ARCNET Tutorial
What is ARCNET?

- Attached Resource Computer NETwork
- Token-Passing Local Area Network (LAN)
- Originally 2.5 Mbps data rate
- 255 Nodes or Stations
- Variable Packet Length
- Bus or Distributed Star Wiring
- Unicast or Broadcast Messages
  - One to one or one to all
What is ARCNET?

- Coaxial, Fiber Optic, Twisted-pair Cabling
- Over 11 Million Installed Nodes
- Originally developed by Datapoint Corporation as an office network
- Chip sets available from SMSC
- ANSI/ATA 878.1-1999 Standard
- Ideally suited for an industrial network
What are ARCNET’s Benefits?

- Broad Acceptance
- Large Installed Base
- Deterministic Performance
- Simple to Install
- Low Cost per Node
- Robust Design
- Multiple Cable Media Support
- Multi-master Communication
Where is ARCNET Used?

- HVAC
- Motor Drives
- Power Generation
- Data Acquisition and Control
- Manufacturing Information Systems
- Office Automation
- Shipboard Automation
Where is ARCNET Used?

- Printing Press Controls
- Telecommunications
- Gaming Machines
- Vehicular Navigation
- Security Systems

Any application where real-time performance, high security and robust design is important.
How Does ARCNET Work?

- Distributed Star topology requires the use of hubs
How Does ARCNET Work?

- OSI Reference Model

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td></td>
</tr>
<tr>
<td>Presentation</td>
<td></td>
</tr>
<tr>
<td>Session</td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td></td>
</tr>
<tr>
<td>Network</td>
<td></td>
</tr>
<tr>
<td>Data Link</td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td></td>
</tr>
</tbody>
</table>

ARCNET defines the bottom two layers of the OSI model
ARSNET Protocol

- Only Five Simple Commands
  - ITT - Invitation to transmit
  - FBE - Free buffer enquiry
  - PAC - Packet
  - ACK - Acknowledgement
  - NAK - Negative acknowledgement
ARCNET Protocol Features

- Deterministic Token Passing
- Packet Flow Control
- Error Detection
- Auto Reconfiguration
- Variable Packet Size
- Supports Various Transceivers & Media
- Supports Various Software Drivers
- Up to 255 Nodes Per Network
Token Passing - Transmitting on the network is only permitted when a node has the token.

Every node can transmit once during each token rotation.

Benefits:
- Every node has a guaranteed response time to transmit
- Deterministic behavior
ARCNET Protocol Features

- **Auto-Reconfiguration** - Network is automatically reconfigured when a node joins or leaves the network
  - Token pass is automatically reconfigured
    - Typical time 20 - 30 ms
  - Supports live node insertion and deletion

- **Variable Packet Size**
  - From 1 to 507 bytes per packet
Packet Flow Control - Transmitter checks receiver to make sure it is ready to receive a packet
- Reduced software overhead
- Increased bandwidth
- No lost packets due to input buffer overruns
ARCNET Protocol Features

- Error Detection - 16 bit CRC checks each packet
  - Corrupted packets automatically rejected
  - Transmitter is aware of the error
  - Reduced software overhead
  - Better CPU utilization
ARCNET Logical Ring

- Token passes from low to high address

Diagram:
- Node 6
- Node 109
- Node 255
- Node 122
ARCNET Frames

ITT = ALERT EOT DID DID

FBE = ALERT ENQ DID DID

PAC = ALERT SOH SID DID DID CP DATA ... DATA CRC CRC

ACK = ALERT ACK

NAK = ALERT NAK

Only PAC has a variable length frame
Token Pass

Source Node

ITT

Destination Node
Packet Transmission

<table>
<thead>
<tr>
<th>Source Node</th>
<th>Destination Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBE</td>
<td>ACK</td>
</tr>
<tr>
<td>PAC</td>
<td>ACK</td>
</tr>
</tbody>
</table>

- FBE: Forward Block Error
- PAC: Page Address Control
Receiver Unavailable

Source Node  Destination Node

FBE  NAK
Failed Packet Transmission

<table>
<thead>
<tr>
<th>Source Node</th>
<th>Destination Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBE</td>
<td></td>
</tr>
<tr>
<td>PAC</td>
<td>ACK</td>
</tr>
</tbody>
</table>
### ARCNET Message Timing in Microseconds (2.5 Mbps)

<table>
<thead>
<tr>
<th>Message Type</th>
<th>Time (µs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITT</td>
<td>15.6</td>
<td>invitation to transmit</td>
</tr>
<tr>
<td>Tta</td>
<td>12.6</td>
<td>turnaround time</td>
</tr>
<tr>
<td>FBE</td>
<td>15.6</td>
<td>free buffer enquiry</td>
</tr>
<tr>
<td>Tta</td>
<td>12.6</td>
<td>turnaround time</td>
</tr>
<tr>
<td>ACK</td>
<td>6.8</td>
<td>acknowledge</td>
</tr>
<tr>
<td>Tta</td>
<td>12.6</td>
<td>turnaround time</td>
</tr>
<tr>
<td>PAC</td>
<td>33.2 + 4.4</td>
<td>+4.4 µsec/byte</td>
</tr>
<tr>
<td>Tta</td>
<td>12.6</td>
<td>turnaround time</td>
</tr>
<tr>
<td>ACK</td>
<td>6.8</td>
<td>acknowledge</td>
</tr>
<tr>
<td>Tta</td>
<td>12.6</td>
<td>turnaround time</td>
</tr>
</tbody>
</table>

141 µsec + 4.4 µsec/byte  
Minimum Message: 141 Microseconds
If You Cut ARCNET...

