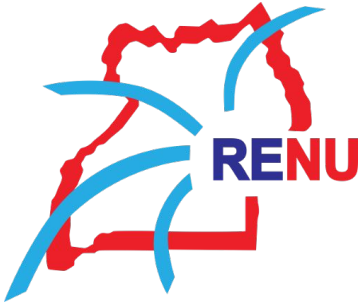

ICT Skilling for Schools

Network Monitoring and Troubleshooting

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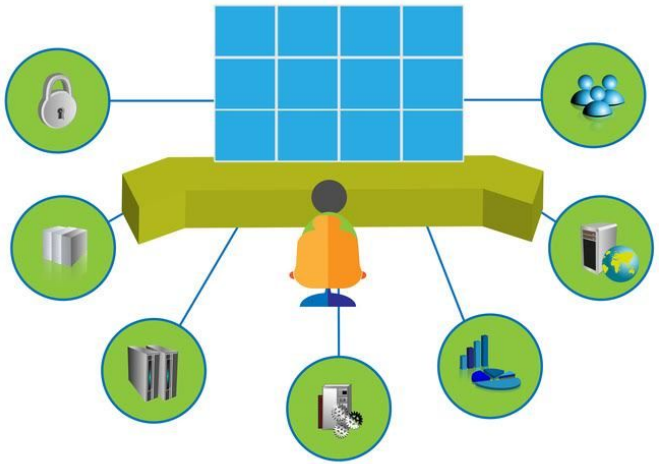
Outline

- Why Monitor Our Networks
- What to Monitor
- Monitoring Tools
- Tips for Effective Monitoring
- Common Network Issues
- The troubleshooting process
- Troubleshooting tools
- Q&A

Why Monitor Our Networks?

We monitor our networks to;

- Measure availability and performance.
- Measure trends vs. resource limits.
- Collect statistics.
- Detect changes to infrastructure and configurations.
- Detect issues.



What to Monitor?

Performance

- Latency, Packet Loss, Throughput, bandwidth

Availability

- Uptime/Downtime
- What's good enough?
- 99.999% Uptime?

Device health

- Temperature, CPU and Memory load

What to Monitor?

Traffic patterns

- Peak usage times, Top Talkers.

User activity

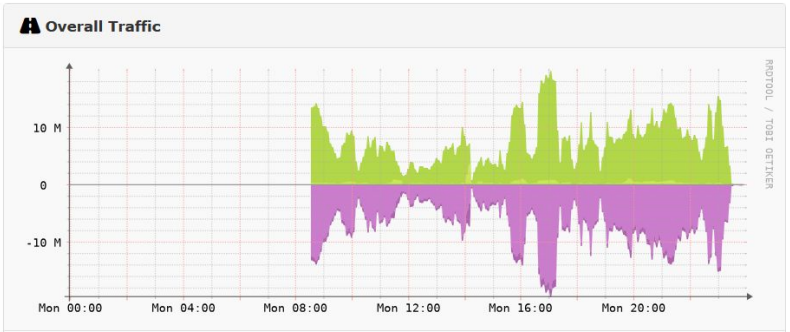
- Connected users, DHCP Leases, Authentication requests.

Wireless Monitoring

- Signal strength (RSSI) and noise levels.

