UNICO I+D 6G - EDGEDT

PREDICT-6G

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Artificial Intelligence Control Plane (AICP) for Deterministic Networks

PoC

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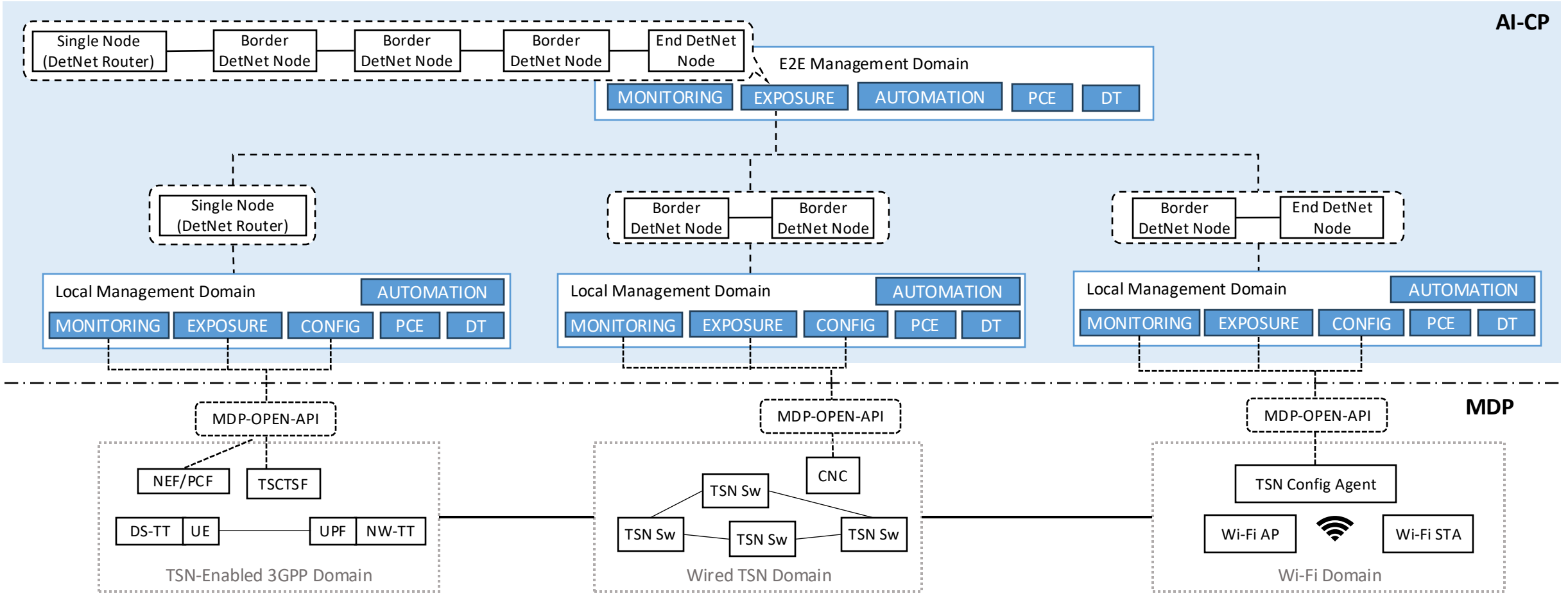
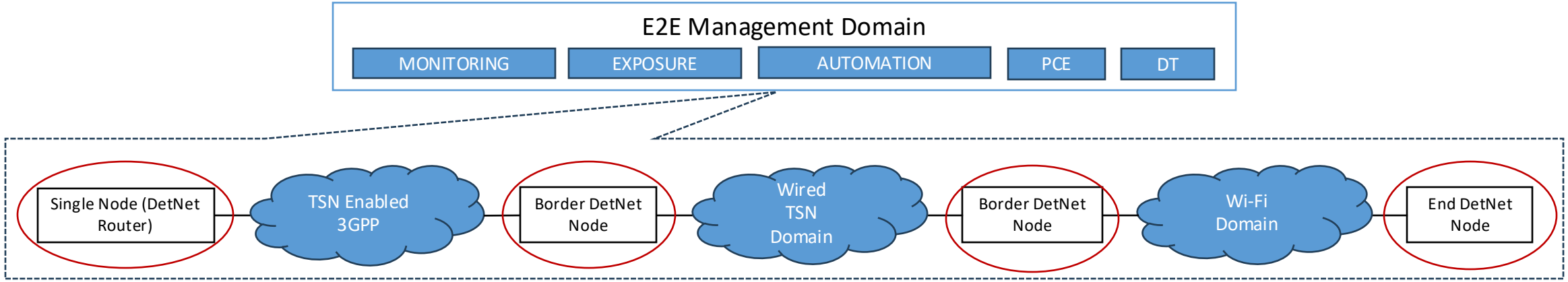
High-level control architecture and abstraction modelling

