

PACIFICON

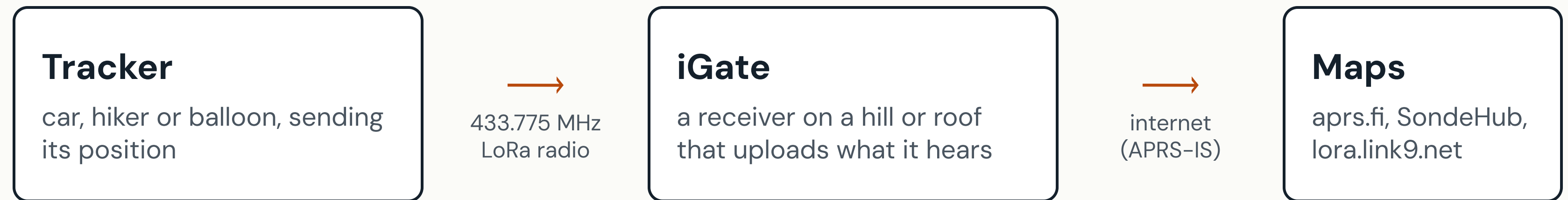
A LoRa APRS Tracker

Our tracker results from HAB balloon flights, and urban driving tests

Walter Dunckel, K6ATV

WHAT IS LORA APRS?

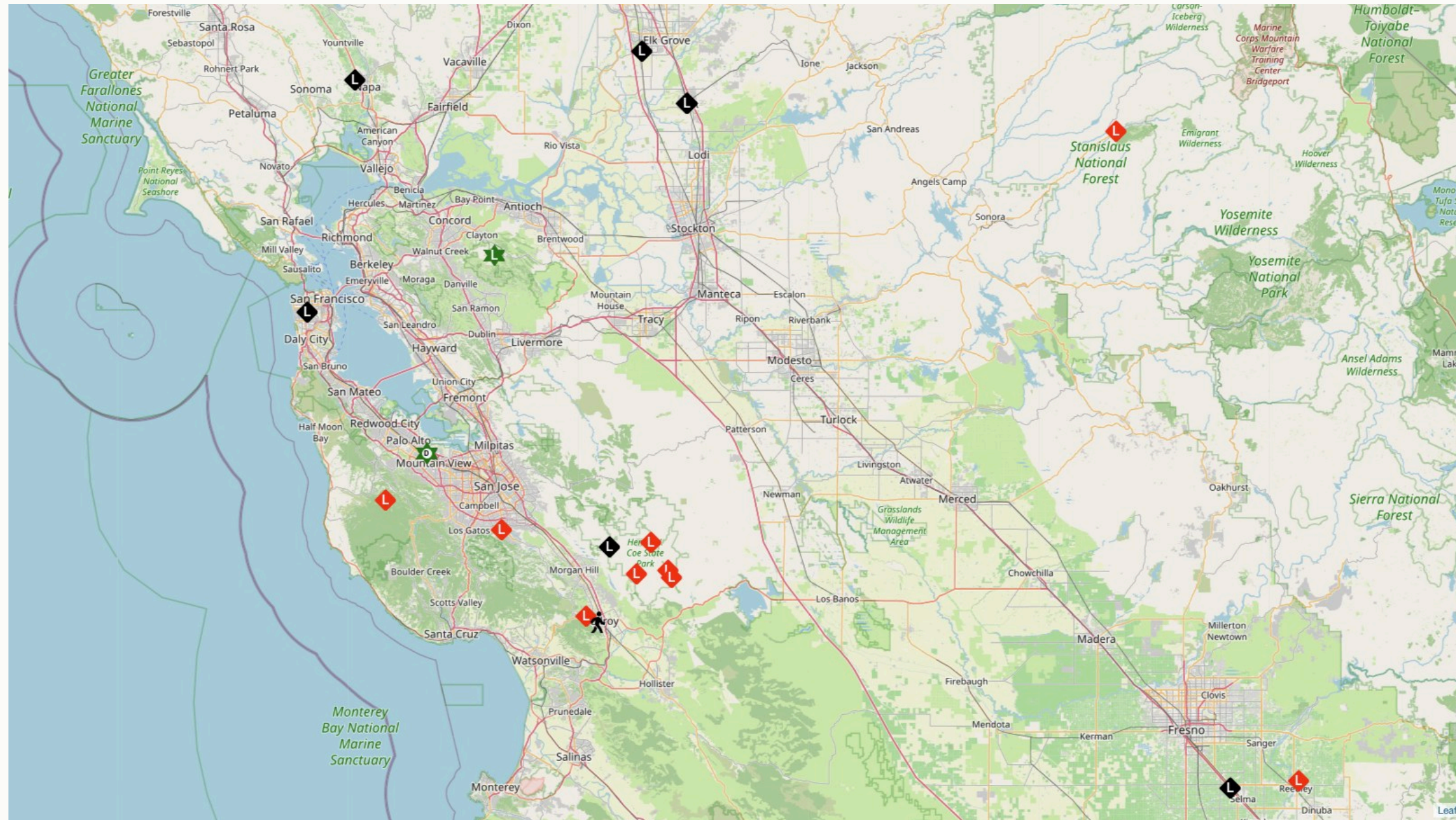
Ham radio position reports, sent on a long-range chirp radio module



