SP Security Primer 101

Peers working together to
battle Attacks to the Net

Version 2.2

Barry Raveendran Greene

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The global leader in open source DNS

isc.org
Internet Systems Consortium

BIND 10

The next big thing in DNS

ISC Professional Services

support	development
training	consulting
audit	design

Call in the experts!

SNS@ISC

The ultimate insurance policy for your DNS

ISC is Public Benefit

F-root	DHCP
SNS-PB	AFTR
BIND	and more

Do what you can to support us

Community Service

Activities to expand the Internet, rough consensus, working code, and Open Source

IPV6

Its real. Its works, It is live. Call the experts to help make it happen.

DNSSEC

Are you ready? Get it Done!

SIE

Changing how the Security Communities Productively Collaborate

Goal

- Provide 10 core techniques/task that any SP can do to improve their resistance to security issues.
- These 10 core techniques can be done on any core routing vendor's equipment.
- Each of these techniques have proven to make a difference.

“Never underestimate the power of human communications as a tool to solve security problems. Our history demonstrates that since the Morris Worm, peer communication has been *the* most effect security tool.”

Barry Raveendran Greene

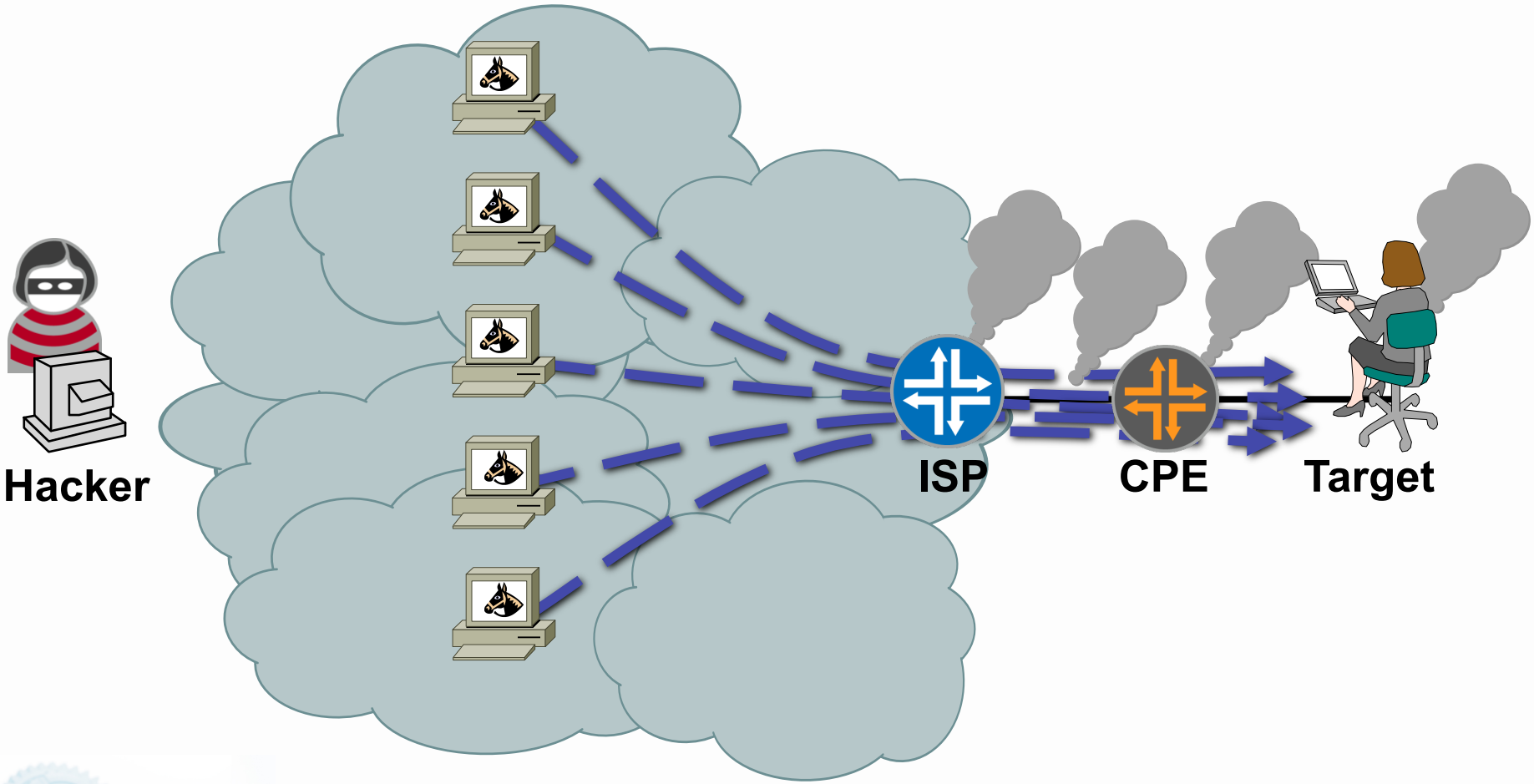
Agenda

- Overview
- Understanding the Threat: *A Typical Cyber-Criminal's Work Day*
- Why Cyber-Crime is Institutionalized?
- Top 10 SP Security Techniques: The Executive Summary
  - Prepare your NOC
  - The New Internet "Civic Society": OPSEC Communities
  - Working with your Peers with "Out of Band" Communications: iNOC DBA
  - Point Protection
  - Edge Protection
  - Remote Trigger Black Hole
  - Sink Holes
  - Source Address Validation
  - Control Plane Protection
  - Total Visibility
- Putting the Tools to Work – DDOS Attack
- Summary

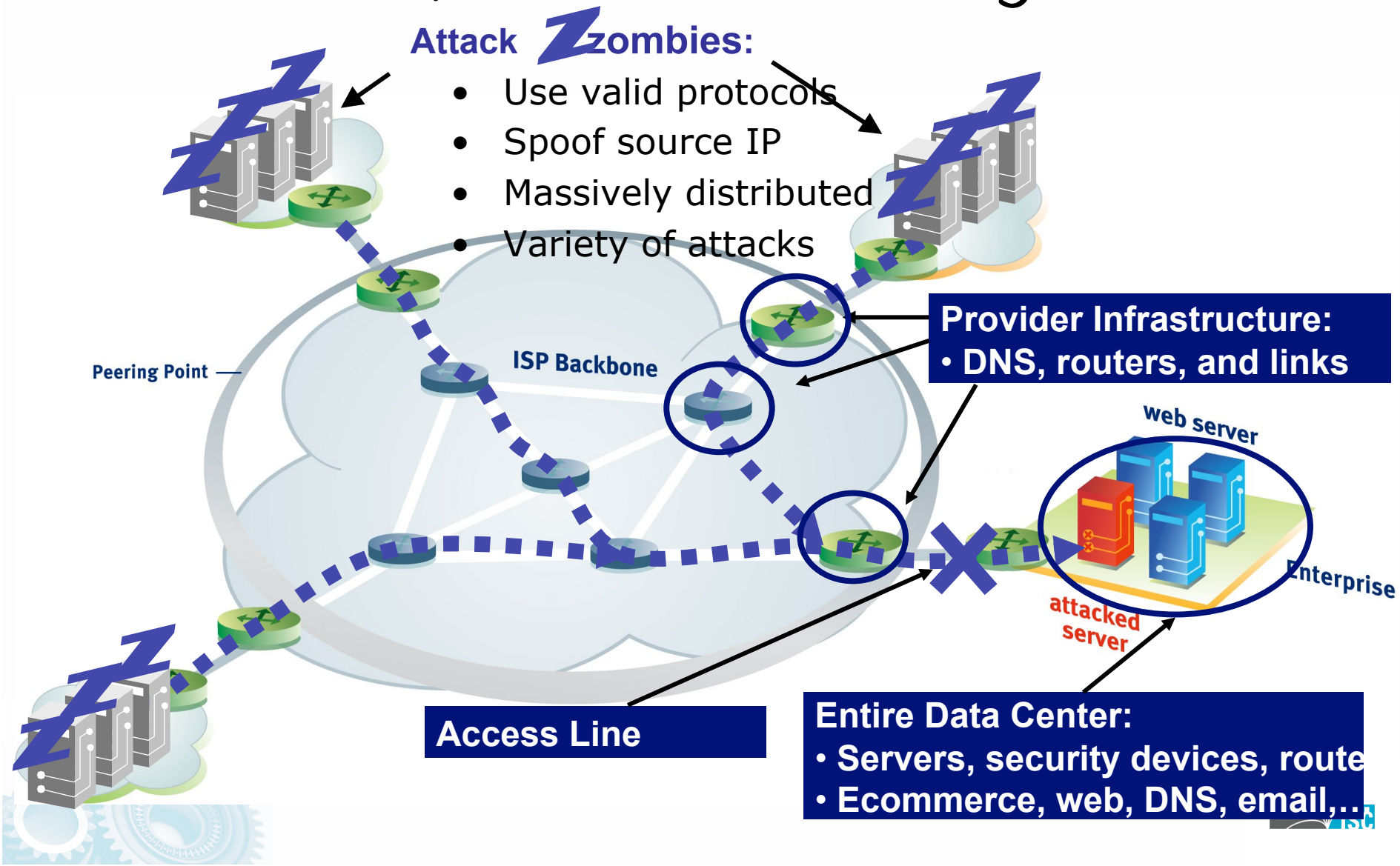
Addendum

- Communications Addendum
- DNS Architecture Idea: Modularization & Compartmentalization
- DNS Backscatter – Knowing when you are being Poisoned
- Total Visibility Addendum

What Do You Tell the Boss?



DDoS Vulnerabilities
Multiple Threats and Targets



The SP's Watershed - Feb 2000

YAHOO!

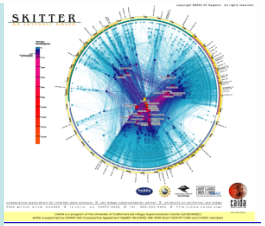
amazon.com

CNN.com

ebay

E*TRADE

Overview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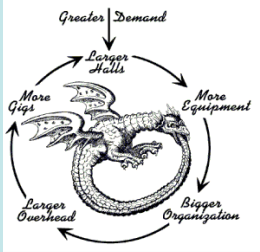
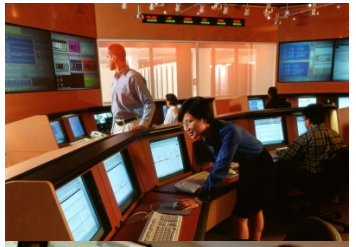

Greater Demand
Larger Halls
More Equipment
Bigger Organization
Larger Overhead
More Gigs



The Vetted – Battling the Bad Guys

WIRED MAGAZINE: ISSUE 15.09

POLITICS : SECURITY RSS

Hackers Take Down the Most Wired Country in Europe

By Joshua Davis 08.21.07 | 2:00 AM

Defense minister Jaak Aaviksoo got help from NATO in the wake of the cyberattacks. *Photo: Donald Milne*

The minister of defense checked the Web page again — still nothing. He stared at the error message: For some reason, the site for Estonia's leading newspaper, the Postimees, wasn't responding. Jaak Aaviksoo attempted to pull up the sites of a couple of other papers. They were all down. The former director of the University of Tartu Institute of Experimental Physics and Technology d been the Estonian defense minister for only four weeks. He hadn't even changed the art on the walls.

An aide rushed in with a report. It wasn't just the newspapers. The leading bank was under siege. Government communications were going down. An enemy had invaded and was assaulting dozens of targets.

Outside, everything was quiet. The border guards had reported no incursions, and Estonian airspace had not been violated. The aide explained what was going on: They were under attack by a rogue computer network.

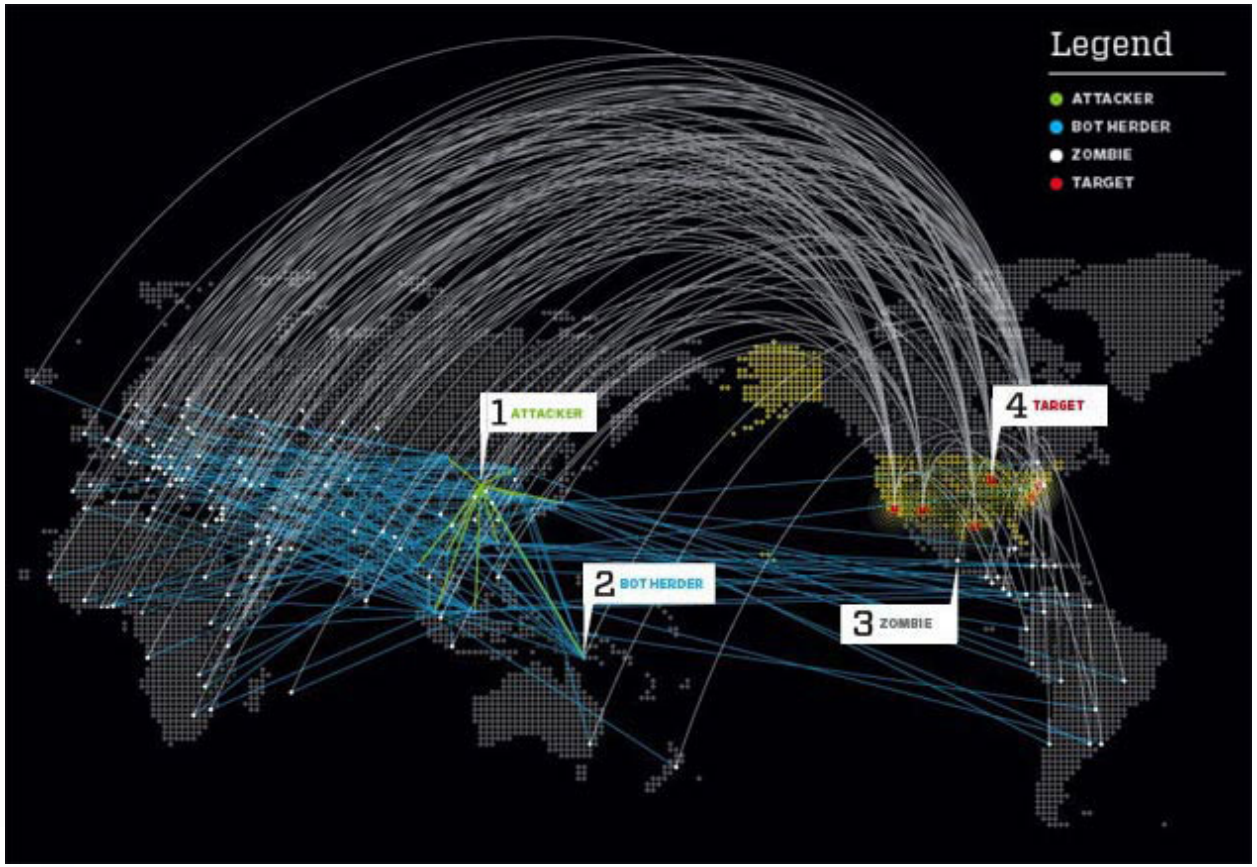
It is known as a botnet, and it had slipped into the country through its least protected border — the Internet

FEATURE

When Bots Attack

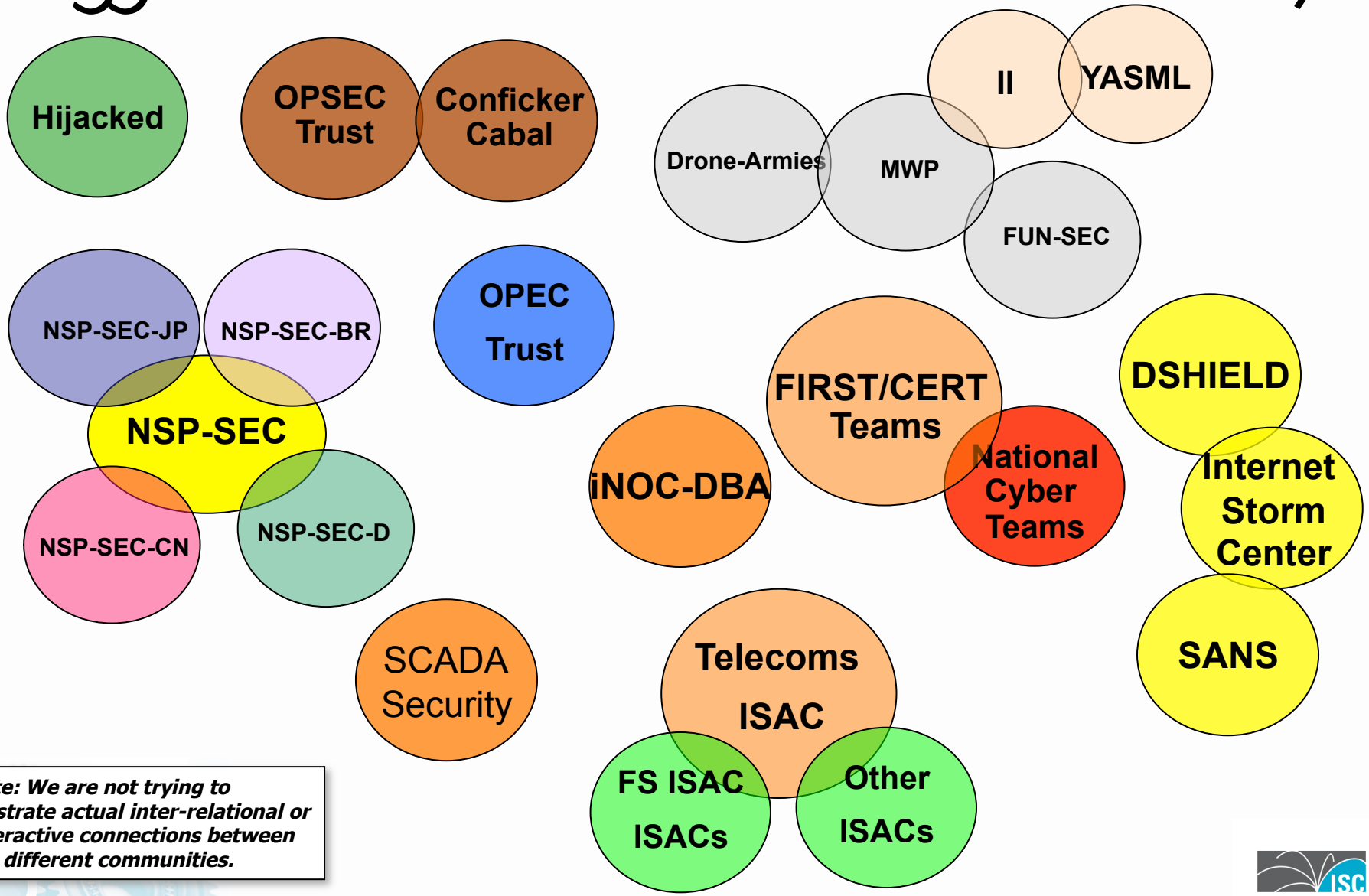
Washington Ignores

When BOTs Attack - Inter AS



http://www.wired.com/politics/security/magazine/15-09/ff_estonia_bots

Aggressive Collaboration is the Key

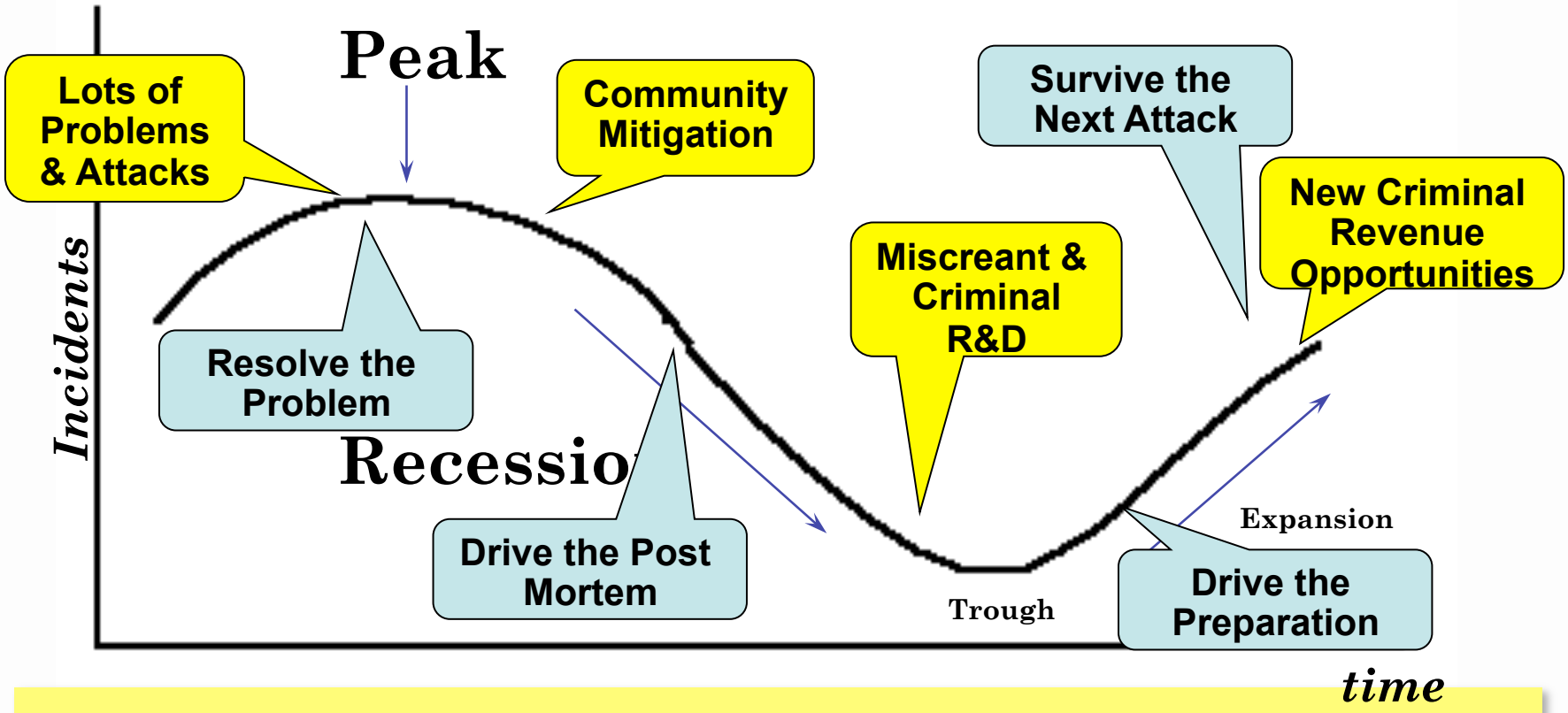


Note: We are not trying to illustrate actual inter-relational or interactive connections between the different communities.

What is NSP-SEC

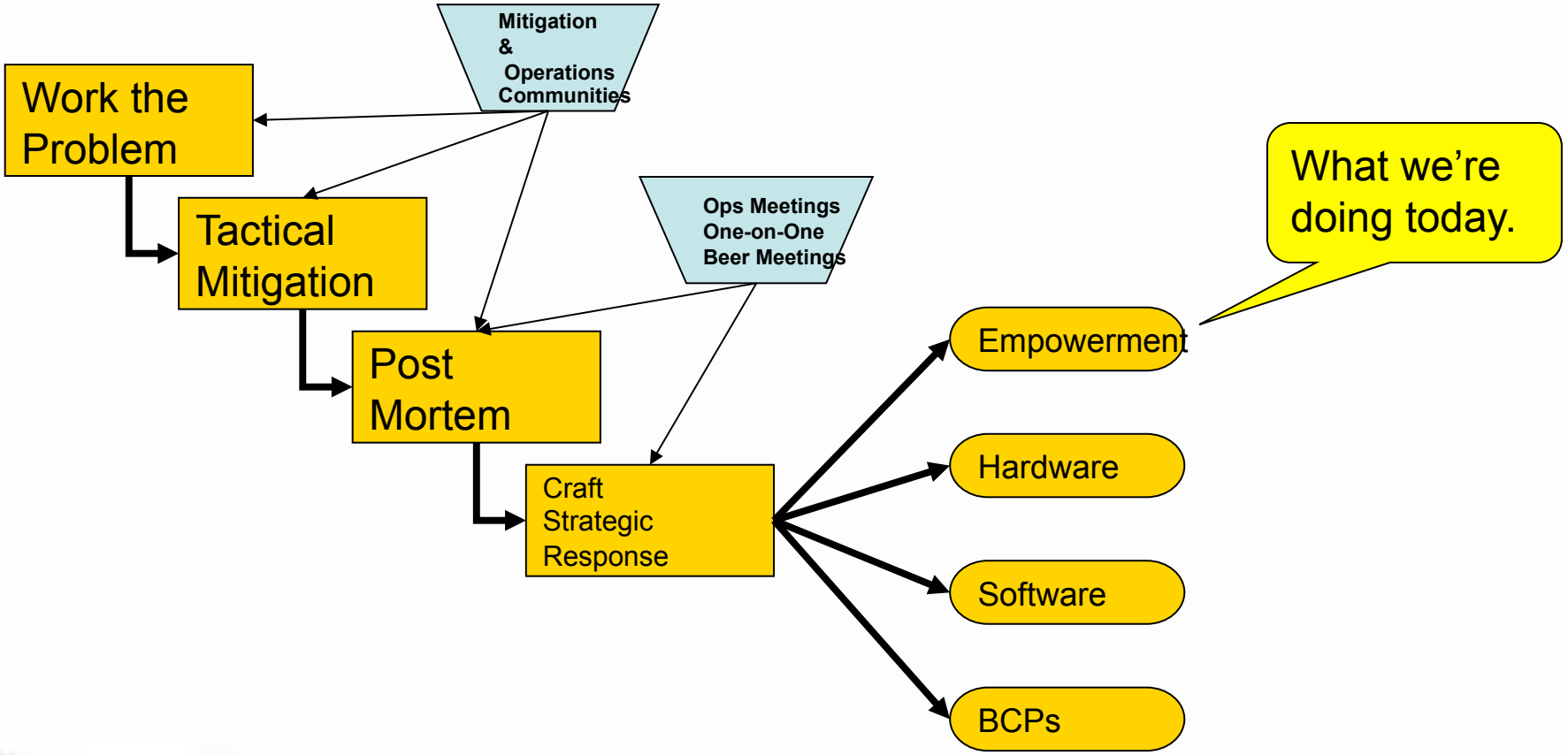
- NSP-SEC – *Closed* Security Operations Alias for engineers actively working with NSPs/ISPs to mitigate security incidents.
- Multiple Layers of sanity checking the applicability and trust levels of individuals.
- Not meant to be perfect – just better than what we had before.
- http://puck.nether.net/mailman/listinfo/nsp-security

Miscreant – Incident Economic Cycles



These Cycles Repeat

Where is This Coming From?



Working the 40/40/20 Rule

- Sean Donelan's (SBC) [sean@donelan.com] rule for end point patching:
  - 40% of the customers care and will proactively patch
  - 40% of the customers may someday care and fix/patch/delouse their machines
  - 20% of the customers just do not care and have never responded to any effort to fix them.

Top Ten List of things that Work

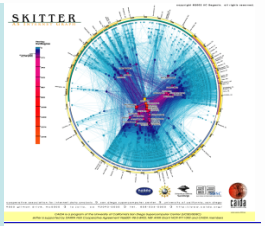
1. Prepare your NOC
2. Mitigation Communities
3. iNOC-DBA Hotline
4. Point Protection on Every Device
5. Edge Protection
6. Remote triggered black hole filtering
7. Sink holes
8. Source address validation on all customer traffic
9. Control Plane Protection
10. Total Visibility (Data Harvesting – Data Mining)

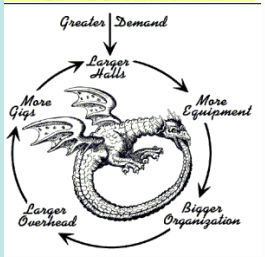
"If you know the enemy and know yourself, you need not fear the result of a hundred battles. If you know yourself but not the enemy, for every victory gained you will also suffer a defeat. If you know neither the enemy nor yourself, you will succumb in every battle."

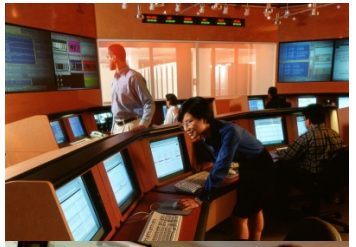
Sun Tzu - Art of War

Understanding the Threat

A Typical Cyber-Criminal's Work Day







Cyber Criminal's Goal

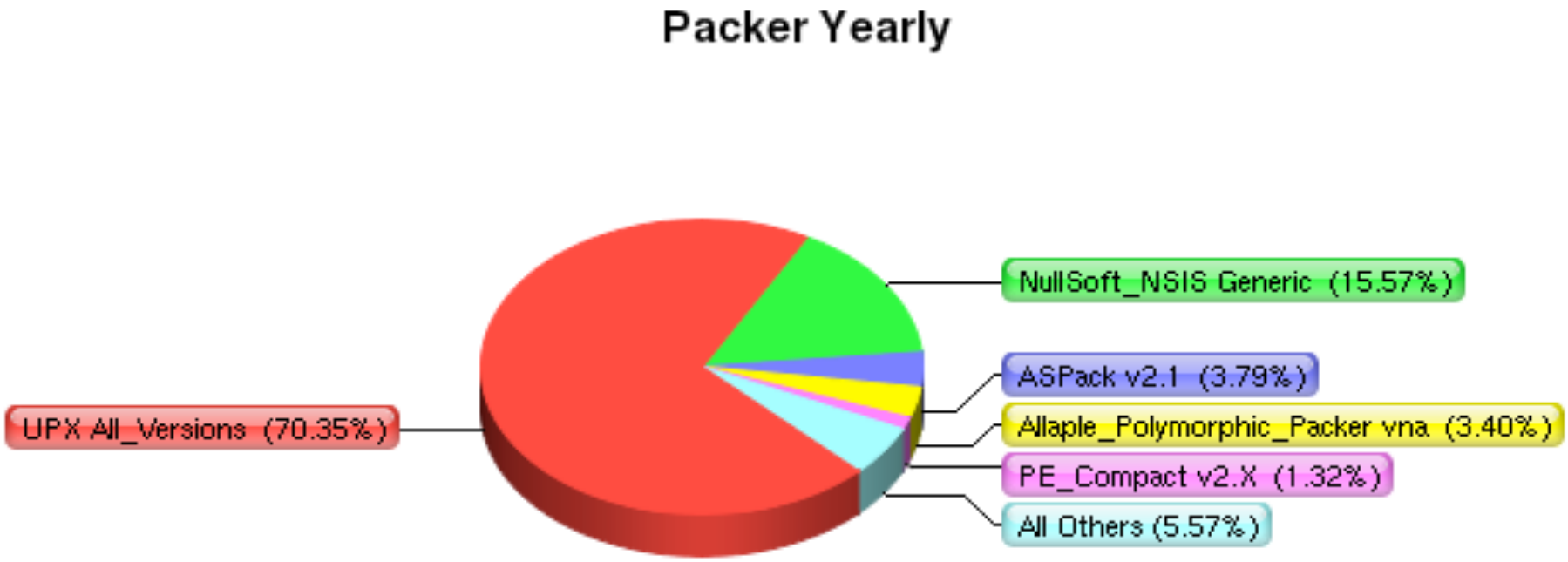
- Build a BOTNET that can be used for:

But What About Anti Virus?

- Packing Tools allow the Cyber-Criminal to change the signature of the malware every hour on the hour
- This bypasses the anti-virus software

AV Engine	Country	Signature
Ahnlab	KR	no_virus
Aladdin (esafe)	IL	no_virus
Alwil (avast)	CZ	no_virus
Authentium	US	no_virus
Avira (antivir)	DE	HEUR/Crypted
BitDefender	RO	no_virus
CA (E-Trust Ino)	US	no_virus
CA (E-Trust Vet)	US	no_virus
CAT (quickheal)	IN	no_virus
ClamAV		Trojan.Crypted-4
Dr. Web	RU	no_virus
Eset (nod32)	US	no_virus
Ewido	DE	no_virus
Fortinet	US	no_virus
Frisk (f-prot)	IS	no_virus
Frisk (f-prot4)	IS	no_virus
F-Secure	FI	Hupigon.gen130
Grisoft (avg)	CZ	no_virus
Ikarus	AT	Backdoor.VB.EV
Kaspersky	RU	no_virus
Mcafee	US	no_virus
Microsoft	US	no_virus
Norman	NO	Hupigon.gen130
Panda	ES	no_virus
Prevx	GB	no_virus
Securecomputing	US	Heuristic.Crypted
Sophos	GB	no_virus
Sunbelt	US	VIPRE.Suspicious
Symantec	US	no_virus
TheHacker	PE	no_virus
UNA	UA	no_virus
VirusBlokAda (vba32)	BY	no_virus

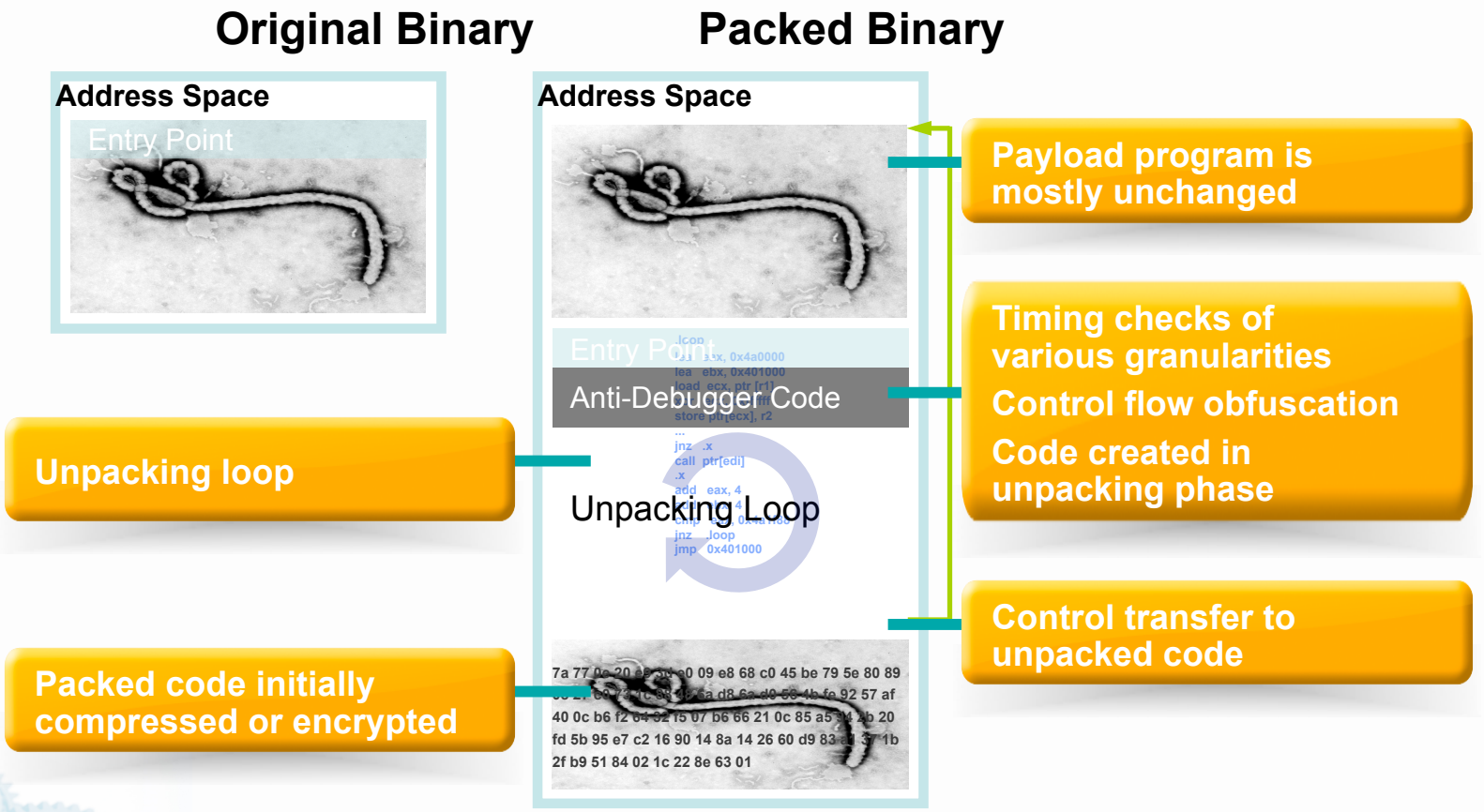
What Packers Are Used?



http://www.shadowserver.org/wiki/pmwiki.php/Stats/PackerStatistics

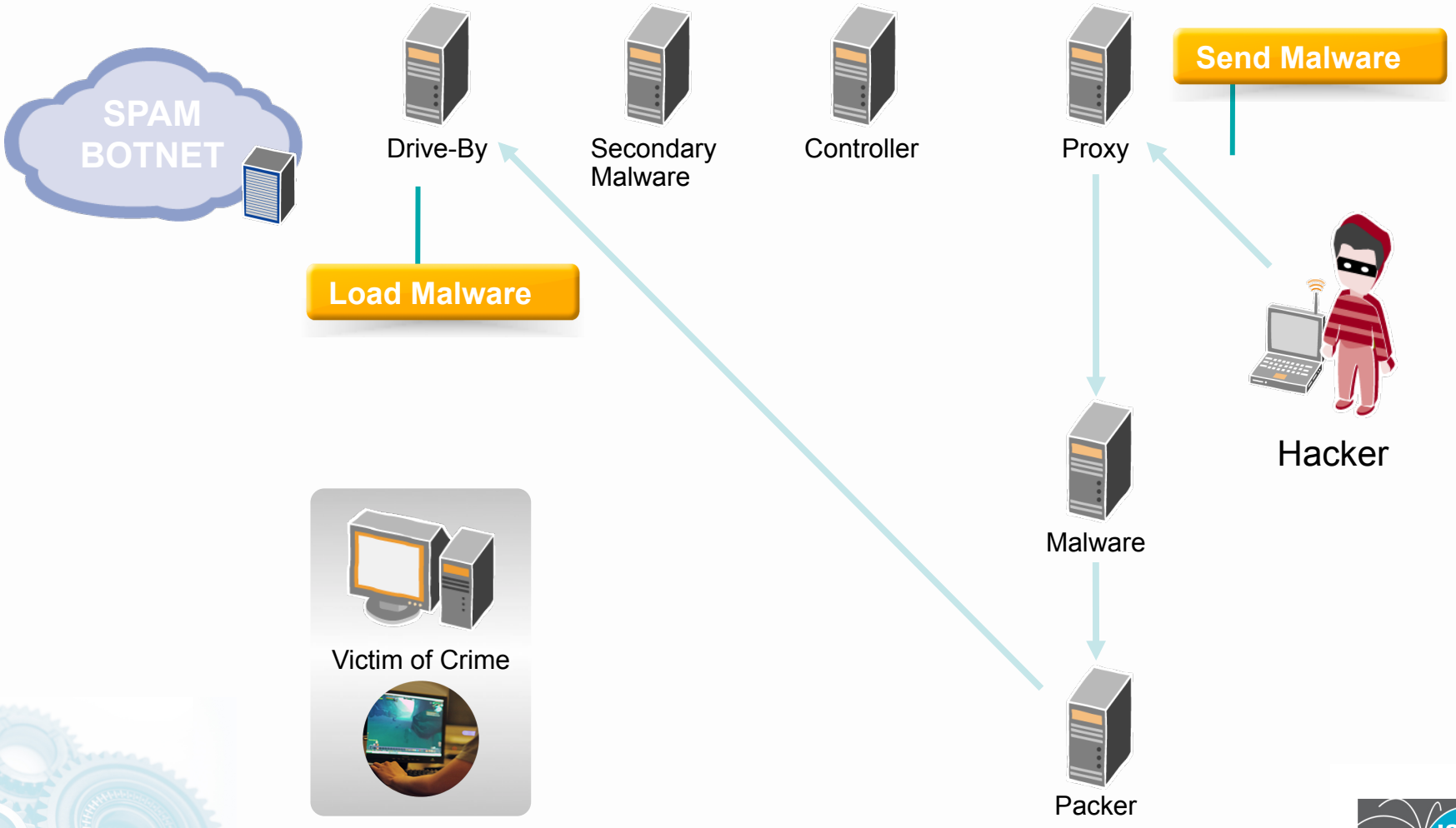
A Packed Malware Binary

A binary is *packed* if some portion of its code is not present until runtime

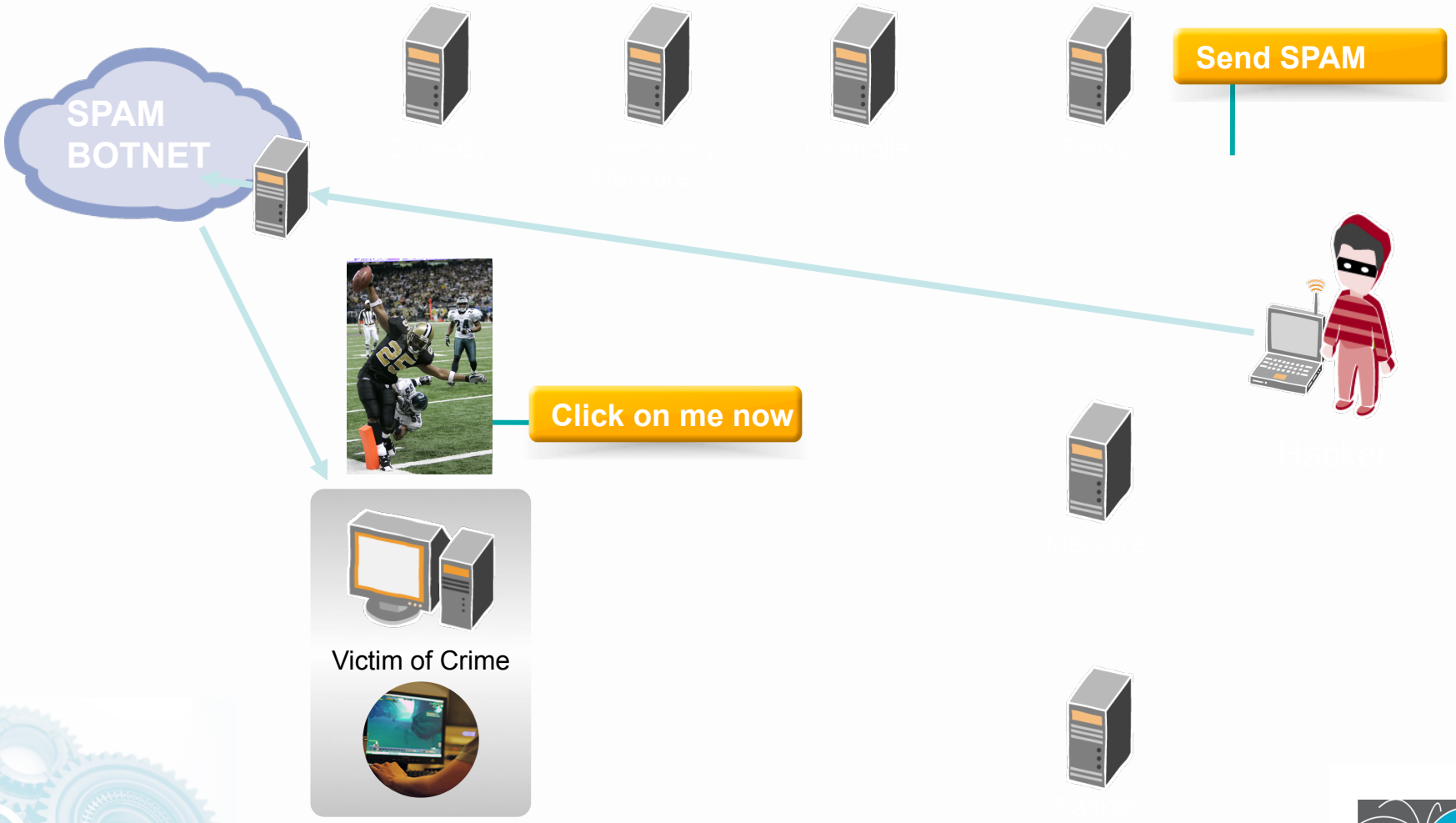


Courtesy of Kevin Roundy (Paradyn Project)

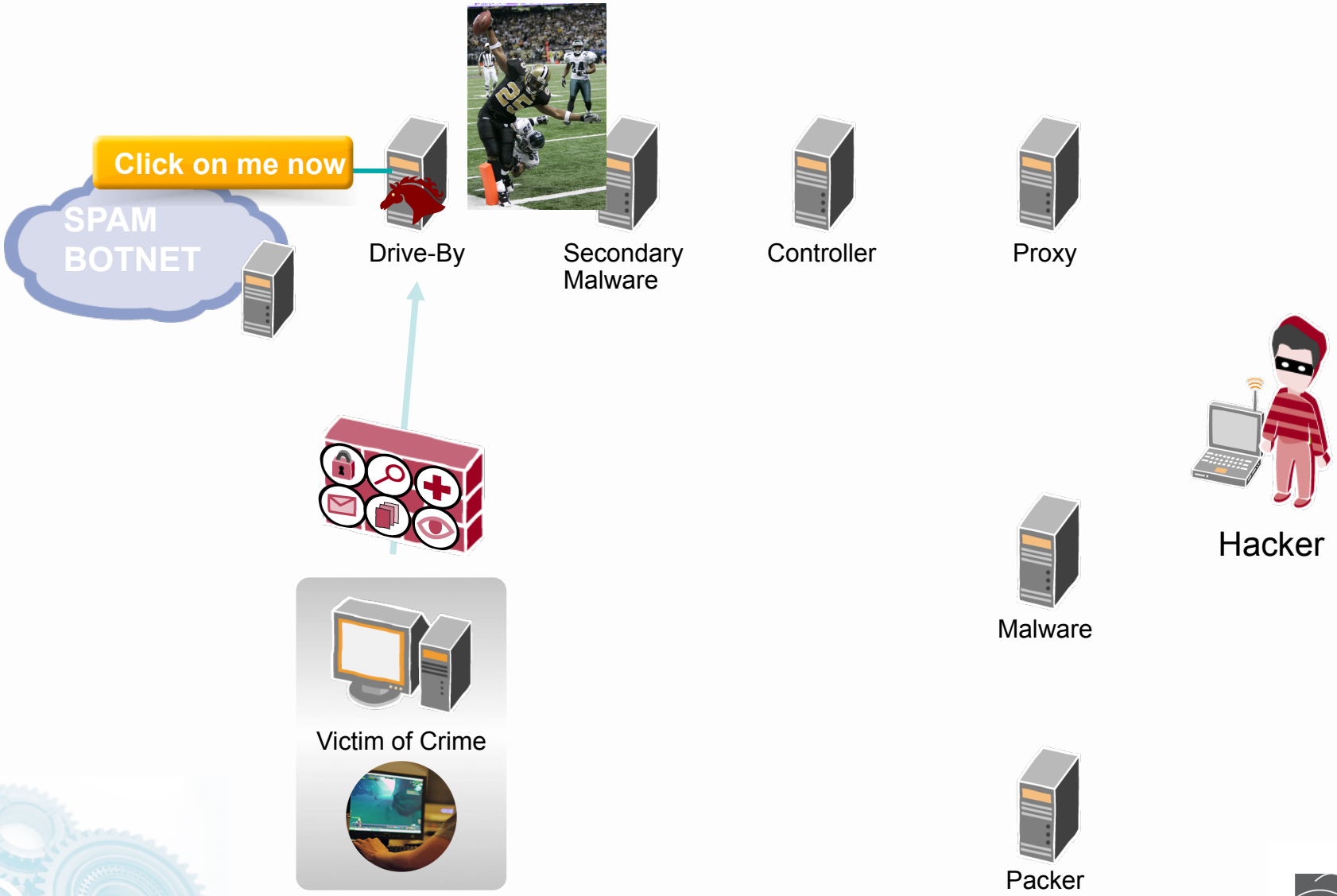
Prepare Drive-By



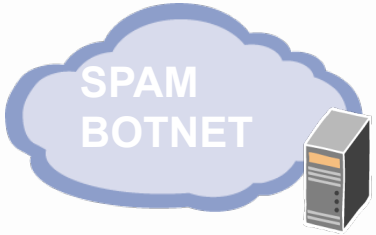
Send SPAM to Get People to Click



Drive-By Violation



Poison Anti-Virus Updates




Drive-By


Secondary Malware


Controller


Proxy


Hacker


Anti-Virus Vendor

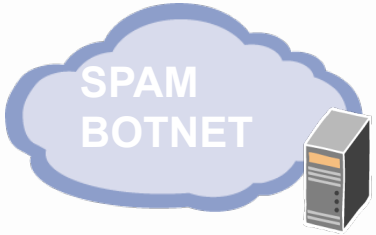
Poison the anti-virus updates

All updates to 127.0.0.1


Malware


Packer

Prepare Violated Computer




Drive-By

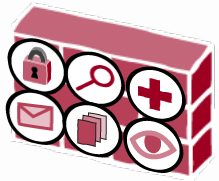

Secondary Malware


Controller


Proxy


Hacker


Anti-Virus Vendor



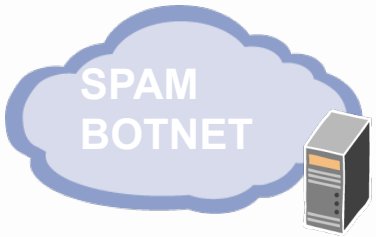
Call to secondary Malware site

Load secondary package


Malware


Packer

Call Home



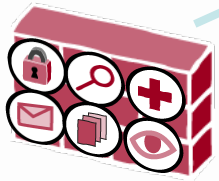

Drive-By


Secondary Malware


Controller


Proxy


Hacker



Call to Controller

Report:

- Operating System
- Anti-Virus
- Location on the Net
- Software
- Patch Level
- Bandwidth
- Capacity of the computer

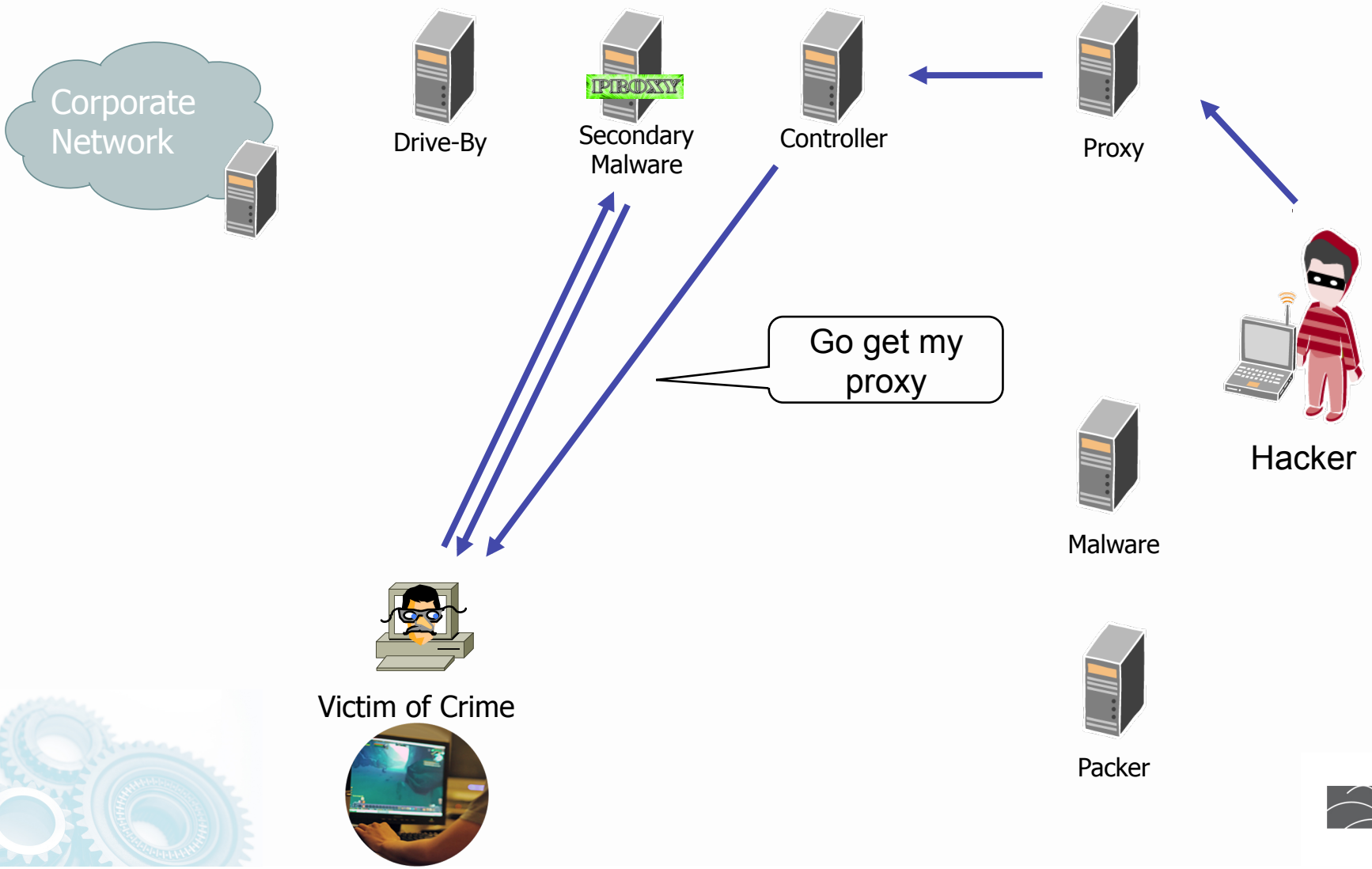

Malware


Packer

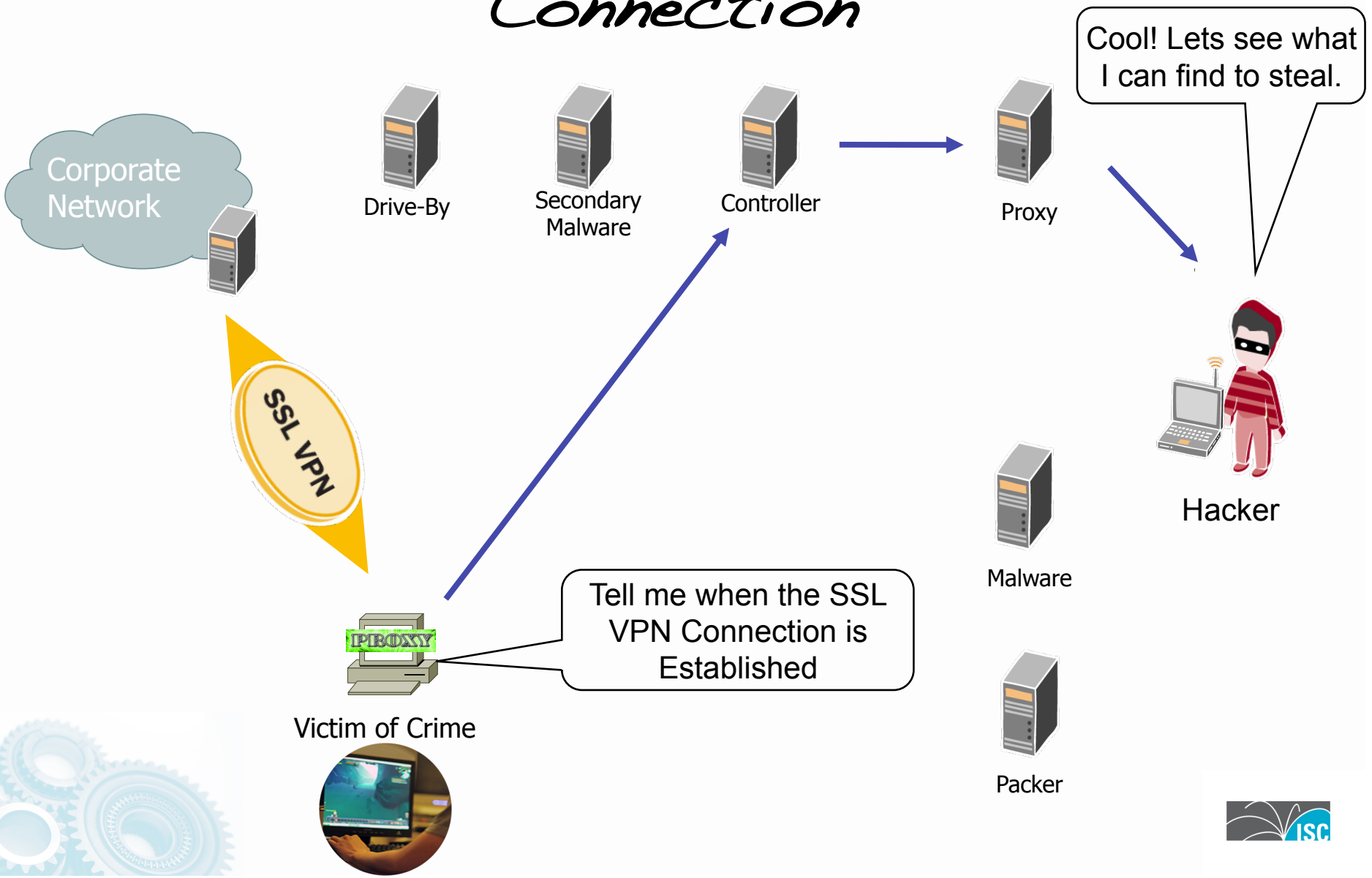
BOTHERDer – Next Steps

- Analyze the results of the BOTNET Run
  - Look for types of systems
  - Look for where the systems are located
- Group the Systems into Sellable Modules
  - SPAM Systems
  - DDOS Systems
  - Phishing Systems
  - Fast Flux Systems
  - Grouped by Domains – .mil, .gov, banks, companies, and other institutions
  - SCADA Systems (never upgraded – never patched)

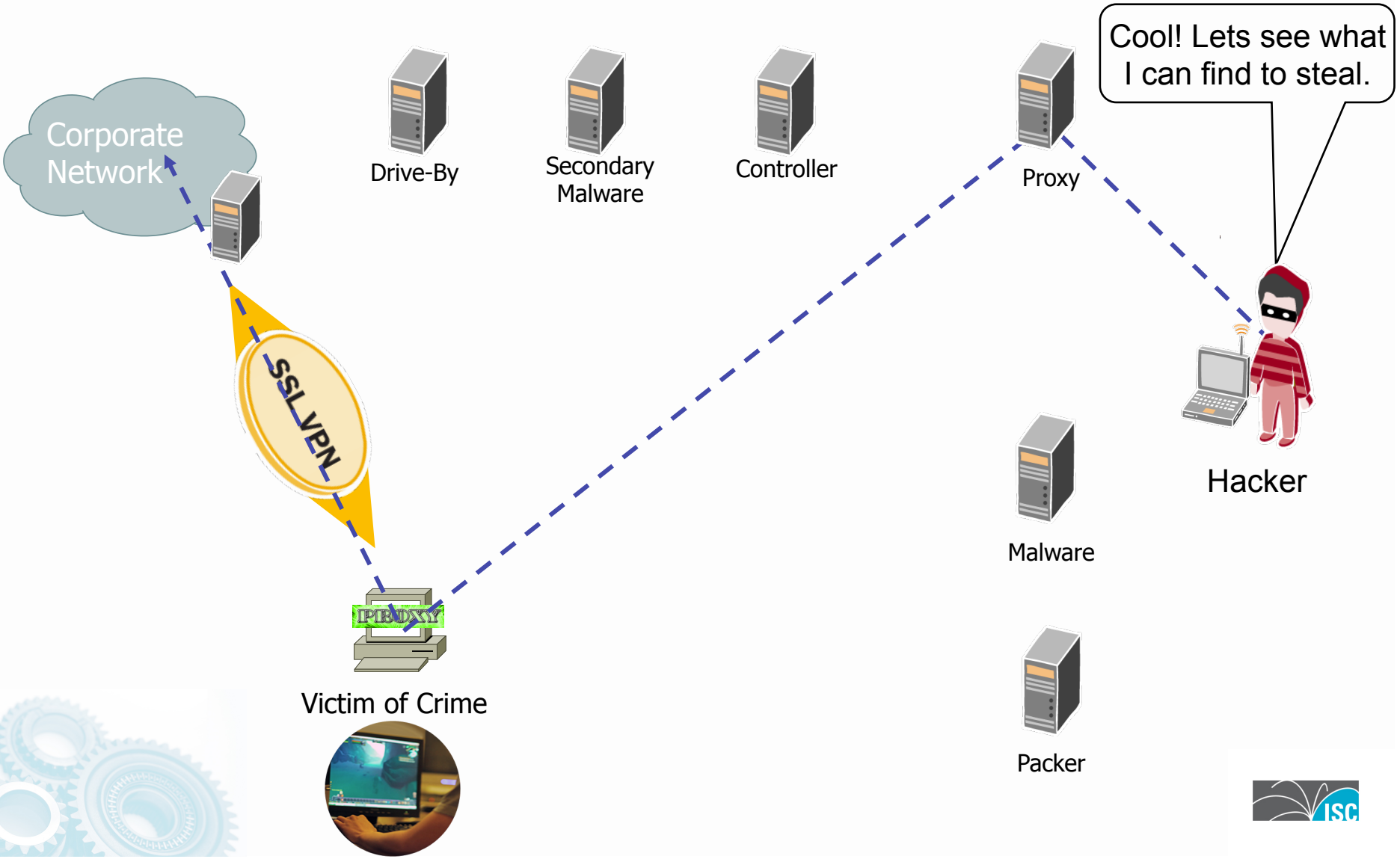
Load a Proxy with Trigger



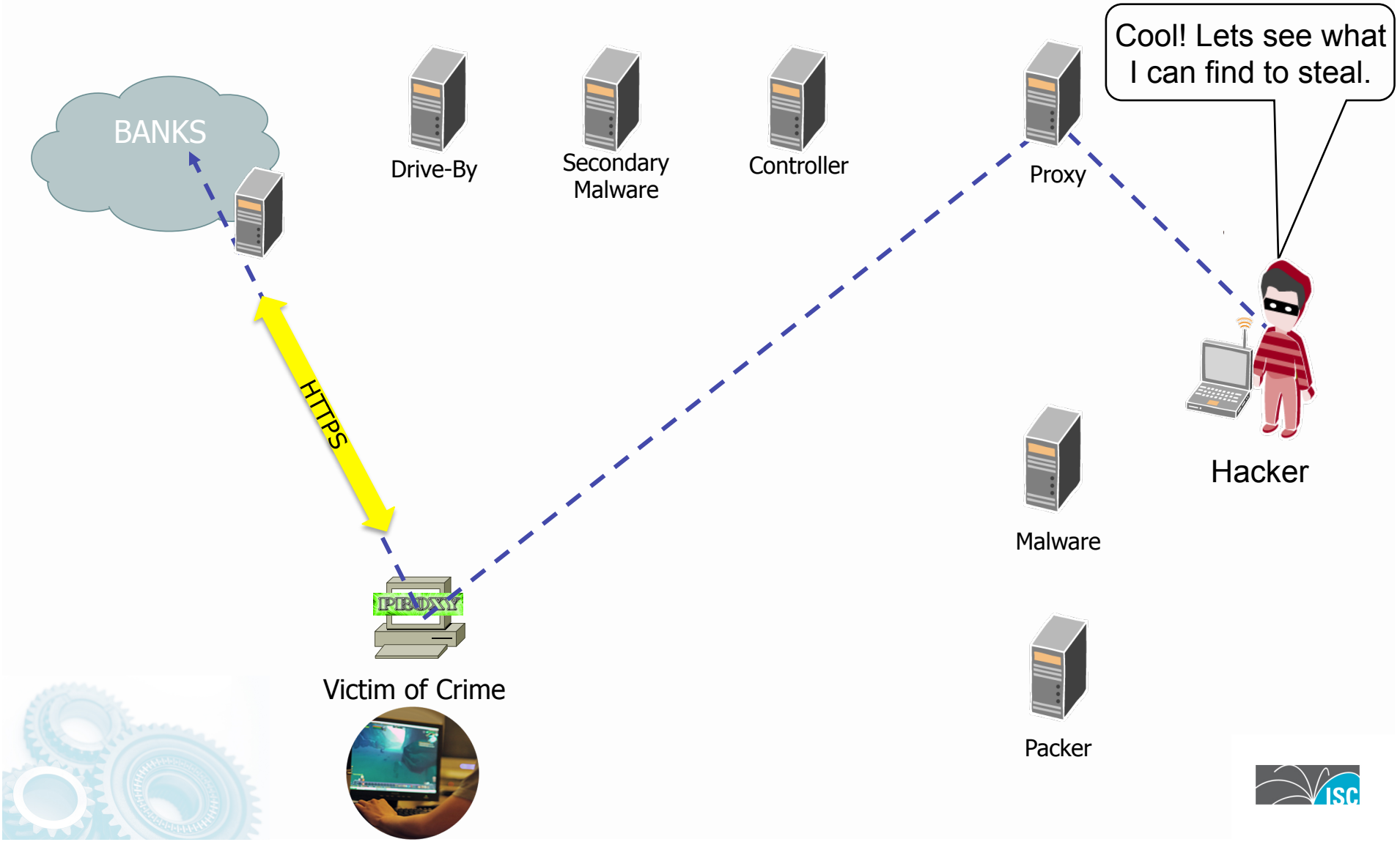
Watch for the SSL VPN Connection



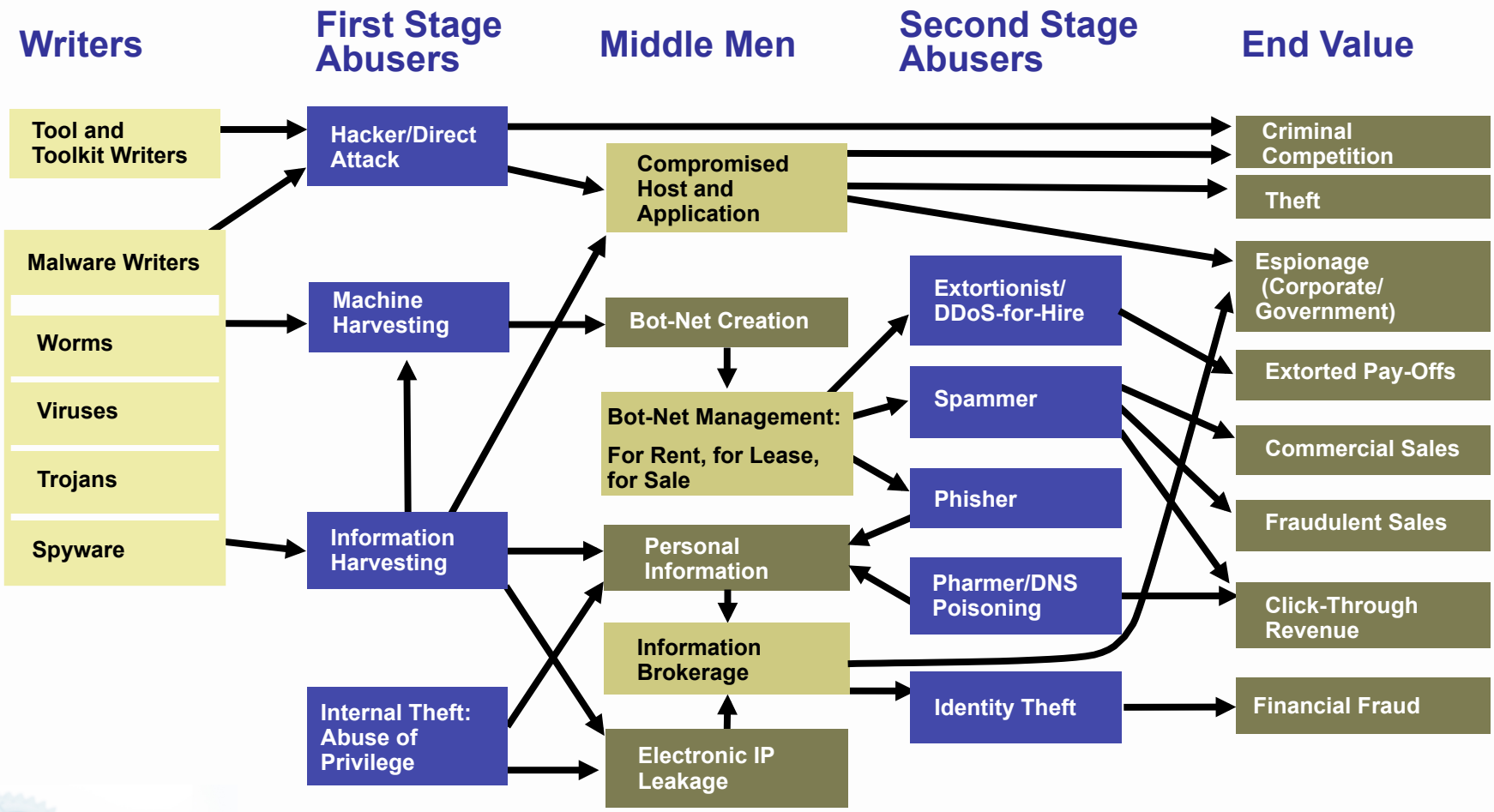
Set up the Proxy Tunnel



Proxy Behind the Bank Login



Threat Economy: Today



$$$ Flow of Money $$$

Enduring Financial Opportunities

Postulate: Strong, Enduring Criminal Financial Opportunities Will Motivate Participants in the Threat Economy to Innovate to Overcome New Technology Barriers Placed in Their Way

Enduring *criminal* financial opportunities:

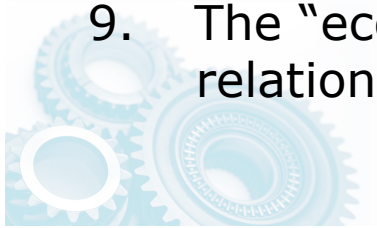
- Extortion
- Advertising
- Fraudulent sales
- Identity theft and financial fraud
- Theft of goods/services
- Espionage/theft of information

Changing Face of Threats

- Change in purpose
  - Shift from fame to other, higher-value motivations: profit, revenge, competition
  - By far the strongest motivator is now profit: there's good, relatively easy money to be made by committing a computer crime or two
- Change in expected behavior
  - Less noisy
  - More sophisticated
  - More variants, smaller scope of each

Scary Consequences

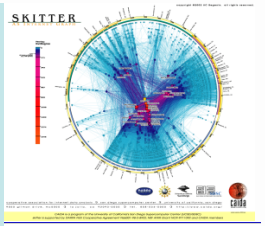
1. Building "Secure" Operating Systems with "Security Development Lifecycles" and aggressive testing are not delivering to expectations.
2. Host Security Tools (anti-virus) are not delivering to expectations.
3. Application Security is not delivering and becoming more complicated.
4. Network Security tools (firewalls, IDP/IPS, etc) are not delivering as expected.
5. Defense in Depth are not delivering as expected.
6. Malware Remediation is not working (i.e. how to clean up infections).
7. The Bad Guys follow equilibrium patterns – finding optimization thresholds.
8. Law Enforcement is not in a position to act on International Crime – where the laws are not in place.
9. The "eco-system" of the "security industry" is locked in a symbiotic relationship.

