

# Build enterprise wireless with **CAPsMAN**

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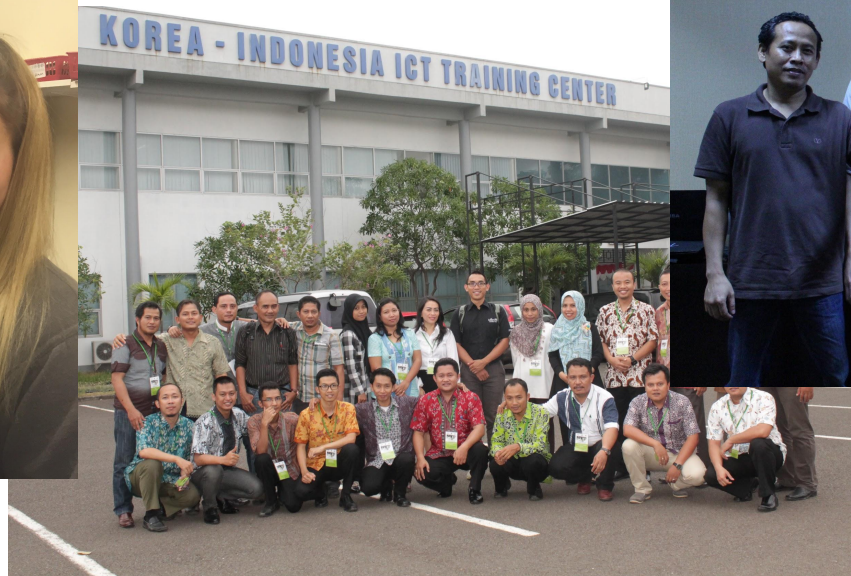
[www.glcnetworks.com](http://www.glcnetworks.com)

# Agenda

- Introduction
- Enterprise wireless
- How CAPsMAN works
- CAPsMAN features
- CAPsMAN tips
- Suggestion for Mikrotik
- Q & A

# 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 foundation
- Product: GLC radius manager
- Regular event: webinar (every 2 weeks, see our schedule on website)



# About me



- Name: Achmad Mardiansyah
- Base: bandung, Indonesia
- Linux user since 1999, mikrotik user since 2007,
- Mikrotik Certified Trainer  
(MTCNA/RE/WE/UME/INE/TCE/IPv6)
- Mikrotik Certified Consultant
- Teacher at Telkom University (Bandung, Indonesia)
- 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 experiences



- 2018, **Malaysia**: integrated monitoring system and bandwidth management for a broadband ISP
- 2017, **Libya (north africa)**: remote wireless migration for a new Wireless ISP
- 2016, **United Kingdom**: facilitates workshop for a wireless ISP, migrating a bridged to routed network
- 2015, **West Borneo**: supporting wireless infrastructure project
- 2014, **Senegal (west africa)**: TAC2 engineer for HLR migration from NOKIA to ERICSSON
- 2013, **Malaysia**: build a wireless network to support an international event



# About Telkom University



- Located in Bandung, Indonesia
- 7 Faculties, 27 schools
- Areas: Engineering, Communications, Computing, Bussiness and management, Arts
- 650+ Academic staff, 400+ Administration staff, 20000+ students
- An exchange program
- Runs mikrotik academy program



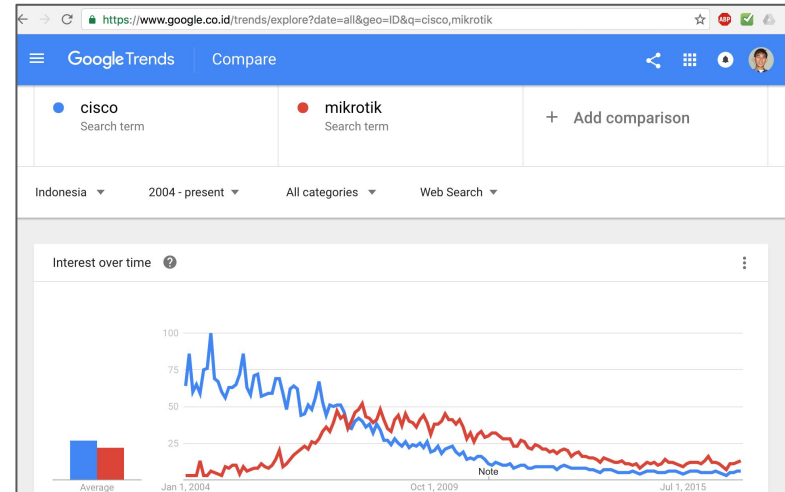
# Mikrotik academy @ TEL-U

- Started in 2013
- Embedded into schools curriculum
- 100% hands-on
- Get MTCNA certification



# Mikrotik in Indonesia

- Very popular product for networking
- Early adopters (beginning of 2000)
- Many schools already join Mikrotik Academy program
- Lots of training classes
- Biggest MUM in the world (3000+ participants, 2-day event)
- Very active community (facebook, telegram, forum, etc)
- What..? you don't know Mikrotik? Where have you been?





# Enterprise wireless

# Characteristics of enterprise wireless

- Usually indoor, on access network (directly connected to end-user)
- PTMP (point to multi point)
- **Centralised** FCAPS (Fault, Configuration, Authentication, Performance, Security)
- **Enterprise features:** load balancing, better mobility (seamless roaming), security, high availability, authentication, band steering, security
- Example: office, campus, hotel

# How CAPsMAN works



# About CAPsMAN

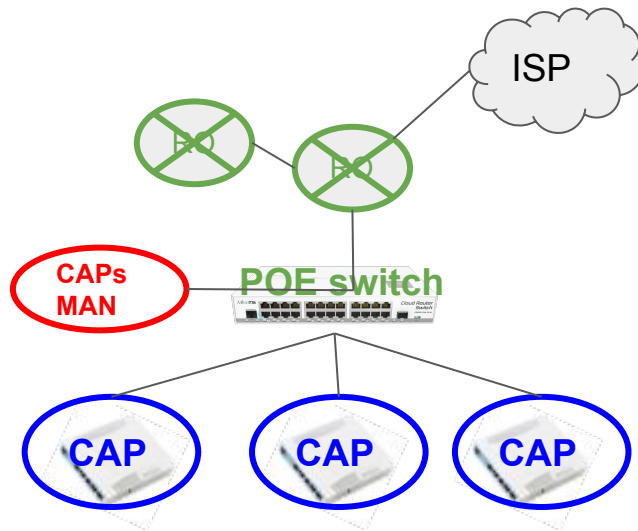
- Offers enterprise features: centralised platform to manage AP
- Software based, free to use
- Available since 6.11, CAPsMAN v1 (march 2014)
- Now its CAPsMAN v2 (since 6.22, nov 2014). Recommended version, not compatible to v1
- CAP: controlled AP
- CAPsMAN: CAP manager (AP controller)



