Let’s Encrypt and DANE

CaribNOG 13 | Barbados | 18 Apr 2017

The Deploy360 Programme

The Challenge:

- The IETF creates protocols based on open standards, but some are not widely known or deployed
- People seeking to implement these protocols are confused by a lack of clear, concise deployment information

The Deploy360 solution:

- Provide hands-on information on IPv6, DNSSEC, TLS for Applications, Securing BGP, and Anti-spoofing to advance real-world deployment
- Work with first adopters to collect and create technical resources and distribute these resources to fast following networks

Web Portal – http://www.isoc.org/deploy360

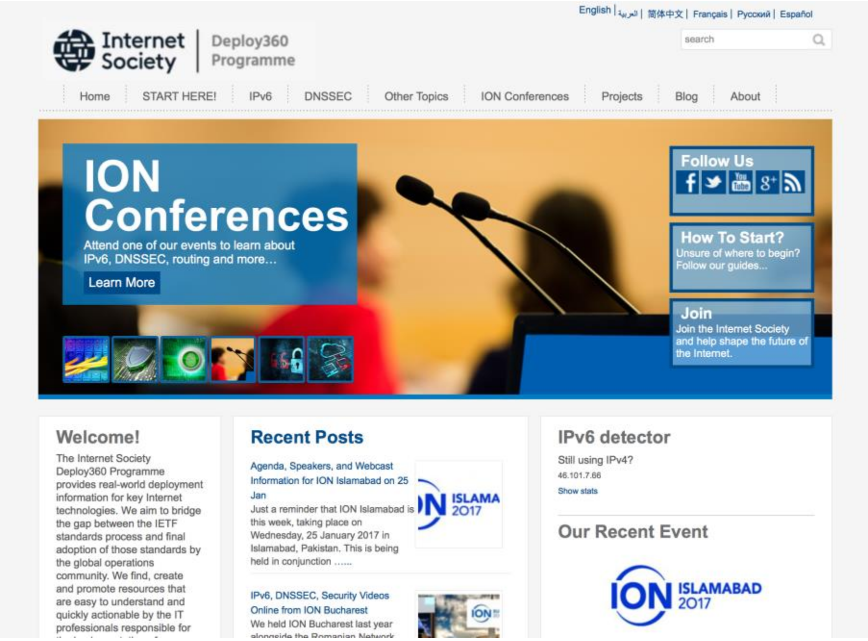
IPv6, DNSSEC, Securing BGP, TLS for Applications, Anti-Spoofing knowledge base including tutorials, case studies, training resources, etc..

Content specific to:

- Network Operators
- Developers
- Content Providers
- Consumer Electronics Manufacturers
- Enterprise Customers

Blog posts

Social media integration



ION Conferences

Attend one of our events to learn about IPv6, DNSSEC, routing and more...

How To Start?

Unsure of where to begin? Follow our guides...

Join

Join the Internet Society and help shape the future of the Internet.

Welcome!

The Internet Society Deploy360 Programme provides real-world deployment information for key Internet technologies. We aim to bridge the gap between the IETF standards process and final adoption of those standards by the global operations community. We find, create and promote resources that are easy to understand and quickly actionable by the IT professionals responsible for

Recent Posts

Agenda, Speakers, and Webcast Information for ION Islamabad on 25 Jan

Just a reminder that ION Islamabad is this week, taking place on Wednesday, 25 January 2017 in Islamabad, Pakistan. This is being held in conjunction ......

IPv6, DNSSEC, Security Videos Online from ION Bucharest

We held ION Bucharest last year alongside the Romanian Network

IPv6 detector

Still using IPv4?

