MODELLING OF THE INTERNET ON AS LEVEL

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AGENDA

- The Internet at AS level?
- Available data & analyses tools
- TNO's Common Sense BGP tool
- Purpose & Scope of the model
- BGP simulation models
- csBGP for What-if scenario Analysis
- Discussion

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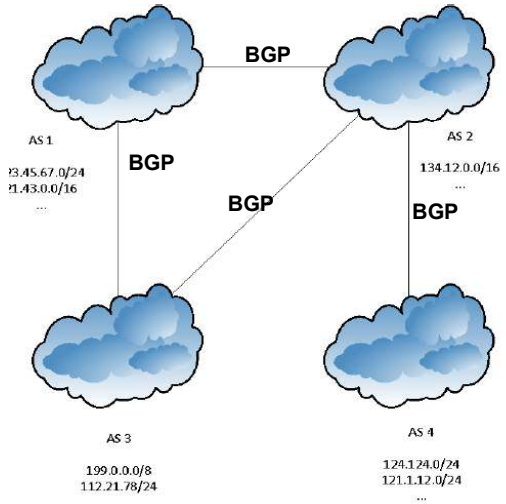
THE INTERNET AT AS LEVEL?



- The Internet consists of “islands”
- An “island” is an Autonomous System (AS)
- Each AS is controlled one operator:
  - Internet Service providers
  - Internet Exchanges (Amsterdam Internet Exchange, AMS-IX)
  - …
- The Border Gateway Protocol (BGP) is used to inform the AS’s *that agree to transfer each others traffic*, which other AS’s can be reached through them.
- Seems simple but in practice complex and: no authentication or encryption

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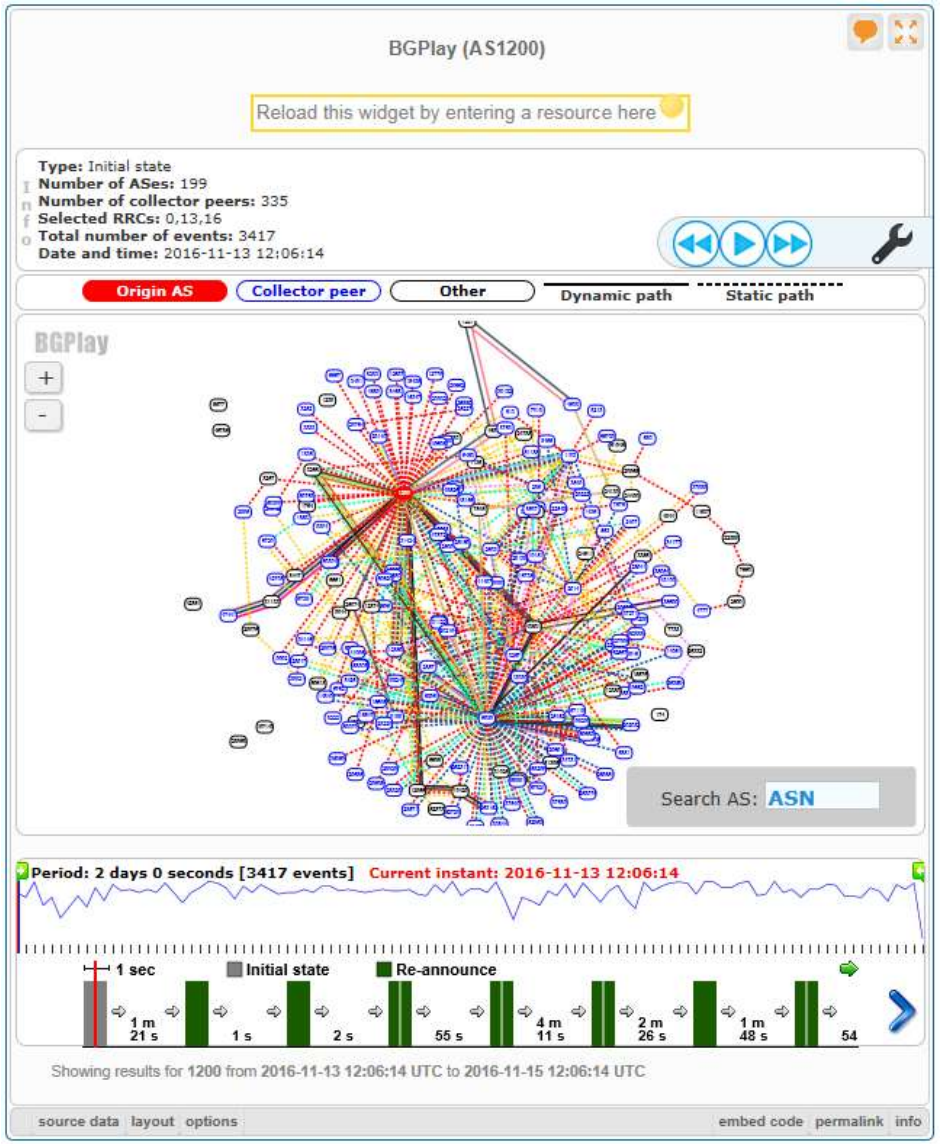
THE INTERNET AT AS LEVEL?

- What information is there available to model actual networks?
- RIPE!
- AMS-IX connected to other AS's



RIPE NCC: Réseaux IP Européens
Located in Amsterdam

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AVAILABLE DATA & ANALYSES TOOLS

- RIPE NCC collects:
  - information about the Internet on AS level in their RIPEStat database
  - data from a large number of “Anchors” and “Probes” in their RIPE Atlas

Locations of 22 Remote Route Collectors: collecting BGP information from Route Beacons

RIPE NCC: Réseaux IP Européens Network Coordination Centre

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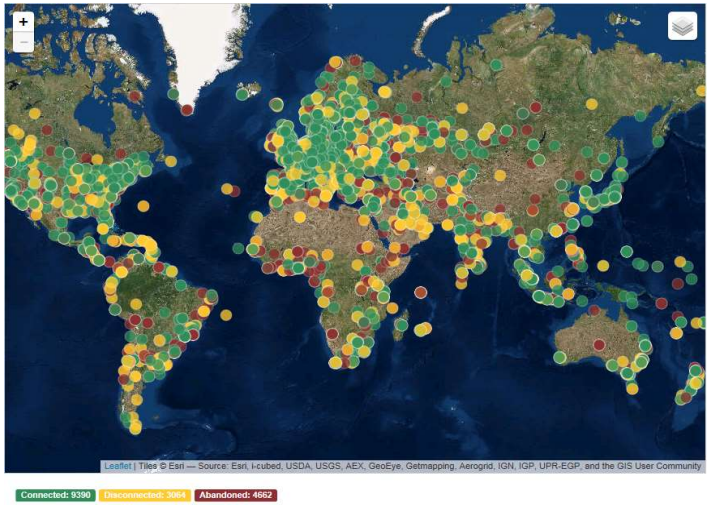
AVAILABLE DATA & ANALYSES TOOLS

- RIPE Atlas:
  - Statistical information on the performance of the Internet
  - Probes: actively measure connectivity through ping, traceroute, DNS, SSL/TLS, NTP and HTTP
  - Anchors: enhanced probes with more measurement capacity: Constantly probed & regional targets for user-defined measurements
  - Volunteers that host probes earn credits to perform own measurements…

226 RIPE Atlas Anchors



9390 Active Probes (green)

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AVAILABLE DATA & ANALYSES TOOLS

- RIPE Atlas also:
  - users can select NLNOG Ring nodes as destinations for their measurements when setting up new, periodic user defined measurements or one-off measurements

RIPE Atlas NLNOG RING nodes

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AVAILABLE DATA & ANALYSES TOOLS

- BGP Looking Glass Servers:
  - acts as a limited, read-only portal to routers of whatever organization is running the Looking Glass server.
  - Typically, publicly accessible LG servers are run by ISPs or NOCs
  - http://www.bgp4.as/looking-glasses (info & software)
  - LG widget on the RIPE site to query RCC's

Result of the RIPE BGP Looking Glass query for prefix 91.200.16.0/22

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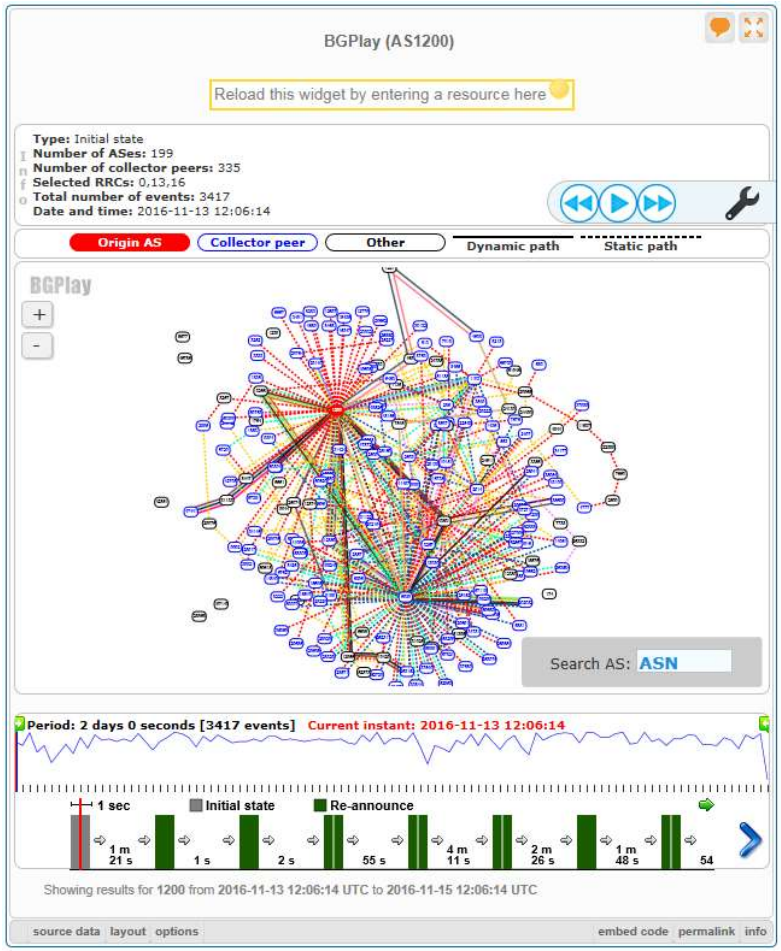
AVAILABLE DATA & ANALYSES TOOLS

