

How GPS Works, Explained

How your phone finds itself by listening to satellites, and what to do when the blue dot gets it wrong.



The short answer

Your phone finds itself by listening. Satellites high above the Earth send out the time. Your phone hears several of them and works out where it is. It never sends anything back.

This guide answers three questions. What is GPS? Why does it matter to you? And what can you do when your blue dot is wrong?

A word on the words

GPS stands for Global Positioning System. It's the American set of satellites. Your phone also listens to satellites run by Europe, China and others. The chip in your phone that listens is called the **receiver**.

What this guide leaves out

Indoors, your phone leans on Wi-Fi and cell towers instead. That story has its own guide: *How Your Phone Knows Where It Is, Explained*.

What's inside

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Satellites that send the time

About 30 GPS satellites circle the Earth, far higher than the Space Station. Each one carries a clock that almost never drifts.



Figure 1. What a satellite sends. Every GPS satellite sends the same two things, over and over: the time, and where it is. That's all GPS sends.

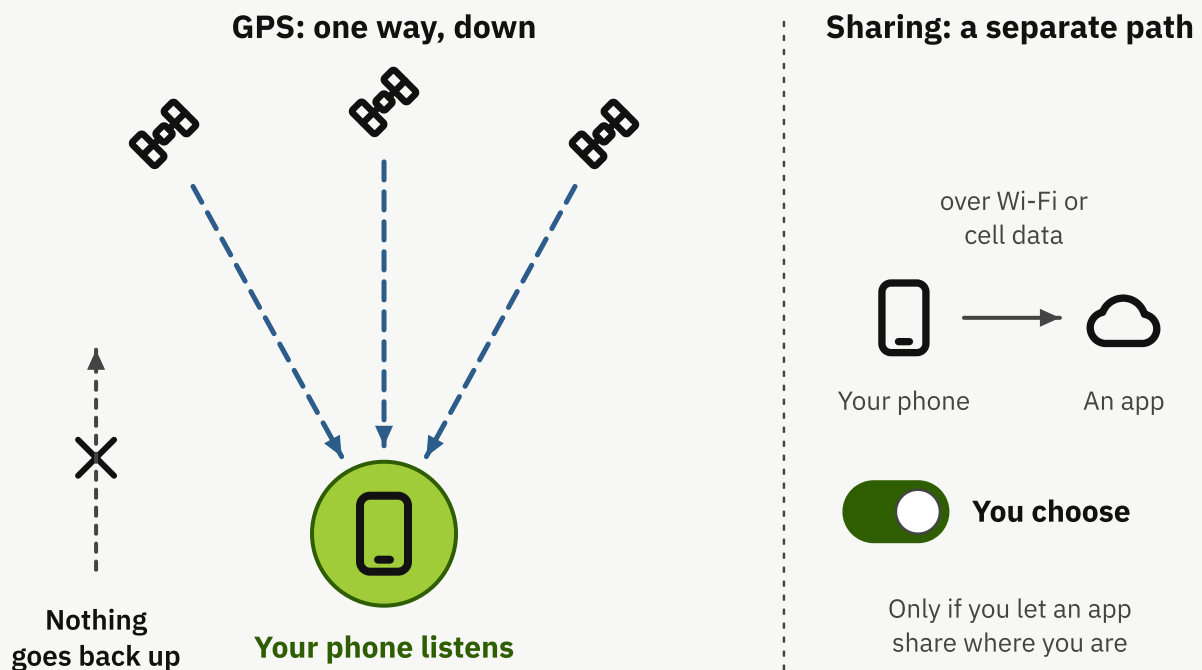


Figure 2. GPS only goes one way. The satellites talk and your phone listens. If an app shares where you are, that happens later, over Wi-Fi or cell data. You control it in your phone's settings.

WHAT IT IS

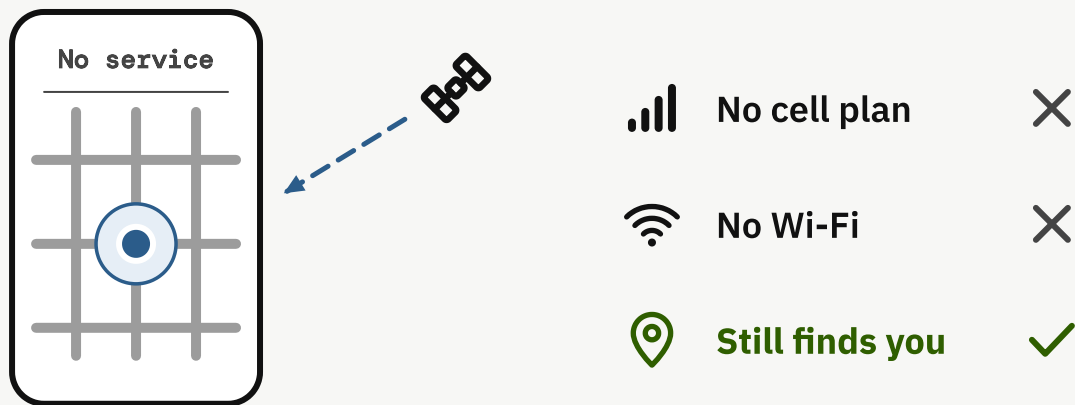


Figure 3. No bars, still a dot. Your phone only listens, so GPS works with no cell plan and no internet.

