Building a Routed Optical Network for Practical Deployment and Customer Migration

Randy Zhang, Principal Architect of Cisco Customer Experience
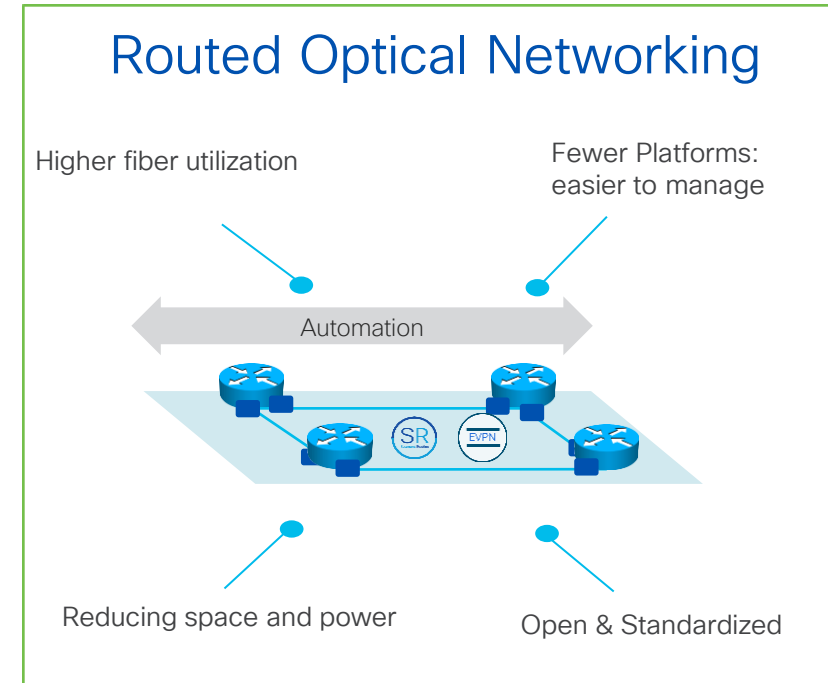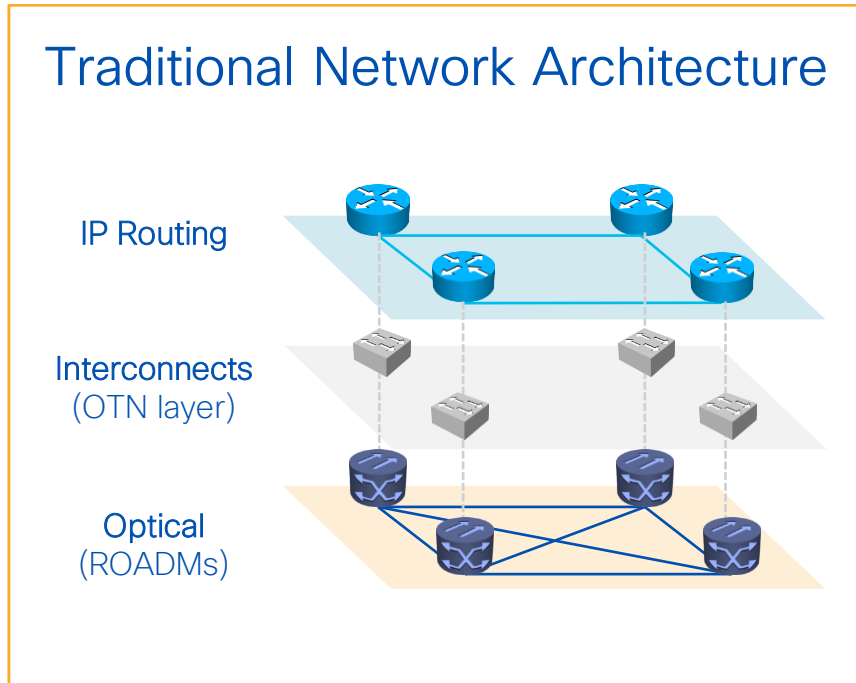
Apr 2023

Agenda

Introduction to the Routed Optical Networking

Economic Value Drives Architectural Change

Traditional Network Architecture

IP Routing

Interconnects
(OTN layer)

Optical
(ROADMs)

