OPERATOR'S MANUAL

MOP

Mesh OFDM Protocol

For MOP 0.19 on Windows 10 and 11 · mopx.duckdns.org/manual

BETA

MOP is beta software, still in development. Things will change, and some may not work yet. Please report anything odd.

I'm looking for **people in the Los Angeles area to help test it** on the air. Interested? Email me at **KO6IKR@gmail.com**. 73 de KO6IKR

Contents

1 Welcome — what MOP is and what you need

2 Install MOP — download, unpack, start

3 The MOP window — a quick tour

4 Your station — callsign, key, equipment, position

5 Connect your radio — sound, push-to-talk, recipes

6 On the air — Connect and your first beacon

7 Messages — send, ticks, CQ, emergency, files

8 Groups

9 Stations

10 The map

11 The public map & updates

12 Your files & backups

13 When something's wrong

14 Where MOP is going — the road map, and the EmComm tab

A Finding your COM port

B Setting your sound card to 48 kHz

C Words you'll meet

The newest version of this manual is always at **mopx.duckdns.org/manual**.

1 Welcome

MOP is a complete digital messaging network for FM: its own high-speed modem, a mesh that builds itself, and delivery you can trust, on the radio you already own. No internet, no repeater, and no central station needed.

Short bursts, not phone calls

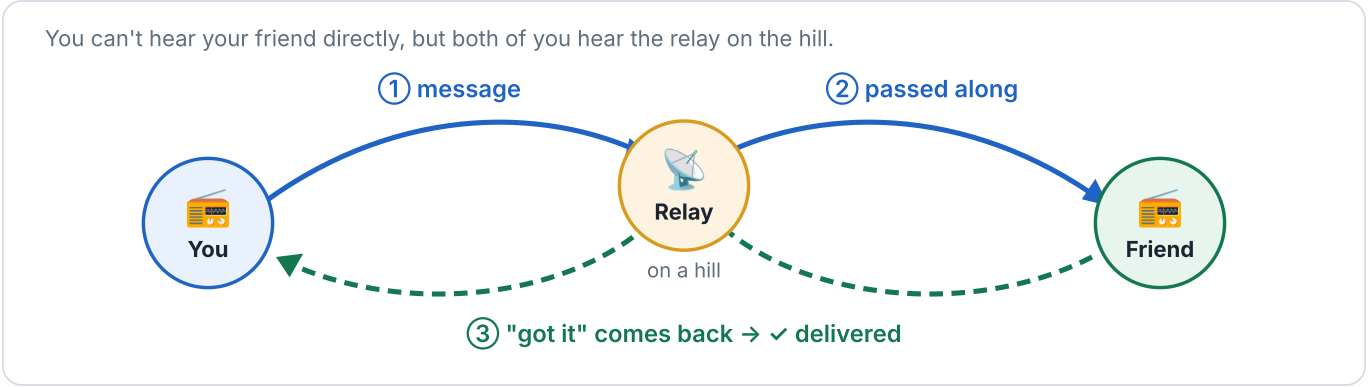
Most digital modes on FM work like a **telephone call**: connect, shake hands, send, wait, disconnect. That's fine for one long email to one gateway. For a short message it means seconds of setup before the first word goes out, and while that call is running, everyone else on the frequency waits. MOP works the way radio is at its best: **like a broadcast**.

> 📞 **Session modes**
>
> Connect → handshake → send → wait → disconnect. One station talks to one station; the rest of the frequency waits. Often built around a gateway or a central server, so when that is unreachable, everything stops.

> 📡 **MOP**
>
> Key up → send one short burst → done. A short message is on the air for about a second. Everyone in range hears it, any MOP station can pass it on, and there is no center: if one station goes off the air, the mesh simply goes around it.

Think of text messaging on a phone, except the cell towers are the MOP stations themselves. You pick a callsign, type, and press `Enter`. MOP finds the way: straight to the other station if it can hear you, or hopping through other MOP stations if it can't. When the message arrives, the other station confirms it and you see ✔ **delivered**, even when it took three hops to get there. If the other station is switched off, your message waits and goes out by itself the moment they're back on the air.

Every MOP station sends a short **beacon** now and then: "I'm here, this is where I am, and these are the stations I can hear." From those beacons, and from everything else it hears, every MOP station learns the map of who can reach whom. That map is the **mesh**, and it repairs itself when stations come and go.



MOP finds the way by itself. You just pick the callsign and type.

The online manual (mopx.duckdns.org/manual) has a live version of this picture: press the buttons and watch the mesh at work.

What's inside

📶 Its own modem

No separate modem program. MOP sends **32 tones at once** in one FM voice channel (OFDM), and picks the speed for each station by itself: from a rock-solid **1,050 bit/s** on a weak path up to **9,450 bit/s** on a clean one. That's up to eight times faster than 1200-baud packet.

🕸️ A mesh that builds itself

No paths to set, no node lists to keep. Every station learns the routes on its own, and any MOP station can pass messages along for others. Stations that can't hear each other learn to take turns instead of talking over each other.

✅ Delivery you can trust

✓ means *the other station has it*, not just "it left my radio". MOP retries by itself, carries the confirmation back through relays, and keeps messages for stations that are off the air until they're heard again.

🔏 Signed, not secret

Every message carries your digital signature, so others know it's really from you and wasn't changed on the way. Nothing is hidden: everyone can read it, as amateur radio rules require. Messages are also compressed, so they're on the air for less time.

👥 Everything a team needs

A conversation per station, groups for your net or ARES team, CQ bulletins to everyone in range, an **emergency channel** that floods the whole mesh, files, pictures and positions, and a live map of who hears whom.

🌍 Internet: optional

MOP never needs the internet to pass messages. Stations that *do* have it can share what they hear on the public MOP-IS map, so everyone can see the mesh grow, live, in a web browser.

How MOP compares

You probably know one or more of these. Each is good at its own job; here's where MOP fits.

	VARA FM + Winlink	Packet (1200 baud)	MOP
How it talks	A connected session: call setup, data, disconnect	A connected session to a node or BBS	**Short bursts, no call setup**
A short message	Seconds of setup before the first word	Connect first, then a second or two at 1200 bit/s	**About a second, at up to 9,450 bit/s**
Who hears it	The one station in the session	The station you're connected to	**Everyone in range**
Finding the way	You pick the gateway or station	Node paths you set up	**Automatic, learned from what every station hears**
Station off the air	Mail waits in the Winlink system	Waits on a BBS	**Waits in MOP, goes out when they're heard again**
Delivery confirmed	Yes, inside the session	Yes, inside the session	**✓ end to end, back through relays**
Emergency	Normal traffic	Normal traffic	**Floods the whole mesh, every station alerted**
Depends on	A gateway in range; Winlink servers for email	Nodes and BBSs run by sysops	**Nothing but other MOP stations**

MOP doesn't replace your other modes: you can keep packet and VARA FM set up next to it. Only one program can use the sound card at a time, so close the others while MOP is connected.

What you need

- A computer with **Windows 10 or 11**.
- Your **FM radio** (2 m, 70 cm, or any FM channel you're licensed for).
- A connection between radio and computer. That's either an **interface** (a Digirig, a SignaLink, an AIOC cable…) or simply the radio's own **USB cable** (FT-991A, IC-7300, IC-705 and similar have a sound card built in).
- Your **amateur radio license** and callsign.
- Someone to talk to: a friend with MOP, or a second radio of your own.

You do **not** need any other software. MOP brings its own modem.

How to read this manual

Words in a grey box, like **▶ Connect**, are exactly what you'll see on the screen: a button, a tab, or a choice in a list. Keys on your keyboard look like **Enter**. Steps are numbered; do them in order.

> **💡 Take your time**
>
> Nothing in this manual can damage your radio or your computer. If something doesn't work, go back one step, or look in chapter 13, When something's wrong.

2 Install MOP

About five minutes. MOP comes as one zip file; there's no installer to click through.

Download

1. Open your web browser and go to **mopx.duckdns.org/download**.

2. Click the big orange **⬇ Download MOP** button. Your browser saves a file called something like `MOP-0.19.2-windows.zip` in your **Downloads** folder. It's large (a few hundred MB), so give it a minute or two.

