

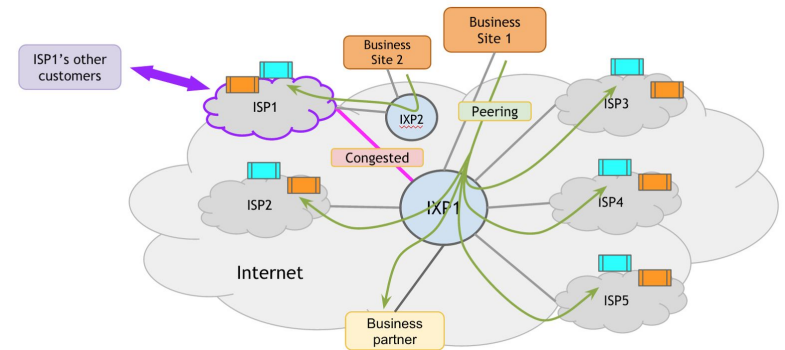
# Build your own Internet Service Provider (ISP) with Mikrotik

MUM Indonesia,  
24 nov 2021

Achmad Mardiansyah

[achmad@glcnetworks.com](mailto:achmad@glcnetworks.com)

GLC Networks, Indonesia



Source: proxim.com, aldrinisaac.blogspot.co.id

# Agenda

- Introduction
- How internet works
- ISP topology
- ISP requirements
- ISP implementation
- ISP maintenance
- ISP troubleshooting
- Tips and trick
- Q & A

# introduction

# What is GLC?

- Garda Lintas Cakrawala ([www.glcnetworks.com](http://www.glcnetworks.com))
- Based in Bandung, Indonesia
- Areas: Training, IT Consulting
- Certified partner for: Mikrotik, Ubiquity, Linux
- Product: GLC radius manager
- Regular event



# Trainer Introduction



- Name: Achmad Mardiansyah
- Base: bandung, Indonesia
- Linux user since 1999, mikrotik user since 2007, UBNT 2011
- Mikrotik Certified Trainer (MTCNA/RE/WE/UME/INE/TCE/IPv6)
- Mikrotik/Linux Certified Consultant
- Website contributor: [achmadjournal.com](http://achmadjournal.com), [mikrotik.tips](http://mikrotik.tips), [asysadmin.tips](http://asysadmin.tips)
- More info: <http://au.linkedin.com/in/achmadmardiansyah>

# Past experience



- 2021 (**Papua New Guinea, Malaysia**): network migration to routed network, radius/billing integration
- 2020 (**Congo DRC, Malaysia**): IOT integration, network automation
- 2019, **Congo (DRC)**: build a wireless ISP from ground-up
- 2018, **Malaysia**: network revamp, develop billing solution and integration, setup dynamic routing
- 2017, **Libya (north africa)**: remote wireless migration for a new Wireless ISP
- 2016, **United Kingdom**: workshop for wireless ISP, migrating a bridged to routed network



# Prerequisite

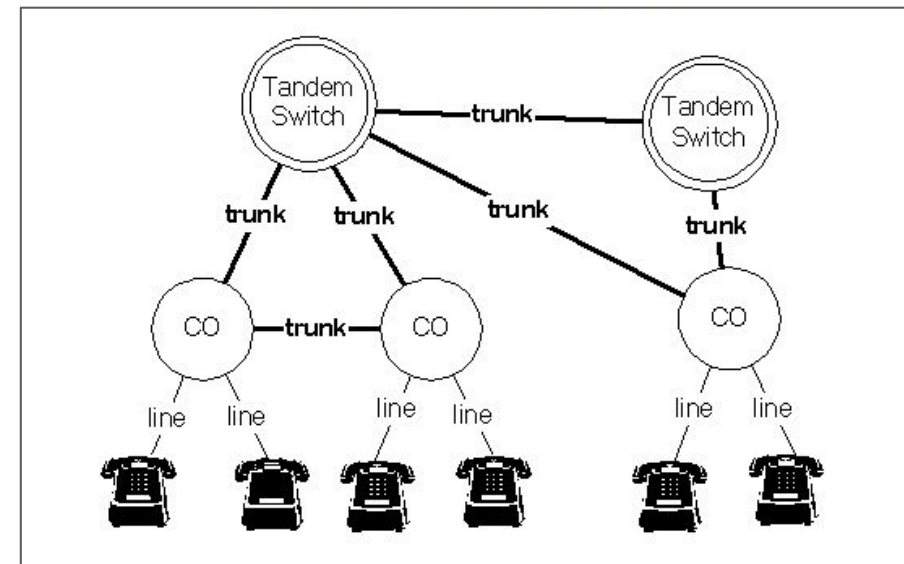
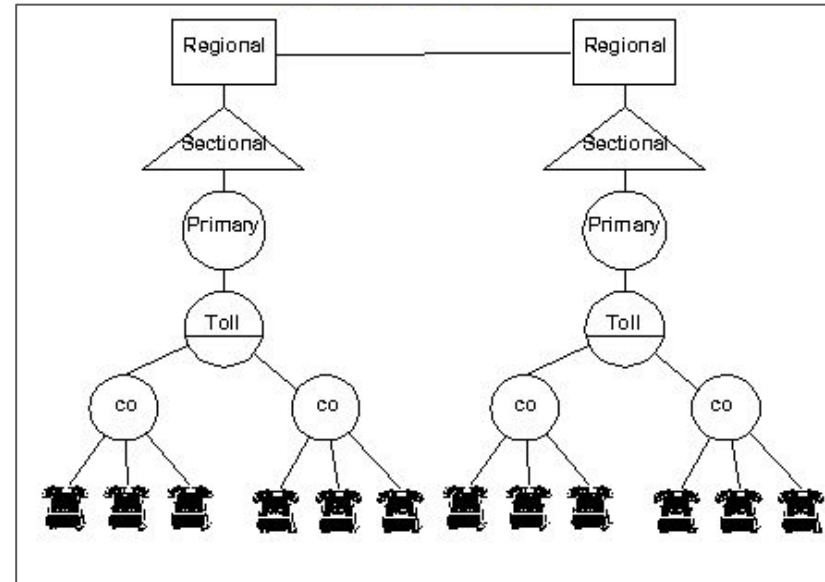
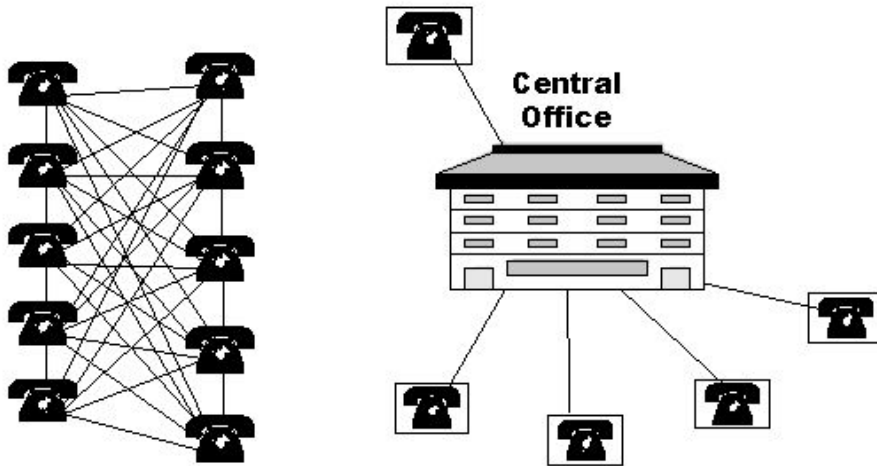
- This presentation some prerequisite knowledge
- We assume you already know:
  - Networking in general
  - Computer network

# How internet works



# We start from telecommunication

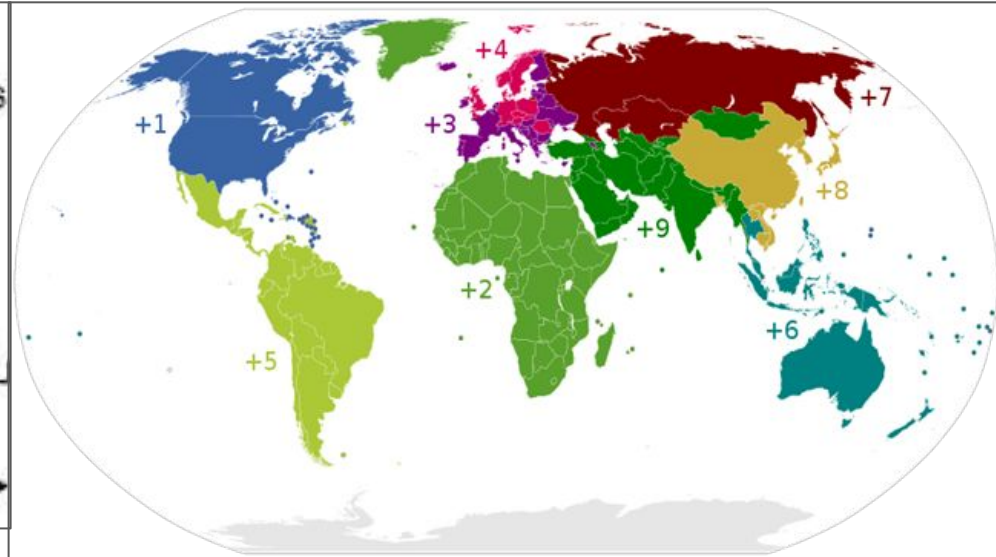
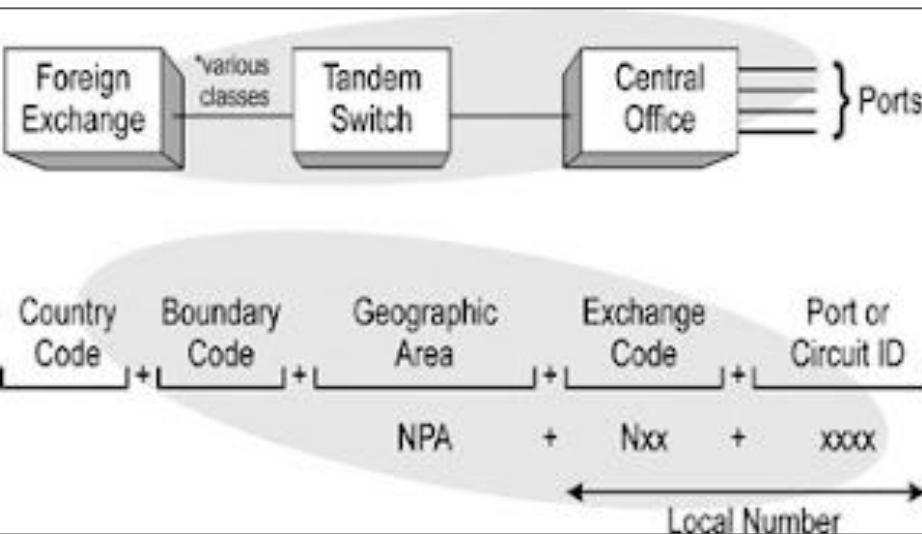
- Star topology
- Nodes:
  - Customer Premise Equipment (CPE)
  - Central Office (CO)
- Links:
  - Local-loop (access network)
  - trunk



