VIPROY

VoIP Wars : Return of the SIP

Fatih Özavcı

Information Security Researcher & Consultant

fatih.ozavci at viproy.com viproy.com/fozavci

whois

- Information Security Consultant @ Viproy / Turkey
- 10+ Years Experience in Penetration Testing
- 800+ Penetration Tests, 40+ Focused on NGN/VoIP
  - SIP/NGN/VoIP Systems Penetration Testing
  - Mobile Application Penetration Testing
  - IPTV Penetration Testing
  - Regular Stuff (Network Inf., Web, SOAP, Exploitation...)
- Author of Viproy VoIP Penetration Testing Kit
- Author of Hacking Trust Relationships Between SIP Gateways
- Blackhat Arsenal USA 2013 – Viproy VoIP Pen-Test Kit

- So, that's me

traceroute

- VoIP Networks are Insecure, but Why?
- Basic Attacks but in Easy Way
  - Discovery, Footprinting, Brute Force
  - Initiating a Call, Spoofing, CDR and Billing Bypass
- SIP Proxy Bounce Attack
- Fake Services and MITM
  - Fuzzing Servers and Clients, Collecting Credentials
- (Distributed) Denial of Service
  - Attacking SIP Soft Switches and SIP Clients, SIP Amplication Attack
- Hacking Trust Relationships of SIP Gateways
- Attacking SIP Clients via SIP Trust Relationships
- Fuzzing in Advance

- Out of Scope
  - RTP Services and Network Tests, Management
  - Additional Services
  - XML/JSON Based Soap Services

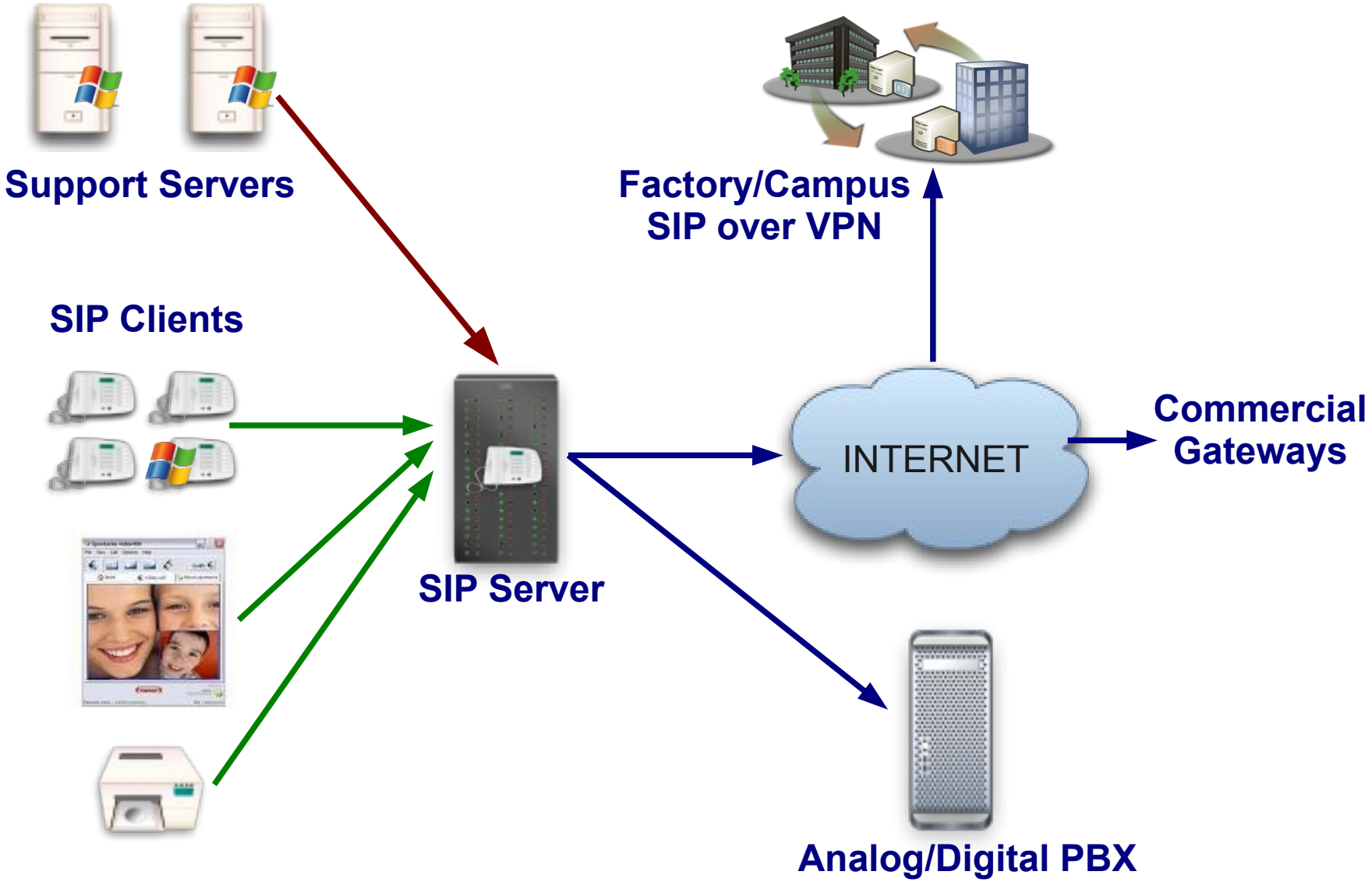
info

- SIP – Session Initiation Protocol
  - Only Signaling, not for Call Transporting
  - Extended with Session Discovery Protocol
- NGN – Next Generation Network
  - Forget TDM and PSTN
  - SIP, H.248 / Megaco, RTP, MSAN/MGW
  - Smart Customer Modems & Phones
  - Easy Management
  - Security is NOT a Concern?!
- Next Generation! Because We Said So!

