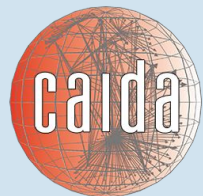


Coordinating BGP Policy and Tooling Across the Global R&E Infrastructure

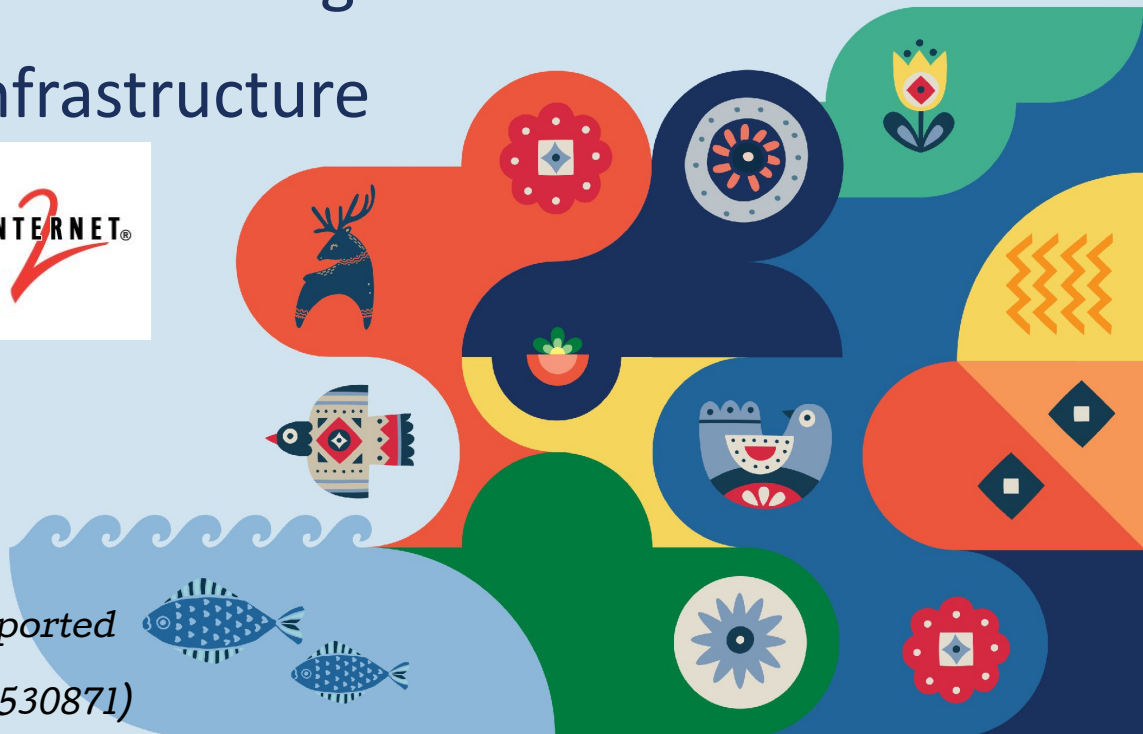


Steven Wallace and Brenna Meade

Rootbeer.internet2.edu

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*Development of these web tools was supported
in part by
the National Science Foundation (OAC-2530871)*



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For this talk, global R&E means four things

01

Network Definition

Interconnected networks predominantly serving research and education institutions.

02

Routing Table Scope

Includes RENs, US Federal agency networks, and Internet2's customer base.

03

Network Scale

~2,700 IPv4 originating ASs and 17,000 IPv4 prefixes.

04

Global Presence

Active in roughly 108 countries.



The need for Collective Action

Ensuring that R&E traffic stays on R&E infrastructure requires coordinated action. For institutions A and B to reliably exchange data over R&E networks, both institutions must prefer R&E routes.

This preference must be adopted across the R&E ecosystem. In many cases, the AS path between A and B may be shorter through the commodity Internet, so local preference is needed to keep traffic on R&E infrastructure.

R&E routes must also be announced with prefixes that are at least as specific as those advertised to commodity networks.



R&E Routing Policy: Inference and Implication

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Preferring R&E routes is not without risk

Route leaks from commodity networks into R&E, or from R&E networks back to the commodity Internet, can have amplified effects when R&E routes are assigned higher local preference or are more specific (see article [here](#)).