Unpack

3. Open **File Explorer**: the yellow folder on the taskbar at the bottom of the screen. Click **Downloads** on the left.

4. **Right-click** the MOP zip file and choose **Extract All...**.

5. A box opens showing where the files will go. The **Desktop** is a good place: click **Browse...**, pick **Desktop**, then click **Extract**.

6. A new folder opens, called `MOP-0.19.2`. It holds many files. The one that matters is **MOP.exe**, with the MOP icon (coloured bars with dots on top).

Make a Desktop shortcut

7. Right-click **MOP.exe**. On Windows 11, click **Show more options** first.

8. Choose **Send to** → **Desktop (create shortcut)**.

From now on you start MOP by double-clicking **MOP** on your Desktop.

The first start

Double-click **MOP**. The first time, Windows may show a blue box:

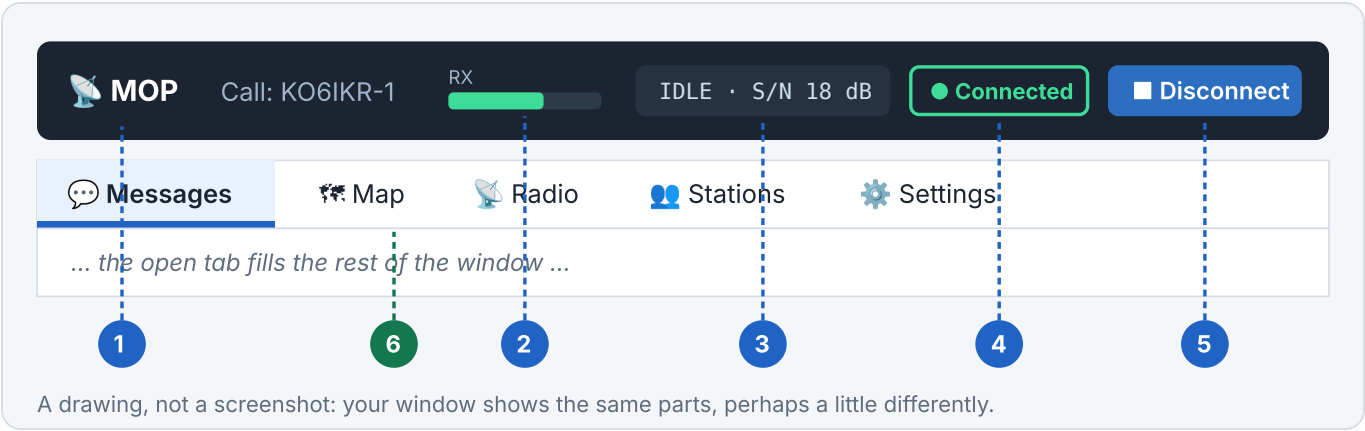
> **⚠️ "Windows protected your PC"**
>
> This appears because MOP isn't signed with a paid certificate yet. Click **More info**, then **Run anyway**. Windows remembers your choice and won't ask again.

> **⚠️ Your antivirus complains**
>
> Some antivirus programs distrust any program they haven't seen before. If yours moves MOP.exe to "quarantine", restore it and mark it as allowed. If you're unsure, ask the person who sent you MOP.

After a few seconds the MOP window opens. On to the tour.

3 The MOP window

One bar along the top, five tabs below it.



A drawing, not a screenshot: your window shows the same parts, perhaps a little differently.

#	What it is
1	**Your callsign.** Shows **Call: —** until you've set it (chapter 4).
2	**RX meter.** How loud the sound coming from your radio is. It should move when the radio receives.
3	**Link strip.** What the modem is doing: **IDLE**, receiving, sending, and the signal quality.
4	**Status.** ● **Disconnected** (red) or ● **Connected** (green): whether MOP is using the radio right now.
5	▶ **Connect** starts using the radio; it then turns into ■ **Disconnect**. Further left you may see 📖 **Manual** (opens this manual) and, when a new version is out, an orange ⬆ **MOP … available** button.
6	**The five tabs.** Click a name to switch.

The five tabs

💬	**Messages**: your conversations, groups, CQ and emergency. Chapter 7.
🗺	**Map**: every station heard, and who hears whom. Chapter 10.
📡	**Radio**: what the modem is doing, and the **Activity Log** of everything MOP did. Handy when you ask for help.
👥	**Stations**: a list of every station MOP knows, your contacts, and making groups. Chapter 9.
⚙️	**Settings**: your callsign, radio, and everything else. Chapters 4 to 6.

Settings at a glance

Click ⚙️ **Settings**. On the left is a list of five sections. Each has a coloured dot:

🟢	**Green**: fine as it is.
🟡	**Amber**: worth a look.
🔴	**Red**: needs filling in before MOP can work.

Click a section to see it. At the bottom right is one button, 💾 **Save and apply**, which saves *all* sections at once. Nothing you change counts until you press it.

4 Your station

Who you are on the mesh, what equipment you use, and where you are.

Where: ⚙️ **Settings → Station**

🪪 Identity

1. **Station ID**: type your callsign in the first box, for example `KO6IKR`.
2. In the box next to it, pick an **SSID** only if you run more than one MOP station (for example **1** for your second station). One station? Leave it at **(none)**.
3. **Role**: leave it on **station**.
   relay means "I'm on a good hill, pass messages along for others". **gateway** means "this station also shares what it hears on the internet map".
4. **Key Status**: click `Generate`, then `Yes`. MOP makes your personal **signing key**. You only do this once.

> 🔏 **What is the signing key?**
> Every message you send carries a digital signature made with your key. Other stations can check it and know the message really came from you and wasn't changed on the way. It does **not** hide anything: everyone can still read your messages, as amateur radio rules require. Back the key up (chapter 12): it's what makes you *you* on the mesh.

📻 Equipment

5. **Radio**: open the list and pick your radio, for example **Yaesu FT-991A**. Not in the list? Just type its name.
6. **Interface**: pick what connects radio and computer, for example **Digirig Mobile**, or **Radio's built-in USB audio** if you only use the radio's USB cable.

These two go into your beacon, so other operators see what you're running, on their map and in their Stations list. They don't change how MOP works.

📍 Position

Where your station is, so it shows on the map.

7. **Source**: choose **Manual only**, unless a GPS receiver is plugged in (see below).

8. **Latitude** and **Longitude**: type your position in degrees, for example `34.10413` and `-118.20832`. West and south are **negative**.

9. **Beacon**: how precisely your position goes out on the air. Everyone can read it.

Exact position (~1 m)	Your exact spot
Rounded ~100 m	Your street, not your house. A good choice at home
Rounded ~1 km	Your neighbourhood
Grid square only	Only your Maidenhead grid square

10. Leave **Set Grid from position** ticked: MOP works out your grid square for you.

> 💡 **Finding your latitude and longitude**
>
> Open Google Maps in your browser, find your house, and **right-click** on it. The first line of the little menu is your position, like `34.10413, -118.20832`. Click it to copy it.

Below the position, MOP shows the **Ground elevation here**, in metres and feet. It looks this up on the internet from NASA and USGS elevation maps. No internet? It says so, and fills it in later.

