



“All of them claim to be the best”:

A Multi-Perspective Study of VPN users and VPN providers

Reethika Ramesh, Anjali Vyas, Roya Ensafi

USENIX Security '23





FTC Staff Report Finds Many Internet Service Providers Collect Troves of Personal Data, Users Have Few Options to Restrict Use



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Why Net Neutrality Can't Wait



PRIVACY INVESTIGATION —
FTC investigates whether ISPs sell your browsing history and location data
AT&T, Comcast, Verizon, T-Mobile, Google face probe into privacy and targeted ads.

THE WALL STREET JOURNAL.

NSA's Domestic Spying Grows As Agency Sweeps Up Data

Terror Fight Blurs Line Over Domain; Tracking Email



ISPs can now collect and sell your data: What to know about Internet privacy rules

Internet traffic is increasingly being **disrupted, tampered with, and monitored** by ISPs, advertisers, and other threat actors

Prior Work in the VPN Ecosystem

Implementation and Efficacy

Technical investigations

Ramesh et al. NDSS'22, Khan and DeBlasio et al. IMC'18, Weinberg et al. IMC'18, Ikram et al. IMC'16, Perta et al. PoPETS 2015

Protocol related studies

Xue et al. USENIX'22, Tolley et al. USENIX'21

Human Factors of VPN Use

Adoption/Retention of VPN use

Namara et al. PETS'20, Zou et al. CHI'20

Attitudes of Students, Corporate Users

Dutkowska-Zuk et al., Binkhorst et al. USENIX'22

Misconceptions around VPNs and their Ads

Story et al. PETS'21, Akgul et al. IEEE S&P 2022

Fundamental Questions Still Unanswered

Why do **users** turn to VPNs?

↪ Dwindling trust in ISPs?

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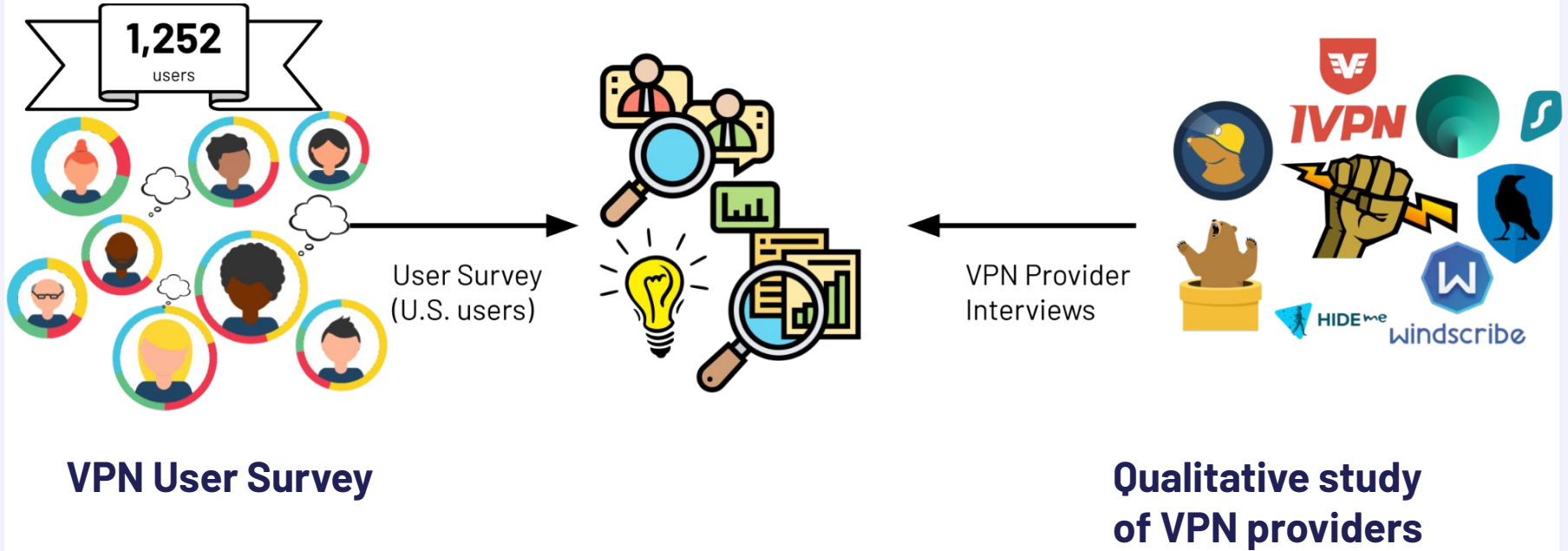
↪ What are the incentives in sustaining such practices?

