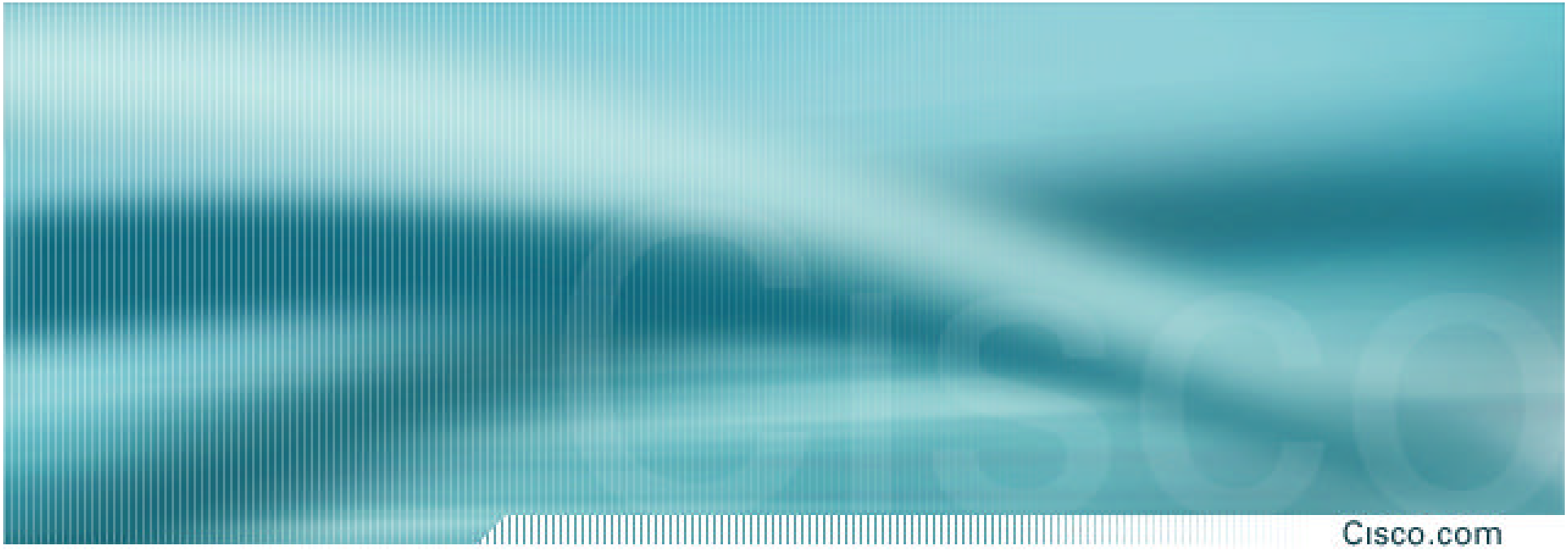

Secure Origin BGP (soBGP)

Alvaro Retana (aretana@cisco.com)

IP Routing Deployment and Architecture

Core IP Engineering

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Agenda

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- **Where is soBGP coming from?**
- **What problems does soBGP solve?**
- **How does soBGP solve these problems?**
  - **Deployment Examples**
  - **What is needed to deploy soBGP?**
- **Current Status**

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BGP Security Background

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- **BGP ties the Internet together**
  - **Critical Communications and Business Infrastructure!**
- **The system is vulnerable to different threats**
  - **Configuration/Human Errors**
  - **“Patches” have been applied as threats are exploded – most implemented on point-to-point connections**
- **End-to-end solutions require collaboration from all the users of the system: SPs, enterprise users, vendors, etc..**

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BGP Security – No Single Answer

- **Solutions exist and have been deployed to solve or counteract individual threats**
  - **Inbound filters, route limits, martian checks, implementation enhancements, etc.**
  - **Independent of each other and include solutions external to the system (to secure compromised routers and/or guarantee availability)**
- **The BGP Transport Connection**
  - **Existing mechanisms have already been designed and deployed to protect it: TCP MD5, IPSec.**
- **soBGP (Secure Origin BGP) targets the need to verify the validity of an advertised prefix**
  - ***Is the originator authorized to advertise the route?***

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Agenda

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soBGP Goal

- **Validate an AS is authorized to originate a prefix.**

  Verify a peer which is advertising a prefix has at least one valid path to the destination.

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soBGP Design Requirements

- **System should take advantage of operational experience and existing Internet Architecture.**
  - **Implicit trust built into the Internet**
  - **IP address assignment and delegation system**
- **Minimize impact to current implementations of the BGP protocol**
  - **Minimum changes to existing protocol formats.**
  - **Optimize memory and processing requirements.**

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soBGP Design Requirements (cont.)

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- **Must *not* rely on a central authority of any type.**

  Distributed processing and trust

- **Should not rely on routing to secure routing (No external database connection on system initialization).**

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soBGP Design Requirements (cont.)

- **Must be incrementally deployable (it must provide some level of security without the participation of every AS).**
- **Must allow deployment flexibility (on box or off box cryptography, etc.).**
- **Flexibility should be provided to allow operators to configure the level of security vs. overhead and convergence speed.**

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Agenda

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soBGP At-a-Glance

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- **Verifies that the originator of a route is authorized to do so.**
  - **Verifies that the advertised AS_PATH represents a valid path to the originator.**
- **BGP Security Message (extension to BGP)**
  - **New BGP Message used to carry security information**
  - **No changes to existing messages for backwards compatibility and incremental deployment.**
  - **Leverages existing and future protocol and security mechanisms**
- **Fixed additional scalability requirements**
  - **Per-AS information and route policies advertised once.**
  - **No additional information in UPDATES, resulting in low processing impact.**

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soBGP At-a-Glance (cont.)

