To V☺IP or not to V☹IP…
…esa es la cuestión

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Arquitecturas Seguras

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Index

- Data & Voice communications
- Traditional telephony vs. VoIP
- VoIP 101
- (A few) VoIP Attacks
- VoIP Defenses
- Summary

VoIP, Hollywood & Real-Life

Until Now…, It's ALL about Data

- Firewalls, NIDS/IPS, HIDS/IPS, AV, Anti-spyware/malware, log and patch management, web application FW, etc
- Network devices and host hardening, intrusion detection, incident handling, perimeter protection, forensics, database security, wireless security, etc
- Data confidentiality, integrity & availability
- Defense-in-depth
  - Secure architectures

Voice Communications…

- What is your preferred communication method?
- Are you using VoIP? Are you sure????
- VoIP is here to stay!!
- Service providers, carriers, and enterprises (and personal communications - FTTH)
- Weaknesses and vulnerabilities on the original design, protocols and specs

Traditional Telephony vs. VoIP

Traditional Telephony

- PSTN (or POTS)
- Cellular networks
  - GSM, GPRS, or UMTS
- Analog or digital communications
- Closed and proprietary nature
- Signaling based on ISDN, SS7, or SS7/MAP (GSM)

Traditional Telephony (2)

- Expectation of privacy and level of trust in the legacy telephony infrastructures
- PSTN: Physical security
  - Neighborhood or end-to-end path
- GSM: Radio waves (bands)
  - MitM attacks (impersonate Base Station)
  - THC-GSM project/sniffer (GNU radio)
    - A5/1 & A5/2 encryption (FPGAs)

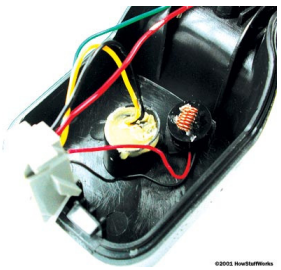
Voice Signaling Attacks

- In-band frequency signaling
- Phreaking culture, 1971
- 2600 Hz tones
- E.g. Captain (Cap'n) Crunch, Steve Wozniak, Steve Jobs…

➢ Network segmentation: ISDN and SS7

Voice Media Attacks

- Analog hidden-phone, alligator clips, tape recorder, or bug
- Modern PSTN or cellular nets
  - Digital switches
- E.g. Greek wiretapping ring (2004-05)



- ➢ Phone encryption
  - ➢ PSTN, GSM
- ➢ Wiretap detectors

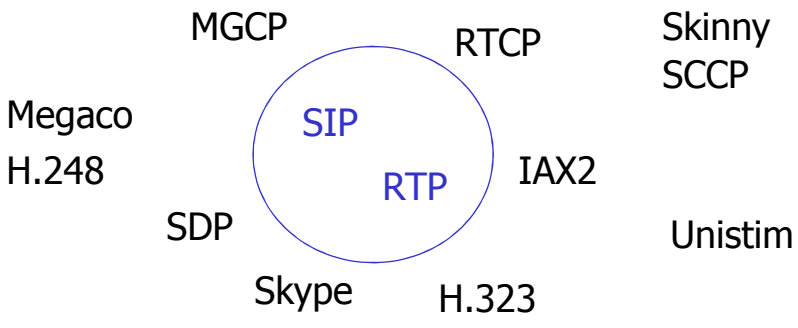
VoIP

- Voice over IP
- Main VoIP concerns:
  - Lowering the telecommunication costs
  - Cost reduction, computer application integration, and unified communications
  - Security
- Open and distributed nature of VoIP infrastructures
- Inherit the IP-based security threats

VoIP vs. Data

- Joining two (different) worlds together
- It's all about IP!!
- Real-time nature of VoIP communications
- Network convergence
- New VoIP protocols
- New VoIP application-layer security devices

VoIP Protocols



DNS, DHCP, NTP, HTTP, SNMP, TFTP, etc

Are we improving security for VoIP while reducing security for the rest of the network?

