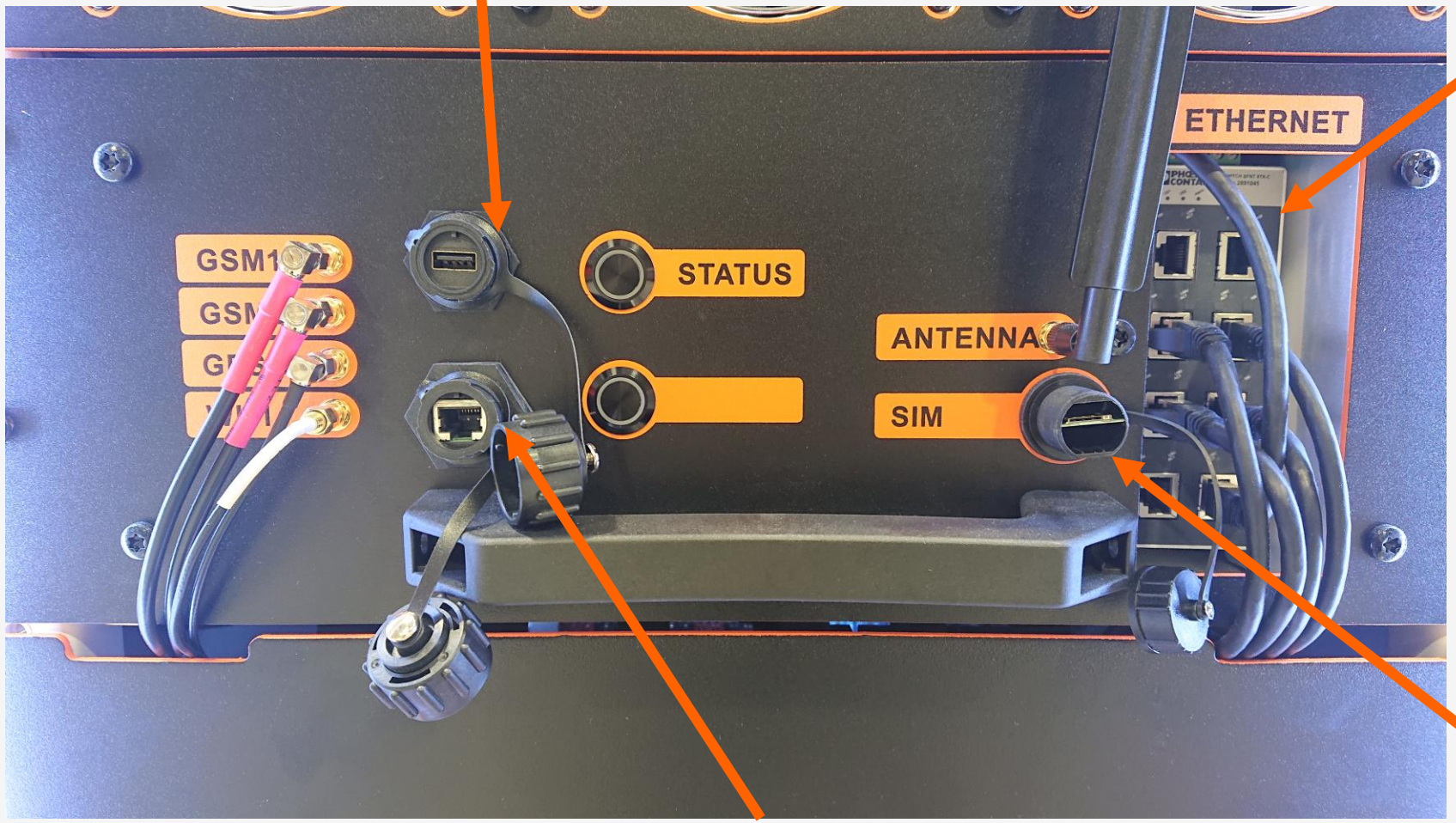
Network Training

Training Objectives

After this training you know...

- What networking choices Kempower chargers have
- How to configure typical network connections
- How to troubleshoot connectivity issues

Network devices



USB for legacy modem

Internal ethernet

SIM for external modem

External ethernet

Networking options

Wired Ethernet

- Most reliable connectivity method!
- DHCP or manual IP option
- Not available on Trolley (and AC satellite with payter)

WiFi

- Not as reliable as ethernet
- Please use with WPA protected network!
- TIP: you can use your Mobile phone hotspot for temporary connectivity