With a GPS receiver

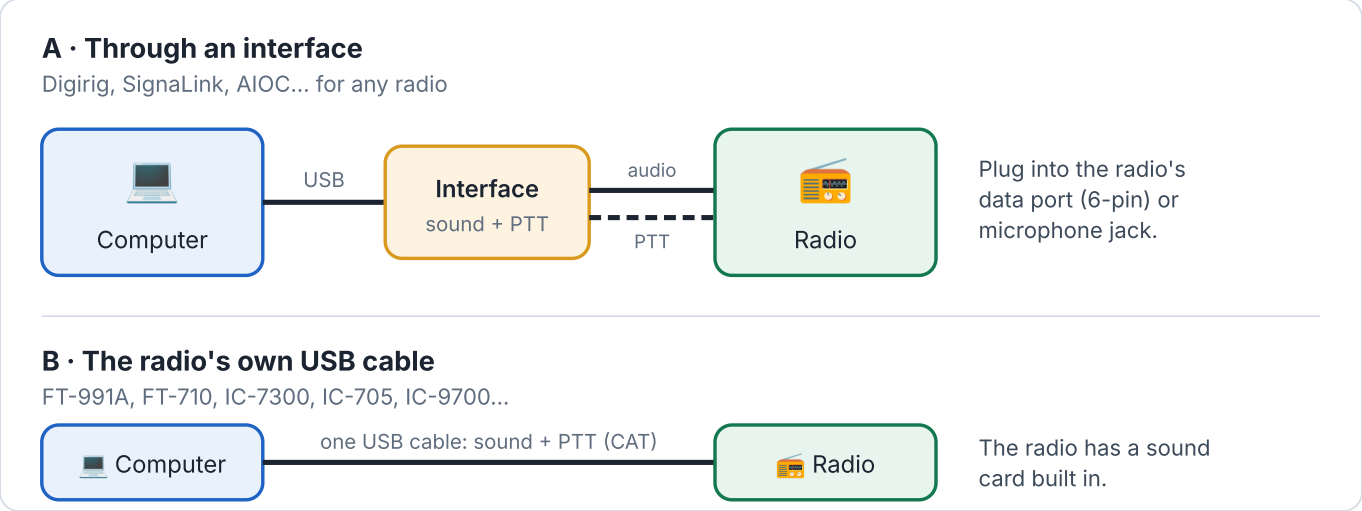
Set **Source** to **GPS (manual if no fix)**. Pick the GPS's **GPS port** (press 🔄 to look again for newly plugged-in devices) and its **Baud** (usually 4800 or 9600), then click **▶ Connect GPS**. Once it has a fix, MOP uses it; **⬇ Use GPS fix** copies that position into the Latitude and Longitude boxes, so it stays even when the GPS is unplugged.

Press **💾 Save and apply** before you move on.

5 Connect your radio

The most important chapter. MOP needs two things: **sound** in and out, and a way to **key the transmitter** (push-to-talk, or PTT).

Where: ⚙️ **Settings → Radio**



Two ways to connect. Either works the same in MOP.

Before you start: plug the interface (or the radio's USB cable) into the computer and **switch the radio on**. Windows only shows devices that are plugged in.

✅ Already using VARA FM? Most of this is done

If VARA FM works on this computer and radio, MOP can use **exactly the same** cable, sound card and push-to-talk. Open VARA FM's **Settings → SoundCard** and **Settings → PTT** menus, and copy what they say:

VARA FM says	In MOP, set
SoundCard: Device Input / Output	**Input (RX)** / **Output (TX)**: the same device
PTT: **VOX** or **SignaLink**	Method **VOX / none**
PTT: **COM**, RTS or DTR	Method **Serial RTS / DTR**, same port, the same line **high**
PTT: **CAT**, your radio and port	Method for your radio's brand (table below), same **Port** and **Speed**
VARA FM **Wide**	Radio on **FM wide** (see the box below): MOP always needs it

Close VARA FM (and Winlink Express) before you click **▶ Connect** in MOP: only one program at a time can use the sound card and the PTT port. Your radio's menu settings for VARA (DATA mode, data port, levels) are usually right for MOP as well; just check the no processing list below.

⚠️ Set the radio to FM wide (25 kHz), not narrow

MOP's 32 tones fill the whole voice channel. On **narrow** FM (12.5 kHz, often shown as **N**, **NAR** or **FM-N**) the radio cuts off the outer tones and MOP fails or slows down to a crawl. Set the radio, or the memory channel you use for MOP, to **wide** (**W**, **FM**, 25 kHz). Both stations must be on wide.

⚠️ No tone squelch on the MOP channel

Use plain **carrier squelch** (or leave the squelch open) on the frequency you use for MOP, **not** tone squelch (CTCSS, "T SQL", DCS). A tone squelch opens a moment too late, and the start of every MOP transmission is the part MOP needs most. Transmitting a tone is fine; only the *receive* side must not wait for one.

🔊 Sound

1. **Input (RX)**: open the list and pick your interface's microphone. It's usually called **USB Audio Device**, **USB Audio CODEC** or **USB PnP Sound Device**. Do *not* pick your computer's own microphone.
2. **Output (TX)**: pick the same interface's speakers (same kind of name).
3. Look for a ✔ next to each one. A ✖ means Windows has that device at the wrong setting. Appendix B fixes it in two minutes.

> 💡 **Your interface isn't in the list?**
> Unplug it, plug it in again, and press 🔄 **Refresh**.

> 💡 **Several USB sound cards that all look the same?**
> Digirigs and most USB interfaces all call themselves **USB Audio Device** or **USB PnP Sound Device**. Give each one its own name in Windows, like **Digirig 991**, so you always pick the right one. It takes two minutes: Appendix B, "Give your interface its own name".

🎙️ Push-to-talk

4. **Method**: pick how MOP keys your radio. Find your setup in the table below.
5. Fill in the boxes that appear under it. Most methods only ask for a **Port** (like `COM5`; Appendix A shows how to find yours) and sometimes a **Speed**.
6. Tune the radio to a **clear frequency**, or connect a dummy load, and press 🔴 **Test PTT (1 s)**. Your radio should transmit for **one second**.

Your setup	Pick this Method
Digirig Mobile, or a serial interface	**Serial RTS / DTR**, with RTS **high**
Digirig Lite, **AIOC** cable, CM108 sound card	**CM108 GPIO**, pin GPIO 3
SignaLink, or the radio on VOX	**VOX / none**
Yaesu **FT-991A, FT-891, FT-710, FTDX10, FTDX101** on USB	**Yaesu CAT (TX1; / TX0;)**
Yaesu **FT-817, FT-818, FT-857, FT-897**	**Yaesu CAT, 5-byte**
Icom (IC-7300, IC-705, IC-9700…) on USB	**Icom CI-V**
Kenwood or **Elecraft**	**Kenwood / Elecraft CAT**
Anything else with computer control	**Hamlib rigctld** (or **flrig**, if it already runs your radio)

> ⚠️ **Test PTT sends a carrier**
> 🔴 **Test PTT (1 s)** keys the transmitter for one second without sound. Use a clear frequency or a dummy load, and make sure you're on a frequency you may transmit on.

Recipes

Find your setup and do just that one. Each recipe ends with 💾 **Save and apply**.

🔌 Digirig Mobile (any radio)

1. **Input (RX)** and **Output (TX)**: the Digirig's sound card (**USB Audio Device** or **USB PnP Sound Device**).
2. **Method**: **Serial RTS / DTR**.
3. **Port**: the Digirig's COM port. In Device Manager it's the **Silicon Labs CP210x USB to UART Bridge** line.
4. **RTS**: **high**. **DTR**: **off**.
5. 🔴 **Test PTT (1 s)**.
6. Going into the **microphone jack**? Switch off the radio's speech processor and mic EQ (see Keep the sound clean).

🎛️ Digirig Lite or AIOC cable

1. **Input (RX)** and **Output (TX)**: the interface's sound card.
2. **Method**: **CM108 GPIO**. **Device**: pick yours, or leave **first one found**.
3. **PTT pin**: **GPIO 3**.
4. 🔴 **Test PTT (1 s)** .

🟦 Yaesu FT-991A on its own USB cable

On the radio:

1. Press **MENU** and set **CAT RATE** to **38400**.
2. Set the menu that chooses where data audio comes from to **USB** (on the FT-991A it's **DATA PORT SELECT**), and use a **DATA** mode for MOP. Your radio's manual has the details.

In MOP:

3. **Input (RX)** and **Output (TX)**: **USB Audio CODEC**.
4. **Method**: **Yaesu CAT (TX1; / TX0;)**.
5. **Port**: the radio's **Enhanced** COM port. Device Manager shows two; use the one that says *Enhanced*.
6. **Speed**: **38400**, the same as CAT RATE on the radio.
7. 🔴 **Test PTT (1 s)** .

🟥 Icom IC-7300, IC-705 or IC-9700 on USB

On the radio:

1. **MENU → SET → Connectors**: set the data modulation input (**DATA MOD**, or *USB MOD Level*, depending on the model) so data audio comes from **USB**.
2. In the **CI-V** menu, note the **CI-V Baud Rate**.

