# Velsanet Path Formation White Paper

Network-Native Path Formation and Maintenance Model

## 1. Purpose

This document defines the path formation model of the Velsanet architecture.

The purpose of this document is to specify how a validated Velsanet Identity and its associated path constraints are transformed into a physical and logical network path, and how such paths are maintained, reconfigured, and terminated.

## 2. Scope

This document covers:

- inputs to path formation
- matching rules for cores, planes, and paths
- path formation semantics
- path maintenance and reconfiguration rules
- path termination semantics

This document does **not** define:

- identity provisioning
- authentication mechanisms
- application semantics
- packet routing or forwarding logic

## 3. Design Principle

In Velsanet, paths are not computed per packet.

Paths are formed as stateful entities based on structural admissibility.

Path formation is deterministic within the constraints defined by identity and topology.

# 4. Input Definition

Path formation operates on the following inputs:

- a validated Velsanet Identity
- a validated Path Constraint Set
- current topology state
- available core and plane resources

No application-level intent or data semantics are used as input.

# 5. Path Constraint Set

A Path Constraint Set defines the required properties of a path.

Constraints may include:

- latency bounds
- continuity requirements
- isolation level
- synchronization requirements
- failure tolerance

Constraints are declarative and do not specify routing instructions.

# 6. Resource Abstraction

The Velsanet network abstracts physical resources as:

- Cores: parallel optical or logical transmission units
- Planes: isolated path domains providing fault and policy separation
- Paths: end-to-end stateful connections formed across cores and planes

Path formation operates exclusively on these abstractions.

# 7. Matching Rules

Path matching is performed in the following order:

1. **Core Admissibility Check**

    - cores must satisfy bandwidth and continuity constraints
2. **Plane Admissibility Check**
    - planes must satisfy isolation and policy constraints
3. **Path Continuity Check**
    - an end-to-end path must exist without violating constraints

If no admissible combination exists, path formation fails.

# 8. Path Formation Semantics

When a valid match is found, a path is formed with the following properties:

- the path is stateful
- the path is bound to the originating identity
- the path exists independently of data transmission

Once formed, the path persists until explicitly terminated or invalidated.

# 9. Path Ownership and Control

Paths are owned by the network.

Devices do not:

- modify paths
- reroute paths
- negotiate intermediate hops

Devices may only update constraint requests within identity bounds.

# 10. Path Maintenance

Formed paths are continuously monitored for constraint compliance.

Maintenance actions may include:

- resource reallocation within the same plane
- core substitution within admissible bounds

Maintenance does not alter the identity–path binding.

# 11. Reconfiguration Rules

Reconfiguration is permitted only when:

- constraints remain within original bounds
- identity scope is unchanged

Reconfiguration is triggered by:

- topology changes
- resource degradation
- fault conditions

Unauthorized reconfiguration is prohibited.

# 12. Failure Handling

Upon failure detection:

- the network attempts recovery within the same plane
- if unsuccessful, recovery may occur across admissible planes

If no admissible recovery path exists, the path is terminated.

# 13. Path Termination

Paths are terminated when:

- the originating device disconnects
- constraints are withdrawn
- identity validity expires
- recovery fails

Termination releases all associated resources.

# 14. Path Record

For each terminated path, the network records:

- identity reference
- constraint profile
- formation timestamp
- termination reason

Records are retained for verification and audit purposes.

## 15. Summary

In Velsanet:

- paths are formed by structural matching
- paths exist as stateful entities
- path control resides exclusively in the network

Path formation is inseparable from identity and topology.