XROS

Porting Micro ROS to xcore.ai

ELECOMP Capstone Design Project 2025-2026

Sponsoring Company:

XMOS Ltd.
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Company Overview:

XMOS is a fabless semiconductor company, headquartered in Bristol in the UK.

Our mission is to change the way systems are deployed on silicon – disrupting system-on-chip economics and time to market by enabling embedded software engineers to create custom SoC solutions simply by loading software onto our uniquely flexible and accessible hardware platforms.

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Project Motivation:

Robotics applications increasingly rely on standardized middleware like ROS2 to enable modular development, real-time data sharing, and system interoperability. While ROS2 has gained significant traction in research and industry, its use in resource-constrained, real-time embedded systems remains limited. The micro-ROS project addresses this gap by bringing ROS2 concepts to microcontrollers, but as of now, support for XMOS xcore.ai, a highly parallel, deterministic, and software-defined embedded platform, is absent.

This project is motivated by the opportunity to extend the micro-ROS ecosystem to xcore.ai, demonstrating how a modern, real-time embedded processor can serve as a reliable and efficient ROS2-compatible node. XMOS's architecture offers a unique blend of parallelism, deterministic I/O, and edge compute capability — qualities that make it well-suited to robotics and time-sensitive control tasks. Enabling micro-ROS on this platform would unlock its potential for broader adoption in distributed robotic systems, reduce reliance on external communication processors, & provide a highly deterministic alternative to conventional MCUs.

The port also serves as a strategic steppingstone toward building a complete reference platform for real-time ROS2 robotics, lowering development barriers and showcasing XMOS technology in an industry-standard ecosystem.

Anticipated Best Outcome:

- Running micro-ROS node on XMOS xcore.ai publishing/subscribing to a ROS2 network. This network should include a node running ROS2 on something like a Raspberry Pi and connect to the XMOS dev kit using CANBUS.
- Benchmark round-trip latency and jitter.
- Example integration with a robot or simulation

- Beyond the ABO:
    - Integrate with another team's project & create a production release

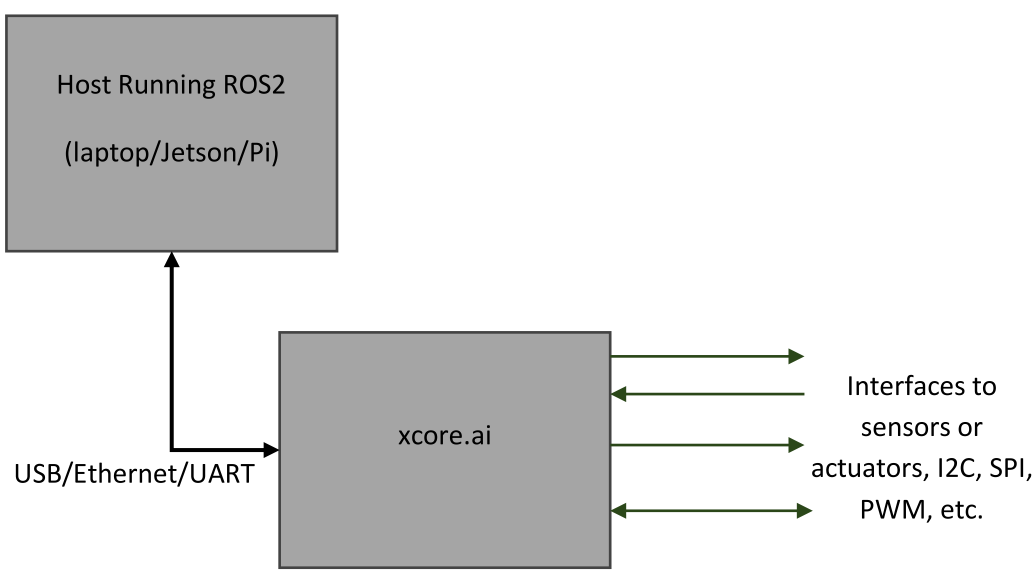
Project Details: The project aims to port the micro-ROS client stack to run on the XMOS xcore.ai platform, using either a bare-metal or FreeRTOS environment, depending on feasibility and micro-ROS requirements.