4G Modem Internal

- Usually has Kempower Telia SIM

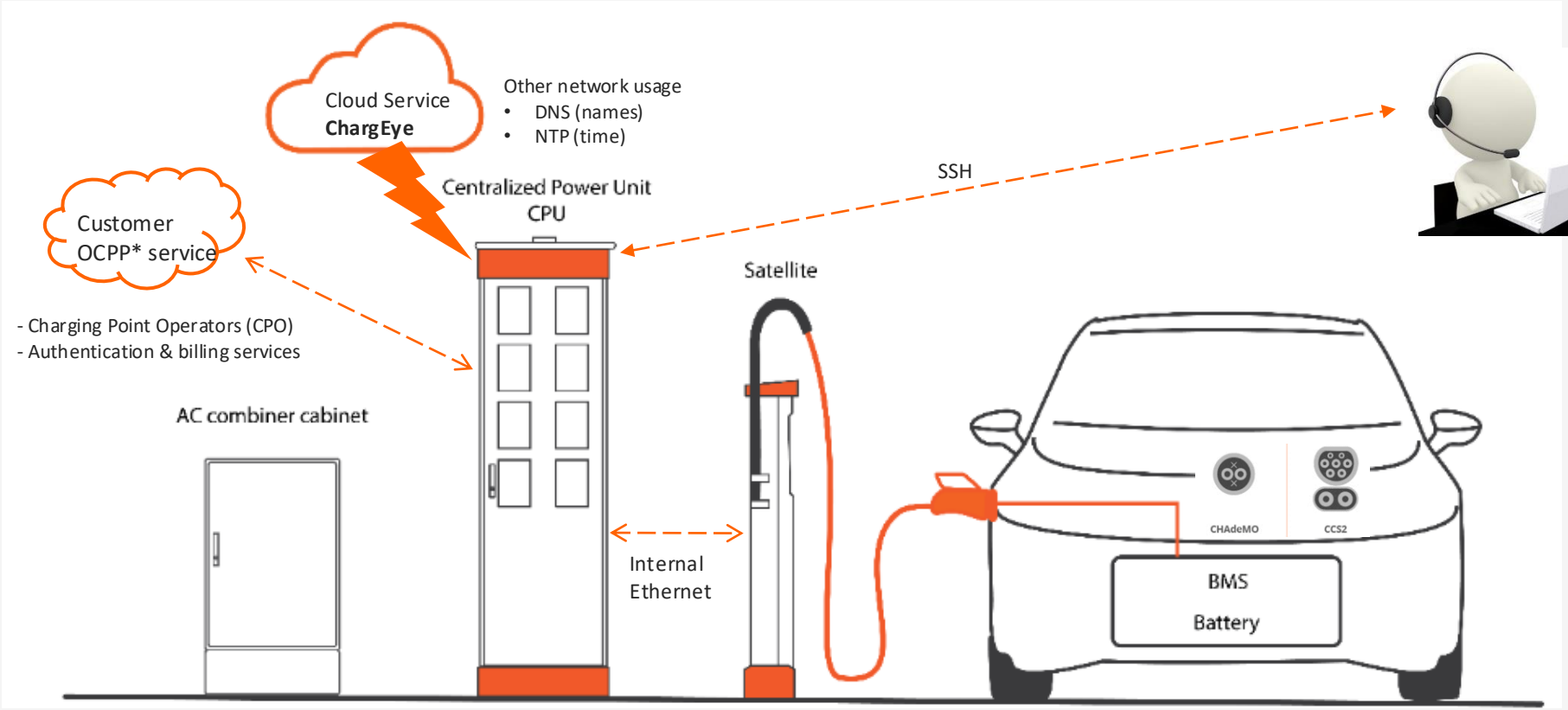
4G Modem External

- Usually has Customer SIM card
- Does not exist in Trolleys

Legacy USB Modem

- Basically, a USB stick
- Backup connection

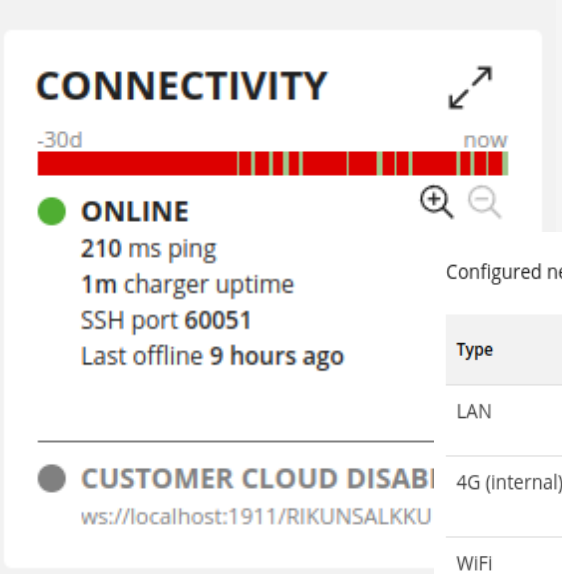
Network Usage



*Open Charging Point Protocol

Connectivity Status

- First place to check connectivity in ChargEye
- ⚠ On idle chargers, updated only every 15 minutes ⚠

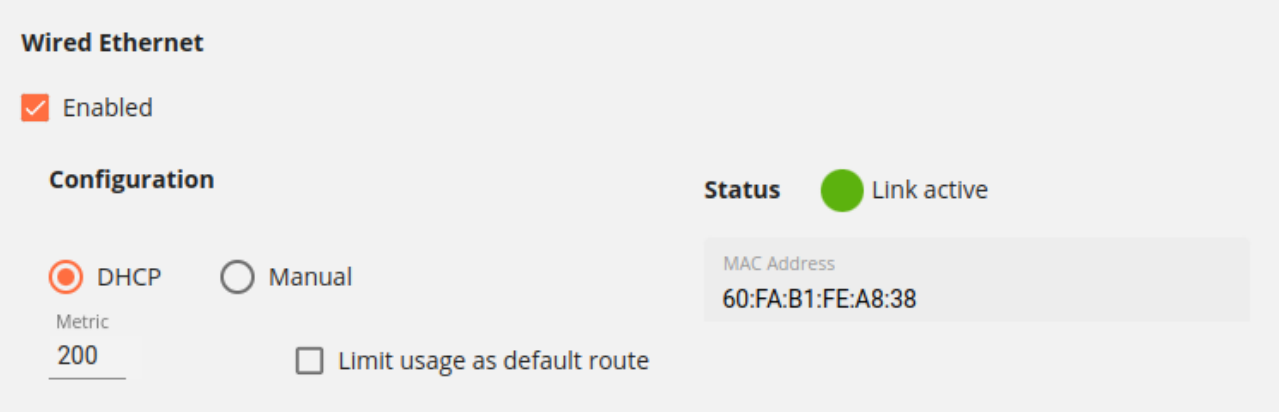


Configured network connections

Type	Status	IP address	ICCID	Mac address	Received	Sent
LAN	Cable connected	192.168.1.135/24		60:FA:B1:FE:A8:38	0.0 MB	0.0 MB
4G (internal)	Connected	10.6.62.103/28	89450421211104018051 (Telia) IMSI 238208702577121, MNC 91, MCC 244, CID 02271D15, LAC FFFE, TAC 001...			0.0 MB
WiFi	Connected (dd-wrt)	192.168.1.140/24		60:FA:B1:FB:7D:B7	0.0 MB	0.0 MB

