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Carrier Ethernet: work in progress

The Carrier Ethernet World Congress, the official annual event of the Metro Ethernet Forum, has staked its claim as Europe's largest meeting of network operators and the Ethernet community. Mark Lum, opening chairman at last month's conference, reports on the latest moves to put Ethernet technology at the heart of Europe's carrier networks.

Ethernet may well be the "shark in the fishtank" of networking technology, but before it can be fully adopted by carriers for mainstream services the shark needs to learn some table manners. The overriding theme of IIR's Carrier Ethernet World Congress (CEWC) in Berlin was that unruly or immature networking behaviour that may be tolerated in a single-company local-area network (LAN) is simply not acceptable in a multicustomer, public-service-provider domain. This is not to fault Ethernet: it was originally designed only for localized, single-domain use. Expectations have changed over the years, however, and now Ethernet needs to be reformulated to meet carrier requirements.

The truth is, carriers continue to feel nervous about Ethernet. On the one hand, they clearly need the technology as the way forward to support low-cost, high-volume packet networking. On the other, carriers see that the widespread use of Ethernet, as currently defined, would increase their operational expenses. Carriers therefore want the technology to prove its much-vaunted low-cost potential in a large-scale network environment without requiring additional manpower and complexity.



[Grown-up Ethernet](#)

Some delegates were concerned that there was nothing radically new presented at CEWC. They missed the point that mainstream carrier networks cannot accept frequent changes in technology without increasing costs and creating operational complexity. Consequently, a slowdown in innovation and an emphasis on industry consensus are prerequisites for general carrier adoption.



[The X-factor](#)

Ethernet: where are we?

Over the past few years, carriers across the spectrum have been making use of low-cost Ethernet services and networks. The core value proposition can be summed up as high access bandwidth at good value with a quality that's sufficient for many customers. In effect, carriers have already made the mental leap of faith towards Ethernet services and, whether incumbents or alternates, there's mounting evidence that Ethernet is a key part of their service portfolio.

CEWC examined the UK national market as a notable hotbed of Ethernet competition, with COLT Telecom, Fibernet, Interoute and Neos

Networks presenting updates on their deployments; NTL presenting an ambitious roll-out of its new Next-Generation Network (NGN) national Ethernet service; and BT introducing new services to its well established Ethernet services portfolio.



Interoperability

Carriers now want much more than basic services and are looking to utilize Ethernet as a foundation - some would say converged - technology across their networks, as well as to support sophisticated virtual-private-network (VPN) offerings and to improve the quality of existing offerings. From the numerous carrier presentations at CEWC, it's clear that high expectations are being placed on Ethernet technology to support NGNs. Yet it's equally clear that there is little consensus about how best to use Ethernet to meet those next-generation requirements. As the UK operator 3 said, "Ongoing techno-economic analysis will determine what and when" (in other words, when Ethernet can do the job and when it's affordable).

Put simply, it's crunch time for Ethernet. After adoption by carriers for simple LAN extension services and private VPNs, the promise, hype and much-vaunted trio of Ethernet's simplicity, cheapness and ubiquity faces the real-world requirements of large-scale carrier operations.

Ethernet is accepted as simple, cheap and ubiquitous for enterprise applications, but this is not the case for carrier applications. Many carrier speakers at CEWC returned to this issue, reflecting a widespread concern, even frustration, that Ethernet is not yet ready for mainstream carrier use. Indeed, it's evident that only slow progress has been made by the equipment makers on these fundamental issues since last year's IIR Ethernet Services conference in Budapest (*FibreSystems* November 2004 p11). Ethernet's situation can be summed up as follows:

- Simple - yes, but too limited for carrier networking. For example, native Ethernet technology and solutions provide inadequate scalability and service management. Operation, administration and maintenance (OAM) functionality is basic, while fault management and performance monitoring are primitive. As a result, it is straightforward to build small-scale networks, but Ethernet's application to large-scale access or metro networks is fraught with problems.
- Cheap - yes, but there are hidden costs for carrier networking. For example, initial capex of Ethernet solutions may be low on paper but ongoing opex is high in practice. This is due largely to missing OAM functionality requiring excessive manual intervention. Weak network-protection features mean lower service availability, while traffic engineering and hard quality-of-service (QoS) features are absent.
- Ubiquitous - yes, but designed for single LAN applications. For example, Ethernet is optimized for local links, not end-to-end networks over multiple domains. Network management is a weak area, together with security (Ethernet is intrinsically a broadcast technology). Interoperability is not yet established or proven, so multivendor networks remain a challenge.