Routed Optical Networking

Higher fiber utilization

Fewer Platforms:
easier to manage

Automation

SR

EVPN

Reducing space and power

Open & Standardized
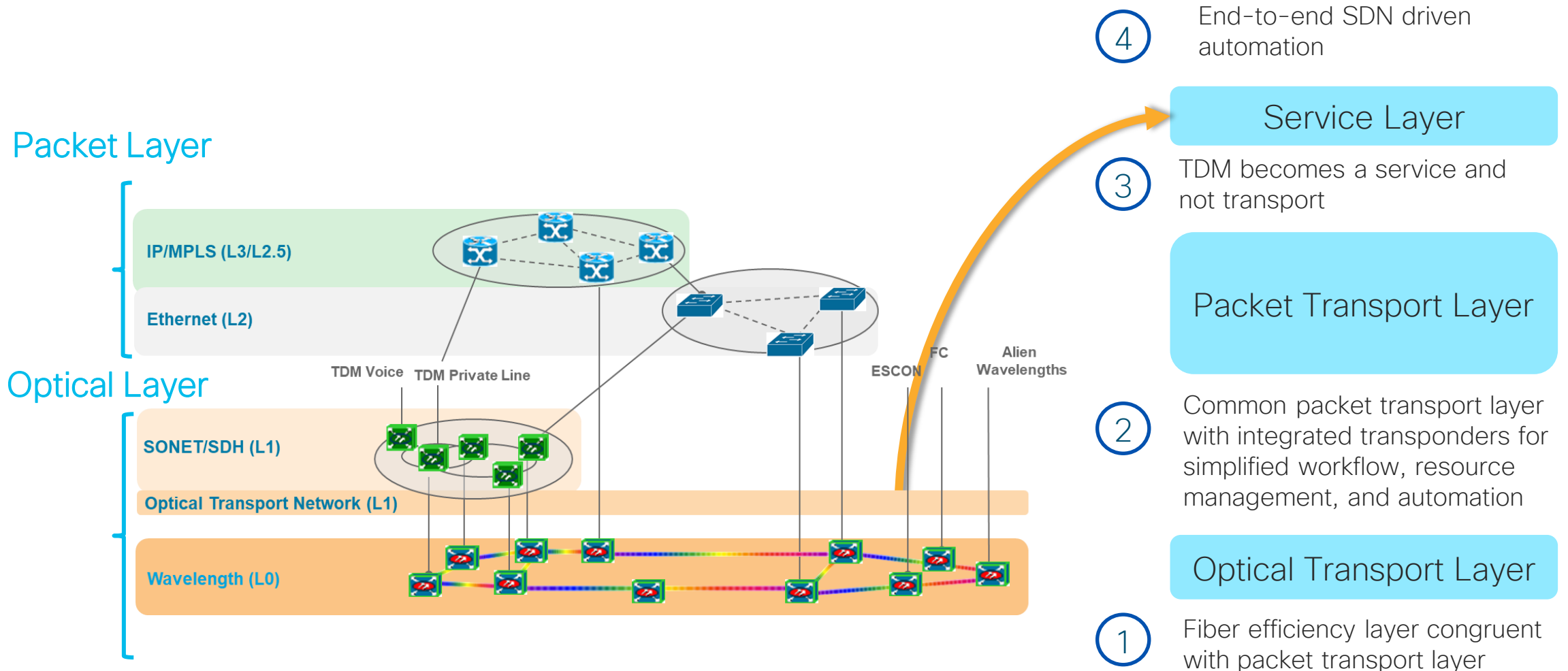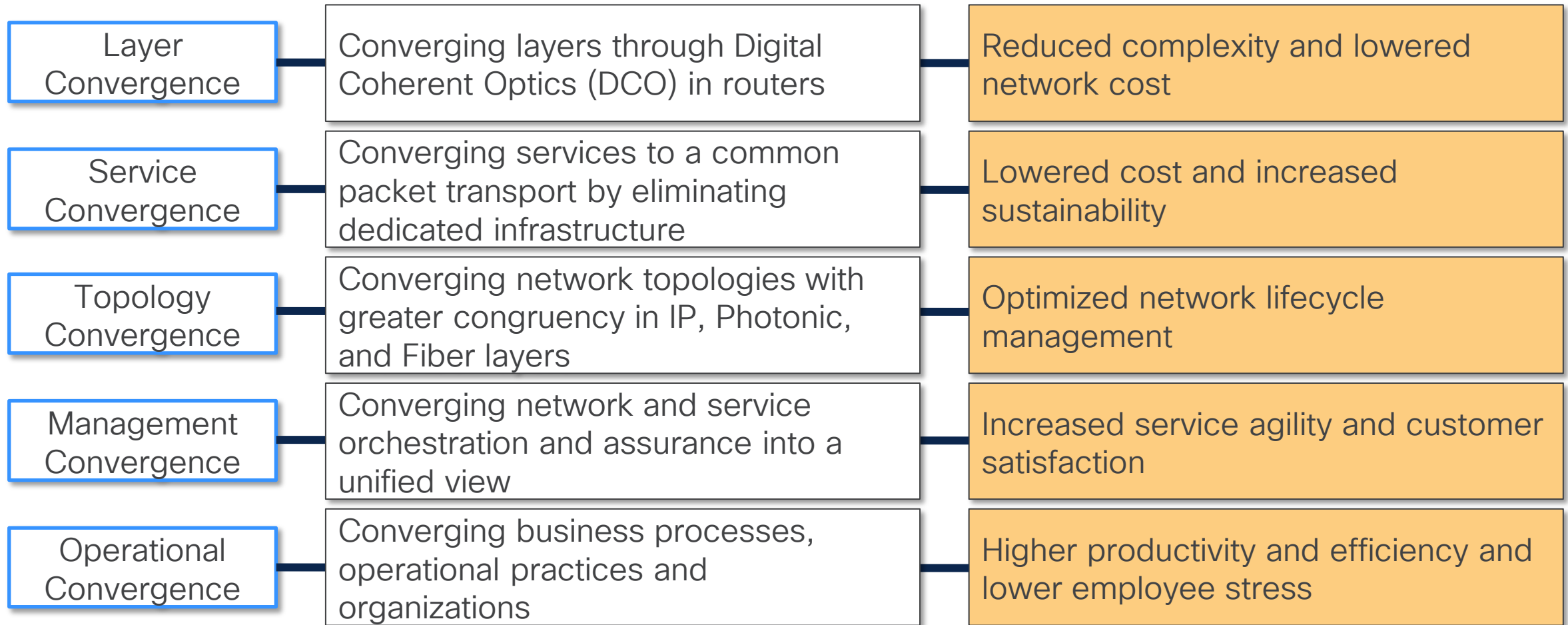
- Complexity
- Silos and inefficiency
- Limited service agility

- Simplified architecture and operations
- Convergence and efficiency
- Automation and faster time to value
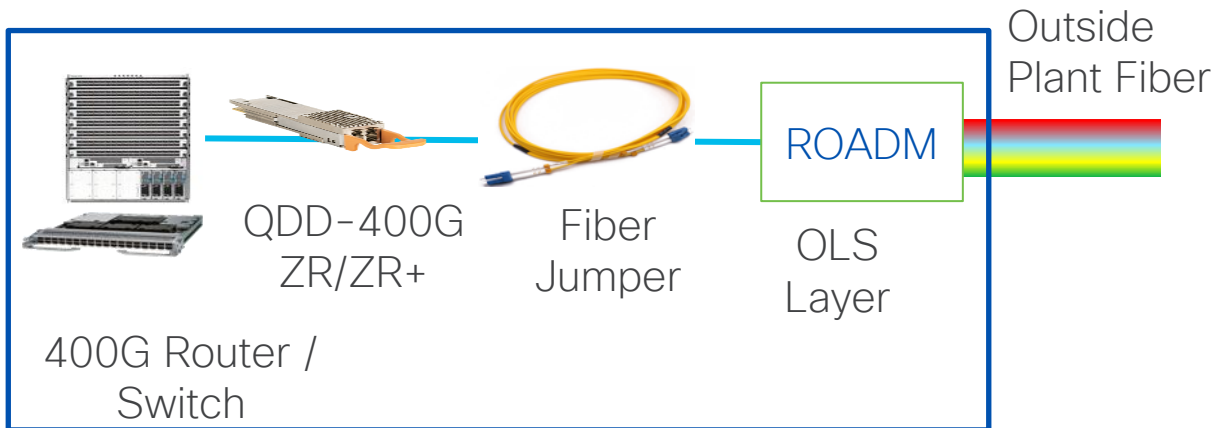
Convergence of IP and Optical Technologies

Packet Layer

IP/MPLS (L3/L2.5)

