DataX – Connecting signal chains to applications
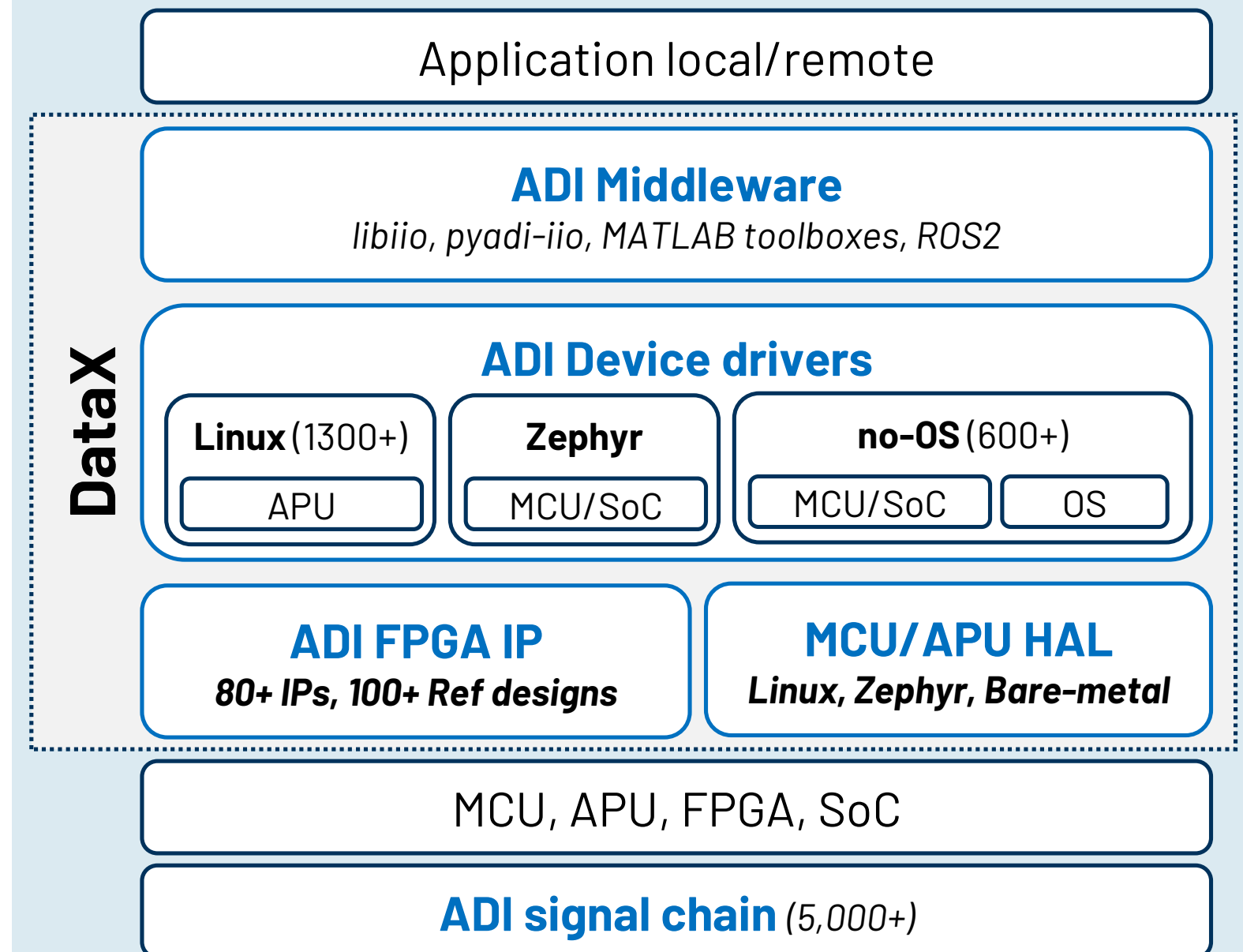
Andrei Cozma

analog.com

Connecting the signal chain to the application

Signal chain data extraction complexity drivers
- Physical interfaces between the ADI signal and the edge processor
- RTL logic for interfacing with FPGA type of devices enabling high-bandwidth data acquisition and processing
- Low-level software drivers for signal chain integration into the edge processor operating system of choice
- Data transfer between the edge system and the compute platform via various connectivity interfaces (e.g. Ethernet, PCIe, USB, UART)
- Integration into industry-standard software frameworks for data processing and AI applications development