In MOP:

3. **Input (RX)** and **Output (TX)**: **USB Audio CODEC**.
4. **Method**: **Icom CI-V**.
5. **Port**: the radio's COM port (Device Manager: **USB Serial Device** or **Silicon Labs**).
6. **Speed**: the CI-V Baud Rate from the radio.
7. **CI-V address**: pick your radio from the list.
8. 🔴 **Test PTT (1 s)**.

🔈 SignaLink, or any interface with its own VOX

1. **Input (RX)** and **Output (TX)**: the SignaLink's sound card (**USB Audio CODEC**).
2. **Method**: **VOX / none**. The SignaLink keys the radio by itself when MOP plays sound.
3. Turn the SignaLink's **DLY** knob fairly low (around 9 o'clock), so the radio goes back to receive quickly after each transmission. MOP needs to hear the answer.
4. Cabled to the **microphone jack**? Switch off the radio's speech processor and mic EQ (see Keep the sound clean).

🧰 Kenwood, Elecraft and other radios

Kenwood and Elecraft radios: **Method Kenwood / Elecraft CAT**, then **Port** and **Speed** as set in the radio's menu.

Other radios with computer control: install the free **Hamlib** package, start `rigctld` for your radio, and choose **Hamlib rigctld** in MOP with address `127.0.0.1:4532`. Already using **flrig**? Choose **flrig**; nothing else to install.

🚫 Keep the sound clean: no processing

> **⛔ Switch off every audio "improvement", on the radio and on the computer**
>
> MOP sends **32 tones side by side**, all at once. Speech processors, compressors, equalizers and noise reduction are made for a *voice*: they make some of those tones louder, others quieter, and smear the rest. The other station then can't read them. Even a little processing can turn a perfect signal into nothing. This matters most when the audio goes into the radio's **microphone jack**, because that path runs through all of the radio's voice processing.

On the radio: switch these OFF (for transmit)

Look for	Also called
Speech processor	PROC, PROCESSOR, COMP, speech compressor
Microphone equalizer	MIC EQ, PRMTRC EQ, TX EQ, TBW (transmit bandwidth set to wide is fine), tone/bass/treble
Voice effects	voice changer, scrambler, "DX voice", VOX delay effects

On the radio: switch these OFF (for receive)

Look for	Also called
Noise reduction	DNR, NR, DSP NR, noise cancel
Noise blanker	NB
Audio filters and tone shaping	CONTOUR, NOTCH, DNF (auto notch), RX EQ, APF

Radios differ: look in your radio's manual for the menu names. If you can, use a **DATA** mode and the **data port** (6-pin mini-DIN) or the radio's USB audio: those paths skip most voice processing. In the microphone jack, also keep **MIC GAIN** moderate: too high squashes the tones just like a compressor.

On the computer: switch off Windows sound effects

Windows can "improve" the interface's sound as well. Turn that off, once, for both directions. Appendix B shows where: in the same **Properties** windows where you set 48 kHz.

- **Enhancements** tab (or **Audio enhancements** in Windows 11): **Off** / tick **Disable all enhancements**. That includes noise suppression, echo cancellation, and loudness equalization.
- Any "sound booster", headset or gaming audio program (Realtek Audio Console, Nahimic, Dolby, Sonic Studio…): off for the interface.

> **💡 How do I know it's clean?**
> The 📡 **Radio** tab shows each received frame's signal quality (S/N) and the constellation: neat, tight dots mean clean audio. If the other station hears you at a *lower* S/N than you hear them, look for processing on your transmit side first.

📊 Levels

Leave **TX drive** at **70 %** and **RX gain** at **100 %** to start with.

> **💡 Fine-tuning later**
> MOP sends 32 tones at once. Too much drive distorts all of them. If the other station's signal quality gets *worse* as you turn TX drive up, turn it back down. On the receive side, set your radio's data-port level first and leave RX gain at 100 %.

📶 Modem

Click **Modem** in the list on the left. It should say **Backend: ofdm** and **Level: Auto**. Leave it like that: MOP picks the fastest speed the path allows by itself.

Now press `💾 Save and apply`**.** A box says *Settings saved*; click `OK`.

6 On the air

Connect, send a beacon, and see the other station appear.

1. Tune both radios to the same **simplex** frequency your group uses for MOP, in **FM wide** (not narrow; see chapter 5).
2. Click `▶ Connect` at the top right. The status turns green: ● **Connected**.
3. Go to ⚙️ **Settings → Beacons & Internet** and click `📡 Beacon Now`. Your radio transmits a short burst, about a second. That's your station announcing itself.
4. Ask the other station to do the same. When their beacon arrives, they appear in the 👥 **Stations** tab and on the 🗺 **Map**.

> **✅ It worked if…**
> …the other station's callsign shows up in 👥 **Stations** with a green dot, and the RX meter at the top jumped when their beacon came in.

Automatic beacons

In ⚙️ **Settings → Beacons & Internet**, **Enable beacons** sends a beacon by itself every **Interval** (2 hours unless you change it). MOP also learns about stations from *everything* it hears, so after a while stations appear without anyone pressing anything.

> **💡 Leave MOP connected**
> MOP only receives while it's connected. Leave it on ● **Connected** when you're near the radio; messages for you, and messages you pass along for others, depend on it.

Messages

Like texting on a phone: one conversation per station, with ticks that tell you when it arrived.

Where: 💬 **Messages**

The list on the left has three parts:

Part	What's in it
CHANNELS	📣 **CQ / Bulletins** (to everyone in range) and 🚨 **Emergency** (to the whole mesh).
GROUPS	Your groups, and **+ New group…**. Chapter 8.
STATIONS	One conversation per station, newest first, with how well you hear each other.

Send your first message

1. Under **STATIONS**, click the other station's callsign. Not there yet? Click **+** at the top of the list and type their callsign, for example `KO6IKS-2`.
2. Type your message in the box at the bottom, for example `Hello from MOP! 73`.
3. Press **Enter**, or click **Send**. For a new line without sending, press **Shift** + **Enter**.
4. Your radio transmits. Watch the mark next to your message.

What the marks mean

Mark	Meaning	What you can do
⏳	**Sending.** On its way; big messages show their progress.	Wait.
✓	**Delivered.** The other station has it and confirmed, even if it went through relays.	Nothing: done.
⏸	**Waiting.** The station isn't reachable right now. MOP sends it the moment that station is heard again.	**Send now** or **Cancel**.
✕	**Failed.** No answer after many tries (or 48 hours).	**Resend** or **Edit**.

> 💡 **You don't need to stay at the computer**
>
> A ⏸ waiting message is fine. It goes out by itself when the other station beacons again, as long as your MOP stays connected.

📣 CQ / Bulletins

Click 📣 **CQ / Bulletins** and type: your message goes to **every station in range**, and relays repeat it a few hops further. Nobody confirms a bulletin, so there's no ✓.

🚨 Emergency

Only for real emergencies. A message here travels through the **whole mesh**: every station passes it on, and every MOP alerts its operator. MOP asks you to confirm before it sends.

📎 Files, pictures and your position

- 📎 next to the message box attaches a file or picture. Pictures are made smaller automatically. Keep files small: radio is slow compared to the internet.
- 📍 attaches your position, which the other station can open on their map.
- Files you receive are kept in **Documents\MOP\attachments**.

More

- The bar above each conversation shows how well you hear each other, the speed level, and buttons for the **Map** and a **Level test**.
- **Right-click** a conversation to delete it.
- Prefer the classic mailbox view (Inbox, Outbox, Sent, Trash)? Click **Folders** at the top of the list; **Conversations** brings you back.

Groups

One message to several stations, for a net, a club, or an ARES team.

A group message goes out once; every member in range receives it and confirms it, one after the other. Members who are out of range get their own copy, through relays or later.

Make a group from the Stations list (easiest)

1. Click the 👥 **Stations** tab.
2. Click the first station you want in the group.
3. Hold **Ctrl** and click each of the others. (Or hold **Shift** and click to pick everything between two stations.) The panel on the right lists who you picked.
4. Click **👥 Create group** at the top right.
5. Type a name, for example `ARES LAX-NE`, check the ticked members, and click **OK**.
6. MOP jumps to 💬 **Messages**. Your group is under **GROUPS**, ready for its first message.

