

Mass-scale Network Transformation



Transform to
Seize Today's
Opportunities



Executive Summary

Transform to Seize Today's Opportunities

As a service provider, you're on the leading edge of digitization and network transformation. But the world is changing fast, and you're up against real challenges. Traditional services have become more commoditized, and providers like you face increasing competitive pressure and changing customer expectations.

What if you could turn those challenges into a serious competitive advantage? To differentiate, you need to transform and evolve to a more open, software-defined, automated network. This mass-scale network transformation sets the stage for three key benefits. It enables you to:



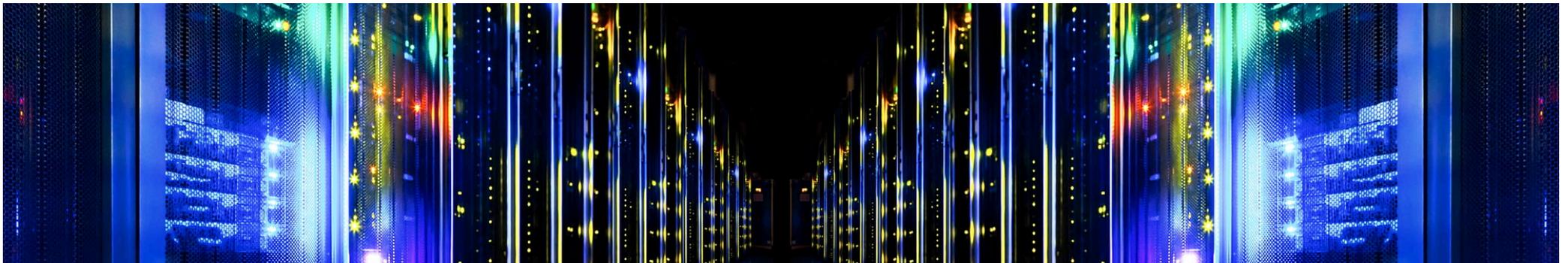
Grow revenue by opening up new markets and offering new services while maintaining customer loyalty



Reduce cost by maintaining a market-leading position through an agile and open infrastructure



Mitigate risk and protect yourselves and customers from security threats



To achieve these goals, you need to consider them holistically, and implement an agile network that can easily scale to enable additional services.

Growing revenues requires end-to-end granular control for different traffic types and associated Service Level Agreements (SLAs). You also need the ability to push applications deeper into the network, extending SLAs into the applications to support a personalized network experience that will command a higher price point.

Segment Routing enables these personalized experiences by scaling many different SLAs out across your network so you can cost-effectively converge multiple services and applications over the same network infrastructure.

Automation and orchestration in a closed-loop operations model provide you with the mass awareness, augmented intelligence, and proactive control that you need in order to reduce your operational costs.

To mitigate risk, you need a safe baseline from which to offer these services, based on highly secure hardware and OS. By measuring and monitoring the secure unique device identifiers (SUDI) in your routing infrastructure systems, you can validate the integrity of your network and ensure it is under your complete control.



A mass-scale network transformation architecture positions you to achieve these benefits. The end-to-end portfolio encompasses:



Access technology used to reach end-users at any customer access point

The **pre-aggregation** domain that aggregates access sites



Aggregation at Edge or Metro Sites, where many infrastructure services and gateways reside

Core sites that interconnect to the Edge sites and provide connection to the outside world via **peering points**



Security, Automation, and Orchestration that spans the architecture



In this eBook, we will present an overview of key components of the architecture and discuss how the unique Cisco technologies and solutions enable you to grow revenue, reduce cost, and mitigate risk within your own organization.

Providers Must Transform





Providers Must Transform

Service providers are some of the largest enterprises in the world and are on the forefront of digitization and network transformation. But the world is changing; influenced by fluid macro-economic and geo-political climates. Regulation and the commoditization of traditional consumer services means that these revenue streams are now beginning to generate minimal growth.

Competition remains fierce, moving beyond local or regional borders to encompass a global scale. Waiting in the wings are yet more competitors, who see the huge opportunities in developing 5G-enabled services designed for a data-hungry public.

