badWPAD:

The Lasting Menace of a Bad Protocol

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A **TrendLabs**SM Research Paper

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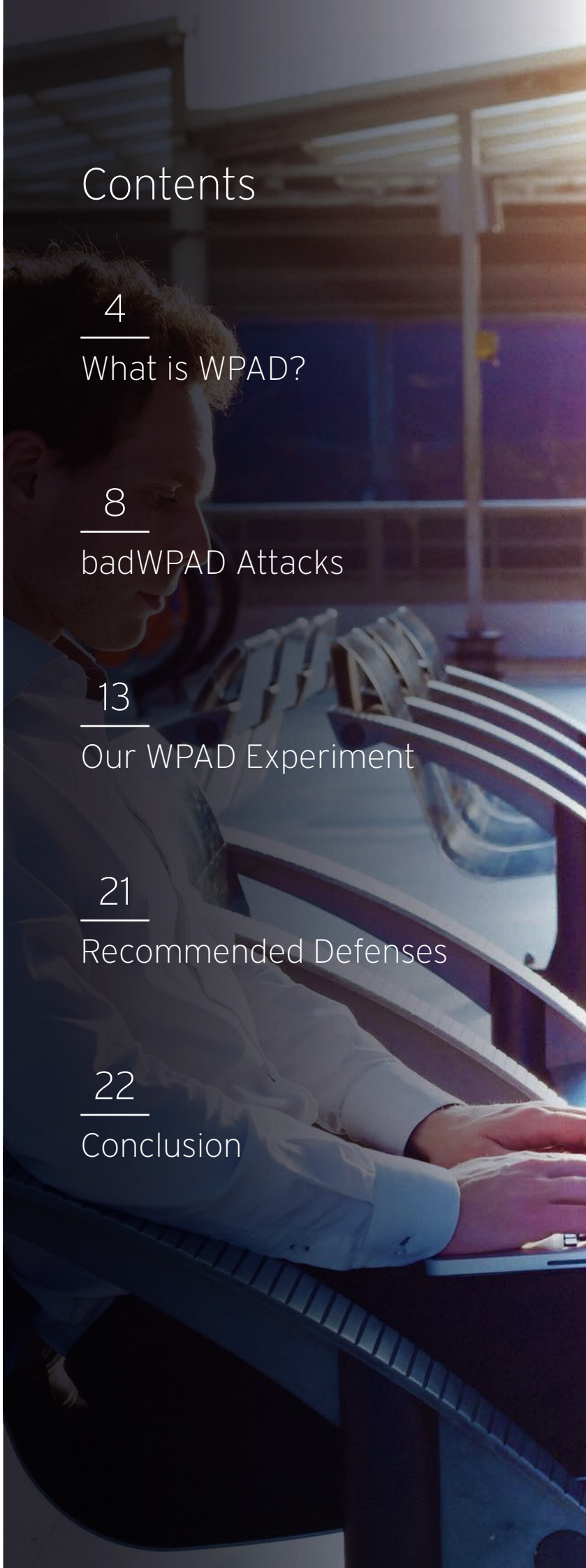

This paper explores the ways in which the Web Proxy Auto-Discovery (WPAD) protocol—an ubiquitous feature used in connecting to the internet—can be exploited. As with most enterprises, the WPAD protocol allows computers to automatically discover web proxy configurations and is primarily used in networks where clients are only allowed to communicate to the outside world through a proxy.

The WPAD protocol bears inherent risks that have already been recognized in the security community for some time, but for some reason these declared risks have been left largely overlooked or ignored. The WPAD feature has, for many years, provided attackers and penetration testers a simple way to perform Man-in-the-Middle (MitM) attacks on web traffic. A malicious user could easily intercept the internet traffic of the client system by forwarding an altered configuration file.

This sparked our interest and prompted us to carry out a few experiments of our own to test the potential promise WPAD holds for an attacker. Researchers have previously, and in multiple instances, pointed out these types of attacks, so we are not presenting novel findings in terms of the attack. But we were somewhat surprised by the results our experiments yielded, which led us to believe that WPAD is badWPAD.

In this paper, we want to bring back attention to the WPAD issue, which is an inherent flaw, and look at it in light of the altered conditions under which WPAD is in use in today's world. End users are more mobile, constantly moving around or traveling, thereby connecting to different networks without being aware of the security implications. Even a typical employee may have multiple portable devices and indiscriminately connect to any available Wi-Fi network from the airport lounge, to the hotel Wi-Fi, and then to the coffee shop around the corner. Today's work world is characterized by agile employees that aren't logging on to closed, protected networks only but are also connecting to public and unprotected ones. This becomes particularly interesting with regard to an auto-proxy tool such as the WPAD which has discovery mechanisms that have been previously identified as vulnerable to subversion.

To explore the implications of these new realities, we will look at the range of ways the WPAD protocol can be exploited in local and public networks along with the multiplying effect we see on several factors such as increasing mobile device usage and the rising number of devices connected to the internet. Our findings will be backed up by statistics and results from our own WPAD experiment. We will conclude with recommendations for the home and business user to help protect them against this serious risk.The danger of using WPAD has long been underestimated. And with WPAD's susceptibility to abuse, it's time these risks be dealt with.

What is WPAD?

The WPAD Protocol and its Weaknesses

In an enterprise setting— large and small organizations alike—a tool to control traffic through a central web proxy is very convenient. As a network administrator, you can conveniently control the proxy configuration of everyone on the network with one file. For this purpose the WPAD protocol offers one of the easiest ways to make such proxy settings available to the end user without complications. It is a built-in feature that enables the end user's browser or other internet-enabled software to automatically configure a proxy so manual configuration is not needed. The WPAD protocol is a discovery method used by different types of clients to locate the URL of a proxy configuration file (named *wpad.dat*) in order to configure web browser proxy settings automatically.

Development of Web Proxy Auto-Discovery Protocol

To easily configure proxy settings for different types of applications which require an internet connection, WPAD, also known as "autoproxy", was first implemented and promoted by Netscape® 2.0 in 1996[1] for Netscape Navigator® 2.0. It was then accepted by Microsoft initially at the browser level (Internet Explorer® 5.0) and later, at the application level using *ProxyCfg.exe*. This feature was available starting with WinHTTP version 5.1 in Windows® 2000 Service Pack 3, Windows® XP Service Pack 1, and Windows® Server 2003. Note that although both Microsoft Internet Explorer (IE) and Microsoft® WinHTTP support WPAD, the specification never progressed beyond the internet draft stage, and expired in May 2001.[2]

WPAD does not only apply to Windows® systems but it can also apply to any system that supports proxy auto-discovery, like most web browsers, operating systems, and some applications not working from operating systems. Seen as a useful feature for auto-proxy discovery, WPAD was soon used in other platforms. In the case of Mac OS X® and iOS 6 the WPAD file is automatically requested if a WPAD machine exists in the network.

How Can WPAD be Exploited?

Warnings of security issues with WPAD have been around for several years, but the problem still exists. It is this most recent aspect we will highlight, but in order to be clear about the impact of the WPAD flaw, we will also explain and discuss well-documented attacks in the following section.

In basic terms, the security issue with the WPAD protocol revolves around the idea that whenever the protocol makes a request to a proxy, anyone else can create a service that answers that request and can practically impersonate the real web proxy. We have been monitoring issues with WPAD protocol for quite some time and decided to take a closer look at its scope.

Why is WPAD Riskier Now Than in the Past?

WPAD is a protocol that has been around for almost 20 years. But the environment and conditions under which it is being used have changed dramatically.

For one, end users today are more mobile, they travel a lot and are therefore more reliant on using public Wi-Fi access. Before, most people accessed the internet through a stationary PC, but now users can access the internet anywhere with various portable devices. This is especially ubiquitous in today's workspace. Employees carry with them multiple devices with which they not only log on to closed, protected company networks. And each Wireless Local Area Network (WLAN) that a user logs on to for Wi-Fi access, theoretically bears the risk of connecting to a system that resolves *wpad.{domain name}* requests.

In the future, we will see more and more devices connecting to the internet. For instance with regard to internet of things (IoT) devices, the use of WPAD could potentially bring about a lot of problems, depending on how IoT devices will be configured to handle auto-proxy configuration some of these devices might use this feature by default, or have the option for it, while some may not. This all depends on how the devices are configured, which is connected to the awareness of the risk that WPAD poses on IoT vendors. Our expectation is that IoT devices will likely have a proxy option, because it makes it easier for the end user to connect to the internet without having to manually configure proxy settings, in case a direct connection to the internet is not possible.

WPAD Protocol Functions and Specifications

There are two mechanisms that WPAD uses to discover the proxy configuration file:

1. Dynamic Host Configuration Protocol (DHCP) and/or
2. Domain Name System (DNS)

DHCP is the first priority discovery method to fetch the configuration file. DNS is triggered if the DHCP is unable to locate the configuration file. Once the configuration file is detected and downloaded, the file will be examined to determine the proxy for a specified URL. Depending on the URL requested by the client, the JavaScript® code in the body of the *wpad.dat* configuration file will determine if the proxy settings need to be invoked. This proxy configuration file is usually downloaded, e.g. when a client machine is restarted or the browser cache is cleaned—it is not requested every time the user requests a URL.

DHCP Discovery Method

1. The web browser, upon loading, issues a DHCPINFORM query to the network's DHCP server, which provides a list of options with their configurations.
2. The DHCP server responds with a DHCP ACK message, containing the list of options and configurations.
3. One of these options, DHCP option 252, contains the location of the proxy configuration file.
4. Now the web browser can perform a request to download the proxy configuration file.
5. If the 252 option wasn't received from the DHCP server, the protocol will try Plan B, the DNS WPAD method.

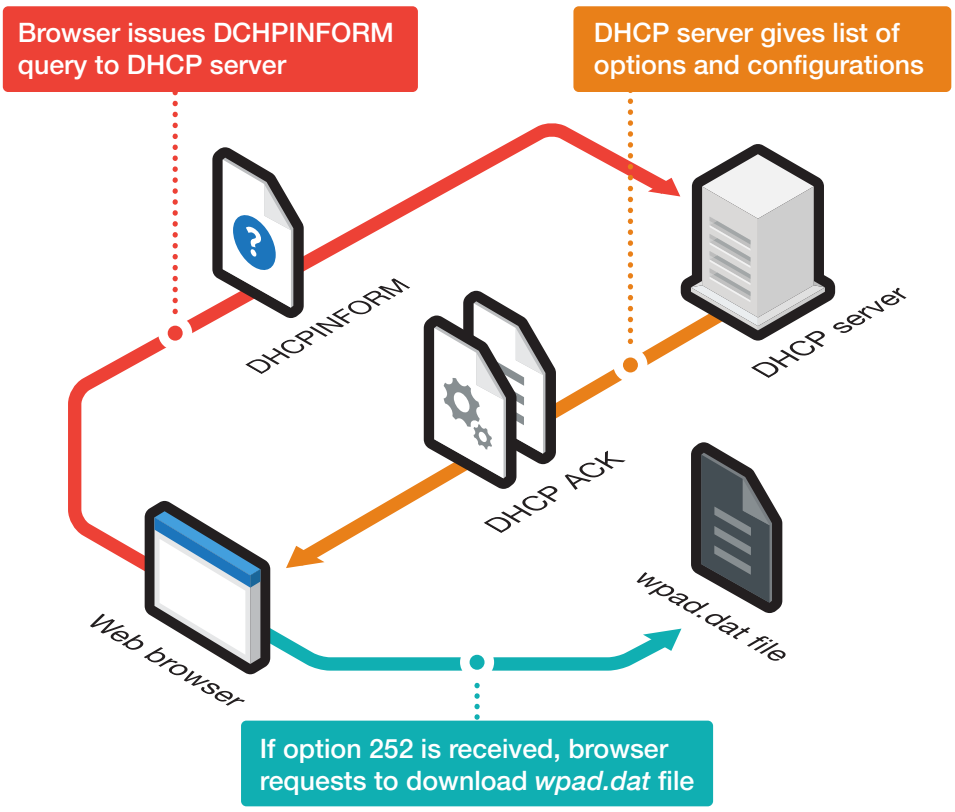

Figure 1. First method of the WPAD DHCP configuration

DNS Discovery Method

1. The other way to retrieve the *wpad.dat* file is to do a DNS lookup for a host named WPAD.
    - For the example below we will assume the following settings:
    - Computer Name: tomknopf
    - Primary DNS suffix (search domain): infosec.mycompany.org
    - Fully Qualified Domain Name: tomknopf.infosec.mycompany.org

2. A piece of software on the machine *tomknopf.pub* which supports DNS WPAD, let's say an IE browser, will request a *wpad.dat* file from a WPAD server existing on the same subdomain, before moving up through the domains one layer at a time. In our example, the order of URL requests would be the following:
    - http://wpad.infosec.mycompany.org/wpad.dat
    - http://wpad.mycompany.org/wpad.dat
    - http://wpad.org/wpad.dat
3. This process continues until one of these servers actually responds with a *wpad.dat* file. If no files are returned, the user's software will access the internet directly without using a proxy.

