IBM

Distributed and Office Systems Support

Customer Material

Local Area Network Concepts

by: O.M. Thomas

G320-0161-0
August 1984

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PREFACE

This publication is the handout for the Local Area Network Concepts presentation. It has been provided so that you can follow along and take notes.

The referenced publications for this presentation fall into two groups:

- Cabling Systems
  - IBM Cabling System Planning and Installation Guide (GA27-3361)
  - A Building Planning Guide for Communications Wiring (G320-8059)
- Local Area Networks
  - An Introduction to Local Area Networks (SC20-8203)
  - Local Area Networks - A Review (G320-0108)
  - A Local Communications Network Based on Interconnected Token Access Rings - A Tutorial (G322-0131)
  - A Token-Ring Network for Local Data Communications (IBM System Journal - G321-5182)

The IBM contributions to the IBM IEEE 802 Project are listed in the foil presentation. These readily available papers provide excellent additional information on the IBM token-ring LAN.

LOCAL

AREA

NETWORK

CONCEPTS

TOPICS

- LAN DEFINITION
- LAN MOTIVATING FACTORS
- LAN ENVIRONMENT
- IBM CABLING SYSTEM
- MEDIA
- TOPOLOGY
- TRANSMISSION TECHNIQUES
- ACCESS PROTOCOL
- PERFORMANCE
- OBSERVATIONS
- STANDARDS

LAN DEFINITION

- **EXIST IN ESTABLISHMENTS**

  WITHIN A BUILDING OR CAMPUS ENVIRONMENT

- **SHORT DISTANCES**

  USUALLY LESS THAN 10 KILOMETERS

- **HIGH SPEEDS**

  TYPICALLY GREATER THAN 1 MBPS

- **INFORMATION HANDLING**

  CODED - DATA AND TEXT

  NON-CODED - VOICE, IMAGE & VIDEO

- **DEVICE INDEPENDENT**

  COMMON CABLING, ADAPTERS & PROTOCOL

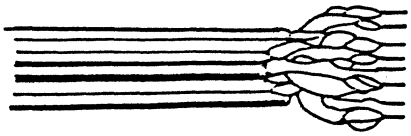
  GOAL IS MULTIPLE VENDOR/NODE ATTACHMENT

