Expansion of UEA LAN Facilities .
Discussion Document.

Frank Charles, May 12, 1988

Contents

1. Existing Facilities.

The main network facilties already installed are :-

1.1 Micom data switches.

The CPC switch provides asynchronous access to a number of hosts, DEC Ethernet and to a second switch in SYS. Terminal login to host features are provided plus the ability to :-

1.1.1. Use a file transfer package, for example Kermit, to transfer data files between a host and a micro PC machine at a maximum speed of 9600bps.

1.1.2. The data switch can connect any two authorised lines together. For example, a connection is setup by replying: Lnnn to the Micom prompt. Data can then be passed between any two co-operating connections.

1.2 DECnet.
DEC's Ethernet connects the main CPC VAXs and their peripheral servers. There is also is a single link, via a repeater, into CSA with DEC terminal servers only attached to it.

1.3 X25.
Triple-X packet switching using terminals connected to PADs in departments linked to a GEC CPSE switch in CPC provides access to CPC hosts, WAN facilities and Cambridge and Manchester access. FTP facilities between hosts is also provided.

1.4 Other LANs.
Some departments have local LAN connections eg CSA have Apple's Mac Localtalk and Sun LANs with Ethernet. CSA also have some PCs linked with PCnet (IBMs early 2 Mhz CATV network). Torch Econet systems are also installed in one or two departments.

2. Network Expansion and Standards.

Extending the existing network of 700 Micom connections, 24 X25 links and enhancing the 10Mhz Ethernet to other buildings can readily be done. However, this will not fully satisfy all requirements in the future. The selection and variety of LANs is vast, from small, cheap intelligent contention switches for sharing printers, communicatons lines and providing file transfer facilities eg (Newbridge Main Street) to high speed networks working to the 100Mhz FDDI (Fibre Distributed Data Interface) standard.

There is a wide choice of :-

a. standards: eg OSI, CCITT, IEEE, ANSI, Industry, propriety etc.

b. media access methods (MACs): eg CSMA/CD, Token, TDM, FDDI, QPSX.

c. topologies: eg ring, buss, star, etc.

d. signalling schemes: eg baseband, broadband.

e. media: eg coaxial, twisted pair, fibre optic.

Many of the ISO/CCITT OSI standards are not yet firm or implemented so most equipment purchased at the present time will only comply in part to OSI standards. For example many products will meet the Ethernet IEEE 802.3 (DIS 8802/3) standard (although there is variation in the degree of conformance with older implementations eg DECnet), but this standard only deals with part of the link and physical levels. It does not cover the whole of level 2 of the ISO model eg (IEEE 802.2) local link control class 1 (LLC1) and class 2 (LLC2) for respectively a connectionless and connection orientated service (cons). Also manufacturers are likely to add propriety facilities to that specified by the standard so that certain features are not available in a mixed equipment environment to permit a really open network. e.g. IBM's token protocol has about double the number of MAC level commands compared to the 802.5 spec (Data Comms Jan 86).
Since the higher levels are not fully realised yet the incompatibilities are worse at these levels. Propriety protocols are used eg Decnet, NFS, TCP/IP. It is clear therefore that any LAN standards adopted now will be a compromise which could mean that in the future, use of a chosen LAN standard may become restricted or possibly extended through Gateways, Bridges and Routers or at worst will have to be discarded which is costly in both equipment, learning, installation and support effort.

X25 packet switching standards are similarly effected with the emerging OSI standards changing the established coloured book (CBS) protocols. Although the changes are not as marked so that the problem is mainly of scale in changing the installed network.

3. User Requirements for early 1990.

The main perceived requirements are:-

3.1. Mail

3.2. Closed User Groups, eg PC LANs, Appletalk or Ether segments.

3.3. Distributed File Systems , for eg graphics, file and print servers.

3.4. 4M Workstations.

3.1. Mail.

Grey book mail is the current Universities standard. It will eventually be replaced by an CCITT X400 MHS service.

3.2. Closed user Groups (Work Groups).

For example Appletalk for MACs (also now available for PCs) or Z-net for RM machines, offer cheap network links which could be readily discarded once appropiate equivalent standards emerge. Gateways to common services are also offered. Alternatively small contention switches may be used to serve a few users.

3.3. Distributed File Systems (DFS).

Some users will need PC or Sun Work stations close coupled to a file server or distributed file file system. There are a several competing non-ISO standards that provide this service and will be used in the absence of the ISO FTAM standard. The three popular DFS protocols are RFS (Remote File sharing by AT&T), NFS (Network File System by SUN but now in the public domain) and SMB (Server Message Block originally for PC IBM networks). NFS and RFS are similar but RFS is tied to UNIX whilst NFS is claimed to be operating system independent.