Ethernet Settings

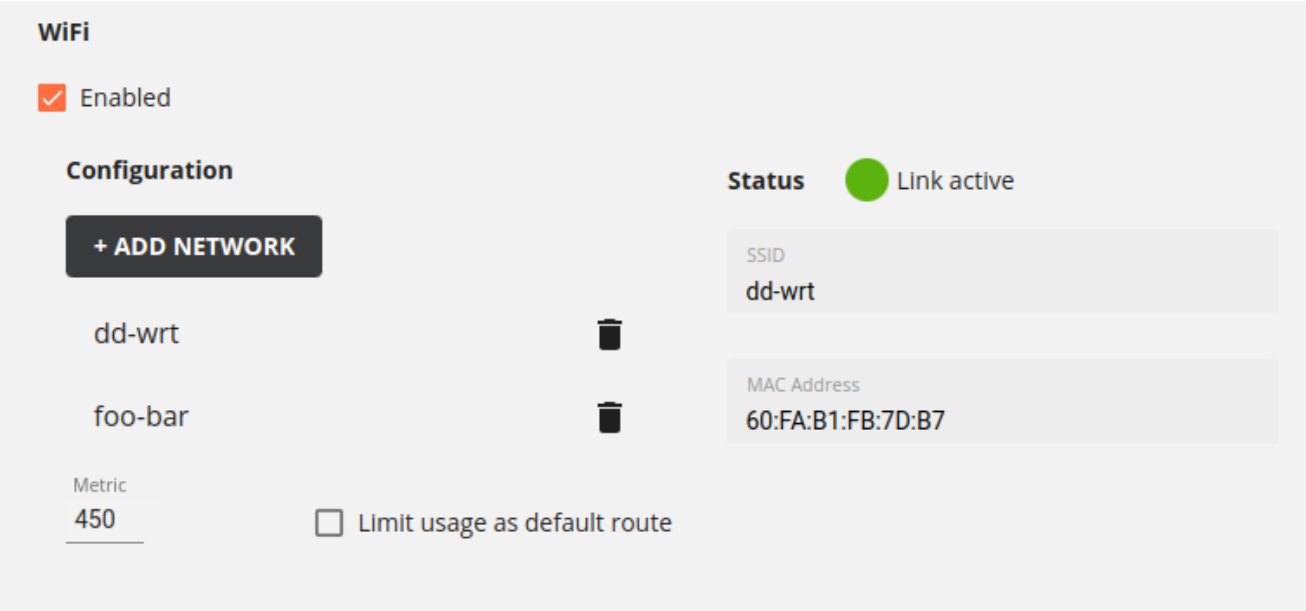
DHCP (automatic IP) or manual



- Protip: Leave Ethernet enabled with DHCP even if site doesn't use ethernet
- ⚠ MAC address is correct only after Link is active!

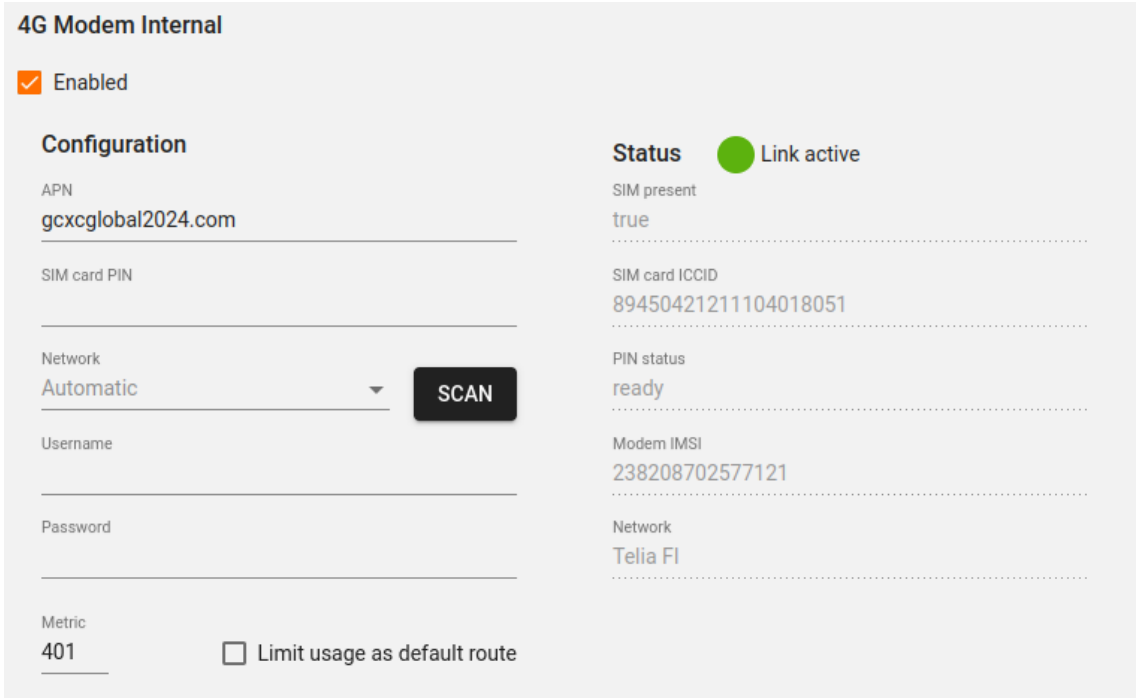
Wifi Settings

- You can have multiple WiFi networks configured
    - Charger will connect to the one with best signal and keep there until dropped offline
- Kempower limitation: can't have special characters in SSID
- ⚠ MAC address is correct only after Link is active!



4G Modem settings

- Same settings for both Internal and External modem
- Default SIM card PIN '0000'
- Default APN 'internet'
    - Telia SIM uses 'gcxcglobal.com'

