The Collapsed LAN: a Solution to a Bandwidth Problem?

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When people first began to connect computers to terminals and computers to each other, it was natural that they should use for the purpose copper pairs supplied by the telephone company. By the late 1970s, copper pairs were fast becoming inadequate and modern LANs began to make their appearance. The resulting increase of bandwidth—from a few Kbits/sec to many hundreds of Kbits/sec—was a major advance. However, bandwidth requirements have continued to increase faster than they can be satisfied by improvements in LAN technology. In particular, present-day LANs come nowhere near to providing enough bandwidth to enable workstations in different part of a building to be used efficiently on the same problem.

It is possible to purchase a plug-compatible fiber link that can be interposed between a workstation or a PC—no distinction will be made between these two things—and its terminal without there being any loss of performance. By terminal we mean the display, the keyboard, and the mouse. It is to be expected that advances in fiber-optics will cause the cost of dedicated fiber links of this kind to fall significantly.

The use of such links would enable workstations to be withdrawn from offices and relocated in a central equipment room, each workstation remaining connected to its terminal in a user's office. The workstation would also retain its connection to a conventional LAN. For an earlier mention of the proposal, see reference 1.

In addition to workstations, a practical computer system will include servers, specifically: print servers, file servers, database servers, and communication servers. Print servers are essentially workstations connected to a printer and these workstations would be withdrawn into the central room along with the others; the printers would remain where they were. File servers and database servers would be withdrawn as a whole into the central room. Communication servers, through which connections are made to wide area networks including the telephone system, would similarly be withdrawn, and the central room would become the one place at which all incoming long-distance links would be terminated.

When all the workstations and servers had been relocated, all the nodes on the LAN would be inside the central equipment room and the entire LAN could therefore be wholly confined to that room. This is the *collapsed* LAN referred to in the title of this

note.

The process of relocation may be thought of as taking place in real time as illustrated diagrammatically in figures 1 to 3. Fig. 1 shows users with workstations located conventionally in their offices and connected to a LAN, in this case, an Ethernet. In Fig. 2 the workstations are in process of being withdrawn from the offices to the central room, the Ethernet going with them. The terminals remain in the offices, but remain connected to the workstations by fibers which become progressively longer as the workstations continue on their journey. In Fig. 3 the workstations have all reached the central room where they are located on shelves. The Ethernet has now become collapsed. The users are back at work and do not notice any difference in the feel of their terminals.

Once the LAN is confined to one room, along with the workstations and servers, its design is no longer constrained by the need for it to extend over the whole building. Indeed, a collapsed LAN need not be a LAN at all in the conventional sense, but could be a bus. The potential bandwidth of a collapsed LAN of this form would exceed anything that could be obtained from a conventional LAN. Similarly the packaging of the equipment could be reconsidered. Instead of the fully-packaged workstations resting on shelves as shown in Fig. 3, the workstations could take the form of boards mounted in racks with a centralized power-supply.

For reasons of upward compatibility, it would be convenient to retain the same interface, as seen by the systems programmer, to a collapsed LAN as to a regular LAN. However, if a bus were used instead of a conventional LAN, some new interface might be more appropriate. In any case, the high reliability of a bus would make it possible to relax the error control discipline and so improve performance.

Other peripherals and attachments

In addition to the main items constituting the terminal, namely the display, the keyboard, and the mouse, a workstation commonly has connected to it a miscellaneous collection of peripherals and attachments. Examples are printers, CD-ROM drives, microphones, and loudspeakers. Most such devices require a connection of relatively modest bandwidth.

It would be possible to design the main fiber link so as to provide, in addition to the channels required for the terminal, a number of channels of suitable bandwidth to cater for the above devices . However, for the present, it would perhaps be better to provide separate connections, using whatever form of transmission appeared to be appropriate. In many cases, a copper pair would be sufficient.

