

Camera Control Nodes

Camera Electronics Workshop

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[LSST](#)

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With notes from:

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APC-Paris 7

[PDF Version](#)

[Account of ELS Work](#)

System Architecture

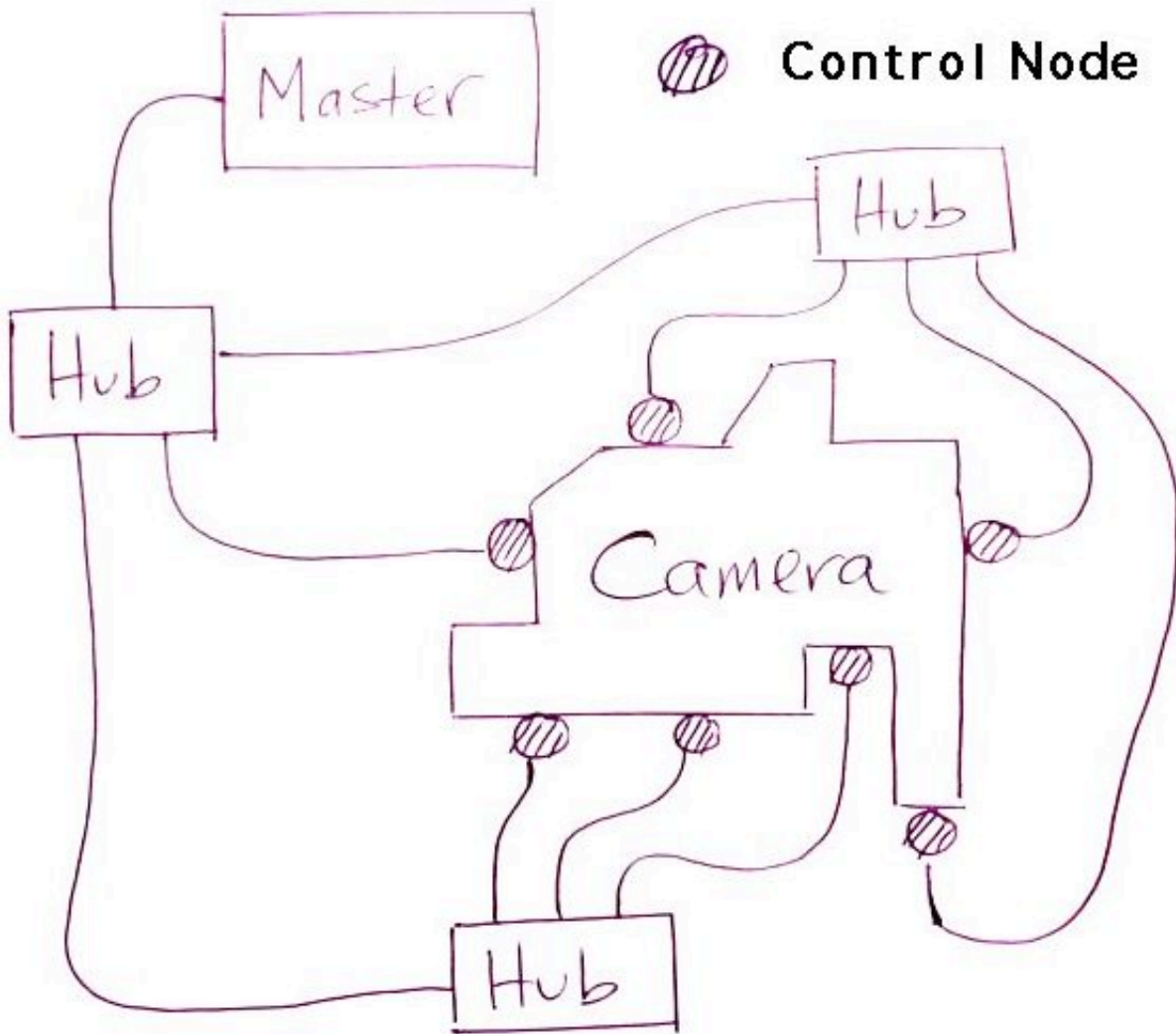


Figure: The Camera Control System.