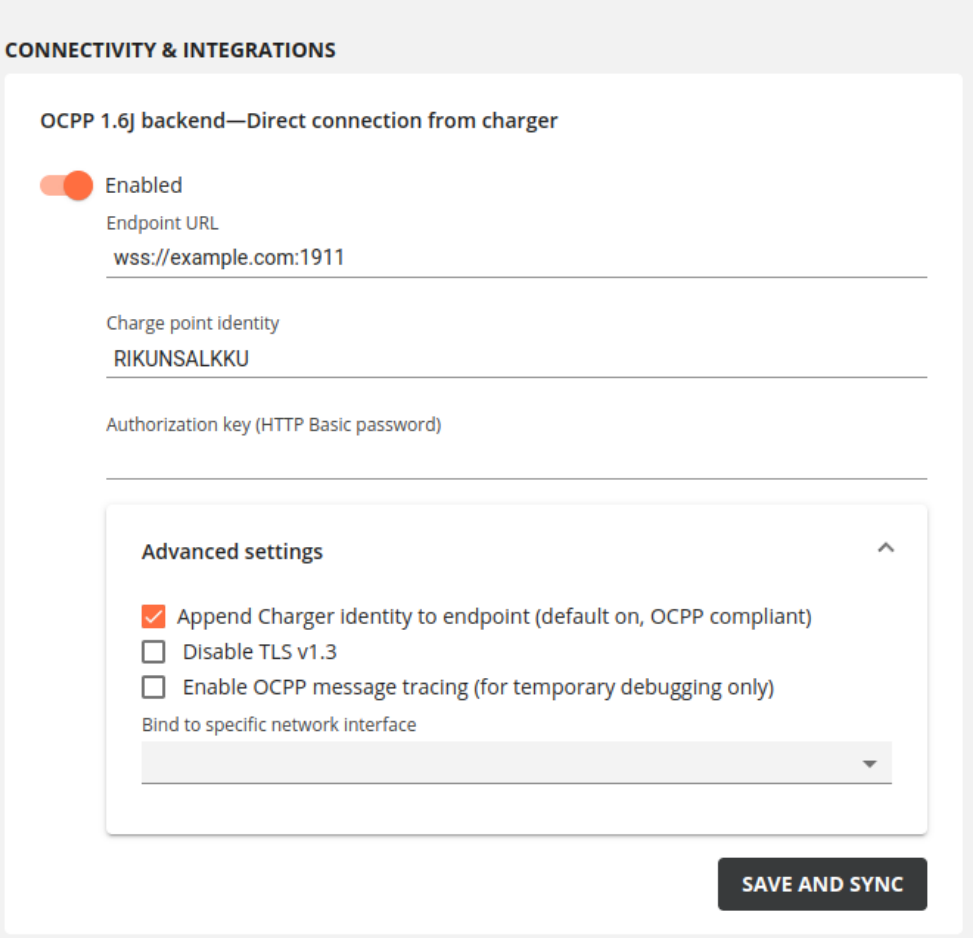


Legacy USB Modem

- For settings and troubleshooting plug the stick in your Laptop and go to http://192.168.8.1
- Recommendation is to leave it enabled so charger connection can be recovered by plugging the USB Modem
- Currently only E3372 supported, expect other models in future

The customer OCPP connection

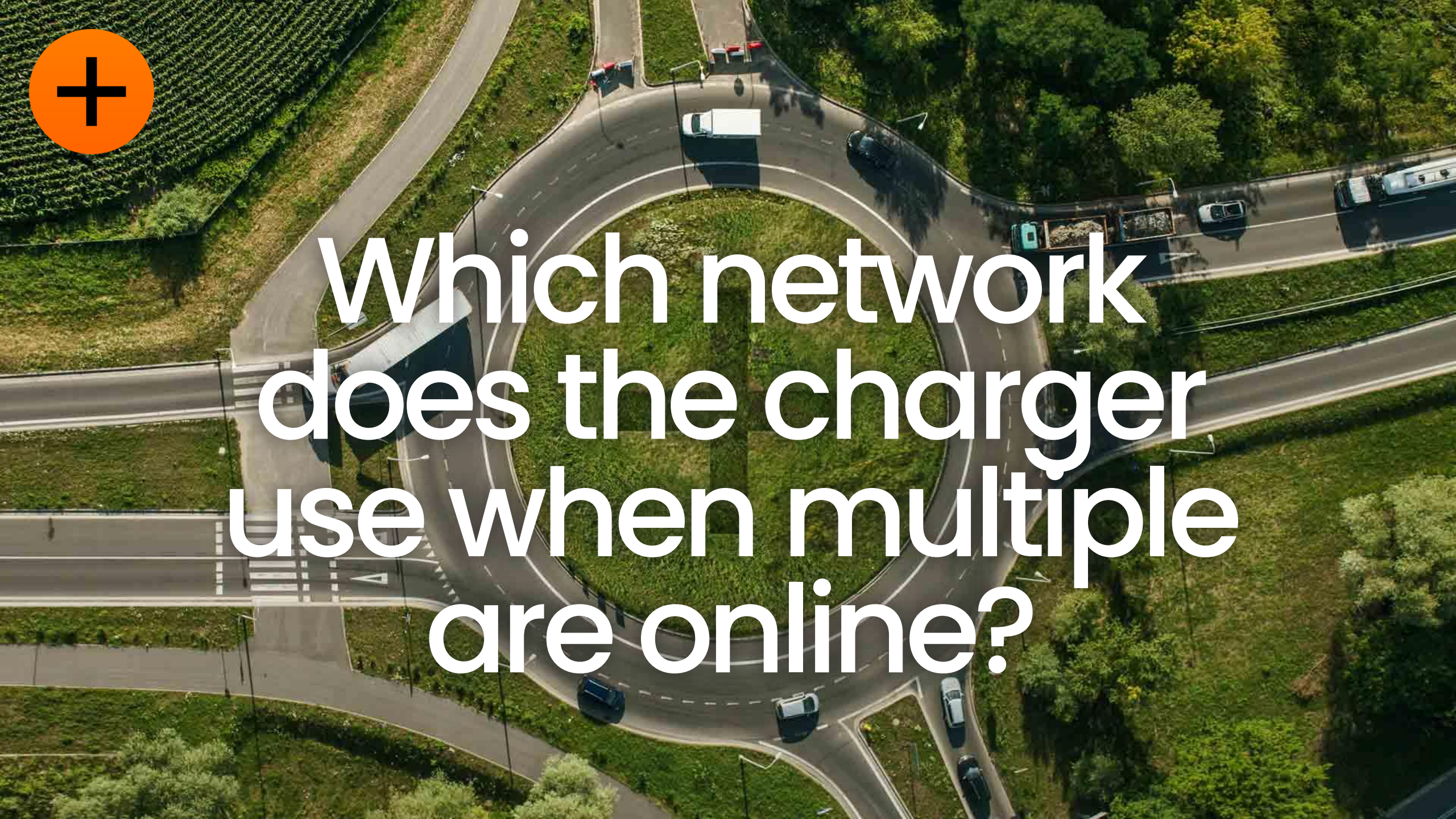
- Usually, the most important network setting
- Make sure the URL is correct and complete
- Disable TLS v1.3 only used for one customer – shouldn't be needed for any new.



