

# UNVEILING NETWORK PERFORMANCE IN THE WILD: AN AD-DRIVEN ANALYSIS OF MOBILE DOWNLOAD SPEEDS

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## ABSTRACT

*adNPM* is a novel, ad-driven methodology to measure mobile network performance at scale —without requiring user participation. By embedding lightweight measurement scripts into online ads, *adNPM* gathers real-world download speed data across diverse demographics and geographic regions. It achieves accuracy comparable to industry standards like *Speedtest by Ookla* and *Opensignal*, while reducing data usage by 60% and enabling rapid, real-world measurements without user disruption. *adNPM* enables fine-grained insights at the country, demographic, and operator level —all through cost-effective real-world ad campaigns.

## MOTIVATION

Internet speed critically impacts mobile user experience —affecting activities such as video streaming, video calling, and app downloads. Traditional network measurement tools like *Speedtest by Ookla* and *Opensignal* face key limitations:

- Require active user participation.
- Depend on dedicated, centralized servers.
- Can consume large amounts of data —up to hundreds of MBs on fast networks.

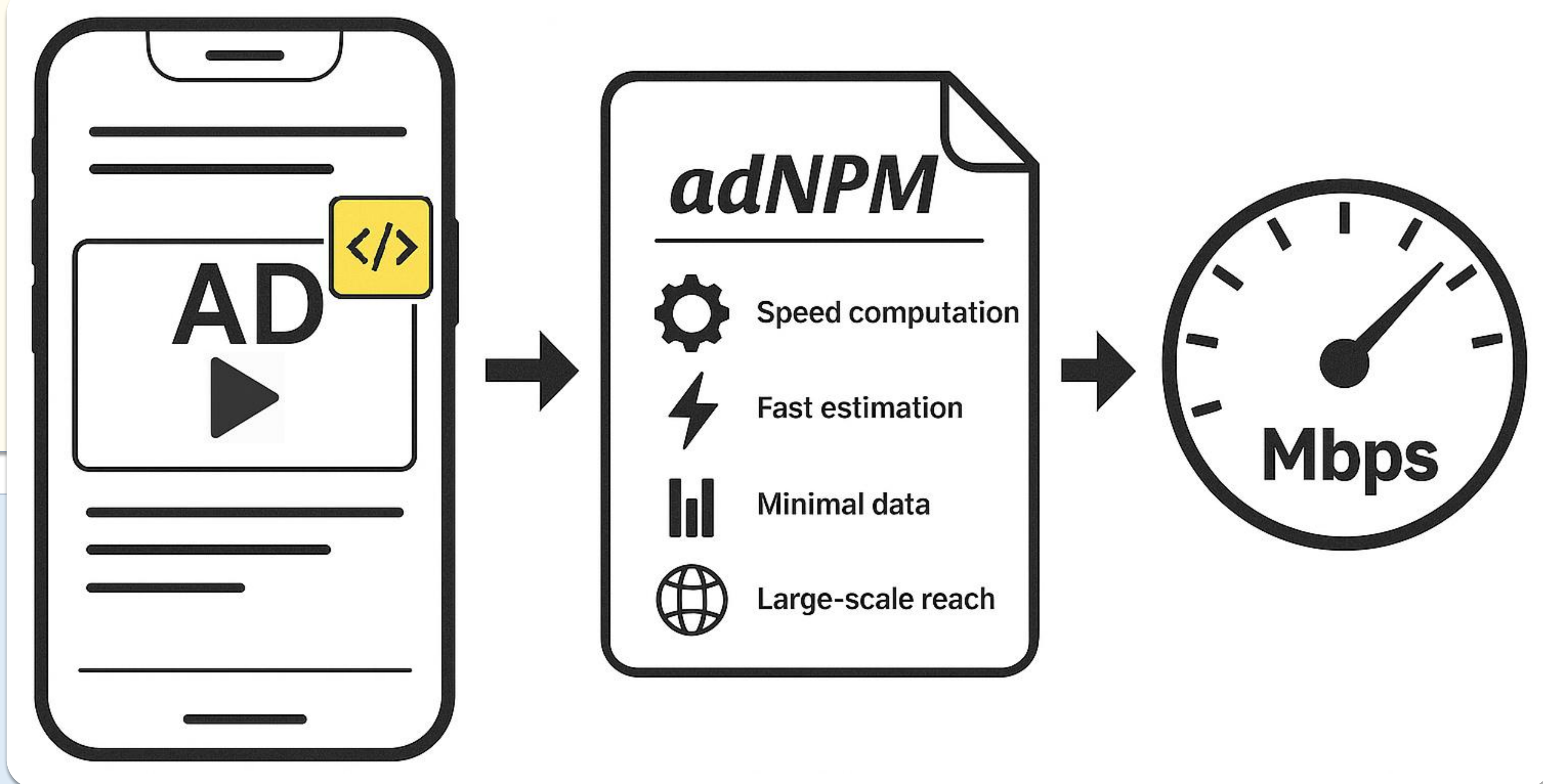
***adNPM* redefines network measurement:** a passive, ad-driven system that captures large-scale, real-world speed insights seamlessly, with minimal resource use.