We must study *both the VPN users and the VPN providers* **to gain a clear understanding of such a large consumer ecosystem**

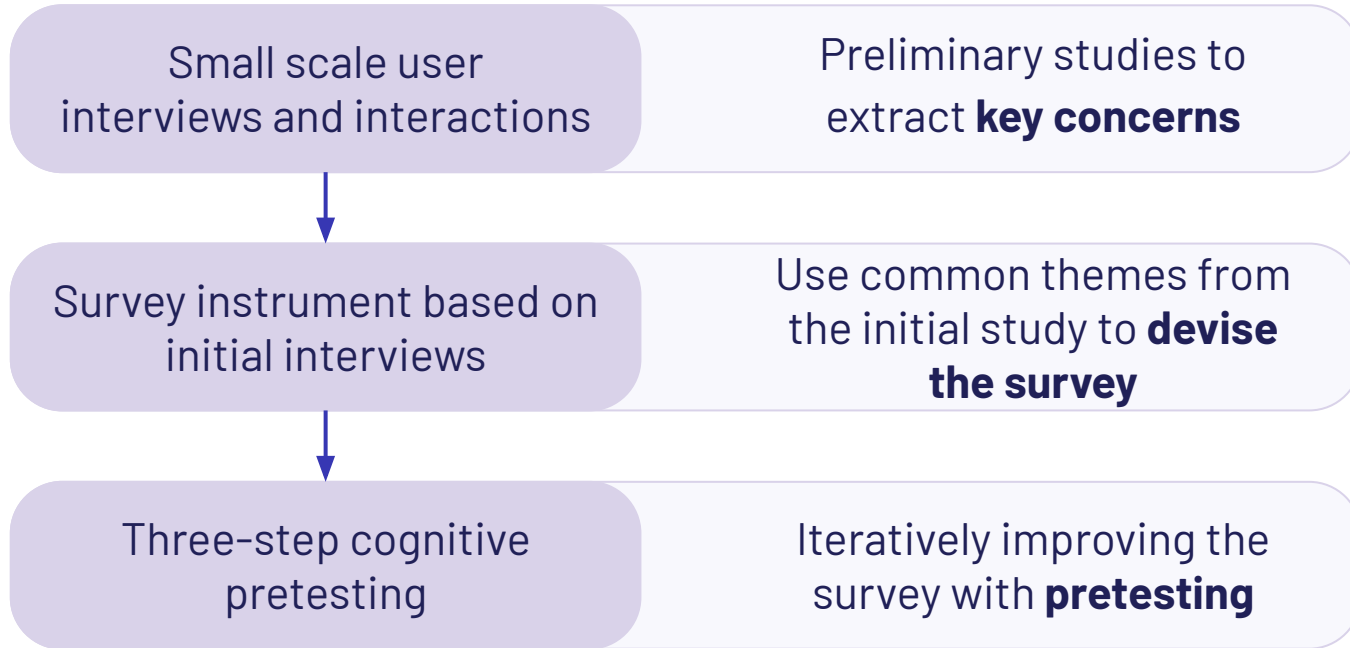
We surveyed 1,252 VPN users in the U.S. and interviewed nine popular, VPN providers

We are the first to conduct such a multi-perspective study of the VPN ecosystem

The Study



Developing the User Survey Instrument



Developing the VPN Provider Interview

Designed questions as counterparts to user survey

Included questions to understand the inner workings of the VPN ecosystem as a business

Insights about their **users**, their **business decisions**, and what they see as **key issues** in the VPN ecosystem

VPNalyzer User Study

- **Mar 1, 2021**— Launched user study in collab. with Consumer Reports Digital Lab

Data Analysis:

- **Chi-square test of independence**, and pairwise **z-tests**
- Correction for multiple comparisons through False Discovery Rate Benjamini–Hochberg procedure (**FDR-BH**)

We received over **1,500 responses** from users in over 40 countries

Focused on **1,252** U.S. users

VPN Provider Interview

- Semi-structured, open-ended interviews
≈ around 44 minutes

Data Analysis:

- **Inductive open-coding**, and **thematic analysis**
- Identified the emerging themes for each question, and common themes across different questions

Interviewed **nine VPN providers**

All quotes and comments are **anonymized**

What did we find?

