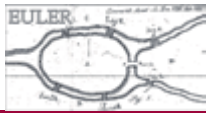
EXPERIMENTAL UPDATELESS EVOLUTIVE ROUTING

EULER



Project overview

The main objective of the EULER exploratory research project is to investigate new routing paradigms so as to design, develop, and validate an experimentally distributed and dynamic routing scheme suitable for the Internet and its evolution. The resulting routing scheme(s) is/are intended to address the fundamental limits of current stretch-1 shortest-path routing in terms of routing table scalability but also topology and policy dynamics. The driving idea of this research project is to make use of the structural and statistical properties of the Internet topology as well as the stability and convergence properties of the Internet policy in order to specialise the design of a distributed routing scheme known to perform efficiently under dynamic network and policy conditions when these properties are met.

Research description

The EULER project will develop new models and tools to extensively analyse the Internet topology to accurately and reliably measure its properties, and to precisely characterise its evolution. These models, that will better reflect the dynamics and the evolution of the network together with its policy, will be used to derive useful properties and metrics for designing

Testbed infrastructure
iLAB-T

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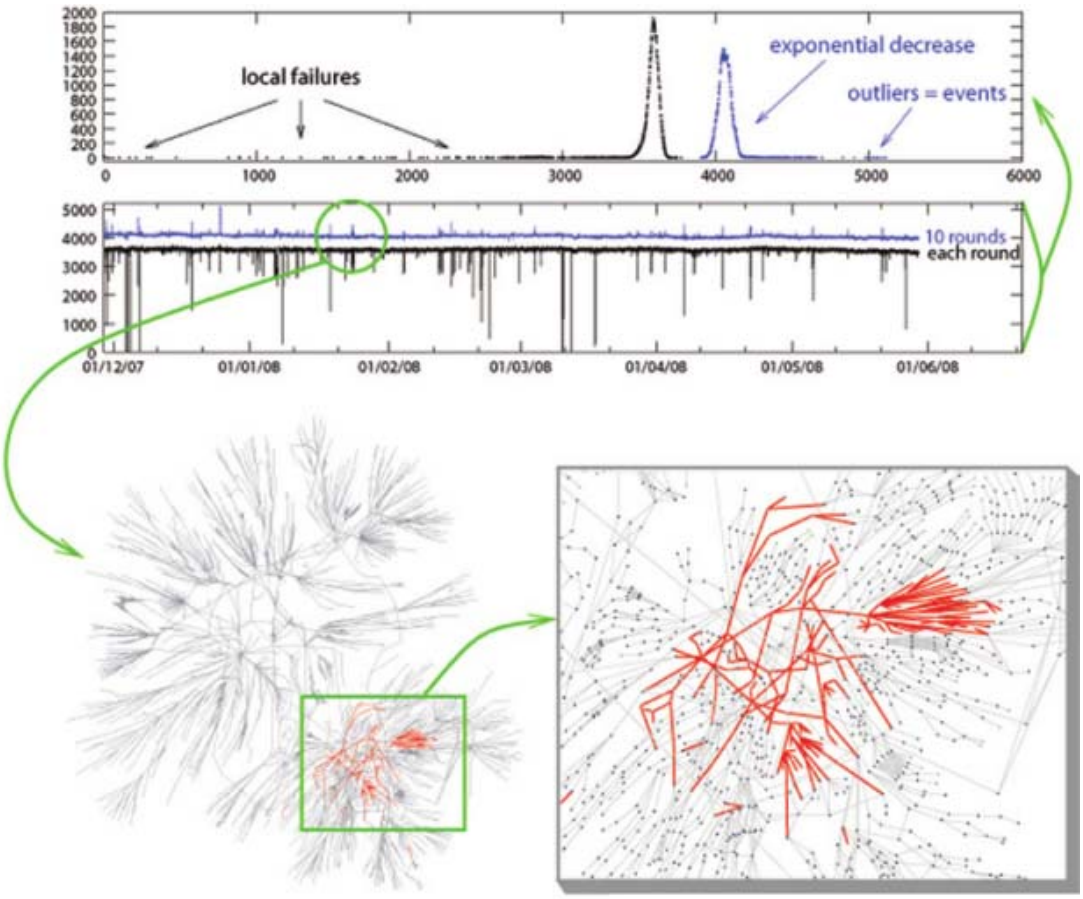
Project website
http://www.euler-fire-project.eu/

Community contribution to the project
EUR 3150000

Project start date
1 October 2010

Duration
36 months

SEVENTH FRAMEWORK PROGRAMME



routing schemes and provide relevant experimental scenarios. The project will also develop appropriate tools to evaluate the performance of the proposed routing schemes on large-scale topologies (of order of 10000 nodes).