With connectivity revenues flattening, service providers are faced with a difficult balancing act. On one side is the need to evolve their network to keep pace with exploding bandwidth and customer expectations, and on the other side are the large capital and operational expenses (CapEx and OpEx) required to operate existing platforms and build new competitive service offerings.

Additionally, security across your vast infrastructure also a top priority. A breach can jeopardize not only your own intellectual property, but compromises customers' data privacy. Service providers need to expand their infrastructure to meet growing capacity demands, but this increases the threat landscape that must be monitored and controlled.

You must meet evolving customer expectations, which requires agility, continuous innovation and frequent technology upgrades. But you may be constrained by rigid operating models and little OpEx left to invest in innovation. It's up to you to transform your organization, including your operating models, technologies, talent acquisition and service creation. The evolution to open, software-defined, automated networks is a central strategy for service providers.

Today's Challenges Set Up Compelling Opportunities



Today's Challenges Set Up Compelling Opportunities

How can you deliver the improved economics and customer engagement that you need to compete? To create the Internet for the Future, you need to focus on three key opportunities:

5G is expected to contribute \$2.2 trillion to the global economy over the next 15 years.¹

5G is coming, bringing with it an opportunity for you to beat competitors, enter new markets, and create new services. Cloud applications are maturing providing an opportunity for you to merge them with your existing operational and infrastructure models.

- 1** **Grow revenue** by opening new markets, such as SMB and Enterprise, and offering new services around 5G and Internet of Things (IoT), while maintaining customer loyalty and increasing Average Revenue Per User (ARPU).
- 2** **Reduce cost** by controlling CapEx investments and connecting them directly to revenues, while maintaining a market leading position through agile and open infrastructure. Use automation to enable new service creation, achieve unmatched operational simplicity and a significant reduction in cost and time-to-market.
- 3** **Mitigate risk** by securing your infrastructure and customers from threats minimizing vulnerabilities. Verify the integrity of your infrastructure and use segmentation and access controls to prevent backdoor access in production and IT networks to help prevent data breaches, network or IoT product hacking.

Cloud business models are also evolving, becoming more standardized and easier to consume. Networking technology is ready for the Internet for the Future with new silicon, optics, software and systems, underpinned by optimization, analytics and automation tools that reduce operational costs.

The size of the overall service provider opportunity is compelling. According to the Cisco Annual Internet Report (AIR), by 2023 service providers will support more than 29.3 billion networked devices and 13.1 billion mobile connected devices.

The global managed services market is expected to grow by 2023 to over \$282 billion. That's a 60 percent growth in comparison to 2018 spanning both SMB and Enterprise markets.

To take advantage of these industry trends, you will need a strong focus on delivering new forms of value for customers. It's essential that you give customers what they want, how and when they want it. The ability to scale offerings rapidly through digitization reduces CapEx and creates multi-sided markets where all parties benefit.



According to research by IDC², the most digitally-advanced service providers show significant business performance gains, including:

- **14%** higher revenue
- **22%** higher profit
- **30%** higher customer retention
- **40%** higher customer satisfaction

An Architecture for Opportunity



An Architecture for Opportunity

Cisco has a comprehensive service provider solution and technology portfolio that can help service providers transition existing networks to be more scalable, agile, and easier to operate. The end-to-end Cisco architecture employs a holistic approach to enabling you to achieve these benefits and position your organization to take advantage of new opportunities.



Grow Revenue

To grow revenues in a competitive marketplace, you'll need differentiated service offerings. A major way to differentiate your network is to build unique network experiences for your clients. To provide this, you first need end-to-end granular control for different traffic types so that you can meet demanding SLAs required by clients. This requires a robust but flexible foundation, from the end user to the application--wherever it may reside. Segment Routing acts as the foundation by providing the ability to slice available bandwidth into performance segments and offer varied Quality of Service (QoS) on those segments. Segment routing automatically routes traffic along different paths aligned to their SLA requirements, in a flexible and simple fashion and can provide automatic rerouting to maintain performance during congestion, maintenance or outage events.