Monitoring Tools

- LibreNMS
  - https://www.librenms.org/



  - Graphing of device data.
  - Network discovery

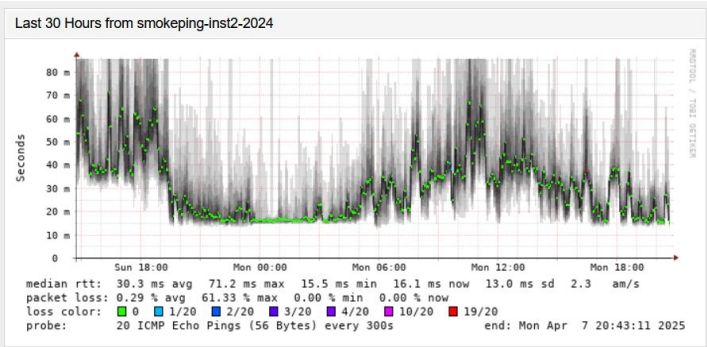
- Nagios
  - https://www.nagios.org/

Host	Status	Last Check	Duration
CPE-ST-LWANGA-KALOOLI-MULAJJE	UP	2025-04-08 00:11:54	0d 0h 5m 23s
CPE-ST-MARKS-COLLEGE-NAMAGOMA	UP	2025-04-08 00:08:24	0d 10h 44m 23s
CPE-ST-MARYS-COLLEGE-RUSHOROZA	UP	2025-04-08 00:11:04	1d 8h 23m 43s
CPE-ST-MARYS-GGABA	UP	2025-04-08 00:10:44	16d 5h 50m 53s
CPE-ST-MARYS-NKOZI	DOWN	2025-04-08 00:08:14	278d 11h 45m 36s
CPE-ST-MATHIAS-KALEMBA	DOWN	2025-04-08 00:08:14	500d 11h 36m 36s
CPE-ST-MICHEAL-HS-SONDE	UP	2025-04-08 00:09:44	0d 3h 54m 53s
CPE-ST-MUGAGGA-SS-JALAMBWA	UP	2025-04-08 00:12:04	0d 7h 29m 33s
CPE-ST-PAUL-OCHERO-SS	DOWN	2025-04-08 00:11:34	3d 2h 13m 13s

  - Monitoring and alerting tool.
  - Tracks uptime/downtime of devices.
  - Supports a number of plugins to improve its functionality.

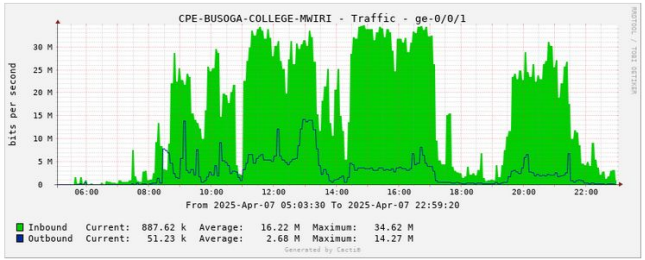
Monitoring Tools

- Smokeping
  - https://oss.oetiker.ch/smokeping/



  - Latency measurement tool.
  - Packet loss and jitter patterns.

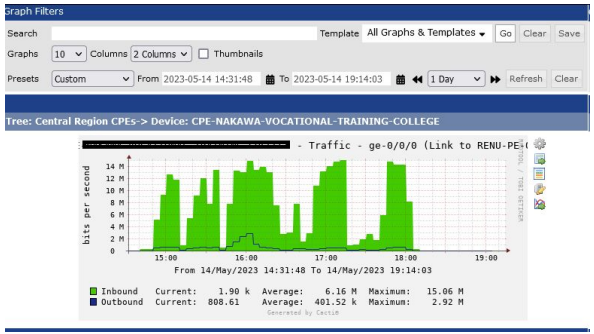
- Cacti
  - https://www.cacti.net/



  - Open-source tool
  - Polls data at predetermined intervals.
  - Allows for graphing of data such as CPU load and interface traffic.

Cacti Bandwidth Utilisation Tracking

- RENU uses the open-source tool, Cacti, to track bandwidth utilization.
- Institution receives credentials to access its utilization.
- How often do you monitor your Cacti bandwidth graph?
- Why should you access your bandwidth graph?



-Plan for your bandwidth efficiently.

-Troubleshooting slow speeds – rule out maximum utilization of bandwidth.

