# IRR Hygiene in the RPKI Era

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## Motivation

The Internet Routing Registry (IRR) and Resource Public Key Infrastructure (RPKI) are designed to protect BGP from origin hijacking. Network operators may query either IRR or RPKI databases to for routing security. However, IRR information may be inaccurate due to improper hygiene. Since RPKI uses a stricter registration and validation process, we use it as a baseline against which to compare the trends in accuracy and coverage of IRR data.

## Research Questions

**RQ1: How much IPv4 address space does the IRR and RPKI cover?**

**RQ2: How consistent are IRR and RPKI?**

**RQ3: How many ASes have good IRR hygiene?**

## RQ1 – IRR and RPKI Coverage

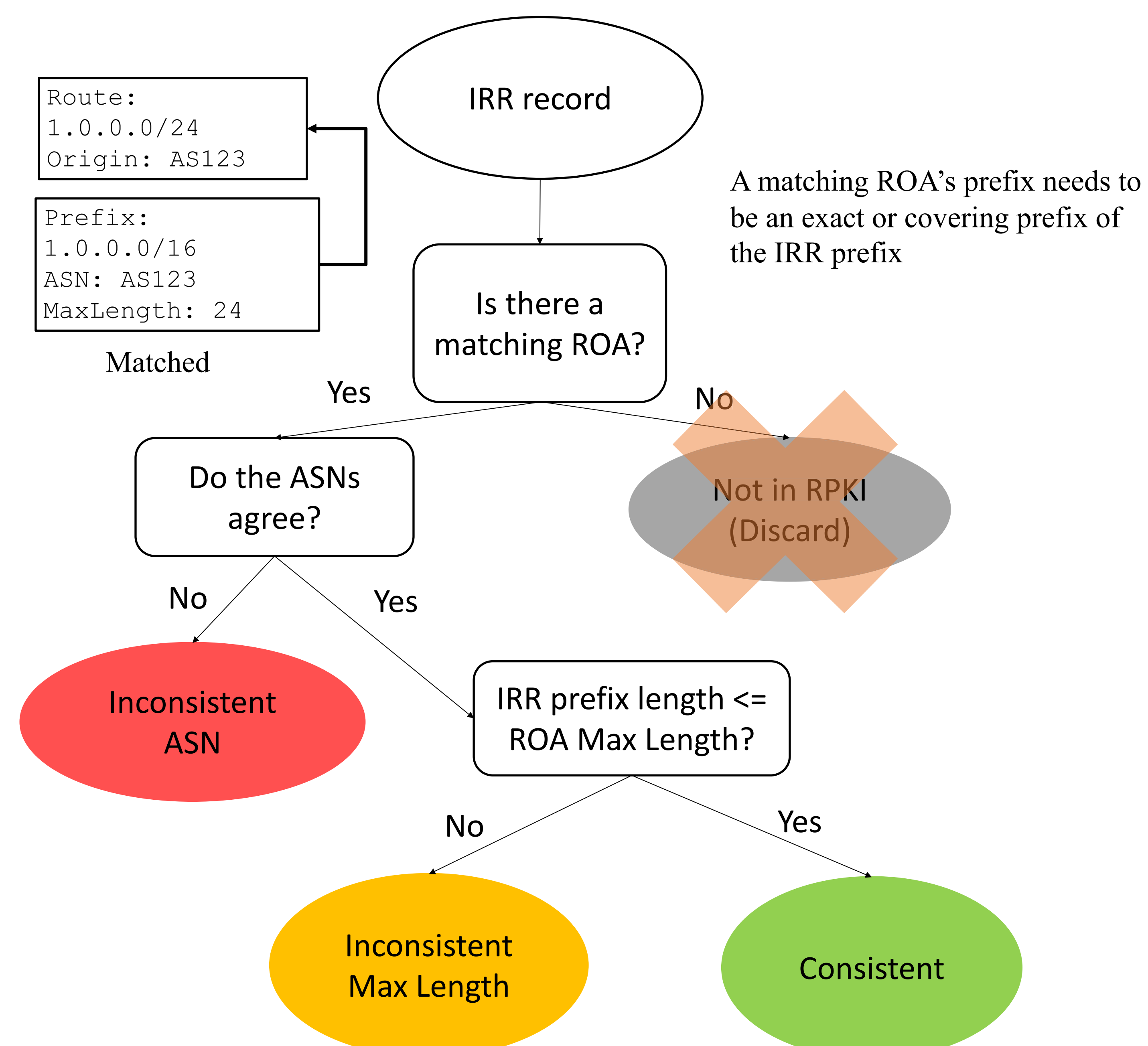IRR dataset: Monthly snapshots of IRR route objects from RADB. August 2016 to October 2021.

