Smart Radio LTE Failover

Advanced MIMO Mesh Router for Private Wireless Networks

Introduction

This application note describes how to use LTE as a failover for the Smart Radio's Mesh Rider wireless link. Smart Radio LTE Failover is an optional add-on license to the Mesh Rider OS to create highly resilient private wireless networks. The Smart Radio's Mesh Rider link creates a high throughput, long range resilient wireless network. However, there are circumstances which could lead to the link being broken such as obstacles impeding a good line-of-sight. In such situations, it maybe useful to have an LTE link as a backup.
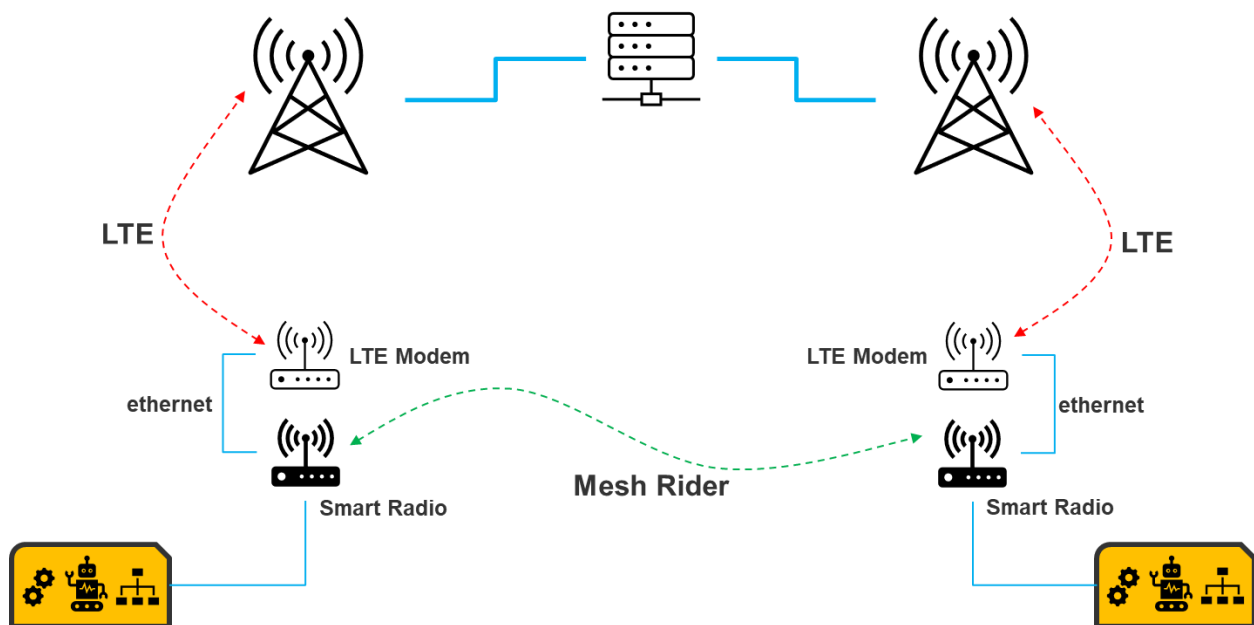
It is shown that the failover and recovery times between Mesh Rider network and LTE network can be as short as 1 seconds.

This application note is organized into the following sections

- System Overview
- Smart Radio + LTE Network Diagram
- Device Configuration
- Testing

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System Overview

The system which we will demonstrate is shown in Fig. 1.

Fig. 1 – LTE Failover System

SIM Cards

In this demonstration, we use SIM cards that support Internet of Things and M2M connectivity. The LTE service provider should be able to provide a private network for connected SIM cards which allows all devices to be addressable from one another over the LTE network. This is important because typical consumer LTE SIM cards only provide a private IP address which is not addressable over the internet.

LTE Modem

For this demonstration, we used the gl-inet Mudi LTE modem [2]. There are many brands of Industrial IoT LTE modems available. Smart Radio LTE Failover should work with them. We do not intend to make a recommendation on any particular LTE modem, but be careful to choose an LTE band suitable for your region of deployment, and a modem which supports sufficient

throughput for your application. Aside from that the modem should support network port forwarding.

