# Exentric Tunnel Network™

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# Description

The product is a data network focused on WiFi, designed for use in tunnels.
It consists of base stations (BS) connected by fiber cables. These are linked to the internet via a 5G router located outside the tunnel. The connection between the 5G router and the first BS can be either fiber or Cat5 data cable, with fiber being strongly preferred for EMC reasons.

If the cable connection is broken, an automatic WiFi backup activates—provided there are no obstacles between units.
If no 4G/5G coverage is available at the site, or an alternative internet connection is preferred, another source (e.g., cable or Starlink) can be connected to the 5G router. The router may also have backup via another mobile operator or two simultaneous internet connections to increase speed. Backup internet routers can also be provided.

Each BS includes two WiFi routers and a switch with fiber ports and ethernet ports with PoE (Power over Ethernet). The PoE ports can be used for devices like surveillance cameras etc.
Each BS features a 2-hour battery backup (expandable if required).
Between BS units, pre-terminated field fiber cables are used (plug and play).

The WiFi range to a mobile phone is approximately 250 meters (average, but with differences between phone types). Up to 500 meters between base stations under line-of-sight and good radio conditions.
If the fiber connection is broken, the network automatically switches to WiFi failover.

Network speed is up to 1.25 Gbit/s, though internet throughput will usually be lower depending on the connection.
WiFi speeds are up to 400 Mbit/s near the BS, decreasing with distance.
With multiple connected devices, available bandwidth is shared (e.g., with 4 devices, about 100 Mbit/s per unit).

While theoretically possible to connect several hundred BS units, this would eventually increase latency for voice communication.
The system includes **QoS (Quality of Service)** to prioritize real-time traffic such as voice, video, and critical control data for tunnel drilling equipment.

## Connections

- 2 × ODC (fiber)
- 1 × RJ45 Ethernet with active PoE 802.3af/at (max 25W)
  - Expandable to 4 × RJ45 PoE ports (max 40W total)
  - PoE default off during operation in battery mode
- 1 × 230VAC cable with IP67 plug

## Signal lamps

- **Internet lamp:** Green when online, off otherwise
- **Battery lamp:** Orange when on battery power, off otherwise
- **Blue ring around On/Off/Reset button:** Power present

## On/Off/Reset switch

- Reset: Turn off, wait 10 seconds and turn on to reset the BS
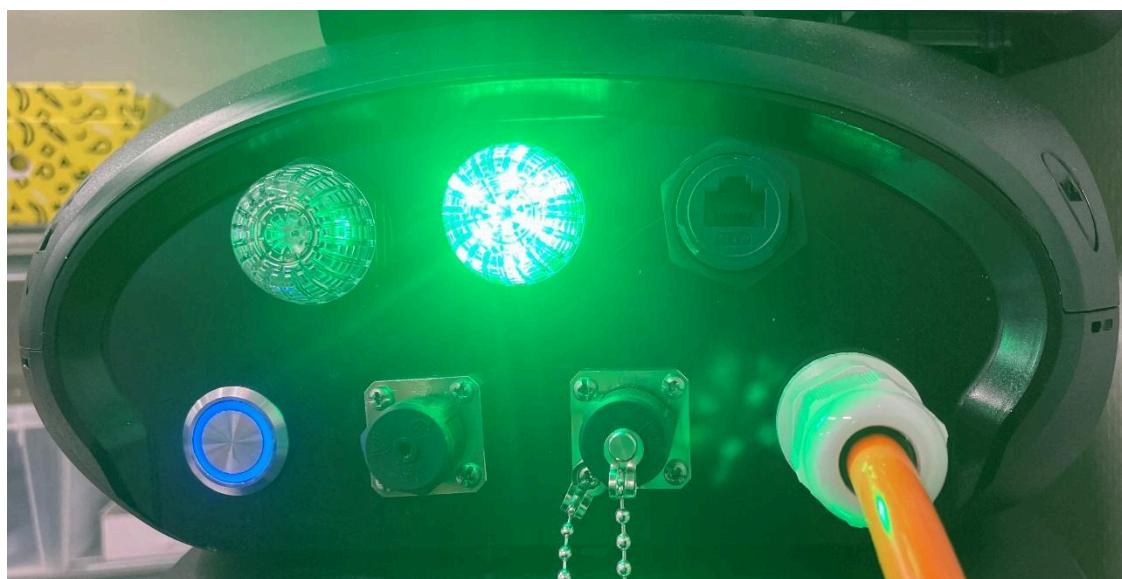


