GeoGuard Effectiveness Testing

Final Test Report

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STATUS RELEASE

VERSION 1.1

Version	Date	Comment
1.0	4 January 2021	Initial release version.
1.1	2 February 2021	Fixed minor typo.

1 Executive Summary

During a four-week period from 23rd November to 17th December 2020, Kingsmead Security Limited performed independent testing of the GeoGuard geolocation technology to establish the effectiveness of GeoGuard for detecting consumer VPN use.

Ten common VPN services were selected and tested across US, UK and European regions. A total of 240 tests were performed against GeoGuard.

In total GeoGuard successfully detected VPN usage 239 times and failed to detect VPN usage 1 time.

The overall success rate for VPN detection was 99.6%.
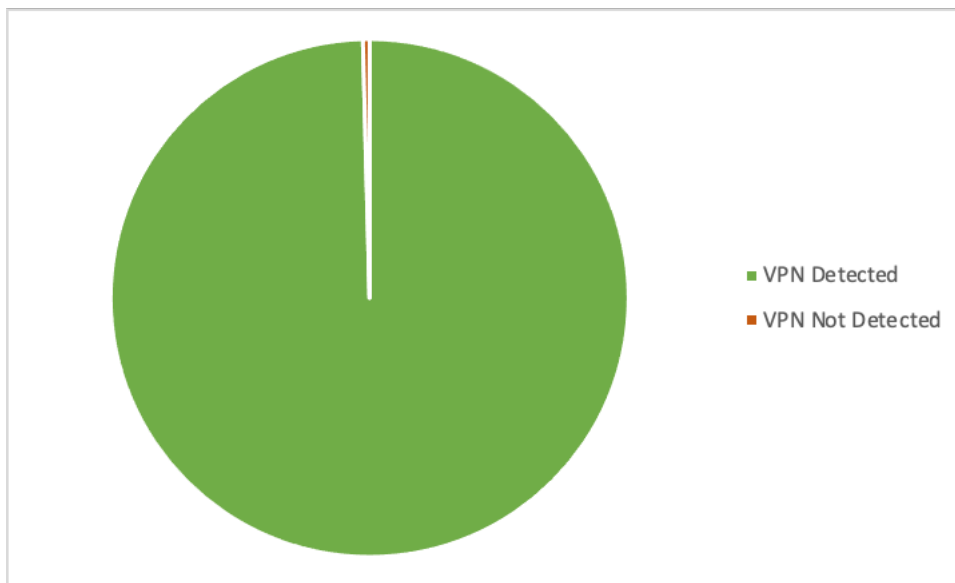

Figure 1-1 GeoGuard VPN Detection Rate

Previous effectiveness testing of GeoGuard by Kingsmead Security reported an overall success rate of 97.5% (report was published on 14 November 2019). Since then, GeoGuard has introduced a new configuration option which identifies IP addresses allocated to hosting providers that are known to be closely collaborating with VPN providers.

Contents

2 Introduction

A Virtual Private Network (VPN) is a technology used to protect the privacy of users on the Internet. Consumers use VPNs for a number of reasons including securing their Internet traffic over public networks, obtaining access to restricted websites, or avoiding government censorship.

A VPN has two objectives:

- To allow consumers to conceal their physical location by creating a virtual presence in a remote location.
- To ensure that consumer's network traffic remains confidential even when presented with the risk of eavesdropping.

A VPN achieves these objectives by creating a secure network tunnel from the consumer's device to a server endpoint in a remote location. The secure network tunnel encrypts all consumer network traffic to protect against eavesdropping, and the remote endpoint provides a virtual presence on the Internet on behalf of the consumer.

The ability to create a presence in a remote location has become a powerful marketing tool for the VPN vendors. VPNs are now commonly used to circumvent the territorial restrictions of over-the-top (OTT) video services. Content rich services such as Netflix (US), HBO Go (US) and BBC iPlayer (UK) are attractive targets for those located overseas.

GeoGuard is a provider of geolocation technology used to detect the use of VPNs. GeoGuard has approached Kingsmead Security Limited to conduct independent testing of the GeoGuard solution to establish its effectiveness at detecting common VPN services.