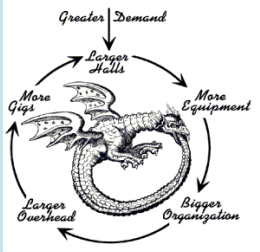


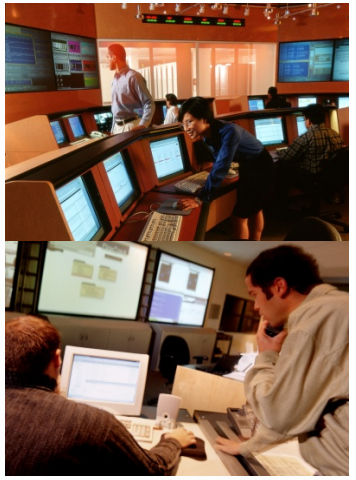
What do we do?

- Build sustainable capabilities and capacities for the industry which will instigate healthy cyber-risk ecosystem.
  - SIE
  - Technology Demonstrations
  - Use the Restricted Grant Vehicle to build software the "ISC Way" which is critical needed by the industry.
  - Grant as seed activities.
  - "Resiliency & Security" Forum
  - Empowerment Training

Why Cyber-Crime is Institutionalized?

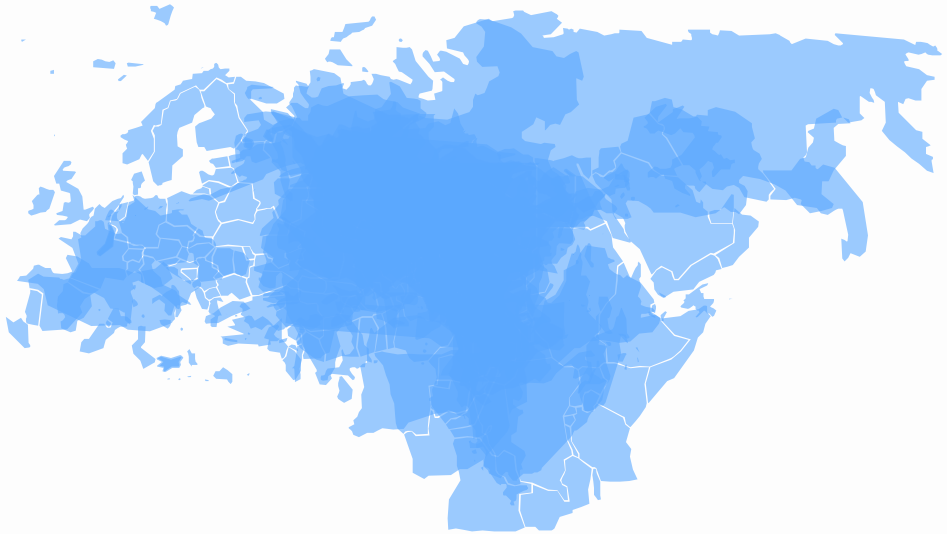






Our Traditional View of the World

The Reality of IP NGN - No Borders



How to project civic society and the rule of law where there is no way to enforce the law?

Three Major Threat Vectors

- Critical Infrastructure has three major threat drivers:
  - Community #1 Criminal Threat
    - Criminal who use critical infrastructure as a tools to commit crime. Their motivation is money.
  - Community #2 War Fighting, Espionage and Terrorist Threat
    - What most people think of when talking about threats to critical infrastructure.
  - Community #3 P3 (Patriotic, Passion, & Principle) Threat
    - Larges group of people motivated by cause – be it national pride (i.e. Estonia & China) or a passion (i.e. Globalization is Wrong)

Essential Principles

- There are key essential principles to a successful miscreant (i.e. cyber criminal)
- These principles need to be understood by SP Security professionals
- Understanding allows one to cut to the core concerns during security incidents
- Attacking the dynamics behind these principles are the core ways we have to attempt a disruption of the Miscreant Economy

Principles

1. Don’t Get Caught
2. Don’t work too hard
3. Follow the money
4. If you cannot take out the target, move the attack to a coupled dependency of the target
5. Always build cross jurisdictional attack vectors
6. Attack people who will not prosecute
7. Stay below the pain threshold

Principle 1: Do Not Get Caught!

- The first principle is the most important – it is no fun getting caught, prosecuted, and thrown in jail
  - (or in organized crime – getting killed)
- All threat vectors used by a miscreant will have an element of un-traceability to the source
- If it can be traced, it is one of three things:
  1. A violated computer/network resources used by the miscreant
  2. A distraction to the real action
  3. A really dumb newbie

Principle 2: Do Not Work Too Hard!

- Use the easiest attack/penetration vector available in the toolkit to achieve the job's objective
- Example: If your job is to take out a company's Internet access the day of the quarterly number's announcement, would you:
  1. Penetrate the Site and Delete files?
  2. Build a custom worm to create havoc in the company?
  3. DOS the Internet connection?
  4. DOS the SP supporting the connection?

Principle 3: Follow the Money

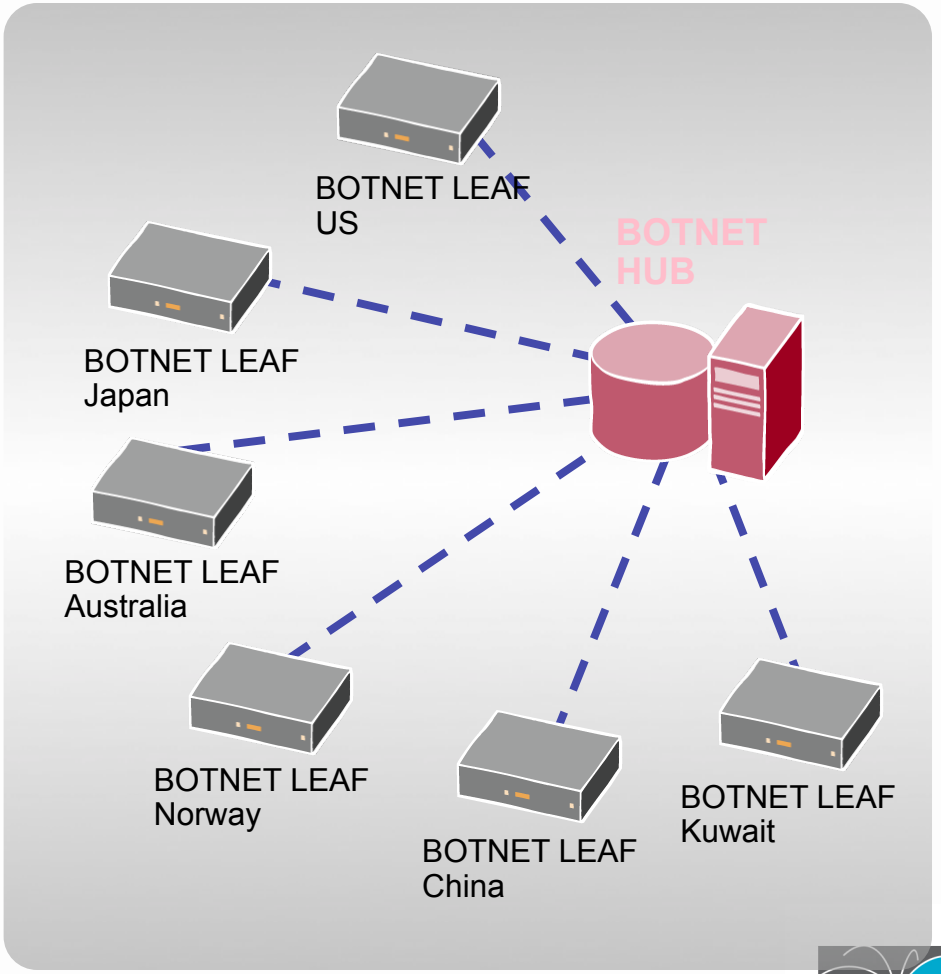
- If there is no money in the crime then it is not worth the effort
- *Follow the money* is the flow of money or exchanged value as one miscreant transfers value to another miscreant (or the victim transfers value to the criminal)
- A *Cyber-Criminal Treat Vector* opens when the miscreant finds a way to move 'stored value' from the victim through the economy
- It is worse if the cyber 'stored value' can cross over to normal economic exchange

Principle 4: If You Cannot Take Out The Target…

- If you cannot take out the target, move the attack to a coupled dependency of the target
- There are lots of coupled dependencies in a system:
  - The target's supporting PE router
  - Control Plane
  - DNS Servers
  - State Devices (Firewalls, IPS, Load Balancers)
- Collateral Damage!

Principle 5: Always Build Cross Jurisdictional Attack Vectors

- Remember – Don't get caught! Do make sure ever thing you do is cross jurisdictional.
- Even better – cross the law systems (Constitutional, Tort, Statutory, Islamic, etc.)
- Even Better – Make sure your "gang" is multi-national – making it harder for Law Enforcement



Principle 6: Attack People Who Will NOT Prosecute

- If your activity is something that would not want everyone around you to know about, then you are a miscreant target
- Why? Cause when you become a victim, you are not motivated to call the authorities
- Examples:
  - Someone addicted to gambling is targeted via a Phishing site
  - Someone addicted to porn is targeted to get botted
  - Someone addicted to chat is targeted to get botted
  - Someone new to the Net is targeted and abused on the physical world
  - Government, Finance, and Defense, Employees – who lose face when they have to call INFOSEC

Principle 7: Stay below the Pain Threshold

- The *Pain Threshold* is the point where an SP or Law Enforcement would pay attention
- If you are below the pain threshold – where you do not impact an SP's business, then the SP's Executive Management do not care to act
- If you are below the pain threshold – where you do not have a lot of people calling the police, then the Law Enforcement and Elected Official do not care to act
- The Pain Threshold is a matter of QOS, Resource Management, and picking targets which will not trigger action

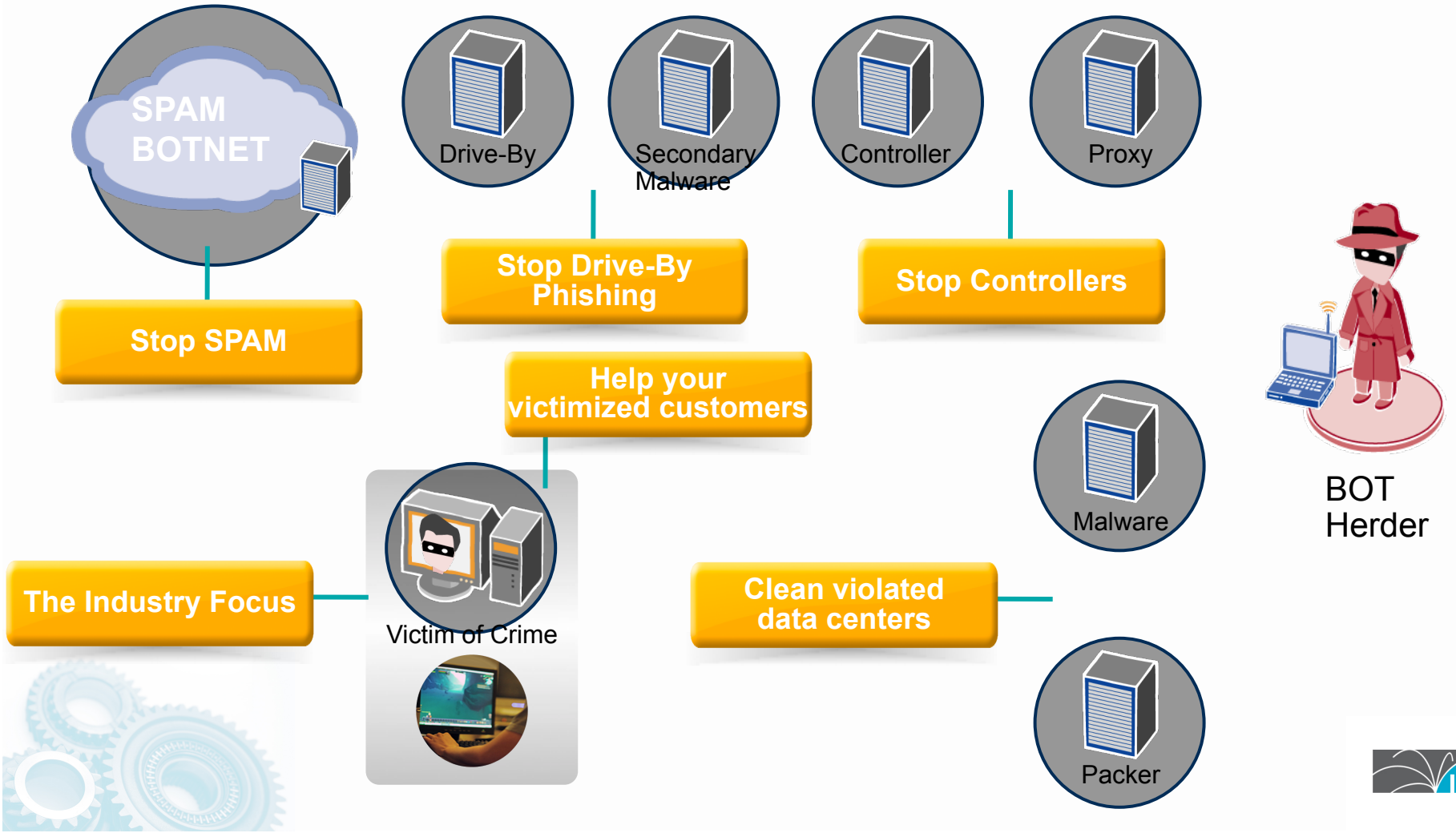
Guard Trust

- Miscreants will guardedly trust each other
- They can be competitors
- They can be collaborators
- But when there is money on the table, criminal human behavior and greed take over

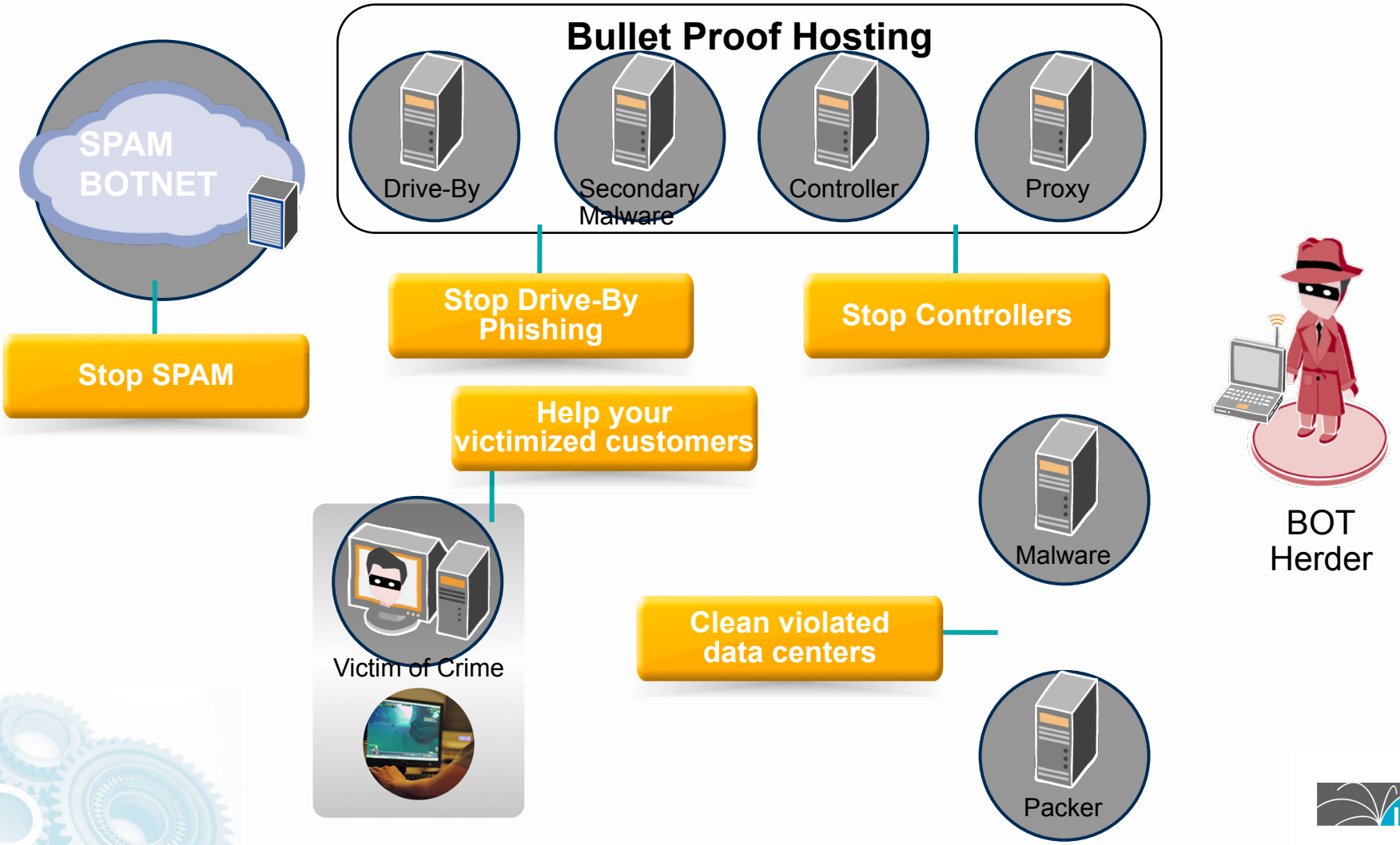
Dire Consequences

- The Miscreant Economy is not a joke. It is not a game. It is not something to play with.
  - PEOPLE DIE
- Once organized crime enter the world of the Miscreant Economy, the days of *fun* were over.
- Now that Cyber-Criminals will use any resource on the net to commit their crime, they don't worry about the collateral damage done.
  - Think of computer resources at a hospital, power plant, or oil refinery – infected and used to commit phishing and card jacking.
  - What happens if someone gets mad at the phishing site, attacks it in retaliation, unintentionally knocking out a key systems.

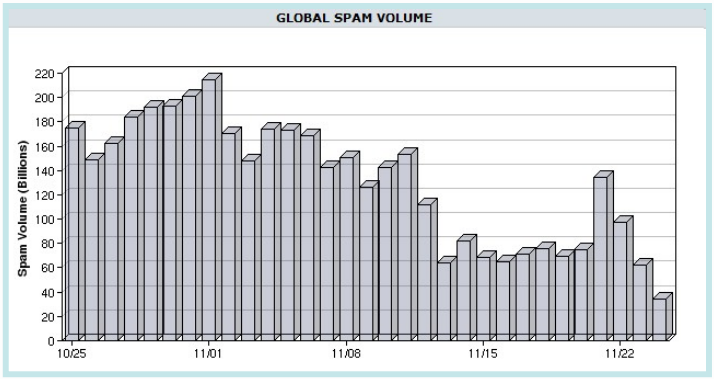
What Can We Do?

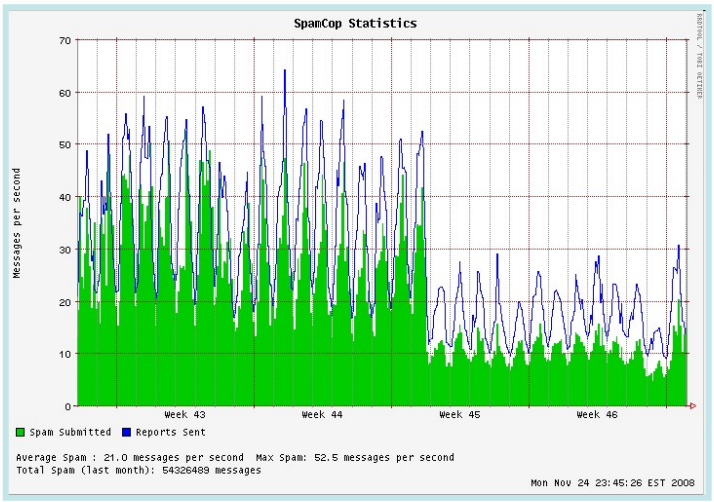


Find the Actionable Target...



Community Action Can Have an Impact





Source: http://voices.washingtonpost.com/securityfix/2008/11/64_69_65_73_70_61_6d_64_69_65.html

But for how long .....

SECURITY FIX

BRIAN KREBS

Brian Krebs on Computer Security

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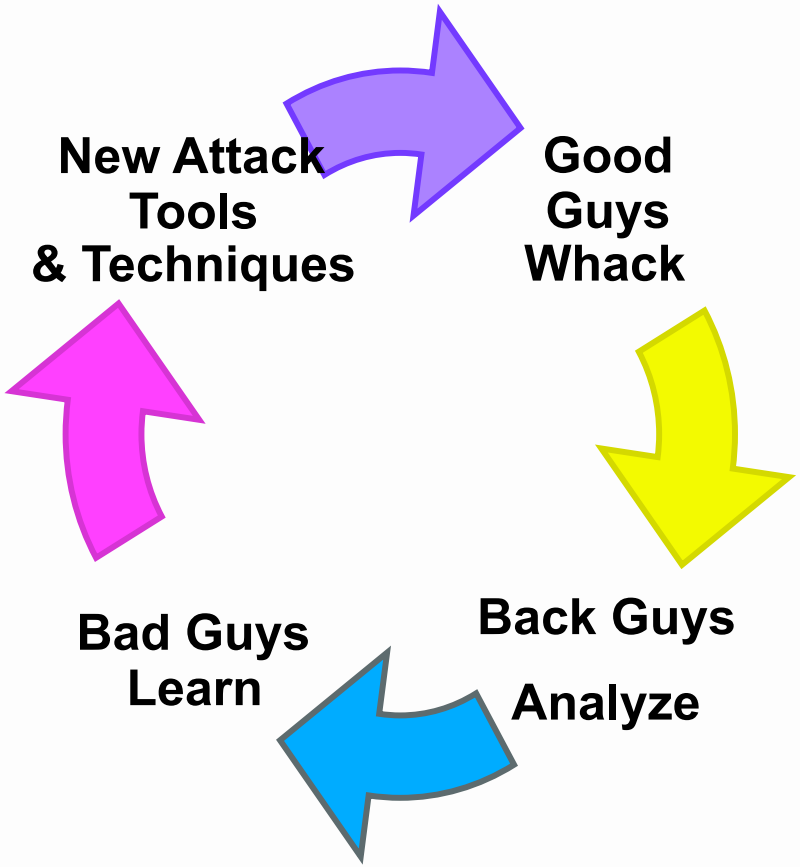
Srizbi Botnet Re-Emerges Despite Security Firm's Efforts

In the fallout resulting from knocking **McColo Corp.** offline, this past week may prove to be a missed opportunity in the prevention of a dramatic reappearance of junk e-mail, as a botnet that once controlled 40 percent of the world's spam apparently has found a new home.

The botnet Srizbi was knocked offline Nov. 11 along with Web-hosting firm McColo, which Internet security experts say hosted machines that controlled the flow of 75 percent of the world's spam. One security firm, FireEye, thought it had found a way to prevent the botnet from coming back online by registering domain names it thought Srizbi was likely to target. But when that approach became too costly for the firm, they had to abandon their efforts.

"This cost us a lot of money. We engaged all the right people. In the end, it comes back to the fact that there wasn't a process in place to do what we were trying to do," said **Alex Lanstein**, senior researcher at FireEye. "The day after we stopped registering the domains, the bad guys started picking them up."

According to FireEye, Srizbi was the only botnet operating through



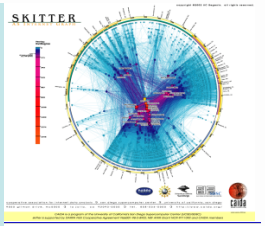
What will we do when the Cyber-Criminals …

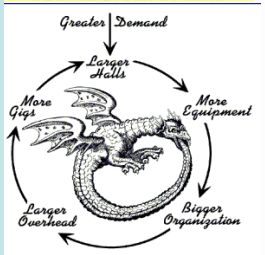
- Retaliate! Historically, Organized Crime will retaliate against civic society to impose their will and influence on civic society.
  - What will the today's organized crime to in a cyber equivalent world?
- How will the world respond when:
  - We cannot as a global society investigate and prosecute International crime?
  - Too much dependence on "security vendors" for protection.
- Global Telecom's *Civic Society* has to step forward – work with each other collectively to protect their interest.

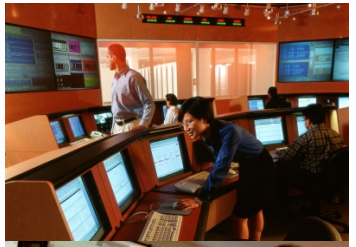
Are you part of the new "Civic Society?

- Are you sitting back and trusting your "security vendors?"
- Or, are you stepping forward, working with all others with like interest in Global Telecom's Civic Society to go after and shutdown the miscreants?
- Two Recommendations for SCADA Organizations to get started:
  - DSHIELD
  - SCADASEC-L

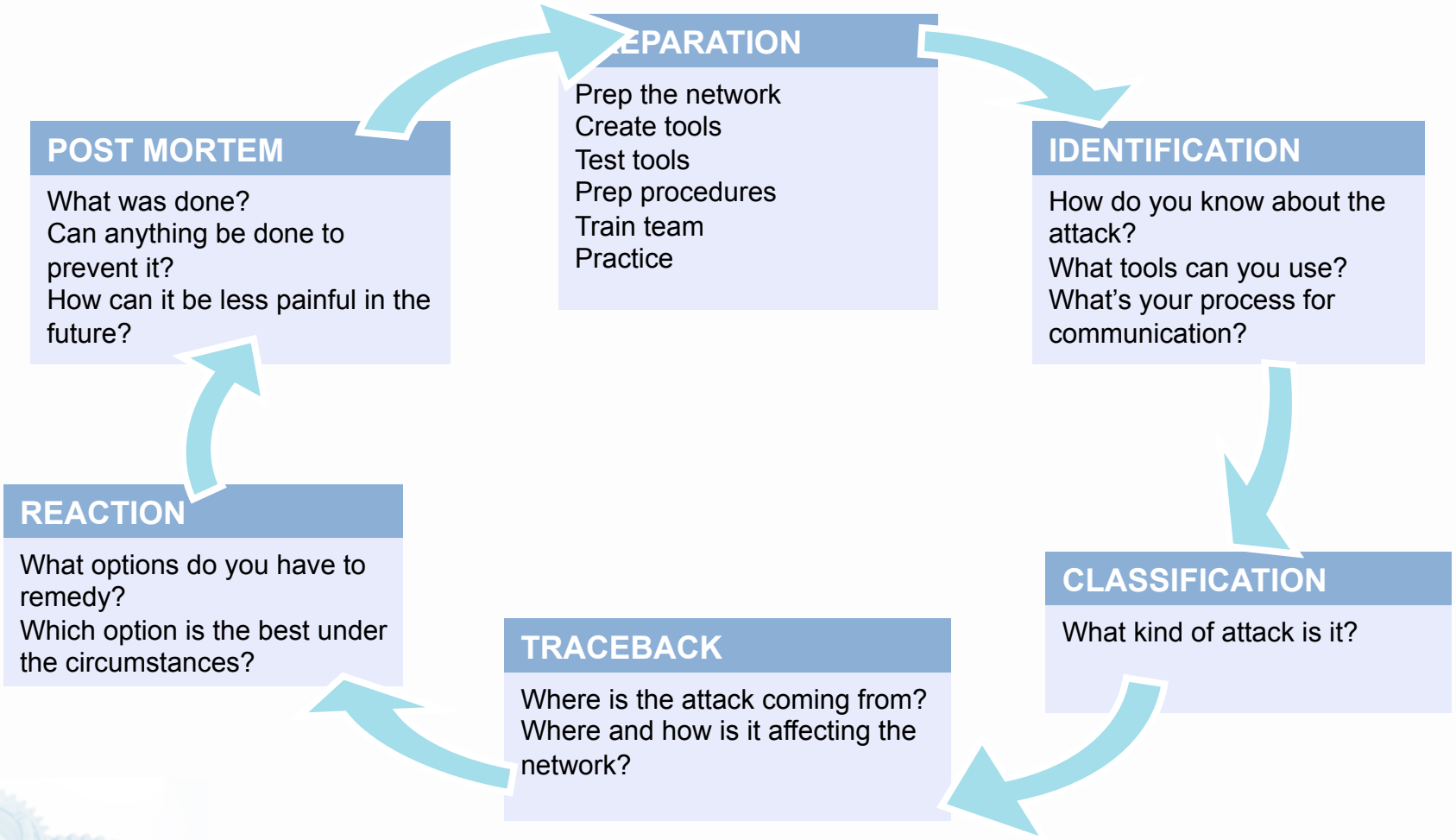
Top 10 SP Security Techniques The Executive Summary



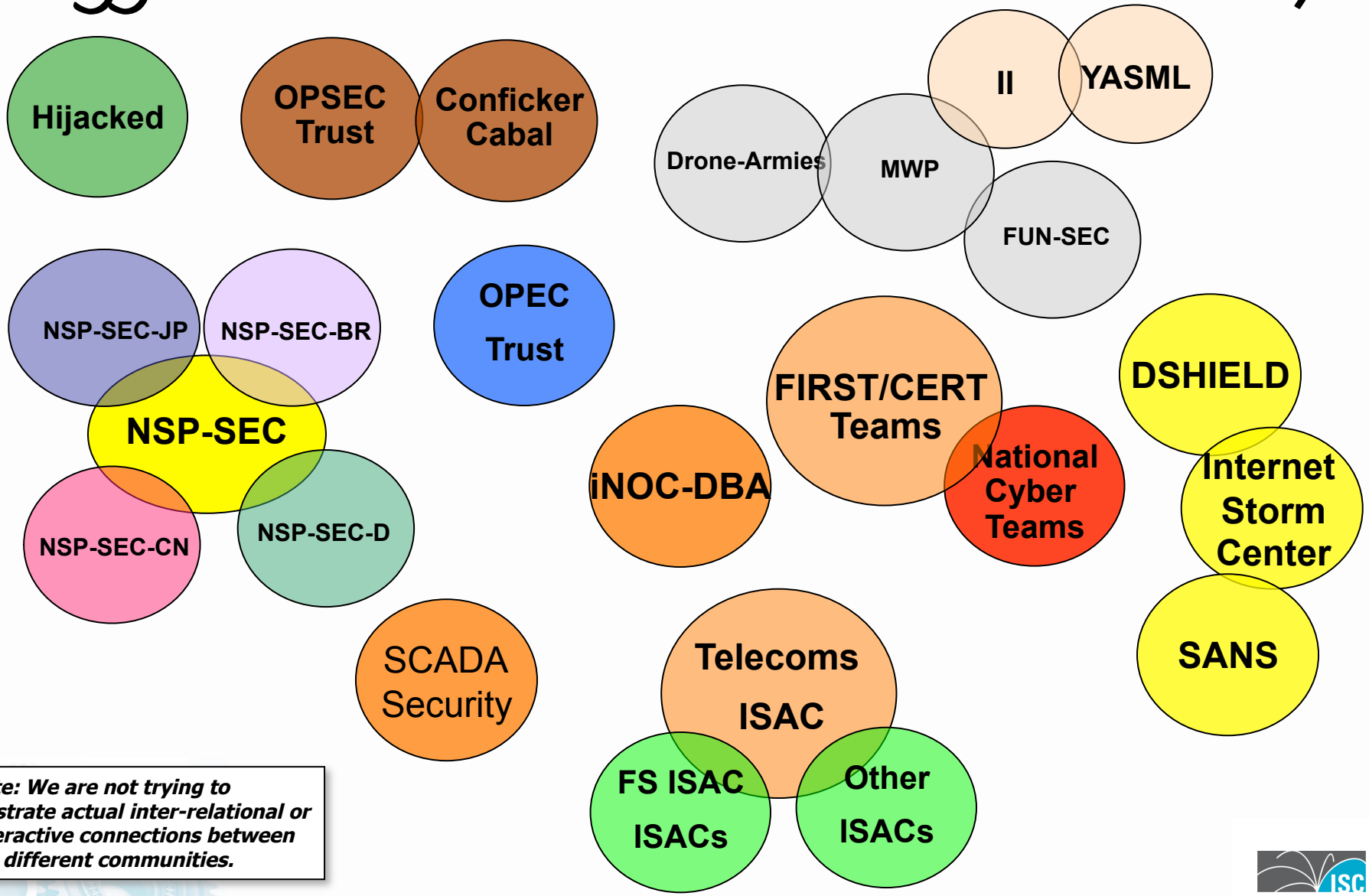




SP Security in the NOC - Prepare

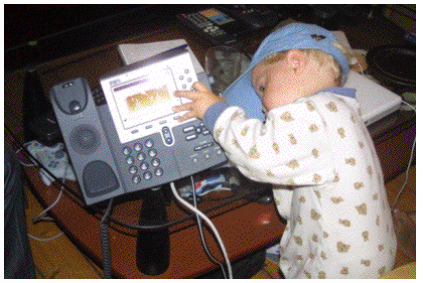


Aggressive Collaboration is the Key



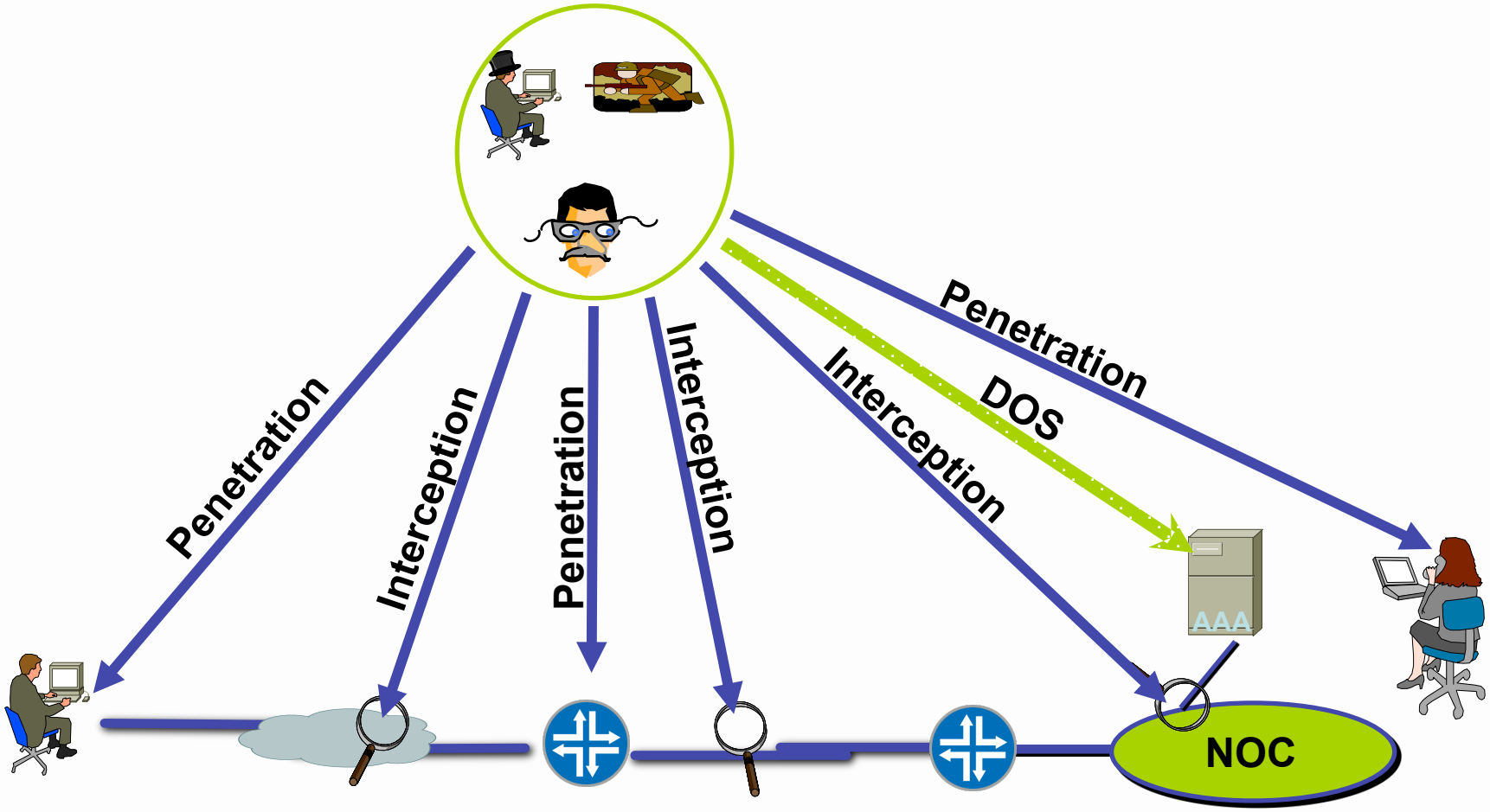
Note: We are not trying to illustrate actual inter-relational or interactive connections between the different communities.

iNOC DBA Hotline



- INOC-DBA: *Inter-NOC Dial-By-ASN*
- The iNOC Hotline was used to get directly to their peers.
- Numbering system based on the Internet:
  - ASnumber:phone
  - 109:100 is Barry's house.
- SIP Based VoIP system, managed by www.pch.net

Point Protection

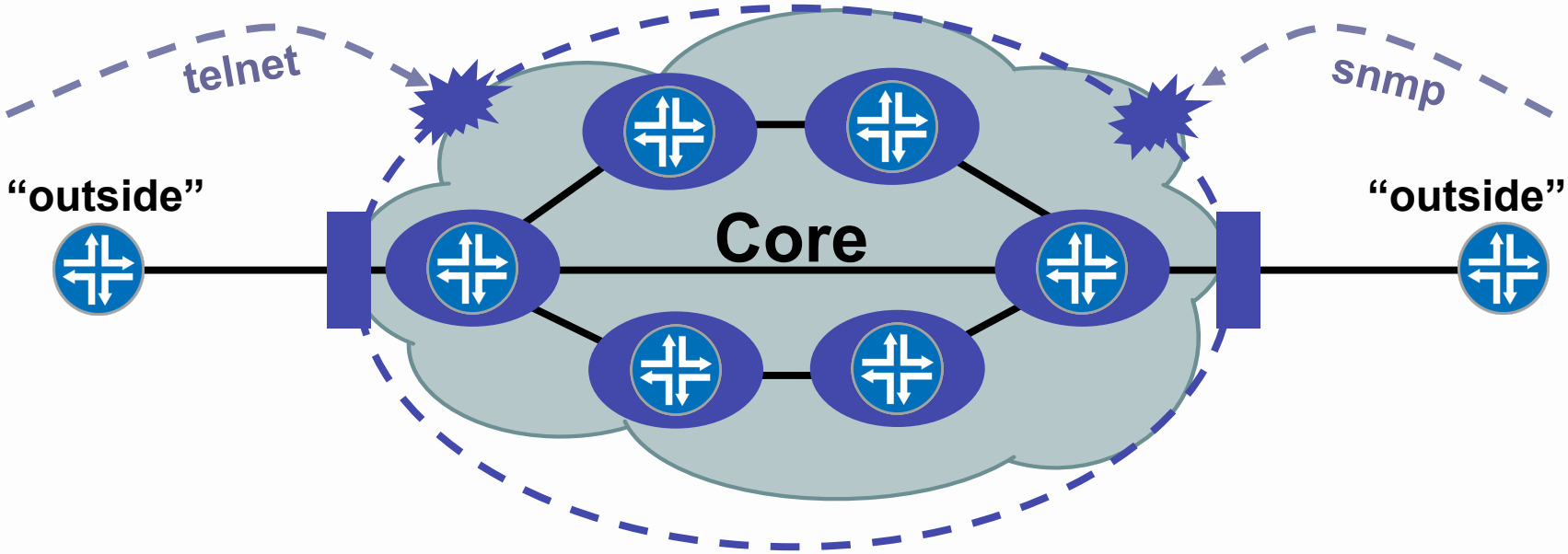


Remote Staff

ISP's Backbone

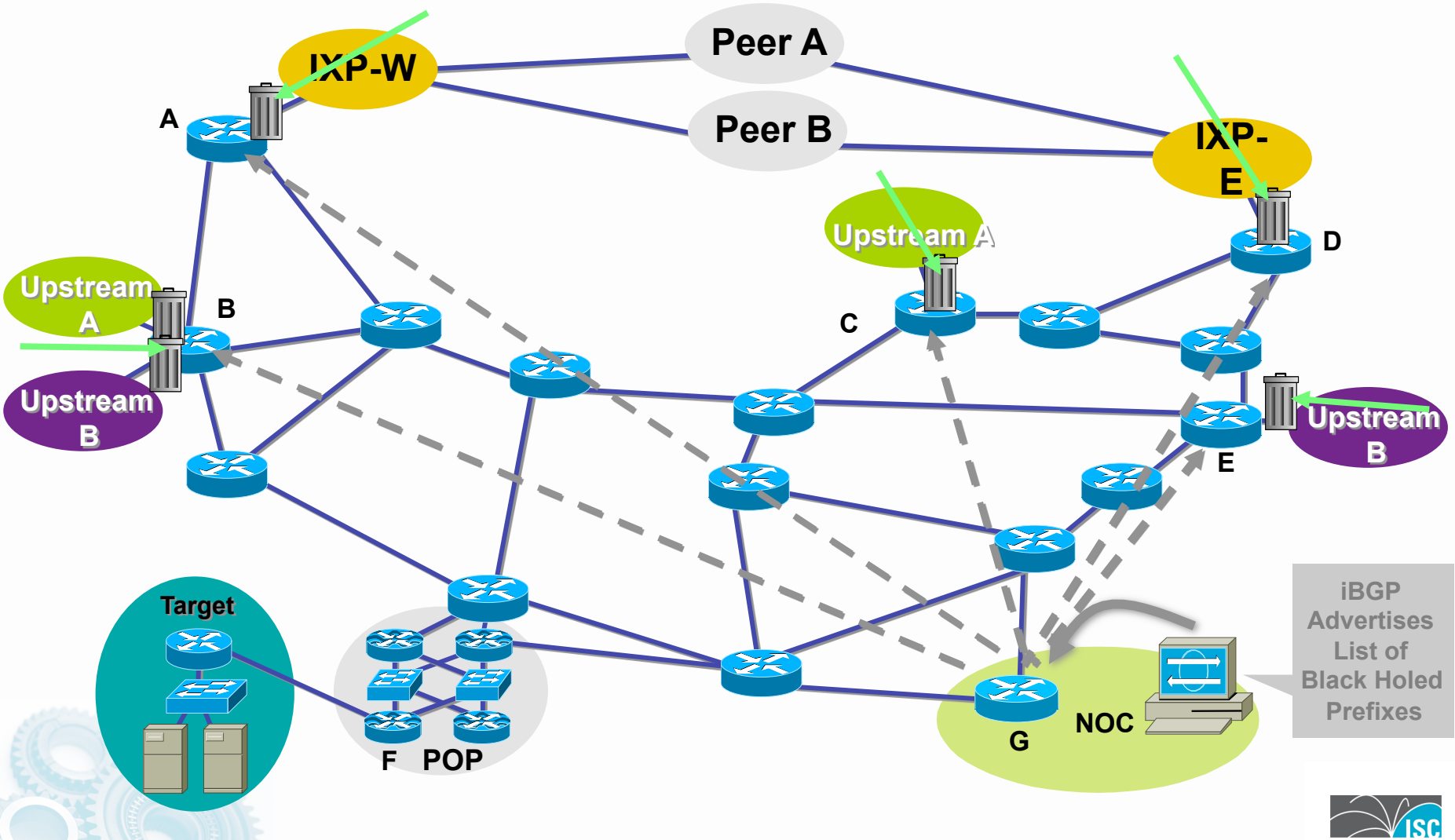
Office Staff

Edge Protection

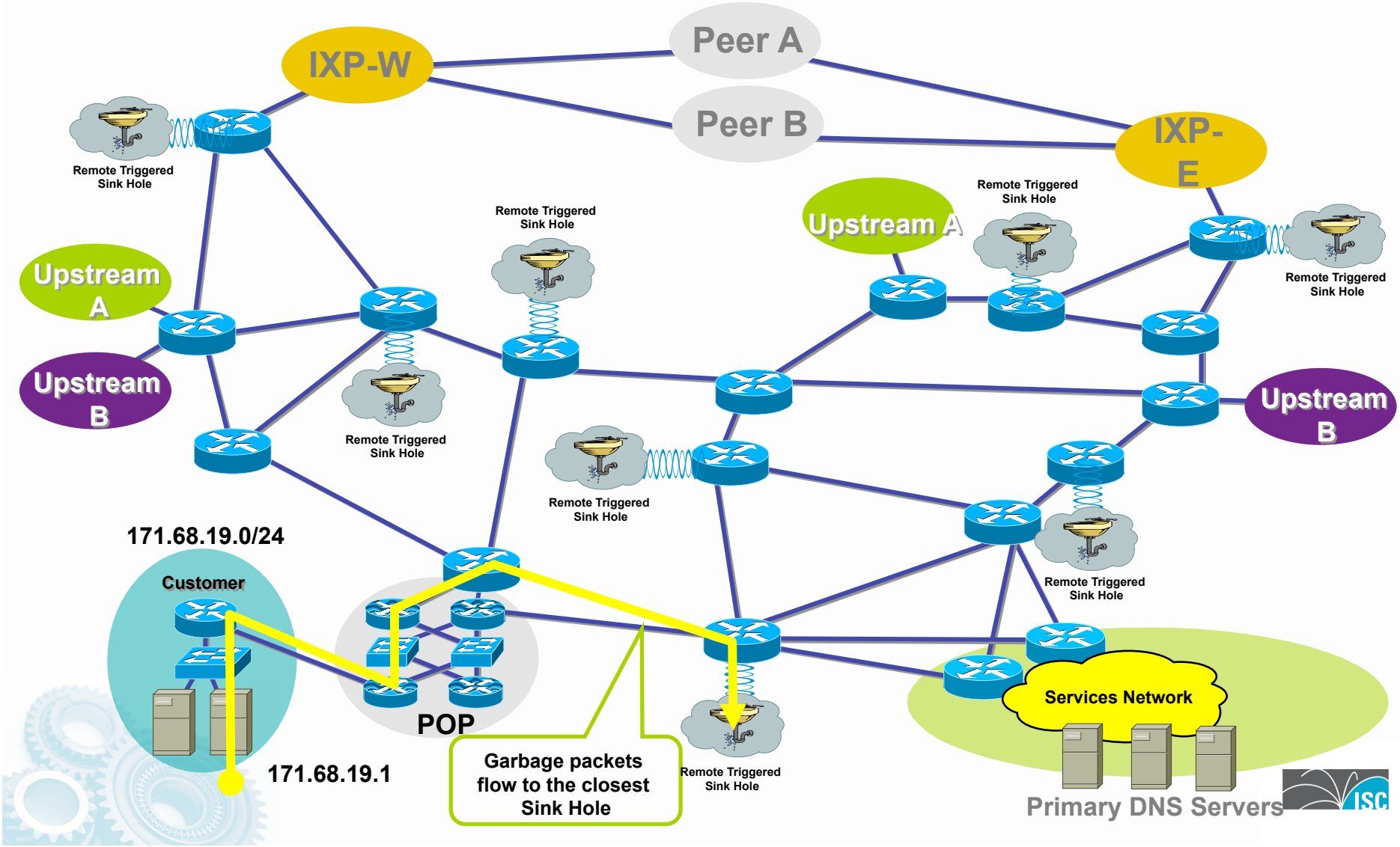


- Core routers individually secured PLUS
- Infrastructure protection
- Routers generally NOT accessible from outside

Destination Based RTBH

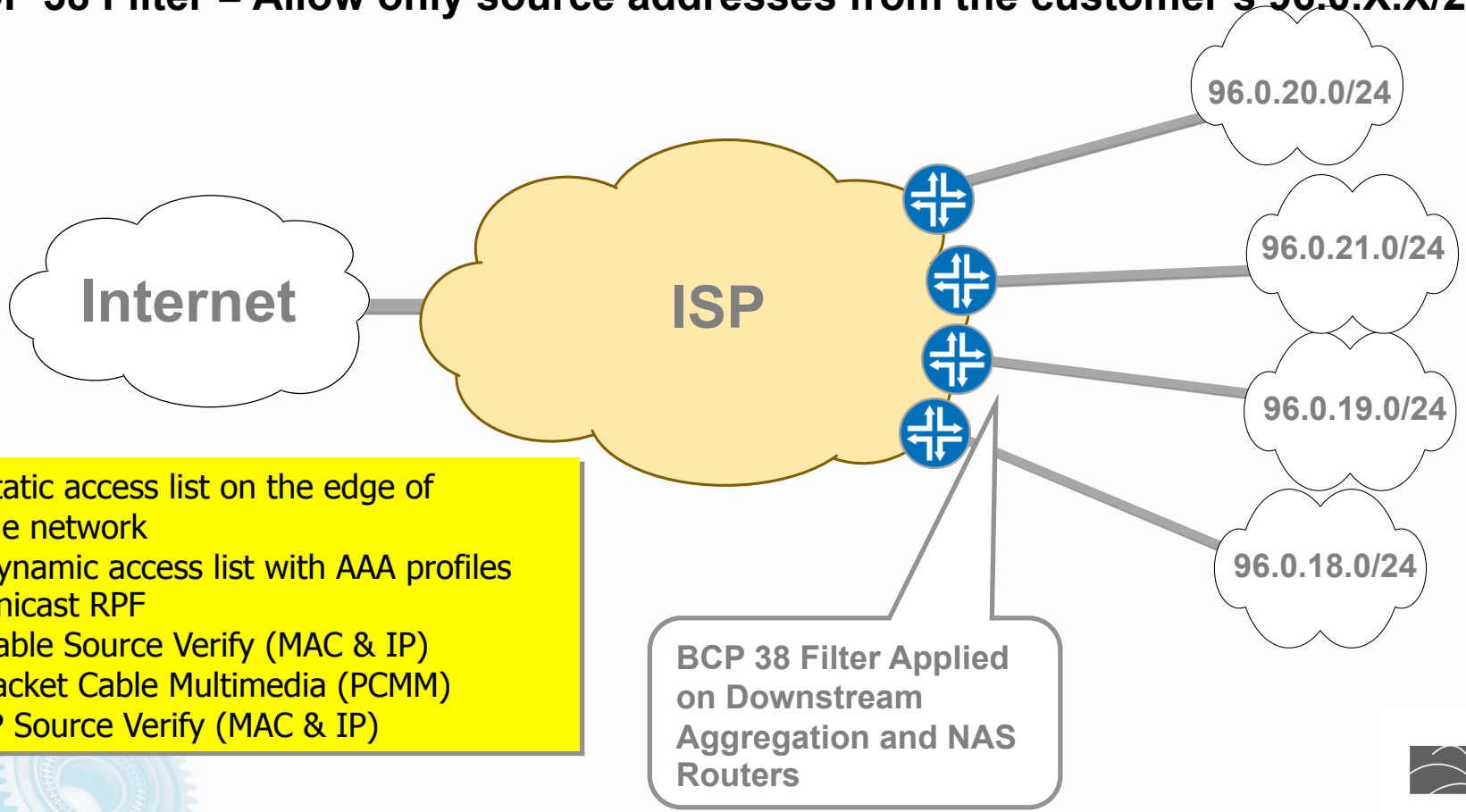


Sink Holes


Peer A
IXP-W
Peer B
IXP-E
Remote Triggered Sink Hole
Upstream A
Upstream B
Upstream A
Upstream B
Remote Triggered Sink Hole
Remote Triggered Sink Hole
Remote Triggered Sink Hole
Remote Triggered Sink Hole
Remote Triggered Sink Hole
Remote Triggered Sink Hole
Remote Triggered Sink Hole
171.68.19.0/24
Customer
171.68.19.1
POP
Garbage packets flow to the closest Sink Hole
Services Network
Primary DNS Servers
ISC

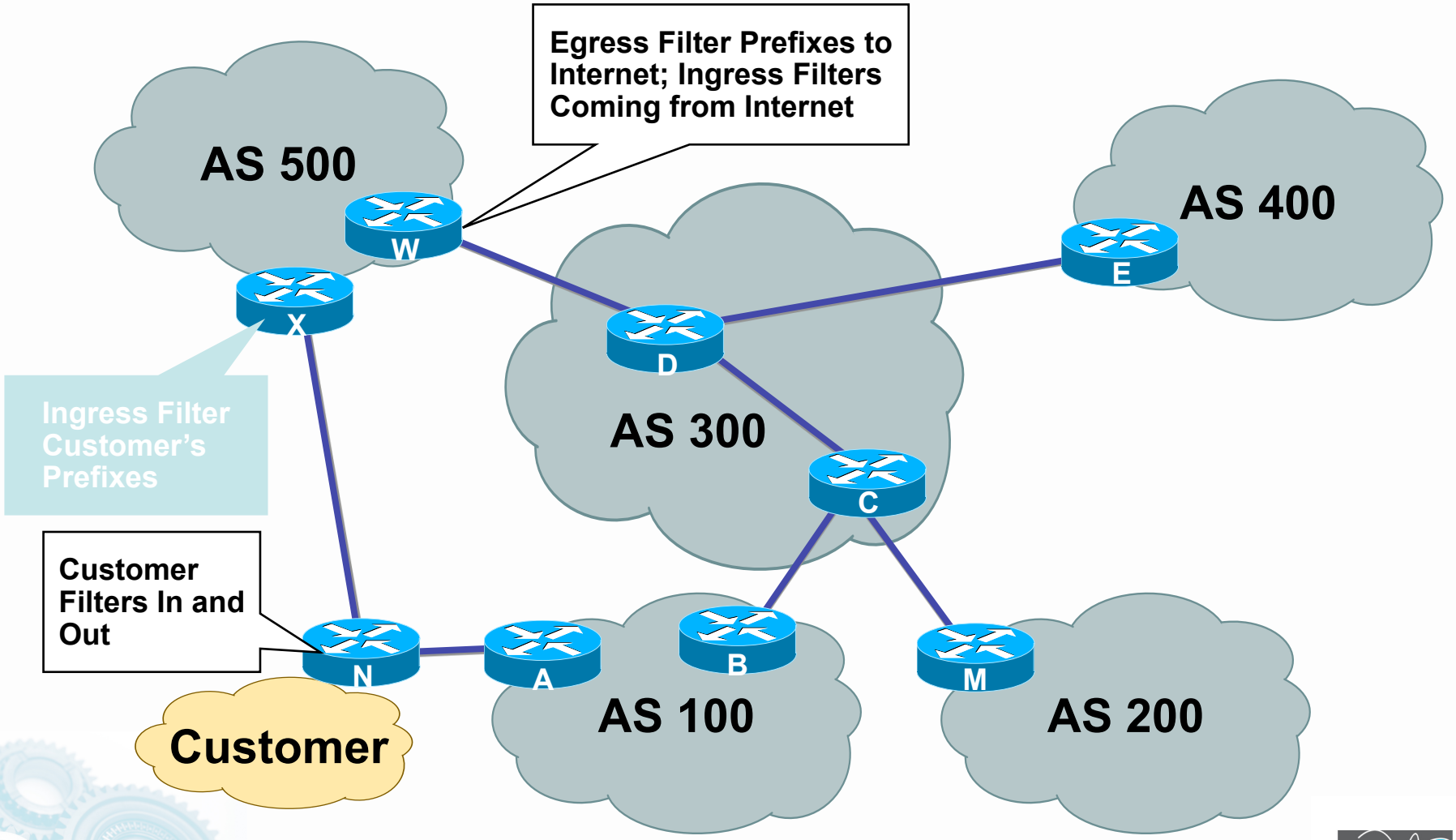
BCP 38 Ingress Packet Filtering

ISP's Customer Allocation Block: 96.0.0.0/19
BCP 38 Filter = Allow only source addresses from the customer's 96.0.X.X/24



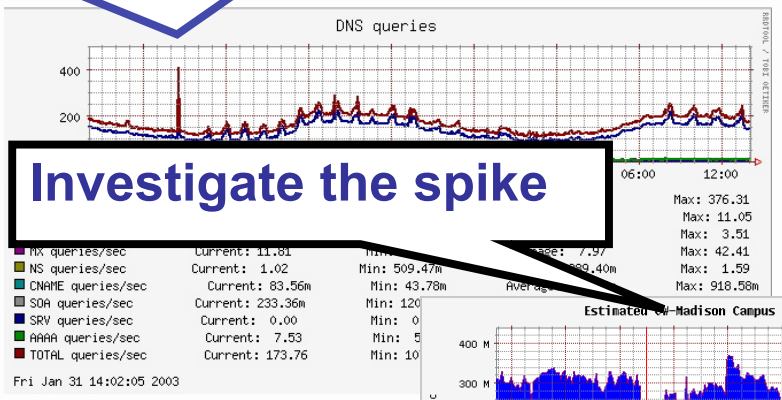
- Static access list on the edge of the network
- Dynamic access list with AAA profiles
- Unicast RPF
- Cable Source Verify (MAC & IP)
- Packet Cable Multimedia (PCMM)
- IP Source Verify (MAC & IP)

BGP Prefix Filtering

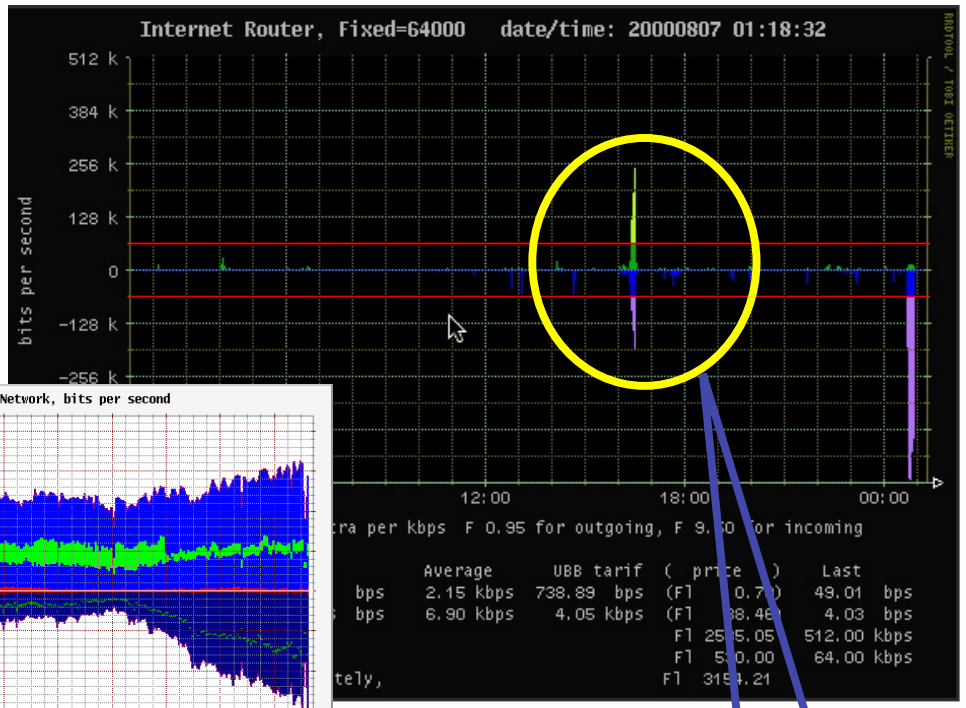


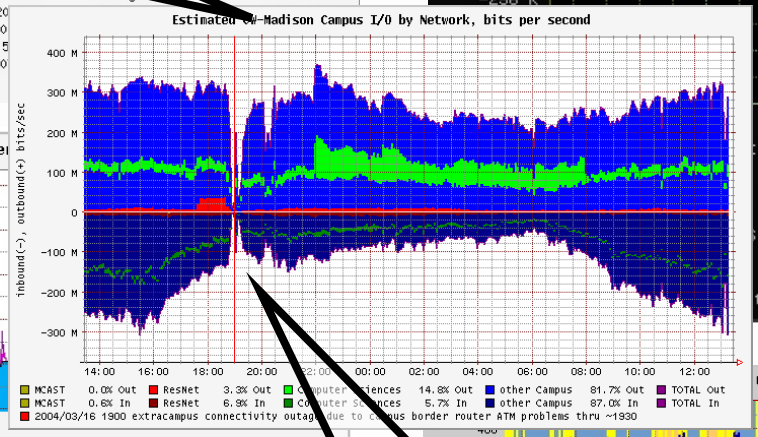
Total Visibility

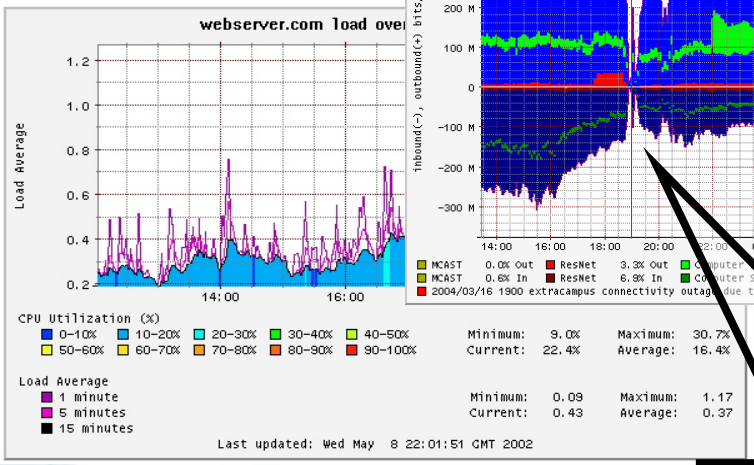
Anomaly for DNS Queries

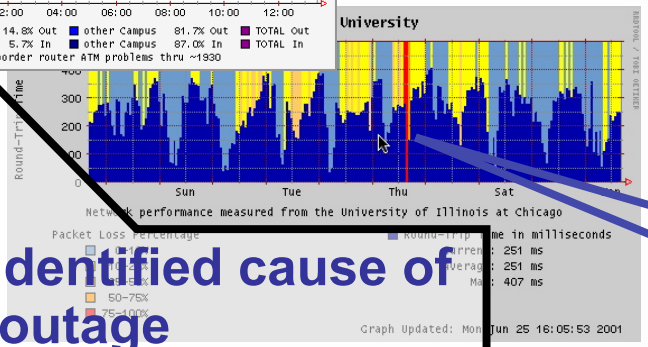


Investigate the spike









An identified cause of the outage

Thru'put Spike

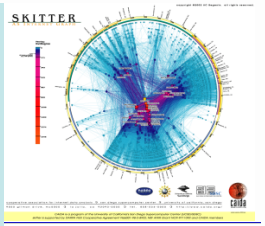
RTT Spike

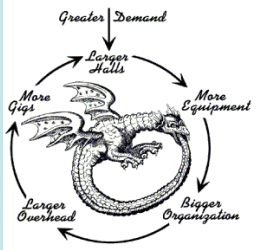
Source: http://people.ee.ethz.ch/~oetiker/webtools/rrdtool/

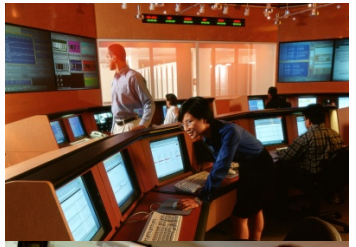
What Really needs to be Done

- Consensus, Desire, but still in work
  - Core Hiding
  - Removed Coupled State Protection on Critical Infrastructure.
  - Architectural Approaches to Security
  - Re-Coloring (TOS/ DSCP) at the Edge
  - Methodologies for effective SP oriented Risk Assessments.
  - Passive DNS
  - Quarantine and End User Remediation
- Working, but no Consensus
  - Common Services Ingress/Egress Port Blocking – (port 25, 53, 135, 139, 445)
  - DNS Poisoning
  - DNS RPZ

Prepare your NOC







SP's/ISP's NOC Team

- Every SP and ISP needs a NOC
- Anyone who has worked or run a NOC has their own list of what should be in a NOC
  - Make your own wish list
  - Talk to colleagues and get their list
  - Then try to make it happen
- No NOC is a perfect NOC—the result is always a ratio of time, money, skills, facilities, and manpower

SP's/ISP's NOC Team

- An SP's/ISP's OPerational SECurity (OPSEC) Team can be:
  - A NOC escalation team
  - A sister to the NOC—reporting to operations
  - Integrated team with the NOC
- The OPSEC Team is a critical component of the day to day operations of a large IP Transit provider.

