Open Airport Vector Grid (OAVG)

A Minimalist, Human-Readable Alternative to Coordinates & Plus Codes
System Specification — Version 2.1 (Draft) · September 2026

0. What Changed From v2.0

Version 2.1 makes OAVG **global**: every point on Earth now gets a code from its nearest commercial airport. The core design is unchanged — an airport code as the origin, clockwise sectors, positive distances, and precision set by code length.

Topic	v2.0	v2.1
Coverage	Up to ~100 km from an airport; ICAO and Plus Code fallbacks elsewhere	Whole globe, always the nearest airport, no fallbacks
Sector letter	A–D (direction only)	A–L: direction + distance band (Section 4)
Projection	Transverse Mercator (breaks down far from the airport)	Azimuthal Equidistant: works globally; $\sqrt{(X^2+Y^2)}$ = exact distance
Anchors	3-letter IATA and 4-letter ICAO	3-letter IATA commercial airports only (4,133 seeded)
Code lengths	4, 6, 8 or 10 digits	Near: same. Regional: +2 digits. Far: +4 digits

1. Executive Summary

The **Open Airport Vector Grid (OAVG)** is a variable-precision location code. Every point on Earth is written relative to its **nearest commercial airport** (IATA code): the airport code, one letter showing direction and distance band, then two distances. A reader can tell at a glance roughly where a place is, and software converts codes to and from latitude/longitude offline.

```
TRZ-D04200355 = 5.5 km North-West of Trichy Airport (near band, 10 m cell)
IPC-K104561248302 = 2,694 km South-West of Easter Island Airport (far band)
```

2. Anchors & the Anchor Registry

- **Anchor:** a commercial airport with scheduled passenger service, identified by its 3-letter IATA code and listed in the **OAVG Anchor Registry**. Only 3-letter codes are used.
- **Seed data:** 4,133 airports from OurAirports open data (public domain), filtered to scheduled service. Each row is marked `verified = no` until checked against the official Aerodrome Reference Point (ARP) in the country's AIP.
- **Frozen coordinates:** once the registry is published, an anchor's coordinates never change. This keeps every issued code valid.
- **No re-pointing:** a code is permanently bound to its coordinates. Closed airports stay as *retired* (decode only). If IATA later reuses a code for a different airport, the new airport is not added under that code.
- **Registry format:** CSV — `code, type, name, lat, lon, status, registered_on, verified, source`.

```
TRZ, IATA, Tiruchirappalli International Airport, 10.7629150, 78.7177410, active,
2026-09-28, no, OurAirports
```

Note: the v2.0 draft used TRZ = 10.7651, 78.7097, about 900 m from the OurAirports value now used. Confirm against India's AIP before the registry is frozen.

3. Grid Geometry

3.1 Canonical anchor

A location is always encoded from the **nearest active anchor**, by true ground distance on the WGS84 ellipsoid. If two anchors are exactly equally near, the alphabetically first code wins. Decoders accept a valid code from any anchor, but encoders must produce the nearest-anchor code by default.

3.2 Projection

Each anchor has its own grid: an **Azimuthal Equidistant projection on the WGS84 ellipsoid**, centred on the anchor. For a point at ground distance *s* and initial bearing α (clockwise from North) from the anchor:

```
X = s · sin(α) metres East (negative = West)
Y = s · cos(α) metres North (negative = South)
+proj=aeqd +lat_0=<anchor lat> +lon_0=<anchor lon> +ellps=WGS84 +units=m
```

This works for the whole globe, and **$\sqrt{(X^2 + Y^2)}$ is exactly the ground distance to the airport**. Near the airport it behaves like a flat East/North grid; far away the cells stretch, but every point still has exactly one code.

3.3 Sectors

The quadrant is A = North-East, B = South-East, C = South-West, D = North-West (clockwise). **Tie rule:** a value of exactly zero counts as East or North, so the anchor point itself is `TRZ-A00000000`.

4. Distance Bands & Letters

The letter carries both the quadrant and a **distance band**. Each band moves the letter 4 places along the alphabet and adds one digit per axis. Rule of thumb: **every 4 letters = 10× further**.

Band	Covers max(|X|, |Y|)	NE	SE	SW	NW	Digits per axis
0 — near	under 100 km	A	B	C	D	base (2–5)
1 — regional	100 – 999.999 km	E	F	G	H	base + 1
2 — far	1,000 – 9,999.999 km	I	J	K	L	base + 2

- **Letter formula:** letter = quadrant letter + 4 × band. Example: North-West at 8,899 km → D + 8 = **L**.
- **Band rule:** the band is the smallest one whose limit is above the *larger* of |X| and |Y|. A code in a higher band must have a non-zero first digit in X or Y; otherwise it belongs in a nearer band and is invalid.
- **Guarantee:** the farthest any point on Earth lies from its nearest commercial airport is about 5,150 km (interior East Antarctica, nearest anchor PLZ). Bands 0–2 therefore cover the entire globe. Letters M–Z are reserved.