46.101.7.66

Our Recent Event

Some IPv6 resources

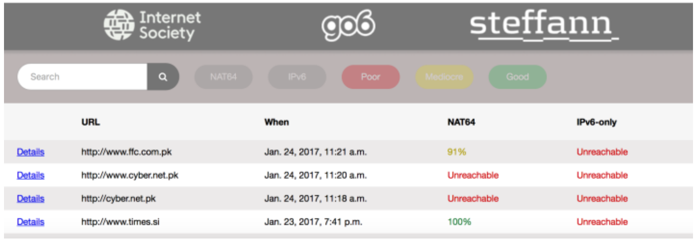
NAT64check

Checks websites display properly over IPv4, IPv6-only and NAT64

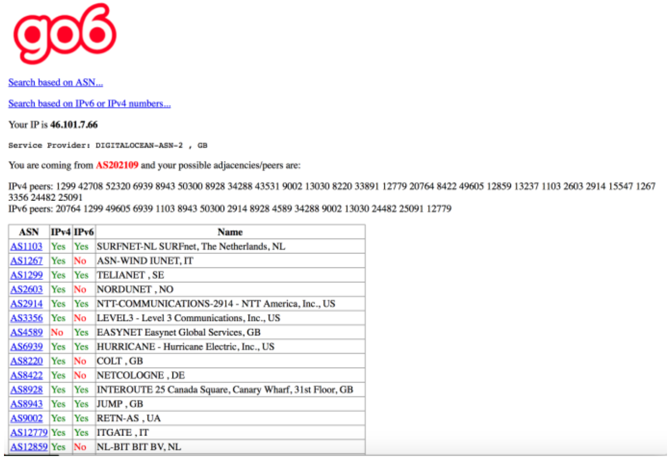
https://nat64check.go6lab.si/

nat64check

Check: http://www.example.com/



	URL	When	NAT64	IPv6-only
Details	http://www.ffc.com.pk	Jan. 24, 2017, 11:21 a.m.	91%	Unreachable
Details	http://www.cyber.net.pk	Jan. 24, 2017, 11:20 a.m.	Unreachable	Unreachable
Details	http://cyber.net.pk	Jan. 24, 2017, 11:18 a.m.	Unreachable	Unreachable
Details	http://www.times.si	Jan. 23, 2017, 7:41 p.m.	100%	Unreachable



Search based on ASN...

Search based on IPv6 or IPv4 numbers...

Your IP is **46.101.7.66**

`Service Provider: DIGITALOCEAN-ASN-2 , GB`

You are coming from **AS202109** and your possible adjacencies/peers are:

IPv4 peers: 1299 42708 52320 6939 8943 50300 8928 34288 43531 9002 13030 8220 33891 12779 20764 8422 49605 12859 13237 1103 2603 2914 15547 1267 3356 24482 25091
IPv6 peers: 20764 1299 49605 6939 1103 8943 50300 2914 8928 4589 34288 9002 13030 24482 25091 12779

ASN	IPv4	IPv6	Name
AS1103	Yes	Yes	SURFNET-NL SURFnet, The Netherlands, NL
AS1267	Yes	No	ASN-WIND IUNET, IT
AS1299	Yes	Yes	TELIANET , SE
AS2603	Yes	No	NORDUNET , NO
AS2914	Yes	Yes	NTT-COMMUNICATIONS-2914 - NTT America, Inc., US
AS3356	Yes	No	LEVEL3 - Level 3 Communications, Inc., US
AS4589	No	Yes	EASYNET Easynet Global Services, GB
AS6939	Yes	Yes	HURRICANE - Hurricane Electric, Inc., US
AS8220	Yes	No	COLT , GB
AS8422	Yes	No	NETCOLOGNE , DE
AS8928	Yes	Yes	INTEROUTE 25 Canada Square, Canary Wharf, 31st Floor, GB
AS8943	Yes	Yes	JUMP , GB
AS9002	Yes	Yes	RETN-AS , UA
AS12779	Yes	Yes	ITGATE , IT
AS12859	Yes	No	NL-BIT BIT BV, NL

BGP@Go6

Compare BGP peering polices between IPv4 and IPv6 for different ASNs

https://bgp.go6.si

The Deploy360 Team

- **Kevin Meynell** – Content & Resource Manager
- **Megan Kruse** – Technology Outreach and Strategic Planning Manager
- **Aftab Siddiqui** – Technical Engagement Manager
- **Jan Žorž** – Operational Engagement Programme Manager

Disclaimer:

I do not work for Let’s Encrypt,
but the Internet Society is a sponsor

Slides contributed by:
Josh Aas (Let’s Encrypt)
Jan Žorž (Internet Society)

Thanks also to Viktor Dukhovni

Let's Encrypt

A Free, Automated and Open Certificate Authority (CA)

- To encourage and simplify adoption of TLS and provide platform for advancing CA and end user security.
- Certificates are free for anyone owning a domain name
- Software running on a web server can automatically obtain, configure and renew a certificate
- All certificates issued or revoked will be publicly recorded and available for anyone to inspect.
- The automatic issuance and renewal protocol is published as an open IETF standard that others can adopt.
- Let's Encrypt is an effort to benefit the community beyond the control of any one organisation.

