TVR (Time-Variant Routing) Requirements
draft-ietf-tvr-requirements-01

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Intention of this Internet-Draft

- This document introduces requirements for TVR computations to improve network communication and resource efficiency.
- From the TVR Charter “This document should include TVR definitions, requirements, notes, rationales, and examples.”
- Our intention is the requirements are derived from the Use Case I-D and other contributions to provide input into the TVR Information Model and Data Model, Internet-Drafts.
Expectation of Time-Variant Networks

• Time-Variant Routing (TVR) refers to calculating a path or subpath through a network where the time of message transmission (or receipt) is part of the overall route computation
  • TVR-based network topologies may be either
    • Systems with intrinsic topological changes
    • Systems with occasional topological changes
  • Topology based on nodes with limited resources or connectivity, this could be based on design or environment
  • Identification of links and when they are available at specific times to help nodes preserve resources
  • Costs of a link may change over time and be dependent on financial or environmental costs
  • Mobility may be the root cause of link/adjacency connectivity, but cause is not significant to the representation or processing of the topology

• Overall, loss of links or nodes is expected
Scope for the Requirements I-D

- Intended to provide time-variant requirements, derived from working group Use Cases (datatracker.ietf.org/doc/draft-ietf-tvr-use-cases)
  - Scenarios include:
    - Resource Preservation
    - Operating Efficiency
    - Dynamic Reachability
- Provide a succinct description of TVR networking, including agreement and definitions for key TVR terms
  - Visibility
  - Locality
  - Temporality
  - Time-Variability
  - Time Precision
  - Periodicity
  - Continuity
  - Interpolation
- Define topology model components, using existing IETF technology where possible, and/or extending for TVR
  - Nodes, Termination Points, Links, Network Layering
  - Routing Architecture, Constraints, Metrics
  - Time Horizon
Progress from 00 to 01

• Document Updates
  • Expanded Terminology Section
  • Introduced Management Entity Functional Architecture
  • Added Resource Scheduling Section
  • Expanded Topology Section
  • Expanded Control Plane Section
  • Added Solution Considerations Section
  • Added Requirements Summary

• Merged requirements and some discussion from
  • draft-wang-tvr-requirements-consideration
  • draft-zhang-tvr-routing-considerations

• Welcome to our new Contributors: Jing, Peng, Li, Zheng (Sandy), and Yuehua.
Expanded Terminology

- **Orchestrator**: The subsystem of a managing device which centralizes control of a network and applies policy to manage a network.

- **Manager**: The subsystem in a managing device which operates a management protocol to control an Agent.

- **Agent**: The subsystem in a managed device which operates a management protocol to be controlled by a Manager.

- **(Routing) Application**: The subsystem of a managed device which performs the functions of a routing protocol and/or algorithm.
Schedule Visibility (Intrinsic & Extrinsic)

• Existing routing algorithms and managed data models do not inherently incorporate scheduled time-variance as part of their routing parameters.
  • Therefore, not all routing applications are designed to handle schedules seamlessly
  • There are two primary approaches to incorporating schedules into routing data:
    • **Intrinsic Scheduling** which doesn't rely on the concept of 'execution' in wall-clock time, as time-varying parameters are seamlessly integrated into the natural operation of the routing algorithms
    • **Extrinsic Scheduling** where the schedule is managed by the Orchestrator, separate from the core managed data. The routing application observes changes in routing parameters as the schedule is executed by the Agent in real-time
Schedule Visibility (Centralised & Distributed)

• Visibility into a time-varying schedule and the location of schedule data within the network topology vary. There are two extremes for schedule data locality:

• The schedule management is **centralised** within a network Orchestrator.
  * Changes are transmitted to routing applications in real-time through a management interface, reflecting Extrinsic schedule visibility.
  * Managed routers remain unaware of the schedule, which doesn’t provide context for parameter changes

• The schedule is **distributed**, possibly with a limited time horizon to devices by the Agent or routing Application
  * Aligns with Intrinsic or intermediate schedule visibility
Topologies (Nodes)

• Aligned discussion with existing IETF terms and provided References where applicable
  • **NODES**: A node in Layer 3 [RFC8346] and Layer 2 [RFC8944] topologies is simply a named entity
  • Schedules on a node indicate either the node's overall validity or changing properties. If a schedule indicates a node's invalidity at a specific time instant, this also applies to all its termination points and links
  • This allows a schedule to represent expected node states, such as power-on state at a specific layer
Topologies (Termination Points)

• **Termination Point** is associated with an IP address in Layer 3 [RFC8346] and a MAC address in Layer 2 [RFC8944].
  • Schedules on a **Termination Point** indicate the validity of the corresponding layer-2/3 interface or changing properties
  • If a schedule indicates a termination point's invalidity at a specific time instant, this applies to all its links
  • This allows a schedule to represent properties like the expected power-on or administrative-enabled state of an attached network interface card (NIC) or virtual private network (VPN) endpoint
Topologies (Links)

• A Link is associated with link metric properties in Layer 3 [RFC8346] and Layer 2 [RFC8944] topologies
  • Link schedules indicate the validity or changing properties of the entire link
  • If a schedule indicates a link's invalidity at a specific time instant, this does not affect its termination points and nodes
  • This allows a schedule to represent expected link properties such as connectivity state, data throughput/rate, and latency/delay
Time-variant Routing

• Document highlights distributed, centralised and hybrid, scenarios
  • Highlights importance of time synchronisation

• Several discussion threads for routing considerations and requirements, including
  • Constraints required for time variant path computation (distributed or centralised)
  • Schedule updates (distributed or centralised)
    • Partial and/or full schedule changes
    • Time-variant interval changes
  • Distribution of schedule using an IGP
  • Path Computation Element (PCE) applicability
  • Updating of schedule(s) via an Orchestrator, change management requirements
  • Sanity checking schedule updates (misconfiguration or DDOS)
Best Practice for the Requirements I-D?

• An Informational Document, not Standards Track
• Requirements for applying schedules to specific existing routing protocols or management models
  • Each specific protocol or model must tailor what and how schedules are applied to its data
• Not tell TVR WG what should be implemented, including
  • Collection methods of time variant information
  • Distribution techniques for schedules
    • Including routing algorithms, procedures and mechanisms
  • Execution procedures for link/adjacency schedules
TVR Requirements I-D Tooling

• We are using GitHub to track open issues and current work in progress revisions
  • https://github.com/danielkinguk/tvr-requirements

• Should the WG create a GitHub repository for adopted I-Ds?
Next Steps

• Continue to address recent comments on the TVR list
  • Thanks Tony, Li, Hesham and Marc

• Discussion of Schedule Identity and Verification

• Further discussion required for control plane implications
  • Topology management (including hierarchical support)
  • Schedule update mechanisms (distributed or centralised)
  • Should computation lag be a “time” consideration?

• Agree format of final Requirements
  • Remove [RFC2119] conformance language
  • List general and specific requirements towards end of document in formal way, such as R1-R24, or section/use case specific?