# TVR (Time-Variant Routing) Requirements

draft-ietf-tvr-requirements-02


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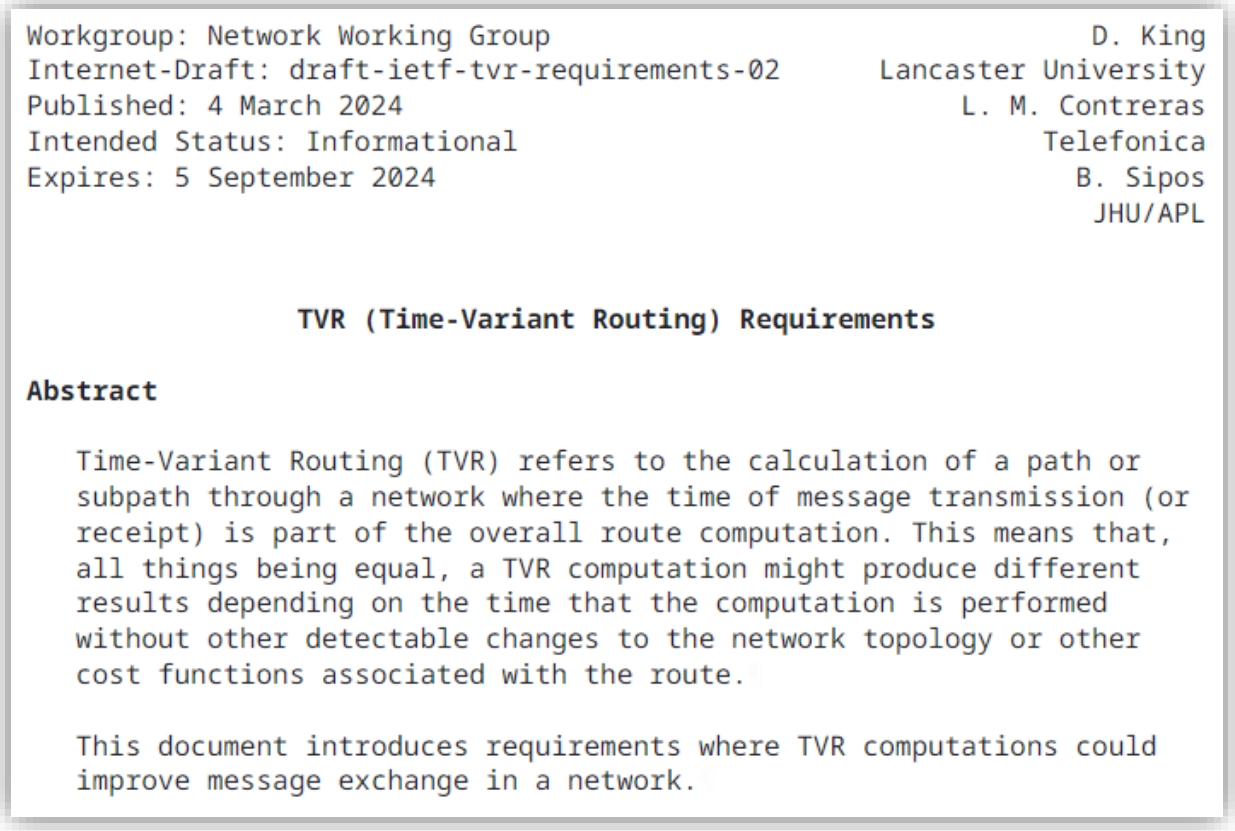
# Intention of this Internet-Draft



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**TVR (Time-Variant Routing) Requirements**

**Abstract**

Time-Variant Routing (TVR) refers to the calculation of a path or subpath through a network where the time of message transmission (or receipt) is part of the overall route computation. This means that, all things being equal, a TVR computation might produce different results depending on the time that the computation is performed without other detectable changes to the network topology or other cost functions associated with the route.

This document introduces requirements where TVR computations could improve message exchange in a network.