The second step toward growing revenues is pushing applications deeper into the network and extending SLAs into those applications for a superior end user experience. Building application specific performance into your transport network allows clients to use your network in a personalized way which changes their perception of your service offering. If using your network is seen as a simple extension of their private WAN, then your service offering is a partnership and will increase customer loyalty and long-term revenues.

Reduce Cost

Enabling segment routing also provides OpEx cost benefits. It gives you the ability to smoothly converge multiple services and applications over the same network infrastructure ensuring efficient use of network resources and maximum return on investments (ROI). This service convergence is less expensive than building siloed networks for each service type and provides a simplified operational structure helping network engineers take control of the network.

You can also reduce costs with layer convergence, integrating the optical transponder layer functions into routers to minimize the need for additional equipment. This further reduces costs with streamlined operations with less network elements to manage and reduces physical footprints needed to power and house these infrastructure elements.

Another major cost savings initiative would be to increase automation within network operations. By using streaming telemetry from infrastructure elements, orchestration and management tools can proactively alter transport routing paths and other areas to avoid congestion or outages. These proactive steps maintain client experiences and empower network engineers to help them be more efficient in management operations.

Controlling costs with automation and orchestration

Managing complex, multi-vendor networks can be time consuming and resource intensive. To control costs, you need to drive operational efficiency by applying automation at scale. This requires:

- **Mass awareness**, by collecting massive amounts of data in a standardized format
- **Augmented intelligence** that enables you to run analytics and apply machine learning for insights
- **Proactive control** that empowers you to take rapid action with an organized approach

Implementing closed-loop, mass scale automation across your end-to-end network helps you achieve cost-saving operational excellence, while ensuring faster innovation, so you can offer the compelling experiences that customers crave.

Mitigate Risk

To mitigate risk, you need a secure baseline from which to offer your services, otherwise your service offerings are fundamentally vulnerable. Starting with your hardware and software, you should be able to validate that the elements and components operating are genuine to their manufactured state and unmodified. By establishing a hardware-level root of trust and a device identity

that cannot be altered, you have the ability to prove that you have complete control of your network infrastructure. The operating software should give you the ability to automatically “call home” to download an un-tampered software image and validate it against your environment’s hardware. With the right combination of automation and security capabilities within your operations, you can minimize risk and confidently deploy services.