# CAPsMAN - CAP connectivity

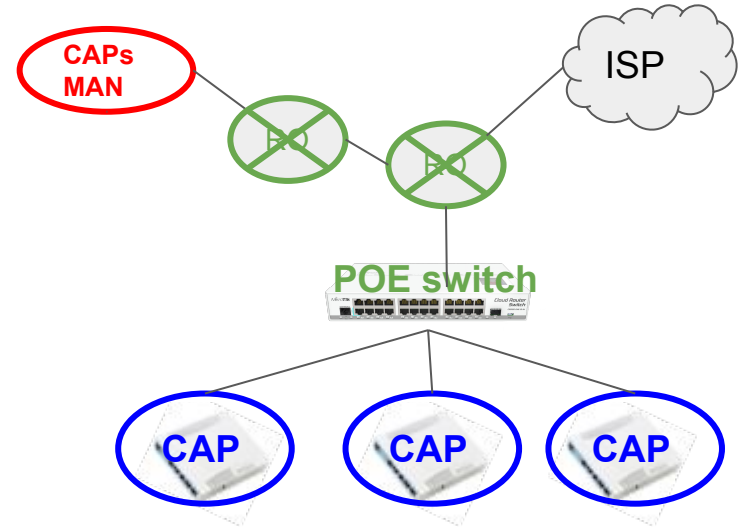
## Layer 2

- CAP and CAPsMAN are in the same network

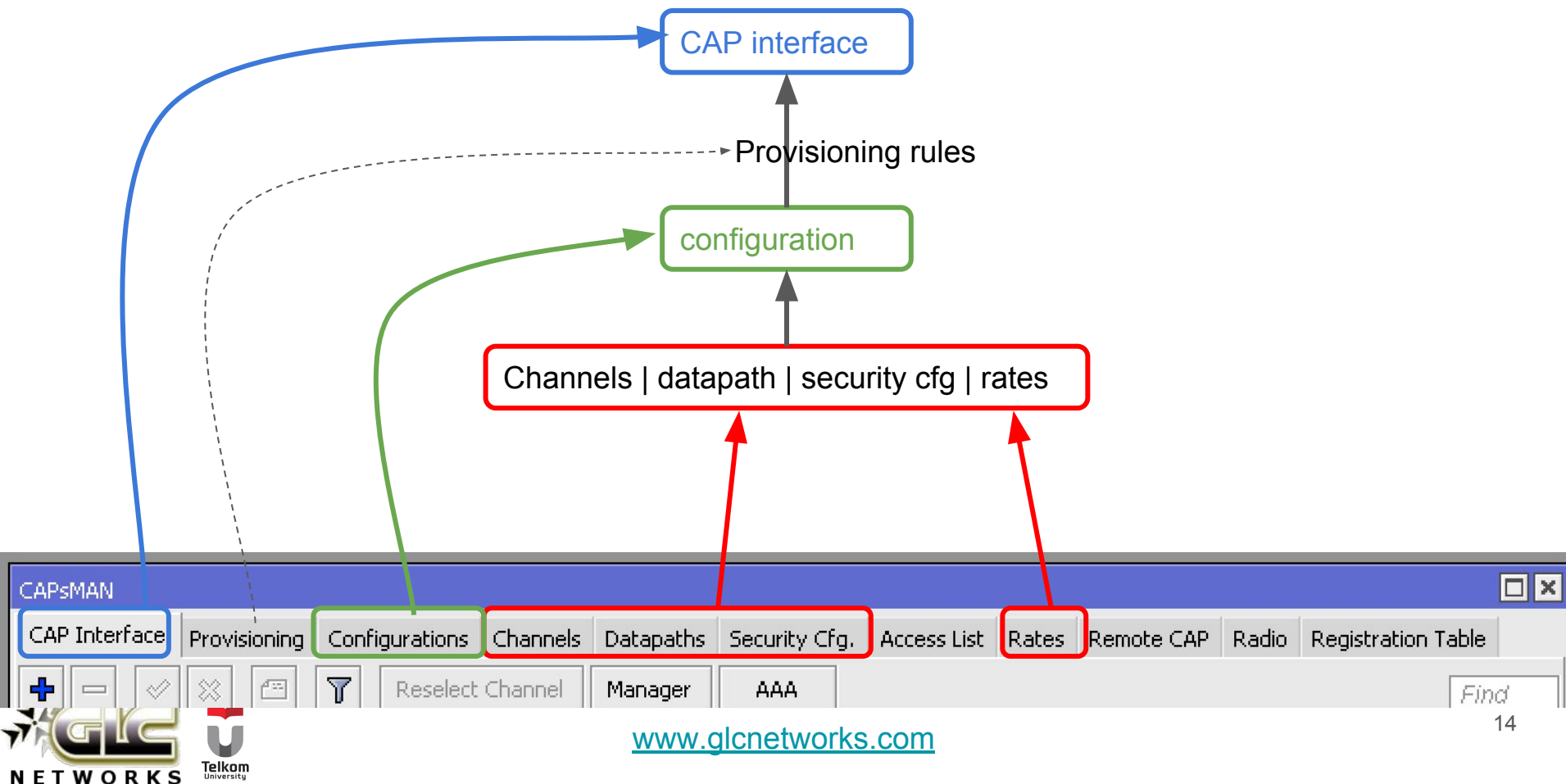


## Layer 3 (recomm.)

- CAP and CAPsMAN are in different network



# CAPsMAN configuration concepts



# Channels | datapath | security cfg | rates

| CAP Interface                                                                                                                                                                                                                                                                                                                                  | Provisioning | Configurations | Channels    | Datapaths       | Security Cfg |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------|-------------|-----------------|--------------|
| <div></div> |              |                |             |                 |              |
| Name                                                                                                                                                                                                                                                                                                                                           | Frequency    | Control C...   | Band        | Extension Ch... | Tx Power     |
| f-2412                                                                                                                                                                                                                                                                                                                                         | 2412         | 20Mhz          | 2ghz-g/n    | disabled        | 17           |
| f-2437                                                                                                                                                                                                                                                                                                                                         | 2437         | 20Mhz          | 2ghz-g/n    | disabled        | 17           |
| f-2462                                                                                                                                                                                                                                                                                                                                         | 2462         | 20Mhz          | 2ghz-g/n    | disabled        | 17           |
| f-5745                                                                                                                                                                                                                                                                                                                                         | 5745         | 20Mhz          | 5ghz-a/n/ac | disabled        | 17           |

| CAP Interface                                                                                                                                                                                                                                                                                                                                  | Provisioning | Configurations | Channels      | Datapaths       | Security Cfg.   | Access L |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------|---------------|-----------------|-----------------|----------|
| <div></div> |              |                |               |                 |                 |          |
| Name                                                                                                                                                                                                                                                                                                                                           | Bridge       | Open...        | Local Forw... | Client To Cl... | VLAN Mode       | VLAN ID  |
| dp-lf                                                                                                                                                                                                                                                                                                                                          |              |                | yes           | no              |                 |          |
| ;;; vlan 22                                                                                                                                                                                                                                                                                                                                    |              |                |               |                 |                 |          |
| dp-lf-vlan22                                                                                                                                                                                                                                                                                                                                   |              |                | yes           | no              | use service tag | 22       |

| CAP Interface                                                                                                                                                                                                                                                                                                                                  | Provisioning        | Configurations | Channels     | Datapaths    | Security Cfg. | Access List | Rate |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------|--------------|--------------|---------------|-------------|------|
| <div></div> |                     |                |              |              |               |             |      |
| Name                                                                                                                                                                                                                                                                                                                                           | Authentication T... | Encryption     | Group Enc... | Group Key... | Passphrase    |             |      |
| wpa-psk-ddsatuvisi                                                                                                                                                                                                                                                                                                                             | WPA PSK WPA2 ...    | aes ccm        | aes ccm      |              | *****         |             |      |
| wpa-psk-old                                                                                                                                                                                                                                                                                                                                    | WPA PSK WPA2 ...    | aes ccm        | aes ccm      |              | *****         |             |      |

| CAP Interface                                                                                                                                                                                                                                                                                                                                          | Provisioning | Configurations       | Channels     | Datapaths                | Security Cfg. | Access List        | Rates | Remote CAP | Radio | Registration |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------|--------------|--------------------------|---------------|--------------------|-------|------------|-------|--------------|
| <div></div> |              |                      |              |                          |               |                    |       |            |       |              |
| Name                                                                                                                                                                                                                                                                                                                                                   | Basic Rates  | Supported Rates      | HT Basic MCS | HT Supported MCS         | VHT Basic MCS | VHT Supported MCS  |       |            |       |              |
| rate-default                                                                                                                                                                                                                                                                                                                                           |              | 9Mbps 12Mbps 18Mb... |              | 3 4 5 6 7 11 12 13 14... | none          | MCS 0-9, MCS 0-... |       |            |       |              |

# configuration

New CAPs Configuration

Wireless Channel Rates Datapath Security

Name: master-AP1

Mode: ap

SSID: OneVision

Hide SSID:

Load Balancing Group: floor1-OneVision-2ghz

Distance: indoors km

Hw. Retries: 4

Hw. Protection Mode:

Frame Lifetime:

Disconnect Timeout:

Keepalive Frames:

Country: indonesia

Max Station Count:

Multicast Helper: disabled

HT Tx Chains: ☒ 0 ☒ 1 ☒ 2

HT Rx Chains: ☒ 0 ☒ 1 ☒ 2

HT Guard Interval: any

Wireless Channel Rates Datapath Security

Rate: rate-default

Basic Rates

Supported Rates

HT Basic MCS

HT Supported MCS

VHT Basic MCS

VHT Supported MCS

Wireless Channel Rates Datapath Security

Channel: f-2412

Frequency:

Control Channel Width:

Band:

Extension Channel:

Tx Power:

Save Selected:

Reselect Interval:

Skip DFS Channels:

Wireless Channel Rates Datapath Security

Security: wpa-psk-old

Authentication Type:

Encryption:

Group Encryption:

Group Key Update:

Passphrase:

EAP Methods:

EAP Radius Accounting:

TLS Mode:

TLS Certificate:

Wireless Channel Rates Datapath Security

Datapath: dp-lf

MTU:

L2 MTU:

ARP:

Bridge:

Bridge Cost:

Bridge Horizon:

OpenFlow Switch:

Local Forwarding:

Client To Client Forwarding:

VLAN Mode:

VLAN ID:

Interface List:



# Provisioning rule

CAPsMAN

CAP Interface | **Provisioning** | Configurations | Channels | Datapaths | Security Cfg. | Access List | Rates | Remote CAP | Radio | Registration Table

+ - ✓ ✗ 📁 🔍 Find

CAPs Provisioning <00:00:00:00:00:00>

Radio MAC: 00:00:00:00:00:00

Hw. Supported Modes: g  
gn

Identity Regexp: GP-AP-1.3

Common Name Regexp:

IP Address Ranges: 10.10.24.2-10.10.31.254

Action: create enabled

Master Configuration: master1-2ghz

Slave Configuration: DDF  
DDF\_FASTER

Name Format: identity

Name Prefix:

enabled

OK  
Cancel  
Apply  
Disable  
Comment  
Copy  
Remove

New CAPs Provisioning

Radio MAC: 00:00:00:00:00:00

Hw. Supported Modes: ac

Identity Regexp: GP-AP-1.3

Common Name Regexp:

IP Address Ranges: 10.10.24.2-10.10.31.254

Action: create enabled

Master Configuration: master1-5ghz

Slave Configuration: DDF  
DDF\_FASTER

Name Format: identity

Name Prefix:

enabled

OK  
Cancel  
Apply  
Disable  
Comment  
Copy  
Remove

# Master vs slave configuration

## Master

- Will be used to set basic wireless parameters: Frequency, channel-width, TX power

## Slave

- Basic wireless parameter will be ignored
- Is used to setup additional SSID (Virtual AP)

# CAP interface

The screenshot displays the CAP interface configuration in a network management system. The left pane shows a list of interfaces, with 'GP-AP-1.1-1' highlighted as the 'master interface'. Other interfaces are grouped as 'Slave interface'.

The right pane shows the configuration for 'GP-AP-1.1-1'.

**Interface <GP-AP-1.1-1>**

General | Wireless | Channel | Rates | Datapath | Security | Status | Traffic

Last Link Down Time: May/17/2018 20:21:02

Last Link Up Time: May/17/2018 16:00:51

Link Downs: 5

Current State: running-ap

Current Channel: 2412/20(gn(17dBm))

Current Rate Set: OFDM:9-54 BW:1x SGI:1x HT:3-7,11-15

Current Basic Rate Set:

Current Registered Clients: 0

Current Authorized Clients: 0

# Access list

- Is used to control wifi access
- Format:
  - Client matching
  - Action:
    - accept | reject | query radius
  - Connection parameter

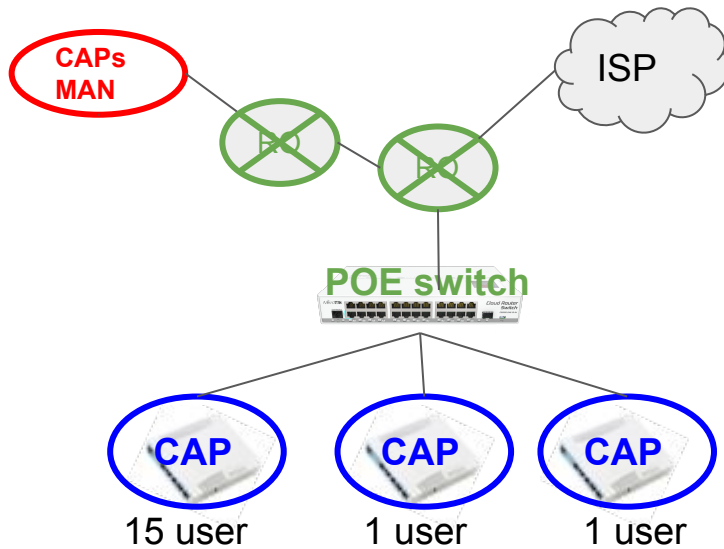
The screenshot shows the 'CAPs Access Rule' configuration window. Red annotations highlight specific fields: a red box encloses the 'MAC Address', 'MAC Mask', 'Interface', 'SSID Regexp', 'Signal Range', and 'Allow Signal Out Of Range' fields; a red arrow points from the 'Client matching' bullet point to the 'MAC Address' field; another red arrow points from the 'Action:' bullet point to the 'Action' dropdown menu, which is currently set to 'accept'; and a third red arrow points from the 'Connection parameter' bullet point to the 'Client To Client Forwarding' field. Other fields visible include 'AP Tx Limit', 'Client Tx Limit', 'Private Passphrase', 'RADIUS Accounting', 'VLAN Mode', and 'VLAN ID'. The 'enabled' checkbox at the bottom is checked.

# CAPsMAN features

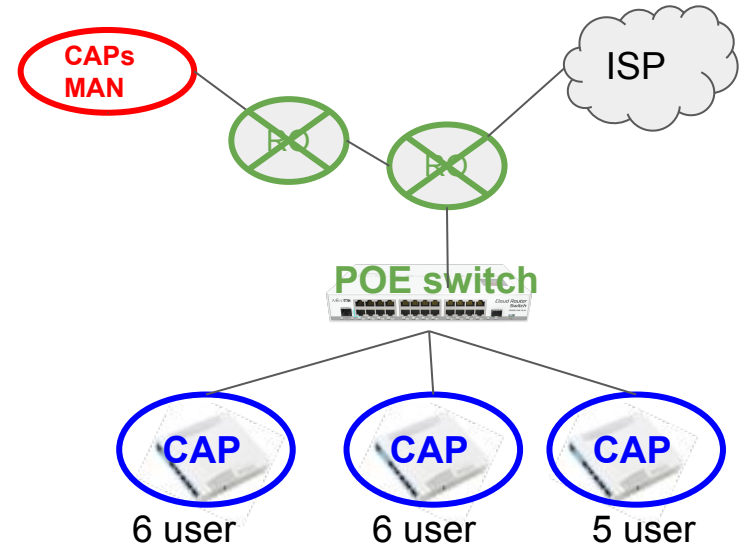


# Load balancing AP

before



after



Configuration interface for a network device:

Name:

Mode:

SSID:

Hide SSID:

Load Balancing Group:

# Roaming

- Unlike GSM, connection to AP is end-user decision, not AP.
- Often, station is **still attached to old AP** even though already moved to new AP
- What AP can set up a threshold for disassociation (based on signal level)
- On CAPsMAN, we use **access rule**

CAPs Access Rule <>

MAC Address:  ▼

MAC Mask:  ▼

Interface: all ▼ ▲

SSID Regexp:

Signal Range: -80..-10 ▲

Allow Signal Out Of Range: 00:00:10 ▼

Time: ▼

Action: accept ▼ ▲

CAPs Access Rule <>

MAC Address:  ▼

MAC Mask:  ▼

Interface: all ▼ ▲

SSID Regexp:

Signal Range: -120..-81 ▲

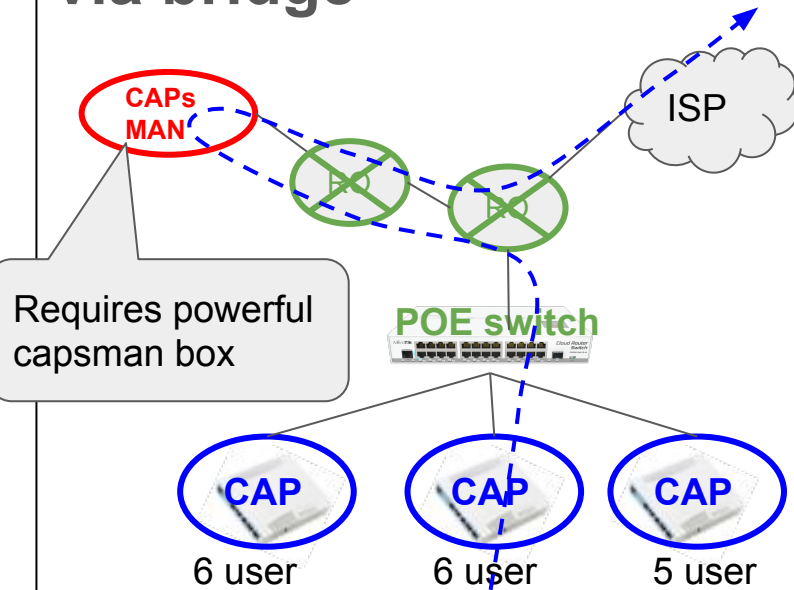
Allow Signal Out Of Range: 00:00:10 ▼

Time: ▼

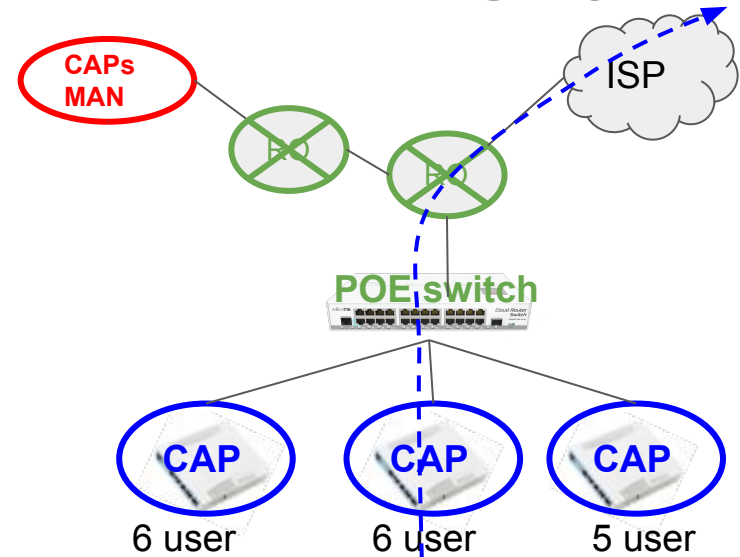
Action: reject ▼ ▲

# Datapath (local forwarding)

## via bridge



## Local forwarding = yes



Bridge:  ▼ Copy

Bridge Cost:  ▼ Remove

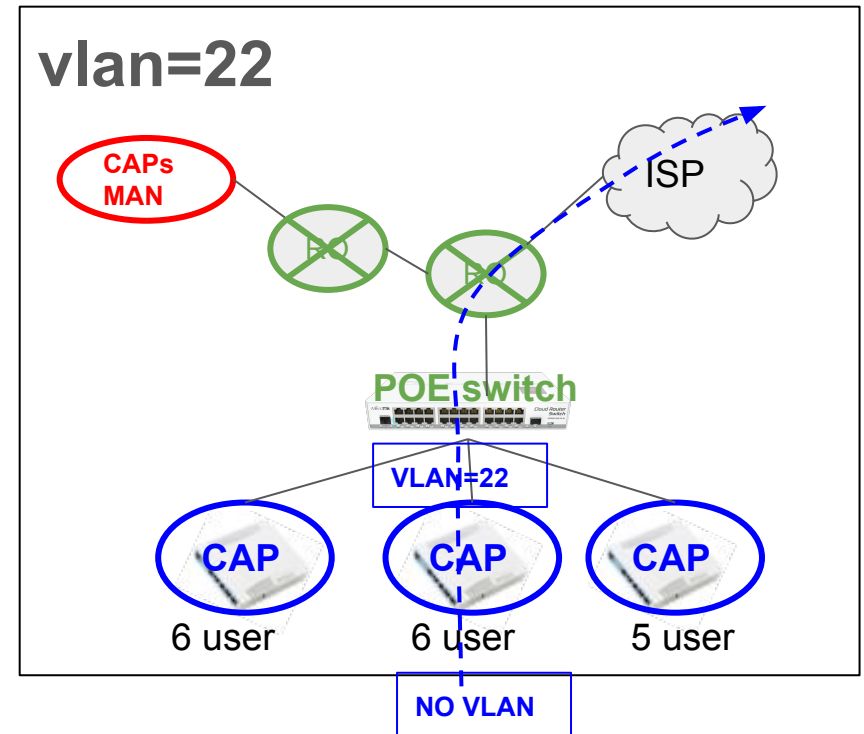
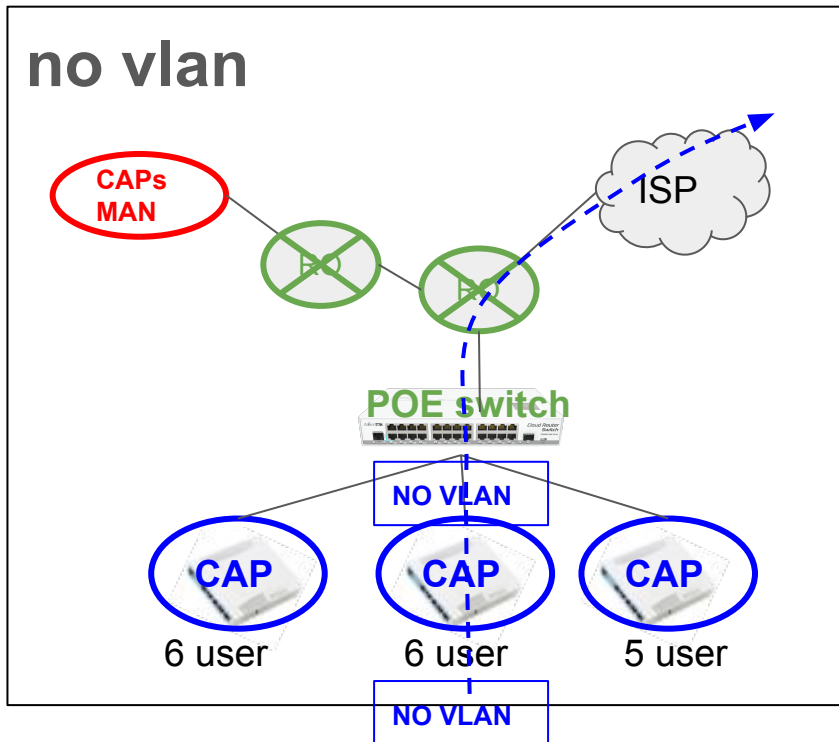
Bridge Horizon:  ▼