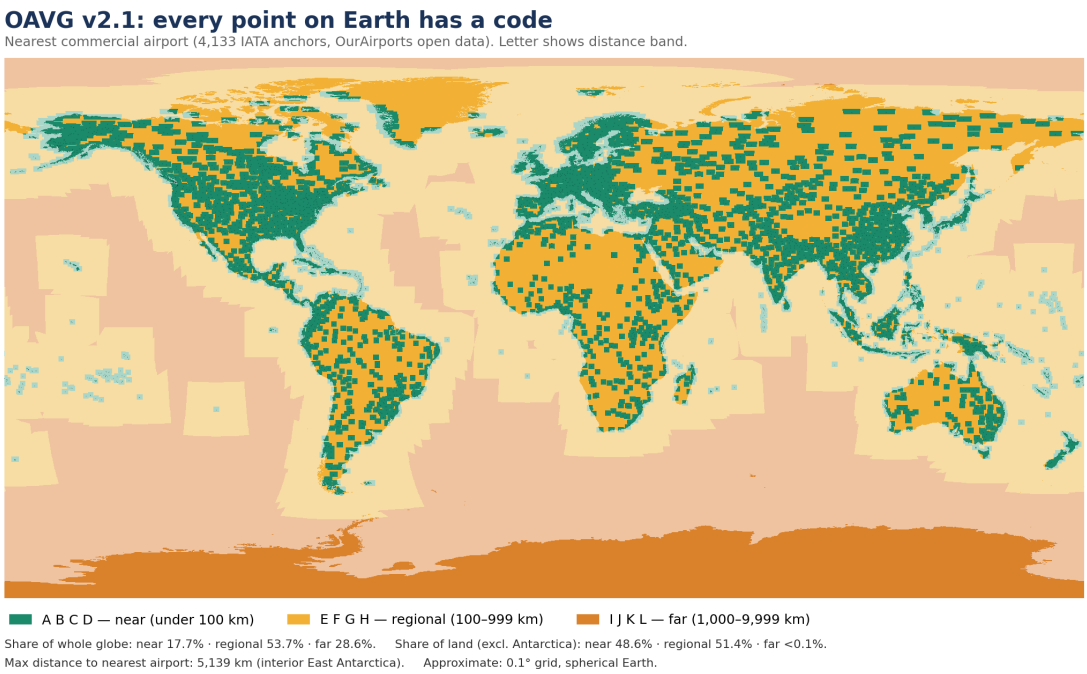

Figure: band of every point on Earth. Share of the globe: near 17.7%, regional 53.7%, far 28.6%. Land (excluding Antarctica): near 48.6%, regional 51.4%, far <0.1%.

5. Code Format & Precision

```
[ANCHOR]-[LETTER][X][Y] X = East/West distance, Y = North/South distance
```

X and Y always have the same number of digits, with leading zeros kept. Digits per axis = **base + band**, where the base sets the cell size: cell = $10^{(5 - \text{base})}$ metres.

Precision (base)	Cell	Near (A–D)	Regional (E–H)	Far (I–L)
1 km (2)	1 km	2+2 · TRZ-D0403	3+3	4+4
100 m (3)	100 m	3+3 · TRZ-D042035	4+4	5+5
10 m (4, default)	10 m	4+4 · TRZ-D04200355	5+5	6+6
1 m (5)	1 m	5+5 · TRZ-D0420303554	6+6	7+7

- **Truncation:** X = floor(|X| ÷ cell), Y = floor(|Y| ÷ cell). A code names a cell; decoders return its centre. A coarse code is always a prefix of the finer one: `TRZ-D0420303554` → `TRZ-D04200355` → `TRZ-D042035` → `TRZ-D0403`.
- **Canonical form:** upper case, no spaces. Parsers accept any case and an optional dot between X and Y: `TRZ-D0420.0355`.
- **Validation:** `^[A-Z]{3}-[A-L](\d+)(\.\d+)?$`, with an even digit count, base 2–5, both halves equal, the minimal-band rule, and a known anchor.

6. Moving Between Cells

People read the letter; software never does arithmetic on it. To move or compare, convert to a **signed cell index**:

```
East/West: i = X if quadrant is A or B; i = −X − 1 if C or D
North/South: j = Y if quadrant is A or D; j = −Y − 1 if B or C
```

Add or subtract on (i, j), then convert back and recompute the band. Band edges fall on cell edges, so a cell never straddles two bands. Examples: one cell East of `TRZ-D00000331` is `TRZ-A00000331`; one 1 km cell East of `TRZ-A9900` is `TRZ-E100000` (near → regional).