- Does the improved security just apply to telephony itself?
- VoIP protocols were designed to be hardly secured ☺
- VoIP makes more difficult to protect the whole IP network
- *Devil's advocate* ☺

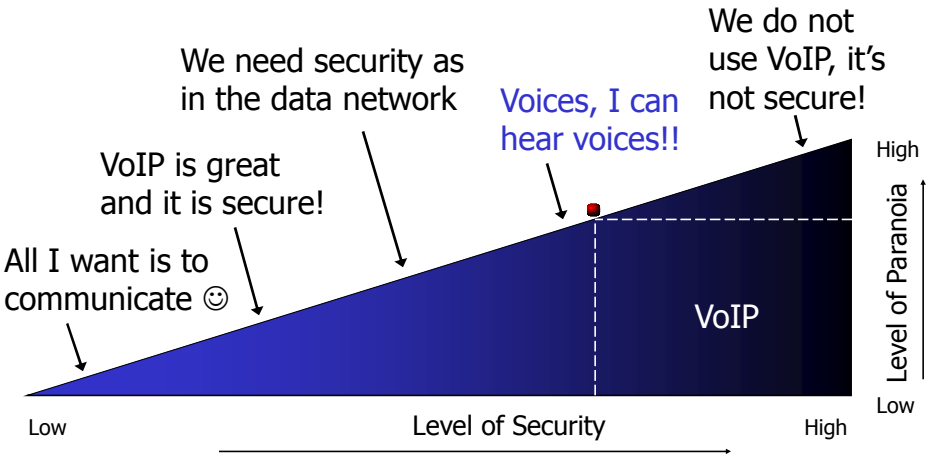
http://radajo.blogspot.com/2007/10/are-we-improving-security-for-voip.html

Are we improving security…?

- Security vs. Complexity
- Security-friendly protocols?
  - H.323 vs. SIP vs. IAX2
- Conventional firewalls:
  - Similar to HTTP/Web Services/Web 2.0
- Network segregation (layer 2/3/4…) to mitigate unified communications risks

Redesign (& secure) your network architecture

VoIP Paranoid-meter



VoIP Security Threats

- Receive someone's calls (C, I)
- Make calls impersonating someone (I)
  - Spoofing
- Capture conversations (C)
  - Eavesdropping
- Modify conversations (C, I, A)
  - MitM
- Denial of service, DoS (A)

Confidentiality
Integrity
Availability

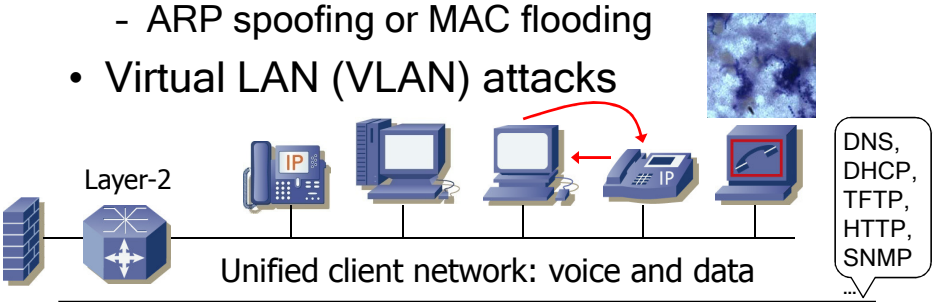
VoIP infrastructure, signaling, and media threats

(A few) VoIP Attacks

- Layer-2 attacks & VoIP hopping
- Google hacking - VoIP
- PBX fingerprinting
- Wardialing (using VoIP)
- Caller ID spoofing
- Eavesdropping VoIP: signaling & media
- VoIP media manipulation
- Vishing & Real-world attacks

Layer-2 Attacks

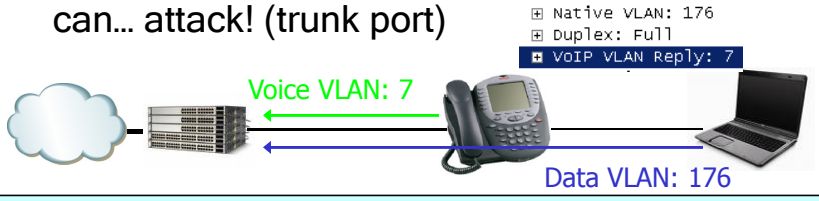
- Unified communications (single net)
- Sniffing, interception & redirection
  - ARP spoofing or MAC flooding
- Virtual LAN (VLAN) attacks



Plus all the traditional layer-3 (IP) attacks...