*Figure 1: Preliminary underside showing switch, indicator lights, and connections on the BS (subject to change).*

# Network

## IPv4-address plan

### VLAN3 - Admin

- 192.168.0.0/20

### VLAN4 – Normal use

- 192.168.16.0/20
- **Gateway & DHCP server:** 192.168.16.1
- **Static addresses:** 192.168.16.2 – 192.168.23.255 (2046 addresses)
- **DHCP pool:** 192.168.24.0 – 192.168.31.254 (2047 addresses)

### VLAN5 – Technical use

- 192.168.32.0/20
- **Gateway & DHCP server:** 192.168.32.1
- **Static addresses:** 192.168.32.2 – 192.168.39.255 (2046 addresses)
- **DHCP pool:** 192.168.40.0 – 192.168.47.254 (2047 addresses)

### VLAN6 – Emergency use

- 192.168.40.0/20
- **Gateway & DHCP server:** 192.168.48.1
- **Static addresses:** 192.168.48.2 – 192.168.55.255 (2046 addresses)
- **DHCP pool:** 192.168.56.0 – 192.168.63.254 (2047 addresses)

### VLAN8 – Network equipment

- 192.168.242.0/20


## IPv6-address plan

### VLAN3 - Admin

- **Global DHCPv6/SLAAC:**
  If assigned by the ISP, global DHCPv6/SLAAC addresses are forwarded to clients.
- **Gateway & DHCPv6 server :**
  - fd00:1234::1
- **DHCP pool:**
  - fd00:1234::2/64 ($2^{64}$ adresser)
- **Local ULA SLAAC:**
  - fd00:1234:1:1/64 ($2^{64}$ adresser)
- **Static clients:**
  - fd00:1234:2::1/64 ($2^{64}$ adresser)

## VLAN4 – Normal use

- **Global DHCPv6/SLAAC:**
  If assigned by the ISP, global DHCPv6/SLAAC addresses are forwarded to clients.
- **Gateway & DHCPv6 server :**
  o fd00:1234:3:1
- **DHCP pool:**
  o fd00:1234:3:2/64 ($2^{64}$ adresser)
- **Local ULA SLAAC:**
  o fd00:1234:4:1/64 ($2^{64}$ adresser)
- **Static clients:**
  o fd00:1234:5:1/64 ($2^{64}$ adresser)

## VLAN5 – Technical use

- **Global DHCPv6/SLAAC:**
  If assigned by the ISP, global DHCPv6/SLAAC addresses are forwarded to clients.
- **Gateway & DHCPv6 server :**
  o fd00:1234:6:1
- **DHCP pool:**
  o fd00:1234:6:2/64 ($2^{64}$ adresser)
- **Local ULA SLAAC:**
  o fd00:1234:7:1/64 ($2^{64}$ adresser)
- **Static clients:**
  o fd00:1234:8:1/64 ($2^{64}$ adresser)

## VLAN6 – Emergency use

- **Global DHCPv6/SLAAC:**
  If assigned by the ISP, global DHCPv6/SLAAC addresses are forwarded to clients.
- **Gateway & DHCPv6 server :**
  o fd00:1234:9:1
- **DHCP pool:**
  o fd00:1234:9:2/64 ($2^{64}$ adresser)
- **Local ULA SLAAC:**
  o fd00:1234:a:1/64 ($2^{64}$ adresser)
- **Static clients:**
  o fd00:1234:b:1/64 ($2^{64}$ adresser)

## Network Components

- **Main Router**:
    - o 5G/4G mobile router placed near BS-1, ideally within 100m (Cat5/6) or 500m+ (fiber).
- **BS-1:**
    - o First base station
- **BS-2 – BS-250:**
    - o Sequential base stations (max distance 500m).
- **Spare:**
    - o Up to 5 spare units for field replacement.