Anywhere on Earth

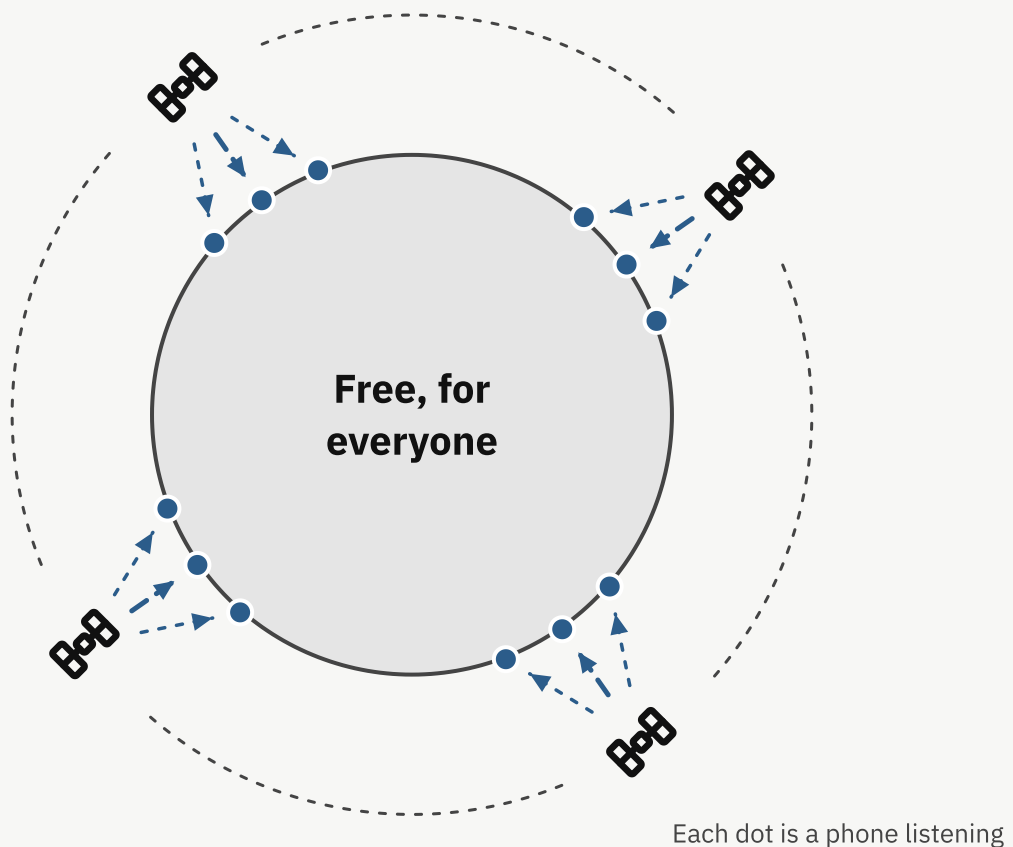


Figure 4. Everyone, everywhere. The satellites send to the whole Earth at once, so any phone can listen, for free. Not to scale.

Four satellites, one spot

A radio signal is fast, but it isn't instant. It takes a tiny moment to reach you. Your phone measures that moment. A longer wait means that satellite is farther away.

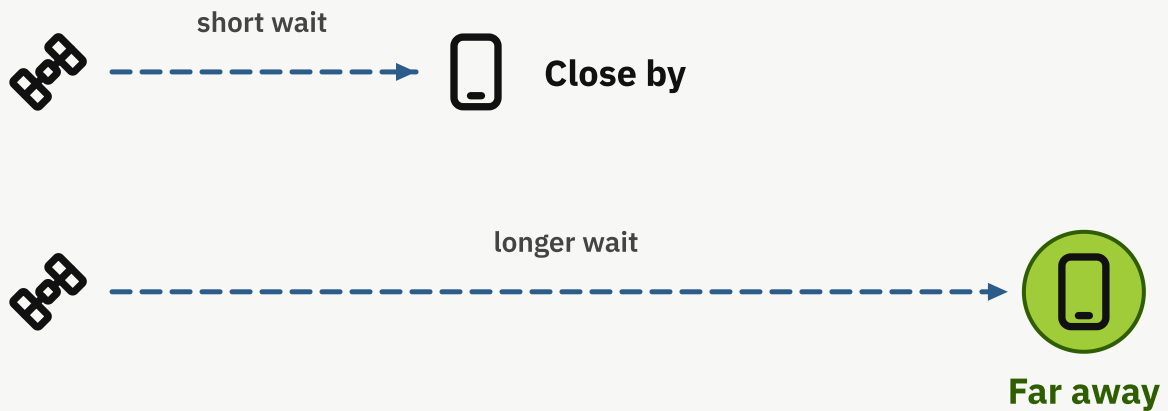


Figure 5. Farther away, longer wait. The wait tells your phone how far away each satellite is. Not to scale.

