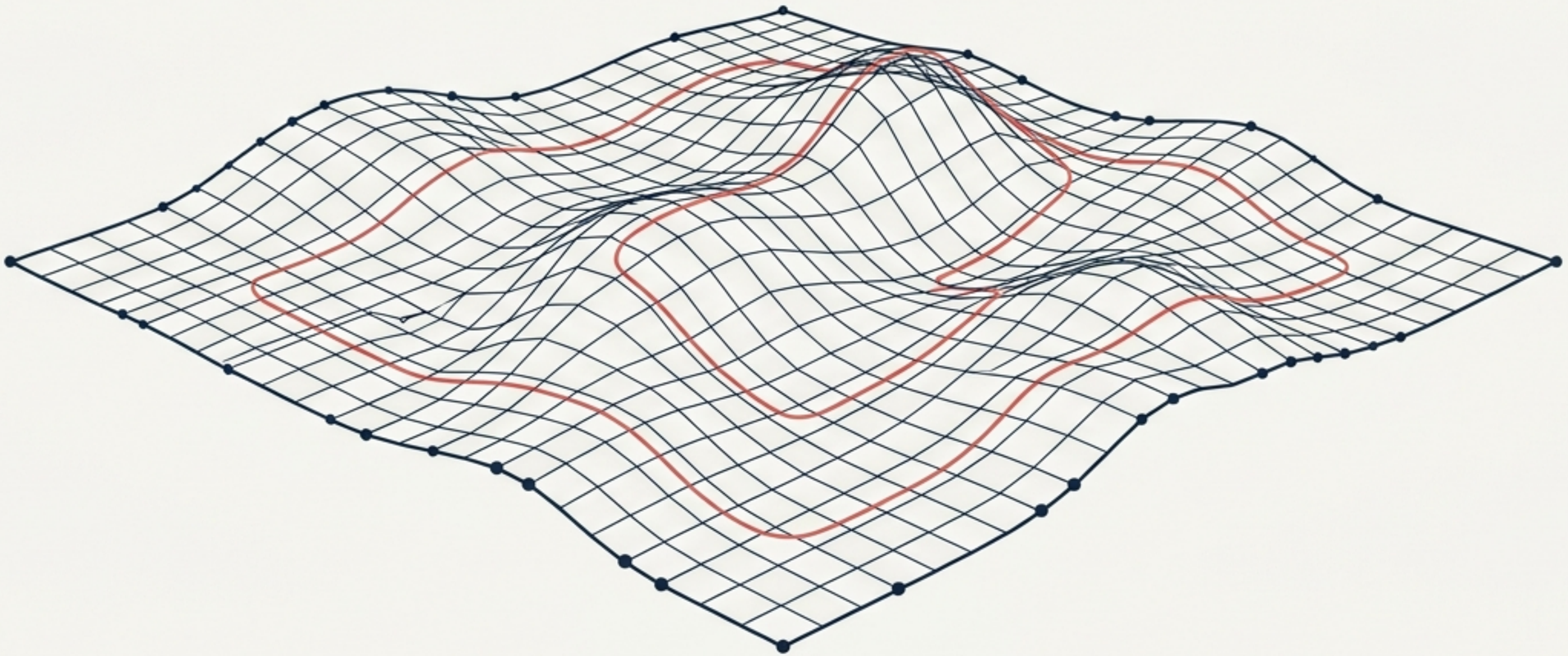


Holographic Telco Infrastructure

Integrating PTCP and TNQG in Next-Generation Telecommunications

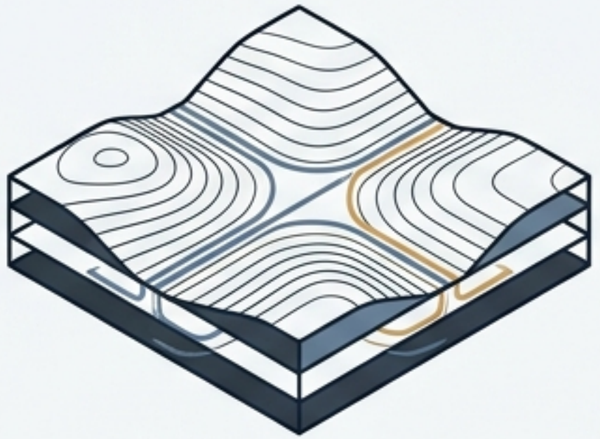
Prepared by Advanced Communications & Topologies Group | May 2026

Overcoming the 5G/6G Bottleneck with Tensor-Network Control

The Crisis

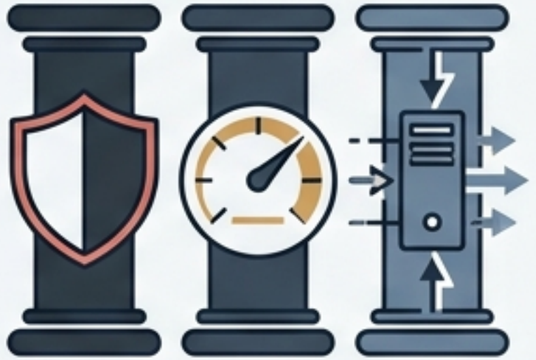
Exponential multi-modal telemetry from massive IoT, MEC, and Network Slicing is overwhelming legacy SDN controllers.