Master controls nodes over CAT-5 Ethernet.

Example Nodes

Possible Input-Output Formats:

- Servo Motor Drive
- Stepper Motor Drive
- TTL Switching Output
- Analog Temperature Input
- LVDS Communication

The Timing and Control Module:

- 50 MHz Data Clock Distribution
- 50 MBPS Serial Transmission
- 50 MBPS Serial Reception
- Transmit 32-MByte images

Reference Design

The CCS group proposes:

- Off-the-shelf ix86 processor in PC104 format
- Off-the-shelf input-output boards in PC104 format
- Custom input-output boards where necessary
- Linux operating system

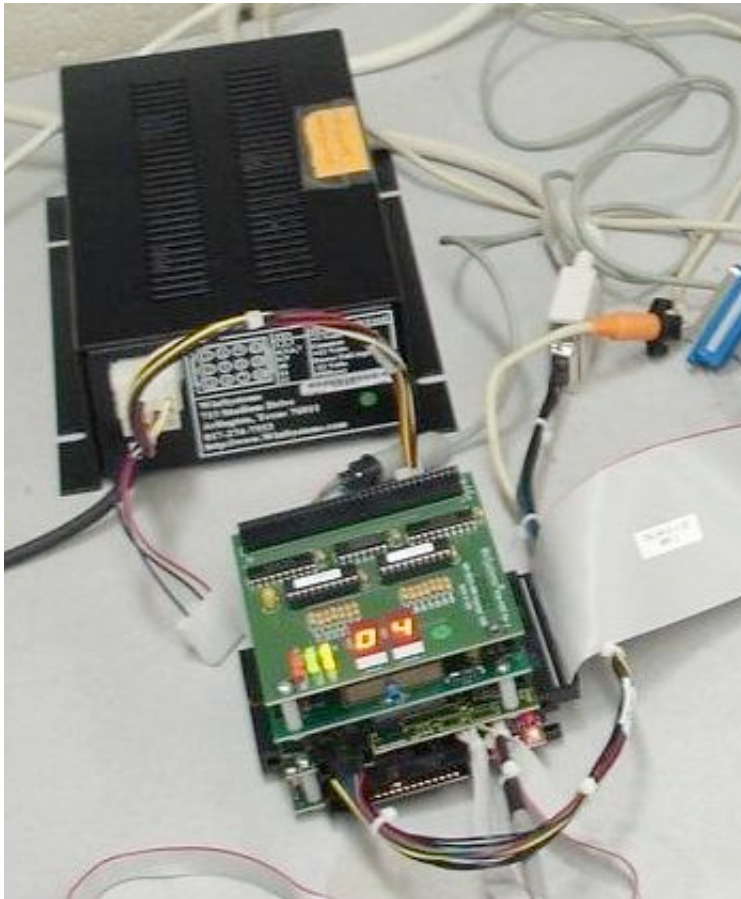


Figure: Our PC104 Embedded Linux System.

Demonstration in Paris

Eric Aubourg and Laurent Guglielmi of APC-Paris 7 (IN2P3+) tried:

- AMD Geode board with 512 Mb RAM and 1 Gb flash memory "HDD"
- Minimal debian linux
- Compile C/C++ on VMWare similar system with full development environment
- Java Runtime (JRE) 6
- Compile Java on Mac/Win/Linux
- DMM IO board
- Digital 8-bit in/out
- Analog 12-bit in (8/16 ch)/out (2 ch)
- 100 kHz sampling
- Two lines of C to interface with Java
- A Java MBean represents its state

Demonstrated:

- Flashes lights fast enough to implement dimmer.
- Receives instructions from laptop running Java application.
- Reads thermometer and produces live temperature plot.
- Observed destruction of a PC104 computer several days after one analog output shorted.

