TVR (Time-Variant Routing) Applicability

draft-zdm-tvr-applicability-02

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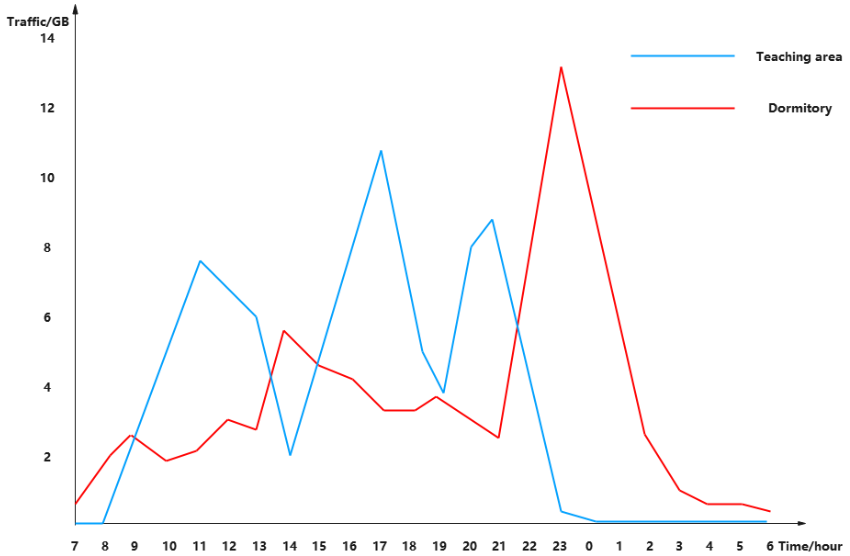
What’s new in this version(01→02)?

- Added a **new use case** as the examples(Dynamic Reachability).
- Updated the **Time Synchronization** (Clause 5)to consider different use cases.
- Provided more detailed description to **Security Considerations**(Clause 8).
- Some editorial updates.

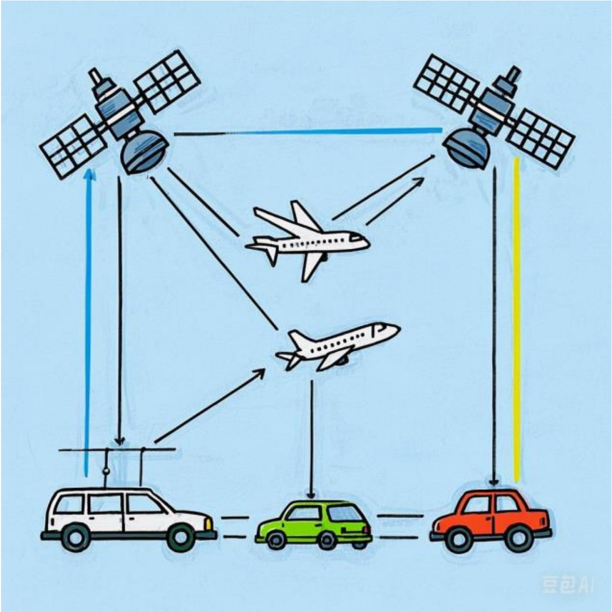
Use Case Examples

- Tidal Network Example



Tidal effect of traffic in campus network

- Dynamic Reachability Example

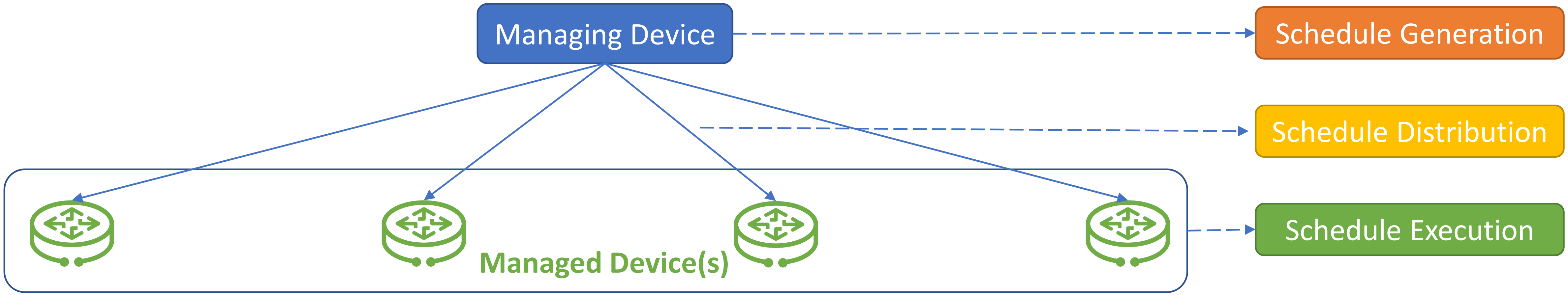


Dynamic Reachability network with satellite, airplanes and vehicles

Is it sufficient to consider these two cases in the Applicability draft?

