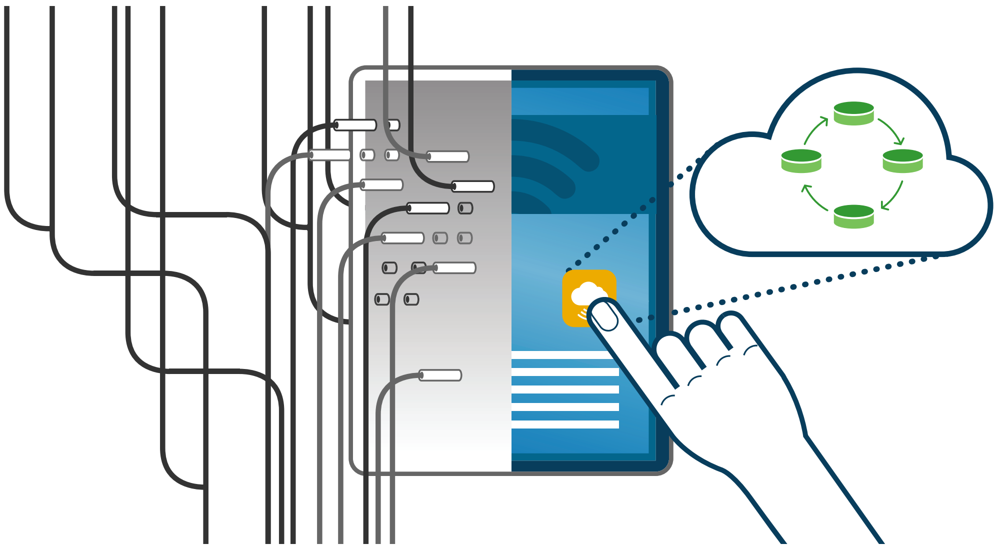
THE BIRTH OF DYNAMIC VSAT SERVICES

HOW NETWORK PROGRAMMABILITY WILL LEAD TO SERVICE AGILITY AND REDUCE COST



A Programmable Network

An army of switchboard operators were once the indispensable force behind the United States telephone network, consisting of a quarter million employees in the 1930's.[1] Callers had to first speak with an operator, who would manually connect two callers through physical cables and plugs. Although technically successful, this system was ultimately unsustainable for future growth. If scaled to today's demand, at least five million operators would have been necessary.

Instead, the telecommunication industry embraced automation early in its history as a means to efficiently scale while improving service quality. The spread of innovations such as the rotary dial for self-service input and automatic electromechanical switching relays eliminated the need for human-based switching and proved enormous gains are possible when system-wide automation is employed.

Now the telecommunications industry is hoping network programmability will deliver similar efficiency gains. Communication networks have functioned largely the same since the 90's, with rows of physical routers managed by teams of people, so they are prime candidates for system improvement. The goal is to reimagine how these networks operate by applying advanced system automation through Software Defined Networking (SDN) and Network Function Virtualization (NFV).

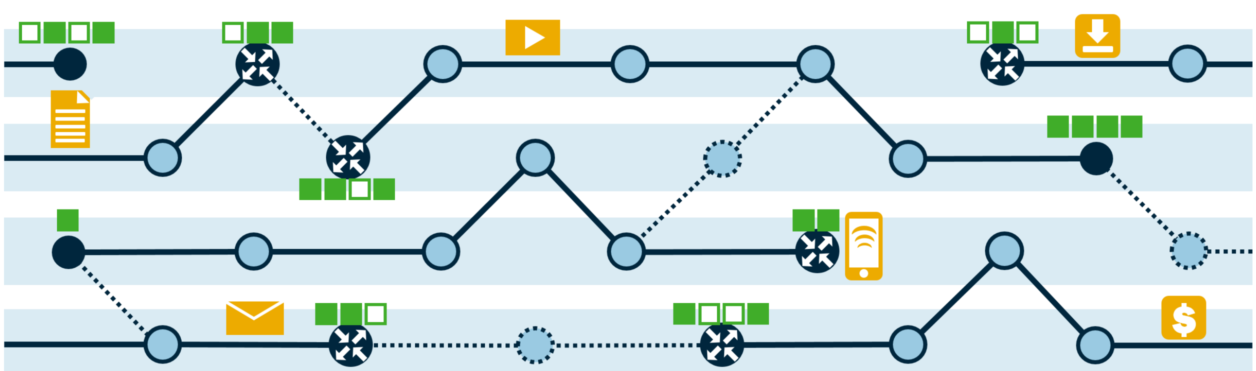
Although the concepts of SDN and NFV are relatively recent, they arose out of the larger trend toward virtualization. Data centers had discovered that if they "virtualized" software, multiple applications could share space on a single server. This led to the "cloud," where automation made it possible to form a vast application processing pool shared across many servers. But while all the applications began converging into the cloud, the network itself was still tied to dedicated hardware devices.