- **APRS** is the amateur radio system for sending positions, weather and short messages as small packets
- **LoRa** is a low-power radio that spreads each bit into a chirp, so it can decode signals weaker than the noise
- At setting SF12 – about 300 bits per second in a 125 kHz channel, at 0.15 W

THE LORA APRS NETWORK

LoRa APRS Igates Around The Bay Area



What LoRa APRS gains, and what it costs

Gains

- **Similar range on far less power:** decodes 20 dB below the noise
- **Low power:** our payloads run 22 dBm, about 160 mW, a thirtieth of a 5 W VHF radio
- **Cheap:** transceiver modules for about \$20
- **Small and light:** Can fit in a pico or HAB balloon

Costs

- **Slow:** about 300 bits per second against 1200, and 2.8 s on the air per packet
- **Wide channel:** 125 kHz against about 12.5 kHz
- **Small network:** far fewer iGates, and not compatible with 144.39 MHz
- **Higher band:** 70 cm loses more signal than 2 m over the same path

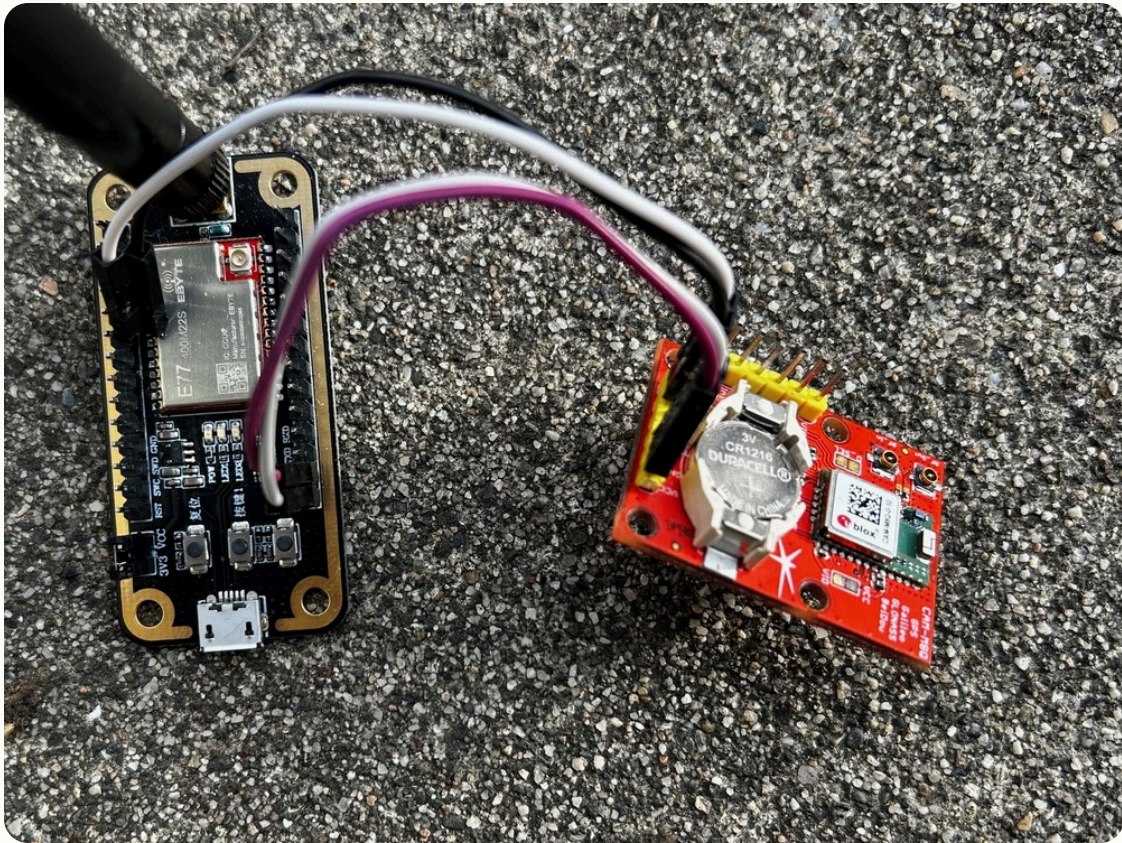
OUR FIRMWARE

