Implementing a ReboT Server on a MicroBlaze.

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Motivation

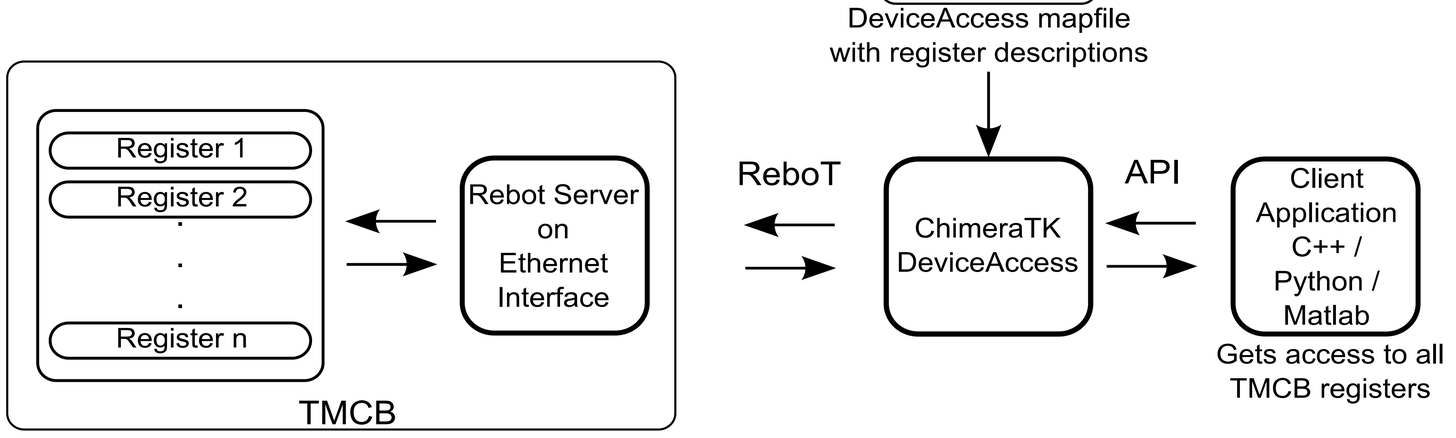
TMCB: Temperature Monitoring and Control Board

- Components:
  - ADCs, DACs
  - 10/100 Base-T Ethernet interface
  - Xilinx Spartan 6 FPGA with MicroBlaze core, AXI Ethernet Lite MAC
- ADC and board data exposed through VHDL Register Space on FPGA
- Write to registers can trigger actions on hardware, e.g. write to a relevant register sets DAC voltage
- End user requires remote access to VHDL Register Space
- Need support for single word read/write on Register Space for board control
- Support read of large data blocks from Register Space

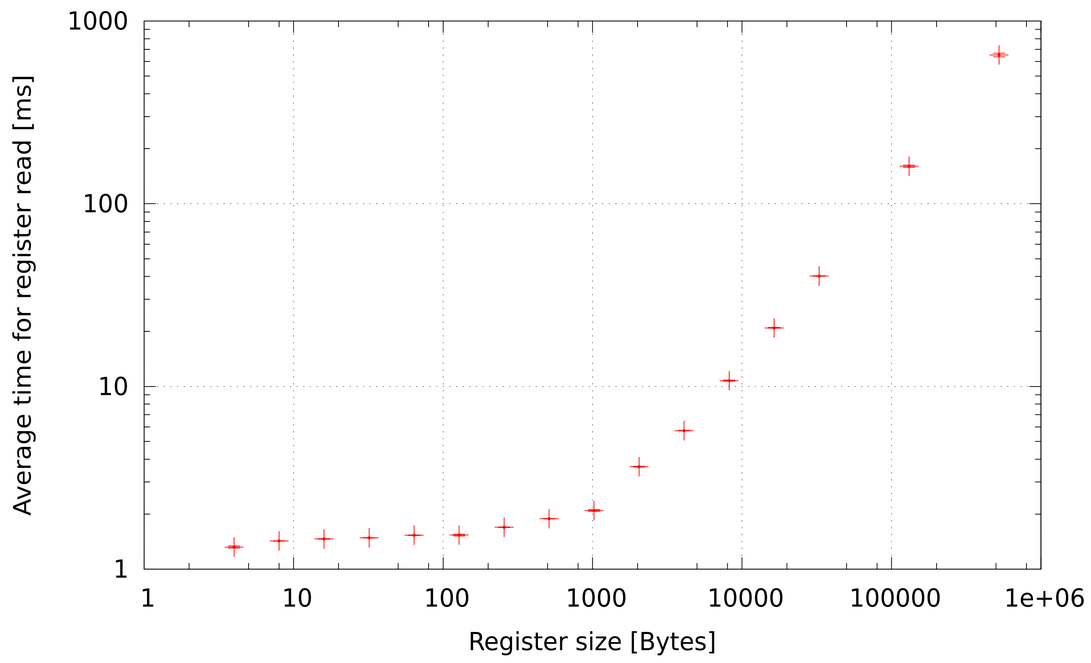
ReboT Protocol: Register Based Access Over TCP