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Let's Encrypt

Why do we need it?

- The Internet is inherently insecure, unencrypted traffic can be read and modified.
- TLS (formerly SSL) is used to encrypt web connections using HTTPS, but can also be used for e-mail, instant messaging, streaming, VoIP and other applications.
- Around 55% of Firefox page loads are HTTPS, and 62% of emails received by Gmail are over STARTLS.
- Aim is to have 100% of Internet traffic encrypted, and by default.
- CAs are (currently) needed to validate domains and link them with public keys used to establish encrypted connections.

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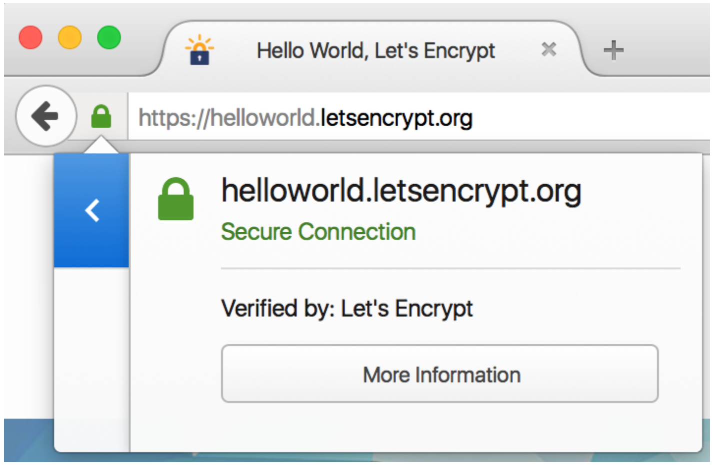
But, authentication via traditional CA is not easy

- CAs issue the X.509 certificates required for TLS on the Web



https://helloworld.letsencrypt.org

helloworld.letsencrypt.org

Secure Connection

Verified by: Let's Encrypt

- Interaction with CAs for certificate issuance and management is complex

In fact, it’s too hard…

I can’t f’ ing figure out how to get a cert … God help people that don’t know what a CSR is… I am like 45 minutes in.

Cullen Jennings, Cisco Fellow

Let's Encrypt

The traditional way…

- Figure out you need a certificate
- Work out where to get the certificate from
- What type of certificate you need - DV, OV, EV or maybe you want the Regular, Pro, Gold or Platinum versions? Hmm...
- Figure out how to request a certificate, including making a CSR
- Go through manual verification process, hoping that responses go to the right e-mail addresses (assuming they exist in the first place), and your organisation has a publicly listed phone number and/or DUNS number etc..
- Pay
- Figure out how to install your certificate
- Don't forget to renew it on time!

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Let’s Encrypt

Let’s Encrypt is born...

- Josh Aas and Eric Rescorla decided to address this problem after discussions in IETF HTTP/2 Working Group
- Decided solution was to establish CA offering free certificates globally, but (only) supporting automated processes.
- Established Internet Security Research Group in May 2013, a foundation with IRS 501(c)(3) status
- Mission is to reduce financial, technological and educational barriers to secure communication over the Internet.
- Let’s Encrypt announced on Nov 2014, started trials in Sep 2015, public beta in Dec 2015, and entered production service in Apr 2016
- Funded by 30+ sponsors making long-term commitments

Let’s Encrypt

What’s different?

