the **real-time** Internet routing observatory

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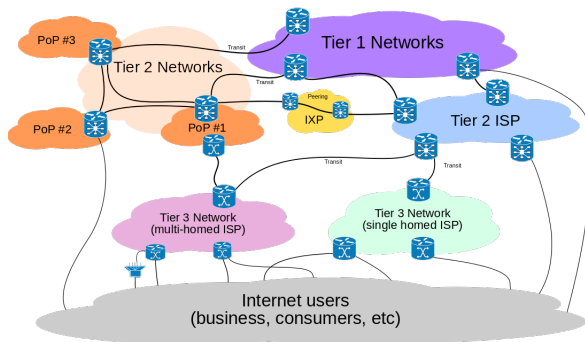
Consiglio Nazionale delle Ricerche
Istituto di Informatica e Telematica

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CHICAGO NETWORK
OPERATORS GROUP
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# Our research interest: the Internet AS-level ecosystem

Why is it important?

- To identify Internet topological properties and drawbacks
- To build realistic network topology generators for simulations
- To evaluate the effectiveness of new protocols

Classic BGP route collector concept

TIME: 02/09/12 08:08:47
TYPE: BGP4MP/MESSAGE/Update
FROM: 67.17.82.114 AS3549
TO: 128.223.51.102 AS6447
ORIGIN: IGP
ASPATH: 3549 137 137 137 8978
NEXT_HOP: 67.17.82.114
MULTI_EXIT_DISC: 14163
ANNOUNCE
  212.77.0.0/19

A Route Collector (RC) is a device which collects BGP routing data from co-operating ASes

BGP UPDATE

AS 137

AS 3549

AS 8978   212.77.0.0/19

Route Collector (RC)

BGP feeder
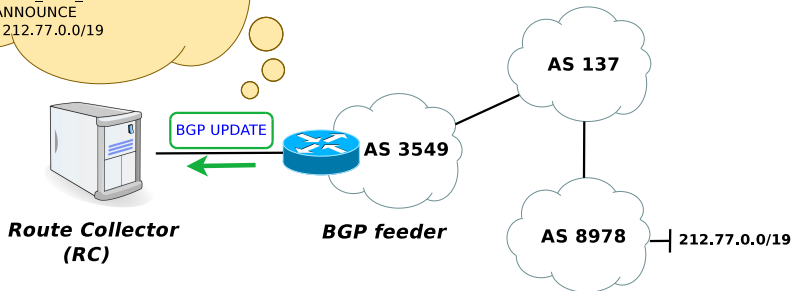
RCs only collect routing information and **__not__** user traffic

BGP route collector projects

University of Oregon Route Views Project

Route Views was originally conceived as a tool for Internet operators to obtain real-time information about the global routing system from the perspectives of several different backbones and locations around the Internet. It collects BGP packets since 1997, in MRT format since 1997
http://www.routeviews.org

RIPE NCC Routing Information Service (RIS)

The RIPE NCC collects and stores Internet routing data from several locations around the globe, using RIS. It collects BGP packets in MRT format since 1999
https://www.ripe.net/analyse/internet-measurements/routing-information-service-ris

Packet Clearing House (PCH)

PCH is the international organization responsible for providing operational support and security to critical Internet infrastructure, including Internet exchange points and the core of the domain name system. It operates route collectors at more than 100 IXPs around the world and its data is made available in MRT format since 2011
https://www.pch.net/resources/Raw_Routing_Data

BGP data incompleteness

BGP data collected up to date has been unvaluable to reveal the Internet inter-domain characteristics, but it is known to be largely **incomplete**

How much incomplete?

$$\text{Minimize} \quad \left(\sum_{AS_i \in \mathcal{U}} x_{AS_i} \right) \tag{1}$$

subject to

$$\sum_{AS_i : n \in S_{AS_i}^{(d)}} x_{AS_i} \geq 1 \qquad \forall n \in \mathcal{N} \tag{2}$$

$$x_{AS_i} \in \{0, 1\}, \qquad \forall AS_i \in \mathcal{U} \tag{3}$$

... or in other words

Select new BGP feeders such that each transit AS has a **finite and bounded** p2c distance from the route collector infrastructure

How much incomplete are BGP data?

