Application of Graceful Graph in MPLS

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Abstract— In this paper graceful graph and application of graceful graph in the field of computer science is defined namely, Multi-Protocol Label Switching (MPLS) which deals with networking. The MPLS used in wide area of networking particularly used in ATM network as the labelled flow can mapped to ATM virtual circuit identifiers and vice versa. This shows there existence of graceful labelling in the field of computer networking via MPLS. One of the important areas in graph theory is Graph Labelling used in many applications like coding theory, x-ray crystallography, radar, astronomy, circuit design, communication network addressing, data base management. This paper addresses how the concept of graceful labelling can be applied to the networking areas. An overview and new ideas has been proposed here.

Key words: Graceful Graph, MPLS, Label Switched Path, Forwarding Equivalence Class, Graceful Numbering, MPLS with Graceful Labeling

I. INTRODUCTION

A graph G=(V,E) where V is the set of vertices and E be the set of edges that connect pairs of point in V. Edges are determined by symmetric irreflexive relation on V*V. The graph G ={V,E}is the set of finite series of graph vertices V with set of graph edges E of two subsets of V. The following procedure deals with graceful graph and their computer application.

Network representation plays an important role in many domains of computer science, ranging from data structures and graph algorithms, to parallel and distributed computing and communication networks .traditional network representation are usually global in nature that is in order to retrieve useful information, and one most access a global data structure representing the entire network.

II. GRACEFUL GRAPH

The name" Graceful Labelling" is because of Solomon W. golomb and this type of labelling was first given by the name "beta labelling" by Alexander Rosa in 1967.

A. Definition

A graph which deals with graceful labelling is said to be GRACEFUL GRAPH. Graceful labelling of graph with n edges is a labelling of its vertices with some subsets of integers between o and n. So that two vertices does not share the label and each edges uniquely defined by the absolute difference between its end points. So that their magnitude lies between 1and n.

B. Methods of Graceful Labelling Problems

- Mathematical programming model of graceful labelling problem.
- Zero one model for graceful labelling problem.
- Branching method for graceful labelling problem.
- Computational results etc.
- Here we are going to see graceful labelling application deals with computer science.

III. WHAT IS MPLS?

Multi-Protocol Label Switching is a routing technique that imitate connection oriented forwarding method in a connectionless

Multi-Protocol Label Switching (MPLS) is a data-carrying mechanism which imitates some properties of a circuit switched network over a packed-switched network. MPLS operates at an OSI Model layer which can be generally considered to lie between data link layer and network layer, and thus is often referred to as a "Layer 2.5" protocol. It was modeled as data-carrying service for both circuit-based clients and packet-switching clients which also provide a datagram service model. It can be used to carry many different kinds of traffic, including IP packets.

MPLS is nothing but which boost up the performance and capacity of the network. Explicit routing and traffic engineering (managers the flow pattern of packets) is very useful. It is used in the separation of routing and proceeding is a Virtual Private Network.

A. How MPLS Works?

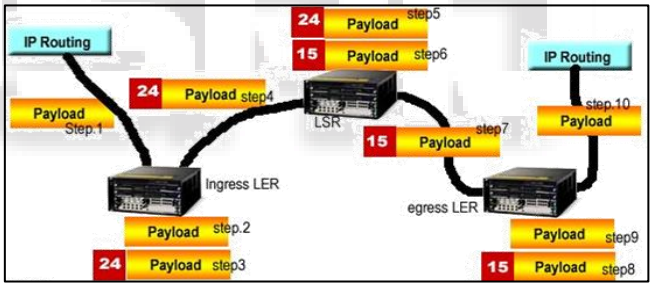

Fig. 1:

B. Carrying the label in the packet

1) Link Layer header
2) MPLS "shim" Label header
3) Network Layer header
4) Network Layer data

- Each LSR manages forwarding table
- typical forwarding table entry
  Incoming label
  Outgoing label Outgoing interface Next hop address
- Label swapping
- Label format
  Label (20 bits) Experimental (3) Stack (1) TTL (8)
- MPLS works by adding some thing at the begining of the packets with an MPLS header contains the 'label'.

There are four fields in the label

- A 20-bit label value.
- A 3-bit field for QoS priority
- A 1-bit bottom of stack flag. If this is set, it specify the current label is the last in the stack.
- An 8-bit TTL (time to live) field.