Other examples, using a Vax, for additional PC file space are DECnetDOS and RAF (remote access facility). For PC use this may be either at serial line speeds 9600bps or via an Ethernet connection for those users that need the extra speed.

3.4 4M Workstations .

A demand for high performance 4M workstations (1 Mips processing power, 1 Mbyte of main memory, 1 Mpixels screen, 1 Mbits I/O), will probably arise. These will use, typically, Ethernet for the transfer of data and graphical images over a LAN. A vision of the future (Kundig,RNDA, p27 EUTECO 88) suggests that beyond the year 2000 human interaction will demand 4G Workstations ! For example, for browsing of high quality picture documents. Future workstations could therefore put a heavy traffic load on a LAN.

4. LAN Performance Requirements.

PC and terminal connections currently operate at a maximum speed of 9600bps with the majority of links working at 2400 bps. 9600 bps is used mainly for FTP or graphics.

Ring or bus LANs use much faster bit rates from say 100Khz to a few Mhz for the cheaper end of the market, to 10Mhz and upward of 100Mhz for the high performance networks. There is ample performance capability if it is really required and can be justified.

For sometime to come the majority of users will probably only require modest speeds (up to 9600bps) but plans should embody expansion capabilties to higher speeds where it is required and is funded.

5. Future Medium Access Methods (MAC) and Network Technologies.

5.1. Contention Circuit Switches.

Contention switches, like the Micom, still have a role for they have the advantage of simplicity and data transparency. They are also suitable for connecting small clusters of machines into a network to enable file interchange and access to shared services. Suppliers (like Newbridge referred to above) are increasing the intelligence of this type of network with

additional software in both the PC and the switch. Although there are no standards for this type of small network they are cheap, reliable, easy to install and operate.

5.2. X25 Packet Switching.

X25 services and speed could be improved. High speed super PADs (Netcom) and X25 switches are available as are EtherPADs (spiderGATE). Lack of high performance host interfaces limits this approach. Also the network reliability is dependent upon one or two central switches. A single fault in a large switch can bring the whole network down. Embodying a standby facility is not easy.

However, by the 1990's a new breed of third generation high performance packet switches is expected to be available capable of switching millions of packets per second (Endrizzi, Research into Networks & Dist. Appl. (RNDA) EUTECO 88). When compared compared with our existing switch of 200 pks/s the new switches will radically change network performance.

5.3. PABX switching.

The University's Plessey ISDX telephone exchange is really a digital exchange with analogue interfaces to the telephone extensions. Digital interfaces can easily be installed to provide 2x64khz digital interfaces plus a signalling channel or 1-voice channel and 1-data channel over a 144Kbps (2B+D channels) interface. The data channels may be used at any speed up to 64kbps ie kilostream speed. It could provide a convenient way of providing data links to departments that do not have multi-pair cables into to CPC and do not need many circuits. If 16 or 32 circuits are installed into the Plessey exchange at one time the cost are comparable to single line driver/modem installations.

To date it has been the policy of most institutions to keep telephone and data traffic seperate. The eventual arrival of B-ISDN (multiple 43Mhz broadband integrated digital services) should change this when data, voice and video will be carried on the same network channel. However, it will be some years before this will be available.

5.4. Ethernet.

Ethernet appears an obvious choice for it is already installed, is an established OSI standard and can transfer data at a speed in excess of most users present needs. However, there are problems in selecting appropriate higher level protocols. Also experience of other sites indicates that large Ethernets can become unreliable and expensive to support (with complex test equipment and effort). Also security is of concern.

An Ethernet backbone with bridges to segments in departments could be installed. This would provide segment partitioning. Ethernet is vulnerable to faults. It does not normally have a standby facility to cover fault events. Also its

speed will probably be insufficient for some future applications with the newer ranges of machines.

5.5. Fibre Optics.

A fibre optic backbone would give a much higher performance capability. One example of an established product using its own protocol is the Proteon80 80 Mhz backbone. It uses token ring technology with gateways to Ethernet.

A non propriety backbone could be based upon the emerging Fibre Distributed Data Interface (FDDI) 100Mhz WAN (to 100 Km) ANSI X3T9.5 standard with bridges or Brouters to Ethernet. Its protocol is derived from the IEEE 802.5 IBM token ring. FDDI is currently held up by the choice of service connector (Hard or soft) ! Meanwhile some propriety products and chip sets are becoming available.