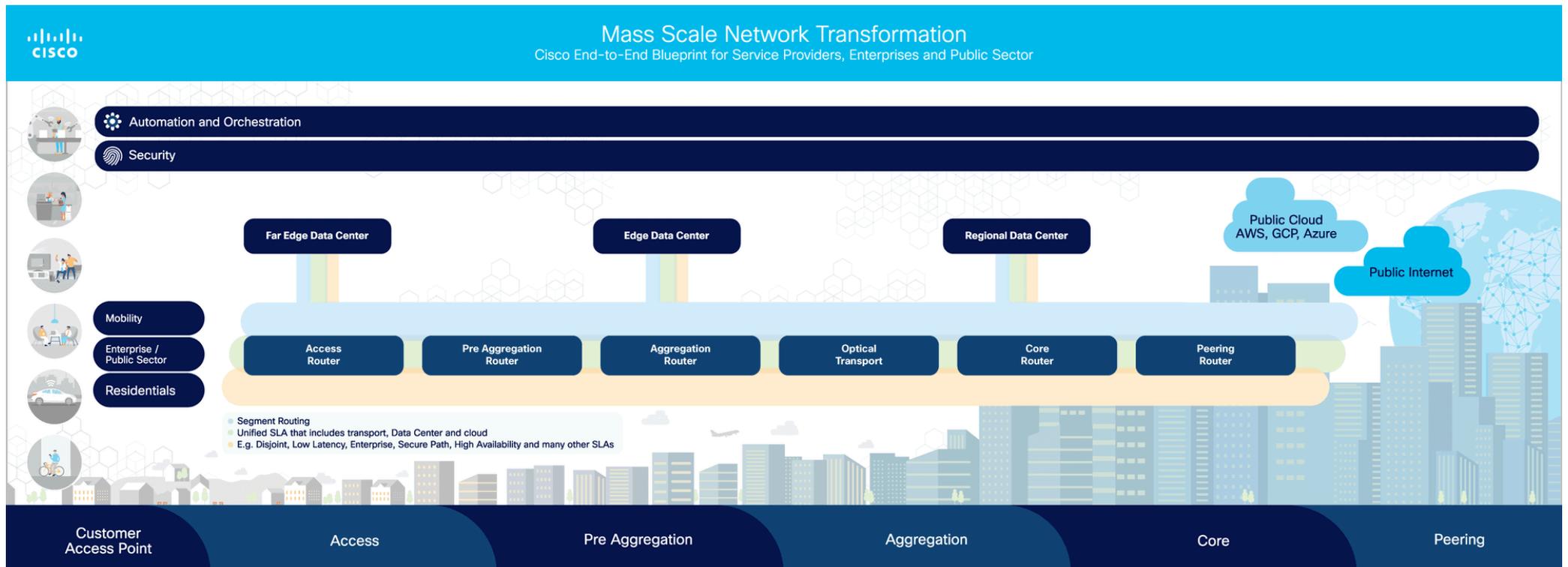


Cisco End-to-end Architecture Essentials



Cisco End-to-end Architecture Essentials

What are some of the key components of the Cisco end-to-end architecture? In this chapter, we will walk you through some of the highlights of our portfolio and discuss how it can help position you to take advantage of today's opportunities.



Customer Access Point and Access

At the edge of the architecture, customer access points represent the end-users you will serve. The access part of the architecture refers to the access technology used to reach end-users.

Your **enterprise** users can take advantage of Cisco's Managed Services offering and SD-WAN solutions with Viptela and/or Meraki, including new 5G Enterprise Services.

40 percent of global IT leaders currently deploy SD-WAN; nearly 55 percent more expect to deploy within 24 months.³

If you are providing **household** consumer services, Cisco solutions enable you to move the physical layer (PHY) circuit out of a device such as a Cable Modem Termination System (CMTS)/Converged Cable Access Platform (CCAP), putting the PHY circuit at the edge of a network. This architecture requires a Converged Interconnect Network (CIN) network, utilizing the Cisco WAN offering.

Radio heads support mobility use cases such as Wi-Fi. These components can help you evolve to 5G services, through support for RAN disaggregation (separation of hardware and software) and decomposition (breaking the RAN into separate components). For Virtual RAN (vRAN) or Open RAN (oRAN) deployments, you can flexibly position components such as the Remote Unit (RU), Distributed Unit (DU) and Central Unit (CU) in different locations in the network. Cisco solutions interoperate smoothly with a variety of RAN components, to provide you full flexibility to deploy the solutions that meet your specific requirements, and avoid vendor lock-in.

You can support centralization and virtualization of the DU using a cloud infrastructure platform based on Cisco Virtualized Infrastructure Manager with real-time kernel capabilities and support for a hardware accelerator, such as Intel N3000 field programmable gate array (FPGA).



As we move into the access layer of our end-to-end architecture, segment routing is a key enabler for enterprise services, and a powerful capability to grow revenues. Segment routing at the access layer lets you take advantage of end-to-end automation and control of stricter SLAs that you can monetize more easily. You can provide support for **low latency** traffic as well as true **disjoint path services** that are especially valuable for enterprises.

Cisco can help you build a best of both worlds **SD-WAN** and segment routing service offering, providing your customers the ability to build their own services and tie it to a guaranteed path through your underlying network. This type of use case could be an excellent offering for a public sector customer where individual departments or public service could operate independently on the network. For example, different departments, such as police, healthcare, or city services, could create their own overlay services on top of the underlying network, and apply their own specific SLA and service requirements for their traffic. Service providers could offer this as a self-service product to clients, or as a managed service offering with both designs providing new revenue streams.

By 2022, service providers will support more than 8 billion personal mobile devices and 4 billion IoT connections.⁴

Supporting and simplifying new services with Telco cloud

The Telco cloud is the hardware and software infrastructure supporting flexible and efficient deployment of the applications that service providers use to manage and deliver their services.

This unified operational environment helps you achieve the benefits of the Cisco service provider infrastructure. It enables each new service and application to leverage the platform investment and take advantage of simplified operational processes.