Routing

The Smart Radio relies on Mesh Rider for layer 2 packet routing, and the same is true for LTE failover. We use a VPN (WireGuard) with a L2TP tunnel to establish a layer 2 pseudowire connection between the two radios over the LTE link. ETH1 is used for the failover link.

Hardware Setup

Fig. 2 shows the hardware setup used in this guide.
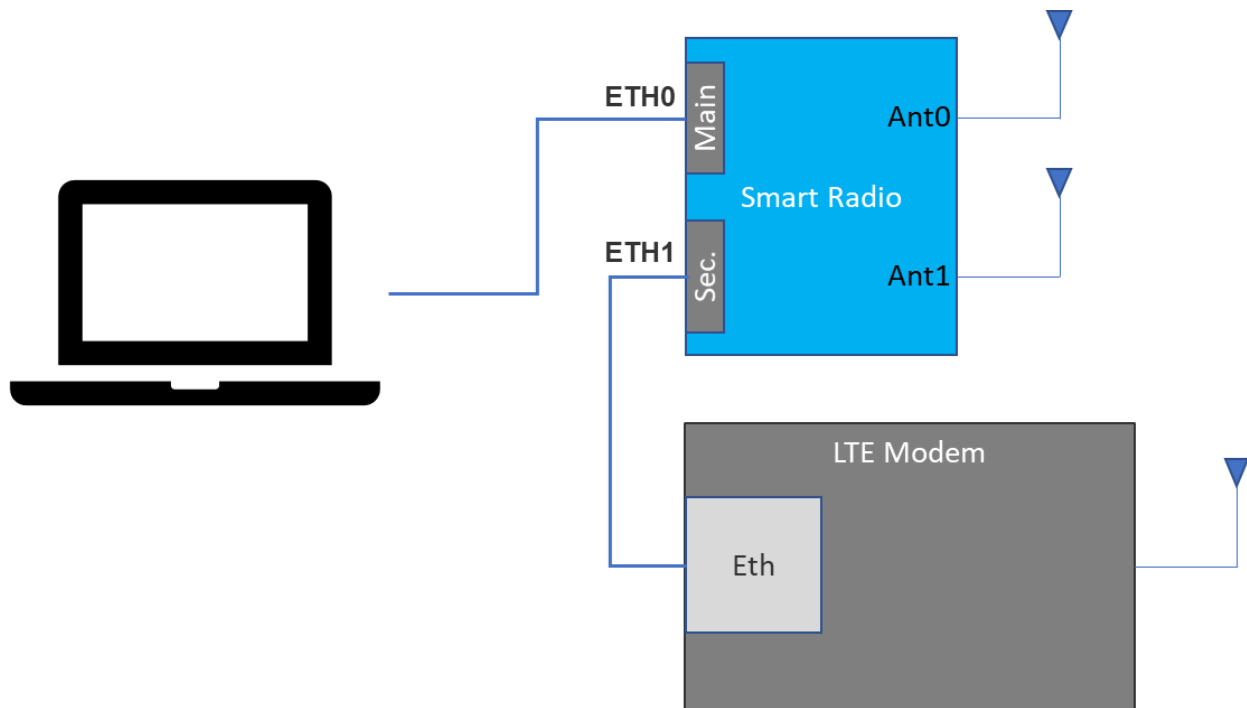
Fig. 2 – Hardware Setup

Of note is that ETH1 should be connected to the LTE Modem. Aside from that, the Smart Radio is setup for typical usage.

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Device Configuration

In our example, we assume that we have PC 1 connected to Smart Radio 1 at ETH0, and Smart Radio 1 is connected to LTE Modem 1 from ETH1. Likewise, PC 2 is connected to Smart Radio 2 at ETH0 and Smart Radio 2 is connected to LTE Modem 2 from ETH1. The steps below need to be repeated for all LTE Modems and Smart Radios.