FDDI-1 has adopted current network techniques eg token ring and facilities have been added as the standard progressed to deal with Isochronous information eg voice and video leading to FDDI-2. The FDDI-2 standard looks like becoming a popular backbone technique for voice and data in the long term. It also has embodied ideas to improve its reliability eg a spare normally unused path to cater for fault events. It uses the slower multi-mode fibres (with a distance limit of 2 Km between stations) and not the mono-mode low loss, high performance fibres (capable of a 30 Km distance).

Another fibre technique of interest, that has recently been approved as a Metropolitan Area Network (MAN) (< 50Km) standard, is the IEEE 802.6 Queued Packet Synchronous Xchange (QPSX) protocol. It is based upon newer (unproven ideas) but looks to have a greater potential in the long term. it also uses a dual bus with a distributed queue system that makes congestion control and faults easier to deal with without involving complex rules and logic to control the network.

5.6. Pink Book.

The JNT/NE have agreed a protocol which with selected ISO DIS 8802/3 options and DIS 8802/2 LLC class 2 enhancements allows X25 protocols to run over Ethernet. It is believed that this is seen as a method of readily applying open standards to Ethernet operation and there are moves to have the pink book adopted as an international standard. Some hosts can now support the pink book (Vaxs) and special purpose PADs (SpiderPAD, Camtec EtherPAD) are used for terminal access. It does not appear to be as effective as DECnet since terminal users still have the full Triple-X packet protocol overhead and complexity with its mode restrictions. Whether the ISO Virtual Terminal (VT) protocol will have options for simple terminal use is uncertain. With the already installed DECnet base for terminal access via the Micom data switch providing an efficient service there is no strong motive for using Pink book apart from the incentive of JNT/NE funding. Money is

available for the purchase of Pink book host, PAD and associated Ethernet products.

6. Protocols.

Most manufacturers use some form of 7-layer protocol model. These are generally incompatible between manufacturers and bridges and gateways are used to couple networks supporting the differing proocols. The ISO effort towards OSI protocols has been to produce standards working from the lowest levels (physical connection) first and eventually covering the whole model. There are also subdivisions within each layer which have to be agreed. Therefore it will be several years before the standards are agreed and are in place.

IBM has influenced standards with the IEEE 802.5 Token ring standard and then with PC protocols. Initially with its NETBIOS standard (originally Systek) then later with SMB (see section on DFS, section 3.3). NETBIOS operates at the session level (level 4/5) and allows applications programs to set up links and send messages without need of a knowledge of the underlying network. Many network suppliers offer NETBIOS compatibility. However, with the introduction of the PS/2 machine this protocol is due to be dropped since its throughput is limited.

7. Security.

The ISO standard for network security will take some years to emerge. Bridges gateways and routers can help. Encryption devices (like Scicons 'Safeword VAX-Safe') would improve Ethernet security where it is needed for sensitive user IDs .

8. Conclusions and Recommendations.

The University's goal should be to install a high performance optical fibre backbone with links to other LAN technologies. However, since standards are still developing there is a choice of actions. These need further study before a firm recommendation can be made. The main choices are for a backbone are :-

1. Ethernet.

An extension of the installed Ethernet with bridges isolating segments to provide an interim backbone of medium performance. This could then be upgraded when the standards issues are settled.

2. High Speed Fibre Optics.

At the present time FDDI would be the first choice for 100Mhz MAC level operation since products are becoming available for this open standard. For example, an Ethernet to FDDI Learning Bridge is already available (from Fibronics for $3200).

However, QPSX could gather momentum since it is favoured by the US telephone companies and it may in the long term become the dominant protocol.

For PCs and Macs a variety of LAN technologies is bound to exist for economic reasons and will provide reasonable performance for small work groups. Those that need improved performance can move to IEEE 802.3 Ethernet or possibly IEEE 802.5 Token ring since both are open standards but they will still need to use propriety higher level protocols.
Propriety and industry protocols will be used for the higher levels for sometime to come. Gateways should help resolve some of the incompatibilities until open standards become established.

Figure 1. shows how the University's backbone LAN network may develop. It embodies a backbone with bridges to Ethernet (using coaxial standards or fibre optic segments) or Token ring or other LAN topologies. Further work is required to determine the paths and gateways that should be established first.
Also since some departments now have several 32 channel multiplexors, consideration is required to see how these complement or are integrated into the overall LAN scheme.

Appendix 1. LAN selection Check list .