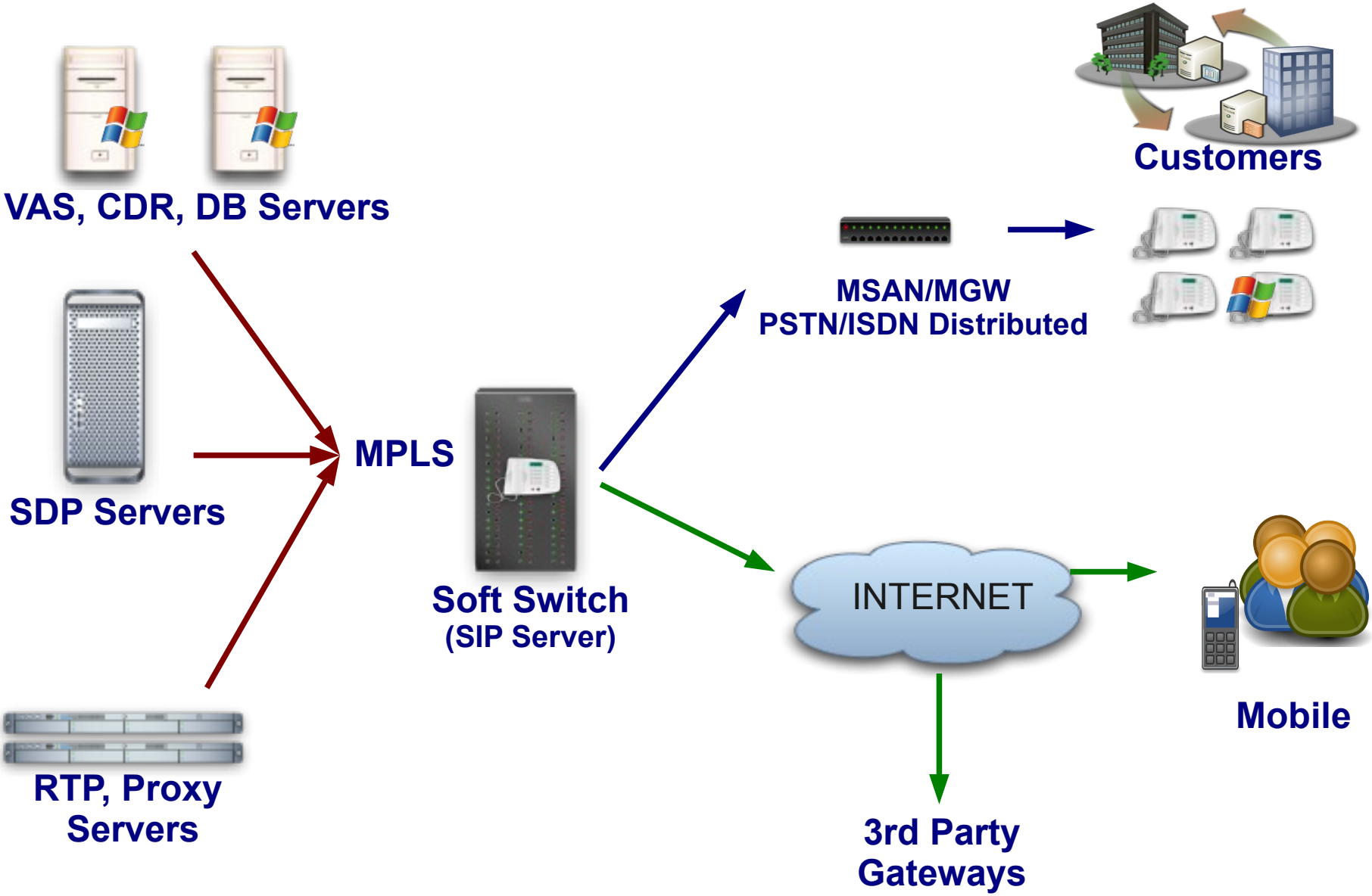
Administrators Think... Root Doesn't!

- Their VoIP Network Isolated
  - Open Physical Access, Weak VPN or MPLS
- Abusing VoIP Requires Knowledge
  - It's Easy with Automated Tools, But That's the Case !
- Most Attacks are Network Based or Toll Fraud
  - DOS, DDOS, Attacking Mobile Clients, Spying
  - Phishing, Surveliance, Abusing VAS Services
- VoIP Devices are Well-Configured
  - Weak Passwords, Old Software, Vulnerable Protocols

SIP Services : Internal IP Telephony



SIP Services : Commercial Services



Viproy What?

- Viproy is a Vulcan-ish Word that means "Call"
- Viproy VoIP Penetration and Exploitation Kit
  - Testing Modules for Metasploit, MSF License
  - Old Techniques, New Approach
  - SIP Library for New Module Development
  - Custom Header Support, Authentication Support
  - New Stuffs for Testing: Trust Analyzer, Proxy etc
- Modules
  - Options, Register, Invite
  - Brute Forcers, Enumerator
  - SIP Trust Analyzer, Service Scanner
  - SIP Proxy, Fake Service, DDOS Tester

Basic Attacks but in Easy Way

- We are looking for...
  - Finding and Identifying SIP Services and Purposes
  - Discovering Available Methods and Features
  - Discovering SIP Software and Vulnerabilities
  - Identifying Valid Target Numbers, Users, Realm
  - Unauthenticated Registration (Trunk, VAS, Gateway)
  - Brute Forcing Valid Accounts and Passwords
  - Invite Without Registration
  - Direct Invite from Special Trunk (IP Based)
  - Invite Spoofing (After or Before Registration, Via Trunk)

- Viproy Pen-Testing Kit Could Automate Discovery

Basic Attacks but in Easy Way

Discovery

OPTIONS / REGISTER / INVITE / SUBSCRIBE

100 Trying
200 OK
401 Unauthorized
403 Forbidden
404 Not Found
500 Internal Server Error

Clients

Gateways

Soft Switch
(SIP Server)

Collecting Information from Response Headers

- User-Agent
- Server
- Realm
- Call-ID
- Record-Route
- Warning
- P-Asserted-Identity
- P-Called-Party-ID
- P-Preferred-Identity
- P-Charging-Vector

Basic Attacks but in Easy Way

Register

REGISTER / SUBSCRIBE (From, To, Credentials)

200 OK
401 Unauthorized
403 Forbidden
404 Not Found
500 Internal Server Error

Clients

Gateways

Soft Switch
(SIP Server)

RESPONSE Depends on Informations in REQUEST

- Type of Request (REGISTER, SUBSCRIBE)
- FROM, TO, Credentials with Realm
- Via

Actions/Tests Depends on RESPONSE

- Brute Force (FROM, TO, Credentials)
- Detecting/Enumerating Special TOs, FROMs or Trunks
- Detecting/Enumerating Accounts With Weak or Null Passwords
- ….