The timing has to be exact. In a billionth of a second, the signal travels about 30 cm (1 foot).

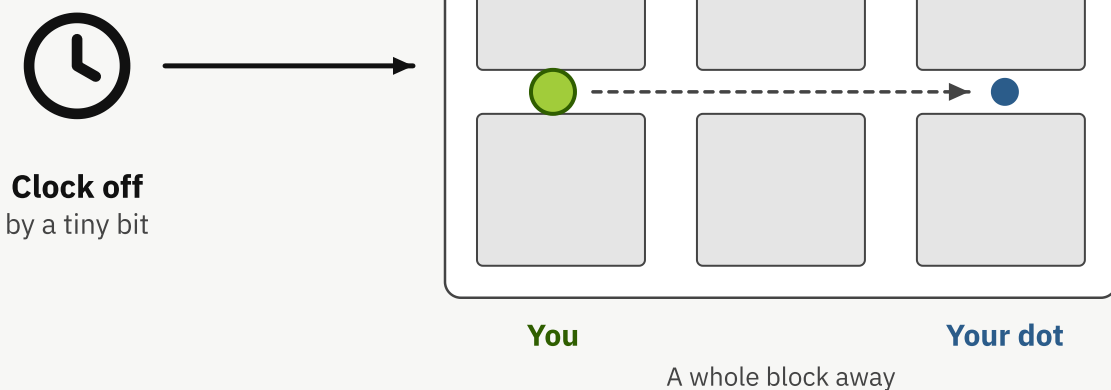


Figure 6. A tiny slip, a big miss. A clock that is off by a hair puts your dot far from where you stand. Not to scale.

HOW IT WORKS

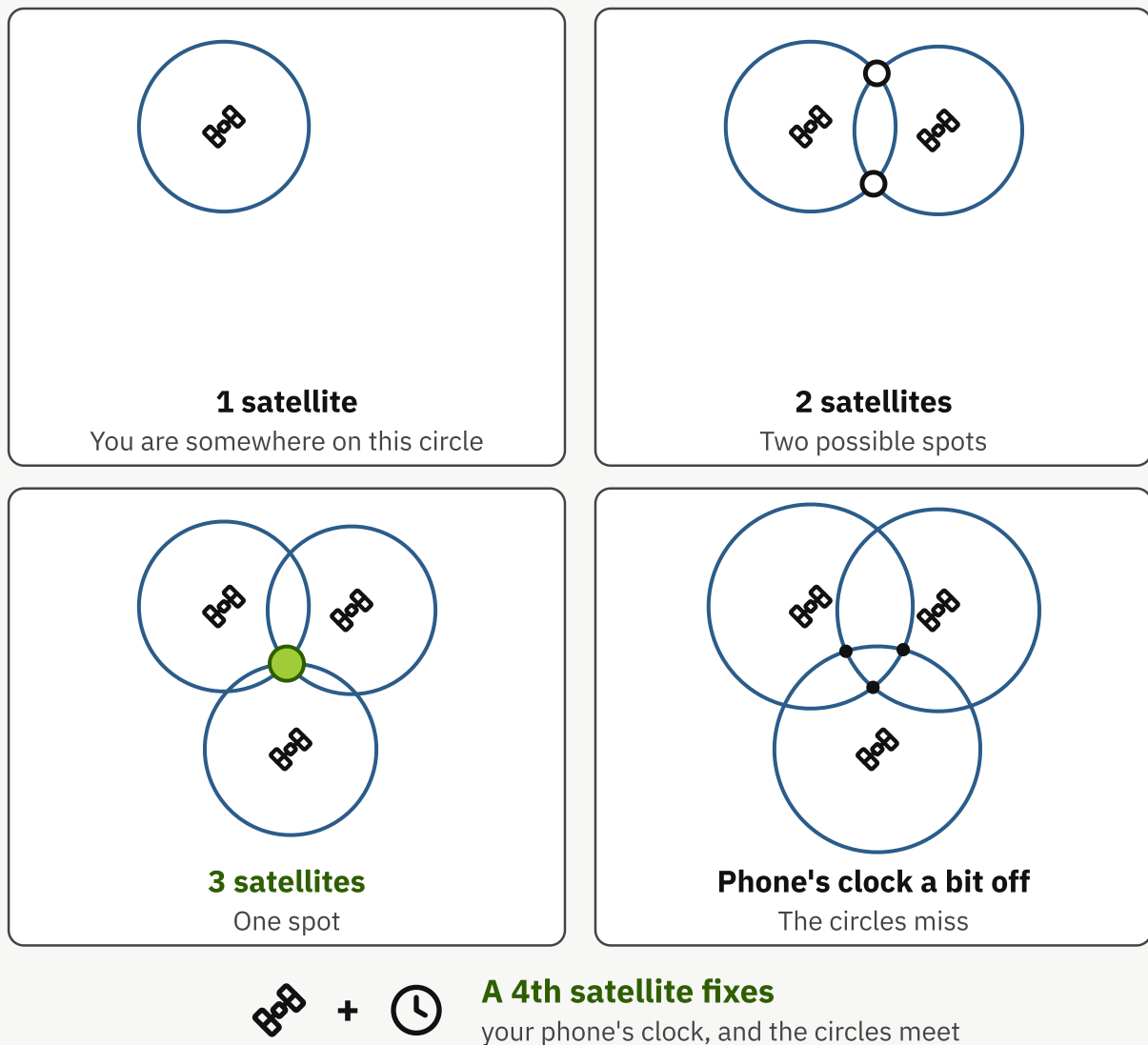


Figure 7. Why it takes four. Each satellite tells your phone how far away it is. Three distances meet at one spot. The fourth satellite corrects your phone's clock, which isn't as good as the ones in space. Drawn flat, not to scale.

