



RIPE Atlas Measurements and Geolocation Providers

A Longitudinal Consistency Evaluation

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Why measure geolocation consistency?

IP geolocation is everywhere, but how reliable it is remains only partially understood



Many services rely on it

content delivery, localization, fraud detection, regulatory compliance, analytics.



Hard to assess

Large-scale ground truth is scarce.



A moving target

Allocations churn: evaluate longitudinally.

Research Question

Are geolocation provider estimates *consistent* with RIPE Atlas latency, and does that hold over time?

Methodology Overview

Six months of public RIPE Atlas latency data checked against four geolocation providers

- ✓ **Dataset.** Public RIPE Atlas ping and traceroute.
- ✓ **Period.** January 1 to June 30, 2026.
- ✓ **Filters.** Auto-GeoIP probes, BGP unannounced, multi-located.
- ✓ **Geoproviders.** DB-IP, IP2Location, IPinfo, and MaxMind.
- ✓ **Metric.** Is the geolocation estimate consistent with the measured Round-Trip Times (RTTs)?
- ✓ **Cuts.** IPv4 vs. IPv6, point vs. country estimates, and router vs. non-router addresses.

≈ **2.3 B**

measurement results

≈ **6.6 M**

unique IP addresses

≈ **13.5 K**

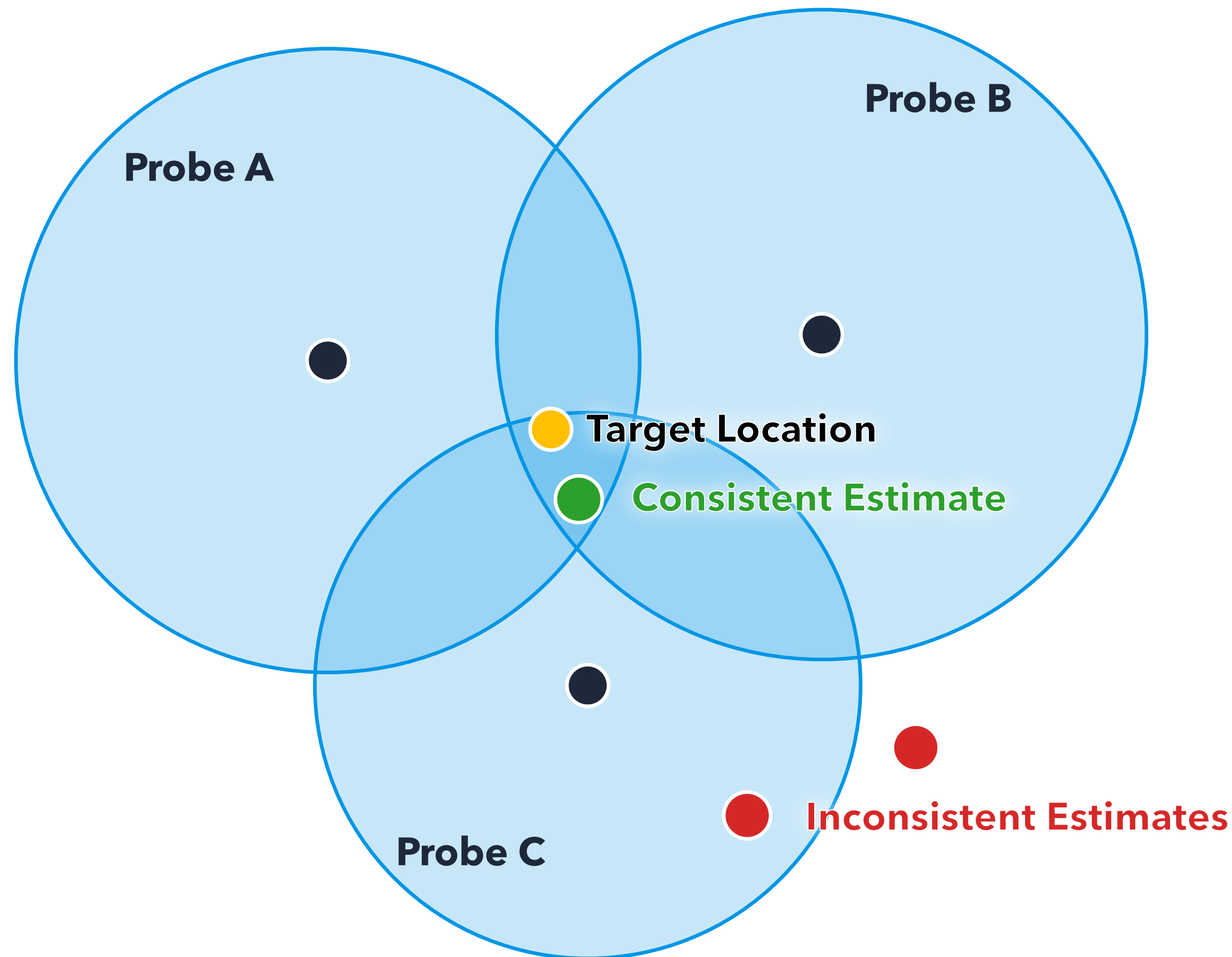
probes

4

geolocation providers

RTT bounds where an address can be

Speed-of-light constraints turn each latency measurement into a feasibility disk

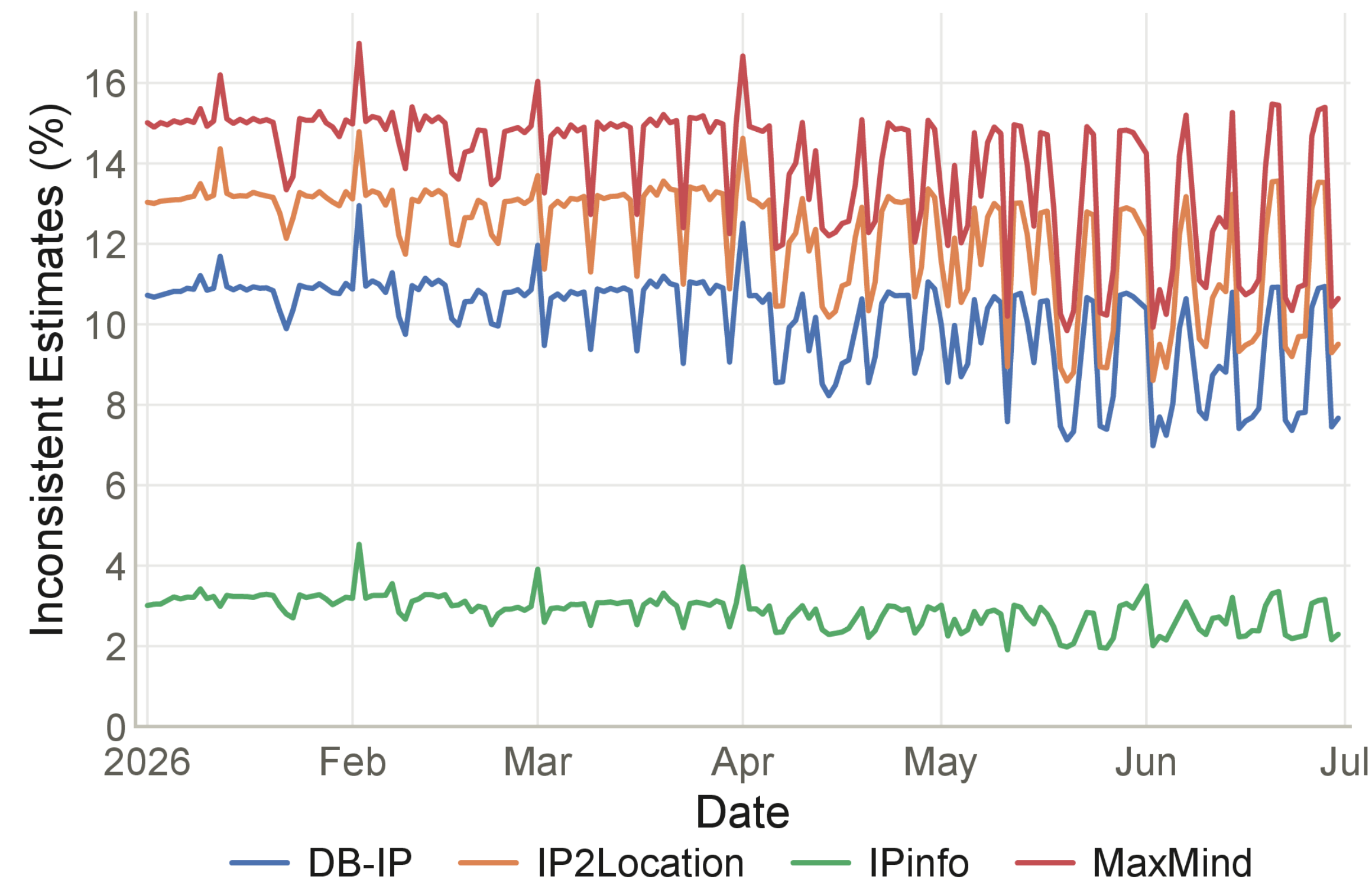


feasibility polygon = intersection of all the disks

- ✓ One RTT → a disk around the probe, radius $\approx \text{RTT}/2 \times 204 \text{ km/ms}$.
- ✓ Intersect disks from several probes → feasibility polygon.
- ✓ Inside: **consistent**. Outside: **inconsistent** (provably wrong).
- ✓ Inflated RTTs only enlarge disks: bounds are conservative.