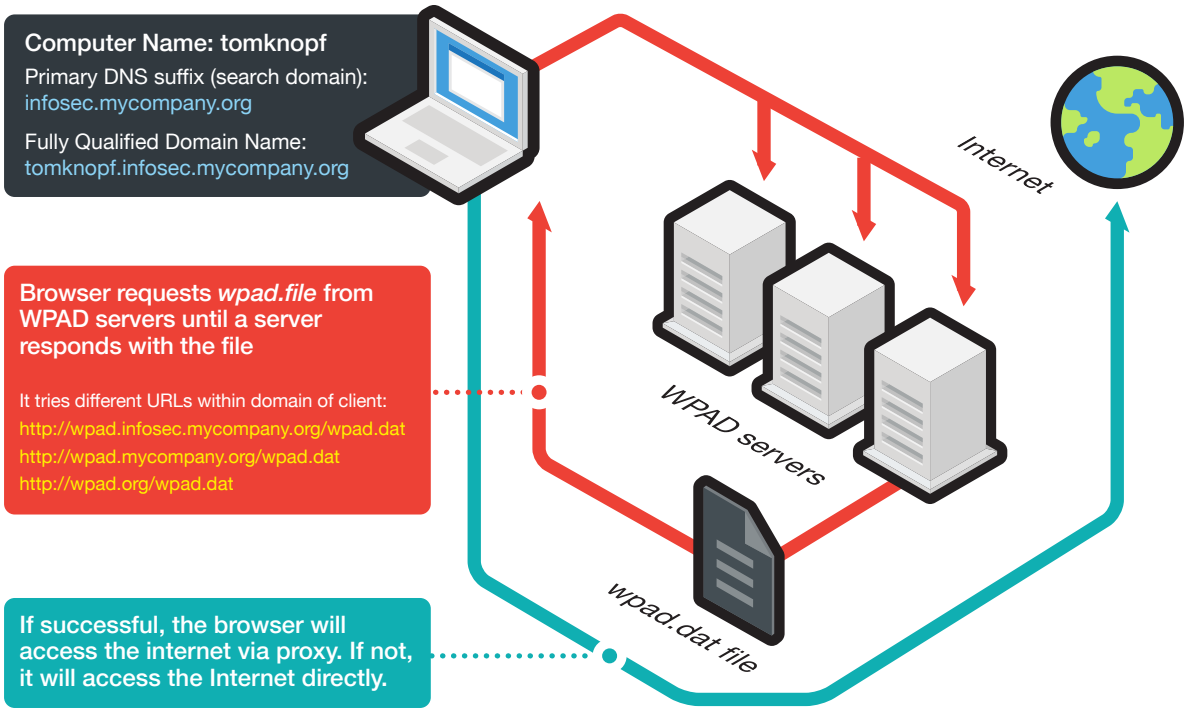

Figure 2. Second method of WPAD DNS configuration

On platforms other than Microsoft, the Primary DNS suffix is also called "Search Domain". This value is used by the operating system to allow other computers on the same network to find each other by name. If a user types a particular machine name into the command line or in his browser, the system will add the search domain to its name to provide a Fully Qualified Domain Name (FQDN).

badWPAD attacks

After explaining the basic setup of the WPAD functionality, we will now look at how attacks with badWPAD can be carried out. We will analyze what parts of the aforementioned processes allow for exploitation. At first we will look at local network attacks that can happen in an enterprise environment but also within any public network. These are known attack modes that have been previously discussed but need to be reconsidered.

Local Network Attacks with WPAD

On a corporate network or an open network connected to the internet, almost any computer can, in a few easy steps, be configured in such a way that the network's WPAD protocol traffic can be seen. This will mostly be the protocol setup looking for the correct parameter inside a DHCP response, or attempts to resolve WPAD DNS names as explained before. This behavior should be familiar to system administrators who routinely check the HTTP traffic of a small or medium-sized business (SMB) or enterprise organization—with HTTP GET requests for */wpad.dat* being very common.

Figure 3. WPAD network requests

WPAD Being Used for Attacks

The problem of WPAD being used to attack local networks has been known for a long time. The attack normally works by a spoofed propagation of the DHCP *NetBIOSNameService* for the network's WPAD computer name, so that the attacker will be the first to respond to any requests for *wpad.myCompanyDomain.* To address and fix this WPAD issue, Microsoft issued a security bulletin (MS09008) in 2009[3] and an advisory (971888)[4] regarding an update for DNS devolution.

Meanwhile, a module for the popular Metasploit security testing tool was released in 2012, making it quite easy for an attacker to quickly carry out a MitM attack utilizing WPAD.[5] The tool emulates a real web server on port 80 and generates a properly configured *wpad.dat* file which, in practice, will be downloaded by machines from the same network segment and deployed for proxy auto-configuration.

```
msf > use auxiliary/server/wpad
msf auxiliary (wpad) > show actions
                ...actions...
msf auxiliary (wpad) > set ACTION <action-name>
msf auxiliary (wpad) > show options
           ...show and set options...
msf auxiliary (wpad) > run
```

Figure 4. Metasploit WPAD module

Even without Metasploit, setting up a malicious WPAD server is very easy for an attacker. It can be achieved by simply renaming your computer name to "wpad", thereby impersonating the actual proxy server. Assuming the attacker's machine is part of the network domain or NetBIOS, it can be propagated to the network demonstrating that the machine name is actually *wpad.{DNS suffix}*. Once that is done the attacker's machine will start receiving connection requests from other machines on the network in the form of "*HTTP 1.1 GET /wpad.dat*"—essentially requesting the *wpad.dat* proxy configuration file. To accept these requests the attacker simply needs to be running a local web server that listens on port 80. The attacker can then serve a *wpad.dat* file instructing the network to use his machine as a proxy for all web requests to the internet.

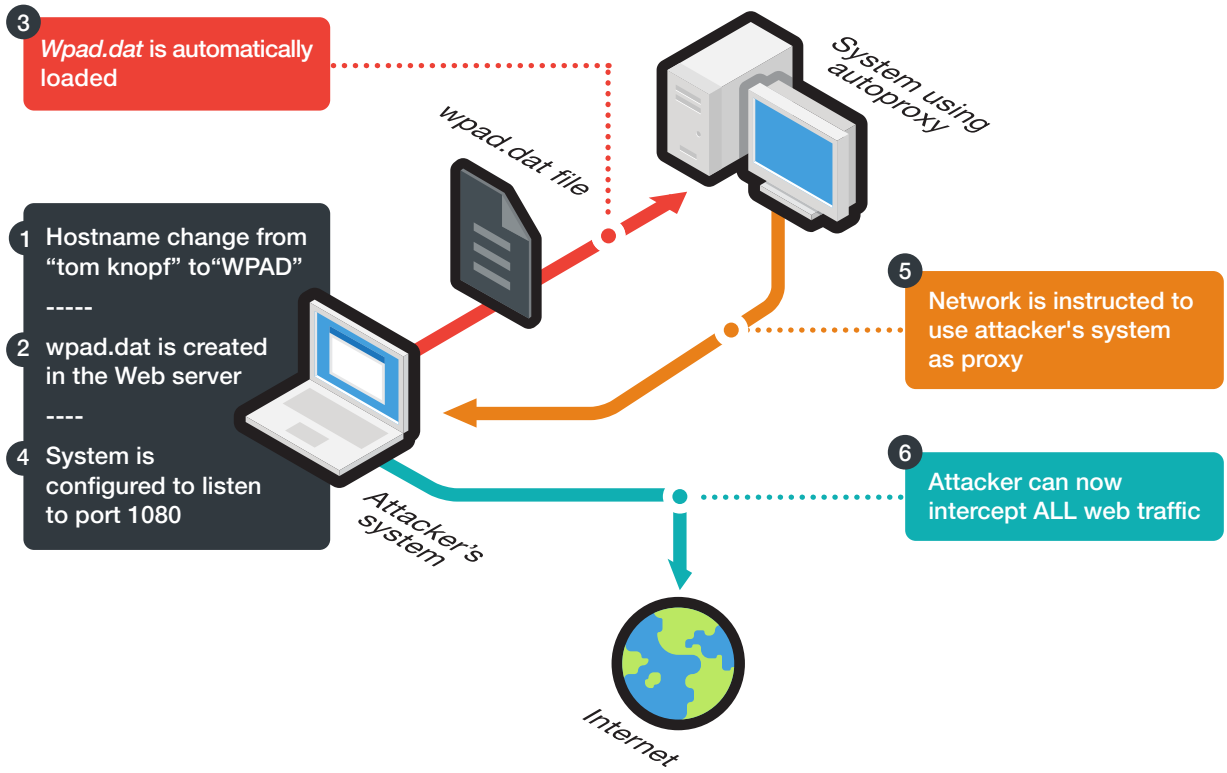

Figure 5. A simple attack setup at the local level

Attack Scenarios

Now that the WPAD function has been prepared for an attack—and this basic badWPAD setup can be implemented within seconds—the attacker can choose from a number of possible attack scenarios:

1. **Transparent proxy**
   The attacker simply saves all of the user's web traffic logs for future analysis. Down the road this could allow the attacker to intercept sensitive information.

2. **Rogue proxy**
   The attacker takes a more active role in traffic interception. WPAD allows for proxy configuration based on the accessed site. The attacker could redirect all requests to access banking websites to a phishing site instead. This type of attack can be very damaging in terms of the attacker's potential to actually compromise account details. If sites are using Secure Sockets Layer (SSL), the attacker would have to impersonate a certificate authority–as is often the case in MitM attacks. However, as any penetration tester will tell you, users will frequently ignore such certificate warnings.

3. **Modifying proxy**

   This is potentially the most dangerous attack out of the three attack scenarios described here, because instead of simply redirecting the victim to a different site, the attacker can actually tamper with the pages they are requesting in different ways in order to gain the target information.

   For example when a user accesses a banking website's page that requests three digits of an eight digit security code, the attacker might modify it to request all the digits in order to intercept them.

   Or when a user's computer is downloading an update for a software package, the attacker can replace the downloaded file with malware, thus infecting the user's machine. The same can also be accomplished by adding browser exploits into websites the user is requesting.

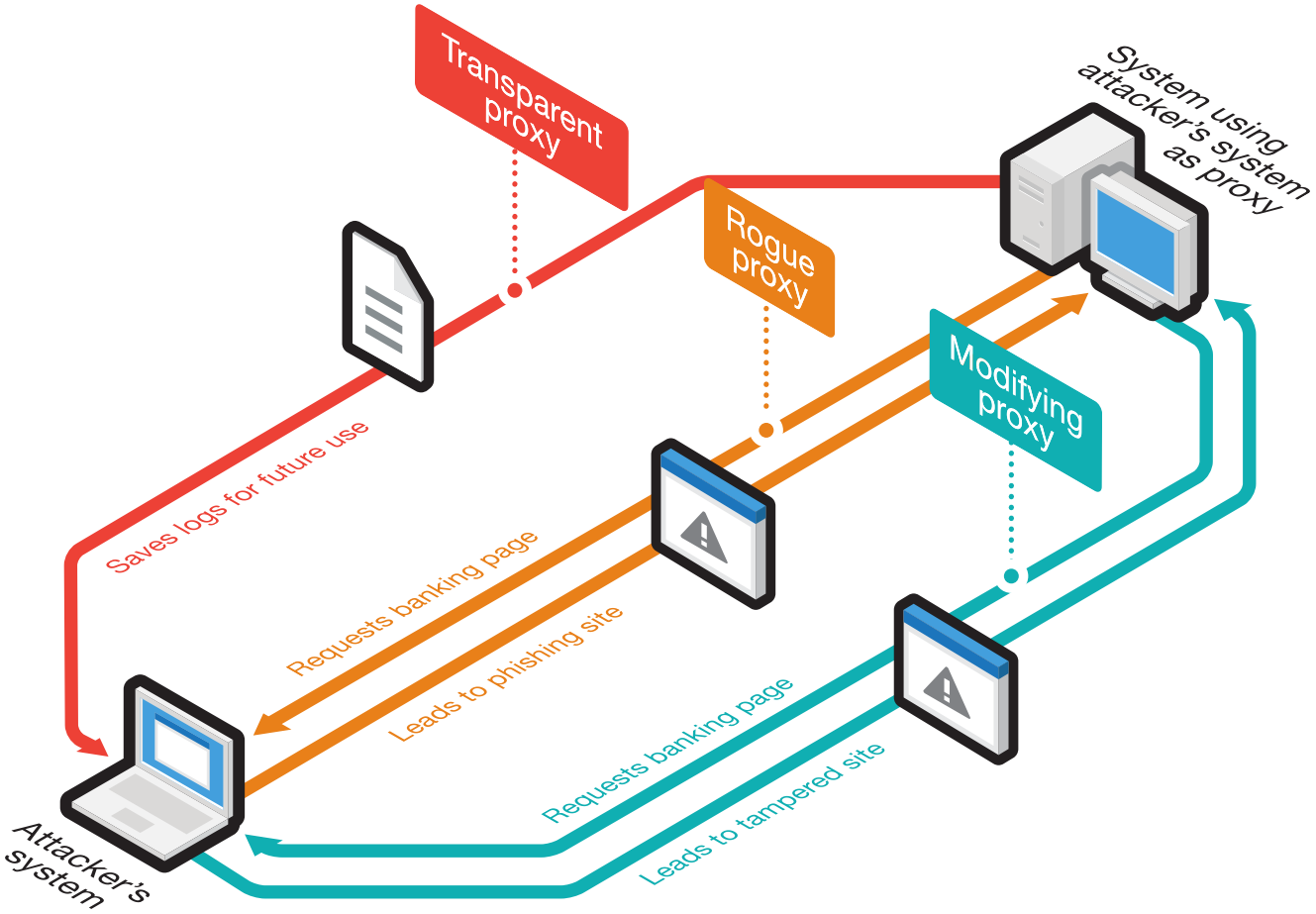

Figure 6. Possible attack scenarios

DNS-level Attacks with WPAD

Attacks leveraging WPAD at the DNS level are also relatively simple to set up with a few prerequisites. For an attacker to set up a MitM proxy that can intercept the user's traffic, he would need to create a server that will appear on the user's WPAD DNS look-up chains.

To carry out our example when describing the protocol, this would mean the attacker would need to create for instance, the server *wpad.mycompany.org*. Of course in most cases this will involve the attacker having to be present on the company network, a clear downside to such an attack. However, if the company is not running such a server on their own, their clients will next try the domain *wpad.org*, a domain that is located outside the company network, and which the attacker could register.

Once the attacker has registered such a Top Level Domain (TLD), WPAD requests from users will immediately show up. For this, one would need to have the following set-up:

1. A computer whose primary DNS Suffix ends with that particular TLD, and
2. An organizational/local network is not already hosting a WPAD server that appears earlier in the WPAD DNS lookup chain

Once the attacker successfully registers such a domain and receives requests, the same three proxy attack scenarios outlined at the beginning of this section will also apply here.

In order to counter this attack technique, Microsoft offers a Security Advisory (MS Security Advisory971888) with some workarounds and an update for DNS devolution in 2009 because it was realized that some users may inadvertently be allowing client systems to treat systems outside the organizational boundary as though they were internal to the organization's boundary. This update helps define an organizational boundary for systems that are domain-joined but do not have a DNS suffix list configured.[4]

Our WPAD Experiment

Our team set up an experiment to determine just how dangerous the protocol can be in actual application. The aim of the experiment was to see how successful WPAD attacks could be on two layers that we described in the last section:

1. On a local corporate network
2. On a public Wi-Fi network

In the two scenarios above (local corporate and public network) a local-level WPAD attack would be carried out, making use of existing tools such as Metasploit®, or simply a web server. These do not represent new and unknown attacks. As mentioned earlier in this paper these attack forms have been known for some time, but we want to elevate public awareness of their existence once more.

