US 20090044266A1

(19) **United States**

(12) **Patent Application Publication**

Sharp et al.

(10) **Pub. No.: US 2009/0044266 A1**

(43) **Pub. Date: Feb. 12, 2009**

(54) **SYSTEM AND METHOD FOR PROVIDING TRANSACTIONAL SECURITY FOR AN END-USER DEVICE**

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(21) Appl. No.: **12/111,777**

(22) Filed: **Apr. 29, 2008**

Related U.S. Application Data

(63) Continuation of application No. 11/694,476, filed on Mar. 30, 2007.

(60) Provisional application No. 60/787,457, filed on Mar. 30, 2006, provisional application No. 60/814,828, filed on Jun. 19, 2006.

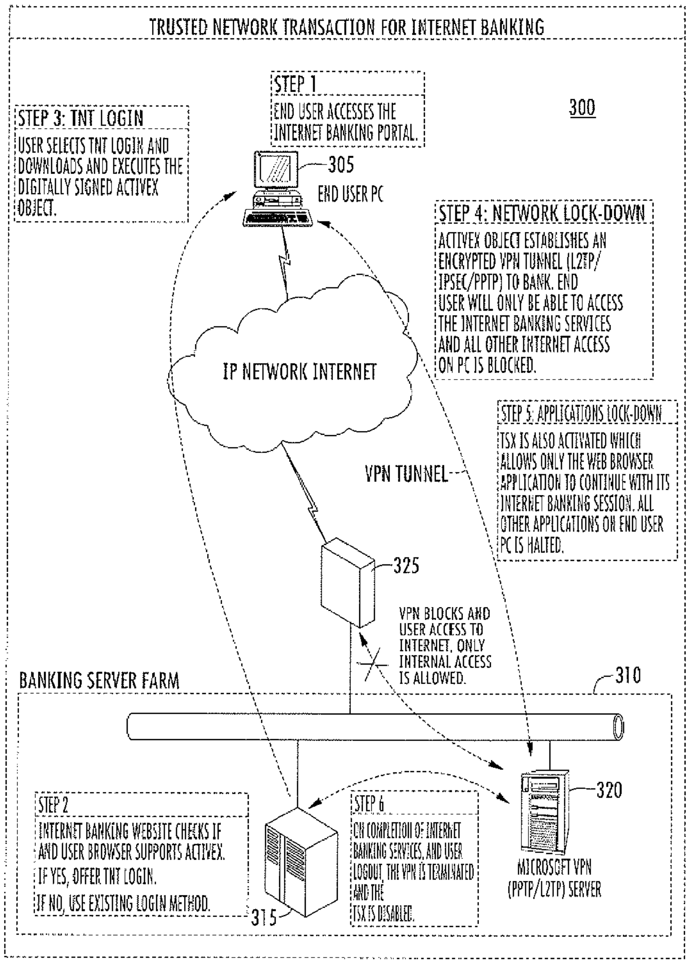
Publication Classification

(51) **Int. Cl.**
H04L 9/00 (2006.01)

(52) **U.S. Cl.** **726/14**; 705/64

(57) **ABSTRACT**

A network system comprises a transaction network operative to provide a transaction with an end user; a trusted source of a security mechanism (e.g., a start/stop trigger module, an application lockout module, a network/file I/O control module, a trusted driver manager, a keystrokes generator driver, a keystrokes deletion hook, and/or a transaction network VPN manager) for at least partially protecting an end-user device from malicious code operative thereon that attempts to capture confidential data presented during the transaction, the security mechanism being maintained by a party other than the end user; and an agent for providing the security mechanism to the end-user device to protect the end-user device during the transaction


TRUSTED NETWORK TRANSACTION FOR INTERNET BANKING
STEP 1
END USER ACCESSES THE INTERNET BANKING PORTAL.
300
STEP 3: TNT LOGIN
USER SELECTS TNT LOGIN AND DOWNLOADS AND EXECUTES THE DIGITALLY SIGNED ACTIVEX OBJECT.
305
END USER PC
STEP 4: NETWORK LOCK-DOWN
ACTIVEX OBJECT ESTABLISHES AN ENCRYPTED VPN TUNNEL (L2TP/IPSEC/PPTP) TO BANK. END USER WILL ONLY BE ABLE TO ACCESS THE INTERNET BANKING SERVICES AND ALL OTHER INTERNET ACCESS ON PC IS BLOCKED.
IP NETWORK INTERNET
STEP 5: APPLICATIONS LOCK-DOWN
TSX IS ALSO ACTIVATED WHICH ALLOWS ONLY THE WEB BROWSER APPLICATION TO CONTINUE WITH ITS INTERNET BANKING SESSION. ALL OTHER APPLICATIONS ON END USER PC IS HALTED.
VPN TUNNEL
325
VPN BLOCKS AND USER ACCESS TO INTERNET, ONLY INTERNAL ACCESS IS ALLOWED.
BANKING SERVER FARM
310
320
STEP 2
INTERNET BANKING WEBSITE CHECKS IF AND USER BROWSER SUPPORTS ACTIVEX.
IF YES, OFFER TNT LOGIN.
IF NO, USE EXISTING LOGIN METHOD.
315
STEP 6
ON COMPLETION OF INTERNET BANKING SERVICES, AND USER LOGOUT, THE VPN IS TERMINATED AND THE TSX IS DISABLED.
MICROSOFT VPN (PPTP/L2TP) SERVER

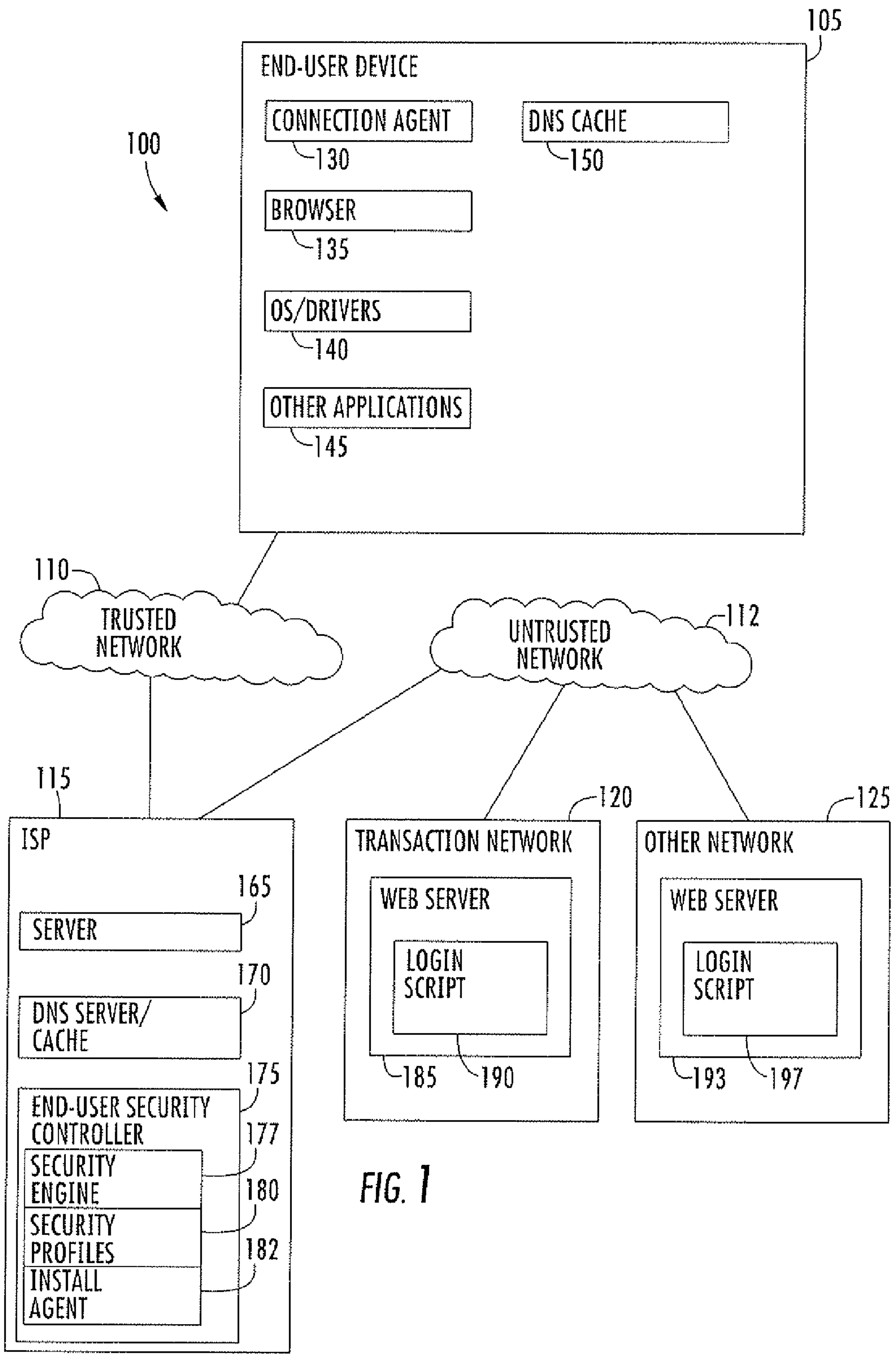

105
END-USER DEVICE
CONNECTION AGENT
130
DNS CACHE
150
100
BROWSER
135
OS/DRIVERS
140
OTHER APPLICATIONS
145
110
TRUSTED NETWORK
UNTRUSTED NETWORK
112
115
ISP
120
TRANSACTION NETWORK
125
OTHER NETWORK
165
SERVER
170
DNS SERVER/ CACHE
175
END-USER SECURITY CONTROLLER
177
SECURITY ENGINE
180
SECURITY PROFILES
182
INSTALL AGENT
WEB SERVER
LOGIN SCRIPT
185
190
WEB SERVER
LOGIN SCRIPT
193
197

FIG. 1

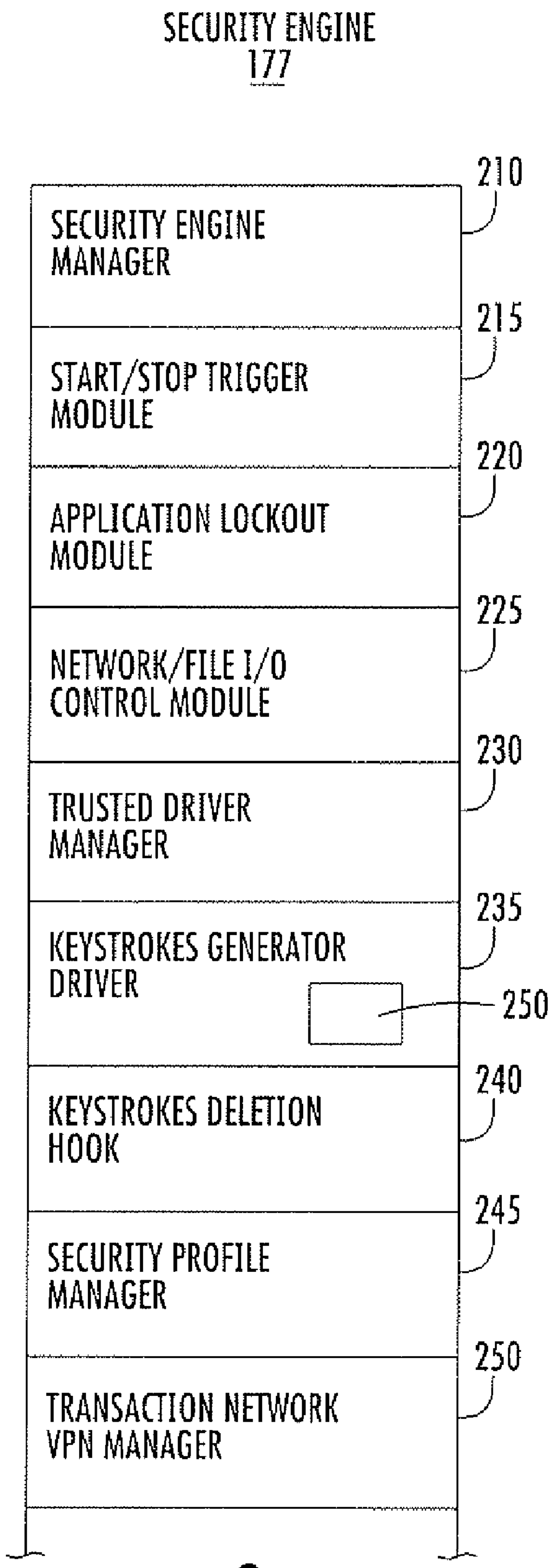
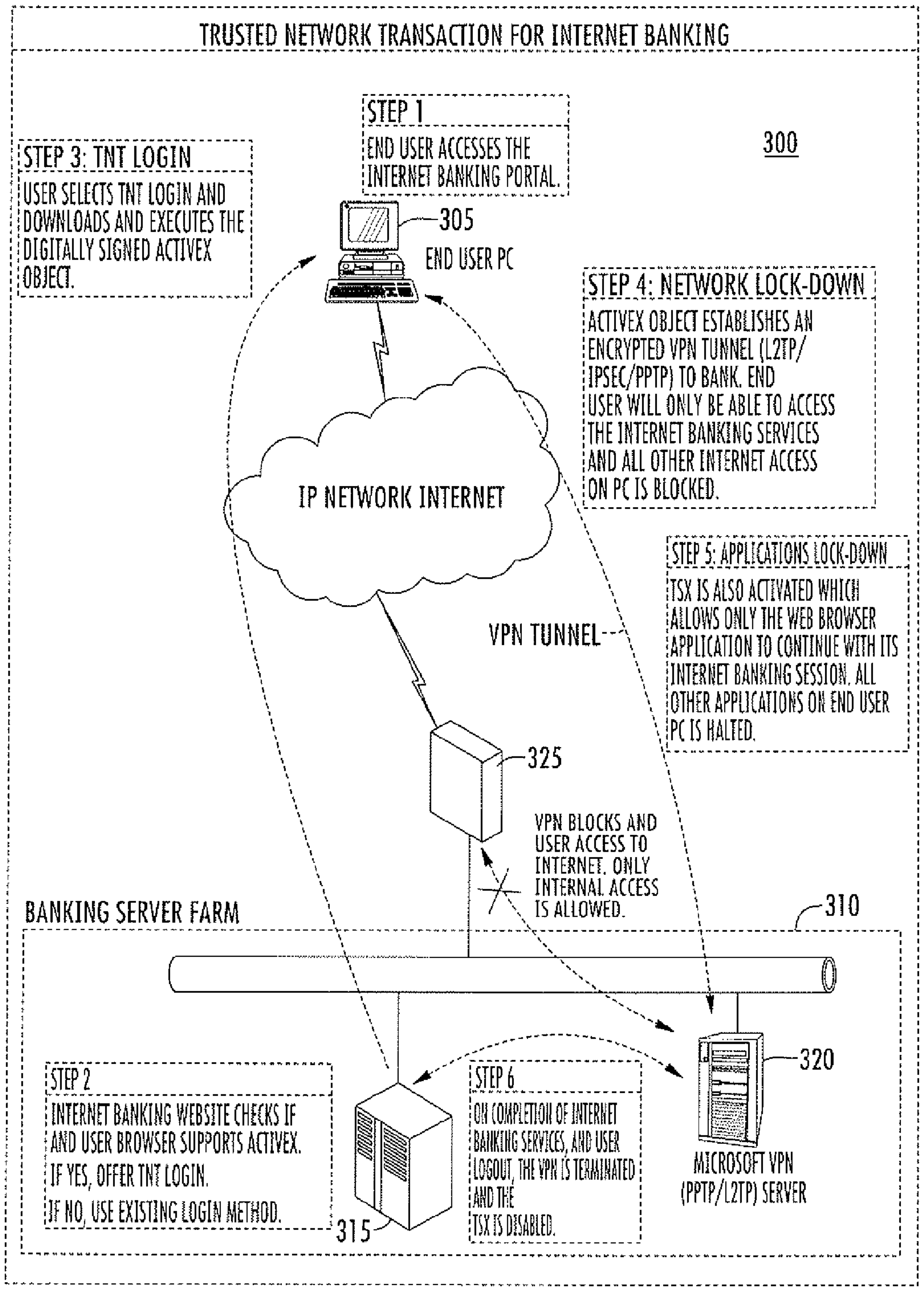

SECURITY ENGINE
177
SECURITY ENGINE MANAGER
210
START/STOP TRIGGER MODULE
215
APPLICATION LOCKOUT MODULE
220
NETWORK/FILE I/O CONTROL MODULE
225
TRUSTED DRIVER MANAGER
230
KEYSTROKES GENERATOR DRIVER
235
250
KEYSTROKES DELETION HOOK
240
SECURITY PROFILE MANAGER
245
TRANSACTION NETWORK VPN MANAGER
250

FIG. 2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MICROSOFT VPN (PPTP/L2TP) SERVER
315

FIG. 3

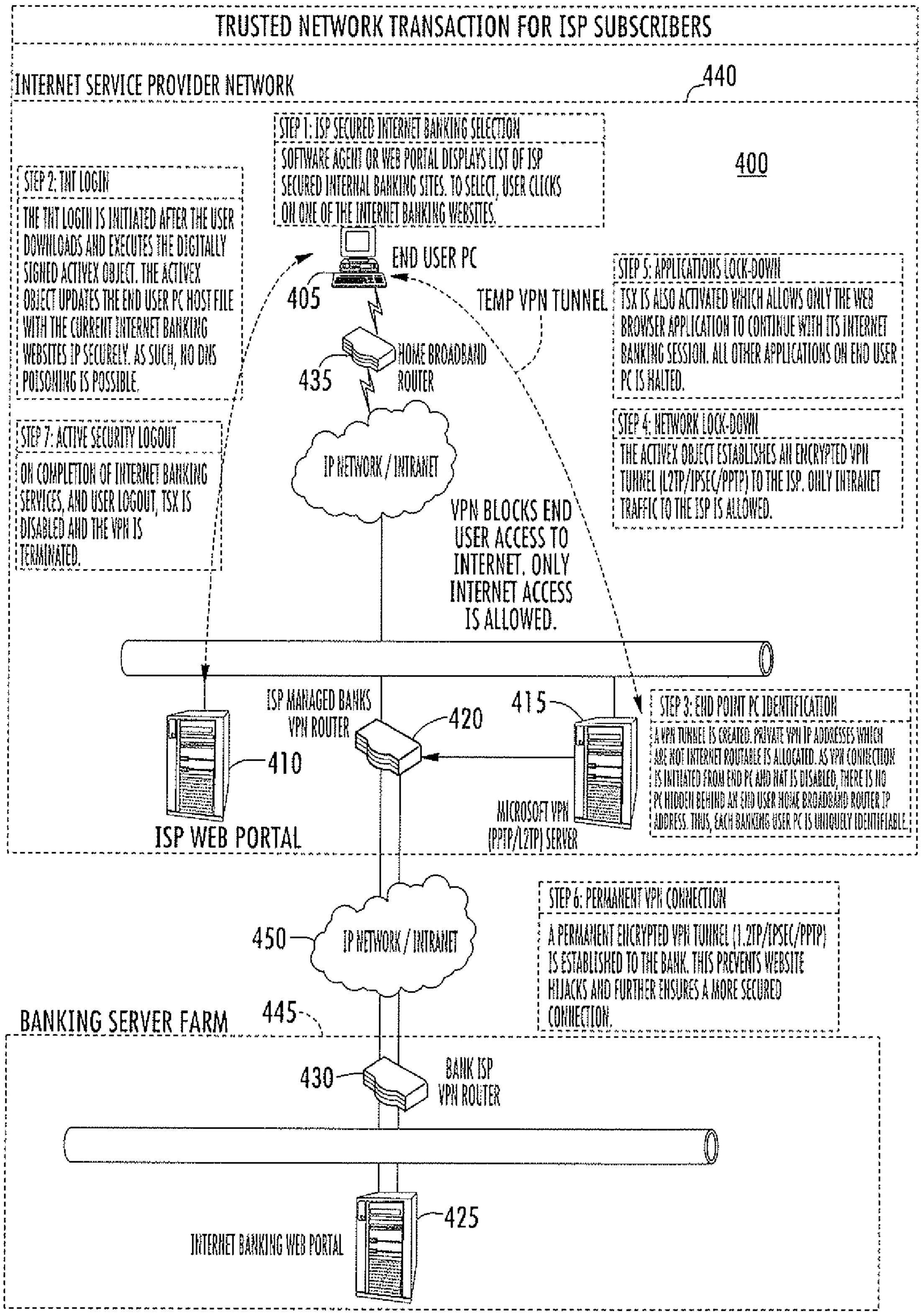

TRUSTED NETWORK TRANSACTION FOR ISP SUBSCRIBERS
INTERNET SERVICE PROVIDER NETWORK
440
400
STEP 1: ISP SECURED INTERNET BANKING SELECTION
SOFTWARE AGENT OR WEB PORTAL DISPLAYS LIST OF ISP SECURED INTERNAL BANKING SITES. TO SELECT, USER CLICKS ON ONE OF THE INTERNET BANKING WEBSITES.
STEP 2: TNT LOGIN
THE TNT LOGIN IS INITIATED AFTER THE USER DOWNLOADS AND EXECUTES THE DIGITALLY SIGNED ACTIVEX OBJECT. THE ACTIVEX OBJECT UPDATES THE END USER PC HOST FILE WITH THE CURRENT INTERNET BANKING WEBSITES IP SECURELY. AS SUCH, NO DNS POISONING IS POSSIBLE.
END USER PC
405
TEMP VPN TUNNEL
STEP 5: APPLICATIONS LOCK-DOWN
TSX IS ALSO ACTIVATED WHICH ALLOWS ONLY THE WEB BROWSER APPLICATION TO CONTINUE WITH ITS INTERNET BANKING SESSION. ALL OTHER APPLICATIONS ON END USER PC IS HALTED.
HOME BROADBAND ROUTER
435
STEP 4: NETWORK LOCK-DOWN
THE ACTIVEX OBJECT ESTABLISHES AN ENCRYPTED VPN TUNNEL (L2TP/IPSEC/PPTP) TO THE ISP. ONLY INTRANET TRAFFIC TO THE ISP IS ALLOWED.
STEP 7: ACTIVE SECURITY LOGOUT
ON COMPLETION OF INTERNET BANKING SERVICES, AND USER LOGOUT, TSX IS DISABLED AND THE VPN IS TERMINATED.
IP NETWORK / INTRANET
VPN BLOCKS END USER ACCESS TO INTERNET. ONLY INTERNET ACCESS IS ALLOWED.
ISP MANAGED BANKS VPN ROUTER
420
415
STEP 3: END POINT PC IDENTIFICATION
A VPN TUNNEL IS CREATED. PRIVATE VPN IP ADDRESSES WHICH ARE NOT INTERNET ROUTABLE IS ALLOCATED. AS VPN CONNECTION IS INITIATED FROM END PC AND NAT IS DISABLED, THERE IS NO PC HIDDEN BEHIND AN END USER HOME BROADBAND ROUTER IP ADDRESS. THUS, EACH BANKING USER PC IS UNIQUELY IDENTIFIABLE.
410
ISP WEB PORTAL
MICROSOFT VPN (PPTP/L2TP) SERVER
STEP 6: PERMANENT VPN CONNECTION
A PERMANENT ENCRYPTED VPN TUNNEL (L2TP/IPSEC/PPTP) IS ESTABLISHED TO THE BANK. THIS PREVENTS WEBSITE HIJACKS AND FURTHER ENSURES A MORE SECURED CONNECTION.
450
IP NETWORK / INTRANET
BANKING SERVER FARM
445
430
BANK ISP VPN ROUTER
425
INTERNET BANKING WEB PORTAL

