The Mirai Botnet

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Truman State University
Binary Beasts

The Paper

- Title: *Understanding the Mirai Botnet*

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- *The Proceedings of the 26th USENIX Security Symposium*

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- Researchers from a number of institutions reversed engineered it to better understand how it spread
- This paper then proposes reforms that can be made to prevent this kind of attack in the future

Contributions

- Lead Author
  - Zane Ma - University of Illinois Urbana-Champaign

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  - Manos Antonakakis - Georgia Institute of Technology
  - Tim April - Akamai Technologies
  - Michael Bailey - University of Illinois Urbana-Champaign
  - Matthew Bernhard - University of Michigan
  - Elie Bursztein - Google
  - Jaime Cochran - Cloudflare
  - Zakir Durumeric - University of Michigan
  - J. Alex Halderman - University of Michigan

Contributions Cont.

- Continued...
  - Luca Invernizzi - Google
  - Michalis Kallitsis - Merit Network
  - Deepak Kumar - University of Illinois Urbana-Champaign
  - Chaz Lever - Georgia Institute of Technology
  - Joshua Mason - University of Illinois Urbana-Champaign
  - Damian Menscher - Google
  - Chad Seaman - Akamai Technologies
  - Nick Sullivan - Cloudflare
  - Kurt Thomas - Google
  - Yi Zhou - University of Illinois Urbana-Champaign

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  - In December 2016, it peaked at 600,000 devices before beginning to fade

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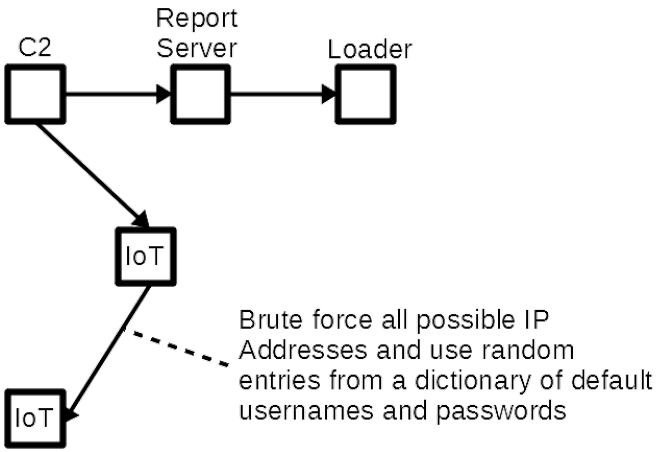

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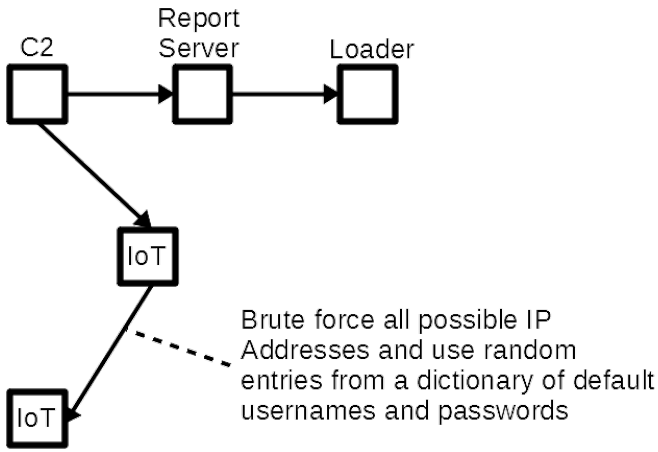

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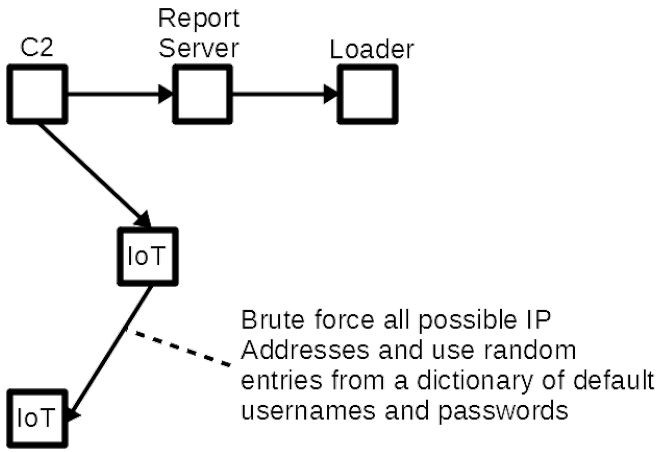