The Catalyst



Predictive Tensor Control Plane (PTCP) uses theoretical physics frameworks to model network states as singular predictive geometries.

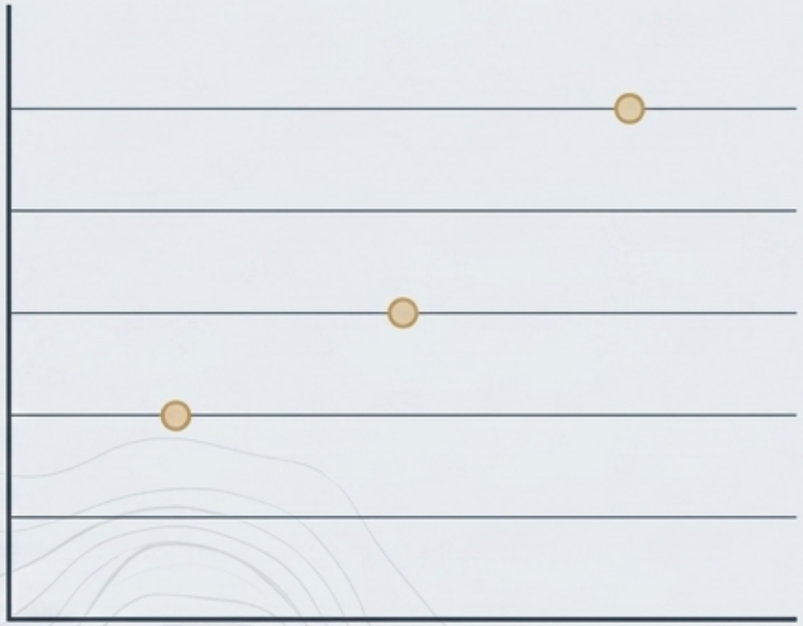
The Business Outcome



Compress telemetry data, execute energy-aware routing, and instantly quarantine edge botnets.

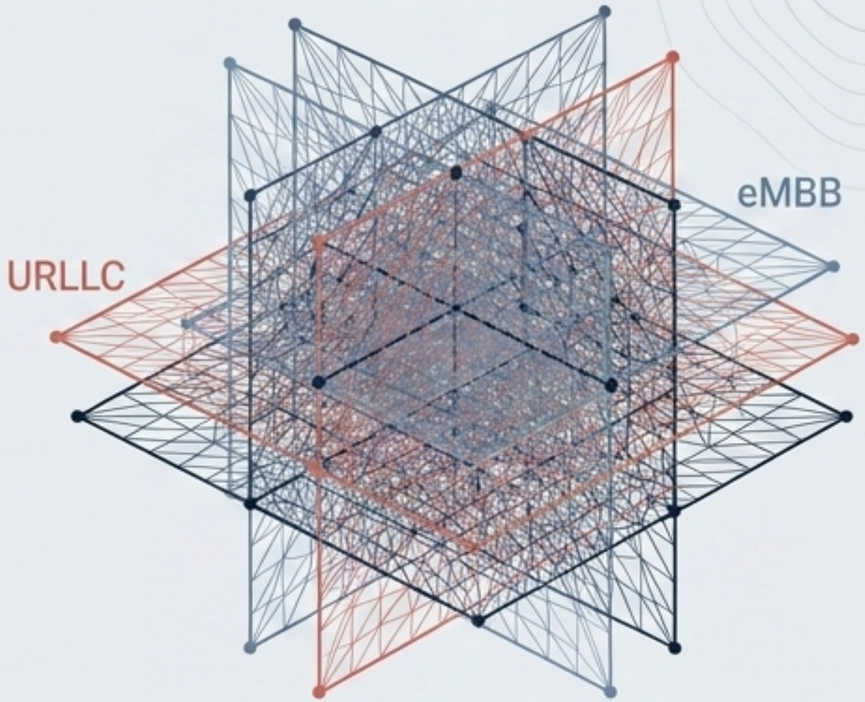
Legacy SDN Cannot Scale to Meet the Multi-Modal Demands of 5G/6G