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- **Takes advantage of the existing Internet Architecture**

  Trust relationships, loose AS associations, etc.

- **Use of Certificates to advertise and correlate AS identity, prefix ownership and route policy.**

  Entity Certificate = Used to establish identity

  Authorization Certificate = Used to assign and delegate IP address space

  Policy Certificate = Used to define per-AS or pre-prefix policies and propagate AS interconnectivity topology map

- **Uses Web-of-Trust model to validate certificates.**

  No specific root (single point of failure), but distributed responsibility.

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soBGP At-a-Glance (cont.)

- **Built in Flexibility**

  UPDATE and Certificate propagation may be de-coupled.

  On or off-box cryptography operations (inside the local AS).

  Incrementally deployable – provides some security in any multi-AS scenario.

  Configurable level of validation and weights.

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Certificate Transport

- **Certificates are transported in a new BGP message type, the SECURITY message.**
  - **Certificates are carried within TLVs**
  - **Expandable to other security related information**
- **Negotiated at session startup (capability exchange)**
  - **Certificates may be exchanged before routing**
  - **Routing may be exchanged before certificates**
  - **Certificates only session may exist**

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BGP Security Message

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- **Security information carried inside the protocol**
  - **The system doesn't rely on routing to secure it.**
  - **Propagation characteristics similar to those of UPDATES: Internet-wide reach!**
- **No changes in UPDATES or other BGP messages.**
  - **Additional memory requirement doesn't increase with the number of routes in the system…but with the number of entities and blocks authorized.**
  - **No additional memory/processing requirements for routers that do not need/want to receive security information.**
- **Ability to have non-congruent UPDATE and Security Information propagation topologies**
  - **Only BGP speakers that need the information have to receive it.**
  - **No need to upgrade non-soBGP routers.**
  - **Configurable security information and UPDATE propagation priorities.**

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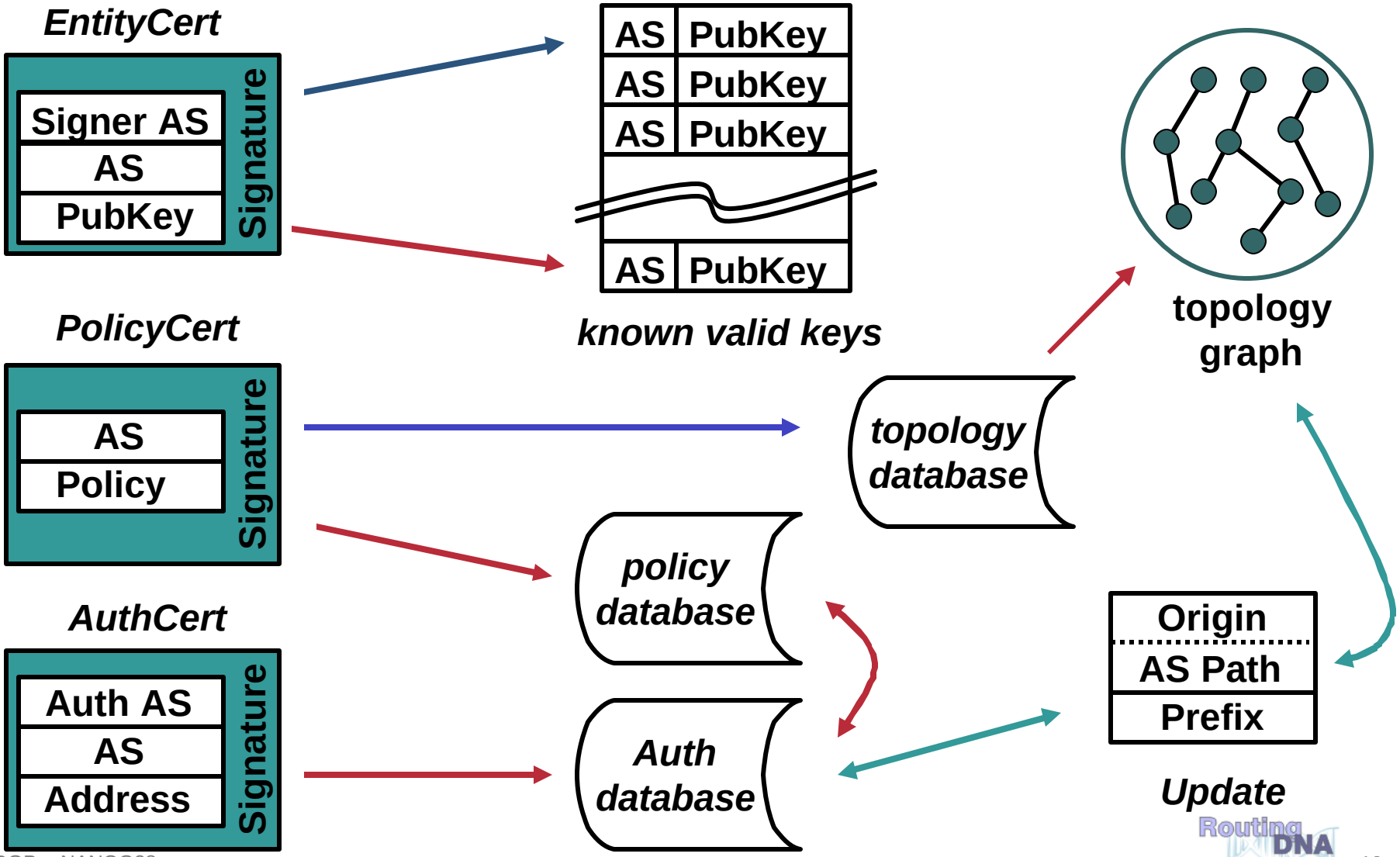
Certificate Operation