VoIP Hopping Attack

- VoIP hardphone (acts like a switch)
  - Single Ethernet cable (voice & data)
- Get physical access to the phone & sniff traffic
  - Meeting rooms, reception, etc
- Enable attacker's computer in "Voice VLAN" ID
- The computer belongs to the VoIP VLAN and can… attack! (trunk port)



VoIP Hopping Attack (2)

- Manually: vconfig & ARP spoofing
- Voiphopper (listen CDP & reconfigure NIC)
- ACE: Automated Corporate Enumerator
  - Get corporate directory as a Cisco IP phone

```
Starting Unified sniffing...

Listening for new calls to or from target John (CEO) Rodgers (Extension 1004, IP 172.16.96.18)
Endpoint station Caller ID 1090 calling target
Target John (CEO) Rodgers (Extension 1004, IP 172.16.96.18) went offhook
Endpoint station Caller ID 1090 calling target
Target call in progress at 16:56:8, receiving call from 1090
Starting media capture between target and Eric Winsborrow (Extension 1004)
Endpoint station Caller ID 1090 calling target
Target call ended.  Call duration is 12 seconds.
Saving target user conversation to file, 'Eric Winsborrow_Calling_John (CEO) Rodgers_16:56:8_both.wav'
Target John (CEO) Rodgers (Extension 1004, IP 172.16.96.18) went onhook

Listening for new calls to or from target John (CEO) Rodgers (Extension 1004, IP 172.16.96.18)
```

UCSniff - Unified Communication Sniffer

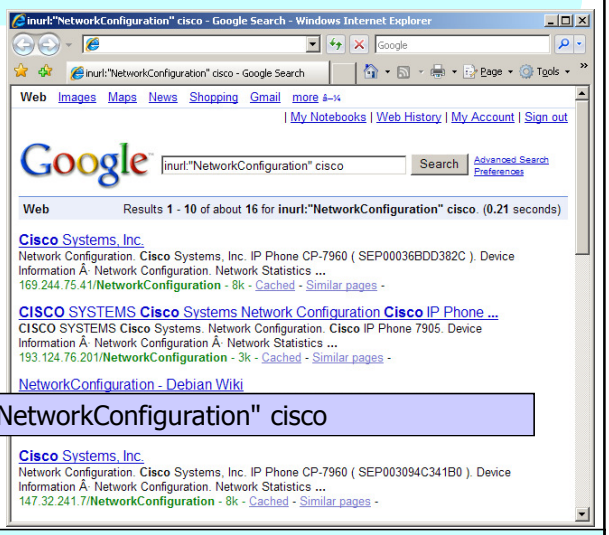
Google Hacking - VoIP

- Why?
  - Google hacking → Web → VoIP
- GHDB:
  - Book - Volume II (pg. 446)
  - VoIP:
    - Various Online Devices
    - Pages containing login portals

http://johnny.ihackstuff.com/ghdb.php
http://www.hackingvoip.com/google.html

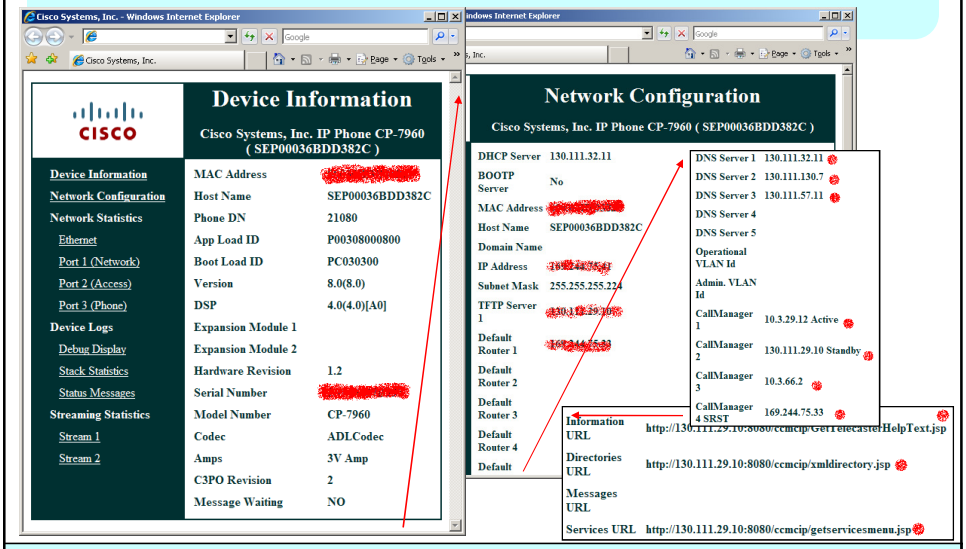
Google Hacking - VoIP (2)

Cisco hardphones: (CP-7960)



