

SPACE AI · HELLO, UNIVERSE!™

Distributed edge supercomputer & ground station.

A service-agnostic, open-source, solar-powered edge supercomputer and ground station — connecting Unmanned Systems, Robotics, IoT and the Space Internet (CCSDS) to the real world.



5 × 5 × 5 CM · CUBESAT STANDARD

POWERED BY LINUX · SOS LINUX

AT A GLANCE

NODE IO · NODE IO LITE

One 5 cm cube. Five function-specific boards, stacked to match the mission.

Edge AI, positioning, LPWAN, wideband radio and solar power — joined through two 64-pin board-to-board headers.

700 TOPS

edge AI on the Hexagon NPU.

100 kHz – 3.8 GHz

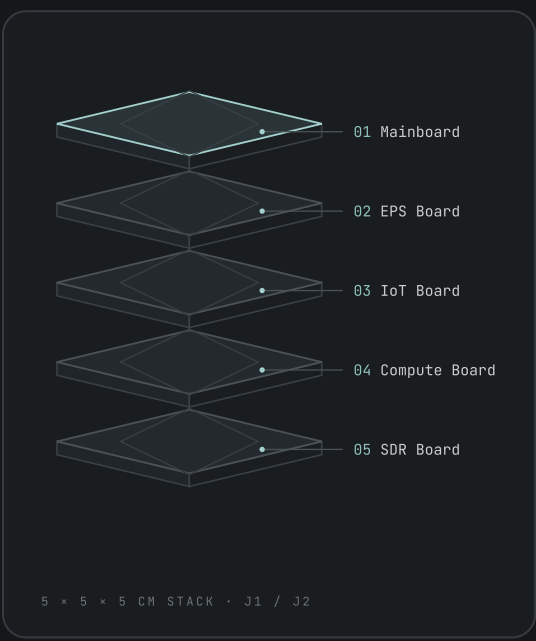
continuous software-defined radio coverage.

CAPABILITIES

HELLO, UNIVERSE!™

01	02	03	04	05
Edge AI	GNSS / RTK	LoRaWAN	Wideband SDR	Solar EPS
Hexagon NPU · up to 700 TOPS	Multi-band SE868K5-RTK receiver	SEMTECH LRT120 · sub-GHz & 2.4 GHz	LMS7002M · 2×2 MIMO	MPPT · terrestrial & space arrays

One cube. Five cooperating boards.



NODE IO is a stack of function-specific boards that snap together into a single 5 × 5 × 5 cm CubeSat-standard module. The Mainboard is the core card; every other board attaches through two 64-pin headers — **J1 carrying power, reset and UART control, and J2 carrying the high-speed CAN, SPI and I²C data fabric.**

Boards are added or removed to match the mission: power and solar harvesting from the EPS, long-range LPWAN links from the IoT board, edge AI and ground-station compute from the Dragonwing IQ10 card, and wideband software-defined radio from the SDR board.

FORM FACTOR	5 × 5 × 5 cm cube
STANDARD	CubeSat
OS	SOS Linux
POWER	Solar · Li-Ion · USB-C
CONNECTORS	J1 + J2, 64-pin
SPACE NET	CCSDS-ready

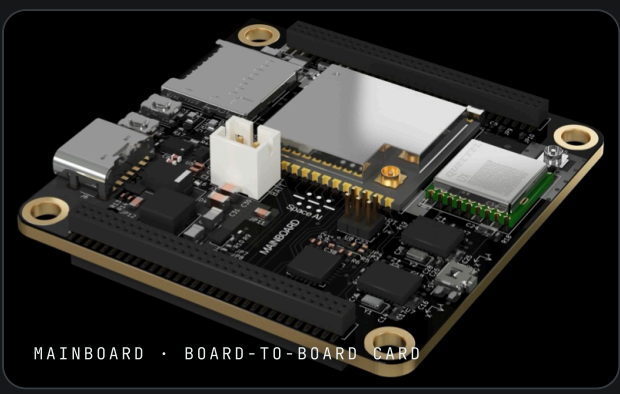
BOARD INDEX	NODE IO: 5 BOARDS • NODE IO LITE: BOARDS 01 - 03
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01	Mainboard	System orchestrator, navigation & motion sensing	NODE IO • LITE
02	EPS Board	Electrical Power System & system watchdog	NODE IO • LITE
03	IoT Board	LPWAN · LF-SDR · LoRa / LoRaWAN connectivity	NODE IO • LITE
04	Compute Board	High-performance edge AI, vision & ground-station compute	NODE IO ONLY
05	SDR Board	Full-duplex wideband software-defined radio	NODE IO ONLY

BOARD 01 - MAINBOARD

AVAILABLE IN · NODE IO · NODE IO LITE

Mainboard. System orchestrator, navigation & motion sensing.