Legacy SDN - Scalar Counters



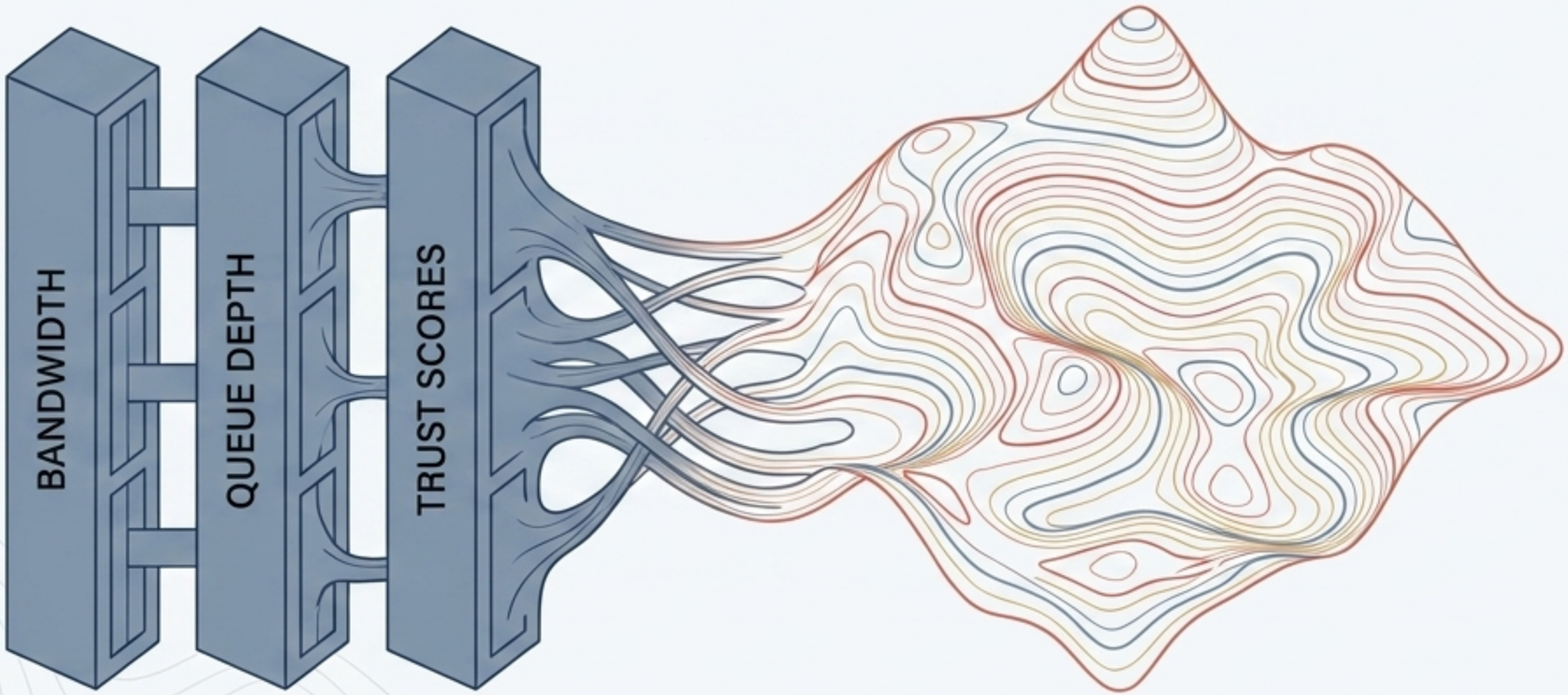
Legacy control planes fail to capture the joint distribution of concurrent state variables.

Next-Gen 5G/6G - Hyper-Dimensional State Space



The result is reactive, inefficient resource allocation crippled by the curse of dimensionality.

The Paradigm Shift: Transforming Disconnected Metrics into Unified Network Geometry



The PTCP Advantage

Rather than processing millions of independent scalar counters, the Predictive Tensor Control Plane tracks a singular, predictive geometry.

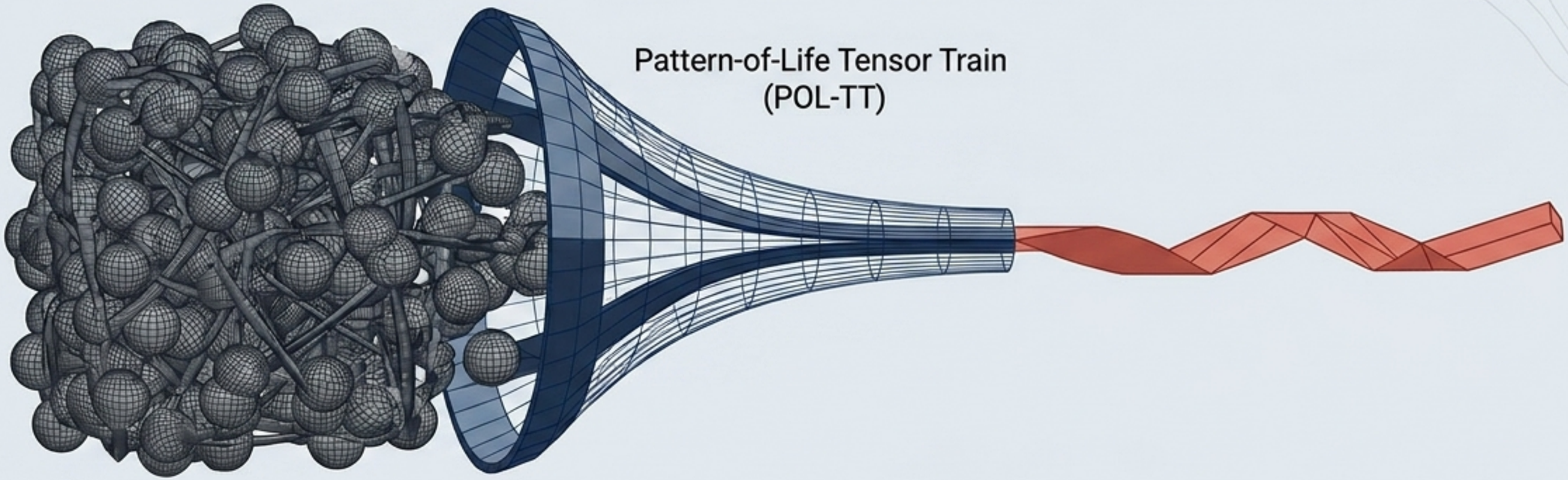
The Outcome

Telemetry is understood holistically, allowing the network to orchestrate traffic based on the ‘shape’ of the network state.