Firewall requirements

- When using connection via customer network
- Request the following **outgoing** access rules in customer firewall

Protocol	Port
HTTPS	443/TCP
SSH	22/TCP
DNS	53/UDP
NTP	123/UDP



Which network does the charger use when multiple are online?

Forcing network

OCPP and ChargEye can be *FORCED* to use a specific interface

- Must be selected, when customer OCPP connection is in a private network
    - Usually customer SIM in "4G External modem"
- Use "bind to specific interface" advanced option for OCPP connection
- ChargEye connection can only by bound in maintenance tool
    - Not recommended except as last measure
    - -> can lock you out of ChargEye if the selected Interface doesn't work

Network Preference order

"Route metric" is standard way of choosing which route to use for traffic

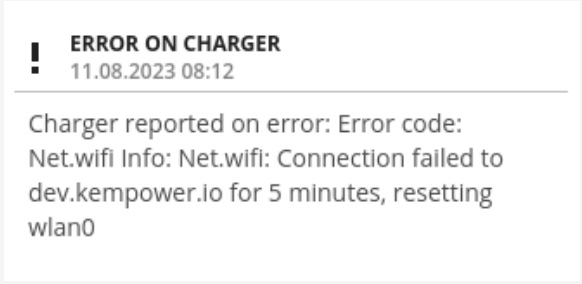
- Route with the smallest metric value is used
- Charger monitors the connectivity of each network
    - Metric value will be increased for non-functioning networks
    - Default metric preference orderis
    - Ethernet -> WiFi -> Internal Modem -> external modem -> legacy modem

```
CABINET-K0022706A ~ # ip route show default
default via 10.160.10.1 dev wlan0 proto dhcp metric 200
default via 10.6.41.240 dev eg25g_int proto static metric 300
default via 10.32.205.54 dev eg25g_ext proto static metric 400
CABINET-K0022706A ~ #
```

Network recovery function

Charger will attempt to recover non-working network interfaces

- Network will be considered non-working if it can't reach kempower.io or customer OCPP URL.
- If the network hasn't functioned for a long time, it will be reset
    - Error reported to ChargEye
    - There is an exponential fallback (5->10->20) minutes between resets



Adjusting network preferences

When to change the default metrics?

- If the ethernet connects to a closed network
  - Set ethernet metric to > 600
- When configuring networks over ChargEye
  - Make sure a "known working" network interface has the lowest metric
  - Example: you are configuring Ethernet (metric 100) over Internal modem (metric: 300)
  - -> Change Ethernet metric to > 600 to avoid being locked out if ethernet connection is half-working.


Enter the
Challenges

Establishing connectivity

Status Link active

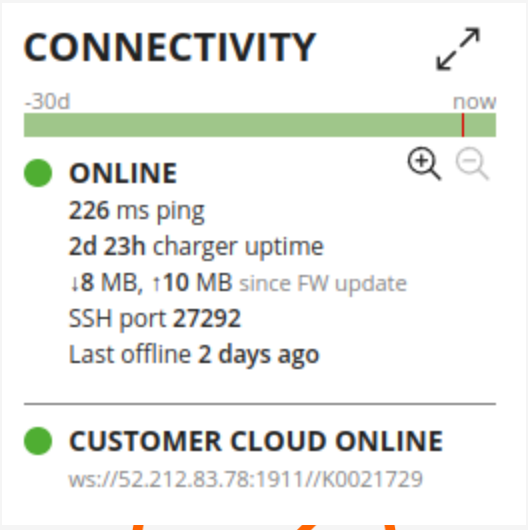
- Establishing the link
- Ethernet
- WiFi Access point
- 4G network attach

Resolving DNS

- Kempower.io -> 2.3.3.4

Open OCPP

- Open TCP socket
- TLS handshake
- Websocket upgrade
- Credentials



Ethernet Link Issues

- Verify physical wire
- Verify ethernet link light
- Check did you get an IP over DHCP
    - Tell customer no DHCP offers
- Security appliances in Customer Network can prevent link

- SSH tips:
- `ip -s a show dev eth_ext`
- `ethtool eth_ext`
- `Journalctl –b –u NetworkManager`

Wifi Link issues

- Double-check SSID and password
- Poor reception to Access Point
  - Or radio interference
- MAC Filtering
  - If in use by customer, verify you gave right MAC!
- Usually not much the charger can do "different" to make connection work

- `SSH tips`
- `iw dev`
- `nmcli d w`

4G Link Issues

SSH: "mmcli -m lteInternal" # lteExternal for customer modem

```
  ----------------------------------
  Status    |                 state: failed
            |          failed reason: sim-missing
            |            power state: on
  ----------------------------------
```

Check SIM is clean and firmly attached

```
  ----------------------------------
  Status    |                  lock: sim-pin
            |        unlock retries: sim-pin (3), sim-puk (10),
            |                 state: locked
            |           power state: on
  ----------------------------------
```

Incorrect PIN

```
  ----------------------------------
  Status    |                  lock: sim-pin2
            |        unlock retries: sim-pin (3), sim-puk (10)
            |                 state: registered
            |           power state: on
            |           access tech: lte
            |        signal quality: 86% (cached)
  ----------------------------------
```

Registered: SIM ok, APN invalid

```
  ----------------------------------
  Status    |                  lock: sim-pin2
            |        unlock retries: sim-pin (3), sim-puk (10),
            |                 state: connected
            |           power state: on
            |           access tech: lte
            |        signal quality: 89% (cached)
  ----------------------------------
```

All fine, link established!