FIG. 4

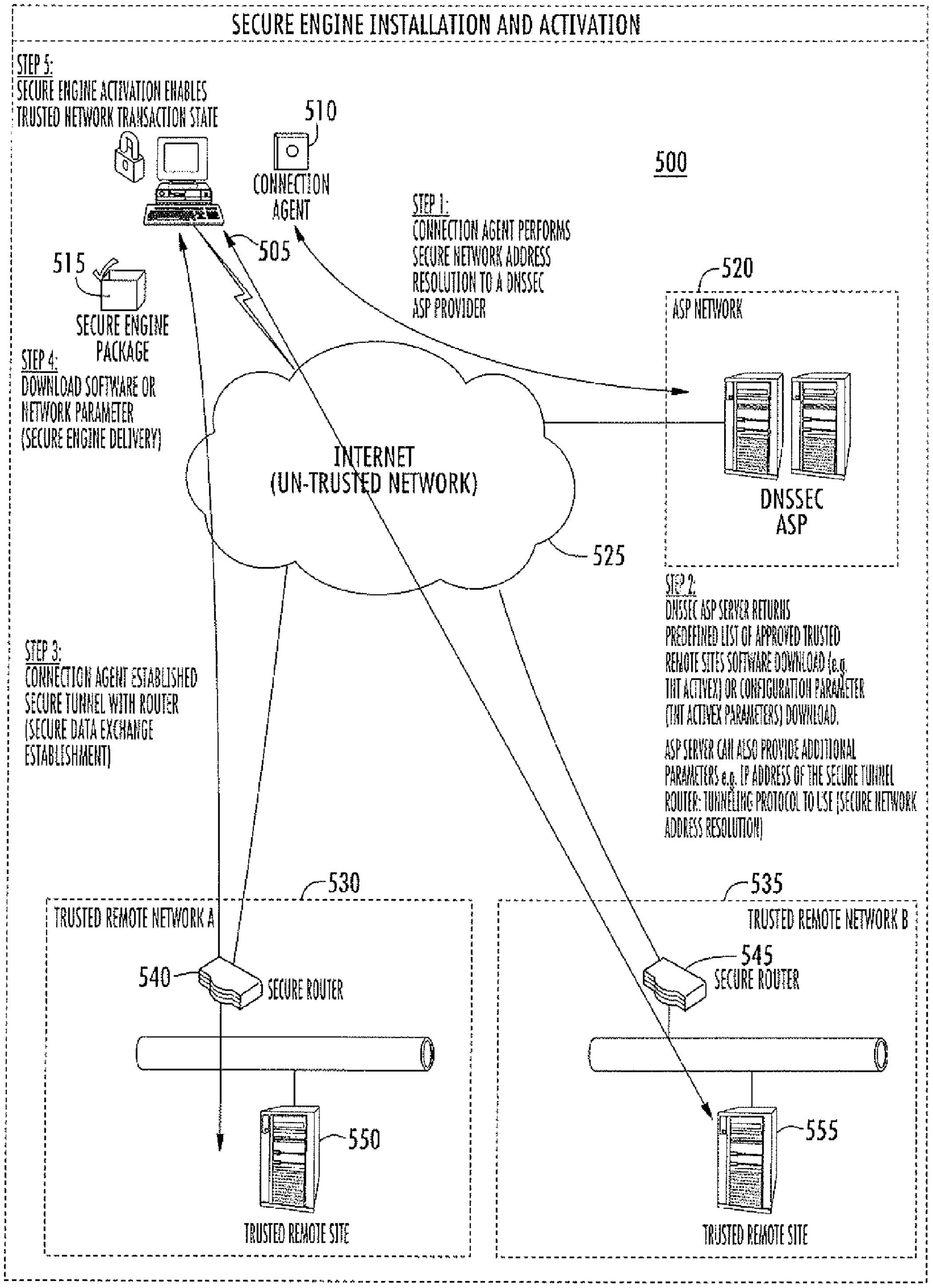
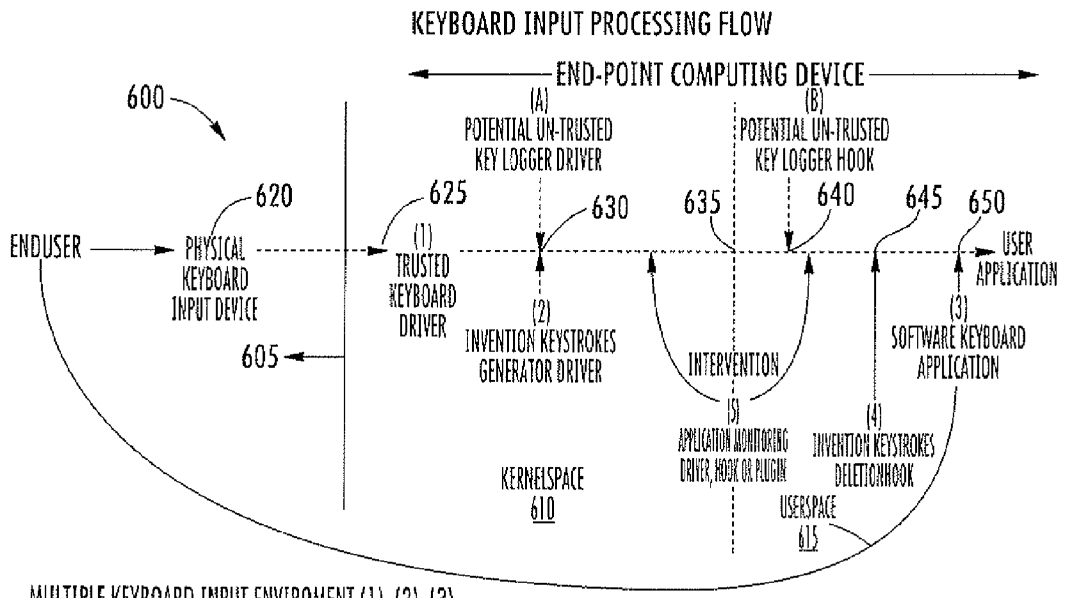

SECURE ENGINE INSTALLATION AND ACTIVATION
STEP 5:
SECURE ENGINE ACTIVATION ENABLES
TRUSTED NETWORK TRANSACTION STATE
510
CONNECTION AGENT
500
STEP 1:
CONNECTION AGENT PERFORMS
SECURE NETWORK ADDRESS
RESOLUTION TO A DNSSEC
ASP PROVIDER
505
515
SECURE ENGINE PACKAGE
520
ASP NETWORK
STEP 4:
DOWNLOAD SOFTWARE OR
NETWORK PARAMETER
(SECURE ENGINE DELIVERY)
INTERNET
(UN-TRUSTED NETWORK)
DNSSEC ASP
525
STEP 2:
DNSSEC ASP SERVER RETURNS
PREDEFINED LIST OF APPROVED TRUSTED
REMOTE SITES SOFTWARE DOWNLOAD (e.g.
TNT ACTIVEX) OR CONFIGURATION PARAMETER
(TNT ACTIVEX PARAMETERS) DOWNLOAD.
ASP SERVER CAN ALSO PROVIDE ADDITIONAL
PARAMETERS e.g. IP ADDRESS OF THE SECURE TUNNEL
ROUTER: TUNNELING PROTOCOL TO USE (SECURE NETWORK
ADDRESS RESOLUTION)
STEP 3:
CONNECTION AGENT ESTABLISHED
SECURE TUNNEL WITH ROUTER
(SECURE DATA EXCHANGE
ESTABLISHMENT)
530
TRUSTED REMOTE NETWORK A
535
TRUSTED REMOTE NETWORK B
540
SECURE ROUTER
545
SECURE ROUTER
550
555
TRUSTED REMOTE SITE
TRUSTED REMOTE SITE

FIG. 5


KEYBOARD INPUT PROCESSING FLOW
END-POINT COMPUTING DEVICE
600
(A)
POTENTIAL UN-TRUSTED KEY LOGGER DRIVER
(B)
POTENTIAL UN-TRUSTED KEY LOGGER HOOK
620
625
630
635
640
645
650
ENDUSER
PHYSICAL KEYBOARD INPUT DEVICE
(1) TRUSTED KEYBOARD DRIVER
USER APPLICATION
(2) INVENTION KEYSTROKES GENERATOR DRIVER
605
INTERVENTION
(5) APPLICATION MONITORING DRIVER, HOOK OR PLUGIN
(4) INVENTION KEYSTROKES DELETIONHOOK
(3) SOFTWARE KEYBOARD APPLICATION
KERNELSPACE 610
USERSPACE 615

-MULTIPLE KEYBOARD INPUT ENVIROMENT (1), (2), (3)

-(A) MAY BE AT THE SAME INPUT PROCESS LEVEL AS (2).
(A) CANNOT BE AT A LOWER INPUT PROCESS LEVEL THAN (2).

-IN THE INVENTION PRODUCER CONSUMER MODEL (4) MUST BE AFTER (B).

-IN THE INVENTION STAND ALONE MODEL (5) CAN BE AT ANY LEVEL (EITHER KERNEL OR USER SPACE) IF THE REQUIRED APPLICATION STATUS INFORMATION CAN BE RETRIEVED. (5) IS INDEPENDENT OF WHERE (A) OR (B) IS INSTALLED.

FIG. 6

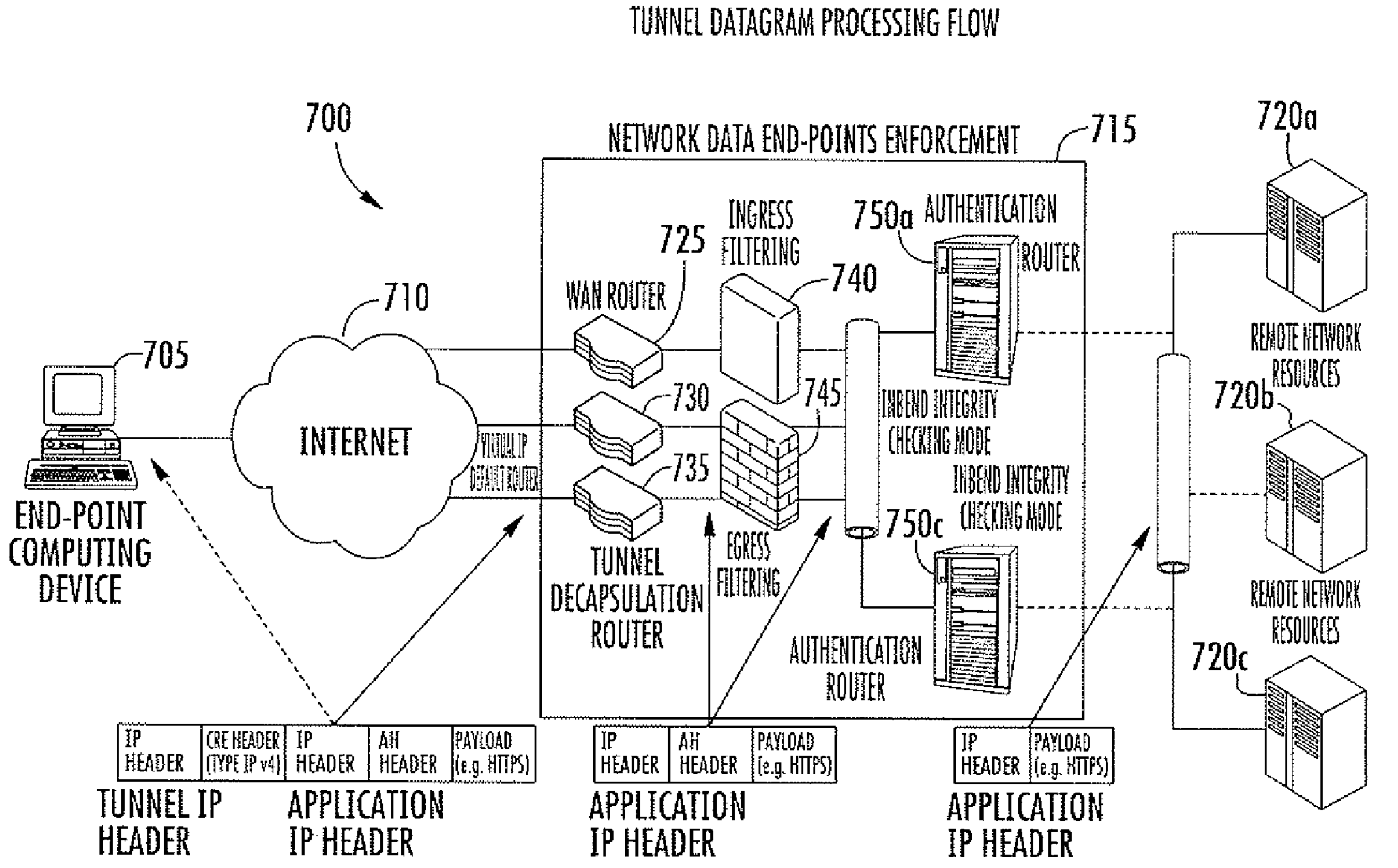

TUNNEL DATAGRAM PROCESSING FLOW
700
NETWORK DATA END-POINTS ENFORCEMENT
715
720a
705
710
INTERNET
END-POINT COMPUTING DEVICE
VIRTUAL IP DEFAULT ROUTER
WAN ROUTER
725
730
735
TUNNEL DECAPSULATION ROUTER
INGRESS FILTERING
740
745
EGRESS FILTERING
750a
AUTHENTICATION ROUTER
INBEND INTEGRITY CHECKING MODE
INBEND INTEGRITY CHECKING MODE
750c
AUTHENTICATION ROUTER
REMOTE NETWORK RESOURCES
720b
REMOTE NETWORK RESOURCES
720c
IP HEADER
GRE HEADER (TYPE IP v4)
IP HEADER
AH HEADER
PAYLOAD (e.g. HTTPS)
TUNNEL IP HEADER
APPLICATION IP HEADER
IP HEADER
AH HEADER
PAYLOAD (e.g. HTTPS)
APPLICATION IP HEADER
IP HEADER
PAYLOAD (e.g. HTTPS)
APPLICATION IP HEADER

FIG. 7

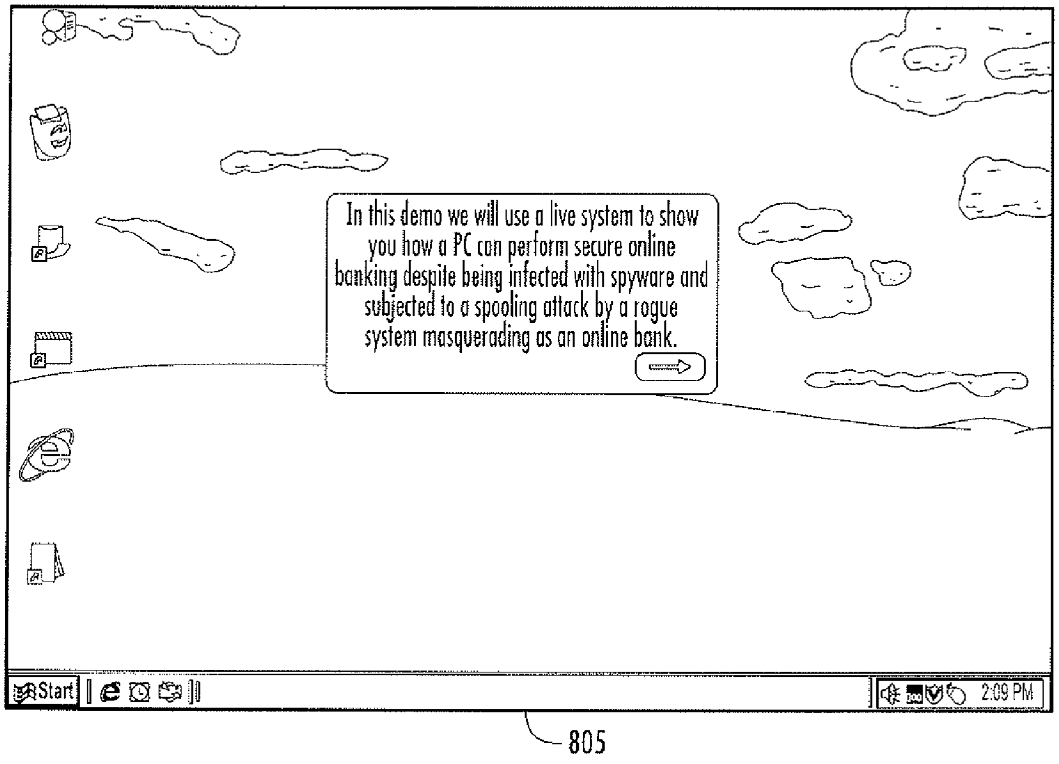

In this demo we will use a live system to show you how a PC can perform secure online banking despite being infected with spyware and subjected to a spooling attack by a rogue system masquerading as an online bank.

FIG. 8

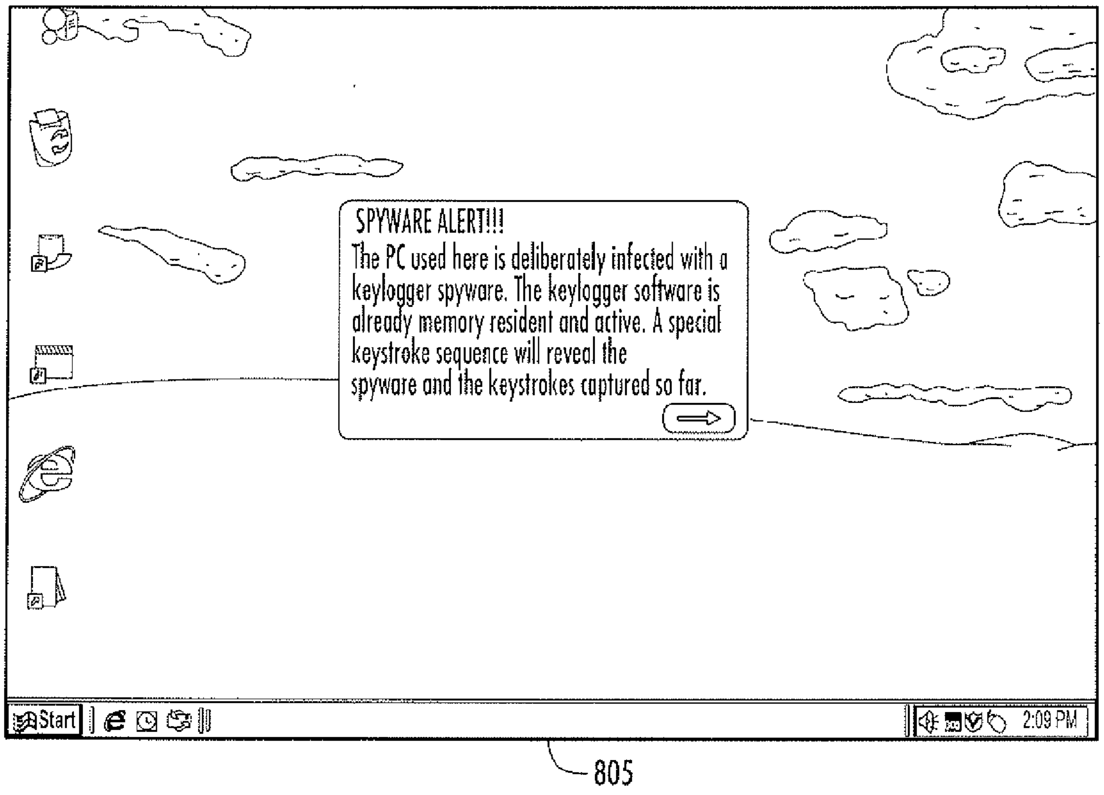
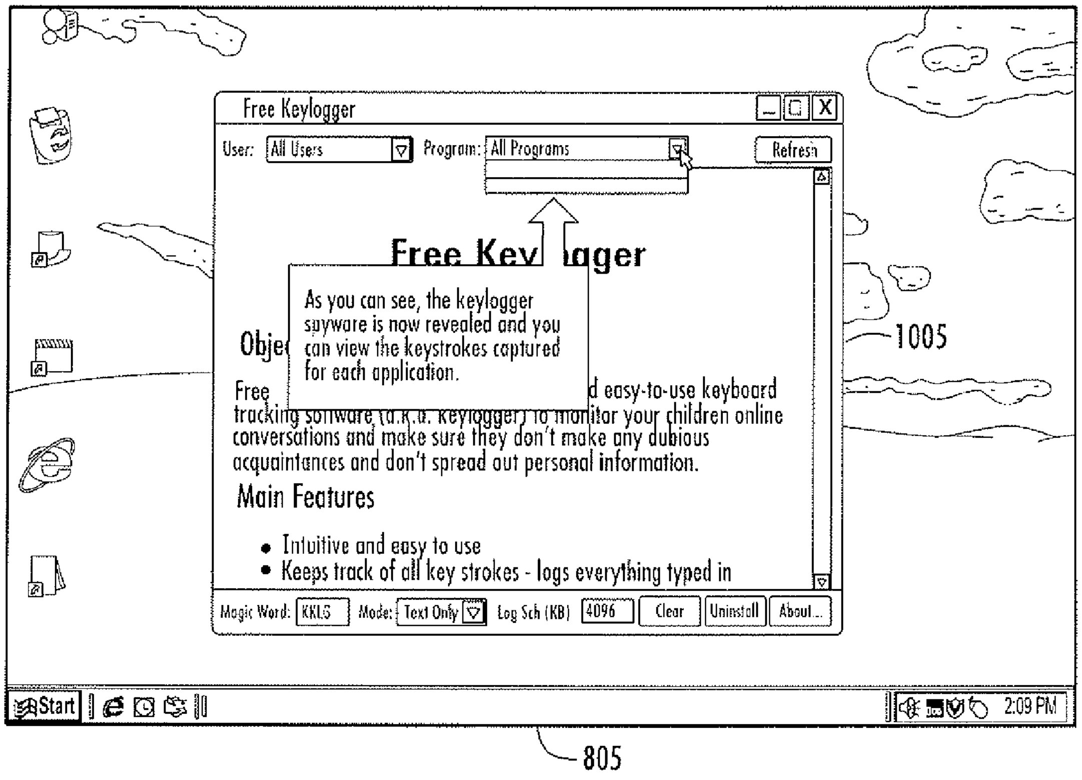

SPYWARE ALERT!!!
The PC used here is deliberately infected with a keylogger spyware. The keylogger software is already memory resident and active. A special keystroke sequence will reveal the spyware and the keystrokes captured so far.

FIG. 9



Free Key ger

As you can see, the keylogger spyware is now revealed and you can view the keystrokes captured for each application.

Obje

Free d easy-to-use keyboard tracking software (a.k.a. keylogger) to monitor your children online conversations and make sure they don't make any dubious acquaintances and don't spread out personal information.

