EULER

Experimental UpdateLess Evolutive Routing

http://www.euler-fire-project.eu/

Main objective

Explore **novel routing paradigms** so as to design, develop and validate experimentally a **distributed** and **adaptive** routing scheme suitable for the Internet dynamics and its evolution. The routing scheme to be designed aims at circumventing the fundamental limits of current BGP Internet routing in terms of routing table scalability (memory space) but also in terms of adaptation efficiency under topology and policy dynamics (communication cost and computational complexity). For this purpose, a wide-spectrum of schemes ranging from **dynamic compact routing** to **geometric routing** and its variants, e.g., **updateful** and **updateless**.

Routing system architecture

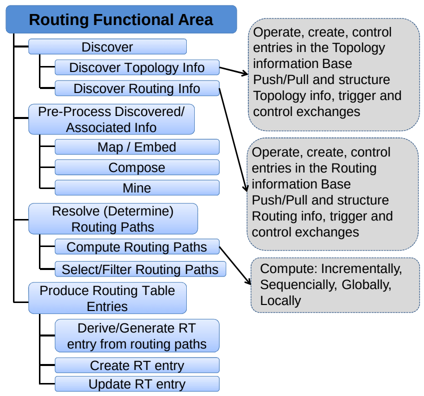
Formally described by

- Function and Procedural model
- Information and Data model
- State and State Machine model

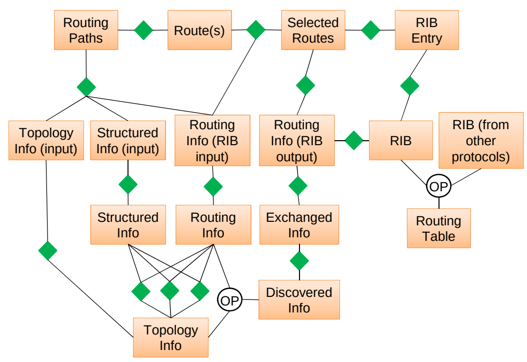
Why routing system architecture driven approach?

- Common baseline –enabler
- Common "language" to prevent misinterpretation among different dimensions involved in designing routing system
- Structuring and cohesive role
- In computer communication context, leads to modular software development (and prevents duplicates)
- Driver for forward looking and for broad perspective
- Without such framework adding or removing functionality leads to further complexity (see IP control plane design today)

Hierarchical decomposition (summary)



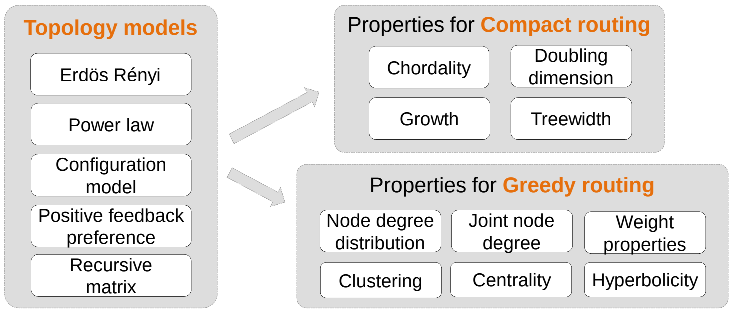
Information Model (summary)



Graph-based topology modeling and analysis

It constructs by means of generative models the network topology as a graph that statistically verifies certain properties (known a priori to best characterize the topology).

Main challenge: to model the short-term dynamics and the evolution of the topology in order to derive properties usable by routing function.

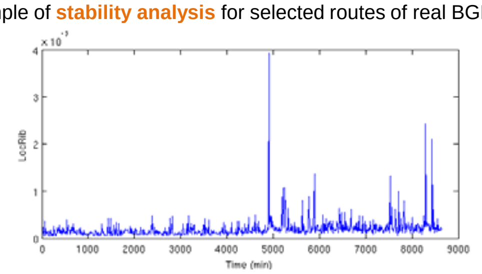


Measurement-based topology modeling and analysis

It considers the network as a dynamic and evolving system known only through 'observables'.

Main challenge: to model the network's characteristics using information derived from measurement (observation) measured at various time instants.

Example of **stability analysis** for selected routes of real BGP data



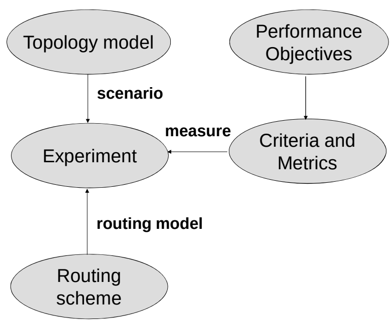
On average the Loc_RIB contains a few, 60-120, unstable routes (out of 318k)
During the 3rd day (5k minutes), 2 spikes indicate large changes in stability

Routing scheme experimentation

To ensure **repeatable** and **reproducible** results common topology and traffic dynamics scenarios are considered. To ensure **verifiable**, and **reliable** results, a common set of functional and performance **objectives**, criteria and **metrics** are defined to be experimented on controlled tools (simulator, and emulator).

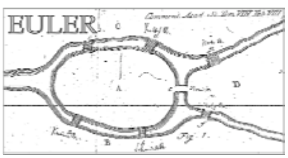
Objectives

- **Scalability**: number of routing table entries in the order of 10^9 (BGP supports today about 3.5 10^6)
- **Complexity**: both in time and space should grow sub-linearly with the routing protocol input size
- **Quality**: minimize the path length, and number of steps to reach a consistent and stable routing state
- **Adaptivity**: capacity to timely response when internal or external events occur (e.g., topology, and policy dynamics).
- **Availability**: maximize number of protectable routing paths while minimizing the recovery resources and stretch of protecting paths



Metrics

- **Stretch**: routing path length vs. min.path length for same (s,d) pair
- **Storage**: number and size of the (local) routing table entries
- **Complexity**: number of execution steps and resources needed to compute routing paths
- **Communication cost**: number, size and rate of routing updates
- **Convergence**: time to reach a stable state upon instability event
- **Fault-tolerance (coverage and time)**: number of reparable routing paths and time required to repair them
- **Forwarding table storage and delay**: number and size of forwarding entries and time to select outgoing interface
- **Throughput**, **delay**, and **packet loss** per routing path



Project information

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Dimitri Papadimitriou (ALB)
contact@euler-fire-project.eu

ALB – Alcatel-Lucent Bell (Belgium)
INRIA – Institut National de Recherche en Informatique et en Automatique (France)
IBBT – Interdisciplinary Institute for Broadband Technology (Belgium)
UPMC – Université Pierre Marie Curie (France)
UCL – Université Catholique de Louvain (Belgium)
RACTI – Research Academic Computer Technology Institute (Greece)
UPC&UdG – Universitat Politècnica de Catalunya / Universitat de Girona (Spain)