- GeoIP from MaxMind:
  - Maps IP Address to Geographic locations
- RIPE Widgets:
  - Extract, filter and display Internet related information from RIPEStat database
  - BGPlay: Visualize BGP topology & dynamics
  - latencyMON: ping statics from probes
  - Speedchecker: bandwidth measurements
  - Observed Network Activity (M-Lab)
  - https://stat.ripe.net/widget/list

https://stat.ripe.net/widget/bgplay
https://atlas.ripe.net/measurements/#!tab-builtin



BGP connectivity and activity for AS1200 (AMSIX, red node)

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AVAILABLE DATA & ANALYSES TOOLS

Examples of use:

- Analysis of the attack on the DNS service provider “Dyn”
  - October 21 2016, a DDoS attack against Dyn’s DNS infrastructure caused issues for a list of well known services: Twitter, GitHub, Spotify, Netflix,…

    https://labs.ripe.net/Members/massimo_candela/a-quick-look-at-the-attack-on-dyn

  - May 13 2015, the Amsterdam Internet Exchange (AMS-IX) was involved in an outage that occurred during maintenance.

    https://labs.ripe.net/Members/massimo_candela/new-ripe-atlas-tool-latencymon

latencyMON results: RTT & Packet loss for pings to an Anchor in AMS-IX from probes in GB, DE, SE, FR, CH

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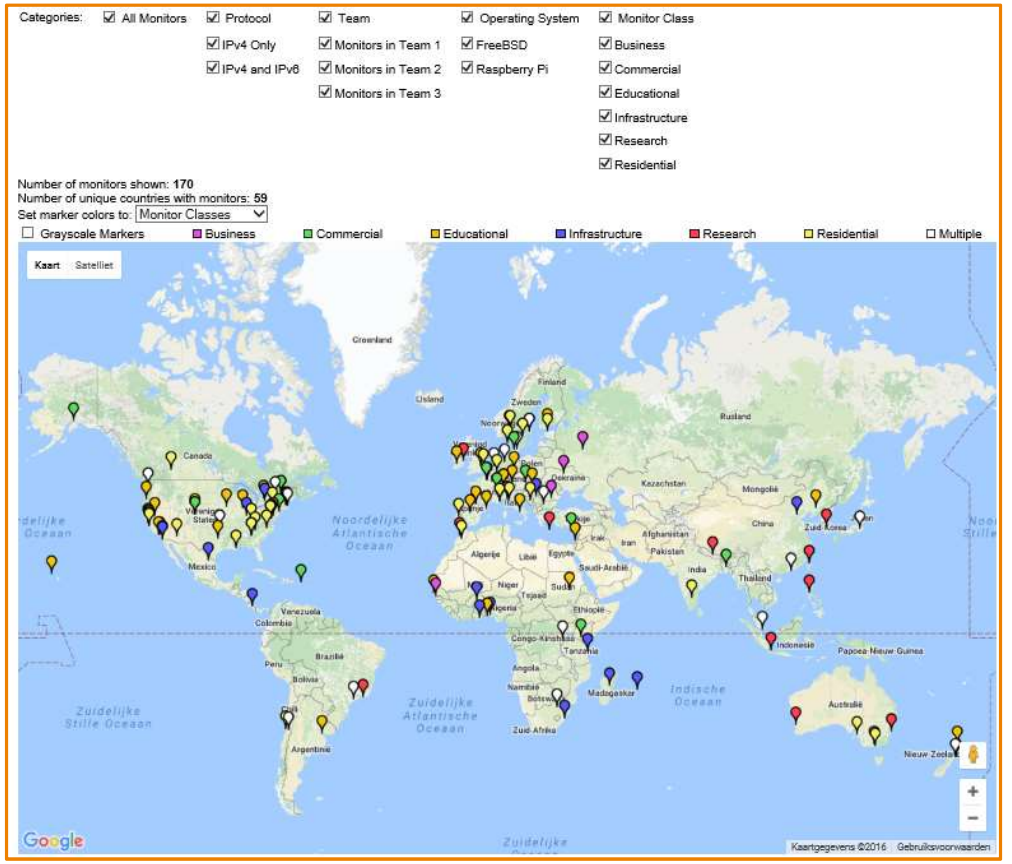
AVAILABLE DATA & ANALYSES TOOLS

- CAIDA / Archipelago
- Archipelago (Ark) is CAIDA's active measurement infrastructure

The traceroute data collected by Ark infrastructure is pre-processed to AS-topologies

The AS-topology data is collected by the AStuary tool and displayed on a geographical map

Number of “AS-hops”



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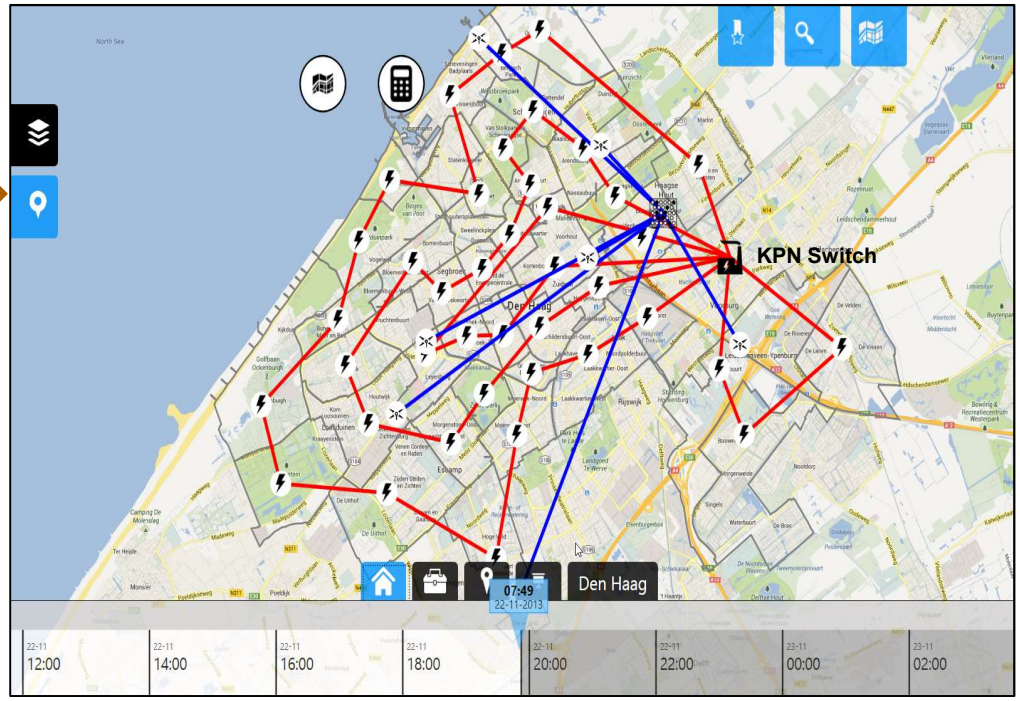
AVAILABLE DATA & ANALYSES TOOLS

- TNO's csWeb: Web-based user friendly GIS application to perform spatial analysis
- Import & combine up-to-date information on critical objects (hospitals, etc.), population etc.
- Apply filters to data, and style it, see what's important: make Common Sense

Locations of C2000 base stations in The Hague

Electric Grid & C2000 chain effects



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TNO'S ASTUARY TOOL

- GUI based on TNO's csWeb ➔ AStuary
- Incorporates RIPE Widgets & "life" data from various source.

  Easy access to:
  - BGPlay, latencyMON, TraceRoute
  - Other RIPE widgets
  - CAIDA AS-Topology
  - IXP, Members, …
  - Sea cable data
- Selects appropriate GeoIP data

AStuary

- Estuary: where a river meets the sea.

