Routing & Tunneling Protocol Attacks

DEFCON 9

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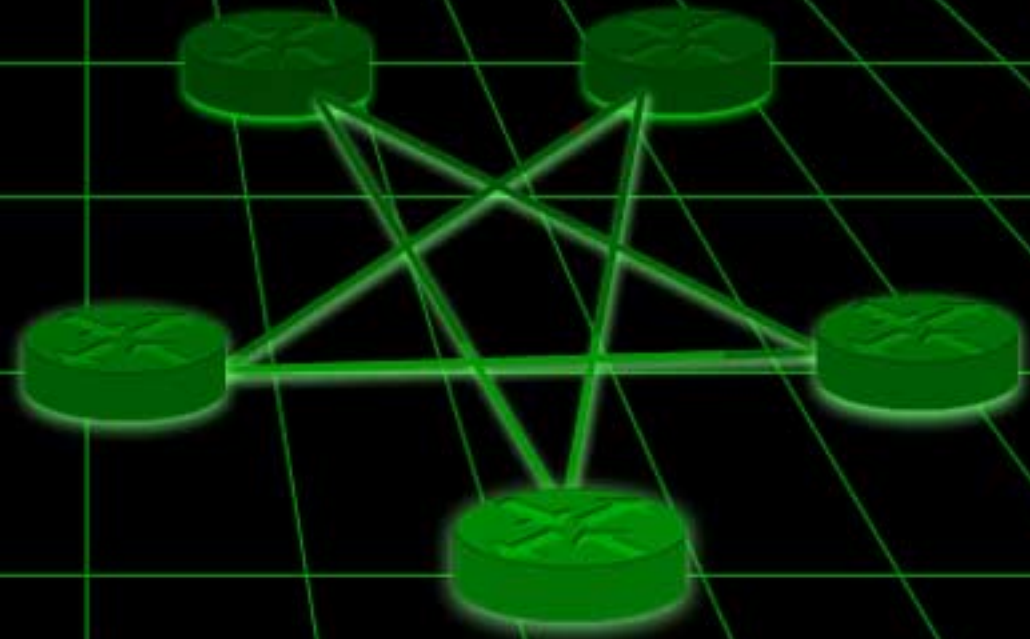
Phenoelit



Session Overview

- Introduction
- Layer 2 and 3 attack scenarios
- Hack the cable: ARP attacks
- ICMP abuse
- Discovering & attacking IGPs
- GRE intrusion & RFC-1918 hacking

Why bother with protocols when I have exploits?

Exploits

- Specific software
- Specific version
- Platform dependent
- Exploit awareness
- Patches protect and are easy to apply

Protocols

- Standards Conformant
- Widely supported
- Platform independent
- Issues are less known
- Only a consistent config and design protects

Use both!

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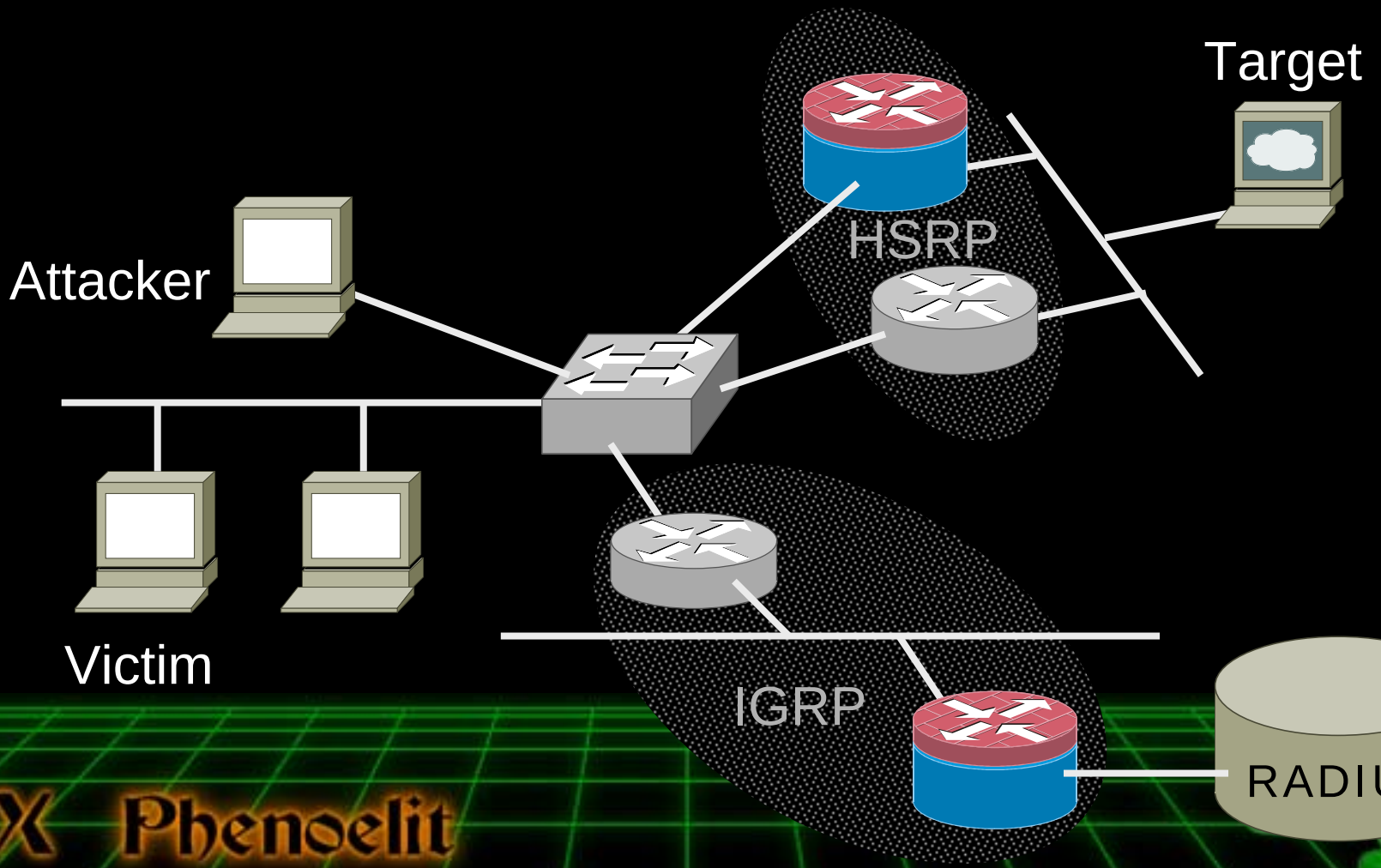
Attack Scenarios [0]
The Network



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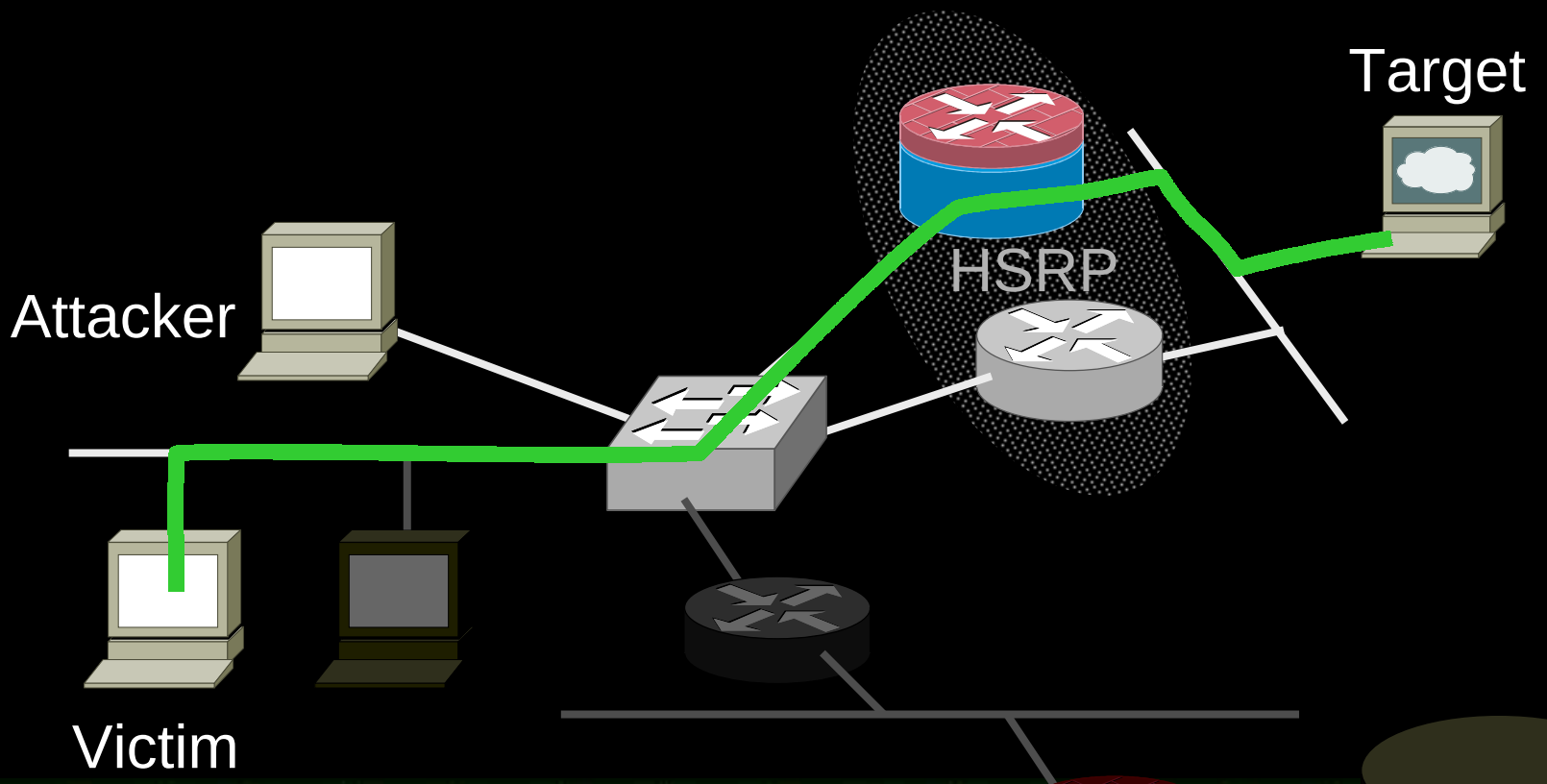
Attack Scenarios [1]
A normal traffic path