What Do ISPs Need to Do?

Security incidence are a normal part of an ISP's operations!

2) Secure Resources
Firewall, Encryption, Authentication, Audit

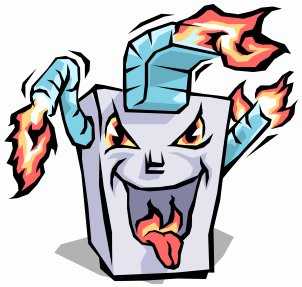
5) Manage and Improve
Post Mortem, Analyze the Incident, modify the plan/ procedures

3) Monitor and Respond
Intrusion Detection, work the incidence,

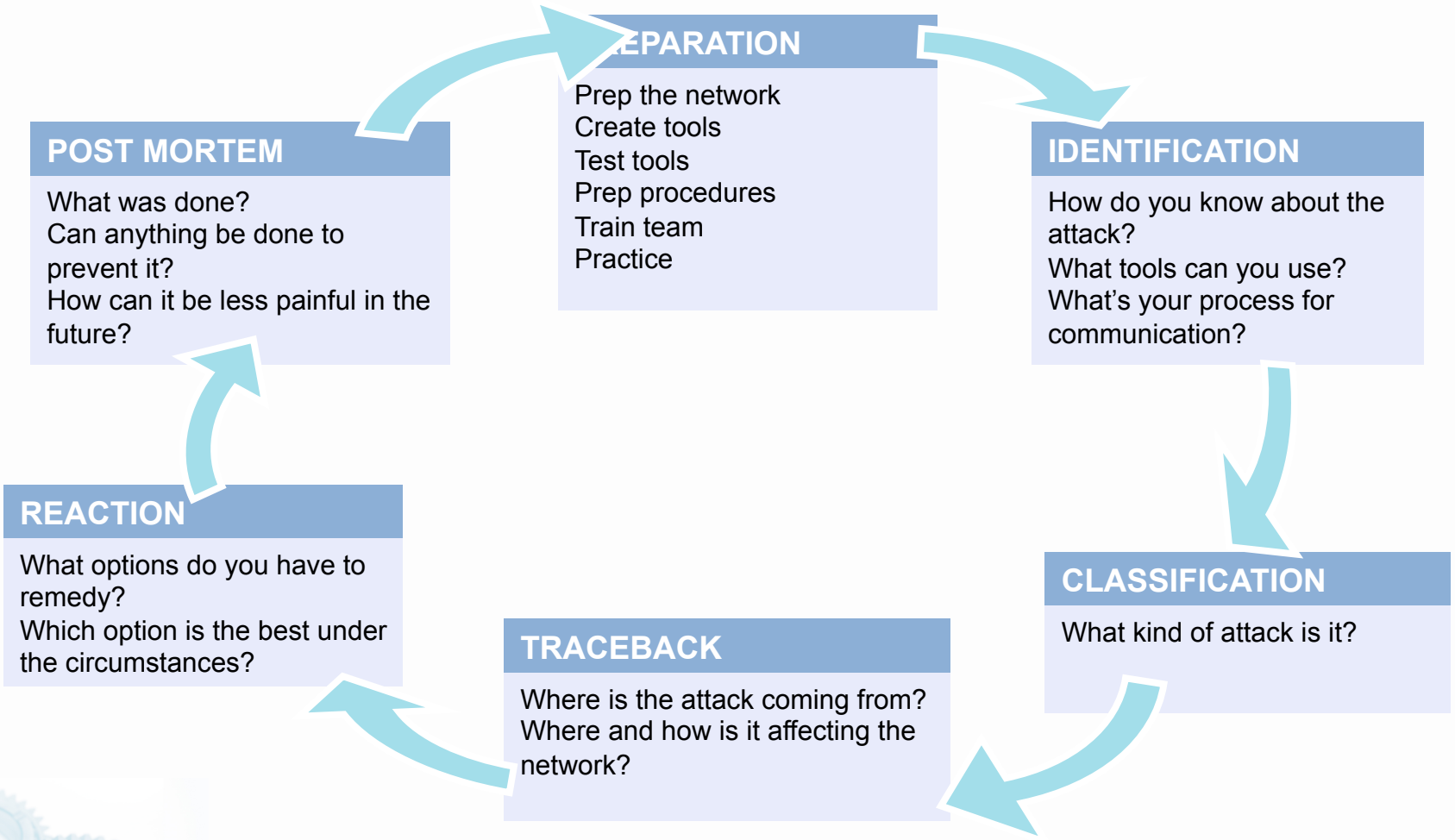
4) Test, Practice, Drill
Vulnerability Scanning

The Preparation Problem

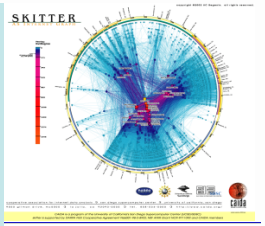
- The problem - Most SP NOCs:
  - Do not have security plans
  - Do not have security procedures
  - Do not train in the tools or procedures
  - OJT (on the job training)—learn as it happens

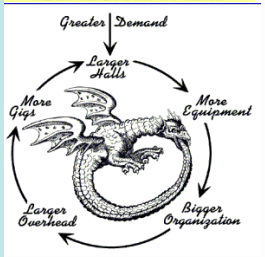


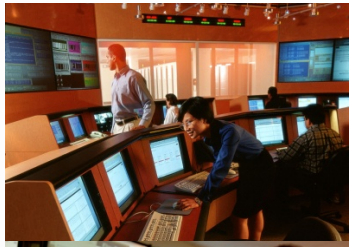
Six Phases of Incident Response



The New Internet
"Civic Society"
OPSEC Communities



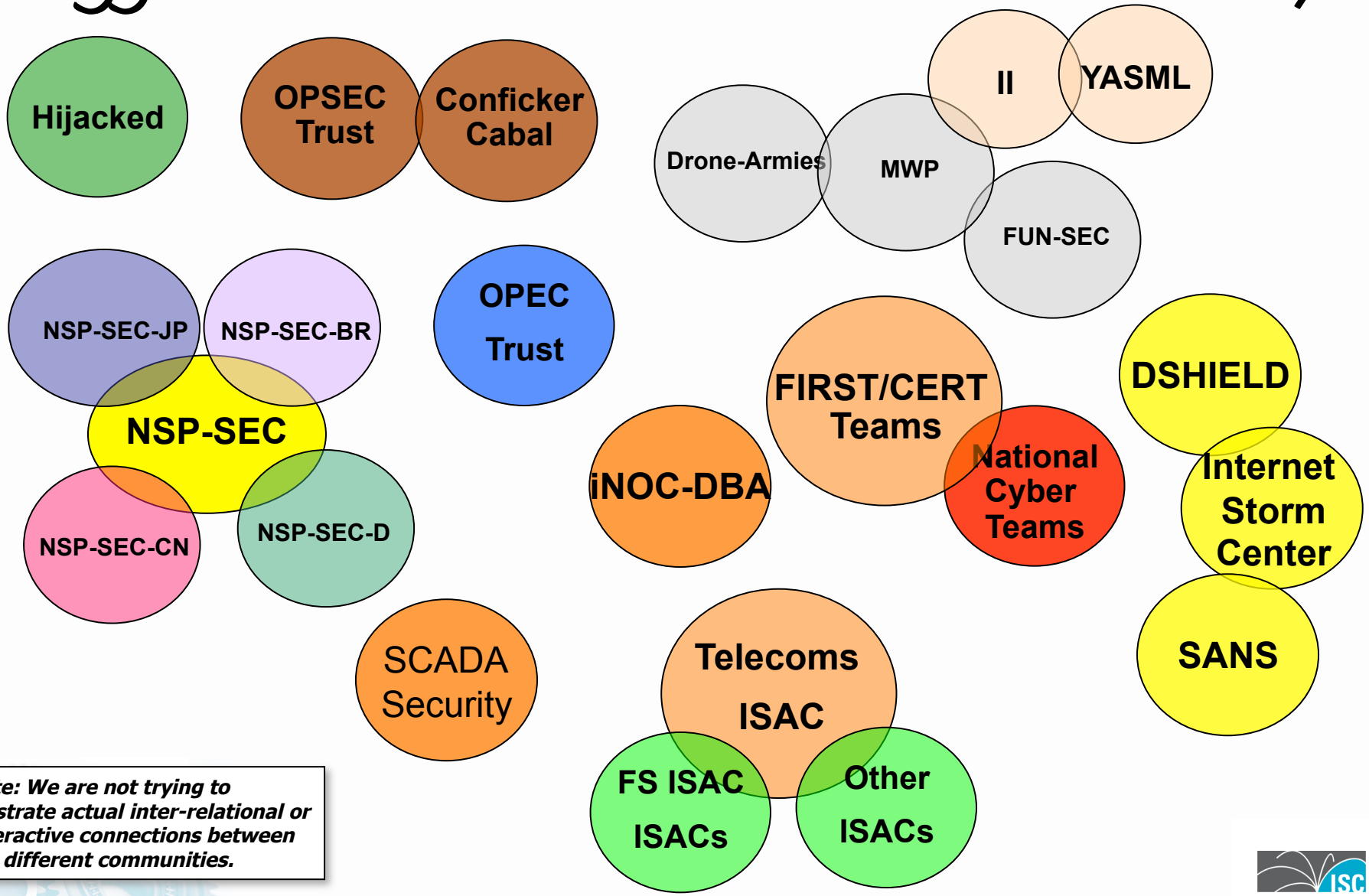




Check List

1. Essentials (see addendum slides)
2. DSHIELD
3. NSP-SEC
4. iNOC-DBA (next section)
5. Vendors (see addendum slides)
6. SP Peers and Upstreams (see addendum slides)
7. Customers (see addendum slides)
8. Law Enforcement (see addendum slides)

Aggressive Collaboration is the Key



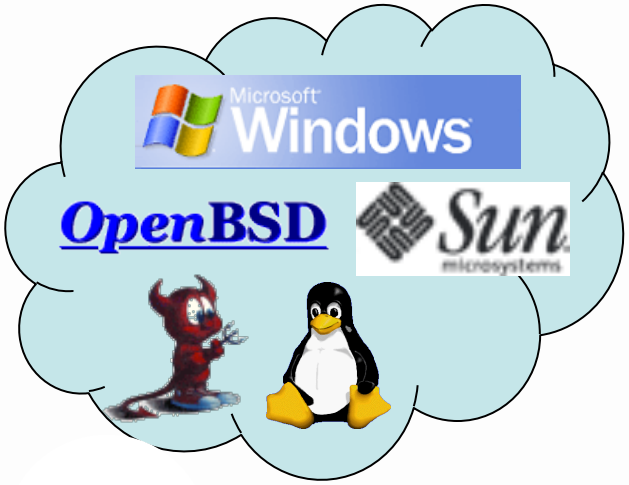
Note: We are not trying to illustrate actual inter-relational or interactive connections between the different communities.

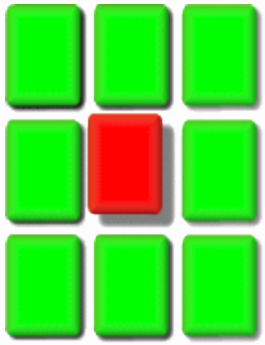
DSHIELD

Data Collection

Analysis

Dissemination

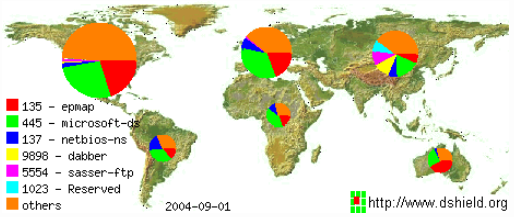




Service Name	Port Number	30 day history	Explanation
epmap	135		DCE endpoint resolution
microsoft-ds	445		Win2k+ Server Message Block
netbios-ns	137		NETBIOS Name Service
dabber	9898		[trojan] Dabber Worm backdoor
sasser-ftp	5554		[trojan] Sasser Worm FTP Server
Reserved	1023		
ms-sql-s	1433		Microsoft-SQL-Server
ms-sql-m	1434		Microsoft-SQL-Monitor
netbios-ssn	139		NETBIOS Session Service
mydoom	3127		W32/MyDoom, W32.Novarg.A backdoor

DShield Users

DShield.org



NSP-SEC – The Details

- NSP-SEC – *Closed* Security Operations Alias for engineers actively working with NSPs/ISPs to mitigate security incidents.
- Multiple Layers of sanity checking the applicability and trust levels of individuals.
- Not meant to be perfect – just better than what we had before.
- http://puck.nether.net/mailman/listinfo/nsp-security

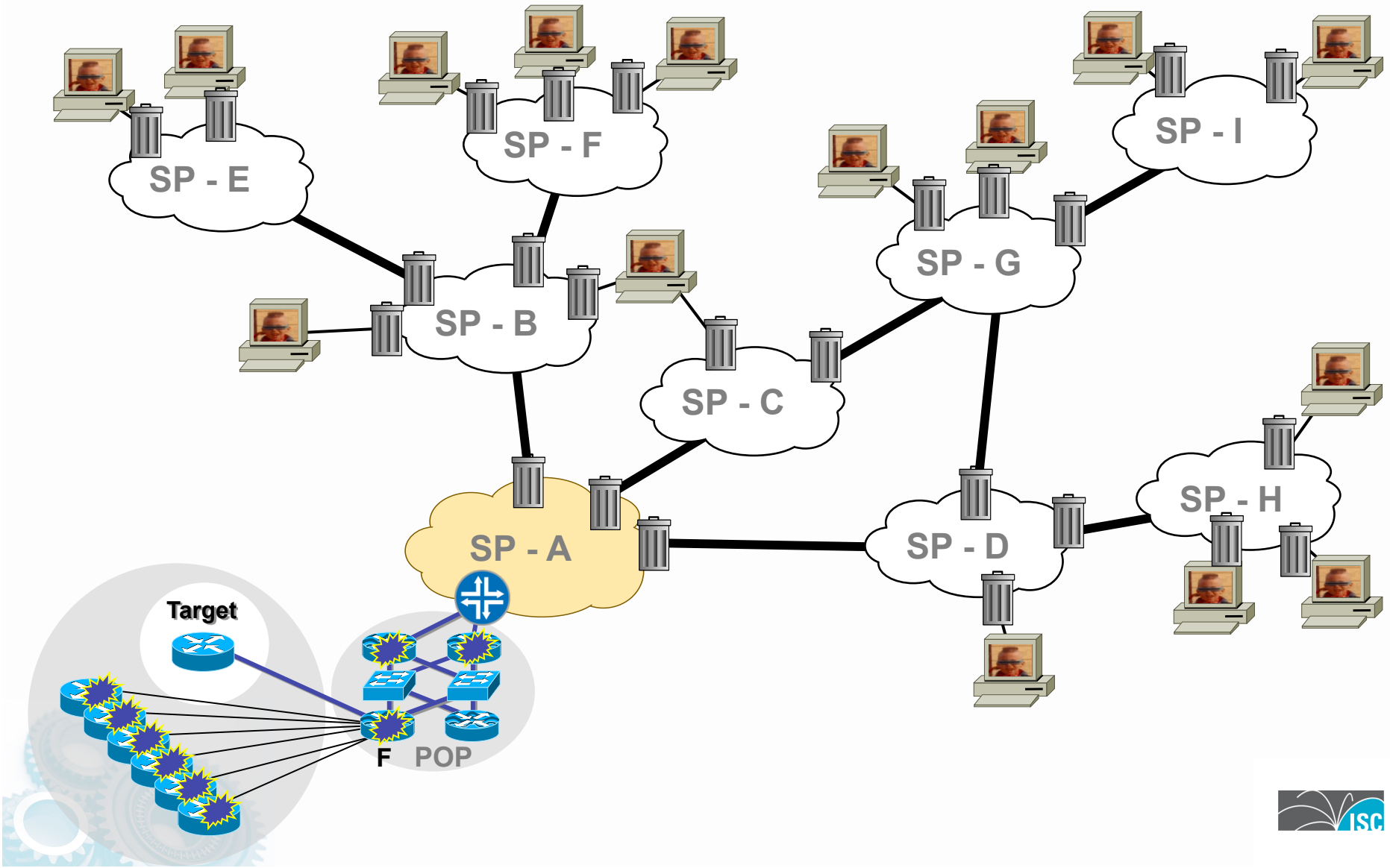
NSP-SEC: Daily DDOS Mitigation Work

I've been working an attack against XXX.YY.236.66/32 and XXX.YY.236.69/32. We're seeing traffic come from <ISP-A>, <ISP-B>, <IXP-East/West> and others.

Attack is hitting both IP's on tcp 53 and sourced with x.y.0.0.

I've got it filtered so it's not a big problem, but if anyone is around I'd appreciate it if you could filter/ trace on your network. I'll be up for a while :/

NSP-SEC: Daily DDOS Mitigation Work



It is all about Operational Trust

Trust is a bet that an entity, which you cannot control, will meet expectations that are favorable to your cause.

Operational trust is the trust that is required from every person and earned by every entity to accomplish an endeavor.

- Lt Col Nicole Blatt

NSP-SEC's Operational Trust

- Inter-Provider Mitigation requires ***operation trust.***
  - You need to trust your colleagues to keep the information confidential, not use it for competitive gain, not tell the press, and not tell the commercial CERTS and *Virus* circus.
  - So all membership applications are reviewed by the NSP-SEC Administrators and Approved by the membership.
  - All memberships are reviewed and re-vetted every 6 months – letting the membership judge their peer's actions and in-actions.

NSP-SEC is not ….

- NSP-SEC is not perfect
- NSP-SEC is not to solve all the challenges of inter-provider security coordination
- NSP-SEC is not the *ultimate solution.*
- *But, NSP-SEC does impact the security of the Internet:*
  - Example: Slammer

NSP SEC Meetings

- NANOG Security BOFs (www.nanog.org)
  Chaperons/Facilitators: Merike Kaeo - kaeo@merike.com
  Barry Raveendran Greene bgreene@senki.org
  Danny McPherson danny@arbor.net

- RIPE Security BOFs (www.ripe.net)
  Coordinator: Hank Nussbacher - hank@att.net.il

- APRICOT Security BOFs (www.apricot.net)
  Coordinators/Facilitators: Derek Tay - dt@agcx.net
  Dylan Greene - dylan@juniper.net

CERT & FIRST

- Find a CERT/FIRST Team to work with.
  - Important avenue of community communication - Forum of Incident Response and Security Teams
  - Consider becoming a FIRST Member.
  - Protect yourself - SP RFPs need to require FIRST/CERT Membership.

http://www.first.org/about/organization/teams/

Operational Security Group Examples

- The following are some example which will provide you a tool and context of the types of groups.
  - Some are open to all.
  - Some are personality driven
  - Some are interest driven
  - Some are highly peer vetted
  - Some are peer meshed – where only the best of the best are involved.

DNS Operations

- An open public forum for informal reporting, tracking, resolving, and discussing DNS operational issues including outages, attacks, errors, failures, and features. Note that discussion of non-ICANN root systems is explicitly off-topic.
- https://lists.dns-oarc.net/mailman/listinfo/dns-operations
- Sponsored by DNS-OARC
  - www.dns-orac.net
  - The operational equivalent of "DNS-CERT"

FUNSEC

- Fun and Misc security discussion for OT posts.
- Created to allow Security Professionals to vent and make fun of news post – some of which gets people very irritated. The alias keeps the venting off operational forums – but often digresses into operational conversations.
- https://linuxbox.org/cgi-bin/mailman/listinfo/funsec

MWP (Malware Protection)

- MWP was created by Gadi Evron to pull together Anti-Virus Vendors, Researchers, SPs, and Law Enforcement (break through at the time).
- Closed (need Gadi's approval)
  - https://linuxbox.org/cgi-bin/mailman/listinfo/mwp

II - Incidents & Insights Discussion Group

- Incidents & Insights This group, copyright 2007-9, is owned and operated by Ken Dunham. This private list encourages sharing of malicious data and analysis related to incidents AND insights about emerging threat trends.
- You're welcomed to share smaller ZIP files through this group, unfiltered. You are also welcomed to join the FTP server managed by Ken Dunham (for access contact ken@kendunham.org).
- General Rules of Conduct Membership is by invitation only, approved by Ken Dunham exclusively. Mr. Dunham generally allows any qualified security professional to join the group with one recommendation from a trusted source.
- Any abuse, illegal behavior, or flaming/disrespectful behavior is not tolerated. No competitor games or blackballing people.
- Rules:
  - 1. Be respectful
  - 2. Be engaged
- Sincerely, Ken Dunham ken@kendunham.org Incidents & Insights Group Founder & Moderator.

Yet Another Security Mailing List - YASML

- The goal of this group is simple, we aim to provide an arena to share data that encourages collaboration on various security topics. It is our goal to build self sufficient community that encompasses a wide range of skill sets and talents whose unified purpose is to effectively address problems related to cybercrime and malware. We aim to provide our members an open forum, free of ego, free of competitive commercial interests, and most of all ideas and services that AID in the analysis and possible capture of criminals. (via sharing and creating actionable intel).
- Peer Vetted Community http://www.opensecnet.com/mailman/listinfo/yasml

NXDomains

- This list is dedicated to the notification, investigation, and takedown of malicious domains.
  - This is the community who works within the DNS registry/registrar system to remove validated malicious domains.
- Members range from registries, registrars, law enforcement, to vetted security professionals.
- http://www.opensecnet.com/mailman/listinfo/nxdomains

OPSEC Trust Mission

OPS-TRUST

Mission

OPSEC-Trust (or "ops-trust") is a highly vetted community of security professionals focusing on the operational robustness, integrity, and security of the Internet. The community promotes mindful action against malicious behavior vs observation/analysis/research. OPSEC Trust carefully expands membership pulling from talent in many other security forums looking for strong vetting with in three areas ; sphere of trust, sphere of action, and the ability to maintain a "need to know" confidentiality. OPSEC-Trust (or "ops-trust") members are in a position to directly affect Internet security operations in some meaningful way. The community's members span the breath of the industry including service providers, equipment vendors, financial institutions, mail admins, DNS admins, and DNS registrars, content hosting providers, law enforcement organizations/agencies, CSIRT Teams, and third party organizations that provide security-related services for public benefit (e.g. monitoring or filtering service providers). The breadth of membership, along with a an action/trust vetting approach provides creates a community which would be in a position to apply focused attention on the malfeasant behaviors which threaten the Internet.

OPSEC-Trust does not accept applications for membership. New candidates are nominated by their peers who are actively working with them on improving the operational robustness, integrity, and security of the Internet.

https://ops-trust.net/

Invitation only ……

OPSEC Trust Invitation

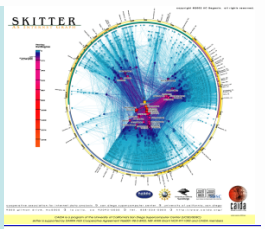
- Route-SEC is a OPSEC Trust Working Group Seeking Participants
- Route-sec is an incident response mailing list to coordinate the interaction between ISPs and NSPs to resolve unauthorized route announcements.

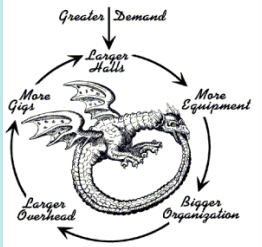
- This Operational Working Group is intended to provide a forum to notify other providers about hijacked routes and other route announcement issues. Participants are expected to request assistance for routes they are directly or indirectly authoritative for. Netblocks you are directly responsible for are those allocated to your organization. Netblocks you are indirectly authoritative for are those allocated or assigned directly to your customer's organization. Participants may also request verification of the authority to announce a netblock from another member. Acknowledgment, either publicly on the list or privately, that an issue is being worked is expected.

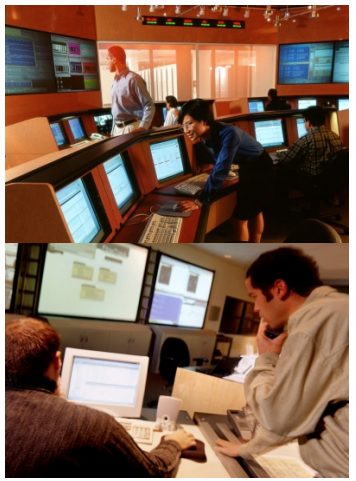
ROUTESEC

- **Applicant Qualifications**
  - Work for a large IP transit provider, large multi-homed content provider
  - Your organization must reallocate or reassign PA space and/or route PI space for your customers
  - Have authorization to actively mitigate incidents in your network
  - Applicants who only announce address space that is directly assigned to their organization, or are otherwise only an enduser of address space are not eligible
  - All posts must have an organizational affiliation via a corporate email address that is identifiable as an ISP/NSP
- If you wish to participate, E-mail:
  - Heather Schiller heather.schiller@verizonbusiness.com
  - Barry Greene bgreene@senki.org

Working with your Peers with "Out of Band" Communications
iNOC DBA







Check List

- Get a SIP Phone or SIP Based soft phone.
- Sign up to iNOC-DBA
  - http://www.pch.net/inoc-dba/
- Find a couple of peers and try it out.

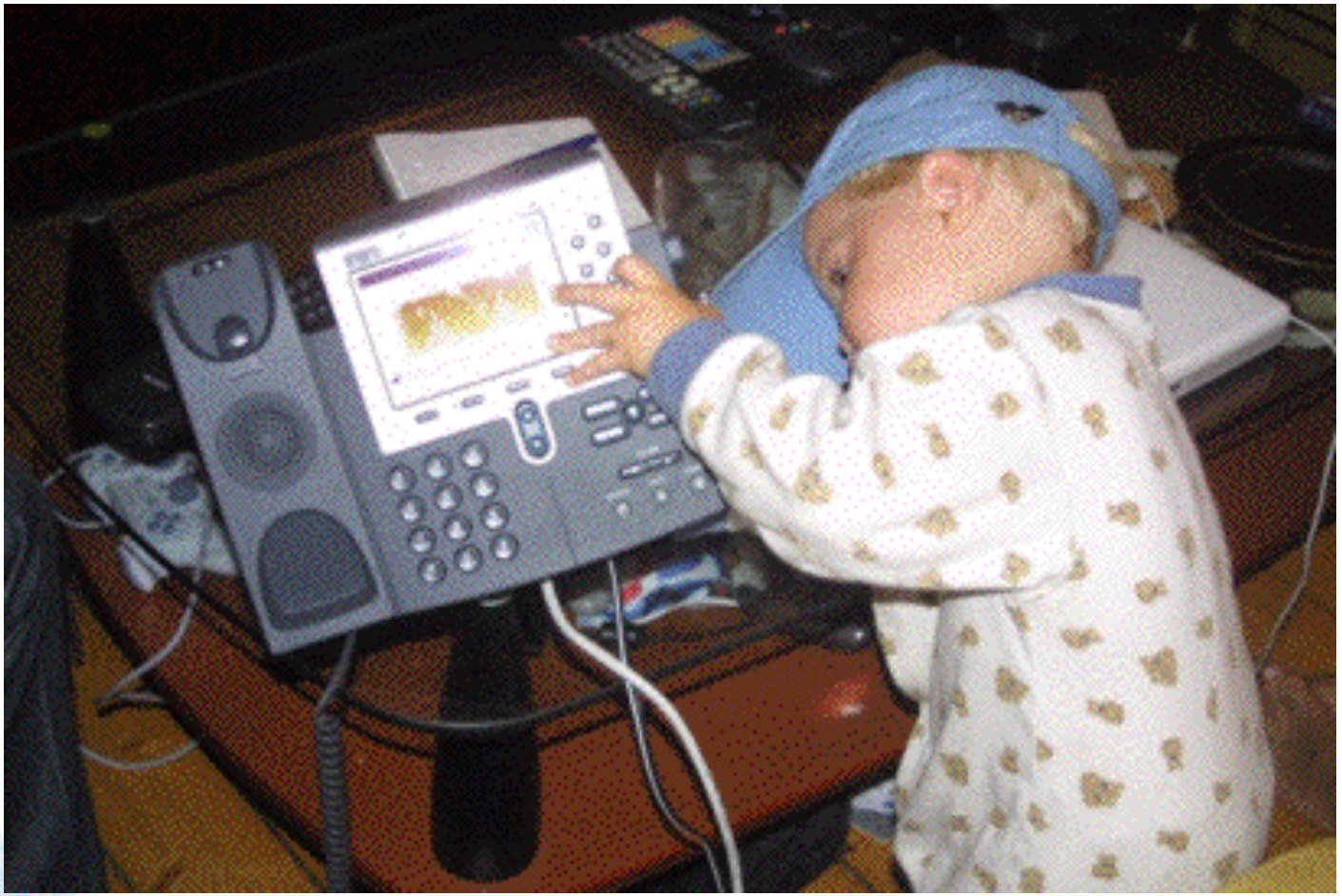
What is the problem?

- SPs needed to talk to each other in the middle of the attack.
- Top Engineers inside SPs often do not pick up the phone and/or screen calls so they can get work done. If the line is an outside line, they do not pick up.
- Potential solution – create a dedicated NOC Hotline system. When the *NOC Hotline* rings, you know it is one of the NOC Engineer's peers.

iNOC DBA Hotline

- INOC-DBA: *Inter-NOC Dial-By-ASN*
- The iNOC Hotline was used to get directly to their peers.
- Numbering system based on the Internet:
  - ASnumber:phone
- SIP Based VoIP system, managed by www.pch.net

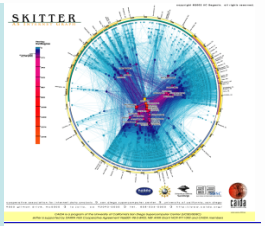
Is set up difficult?

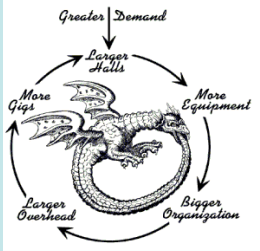


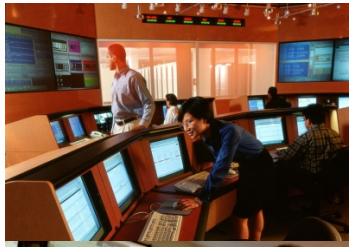
How is iNOC being used today?

- Used during attacks like Slammer
  - Barry was using his iNOC phone at home to talk to SPs in the early hours of Slammer to peers in their homes.
- D-GIX in Stockholm bought 60 phones for their members (ISP's around Stockholm)
- People have started carrying around their SIP phones when traveling
- Many DNS Root Servers are using the iNOC Hotline for their phone communication.
- General Engineering consultation – SP Engineers working on inter-SP issues.

Point Protection



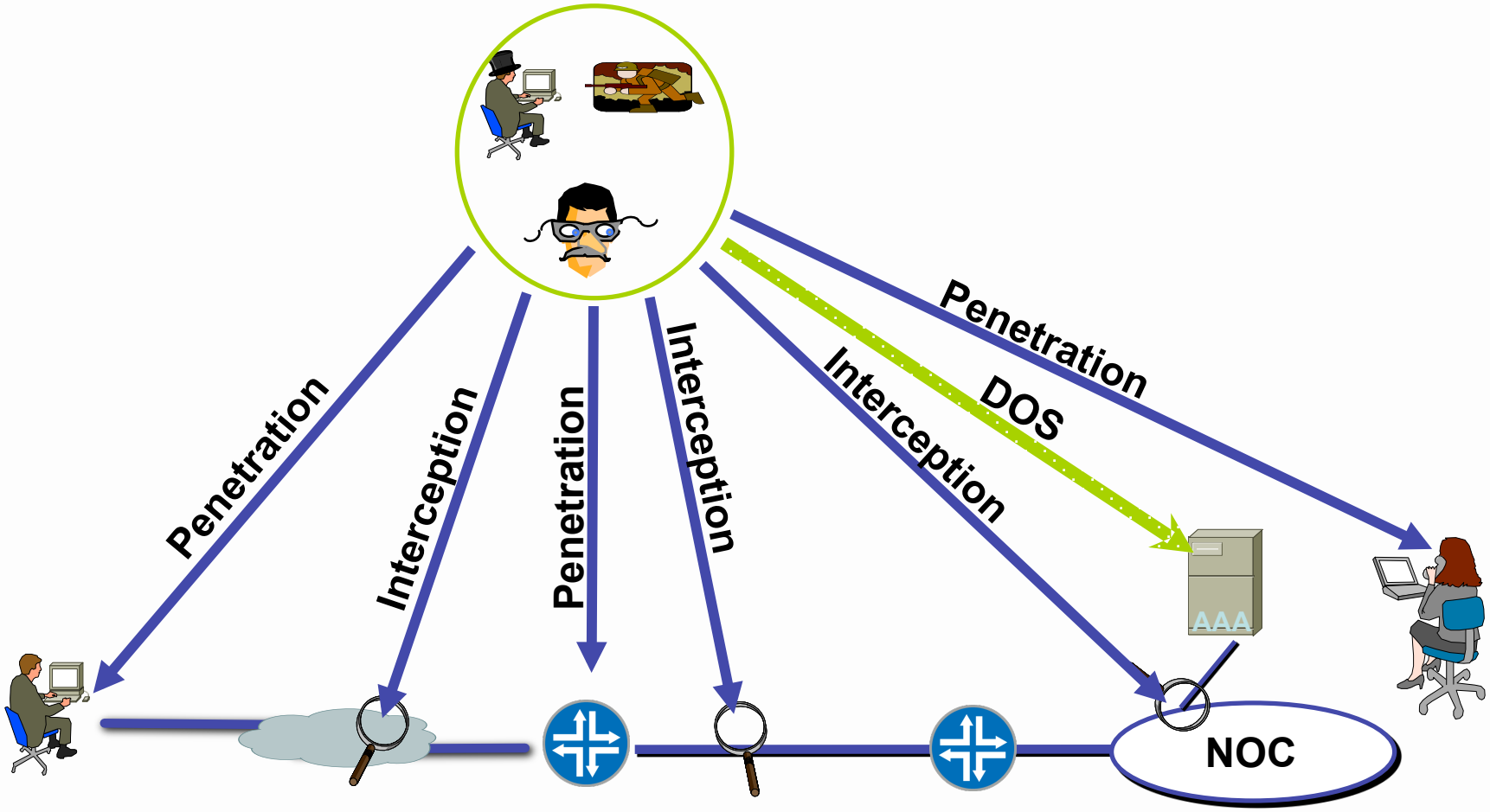




Check List

- AAA to the Network Devices
- Controlling Packets Destined to the Network Devices
- Config Audits

RISK Assessment

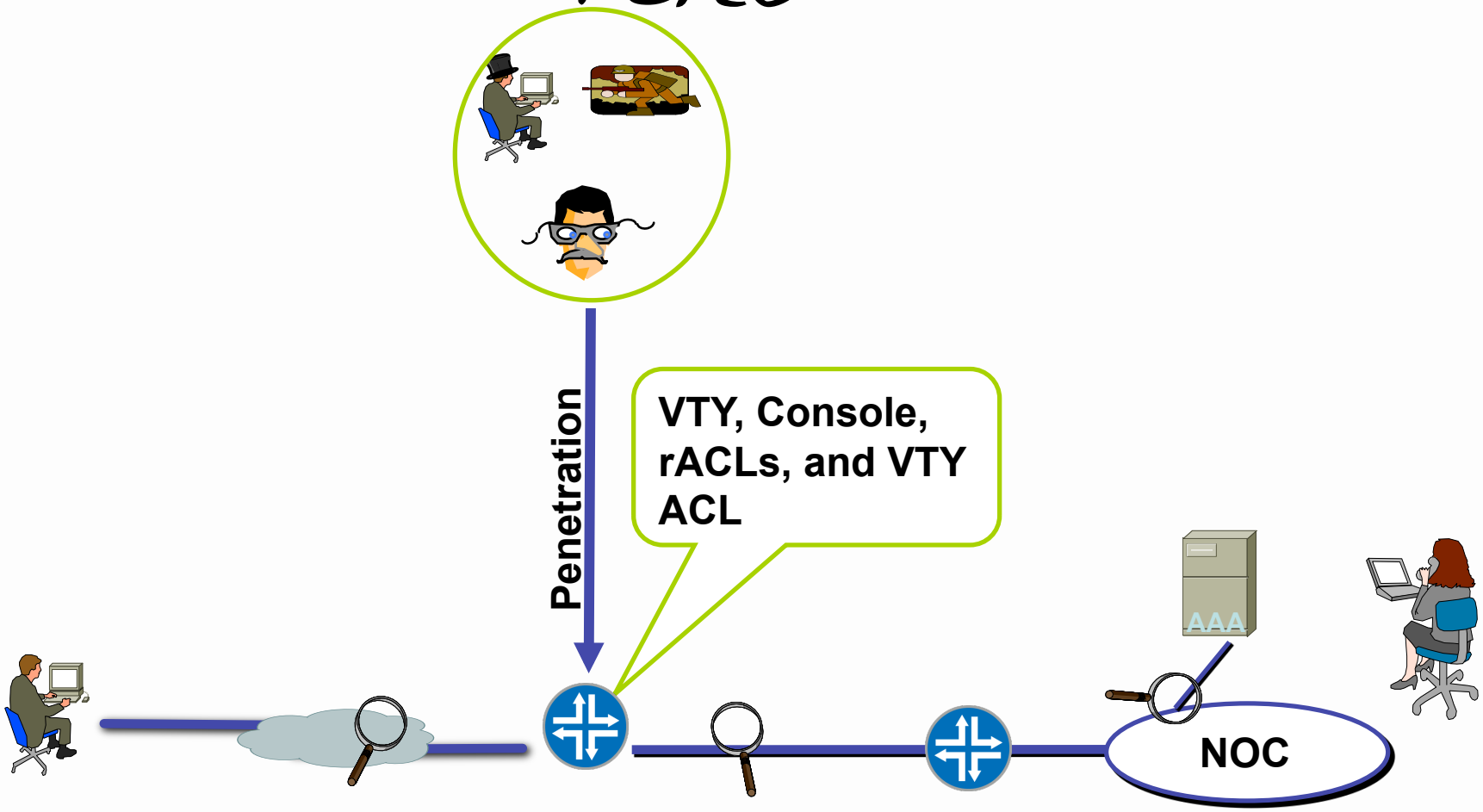


Remote Staff

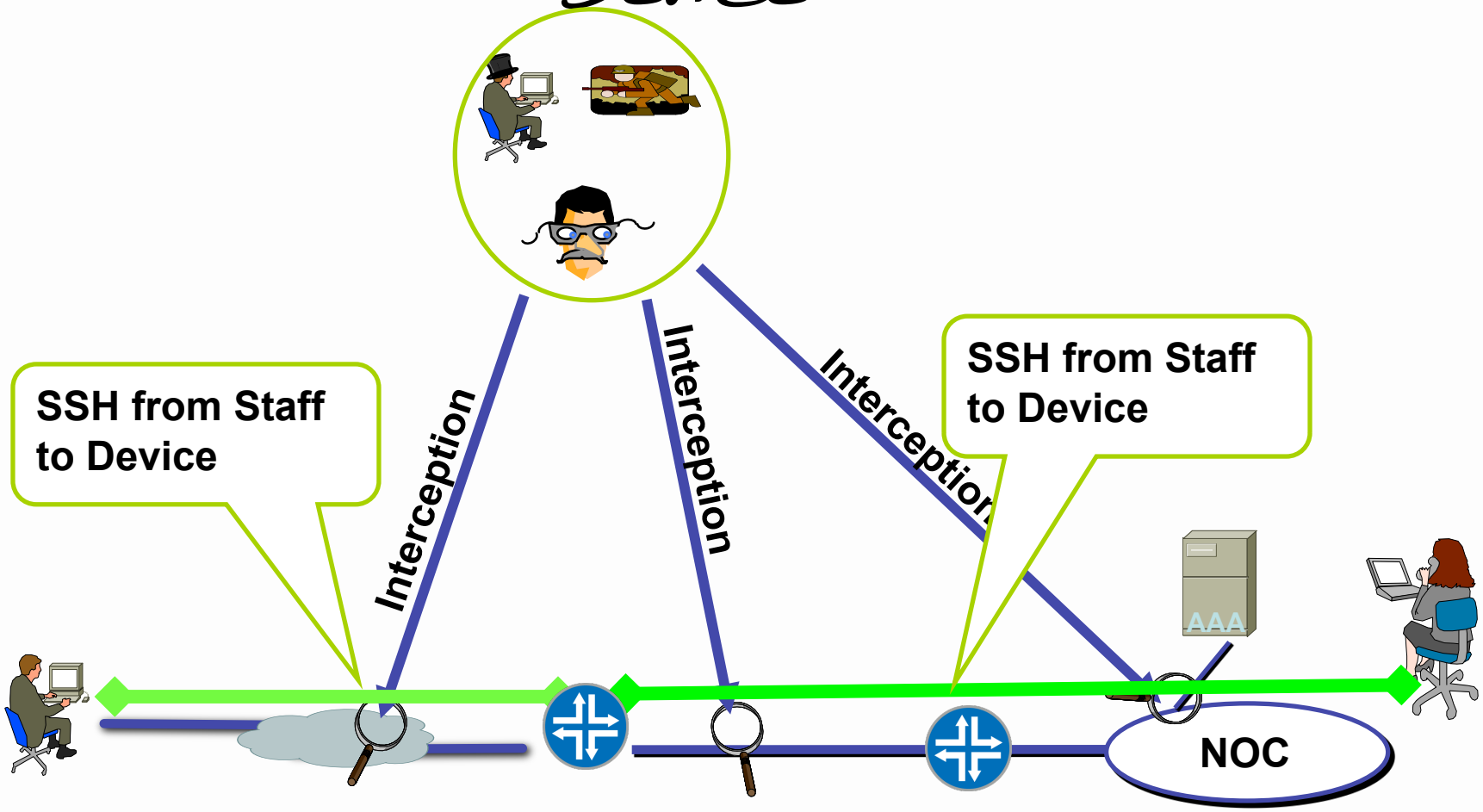
ISP's Backbone

Office Staff

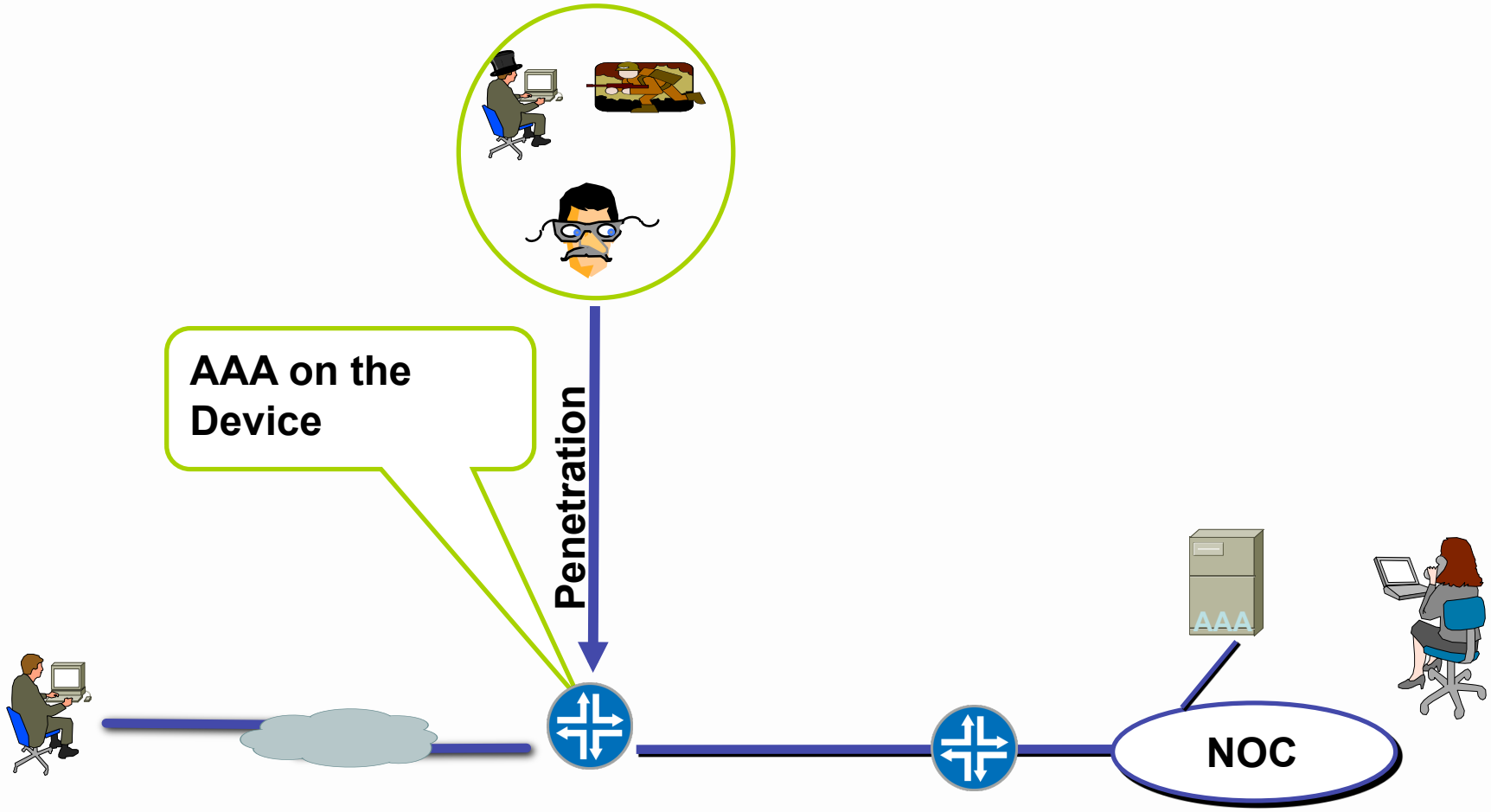
Lock Down the VTY and Console Ports



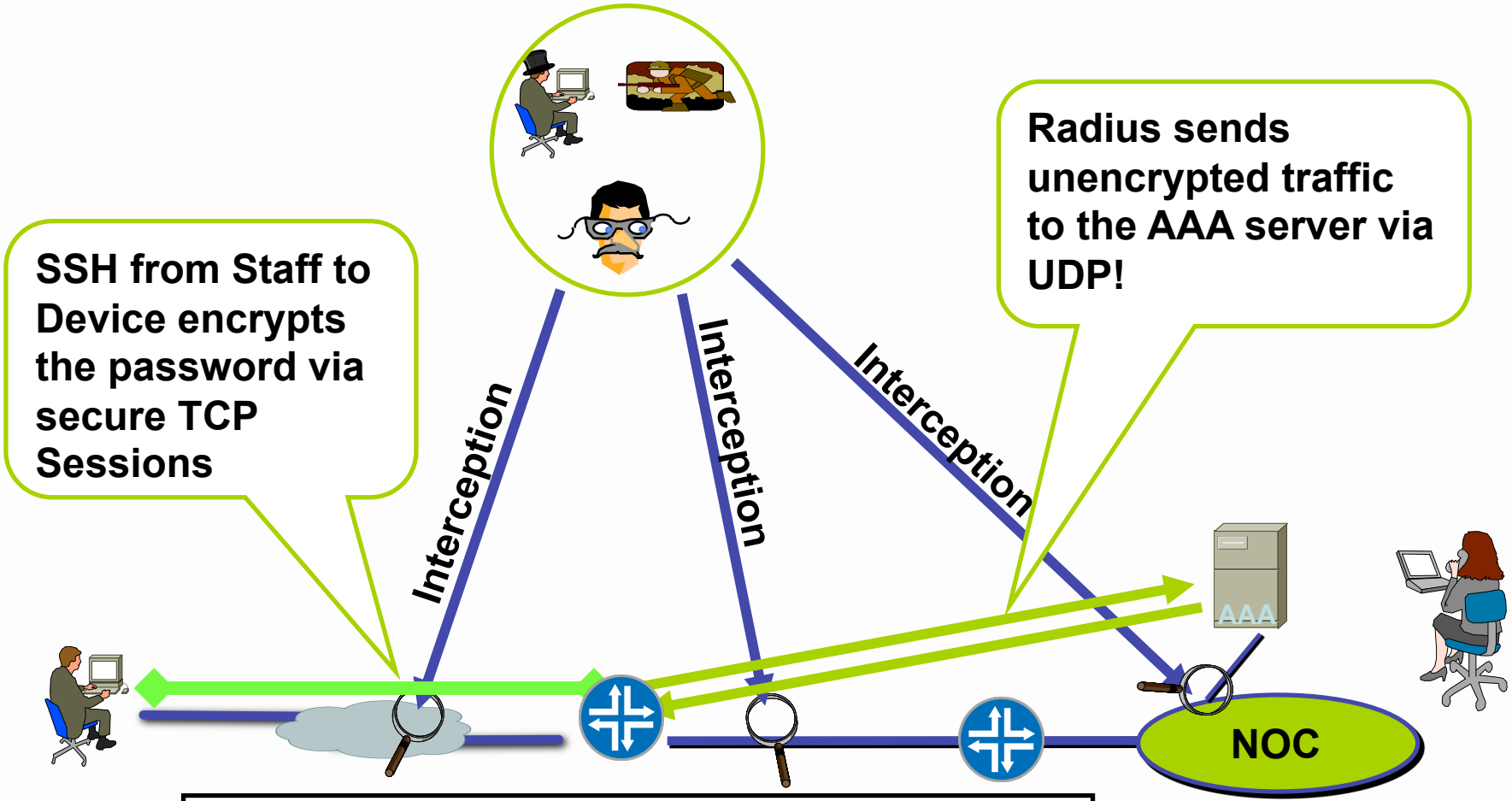
Encrypt the Traffic from Staff to Device



Staff AAA to get into the Device

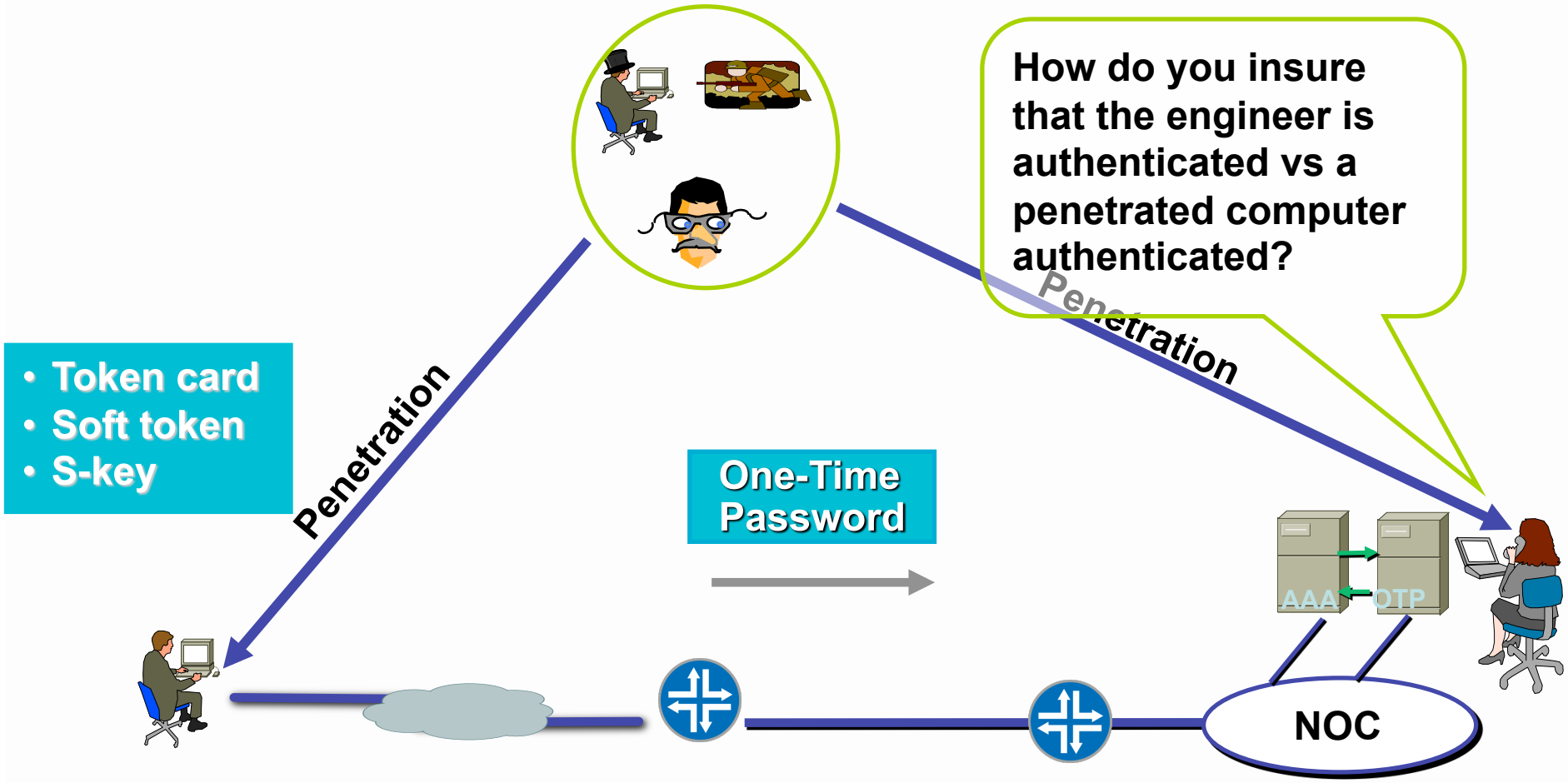


Radius is not an SP AAA Option!

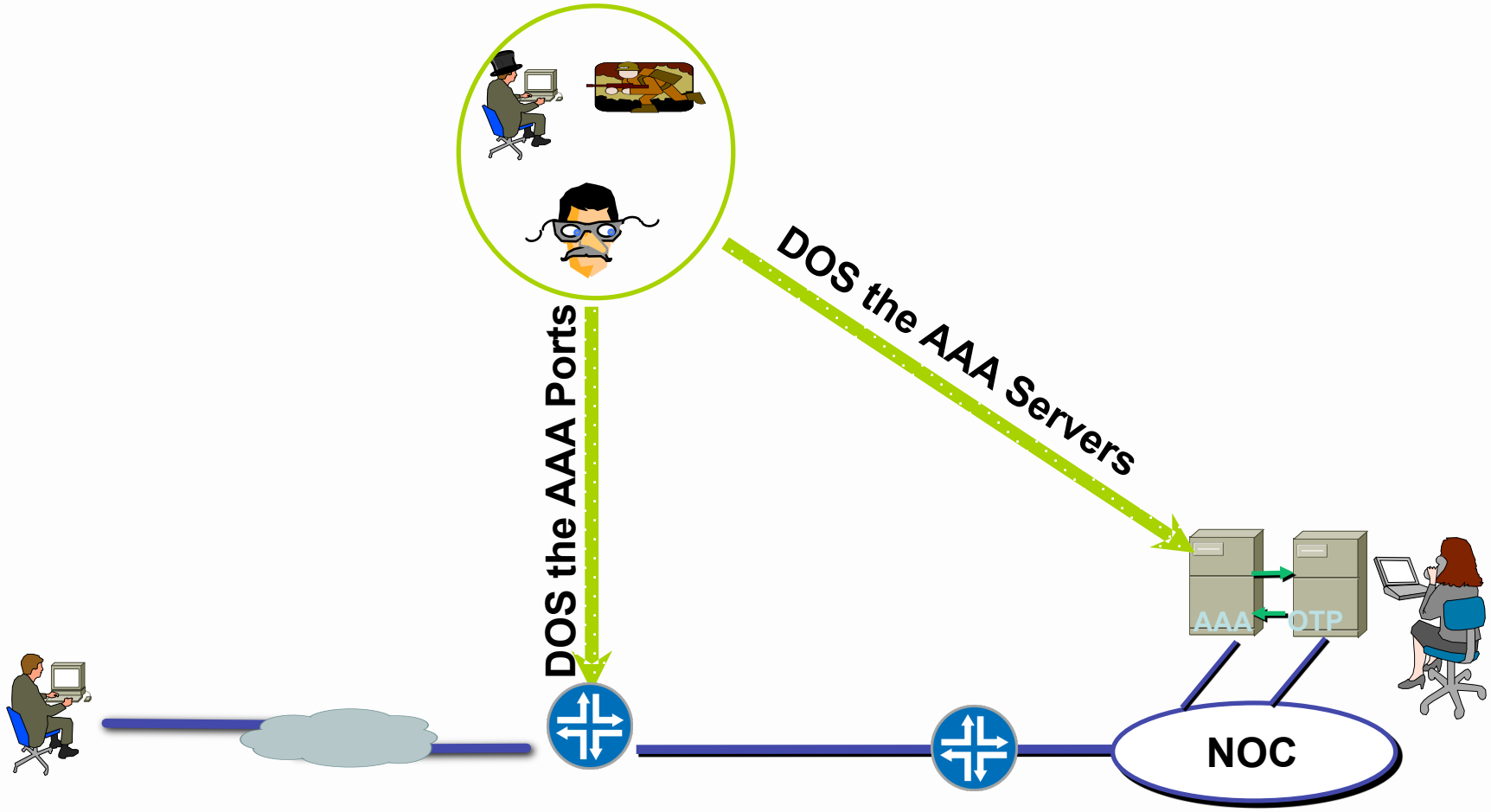


Why make a big deal about SSH to the router when you choose to put your network at risk using Radius as a AAA solution?