Kingsmead Security Limited is an independent content security consultancy serving the TV and film industry. Kingsmead Security supports content owners, service providers and technology vendors protect movie, sports and other premium content.

This report summarises the results from testing GeoGuard's performance against ten of the most common VPN services available today.

3 Test Methodology

3.1   Test Setup

Testing was conducted using a MacBook Air (macOS Bug Sur 11.0.1) and the Safari browser (14.0.1).

A UK residential ISP connection was used for testing (provided by Virgin Media).

Testing was conducted using a simple test website hosted by GeoGuard. This website displays one of the messages shown in Figure 3-1.
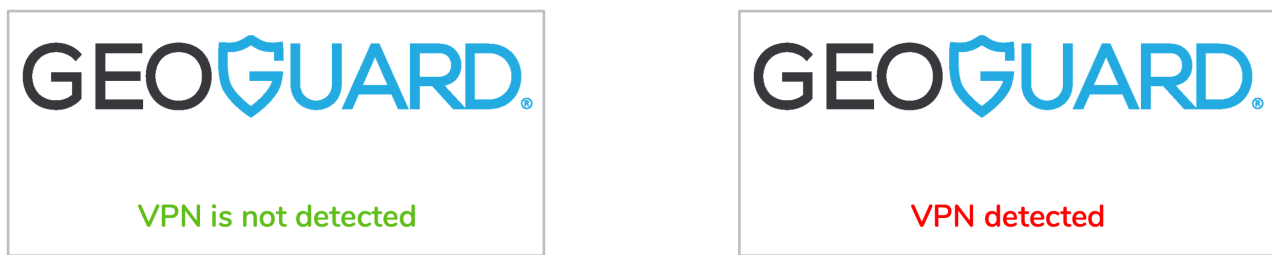

Figure 3-1 GeoGuard Test Website

Kingsmead Security previously tested the effectiveness of GeoGuard, publishing test results on 14 November 2019. Since then, GeoGuard has introduced a new configuration option "is_vpn_datacenter". If this option is enabled, any IP address allocated to hosting providers that are known to be closely collaborating with VPN providers is assumed to be an VPN endpoint.

This option is enabled during this testing project.

3.2   VPN Services

Ten VPN services were chosen for testing based on:

- Recommendations from the technology press. Examples include:
  - https://www.techradar.com/uk/vpn/the-best-vpn-for-streaming
  - https://www.techadvisor.co.uk/test-centre/internet/best-vpn-reviews-3657732
  - https://uk.pcmag.com/vpn/138/the-best-vpn-services
  - https://www.tomsguide.com/best-picks/best-vpn
- VPN services advertising access to OTT services. Examples include:
  - https://www.expressvpn.com/vpn-service/netflix-vpn
  - https://nordvpn.com/features/streaming/
- VPN comparison sites. Examples include:
  - https://thebestvpndeals.com
  - https://www.top10vpn.com/
  - https://www.vpnmentor.com
- Industry experience

The final list of VPNs is listed in Table 3-1.

VPN	Web
ExpressVPN	https://www.expressvpn.com
NordVPN	https://nordvpn.com
IPVanish	https://www.ipvanish.com
SaferVPN	https://www.safervpn.com
Hide My Ass	https://www.hidemyass.com
SurfShark	https://surfshark.com
StrongVPN	https://strongvpn.com
UltraVPN	https://ultravpn.com
TunnelBear	https://www.tunnelbear.com
MyExpatNetwork	https://www.my-expat-network.com/

Table 3-1 VPN Services under Test

3.3   Testing Process

Testing was conducted over a four-week period from 23rd November to 17th December 2020.

Two testing cycles were executed each week; each testing cycle tested all ten VPN services across three regions – US, UK and Europe.

For each VPN/region test, the following was executed:

- Start the VPN software.
- Select a VPN exit point in the geographic region under test. The VPN exit point will be varied on each testing run to ensure a wide coverage of exit points.
- Establish a VPN connection to the selected exit point.
- Record the exit point IP address.
- Using Safari, use the GeoGuard test webpage to confirm detection.