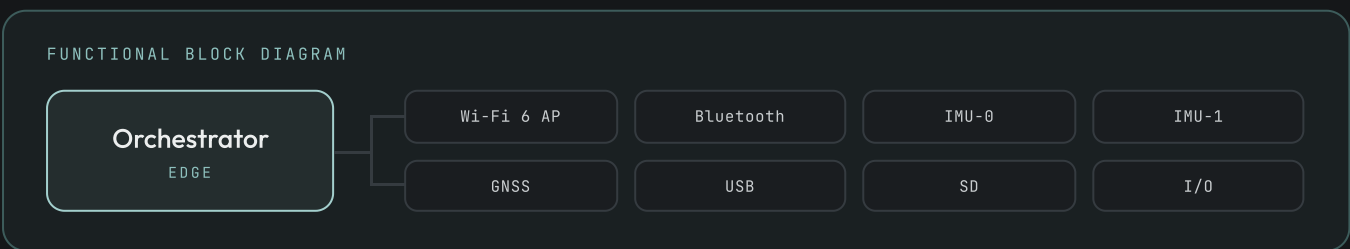
The Mainboard is the central intelligence and primary controller of the NODE IO system, orchestrating every other card in the stack. It extends a low-power ESP32-C6 SoC with a dual 9-DOF IMU and a multi-constellation GNSS receiver for precise motion sensing and positioning, and **exposes the full I/O fabric through the J1 / J2 board-to-board headers.**

KEY FEATURES	
01	Dual 9-DOF absolute-orientation IMU (BNO055)
02	Multi-GNSS: GPS · Galileo · QZSS · GLONASS · BeiDou · SBAS · IRNSS
03	Wi-Fi 6 dual-mode access point and client
04	Cryptographic accelerator · TRNG · RTC
05	Power on/off management over PMB / PMA bus
06	FCC · CE · RED · IC · TELEC · KCC · SRRC · NCC · REACH/RoHS

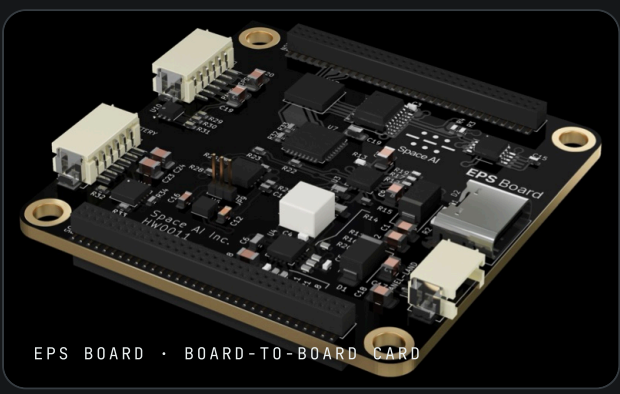
SPECIFICATIONS		BOARD 01
MODULE	ESP32-C6-WROOM-1	
PROCESSOR (HP)	32-bit RISC-V @ 160 MHz	
PROCESSOR (LP)	32-bit RISC-V @ 20 MHz	
MEMORY	320 KB ROM · 512 KB SRAM	
FLASH	16 MB integrated SPI	
WI-FI	Wi-Fi 6 802.11 b/g/n/ax · 2.4 GHz · 20 dBm	
BLUETOOTH	BLE 5.3 · Bluetooth mesh (BQB)	
802.15.4	Zigbee & Thread · Matter compliant	
IMU	2 × BNO055 9-DOF absolute orientation	
GNSS	SE868K5-RTK multi-band	
INTERFACES	SD · UART · SPI · SDIO · I ² C	
USB	USB 2.0 full-speed	

GNSS bands – GPS L1 C/A+L5 · Galileo E1+E5a · QZSS · GLONASS L10F · BeiDou B1I+B2a · SBAS · IRNSS L5

Board-to-board J1 / J2 pin assignment – see Connector Reference, p.08.



EPS Board. Electrical Power System & system watchdog.



