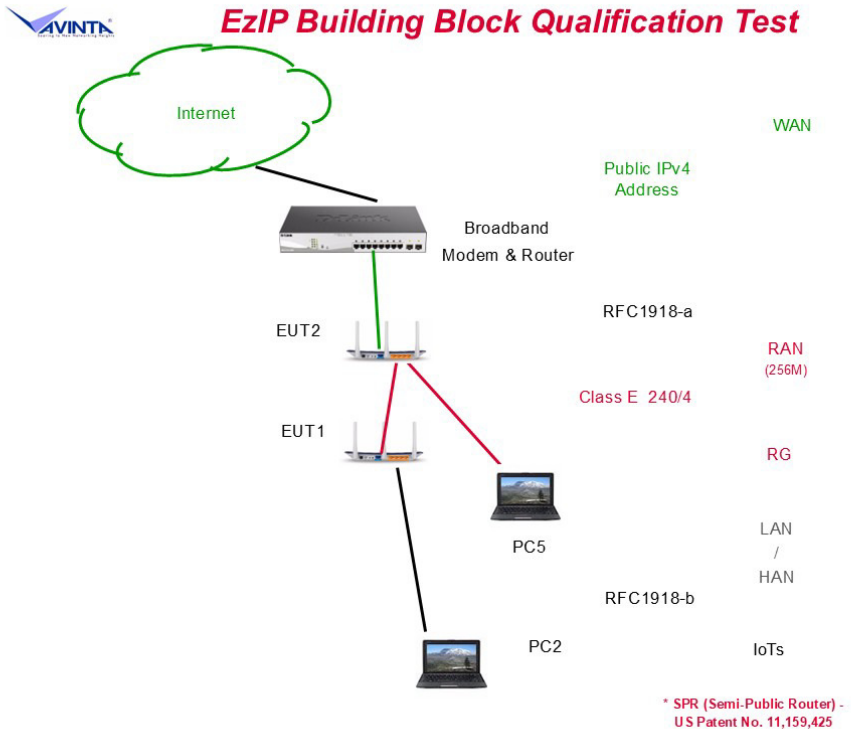
EzIP Building Block Qualification Test - Template

1. Introduction: This document outlines the qualification of a Networking Equipment as an EzIP Building Block by verifying whether it is capable of supporting Class E (240/4) netblock. Both L3 Managed Switch and Home WiFi Router are very similar in terms of basic transmission characteristics which is the primary focus of the EzIP project. So, the same configuration may be used for verifying either or together.

2. Setup: In the diagram below, EUT (Equipment Under Test) 1 & 2 can be a pair of candidates, either Switches or Routers, or even a combination of a Router accessing a Switch, respectively. The first two are for qualifying individual types of products. The third simulates the basic EzIP network module, called the RAN (Regional Area Network).



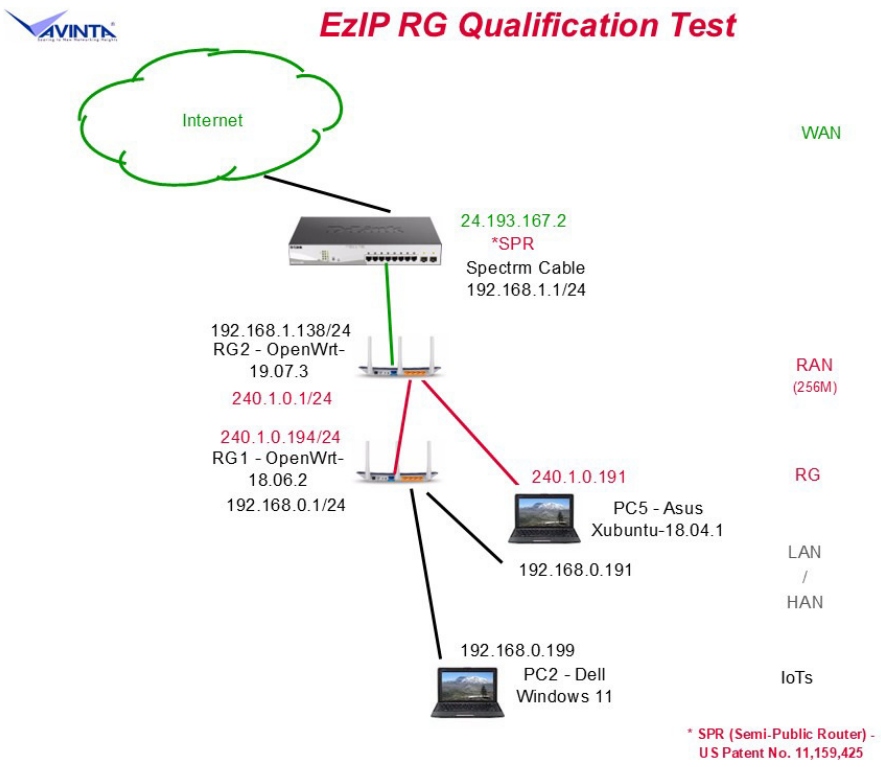
Both EUT1 and EUT2 should be fully compatible with 240/4 netblock on their WAN (upstream) and LAN (downstream) ports. For the incident experiments, the WAN port of both should be set to the DHCP client mode. The LAN port of EUT2 should provide 240/4 netblock DHCP service. That of EUT1 should be an RFC1918 DHCP server. The former may serve additional Switches like the EUT2 itself to establish an RAN. The latter enables internet access from a conventional private network with ordinary IoTs, including Windows based PCs.