(Max total: 255 base stations.)

# Installation in tunnel
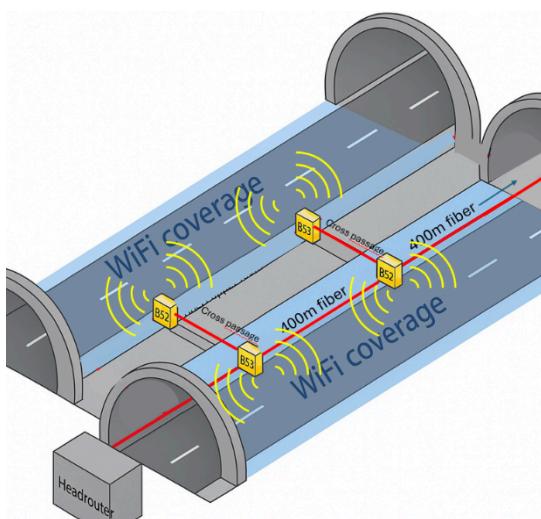


*Figure 2: Normal installation in dual tunnels*

## Installation Order

- Main router mounted outside tunnel with optimal 5G/4G coverage.
- BS-1 placed within ~250 m from the entrance.
- Continue sequentially (BS2, BS3, …).
- In dual tunnels, numbering must continue consecutively from last nr in tunnel 1 to first nr in tunnel 2 (e.g., BS3 → BS4 in figure 3) for WiFi failover to work.
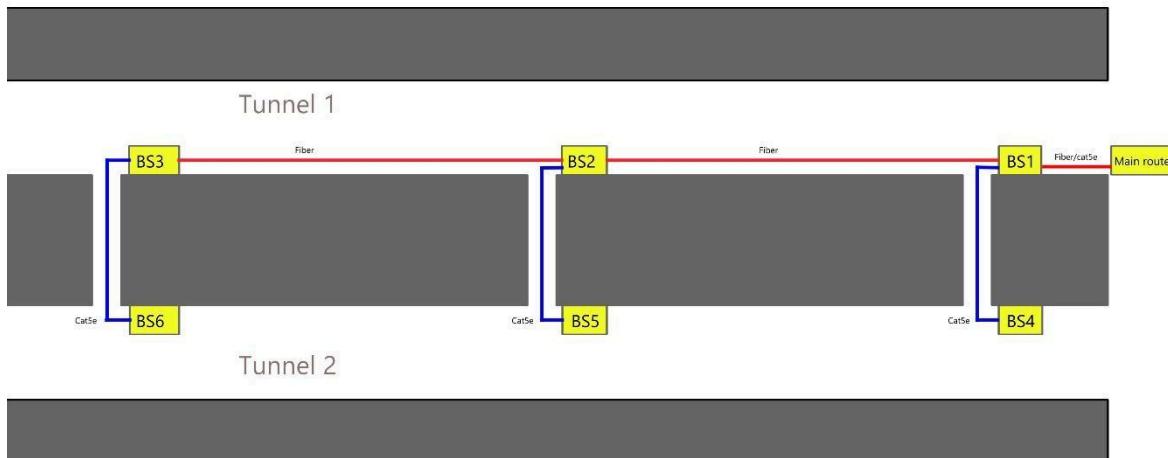
*Figure 3: Dual tunnels. Last BS in tunnel 1 (e.g. BS3) to next BS first in tunnel 2 (e.g. BS4)*

## Connection

Connection to 230V mains power. The battery backup is not active until mains power has been connected and the battery has been charged.

Connections between the main router and BS1, as well as between BS units, can be fiber, copper (minimum Cat 5e unshielded cable), or WiFi.