WPAD Honeypot Configuration at the Local Level

For scenarios 1 and 2, our local level (closed local corporate network or public Wi-Fi) WPAD attacks, we simply made use of two setups that are commonly deployed in penetrations tests:

1. Renaming our machine to "wpad" with a web server accepting *wpad.dat* requests on port 80
2. The Metasploit *auxiliary/server/wpad* module

We first tested the attacks to show that we could successfully alter the proxy setting of other computers on our closed test network, and subsequently also exploit them. The goal of this test was not to simply carry out an already known attack, but to show how vulnerable this protocol is under current conditions.

As such we carried out a number of experiments with WPAD on several public and private (Trend Micro's own domain) networks. In all cases an empty *wpad.dat* file was served to any connection request, so no user connection was actually relayed or tampered with. Statistics were then generated from these logs to show a breakdown of connection by device type.

The following is the list of public locations we carried out a WPAD honeypot experience at the local level:

- Toronto Airport Wi-Fi
- Business Lounge Lufthansa Terminal 2
- Lufthansa's onboard Wi-Fi
- Emirates Airline's onboard Wi-Fi
- San Francisco International Airport's free Wi-Fi
- Enigma Conference Wi-Fi
- A home Wi-Fi

User Agents and Platforms

One of the most interesting pieces of information to analyze in our logs was the user-agent strings. User-agent strings are sent by the user's program, either through a browser or another software, with each HTTP GET request for our *wpad.dat* file. It can be used to determine what sort of devices are making those requests.

The WPAD protocol is well known to Microsoft® platforms, as are the proxy settings associated with it. But in the screenshot below we can see these same settings on an iOS 9.1 device with HTTP PROXY: Auto settings enabled, and the corresponding traffic it will generate.

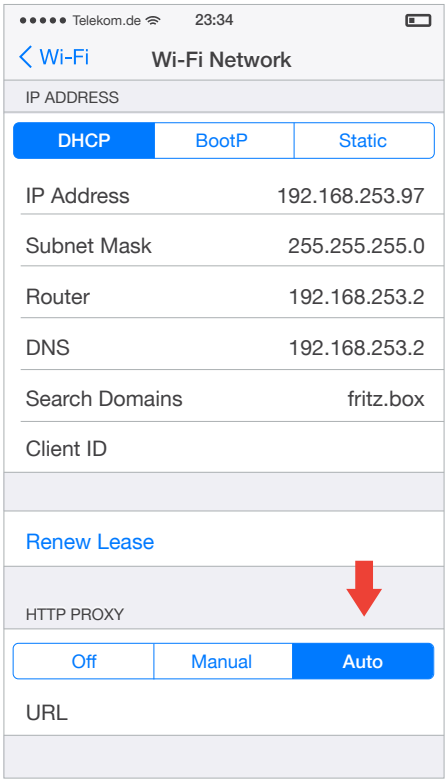

Figure 7. iOS WPAD proxy settings

```
192.168.253.97 - - [27/Nov/2015: 17:36:19 +0100] GET /wpad.dat HTTP/1.1" 200 1 "-" "com.appler.Webkit.WebContent/8601.1.46.25.2.CFNetwork/758.1.6
192.168.253.97 - - [27/Nov/2015: 17:46:34 +0100] GET /wpad.dat HTTP/1.1" 200 1 "-" "iZipow/3.5.6 CFNetwork/758.1.6 Darwin/15.0.0"
192.168.253.97 - - [27/Nov/2015: 19:06:42 +0100] GET /wpad.dat HTTP/1.1" 200 1 "-" "locationd/1861.0.15 CFNetwork/758.1.6 Darwin/15.0.0"
192.168.253.97 - - [27/Nov/2015: 19:06:55 +0100] GET /wpad.dat HTTP/1.1" 200 1 "-" "networkd (unknown version) CFNEtwork/758.1.6 Darwin/15.0.0"
192.168.253.97 - - [27/Nov/2015: 19:06:55 +0100] GET /wpad.dat HTTP/1.1" 200 1 "-" "networkd (unknown version) CFNEtwork/758.1.6 Darwin/15.0.0"
192.168.253.97 - - [27/Nov/2015: 19:06:55 +0100] GET /wpad.dat HTTP/1.1" 200 1 "-" "networkd (unknown version) CFNEtwork/758.1.6 Darwin/15.0.0"
192.168.253.97 - - [27/Nov/2015: 23:22:23 +0100] GET /wpad.dat HTTP/1.1" 200 1 "-" "locationd/1861.0.15 CFNetwork/758.1.6 Darwin/15.0.0"
192.168.253.97 - - [27/Nov/2015: 10:59:23 +0100] GET /wpad.dat HTTP/1.1" 200 1 "-" "networkd (unknown version) CFNEtwork/758.1.6 Darwin/15.0.0"
```

Figure 8. iOS WPAD connection requests

As mentioned above, user-agent strings can help us determine the devices accessing our servers. Looking closer at the user-agent information sent by iOS device which requested our *wpad.dat* file we can see that the user-agent information consists of three main parts.

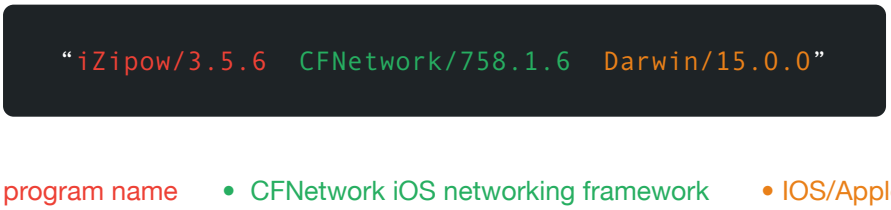

Figure 9. iOS User-agent string

During our research between October 2015 and January 2016, we collected data in the form of log files. In the course of analyzing the user-agent strings, we made a few interesting findings. Below, we list the user agents and analyze them by certain categories. More details to the statistics for each category can be found in the appendix. Bear in mind that these statistics only refer to the domain names that we registered for this research and we own them now.

1. **General list of user agents**

   When we look at the complete log file of user agents requesting our *wpad.dat* file, it is striking that a large portion are undetected user agents, i.e. anonymous requests. We analyzed the IP address to determine where these undetected user agents came from and identified their locations:

Country	Count	Country	Count
United States	2,468,828	Ukraine	177,228
Poland	921,977	Spain	175,172
Canada	700,060	Tunisia	169,200
United Kingdom	594,8 4	Japan	168,607
Netherlands	295,553	Hungary	163,513
Chile	260,556	Switzerland	117,203
Russia	227,316	Brazil	112,566
Australia	223,308	Colombia	98,829
India	211,926	Czech Republic	87,163
Germany	186,222	Italy	77,388

Table 1. Top 20 countries with the most number of undetected agents

For an analysis of the corresponding IP addresses, please see the appendix.

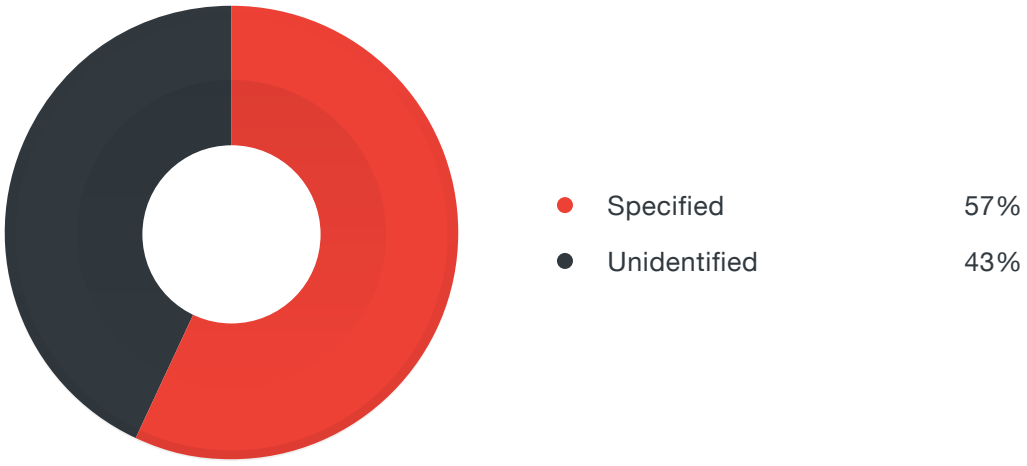

Figure 10. Percentage of specified and unidentified user agents

2. **User agents by providers**

We also listed user agents according to providers. The highest amount of requests came from providers located in United States, Poland, and France.

We cannot make any assumptions about this correlation, given that it is linked to the domain names we selected or the size of the customer base of the provider.

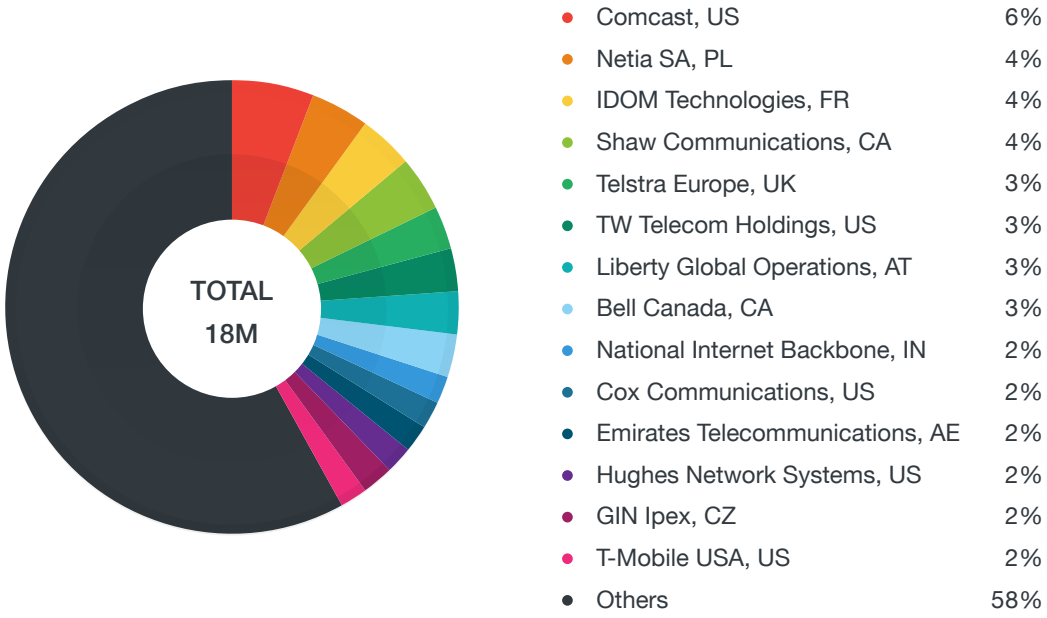

Figure 11. User agents by provider

3. **User agents by country**

In the setup, we did not use domain names that have countries denoted but TLDs. The most requests came from:

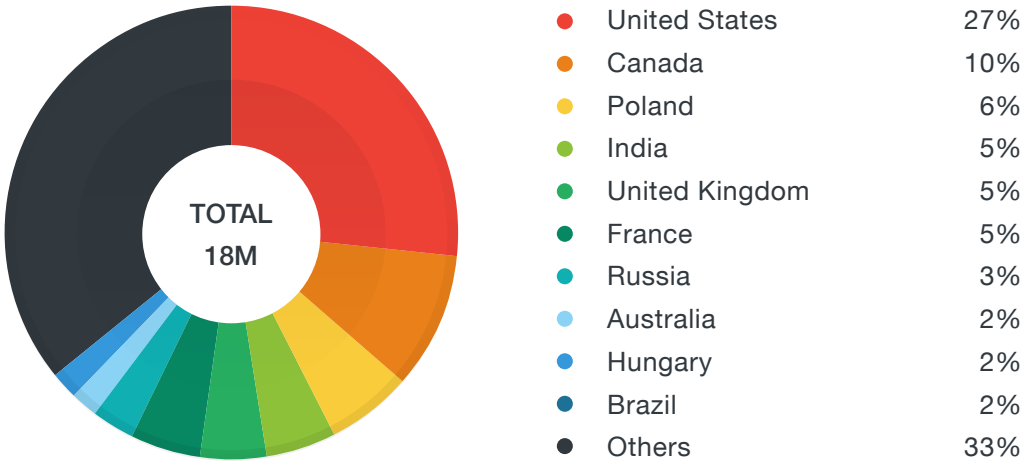

Figure 12. User agents by country

4. **User agent updates**

   User agents can also be the update client of any piece of software operating on a machine that regularly updates. For instance, if a program's update client is trying to download updates, it will first look for the proxy server and retrieve the update as a file from the original server. But if the update agent is made to search for the wrong name, for instance, a file named "wpad" it will not download the required update file but the *wpad.dat* file via proxy, thus exposing itself to malicious activity.

User Agent	Update client count
WindowsUpdateAgent	29,171
AAM%20Updates%20Notifier/1.0.162.0 CFNetwork/720.5.7 Darwin/14.5.0 (x86_64)	59
AAM%20Updates%20Notifier/1.0.162.0 CFNetwork/720.5.7 Darwin/14.5.0 (x86_64)	57
AAM%20Updates%20Notifier/1.0.162.0 CFNetwork/720.5.7 Darwin/14.5.0 (x86_64)	42
avast! Emergency Update Agent	9
XProtectUpdater (unknown version) CFNetwork/596.6.4 Darwin/12.6.0 (x86_64) (MacBookAir5%2C2)	7
Software%20Update (unknown version) CFNetwork/596.6.4 Darwin/12.6.0 (x86_64) (MacBookAir5%2C2)	7
Microsoft%20AutoUpdate/2.3.6 CFNetwork/720.5.7 Darwin/14.5.0 (x86_64)	7
XProtectUpdater (unknown version) CFNetwork/454.12.4 Darwin/10.8.0 (i386) (MacBookPro2%2C2)	6
GoogleSoftwareUpdateAgent/1.2.2.428 CFNetwork/596.6.4 Darwin/12.6.0 (x86_64) (MacBookPro8%2C1)	3
GoogleSoftwareUpdateAgent/1.2.2.428 CFNetwork/596.6.4 Darwin/12.6.0 (x86_64) (MacBookPro8%2C1)	29,368

Table 2. User agents of update clients

The statistics in this category are a collection of requests that we got from different locations, including Wi-Fi access in public areas, conferences, business lounges, airports, aircrafts, offices, and homes.

