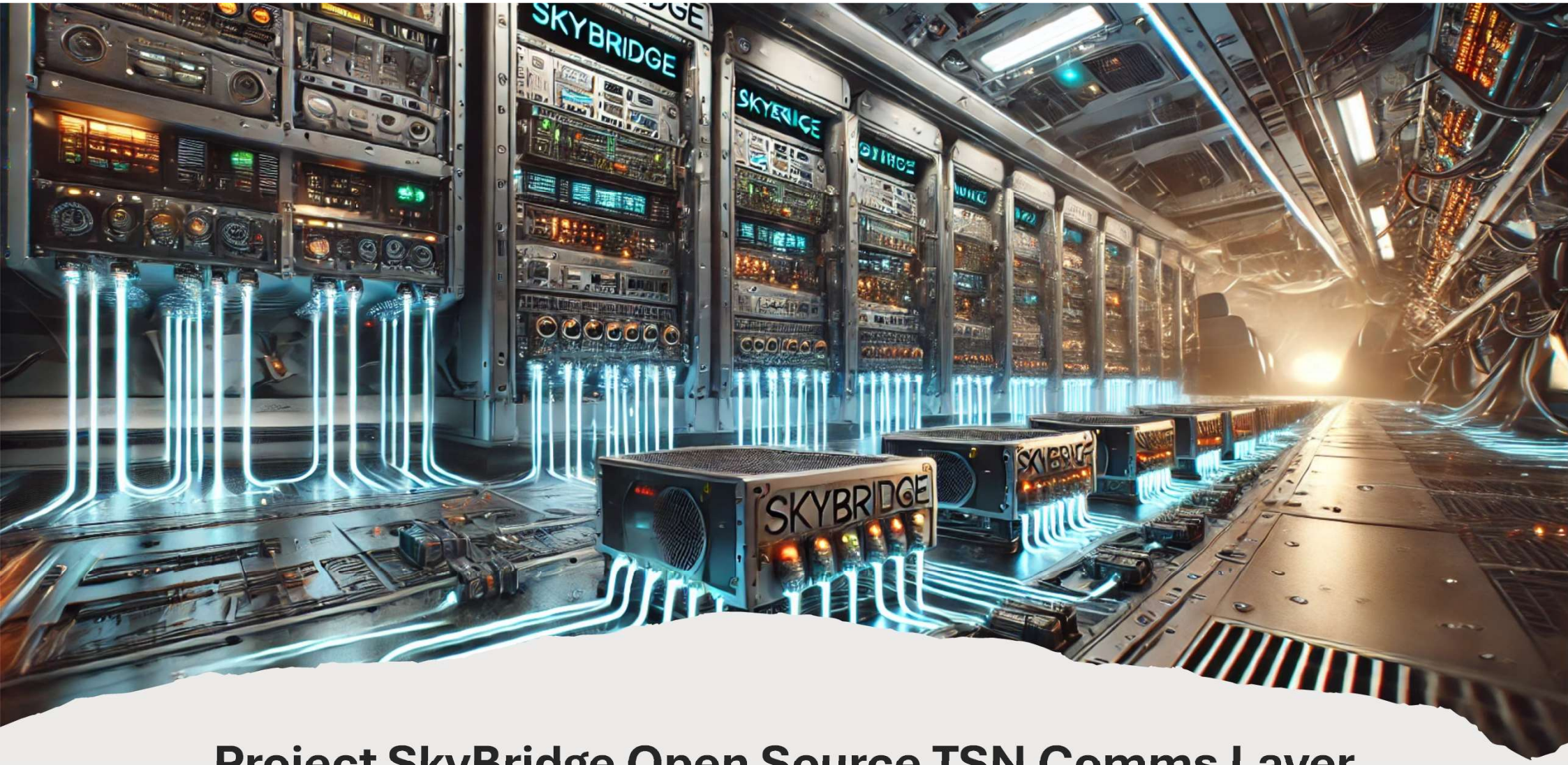



# Project SkyBridge Open Source TSN Comms Layer

**Technical Summary**

**Type:** Deterministic communications link, designed for point-to-point connections

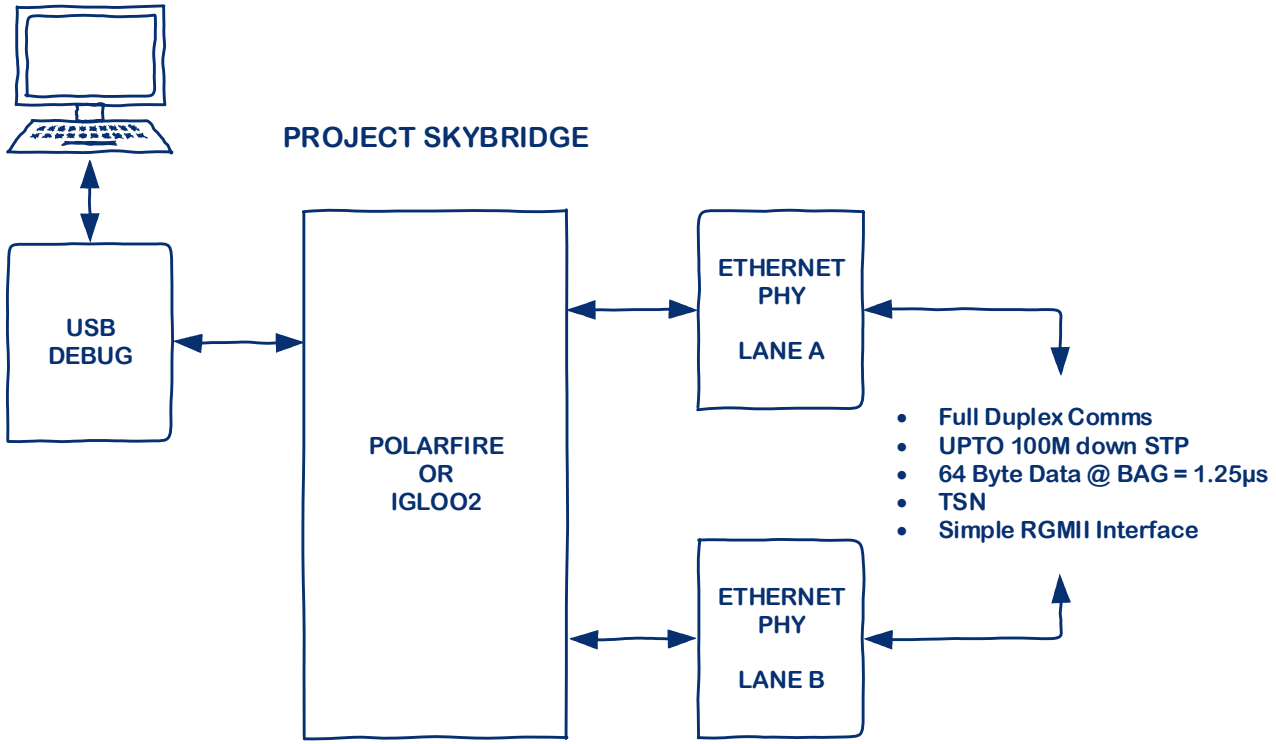
**Speed:** 1000Base-T utilizing RGMII

**PHY:** Suggested discrete Ethernet PHYs, specifically “VSC8531”

**MAC:** Customized firmware implementation

**Management:** MDIO controller integrated within the firmware

**Topology:** Exclusively point-to-point, eliminating the need for switching or discovery processes




## Fundamental Block Diagram of the Concept

# Project SkyBridge Goals (Part of the Open Source REU Project)

### 🔹 Characteristics of Time-Sensitive Networking (TSN)

- **Bandwidth Allocation Gap (BAG):** 1.25 µs cycle
- **Payload Rate:** 64 bytes per 1.25 µs, translating to 51.2 MB/s of raw data
- **Deterministic Timing:** Employs fixed slot-based transmission
- **Inter-Frame Gap (IFG):** Fully complies with Ethernet standards

### 🔹 Design Goals

- Provide reliable data transmission with minimal latency
- Completely open source and compatible with FPGAs
- User-friendly interface for Remote Electronics Units (REUs)
- Designed for scalability to incorporate additional TSN features (such as 802.1AS)

### 🔹 Structure of Data Packets

- **Standard Raw Ethernet Frames:**
- Consists of a preamble, MAC headers, and a CRC (Frame Check Sequence)
- Each frame supports a payload of 64 bytes
- **Payload Composition:**
- Includes a 4-byte timestamp counter that increments with each cycle
- 56 bytes allocated for user or application-specific data
- A 4-byte internal CRC (IEEE CRC-32)

# Project SkyBridge Goals (Part of the Open Source REU Project)

- **Deterministic Data Transmission**

SkyBridge adheres to a precise timing protocol, sending 64 bytes every 1.25 microseconds. This guarantees a steady and reliable data stream, making it well-suited for applications requiring timely responses, such as real-time control systems, data collection, and distributed computing.

