# Operating Systems, Networks, and the IoT

Sean Smith Jason Reeves COSC 69: Risks of the IoT to Society June 30, 2015

# Outline

- What is an Operating System?
- Attacking the OS
- Defending the OS
- A Little Philosophy
- Networking Basics
- Network Security Protocols

# Outline

- What is an Operating System?
- Attacking the OS
- Defending the OS
- A Little Philosophy
- Networking Basics
- Network Security Protocols

- "An operating system (sometimes abbreviated as "OS") is the program that...manages all the other programs in a computer." (http://whatis.techtarget.com/definition/operating-system-OS, emphasis added)
- An OS has 3 primary roles:

- "An operating system (sometimes abbreviated as "OS") is the program that...manages all the other programs in a computer." (http://whatis.techtarget.com/definition/operating-system-OS, emphasis added)
- An OS has 3 primary roles:
  - Resource Allocator



- "An operating system (sometimes abbreviated as "OS") is the program that...manages all the other programs in a computer." (http://whatis.techtarget.com/definition/operating-system-OS, emphasis added)
- An OS has 3 primary roles:
  - Resource Allocator
  - Program Scheduler



- "An operating system (sometimes abbreviated as "OS") is the program that...manages all the other programs in a computer." (http://whatis.techtarget.com/definition/operating-system-OS, emphasis added)
- An OS has 3 primary roles:
  - Resource Allocator
  - Program Scheduler
  - Program Mediator



Basic OS Elements









- Basic OS Elements
  - User Interface

User



- Basic OS Elements
  - User Interface



#### Basic OS Elements



- Basic OS Elements
  - User Interface





- Basic OS Elements
  - User Interface





- Basic OS Elements
  - User Interface





- Basic OS Elements
  - User Interface
  - Memory Management Unit





- Basic OS Elements
  - User Interface
  - Memory Management Unit





- Basic OS Elements
  - User Interface
  - Memory Management Unit





- Basic OS Elements
  - User Interface
  - Memory Management Unit
  - Kernel API





- Basic OS Elements
  - User Interface
  - Memory Management Unit
  - Kernel API





\*System Calls From http://blog.rchapman.org/post/36801038863/linux-system-call-table-for-x86-64

- Basic OS Elements
  - User Interface
  - Memory Management Unit
  - Kernel API
  - "Policy Engine"





- Basic OS Elements
  - User Interface
  - Memory Management Unit
  - Kernel API
  - "Policy Engine"



- Basic OS Elements
  - User Interface
  - Memory Management Unit
  - Kernel API
  - "Policy Engine"



• What does an OS "Policy Engine" mean?

- What does an OS "Policy Engine" mean?
  - Privilege Levels
    - Ring 0 vs. Ring 3



- What does an OS
  "Policy Engine" mean?
  - Privilege Levels
    - Ring 0 vs. Ring 3
  - File Access Controls
    - Access Control Lists
    - Capabilities
    - Unix Permissions

Latark, TEDD		104) 1					
[stark:TEDDI]		104) (9	5 - L				
total 7224							
-rw-rr	1	reeves	reeves	2197	Mar	26	08:53
-rw-rr	1	reeves	reeves	3065	May	18	11:13
-rw-rr	1	reeves	reeves	2971	May	28	14:41
-rw-rr	1	reeves	reeves	3097	Jun	5	13:14
-rw-rr	1	reeves	reeves	10351	Apr	10	10:55
-rw-rr	1	reeves	reeves	13854	Apr	2	11:35
-rw-rr	1	reeves	reeves	8360	Apr	27	15:47
-rw-rr	1	reeves	reeves	19385	Apr	28	14:25
-rw-rr	1	reeves	reeves	14081	Apr	1	15:52
-rw-rr	1	reeves	reeves	6974	Mar	30	16:21
-rw-rr	1	reeves	reeves	14222	Apr	15	17:16
-rw-rr	1	reeves	reeves	3572	Apr	29	12:56
-rw-rr	1	reeves	reeves	5940	Mar	26	10:52
-rw-rr	1	reeves	reeves	5646	Jun	9	13:39
drwxr-xr-x	2	reeves	reeves	4096	Jun	20	16:22
-rw-rr	1	reeves	reeves	4241	Jun	18	13:11
-rw-rr	1	reeves	reeves	2490	Jun	3	17:05
-rw-rr	1	reeves	reeves	2695	Jun	18	13:13
-rw-rr	1	reeves	reeves	6393	Jun	3	17:08
-rw-rr	1	reeves	reeves	1340	Jun	18	13:12
-rw-rr	1	reeves	reeves	1529	Jun	18	13:12