MEDIA MULTIPLICITY CONCERNS

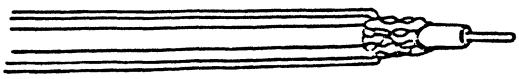
OPTIMIZED FOR EACH APPLICATION

TWISTED PAIR

SHIELDED MULTIPLE TWISTED PAIRS



COAXIAL CABLE

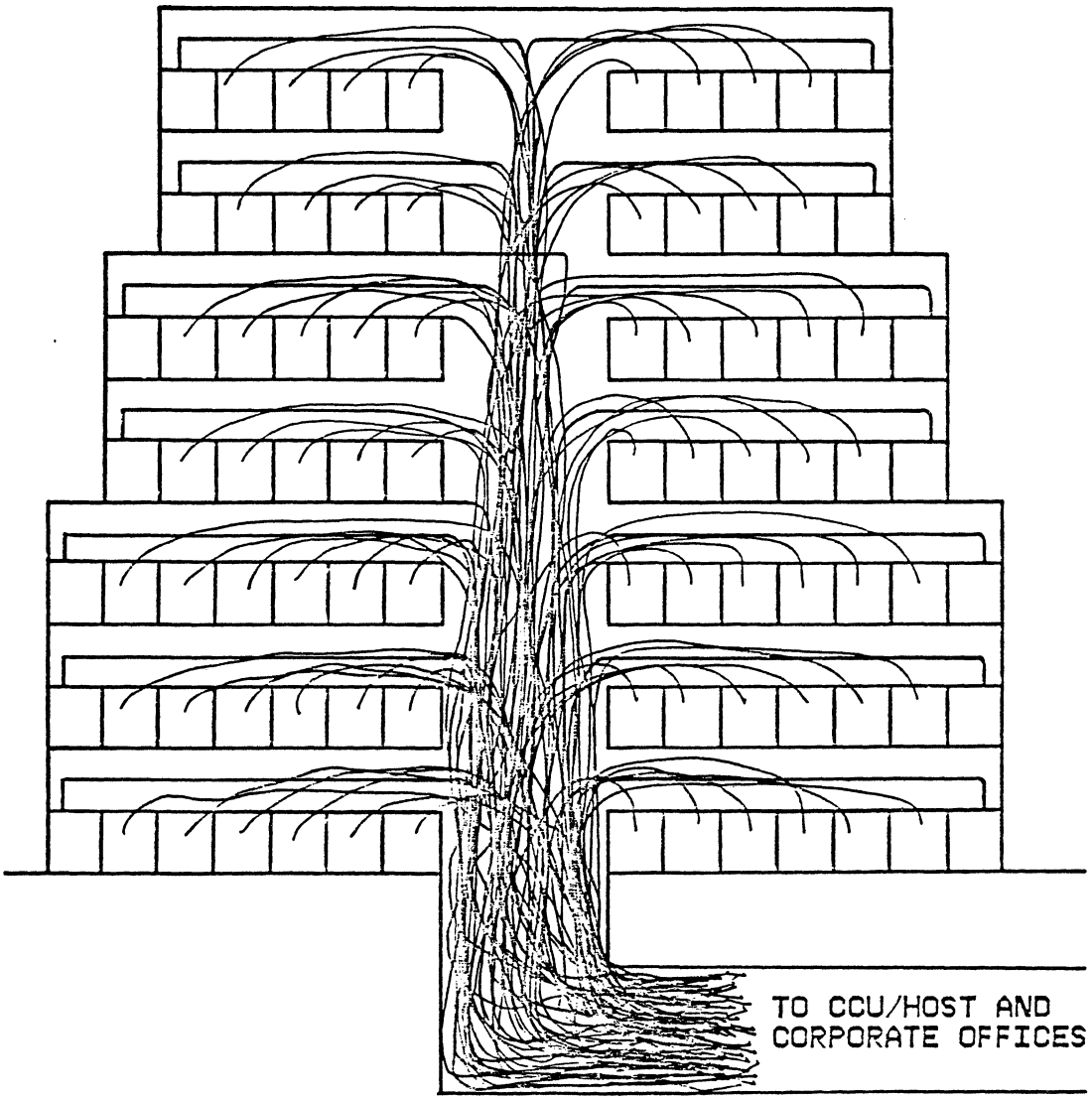


TWINAXIAL CABLE

- TERMINAL/SYSTEM SENSITIVE
- PRE-WIRING NOT EFFECTIVE

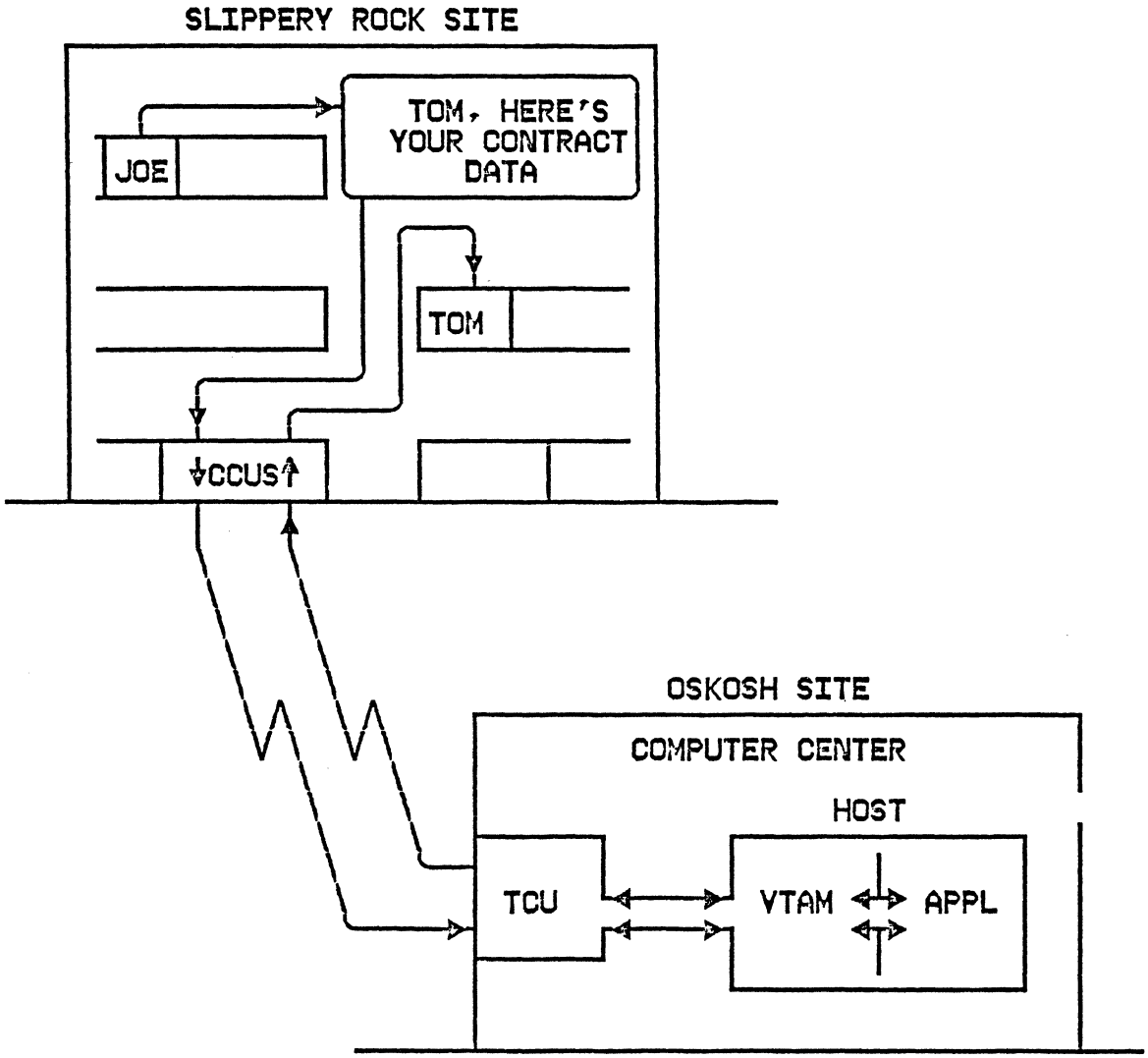
BUILDING CABLING SITUATION

ABC CORPORATE OFFICES



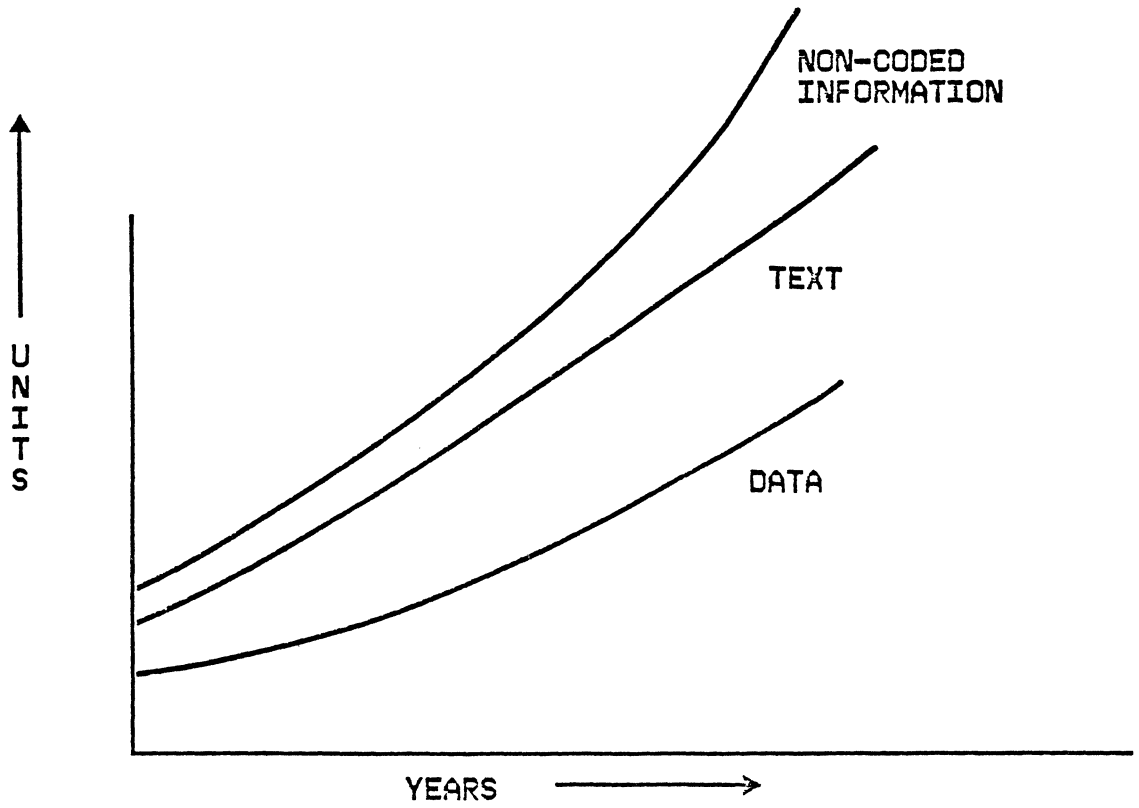
- MANY ABANDONED CABLES
- RECABLING FREQUENT AND COSTLY
- CONFUSION REIGNS SUPREME

PATH CONCERNS



- TCU/HOST TRAFFIC LOAD
- PATH LENGTH
- LOW SPEED TRANSMIT PATHS

INFORMATION GROWTH



- GROWTH RATE OF NON-CODED INFORMATION GREATER THAN TEXT OR DATA

LAN APPLICATIONS

- CODED INFORMATION
  - DATA
    - BUSINESS GRAPHICS
    - ENGINEERING GRAPHICS
    - DATA SHARING
    - PROGRAM SHARING
    - SPOOL PRINT FACILITY SHARING
    - DATA ENTRY
    - SHARED LOGIC
  - TEXT
    - ELECTRONIC MAIL
    - WORD PROCESSING
- NON-CODED INFORMATION
  - IMAGE PROCESSING
  - DIGITIZED VOICE
  - VIDEO

NODE HARDWARE MIX

- CENTRAL PROCESSING UNITS
- COMMUNICATION CONTROL UNITS
- INTELLIGENT WORKSTATIONS
- GRAPHICS TERMINALS
- FILE AND PRINT SERVERS
- FACSIMILE DEVICES
- PLOTTERS
- PROTOCOL/SPEED CONVERTERS
- LAN MONITOR/CONTROL
- BRIDGES AND GATEWAYS

LAN TRAFFIC CHARACTERISTICS

- "BURSTY" TRAFFIC WHERE:
  - A CLUSTER OF REQUESTS FOR:
    - MANY SEPARATE DATA ENTITIES OR
    - A LARGE AMOUNT OF DATA (GRAPHICS)
  - RESPONSE TIME IS TIME FOR TOTAL CLUSTER
  - VARIOUS FREQUENCY DISTRIBUTIONS
- PRIORITY ACCESS (BRIDGES)
  - SYNCHRONOUS OR ASYNCHRONOUS
  - BURST AND NON-BURST
- ASYNCHRONOUS NON-BURST
  - FEW ACCESS REQUESTS
  - TYPICALLY LESSER TERMINAL GENERATED

DESIRABLE LAN ATTRIBUTES

A COMMON CABLING SYSTEM, ADAPTERS, AND PROTOCOL THAT PROVIDES:

- PERFORMANCE CAPABILITIES
  - TYPICALLY GREATER THAN 1 MBPS
  - FAIR SHARE SUPPORT
  - PRIORITY ACCESS
- EASE OF:
  - INSTALLATION
  - FAULT ISOLATION
  - BYPASS AND REPAIR
  - NODE ADD/CHANGE
  - NETWORK MANAGEMENT
  - MIGRATION
- HOT PLUGGABILITY
- DYNAMIC CONNECTIVITY
- SNA COMPATABILITY
- DEVICE INDEPENDENCE
- REASONABLE DROP COST
- IEEE 802 STANDARD ACCORD

CABLING SYSTEM CRITERIA

- STRUCTURED DESIGN APPROACH THAT
  - SUPPORTS EXISTING ARCHITECTURES
  - PROVIDES MIGRATION PATH
  - FACILITATES BUILDING PRE-CABLING
- EASE OF:
  - INSTALLATION
  - FAULT RESOLUTION
  - BYPASS/REPAIR
- OFFERS NODE INTERCHANGEABILITY
- READY AVAILABILITY OF:
  - SKILLS
  - TOOLS AND TEST EQUIPMENT
- LONG LIFE EXPECTANCY
- GOOD RETURN ON INVESTMENT

IBM CABLING SYSTEM

- A CABLING SYSTEM PRODUCT
- SYSTEM FUNCTION IS UNCHANGED
- MAJOR PRODUCT COMPONENTS:
  - CABLES
  - CONNECTORS
  - CABLING ACCESSORIES
  - SYSTEM ACCESSORIES
  - DISTRIBUTION PANELS
  - DOCUMENTATION

IBM CABLING SYSTEM RATIONALE

- THE IBM CABLING SYSTEM MAY RESOLVE BUILDING CABLING PROBLEMS SUCH THAT ITS USE IS ECONOMICALLY JUSTIFIED ON ITS OWN MERITS, IGNORING FUTURE LOCAL AREA NETWORK CONSIDERATIONS.

- COMPREHENSIVE LOCAL AREA NETWORKS AND CABLING SYSTEMS ARE INTERDEPENDENT. THE CABLING SYSTEM MUST ARRIVE FIRST.

- A STAR WIRED TOPOLOGY IS BEST FOR ANY CABLING SYSTEM, AND THE RING AND STAR TOPOLOGIES COMBINE EXTREMELY WELL.

