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A COMPUTER WEEKLY BUYER'S GUIDE TO SD-WAN SERVICES

The emergence of SD-WAN technology allows businesses to rethink their storage strategies. In this 14-page buyer's guide, Computer Weekly looks at how SD-WAN effectively removes telcos' lock-in, the ways hybrid deployment hinges on the network, and the flexibility demanded by cloud-based workloads

BATTLE HOTS UP OVER NEXT-GEN NETWORKS

The arrival of SD-WAN technology effectively removed telcos' lock-in for WAN services. **Bernt Ostergaard** assesses the current market



Il companies need fixed, dedicated and mobile access options for their wide area networks (WAN) and pay subscription and usage fees to a wide range of service providers (mostly telcos). Much of the time, the individual access channels are not in use. This allows telcos to oversubscribe their access circuits, and simultaneously set a higher price for guaranteed quality of service (QoS) offerings, such as multi-protocol label switching (MPLS) services.

Software-defined wide area network (<u>SD-WAN</u>) technology changes this state of affairs by shifting hardware-defined access channels to software, in parallel with developments in <u>virtualisa-tion</u> and cloud services.

All WAN access channels (MPLS, broadband, 4G/LTE, VSAT, and so on) as well as network functions such as firewall, load balancing, security, switching, routing and optimisation, hitherto locked in purpose-specific boxes, are programmed into a bare metal SD-WAN router at the WAN edge.

REMOVES TELCOS' LOCK-IN

The SD-WAN router combines intelligent path control with over-the-top (OTT) connection to internet cloud services. It effectively removes the telcos' lock-in by separating the control and data planes and adding an orchestration plane.

This shifts control back to the user, who can combine all WAN access channels into a single virtual channel that can handle a wide range of communication tasks, from low-bandwidth internet of things (<u>loT</u>) traffic to latency sensitive voice and high-bandwidth data traffic.

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Cloud culture calls for flexible networks Cloud-based workloads demand more flexibility. How can firms rethink WAN strategies? For the user, it delivers network connection flexibility – increasing <u>bandwidth</u>, lowering costs – and simplified central management.

These trends hit a wide range of network suppliers: telcos, network optimisation suppliers, application delivery controllers, load balancers, firewalls and the traditional router markets, notably core switch/routers (Ericsson, Huawei, Cisco,

Brocade, and so on); commercial routers (Cisco, Juniper, HP, and so on); and consumer/small business CPE (customer premise equipment). In addition to traditional hardware suppliers, the SD-WAN sector has catalysed the emergence of a number of cloud-centric, software-only technologies for telco and other network service providers.

SD-WAN SUPPLIERS CATERING TO TELCOS

The market leader in SD-WAN for telcos is <u>VeloCloud</u>, founded in 2012. It bills itself as the only SD-WAN company to support data plane services in the cloud. Telco customers include Deutsche Telekom, AT&T, TelePacific, Sprint, Windstream,

Vonage, MetTel, EarthLink, Telstra, MegaPath, CHT Global, Global Capacity and NetOne. The company claims to have more than 1,000 customers and has just been acquired by VMware.

VMware is looking to expand its portfolio of networking products

Traditional branch networks have not adapted well to new tech, but a mature SD-WAN market can bring distributed networks up to speed. with this acquisition as it appears to be taking direct aim at Cisco, which was an early investor in VeloCloud. Interestingly, Cisco is now building a cloud-based service business on top of its core networking business.

Since 1986, Cisco has been a global tier-1 WAN hardware provider, competing with Ericsson, Nokia and recently also Huawei. Cisco was an early

entrant into the telco SD-WAN market with its intelligent WAN (iWAN) technology. However, although fully featured, it is complex and difficult to manage, often requiring third-party products such as Glue Networks to provide orchestration around iWAN to reduce complexity and make it more agile.

Cisco expanded its SD-WAN presence with its acquisition of <u>Viptela</u>. SD-WAN has momentum and customers love it. Most importantly, Viptela is a pure software play, so Cisco can now offer this to its customer base on top of its existing hardware products.

Nokia acquired Nuage Networks when it merged with Alcatel-Lucent. Its virtualised network services (VNS) complements customers' existing IP and Carrier Ethernet VPN services. Nuage

> Networks VNS was developed to serve enterprises adopting a cloudbased IT consumption model.