The performance tests should consist of configuring the ports, PING and TraceRoute between ports and Internet Speed Test, etc.

Note that this architecture is purposely configured as an on-premises equipment cluster, so that there is no need to rely on a carrier environment.

3. Example I (EzIP RG): In the below setup, both EUTs are EzIP RG candidates as described in Slides #4 & #6 of an earlier report called "RAN Simulator" (circa 2019):

https://avinta.com/gallery/RegionalAreaNetworkSimulator.pdf

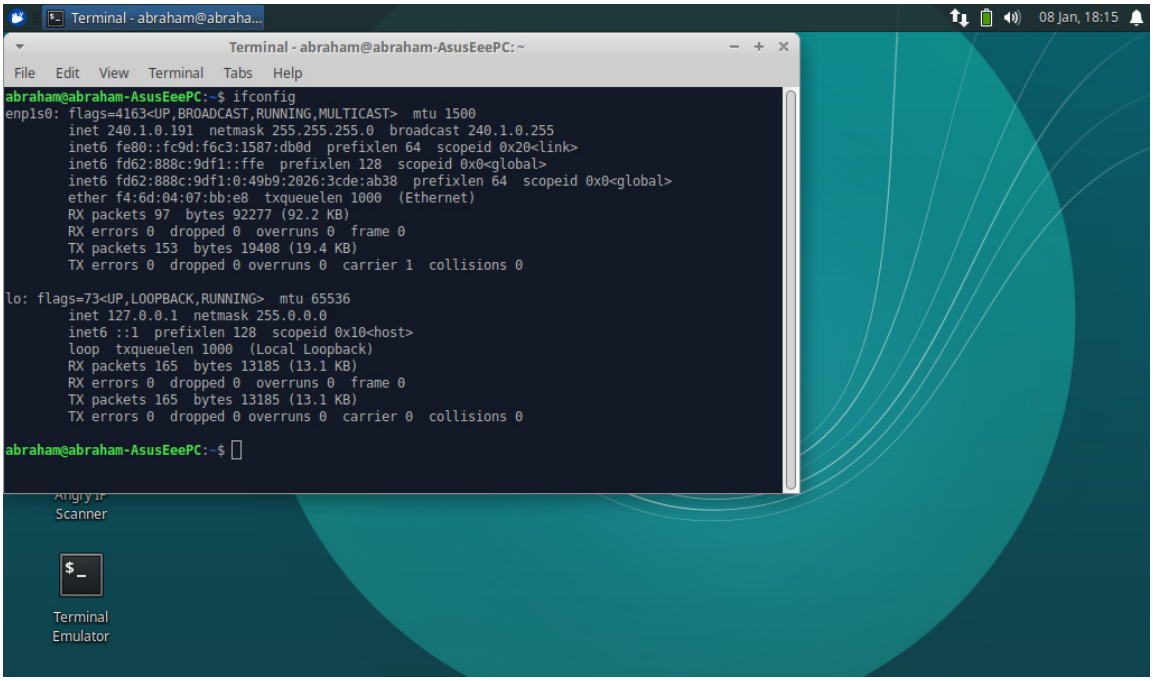


Notes:

