Autonomic Networking in mobile wireless backhaul
draft-bogdanovic-nmrg-mobile-backhaul-use-case-00

Abstract

Mobile backhaul networks that utilize microwave technology in transport are suspicious to seasonal and/or meteorological changes. For those reasons throughput can vary significantly. This draft provides problem statement and how autonomic networking can be applied to the problem.

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1. Introduction

Microwave technology is one of the workhorses in MBH networks today. Unlicensed microwave links can be set up in days rather than the weeks or months it might take to implement additional wireline capacity for backhaul. Even licensed links, while requiring some mildly time-consuming bureaucratic approval, still easily outpace the time-to-deployment of wireline alternatives. Fiber may offer unlimited bandwidth, but the tradeoff is in time and cost savings. Microwave's improvements in bandwidth, capacity, and reliability in the past few years have made it an ideal interim broadband connectivity solution during the often lengthy process of deploying fiber. In fact, these improvements go as far as to establish microwave as a legitimate permanent alternative to fiber. Although its many benefits, because of other restrictions that microwave links have, they can't be utilized at maximum. OSPF/MPLS networks that are overlayed on top of microwave transport and provide additional benefits of packet routing and switching to mobile backhaul.

1.1. Definitions and Acronyms

MBH: Mobile Backhaul

BTS: Base Transceiver Station

OSPF: Open Shortest Path First

MPLS: Multi Protocol Label Switching

PLMN: Public Land Mobile Networks

CoS: Class of Service

MTTR: Mean Time To Recovery

MNO: Mobile Network Operator

IDU: In Door Unit

ODU: Out Door Unit

SNMP: Simple Network Management Protocol

IP: Internet Protocol

IPv4: Internet Protocol version 4

IPv6: Internet Protocol version 6

2. Problem Statement

Mobile backhaul (MBH) networks utilize microwave networks to transport traffic back to Public Land Mobile Networks (PLMN). Base transceiver stations (BTS) and/or eNodeBs connect to a device that has multiple microwave connections to PLMN. Not each link has the same throughtput and the quality of the link varies with different factors,like air temperature, percipitation, vegetation, etc. Today those networks are overlayed with OSPF/MPLS networks and although OSPF provides automatic redirection of traffic in case of primary link failure, it reduces network throughput, as microwave link bandwidth slowly degrades, due to rain, snow, tower bending due to wind and/or temperature, vegatation growing. During the link degradation period, the throughput of MBH part is going down and the overall service is impacted. Being able to detect the degradation of the microwave link bandwidth and redirect traffic over higher throughput links is very beneficial to mobile network operators.

3. Intended User and Administrator Experience

As MBH links are lowering the bandwidth, the user experience is impacted, as the data hungry applications are not served with usual quality of service and latency is increasing, due to dropped packets. MBH network administrator are not getting real time picture (usually today they see average link performance over 15 minutes period) and with users being highly mobile, they can't react to the challenges in the network. Administrators should be able to set intended policy on device, based on which device wwould start changing network

forwarding parameters based on which the current traffic would be routed via links with moste throughput. With monitoring the link statistics, device can change forwarding and routing parameters in realtime based on the intended policy pushed on the device, without the need to interact with centralized management system, which would act based on sent link performance indicators. Such a network would improve end user experience, as well network administrators would be able to create better performing networks.

4. Analysis of Parameters and Information Involved

Numerous parameters are involved in monitoring MBH, from microwave link performance, to miscellaneous OSFP and MPLS parameters. MNO has to look at KPI that will relate to those that may impact revenue negatively, such as unavailability and MTTR. One thing to note here is that much emphasis is usually placed on availability, while most times not enough emphasis is placed on reliability. In defining Key Performance Indicators effectively, KPIs must align with BTS availability information for a mobile operator.

Microwave transmission

o availability

o capacity

o delay

o jitter

4.1. Parameters each device can decide for itself

All OSPF interfaces have a cost, which is a routing metric that is used in the link-state calculation. Routes with lower total path metrics are preferred to those with higher path metrics. OSPF assigns a default cost metric of 1 to reference bandwidth and default cost metric of 0 to the loopback interface (lo0). No bandwidth is associated with the loopback interface. So if reference bandwidth is set to 1Gbps, it means that all interfaces faster than 1Gbps have the same default cost metric of 1. If multiple equal-cost paths exist between a source and destination address, OSPF routes packets along each path alternately, in round-robin fashion.

Having the same default metric might not be a problem if all of the interfaces are running at the same speed. In MBH, microwave units will connect via ethernet to ethernet ports on routers and each link will have the same metric. That would not be a problem if all microwave links would have same performance, but links operate at

different speeds, and it is very probable that traffic is not routed over the fastest interface because OSPF equally routes packets across the different interfaces.