Basic Attacks but in Easy Way

- this isn't the call you're looking for
- We are attacking for...
  - Free Calling, Call Spoofing
  - Free VAS Services, Free International Calling
  - Breaking Call Barriers
  - Spoofing with...
    - Via Field, From Field
    - P-Asserted-Identity, P-Called-Party-ID, P-Preferred-Identity
    - ISDN Calling Party Number, Remote-Party-ID
  - Bypass with...
    - P-Charging-Vector (Spoofing, Manipulating)
    - Re-Invite, Update (Without/With P-Charging-Vector)

- Viproy Pen-Testing Kit Supports Custom Headers

Basic Attacks but in Easy Way

Invite, CDR and Billing Tests

INVITE/ACK/RE-INVITE/UPDATE (From, To, Credentials, VIA ...)

100 Trying
183 Session Progress
180 Ringing
200 OK

401 Unauthorized
403 Forbidden
404 Not Found
500 Internal Server Error

Clients

Gateways

Soft Switch
(SIP Server)

RESPONSE Depends on Informations in INVITE REQUEST

- FROM, TO, Credentials with Realm, FROM <>, TO <>
- Via, Record-Route
- Direct INVITE from Specific IP:PORT (IP Based Trunks)

Actions/Tests Depends on RESPONSE

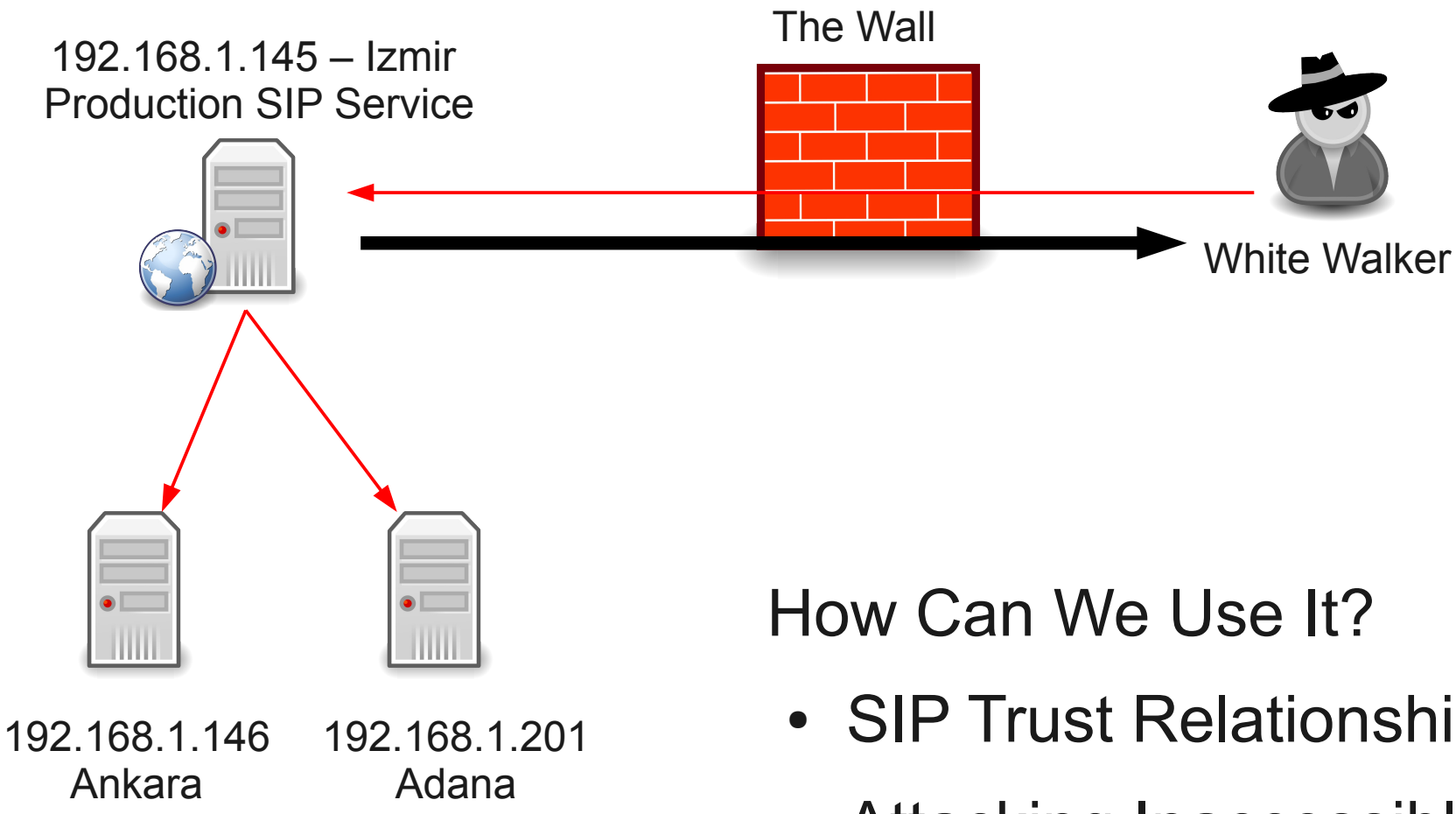
- Brute Force (FROM&TO) for VAS and Gateways
- Testing Call Limits, Unauthenticated Calls, CDR Management
- INVITE Spoofing for Restriction Bypass, Spying, Invoice
- ….

