Intelligent Motor Control Centers - The Present and the Future

Dave Blair
Commercial Marketing Manager
Rockwell Automation MCC Business

Greg Witte
AGG/Cement & Mining Bus Dev Mgr
Rockwell Automation Sales Group
MCC is basically just familiar motor control components in a common enclosure

Combination Starters

Circuit Breakers
The MCC Difference: Ability to Plug In

Plug in an Electric Device

Plug in a Combination Starter
Definitions

Section
-provides grid of power
-integral wireways

Unit
-plugs into section
1990’s: Clear Trend Toward More Intelligence in MCC

- 35% of sections include intelligent products:
  - AC drives
  - Solid-state controllers
  - PLC I/O chassis
  - Power monitoring devices
  - Electronic overload relays

- Drivers
  - More devices designed to fit plug-in units
  - Fault containment
  - Servicing of devices with adjacent equipment energized
  - Wiring and installation time
Integration Accomplished via Hardwiring

- Devices hardwired to I/O Chassis
- On-Off control and monitoring
  - Contactor status
  - Disconnect status
  - Overload status
- Transducers sometimes used for process monitoring

*Roundtables held in 1998 to discuss opportunities for better utilizing current technology and integrating new technology*
1. Users focusing more on device intelligence and system integration than traditional MCC features
2. Users approaching device-level communication networks with caution
3. Users demanding useful information
   - Improved diagnostics and predictive failure information
     - intelligence in all end devices, not just critical areas
     - networked access to device information
     - real-time device monitoring and trending
     - process or component history
4. Users demanding Plug & Play solutions
   - Pre-tested, pre-configured systems for reduced installation time & start-up
   - User-friendly PC interface
Consider the Following Scenario

What tripped?

Why did it trip?

Was it preventable?

How do we fix it?

Is anything else going to trip... how soon?

Enough with technology.
Provide answers to these simple questions!
Concept

• Traditional interwiring replaced by single open device-level network cable
• Network-ready device in every MCC unit
• Transportable MCC software for monitoring and documentation
• System pre-tested and pre-configured before shipment
Network Cabling Alternatives

Obvious Cabling Approach

• Route Cabling Through Wireways
  – Trunk line in horizontal wireway
  – Drop line in vertical wireways
    • Device connected via “daisy chain”

Typical Smart MCC Lineup

Control-level Network
Device-level Network Trunk Line
Device-level Network Drop Line
Network Cabling Alternatives

Optimized Cabling Approach

- Network cabling behind barriers
  - Prevents damage which may occur during installation
- 8A, Class 1 cabling
  - Eliminates need for >1 power supply in most MCC line-ups
  - Eliminates need for separation from power cables
Optimized Cabling Approach

- Device-level network ports in each vertical wireway
  - Simplified installation, relocation, and adding of units
  - Superior to daisy-chain, where downstream equipment may unintentionally be shut-down
Network-ready Devices

Interface Module for Non-intelligent units

• Network capability required in all units, even non-intelligent units
  – Traditional motor starter
  – Feeder and main disconnects
• Solution: Low-cost, mini “I/O Chassis” in each unit
  – 4 inputs and 2 outputs
  – monitoring of contactor, hand-off-auto, overload relay, and disconnect
  – direct control of contactor coil
Network-ready Devices

Electronic Overload Relay at Core of Intelligent MCC

- Protection that extends beyond OL protection
  - Thermal Overload
  - Phase Loss
  - Stall (high overload during start)
  - Jam (high overload during run)
  - Underload
  - Current Imbalance
  - Zero sequence ground fault, sensitive to 1A
- Input points

- Programmable protective functions
  - alarm level
  - trip level
  - time delay
  - inhibit window

- Information:
  - Time-to-trip
  - Time-to-reset
  - Percent thermal capacity
  - Cause of last 5 trips and warnings
Electronic OL Relay Capabilities Illustration

- Solid-state Overload
- DeviceNet Comm Module
- Ground Fault
- I/O Aux. Module
- Jam / UL Relay
- Thermistor Relay

Intelligent Motor Control Centers - 15
Transportable MCC Software

The ultimate window into MCC’s

- MCC monitoring in Windows environment
- Pre-configured screens display real-time information
- Complete system documentation
- Software optimized to ensure performance
  - Polling algorithm segregates monitoring and control, so monitoring scans do not affect control scans
Transportable MCC Software

Elevation View
Unit View
User Manuals
AutoCAD Drawings

Additional Screens
• Spare parts
• Event logging
• Spreadsheet view
Transportable MCC Software

- Software can reside anywhere in user’s facility
  - Control room
  - Engineer’s desk
  - Laptop used by maintenance personnel
- Flexibility made possible by communication driver
The Future of MCCs…

The *Intelligent* MCC

- **Software provides ultimate window into MCC**
  - Real-time monitoring
  - Access from anywhere in the facility
  - Complete documentation and MCC history

- **Device-level products capture new information**
  - Allows predictive maintenance, process monitoring, and advanced diagnostics

- **Built-in network simplifies MCC design and installation**
  - Ease of moving and adding units
  - Prevents accidental damage to network cables

- **Plug & Play system**
  - Pre-tested and pre-configured
  - No set-up, no programming, no expert required
Intelligent Motor Control Centers - 20

- Ethernet
- DeviceNet
- PV 1000C
- 24vdc
- 509 -BOD
- Flex I/O
- Conveyor / Zone Controller
- ControlLogix/ProcessLogix
- Open Network for Mine Site Monitoring and Control