- What does an OS "Policy Engine" mean?
  - Privilege Levels
    - Ring 0 vs. Ring 3
  - File Access Controls
    - Access Control Lists
    - Capabilities
    - Unix Permissons
  - Formal Policy Engines (ex. SELinux)

SELinux Administration							
Revert	👰 Customized						
Filter							
A	Man aluda	Description	N				
ACLIVE	Module V	Allow between the set of a STD service by listening on the	Name				
	apacne	Allow httpd to act as a FTP server by listening on the	httpd_enable_ftp_server				
	apacne	Allow HITPD to run SSI executables in the same dom	nttpd_ssl_exec				
	apache	Allow Apache to communicate with avahi service via (	allow_httpd_dbus_avahi				
	apache	Allow httpd to use built in scripting (usually php)	httpd_builtin_scripting				
	apache	Allow http daemon to send mail	httpd_can_sendmail				
	apache	Allow httpd to access nfs file systems	httpd_use_nfs				
	apache	Unify HTTPD to communicate with the terminal. Nee	httpd_tty_comm				
	apache	Allow Apache to use mod_auth_pam	allow_httpd_mod_auth_ntlm_win				
	apache	Allow HTTPD scripts and modules to connect to the r	httpd_can_network_connect				
	apache	Unify HTTPD handling of all content files	httpd_unified				
	apache	Allow apache scripts to write to public content. Dire	allow_httpd_sys_script_anon_wri				
	apache	Allow httpd to read home directories	httpd_enable_homedirs				
	apache	Allow Apache to modify public files used for public fil	allow_httpd_anon_write				
	apache	Allow Apache to use mod_auth_pam	allow_httpd_mod_auth_pam				
	apache	Allow httpd to access cifs file systems	httpd_use_cifs				
	apache	Allow httpd cgi support	httpd_enable_cgi				
	apache	Allow HTTPD scripts and modules to network connect	httpd_can_network_connect_db				
	apache	Allow httpd to act as a relay	httpd_can_network_relay				
	bind	Allow BIND to write the master zone files. Generally 1	named_write_master_zones				
	cdrecord	Allow cdrecord to read various content. nfs, samba, r	cdrecord_read_content				
	cron	Enable extra rules in the cron domain to support fcro	fcron_crond				
	cvs	Allow cvs daemon to read shadow	allow cvs read shadow				
	domain	Allow unlabeled packets to work on system	allow unlabeled packets				
	exim	Allow exim to connect to databases (postgres, mysg	exim can connect db				
	exim	Allow exim to create, read, write, and delete unprivile	exim manage user files				
	exim	Allow exim to read unprivileged user files	exim read user files				
	ftn	Allow ftp to read and write files in the user home dire	ftp home dir				
	ftp	Allow ftp servers to login to local users and read/write	allow ftpd full access				
	ftn	Allow ftp servers to use nfs used for public file trans	allow find use of				
	ntp	Anow it piservers to use it is used for public file trans					

- Other Useful Tools
  - File System



- Other Useful Tools
  - File System
  - Reference Monitor
    - What should a reference monitor look for?



- Important Questions:
  - What happens when a user needs to perform an admin-level task?
    - Temporary Solution: sudo
    - Permanent Solution: "System High"
  - What happens when processes need to communicate?
    - IPC primitives: Pipes, message-passing, etc.
  - What do we do about side channels?
    - Ex. Memory re-use
- "It's hard to get all this right." —Sean Smith

Consider the following devices:





How do their operating systems differ?

# Outline

- What is an Operating System?
- Attacking the OS
- Defending the OS
- A Little Philosophy
- Networking Basics
- Network Security Protocols

# Attacking the OS

- Why attack an OS?
  - May contain valuable information itself
  - Can be used as a launchpad for attacks on other machines
  - Can be used to disguise true origin of an attack
    - Hacked by the Catholic Church?



# Attacking the OS

How to 0wn an Operating System
- How to 0wn an Operating System
  - 1. Find a vulnerability in the OS you are targeting.
    - Many different ways to do this!