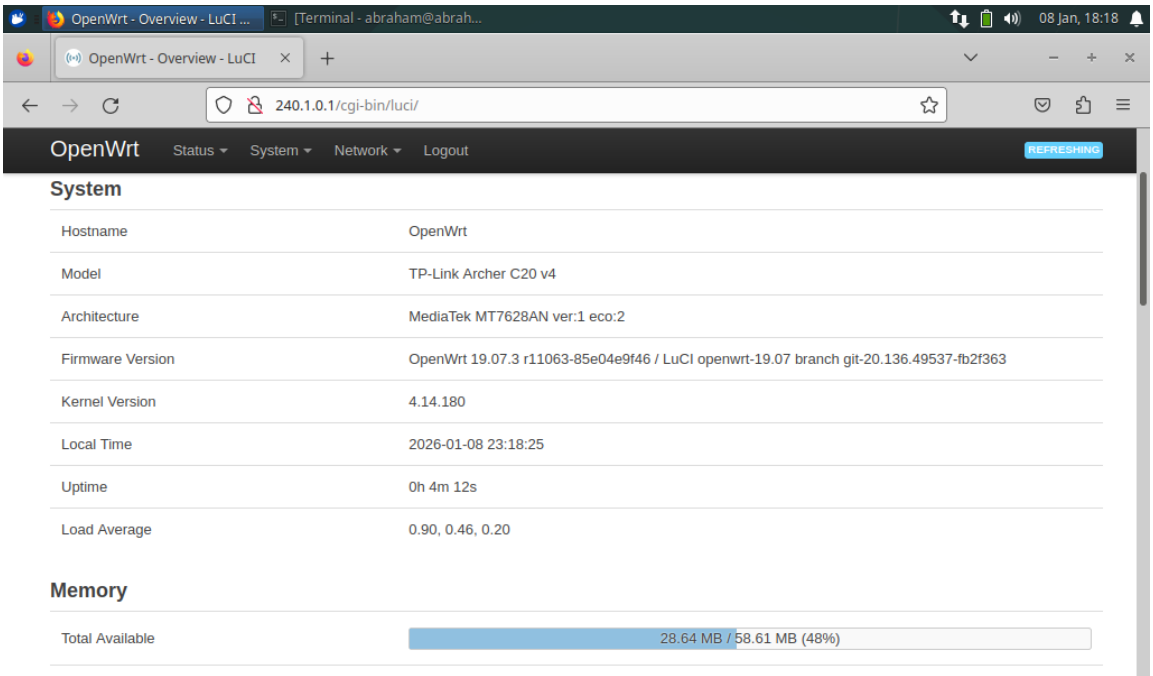
. PC2: Dell Inspiron NB with Windows-11 (DHCP client)
. PC5: Asus EeePC NB with Xubuntu-18.04.1 (DHCP client)
. RG1: TP-Link Archer C20 V4 with OpenWrt-18.06.2 (WAN: DHCP client, LAN: DHCP host at 192.168.0.1/24)
. RG2: TP-Link Archer C20 V4 with OpenWrt-19.07.3 (WAN: DHCP client, LAN: DHCP host at 240.1.0.1/24)
. SPR: To simplify replication, this is replaced by a common private premises Home WiFi Router (LAN: DHCP host at 192.168.1.1/24).