- Automated Certificate Management Environment (ACME), the key to Let’s Encrypt
- Provides API for requesting, validating, revoking and otherwise managing certificates
- Clients **must** request certificates from Let’s Encrypt via ACME
- Certbot is recommended client software, but others are available
- ACME is being standardized: IETF®

The technical details…

- Let’s Encrypt certificates are Domain Validation (DV) – asserts that holder has control over a domain
- Validation is undertaken through challenge verification
  - HTTP: a file on your web server
  - DVSNI: provisioning virtual host at your domain’s IP address
  - DNS: provision a DNS TXT record for your domain
- Certificates have 90-day lifetime
  - Encourages automation
  - Limits damage from key compromise or mis-issuance
  - Mitigates the problems of certificate revocation

Let's Encrypt

Trust anchor…

- End entity certificates are validated through a chain-of-trust originating from a root certificate, known as the trust anchor
- Root certificate trust is established through distribution of root certificates in operating systems or browsers
  - Main certification programs are Microsoft, Apple and Mozilla
- Let's Encrypt issues certificates from intermediate CA called Let's Encrypt Authority X3, signed by ISRG Root X1
- ISRG Root X1 accepted by Mozilla, Apple and Google root programs
- ISRG Root X1 is cross-signed by IdenTrust DST Root CA X3 to support other OSs and browsers

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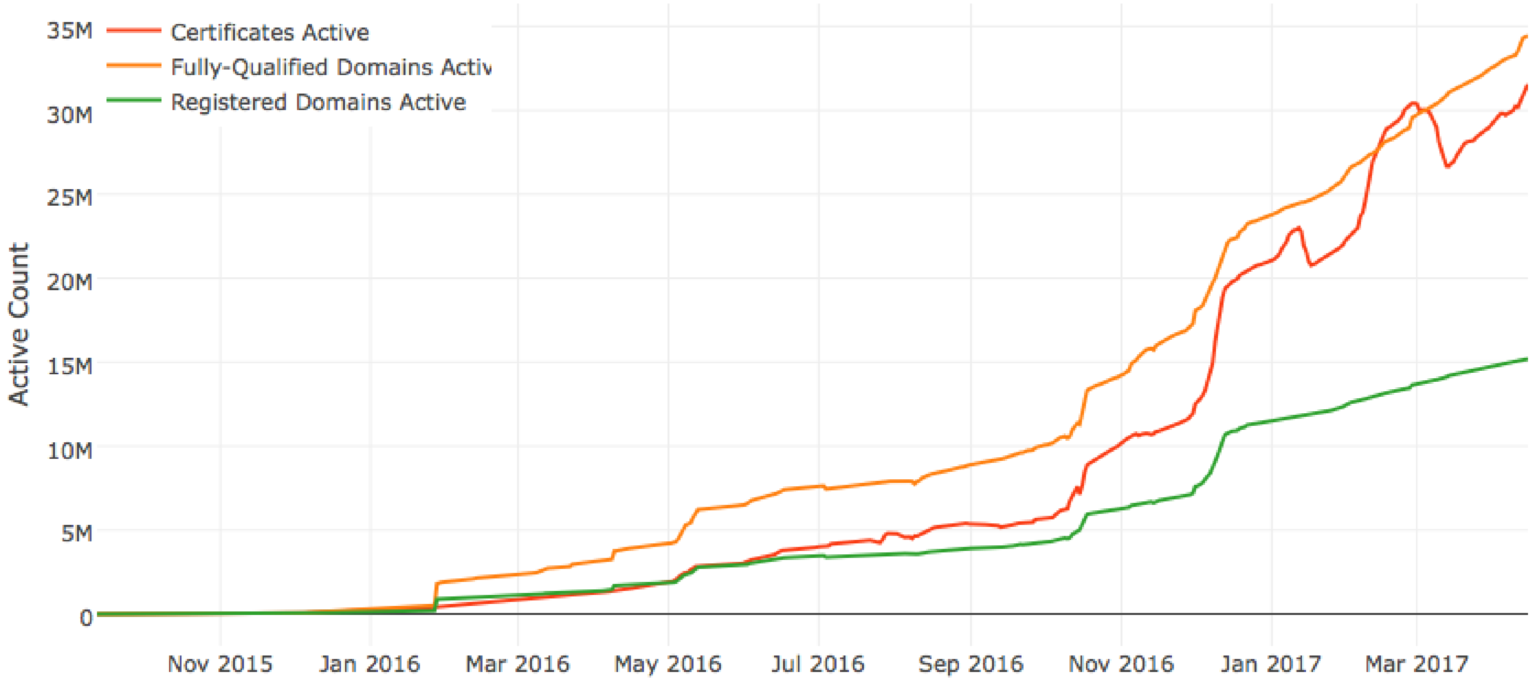
ACME Clients…