People are now rewriting how networks should be architected, using SDN to centralize routing control and NFV to virtualize network equipment. These concepts envision a world in which networks become embedded within the cloud. The goal is to make networks dynamically reconfigurable, so changes can happen within minutes rather than days or weeks. Essentially, the ability to offer dynamic services to customers.

Terrestrial telecommunication companies have assumed a prominent role in this new technological paradigm. All the major carriers are incorporating SDN and NFV as core strategic efforts, with recent examples including:

- AT&T intends more than 75% of its network to be software centric by 2020[2] and formally described its Domain 2.0 enhanced control and orchestration architecture.[3]
- Verizon released a whitepaper stating its vision for SDN and NFV architecture, formulated with partners Cisco, Hewlett Packard Enterprise, Intel, Nokia, Ericsson, Samsung, and Red Hat.[4]
- BT Group has developed a "Cloud of Clouds" platform that incorporates SDN[5] and is starting to offer NFV-based services on this platform.[6]
- Orange has shown a proof of concept network[7] and announced it will join forces with AT&T on standardizing an approach to SDN and NVF.[8]
- Telstra is working with Ericsson to transition its mobile network to a virtualized cloud[9] and has announced the launch of an SDN and NVF-based service for enterprise customers.[10]

If the telecommunications industry is steadily embracing network programmability and virtualization, what are the implications for satellite service providers?



Three Important Forces

The same forces encouraging terrestrial communication companies to adopt network programmability also apply to satellite service providers. These forces are summarized by the demand for value added services, the increasing complexity of networks, and increasing operational costs.

Demand for Value Added Services

Telecommunications companies consistently rank customer experience management as the highest strategic priority to maintain differentiation over competitors.[11] End users demand customer centric approaches, so companies able to deliver highly tailored solutions while also reducing time to market not only achieve the best service offering, they gain a true competitive advantage.

In contrast, end users traditionally experience satellite communication as a cumbersome solution with limited options. Until satellite service providers become more agile and improve responsiveness, they will always be relegated to be an access technology of last resort. With an expected doubling of connected devices, reaching 28 Billion by 2021,[12] the winners of this booming growth will be those companies that can meet emerging market requirements and quickly ramp deployment of services.

Increasing Network Complexity

Satellite communication has survived global economic slowdowns and the spread of cellular services, seeing an average 5% growth rate over the past five years.[13] This consistent growth is projected to continue and may even accelerate given decreasing service costs and faster data rates. And the demand for value added services is driving satellite service providers to aim for the same level of sophistication as traditional telecommunication companies.

Every additional site and each new service capability adds burden to the staff. But this burden is not merely linear… the more complex the network, the more exponential the curve. Every additional router, switch, line card, and remote multiplies interconnections to maintain. Enterprise firewalls and intrusion protection devices must physically installed and configured per business customer. And the sheer number of users on a consumer network overwhelms any but the most streamlined operations.

Value Added Services
Companies that deliver highly tailored solutions gain competitive differentiation

Increasing Complexity
The more complex the network, the greater the challenges to delivering highly tailored services

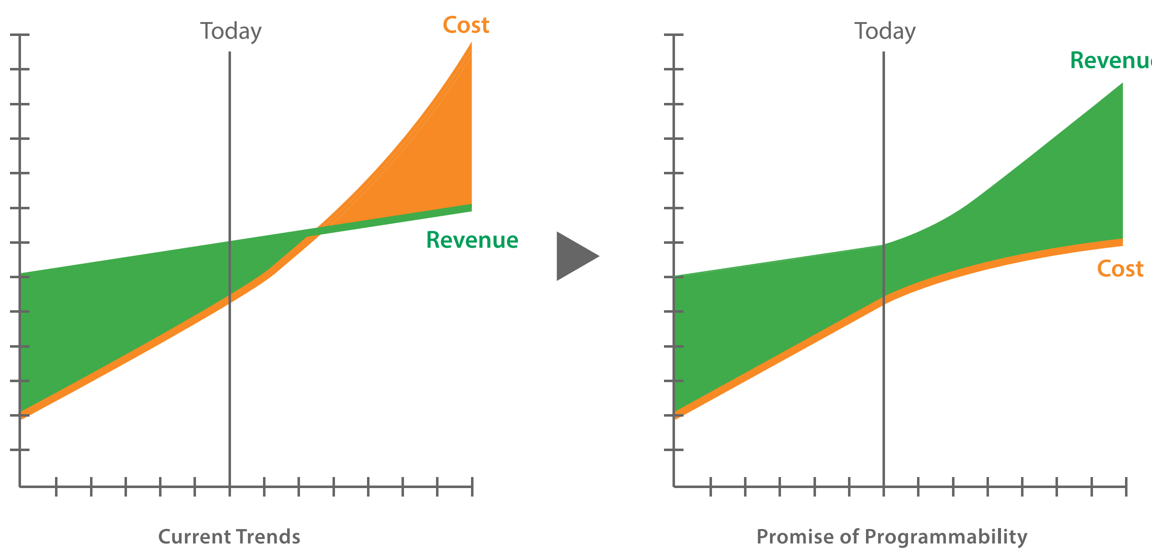
Rising Costs
Operational costs to sustain growth are increasing faster than the rise in revenue