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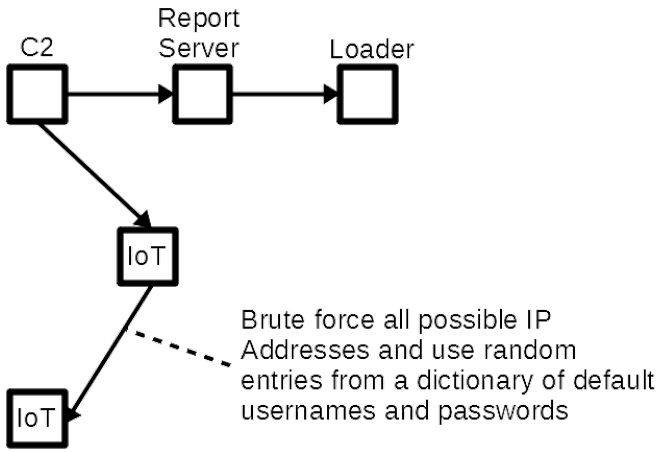

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- These were small dictionaries, containing 60 to about 200 credentials

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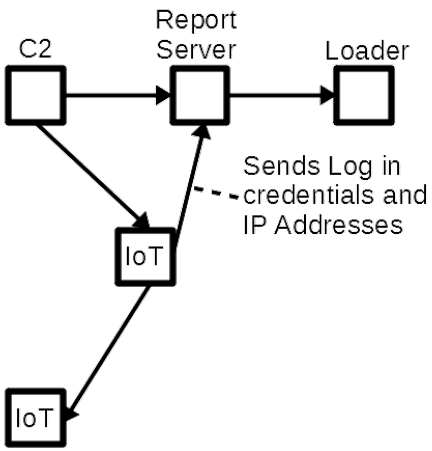

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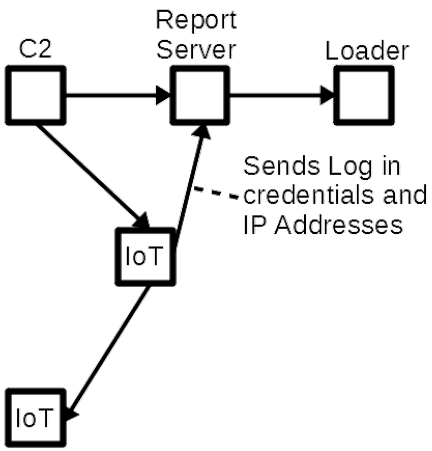

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- This information could later be used by the Command and Control (C2) server

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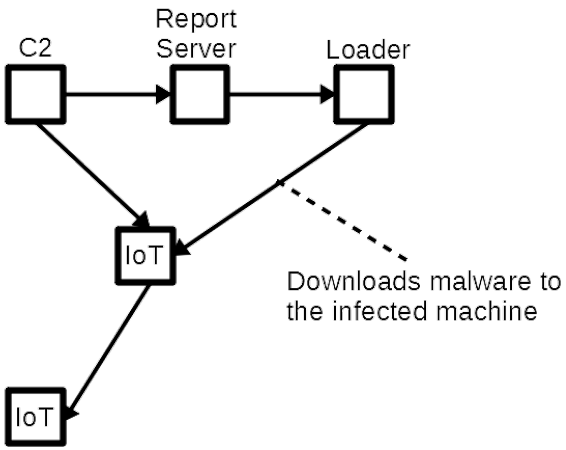

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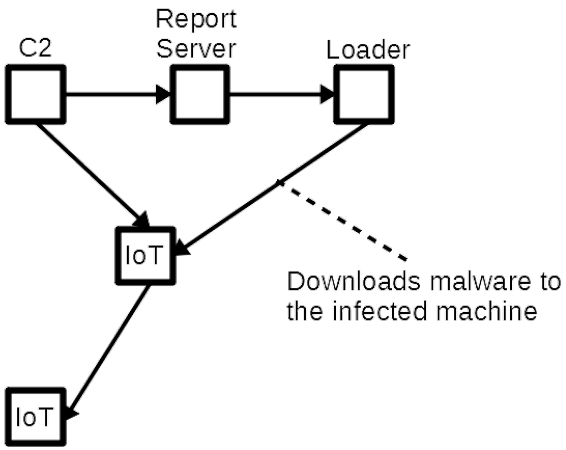

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- This program would download a binary onto the victim and run the program

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  - These organizations would be much more likely to start search for and exploiting weaknesses in the malware if it infected their machines

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  - Most infected devices were from South America and South-east Asia
  - Brazil, Colombia, and Vietnam hosted most of the bots

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  - A DDoS seeks to restrict a servers capabilities to respond to users by flooding it with requests from multiple different machines.
  - DDoS attacks are more difficult to protect against compared to a DOS attack because it is difficult to blacklist multiple IP Addresses and distinguish between real requests and the attack.

