

How to change the Internet?

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*I seek serenity to accept the things I cannot change,
courage & patience to change the things I can,
and wisdom to know the difference.*

– ancient Internet engineering prayer

Evolving roles

1. ~~Teenager interested in computers~~
2. ~~Computer Repair Technician on Saturdays~~
3. ~~System Administrator~~
4. ~~Network Engineer~~

Now: RPKI doctor, advisor, protocol designer, developer

General structure of this talk

- ▶ Explore various problem/solution cases
- ▶ Identify commonalities between the cases
- ▶ Provide suggestions how to effect change
- ▶ Q & A

Case #1: BGP Communities

The context:

- ▶ The pool of available 16-bit ASNs was running out
- ▶ 32-bit ASNs were the designated successor
- ▶ Everyone used BGP communities to operate networks

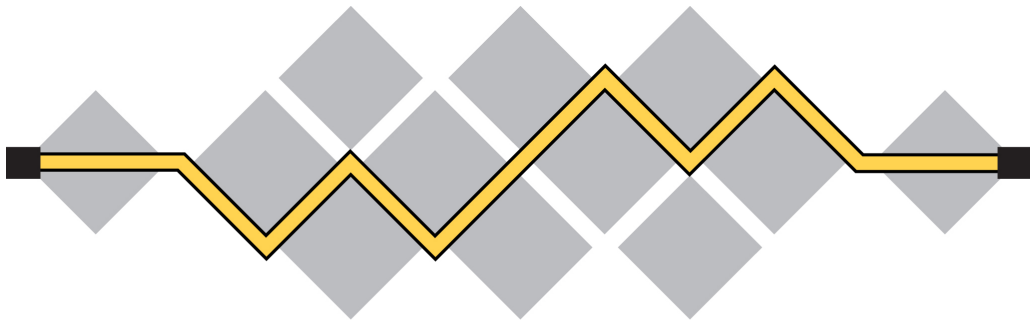
5. Handling BGP Communities

As specified in [[RFC1997](#)], when the high-order two-octets of the community attribute is neither 0x0000 nor 0xffff, these two octets encode the Autonomous System number. **Quite clearly this would not work for BGP speakers that use 4-octets Autonomous System numbers.** Such BGP speakers should use the Four-octet AS Specific Extended Communities [[AS-EXT-COM](#)] instead.



Who is in charge of this???





I E T F[®]

What had been done so far

- ▶ Proliferation of misconception that BGP Extended Communities were a good fit for the problem space
- ▶ Flexible BGP Communities draft (2003 .. 2010)
- ▶ Wide BGP Communities draft (2010 .. still ongoing!)

The discussions in IETF about extending this (red: BGP communities) have been around for many years, and no progress has been made.

Any proposal that has an extended functionality, comes with the problem that that discussion of the additional functionality does not have a proof of termination.

– Ruediger Volk

Seizing the opportunity: Large Communities

- ▶ Easy to explain over a beer
“it is like normal BGP communities, just a bit bigger”
- ▶ Easy to implement, so easy that it was hard for router vendors to refuse
- ▶ Timely solution for urgent problem:
the 16-bit ASNs pool was nearly depleted!
- ▶ A minimum viable solution

How did the change actually materialize?

- ▶ I was the producer, not the artist:
 - ▶ Ignas Bagdonas came up with “lets just double”
 - ▶ A suggestion from Ruediger Volk made it triple
 - ▶ Many developers wrote running code
- ▶ I studied how to navigate IETF processes
- ▶ For well over half a year this was all I focused on!
 - ▶ Tireless evangelization & coordination

Case #2: Routing Security

The context:

- ▶ BGP hijacks constantly caused on-call phones to ring
- ▶ Routing incidents usually required human remediation
- ▶ In effect, the DFZ was exhibiting severe scaling issues

the Internet routing system (many years ago)



Who is in charge of this???



Collective action problem



Snowball effect

Fun fact: the global deployment of RPKI ROV started **here**, in the Netherlands! 

- ▶ Created a buzz around *routing security*, making it a priority topic.
- ▶ Consistently emphasize self-interest / unilateral benefit
- ▶ Talked to the press about large Internet outages
- ▶ Provided hands-on assistance, acting as helpdesk

Unintended consequence

I became heavily involved in low-level RPKI development.

Many bugs, misunderstandings, flaws in RFCs, and security issues observed in the field urgently needed fixing.

I felt it was my responsibility to make RPKI work well.

Case #3: about the ASPA design

Context:

- ▶ Accidents will happen in the best regulated families.
- ▶ Operator wants automated route leak prevention.
- ▶ Preferably something effective, low effort, easy to use.

ASPA: equal treatment for IPv4 and IPv6

Historically, IPv4/IPv6 BGP operations are always isolated.

