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SECOND WORKSHOP ON TELEMATICS

6 - 24 November 1989

Cambridge HSLAN's and Real-time Multimedia Applications

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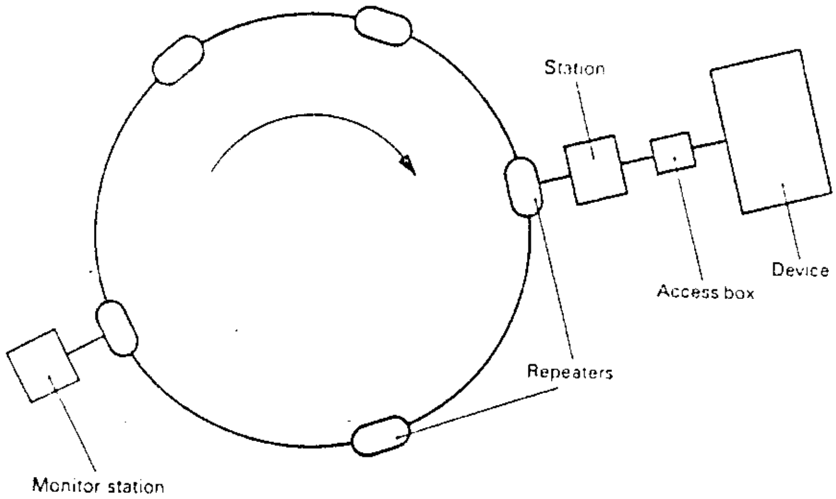
History — The Cambridge Ring

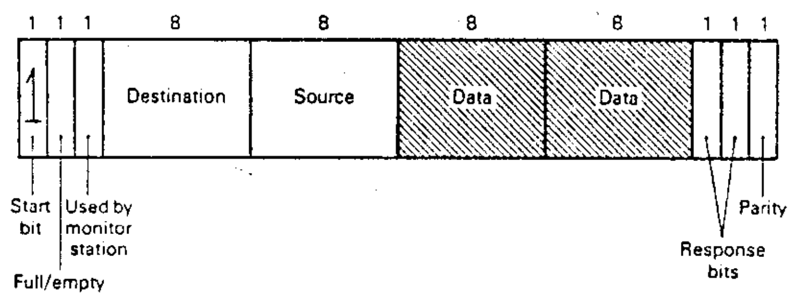
- **History of ring network**
  - Token ring by Farmer and Newhall (1969)
  - Slotted ring by Pierce (1971)
  - Register insertion ring by Hafner (1974)

- **The Cambridge Ring**
  - Prototype at Cambridge University Computer Laboratory using SSI and MSI TTL (1975)
  - Integrated version, Hopper (1983)
  - 10 Mbits/s, slotted ring
  - Main objectives: computer networking & resource sharing