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Route Validation

- No cryptographic overhead in UPDATE validation and propagation
  - Databases may be pre-built for faster lookup.
  - Origin authorization and validity of AS_PATH verified.
- Web Of Trust used to authenticate and validate the information carried in the certificates.
  - Known keys are seeded by local administrator.
- Certificate Memory and processing requirements are a function of the number of Autonomous Systems and the number of authorized blocks
  - Reduced incremental memory and processing (vs carrying information in UPDATES).
  - No impact if router doesn't need to verify authorization.
- Policy Information carried independent of authorization information
  - Flexible policies.
  - Allows originator to change policy (or connectivity information) without having to re-advertise UPDATES or other certificates.

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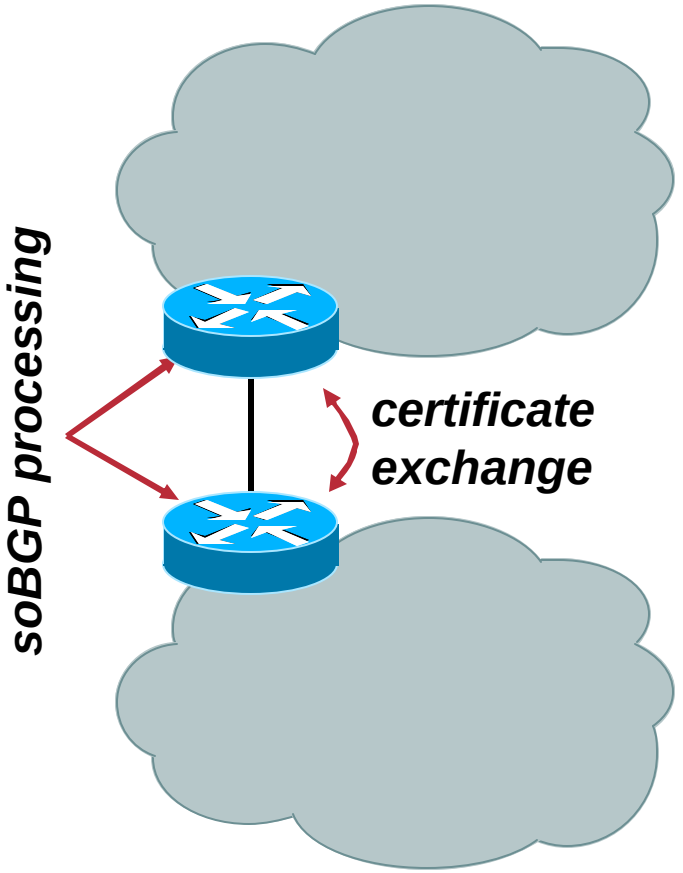
Deployment

- The most straightforward deployment option is:
  - Exchange certificates at all eBGP peering points (AS edges).
  - Process the certificates, and build the required soBGP tables at each eBGP speaker.
- Each eBGP speaker must then be capable of running the cryptographic processes needed to process certificates.



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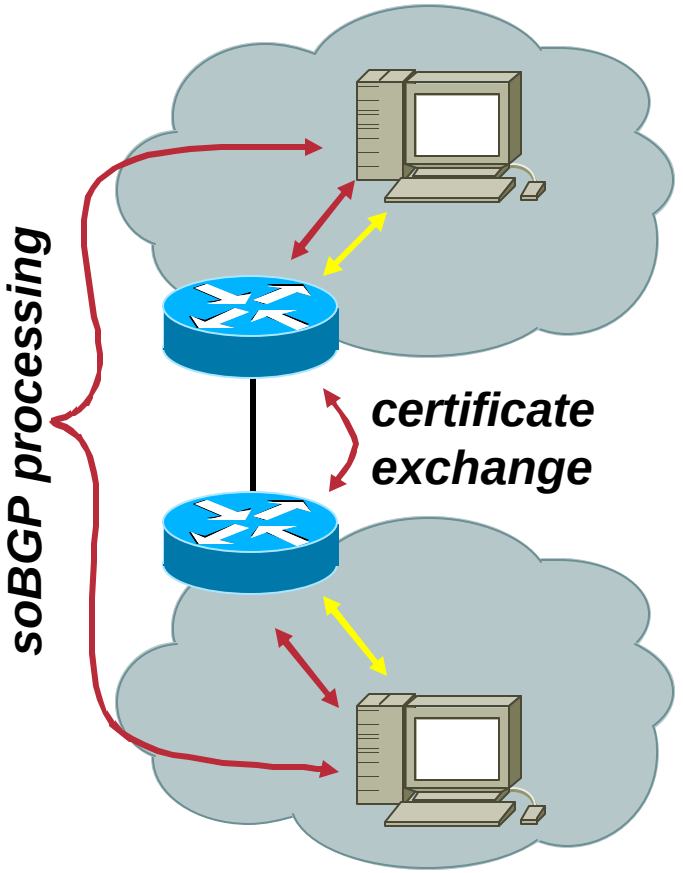
Deployment

- Certificates can also be exchanged at the AS edge, and “shuttled,” using iBGP connections, to a server within the AS.
- These servers then perform all certificate processing, and build the necessary databases.
- The edge routers then consult these servers, using RADIUS, to validate received updates.