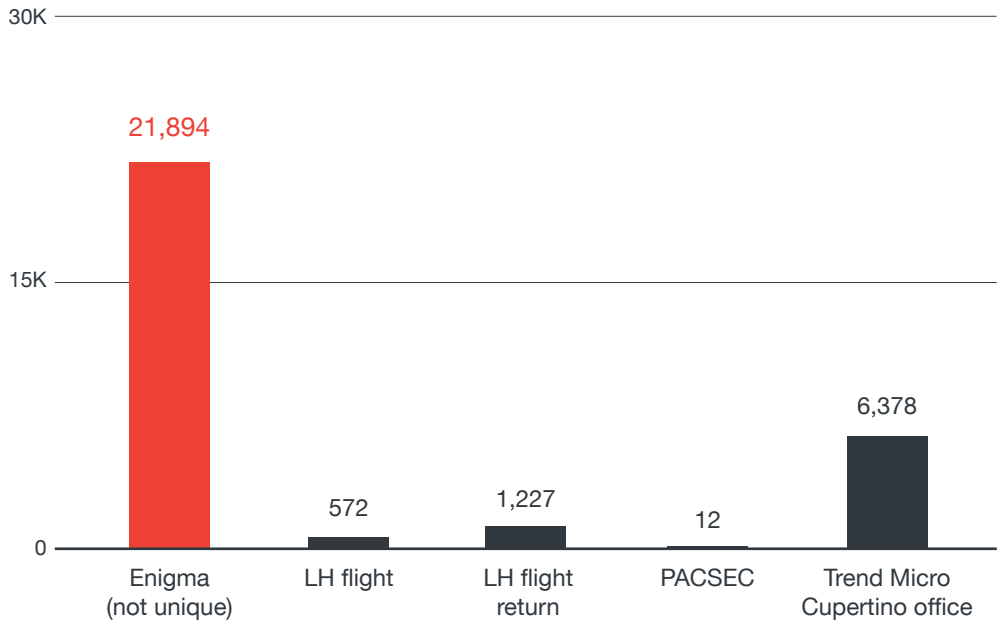

Figure 13. Requests in various locations while traveling

5. **Non-browser user agents**

   We list this category to address the common perception that WPAD is only a browser issue. This category shows that a user agent utilizing WPAD does not necessarily have to be a browser, but can be any operating system and also other software not directly related to an operating system – for instance mobile applications such as QQ on the iPhone®, SmartNews, or other applications. What these applications have in common is that they use the WPAD settings to use the internet. For a more comprehensive list, see the appendix. The most interesting examples are in the table below.

User Agents	Description
WinHttp-Autoproxy-Service	Microsoft Windows HTTP Services (WinHTTP) provides developers with a server-supported, high-level interface to the HTTP/1.1 Internet protocol.
Microsoft-CryptoAPI	The Cryptographic Application Programming Interface (also known variously as CryptoAPI, Microsoft Cryptography API, MS-CAPI or simply CAPI) is an application programming interface included with Microsoft Windows operating systems that provides services to enable developers to secure Windows-based applications using cryptography. It is a set of dynamically linked libraries that provides an abstraction layer which isolates programmers from the code used to encrypt the data. The Crypto API was first introduced in Windows NT 4.0 and enhanced in subsequent versions.
ownCloud	ownCloud is a suite of client-server software for creating file hosting services using them

User Agents	Description
Microsoft-WebDAV-MiniRedir	A Windows component that allows folders exported with WebDAV to be accessible as UNC shares
kugou	A Chinese music app
syncdefaultsd	iCloud synchronization infrastructure
WeChat	The popular messaging app WeChat
QQ	The QQ chat client for iOS
GMX	The GMX Mail Client for iOS

Table 3. List of interesting non-browser user agents

6. **iOS-based user agents**

We list this category to address the common misconception that WPAD is an issue tied solely to MS Windows-based systems. In our log files we find user agents that stem from software based on different other operating system, e.g. iOS. These applications use WPAD settings to use the internet. For a comprehensive list of user agents, see the appendix.

User agents	User agents count
networkd (unknown version) CFNetwork/	338471
locationd/	44172
securityd (unknown version) CFNetwork/	38804
itunesstored (unknown version) CFNetwork/	20591
mediaserverd (unknown version) CFNetwork/	13227
dataaccessd (unknown version) CFNetwork/	7470
mobileassetd (unknown version) CFNetwork/	6587
backupd (unknown version) CFNetwork/	5897

Table 4. List of interesting user agents tied to iOS

Recommended Defenses

In light of the security concerns WPAD usage evokes, what can home and enterprise users do in order to protect themselves? We recommend a few steps for users to better secure themselves from this threat.

For Home Users

- In most cases the proxy auto-configuration feature is not necessary at home. In your operating system's proxy settings, disable auto-configuration if you do not require it at home.
- If possible try to block all WPAD requests to the wpad.* domains. Some home routers allow you to block outgoing traffic for certain domain names, including wildcards.
- If you are using your device in a Wi-Fi network, make sure that your browser does not have auto-proxy enabled.

For Enterprises

- The easiest and first thing to do would be to simply not use the auto-configuration of proxies but configure proxy settings manually. Allowing proxy settings to be configured automatically exposes your employees to a high risk of falling prey to a WPAD attack.
- Check if the DHCP Option 252 is enabled and if not, enable it and point the WPAD path to a configuration file on a non-existing machine name, or better yet, to an existing machine where you can block this traffic if it is not necessary.
- On the internal network, host a machine/virtual private server (VPS) with the machine name 'wpad' and use NetBIOS to propagate the location of the local WPAD-enabled box.
- On the internal network, host a machine/virtual private server (VPS) with the machine name 'wpad' and use NetBIOS to propagate the location of the local WPAD-enabled box.
- For public Wi-Fi operators of places such as Starbucks, Lufthansa, etc., we recommend using Wireless/IP Isolation. When IP Isolation is switched on, any two computers on the same wireless network won't be able to see each other, but the Wi-Fi operator can still see computers on the network. Basically, it isolates the Wi-Fi connection on IP bases and enables protection of local users (within a free or public Wi-Fi setting) from being attacked by other machines, once they are isolated.

Conclusion

The WPAD protocol was originally designed to simplify configuration processes for system administrators and internet users. Unfortunately, while it was created with the best of intentions of providing automatic configuration that will save time and resources, its design is inherently flawed. This protocol has had a lifetime of about 20 years and though these flaws are known and recognized by the community, they can still lead to some serious security concerns for home and enterprise users alike. It is relatively easy for an attacker to exploit the WPAD.

In today's environment where multiple devices are indiscriminately connected to available networks, the risk is extremely high. In light of these realities, we have conducted our own tests to observe the role that the WPAD protocol still plays and how easily it can be exploited. Our final recommendation besides immediate mitigation suggestions for the end user would be to essentially do away with this protocol.

Appendix

General list (no user agents)

	Country	Count		Country	Count		Country	Count
1	United States	2,468,828	32	Latvia	26,664	63	Bangladesh	898
2	Poland	921,977	33	Serbia	24,330	64	Madagascar	860
3	Canada	700,060	34	Faroe Islands	22,677	65	Cameroon	579
4	United Kingdom	594,814	35	Belgium	20,746	66	Bosnia and Herzegovina	578
5	Netherlands	295,553	36	Pakistan	16,847	67	Bahrain	518
6	Chile	260,556	37	Belarus	16,548	68	Armenia	334
7	Russia	227,316	38	Portugal	16,286	69	Ecuador	328
8	Australia	223,308	39	Mexico	14,862	70	Bulgaria	272
9	India	211,926	40	Slovenia	11,844	71	Saudi Arabia	234
10	Germany	186,222	41	Taiwan	9,702	72	Palestinian Territory	211
11	Ukraine	177,228	42	Vietnam	7,865	73	Morocco	196
12	Spain	175,172	43	Romania	6,807	74	Norway	155
13	Tunisia	169,200	44	Oman	6,778	75	Greece	126
14	Japan	168,607	45	Burkina Faso	6,424	76	Nigeria	119
15	Hungary	163,513	46	United Arab Emirates	5,987	77	Uganda	117
16	Switzerland	117,203	47	Costa Rica	5,514	78	Puerto Rico	84
17	Brazil	112,566	48	Nepal	5,058	79	Bolivia	55
18	Colombia	98,829	49	Malaysia	4,021	80	Panama	54
19	Czech Republic	87,163	50	Iran	3,799	81	Kuwait	35
20	Italy	77,388	51	US Virgin Islands	3,312	82	Singapore	27
21	China	76,402	52	Indonesia	3,104	83	Jamaica	23
22	Denmark	75,288	53	Peru	2,912	84	Uruguay	20
23	Israel	70,450	54	Philippines	2,813	85	Nicaragua	12
24	Estonia	61,820	55	Namibia	2,098	86	Dominican Republic	10
25	France	49,807	56	Croatia	1,805	87	Ireland	9
26	Argentina	42,587	57	Hong Kong	1,549	88	Azerbaijan	8
27	South Korea	41,868	58	South Africa	1,504	89	Bermuda	7
28	Venezuela	34,170	59	Thailand	1,265	90	Algeria	7
29	Austria	31,695	60	Sweden	1,241	91	Uzbekistan	6
30	Finland	29,907	61	Lebanon	1,058	92	Timor-Leste	4
31	Turkey	29,673	62	Myanmar	914	93	Mauritius	1

User agents by provider

ASN	Provider	Count
7922	COMCAST-7922 - Comcast Cable Communications, Inc.,US	1,111,855
12741	AS-NETIA Netia SA,PL	779,044
51110	IDOMTECHNOLOGIES-AS IDOM TECHNOLOGIES,FR	740,156
6327	SHAW - Shaw Communications Inc.,CA	710,462
1290	TELSTRAEUROPELTD-BACKBONE Telstra Europe Ltd,GB	617,428
4323	TWTC - tw telecom holdings, inc.,US	487,619
6830	LGI-UPC Liberty Global Operations B.V.,AT	478,127
577	BACOM - Bell Canada,CA	460,147
9829	BSNL-NIB National Internet Backbone,IN	439,248
22773	ASN-CXA-ALL-CCI-22773-RDC - Cox Communications Inc.,US	370,913
5384	EMIRATES-INTERNET Emirates Telecommunications Corporation,AE	351,418
6621	HNS-DIRECPC - Hughes Network Systems,US	348,530
9080	GIN Ipex Ltd.,CZ	343,179
22140	T-MOBILE-AS22140 - T-Mobile USA, Inc.,US	303,547
6407	PRIMUS-AS6407 - Primus Telecommunications Canada Inc.,CA	297,744
27747	Telecentro S.A.,AR	287,680
37492	ORANGE-TN,TN	256,401
22047	VTR BANDA ANCHA S.A.,CL	250,353
812	ROGERS-CABLE - Rogers Cable Communications Inc.,CA	218,596
28573	CLARO S.A.,BR	211,595
45510	TELCOINABOX-AU Level 10, 9 Hunter Street,AU	210,197
4766	KIXS-AS-KR Korea Telecom,KR	198,384
43529	VIDANET-AS ViDaNet Cabletelevision Provider Ltd.,HU	196,294
11427	SCRR-11427 - Time Warner Cable Internet LLC,US	190,688
30036	MEDIACOM-ENTERPRISE-BUSINESS - Mediacom Communications Corp,US	173,475
4134	CHINANET-BACKBONE No.31,Jin-rong Street,CN	170,820
701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	160,947
286	KPN KPN International / KPN Eurorings,NL	154,721
1136	KPN KPN Internet Solutions,NL	154,721
2516	KDDI KDDI CORPORATION,JP	152,918
33363	BHN-TAMPA - BRIGHT HOUSE NETWORKS, LLC,US	131,955
4755	TATACOMM-AS TATA Communications formerly VSNL is Leading ISP,IN	131,828
3320	DTAG Deutsche Telekom AG,DE	130,553
8048	CANTV Servicios, Venezuela,VE	128,457
7018	ATT-INTERNET4 - AT&T Services, Inc.,US	125,849
55577	BEAMTELE-AS-AP Beam Telecom Pvt Ltd,IN	125,446
22394	CELLCO - Cellco Partnership DBA Verizon Wireless,US	124,266
25605	SCANSAFE - Cisco Systems Ironport Division,US	122,960
9121	TTNET Turk Telekomunikasyon Anonim Sirketi,TR	122,356
10796	SCRR-10796 - Time Warner Cable Internet LLC,US	120,775
6128	CABLE-NET-1 - Cablevision Systems Corp.,US	117,434
13489	EPM Telecomunicaciones S.A. E.S.P.,CO	116,478
3249	ESTPAK Telia Eesti AS,EE	114,670
24589	TELENETSIA-AS TELENET, sia,LV	102,287
25372	ITCONSULTING-AS IT Consulting L.L.C.,UA	101,840
8764	TEOLTAB TEO LT, AB,LT	100,343
2386	INS-AS - AT&T Data Communications Services,US	98,372
50481	FIBERTECH Fibertech Networks Sp. z o.o.,PL	98,030
18881	Global Village Telecom,BR	95,297
4837	CHINA169-BACKBONE CNCGROUP China169 Backbone,CN	93,802
3209	VODANET Vodafone GmbH,DE	85,822
39356	AVANTI-UK-AS Avanti Broadband Ltd.,GB	85,579