One open-source program for a tracker and a digipeater

github.com/radiohound/LoRa-Tracker-Digipeater · Ebyte E77 module (STM32WLE5, 433 MHz)

MODE	WHAT IT DOES
Tracker only	Sends a GPS position beacon, then sleeps
Tracker + digipeater	Beacons, then listens and repeats until the next beacon
Digipeater only	Listens all the time and repeats WIDE1-1 and WIDE2-N packets
Solar digipeater	Sleeps, checks the channel every second, wakes to repeat everything it hears
Battery digipeater	Same, but repeats only stations that have moved: balloons and vehicles

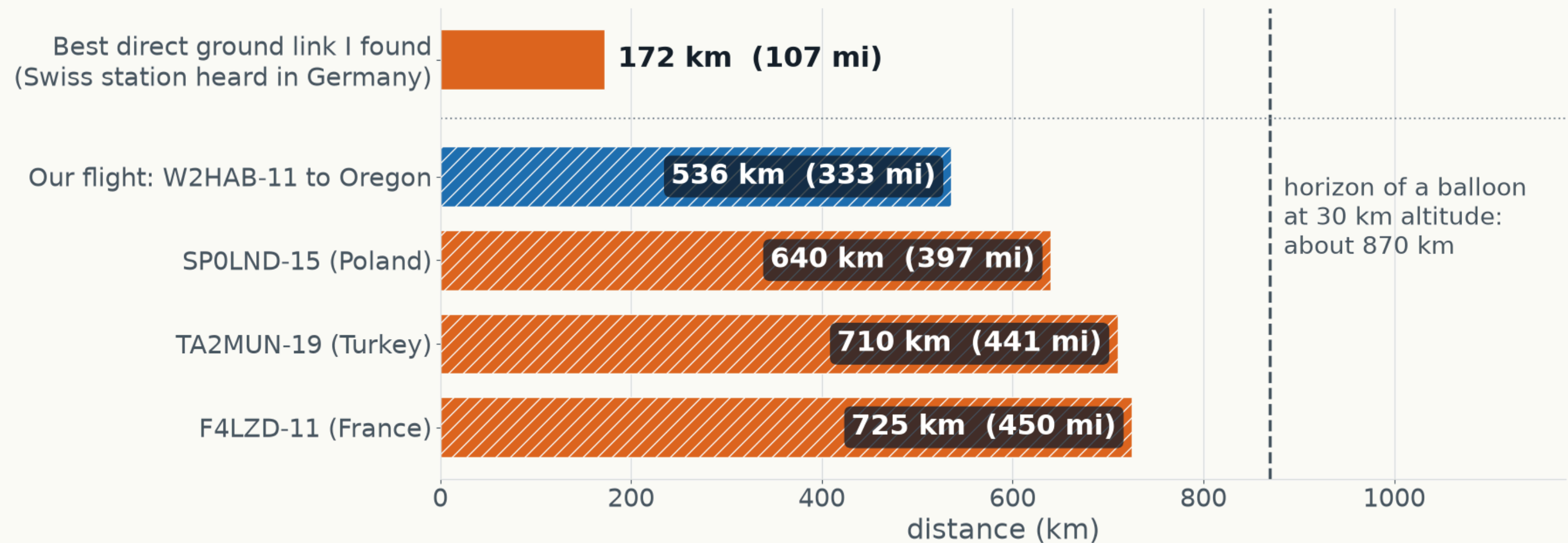
- Standard LoRa APRS settings (433.775 MHz, 125 kHz, SF12, 22 dBm), all in one config file
- Digipeating: random 80 to 450 ms delay, duplicate suppression, never repeats its own beacons



Our tracker: Ebyte E77 board and a u-blox GPS module

RECORD-SETTING CONTACTS

From balloons LoRa APRS reaches 500 to 725 km; the best ground link I found is 172 km



Our 536 km ranks about 35th of the 334 LoRa APRS balloons flown since January 2025.