A. PC5 behind RG2 (Router – RG2 – PC5):

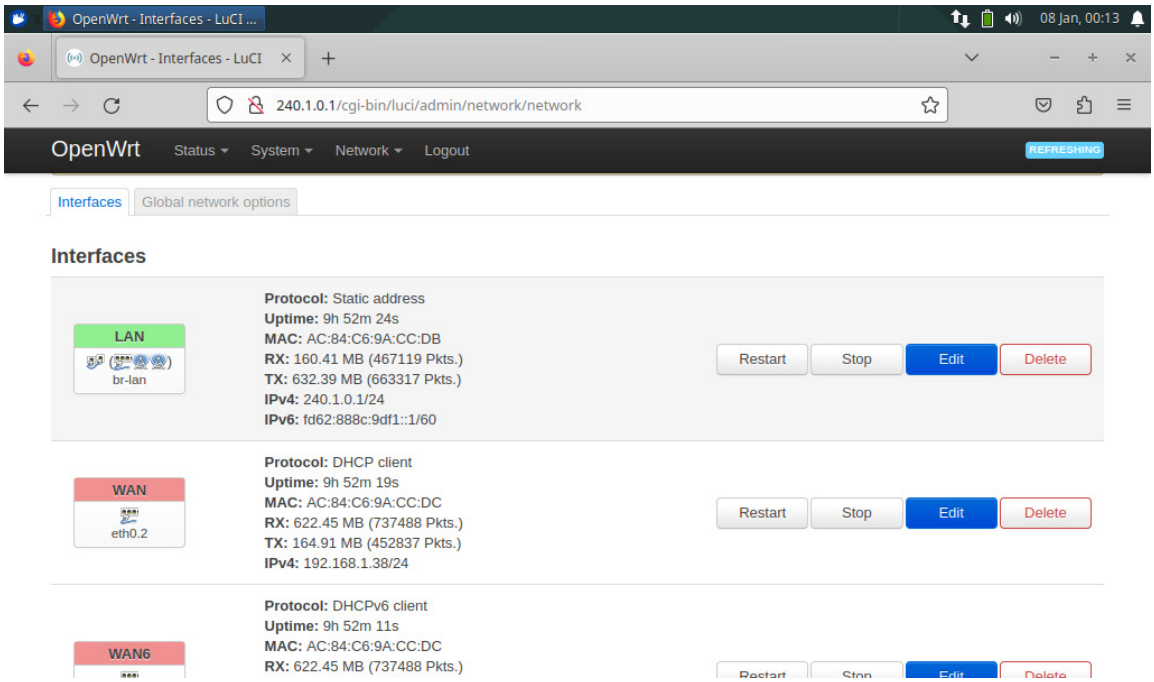
a. PC5 TCP/IP Properties (Terminal Emulator -> ifconfig):



b. RG2 Firmware (OpenWrt-19.07.3 Status -> Overview):