Main Features

- Intuitive and easy to use
- Keeps track of all key strokes - logs everything typed in

FIG. 10

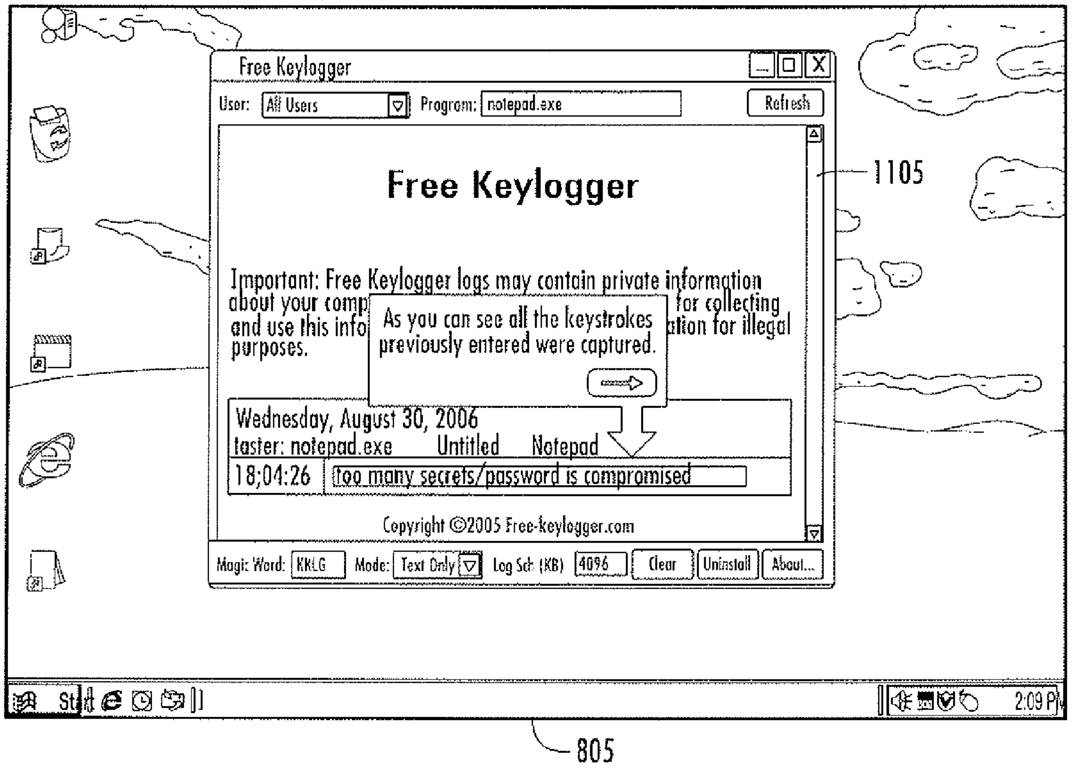

Free Keylogger
User: All Users
Program: notepad.exe
Refresh
Free Keylogger
Important: Free Keylogger logs may contain private information about your comp... for collecting and use this info... ation for illegal purposes.
As you can see all the keystrokes previously entered were captured.
Wednesday, August 30, 2006
taster: notepad.exe Untitled Notepad
18;04:26 too many secrets/password is compromised
Copyright ©2005 Free-keylogger.com
Magic Word: KKLG
Mode: Text Only
Log Sz (KB) 4096
Clear
Uninstall
About...
Start
2:09 P
1105
805

FIG. 11

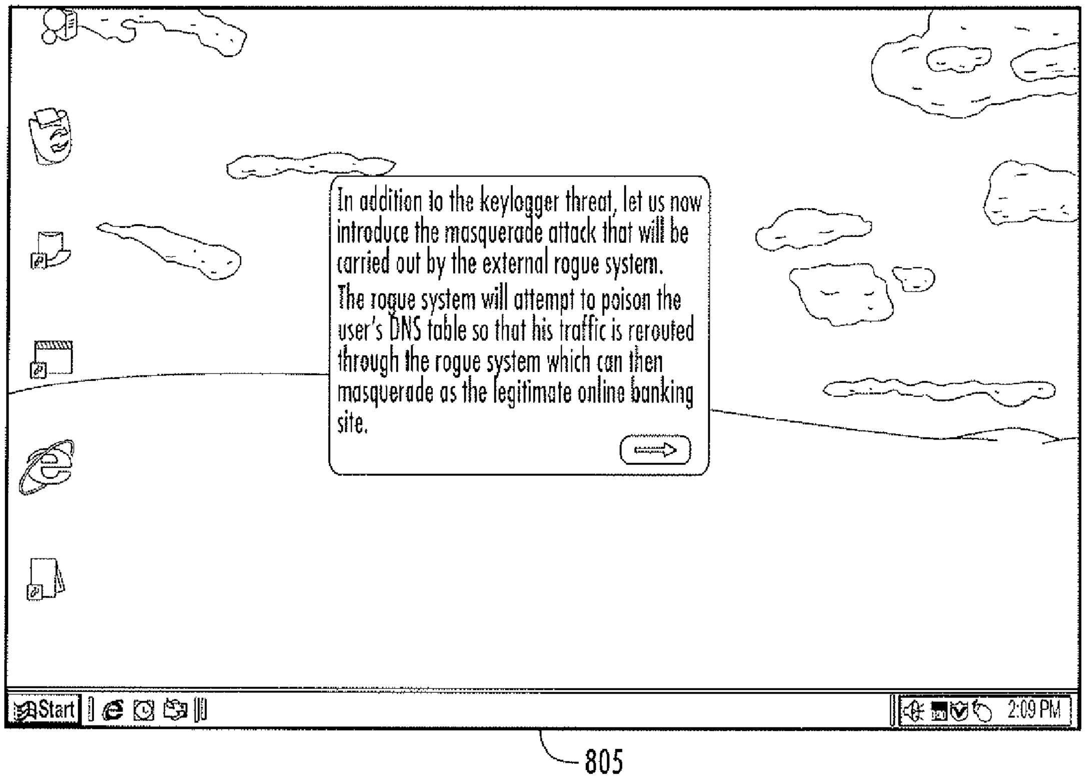
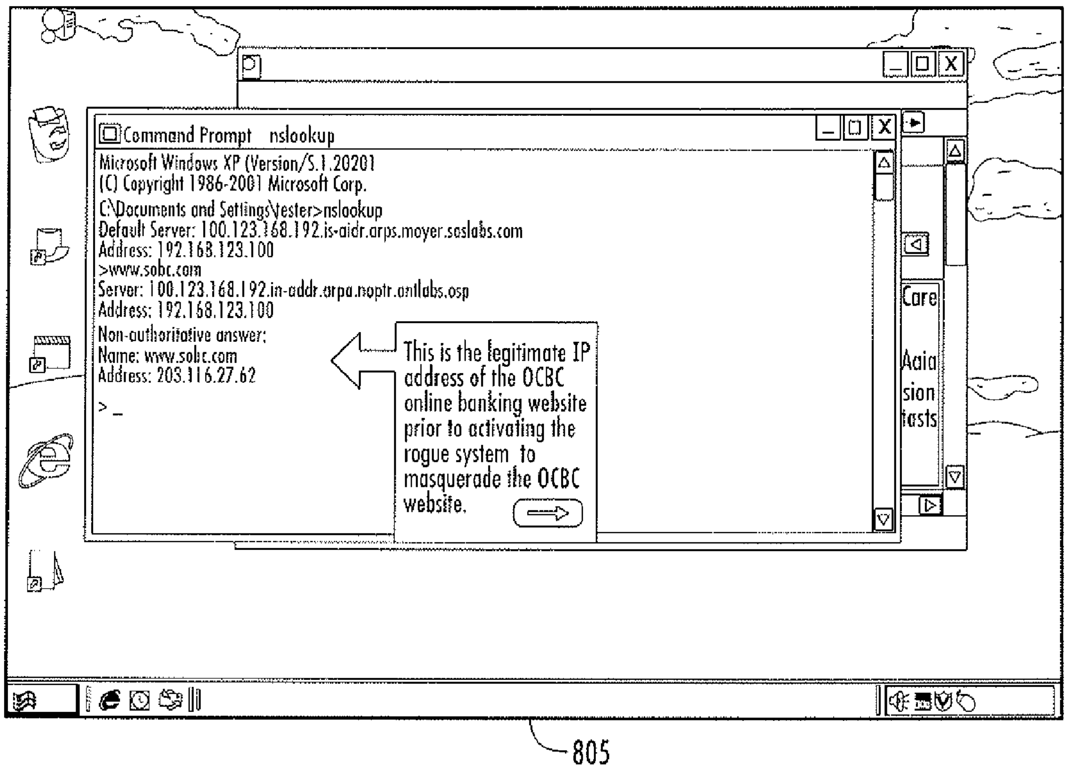

In addition to the keylogger threat, let us now introduce the masquerade attack that will be carried out by the external rogue system.
The rogue system will attempt to poison the user's DNS table so that his traffic is rerouted through the rogue system which can then masquerade as the legitimate online banking site.

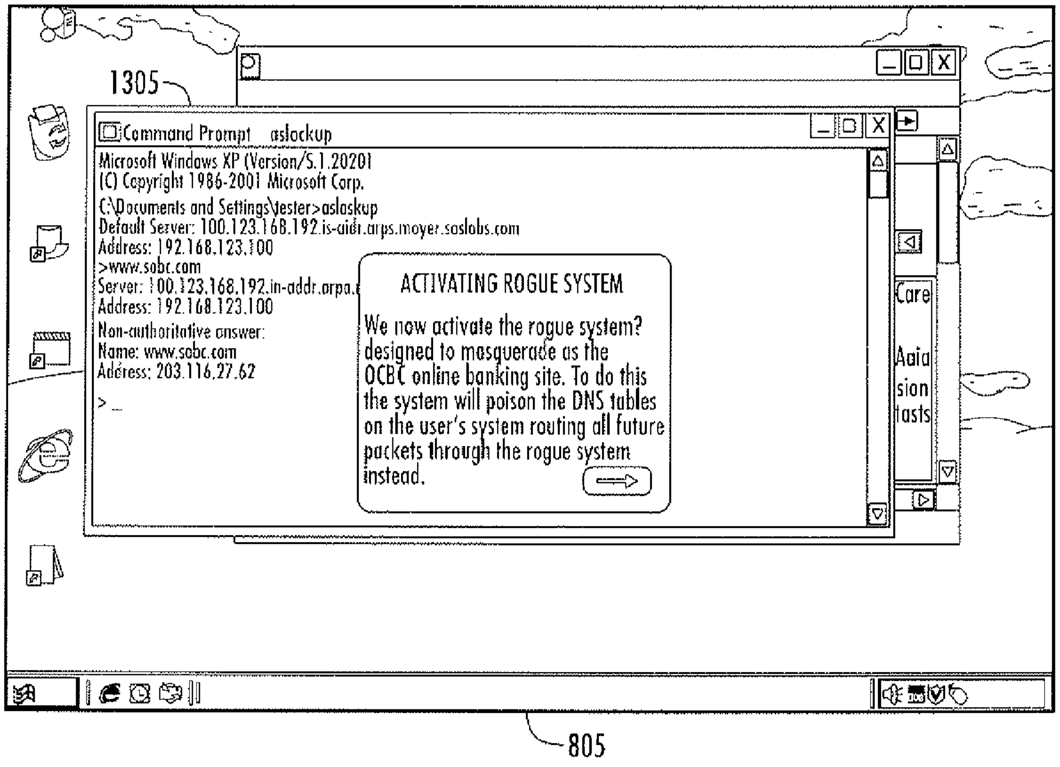
FIG. 12



```
Microsoft Windows XP (Version/S.1.20201
(C) Copyright 1986-2001 Microsoft Corp.
C:\Documents and Settings\tester>nslookup
Default Server: 100.123.168.192.is-aidr.arps.moyer.saslabs.com
Address: 192.168.123.100
>www.sobc.com
Server: 100.123.168.192.in-addr.arpa.noptr.ontlabs.osp
Address: 192.168.123.100
Non-authoritative answer:
Name: www.sobc.com
Address: 203.116.27.62

> _
```

This is the legitimate IP address of the OCBC online banking website prior to activating the rogue system to masquerade the OCBC website.

FIG. 13

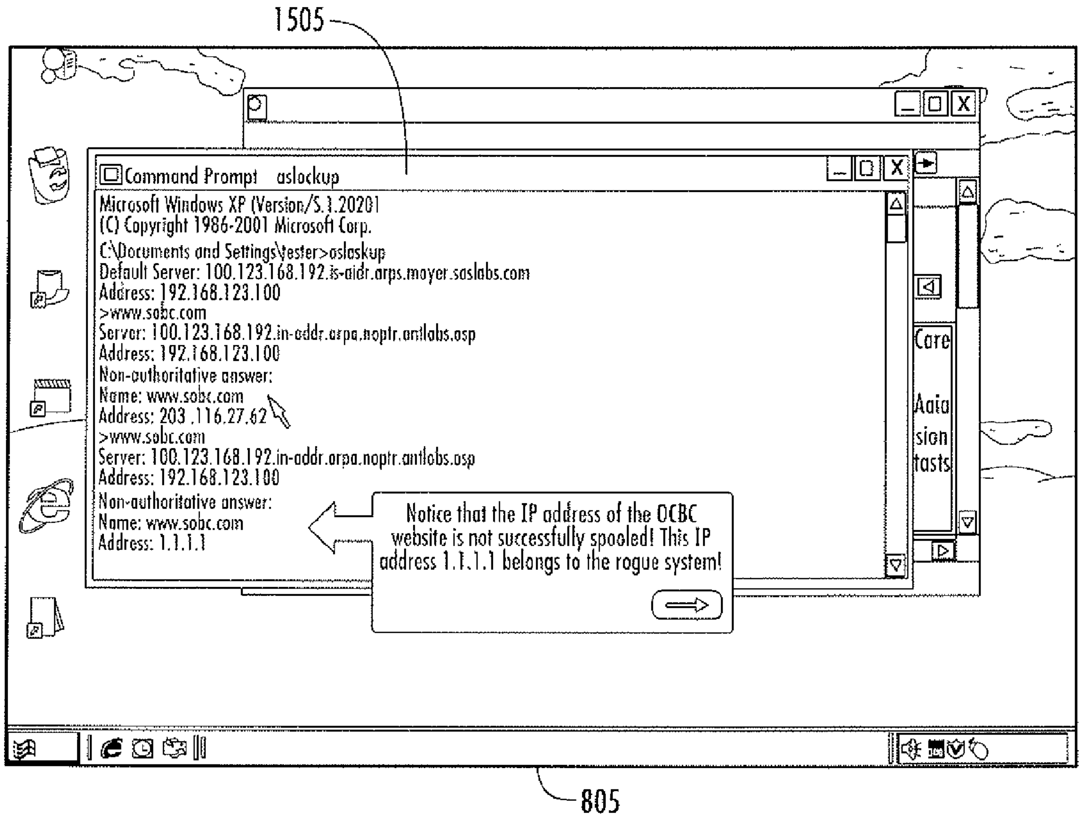


```
Microsoft Windows XP (Version/S.1.20201
(C) Copyright 1986-2001 Microsoft Corp.
C:\Documents and Settings\tester>aslaskup
Default Server: 100.123.168.192.is-aidr.arps.moyer.soslabs.com
Address: 192.168.123.100
>www.sobc.com
Server: 100.123.168.192.in-addr.arpa.
Address: 192.168.123.100
Non-authoritative answer:
Name: www.sobc.com
Address: 203.116.27.62

> _
```

ACTIVATING ROGUE SYSTEM

We now activate the rogue system? designed to masquerade as the OCBC online banking site. To do this the system will poison the DNS tables on the user's system routing all future packets through the rogue system instead.

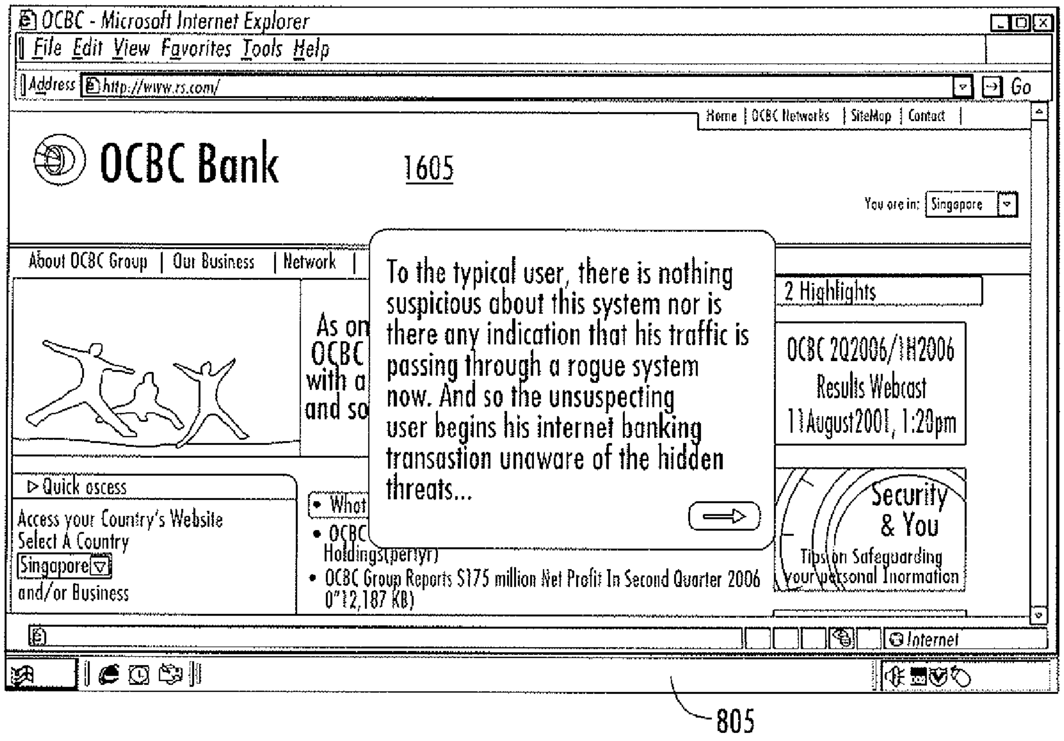
FIG. 14



```
Microsoft Windows XP (Version/S.1.20201
(C) Copyright 1986-2001 Microsoft Corp.
C:\Documents and Settings\tester>aslaskup
Default Server: 100.123.168.192.is-aidr.arps.moyer.saslabs.com
Address: 192.168.123.100
>www.sobc.com
Server: 100.123.168.192.in-addr.arpa.noptr.antlabs.asp
Address: 192.168.123.100
Non-authoritative answer:
Name: www.sobc.com
Address: 203 .116.27.62
>www.sobc.com
Server: 100.123.168.192.in-addr.arpa.noptr.antlabs.asp
Address: 192.168.123.100
Non-authoritative answer:
Name: www.sobc.com
Address: 1.1.1.1
```

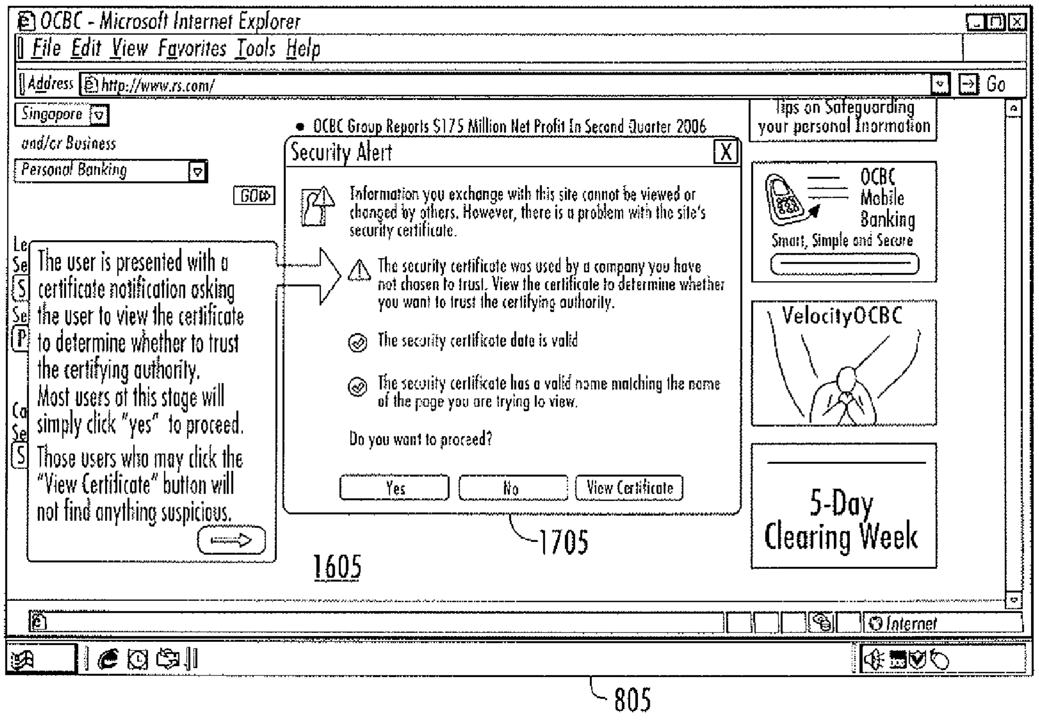
Notice that the IP address of the OCBC website is not successfully spooled! This IP address 1.1.1.1 belongs to the rogue system!

FIG. 15


To the typical user, there is nothing suspicious about this system nor is there any indication that his traffic is passing through a rogue system now. And so the unsuspecting user begins his internet banking transastion unaware of the hidden threats...

OCBC - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.rs.com/ Go
Home | OCBC Networks | SiteMap | Contact |
OCBC Bank
1605
You are in: Singapore
About OCBC Group | Our Business | Network |
2 Highlights
OCBC 2Q2006/1H2006 Results Webcast 11August2001, 1:20pm
Security & You Tips on Safeguarding your personal Inormation
Quick ascess
Access your Country's Website
Select A Country
Singapore
and/or Business
OCBC Group Reports $175 million Net Profit In Second Quarter 2006 0"12,187 KB)
Internet
805

FIG. 16


OCBC - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.rs.com/
Go
Singapore
and/or Business
Personal Banking
GO
OCBC Group Reports $175 Million Net Profit In Second Quarter 2006
Tips on Safeguarding your personal Information
OCBC Mobile Banking
Smart, Simple and Secure
VelocityOCBC
5-Day Clearing Week
Security Alert
Yes
No
View Certificate
Internet
1705
1605
805

Information you exchange with this site cannot be viewed or changed by others. However, there is a problem with the site's security certificate.

The security certificate was used by a company you have not chosen to trust. View the certificate to determine whether you want to trust the certifying authority.

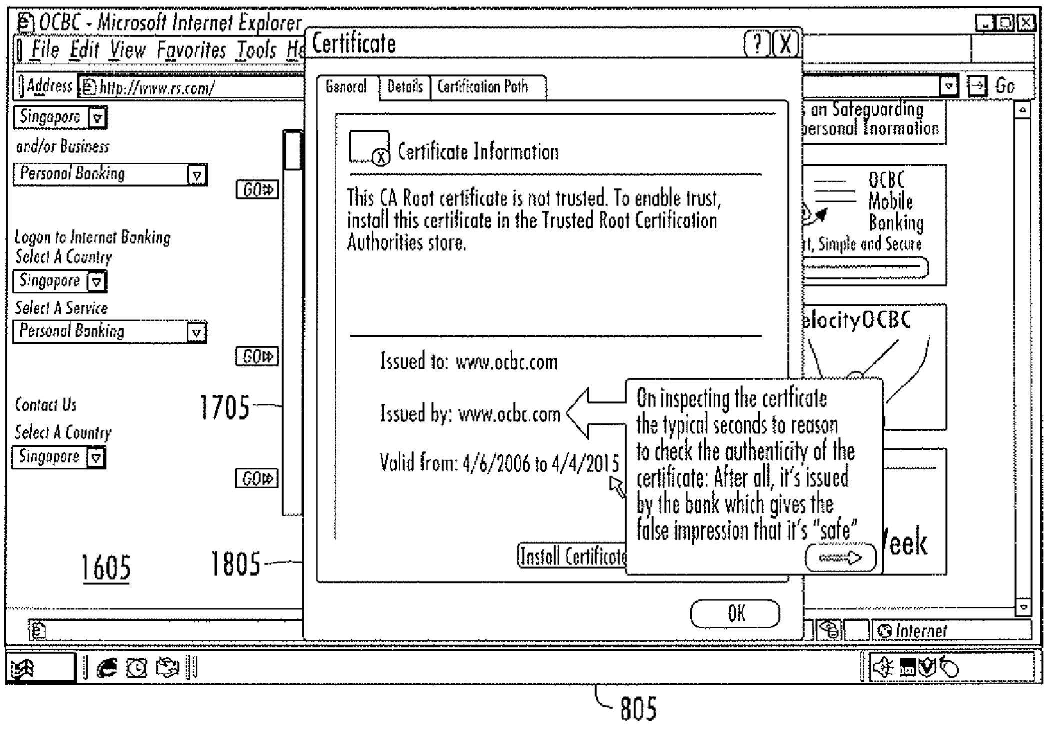
The security certificate date is valid

The security certificate has a valid name matching the name of the page you are trying to view.

Do you want to proceed?

The user is presented with a certificate notification asking the user to view the certificate to determine whether to trust the certifying authority.
Most users at this stage will simply click "yes" to proceed.
Those users who may click the "View Certificate" button will not find anything suspicious.

FIG. 17



This CA Root certificate is not trusted. To enable trust, install this certificate in the Trusted Root Certification Authorities store.