RPKI dataset: Monthly snapshots of validated ROAs from RIPE NCC. August 2016 to October 2021.

| Year | IRR | | | RPKI | | |
|------|--------|--------|----------|--------|--------|----------|
|      | Prefix | ASN    | IP Space | Prefix | ASN    | IP Space |
| 2016 | 769k   | 24,112 | 70.52%   | 20k    | 3,741  | 11.62%   |
| 2017 | 813k   | 27,151 | 73.39%   | 34k    | 4,918  | 14.25%   |
| 2018 | 900k   | 30,531 | 74.23%   | 44k    | 6,185  | 15.08%   |
| 2019 | 958k   | 33,608 | 74.73%   | 75k    | 9,394  | 23.55%   |
| 2020 | 1M     | 37,427 | 82.59%   | 128k   | 15,039 | 35.06%   |
| 2021 | 1.06M  | 40,574 | 92.73%   | 209k   | 23,472 | 49.26%   |

The IRR dataset contained 38 times more prefixes and covered almost 7 times more allocated IPv4 address space than RPKI in 2016. The RPKI dataset grew over 10 times over the past 6 years.

## RQ2 – IRR Record Classification

We classify the records in the IRR dataset into 4 categories. We focus on records belong to Inconsistent ASN, *Inconsistent Max Length*, or *Consistent.*



```
Route:
1.0.0.0/24
Origin: AS123
```
```
Prefix:
1.0.0.0/16
ASN: AS123
MaxLength: 24
```
Matched

IRR record

Is there a matching ROA?

A matching ROA's prefix needs to be an exact or covering prefix of the IRR prefix

Do the ASNs agree?

Not in RPKI (Discard)

Inconsistent ASN

IRR prefix length <= ROA Max Length?

