XMon-BGP: Securing BGP Using External Security Monitors

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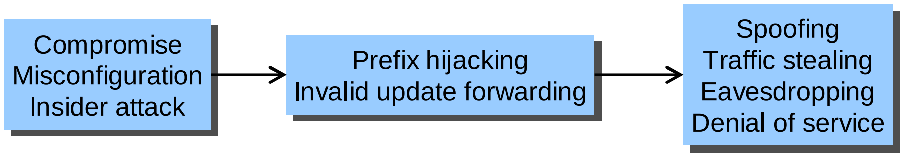
BGP Security



Compromise
Misconfiguration
Insider attack

Prefix hijacking
Invalid update forwarding

Spoofing
Traffic stealing
Eavesdropping
Denial of service

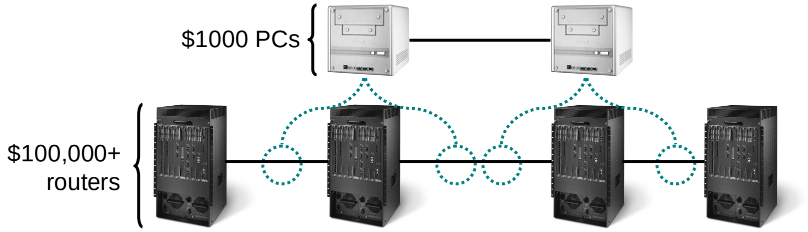
Border Gateway Protocol

- Connects autonomous systems (ASes)
- Critical infrastructure
  - All interdomain traffic depends on it
- Outdated trust model
- Security problems known for 10+ years

Lots of attempts to secure it

- None widely adopted
- Needs new routers, software
- Provides little incremental benefit
- Forces ASes to reveal peering info

XMon-BGP: an External Security Monitor for BGP



Monitor BGP externally: External Security Monitor (XMon)

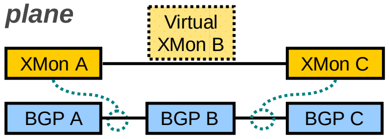
- New type of network component
- Checks the packets a router sends against packets it has received
- Runs on a trusted platform
  - Nexus and a Trusted Platform Module (TPM)
  - Everyone can be sure we're checking BGP correctly
- Agnostic to implementation and configuration
  - Any legal BGP implementation is OK

Why not run BGP on trusted hardware directly?

- Requires replacing the router
- Everyone has to agree which implementations are trusted (and bug-free!)

XMon-BGP nodes connect to form a *security plane*

- Notify each other of invalid messages
- Cooperate to monitor adjacent nodes
  - All of *B*'s messages are seen at *A* or *C*
  - *Virtual XMon*
  - Allows XMon-BGP to secure paths with some unmonitored ASes



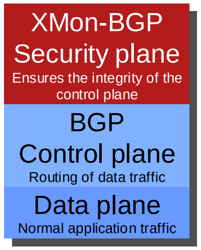
Architecture

XMon-BGP is a sniffer or a proxy

- Sniffer: applicable at low link speeds; minimizes disruption
- Proxy: blocks bad traffic directly; applicable at all speeds
- Sniffers and proxies interoperate

How XMon-BGP reacts to invalid messages

- Block the message (proxy XMon only)
- Notify administrators
- Roll back invalid route: remedial IOS script



XMon-BGP Security plane
Ensures the integrity of the control plane

BGP Control plane
Routing of data traffic

Data plane
Normal application traffic

Safety and Policy Checking

Safety specification

- Based on the RFC: rules everyone agrees on
- Update is valid if it originates a local prefix or forwards a received route
- Forwarded routes must preserve received path, prepend local AS number
- Aggregation is allowed

Policy rules

- Negotiated pair-wise with other ASes, often peers
- Remote AS's XMon enforces rules you specify
  - Route preference, load balancing, privacy
- Written in standard Routing Policy Specification Language (RPSL)

XMon-BGP state

- XMon-BGP stores all routes received and not withdrawn
  - Set of valid outputs is based on it
- Must remember all routes to each prefix, not just the best

Results

Is it correct?

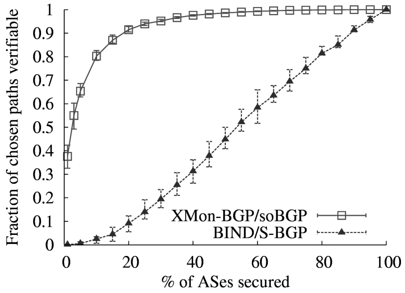
- Never generates warnings for legal behavior
- Tests with Linux+Quagga, IOS
- Traces from PLUTO, RouteViews, and NLR

Is it fast enough?

- Checks 335,000 messages/sec
  - 10^5 times faster than BGP traffic

How much incremental benefit?

- Securable path available for 80% of routes given 10% random deployment


Fraction of chosen paths verifiable
% of ASes secured
XMon-BGP/soBGP
BIND/S-BGP