

When the Vehicle Is Certified and the Route Is Not

A route authorization lead at a regional drayage carrier can prove her vehicle was certified. She cannot prove her vehicle was authorized to be on the segment where the contact happened, at the hour it happened, under the speed envelope that applied. Her certification file describes a machine. The inquiry in front of her asks about a place. In her operation the moment to establish that a segment was authorized was the moment her unit entered it, and that moment does not return. U.S. Provisional Application No. 64/049,409 discloses a marker-track transport primitive in which governance-credentialed marker sequences serve as the primary routing reference and a pre-departure authorized-route manifest is composed across authority-credentialed track segments.

The Inquiry That Arrives on an Ordinary Tuesday

She is the route authorization lead at a regional drayage carrier that moves containers overnight between a marine terminal and three inland yards. Forty-one units, one vehicle model, one certification file, one nightly pattern she has run without event for two years. The inquiry that lands in her inbox on a Tuesday morning concerns a low-speed contact at a merge at 4:12 a.m., and it does not ask whether her vehicle was safe.

It asks which authority authorized that unit to be on that segment at that hour, under what speed envelope, and for what permitted vehicle class.

She has answers to adjacent questions. She has the vehicle certification, the maintenance record, the operator class registration, and eleven hours of telemetry from the unit itself. What she does not have, as her fleet is configured tonight, is any artifact that named that segment as authorized before her unit entered it. Her units chose the path. The path was reasonable. The path was inferred at speed from the unit's own perception, and the record of it was written by the same unit whose behavior is now the subject of the inquiry.

The merge in question sits where a port authority's jurisdiction ends and a municipal one begins, roughly nine hundred meters before a state-maintained ramp. She knows this because she drove it herself the following morning. Nothing in her deployment recorded that boundary as a boundary. Her unit crossed from one governing authority to another without any step in her stack noticing that a crossing had occurred, because in her setup no object in the loop carries per-segment authority at all.

She can show what the unit did. She is being asked what the unit was permitted to do, and those are not the same file.

What She Loses When the Route Cannot Be Established

Her corridor operating permission is suspended pending the response. That is the visible loss and the recoverable one. The loss underneath it is that she cannot construct the missing artifact now, and the work available to her now does not reach it, because in her operation the authorization of that segment would have had to be contemporaneous with her unit's traversal of it. She can produce a reconstruction. The reconstruction she can produce is an argument. What the authority asked for was a record, and in her operation the window to create that record closed at 4:12 a.m. on a night that has already happened.

The drayage contract has a substitution clause with a fourteen day cure period. She will spend those fourteen days assembling a document that concedes, in its own structure, that her fleet's route was inferred rather than authorized. Her shipper does not need to find her at fault. Her shipper needs to conclude nothing more than that the next inquiry will go the same way, because nothing in her deployment will answer it differently.

What she loses is narrower than her business and harder to replace. She loses the corridor. The nightly port run was what her carrier had built its position on: two years of clean operation on a specific set of segments, the relationship with the terminal, the 4 a.m. slot, the yard sequencing that made the economics work. Certification travels with her vehicles. Her corridor does not travel with anything. It was granted for a route, and the route is the part of her operation she has no evidence for.

Why Her Certification Does Not Reach the Segment

The shape of her problem is that her evidence is organized around the wrong object. Her certification file is indexed by vehicle: this sensor suite, this software revision, this validation campaign. The question she was asked is indexed by place and time: this segment, this hour, this authority, this class of unit. In her setup nothing translates between those two indexes, so the further she reads into her own archive the more confident she becomes that the answer is not in it.

Her corridor also crosses three authorities in twenty-two kilometers. Were her units able to carry a single pre-departure object composed across all three, with each segment's credential evaluated against her operator class before departure, the Tuesday inquiry would be a lookup rather than an investigation. As her deployment stands, each authority holds its own approvals, her fleet holds none of them in machine-readable form, and the composition across them exists nowhere except in her own understanding of the route.

