As service providers dive deeper into Software-Defined Networking/Network Functions Virtualization (SDN/NFV), they realize existing operational and Business Support Systems (OSS/BSS) lack the capability and flexibility to fully achieve agile service delivery. This paper outlines how the evolution to SDN/NFV requires an agile service fulfillment solution that supports the service provider’s journey from their current architecture to a hybrid of traditional and SDN/NFV domains, and ultimately to a fully virtualized environment. Ciena’s Blue Planet architecture provides a cornerstone in the Lifecycle Service Orchestration (LSO) of SDN/NFV services, delivering significant value-add in the evolution of the service provider OSS/BSS. As a trusted advisor, Ciena provides guidance in this paper on OSS/BSS architectural considerations to simplify and accelerate service delivery.

Current state of SDN/NFV evolution
As service providers accelerate the trial and adoption of SDN/NFV solutions, they are increasingly realizing the limitations and barriers of existing OSS/BSS systems, as illustrated by an industry survey in Figure 1. A key problem facing service providers is how to build on the promises of SDN/NFV, without the numerous risks and complexities of overhauling massive legacy OSS/BSSs that currently support revenue-generating services. For most service providers, this is a question of intelligent evolution versus potentially costly revolution.

Service providers are realizing they cannot easily build on legacy infrastructure and processes from traditional vendors. Instead, they are looking for guidance from SDN/NFV thought leaders like Ciena to light an evolutionary path to realize the values and benefits of SDN/NFV, while entrusting that the proposed solution is aligned with the service provider’s unique business and operational objectives.

Ciena sees the service provider evolution to SDN/NFV and intelligent automation progressing in three stages (as shown in Figure 2).

**Present Mode of Operations (PMO):** This represents today’s service provider architecture and the current state of OSS/BSS, which is typically based on silos of physical network functions and/or service-centric operations and processes. As service providers begin the evolution toward SDN/NFV, they find it is becoming increasingly key to successful transformation to engage with an industry thought-leader who serves as a trusted advisor to map out the impact to the company’s OSS/BSS systems and processes.

**Transitional Mode of Operations (TMO):** In this hybrid architecture approach, the service provider has identified a subset of physical networks functions to be virtualized, and where the Management and Orchestration (MANO) of these functions begins, with lightweight integration into key OSS/BSS systems (such as customer and self-service portals, service assurance, and billing) for rapid delivery of new revenue-generating services. An important evolutionary step for the service provider at this stage is moving from an inventory-centric service fulfilment model to an LSO approach and virtualized services delivery. Here, LSO is meant in wider context than originally defined by MEF. It refers to the general...

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**Figure 1. OSS/BSS survey of service providers**

**Figure 2. From PMO to TMO to FMO**

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context of services being delivered across multiple networks, as jointly defined by the TM Forum and the MEF through Open API initiatives.

**Future Mode of Operations (FMO):** The service provider’s target architecture for a fully virtualized network supports service orchestration end-to-end, across MANO and OSS/BSS functions. At this stage, intelligent automation and end-to-end orchestration are the cornerstones of rapid service definition, deployment, and management. At the heart of the LSO concept is Multi-Domain Service Orchestration (MDSO), where a domain can represent different technologies, services, and even Operating Companies (OpCos) within the service provider. By building a target architecture based on MDSO principles, the service provider is free to flexibly define a domain that meets its business objectives, while stitching these services end-to-end. This avoids the need to redefine domains for new services, in contrast to what is required today with current monolithic operational models and processes. This hierarchical approach simplifies and accelerates the operational evolution of OSS/BSS toward intelligent automation to enable rapid SDN/NFV services deployment. Today, many traditional OSS/BSS software vendors are still locked into a monolithic architecture where multiple domains each represent different software implementations loosely coupled across network technologies and services. This makes end-to-end orchestration slow, process-heavy, and error-prone. Rather, a modern orchestration solution like Ciena’s Blue Planet offers a flexible software architecture that provides powerful modeling and programming tools that are common across the domain and multi-domain scope to significantly help operationalize SDN/NFV services.

**How Blue Planet helps operationalize SDN/NFV services**

MDSO is essential in the evolution toward SDN/NFV services, and is at the heart of Ciena’s Blue Planet solution, as illustrated in Figure 3.