One Time Password - Checking the ID

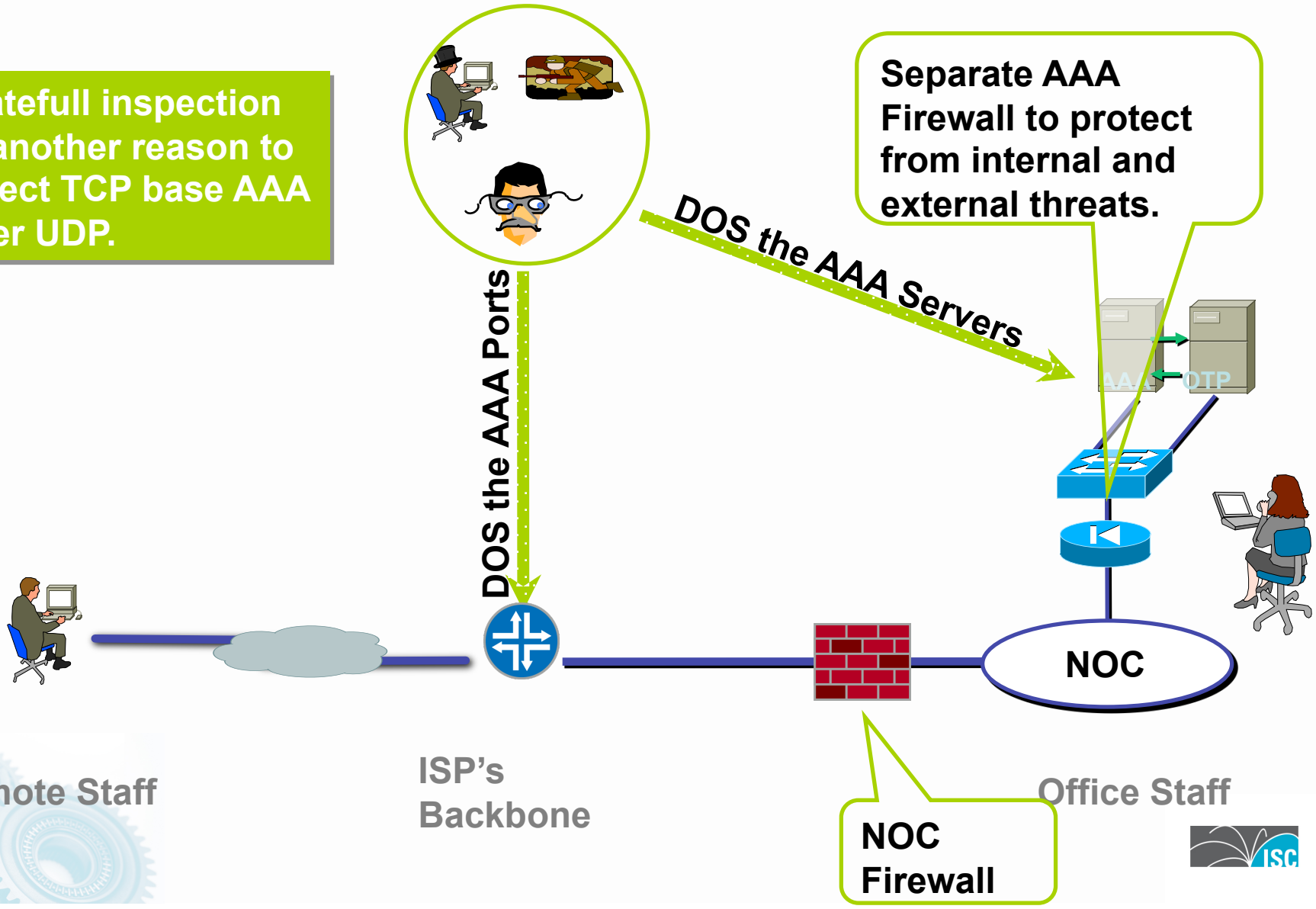


DOSing the AAA Infrastructure

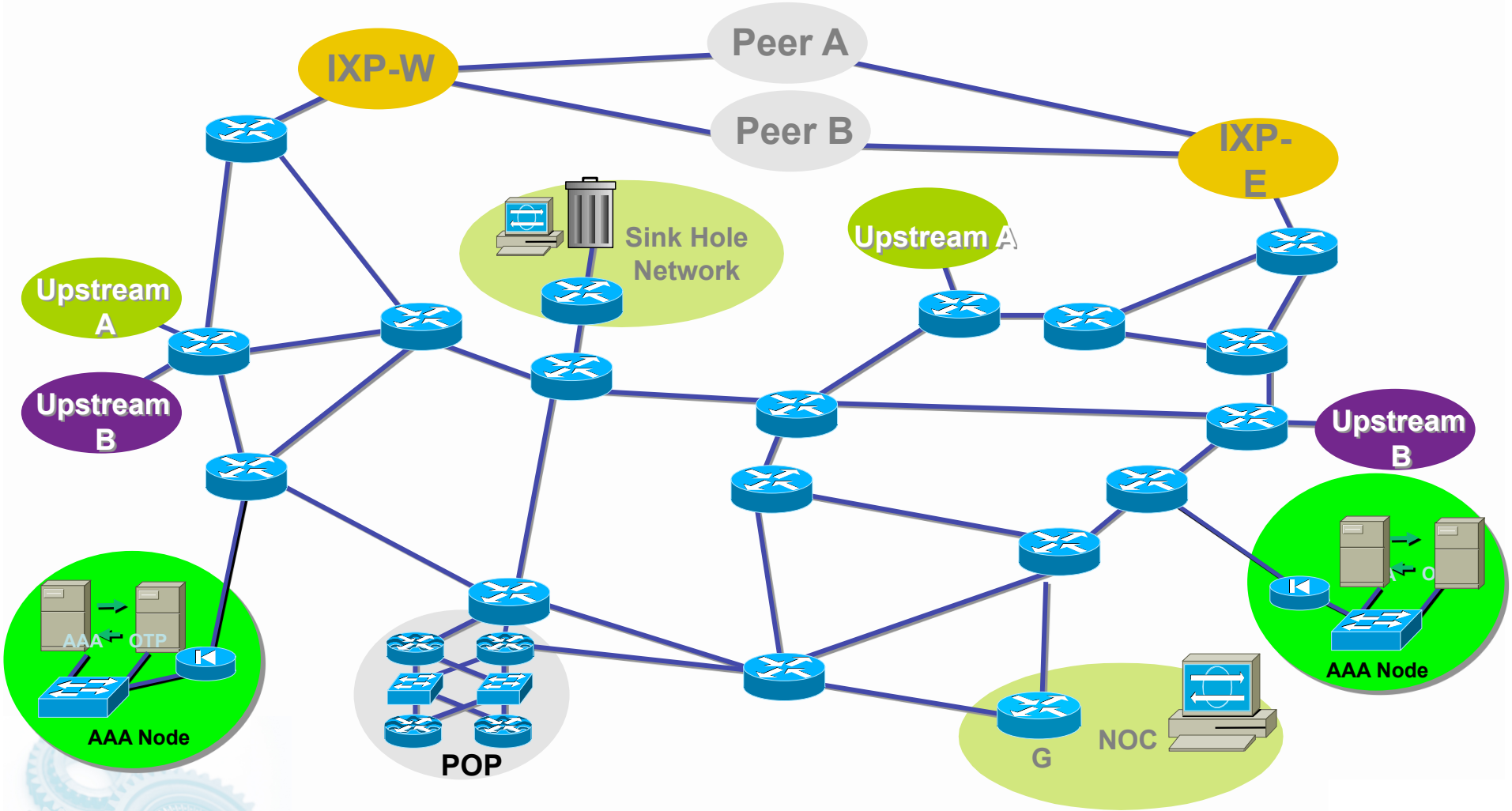


Use a Firewall to Isolate the AAA Servers

Statefull inspection is another reason to select TCP base AAA over UDP.



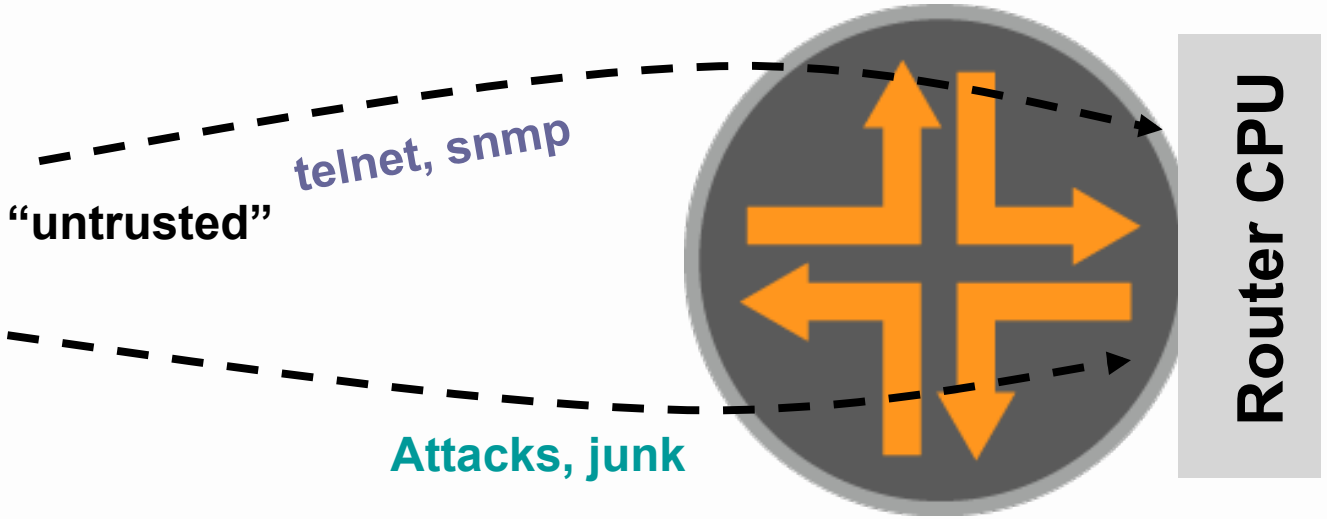
Distribute AAA Servers and Config Backup



TACACS+ URLs

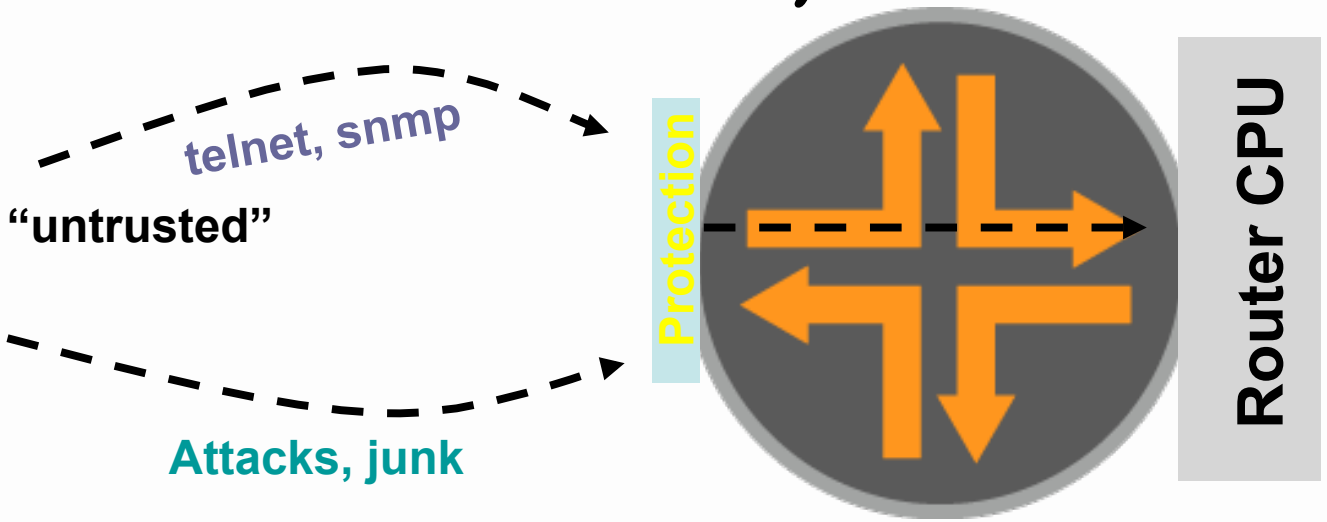
- TACACS+ Open Source
  - ftp://ftp-eng.cisco.com/pub/tacacs/
  - Includes the IETF Draft, Source, and Specs.
- Extended TACACS++ server
  - http://freshmeat.net/projects/tacpp/
- TACACS + mods
  - http://www.shrubbery.net/tac_plus/

The Old World: Router Perspective



- Policy enforced at process level (VTY ACL, Kernel ACL, SNMP ACL, etc.)
- Some early features such as ingress ACL used when possible

The New World: Router Perspective



- Central policy enforcement, prior to process level
- Granular protection schemes
- On high-end platforms, hardware implementations
- Protecting The Router Control Plane draft-ietf-opsec-protect-control-plane-04

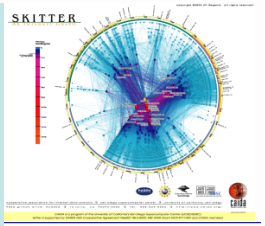
Watch the Config!

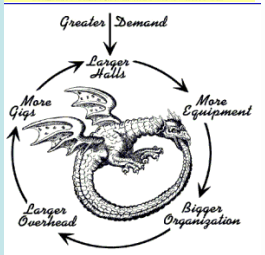
- There has been many times where the only way you know someone has violated the router is that a config has changed.
- If course you need to be monitoring your configs.

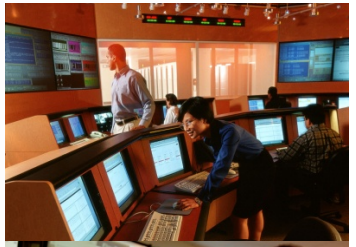
Config Monitoring

- **RANCID - Really Awesome New Cisco config Differ (but works with lots of routers – used a lot with Juniper Routers)**
  - **http://www.shrubbery.net/rancid/**
  - **http://www.nanog.org/mtg-0310/rancid.html**
- **Rancid monitors a device's configuration (software & hardware) using CVS.**
- **Rancid logs into each of the devices in the device table file, runs various show commands, processes the output, and emails any differences from the previous collection to staff.**

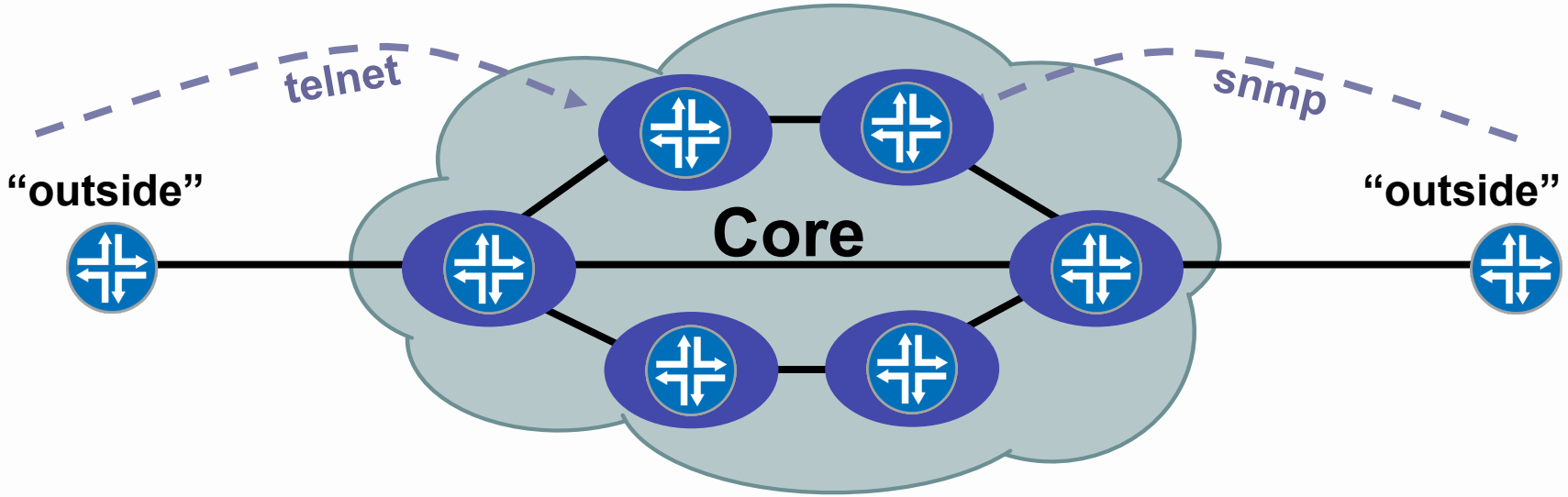
Edge Protection





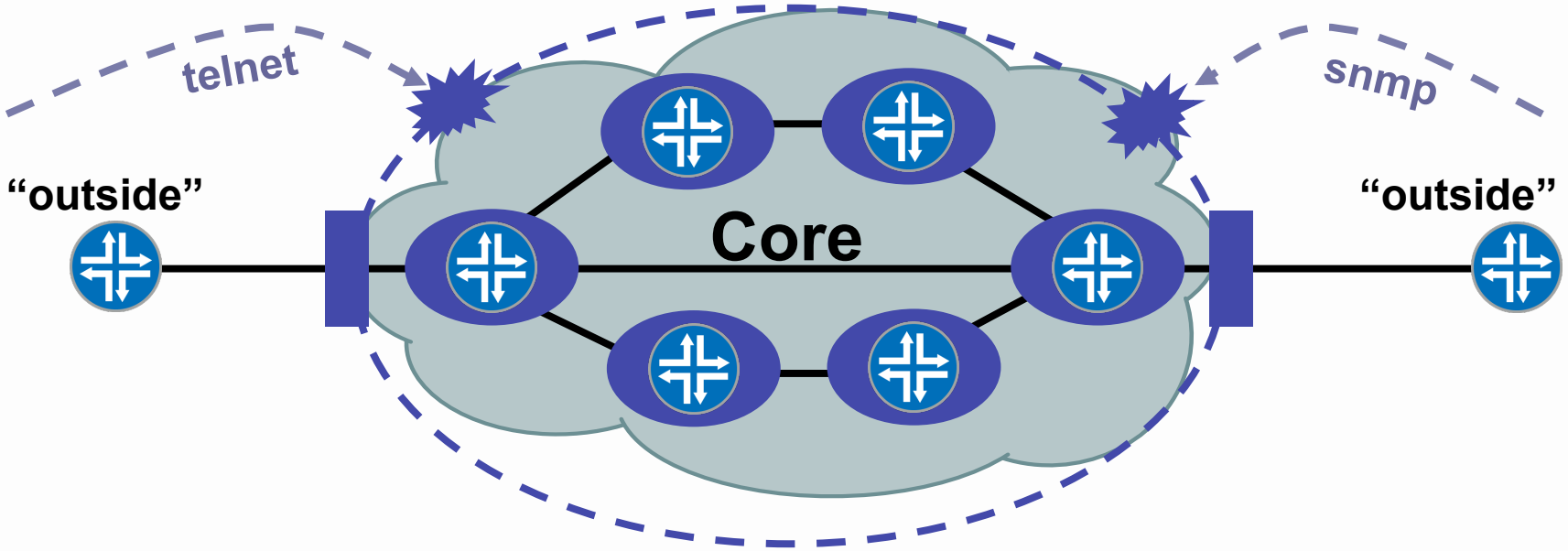


The Old World: Network Edge



- Core routers individually secured
- Every router accessible from outside

The New World: Network Edge



- Core routers individually secured PLUS
- Infrastructure protection
- Routers generally NOT accessible from outside

Infrastructure ACLs

- Basic premise: filter traffic destined TO your core routers
  - Do your core routers really need to process all kinds of garbage?
- Develop list of required protocols that are sourced from outside your AS and access core routers
  - Example: eBGP peering, GRE, IPSec, etc.
  - Use classification ACL as required
- Identify core address block(s)
  - This is the protected address space
  - Summarization is critical → simpler and shorter ACLs

Infrastructure ACLs

- Infrastructure ACL will permit only required protocols and deny ALL others to infrastructure space
- ACLs now need to be IPv4 and IPv6!
- ACL should also provide anti-spoof filtering
  - Deny your space from external sources
  - Deny RFC1918 space
  - Deny multicast sources addresses (224/4)
  - RFC3330 defines special use IPv4 addressing

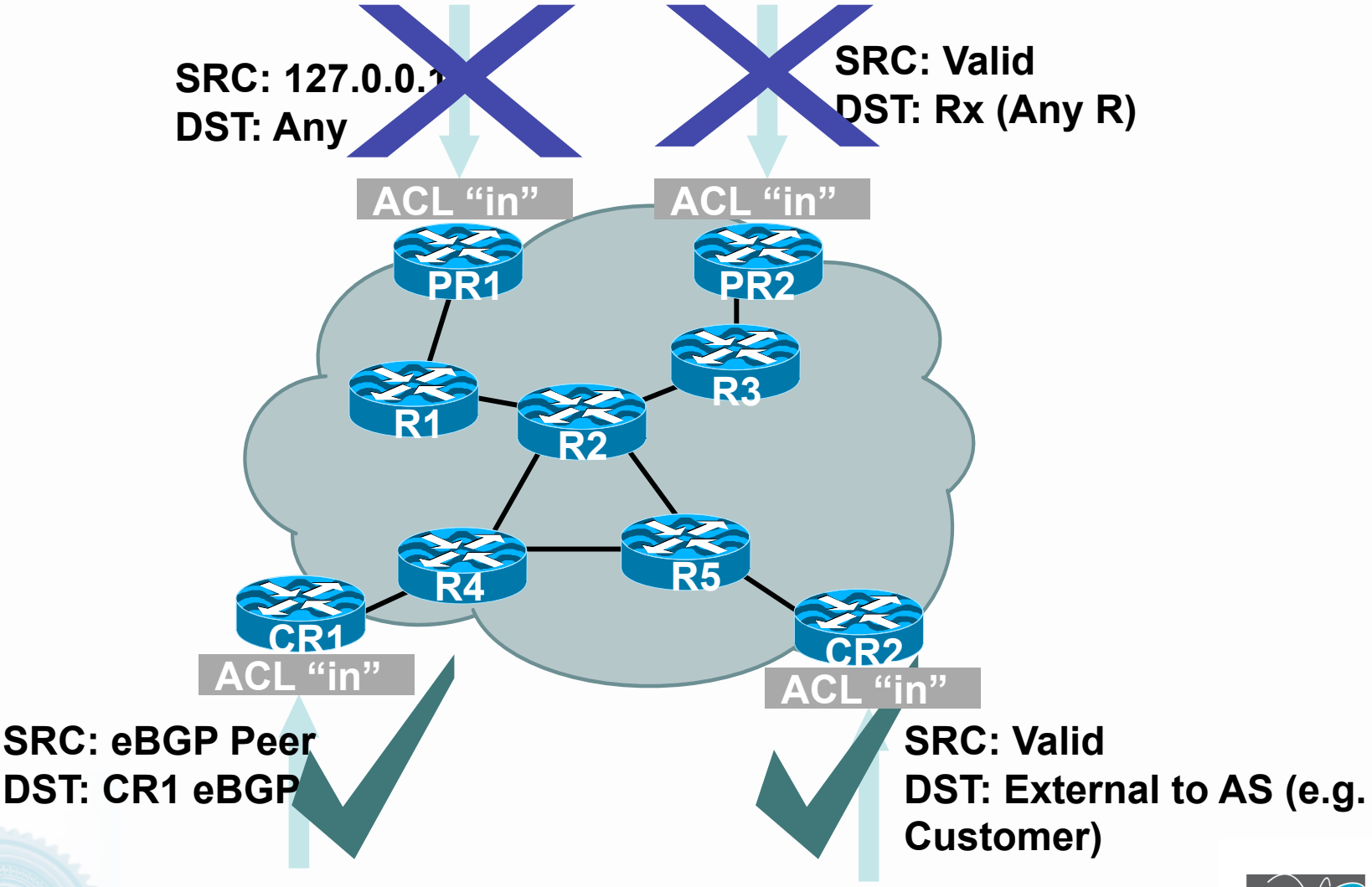
Digression: IP Fragments

- Fragmented Packets can cause problems...
  - Fragmented packets can be used as an attack vector to bypass ACLs
  - Fragments can increase the effectiveness of some attacks by making the recipient consume more resources (CPU and memory) due to fragmentation reassembly
- Reality Check – Routers & Switches should not be receiving fragments!
  - In today's networks, management & control plane traffic should not be fragmenting.
  - If it does, it means something is BROKE or someone is attacking you.
- Recommendation – Filter all fragments to the management & control plane … logging to monitor for errors and attacks.

Infrastructure ACLs

- Infrastructure ACL must permit transit traffic
  - Traffic passing through routers must be allowed via permit IP any any
- iACL is applied inbound on ingress interfaces
- Fragments destined to the core can be filtered via the iACL

Infrastructure ACL in Action



Iterative Deployment

- Typically a very limited subset of protocols needs access to infrastructure equipment
- Even fewer are sourced from outside your AS
- Identify required protocols via classification ACL
- Deploy and test your iACLs

Step 1: Classification

- Traffic destined to the core must be classified
- NetFlow can be used to classify traffic
  - Need to export and review
- Classification ACL can be used to identify required protocols
  - Series of permit statements that provide insight into required protocols
  - Initially, many protocols can be permitted, only required ones permitted in next step
  - ACL Logging can be used for additional detail; hits to ACL entry with *logging* might increase CPU utilization: impact varies by vendor/platform
- Regardless of method, unexpected results should be carefully analyzed → do not permit protocols that you can't explain!

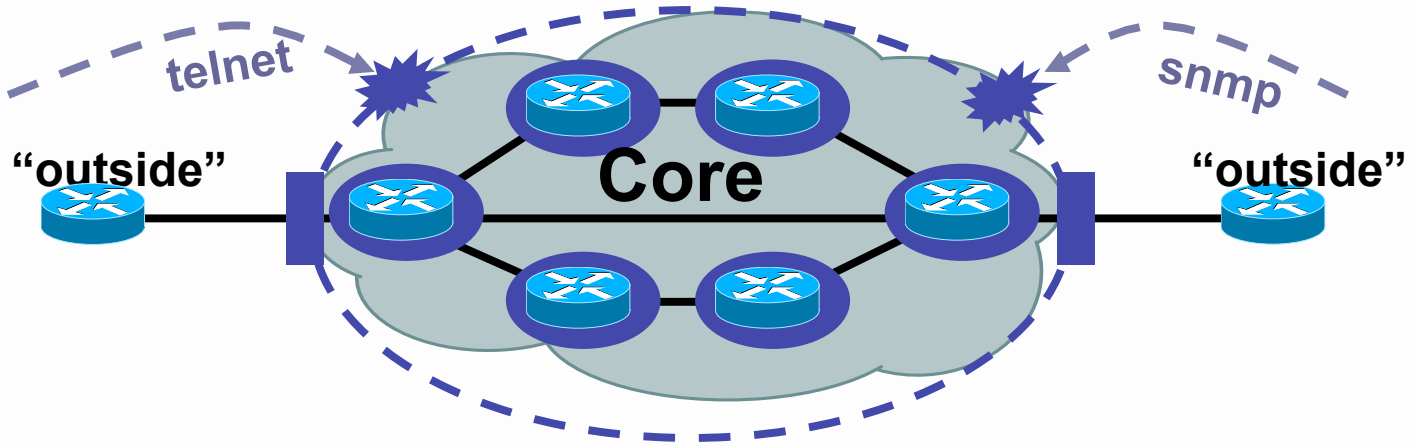
Step 2: Begin to Filter

- Permit protocols identified in step 1 to infrastructure only address blocks
- Deny all other to addresses blocks
  - Watch access control entry (ACE) counters
  - ACL logging can help identify protocols that have been denied but are needed
- Last line: permit anything else ← permit transit traffic
- The iACL now provides basic protection and can be used to ensure that the correct suite of protocols has been permitted

Steps 3 & 4: Restrict Source Addresses

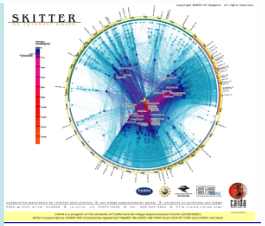
- Step 3:
  - ACL is providing basic protection
  - Required protocols permitted, all other denied
  - Identify source addresses and permit only those sources for requires protocols
  - e.g., external BGP peers, tunnel end points
- Step 4:
  - Increase security: deploy destination address filters if possible

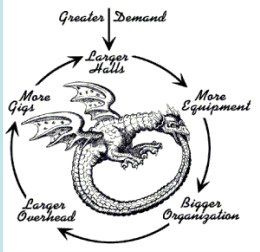
Infrastructure ACLs

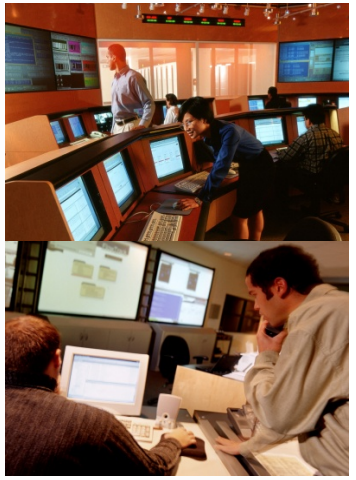


- Edge "shield" in place
- Not perfect, but a very effective first round of defense
  - Can you apply iACLs everywhere?
  - What about packets that you cannot filter with iACLs?
  - Hardware limitations
- Next step: secure the control/management planes per box

Remote Trigger Black Hole



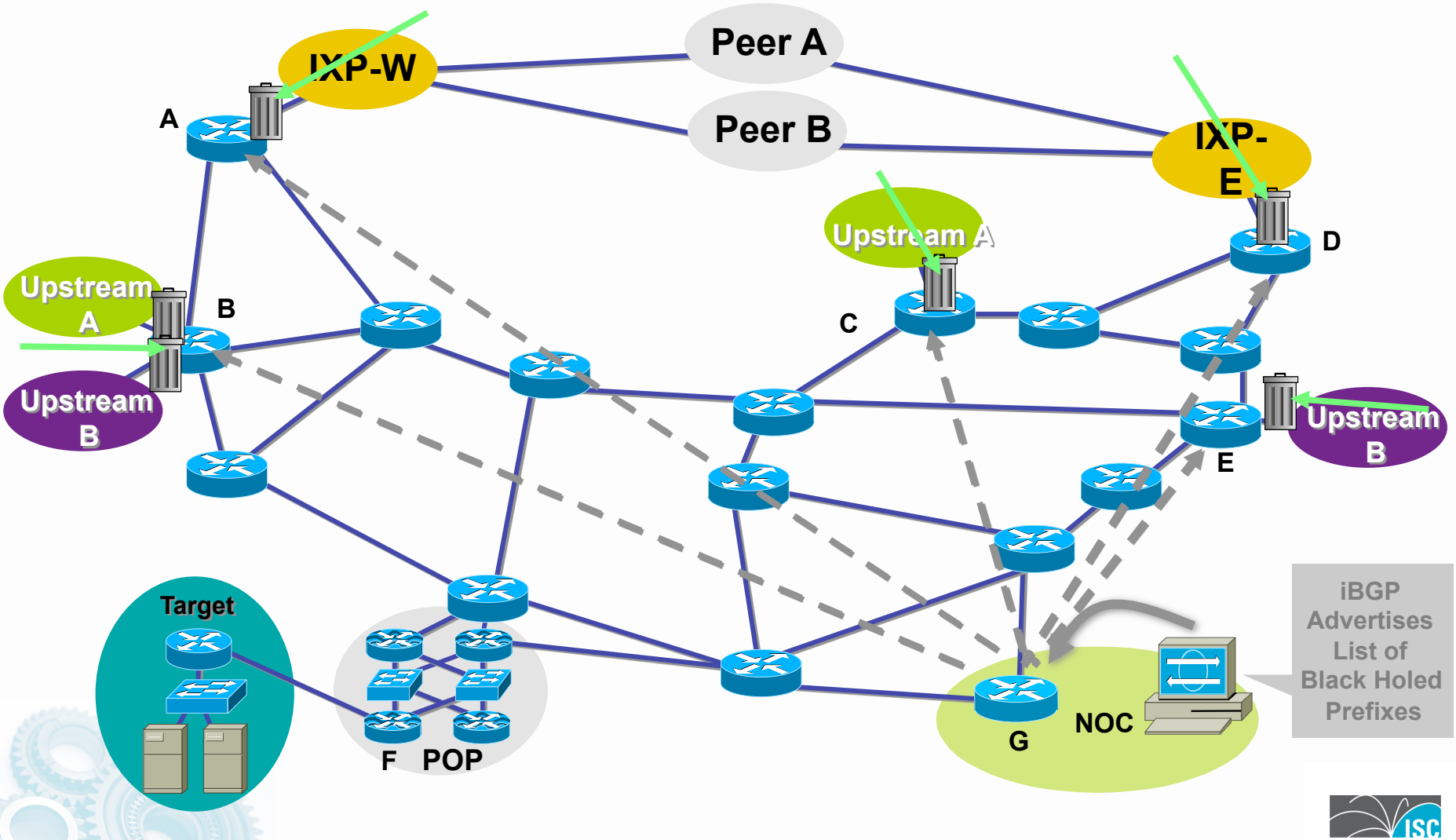




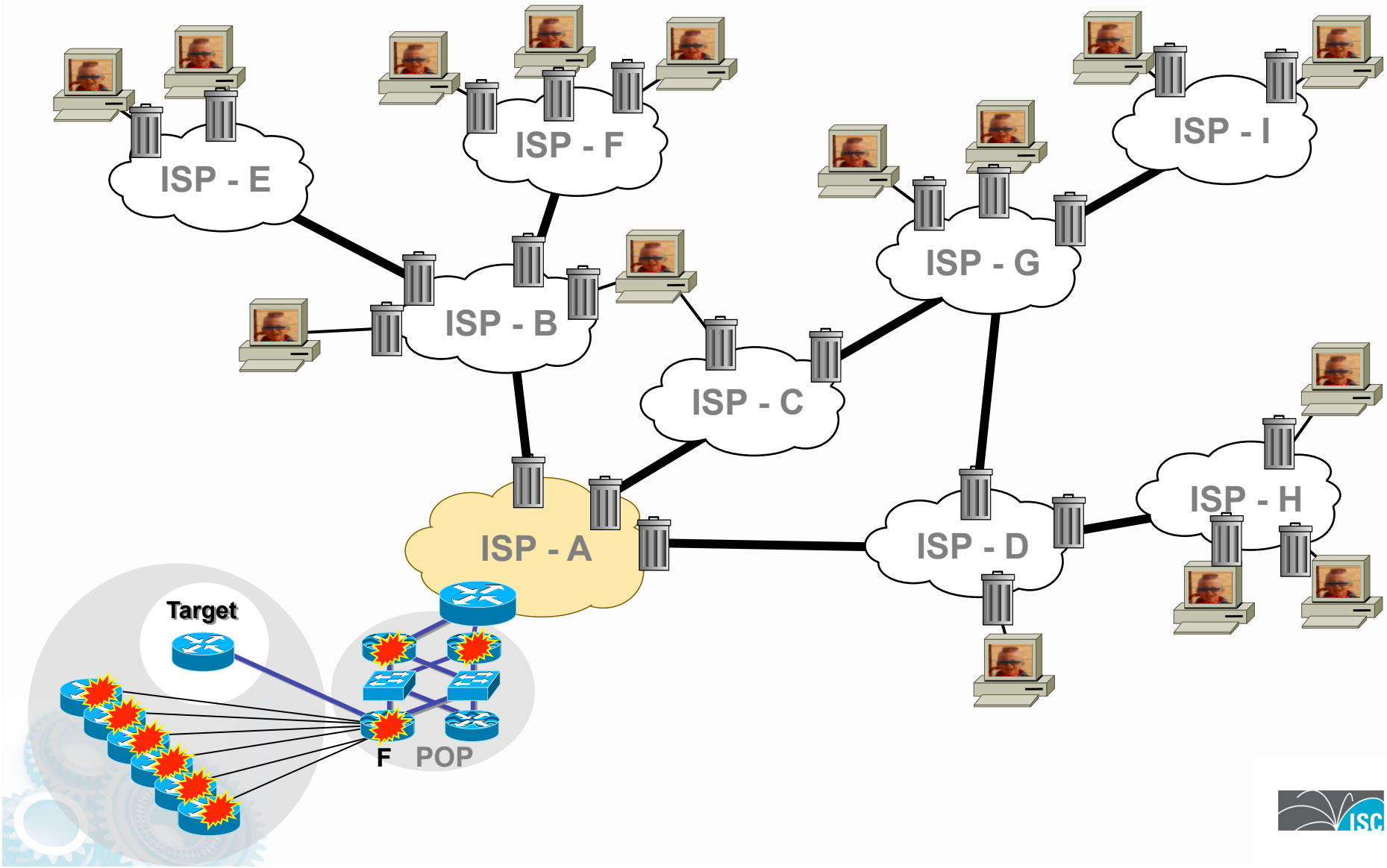
Remotely Triggered Black Hole Filtering

- We use BGP to trigger a network wide response to a range of attack flows.
- A simple static route and BGP will allow an SP to trigger network wide black holes as fast as iBGP can update the network.
- This provides SPs a tool that can be used to respond to security related events or used for DOS/DDOS Backscatter Tracebacks.

Customer is DOSed - After - Packet Drops Pushed to the Edge



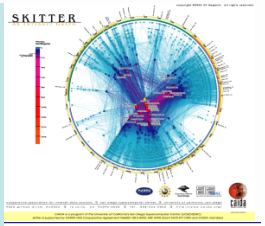
Inter-Provider Mitigation

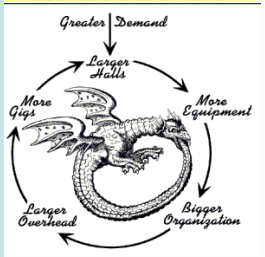


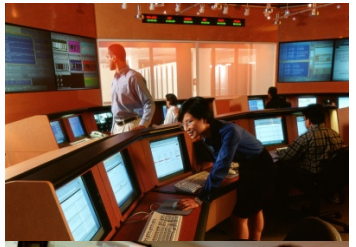
What can you do to help?

- Remote Triggered Black Hole Filtering is the most common ISP DOS/DDOS mitigation tool.
- Prepare your network:
  - ftp://ftp-eng.cisco.com/cons/isp/essentials/ (has whitepaper)
  - ftp://ftp-eng.cisco.com/cons/isp/security/ (has PDF Presentations)
  - NANOG Tutorial:
    - http://www.nanog.org/mtg-0110/greene.html (has public VOD with UUNET)
  - Turk, D., "Configuring BGP to Block Denial-of-Service Attacks", RFC 3882, September 2004.

Sink Holes


SKITTER


Greater Demand
Larger Halls
More Equipment
Bigger Organization
Larger Overhead
More Gigs



Sink Hole Routers/Networks

- Sink Holes are a *Swiss Army Knife* security tool.
  - BGP speaking Router or Workstation that built to *suck in* attacks.
  - Used to redirect attacks away from the customer – working the attack on a router built to withstand the attack.
  - Used to monitor *attack noise, scans,* and other activity (via the advertisement of default)
  - http://www.nanog.org/mtg-0306/sink.html

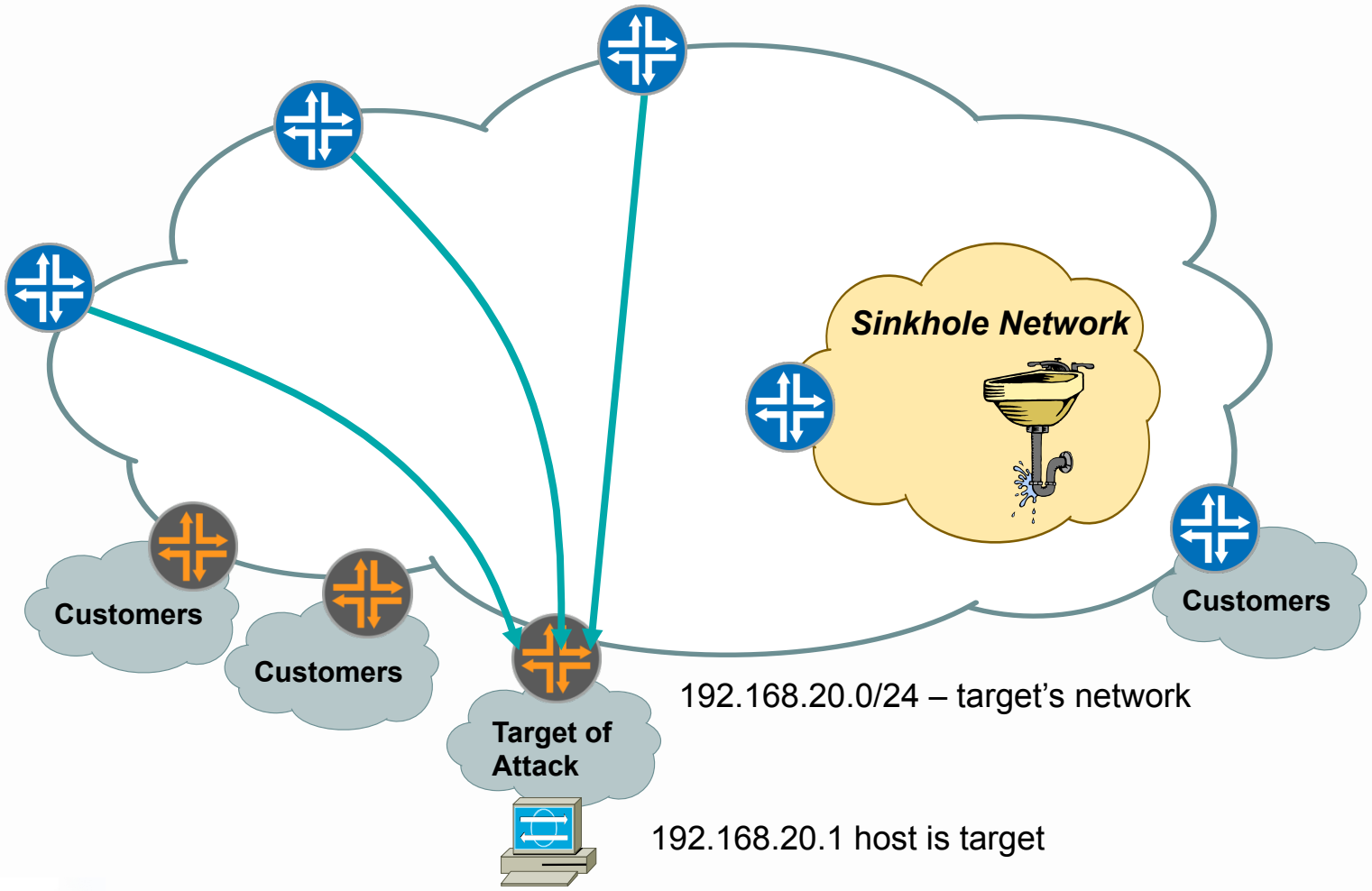
Why Sinkhole?

- Sinkhole is used to describe a technique that does more than the individual tools we've had in the past:
  - **Blackhole Routers** – Technique used to exploit a routers forwarding logic in order to discard data, typically in a distributed manner, triggered by routing advertisements.
  - **Tar Pits** – A section of a honey net or DMZ designed to slow down TCP based attacks to enable analysis and traceback. Often used interchangeably with Sinkhole.
  - **Shunts** – Redirecting traffic to one of the router's connected interfaces, typically to discard traffic.
  - **Honey Net** – A network of one or more systems designed to analyze and capture penetrations and similar malicious activity.
  - **Honey Pot** - A system designed to analyze and capture penetrations and similar malicious activity.

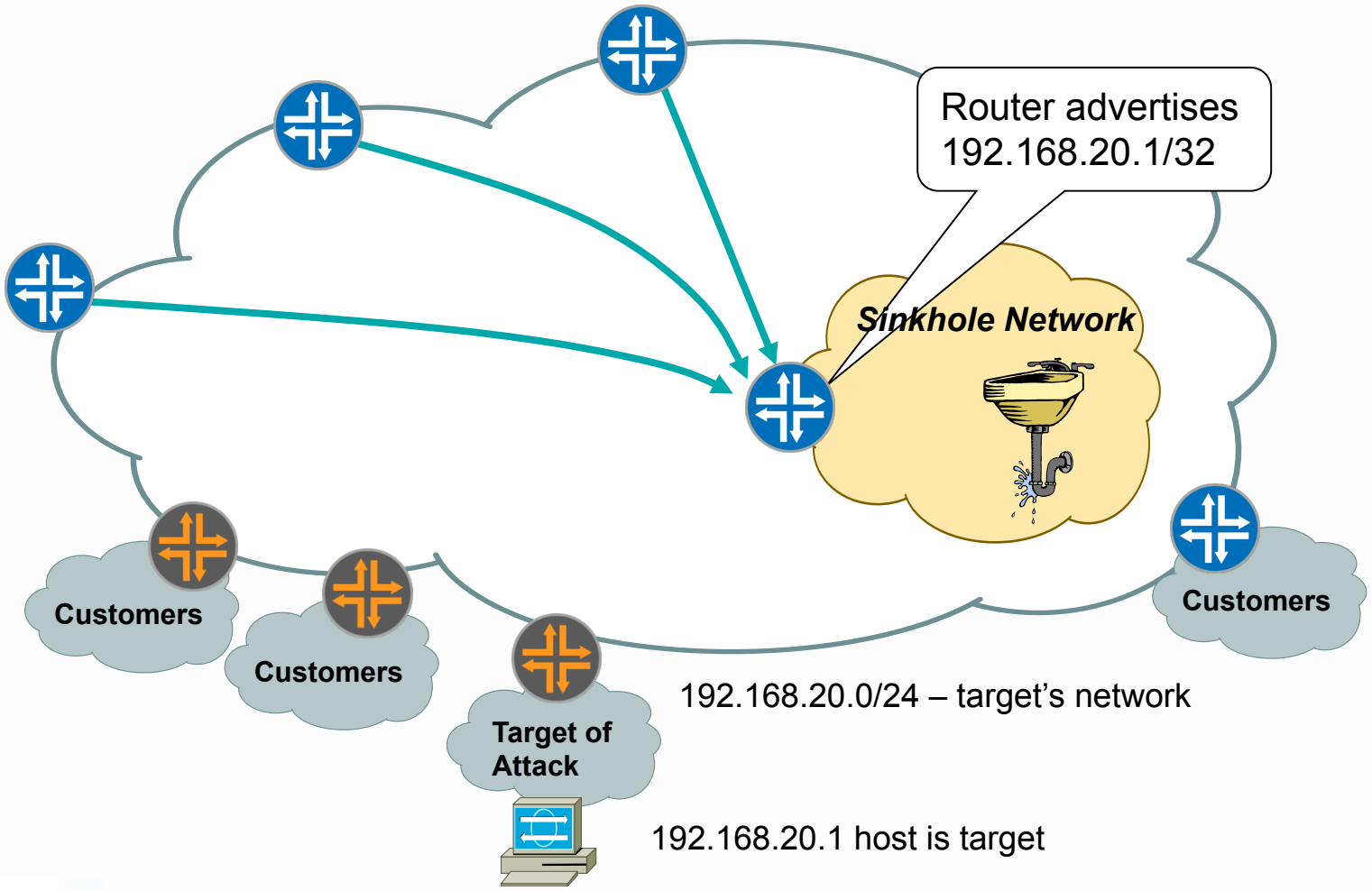
Sinkhole Routers/Networks

- Sinkholes are the network equivalent of a ***honey pot***, also commonly referred to as a ***tar pit***, sometimes referred to as a ***blackhole***.
  - Router or workstation built to *suck in* and assist in analyzing attacks.
  - Used to redirect attacks away from the customer – working the attack on a router built to withstand the attack.
  - Used to monitor *attack noise, scans, data from mis-configuration* and other activity (via the advertisement of default or unused IP space)
  - Traffic is typically diverted via BGP route advertisements and policies.

Sinkhole Routers/Networks

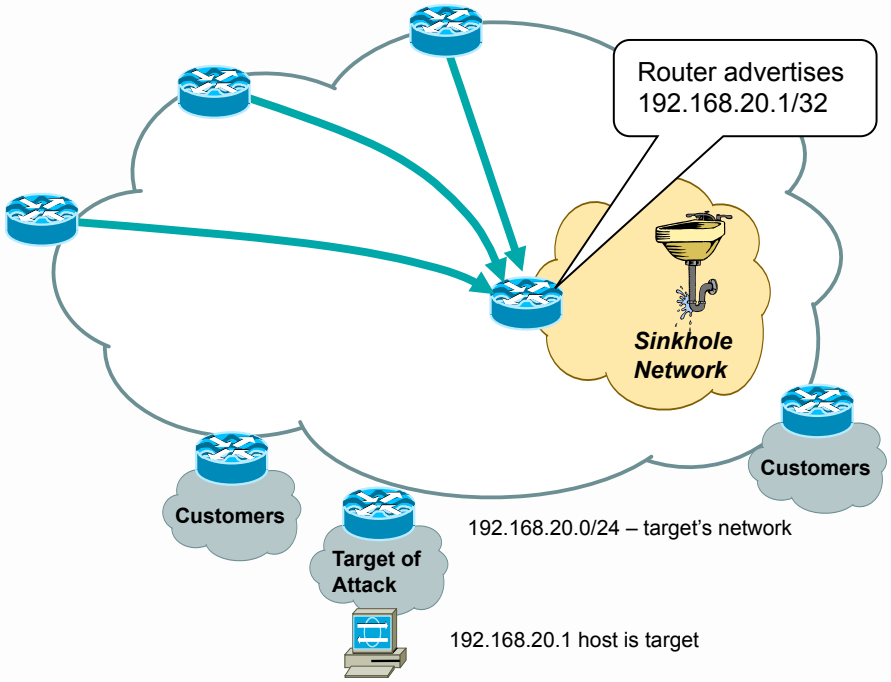


Sinkhole Routers/Networks

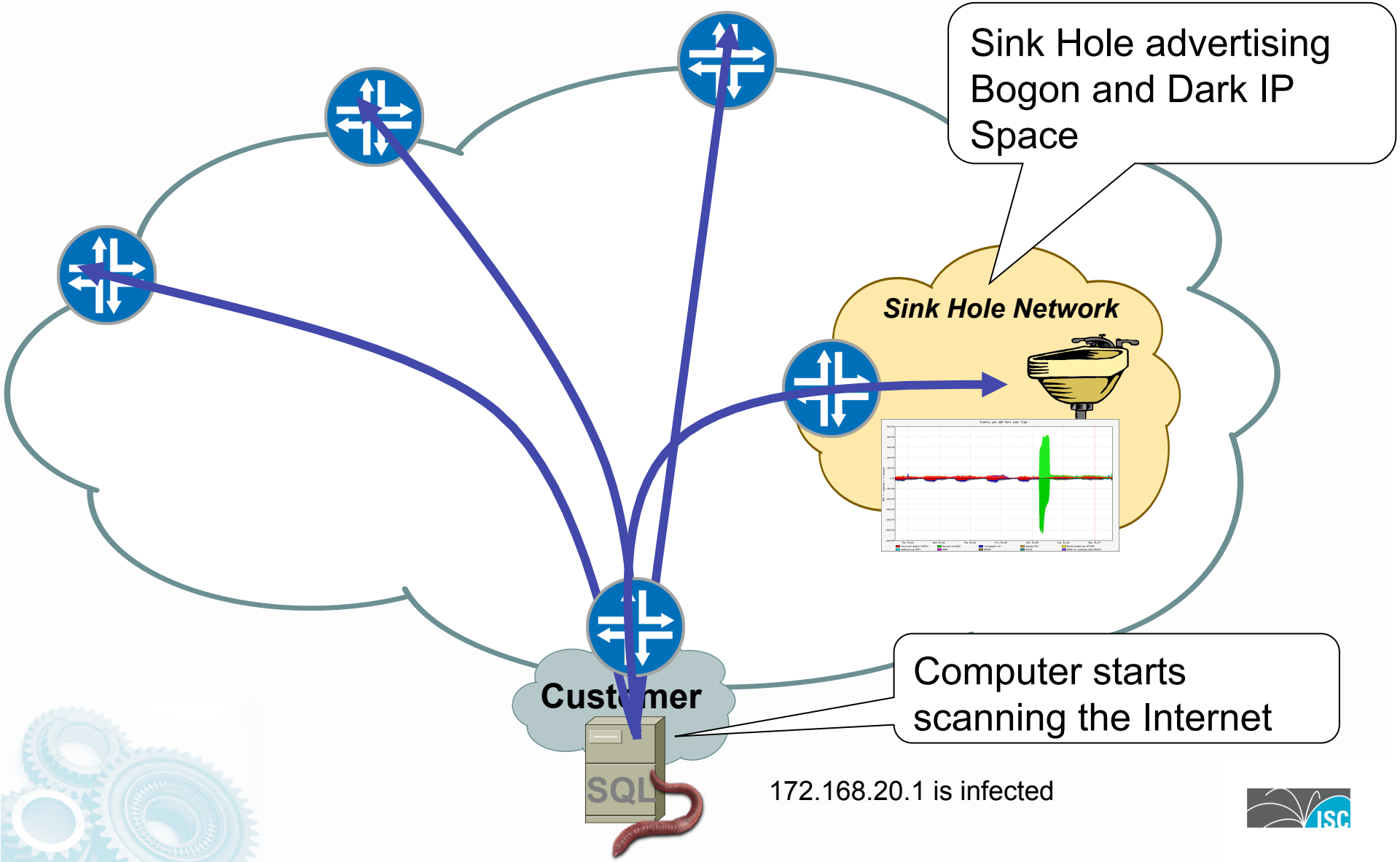


Sinkhole Routers/Networks

- Attack is pulled away from customer/ aggregation router.
- Can now apply classification ACLs, Packet Capture, Etc…
- Objective is to minimize the risk to the network while investigating the attack incident.

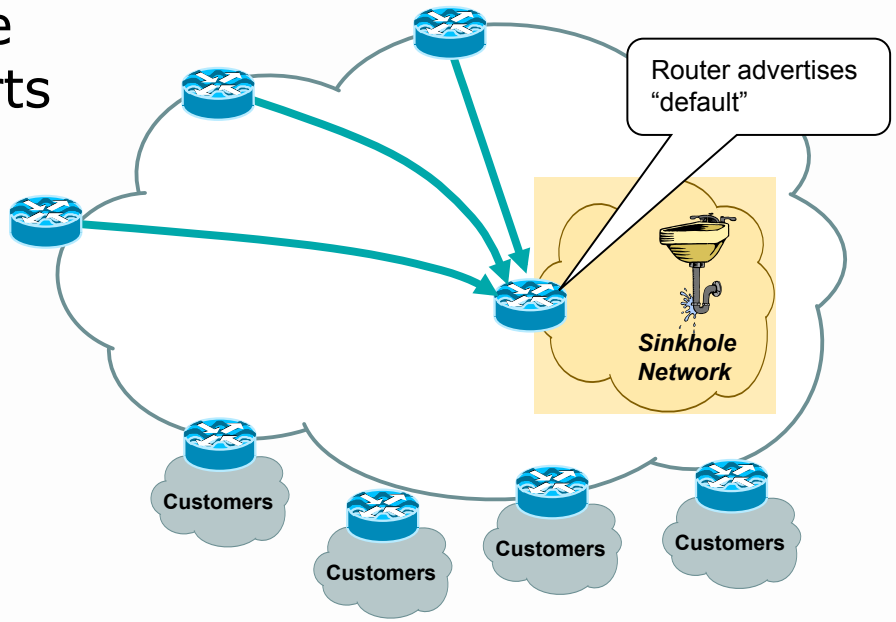


Infected End Points



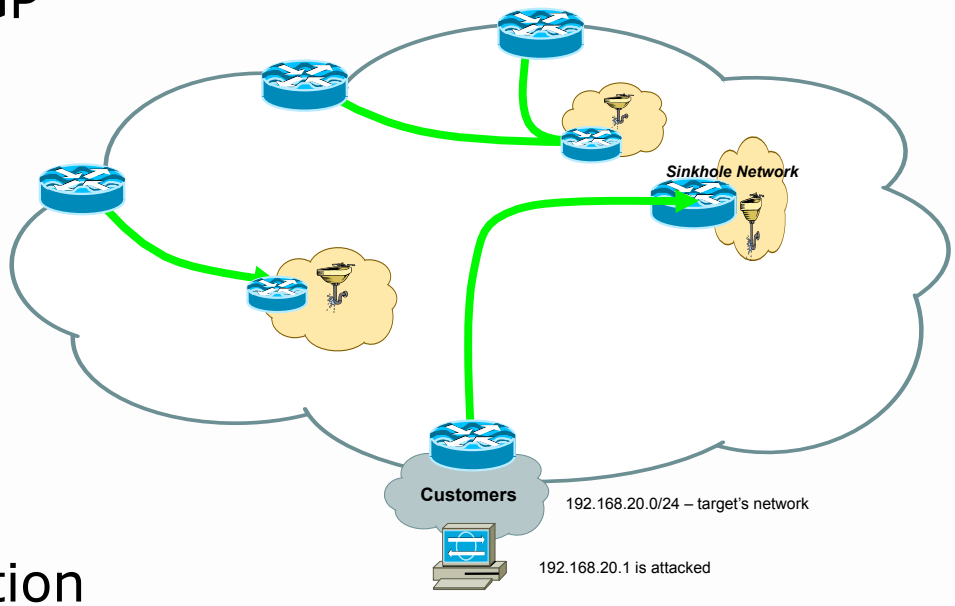
Sinkhole Routers/Networks

- Advertising "default" from the Sinkhole will pull down all sorts of *garbage* traffic:
  - Customer Traffic when circuits flap
  - Network Scans to unallocated address space
  - Code Red/NIMDA/Worms
  - Backscatter
- Can place tracking tools in the Sinkhole network to monitor the noise.



Scaling Sinkhole Networks

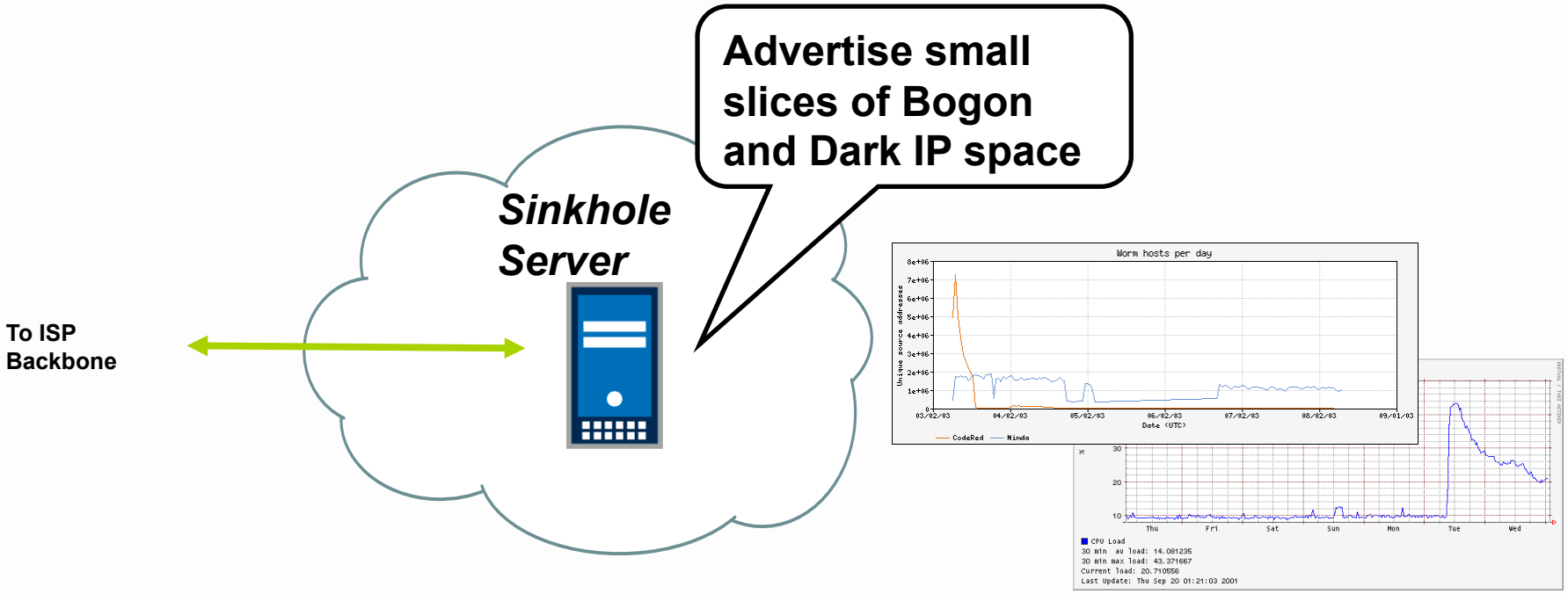
- Multiple Sinkholes can be deployed within a network
- Combination of IGP with BGP Trigger
- Regional deployment
  - Major PoPs
- Functional deployment
  - Peering points
  - Data Centers
- Note: Reporting more complicated, need aggregation and correlation mechanism



Why Sinkholes?

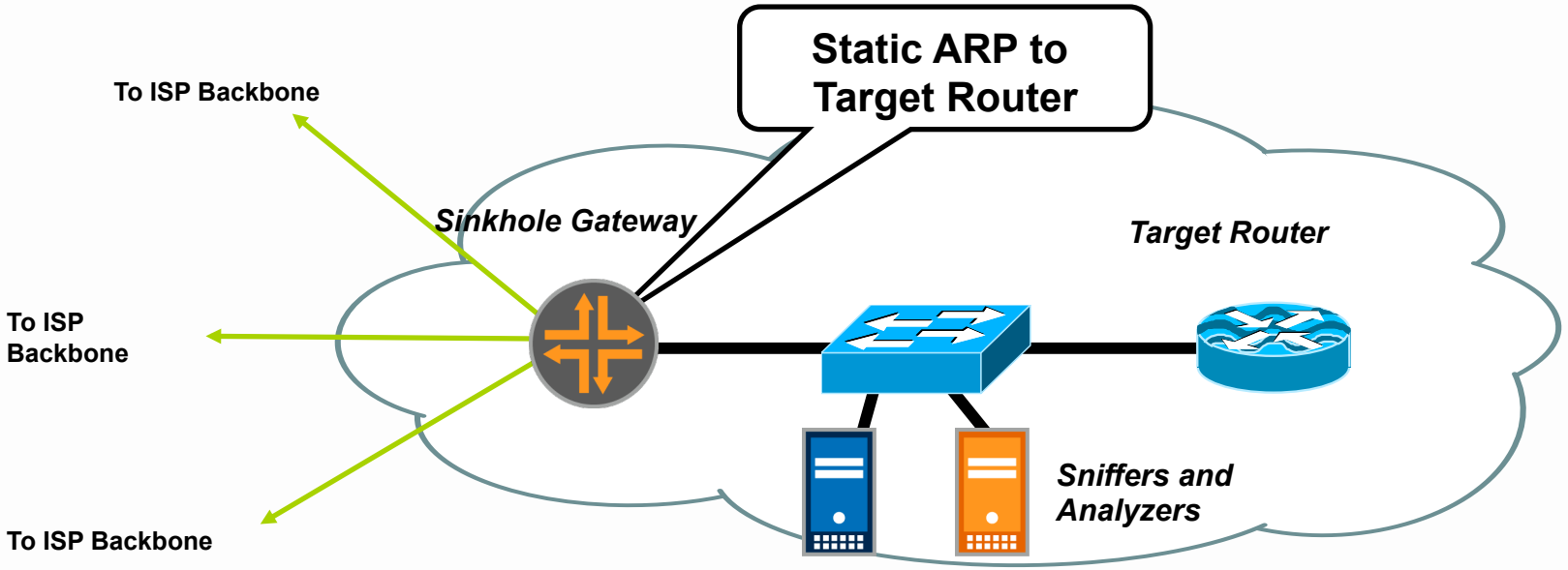
- They work! Providers and researchers use them in their network for data collection and analysis.
- More uses are being found through experience and individual innovation.
- Deploying Sinkholes correctly takes preparation.

The Basic Sinkhole



- Sinks Holes do not have to be complicated.
- Some large providers started their Sinkhole with a spare workstation with free unix, Zebra, and TCPdump.
- Some GNU or MRTG graphing and you have a decent sinkhole.