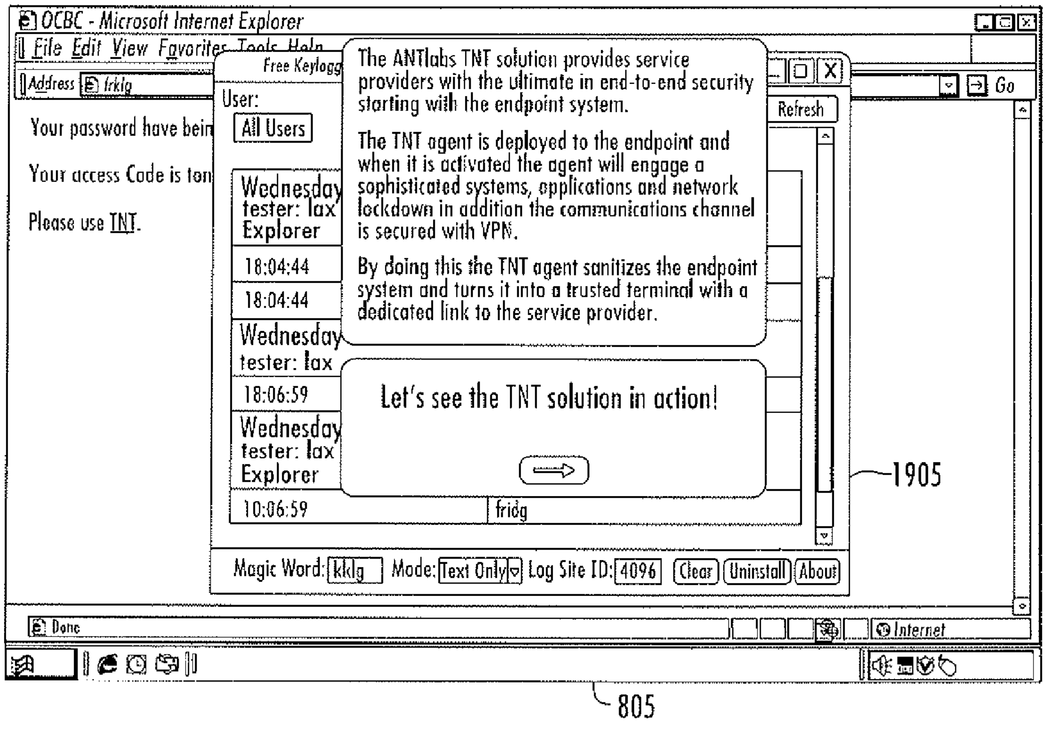
Issued to: www.ocbc.com

Issued by: www.ocbc.com

Valid from: 4/6/2006 to 4/4/2015

On inspecting the certficate the typical seconds to reason to check the authenticity of the certificate: After all, it's issued by the bank which gives the false impression that it's "safe"

FIG. 18


The ANTlabs TNT solution provides service providers with the ultimate in end-to-end security starting with the endpoint system.

The TNT agent is deployed to the endpoint and when it is activated the agent will engage a sophisticated systems, applications and network lockdown in addition the communications channel is secured with VPN.

By doing this the TNT agent sanitizes the endpoint system and turns it into a trusted terminal with a dedicated link to the service provider.

Let's see the TNT solution in action!

Your password have bein

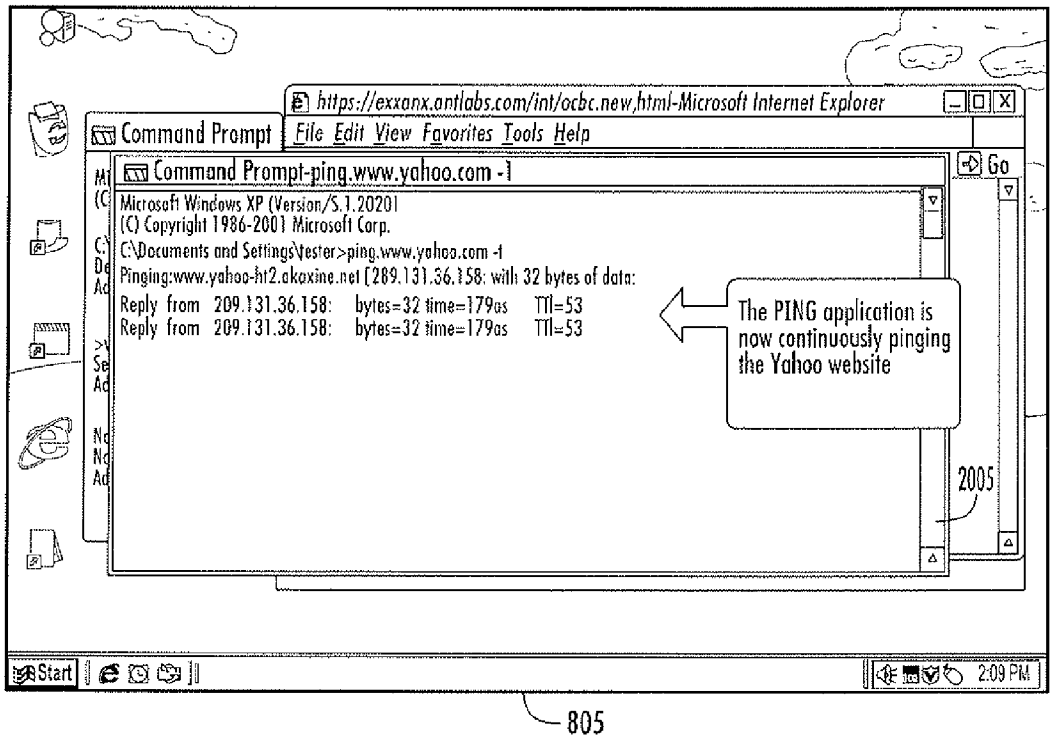
Your access Code is ton

Please use TNT.

Wednesday tester: lax Explorer	
18:04:44	
18:04:44	
Wednesday tester: lax	
18:06:59	
Wednesday tester: lax Explorer	
10:06:59	fridg

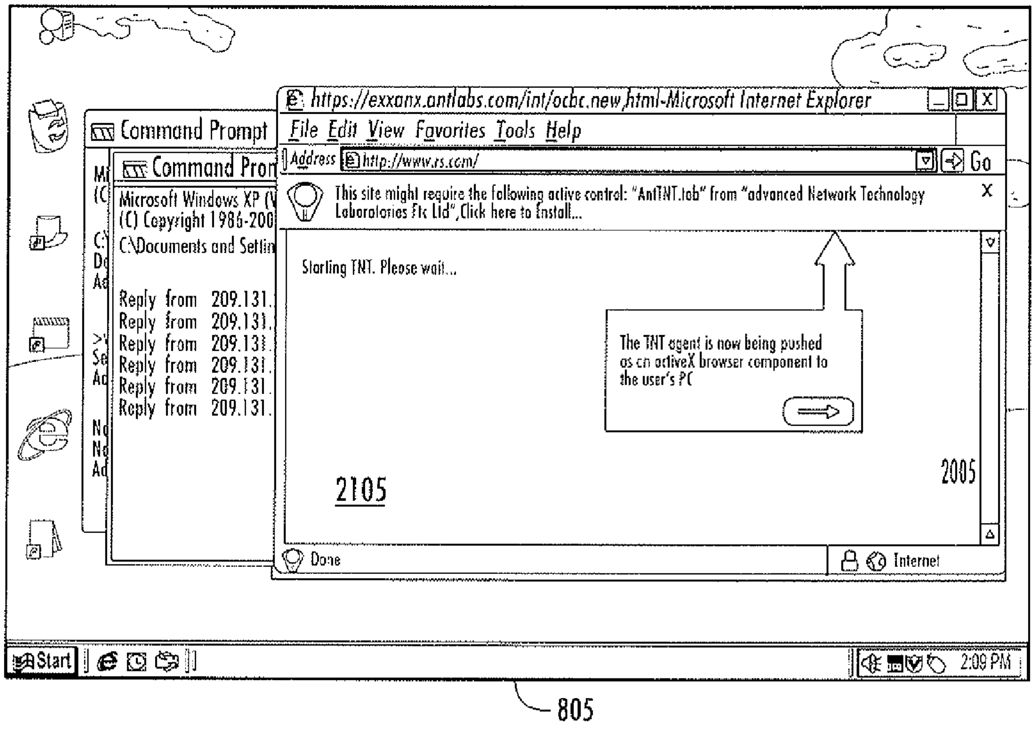
Magic Word: kklg Mode: Text Only Log Site ID: 4096

FIG. 19


https://exxanx.antlabs.com/int/ocbc.new,html-Microsoft Internet Explorer
File Edit View Favorites Tools Help
Go
Command Prompt
Command Prompt-ping.www.yahoo.com -1
The PING application is now continuously pinging the Yahoo website
2005
Start
2:09 PM
805

```
Microsoft Windows XP (Version/S.1.20201
(C) Copyright 1986-2001 Microsoft Corp.
C:\Documents and Settings\tester>ping.www.yahoo.com -1
Pinging:www.yahoo-ht2.akaxine.net [289.131.36.158: with 32 bytes of data:
Reply from 209.131.36.158:  bytes=32 time=179as  Tll=53
Reply from 209.131.36.158:  bytes=32 time=179as  Tll=53
```

FIG. 20


Command Prompt
Command Prom
https://exxanx.antlabs.com/int/ocbc.new,html-Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address
Go
Done
Internet
Start
2:09 PM
2105
2005
805

```
Microsoft Windows XP (V
(C) Copyright 1986-200
C:\Documents and Settin

Reply from 209.131.
Reply from 209.131.
Reply from 209.131.
Reply from 209.131.
Reply from 209.131.
Reply from 209.131.
```

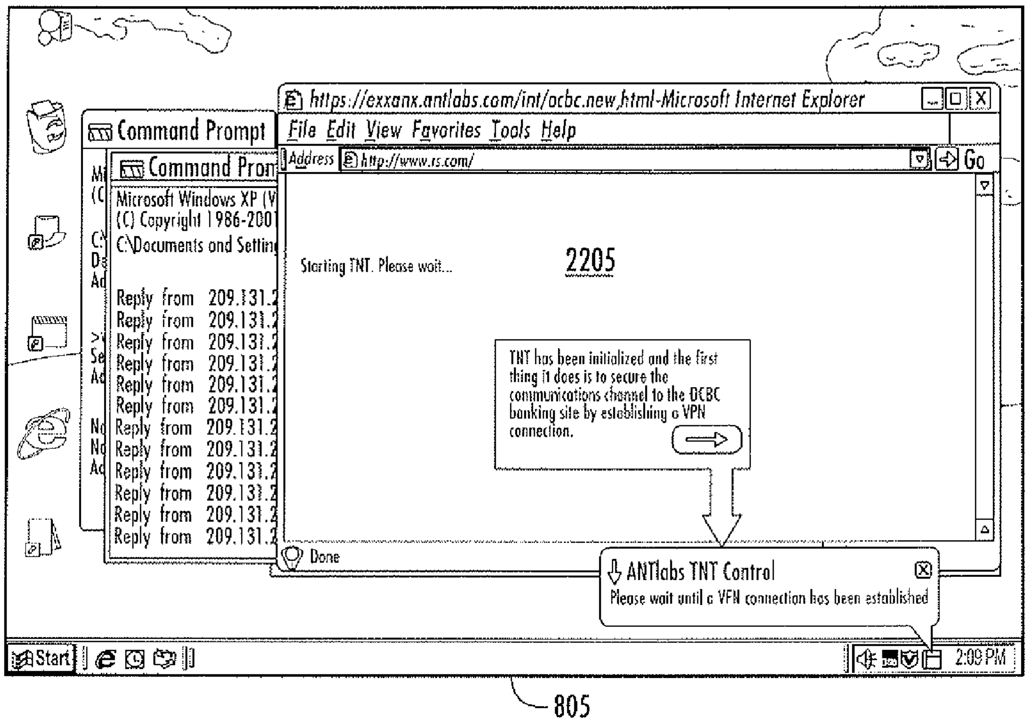
http://www.rs.com/

This site might require the following active control: "AntTNT.tab" from "advanced Network Technology Laboratories Ftc Ltd",Click here to Install...

Starting TNT. Please wait...

The TNT agent is now being pushed as cn activeX browser component to the user's PC

FIG. 21


Command Prompt
Command Prom
https://exxanx.antlabs.com/int/ocbc.new.html-Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.rs.com/
Go
2205
Done
ANTlabs TNT Control
Start
2:09 PM
805

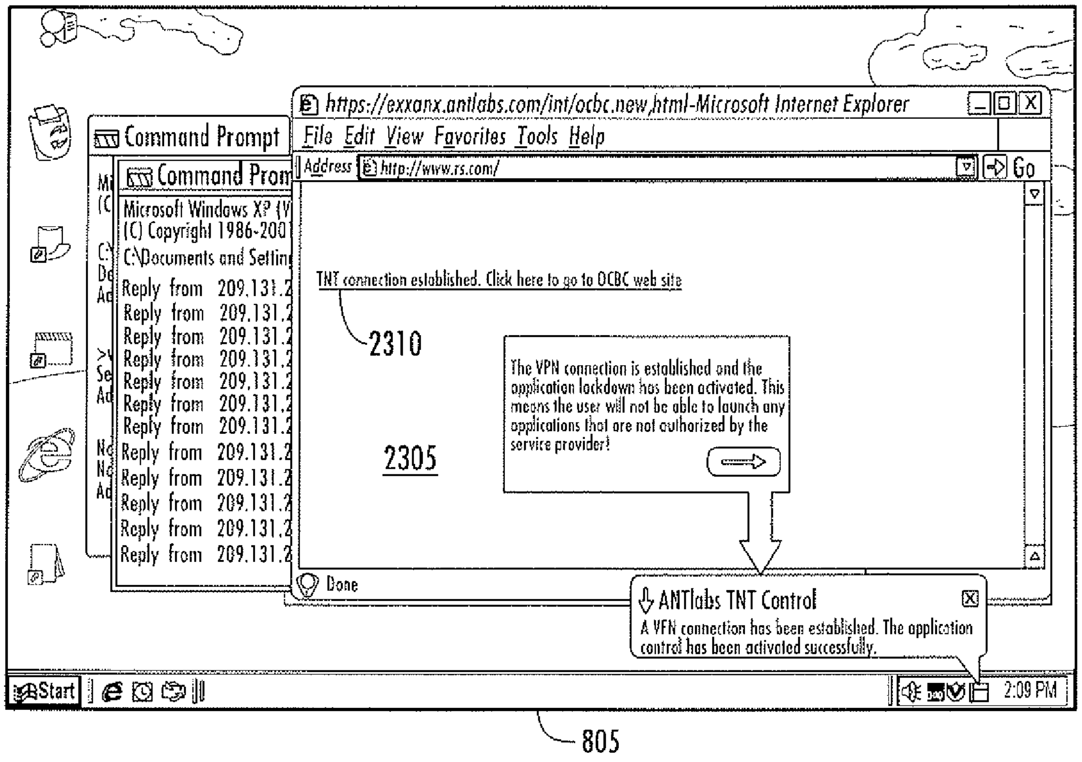
```
Microsoft Windows XP (V
(C) Copyright 1986-2001
C:\Documents and Settin

Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
```

Starting TNT. Please wait...

TNT has been initialized and the first thing it does is to secure the communications channel to the OCBC banking site by establishing a VPN connection.

Please wait until a VPN connection has been established

FIG. 22


Command Prompt
Command Prom
https://exxanx.antlabs.com/int/ocbc.new,html-Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.rs.com/
Go
2310
2305
Done
Start
2:09 PM
805

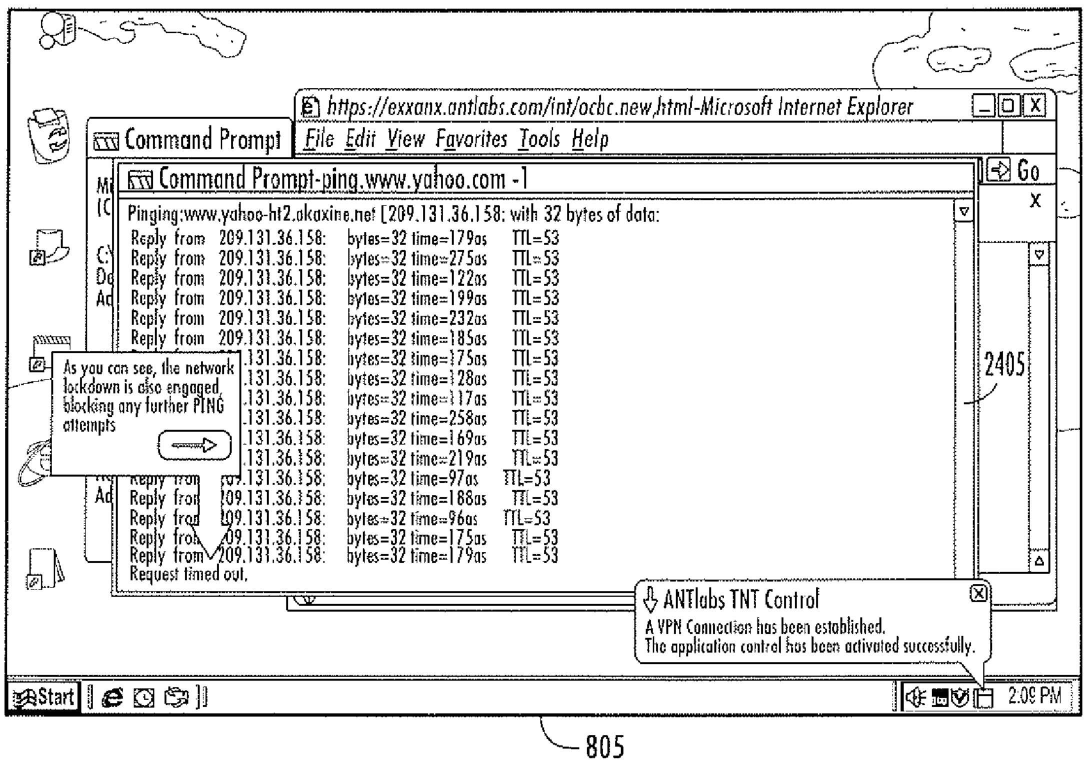
```
Microsoft Windows XP [V
(C) Copyright 1986-2001
C:\Documents and Settin
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
Reply from 209.131.2
```

TNT connection established. Click here to go to OCBC web site

The VPN connection is established and the application lockdown has been activated. This means the user will not be able to launch any applications that are not authorized by the service provider!

ANTlabs TNT Control
A VPN connection has been established. The application control has been activated successfully.

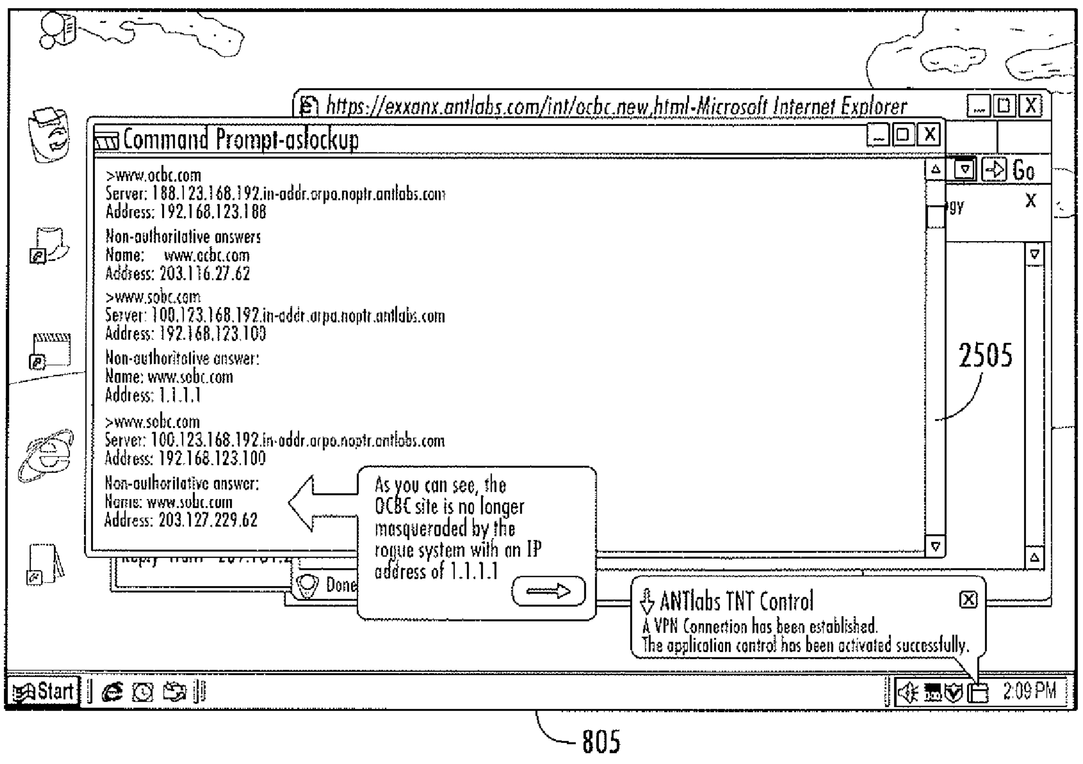
FIG. 23


https://exxanx.antlabs.com/int/ocbc.new,html-Microsoft Internet Explorer
File Edit View Favorites Tools Help
Go
Command Prompt
Command Prompt-ping.www.yahoo.com -1
As you can see, the network lockdown is also engaged, blocking any further PING attempts
ANTlabs TNT Control
Start
2:09 PM
2405
805

```
Pinging:www.yahoo-ht2.akaxine.net [209.131.36.158: with 32 bytes of data:
 Reply from  209.131.36.158:   bytes=32 time=179as    TTL=53
 Reply from  209.131.36.158:   bytes=32 time=275as    TTL=53
 Reply from  209.131.36.158:   bytes=32 time=122as    TTL=53
 Reply from  209.131.36.158:   bytes=32 time=199as    TTL=53
 Reply from  209.131.36.158:   bytes=32 time=232as    TTL=53
 Reply from  209.131.36.158:   bytes=32 time=185as    TTL=53
             .131.36.158:      bytes=32 time=175as    TTL=53
             .131.36.158:      bytes=32 time=128as    TTL=53
             .131.36.158:      bytes=32 time=117as    TTL=53
             .131.36.158:      bytes=32 time=258as    TTL=53
             .131.36.158:      bytes=32 time=169as    TTL=53
             .131.36.158:      bytes=32 time=219as    TTL=53
 Reply from  209.131.36.158:   bytes=32 time=97as    TTL=53
 Reply from  209.131.36.158:   bytes=32 time=188as    TTL=53
 Reply from  209.131.36.158:   bytes=32 time=96as    TTL=53
 Reply from  209.131.36.158:   bytes=32 time=175as    TTL=53
 Reply from  209.131.36.158:   bytes=32 time=179as    TTL=53
Request timed out.
```

A VPN Connection has been established.
The application control has been activated successfully.