  Either with rich ecosystems or heavily populated by humans

SELECT, VISUALIZE, ANALYZE

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START UP SCREEN

AStuary

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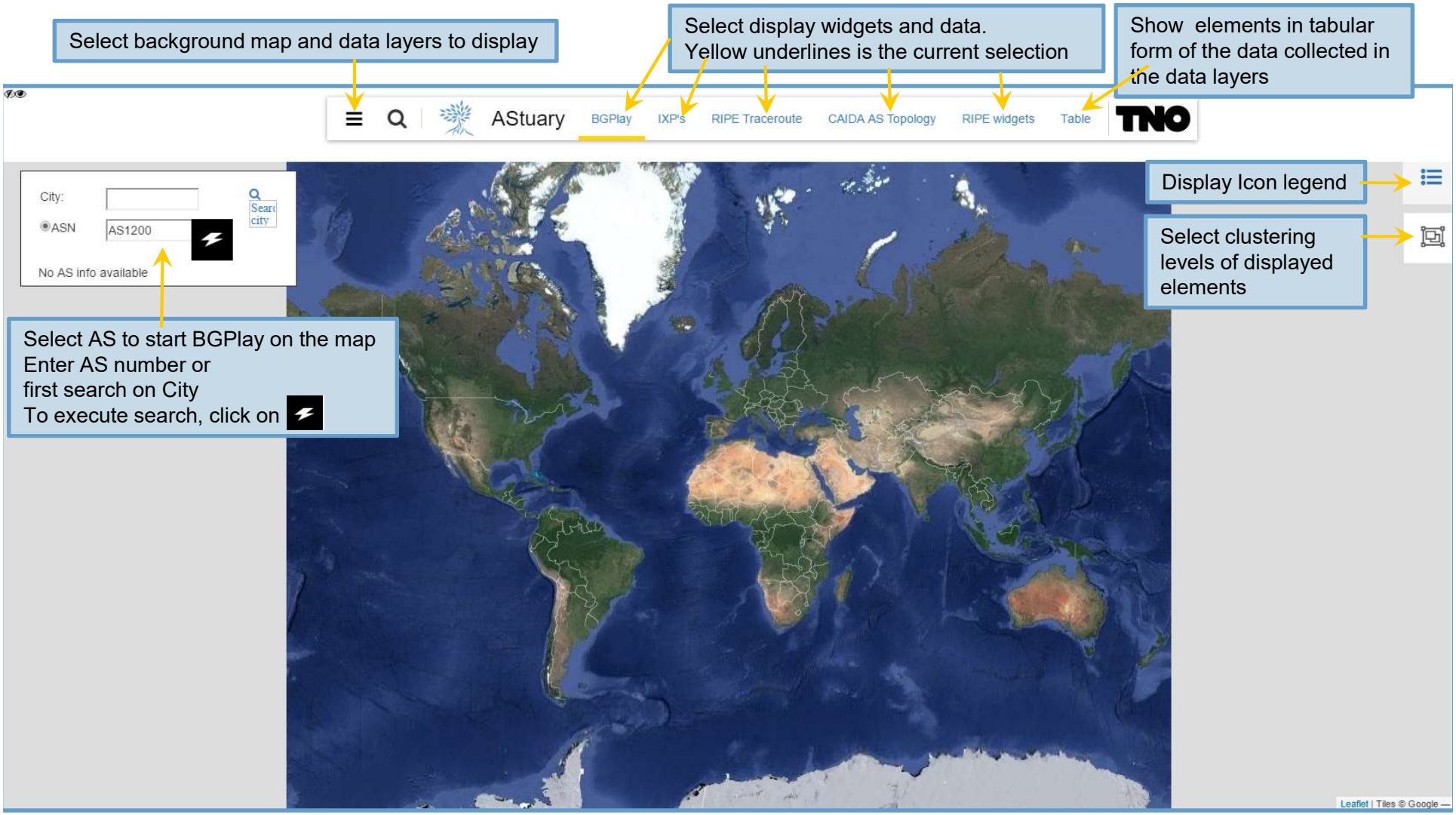

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AStuary RIPE BGPLAY & LATENCYMON

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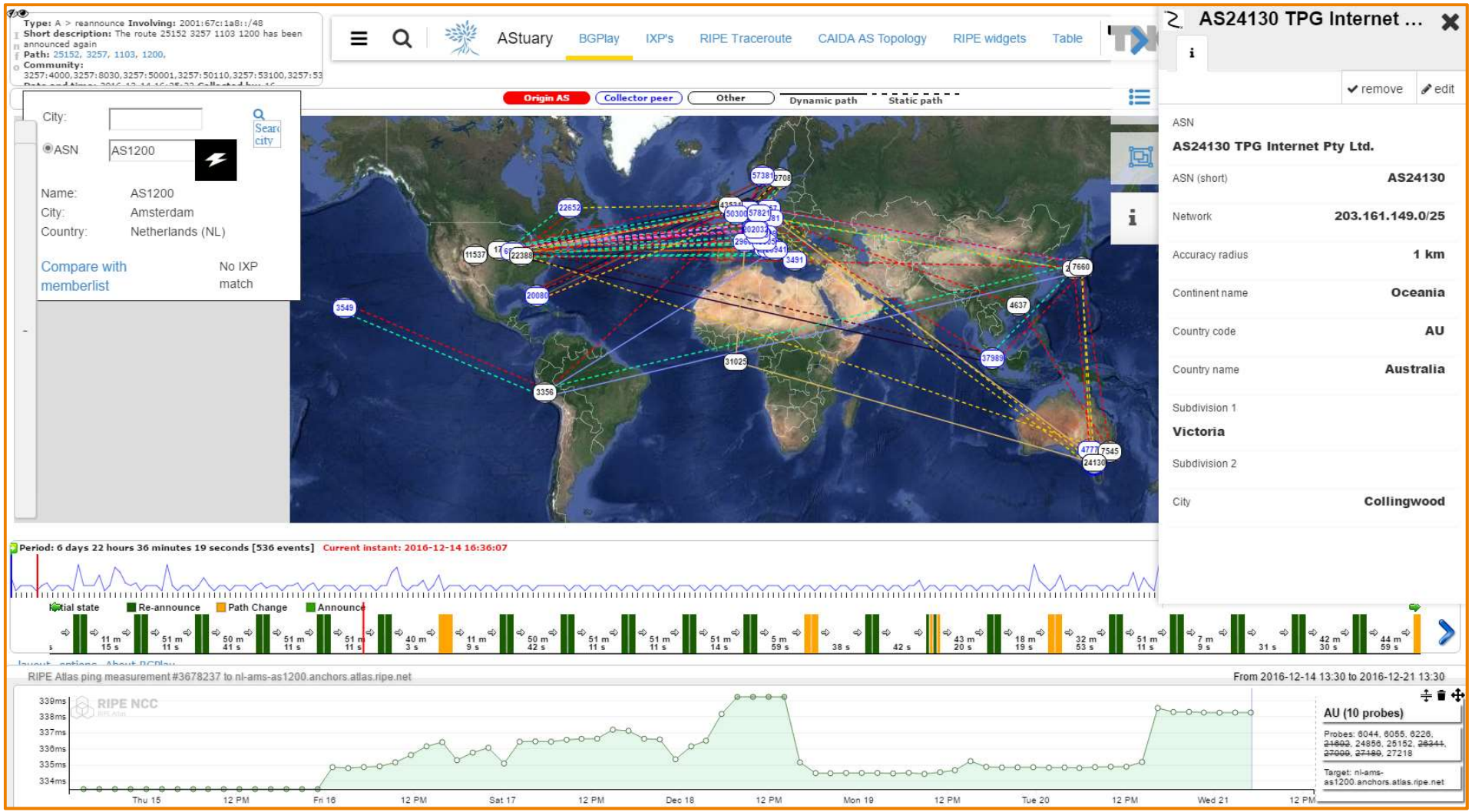

- Average latency from AS1200 (AMSIX) to probes in AUS in msec.

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AStuary INTERNET EXCHANGE PROVIDERS

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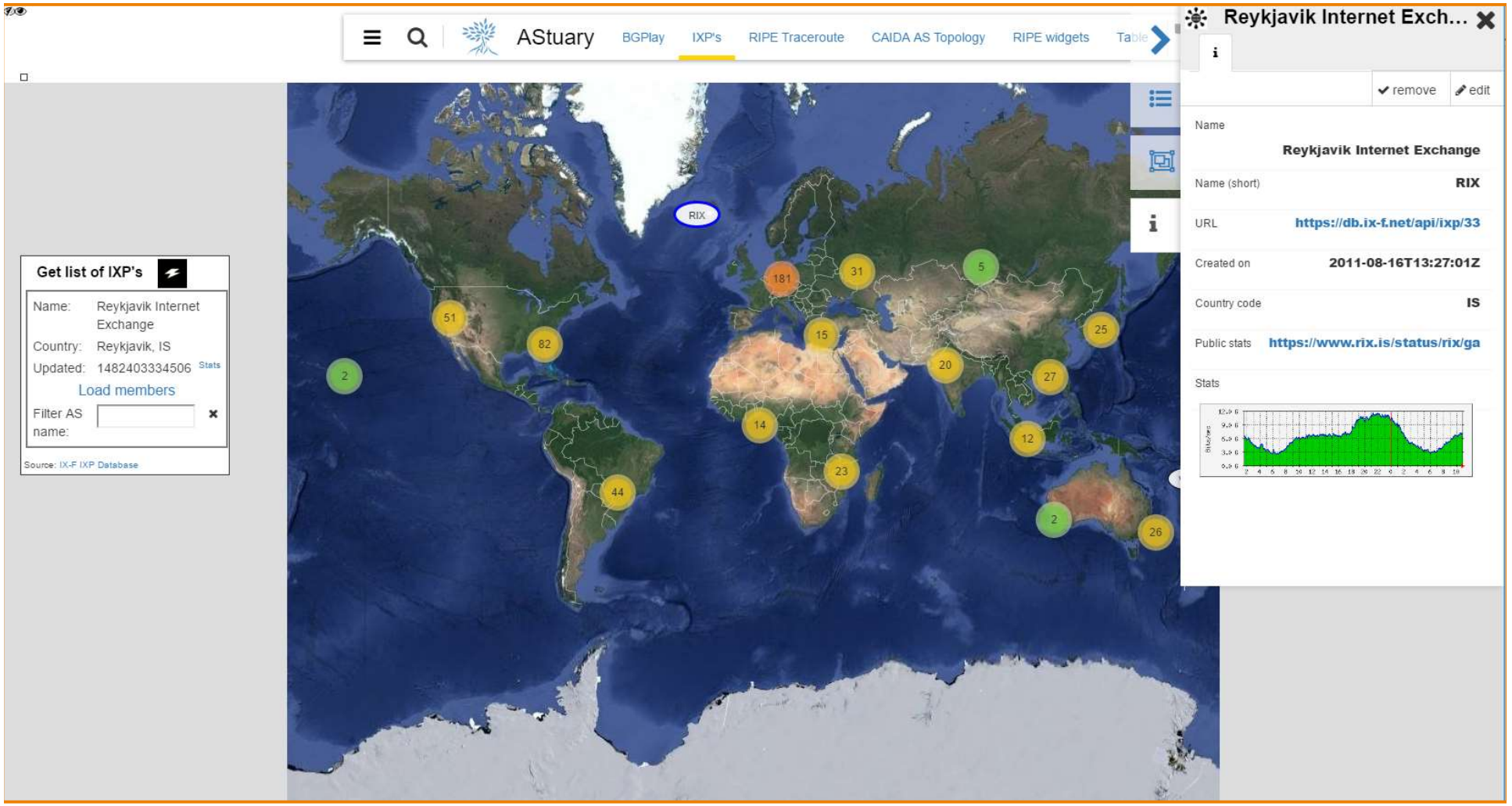