> <u>Versa Networks</u> has been deployed by carriers such as Colt and Verizon. It provides a multi-tenant system that can seriously scale, enabling telcos to support large

THE SD-WAN SECTOR HAS CATALYSED THE EMERGENCE OF A NUMBER OF CLOUD-CENTRIC, SOFTWARE-ONLY TECHNOLOGIES

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Cloud culture calls for flexible networks Cloud-based workloads demand more flexibility. How can firms rethink WAN strategies? customers and retail service providers on a single platform that can host any number of internal units or separate customers, and manage it all from a single user interface. Without multi-tenancy, telcos must build a controller and a director infrastructure per customer, which almost turns into a professional services type of sale. Verizon Ventures is a main investor in this company.

Viptela has been deployed by major carriers including Verizon and Singtel to deliver managed SD-WAN services. The Viptela Fabric is purpose-built from the ground up to provide secure, scalable, resilient WAN applications performance. It is built based on the zero-trust model. All the components mutually authenticate each other and all the edge devices are authorised before they are allowed into the network. Using Viptela, telcos can build largescale <u>IPsec</u> network across tens of thousands of branches.

TELCO SD-WAN TRANSFORMATIONS

The first wave of SD-WAN routers from 2012-2015 combined all available WAN access channels, provided optimal path controls and centralised management. It gave customers a much better utilisation of their available bandwidth. They were great for midsize companies with many branches, and remote offices that needed connectivity but lacked local IT management capacity.

But for more complex corporate network issues, such as <u>SIP</u> gateways in MPLS, managing multiple orchestration platforms and compliance with the EU's General Data Protection Regulation (<u>GDPR</u>) security requirements, more effort is needed. So the second-wave SD-WANs have emerged as managed services that are implemented and integrated inside software-defined network

(SDN) orchestration platforms within a carrier's infrastructure. The second wave brought SD-WAN technology back into the telco fold. In the EU, more than 70% of enterprises outsource WAN delivery and management to a network service provider, usually a telco. Telcos have all jumped on the SD-WAN bandwagon, but are at very different stages.

THE DOUBTER: ORANGE

Orange has yet to deploy a full SD-WAN service, arguing that in using a standard OTT implementation of SD-WAN, customers lose a lot of existing services, notably cloud connectivity to more than 20 popular cloud providers.

Orange does not want to make that trade-off and instead offers virtual access to its network-as-a-service (NaaS) platform via an on-site uCPE that integrates the Fortinet firewall as an initial virtual network function. Orange Business Services and Riverbed SteelConnect are working together to create the virtual network functions (VNF) software and integrate it into the existing Orange SDN and network functions virtualisation (NFV) infrastructure, to be managed by the Ciena Blue Planet orchestration.

FIRST-WAVE SD-WAN TELCO: COLT

The <u>Colt</u> SD-WAN provides basic global SD-WAN functionality. The telco uses Versa Networks SD-WAN technology with preconfigured firewall, routing, application performance monitoring and security on an Advantech CPE on customer sites. Multiple regional gateways across the EU, Asia and the US provide coverage and connectivity between MPLS and the internet cloud.

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SECOND-LEVEL SD-WAN TELCO: BT

BT adopted Cisco's iWAN technology for its first venture into SD-WAN in early 2016 offering businesses cheaper secure interconnections to remote sites using MPLS, VPNs, private and public internet and mobile technologies. Later that year, the telco expanded its SD-WAN service by incorporating Nokia Nuage Networks' VNS to help enterprises create self-service VPNs, on-demand bandwidth and additional virtual services.

Next up is "try before you buy" capabilities that can be consumed on a utility basis.

Key user advantages of SD-WAN communications

Cost reduction

SD-WAN routers distribute traffic between multiple WAN connections by following application-based rules. By using multiple affordable internet connections simultaneously, they can achieve link reliability exceeding that of traditional WAN routers at 10-20% of the cost. This leads organisations to expand their networks to additional locations.

Increase in bandwidth

SD-WAN routers can support bonding technology, which combines multiple WAN connections to increase bandwidth. This ensures speedy transfer of data between datacentres and branch offices, such as file transfer, video streaming and data backup. It allows organisations to increase bandwidth in remote, mobile or temporary locations, such as near-shore cruises, mobile clinics and retail pop-up stores, which is difficult using traditional WAN routers.