FIG. 24

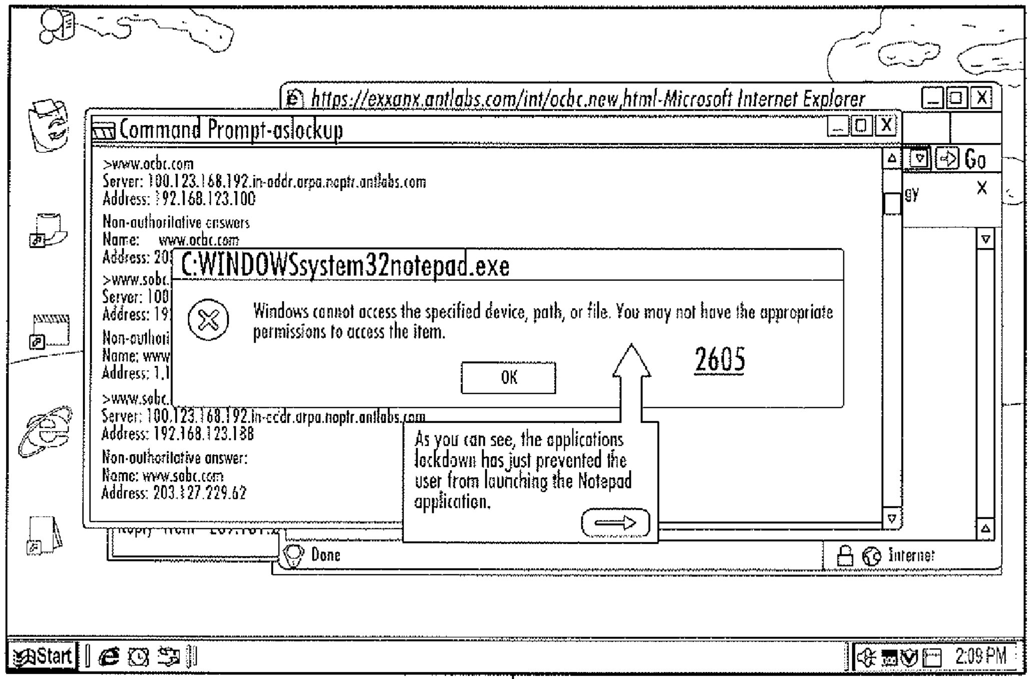

https://exxanx.antlabs.com/int/ocbc.new.html-Microsoft Internet Explorer
Command Prompt-aslockup
Go
2505
Done
805
Start
2:09 PM

```
>www.ocbc.com
Server: 188.123.168.192.in-addr.arpa.noptr.antlabs.com
Address: 192.168.123.188
Non-authoritative answers
Name:    www.ocbc.com
Address: 203.116.27.62
>www.sobc.com
Server: 100.123.168.192.in-addr.arpa.noptr.antlabs.com
Address: 192.168.123.100
Non-authoritative answer:
Name: www.sobc.com
Address: 1.1.1.1
>www.sobc.com
Server: 100.123.168.192.in-addr.arpa.noptr.antlabs.com
Address: 192.168.123.100
Non-authoritative answer:
Name: www.sobc.com
Address: 203.127.229.62
```

As you can see, the OCBC site is no longer masqueraded by the rogue system with an IP address of 1.1.1.1

ANTlabs TNT Control
A VPN Connection has been established.
The application control has been activated successfully.

FIG. 25

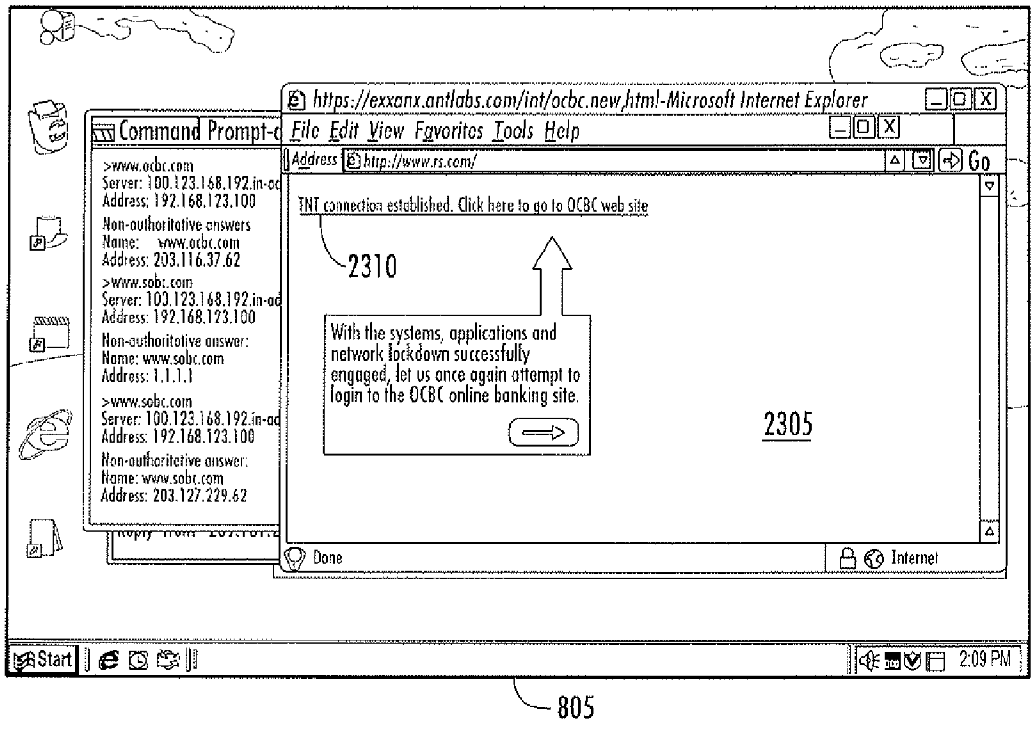

https://exxanx.antlabs.com/int/ocbc.new,html-Microsoft Internet Explorer
Command Prompt-aslockup
C:WINDOWSsystem32notepad.exe
OK
2605
Go
Done
Internet
Start
2:09 PM
805

```
>www.ocbc.com
Server: 100.123.168.192.in-addr.arpa.noptr.antlabs.com
Address: 192.168.123.100
Non-authoritative answers
Name:    www.ocbc.com
Address: 20
>www.sobc.
Server: 100
Address: 19
Non-authori
Name: www
Address: 1.1
>www.sobc.
Server: 100.123.168.192.in-ccdr.arpa.noptr.antlabs.com
Address: 192.168.123.188
Non-authoritative answer:
Name: www.sobc.com
Address: 203.127.229.62
```

Windows cannot access the specified device, path, or file. You may not have the appropriate permissions to access the item.

As you can see, the applications lockdown has just prevented the user from launching the Notepad application.

FIG. 26

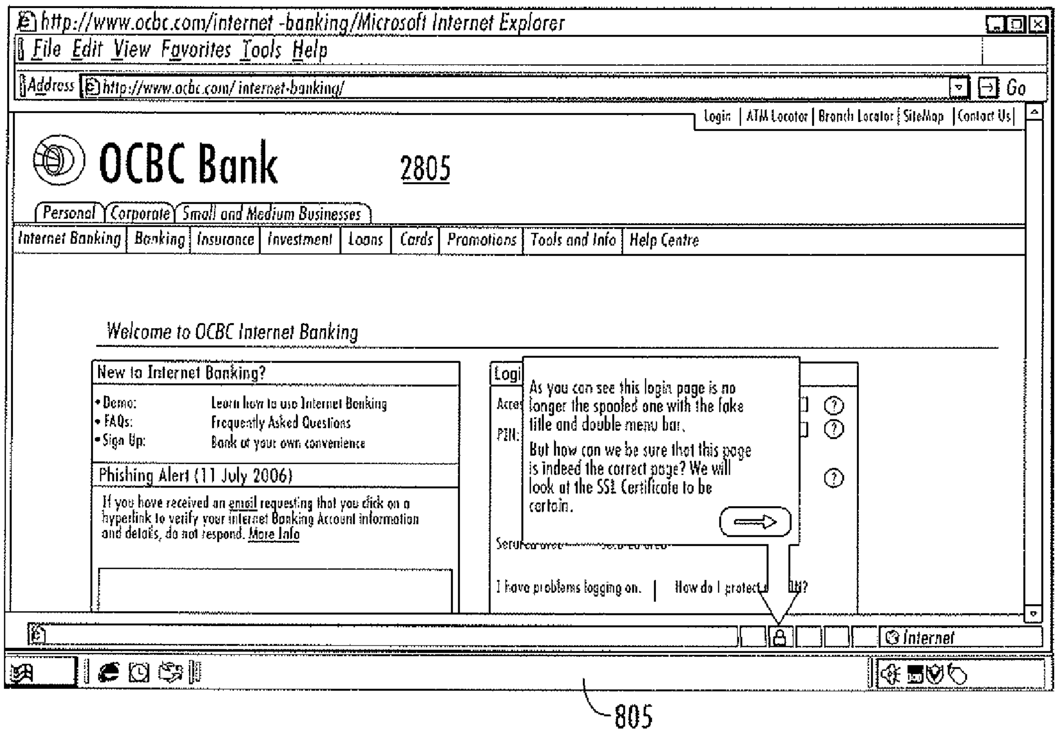

https://exxanx.antlabs.com/int/ocbc.new.html-Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.rs.com/
Go
Command Prompt-
Done
Internet
Start
2:09 PM
2310
2305
805

```
>www.ocbc.com
Server: 100.123.168.192.in-ad
Address: 192.168.123.100
Non-authoritative answers
Name:    www.ocbc.com
Address: 203.116.37.62
>www.sobc.com
Server: 100.123.168.192.in-ad
Address: 192.168.123.100
Non-authoritative answer:
Name: www.sobc.com
Address: 1.1.1.1
>www.sobc.com
Server: 100.123.168.192.in-ad
Address: 192.168.123.100
Non-authoritative answer:
Name: www.sobc.com
Address: 203.127.229.62
```

TNT connection established. Click here to go to OCBC web site

With the systems, applications and network lockdown successfully engaged, let us once again attempt to login to the OCBC online banking site.

FIG. 27


http://www.ocbc.com/internet -banking/Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://www.ocbc.com/ internet-banking/
Go
Login | ATM Locator | Branch Locator | SiteMap | Contact Us |
OCBC Bank
2805
Personal Corporate Small and Medium Businesses
Internet Banking | Banking | Insurance | Investment | Loans | Cards | Promotions | Tools and Info | Help Centre
Internet
805

Welcome to OCBC Internet Banking

New to Internet Banking?

• Demo:	Learn how to use Internet Banking
• FAQs:	Frequently Asked Questions
• Sign Up:	Bank at your own convenience

Phishing Alert (11 July 2006)

If you have received an email requesting that you click on a hyperlink to verify your internet Banking Account information and details, do not respond. More Info

Logi

Acce

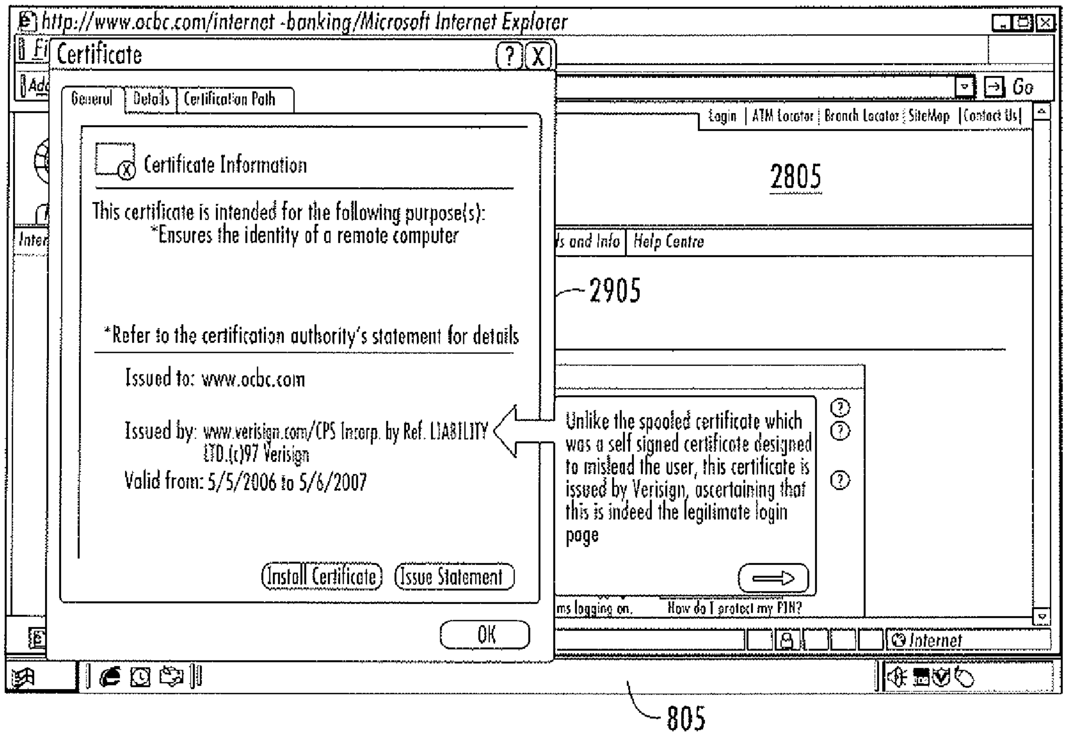
PIN:

As you can see this login page is no longer the spoofed one with the fake title and double menu bar.

But how can we be sure that this page is indeed the correct page? We will look at the SSL Certificate to be certain.

I have problems logging on. | How do I protect

FIG. 28



This certificate is intended for the following purpose(s):
*Ensures the identity of a remote computer

*Refer to the certification authority's statement for details

Issued to: www.ocbc.com

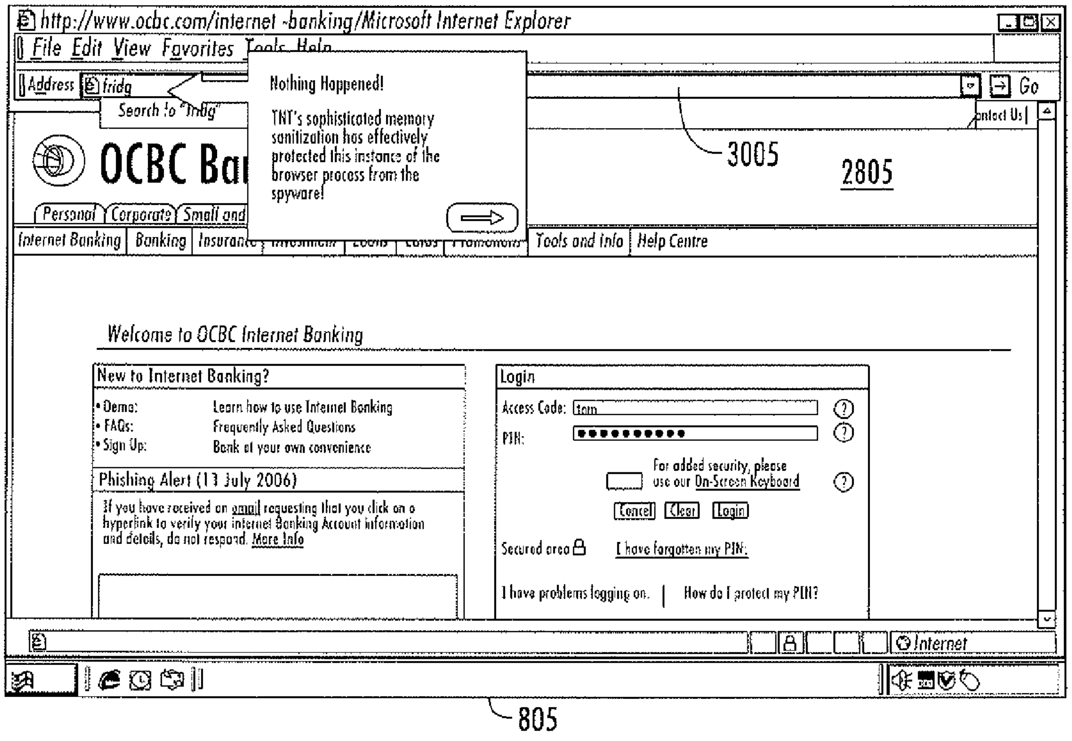
Issued by: www.verisign.com/CPS Incorp. by Ref. LIABILITY LTD.(c)97 Verisign

Valid from: 5/5/2006 to 5/6/2007

Unlike the spoofed certificate which was a self signed certificate designed to mislead the user, this certificate is issued by Verisign, ascertaining that this is indeed the legitimate login page

ms logging on. How do I protect my PIN?

FIG. 29



Nothing Happened!

TNT's sophisticated memory sanitization has effectively protected this instance of the browser process from the spyware!

Welcome to OCBC Internet Banking

New to Internet Banking?

• Demo:	Learn how to use Internet Banking
• FAQs:	Frequently Asked Questions
• Sign Up:	Bank at your own convenience

Phishing Alert (13 July 2006)

If you have received an email requesting that you click on a hyperlink to verify your internet Banking Account information and details, do not respond. More Info

Login

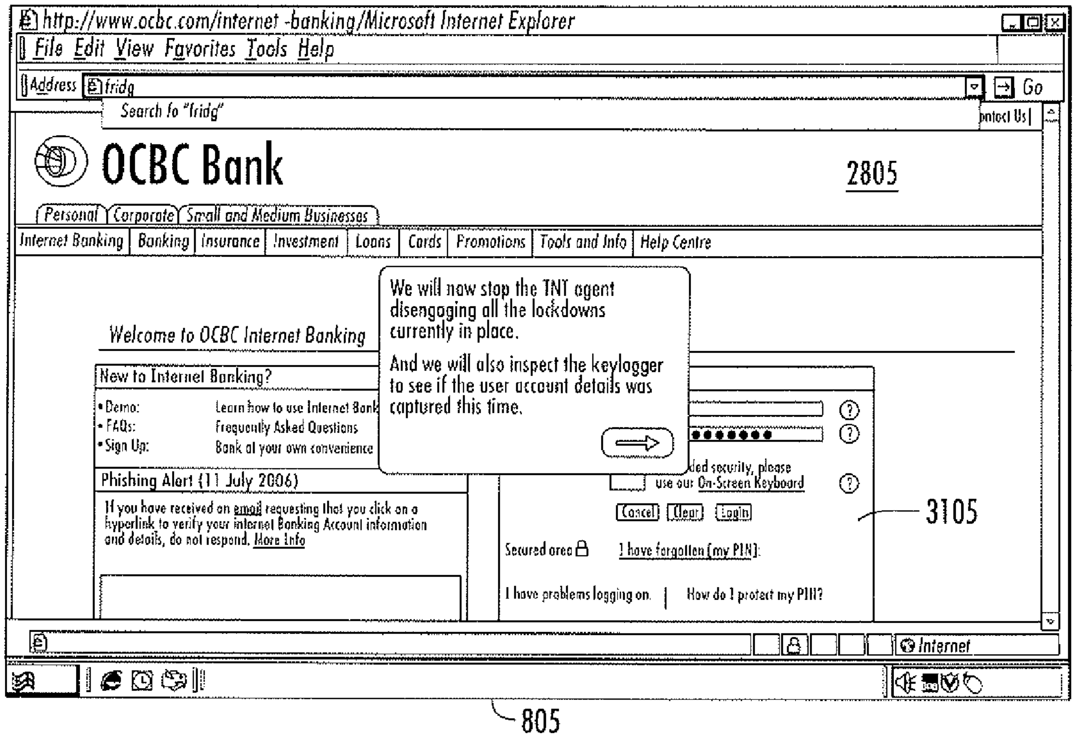
Access Code: tom

PIN: ●●●●●●●●●●

For added security, please use our On-Screen Keyboard

http://www.ocbc.com/internet -banking/Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address fridg
Search fo "fridg"
Go
ontact Us
OCBC Ba
Personal Corporate Small and
Internet Banking Banking Insurance Tools and Info Help Centre
Cancel Clear Login
Secured area
I have forgotten my PIN:
I have problems logging on.
How do I protect my PIN?
Internet
3005
2805
805

FIG. 30

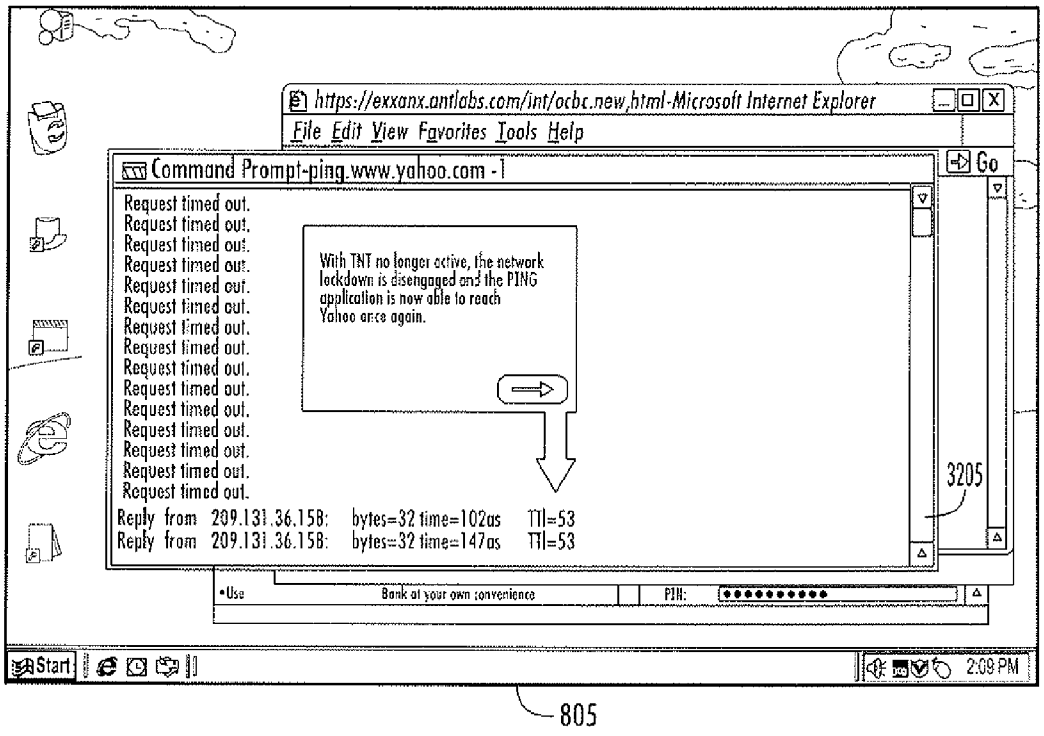

http://www.ocbc.com/internet -banking/Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address fridg
Go
Search fo "fridg"
ontact Us
OCBC Bank
2805
Personal Corporate Small and Medium Businesses
Internet Banking Banking Insurance Investment Loans Cards Promotions Tools and Info Help Centre
Welcome to OCBC Internet Banking
New to Internet Banking?
• Demo: Learn how to use Internet Bank
• FAQs: Frequently Asked Questions
• Sign Up: Bank at your own convenience
Phishing Alert (11 July 2006)
use our On-Screen Keyboard
Cancel Clear Login
Secured area
I have forgotten my PIN
I have problems logging on.
How do I protect my PIN?
Internet
3105
805

We will now stop the TNT agent disengaging all the lockdowns currently in place.

And we will also inspect the keylogger to see if the user account details was captured this time.

If you have received an email requesting that you click on a hyperlink to verify your internet Banking Account information and details, do not respond. More Info

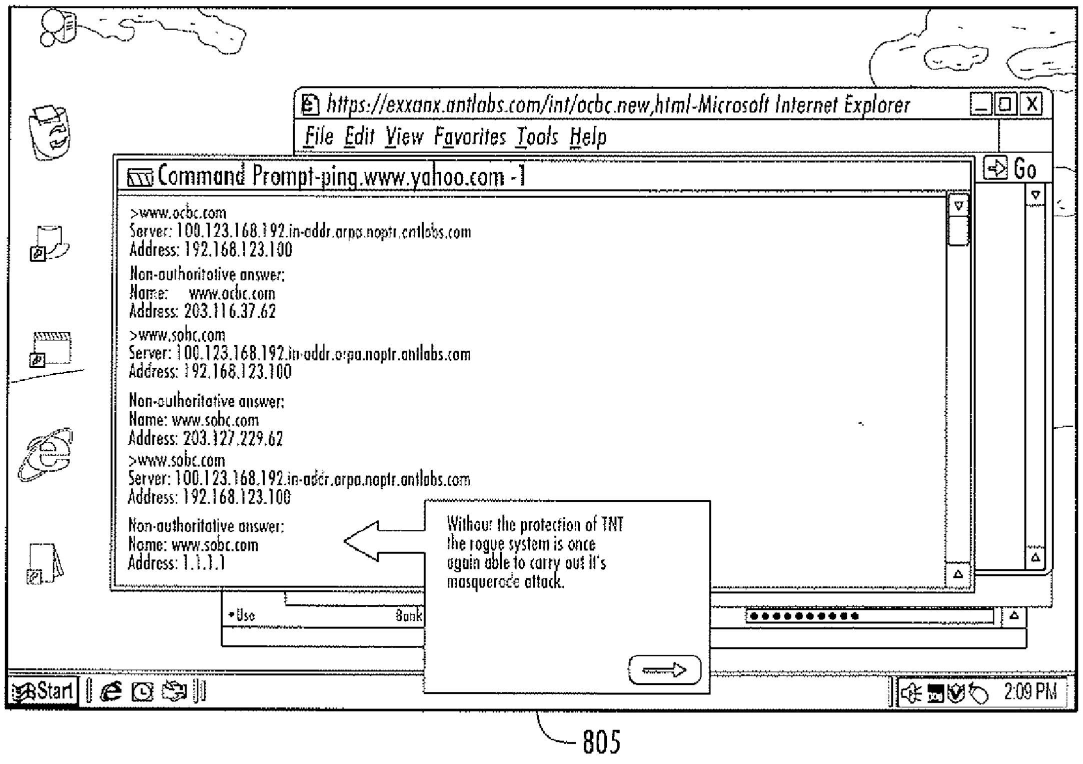
FIG. 31


https://exxanx.antlabs.com/int/ocbc.new,html-Microsoft Internet Explorer
File Edit View Favorites Tools Help
Go
Command Prompt-ping.www.yahoo.com -1
•Use
Bank at your own convenience
PIN:
Start
2:09 PM
3205
805

```
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Reply from 209.131.36.158:  bytes=32 time=102ms  TTL=53
Reply from 209.131.36.158:  bytes=32 time=147ms  TTL=53
```

With TNT no longer active, the network lockdown is disengaged and the PING application is now able to reach Yahoo once again.