We systematize our various lines of inquiry into six research questions

Data Characterization: User Population

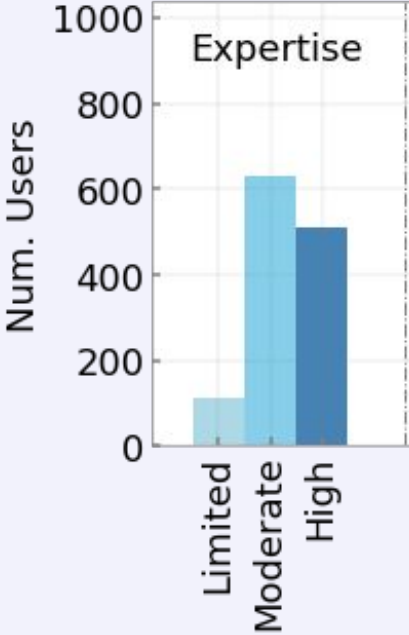
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users



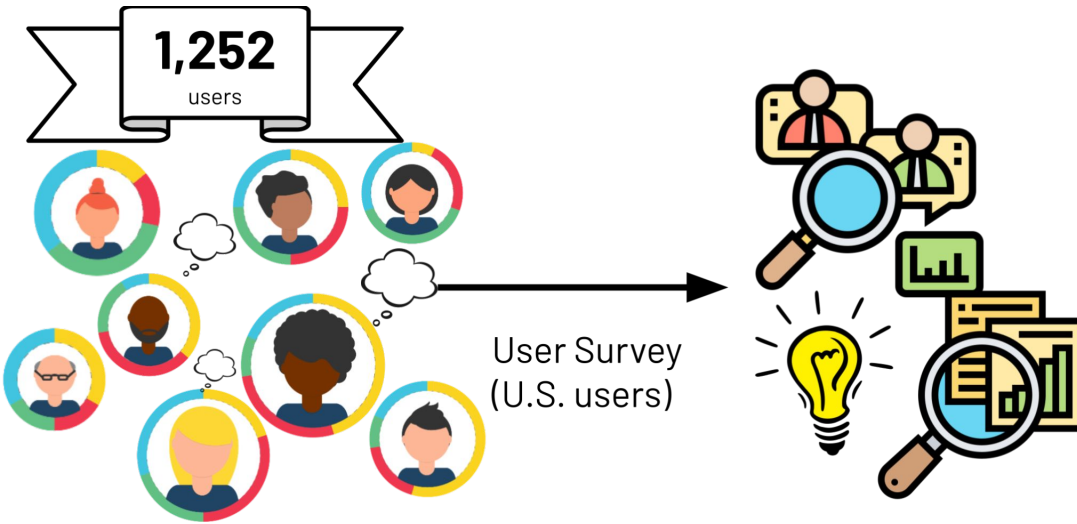
User Survey
(U.S. users)