VPN endpoint selection options vary across VPN services, with some services offering fine-grained control over the endpoint location. Where more control is offered, the endpoint was varied across tests.

If a VPN endpoint was unavailable for test due to a service outage, tested was rescheduled for a later day.

For each test, the following was recorded:

- Test number
- Date and time of test
- VPN name
- Region under test
- Target VPN endpoint selected
- Local IP address
- Exit IP address of VPN
- Result of test case (VPN detected/VPN is not detected)

A total of 240 tests were executed (4 weeks x 2 test runs x 10 VPN services x 3 regions).

4   Test Results

4.1   Executive Summary

A total of 240 tests were performed against the GeoGuard service. VPN usage was successfully detected in 239 cases, with 1 failure. The overall success rate for VPN detection was 99.6%.

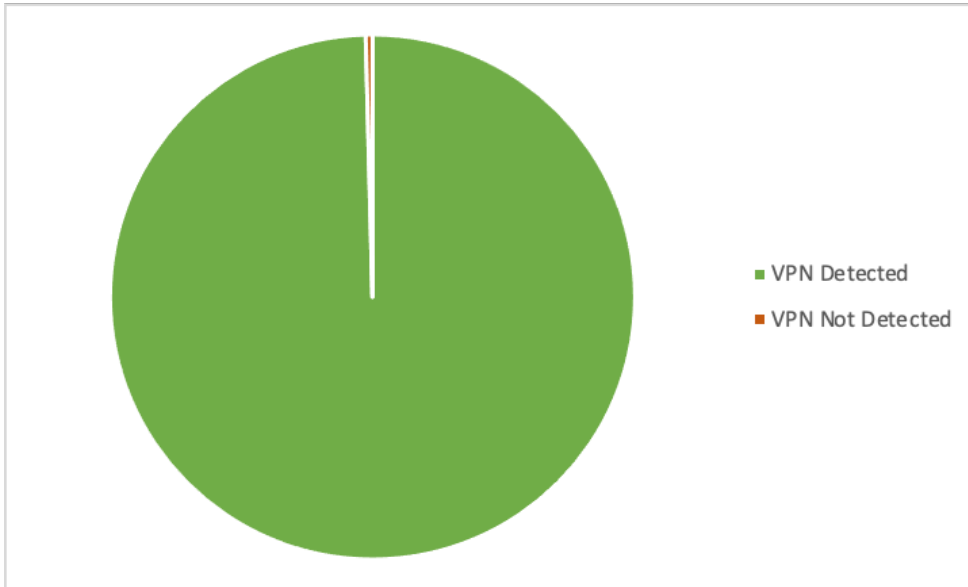**Figure 4-1 Overall Detection Rate**

Full results are listed in Appendix A.

4.2   Summary by VPN Service

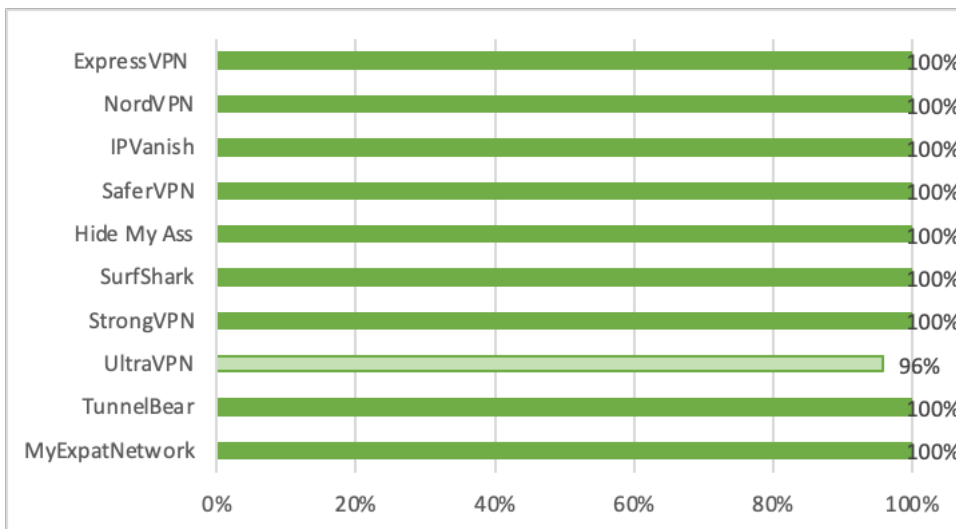Figure 4-2 shows the VPN detection rates for each VPN service. Each VPN was tested 24 times.