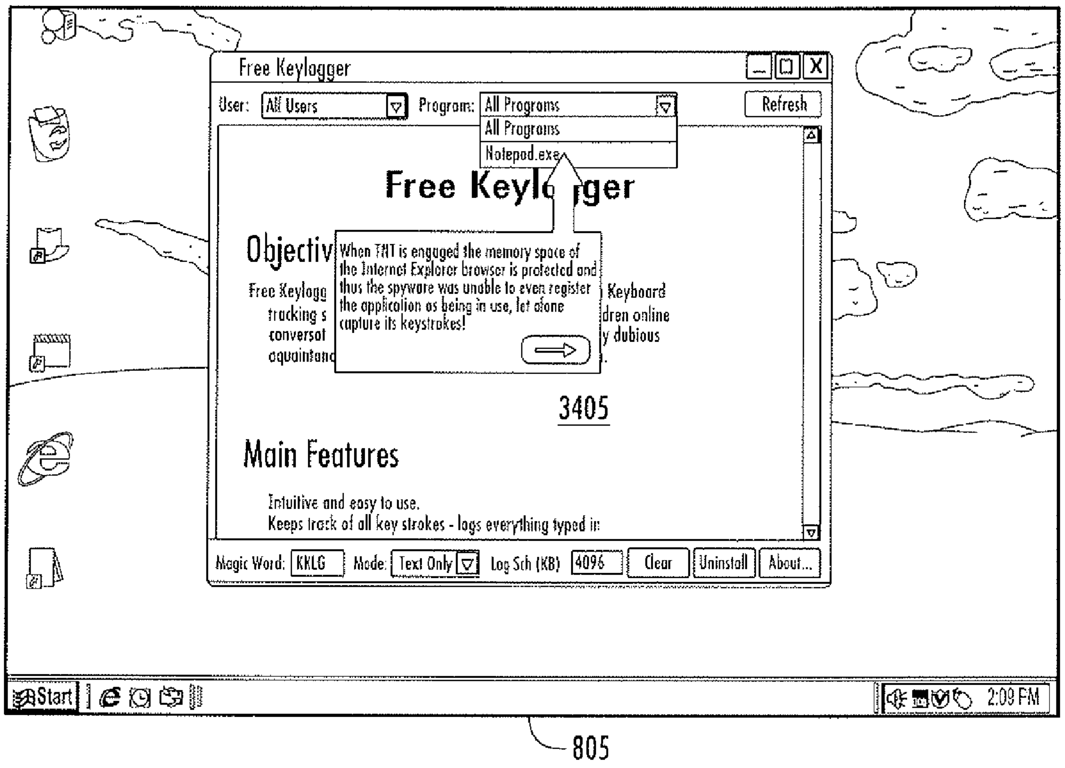
FIG. 32


https://exxanx.antlabs.com/int/ocbc.new,html-Microsoft Internet Explorer
File Edit View Favorites Tools Help
Go
Command Prompt-ping.www.yahoo.com -1
Use
Bank
Start
2:09 PM
805

```
>www.ocbc.com
Server: 100.123.168.192.in-addr.arpa.noptr.antlabs.com
Address: 192.168.123.100

Non-authoritative answer:
Name:    www.ocbc.com
Address: 203.116.37.62
>www.sobc.com
Server: 100.123.168.192.in-addr.arpa.noptr.antlabs.com
Address: 192.168.123.100

Non-authoritative answer:
Name: www.sobc.com
Address: 203.127.229.62
>www.sobc.com
Server: 100.123.168.192.in-addr.arpa.noptr.antlabs.com
Address: 192.168.123.100

Non-authoritative answer:
Name: www.sobc.com
Address: 1.1.1.1
```

Without the protection of TNT the rogue system is once again able to carry out it's masquerade attack.

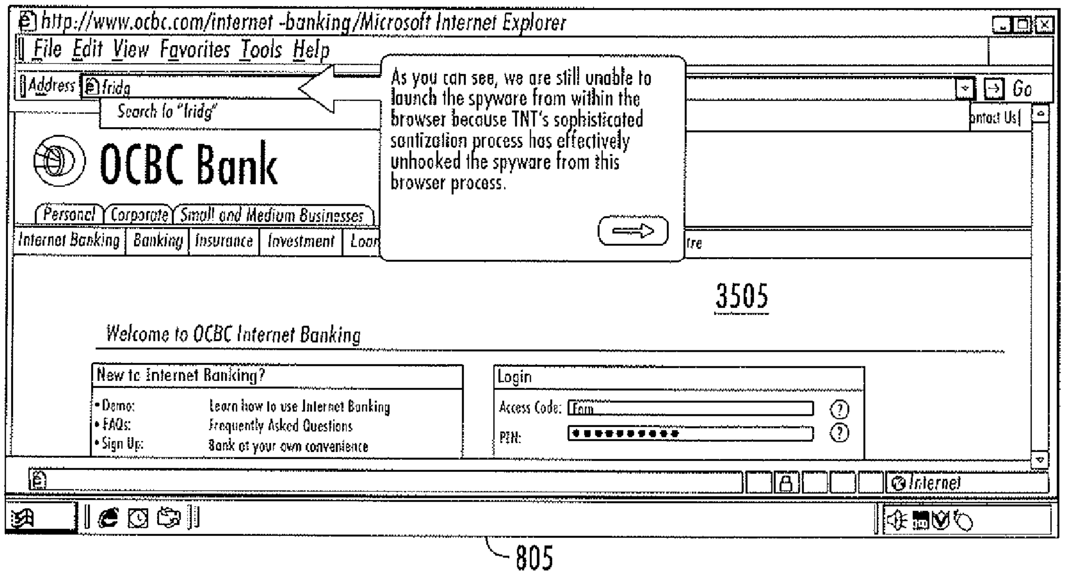
FIG. 33



When TNT is engaged the memory space of the Internet Explorer browser is protected and thus the spyware was unable to even register the application as being in use, let alone capture its keystrokes!

Intuitive and easy to use.
Keeps track of all key strokes - logs everything typed in

FIG. 34



As you can see, we are still unable to launch the spyware from within the browser because TNT's sophisticated sanitization process has effectively unhooked the spyware from this browser process.

Welcome to OCBC Internet Banking

New to Internet Banking?

- Demo: Learn how to use Internet Banking
- FAQs: Frequently Asked Questions
- Sign Up: Bank at your own convenience

Login

Access Code: Tom

PIN: ●●●●●●●●●●

FIG. 35

SYSTEM AND METHOD FOR PROVIDING TRANSACTIONAL SECURITY FOR AN END-USER DEVICE

PRIORITY CLAIM

[0001] This application is a continuation of and claims benefit of utility patent application Ser. No. 11/694,476, filed Mar. 30, 2007, by inventor, Wee Tuck Teo, entitled: "System and Method for Providing Transactional Security For An End-User Device; provisional patent application Ser. No. 60/787,457, entitled "Trusted Network Transaction," filed on Mar. 30, 2006, by inventor Wee Tuck Teo; and provisional patent application Ser. No. 60/814,828 entitled "End Point Remote Data Exchange Security," filed on Jun. 19, 2006, by inventor Wee Tuck Teo.

COPYRIGHT NOTICE

TECHNICAL FIELD

[0003] This invention relates generally to network systems, and more particularly provides a system and method for providing transactional security to an end-user device.

BACKGROUND

[0004] Security is a key concern during online transactions. Commercial Internet transactions, e.g., Internet banking, credit card purchases, etc., are only as secure as the weakest link, Traditional security solutions focus on server-side infrastructure security, e.g., HTTPS web site, two-factor authentication, etc. While the server side has security expert management and maintenance, the end user's computers do not have such benefit.

[0005] Current online transaction risks increase due to poor end user security practices. The current solution to end user security tends to focus on end user education, e.g., training end users to recognize phishing attempts and ignore spoofed emails, and installing end-user security software to clean up and secure end-user devices from malicious code, e.g., viruses, spyware, adware, keyloggers, backdoors, Trojans, etc. Solving the end-user device vulnerabilities using the above approach is dependent on end-user efforts, e.g., regular installation of security software updates such as signature files, regular execution of scans, regular application of the security patches, etc.

[0006] Additionally, the generally open nature of the Internet makes shared Internet resources, e.g., DNS servers, intermediate routers, etc., susceptible to web site hijacking. Shared Internet resources are not managed by web site owners or end users, making securing these shared resources outside the control of the stakeholders.

[0007] A system and method that facilitates protection of an end-user device are needed.

SUMMARY

[0008] According to one embodiment, instead of ensuring that an end-user device is permanently secure, which requires ongoing security management, embodiments of the invention ensure that the end-user device is secure only during a transaction, e.g., an online transaction. This reduces end-user security management overhead. For example, an end-user device may be infected with keyloggers or remote backdoors during normal operation. However, according to embodiments of the invention, these threats need only be disabled during the transaction. According to another embodiment, instead of depending on an end user to manage the security software, software that enables a trusted network transaction (TNT) environment is managed and provided by a trusted source that provides the security software or security policy on demand. For example, the security software or security policy may be delivered/pushed from a transaction site, from a service provider site (e.g., the end user's Internet service provider, the transaction site's security provider, an independent service provider, or the like) onto the end-user device. According to yet another embodiment, the security software delivered/pushed onto an end-user device may remove dependencies on shared Internet resources. For example, the IP address of a destination web or VPN server may be provided directly to the end-user device to determine or force a new connection over the Internet with the destination web or VPN server. Yet another embodiment secures data exchange by ensuring that confidential data cannot be permanently captured by malicious software residing on an end-user device, or that confidential data captured cannot be sent or misdirected to untrusted remote sites. These and other TNT mechanisms (security engines, security profiles, and/or the like) can be deployed independently or in different combinations.

[0009] According to one embodiment, the present invention provides a network system comprising a transaction network operative to provide a transaction with an end user; a trusted source of a security mechanism for at lest partially protecting an end-user device from malicious code operative thereon that attempts to capture confidential data presented during the transaction, the security mechanism being maintained by a party other than the end user; and an agent for providing the security mechanism to (e.g., installing or configuring the security mechanism on) the end-user device so that the appropriate security mechanism for the expected transaction protects the end-user device during the transaction.

[0010] The transaction network may provide a banking site and/or a gaming site. The trusted source may reside on an ISP network, SAS (software-as-a-service) operator network or on the transaction network. The trusted source and the transaction network may be managed by the same entity. The security mechanism any include a security engine and/or a security profile. The security mechanism may include a start/stop trigger module for controlling when to initiate one or more aspects of the security mechanism and when to deactivate the one or more aspects of the security mechanism; an application lockout module for suspending at least one application not needed to effect the transaction; a file/network I/O control module for disabling at least one file or network operation during the transaction; a trusted driver module for determining whether a driver, e.g., a keyboard driver, on the end-user devices matches a known trusted driver; a keystrokes generator driver for generating additional keystrokes to a keystroke pattern generated by the end user; a keystrokes deletion hook for deleting the additional keystrokes generated by the keystrokes generator driver; and/or a VPN manager capable of establishing a directional or undirectional secure tunnel between the end-user device and the transaction network. The security mechanism may include an IP address to a server within the transaction network. The agent or another agent may be capable of removing the security mechanism upon completion of the transaction. The agent may include an install agent downloaded from the trusted source, an install agent downloaded from a third-party server, and/or a connection agent preloaded onto the end-user device.

[0011] According to another embodiment, the present invention provides a method comprising initiating the security mechanism for a secure transaction by an end user a request with a transaction network providing a transaction; receiving from a trusted source a security mechanism for at least partially protecting an end-user device from malicious code operative thereon that attempts to capture confidential data presented during the transaction, the security mechanism being maintained by a party other than the end user; activating the security mechanism; establishing a secure connection between an end-user device and the transaction network; and enabling the transaction.

[0012] The transaction network may provide a banking site and/or a gaming site. The trusted source may reside on an ISP network, SAS operator network or on the transaction network. The trusted source and the transaction network may be managed by the same entity. The security mechanism may include a security engine and/or a security profile. The security mechanism may include a start/stop trigger module for controlling when to initiate one or more aspects of the security mechanism and when to deactivate the one or more aspects of the security mechanism; an application lockout module for suspending at least one application not needed to effect the transaction; a file/network I/O control module for disabling at least one file or network operation during the transaction; a trusted driver module for determining whether a driver, e.g., a keyboard driver, on the end-user device matches a known trusted driver; a keystrokes generator driver for generating additional keystrokes to a keystroke pattern generated by the end user; a keystrokes deletion hook for deleting the additional keystrokes generated by the keystrokes generator driver; and/or a VPN manager capable of establishing a secure tunnel between the end-user device and the transaction network. The security mechanism may include an IP address to a server within the transaction network. The method may further comprise removing the security mechanism upon completion of the transaction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1** is a block diagram of a network system operative to secure an end-user device, in accordance with an embodiment of the present invention.

[0014] FIG. **2** is a block diagram illustrating details of the security engine of FIG. **1**, in accordance with an embodiment of the present invention.

[0015] FIG. **3** is a block diagram illustrating a network system operative to effect a trusted network transaction with an Internet banking portal, in accordance with an embodiment of the present invention.

[0016] FIG. **4** is a block diagram illustrating a network system operative to effect a trusted network transaction managed by the end user's Internet service provider, in accordance with an embodiment of the present invention.

[0017] FIG. **5** is a block diagram illustrating a network system operative to effect security engine installation, in accordance with an embodiment of the present invention.

[0018] FIG. **6** is a timing diagram illustrating keyboard-input processing, in accordance with an embodiment of the present invention.

[0019] FIG. **7** is a block diagram illustrating a network system operative to effect tunnel datagram processing, in accordance with an embodiment of the present invention.

[0020] FIG. **8** is a screen shot of an end-user device before spyware infection or spoofing attack.

[0021] FIG. **9** is a screen shot of an end-user device after spyware infection.

[0022] FIG. **10** is a screen shot of an end-user device with a window illustrating keylogger infection.

[0023] FIG. **11** is a screen shot of an end-user device with a window illustrating keystroke capture.

[0024] FIG. **12** is a screen shot of an end-user device before DNS poisoning.

[0025] FIG. **13** is a screen shot of an end-user device with a window illustrating a legitimate IP address in a DNS cache, before DNS poisoning.

[0026] FIG. **14** is a screen shot of an end-user device after DNS poisoning.

[0027] FIG. **15** is a screen shot of an end-user device with a window illustrating a spoofed IP address in the DNS cache, after DNS poisoning.

[0028] FIG. **16** is a screen shot of an end-user device with a browser window illustrating the spoofed site at the IP address of FIG. **15**.

[0029] FIG. **17** is a screen shot of an end-user device with a browser window illustrating the spoofed site and with a security alert.

[0030] FIG. **18** is a screen shot of an end-user device with a browser window illustrating the spoofed site and with a spoofed security certificate.

[0031] FIG. **19** is a screen shot of an end-user device after keylogger infection and DNS poisoning and before protection by embodiments of the invention.

[0032] FIG. **20** is a screen shot of an end-user device with a window illustrating continuous pinging of the Yahoo website to evidence the availability of outbound communication.

[0033] FIG. **21** is a screen shot of an end-user device with a window illustrating that a download agent, e.g., an ActiveX control, is being delivered to the end-user device.

[0034] FIG. **22** is a screen shot of an end-user device with a window illustrating that the download agent is being executed and is establishing a VPN connection with a trusted source of a security engine.

[0035] FIG. **23** is a screen shot of an end-user device with a window illustrating that the download agent has established a VPN connection with the trusted source, has downloaded and installed the security engine, and is presenting a button to navigate to the legitimate banking site.

[0036] FIG. **24** is a screen shot of an end-user device with a window illustrating that the continuous pinging of the Yahoo website has stopped, evidencing that outbound communication has been suspended.

[0037] FIG. **25** is a screen shot of an end-user device with a window illustrating the legitimate IP address of the legitimate banking site.

[0038] FIG. **26** is a screen shot of an end-user device with a window illustrating application lockout.

[0039] FIG. **27** is a screen shot of an end-user device with a window illustrating the button to navigate to the legitimate banking site.

[0040] FIG. **28** is a screen shot of an end-user device with a browser window illustrating the legitimate banking site.

[0041] FIG. **29** is a screen shot of an end-user device with a window illustrating the legitimate banking site certificate of the legitimate banking site.

[0042] FIG. **30** is a screen shot of an end-user device with a browser window illustrating the legitimate banking site and illustrating that the keylogger is no longer active.

[0043] FIG. **31** is a screen shot of an end-user device with a browser window just before the security engine is deactivated and/or removed.

[0044] FIG. **32** is a screen shot of an end-user device with a window illustrating that outbound communication has resumed.

[0045] FIG. **33** is a screen shot of an end-user device with a window illustrating resumed vulnerability to the DNS poisoning of the DNS cache.

[0046] FIG. **34** is a screen shot of an end-user device with a window illustrating that the security engine protected the memory space from registering the browser window.

[0047] FIG. **35** is a screen shot of an end-user device with a window illustrating that the keylogger infection has been neutralized.

DETAILED DESCRIPTION

[0048] The following description is provided to enable any person skilled in the art to make and use the invention and is provided in the context of a particular application. Various modifications to the embodiments are possible, and the generic principles defined herein may be applied to these and other embodiments and applications without departing from the spirit and scope of the invention. Thus, the invention is not intended to be limited to the embodiments and applications shown, but is to be accorded the widest scope consistent with the principles, features and teachings disclosed herein.

[0049] According to one embodiment, instead of ensuring that an end-user device is permanently secure, which requires ongoing security management, embodiments of the invention only ensure that the end-user device is secure during a data sensitive transaction. This reduces end-user security management overhead. For example, an end-user device may be infected with keyloggers or remote backdoors during normal operation. However, according to embodiments of the invention, these threats need only be disabled during the transaction. According to another embodiment, instead of depending on an end user to manage the security software, software that enables a trusted network transaction (TNT) environment is managed and provided by a trusted source that provides the security software on demand. For example, the security software may be delivered/pushed from an online transaction site, from a service provider site (e.g., the end user's Internet service provider, the transaction site's security provider, an independent service provider, or the like) onto the end-user device. According to yet another embodiment, the security software delivered/pushed onto an end-user device may remove dependencies on shared Internet resources. For example, the IP address of a destination VPN server may be provided directly to the end-user device to force a new connection over the Internet with the destination VPN server. Yet another embodiment secures data exchange by ensuring that confidential data cannot be permanently captured by malicious software residing on an end-user device, or that confidential data captured cannot be sent or misdirected to untrusted remote sites. These and other TNT mechanisms (security engines, security profiles, and/or the like) can be deployed independently or in different combinations. It will be appreciated that the transaction is not necessarily an online transaction; it could be a local transaction, e.g. opening an encrypted local file.

[0050] FIG. **1** is a block diagram of a network system **100** operative to secure an end-user device **105**, in accordance with an embodiment of the present invention. The network system **100** includes an end-user device **105** coupled via a trusted network **110** to an Internet service provider (ISP) network **115**, which is coupled via an untrusted network **112** to a transaction network (e.g., server, network of servers, etc.) **120** (e.g., bankofamerica.com, amazon.com, ebay.com, etc.) and to another network **125**.

[0051] The end-user device **105** includes a browser **135** (e.g., Microsoft Internet Explorer or Netscape Navigator), an operating system (e.g., Microsoft Vista or Apple Mac OS X) and device drivers **140**, and other applications **145**. The end-user device **105** also includes a connection agent **130** capable of communicating with a trusted source of a security mechanism (e.g., security engine and/or security profiles) that secures the end-user device **105** during an online transaction. The end-user device **105** may also maintain a local DNS cache **150**.

[0052] The ISP network **120** includes a server **165**, a DNS server/cache **170**, and an end-user security controller **175**. In another embodiment, components of the end-user security controller **175** may be located elsewhere (e.g., the security engine can be on the trusted network and the security policy can be on the transaction network), such as on the transaction network **120** or on another trusted source. The end-user security controller **175** includes a security engine **177** and security profiles **180** for download to the end-user device **105**. The security engine **177** contains software that sets up a secure data exchange between the end-user device **105** and a remote network application running on a trusted device in a trusted network, e.g., a trusted server on the transaction network **120**. The security profiles **177** contain the rules, definitions and/or identification information for the security engine **180** to block unexpected behaviors due to, e.g., viruses, spyware, adware, Trojans, etc. It will be appreciated that the ISP network **120** may support multiple transaction networks **120**, and may include multiple security controllers **175** (each dedicated to a particular transaction network **120**). Alternatively, the ISP network **120** may have a single security controller **175**, and may customize the security engine **177** and/or security profiles **180** on the fly for the particular transaction network **120**.

[0053] It will be appreciated that the security engine **177** and/or security profiles **180** may be updated on a regular basis by a security manager. Then, as needed, possibly on an irregular basis as the end user connects to the ISP network **120** and/or to the transaction network **120**, the end-user security controller **175** downloads the security engine **177** and/or security profiles **180** to the end-user device **105**. In one embodiment, the security engine **177** and/or security profiles **180** are maintained only during the transaction session, and are removed upon completion of the transaction. In another embodiment, the security engine **177** and/or security profiles are not removed, and are updated before each new transaction begins. In another embodiment, the security engine **177** and/or security profiles **180** are operative between transactions, and serve to protect the end-user device **105** in the current state until a subsequent transaction request deploys an update. Additional details of the security engine **177** are shown and described with reference to FIG. **2**.

[0054] The transaction network **120** includes at least one web server **185**, which includes a login script **190**. The login script **190** may request confidential information from the end user. After download, the security engine **177** and security profiles **180** protect the confidential data being provided by the end user from unintended capture, undesired transfer to third parties, etc.

[0055] The other network **125** includes at least one web server **193**, which includes a login script **197**. In one embodiment, the other network **125** may provide a malicious site developed to mimic the site provided by transaction network **120**. In such embodiment, the security engine **177** and security profiles **180** protect the end user from being misdirected to the other network **125**, e.g., via DNS poisoning, etc.

[0056] In one embodiment, the connection agent **130** is securely delivered and pre-installed on the end-user device **105**. Whenever secure data exchange is required, the connection agent **130** downloads a trusted copy of the security engine **177** and/or security profiles **180**. The connection agent **130** can be implemented as a standalone executable application, as a plug-in to the browser **135**, as a part of the operating system **140**, etc. In one embodiment, it is assumed that the connection agent **130** is delivered, pre-installed and executed on the end-user device **105** without modification. If the connection agent **130** does not come from a trusted source, then secure data exchange may be compromised.