IPv4: consistency is stable over six months

Daily share of point estimates inconsistent with RTT measurements, per provider

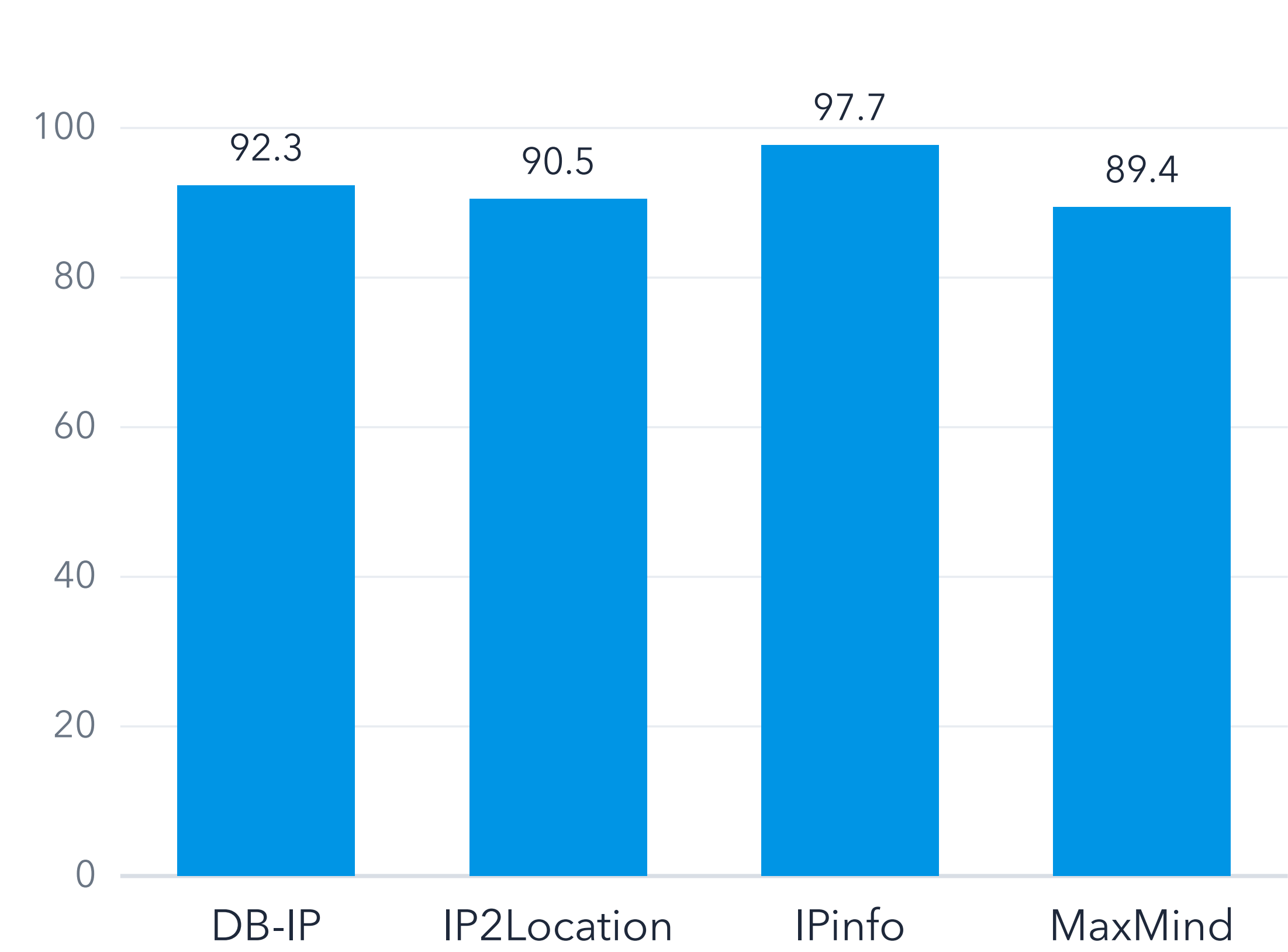


- ✓ Stable levels for six months; ranking never changes.
- ✓ Late Feb onward: multiple *one-off* user-defined measurements toward ISP addresses add daily swings.
- ✓ More IPs measured → lower inconsistency (Pearson $r \approx -0.9$).
- ✓ ISP addresses are easier to geolocate than the usual RIPE Atlas target mix.