Sponsored by DHS/NCCIC/US-CERT		NIST National Institute of					
National Vulnerability Database							
automating vulnerability management, security measurement, and compliance checking							
Vulnerabilities	Checklists 800-53/800-53A	Product Dictionary	Impact Metric	s	Data Feeds	Statistics	FAQs
Home SCAP	SCAP Validated Tools	SCAP Events	About	Contact	Vendor Comments		Visualizations
Mission and Overview NVD is the U.S. government repository of standards based vulnerability management data. This data enables automation of vulnerability management, security measurement, and compliance (e.g. FISMA).	National Vulnerability Database NVD is the U.S. government repository of standards based vulnerability management data represented using the Security Content Automation Protocol (SCAP). This data enables automation of vulnerability management, security measurement, and compliance. NVD includes databases of security checklists, security related software flaws, misconfigurations, product names, and impact metrics. Announcements CVSS v3 Preview Information CVE-ID Format Change Information Endered Deskton Core Configuration settings (EDCC) / United States Government Configuration Baseline (USGCB)						
Resource Status NVD contains: 70780 <u>CVE Vulnerabilities 296 Checklists 249 US-CERT Alerts 4358 <u>US-CERT Vuln Notes 10286 OVAL Queries 104739 CPE Names Last updated: 6/23/2015 10:35:45 AM CVE Publication rate: 17.2</u></u>	NVD contains content (and pointers to scanning products) for FDCC/USGCB Checklists are available here (to be used with S SCAP Validated Products are available here. NVD Primary Resources • Vulnerability Search Engine (CVE software flaws • National Checklist Program (automatable security • SCAP (program and protocol that NVD supports) • SCAP Compatible Tools • SCAP Data Feeds (CVE, CCE, CPE, CVSS, XCCDF, • Product Dictionary (CPE) • Impact Metrics (CVSS) • Common Weakness Enumeration (CWE)	performing configuration checking of SCAP 1.2 validated tools). and CCE misconfigurations) v configuration guidance in XCCDF OVAL)	systems implementing the <u>F</u> and OVAL)	DCC/USGCB using t	the Security Content Automation	Protocol ( <u>SCAP</u> ).	

- How to 0wn an Operating System
  - 1. Find a vulnerability in the OS you are targeting.
    - Many different ways to do this!



- How to 0wn an Operating System
  - 1. Find a vulnerability in the OS you are targeting.
    - Many different ways to do this!
    - "0-Days" vs. Known vulnerabilities



- How to 0wn an Operating System
  - 1. Find a vulnerability in the OS you are targeting.
  - 2. Find (or build) an exploit that targets that vulnerability.



#### Viruses

- Insert themselves into a piece of legitimate code
- Alter the behavior of their host, generally to do something nasty
- Examples
  - ILOVEYOU
  - Agent.btz



- Worms
  - Self-propagating program that does not require another program to spread
- Examples
  - Morris Worm
  - Sasser Worm



- Trojan Horses
  - Software that has a legitimate use...
  - ...But also has some "extra" functionality that isn't revealed to the user
- Examples
  - Thompson's compiler



- Logic Bombs
  - Code that does something nasty when a trigger condition is met
    - Specific Time
    - Specific Action
- Examples
  - UBS PaineWebber
  - Conficker?



- How to 0wn an Operating System
  - 1. Find a vulnerability in the OS you are targeting.
  - 2. Find (or build) an exploit that targets that vulnerability.
  - 3. Deliver the exploit to the target.



- How to 0wn an Operating System
  - 1. Find a vulnerability in the OS you are targeting.
  - 2. Find (or build) an exploit that targets that vulnerability.
  - 3. Deliver the exploit to the target.
  - 4. Escalate privileges as needed.



- How to 0wn an Operating System
  - 1. Find a vulnerability in the OS you are targeting.
  - 2. Find (or build) an exploit that targets that vulnerability.
  - 3. Deliver the exploit to the target.
  - 4. Escalate privileges as needed.
  - 5. Profit!



• So you've rooted a device...what's next?

- So you've rooted a device...what's next?
  - Exfiltrate Data



- So you've rooted a device...what's next?
  - Exfiltrate Data
  - Explore Network



- So you've rooted a device...what's next?
  - Exfiltrate Data
  - Explore Network
  - Install Spyware



- So you've rooted a device...what's next?
  - Exfiltrate Data
  - Explore Network
  - Install Spyware
  - Build a Botnet



- So you've rooted a device...what's next?
  - Exfiltrate Data
  - Explore Network
  - Install Spyware
  - Build a Botnet
  - Install a Rootkit



- So you've rooted a device...what's next?
  - Exfiltrate Data
  - Explore Network
  - Install Spyware
  - Build a Botnet
  - Install a Rootkit



- So you've rooted a device...what's next?
  - Exfiltrate Data
  - Explore Network
  - Install Spyware
  - Build a Botnet
  - Install a Rootkit



- So you've rooted a device...what's next?
  - Exfiltrate Data
  - Explore Network
  - Install Spyware
  - Build a Botnet
  - Install a Rootkit

Which of these might be interesting from an IoT perspective?