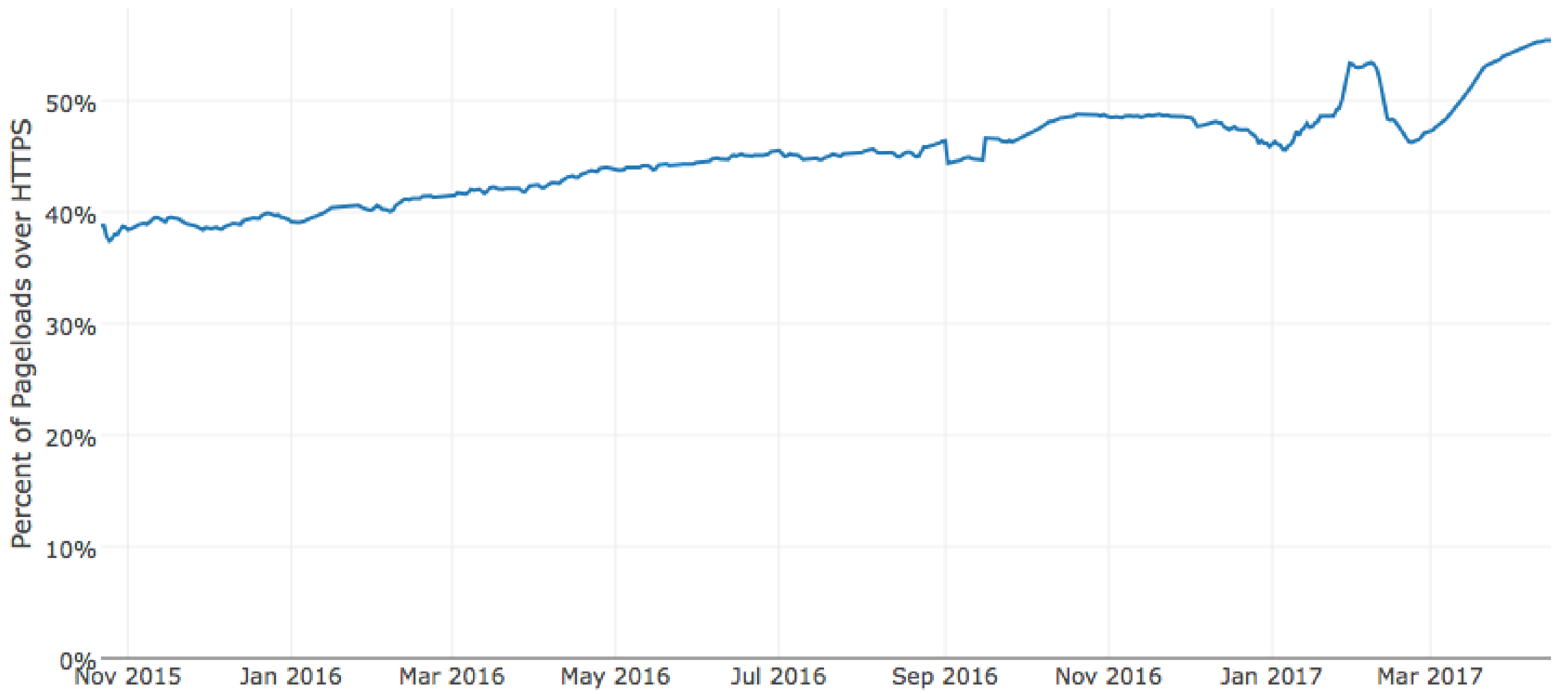
- Let’s Encrypt uses ACME protocol to verify and issues certificates
- Need to use ACME-compliant client software
- Recommended to use Certbot developed by EFF
  - Supports MacOS, Linux and various Unix flavours
  - This also works with other CAs supporting ACME
  - https://certbot.eff.org
- Many other clients supporting other platforms (e.g. Windows)
  - https://letsencrypt.org/docs/client-options/

How successful is it?



Let's Encrypt

Is it encouraging use of TLS?