Carrier Ethernet: getting serious?

It's time for grown-up Ethernet - or Carrier Ethernet - to enter the fray. The big question is whether Carrier Ethernet is really up to the job, or is it simply another marketing makeover and perhaps even just a load of old hokum? Carriers such as BT, Deutsche Telekom and many others are convinced that business customers

expect the same carrier-class features that they are used to from leased lines: fault and performance monitoring, simple and quick error location, network-layer management, remote configuration, flexible topologies, fast protection switching, guaranteed and predictable throughput, low latency and high availability - together with OAM signalling. None of these was part of the original design parameters for Ethernet networks.

The Metro Ethernet Forum (MEF) headlined at CEWC, presenting the minimum set of attributes that should be present to reformulate Ethernet as Carrier Ethernet. All five categories are supported by multiple MEF specifications together with test plans to ensure conformance and enable Carrier Ethernet certification of vendors against the specifications. The categories are:

- Reliability - network protection within 50 ms and "five nines" service availability;
- Hard QoS, guaranteeing an end-to-end service-level agreement;
- Scalability to hundreds of thousands of Ethernet virtual connections;
- Service management with carrier-class OAM; and
- TDM support through circuit emulation services.

In effect, the MEF has successfully created an industry rallying point by establishing the concept of Carrier Ethernet. The signs are that this is being properly supported by principal industry players from both the vendor and the service-provider communities, and that Carrier Ethernet is therefore more than a marketing makeover. As such, it will help to achieve functional and operational consensus across the industry, which is going to be essential if carriers are to adopt Ethernet in a meaningful fashion.

Carrier Ethernet = Ethernet + X

It's worth pointing out that Ethernet can mean three distinct things. It may be an end-user service, such as private line or VPN; a service bearer for higher-layer services/ applications, such as IP-VPNs, voice-over-IP or triple-play; or an underlying transport-network infrastructure. Carrier Ethernet encompasses all three.

So what, in fact, is Carrier Ethernet? The MEF has carefully defined Carrier Ethernet in terms of attributes and functions, not technology. Delegates at CEWC were happy to accept that Carrier Ethernet has tremendous growth prospects for service revenue and equipment revenue - with growth factors ranging from $\times 3$ to $\times 10$ over the next four years, according to different analysts. Such a tremendous variation reflects the uncertainty of market adoption rates and even ambiguity about what Carrier Ethernet actually is.

All at CEWC could agree with Kireeti Kompella of Juniper Networks that "Ethernet + X = Carrier Ethernet", but what is X? Different speakers illustrated that X could be Multiprotocol Label Switching (MPLS), including Virtual Private LAN Service (VPLS); X could be Ethernet extensions, such as Rapid Spanning Tree Protocol (RSTP), QinQ and MACinMAC; X could be IP; X could be Layer 3 with Pseudo-Wire Emulation Edge-to-Edge; or X could even be the subtraction of features such as broadcast, multicast, media-access-control learning or STP. That's a lot of variations, though two general approaches are evident.

One approach takes MPLS from the converged IP/MPLS core out to the edge of the network, most likely with an Ethernet access link to the customer, or a simple aggregation network reaching out to multiple customers, or possibly taking an MPLS system to the customer site. Ethernet is encapsulated into the carrier MPLS network (EoMPLS) and networked accordingly. Concerns

expressed centre on whether this VPLS/MPLS approach can be cost-effective, whether in fact this is overkill and destroys Ethernet's intrinsic value, or whether this is simply ATM's complexity by another name.

The alternative approach takes Ethernet with extensions (either standardized or proprietary) and builds an Ethernet access/aggregation/metro network from the customer premises towards the IP/MPLS core; or even, with the provider-bridging (IEEE 802.1ad) and provider-backbone-bridging (IEEE 802.1ah) standards currently being worked on, avoids the IP/MPLS core completely. Concerns centre on whether this approach can truly support carrier QoS requirements, and on the service and network interoperability that will be required.

Let's not forget that Carrier Ethernet also encompasses any underlying transport network - whether that is dark fibre, WDM, SDH, NG-SDH or Resilient Packet Ring - which may be used to interconnect different Ethernet service, switching or customer nodes.

Which approach will prevail? Ethernet-over-MPLS or "Extended Ethernet"? The most likely scenario is that both will be accepted in the marketplace - there are already many vested interests, and indeed the different approaches will appeal to different carriers. However, it's my view that EoMPLS will ultimately be chosen by many carriers, leveraging their IP/MPLS core investments and meeting their concerns about QoS, manageability and robustness. That means, as many CEWC speakers testified, that EoMPLS/ VPLS will be the carrier-preferred approach for large-scale network deployments.