Most of the time your phone can hear far more than four. More satellites give a better answer.

A fun fact

Einstein is part of every map app. Clocks in orbit tick at a slightly different speed than clocks on the ground. GPS corrects for that every day. Without the fix, your dot would slowly wander off.

Where GPS works, and where it doesn't

GPS needs to see the sky. Anything overhead gets in the way.

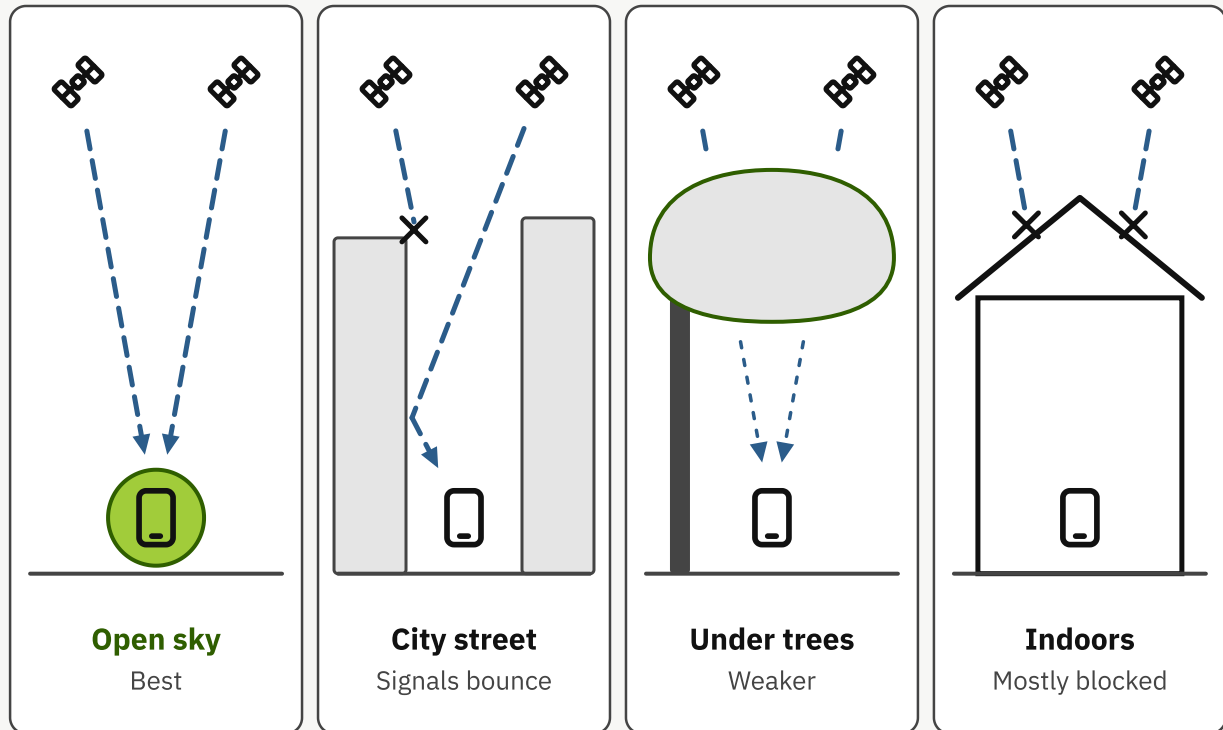


Figure 8. Open sky is best. Tall buildings bounce the signal around. Leaves weaken it. A roof blocks most of it.

On a city street, your phone may see only a strip of sky.

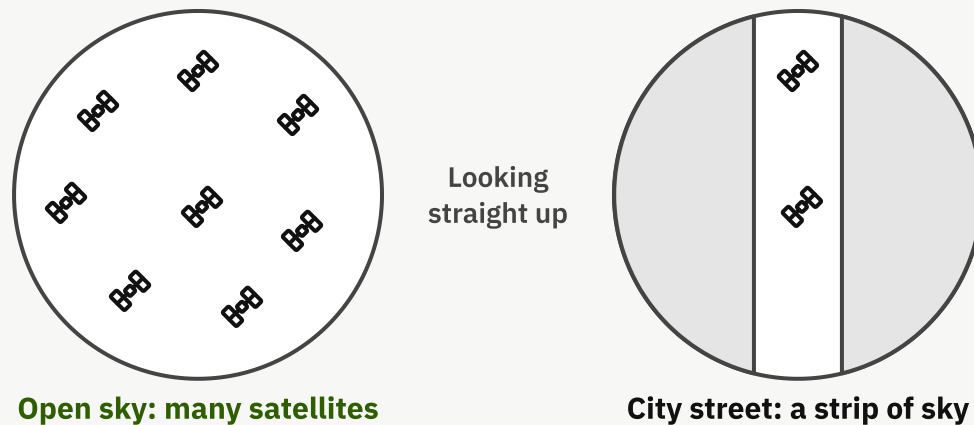


Figure 9. A strip of sky. Looking straight up from a city street, tall buildings hide most of the satellites.