SIP Proxy Bounce Attack

- SIP Proxies Redirect Requests to Other SIP Servers
  - We Can Access Them via SIP Proxy then We Can Scan
  - We Can Scan Inaccessible Servers
  - URI Field is Useful for This Scan
- Viproy Pen-Testing Kit Has a UDP Port Scan Module

```
msf auxiliary(vsipportscan-options) > run

[+] 192.168.1.146:5060 is Open
    Server       : FPBX-2.11.0beta2(11.2.1)

[+] 192.168.1.145:5070 is Open
    User-Agent   : sipXecs/4.7.0 sipXecs/registry (Linux)

[+] 192.168.1.201:5061 is Open
    Server       : sipXecs/xxxx.yyyy sipXecs/sipxbridge (Linux)

[+] 192.168.1.203:5060 is Open
    User-Agent   : 3CXPhoneSystem 11.0.28976.849 (28862)
```

SIP Proxy Bounce Attack

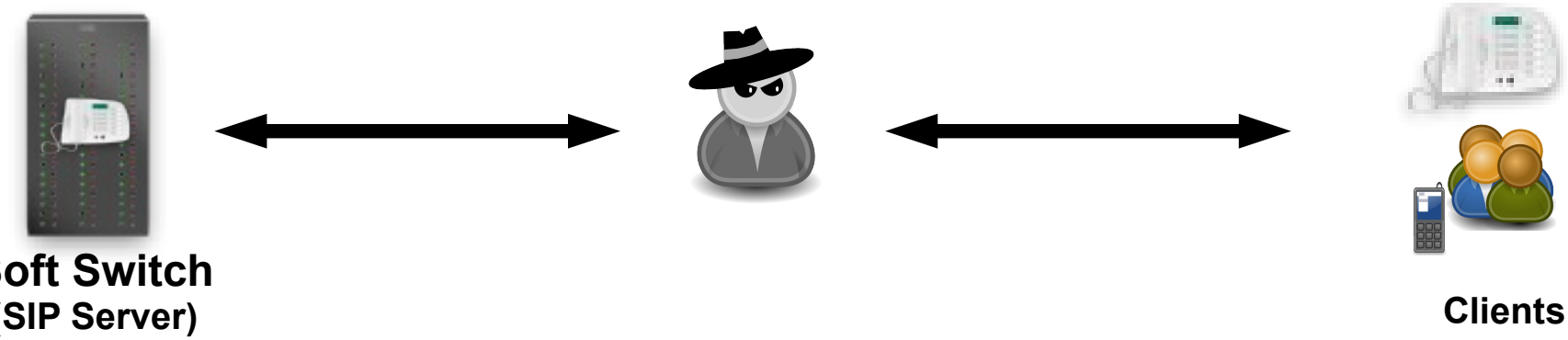


How Can We Use It?

- SIP Trust Relationship Attacks
- Attacking Inaccessible Servers
- Attacking SIP Software
  - Software Version, Type

Fake Services and MITM

Usage of Proxy & Fake Server Features



- Use ARP Spoof & VLAN Hopping & Manual Config
- Collect Credentials, Hashes, Information
- Change Client's Request to Add a Feature (Spoofing etc)
- Change the SDP Features to Redirect Calls
- Add a Proxy Header to Bypass Billing & CDR
- Manipulate Request at Runtime to find BOF Vulnerabilities

Fake Services and MITM

- We Need a Fake Service
  - Adding a Feature to Regular SIP Client
  - Collecting Credentials
  - Redirecting Calls
  - Manipulating CDR or Billing Features
  - Fuzzing Servers and Clients for Vulnerabilities
- Fake Service Should be Semi-Automated
  - Communiation Sequence Should be Defined
  - Sending Bogus Request/Result to Client/Server

- Viproy Pen-Testing Kit Has a SIP Proxy and Fake Service
- Fuzzing Support of Fake Service is in Development Stage

DOS – It's Not Service, It's Money

- Locking All Customer Phones and Services for Blackmail
- Denial of Service Vulnerabilities of SIP Services
  - Many Responses for Bogus Requests → DDOS
  - Concurrent Registered User/Call Limits
  - Voice Message Box, CDR, VAS based DOS Attacks
  - Bye And Cancel Tests for Call Drop
  - Locking All Accounts if Account Locking is Active for Multiple Fails
- Multiple Invite (After or Before Registration, Via Trunk)
  - Calling All Numbers at Same Time
  - Overloading SIP Server's Call Limits
  - Calling Expensive Gateways,Targets or VAS From Customers

- Viproy Pen-Testing Kit Has a few DOS Features

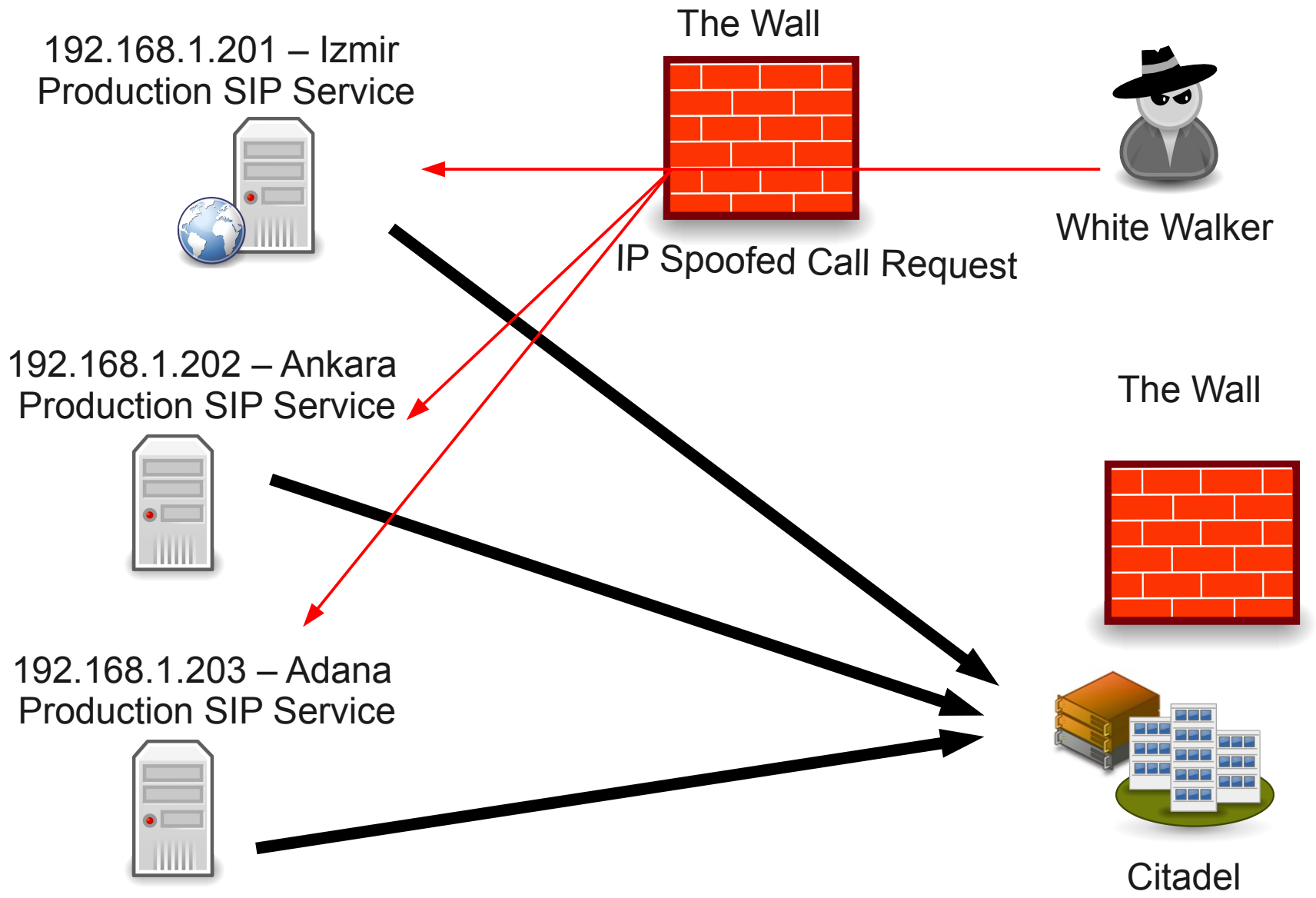
DDOS – All Your SIP Gateways Belong to Us !