Inconsistent Max Length

Consistent

## RQ2- Substantial Inconsistency between IRR and RPKI

The number of IRR records in each category has grown as RPKI gained popularity, but notably there are more inconsistent records between IRR and RPKI than consistent ones.
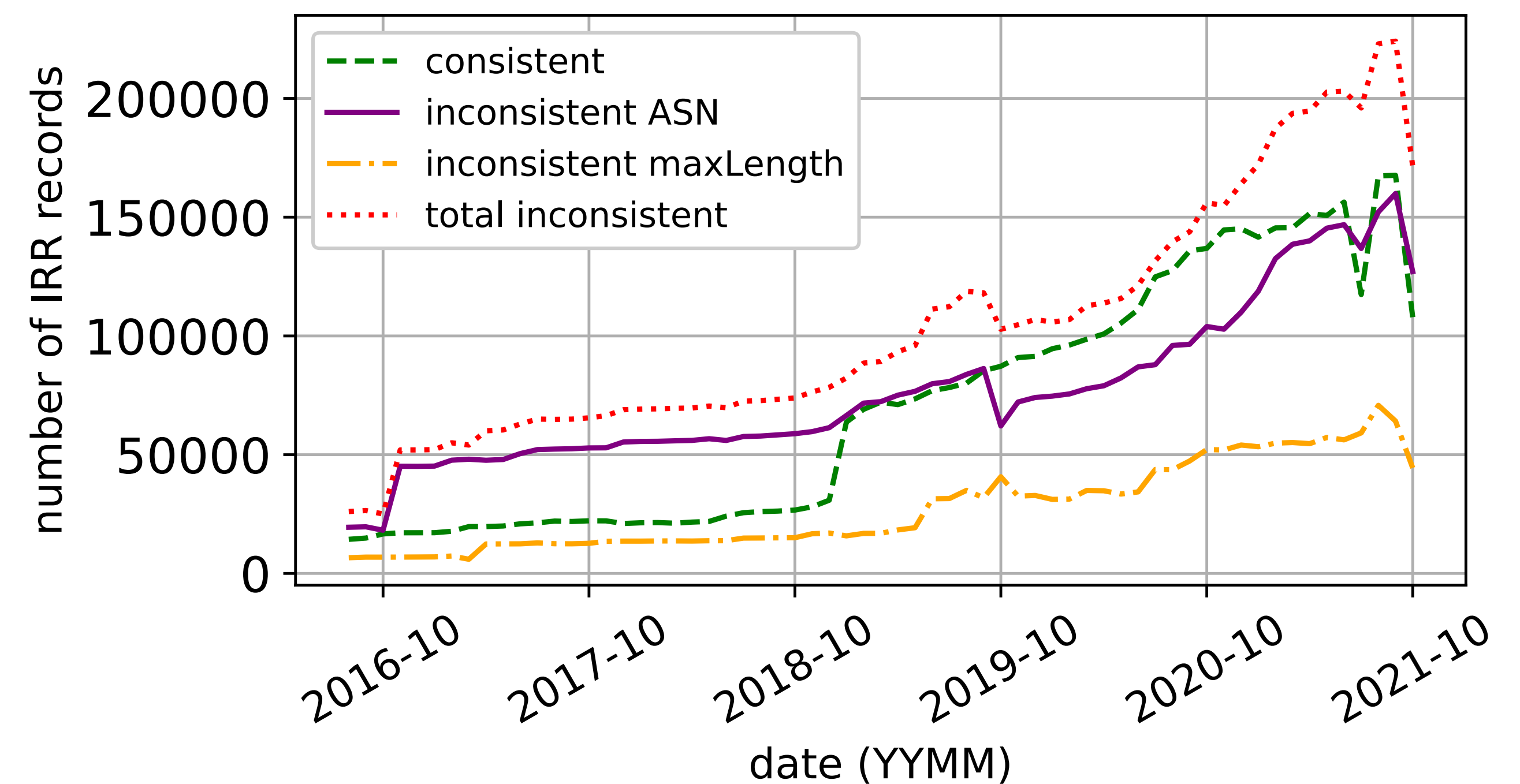


October 2016: **Verisign** customers registered in RPKI, conflicting with existing Verisign IRR records.

January 2019: **TWNIC** ASes registered in RPKI, agreeing with existing IRR records.

September 2019: Verisign deleted outdated IRR records.

July 2021 and after: Fluctuations caused TWNIC RPKI records disappearing and re-appearing from our RPKI dataset.

## RQ3- 4326 ASes With Good IRR Hygiene

We classify ASes into the following three categories based on their record consistency. More ASes keep their entire IRR records consistent with RPKI. However, there are fewer consistent than inconsistent records (155,506 , 43.3% ; 203,947 , 56.8%). The figure below shows that *Entirely Inconsistent* ASes are less likely to update their IRR records.