WHY IT MATTERS TO YOU

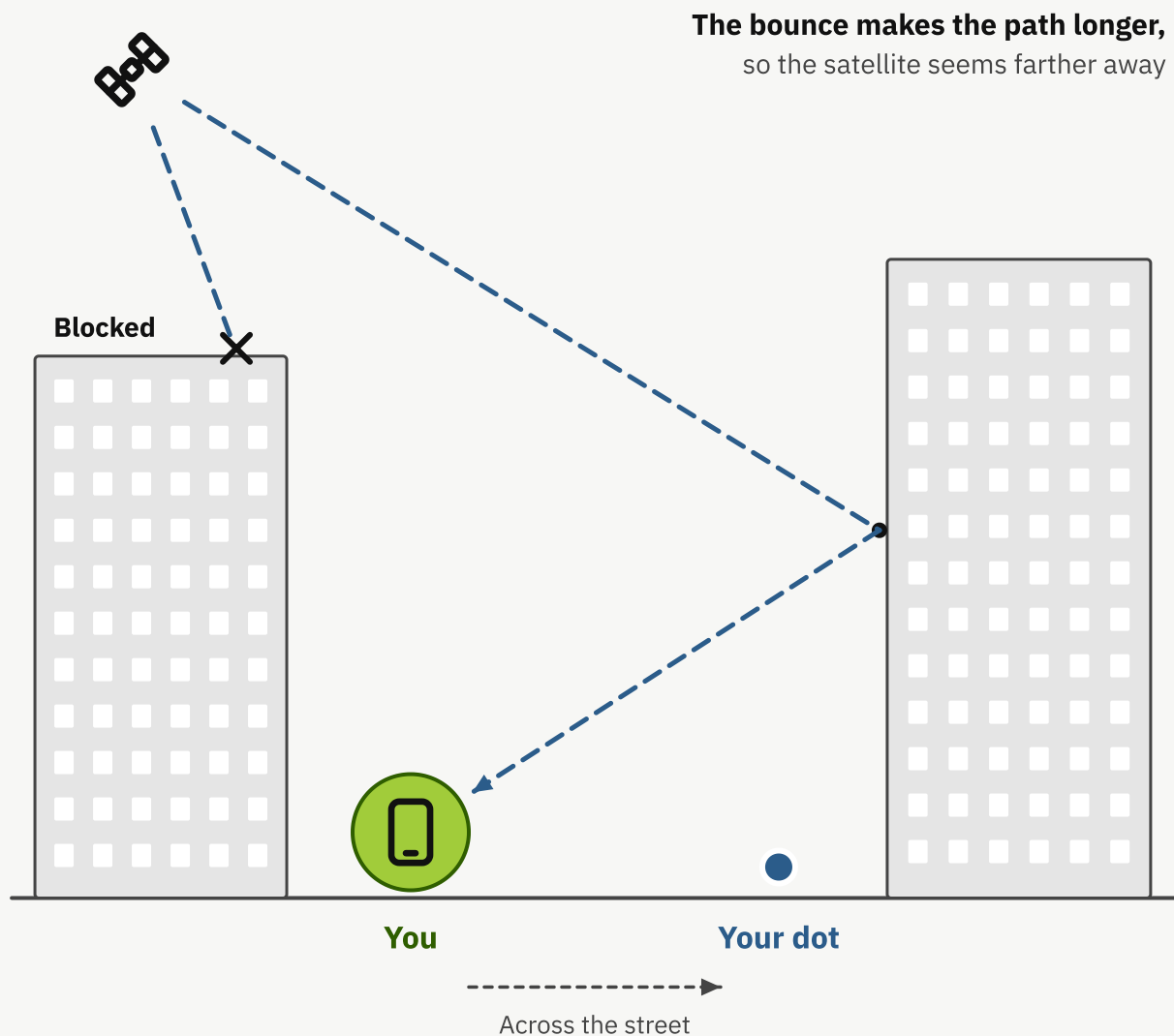


Figure 10. Why the dot jumps across the street. A bounced signal travels farther, so your phone thinks that satellite is farther away than it is. Not to scale.

Indoors, GPS mostly gives up. Your phone switches to Wi-Fi and cell towers instead.

Why it can be slow to start

After your phone has been off, or after a long flight, it has to find the satellites again. That can take a minute.