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Issues with conventional Internet PKI

Inherent weakness is that third parties (CAs) are able to issue certificates for any name or organisation

- CAs have issued incorrect certificates in the past
- Risk of CA issuing incorrect certificate increases with number of CAs
- Particular concern with code-signing certificates as comprise can allow malware to be distributed as digitally-signed trusted applications
- OV and EV were introduced to improve checks, but still problematic on a global scale + largely requires users to identify these types of certificates are being used
- Not ideal for automated systems such as e-mail servers

Using the DNS and DNSSEC

DNS is the main method to locate Internet services, and allows domain name holders to control the records related to their services

DNS Security Extensions (DNSSEC) uses public key cryptography to digitally sign their DNS records, ensuring only the domain name holder can make changes

DNSSEC records can be validated through chain-of-trust up to the root zone, ensuring that a client making a query can verify the returned information is from the entity authorised to provide it

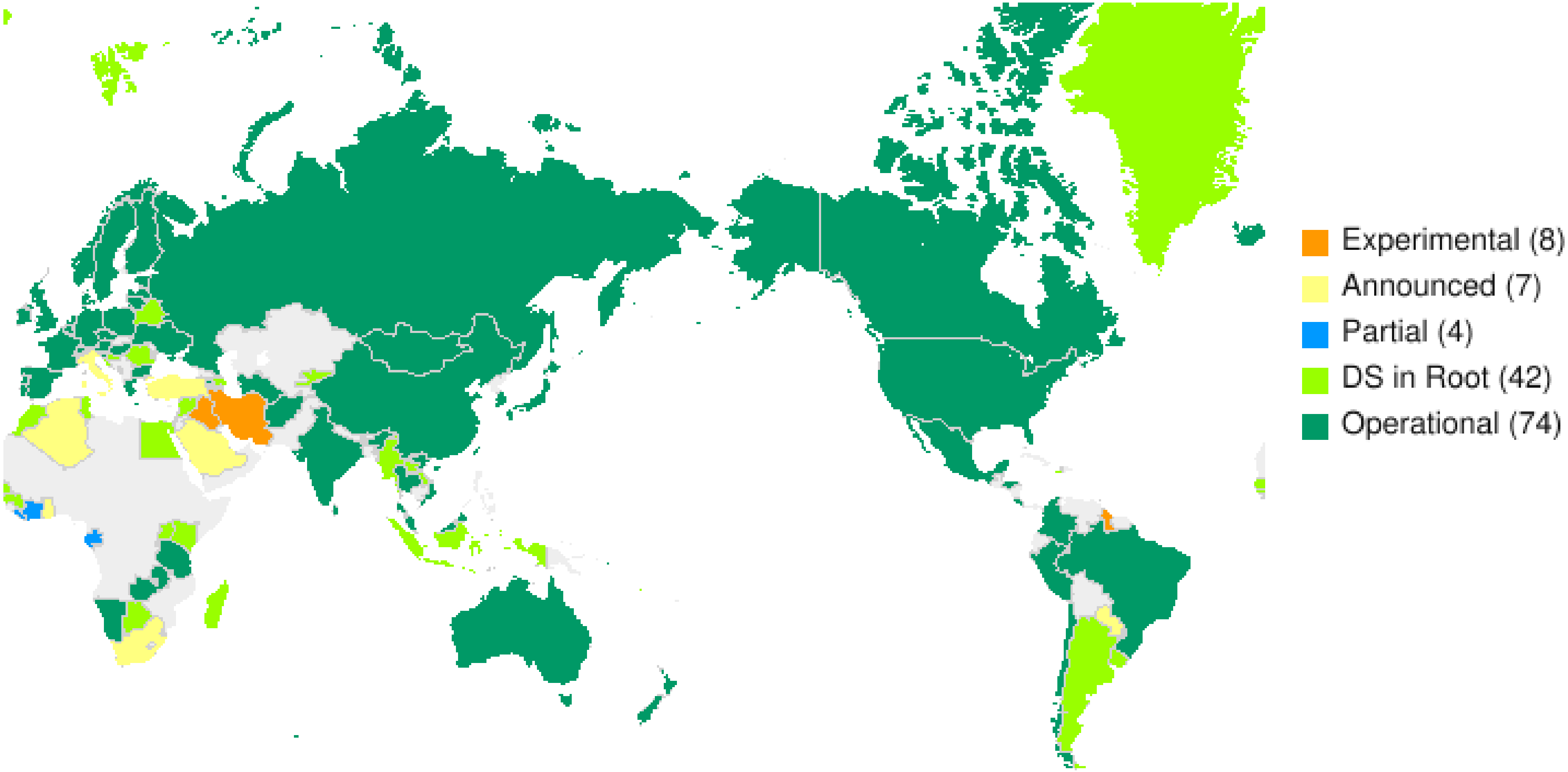
DNSSEC can also be used to authenticate TLS client and server entities