Translating Quantum Gravity Frameworks into Concrete Telco Value

Physics/PTCP Concept	Telco Application	Strategic Business Advantage
Tensor-Train Compression	Multi-Modal Network Slicing	Linear scaling for massive edge SLA tracking.
Information-Geometric Link Length	Composite Link Metric	Seamless integration of OpEx (energy) into routing decisions.
Geodesic Optimization	Predictive Traffic Engineering	Ensures low-latency avoidance of congestion.
Graph Curvature Anomalies	IoT Botnet Defenses	Topology-native detection without Deep Packet Inspection.

POL-TT Compression Models Complex Network States Without Exponential Memory Overheads



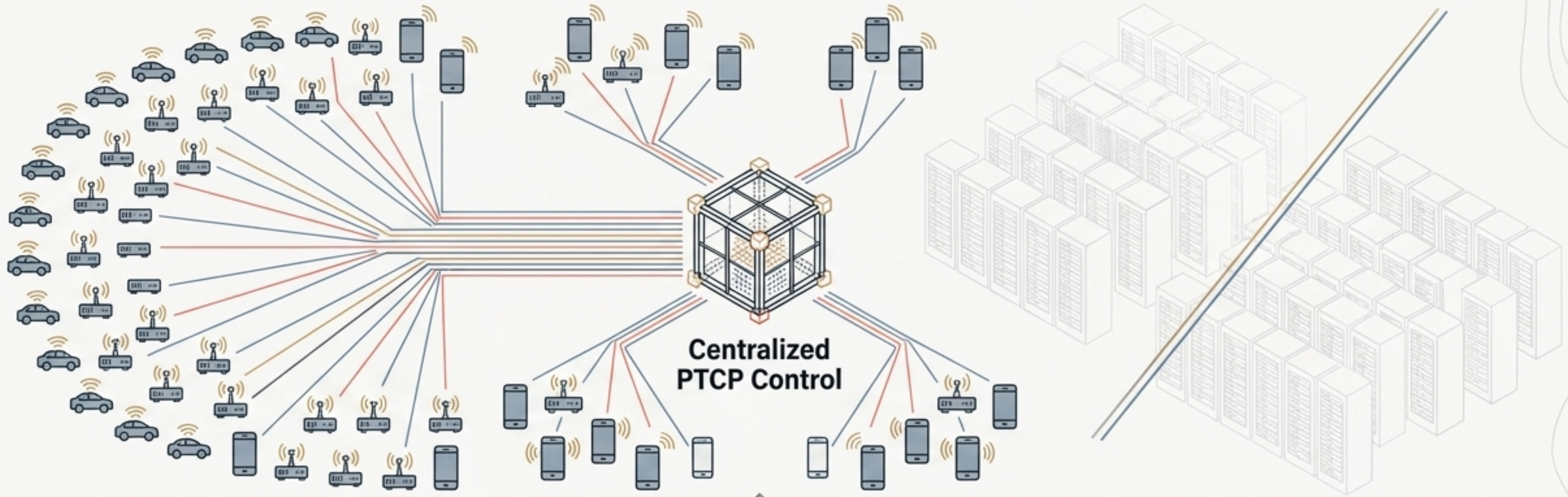
The Mechanism

Discretizes global telemetry into bounded probability models to establish a baseline ‘normal’ state of the network.

The Impact

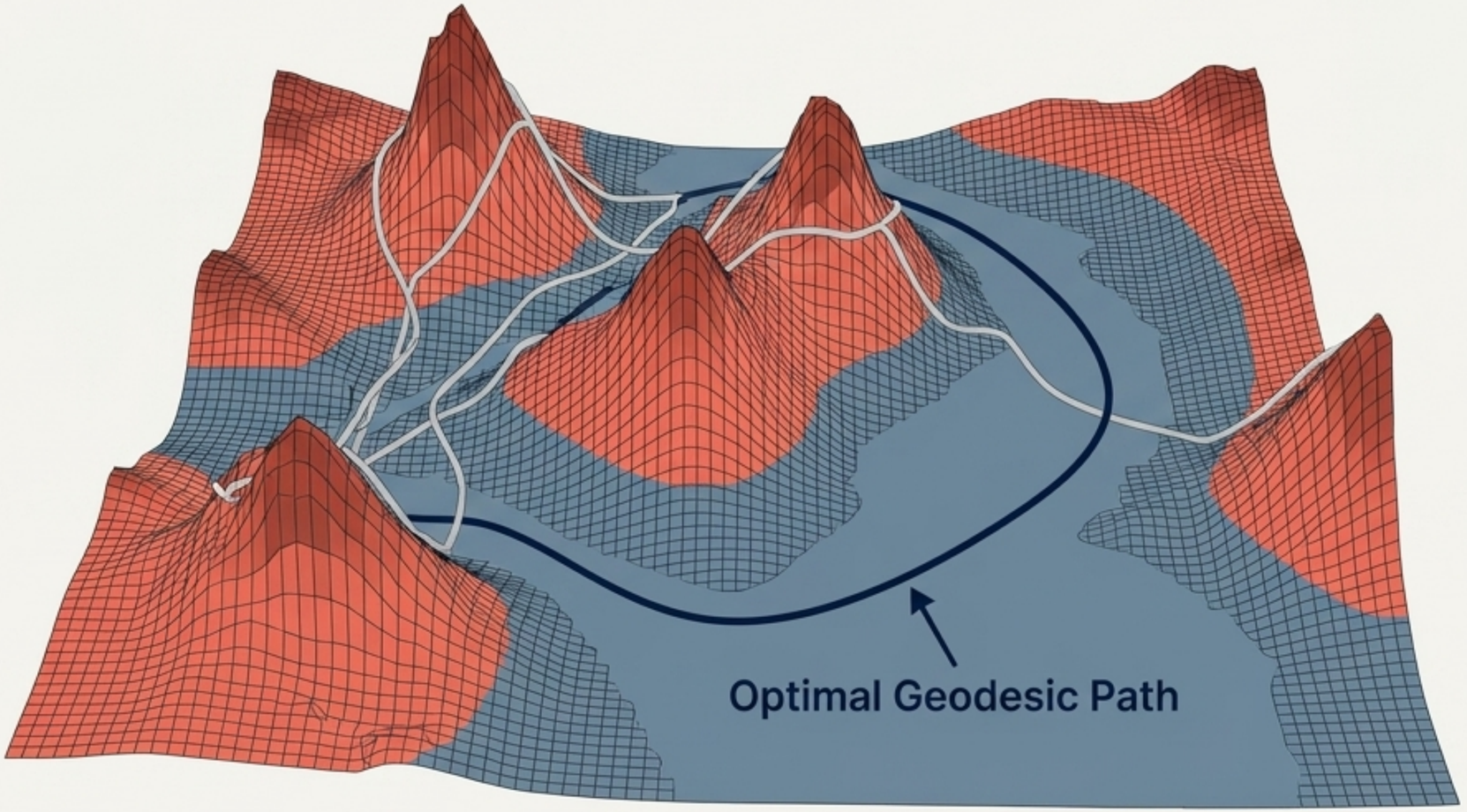
Transforms data storage requirements from an exponential trajectory to a manageable linear scale.