Lower Performance Systems

If the cost of the dedicated links could be sufficiently reduced, a centralized system of the type described here would also be attractive in circumstances in which performance

is not the prime consideration. Offices would be quieter on account of the removal of the workstations with their attendant fans. Centralization would facilitate maintenance and enable a significant reduction to be made in the number of occasions on which members of the maintenance staff would need to visit a user's office.

It would also be possible to make economies, in some cases significant, in the air-conditioning of the offices. This would offset any higher cost that there might be in installing dedicated fibers instead of a regular LAN.

Collapsed Distributed System

We have remarked that a collapsed LAN can be more like a bus than a conventional LAN, and can have a correspondingly higher performance. We should perhaps speak of a *collapsed distributed system,* or a *collapsed cluster,* rather than simply of a collapsed LAN.

Our primary purpose in writing this note was to point out the potential advantages that a collapsed system might have over a conventional system. However, some readers may be attracted by the architectural developments that become posible with a collapsed distributed system.

Given a sufficiently large number of workstations—with perhaps some kind of very fast non-blocking switch replacing the LAN or bus—it would be possible to design a configuration that could be used either as a conventional cluster of workstations, or as a highly-parallel super-computer. The possibility of dual use in this way might have the effect of improving the economic viability of highly parallel systems.

There are other applications of interconnected computers which could profit from all the computers being brought together in one room. However, we will not follow this line of thought in detail, but simply point out that a collapsed system provides the designer with a variety of opportunities to apply his ingenuity

Conclusion

We are aware that the user community in general is not yet ready for a return to a centralized system, and would in particular require to be reassured on the question of reliability. It is certainly true that nothing could be more reliable than a copper connection between a terminal on a user's desk and a workstation on the same desk. However, if the user has need to use a shared file server or access external networks, at present he must go through a LAN. We have no doubt that the reliability of a dedicated fiber link would in practice greatly exceed that of a LAN. Moreover, since there would be no contention, the performance of the link would be entirely predictable.

We are also aware that, at the present time, the high cost of the fiber links is an obstacle to the implementation of a collapsed distributed system, even if the advantages of doing so are fully admitted. However, we believe that, in the relatively short term, costs will

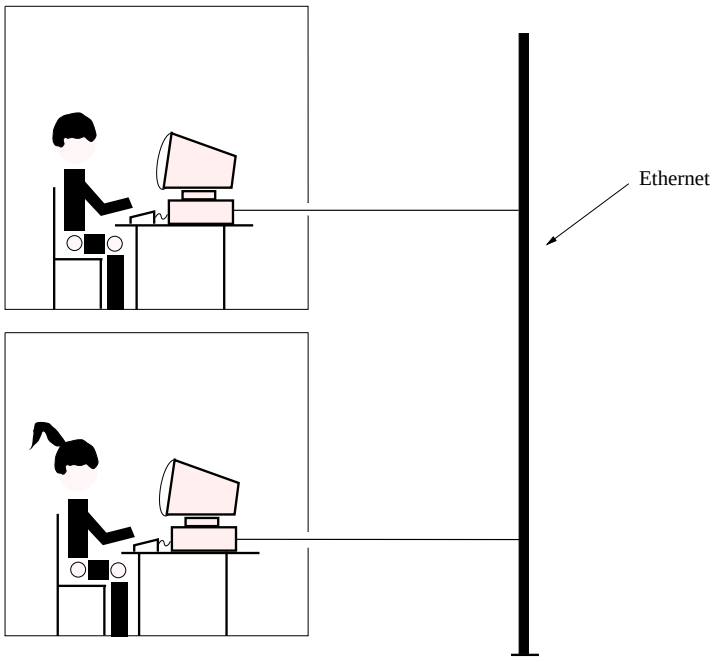

Figure 1: Conventional arrangement with workstations in offices

fall sufficiently for this obstacle to become less formidable. If this happens, then we suggest that putting personal computers and workstations in a central room, with a collapsed LAN, may become the preferred arrangement in most situations.