These MPLS labeled packets change their direction after a Label Lookup/Switch instead of a lookup into the IP table. The exit points of an MPLS network is known as Label Edge Routers (LER). Routers that acts routing based only on Label Switching is known as Label Switch Routers (LSR) Penultimate Hop Popping (PHP) is a function which was done by certain routers in an MPLS enabled network. This process refers to the outermost label of a MPLS tagged packet is neglected by a Label Switched Router (LSR) before the packet is moved to an adjacent Label Edge Router (LER).

C. Label Switched Path

The router which first add something at the beginning to the MPLS header to a packet is known as ingress router. The last router in an LSP, which burst the label from the packet, can be said as an egress router. Routers in the middle that need only swap labels, are called transit routers or Label Switching Routers. When an unlabeled packet enters the entry router and needs to be passed on to an MPLS tunnel, the router first decides to keep moving in the forwarding equivalence class the packet should be inside and after that fit one (or more) label in the packets newly introduced MPLS header. The packet is then passed on to the next hop router for this tunnel. When a labeled packet is received by an MPLS router, the topmost Label is determined.

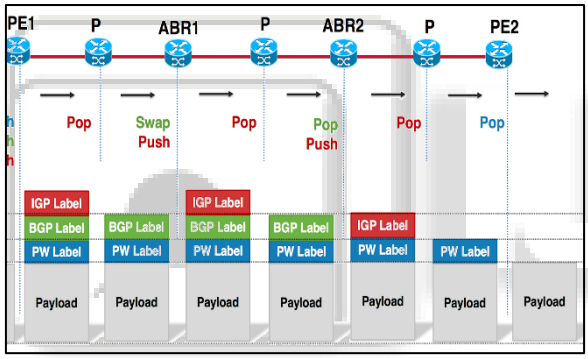

Fig. 2:

Based on the above contents of the label, a swap can be impose or pop dispose operation can be done on the bases of the packet's label stack. Routers can have prebuilt the view on the tables that tells them which kind of operation can be do based on the topmost label of the incoming packet so that they can process the packet very quickly. In an exchange of the operation the label is swapped with a new label and the packet is moved forwarded along the path associated with the new label. Basically in a push operation, a new label is pushed on the top of the existing label, effectively "capsulation" the packet in another layer of an MPLS. This permit the hierarchical routing of an MPLS packets. This is used by MPLS VPNs. In a pop operation the label can be separated from the packet that may disclose an inner label below. This operation is called "decapsulation". If the burst label was the final on the label heap, then the packet "leaves" the MPLS tunnel. These are usually done by the egress router, but see PHP below.

During these process, the contents of the packet down the MPLS Label stack are not determined. Actual transit routers typically need only to examine the topmost label on the stack. The forwarding of the packet is done based on the contents of the labels, which permits "protocol independent packet forwarding" that does not need to look at a protocol-dependent routing table and keeps away the expensive IP which is placed before another match at each hop. At the emersion router, when the last label has been busted, only the payload left. This is said be an IP packet, or any of the number of other kinds of payload packet. The egress router must therefore have a routing data for the packet's payload, since it must forward it without the need of label lookup tables. An MPLS transit router has no such necessity. In some special cases, the final label can also be burst off at the penultimate hop (the hop before the egress router). This is known as Penultimate Hop Popping (PHP). This may be catches attention in cases where the emersion router has lots of packets quit MPLS tunnels, and thus they spends excessive amounts of CPU time on this. By using PHP, transit routers can be connected directly to this emersion router explicitly deposit it, by bursting the last label themselves.

MPLS can make use of current ATM network structure and facility, as its labelled flows can be mapped to ATM virtual circuit identifiers, and vice-versa.

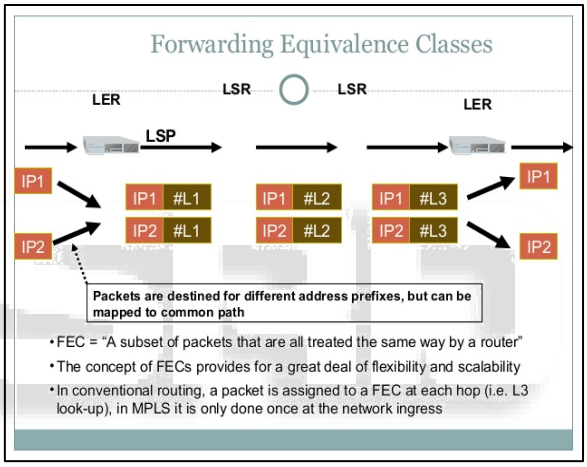

Fig. 3:

1) Flow of IP packets

- Over the similar path
- Treated in the similar manner
- Mapped to the similar label

2) MPLS Signaling Protocols

- Hop-by-hop & Explicit
- Label Distribution Protocol (LDP)
- Constraint-based Routing LDP (CR-LDP)
- Extensions to RSVP

3) Benefits of using MPLS

Forwarding packets between different types of networks is easier to get a great extent, because there is a single forwarding algorithm irrespective of the routing or link layer protocol is utilized. The switching based on the short labels is a head over long headers.