- ▶ duplicity in work → increased risk of mistakes

But, in ASPA, you don't separate IPv4/IPv6 upstreams!

A long debate: what ASPA should be?

Some people considered unifying IPv4/IPv6 controversial.

My take: is more buttons more choices more better? No!!

Challenge the status quo: is the separation of IPv4 & IPv6 in BGP policy UI/UX *maybe* a form of cargo culting?

Intuition & experience: **simple sells better.**

How it materialized

- ▶ I prioritised the preferences of the implementers over the academic perspective: running code is king.
- ▶ Perseverance: don't be sent off empty-handed. Ultimately, people can't just ignore the IETF consensus process. Standardisation is a group effort.

Case #4: Making RPKI go faster

Context:

- ▶ I look at global RPKI health & telemetry every day
- ▶ I started to wonder: is this all slower than it should be?
- ▶ Slow RPKI is bad for business when you f*ck up ROAs!

Rsync in a nutshell

On paper, `rsync` is super efficient:

1. transfer the list of files
2. transfer the data the client doesn't have

What do you
have for me?

```
$ rsync -rt rsync://chloe.sobornost.net/rpki/RIPE-nljobsnijders/  
drwxr-xr-x 512 2026/09/02 11:06:31 .  
-rwxr-xr-x 1,729 2026/04/09 10:24:49 24uSj6d9yFEZmLIYGdo_5uEBPY.roa  
-rwxr-xr-x 1,705 2024/02/27 18:32:14 5m80fwYws_3FiFD7JiQjAqZlRYQ.asa  
-rwxr-xr-x 1,727 2026/04/09 10:37:43 76ulW5E_Ouq5QH7w6qX0alj5iCI.roa  
-rwxr-xr-x 1,853 2024/02/27 18:04:04 9X0AhXWTJD18lJhfOwvnac-42CA.spl  
-rwxr-xr-x 1,729 2026/04/09 10:24:48 K50pgQSImpHhNKd0Lg4zifkae08.roa  
-rwxr-xr-x 1,724 2026/04/09 10:36:49 W-IMAJK6gZWEHMYOULhP9_ElGmM.roa  
-rwxr-xr-x 898 2026/06/15 08:09:45 XUJQ4tgdREjYop786R0p_wdeyeI.cer  
-rwxr-xr-x 1,729 2026/04/09 10:24:48 cr114rqldvV_dmNbCgm_LXj6xuw.roa  
-rwxr-xr-x 898 2026/06/15 08:09:49 voibVdC3Nz19dcSfSFuFj6mKOR8.cer  
-rwxr-xr-x 615 2026/06/15 11:06:31 yqgF26w2R0m5sRVZCrbdV5cM29g.crl  
-rwxr-xr-x 2,348 2026/06/15 11:06:31 yqgF26w2R0m5sRVZCrbdV5cM29g.mft
```