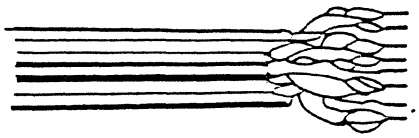
MEDIA

"WHAT KIND OF CABLE IS USED"

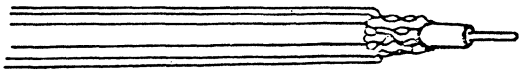
MEDIA TYPES

A. UNSHIELDED TWISTED-PAIR

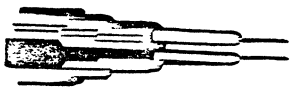
B. SHIELDED MULTIPLE TWISTED-PAIR



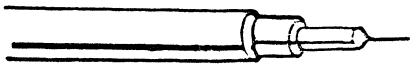
C. COAXIAL CABLE



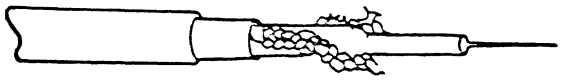
D. TWINAXIAL CABLE



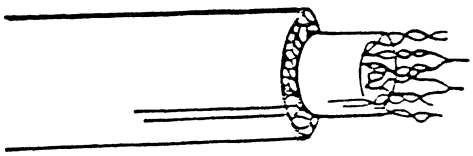
E. CATV BROADBAND CABLE



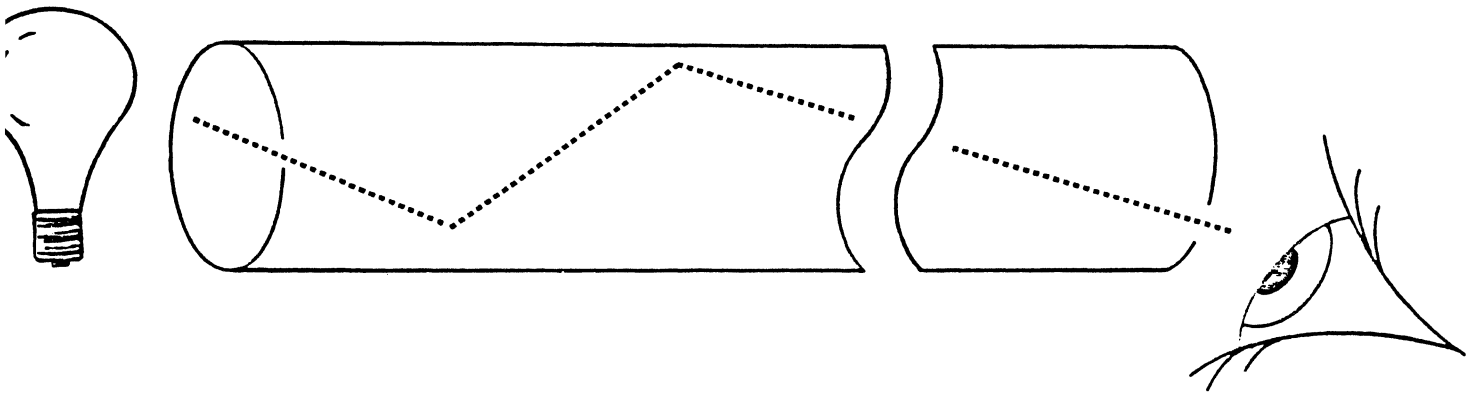
F. FIBER OPTIC LINK



G. MIXED MEDIA



FIBER OPTIC MEDIA



- LIGHT TRANSMISSION
- GIGAHERTZ SPEED CAPACITY
- UNIDIRECTIONAL POINT-TO-POINT
- BASEBAND ONLY
- HIGH SECURITY

MEDIA/CONNECTOR CHARACTERISTICS

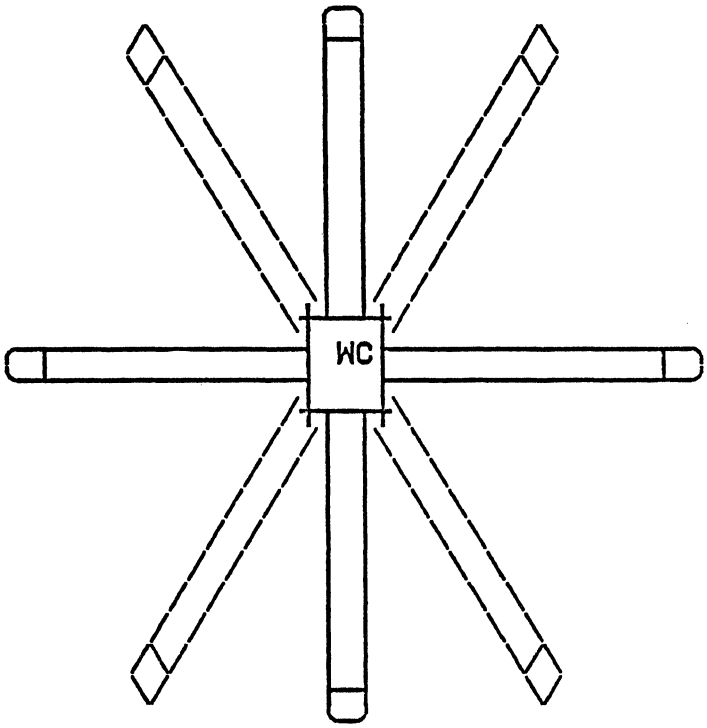
- ELECTRICIAL
  - ATTENUATION
  - RADIATION
  - CROSSTALK
  - NOISE SENSITIVITY
  - PROPAGATION DELAY
- MECHANICAL
  - PULL STRENGTH
  - DIAMETER
  - BEND RADIUS
  - WEIGHT
  - CONNECTION/ASSEMBLY EASE
- ENVIRONMENTAL
  - SAFETY HAZARDS
  - GROUNDING
  - EMI
  - COMBUSTION HAZARDS
  - SECURITY

TOPOLOGY

GEOMETRIC VIEW OF THE NETWORK

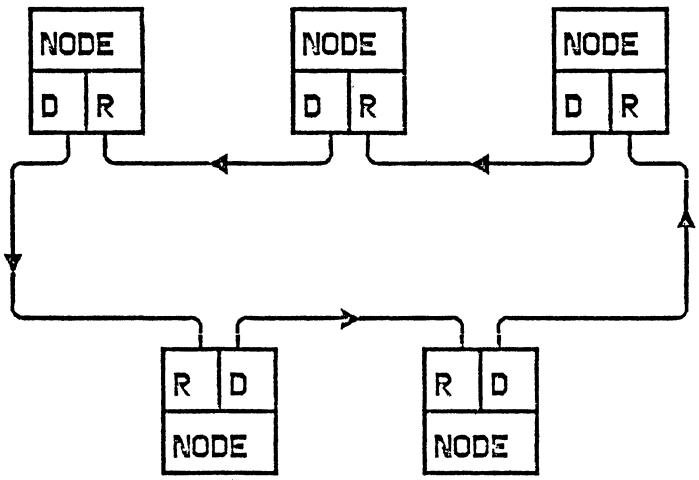
"HOW IT LOOKS"

STAR/RADIAL TOPOLOGY



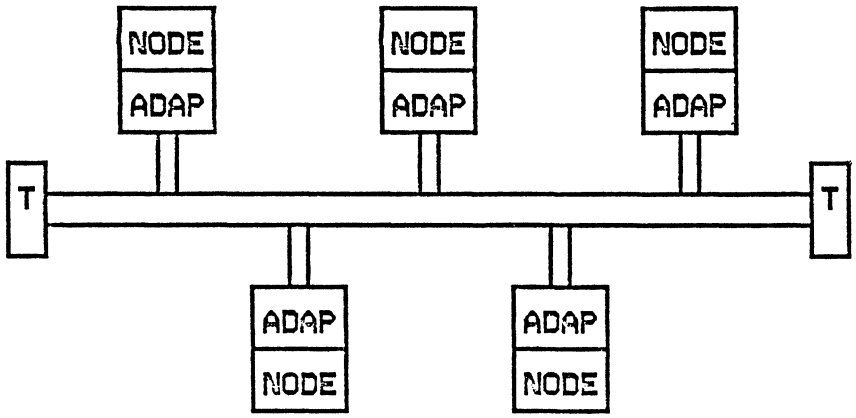
- CHARACTERISTICS
  - TELEPHONE SYSTEM ORIGIN
  - POINT-TO-POINT THROUGH CONTROL POINT
- ADVANTAGES
  - BEST CABLE SYSTEM DUE TO:
    - EASIER FAULT ISOLATION
    - EASIER BYPASS & REPAIR
- DISADVANTAGES
  - MOST CABLE TO INSTALL ONE TIME