LTE Modem

LTE Modem configuration varies from device to device and so we will not go into any detail. Most importantly, it will be necessary to forward ports for WireGuard and L2TP through the modem. We set WireGuard's default network port to 5000, and L2TP uses port 1701.

Our LTE Modem 1 has been assigned the IP address 10.124.16.3 and LTE Modem 2 has been assigned the IP address 10.124.16.2. Each LTE Modem will also create a local network (LAN) and perform NAT from the LAN to the WAN(LTE). In our case, we used the subnet 192.168.8.0/24. To avoid confusion, we assigned LTE Modem 1 with LAN IP address 192.168.8.1 and LTE Modem 2 with LAN IP address 192.168.8.2. DHCP was also disabled for simplicity.

Smart Radio Configuration

Setup
The Smart Radio LTE Failover license has a wizard for automatic setup. In order to run the wizard, first SSH into the radio.

```
user@host-pc:~$ ssh root@<IP ADDRESS>
```
After logging in, run the Smart Radio LTE Failover wizard.

```
root@smartradio:~# dl-lte-wizard
```
The wizard will prompt the user with several questions including

1. Encryption key generation and sharing
2. The IP address settings of the local connection to the LTE modem.
3. The IP address of the VPN interface. You will need to choose an IP address for the local VPN interface, and also input the IP address of the remote VPN interface.

The wizard will then reconfigure the Mesh Rider networking stack and the settings.

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Verification

At this point, the setup is complete. To confirm that the failover link is active, check Mesh Rider's list of originatory nodes. This will only work once both nodes are setup.

```
root@smartradio-301a4ebb10:~# batctl o
[B.A.T.M.A.N. adv 2021.0-openwrt-1, MainIF/MAC: l2tp0/1a:04:32:ac:26:53
(bat0/4a:9b:e6:37:f9:87 BATMAN_V)]
  Originator        last-seen ( throughput)  Nexthop         [outgoingIF]
* ea:ab:88:d0:05:c2    0.030s (       41.0)  00:30:1a:4e:bb:09 [    wlan0]
  ea:ab:88:d0:05:c2    0.030s (        4.0)  ea:ab:88:d0:05:c2 [    l2tp0]
```

Instead of just one path to the destination, there are now two paths. The preferred path has a star (*) next to it, and in this case it is the Mesh Rider link which has an estimated throughput of 41 Mbps. The LTE link is the failover path, but if the throughput of the Mesh Rider link were to go below 3 Mbps, the LTE link would become the preferred path.

Testing

As a first test, we performed a hard disconnect on the Mesh Rider signal while pinging one radio from the other. The ping was performed at a 1 second interval with a 1 second timeout. **From the results, only one sequence number was missing (sequence #9) indicating that the failover time is about 1 to 2 seconds.** The latency on the LTE link was more than 100ms while the Mesh Rider's latency was around 2ms. The results are shown below.
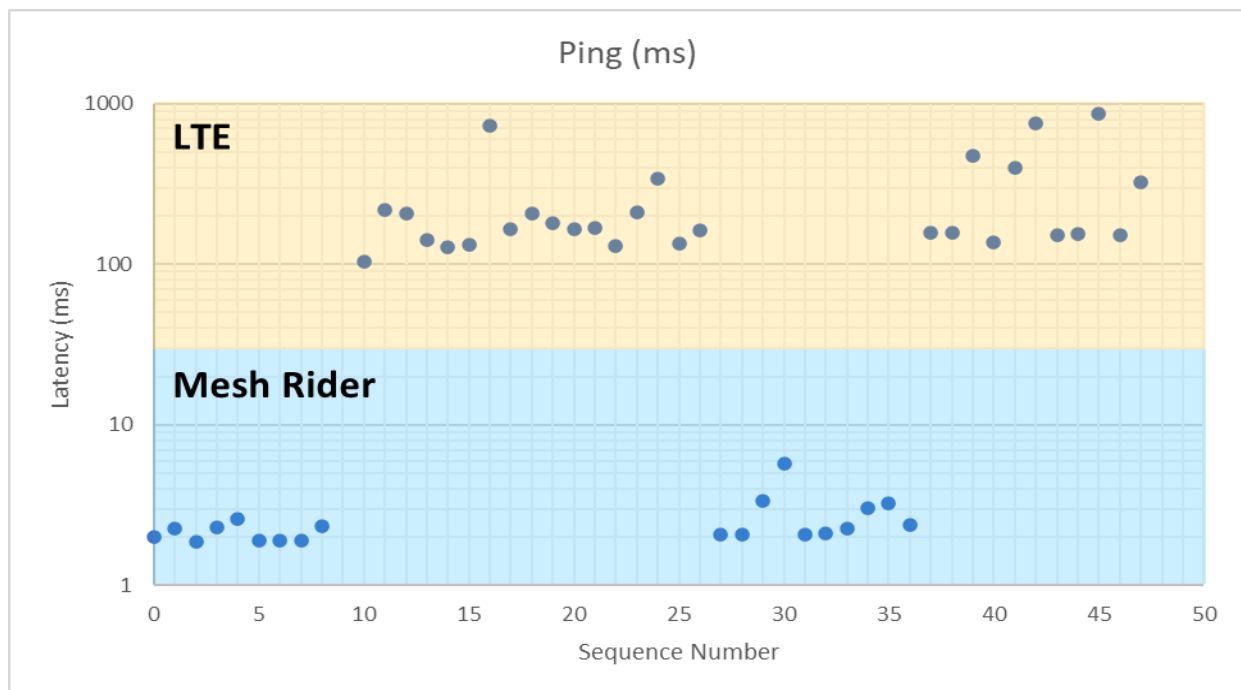
Fig. 3 Mesh Rider LTE hard failover ping test