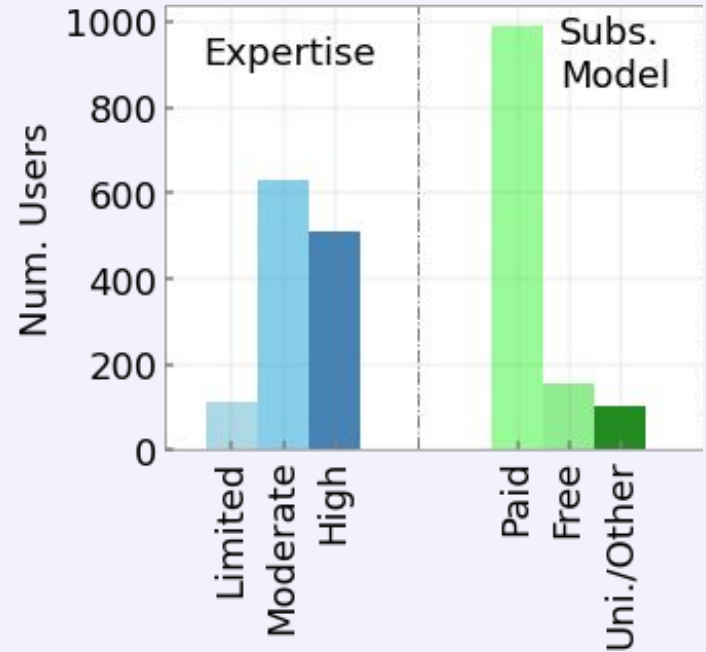
Based on **self-reported expertise**



Data Characterization: User Population



Based on **self-reported expertise** and
VPN **subscription types**



Research Question 1:

Why do users use VPNs?

Security and privacy are the top reasons

82.1% Protection from Threats

58.4% Make Public Networks Safer to Use

Circumvention, torrenting among the least popular reasons

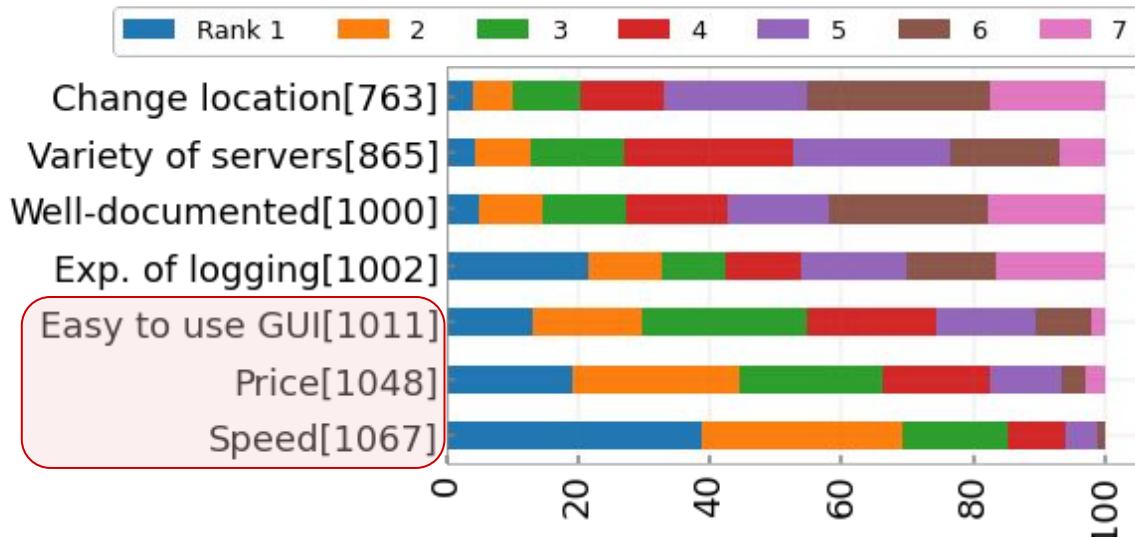
Research Question 2:

What are users' needs and considerations?

Top requirements in a VPN:

- Speed (72.6%)
- Price (55.4%)
- Easy to use app or GUI (44.1%)

Price is a big criteria for **limited-to-moderate expertise** users
→ exploited by malicious marketing