| AS Class | AS Count | Records | |
|----------|----------|------------|-------------|
|          |          | Consistent | Inconsistent |
| Entirely Consistent | 4326 (43.4%) | 31,897(8.9%) | 0 |
| Entirely Inconsistent | 3600 (36.1%) | 0 | 47,395(13.2%) |
| Mixed | 2040 (20.5%) | 123,609(34.4%) | 156,552(43.6%) |
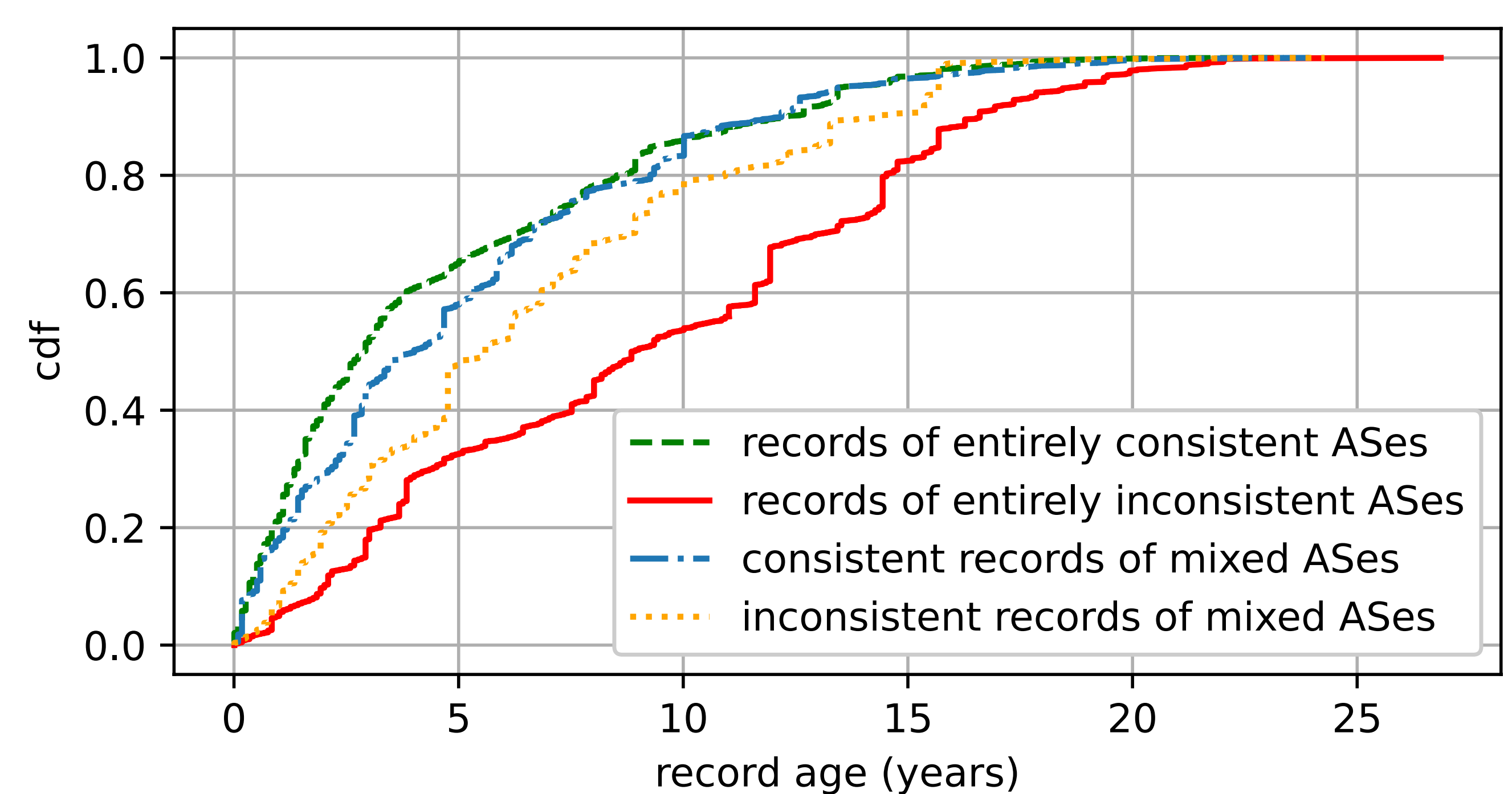


## Summary

We find the rapid growth of RPKI adoption helpful for measuring IRR correctness and better routing security. However, because lack of consistency suggests stale IRR data, tools that identify such inconsistencies can help those wanting (or willing) to maximize the utility of both platforms.

## Challenges and Future Work

**Impact on networks**: How does the inconsistency between IRR and RPKI affect networks?

**False IRR records**: How can we identify malicious IRR registrations?