Source: [www.mikundan.com](http://www.mikundan.com)

# Telecommunication addressing (numbering plan)

- Objective:
  - To identify subscriber
  - As basis for routing
- Recommendation: ITU-T E160-163
- Schemes: Open scheme, Semi open, closed



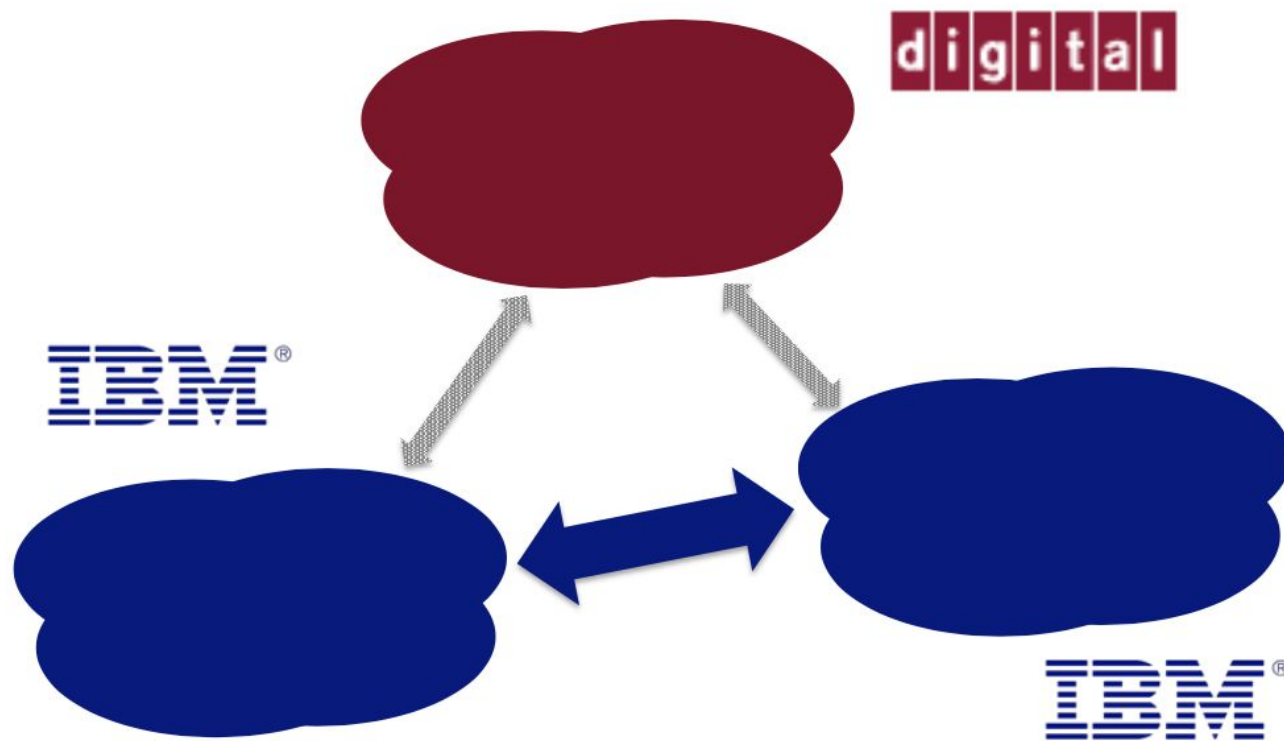
# A bit of history...

- Initially, research project ('70-'80s) – Open, cooperative, public domain
  - “Rough consensus and running code”
- Then, product of liberalisation ('90s) – Also, catalyst for deregulation
  - Commercial, competitive environment
- Now, public utility and critical infrastructure (since 2000 and beyond)
  - “Internet governance” is a recent afterthought

Source: APNIC

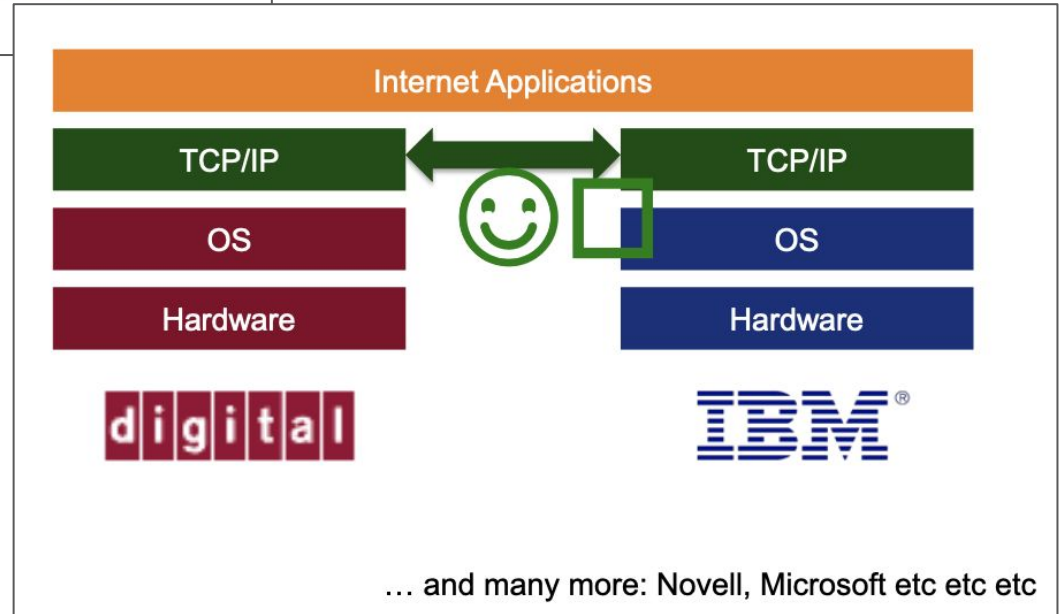
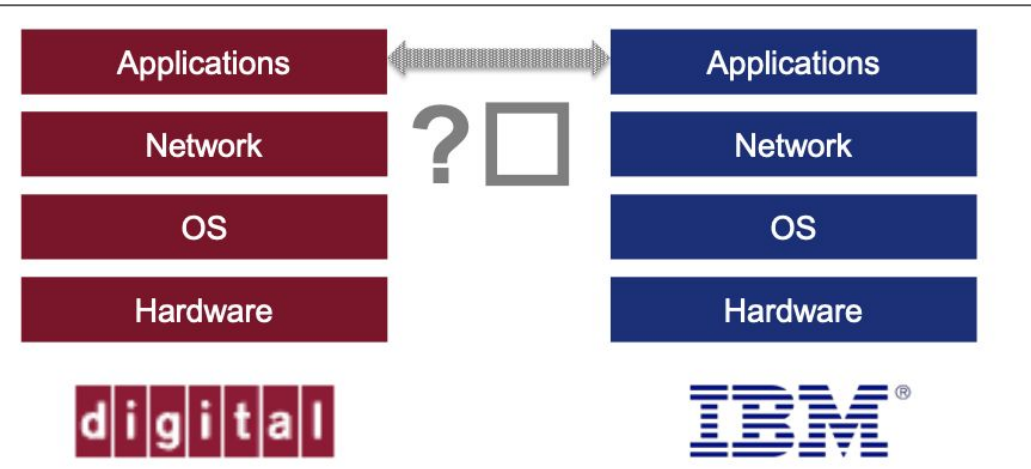
# Before internet...