April 2017

It was possible to discover the **full** connectivity of:

- 935 out of 9334 ASes (10.02%) which transit v4 traffic for other ASes
- 382 out of 2978 ASes (12.83%) which transit v6 traffic for other ASes

|	v4 ASes	v6 ASes		v4 ASes	v6 ASes
AG	2 (15.38%)	5 (0%)	**KY**	0 (0%)	0 (0%)
AI	0 (0%)	0 (0%)	**LC**	0 (0%)	0 (0%)
BB	0 (0%)	0 (0%)	**MF**	0 (0%)	2 (50%)
BL	0 (0%)	0 (0%)	**MQ**	0 (0%)	0 (0%)
BM	0 (0%)	0 (0%)	**PR**	14 (28.00%)	6 (19.35%)
BS	0 (0%)	0 (0%)	**TC**	0 (0%)	0 (0%)
CA	**83 (20.75%)**	**36 (17.48%)**	**UM**	0 (0%)	0 (0%)
DM	0 (0%)	0 (0%)	**US**	**336 (12.67%)**	**145 (14.45%)**
GD	0 (0%)	0 (0%)	**VC**	0 (0%)	0 (0%)
GP	0 (0%)	0 (0%)	**VG**	0 (0%)	0 (0%)
JM	0 (0%)	0 (0%)			
KN	2 (13.33%)	2 (22.22%)			

Main cause: small number of small ASes connected

Do AS administrators see any direct outcome in sharing their routing information?

Isolario project

Objective: push more ASes to join

The more the ASes, the more the completeness of public BGP data
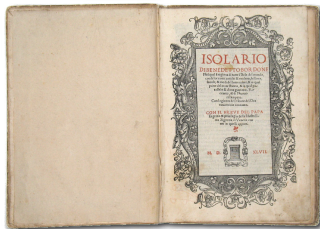
Isolario - The Book of Islands

"where we discuss about all islands of the world, with their ancient and modern names, histories, tales and way of living..."

Benedetto Bordone
(Italian cartographer)

Approach: Do-ut-des

- Participants open a BGP session with Isolario providing the BGP full routing table and its evolution over time
- In change, Isolario offers **real-time** applications based on the aggregation of every routing information collected

Why Isolario?

What's the need of ***yet*** another routing analysis tool?

- The more (and diversified) the BGP data sources, the better
- Isolario tools are **just** an incentive to push network admins to share their BGP routing data with the research community
- Most routing analysis tools (commercial and not) either use BGP data publicly available *or* do not publish the BGP data they collect

What's the need of ***yet*** another route collector?

- Real-time services require a different route collecting infrastructure
- The do-ut-des paradigm **may** be appealing to some of those network admins who are not sharing data with any route collector (yet)

It is not relevant whether you decide to connect to Isolario, Route Views, RIPE NCC RIS and/or PCH, as long as you share the data!
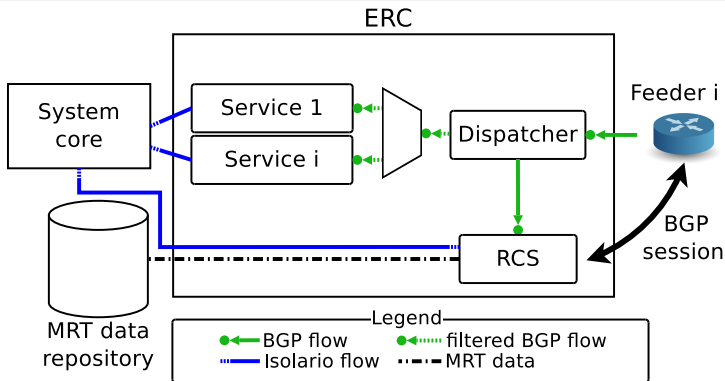
Isolario system overview

Incoming BGP flows are used as **real-time streams** for services dedicated to participants
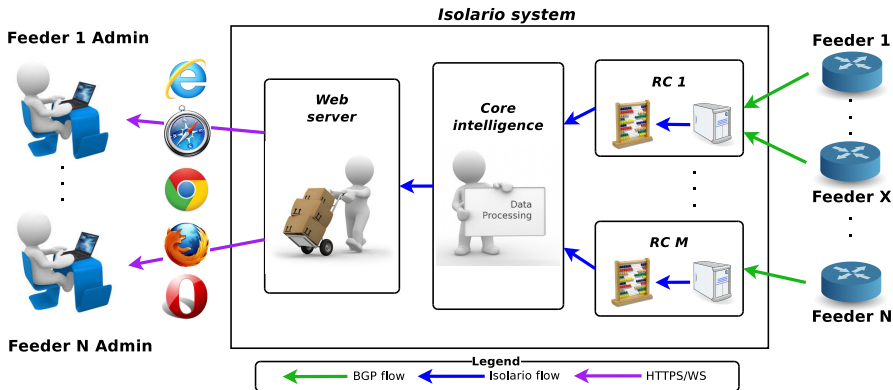
Results are provided to users via WebSockets