ASN	Provider	Count
3269	ASN-IBSNAZ Telecom Italia S.p.a.,IT	85,113
11351	RR-NYSREGION-ASN-01 - Time Warner Cable Internet LLC,US	84,728
3262	SARENET SARENET, S.A.,ES	81,292
2856	BT-UK-AS British Telecommunications PLC,GB	78,015
29314	VECTRANET-AS VECTRA S.A.,PL	77,475
11830	Instituto Costarricense de Electricidad y Telecom.,CR	77,278
63969	RACEONLINE-BD Race Online Limited,BD	76,817
3352	TELEFONICA_DE_ESPANA TELEFONICA DE ESPANA,ES	76,611
7155	WB-DEN2 - ViaSat,Inc.,US	75,809
9116	GOLDENLINES-ASN 012 Smile Communications Ltd.,IL	75,410
8359	MTS MTS PJSC,RU	69,997
41872	FLASHCABLE GIB-Solutions AG,CH	69,705
5769	VIDEOTRON - Videotron Telecom Ltee,CA	68,483
1221	ASN-TELSTRA Telstra Pty Ltd,AU	65,675
20704	FUNKNETZ-AS www.funknetz.at GmbH,AT	64,886
7522	STCN STNet, Incorporated,JP	63,440
25620	COTAS LTDA.,BO	63,011
7385	INTEGRATELECOM - Integra Telecom, Inc.,US	62,677
49120	GORSET-AS Gorset Ltd.,RU	60,260
3292	TDC TDC A/S,DK	59,282
18126	CTCX Chubu Telecommunications Company, Inc.,JP	58,038
24652	JUNIPER-EMEA-AS Juniper Networks International B.V.,NL	54,152
14464	RINET - Rhode Island Network for Educ. Technology,US	53,597
35244	KMS-DE_AS AS for KMS Munich,DE	52,781
21814	PARSONS - Parsons Corp.,US	50,876
18723	SEAGATE-USA-MN-1 - Seagate Technology,US	50,658
15772	WNET LLC _WNET UKRAINE_,UA	50,233
10113	EFTEL-AS-AP Eftel Limited.,AU	48,691
39513	ONECOM-AS TOV ONECOM,UA	48,546
12406	BN-AS Business Network JV,BY	48,241
25513	ASN-MGTS-USPD OJS Moscow city telephone network,RU	46,581
9756	CHEONANVITSSEN-AS-KR Cheonan Broadcast Corporation,KR	46,416
5645	TEKSAVVY - TekSavvy Solutions, Inc.,CA	46,144
1759	TSF-IP-CORE TeliaSonera Finland Oyj,FI	42,826
5617	TPNET Orange Polska Spolka Akcyjna,PL	41,699
10318	CABLEVISION S.A.,AR	40,504
8151	Uninet S.A. de C.V.,MX	37,733
42643	BLAST-PL-AS Sebastian Baginski BLAST.PL,PL	37,541
15128	COMWAVE-BGP-01 - Comwave Telecom Inc.,CA	36,518
50477	SV-EN-AS Svyaz-Energo Ltd,RU	36,446
7992	COGECOWAVE - Cogeco Cable,CA	35,717
8167	Brasil Telecom S/A - Filial Distrito Federal,BR	35,386
15895	KSNET-AS _Kyivstar_ PJSC,UA	33,681
20115	CHARTER-NET-HKY-NC - Charter Communications,US	33,450
15389	FAROESE-TELECOM-AS P/F Telefonverkid,FO	32,410
14618	AMAZON-AES - Amazon.com, Inc.,US	32,403
12322	PROXAD Free SAS,FR	32,293
24186	RAILTEL-AS-IN RailTel Corporation of India Ltd., Internet Service Provider, New Delhi,IN	31,858
49058	PRIMELINK-AS Private Limited Company _PrimeLink Telecom_,RU	31,339
17229	ATT-CERFNET-BLOCK - AT&T Enhanced Network Services,US	31,203
9808	CMNET-GD Guangdong Mobile Communication Co.Ltd.,CN	29,846
4739	INTERNODE-AS Internode Pty Ltd,AU	29,831
24560	AIRTELBROADBAND-AS-AP Bharti Airtel Ltd., Telemedia Services,IN	29,636
31334	KABELDEUTSCHLAND-AS Vodafone Kabel Deutschland GmbH,DE	29,537

ASN	Provider	Count
20001	ROADRUNNER-WEST - Time Warner Cable Internet LLC,US	28,519
15516	DK-ARROWHEAD Arrowhead A/S,DK	28,303
5432	BELGACOM-SKYNET-AS Proximus NV,BE	28,243
18087	TOYO Toyo University,JP	28,140
29091	IPNXng,NG	28,053
12133	LISCO - LISCO,US	26,747
15982	VERAT-AS-1 BeotelNet-ISP d.o.o,RS	26,439
49902	SRR-AS SOCIETE REUNIONNAISE DU RADIOTELEPHONE SCS,FR	25,917
14566	AS14566 - Xerox Business Services LLC,US	24,750
7303	Telecom Argentina S.A.,AR	24,739
38713	CONNECT2B-AS-PK Broadband ISP, FTTH and Cable Service Provider,PK	23,983
56040	CMNET-GUANGDONG-AP China Mobile communications corporation,CN	23,117
55740	TATAINDICOM-IN TATA TELESERVICES LTD - TATA INDICOM - CDMA DIVISION,IN	23,043
45117	INPL-IN-AP Ishan_s Network,IN	22,989
35699	ADAMOEU-AS Adamo Telecom Iberia S.A,ES	22,888
8641	NAUKANET-AS LLC _Nauka-Svyaz_,RU	22,615
18289	AGNS-JP-IBM AT&T JAPAN KK,JP	22,590
19817	DSLEXTREME - DSL Extreme,US	22,454
39707	SINFORM-AS OOO _SvyazInform_,RU	22,218
9003	ASN-ALTITUDETELECOM COMPLETEL SAS,FR	22,077
31252	STARNET-AS StarNet Moldova,MD	21,928
17552	TRUE-AS-AP True Internet Co.,Ltd.,TH	21,863
8767	MNET-AS M-net Telekommunikations GmbH, Germany,DE	21,822
6471	ENTEL CHILE S.A.,CL	21,577
0	NA	20,750
1930	RCCN Fundacao para a Ciencia e a Tecnologia, I.P.,PT	20,731
46690	SNET-FCC - Southern New England Telephone Company and SNET America, Inc.,US	20,477
4812	CHINANET-SH-AP China Telecom (Group),CN	20,470
34318	MINNIBERGER-AS Flashnet GmbH,AT	20,451
4804	MPX-AS Microplex PTY LTD,AU	20,398
50010	NAWRAS-AS Omani Qatari Telecommunications Company SAOC,OM	20,117
45899	VNPT-AS-VN VNPT Corp,VN	19,957
12301	INVITEL Invitel Tavkozlesi Zrt.,HU	19,544
3737	PTD-AS - PenTeleData Inc.,US	19,361
17816	CHINA169-GZ China Unicom IP network China169 Guangdong province,CN	19,015
2857	RLP-NET Johannes Gutenberg-Universitaet Mainz,DE	18,171
9050	RTD TELEKOM ROMANIA COMMUNICATION S.A,RO	17,987
8334	CO-2COM-AS 2COM Co ltd.,RU	17,922
852	ASN852 - TELUS Communications Inc.,CA	17,895
6222	CENTURYLINK-LEGACY-EMBARQ-CLTN - Embarq Corporation,US	17,677
42610	NCNET-AS PJSC Rostelecom,RU	17,615
13340	RIML-CORP-AS-3 - BlackBerry Limited,CA	17,272
3215	AS3215 Orange S.A.,FR	17,157
15547	NETPLUS netplus.ch SA,CH	16,982
6739	ONO-AS VODAFONE ONO, S.A.,ES	16,897
10292	CWJ-1 - Cable & Wireless Jamaica,JM	16,886
8615	CNT-AS _Central Telegraph_ Public Joint-stock Company,RU	16,068
28571	UNIVERSIDADE DE SAO PAULO,BR	15,907
27738	Ecuadortelecom S.A.,EC	15,816
5610	O2-CZECH-REPUBLIC O2 Czech Republic, a.s.,CZ	15,738
8905	DIGIT1-AS Digit One LLC,RU	14,763
55644	IDEANET1-IN Idea Cellular Limited,IN	14,647
7738	Telemar Norte Leste S.A.,BR	14,618
11426	SCRR-11426 - Time Warner Cable Internet LLC,US	14,533

ASN	Provider	Count
19108	SUDDENLINK-COMMUNICATIONS - Suddenlink Communications,US	14,418
51281	COUNTRY-TELECOM-AS Morton-Telekom Ltd.,RU	14,326
15435	KABELFOON CAIW Diensten B.V.,NL	13,886
29954	JLL-AM-CHI - Jones Lang LaSalle, Inc.,US	13,701
7545	TPG-INTERNET-AP TPG Telecom Limited,AU	13,471
9143	ZIGGO Ziggo B.V.,NL	13,228
17494	BTTB-AS-AP Telecom Operator & Internet Service Provider as well,BD	12,738
23860	ALLIANCE-GATEWAY-AS-AP Alliance Broadband Services Pvt. Ltd.,IN	12,587
719	ELISA-AS Elisa Oyj,FI	12,050
45587	CBCNET-CERNET-AS-AP China Broadband Communications (CBCnet),CN	12,034
19165	WEBPASS - Webpass Inc.,US	11,672
14007	SOHOSKYWAY1 - Skyway West,CA	11,579
47586	BUSINESS-SVYAZ Business-Svyaz LTD,RU	11,574
30689	FLOW-NET - FLOW,JM	11,473
6389	BELLSOUTH-NET-BLK - BellSouth.net Inc.,US	11,433
40290	COMTECHNOLOGIES - Communications Technologies, Inc.,US	11,430
39229	SAN-AS PJSC Rostelecom,RU	11,099
42298	GCC-MPLS-PEERING Ooredoo Q.S.C.,QA	11,091
28583	RuralWeb Telecomunica	11,079
12594	EXTERNET-AS Externet Nyrt,HU	11,031
5089	NTL Virgin Media Limited,GB	11,021
38584	CUBEXS-AS-AP CubeXS Pvt Ltd, Internet Service Provider Pakistan,PK	10,998
21826	Corporaci	10,801
15964	CAMNET-AS,CM	10,404
50261	ACENET ACE Telecom Kft,HU	10,372
196735	AS-JONCZ JON.CZ, s.r.o.,CZ	10,096
11492	CABLEONE - CABLE ONE, INC.,US	9,785
20473	AS-CHOOPA - Choopa, LLC,US	9,691
31242	TKPSA-AS 3S S.A.,PL	9,383
23100	CT-METROCAST-NET - Atlantic Broadband Finance, LLC,US	9,333
34918	IR-PISHGAMAN-ICP Pishgaman Kavir Yazd,IR	9,304
12353	VODAFONE-PT Vodafone Telecel, Comunicacoes Pessoais, SA,PT	9,284
5603	SIOL-NET Telekom Slovenije d.d.,SI	9,200
4780	SEEDNET Digital United Inc.,TW	9,107
18390	SPIN-INTERNET-AP Spin Internet Service,AU	9,100
62422	FAS-AS Federal Antimonopoly Service,RU	8,950
5483	HTC-AS Magyar Telekom Plc.,HU	8,907
25019	SAUDINETSTC-AS Saudi Telecom Company JSC,SA	8,860
25405	NMTS-AS PJSC Rostelecom,RU	8,829
45528	TDN Tikona Digital Networks Pvt Ltd.,IN	8,753
9534	MAXIS-AS1-AP Binariang Berhad,MY	8,711
132106	BDREN-UGC-BD-AS University Grants Commission of Bangladesh,BD	8,695
43234	TT-AOLUK-AS TalkTalk Communications Limited,GB	8,584
17511	K-OPTICOM K-Opticom Corporation,JP	8,495
17974	TELKOMNET-AS2-AP PT Telekomunikasi Indonesia,ID	8,362
45999	CAR Korea Transportation Safety Authority,KR	8,078
23944	SKYBB-AS-AP SKYBroadband SKYCable Corporation,PH	7,441
41232	SSN SouthSide Network LLC,UA	7,378
8426	CLARANET-AS ClaraNET LTD,GB	7,361
16929	SURGE-COMMUNICATIONS - Surge Communications LLC,US	7,319
25159	SONICDUO-AS PJSC MegaFon,RU	7,185
18566	MEGAPATH5-US - MegaPath Corporation,US	7,122
3216	SOVAM-AS OJSC _Vimpelcom_,RU	7,080
21211	SKY-NET-AS Penkiu kontinentu komunikaciju centras, Ltd.,LT	6,836

ASN	Provider	Count
25543	FasoNet-AS,BF	6,805
57583	ASVASHNET IP Shefer Vitaliy Vyacheslavovich,RU	6,784
56041	CMNET-ZHEJIANG-AP China Mobile communications corporation,CN	6,772
9824	JTCL-JP-AS Jupiter Telecommunication Co. Ltd,JP	6,712
3243	MEO-RESIDENCIAL MEO - SERVICOS DE COMUNICACOES E MULTIMEDIA S.A.,PT	6,536
22927	Telefonica de Argentina,AR	6,495
17676	GIGAINFRA Softbank BB Corp.,JP	6,047
12874	FASTWEB Fastweb SpA,IT	5,975
262197	MILLICOM CABLE COSTA RICA S.A.,CR	5,910
6332	Telefonos del Noroeste, S.A. de C.V.,MX	5,900
48159	TIC-AS Telecommunication Infrastructure Company,IR	5,855
25229	VOLIA-AS Kyivski Telekomunikatsiyni Merezhi LLC,UA	5,830
15802	DU-AS1 Emirates Integrated Telecommunications Company PJSC (EITC-DU),AE	5,818
49218	NTKS-AS Nizhnetagilskie Kompyuternye Seti LLC,RU	5,723
16880	AS2-TRENDMICRO-COM - TREND MICRO INCORPORATED,US	5,689
11215	LOGIXCOMM-AS - Logix,US	5,550
6079	RCN-AS - RCN,US	5,548
7106	OHIOBRIGHTNET - Com Net, Inc.,US	5,467
51803	SI-TELEING TELEING d.o.o.,SI	5,450
27901	Pacifico Cable S.A.,CL	5,256
1236	GDC4S-GROUP-2 - General Dynamics C4 Systems, Inc.,US	5,139
38457	HNS-AS-AP Honesty Net Solution (I) Pvt Ltd,IN	5,115
6147	Telefonica del Peru S.A.A.,PE	5,049
30969	ZOL-AS Zimbabwe OnLine (Private) Ltd.,GB	5,039
19037	AMX Argentina S.A.,AR	5,021
24444	CMNET-V4SHANDONG-AS-AP Shandong Mobile Communication Company Limited,CN	4,984
35154	TELENET-AS PJSC Rostelecom,RU	4,909
29695	ALTIBOX_AS Altibox AS,NO	4,861
12392	ASBRUTELE Brutele SC,BE	4,853
87	INDIANA-AS - Indiana University,US	4,817
4613	MOS-NP Mercantile Office Systems,NP	4,721
18403	FPT-AS-AP The Corporation for Financing & Promoting Technology,VN	4,719
10396	COQUI-NET - DATACOM CARIBE, INC.,PR	4,657
21704	NYCBOE-BGPNET - New York City Board of Education,US	4,653
44489	STARNET Starnet s.r.o.,CZ	4,644
4788	TMNET-AS-AP TM Net, Internet Service Provider,MY	4,612
1103	SURFNET-NL SURFnet, The Netherlands,NL	4,541
20207	Gigared S.A.,AR	4,453
31240	OLD-HT-SYSTEMS-AS JSC Hosting Telesystems autonomous system,RU	4,427
8823	AUTONOMOUSSYSTEMROCKENSTEINAG Rockenstein AG,DE	4,413
38058	AMDOCSDVCI-AS-IN Amdocs Development centre India limited,IN	4,408
9908	HKCABLE2-HK-AP HK Cable TV Ltd,HK	4,370
48424	GLOBITEL-AS GLOBITEL Sp. z o.o.,PL	4,302
24086	VIETTEL-AS-VN Viettel Corporation, VN	4,297
32890	BTC-AS-1 - Beehive Telephone Company, Inc.,US	4,274
12670	AS-COMPLETEL COMPLETEL SAS France,FR	4,260
19429	ETB - Colombia,CO	4,166
29124	ISKRATELECOM-AS Iskratelecom CJSC,RU	4,141
34168	ELCOM-ISP-AS PJSC Rostelecom,RU	4,089
6057	Administracion Nacional de Telecomunicaciones,UY	4,063
22581	ACE-STX - Broadband VI, LLC,VI	4,034
18101	RELIANCE-COMMUNICATIONS-IN Reliance Communications Ltd.DAKC MUMBAI,IN	3,968
8608	QINIP EspritXB B.V.,NL	3,928
26599	TELEFÌƒ	3,915