- Computer networking already exist... but many are proprietary



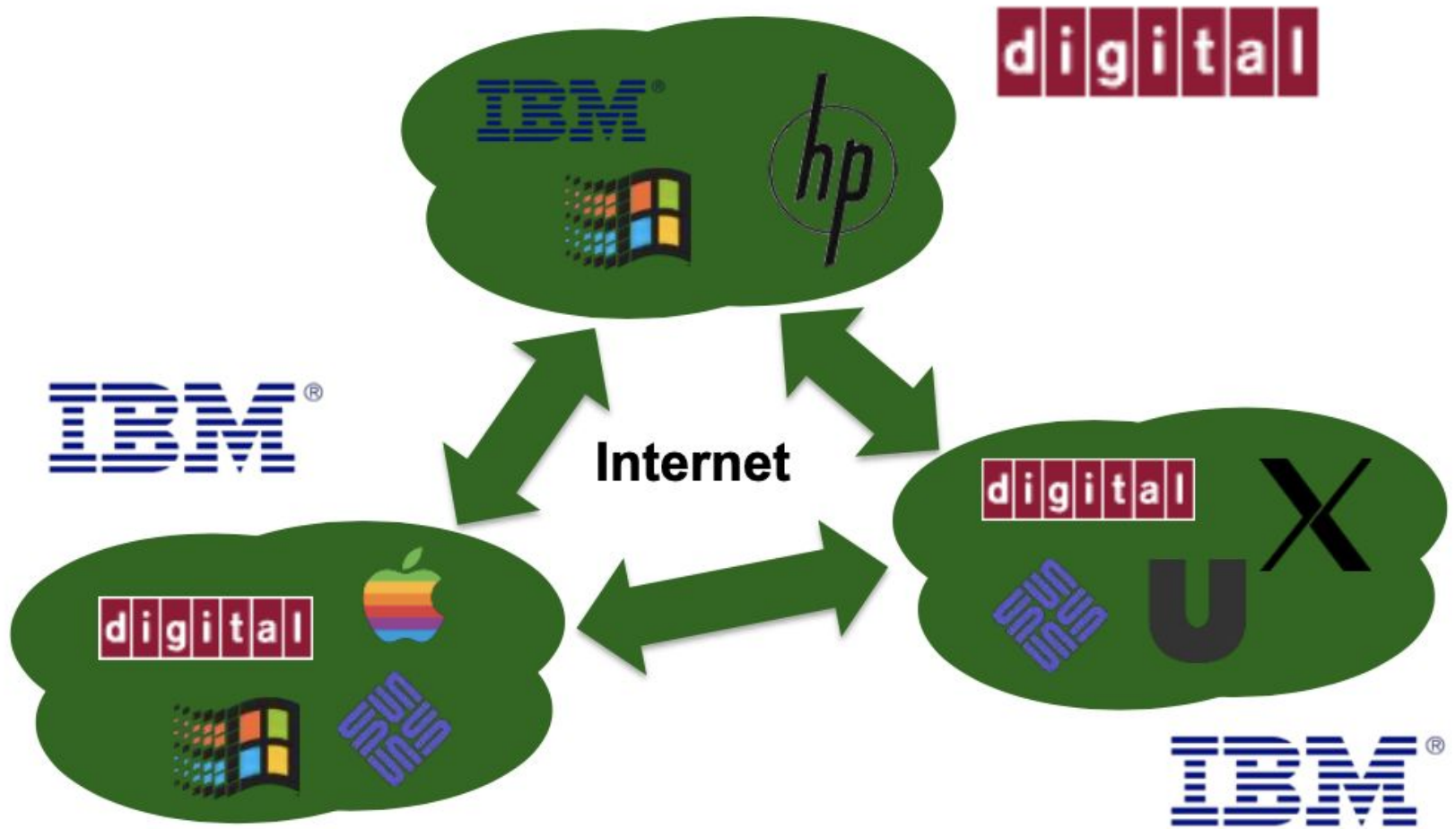
Source: APNIC

# Internet defines a standard for communication



Source: APNIC

After internet...



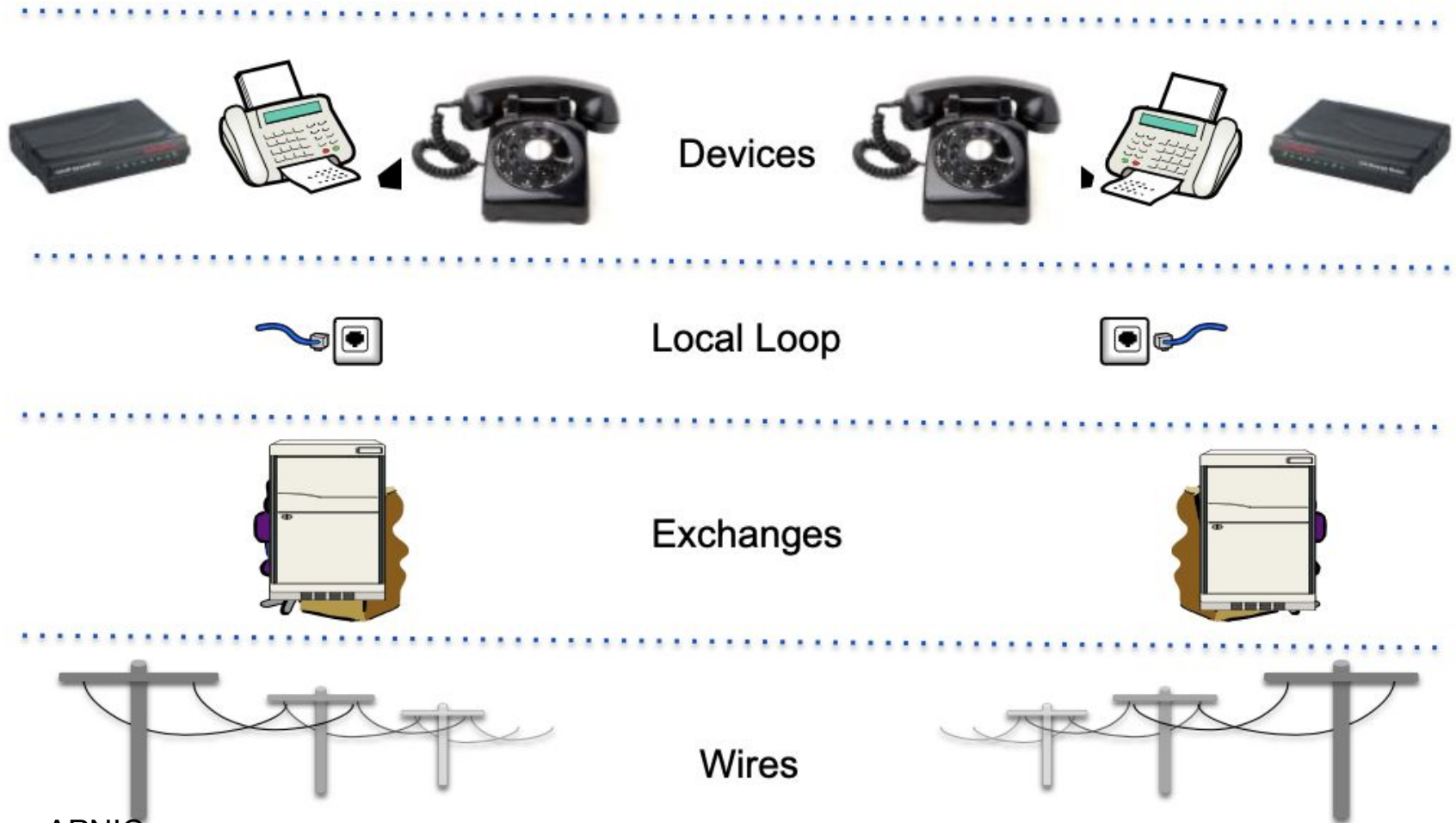
Source: APNIC

# Why use internet

- Open
  - Free standards and implementations – Low barrier to entry
- Lightweight
  - “Dumb”: simple and efficient
  - Intelligence at the edges: in applications and devices
- Global
  - Uniform, “End-to-End”
- Neutral
  - By default