Demonstration in Boston

Kevan Hashemi of Brandeis University tried:

- From [WinSystems](#)
- [PCM-SC520](#) embedded computer, i486 133 MHz.
- [PCM-UIO48A](#) 48-line digital I/O card
- Embedded Linux System based upon [Simply MEPIS](#)
- Total [price](#) \$1500 with flash card and power supply.
- Use PCM-UIO48A device driver binary supplied by WinSystems.
- Compile C-code on desktop Scientific Linux Machine.
- Copy compiled code to flash disk or transfer by ftp.

Demonstrated:

- Flash lights at up to 90 kHz.
- TCPIP transfer at 4 MBytes/s.

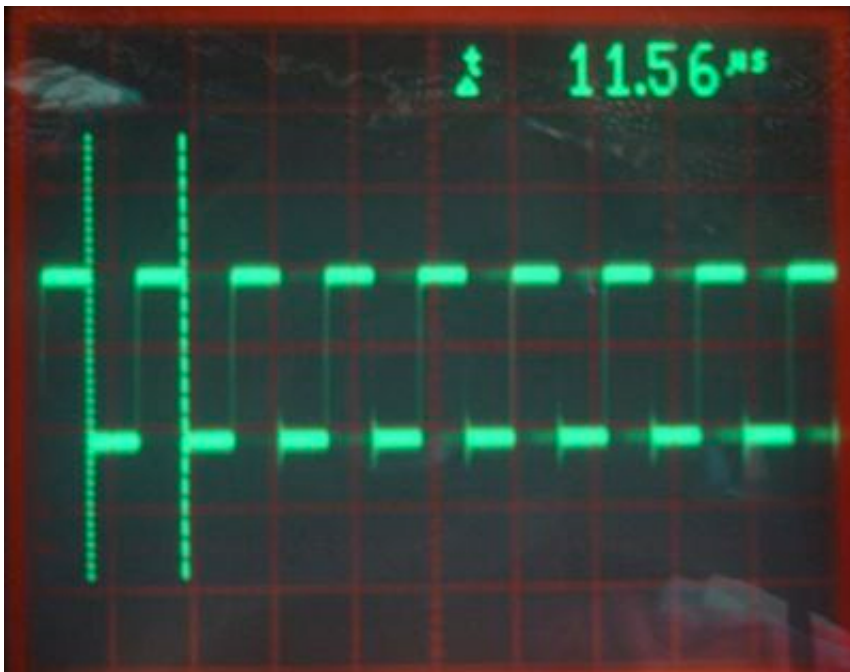


Figure: Minimum Output Bit Period.

Implications

- Cannot compile device drivers on Scientific Linux for our ELS.
- Can compile drivers from source code in VMWare emmulator.
- VMWare emmulation of embedded system easy to install.

Recommend: VMWare for development.

- Byte-by-byte device drivers compiled from C are slow.