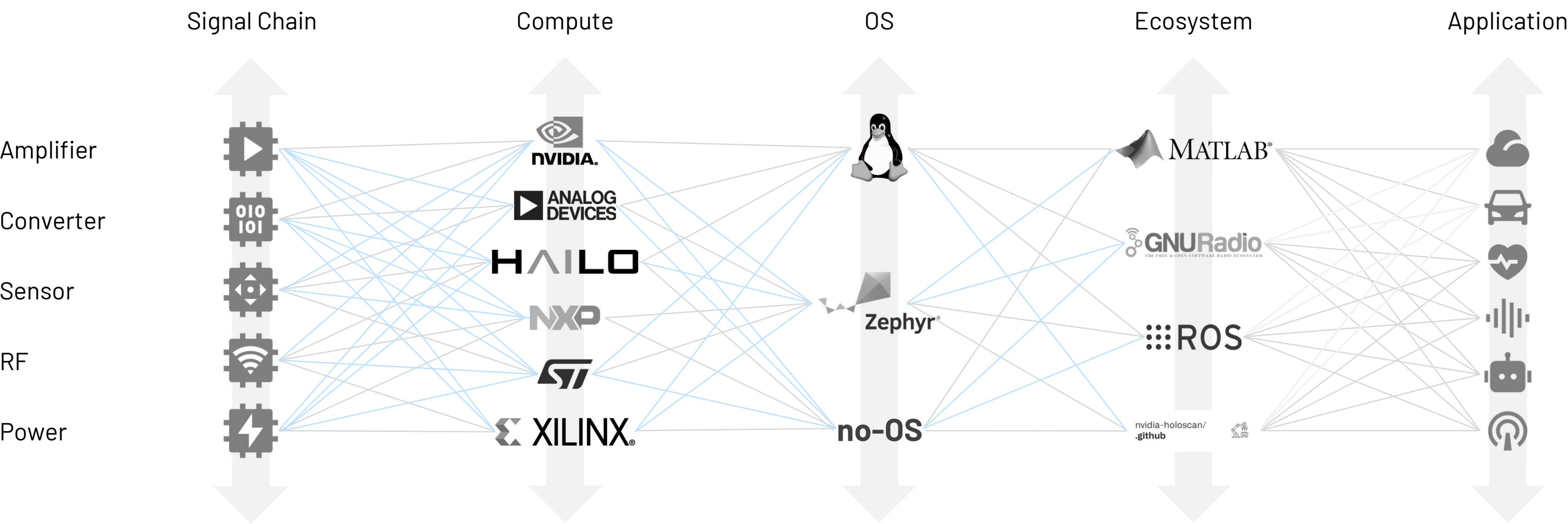**ADI integrated data extraction hardware and software stack**
- Enables seamless connectivity between signal chains and applications on the customer's processing platform of choice
- Allows for flexible data flow partitioning between edge and host compute devices

ANALOG DEVICES

Application local/remote

DataX

ADI Middleware
libiio, pyadi-iio, MATLAB toolboxes, ROS2

ADI Device drivers

Linux (1300+)	**Zephyr**	**no-OS** (600+)
APU	MCU/SoC	MCU/SoC · OS

ADI FPGA IP
80+ IPs, 100+ Ref designs

MCU/APU HAL
Linux, Zephyr, Bare-metal

MCU, APU, FPGA, SoC

ADI signal chain *(5,000+)*

Any *signal chain* to **Any** *application* on **Any** *platform*

DataX

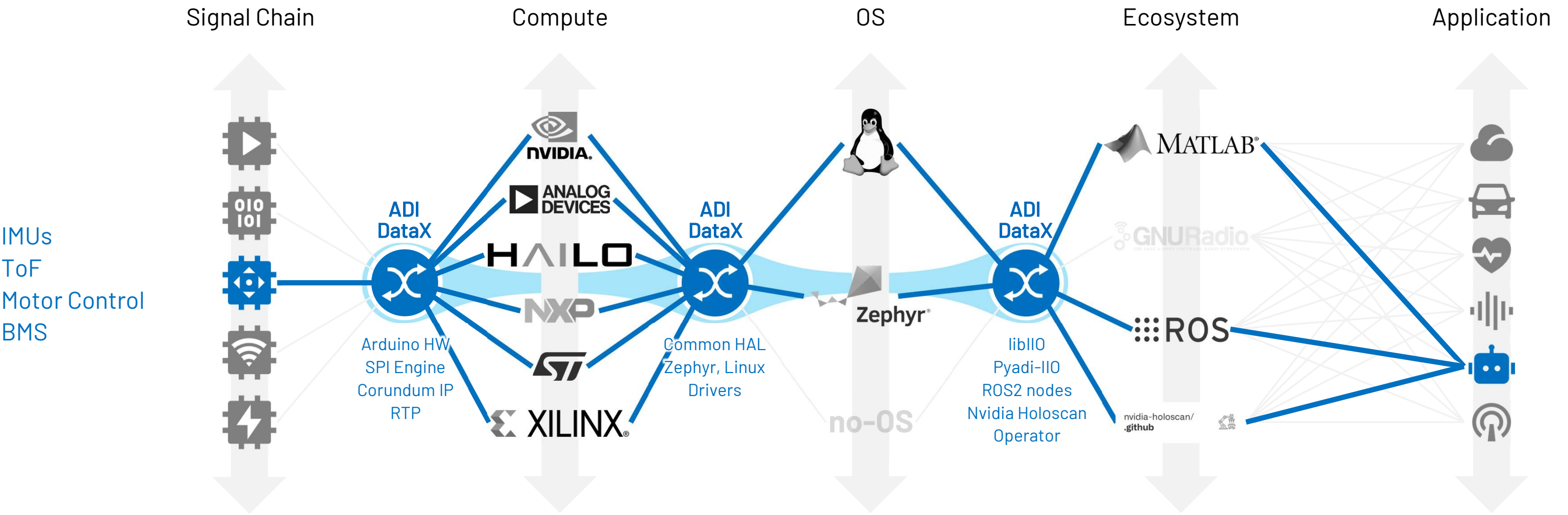## Enablement in a rapidly evolving ecosystems and applications space