- **High Raw Throughput – 51 MB/s**

The network delivers a raw payload throughput of around **51 megabytes per second for each link**, allowing substantial amounts of time-sensitive data to be transmitted with minimal delay and variation.

- **Enhanced Ethernet Efficiency**

While the network employs standard Ethernet framing (including preamble, MAC headers, CRC, and IFG), the payload design is refined to transmit only essential information:

  - 4-byte timestamp for synchronization or latency measurement
  - 56 bytes of application-specific data
  - 4-byte internal CRC to ensure end-to-end integrity
  - This approach guarantees high efficiency while upholding protocol compliance and adaptability.

# Project SkyBridge Goals (Part of the Open Source REU Project)

- **Direct Communication Efficiency**

The point-to-point design of the system removes the necessity for switching or routing mechanisms, facilitating efficient communication and minimizing protocol overhead. Each connection is dedicated and predictable, that being said a custom low latency TSN switch could be developed.

- **Expandable & Open Framework**

SkyBridge is built with scalability at its core. Being an open-source initiative, it can be readily enhanced to incorporate more sophisticated TSN functionalities, accommodate larger payloads, or provide synchronized global timestamps through 802.1AS.

- **Smooth Integration into FPGAs**

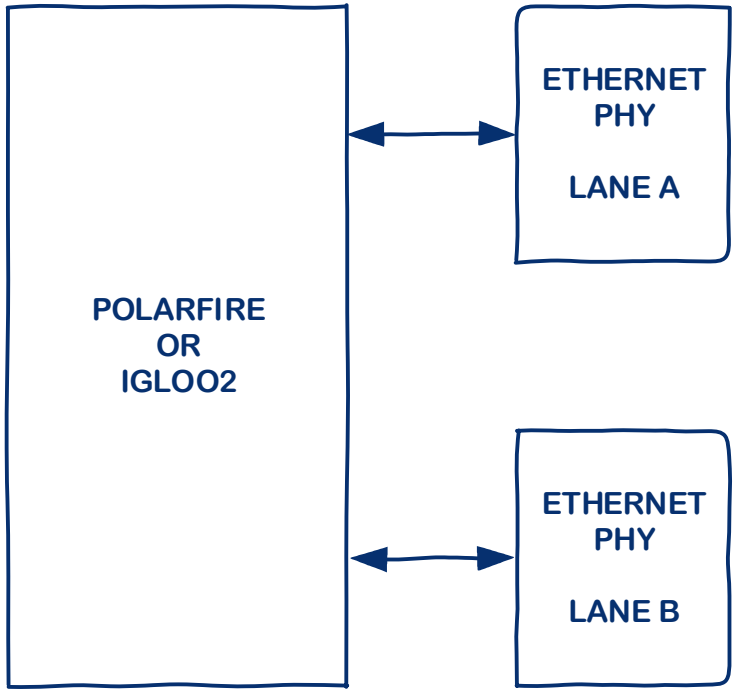
SkyBridge’s open-source MAC and MDIO layers are designed in VHDL, facilitating close integration with soft-core CPUs, DSPs, or hardware accelerators within FPGAs. This allows for **genuine real-time edge processing** and decision-making at every REU.

- **Mitigates Timing Jitter**

In contrast to conventional IP-based networks, SkyBridge's TSN-inspired scheduling eliminates unpredictability in both transmission and reception. This significantly decreases timing jitter, making it perfect for applications in flight control, robotics, industrial automation, or space systems where **microsecond-level determinism** is essential.

# Project SkyBridge Goals (Part of the Open Source REU Project)

- 🛡️ **Integrated Redundancy via Full Duplex Links**
- SkyBridge utilizes full duplex Ethernet not only to boost throughput if that mode is chosen but also as a **fault-tolerant mechanism**. In redundancy mode each Remote Electronic Unit (REU) receives **two concurrent copies** of the identical data stream.
- **Real-time validation** of data integrity across both channels
- **Failure detection** in the case of line faults or bit errors
- **Increased confidence** in command execution and sensor feedback for safety-critical applications
- This approach maintains the deterministic 1.25 µs cycle while adding an extra layer of reliability — all without requiring additional hardware or complex protocol overhead.



# Project SkyBridge Goals (Part of the Open Source REU Project)

- The primary objectives for this part of the REU project is to showcase point-to-point communications, likely utilizing two Skybridge development boards connected by 50 meters of STP.
- Additionally, the project aims to create an IP core written in VHDL and produce schematics along with a PCB reference design.
- ETA of project start Oct 2025