Babel Routing Protocol Research using Quagga Software Router

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Abstract. This article focuses on the Babel routing protocol, its features and the way of studying it. Babel is a loop-free distance vector routing protocol that is designed to work well not only in wired networks but also in wireless mesh networks. In order to research the Babel routing protocol the research area has been created by student scientific society of our university. Our project that is described below gives an opportunity for researching and enhances teaching program.

Keywords. Babel routing protocol, research area, software routers.

1 Introduction

Education is known to be behind the process of the invention of new technology. Therefore we try to create a teaching project that is close to the modern trends of data networks as much as possible. Also we try to teach students how to research new technology by themselves in the future. Use the technology on practice is necessary for its more effective study. That is why we created a research area of the Babel routing protocol.

In this article, we will review the Babel routing protocol, its features and the creation of a research area of Babel routing protocol.

2 Babel routing protocol

Babel is a loop-avoiding distance-vector routing protocol that is designed to be robust and efficient both in networks using prefix-based routing and in networks using flat routing ("mesh networks"), and both in relatively stable wired networks and in highly dynamic wireless networks. [1]

Babel was originally designed for wireless ad-hoc networks. Because of that, Babel is extremely robust in the presence of mobility: only under very exceptional situations circumstances will Babel cause a transient routing loop.

The Babelz protocol variant is also able to take radio frequency into account in order to avoid interference. [2]

Babel on dual-stack networks. Unlike most routing protocols, which route either IPv4 or IPv6 but not both at the same time, Babel is a hybrid routing protocol, in the sense that a single update packet can carry routes for multiple network-layer protocols (both IPv6 and IPv4 routes). This makes Babel particularly efficient and simple to manage on dual (IPv6 and IPv4) networks.

Limitations. Babel has two limitations that make it unsuitable for use in some environments:

1) Babel relies on periodic routing table updates rather than using a reliable transport (hence, in large, stable networks it generates more traffic than protocols that only send updates when the network topology changes);
2) Babel does impose a hold time when a prefix is retracted. This makes Babel unsuitable for use in mobile networks that implement automatic prefix aggregation. [1]

Transmission routing information. Babel protocol packets are sent in the body of a UDP datagram. Babel puts routing information into a type-length-value (TLV). Each Babel packet consists of one or more TLVs.

Optionally a Babel node can request an acknowledgment for any Babel packet it sends by adding an Acknowledgment Request TLV. [3]

A Babel node periodically broadcasts Hello messages to all of its neighbours; it also periodically sends an IHU ("I Heard You") message to every neighbour from which it has recently heard a Hello. [1]

From the information derived from Hello and IHU messages received from its neighbour a Babel node calculates the cost *c* of the link from the neighbour to the node.

Route selection. Route selection is the process by which a single route for a given prefix is selected to be used for forwarding packets and to be re-advertised to a node's neighbours.

Babel is designed to allow flexible route selection policies. As far as the protocol's correctness is concerned, the route selection policy must only satisfy the following properties:

1) a route with infinite metric (a retracted route) is never selected;
2) an unfeasible route is never selected. [1]

Route selection criteria are metric, router-id, stable neighbours and routes, next hops.

A Babel speaker advertises to its neighbours its set of selected routes by sending packets that contain Update TLVs.

Feasibility condition. Babel uses a feasibility condition that guarantees the absence of routing loops whenever all routers ignore route updates that do not satisfy the feasibility condition [1]: route is feasible only when its metric at the local node would be no larger than the metric of the currently selected route. Obviously, the

feasibility conditions defined above cause starvation when a router runs out of feasible routes. Babel reacts to starvation by using sequenced routes.

Each route contains a sequence number *s* and a metric *m* for a node *n*. The sequence number *s* determines the freshness of the route advertisement and is propagated unchanged through the network and is only incremented by *n*. For example, if a node receives two route advertisements for *n* from two different neighbours, it will take the route with newer *s*. [3]

Convergence. To speed up convergence when the topology changed Babel node can request a new sequence number (with a sequence number request TLV) when it has needed instead of waiting until the new sequence number is sent in the next periodic interval as it is in DSDV.

Babel enjoys fairly fast convergence. Since Babel uses triggered updates and explicit requests for routing information, it usually converges almost immediately after the link quality measure has completed. This initial solution is not optimal — after converging to a merely satisfactory set of routes, Babel will take some time before optimising the routing tables. In the presence of heavy packet loss, converging on an optimal set of routes may take up to a minute or so (with the default update interval of 20 seconds). [2]

3 The research area of the Babel routing protocol

3.1 About the area

Within the project a research area of Babel routing protocol has been created. The area is based on virtual hosts of a single server but IP-network of the area is a complete network based on software routers with working routing protocol, data transfer, interaction with other networks and the ability to use the network for educational purposes.