OUR OREGON STATION



May 9, 2026: W2HAB-11 flight

Launch near Walnut Creek, peak 31.0 km (101,572 ft)

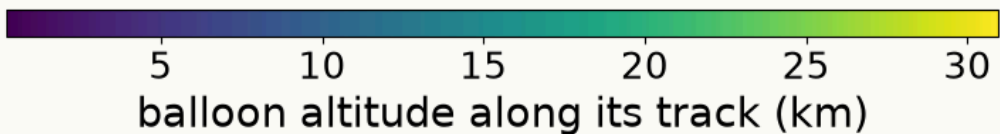
▲ **BALLPT-10** 536 km (333 mi)

Ball Mountain, OR: 6 packets; balloon at 30.2 km

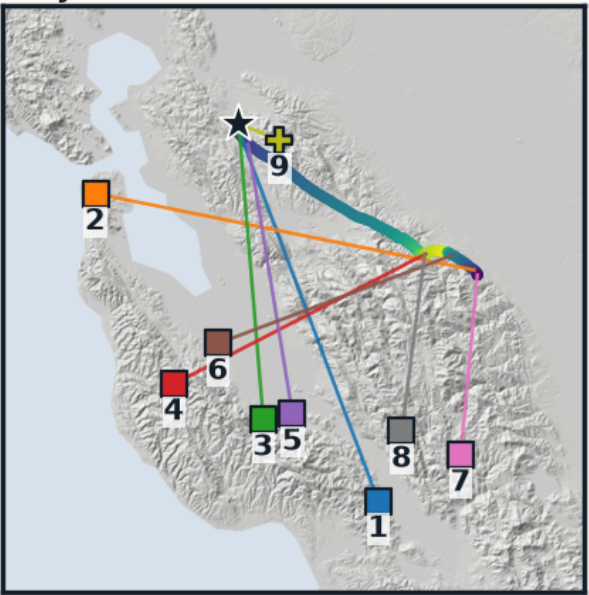
▲ **HOGBAK-10** 515 km (320 mi)

Hogback Mountain, OR: 39 packets; balloon at 24.6 km

★ launch ◇ highest point ○ balloon at farthest packet



Bay Area stations



farthest packet heard

- 1 **K6ATV-10**
106 km, 48 pkts
- 2 **K6PLI-10**
102 km, 21 pkts
- 3 **N5YJZ-2**
79 km, 4 pkts
- 4 **KI6FAO-9**
75 km, 5 pkts
- 5 **AG6GH-10**
73 km, 15 pkts
- 6 **KI6TSF-L1**
66 km, 90 pkts
- 7 **K6ATV-8**
48 km, 2 pkts
- 8 **K6ATV-15**
47 km, 1 pkts
- 9 **W6CX-4***
12 km, 2 pkts

* Mt Diablo summit assumed

536 km

333 miles, from a balloon at 30.2 km altitude

- W2HAB-11, May 9, 2026, 22 dBm payload
- Only 61% of the radio horizon (872 km): not the link's limit
- Feb 8, 2025: K6ATV-7 reached the same iGate at 497 km (309 mi)

Each step down in spreading factor buys speed and costs sensitivity

Setting	Decodes down to	Packet time	Where it is used
SF12	20 dB below the noise	about 2.8 s	The standard: virtually all of the US, most of Europe
SF9	12.5 dB below	about 0.6 s	Polish beacons on 434.855 MHz
SF7	7.5 dB below	about 0.11 s	Most of Arizona, part of Southern California