Ethernet (L2)

Optical Layer

SONET/SDH (L1)

Optical Transport Network (L1)

Wavelength (L0)

TDM Voice TDM Private Line

ESCON FC Alien Wavelengths

④ End-to-end SDN driven automation

Service Layer

③ TDM becomes a service and not transport

Packet Transport Layer

② Common packet transport layer with integrated transponders for simplified workflow, resource management, and automation

Optical Transport Layer

① Fiber efficiency layer congruent with packet transport layer

Convergence through Routed Optical Networking

Layer Convergence	Converging layers through Digital Coherent Optics (DCO) in routers	Reduced complexity and lowered network cost
Service Convergence	Converging services to a common packet transport by eliminating dedicated infrastructure	Lowered cost and increased sustainability
Topology Convergence	Converging network topologies with greater congruency in IP, Photonic, and Fiber layers	Optimized network lifecycle management
Management Convergence	Converging network and service orchestration and assurance into a unified view	Increased service agility and customer satisfaction
Operational Convergence	Converging business processes, operational practices and organizations	Higher productivity and efficiency and lower employee stress

Not necessarily all 5 types of convergence are required in a given project to realize the benefits

Simplification through Reduction

Router / Switch — Grey Optic 4x100G — 4x Fiber Jumpers — Grey Optic 4x100G — Transponder/ Muxponder — Transponder Chassis — Fiber Jumper — ROADM / OLS Layer — Outside Plant Fiber

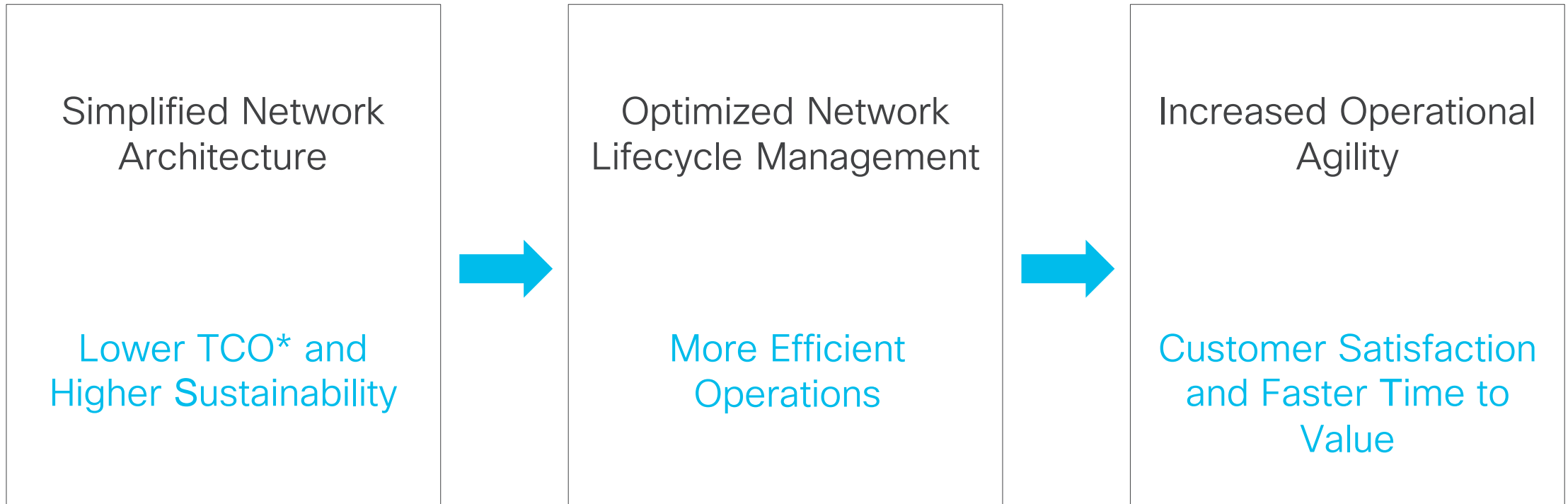400G Router / Switch — QDD-400G ZR/ZR+ — Fiber Jumper — ROADM / OLS Layer — Outside Plant Fiber
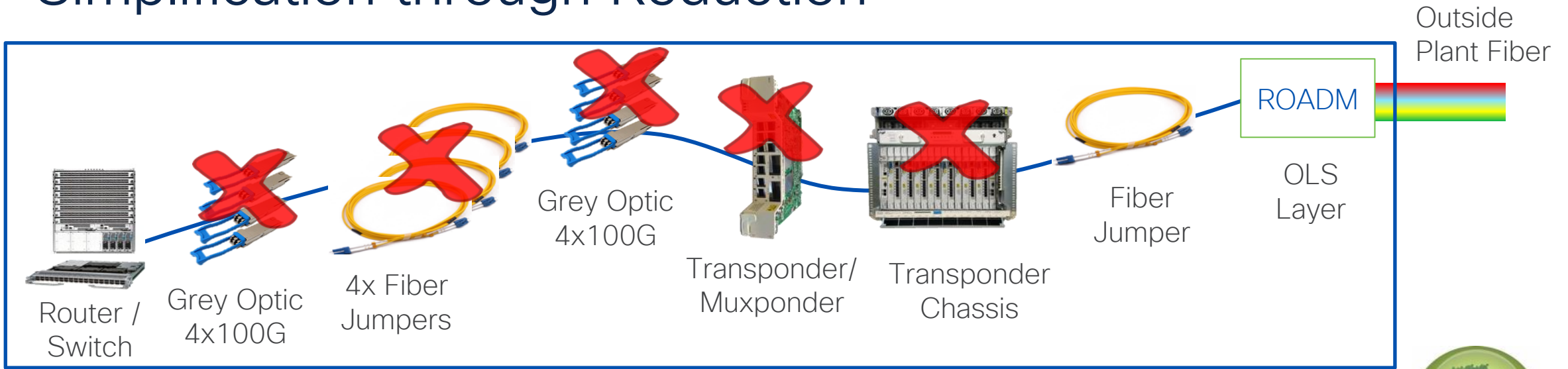
Business Outcome

- Over 66% in Cost Optimization
- Up to 90% in Power Savings
- 100% TXP Shelf Reduction

Business Benefits of Routed Optical Networking

Simplified Network Architecture

Lower TCO* and Higher Sustainability

Optimized Network Lifecycle Management

More Efficient Operations

Increased Operational Agility

Customer Satisfaction and Faster Time to Value

Cisco Routed Optical Networking Solution

>250Tbps **+** 400GE ZR/ZR+ **+** Private Line Emulation **+** Automation, Modern Software & Control Plane **=** New Network Paradigm

