

Subterranean Operations Positioning

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What This Application Specifies

Subterranean operations deploy with on-unit multi-modality ranging, deployable reference nodes (where physical placement permits), and cooperative localization across operating units. Operating regions establish relative-frame coordinates cooperatively; absolute-frame binding follows where surface communication permits.

Operations adapt to subterranean reality. Tunnels gain linear-array reference nodes; chambers gain volumetric reference deployment; mobile operations rely on inter-unit cooperative ranging. The architecture supports the structural variation in subterranean operating geometry.

Why It Matters Operationally

Current subterranean positioning depends on UWB-only deployments, lidar-SLAM, and dead-reckoning. Single-modality solutions face structural limitations: UWB infrastructure burden, SLAM accumulation drift, dead-reckoning unbounded error growth.

Mesh-derived coordinates produce structural improvement. Multi-modality observations counter single-modality limitations; cooperative localization counters

individual-unit drift; credentialed observations support audit-grade subterranean positioning.

How It Composes With the Domain

Force or operation elements contribute multi-modality observations as credentialed events. Reference nodes deploy where geometry permits. Cooperative localization operates between mobile units. Frame-promotion proceeds as surface communication or anchor observations accumulate.

Emergency operations gain structural support. Disaster-response in subterranean environments (mine collapse, tunnel emergency, urban-rescue) gains positioning capability; cross-team coordination operates against shared coordinates; audit reconstruction supports post-incident review.

What This Enables

Mining and tunneling operations gain structurally-supported positioning where GNSS denial is structural. Search-and-rescue operations gain coordinated positioning capability. Defense underground operations gain GNSS-independent positioning that contested-environment doctrine requires.

The architecture also supports subterranean evolution. As autonomous mining matures, as tunnel-construction autonomy advances, as urban-search-and-rescue capabilities improve, the architecture admits the new operations through declared specification.