Rising Operational Costs

The satellite communication industry faces a challenging transition as a large amount of capacity comes online. High Throughput Satellites (HTS) are dramatically increasing broadband capacity and forcing prices per Mbps downward. The industry is still adjusting to the new market dynamics.

While the drop in the prices is encouraging existing customers to purchase faster data plans and growing the customer base, satellite operators and service providers are being squeezed between the amount of revenue collected per user and the cost of offering that service per user. So service providers face an unenviable position of having unlimited opportunity for growth, but the cost structure to sustain that growth means the opportunity is becoming less profitable.

Figure A: The Rising Cost of Network Growth



Service providers face two realities for future growth. Either the cost of network deployment and management eventually outstrips revenue gains, or they find a way to lower costs significantly to protect revenue and even expand profitability.

The Promises of Programmability

Since network programmability fully embraces automation (SDN) and virtualization (NFV), it promises to satisfy the three forces facing satellite service providers by

- Improving agility for supplying value added services,
- Making network complexity manageable, and
- Achieving this while reducing operational cost.

Each of these outcomes are critical to future success and they are logically linked to each other. If the complexity is better managed, then companies become more agile. Better agility also boosts productivity, which leads to a reduction in expenses.

Network programmability encourages business to focus on investing in infrastructure solutions that lead to dynamic service capabilities and a reduction in OpEx. A service provider that implements network programmability directly cuts manual processes and consolidates network hardware, leading to positive operational impacts such as:

- Less facility space, resulting in less power and cooling requirements
- Systems scale precisely to demand, rather than being overprovisioned
- Traffic is engineered and optimized precisely as desired
- Less personnel are required to configure and maintain systems
- Network is centrally managed with better visibility
- New services are deployed in minutes rather than weeks
- Services are flexibly tailored to satisfy each customer

In addition to operational benefits, companies often hope to trim CapEx through network programmability. This may or may not be possible depending upon the form of network programmability implemented. Savings on networking hardware might be outweighed by software licenses, scalable fees, or integration services. Until specific use cases and architectures are defined, there are too many variables to provide a blanket statement on CapEx benefits.

> "Network programmability encourages businesses to focus on investing in infrastructure solutions that lead to dynamic service capabilities and a reduction in OpEx."

Transformational Concepts

The Problem of Too Many Minds

In a standard network, each router has autonomy to make decisions on how to best pass information through the network. A router handles both the forwarding of data packets (i.e. data plane) and forming the network "map" (i.e. the control plane).

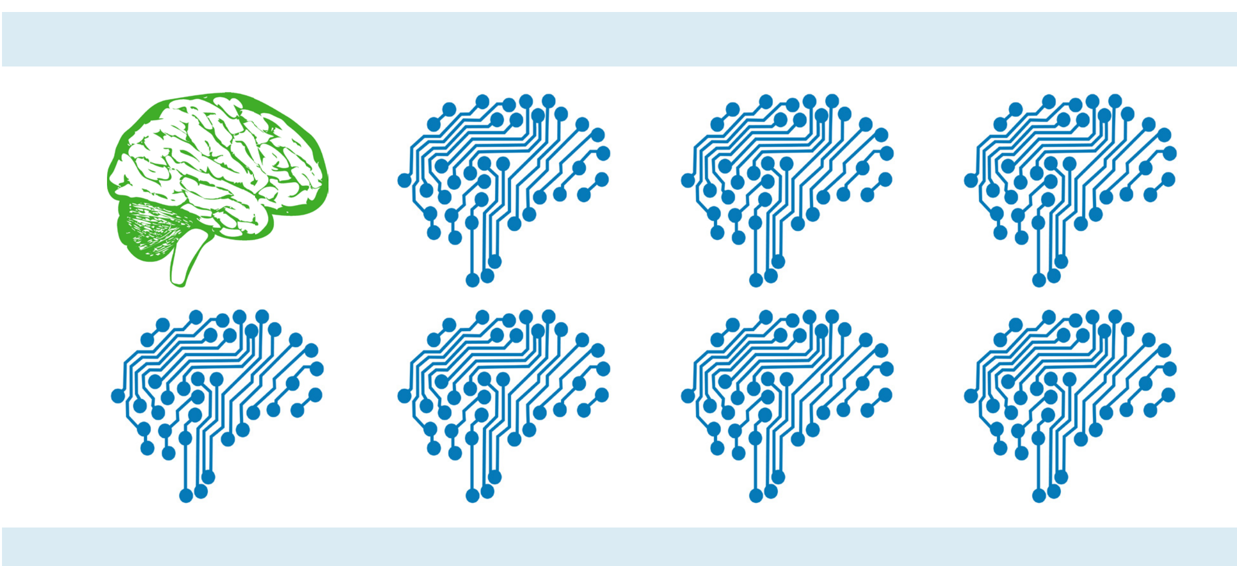
A router's data plane simply forwards packets to the next router by looking at routing tables. These operations are quick and require little processing. But similar to a human brain, a router has higher-order intelligence capable of collecting information and making decisions. The router's control plane sends out requests to nearby routers and uses that input to identify new routes, then adjusts the routing tables accordingly.