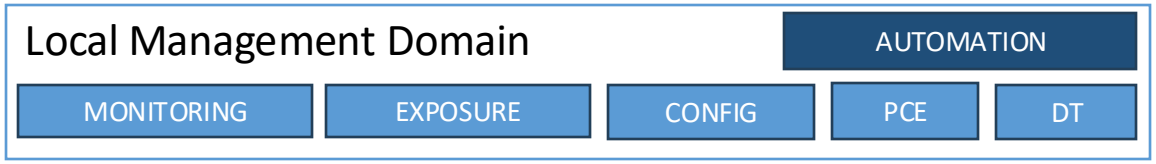


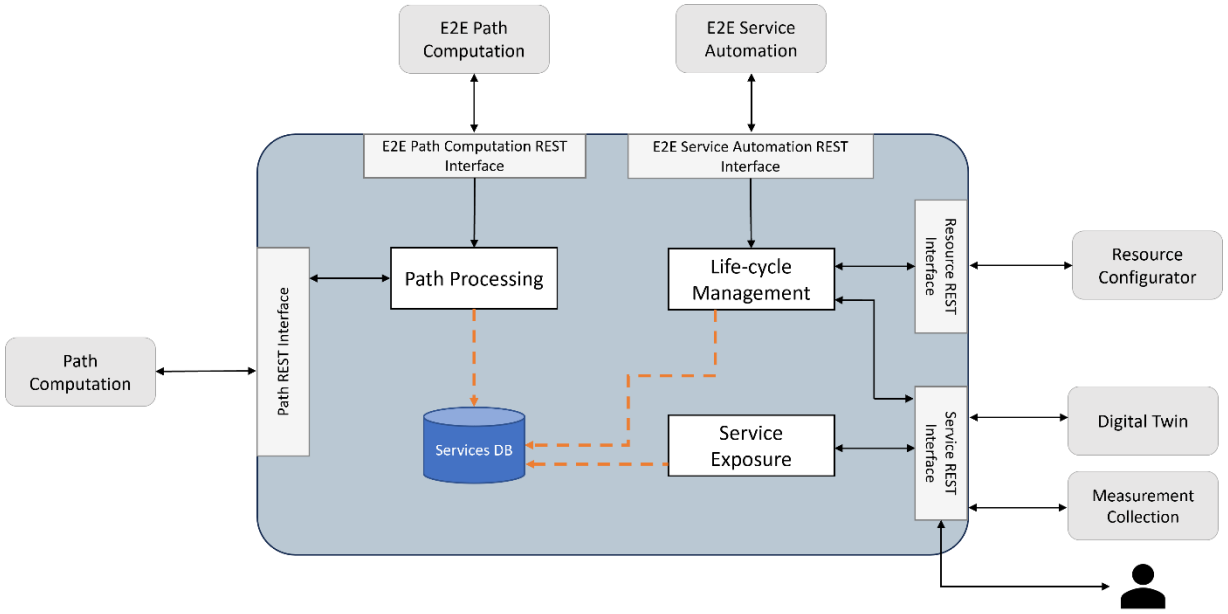
E2E Domain Abstraction



- **Objective**: Unify control across different technology domains (3GPP, WiFi, wired TSN) to provide deterministic E2E service.
- **IETF DetNet:** Ensures the encapsulation at domain entry points (DetNet Nodes) maintains data integrity
- **Layer-3 Overlay**: Creates a unified E2E path accross multiple network domains. MPLS serves as a “glue” to maintain deterministic behaviour through different network segments.
- **Service & Forwarding Sub-Layers**:
  - Service Sub-layer: Assigns S-labels and uses a DetNet Control Word (d-CW) to identify and sequence flows, ensuring packets are managed predictably.
  - Forwarding Sub-layer: Manages explicit paths and resources for QoS.