The autonomic agent agents collects operational statistics from ethernet ports to which microwave IDU is connected, as well from microwave ODU (local and remote) using SNMP. By collecting this statistics, optimal MBH OSPF agent can callculate links with best performance and change the metric value for each link accordingly.

```
     +-------------------------------------------------------+  +------+
     |          +----------+ +--------------+                |  | MW   |
     |          |          | | SNMP Agent   |<---------------|->| IDU  |
     |          | Intent   | |              |<----------     |  +------+
     |          +----------+ +--------------+           \    |
     |                  ^       ^                        \   |  +------+
     |                  |       |                         ---|->| MW   |
     |       +-----> Autonomic User Agent <--------+         |  | ODU  |
     |       |                  |                  |         |  +------+
     |       V                  V                  V         |
     | +-----+------+      +--------------+    +---------+   |
     | |            |      |Optimal MBH   |    |Ethernet |   |
     | | Performance|<---->|OSFP Selection|    |Interface|   |
     | | topology   |      | Agent        |    |Counters |   |
     | |            |      |              |    |         |   |
     | +------------+      +--------------+    +---------+   |
     |                       ^                     ^         |
     |                       |                     |         |
     |                       V                     V         |
     |-------------------------------------------------------|
     |                  Control Plane                        |
     |-------------------------------------------------------|
     |      Standard Operating System Functions              |
     +-------------------------------------------------------+
```

Figure 1

4.2. Information needed from policy intent

The section describers what information is needed to be provided by external entity, so that devices can operate autonomicly. The policy would have to set:

- o reference bandwidth - example 1Gbps

- o low water mark threshold, at which point to change the metric

- o IP address or addresses of local IDU
- o IP address or addresses of local ODU
- o IP address or addresses of remote IDU
- o IP address or addresses of remote ODU
- o which ethernet port is connect to which microwave link

This list is not extensive and with more research it can be augmented with new parameters. The experience will show what parameters are important. There might be a need to put time restrictions between metric updates on the device or how often are statistics collected, as it is important not to negatively effect device forwarding capabilities.

5. Interaction with other devices

The device would interact with microwave IDU and ODU. It would interact with them via SNMP or some other protocol that allows to collect operating statistics of the microwave link. By collecting those statistics, it can compute the link perfomance. It is also possible to communicate with other autonomic device in MBH and to exchange information, so that devices can learn the whole topology in segment and performance of the microwave links in possible path.

5.1. Information needed from other devices

In Figure 2, a small example is shown how MBH router 1 is connected via microwave links to router MBH 2 and MBH 3. Microwave IDUs are connected via ethernet to MBH routers and each IDU has two ODUs connected. Microwave links usually have two beams in a link. Microwave IDUs send each incoming packet from MBH router 1 to each ODU connected to them, essentially copying packets over each beam in the microwave links. The terminating IDU C and D, on the other side, compare incoming packets from each ODU and drop the duplicate packets prior to forwarding the packet to their connected MBH routers. This mechanism allows collecting good operating statistics of the links, so autonomic agent on MBH routers can calculate end to end performance of each link, like latency, throughput, jitter, delay etc. This allows building performance topology on the MBH router by autonomic agent

```
                     +-----------------------------+
                     |                             |
                     |         MBH Router 1        |
                     |     eth        eth      |
                     |    port A         port B    |
                     +-------+--------------+------+
                         |              |
                         |              |
                     +-------+----+     +---+--------+
                     |  Microwave |     |  Microwave |
                     |    IDU A   |     |   IDU B    |
                     +-+--------+-+     +---+------+-+
                       |        |           |      |
                 +-----+-+  +---+---+  +----+--+ +-+-----+
                 |  MW   |  |  MW   |  |  MW   | |  MW   |
                 |  ODU  |  |  ODU  |  |  ODU  | |  ODU  |
                 +---+---+  +---+---+  +---+---+ +---+---+
                     ||         ||         ||        ||
                     ||         ||         ||        ||
                 +---+---+  +---+---+  +---+---+ +---+---+
                 |  MW   |  |  MW   |  |  MW   | |  MW   |
                 |  ODU  |  |  ODU  |  |  ODU  | |  ODU  |
                 +-----+-+  +-+-----+  +--+----+ +-+-----+
                       |      |       |    |
                       |      |       |    |
                     +-+------+---+     +-+--------+-+
                     |  Microwave |     |  Microwave |
                     |   IDU C    |     |   IDU D    |
                     +-----+------+     +-----+------+
                       |                  |
                     +-----+------+     +-----+------+
                     |    port A  |     |  port A    |
                     |     eth    |     |   eth      |
                     | MBH Router |     | MBH Router |
                     |     2      |     |     3      |
                     +------------+     +------------+

                --- eth links
                === microwave links
```

Figure 2

5.2. Monitoring, diagnostics and reporting

The autonomic user agent should provide feedback data to centralized management system, so that new improved intent policies can be created. Most of the data doesn't have to be provided in real time, except for cases when microwave link failure happens and causes loss

of data. This means that the autonomic agent didn't provide alternative path in time or all microwave links from the MBH router are down. Historical data, like what were the network conditions under which the autonomic agent enforcing the intent policies are very valuable, as well the performance topology from each device, as it allows to create whole performance view of the MBH.

6. Comparison with current solutions

There are some vendors (NSN, Ericsson) that are trying to create self organizing networks, but the inteligence is always centralized, which prevents distribution of the network inteligence and using it for autonomic use cases.

7. Security Considerations

As this stage, author of the draft didn't look into security considerations of the use case.

8. IANA Considerations

This document requests no action by IANA.

9. Acknowledgements

10. Change log [RFC Editor: Please remove]

11. References

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Author's Address

Dean Bogdanovic
Juniper Networks

Email: deanb@juniper.net