Source: APNIC

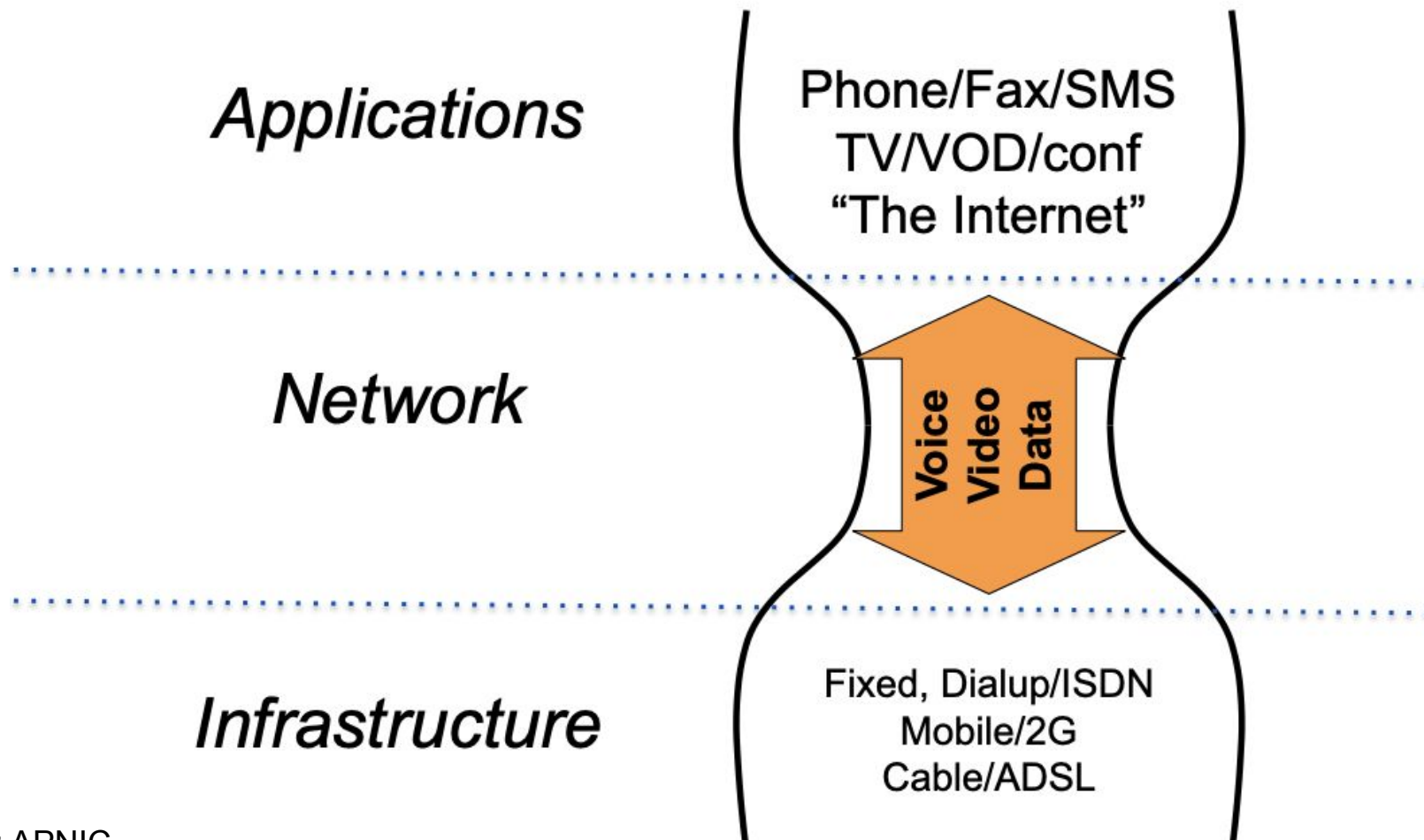
# Layers in telecommunication



Source: APNIC

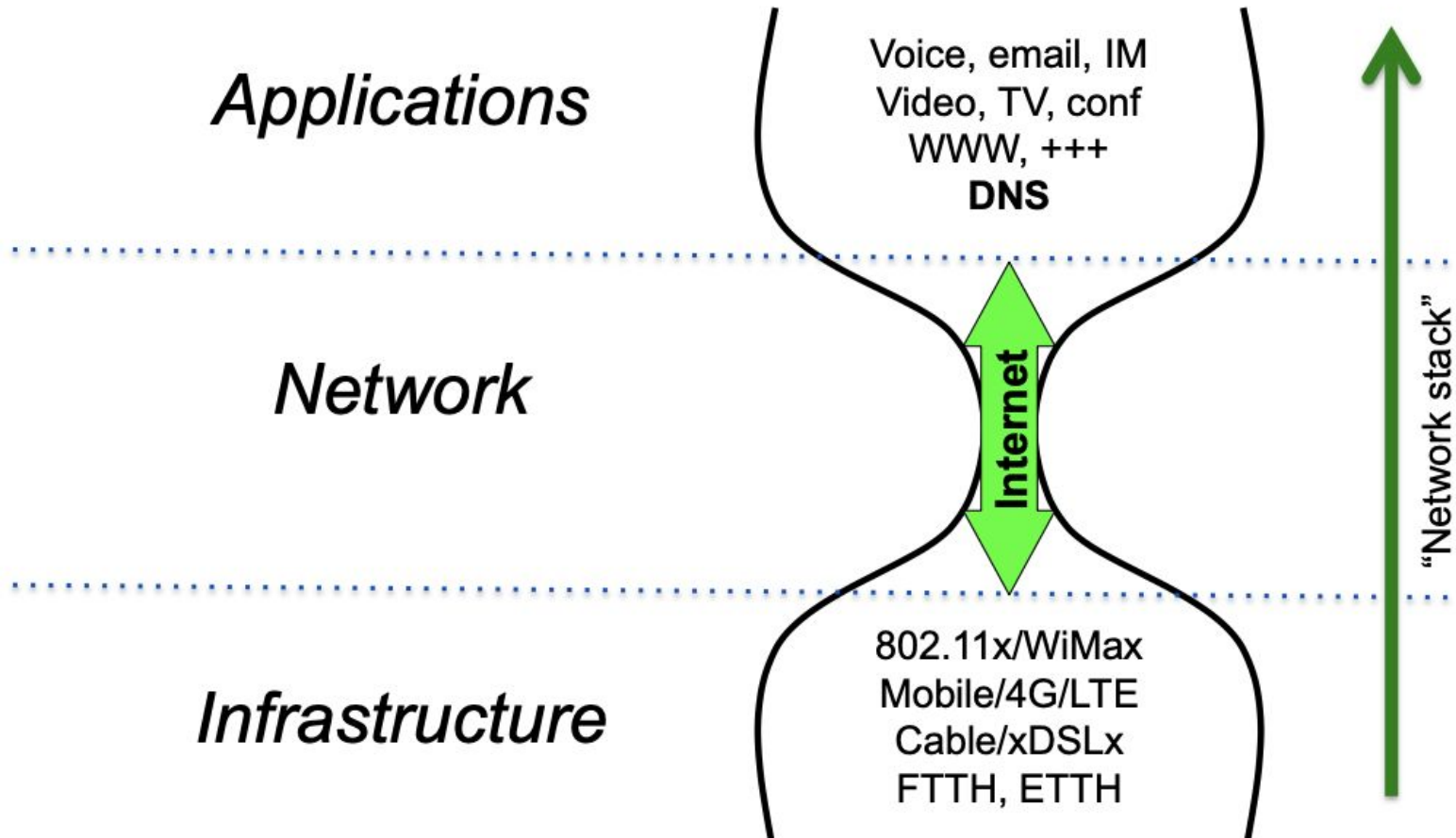


# Layers in traditional communication



Source: APNIC

# Layers in internet communication



Source: APNIC

# We need standards

- Standards operate at different levels of the network “stack”
  - in fact they define the stack
- A standard (or protocol) is simply an **agreement**
  - among members of a community,
  - on a set of guidelines or rules,
  - which allow cooperation (interoperability),
  - sometimes, in a forum such as ISO, ITU, W3C or IETF.
- An open standard is a standard which is
  - Developed through open and accessible processes
  - Freely accessible, implementable and usable
  - Available without barriers such as licenses and fees.
  - ... “ideally”, at least.

Source: APNIC

# We need Addressing (identification) and Routing

- Addressing has to be unique. just like your id, phone,
- Internet is based on IP (internet protocol) addressing scheme -> RFC791
- Every organisation must have IP address block to join the internet and build a routing scheme among their equipment
- IP address needs to be grouped into subnet → similar like **area code**
- 

→ <https://tools.ietf.org/html/rfc791>

[Docs] [txt|pdf] [Errata]

Updated by: [1349](#), [2474](#), [6864](#) INTERNET STANDARD  
Errata Exist

RFC: 791

INTERNET PROTOCOL

DARPA INTERNET PROGRAM

PROTOCOL SPECIFICATION

September 1981

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→ <https://tools.ietf.org/html/rfc1878>

[Docs] [txt|pdf] [draft-rfced-info-...] [Diff1] [Diff2] [Errata]

HISTORIC  
Errata Exist

Network Working Group T. Pummill  
Request for Comments: 1878 Alantec  
Obsoletes: [1860](#) B. Manning  
Category: Informational ISI  
December 1995

**Variable Length Subnet Table For IPv4**

Status of this Memo

This memo provides information for the Internet community. This memo does not specify an Internet standard of any kind. Distribution of this memo is unlimited.

Abstract

This memo clarifies issues surrounding subnetting IP networks by providing a standard subnet table. This table includes subnetting for Class A, B, and C networks, as well as Network IDs, host ranges and IP broadcast addresses with emphasis on Class C subnets.

This memo is intended as an informational companion to Subnetting RFC [\[1\]](#) and the Hosts Requirements RFC [\[2\]](#).

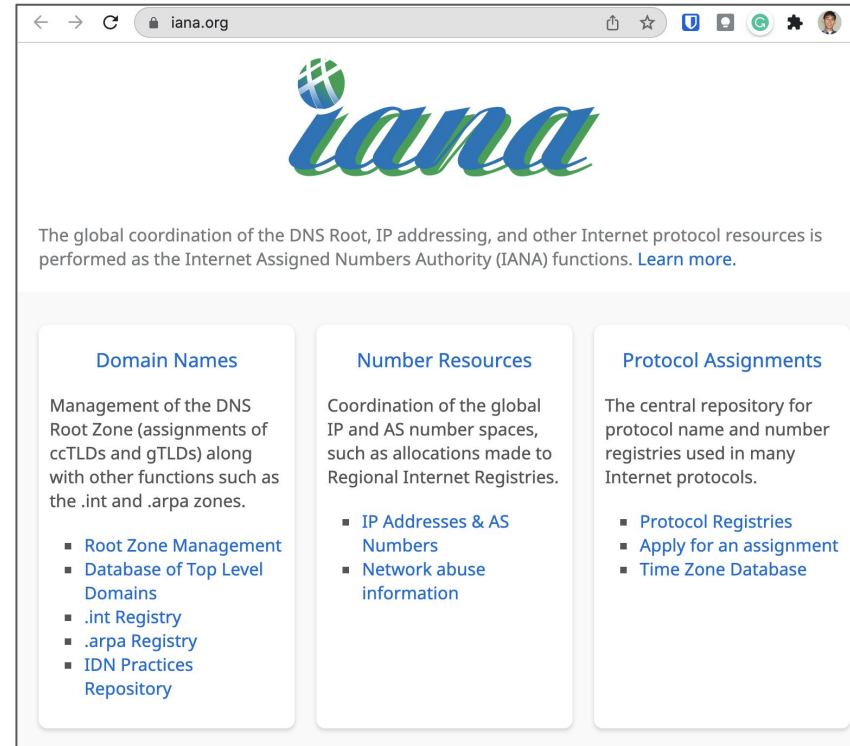
Introduction

The growth of networking since the time of STD 5, [RFC 950](#) and STD 3, [RFC 1123](#) has resulted in larger and more complex network subnetting. The previously mentioned RFCs comprise the available guidelines for creating subnetted networks, however they have occasionally been misinterpreted leading to confusion regarding proper subnetting.

