softGlue

(software configurable Glue electronics)

User programmable digital electronics
softGlue: at a glance

• Fixed collection of digital logic elements
  – Gates, counters, flip-flops, etc.
  – Loaded into FPGA at boot time
• Programmable connection to field I/O
• Circuit is “wired” by the values of EPICS string PV’s:

Same name: connected (* means “invert”)

Display signal value
softGlue: EPICS API

• EPICS records, clients can also read and write logic/parameter values directly:

“Show me everything this signal is connected to”
softGlue: field I/O

• Software configurable digital I/O
  – 48-bit TTL (or 24-bit RS-422, LVDS, etc.)
  – field I/O direction specified at boot time
  – **Safe**, run-time modifiable, interrupt dispatch:
    • On rising edge
    • On falling edge
    • On both
    • On neither
softGlue: FPGA content

Typical collection of electronics elements:

~anything can go here
softGlue: FPGA content

- 4 AND gates
- 4 OR gates
- 4 Buffers
- 2 XOR gates
- 48 field I/O points (inputs or outputs)
- 4 Down counters
- 4 Up counters
- 4 Divide-by-N’s
- 4 D Flipflops
- 2 Multiplexers
- 2 Demultiplexers

Also can add custom FPGA content, and provide softGlue interface to selected inputs, outputs, and numeric parameters. Talk to Kurt Goetze.
softGlue: example applications

- Digital I/O
  - With no programming, softGlue functions as 48-bit I/O
- Coordinate digital electronic devices
  - Drive shutters, detectors from motor step pulses
  - Disable data acquisition during motor accel/decel
- Trigger EPICS software on complex I/O events
  - While A and B, process record on the falling edge of C
- Programmable time base for EPICS software
  - Process record at 300 Hz; wait for 470 µs; etc.
- Exceptionally smart oscilloscope trigger
  - Trigger when A rises after and within 50 µs of B, if motor 7 is moving, the shutter is open, and userStringCalc.AA==“scope”.
softGlue: requirements

• IndustryPack carrier board
• Acromag IP-EP200-series FPGA module
• Field I/O breakout hardware
  – 50-pin ribbon connector
• softGlue EPICS software module
  – softGlue is a synApps module
  – softGlue module requires ASYN and IPAC
softGlue: pros and cons

Advantages

• Hardware in close coordination with EPICS software
• Software and hardware in the same repository
• Easy to distribute/install hardware
• Autosave user configured circuitry
• Convenient, standard platform for developer-engineered circuitry
• Easy to implement/deploy experiment-specific circuitry

Limitations

• Only 15 signal names
• Field I/O signals are not maintained during VME reset.
• IP-EP201 field I/O requires special care for high-frequency signals.
  – Unterminated TTL, shared ground line, ribbon cable
  – Other IP-EP200-series modules have terminated differential (RS-422 or LVDS) signals.
## softGlue: in context

**Custom Electronics Options at APS**

<table>
<thead>
<tr>
<th>Low end</th>
<th>Midrange</th>
<th>High end</th>
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**B.O.N.E Box**
- Always on
- No connection to EPICS
- Limited circuitry
- Difficult to modify
- Difficult to reproduce
- Analog and digital

**softGlue**
- Off during reboot
- Connection to EPICS
- Limited circuitry
- Easy to modify
- Off the shelf
- Digital only
- For users

**“Generic Digital” Support**
- Always on
- No connection to EPICS
- Unlimited circuitry
- Difficult to modify
- Difficult to reproduce
- Analog and digital
- For users
- EE support required

* oversimplification
softGlue: implementation

• The basic idea, schematically:
softGlue: implementation

• Asyn driver
  – Programs FPGA from .hex file
  – Writes to registers implemented in FPGA
  – Manages interrupts

• Asyn device support
  – Standard support for parameter values
  – Custom string support implements signal names

• EPICS database
  – Polls signals for display
  – Marks connected signals for display

• MEDM display files, autosave/BURT request files
The cast, in order of appearance:

• Eric Norum – IndustryPack Bridge (interfaces FPGA components to IP/VME bus)
• Marty Smith – EPICS driver, field I/O FPGA
• Kurt Goetze – FPGA content
• Tim Mooney – EPICS application