RING TOPOLOGY



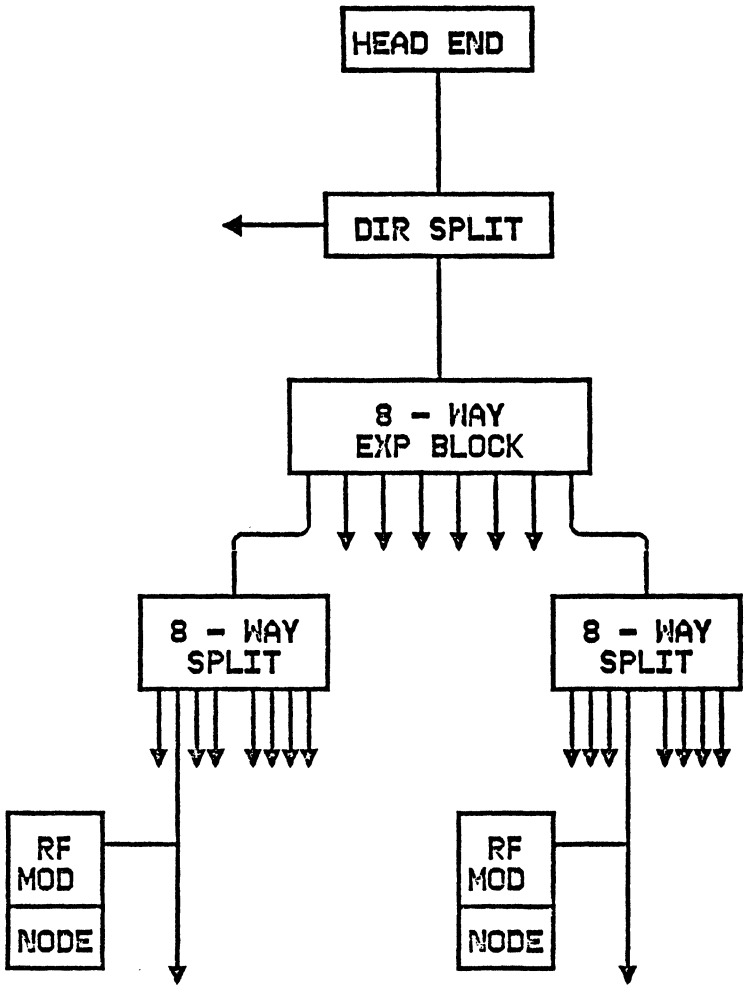
- ADVANTAGES
  - UNIDIRECTIONAL POINT-TO-POINT RING
  - MATCHES CURRENT FIBER CHARACTERISTICS
  - NODAL SIGNAL REDRIVE FACILITATES:
    - DECREASED DISTANCE SENSITIVITY
    - REDUCED NOISE SENSITIVITY
    - DISTRIBUTED CONTROL & CHECKING
- DISADVANTAGES
  - SENSITIVE TO MULTIPLE NODAL FALLOUT
  - ADD/CHANGE NODES DIFFICULT

BUS TOPOLOGY



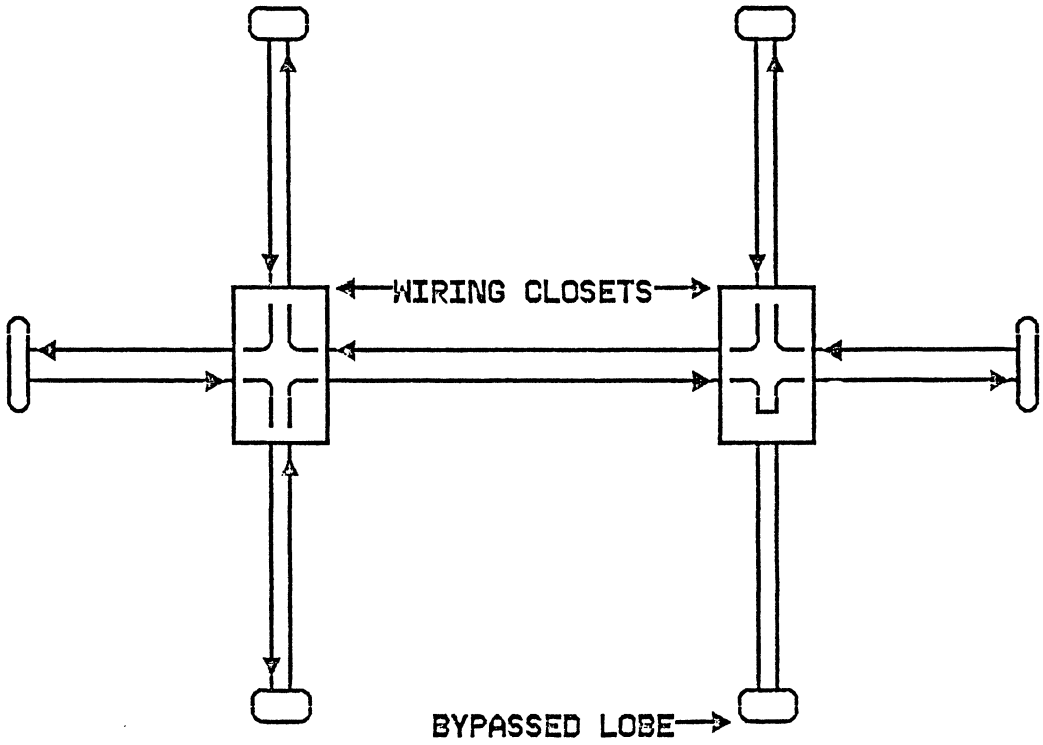
- CHARACTERISTICS
  - T-CONNECTED NODES
  - BIDIRECTIONAL POINT-TO-POINT
- ADVANTAGES
  - USES LESS CABLE
  - LESS SENSITIVE TO NODAL FALLOUT
- DISADVANTAGES
  - HIGH DISTANCE SENSITIVITY <BASEBAND>
    - AMPLIFIERS OFTEN REQUIRED
  - RESPONSE MUST BE SEPARATE
  - BUILDING PRE-WIRING DIFFICULT <BASEBAND>
  - COMPLEX DESIGN & MAINTENANCE
  - SINGLE SOURCE FOR POTENTIAL MULTIPLE FAILURES

TREE TOPOLOGY



- CATV BROADBAND TOPOLOGY

STAR WIRED LOGICAL RING

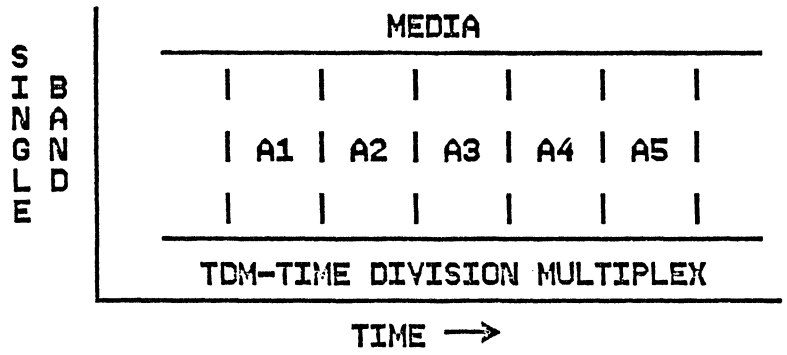


- COMBINED STAR & RING TOPOLOGIES OFFERS BEST OF BOTH
  - LOGICAL RING - PHYSICAL STAR
  - EXCELLENT FOR COMMON CABLING SYSTEM
  - UNIDIRECTIONAL POINT-TO-POINT RING
  - NODAL SIGNAL REDRIVE

TRANSMISSION TECHNIQUES

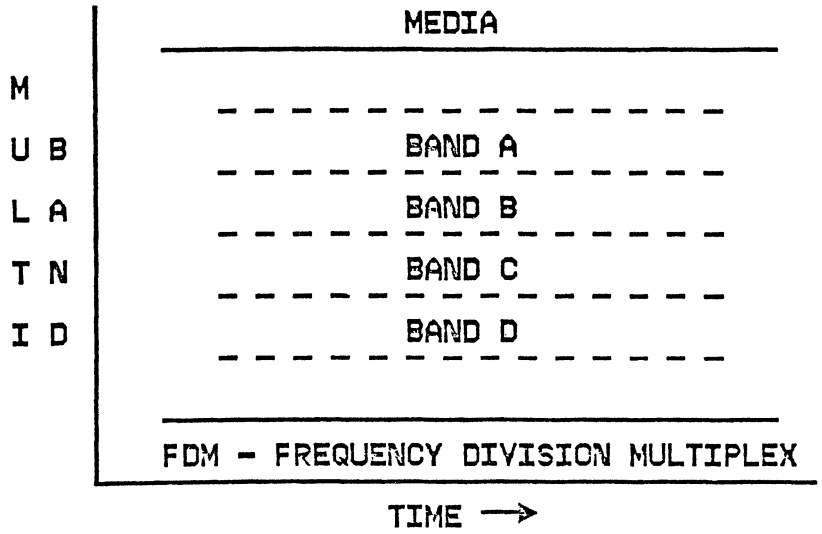
"HOW MEDIA CAPACITY IS ALLOCATED"