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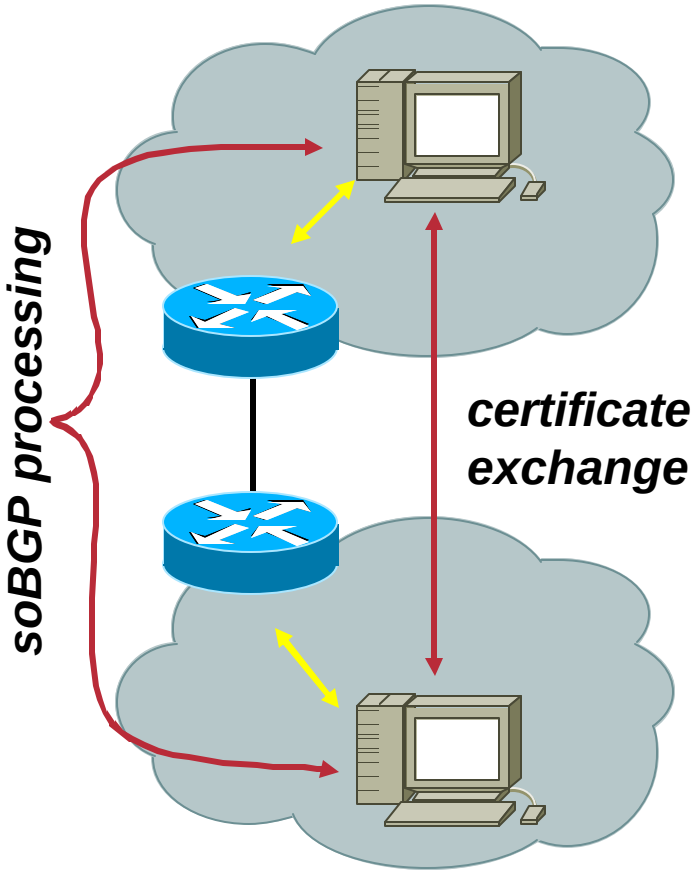
Deployment

- **Certificates can also be exchanged, using multihop eBGP directly between the soBGP servers in each AS.**



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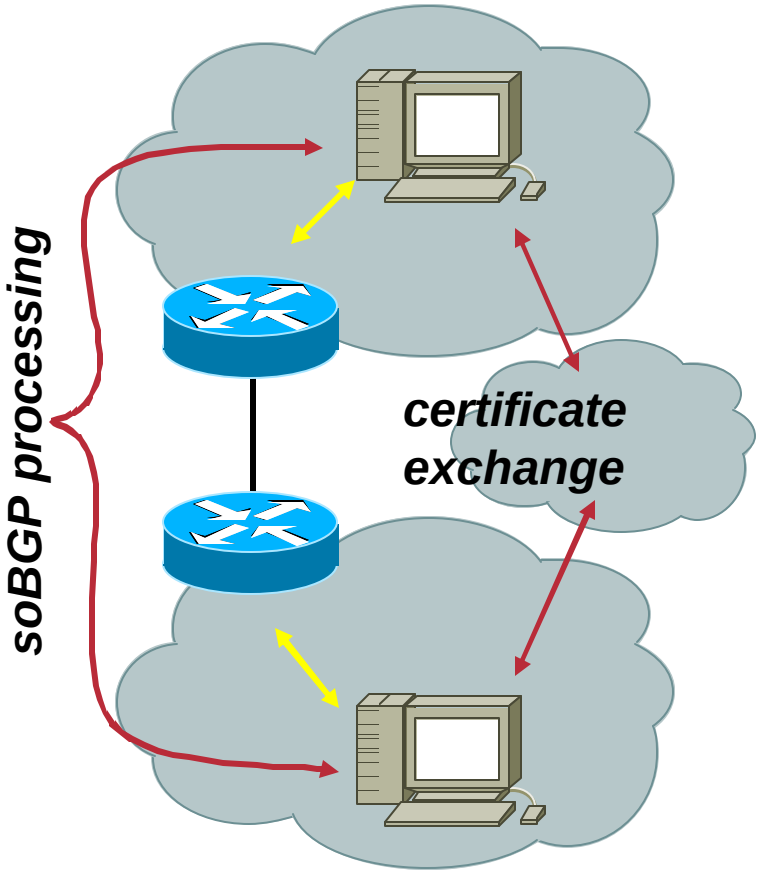
Deployment

- Certificates may also be exchanged with third party providers of some type.
- Certificates may be generated by one AS, and advertised by another AS.
- It doesn't matter how the certificates injected into the internetwork, or received, as long as the same validation process is used.