For example, a Cloudflare route leaked into the R&E ecosystem caused widespread global impairments.

In another case, a more-specific Baylor University route was announced to commodity by an R&E institution outside the United States, causing traffic destined for Baylor to traverse the globe before reaching campus.



Purpose of the BoF

01

Share the Current State

Update stakeholders on the latest ROOTBEER tools development.

02

Generate Discussion

Gather feedback to drive continuous improvement for the toolset.

03

Improve Connectivity Knowledge

Explore potential for sharing pre-policy routing data for better insights.



ROOTBEER Measures Routing Policy, Security, and Topology

For the global R&E infrastructure, ROOTBEER answers:

- Does a network prefer R&E routes, commodity routes, or AS-path length?
- Does the network use a full routing table, or only commodity default?
- Do more-specific commodity routes divert traffic away from R&E?
- What is the adoption of RPKI-ROAs and RPKI-ASPs?
- What is the underlying pre-policy network connectivity?



ROOTBEER Assists with RPKI-ROA and ASPA Planning

ROOTBEER helps network operators create and visualize RPKI-ROAs and RPKI-ASPs.

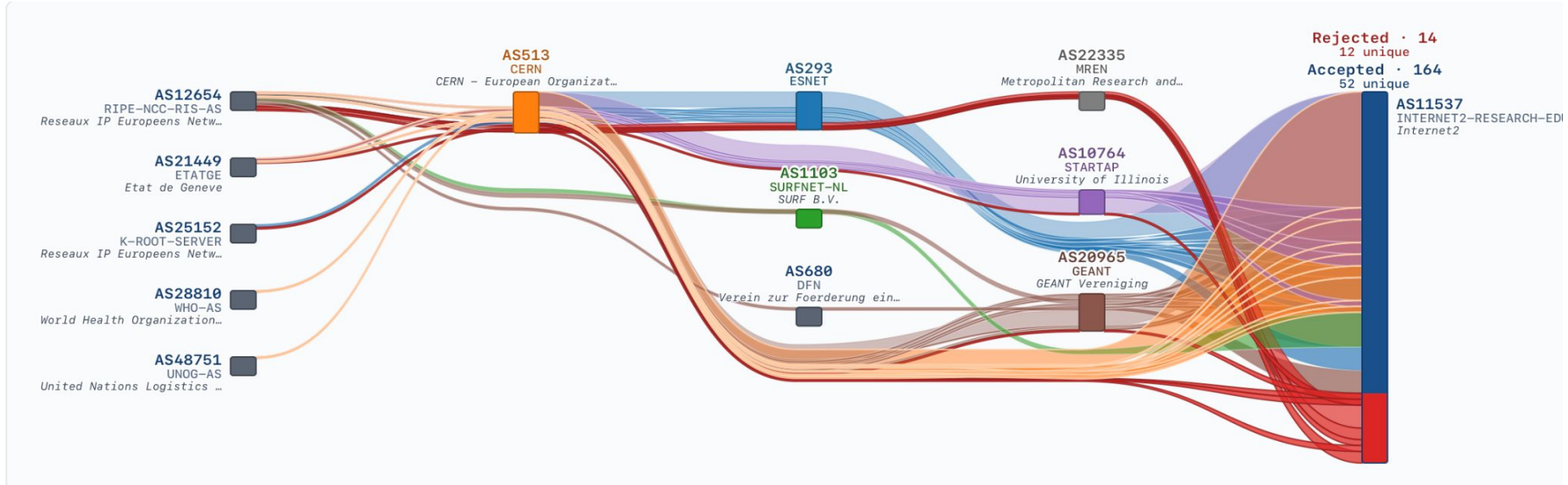
- RPKI-ROA Planner: uses routing and IRR route objects to suggest candidate ROAs.
- RPKI-ROA Visualizer: explains how BGP routes are evaluated against ROAs.
- RPKI-ASPA Pre-planner: combines CAIDA AS relationships and routing data to suggest candidate ASPAs.

These are limitations-aware planning tools, not automated policy changes.