IPv4 on June 30, 2026

Consistency of point estimates for about 1M IPv4 addresses measured that day

Consistent estimates (%)

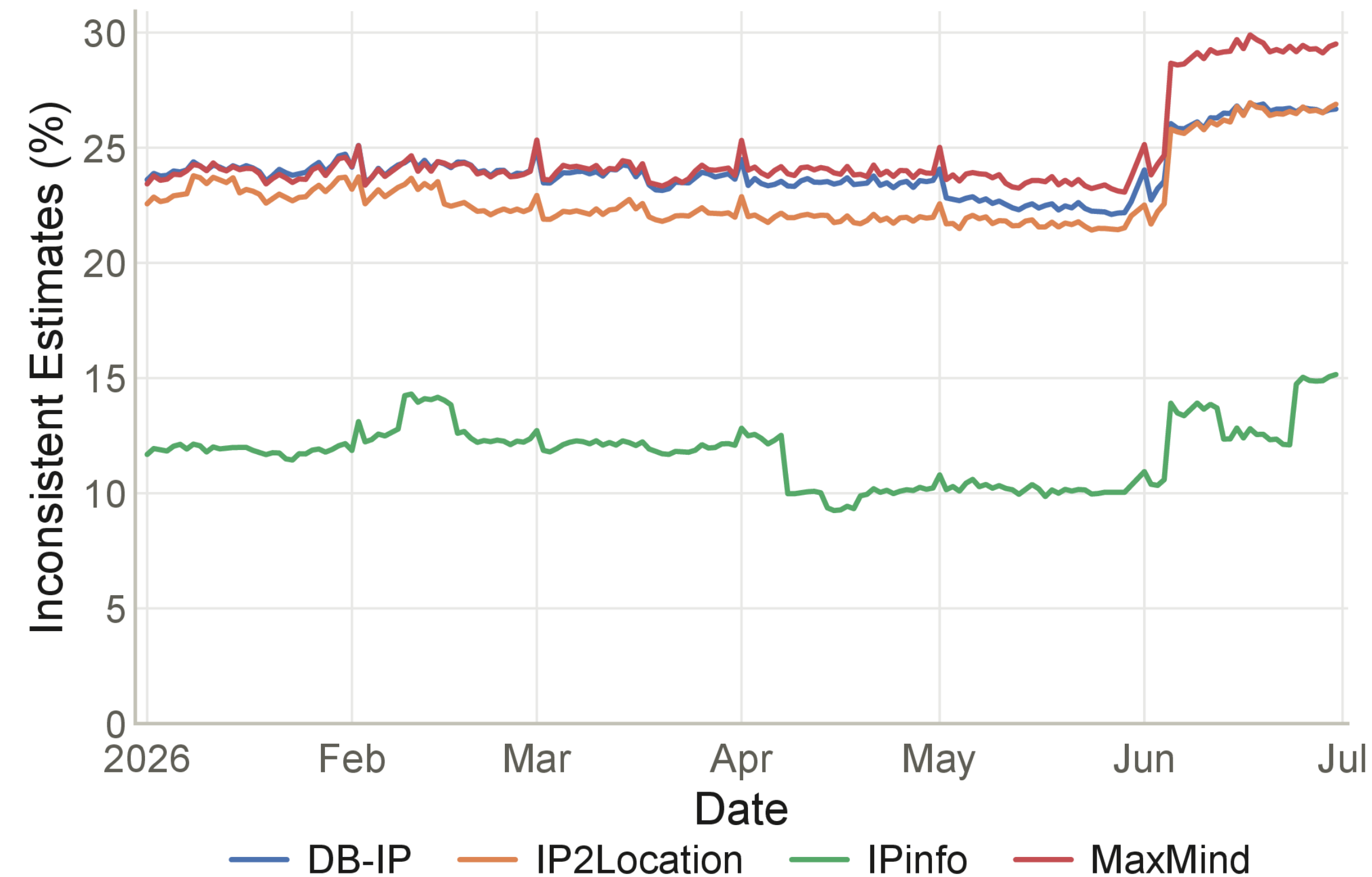


Provider	Consistent	Inconsistent	Missing
DB-IP	983,913	81,696	0
IP2Location	962,783	101,142	1,684
IPinfo	1,041,168	24,440	1
MaxMind	944,863	112,524	8,222