## adNPM SYSTEM

*adNPM* passively measures mobile download speed by embedding a lightweight JavaScript pixel into ad creatives. When an ad is served on a device, the script silently downloads video chunks within the ad to estimate network throughput, while collecting minimal metadata such as OS, ISP, or region.

Key features:

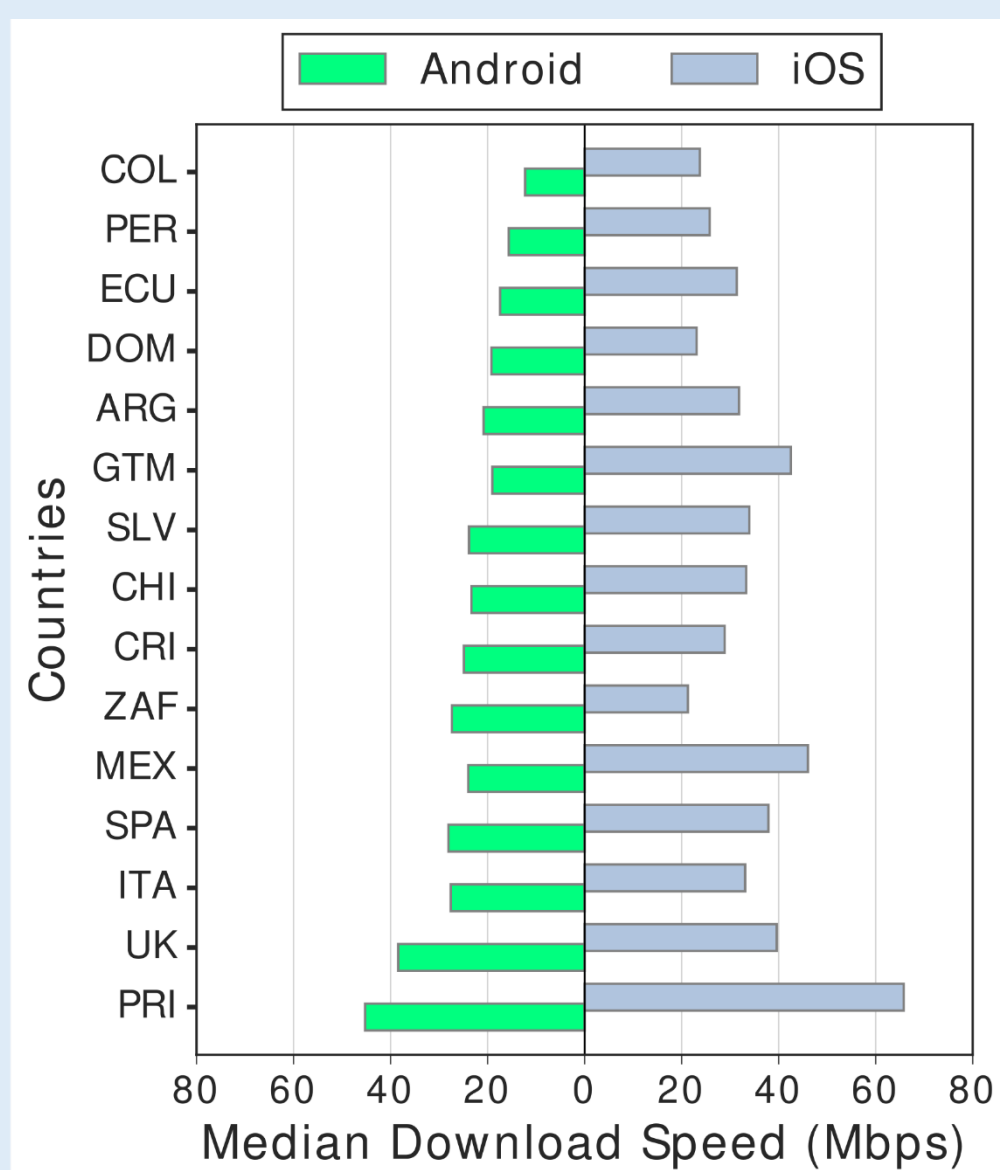
- Optimized design: tuned for accurate measurements up to 110 Mbps, (scalable to higher speeds).
- Fast estimation: download speed computed estimated within ~7.5 seconds.
- Minimal impact: average data usage ~45 MB.
- Diverse coverage: measurements collected across regions and multiple demographics.