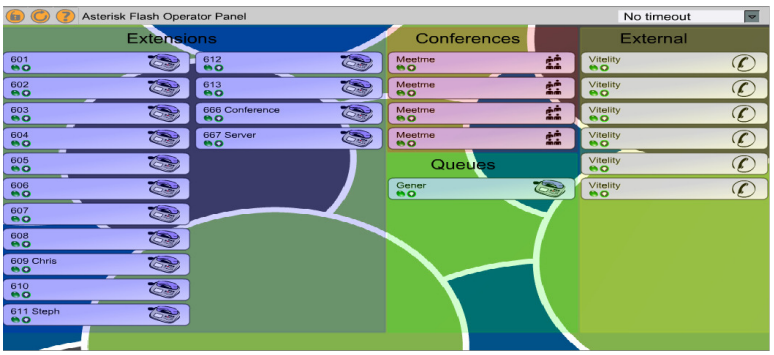
inurl:"NetworkConfiguration" cisco

Google Hacking - VoIP (3)



Google Hacking - VoIP (4)

- Flash Operator Panel: switchboard Asterisk PBX
  - http://johnny.ihackstuff.com/ghdb.php?function=detail&id=1134



PBX fingerprinting

- Manual PBX identification
- Collection of default sound files of popular VoIP voicemail systems to assist in properly identifying the vendor
  - Asterisk, Avaya, Cisco…
  - Risk of default settings!!
- Change ALL settings: tech and human

http://www.hackingvoip.com/voicemail.html

Wardialing (using VoIP)

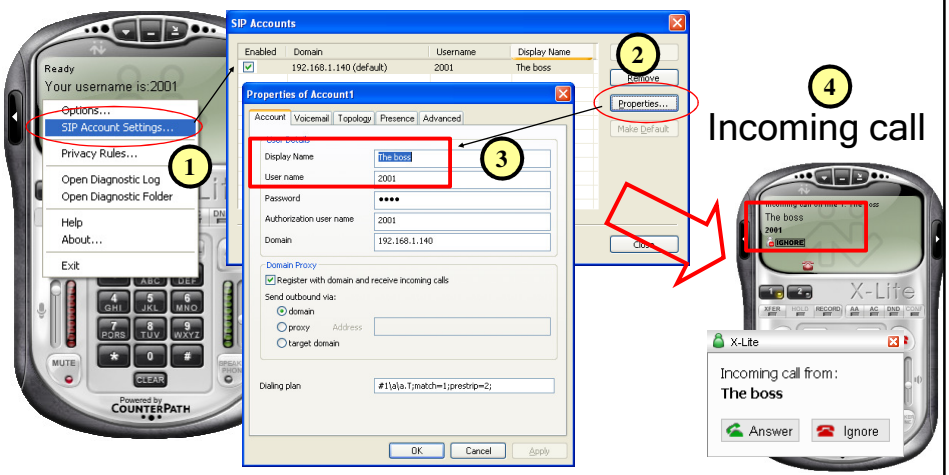
- Wardialing on steroids (without a modem)
- xDSL (home) + VoIP provider account
  - 1000 phone lines or numbers / hour
- Record audio (archived) & signatures
  - Modems, faxes, voice mailbox, PBX, loops, dial tones, IVR, forwarders, etc (classify)
- Like nmap for the PSTN
- Laws regulating automated dialing

WarBOX

Caller ID spoofing

- Common “trusted” authentication mechanism
  - Relative, boss, bank, etc
- Trivial and unavoidable in the PSTN
- Strong authentication methods are available in VoIP
  + Anti-SPIT (RFC 5039)
- Mitigate impersonation attacks

Caller ID Spoofing (2)



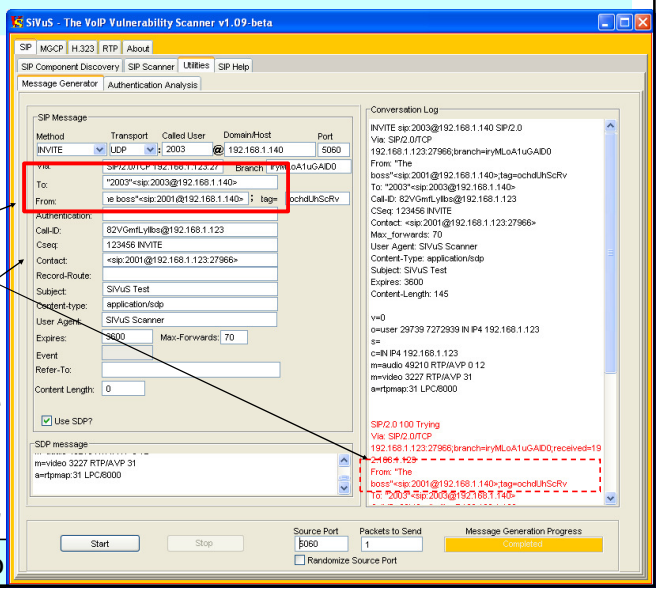
Caller ID Spoofing (3)