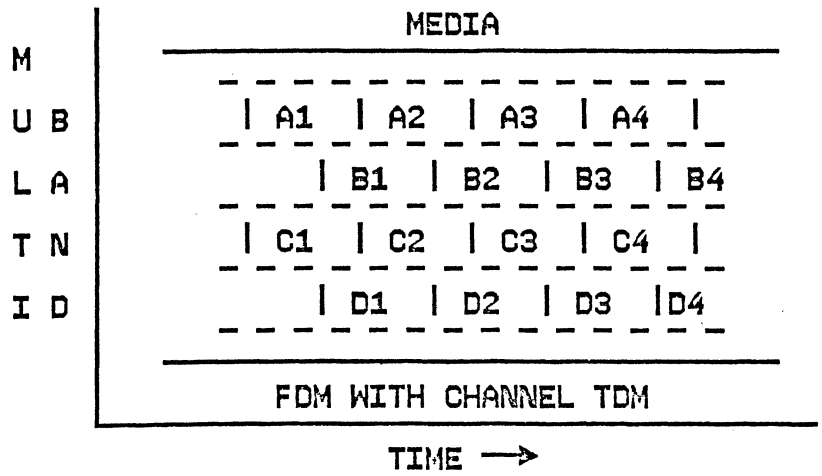
BASEBAND TRANSMISSION



- SINGLE CHANNEL
- TDM SHARING
- DIGITAL INTERFACE COST DECREASING
- ANY-TO-ANY NODE ADDRESSABILITY
- DIGITAL SIGNAL

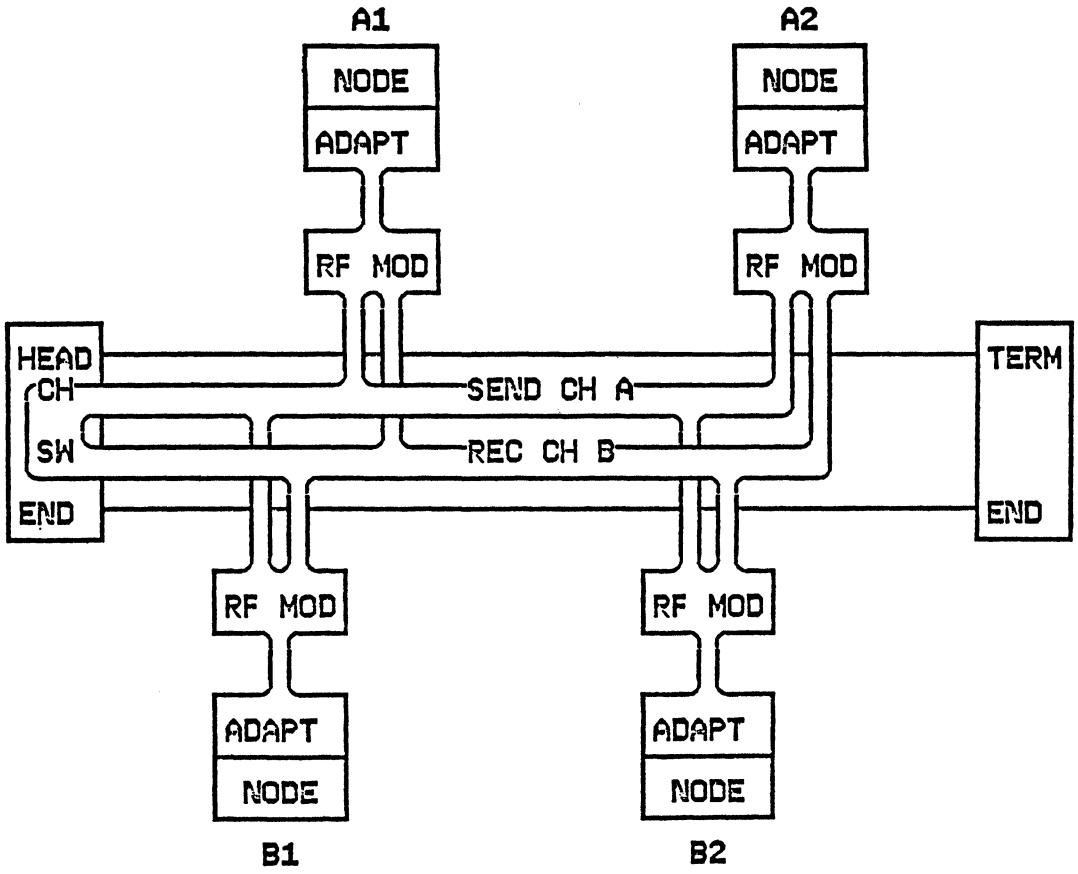
BROADBAND TRANSMISSION





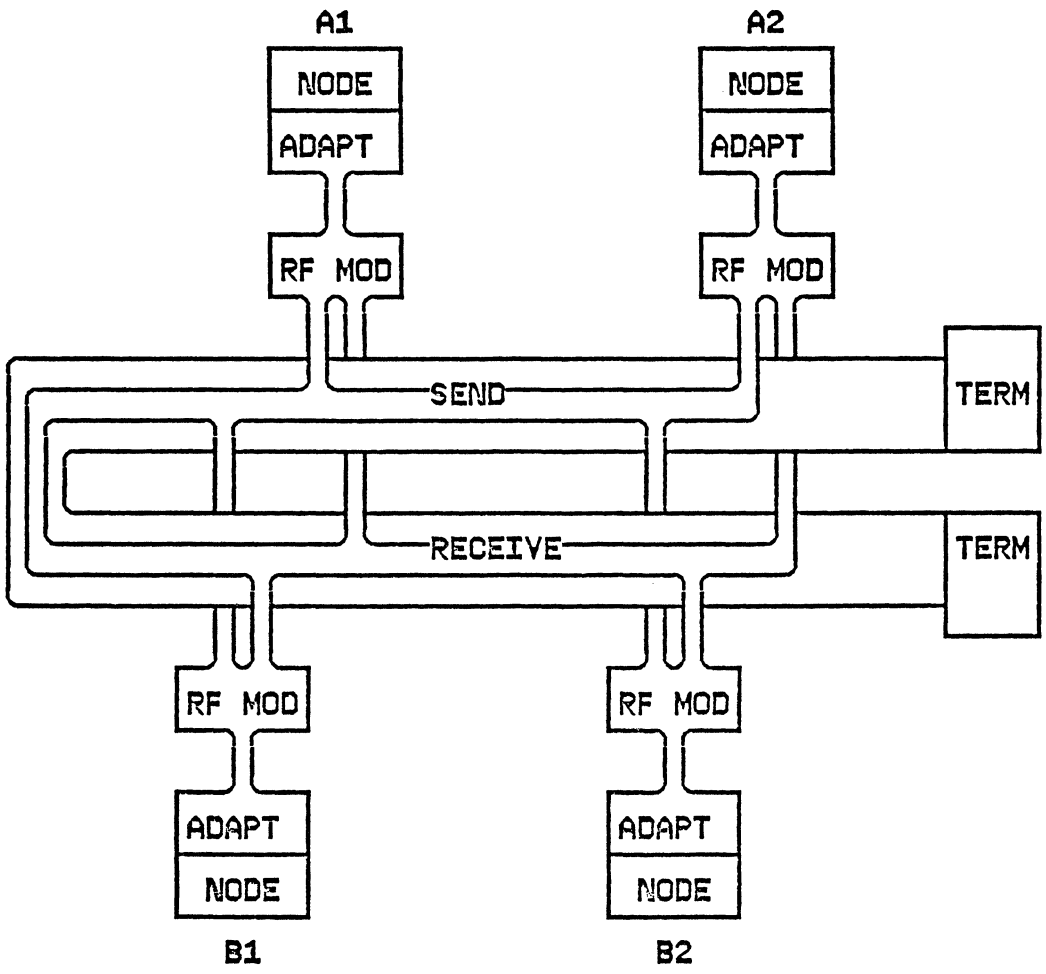
- FDM AND TDM WITHIN EACH CHANNEL
- MULTI-CHANNEL AND MULTI-SPEED CAPABILITY
- MAY INCREASE MEDIA UTILIZATION
- USES RADIO FREQUENCY MODEMS
- CATV BROADBAND ORIGIN

MID-SPLIT BROADBAND BUS



- HEAD END CHANGES CHANNEL
- LESS SENSITIVE TO CABLE FAULT

DUAL CABLE BROADBAND BUS



- HIGHER CAPACITY
- HEAD END NOT REQUIRED
- DOUBLES CABLE USAGE

CATV BROADBAND OBSERVATIONS

- **ADVANTAGES**
  - PROVEN TECHNOLOGY:
    - HIGH CAPACITY MEDIA
    - EXCELLENT AMPLIFIERS
  - MULTI-CHANNEL IMPLEMENTATION CAN:
    - INCREASE MEDIA CAPACITY UTILIZATION
    - CARRY DISSIMILAR INFORMATION TYPES
  - SOME ADAPTABILITY TO STRUCTURED CABLING
- **DISADVANTAGES**
  - ANY-TO-ANY CONNECTION DIFFICULT IN MULTI-CHANNEL MODE
  - RADIO FREQUENCY MODEM USAGE
    - DIGITAL-ANALOG-DIGITAL CONVERSION
    - EFFICIENCY VS EXPENSE
    - INCREASED DROP COSTS
  - SOPHISTICATED TUNING REQUIRES SPECIAL
    - SKILLS
    - TOOLS/TEST EQUIPMENT
  - CABLE IS SINGLE SOURCE OF POTENTIAL MULTIPLE FAILURES