- All IXP's known to the IX-F on a world map

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AStuary IXP MEMBERS

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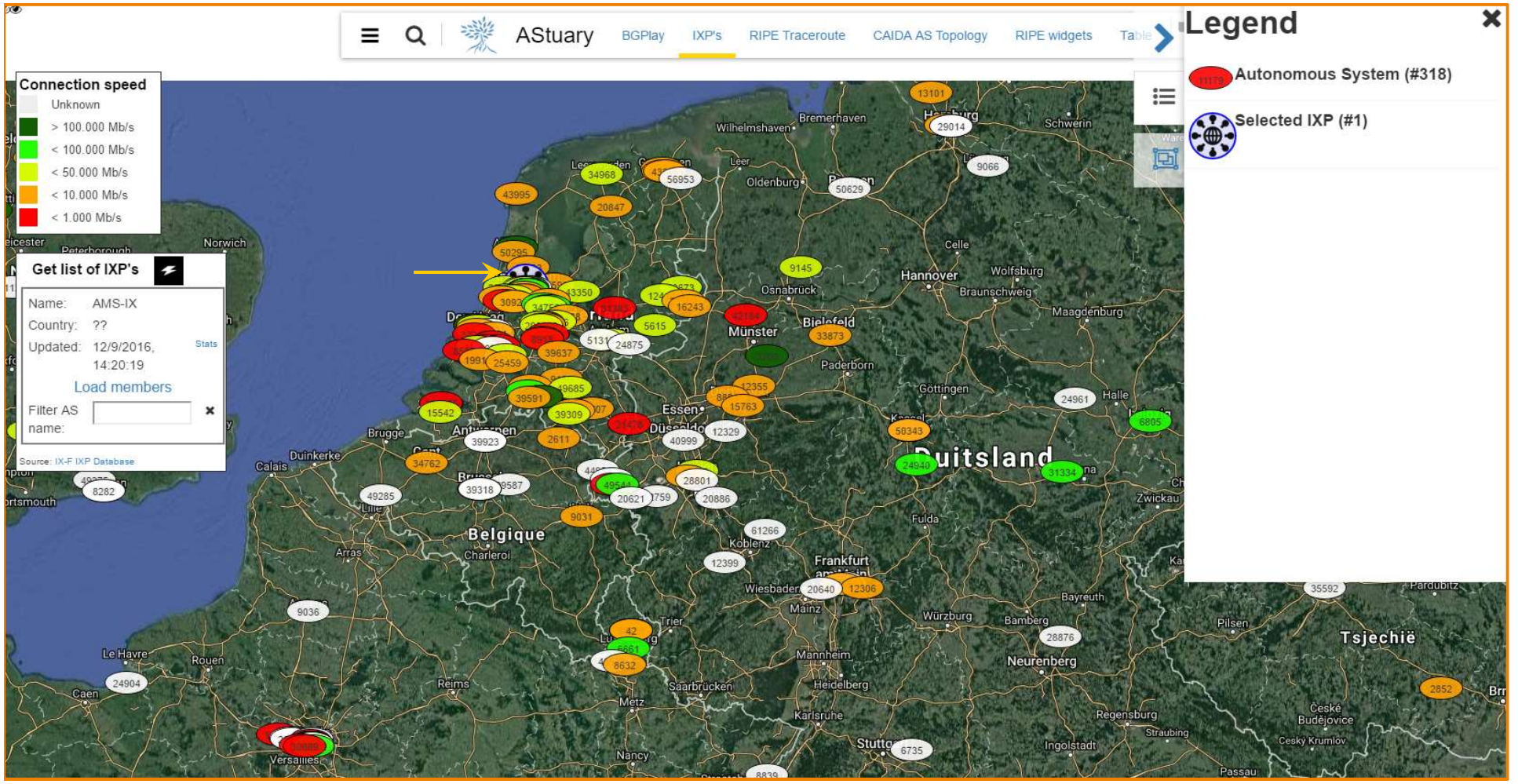

- AMS-IX (nearly hidden round-white icon with 3 black spots) and its 318 members

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AStuary RIPE TRACEROUTE

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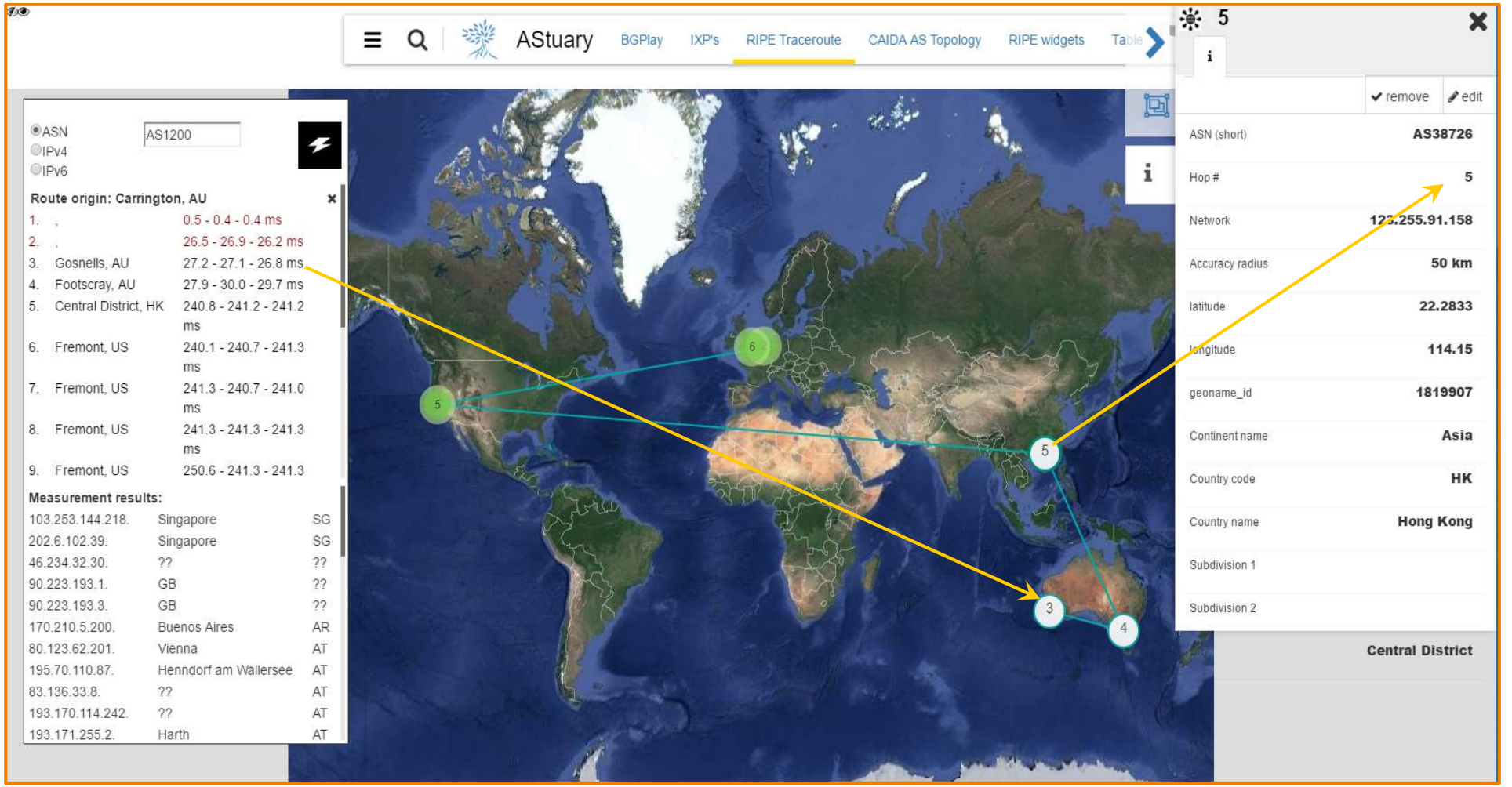

- Traceroute measurement from RIPE probe near Carrington (AUS) to the AMSIX
- Carrington is near Sydney…