There is a further difficulty specific to how her fleet is instrumented. Every artifact she can hand over originates inside the unit under review. Her telemetry is self-attested. Her trajectory is self-derived. She has no contribution from the infrastructure her unit traversed, so she cannot corroborate her own account with anything her unit did not itself produce. For her purposes that is the hardest part of the file to write, and she is aware that it will read as thin no matter how carefully she writes it.

Marker Sequences as the Primary Routing Reference

Chapter 19 of the cited filing discloses a marker-track transport primitive directed to governance-chain-preserving operation of transport units along governance-credentialed marker sequences, producing rail-analogous guidance properties on existing public infrastructure without dedicated rail construction, right-of-way acquisition, or displacement of existing road users.

In embodiments, the primitive comprises governance-credentialed markers deployed in, on, or adjacent to transport infrastructure, each marker encoding governance-policy-defined topology information and carrying authority-credentialed attestation of authorized transport-unit use. A marker-reader interface admits governance-credentialed marker-read observations with authority-validated interrogation and response. A route-manifest constructor produces an authorized-route manifest through governance-policy-configurable composition across one or more authority-credentialed track segments. A marker-sequence-primary navigation engine produces transport-unit navigation from the governance-credentialed sequence of marker reads as primary reference, with a marker-sensor fusion mechanism combining marker-primary routing with sensor-based obstacle detection and edge-case supplementation per Chapter 4. A marker-track lineage recorder records each marker read, navigation determination, admissibility evaluation, coordination event, topology update, and fail-safe transition in the governance chain lineage field.

The marker-encoded track topology described in the filing includes linear-segment markers encoding segment geometry such as curvature, grade, speed envelope, lane assignment, and permitted vehicle classes; switch-point markers encoding branch identifiers and governance-policy-defined switching rules; junction markers encoding priority rules and coordination-agent identifiers; yard markers encoding internal path graphs, marshaling sequences, loading-position identifiers, and dock assignments; regulatory-zone entry and exit markers encoding speed reductions, access restrictions, or coordination requirements; platooning-zone markers; and emergency-egress markers identifying locations where units may safely exit the track under emergency conditions.

The route-manifest constructor is described as comprising a route-request interface receiving a governance-credentialed route request with origin, destination, and operational constraints; a topology retrieval interface retrieving applicable track topology from the shared environmental world view of Chapter 15; a per-segment authority evaluator verifying each segment's authority credential against the unit's operator class and authority credentials; a cross-authority composition engine composing segments across multiple authorities subject to governance-policy-defined cross-authority compatibility; a route admissibility evaluator applying the composite admissibility evaluator of Chapter 4 to candidate route manifests; a route-lineage recorder recording manifest construction; and a route-emission interface emitting the authorized-route manifest as a governance-credentialed observation. Cross-authority composition patterns disclosed include sequential-authority composition with transitions at credentialed authority-boundary markers, joint-authority composition, delegated-authority composition, federated-authority composition, and escalated-authority composition for route types such as emergency response or regulatory inspection.

During operation in described embodiments, the unit validates each marker's authority credential through the governance chain at each marker read, updates its route-progress state against the pre-departure authorized-route manifest, and verifies that

the next-expected marker is consistent with the current marker's distance-to-next and topology data. On each segment the unit operates within that segment's governed speed envelope, lane assignment, and regulatory overlay, while the unit's sensor suite operates in parallel and its observations are consumed through the cross-domain coherence evaluator. Where a sensor observation conflicts with the track topology, the filing describes applying multi-source conflict resolution and the graduated response of Chapter 6 to select an admissible response.