Network connection flexibility

SD-WAN routers enable WAN connections to be added or removed easily to accommodate changes in bandwidth demand. Also, WAN connections can be added for backup. Branch offices typically add cellular as a back-up to fixed lines to ensure a continuous connection if fixed line connections are disrupted. Retail operations find this useful for adding a layer of protection to their critical point-of-sale and IP phone systems. This application is important for keeping unmanned deployments online, such as digital signage and ATMs.

Simplified central management

Unlike traditional WAN edge devices, which are managed individually, all SD-WAN devices in an organisation can be managed centrally by an SD-WAN controller that enables network administrators to view and manage the network and perform maintenance of hundreds of devices remotely.

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VERIZON

Verizon's VNS is also built on Cisco's iWAN technology. It provides VNFs to simplify customers' ability to migrate to an intelligent hybrid network that integrates broadband or other network services into the corporate WAN. The on-site universal CPE (uCPR) unit handles multiple network services, such as routing,

security and WAN optimisation in plug-and-play fashion. Automated orchestration and service chaining link all the different services, so they appear as a unified service.

THE FUTURIST: AT&T

The <u>AT&T</u> SD-WAN is a VNF that sits on the AT&T FlexWare CPE device and connects into the AT&T Integrated Cloud zones. Customers

can buy a first-generation, premises-based service aimed at companies with uniform needs at their end-user locations. AT&T's second-generation option is aimed at multinational companies with sites that have a wide variety of reliability, performance and bandwidth requirements.

Beyond that comes an application-aware concept called Indigo, which builds on a software-centric core and creates a network that is not only software-centric, but also data-driven. This service concept blends SDN, AT&T's ECOMP orchestration platform, big data analytics, artificial intelligence, machine learning, cyber security and <u>5G</u> elements to create a new data-sharing network.

WILL TELCOS INHERIT THE SD-WAN MARKET?

SD-WAN PROVIDES MUCH

BETTER WAN BANDWIDTH

UTILISATION, MUCH SHORTER LEAD

TIMES, GREATER FLEXIBILITY AND

BETTER AD-HOC WAN ACCESS

It certainly looks like what was originally a WAN routing technology to free customers from constraining telco embraces has now reverted back to the same telcos as network demands increase in both volume and complexity. Merely providing an SD-WAN CPE on-site connecting to a cloud control centre does

> not cut it as security and application requirements become more stringent. SD-WAN, no matter how it is delivered, provides much better WAN bandwidth utilisation, much shorter lead times, greater flexibility and better ad-hoc WAN access.

> For many SME customers with branch office connectivity issues and companies in specific verticals such as transport and retail, acquir-

ing a first wave SD-WAN setup from a specialist SD-WAN router provider makes sense. There are lots of use case examples and references available for SMEs that are planning to go down the SD-WAN route.

Larger companies operating across different national jurisdictions and storing personal identifiable data will need more handholding and more complex integration of SD-WAN into their existing corporate network. Generally, the telco experience with SD-WANs is still relatively new, so also bringing in a trusted system integrator with deep insight into the business-critical applications involved is highly recommended.

HARNESSING HYBRID DEPLOYMENT



usinesses increasingly depend on <u>cloud</u> to help deliver differentiated services to customers. As a consequence, rampant adoption of new infrastructure platforms has changed the composition of the enterprise network, altering provider solutions, consumption models and performance-driven architectures.

Gone are the days when telecom firms were your only choice for network services. Cloud giants, colocation providers and wireless services are among the new choices that will augment (but not replace) the telecoms titans.

Communications services are already moving from fixed pricing and long-term contracts with slow changes to models that flex quickly with equally agile pricing - similar to cloud computing.

THE CONNECTED ENTERPRISE

Connectivity is the central nervous system of the business and cloud adoption has changed the network's composition. Intense cloud adoption continues to transform service design and delivery, and places additional strain on networking infrastructure.

Some 83% of enterprise network and telecoms decision makers at enterprises have already responded to local performance challenges with network hardware and software upgrades as part of private cloud initiatives, but organisations must also address challenges introduced by integrating various external resources.

Compounded with increasing bandwidth requirements, hybrid cloud pursuits have exaggerated the limitations of the network beyond the datacentre. Integrations among an increasingly distributed portfolio of applications, services and data require new

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Distinct products, suppliers and strategies have traditionally served datacentre and branch office network infrastructure. However, organisations can't build cohesive solutions atop disparate networking segments.

To address this, a single virtualised business-wide fabric has emerged to support the new digital business network.