Spoofed INVITE

Spoofed caller ID

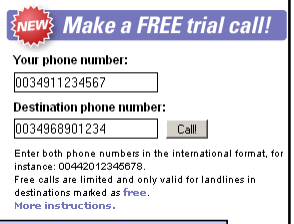
Attacker

Valid SDP contents



Caller ID Spoofing Services

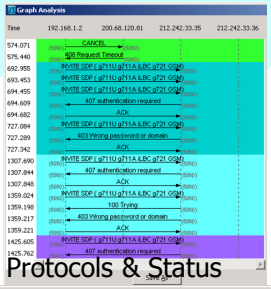
- Spoof the caller ID on all your phone calls (VoIP or PSTN)
- Pay per call/minute services: Spoofcard, Telespoof, Spooftel…
- Some VoIP providers use similar techniques for some of their offering: Web-based user to user calls



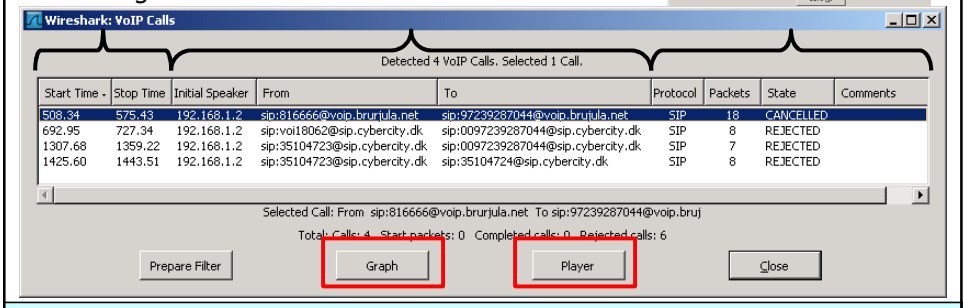
… " intended for entertainment purposes only"

Eavesdropping VoIP Call Signaling

Wireshark: “Statistics” → “VoIP Calls”

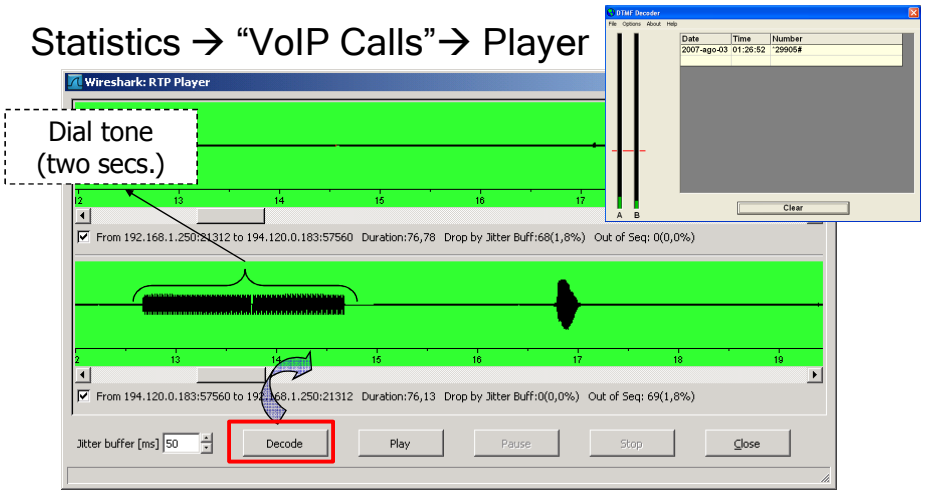


Timing IP & SIP entities Protocols & Status



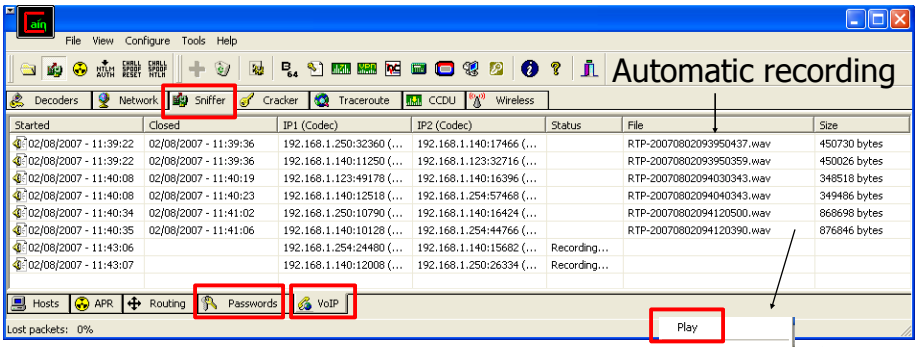
Eavesdropping VoIP Media (RTP)