- SIP Amplification Attack
  - + SIP Servers Send Errors Many Times (10+)
  - + We Can Send IP Spoofed Packets
  - + SIP Servers Send Responses to Victim
  - => 1 packet for 10+ Packets, ICMP Errors (Bonus)

No.	Time	Source	Destination	Protocol	Length	Info
2	8.315312000	192.168.1.100	192.168.1.145	SIP/SDP	938	Request: INVITE sip:701@viproy.com, with s
3	8.324730000	192.168.1.145	192.168.1.100	SIP	358	Status: 100 Trying
4	8.325086000	192.168.1.145	192.168.1.100	SIP	587	Status: 407 Proxy Authentication Required
5	8.430072000	192.168.1.145	192.168.1.100	SIP	587	Status: 407 Proxy Authentication Required
6	8.638928000	192.168.1.145	192.168.1.100	SIP	587	Status: 407 Proxy Authentication Required
7	9.040660000	192.168.1.145	192.168.1.100	SIP	587	Status: 407 Proxy Authentication Required

- Viproy Pen-Testing Kit Has a PoC DDOS Module
- Can we use SIP Server's Trust ? -wait for it-

DDOS – All Your SIP Gateways Belong to Us!



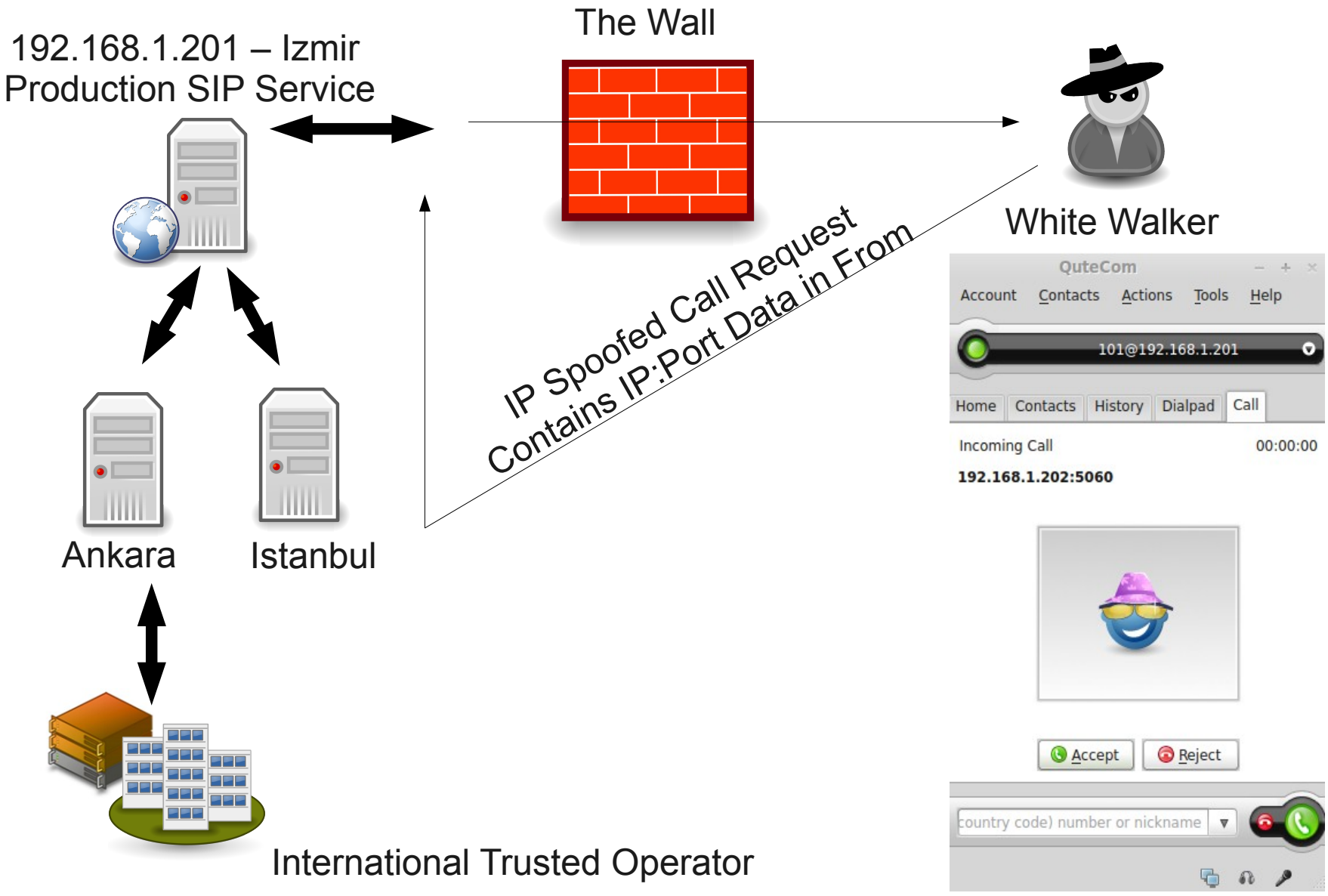
Hacking SIP Trust Relationships

- NGN SIP Services Trust Each Other
  - Authentication and TCP are Slow, They Need Speed
  - IP and Port Based Trust are Most Effective Way
- What We Need
  - Target Number to Call (Cell Phone if Service is Public)
  - Tech Magazine, Web Site Information, News