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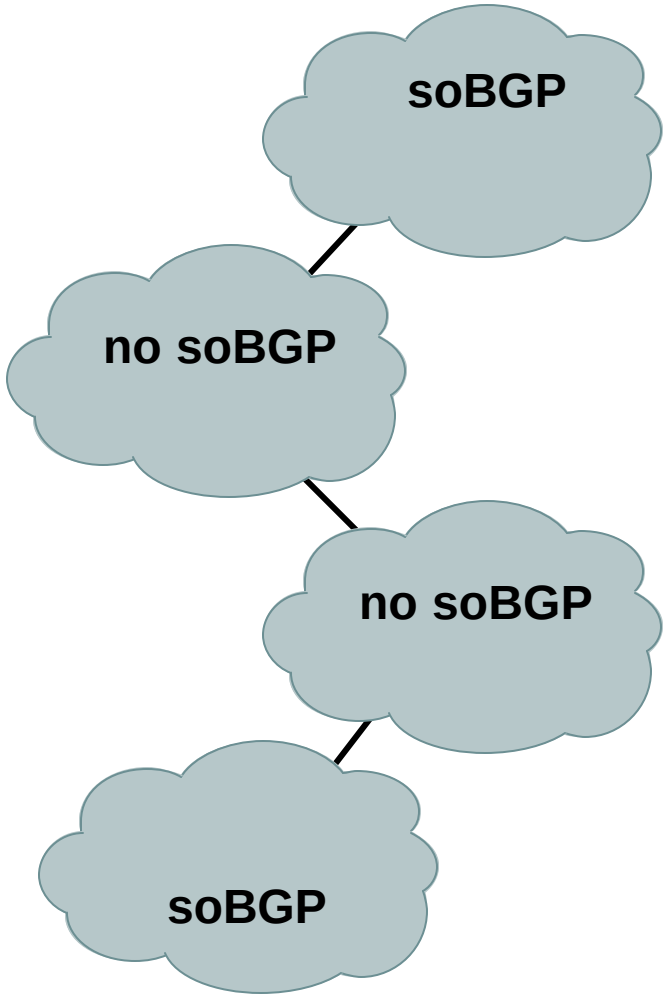
Incremental Deployment

- **Incremental deployment is a large hurdle for any security system.**
- **There's no way to have a "flag day," after which all AS' must be running the security system, in a large internetwork.**
- **soBGP allows incremental deployment—*but the amount of security provided is proportional to the completeness of the deployment!***



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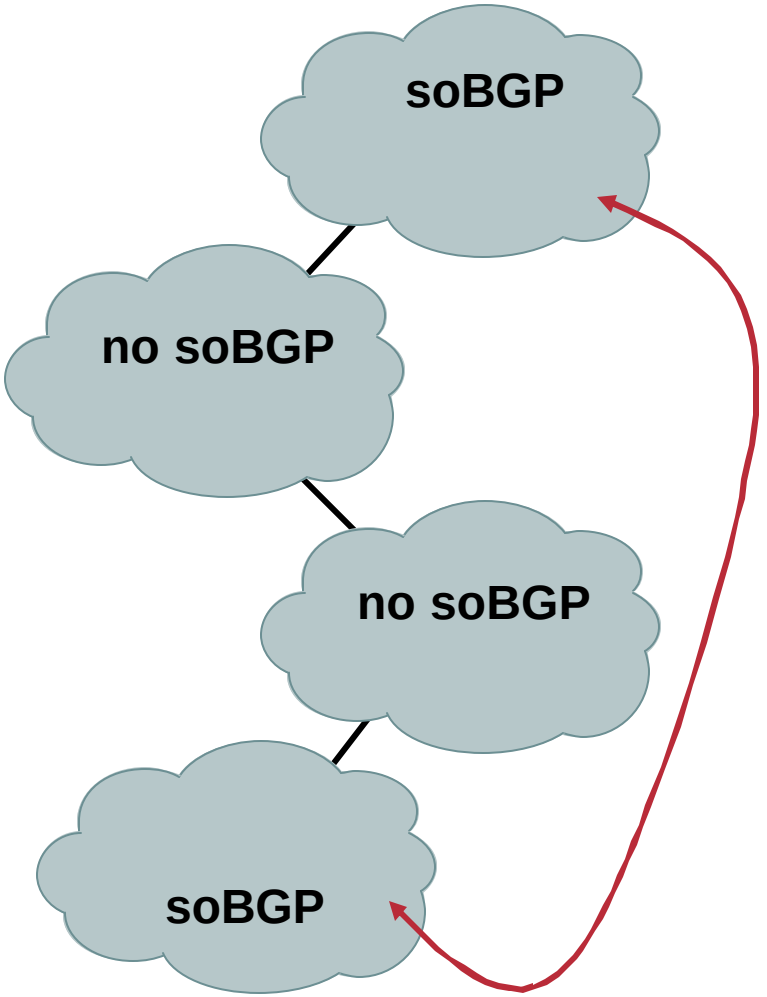
Incremental Deployment

- **The two autonomous systems which would like to run soBGP can exchange their certificates directly through eBGP multihop sessions, or through some other mechanism.**