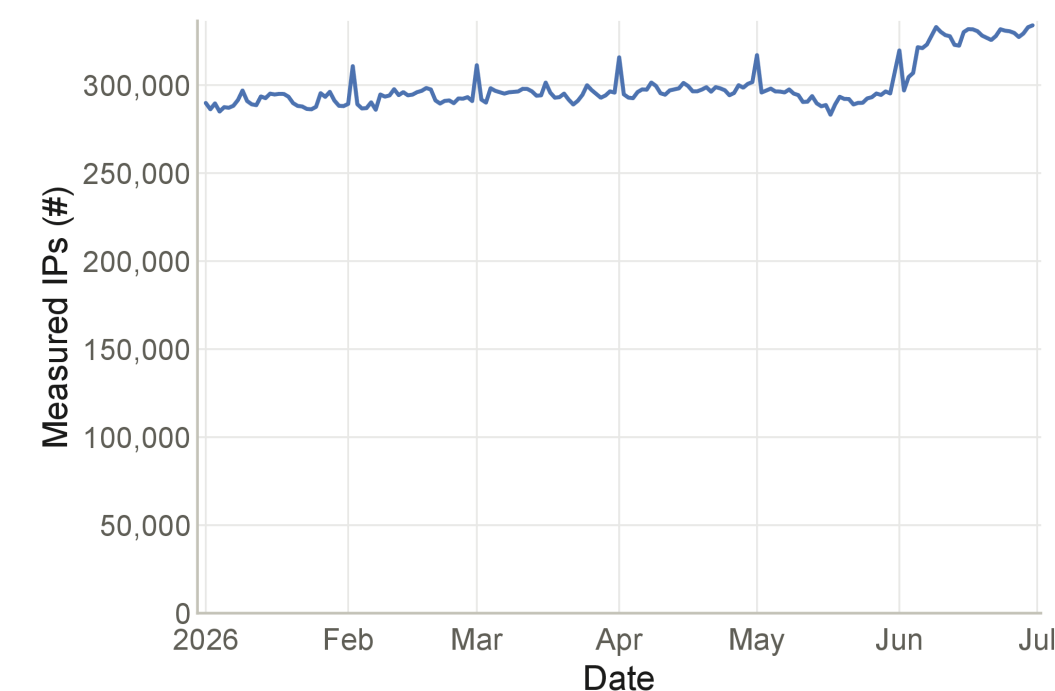
- ✓ **IPinfo: 97.7% consistent**, 24k inconsistent.
- ✓ DB-IP: about 3× as many inconsistent; others 101k to 113k.
- ✓ Missing: MaxMind 8,222, IP2Location 1,684 (mostly backbone and hosting routers).

IPv6: stable, then a step change in June

Daily share of point estimates inconsistent with RTT measurements, per provider



- ✓ Smoother than IPv4, but 2 to 3× the inconsistency.
- ✓ Early June: additional 15k to 25k inconsistent estimates for everyone.
- ✓ Cause: new built-in period traceroutes to popular services shifted the target mix to a harder set.