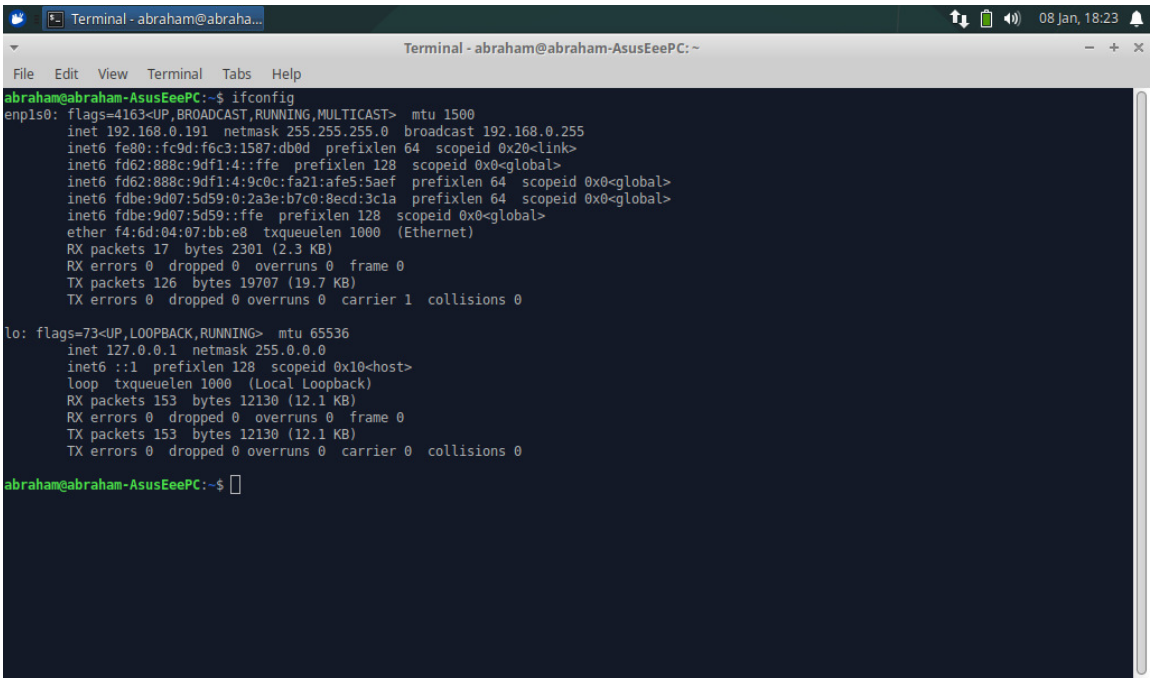


c. RG2 Interface Setup (Network -> Interfaces):

