

Progressive-Density Fallback

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What Progressive-Density Operation Specifies

The architecture supports three operating regimes within a single deployment: fully-marked segments where the marker stream provides primary routing authority; partially-marked segments where marker observations contribute alongside sensor-derived perception; unmarked segments where the vehicle operates in sensor-primary mode under explicit credentialed acknowledgment of the diminished authority basis.

Mode transitions between regimes operate structurally. As the vehicle moves from fully-marked to partially-marked, the admissibility framework adjusts mode selection accordingly. As it moves from partially-marked to unmarked, the framework adjusts again. The transitions are recorded in lineage.

Why Progressive Density Solves V2I Deployment

The chicken-and-egg deployment problem that has stalled V2I for two decades is structural. Current V2I architectures require dense coverage before fleet operators see meaningful value; without fleet adoption, deployment investment lacks justification; without deployment, fleets see no benefit.

Progressive density breaks the cycle. A region's first marker installation provides immediate value (the vehicles passing through gain marker-track operation in that segment). Coverage grows incrementally as deployment economics justify; vehicles

gain incremental benefit as coverage grows. The deployment economics work for any density.

How Mode Transitions Compose With Operation

On a fully-marked segment, the vehicle operates in marker-primary mode with sensor-primary as cross-check. On a partially-marked segment, the vehicle operates in hybrid mode with both contributions weighted. On an unmarked segment, the vehicle operates in sensor-primary mode with regulatory framework explicitly recognizing the diminished authority basis.

The credentialing framework recognizes the diminished authority on unmarked segments. The vehicle's operating envelope in marker-primary mode may exceed what's authorized in sensor-primary mode (higher speed, more permissive lane usage, less restrictive turn discipline) because the credentialed authority basis differs.

What This Enables for Incremental Deployment

Cities and DOTs can deploy markers incrementally. First-mile/last-mile city deployments provide immediate value; corridors get retrofitted incrementally; coverage densifies based on demand. Each step provides benefit; the cumulative deployment grows with the value gained.

The architecture also supports the long tail of unmarked geography. Vehicles operating in regions where marker deployment is uneconomic continue to operate under sensor-primary mode. The architecture doesn't require complete coverage to provide value.