The Electrical Power System conditions and distributes energy to every board in the NODE IO stack. It feeds the VBAT rail from a Li-Ion pack whenever USB-C power is absent, accepts terrestrial or space-grade solar input with MPPT charging, and **supervises the whole system — power scheduling, alarms, event logging and watchdog resets.**

KEY FEATURES	
01	Fully programmable and monitored power supply
02	Accepts any DC source — battery, solar or USB-C
03	MPPT charging from terrestrial or space solar arrays
04	Per-board power on/off scheduling for ultra-low-power ops
05	Short-circuit, overcurrent and malfunction alarms
06	Redundant-mainboard operation support

SPECIFICATIONS		BOARD 02
BATTERY INPUT	Li-Ion 3.6 V pack · dedicated connector	
5 V BUSES	3 independent (2 switchable)	
3.3 V BUS	Switchable	
SOLAR (TERRESTRIAL)	12 V Si mono/poly panels, MPPT	
SOLAR (SPACE)	4–6–8 V GaAsInP arrays, MPPT	
EXTERNAL POWER	VPOW bus via USB-C on any board	
EXT. CONNECTORS	3.3 V & 5 V, current-limited	
SUPERVISION	PMB / PMA control + alarm bus	
LOGGING	RTC-timestamped event log	
WATCHDOG	Resets main/compute board on timeout	
Board-to-board J1 / J2 pin assignment – see Connector Reference, p.08.		



BOARD 03 - IOT BOARD

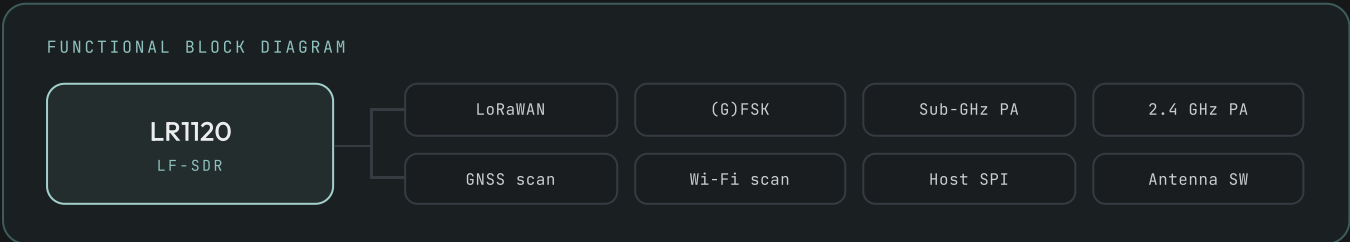
AVAILABLE IN · NODE IO · NODE IO LITE

IoT Board. LPWAN · LF-SDR · LoRa / LoRaWAN connectivity.

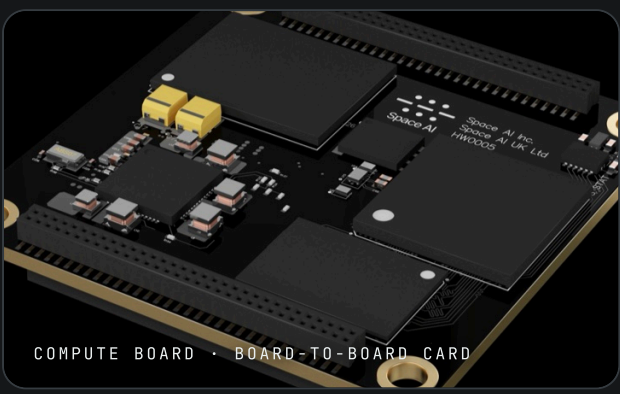


The IoT Board gives NODE IO ultra-low-power, long-range wireless links to smart sensors and back-end servers using the most widely deployed IoT protocols. Built on the SEMTECH LR1120, it operates LoRa / LoRaWAN across sub-GHz and 2.4 GHz ISM, and **doubles as a multi-purpose radio front-end and GNSS / Wi-Fi scanner.**

KEY FEATURES		SPECIFICATIONS		BOARD 03
01	Ultra-low-power multiband long-range transceiver	TRANSCEIVER	SEMTECH LR1120	
02	LoRa and LoRaWAN, point-to-point or point-to-multipoint	ARCHITECTURE	LoRa® / (G)FSK half-duplex	
03	Worldwide multi-region BOM, auto-adapts to regulatory limits	SUB-GHZ	150-960 MHz	
04	Integrated PA regulator for single-board +15/+22 dBm	ISM	2.4 GHz	
05	Low-noise modes for enhanced LoRa / (G)FSK sensitivity	S-BAND	1.9-2.1 GHz licensed (satellite)	
06	GNSS and Wi-Fi passive scanning on-chip	SYNTHESIZER	150-2600 MHz continuous	
		PA (SUB-GHZ)	+22 dBm HP · +15 dBm HE	
		PA (2.4 GHZ)	+13 dBm, 50 Ω matched	
		SCANNING	GPS / BeiDou · Wi-Fi passive	
		COMPATIBILITY	SX1261/2/8 · LoRaWAN® · LR-FHSS	
		Board-to-board J1 / J2 pin assignment - see Connector Reference, p.08.		