DNS-Authenticated Name Entities (DANE)

DANE is a protocol that allows certificates to be cryptographically bound to DNS names

- Domain administrators can certify the keys used for establishing TLS sessions by storing them in the DNS
- Aims to improve inherent situation whereby any CA can issue certificate for any name
- Requires DNS records to be signed with DNSSEC
- Uses TLSA records to associate a TLS certificate or public key with a domain name
- Clients need to be DNSSEC and DANE aware

ccTLD DNSSEC Status on 2016-12-12



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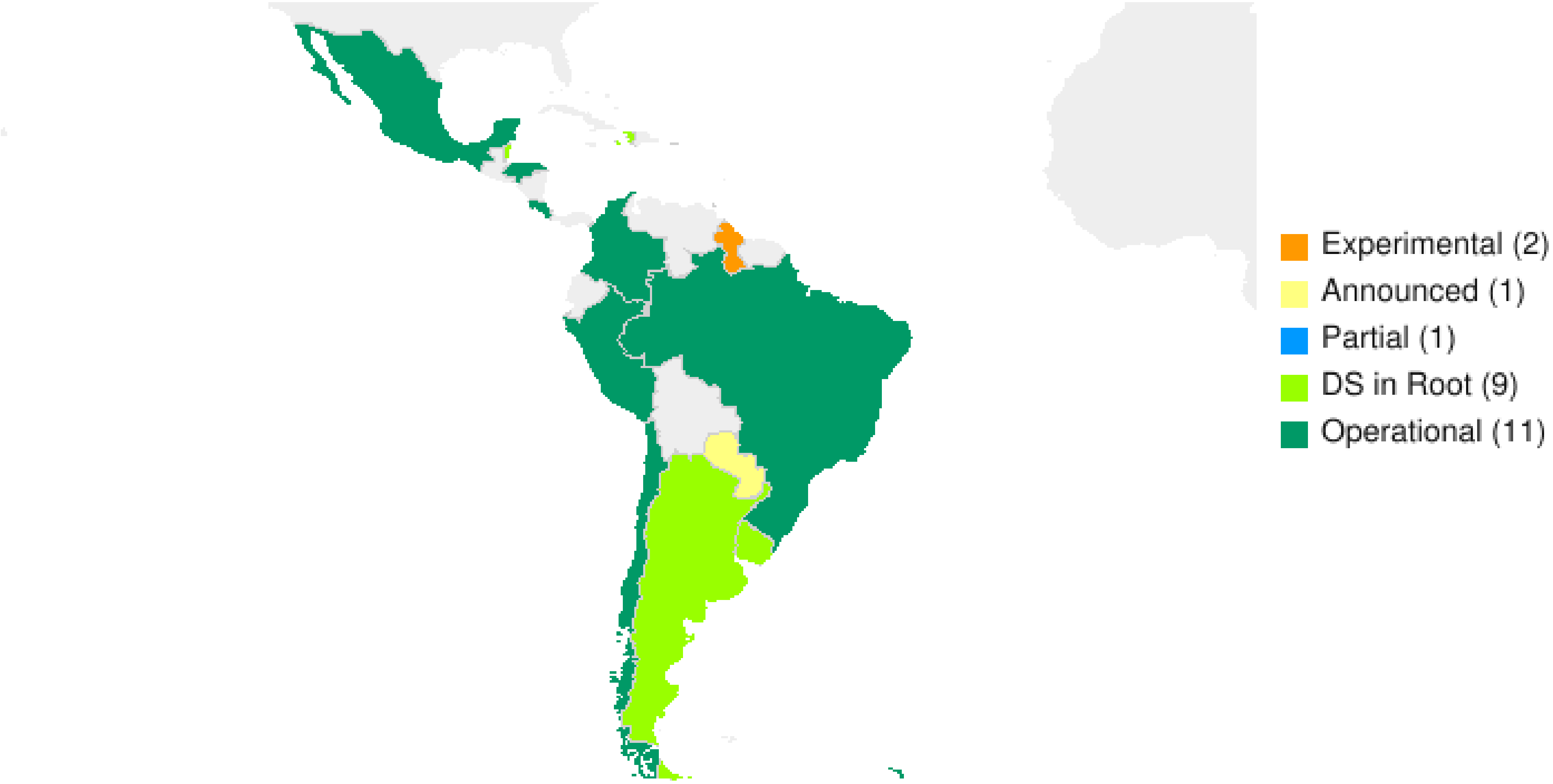
LAC ccTLD DNSSEC Status on 2016-12-12