This document itemizes the potential values for IPv4 subnets. Additional information is provided for Hex and Decmial values, classfull equivalants, and number of addresses available within the indicated block.

# IANA and RIR

- We need an international body that regulates IP addressing -> IANA (Internet Assigned Number Authority)
- IANA delegates (some of its authority) to RIR “Regional Internet Registry”
- RIR delegates to country’s
- 



The screenshot shows the IANA website with the following content:

- Domain Names**  
Management of the DNS Root Zone (assignments of ccTLDs and gTLDs) along with other functions such as the .int and .arpa zones.
  - Root Zone Management
  - Database of Top Level Domains
  - .int Registry
  - .arpa Registry
  - IDN Practices Repository
- Number Resources**  
Coordination of the global IP and AS number spaces, such as allocations made to Regional Internet Registries.
  - IP Addresses & AS Numbers
  - Network abuse information
- Protocol Assignments**  
The central repository for protocol name and number registries used in many Internet protocols.
  - Protocol Registries
  - Apply for an assignment
  - Time Zone Database



# Motivation to build ISP

# Motivation to build ISP with mikrotik

## Why build ISP?

- Can be a source of income (Commercialisation), high demand
  - Residential services
  - Business services
  - Other services
- A cheaper way to access internet (sharing connection)
- Extend current network

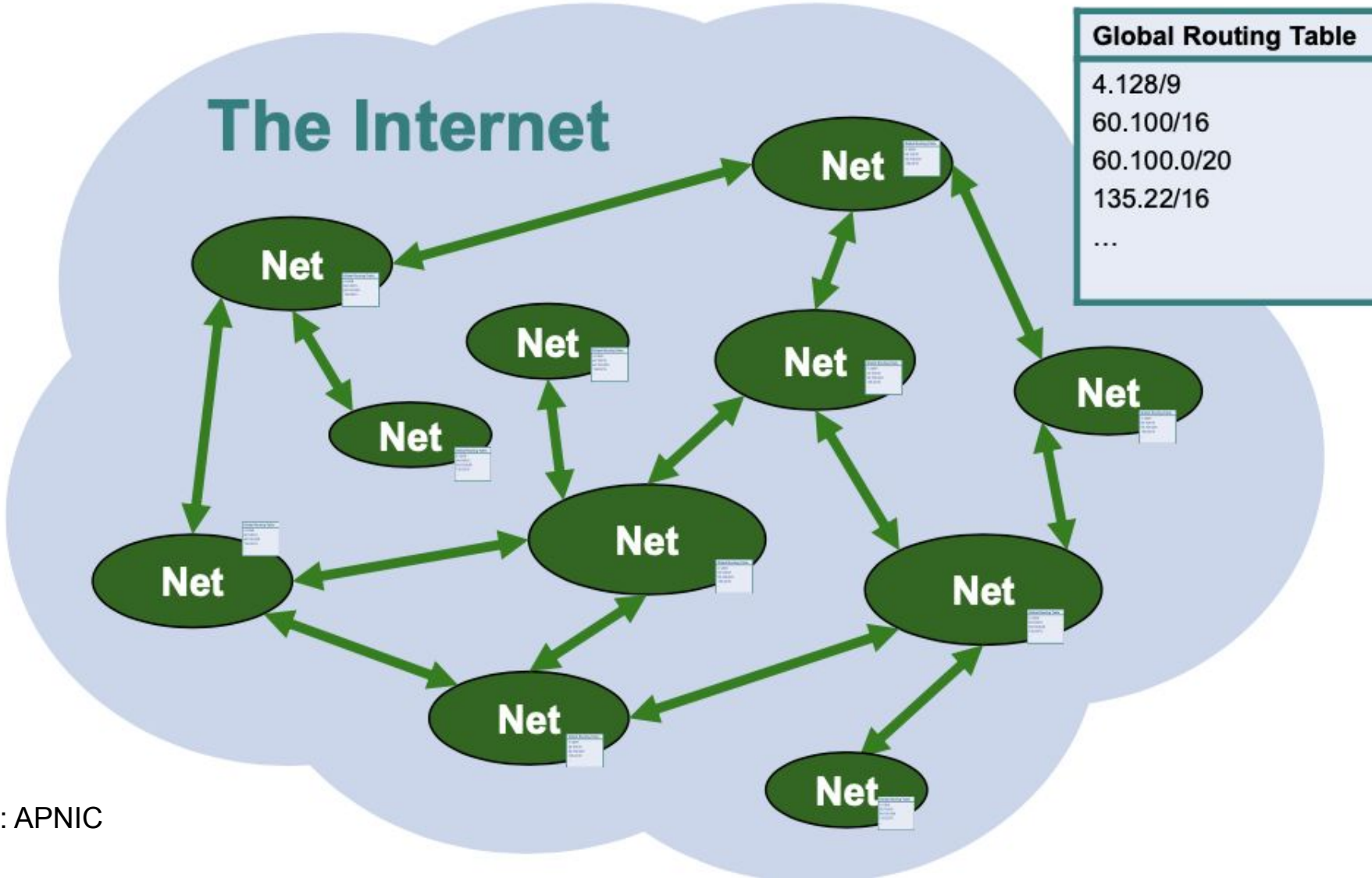
## Why mikrotik?