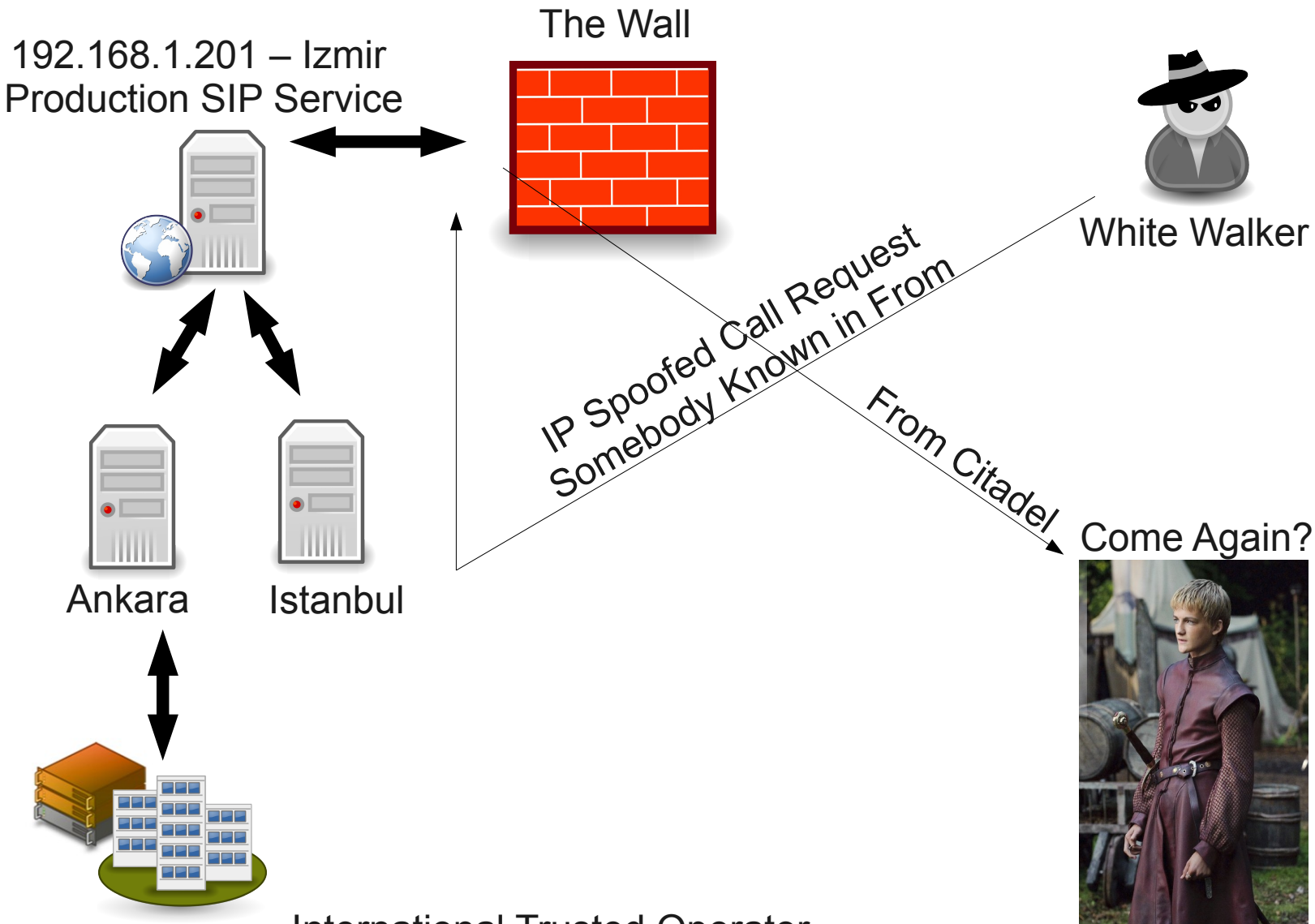
- Baby Steps
  - Finding Trusted SIP Networks (Mostly B Class)
  - Sending IP Spoofed Requests from Each IP:Port
  - Each Call Should Contain IP:Port in From Section
  - If We Have a Call, We Have The Trusted SIP Gateway IP and Port
  - Brace Yourselves The Call is Coming

Hacking SIP Trust Relationships

Slow Motion



Brace Yourselves, The Call is Coming



- Billing ?
- CDR ?
- Log ?