ACCESS PROTOCOL

"WHO GETS ACCESS WHEN"

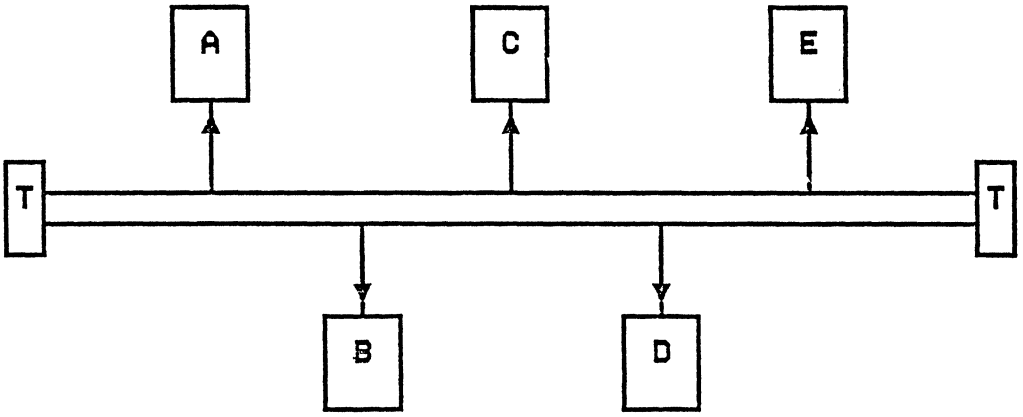
ACCESS PROTOCOLS

- **IEEE 802 STANDARD PROTOCOLS**
  - CSMA/CD BUS
  - TOKEN PASSING
    - RING
    - BUS
- **NON-STANDARD PROTOCOLS**
  - SLOTTED RING
  - BUFFER INSERTION RING
  - CSMA/CA (PC CLUSTER)
  - CONTENTION RING

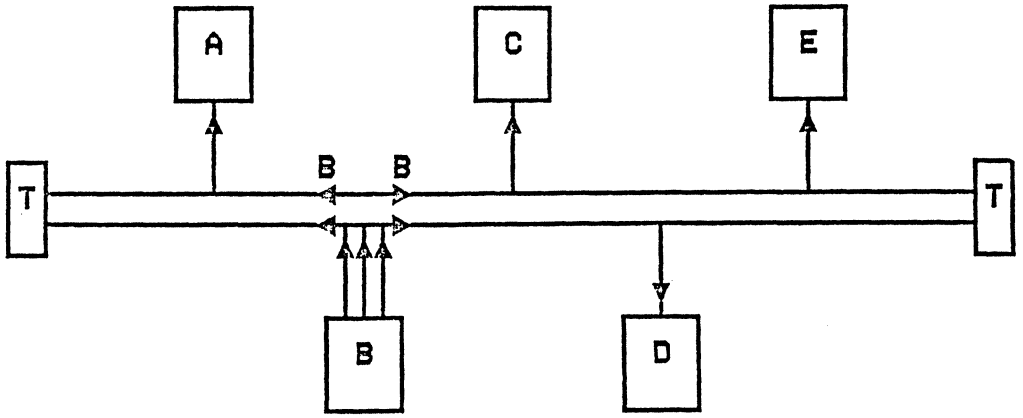
CSMA/CD ACCESS PROTOCOL

- BUS IS STANDARD TOPOLOGY
- CONTENTION ACCESS SYSTEM
- LISTEN - IF QUIET:
  - TRANSMIT
  - LISTEN FOR COLLISION
- IF COLLISION DETECTED:
  - STOP TRANSMITTING
  - UNLIKE RANDOM DELAYS

CSMA/CD BUS OPERATION

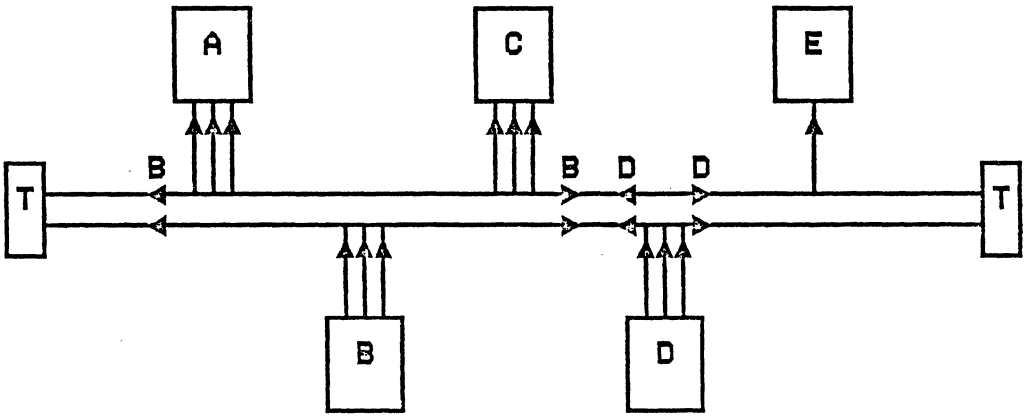


T1- ALL NODES LISTENING & NO ACTIVITY



T2- B TRANSMITS - ANY OTHER NODE MAY ALSO

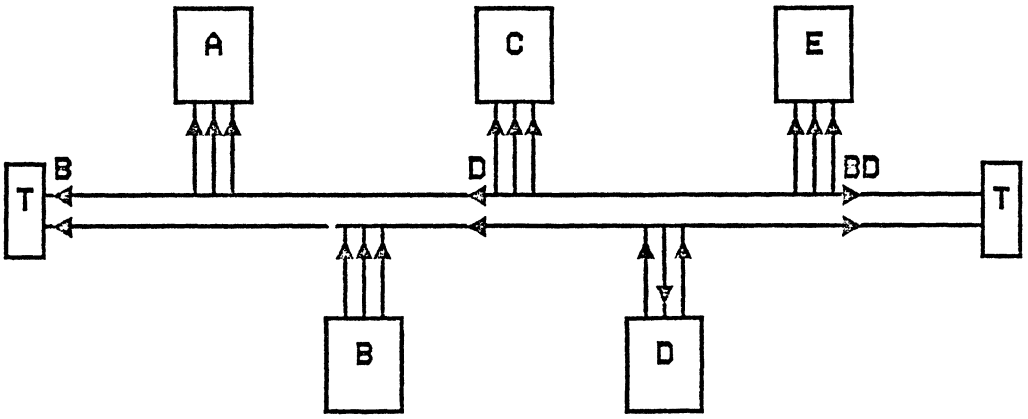
CSMA/CD BUS OPERATION (CON'T)



T3. B STILL TRANSMITTING

A & C CANNOT TRANSMIT

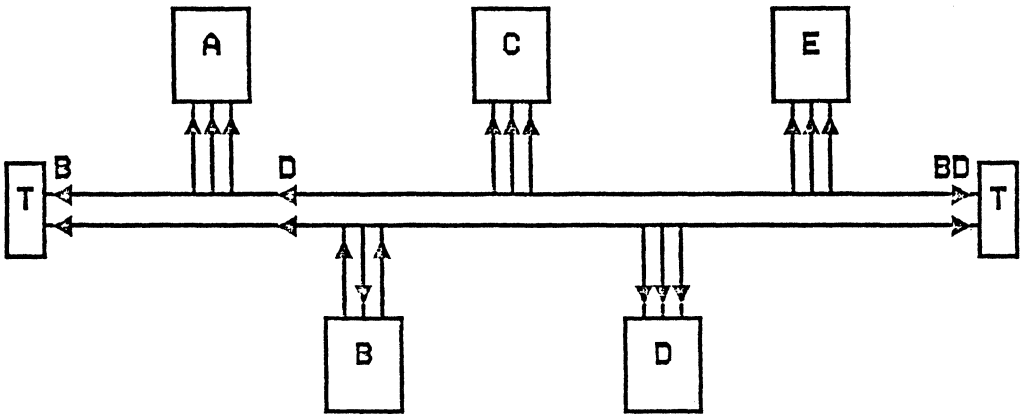
D STARTS TRANSMITTING



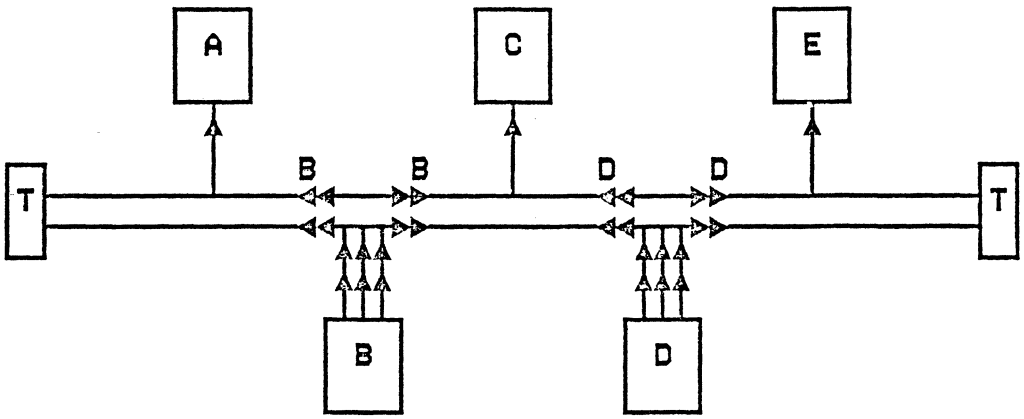
T4. D DETECTS COLLISION AND STOPS TRANSMITTING

B MUST TRANSMIT UNTIL D SIGNAL PROPAGATES TO B

CSMA/CD BUS OPERATION (CONT.)