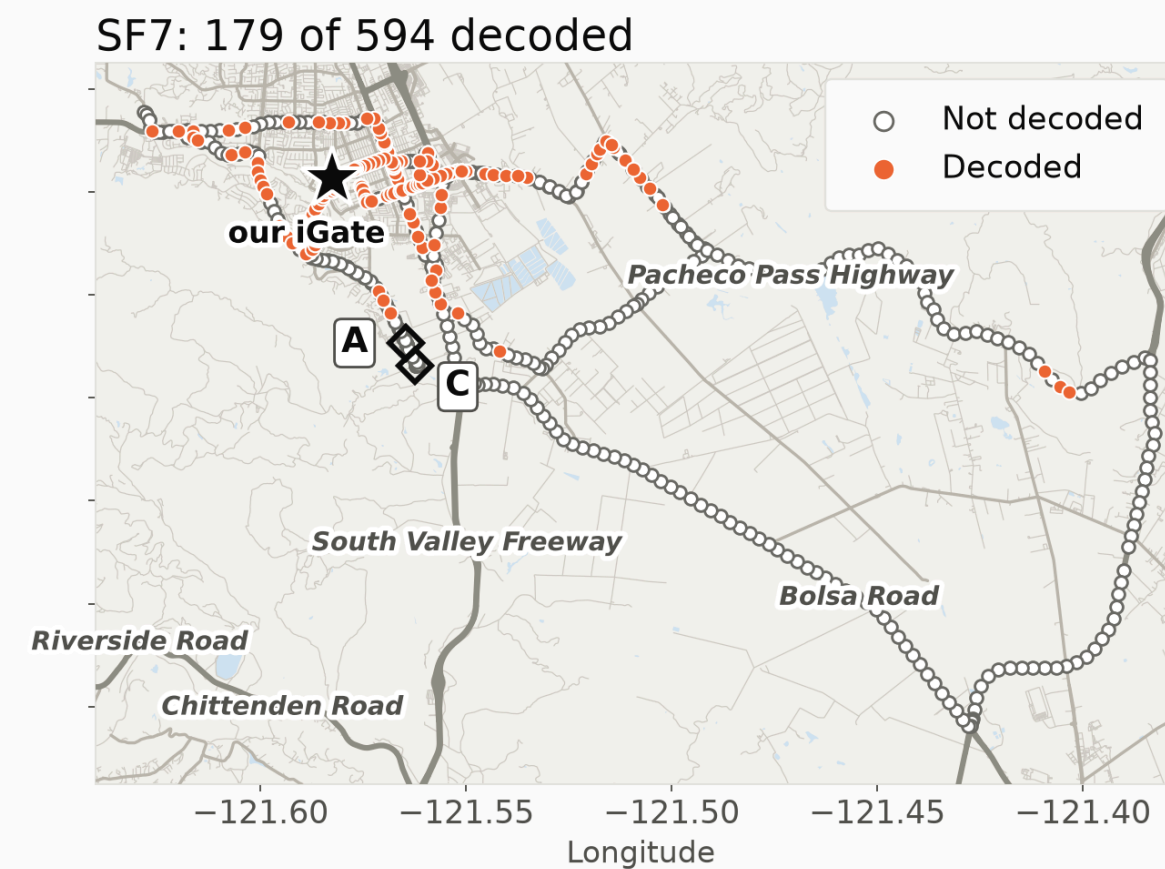
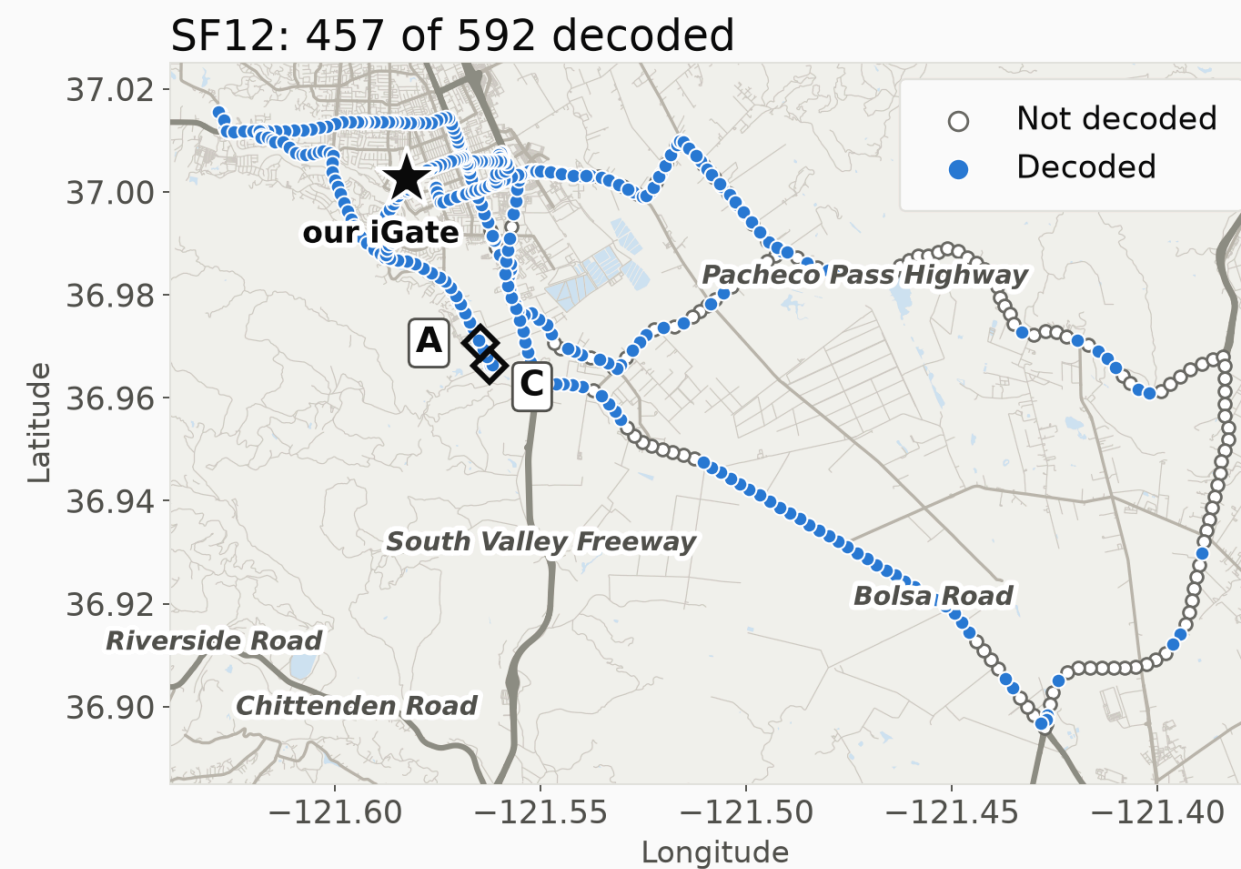
Same 125 kHz channel on 433.775 MHz. SF12 hears signals 12.5 dB weaker than SF7 can, and takes about 25 times longer to send a packet.