ASN	Provider	Count
29107	SYNAPSE-AS Open JSC _Stock company _Sater_,UA	3,885
45595	PKTELECOM-AS-PK Pakistan Telecom Company Limited,PK	3,878
62423	TCENTER-AS Telecom Center LLC,RU	3,857
26488	SCU-ASN - Santa Clara University,US	3,784
35788	FORCEPOINT-CLOUD-AMER-AS Websense Hosted R&D Ltd.,GB	3,701
48847	CONNECT WAVES S.A.L,LB	3,697
4761	INDOSAT-INP-AP INDOSAT Internet Network Provider,ID	3,689
47232	GRAPESC ISP Alliance a.s.,CZ	3,558
28481	SERVICIO Y EQUIPO EN TELEFONÌƒ	3,544
17762	HTIL-TTML-IN-AP Tata Teleservices Maharashtra Ltd,IN	3,485
5391	T-HT Hrvatski Telekom d.d.,HR	3,361
132199	GLOBE-MOBILE-5TH-GEN-AS Globe Telecom Inc.,PH	3,302
43975	VTK-AS PJSC Rostelecom,RU	3,295
12844	ASN-BOUYGTEL-MOBILE Bouygues Telecom SA,FR	3,238
3462	HINET Data Communication Business Group,TW	3,232
18840	EQUIPOS Y SISTEMAS S.A.,NI	3,226
8325	YARSU-AS OOO FREEnet Group,RU	3,212
45654	BI-AS-AP Internet Services,AU	3,190
31593	BLACKSEA TV Company _Black Sea_ Ltd,UA	3,127
28548	Cablevisi	3,118
17488	HATHWAY-NET-AP Hathway IP Over Cable Internet,IN	3,103
15502	VODAFONE-IRELAND-ASN Vodafone Ireland Limited,IE	3,092
15146	CABLEBAHAMAS - Cable Bahamas,BS	3,017
10139	SMARTBRO-PH-AP Smart Broadband, Inc.,PH	2,939
10199	TATA-AS Tata Communications Ltd,IN	2,794
8402	CORBINA-AS OJSC _Vimpelcom_,RU	2,704
14754	Telgua,GT	2,650
24860	ASHSL-AS HSL SystemDesign GmbH,DE	2,644
9506	MAGIX-SG-AP Magix Broadband Network,SG	2,614
5607	BSKYB-BROADBAND-AS Sky UK Limited,GB	2,506
11941	PWLLP-AS001 - Pillsbury Madison & Sutro, Inc.,US	2,439
36903	MT-MPLS,MA	2,419
48309	AGS-AS Ariana Gostar Spadana (PJSC),IR	2,412
22085	Claro S/A,BR	2,399
56046	CMNET-JIANGSU-AP China Mobile communications corporation,CN	2,382
29555	ALTEL-AS JSC _ALTEL_,KZ	2,379
16342	TOYA Toya sp.z.o.o,PL	2,337
9145	EWETEL EWE TEL GmbH,DE	2,260
35540	OVH-TELECOM OVH SAS,FR	2,231
38285	M2TELECOMMUNICATIONS-AU M2 Telecommunications Group Ltd,AU	2,188
33763	Paratus-Telecom,NA	2,175
47395	SCARTEL-AS PJSC MegaFon,RU	2,155
17638	CHINATELECOM-TJ-AS-AP ASN for TIANJIN Provincial Net of CT,CN	2,129
21479	ROSTOV-TELEGRAF-AS PJSC Rostelecom,RU	2,115
553	BELWUE Universitaet Stuttgart,DE	2,108
8452	TE-AS TE-AS,EG	2,087
44957	OPITEL Vodafone Omnitel B.V.,IT	2,057
1267	ASN-WIND Wind Telecomunicazioni SpA,IT	2,054
2860	NOS_COMUNICACOES NOS COMUNICACOES, S.A.,PT	2,011
17465	ASIANET Cable ISP in India,IN	2,005
41349	MVMTECH-AS Limited Liability Company MVM Technology,RU	2,001
12715	JAZZNET Jazz Telecom S.A.,ES	1,982
7552	VIETEL-AS-AP Viettel Corporation,VN	1,954
28220	CABO SERVICOS DE TELECOMUNICACOES LTDA,BR	1,917

ASN	Provider	Count
6799	OTENET-GR Ote SA (Hellenic Telecommunications Organisation),GR	1,908
38841	KBRO-AS-TW kbro CO. Ltd.,TW	1,828
27755	Mobilphone de Panama,PA	1,821
19271	PEAK10 - Peak 10,US	1,810
11139	CWDOM - Cable & Wireless Dominica,DM	1,784
196750	SETI-WEBA SETI WEBA LTD,RU	1,738
1668	AOL-ATDN - AOL Transit Data Network,US	1,687
43179	TEAMC-AS Team Consulting d.o.o.,BA	1,646
58243	TELEAG TELE AG,DE	1,609
12880	DCI-AS Information Technology Company (ITC),IR	1,591
38266	HUTCHVAS-AS Vodafone Essar Ltd., Telecommunication - Value Added Services,IN	1,590
24550	WEBSURFERNP-AS-NP Websurfer Nepal Internet Service Provider,NP	1,590
43727	KVANT-TELECOM KVANT-TELEKOM Closed Joint Stock Company,RU	1,565
9105	TISCALI-UK Tiscali UK Limited,GB	1,554
17477	MCT-SYDNEY Macquarie Telecom,AU	1,519
9318	HANARO-AS Hanaro Telecom Inc.,KR	1,504
37521	Internet-Solutions-NG,NG	1,457
58239	ASHANSPAULCITY hanspaul-city.net s.r.o.,CZ	1,446
4181	TDS-AS - TDS TELECOM,US	1,413
45609	BHARTI-MOBILITY-AS-AP Bharti Airtel Ltd. AS for GPRS Service,IN	1,389
17785	CHINATELECOM-HA-AS-AP asn for Henan Provincial Net of CT,CN	1,380
24445	CMNET-V4HENAN-AS-AP Henan Mobile Communications Co.,Ltd,CN	1,363
11172	Alestra, S. de R.L. de C.V.,MX	1,342
198068	FASTNET FASTVPS EESTI OU,EE	1,340
9443	INTERNETPRIMUS-AS-AP Primus Telecommunications,AU	1,323
10029	CITYCOMNETWORKS-AS CITYCOM NETWORKS PVT LTD,IN	1,319
36996	TELECOM-NAMIBIA,NA	1,318
9583	SIFY-AS-IN Sify Limited,IN	1,298
13999	Mega Cable, S.A. de C.V.,MX	1,296
55441	TATA-DOCOMO-AS-AP D 26/2 TTC INDUSTRIAL AREA MIDC SANPADA,IN	1,291
59955	ABS Advanced Broadband Services S.A.L,LB	1,278
30722	VODAFONE-IT-ASN Vodafone Omnitel B.V.,IT	1,276
9394	CTTNET China TieTong Telecommunications Corporation,CN	1,274
4808	CHINA169-BJ CNCGROUP IP network China169 Beijing Province Network,CN	1,259
8865	ASN-BIAMAN-EDU Politechnika Bialostocka,PL	1,247
1257	TELE2,SE	1,229
25549	AVANTEL-AS Closed Joint-stock company Avantel,RU	1,222
45271	ICLNET-AS-AP Idea Cellular Limited,IN	1,205
25124	DATAK DATAK Internet Engineering, Inc,IR	1,191
38657	WAWB-AS-AP WAWB Pty Ltd,AU	1,190
133392	SKY-AS-AP Skynet MPS,MM	1,188
31549	RASANA Aria Shatel Company Ltd,IR	1,185
29125	TATINT-AS OJSC _Vimpelcom_,RU	1,178
37076	EMTS-NIGERIA-AS,NG	1,138
27947	Telconet S.A,EC	1,126
43939	INTERNETIA_ETTH2-AS Internetia Sp.z o.o.,PL	1,100
13285	OPALTELECOM-AS TalkTalk Communications Limited,GB	1,100
7029	WINDSTREAM - Windstream Communications Inc,US	1,096
6400	Compa	1,093
46562	TOTAL-SERVER-SOLUTIONS - Total Server Solutions L.L.C.,US	1,073
8732	COMCOR-AS OJSC Comcor,RU	1,031
29975	VODACOM-ZA,ZA	1,022
56696	ASLIQUID-MPLS Liquid Telecommunications Ltd,GB	1,000
6503	Axtel, S.A.B. de C.V.,MX	994

ASN	Provider	Count
6805	TDDE-ASN1 Telefonica Germany GmbH & Co.OHG,DE	990
3816	COLOMBIA TELECOMUNICACIONES S.A. ESP,CO	965
31042	SERBIA-BROADBAND-AS Serbia BroadBand-Srpske Kablovske mreze d.o.o.,RS	963
44375	AISDP ASMANFARAZ SEPAHAN ISDP (PJS),IR	953
50644	TPS-TTC-AS Topcon Positioning Systems,RU	948
12688	BAIKALTRANSTELECOM Closed Joint Stock Company TransTeleCom,RU	942
16567	NETRIX-16567 - Netrix LLC,US	925
3527	NIH-NET - National Institutes of Health,US	920
264238	Link Net-Igarapava,BR	900
31148	FREENET-AS Freenet Ltd.,UA	894
34977	PROCONO-AS PROCONO S.A.,ES	886
393406	DIGITALOCEAN-ASN-NY3 - Digital Ocean, Inc.,US	884
5591	MARTELCOM-AS PJSC Rostelecom,RU	864
37054	TGN,MG	860
5615	TISNL-BACKBONE KPN B.V.,NL	839
24757	EthioNet-AS,ET	825
16629	CTC. CORP S.A. (TELEFONICA EMPRESAS),CL	819
134813	CYBERCOMM-BD Cyber Communication Bangladesh,BD	799
21034	MICSO-SRL-AS Micso S.r.l.,IT	797
24378	ENGTAC-AS-TH-AP Total Access Communication PLC.,TH	790
4764	WIDEBAND-AS-AU Wideband Networks Pty Ltd, Transit AS,AU	790
31841	NKTC - NEW KNOXVILLE TELEPHONE COMPANY,US	772
12768	ER-TELECOM-AS JSC _ER-Telecom Holding_,RU	747
3491	BTN-ASN - Beyond The Network America, Inc.,US	739
12968	CDP Netia SA,PL	735
59196	KOSNET-AS Kavish online services private limited,IN	735
24400	CMNET-V4SHANGHAI-AS-AP Shanghai Mobile Communications Co.,Ltd.,CN	724
9374	EDION EDION Corporation,JP	718
9299	IPG-AS-AP Philippine Long Distance Telephone Company,PH	711
5390	EURONET Euronet Communications B.V.,NL	710
18687	MPOWER-2 - MPOWER COMMUNICATIONS CORP.,US	710
36962	MTNZ-AS,ZM	710
5416	Batelco,BH	708
19751	CCRTC - Endeavor Communications,US	707
39087	PAKT-AS P.A.K.T LLC,RU	704
11050	KENT-STATE - Kent State University,US	690
22703	ANTHEM - Anthem Blue Cross Blue Shield,US	687
45820	TTSL-MEISISP Tata Teleservices ISP AS,IN	684
16527	GVTCINTERNET - Guadalupe Valley Telephone Cooperative, Inc.,US	683
48470	JSCMTUKRISTALL-AS Joint Stock Company MTU Kristall,RU	668
6697	BELPAK-AS Republican Unitary Telecommunication Enterprise Beltelecom,BY	652
3301	TELIANET-SWEDEN TeliaSonera AB,SE	637
48661	AIRWAYNET AIRWAYNET, a.s.,CZ	627
21502	ASN-NUMERICABLE NC Numericable S.A.,FR	607
5410	ASN-BOUYGTEL-ISP Bouygues Telecom SA,FR	597
13127	VERSATEL Tele 2 Nederland B.V.,NL	589
11290	RAPIDUS - COGECO Cable Canada Inc.,CA	588
1901	EUNETAT-AS A1 Telekom Austria AG,AT	582
32908	TRIMBL-NUM - Trimble,US	575
27262	TVCCONNECT-AS - Thames Valley Communications, Inc.,US	565
4713	OCN NTT Communications Corporation,JP	563
2586	UNINET-AS Elisa Eesti AS,FI	562
22884	TOTAL PLAY TELECOMUNICACIONES SA DE CV,MX	557
198282	SATANNET SAT - AN CableNet SE,CZ	547