Traditional approaches to software, infrastructure, application management, and cloud operating models have been fragmented and limit your business growth. They create inefficiencies, contribute to operational complexity, and hamper your ability to use technology resources efficiently. This inefficiency limits how well you can innovate, bring services to market quickly and compete effectively.

Telco cloud lets you differentiate your services in terms of service availability and latency, by putting them in closer proximity to the customer. This unified platform also helps you design and deploy new services and features much more rapidly. Telco cloud enables you to create economies of scale with each additional service through a common operational environment and infrastructure.

Pre-Aggregation

The pre-aggregation section of the end-to-end architecture aggregates access sites. It utilizes routing solutions such as the Cisco NCS family of routers, including the NCS540 and NCS 5500 series.

The Cisco NCS 55A2 Series Router provides IP over Dense Wavelength-Division Multiplexing (IPoDWDM) capability through the Modular Port Adapter (MPA). It collapses network layers by tightly integrating DWDM interfaces with the routing platform. This helps you increase operational efficiency by simplifying management and accelerating service delivery. This IPoDWDM solution not only reduces transport elements, but also supports advanced features to help you dramatically reduce operating expenses and capital cost.

The Cisco Telco cloud environment supports telco apps related to end user services. It is made up of compute, switching and networking hardware, and a virtualization stack with full orchestration and automation. Cisco Nexus switches support these services, as well as the Remote Leaf (RL) feature that is part of the Cisco Application Centric Infrastructure (ACI) offering.

The RL feature lets you extend the ACI policy model from outside the main data center to remote sites over an IP backbone. It allows service providers to apply the policy controls needed for specific service offerings by extending the ACI fabric to a small data center without investing in a full-blown ACI fabric.

Aggregation

The next area of our end-to-end architecture is Aggregation. Aggregation at **Edge or Metro Sites** is where many infrastructure services and gateways reside, such as Business Provider Edge (PE), Broadband Network Gateway (BNG), and mobility gateways. **Cisco ASR9000 Routers** and NCS5500 Series families let you power these components.

Cisco's Telco cloud has also been optimized for lean, cost-efficient edge distribution to help you reduce costs. In Telco cloud deployments at the **Edge Data Center**, the scalable Cisco Nexus platforms support 100/400G

interfaces. You can take advantage of dynamic interworking between segment routing environments in the WAN and ACI in the data center. This enables seamless, automated mapping of virtual machines (VM) and container traffic to WAN network slices with strong SLAs.

Cisco Network Functions Virtualization Infrastructure (NFVI) pods support the more centralized **Telco cloud** applications. These pods are available in multiple versions at a variety of scales to support locations that require more scale or additional data center services such as storage. For these environments, Cisco offers many flexible options including hyperconverged storage or remote storage.





Core and Peering

The core sites in the architecture generally interconnect to the Edge sites and provide connection to the outside world via peering points. These sites often have high bandwidth and resiliency requirements. Cisco routing and optical products, including high capacity Cisco ASR 9000 Series Routers or the NCS 5500 series, can provide the performance and dependable operation you need in these core or peering site locations.

Cisco Optical platforms, such as the NCS1001, NCS1004, and NCS2000 offer data center interconnect and dense wavelength-division multiplexing (DWDM) solutions.

At peering points, you can deploy the Cisco 8000 Series Router, the industry's most scalable 400G-optimized routing system capable of supporting from 10 Tbps up to 260 Tbps. It delivers unprecedented petabit scale, an embedded

trust anchor module, and cloud-enhanced software technology. The system comes in both fixed and modular platforms, and is purpose built to be applicable to any network including mobile, cable or wireline. It offers flexible consumption models for port licensing allowing service providers to invest in leading technology without overpaying. The flexible consumption model allows you to pay as you grow, scaling up port capacity to support additional traffic when 5G and other innovations arrive.

By 2023, 70 percent of the global population will use mobile technology, up from 65 percent in 2018.⁵

For Telco cloud deployments, the infrastructure's core sites often utilize both regional and central data centers. Cisco scalable Nexus platforms support 100G and 400G interfaces. ACI features such as Multi-Site Orchestration (MSO) are key to enabling **automation** and **policy consistency** at scale across multiple sites.