## Outline

- What is an Operating System?
- Attacking the OS
- Defending the OS
- A Little Philosophy
- Networking Basics
- Network Security Protocols

- How do we defend IoT devices?
  - We've been defending "normal" systems for attackers for years... are there lessons learned that we can apply?



- Patching
  - Updating the OS to fix vulnerabilities
- IoT Concerns
  - How will patches be deployed?
  - How much downtime will be required?
  - How will users know if a device is patched?



- Antivirus Software
  - Programs that monitor your system for malware

#### IoT Concerns

- Can an IoT device support an AV system?
- Will AV vendors support their products on IoT?



- Virtualization
  - Using a hypervisor to isolate and mediate vulnerable OSes
- IoT Concerns
  - Do IoT devices have the resources to support a hypervisor?
  - Does a hypervisor really make things safer?



- Intrusion Detection
   Systems (IDS)
  - Programs that monitor your systems for bad behavior
- IoT Concerns
  - How do devices manage IDS alerts?
  - How do consumers respond to alerts?



- LangSec
  - Treat inputs as a formal language, and verify them!
- IoT Concerns
  - What exactly are the inputs to these devices?
  - How ambiguous are the protocols that these devices use?



- Training
  - Teach users proper computer hygiene!
- IoT Concerns
  - How do we account for the different ways we interact with the IoT?
  - What about 'set and forget' IoT devices?



## Outline

- What is an Operating System?
- Attacking the OS
- Defending the OS
- A Little Philosophy
- Networking Basics
- Network Security Protocols

## A Little Philosophy

- Scenario 1: Suppose you are the CTO of a large manufacturer of IoT devices.
  - Your development team comes to you one day with a question: "What operating system should our device use?"
  - Your choices:



Which would you choose? Why?

## A Little Philosophy

- Scenario 2: One of your co-workers lobbies for you to choose Linux because "open-source software is more secure."
- Do you agree with your co-worker? Why or why not?

## Outline

- What is an Operating System?
- Attacking the OS
- Defending the OS
- A Little Philosophy
- Networking Basics
- Network Security Protocols

• In the beginning...





• In the beginning...





Generally, networked computers have three important addresses:



- Generally, networked computers have three important addresses:
  - MAC Address ("00:0a:74:2b:45:88")
    - Address associated with the computer's network card
    - "Unique" to each machine


- Generally, networked computers have three important addresses:
  - MAC Address ("00:0a:74:2b:45:88")
    - Address associated with the computer's network card
    - "Unique" to each machine
  - IP Address ("129.170.212.34")
    - Assigned to a computer by the network itself
      - Static vs. Dynamic
      - IPv4 vs. IPv6



- Generally, networked computers have three important addresses:
  - MAC Address ("00:0a:74:2b:45:88")
    - Address associated with the computer's network card
    - "Unique" to each machine
  - IP Address ("129.170.212.34")
    - Assigned to a computer by the network
      - Static vs. Dynamic
      - IPv4 vs. IPv6
  - Hostname ("lolcat.dartmouth.edu")
    - Human-readable name
    - Hierarchical setup



- Domain Name System (DNS)
  - Translates from Hostname to IP



#### Domain Name System (DNS)

Translates from Hostname to IP

I want to go to lolcat.cs.dartmouth.edu

- Domain Name System (DNS)
  - Translates from Hostname to IP

DNS QUEN





Domain Name System (DNS)

Translates from Hostname to IP





- Domain Name System (DNS)
  - Translates from Hostname to IP



- Domain Name System (DNS)
  - Translates from Hostname to IP





- Domain Name System (DNS)
  - Translates from Hostname to IP



- Domain Name System (DNS)
  - Translates from Hostname to IP





- Address Resolution Protocol (ARP)
  - Translates from IP to MAC



- Address Resolution Protocol (ARP)
  - Translates from IP to MAC



- Address Resolution Protocol (ARP)
  - Translates from IP to MAC



• The Network Stack: How To Send The Bits

Data To Send



- Application Layer
  - Protocols used for appto-app communication
    - HTTP
    - FTP
    - SSH



- Transport Layer
  - Facilitates end-to-end communication between applications
    - TCP
    - UDP



- IP Layer
  - Deals with routing data packets from A to B



- Link Layer
  - Transports data frames across smaller networks, such as LANs
    - Ethernet
    - Wifi



- Physical Layer
  - "Bits on the Wire" actual physical medium used to transport data



- Other Important Questions
  - Q: How is traffic directed to the right program on a server?