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DNS TLSA Records

DNS TLSA records associate certificates or public keys with domains

- Defined in RFC 6698
- *Usage*, *Selector* and *Matching Types* fields determine which CAs, certificates and hashes can be accepted
- Let’s Encrypt recommends *2 1 1* and *3 1 1* records

TLSA record for mx.go6lab.si

```
_25._tcp.mx.go6lab.si. IN      TLSA    3 0 1
B4B7A46F9F0DFEA0151C2E07A5AD7908F4C8B0050E7CC25908DA0
5E2 A84748ED
```

The above is a hash of TLS certificate on mx.go6lab.si

When do things fail in DANE?

When do things fail in DANE?

- TLSA record is published in non-DNSSEC zone (therefore can’t trust the data)
- Domain where looked up records (e.g. MX) reside are not DNSSEC signed (therefore no verification)
- Wrong certificate hash in TLSA record

Let’s Encrypt & DANE Experiment

Internet Society & Go6Lab experimented with DANE & e-mail

- Setup DNSSEC on PowerDNS and signed with OpenDNSSEC
- Used Postfix mail server with TLS support (3.0.1, although 3.2 now available)
- Requested and downloaded Let’s Encrypt certificate
- Generated TLSA record for mx.go6lab.si (using *chaingen*)
- Added TLSA record to DNS
- Verified TLS certificates on domains known to have DANE support (e.g. nlnetlabs.nl)
- Developed script that fetched top 1 million Alexa domains and sent an e-mail to each of them

Experiment Results

ISOC / Go6Lab tested SMTP connections to Alexa Top 1 million domain names

- 70% of attempted sessions were encrypted with TLS
- 60% of TLS sessions were established with trusted certificate
- Other sessions used untrusted certificate or opportunistic TLS
- None of the top 10 mail servers and their domains were DNSSEC signed (as of Jan 2016)
- Only 128 sites could be verified with TLSA by DANE!
- How can this be improved?

Let’s Encrypt Issues

Validity of Let’s Encrypt certificate is 90 days

- By default the underlying key is changed when renewing
- So also is hash, so work needed if planning to publish 3 1 1 TLSA
- Using 2 1 1 TLSA means lack of DST Root CA X3 in certificate chain
- So need to fetch DST Root CA X3 certificate and add it to *fullchain.pem* file
- However, how do we know if root certificate has changed?
- Trick is to use same CSR when Let’s Encrypt certificate is renewed, and generate 2048 bit RSA private key
- This means same underlying key can be used for 3 1 1 TLSA records, so hash doesn’t change
- Underlying key can be rotated on different schedule

Moral of the story…

70% of e-mail can already be encrypted in some way – so enable TLS on your server!

Let’s Encrypt offers free certificates and automated ordering/installation, so no excuse not to make encryption the default on the Internet

Using DANE is not that difficult and can be automated

But…

We need more DNSSEC signed domains!

We need even more DANE/TLSA verified servers!

Further Information

Deploy360 - DNSSEC

http://www.isoc.org/deploy360/dnssec/

Let’s Encrypt

https://letsencrypt.org/

HOWTO

http://www.internetsociety.org/deploy360/blog/2016/01/lets-encrypt-certificates-for-mail-servers-and-dane-part-1-of-2/

http://www.internetsociety.org/deploy360/blog/2016/03/lets-encrypt-certificates-for-mail-servers-and-dane-part-2-of-2/

https://dane.sys4.de/common_mistakes

Thank You!

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