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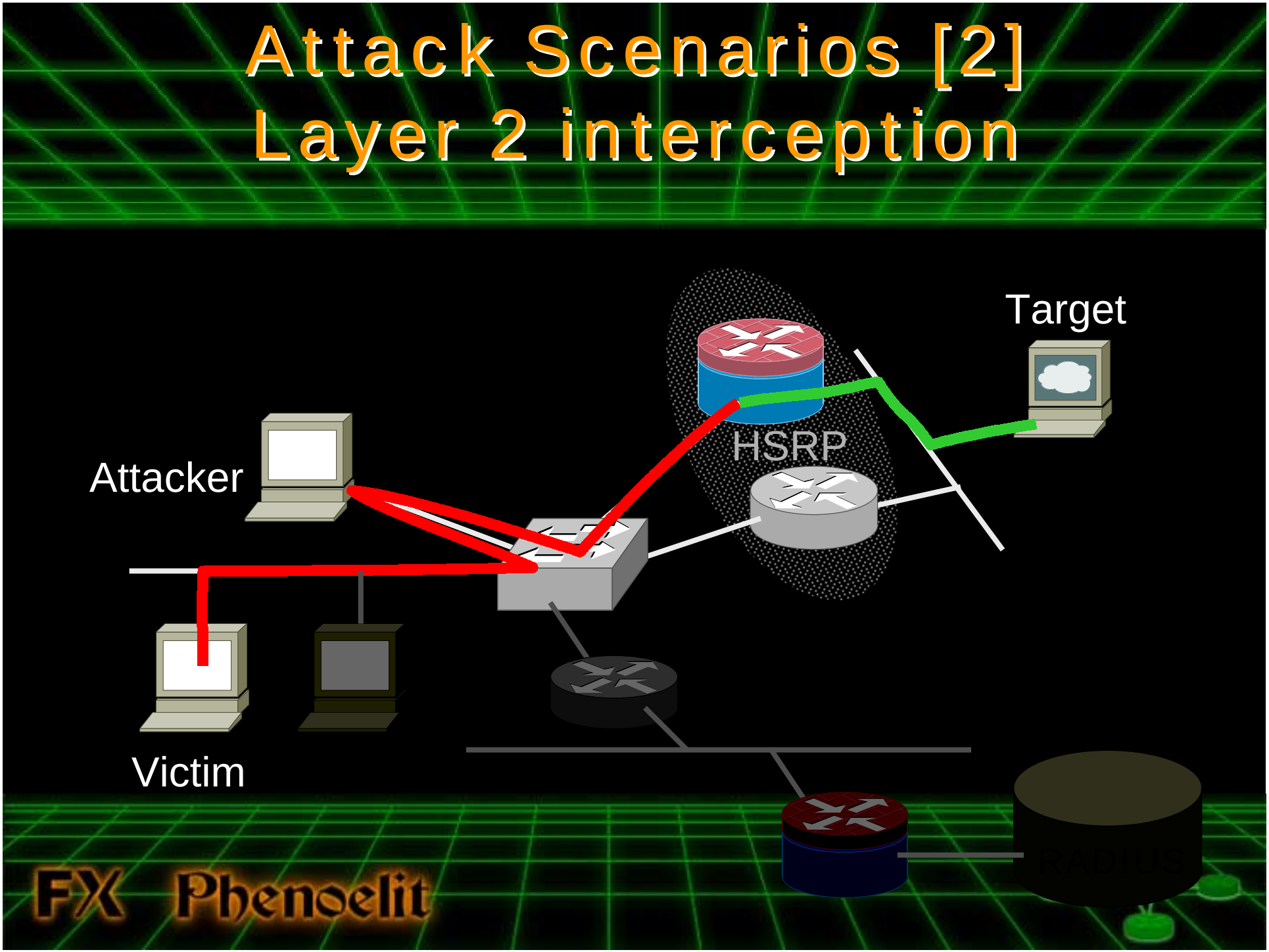
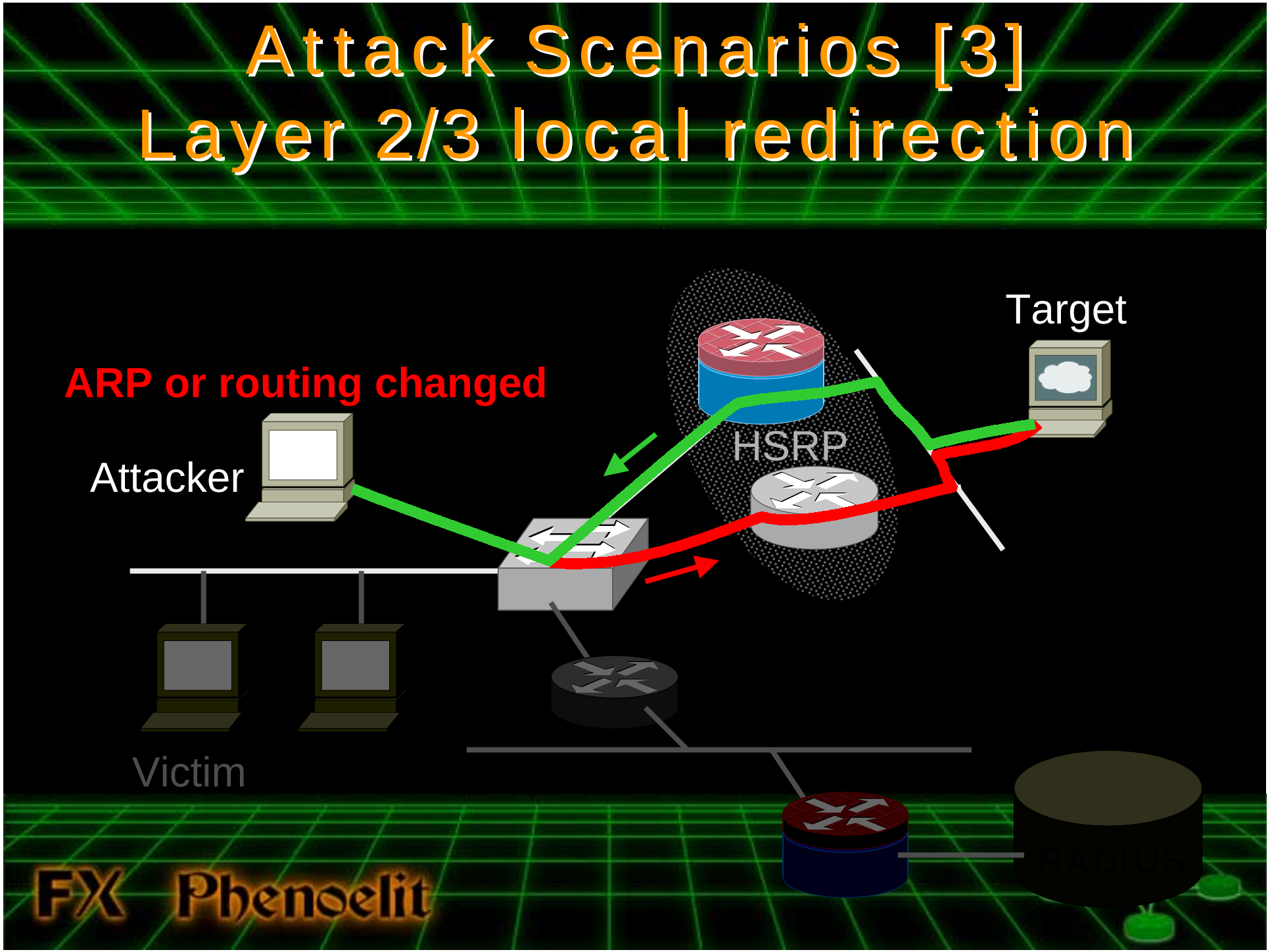
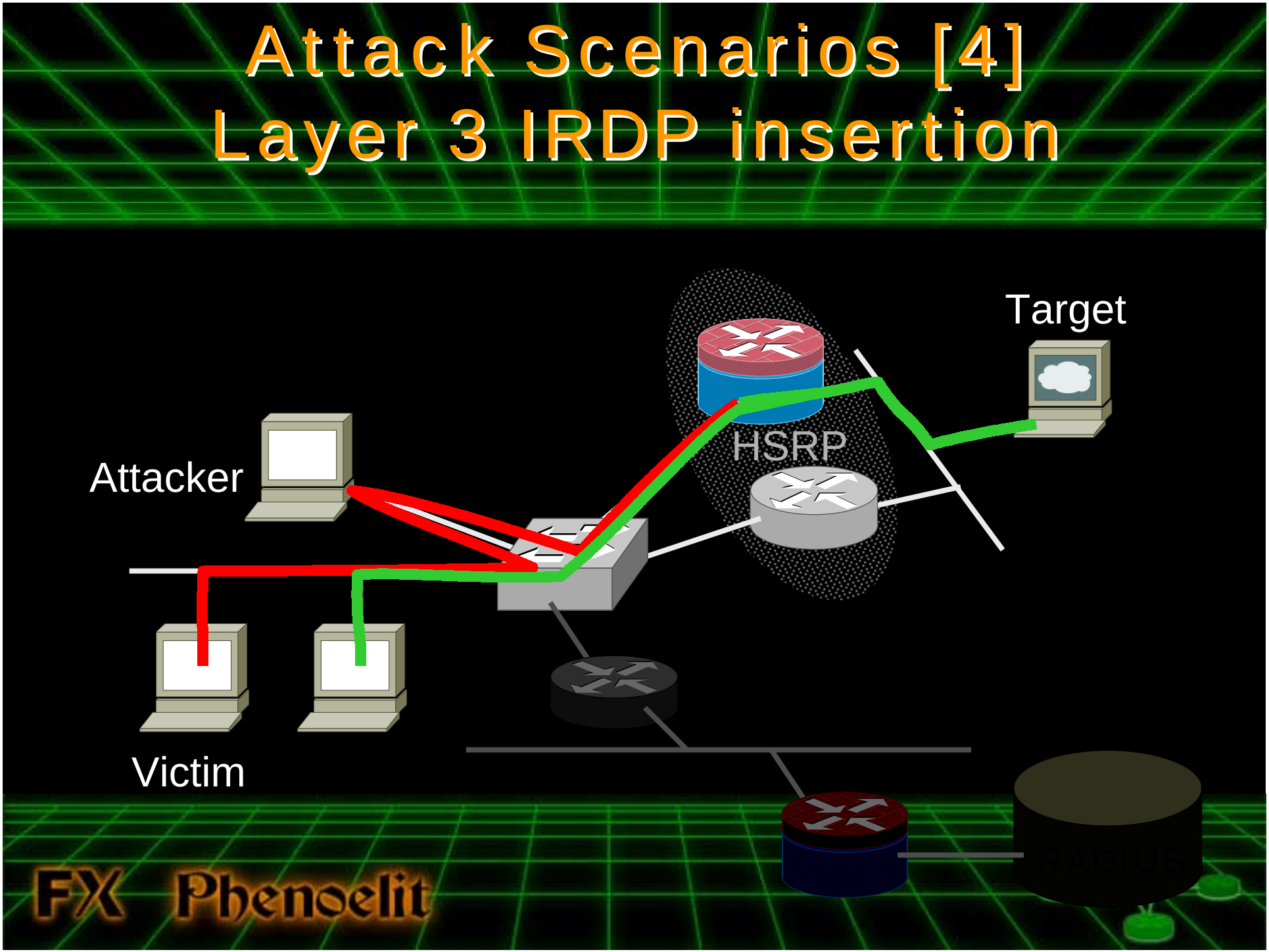
Attack Scenarios [2]
Layer 2 interception