Expanding the Sinkhole

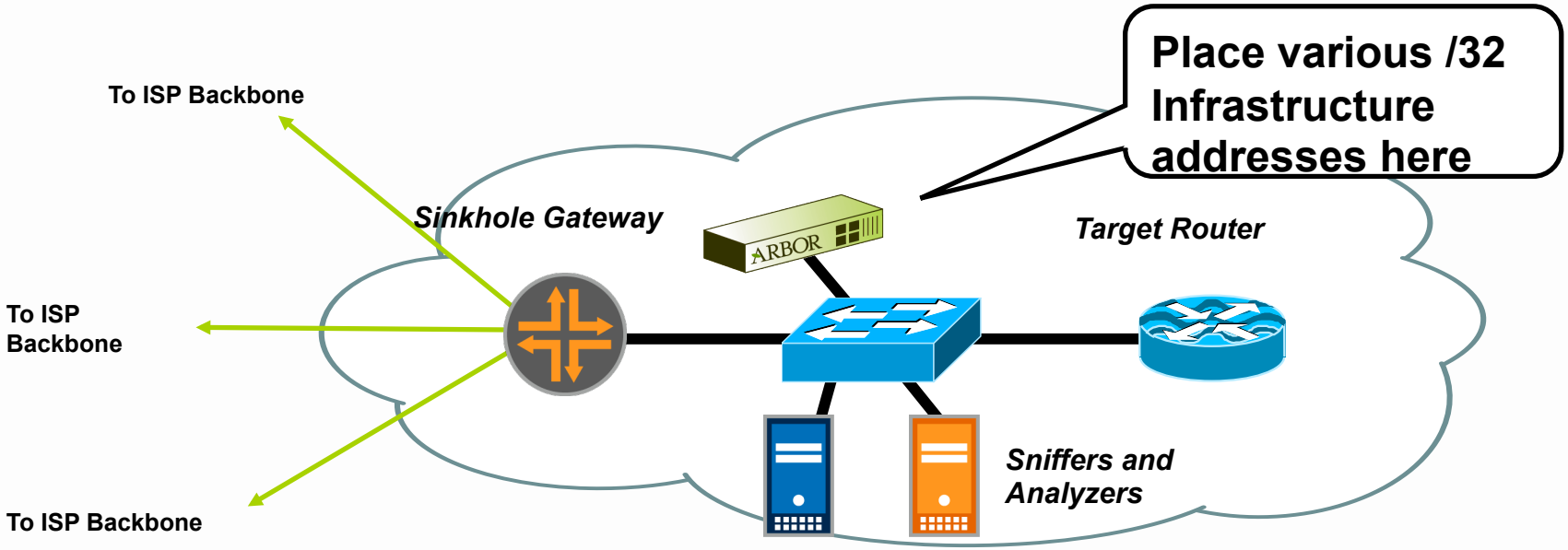


- Expand the Sinkhole with a dedicated router into a variety of tools.
- Pull the DOS/DDOS attack to the sinkhole and forwards the attack to the target router.
- Static ARP to the target router keeps the Sinkhole Operational – Target Router can crash from the attack and the static ARP will keep the gateway forwarding traffic to the Ethernet switch.

What to monitor in a Sinkhole?

- Scans on Dark IP (allocated & announced but unassigned address space).
  - Who is scoping out the network – pre-attack planning.
- Scans on Bogons (unallocated).
  - Worms, infected machines, and Bot creation
- Backscatter from Attacks
  - Who is getting attacked
- Backscatter from Garbage traffic (RFC-1918 leaks)
  - Which customers have misconfiguration or "leaking" networks.

Monitoring Scan Rates

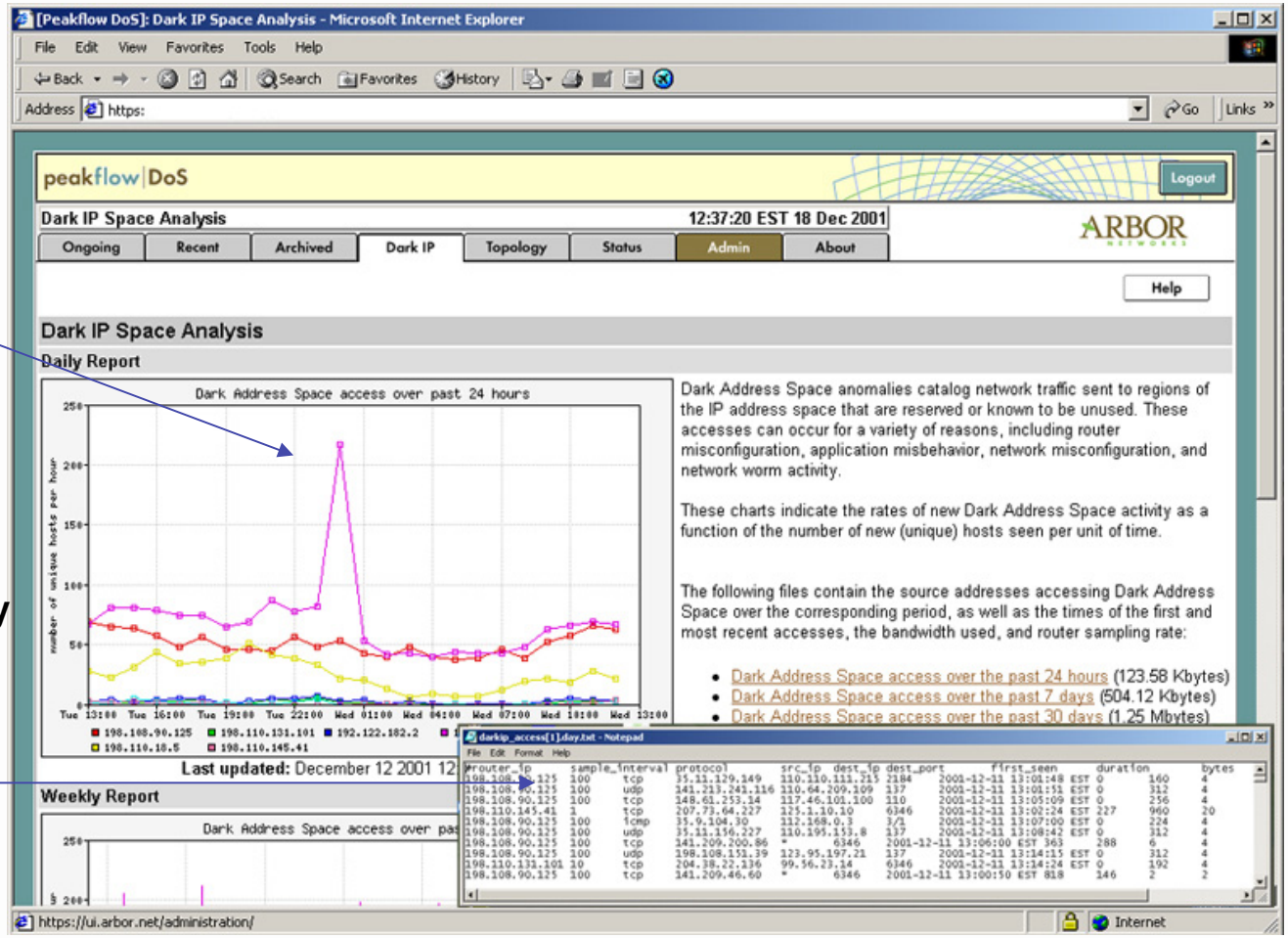


- Select /32 (or larger) address from different block of your address space. Advertise them out the Sinkhole
- Assign them to a workstation built to monitor and log scans. (Arbor Network's *Dark IP* Peakflow module is one turn key commercial tool that can monitor scan rates via data collected from the network.)

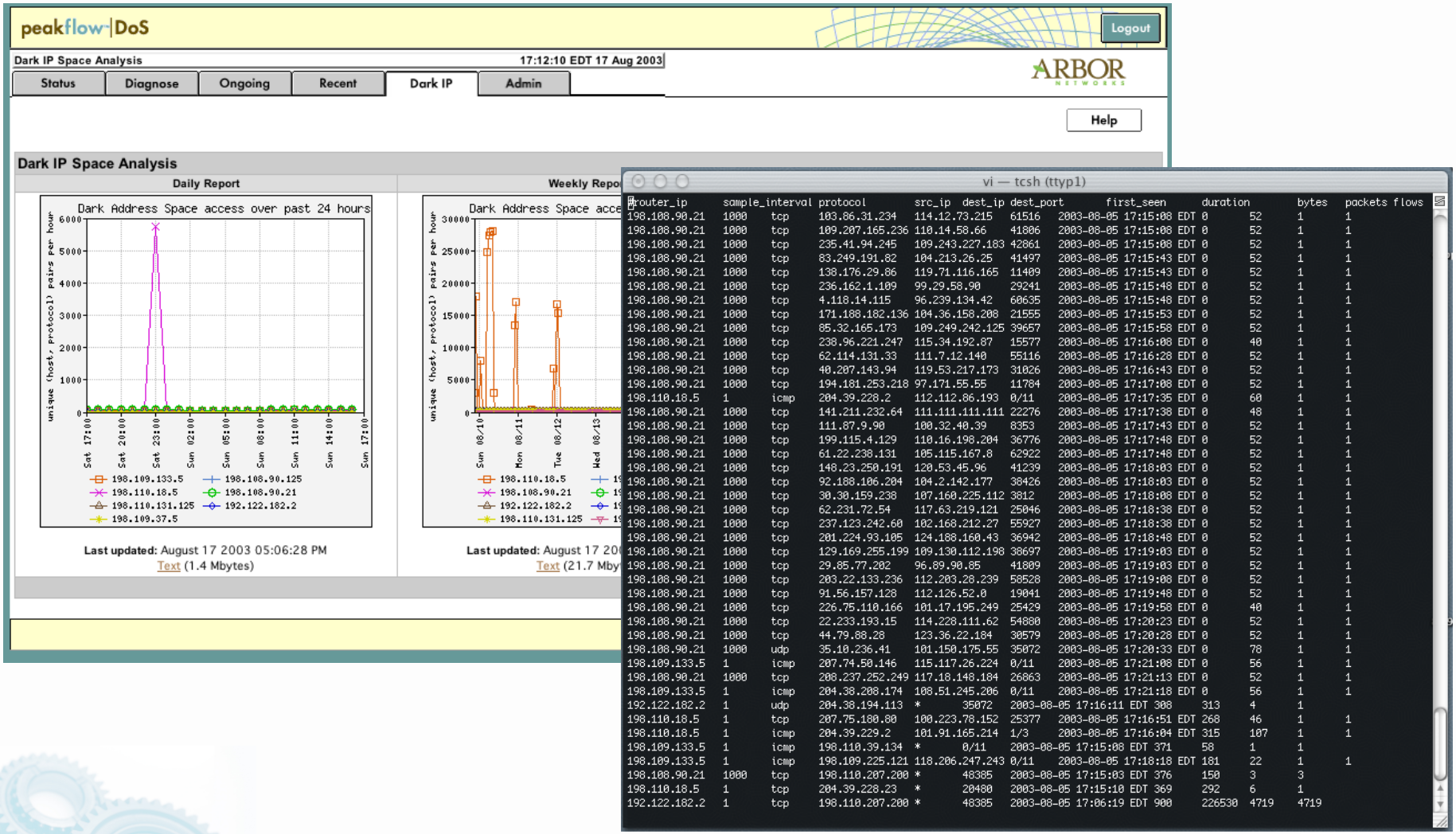
Worm Detection & Reporting UI

Operator instantly notified of Worm infection.

System automatically generates a list of infected hosts for quarantine and clean-up.

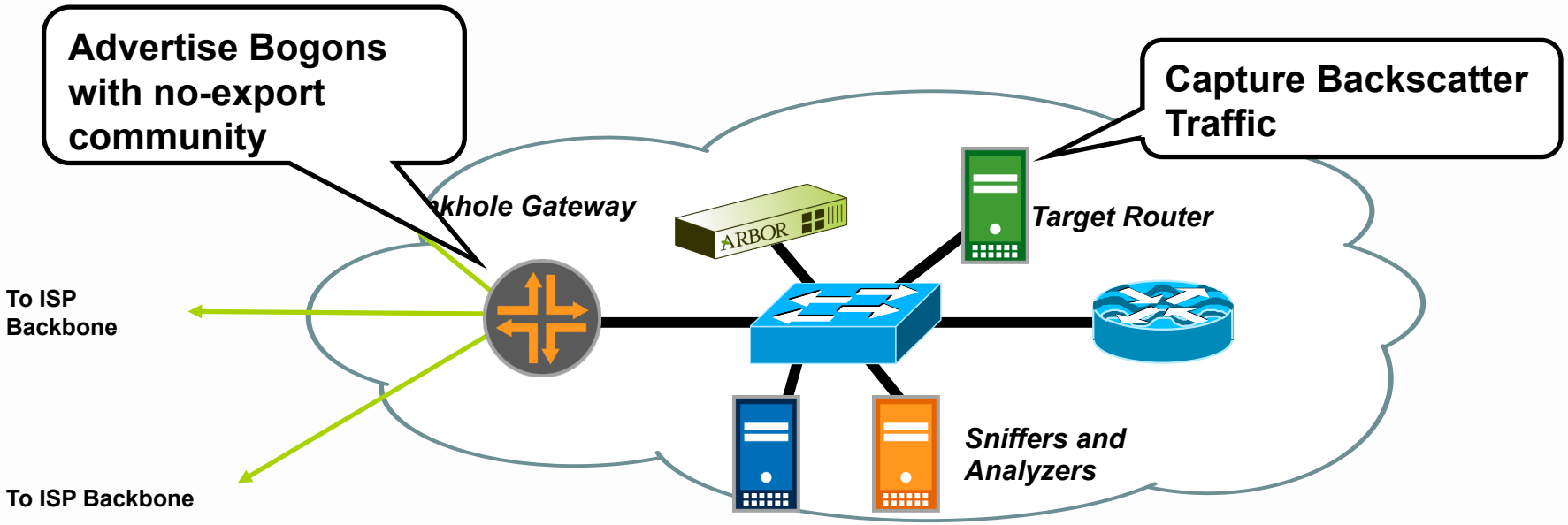


Automate Quarantine of Infected Hosts



#router_ip	sample_interval	protocol	src_ip	dest_ip	dest_port	first_seen	duration	bytes	packets	flows
198.108.90.21	1000	tcp	103.86.31.234	114.12.73.215	61516	2003-08-05 17:15:08 EDT	0	52	1	1
198.108.90.21	1000	tcp	109.207.165.236	110.14.58.66	41806	2003-08-05 17:15:08 EDT	0	52	1	1
198.108.90.21	1000	tcp	235.41.94.245	109.243.227.183	42861	2003-08-05 17:15:08 EDT	0	52	1	1
198.108.90.21	1000	tcp	83.249.191.82	104.213.26.25	41497	2003-08-05 17:15:43 EDT	0	52	1	1
198.108.90.21	1000	tcp	138.176.29.86	119.71.116.165	11409	2003-08-05 17:15:43 EDT	0	52	1	1
198.108.90.21	1000	tcp	236.162.1.109	99.29.58.90	29241	2003-08-05 17:15:48 EDT	0	52	1	1
198.108.90.21	1000	tcp	4.118.14.115	96.239.134.42	60635	2003-08-05 17:15:48 EDT	0	52	1	1
198.108.90.21	1000	tcp	171.188.182.136	104.36.158.208	21555	2003-08-05 17:15:53 EDT	0	52	1	1
198.108.90.21	1000	tcp	85.32.165.173	109.249.242.125	39657	2003-08-05 17:15:58 EDT	0	52	1	1
198.108.90.21	1000	tcp	238.96.221.247	115.34.192.87	15577	2003-08-05 17:16:08 EDT	0	40	1	1
198.108.90.21	1000	tcp	62.114.131.33	111.7.12.140	55116	2003-08-05 17:16:28 EDT	0	52	1	1
198.108.90.21	1000	tcp	40.207.143.94	119.53.217.173	31026	2003-08-05 17:16:43 EDT	0	52	1	1
198.108.90.21	1000	tcp	194.181.253.218	97.171.55.55	11784	2003-08-05 17:17:08 EDT	0	52	1	1
198.110.18.5	1	icmp	204.39.228.2	112.112.86.193	0/11	2003-08-05 17:17:35 EDT	0	60	1	1
198.108.90.21	1000	tcp	141.211.232.64	111.111.111.111	22276	2003-08-05 17:17:38 EDT	0	48	1	1
198.108.90.21	1000	tcp	111.87.9.90	100.32.40.39	8353	2003-08-05 17:17:43 EDT	0	52	1	1
198.108.90.21	1000	tcp	199.115.4.129	110.16.198.204	36776	2003-08-05 17:17:48 EDT	0	52	1	1
198.108.90.21	1000	tcp	61.22.238.131	105.115.167.8	62922	2003-08-05 17:17:48 EDT	0	52	1	1
198.108.90.21	1000	tcp	148.23.250.191	120.53.45.96	41239	2003-08-05 17:18:03 EDT	0	52	1	1
198.108.90.21	1000	tcp	92.188.106.204	104.2.142.177	38426	2003-08-05 17:18:03 EDT	0	52	1	1
198.108.90.21	1000	tcp	30.30.159.238	107.160.225.112	3812	2003-08-05 17:18:08 EDT	0	52	1	1
198.108.90.21	1000	tcp	62.231.72.54	117.63.219.121	25046	2003-08-05 17:18:38 EDT	0	52	1	1
198.108.90.21	1000	tcp	237.123.242.60	102.168.212.27	55927	2003-08-05 17:18:38 EDT	0	52	1	1
198.108.90.21	1000	tcp	201.224.93.105	124.188.160.43	36942	2003-08-05 17:18:48 EDT	0	52	1	1
198.108.90.21	1000	tcp	129.169.255.199	109.130.112.198	38697	2003-08-05 17:19:03 EDT	0	52	1	1
198.108.90.21	1000	tcp	29.85.77.202	96.89.90.85	41809	2003-08-05 17:19:03 EDT	0	52	1	1
198.108.90.21	1000	tcp	203.22.133.236	112.203.28.239	58528	2003-08-05 17:19:08 EDT	0	52	1	1
198.108.90.21	1000	tcp	91.56.157.128	112.126.52.0	19041	2003-08-05 17:19:48 EDT	0	52	1	1
198.108.90.21	1000	tcp	226.75.110.166	101.17.195.249	25429	2003-08-05 17:19:58 EDT	0	40	1	1
198.108.90.21	1000	tcp	22.233.193.15	114.228.111.62	54880	2003-08-05 17:20:23 EDT	0	52	1	1
198.108.90.21	1000	tcp	44.79.88.28	123.36.22.184	30579	2003-08-05 17:20:28 EDT	0	52	1	1
198.108.90.21	1000	udp	35.10.236.41	101.150.175.55	35072	2003-08-05 17:20:33 EDT	0	78	1	1
198.109.133.5	1	icmp	207.74.50.146	115.117.26.224	0/11	2003-08-05 17:21:08 EDT	0	56	1	1
198.108.90.21	1000	tcp	208.237.252.249	117.18.148.184	26863	2003-08-05 17:21:13 EDT	0	52	1	1
198.109.133.5	1	icmp	204.38.208.174	108.51.245.206	0/11	2003-08-05 17:21:18 EDT	0	56	1	1
192.122.182.2	1	udp	204.38.194.113	*	35072	2003-08-05 17:16:11 EDT	308	313	4	1
198.110.18.5	1	tcp	207.75.180.80	100.223.78.152	25377	2003-08-05 17:16:51 EDT	268	46	1	1
198.110.18.5	1	icmp	204.39.229.2	101.91.165.214	1/3	2003-08-05 17:16:04 EDT	315	107	1	1
198.109.133.5	1	icmp	198.110.39.134	*	0/11	2003-08-05 17:15:08 EDT	371	58	1	1
198.109.133.5	1	icmp	198.109.225.121	118.206.247.243	0/11	2003-08-05 17:18:18 EDT	181	22	1	1
198.108.90.21	1000	tcp	198.110.207.200	*	48385	2003-08-05 17:15:03 EDT	376	150	3	3
198.110.18.5	1	tcp	204.39.228.23	*	20480	2003-08-05 17:15:10 EDT	369	292	6	1
192.122.182.2	1	tcp	198.110.207.200	*	48385	2003-08-05 17:06:19 EDT	900	226530	4719	4719

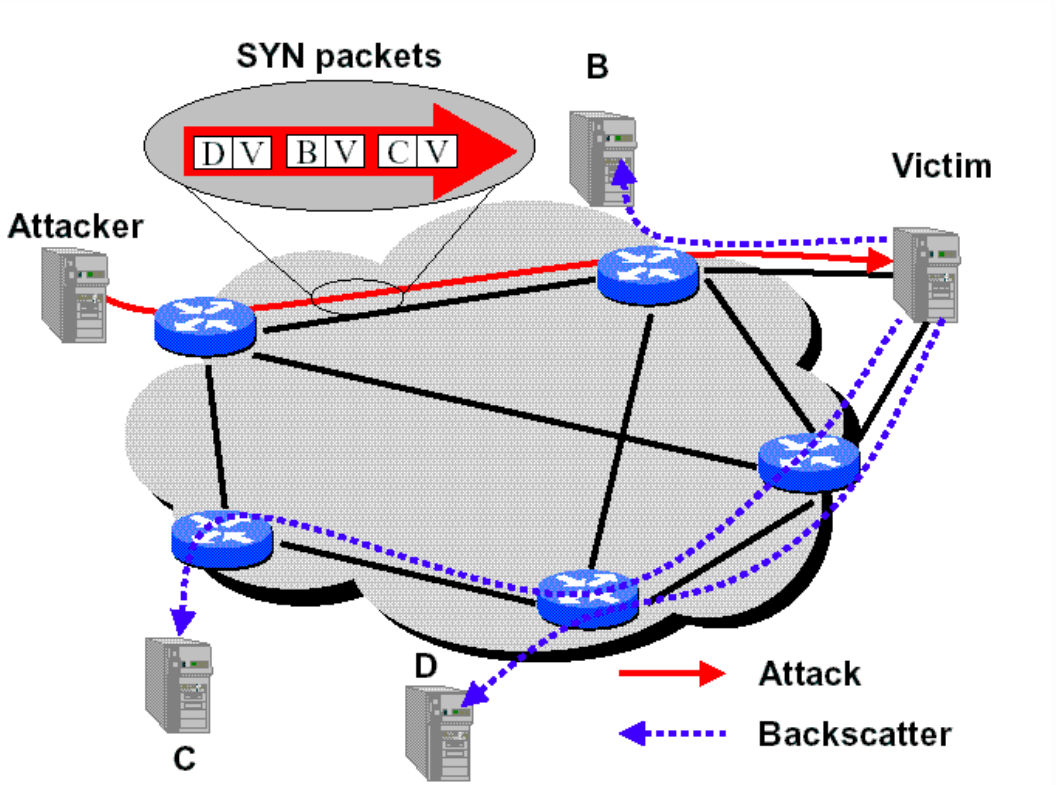
Monitoring Backscatter



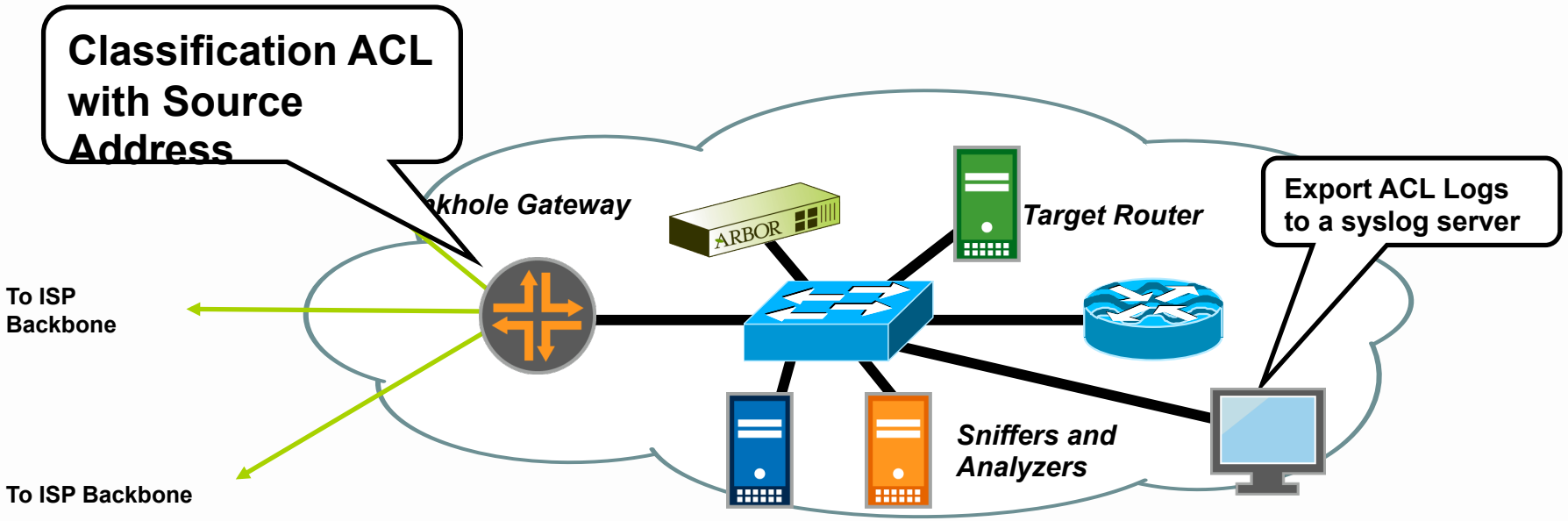
- Advertise bogon blocks with NO_EXPORT community and an explicit safety community (plus prefix-based egress filtering on the edge)
- Static/set the BGP NEXT_HOP for the bogon to a backscatter collector workstation (as simple as TCPdump).
- Pulls in backscatter for that range – allows monitoring.

Monitoring Backscatter

- Inferring Internet Denial-of-Service Activity
  - http://www.caida.org/outreach/papers/2001/BackScatter/



Monitoring Spoof Ranges



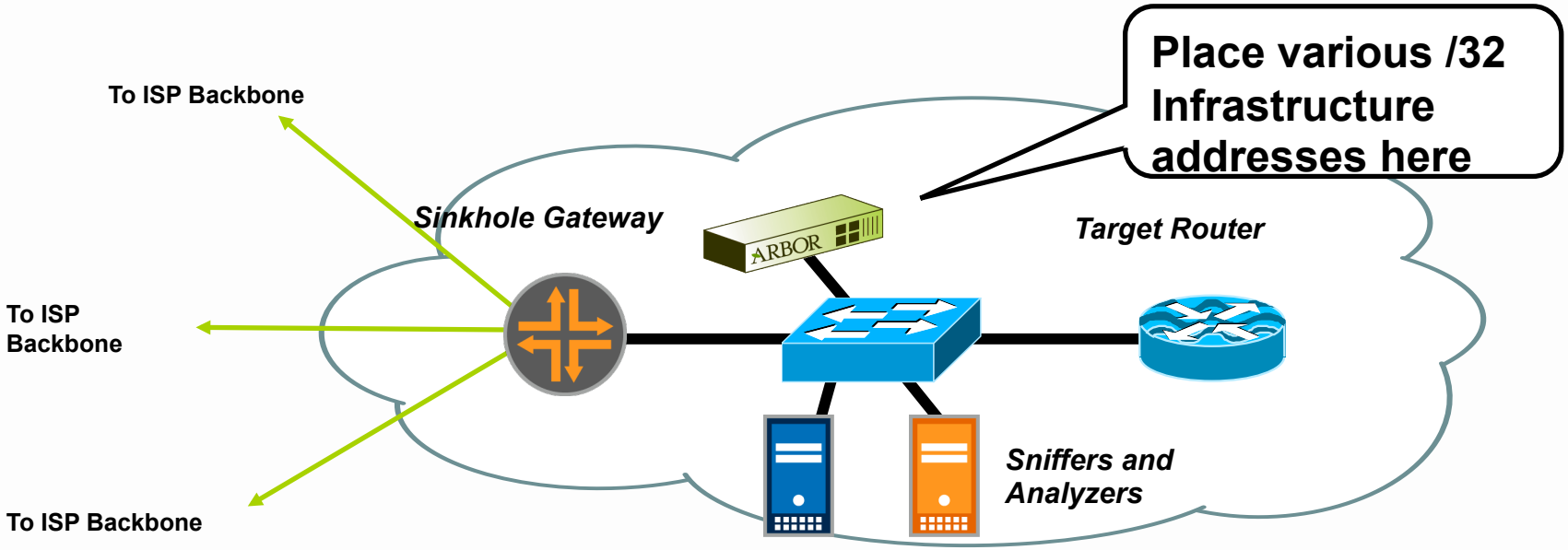
- Attackers use ranges of valid (allocated blocks) and invalid (bogon, martian, and RFC1918 blocks) spoofed IP addresses.
- Extremely helpful to know the spoof ranges.
- Set up a classification filter on source addresses.

Monitoring Spoof Ranges

Example: Jeff Null's [jnull@truerouting.com] Test

```
Extended IP access list 120 (Compiled)
    permit tcp any any established (243252113 matches)
    deny ip 0.0.0.0 1.255.255.255 any (825328 matches)
    deny ip 2.0.0.0 0.255.255.255 any (413487 matches)
    deny ip 5.0.0.0 0.255.255.255 any (410496 matches)
    deny ip 7.0.0.0 0.255.255.255 any (413621 matches)
    deny ip 10.0.0.0 0.255.255.255 any (1524547 matches)
    deny ip 23.0.0.0 0.255.255.255 any (411623 matches)
    deny ip 27.0.0.0 0.255.255.255 any (414992 matches)
    deny ip 31.0.0.0 0.255.255.255 any (409379 matches)
    deny ip 36.0.0.0 1.255.255.255 any (822904 matches)
    .
    .
    permit ip any any (600152250 matches)
```

Monitoring Spoof Ranges



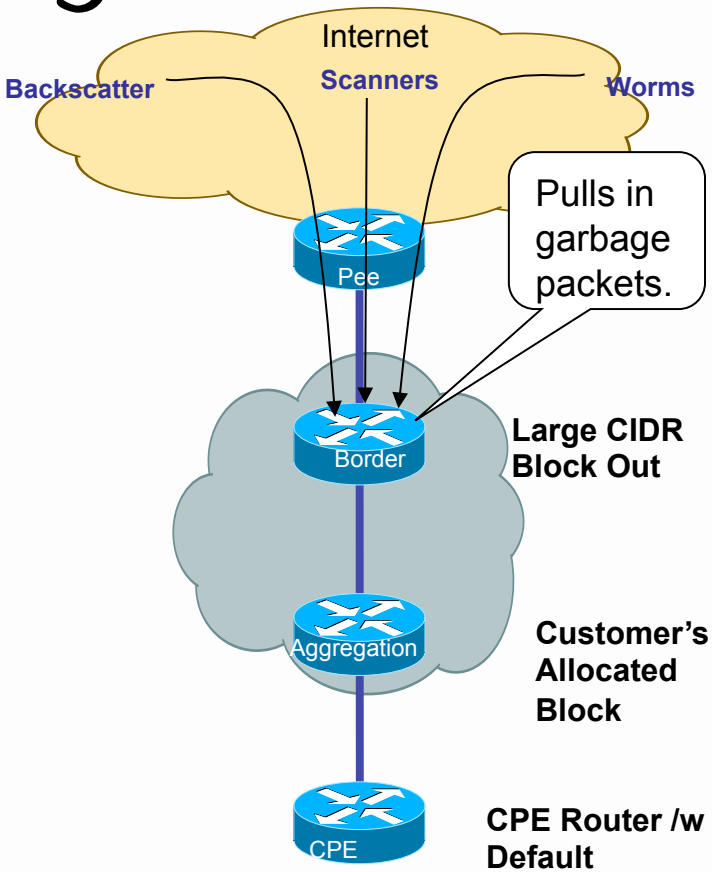
- Select /32 address from different block of your address space. Advertise them out the Sinkhole
- Assign them to a workstation built to monitor and log scans.
- Home grown and commercial tools available to monitor scan rates (Arbor Network's *Dark IP* Application is one turn key commercial tool that can monitor scan rates.)

Safety Precautions

- Do not allow bogons to leak:
  - BGP "NO_EXPORT" community
  - Explicit Egress Prefix Policies (community, prefix, etc.)
- Do not allow traffic to escape the sinkhole:
  - Backscatter from a Sinkhole defeats the function of a *Sinkhole (egress ACL on the Sinkhole router)*

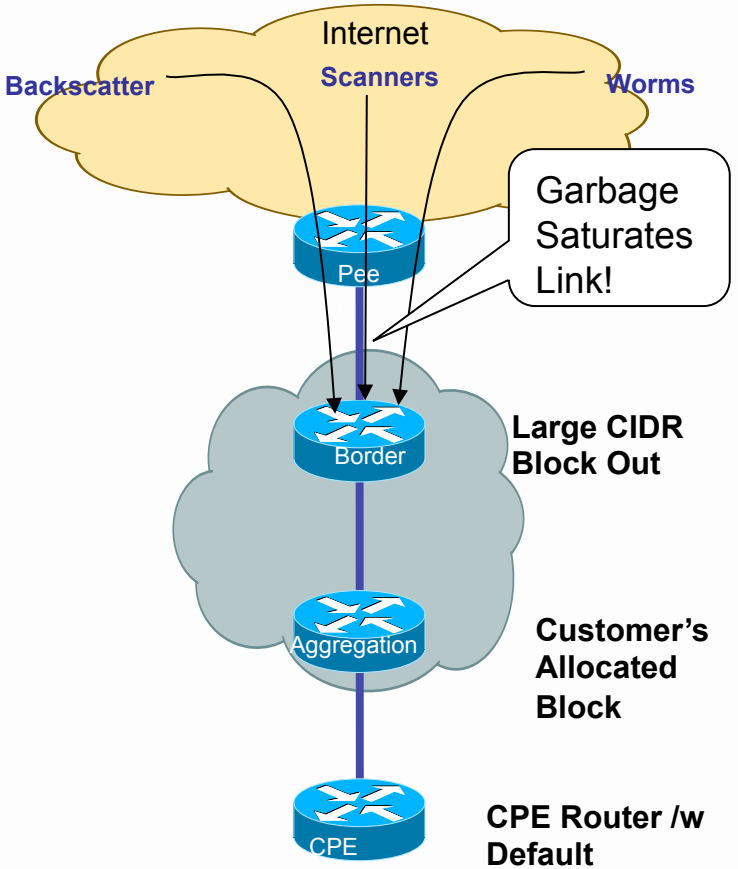
Simple Sinkholes - Internet Facing

- BCP is to advertise the whole allocated CIDR block out to the Internet.
- Left over unallocated Dark IP space gets pulled into the advertising router.
- The advertising router becomes a Sinkhole for garbage packets.



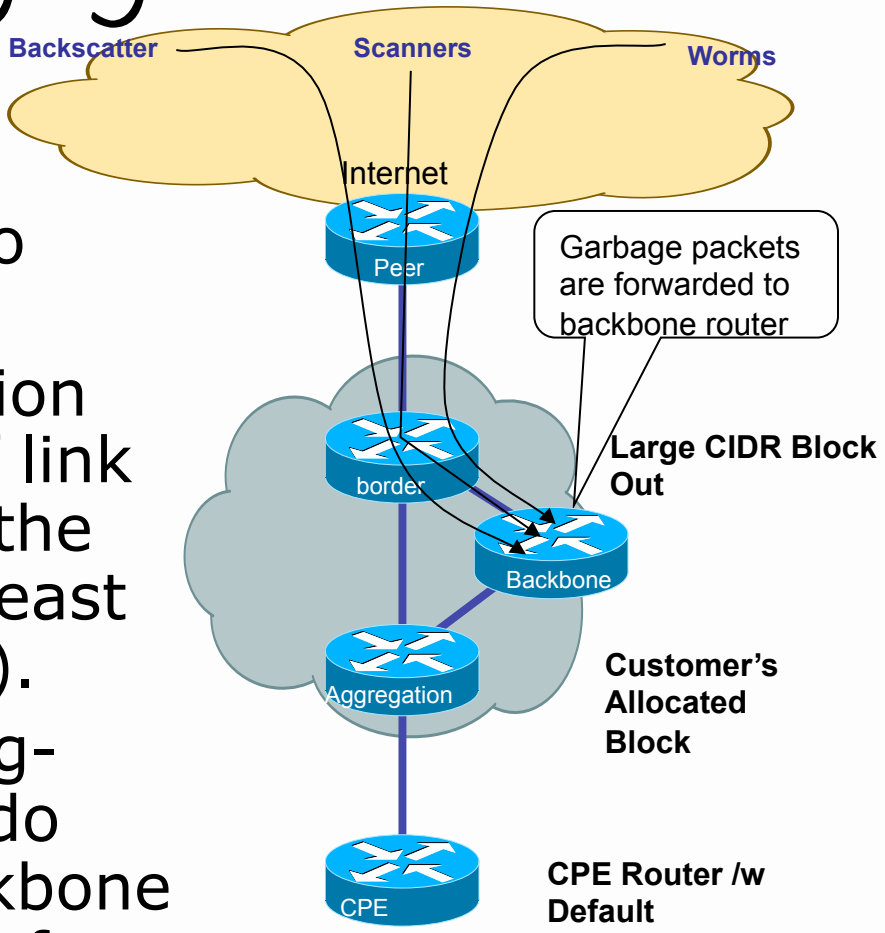
ASIC Drops at Line Rate?

- Forwarding/Feature ASICs will drop packets with no performance impact.
- Line Rate dropping will not solve the problem of garbage packets saturating the link.



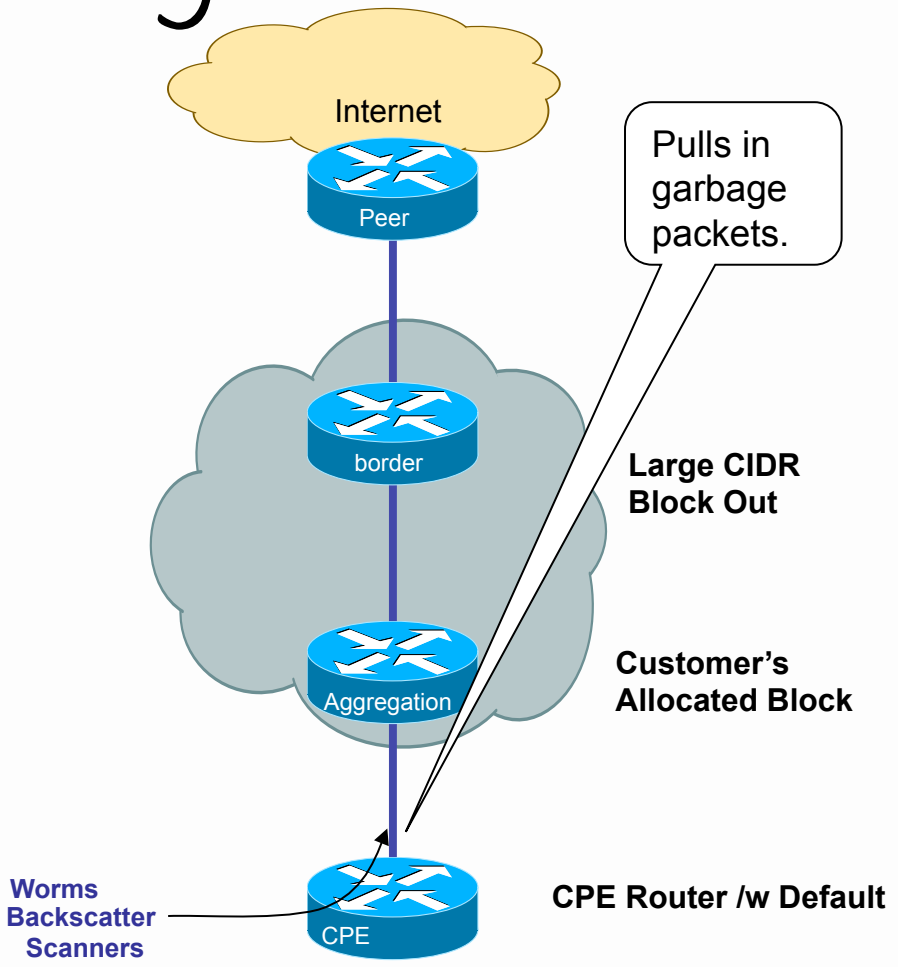
Backbone Router Injecting Aggregates

- Some ISPs use the Backbone/core routers to inject their aggregates.
- Multiple Backbone injection points alleviate issues of link saturation, but exposes the loopback addresses (at least the way it is done today).
- In a world of multiple Gig-Bots and Turbo worms, do you really want you backbone routers playing the role of garbage collectors?



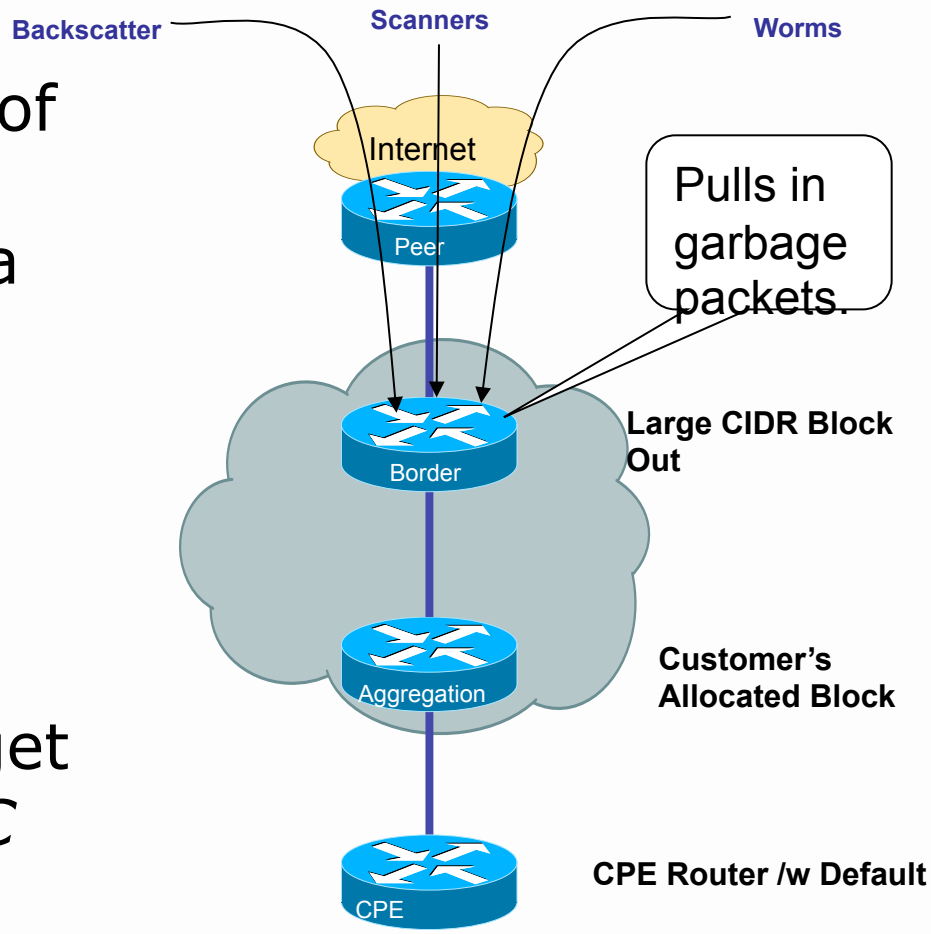
Simple Sinkholes - Customer Facing

- Defaults on CPE devices pull in everything.
- Default is the ultimate packet vacuum cleaner
- Danger to links during times of security duress.

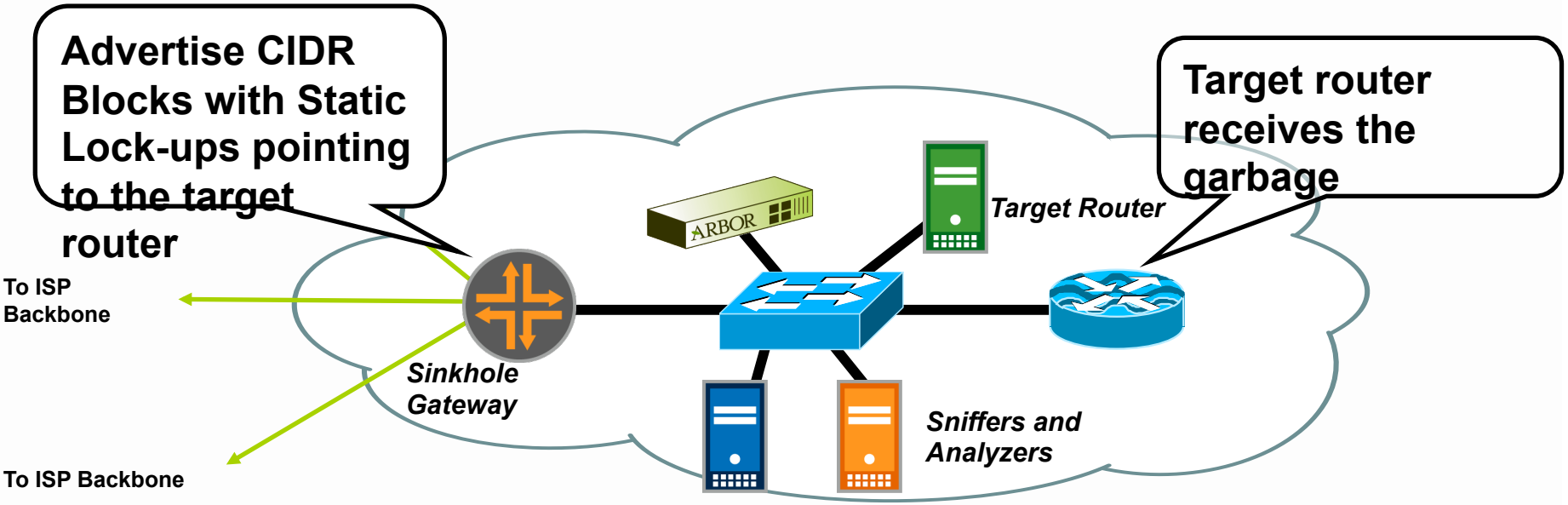


Simple Sinkholes - Impact Today

- In the past, this issue of pulling down garbage packets has not been a big deal.
- GigBots and Turbo Worms change everything
- Even ASIC-based forwarding platforms get impacted from the *RFC 1812 overhead.*

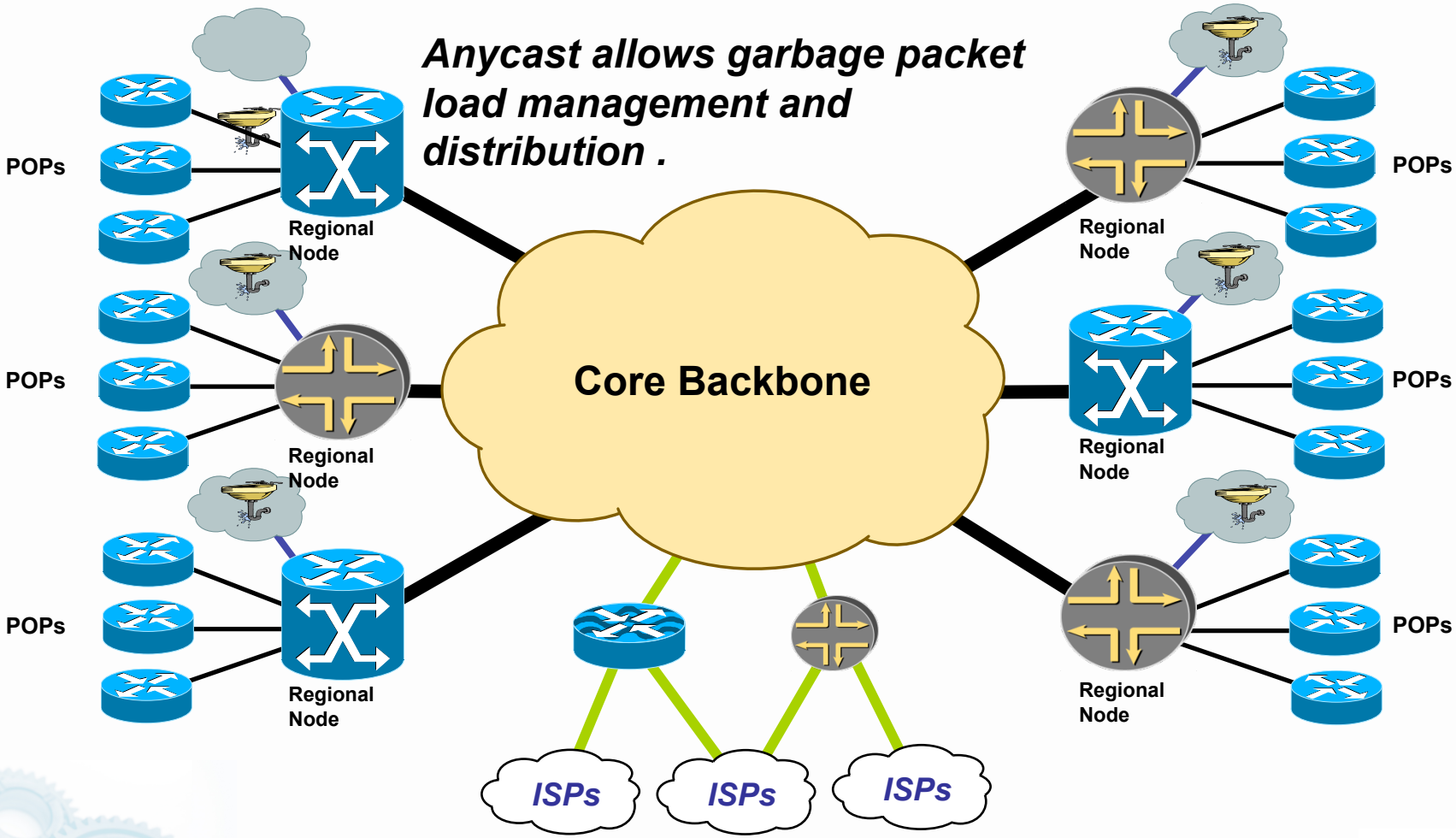


Sinkholes – Advertising Dark IP

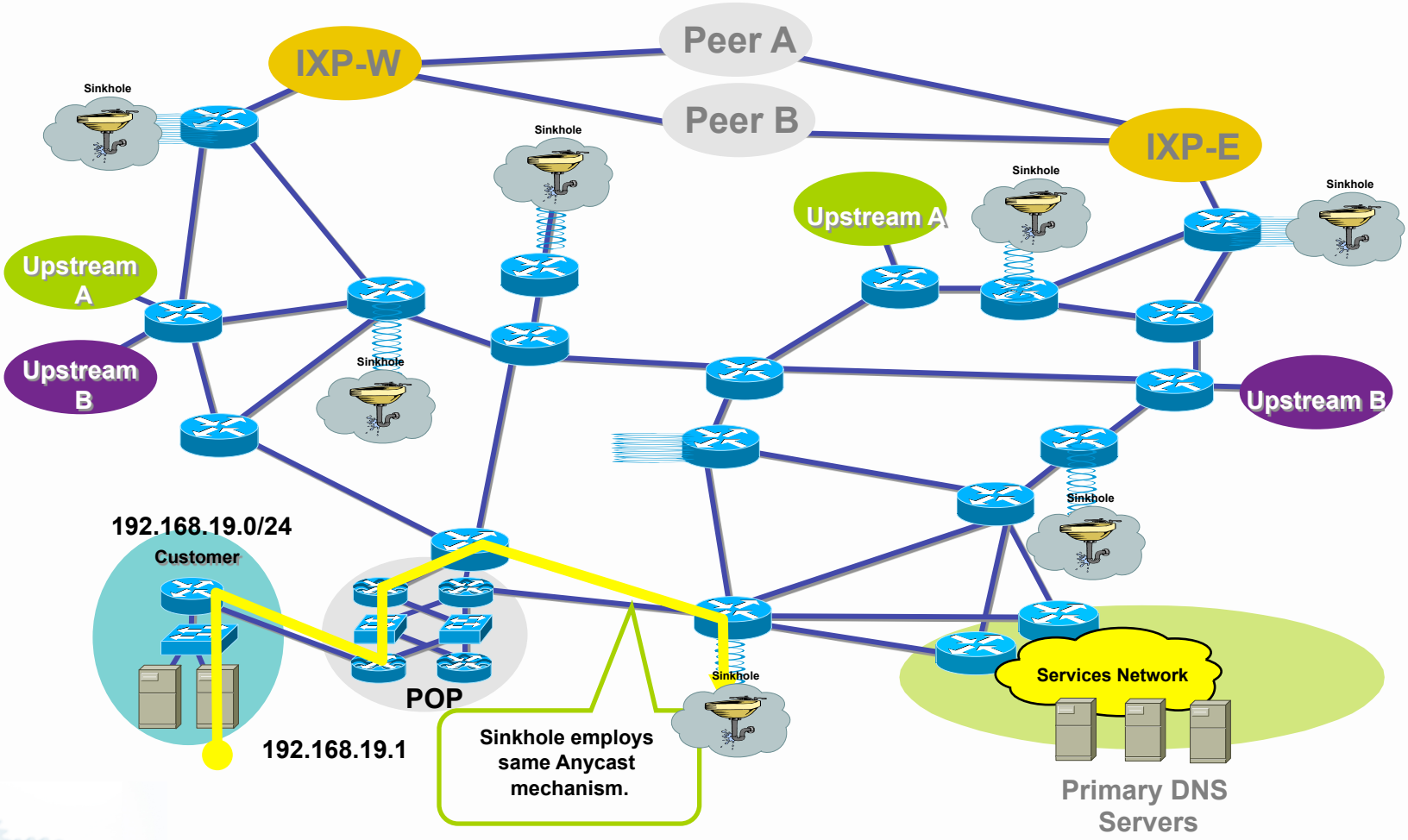


- Move the CIDR Block Advertisements (or at least more-specifics of those advertisements) to Sinkholes.
- Does not impact BGP routing – route origination can happen anywhere in the iBGP mesh (careful about MEDs and aggregates).
- Control where you drop the packet.
- Turns networks inherent behaviors into a security tool!

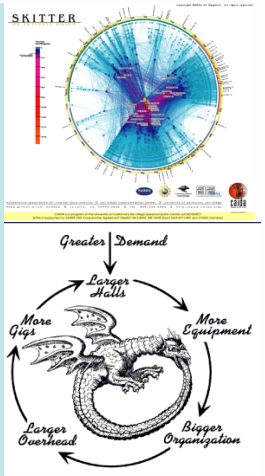
Anycast Sinkholes to Scale

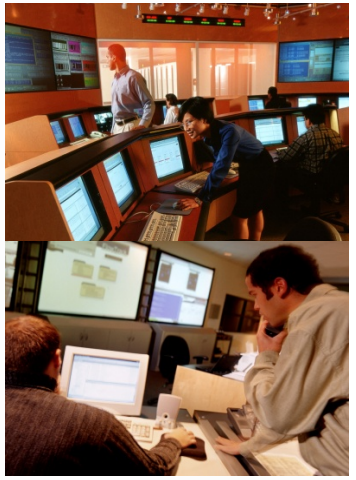


Anycast Sinkholes



Source Address Validation





BCP 38 Ingress Packet Filtering

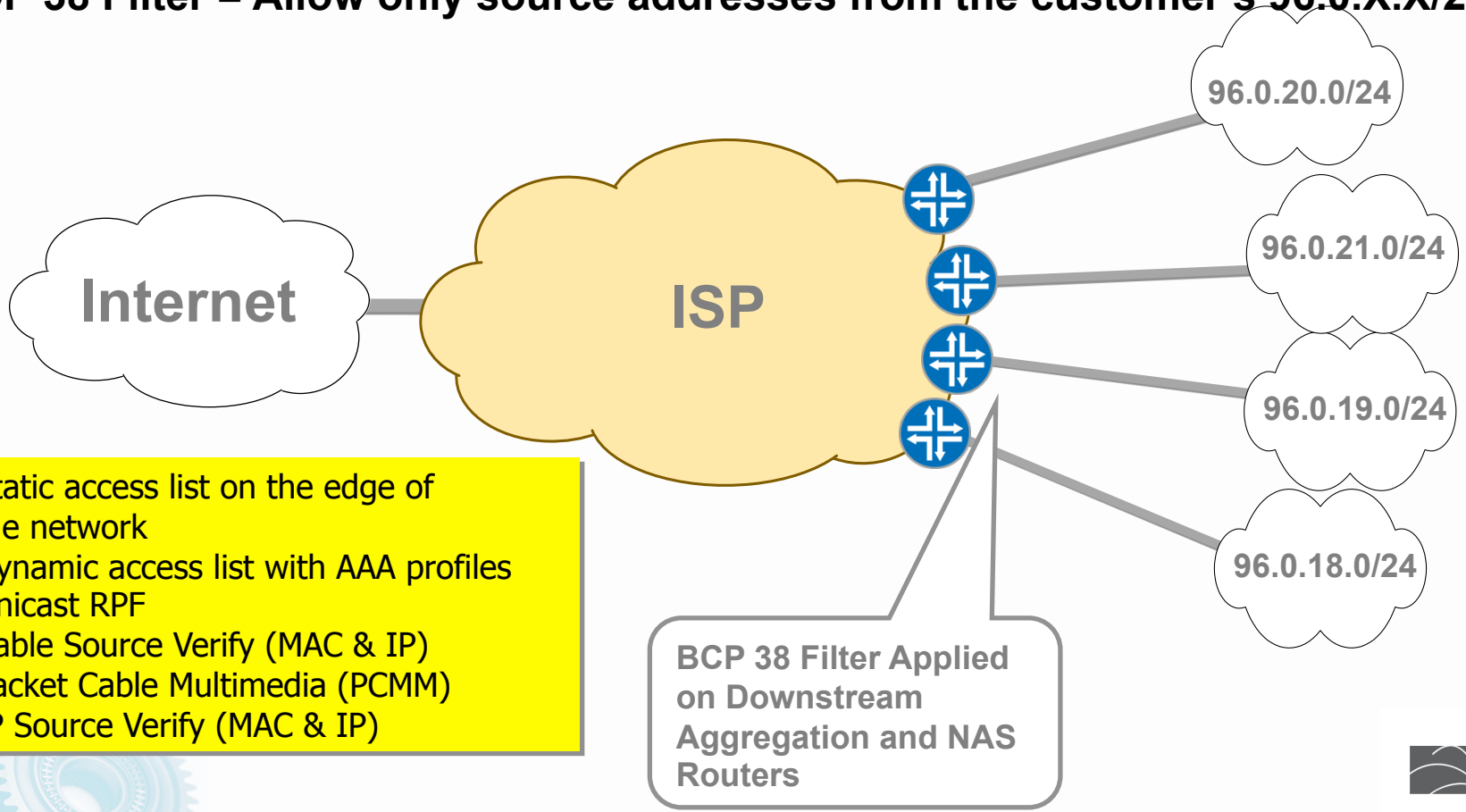
Your customers should not be sending any IP packets out to the Internet with a source address other then the address you have allocated to them!

BCP 38 Ingress Packet Filtering

- BCP 38/ RFC 2827
- Title: Network Ingress Filtering: Defeating Denial of Service Attacks which Employ IP Source Address Spoofing
- Author(s): P. Ferguson, D. Senie

BCP 38 Ingress Packet Filtering

ISP's Customer Allocation Block: 96.0.0.0/19
BCP 38 Filter = Allow only source addresses from the customer's 96.0.X.X/24



- Static access list on the edge of the network
- Dynamic access list with AAA profiles
- Unicast RPF
- Cable Source Verify (MAC & IP)
- Packet Cable Multimedia (PCMM)
- IP Source Verify (MAC & IP)

BCP 38 Packet Filtering: Principles

- Filter as close to the edge as possible
- Filter as precisely as possible
- Filter both source and destination where possible

Many Working Techniques

- Static access list on the edge of the network
- Dynamic access list with AAA profiles
- Unicast RPF
- Cable Source Verify (MAC & IP)
- Packet Cable Multimedia (PCMM)
- IP Source Verify (MAC & IP)

Source Address Validation Works

- Successful SPs have extremely conservative engineering practices.
- Operational Confidence in the equipment, functionality, and features are a prerequisite to any new configs on a router.
- The core reason why SPs have not been turning on Source Address Validation is their lack of *Operational Confidence.*

One Major ISP's Example – uRPF

- Month 1 – Cisco Lab Test and Education to help the customer gain confidence in uRPF.
- Month 2 – One port on one router – turning uRPF Strict Mode on a 16xOC3 Engine 2 LC (Cisco 12000)
- Month 3 – One LC on one router – 16xOC3.
- Month 4 – One router all customer facing LCs
- Month 5 – One POP – all customer facing LCs
- Month 6 – Several routers through out the network (other POPs)
- Month 7 – Adopted as standard config for all new customer circuits. Will migrate older customer over time.

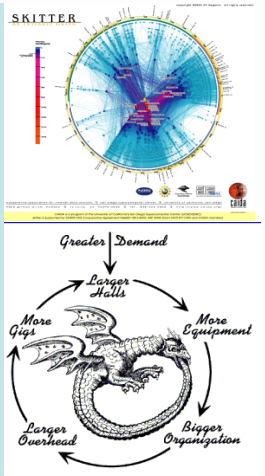
One Major ISP's Example – uRPF

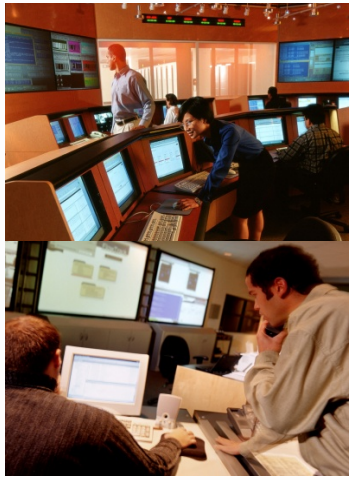
- Lessons Learned:
  - It took time and patience.
  - uRPF did not work for all customers. That is OK, uRPF is not suppose to be a *universal solution.*
  - Going slow and steady allowed the operations team to *gain a feel* of the feature's performance envelope --- with out putting the network at risk.
- It works! A year later it is a standard config with over 40K ports running uRPF Strict or Loose Mode.

What can you do to help?

- Cut the excuses! BCP 38 is an operational reality!
- Walk them through source address validation techniques, see which ones will work for you, and do not expect more than a 80% success rate.
- Find ways to gain operational confidence in the BCP 38 techniques.
- Source Address validation works – it just take patience and persistence.