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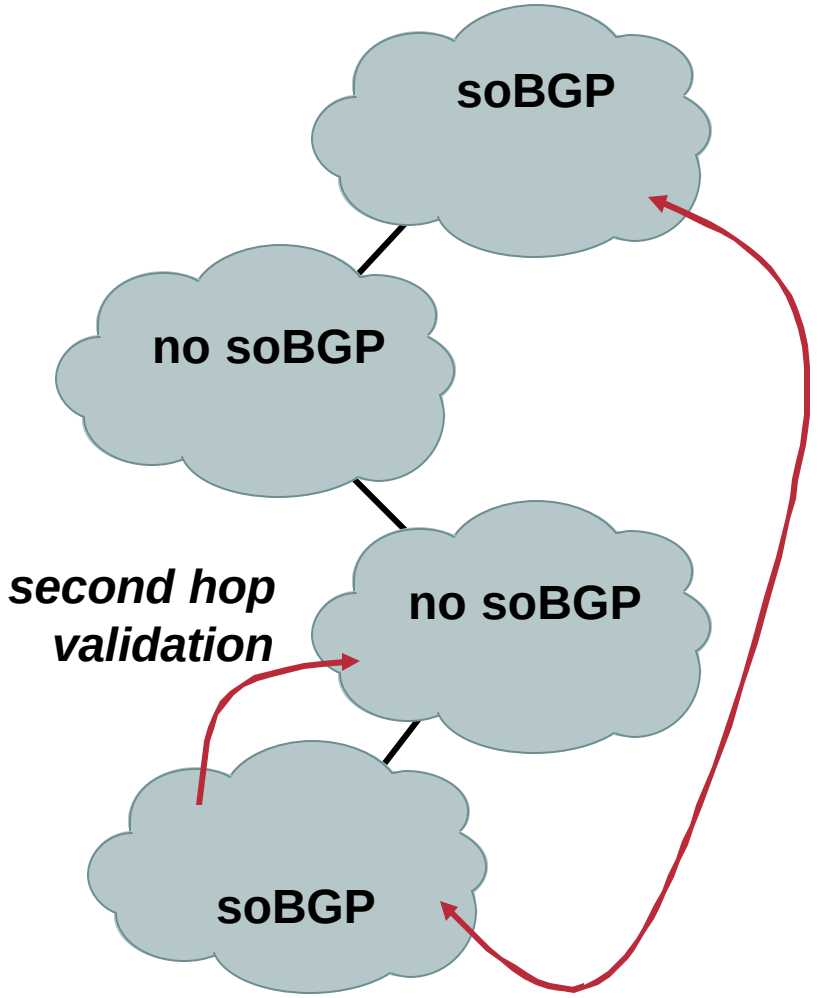
Incremental Deployment

- They are able to validate the second hop in the AS Path, using the connectivity advertised in the PolicyCerts.
- As more of the AS' participate, more of the path can be validated.



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Deployment Example

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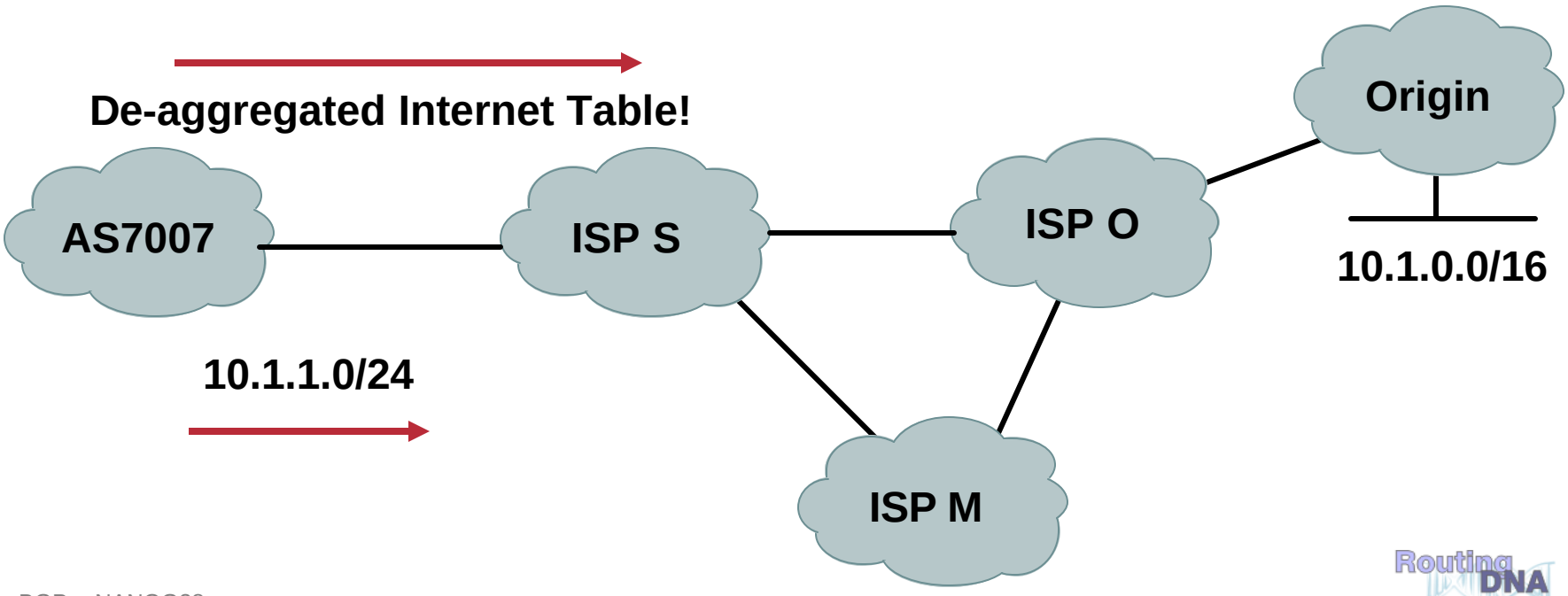
The AS7007 Case