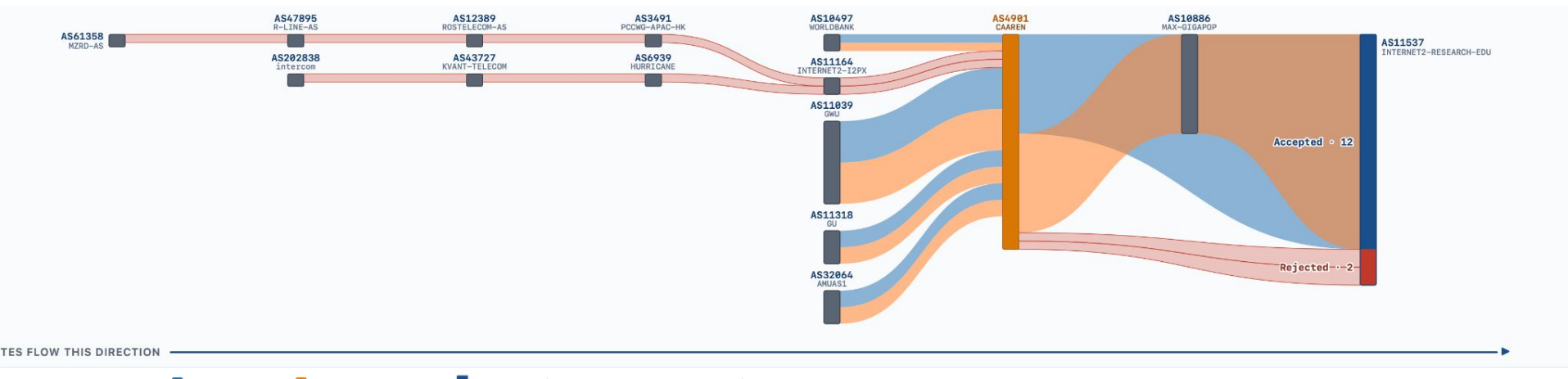


ROOTBEER Helps Visualize Network Topology

CERN's Connectivity



“A picture is worth a thousand words”



ROOTBEER will Assist with Filtering IP Prefixes

ROOTBEER will maintain a prefix list for the global R&E ecosystem.

Internet2 can use the list to filter routes announced by other R&E networks.

The list will be published via IRR. Prefix Manager will let networks interrogate and update entries.

ROOTBEER will also flag candidate leaks.



https://rootbeer.internet2.edu



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Experimental Service



ROOTBEER 



Routing Operations Observational Technology:
Building to Enable Education and Research

A project of [CAIDA](#) and [Internet2](#)

Your address is on the commodity Internet

- Your address 64.38.181.221 is on the commodity Internet (not in an R&E prefix). Routing-policy classification is skipped because the comparison only applies to R&E addresses.



Refresh

ROA Planner



Plan and validate RPKI ROAs for your prefixes.

[Launch →](#)

Partial ASPA Planner

Experimental



Suggest RPKI-ASPA providers for your Autonomous System. Doesn't yet cover every case — provides a starting point, not a comprehensive plan.

[Launch →](#)

IRR AS-SET Planner

R&E only



Build and analyze IRR AS-SET objects for your customer cone.

[Launch →](#)

Whois Web

Look up RIR registration and IP allocation hierarchy for any address or prefix.

[Launch →](#)

LPP Probe



Test BGP Local Preference for R&E networks on demand.

[Launch →](#)

ROA Visualizer



Visualize RPKI ROA coverage across your routing footprint.

[Launch →](#)

Global LPP Report



Daily R&E network routing policy report across 2,700+ autonomous systems.

[View Report →](#)

Global ASPA Coverage



Visualize the deployed RPKI-ASPA topology of the Internet, with optional cross-validation against CAIDA's inferred AS relationships.

[Explore →](#)

RE Topology Report

Experimental

R&E only

Explore Internet2's peering topology and the routes seen across each session, refreshed daily.