Or from Messages

Under **GROUPS**, click **+ New group…**, type a name, tick the members, and click **OK**. A member who's never been heard? Type their callsign in the box at the bottom and click **Add**.

Change a group

- **Add stations:** in 👥 **Stations**, pick them, **right-click**, and choose **Add to group** → the group.
- **Rename, add or remove members:** open the group in Messages and click **Members**.
- **Delete:** right-click the group in Messages → **Delete group…**. Its messages stay.

Members learn about the group with your first message to it. From then on, anyone in the group can write to all members.

9 Stations

Every station MOP knows: heard on the air, passed along by relays, or saved as a contact.

Where: 👥 **Stations**

Column	What it tells you
Station	The callsign. The dot is **green** if heard in the last 10 minutes, **amber** within the hour, grey if longer ago.
Name	The name you saved for this contact.
Route	**direct** (you hear each other), or **via** a relay. Also shows if it's a relay or gateway.
We hear / they hear	Signal quality both ways, in dB. Higher is better: green is good, amber is fair, red is weak.
Level	The speed MOP uses toward that station (L0 is slowest and toughest).
Grid · km	Their grid square and distance from you.
Heard	How long ago MOP last heard them.

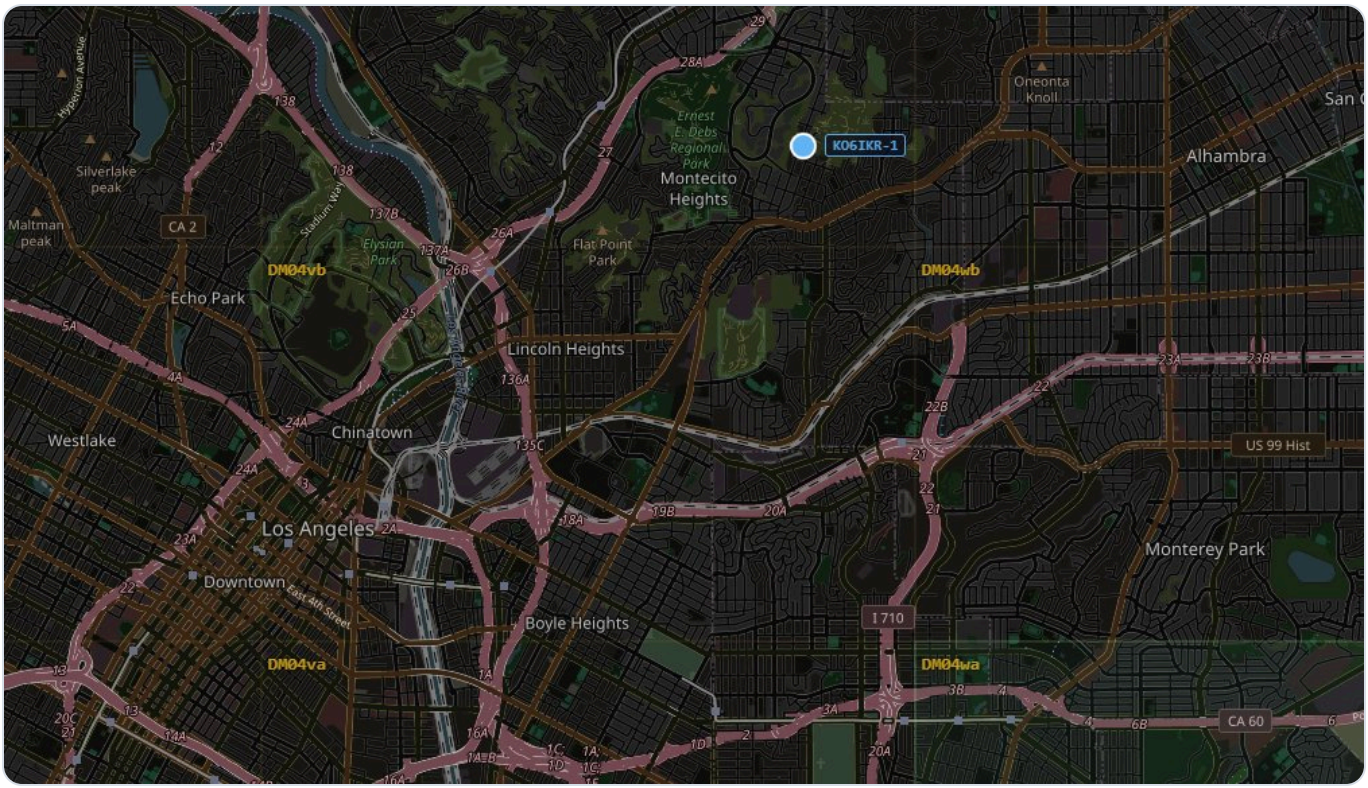
Click a station and the panel on the right shows everything about it: route, signal both ways, position, **ground elevation**, the **radio** and **interface** they use, who they hear, and which of your groups they're in.

- **Message** opens your conversation with them (double-clicking the row does the same).
- **Map** shows them on the map.
- **Name** and **Notes**, then **Save contact**, keep them in your contacts.
- **Add contact** (top right) adds a station you haven't heard yet.
- The search box finds a callsign, name or grid.

10 The map

Where everybody is, and who can hear whom.

Where: 🗺 **Map**



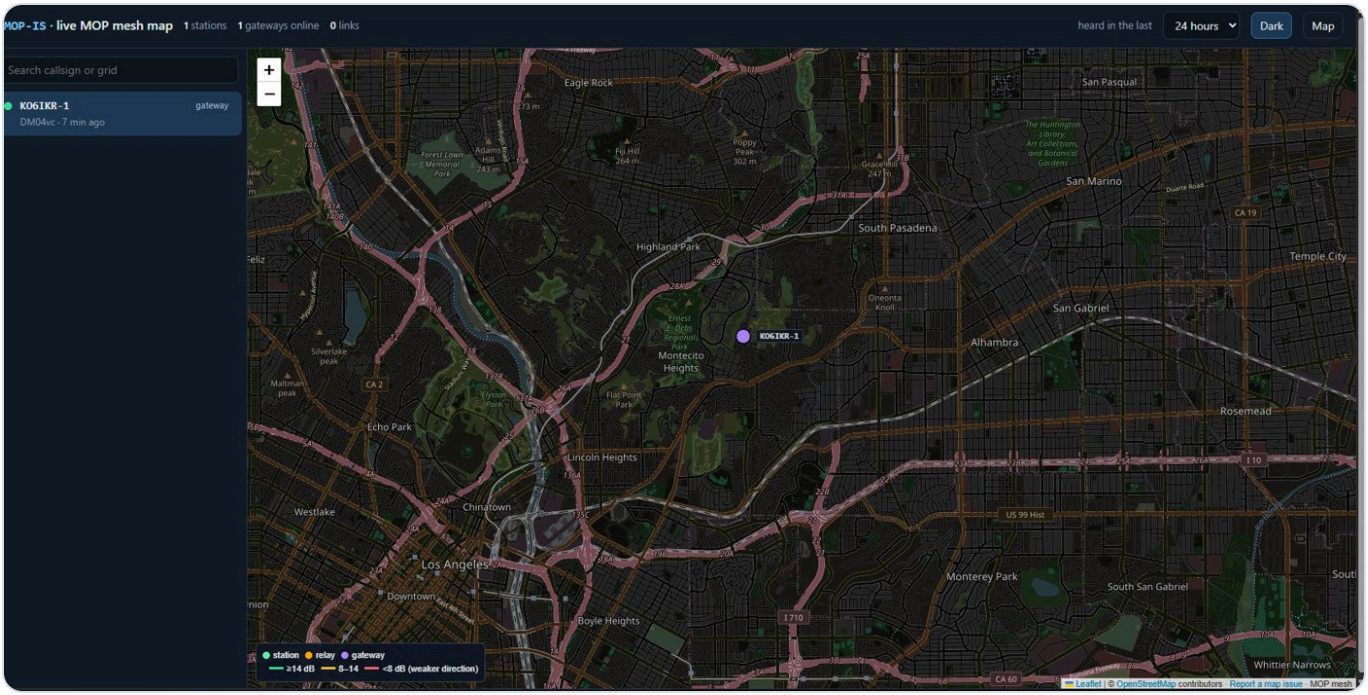
The map, zoomed in, with Maidenhead grid squares.