Figure 4-2 Detection Rate by VPN Service

4.1   Summary by Region

Figure 4-3 shows the VPN detection rates for each region. Each region was tested 80 times.
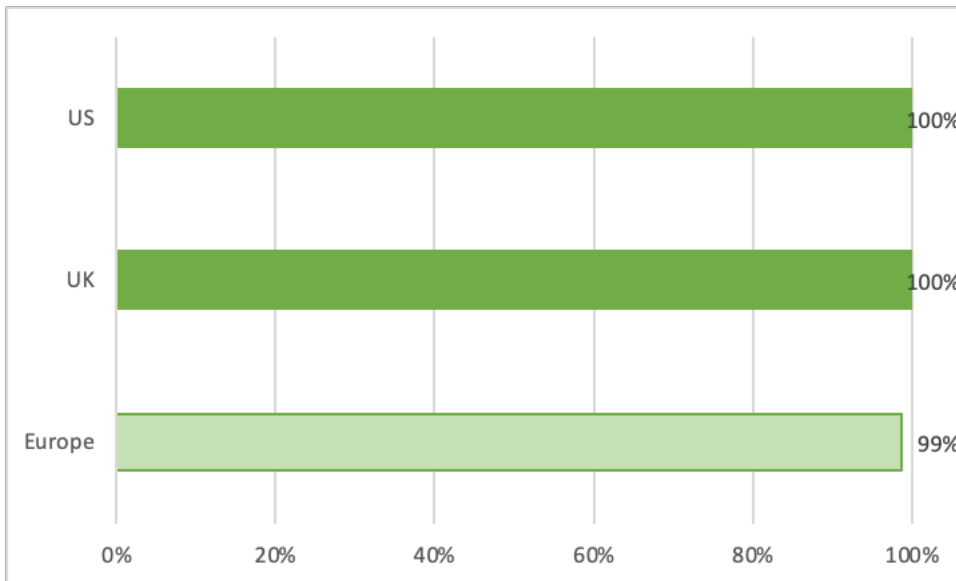
Figure 4-3 Detection Rate by Region

4.2   General Observations

During testing only one VPN connection was not detected by GeoGuard. This was an UltraVPN connection to Sweden on 14th December. All other VPN connections were detected by GeoGuard.

The tests show that GeoGuard is very successful at detecting VPN usage. The introduction of the new configuration option "is_vpn_datacenter" ensures a very high detection rate of 99.6% compared to a detection rate of 97.5% reported on 14 November 2019 from previous testing.

Note that some service providers who use this option may encounter false positive VPN detections from some consumers as residential properties can potentially be routed through these VPN hosting data centers. Whitelisting may need to be introduced to provide service to these consumers.

During testing, the following were observed:

UltraVPN allocates IPv6 addresses as well as IPv4 addresses in many EU countries (as reported by https://whatismyipaddress.com). During testing, this included Ireland, Sweden, France, Spain, Netherlands and Italy. The GeoGuard testing was conducted based on IPv4 addresses only.

MyExpatNetwork has the poorest selection of countries (12). Additionally, there are a limited number of endpoint servers in the US, and so testing encountered many duplicate endpoint IP addresses for the US.

SaferVPN remains the most unreliable VPN, especially when connecting to the UK. During 5 out of the 8 test days, SaferVPN testing of the UK had to be delayed due to a failure to establish a connection. These test cases were delayed until a successful connection was possible (normally a few minutes but potentially many hours).

5 Appendix A : Full Test Results

The following table summarises the tests performed.