1.Parameters for choosing a LAN (not in order of importance).

1.1. Speed
1.2. Cost

1.3. Reliability
1.4. Number of nodes
1.5. Type of communication medium,eg copper,fibre
1.6. Security requirments
1.7. topology eg ring, ring buss etc.
1.8. Facilities
1.9. Expansion capabilities
1.10.Conformance to standards
1.11.Compatibility with other networks
1.12.Suppliers development program
1.13.Ease of use,learning, management and maintenance

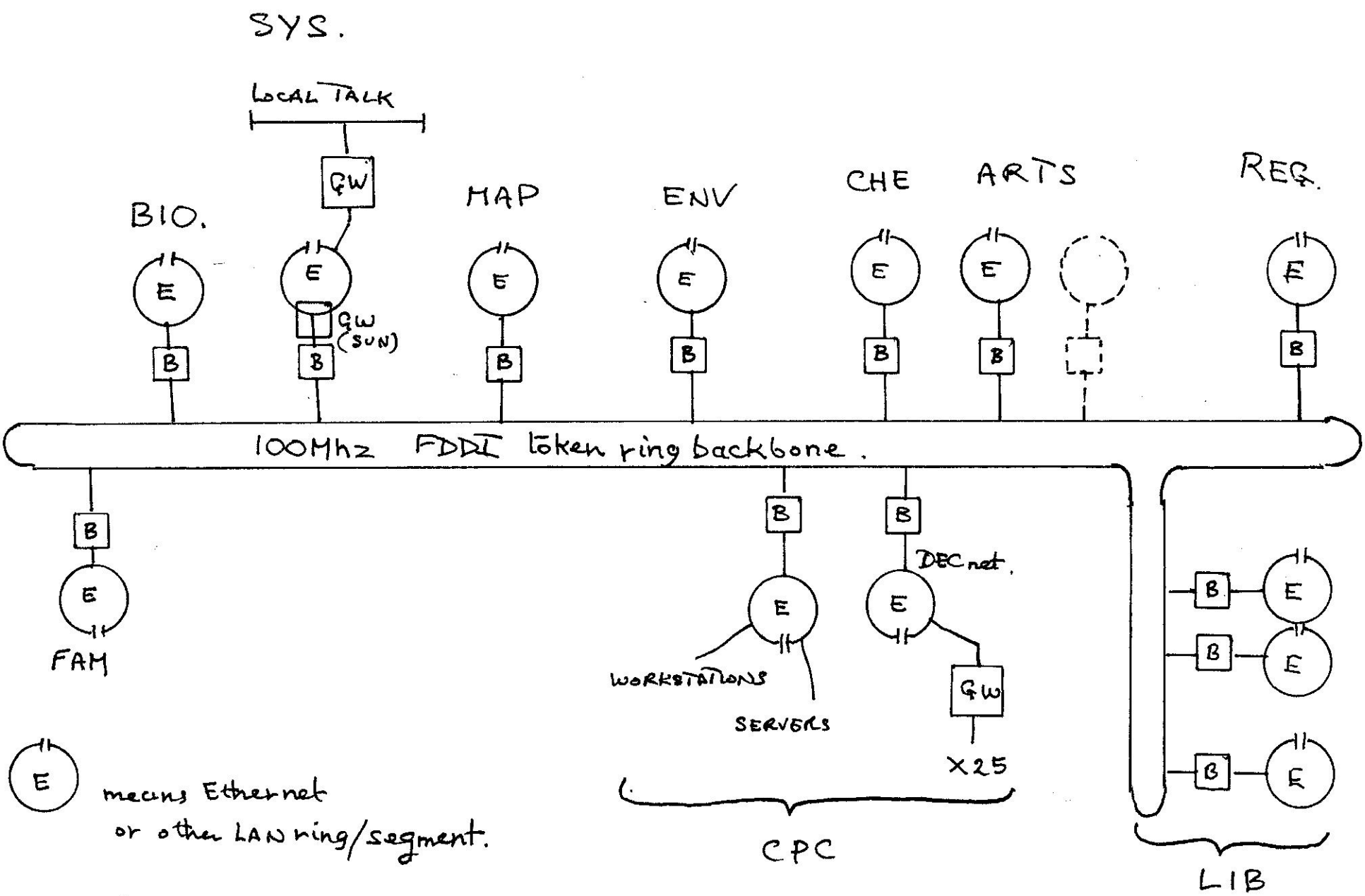

Fig 1 – Schematic of UEA LAN BACKBONE.

Frank Chambers
11.5.88.