| Signal Chain | Compute | OS | Ecosystem | Application |

Signal Chain: Amplifier, Converter, Sensor, RF, Power

Compute: NVIDIA, ANALOG DEVICES, HAILO, NXP, ST, XILINX

OS: Linux, Zephyr, no-OS

Ecosystem: MATLAB, GNURadio, ROS, nvidia-holoscan/.github

DataX

Enablement in a rapidly evolving ecosystems and applications space

Signal Chain — Compute — OS — Ecosystem — Application

Amplifier, Converter, Sensor, RF, Power

ADI DataX — Common Boards, HDL Interface IP, Connectivity IP

NVIDIA, ANALOG DEVICES, HAILO, NXP, ST, XILINX

ADI DataX — Common HAL, OS factories, Drivers

Linux, Zephyr, no-OS

ADI DataX — System APIs, Ecosystem Integration

MATLAB, GNURadio, ROS, nvidia-holoscan/.github

DataX for Robotics

Signal Chain   Compute   OS   Ecosystem   Application

IMUs
ToF
Motor Control
BMS

ADI DataX

Arduino HW
SPI Engine
Corundum IP
RTP

NVIDIA.
ANALOG DEVICES
HAILO
NXP
ST
XILINX

ADI DataX

Common HAL
Zephyr, Linux
Drivers

Zephyr
no-OS

ADI DataX

libIIO
Pyadi-IIO
ROS2 nodes
Nvidia Holoscan
Operator

MATLAB
GNURadio
ROS
nvidia-holoscan/
.github

DataX: ADI Open-source FPGA & SW Infrastructure

DataX

Middleware
https://github.com/analogdevicesinc/libiio
https://github.com/analogdevicesinc/pyadi-iio
https://github.com/analogdevicesinc/TransceiverToolbox
https://github.com/analogdevicesinc/adi_ros2

python

ROS GNURadio MathWorks

Device drivers
https://github.com/analogdevicesinc/linux
https://github.com/analogdevicesinc/no-OS
https://github.com/analogdevicesinc/zephyr

Linux no-OS Zephyr

1300+ Linux drivers

600+ no-OS drivers

FPGA IP library and reference designs
https://github.com/analogdevicesinc/hdl

XILINX ALTERA LATTICE SEMICONDUCTOR

80+ ADI IPs

100+ Reference Designs

40+ Converters in **ADI JESD204 IP Framework**

30+ Converters in **ADI SPI Engine**

17 Xilinx carriers, **5** Altera Carriers, **1** Lattice carrier

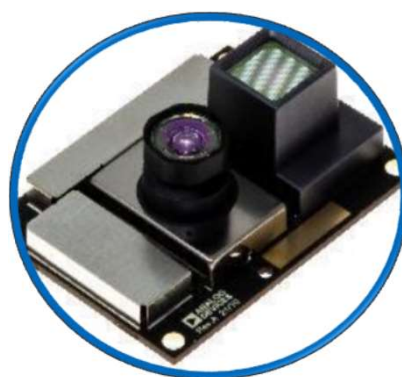*2 x releases/year, open support, CI/CD with board farm*

DataX Demos

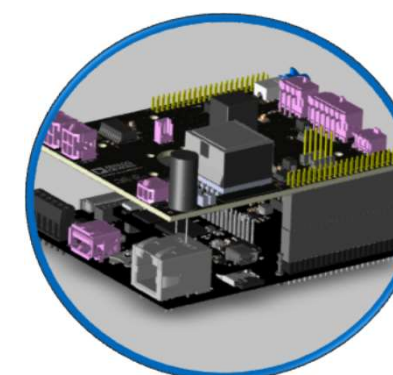# Robotics: Open Mobile Robot Platform

enabled by **DataX**

ANALOG DEVICES

HARDWARE

ADRD5161
– Battery Management System (BMS)

ADTF3175 + ADRD8041
– Perception Module (Depth)

ADRD3161
– Motion Control Module

ADRD2161
– Compute Interface Module

SOFTWARE

- Zephyr Open-Source Firmware running on the modular sub-systems enabling code reuse for customer developments

- Mobile Robot ROS2 nodes for seamless integration into compute platforms
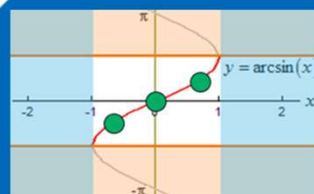
Wireless Comms: Phased Array Platform
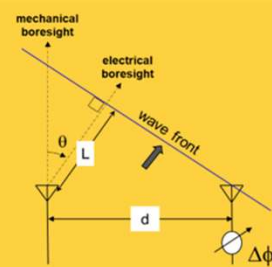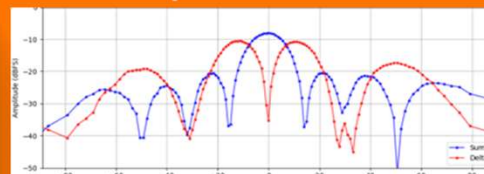
enabled by **DataX**