- Every station heard is a dot. Lines between stations are links, coloured by signal quality.
- **Click a station** for its details. The box stays open until you click again.
- 📍 **Me** brings you back to your own position.
- **Dark** and **Map** switch between a dark background and a normal street map.
- As you zoom in, the **Maidenhead grid** appears, down to 8 characters.
- Map pictures you've looked at are kept on your computer, so those areas still show without internet.

Map data © OpenStreetMap contributors.

11 The public map & updates

Optional: share what your station hears on the MOP-IS map, which anyone can watch in a browser.

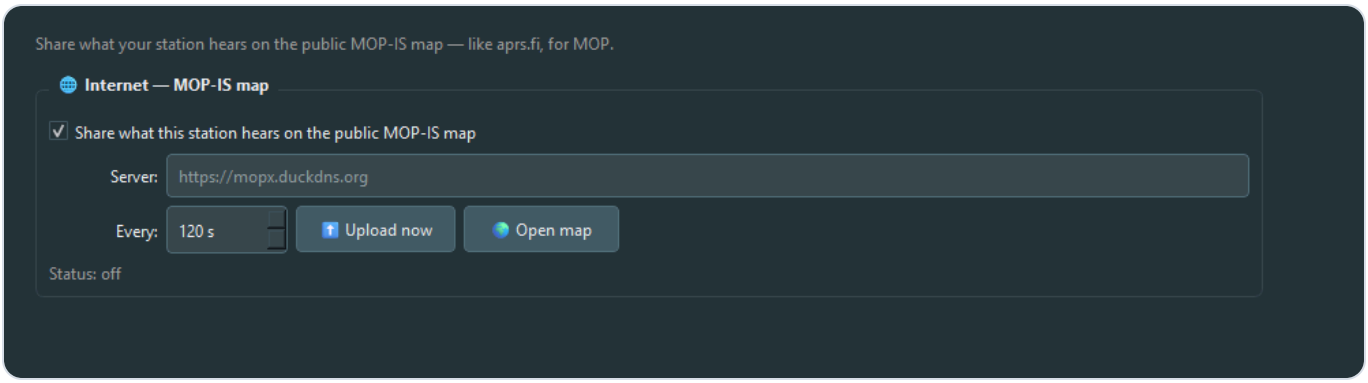


The MOP-IS map at mopx.duckdns.org: stations, links and gateways, live.

Share what you hear

Where: ⚙️ **Settings → Beacons & Internet**, the 🌐 **Internet** box

1. Tick **Share what this station hears on the public MOP-IS map**.
2. Leave **Server** empty (MOP uses `https://mopx.duckdns.org`) and **Every** as it is.
3. Press 💾 **Save and apply**, and make sure MOP is ● **Connected**.
4. The status line shows ✔ **uploaded** after the first upload, or press ⬆ **Upload now**. 🌍 **Open map** opens the map in your browser.



> 🔒 **What is shared, and what isn't**
>
> Shared: callsigns, positions (as precise as each station's own beacon setting), grid, role, radio and interface, who hears whom and how well. **Never** the contents of messages. Every upload is signed with your key, so nobody else can upload under your callsign.

Updates

With **Check for MOP updates** ticked (it is, unless you untick it), MOP asks the server once a day whether there's a newer version. If there is, an orange **⬆ MOP … available** button appears at the top.

1. Click it. Your browser opens the download page.
2. Download and **Extract All…** the new zip, exactly as in chapter 2.
3. Start **MOP.exe** from the new folder, and make a new Desktop shortcut (delete the old one).
4. Happy with the new version? Delete the old `MOP-…` folder.

Your callsign, settings, messages and key carry over by themselves (chapter 12 explains why).

12 Your files & backups

MOP keeps the program and *your* things in two separate places.

Folder	What's in it	Delete it?
MOP-0.19.2 wherever you extracted it, e.g. the Desktop	The program: **MOP.exe** and the files it needs.	Yes, once a newer version runs.
Documents\MOP	*Your* things: settings, messages, signing key, received files, map pictures.	**No.** Back it up now and then.

Inside Documents\MOP

`KO6IKR.key` (your callsign)	Your **signing key**. The one file you really must back up.
`mop_settings.ini`	Your settings.
`mop_data.db`	Your messages and contacts.
`attachments`	Files and pictures you've received.
`map_cache`	Map pictures, for the map without internet.

Back up your key

1. Open **File Explorer**, click **Documents** on the left, and double-click **MOP**.
2. Find the file named after your callsign, ending in `.key`.
3. Copy it to a USB stick (right-click → **Copy**, then on the stick right-click → **Paste**).

> **⚠ New computer?**
>
> Install MOP on the new computer, start it once, close it, and put your `.key` file (or the whole **Documents\MOP** folder) in **Documents\MOP** on the new computer. You're "you" again on the mesh. Without your old key, other stations and the public map will see a *different* key under your callsign and distrust it.

13 When something's wrong

Find what you see in the left column.

🚦 MOP won't start

You see	Do this
Blue box **"Windows protected your PC"**	Click `More info`, then `Run anyway`.
Antivirus warns, or MOP.exe disappeared	Restore it from quarantine and mark it as allowed.
Nothing happens when you double-click	Wait 20 seconds. Still nothing? In the MOP program folder, look for **MOP-errors.log** and send it to whoever gave you MOP.

🎙️ Radio

You see	Do this
The radio doesn't transmit	Check **Method**, **Port** and **Speed** against the recipes in chapter 5, then 🔴 **Test PTT (1 s)** again.
`cannot open COM5` in the Activity Log	Another program is using that port (close it), or it's the wrong number (Appendix A).
You hear MOP in your headset or PC speakers instead of on the radio	Several devices share a name, or Windows renumbered them. Give your interface its own name (Appendix B), then pick it again in Settings → Radio and 💾 **Save and apply**. The Activity Log shows which device MOP opened.
A ✖ next to a sound device	Pick the interface's own sound card, and set it to 48 kHz (Appendix B).
The radio transmits but nobody hears you	Check the radio is in the right mode (DATA on Yaesu/Icom USB), and that TX drive isn't at zero.
They hear your beacon, but at a poor S/N, or messages fail while theirs come through fine	Audio processing on your side: switch off the speech processor, compressor and mic EQ on the radio, and Windows sound enhancements (chapter 5, Keep the sound clean). Then try a lower TX drive.
Nothing from one station decodes at all, though you hear it	Tone squelch (CTCSS / T SQL / DCS) on your receive side: switch to carrier squelch on the MOP channel (chapter 5).
Short beacons work, longer messages fail, or MOP stays at the slowest level	Check both radios are on **FM wide**, not narrow (chapter 5).
`cannot open` the sound card or COM port, and VARA FM is installed	Close VARA FM and Winlink Express first: only one program can use them at a time.
You hear their beacons but often can't read them	Switch off noise reduction (DNR/NR), noise blanker and audio filters on your radio's receive side, and Windows sound enhancements on the microphone side.
The RX meter never moves	Wrong **Input (RX)**, or the radio's squelch/volume to the data port is off.
`rigctld … not reachable`	Start rigctld first, and check the address.

💬 Messages

You see	Do this
▮ **waiting** for a long time	That station hasn't been heard since. It goes out when they beacon. In a hurry? **Send now**.
✕ **failed**	Look at the signal numbers in the conversation's top bar. **Resend**, or try when a relay is on the air.
⚠️ **BAD SIG** on a message	The message changed on the way, or the key isn't theirs. Be careful with it, and check with the sender.