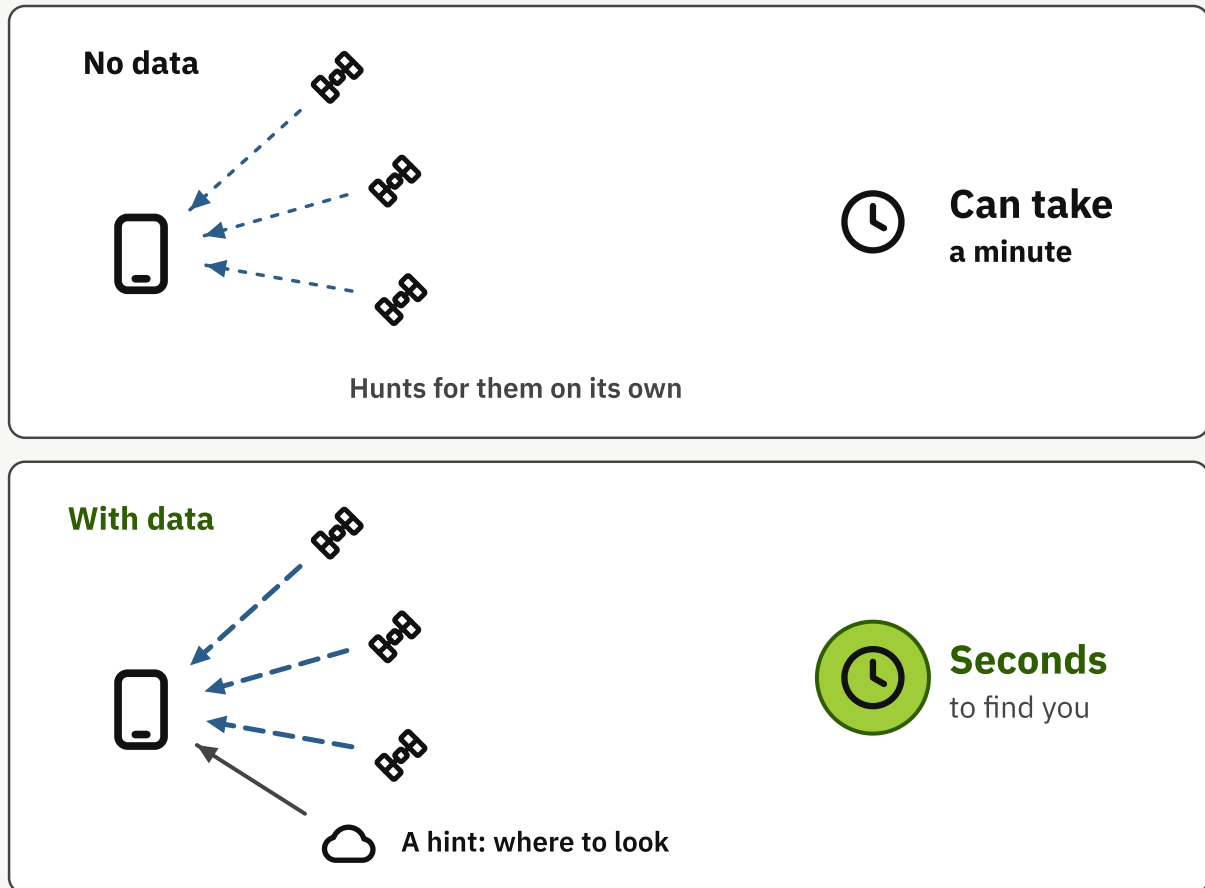


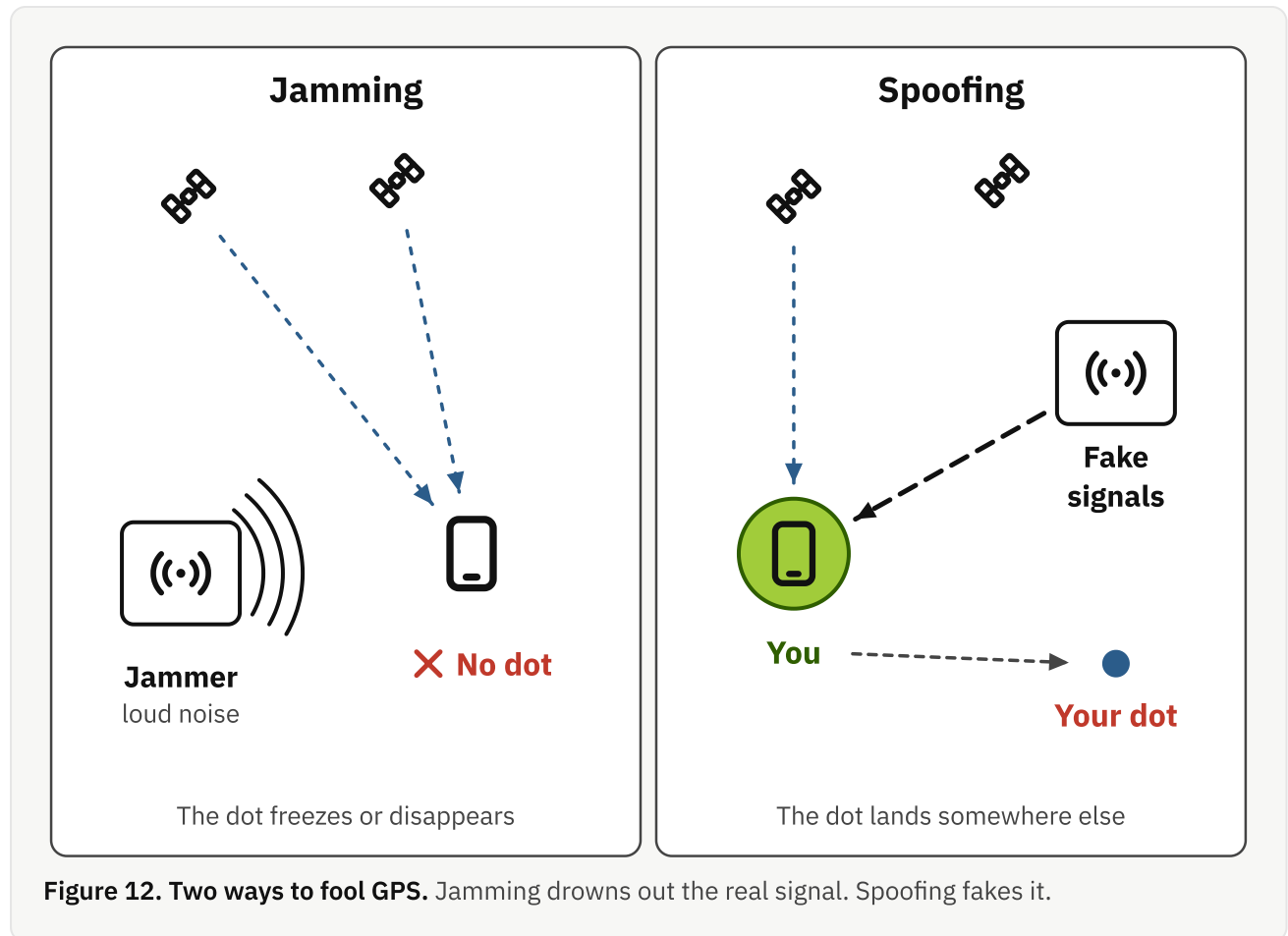
Figure 11. A head start. With a data connection, your phone is told where to look, so it finds you in seconds.

WATCH OUT

When the dot is wrong on purpose

Some people use gadgets that drown out GPS. That's called jamming, and it's illegal in the US. Your dot freezes or disappears.

A rarer trick sends fake satellite signals. That's called spoofing. It can move your dot to a place you've never been.



You can't stop either one. If your dot looks wrong, trust your eyes and the road signs. Your phone falls back on Wi-Fi and cell towers where it can.

Four things people get wrong

MYTH GPS tracks me.