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AStuary CAIDA / ARCHIPELAGO

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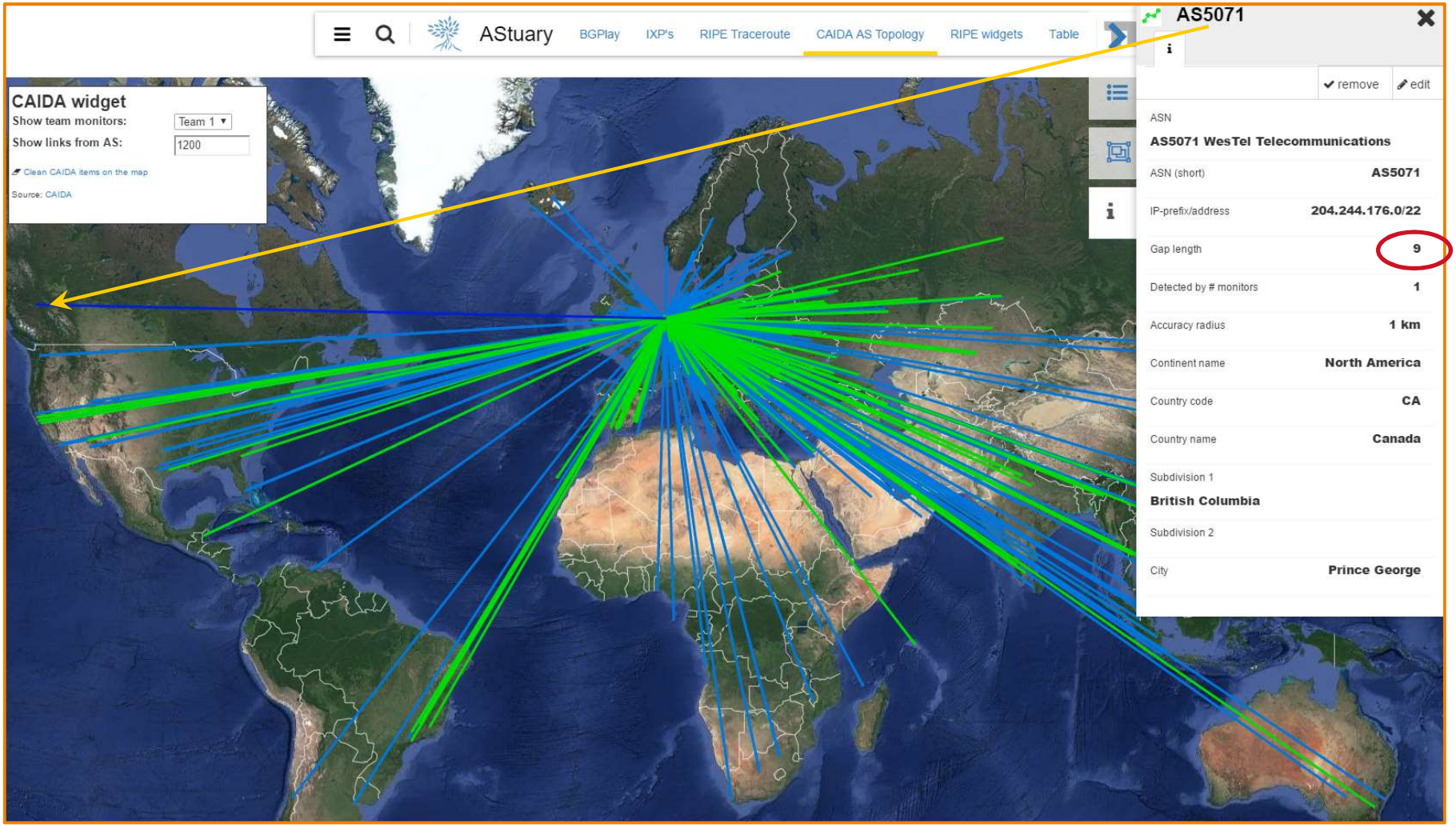

- AS-topology:

  Number of AS-hops

- Direct links (no intermediate AS): light blue.
- Indirect links (1 or more intermediate AS-es): green

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AStuary CAIDA / ARCHIPELAGO

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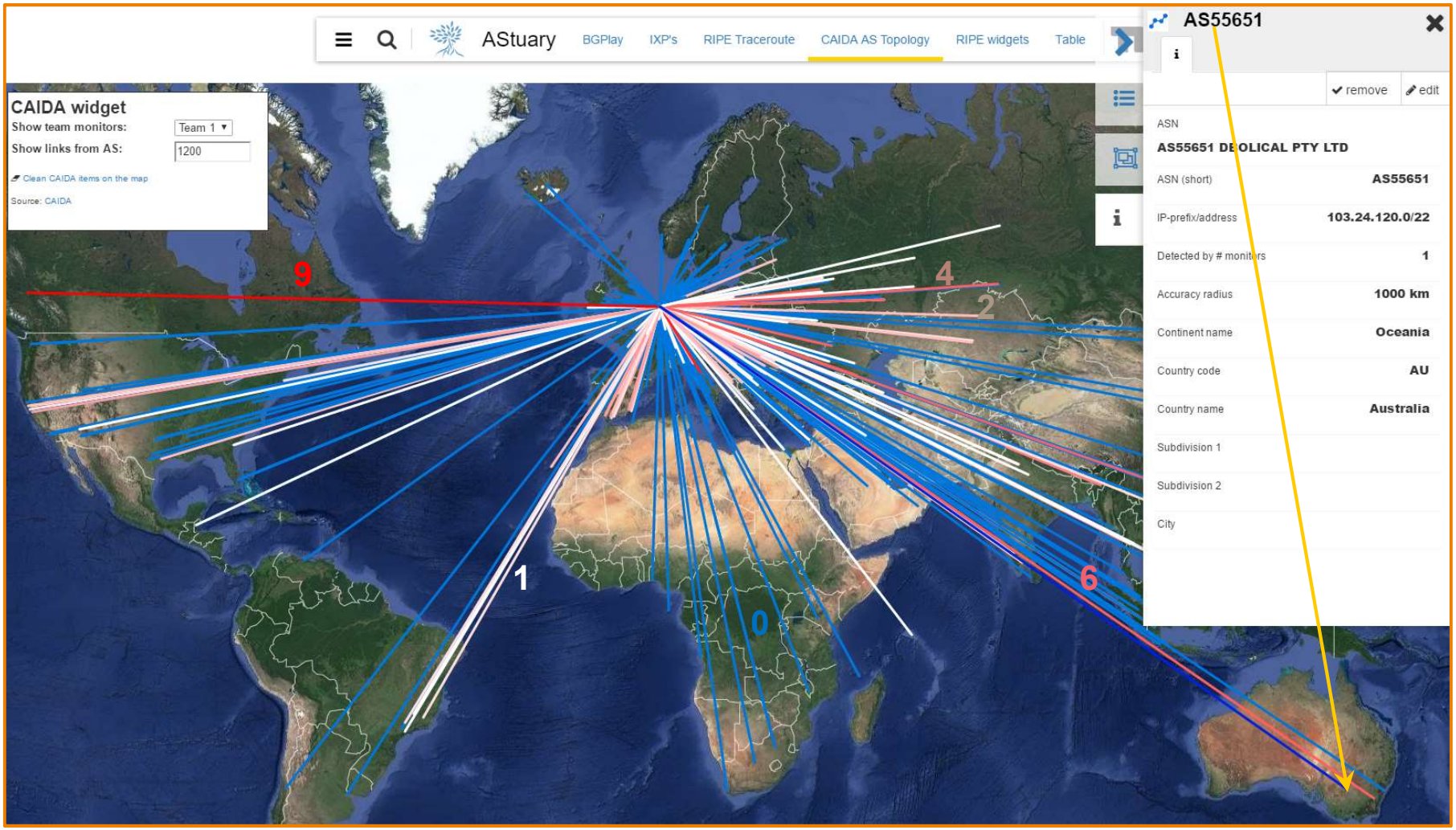

- AS-topology: up to 9 intermediate AS-es (red link)

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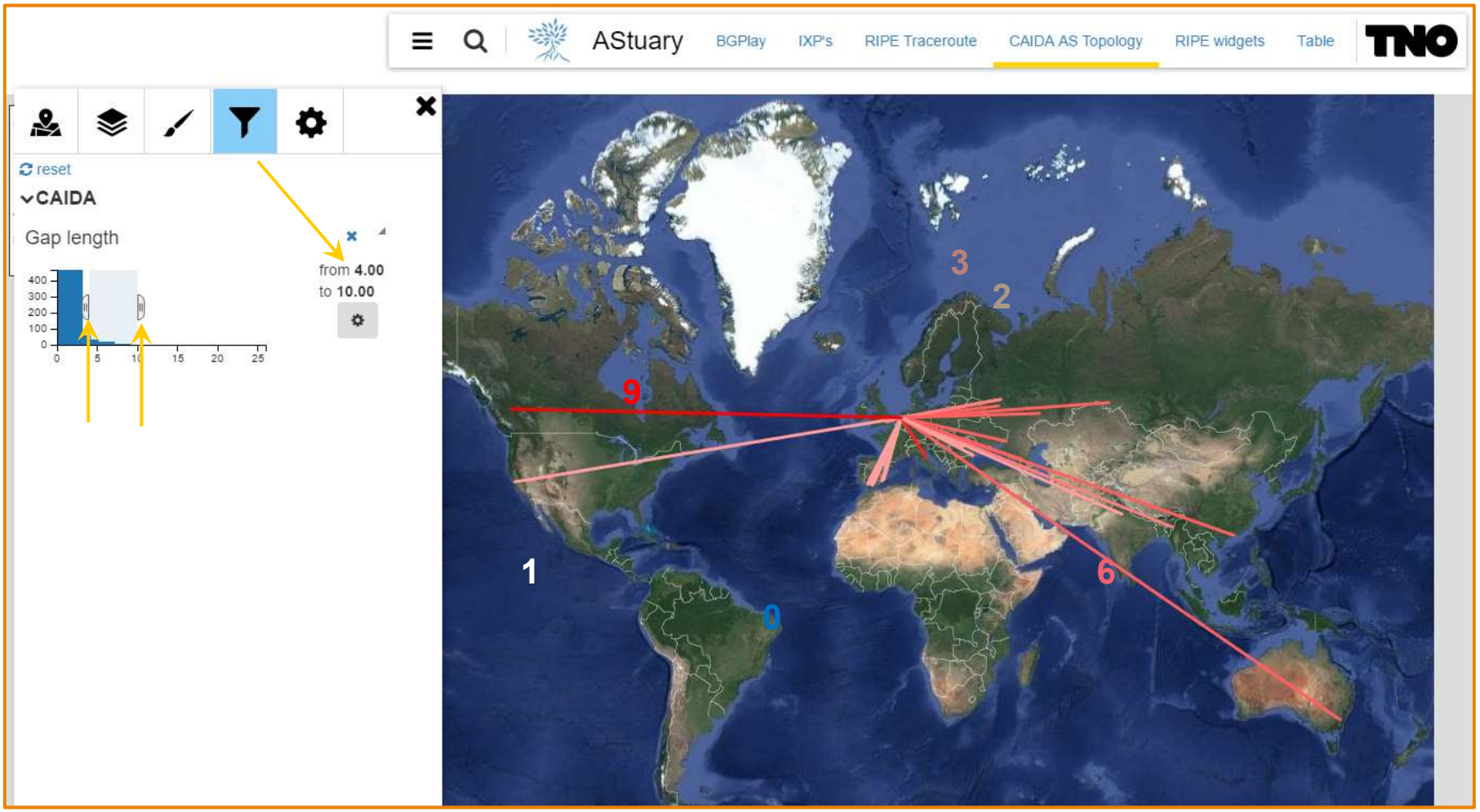

