

The logo for Routing Integrity features a stylized 'I' and '2' in black and red, followed by the word 'Routing' in a large, bold, black sans-serif font. A light blue house-like icon is positioned above the 'o' in 'Routing'. Below 'Routing' is the word 'INTEGRITY' in a smaller, bold, black, all-caps sans-serif font.

# **I2 Routing** **INTEGRITY**

Steven Wallace  
Director, Routing Integrity  
([ssw@internet2.edu](mailto:ssw@internet2.edu))

# Purpose

The Internet2 Routing Integrity Initiative aims to improve the research and education (R&E) community's adoption of best practices that strengthen the resilience and reliability of data movement across the R&E network ecosystem to support our shared missions. Routing integrity is an end-to-end challenge that requires the participation of the entire Internet2-networked community and beyond.

# Scope

- From the network perspective, the Internet2-connected R&E community consists of over 1,000 BGP autonomous systems and 2,400+ IP Networks, making Internet2 the 53rd most connected network in the world according to [asrank.caida.org](http://asrank.caida.org).
- Internet2-connected organizations include:
  - over 350 Primary Network Participants (e.g., universities, research centers, industry affiliates, etc.)
  - Thousands of sponsored participants (K12, libraries, research hospitals, local and state government facilities, etc).
- Internet2 reaches these organizations via 37 Internet2 Connectors (i.e., state and regional networks)

# Elements of Routing Integrity (today)

- **Routing Security** as defined by Mutually Agreed Norms for Routing Security (see MANRS.org)
- **Hardening of network devices** (MFA authentication, regular review of firmware, logging, etc.)
- **Detection and mitigation of DDoS attacks**
- **Resilient cloud connectivity**
- **IPv6 Deployment**

# Internet2's Routing Integrity Initiative

- Measurement and Reporting
  - Route Reports
  - Internet Routing Integrity Assessment
- Education
  - Online workshops (e.g., creating RPKI ROAs, maintaining IRR records, etc.)
  - Office Hours
- Global Coordination
  - Working with other NREN around the world to improve worldwide R&E routing security
- Outreach and Advocacy
  - Promote the benefits of routing integrity
  - Work with stakeholders such as American Registry for Internet Numbers (ARIN) to improve adoption of routing security features
- Adopt the best practices within the Internet2 operated infrastructure

# Progress Made

- Motivated by requirements of networks such as Google, community wide publishing of routing policy increased from ~50% to 95% (80% if assessed via a more strict standard)
- Adoption of RPKI ROAs to protect networks from being hijacked or leaked has likely doubled, and now sits at 6%.
- Working with ARIN, we've been able to reduce the barriers to RPKI for some networks.
- More networks are now MANRS Participants

# Challenges Ahead

- Most of the Internet2-connected IP networks aren't covered by an ARIN agreement, leaving them unable to use ARIN routing security services (e.g., RPKI ROAs and authenticated IRR).
- Route reporting needs to gain capabilities, including alerting users to routes that may be dropped by Internet2 due to policy.
- Need to develop/curate reference resources for best practices such as BGP router configuration.
- Need to expand and make the routing integrity assessments more accessible.

# Internet2 is offering Routing Integrity Assessment workshops

## Promote Routing Integrity!

Capture a snapshot of the measure of routing integrity capabilities adopted.

Provide leadership with an accessible assessment of routing integrity capabilities and their adoption status.

Help Internet2 understand common routing integrity challenges, so that we can improve our outreach efforts.



# Routing Integrity Assessment workshop details

- The questionnaire is a guided self-assessment.
  - Virtual workshop
  - Attendees sign up in advance (copies of the questionnaire are preprovisioned)
  - During the workshop
    - there will be a brief overview of each question
    - Participants are asked to partially answer each question in real time
    - Participants can provide more complete response over the next seven days.

The questionnaire can be viewed here:

<https://docs.google.com/spreadsheets/d/1u2uAMu9AYich12eJqOvk3SiL0MZLWbnJxXubC9UibDg/edit?usp=sharing>

# A brief overview of the Route Reports

<https://github.internet2.edu/ssw/IRR-report/tree/master/Connectors>

Questions?

Thank You!

*"Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Networking and Information Technology Research and Development Program."*

The Networking and Information Technology Research and Development  
(NITRD) Program

**Mailing Address:** NCO/NITRD, 2415 Eisenhower Avenue, Alexandria, VA 22314

**Physical Address:** 490 L'Enfant Plaza SW, Suite 8001, Washington, DC 20024, USA Tel: 202-459-9674,  
Fax: 202-459-9673, Email: [nco@nitrd.gov](mailto:nco@nitrd.gov), Website: <https://www.nitrd.gov>