-Build a case for bandwidth upgrade needs for your institution

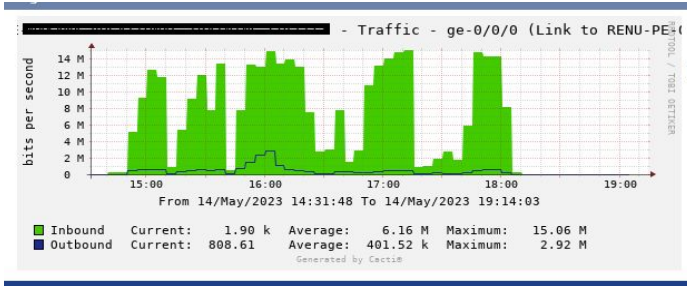
Tracking Bandwidth Utilisation – Cacti Interpretation

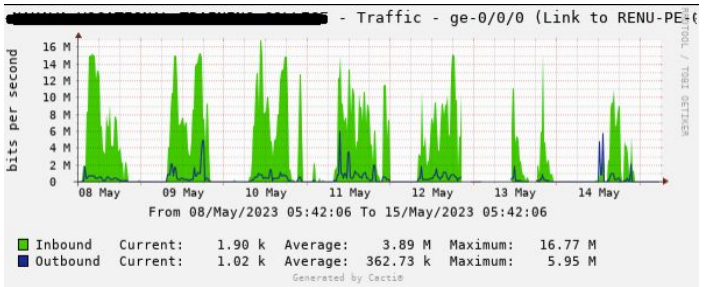
- Cacti graphs the speed of traffic going through an interface or port (on CPE for RENU).
- Shows download and upload bandwidth history.
- On CPE graph, interface facing RENU;

  Inbound = Download
  Outbound = Upload

- On interface facing school LAN;

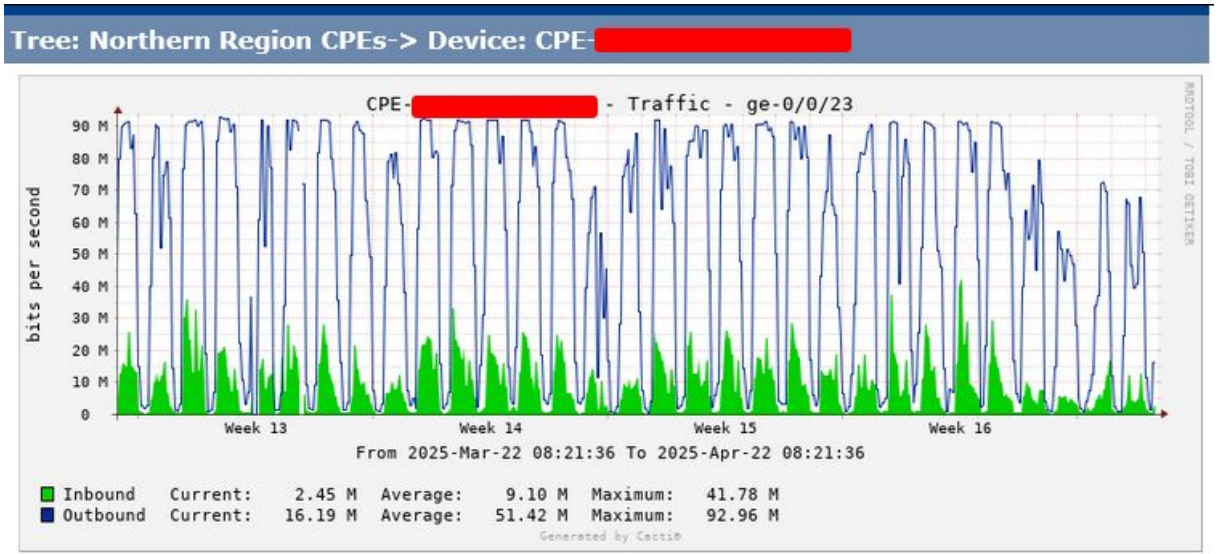
  Inbound = Upload
  Outbound = Download