- AS-topology: filtering using the value of gap length attributes of links

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AStuary SEA CABLES & LANDING POINTS

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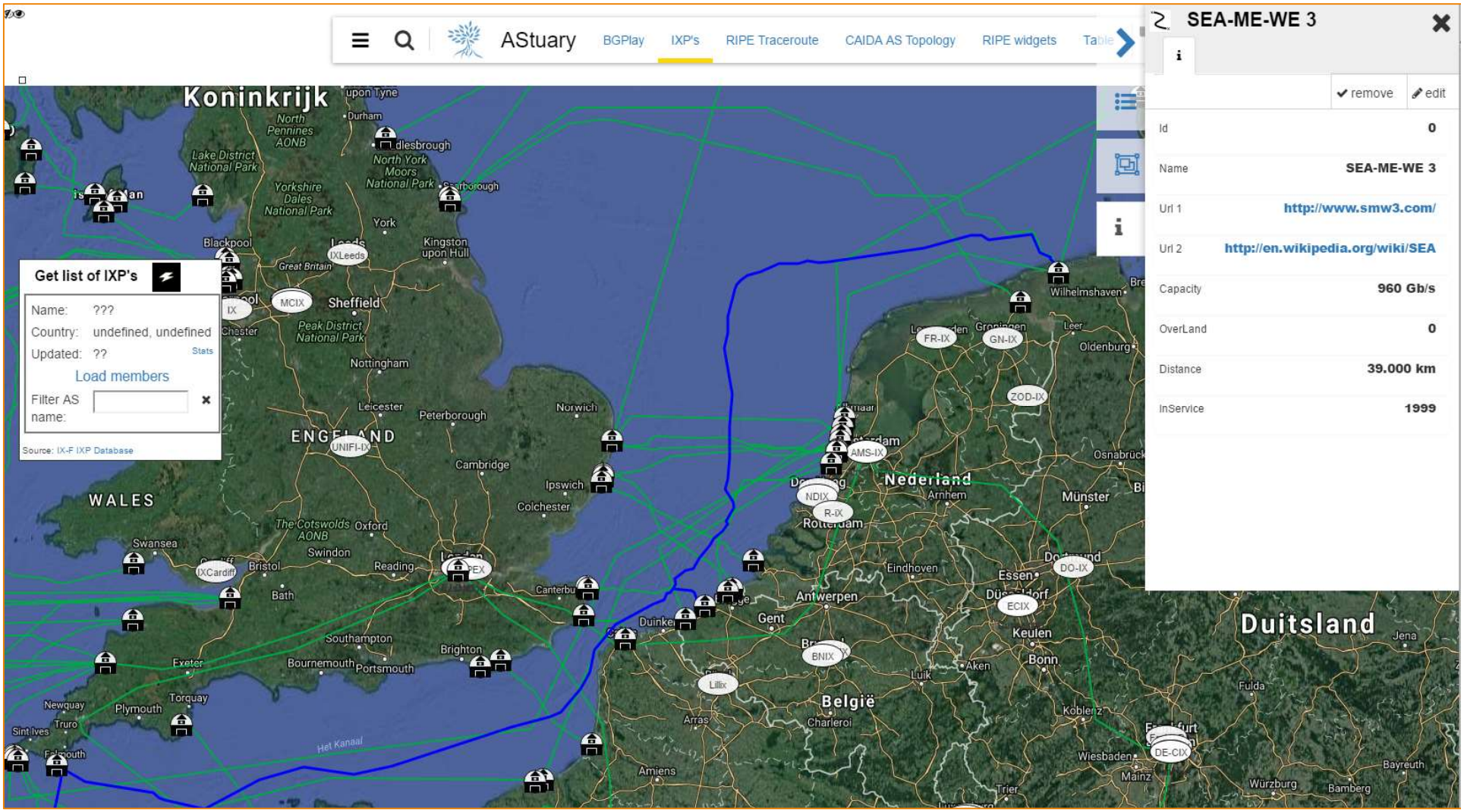

- Click on a cable shows details on its owner, URL, data capacity etc.
- Including physical infrastructures…

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AStuary SATELLITE GROUND STATIONS

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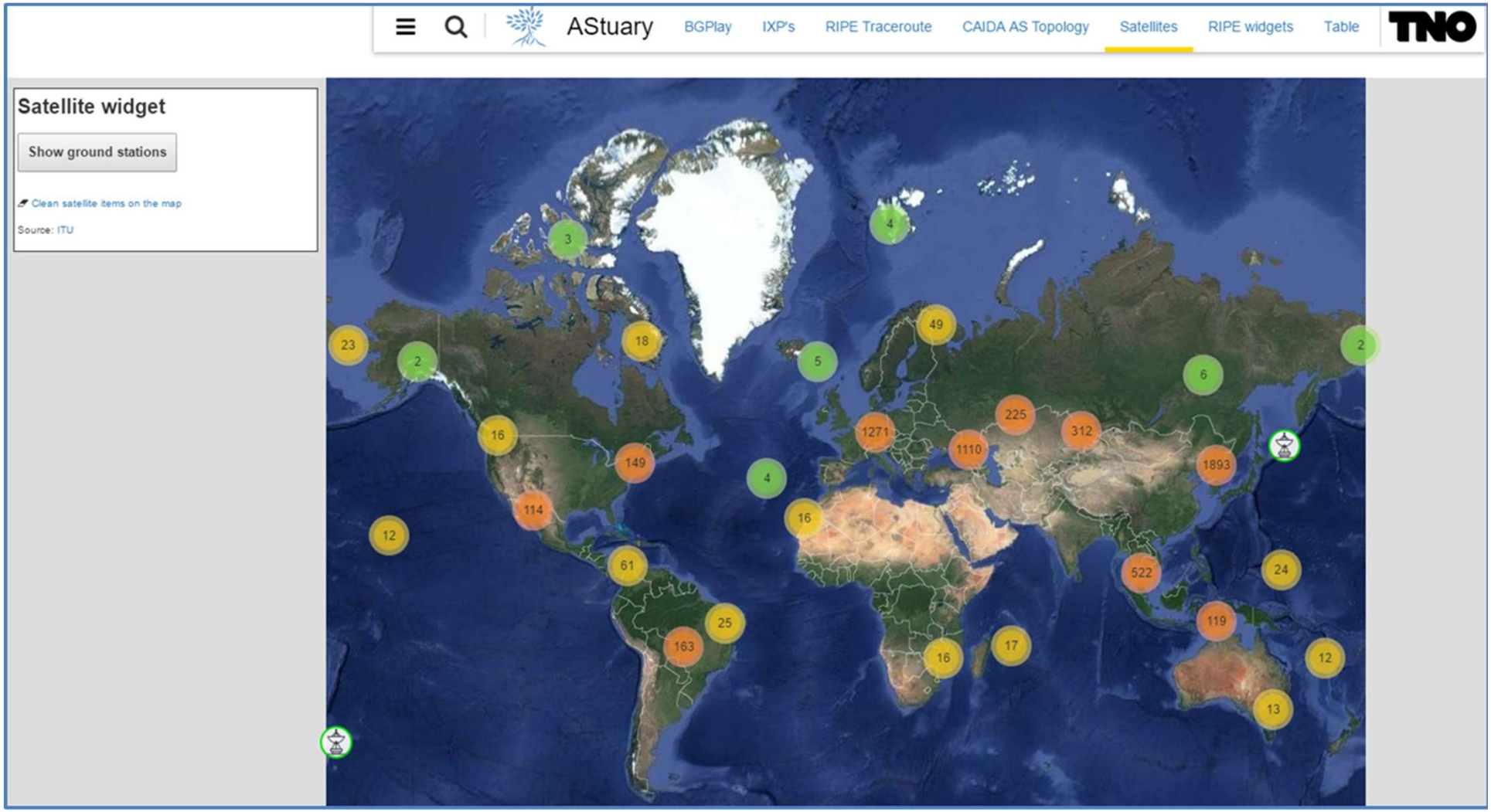

- 6434 satellite ground stations that communicate with geostationary satellites (ITU_

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AStuary SATELLITE GROUND STATIONS