Hacking SIP Trust Relationships – Business Impact

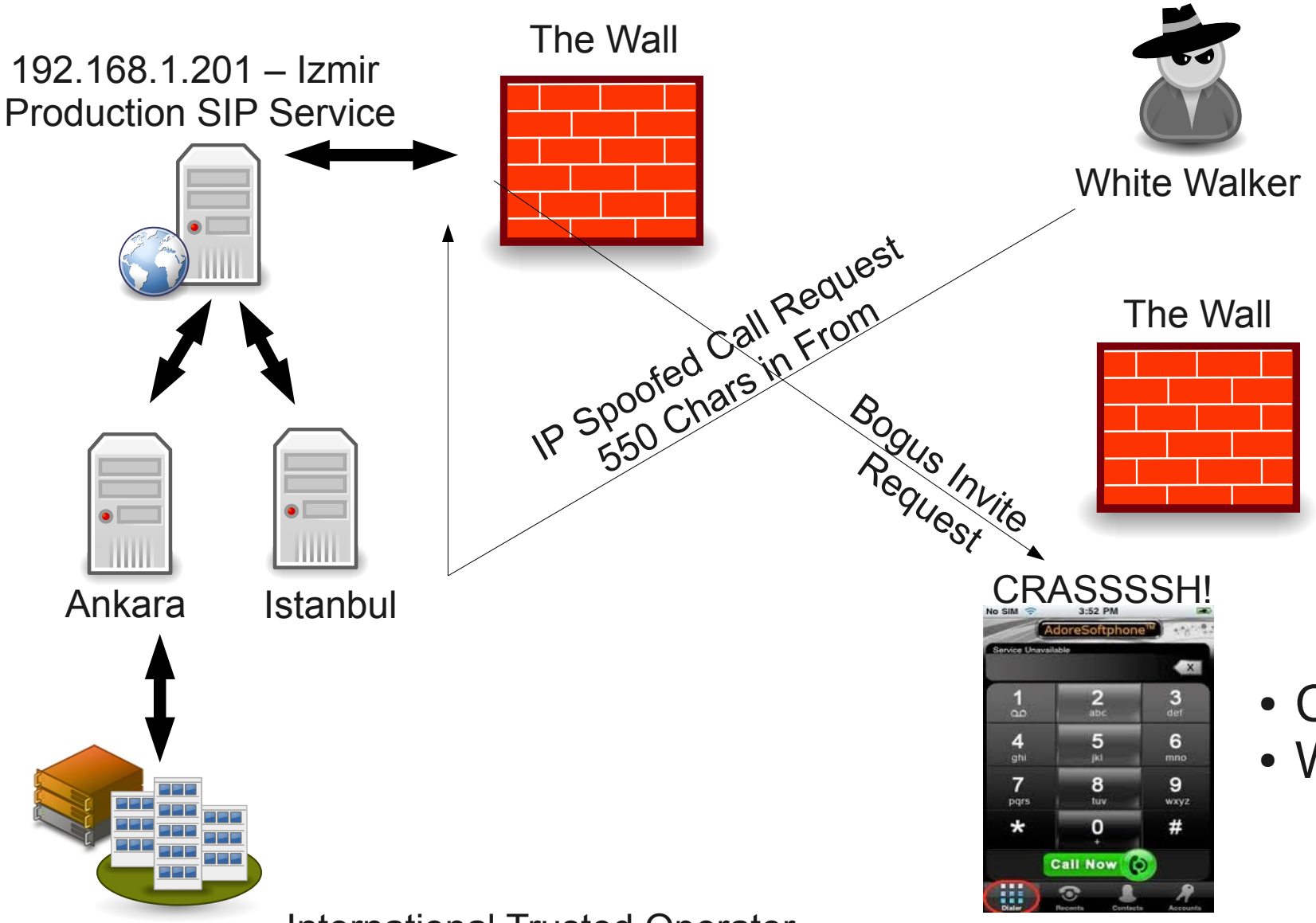
- Denial of Service
  - Short Message Service and Billing
  - Calling All Numbers at Same Time
  - Overloading SIP Server's Call Limits
  - Overloading VAS Service or International Limits
  - Overloading CDR Records with Spoofed Calls
- Attacking a Server Software
  - Crashing/Exploiting Inaccesible Features
  - Call Redirection (working on it, not yet :/)
- Attacking a Client?
  - Next Slide!

Attacking a Client via SIP Trust Relationships

- SIP Server Redirects a few Fields to Client
  - FROM, FROM NAME, Contact
  - Other Fields Depend on Server (SDP, MIME etc)
- Clients Have Buffer Overflow in FROM?
  - Send 2000 Chars to Test it !
  - Crash it or Execute your Command if Available
- Clients Trust SIP Servers and Trust is UDP Based
  - This module can be used for Trust Between Client and Server
- Viproy Pen-Testing Kit SIP Trust Module
  - Simple Fuzz Support (FROM=FUZZ 2000)
  - You Can Modify it for Further Attacks

Attacking a Client via SIP Trust Relationships

Brace Yourselves 550 Chars are Coming



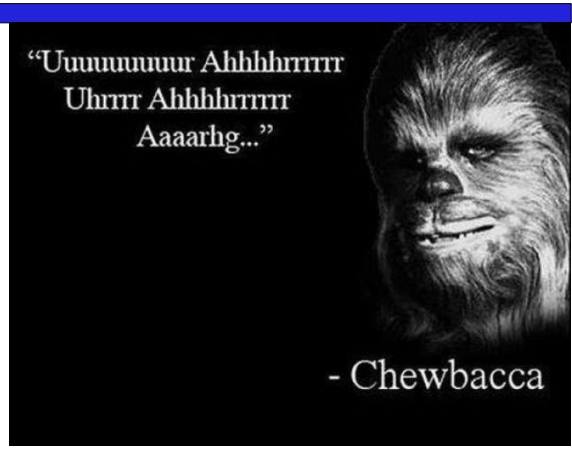
- Command?
- Why Not!

Fuzz Me Maybe

- Fuzzing as a SIP Client | SIP Server | Proxy | MITM
- SIP Server Software
- SIP Clients
  - Hardware Devices, IP Phones, Video Conference Systems
  - Desktop Application or Web Based Software
  - Mobile Software
- Special SIP Devices/Software
  - SIP Firewalls, ACL Devices, Proxies
  - Connected SIP Trunks, 3rd Party Gateways
  - MSAN/MGW
  - Logging Software (Indirect)
  - Special Products: Cisco, Alcatel, Avaya, Huawei, ZTE...

Old School Fuzzing

- Request Fuzzing
  - SDP Features
  - MIME Type Fuzzing
- Response Fuzzing
  - Authentication, Bogus Messages, Redirection
- Static vs Stateful
- How about Smart Fuzzing
  - Missing State Features (ACK,PHRACK,RE-INVITE,UPDATE)
  - Fuzzing After Authentication (Double Account, Self-Call)
  - Response Fuzzing (Before or After Authentication)
  - Missing SIP Features (IP Spoofing for SIP Trunks, Proxy Headers)
  - Numeric Fuzzing for Services is NOT Memory Corruption
  - Dial Plan Fuzzing, VAS Fuzzing



How Viproy Pen-Testing Kit Helps Fuzzing Tests

- Skeleton for Feature Fuzzing, NOT Only SIP Protocol
- Multiple SIP Service Initiation
  - Call Fuzzing in Many States, Response Fuzzing
- Integration With Other Metasploit Features
  - Fuzzers, Encoding Support, Auxiliaries, Immortality etc.
- Custom Header Support
  - Future Compliance, Vendor Specific Extensions, VAS
- Raw Data Send Support (Useful with External Static Tools)
- Authentication Support
  - Authentication Fuzzing, Custom Fuzzing with Authentication
- Less Code, Custom Fuzzing, State Checks
- Some Features (Fuzz Library, SDP) are Coming Soon

Fuzzing SIP Services

Request Based

OPTIONS/REGISTER/SUBSCRIBE/INVITE/ACK/RE-INVITE/UPDATE....