Date	VPN	Target	VPN End Point	Result
Week 1				
23-Nov	ExpressVPN	US	New York	VPN detected
23-Nov	ExpressVPN	UK	Docklands	VPN detected
23-Nov	ExpressVPN	Europe	Germany - Frankfurt - 1	VPN detected
23-Nov	NordVPN	US	New York	VPN detected
23-Nov	NordVPN	UK	#2054	VPN detected
23-Nov	NordVPN	Europe	Germany - Frankfurt	VPN detected
23-Nov	IPVanish	US	New York	VPN detected
23-Nov	IPVanish	UK	Birmingham	VPN detected
23-Nov	IPVanish	Europe	Germany - Frankfurt	VPN detected
23-Nov	SaferVPN	US	USA East	VPN detected
24-Nov	SaferVPN	UK	UK	VPN detected
23-Nov	SaferVPN	Europe	Germany	VPN detected
23-Nov	HideMyAss	US	New York	VPN detected
23-Nov	HideMyAss	UK	Donkey Town	VPN detected
23-Nov	HideMyAss	Europe	Germany - Berlin	VPN detected
23-Nov	SurfShark	US	New York	VPN detected
23-Nov	SurfShark	UK	London	VPN detected
23-Nov	SurfShark	Europe	Germany - Nuremberg	VPN detected
24-Nov	StrongVPN	US	New York	VPN detected
24-Nov	StrongVPN	UK	Canterbury	VPN detected
24-Nov	StrongVPN	Europe	Germany, Frankfurt	VPN detected
23-Nov	UltraVPN	US	New York	VPN detected
23-Nov	UltraVPN	UK	UK	VPN detected
23-Nov	UltraVPN	Europe	Germany	VPN detected
23-Nov	TunnelBear	US	US	VPN detected
23-Nov	TunnelBear	UK	UK	VPN detected
23-Nov	TunnelBear	Europe	Germany	VPN detected
23-Nov	MyExpatNetwork	US	US	VPN detected
23-Nov	MyExpatNetwork	UK	UK	VPN detected
23-Nov	MyExpatNetwork	Europe	Germany	VPN detected
26-Nov	ExpressVPN	US	Los Angeles - 2	VPN detected
26-Nov	ExpressVPN	UK	East London	VPN detected
26-Nov	ExpressVPN	Europe	France - Paris - 1	VPN detected
26-Nov	NordVPN	US	Los Angeles	VPN detected
26-Nov	NordVPN	UK	#2159	VPN detected
26-Nov	NordVPN	Europe	France #719	VPN detected
26-Nov	IPVanish	US	Los Angeles	VPN detected
26-Nov	IPVanish	UK	Glasgow	VPN detected
26-Nov	IPVanish	Europe	France - Marseille	VPN detected
26-Nov	SaferVPN	US	USA West	VPN detected
26-Nov	SaferVPN	UK	UK	VPN detected
26-Nov	SaferVPN	Europe	France	VPN detected
26-Nov	HideMyAss	US	Los Angeles	VPN detected
26-Nov	HideMyAss	UK	Glasgow	VPN detected
26-Nov	HideMyAss	Europe	France - Paris	VPN detected
26-Nov	SurfShark	US	Los Angeles	VPN detected
26-Nov	SurfShark	UK	Glasgow	VPN detected
26-Nov	SurfShark	Europe	France - Bordeaux	VPN detected
26-Nov	StrongVPN	US	Los Angeles	VPN detected
26-Nov	StrongVPN	UK	Glasgow	VPN detected
26-Nov	StrongVPN	Europe	France - Paris	VPN detected
26-Nov	UltraVPN	US	Los Angeles	VPN detected
26-Nov	UltraVPN	UK	UK	VPN detected