Cambridge Ring Structure



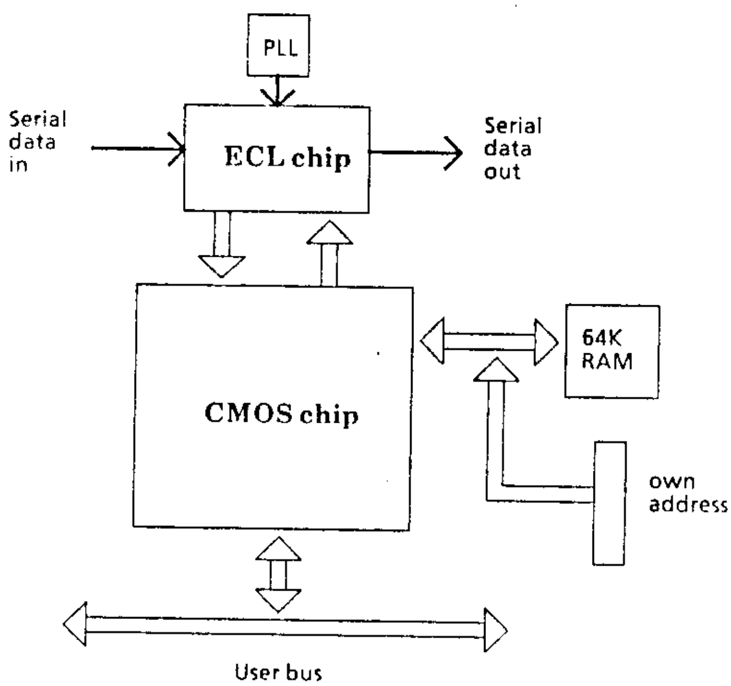
Cambridge Ring Minipacket Format



The Cambridge Fast Ring

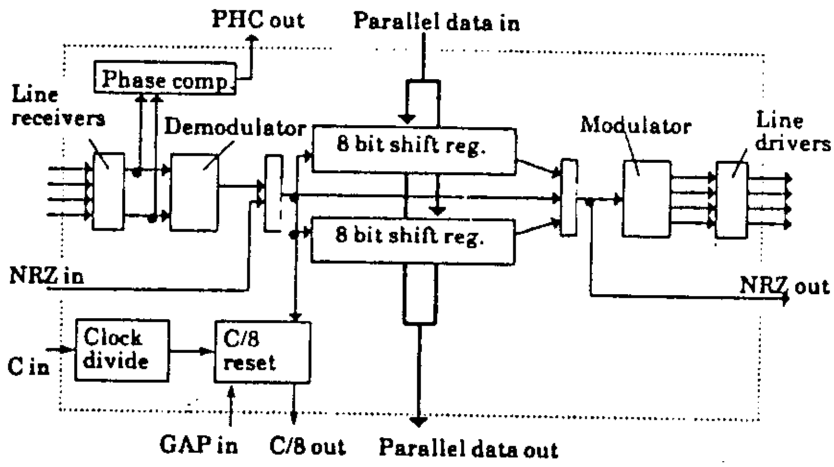
- **Main features**
  - 10 – 100 Mbits/s
  - Source-release pass-on-free slotted ring
  - link: twisted pair or optical fibre
  - 32 bytes data field
  - 1983 — circuit design
  - 1984 — VLSI design, 1986 — operational