FACT The satellites only send. They can't hear your phone at all. An app gets your exact location only if you let it.

MYTH GPS needs cell data.

FACT Your position comes from the satellites alone. Data only helps it start faster and loads the map.

MYTH GPS works indoors.

FACT Mostly not. A roof blocks the signal. Indoors, your phone uses Wi-Fi and cell towers instead.

MYTH My phone knows exactly where I am.

FACT Outdoors, it's usually within about 5 m (16 feet). Near tall buildings or under trees, it can be off by much more.

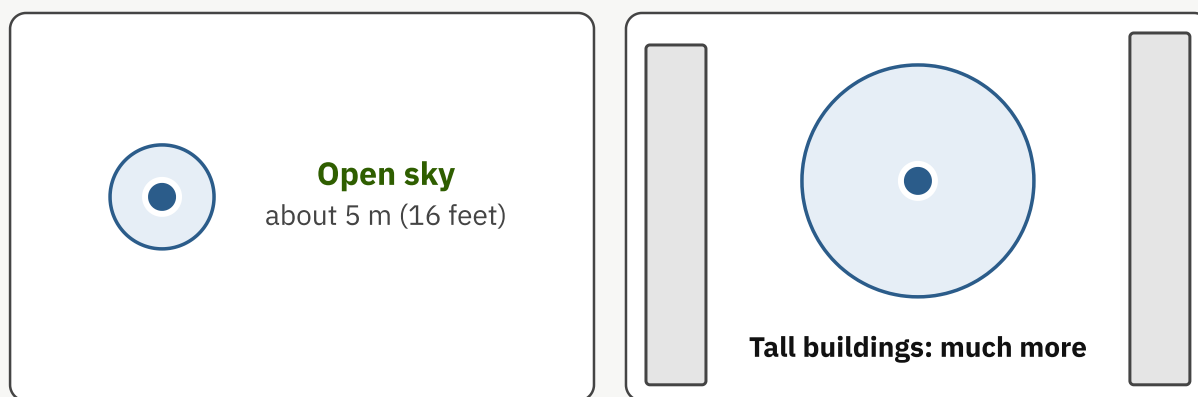


Figure 13. The circle around the dot. A small circle means a close fix. Tall buildings make it bigger. Not to scale.