The filing describes a marker-read admissibility evaluator that rejects spoofed, injected, malicious, or otherwise inadmissible marker reads, comprising a marker-integrity verifier, a marker-authority evaluator, a marker-sequence-consistency evaluator, a marker-position-consistency evaluator working against mesh-derived position, a marker-temporal-consistency evaluator working against mesh-derived time, a cross-modality marker-consistency evaluator where multi-modal markers are deployed, a marker-revision evaluator, a reputation-weighted marker-read admission evaluator, and a marker-rejection-lineage recorder. Adversarial-marker rejection categories described include replay, injection, substitution, tampering, supply-chain, denial, and composite multi-vector campaigns, with rejections triggering graduated response and cascade propagation to adjacent units and infrastructure agents where governance policy so defines.

Among the properties the filing attributes to the marker-sequence-primary model are provable route authorization through authority-credentialed attestation admitting regulatory and liability review, predictable operation through segment-governed parameters, marker-primary routing continuity where sensors are impaired by weather, visibility, or failure, per-segment regulatory approval rather than per-unit sensor-stack approval, and governance-chain-preserving path provenance supporting incident reconstruction and liability determination.

What the Disclosed Architecture Leaves Open for Her

The disclosed architecture does not put markers in her corridor. Someone with authority over each of her three jurisdictions would have to deploy and credential them, and until that happens on the municipal stretch her run crosses, that stretch of her route stays exactly as unauthorized as it is today. The filing describes progressive-density operation with governed fallback, under which a unit on unmarked segments operates as a governance-credentialed autonomous unit with sensor-primary navigation and governed-conservative parameters. For her purposes that is continuity of operation, not the per-segment authorization she needs for the nine hundred meters before the ramp.

Cross-authority composition in the filing is subject to governance-policy-defined compatibility. Whether her port authority would accept delegated composition from the municipality, or whether the two would sit under a federated mapping, is a policy negotiation in her region rather than something the architecture decides for her.

Admissibility evaluation is conditioned on declared thresholds, and rejections trigger graduated response. In her deployment, on a corridor she runs to a terminal appointment schedule, a period of derated operation following a run of rejected marker reads would carry a cost she would have to plan for, and the disclosure describes the transition criteria as governance-policy-defined rather than fixed for her case.

Lineage supports incident reconstruction. It does not adjudicate her liability, and the Tuesday inquiry would still be an inquiry. What would change for her is the character of the answer she can give.

The filing is also explicit that human-driven traffic is not required to read or conform to marker-track governance. The merge where her contact occurred carries traffic she has no governance relationship with, and in a marker-equipped version of her corridor her

units would conform to both governance layers at once and yield where the combined governance directs. Her exposure to the vehicle that did not yield is not something her side of the architecture resolves.

Disclosure Scope

This article is a technical description of subject matter disclosed in U.S. Provisional Application No. 64/049,409, "Governed Spatial Mesh for Physical-World Perception, Coordination, and Actuation." The mechanisms described above are drawn from the marker-track transport primitive of Chapter 19 of that filing and are presented as embodiments described there.

Nothing in this article characterizes the scope of any claim, present or future, in that application or in any application claiming priority to it. Nothing here is an admission regarding the state of the art, and the scenario described is illustrative rather than a description of any actual party, deployment, or event. Descriptions of conditioned behavior follow the filing, in which outcomes are stated with respect to governance-policy-defined thresholds, credentials, and declared bounds.

Marker Track Transport (</marker-track>)

[All 49 steps → \(/inventive-steps\)](/inventive-steps)

Rail-analogous guidance on existing roads. Per-segment regulatory authorization.