🌍 The public map

Status says	Do this
`press 💾 Save and apply to start sharing`	Press **💾 Save and apply**.
`waiting for Connect`	Sharing only runs while connected: click **▶ Connect**.
`registered with another key`	Your callsign is tied to your old key (new computer?). Put your old key back (chapter 12), or ask the map's administrator to reset it.

🆘 Still stuck? Send the log

1. Click the 📡 **Radio** tab. The **Activity Log** on the right lists everything MOP did.
2. Click inside the log, press **Ctrl** + **A** (select all), then **Ctrl** + **C** (copy).
3. Paste it (**Ctrl** + **V**) into an email to whoever gave you MOP, and say what you expected to happen.

14 Where MOP is going

MOP is young and growing fast. Here's what it can do today, where you are on the road, and what's coming. Plans can change; your feedback helps decide what comes first.

DONE

A modem of its own

32 tones in one FM voice channel, from a tough 1,050 bit/s up to 9,450 bit/s on a clean path. MOP picks the speed for each station by itself.

DONE

A mesh that finds its own way

- Beacons, routes, and relays that pass messages along, with the ✓ coming back the same way.
- Messages wait for stations that are off the air (store-and-forward).
- Conversations, groups, CQ bulletins, and the emergency channel; files, pictures, positions.
- Every message signed; compressed when that makes it shorter.

DONE

Ready for your shack

- Push-to-talk for practically every radio and interface.
- The public MOP-IS map, the download page, and automatic update notices.
- Radio, interface and ground elevation for every station; this manual.

YOU ARE HERE MOP 0.19

The first testers on the air

That's you. Every beacon, delivered message, and problem you report shows what works on real radios, real antennas and real hills. When something goes wrong, send the Activity Log (chapter 13).

NEXT

The EmComm tab

A sixth tab for emergency and public-service work, built on the forms and net tools served agencies already know. See the sketch below.

NEXT

Mesh islands, linked: coast to coast

Gateways pass messages between separate MOP meshes over the internet, directly from gateway to gateway, with no central server. A message from Los Angeles reaches a mesh in New York, and the ✓ still comes back. See the story below.

LATER

Faster and further

- Big files in fewer transmissions.
- Shorter messages through smarter compression, tuned to ham traffic.
- Signed beacons, and the published on-air specification.

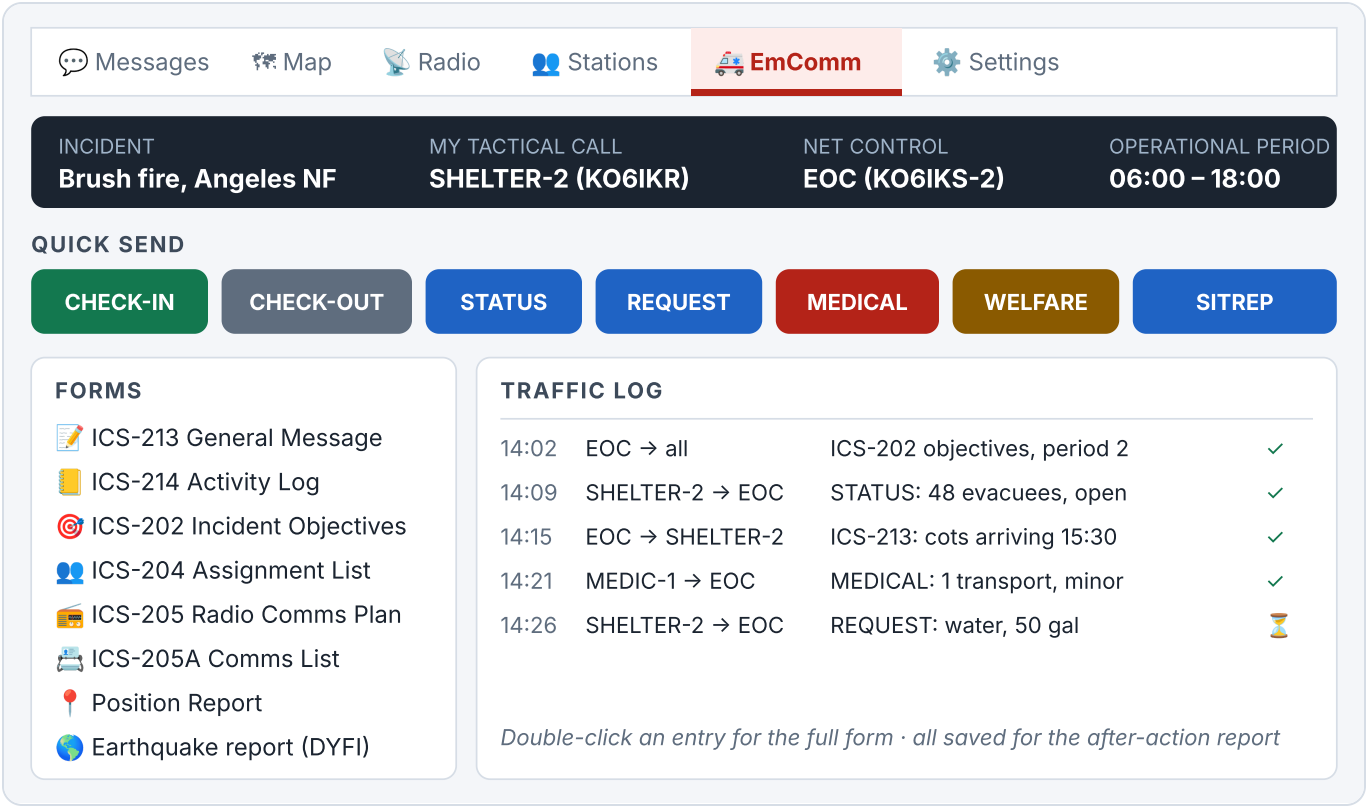
GOAL

MOP 1.0

A dependable mesh that any served agency, club, or ARES group can put on the air and count on when the phones and the internet are down.

A first look at the EmComm tab

A design sketch, not the finished screen. It brings back and improves the EmComm tools from an earlier MOP, on top of today's mesh:



Design sketch of the planned EmComm tab. Names, places and messages are made up.

📋 Incident session

Set the incident, your tactical callsign (SHELTER-2, EOC, MEDIC-1…), net control and the operational period once. Every message and form carries them; the session survives a restart.

⚡ Quick send

One button for the messages a net sends over and over: check-in, check-out, status, request, medical, welfare, sitrep. Fill in the blanks, send.

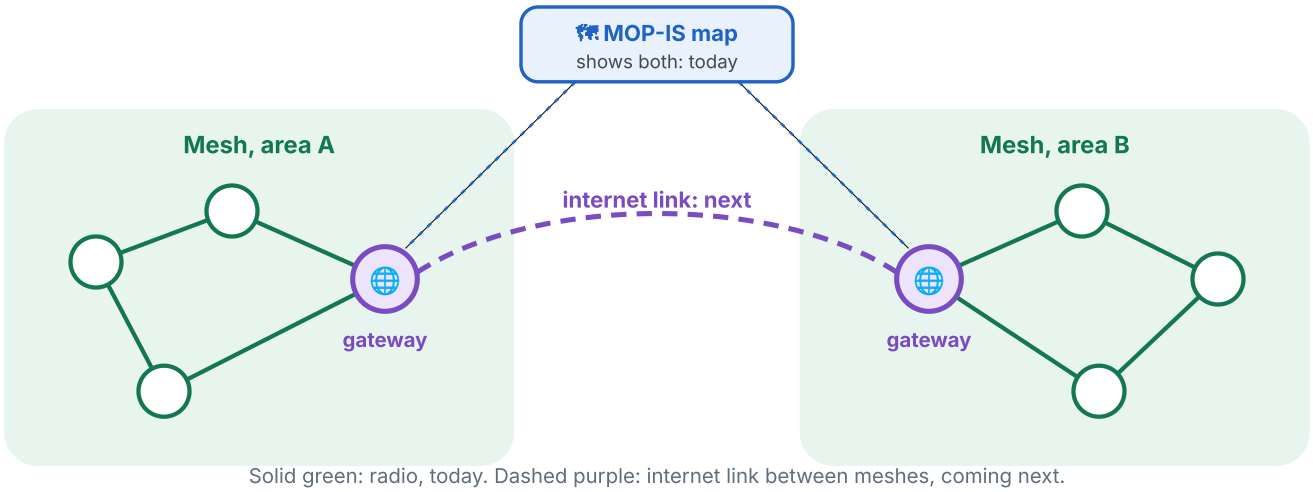
📝 ICS forms

ICS-213, 214, 202, 204, 205 and 205A, a position report and an earthquake report, filled in on screen, sent compact over the mesh, and shown as a proper form on the other side.