- **In short, AS7007 de-aggregated the full BGP table and injected it back in to the Internet. The result was that all the Internet traffic black holed into it.**

http://flix.flirble.org/



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Deployment Example I

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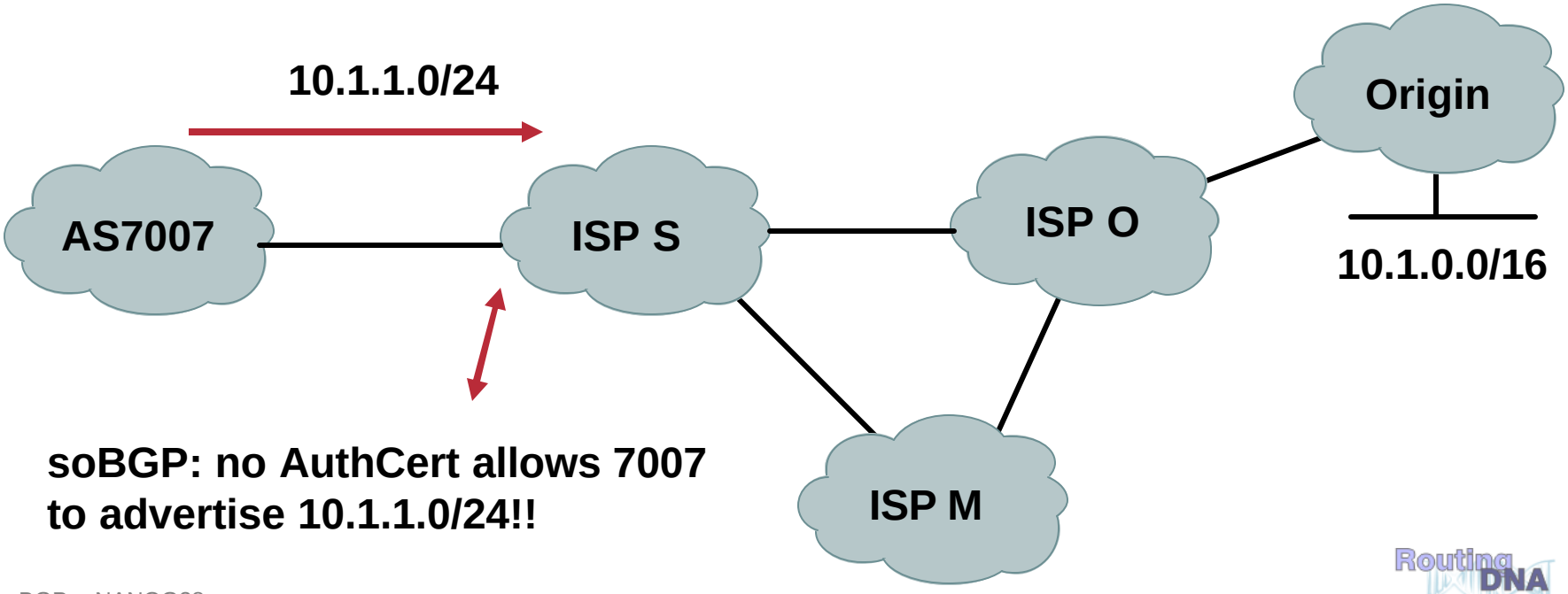
The AS7007 Case

- **AS7007 re-advertises the prefixes as originated by itself.**

AS_PATH = 7007



soBGP: no AuthCert allows 7007 to advertise 10.1.1.0/24!!

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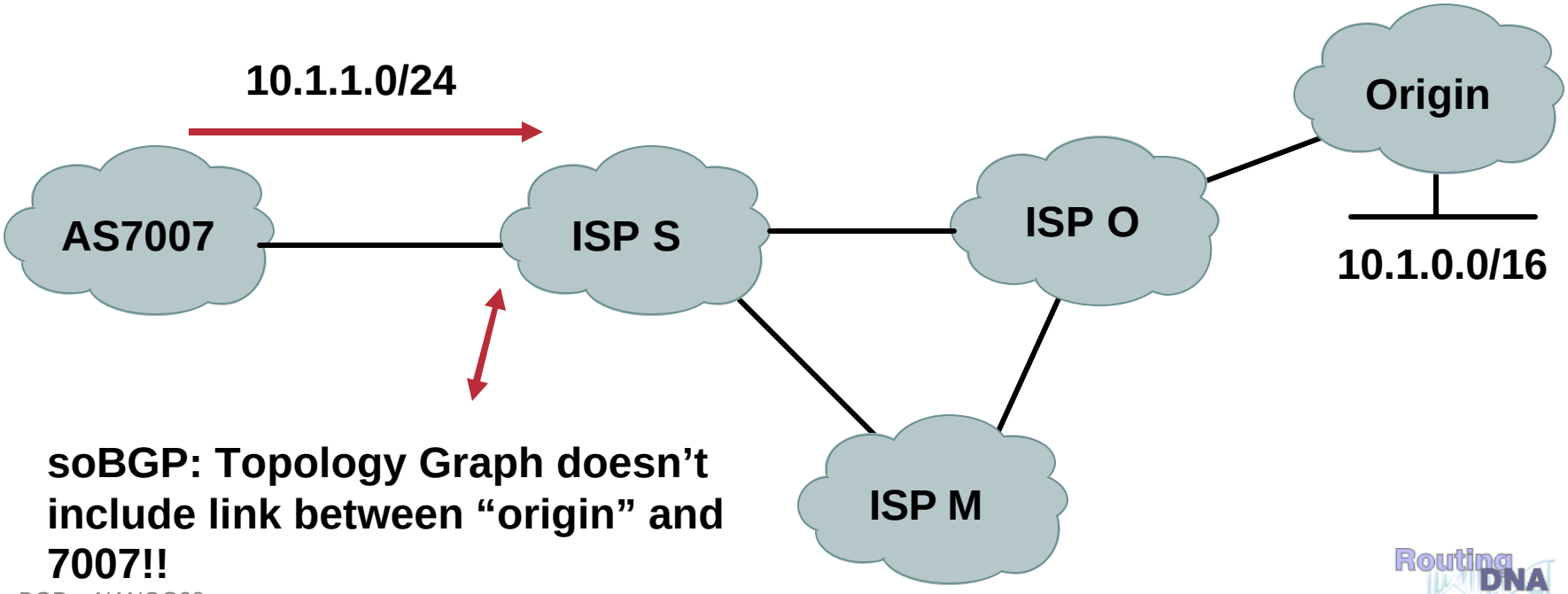
Deployment Example II

The AS7007 Case

- **AS7007 re-advertises the prefixes as originated by the “origin”.**

AS_PATH = 7007 Origin



soBGP: Topology Graph doesn’t include link between “origin” and 7007!!