- T5. B DETECTS COLLISION AND ALSO STOPS TRANSMITTING



- T6. B/D TRANSMIT JAM & PERFORM UNLIKE RANDOM DELAYS

- SPEED/DISTANCE SENSITIVE

CSMA/CD BUS OPERATION (CON'T)

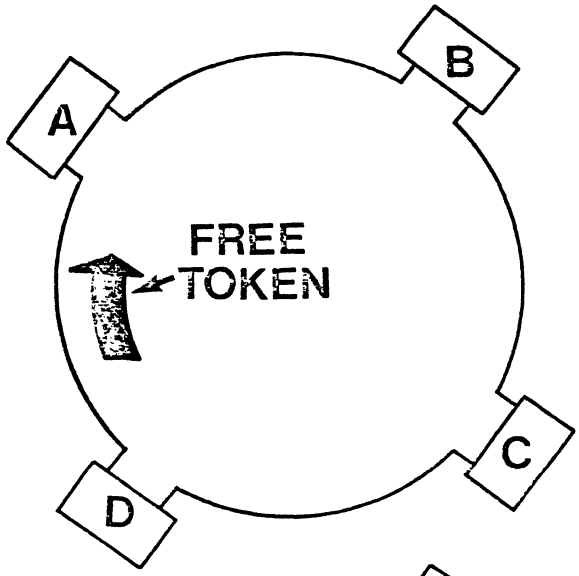
- PROVEN TECHNOLOGY
- LACKS PRIORITY ACCESS SCHEME
- COLLISIONS/INSTABILITY FROM:
  - HIGH OR PEAKY LOADS
  - REDUCE ACTIVITY TO RECOVER
- MAINTENANCE RELATIVELY DIFFICULT
- SPEED/DISTANCE SENSITIVE
- SHORT MESSAGE UTILIZATION CAN BE RELATIVELY POOR

TOKEN PASSING ACCESS PROTOCOL

GENERIC TO RING OR BUS

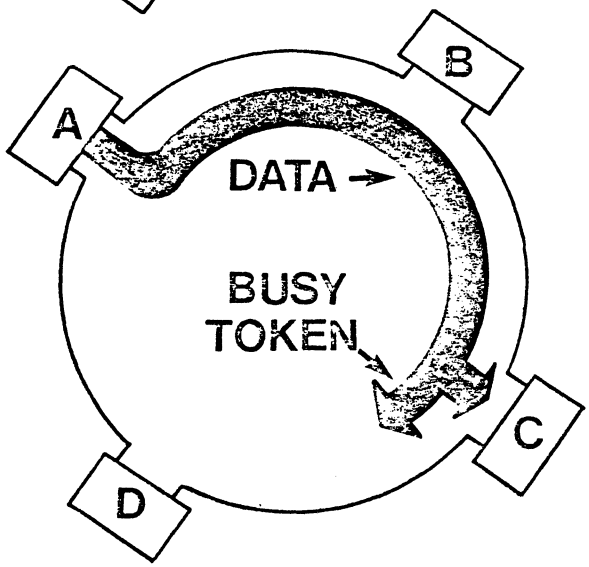
- STABLE AT HIGH UTILIZATION
- FAIR SHARE ORIENTED PERFORMANCE
- FACILITATES PRIORITY MANAGEMENT
- SPEED/DISTANCE INDEPENDENCE
- MONITOR CHECKS TOKEN STATUS
- ANY NODE MAY BE MONITOR

TOKEN PASSING RING

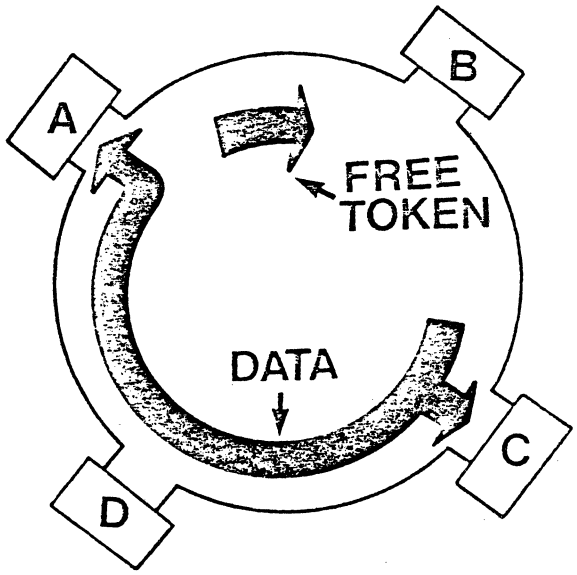


NODE READY TO SEND LOOKS FOR FREE TOKEN

CHANGES FREE TOKEN TO BUSY TOKEN AND APPENDS DATE



RECEIVER COPIES DATA ADDRESSED TO IT



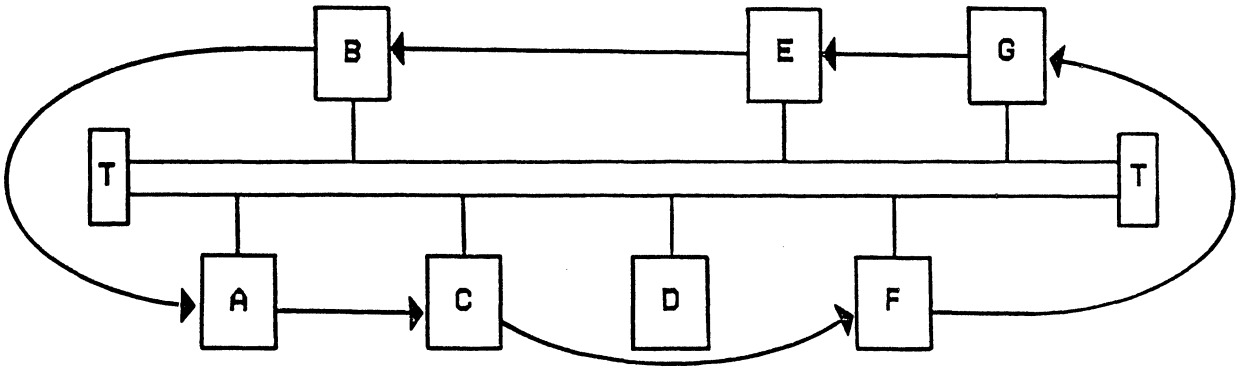
SENDER REMOVES BUSY TOKEN AND DATA FROM RING

SENDER GENERATES FREE TOKEN UPON RECEIPT OF BUSY TOKEN

TOKEN PASSING RING (CON'T)

- DYNAMIC PRIORITY RESERVATION
  - PRIORITY ACCESS (BRIDGES)
  - MONITOR/CONTROL ACTIVITY
- "FREE" RESPONSE (SAME RING)
- ALL NODES ERROR CHECK

TOKEN PASSING BUS



- LOGICAL RING
- TYPICALLY IN SIGN-ON ORDER
- IN-TURN PRIORITY RESERVATION
- TOKEN TRANSFER DELAY CAN BE HIGH

LAN PERFORMANCE FACTORS

- PROPAGATION DELAY (PROPDEL)
- TRANSMISSION SPEED
- ACCESS DELAY
- TRANSFER DELAY
- CSMA/CD SLOT TIME
- TOKEN TRANSFER DELAY
- RING DELAY

PBX/DBX LANS

- PBX/DBX
  - CENTRAL CONTROL
  - SWITCHING DELAYS
  - POINT-TO-POINT
  - OPTIMIZED FOR VOICE
- MULTI-SESSION DIFFICULTIES
  - FILE AND PRINT SERVERS
- UNSHIELDED TWISTED PAIR MEDIA
  - CONTINUOUS 64 KBPS
  - NOISE SENSITIVE
- COMPLEMENTS DATA LAN

OBSERVATIONS

- CSMA/CD BUS FITS SIMILAR:
  - NODES
  - APPLICATIONS
  - FILE/PRINT SERVERS

  PRESENTING:
  - NON-PRIORITY ACCESS TRAFFIC
  - LOW TO MEDIUM LOADS
- GOOD FOR PC ENVIRONMENTS

OBSERVATIONS (CON'T)

- TOKEN PASSING BUS FITS BACKBONE LAN CHARACTERISTICS
  - LIMITED DISTANCE (BASEBAND)
  - FEW NODES (BRIDGES) LOWERS TOKEN PASSING OVERHEAD
  - STABLE CONNECTIONS
  - BASEBAND OR BROADBAND AS CAPACITY NEEDS DICTATE