- Hazardous Area
- ControlNet
- Flex EX I/O
- DeviceNet
- EZ-Link
- Controlled Start Transmission
- EZ-Link
- Flex I/O
- PV 600C
- CNET
- DNET
- EZ-Link
- CNET
- Fieldbus
- CNET
- ControlLogix
- 1305/1336+
- Drive

Open Network for Mine Site Monitoring and Control
Typical Devices on DeviceNet

- Sensors, actuators & switches
- Simple Human-Machine Interfaces
- Operator Interfaces
- Push buttons
- Micro Drives
- Robots
- Software
- Pneumatic Valves
- Bridges/Gateways etc.
While overlap exists, polarized needs demand two physical networks.
**Network Specifications**

**Network Power**
- 24vDC power to devices
- Thick & Flat trunk rated to 8 amps
- Thin wire rated at 3 amps

**Maximum Devices**
- 64 Nodes per Network

**Physical Media (Shielded Twisted Pair)**
- Communications and Power
  - Thick - Trunk or drop
  - Thin - Trunk or Drop
  - Flat - Trunk only

**Trunk line Distance and Baud rate**
- 100m Max. with Thin cable
- 500m @ 125Kbaud (thick)
- 250m @ 250Kbaud (thick)
- 100m @ 500Kbaud (thick)
  (4Km with Repeaters)

**Device Connections**
- T-Taps
- Zero-drop

**Terminating Resistors**
- 120Ω Resistors at both network trunkline ends

**Messaging Services**
- Producer/Consumer
  - High-speed I/O
  - Programming
  - Configuration
  - Diagnostics

**Drop-line wiring**
- Single drop
- Daisy-chaining off drop
- Branching off drop

**Cumulative Drop-line Budget**
- 156m @ 125Kbaud
- 78m @ 250Kbaud
- 39m @ 500Kbaud
  (Maximum of 6m each)
Open DeviceNet Vendor Association (ODVA)

• **Ownership of DeviceNet technology**
  – Specifications
  – Electronic Data Sheets (EDS)
  – Trademark

• **Over 360 members worldwide**
  – ABB, Allen-Bradley, ASCO/Joucomatic, Banner, Beldon, Cutler-Hammer, Festo, Hitachi, Intellution, Mitsubishi, Modicon, Nematron, Omron, Parker Hannifin, Pepperl+Fuchs, Reliance, Square D, SMC, Toshiba, Turck, Wonderware, etc.

• **Over 40 SI/OEM members**
  – Alvey, Jervis B. Webb, KR Automation, Rapistan Demag, ...

• **Internet Home Page (http://www.odva.org)**
  – On-line Product Catalog
  – Newsletters/Current Events
  – Member companies + contact names
  – Specifications order form
CAN is an excellent foundation for a simple device network

(Controller Area Network)

- CAN is open technology supporting multiple applications
- Chips available today from Intel, Motorola, Philips/Signetics, NEC, Hitachi, Siemens
- Volumes from multiple industry usage insures downward price pressure - over 120 million chips in 2000
- Original use in automobile environment
  - an excellent proxy for industrial applications
  - temperature extremes, high noise environment
What is the basis of DeviceNet??

In terms of network bandwidth efficiency and overall system performance, DeviceNet have implemented a paradigm that is ahead of traditional source-destination networks. It’s called Producer - Consumer.
Source/Destination Example

One person ("source") tells each person ("destinations") in the room, one at a time, the current time of day (data)

- People may choose to ignore, but time and effort is wasted
- Time will pass as the "source" communicates to each "destination", one by one
- Delivery time changes with the number of people in the room
Producer/Consumer

One person states (“produces”) the current time of day (data) once to one or more people (“consumers”)

- All people hear the data **simultaneously**
- Some people may choose to listen to (“consume”) the data (acknowledge by nodding, adjust their watch, etc.)
- Others may choose to ignore (“not consume”) the data
- Highly efficient (delivery time consistent if more people enter or people leave the room)
DeviceNet Cable Highlights

- **5 Conductors**
  - 1 pair for 24 Volts DC power
  - 1 pair for CAN communication
  - 1 Shield
Node Commissioning of Devices

- Every DeviceNet device needs at a minimum a unique node address (0-63) and appropriate data rate (125kb, 250kb, or 500kb) set prior to gaining access to the network.

- **NOTE:** devices default to address #63, data rate 125 kbps
Replacing Devices

- Set node address, data rate (or Autobaud)
- Configure device parameters
- Connect device to system
- Slave devices must pass electronic “key”
  - device type
  - manufacturer
  - part number
- NEW! Auto Device-Replace (ADR)
Auto Device Replace (ADR)

- ADR consists of two parts which are Node Recovery and Configuration Recovery. Node Recovery cause the node number of the replacement device to be automatically changed to the node number of the original device.

- Configuration Recovery will cause the replacement devices configuration to be made identical to the original device.
Configure and Monitor Devices Online

Using an Electronic Data Sheet (EDS) for any device, from any vendor, configure and monitor devices Online. The EDS file format is a standard and is defined by ODVA in the DeviceNet specification.
Each EZLINK interface acts like a node on the network and gives diagnostic information about the bearing status back to the network master. (Speed, vibration, and temperature)

Dodge bearing also has available a PC-based monitoring software package that monitors the diagnostic information over DeviceNet. The software then displays the data in various forms such as meters, graphs, etc.

EZLINK Smart Bearing
Reliability Centered Maintenance

Asset maintenance requirements

Reliability Centred Maintenance

Design Out  Run to Fail  Planned  Predictive

Engineering  Breakdown  CMMS  CM