Enhanced BGP Route Collector

Incoming flows are duplicated as soon as they arrive and feed both the Route Collecting Software (RCS) and service modules

As usual, RCs only collect routing information and **not** user traffic

Isolario free services for feeders

Every feeder has **free** access to a set of services tailored to monitor and analyse BGP data coming into Isolario system

Real-time services

- BGP flow viewer
- Routing table viewer
- Website reachability
- Subnet reachability

Historic services

work in progress

- Routing table viewer
- Subnet reachability

## Diagnostic services

- Alerting system
- Daily report

Isolario free services for feeders

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Real-time services
- BGP flow viewer
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Historic services *work in progress*
- Routing table viewer
- Subnet reachability

Diagnostic services
- Alerting system
- Daily report

Please, feel free to try our real-time services!
```
https://www.isolario.it
```
Username: *guest*
Password: *guest*

Real-time services
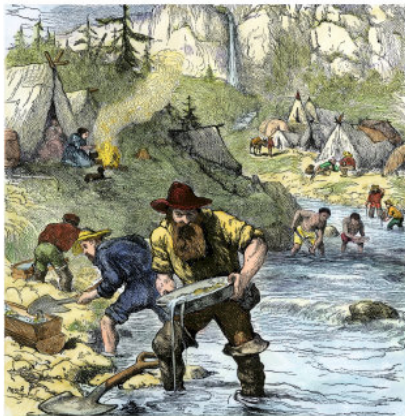
Real-time services allow to monitor BGP
data flowing into Isolario system

Allows to analyse in real-time the routes that a feeder is currently announcing to Isolario to reach a portion of the IP space
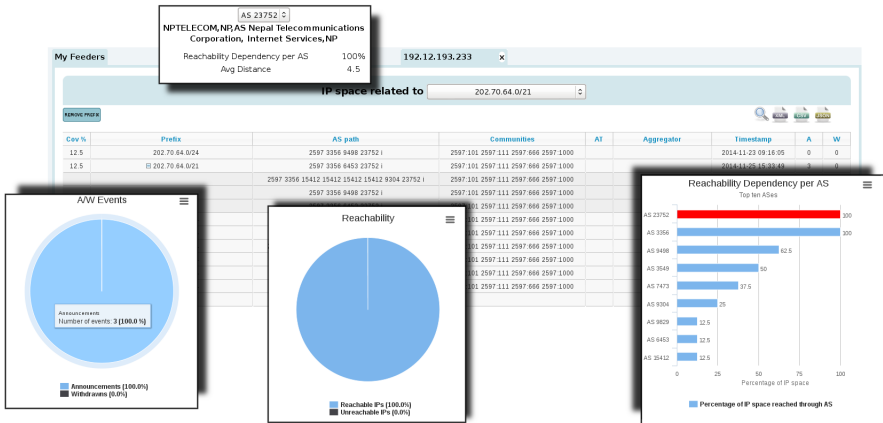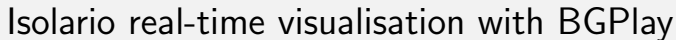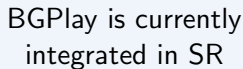
Subnet reachability

Allows to analyse in real-time the routes that every Isolario feeder is announcing to Isolario to reach a portion of the IP space
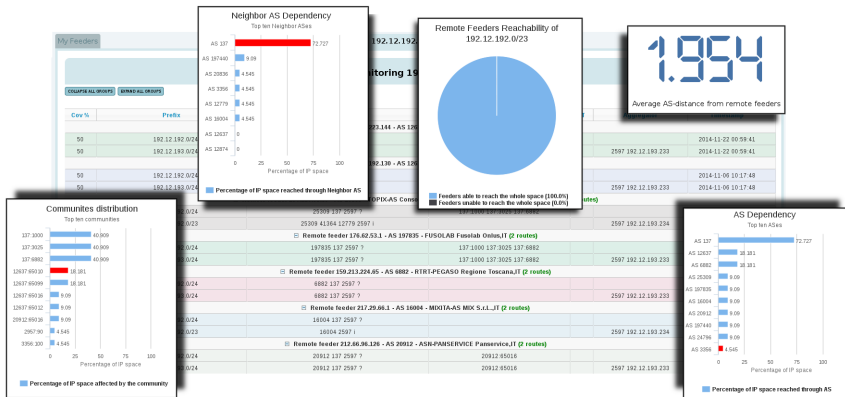
The more the feeders, the more SR is useful!