4) Graceful Numbering of Graphs is used in MPLS for the Following Reasons

- It is a well-known labeling method in graphs.
- Number the nodes of a graph G with 1, 2... e so that impel edge labels computed by absolute node number differences are all distinct.

D. MPLS Unicast with Graceful Numbering

The following diagram shows the connection of MPLS with graceful numbering

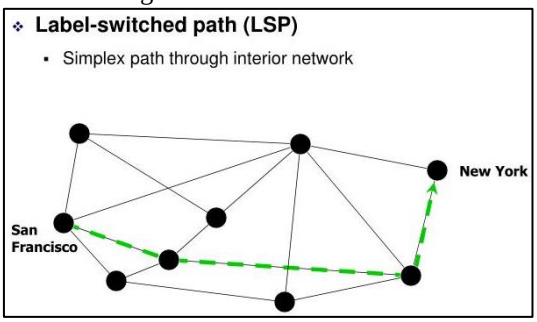

Fig. 4: MPLS Vocabulary

E. MPLS combined with Graceful Numbering

By imposing the graceful labeling concept, we can neglect the label switching operation. Here the whole LAN Network is considered as the graph and they are labelled graceful. And the labelled stack is preserved by each node in the LAN Network. Labelling is automatically done when the system on the network is kicked away. MPLS works by prepending packets with an MPLS header, containing one or more 'labels'. This is called a label stack.

1) Each Label Stack Entry Contains Four Fields

– A 20-bit label value.
– A 3-bit field for QoS priority
– A 1-bit bottom of stack flag. If this is set, it signifies the current label is the last in the stack.
– An 8-bit TTL (time to live) field.

A Packet may carry an entire stack of labels with it. Once it passes through an edge whose corresponding label will be stripped at each router. An example for packet transmission in MPLS domains as follow

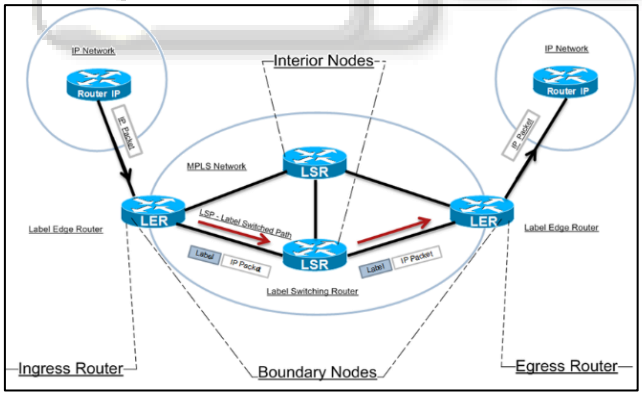

Fig. 5:

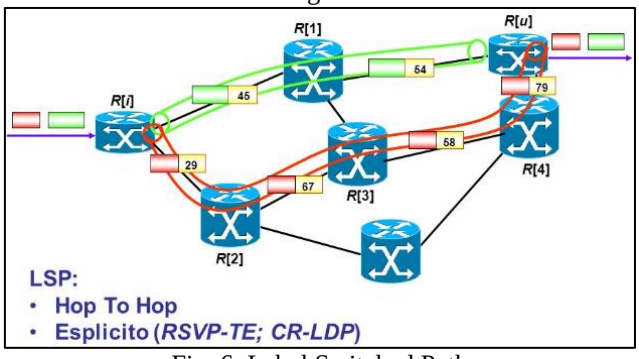

Fig. 6: Label Switched Path

– Packet transmission in MPLS domain using graceful labelling

The current label with S bit is 1 then it is the last edge to reach the destination node. This feature is mostly used in virtual private network.

IV. Conclusion

Graceful graphs are easy to understand, but have many seemingly simple unresolved questions that no one has been able to answer yet. Graceful graphs lend themselves naturally to computational approaches. As discussed in our paper, Graceful graphs have wider scope for implementation mainly in the field of Networking and with respect to MPLS protocol, Graceful labeling is highly useful in the forwarding of packets with greater efficiency due to following reasons:

1) Label swapping operation is not needed. 2. Provides an efficient technique for labeling a Network. 3. Forwarding table is needed 4. Existence of protocol independent packet forwarding.

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