CFR Node Structure

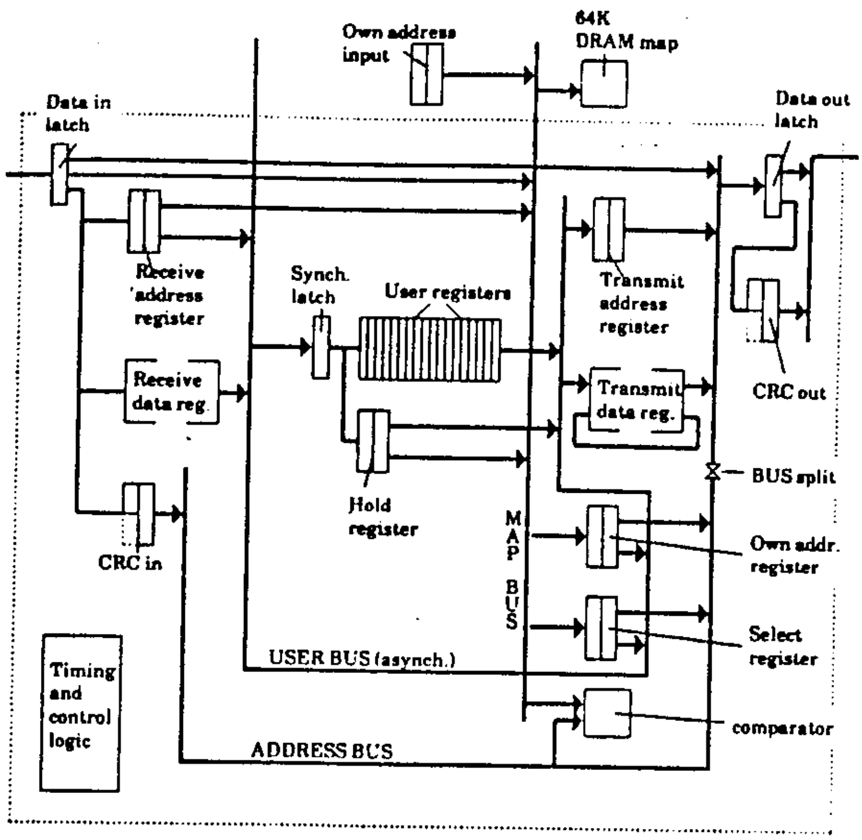


CFR Packet Format

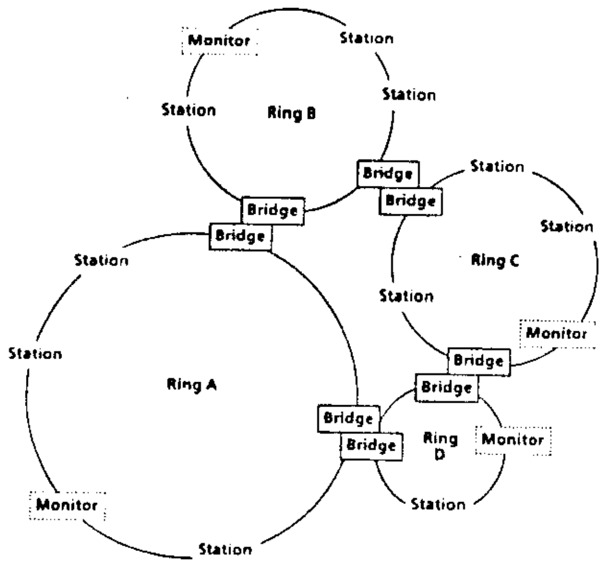
ECL Repeater Chip



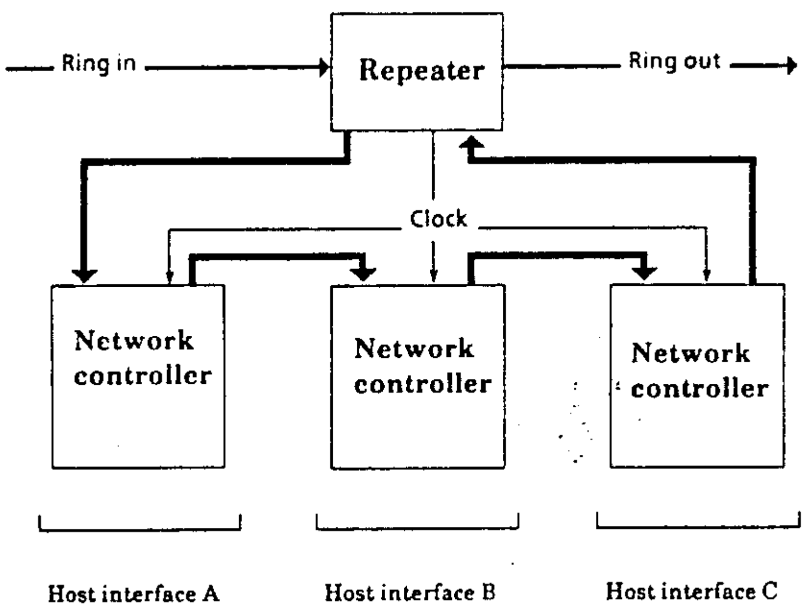
CMOS Network Controller Chip



CFR Network Architecture

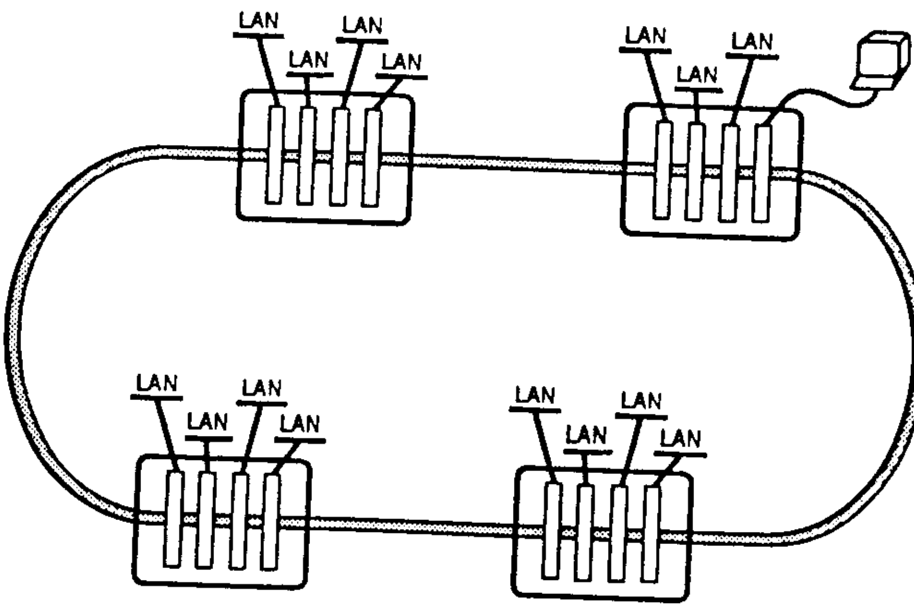


CFR Station Cluster



CFR Application

- **Olivetti MetroBridge**
  - CFR as backbone network
  - Protocol transparent bridge for Ethernet LANs
  - Up to 15 LANs
  - Bridge node: PC format LAN card & transputer-based *bridge engine*
  - Adaptive filtering and routing algorithm