OBSERVATIONS (CON'T)

MULTI-PURPOSE LAN PLANNING

- **LAN/CABLING SYSTEM DEPENDENCE**
  - DICTATES IBM CABLING SYSTEM
    - STAR/RADIAL TOPOLOGY
    - MIXED MEDIA
    - EASY FAULT ISOLATION
    - EASY BYPASS & REPAIR
    - RECEPTIVE TO CHANGE
- **RING/STAR TOPOLOGY MARRIAGE**
  - STAR WIRED TOKEN-RING
    - LOGICAL RING - PHYSICAL STAR
    - EXCELLENT PERFORMANCE QUALITIES
    - RETAINS RING REDRIVE
    - DISTANCE/SPEED INDEPENDENCE
    - HANDLES EXTREMELY VARIED TRAFFIC
    - PRIORITY CAPABILITIES

POTENTIAL LAN BENEFITS

- **PERCEPTIONS**
  - SIMPLIFIES COMMUNICATION COMPLEXITY
    - MULTI-VENDOR SUPPORT
    - REDUCES CABLING PROBLEMS
    - SIMPLIFIES INTERCONNECTIVITY
  - COMMUNICATIONS STAY IN-HOUSE
    - SHORTENS PATH LENGTHS
    - BETTER REPONSE
    - UNLOAD COMMUNICATIONS NETWORK
  - DASD/PRINTER SAVINGS
  - NON-CODED INFORMATION AVAILABILITY
  - HIGH-TECH APPLICATION PRACTICALITY
- **BUT THIS REQUIRES:**
  - AN ARCHITECTURED APPROACH WITH COMMON:
    - CABLING
    - ADAPTERS
    - PROTOCOL
  - PLANNED INTEGRATION OF:
    - HARDWARE
    - SOFTWARE
    - APPLICATION CODE

FUTURE LAN CONSIDERATIONS

- THE CAPACITIES OF ALL DATA COMMUNICATION MEDIA HAVE BEEN EXCEEDED EXCEPT FOR FIBER.

- CURRENT FIBER CHARACTERISTICS:
  - POINT-TO-POINT
  - UNIDIRECTIONAL
  - BASEBAND TRANSMISSION

- SUITED TO IBM'S ARCHITECTURAL AND DEVELOPMENT DIRECTION OF THE TOKEN PASSING RING LOCAL AREA NETWORK.

KEY LAN DEVELOPMENT FACTORS

- CABLING SYSTEMS VALUABLE ON THEIR OWN MERITS
- CABLING SYSTEMS AND LANS ARE INTERDEPENDENT
- CABLING SYSTEM SHOULD PRECEDE THE LAN
- STAR TOPOLOGY IS SUPERIOR FOR CABLING SYSTEMS
- INHERENT NODE REGENERATION OF RING VALUABLE
- TOKEN-RING PRIORITY CAPABILITIES VALUABLE
- STAR AND RING TOPOLOGIES COMBINE VERY WELL
- TOKEN PASSING IS BEST RING ACCESS PROTOCOL

THE STAR-WIRED TOKEN-RING CONCLUSION.

AVAILABLE REFERENCE DOCUMENTATION

• IBM IEEE 802 PROJECT SUBMISSIONS

- RING NETWORK TOPOLOGY FOR LOCAL DATA COMMUNICATIONS
- TOKEN-RING LOCAL AREA NETWORKS: A PERSPECTIVE
- A TOKEN-RING ARCHITECTURE FOR LOCAL AREA NETWORKS: AN UPDATE
- LOCAL AREA NETWORKS AND HIGHER LEVEL PROTOCOLS: AN SNA EXAMPLE
- LOCAL AREA NETWORK MEDIA SELECTION FOR RING TOPOLOGIES
- FAULT DETECTION AND ISOLATION IN A TOKEN-RING LOCAL-AREA NETWORK

• IBM SYSTEMS JOURNAL

- A TOKEN-RING NETWORK FOR LOCAL DATA COMMUNICATIONS (G321-5182)

• IBM PUBLICATIONS

- A BUILDING PLANNING GUIDE FOR COMMUNICATION WIRING (G320-8059)
- IBM CABLING SYSTEM PLANNING AND INSTALLATION GUIDE (GA27-3361)

IEEE PROJECT 802:

LOCAL NETWORKS STANDARDS COMMITTEE

INTRODUCTION

LOGICAL LINK CONTROL
* 2/3 SERVICE SPEC
* LLC
* LLC/MAC SERVICE SPEC

CSMA/CD
* CSMA/CD MAC
* 1/2 SERVICE SPEC
* PLS/AUI
* BASEBAND COAX MEDIA
* BROADBAND BUS MEDIA (REVIEW ONLY)

TOKEN BUS
* TOKEN BUS MAC
* 1/2 SERVICE SPEC
* PHASE-CONTINUOUS FSK MEDIA
* PHASE-COHERENT FSK MEDIA
* BROADBAND BUS MEDIA

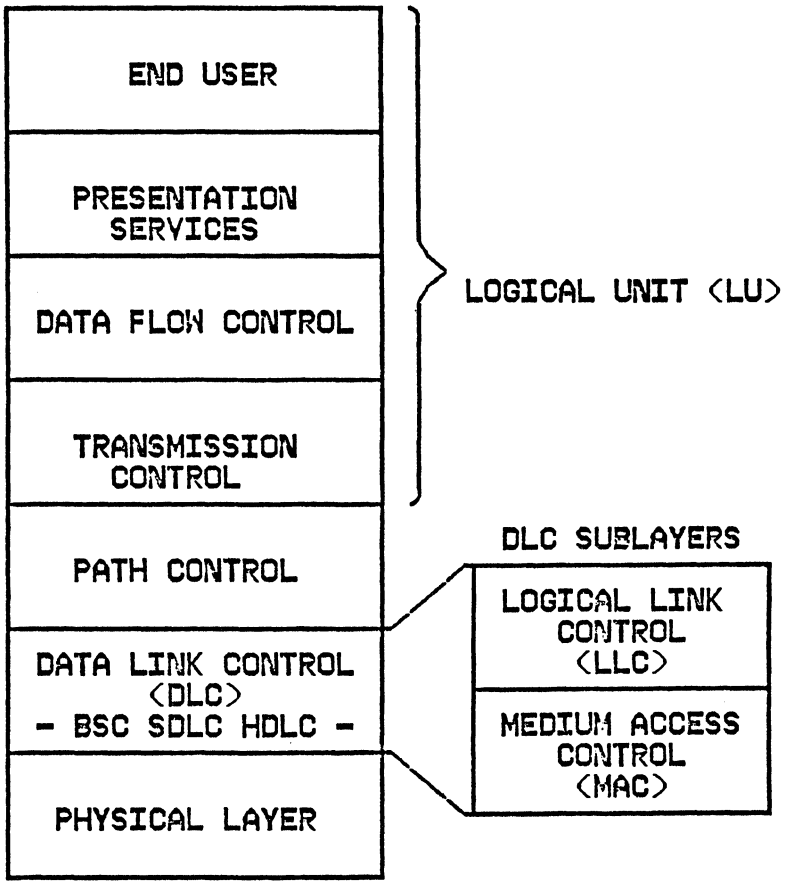
TOKEN RING
* TOKEN RING MAC
* 1/2 SERVICE SPEC
* TW-PAIR MEDIA
* COAX MEDIA

* FUNCTIONAL REQUIREMENTS
* GLOSSARY
* MANAGEMENT
* INTERNET

DRAFT C STANDARD STRUCTURE

SYSTEMS NETWORK ARCHITECTURE

(SNA)



IEEE 802 DLMAC GOALS

- HDLC CONVERGENCE
- MEDIA TRANSPARENCY
- ENCODING TECHNIQUE TRANSPARENCY
- TOPOLOGY TRANSPARENCY
- TRANSMISSION RATE TRANSPARENCY

IEEE 802 REQUIREMENTS

- BROAD FUNCTIONAL APPLICABILITY
  - FILE TRANSFER
  - WORD PROCESSING
  - GRAPHICS
  - ELECTRONIC MAIL
  - REMOTE DATA BASE ACCESS
  - DIGITAL VOICE APPLICATIONS
- PROVIDE A LAYERED ARCHITECTURE WHICH:
  - CORRESPONDS TO THE ANSI/ISO OSI REFERENCE MODEL
  - PERMITS EFFICIENT INTERCONNECTION OF MODERATELY PRICED DEVICES
  - CAN BE IMPLEMENTED AT MODERATE PRICE
- BROAD DEVICE SUPPORT
  - TERMINALS
  - MINICOMPUTERS
  - MAINFRAMES
  - MASS STORAGE DEVICES
  - PRINTERS/PLOTTERS
  - MONITOR AND CONTROL EQUIPMENT
  - BRIDGES AND GATEWAYS

READER'S COMMENT FORM

Local Area Network Concepts Customer Materials **G320-0161-0**

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