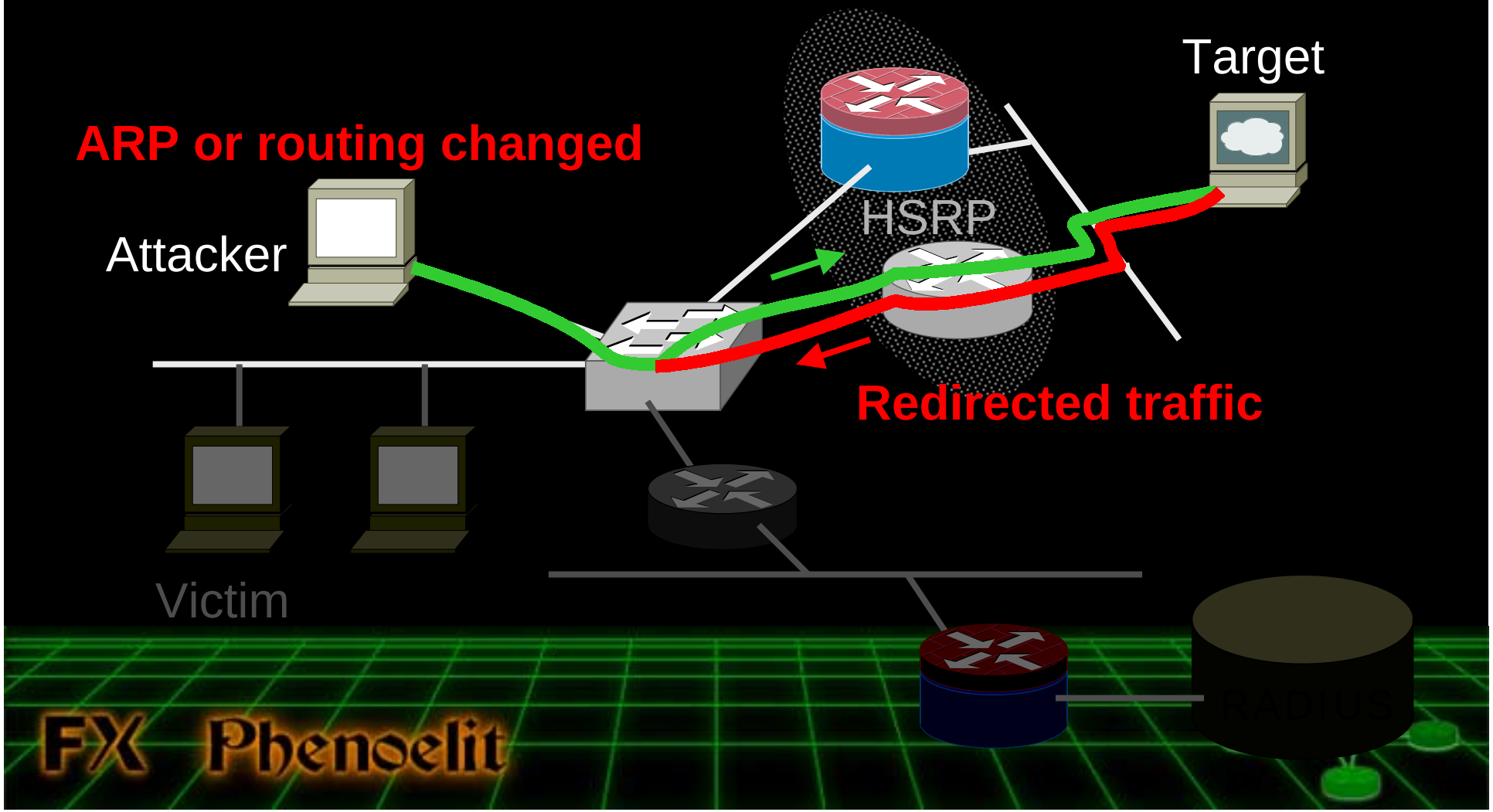
Attack Scenarios [3]
Layer 2/3 local redirection



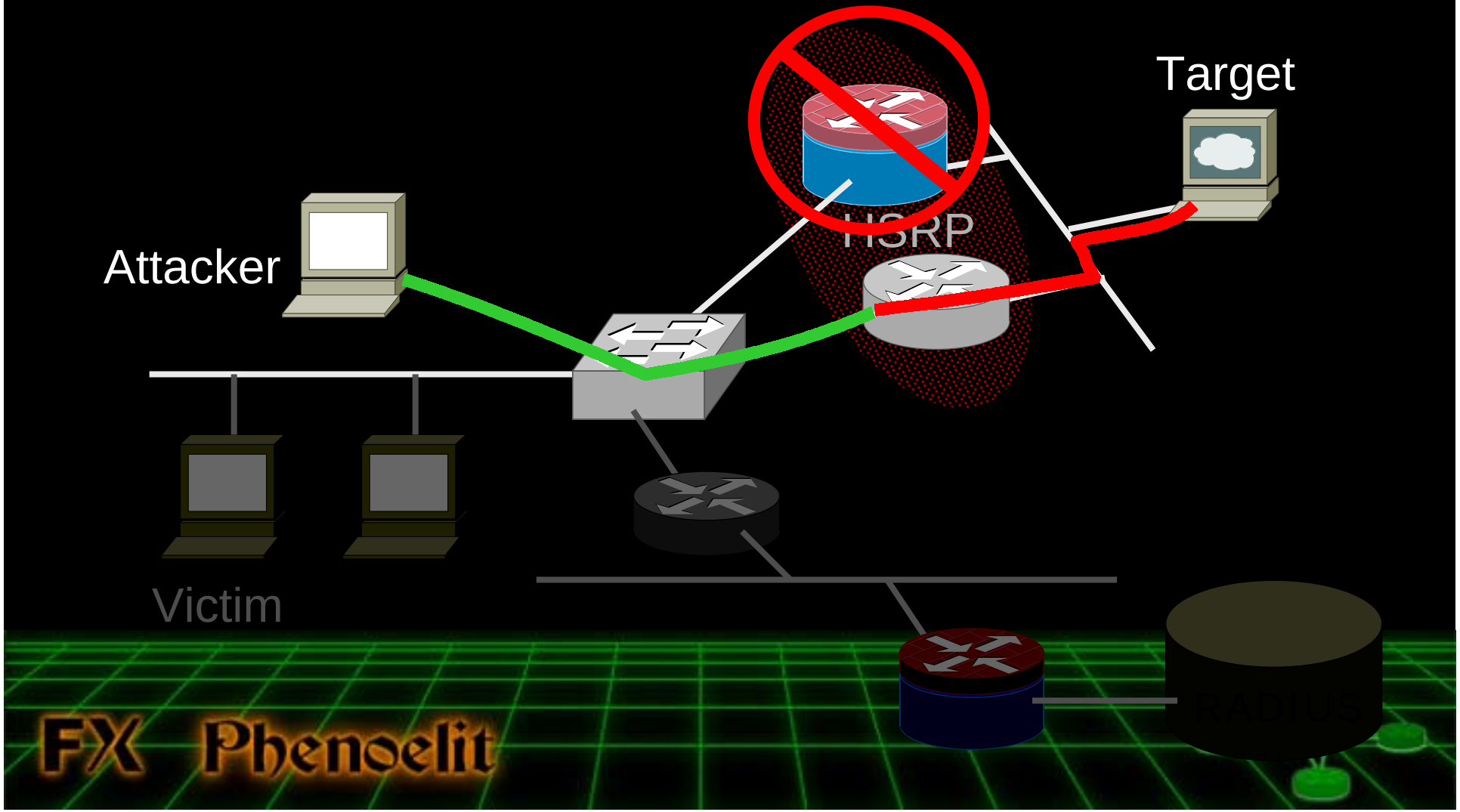
Attack Scenarios [4]
Layer 3 IRDP insertion



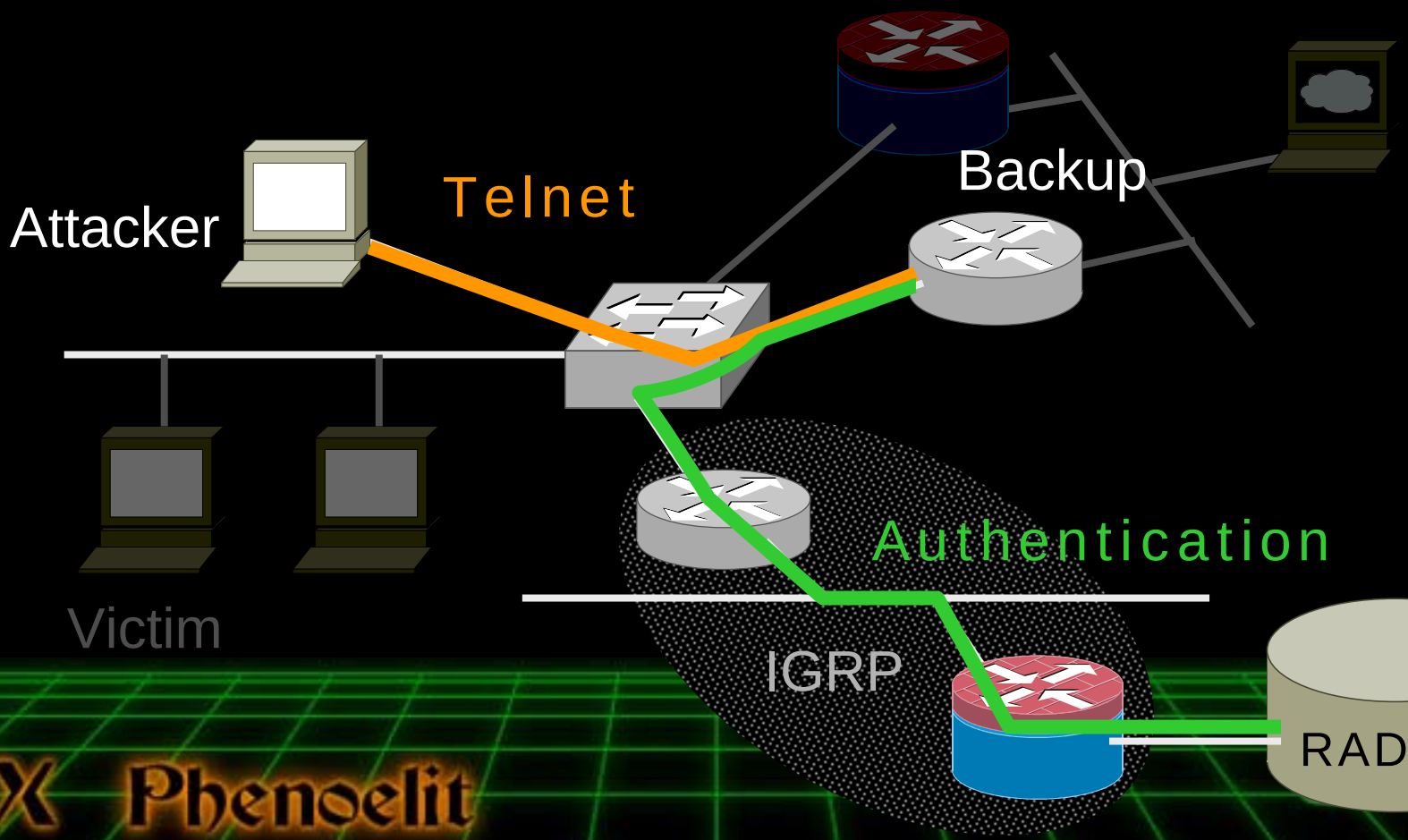
Attack Scenarios [5]
Layer 3 redirection (ICMP)