NGN applications: driving growth

Meanwhile, CEWC highlighted a range of NGN applications driving Ethernet growth, including LAN extension, storage extension, Internet access, IP-VPN access, IP telephony, FTTH, IP DSLAM backhaul/aggregation, IP-TV backhaul/triple-play delivery and mobile backhaul (R6 UMTS). In terms of business-service dynamics, the consensus is that Ethernet private lines will cannibalize TDM leased-line services, while Ethernet-VPN is increasingly seen as a competitor to IP-VPN services. With a 35% compound annual-growth rate and around 10 million homes passed in Europe, FTTH may only be a small driver but Ethernet dominates as the technology of choice, according to the FTTH Council Europe.

As a mobile access and backhaul technology, Ethernet may have a role to play in replacing today's TDM, ATM and SDH technology, but only if it can drive the transport cost-per-bit to lower levels, while simultaneously providing enough technical performance to enable base-station synchronization. This is work in progress.

For triple-play applications, many new requirements drive the adoption of Carrier Ethernet: massive bandwidth scaling to support 20-100 Mbit/s for each subscriber; QoS for multiple services for each subscriber; policy and security scaling; multicast and unicast capability to support any combination of broadcast TV and video-on-demand; high availability of paths, links and nodes; optimized cost structure that scales linearly; and streamlined operations. On top of this, the quality of experience must meet or exceed subscriber expectations for TV/video - basically, a non-stop service of a clear picture.

Despite the growing momentum on applications, it's clear that Ethernet standards are late to the Carrier Ethernet party. As Mario Huterer of Telekom Austria stated, "Despite VERY strong efforts across the standards bodies, which should 'lift Ethernet technology to carrier class', it will take at best two to three years to consolidate the standards, and further time to get the

implementations right." More specifically, Ethernet OAM is still in its infancy. Link-level OAM only exists for Ethernet over fibre and copper (IEEE 802.3ah EFM). End-to-end connectivity fault management is promised by IEEE 802.1ag but is still in development together with ITU-T Y.ethoam. Ethernet-MPLS interworking is supported by a draft ITU-T Y.ethmpls-oam standard. Completion of these is slated for 2006-2007.

Does this mean that Carrier Ethernet deployment is on hold until 2007? Well yes and no, according to many service providers. OAM is essential to large-scale network operations, so much so that deployment cannot be contemplated without it. In the near term, proprietary, stop-gap or non-OAM solutions may be acceptable for small-scale or localized deployments. Longer term, it's clear that mainstream adoption needs multivendor sourcing, following a standardized OAM model.

CEWC also heard how Ethernet QoS and class of service requires further work, since standards for packet loss, latency and frame-delay variation, for example, are immature, while end-to-end QoS is not yet supported by interoperability standards.

Carrier Ethernet: time to accelerate

What's next for Carrier Ethernet? While the technology details must change as standards continue to be pinned down, it's clear that Ethernet is required to support new customer demand and triple-play services. Equally, carriers need the efficient packet networking capability of Ethernet for their NGN infrastructure. MPLS has been adopted as the core packet-convergence technology and it is most likely that this will be a major constituent of Carrier Ethernet systems.

Evidence from CEWC shows that the early-adopter phase has passed and that end-user customers are there for the taking. Once a carrier with marketing muscle and a migration strategy puts on the table a simply defined, fairly priced, good-quality Ethernet service, uptake can be progressive. Fears of revenue cannibalization have receded, and carriers of all sizes have the chance to gain market share.

Mandatory carrier requirements of management, scalability, protection, QoS and interoperability are still being worked on as proprietary approaches are replaced by standardized methods. Nevertheless, Ethernet deployments by still-cautious carriers continue to gather pace and size as the industry cycles through new product releases and new functionality to meet increasingly standardized carrier requirements. Network transformation is an evolutionary process for even small carriers, and the correct focus is on new services rather than the underlying technology *per se*.

The mood at CEWC was optimistic, suggesting a bright future for Carrier Ethernet in all its various implementations. With the backing of industry giants such as Alcatel and Cisco, innovators such as Atrica and Riverstone, dynamic players such as ADVA and Covaro, together with the large number of other sponsors and exhibitors at CEWC, carriers of all types will continue to be spoiled for choice in Carrier Ethernet systems.

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