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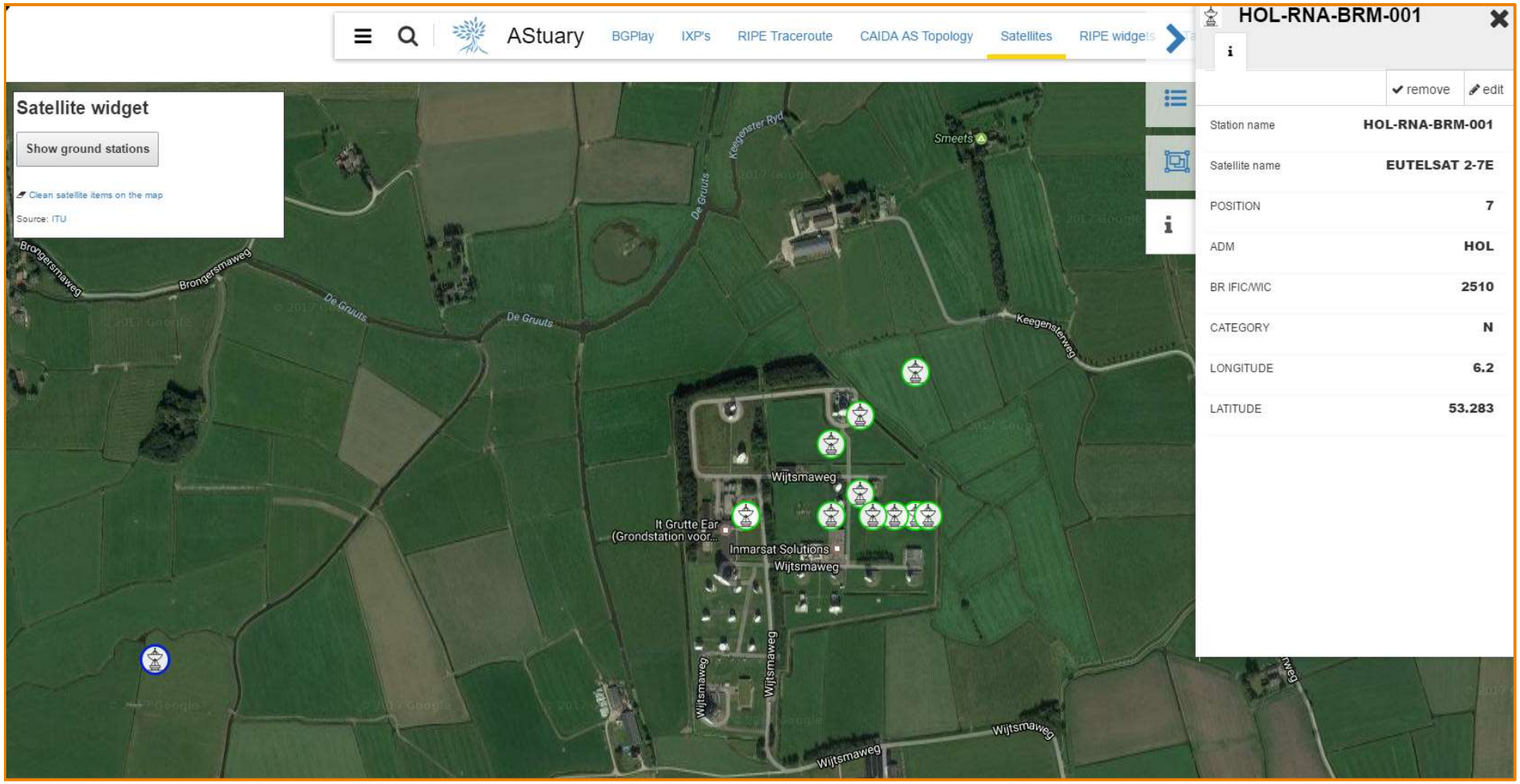

› Click on an icon reveals it name, satellite, Tx& Rx Frequencies etc. view

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AStuary SATELLITE GROUND STATIONS

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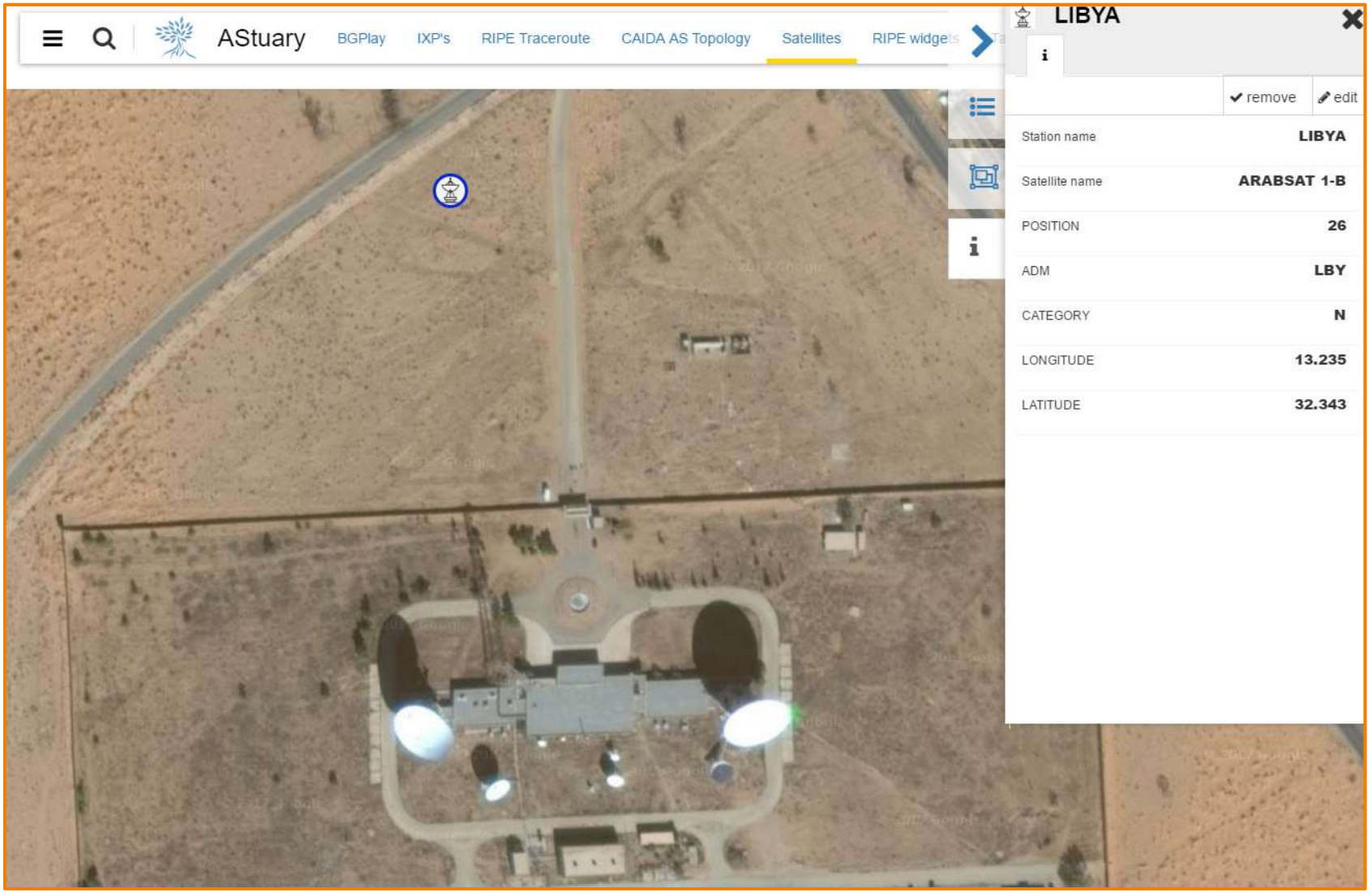

- South of Tripoli: the single listed ground station in Libya…

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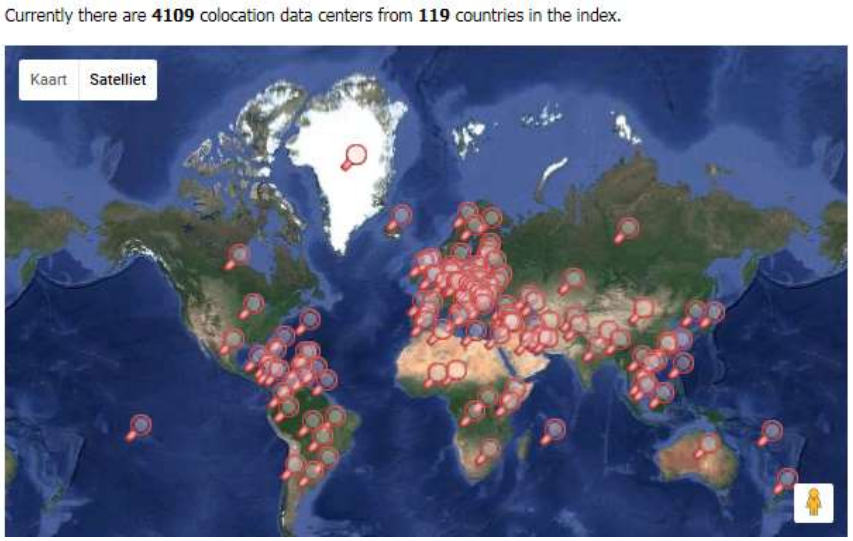
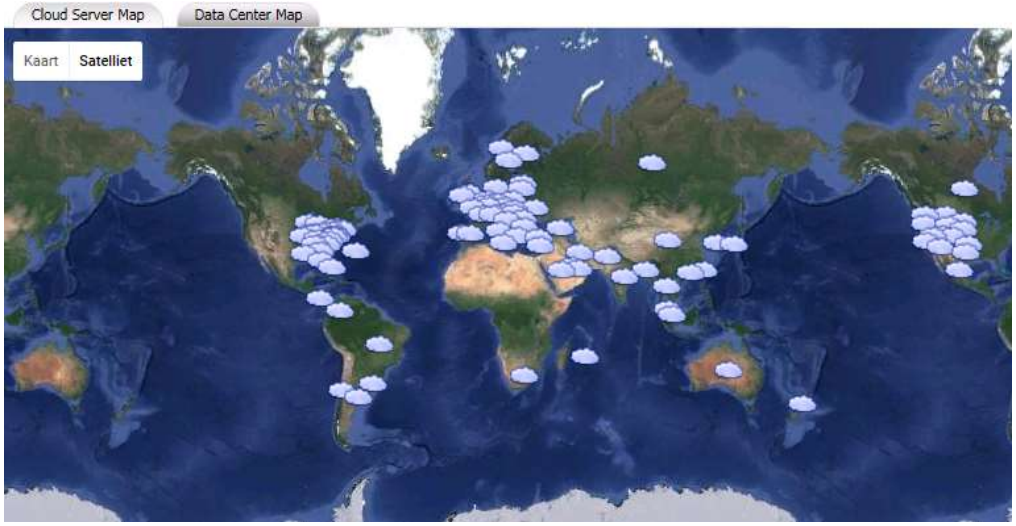
MORE DATA:

- Information on physical landlines are difficult to find.
- Data Centres: information available at cost (http://www.datacentermap.com/)
- …