- Affordable price
- Feature rich
- Better margin

# ISP topology



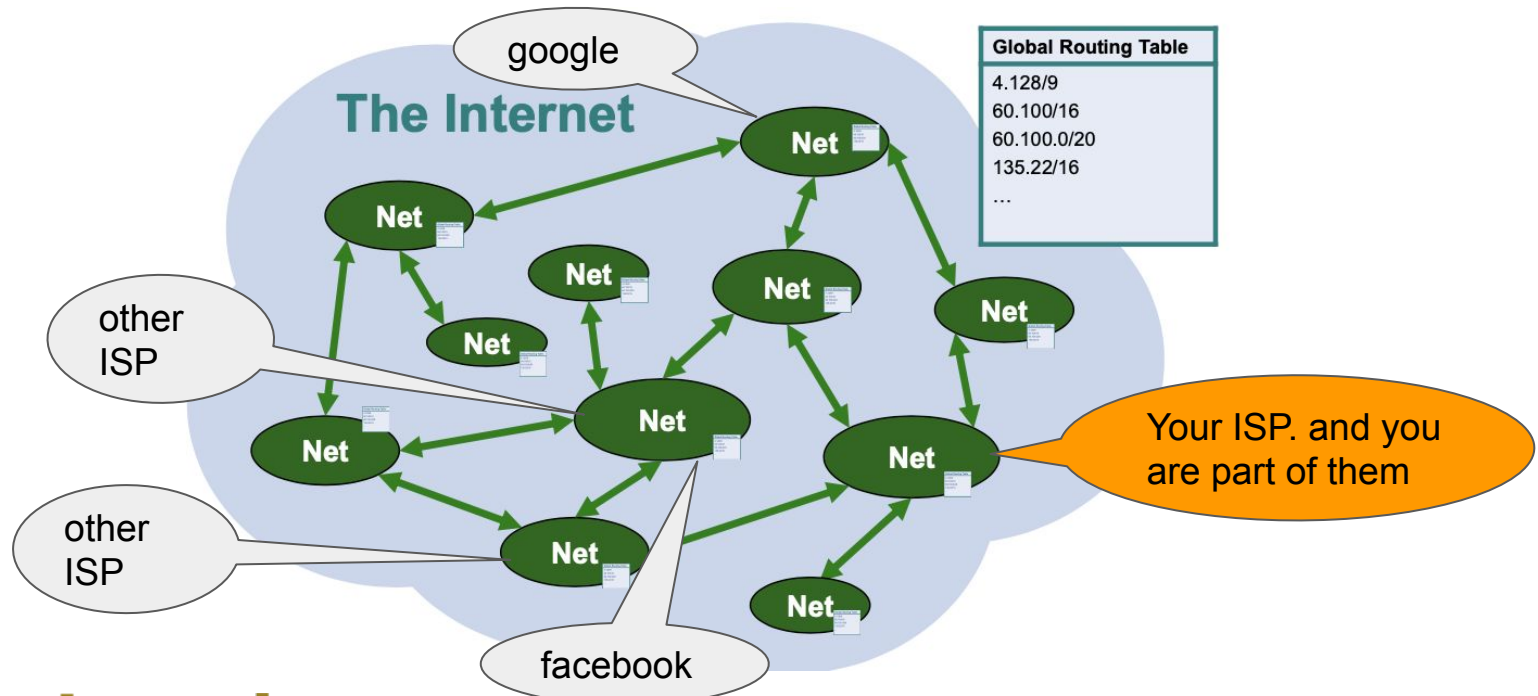
# Inter-connected networks



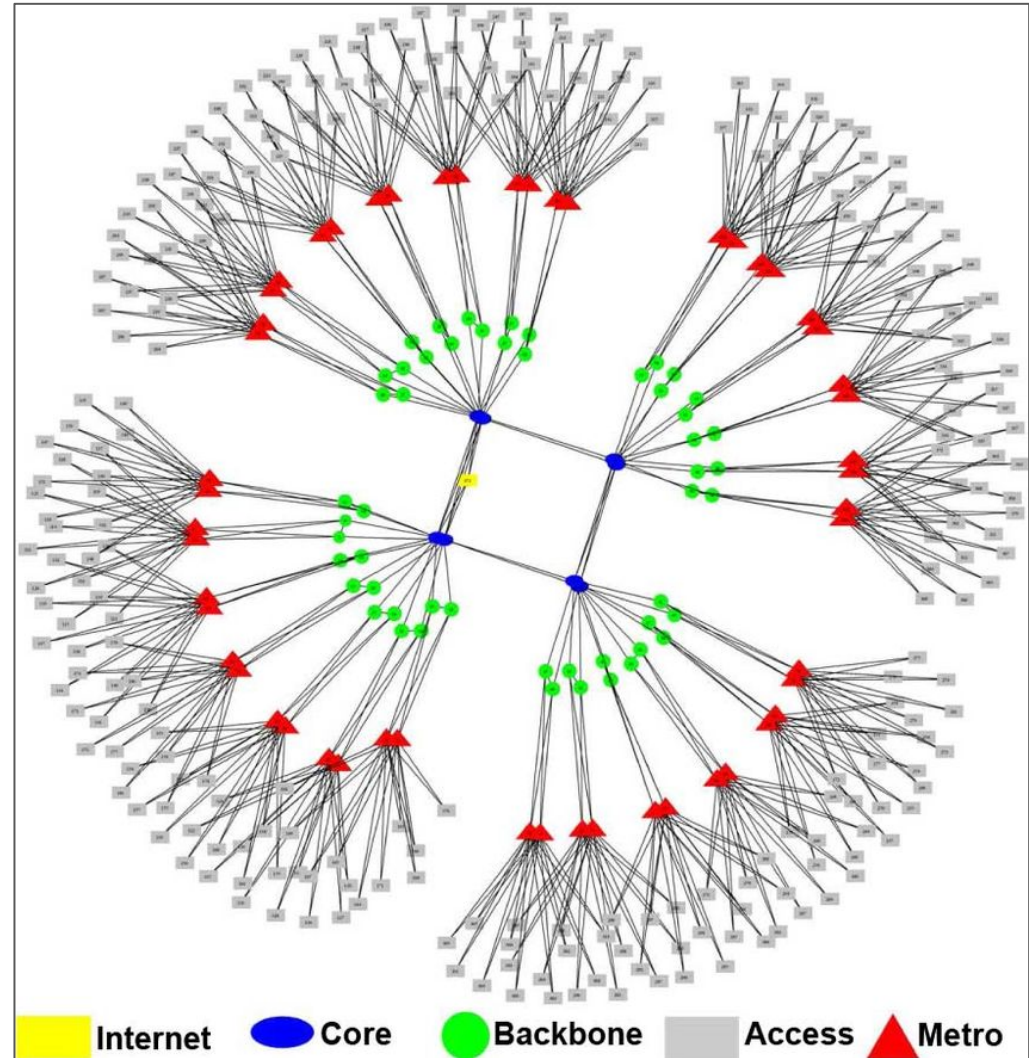
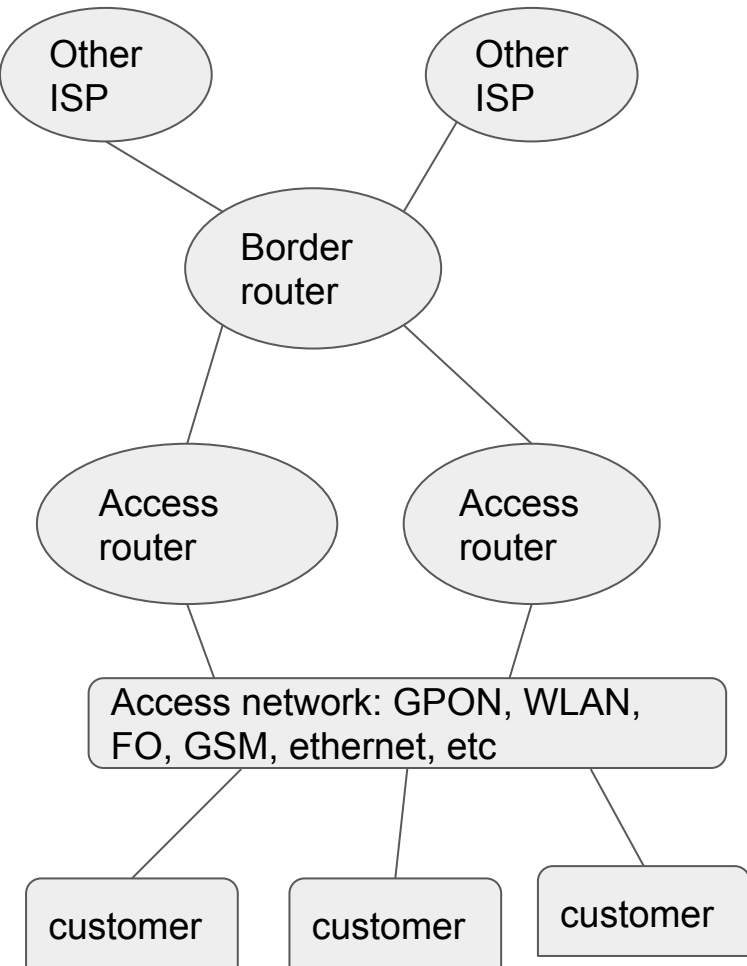
Source: APNIC

# Your ISP and you

- ISP is an organisation that is part of internet that provides connectivity to their customers
  - Identified by their AS (Autonomous System) number
  - Identified by their IP address block
- When you connect to internet, you will use your ISP's address



# At your ISP (physical connection)



# ISP requirements

# Requirements

- Technical
  - Upstream bandwidth (important!!)
  - Hardware
    - Routers, switch, cables, access point, CPE
    - Physical topology
  - Software
    - Addressing (ip address block, AS number)
    - Logical topology (IP planning)
    - Routing (IGP vs EGP)
    - Billing
    - Monitoring
    - automation
  - Brainware
    - Skilled engineer
- Non-tech
  - Services: pppoe, hotspot, dhcp
  - Legal: business registration
  - Money: Investor, loan

# Legal requirements... (from KBI indonesia)

61921	Internet Service Provider	Kelompok ini mencakup usaha jasa pelayanan yang ditawarkan suatu perusahaan kepada pelanggannya untuk mengakses internet, atau bisa disebut sebagai pintu gerbang ke internet
61923	Jasa Internet Teleponi Untuk Keperluan Publik (itkp)	Kelompok ini mencakup usaha jasa untuk mentransmisi panggilan melalui jaringan Internet Protocol (IP). Kegiatan ini menyelenggarakan internet teleponi yang bersifat komersial, dihubungkan ke jaringan telekomunikasi
61924	Jasa Interkoneksi Internet (nap)	Kelompok ini mencakup kegiatan menyelenggarakan akses dan atau ruting bagi penyelenggara jasa akses internet. Dalam menyelenggarakan akses bagi penyelenggara jasa akses internet, penyelenggara jasa interkoneksi internet dapat menyediakan jaringanh untuk transmisi internet. Penyelenggara jasa interkoneksi internet wajib saling terhubung melalui interkoneksi. Penyelenggara jasa interkoneksi melelkukan pengaturan trafik penyelenggaraan jasa akses internet
61994	Jasa Jual Kembali Akses Internet	Kelompok ini mencakup usaha penyelenggaraan jasa jual kembali akses internet seperti Warung Internet/Internet Cafe.
63121	Portal Web Dan/atau Platform Digital Tanpa Tujuan Komersial	Kelompok ini mencakup: - Pengoperasian situs web tanpa tujuan komersial yang menggunakan mesin pencari untuk menghasilkan dan memelihara basis data (database) besar dari alamat dan isi internet dalam format yang mudah dicari. - Pengoperasian situs web yang bertindak sebagai portal ke internet, seperti situs media yang menyediakan isi yang diperbarui secara berkala tanpa tujuan komersial. - Pengoperasian platform digital dan/atau situs/portal web yang melakukan transaksi elektronik berupa kegiatan usaha fasilitasi dan/atau mediasi pemindahan kepemilikan barang dan/atau jasa dan/atau layanan lainnya melalui internet dan/atau perangkat elektronik dan/atau cara dengan sistem elektronik lainnya tanpa tujuan komersial.

# ISP deployment

# Deployment steps

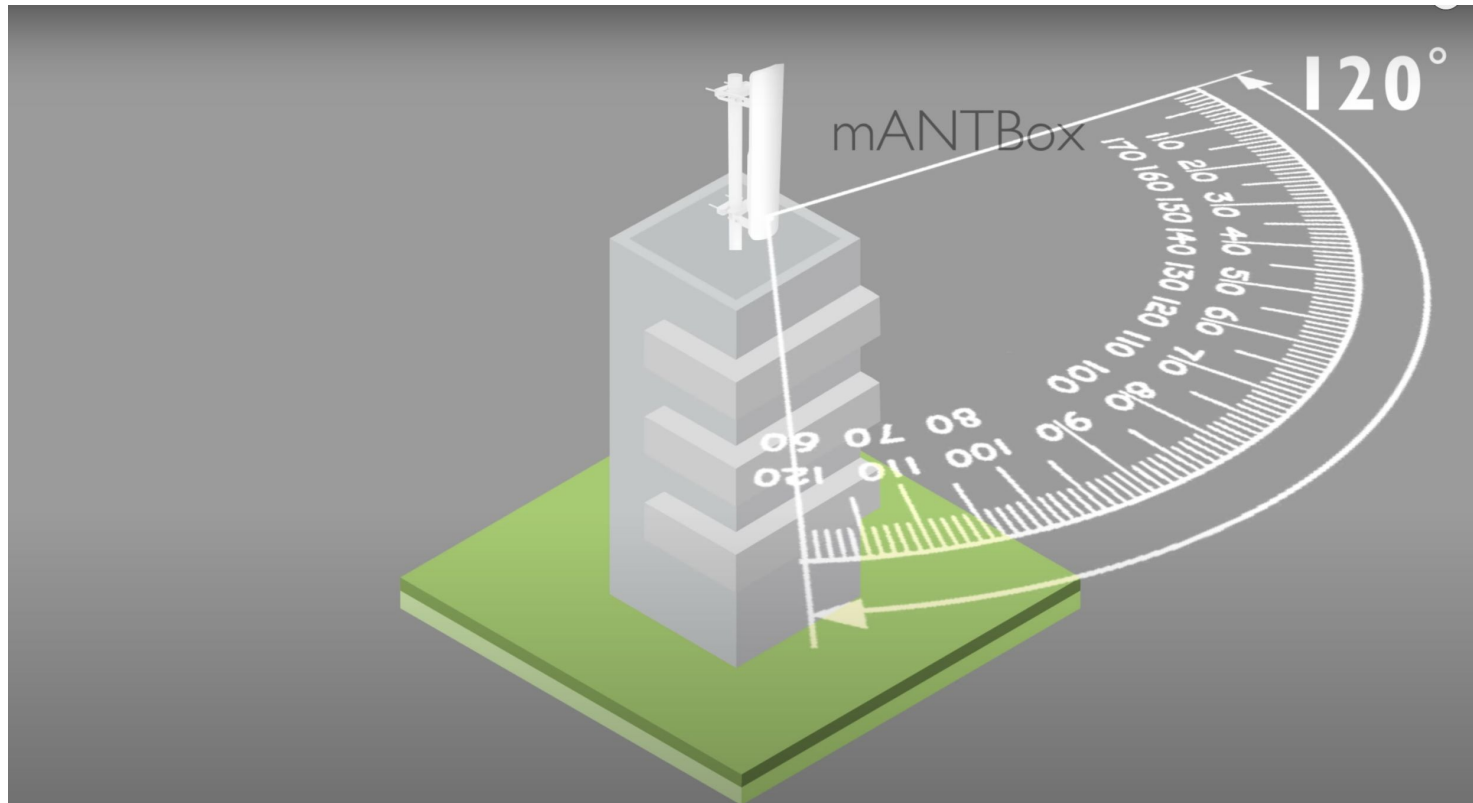
- Planning
  - Physical topology
  - Logical topology
- Installation
  - Network devices: router, switches
  - Links:
    - Wired: copper, fiberoptic
    - Wireless
      - Unlicensed frequency (802.11xx)
        - Can be very crowded
      - Licensed frequency