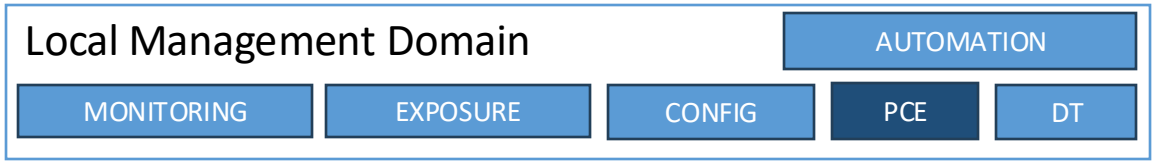
Service Automation

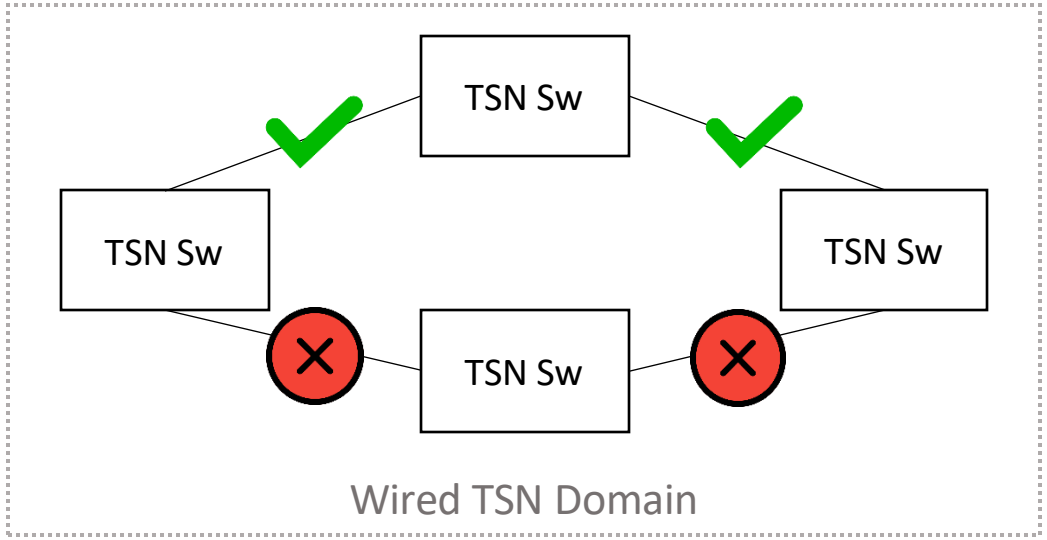




- **Objective**: Provides automated, closed-loop management of deterministic services across diverse network domains, ensuring they meet performance requirements throughout their lifecycle.
- Three Key Lifecycle Stages:
  1. **Service Provisioning**: Configures each domain to meet service-specific QoS and determinism requirements.
  2. **Service Assurance**: Adjusts service parameters in real-time to maintain QoS
  3. **Service Termination**: Safely decommissions services when no longer needed.