Routed Optical Network

Building Routed Optical Networks

Summary

Situation

Routed Optical Networking brings disruptive network convergence with real business benefits and presents a great opportunity for customers and Cisco to lead an architectural simplification with an enduring impact

Complication
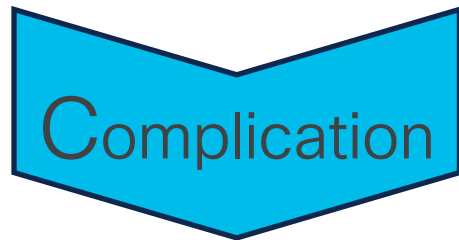
There are a number of adoption obstacles to overcome, myths and concerns, inertia of the status quo, interoperability, solution maturity, cost of deployment and migration, operational readiness

Resolution

One approach is to construct a use case based adoption journey that aligns products and services, gradually with controlled risk, leading down a path with sustainable business outcome and continual improvement

Convergence Adoption Barriers

Entry Points
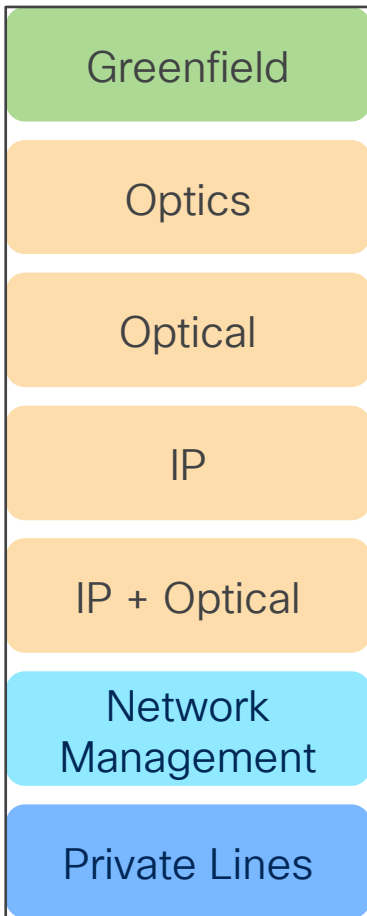
- Greenfield
- Optics
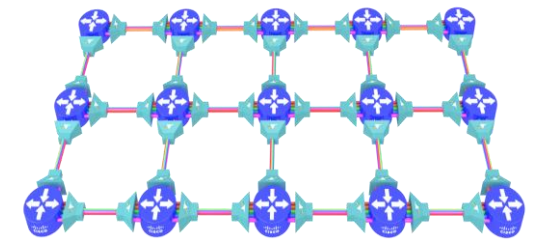- Optical
- IP
- IP + Optical
- Network Management
- Private Lines

- Architectural transformation and technology mix
- Multivendor interop and integration
- New operating models and business processes
- Status quo, myths, and nay-sayers
- Skillset gap and organizational boundaries

Goal
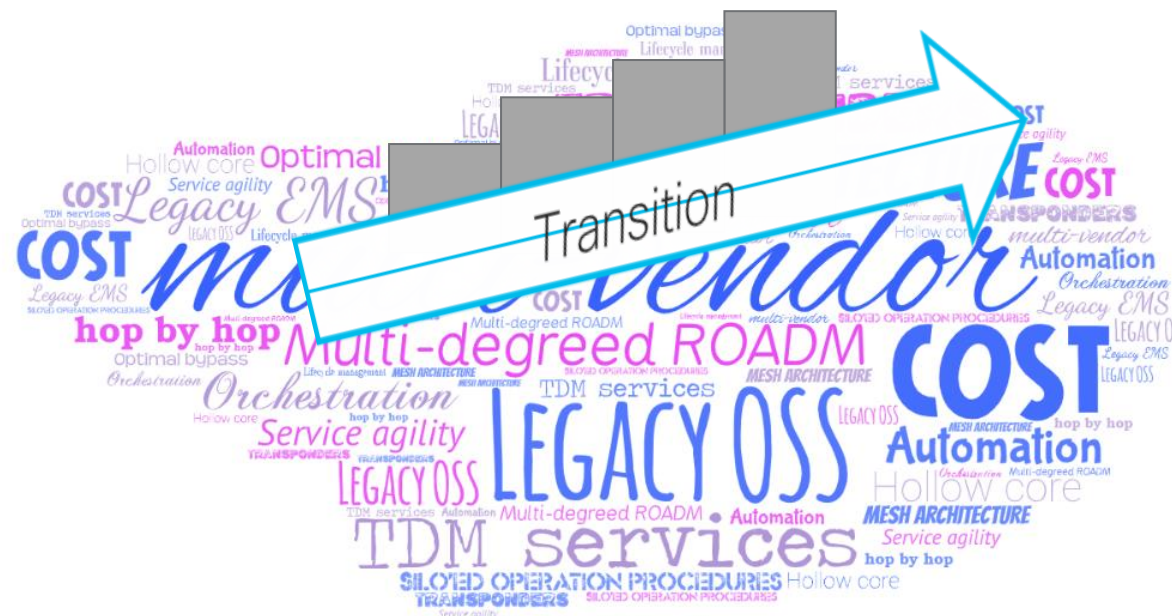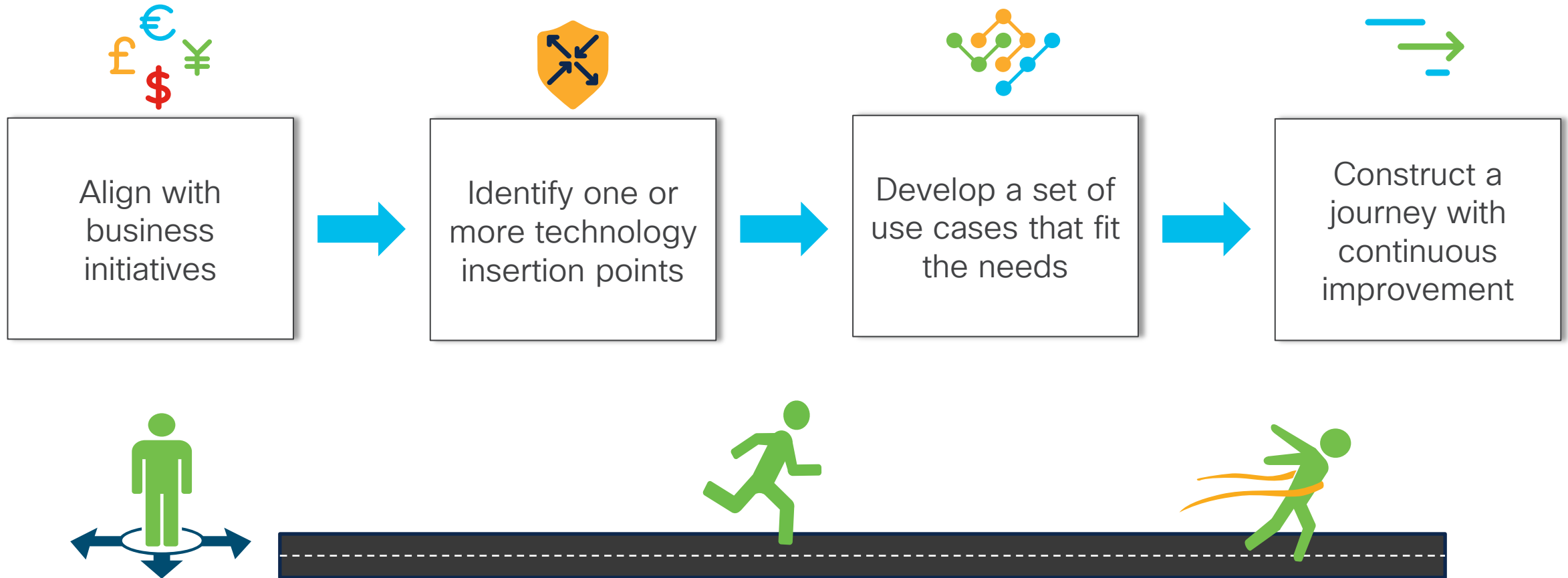
Routed Optical Network Architecture