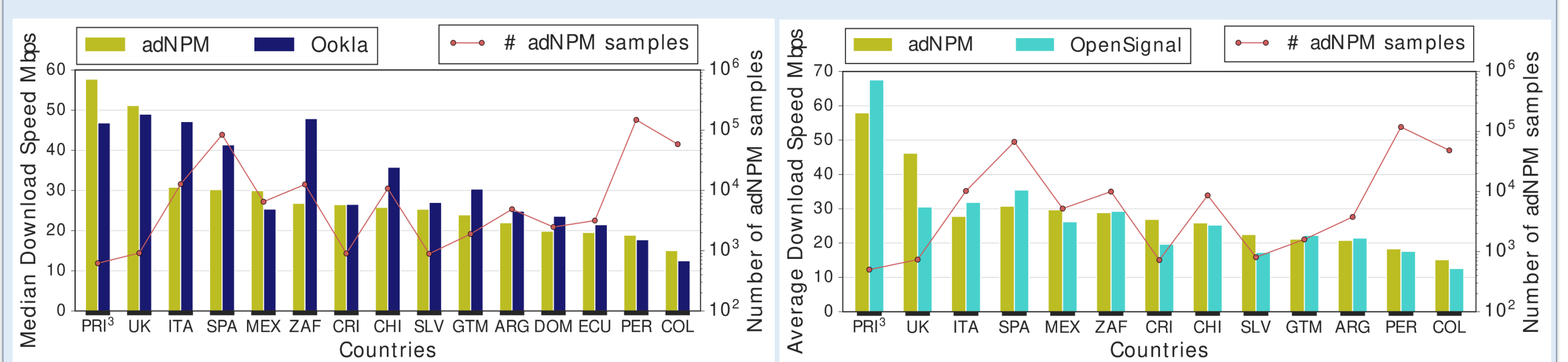
## OS-Level Analysis

iOS users consistently show higher download speeds — up to 2× faster in some countries.

