Dynamic Network Routing

IETF 118 Hackathon

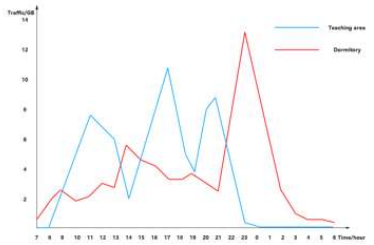
Huawei & Nanjing University

November 4-5, 2023

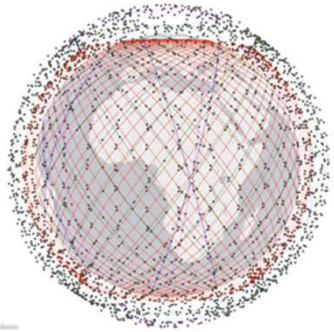
Dynamic Network

Dynamic Network means the topology of network changes frequently(includes predictable and unpredictable changes), typical use cases includes:

- **Resource-constrained Network**: some nodes or some functions of the nodes can not work all the time because of limited resource, which result in the topology changes dynamically.
- **Energy-saving Network**: some nodes or some functions of the nodes are turned off dynamically to improve the energy efficiency, such as the Tidal Network.
- **Satellite Network**: the fast movement and space environment lead to the frequent link handover and node failures.



Tidal effect of traffic in campus network


Satellite network

Hackathon Plan

- Simulation of Dynamic Network based on NS3.
- Combine Dynamic Network with existing routing protocols.
- Evaluation of existing routing protocols in Dynamic Network.
  - Packet Loss of Dynamic Network;
  - End-to-End delay variation of Dynamic Network;
  - Throughput of Dynamic Network;

Hackathon Development

Build Enviroment:

- **OS**
  - Windows10
- **Hyper-v**
  - 10.0
- **Virtual Machine OS**
  - Ubuntu 20.04

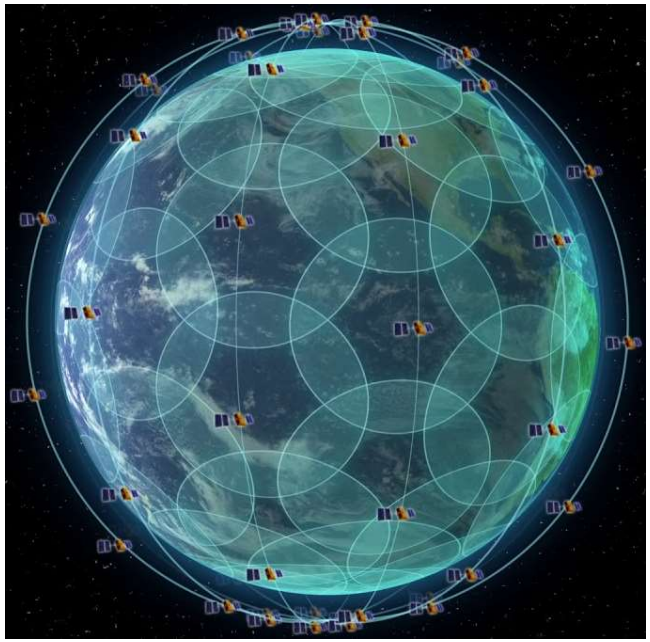
- **G++/Gcc**
  - 9.4
- **NS3**
  - 3.31

Simulation Introduction

Simulation for Dynamic Network(Take the satellite network as an example).

Topology Configuration

- Satellite number: 6*11
- Inclination angle: 86.4°
- Altitude：780km
- Inter-Satellite Link bandwidth: 100Mbps
- Ground-Satellite Link bandwidth: 150Mbps
- Ground Stations：50 Ground Stations at the world's 50 most populous cities.