Compute Board. High-performance edge AI, vision & ground-station compute.



The high-performance compute card is built on Qualcomm's Dragonwing IQ10 — an 18-core Oryon platform purpose-built for physical AI. A multi-core Hexagon NPU delivers up to 700 TOPS, paired with an Adreno X2-90 GPU and native multi-sensor ingest, **running the SOS Linux distribution as the system's edge supercomputer and ground-station host.**

KEY FEATURES

- 01 18-core Oryon CPU + multi-core Hexagon NPU, up to 700 TOPS
- 02 Adreno X2-90 GPU for on-device vision-language workloads
- 03 Native ingest of 12× GMSL2 cameras, LiDAR, ToF & IMU
- 04 2× 10GbE, TSN, EtherCAT & 8× CAN-FD deterministic I/O
- 05 PCIe Gen5, USB 3.2 & M.2 2280 NVMe expansion
- 06 Wi-Fi 7, Bluetooth & optional 5G · secure boot, ECC memory

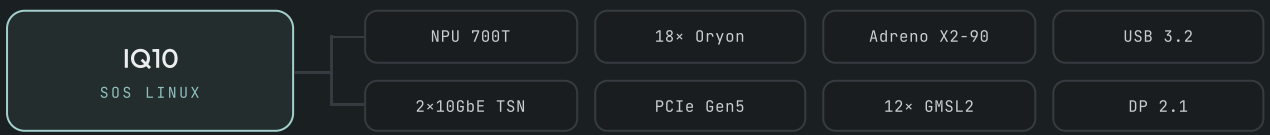
SPECIFICATIONS

BOARD 04

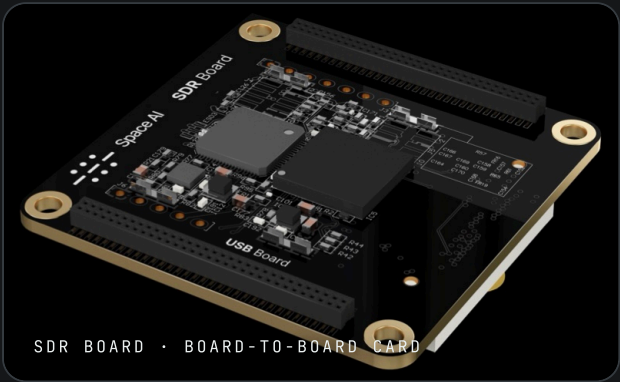
SOC	Qualcomm Dragonwing IQ10
CPU	18 × Qualcomm Oryon (12 × 5.0 GHz + 6 × 3.6 GHz)
NPU	Multi-core Hexagon · up to 700 TOPS (sparse)
AI COMPUTE	350 TOPS dense · extensible to 2,000 TOPS
GPU	Adreno X2-90 · 7.58 TFLOPS FP32
RAM	64 GB LPDDR5x (in-package, ECC)
STORAGE	512 GB UFS 4.0 + M.2 2280 NVMe
OS	SOS Linux
ETHERNET	2 × 10GbE · 1 × 2.5GbE · TSN
FIELDBUS	EtherCAT · 8 × CAN-FD
EXPANSION	PCIe Gen5 · USB 3.2
SENSOR INGEST	12 × GMSL2 · LiDAR · ToF · IMU
VIDEO / DISPLAY	8K120 H.265 enc · dual DisplayPort 2.1

Board-to-board J1 / J2 pin assignment — see Connector Reference, p.08.

FUNCTIONAL BLOCK DIAGRAM



SDR Board. Full-duplex wideband software-defined radio.