ANALOG DEVICES

Digitizer

Steering Angle

Antenna Patterns

The PHASER (CN0566)
Software Defined Phased Array Radar

Antenna Impairments

Monopulse Tracking

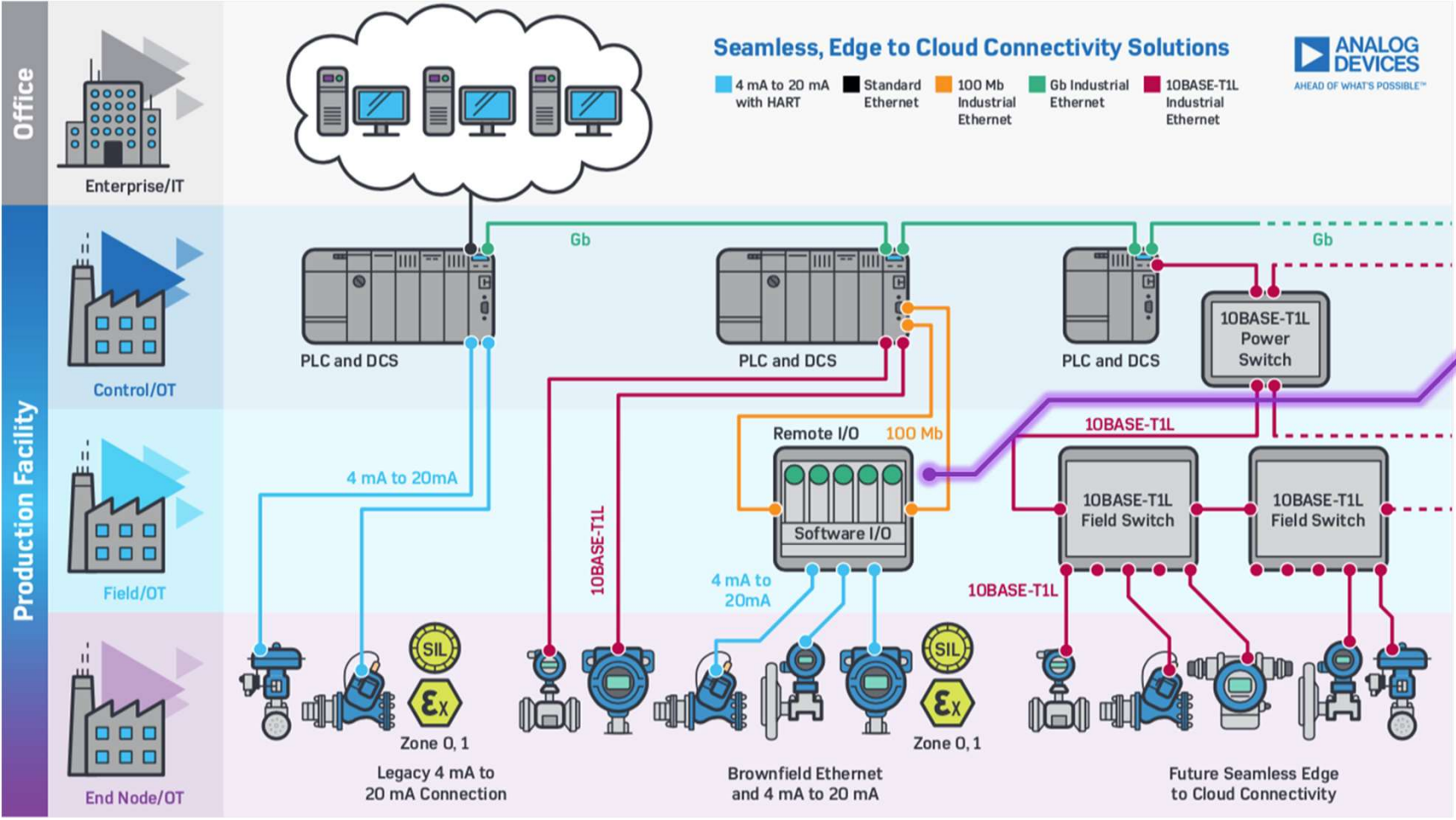**Radar**

300+
Units shipped

30+
Hands-on training sessions

1000+
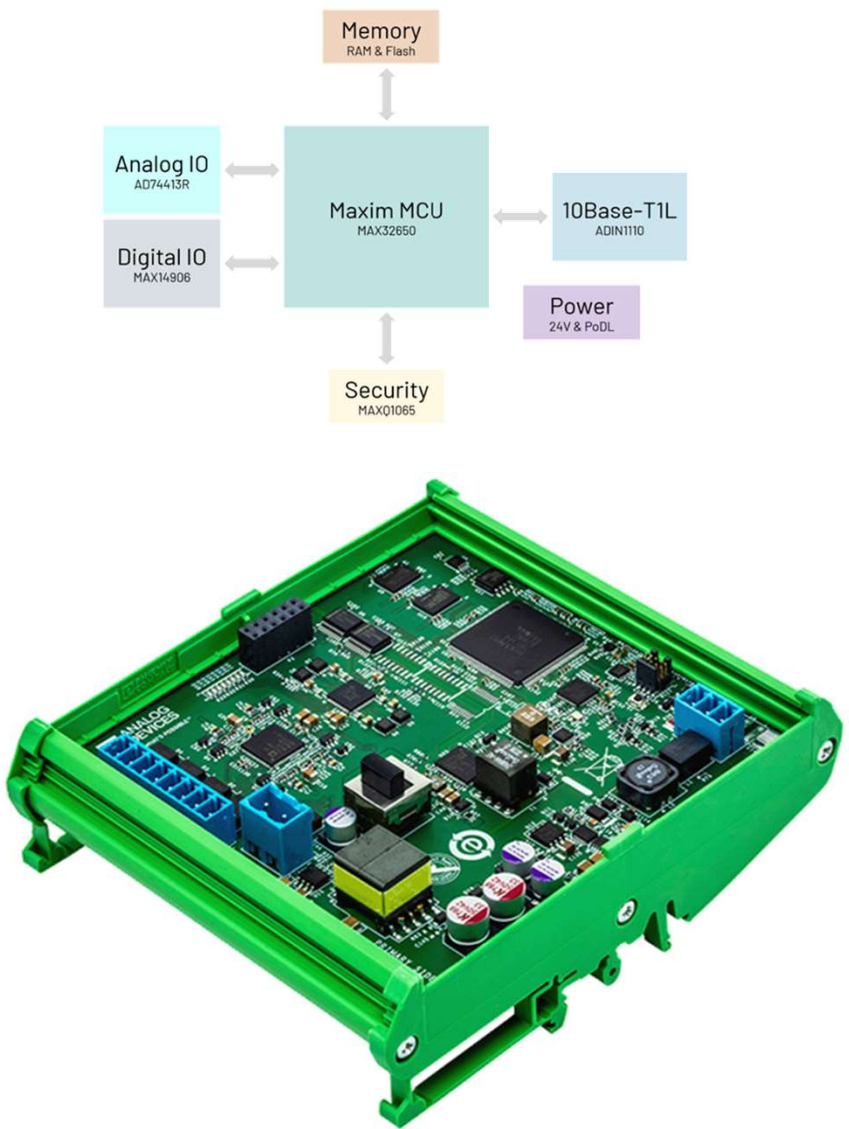People trained

800k+
Training videos visualizations

Industrial: Software Defined IO RTU Module

enabled by **DataX**

Seamless, Edge to Cloud Connectivity Solutions

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

- 4 mA to 20 mA with HART
- Standard Ethernet
- 100 Mb Industrial Ethernet
- Gb Industrial Ethernet
- 10BASE-T1L Industrial Ethernet