4G Link Issues

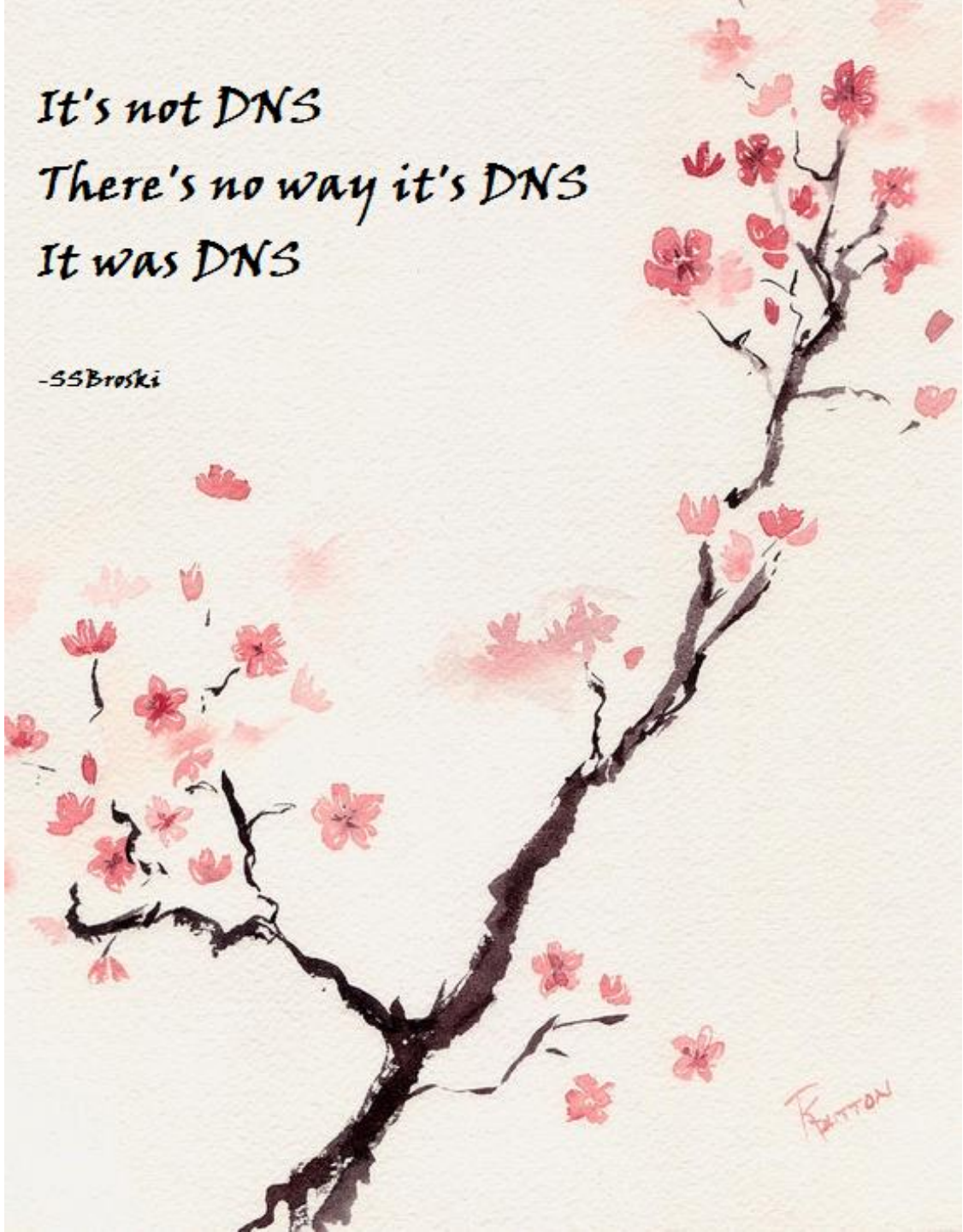
Part 2: Attaching to packet network: the APN setting

- SIM ok but No IP address?
  - APN incorrect
  - SIM not activated?
- Still not connected?
  - Poor cell coverage
  - Too busy cell network
- Logs: look for call end reason

```
RIKUNSALKKU ~ # journalctl -u ModemManager |grep "call end reason"
May 22 13:17:36 omega ModemManager[340]: <info>  [modem0/bearer1] verbose call end reason (3,1009): [cm] implicitly-detached
May 22 13:17:36 omega ModemManager[340]: <info>  [modem0/bearer1] verbose call end reason (3,2001): [cm] no-service
May 22 13:17:36 omega ModemManager[340]: <info>  [modem0/bearer1] verbose call end reason (3,2001): [cm] no-service
May 22 13:17:36 omega ModemManager[340]: <info>  [modem0/bearer1] verbose call end reason (3,2001): [cm] no-service
Aug 10 13:32:50 omega ModemManager[385]: <info>  [modem2/bearer6] verbose call end reason (6,33): [3gpp] option-unsubscribed
Aug 10 13:32:50 omega ModemManager[385]: <info>  [modem2/bearer6] verbose call end reason (6,33): [3gpp] option-unsubscribed
```

Resolving names can't be that hard!

- Link is open, the next step is to find the IP to connect to
- Issues you might encounter:
- Firewall preventing DNS
- Split Horizon DNS
- Incorrect DNS records by customer
- Captive portal



DNS

DNS settings

- Each network interface has DNS servers
- Charger uses the DNS servers of the network with the lowest metric
- Fallback DNS servers 1.1.1.1 and 8.8.8.8

Special case: "Bind to interface" means the OCPP server address will be resolved from that interface!

Checking DNS

DNS settings

- Nslookup kempower.io
- Nslookup kempower.io 8.8.8.8
  - Failure: firewall problem
- resolvectl
- Resolvectl query kempower.io
  - Different answer on different interfaces -> split-horizon DNS or captive portal
- If using "bind to interface" option
  - ./bin/kp-resolve <interface> kempower.io

- SSH tips:
- resolvectl
- nslookup
- kp-resolve

Open OCPP

So the IP looks good, but CE is still not connecting?

- Double-check the customer gave you the right URL and authentication credentials
- Connection test in maintenance tool
- curl -i -H "Connection: Upgrade" -H "Upgrade: websocket" https://kempower.io/ocpp/

Open OCPP

Errors

- Timeout -> firewall
- No route to host -> firewall or routing problem
- Error "426 Upgrade required" expected
- Other errors: check NCM logs
    - WebSocketConnectionHandler
    - BootController