Attack Scenarios [6]
HSRP switchover & takeover



Attack Scenarios [7]
Another normal traffic path



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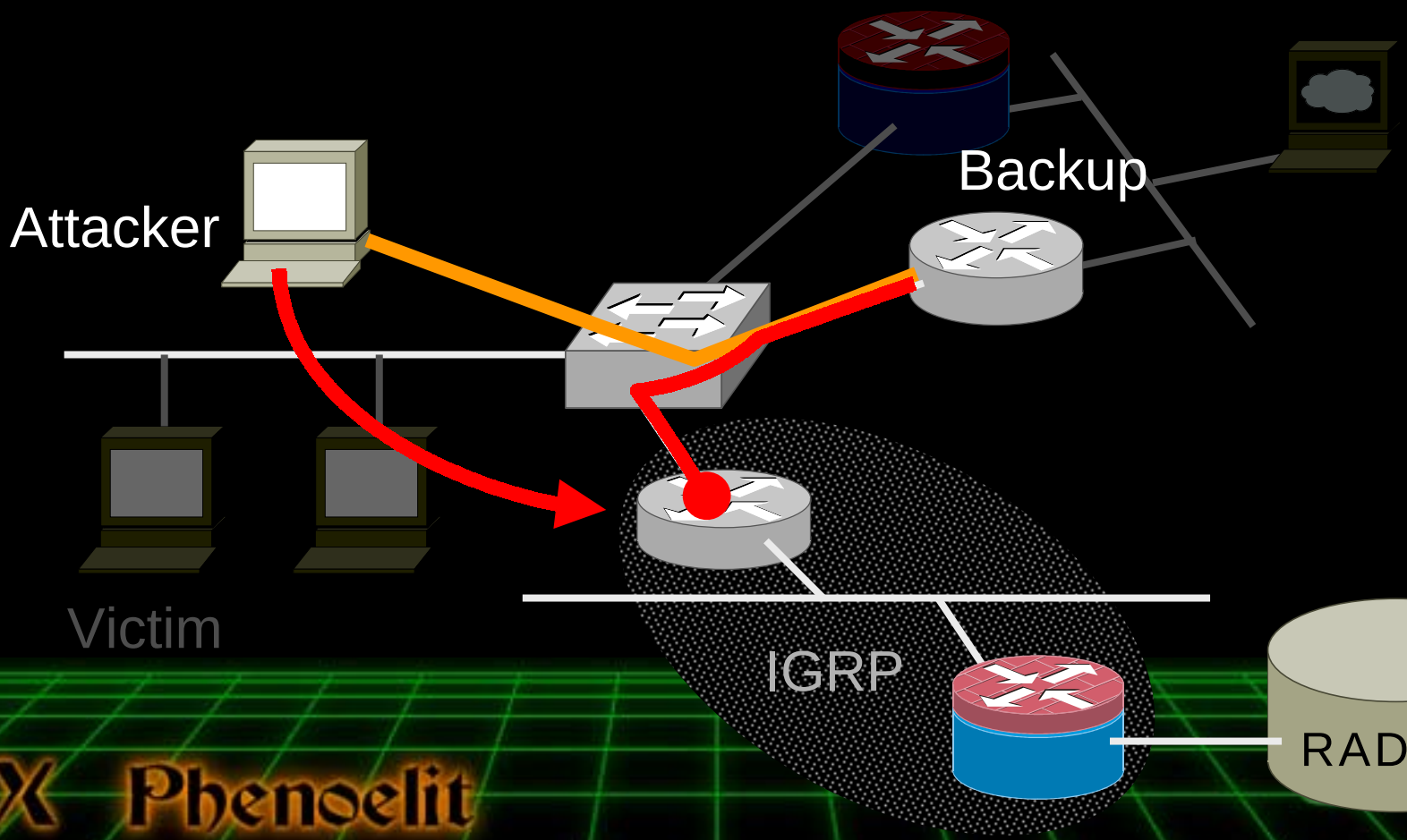
Attack Scenarios [8]
IGRP Routing attack



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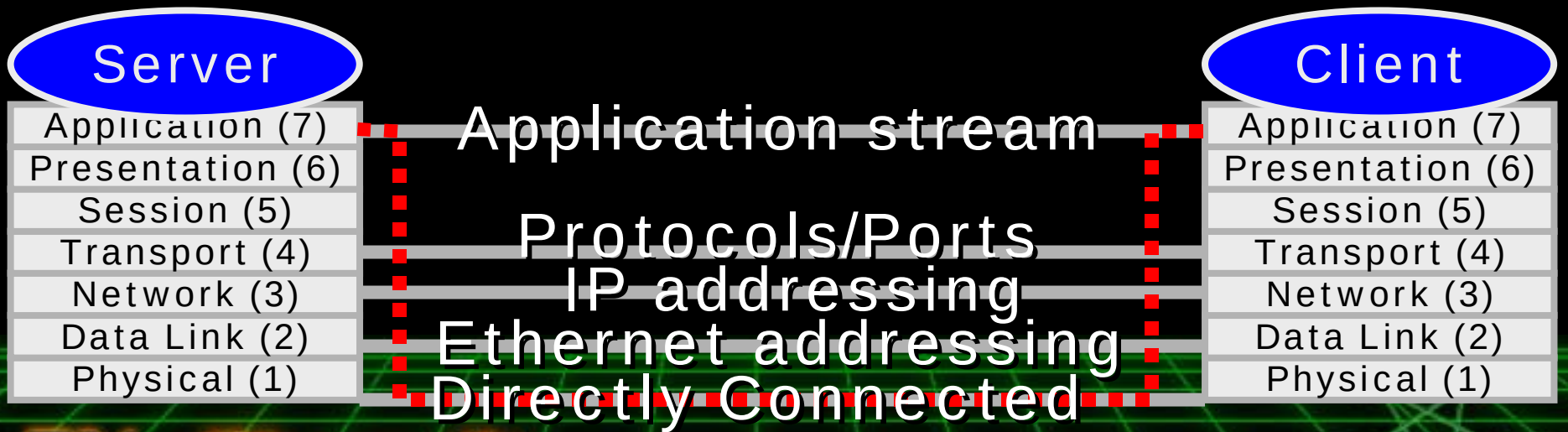
How do these attacks work in general?

- Normal communication goes down the OSI layers
- All attacks on Layer 2 and Layer 3 work on
  - Modification of the **addressing**
  - Therefore modification of the **traffic path**



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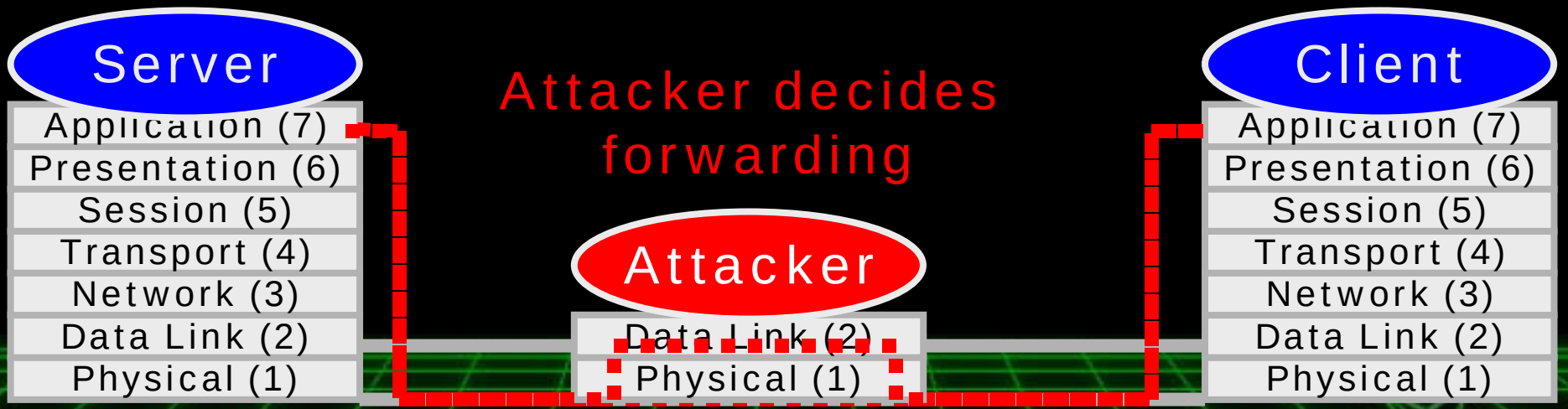
Layer 2 Attack

- Man in the middle attack
- Intercepting traffic by giving false data link address information to both parties
- Layer 3 remains untouched
- The only effective way is ARP interception



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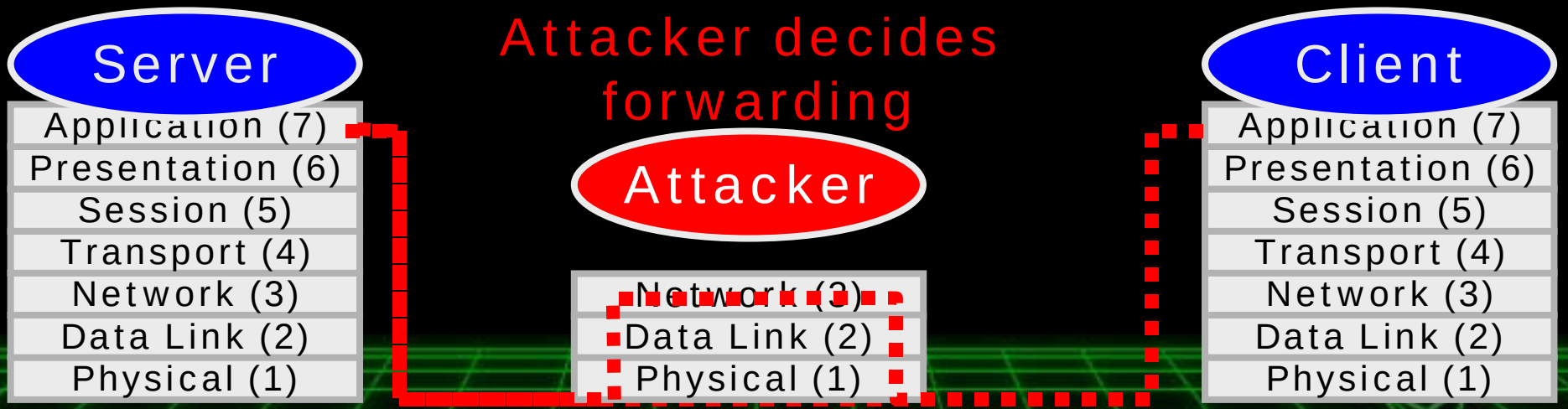
Layer 3 Attack

