

FOR EVALUATION

DOC TORUS-SNV-DS-001 REV 2026-07

PacketFive

TORUS-SN • NODE VARIANTS

SN-V1 ... V4

PRELIMINARY

TORUS-SNV-DS-001

Four sensor-node classes on one event contract, covering fixed wireless, programmable SDR, wired optical, and transducer.

1 Overview

All TORUS-SN nodes share the same seismic/acoustic sensing core, the same event contract (per-source sequence numbers for zero-miss processing), and the same command integration. They differ in the communications and effect layer, which is selected per node to match cost, alarm profile, assurance requirements, and facility constraints. A single deployment routinely mixes classes. Cheap fixed-wireless nodes cover the bulk of a ring, programmable or wired nodes on the highest-value segments, and transducer nodes where a response is authorised.

Hardware design status

Only variant 1 has a complete hardware design (generated schematic, 4-layer PCB, and 3D model, pre-production). Variants 2, 3, and 4 are at design-brief stage with host architecture, block diagram, candidate BOM, and open engineering flags are documented per variant in the repository under `hw/variants/`, with no schematic or PCB yet. Notably, the SDR variant requires an FPGA/SoC class host (the AD9371's JESD204B interface cannot be serviced by the V1 node's MCU), so it is architected as a carrier board stacked on an unmodified V1 node.

2 Variant comparison

#	Variant	Link / RF	Rel. cost	Mat.	Best fit
1	Fixed Wireless	LoRa 433 MHz	Low	FIELDDED	Wide, dense perimeter rings
2	Programmable Wireless	SDR AD9371 / AD9363 (+LoRa failsafe)	High	R&D	Experimental, R&D, high-assurance facility segments
3	Wired Optical	Optical fibre	Site-dep.	R&D	Highest-assurance, emanation-quiet segments
4	Transducer	per host node	Add-on	CONCEPT	Authorised, validated response points

3 Variant 1 • Fixed Wireless (LoRa)

- **Lowest cost per node.** The default element for the bulk of a perimeter ring.
- **LoRa 433 MHz** (EU ISM) long-range uplink to the TORUS-MEG gateway via SMA antenna.
- **Fixed-function radio** - no field reconfiguration of the RF, which keeps power and cost down.
- This is the production TORUS-SN board described in the SN node datasheet (TORUS-SN-DS-001).

4 Variant 2 • Programmable Wireless (SDR)

- **Software-defined radio front end** (Analog Devices AD9371 preferred, AD9363 as a lower-cost option) for reconfigurable waveform, band, and protocol.
- **Ships with a LoRa failsafe.** The LoRa link is a guaranteed fallback and can also serve as the main link; where LoRa alone meets the requirement, variant 1 is the more economical choice and the SDR is not warranted.
- **Significant per-node cost premium.** Justified for experimental and R&D deployments, spectrum work, and customers with high-assurance facility or congested-RF requirements.
- Higher power draw and compute demand than the fixed variant; power budget and enclosure sized accordingly.

Engineering flag

AD9371/AD9363 carrier board, clocking, and power tree are a distinct design from the fixed node; not yet on the fielded TORUS-SN PCB. See `hw/variants/sn-v2-sdr.md` for the design brief.

5 Variant 3 • Wired Optical

- **Wired optical transport** instead of RF means there is no radio emanation to detect or jam.
- **Tamper-resistant and emanation-quiet**, suited to the highest-assurance segments of a perimeter where wiring is feasible.
- Trades the free-placement advantage of wireless for assurance; used selectively, not across a whole ring.
- **Under research.** Optical transceiver, powering, and mechanical integration are in development.

6 Variant 4 • Transducer (Activate / Trigger)

- **Response node**, not a sensor. On a validated cue it actuates a facility response (the response type is deployment-defined and authorised separately).

- **Mandatory safety interlock.** A transducer never actuates straight from a raw cue. It walks a state machine with a compulsory safety-validation stage between activation and trigger.
- Every arm, validate, trigger, and abort is logged for post-incident review.

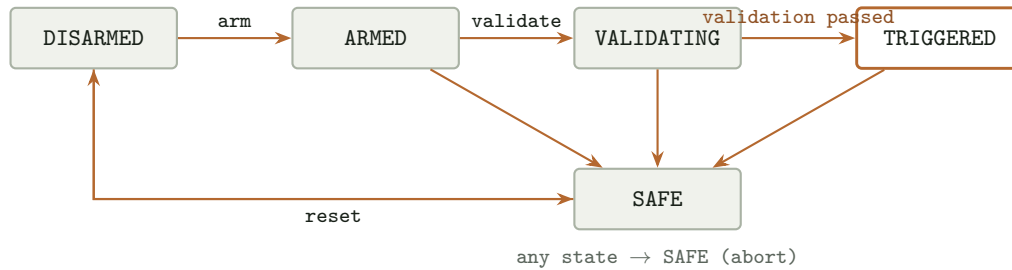


Figure 1: Transducer safety interlock. Trigger is refused unless validation has passed.

The interlock is implemented in the CCISRT layer and enforced in code; see the TORUS-CCISRT datasheet (TORUS-CCISRT-DS-001) and the reference implementation in the `torus-ccisrt` repository.

7 Selection guidance

If the segment needs...	Choose
Lowest cost, wide coverage, standard alarm profile	1 • Fixed Wireless
Reconfigurable RF, congested spectrum, R&D	2 • Programmable SDR
No RF emanation, maximum tamper resistance	3 • Wired Optical
An authorised, validated physical response	4 • Transducer

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