The SDR Board is a full-duplex, wideband software-defined radio pairing an Altera FPGA front-end (USB board) with a Lime LMS7002M FPRF transceiver (radio board). The LMS7002M covers 100 kHz to 3.8 GHz with 2×2 MIMO and on-chip DSP, **supporting effectively any 2G/3G/4G or Wi-Fi waveform, licensed or unlicensed.**

KEY FEATURES

- 01 Continuous 100 kHz – 3.8 GHz coverage, user-programmable on the fly
- 02 Single-chip 2×2 MIMO with on-chip RF calibration
- 03 Both TDD and full-duplex FDD operation
- 04 LimeLight™ digital IQ — JEDEC JESD207 compliant
- 05 Runs any 2G / 3G / 4G and Wi-Fi waveform, licensed or not
- 06 ≈880 mW full 2×2 MIMO (550 mW SISO) via external LDOs

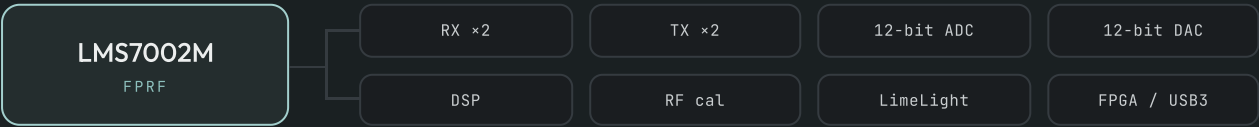
SPECIFICATIONS

BOARD 05

FPRF TRANSCEIVER	Lime LMS7002M
FPGA	Altera (USB board)
COVERAGE	100 kHz – 3.8 GHz
RF BANDWIDTH	30.72 MHz (up to 160 MHz analog)
SAMPLE RATE	72 MSPS
SAMPLE DEPTH	12-bit on-chip DAC / ADC
CHANNELS	1 TX / 1 RX · LMS7002M 2×2 MIMO
INTERFACE	USB 3.0
LOGIC GATES	16 K programmable
OSCILLATOR	±1 ppm initial · ±4 ppm stable
TX POWER	max 10 dBm (frequency dependent)
ANTENNA	Integrated wideband nano antenna

Board-to-board J1 / J2 pin assignment — see Connector Reference, p.08.

FUNCTIONAL BLOCK DIAGRAM



CONNECTOR REFERENCE

J1 / J2 board-to-board pinout.

Every stacked card exposes the same two 64-pin headers. The North connector (J1) distributes battery power, system grounding, power-management signalling, four UARTs and the system-wide reset bus. The South connector (J2) carries the power return plus the high-speed data fabric — **dual CAN, dual SPI, dual I²C and a wide bank of configurable GPIO**.

NORTH · J1			POWER · UART · RESET		
PIN	NAME	FUNCTION			
1-10	VBAT	Main power supply of the system (battery)			
11-24	GND	Main system grounding			
25	PMB	Power management bus (control from EPS)			
26	PMA	Power management alarm (alarms to EPS)			
27	UART1-TX	UART 1 transmission			
28	UART1-RX	UART 1 reception			
29	UART2-TX	UART 2 transmission			
30	UART2-RX	UART 2 reception			
31	UART3-TX	UART 3 transmission			
32	UART3-RX	UART 3 reception			
33	UART4-TX	UART 4 transmission			
34	UART4-RX	UART 4 reception			
35	RESET-0	Systemwide reset bus 0			
36	RESET-1	Systemwide reset bus 1			
37	RESET-2	Systemwide reset bus 2			
38	RESET-3	Systemwide reset bus 3			
39-64	GPIO	Addressable · configurable · interrupt-capable			

SOUTH · J2			CAN · SPI · I ² C · GPIO		
PIN	NAME	FUNCTION			
1-10	VPOW	Power return to the EPS board			
11-50	GPIO	Addressable · configurable · interrupt-capable			
51	CAN0-P	CAN bus channel 0 positive			
52	CAN0-N	CAN bus channel 0 negative			
53	CAN1-P	CAN bus channel 1 positive			
54	CAN1-N	CAN bus channel 1 negative			
55	SPI0-SCK	SPI channel 0 serial clock			
56	SPI0-MOSI	SPI channel 0 master out / slave in			
57	SPI0-MISO	SPI channel 0 master in / slave out			
58	SPI1-MOSI	SPI channel 1 master out / slave in			
59	SPI1-SCK	SPI channel 1 serial clock			
60	SPI1-MISO	SPI channel 1 master in / slave out			
61	I2C0-SCK	I ² C channel 0 serial clock			
62	I2C0-SDA	I ² C channel 0 serial data			
63	I2C1-SCK	I ² C channel 1 serial clock			
64	I2C1-SDA	I ² C channel 1 serial data			

FULL CONFIGURATION

NODE IO

All five boards supported, including the Compute and SDR cards for edge AI and wideband radio.

COMPACT CONFIGURATION

NODE IO Lite

Built around the Mainboard, EPS and IoT cards for low-power sensing, navigation and LPWAN links.

Hello, Universe!™

NODE IO — Distributed Edge Supercomputer & Ground Station.

SPACE AI

NODE IO.