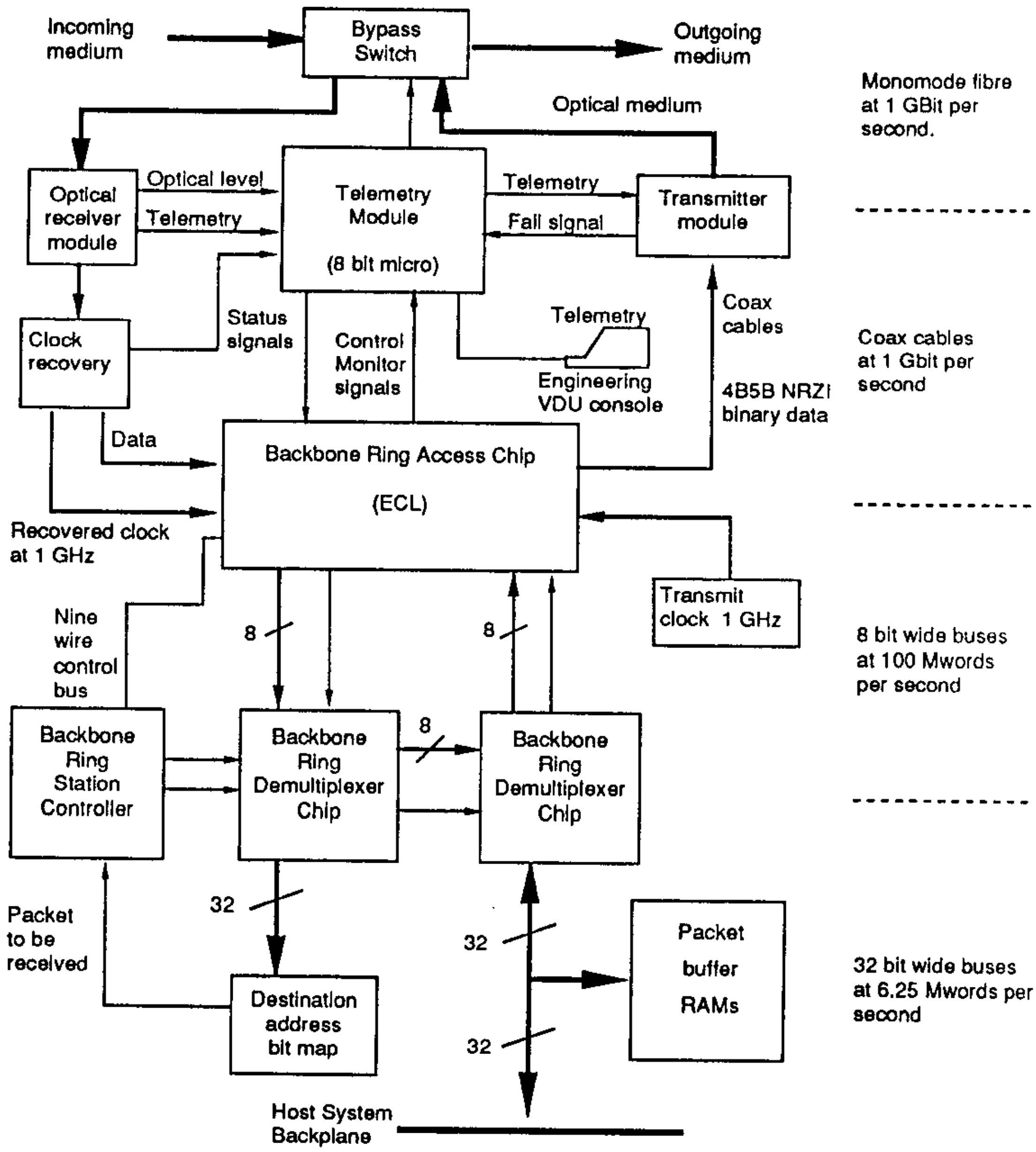
The Cambridge Backbone Ring

- **Main features**
  - Ongoing project, Greaves (1989)
  - Fibre optic ring
  - 500 Mbits/s – 1 Gbits/s
  - CFR compatibility
  - Real-time traffic capability
  - Metropolitan area network
  - Backbone network