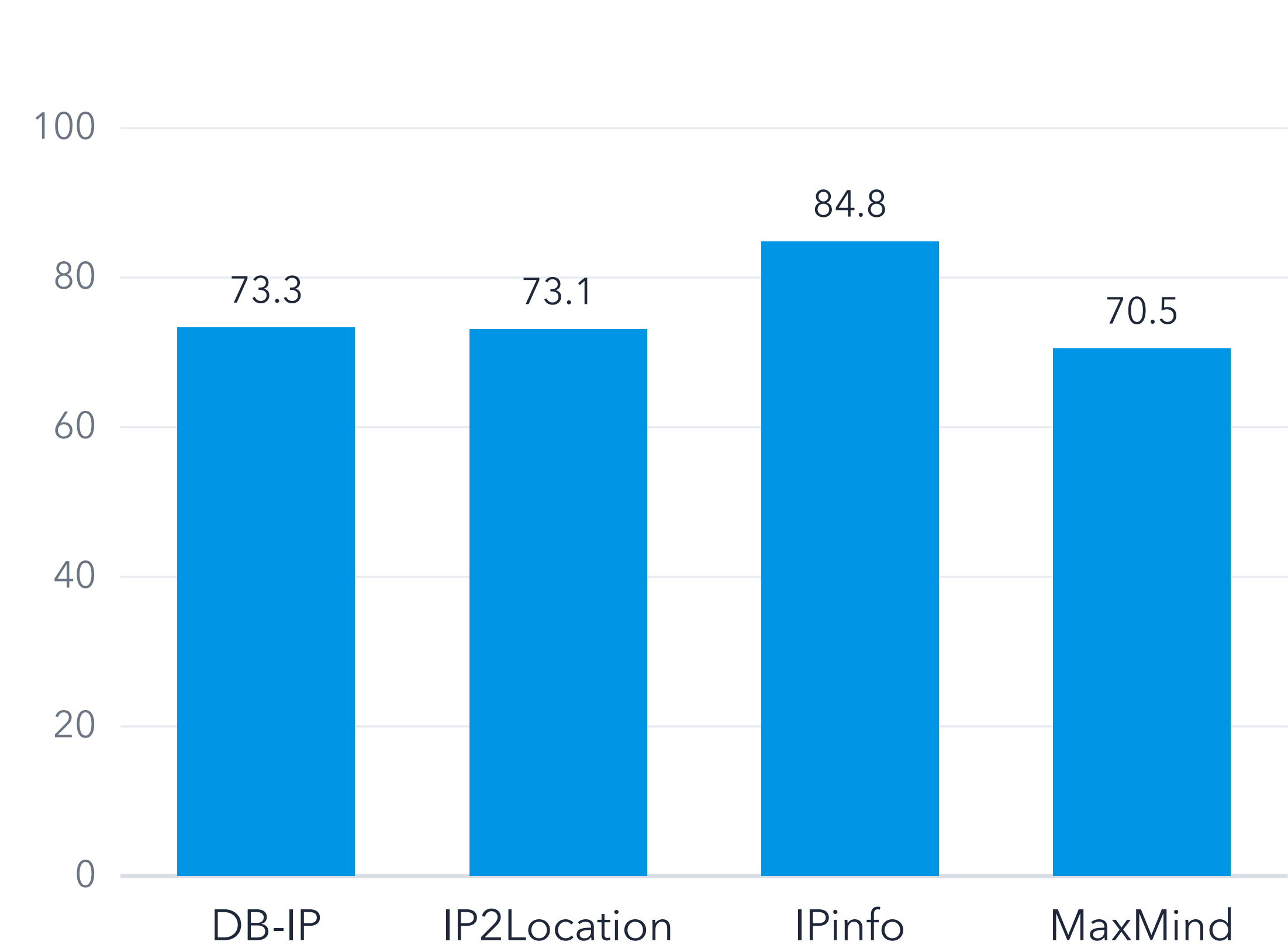


Unique IPv6 addresses per day: same jump in June.

IPv6 on June 30, 2026

Consistency of point estimates for about 334 thousand IPv6 addresses measured that day

Consistent estimates (%)



Provider	Consistent	Inconsistent	Missing
DB-IP	244,848	89,099	0
IP2Location	244,020	89,742	185
IPinfo	283,343	50,604	0
MaxMind	219,037	91,668	23,242

- ✓ IPv6 is harder to cover and to geolocate.
- ✓ MaxMind misses about 7% (IPv4: 0.8%).
- ✓ **13 to 19 pp lower than IPv4** for every provider.
- ✓ Same ranking; IPinfo-DB-IP gap 5.4 → 11.5 pp; DB-IP-IP2Location 1.8 → 0.2 pp.

Country estimates are more forgiving

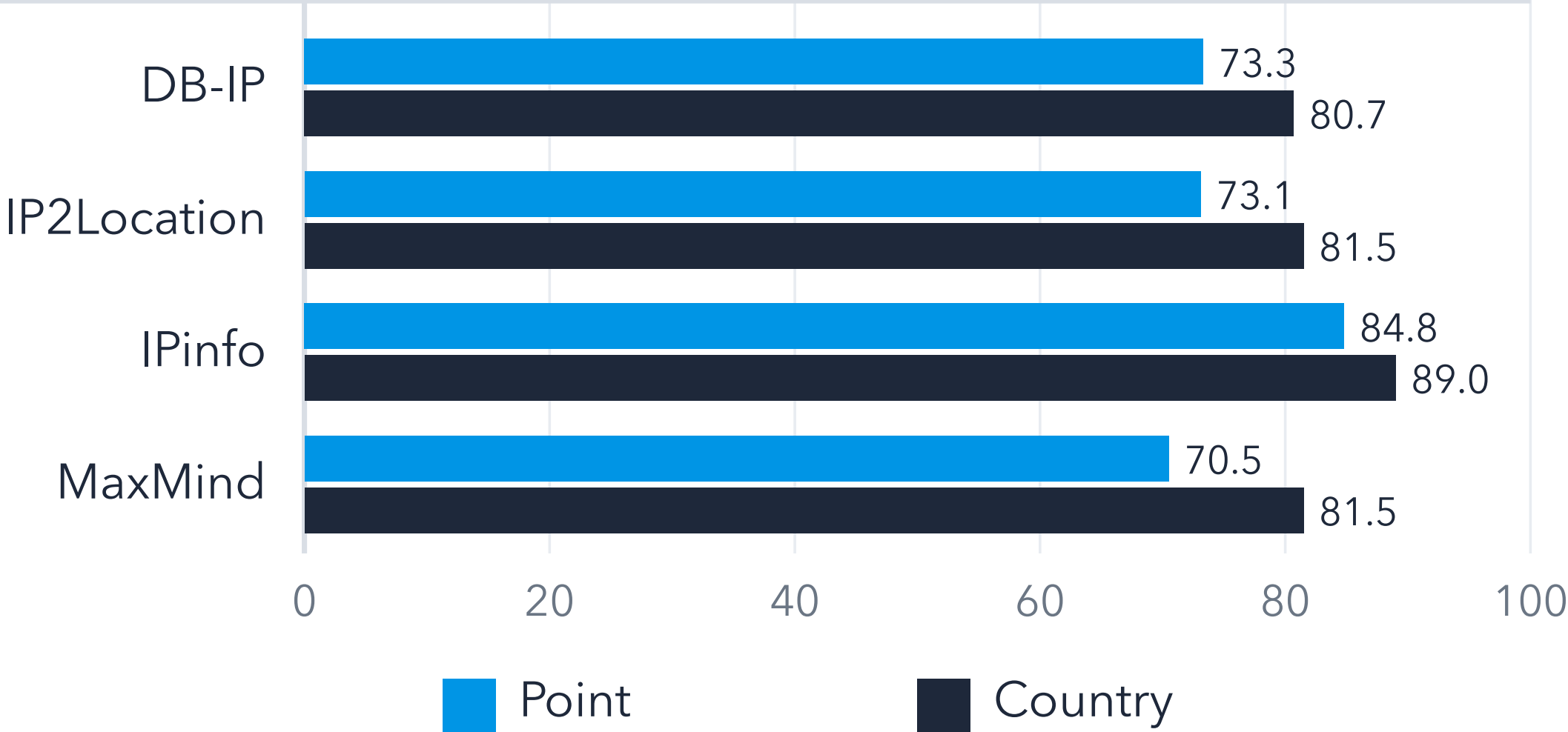
June 30, 2026: point vs. country consistency per provider and family. The gain is largest for IPv6