As customers increase their use of cloud platforms and expand to multiple regions, cloud providers will be responsible for a larger portion of their networks. And as cloud providers continue to increase the number of direct connect <u>points of presence</u> (PoPs) and lay proprietary connections between their facilities, customers have more options to leverage cloud network infrastructure and controls in and between these datacentres.

NETWORK DISRUPTERS

Cloud adoption has expanded the heterogeneity of transport technologies in the enterprise network. <u>Software as a service</u> (SaaS) adoption accelerated broadband use at the branch

office, and cloud direct connections have increased to both proprietary datacentres and branch office wide-area networks (WANs).

<u>Software-defined WAN</u> (SD-WAN) solutions have emerged to abstract this complexity, in turn providing a Cloud networks still demand consistency and security. But hybrid and multicloud add another layer of complexity. software-defined overlay to manage multiple connection types as well as automate traffic between links per defined application policies.

While many carriers sell this kind of solution via a white-label model, the intrinsic capabilities of these platforms enable customers to take back control of the WAN, and reduce dependency on <u>multiproto-col label switching</u> (MPLS) and managed solutions.

With growing pressure to design and deliver dependable services that provide compelling digital experiences, businesses have already begun to shift network design and supplier relationships to accommodate these demands.

Many expected cloud service adoption to simplify networking, but it has only accelerated network evolution in positive (but complex) ways.

CLOUD-READY NETWORKING

Cloud has reset expectations of infrastructure flexibility and puts strain on inflexible network components and services. To achieve true cloud benefits, the network must be adaptable to real-time traffic patterns and scale capacity allocations to meet changing demands.

> While traditional connectivity offerings are rigid, many actively follow Forrester's virtual network infrastructure tenets to increase flexibility, simplify management and extend granular controls and <u>application program-</u> <u>ming interfaces</u> (APIs) to customers.

CLOUD SERVICE ADOPTION HAS ACCELERATED NETWORK EVOLUTION IN POSITIVE (BUT COMPLEX) WAYS

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Incumbent telcos aren't the only providers of connectivity services. Increasingly, customers are purchasing connectivity through myriad providers: systems integrators, resellers or other types of suppliers.

Colocation and managed infrastructure services suppliers often bundle their own connectivity capabilities, and some have gone even further to offer aggregated solutions, managing routing across the best connection at any given time. While carriers still sit below many of these services, they're further removed from the customer and more easily swapped out in favour of alternatives.

Despite constant pressure to consolidate and reduce sprawl in the infrastructure environment, multi-cloud adoption continues to distribute infrastructure resources across a wider variety of providers and locations. As resources become more distributed, increasing traffic between a variety of internal and external



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components will strain <u>hub and spoke models</u> (star topologies) designed for legacy traffic patterns.

As a result, hub and spoke WAN design is eroding, giving way to a more richly interconnected mesh-fabric WAN to support hybrid infrastructure environments.

Emerging solutions are going beyond reselling carrier services, with more of them offering abstracted, aggregated or propri-

As the major infrastructure-asa-service (laaS) providers continue to expand, they are investing in both datacentre capacity and network connectivity between their facilities.

etary alternatives for connectivity.

Because they provide globally distributed platforms, intersite connectivity is a key component of their services, so owning and managing the network layer allows for full system engineering and optimisation.

<u>Content delivery networks</u> (CDNs) optimise routes and caches over an aggregated network. Colocation providers bundle carrier services and offer blended IP products.

With cloud services inflating expectations of speed and agility, many telecommunications providers have started to invest heavily in <u>virtual network infrastructure</u> (VNI).

However, due to the scope of requirements to implement VNI and recognising limited internal resources, many providers have put aside legacy feuds and looked to open source communities to collaborate with their peers, including the Open Compute Project, OpenDaylight and <u>OpenStack</u>. These serve as mechanisms to jointly innovate and move the industry further and faster.

In addition, APIs open telcos up to new opportunities for digital integration with enterprise customers and ecosystem partners.

As major IAAS providers expand, they are investing in datacentre capacity and network connectivity between facilities

THE CHANGING ROLE OF NETWORKING

Infrastructure and operations teams will always be responsible for service quality and availability, regardless of who owns and operates the service.

As organisations adopt multiple

cloud services across their software and infrastructure, they're not only strategically replacing in-house capabilities but also increasing the number of providers nested in their service delivery models.

More suppliers translates to increasingly distributed responsibilities, and multiple deployment types indicate multiple hand-off points.