Office — Enterprise/IT

Production Facility — Control/OT, Field/OT, End Node/OT

PLC and DCS

10BASE-T1L Power Switch

Remote I/O — 100 Mb

Software I/O

10BASE-T1L Field Switch

4 mA to 20mA

10BASE-T1L

Zone 0, 1

Legacy 4 mA to 20 mA Connection

Brownfield Ethernet and 4 mA to 20 mA

Future Seamless Edge to Cloud Connectivity

SW Configured I/O

- Per channel configurable
- Any combination
- Per channel granularity
- Dramatically reduces installation and design cost
- Standardized remote I/O

Memory — RAM & Flash
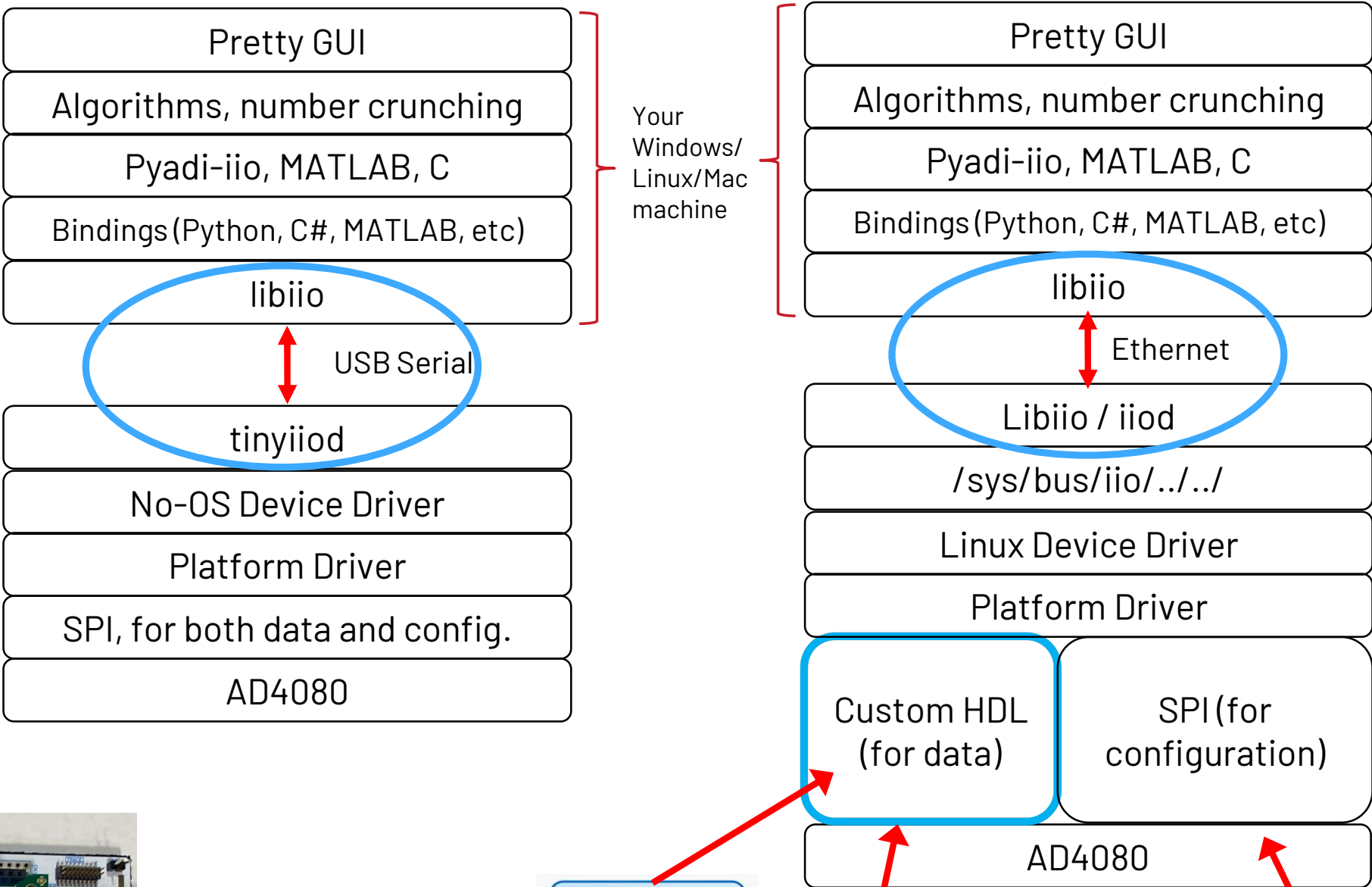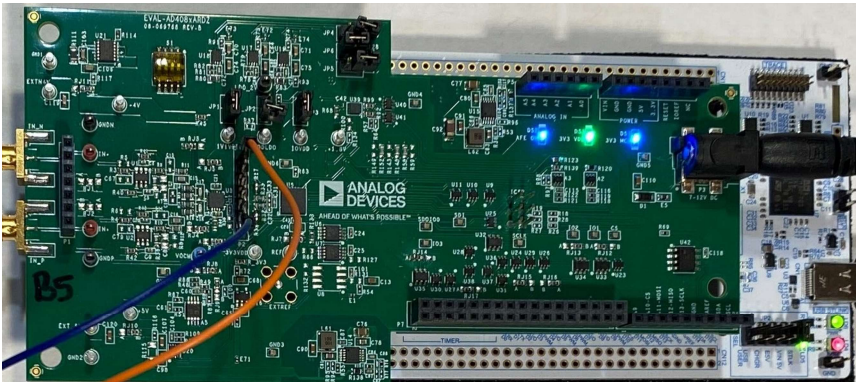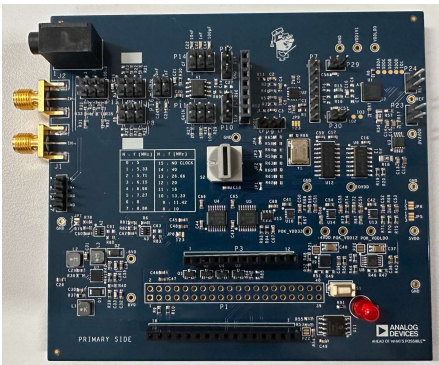
Analog IO — AD74413R