OpenFlow Switch:  ▼

Local Forwarding: ☒ ▼

Client To Client Forwarding: ☐ ▲

# Datapath (vlan)

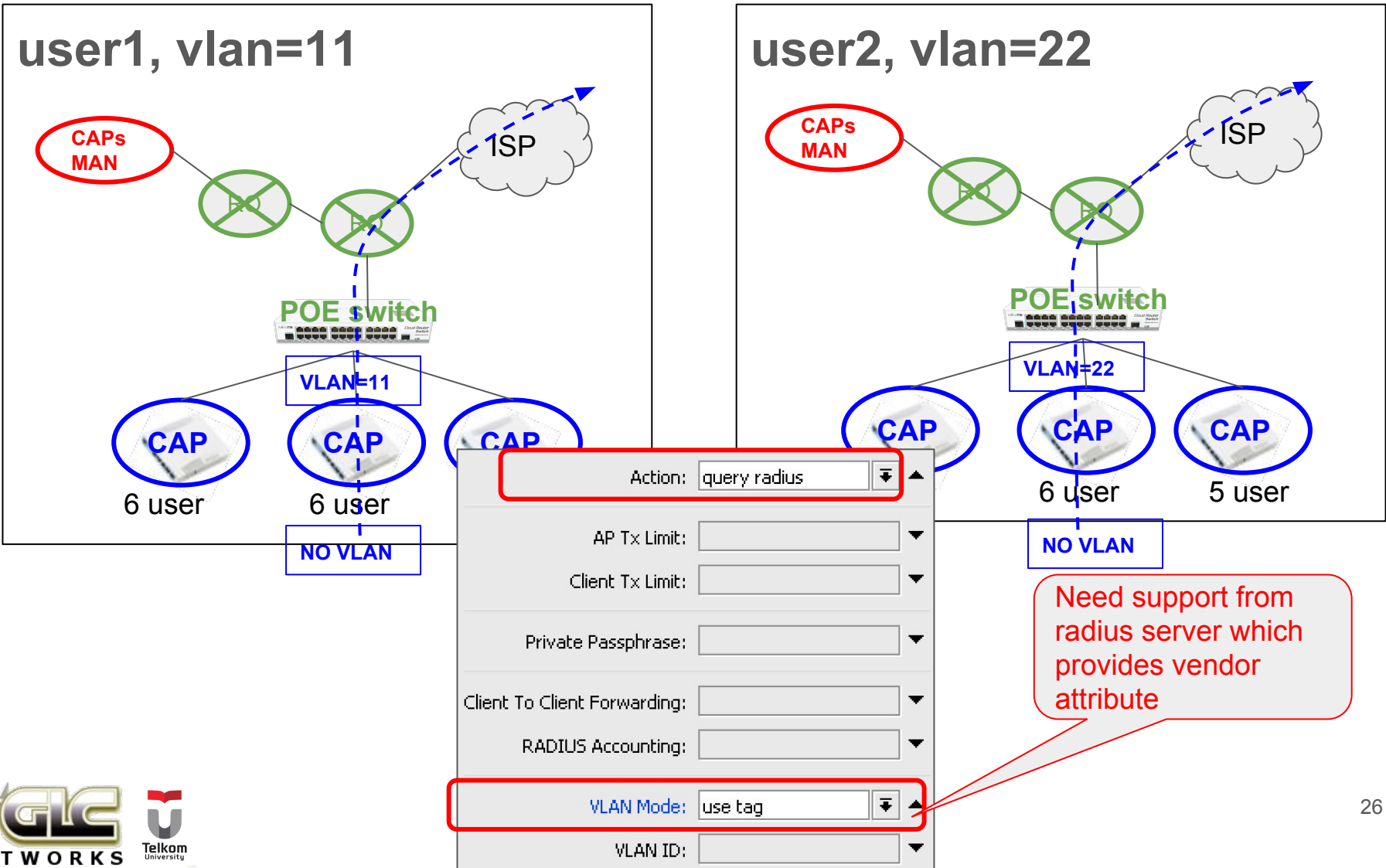


VLAN Mode: use tag

VLAN ID: 22

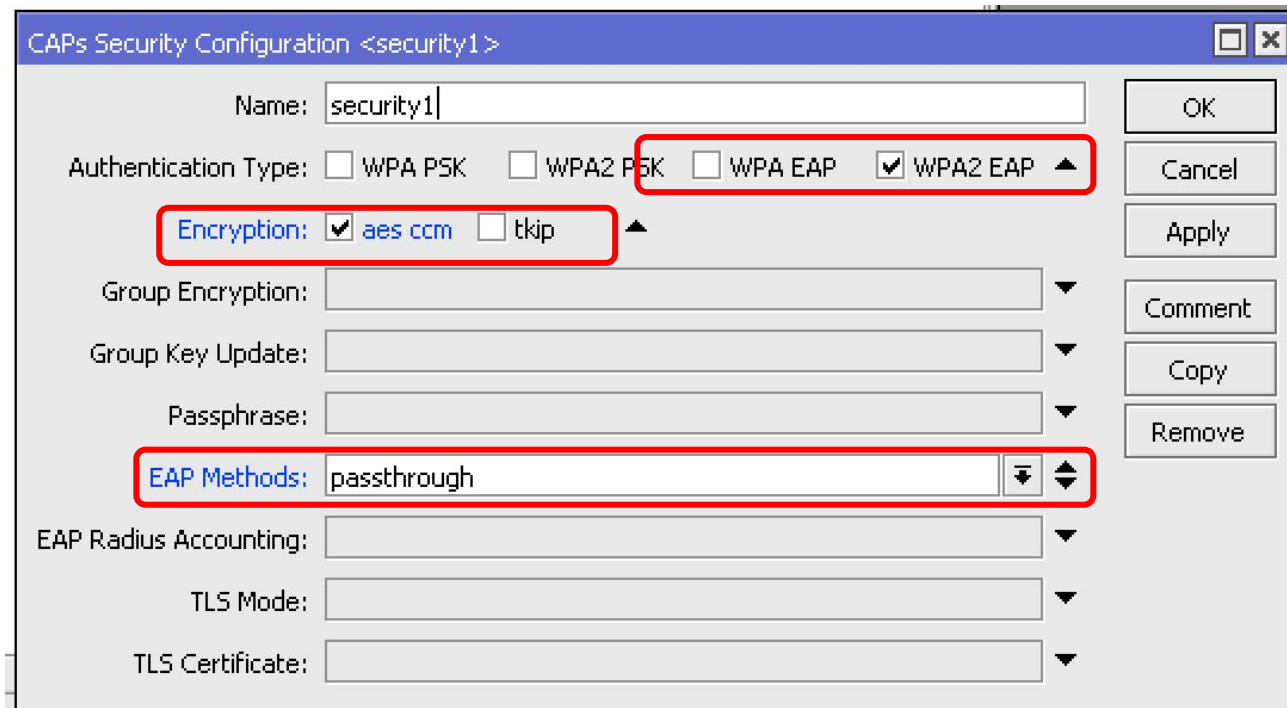
Interface List:

## Datapath (vlan per user)



# Security: EAP (layer 2 authentication)

- Username and password will be asked on layer2
- Need support from radius server



The screenshot shows a 'CAPs Security Configuration <security1>' dialog box. The 'Name' field is set to 'security1'. Under 'Authentication Type', 'WPA2 EAP' is selected with a checkmark. The 'Encryption' section shows 'aes ccm' selected with a checkmark. The 'EAP Methods' dropdown menu is set to 'passthrough'. Other fields like 'Group Encryption', 'Group Key Update', 'Passphrase', 'EAP Radius Accounting', 'TLS Mode', and 'TLS Certificate' are empty. On the right side, there are buttons for 'OK', 'Cancel', 'Apply', 'Comment', 'Copy', and 'Remove'.

CAPs Security Configuration <security1>

Name: security1

Authentication Type: ☐ WPA PSK ☐ WPA2 PSK ☐ WPA EAP ☒ WPA2 EAP ▲

Encryption: ☒ aes ccm ☐ tkip ▲

Group Encryption: ▼

Group Key Update: ▼

Passphrase: ▼

EAP Methods: passthrough ▼▲

EAP Radius Accounting: ▼

TLS Mode: ▼

TLS Certificate: ▼

OK  
Cancel  
Apply  
Comment  
Copy  
Remove



# MAC based authentication

- It is possible to allow client to connect based on MAC address
- We need support from radius server which contains MAC address database
- Combined with access-list

CAPs Access Rule <>

MAC Address:

MAC Mask:

Interface:

SSID Regexp:

Signal Range:

Allow Signal Out Of Range:

Time

Action:

AP Tx Limit:

Client Tx Limit:

Private Passphrase:

Client To Client Forwarding:

RADIUS Accounting:

VLAN Mode:

VLAN ID:

enabled

# CAPsMAN tips

# CAP: use auto certificate

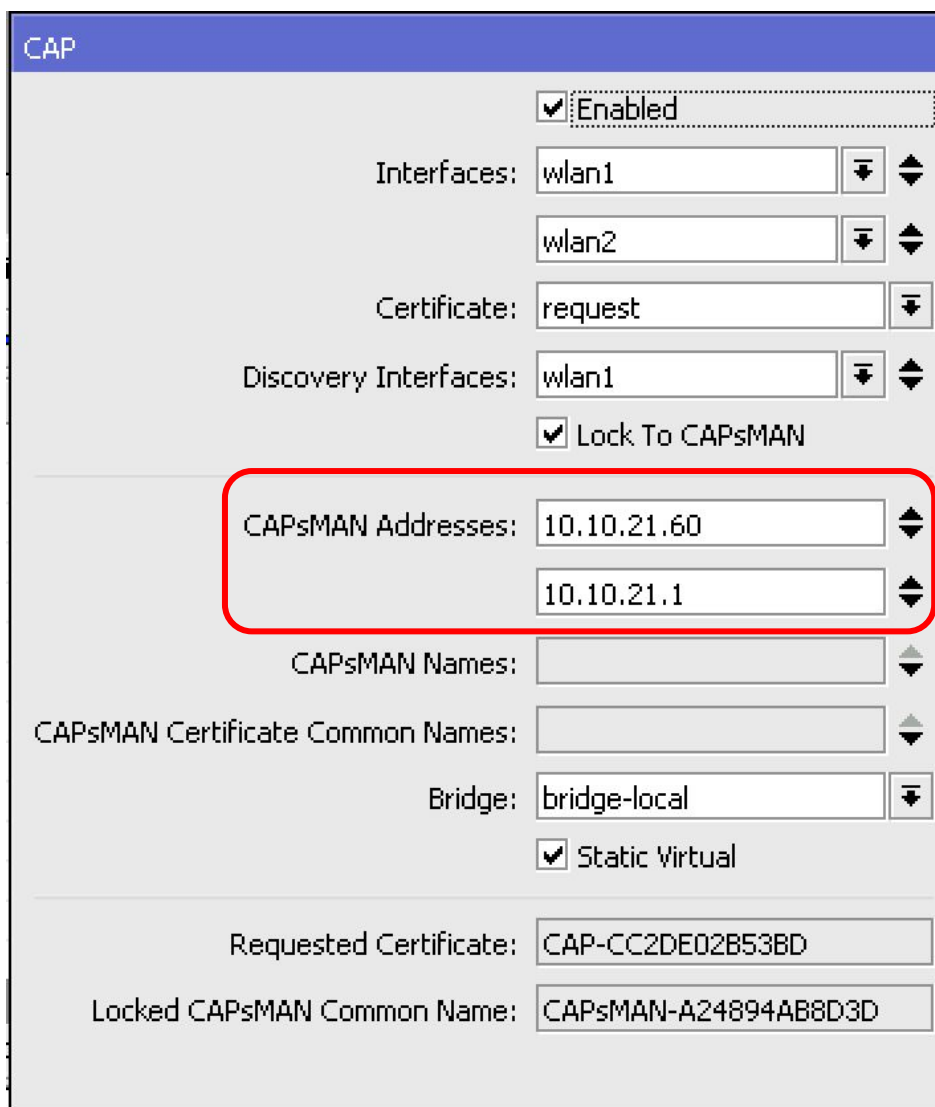
- Use certificate for **stable** CAP - CAPsMAN connection
- Use “Lock to CAPsMAN” to bind CAP to a particular CAPsMAN

The screenshot displays the CAP configuration window. The 'Enabled' checkbox is checked. Under 'Interfaces', 'wlan1' and 'wlan2' are listed. The 'Certificate' dropdown is set to 'request' and is highlighted with a red box. Under 'Discovery Interfaces', 'wlan1' is listed, and the 'Lock To CAPsMAN' checkbox is checked, also highlighted with a red box. The 'CAPsMAN Addresses' field contains '10.10.21.60' and '10.10.21.1'. The 'CAPsMAN Names' and 'CAPsMAN Certificate Common Names' fields are empty. The 'Bridge' is set to 'bridge-local' and 'Static Virtual' is checked. The 'Requested Certificate' is 'CAP-CC2DE02B53BD' and the 'Locked CAPsMAN Common Name' is 'CAPsMAN-A24894AB8D3D'.

| Field                            | Value                               |
|----------------------------------|-------------------------------------|
| Enabled                          | <input checked="" type="checkbox"/> |
| Interfaces                       | wlan1, wlan2                        |
| Certificate                      | request                             |
| Discovery Interfaces             | wlan1                               |
| Lock To CAPsMAN                  | <input checked="" type="checkbox"/> |
| CAPsMAN Addresses                | 10.10.21.60, 10.10.21.1             |
| CAPsMAN Names                    |                                     |
| CAPsMAN Certificate Common Names |                                     |
| Bridge                           | bridge-local                        |
| Static Virtual                   | <input checked="" type="checkbox"/> |
| Requested Certificate            | CAP-CC2DE02B53BD                    |
| Locked CAPsMAN Common Name       | CAPsMAN-A24894AB8D3D                |

# CAP: high availability

- If no connection between CAP and CAPsMAN, **station will be disconnected**
- Use more than 1 CAPsMAN for high availability



The screenshot displays the 'CAP' configuration window. At the top, a blue header bar contains the text 'CAP'. Below this, the configuration is organized into several sections. The first section includes a status dropdown set to 'Enabled', followed by 'Interfaces' with two entries: 'wlan1' and 'wlan2'. Below that is 'Certificate' set to 'request', and 'Discovery Interfaces' set to 'wlan1'. A checkbox labeled 'Lock To CAPsMAN' is checked. The second section, highlighted with a red rectangle, is titled 'CAPsMAN Addresses' and contains two IP address entries: '10.10.21.60' and '10.10.21.1'. Below this are fields for 'CAPsMAN Names' and 'CAPsMAN Certificate Common Names', both currently empty. The third section includes a 'Bridge' dropdown set to 'bridge-local' and a checked 'Static Virtual' checkbox. The final section contains 'Requested Certificate' set to 'CAP-CC2DE02B53BD' and 'Locked CAPsMAN Common Name' set to 'CAPsMAN-A24894AB8D3D'.

CAP

☒ Enabled

Interfaces: wlan1  
wlan2

Certificate: request

Discovery Interfaces: wlan1

☒ Lock To CAPsMAN

CAPsMAN Addresses: 10.10.21.60  
10.10.21.1

CAPsMAN Names:

CAPsMAN Certificate Common Names:

Bridge: bridge-local

☒ Static Virtual

Requested Certificate: CAP-CC2DE02B53BD

Locked CAPsMAN Common Name: CAPsMAN-A24894AB8D3D

# CAPsMAN: upgrade CAP version

- It is recommended to use latest version of RouterOS
- CAPsMAN can upgrade CAP
- CAPs do not need to connect to internet directly

CAPs Manager

☒ Enabled

Certificate:

CA Certificate: auto

☐ Require Peer Certificate

Generated Certificate:

Generated CA Certificate: CAPsMAN-CA-694D850...