Automation

- Single layer network – single view into network, single control plane
- Optical operations team manage point-to-point networks
- Simplified model with converged operations

Building a Routed Optical Networking Journey

Align with business initiatives	→	Identify one or more technology insertion points	→	Develop a set of use cases that fit the needs	→	Construct a journey with continuous improvement

Common Business Drivers

Bandwidth and capacity expansion

Bandwidth upgrade in routers and optical transport, introducing or upgrading to 400G/800G, expanding fiber capacity
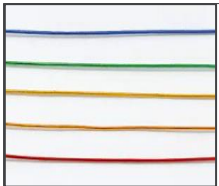
Network cost reduction

Consolidate and migrate legacy services to IP based transport, migration of enterprise wavelengths to dark fibers

Network transformation
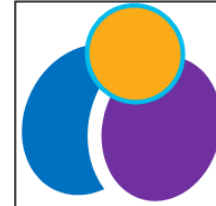
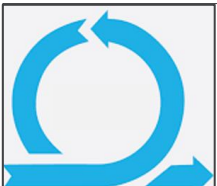Metro, xhaul, long-haul network transformation for new services and architectures, service outage reduction

Architecture simplification

Simplify the current network architecture, network elements, operating procedure, and lifecycle management

Agile service delivery

Accelerate the speed of service delivery and response to changing market needs, increase service reliability

Sustainability and circular economy

Reduce power and space consumption, upgrade devices for more efficient energy use

Introduce Routed Optical Networking through Insertion Points

Insertion Point	Key Benefits	CX Service Examples
Simplification through DCO	Quick return on investment in select applications	Readiness assessment, deployment, transponder to DCO migration
Private line cost reduction	A genuine business need to cut cost and increase sustainability	TDM data analysis and assessment, circuit migration, managed service
Network automation and control	Align with the SDN need to streamline workflows and increase service agility	Design, deployment, customization, integration, optimization
Capacity expansion with routers	Expand capacity, align with 5G/private 5G, and create an anchoring platform to build on for convergence	Design, deployment, integration, optimization, migration
Network efficiency at IP	Shift the focus from capacity discussion to network efficiency	Architectural modeling and planning, network design and advisory
Security and trust	Attach and expand	Security assessment and validation, integration, design
Broadband and digitization	Large government funding	Design, deployment, optimization, managed service

Insertion Point Example Detail

Tail Wind

Network simplification through digital coherent optics (DCO)

Architecture simplification, sustainability, cost reduction, capacity upgrade

- Clear business benefits demonstrated for point-to-point applications
- OIF industry standard, wealth of interoperability studies, PoCs, and deployments
- No density penalty on routers: no need for specialized line card
- High-powered DCO fits nicely with the ROADM-based DWDM transport
- QDD OLS pluggable simplifies point-to-point deployment

Insertion Point Example Detail

Network simplification through digital coherent optics (DCO)

Head Wind

- Uncertainty on brownfield deployment multivendor interop with ROADM applications
- Management: optics ownership and how to manage DCOs in the converged architecture, OSS and tooling update
- Workforce skill readiness
- Status quo resistance (technology and job impact concerns)
- Some networks with fixed 50 GHz DWDM grid (need 200G legacy mode support on DCO)
- Alien wavelength tax from transport vendors

Insertion Point Example Detail

Network simplification through digital coherent optics (DCO)

Insertion Considerations

- Interop publications and validation through PoC for specific interoperability needs of the customer
- Defining operational demarcation and procedures for DCO that is consistent with organizational requirements
- Network management and automation strategies aligned with the long term SDN plan
- Skillset update and cross training for IP and optical teams, re-aligning workforce resources
- Differentiating DCO applications in DCI and SP environments
- Addressing alien wave tax with the transport vendors