Digital IO — MAX14906

Maxim MCU — MAX32650

10Base-T1L — ADIN1110

Power — 24V & PoDL

Security — MAXQ1065

AD-SWIOT1L-SL

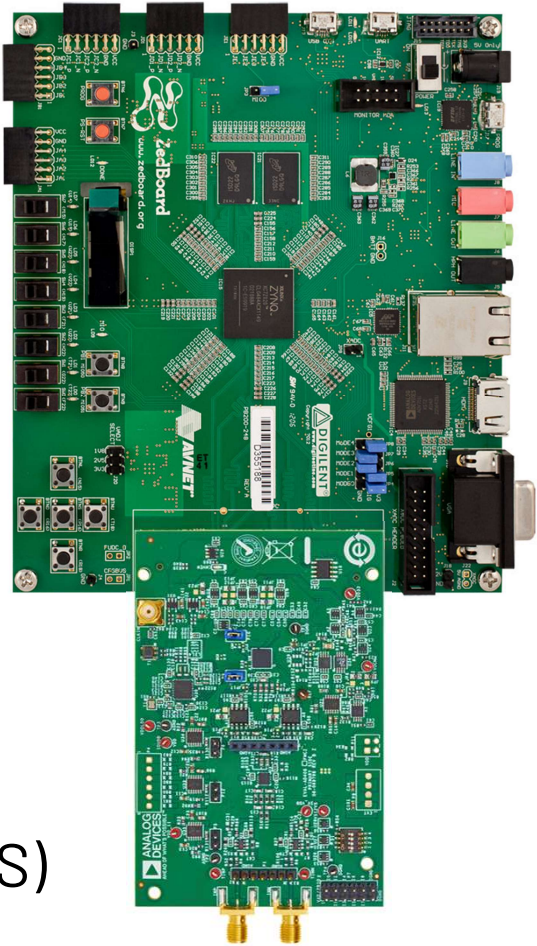# Instrumentation: "Full Stack" Enablement for ultra-low noise* ADC

 ANALOG DEVICES

FPGA for continuous streaming, wideband applications.

Microcontroller for lower bandwidth, standalone applications (internal FIFO only).
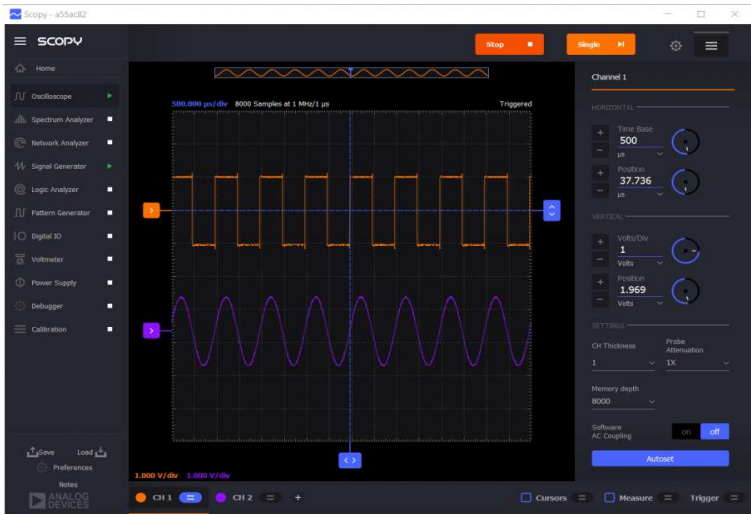
enabled by **DataX**