7. Reading a Code Without a Computer

- **Direction:** the letter's position in its group of four — A/E/I = NE, B/F/J = SE, C/G/K = SW, D/H/L = NW.
- **How far:** A–D under 100 km, E–H under 1,000 km, I–L under 10,000 km.
- **Exact distance:** $\sqrt{(X^2 + Y^2)}$. Quick estimate: the larger number + half the smaller one.
  `TRZ-D04200355`: 4.2 km W, 3.55 km N → 5.5 km NW.

8. Worked Examples (10 m precision)

Place (lat, lon)	Code	Plain reading
Near Trichy Bus Stand (10.7950461, 78.6793020)	`TRZ-D04200355`	5.5 km NW of TRZ
Central London (51.5074, –0.1278)	`LCY-D12710024`	13 km W of LCY
Sahara (23.5, 12.0)	`DJG-F2590508465`	273 km ESE of DJG
Mid-Atlantic (0.0, –30.0)	`FEN-E2699342596`	504 km NNE of FEN
Point Nemo (–48.8767, –123.3933)	`IPC-K104561248302`	2,694 km SSW of IPC
Farthest point (–75.85, 67.95)	`PLZ-J117660500993`	5,146 km SSE of PLZ
South Pole (–90, 0)	`USH-J000000392217`	3,922 km S of USH

Note: the Trichy point is illustrative; replace it with the Bus Stand's surveyed coordinates before publishing. All codes depend on registry coordinates, which are not yet verified.

9. Conformance Test Vectors

A conforming implementation must reproduce these with the registry shipped with v2.1 (TRZ = 10.7629150, 78.7177410).

Input	Expected output
`encode(10.7950461, 78.6793020), 1 km / 100 m`	`TRZ-D0403 / TRZ-D042035`
`encode(10.7950461, 78.6793020), 10 m / 1 m`	`TRZ-D04200355 / TRZ-D0420303554`
`decode(TRZ-D04200355) [cell centre]`	`10.795052, 78.679291`
`decode(TRZ-D0420303554) [cell centre]`	`10.795047, 78.679305`
`encode_grid(TRZ, X=100,000, Y=0), 1 m`	`TRZ-E100000000000`
`encode_grid(TRZ, X=–8,899,000, Y=1,000), 1 km`	`TRZ-L88990001`
`move(TRZ-A9900, +1 East)`	`TRZ-E100000`
`move(TRZ-D04200355, +430 East)`	`TRZ-A00090355`
`parse(TRZ-E050050)`	`error: belongs in a nearer band`
`any max(|X|, |Y|) ≥ 10,000 km`	`error: out of range`

Reference implementation checks: projection matches PROJ `aeqd` to 0.1 mm; random round trips in every band and precision decode within half a cell; 300 random points anywhere on the globe all encode and decode.

10. Implementation Notes

- **Maths:** Vincenty's formulae on WGS84 (about 0.1 mm accuracy), pure Python, no dependencies. They only fail for nearly antipodal points, which never occur because every point is under ~5,200 km from its anchor.
- **Nearest airport:** a quick spherical pre-filter, then exact distances for the few closest candidates. About 3 ms per encode with 4,133 anchors in Python.
- **Offline footprint:** the registry CSV is about 380 KB; a compact binary form (code + two 32-bit coordinates) is about 50 KB.
- **Compatibility:** v2.1 codes differ from v2.0 (new projection and anchor coordinates). Neither has users, so v2.1 replaces v2.0.

11. Advantages Over Existing Systems

- **Human context:** unlike What3Words or Plus Codes, the code tells a person the nearest airport, the direction and roughly how far — with no lookup.
- **Global and gap-free:** one rule (nearest airport) covers every point on Earth, including oceans and poles.
- **Simple maths:** distances to the airport are exact; nearby codes can be compared by subtraction.
- **Offline and stable:** a small registry file, frozen anchors and truncation mean a code always points to the same cell.

12. Open Items (Author Decisions)

- **Registry verification:** check anchor coordinates against official ARPs, starting with the busiest airports, before freezing.
- **Licensing alignment:** the reference code is under BSL 1.1 (source-available, not open source). Consider open licenses for the spec and registry. Get legal advice.
- **Letter I:** I (far, NE) can be misread as 1. Displays should use a clear font; parsers already know the letter's position.
- **Far-band meaning:** far codes (mostly ocean and Antarctica) carry less everyday meaning; acceptable for a single simple rule.
- **Future:** optional check character for typos; building floor / altitude; registry governance.