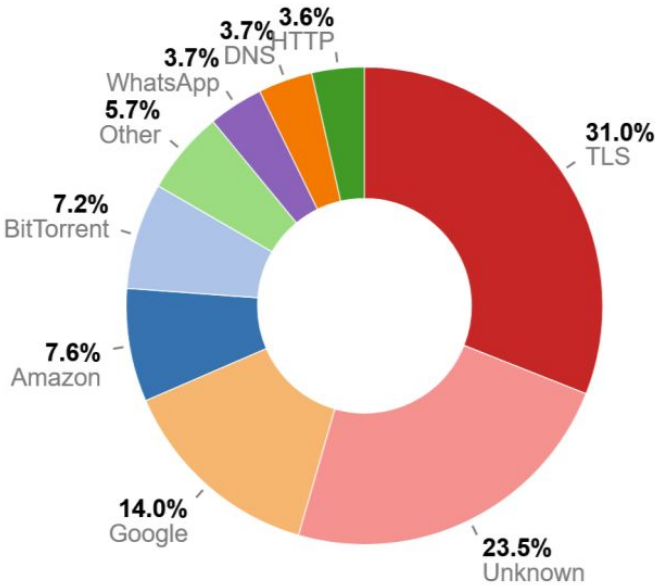
Tracking Bandwidth Utilisation

- Maximum utilization example – Institution has 90 Mbps

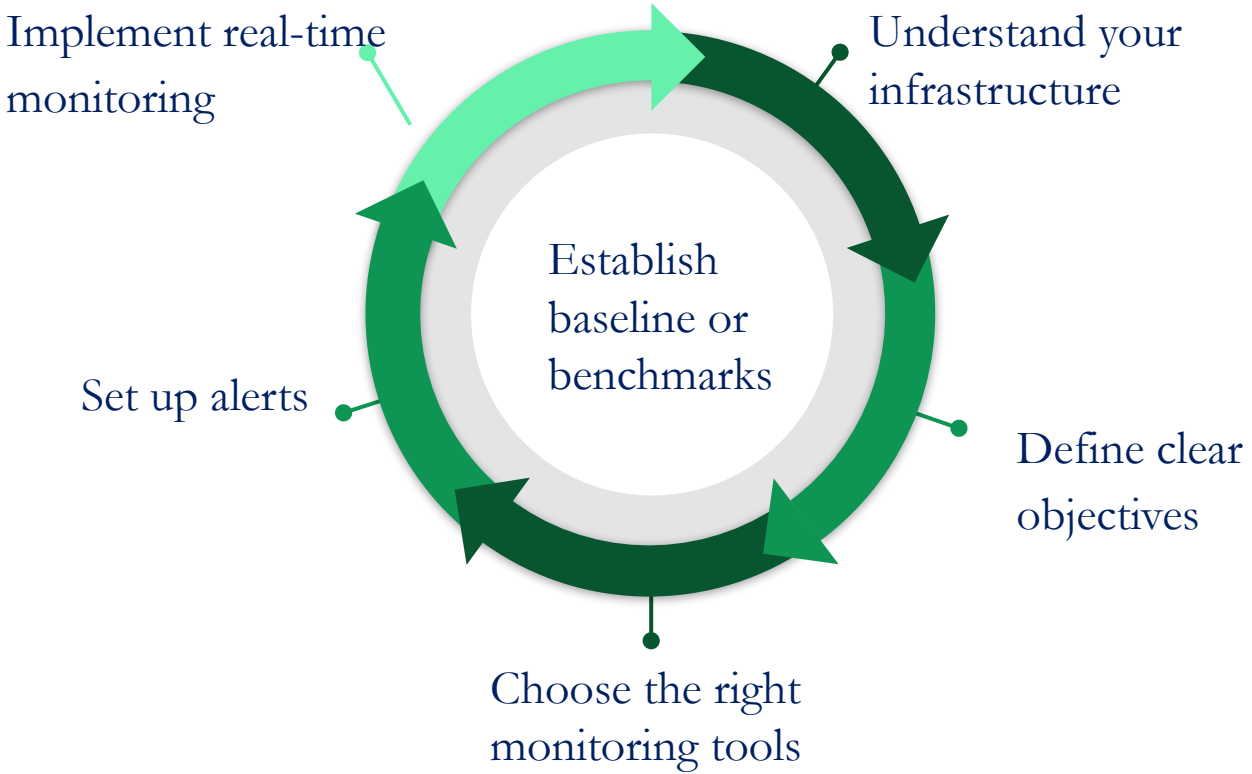


What consumes my bandwidth?