Virtually the entire US uses SF12, except for Arizona and Southern California, which have gone to SF7.

THE GILROY DRIVE TEST

Where each packet made it, on our own roads

Where we drove, and where each spreading factor was heard



◇ A: parked near side of road. C: parked behind a 2.8 m earth berm (SF12 7 dB weaker than at A). SF7 decoded nothing at either. Roads and water: our California R2 data (OSM-derived).

Data: our drive-test logs; roads and water from our terrain map.

THE GILROY DRIVE TEST

Parked behind a berm: SF12 still got through, SF7 never did

	A: near side of road	C: behind a 2.8 m berm
Distance to the iGate	3.93 km	4.42 km
SF12 decoded	7 of 8	2 of 5
SF12 median SNR	-9.2 dB	-16.9 dB
SF7 decoded	0 of 8	0 of 5

The berm cost about 8 dB. SF12's SNR was already below SF7's floor of -7.5 dB at both spots, so SF7 had no chance either way.

SOURCES AND DATA

Where the numbers came from

- Our Gilroy drive-test logs: 1,186 transmissions
- lora.link9.net: iGate list and packet logs
- lora.ham-radio-op.net: the Bay Area station map (OpenStreetMap data)
- SondeHub amateur database: balloon telemetry and receiver descriptions, Jan 2025 to Oct 2026
- USGS 3DEP lidar (Santa Clara County, 2020), FEMA 2018 lidar, OpenStreetMap, USGS elevation data
- Context, not LoRa APRS (LoRaWAN records): [The Things Network balloon record, 1,336 km record, Andreas Spiess, 201 km](#)
- SPOLND payloads: sp0Ind.pl (operator page, callsign and frequency rules)

Links:

Our Lora APRS tracker and digipeater code: github.com/radiohound/LoRa-Tracker-Digipeater

Richard Guzman's tracker: github.com/richonguzman/LoRa_APRS_Tracker

Richard Guzman's iGate and digipeater: github.com/richonguzman/LoRa_APRS_iGate

Install his tracker from a browser: richonguzman.github.io/lora-tracker-web-flasher

SF-HAB: sf-hab.org

Walter Dunckel, K6ATV
radiohound@gmail.com