26-Nov	UltraVPN	Europe	France	VPN detected
26-Nov	TunnelBear	US	US	VPN detected
26-Nov	TunnelBear	UK	UK	VPN detected
26-Nov	TunnelBear	Europe	France	VPN detected
26-Nov	MyExpatNetwork	US	US - StealthMode	VPN detected
26-Nov	MyExpatNetwork	UK	UK - StealthMode	VPN detected
26-Nov	MyExpatNetwork	Europe	France	VPN detected
Week 2				
30-Nov	ExpressVPN	US	Washington DC	VPN detected
30-Nov	ExpressVPN	UK	London	VPN detected
30-Nov	ExpressVPN	Europe	Spain - Barcelona	VPN detected
30-Nov	NordVPN	US	Atlanta	VPN detected
30-Nov	NordVPN	UK	#1877	VPN detected
30-Nov	NordVPN	Europe	Spain	VPN detected
30-Nov	IPVanish	US	Atlanta	VPN detected
30-Nov	IPVanish	UK	London	VPN detected
30-Nov	IPVanish	Europe	Spain	VPN detected
30-Nov	SaferVPN	US	USA East	VPN detected
30-Nov	SaferVPN	UK	UK	VPN detected
30-Nov	SaferVPN	Europe	Spain	VPN detected
30-Nov	HideMyAss	US	Atlanta	VPN detected
30-Nov	HideMyAss	UK	London	VPN detected
30-Nov	HideMyAss	Europe	Spain	VPN detected
30-Nov	SurfShark	US	Atlanta	VPN detected
30-Nov	SurfShark	UK	Manchester	VPN detected
30-Nov	SurfShark	Europe	Spain - Valencia	VPN detected
30-Nov	StrongVPN	US	Atlanta	VPN detected
30-Nov	StrongVPN	UK	London	VPN detected
30-Nov	StrongVPN	Europe	Spain -Madrid	VPN detected
30-Nov	UltraVPN	US	Atlanta	VPN detected
30-Nov	UltraVPN	UK	UK	VPN detected
30-Nov	UltraVPN	Europe	Spain	VPN detected
30-Nov	TunnelBear	US	US	VPN detected
30-Nov	TunnelBear	UK	UK	VPN detected
30-Nov	TunnelBear	Europe	Spain	VPN detected
30-Nov	MyExpatNetwork	US	US	VPN detected
30-Nov	MyExpatNetwork	UK	UK	VPN detected
30-Nov	MyExpatNetwork	Europe	Spain	VPN detected
03-Dec	ExpressVPN	US	New Jersey - 3	VPN detected
03-Dec	ExpressVPN	UK	Docklands	VPN detected
03-Dec	ExpressVPN	Europe	Netherlands	VPN detected
03-Dec	NordVPN	US	Seattle	VPN detected
03-Dec	NordVPN	UK	#2204	VPN detected
03-Dec	NordVPN	Europe	Netherlands	VPN detected
03-Dec	IPVanish	US	Seattle	VPN detected
03-Dec	IPVanish	UK	Maidenhead	VPN detected
03-Dec	IPVanish	Europe	Netherlands	VPN detected
03-Dec	SaferVPN	US	USA West	VPN detected
03-Dec	SaferVPN	UK	UK	VPN detected
03-Dec	SaferVPN	Europe	Netherlands	VPN detected
03-Dec	HideMyAss	US	Seattle	VPN detected
03-Dec	HideMyAss	UK	Donkey Town	VPN detected
03-Dec	HideMyAss	Europe	Netherlands	VPN detected
03-Dec	SurfShark	US	Seattle	VPN detected
03-Dec	SurfShark	UK	London	VPN detected
03-Dec	SurfShark	Europe	Netherlands	VPN detected
03-Dec	StrongVPN	US	Seattle	VPN detected
03-Dec	StrongVPN	UK	Maidenhead	VPN detected
03-Dec	StrongVPN	Europe	Netherlands	VPN detected
03-Dec	UltraVPN	US	Seattle	VPN detected
03-Dec	UltraVPN	UK	UK	VPN detected