Control Plane Protection





BGP Attack Vectors

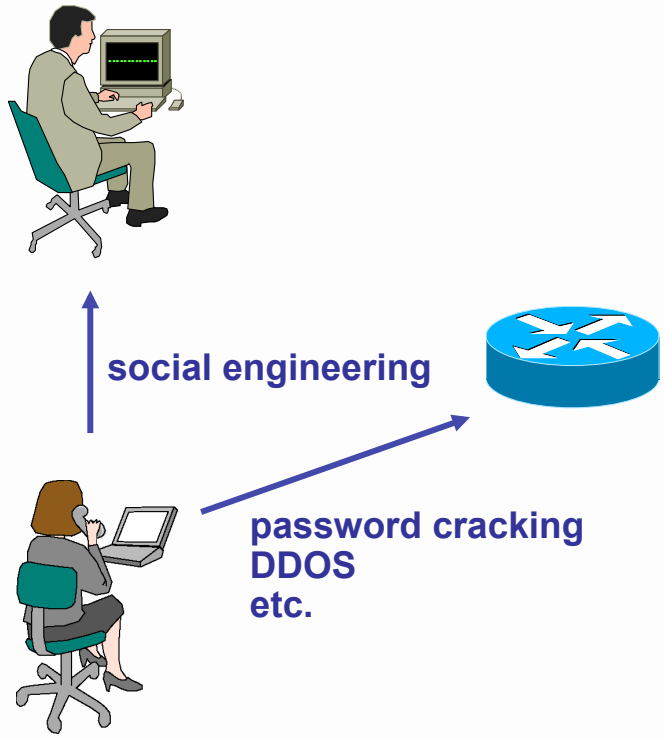
- Understanding BGP Attack Vectors will help you plan and prioritize the techniques deployed to build greater resistance into the system.
- The following documents will help you gain perspective on the realistic Risk Assessment:
  - NANOG 25 - BGP Security Update
    - http://www.nanog.org/mtg-0206/barry.html
  - NANOG 28 - BGP Vulnerability Testing: Separating Fact from FUD
    - http://www.nanog.org/mtg-0306/franz.html
- Look for the *updates* links to get the latest risk assessments.
  - http://www.cisco.com/security_services/ciag/initiatives/research/projectsummary.html

Whacking the BGP Session

- Four Macro Ways you can Whack the BGP Session:
  - Saturate the Receive Path Queues: BGP times out
  - Saturate the link: link protocols time out
  - Drop the TCP session
  - Drop the IGP causing a recursive loop up failure

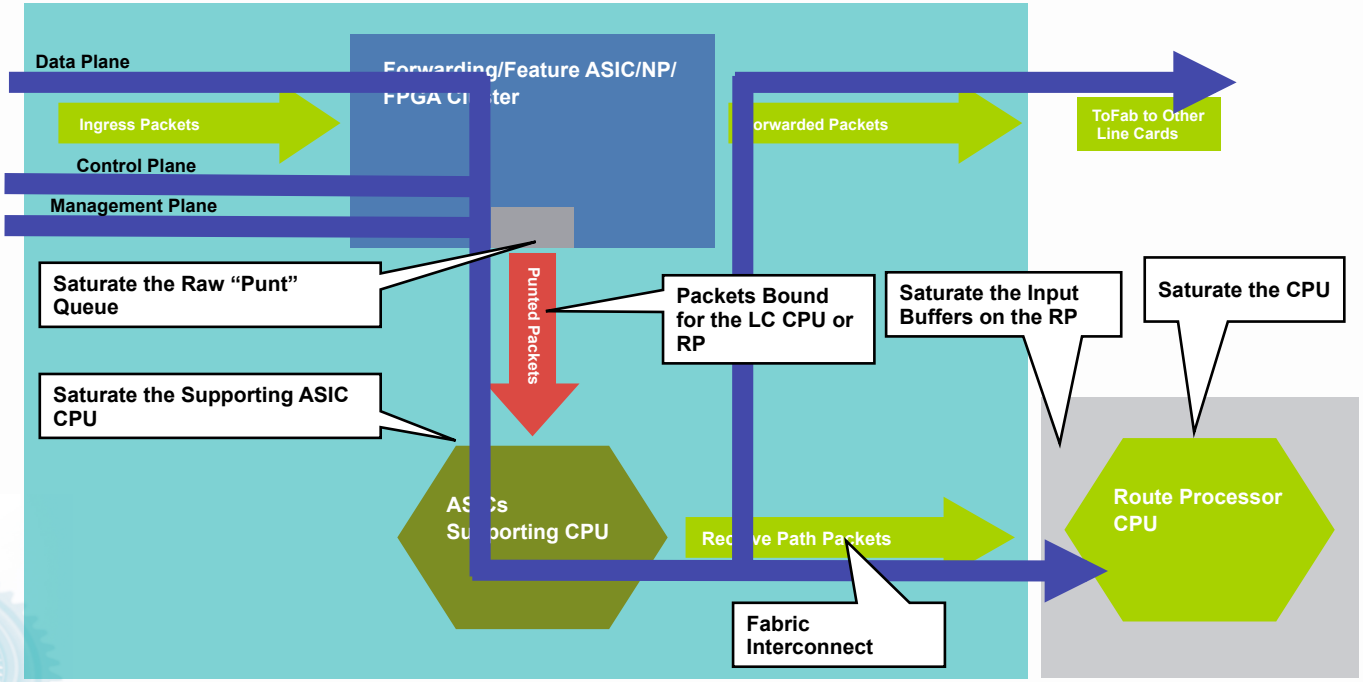
Attacking Routing Devices

- All the normal host attack methods apply to routers
  - Social engineering
  - Password cracking
  - Denial of service
  - etc.
- What an attacker needs:
  - Access to the router
  - *(or)*
  - Access to the network



Saturate the Receive Path Queues

- Routers usually have various *receive path* queues that are hit as the packet heads for the TCP Stack.
- Saturation Attacks fill these queues – knocking out valid packets from the queues.
- Consequence: BGP Times out – Dropping the BGP Session



Saturate the Link

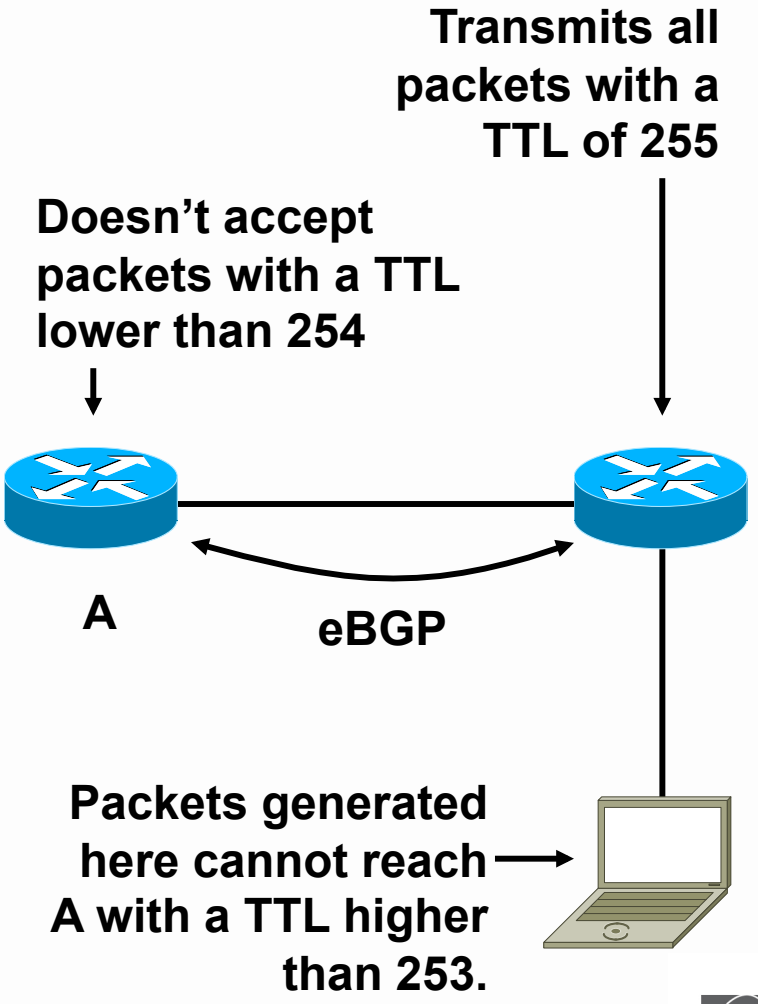
- DOS Attacks Saturating the link will knock out valid control plane packets.
- Link packet over POS, ATM, or Ethernet will drop out – which drop out the link – which drop out the FIB's next hop – which knocks out the BGP Entries
- This is a very effective brute force attack.

Drop the TCP Session

- Dropping the TCP Session was thought to require a breath of packets.
- TCP Session can be dropped with a RST or a SYN (per RFC).
- Successful L4 Spoof is required
  - Match source address
  - Match source port
  - Match destination address (obvious)
  - Match destination port
  - Match Sequence Number (now just get inside the window)

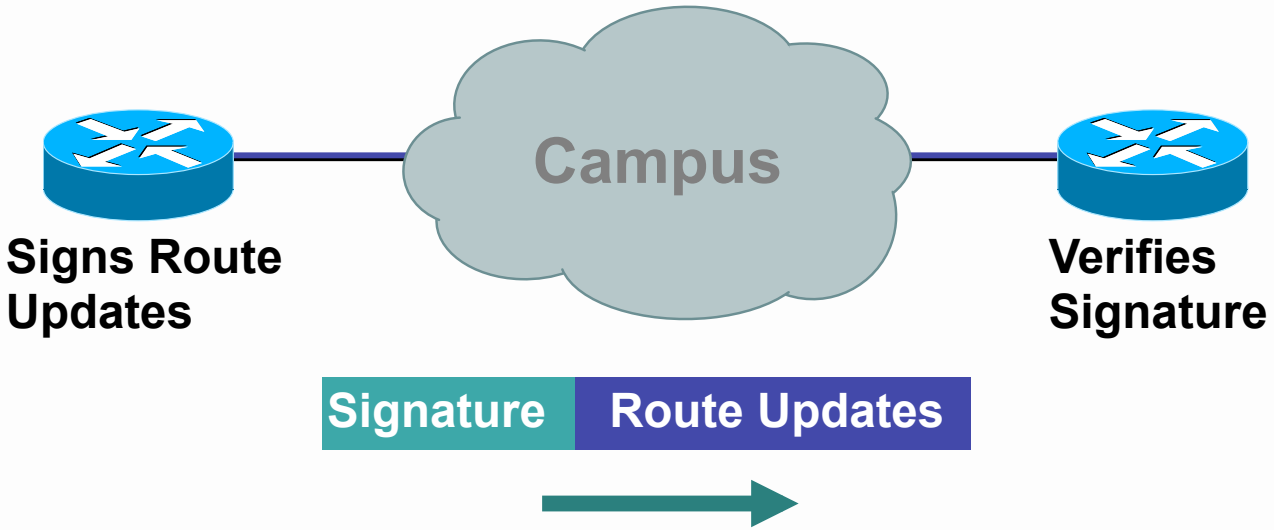
Generalized TTL Security Mechanism

- GTSH is a hack which protects the BGP peers from multihop attacks.
- Routers are configured to transmit their packets with a TTL of 255, and to reject all packets with a TTL lower than 254 or 253.
- A device which isn't connected between the routers cannot generate packets which will be accepted by either one of them.



Secure Routing - Route Authentication

Configure Routing Authentication



Certifies Authenticity of Neighbor and Integrity of Route Updates

Peer Authentication

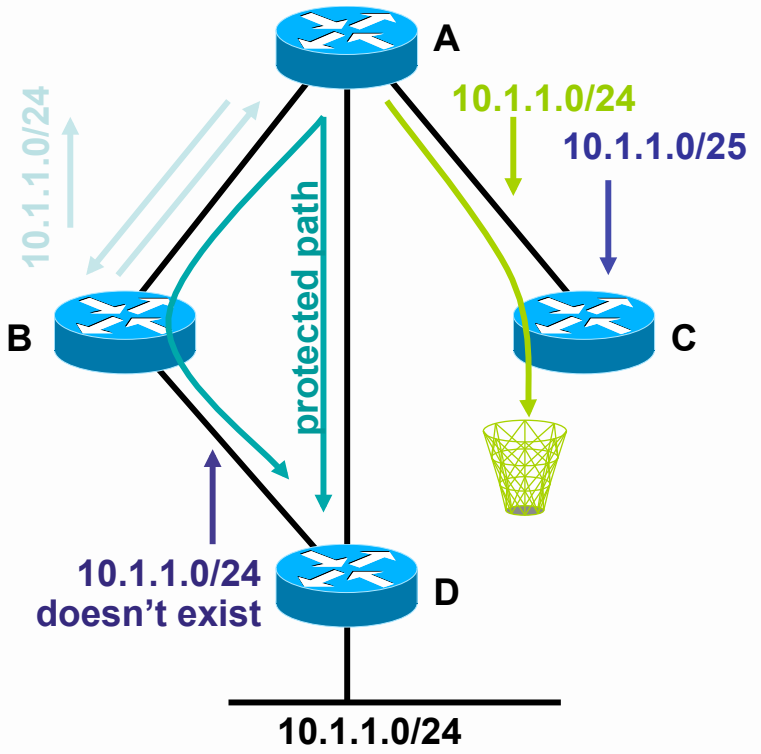
- MD5 Peer authentication can protect against:
  - Malformed packets tearing down a peering session
  - Unauthorized devices transmitting routing information
- MD5 Peer authentication cannot protect against:
  - Reset routing protocol sessions due to denial of service attacks
  - Incorrect routing information being injected by a valid device which has been compromised

Drop the IGP

- Miscreant Success Principle - If you cannot take out the target, move the attack to a coupled dependency of the target.
- BGP's coupled dependency is the IGP it requires for recursive look-up.
- EIGRP and OSPF are both open to external attacks.

Attacking Routing Data

- How could you attack routing data?
- Modification
  - Direct traffic along an unprotected path
  - Direct traffic into a black hole
  - Create a routing loop
- Overclaiming
  - Injecting nonexistant destinations
  - *A longer prefix!*
- Underclaiming
  - Removing destinations



Pakistan and YouTube

February 24, 2008 12:17 PM PST

YouTube blames Pakistan outage

Posted by Greg Sandoval

Updated, 9:40 p.m. to add YouTube's explanation outage.

YouTube suffered a two-hour long, system-wide ou
the company said was triggered by a network bas

Pakistan Blocks YouTube Video Access

SADAQAT JAN | February 24, 2008 09:04 AM EST | AP

Read More: Pakistan, Pakistan Blocks Youtube, Pakistan Elections, Pakistan Youtube, Pervez Musharraf, Youtube, Youtube Pakistan Anti-Islamic Movies, Breaking Politics News

Email ▸
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Comments ▸

Buzz up! on Yahoo!

ISLAMABAD, Pakistan — Pakistan's government has banned access to the video-sharing Web site YouTube because of anti-Islamic movies that users have posted on the site, an official said Sunday.

The Pakistan Telecommunication Authority told the country's 70 Internet service providers Friday that the popular Web site would be blocked until further notice.

The authority did not specify what the offensive material was, but a PTA

http://www.ripe.net/news/study-youtube-hijacking.html

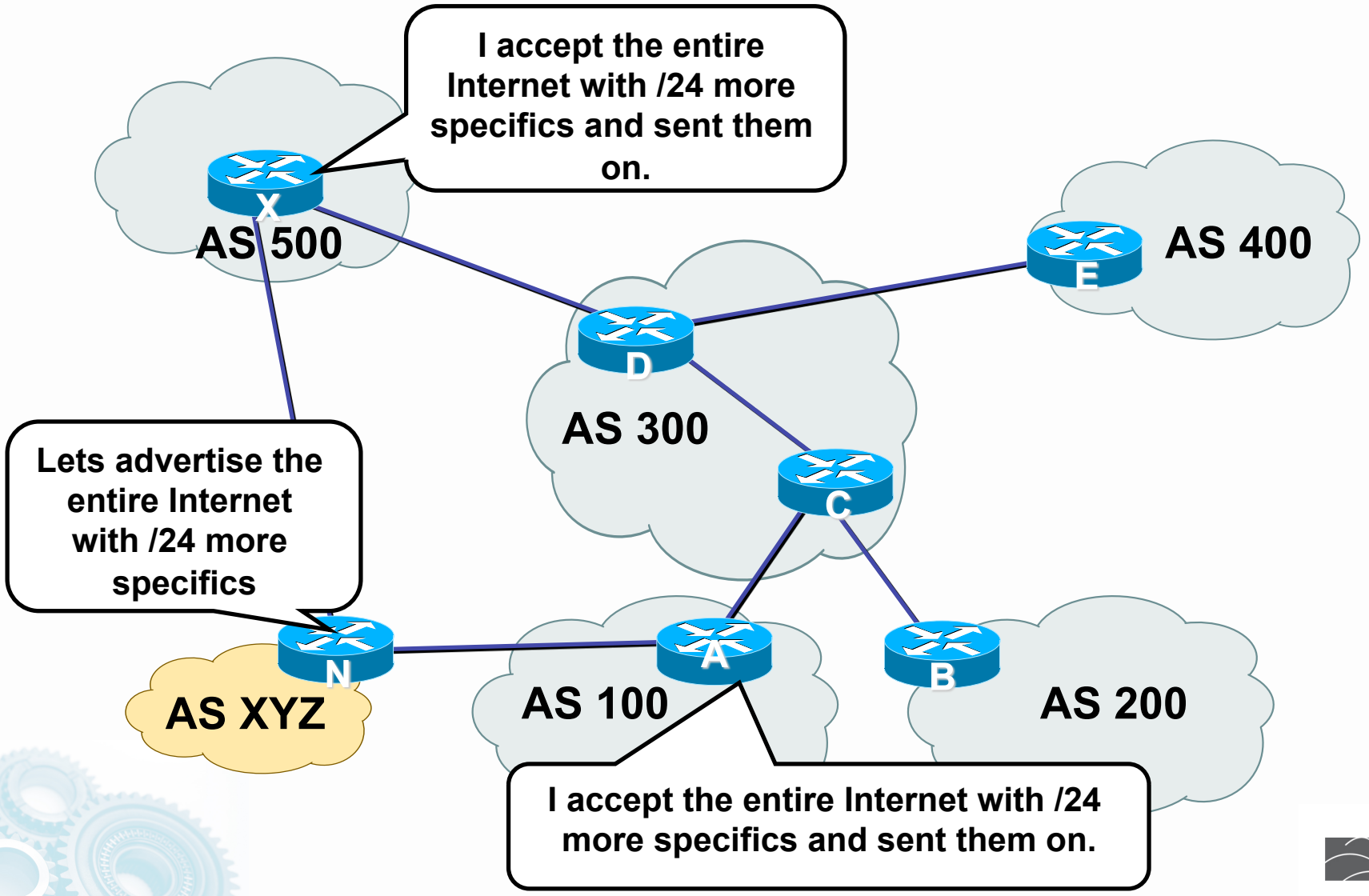
Malicious Route Injection
Perceive Threat

- Bad Routing Information does leak out. This has been from mistakes, failures, bugs, and intentional.
- Intruders are beginning to understand that privileged access to a router means route tables can be altered
- CERT/CC is aware of a small number of incidents involving malicious use of routing information.
- Perceived Threat is that this will be a growth area for attackers.

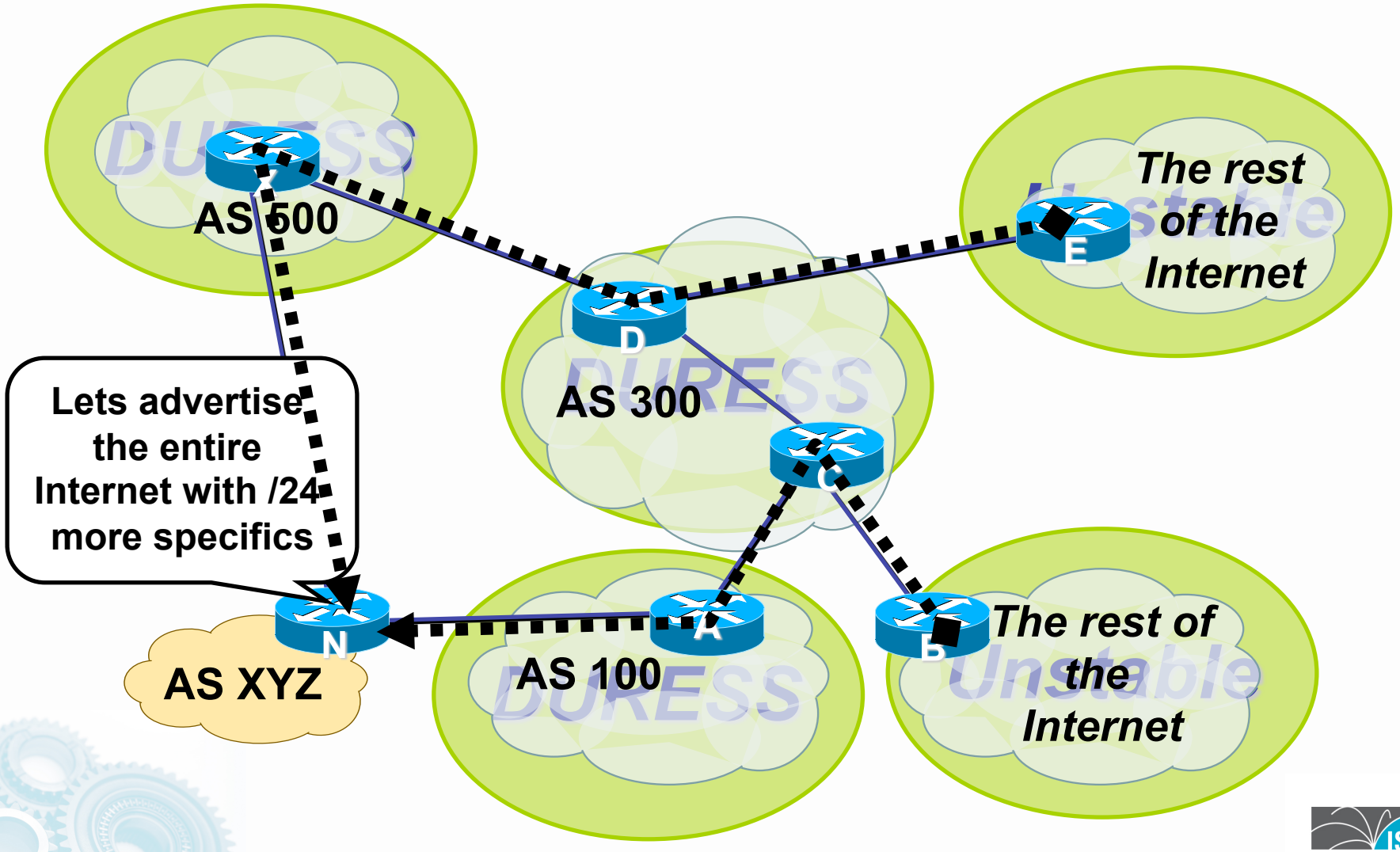
Malicious Route Injection Reality – an Example

- AS 7007 incident used as an attack.
- Multihomed CPE router is violated and used to "de-aggregate" large blocks of the Internet.
- Evidence collected by several CERTs that hundreds of CPEs are violated.

Garbage in – Garbage Out: What is it?

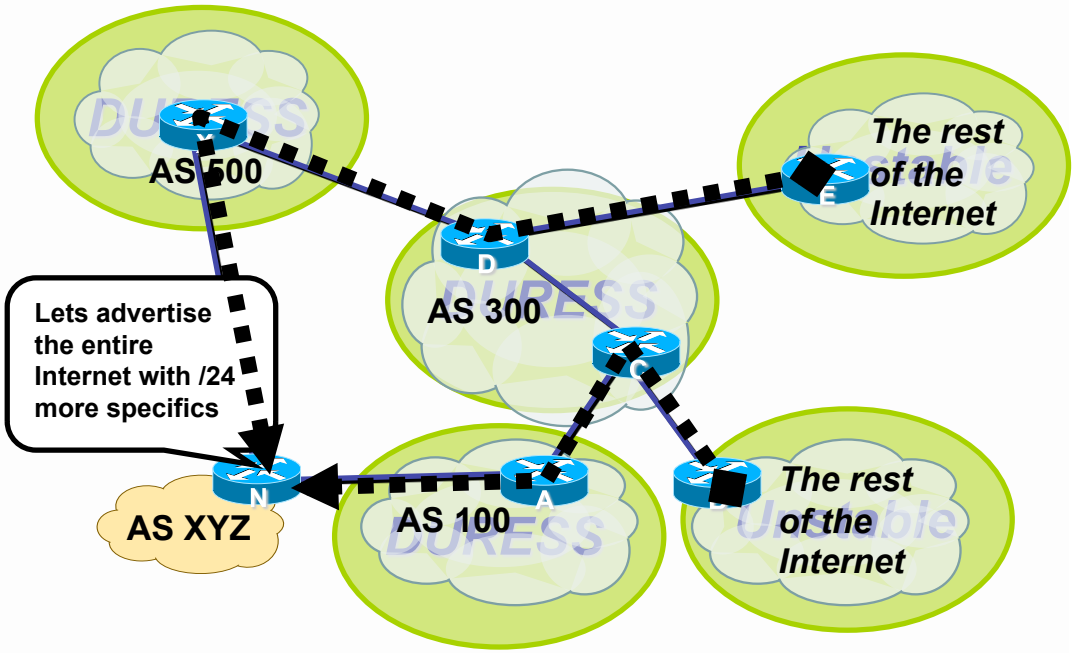


Garbage in - Garbage Out: Results



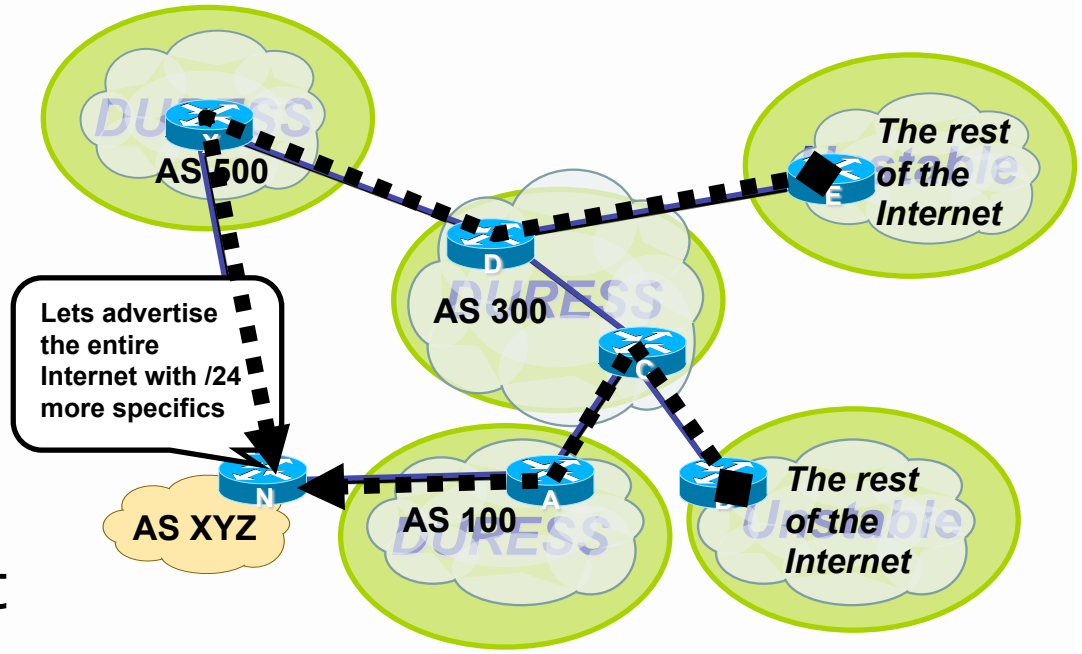
Garbage in – Garbage Out: Impact

- Garbage in – Garbage out does happen on the Net
- AS 7007 Incident (1997) was the most visible case of this problem.
- Key damage are to those ISPs who pass on the garbage.
- Disruption, Duress, and Instability has been an Internet wide effect of Garbage in – Garbage out.



Garbage in – Garbage Out: What to do?

- Take care of your own Network.
  - Filter your customers
  - Filter you advertisements
- Net Police Filtering
  - Mitigate the impact when it happens
- Prefix Filtering and Max Prefix Limits



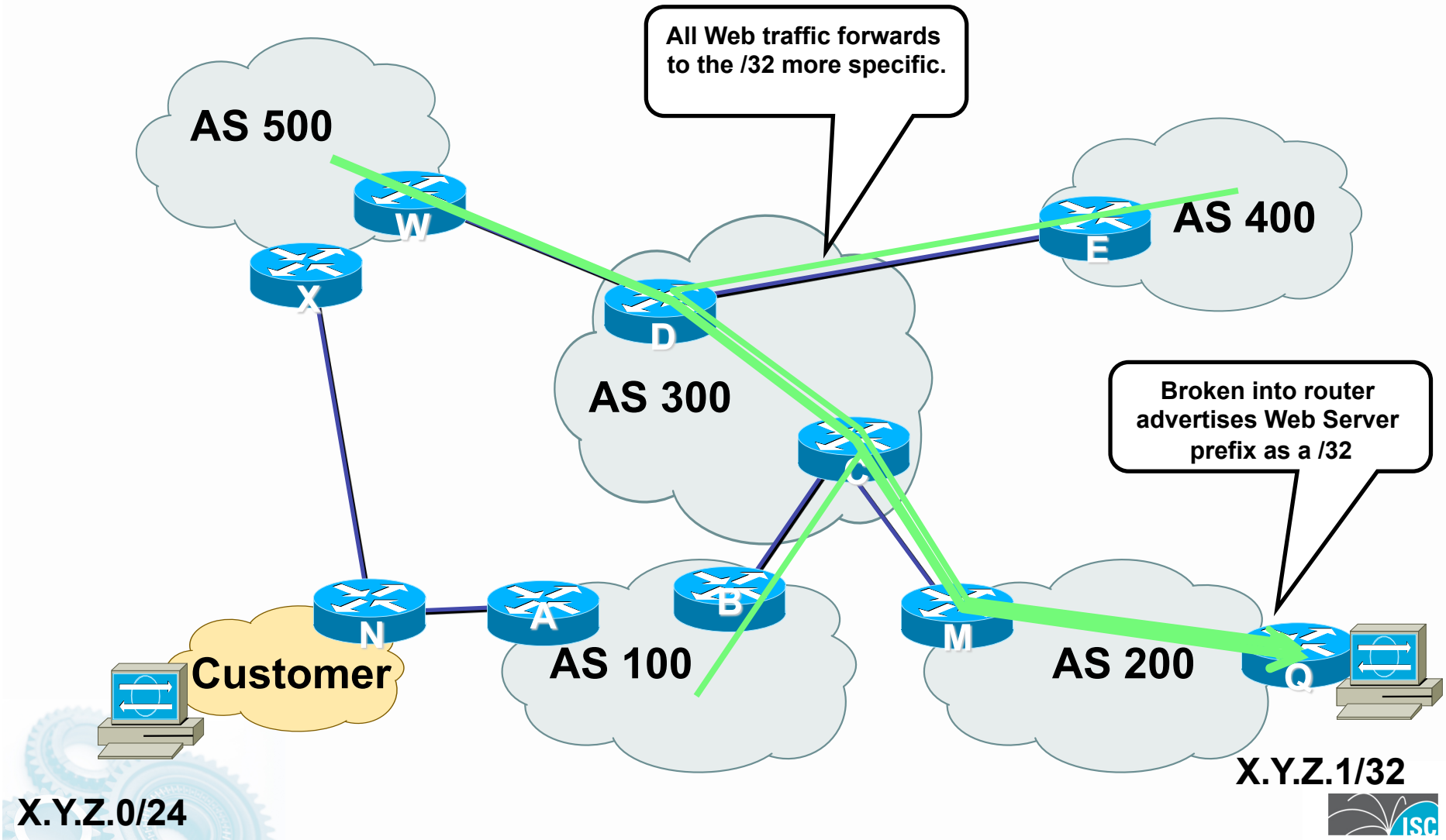
Malicious Route Injection Attack Methods

- Good News – Risk is mainly to BGP speaking Routers.
- Bad News – Multihomed BGP Speaking customers are increasing!
- Really Bad News – Many of these routers have no passwords!
- Local layer 3 configuration alteration on compromised router
- Intra-AS propagation of bad routing information
- Inter-AS propagation of bad routing information

Malicious Route Injection Impact

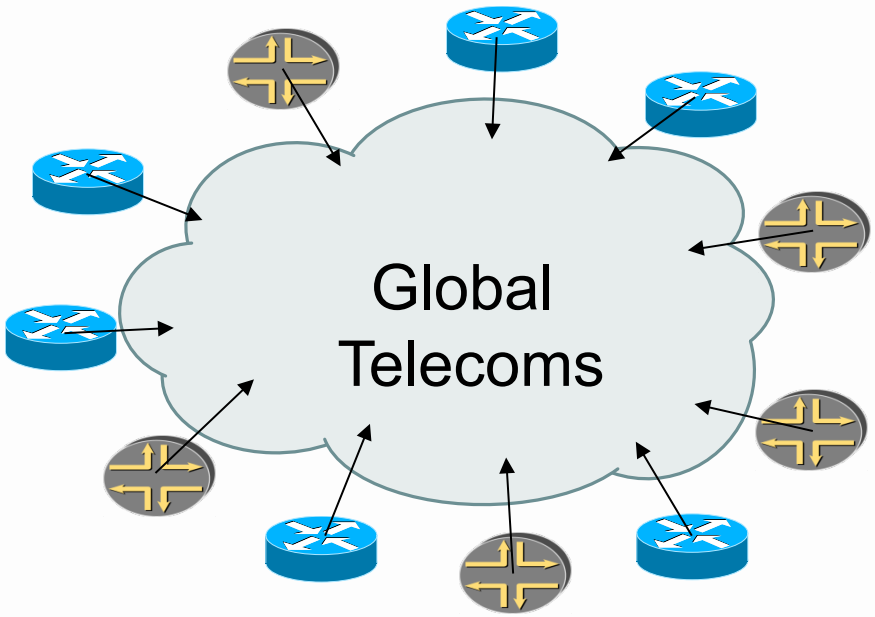
- Denial-Of-Service to Customer(s), ISP(s), and the Internet.
- Traffic Redirection / Interception
- Prefix Hijacking
- AS Hijacking

What is a prefix hijack?



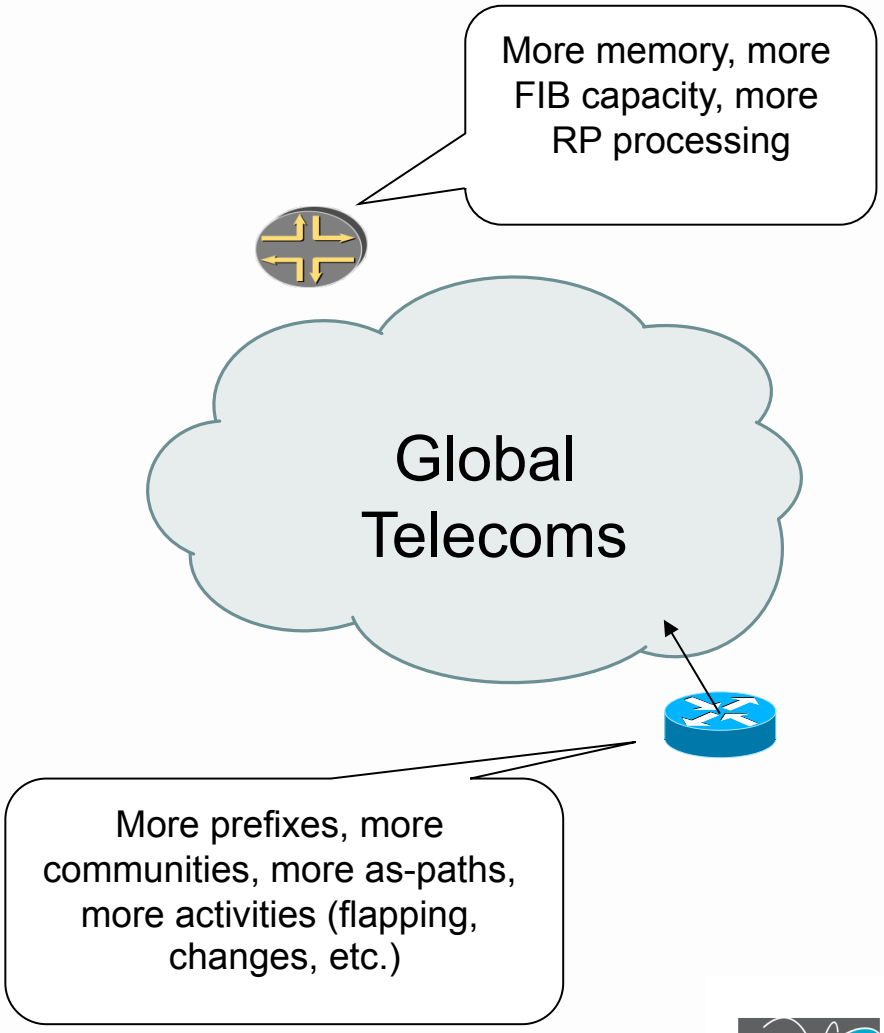
What could be worse?

- The Miscreant Economy Trades violated "BGP Speaking" routers. Get 20 in different parts of the Internet.
- Take each, pick your targets, and start disaggregating.



Why?

- Today's (and tomorrow's) NGN will is different from the past
- A business on one side of the planet will force you into OPEX and CAPEX expenditure!



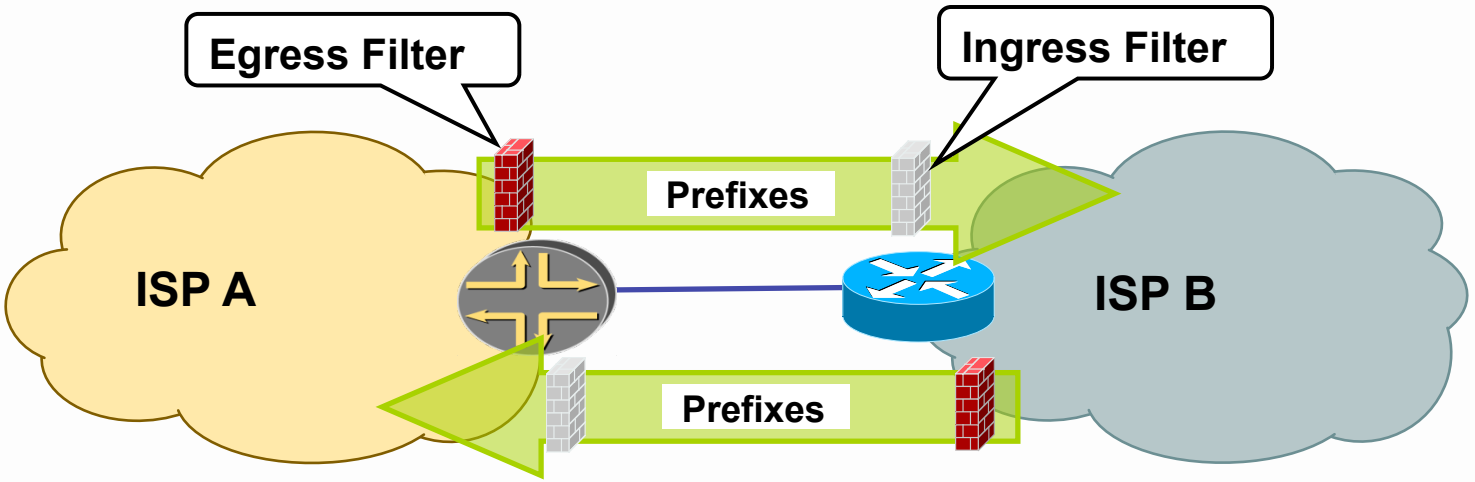
Malicious Route Injection What can ISPs Do?

- Customer Ingress Prefix Filtering!
- ISPs should only accept customer prefixes which have been assigned or allocated to their downstream customers.
- For example
  - Downstream customer has 220.50.0.0/20 block.
  - Customer should only announce this to peers.
  - Upstream peers should only accept this prefix.

BGP Peering Fundamentals

- BGP Peering assumes that something could go wrong with the policy filters between the neighboring routers.
- Filters are all created to mutually reinforce each other. If one policy filter fails, the policy filter on the neighboring router will take over – providing redundancy to the policy filters.
- This mutually reinforcement concept used BGP peering filters are created are also called guarded trust, mutual suspicion, or Murphy Filtering.

Guarded Trust



- SP A trust SP B to send X prefixes from the Global Internet Route Table.
- SP B Creates a egress filter to insure only X prefixes are sent to SP A.
- SP A creates a mirror image ingress filter to insure SP B only sends X prefixes.
- SP A's ingress filter reinforces SP B's egress filter.

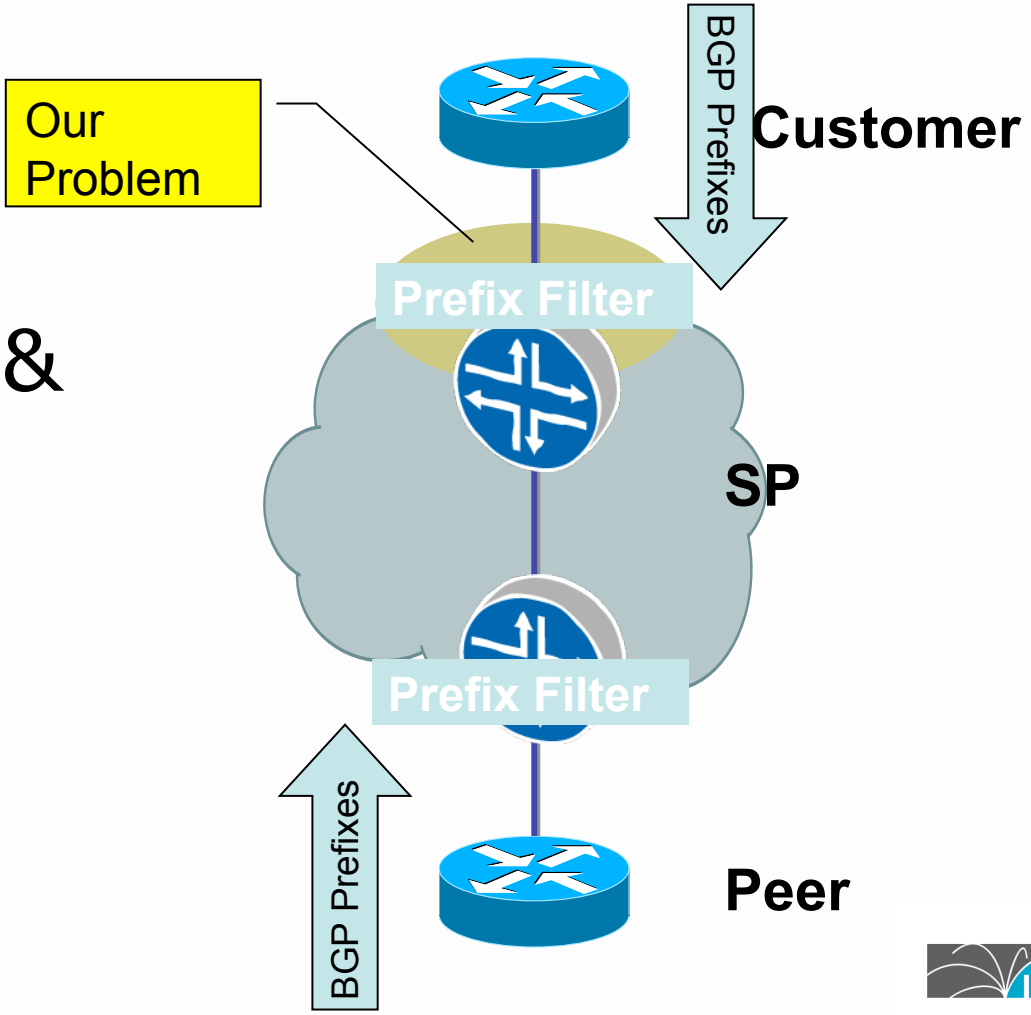
Malicious Route Injection
What can SPs Do?

- Know your network – What to filter, where to filter.
- Customer Ingress Prefix Filtering!
- SPs should only accept customer prefixes which have been assigned or allocated to their downstream customers.
- For example
  - Downstream customer has 220.50.0.0/20 block.
  - Customer should only announce this to peers.
  - Upstream peers should only accept this prefix.

Prefix Filters: In

Apply Prefix Filters to All eBGP Neighbors

- From Customers
- From Peers & Upstreams



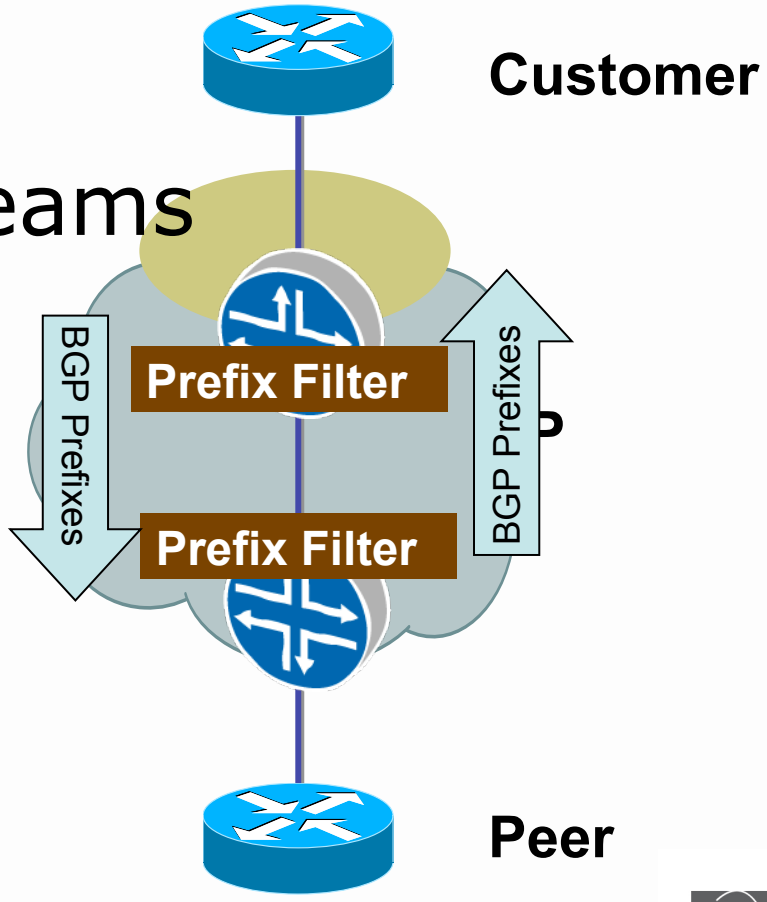
Malicious Route Injection What can ISPs Do?

- Containment Filters!
  - Design your network with the principles of of survivability.
  - Murphy's Law of Networking implies that the customer ingress prefix filter will fail.
  - Remember 70% to 80% of ISP problems are maintenance injected trouble (MIT).
  - Place Egress Prefix Filters on the Network to contain prefix leaks.

Prefix Filters: Out

Apply Prefix Filters to All eBGP Neighbors

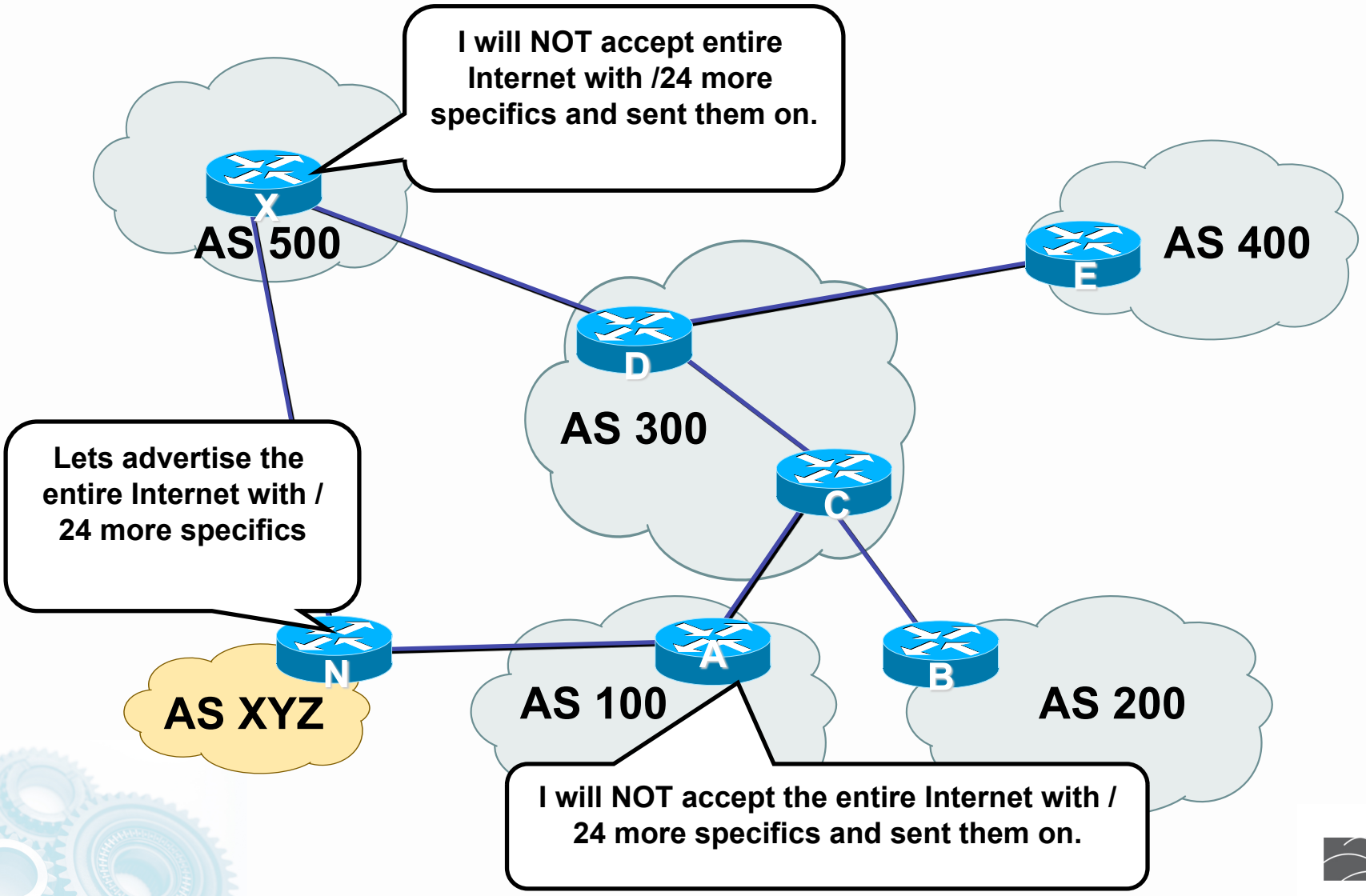
- To Customers
- To Peers & Upstreams



What can ISPs Do? Containment Egress Prefix Filters

- What about all my multihomed customers with prefixes from other ISPs?
- Add them to the customer ingress prefix filter.
  - You should know what you will accept.
- Add them to the master egress prefix-filter.
  - You should know what you're advertising to everyone else.
  - *Bigness* is not an excuse.

Containment Filters



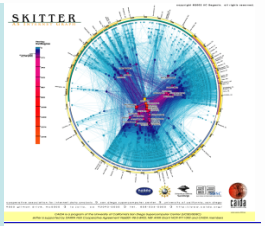
Malicious Route Injection
What can ISPs Do?

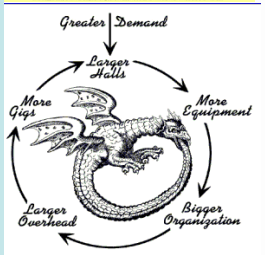
- Customer Ingress Prefix Filtering
- Prefix filtering between intra-AS trust zones
- Route table monitoring to detect alteration of critical route paths
- SPAMers are using route-hijacking.

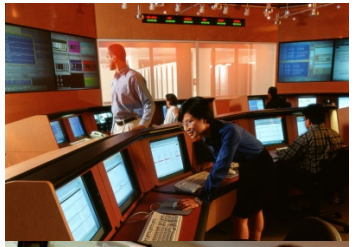
Bogons and Special Use Addresses

- IANA has reserved several blocks of IPv4 that have yet to be allocated to a RIR:
  - http://www.iana.org/assignments/ipv4-address-space
- These blocks of IPv4 addresses should never be advertised into the global internet route table
- Filters should be applied on the AS border for all inbound and outbound advertisements
- Special Use Addresses (SUA) are reserved for special use :-)
  - Defined in RFC3330
  - Examples: 127.0.0.1, 192.0.2.0/24

Total Visibility

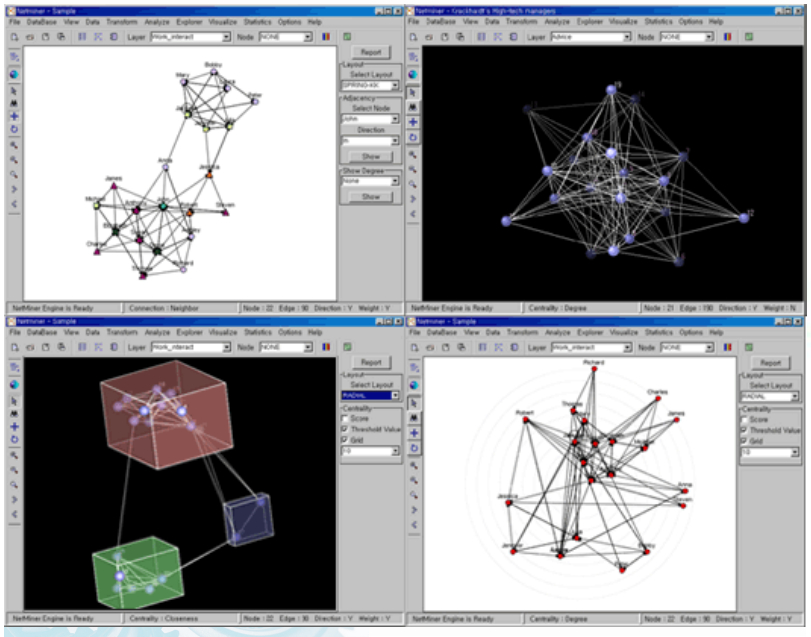


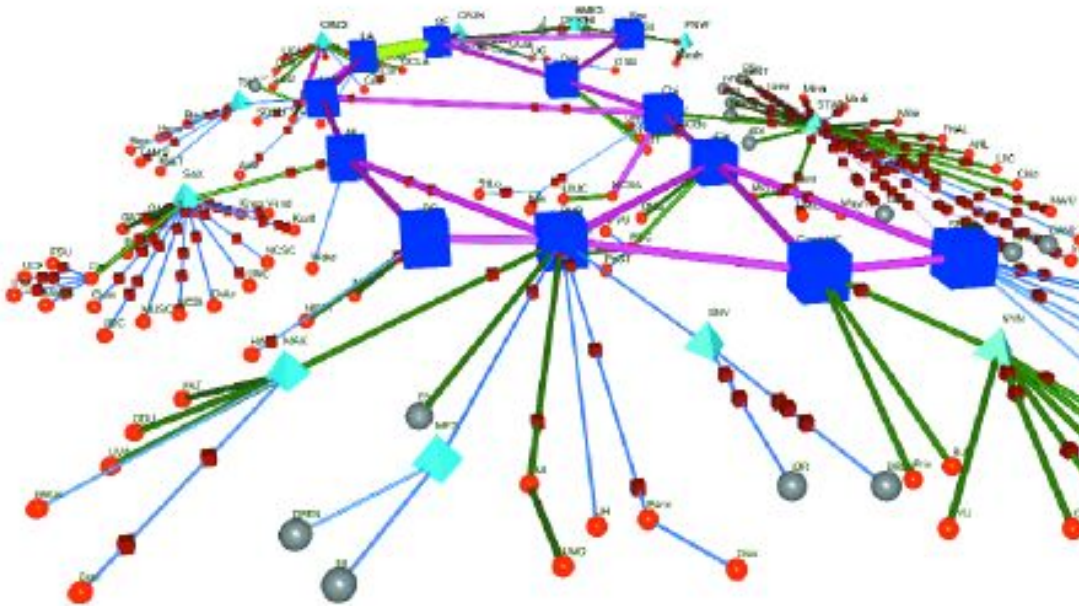




What Is Meant by 'Telemetry'?

Te·lem·e·try — a technology that allows the remote measurement and reporting of information of interest to the system designer or operator. The word is derived from Greek roots *tele* = remote, and *metron* = measure

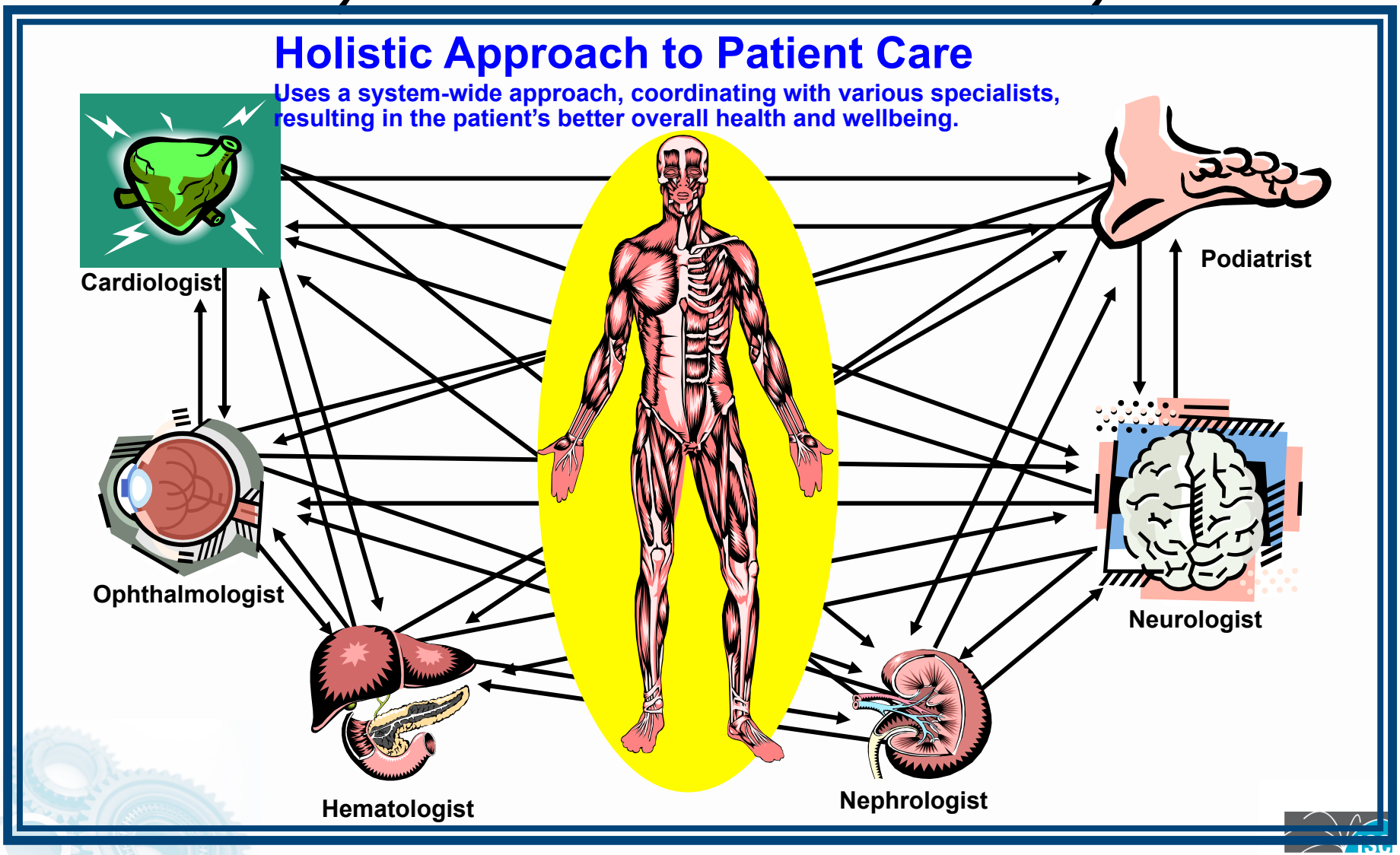




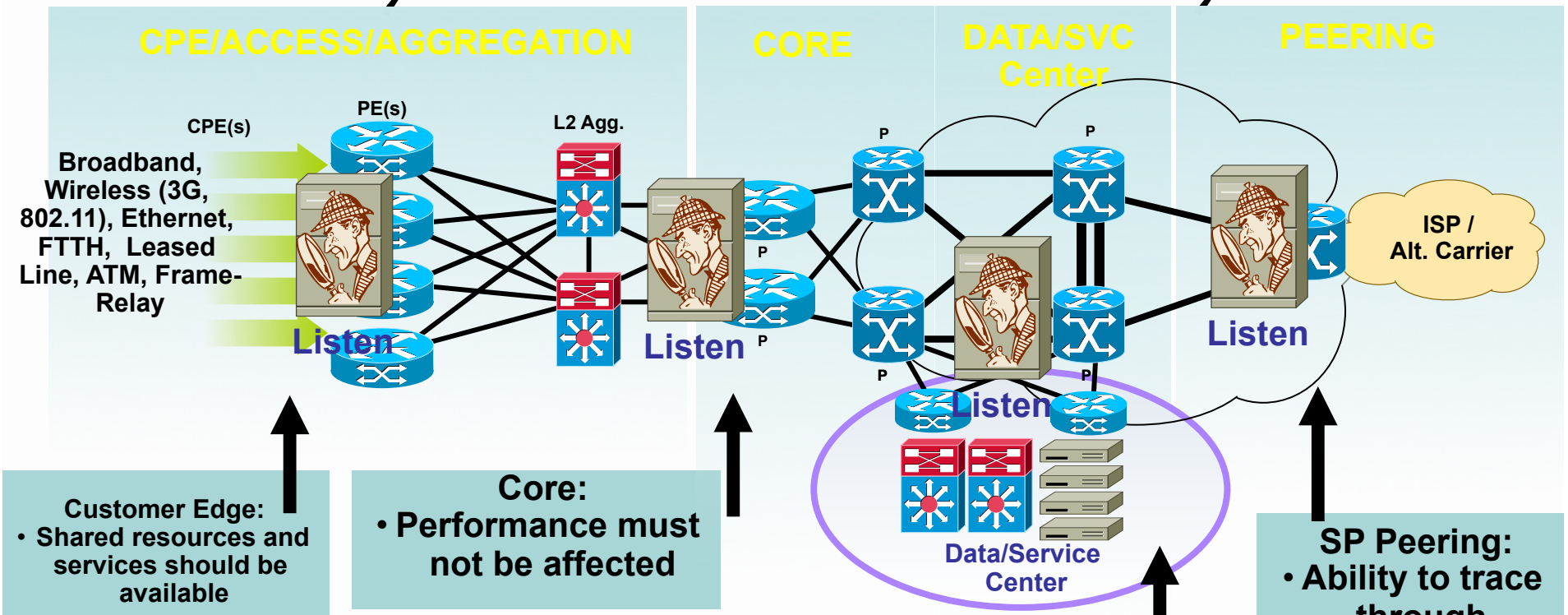
Check List

- Check SNMP. Is there more you can do with it to pull down security information?
- Check RMON. Can you use it?
- Check Netflow. Are you using it, can you pull down more?
- Check Passive DNS
- See addendum for lots of links.