- Man in the middle or remote attack
- Intercepting traffic by giving false next hop information to one or both parties
- Works from remote segments
- There are various methods of applications



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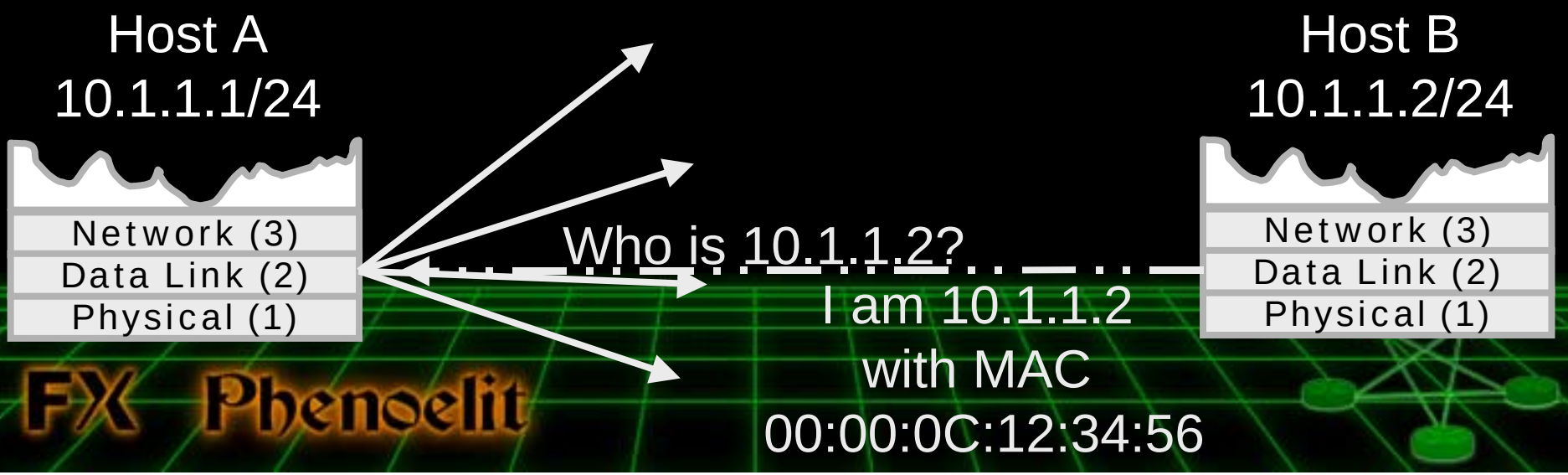
Address Resolution Protocol
ARP (RFC 826)

- IP addresses are resolved into Media Addresses
- If the Media Address is unknown, request it via Broadcast
- First or most recent answer is used to communicate
- Address cache times out on most systems



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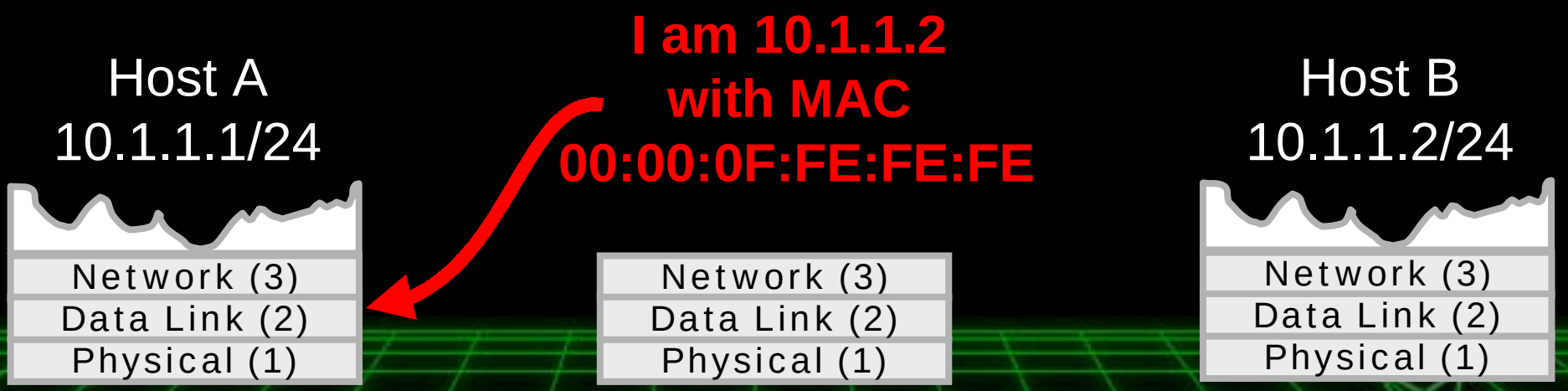
ARP Interception

- Be faster or „more chatty“ than the recipient
- Intercept both directions to prevent direct communication
- Invisible for Layer 3 integrity checks
- Requires bridging/routing (Tool or OS)
- Can be used to insert packets or prevent traffic



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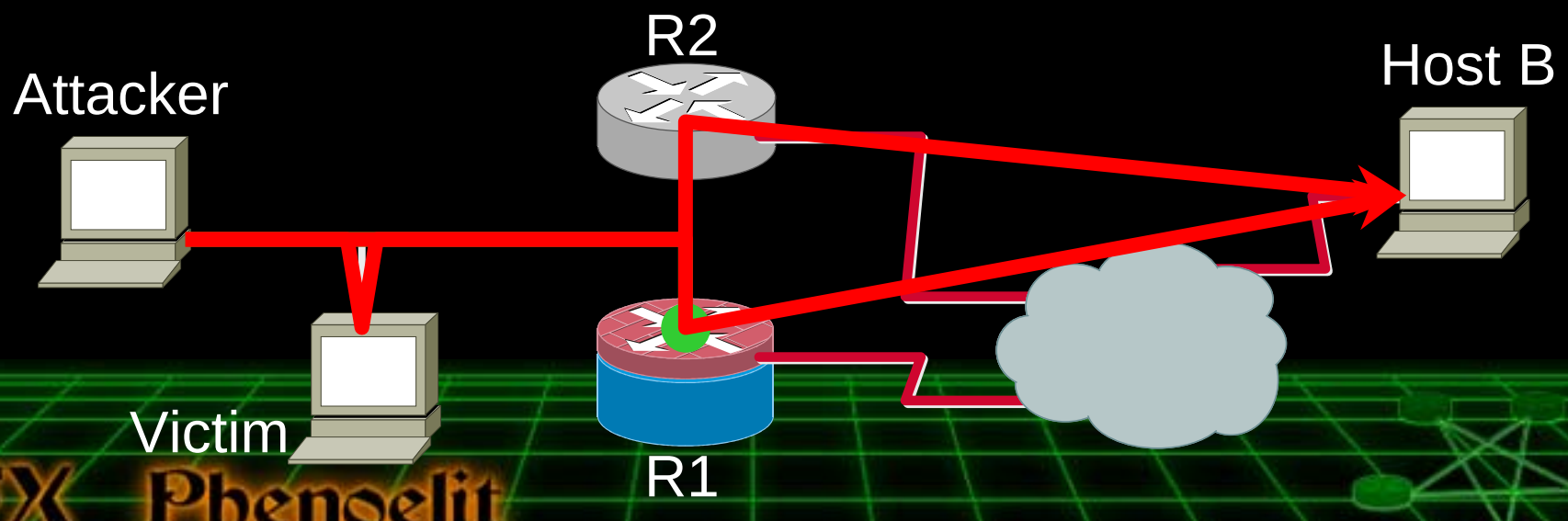
ARP Attack Tools

Tools for ARP attacks

- Phenoelit ARP0c (Linux) & WCI (Windows)
- THC Parasite
- Ettercap by ALoR & NaGA
- arpspoof by Dug Song
- HUNT by Pavel Krauz
- lots of others ...

Local Redirection

- Fixed ARP entries mapped to other IP address
- Alternative routes to circumvent packet filters
- Adding another local hop
- Can be done by hostile code on target system



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Discovering Routers

- Routers can be discovered passively by
  - Listening for Multicast emissions (HELLO and Updates)
  - Listening for Router advertisements and CDP
- Routers can be discovered actively by
  - Querying Routing processes (AS scanning)
  - Router Solicitations
  - OS Fingerprinting
  - Protocol scans
  - Port scans

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Router Discovery Tools

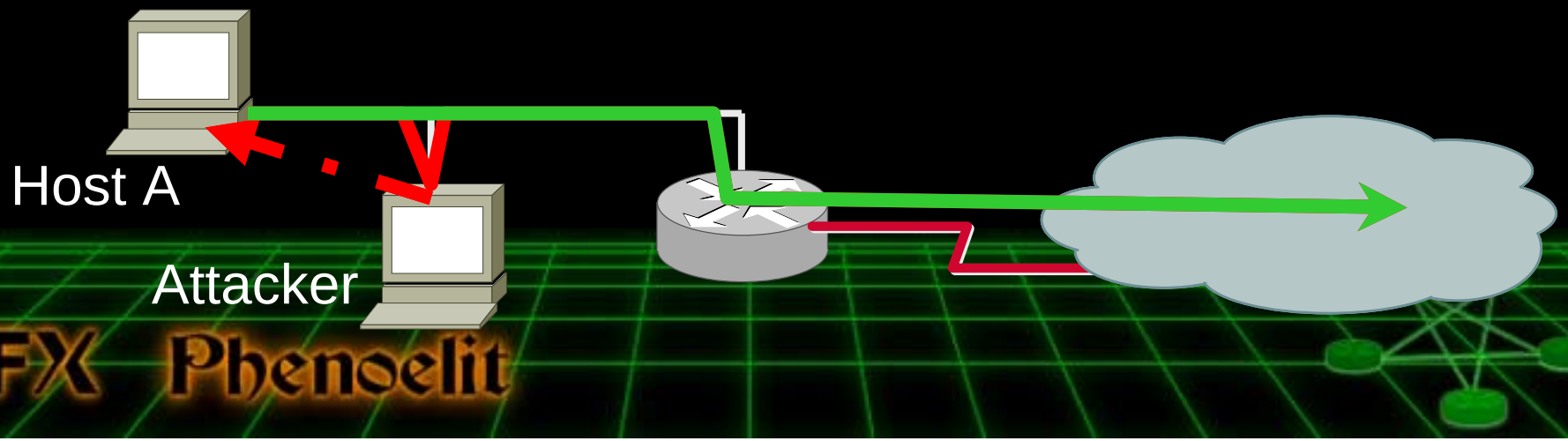
- Autonomous System Scanner (ASS) can be used for active or passive detection
- Ethereal can decode most routing protocols
- ntop can be used to discover central traffic points
- tcpdump‘s -e option shows data link addresses
- Fyodor‘s nmap and Phenoelit‘s protos scan for IP protocols
- DHCP queries reveal router addresses