Consistent estimates (%)

IPv4



IPv6



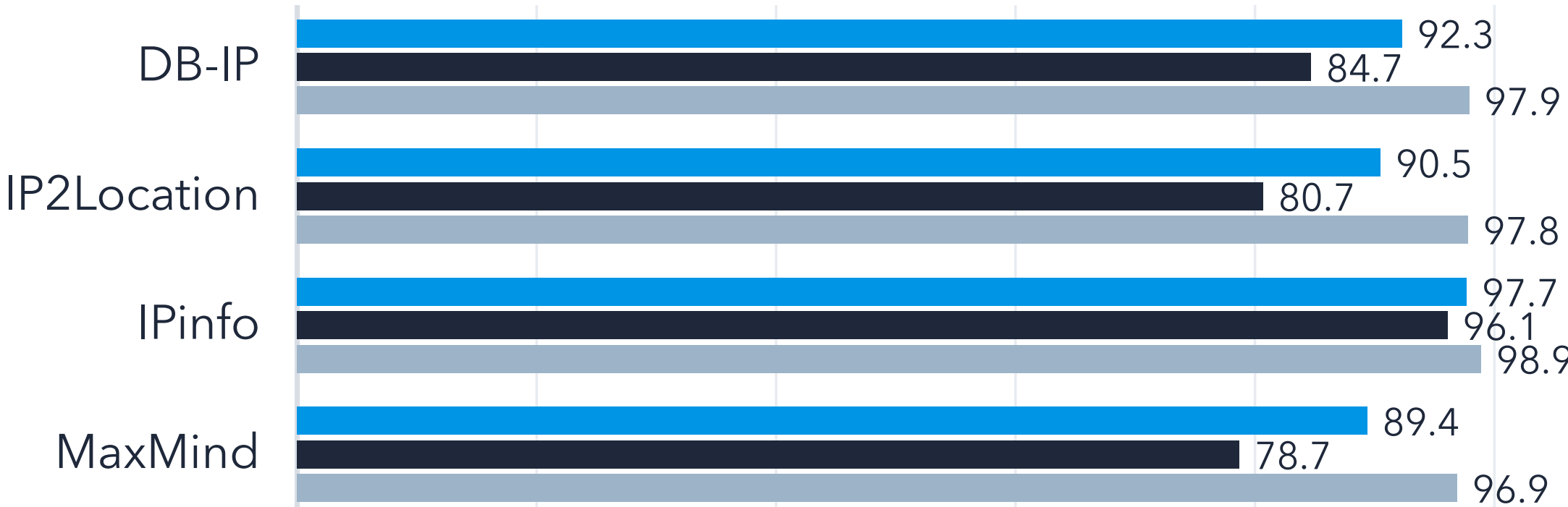
- Country: consistent if the feasibility polygon intersects the country.
- Gains of 1 to 11 pp:** an area is easier to hit than a point.
- Larger for IPv6: max IPv4 gain (4.2 pp) = min IPv6 gain.
- IPv4 ranking unchanged; IPv6: DB-IP drops below IP2Location and MaxMind.