[Explore →](#)

ROOTBEER's Data Sources other than Internet2



American Registry for Internet Numbers (ARIN)

IP Registration Data



University of Oregon RouteViews Project

Internet Routing Data



Center for Applied Internet Data Analysis (CAIDA)

AS to AS Name Mappings, and AS Relationship Data —
provider/peer/customer classification for AS pairs



RIPEstat

Routing History and Internet Routing Registry Route Objects



USC Information Sciences Institute: ANT Lab

Responsive IPv4 Addresses

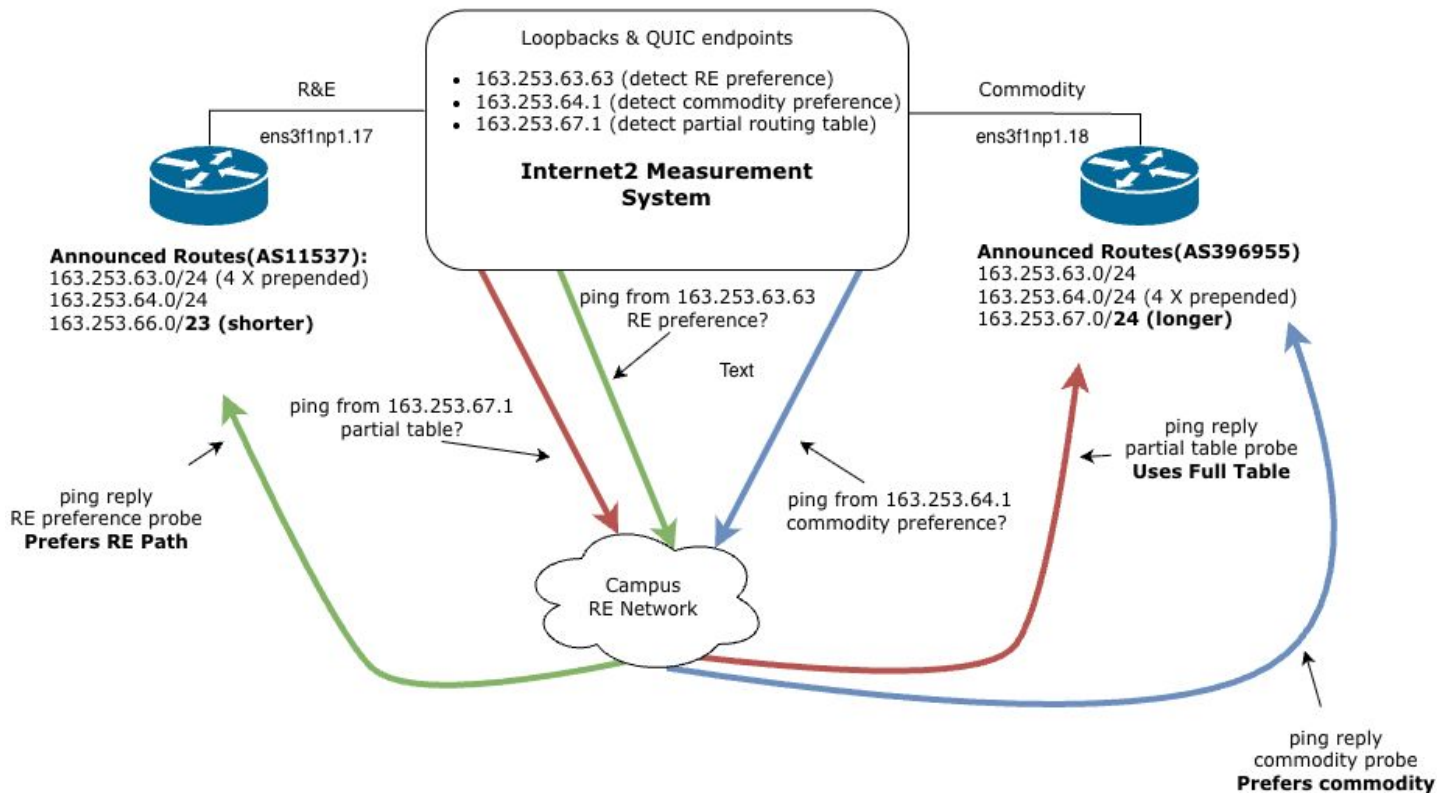
How ROOTBEER Measures Routing Policy

ROOTBEER infers routing policy from where probe replies return.

1. Measurement hosts ping responsive IPv4 addresses across the Internet.
2. Loopback sources are announced through R&E and commodity.
3. Results are useful signals, results still require operator interpretation.