NCM logs

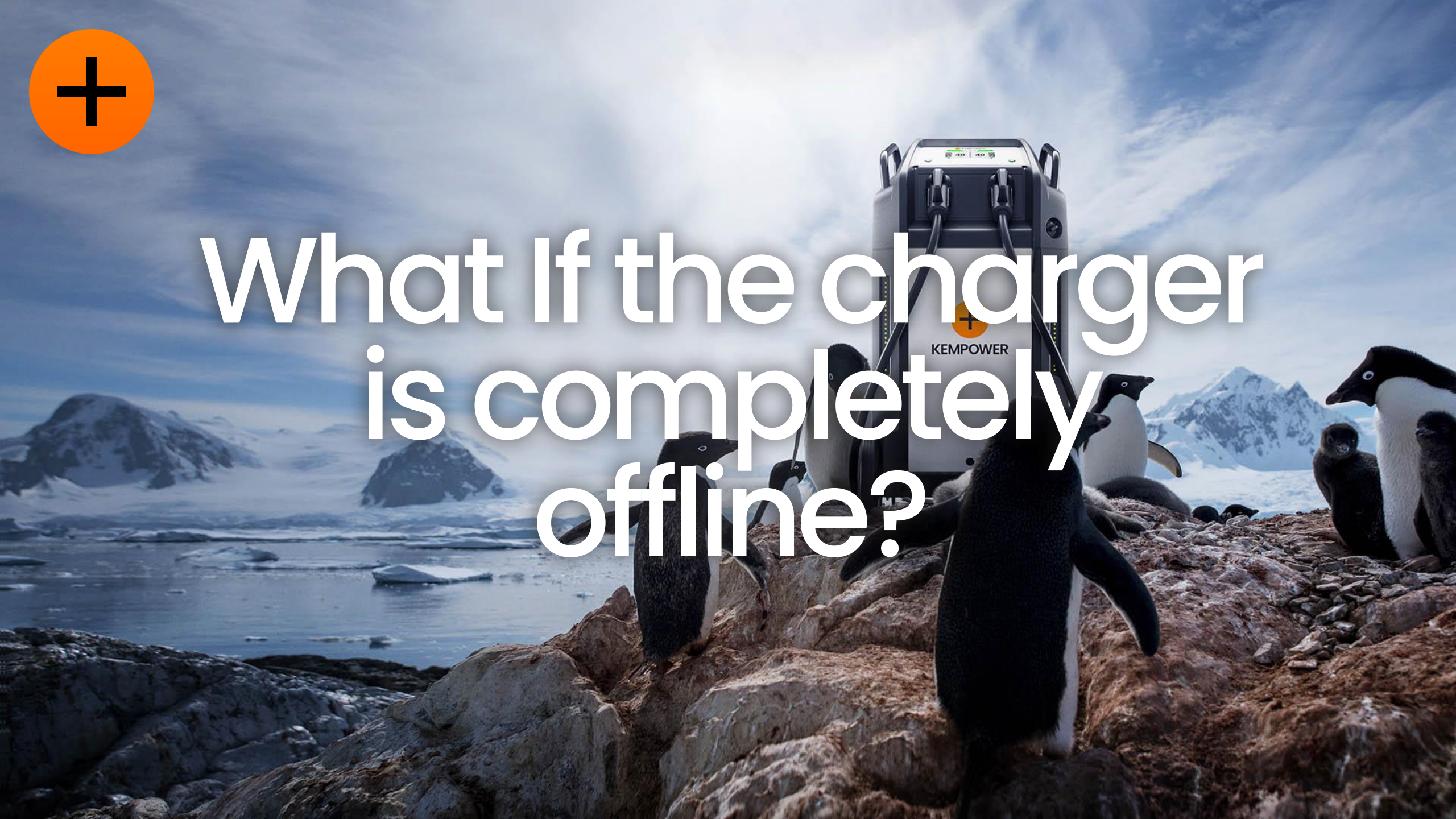
journalctl -b -t ncm

- Look for BootController or WebSocketConnectionHandler
  - Bootcontroller errors usually authentication
  - WebSocketConnectionHandler network

```
Aug 08 13:15:07 omega ncm[944]: 2023-08-08T13:15:07.826Z WebSocketConnectionHandler::kempower-csms [INFO] [2023-08-08T13:15:07.826Z]: Connecting to wss://dev.kempower.io/ocpp/K0021729
Aug 08 13:15:07 omega ncm[944]: 2023-08-08T13:15:07.845Z WebSocketConnectionHandler::kempower-csms [INFO] [2023-08-08T13:15:07.844Z]: Connecting to wss://dev.kempower.io/ocpp/K0021729
Aug 08 13:15:08 omega ncm[944]: 2023-08-08T13:15:08.080Z WebSocketConnectionHandler::cloud1 [INFO] [2023-08-08T13:15:08.080Z]: Connecting to ws://52.212.83.78:1911//K0021729
Aug 08 13:15:08 omega ncm[944]: 2023-08-08T13:15:08.088Z WebSocketConnectionHandler::cloud1 [INFO] [2023-08-08T13:15:08.087Z]: Connecting to ws://52.212.83.78:1911//K0021729
Aug 08 13:15:10 omega ncm[944]: 2023-08-08T13:15:10.026Z WebSocketConnectionHandler::cloud1 [INFO] [2023-08-08T13:15:10.026Z]: Connected
Aug 08 13:15:10 omega ncm[944]: 2023-08-08T13:15:10.061Z BootController::OCPP16J [INFO] [2023-08-08T13:15:10.060Z]: Connection established - Sending BootNotification
Aug 08 13:15:11 omega ncm[944]: 2023-08-08T13:15:11.243Z WebSocketConnectionHandler::kempower-csms [INFO] [2023-08-08T13:15:11.243Z]: Connected
Aug 08 13:15:11 omega ncm[944]: 2023-08-08T13:15:11.326Z BootController::OCPP20 [INFO] [2023-08-08T13:15:11.325Z]: Connection established - Sending BootNotification
Aug 08 13:15:11 omega ncm[944]: 2023-08-08T13:15:11.421Z BootController::OCPP16J [WARN] [2023-08-08T13:15:11.421Z]: Received Pending status for BootNotification. Standing by.
Aug 08 13:15:11 omega ncm[944]: 2023-08-08T13:15:11.425Z BootController::OCPP16J [INFO] [2023-08-08T13:15:11.425Z]: Waiting for 1 seconds before retrying BootNotification
Aug 08 13:15:12 omega ncm[944]: 2023-08-08T13:15:12.106Z BootController::OCPP20 [INFO] [2023-08-08T13:15:12.105Z]: BootNotification Accepted.
Aug 08 13:15:12 omega ncm[944]: 2023-08-08T13:15:12.431Z BootController::OCPP16J [INFO] [2023-08-08T13:15:12.431Z]: Pending/Rejected interval elapsed - Sending BootNotification
Aug 08 13:15:12 omega ncm[944]: 2023-08-08T13:15:12.541Z BootController::OCPP16J [INFO] [2023-08-08T13:15:12.541Z]: BootNotification Accepted.
Aug 08 15:15:10 omega ncm[944]: 2023-08-08T15:15:10.935Z WebSocketConnectionHandler::kempower-csms [ERROR] [2023-08-08T15:15:10.935Z]: Connection closed due to 1001 Going away
Aug 08 15:15:10 omega ncm[944]: 2023-08-08T15:15:10.949Z WebSocketConnectionHandler::kempower-csms [INFO] [2023-08-08T15:15:10.948Z]: Connecting to wss://dev.kempower.io/ocpp/K0021729
Aug 08 15:15:10 omega ncm[944]: 2023-08-08T15:15:10.952Z WebSocketConnectionHandler::kempower-csms [INFO] [2023-08-08T15:15:10.952Z]: Connecting to wss://dev.kempower.io/ocpp/K0021729
Aug 08 15:15:12 omega ncm[944]: 2023-08-08T15:15:12.818Z WebSocketConnectionHandler::kempower-csms [INFO] [2023-08-08T15:15:12.818Z]: Connected
Aug 08 15:15:12 omega ncm[944]: 2023-08-08T15:15:12.860Z BootController::OCPP20 [INFO] [2023-08-08T15:15:12.860Z]: Connection established - Sending BootNotification
Aug 08 15:15:13 omega ncm[944]: 2023-08-08T15:15:13.187Z BootController::OCPP20 [INFO] [2023-08-08T15:15:13.187Z]: BootNotification Accepted.
```