Statistics → “VoIP Calls”→ Player



Eavesdropping VoIP
Signaling, Media, Authentication…

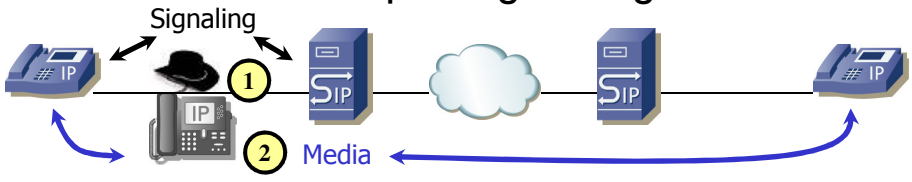
Cain & Abel → "Sniffer"→ "VoIP" (1)



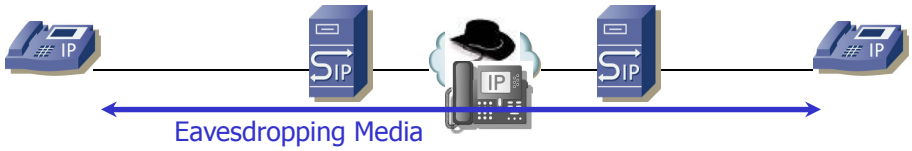
Windows Media Player (.wav files) (3) (2)

VoIP Media Manipulation

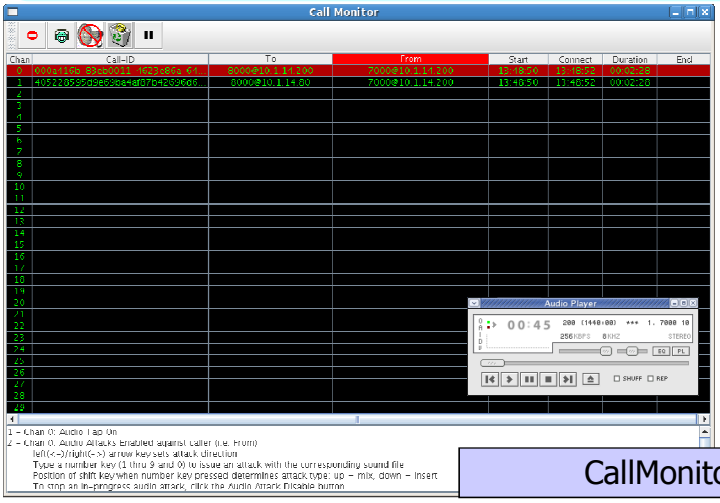
- MitM attack: Replacing/Mixing audio



- Non-MitM attack: Inserting/Mixing audio



VoIP Media Manipulation (2)



- Monitor, tear down, tap & insert audio

CallMonitor

Vishing - Voice Phishing

- Someone calling you impersonating the bank
- Important message (e-mail) asking user to call a specific phone number
- Inherent trust in phone numbers
  - Caller ID spoofing ☺
- System ready to gather sensitive information (CC#, expiration date, PIN#, etc)

http://isc.sans.org/diary.html?storyid=3486 & 4946

Vishing – Real Incidents

- Enhancements over time
  - Record voice snippets of the target IVR (Interactive Voice Recording) system
- Easily accomplished through Asterisk and recorded audio files
  - Similar to duplicate a Web site in a traditional Phishing scam (except SSL)

Vishing – Real Incidents (2)

- Federal Trade Commission (FTC) 
  - IR: Warn customers that the phone number they called is being used to scam personal information
- Call forwarding through VoIP ISP accounts (like Vonage)
  - Compromised through Web page (login credentials)
  - Others: Asterisk, traditional PBX…

Vishing – Real Incidents (3)

- More control checks on expected information (e.g. data length, expiration date format…)
- Text-to-voice systems, so they can change the message and not leave a voice print behind (forensic evidence)
- SMS-attacks using a VoIP infrastructure
  - "Your bank account has been locked due to a possible compromise. Please call 800… to re-activate your account." (related Trixbox scanner)

http://isc.sans.org/diary.html?storyid=4507

Vishing Best Practices

- Verify the number belongs to the "calling" company
  - Company Web page or printed material
  - Unfortunately, we're used to search engines
- Directly call the company number instead of trusting a received caller ID
  - Did I mention you cannot trust the caller ID?
- Counterhack: Reverse Vishing & SEO