Left stack:

| Pretty GUI |
| Algorithms, number crunching |
| Pyadi-iio, MATLAB, C |
| Bindings (Python, C#, MATLAB, etc) |
| libiio |

Your Windows/ Linux/Mac machine

USB Serial

| tinyiiod |
| No-OS Device Driver |
| Platform Driver |
| SPI, for both data and config. |
| AD4080 |

Right stack:

| Pretty GUI |
| Algorithms, number crunching |
| Pyadi-iio, MATLAB, C |
| Bindings (Python, C#, MATLAB, etc) |
| libiio |

Ethernet

| Libiio / iiod |
| /sys/bus/iio/../.. |
| Linux Device Driver |
| Platform Driver |
| Custom HDL (for data) | SPI (for configuration) |
| AD4080 |

How low?
9.8 nV/rootHz
167dB SNR, 1 Hz BW

Serialized LVDS

SPI (LVCMOS)

axi_ad408x

s_axi	adc_clk
s_axi_aclk	adc_data
s_axi_aresetn	adc_valid
delay_clk	
dclk_in_p	
dclk_in_n	
data_a_in_p	
data_a_in_n	
data_b_in_p	
data_b_in_n	
cnv_in_p	
cnv_in_n	
sync_n	
filter_data_ready_n	
adc_dovf	

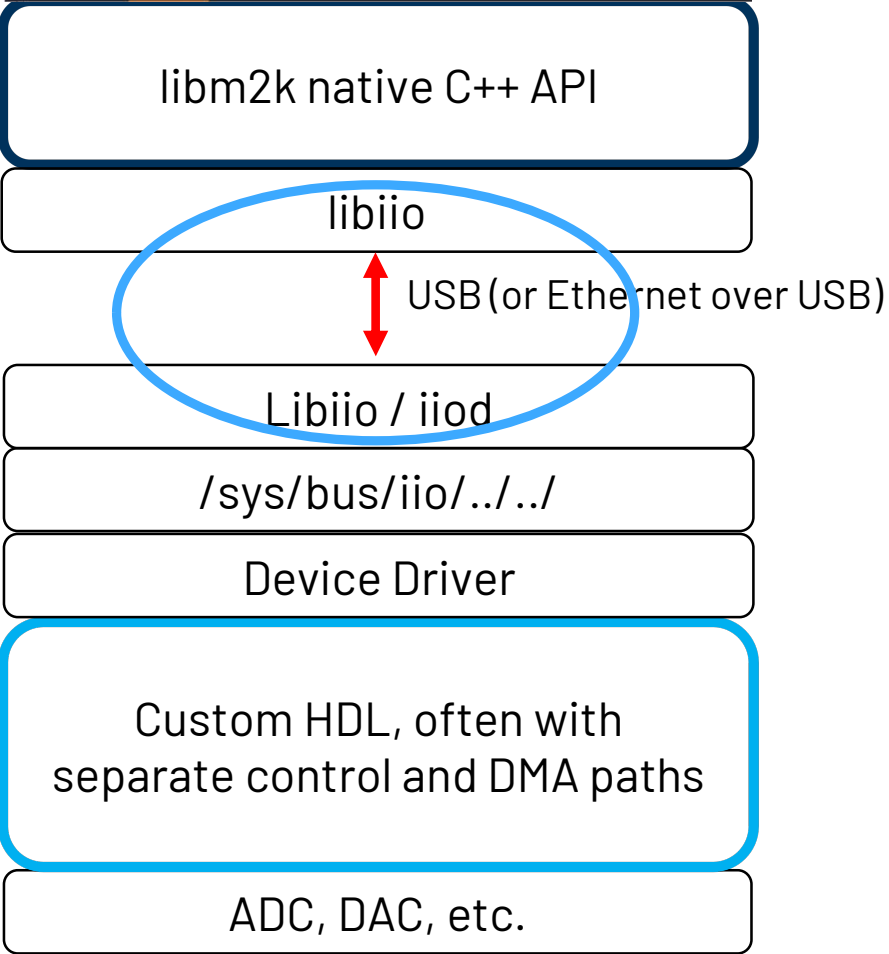FTC | Orlando, FL | November 4-8, 2024

ADALM2000 / Scopy stack: Reduce, Re-use, Recycle

Every nanosecond you spend studying the m2k stack applies to real life.
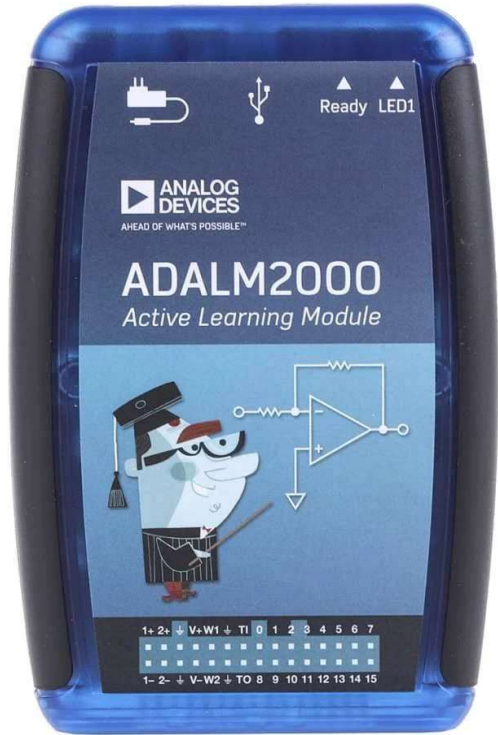
enabled by **DataX**