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We also ran a test to check the failover and recovery of the network when the nodes are moving away from each other and the Mesh Rider signal strength is gradually descreasing. The RSSI and IFACE is plotted on the primary axis of Fig 4. When the IFACE value is high, it means that the Mesh Rider interface was being used, and when the IFACE value is low, it means the LTE interface was being used. In the experiment, 10 dB attenuators were added to each radio to reduce the scale of the test. As can be seen, at lower RSSI values, the network fails over to LTE and then recovers again to use the Mesh Rider. This illustrates the added resiliency in the network by using the best of the interface available at any time.
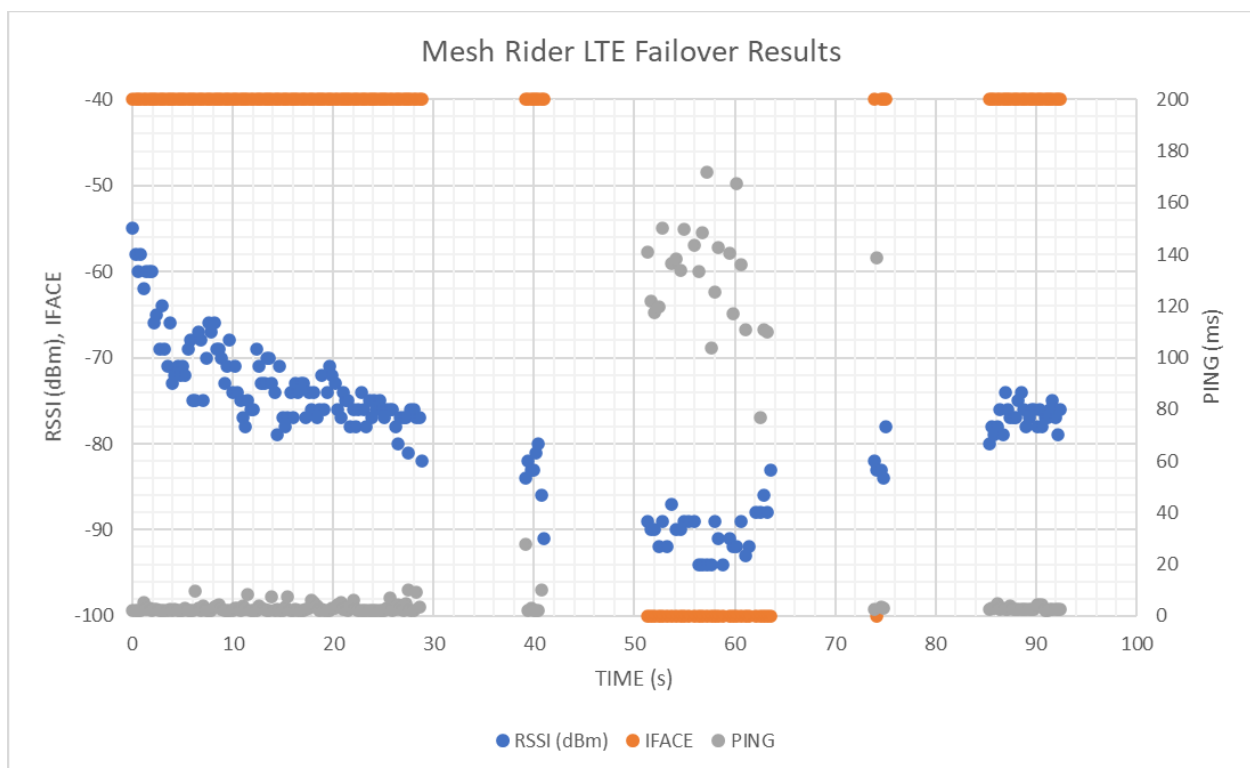
Fig. 4 – Failover Results