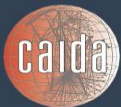


Measuring a Remote RE Network's Routing Policy



ROOTBEER's homepage tests your connection and policy

Experimental Service



ROOTBEER



Routing Operations Observational Technology:
Building to Enable Education and Research

A project of [CAIDA](#) and [Internet2](#)

✓ **Your connection prefers R&E (via local-preference)**

Specific R&E routes are preferred over the commodity Internet path on your network. Your address 109.105.115.65 is in an R&E prefix (109.105.112.0/21) originated by AS2603.

i

Refresh



How ROOTBEER Measures Routing Policy cont.

ROOTBEER also compares RE IP Routes against commodity routes.

It then calculates the percentage of IP addresses for a given RE route that are seen as more specific commodity routes.

It's also highlights when RE routes include AS-prepend in the path.



The Principal Tool to Explore Routing Policy

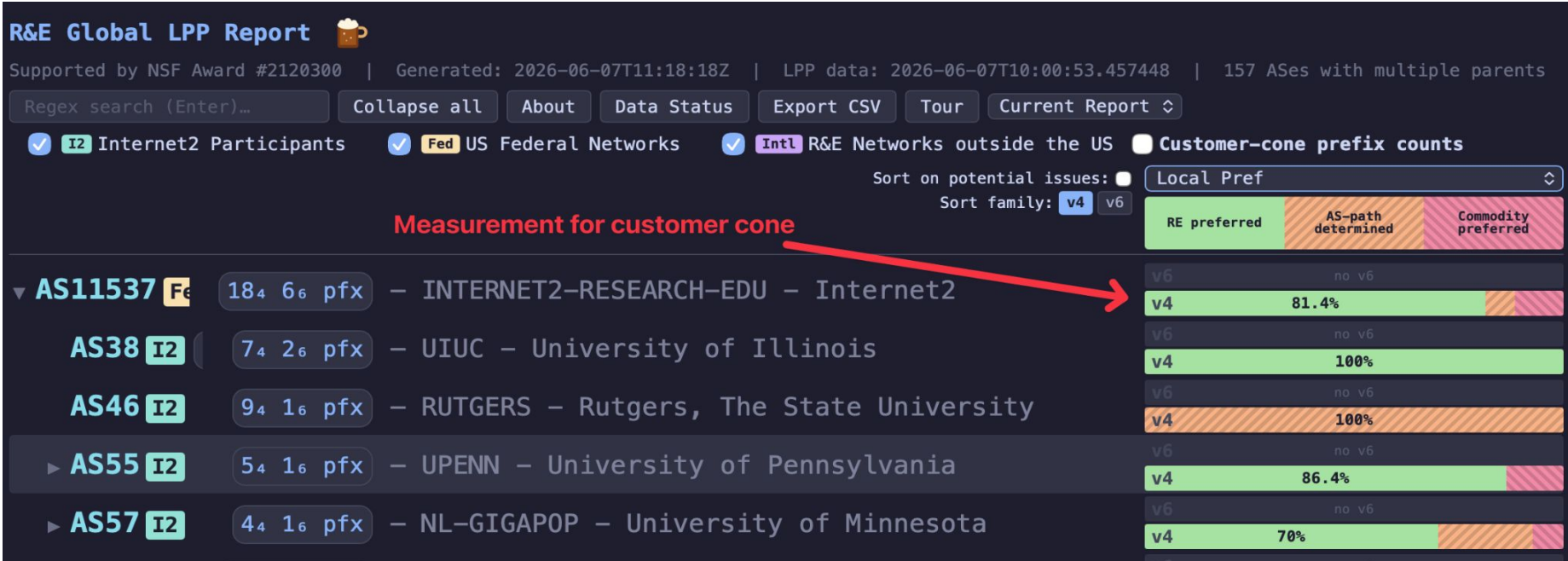
The Global LPP Report

For every R&E network, it shows:

- whether local preference favors R&E routes
- whether R&E routes are more specific than commodity routes
- whether the network takes a full commodity table or only default
- whether the network prepends AS paths toward R&E
- RPKI ROA and ASPA adoption



R&E Global LPP Report



The Principal Tool to Explore Routing Topology

The R&E Topology Report

For every R&E network, it shows:

- routing paths that transit the network's AS
- paths that traverse the network's customer cone
- drill-down views for individual ASs and prefixes
- poster-ready topology views for discussion and sharing



Demo ROOTBEER Tools

rootbeer.internet2.edu



Thank you

Any questions?

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