Isolario real-time visualisation with BGPlay

- BGPlay is an **open-source** tool for the visualisation of BGP routing
- Thanks to the close collaboration with Massimo Candela (RIPE NCC) we integrated in Isolario the BGPlay **real-time version** (**http://bgplay.massimocandela.com**)

BGPlay is currently integrated in SR

Diagnostic services

Diagnostic services exploit incoming BGP flows and/or historic data to report anomalies of the inter-domain routing status

Alerting system

Alerting system

- **BGP attributes:** BGP UPDATEs matching attributes of interest
- **Flap events:** a prefix UPDATE rate is larger than a threshold
- **Hijack attempts:** BGP UPDATEs hijacking a feeder subnet
- **Prefix reachability:** (un)reachability of prefixes of interest

Summary about the feeder inter-domain routing status as perceived by the Isolario system

For example...

Routing statistics
- #Announce, #Withdrawn
- Most (un)stable prefixes

Reachability statistics
- Inbound reachability

BGP attributes statistics
- AS path anomalies

Isolario
Project

Daily report

Feeder 192.65.131.235 (AS 2598)

Thursday 21st May, 2015

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Summary: how to use Isolario?

Real-time services
Something is happening
How is my RIB(s) evolving?
How is my reachability affected?

Alerting System
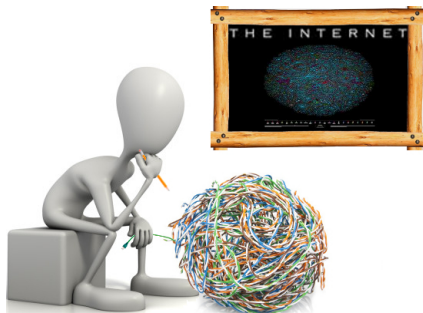**Something is happening NOW!**
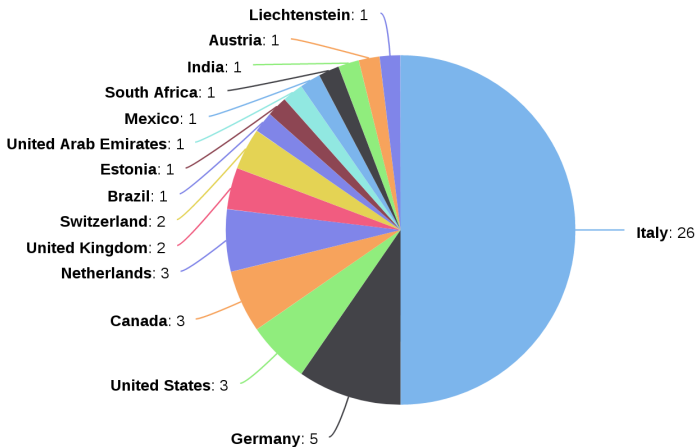Check real-time services!
Do something! (if needed)

Daily report
Did something happen yesterday?
Check historic services!
Do something! (if needed)

Current participants

Liechtenstein: 1
Austria: 1
India: 1
South Africa: 1
Mexico: 1
United Arab Emirates: 1
Estonia: 1
Brazil: 1
Switzerland: 2
United Kingdom: 2
Netherlands: 3
Canada: 3
United States: 3
Germany: 5
Italy: 26

57 ASes connected | 65 v4 sessions | 48 v6 sessions

What we provide to the research community?

MRT data (same format as RIPE RIS, Route Views, ⋯)
1. RIB feeder snapshots every 2 hours
2. UPDATE collections every 5 minutes

Periodic analyses (daily, weekly, monthly, ⋯)
1. AS characteristics
2. Feeder contribution
3. Total coverage of RCs

Open source software
1. Interactive Collecting Engine (ICE)
2. MRT Data Reader
3. ⋯

Thank you for your attention

Join us and help us to unveil the Internet AS-level structure!

To participate, contact us at:
info@isolario.it