While <u>service-level agreements</u> will state performance requirements, IT professionals must monitor this heterogeneous supply chain to hold suppliers accountable to their requirements.

This article is based on the Forrester report, "Adapt your network strategy to thrive in a shifting ecosystem". Sophia Vargas is an analyst at Forrester.



CLOUD CULTURE CALLS FOR FLEXIBLE NETWORKS

Cloud-based workloads demand more flexibility, so how can businesses rethink their WAN strategies to accommodate this? Rene Millman reports ith more and more workloads being cloud-based, there is a greater need for agility and flexibility from an enterprise's wide area network (WAN). This agility and flexibility can be found in the latest software-defined WANs (<u>SD-WANs</u>), but this means that businesses need to rethink their strategy around these nextgeneration technologies.

As with all major networks in today's enterprise ecosystem, the next generation of WAN will be increasingly software-defined. "We are already seeing the huge impact that software-defined network (<u>SDN</u>) technology has had on WAN, with the inception and now widespread use of SD-WAN services," says Oliver Cantor, associate director of product strategy at Verizon. "This trend is set to accelerate in the future and we expect the process of managing WANs through SD platforms will grow even further."

UNLOCKING THE BENEFITS

Cantor says unlocking the benefits of SD-WAN in the near term due to business and customer demand is clearly important and growing rapidly. "In addition, we will see the purchasing and contracting models for WAN evolve towards a utility-based model focusing on opex [operating expenditure] rather than capex [capital expenditure] and pay-as-you-go monthly licensing."

The reasons behind the need for next-generation networks are manifold. Businesses are looking to cut their IT spend and improve operating costs while delivering services more quickly and maintaining superior-quality services. In an attempt to do that, enterprises are looking for systems that are <u>agile</u> and easy to deploy.

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<u>Cloud-based applications</u> and infrastructure platforms are the right match to meet high-level business objectives. Enterprises are adopting softwareas-a-service (<u>SaaS</u>) such as <u>Microsoft Office 365</u> and <u>Salesforce</u> and that has made the internet an essential component of the enterprise backbone.

Archana Kesavan, senior product marketing manager at ThousandEyes, says that when the internet

becomes the backbone of enterprise communication, organisations need to think proactively about their next-generation WAN having network monitoring tightly integrated within it.

"As these trends continue and <u>IoT</u> [internet of things] deployments continue to proliferate, the need for a more robust nextgeneration WAN that is agile, responsive and cloud-friendly as well as a network monitoring solution for this kind of environment becomes even greater, given the myriad network and application dependencies," says Kesavan.

At the heart of the issue is who will use next-generation WANs and for what purpose, says Tony Lock, director of engagement and distinguished analyst at Freeform Dynamics. "The business

case for developments such as <u>5G</u> are far from clear, especially for the telcos that have to acquire the airwave licences and build the core infrastructure," he says.

So far, says Lock, the technology standards are well developed, although there is still much to do, > Networking analyst John Burke explains managed SD-WAN and discusses why providers are starting to offer the service to their customers. but the question of which customers are going to pay to use it and how much are they willing to pay has never been tackled convincingly.

"There is lots of speculation that the IoT needs 5G, but the fact is it doesn't, or not until things get far more widely deployed than now," he says. "And the forecasts of growth do appear to be at least a little optimistic."

The shift to next-generation WAN is being fuelled by the realisation that access via the public internet is still not reliable enough to give businesses the service quality, performance and reliability they need. Network administrators need flexibility and choice when it comes to the transfer of data.

"The key here is the ability to choose the right infrastructure to meet customer demand," says Conrad Mallon, chief network architect at SSE Enterprise Telecoms. "If low-cost private connectivity is universally available, it is likely to be the preferred choice, but if alternatives such as internet and radio backhaul provide greater reach, faster turn-up or lower cost, they have to be considered."

> Marc Sollars, CTO at systems integrator Teneo, says these increasingly complex WANs demand a strategy that provides end-to-end visibility into the global network, from the user's experience to the cloud, and one that automates many of the processes used to

"THE KEY HERE IS THE ABILITY TO CHOOSE THE RIGHT INFRASTRUCTURE TO MEET CUSTOMER DEMAND" CONRAD MALLON, SSE ENTERPRISE TELECOMS

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manage WAN performance and security with as little burden on the network team – and their budget – as possible.

"Many networking technologies are now available in as-aservice delivery models," says Sollars. "It's just as important to consider how you're going to manage the technology as deciding what networking technology you're going to deploy."