Deployment through Use Cases
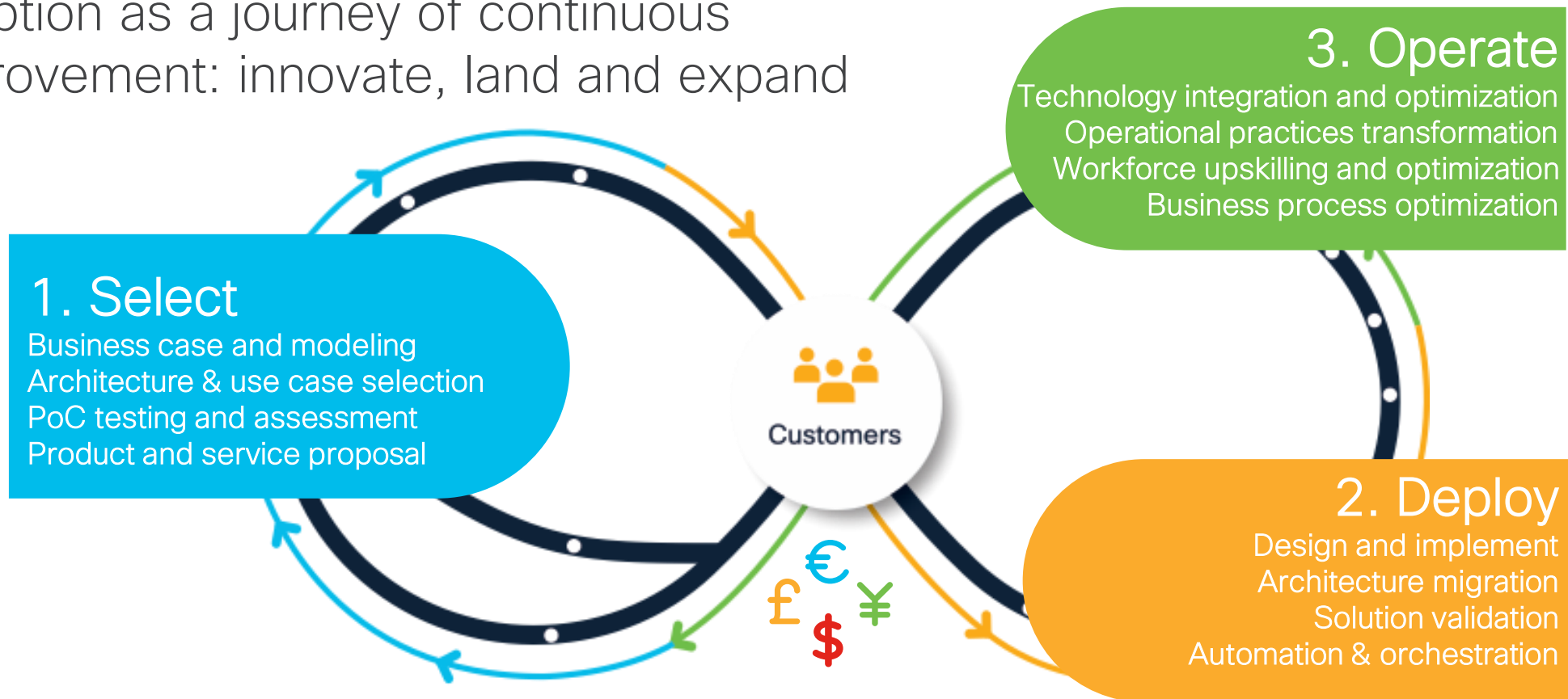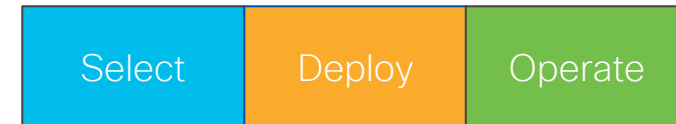
Practical Use Cases

Use Cases	Integrate DCO into routers (UC1)	Implement segment routing (UC2)	Simplify optical transport (UC3)	Remove OTN infrastructure (UC4)	Automate service delivery workflow (UC5)	Operationalize convergence (UC6)
Business Goals	Converge layers to reduce energy cost and space footprint	Provide simplified and multi-tiered service infrastructure	Simplify optical layer for a converged operating model	Reduce or remove dedicated OTN infrastructure	Streamline service provisioning and assurance for faster service agility	Achieve business optimization and process enhancement
Technical Considerations	Optics interop with transport, power budget management, control and management with alien wavelength, architectural mind shift, IP and optical demarcation, multivendor integration	Assessment of the capability, MPLS vs SRv6, design and deploy the solution network wide, circuit style traffic engineering requirements, skill gaps, operational practices	Co-existing of CDC ROADM vs hop-by-hop, DWDM CP vs SDN automation, L0 protection and restoration vs SR protection, C band vs C+L bands, end to end circuit connectivity	Timing and latency, QoS design and implementation, bw management, circuit protection, OSS/BSS update and integration, operating model and procedure update, new skillset	Integration of disparate management tooling, unified workflow, single provisioning workflow, context-aware FM and PM, service reliability, trouble ticket reporting	Organizational convergence, workforce consolidation and upskilling, process consolidation, value stream mapping, cultural change, business life cycle management
Outcomes	Reduced complexity and lowered network cost	Simplified and scaled packet transport	Simplified architecture with optimized lifecycle management	Reduced operating cost and increased sustainability	Faster time to value and better customer experience	Higher productivity and operational efficiency

Additional use cases may be developed as more customers adopt Routed Optical Networking

Implement Routed Optical Networking

Think of a Routed Optical Networking adoption as a journey of continuous improvement: innovate, land and expand
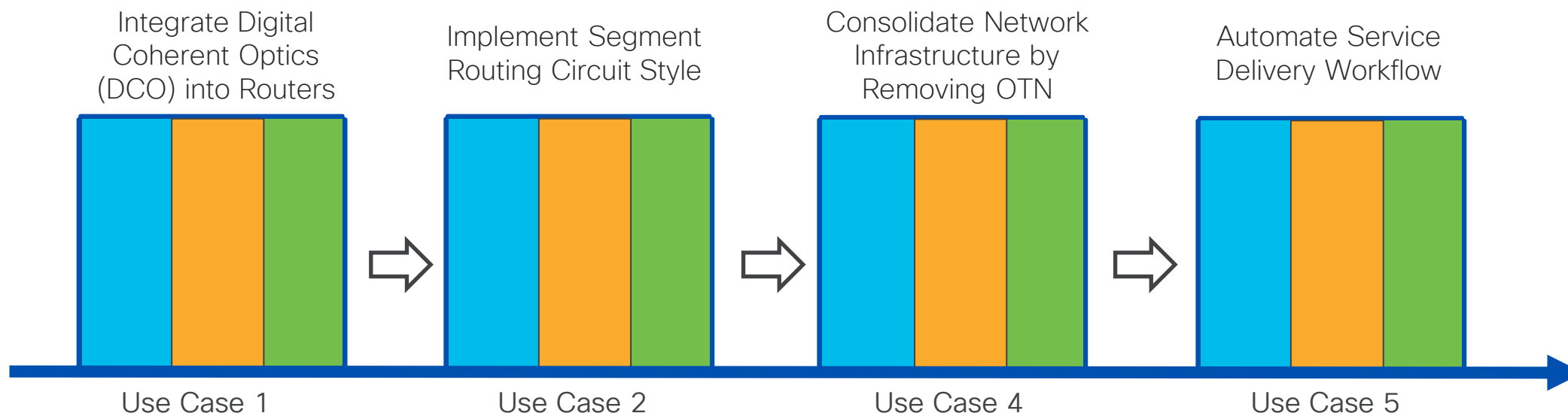
カイ ゼン
改 善
Kaizen