Reverse Vishing and SEO

- Use search engine optimization (SEO) poisoning techniques
  - Fake phone numbers associated to legitimate organizations on top of the list
- Encourage the victim to call the fake number
- My prediction for the near future…
  - Compromise the company Web page to subtlely modify the numbering data

http://isc.sans.org/diary.html?storyid=4996

Phone Number Authentication

- Add strong authentication to ENUM (E.164 numbers - domain names) & DNS
- Correlate phone numbers from ≠ sources:
  - Company Web page, printed material, multiple search engines, and specific phone queries
  - Specific phone searching services: Who Called Us, 800Notes, NumberZoom, Switchboard.com, Whitepages.com, Reversephonedirectory.com, or Phonenumber.com (US-centric)

Bogus Robocall Tells Floridians They Can Vote By Phone

- US elections (October 31, 2008)
- Residents of Broward County, Florida
  - Vote by phone on Election Day
  - The voice identifies herself as Elections Supervisor Brenda Snipes
  - Voting by phone is not allowed
- Residents of the Pittsburgh region
  - Votes on two different dates (Republicans/Democrats)
- Can you say…VoIP!!

http://blog.wired.com/27bstroke6/2008/10/bogus-robocall.html

Trixbox Scans in 2009

- Scanning for Trixbox vulnerabilities
  - February 2009 (SMS-scams before that…)
- HTTP scans now include…
  - Cisco Domit RSS feature
- Discovery of 0-day: disclose the contents of local files through the Web server (pass hash)

```
xxx.xxx.xxx.xxx - - [31/Jan/2009:00:58:15 -1000] "GET
/cisco/services/rss/DOMIT/domit_rss/domitBanner.gif HTTP/1.1"
404 26 "-" "Mozilla/4.0 (compatible; MSIE 6.0; Windows 98)"
```

http://isc.sans.org/diary.html?storyid=5782

VoIP Defenses

- Secure network architectures (by design)
- Layer-2 robust architectures
- VoIP network traffic segregation
  - The VoIP softphone paradox
- Secure VoIP protocols
- VoIP security devices
- Integrating VoIP into security

Secure Network Architectures (by design)

- Defense in depth and layered security principles
- Physical network segregation?
- Logical segregation using VLAN's
  - Define multiple VLAN's: voice, data, management, backup, etc.
- Apply strong layer-3 controls and traffic filters between VLAN's (voice & data)
- VoIP hardphones in the office and VoIP softphones only for road warriors

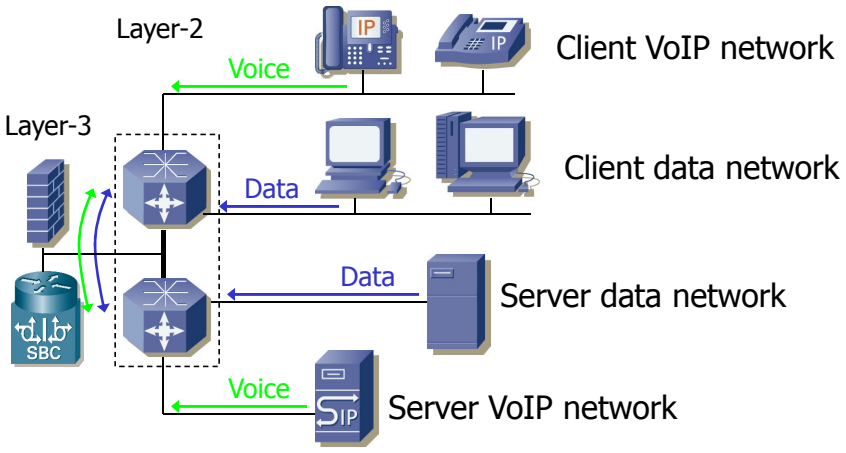
Layer-2 Robust Architectures

- Layer-2 security
  - VLAN's, PVLAN's, switch port security & MAC address filtering, PACL's, VACL's, Dynamic VLAN's, MAC and ARP monitoring, DHCP snooping, DAI, etc
  - ARP spoofing: arpwatch, XArp2, ArpON…
- Free network access vs. 802.1x/EAP (NAC/NAP)
- Disable (if possible) CDP, STP, CDP, PAgP, or VTP, plus non-used ports
- Protection & Detection capabilities