ASN	Provider	Count
14288	MPINET - MPInet,US	546
16232	ASN-TIM TELECOM ITALIA SPA,IT	541
34577	SKATTV-AS SKAT TV Ltd.,BG	537
8551	BEZEQ-INTERNATIONAL-AS Bezeq International-Ltd,IL	524
29838	AMC - Atlantic Metro Communications,US	519
786	JANET Jisc Services Limited,GB	518
39706	O2-GERMANY-AS Telefonica Germany GmbH & Co.OHG,DE	510
262210	VIETTEL PER	510
2828	XO-AS15 - XO Communications,US	505
12066	TRICOM,DO	481
209	CENTURYLINK-US-LEGACY-QWEST - Qwest Communications Company, LLC,US	473
54483	CALIFORNIA-INTERNET-SOLUTIONS - California Internet, L.P.,US	450
6849	UKRTELNET PJSC UKRTELECOM,UA	447
31133	MF-MGSM-AS PJSC MegaFon,RU	445
53006	ALGAR TELECOM S/A,BR	444
8928	INTEROUTE Interoute Communications Limited,GB	441
13037	ZEN-AS Zen Internet Ltd,GB	437
30848	IT-TWT-AS TWT S.p.A.,IT	428
2018	TENET-1,ZA	418
51207	FREEM Free Mobile SAS,FR	405
19875	TERAGO-RACKFORCE - TeraGo Networks Inc.,CA	404
20857	TRANSIP-AS TransIP B.V.,NL	402
41440	SIBIRTELECOM-AS PJSC Rostelecom,RU	401
47438	PSKOVLINE-AS Pskovline Ltd.,RU	400
11957	CACHEFLOW-AS - Bluecoat Systems, Inc.,US	397
38902	GLOBALLOGIC-IN GlobalLogic India Ltd.,IN	394
17551	DCSINTERNET-AS-AP DCS Internet,AU	392
12042	ENVENTIS - Enventis Telecom Inc.,US	388
36955	Matrix-ASN1,CM	378
32013	CATHOLIC-HEALTH-CARE-WEST - Dignity Health,US	374
13977	CTELCO - FAIRPOINT COMMUNICATIONS, INC.,US	364
20845	DIGICABLE DIGI Tavkozlesi es Szolgaltato Kft.,HU	359
3303	SWISSCOM Swisscom (Switzerland) Ltd,CH	353
17754	EXCELL-AS Excellmedia,IN	352
21193	XARXA-AS Centre de Telecomuncaciones i Tecnologies de la Informacias de la Generalitat de Catalunya,ES	350
6868	BMSTU-AS Moscow State Technical University named NE Bouwman (state enterprise no commercial organisation),RU	349
21219	DATAGROUP PRIVATE JOINT STOCK COMPANY _DATAGROUP_,UA	345
13490	BUCKEYECABLEVISION - Buckeye Cablevision, Inc.,US	335
22561	CENTURYLINK-LEGACY-LIGHTCORE - CenturyTel Internet Holdings, Inc.,US	333
37705	TOPNET,TN	331
24309	CABLELITE-AS-AP Atria Convergence Technologies Pvt. Ltd. Broadband Internet Service Provider INDIA,IN	329
38174	CAPGEMINI-MUMBAI-AS Capgemini India Pvt Ltd,IN	328
38934	PRIDENET-AS Pride Limited,RU	318
2687	ATGS-MMD-AS - AT&T Global Network Services, LLC,US	315
12252	America Movil Peru S.A.C.,PE	308
10474	MWEB,ZA	305
25117	EI-TELECOM Euro-Information-Europeenne de Traitement de l_Information SAS,FR	301
12271	SCRR-12271 - Time Warner Cable Internet LLC,US	296
26615	Tim Celular S.A.,BR	294
15785	TELEPORTSV PrivateJSC DataGroup,UA	286
43266	ABUA-AS LLC AB Ukraine,UA	285
2518	BIGLOBE BIGLOBE Inc.,JP	282
28840	TATTELECOM-AS OJSC _OAO TATTELECOM_,RU	280
28753	LEASEWEB-DE Leaseweb Deutschland GmbH,DE	277

ASN	Provider	Count
3851	NSHE-NEVADANET - Nevada System of Higher Education,US	277
17813	MTNL-AP Mahanagar Telephone Nigam Ltd.,IN	276
9381	NEWTT-IP-AP Wharf T&T Ltd.,HK	276
15372	IBH-AS IBH IT-Service GmbH,DE	275
31357	TOMICA-AS Tomsk Information and Consulting Agency,RU	263
24203	NAPXLNET-AS-ID PT Excelcomindo Pratama (Network Access Provider),ID	248
10620	Telmex Colombia S.A.,CO	246
7418	TELEF	245
31452	MTC-VB-AS MTC-Vodafone Bahrain,BH	243
4775	GLOBE-TELECOM-AS Globe Telecoms,PH	242
3356	LEVEL3 - Level 3 Communications, Inc.,US	242
24709	HYPERION MNI Telecom S.A.,PL	233
12297	ARMENTEL _ArmenTel_ CJSC,AM	229
12638	AS12638 E-Plus Mobilfunk GmbH,DE	227
8163	Metrotel SA ESP,CO	225
37693	TUNISIANA,TN	224
13184	HANSENET Telefonica Germany GmbH & Co.OHG,DE	221
42863	MEO-MOVEL MEO - SERVICOS DE COMUNICACOES E MULTIMEDIA S.A.,PT	219
23693	TELKOMSEL-ASN-ID PT. Telekomunikasi Selular,ID	217
251	KAIAGLOBAL-AS Kaia Global Networks Ltd.,GB	216
46353	INTERMAX-AS - Intermax Networks,US	208
12479	UNI2-AS France Telecom Espana SA,ES	208
1241	FORTHNET-GR Forthnet,GR	204
8447	TELEKOM-AT A1 Telekom Austria AG,AT	203
13156	AS13156 Cabovisao, televisao por cabovisao, sa,PT	200
40317	PEOPLESCOMMUNICATIONS - Peoples Communications Inc.,US	200
50623	INFOTECH Infotech LLC,AM	196
18828	TRIMBLE-WEST - Trimble,US	194
10013	FBDC FreeBit Co.,Ltd.,JP	193
262181	Scarlet B.V.,CW	193
2609	TN-BB-AS Tunisia BackBone AS,TN	192
36905	Creolink-ASN,CM	191
5522	OMNITEL OMNITEL Net,LT	188
27471	BC-CLOUD-SERVICES - Blue Coat Systems, Inc,US	187
4760	HKTIMS-AP PCCW Limited,HK	184
6702	APEXNCC-AS Science Production Company _Trifle_ Ltd.,RU	182
6535	Telmex Servicios Empresariales S.A.,CL	182
30873	PTC-YEMENNET Public Telecommunication Corporation,YE	181
55953	XIM-HK Room 704, ChinaChen Leighton Plaza,HK	174
197350	ZAYTONA AL Zaytona Company For Communication Ltd.,PS	171
8717	SPECTRUMNET MOBILTEL EAD,BG	166
9930	TTNET-MY TIME dotCom Berhad,MY	165
31566	ASSKYNETWORK SkyNetwork Ltd.,RU	158
9009	M247 M247 Ltd,GB	157
55836	RELIANCE-INFOTEL-IN Reliance Jio INFOCOMM Ltd,IN	155
35114	GIUNTI-AS GIUNTI EDITORE S.p.a.,IT	154
16637	MTNNS-AS,ZA	154
21928	T-MOBILE-AS21928 - T-Mobile USA, Inc.,US	154
22684	SSIMICRO - SSI Micro Ltd.,CA	149
45727	THREE-AS-ID Hutchison CP Telecommunications, PT,ID	143
61795	Arion Servicos de Telecomunicacoes LTDA,BR	139
2497	IIJ Internet Initiative Japan Inc.,JP	139
36991	ORANGE-UG,UG	139
1680	NV-ASN 013 NetVision Ltd.,IL	136

ASN	Provider	Count
10143	EXETEL-AS-AP Exetel Pty Ltd,AU	134
16130	FiberLink Networks,LB	132
45629	JASTEL-NETWORK-TH-AP JasTel Network International Gateway,TH	131
45758	TRIPLETNET-AS-AP TripleT Internet Internet service provider Bangkok,TH	131
7049	Silica Networks Argentina S.A.,AR	130
15399	WANANCHI-KE,KE	130
8448	PGSM-HU Telenor Hungary plc,HU	129
132770	GAZON-AS-IN Gazon Communications India Limited,IN	127
51407	MADA-AS Mada ALArab LTD,PS	122
36923	SWIFTNG-ASN,NG	122
48434	TEBYAN Tebyan-e-Noor Cultural-Artistic Institute,IR	122
2119	TELENOR-NEXTEL Telenor Norge AS,NO	122
17501	WLINK-NEPAL-AS-AP WorldLink Communications Pvt Ltd,NP	122
4802	ASN-IINET iiNet Limited,AU	121
17506	UCOM UCOM Corp.,JP	119
137	ASGARR Consortium GARR,IT	117
45143	SINGTELMOBILE-AS-AP SINGTEL MOBILE INTERNET SERVICE PROVIDER Singapore,SG	117
37148	globacom-as,NG	115
23752	NPTELECOM-NP-AS Nepal Telecommunications Corporation, Internet Services,NP	115
9988	MPT-AP Myanma Posts and Telecommunications,MM	112
18103	NEUVIZ-AS-ID-AP Neuviz Net,ID	111
27884	CABLECOLOR S.A.,HN	109
22394	CELLCO - Cellco Partnership DBA Verizon	109
5650	FRONTIER-FRTR - Frontier Communications of America, Inc.,US	109
12849	HOTNET-IL Hot-Net internet services Ltd.,IL	108
18933	USCC-MPLS01 - UNITED STATES CELLULAR TELEPHONE COMPANY (GREATER KNOXVILLE), L.P.,US	108
29562	KABELBW-ASN Kabel BW GmbH,DE	105
6713	IAM-AS,MA	100
5413	AS5413 Daisy Communications Ltd,GB	99
37620	VIETTEL-CM-AS,CM	99
47589	KTC3G Kuwait Telecommunication Company (Under Association),KW	96
23724	CHINANET-IDC-BJ-AP IDC, China Telecommunications Corporation,CN	94
38333	SYMBIO-AS-AU-AP Symbio Networks,AU	94
14654	WAYPORT - Wayport, Inc.,US	94
13739	DATACENTER-IP - Datacenter IP, LLC,US	92
12284	IPNS-AS - Computer Solutions, Inc.,US	92
3257	TINET-BACKBONE Tinet SpA,DE	92
133385	TELENORMYANMAR-AS Telenor Myanmar,MM	91
50664	PUBGROUPE-FR Re:Sources France SAS,FR	90
6848	TELENET-AS Telenet N.V.,BE	90
15600	FINECOM Quickline AG,CH	87
37251	TELKOMMOBILE,ZA	87
262202	Telefonica de Costa Rica TC, SA,CR	85
10148	UNIMELB-AS-AP The University of Melbourne, Melbourne, Victoria,AU	83
4847	CNIX-AP China Networks Inter-Exchange,CN	82
20057	ATT-MOBILITY-LLC-AS20057 - AT&T Mobility LLC,US	80
13912	COMMTOUCH-INC - Commtouch Inc.,US	75
44395	ORG-UL31-RIPE UCOM LLC,AM	75
14762	AMGEN - AMGEN, Inc.,US	72
8374	PLUSNET Polkomtel Sp. z o.o.,PL	70
39028	ULSK-AS JSC _ER-Telecom Holding_,RU	70
34277	ALFA-LTD-AS Alfa Ltd.,RU	69
2527	SO-NET So-net Entertainment Corporation,JP	68
22799	DCC - Delta Cable Communications Ltd.,CA	66

ASN	Provider	Count
12430	VODAFONE_ES VODAFONE ESPANA S.A.U.,ES	65
7474	OPTUSCOM-AS01-AU SingTel Optus Pty Ltd,AU	64
15305	SYRINGANETWORKS - Syringa Networks, LLC,US	63
8595	WESTCALL-AS WestCall Ltd,RU	63
31103	KEYWEB-AS Keyweb AG,DE	62
7270	NET2PHONE - IDT Corporation,US	62
8147	ASERICY - Ericsson Inc.,US	61
12111	ONEEIGHTY-NET - One Eighty Networks,US	61
3926	FFX-CNTY - Fairfax County Dept of Information Technology,US	60
47377	MES Mobistar SA,BE	60
133421	ISSB-AS-AP INNET SOLUTIONS SDN BHD,MY	59
9198	KAZTELECOM-AS JSC Kazakhtelecom,KZ	59
25515	CTCNET-AS PJSC Rostelecom,RU	58
35908	VPLSNET - Krypt Technologies,US	55
13628	ABSG - AMERISOURCEBERGEN,US	52
53889	MICFO - Micfo, LLC.,US	51
24852	VINITA UAB INIT Corporation,LT	50
9354	TDNC Community Network Center Inc.,JP	49
22302	INOC - INOC, LLC,US	47
15557	LDCOMNET Societe Francaise du Radiotelephone S.A,FR	45
8990	AHRT-AS _ANTENNA HUNGARIA_ Magyar Musorszoro es Radiohirkozlesi Zartkoruen Mukodo Reszvenytarsasag,HU	42
54538	PAN0001 - PALO ALTO NETWORKS,US	42
12310	INES iNES GROUP SRL,RO	41
25135	VODAFONE_UK_ASN Vodafone Limited,GB	41
27831	Colombia M	40
37154	ZAMTEL,ZM	38
19009	ONECLEVELAND - OneCleveland,US	36
36947	ALGTEL-AS,DZ	35
41311	CSIT-AS Open Joint Stock Company Center of Connection, Informatic and Telecommunication,RU	35
9304	HUTCHISON-AS-AP Hutchison Global Communications,HK	34
36884	MAROCCONNECT,MA	34
37266	AMOBIA-ASN,ZA	33
133977	CYBER_CLOUD_SHIELD-AS CYBER CLOUD SHIELD BROADBAND SERVICES PRIVATE LIMITED,IN	33
8218	NEO-ASN Neo Telecoms S.A.S.,FR	33
58543	CHINATELECOM-GUANGDONG-IDC Guangdong,CN	32
25180	EXPONENTIAL-E-AS Exponential-e Ltd,GB	32
4832	INTERNUXNET-AS-ID PT. iNterNUX,ID	32
5402	-Reserved AS-,ZZ	31
45916	GTPL-AS-AP Gujarat Telelik Pvt Ltd,IN	31
29465	VCG-AS MTN NIGERIA Communication limited,NG	31
603	BACOM2-AS - Bell Canada,CA	30
133612	VODAFONE-AS-AP Vodafone Australia Pty Ltd,AU	29
5071	WESTEL-1 - WesTel Telecommunications,CA	28
39891	ALJAWWALSTC-AS Saudi Telecom Company JSC,SA	27
9269	HKBN-AS-AP Hong Kong Broadband Network Ltd.,HK	26
131160	WI2 Wire and Wireless Co.,Ltd.,JP	26
5713	SAIX-NET,ZA	25
6461	ABOVENET - Abovenet Communications, Inc,US	23
10316	CODERO-AS - Codero,US	22
133118	UNICOM-CN China Unicom IP network,CN	22
4565	MEGAPATH2-US - MegaPath Networks Inc.,US	21
766	REDIRIS Entidad Publica Empresarial Red.es,ES	21
25490	STC-AS PJSC Rostelecom,RU	21
3741	IS,ZA	20