The creation of the research area has been done by student scientific society. At this moment the area is configured and it interacts with hardware routers. It also has access to the external network. There is a full access to any virtual machine of the Babel area from the laboratory network so it is possible to change current settings and analyze data.

It is not profitably to create this kind of areas using real routers because of its high cost. Particularly it applies to universities. Obviously the more the network is, the more expensive it will be. For this reason it is easier to use Quagga package.

Quagga is a routing software package that provides TCP/IP based routing services with routing protocols support such as RIPv1, RIPv2, RIPng, OSPFv2, OSPFv3, BGP-4, BGP-4+, and Babel. It allows you to create on individual server dozens of

virtual routers and to ensure their cooperation by prescribing the appropriate route. [4] In addition there is a possibility to connect hardware routers to this network.

One of the features of Quagga is a flexibility of construction, an ease of adding new network devices and an ability of fast topology changing.

At this moment the Babel area consist of 5 routers. The area topology is shown in figure 1. It can easily be expanded by adding workplaces or routers or by copying virtual machines that already exist and its reconfiguring.

When we actuate a traffic-analyzer (for example Wireshark) in any point of the network we can see accepted and sent packets, its contents, hence, we can test a routing protocol.

As a result of work of a routing protocol the routing tables are changing and filling with new entries. You can see the routes and data paths by using certain commands on the command line.

Modern networks are not stable: the composition of the network and link characteristics can be changed, the equipment can fail. The created area is able to emulate these events. Within the developed area we can emulate these events оценить последствия. These are some possible destabilizing factors: router denial, configuration change, topology change.

All of it is implemented by editing Quagga configuration files and by possibility of fast switching software routers or its interfaces.

Routers respond to network changes and switch the data paths by exchanging the necessary messages.

Represented area is completely self-contained project but it also is able to interact with other Quagga projects and real-life projects.

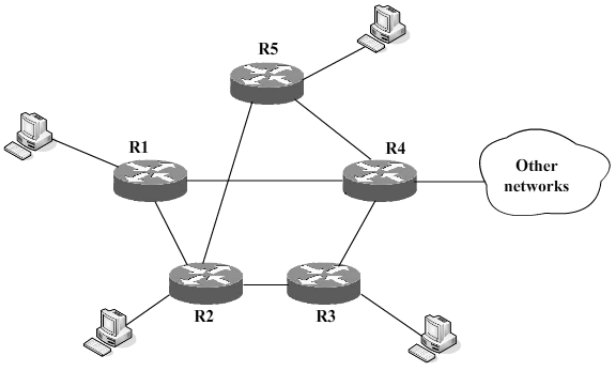

Fig. 1. The topology of the Babel routing protocol study area

3.2 Researching

There is a great possibility to observe the work of the Babel protocol using the created research area.

Students are able to study the routing protocol packet formats, the order of exchange of these packets and also see how contents of basic fields of the packet affect the functioning of the routing protocol by checking the packets of the protocol using Wireshark program.

There is also a possibility to do the research by some influence on the network such as router denial (or link denial), configuration changing, topology changing.

Defining a good route selection policy for Babel is an open research problem. Route selection can take into account multiple mutually contradictory criteria; in roughly decreasing order of importance, these are:

1) routes with a small metric should be preferred over routes with a large metric;
2) switching router-ids should be avoided;
3) routes through stable neighbours should be preferred over routes through unstable ones;
4) stable routes should be preferred over unstable ones;
5) switching next hops should be avoided. [1]

A simple strategy is to choose the feasible route with the smallest metric, with a small time delay in the transition from one state to another applied to avoid switching router-ids.

Students are able to investigate Babel protocol work and see how it changes its selected routes, for example, by changing the network topology (adding or deleting some routers or its interfaces) which cause changing the smallest metrics, next hops for some routers.

It is also available to change the link quality (for example, by changing its bandwidth). This will lead to changing the cost of the link and so to changing metrics of the routes that contain this link.

Moreover, students can set the routing and get to know how to configure software routers. Through changing the configuration files they can change router-ids and cause routes reselection.

4 Conclusion

The area that we created is very useful for studying Babel routing protocol. At the moment, it allows to do labs for students. Students gain practical skills of working with Babel protocol. These classes help to learn the theory, are of interest to students and inspire them to further study of telecommunication technology, to do master's researches.

An interesting feature of this project is the ability of imitation unstable network. This could be achieved using special script that constantly changes the configuration files, which leads to changes in the network. Thus, we can create a destabilizing factor that is analogous to the factor in a sensor network. In this regard, there is much more opportunities for network researches, data transfer in the network, etc.

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