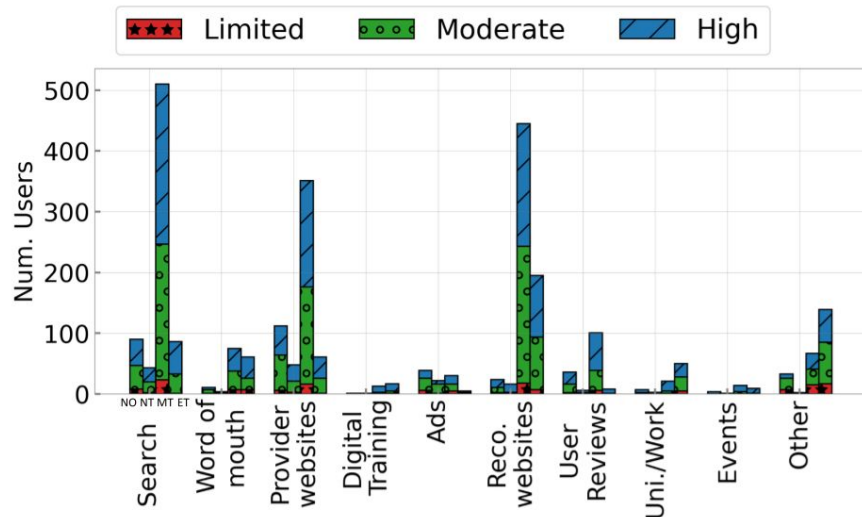


Research Question 2:

Resources to Find VPNs

- Actively researching on the Internet (61.1%)
- **Recommendation websites** (56.5%)
- Reading the VPN providers' websites (48.1%)
- ↪ Rather than traditional methods like word of mouth (5.7%)

Users rate search engines and recommendation websites trustworthy; 93.9% rate them moderately/extremely trustworthy



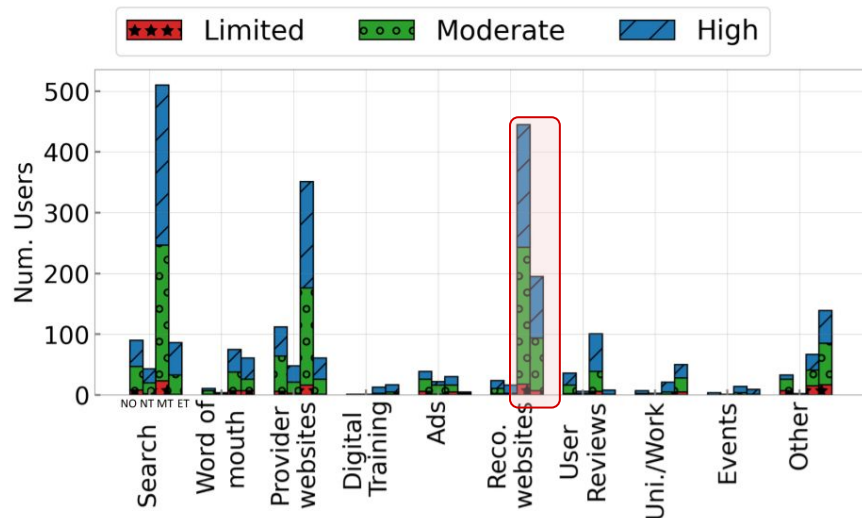
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Research Question 3:

Threat Model

83.9% Hackers or Eavesdroppers

65.4% Advertising Companies

46.9% ISPs (Internet Service Providers)

Possible Shifting attitudes:

Governments → → Hackers/Ads



Research Question 4:

Mental Models

Almost 40% of users have a flawed mental model, including users of all different expertise levels

Focus Area for improvement:

Effective user education campaigns

At least 40% users indicate they are unsure what data VPN providers can collect about them

13% of the remaining users think unreasonable kinds of data are collected by VPNs

Themes from the VPN Provider Interviews

**Key Efforts
from Providers**

**High-level
Challenges**

**Understanding
the User Base**

**Pricing and
Marketing**

**VPN Review
Ecosystem**

**Dark Patterns
in the Industry**

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Reliance on Recommendation Sites

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One provider said:

“You honestly cannot find even one ranking site that is honest...just tell people that...so that people know”

Research Question 6:

Misalignments between VPN users and providers

Reliance on Recommendation Sites

Users strongly rely on them and believe them to be trustworthy

6 of 9 VPN providers claim recommendation ecosystem is largely money-motivated

View on Data Collection

Over 40% users unsure what data is being collected about them

VPN providers claim clear communication on logging and data audit practices

Actionable Recommendations

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Oversight on VPN Ads and Marketing

FTC and government orgs to exert oversight on VPN ads and malicious marketing tactics

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Coordinated efforts from industry, academia, and consumer protection orgs to shed light on their practices

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Focused User Education Campaigns

Improve mental model of what a VPN provides, what it can do, and the threat models for which VPNs can be useful



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