The focus of this research project is the introduction of new routing schemes that (i) produce routing paths whose stretch is bounded and independent of the network size, and (ii) store corresponding entries in routing tables whose memory size is sub-linear in the number of nodes based on the exploitation of unique properties of the Internet topology.

These Internet topology properties offer the possibility to design a routing scheme using a metric space that would significantly reduce the amount of routing updates required to timely maintain non-local but consistent knowledge about the network topology.

Prototypes of the designed routing protocols as well as their functional validation and performance evaluation will be executed on the iLAB-T experimental facility and/or virtual experimental facilities such as PlanetLab/ OneLab. These experiments will ensure that the proposed routing schemes will be validated under realistic running conditions.

Scientific and technical objectives

The main scientific and technical objectives of the EULER project are:

- Elaboration of methods and tools for modelling the Internet AS/router topology dynamics and their evolution (including intermittent and permanent topology failures, short-term and long-term network topology evolution, etc.), as well as policy interactions and associate dynamics. Figure 1 presents an example of such method and associated measurement-based tool: an event detection method which proceeds in several steps. It consists in monitoring the evolution of a chosen statistical property of the network over time. This monitoring leads to the detection of any statistically relevant variation (top), which in turn allows to determine (bottom left) the region of the network which has triggered the variation and then (bottom right) to zoom in this region in order to interpret the identified event. The crucial point here relies in choosing carefully the relevant properties to monitor. This selection will directly depend on the kind of event to be detected. This is why part of the project is dedicated to identify a set of such properties and their relation to the interpretation in terms of network dynamics.

- Development of novel routing paradigms so as to architect a routing system that is suitable for the Internet and its foreseeable evolution. This routing system will enhance the existing system by finding better trade-off(s) between routing table size (so as to enhance its scalability), routing scheme stretch (so as to ensure routing quality) and communication cost (so as to efficiently and timely react to topological failures).

- Validation and evaluation of the benefits of the proposed routing schemes by systematic experimentation and comparing them to the current Internet routing system by means of several distinct set of representative scenarios. The experimentation will take place on the iLAB-T experimental facility and/or in an Internet connected experimental facility such as Planet-Lab/OneLab.

Target users and benefits

This project cross-fertilises:

- structural, stochastic as well as measurement-based topology (dynamics and evolution) modelling,
- policy interactions and dynamics modelling,
- distributed routing algorithmic.

Following the application of graph theory to networking that allowed the emergence of the distributed routing research discipline; exploitation of this renewed cycle of research is expected to position Europe at the forefront of routing algorithmic and protocols for the Internet. Our results will serve as suitable basis to:

- drive major improvements compared to the current knowledge and understanding of the Internet topology dynamics and evolution modelling;

- introduce new Internet measurement approaches by identifying properties of interest and then by estimating them rigorously. This new approach to Internet measurement is expected to be more widely applicable to complex networks;

- sustain growth and evolution of the Internet infrastructure by designing routing scheme(s) that:
  - scale independently of the number of network nodes and links but also the number of reachable address prefixes;
  - rely on an addressing space not subject to allocation policies;
  - can support resiliency and recoverability against topological failures (without resulting into instabilities) as well as dynamic multi-homing;
  - can adapt to the network policy and topology evolution.

Moreover the developed techniques, algorithms and tools will also be useful to a larger scientific and technical community:

- Computer scientists and network engineers working on routing algorithms and protocols (sensor networks, peer-to-peer, etc.) will use our results and tools for generating topologies on which they will perform experiments.
- Scientists from other research areas are also dealing with large-scale networks with specific properties (sociology, biology, economy, etc.).

Therefore, our tools and results might also be helpful to handle other kind of problems (identification of communities, pattern matching, etc.), and thus create synergies with scientists of the aforementioned scientific areas.

Project partners		**Country**
ALB	**Alcatel-Lucent Bell** (ALB), Antwerpen	Belgium
INRIA	**Institut National de Recherche en Informatique et en Automatique** (INRIA) . CEPAGE, Bordeaux - Sud-Ouest . GANG, Paris - Rocquencourt . MASCOTTE, Sophia Antipolis - Méditerranée	France
IBBT	INTEC Broadband Communication Networks (IBCN) Department of Information Technology (INTEC) of the Ghent University (UGent) and **Interdisciplinary Institute for Broadband Technology** (IBBT)	Belgium
UPMC	Complex Networks Laboratoire d'Informatique de Paris 6 (LIP6) **Université Pierre Marie Curie** (UPMC)	France
UCL	Research group on large graphs and networks Department of Mathematical Engineering (INMA) **Université Catholique de Louvain** (UCL)	Belgium
CTI	**Computer Technology Institute** (CTI) and Press "Diophantus" University of Patras	Greece
UPC&UdG	**Universitat Politècnica de Catalunya** (UPC) and **Universitat de Girona** (UdG) . Advanced Broadband Communications Center . Broadband Communications and Distributed Systems	Spain