- Other Important Questions
  - Q: How is traffic directed to the right program on a server?
  - A: Ports!

- Other Important Questions
  - Q: How is traffic directed to the right program on a server?
  - A: Ports!



- Other Important Questions
  - Q: How is traffic directed to the right program on a server?
  - A: Ports!



- Other Important Questions
  - Q: How is traffic directed to the right program on a server?
  - A: Ports!





- Other Important Questions
  - Q: How is traffic directed to the right program on a server?
  - A: Ports!



outh.edu:80		
	Here's my webpage!	
	A LAND	Sec. 2

- Other Important Questions
  - Q: How is traffic directed to the right program on a server?
  - A: Ports!





- Other Important Questions
  - Q: How is traffic directed to the right program on a server?
  - A: Ports!



lolcat.cs.dartmouth.edu:79



- Other Important Questions
  - Q: How are routing decisions made by the IP layer?

- Other Important Questions
  - Q: How are routing decisions made by the IP layer?
  - A: The Border Gateway Protocol (BGP)!

- Other Important Questions
  - Q: How are routing decisions made by the IP layer?
  - A: The Border Gateway Protocol (BGP)!



- Other Important Questions
  - Q: How are routing decisions made by the IP layer?
  - A: The Border Gateway Protocol (BGP)!



- Other Important Questions
  - Q: How are routing decisions made by the IP layer?
  - A: The Border Gateway Protocol (BGP)!





- Other Important Questions
  - Q: How are routing decisions made by the IP layer?
  - A: The Border Gateway Protocol (BGP)!



- Other Important Questions
  - Q: How are routing decisions made by the IP layer?
  - A: The Border Gateway Protocol (BGP)!


# Outline

- What is an Operating System?
- Attacking the OS
- Defending the OS
- A Little Philosophy
- Networking Basics
- Network Security Protocols













































.com Nameserver























































- Network Security and the IoT
  - The projection is that the number of IoT devices will exceed *1 billion*. Can our current security protocols operate at that scale?
    - Hint: Some of them don't operate at the current scale...
  - IoT devices will generally have limited resources. How might we get them to support secure protocols without hindering their primary tasks?