Reference

1. Wilkes, M.V., 'Computers Then and Now - Part 2' *Proc. ACM Computer Science Conference,* February 1996.

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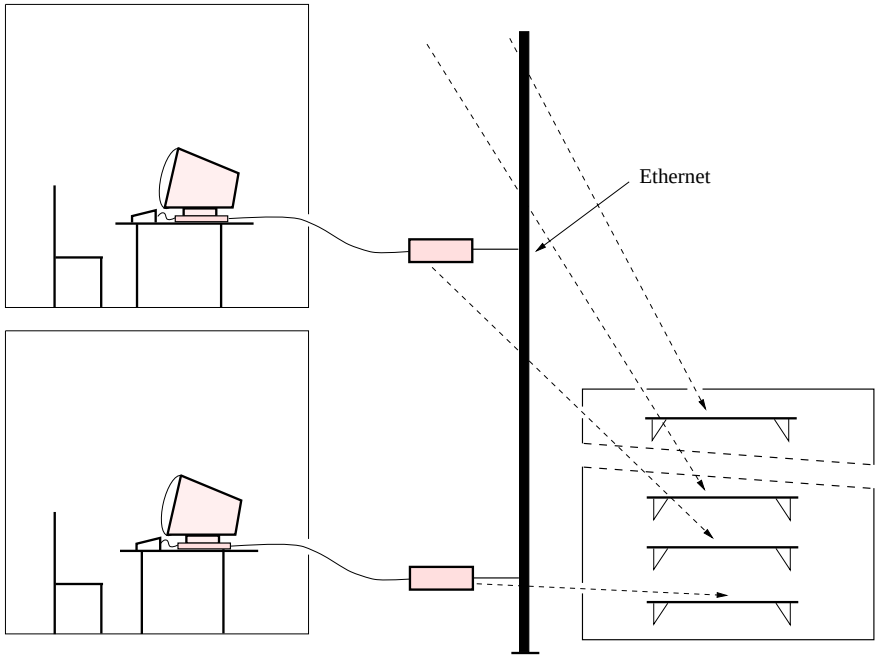

Figure 2: Workstations on their way to a central room

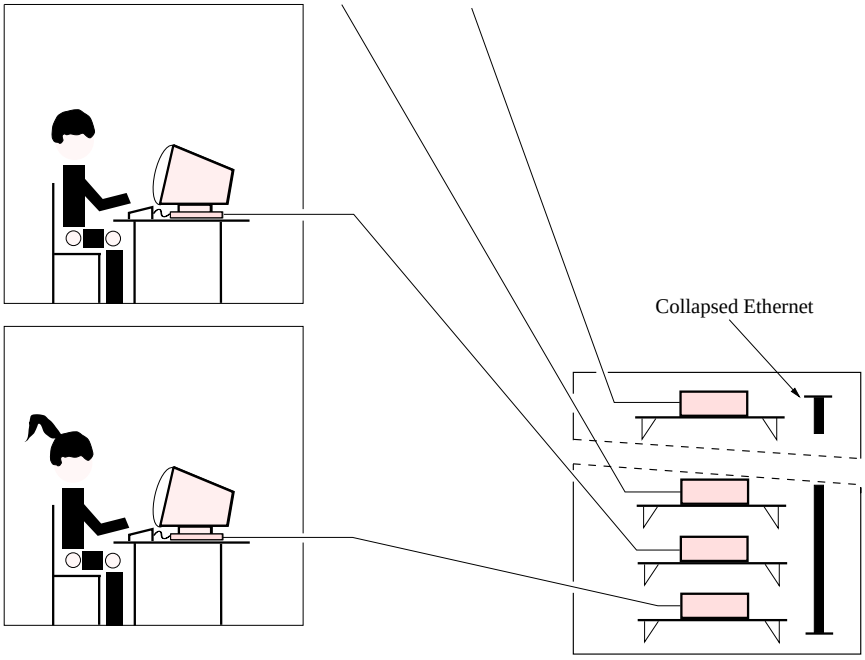

Figure 3: The new arrangement, showing the collapsed Ethernet