RDL: A programmatic approach to generating router configurations

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RDL: The background

- ENGRIT: Extensible Next Generation Routing Information Toolset
- Improve Internet routing security and stability
- Multi-pronged approach, RDL is one aspect
- Other aspects will focus on authentication, etc
- NLnetLabs has done much work with DNS
- RDL development done by Per Bilse (EUnet, AS286)

RDL: The rationale

- Global turnover $dozens of millions per hour
- Even small problems can be very costly
- Router configuration is inherently low level
- Large number of only moderately related detail
- Limited or no verification tools
- Limited scope for inter-ISP routing management

RDL: The idea

- A high level Routing Documentation Language
- Dual purpose:
- 1) Architecture independent generation of BGP config:
  - RDL->Cisco, RDL->Juniper, RDL->BIRD
  - C->68k, C->x86_64, C->ARM
- 2) Description and publication of routing policies:
  - Enable automated verification and proofing
  - Improve exchange of information between peers

RDL: Not RPSL NG NG

- RDL will reuse data sources also used by RPSL:
  - Some objects
  - Publication/repository means, where feasible
- But, more importantly:
  - RDL to describe BGP topology
  - RDL to cover both iBGP and eBGP peerings
  - RDL to fully qualify and identify routing policies

RDL: Also not YANG (RFC6020)

- YANG is geared for NETCONF
- YANG and NETCONF are generally focused on **physical** Device Configuration and Management
- YANG is itself low level and riddled with detail
- RDL is for humans
- RDL is focused on a **logical** and **abstract** BGP view, independent of underlying network and devices
- YANG could be a compilation target for RDL

RDL: What is a policy?

- Much confusion between **Policy** and **Enforcement Action**
- A policy is **Thieves will be prosecuted**
- An enforcement action is **Arrest Nosey Parker**
- Existing tools and approaches focus on enforcement actions
- Quickly degenerate into **route filter mechanics**

RDL: Policies in 3D

- A routing policy as seen by RDL has three dimensions to it:
  - Where it applies: topological location
  - When it applies: NLRI attributes
  - What to do: filtering and attribute manipulation
- Think of it as similar to a piece of legislation, eg speed limits: Where, When, What
- These three aspects jointly describe a given policy in its entirety

RDL: A policy example

- Policy: My AS will not announce bogons
- RDL's 3D approach:
  - Where: all peerings with foreign ASs
  - When: prefix is in list of bogons
  - What: block it
- RDL's BGP topology description is the key to specifying the **Where** of a policy
- the **Where** is statically analysed and applied when generating configurations
- The **When** and the **What** are done by the routers

RDL: The language

- Designed specifically for the purpose of describing BGP topologies simply and intuitively
- Free form curly brace, recursive, and concatenative syntax, allowing quick and easy specification of objects and their location
- Borrows inadvertently and disrespectfully from several unusual languages
- Fully dynamically typed and declaration free

RDL: BGP topology

- RDL describes BGP topology by way of three logical components:
  - Zones – may contain other zones, and routers
  - Routers – may contain one or more BGP peers
  - Peers
- Structure similar to file system directories
- Each object has a number of attributes
- Attributes may be inherited from lexical scope
- iBGP is configured automatically

RDL: Topology example

```
hibernia = new(zone) . {
  .asn = 5580;
  EU = new(zone) . {
    NL = new(zone) . {
      ams1 = new(router) . {
        .address = 134.222.1.1;
        ripe = new(peer) . { 1.2.3.4, 3333 };
      };
    };
  };
  US = new(zone) . { .... };
  APAC = new(zone) . { ... };
};
```

RDL: What's in a zone

- Zones are containers for similar policies
  - often significant geographical correlation
  - should be chosen to reflect the reality of your network, not the other way around (your network is the ground, the zone map is the map)
  - you decide what your zone map should be, it is there to help you
  - again: RDL is all about BGP topology
  - the zone map identifies reference points for policies

RDL: Policy example

- Policy descriptions follow the topology format

```
nobogons = new(policy) . {
  .where = export peer.asn != peer.router.asn;
  .when = nlri.prefix & bogons;
  .what = reject;
};
bogons = { 0.0.0.0/8^+, 10.0.0.0/8^+, 100.64.0.0/10^+, ... };
```

- Policy syntax is experimental/undecided
- Probably a good idea to stick to general syntax of RDL

RDL: Unusual Example I

```
hibernia = new(zone) . {
  .asn = 5580;
  RR1 = new(router) . { 134.222.12.1 };
  RR2 = new(router) . { 134.222.14.1 };
  EU = new(zone) . {
    .ibgp = { RR1, RR2, “localmesh” };
    NL = new(zone) . {
      ams1 = new(router) . { 134.222.1.1 } . { ... };
    };
  };
  US = new(zone) . { .ibgp = { RR1, RR2, “localmesh” }; ... };
};
```

RDL: Unusual Example II

- Policy: de-prioritise all EU routes in US
- RDL to the rescue:

```
EUexport = new(policy) . {
  .where = import peer.zone <= US && peer.remote.zone <= EU;
  .when = ;
  .what = local-preference = 90;
};
```

- RR1 and RR2 are route reflectors and are therefore transparent

RDL: Unusual Example III

Changing iBGP to full mesh requires only a few edits:

```
hibernia = new(zone) . {
  .asn = 5580;
  RR1 = new(router) . { 134.222.12.1 };
  RR2 = new(router) . { 134.222.14.1 };
  EU = new(zone) . {
    .ibgp = { RR1, RR2, “localmesh” };
    NL = new(zone) . {
      ams1 = new(router) . { 134.222.1.1 } . { ... };
    };
  };
  US = new(zone) . { .ibgp = { RR1, RR2, “localmesh” }; ... };
};
```

RDL: Unusual Example IV

- And now RDL's pièce de résistance
- Recall the policy: de-prioritise all EU routes in US

```
EUexport = new(policy) . {
  .where = import peer.zone <= US && peer.remote.zone <= EU;
  .when = ;
  .what = local-preference = 90;
};
```

- Absolutely nothing needs to be done for the iBGP change.
- Jus' like that!

RDL: Policies for the future

- As shown, policies are generally modular and independent of underlying topology detail.
  - Eg adding or deleting a normal router requires no change to any regular policies, internal or external.
- What if two peers could exchange policies before peering? “Here's mine, I've got yours, thank you”.
  - Eg “I want a default, and no US routes”; plug in and peer.
- Can't be done “Jus' like that!”, will require either coordination on parameters or a higher level meta-description.
- Outside current scope of project, but not at all impossible.

Acknowledgments

- Job Snijders and Andreas Polyrakis
  - valuable discussions
  - providing use cases for RDL
  - reviewing the previous versions of RDL

RDL: Nirvana?

RDL is all about **not configuring routers**, but **documenting and programming the AS**.

Open source project and open discussions

http://lists.rpsl.net/mailman/listinfo/progress

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