ASN	Provider	Count
15003	NOBIS-TECH - Nobis Technology Group, LLC,US	20
28171	S. O. do Brasil Telecomunica	20
10010	TOKAI TOKAI Communications Corporation,JP	20
22724	PUNTONET S.A.,EC	19
7672	FITWEB Hokuden Information System Service Co.,Ltd.,JP	18
12400	PARTNER-AS Partner Communications Ltd.,IL	18
4657	STARHUBINTERNET-AS StarHub Internet Exchange,SG	18
9498	BBIL-AP BHARTI Airtel Ltd.,IN	17
42010	ITPS ITPS Ltd,GB	17
17923	CHINATELECOM-NMG-AS-AP asn for Neimenggu Provincial Net of CT,CN	15
12455	JAMBONET,KE	15
45044	SPIDER-UA-AS FOP Kichuk Ivan Ivanovich,UA	15
26496	AS-26496-GO-DADDY-COM-LLC - GoDaddy.com, LLC,US	14
5466	EIRCOM Eircom Limited,IE	14
44512	RUNAG-AS AS Number Raising Unified Network AG S.p.a.,IT	14
16345	BEE-AS Public Joint Stock Company _Vimpel-Communications_,RU	13
58762	CANDOR-AS-IN Candor infosolution Pvt Ltd,IN	13
22093	CCF-NETWORK - Cleveland Clinic Foundation,US	13
36049	RISE-TX-AS36049 - JAB Wireless, INC.,US	13
24389	GRAMEENPHONE-AS-AP GrameenPhone Ltd.,BD	12
6306	TELEFONICA VENEZOLANA, C.A.,VE	12
34984	TELLCOM-AS TELLCOM ILETISIM HIZMETLERI A.S.,TR	12
50266	WIERICKE Vodafone Libertel B.V.,NL	12
41733	ZTELECOM-AS Perspectiva Ltd.,RU	12
36352	AS-COLOCROSSING - ColoCrossing,US	11
37457	Telkom-Internet,ZA	11
38077	TIMOR-TELECOM-AS-AP Timor Telecom, SA,TL	11
23969	TOT-NET TOT Public Company Limited,TH	11
36375	UMICH-AS-5 - University of Michigan,US	11
41202	UNITEL UNITEL LLC,UZ	11
4193	WA-STATE-GOV - Department of Information Services,US	10
174	COGENT-174 - Cogent Communications,US	9
41572	HAFSLUND Kvantel AS,NO	9
2510	INFOWEB FUJITSU LIMITED,JP	9
29863	LATISYS-DENVER - Latisys-Denver, LLC,US	9
37340	Spectranet,NG	9
10429	Telefonica Data S.A.,BR	9
8881	VERSATEL Versatel Deutschland GmbH,DE	9
34170	AZTELEKOM Azerbaijan Telecomunication ISP,AZ	8
35958	CCN42 - MCCARRAN INTERNATIONAL AIRPORT,US	8
15428	DAGNET-AS Regional Public Organization, _Dagestan computers networks Dagnet_,RU	8
16086	DNA DNA Oy,FI	8
24554	FIVE-NET-AS-IN Fivenetwork Solution India Pvt Ltd Internet,IN	8
2847	LITNET Kaunas University of Technology,LT	8
29226	MASTERTEL-AS CJSC Mastertel,RU	8
131222	MTS-INDIA-IN 334,Udyog Vihar,IN	8
58542	CHINATELECOM-HUNAN-YUEYANG-MAN Yueyang,CN	7
13802	LOGIC-BERMUDA-NORTHROCK - North Rock Communications Ltd.,BM	7
8636	MAXNET MAXnet Systems Ltd.,RU	7
12389	ROSTELECOM-AS PJSC Rostelecom,RU	7
36522	BELLMOBILITY-1 - BELL MOBILITY INC.,CA	6
4538	ERX-CERNET-BKB China Education and Research Network Center,CN	6
25780	HUGESERVER-NETWORKS - HugeServer Networks, LLC,US	6
28618	LINKTEL TELECOMUNICACOES DO BRASIL LTDA,BR	6

ASN	Provider	Count
31200	NTK Novotelecom Ltd,RU	6
4771	SPARKNZ Spark New Zealand Trading Ltd.,NZ	6
131090	CAT-IDC-4BYTENET-AS-AP CAT TELECOM Public Company Ltd,CAT,TH	5
46093	PALM-BEACH-COUNTY-FLORIDA - Palm Beach County,US	5
131215	SANCHARONLINE-IN 116 MADHAV DARSHAN,IN	5
37122	SMILE-UG,UG	5
50825	UVT UVT s.r.o.,CZ	5
13448	WEBSENSE - Websense, Inc,US	5
8228	CEGETEL-AS Societe Francaise du Radiotelephone S.A,FR	4
24921	LMT-3G Latvian Mobile Telephone Co.,LV	4
49335	NCONNECT-AS Mir Telematiki Ltd.,RU	4
2549	Universidad de Guadalajara,MX	4
198605	AVAST-AS-DC AVAST Software s.r.o.,CZ	3
13188	BANKINFORM-AS CONTENT DELIVERY NETWORK LTD,UA	3
37475	HTT,CM	3
13927	KANOKLA-NETWORKS - KanOkla Communications, LLC,US	3
31163	MF-KAVKAZ-AS PJSC MegaFon,RU	3
262717	Net Artur Ind. Com. Caixas hermeticas Ltda - me,BR	3
10481	Prima S.A.,AR	3
24499	TPP-AS-PK Telenor Pakistan,PK	3
59257	CMPAKLIMITED-AS-AP CMPak Limited,PK	2
16519	CUDENVER - University of Colorado Denver,US	2
9674	FET-TW Far EastTone Telecommunication Co., Ltd.,TW	2
35539	INFOLINK-T-AS Information and Communication Technologies LLC,RU	2
29256	INT-PDN-STE-AS Syrian Telecom,SY	2
8075	MICROSOFT-CORP-MSN-AS-BLOCK - Microsoft Corporation,US	2
8708	RCS-RDS RCS & RDS SA,RO	2
9737	TOTNET-TH-AS-AP TOT Public Company Limited,TH	2
38466	UMOBILE-AS-AP U Mobile Sdn Bhd,MY	2
16509	AMAZON-02 - Amazon.com, Inc.,US	1
32604	COSCO-NJ-NA - China Ocean Shipping Company North America, Inc.,US	1
39927	ELIGHT-AS E-Light-Telecom,RU	1
37903	EMOBILE Ymobile Corporation,JP	1
57588	HAYAT-ISP-ASN Hayat for Internet & communication LLC,IQ	1
21246	IPKO-AS Ipko Telecommunications LLC,AL	1
23889	MauritiusTelecom,MU	1
43341	MDLINK MDlink online service center GmbH,DE	1
37009	MTCASN,NA	1
8422	NETCOLOGNE NetCologne GmbH,DE	1
56089	OFFRATEL-AS-AP OFFRATEL,NC	1
29190	OVERTA-AS MTS PJSC,RU	1
134121	RAINBOW-HK Rainbow network limited,HK	1
45763	SELEMENTS-AU-SYD Service Elements,AU	1
6730	SUNRISE Sunrise Communications AG,CH	1
133731	TOINTER-AS-AP Royal Network Technology Co., Ltd. in Guangzhou,CN	1

User agents by country

	Country	Count		Country	Count		Country	Count
1	United States	4,911,101	38	Mexico	54,488	76	Bahamas	3,017
2	Canada	1,921,828	39	Belarus	48,893	77	Singapore	2,749
3	Poland	1,073,171	40	Vietnam	39,005	78	Morocco	2,553
4	India	880,937	41	Portugal	38,981	79	Kazakhstan	2,438
5	United Kingdom	870,348	42	Pakistan	38,864	80	Greece	2,112
6	France	849,527	43	Belgium	33,246	81	Egypt	2,087
7	Russia	488,919	44	Faroe Islands	32,410	82	South Africa	2,065
8	Australia	408,489	45	Nigeria	30,926	83	Sweden	1,988
9	Hungary	400,639	46	Serbia	27,402	84	Honduras	1,862
10	Brazil	394,003	47	Romania	24,257	85	Panama	1,821
11	China	391,544	48	Thailand	23,024	86	Barbados	1,784
12	Czech Republic	384,321	49	Iran	22,613	87	Bosnia and Herzegovina	1,646
13	Germany	371,983	50	Moldova	21,928	88	Dominican Republic	1,574
14	Argentina	369,028	51	Oman	20,117	89	Myanmar	1,300
15	Netherlands	361,808	52	Ecuador	16,961	90	Bahrain	951
16	United Arab Emirates	357,236	53	Jamaica	16,886	91	Madagascar	860
17	Japan	354,680	54	Slovenia	14,650	92	Ethiopia	825
18	Chile	278,429	55	Philippines	14,635	93	Bulgaria	703
19	Tunisia	257,148	56	Taiwan	14,169	94	Armenia	500
20	Ukraine	256,977	57	Malaysia	13,549	95	Palestinian Territory	293
21	South Korea	246,304	58	Indonesia	12,802	96	Curacao	193
22	Switzerland	222,619	59	Qatar	11,091	97	Yemen	180
23	Spain	201,135	60	Cameroon	11,085	98	Kenya	145
24	Austria	142,907	61	Saudi Arabia	8,887	99	Uganda	144
25	Venezuela	139,270	62	Burkina Faso	6,805	100	Kuwait	96
26	Turkey	122,368	63	Nepal	6,548	101	Algeria	35
27	Colombia	122,120	64	Peru	5,867	102	Uzbekistan	11
28	Estonia	116,572	65	Zambia	5,787	103	Timor-Leste	11
29	Lithuania	107,425	66	Hong Kong	5,128	104	Azerbaijan	8
30	Latvia	102,291	67	Lebanon	5,107	105	Bermuda	7
31	Bangladesh	99,450	68	Norway	4,870	103	New Zealand	6
32	Italy	98,410	69	Puerto Rico	4,657	107	Syrian Arab Republic	2
33	Denmark	87,585	70	Nicaragua	4,121	108	Iraq	1
34	Costa Rica	83,275	71	Uruguay	4,063	109	Albania	1
35	Israel	76,098	72	US Virgin Islands	4,034	110	Mauritius	1
36	Bolivia	63,011	73	Namibia	3,494	111	New Caledonia	1
37	Finland	54,884	74	Croatia	3,361			

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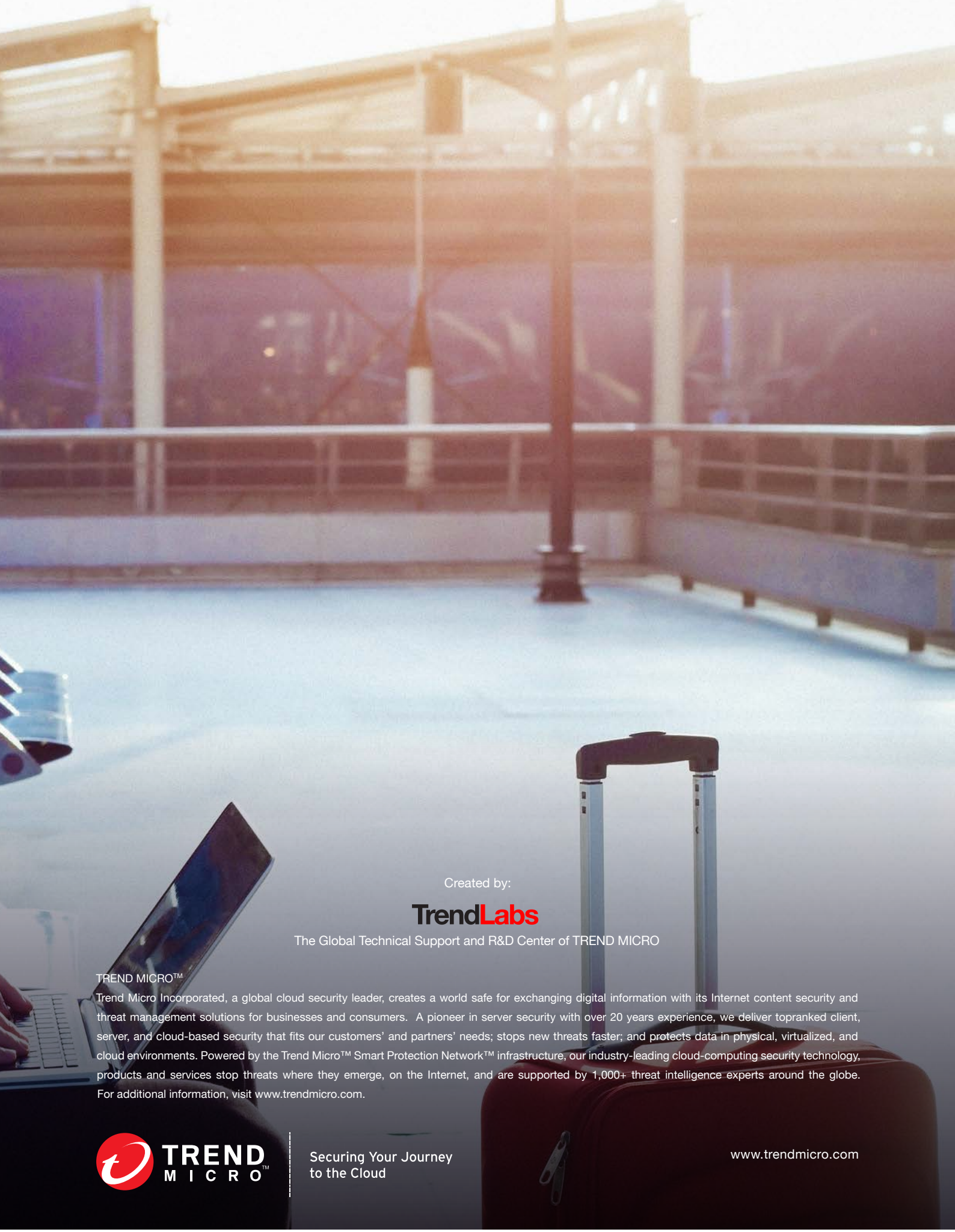

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