CARRIER SCALE ETHERNET

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Ethernet's ubiquity in both the enterprise and residential markets coupled with the universal existence of mature low-cost technology to implement it is driving the need for Ethernet solutions in the wide area network (WAN) environment. Part of this challenge is to deliver scalable solutions that can support a basket of services from simple point-to-point connectivity through to virtual private LAN services. Today this is being achieved using a number of technologies including synchronous digital hierarchy (SDH), asynchronous transfer mode (ATM), multiprotocol label switching (MPLS), and of course native Ethernet.

At the same time, many carriers face the challenge of migrating toward next-generation networks with the aim of converging onto networks that contain fewer technologies, avoid single-service network solutions, reduce the number of operational support systems, and minimize the cost of ownership. In doing so it is necessary to consider how Ethernet services will be delivered over these new networks and whether the existing Ethernet service model should be maintained or modified.

Our goal with this feature topic has been to focus on some of the capabilities that together make carrier scale Ethernet. Specifically, to differentiate from recent feature topics that explored Ethernet services over MPLS networks, this feature topic explores Ethernet services over Ethernet networks. Many excellent papers were submitted for this Feature Topic, and we struggled to eliminate almost three-quarters of the papers in order to fit into the original allocation of only five articles. We are grateful to have been given more space so that we can present the seven articles we believe cover many of the current themes related to carrier scale Ethernet technologies.

There is, of course, considerable activity in developing Ethernet solutions in standards bodies such as the IEEE, International Telecommunications Union — Telecommunications Standardization Sector (ITU-T), Metro Ethernet Forum (MEF), and TMF. The first article from Sánchez *et al.* summarizes these activities and provides a general overview, setting the scene for the remaining papers. It explains recent improvements to Ethernet, related to scalability, OAM functionality and enhanced forwarding capability, which will greatly enhance the usefulness of Ethernet in carrier networks.

The second article by Reid *et al.* provides an economic perspective suggesting how a carrier might choose to partition its network to optimize its cost and functionality, and also demonstrating how carrier scale Ethernet could complement and interoperate with other technologies.

The next article (by Bottorff and Saltsidis) provides a tutorial on work in the IEEE 802.1 committee related to provider backbone bridging (PBB) and discussion of PBB-TE (PBB with traffic engineering) by editors of these IEEE documents. PBB has recently been published as a standard, and its aim is to significantly increase the scalability of Ethernet in the WAN environment. By introducing hierarchy in the form of MAC-in-MAC encapsulation, PBB overcomes the current limitations for the support of service instances with the use of a new service identifier that can support over 16 million service instances. PBB-TE is currently being addressed by the IEEE 802.1Qay standards project and builds on existing Ethernet bridging technologies by providing traffic engineering capabilities and also rapid recovery from failure. Simplification of Ethernet for connection-oriented operation is achieved by disabling flooding, learning, and spanning tree protocols. In addition, operations, administration, and maintenance (OAM) funcationality is made similar to that of synchronous optical network (SONET)/SDH by using extensions to 802.1ag, which provides extensive OAM tools for Ethernet.

The next two articles, from Allan *et al.* and Takács *et al.*, describe two contrasting approaches to implementing control planes for Ethernet. The first of these (PLSB, provider link state bridging) enhances PBB by adding layer 2 routing and loop mitigation so that all trees are shortest path, and the only traffic affected by a fault is that travers-

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ing the failed path. It is currently being standardized as part of IEEE 802.1aq. The second introduces the concepts and standards work that define the extensions to generalized MPLS (GMPLS) necessary for it to control Ethernet. GMPLS is based on mature signaling and routing protocols. It is gaining widespread acceptance as a transport control plane, providing fast restoration and supporting automatic provisioning.

The penultimate article, from Ferrant *et al.*, describes Synchronous Ethernet standards being developed to allow transportation of synchronization information over Ethernet. Of course, Ethernet was not originally designed for this purpose, but it is a key requirement for certain existing applications, especially those involving time-division multiplexing (TDM) emulation and mobile backhaul solutions.

The final article by Ryoo *et al.* covers the new Ethernet ring standard that has recently been published by Study Group 15 of the ITU-T as Recommendation G.8032. In contrast to existing solutions based on the use of spanning tree protocols, resilience is implemented by a simple automatic protection switching (APS) protocol, achieving reliable carrier-class network operation in Ethernet topologies which form a closed loop.

We would like to thank all the authors who submitted papers to this feature topic. In particular, we would like to thank those whose articles are included here for their willingness to revise their manuscripts to tight deadlines.

BIOGRAPHIES

ALAN MCGUIRE [SM] (alan.mcquire@bt.com) is a principal engineer at BT where he currently leads a multi-disciplinary team focused on optical and Ethernet access technologies. He is also active in international standards, including in the ITU-T and IEEE. He graduated from the University of St Andrews in 1987 with a first in physics and an M.S. in medical physics one year later from the University of Aberdeen. He is both a Chartered Engineer and Chartered Physicist, and a member of the IET and the Institute of Physics.

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