- Explosive network growth
- Software updates
- Server backups
- Number of users on the network
- Capacity hungry applications(Video, streaming)
- Peer-to-peer (P2P) software, Torrents, downloads



Tips for Effective Monitoring



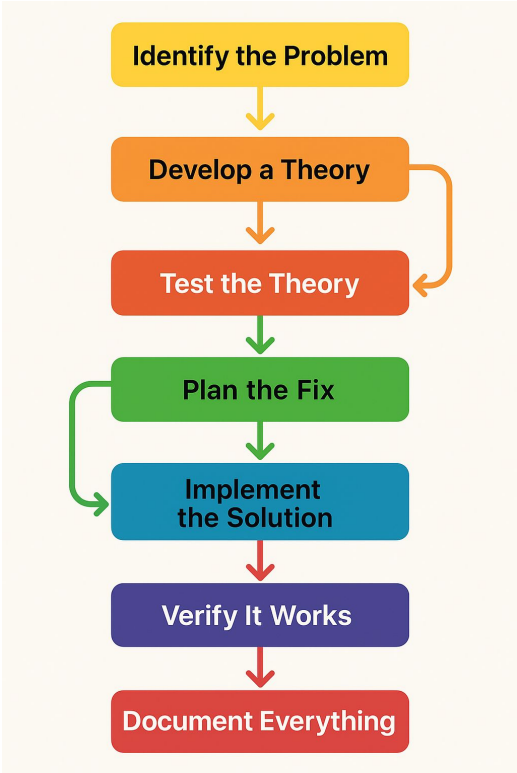
Common Network Issues

- Connectivity Issues –
  - Slow Internet connection, intermittent connectivity, weak Wi-Fi Signal.
- DNS and IP Address Issues –
  - DNS resolution problems, IP address conflicts, IP address exhaustion.
- Hardware failures – router, switches or other network devices.
- Firewall Misconfigurations.
- Software Problems – Outdated drivers, software glitches.

The troubleshooting process

The process of solving problems that are occurring on your network, using a methodical approach.

- Troubleshooting can be time-consuming because networks differ, problems differ, and troubleshooting experience varies.
- The figure displays the logic flowchart of a simplified seven-stage troubleshooting process.

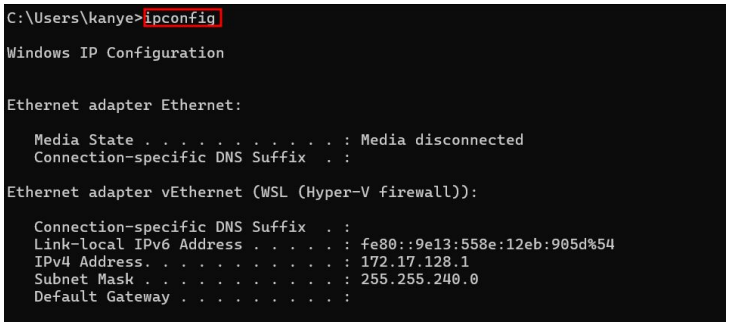


Troubleshooting process : Question Users

Guidelines	Example Open Ended End-User Questions
Ask pertinent questions.	• What does not work? • What exactly is the problem? • What are you trying to accomplish?
Determine the scope of the problem.	• Who does this issue affect? Is it just you or others? • What device is this happening on?
Determine when the problem occurred / occurs.	• When exactly does the problem occur? • When was the problem first noticed? • Were there any error message(s) displayed?
Determine if the problem is constant or intermittent.	• How often does the problem occur? • Can you send me a screenshot or video of the problem?
Determine if anything has changed.	What has changed since the last time it did work?
Use questions to eliminate or discover possible problems.	• What works? • What does not work?