[0057] In one embodiment, the connection agent **130** uses a pre-configured and unchangeable network address to contact a secure network address resolution service to obtain the IP address of the trusted source providing the security engine **177** and/or security profiles **180**. For example, an IP address of a trusted DNS security extensions (DNSSEC) server may be embedded in the connection agent **130**. The connection agent **130** may use this IP address to connect to the DNSSEC server to resolve the domain name of the trusted source to an IP address. Using the network address of the trusted source, a secure data exchange may be established to provide a secure connection to the trusted source, preventing network traffic from the end-user device **105** from being misdirected to untrusted sources and guarding against other forms of network intrusion and attacks. For example, in a TCP/IP network, the connection agent **130** may use the resolved IP address to connect to the trusted source, e.g., via a secure tunnel. This connection technique ensures that the IP address is accurate (e.g., not poisoned by a DNS attack), and assures that the end-user device **105** connects to the intended trusted source. Further, communication protocols employed in the secure network address resolution service ensures that communication to and from the end-user device **105** is authenticated, authoritative and accurate.

[0058] With a secure data exchange established, the end-user device **105** can download the security engine **177** and/or security profiles **180**, e.g., using protocols like HTTP or FTP. The secure tunnel established by the connection agent **130** ensures that data traffic between the end-user device **105** and the trusted source is secure and cannot be compromised, even when insecure protocols like HTTP and FTP are used.

[0059] After delivery of the security engine **177** and/or security profiles **180**, the end-user device **105** executes the security engine **177**. The security engine **177** effectively secures the end-user device **105**, e.g., allows the end-user device **105** to communicate only with trusted sites, prevents other applications **145** running on the end-user device **105** from capturing or sending information, especially to untrusted sites, etc. The user can then access and interact with the transaction network **120** in confidence.

[0060] In another embodiment, the connection agent **130** and security engine **177** are pre-loaded onto the end-user device **105**. Then, using the techniques described above to obtain the security engine **177** and/or security profiles **180**, the connection agent **130** and security engine **177** may obtain current security profiles **180** to configure and/or operate with the pre-loaded security engine **177**.

[0061] It will be appreciated that the connection agent **130** may cooperate with the end-user security controller **175** to establish a preliminary VPN tunnel (e.g., Microsoft PPTP or L2TP/IPSEC) before obtaining the security engine **177** and/or security profiles **180**. This preliminary VPN tunnel ensures that the security engine **177** and/or security profiles **180** are not modified or replaced in transit. In one embodiment, the preliminary VPN tunnel is dynamically established using IP (instead of DNS) as the destination address. This bypasses the dependency on the Internet-shared DNS service.

[0062] It will be further appreciated that security engine **177** may establish a transaction network VPN tunnel (e.g., Microsoft PPTP or L2TP/IPSEC) with the transaction network **120**. This VPN tunnel ensures that confidential data communicated with the transaction network **120** is not captured. In one embodiment, the VPN tunnel is dynamically established using IP (instead of DNS) as the destination address. The IP address can be securely updated immediately (as compared to using DNS) because the IP address can be directly set in the security engine **177** and/or security profiles **180** (which is directly managed by the trusted party). This bypasses the dependency on the Internet-shared DNS service. In certain embodiments, the preliminary VPN tunnel may connect with the transaction network **120**. Accordingly, in such embodiments, the security engine **177** need not establish a different tunnel.

[0063] FIG. **2** is a block diagram illustrating details of the security engine **177**, in accordance with an embodiment of the present invention. The security engine **177** includes a security manager **210**, a start/stop trigger module **215**, an application lockout module **220**, a network/file I/O control module **225**, a trusted driver manager **230**, a keystrokes generator driver **235**, a keystrokes deletion hook **240**, a security profile manager **245**, and a transaction network VPN manager **250**.

[0064] The security manager **210** includes hardware, software and/or firmware to manage the execution of and interaction between the various components of the security engine **177**. The start/stop trigger module **215** includes hardware, software and/or firmware to determine where and when data protection is needed. The application lockout module **220** includes hardware, software and/or firmware to effectively suspend other applications not needed during the online transaction (e.g., Authentium Trusted Security Extensions, SecureWave Sanctuary, and/or the like). The network/file I/O control module **225** includes hardware, software and/or firmware to prevent network and/or file I/O by other applications, e.g., by other applications that cannot be suspended. The trusted driver manager **230** includes hardware, software and/or firmware to determine whether device drivers, e.g., the keyboard input driver, on the end-user device **105** can be trusted. The keystrokes generator driver **235** includes hardware, software and/or firmware to generate additional keystrokes and/or replace keystrokes generated by the keyboard input driver **140**, e.g., to input fake keystrokes in a keyboard input pattern. The keystrokes deletion hook **240** includes hardware, software and/or firmware to remove the additional keystrokes and/or replace the original keystrokes generated by the keyboard input driver **140**, e.g., to regenerate the original keyboard input pattern modified by the keystrokes generator driver **235**. The security profile manager **245** includes hardware, software and/or firmware to replace and/or update the security profiles **180**. The transaction network VPN manager **250** includes hardware, software and/or firmware to establish a VPN tunnel with the transaction network **120**.

[0065] It will be appreciated that one method of security leaks of confidential data (e.g., userid, password, credit card number, visual login screen, etc.) require the data to be locally captured and network transmitted. Thus, in some embodiments, instead of focusing on updating traditional anti-virus/anti-spyware with the latest security protection, the application lockout module **220** treats all applications not explicitly needed to use the transaction network **120** as a security threat and disables them for the duration of the online transaction. For example, during the online transaction, the application lockout module **220** allows only the browser **135** and browser-helper applications (e.g., PDF reader) to continue normal execution, while effectively suspending all other applications **145** (regardless of whether they are benign or malevolent). Optionally, the application lockout module **220** could permanently terminate (instead of temporarily suspend) well-known spyware or Trojans.

[0066] Depending on the OS and applications control component features, it is possible for the application lockout module **220** in a first stage to suspend unrequired applications **145** by placing them into background mode, by preventing OS event (e.g., Microsoft windows event messages) from being received by these applications **145**, by intercepting all keyboard and mouse operations to these applications **145**, and/or the like. Further, in a second stage, the application lockout module **220** may stop new applications or processes from being executed, e.g., to prevent changes to the security engine **177** and/or security profiles **180** during the transaction. Thus, unrequired or infected applications that bypass the first stage of protection cannot create another process to capture confidential information or disable the security software.

[0067] In some embodiments, it might not be technically possible for the application lockout module **220** to suspend all unrequired applications **145** and OS processes (e.g., the OS timer), as such might create unintended side effects (e.g., application crashes). When an application **145** cannot be suspended, the network/file I/O control module **225** may provide a second level of global security. The network/file I/O control module **225** effectively prevents information leakage by these unrequired applications **145**. Since unrequired applications **145** need to store and/or transmit the captured information, preventing file I/O operations and/or network I/O transmissions can stop permanent storage and/or transfer of the data. Thus, even if the information is captured by the malicious code, no one can obtain the compromised data. In the extreme case, if the leaked information is cached in memory, rebooting the OS would clear the data. The network/file I/O control module **225** can deny write attempts to all files/directories or the OS registry not required by the browser **135**. Using a VPN tunnel may prevent the confidential data from being sent to the Internet by spyware, Trojans, or the like.

[0068] Embodiments of the invention attempt to enforce protection and/or application/network lockout on demand during a secured data exchange session with less user disruption. Traditional end-point protection and/or lockout solutions, e.g., SecureWave, Bit9, etc., apply full protection or lockout of the end-user device **105** to ensure that only valid or authorized applications are allowed to run. However, this approach is intrusive and disruptive to the end user, who loses the capability to perform normal computing tasks. Embodiments of the invention achieve protection and/or lockout by determining interaction points where and when important sensitive information is being sent to and/or received by the user; by activating end-point protection and/or lockout mechanisms only during these sensitive interaction points; and by de-activating protection and/or lockout outside these interaction points where and when the user is doing things that do not compromise security.

[0069] The start/stop trigger module **215** determines the interaction points during a user's data exchange session where and when sensitive data needs protection. The start/stop trigger module **215** generates a Sensitive_Start flag when sensitive information is present, e.g., when sensitive information is about to be sent, sensitive data is about to be received, sensitive data is about to be displayed, combinations of these points, etc. The start/stop trigger module **215** generates a Sensitive_Stop flag when no sensitive information is present, e.g., when no sensitive data is being sent, received, displayed, etc.

[0070] These flags activate or de-activate end-point protection and/or lockout mechanisms by the application lockout module **220** and/or network/file I/O control module **225** in a more granular manner, which is less intrusive to the end user. For example, assuming the security software is deployed to protect a payment transaction performed on Paypal, the start/stop trigger module **215** could determine when the user's keyboard focus is on the Paypal browser instance, e.g., the user is likely to be sending sensitive login credentials or credit card information to complete the payment, or when any part of the Paypal browser is visible, e.g., personal Paypal user information or transaction data may be displayed. Full security protection may be enforced when this event is detected.

[0071] If the user opens a word documents for editing, the start/stop trigger module **215** may issue a Sensitive_Stop flag, e.g., when it determines that the Paypal browser **135** that it is protecting no longer has keyboard focus (such that no sensitive information meant for Paypal can be captured by keyloggers), or when it determines that the Paypal browser **135** no longer has window focus and no visible area is shown (such that no sensitive personal information related to Paypal can be captured through screen capturing software). Thus, security mechanisms can be turned off when this even occurs.

[0072] The timing for the start/stop trigger module **215** to issue Sensitive_Start and Sensitive_Stop flags can be further customized and refined to fit various security levels for various applications. For example, it may be deemed important to protect the user's login credentials only for an online gaming application and not the gaming screen. Therefore, the Sensitive_Start and Sensitive_Stop flag requirement can be refined to detect only keyboard focus acquired or lost in the gaming application, and not to require detection of window focus.

[0073] In certain embodiments, the start/stop trigger module **215** may listen for a window-focus loss event of the protected application and may minimize the protected application's window. Then, the start/stop trigger module **215** may trigger the Sensitive_Stop event, since it is certain that the protected area is not visible when minimized.

[0074] As an enhancement to achieve transparent and seamless end-point protection, current end-point protection and/or lockout mechanisms on the end-user device **105** may need to be modified to support fast and on-demand activation and de-activation. Working in collaboration with the start/stop trigger module **215**, a fast-switching engine may provide seamless transition when switching between a protected application and a non-protected application. End-point protection may be turned on quickly when the user is working on the protected application and may be turned off quickly when the user switches to a non-protected application. To achieve fast switching, traditional techniques like network tunnel pre-establishment or keep-alive and application pre-loading of the end-point protection process can be used. In one embodiment, the pre-establishment and pre-loading can be done when the OS starts up and/or when the end-point protection mechanism is first activated. The corresponding cleanup can be done when the last protected application is closed and/or when the OS shutdown.

[0075] An example process incorporating start/stop triggers includes:

[0076] (1) The end user boots up computer and launches messaging software like MSN and skype.

[0077] (2) The end user opens a browser **135** session, and activates the connection agent **130** to access his Internet Banking site (e.g., Citibank), which has implemented TNT security software, to transfer funds to his friend.

[0078] (3) The connection agent **130** establishes a secure data exchange to the Citibank site.

[0079] (4) An install agent **182**, e.g., Citibank ActiveX object, is downloaded and loaded into memory.

[0080] (5) The install agent **182** downloads and installs the security engine **177** and/or security profiles **180**.

[0081] (6) The start/stop trigger module **215** determines that the Citibank Webpage is in focus, issues a Sensitive_Start flag, and activates the security engine **177**. All traffic goes through the compulsory non-hijack tunnel and other applications are blocked. The MSN and skype connections break during this stage.

[0082] (7) The end user logs securely into the Citibank Internet banking site and his login credentials are protected by the security engine **177**.

[0083] (8) Before completing the fund transfer transaction, the end user switches to his MSN application to chat with his friend to confirm the amount of transfer.

[0084] (9) Since focus is lost from the Citibank Internet banking site, the start/stop trigger module **215** detects the window focus loss event, minimizes the Citibank browser **135** session, issues the Sensitive_Stop flag, and disables the security engine **177**. Thus, traffic is allowed to go through the original route and not the compulsory tunnel. Further, application blocking is turned off.

[0085] (10) MSN detects network connectivity and reconnects, allowing the end user to chat with his friend.

[0086] (11) The end user launches his Excel application and updates his daily expenses spreadsheet.

[0087] (12) The end user switches back to the Citibank website. The start/stop trigger module **215** notes the Sensitive_Start flag and re-enables the security engine **177**. The MSN and skype connections break again.

[0088] (13) The end user completes the fund-transfer transaction and closes the Citibank browser **135** session.

[0089] (14) The security engine **177** and/or security profiles **180** are unloaded from memory.

[0090] It will be appreciated that traditional keylogger protection mechanisms employ anti-virus detection logic to find and remove resident keyloggers on the end-user device. Unlike computer virus or worms, keyloggers on their own do not attempt to propagate, making keyloggers hard to detect or block using heuristics. Generally, keyloggers hook onto processes available in the end-user device operating system to capture but not modify keystrokes entered by the end user using any keyboard input device or software (e.g., visual keyboard). In certain embodiments, as an alternative approach, the trusted driver manager **230** allows resident intended or unintended keyloggers to continue execution, but renders the keylogging operation ineffective when necessary.

[0091] In certain embodiments, the keyboard input device driver **140** must be trusted. The trusted driver manager **230** validates the current driver **140** by comparing a secure **11**D a secure hash, and/or the like against a list of trusted and/or untrusted keyboard input secure drivers, IDs, hashes, and/or the like. When the keyboard input device driver **140** is unknown, i.e., not in the list of trusted and/or untrusted drivers, the trusted driver manager **230** can temporarily or permanently replace the unknown driver **140** with a trusted driver, possibly only for the duration of the data exchange session.

[0092] In certain embodiments, resident keyloggers may capture keystrokes from any available OSI level beginning from keyboard input device driver **140** to the user space application **145**. Since keyloggers invisibly and passively capture keystrokes, it is reasonable to assume that the keyloggers (unlike the end user, end user application or remote application) cannot differentiate valid or invalid keystrokes from keyboard input devices. Accordingly, the keystrokes generator driver **235** an modify the sequence of end user supplied keystrokes. The modified pattern can be application sensitive, such that it is only generated when specific applications that require keylogger protection are active.

[0093] The keyboard data exchange end-point protection may follow one of various implementation models, e.g., a standalone keystrokes generator driver **235** with application monitoring hook **250** (standalone mode); or a dual keystrokes generator driver **235** and keystrokes deletion hook **240** with optional application monitoring hook **250** (producer consumer mode).

[0094] In standalone mode, the keystrokes generator driver **235** generates fake keystrokes when the keystrokes input by the end user need to be protected. For example, the keystrokes generator driver **235** can generate invalid keystrokes such as non-existent application shortcut menu options that will be silently dropped by the browser **135** when confidential data is input by the end user. The application monitoring hook **250**, which in one embodiment may be part of the start/stop trigger module **215**, determines when the keystrokes input by the end user need to be protected based on the current application status receiving the keystrokes. A non-exhaustive list of relevant application status information includes the application process name, current active text input frame (e.g., application configuration input or user specific data input), valid and invalid application keystrokes, etc. In one embodiment, the keystrokes generator driver **235** determines the keystrokes to generate. In another embodiment, the application monitoring hook **250** analyzes the application status and determine the keystrokes for the keystrokes generator driver **235** to generate.

[0095] In producer consumer mode, the keystrokes generator driver **235** and keystrokes deletion hook **240** control keystroke generation and deletion. In one embodiment, the keystrokes generator driver **235** may embed identification of the fake keystrokes within the keystrokes data flow (inband mode), may be managed by an external controller such as the application monitoring hook **250** (outband mode), or may employ a combination of inband and outband controls. The keystrokes deletion hook **140** can be implemented as an OS hook or application-specific plug-in installed at the last possible level of the keyboard input processing flow shown in FIG. **6**. The execution point of the keystrokes deletion hook **240** is operatively contradictory to keyloggers implementation requirement, which attempts to be at the earliest input processing flow closest to avoid being circumvented. The keystrokes deletion hook **240** deletes fake keystrokes generated by the keystrokes generator driver **235**, before the fake keystrokes are processed by the protected end-user applications.

[0096] For keyloggers requiring local or remote keystrokes disk storage with limited keystrokes memory buffer, I/O blocking logic (possibly combined with either or both of the above mentioned approaches) can cause such keyloggers to lose keystrokes data or malfunction. One example process includes:

[0097] (1) Start I/O blocking

[0098] (2) Before the end user inputs confidential data, the keystrokes generator driver **235** generates fake keystrokes to fill up keyloggers limited memory buffer or causes the keyloggers to lose data.

[0099] (3) After the end inputs confidential data, the keystrokes generator driver **235** generates fake keystrokes to overwrite any keyloggers limited memory buffer or causes the keyloggers to lose data.

[0100] (4) Stop I/O blocking.

[0101] It will be appreciated that VPN tunneling is a well-established concept used to authenticate access to a remote network with private resources, to provision access to the remote network with the private resources, and to secure the confidentiality and integrity of the private data exchanged between the end-user device and the remote network. VPN tunneling can also indirectly prevent access to other public resources originally accessible to the end-user device. Further, VPN tunneling may be used for server authentication (authenticating the transaction network **120**) and for client authentication (authenticating the end-user device **105**). VPN tunnel encryption indirectly prevents tunnel hijacking, since encrypted data cannot be spoofed. VPN tunneling may be used to allow access to a predetermined set of resources without requiring network revamp. This predetermined set of resources can be a combination of public resources (e.g., resources the end-user device **105** can remotely access before the VPN tunnel is established) and private resources (resourced that the end-user device **105** can only access after the VPN tunnel is established).

[0102] For certain embodiments of the invention, a VPN may be valued to authenticate the remote network, to provision access to the authenticated remote network resources, to prevent access to all other remote resources outside the authenticated remote network, and to ensure the integrity of the data exchanged between the two end-points (the end-user device and the authenticated remote network).

[0103] To authenticate the remote network, the connection agent **130** and/or transaction network VPN manager **250** may authenticate the remote network (e.g., the transaction network **120**) using any predefined direct or indirect trust relationship. Authentication can be achieved indirectly using existing public key infrastructure (PKI) mechanisms or directly using a predefined secret key.

[0104] To ensure the integrity of the data exchanged, after the authentication phase, the connection agent **130** and/or transaction network VPN manager **250** may employ a key exchange process with the authentication router, e.g., using Diffie-Hellman key exchange. This key exchange process may be integrated with the authentication process as a single phase, e.g. Perfect Forward Secrecy. The transaction network **120** may use the ephemeral key negotiated by the key exchange process to ensure data integrity between the two end-points, to verify data integrity received from the end-user device **105**, and/or to generate message authentication code for the data sent from the remote network to the end-user device **105**, e.g. Message-Digest algorithm 5. The same reverse logic applies to the connection agent **130** and/or transaction network VPN manager **250**. The message authentication code can be inband (part of the data exchange, e.g. IPSEC Authentication Header) or outband (e.g., using a different communication channel).

[0105] Tunneling, authentication and data integrity verification can be decoupled in implementation, i.e., they may be performed by independent entities. For example, the VPN tunnel can be established between the end-user device **105** and a hardware-based dedicated tunneling router. Authentication may be performed between the end-user device **105** and a server behind the tunneling router. Since in one embodiment tunneling involves only encapsulation and decapsulation, a dedicated tunneling router can perform it efficiently. If traffic integrity checking is performed inband of the tunnel, then, based on the source and the destination IP address of the traffic with message authentication code, the tunneling router could route or load balance the traffic to different authentication servers to perform data integrity checking.

[0106] To prevent access to remote resources, the connection agent **130** and/or VPN manager **250** may establish a compulsory tunnel from the end-user device **105** to the transaction network **120**. Conversely, traffic from the transaction network **120** to the end-user device **105** need not necessarily be tunneled. To provide access to authenticated resources and to prevent access to all other remote resources, a bi-directional or unidirectional tunnel may be used, a virtual IP may be allocated to the end-user device **105**, and/or ingress or egress filtering may be used.

[0107] If a virtual IP is allocated to each end-user device **105** to access the remote network resources, all end-user devices **105** can be grouped under a common pool of IP addresses. As illustrated in FIG. **7**, ingress filtering of these virtual IP addresses can be used to prevent data from the end-user devices **105** from being routed out of the authenticated remote network. Ingress filtering may not be possible if a uniquely identifiable virtual IP address pool is not allocated. In the case where ingress filtering is not possible, egress filtering can be done after the tunnel decapsulation router to ensure that only resources within the authenticated network are accessible.

[0108] There may be one or more default routers for the pool of virtual IP addresses. All data sent to these virtual IP address may be routed to these default routers. Bi-directional tunneling may be used if a virtual IP address is allocated, because the virtual IP address is only routable within the remote network. An exception may be employed when the virtual IP address used is a publicly routable IP address belonging to the end-user device **105**. When bi-directional tunneling is employed, the virtual IP addresses default routers can encapsulate the data from the remote network back to the end-user device **105**. Unlike the tunnel decapsulation router that is stateless, the default routers can maintain the tunnel state information. The tunnel state information may include the WAN IP to virtual IP association of the end-user device **105**, to encapsulate and tunnel data back to the end-user device **105**. The expiry of the tunnel state information may be effected via keep-alive messages sent from the connection agent **130** directly or indirectly to the default router(s).

[0109] In one embodiment, tunneling protocols can reuse the IP address of the end-user device **105** for both the tunnel IP header (traffic between the end-user device **105** and the decapsulation router) and the application IP header (traffic between the end-user device **105** and the remote network resources). If the tunneling protocol can reuse the IP address of the end-user device **105** for both tunneling and application communication, virtual IP provisioning by the remote network may be unnecessary. If computing device IP address reuse is not automatic, the remote network may use the virtual IP provisioning mechanism to decide if a localized virtual IP may be used for application communication or allocate the computing device IP address as the virtual IP.

[0110] The remote network virtual IP provisioning system may determine if the end-user device **105** is behind a Network Address Translation (NAT) or Network Address and Port Translation (NAPT) router, to determine what application communication IP address and tunneling protocol to use. By reusing the IP address of the end-user device **105** instead of a localized virtual IP for the tunnel IP header, bi-directional tunneling can be avoided. The application traffic from the remote network resources may be sent directly to the end-user device **105**. Thus, virtual IP default router(s) to encapsulate the return traffic may be necessary.

[0111] If the end-user device is behind a NAT or NAPT router, a unidirectional transport level tunneling protocol that is NAT and NAPT friendly may be used. Instead of having both a tunnel IP header and an application IP header, there may be only one IP header. The unidirectional transport level tunneling protocol may be intended for application traffic from the end-user device **105** to the remote network decapsulation router.

[0112] An example tunneling encapsulation procedure is provided as follows:

[0113] (1) The end-user device **105** generates application data and application IP header (i.e., an application IP datagram).

[0114] (2) The application IP datagram is sent to the tunneling driver.

[0115] (3) The tunneling driver inserts the original destination IP address in the transport header field (e.g., the TCP option field) or between the transport header and the application payload.

[0116] (4) The tunneling driver replaces the destination IP address with the IP address of the remote network decapsulation router.

[0117] (5) The tunneling driver may set the IP header type-of-service field to indicate the datagram is encapsulated.

[0118] (6) The tunneling driver adjusts the IP header total length and re-computes the IP header checksum.

[0119] (7) The encapsulated IP datagram is transmitted.

[0120] An example tunneling decapsulation procedure is as follows:

[0121] (1) The decapsulation router checks if the datagram is encapsulated, e.g., checks the IP header type-of-service field or TCP option field.

[0122] (2) If the datagram is encapsulated, the decapsulation router replaces the destination IP address with the original embedded application destination IP address.

[0123] (3) The embedded application destination IP address may or may not be removed by the decapsulation router.

[0124] (4) The decapsulation router re-computes the IP header checksum and adjusts the IP header total length if necessary.

[0125] (5) The decapsulated IP datagram is transmitted.