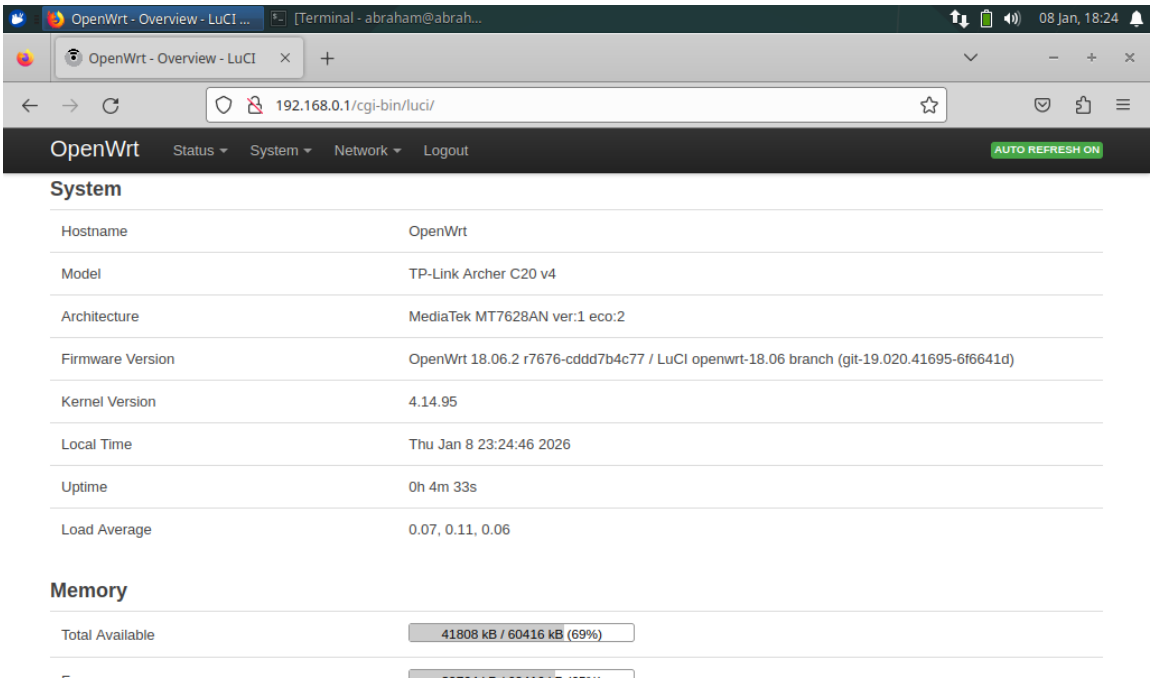


B. RG1 inserted between RG2 and PC5 (Router – RG2 – RG1 – PC5):

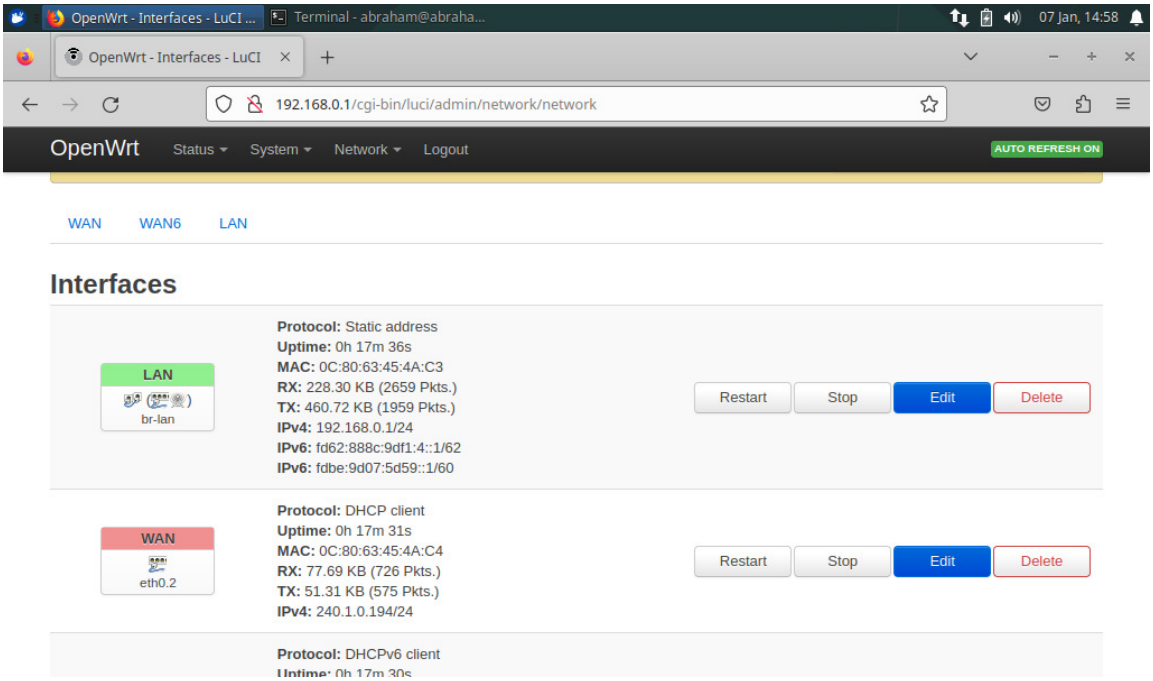
a. PC5 TCP/IP Properties (Terminal Emulator -> ifconfig):



b. RG1 Firmware (OpenWrt-18.06.2 Status -> Overview):

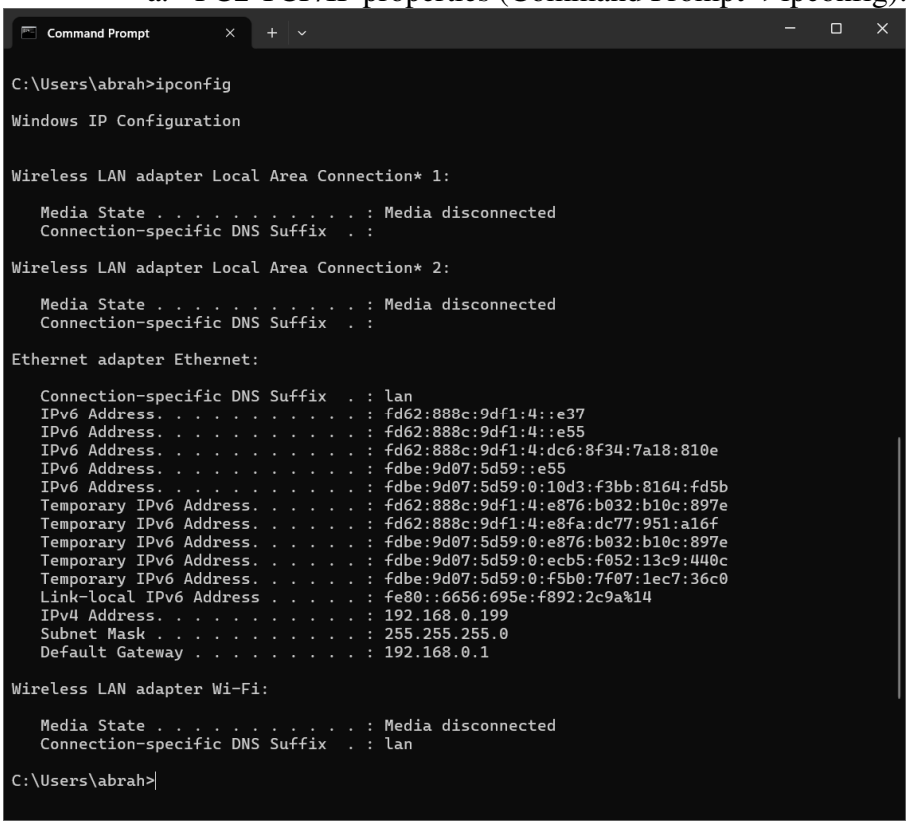


c. RG1 Interface Setup (Network -> Interfaces):