Router consistency flips between IPv4 and IPv6

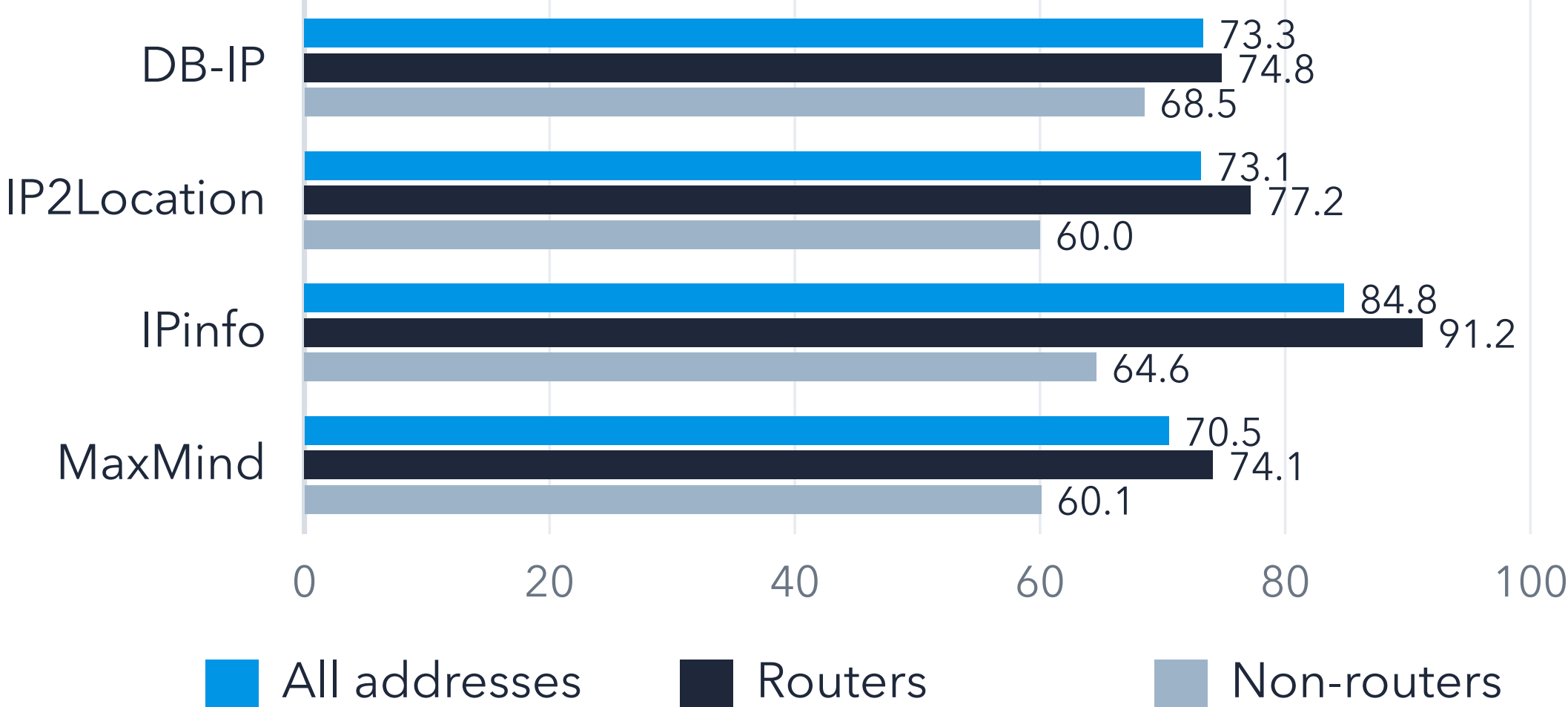
June 30, 2026: routers are addresses seen as traceroute hops; non-routers appear only as destinations

Consistent estimates (%)

IPv4



IPv6



- ✓ **IPv4:** routers are harder: -7.6 to -10.7 pp; IPinfo -1.6 pp.
- ✓ **IPv6:** flipped: routers beat non-routers by up to 26.6 pp.
- ✓ IPv4 non-routers within 2 pp; routers spread 17.4 pp.
- ✓ IPv6 ranking shifts: DB-IP leads non-routers; IP2Location second on routers.

What this tells us about evaluating geoproviders



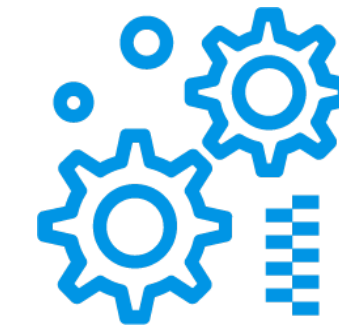
Use several perspectives

Results differ by family, role, and estimate type. Slice the address space; measure longitudinally.



Know the dataset

The June shift was RIPE Atlas changing targets, not geoproviders degrading.



Mind the limits of the method

Needs accurate probe locations and tight RTTs. Given both, an inconsistency is proof of error.

Conclusion

Takeaways

- ✓ Consistency is mostly stable over six months.
- ✓ Shifts trace back to what Atlas measures, not to providers.
- ✓ IPinfo leads by **5.4 pp (IPv4) and 11.5 pp (IPv6)**; router behavior flips between families.

Future Work

- ✓ Misreported probes [Izhikevich *et al.*, 2026].
- ✓ Anycast filtering with LACeS [Hendriks *et al.*, 2025].
- ✓ Characterize challenging addresses and provider agreement on errors.



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