Monitor Millions of Edge SLAs Concurrently Without Hyperscale Compute



Telcos can **actively monitor complex, multi-modal SLA compliance** (combining jitter, bandwidth, and energy) for **millions of 5G edge devices** without requiring expensive, hyperscale datacenter hardware deployments at the edge.

Geodesic Optimization Identifies Minimum-Risk Routing Paths Across the Network



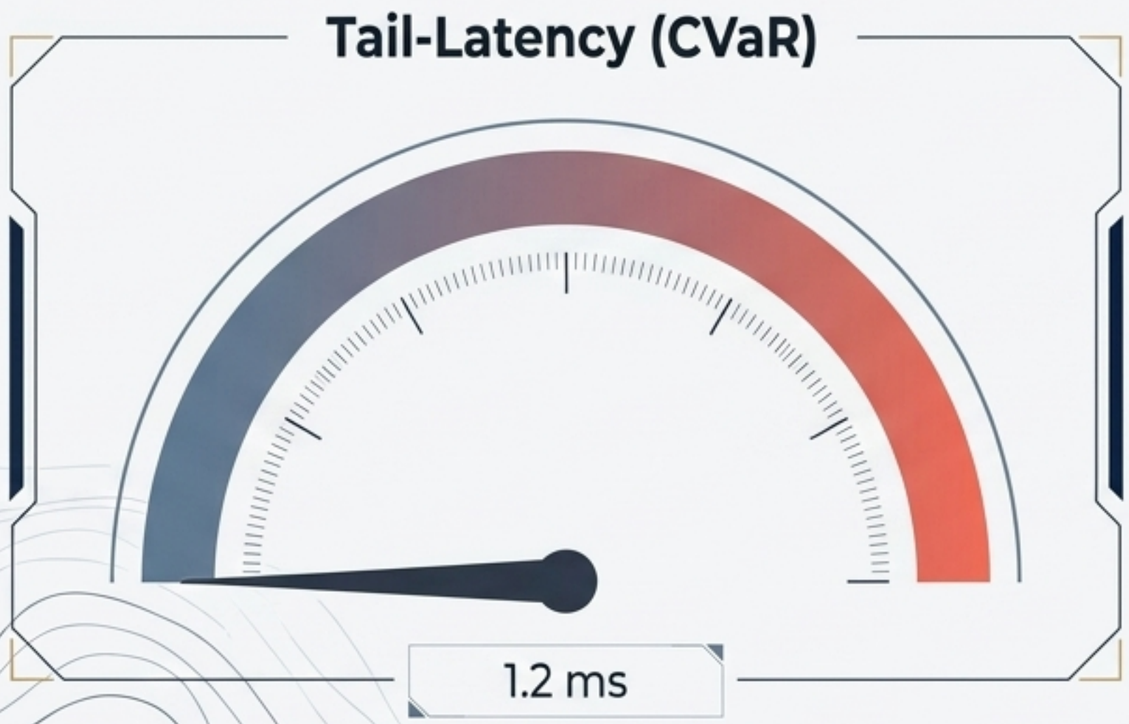