- 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
- Fundamentally, <u>loss of links or nodes is expected</u>

# Scope for the Requirements I-D

- Define topology model components for resource scheduling
  - Using existing IETF technology where possible, and/or extending for TVR:
    - Proxies, Nodes, Termination Points, Links, Layering
- Discuss requirements from the use case scenarios, including:
  - 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 Horizon
  - Time Precision
  - Periodicity
  - Continuity
  - Interpolation

# Progress from 01 to 02

- Document updates include:
  - Further discussion on "Generation Locality" and "Execution Locality"
  - Added requirements for changes to the topology, such as:
    - "Freshness" of the schedule
    - Maintaining schedule consistency in different deployment scenarios
  - Discussion on deployment scenarios
    - Distributed, centralised and hybrid usage
    - Impact on routing protocols
    - Use of NETCONF for schedule updates
  - Schedule identity and database management
  - Managing schedule changes (partial, full)
  - Document now uses Path Computation Element (PCE) language
  - Security considerations section started
  - Removal of mandatory conformance language
    - Such as SHOULD, MUST, et al.
- Current open issues being discussed by the Authors and Contributors are tracked in GitHub: https://github.com/danielkinguk/tvr-requirements/issues

# Generation Locality

- The generation of a scheduled data model depends on collecting source data, choosing a time horizon to schedule within, and then processing the source data into an overall schedule.
- Two models for locality of schedule generation are:
  - Centralized: A schedule could be generated in a central orchestrator synchronized to all managed devices which then execute the schedule in a distributed manner.
  - Distributed: A separate schedule is generated on each managed device to be handled either by the Agent or by the routing instance. The source data could come from a central orchestrator or be collected by the managed device itself.

# Execution Locality

- Depending on the visibility of schedules within a data model there are different options for where the schedule may be executed to ultimately affect a time-varying configuration on a managed device
- Centralized Execution
  - All schedule execution is centralized within a network Orchestrator and changes are sent to routing applications in wall-clock time via a management interface
  - This can apply to any type of schedule visibility, but only to centralized generation because the full scheduled data model needs to be available to the entity performing the execution
- Distributed Execution:
  - Schedules are executed on each managed device independently but based on synchronized clocks.
  - This situation corresponds with the Intrinsic or intermediate schedule visibility, where a schedule (with a potentially limited time horizon from what is known at the Orchestrator) is part of the managed data which is distributed to managed devices to be handled either by the Agent or by the routing Application itself
- When schedules are distributed to the managed devices, it necessarily increases the amount of data that the managing device needs to synchronize across the network

# Assumptions for Multi-Domain Use Case

- The requirements described in this document have been identified as applicable for Time-Variant Routing scenarios under the following assumptions:
  - The TVR information is generated and distributed within a single domain, where both the routing and the scheduling information is under control of the same administrative entity. In consequence, multi-domain scenarios are out of scope
  - The TVR changes are not due to random mobility events of end-users or nodes. While TVR considers scenarios where topological changes occur motivated by a mobility pattern (as in the case of non-terrestrial networks, where the mobility pattern can be predicted and follows a clear pattern), generic random mobility events are not considered as part of the scope of this document
  - The potential implications of topological changes on the addressing of nodes is considered out of scope for the requirements analysis

# Time-variant Routing Requirements

- Document highlights distributed, centralised and hybrid scenarios
- Several IETF documents for LEO satellite routing considerations, including:
  - draft-li-arch-sat
  - draft-jiang-tvr-sat-routing-consideration
  - draft-lhan-problems-requirements-satellite-net
- Issues include:
  - 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
  - Discussion on distribution of schedule using an IGP
  - Updating of schedule(s) via an Orchestrator, change management requirements (sanity checking schedule updates and trust)
- Feels like a further, more detailed discussion on control plane may be required?
  - Maybe an interim session or more discussion on the list.

# Time-variant Security Considerations

- Latest version of the document begins to discuss the security implications of time variant networks, including:
- Security Considerations
  - The security implications for networks using time-variant routing mechanisms must also be considered. Current text needs to be reviewed and expanded as needed.
- Several potential security implications will need careful investigation, these including:
  - Denial-of-Service (DoS) attacks: Malicious actors could manipulate or disrupt the time information shared within the network
  - Traffic analysis and route prediction
  - Predicting network activity
  - Identifying user activity
  - Time spoofing and resource manipulation

# Next Steps

- Agree the Multi-domain Assumptions
  - Proposed text available https://github.com/danielkinguk/tvr-requirements/issues/26
- Further discussion required for control plane implications
  - Possible satellite requirements
  - Topology management (including hierarchical support)
  - Should computation lag be a “time” consideration/requirement?
- Further discussion of Schedule Identity and Verification
  - Should a requirement exist for schedule source authentication and authorisation exist?
- Further discussion on Operational Considerations
  - Manage TVR schedule between peers
    - Do we need to consider trust models?
    - Does clock synchronisation, consistency and verification need to be mandated or is it assumed?