...You Just Get Two ARCNETS Within Milliseconds
ARCNET Cabling

- Flexibility
  - Distributed Star Topology Requiring Hubs
  - Hub-less Bus Topology
  - Coaxial Cable
  - Twisted Pair
  - Fiber Optics
Traditional ARCNET

- Coaxial Cable In a Star Topology
  - Either a star or distributed star topology
  - Utilize active or passive hubs
Coaxial Star

- Original method of communication
- RG-62/u coaxial cable
- BNC connectors
- Only two transceivers per segment
- Segment length up to 2,000 feet
- Requires the use of a hub to go beyond two stations

We call this –CXS.
Traditional ARCNET

- **Coaxial Bus**
  - Lower cost hub-less network
  - RG-62/u coaxial cable
  - Up to eight NIMs per bus segment
  - Segment length limited to 1,000 feet
  - BNC connectors and Tees
  - Requires end of line terminators

We call this –CXB.
Traditional ARCNET

- Twisted-Pair Star
  - Requires active hubs for network expansion
  - Only 328 foot segment length
  - RJ-11 connectors
  - Utilizes BALUN’s to convert from coaxial cable to twisted-pair

We call this –TPS.
Traditional ARCNET

- Twisted-Pair Bus
  - Modified circuitry of coaxial bus implementation
  - Supports eight nodes
  - Reduction in segment length to 400 feet
  - RJ-11 or RJ-45 connectors
  - Requires end of line terminators

We call this –TPB when using RJ-11 connectors and –TB5 when using RJ-45 connectors.
Traditional ARCNET

- Fiber Optics
  - 850 nm wavelength with ST connectors
  - 62.5/125 duplex multimode fiber cable
  - 6000 foot segment length
  - Large networks can be achieved by cascading hubs
  - ARCNET controller chips may need to be set to extended timeouts

We call this –FOG.
Traditional ARCNET

- Fiber Optics
  - 1300 nm wavelength with ST connectors
  - 62.5/125 duplex multimode or duplex single-mode fiber cable
  - 10,000 m multimode and 14,000 m single-mode

We call this –FG3.
Traditional ARCNET

- Dipulse Signaling at 2.5 Mbps
Newer ARCNET Controllers

- Will default to traditional ARCNET or can be set for additional features
- SMSC 20019; 20020; 20022
  - Wide data rate selection up to 10 Mbps
  - Introduces backplane mode as a lower cost alternative to dipulse signaling
  - Directly supports low cost EIA-485 transceivers
    - AC coupled EIA-485
    - DC coupled EIA-485
COM20020

- ARCNET Communications Processor
  - Direct bus interface to all processors (maps into data memory)
  - Internal 2Kx8 Packet buffer RAM
  - Data rates up to 5Mbps
  - Various media and topology
  - Command chaining
  - Receive all packets mode
  - Built-in diagnostics
  - Industrial temperature range (-40C to +85C)
  - 28 pin PLCC or 24 pin DIP package
COM20022

- High Performance ARCNET Controller
  - 19 Kbps to 10 Mbps
  - 8/16 bit bus
  - DMA channel
  - Programmable Reconfiguration Timer
  - 48 pin TQFP package
Enhanced ARCNET

- DC coupled EIA-485 transceivers
  - Non-return to zero (NRZ) encoding
  - Twisted-pair bus cabling
  - RJ-11 or screw terminals
  - 17 stations per bus segment
  - 900 foot maximum segment length
  - Data rates from 156 kbps to 10 Mbps

We call this –485 for backplane mode and –485D for non-backplane mode.
Enhanced ARCNET

- AC coupled EIA-485 tranceivers
  - Alternate mark inverted (AMI) encoding
  - Twisted pair bus cabling
  - RJ-11 or screw connectors
  - 13 stations per bus segment
  - 700 foot maximum segment length
  - Data rates from 125 Mbps to 10 Mbps

We call this –4000 for backplane mode and –485X for non-backplane mode.
Nework Interface Modules

- We support all the popular bus structures
  - PCX20 series for 8-bit ISA bus
  - PC10420, PC10422 series for PC/104 bus
  - PCI20U series for universal PCI bus
  - USB22 series for USB 2.0 bus
Active Hubs

- MOD HUB series of modular active hubs
  - 2.5 Mbps operation
  - EXP expansion modules

- AI Series of fixed port hubs links and repeaters
  - Data rates up to 10 Mbps
  - Two or three ports
ARCNET Trade Association

- Promotes the Use of ARCNET
- Resource for ARCNET Users
- ANSI Recognized Standards Body
- Establishes Standards
  - ANSI / ATA 878.1-1999
  - ATA 878.2
  - ATA 878.3
Thank You

Visit our web site at http://www.ccontrols.com/