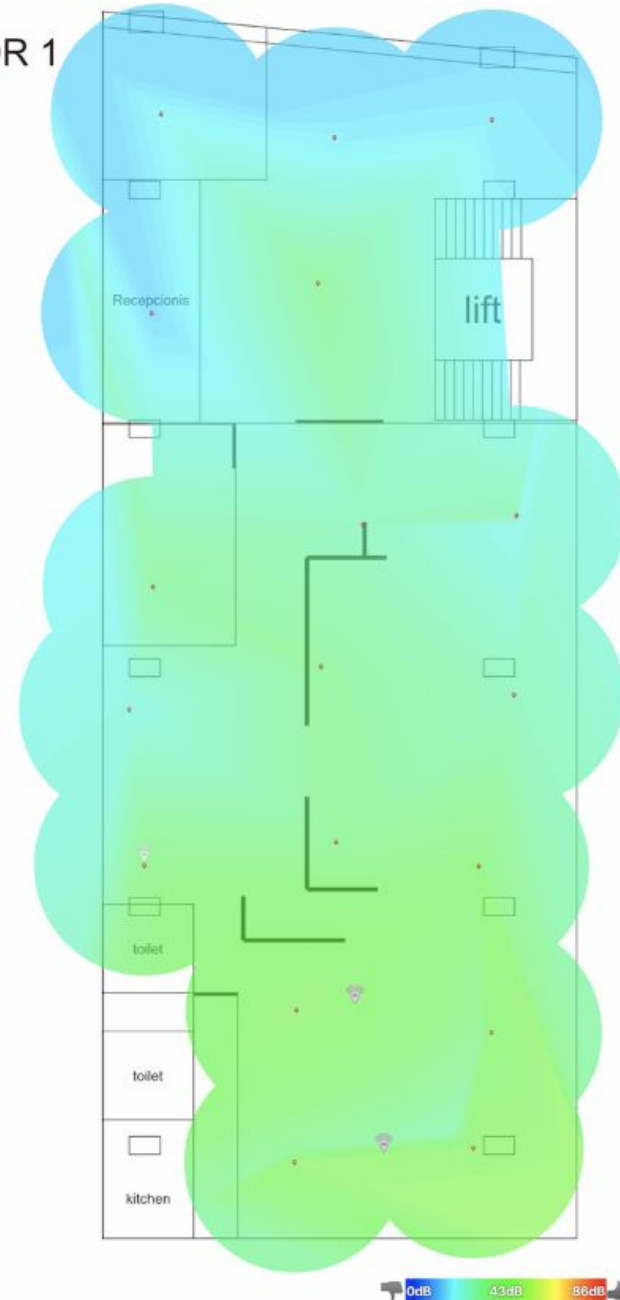
Package Path:

Upgrade Policy:

# Wireless survey

- Wireless survey is very useful for troubleshooting and verify your wireless setting

FLOOR 1  
1:100



# Enable client isolation and port isolation

- To gain more airtime, better if we disable client-to-client communication:
  - Do not activate “client-to-client forwarding”
  - Apply port isolation. Check your switch documentation
  - Do not put server on wireless network. Example: wireless printer

CAPs Datapath Configuration <dp-lf>

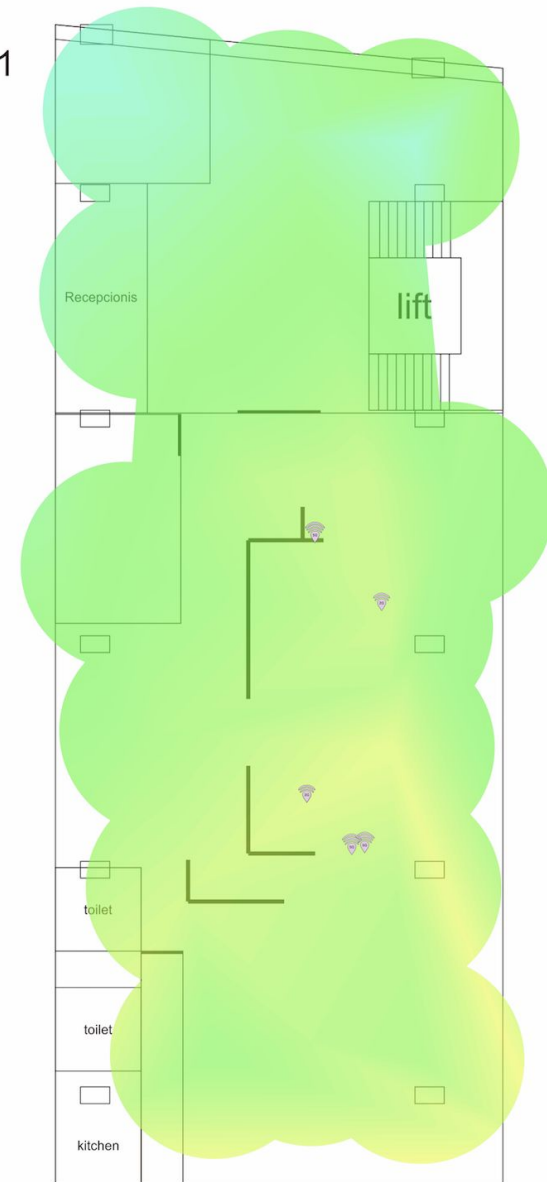
|                              |                                       |
|------------------------------|---------------------------------------|
| Name:                        | <input type="text" value="dp-lf"/>    |
| MTU:                         | <input type="text"/> ▼                |
| L2 MTU:                      | <input type="text"/> ▼                |
| ARP:                         | <input type="text"/> ▼                |
| Bridge:                      | <input type="text"/> ▼                |
| Bridge Cost:                 | <input type="text"/> ▼                |
| Bridge Horizon:              | <input type="text"/> ▼                |
| OpenFlow Switch:             | <input type="text"/> ▼                |
| Local Forwarding:            | <input checked="" type="checkbox"/> ▲ |
| Client To Client Forwarding: | <input type="checkbox"/> ▲            |
| VLAN Mode:                   | <input type="text"/> ▼                |
| VLAN ID:                     | <input type="text"/> ▼                |
| Interface List:              | <input type="text"/> ▼                |



# Smooth mobility for client

- Maintain layer 3 address. Changing on layer 3 address (ex. renew dhcp-client ip address) will make disconnection time longer.
- Can use flat layer 3 network for whole wireless. Check layer 2 vendor to minimise broadcast traffic
- Can use vlan id per user

FLOOR 1  
1:100



# Flexible provisioning

- Setup pattern on CAP identity
- Use regex facility on CAPsMAN provisioning

New CAPs Provisioning

Radio MAC:

Hw. Supported Modes:

Identity Regexp:

Common Name Regexp:

IP Address Ranges:

Action:

Master Configuration:

Slave Configuration:

Name Format:

Name Prefix:

# Suggestions for mikrotik

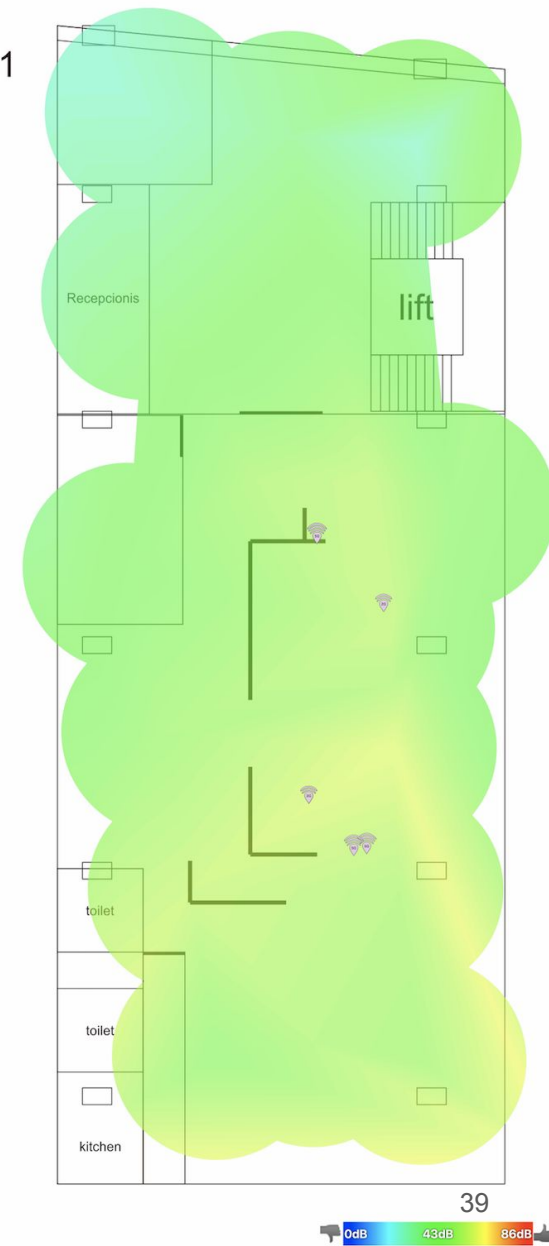
# Automatic band steering

- We encourage users to connect to 5GHz band
- Currently its done manually. Example:
  - 2GHz, SSID = wifi
  - 5GHz, SSID = wifi\_faster
- In the future, this process needs to be automatic

# Signal visualisation on floor layout

- Similar to wifi survey
- Useful to check wireless settings
- Thedude integration?