03-Dec	UltraVPN	Europe	Netherlands	VPN detected
03-Dec	TunnelBear	US	US	VPN detected
03-Dec	TunnelBear	UK	UK	VPN detected
03-Dec	TunnelBear	Europe	Netherlands	VPN detected
03-Dec	MyExpatNetwork	US	US	VPN detected
03-Dec	MyExpatNetwork	UK	UK	VPN detected
03-Dec	MyExpatNetwork	Europe	Netherlands	VPN detected
Week 3				
07-Dec	ExpressVPN	US	New York	VPN detected
07-Dec	ExpressVPN	UK	East London	VPN detected
07-Dec	ExpressVPN	Europe	Italy - Cosenza	VPN detected
07-Dec	NordVPN	US	Denver	VPN detected
07-Dec	NordVPN	UK	#2040	VPN detected
07-Dec	NordVPN	Europe	Italy	VPN detected
07-Dec	IPVanish	US	Denver	VPN detected
07-Dec	IPVanish	UK	Manchester	VPN detected
07-Dec	IPVanish	Europe	Italy	VPN detected
07-Dec	SaferVPN	US	USA East	VPN detected
07-Dec	SaferVPN	UK	UK	VPN detected
07-Dec	SaferVPN	Europe	Italy	VPN detected
07-Dec	HideMyAss	US	Omaha	VPN detected
07-Dec	HideMyAss	UK	Glasgow	VPN detected
07-Dec	HideMyAss	Europe	Italy	VPN detected
07-Dec	SurfShark	US	Denver	VPN detected
07-Dec	SurfShark	UK	Glasgow	VPN detected
07-Dec	SurfShark	Europe	Italy - Rome	VPN detected
07-Dec	StrongVPN	US	Denver	VPN detected
07-Dec	StrongVPN	UK	Manchester	VPN detected
07-Dec	StrongVPN	Europe	Italy - Milan	VPN detected
07-Dec	UltraVPN	US	Denver	VPN detected
07-Dec	UltraVPN	UK	UK	VPN detected
07-Dec	UltraVPN	Europe	Italy	VPN detected
07-Dec	TunnelBear	US	US	VPN detected
07-Dec	TunnelBear	UK	UK	VPN detected
07-Dec	TunnelBear	Europe	Italy	VPN detected
07-Dec	MyExpatNetwork	US	US - StealthMode	VPN detected
07-Dec	MyExpatNetwork	UK	UK- StealthMode	VPN detected
07-Dec	MyExpatNetwork	Europe	Italy	VPN detected
10-Dec	ExpressVPN	US	Los Angeles - 2	VPN detected
10-Dec	ExpressVPN	UK	London	VPN detected
10-Dec	ExpressVPN	Europe	Ireland	VPN detected
10-Dec	NordVPN	US	Miami	VPN detected
10-Dec	NordVPN	UK	#2206	VPN detected
10-Dec	NordVPN	Europe	Ireland	VPN detected
10-Dec	IPVanish	US	Miami	VPN detected
10-Dec	IPVanish	UK	Birmingham	VPN detected
10-Dec	IPVanish	Europe	Ireland	VPN detected
10-Dec	SaferVPN	US	USA West	VPN detected
10-Dec	SaferVPN	UK	UK	VPN detected
10-Dec	SaferVPN	Europe	Ireland	VPN detected
10-Dec	HideMyAss	US	Miami	VPN detected
10-Dec	HideMyAss	UK	UK via USA, New York	VPN detected
10-Dec	HideMyAss	Europe	Ireland	VPN detected
10-Dec	SurfShark	US	Tampa	VPN detected
10-Dec	SurfShark	UK	Manchester	VPN detected
10-Dec	SurfShark	Europe	ireland	VPN detected
10-Dec	StrongVPN	US	Miami	VPN detected
10-Dec	StrongVPN	UK	Rugby	VPN detected
10-Dec	StrongVPN	Europe	Ireland - Dublin	VPN detected
10-Dec	UltraVPN	US	Miami	VPN detected
10-Dec	UltraVPN	UK	UK	VPN detected