Most global businesses are looking for one or all of three fundamental improvements from running their WANs: faster provisioning of new sites/services; greater reliability and based on simpler and faster device configuration and application-driven perfor-

mance rules; and reducing overall networking costs by smarter routing of traffic, with reduced reliance on often-costly <u>MPLS</u> networks.

SD-WAN technologies help global companies boost their application performance by configuring their network traffic and performance options centrally and rapidly. Analyst IDC predicts an \$8bn SD-WAN market by 2021. "It's just as important to consider how you're going to manage the technology as deciding what networking technology to deploy" Marc Sollars, Teneo

networks and components in place. "It enables network teams to route appropriate traffic over different links and configure new sites' networking needs remotely, avoiding in-situ provisioning."

LITTLE CONTROL AND VISIBILITY

A problem for many IT managers is that they have very little control and visibility over their networks. They tend to receive a monthly report setting out how much <u>bandwidth</u> they have used, and possibly the top apps they have used, but this is retrospective and doesn't give much insight into tuning the network.

"Next-generation WAN enables reporting that tracks and analyses end-to-end application performance in real time, so the network can quickly react to any changes," says Chris Gilmour, technical practice lead at Axians.

As well as solving business issues, next-generation WANs must overcome their own design problems to be of use to the rest

"While companies use different types of connectivity – from MPLS and internet to $\underline{4G}$ – to expand and grow, challenges include poor branch application performance, connectivity issues, security concerns over encryption as users move between devices, and rising network maintenance costs over time," says Sollars.

He adds that based on a mix of software and hardware technologies, SD-WAN creates a control layer from the physical of the business. Dave Chen, product manager at HPE Aruba, says the most important aspect of designing a next-gen WAN is understanding how it will be used, and what other factors are present.

"The WAN must be intelligent enough to understand and adapt to the changing behaviour of users on the network, and the changing dynamics of the access layer, as well as any combination of <u>firewalls</u>, applications and third-party services," he says. "This

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means that IT must take a holistic view of all branch networks and optimise any component that contributes to the flow of traffic."

When they set up <u>next-generation WANs</u>, enterprises need to consider how they will actually use them. Lock says usage has always revolved around services and device configurations. "Working out what services are required and by whom should

always be the first step in any project, never mind something as big as WAN infrastructure," he says. "But this is not always followed efficiently, effectively and thoroughly, without 'blinkers' restricting the view ahead."

ThousandEyes' Kesavan says enterprises need to think about what matters to the business and take a holistic view of ser-

vice delivery and user experience. "Understand service delivery and application performance as it relates to user-experience and not in silos," she says. "Network infrastructure, internet routing and device behaviour can all affect performance and end-user experience, and understanding all these aspects is critical."

NO ONE SIZE FITS ALL

Although there is no one-size-fits-all approach to building a business case for next-generation WAN, the benefits vary significantly according to industry and location. But at its core, it is a new networking mindset. "Over the next 12 to 18 months, enterprises are likely to increasingly look to implement next-generation WAN setups to help power a seamless shift to cloud computing more quickly," says SSE Enterprise Telecoms' Mallon.

In the future, 5G looks set to combine several features to create a next-generation network, says Todd Krautkremer, CMO at Cradlepoint. "It will have all the features of 4G, with its capac-

"THE CHALLENGE FOR NETWORK SUPPLIERS WILL BE TO MANAGE AND BALANCE LATENCY AND BANDWIDTH WHILE TAILORING THE NETWORK ELEMENTS" TODD KRAUTKREMER, CRADLEPOINT ity for massive mobile data; it will offer the voice, video and mobile data features of <u>3G</u>; it will fall back to <u>2G</u> for IoT deployments; and it will include <u>Wi-Fi</u> spectrum," he says. "With virtually zero latency and gigabit throughput, these features will together form the next-generation 5G WAN."

Krautkremer points out that

the potential benefits of 5G technology are huge: less latency with more throughput, connection density, spectrum efficiency, traffic capacity and network efficiency – and all happening within the next couple of years.

"The challenge for network suppliers will be to manage and balance <u>latency</u> and bandwidth while tailoring the network elements, such as network function virtualisation [<u>NFV</u>] for the needs of their customers," he says. "To manage the next-generation network, companies will need to consider the value of hardware combined with SDN technology. Enabling this on the next-generation 5G WAN will be fundamental for <u>secure connectivity</u>."