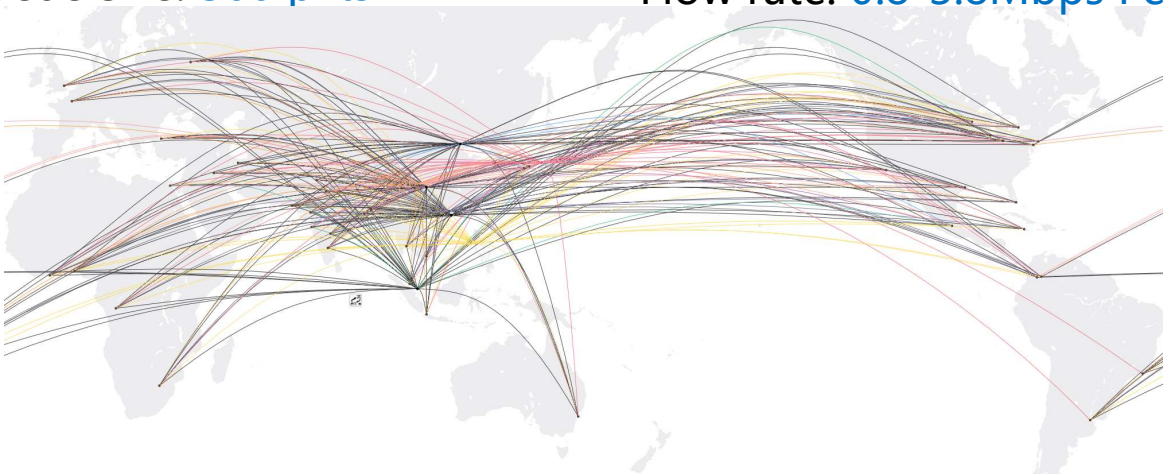


Simulation Introduction

Simulation for Dynamic Network(Take the satellite network as an example).

Traffic Configuration:

- Simulation time: 60 seconds
- Transport layer protocol: UDP
- Max queue size: 500 pkts
- Source: 42 cities around the world
- Destination: 8 east Asian cities
- Flow Number: 250
- Flow rate: 0.8-3.8Mbps Per flow



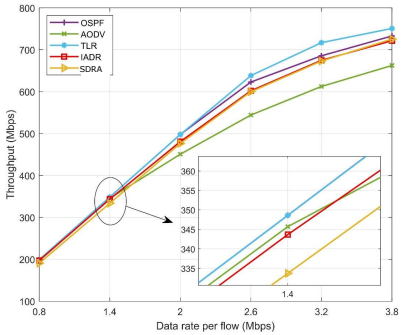
Simulation Introduction

Simulation for Dynamic Network(Take the satellite network as an example).

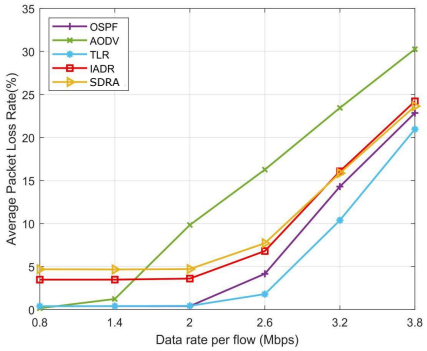
Routing Protocols（Algorithms）：

- **Distributed Routing Protocols(Algorithms)**
  - OSPF, Advertise **link state information** and calculate **routing paths with minimal hop**.
  - AODV, build a **minimal-hop** routing path **on demand**.
  - TLR(Traffic-Light-Based Intelligent Routing), considering the **queuing delay** into link cost, calculate routing paths with **least congestion**.
- **Centralized Routing Protocols(Algorithms)**
  - IADR(ISL Attributes based Dynamic Routing), selects the optimal path based on various link attributes(such as delay, SNR, etc.).
  - SDRA(software defined routing algorithm), collect the topology, and calculate paths with minimal-hop for each satellite.

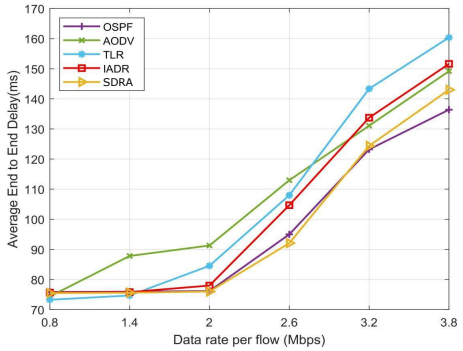
Demo & Result



Variation of Throughput



Variation of Packet Loss



Variation of End-to-End Delay

- TLR has the best performance in the Throughput and packet loss;
- OSPF and SDRA has the best performance in the End-to-End delay;
- **The packet loss is a common problem.**

What we learned

- Packet loss may occur when existing protocols are run directly on a dynamic network. Maybe we need to take advantage of the predictable changes in the dynamic network to prevent it.
- Routing protocols with link attribute awareness usually have better performance.

In the future:

- Improve the existing routing protocols to adapt to the dynamic network.
- Cooperate with partners who interest in dynamic network, join us to improve it together!

Thank you :)

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- Related Drafts:
  draft-zzd-tvr-use-case-tidal-network-02 - Use Case of Tidal Network (ietf.org)
  draft-zzd-idr-sr-policy-scheduling-03 - BGP SR Policy Extensions for Path Scheduling (ietf.org)
  draft-zzd-idr-flowspec-path-scheduling-00 - BGP Flow Specification Extensions for Path Scheduling (ietf.org)