If you require **multi-cloud support** at core locations, Cisco Cloud ACI lets you extend the ACI fabric into public cloud providers like Amazon, Google or Microsoft. This enables you to offer enterprise Multi-access Edge Computing (MEC) application hosting on your private cloud infrastructure, while allowing simple and non-intrusive interworking with existing backend components deployed in public cloud.

You can also tap into the extensive Cisco multi-cloud portfolio to provide complete application lifecycle support. Cisco provides the ability to interconnect any workload from wherever it is deployed by utilizing segment routing and Cisco ACI.

Enabling all wireline, wireless, and business services to traverse a segment routing (SR) or SRv6-enabled network is one of the underlying principles of the **Cisco WAN strategy**. Segment routing is one of the key enablers of network slicing in the transport network. It allows for different transport characteristics such as low latency, to be assigned to different transport slices via features such as Flex-Algorithm.



Security

To protect your environment and mitigate risk, Cisco has a full suite of security service offerings and all routing platforms have built-in security features, extending protections up through the layers. Cisco security solutions are unique in the industry because they share security contexts and threat information between themselves and third parties. This allows faster detection and mitigation; even for threats in the encrypted layer - without the need for decryption. They harness the power of TALOS' intelligence, the industry's leading threat intelligence feed, which flows to each one of the Cisco security products.

Automation, Orchestration and Assurance

The Cisco Automation, Orchestration and Assurance layer spans the entire architecture and is critical for enabling **cross-domain services**. It includes the Cisco Network Services Orchestrator (NSO), a software package for automating service orchestration across Cisco and third-party hardware in both traditional and virtualized networks. NSO lets you add, change, and delete services in real time without disrupting overall service operations using standards-based Netconf and Yang interfaces.

To help you control costs and manage your environment more efficiently, the Cisco Elastic Services Controller (ESC) gives you sophisticated tools to **manage your services and component Virtualized Network Functions (VNFs)** across their entire lifecycle.

It provides support for onboarding and deploying new VNFs, monitoring performance health, scaling up and down instances in response to demand, and helping to automatically remediate issues.

Another powerful management tool, Cisco Evolved Programmable Network Manager (EPNM), is designed for element and network management systems. It offers simplified lifecycle management for carrier-grade networks of all sizes. It lets you improve agility and operational efficiencies through automated device operations, fast provisioning, and proactive assurance.

For strategic insight and visibility, Cisco Crosswork software helps you plan, design, implement, operate, and optimize your network. It delivers insights and awareness, augmented intelligence, and proactive control for a comprehensive data-driven, intent-based networks.

Differentiate
Your Offerings
with Cisco



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Cisco is pivoting its entire orientation to focus on cloud, software, subscription, services and selling solutions; transforming the way we go to market in parallel with our service provider customers and partners.

Converged SDN Transport demonstrated significant savings of 62 percent, CapEx savings of 60 percent, and OpEx savings of 66 percent over traditional networks.⁶

Grow Revenue

Managed B2B services

Delivered quickly and easily via the Cisco open service creation platform, Managed Services let you develop differentiated services to bring increased customer value. They enable you to increase SD-WAN (Viptela and Meraki) and other managed service revenues while controlling service operational costs. They also position you to scale up with additional services such as SD-Branch, SD-Access, Managed Device, Secure Network, and more. The benefits for service providers are lower costs to build and operate, improved customer experiences, and increased service velocity and agility.

5G Enterprise services

Cisco aspires to make 5G enterprise services a reality. The solutions are designed to deliver 5G enterprise applications specific to industry pillars and company size, allowing you to monetize new opportunities.

Strict, Agile End to End SLAs

Cisco can deliver segment routing across the architecture up to the application level; distributing this Software Defined Network (SDN) enabling technology into cell sites and business access points. Applications can now have strict, enforceable SLAs allowing them to run seamlessly across any type of access technology.