When TVR YANG Model is Applicable?

Schedule Generation Manner	Schedule Execution Manner	TVR YANG Applicable?
Centralized	Centralized	No
Distributed	Distributed	No
Centralized	Distributed	Yes



How to deliver TVR YANG Model?

- NETCONF
  - Provides a robust mechanism for managing complex network configurations;
  - Supports atomic transactions, which ensures schedules involving multiple resources are applied fully, preventing partial updates that could lead to configuration inconsistencies. This is important for TVR environments.
  - Supports the validation of configurations prior to commitment, allowing operators to verify the correctness of schedules before they are applied;
- RESTCONF
  - Provides a simpler, stateless method for interacting with network devices, suitable for use cases requiring lightweight, rapid configuration;
  - Provides a streamlined approach to network configuration and management by RESTful interface over HTTP. It has advantages in scenarios where quick adjustments to schedules are needed or where integration with web-based or cloud-native systems is a priority;
- Summary
  - NETCONF would be the preferred protocol for **large-scale**, **critical scheduling operations requiring validation and rollback mechanisms**.
  - RESTCONF would be the preferred protocol for **smaller-scale or isolated scheduling tasks**.

Time Synchronization Considerations

- Hardware-based time synchronization:
  - **Features:** **Rely on dedicated hardware** to ensure clock synchronization, **have higher precision and stability**, but also **more expensive**.
  - **GPS:** provides a precise time synchronization service based on the signals transmitted by the GPS satellites. It is preferred for **large-scale, high dynamic** and open-air networks, especially networks with **unreliable links**. → **Nanoseconds**
  - **PTP:** a network protocol that complies with the IEEE 1588 standard. Based on the hardware timestamp, the precision of time synchronization is much higher than that of NTP. It is preferred for **small-scale** networks with **stable links** but have high-precision time synchronization requirements. → **Sub-microseconds**
- Software-based time synchronization:
  - **Features:** **Synchronize clocks through software packages running on systems**, **applicable to common hardware devices**, but have **lower precision**.
  - **NTP:** An application layer protocol in the TCP/IP protocol suite. It is used to synchronize clocks between clients and servers. It is preferred in **large-scale** networks with **reliable links** and **long-term changes**. → **Tens of milliseconds**
  - **SNTP:** A subset of NTP, which simplifies the complex NTP synchronization function. It is preferred for large- scale networks with reliable links, long-term changes, and **limited resources**. → **Seconds**

Schedule Database Considerations

- Data Structure

Based on TVR YANG, the schedule database should contain four types of schedule entries.

  - **Nodes power schedule** entry;
  - **Interfaces schedule** entry;
  - **Nodes schedule** entry;
  - **Links schedule** entry;

- Schedule Database Requirements
  - Schedule database should support the add, update, and delete operations.
  - When adding or updating a schedule entry, the execution node needs to check whether resource conflicts exist between the current schedule and existing schedules.
  - Schedules are updated and deleted based on schedule IDs. Schedule IDs must be unique in a time-variant domain.

Operational Considerations

- **Coordinated Network Events**: TVR often coordinates routing changes anticipating events like predictable link downtimes.
- **Accurate Scheduling of Paths**: TVR schedule capable nodes will dynamically adjust forwarding paths based on planned changes.
- **Time-Stamped Data Models**: TVR will require use time-stamped data model to make interface management decisions.
- **Different Schedule Actions:** Different kind of schedules requires different kind of action(the actions for link coming up and remove should be different).

Security Considerations

- This part provides possible measures and suggestions to mitigate these security challenges described in requirements draft.
  - Denial-of-Service (DoS) Attack
  - Traffic Analysis and Path Prediction
  - Activity Identification and Privacy
  - Spoofing and Manipulation of Time Information
  - Replay Attacks on Time-Sensitive Data
  - Compromised Time Sources

Next Steps

- Are these two cases sufficient for TVR?
- Optimize the Operational Consideration clause.
- Welcome for contribution and suggestions.
- Ready for WG adoption?