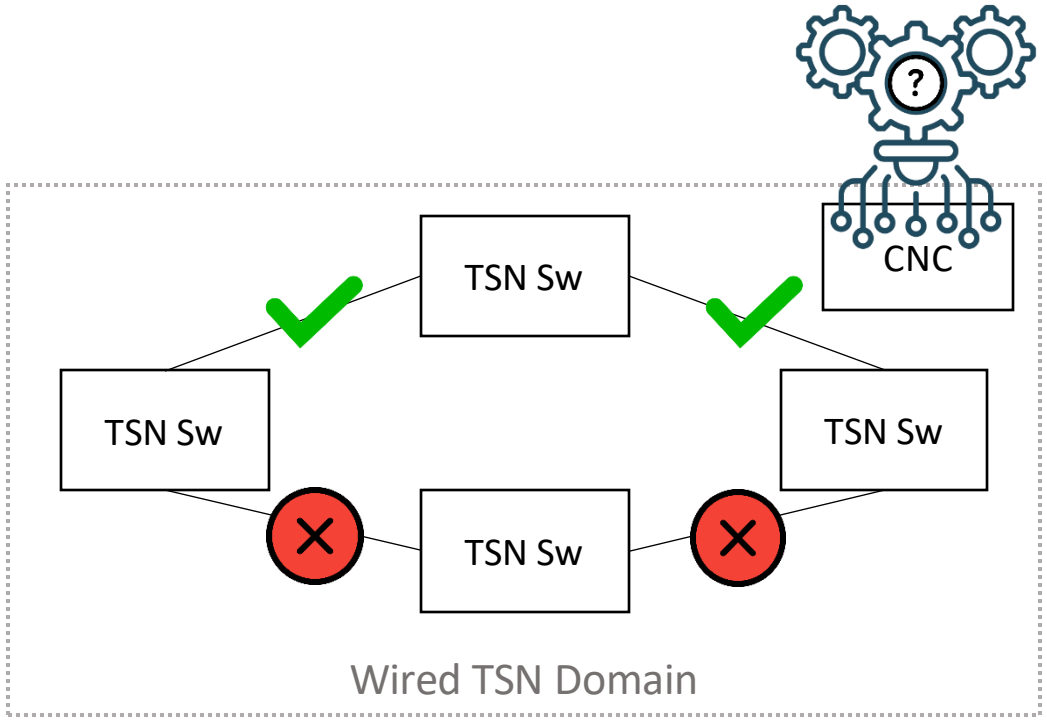
Path Computation





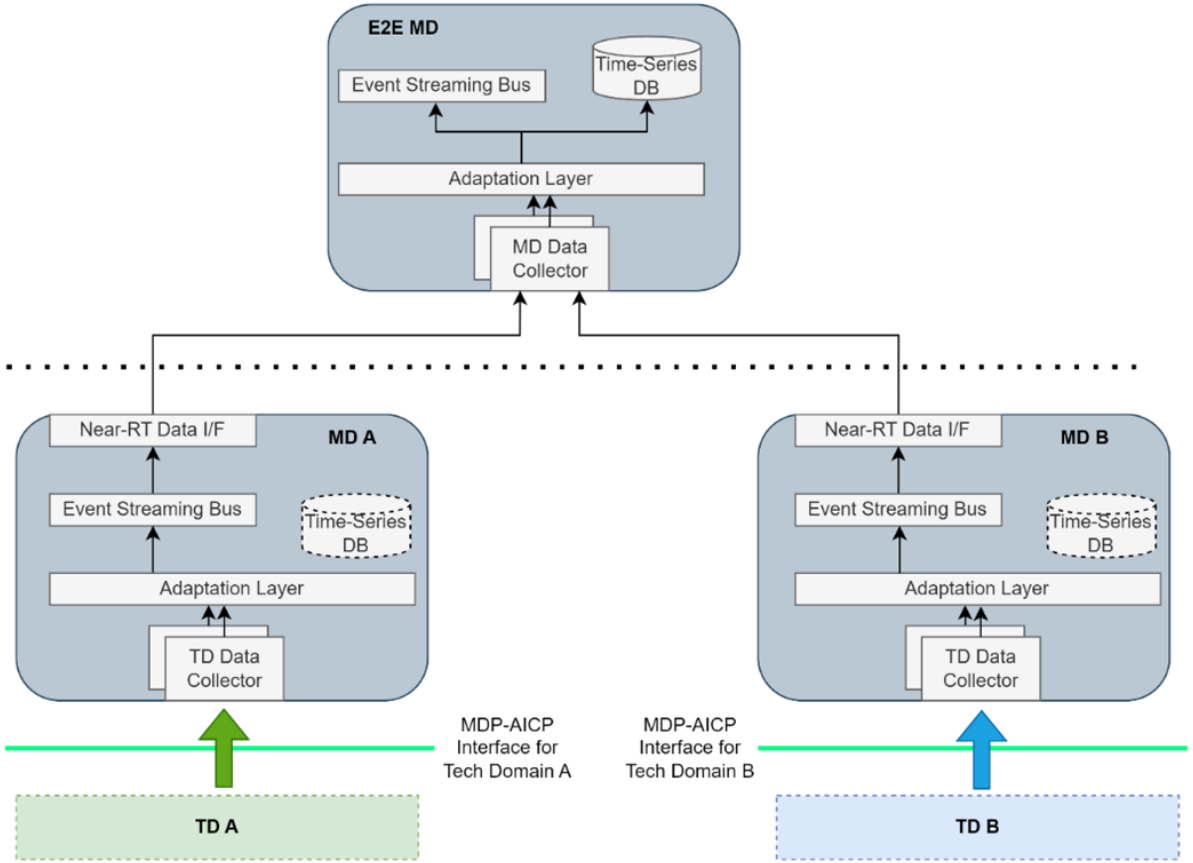
- **Objective**: Establishes deterministic paths that meet strict performance requirements across multi-domain networks.
- Two-Level Path Computation
  1. **E2E Path Computation**: Calculates the high-level path across domains, integrating abstracted topologies of each domain as a connected graph. This path meets overall service KPIs.
  2. **Domain-level Path Computation**: Calculates a more detailed path within each domain, considering local topology, technology specifics, and current resource usage.