Volumetric Attacks

- Volumetric Attacks consist of a flooding a server with request packets to overwhelm its ability to respond. Volumetric attacks require little work to generate a high count of requests. With requests from multiple machines, it is difficult to prevent or dampen an attack on a server.

Protocal Attacks

- Protocol Attacks seek to disable a server by exloiting a weakness in a protocl. SYN flood attacks TCP by exploiting the three-way handshake process to create a backlogged queue. Ping attacks uses a large number of pings to attack a server. UDP floods send massive amounts of packets to random ports to overwhelm the queue of responses.

Application Layer Attacks

- Application layer attacks attempt to exploit the layer of human interaction with a machine. These attacks are nearly indistinguishable from real user interaction. They requires far less resources to execute this attack than it takes to prevent that attack. This makes these attacks resource efficient for an attacker.

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- Several Mirai C2 servers were attacked by some of its other C2 servers. These are from renting DDoS attackers against other renting DDoS attackers.

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  - Lonestar Cell - most attacked target, destroyed internet capabilities in Liberia

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  - Identified scans that targeted the IPv4 address space at an estimated rate of at least five packets per second.

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  - Process each banner to identify the device manufacturer and model using Nmap.
  - In total, identified for 31.5 % of banners (about 600k banners)

Telnet Honeypots

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  - Identified 67 C2 domains and 48 distinct username password dictionaries (containing a total 371 unique passwords)

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  - In the end, from a single domain name, we can expand a set of domain name and IP addresses.

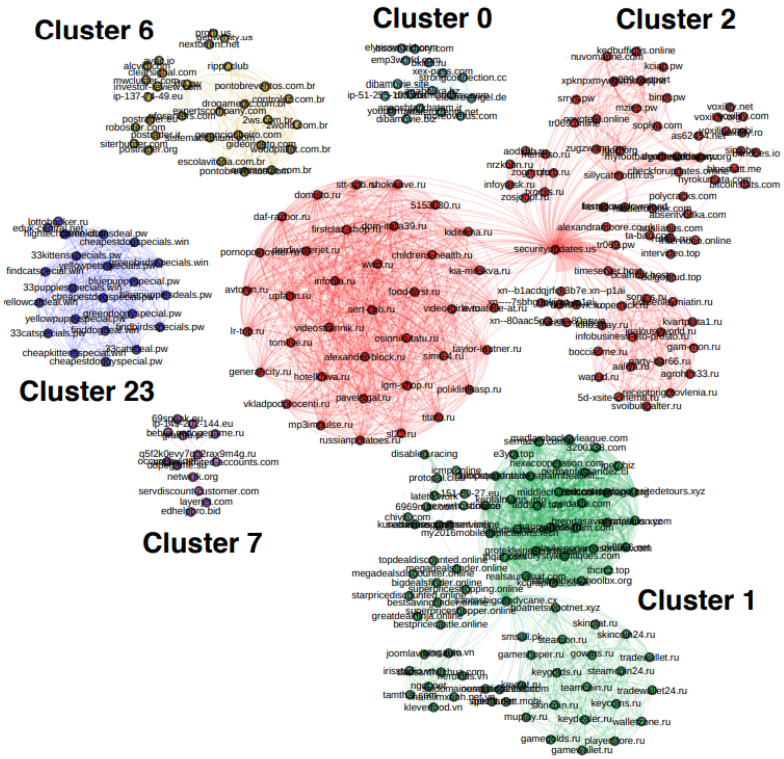

Figure: C2 Domain Relationships – We visualize related C2 infrastructure, depicting C2 domains as nodes and shared IPs as edges between two domains.

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  - Form a statistics to calculate what fraction of these IP addresses matched the list of IP address obseved by our network telescope.

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  - At various points, competing command and control servers were subject to DDoS attacks

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Defense Against the Dark Arts

- Randomized default passwords prevent attackers from employing a dictionary of default passwords.
- Having ports not used default to closed mitigates the chances of a successful attack.
- Automatic updates prevent users from refusing updates during hours of use and keeps systems secure against previous exploits. Bug bounties encourage the community to find and report all possible exploits to be patched.
- Standards for model and version identification allow server admins to easily see any and all machines that have known vulnerabilities.

Defense Against the Dark Arts

- Users should create secure usernames and passwords for all devices to mitigate the chance of it being hacked using brute force.
- Smart purchases from known and trusted companies that prioritize security of their manufactured devices acts as a deterrent from would be attackers.
- Old and unsupported devices should be replaced with newer models that conform with current security standards and have strong customer support.

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- Many attacks, such as the attack on Dyn, are believed to be a result of copy cat attackers

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- This attack served as a wake up call, prompting reform in these industries