[0126] Embodiments of the tunneling protocol achieve functionality similar to TCP or UDP port forwarding, without the need for the decapsulation router to keep state or port to IP address mapping configuration information. Such information is encapsulated in the tunneled datagram.

[0127] If the remote network provisioning system can verify that the traffic from the end-user device **105** will not be NATed, standard tunneling protocols (e.g., GRE, IP-in-IP, etc.) can be used. The IP of the end-user device **105** can be reused for both the tunnel IP header and application IP header using standard tunneling protocol. The tunneled traffic can be decapsulated by standard routers and the remote network resources can directly reply to the end-user device **105** without bi-directional tunneling.

[0128] Embodiments of the invention enable application-specific encryption (e.g., HTTPS) to be used in conjunction with the tunneling mechanism described herein to ensure privacy of confidential data. That is, there can be a combination of encrypted and unencrypted data exchange through the tunnel. This reduces encryption and decryption overhead to only confidential data, instead of maintaining encryption and decryption overhead for all data in a VPN architecture.

[0129] FIG. **3** is a block diagram illustrating a network system **300** operative to effect a trusted network transaction (TNT) with an Internet banking portal, in accordance with an embodiment of the present invention.

[0130] As shown, in step **1**, the end user accesses his original Internet banking portal URL via a browser **135** installed on an insecure end-user device **105**.

[0131] In step **2**, the existing Internet banking login page detects whether the end user's browser **135** is capable of supporting TNT, e.g., supports ActiveX controls. If so, the Internet server **315** displays the Internet banking login page with an additional "button" for the end user to selectively enable TNT security. If the end-user device **105** cannot support TNT, then the original Internet banking login page is displayed without the TNT button.

[0132] In step **3**, the end user clicks on the TNT button, which causes the Internet banking server **315** to download the install agent **182**, e.g., an ActiveX control, to the end-user device **105**. The end-user device **105** confirms that the install agent **182** is digitally signed by the bank, which is a trusted party by the end-user device **105**. The end-user device **105** allows the trusted install agent **182** to execute.

[0133] In step **4**, the install agent **182** establishes a VPN tunnel to a predefined VPN server **320** in the banking server farm **310** and establishes predefined VPN authentication credentials. After the VPN tunnel is established, all network traffic from the end-user device **105** is sent to the VPN server **320**. That is, the end-user device **105** is disconnected from the rest of the Internet. The VPN server **320** (or a firewall) manages network resources accessible by the end-user device **105**. That is, only network resources (e.g., the Internet banking web site) required for Internet banking transactions are made accessible to the end-user device **105**.

[0134] In step **5**, the security engine **177** is downloaded over the VPN. Armed with the security engine **177**, an application lockout module **220** may be used to suspend applications not required for the Internet banking transaction and to prevent new applications from being executed.

[0135] In step **6**, after the end user completes all Internet banking transactions and requests logout, the install agent **182** may be downloaded again. The install agent **182** detects the previously existing active TNT session, removes the security engine **177**, and terminates the VPN tunnel before ending the install agent **182** process.

[0136] FIG. **4** is a block diagram illustrating a network system **400** operative to effect a TNT by an end-user device **405** with a banking portal, the TNT being managed by the end user's ISP network **440**, in accordance with an embodiment of the present invention. In one embodiment, the end user's ISP network **440** may provide TNT protection for multiple transaction sites **120**. The network system includes the ISP network **440** coupled via the Internet **450** to a banking server farm **445**. The ISP network **440** includes the end-user device **405** coupled via an intranet **435** to an ISP server **410**, to a VPN server **415**, and to a VPN router **420**. The banking server farm **445** includes a banking server **425** and a VPN router **430**. The VPN router **420** of the ISP network **440** is coupled to the VPN router of the banking server farm **445** via the Internet **450**.

[0137] In step **1**, the end-user device **405** accesses the banking server **425** via a software application, e.g., the connection agent **130**, that enables the user to select from multiple specific URLs of TNT-enabled sites **120**. Upon selection of a URL, the software application is configured to direct the browser **135** to the selected URL. The list of specific URLs may be installed on the end-user device **405** by the ISP **410** or may be available on the portal page of the ISP **410**. Alternatively, the end-user device **405** may navigate directly to the banking server **425**, possibly via a TNT "button" from the site presented by the ISP server **410**.

[0138] In step **2**, the end user selects the URL of the transaction network **120** to access with TNT protection. The connection agent **130** establishes a preliminary VPN with the ISP server **410**. The install agent **182** is downloaded from the ISP server **410** (or other trusted source dedicated to supporting TNT for the banking site **425**). The end-user device **405** is informed that the install agent **182** is digitally signed by the ISP server **410**, which is a trusted by the end-user device **405**. The end-user device **405** allows the install agent **182** to execute. The install agent **182** may be embedded with the latest IP addresses of the TNT-enabled sites or VPN servers (independent of DNS updates propagation delays or DNS security risks). The OS host file of the end-user device **105** may be updated by the install agent **182** with the IP addresses to prevent URL redirection for TNT protected sites due to DNS poisoning. Any changes to the TNT-managed IP addresses may be controlled by the ISP server **410**. A transaction network **120**, e.g., banking server **425**, informs the ISP server **410** whenever changes in the IP addresses of web servers occur (instead of depending on Internet DNS updates).

[0139] In step **3**, the install agent **182** establishes a VPN tunnel to the VPN server **415** using predefined VPN authentication credentials specified in the ISP server's web page (from the URL selected in Step **2**). The VPN authentication credentials can be uniquely created from each TNT session to associate the specific end-user device **405** to access the banking server **425**, even if the end-user device **405** is hidden behind an NAT router. For example, the VPN login userid could be the subscriber ISP userid+end-user device **105** MAC address or computer name (detected by the TNT ActiveX control)+target TNT site. This allows the ISP server **410** to track down the actual end-user device **405** performing online TNT transactions if there is any audit requirements or to "blacklist" an end-user device **105** (instead of the end user who can continuously change his login credentials) that regularly posts false offers for online auctions web sites, etc.

[0140] In step **4**, after the temp VPN tunnel is established, all network traffic from the end-user device **405** is sent to the VPN server **415**. That is, the end-user device **405** is disconnected from the rest of the Internet. The VPN server **415** (or a firewall) within the ISP network **440** manages the network resources accessible by the end-user device **405**. That is, only network resources (e.g., the banking server **425**) required for the Internet banking transactions are made accessible.

[0141] In step **5**, the security engine **177** and/or security profiles **180** are downloaded, installed and executed. Using the application lockout module, the security engine **177** blocks applications not required for the Internet banking transactions and prevents new applications from being executed. Other TNT protection mechanisms may also be used. The transaction network VPN manager **250** establishes a VPN tunnel with the VPN server **415**.

[0142] In step **6**, the VPN server **415** is deployed. To ensure network security over the Internet **450** from the ISP network **440** to the banking server **425**, a permanent VPN tunnel may be established between the ISP network **440** and the banking server **425**, e.g., using the ISP-managed VPN router **420** and the bank-managed VPN router **430**. This ensures that intermediate Internet routers between the ISP network **440** and the banking server **425** cannot hijack traffic to and/or from the end-user device **405**. This also allows the banking server **425** to manage additional network security policies within their own network on top of those provided by the ISP network **440**.

[0143] In step **7**, after the end user completes his Internet banking transactions and requests logout, the install agent **182** is downloaded again from the ISP server **410**. The install agent **182** detects the previous existing active INT session, removes the security engine **177**, and terminates the VPN tunnel before ending the install agent **182** process.

[0144] Combinations of the various techniques described in this invention could be used in an actual deployment of TNT. Various alternative technologies, e.g., a Java applet instead of Microsoft ActiveX, SSL instead of PPTP VPN tunnel, etc., can be used.

[0145] FIG. **5** is a block diagram illustrating a network system **500** operative to effect security engine installation, in accordance with an embodiment of the present invention.

[0146] In step **1**, the connection agent **130** uses a pre-configured and unchangeable network address to contact a secure network address resolution service **520** to obtain the network address of a trusted source of the security engine **515** or a list of trusted sources. For example, an IP address of a trusted DNS security extensions (DNSSEC) server **520** may be pre-configured in the connection agent **130**.

[0147] In step **2**, the connection agent **130** uses this IP address to connect to the DNSSEC server **520** to resolve the domain name of the trusted source to an IP address. In another embodiment, the DNSSEC server **520** may download a list of approved sites, from which the end-user device **505** may select a URL of the trusted source of the security engine **515**.

[0148] In step **3**, using the network address of the trusted source, the connection agent **130** establishes a secure data exchange with the trusted source, preventing network traffic from the end-user device **105** from being misdirected to untrusted sources and guarding against other forms of network intrusion and attacks. For example, in a TCP/IP network, in connection agent **130** may use the resolved IP address to connect to the trusted source, e.g., via a secure tunnel. This connection technique ensures that the network address is accurate (e.g., not poisoned by a DNS attack), and assures that the end-user device **105** connects to the intended trusted source. Further communication protocols employed in the secure network address resolution service **520** ensures that communication to and from the end-user device **105** is authenticated, authoritative and accurate.

[0149] In step **4**, with a secure exchange established, the end-user device **105** downloads the security engine **515**, e.g., using protocols like HTTP or FTP. The secure tunnel established by the connection agent **130** ensures that data traffic between the end-user device **105** and the trusted source is secure and cannot be compromised, even when insecure protocols like HTTP and FTP are used.

[0150] In step **5**, after delivery of the security engine **515**, the end-user device **105** executes the security engine **515**. The security engine **515** effectively secures the end-user device **105**, e.g., allows the end-user device **105** to communicate only with trusted transaction sties, e.g., trusted remote network **535**, prevents other applications **145** running on the end-user device **105** from capturing or sending information, especially to untrusted sites, etc. The user can then access and interact with the transaction sites in confidence.

[0151] FIG. **6** is a hierarchical level diagram illustrating keyboard-input processing flow **600**, in accordance with an embodiment of the present invention. Flow **600** is divided into physical space **605**, kernel space **610**, and application space **615**. In physical space **605**, the end user makes keystrokes on the keyboard at level **620**. In kernel space **610**, the trusted keyboard driver receives keystrokes at level **625**. The keystrokes generator driver resides and generates fake keystrokes at level **630**. The potential untrusted keylogger driver captures keystrokes at level **620** or thereafter. In application space **615**, a potential untrusted keylogger hook potentially captures keystrokes at level **640**. The keystrokes deletion hook removes fake keystrokes at level **645**. The application receives the cleaned keystroke pattern at level **650**. Somewhere between level **630** in kernel space and level **645** in application space **615**, an application monitoring hook, plugin and/or driver monitors application status, and possibly feeds information to the keystrokes generator driver at level **630**.

[0152] FIG. **7** is a block diagram illustrating a network system **700** operative to effect tunnel datagram processing, in accordance with an embodiment of the present invention. The embodiment uses standard GRE and IPsec AH mechanisms to illustrate the tunneling mechanism. Embodiments of the invention may be applicable to other combinations of tunneling and data integrity protocols.

[0153] It is assumed that a GRE tunnel has been established between the end-user device **705** and a GRE router **735**. The tunneling driver adds an AH header to the IP packet generated by the computing device **705**. The AH header is used to authenticate with the authentication router **750***a* or **750***b*. The IP packet with AH header is further encapsulated in a GRE packet before it is sent out.

[0154] The GRE packet is transferred through the GRE tunnel via the Internet **710**, until it reaches the GRE router **735**. The GRE router **735** decapsulates the GRE packet back to the IP packet with AH header. Further, based on the source and destination IP addresses, the GRE router **735** routes the decapsulated packet to an authentication router **750***a* or **750***b*.

[0155] Before the packet reaches the authentication router **750***a* or **750***b*, it passes through a firewall **745**, which performs egress filtering to ensure that access only to intended resources is allowed and that access to forbidden resources is blocked.

[0156] Upon receiving the IP AH packet, the authentication router **750***a* and **750***b* performs an authentication check to ensure that the packet comes from the computing device **705**. It removes the AH header and routes the packet to the intended resources **720***a*, **720***b* or **720***c*. That is, the packet is returned back to the format as originally generated by the computer device **705**.

[0157] The intended resource processes the packet and generates a reply to the authentication router **750***a* or **750***b*.

[0158] The authentication router **750***a* or **750***b* adds an AH header to the reply packet. The AH header is used to authenticate any remote network resources **720***a*, **720***b* or **720***c*. The authentication router **750***a* or **750***b* routes the new IP AH packet back to the GRE server **735**.

[0159] The GRE router **735** encapsulates the reply packet and sends it back to the end-user device **705** via the tunnel.

[0160] The tunneling driver on the end-user device **705** decapsulates the packet and verifies the AH header. If the AH header passes the check, the packet is trusted as coming from the authenticated remote network resources **720***a*, **720***b* or **720***c*. The AH header is removed before the packet is passed to the upper layer of the network stack for further processing. If the AH header fails the check, then a security measure is taken. The measure could include breaking the tunnel or alerting the end user.

[0161] There are many other possible variation of the example described. The authentication server **750***a* or **750***b* can be moved outband of the communication between the end-user device **705** and the network resources **720***a*, **720***b* or **720***c*. The authentication server **750***a* or **750***b* can communicate with the GRE router **735** to retrieve a checksum of packets received from the tunnel and can encrypt it with a private key whose public key is known to the tunneling software. The encrypted checksum may be transferred to the tunnel software regularly in a separate channel so that the tunnel software is able to ensure that it is communicating with the actual remote network resource **720***a*, **720***b* or **720***c*.

[0162] Certain embodiments facilitate the use of data protection mechanisms to have negligible demand on the end user and end-user device. In one embodiment, the end user need only select the network software application that the end user wants to use to exchange data and the trusted remote network with which the end user wishes to establish a secure data exchange session. After the data protection mechanism are enabled, the end user need not differentiate between trusted and untrusted software and remote networks. Further, certain embodiments enable minimal change to existing Internet banking or shopping sites, minimal TNT deployment effort, and minimal change to end user web site usage experience.

[0163] FIG. **8** is a screen shot of a desktop **805** on an end-user device **105** before spyware infection or spoofing attack.

[0164] FIG. **9** is a screen shot of the desktop **805** on an end-user device **105** after spyware infection.

[0165] FIG. **10** is a screen shot of the desktop **805** of an end-user device **105** with a window **1005** illustrating keylogger infection.

[0166] FIG. **11** is a screen shot of the desktop **805** on an end-user device **105** with a window **1105** illustrating keystroke capture.

[0167] FIG. **12** is a screen shot of the desktop **805** on an end-user device **105** before DNS poisoning.

[0168] FIG. **13** is a screen shot of the desktop **805** on an end-user device **105** with a window **1305** illustrating a legitimate IP address in a DNS cache before DNS poisoning.

[0169] FIG. **14** is a screen shot of the desktop **105** on an end-user device **105** with the window **1305** after DNS poisoning.

[0170] FIG. **15** is a screen shot of the desktop **805** on an end-user device **105** with a window **1505** illustrating a spoofed IP address in the DNS cache, after DNS poisoning.

[0171] FIG. **16** is a screen shot of the desktop **805** on an end-user device **105** with a browser window **1605** illustrating the spoofed site at the IP address of FIG. **15**.

[0172] FIG. **17** is a screen shot of the desktop **805** on an end-user device **105** with a browser window **1605** illustrating the spoofed site and with a security alert **1705**.

[0173] FIG. **18** is a screen shot of the desktop **805** on an end-user device **105** with a browser window **1605** illustrating the spoofed site and with a spoofed security certificate **1805**.

[0174] FIG. **19** is a screen shot of the desktop **805** on an end-user device **105** with a window **1905** illustrating keylogger infection and after DNS poisoning but before protection by embodiments of the invention.

[0175] FIG. **20** is a screen shot of the desktop **805** on an end-user device **105** with a window **2005** illustrating continuous pinging of the Yahoo website to evidence the availability of outbound communication.

[0176] FIG. **21** is a screen shot of the desktop **805** on an end-user device **105** with a window **2105** illustrating that a download agent, e.g., an ActiveX control, is being delivered to the end-user device.

[0177] FIG. **22** is a screen shot of the desktop **805** on an end-user device **105** with a window **2205** illustrating that the download agent is being executed and is establishing a VPN connection with a trusted source of a security engine **177**.

[0178] FIG. **23** is a screen shot of the desktop **805** on an end-user device **105** with a window **2305** illustrating that the download agent has established a VPN connection with the trusted source, has downloaded and installed the security engine **177**, and is presenting a button **2310** to navigate to the legitimate banking site. Installation of the security engine **177** enables network communication lockout, application lockout, driver management, keystroke pattern modification, and like TNT mechanisms.

[0179] FIG. **24** is a screen shot of the desktop **805** on an end-user device **105** with a window **2405** illustrating that the continuous pinging of the Yahoo website has stopped, evidencing that outbound communication has been suspended.

[0180] FIG. **25** is a screen shot of the desktop **805** on an end-user device **105** with a window **2505** illustrating the legitimate IP address of the legitimate banking site.

[0181] FIG. **26** is a screen shot of the desktop **805** on an end-user device **105** with a window **2605** illustrating application lockout.

[0182] FIG. **27** is a screen shot of the desktop **805** on an end-user device **105** with the window **2305** illustrating the button **2310** to navigate to the legitimate banking site.

[0183] FIG. **28** is a screen shot of the desktop **805** on an end-user device **105** with a browser window **2805** illustrating the legitimate banking site.

[0184] FIG. **29** is a screen shot of the desktop **805** on an end-user device **105** with the browser window **2805** and the legitimate banking site certificate **2905** of the legitimate banking site.

[0185] FIG. **30** is a screen shot of the desktop **805** on an end-user device **105** with the browser window **2805** of the legitimate banking site and illustrating that the keylogger is no longer active when the keylogger reveal word, "frklg," is typed in the address field **3005**.

[0186] FIG. **31** is a screen shot of the desktop **805** on an end-user device **105** with the browser window **2805** and after entry of confidential data into the login window **3105**, just before the security engine **177** is deactivated and/or removed.

[0187] FIG. **32** is a screen shot of the desktop **805** on an end-user device **105** with a window **3205** illustrating that outbound communication has resumed.

[0188] FIG. **33** is a screen shot of the desktop **805** on an end-user device **105** with a window **3305** illustrating resumed vulnerability to the DNS poisoning of the DNS cache.

[0189] FIG. **34** is a screen shot of the desktop **805** on an end-user device **105** with a window **3405** illustrating that the security engine **177** protected the memory space from registering the browser window **2805**.

[0190] FIG. **35** is a screen shot of the desktop **805** on an end-user device **105** with a window **3505** illustrating that the keylogger infection has been permanently neutralized.

[0191] The foregoing description of the preferred embodiments of the present invention is by way of example only, and other variations and modifications of the above-described embodiments and methods are possible in light of the foregoing teaching. Although the network sites are being described as separate and distinct sites, one skilled in the art will recognize that these sites may be a part of an integral site, may each include portions of multiple sites, or may include combinations of single and multiple sites. The various embodiments set forth herein maybe implemented utilizing hardware, software, or any desired combination thereof. For that matter, any type of logic may be utilized which is capable of implementing the various functions set forth herein. Components may be implemented using a programmed general-purpose digital computer, using application specific integrated circuits, or using a network of interconnected conventional components and circuits. Connections may be wired, wireless, modem, etc. The embodiments described herein are not intended to be exhaustive or limiting, The present invention is limited only by the following claims.

1. A network system comprising: a transaction network operative to provide a transaction with an end user; a trusted source of a security mechanism for at least partially protecting an end-user device from malicious code operative thereon that attempts to capture confidential data presented during the transaction, the security mechanism being maintained by a party other than the end user; and an agent for providing the security mechanism to the end-user device to protect the end-user device during the transaction.

2. The network system of claim **1**, wherein the transaction network provides banking site.

3. The network system of claim **1**, wherein the transaction network provides a gaming site.

4. The network system of claim **1**, wherein the trusted source resides on an ISP network.

5. The network system of claim **1**, wherein the trusted source and the transaction network are managed by the same entity.

6. The network system of claim **1**, wherein the trusted source resides on the transaction network.

7. The network system of claim **1**, wherein the security mechanism includes a security engine.

8. The network system of claim **1**, wherein the security mechanism includes a security profile.

9. The network system of claim **1**, wherein the security mechanism includes a security engine and a security profile.

10. The network system of claim **1**, wherein the security mechanism includes a start/stop trigger module for controlling when to initiate one or more aspects of the security mechanism and when to deactivate the one or more aspects of the security mechanism.

11. The network system of claim **1**, wherein the security mechanism includes an application lockout module for suspending at least one application not needed to effect the transaction.

12. The network system of claim **1**, wherein the security mechanism includes a file/network I/O control module for disabling at least one file or network operation during the transaction.

13. The network system of claim **1**, wherein the security mechanism includes a trusted driver module for determining whether a driver on the end-user device matches a known trusted driver.

14. The network system of claim **13**, wherein driver is a keyboard driver.

15. The network system of claim **1**, wherein the security mechanism includes a keystrokes generator driver for generating additional keystrokes to a keystroke pattern generated by the end user.

16. The network system of claim **15**, wherein the security mechanism includes a keystrokes deletion hook for deleting the additional keystrokes generated by the keystrokes generator driver.

17. The network system of claim **1**, wherein the security mechanism includes an IP address to a server with the transaction network.

18. The network system of claim **1**, wherein the security mechanism includes a VPN manager capable of establishing a secure tunnel between the end-user device and the transaction network.

19. The network system of claim **1**, wherein the agent is capable of removing the security mechanism upon completion of the transaction.

20. The network system of claim **1**, further comprising a second agent being capable of removing the security mechanism upon completion of the transaction.

21. The network system of claim **1**, wherein the agent includes an install agent downloaded from the trusted source.

22. The network system of claim **1**, wherein the agent includes an install agent downloaded from a third-party server.

23. The network system of claim **1**, wherein the agent includes a connection agent preloaded onto the end-user device.

24. A method comprising: requesting by an end user a secure transaction with a transaction network providing a transaction; receiving from a trusted source a security mechanism for at least partially protecting an end-user device from malicious code operative thereon that attempts to capture confidential data presented during the transaction, the security mechanism being maintained by a party other than the end user; activating the security mechanism; establishing a secure connection between an end-user device and the transaction network; and enabling the transaction.

25. The method of claim **24**, wherein the transaction network provides a banking site.

26. The method of claim **24**, wherein the transaction network provides a gaming site.

27. The method of claim **24**, wherein the trusted source resides on an ISP network.

28. The method of claim **24**, wherein the trusted source and the transaction network are managed by the same entity.

29. The method of claim **24**, wherein the trusted source resides on the transaction network.

30. The method of claim **24**, wherein the security mechanism includes a security engine.

31. The method of claim **24**, wherein the security mechanism includes a security profile.

32. The method of claim **24**, wherein the security mechanism includes a security engine and a security profile.

33. The method of claim **24**, wherein the security mechanism includes a start/stop trigger module for controlling when to initiate one or more aspects of the security mechanism and when to deactivate the one or more aspects of the security mechanism.

34. The method of claim **24**, wherein the security mechanism includes an application lockout module for suspending at least one application not needed to effect the transaction.

35. The method of claim **24**, wherein the security mechanism includes a file/network I/O control module for disabling at least one file or network operation during the transaction.

36. The method of claim **24**, wherein the security mechanism includes a trusted driver module for determining whether a driver on the end-user device matches a known trusted driver.

37. The method of claim **36**, wherein driver is a keyboard driver.

38. The method of claim **24**, wherein the security mechanism includes a keystrokes generator driver for generating additional keystrokes to a keystroke pattern generated by the end user.

39. The method of claim **38**, wherein the security mechanism includes a keystrokes deletion hook for deleting the additional keystrokes generated by the keystrokes generator driver.

40. The method of claim **24**, wherein the security mechanism includes an IP address to a server within the transaction network.

41. The method of claim **24**, wherein the security mechanism includes a VPN manager capable of establishing a secure tunnel between the end-user device and the transaction network.

42. The method of claim **24**, further comprising removing the security mechanism upon completion of the transaction.

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