*Due to device class and OS efficiency.*



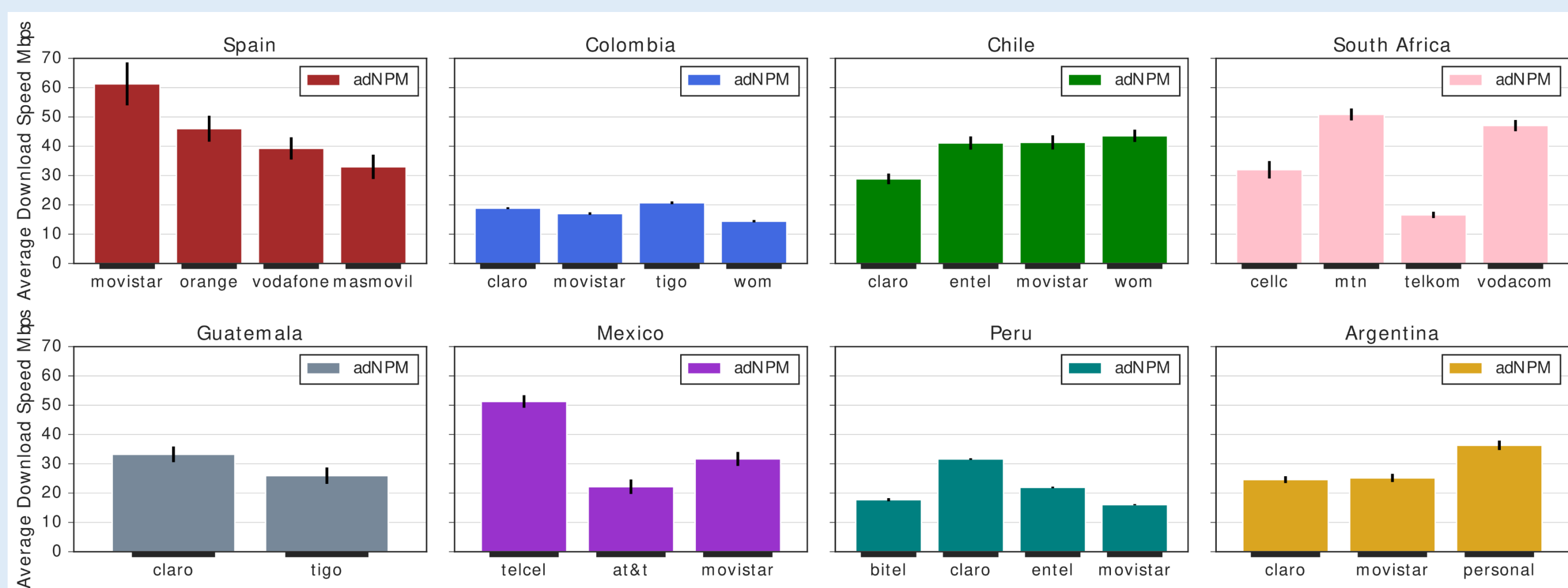
## Country-level Speed Comparison



*adNPM* generally offers download speed results closely aligned with *Opensignal*. *Speedtest by Ookla* tends to overestimate, especially for medium and high-speed networks.