Here, a domain represents a grouping (or silo) of vendor equipment or networking technology that is supported by people, processes, and management tools. A multi-domain service is a service that spans several domains such as WAN, NFV, and cloud, and, requires coordination between these domains. MDSO supports the fulfillment and assurance processes of dynamically managing services end-to-end across different domains based on customer demand and resource availability. With Blue Planet MDSO, the service provider can quickly simplify and automate the delivery of new revenue-generating services as part of a single and unified view of capabilities for consuming the network as a programmatic resource. Furthermore, with Blue Planet open APIs, the service provider can expose a normalized view of services across complex domains, simplifying integration into key OSS/BSS systems such as customer portals and third-party applications for rapid service delivery and monetization.

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Blue Planet integration across OSS/BSS

Blue Planet does not require extensive and expensive forklift upgrades, as experienced by service providers with many traditional OSS/BSS vendors. Instead, Blue Planet implements key automation and orchestration functions that enable the rapid evolution toward, and delivery of, SDN/NFV services. Using the TM Forum Business Framework (eTOM), Figure 4 highlights the key support systems Blue Planet helps operationalize across a service provider OSS/BSS (in dark blue), as well as the remaining support systems that benefit from Blue Planet value-add data.

At the Network Management layer, the Blue Planet Resource Adapters (RAs) discover the network and are responsible for delivering configuration commands to the network elements. Blue Planet RAs have the role of Resource Data Collection and Distribution for end-to-end service orchestration. Blue Planet includes the function of Resource Provisioning, which is responsible for defining the multi-technology and multi-vendor resource configuration instructions communicated by the RAs into the network. Blue Planet can also be extended to map fault events and performance-related events to a normalized view of combined physical and virtualized resources as part of Fault Management and Performance Management functions in eTOM.

To be clear, Blue Planet today does not by default perform Alarm Correlation, Alarm Suppression, or Root Cause Analysis; rather, large service providers have extensive fault and performance management systems and investments in those functions that Blue Planet can leverage. By actively discovering the network, creating a consistent and normalized view of combined physical and virtualized resources, and providing the ability to map (Fault or Performance) ongoing events to this dynamic network model, Blue Planet provides a stream of enriched, accurate data that augments the value and capabilities of network and service assurance functions.

For Blue Planet, the network is the database and, through discovery, Blue Planet maintains an ‘as-is’ view of the resources for Fulfillment and Assurance service providers can use to align their physical and logical Inventory Systems with the dynamic changes in the SDN/NFV environment. Today, up to 60 percent of traditional Inventory System data can be out of sync with the network, and these discrepancies are the cause of significant service fulfillment fallout. Service providers can access the ongoing discovered addressable network data through Blue Planet’s open API to keep inventory systems in sync with the network.
At the Service Management level, Blue Planet’s MDSO capabilities implement the eTOM Service Configuration and Activation function across technology and vendor domains. When services, as defined in Blue Planet’s Service Catalog, are invoked through GUI or open API (such as the Order Management System), these services are stitched from end-to-end across the network. Here, Blue Planet maintains a real-time Inventory view of the end-to-end services configured across domains. Furthermore, as fault and performance events are captured from the network through RAs, Blue Planet can be extended to map these events at the resource and services level, enabling an end-to-end view of service impact across the network that adjacent Support Systems (such as CRM) can use for faster customer problem resolution steps and greater accuracy in Quality of Service (QoS) and Service Level Agreement (SLA) reporting. Above Service Management, Blue Planet does provide the basic capabilities of portal/GUI order submission (Customer Interface Management) and order decomposition (Order Handling), enabling service providers to deliver Day One SDN/NFV services while defining a wider integration strategy into more complex BSSs.

Blue Planet can be programmed to report on Usage Data Records (UDRs) of the network resources consumed by end-to-end services. For a given service, these UDRs may include the resource supporting the end-to-end service, the duration these resources were used, the amount of bandwidth consumed, and the customer connected to the service. UDRs provide an important insight into how valuable network resources are used by customer services stitched end-to-end. Service providers can use the UDRs to analyze and optimize resources assigned to customer services, and UDRs can also feed into rating and charging systems for dynamic real-time billing.