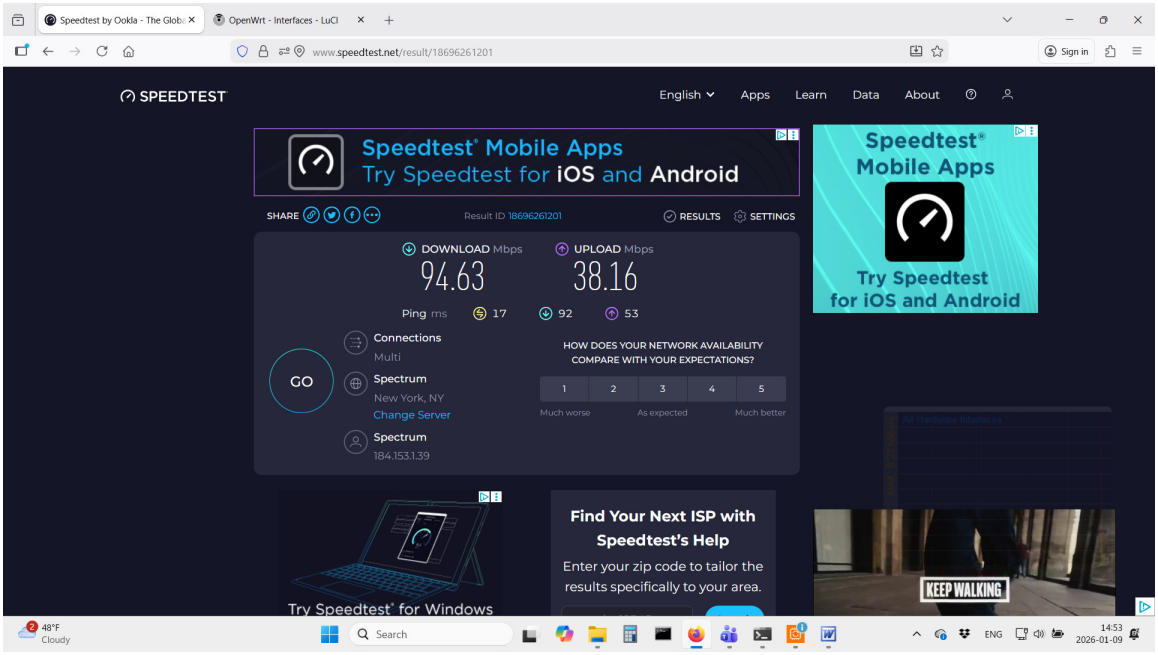


C. Plug PC2 into RG1 (Router – RG2 – RG1 – PC2):

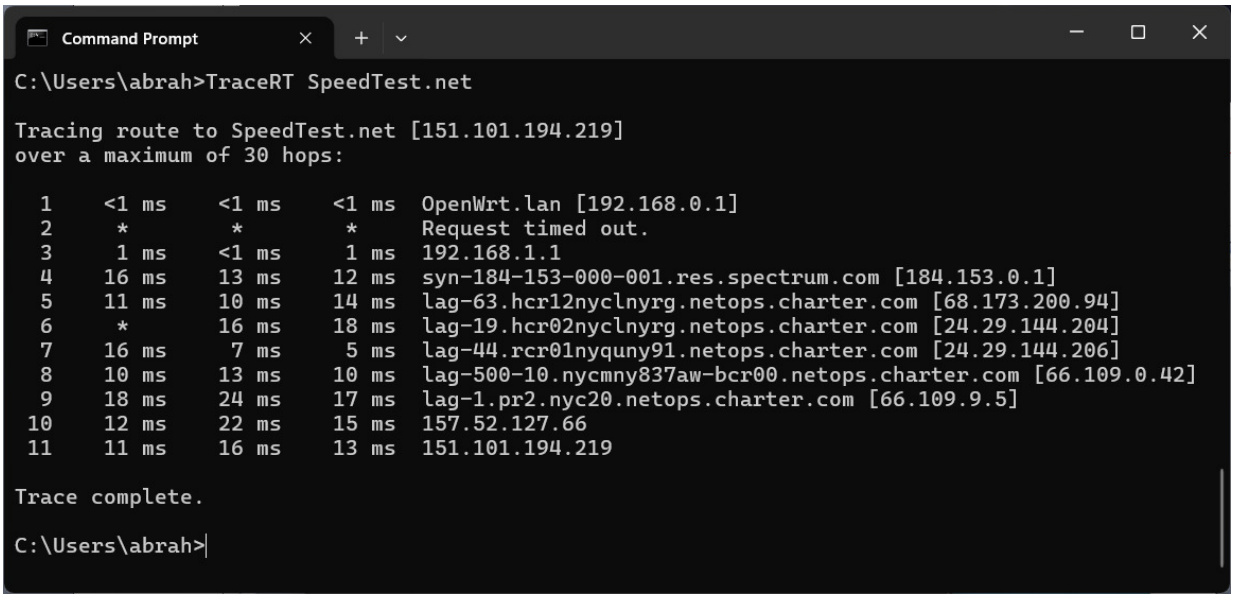
a. PC2 TCP/IP properties (Command Prompt ->ipconfig):



b. Speed Test (Browser -> SpeedTest.net):



c. PC2 to SpeedTest.net (Command Prompt -> TraceRT)



Note:

In Step 2, the display skipped 240.1.0/24 environment by showing “Request timed out”, as if it did not respond, while packets transmission actually successfully passed / tunneled through it.

4. Summary:

A. Common Home WiFi Routers (TP-Link Archer C20 V4) loaded with generic OpenWrt firmware code, without any customizations, support 240/4 just fine:

   a. OpenWrt-19.07.3 fully supported 240/4 (both in WAN & LAN ports).
   b. OpenWrt-18.06.2 (probably even earlier releases), having the WAN port acting as a DHCP client, was already capable of performing the basic RG function.

B. PC2 (Windows-11) accessed SpeedTest.net, through multiple RGs & NATs, with satisfactory results (The Ethernet ports of TP-Link Archer C20 V4 were factory rated at 100 Mbps). The IP packets went through at least four links between five hosts (three routers plus two end-points). Each link used a different network segment.

   a. PC2 - 192.168.0/24 <- RG1 –> 240.1.0/24,
   b. 240.1.0/24 < - RG2 - >192.168.1/24and
   c. 192.168.1/24 <-Home WiFi Router ->100.64/10 – SpeedTest.net

C. The above confirms that ***Windows based IoTs on private premises*** are not being affected by the intermediate 240/4 environment. This is because they ***are properly***

buffered to continue functioning normally through the EzIP network, as if nothing has changed.

5. Conclusions:

   A. Since the environment between RG2 and RG1 above is equivalent to that between the SPR and RG1 in the left-hand side branch of the RAN Simulator, which is the proposed long-term EzIP network configuration, this series of tests validate that such an architecture should serve RAN deployment well.

   B. Hypothesis: TP-Link routers flashed with generic OpenWrt firmware codes supported 240/4 without issues since 2019. Yet, current commercial routers factory pre-loaded with OpenWrt releases appear to be uncapable of the same. This apparent paradox is likely due to the latter being developed with un-justified extra program functions introduced during the customization process by respective engineering teams. It is recommended that ***a thorough review of the respective software build-up process be conducted, so that such extraneous disabling function in the stack may be identified and disabled.*** Then, Home WiFi Routers factory-loaded with OpenWrt will qualify as an EzIP RG.

   C. Since OpenWrt kernel was forked off from Linux after the latter began to support 240/4 back in 2008, ***the above line of reasoning should be equally valid in applying to other Linux based Switches and Routers.*** The fact is, although not formally documented by most first-tier networking equipment manufacturers, it is known that many networking types equipment are being used by multi-national conglomerates for transmitting 240/4 packets in various applications without announcement. Such equipment must be 240/4 compatible, after all. In addition, ***at least one second-tier Switch vendor has documented the 240/4 support.***