- **Frame structure**

Header (4)	Full Monitor Type (4+4+4)	Four CFR size mini-packets, each contains nine 32 bit words including the routing fields. ($4 \times 9 \times 32 = 1152$ bits)	Response and Qualifier (4+4)	CRC (12)

CBR Station Structure



Multimedia Information and Message Systems

- **DARPA**
  - Diamond
  - The ISI multimedia mail system
  - CCWS
- **Xerox PARC**
  - Etherphone
- **Bellcore**
  - MICE
  - Telesophy
  - RAP

- **MIT**
- **MINOS**
- **Sydis SIM**
- **Cambridge**
- **Janpan**
- **Others**

Audio & Video Services on LANs

- Video services without data compression

Video Service	Bit Rate
Videophone 256 pixels x 256 lines, 8 bits quantization Frame rate: 25 Hz	12 Mbps
Standard Colour Television CCIR 4:2:2 digital coding Format: 625/50/2:1 Resolution: 110,000 pixels	432 Mbps
High Definition Television Eureka 95 proposal Format: 1125/60/2:1 Resolution: 440,000 pixels	1.7 Gbps

- Video Services with data compression

Video Service	Bit Rate With Compression
Low grade videophone	64 Kbps
Videophone	384 Kbps
High grade videophone	2 Mbps
Television	30 Mbps
High definition television	140 Mbps

- **First generation image coding techniques**

Method	Compression Ratio	Comments
Zero Memory Methods PCM; Pseudorandom Noise Quantization; Interlace.	1:1 — 2.5:1	Simple to implement
Predictive Coding DM; DPCM, Interframe, Intraframe; ADPCM, Interframe, Intraframe; Conditional Replenishment.	2.5:1 — 4:1	These methods are generally simple to implement, are sensitive to data statistics. Adaptive techniques improves performance substantially. Channel error effects are cumulative and severely degrade image quality.
Transform Coding Fast Transformations; Intraframe, Adaptive; Interframe, Adaptive.	5:1 — 15:1	These methods achieve high performance with low sensitivity to fluctuation in data statistics. Channel and quantization errors distributed over the image block. Hardware complexity is high.
Hybrid Coding and Others DCT/DPCM; Subband Coding / Vector Quantization; Intraframe, Adaptive; Interframe, Adaptive.	4:1 — 10:1	Hybrid coding combines the advantage of transform coding and predictive coding. Complexity lies between the two types. Subband coding achieve good performance with less complex hardware.

- **Second generation image coding techniques**

Method	Compression Ratio	Comments
Pyramidal Coding	10:1	This combines features of transform and predictive coding methods. Its hierarchical structure uses functions close to those of human visual system. It has elegant capabilities for progressive transmission or reconstruction.
Anisotropic Nonstationary Predictive Coding	35:1	This method also uses the properties of the human visual system to achieve high compressions.
Regional Growing Based Coding	70:1	This contour-texture oriented technique segments the image into textured regions surrounded by contours. Contour and texture are then coded separately. In this method contour is extracted by regional growing method.
Directional Decomposition Based Coding	70:1	This is another contour-texture oriented technique. Edge detection technique is used.

- **Voice coding standards**

CCITT Recommendation	Coding Technique	Bit Rate (Kbps)	Bandwidth (Hz)	Audio Quality	Application
G.711	PCM	64	300–3400	Toll	Telephony
G.721	ADPCM	32	300–3400	Toll	Telephony
G.722	SB-ADPCM	64/56/48	50–7000	High Fidelity	Telephony Conference