3. Operate
Technology integration and optimization
Operational practices transformation
Workforce upskilling and optimization
Business process optimization

1. Select
Business case and modeling
Architecture & use case selection
PoC testing and assessment
Product and service proposal

Customers

2. Deploy
Design and implement
Architecture migration
Solution validation
Automation & orchestration

Adoption through Use Cases

- Not all customers will have the same requirements or journeys
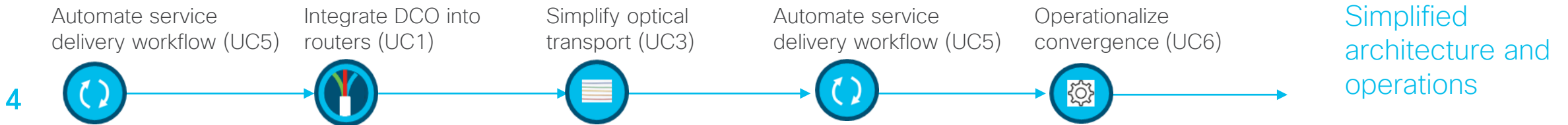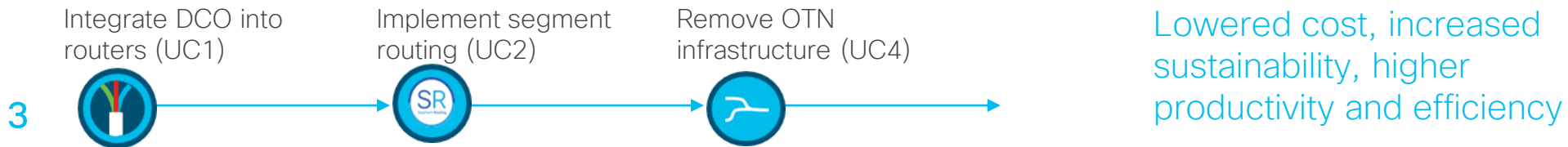- A use-case based adoption provides flexibility to

⟹

- Better align with business needs,
- Reduce risk of new technology introduction
- Limit the scope and size of budget

A hypothetical adoption example (for illustration purpose)

Integrate Digital Coherent Optics (DCO) into Routers

Implement Segment Routing Circuit Style

Consolidate Network Infrastructure by Removing OTN

Automate Service Delivery Workflow

Use Case 1 ⟹ Use Case 2 ⟹ Use Case 4 ⟹ Use Case 5

Adoption Journey Examples

- Journey start and end points may vary
- Journey can stop and continue depending on requirements

1 Integrate DCO into routers (UC1) → **Reduced complexity and lowered network cost**

2 Re-architect network → Implement high capacity, low latency routers → Integrate DCO into routers → **Higher network capacity, converged architecture for growth**

3 Integrate DCO into routers (UC1) → Implement segment routing (UC2) → Remove OTN infrastructure (UC4) → **Lowered cost, increased sustainability, higher productivity and efficiency**

4 Automate service delivery workflow (UC5) → Integrate DCO into routers (UC1) → Simplify optical transport (UC3) → Automate service delivery workflow (UC5) → Operationalize convergence (UC6) → **Simplified architecture and operations**

A Practical Deployment Example

Integrate DCO into
routers (UC1)

1

Mapping out a Routed Optical Networking Journey

Goal of the journey

What business initiatives is the journey trying to address? What is the starting point (present mode of operation)?

Steps to get there

What are the steps to get there? How to align products and services together? What specific business outcomes are achieved at each step?

Target of the journey

What is the future mode of operation? Does the target align with the goal of the journey

Considerations for Journey Construction

?

1. Does it alleviate immediate painpoints and satisfy urgent business needs?

2. Does it provide quick and compelling value realization initially and incrementally to build the momentum?

3. Does it lead to a sustainable operating model?

4. Is there a long term plan for continuous improvement?

5. Is there a need for BOT (build, operate, and transfer) to accelerate the new solution introduction?

6. ... ...

Integrate DCO into routers (UC1)

1

Journey Example: Setting Goals

Present Mode of Operations

- State: Multidomain network with packet and optical transport at 100G. Transponders are part of the optical transport
- Goals: Simplify network, reduce cost, deliver higher capacity
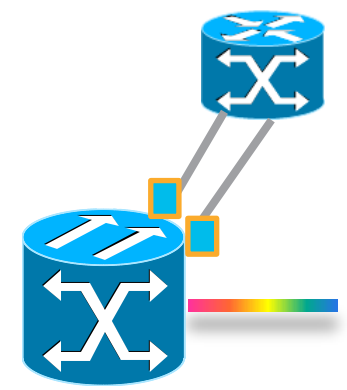
Future Mode of Operations

- Converged layers with DCO directly in routers
- DCO traffic carried over existing ROADM network as alien wavelengths
- DCO management integrated into the operations
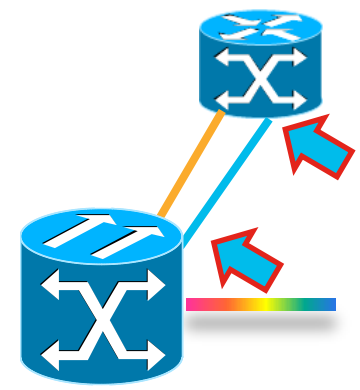
Journey Example: Journey Steps