ICMP Router Discovery Protocol (IRDP – RFC 1256)

- ICMP Router Discovery Protocol enabled router sends out periodic updates as broadcast
- IRDP requests (called Router Solicitations) are send as broadcast by Hosts that look for a default gateway
- Announcing Router is inserted in Host routing table
  - Metric is higher then the static default
  - Metric is lower then anything else
  - Metric depends on „preference“ value of the updates

IRDP Attacks

- Attacker sends IRDP updates
- Attacker then makes the default gateway temporary unavailable
  - CDP overflow attacks (Router reboot)
  - ICMP Redirect
  - Temporary ARP interception
- Attacker is now the default router



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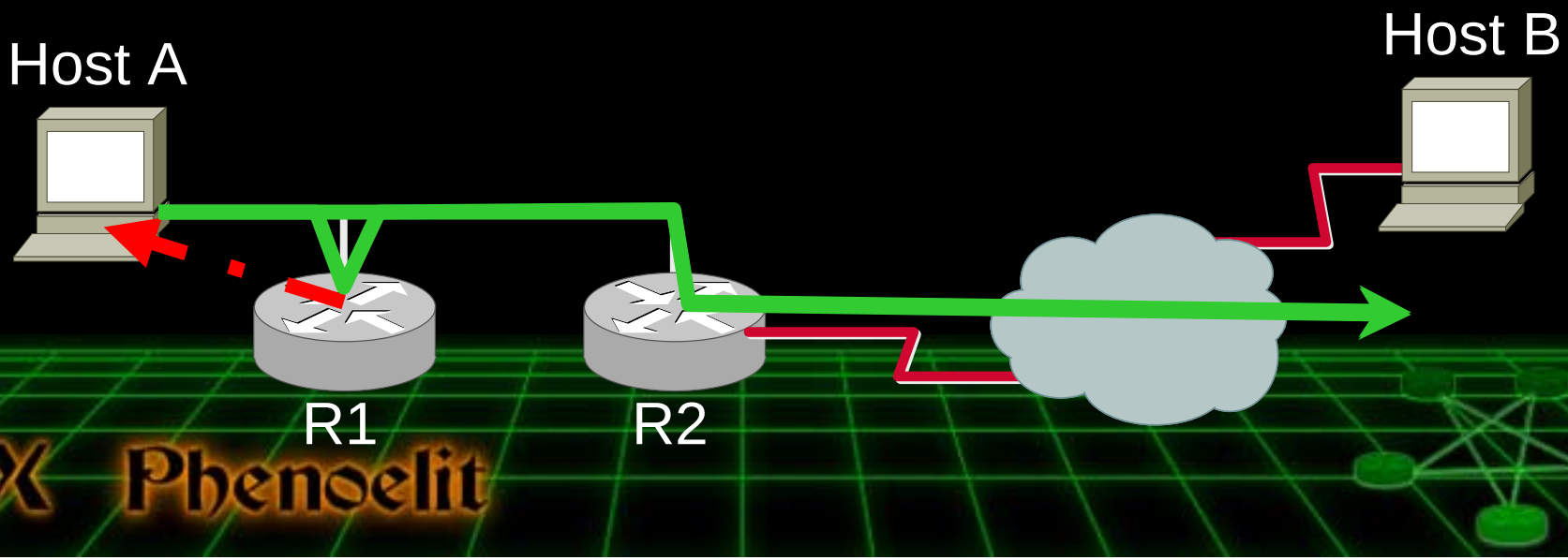
IRDP Attacks

- Phenoelit IRPAS tools
  - Irdp & Irdpresponder
  - ASS
- Best as additional interception because of metric
- Can be used to prevent interception recovery
- Lifetime of a route max **18h:12min:15sec**
- Windows 9x does IRDP **all the time**, NT on boot
- Linux doesn't care

ICMP Redirects (RFC 792)

- Introduced to make routing more effective
- Packet is send from Host A to B through router R1
- R1 finds next hop R2 on same segment and network
- R1 forwards the packet
- R1 sends ICMP Redirect to A



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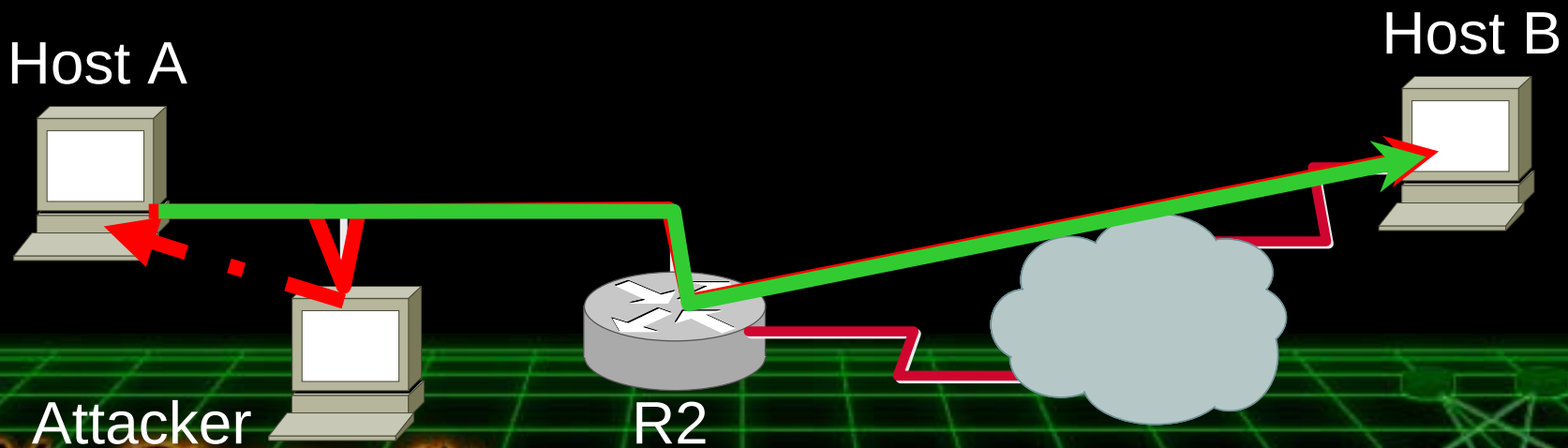
ICMP Redirect Attack

- Packet is sent from Host A to B through router R2
- Attacker sees traffic (A->B) and sends spoofed ICMP redirect to Host A
- Host A adjusts routing and sends traffic through Attacker
- Normally requires copy of the first 64bits of the packet
- Even works across routers !



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ICMP Redirect Host Reactions

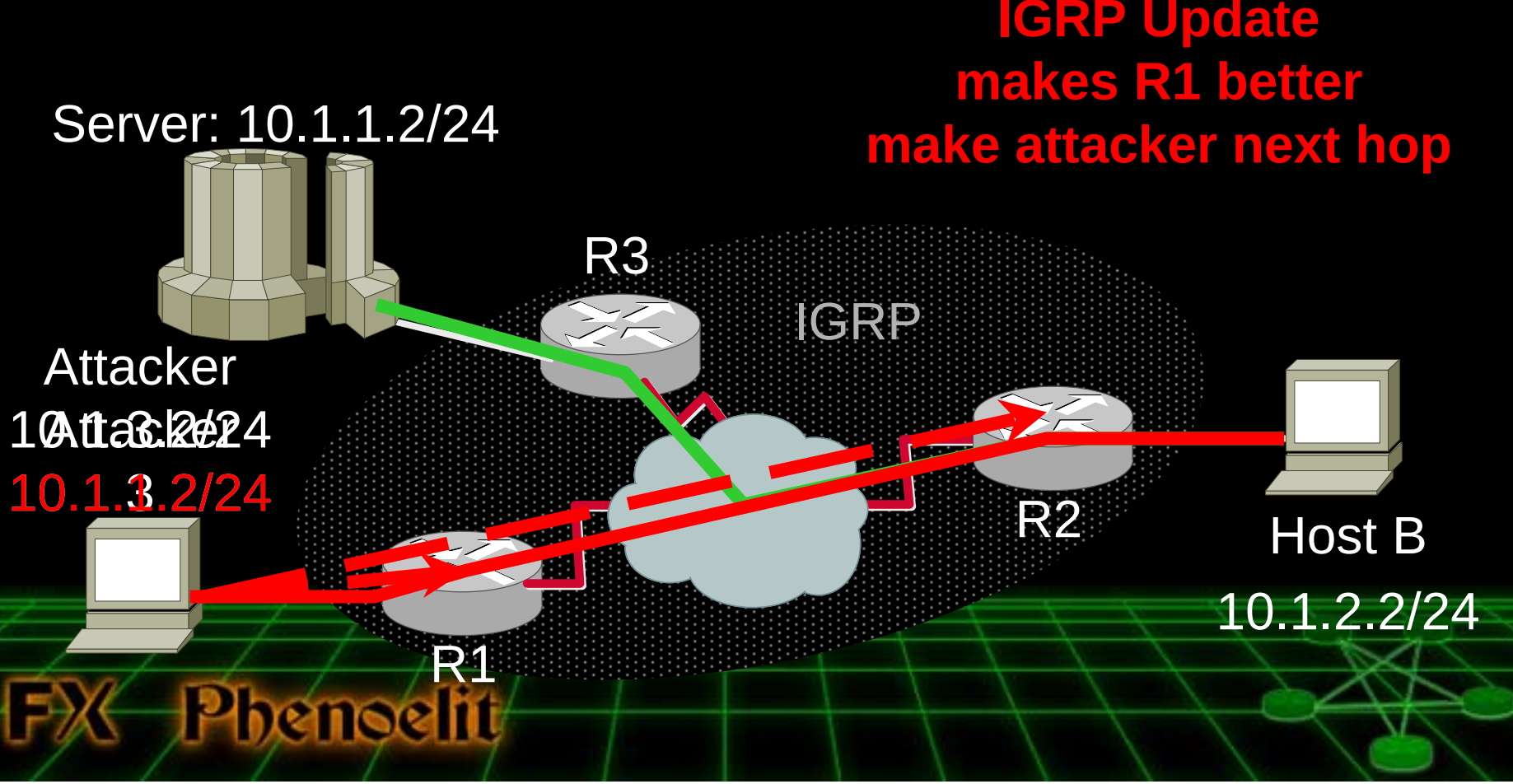
- Windows 9x Hosts
  - Accepts ICMP redirects by default
  - Adds a host route to routing table
- Linux Hosts
  - Accepts ICMP redirects by default in some distributions
  - See /proc/sys/net/ipv4/conf/*/accept_redirects
    Does not show redirects in routing table
- Tools:
  - IRPAS icmp_redirect
  - icmp_redir from Yuri Volobuev