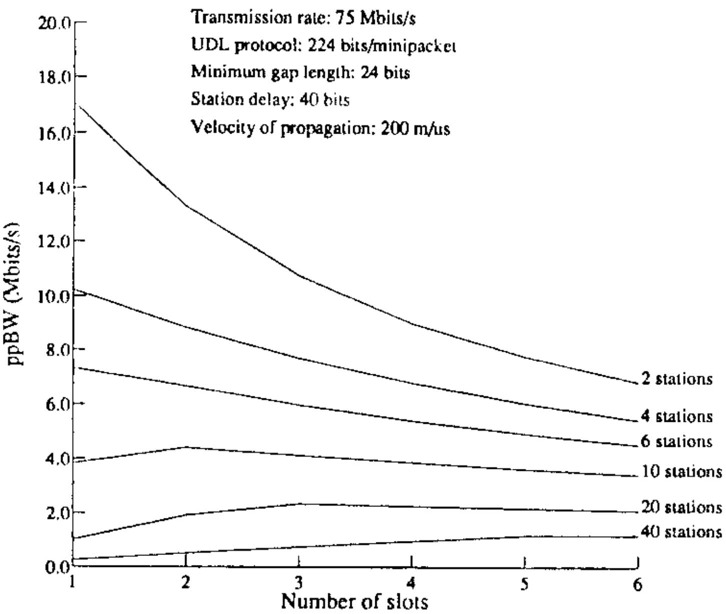
- **Audio services**

Audio Service	Bit Rate (Kbps)
Audio library (LPC)	2.4
Voice mail (ADPCM, PCM)	32–64
Telephone (ADPCM, PCM)	32–64
High grade telephone (SB-ADPCM)	48–64
Hi-fi audio broadcast (DPCM)	160–480

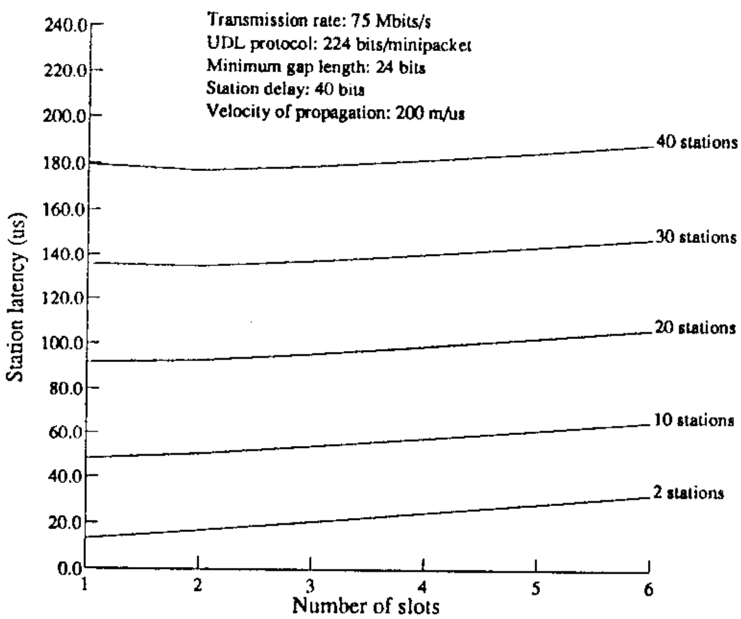
- **Real-time service data transmission modes**
  - isochronous
  - synchronous
  - asynchronous

- **HSLANs for real-time services**
  - FDDI
  - CFR/CBN
  - METROCORE
  - LION
  - DQDB(SONET)

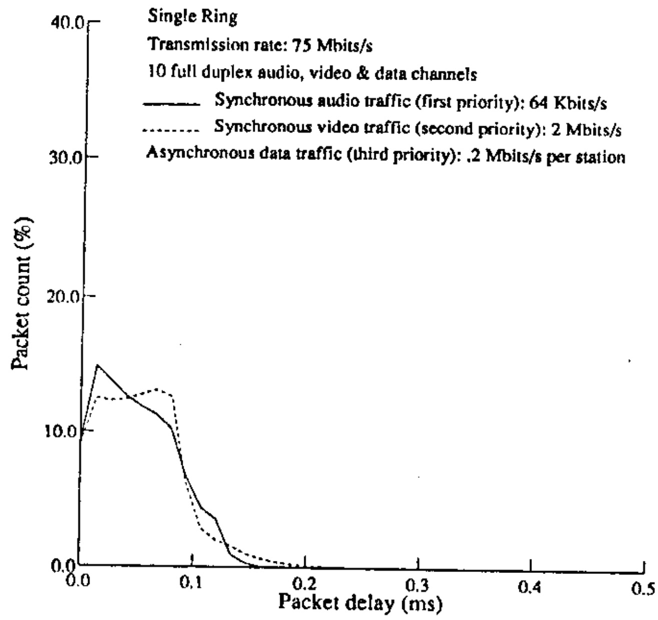
Guaranteed point-to-point bandwidth of CFR