Once ported, the xcore.ai will operate as a fully functional ROS2 node, capable of:

- Publishing sensor data (e.g., IMU, encoder) to a ROS2 network.
- Subscribing to actuator commands (e.g., motor PWM values or LED control).
- Managing real-time I/O and processing using the deterministic, multicore capabilities of the XMOS architecture.

The system will communicate with a host PC or embedded companion running full ROS2 (e.g., on Ubuntu or a Jetson) via Ethernet, UART, or USB, using micro XRCE-DDS as the transport layer. Real-world peripherals such as an IMU or motor controller can be connected via SPI, I²C, or GPIO.

Block Diagram:



Hardware/Electrical Tasks:

- Learn the capabilities of the xmos development kit(s) that you have available
- Pick some interesting devices to interface with which will be compatible based on the criteria you determine based on:
    - IO voltage / current characteristics
    - Data rates
    - Port/pin map
    - Size/weight/power/cost considerations
- Build any supporting infrastructure for components such as:
    - Power supplies
    - Voltage conversions / single ended to LVDS conversions
    - Wiring, housing, any mechanical design.

Firmware/Software/Computer Tasks:

- Get familiar with the xcore architecture, tools, and simulator
- Determine the fastest possible port to get "proof of life"
- Evaluate feasibility and tradeoffs for a bare metal vs. FreeRTOS based implementation
- Design tests
- Write documentation
- Organize all code / tests / docs into a coherent repository on Github
- Learn protocols based on the sensors / actuators selected

Composition of Team:

1 Electrical Engineer & 2 Computer Engineers

Skills Required:

Electrical Engineering Skills Required:

- Strong basic Physics / Math background
- Ability to read datasheets and evaluate components
- PCB design experience is a plus
- Any of the computer engineering skills below would also be a plus

Computer Engineering Skills Required:

- Strong c/c++ programming
- Experience with embedded systems (Microcontrollers/FPGAs)
- Good troubleshooting skills
- Signal processing / control systems knowledge is a plus
- Experience with version control systems, preferably Git
- Good written communication skills

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

The anticipated best outcome of this project is the demonstration of a compelling, real-world application of the XMOS xcore.ai processor in a robotics context, showcasing its unique capabilities in deterministic real-time control, parallel processing, and low-latency I/O. By validating the xcore.ai platform in a domain that demands both performance and reliability, this project supports XMOS's strategic goal of expanding into high-growth markets such as robotics, industrial automation, and intelligent edge systems.

Economically, the project has the potential to yield reusable software components, hardware designs, or integration patterns that can accelerate future product development or form the basis of customer reference designs. A successful outcome enhances the marketability of XMOS technology by providing demonstrable proof-of-concept systems, reducing customer adoption friction, and highlighting differentiators against conventional MCUs or SoCs. Over time, this could contribute to increased design wins and licensing opportunities, particularly in emerging application areas where deterministic compute is critical.

Broader Implications of the Best Outcome on the Company's Industry:

The anticipated best outcome of this project would highlight the practical advantages of software-defined architecture like xcore.ai in robotics and sensing applications where deterministic behavior, low latency, and I/O flexibility are essential. It would demonstrate that complex, time-sensitive control systems can be implemented without resorting to power-hungry FPGAs or multi-chip solutions, thereby reducing system cost, board space, and integration complexity.

In sectors like industrial robotics and drones, there is a growing demand for systems that combine precise real-time control with increasing levels of autonomy and sensor integration. Traditional architectures often struggle to balance these needs without adding cost, complexity, or power consumption. This project aligns with the broader industry movement toward consolidating different workloads onto fewer, more capable platforms that can meet tight timing requirements while remaining adaptable. Demonstrating these capabilities in a practical, working system reinforces the feasibility of this approach and may help shape future design decisions in high-growth, performance-sensitive applications.