Resource Configuration



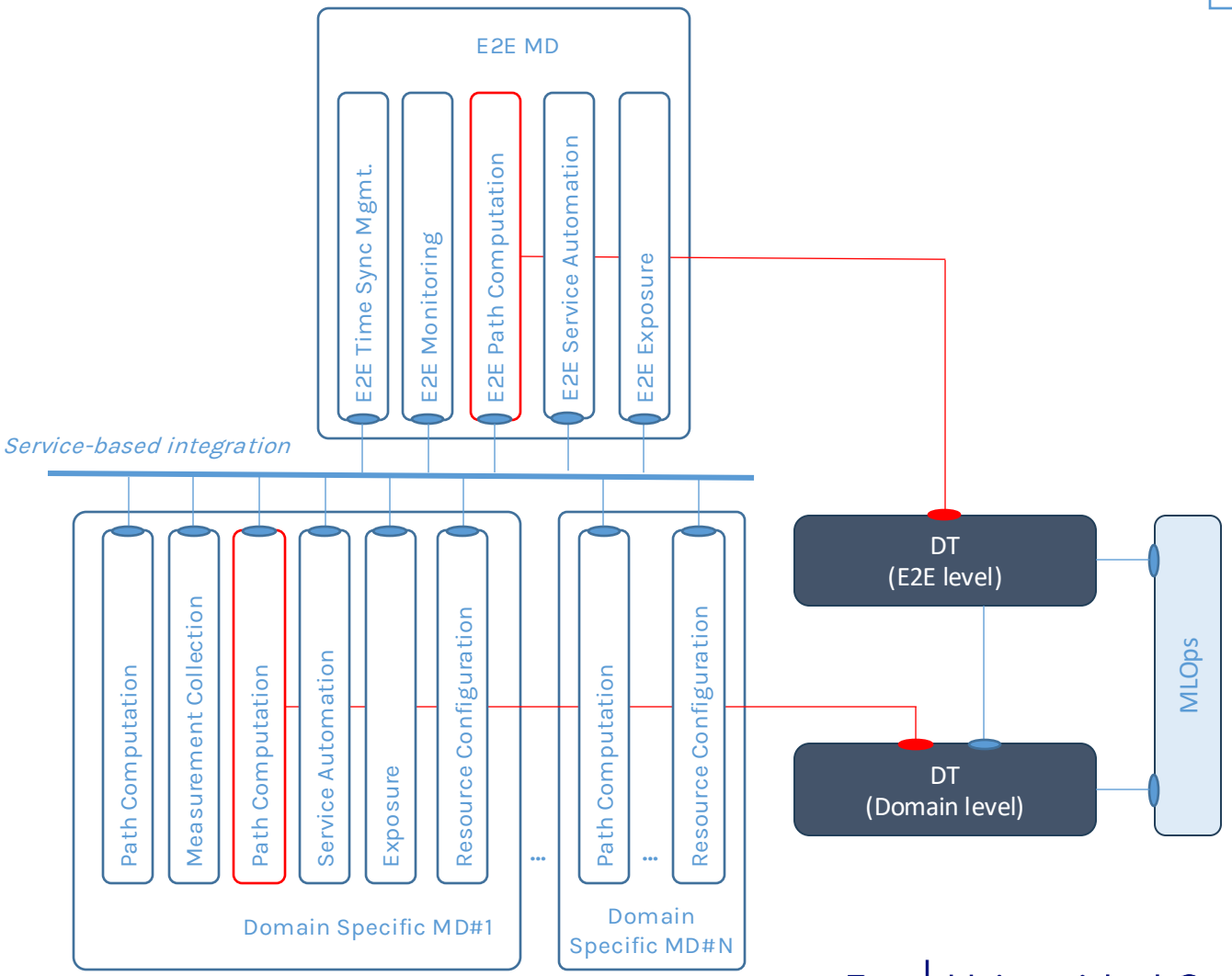
- **Objective**: Manages and allocates network resources dynamically to meet the performance requirements.
- **Multi-Domain Resource Management**:
  - Configures resources individually within each domain (e.g., Ethernet, WiFi, 3GPP) using dedicated Resource Configurators tailored to each technology's requirements.
  - Ensures deterministic behavior by handling VLANs, traffic classifications, and scheduling configurations specific to each domain.
- **Worst-Case Traversal Time (WCTT) Analysis.**