Troubleshooting tools/Utilities

- **ipconfig/ifconfig**
  - CLI-based
  - Checks for IP address and DNS settings.
  - IP address,Subnet Mask, Gateway



- **ipconfig /all** – displays additional information
  - DHCP, DNS information
- **ipconfig /release** – used with DHCP
  - release IP address
- **ipconfig /renew** – used with DHCP
  - refreshes IP

Troubleshooting tools/Utilities

Ping

- Tests the reachability of a host or device.
- Can also be used to test internet connectivity.
- Latency and packet loss.

```
C[redacted]>ping google.com

Pinging google.com [172.217.170.174] with 32 bytes of data:
Reply from 172.217.170.174: bytes=32 time=33ms TTL=49
Reply from 172.217.170.174: bytes=32 time=35ms TTL=49
Reply from 172.217.170.174: bytes=32 time=35ms TTL=49
Reply from 172.217.170.174: bytes=32 time=35ms TTL=49

Ping statistics for 172.217.170.174:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 33ms, Maximum = 35ms, Average = 34ms
```

- **Ping options:**
  - -t: Continuously runs until stopped manually.
  - -4 or -6: forces use of ipv4 or ipv6 respectively.
  - -n: Specifies the number of echo requests sent before stopping.

Troubleshooting tools/Utilities

Traceroute/tracert

- Traces the path taken by a packet.
- Identifies the routers (hops).
- Measures the time it takes to reach each hop.

```
C:\[redacted]>tracert 1.1.1.1

Tracing route to one.one.one.one [1.1.1.1]
over a maximum of 30 hops:

  1     1 ms    <1 ms    <1 ms  192.168.45.1
  2     *        *        *     Request timed out.
  3    38 ms    18 ms    21 ms  192.168.109.34
  4    35 ms    20 ms    34 ms  10.10.5.1
  5    34 ms    24 ms    23 ms  10.10.5.2
  6    36 ms    19 ms    22 ms  102.34.188.2
  7    20 ms    30 ms    28 ms  102.34.188.0
  8    38 ms    21 ms    22 ms  kla1.p1-kla1.pe.net.renu.ac.ug [196.43.190.225]
  9    33 ms    22 ms    32 ms  kla1.p2-kla1.p1.net.renu.ac.ug [196.43.190.246]
 10    25 ms    28 ms    18 ms  kla1.peer1-kla1.p2.net.renu.ac.ug [196.43.190.174]
 11    21 ms    22 ms    21 ms  105.21.88.57
 12    43 ms    37 ms    34 ms  xe-0-7-0-2.cr-01-nbo.ke.seacomnet.com [105.16.11.253]
 13    35 ms    34 ms    35 ms  ce-0-0-11.cr-01-mba.ke.seacomnet.com [105.25.160.194]
 14    46 ms    37 ms    33 ms  ae-0.dr-01-mba.ke.seacomnet.com [105.16.16.14]
 15    55 ms    37 ms    34 ms  41.206.127.86
 16    36 ms    36 ms    38 ms  one.one.one.one [1.1.1.1]
```

nslookup

- Obtains the mapping between domain name and IP address.
- Used to check website accessibility issues.

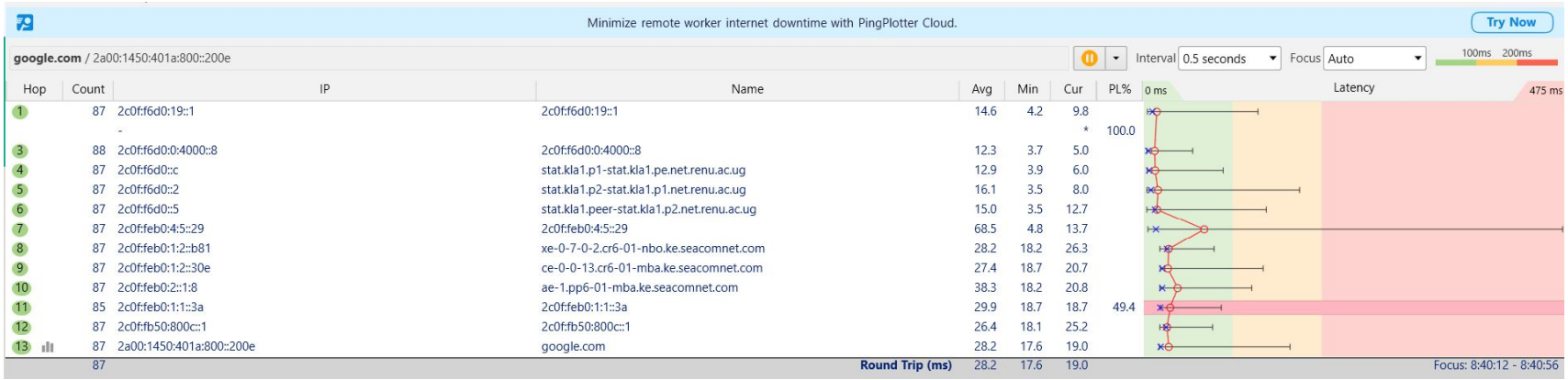
```
[redacted]>nslookup renu.ac.ug 196.43.185.3
Server:  ns1.renu.ac.ug
Address:  196.43.185.3

Name:    renu.ac.ug
Address:  196.43.185.200
```