Finally, the Blue Planet environment includes business process capabilities (BPMN 2.0), allowing for the management of tasks and events internal to Blue Planet automation and orchestration, and for the trigger of external processes across Fulfillment and Assurance domains. As an example, the orchestration of service may require a manual task to complete the service fulfillment flow. Blue Planet may trigger such a task into a Workforce Management system to complete the provisioning steps. Or, in another instance, the delivery of service to a customer requires resources from a third-party partner/supplier (see Supplier/Partner Relationship Management in Figure 4). Although Blue Planet does not provide the e-portal and functions to negotiate/bind the resources from the supplier/partner by default, Blue Planet can determine the third-party resources needed for the end-to-end service and trigger the resource request/process, with the service provider operations functions executing the supplier/partner engagement.

**OSS/BSS architectural considerations**

Based on discussions with IT and network teams with multiple service providers, Ciena has developed the following OSS/BSS architectural considerations, which support the evolution to automation of multi-domain service delivery.
First, as shown in Figure 5, service definitions are modeled based on the MDSO approach, where each technology in the service provider network is managed as part of its own domain and MDSO provides the end-to-end service stitching across domains. This approach will enable the service provider to model each technology domain independently, rather than trying to define a single model that covers all domain possibilities from the start. The RAs will allow each domain to expose Resource-Facing Service (RFS) definitions specific to the resources capabilities and under domain control. At the MDSO level, the service catalog will contain the Customer-Facing Service (CFS) definitions that support the product offered to the customer.

In this model, the Service Order Management system will trigger the CFS through Blue Planet’s open API, and MDSO will use the service definition within the Service Catalog to orchestrate the service end-to-end across technology domains. This hierarchical approach provides greater solution flexibility and accelerates service delivery by separating the technology-specific RFS from Service Order Management CFS definitions through Blue Planet’s Service Catalog. Furthermore, in the case of end-to-end services that may span resources beyond the service provider’s control, the service definitions in the catalog can be extended to include the business process request to an adjacent domain for coordination of service orchestration across all domains.

The solution becomes a federated orchestration system when an end-to-end service request is triggered through a common open API with Blue Planet, and MDSO coordinates the orchestration of end-to-end services as part of a single contained order request. In that case, the service provider and the adjacent domain can evolve their domain-specific RFS definitions independently, while the service provider can use the higher-layer Service Catalog and CFS definitions to trigger the requested RFS from adjacent domains. The result is a higher-level RFS, CFS and service provider inter-domain flexibility, and speed of service delivery.

Second, for large service providers for which services span multiple Operating Companies, there is an architecture evolution whereby services will be orchestrated both at the OpCo (Domain) level and across OpCos for end-to-end service orchestration. Figure 6 illustrates a scenario where different OpCos could leverage Blue Planet for end-to-end service orchestration within their domains, allowing each OpCo to deliver new revenue-generating services tailored to the specific needs of their domain while remaining independent of each other’s operations. For corporate-wide services spanning multiple OpCo domains, Blue Planet MDSO will stitch services across the RFS definitions exposed through the Domain RFS Catalog. Through the Domain Catalog, each domain will expose the RFS made available for higher-level end-to-end services across the OpCo. Within each OpCo, the Blue Planet Catalog will also contain the service templates for end-to-end services (multi-vendor and multi-technology) within the OpCo domain that are triggered through the OpCo’s Order Management system, for those customers the OpCo is serving within its domain. In this approach, each OpCo has the flexibility to define revenue-generating service specific to their customer domain, and then expose for end-to-end service across OpCo the Resource Facing Services that are relevant and meaningful for corporate-wide service offerings to global customers.

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**Figure 6. MDSO across OpCos**

[Diagram showing end-to-end service orchestration across OpCos]
Operationalizing SDN/NFV through intelligent automation

Although SDN and NFV technologies provide the underpinnings of an agile network, rapid rollout of new services cannot happen without end-to-end automation across multi-domain infrastructure and processes. The situation becomes more complex when taking into account integration with legacy OSS/BSS, coordination with adjacent domains, and interoperability across OpCos. As described in this paper, Ciena’s Blue Planet MDSO approach provides the evolutionary path to support service providers’ operational requirements, and help realize agile service delivery.

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