Holistic Approach to System-Wide Telemetry



Holistic Approach to System-Wide Telemetry



Customer Edge:
- Shared resources and services should be available

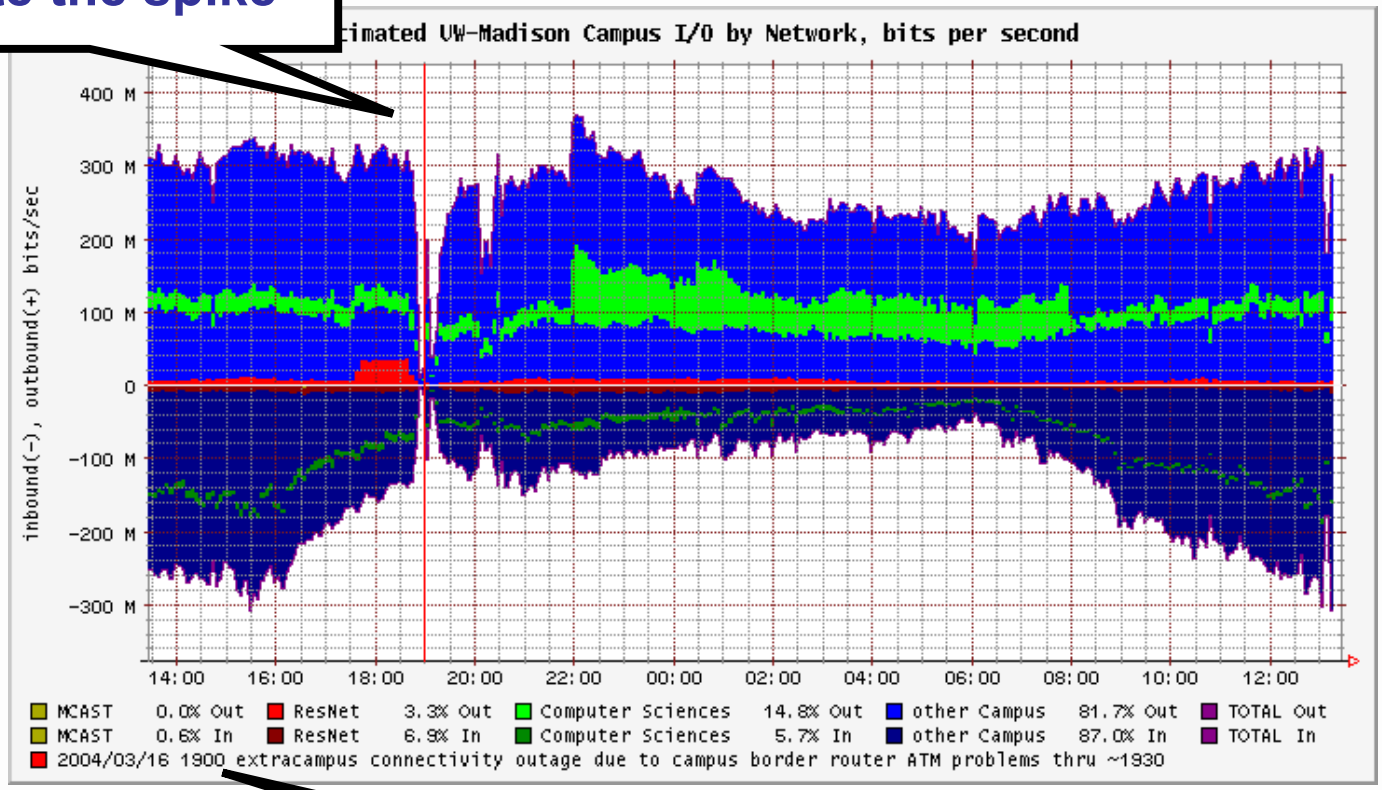
Core:
- Performance must not be affected

Data Center:
- Inter as well as Intra Data Center traffic

SP Peering:
- Ability to trace through asymmetric traffic

Open Source Tools for NetFlow Analysis Visualization–FlowScan

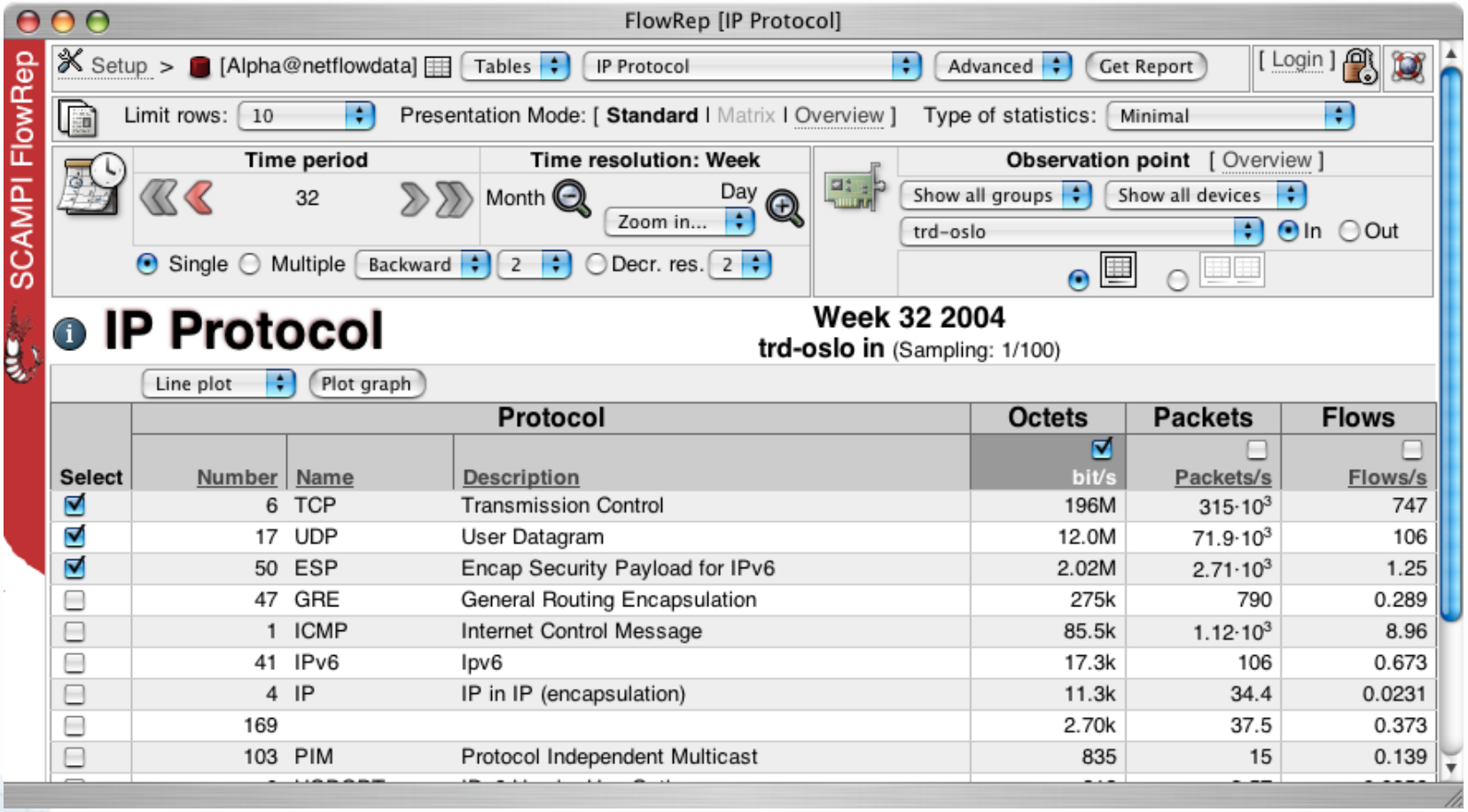
Investigate the spike



An identified cause of the outage

Source: University of Wisconsin

NetFlow - Stager

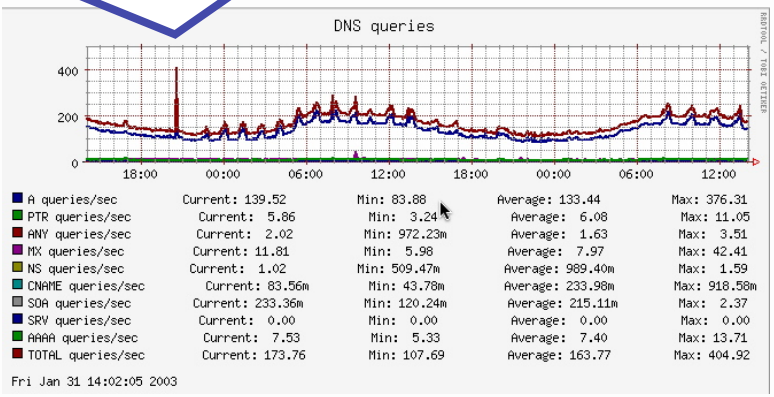


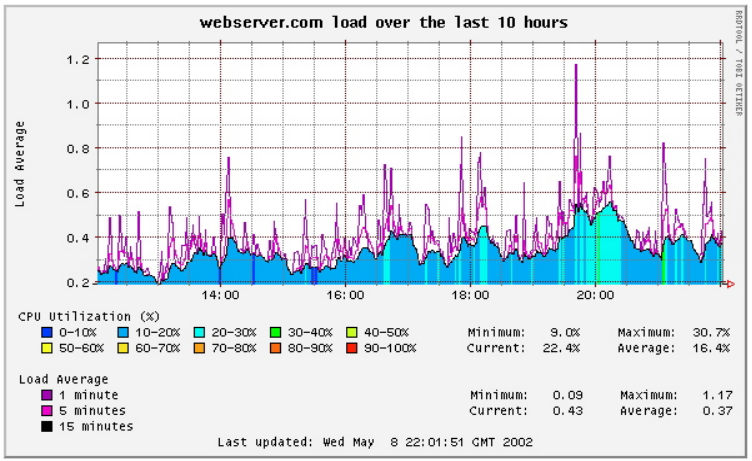
Select	Protocol Number	Name	Description	Octets bit/s	Packets Packets/s	Flows Flows/s
☑	6	TCP	Transmission Control	196M	$315 \cdot 10^3$	747
☑	17	UDP	User Datagram	12.0M	$71.9 \cdot 10^3$	106
☑	50	ESP	Encap Security Payload for IPv6	2.02M	$2.71 \cdot 10^3$	1.25
☐	47	GRE	General Routing Encapsulation	275k	790	0.289
☐	1	ICMP	Internet Control Message	85.5k	$1.12 \cdot 10^3$	8.96
☐	41	IPv6	Ipv6	17.3k	106	0.673
☐	4	IP	IP in IP (encapsulation)	11.3k	34.4	0.0231
☐	169			2.70k	37.5	0.373
☐	103	PIM	Protocol Independent Multicast	835	15	0.139

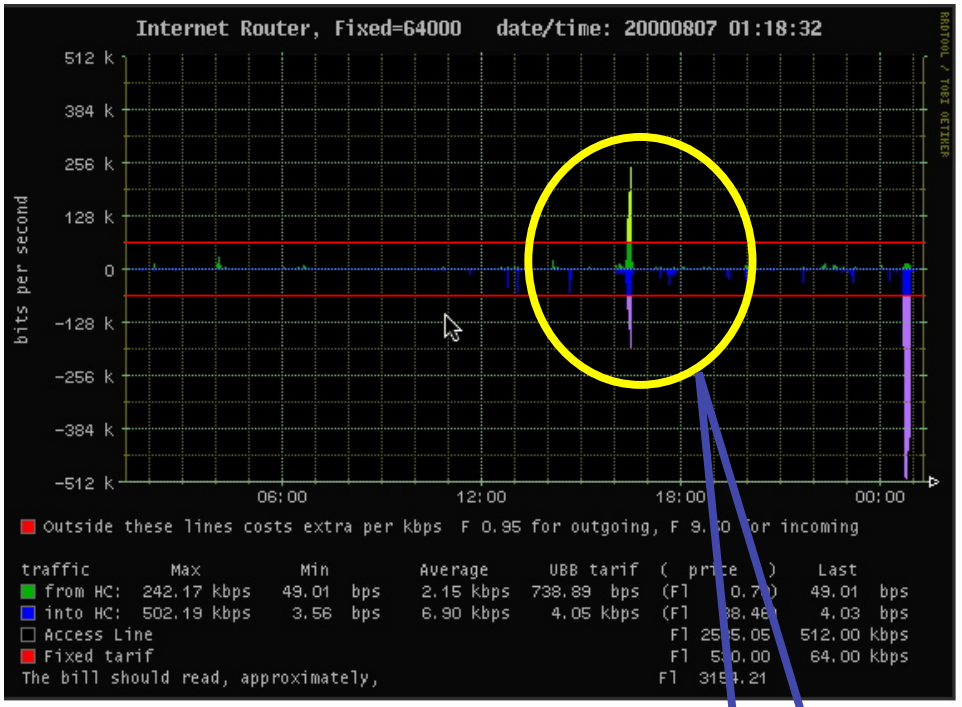
Source: UNINETT

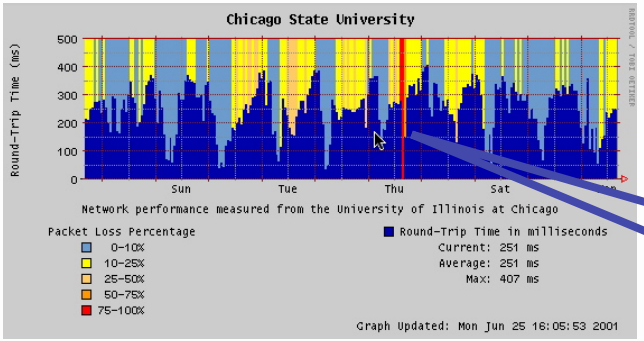
Other Visualization Techniques Using SNMP Data with RRDTool

Anomaly for DNS Queries







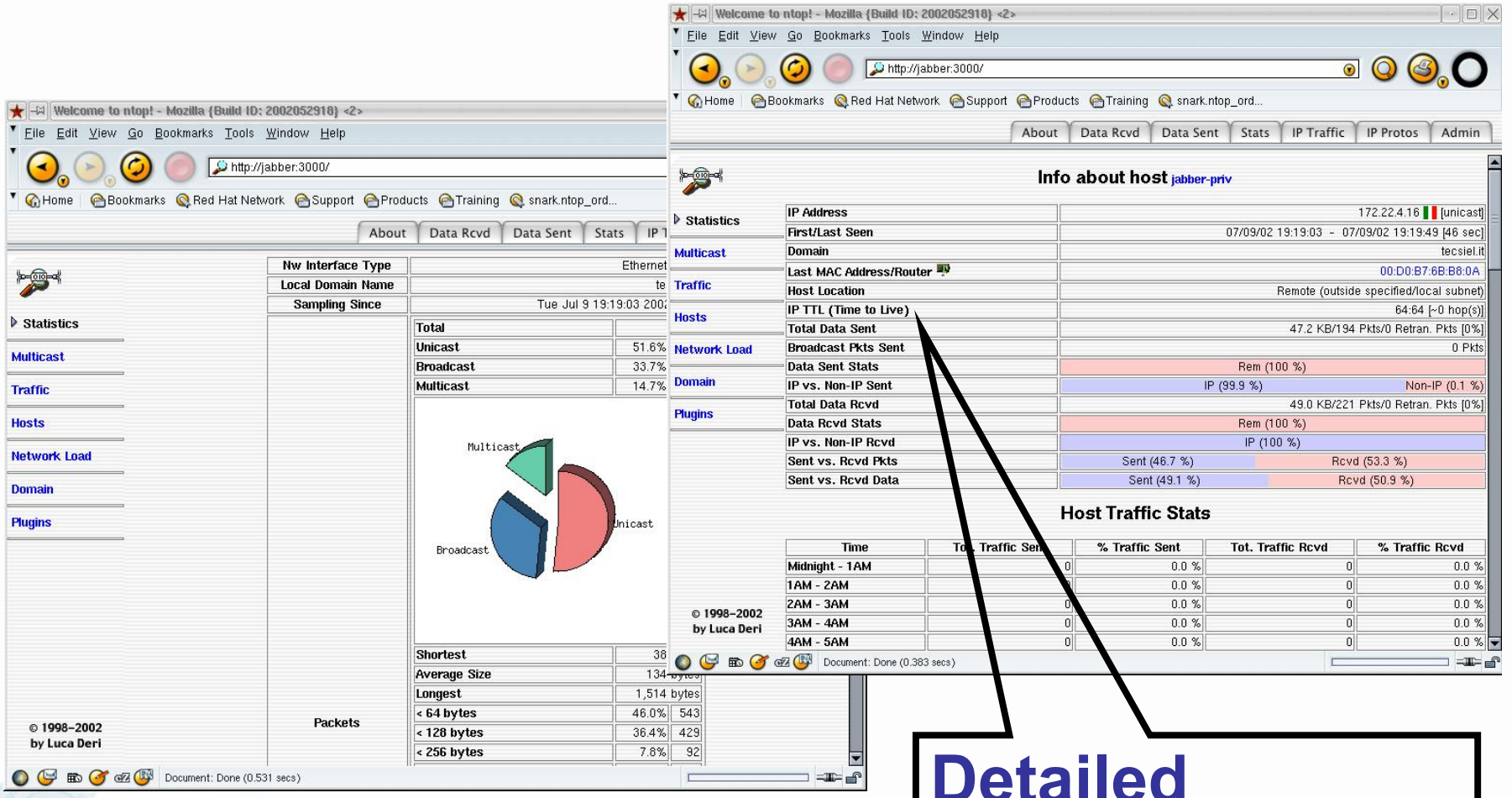


Thru'put Spike

RTT Spike

Source: http://people.ee.ethz.ch/~oetiker/webtools/rrdtool/

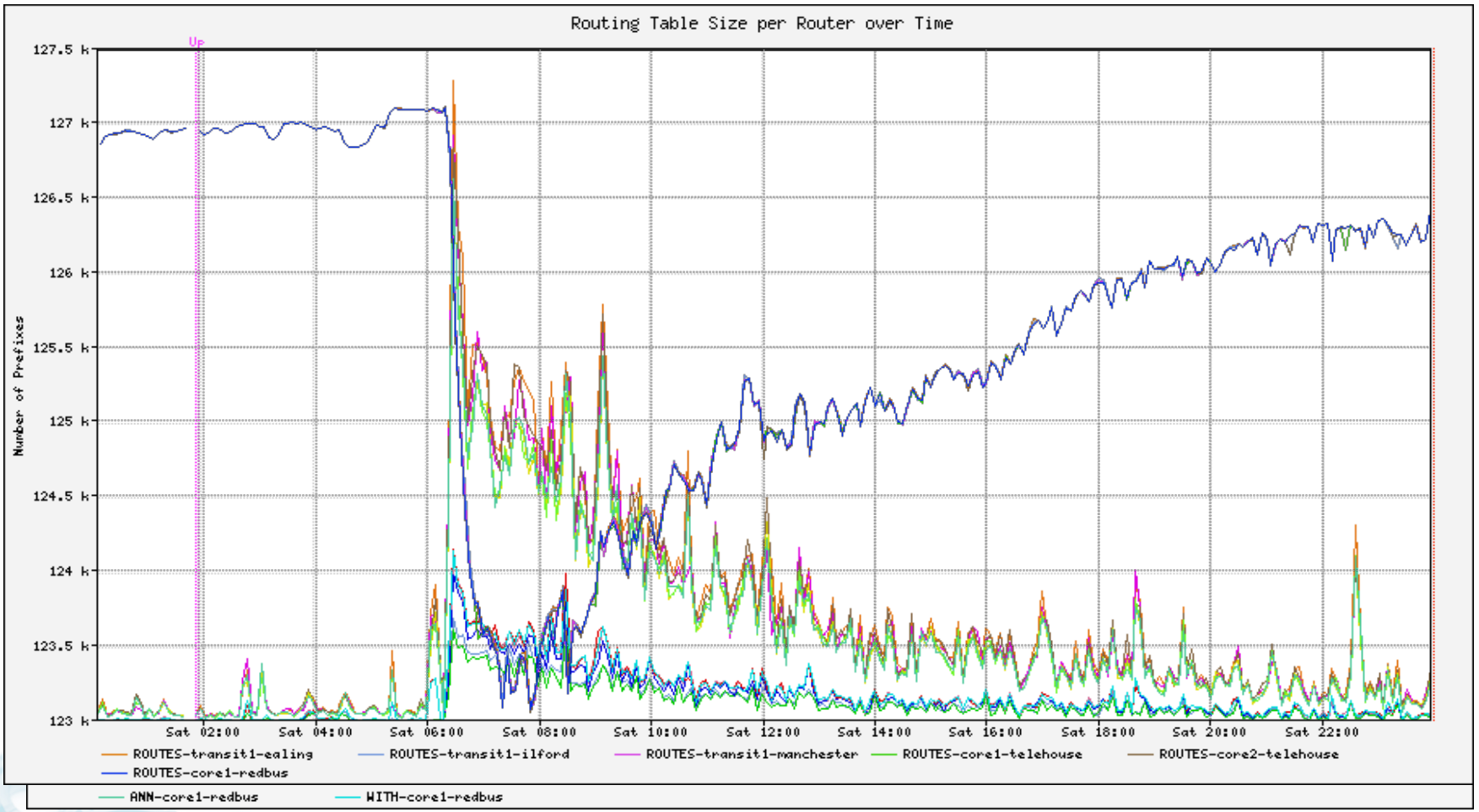
Displaying RMON-ntop Examples



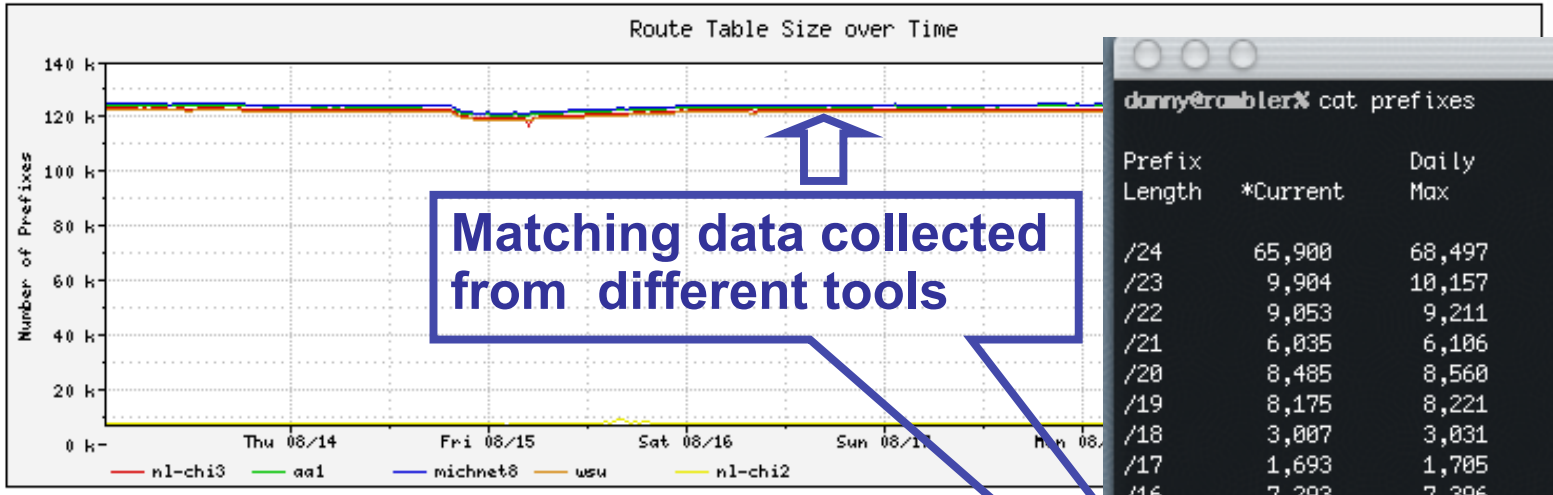
Source: http://www.ntop.org

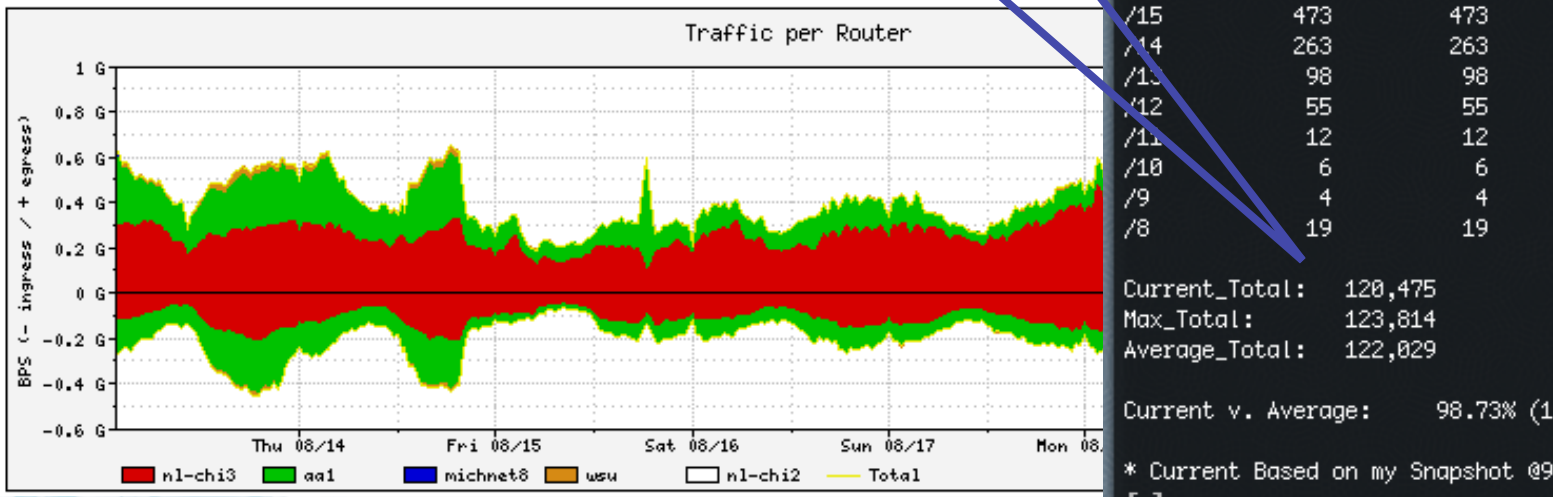
Detailed Analysis i.e. TTL

BGP Example–SQL Slammer



Correlating NetFlow and Routing Data





Matching data collected from different tools

tcsh — tcsh

```
donny@rambler% cat prefixes

Prefix                Daily       Daily
Length   *Current     Max         Average

/24        65,900     68,497      67,259
/23         9,904     10,157      10,027
/22         9,053      9,211       9,110
/21         6,035      6,106       6,045
/20         8,485      8,560       8,487
/19         8,175      8,221       8,161
/18         3,007      3,031       3,005
/17         1,693      1,705       1,690
/16         7,293      7,396       7,326
/15           473        473         469
/14           263        263         262
/13            98         98          97
/12            55         55          54
/11            12         12          11
/10             6          6           5
/9              4          4           3
/8             19         19          18

Current_Total:   120,475
Max_Total:       123,814
Average_Total:   122,029

Current v. Average:     98.73% (1554 prefixes)

* Current Based on my Snapshot @9P MDT 8.14.2003
[~]
donny@rambler%
```

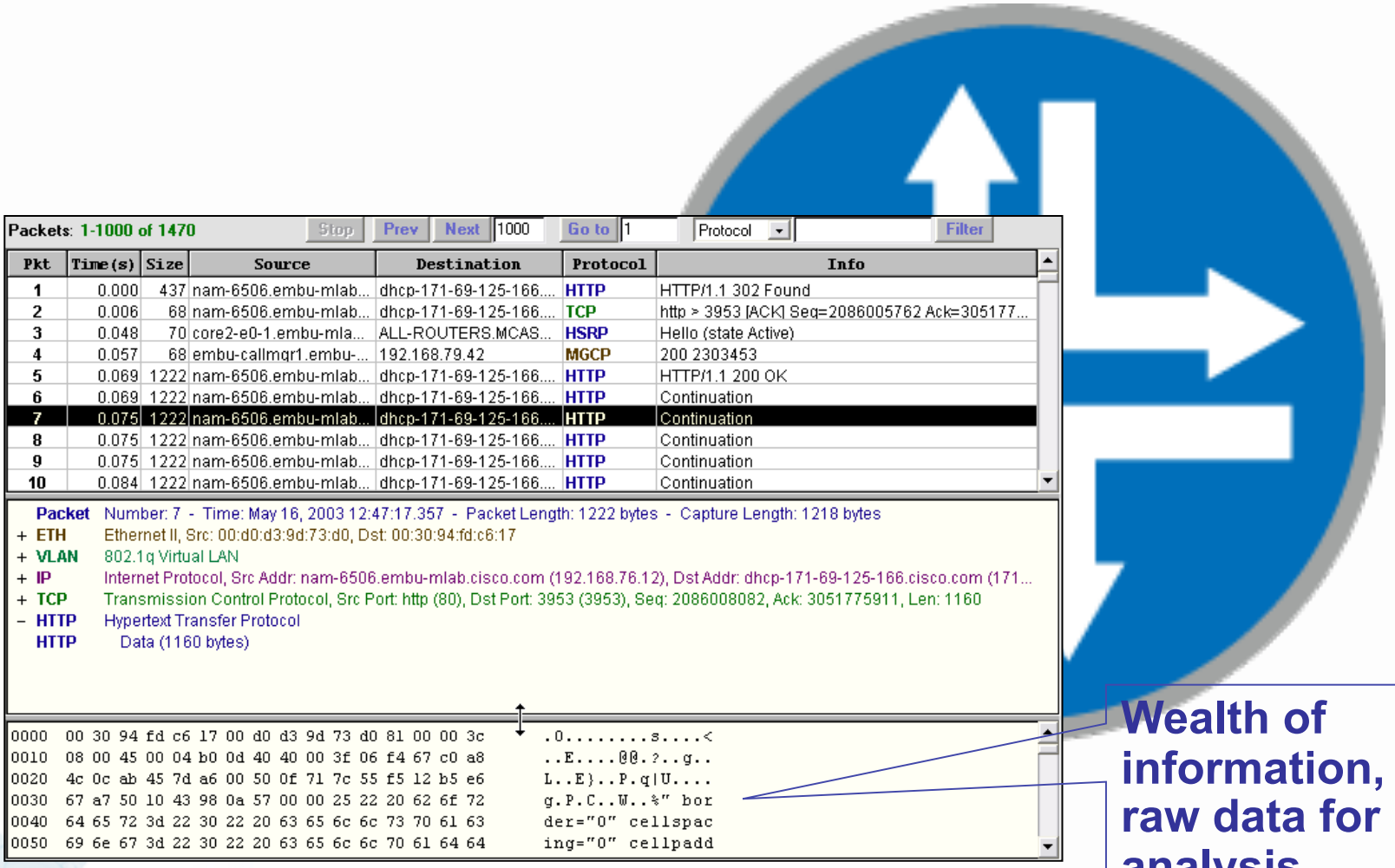
Syslog

- De facto logging standard for hosts, network infrastructure devices, supported in all most routers and switches
- Many levels of logging detail available—choose the level(s) which are appropriate for each device/situation
- Logging of ACLs is generally contraindicated due to CPU overhead—NetFlow provides more info, doesn't max the box
- Can be used in conjunction with Anycast and databases such as MySQL (http://www.mysql.com) to provide a scalable, robust logging infrastructure
- Different facility numbers allows for segregation of log info based upon device type, function, other criteria
- Syslog-ng from http://www.balabit.com/products/syslog_ng/ adds a lot of useful functionality—HOW-TO located at http://www.campin.net/newlogcheck.html

Benefits of Deploying NTP

- Very valuable on a global network with network elements in different time zones
- Easy to correlate data from a global or a sizable network with a consistent time stamp
- NTP based timestamp allows to trace security events for chronological forensic work
- Any compromise or alteration is easy to detect as network elements would go out of sync with the main 'clock'
- Did you there is an NTP MIB? Some think that we may be able to use "NTP Jitter" to watch what is happening in the network.

Packet Capture Examples



Packets: 1-1000 of 1470 Stop Prev Next 1000 Go to 1 Protocol Filter

Pkt	Time(s)	Size	Source	Destination	Protocol	Info
1	0.000	437	nam-6506.embu-mlab...	dhcp-171-69-125-166....	HTTP	HTTP/1.1 302 Found
2	0.006	68	nam-6506.embu-mlab...	dhcp-171-69-125-166....	TCP	http > 3953 [ACK] Seq=2086005762 Ack=305177...
3	0.048	70	core2-e0-1.embu-mla...	ALL-ROUTERS.MCAS...	HSRP	Hello (state Active)
4	0.057	68	embu-callmgr1.embu-...	192.168.79.42	MGCP	200 2303453
5	0.069	1222	nam-6506.embu-mlab...	dhcp-171-69-125-166....	HTTP	HTTP/1.1 200 OK
6	0.069	1222	nam-6506.embu-mlab...	dhcp-171-69-125-166....	HTTP	Continuation
7	0.075	1222	nam-6506.embu-mlab...	dhcp-171-69-125-166....	HTTP	Continuation
8	0.075	1222	nam-6506.embu-mlab...	dhcp-171-69-125-166....	HTTP	Continuation
9	0.075	1222	nam-6506.embu-mlab...	dhcp-171-69-125-166....	HTTP	Continuation
10	0.084	1222	nam-6506.embu-mlab...	dhcp-171-69-125-166....	HTTP	Continuation

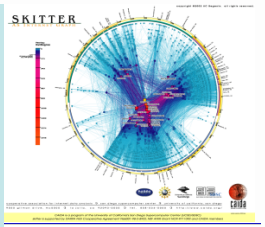
```
  Packet  Number: 7 - Time: May 16, 2003 12:47:17.357 - Packet Length: 1222 bytes - Capture Length: 1218 bytes
+ ETH     Ethernet II, Src: 00:d0:d3:9d:73:d0, Dst: 00:30:94:fd:c6:17
+ VLAN    802.1q Virtual LAN
+ IP      Internet Protocol, Src Addr: nam-6506.embu-mlab.cisco.com (192.168.76.12), Dst Addr: dhcp-171-69-125-166.cisco.com (171...
+ TCP     Transmission Control Protocol, Src Port: http (80), Dst Port: 3953 (3953), Seq: 2086008082, Ack: 3051775911, Len: 1160
- HTTP    Hypertext Transfer Protocol
  HTTP      Data (1160 bytes)
```

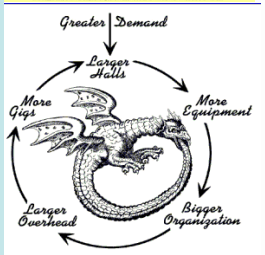
```
0000  00 30 94 fd c6 17 00 d0 d3 9d 73 d0 81 00 00 3c    .0........s....<
0010  08 00 45 00 04 b0 0d 40 40 00 3f 06 f4 67 c0 a8    ..E....@@.?..g..
0020  4c 0c ab 45 7d a6 00 50 0f 71 7c 55 f5 12 b5 e6    L..E}..P.q|U....
0030  67 a7 50 10 43 98 0a 57 00 00 25 22 20 62 6f 72    g.P.C..W..%" bor
0040  64 65 72 3d 22 30 22 20 63 65 6c 6c 73 70 61 63    der="0" cellspac
0050  69 6e 67 3d 22 30 22 20 63 65 6c 6c 70 61 64 64    ing="0" cellpadd
```

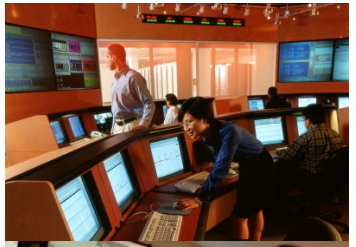
Wealth of information, L1-L7 raw data for analysis

Source: http://www.ethereal.com

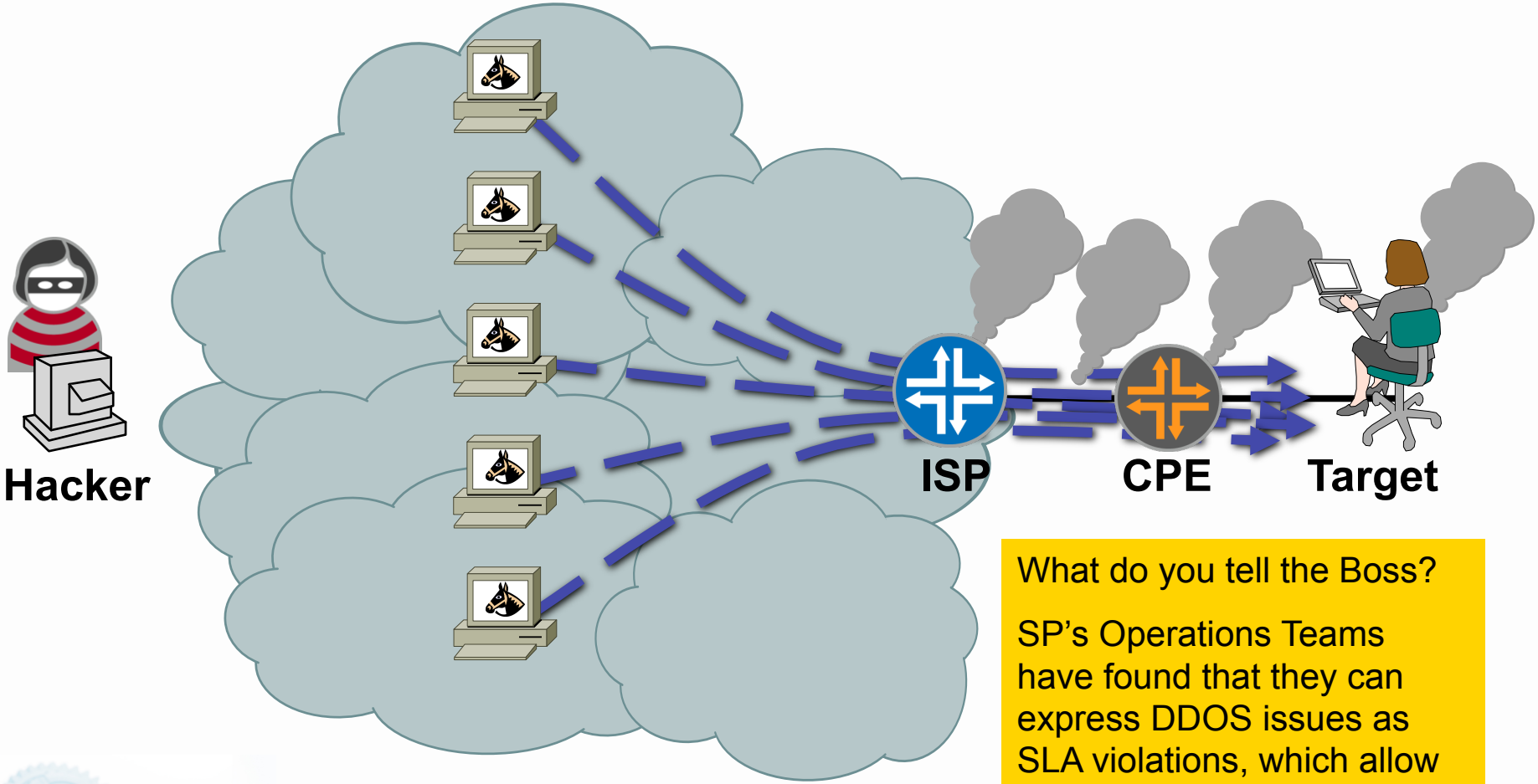
Putting the Tools to Work - DDOS Attack







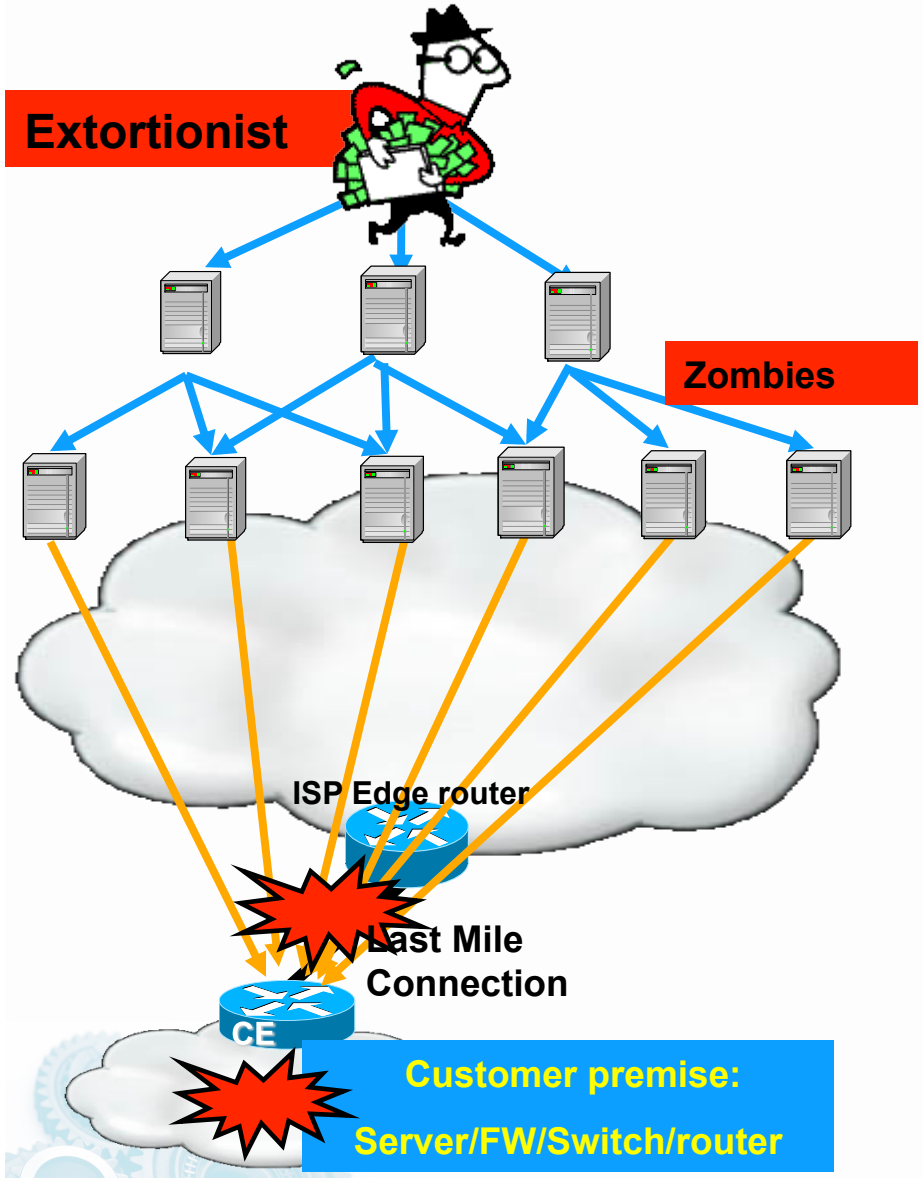
DDOS = SLA Violation!



What do you tell the Boss?

SP's Operations Teams have found that they can express DDOS issues as SLA violations, which allow for their management to understand why they need to act.

BOTNETS - Making DDoS Attacks Easy

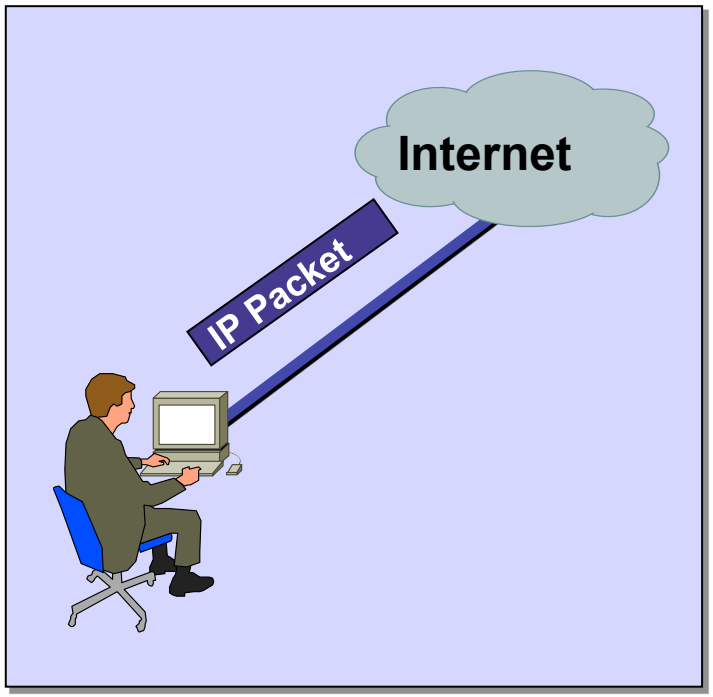


2 for 1 Special

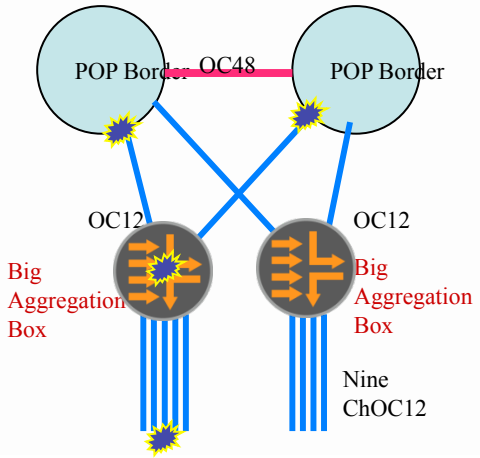
BOTNETs for Rent!

- A BOTNET is comprised of computers that have been broken into and planted with programs (zombies) that can be directed to launch attacks from a central controller computer
- BOTNETs allow for all the types of DDOS attacks: ICMP Attacks, TCP Attacks, and UDP Attacks, http overload
- Options for deploying BOTNETs are extensive and new tools are created to exploit the latest system vulnerabilities
- A relatively small BOTNET with only 1000 zombies can cause a great deal of damage.
- For Example: 1000 home PCs with an average upstream bandwidth of 128KBit/s can offer more than 100MBit/s
- Size of attacks are ever increasing and independent of last mile bandwidth

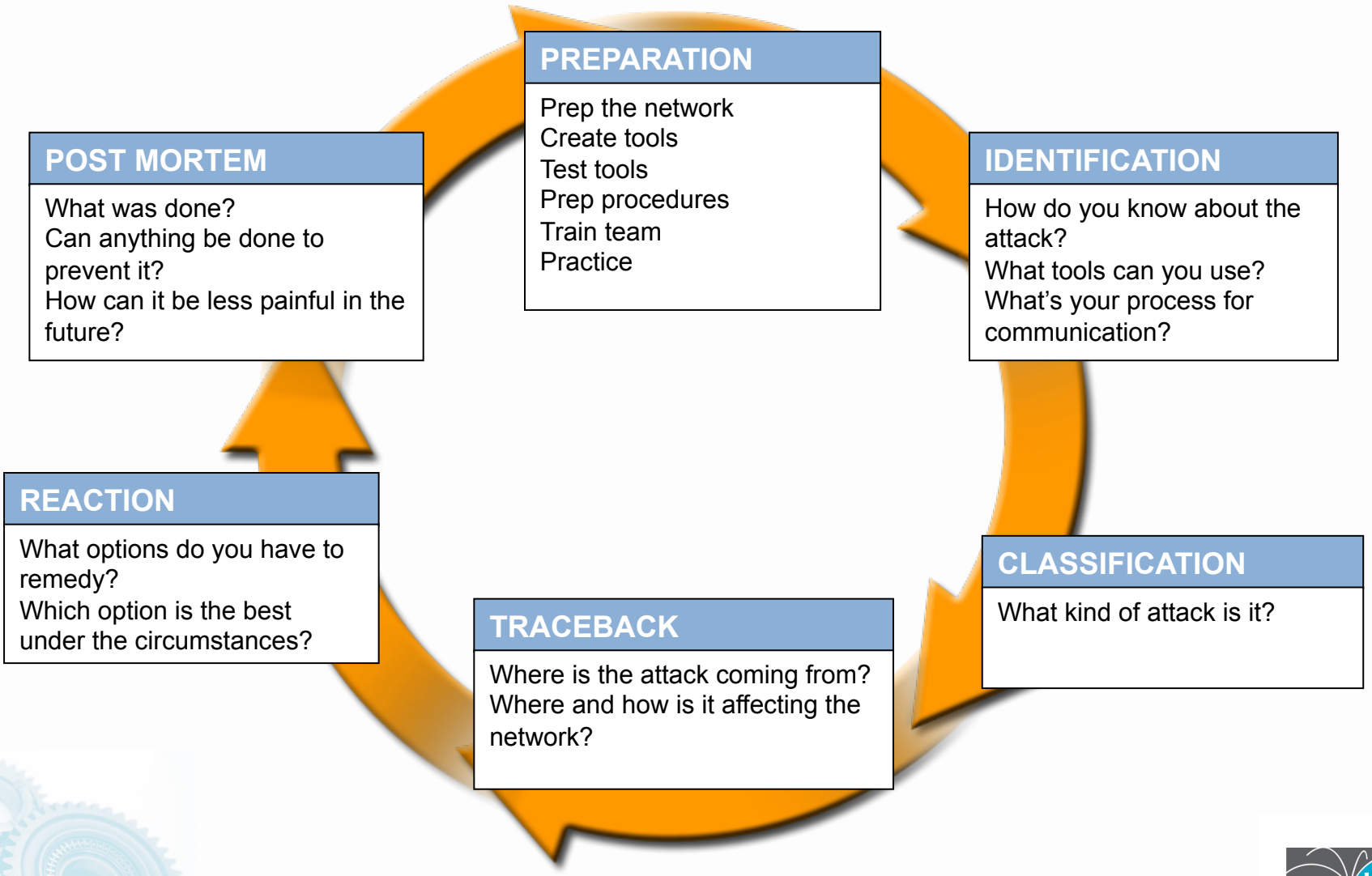
It is all about the packet .....



- **It is all about the packet .....**
- **Once a packet gets into the Internet, someone, somewhere has to do one of two things:**
  - ***Deliver the Packet***
  - ***Drop the Packet***
- **In the context of DoS attacks, the questions are *who* and *where* will the "drop the packet" action occur?**



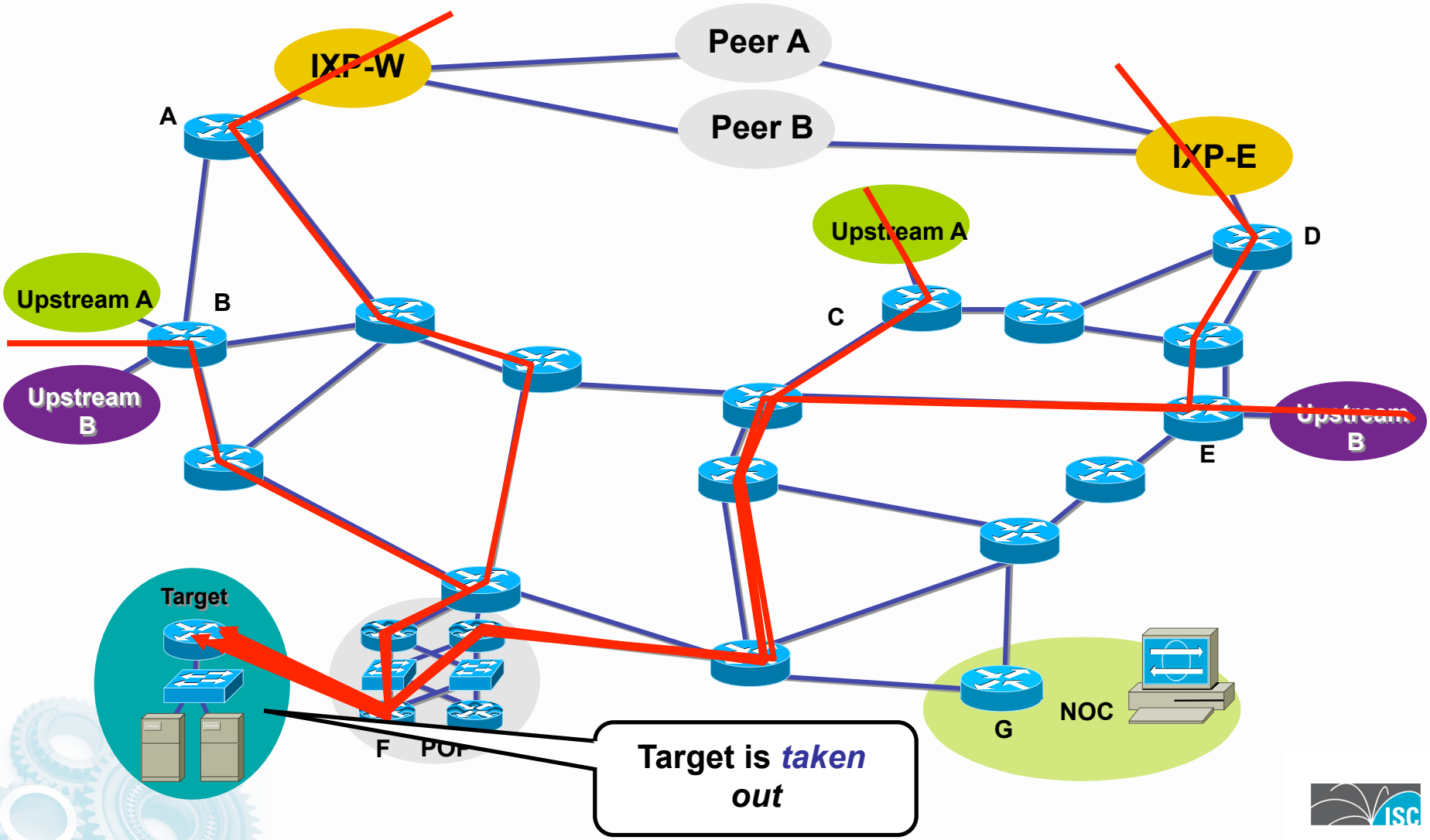
Six Phases of Incident Response



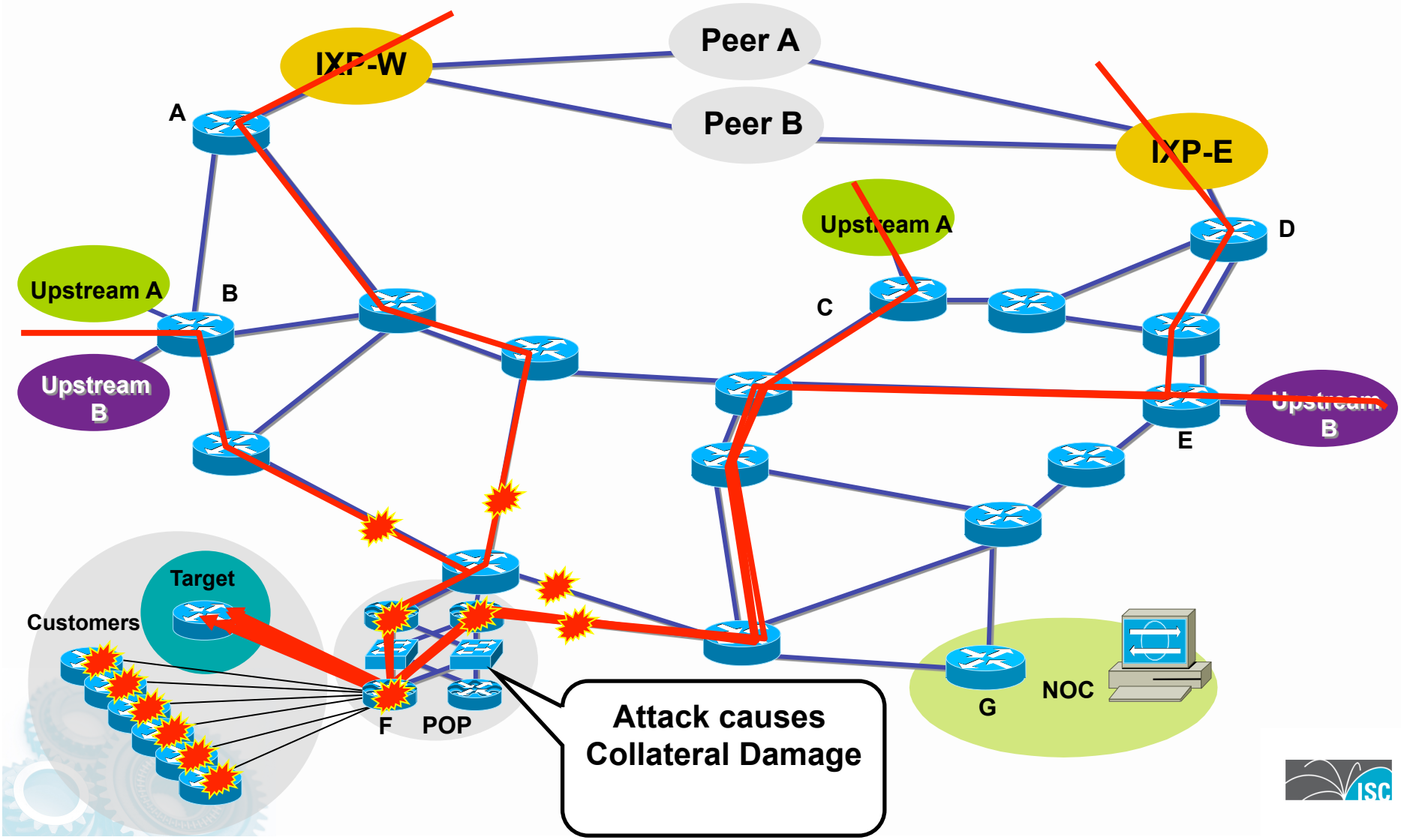
SITREP

- Everything is normal in the Network.
- Then alarms go off – something is happening in the network.

Customer Is DOSed-Before



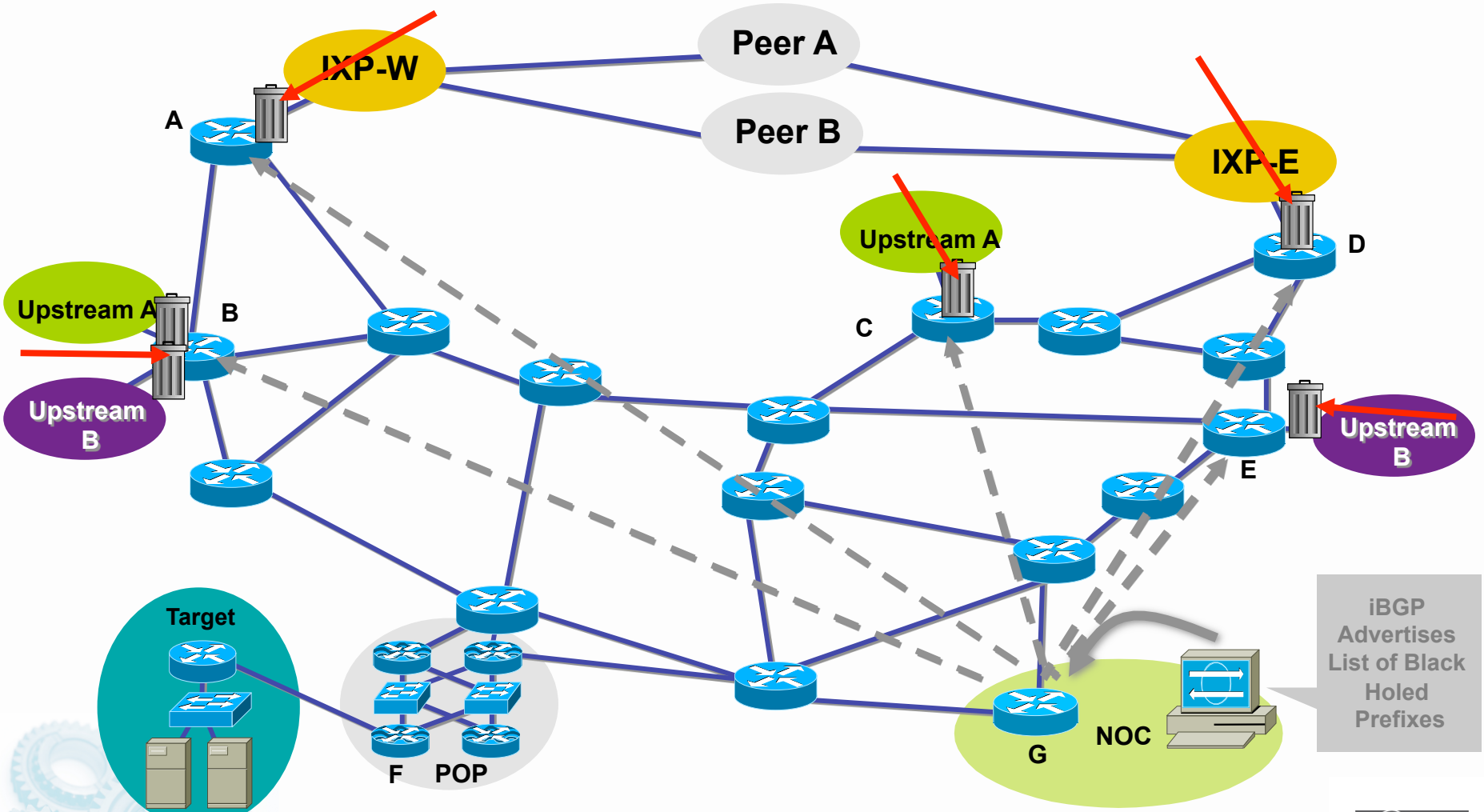
Customer Is DOSed-Before-Collateral Damage



SITREP – Attack in Progress

- Attack on a customer is impacting a number of customers.
- COLATERAL DAMAGE INCIDENT!
- Immediate Action: Solve the Collateral Damage issues.

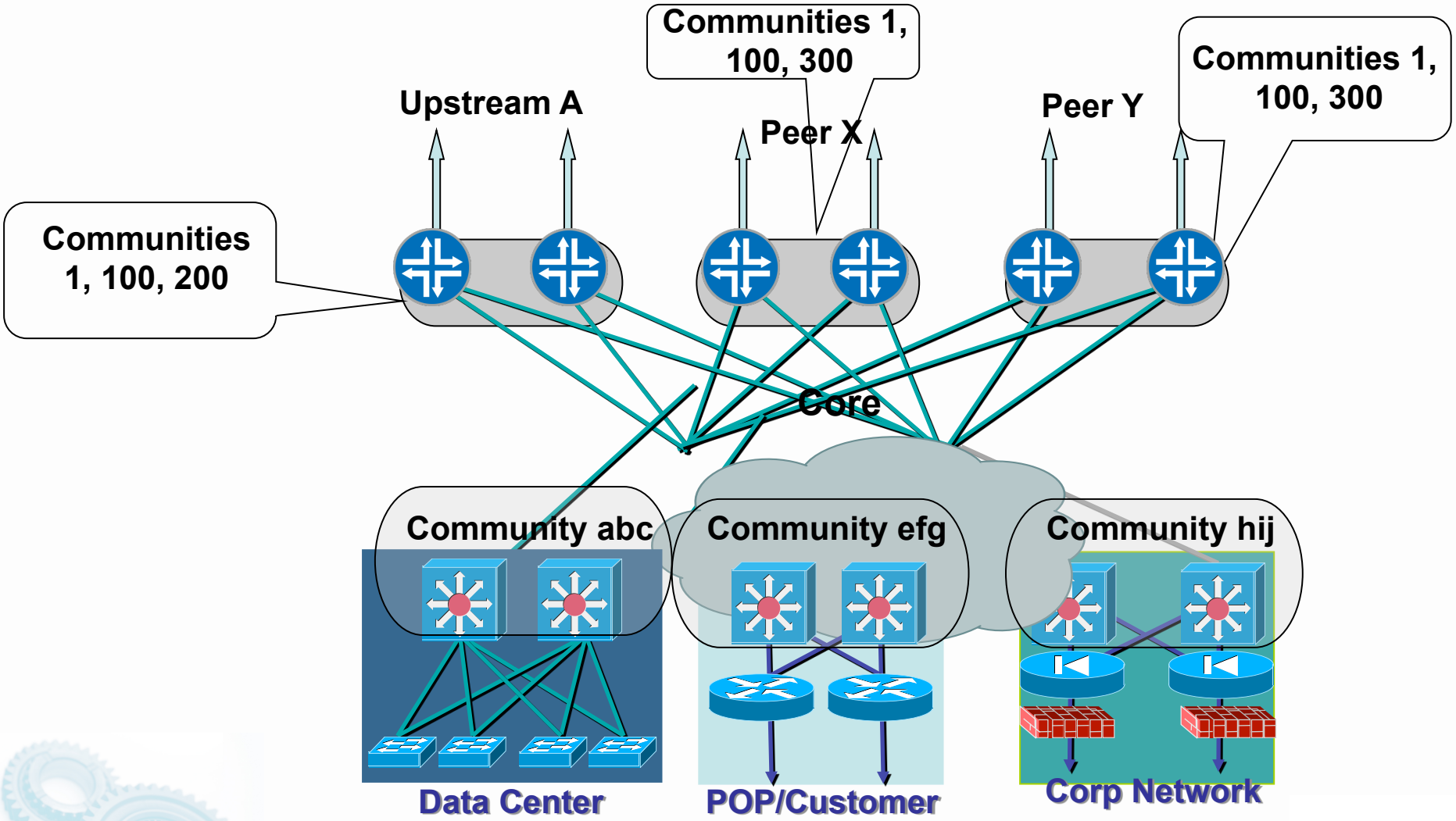
Customer Is DOSed-After-Packet Drops Pushed to the Edge



SITREP – Attack in Progress

- Collateral Damage mitigated
- Customer who was attacked has PARTIAL SERVICE.
- DOS Attack is Still Active
- Options:
  - Sink Hole a part of the traffic to analyze.
  - Watch the DOS attack and wait for Attack Rotation or cessation.
  - Activate "Clean Pipes" for a Full Service Recovery.