Troubleshooting tools/Utilities

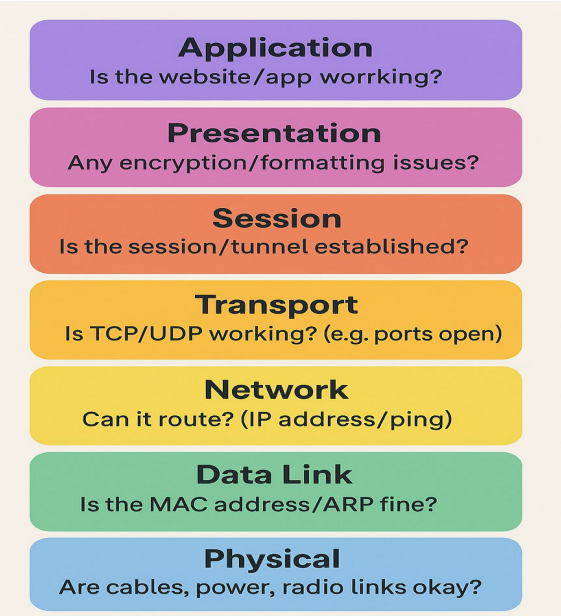
pingPlotter

- Identifies problems such as;
  - Congestion, packet loss, link health.
- Pinpoints the sources of bottlenecks.
- Tracks key metrics like;
  - Latency, jitter, and packet loss
- Identifies the culprit—whether it's your router, ISP, or beyond.



Structured Troubleshooting Approaches

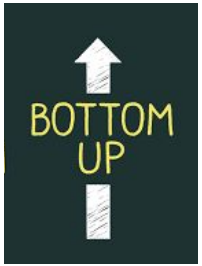
The OSI Model - Overview



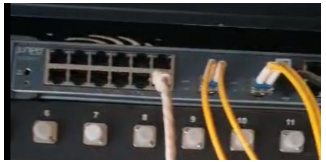
- 7 layer model
- Defines how media, protocols and standards work together.
- Isolates faults layer by layer, ensuring no critical checks are skipped, from physical links to application-level services.

Structured Troubleshooting Approaches

Approach	Description
Bottom-Up	When the problem is suspected to be a physical one.
Top-Down	When you think the problem is with a piece of software.
Divide-and-conquer	Start at a middle layer (i.e, Layer 3) and tests in both directions from that layer.
Follow-the-path	Trace the actual traffic path from source to destination.
Substitution	Swap a suspected problematic component with a known, working one.
Comparison	Compare a non-operational element with the working one.



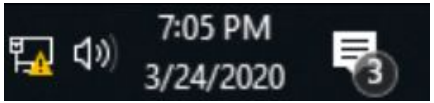
Layered Approach - Bottom-Up

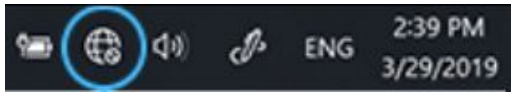


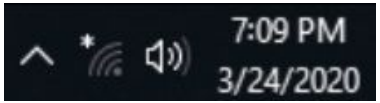
Layer	Symptoms	Cause
Physical	Devices off, indicator LEDs off, Heating up, slow connection, no connection.	Loose cable connections, High temperature, no power supply, signal attenuation, faulty equipment, dust, noise, CPU overload.
Data Link	Slow connection, no connection.	Loops, ARP problems, MTU mismatch, misconfiguration.
Network	No IP address, timeouts, packet loss.	DHCP failure, misconfiguration, IP address conflicts, congestion.
Transport	Timeouts	Firewall, misconfiguration, port conflicts.

