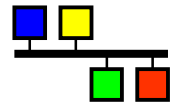


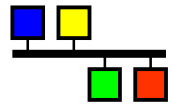
DirectNet for MPF

Andrew Johnson

APS / ANL

DirectNet Protocol

EPICS



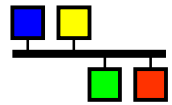
- Used by Direct Logic PLCs from Automation Direct
  - 205 series: DL250 and DL240 CPUs have built-in support
  - Some 305 and 405 series CPUs also support directNet
    - Some changes may be needed to support these
- Master/slave serial protocol for PLC data
- Asynchronous RS232C or RS422, 300 to 38,400 baud
- Can drive up to 90 PLCs on one serial line
  - Point-to-point or multi-drop configurations possible
  - Up to 3300 feet/1000 meters
- Provides remote access to PLC data
  - I/O points, V-memory, timers, counters, relays and stages
  - Ladder logic and internal scratchpad data also accessible
    - Remote ladder logic programming is not implemented yet

DirectNet for Bitbus at APS

- DirectNet used in APS vacuum controls since 1999
- Connected to an RS232 Bitbus Universal Gateway with custom BUG firmware
  - Implemented directNet protocol in BUG
  - Reduce Bitbus link traffic and protocol handshake delays
- Disadvantages:
  - Needs Bitbus — extra VME board, limited message size
  - BUG firmware is hard to modify and debug
  - Doesn’t support remote ladder logic programming
  - Not usable outside of APS

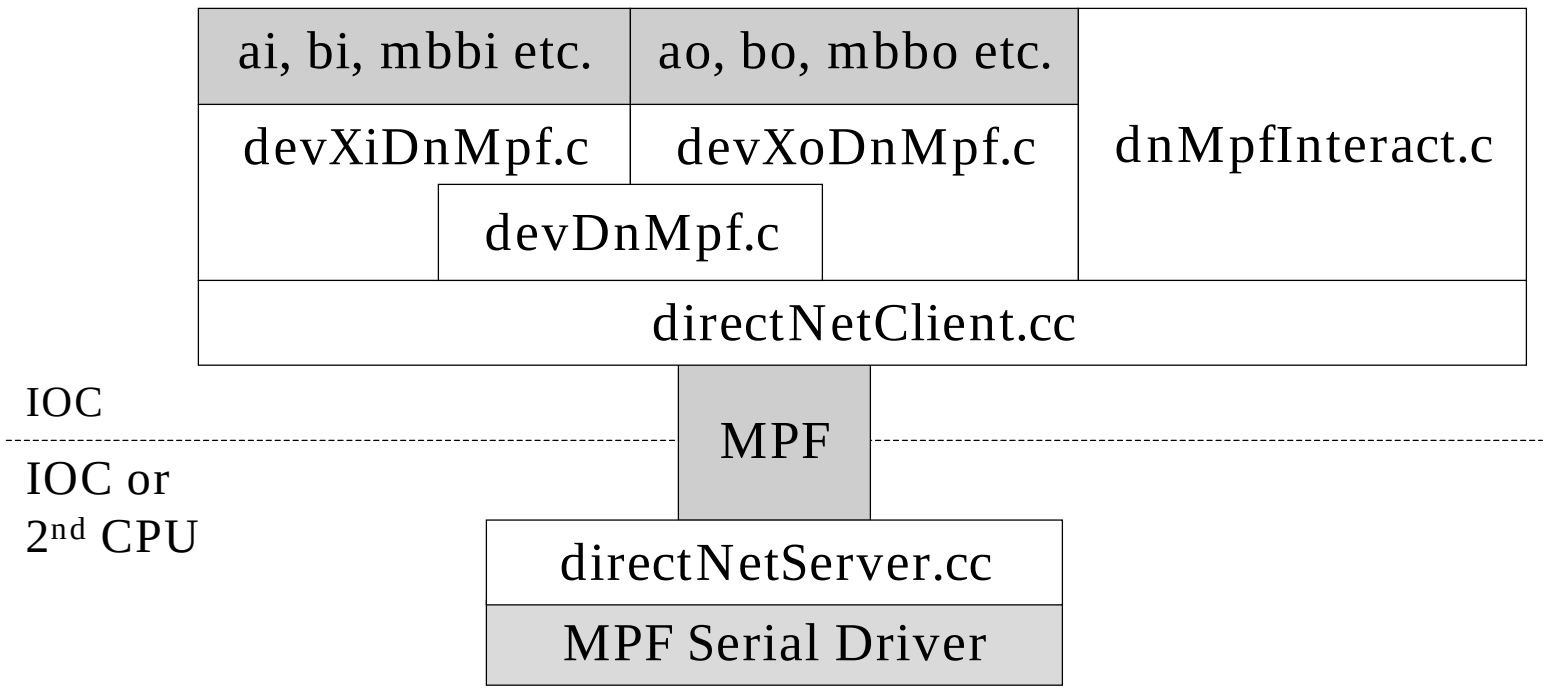
Why use MPF?