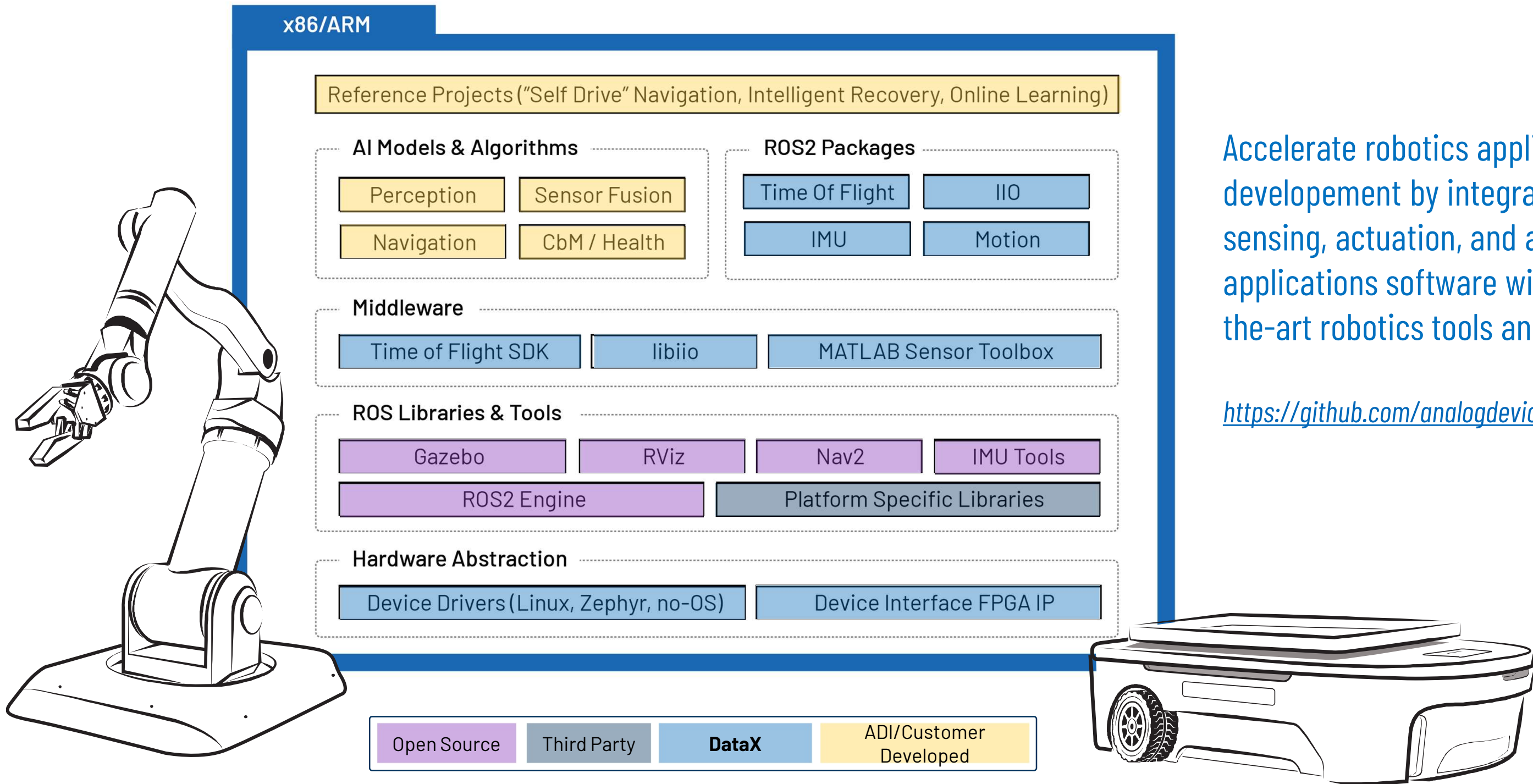| libm2k native C++ API |
| --- |

libiio

USB (or Ethernet over USB)

Libiio / iiod

/sys/bus/iio/../../

Device Driver

Custom HDL, often with separate control and DMA paths

ADC, DAC, etc.

Backup

Analog Devices: Robotics Software Development Kit

ANALOG DEVICES

x86/ARM

Reference Projects ("Self Drive" Navigation, Intelligent Recovery, Online Learning)

AI Models & Algorithms

Perception	Sensor Fusion
Navigation	CbM / Health

ROS2 Packages

Time Of Flight	IIO
IMU	Motion

Middleware

Time of Flight SDK	libiio	MATLAB Sensor Toolbox

ROS Libraries & Tools

Gazebo	RViz	Nav2	IMU Tools
ROS2 Engine		Platform Specific Libraries	

Hardware Abstraction

Device Drivers (Linux, Zephyr, no-OS)	Device Interface FPGA IP

Open Source	Third Party	**DataX**	ADI/Customer Developed

Accelerate robotics applications developement by integrating ADI's sensing, actuation, and advanced applications software with state-of-the-art robotics tools and frameworks

https://github.com/analogdevicesinc/adi_ros2