Station latency of CFR



Packet delay distribution of multimedia traffic

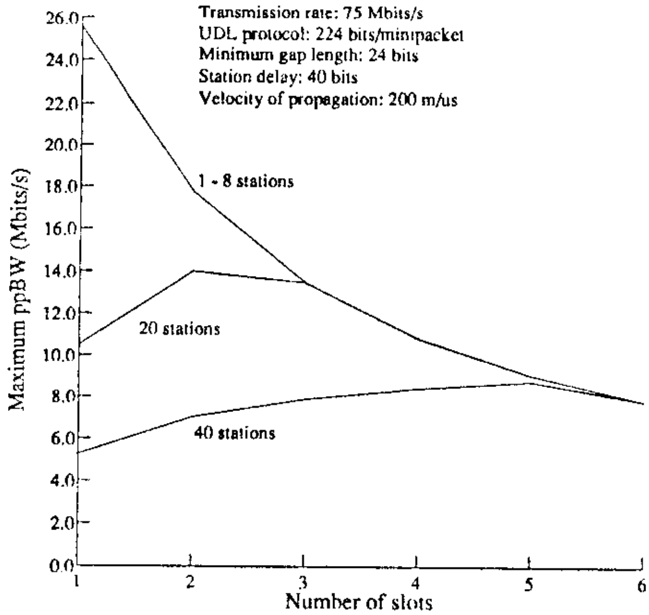


Blocking probability in singly ring CFR

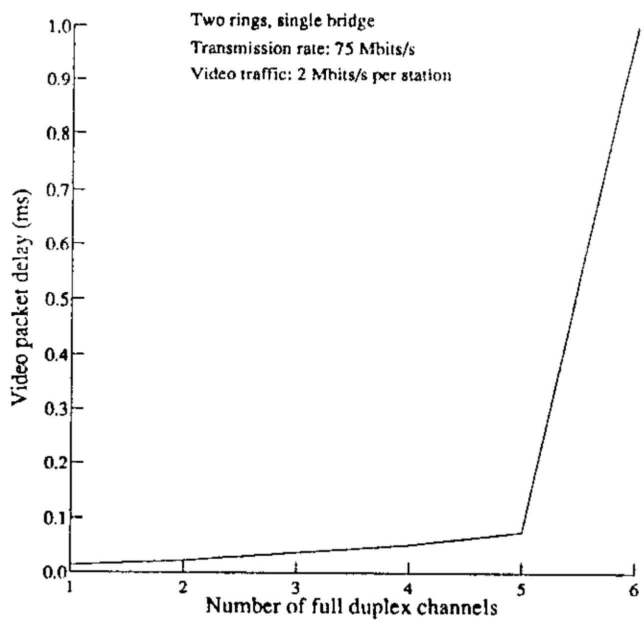
Offered traffic in single CFR with Erlang-B formula

No. of Stations	Offered Traffic per Station in *Erlangs*	
	1% Blocking	10% Blocking
50	0.24	0.35
100	0.12	0.18
150	0.08	0.12
200	0.06	0.09