Structured Troubleshooting Approaches

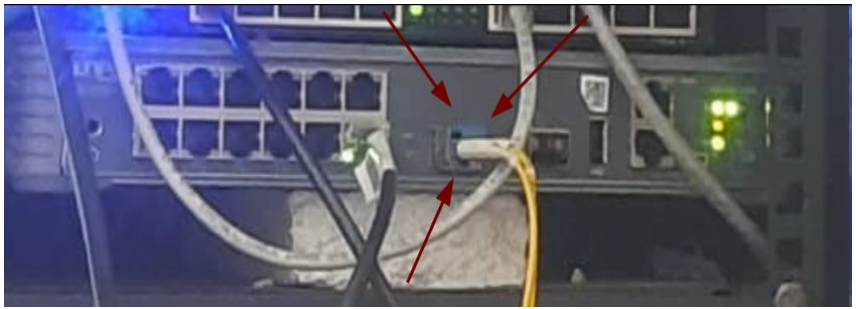
Layer	Symptoms	Cause
Session	Session timeouts.	Authentication or handshake failures.
Presentation	Data not displaying properly.	Incompatible data formats, decryption failures.
Application	Application crashes, slow response, timeouts, denied access.	Server down, misconfiguration, security compromise, DNS issues.

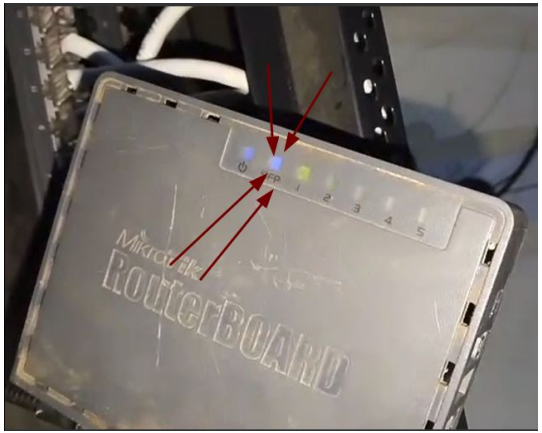






Last-mile Troubleshooting - Fiber





Last-mile Troubleshooting- LTE and Microwave

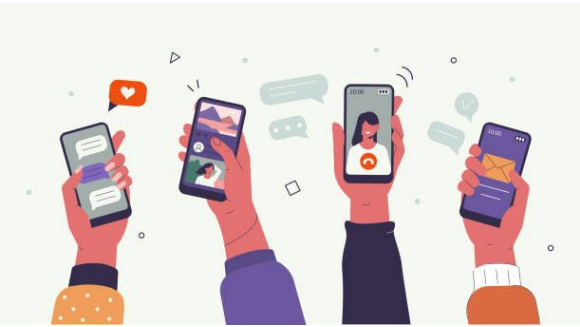
LTE

Microwave

How to contact the ISP/NOC

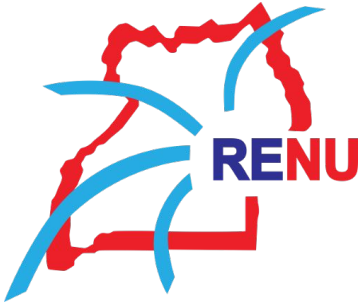
Contact Methods

- Phone Number/WhatsApp- 0783979515
- Email Address - noc@renu.ac.ug



Information to Provide

- Institution/Site Name
- Affected Service
- Description of the Issue
- Time Issue Started
- Troubleshooting Already Done (e.g. rebooted router, checked cabling).



THE END

Thank you for your time