SAVE RESULTS TO CSV FILE

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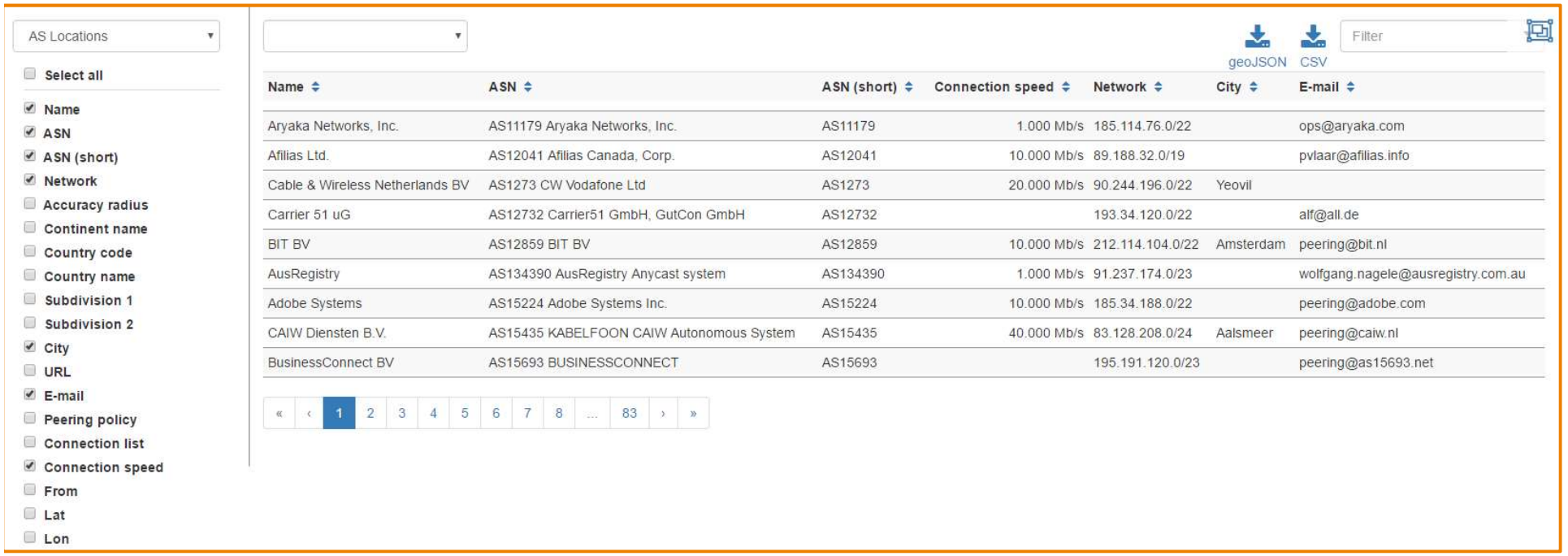

- Only the checked items are exported

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TNO'S COMMON SENSE BGP TOOL

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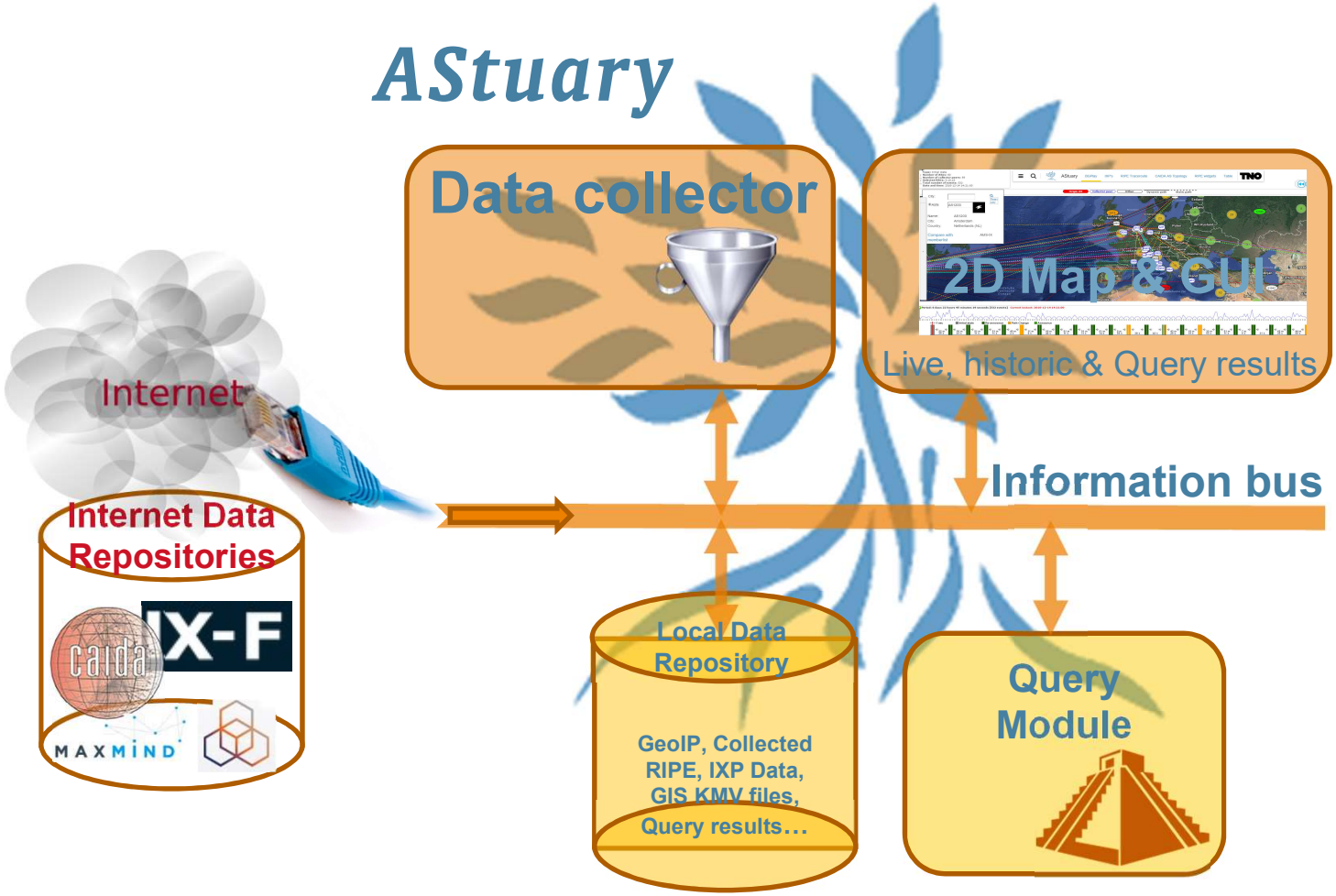
WHAT-IF SCENARIO ANALYSIS



Current idea on the TNO AS-level consequence prediction environment

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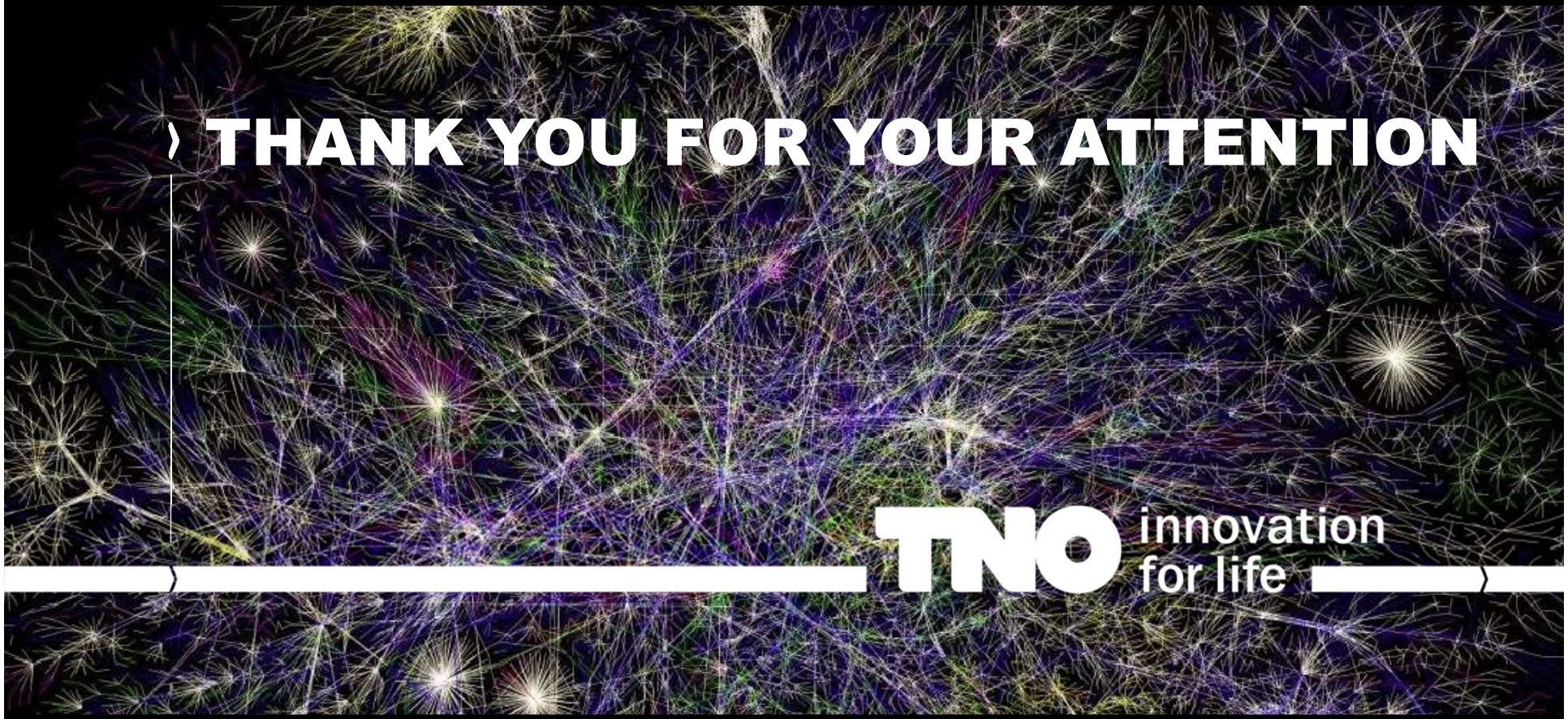

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RESERVE SLIDES

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DISCUSSION