*Realistic, population-level bandwidth view.*

## ISPs



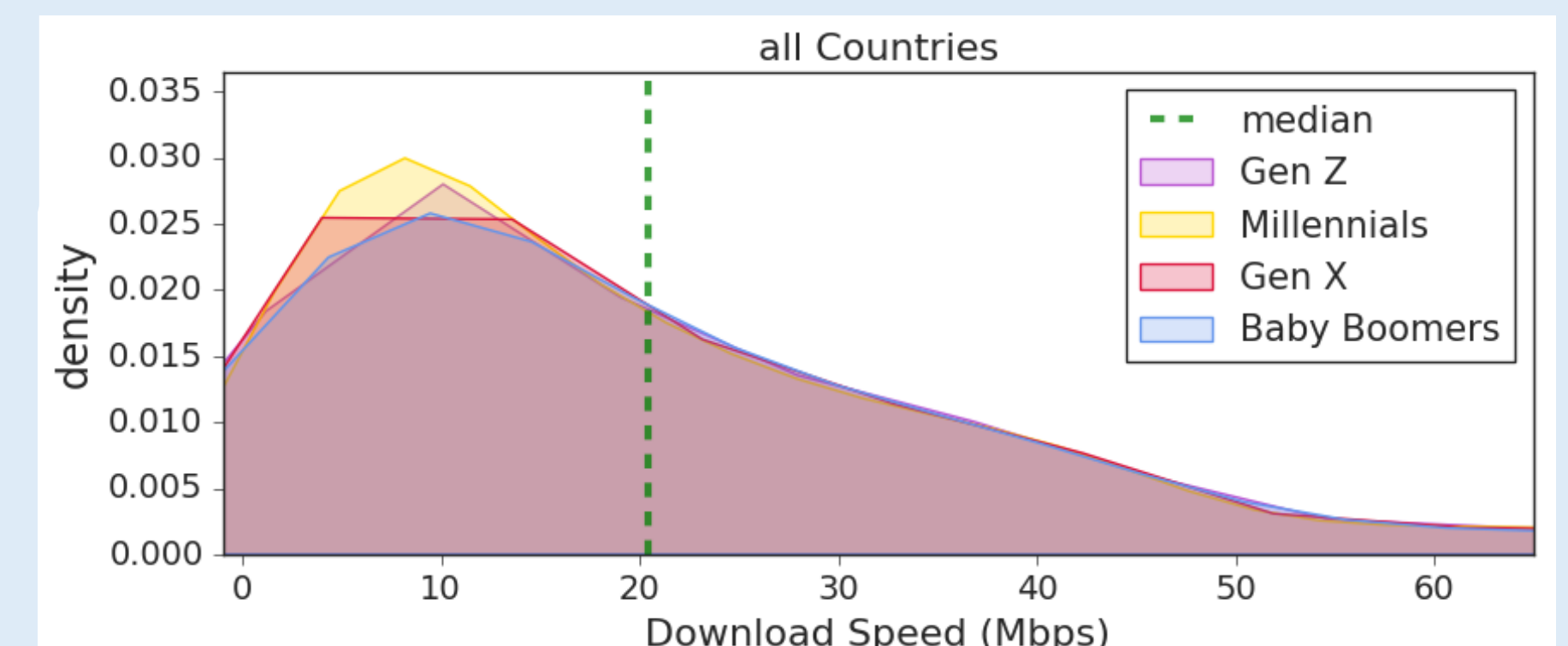
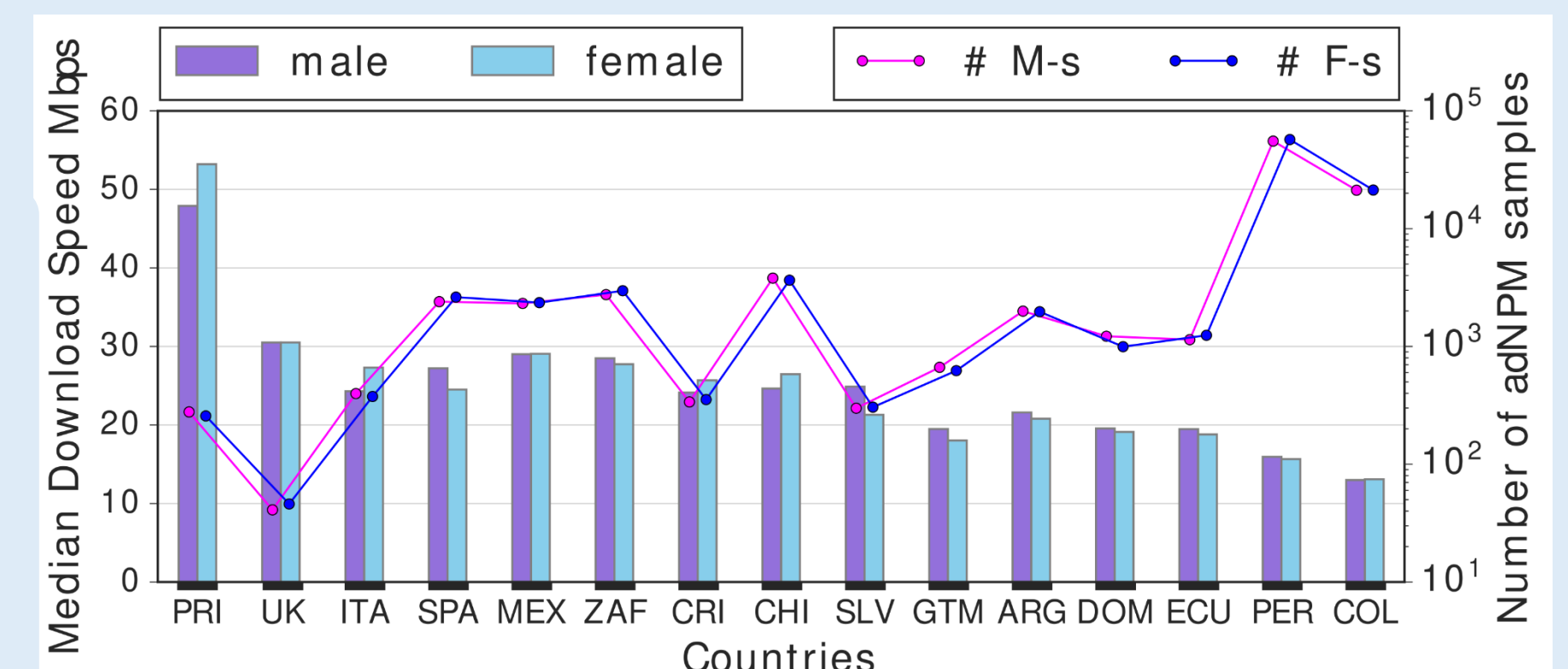
Large ISP performance gaps in some countries: 30+ Mbps between fastest and slowest.

*ISP choice strongly impacts user experience.*

## Demographics

No meaningful download speed differences across age or gender.

*Connectivity equitably distributed across populations.*



## TAKEAWAYS

- ⊘ No infrastructure. No volunteers. No user action. *adNPM* works invisibly via real ads.
- 🔍 Accurate speed insights, scalable and low-cost. No selection bias.
- 🌐 A paradigm shift for measuring connectivity —passive, inclusive, real.