Provisional application

PRIMARY TECHNICAL DISCLOSURE

- [Marker Track Transport: Credentialed Marker Sequences as Primary Routing \(/articles/marker-track-transport-credentialed-marker-sequences-as-primary-routing\)](/articles/marker-track-transport-credentialed-marker-sequences-as-primary-routing)

SECONDARY TECHNICAL

- [Credentialed Markers as Primary Routing Reference \(/articles/marker-track/credentialed-marker-primary\)](/articles/marker-track/credentialed-marker-primary)
- [Per-Segment Authority Attestation \(/articles/marker-track/per-segment-attestation\)](/articles/marker-track/per-segment-attestation)
- [Route Manifest Composition \(/articles/marker-track/route-manifest-composition\)](/articles/marker-track/route-manifest-composition)
- [Cross-Authority Route Composition \(/articles/marker-track/cross-authority-routes\)](/articles/marker-track/cross-authority-routes)
- [Progressive-Density Fallback \(/articles/marker-track/progressive-density-fallback\)](/articles/marker-track/progressive-density-fallback)
- [Byzantine-Robust Platooning Under Credentialed Sequences \(/articles/marker-track/byzantine-platooning\)](/articles/marker-track/byzantine-platooning)
- [Adversarial Marker Rejection \(/articles/marker-track/adversarial-marker-rejection\)](/articles/marker-track/adversarial-marker-rejection)
- [Regulatory Segment Approval \(/articles/marker-track/regulatory-segment-approval\)](/articles/marker-track/regulatory-segment-approval)
- [Multi-Class Operator Parameterization \(/articles/marker-track/multi-class-parameterization\)](/articles/marker-track/multi-class-parameterization)
- [Dual-Use Marker Article: Roadway Infrastructure as Credentialed Device \(/articles/marker-track/dual-use-marker-article\)](/articles/marker-track/dual-use-marker-article)

APPLICATIONS · GENERAL

- [Automated Guideway Transit Without Rails: A Virtual Fixed Guideway From Credentialed Track Markers \(/articles/marker-track/automated-guideway-transit\)](/articles/marker-track/automated-guideway-transit)
- [Credentialed Highway Marker Network for GNSS-Denied Autonomous Vehicle Positioning \(/articles/marker-track/highway-infrastructure-marker-network\)](/articles/marker-track/highway-infrastructure-marker-network)
- [Indoor Positioning Without Vendor Lock-In: Credentialed Marker Infrastructure for Hospitals, Airports, and Multi-Tenant Buildings \(/articles/marker-track/indoor-positioning-credentialed-infrastructure\)](/articles/marker-track/indoor-positioning-credentialed-infrastructure)
- [Audit-Grade Warehouse RFID Positioning: A Credentialed Marker Mesh for DSCSA, FSMA 204, and FTZ Compliance \(/articles/marker-track/warehouse-credentialed-rfid-mesh\)](/articles/marker-track/warehouse-credentialed-rfid-mesh)
- [Credentialed Field Markers for Precision Agriculture and GPS-Resilient Autonomy \(/articles/marker-track/agricultural-marker-network\)](/articles/marker-track/agricultural-marker-network)
- [Credentialed Markers for Construction Site Safety and Autonomous Equipment Authorization \(/articles/marker-track/construction-site-credentialed-markers\)](/articles/marker-track/construction-site-credentialed-markers)
- [Credentialed Marker Positioning for Underground and Open-Pit Mining \(/articles/marker-track/mining-credentialed-positioning\)](/articles/marker-track/mining-credentialed-positioning)
- [Credentialed Trail Markers for National Parks: Multi-Authority Positioning for Hikers, SAR, and Park Shuttles \(/articles/marker-track/national-park-trail-markers\)](/articles/marker-track/national-park-trail-markers)
- [Smart Stadium Positioning: Credentialed Marker Networks for Event Venues \(/articles/marker-track/smart-stadium-event-positioning\)](/articles/marker-track/smart-stadium-event-positioning)

- [When the Vehicle Is Certified and the Route Is Not \(/articles/marker-track/marker-track-stakes\)](/articles/marker-track/marker-track-stakes)