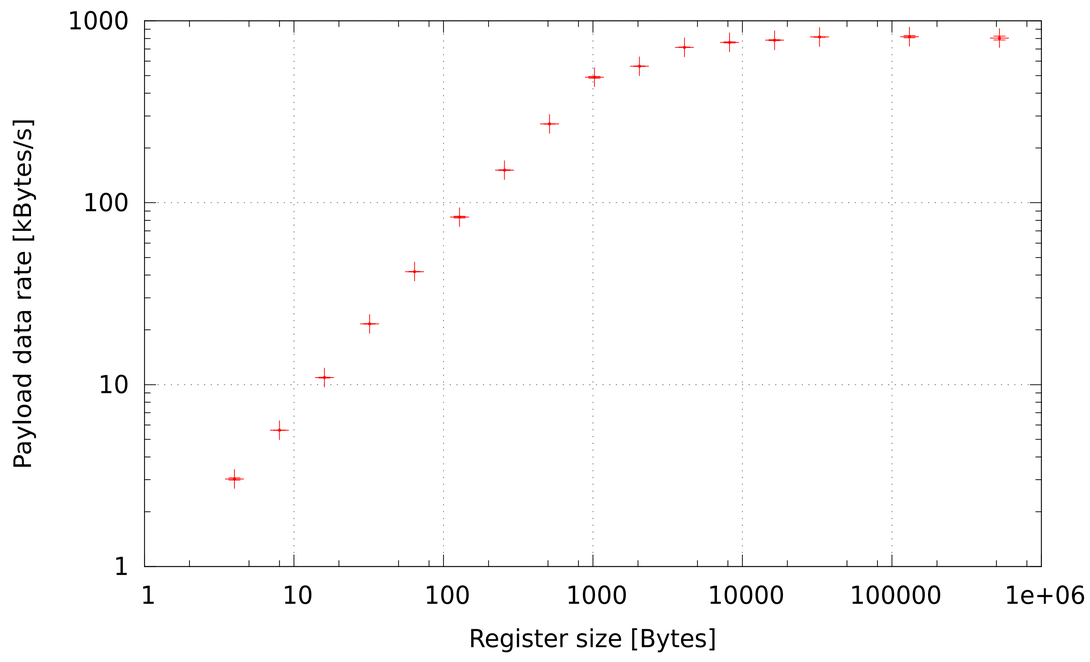
- ReboT: A custom TCP payload format
- Client with ReboT support and register description, has access to hardware Register Space, e.g. ChimeraTK DeviceAccess library with map file.

TMCB integration for ChimeraTK DeviceAccess



Performance Measurements on the Implemented Server





Implementation Details

- TMCB board and network management functions provided by MicroBlaze softcore on FPGA
- FreeRTOS v8.2 as embedded OS
- No dedicated on board MAC; AXI Ethernet Lite on FPGA instead
- lwIP v1.4 for network stack
- ReboT server based on lwIP Netconn API
- Received ReboT commands processed sequentially. Next command processed only after previous command completes response to client
- Blocking API

Stack's TCP Connection Throughput

Measured using iPerf tool

- A server component on the MicroBlaze is needed.
- Server accepts TCP connections but discards payload

```
------------------------------------------------------------
TCP window size: 85.0 KByte (default)
------------------------------------------------------------
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-60.1 sec   148 MBytes  20.6 Mbits/sec
```

ReboT read of one word register (4bytes)	1.12 ± .014ms
ReboT write of one word register	1.15 ± .038 ms
ReboT read 4096 byte long data	5.55 ± .039 ms

Summary and Outlook

- ReboT protocol: lets end user software connect to TMCB over TCP/IP
- FreeRTOS with the lwIP Netconn API on a Spartan 6 hosted Microblaze, with AXI EthernetLite MAC is capable of 20 Mbits/sec TCP throughput
- ReboT read time for register sizes below 1460 bytes (TCP Maximum Segment Size): between 1-2 ms; Flat growth profile because data is transferred over a single IP packet. Around 800 single word (4 byte) commands per second possible.
- Rebot read times for sizes above 1460 bytes have linear growth profile; Data is sent over multiple IP packets, hence have increased header over heads. Payload throughput for block transfers level off at 900 Kbytes/s.
- Achieved numbers were sufficient for our current requirements

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