Interior Gateway Routing Protocol (IGRP)

- Cisco proprietary protocol
- 2^{16}-1 = 65535 possible autonomous systems
- No authentication
- Delay, bandwidth, reliability, load and hop count used to calculate metric
- Passive or silent hosts possible (protocol scan)
- Spoofed updates have better metric then real links
- Requires spoofed source network to be enabled

IGRP Attacks

Introducing new routes or modifying routes



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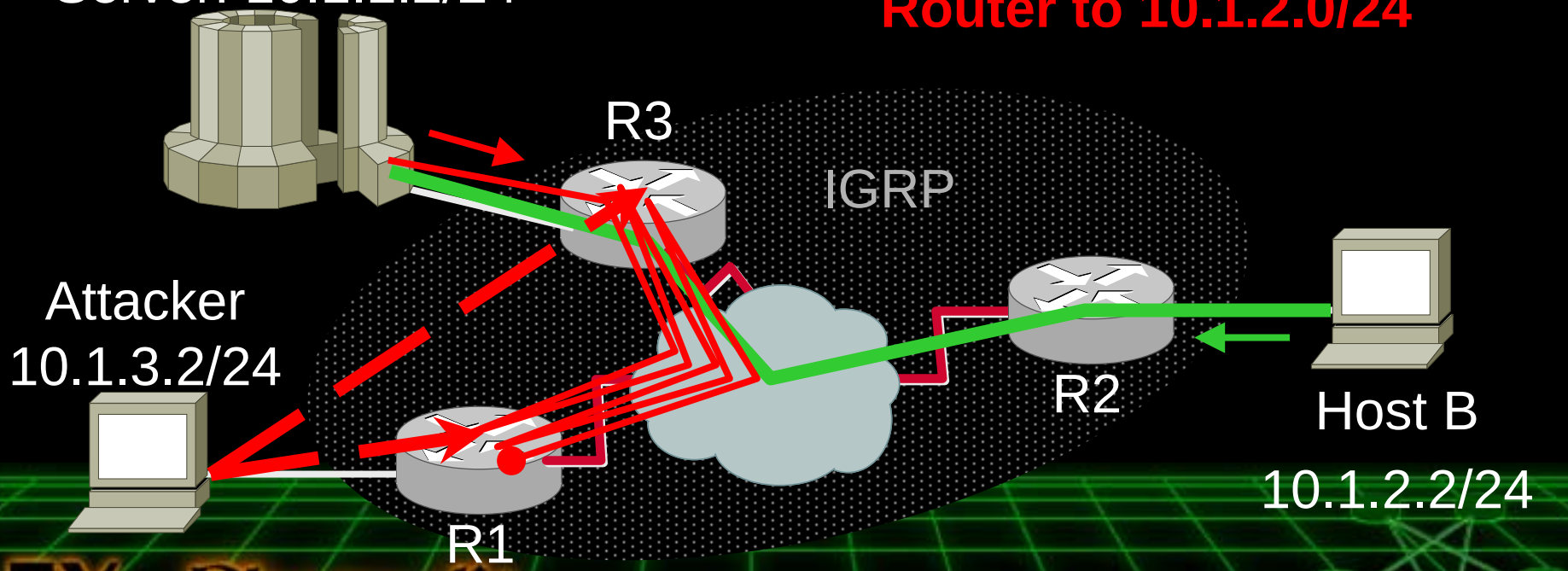
IGRP Attacks

Creating routing loops

Tell R3 that R1 is the best Router to 10.1.2.0/24

Tell R1 that R3 is the best Router to 10.1.2.0/24



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Routing Information Protocol Version 1 (RFC 1058)

- RFC published 1988
- Uses fixed network size
  (no subnet information possible)
- No autonomous systems
- Runs on UDP port 520
- Broadcast or unicast traffic
- Passive or silent hosts possible (port scan)

Routing Information Protocol Version 2 (RFC 2453)

- Uses destination network/net mask
- Includes next hop information and net masks
- No autonomous systems
- Runs on UDP port 520
- Multicast or unicast traffic
- Passive or silent hosts possible (port scan)
- Clear text authentication defined
- Cisco supports MD5 authentication (double authentication block forbidden by the RFC)

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RIP Attacks

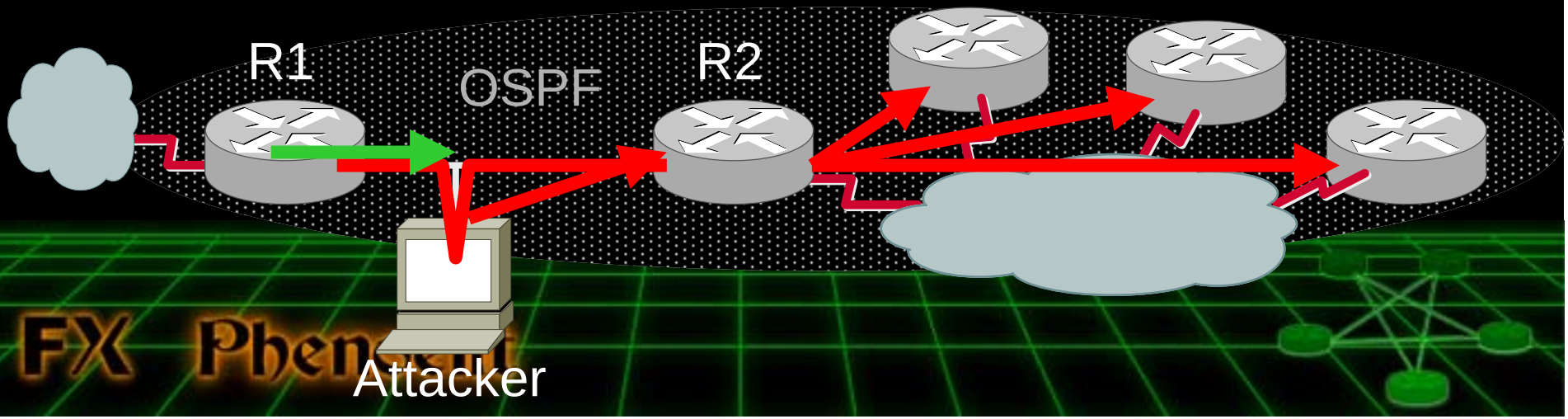
- Same attacks as with IGRP
- Network boundaries are important for RIPv1
- Multicast RIPv2 (224.0.0.9) may be forwarded across segments
- Split Horizon algorithm with poisoned reverse
  - Sends „unreachable“ back to sender of the route (metric 16)
  - May prevent routing loop attacks
  - Protects only if more than 2 routers are in the segment
- Tools:
  - rprobe.c and srip.c from humble
  - Nemesis-rip from Mark Grimes
  - ASS to scan

Opens Shortest Path First OSPF (RFC 2328)

- Sends LSA (Link State Advertisements) through the Area
- Uses HELO packets to Multicast (224.0.0.5)
- Every router knows the status of the Area
- No authentication, clear text or md5 defined
- IP Protocol 89 (protocol scan)
- More security features then other routing protocols
- The „hard-to-understand“ factor helps the attacker

OSPF Attacks

- Attacks tend to be very complex
- Forged LSAs are contested by routers
- Best attack seems to be „extended-Layer 2“
  - Run modified ARP interception software
  - Change OSPF packets while bridging them from R1 to R2
  - Let R2 distribute the false information through the area



Border Gateway Protocol
BGP 4 (RFC 1771)

- Exterior Gateway Protocol that connects Autonomous Systems
- Uses TCP Port 179 for communication
- IBGP (interior BGP) needs an IGP or static routes to reach neighbors
- Possible attacks include:
  - Bad updates
  - Abuse of BGP communities
  - TCP Sequence Number and Layer 2 attacks
  - IBGP is a softer targen than EBGP

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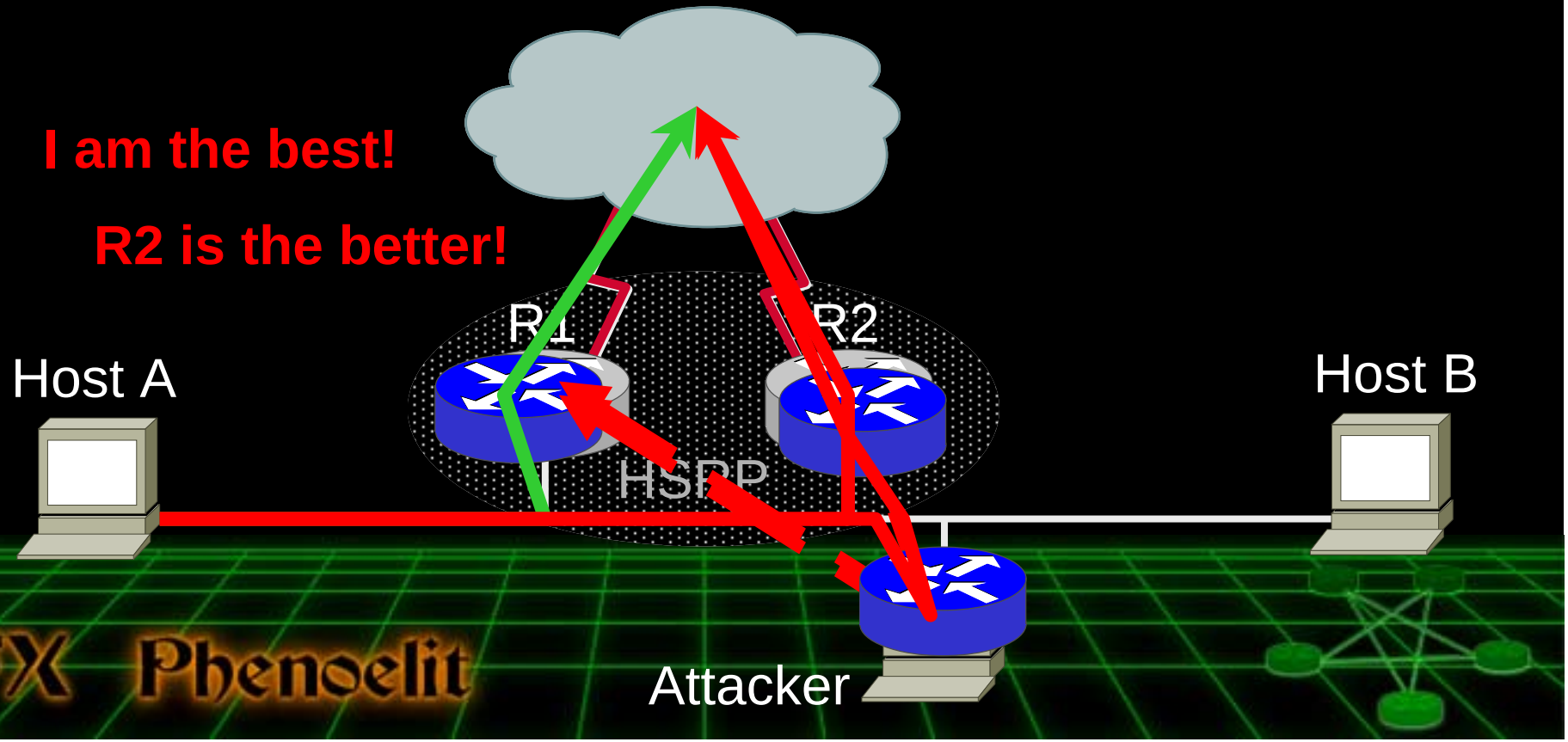
Hot Standby Router Protocol HSRP