10-Dec	UltraVPN	Europe	Ireland	VPN detected
10-Dec	TunnelBear	US	US	VPN detected
10-Dec	TunnelBear	UK	UK	VPN detected
10-Dec	TunnelBear	Europe	Ireland	VPN detected
10-Dec	MyExpatNetwork	US	US	VPN detected
10-Dec	MyExpatNetwork	UK	UK	VPN detected
10-Dec	MyExpatNetwork	Europe	Denmark	VPN detected
Week 4				
14-Dec	ExpressVPN	US	Washington DC	VPN detected
14-Dec	ExpressVPN	UK	Wembley	VPN detected
14-Dec	ExpressVPN	Europe	Sweden - 2	VPN detected
14-Dec	NordVPN	US	Chicago	VPN detected
14-Dec	NordVPN	UK	#2217	VPN detected
14-Dec	NordVPN	Europe	Sweden	VPN detected
14-Dec	IPVanish	US	Chicago	VPN detected
14-Dec	IPVanish	UK	Glasgow	VPN detected
14-Dec	IPVanish	Europe	Sweden	VPN detected
14-Dec	SaferVPN	US	USA East	VPN detected
14-Dec	SaferVPN	UK	UK	VPN detected
14-Dec	SaferVPN	Europe	Sweden	VPN detected
14-Dec	HideMyAss	US	USA (via Germany)	VPN detected
14-Dec	HideMyAss	UK	London	VPN detected
14-Dec	HideMyAss	Europe	Sweden	VPN detected
14-Dec	SurfShark	US	Chicago	VPN detected
14-Dec	SurfShark	UK	London	VPN detected
14-Dec	SurfShark	Europe	Sweden	VPN detected
14-Dec	StrongVPN	US	Chicago	VPN detected
14-Dec	StrongVPN	UK	Canterbury	VPN detected
14-Dec	StrongVPN	Europe	Sweden - Stockholm	VPN detected
14-Dec	UltraVPN	US	Chicago	VPN detected
14-Dec	UltraVPN	UK	Coventry	VPN detected
14-Dec	UltraVPN	Europe	Sweden	VPN is not detected
14-Dec	TunnelBear	US	US	VPN detected
14-Dec	TunnelBear	UK	UK	VPN detected
14-Dec	TunnelBear	Europe	Sweden	VPN detected
14-Dec	MyExpatNetwork	US	US	VPN detected
14-Dec	MyExpatNetwork	UK	UK	VPN detected
14-Dec	MyExpatNetwork	Europe	Sweden	VPN detected
17-Dec	ExpressVPN	US	Seattle	VPN detected
17-Dec	ExpressVPN	UK	Wembley	VPN detected
17-Dec	ExpressVPN	Europe	Switzerland	VPN detected
17-Dec	NordVPN	US	Phoenix	VPN detected
17-Dec	NordVPN	UK	#2138	VPN detected
17-Dec	NordVPN	Europe	Switzerland	VPN detected
17-Dec	IPVanish	US	Charlotte	VPN detected
17-Dec	IPVanish	UK	London	VPN detected
17-Dec	IPVanish	Europe	Switzerland	VPN detected
17-Dec	SaferVPN	US	USA West	VPN detected
17-Dec	SaferVPN	UK	UK	VPN detected
17-Dec	SaferVPN	Europe	Switzerland	VPN detected
17-Dec	HideMyAss	US	USA (via Singapore)	VPN detected
17-Dec	HideMyAss	UK	Donkey Town	VPN detected
17-Dec	HideMyAss	Europe	Switzerland	VPN detected
17-Dec	SurfShark	US	Phoenix	VPN detected
17-Dec	SurfShark	UK	Glasgow	VPN detected
17-Dec	SurfShark	Europe	Poland - Gdansk	VPN detected
17-Dec	StrongVPN	US	Phoenix	VPN detected
17-Dec	StrongVPN	UK	Rugby	VPN detected
17-Dec	StrongVPN	Europe	Poland - Warsaw	VPN detected
17-Dec	UltraVPN	US	Portland	VPN detected
17-Dec	UltraVPN	UK	UK	VPN detected

17-Dec	UltraVPN	Europe	Poland	VPN detected
17-Dec	TunnelBear	US	US	VPN detected
17-Dec	TunnelBear	UK	UK	VPN detected
17-Dec	TunnelBear	Europe	Switzerland	VPN detected
17-Dec	MyExpatNetwork	US	US	VPN detected
17-Dec	MyExpatNetwork	UK	UK	VPN detected
17-Dec	MyExpatNetwork	Europe	Norway	VPN detected

Table 5-1 Full Test Results

Kingsmead Security Ltd

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