100 Trying
183 Session Progress
180 Ringing
200 OK

401 Unauthorized
403 Forbidden
404 Not Found
500 Internal Server Error

Clients

Gateways

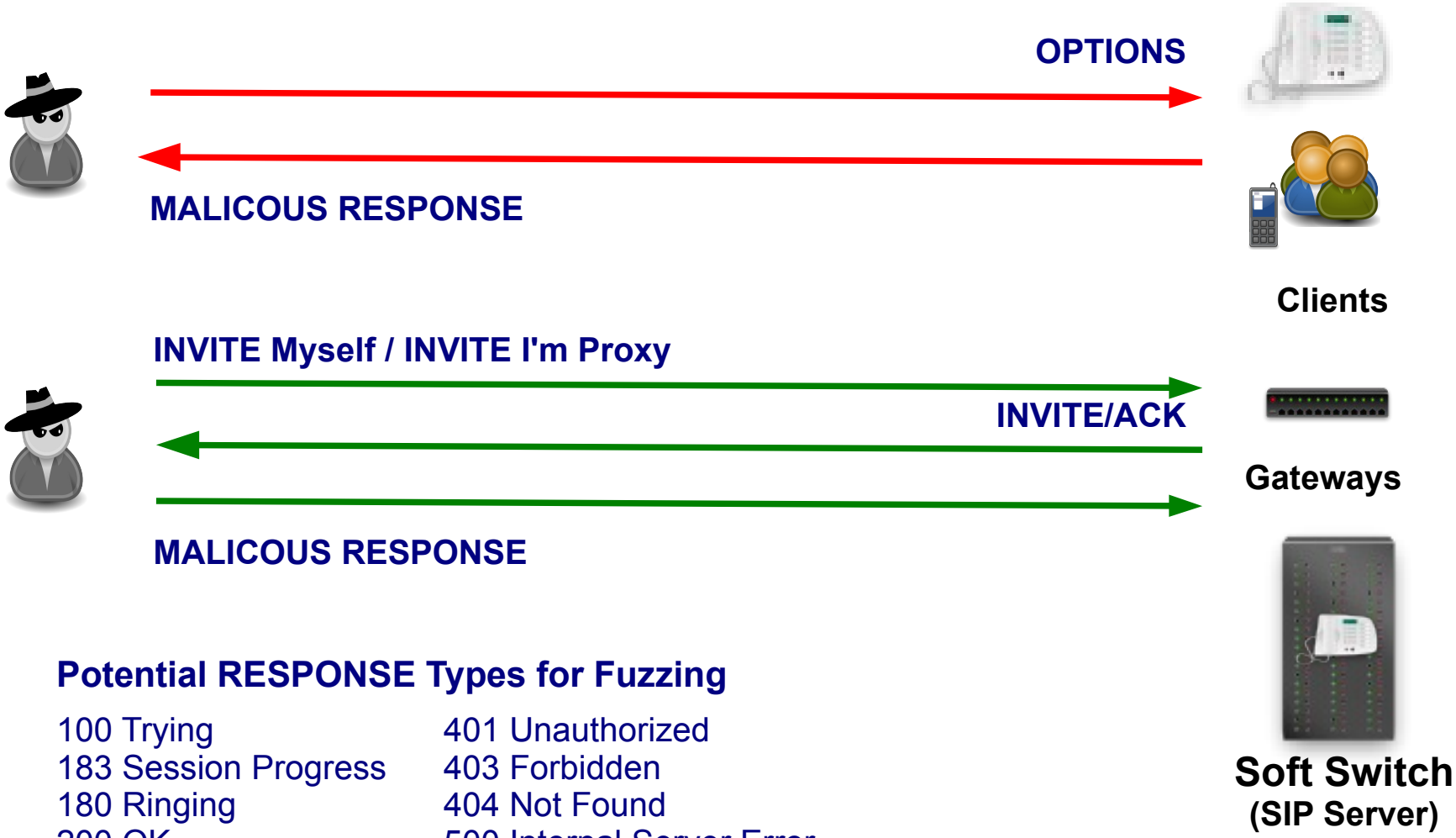
Fuzzing Targets, REQUEST Fields

- Request Type, Protocol, Description
- Via, Branch, Call-ID, From, To, Cseq, Contact, Record-Route
- Proxy Headers, P-*-* (P-Asserted-Identity, P-Charging-Vector...)
- Authentication in Various Requests (User, Pass, Realm, Nonce)
- Content-Type, Content-Lenth
  - SDP Information Fields
  - ISUP Fields

Soft Switch
(SIP Server)

Fuzzing SIP Services

Response Based



Potential RESPONSE Types for Fuzzing

100 Trying	401 Unauthorized
183 Session Progress	403 Forbidden
180 Ringing	404 Not Found
200 OK	500 Internal Server Error

DEMO

Attacking SIP Servers for Fun & Profit

Demo Sample

https://www.youtube.com/watch?v=AbXh_L0-Y5A

References

- Viproy VoIP Penetration and Exploitation Kit

  Author : http://viproy.com/fozavci

  Homepage : http://viproy.com/voipkit

  Github : http://www.github.com/fozavci/viproy-voipkit

- Attacking SIP Servers Using Viproy VoIP Kit (50 mins)

  https://www.youtube.com/watch?v=AbXh_L0-Y5A

- Hacking Trust Relationships Between SIP Gateways (PDF)

  http://viproy.com/files/siptrust.pdf

- VoIP Pen-Test Environment – VulnVoIP

  http://www.rebootuser.com/?cat=371

Q ?

Thanks