# Wireless ISP (WISP) example

Start with an Access Point (Sectoral antenna)



# Connect it to customer (CPE)



# At customer site

hAP



# Example equipment

mANTBox 19s



mANTBox 15s



SXT



LHG 5



DynaDish



hEX



hAP lite



hAP ac





# ISP operation

# Operation: monitoring

- FCAPS
  - Fault
  - Configuration
  - Accounting
  - Performance
  - Security
- Mikrotik tools:
  - Profiling
  - Freq usage
  - Spectrum analyzer
  - The dude

**ZABBIX** Global view

All dashboards / Global view

**System information**

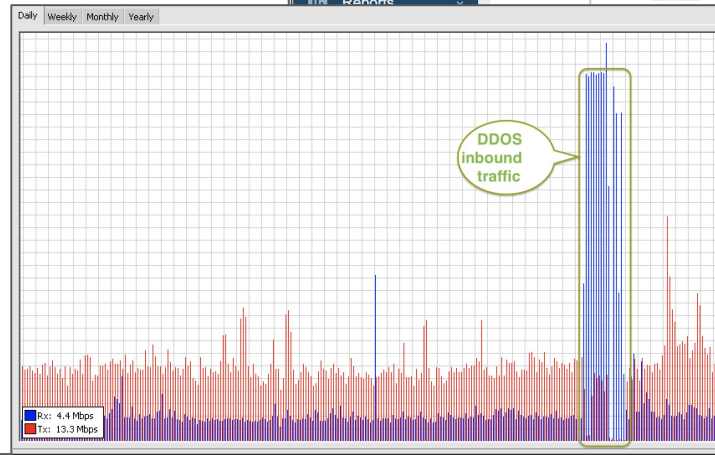
Parameter	Value	Details
Zabbix server is running	Yes	localhost:10051
Number of hosts (enabled/disabled)	12	12 / 0
Number of templates	219	
Number of items (enabled/disabled/not supported)	30887	20955 / 0 / 9932
Number of triggers (enabled/disabled [problem/ok])	15011	15011 / 0 [507 / 14504]
Number of users (online)	3	1
Required server performance, new values per second	226.43	

**Problems**

12:38:15 CCA-RO

1 Available 0 Not available

0 Disaster 0 High 495 Average

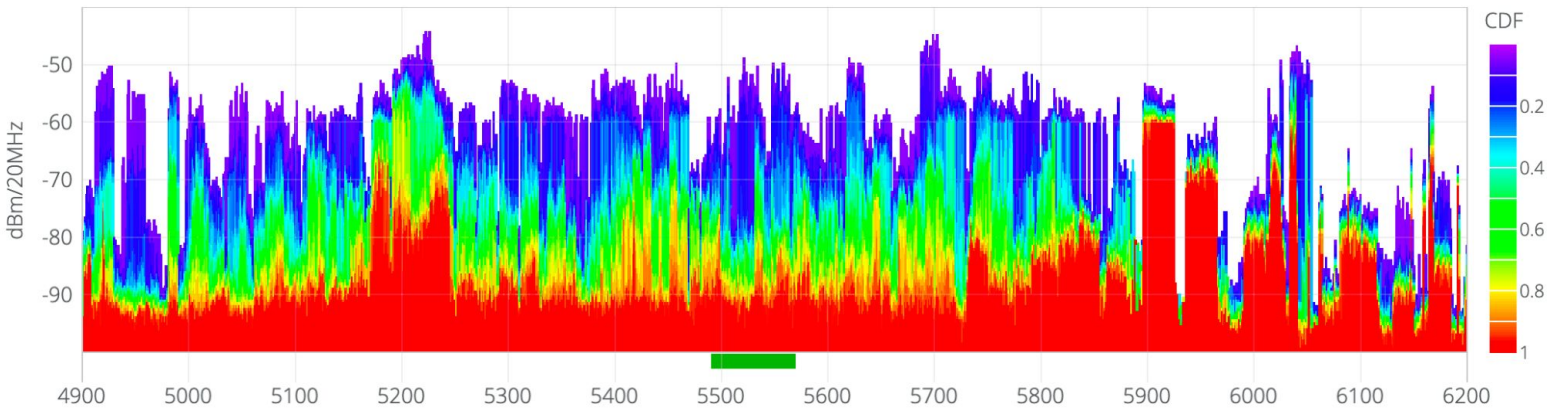


Interface pppoe-cca_2b81@veve.my(): Link down	1h 3
Interface pppoe-cca2_e152@veve.my(): Link down	1h 7
Interface pppoe-uca22c07_rose@wit.net.my(): Link down	1h 1
Interface pppoe-uca22116_junaidi@wit.net.my(): Link down	1h 2
Interface pppoe-uuc3_2v07g@veve.my(): Link down	1h 2
Interface pppoe-cca_1a3a3@veve.my(): Link down	1h 2

Profile (Running)

CPU: all

Name	CPU	Usage
cpu68	100.0	
cpu50	100.0	
cpu58	100.0	
cpu68	99.0	
cpu52	98.0	
cpu28	96.5	
incoming	50	95.5
uing	68	94.0
uing	8	93.5
5		92.0
uing	28	92.0
10		90.0
50		89.5
uing	52	89.5
1		89.0
uing	58	89.0
uing	5	85.0
uing	1	81.5
uing	60	79.5
uing	10	77.5
wall	58	7.5
working	10	7.5
wall	60	5.5
1		5.0



# Operation: billing

- Money collection
- Invoice
- Balance inquiry
- Integration with payment gateway

BILLING APP Welcome, Achmad Mardiansyah

HOME  
MANAGER  
CUSTOMERS  
PACKAGE  
SECURITY  
REPORT / LOG  
BILLING  
Billing Summary  
Billing List  
Manual Billing  
PAYMENT  
MASTER DATA  
LOGOUT

Billing Summary X

Statement	Account Number	Project	User Activated At	Total Service	Total Service Price (MYR)	Last Billing Gen Date (MYR)	Billing Next Gen Date	Lastest Billing (MYR)	Lastest Payment (MYR)	Lastest Rebate (MYR)
			04 Nov 2017	1	20.65	24 Oct 2020	31 Oct 2020	260.65	0.00	0.00
			10 Dec 2015	1	98.00	24 Sep 2020	24 Oct 2020	223.00	0.00	0.00
			27 Feb 2019	1	98.00	24 Sep 2020	24 Oct 2020	285.50	0.00	0.00
			25 Oct 2019	1	98.00	24 Sep 2020	24 Oct 2020	98.00	0.00	0.00
			19 Jul 2019	1	148.00	24 Sep 2020	24 Oct 2020	148.00	0.00	0.00
			18 Jul 2018	1	0.00	24 Sep 2020	24 Oct 2020	0.00	0.00	0.00
			17 Oct 2018	1	0.00	24 Sep 2020	24 Oct 2020	0.00	0.00	0.00
			09 Oct 2019	1	80.00	24 Sep 2020	24 Oct 2020	160.00	0.00	0.00

Billing Summary X Customer Statement X

Date	Transaction Type	Description	Amount	Balance
24 Apr 2020	Billing	24 Apr 2020 - 23 May 2020	80.00	240.00
30 Apr 2020	Payment		240.00	0.00
24 May 2020	Billing	24 May 2020 - 23 Jun 2020	80.00	80.00
24 Jun 2020	Billing	24 Jun 2020 - 23 Jul 2020	80.00	160.00
24 Jul 2020	Billing	24 Jul 2020 - 23 Aug 2020	80.00	240.00
03 Aug 2020	Payment		160.00	80.00
24 Aug 2020	Billing	24 Aug 2020 - 23 Sep 2020	80.00	160.00
24 Sep	Billing	24 Sep 2020 - 23 Oct	80.00	240.00



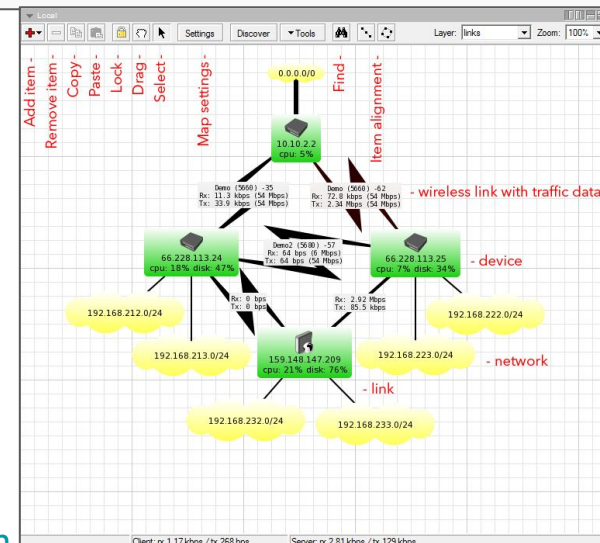
# Operation: planning

- Hardware
- Physical topology
- Logical topology
  - Subnet
  - Routing
  - NAT

No ms excel please, use proper tool

The screenshot shows the IPAM-GLCNETWORKS web interface. The top navigation bar includes the logo, search bar, and user information (Hi, IPAM admin). The main content area displays a table of available subnets under the 'Business customers' folder.

