as 0800 calls. Calls to ported numbers could potentially be handled using a database approach but at present this seems to offer little additional advantage over `switch-based' techniques such as drop-back. We have been given various estimates as to when a transition to a full IN solution might occur, but it is not expected to be for a number of years. The extent of the investment needed to implement IN makes it unlikely to be introduced primarily to provide NP, but it has other uses such as personal numbering, telemarketing and value-added services, to which NP could become an adjunct.

Migration path between technical solutions

5.32. The above solutions to the technical problems of NP form themselves into a possible migration path. This path is shown in Figure 5.6. The migration path is characterized by additional capital investment being offset at certain points by a reduction in the variable costs associated with the porting of numbers.

5.33. The transition between phases in the migration path depends both on the time-scales on which new technology can be introduced and on the volume of ported numbers. On the basis of submissions made to the MMC, a possible timetable might be as follows:

- data decode in early 1996, using tromboning where necessary;
- call drop-back replacing tromboning before the end of 1997;
- IN solutions with database reference at appropriate points in the network, potentially being introduced by 1998/99; and
- IN solutions with database reference at the originating exchange available some time after 2000.

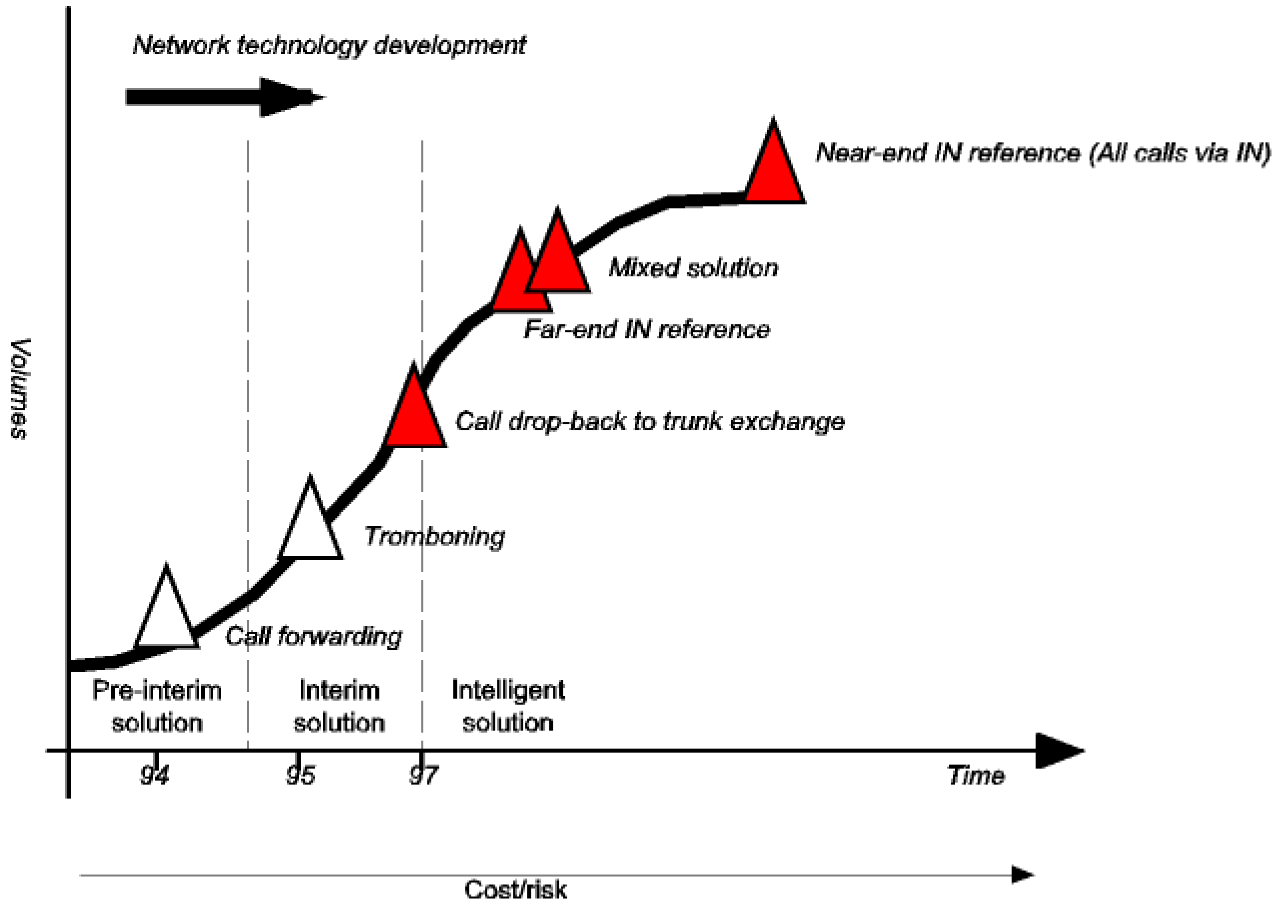
This timetable might vary from operator to operator.

Implementing different types of portability

5.34. The data decode solution has been designed specifically for the portability of a single exchange line at a fixed location. Nonetheless, both data decode and IN solutions could also be applied to other forms of portability. We understand that the relative merits of the technical options may, however, be different in these circumstances. The following points have been put to us:

FIGURE 5.6

Migration path between technical solutions for NP



Source: BT.

(a) Number block portability may be achievable, at least for complete blocks of 10,000 numbers, without the use of local exchange data decode. In this case the changes in routeing procedures could be made at the trunk exchange by reassigning the full 10,000 number block. Thus there is no need for data decode at the local exchange, and no resultant tromboning.

(b) It is only for small blocks of 10 to 1,000 numbers that data decode will be necessary. Data decode may only be justified for portability of number blocks once call drop-back is available (the porting of number blocks may generate a high volume of demand and hence a high level of the additional conveyance required by the tromboning solution).

(c) It appears that IN could provide the best approach to NP for certain non-geographic services such as freephone. These services already employ a form of IN technology, so it may make sense to use this same IN platform for the provision of NP.