References

[1] M2MOne, https://www.m2mone.co.nz/, 14 June 2021

[2] Gl-inet Mudi, https://www.gl-inet.com/products/gl-e750/, 14 June 2021

[3] Installing Wireguard on Routers Running Openwrt and Luci, https://www.azirevpn.com/support/guides/router/openwrt/wireguard, 14 June 2021

[4] OpenVPN, https://openvpn.net/, 14 June 2021

[5] WireGuard, https://www.wireguard.com/, 14 June 2021

[6] Linux L2TP ethernet pseudowires, https://remote-lab.net/linux-l2tp-ethernet-pseudowires, 14 June 2021

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Appendix A – Configuration File Listings

/etc/ltefailover/ltefailover.conf

```
# June 2021
# tech_support@doodlelabs.com
# File location: /etc/ltefailover/ltefailover.conf
# Make sure to run wgKeyGen first


##### LTE Model/Router CONF
# required change
LTELANIP="192.168.8.9"
LTELANMASK="255.255.255.0"
LTELANGATEWAY="192.168.8.1"
# Optional change
LTEINTERFACE="eth1"



##### WireGuard CONF
# local information
# required change
WGLOCALIP="192.168.13.9/24"
# optional change
WGLOCALPORT=5000
# do not change
WGPRIVKEY=$(cat /opt/ltefailover/wg-privatekey)

# remote information
# required change
WGPEERIP="10.124.16.2"
WGPEERALLOWEDIP="192.168.13.10"
# optional change
WGPEERPORT=5000
# do not change
WGPEERPUBKEY=$(cat /opt/ltefailover/wg-peerpubkey)



##### L2TP CONF
# local information
L2TPEN=0
# required change
L2TPLOCALTUNNELID=1000
L2TPLOCALSESSIONID=3000
# optional change
L2TPIFACE="l2tp0"
L2TPLOCALPORT=1701
```

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```
# remote information
# required change
L2TPPEERTUNNELID=2000
L2TPPEERSESSIONID=4000
# optional change
L2TPPEERPORT=1701




##### MESH CONF
# optional change
# Throughput below which the link will failover to LTE.
LTETPOVERRIDER=3000
OGMINT=1000
```

/etc/ltefailover/preserve.conf

```
# This is a list of UCI parameters to preserve (optional)
# June 2021
# tech_support@doodlelabs.com

# Usage - add parameters to preserve in UCI readable format.
# To see a list of wireless parameters, run "uci show wireless"
# To see a list of network parameters , run "uci show network"

# Wireless
wireless.radio0.distance
wireless.radio0.chanbw
wireless.radio0.channel
wireless.wifi0.mesh_id
wireless.wifi0.key

# network
network.wan2.ipaddr
```

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