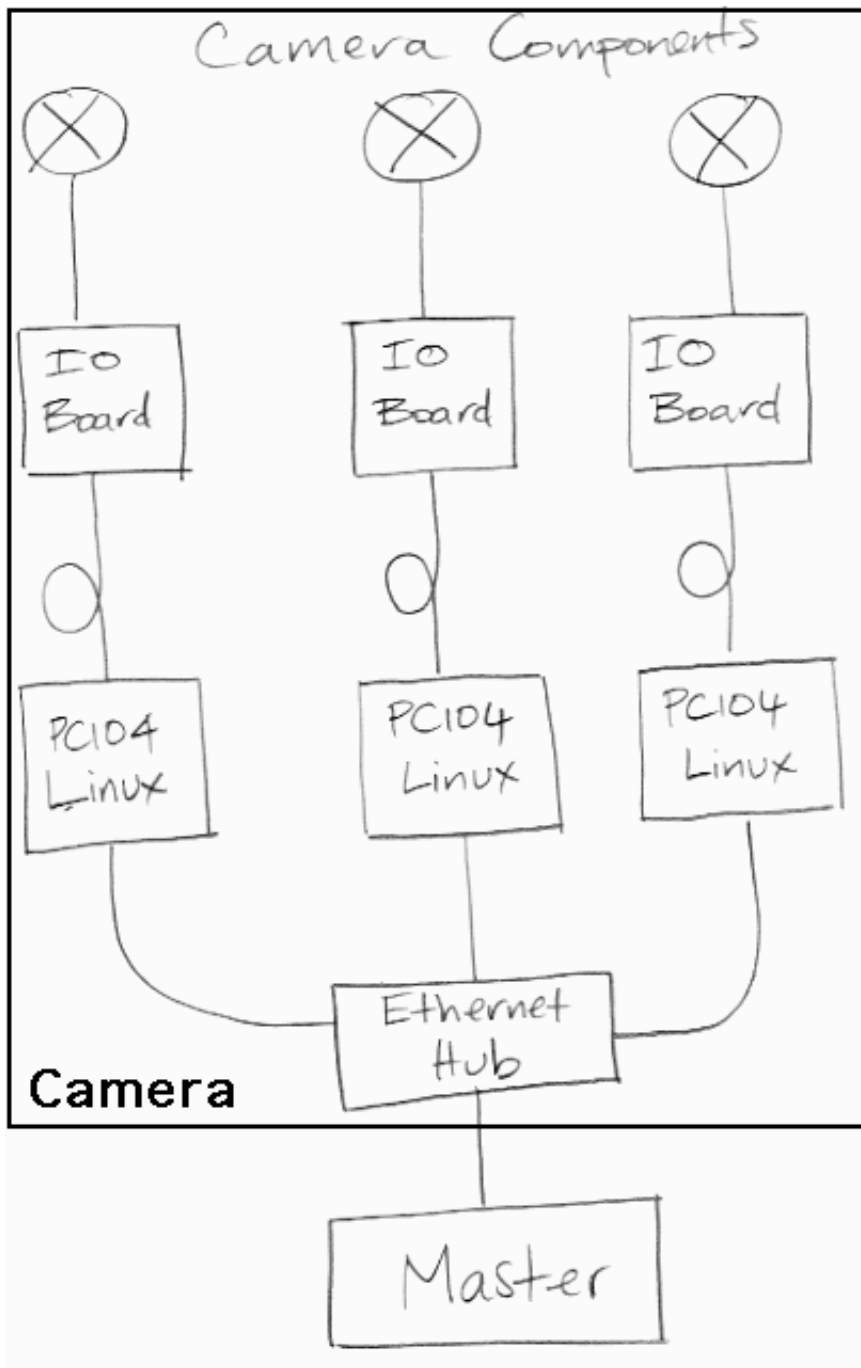
Recommand: Block moves or drivers written in assembler.

- Off-the-shelf IO boards can expose PC104 motherboard to damage.