Composite Link Metric

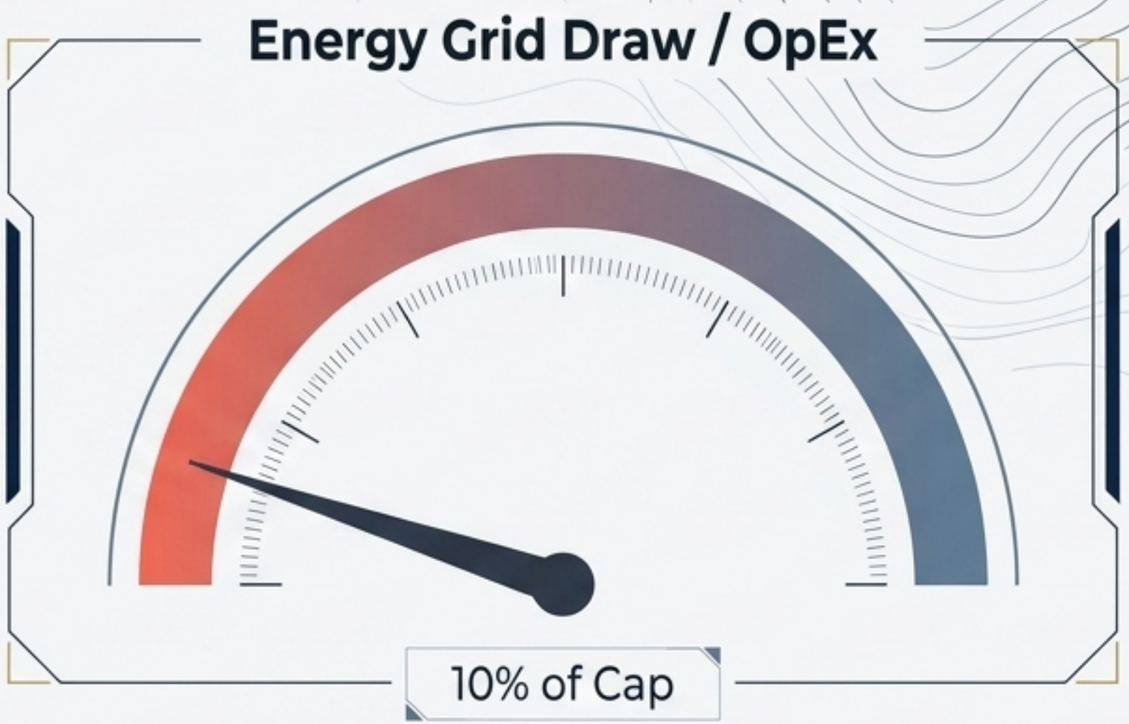
The system integrates energy/operating costs alongside traditional metrics (latency, bandwidth, trust) into a unified, dimensionless capacity score.

Minimum-Risk Navigation

Routes are selected by evaluating expected path costs across a forecasted horizon.

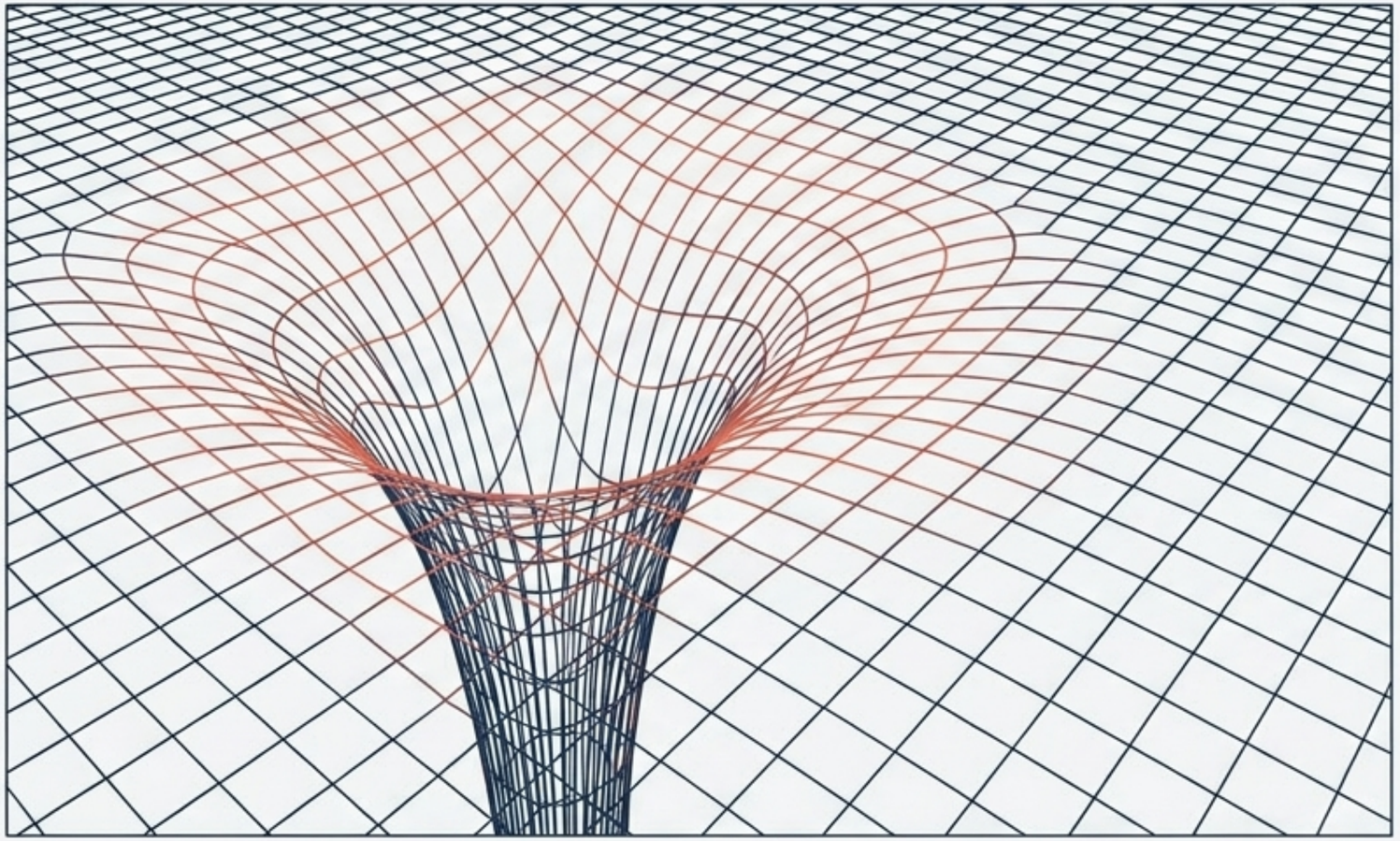
Simultaneously Reduce OpEx Energy Draw and Prevent Tail-Latency Spikes