1. Select

2. Deploy

3. Operate
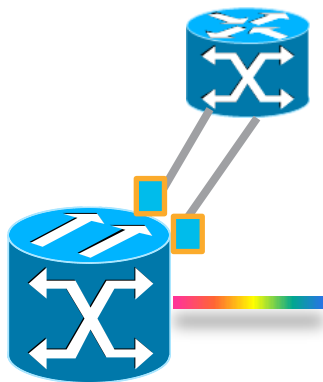
400G readiness assessment

1

Assessing the transport and routing hardware readiness for 400G
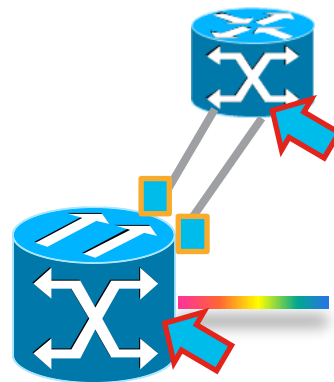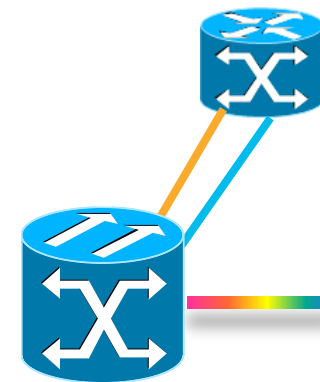
400G upgrade

2

Upgrading routers and redesigning transport as applicable to support 400G DCO
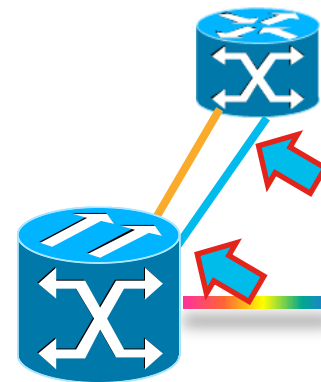
Transponder to optics

3

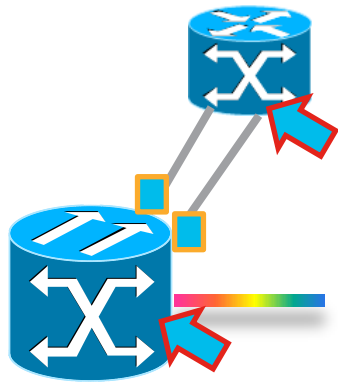Migrating transponder circuits to DCO optics

Operational update

4

Performing operational update to support 400G DCO

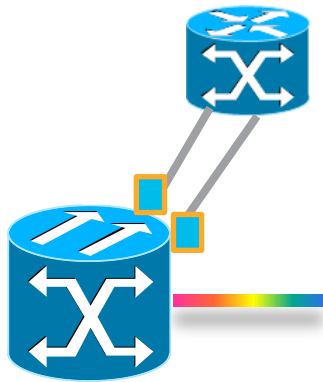# Journey Example: Aligning Products and Services

1. Select

1 **400G readiness assessment**

Cisco Products	• Existing products
Services Considerations	• Network modeling and planning to support 400G DCO over the current optical transport • Transport readiness for 400G, alien wavelength support from transport equipment • Power, space, and fiber availability • Routing hardware and software readiness for 400G • Network management and SDN controllers for 400G • Traffic optimization recommendations for 400G • Operational practices and procedures for the converged infrastructure
Business Outcomes	• Understanding the risk and readiness • Preparing budget and starting schedule planning

Journey Example: Aligning Products and Services
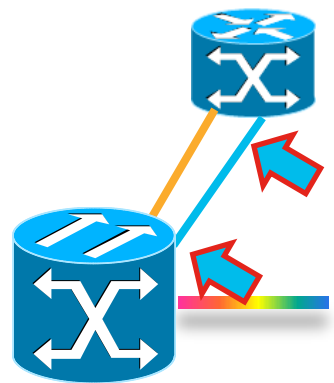
2. Deploy

2 400G upgrade

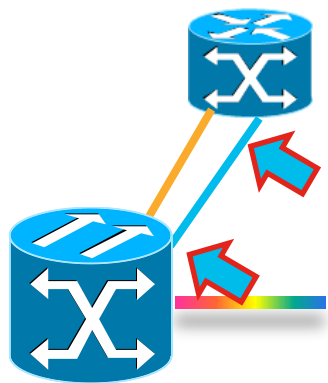| Cisco Products	• Routing products that support 400G DCO: Cisco 8000, ASR 9000, NCS 5x00, NCS 540 • 400G ZR/ZR+ optics, 400G Bright ZR+ optics • IOS-XR software release that supports 400G DCO
Services Considerations	• Network design updates for 400G support • Site readiness checks • Upgrade procedures • Upgrade routers to support 400G DCO • Integration plan for 400G DCO into transport • OSS and SDN controllers upgrade
Business Outcomes	• Network is ready for 400G

Journey Example: Aligning Products and Services

2. Deploy

3 Transponder to optics

Cisco Products	
Services Considerations	• Review solution designs and fiber routing • Proof of concept and lab validation for migration • Network discovery to collect required data for migration preparation and document transponder information • Migration procedures • Pre-migration readiness checks
Business Outcomes	• Simplified architecture • Reduced network cost

Journey Example: Aligning Products and Services

3. Operate

4 Operational update

Cisco Products	
Services Considerations	• Integrate optics management into the existing network with incremental updates • DCO organizational ownership and collaboration • Optics visibility and lifecycle management • Review and update operational procedure to support DCO in routers • Cross training and skillset update
Business Outcomes	• Simplified operations

Considerations for Next Steps

?

1. Does this journey achieve the original business and technology goals?

2. Is the operational team trained to support the solution?

3. What additional optimizations are needed?

4. Is organizational change required to support the converged architecture?

5. Identify any business needs to continue to drive the convergence journey

6. ... ...

Conclusion

Cisco's Convergence Story

- Routed Optical Networking is a Cisco innovation that is gaining significant industry momentum because of its key business value in driving architecture simplification and cost reduction

- Cisco has designed a product portfolio and services offers for Routed Optical Networking to help customers accelerate adoption with faster time to value

Cisco's Routed Optical Networking Solution brings

Simplified Network Architecture	Optimized Network Lifecycle Management	Increased Operational Agility
Cost reduction and sustainability	More Efficient Operations	Customer satisfaction and faster time to value

Let CX Help with Your Journey to Routed Optical Networking

1. Select

- Proof-of-concept testing
- Unified IP and optical network planning and validation, architecture comparison, failure analysis and capacity planning
- Expert guidance for network transformation and operational advisory, strategy & analysis, readiness assessment

2. Deploy

- Design and implement use cases of Routed Optical Networks
- Certify and validate customer specific solution and components, along with deployment procedures
- Migration from legacy technologies or systems to Routed Optical Network solutions

3. Operate

- Hardware support, software support, solution-level support
- Analytics-driven expert guidance, audits, insights, and automation
- Customer specific outcomes services and continuous optimization
- Training and skill update

Call to Action

Reach out to Cisco and get started on your journey to Routed Optical Networking

Cisco
Customer Experience