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Deployment Example III

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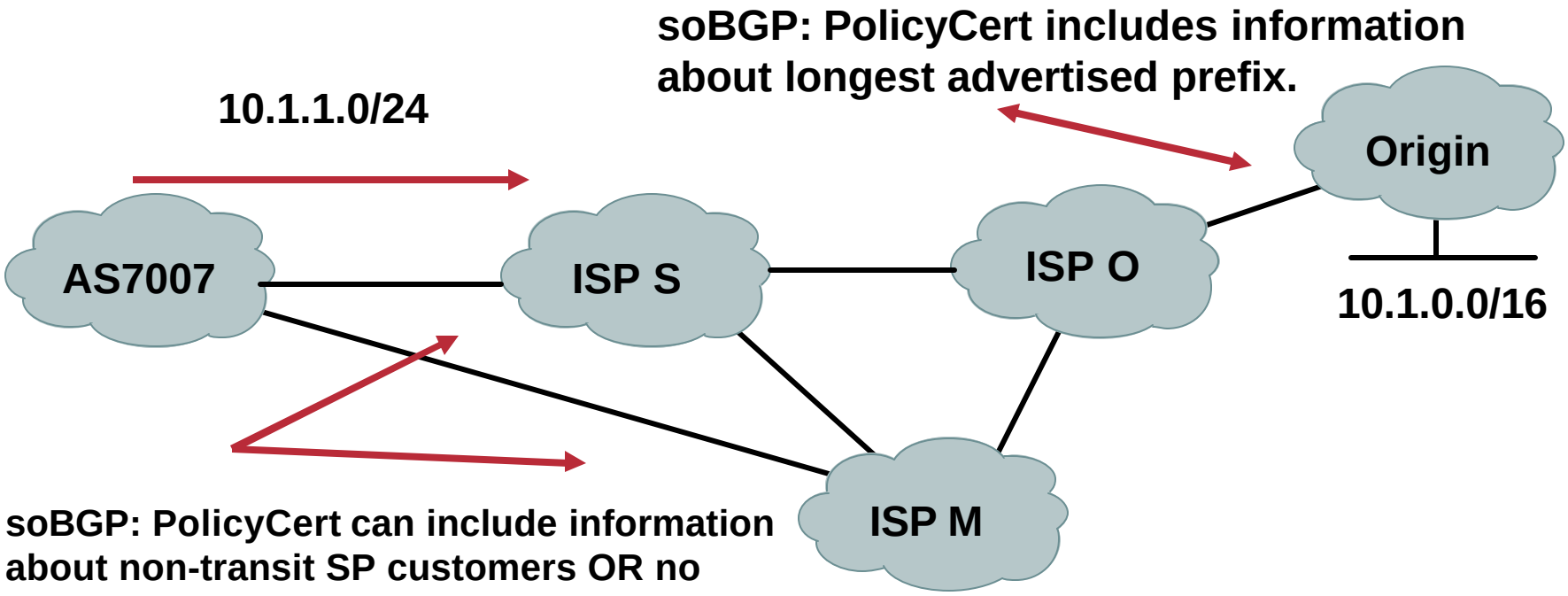
The AS7007 Case

- **AS7007 re-advertises the prefixes as originated by the "origin" and adds itself to the AS_PATH; multi-homed case.**

  AS_PATH = 7007 ISP-S ISP-O Origin



soBGP: PolicyCert can include information about non-transit SP customers OR no connectivity information (results in only being able to originate routes).

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What is needed to deploy soBGP?

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- soBGP capable software in routers and supporting devices.
- Infrastructure to generate certificates (local PolicyCerts, etc.)
- Certificates from other ISPs, RIRs or other trusted entities authenticating identity (ASN) and address allocation.
- Propagate certificates in-band using BGP Security Message.
  - New information propagated on-demand (no periodic download needed).

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Current Status

- **Drafts Submitted to IETF**

  Extensions to BGP to Support Secure Origin BGP (soBGP) **(draft-ng-sobgp-bgp-extensions –xx)**

  Deployment Considerations for Secure Origin BGP (soBGP) **(draft-white-sobgp-bgp-deployment- xx)**

  RADIUS Attributes for soBGP Support **(draft-lonvick-sobgp-radius- xx)**

- **Definition of Extensions complete**

  Complete PKI definition, X.509 Certificate formats, etc. in progress.

- **Code in Development (in IOS)**

  Stretch goal is to be able to deploy soBGP in existing routers. **

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Summary

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- soBGP addresses the problem of verifying the ability of an AS to originate a route
- Incremental deployment without impact to ASes not implementing soBGP
  - Partial deployment also possible
- soBGP follows the existing Internet Architecture taking advantage of the implicit trust between ASes.

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For More Information

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soBGP:

ftp://ftp-eng.cisco.com/sobgp

The mailing list is open, archives are available, draft participation is encouraged!

Routing Protocols Security:

http://www.rpsec.org

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