By **dynamically steering** traffic from 5G MEC nodes around highly power-expensive or congested paths, PTCP guarantees strict **SLA adherence** while actively **minimizing RAN** and **core router power consumption**.

Identify Massive IoT Botnets by Mapping Topological Deformations in the Network Fabric



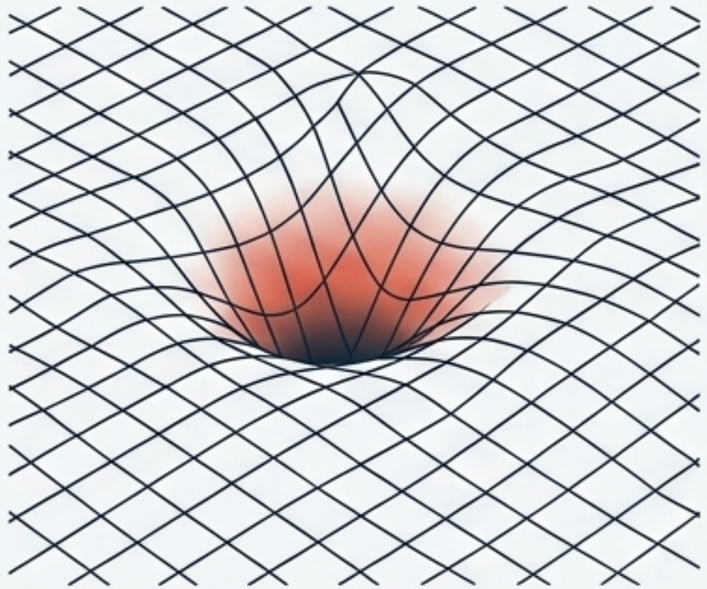
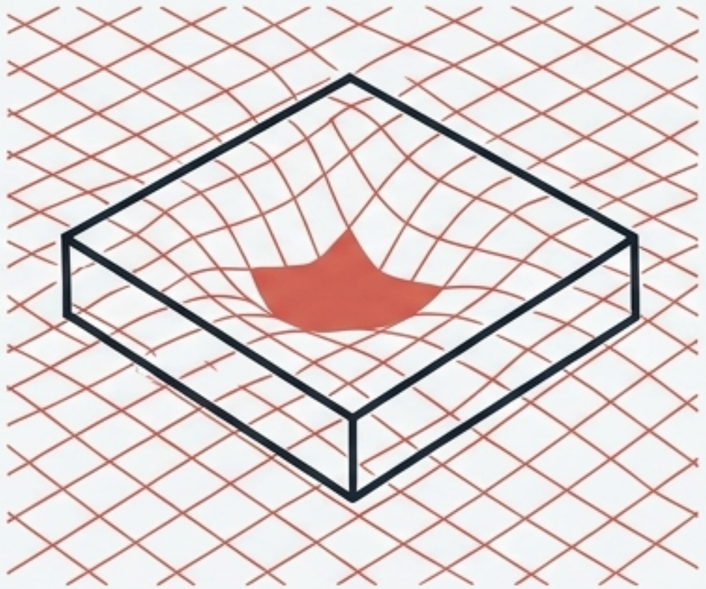
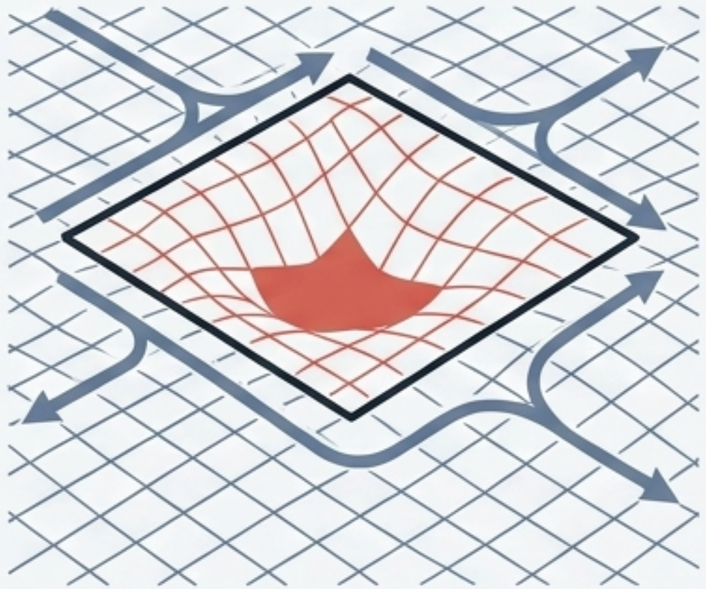
The Threat

Volumetric DDoS attacks from massive distributed IoT botnets can easily overwhelm the core while masquerading as legitimate traffic.