Monitoring



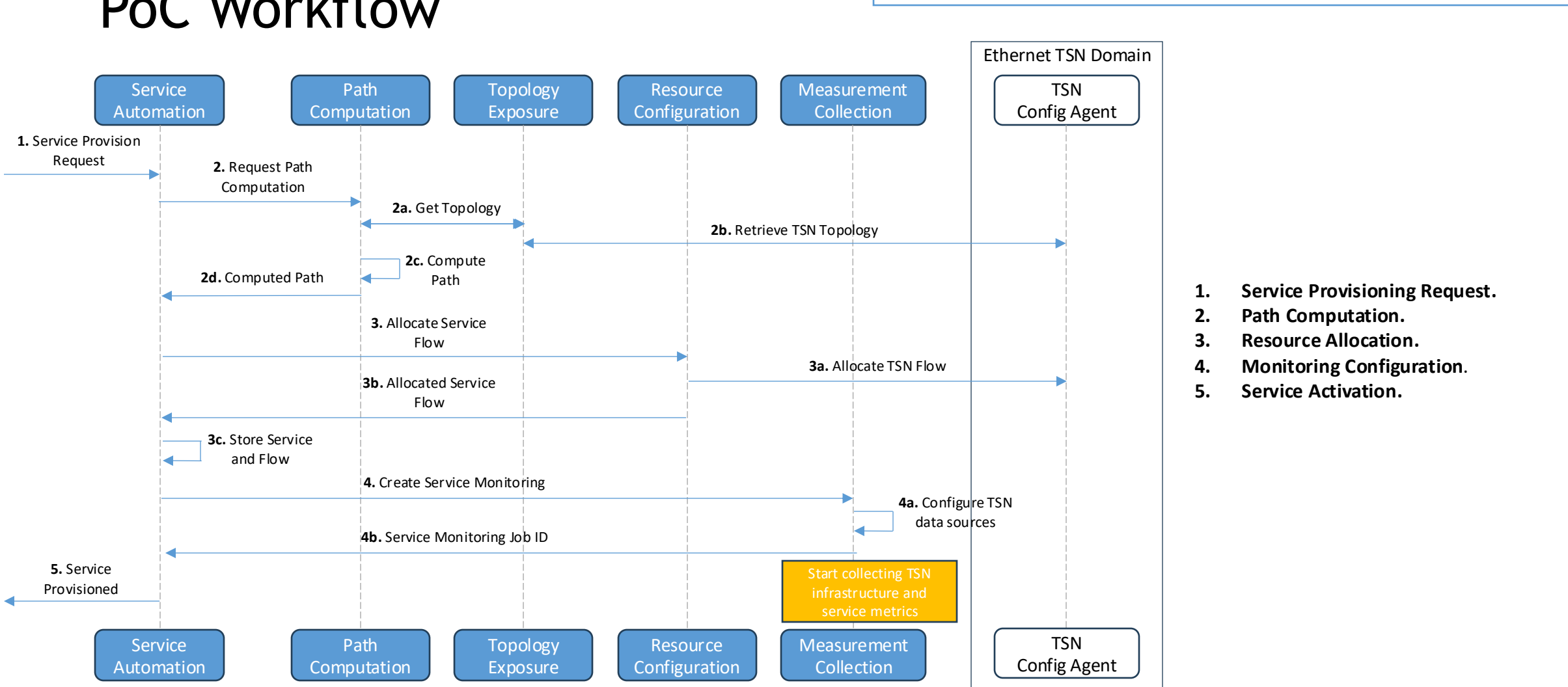
- **Objective**: Provides continious, real-time data collection and analisis across domains to ensure predictable performance.
- Data Collection and Management Platform:
  - Collects metrics from diverese data sources, normalizes them, and provides near real-time Access via an Event Streaming Bus.
  - Aggregate key metrics, such as mínimum, mean, máximum values, and standard devieation, supporting KPI tracking.
- **Plugin-Based Architecture**
- **Hierarchical Data Aggregation**

The Digital Twin



- **Objective**: Emulates network conditions to estimate KPIs for deterministic services, supporting real-time adjustments and proactive service management.
- Network Scenario Emulation:
  - **Components**: The DT models traffic and network behavior with fine-grained accuracy, using four main components: generators, queues, links, and sinks.
  - **Traffic Generation**: Synthetic traffic is generated at both macroscopic (e.g., hourly load) and microscopic (e.g., microsecond packet bursts) levels, reflecting real-world network dynamics.
- **Queue and Link Modeling**
- **E2E KPI Estimation**

PoC Workflow



1. **Service Provisioning Request.**
2. **Path Computation.**
3. **Resource Allocation.**
4. **Monitoring Configuration.**
5. **Service Activation.**

Thank You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