📒 Traffic log

Every message in and out, with time and delivery tick. Saved for the ICS-214 activity log and the after-action report.

The bigger picture



Solid green: radio, today. Dashed purple: internet link between meshes, coming next.

Today each area is its own mesh, and the public map shows them all. Next, gateways will carry messages between them.

Coming next: a message from Los Angeles to New York

How a message will cross the country once gateways are linked. Callsigns are made up.

1. **W6QQQ in Los Angeles** writes to K1ZZZ in New York. Her MOP doesn't know K1ZZZ, but from the beacons it hears it knows a **gateway** nearby, KO6IKR-GW, that has internet.
2. MOP sends the message as **one short burst**, about a second on the air. No connecting, no handshake.
3. **A relay** on a hill hears it and passes it on toward the gateway.
4. **The LA gateway** doesn't have K1ZZZ nearby, but it has heard from the New York gateway, W1ABC-GW, that K1ZZZ is one of *its* stations.
5. The LA gateway sends the message **straight to the New York gateway** over the internet. Gateway to gateway, no central server. The signature travels with it, so New York can check it really came from W6QQQ.

6. K1ZZZ's radio is off. The New York gateway **holds the message** and waits.

7. K1ZZZ switches on. As soon as his station is heard, the gateway **sends him the message**.

8. K1ZZZ's MOP confirms, and the confirmation travels all the way back. In Los Angeles, W6QQQ's message turns to ✔ **delivered**.

Everything up to step 3, and steps 6 to 8 inside one mesh, works today. Steps 4 and 5, the gateways talking to each other, are what's being built next.

> 💬 **Tell us what you need**
>
> Served agencies, ARES teams and clubs all work a little differently. Which forms, which quick messages, which features would make MOP useful in *your* next exercise? Tell the person who gave you MOP: that's how the road map gets its order.

Finding your COM port

When an interface or radio connects over USB, Windows gives it a number like COM5. MOP needs that number to key your radio.

1. **Plug in** the interface or radio, and switch the radio on.
2. Press the **Windows key** (bottom-left of the keyboard, with the Windows logo), type `device manager`, and click **Device Manager**.
3. Find **Ports (COM & LPT)** and click the little arrow **›** in front of it.
4. Look for a line like these, and write down the number in brackets:

You see	It is
`Silicon Labs CP210x USB to UART Bridge (COM5)`	A **Digirig Mobile**
`Silicon Labs Dual CP2105 USB to UART Bridge: Enhanced COM Port (COM6)`	A Yaesu FT-991A, FT-710 or similar: use this **Enhanced** one
`Silicon Labs Dual CP2105 … Standard COM Port (COM7)`	The radio's other port: not this one
`USB Serial Device (COM4)`	Many Icom radios (IC-7300, IC-705, IC-9700)

> 💡 **Which one is mine?**
> Unplug the USB cable and watch which line disappears. Plug it back in: that's yours.

> ⚠️ **No "Ports" section, or a yellow ⚠ mark?**
> Windows is missing the driver. For a Digirig and most Yaesu radios it's the **Silicon Labs CP210x driver**, free from silabs.com or your radio maker's website. Install it, then unplug and plug in again.

Setting your sound card to 48 kHz

MOP's modem needs the interface's sound card set to 48 kHz, both directions. Two minutes.

Speaker side (MOP → radio)

1. Right-click the **speaker icon** 🔊 at the bottom-right of the screen, next to the clock.
2. Click **Sound settings**.
3. Scroll down and click **More sound settings** (Windows 11) or **Sound Control Panel** (Windows 10). A small window with tabs opens.
4. On the **Playback** tab, click your interface once (**USB Audio Device**, **USB Audio CODEC** or **USB PnP Sound Device**).
5. Click **Properties**, then the **Advanced** tab.
6. Under **Default Format**, choose **2 channel, 16 bit, 48000 Hz (DVD Quality)**, or 1 channel if that's all it offers. Click **OK**.

Microphone side (radio → MOP)

7. In the same small window, click the **Recording** tab.
8. Click your interface's microphone once, then **Properties** → **Advanced**.
9. Choose **… 48000 Hz** again, and click **OK**, then **OK** to close.

> ⚠️ **Don't make the interface your default speaker**
>
> On the **Playback** tab, keep your normal speakers as the *default* device. Otherwise Windows sounds (dings, notifications) go out over the air.

Give your interface its own name

With more than one USB sound card plugged in (a Digirig for each radio, a USB headset, a webcam), they often all have the same name. Windows lets you rename them, and MOP then shows your name.

10. In the same small sound window, on the **Playback** tab, **right-click** the interface and choose **Properties**.

11. On the **General** tab, the name at the top is a box you can type in. Replace it with a short name of your own, for example `Digirig 991`. Keep it under about 25 letters. Click **OK**.
    Not sure which one it is? Unplug the interface: the one that disappears is it.

12. Do the same on the **Recording** tab for its microphone side, for example `Digirig 991 RX`.

13. In MOP: ⚙️ **Settings → Radio**, press 🔄 **Refresh**, pick your newly named devices, and press 💾 **Save and apply**.

> ⚠️ **Keep it in the same USB socket**
>
> Windows remembers the name for that interface **in that USB socket**. Plugged into a different socket, it may come back as "USB Audio Device", and you rename it once more.

Switch off sound enhancements (both sides)

14. Still in the **Properties** window of the interface (Playback side, then Recording side), look for an **Enhancements** tab. Tick **Disable all enhancements** (or untick every effect).
    Windows 11 may show this as **Audio enhancements: Off** in the device's page in Sound settings instead.

15. If you see an **Advanced** tab option **Enable audio enhancements**, untick it too. Click **OK**.

16. On the **Communications** tab of the small sound window, choose **Do nothing**, so Windows never turns the interface down when it thinks you're on a call.

Back in MOP, ⚙️ **Settings → Radio** now shows a ✔ next to both.

⊏ Words you'll meet

Word	Plain meaning
Beacon	A short "I'm here" transmission: callsign, position, who you hear.
Mesh	All MOP stations together, passing messages for each other.
Relay	A station that passes messages along for stations that can't hear each other.
Gateway	A station that also shares what it hears on the public internet map.
Hop	One trip from one station to the next. Via one relay is two hops.
ACK	"Got it": the confirmation that turns ⏳ into ✓.
S/N, dB	Signal-to-noise ratio: how clearly a signal comes through. Higher is better.
Level (L0–L6)	MOP's speed steps. L0 is slow and tough; higher levels are faster but need a cleaner signal.
OFDM	How MOP's modem works: 32 tones at once in one FM voice channel.
Signing key	Your personal digital signature. Proves a message is yours; hides nothing.
PTT	Push-to-talk: how MOP switches your radio to transmit.
CAT	Computer control of a radio over its USB or serial port.
COM port	The number Windows gives a USB serial connection, like COM5.
Sound card	The audio part of your interface or the radio's USB connection.
48 kHz	The sound setting MOP needs (48,000 samples per second).
Driver	A small program that lets Windows talk to a piece of hardware.
Grid square	A Maidenhead locator like DM04, the ham way to say roughly where you are.
FM wide / narrow	Channel width: wide is 25 kHz, narrow 12.5 kHz. MOP needs wide.
SSID	A number after your callsign (KO6IKR-1) when you run more than one station.

MOP is free for licensed amateur radio operators. It includes third-party components under their own licenses (Qt and PySide6 under the LGPL v3); see `LICENSE` and `THIRD_PARTY_NOTICES.md` in the MOP folder. Elevation data: Terrain Tiles (SRTM/NASA, USGS 3DEP). Map data © OpenStreetMap contributors. 73 de KO6IKR.