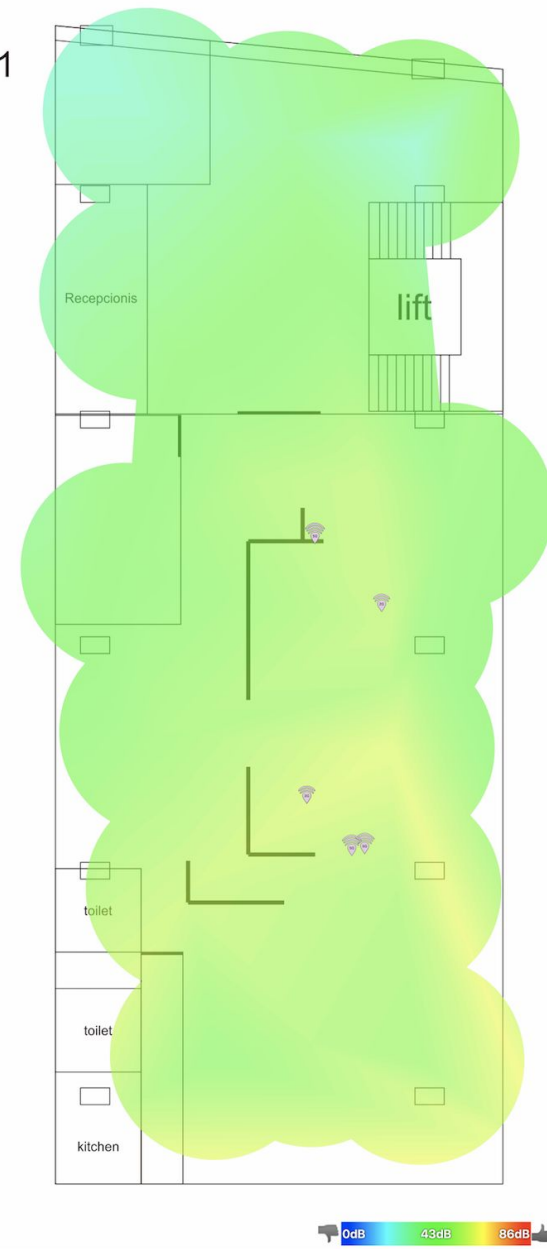
FLOOR 1  
1:100



# Detecting rogue access point

- After all AP are integrated in capsman,
- CAPsMAN can detect a rogue AP in wireless network
- Thedude integration?

FLOOR 1  
1:100



# EAP support on usermanager

- Currently EAP support is not available on Mikrotik Usermanager
- We use other radius software for EAP authentication
- Perhaps in the future?

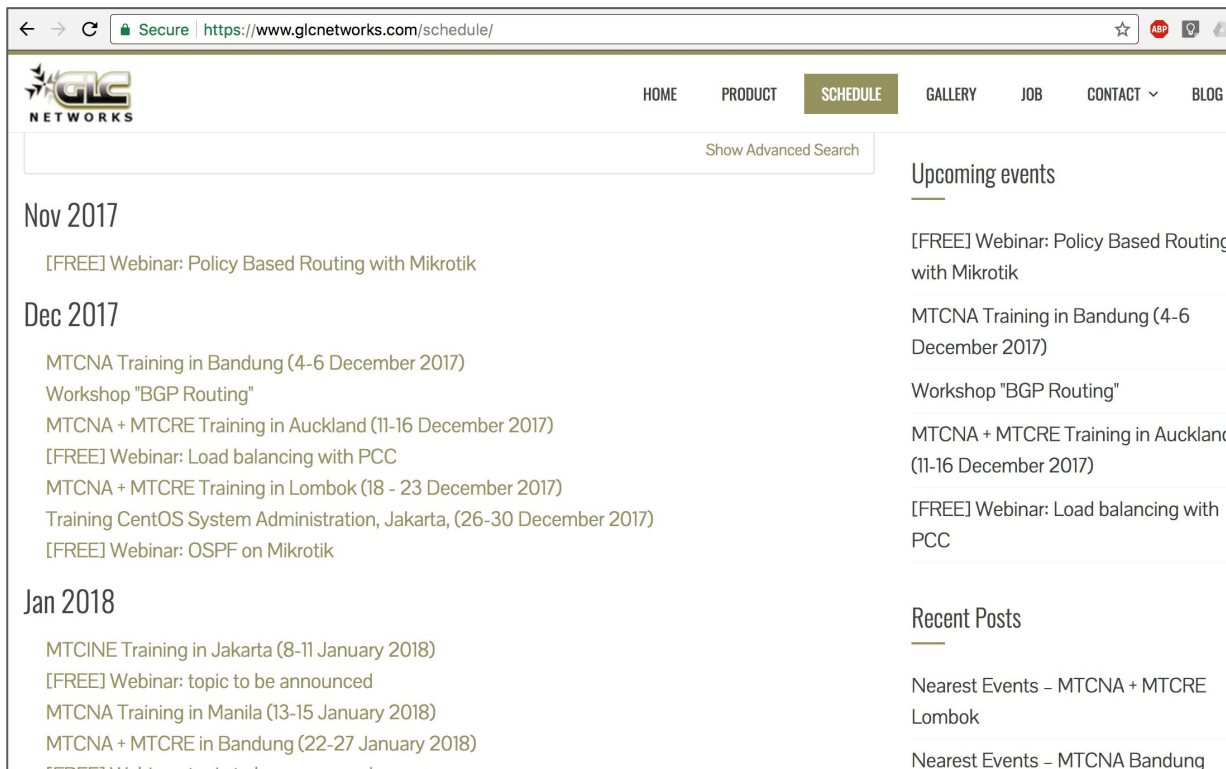
# Training topics

- Previously, mikrotik wireless product was focusing on outdoor environment, Point-To-Point / Point-To-Multi-Point
- Since CAPsMAN appears, mikrotik is focusing on indoor wireless
- Suggestion for the training track:
  - Mikrotik certified outdoor wireless engineer, focusing on outdoor wireless application
  - Mikrotik certified enterprise wireless engineer, focusing on indoor implementation with CAPsMAN



# Interested? Just come to our training...

- **Check schedule on our website**
- More hands-on
- Not only learn the materials, but also sharing experiences, best-practices, and networking



The screenshot shows the GLC Networks website's training schedule page. The browser address bar displays the URL <https://www.glcnetworks.com/schedule/>. The website's navigation menu includes links to HOME, PRODUCT, SCHEDULE (highlighted), GALLERY, JOB, CONTACT, and BLOG. A search bar with the text "Show Advanced Search" is located below the navigation menu. The main content area is divided into two columns. The left column lists training events by month: Nov 2017, Dec 2017, and Jan 2018. The right column features "Upcoming events" and "Recent Posts".

**Nov 2017**

- [FREE] Webinar: Policy Based Routing with Mikrotik

**Dec 2017**

- MTCNA Training in Bandung (4-6 December 2017)
- Workshop "BGP Routing"
- MTCNA + MTCRE Training in Auckland (11-16 December 2017)
- [FREE] Webinar: Load balancing with PCC
- MTCNA + MTCRE Training in Lombok (18 - 23 December 2017)
- Training CentOS System Administration, Jakarta, (26-30 December 2017)
- [FREE] Webinar: OSPF on Mikrotik

**Jan 2018**

- MTCINE Training in Jakarta (8-11 January 2018)
- [FREE] Webinar: topic to be announced
- MTCNA Training in Manila (13-15 January 2018)
- MTCNA + MTCRE in Bandung (22-27 January 2018)

**Upcoming events**

- [FREE] Webinar: Policy Based Routing with Mikrotik
- MTCNA Training in Bandung (4-6 December 2017)
- Workshop "BGP Routing"
- MTCNA + MTCRE Training in Auckland (11-16 December 2017)
- [FREE] Webinar: Load balancing with PCC

**Recent Posts**

- Nearest Events - MTCNA + MTCRE Lombok
- Nearest Events - MTCNA Bandung

QA

End of slides

**Terima Kasih**



**Thank You**