Maximum point-to-point bandwidth of CFR

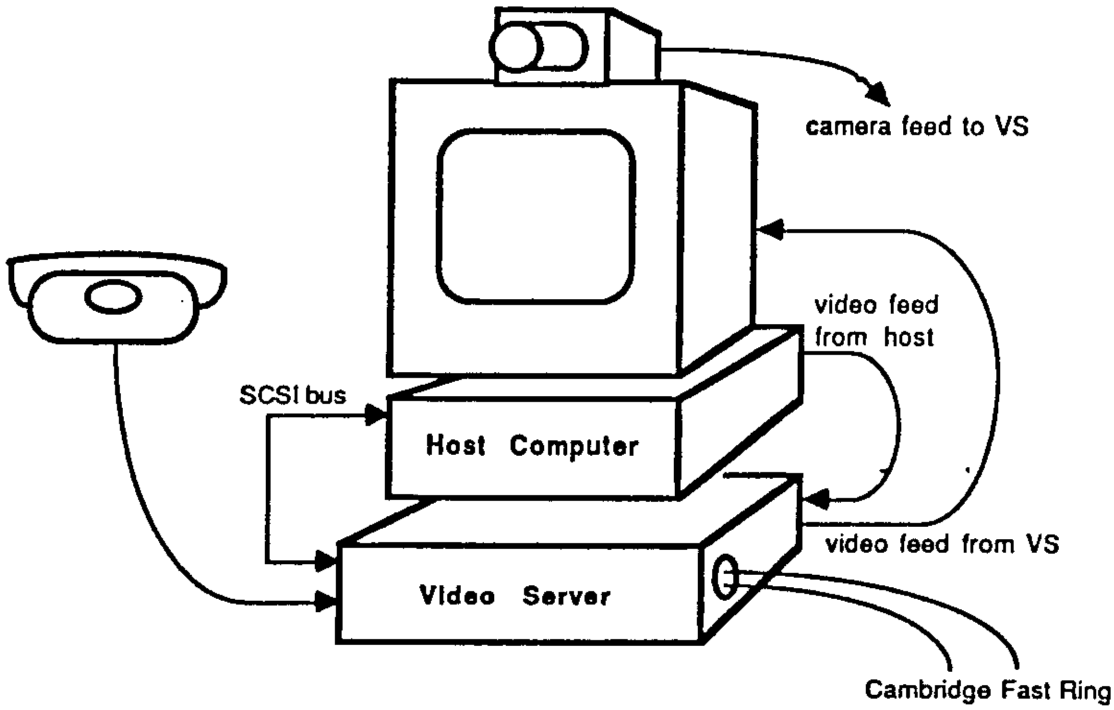


Inter-ring video packet delay in bridged CFRs

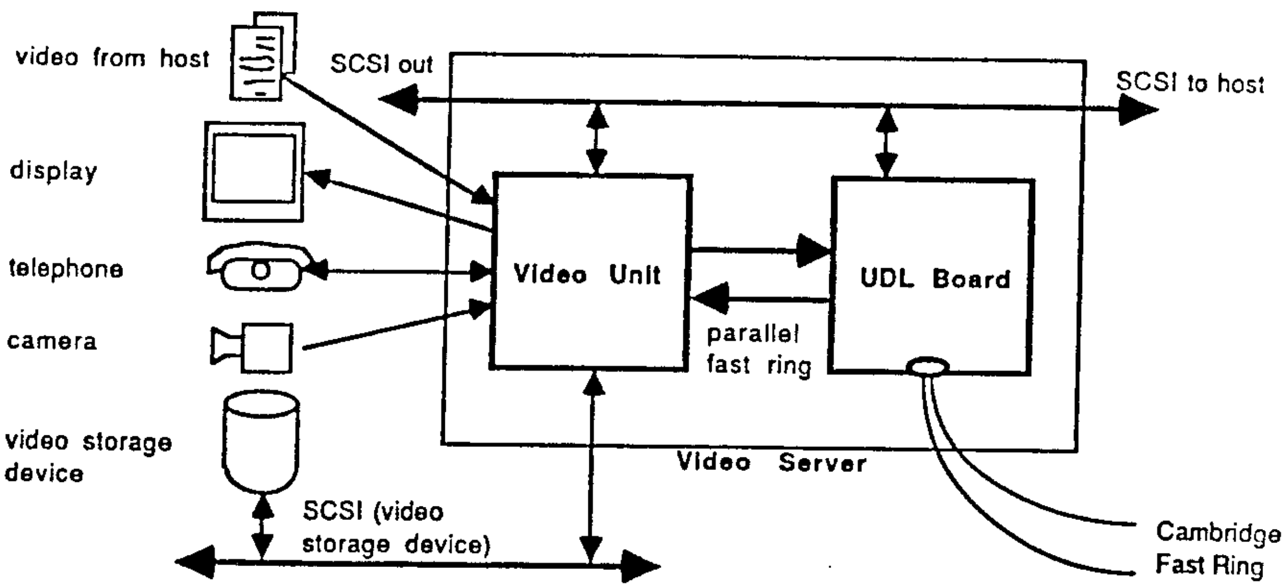


Project Pandora

- A research vehicle for multimedia applications
- Joint project of ORL and CUCL
- Transputer-based video processor



- **Video server structure**
  - Video capture
  - Overlay of video to host
  - Pandora direct CFR access
  - Host CFR access using standard interface
  - Local storage on private SCSI bus



- **Video server design**
  - Modules controlled by transputers
  - 32-bit transputer bus links modules