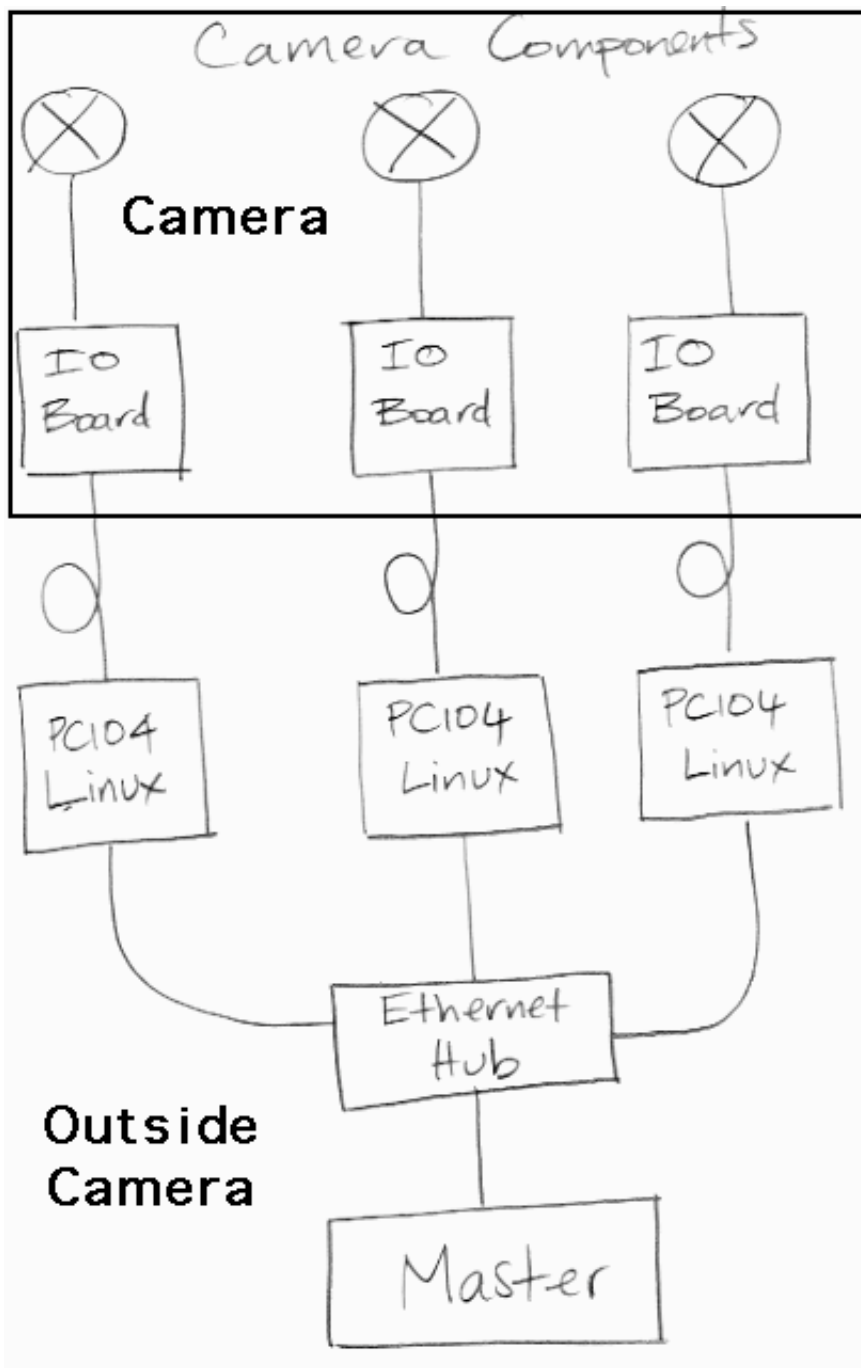
Recommend: Thorough destructive testing of Off-the-shelf boards.

Suggest: PC104-format custom-made IO boards for speed and reliability.