- Cisco proprietary protocol for high availability
- „Standby“ IP address and MAC address are bound to the active router
- There are one or more inactive routers
- Multicast driven communication, UDP Port 1985
- Authentication is done in clear text
- If active router no longer says „Hello“ ...
  - Inactive routers send out a request to take over
  - Router with the highest priority „wins“ state ACTIVE

HSRP Attacks

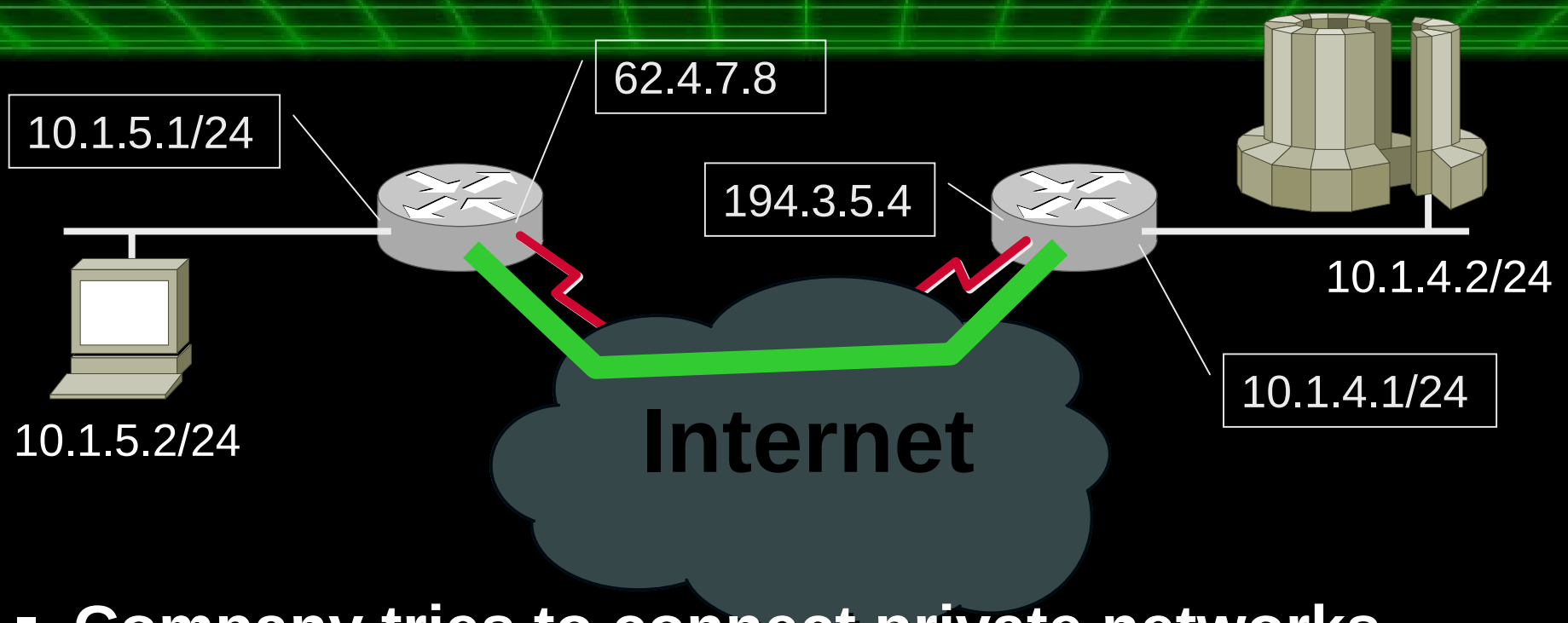
- New routers with high priority can take over the „standby“ addresses



Generic Routing Encapsulation GRE (RFC 1701, 1702, 2784)

- Used to transport protocol A over domain of protocol B in B‘s payload
  - IPv4 in IPv4
  - IPv6 in IPv4
  - IPX in IPv4
  - etc.
- No authentication or 32bit tunnel key
- Sequence numbers defined but weak
- Supports source routing!

Once upon a time ...



- **Company tries to connect private networks**
- **Carrier offers „VPN“ solution based on GRE**
- **IP traffic from remote location to HQ encapsulated in GRE**

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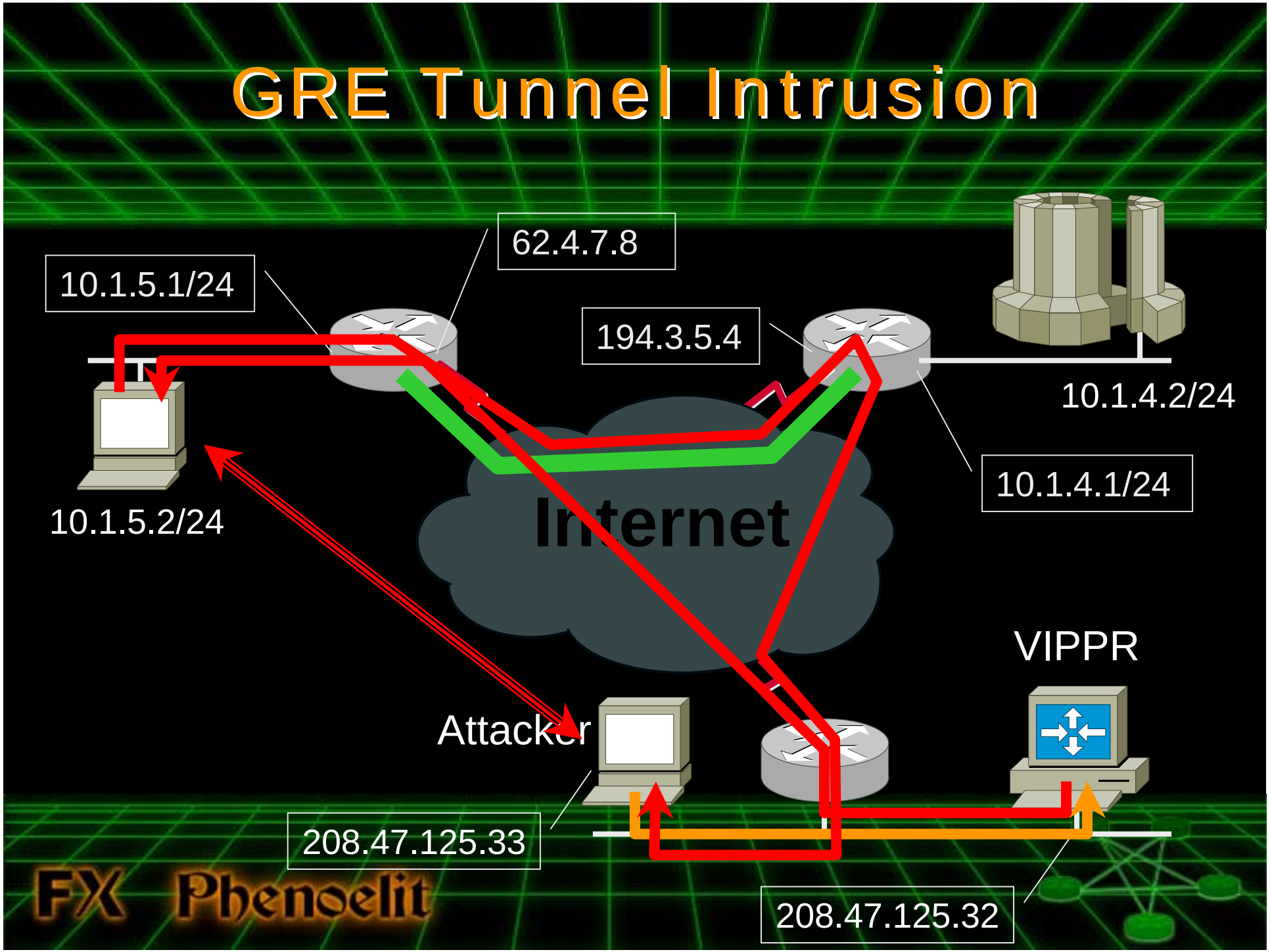
GRE Tunnel Intrusion
62.4.7.8
10.1.5.1/24
194.3.5.4
10.1.4.2/24
10.1.4.1/24
10.1.5.2/24
Internet
VIPPR
Attacker
208.47.125.33
208.47.125.32
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More Tunnel Attacks

- GRE attack functionality in VIPPR will be extended to support source routing
- Same attack can be applied to
  - IPX encapsulation (RFC 1234)
  - AX.25 encapsulation (RFC 1226)
  - Internet Encapsulation Protocol (RFC 1241)
  - IPv4 in IPv4 encapsulation (RFC 2003)
  - IPv6 in IPv4 encapsulation (mostly GRE)

Phenoelit IRPAS Tools

- Autonomous System Scanner
- Protocol sender:
  icmp_redirect, cdp, hsrp, igrp, irdp, irdpresponder
- Trace programs: itrace & tctrace
- Protocol scanner: protos
- Virtual IP attack router (1st beta): VIPPR

Tools and slides available on
http://www.phenoelit.de/

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Summary

- There are many ways to alter a traffic path
- Most routing protocols are insufficient protected – this makes routing protocol attacks successful
- Unencrypted tunneling protocols represent a high risk and demonstrate the fact that so-called „private“ IP addresses do not protect!

Thanks go to ...

- FtR, kim0, Zet, DasIch and Bine for being Phenoelit
- Curt Wilson for his paper about routing attacks
- smoovB for ideas and support

Lucent Technologies
Bell Labs Innovations

LWS Security Practice

The DEFCON 9 audience for being here !

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