Reference Node Densification

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What Reference Node Densification Specifies

Reference nodes are mesh units with externally-derived absolute position. Surveyed markers (precise post-installation survey), GNSS-fix nodes (units that maintain GNSS lock and contribute their absolute position), and externally-broadcast reference nodes (units bound to external geodetic infrastructure) all serve as anchors.

Densification adds reference nodes to an operating region. As density increases, the cooperative solution's absolute-frame binding strengthens: more constraints reduce solution uncertainty, redundancy permits cross-check against bad anchors, and operational coverage extends across regions previously unsupported.

Why Densification Is the Adoption Path

Greenfield deployment of cooperative positioning faces an adoption gradient. Initial deployments have low anchor density; positioning quality is limited; operational value is constrained.

Densification produces the adoption gradient. Each new anchor improves the regional solution; the marginal value of additional anchors grows with operational adoption. The architecture supports incremental densification rather than requiring complete deployment before operation.

How Anchor Integration Composes

New reference nodes enter the mesh with credentialed absolute position. The credential includes the survey provenance (who surveyed, to what tolerance, when), the binding modality (surveyed marker, GNSS lock, external reference), and the declared uncertainty.

The cooperative solver integrates the new anchor's contributions to the solution. Existing solution covariance updates to reflect the new constraint. The architecture supports anchor integration without solution restart; operations continue while the solution improves.

What This Enables for Phased Deployment

Smart-infrastructure deployments gain a structurally-coherent rollout path. Cities deploy initial anchor density across high-value corridors; expand density as adoption grows; reach high-density coverage as the architecture matures.

Defense forward-deployment gains the same. Initial mesh deploys with rapid-deployable anchors; survey-grade anchors arrive with sustained operations; the operating region's positioning quality grows with the deployment maturity.