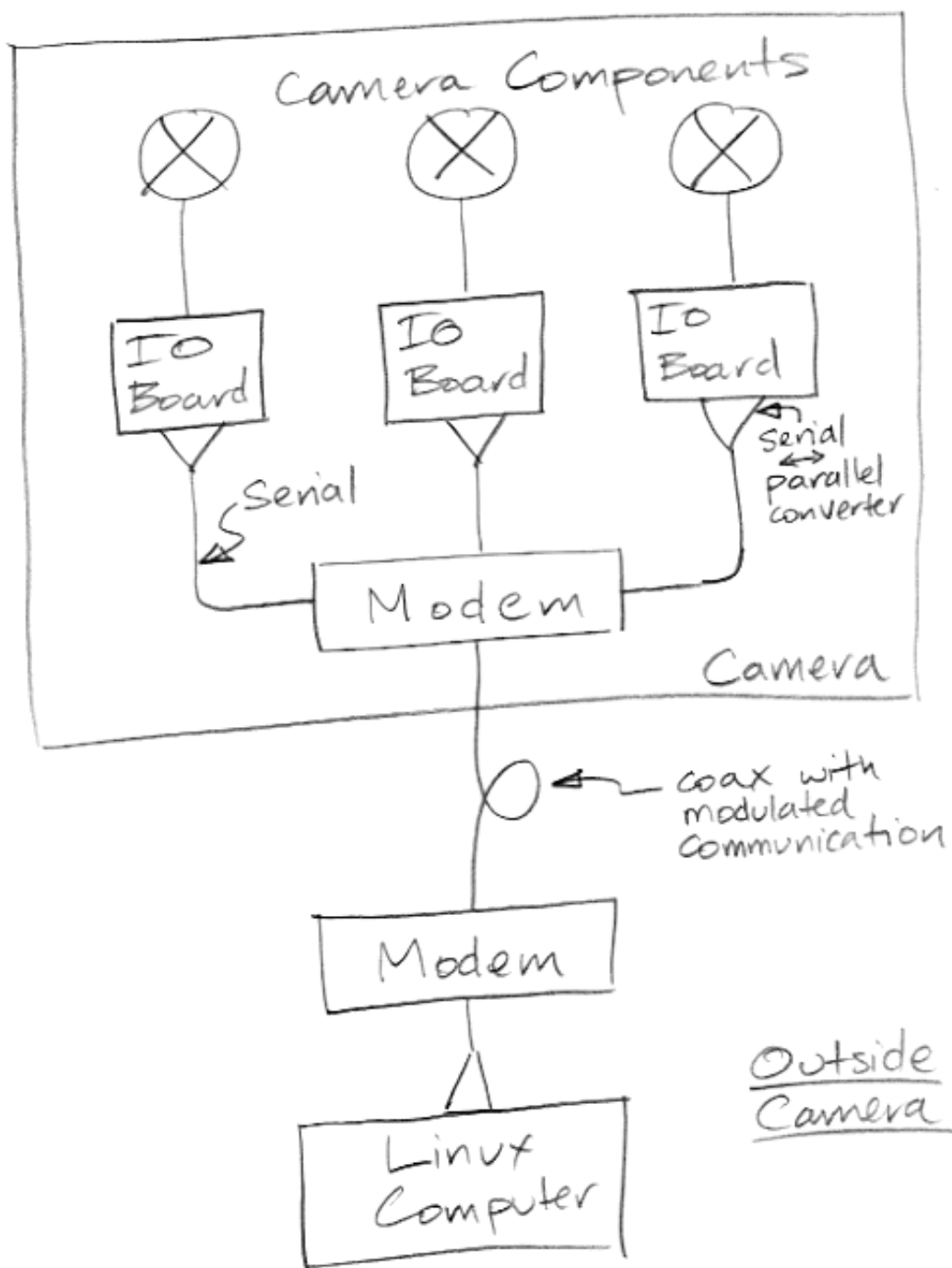
Re-Examination of CCS Architecture



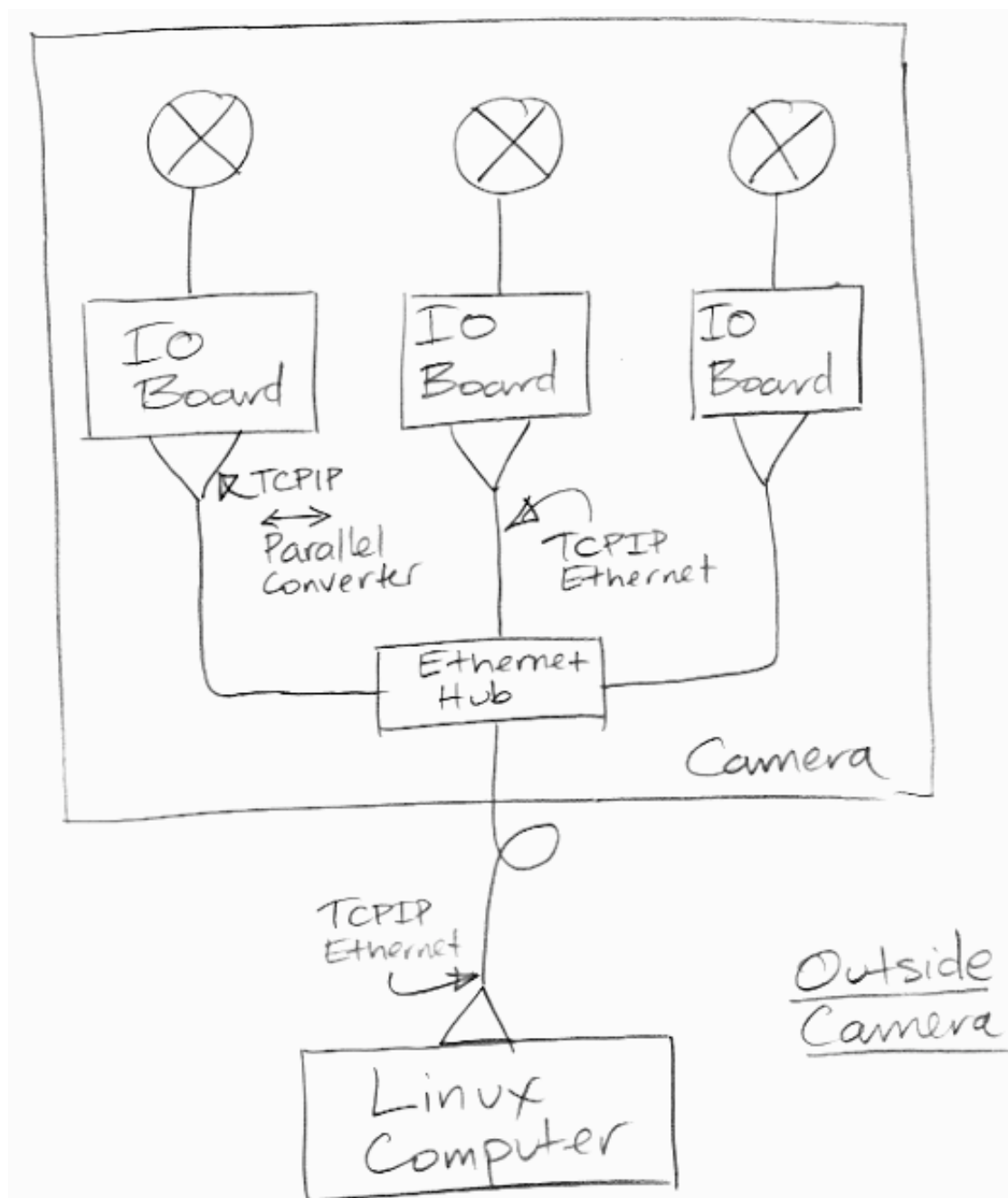
Move PC104s Outside Camera



Reduce Cables: Old-Fashioned Way



Reduce Cables: New-Fangled Way



TCPIP-Parallel Converter



The [RCM4200](#):

- 60 MHz 8-bit processor
- 10/100 Ethernet and TCPIP Stack
- Byte-Wide IO Ports
- Real-Time Clock
- \$100 in single quantity
- Byte-wise IO: 3 MBytes/s
- TCPIP IO: 500 kBytes/s
- Development environment available only for Windows
- Development environment costs \$200.

Conclusion

With Linux computers in Camera:

- VMWare is effective platform for embedded Linux development.
- Java libraries provide open-source publish-and-subscribe protocols.
- Expect no problems adding DDS to PC104 modules.
- Doubt we can run LabView effectively on PC104 modules.
- For fast response, need to find fast IO boards and drivers.
- For rugged system, need to make or find rugged IO boards.

With Linux computers out of Camera:

- Can use TCPIP-Parallel converter modules to communicate with IO boards.
- Camera-resident electronics becomes simpler and more rugged.
- Provides fast response at IO Boards.
- Minimal load upon local network.
- Branedis has extensive experience with this solution.
- Shorter development time for camera control nodes.
- DDS and other control software runs on larger, faster machines.