Reduce Cost

Cisco converged transport

The Cisco 8000 Series router is the industry's only platform optimized for 400G and beyond. It delivers unprecedented petabit scale, embedded trust, and cloud-enhanced software technology. Modular, purpose-built, and applicable to any network - mobile, cable and wireline - it helps you significantly reduce the costs of building and operating mass-scale networks, making them more secure and preparing them for 5G.

IOS XR

The latest release of IOS XR, IOS XR7, is a simpler operating system (OS) architecture which provides significant savings in resources. It simplifies operations by verifying upgrade cycles in a cloud enhanced environment. It

provides advanced modularity and open API along with standard development environments, to integrate into new or existing operational workflows. Built on a trustworthy foundation, this architecture can prevent unauthorized code from running in, or across, the network.

Cisco Silicon One

Cisco Silicon One is a new programmable silicon architecture poised to power the Internet for the Future. The initial device in the family is the Q100 - the first routing silicon to break the 10Tbps barrier. This performance is double the bandwidth and triple the packets-per-second rate over other routing silicon solutions. The Silicon One family is a single, unified silicon architecture with comprehensive routing features and switching efficiency to power multiple platforms - fixed or modular - and addresses multiple segments.

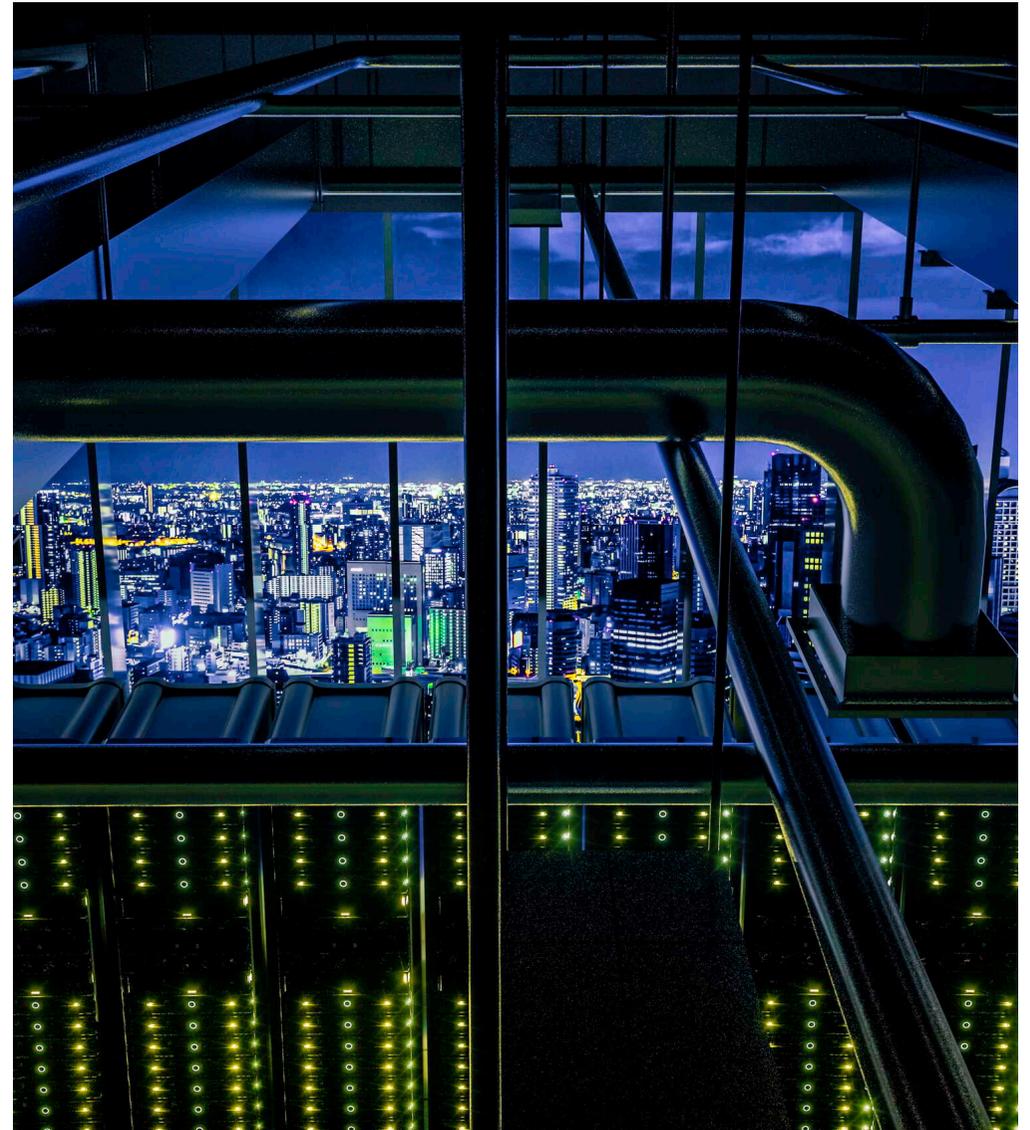
Cisco Optics

Optics has become an increasing component of the total overall cost in service provider networks. Cisco has focused on reducing cost and accelerating adoption of standardized 400G optics across:

- **Technology**, using a foundation for single wavelength 100G optics to reduce the cost and complexity for 400G
- **Manufacturing**, utilizing our semiconductor industry processes to manufacture optics at high volume and quality
- **Innovation** in silicon photonics, which integrates photonics into the chip layer, further improving the yield and the cost structure
- **Rigorous qualification** processes for optics, ensuring reliability in Cisco systems, and across multi-vendor systems

Service and Layer Convergence

Cisco's Segment Routing is stateless, enabling many different SLA across networks in an automated fashion to support smooth convergence of multiple services over the same infrastructure. Through an optimal absorption of the optical transport layer into routers through a ground-breaking new integrated pluggable, the convergence of network layers will be incredibly compelling with a drastically lower network-wide Total Cost of Ownership (TCO).



Automation and operations