# Image Credits

- Home Depot: http://blogs-images.forbes.com/paularosenblum/files/2014/09/670px-2009-04-12 the home depot in knightdale.jpg
- Traffic Cop: http://www.infocellar.com/networks/graphics/images/traffic%20cop1.jpg
- Fridge Inside: https://talkandspoon.files.wordpress.com/2014/09/tupaus ckp fridge-after.jpg
- French-English Dictionary: http://ecx.images-amazon.com/images/l/51F2QJ7MJWL.ipg
- Privilege Rings: https://upload.wikimedia.org/wikipedia/commons/thumb/2/2f/Priv\_rings.svg/500px-Priv\_rings.svg.png
- SELinux GUI: https://upload.wikimedia.org/wikipedia/commons/7/78/SELinux admin.png
- Filing Cabinet: http://ak1.ostkcdn.com/images/products/5853265/Office-Designs-Metallic-Charcoal-colored-2-drawer-Steel-File-Cabinet-P13565566.jpg
- Detective: http://static.tvtropes.org/pmwiki/pub/images/PP detective magnifying glass 4337.jpg
- MacBook Pro: http://g-ecx.images-amazon.com/images/G/01/electronics/apple/apple-12g2-macbook-pro-13-front-lg.jpg
- Nest Thermostat: http://downloads.nest.com/nest\_uk\_heating.png
- Hacker Cracking "Safe" Computer: http://www.bbb.org/blog/wp-content/uploads/2013/03/hacker.jpg
- National Vulnerability Database: https://nvd.nist.gov/
- Ida Pro: https://www.hex-rays.com/products/ida/pix/5 plain graph view.gif
- Virus: http://internal.champaignschools.org/staffwebsites/isabelgi/Soph Bio/Viruse13.jpg
- Caterpie: http://img3.wikia.nocookie.net/ cb20140911042209/pokemon/images/8/89/010Caterpie Dream.png
- Rainbow Dash: http://img3.wikia.nocookie.net/ cb20111219045903/mlp/images/archive/3/31/20150414055440!Rainbow Dash Commander Hurricane S2E11.png
- Bob-omb: http://vignette2.wikia.nocookie.net/mario/images/7/79/Bob-omb %28Mario Kart 8%29.png/revision/latest?cb=20140505194042
- Hooded Hacker: http://www.v3.co.uk/IMG/494/302494/hacker-hacking-dark-hoodie.jpg
- Botnet Cartoon: https://upload.wikimedia.org/wikipedia/commons/thumb/c/c6/Botnet.svg/2000px-Botnet.svg.png
- Burglar with Crowbar: http://www.clker.com/cliparts/T/A/x/7/k/7/burglar-hi.png
- Dead Computer: https://a.disguscdn.com/get?url=http%3A%2F%2Fboomshadow.net%2Fwp-content%2Fuploads%2F2011%2F02%2Fbroken-icon.jpg&kev=C7bFagjAiMztOzWiJF5xFA
- Luigi: http://themushroomkingdom.net/images/lm/lm\_luigi-flashlight.ipg
- Network Diagram: https://upload.wikimedia.org/wikipedia/en/thumb/1/12/Sample-network-diagram.png/400px-Sample-network-diagram.png
- Man on Computer: http://www.clker.com/cliparts/C/0/9/N/O/d/man-using-computer-md.png
- Cat on Computer: https://nvoobserver.files.wordpress.com/2014/04/cat.ipg
- Windows Update: http://www.jmu.edu/computing/security/info/wm library/update3.jpg
- Road Patches: http://lgam.wdfiles.com/local--files/road-photos/Patches-01.JPG
- Peter Norton: http://www.technologizer.com/wp-content/uploads/2014/06/image5.jpg
- Stop Weird Machines: http://www.cs.dartmouth.edu/~sergey/langsec/occupy/WeirdMachines.jpg
- Windows Logo: https://upload.wikimedia.org/wikipedia/commons/thumb/6/64/Microsoft Windows logo %28Pre-XP%29.svg/1250px-Microsoft Windows with Windows logo %28Pre-XP%29.svg/1250px-Microsoft Windows with Wi
- Apple Logo: https://upload.wikimedia.org/wikipedia/commons/thumb/f/fa/Apple logo\_black.svg/500px-Apple\_logo\_black.svg.png
- Tux: https://upload.wikimedia.org/wikipedia/commons/a/af/Tux.png
- Black and White Cat on Computer: https://s3.amazonaws.com/ymp blog/2013/06/media-image-346120-article-ajust 930.jpg
- Grev and White Kitten on Computer: http://cdn.cutestpaw.com/wp-content/uploads/2012/05/Computer-cat.ipeg
- Mr. T. http://spinoff.comicbookresources.com/wp-content/uploads/2014/06/mr-t.ipeg
- It's About To Get Real: http://d2uza3cs9or1cf.cloudfront.net/wp-content/uploads/2015/04/EastonCorbin ATGR HIres WEB-768x768.jpg
- Cat Screaming At Computer: http://growabrain.typepad.com/photos/uncategorized/cat on computer 1.jpg
- Sean with Bike Parts: http://www.cs.dartmouth.edu/~sws/fun/runtales/downtube.jpg
- Easton Corbin on Amazon: http://www.amazon.com/gp/product/B00W8W31K4/ref=s9 simh gw p15 d21 i1? pf rd m=ATVPDKIKX0DER&pf rd s=desktop-1&pf rd r=1QTZ2AVBJTJ9M66CPKGE&pf rd t=36701&pf rd p=2079475242&pf rd i=desktop
- Mercedes: http://assets.mbusa.com/vcm/MB/DigitalAssets/Vehicles/ClassLanding/2014/SL/Overview/2014-SL-CLASS-SL550-ROADSTER-CGT-D.png
- Dora Dance Fiesta: http://ecx.images-amazon.com/images/I/61EgnyraEVL.jpg
- Sean's Homepage: http://www.cs.dartmouth.edu/~sws/
- Black Hole: https://www.nasa.gov/sites/default/files/cygx1 ill.jpg
- Processor Ecosystem Graph: Provided by Sean Smith, who found it "via ExtremeTech"
- Sean Smith w/Snowy Beard: http://www.cs.dartmouth.edu/~sws/snow.jpg
- Darren O'Day: http://mlb.mlb.com/images/players/525x330/503285.jpg
- All clipart not explicitly mentioned above is originally from the Microsoft Corporation.
## Thank You!