VoIP Network Traffic Segregation

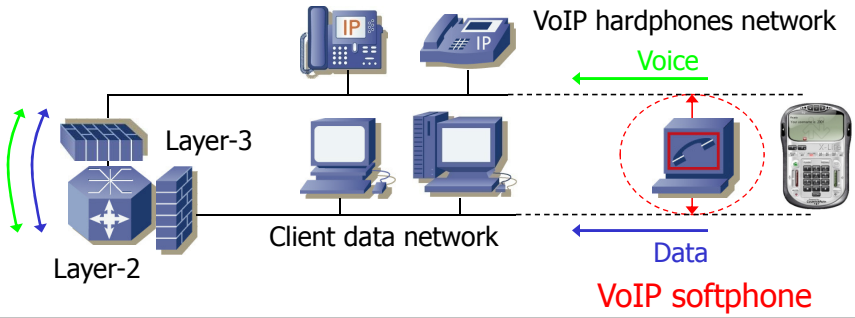
- Logical (or physical) segregation of voice and data traffic
- Relevant security benefits
- Layer-2 segregation (VLAN's) + ...
- Facilitates layer-3 segmentation using ACL's, VoIP-aware firewalls, ALG's or SBC's
- QoS benefits too
- Unified communications paradox?...

VoIP Network Traffic Segregation Diagram



The VoIP Softphone Paradox

- Software-based VoIP phone application
  - Single network; no segregation
- Any other VoIP integrated application



Secure VoIP Protocols

- Secure network protocols
  - 802.1x, DNS?, SCP, SNMPv3, HTTPS…
- Signaling authentication and identity
  - Digest (MD5), digital certificates, authenticated identity (RFC 4474)…
- Signaling encryption
  - SIPS (TLS-based SIP) or SIP over DTLS
  - S/MIME
  - VPNs: IPSec or SSL

Secure VoIP Protocols (2)

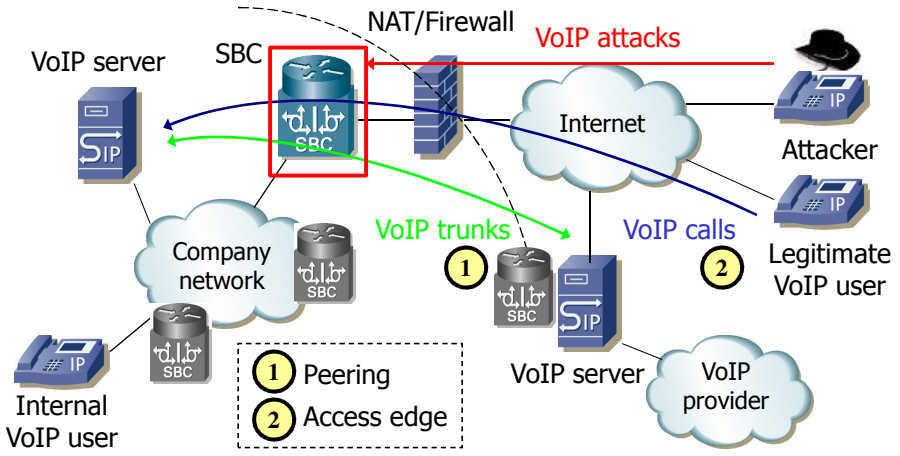
- Media encryption
  - SRTP (Secure RTP) & SRTCP
  - RTP over IPSec
- Key exchange mechanisms
  - SDescriptions
  - MIKEY
  - ZRTP
  - DTLS-SRTP

Other proprietary solutions & Lawful Interception (LI)

VoIP Security Devices

- Standard NAT/Firewall issues
  - STUN, TURN, or ICE
- VoIP-aware firewalls
- Application-layer Gateways (ALG's)
- VoIP IDS/IPS
- Session Border Controllers (SBC's)
  - Peering edge and Access edge

SBC's



Integrating VoIP into your Security Regime

- Key technology (more than data)
  - Expected availability: 99.999%
- Include it within all security tasks:
  - Incident handling
  - Auditing
  - Penetration testing
    - VoIP & Wardialing

Summary

- Data & Voice communications
- Lots of VoIP Attacks…
- VoIP Defenses
  - Secure architecture (defense in-depth and multiple layers), network segregation, secure layer-2 setup & protocols, secure VoIP protocols, VoIP security devices (SBC's)

References

- “Practical VoIP Security”. Thomas Porter.
- “Hacking Exposed VoIP”. D. Endler, M.Collier.
  - http://www.hackingvoip.com
- “Securing VoIP Networks: Threats, Vulnerabilities, and Countermeasures”. Peter Thermos, A. Takanen.
- “LAN Switch Security: What Hackers Know About Your Switches“. Eric Vyncke.
- Blue Box Podcast (www.blueboxpodcast.com)
- VoIPSA (www.voipsa.org)
- SANS “VoIP Security” course (SEC540)

Thanks!!

“To V☺IP or not to V☹IP…
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