**Fiber** is the preferred option in terms of range, noise immunity, stability, and speed — allowing up to **500 meters** between BS units.
**Copper** is the next best option but limited to **100 meters** between BS units.
**WiFi** offers lower speed, is more prone to interference, and has higher latency. It can also cover up to **500 meters** between BS units under *line-of-sight* conditions.

When using cables or fiber, it does not matter which connector is attached in which direction.
Cables must be routed as protected as possible, avoiding excessive stretching or bending.
Maximum tension: **50 kg**, except for the connectors, which must not be under strain.
Minimum bend radius: **20 cm** for both fiber and copper cables.

## Placement

The BS units must be mounted as high and as unobstructed as possible on the tunnel wall.
They **MUST** be installed facing outward from the wall, with the connectors positioned underneath, facing the ground.

It is **IMPORTANT** that they are mounted approximately vertically to the side to ensure optimal WiFi signal transmission.

It is **VERY IMPORTANT** that they are placed at the points extending furthest into the traffic lane, providing the best possible **line of sight** between BS units.
They **MUST NOT UNDER ANY CIRCUMSTANCES** be installed in wall recesses where rock could block WiFi signals.

No other equipment should be installed at the same height near the BS units, as this will also obstruct the signals.
In curved sections of the tunnel or where there are major obstacles, the distance between BS units will likely need to be shorter than 500 meters to achieve full WiFi coverage.
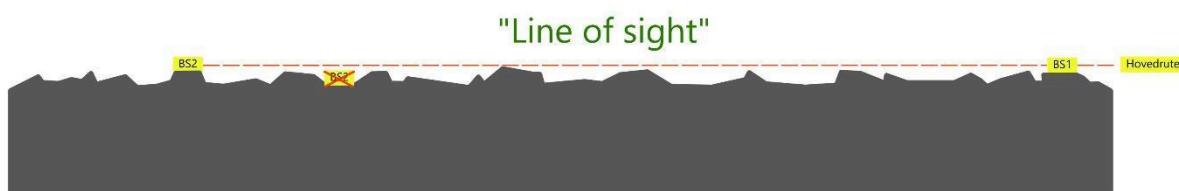


*Figure 4: Tunnel wall seen from above. No obstacles between BS units — "Line of sight"*

# Troubleshooting

Each BS has its own SSID to simplify troubleshooting: BSx_5GHz_test and BSx_2.4GHz_test, where x represents the BS number.

## No WIFI Coverage far from BS units

Check that the nearest BS units have power.
A blue light (ring around the reset button) with no orange light means 230V power is present. An orange light indicates battery operation.

Verify that the distance to the nearest BS is not too great — approximately 250 meters under good conditions using, for example, a mobile phone. Other devices, especially those with internal antennas such as IoT equipment, may have significantly shorter range.

Ensure the BS is mounted high and free, with no obstacles between it and the device lacking coverage. Press and hold the reset button for 10 seconds.
WiFi should be restored within about 5 minutes.

## No WIFI coverage near BS units

Check that the BS has power.
A blue light (ring around the reset button) with no orange light means 230V power is present. An orange light indicates battery operation.

If the BS has power, press and hold the reset button for 10 seconds.
WiFi should be restored within about 5 minutes.

## No internet connection

Verify if the BS units have a green light on. If not, the BS has lost internet connection.

If green light off on several BS, on the BS closest to the main router that has no green light, press and hold the reset button for 10 seconds.
The light should turn on within 5 minutes.

If not, reset the BS before (the last with green light on).

Inspect the cable to the nearest BS toward the main router for any damage, and ensure that all plugs are properly seated.
Clean fiber connectors using the appropriate cleaning tools.

If internet still is down, the BS is probably faulty and must be replaced with a spare unit.

If the main router itself has no internet connection after a reset but is broadcasting WiFi, check for 4G/5G coverage from the connected mobile network (the same operator as the main router) using a mobile phone.
If coverage is available, try moving the router to the area with the best signal.
If it still does not connect, the router is probably faulty and must be replaced with a spare unit.

## Support

If this does not solve the problem, please contact **Exentric AS** at **+47 466 39 000**.