Cisco is working to help reduce your operational costs and extend the useful life of previous CapEx investments through automation. Combining hardware and software with synchronized programmability and automation tools means provisioning, day one operations, data configurations, and back-up and restore operations no longer take hours or days to complete. Automation simplifies the daily tasks for network engineers making them more productive and allowing them to focus on more critical work.

The IOS XR software in Cisco devices enables connectivity to any automation solution with Northbound APIs, while Southbound APIs connect the automation and orchestration tools to any device operating IOS XR.

Open vRAN

Previous RAN approaches have been limited by single vendor lock-in, operational complexity, and a lack of architectural flexibility. This has resulted in the interest in developing Open vRAN. Cisco along with key partners is leading development efforts to make the RAN open, programmable, and more profitable.

Mitigate Risk

Security

Cisco products are inherently built with security protections in mind. The routing and security products that Cisco offers are designed to share security contexts and threat information with third parties to allow faster detection and mitigation.

Our security solutions harness the power of TALOS' intelligence; the industry's leading threat intelligence feed, which flows to each one of our products.

Trust

For service providers, building customer trust is essential to value. Loss of trust ends customer relationships forever, while strong trust creates loyalty and raises ARPU. A trustworthy foundation embeds security throughout the network directly into routers and other network devices. Trustworthiness starts with network devices that have a secure unique device identifiers (SUDI) for authentication. This information is used to create a root of trust anchored in hardware. This establishes a chain of trust that can be used to allow only genuine, unmodified software to boot on a Cisco platform. Cisco provides the opportunity for you to measure the authenticity of the Cisco hardware and software operating in your network so you can start with a verifiable infrastructure that you can trust to operate critical services.



Conclusion



Conclusion

In a world of evolving challenges, Cisco enables the mass scale network transformation required to help you improve performance and uptime, deliver an optimized and automated application experience, and provide a personalized approach that builds customer trust and loyalty. Cisco solutions allow you to empower your customers' and teams' experiences through smarter, simpler, more secure enterprise IT network and collaboration tools.

Together, we will achieve success by building agile, cost-effective networks and solutions that support your services. At Cisco, we strive to be the trusted partner that offers insight and expertise and can help you to realize your network vision by delivering engagement projects at scale and speed while lowering your operational risk.



Reference



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Thank you for reading the

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