APPLICATIONS • SPECIFIC

- [3M Connected Roads vs Credentialed Marker Architecture \(/articles/marker-track/3m-connected-roads\)](/articles/marker-track/3m-connected-roads)
- [Avery Dennison RFID vs Credentialed Marker Observations \(/articles/marker-track/avery-dennison-rfid\)](/articles/marker-track/avery-dennison-rfid)
- [Trimble RTK Alternative for GNSS-Denied Positioning: Credentialed Markers \(/articles/marker-track/trimble-rtk-corrections\)](/articles/marker-track/trimble-rtk-corrections)
- [Impinj RFID Alternative: Credentialed Marker Substrate Beyond Item Identity \(/articles/marker-track/impinj-rfid\)](/articles/marker-track/impinj-rfid)
- [NXP RFID IC Alternative: Credentialed Marker Specification Beyond UCODE and NTAG \(/articles/marker-track/nxp-rfid-ic\)](/articles/marker-track/nxp-rfid-ic)
- [Does a RoadVista retroreflectometer read a credentialed road marker? \(/articles/marker-track/roadvista-tape\)](/articles/marker-track/roadvista-tape)
- [Trimble Survey Markers vs Credentialed Machine-Readable Monuments \(/articles/marker-track/trimble-survey-marker\)](/articles/marker-track/trimble-survey-marker)
- [Zebra RFID Alternative: Credentialed Marker and Track Beyond EPC Identification \(/articles/marker-track/zebra-rfid\)](/articles/marker-track/zebra-rfid)
- [6 River Systems \(Shopify/Ocado\) Chuck vs Credentialed Marker and Track \(/articles/marker-track/6-river-systems-shopify\)](/articles/marker-track/6-river-systems-shopify)
- [AutoStore Alternative: Credentialed Marker and Track Positioning for Warehouse Robots \(/articles/marker-track/autostore-warehouse\)](/articles/marker-track/autostore-warehouse)
- [Berkshire Grey Alternative: Credentialed Marker and Track for Mixed-Vendor Fulfillment \(/articles/marker-track/berkshire-grey\)](/articles/marker-track/berkshire-grey)
- [Brain Corp Alternative: Credentialed Lane Authority for Mixed-Fleet Floor Care \(/articles/marker-track/brain-corp-floor-care\)](/articles/marker-track/brain-corp-floor-care)
- [Fetch Robotics \(Zebra\) FetchCore Alternative: Credentialed Marker and Track for Mixed Fleets \(/articles/marker-track/fetch-zebra-fulfillment\)](/articles/marker-track/fetch-zebra-fulfillment)
- [Geek+ Alternative for Multi-Vendor Warehouses: Credentialed Marker and Track \(/articles/marker-track/geek-plus-warehouse\)](/articles/marker-track/geek-plus-warehouse)
- [inVia Robotics Alternative: Credentialed Marker-Track Routing for Multi-Vendor Warehouses \(/articles/marker-track/invia-robotics\)](/articles/marker-track/invia-robotics)
- [Locus Robotics vs Credentialed Marker and Track Warehouse Positioning \(/articles/marker-track/locus-robotics\)](/articles/marker-track/locus-robotics)
- [Ocado Smart Platform Alternative: Credentialed Marker-Track Routing Beyond the Grid \(/articles/marker-track/ocado-smart-platform\)](/articles/marker-track/ocado-smart-platform)

HOW-TO GUIDES

- [How to Build a Guideway or Highway Positioning System from Credentialed Markers \(/articles/guides/guideway-positioning-from-credentialed-markers\)](/articles/guides/guideway-positioning-from-credentialed-markers)
- [How to Build a Warehouse RFID Mesh Robots Can Navigate By \(/articles/guides/warehouse-rfid-mesh-robots-navigate-by\)](/articles/guides/warehouse-rfid-mesh-robots-navigate-by)
- [How to Build Credentialed Infrastructure Markers for Indoor Positioning \(/articles/guides/credentialed-markers-for-indoor-positioning\)](/articles/guides/credentialed-markers-for-indoor-positioning)

TERMINOLOGY

- [marker-track transport \(/glossary#marker-track-transport\)](/glossary#marker-track-transport)

[Marker Track Transport overview → \(/marker-track\)](/marker-track)