Relevant Log units

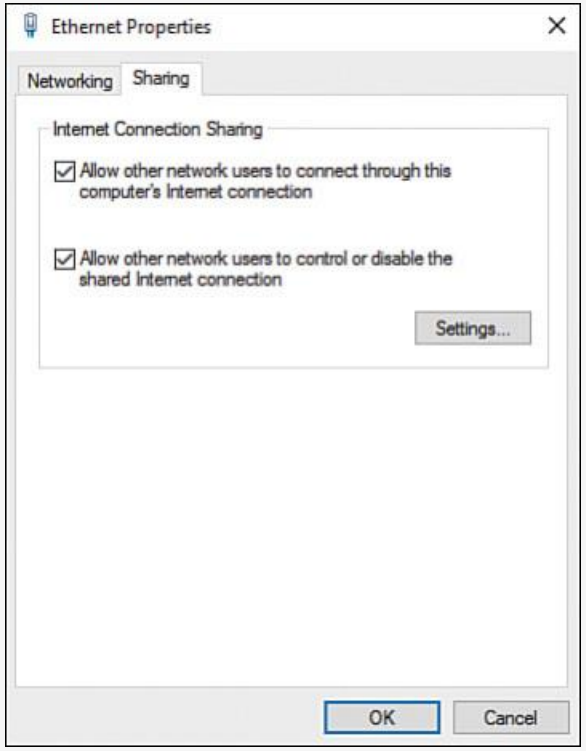
- `journalctl –b # -b means since boot`
- `journalctl –t ncm # cloud connection`
- `journalctl –t NetworkManager # Main networking`
- `journalctl –t ModemManager # 4G connections`
- `journalctl –t nm-online # network quality monitoring`
- `journalctl –t configuration # saving network settings`
- `Journalctl -t wpa_supplicant # wifi connections`



What If the charger is completely offline?

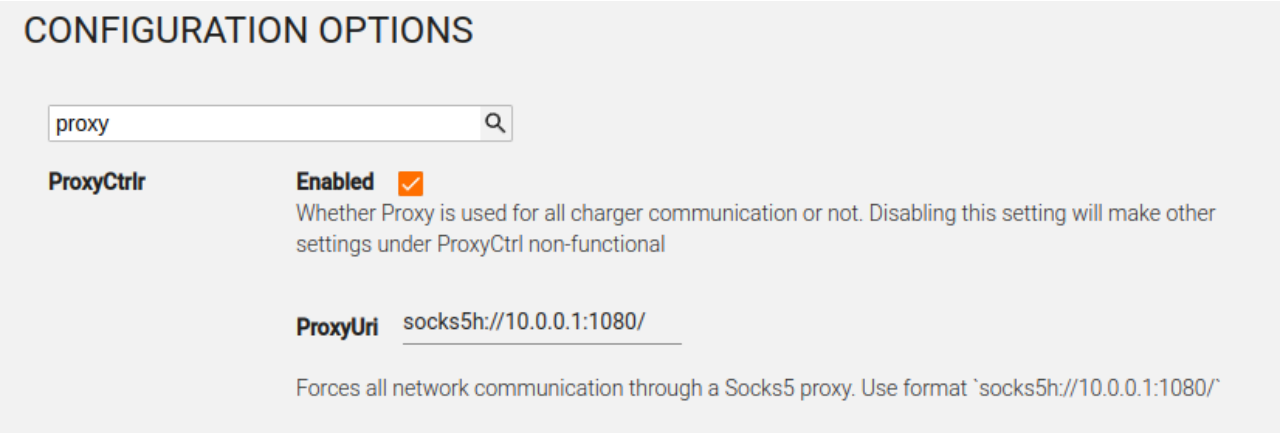
Getting charger back online

- Needs someone at the site
- Did you leave ethernet on and automatic?
  - Instruct customer to enable internet connection sharing on their windows laptop, and connect ethernet wire from charger to laptop
  - 4G router with ethernet port works too
  - ChargEye connection should recover, allowing remote diagnostics
- Likewise, with Legacy USB modem if it was enabled
- Else, someone with maintenance tool access needs visit site



Special case: proxy

- Socks proxy can be used to route Charger connection from highly restricted networks
- Recommendation: Change this setting only from Maintenance tool



Missing SSH port

- Patience: It might take upto 15 minutes for the data to refresh in ChargEye
- There is a working ChargEye connection and ssh port doesn't appear in 15 minutes
  - Likely a firewall issue when using customer networks
  - -> outgoing port 22/TCP closed
- Notice: SSH Access will be removed (cybersecurity regulation)!
  - When something has to be configured over SSH, there should be a ticket requesting the feature in ChargEye and Maintenance tool!

Thank You.