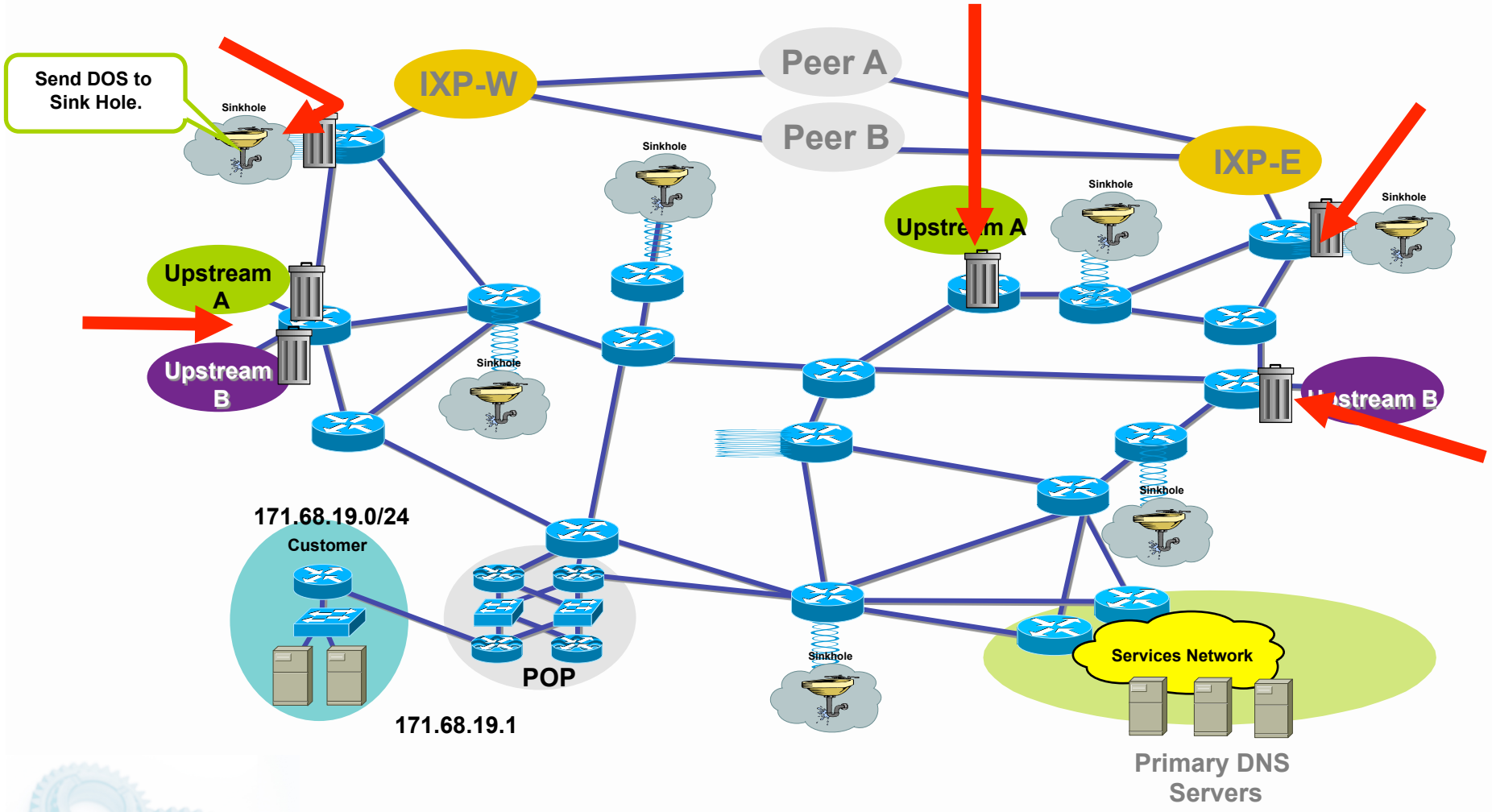
Remote Triggered Drops and Communities



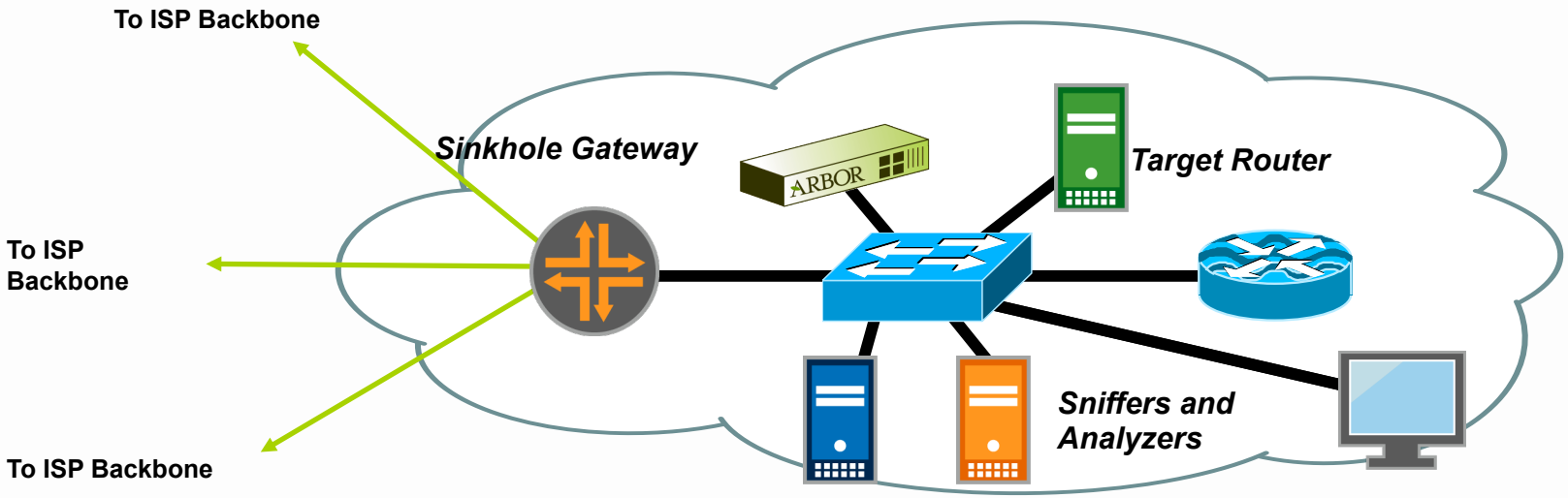
SITREP – Attack in Progress

- Collateral Damage mitigated
- Customer who was attacked has PARTIAL SERVICE.
- DOS Attack is Still Active
- Action: Monitor the Attack & Get more details on the Attack – Use BGP Community based triggering to send one regions flow into a Sink Hole

BGP Community Trigger to Sinkhole



Analyze the Attack



- Use the tools available on the Internet and from Vendors to analyze the details of the attack.
- This will provide information about what you can or cannot do next.

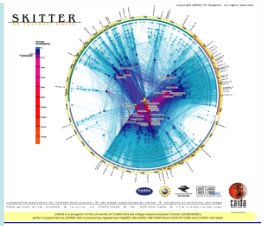
SITREP – Attack in Progress

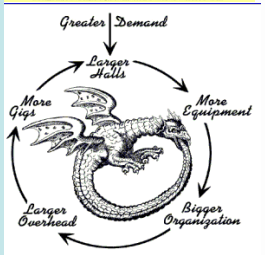
- Collateral Damage mitigated
- Customer who was attacked has PARTIAL SERVICE.
- DOS Attack is Still Active
- Action: Provide the Customer who is the victim with a Clean Pipes FULL SERVICE RECOVERY (off to vendor specific details).

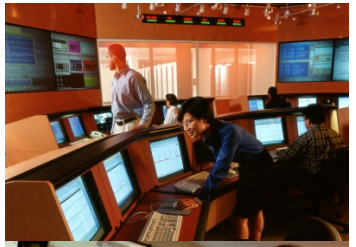
What is Full Service Recovery

- "Clean Pipes" is a term used to describe *full service recovery*. The expectations for a full service recovery is:
  - DDOS Attack is in full force and ALL customer services are operating normally – meeting the contracted SLA.
  - The Device used for the full service recovery is not vulnerable to the DDOS & the infrastructure is not vulnerable to collateral damage.
- Full Service Recovery/Clean Pipes products are very specialized. Talk to the appropriate vendor.

SUMMARY


SKITTER

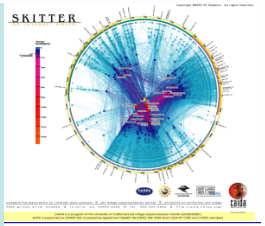

Greater Demand
Larger Halls
More Equipment
Bigger Organization
Larger Overhead
More Gigs

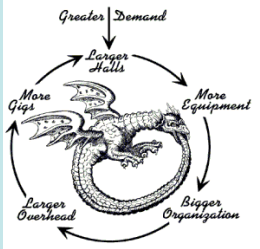


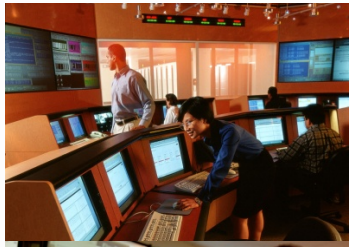
These Top 10 are a Basic Foundation

- These 10 techniques are proven as the foundation for all the SP Security developments deployed and used today.
- They are a starting point – opening the door for other techniques which help a SP save money, meet customer SLAs, and keep their business moving forward.

Communications Addendum







“Never underestimate the power of human communications as a tool to solve security problems. Our history demonstrates that since the Morris Worm, peer communication has been *the* most effect security tool.”

Barry Raveendran Greene

Preparation as Empowerment

- It is imperative that an SP's operations team prepare by empowering them for action.
  - Contacts for all ISPs who you inter-connect (peers, customers, and upstreams)
  - Contacts for all vendor's product security reaction teams.
  - Document your policies. Will you help your customers? Will you classify the attacks? Will you traceback the attacks? Will you drop the attacks on your infrastructure?

Important Points

- Create your company's Computer Emergency Response Team
- Know your peers (neighboring CERTs), build relationships
- Get on NSP-SEC mailing list and on iNOC Phone
- Know Each's Vendors Security Team

  Example: psirt@cisco.com, security-alert@cisco.com and www.cisco.com/security to contact Cisco Systems.

- Be prepared ! Define what to do & whom to contact for various incidents.

Step #1 – Take Care of Your Responsibilities

- Before knocking on doors to collect information on others, it is best that you take the time to insure you are fulfilling your responsibilities to facilitate communications.
- Make sure you have all the E-mail, phones, pagers, and web pages complete.
- Make sure you have procedures in place to answer and communicate.

OPSEC Communications

- Operations teams have a responsibility to communicate with
  - All peers, IXPs, and transit providers
  - Teams inside their organization
  - Customers connected to their network
  - Other ISPs in the community
- E-mail and Web pages are the most common forms of communication
- Pagers and hand phones are secondary communication tools

OPSEC Communications

Q. Does noc@someisp.net work?

Q. Does security@someisp.net work?

Q. Do you have an Operations and Security Web site with:

- Contact information
- Network policies (i.e. RFC 1998+++)
- Security policies and contact information

Q. Have you registered you NOC information at one of the NOC Coordination Pages?

- http://puck.nether.net/netops/nocs.cgi

SOC's Public Mailboxes

- RFC 2142 defines E-mail Aliases all ISPs should have for customer – ISP and ISP – ISP communication
- Operations addresses are intended to provide recourse for customers, providers

MAILBOX	AREA	USAGE
ABUSE	Customer Relations	Inappropriate public behavior
NOC	Network Operations	Network infrastructure
SECURITY	Network Security	Security bulletins or queries

/Security Web Page

- New Industry Practices insist that every IT company has a /security web page. This page would include:
  - Incident Response contacts for the company.
  - 7*24 contact information
  - Pointers to best common practices
  - Pointer to company's public security policies
  - Etc.
- See www.microsoft.com/security, www.cisco.com/security or www.juniper.net/security as an examples.

Emergency Customer Contact List

- E-mail alias and Web pages to communicate to your customer
  - Critical during an Internet wide incident
  - Can be pushed to sales to maintain the contact list
  - Operations should have 7*24 access to the customer contact list
  - Remember to exercise the contact list (looking for bounces)

Exercising the Customer Contact List

- Use Internet warning to look for bounces before a crisis ….

Dear Customers,

You are receiving this email because you have subscribed to one or more services with Infoserve. We have received a virus alert from security authorities and we believe that you should be informed (please see information below). If you do not wish to be included in future information service, please click "Reply" and type "Remove from subscription" in the subject field.

We have received warning from security authorities on a new virus, W32.Sobig.E@mm. W32.Sobig.E@mm is a new variant of the W32.Sobig worm. It is a mass-mailing worm sends itself to all the email addresses, purporting to have been sent by Yahoo (support@yahoo.com) or obtained email address from the infected machine. The worm finds the addresses in the files with the following extensions: .wab .dbx .htm .html .eml .txt

You should regularly update your antivirus definition files to ensure that you are up-to-date with the latest protection.

For more information, please follow the following links:

Information from Computer Associates: http://www3.ca.com/solutions/collateral.asp?CT=27081&CID=46275
Information from F-Secure: http://www.europe.f-secure.com/v-descs/sobig_e.shtml
Information from McAfee: http://vil.mcafee.com/dispVirus.asp?virus_k=100429
Information from Norman: http://www.norman.com/virus_info/w32_sobig_e_mm.shtml
Information from Sophos: http://www.norman.com/virus_info/w32_sobig_e_mm.shtml
Information from Symantec: http://www.symantec.com/avcenter/venc/data/w32.sobig.e@mm.html
Information from Trend Micro: http://www.trendmicro.com/vinfo/virusencyclo/default5.asp?VName=WORM_SOBIG.E

Remember to Communicate

- Make sure there is someone behind all the
  E-mail aliases
- It is of no use to have a mean for people to communicate with your when you have no one behind the alias/ phone/pager/web page to communicate back
- Many aliases are unmanned—with E-mail going into limbo

CERTs (Computer Emergency Response Teams)

- Origin: The Internet Worm, 1988
- Creation of "The" CERT-CC (co-ordination centre)
  - Carnegie Mellon University, Pittsburgh
    http://www.cert.org/
- The names vary:
  - IRT (Incident Response Team)
  - CSIRT (Computer security incident response team)
  - … and various other acronyms
- Start with the following URLs:
  - www.cert.org
  - www.first.org

How to Work with CERTs

- Confidentiality
- Use signed and encrypted communication

  Use PGP, S/MIME or GPG, have your key signed!
- CERTs coordinate with other CERTs and ISPs
- CERTs provide assistance, help, advice
- They do not do your work!

Collecting Information from Peers

- Do you have the following information for every peer and transit provider you interconnect with?
  - E-mail to NOC, abuse, and security teams
  - Work phone numbers to NOC, abuse, and security teams
  - Cell Phone numbers to key members of the NOC, abuse, and security teams
  - URLs to NOC, abuse, and security team pages
  - All the RFC 1998+++ remote-triggered communities

Questions

Q. Do you have the NOC and Security Contacts for every ISP you are peered?

Q. Do you test the contact information every month (E-mail, Phone, Pager)?

Q. Have you agreed on the format for the information you will exchange?

Q. Do you have a customer security policy so your customers know what to expect from your Security Team?

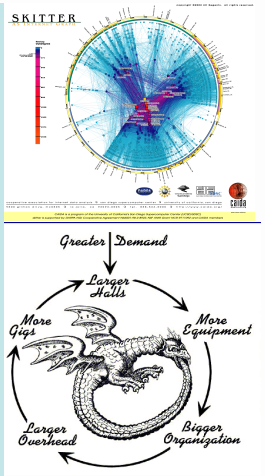
Over Dependence on Vendors- Danger!

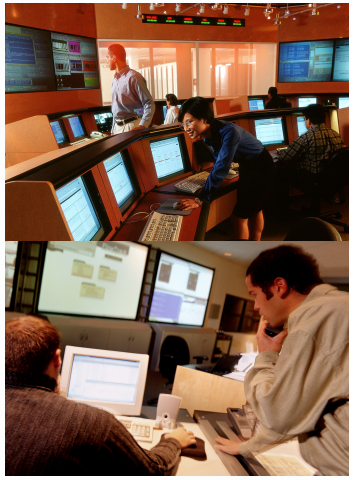
- Operators who use their Vendors as Tier 2 and higher support endanger their network to security risk.
  - Vendors are partners with an operator. They should not maintain and troubleshoot the entire network.
  - Way too many operators today see a problem on a router and then call the vendor to fix it.
  - This is not working with Turbo Worms.

What you should expect from your vendor?

- Expect 7x24 Tech Support (paid service)
- You should not expect your vendor to run your network.
- Membership in FIRST (http://www.first.org/about/organization/teams/)

DNS Architecture Idea: Modularization & Compartmentalization

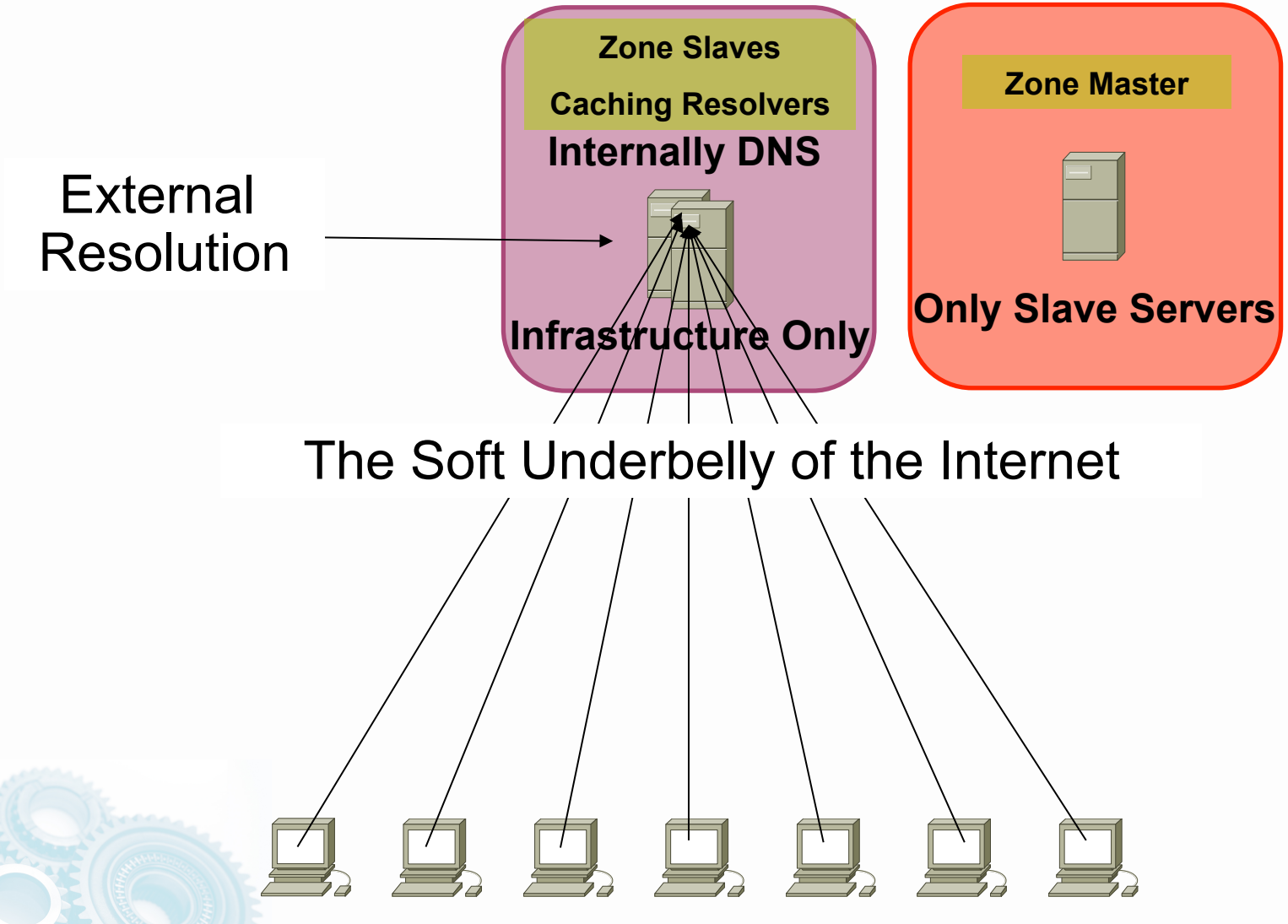




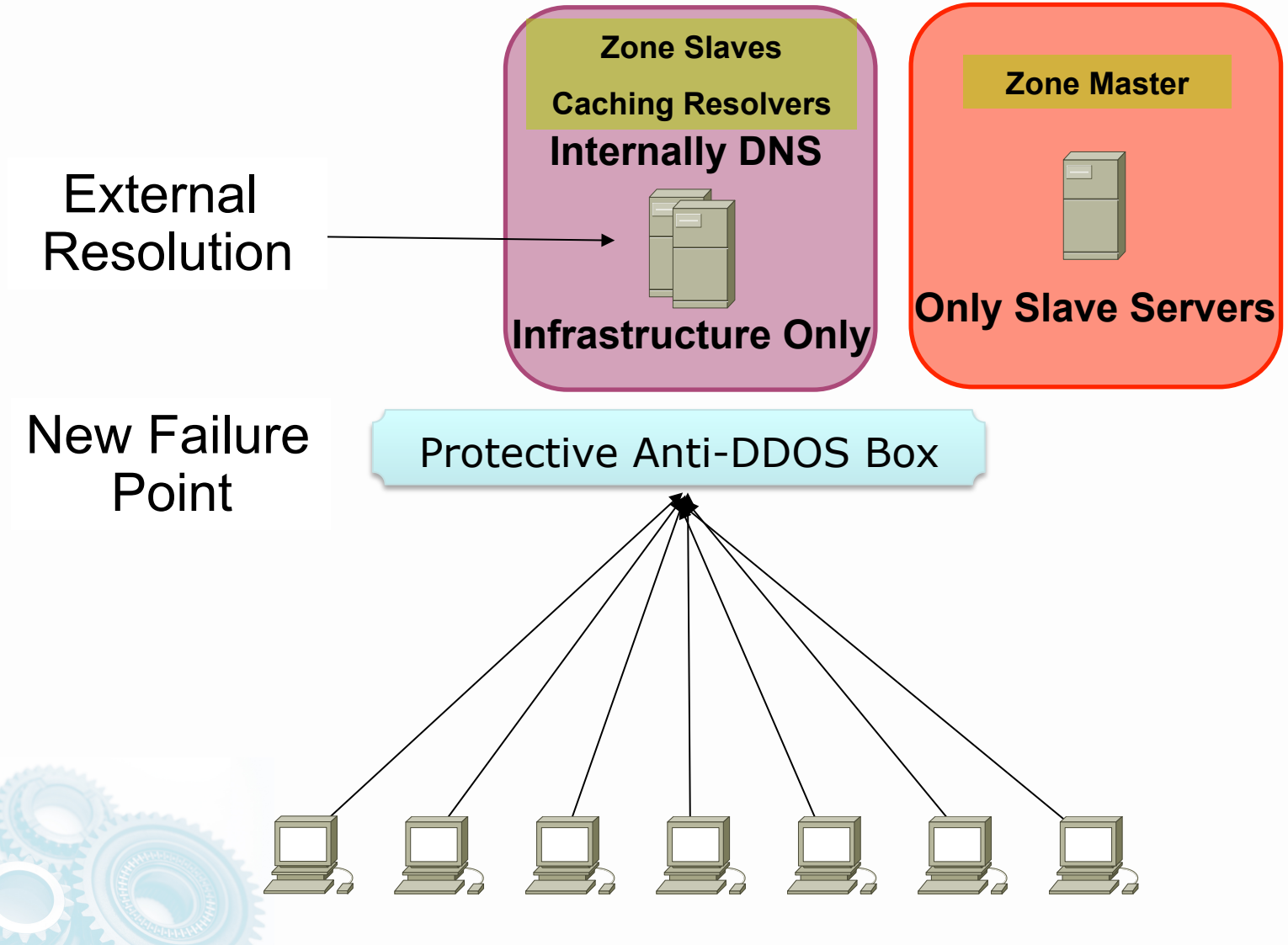
Agenda

- Consultation about the key “DNS” problems.
- Review of the key operational issue seen with DNS robustness.
- Modularization & Compartmentalization

Most DNS Today



Protecting DNS like HTTP does not work



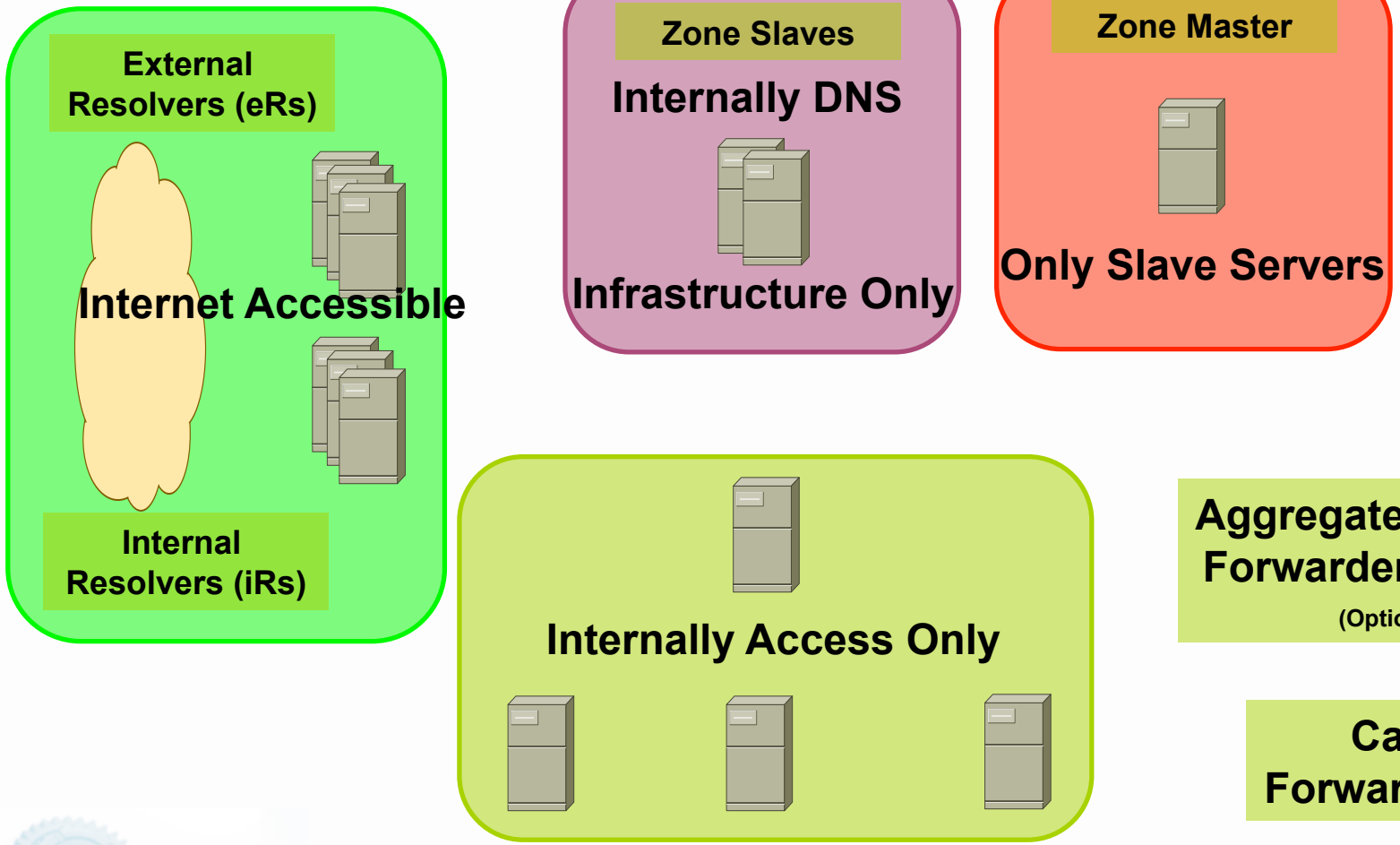
DNS Resiliency Requires "Engineering"

- DNS Resiliency requires engineers to execute "engineering."
  - The technology must be understood.
  - DNS's Interdependency and Coupled Dependency with all parts of the other services must been mapped out.
  - Architectural Plans must be drawn and tested.
- Some of the world's biggest company's have had complete DNS failures …. where the root cause was based on throwing DNS into a network, putting a router/load balancer/anti-DOS device in front of it, and thinking it is going to "just work."
- *Architectural Principles are the key to DNS Resiliency*

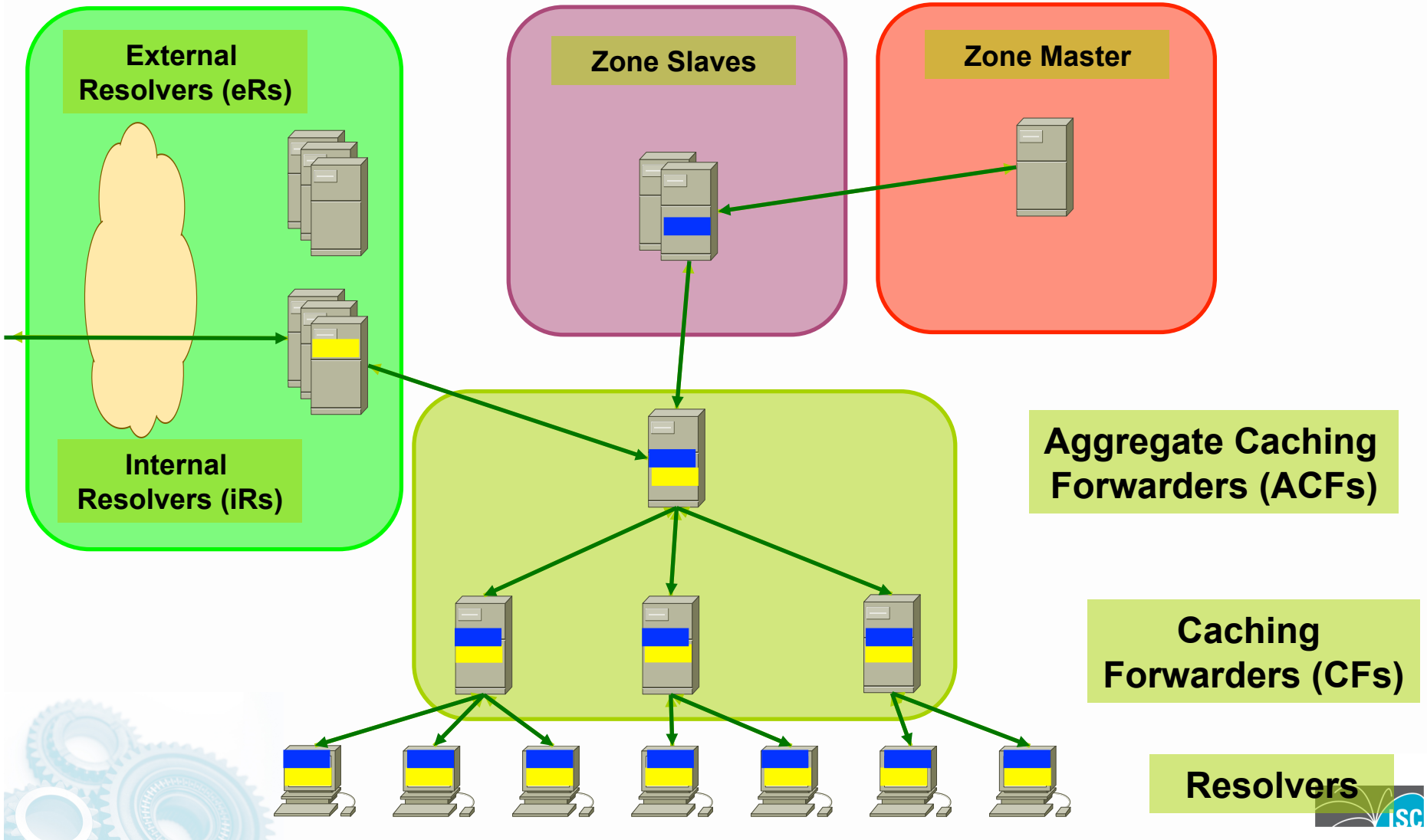
Options

- There are key options a provider has to "re-architect" their DNS. Two key requirements are:
  - Investing in your own people to turn them into DNS Gurus.
  - Join DNS-OARC (https://www.dns-oarc.net/)
  - Active Participation in your network operations communities (RIPE and MENOG)
- The "kick start" options to change fast include:
  - Contracting with Internet Systems Consortium (http://www.isc.org/)
  - Outsourceing to a DNS provider (i.e. ISC)
  - Work with one of the two big DNS product Vendors (ISC, Nominum, or Infoblox).

Robust DNS Topology for Big Networks



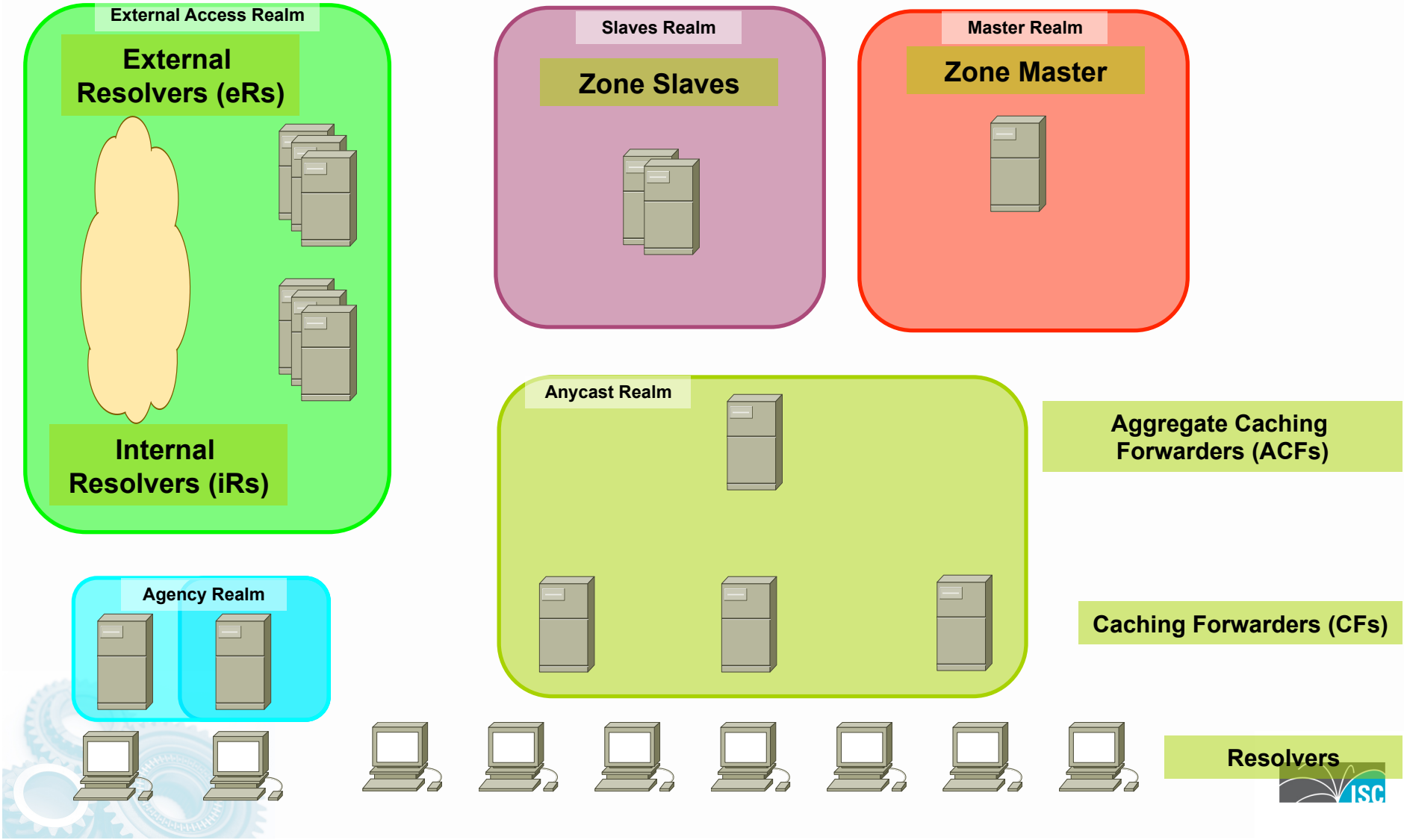
Out Bound Recursion/Resolution



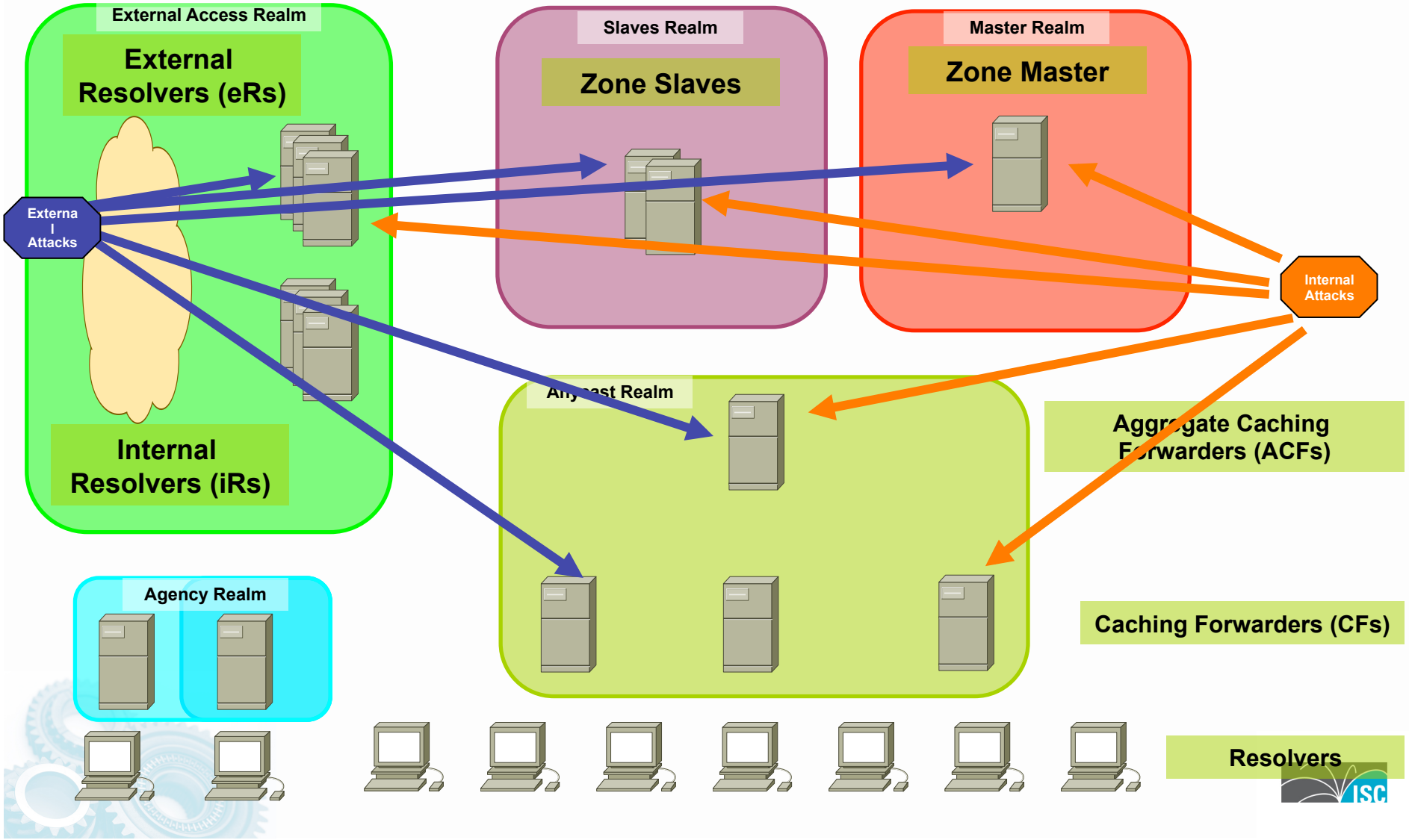
Compartmentalization Simplifies Security

- Modularization and Role allow for distinct relationship to be turned into policy.
- That policy can be enforced and monitored.

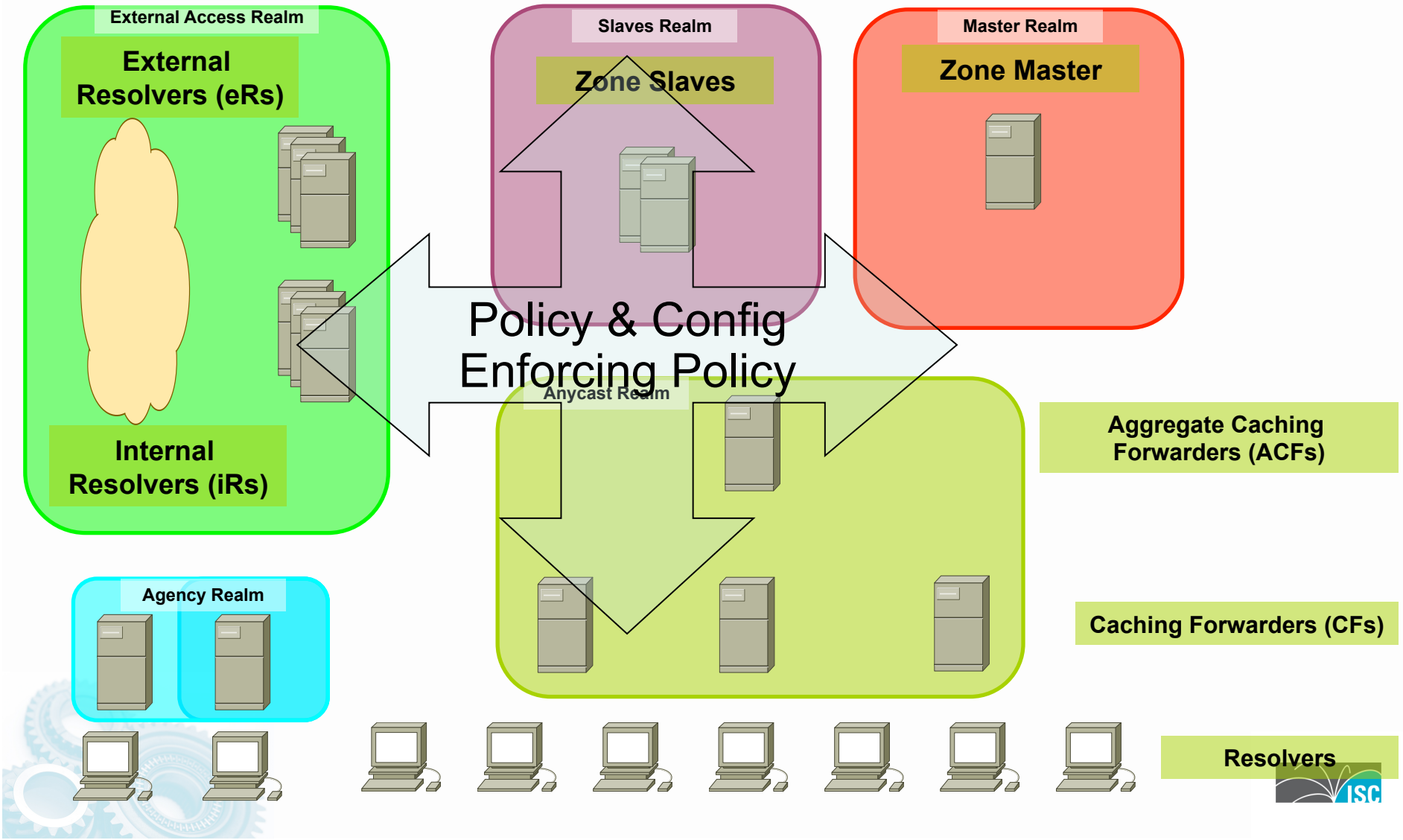
Roles and Security Realms



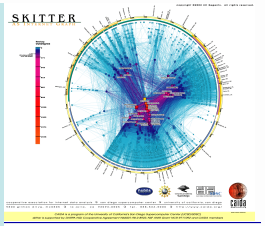
Attack Vectors

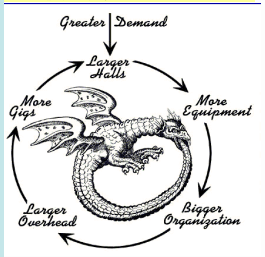


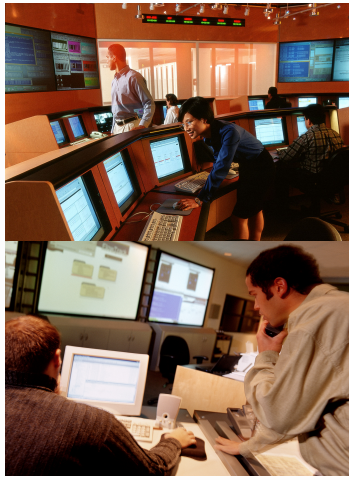
Configure Policy



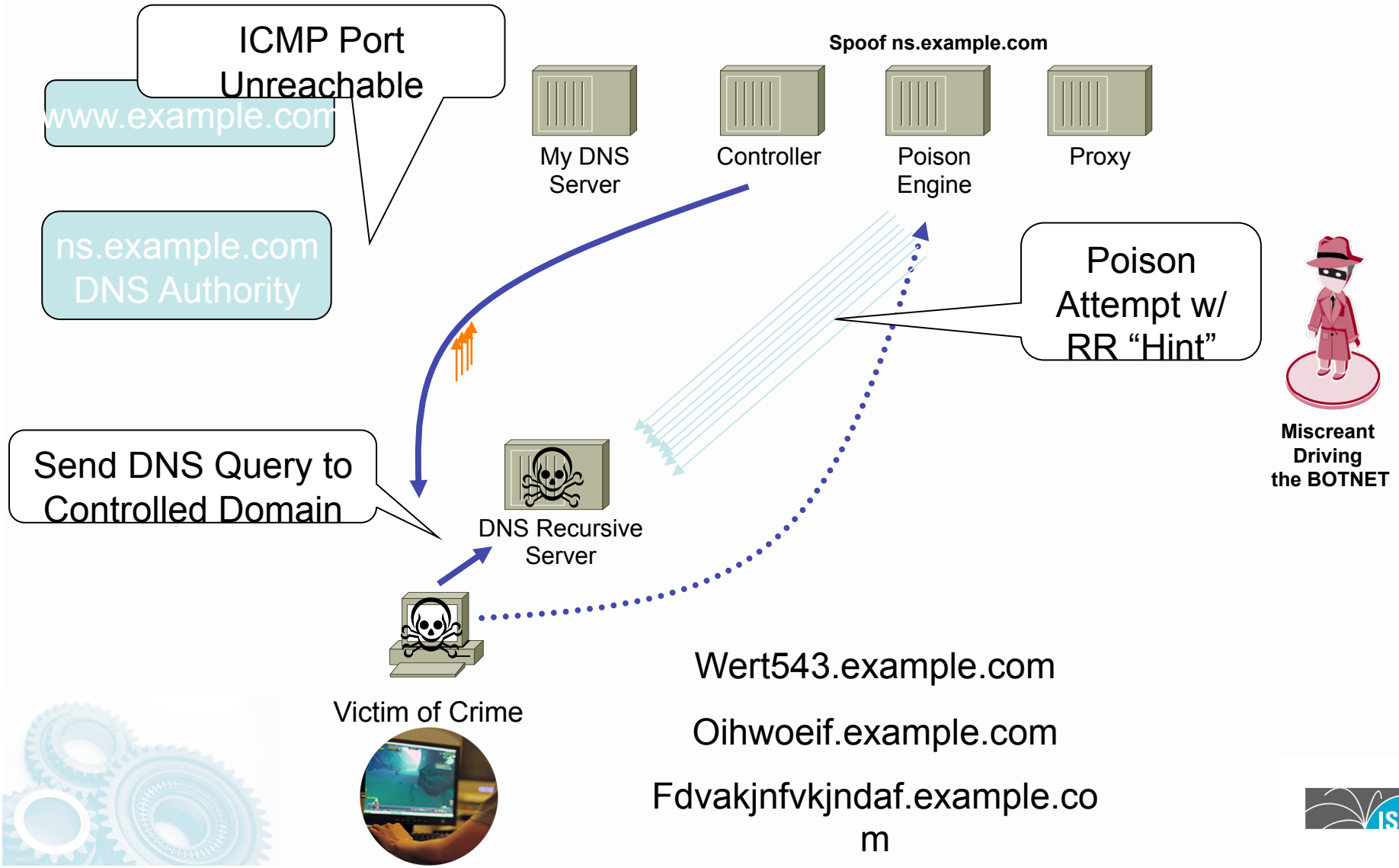
DNS Backscatter - Knowing when you are being Poisoned







Backscatter – ICMP Port Unreachable



ICMP Unreachable & DNS

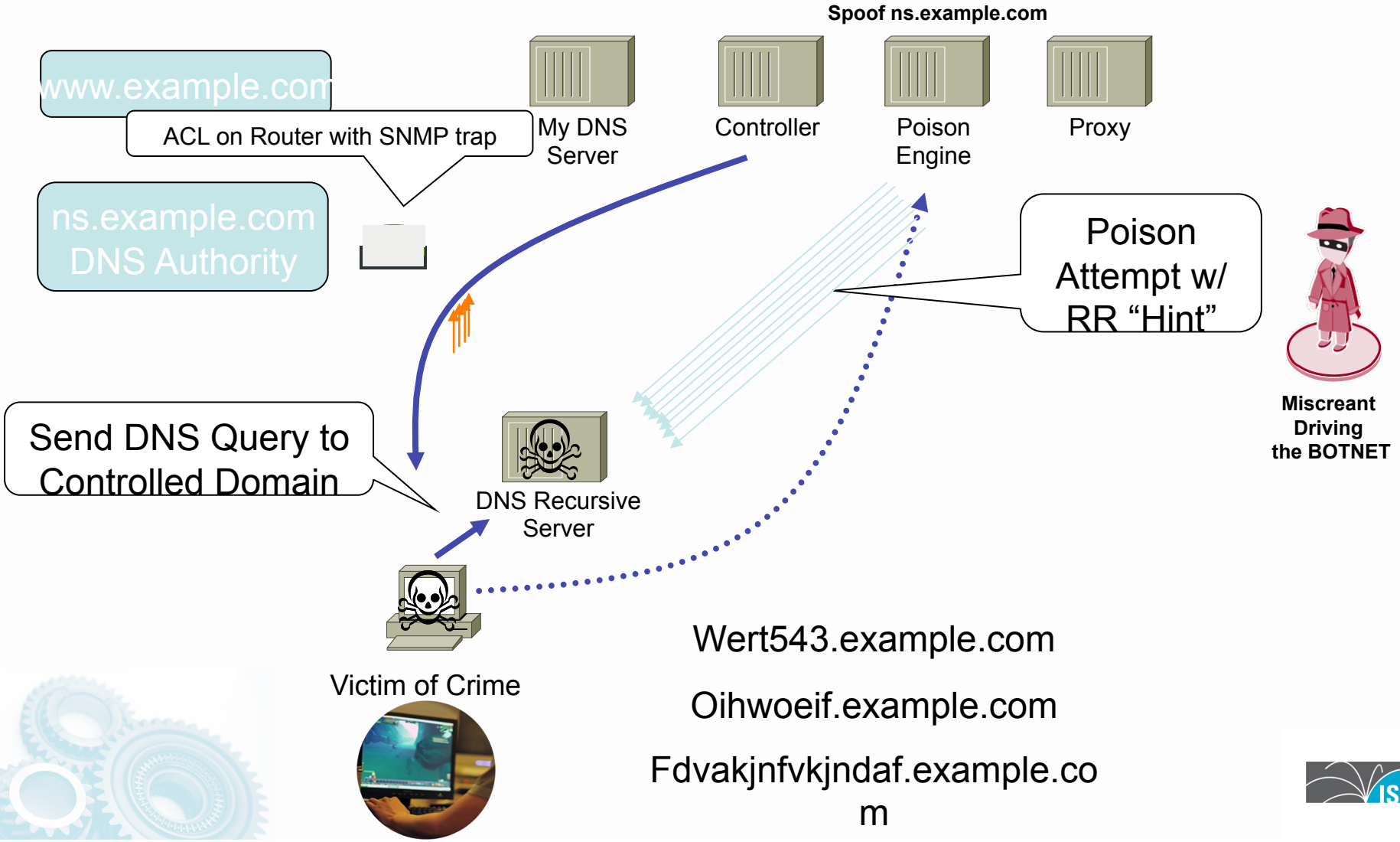
- ICMP Unreachable – specific port unreachable – are not normal packets which arrive at:
  - DNS Masters
  - DNS Slaves
  - DNS Split-Horizon Authoritative Servers
- Live Observation
  - Launching the attack results packets arriving on closed ports of the recursive DNS Server.
  - This send ICMP Port Unreachable to the source packet – which is the DNS Authority being spoofed.

ICMP Port Unreachable

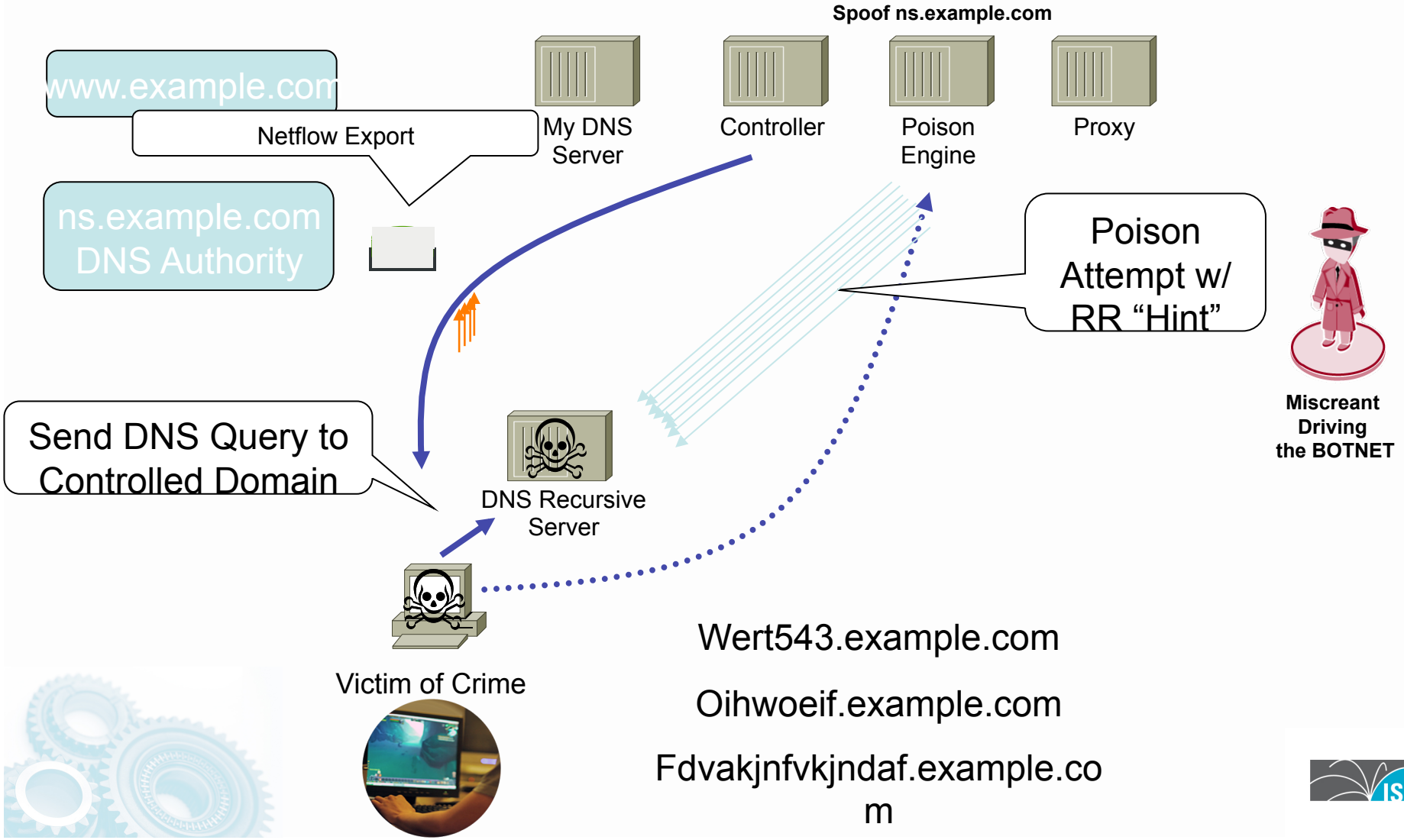
- This will tell you that someone somewhere is poising somewhere so that they can be a man in the middle between you and your customer!

- How to monitor:
  - Classification ACLs (match ingress on ICMP port unreachable)
  - Netflow
  - IDP/IPS
  - Firewalls
  - DPI Boxes

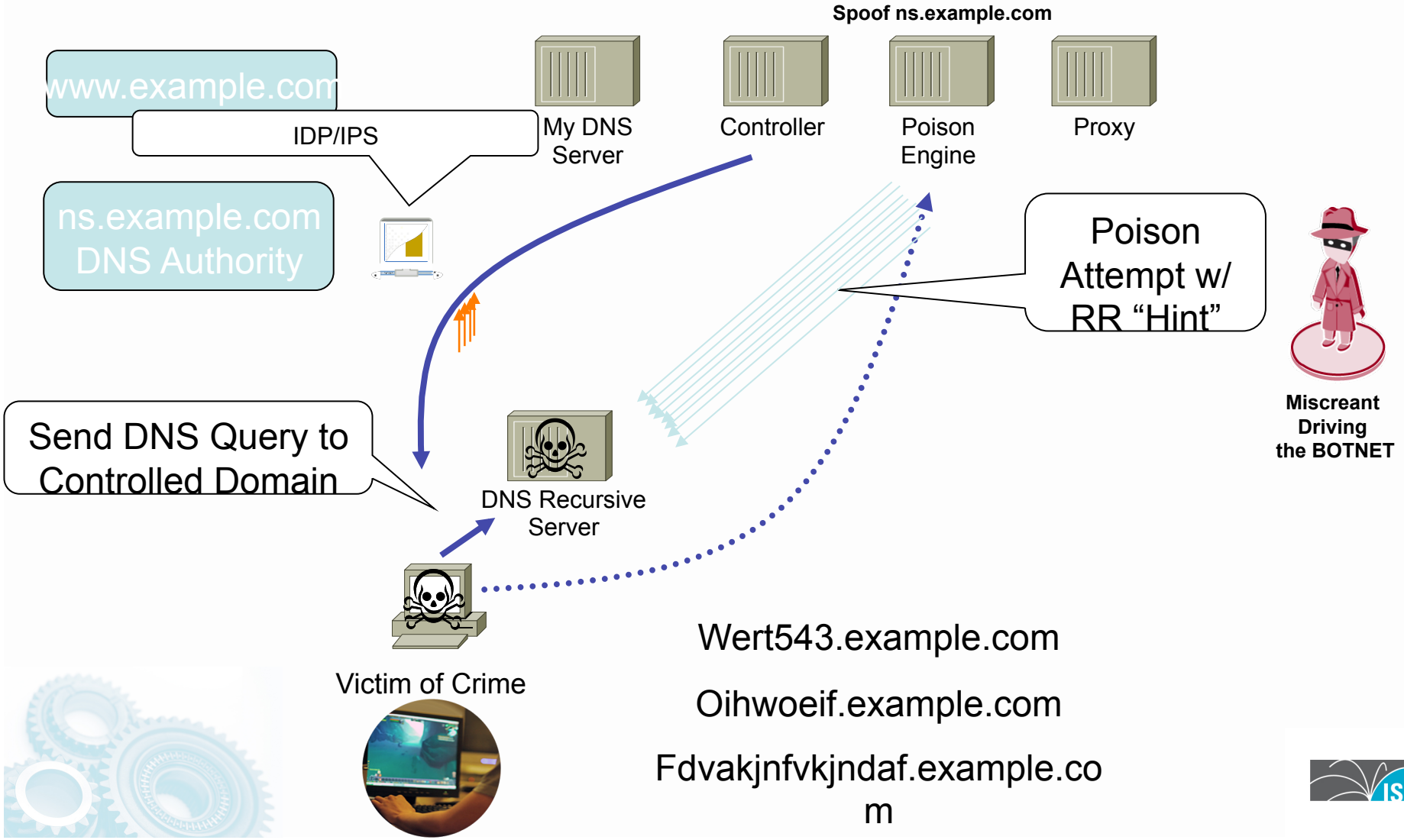
ACLs - How?


Spoof ns.example.com
www.example.com
ACL on Router with SNMP trap
My DNS Server
Controller
Poison Engine
Proxy
ns.example.com DNS Authority
Poison Attempt w/ RR "Hint"
Miscreant Driving the BOTNET
Send DNS Query to Controlled Domain
DNS Recursive Server
Victim of Crime
Wert543.example.com
Oihwoeif.example.com
Fdvakjnfvkjndaf.example.com

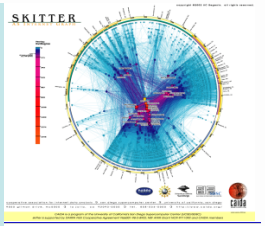
Netflow

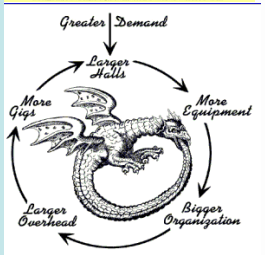

Spoof ns.example.com
www.example.com
Netflow Export
ns.example.com
DNS Authority
My DNS Server
Controller
Poison Engine
Proxy
Poison Attempt w/ RR “Hint”
Miscreant Driving the BOTNET
Send DNS Query to Controlled Domain
DNS Recursive Server
Victim of Crime
Wert543.example.com
Oihwoeif.example.com
Fdvakjnfvkjndaf.example.com

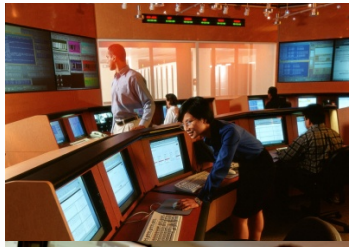
IDP/IPS


Spoof ns.example.com
www.example.com
IDP/IPS
My DNS Server
Controller
Poison Engine
Proxy
ns.example.com DNS Authority
Poison Attempt w/ RR "Hint"
Miscreant Driving the BOTNET
Send DNS Query to Controlled Domain
DNS Recursive Server
Victim of Crime
Wert543.example.com
Oihwoeif.example.com
Fdvakjnfvkjndaf.example.com

Total Visibility Addendum







NetFlow—More Information

- Cisco NetFlow Home—http://www.cisco.com/warp/public/732/Tech/nmp/netflow
- Linux NetFlow Reports HOWTO—http://www.linuxgeek.org/netflow-howto.php
- Arbor Networks Peakflow SP—http://www.arbornetworks.com/products_sp.php

More Information about SNMP

- Cisco SNMP Object Tracker—http://www.cisco.com/pcgi-bin/Support/Mibbrowser/mibinfo.pl?tab=4
- Cisco MIBs and Trap Definitions—http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml
- SNMPLink—http://www.snmplink.org/
- SEC-1101/2102 give which SNMP parameters should be looked at.

RMON—More Information

- IETF RMON WG— http://www.ietf.org/html.charters/rmonmib-charter.html
- Cisco RMON Home— http://www.cisco.com/en/US/tech/tk648/tk362/tk560/tech_protocol_home.html
- Cisco NAM Product Page— http://www.cisco.com/en/US/products/hw/modules/ps2706/ps5025/index.html

BGP—More Information

- Cisco BGP Home—
  http://www.cisco.com/en/US/tech/tk365/tk80/tech_protocol_family_home.html
- Slammer/BGP analysis—
  http://www.nge.isi.edu/~masseyd/pubs/massey_iwdc03.pdf
- Team CYMRU BGP Tools—
  http://www.cymru.com/BGP/index.html

Syslog—More Information

- Syslog.org - http://www.syslog.org/
- Syslog Logging w/PostGres HOWTO—http://kdough.net/projects/howto/syslog_postgresql/
- Agent Smith Explains Syslog—http://routergod.com/agentsmith/

Packet Capture—More Information

- tcpdump/libpcap Home—
  http://www.tcpdump.org/
- Vinayak Hegde's Linux Gazette article—
  http://www.linuxgazette.com/issue86/vinayak.html

Remote Triggered Black Hole

- Remote Triggered Black Hole filtering is the foundation for a whole series of techniques to traceback and react to DOS/DDOS attacks on an ISP's network.
- Preparation does not effect ISP operations or performance.
- It does adds the option to an ISP's *security toolkit.*

More Netflow Tools

- **NfSen - Netflow Sensor**
  - http://nfsen.sourceforge.net/
- **NFDUMP**
  - http://nfdump.sourceforge.net/
- FlowCon
  - http://www.cert.org/flocon/