The Topology-Native Solution

PTCP defines a cyberattack geometrically. Instead of inspecting packets, the system calculates graph-curvature. A coordinated botnet creates a severe, localized structural deformation—a “defect score” in the telemetry distribution.

Instantly Quarantine Compromised IoT Slices Without Deep Packet Inspection

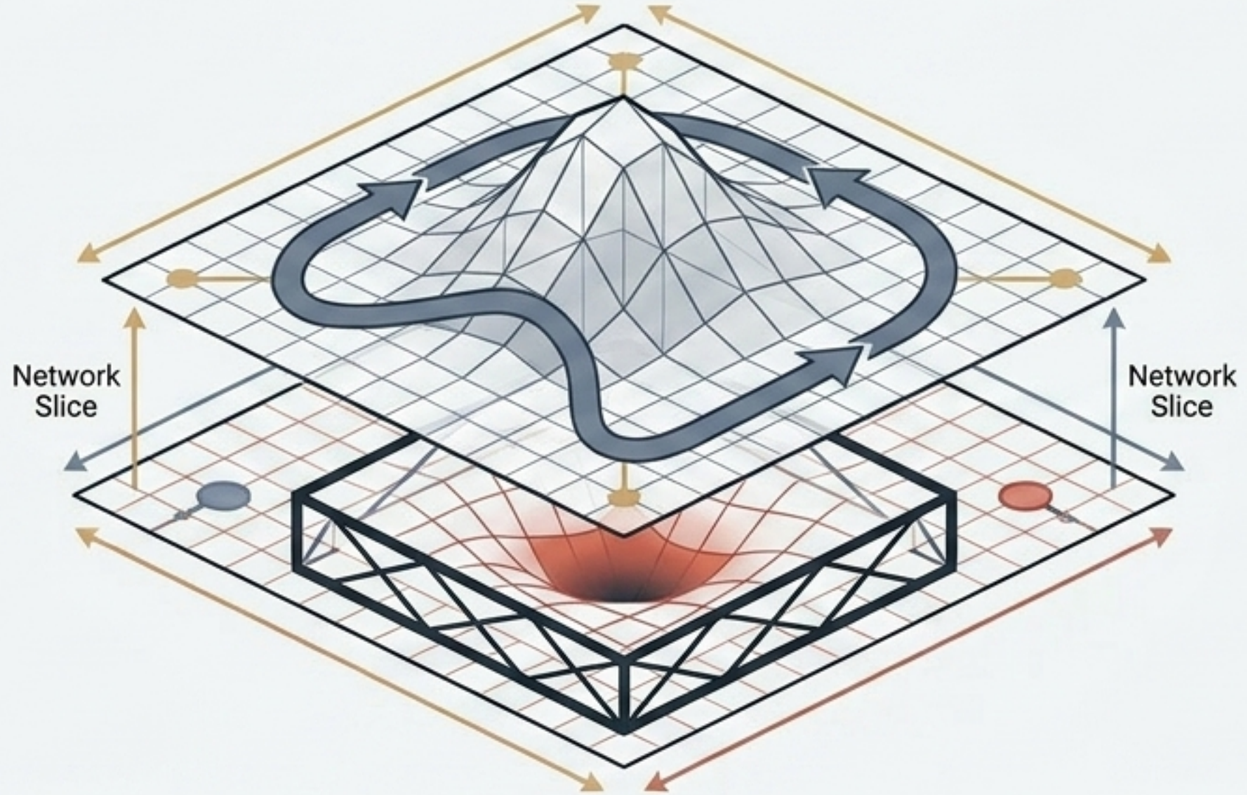
1. Anomaly Identified	2. Area-Cut Consistency	3. Seamless Flow
		

The defect score instantly flags structural anomalies. The SDN executes a safe policy envelope projection, surgically severing the compromised slice without impacting adjacent critical infrastructure communications.

Calibrating for Mobile Non-Stationarity and NPU Hardware Integration

 As users commute between cell towers, telemetry naturally spikes.	 Online rank-truncated updates must be finely calibrated to prevent routine urban mobility from triggering false topological anomalies.
 Evaluating routing paths over complex scenarios requires immense mathematical processing.	 Core infrastructure must integrate advanced Network Processing Units (NPUs) specifically optimized for tensor mathematics.

The Holographic Infrastructure Paradigm Unifies Slicing, Routing, and Security



By shifting from classical scalar metrics to compressed tensor-train geometries, Telco operators can efficiently orchestrate hyper-dimensional network slices, execute energy-and-risk-aware routing, and deploy topology-native defenses against massive edge-device botnets. The future of 5G/6G is geometric.