

# Study of Decoupler: Empowering FPGA Debugging with ESP32 and IoT

Different name:

Front end/back end

Trigger/streaming readout/DAQ

Common features:

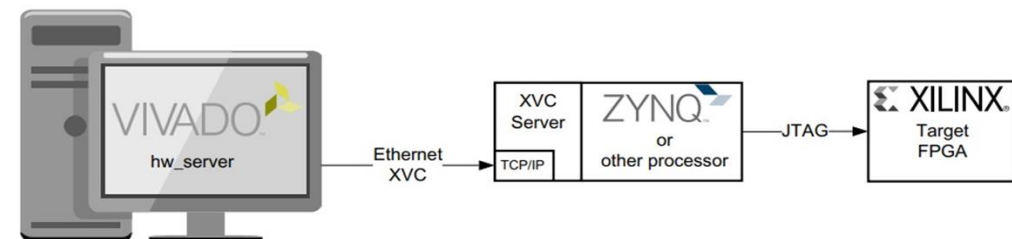
Large number of custom designed FPGA based PCBs

Coupling between functionality, delivery deadlines, budgetary constraints

Coupling between core function and peripheral functions:

Constantly parameter monitoring at low frequency( ~minutes)

Remote configuration/debugging



# Desired:

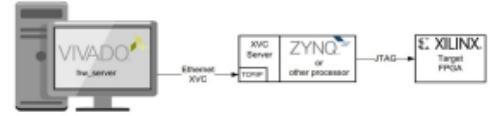
- Wireless debugging
- With environment parameter monitoring
- Accessible from all over the world while keeping security
- Low cost
- Low power
- No extra PCB or FPGA resource needed
- Plug and play

## Common features of high energy physics experiment electronics system

- Front-end electronics (~1000s of channels).
- Back-end electronics (~100s of boards).
- Large number of custom designed FPGA based PCBs.
- Either easy or difficult to access after installation.
- Require constantly parameter monitoring before and after installation at low frequency (~minutes).



## Limitations of traditional solution



- Using JTAG programmer at early stages.
- Remote configuration and slow control system at late stages.
- Solution requires extra logic and space resource and not available at the beginning.

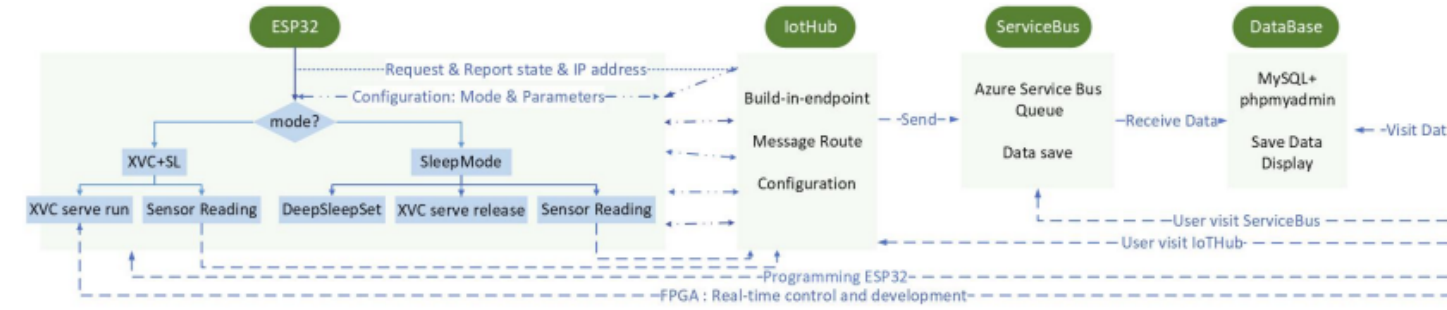
## Decoupler

By implementing remote configuration and environment monitoring independently:

1. Decouple the core function design with peripheral function and environment monitoring.
2. Decouple the installation with maturation of the firmware.

## Key advantages:

- Better security and reliability.
- Lower logic and PCB resource.
- Less material and power consumption.
- Easier maintainability and scalability.



ESP32	XVC	Azure IoT Hub	Azure servicebus queue	DataBase
n.a.® dual-core 32-bit LX6 processor, up to 240 MHz included/Up to 34 GPIOs can send data to server access to FPGA	-TCP/IP-based protocol that acts like a JTAG cable. -Facilitate hardware debug for designs that: have the FPGA in a hard-to-access location, where a "lab-PC" is not close by.	-Security-enhanced communication channel for sending and receiving data from IoT devices. -Route message to different destinations automatically.	-Queues store messages until the receiving application is available. -Messages in queues are ordered and timestamped on arrival. -Messages are delivered in pull mode, only delivering messages when requested.	-MySQL+phpmyadmin -Save Data Display -Visit Data