EPICS



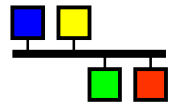
- Supports multi-port serial IP module (SBS Octal Serial)
  - Other ports can be used if MPF serial support is written
- Works with any drvIpac IP carrier board
- Optional secondary CPU can reduce IOC workload
- The IOC can be distant from the secondary CPU & PLC
- DirectNet for MPF was developed with
  - MPF 1-7
  - MPF Serial 1-3
  - Earlier versions might also work

Driver Structure



PLC Addressing

EPICS



- PLCs are named in the vxWorks startup script

  `createDnMpfPLC("VAC01", 1, "DNServ01", 0)`

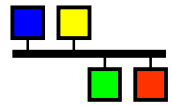
- Records use addresses familiar to PLC programmers

`@VAC01 X24`	X-input bit 024
`@PLC5 V2005`	V-memory word 02005
`@Mul9 CTA6`	Counter 6 value
`@RM101 T42`	Timer 042 status bit

- Addresses are expressed in octal
- Input records can address any PLC location
- Output records can only write to locations V2000-V2777
  - Prevents IOC from changing PLC outputs directly
    - To control hardware, a PLC program must copy the value
  - Ensures PLC programs can avoid all interference from an IOC

Record Types Supported

EPICS



Input Records:

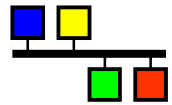
- Binary input (bi)
- Multi-bit binary input (mbbi)
  - Reads up to 16 bits from any single PLC data word
- Multi-bit binary input direct (mbbiDirect)
  - As for mbbi
- Analog input (ai)
  - Reads a whole PLC data word
  - PLC must convert internal BCD values to Binary first
  - Input conversions (LINR field) are not supported

Output Records:

- Binary output (bo)
- Multi-bit binary output (mbbo)
  - Writes up to 16 bits to any single PLC data word
- Multi-bit binary output direct (mbboDirect)
  - As for mbbo
- Analog output (ao)
  - Writes a whole data word
  - PLC must convert from Binary to BCD if needed

Read and Write Caches

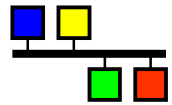
EPICS



- Read data from a PLC is cached
  - "Nearby" data values are grouped into a single request
    - Locations up to 16 words (32 bytes) apart are considered "nearby"
  - Periodic scanned records get cached data unless it is older than half their scan period
    - Many records addressing the same location or group will not cause unnecessary repeat reads
  - SCAN = I/O Interrupt can be used to process a record whenever its cache group gets new data
    - At least one record in the group must initiate a read
- Write data uses a separate write-through cache
  - Multiple bo records can safely set different bits in the same word
  - IOC and PLC cannot both safely update bits in the same word

Status Information

EPICS



- **`dbior`** displays per-PLC status information
  - Communications statistics (#reads, #writes, #failures)
  - Cache line ranges and timestamps
  - Cache buffer contents
- DirectNet Interactive program for command line use
  - Displays data from any PLC location
  - Can modify the value at any V-memory location
    - A hidden command is needed to write outside the usual limits
  - May eventually be able to update PLC ladder logic programs