Tips for a better fix

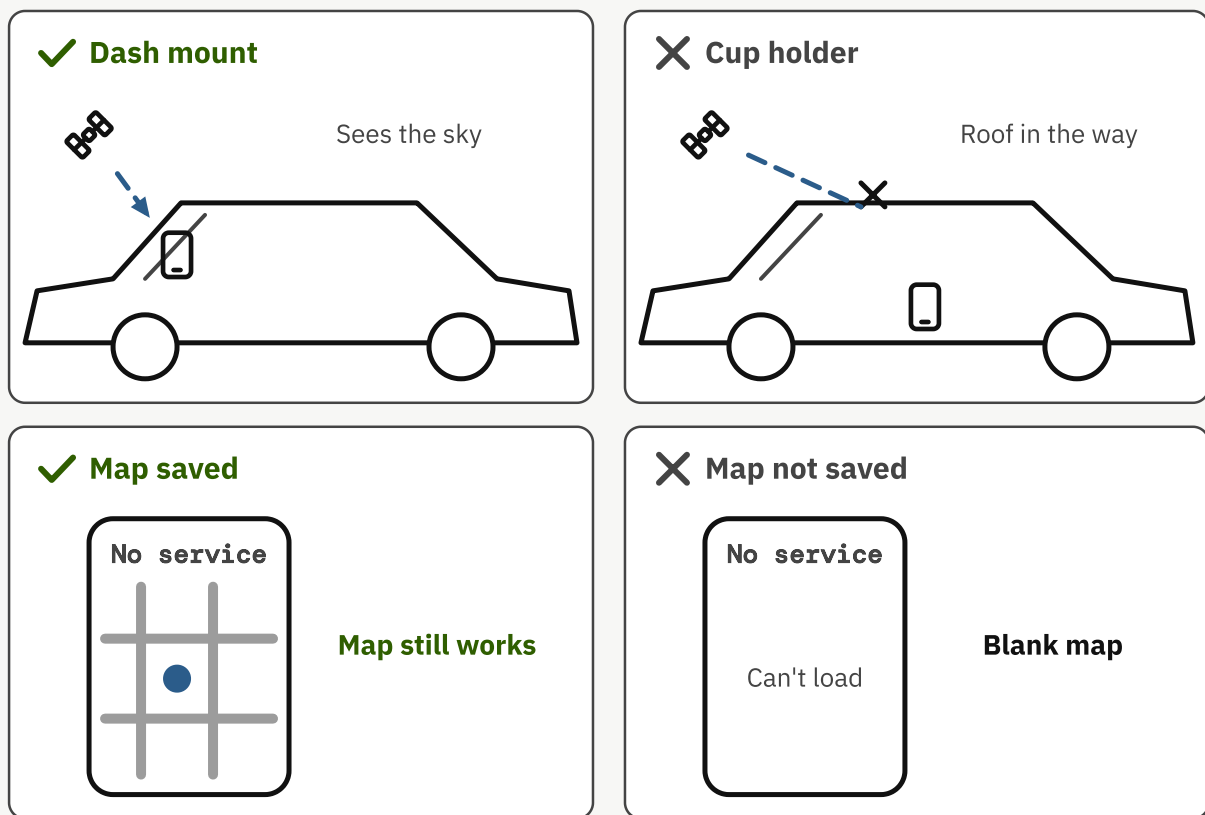


Figure 14. Two easy wins. Keep the phone where it can see the sky, and save the map before you lose signal.

- 1 **Step outside, or stand by a window.** GPS finds you fastest under open sky.
- 2 **Keep your phone where it can see the sky.** In a car, a dash mount beats a cup holder or a pocket.
- 3 **Download maps before you travel.** Then saved areas work with no signal.
- 4 **Give it a moment in a city.** If the dot jumps around, wait a few seconds or walk to a wider street.
- 5 **Check which apps can see your location.** Turn it off for any app that doesn't need it.

Privacy lives in your settings

GPS itself tracks no one. Which apps get your location is up to you. On iPhone, look in Settings, then Privacy & Security. On Android, look in Settings, then Location.

SOURCES

Where these facts come from

Checked on 28 September 2026.

- GPS.gov: Space Segment (figures dated 3 July 2023); GPS Accuracy; Frequently Asked Questions; New Civil Signals; GPS Legislation (10 U.S.C. § 2281)
- US Space Force, Mission Delta 31, briefing to the Civil GPS Service Interface Committee, as of 13 April 2026, hosted on gps.gov
- US Coast Guard Navigation Center, GPS Frequently Asked Questions
- NIST, "Putting Einstein to the Test"
- van Diggelen and Enge, ION GNSS+ 2015 (the source of GPS.gov's 4.9 m (16 feet) phone figure)
- United Nations Office for Outer Space Affairs, Global Navigation Satellite Systems
- Google Maps Help 6291838, download areas and use offline maps
- FCC, Jammer Enforcement (fcc.gov/general/jammer-enforcement)

About this guide

Written for people who aren't technical and want to know what their phone is doing when it shows a dot on a map. It is independent, and isn't affiliated with or endorsed by any government agency, satellite operator or phone maker.

About the author

Keith Parsons, CWNE #3, has designed, installed and troubleshot Wi-Fi for over 25 years. He runs Wireless LAN Professionals and the WLPC conferences.