I'll read you
the FULL
list

Rsync Repository

What do you have
for me now?

```
$ rsync -rt rsync://chloe.sobornost.net/rpki/RIPE-nljobsnijders/  
drwxr-xr-x 512 2026/09/02 11:06:31 .  
-rwxr-xr-x 1,729 2026/04/09 10:24:49 24uSj6d9yFEZmLIYGdo_5uEBPY.roa  
-rwxr-xr-x 1,705 2024/02/27 18:32:14 5m80fwYws_3FiFD7JiQjAqZlRYQ.asa  
-rwxr-xr-x 1,727 2026/04/09 10:37:43 76ulW5E_Oug5QH7w6qX0alj5iCI.roa  
-rwxr-xr-x 1,853 2024/02/27 18:04:04 9X0AhXWTJD18lJhfOwvnac-42CA.spl  
-rwxr-xr-x 1,729 2026/04/09 10:24:48 K50pgQSImpHhNKd0Lg4zifkae08.roa  
-rwxr-xr-x 1,724 2026/04/09 10:36:49 W-IMAJK6gZWEHMYOULhP9_ElGmM.roa  
-rwxr-xr-x 898 2026/06/15 08:09:45 XUJQ4tgdREjYop786R0p_wdeyeI.cer  
-rwxr-xr-x 1,729 2026/04/09 10:24:48 cr114rqldvV_dmNbCgm_LXj6xuw.roa  
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```

Let me
read you
the full list
again

Rsync Repository

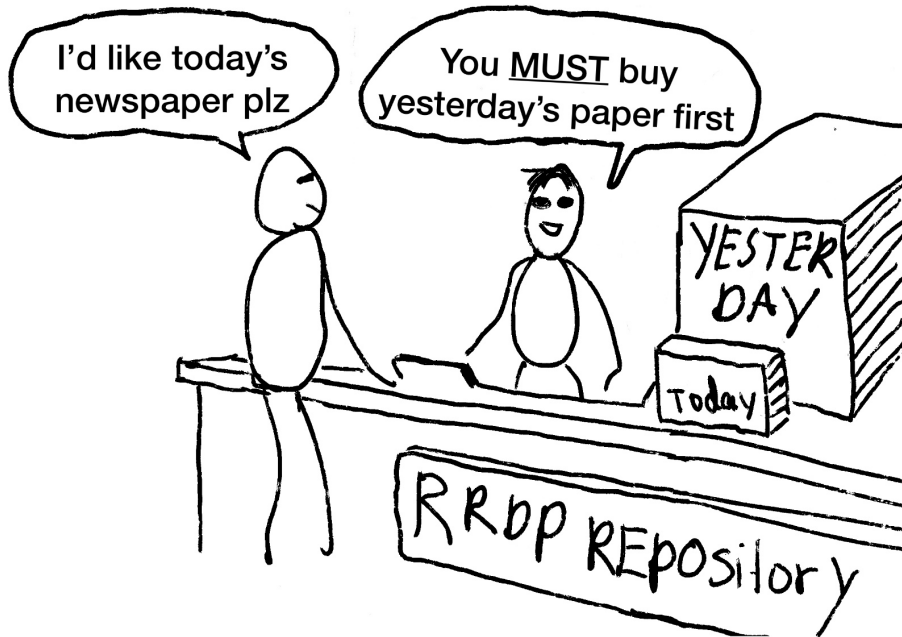
5 minutes later...

Then came RRDP

People realized rsync wasn't good fit for RPKI.

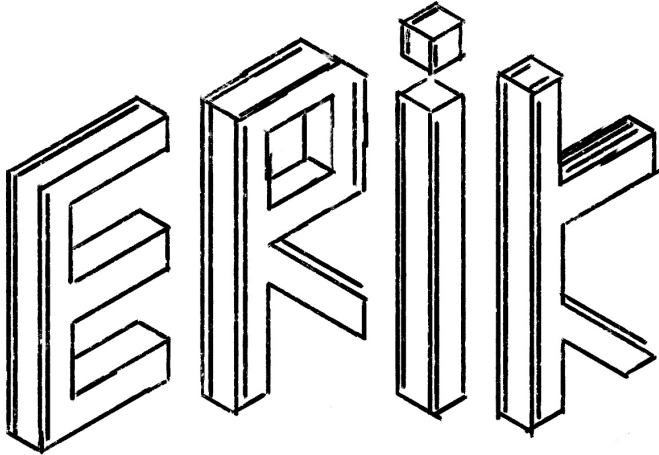
RRDP essentially is an operation-based journal:

1. Download journal segments one by one over HTTPS
2. Replay the operations in these segments
3. You are up-to-date!





A distribution solution for a distributed database problem



Erik Synchronisation in a nutshell

The Erik Synchronisation protocol combines Merkle trees, content-addressable storage, concurrency control, and efficient message layer reuse; with the best features from Rsync & RRDP:

Rsync: stateless, 'jump to latest', only transfer changes

RRDP: static pre-calculated content, HTTP-based

What truly sets Erik apart from Rsync/RRDP

- ▶ As client you can only *hope* the remote repository runs things decently or sits behind proper CDN. You cannot force the origin to use a CDN.
- ▶ In Erik Synchronisation anyone can stand up “Erik Relays”, instances which mirror all global RPKI data.
- ▶ Clients can rotate between different relays for robustness, thanks to stateless nature of the protocol.

Path towards materializing this change

- ▶ RPKI repositories being down or slow annoyed me.
- ▶ As maintainer of a RPKI validator implementation saw opportunity for permissionless incremental deployment.
- ▶ Studied the state of the art in data replication:
Kleppmann's [Designing Data-Intensive Applications](#).

Case #N: What about you?

Your mission usually has three parts

- ▶ Imagining it (innovation)
- ▶ Explaining it to others (education)
- ▶ Building it (standardisation)

Recommendations how to effect change (1)

- ▶ **Pick a problem you care about.**
- ▶ Figure out who “owns” the solution space.
- ▶ What anti-patterns make the problem persist?

Recommendations how to effect change (2)

- ▶ Talk to friends to validate your thinking.
- ▶ Talk to the “competition” to hear their side.

Recommendations how to effect change (3)

- ▶ Properly write down the problem & solution.
- ▶ Make proof-of-concepts & **iterate**.
- ▶ Teach people how it works, so they can evaluate it.
- ▶ Show people how the solution benefits them in the short term.

Recommendations how to effect change

- ▶ A bit of luck: being at the right time right place.
- ▶ Patience!

Need a break from the Internet? :-)

Some book & music recommendations:

Exhalation: Stories - Ted Chiang

De Pelikaan - Martin Michael Driessen

The Clearing - Wolf Alice

Crooked Wing - These New Puritans

Q&A: Let's chat!