Subnet	Description	VLAN	Master Subnet	Device	Customer
My folder	My folder	Default	/	/	/
10.65.22.0/24	DHCP range	Default	My folder	/	/
10.10.0.0/16	Business customers	Default	/	/	/
10.10.1.0/24	Customer 1	Default	10.10.0.0/16	/	/
10.10.2.0/24	Customer 2	Default	10.10.0.0/16	/	/
10.67.0.0/16	>/	Default	/	/	/




# ISP troubleshooting

# Troubleshooting

- Sometimes problem is not originate from our ISP
  - Google is down. YES, youtube had a downtime
  - Connection to blah is down
  - Customer itself
- Skills needed:
  - Technical skill
  - Soft Skill: calm down angry customers
- Tools:
  - Ping
  - Traceroute
  - Protocol analyzer (K15, wireshark)
  - Remote desktop
  - notification





 **HURRICANE ELECTRIC**  
INTERNET SERVICES

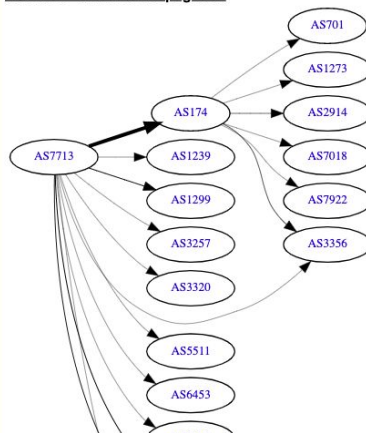
AS7713 PT Telekomunikasi Indonesia

**Quick Links**

- [BGP Toolkit Home](#)
- [BGP Prefix Report](#)
- [BGP Peer Report](#)
- [Exchange Report](#)
- [Bogon Routes](#)
- [World Report](#)
- [Multi Origin Routes](#)
- [DNS Report](#)
- [Top Host Report](#)
- [Internet Statistics](#)
- [Looking Glass](#)
- [Network Tools App](#)
- [Free IPv6 Tunnel](#)
- [IPv6 Certification](#)
- [IPv6 Progress](#)
- [Going Native](#)
- [Contact Us](#)

**AS7713 IPv4 Route Propagation**



```
graph LR; AS7713((AS7713)) --> AS174((AS174)); AS7713 --> AS1239((AS1239)); AS7713 --> AS1299((AS1299)); AS7713 --> AS3257((AS3257)); AS7713 --> AS3320((AS3320)); AS7713 --> AS5511((AS5511)); AS7713 --> AS6453((AS6453)); AS7713 --> AS6461((AS6461)); AS174 --> AS701((AS701)); AS174 --> AS1273((AS1273)); AS174 --> AS2914((AS2914)); AS174 --> AS7018((AS7018)); AS174 --> AS7922((AS7922)); AS174 --> AS3356((AS3356));
```

# Tips and trick

# Tips to choose mikrotik product

- Know what you want to do
- Allocate your budget
- Use feature selection on mikrotik website
- Mikrotik “**Can do**” ....
  - **doesn't mean** “must do”
  - **doesn't mean** appropriate
  - How can you use cheapest router for high traffic site?
- For outdoor wireless:
  - Understand RF
  - Use wireless product selection guide
  - Use wireless link calculator application
  -

# Mikrotik wireless products

## Wireless categories:

- Indoor
- Outdoor
  - Unit only (you buy antenna separately)
  - Built-in antenna

The screenshot shows the Mikrotik website's 'Products' page for wireless systems. The URL is [mikrotik.com/products/group/wireless-systems](http://mikrotik.com/products/group/wireless-systems). The page features a search bar, a list of product categories (All products, Ethernet routers, Switches, Wireless systems, Wireless for home and office, LTE products, Data over Powerlines), and two featured products: LDF 5 (Dual chain 5GHz system for long distance links with satellite offset dish antennas) and SXTsq Lite2 (Low-cost small-size 10dBi 2.4GHz dual chain integrated CPE/Backbone).

The screenshot shows the Mikrotik website's 'Products' page for a matrix view. The URL is [mikrotik.com/products/matrix](http://mikrotik.com/products/matrix). The table lists various product models with their specifications.

Product name	Product code	Architecture	CPU	CPU core count	CPU nominal frequency	Dimensions	License level	Operating System	Size of RAM	Storage size	PoE in	PoE out
911 Lite5 ac	RB911-5HacD	MIPSBE	QCA9531	1	650 MHz	113 x 89 mm	3	RouterOS	64 MB	16 MB	Passive PoE	No
911 Lite5 dual	RB911-5HnD	MIPSBE	AR9344	1	600 MHz	105x105mm	3	RouterOS	64 MB	16 MB	Passive PoE	No
BaseBox 2	RB912UAG-2HPnD-OUT	MIPSBE	AR9342	1	600 MHz		4	RouterOS	64 MB	64 MB	Passive PoE	No
BaseBox 5	RB912UAG-5HPnD-OUT	MIPSBE	AR9342	1	600 MHz	246x135x50mm	4	RouterOS	64 MB	128 MB	Passive PoE	No
BaseBox 6	RB912UAG-6HPnD-OUT	MIPSBE	AR9342	1	600 MHz	246 x 135 x 50 mm	4	RouterOS	64 MB	128 MB	Passive PoE	No
cAP	RBcAP2nD	MIPSBE	QCA9533	1	650 MHz	185mm diameter,	4	RouterOS	64 MR	16 MR	802.3af/at	No

# Wireless product guide

The screenshot shows the Mikrotik website's PtP calculator tool. The browser address bar displays [mikrotik.com/products/ptp](http://mikrotik.com/products/ptp). The navigation menu includes Home, About, Buy, Jobs, Hardware (selected), Software, Support, Training, and Account. The main heading is "Products".

On the left, there is a search bar and a "Product categories" list:

- All products
- Ethernet routers
- Switches
- Wireless systems
- Wireless for home and office
- LTE products
- Data over Powerlines
- IoT products
- 60 GHz products
- RouterBOARD
- Enclosures
- Interfaces
- Accessories

The main content area is titled "Selection guide for PtP links". It features a "Select frequency" dropdown menu set to "5 GHz". Below this is the "PTP calculator" which displays a horizontal bar chart comparing five product models. Each model is accompanied by a small product image on either side of the bar.

Product Model	Relative Performance (Estimated)
Cube 60G ac	Very Low
DISC Lite5	Low
DISC Lite5 ac	Low
DynaDish 5	High
LDF 5	Very Low

# Wireless link calculator

← → ↻ mikrotik.com/calculator

### Specifications and results

<b>Frequency</b> 5 GHz	<b>Desired data rate: 45 Mbps</b> <input type="range"/>
<b>Point A device</b> SXTsq 5 ac	<b>Point B device</b> mANTBox 19s
<b>Antenna Gain (dBi)</b> 16	<b>Antenna Gain (dBi)</b> 19
<b>RX Sensitivity (dBm)</b> -96	<b>RX Sensitivity (dBm)</b> -96
<b>Output Power (dBm)</b> 25	<b>Output Power (dBm)</b> 30

**Point A, Point B**  
Distance: 1.1 Km (0.68 miles)  
Free Space Path Loss: 107.925 dB  
Theoretical signal level at Point A: -51  
Theoretical signal level at Point B: -46  
Link status: **Reliable**

670

0.0 0.2 0.4 0.6 0.8 1.0

Surabaya 40831

Leaflet



# A new (internship) opportunity

- Job desc: network engineer level 1 (basic skill is OK)
- Location: **overseas**
- Duration: 1-3 months
- Benefits: visa, transport, accomodation, pocket money
- Requirements
  - Have/will have a passport
  - Basic english
  - Able to do physical work
  - Able to operate mikrotik
  -



LIVE practice



# Q & A

# Interested? Just come to our training...

- Topics are arranged in systematic and logical way
- You will learn from **experienced teacher**
- Not only learn the materials, but also sharing experiences, best-practices, and networking



# End of slides

- Thank you for your attention
- Please submit your feedback: <http://bit.ly/glcfeedback>
- Find our further event on our website : <https://www.glcnetworks.com/en/>
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- Slide: <https://www.slideshare.net/glcnetworks/>
- Discord (bahasa indonesia): (<https://discord.gg/6MZ3KUHHBX>)
- Recording (youtube): <https://www.youtube.com/c/GLCNetworks>
- Stay tune with our schedule
- Any questions?