Distributing intelligence among all these individual devices creates a resilient network that is able to self-adapt to changes. But this benefit incurs high costs.

First, just as a brain consumes an inordinate amount of energy to sustain higher-order thought, every router must be oversized to sustain the control plane load. This produces extreme inefficiencies when considering the total wasted processing spread across the network and devoted to duplicate tasks.

Second, relying on each individual router to make judgements on the best routes introduces a type of rigidity. The system is constrained by standardized routing protocols, making it difficult if network operators feel they have a better perspective on how to engineer the traffic, apply QoS policies, or add security features. Any human intervention requires logging into and manually modifying each item of equipment along the entire network chain.

Software Defined Networking is the transformational concept that seeks to remove these system costs.



Transformation through Software Defined Networking

Software Defined Networking (SDN) is a simple concept: Separate the data plane from the control plane and use programmable interfaces to centralize the control intelligence.

In other words, SDN fundamentally rewrites networking by removing the intelligence from each router so there is no longer a multiplication of minds. In its fullest expression, SDN entirely replaces traditional router functionality with a flow controller.

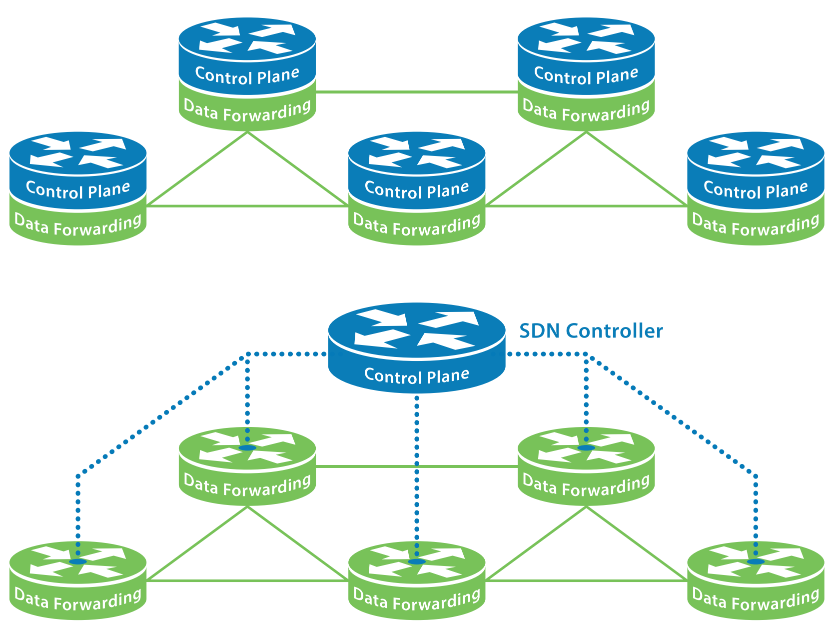
If a single, overarching flow controller has visibility of the entire network, it is able to analyze the control plane and plan the data flow much more efficiently. Each router can become "dumb," relying upon the flow controller for higher-order decisions. And since the controller is centralized, humans only have to access that single system when modifying the network flow. The changes are pushed downward across all the equipment through shared programmable interfaces.

Telecommunications companies are still exploring the technology and trying to determine the best path to SDN success. Important questions to consider when evaluating approaches include:

- How much logic should reside in router hardware versus the central flow controller?
- Should SDN rely on an open API and multiple vendors, or a closed API from a single vendor?
- Should SDN supersede or be complementary to routing protocols such as BGP and MPLS?
- What hybrid approaches mix the strengths of both traditional and SDN networking?

Although SDN resolves the problem of too many minds, it doesn't necessarily reduce the amount of networking hardware. That benefit comes through Network Function Virtualization.

Figure B: Software Defined Network Routing



By separating the data plane from the control plane, SDN moves intelligence outside the router and into a centralized flow controller. This establishes a single system to govern network flow.

The Problem of Too Many Boxes

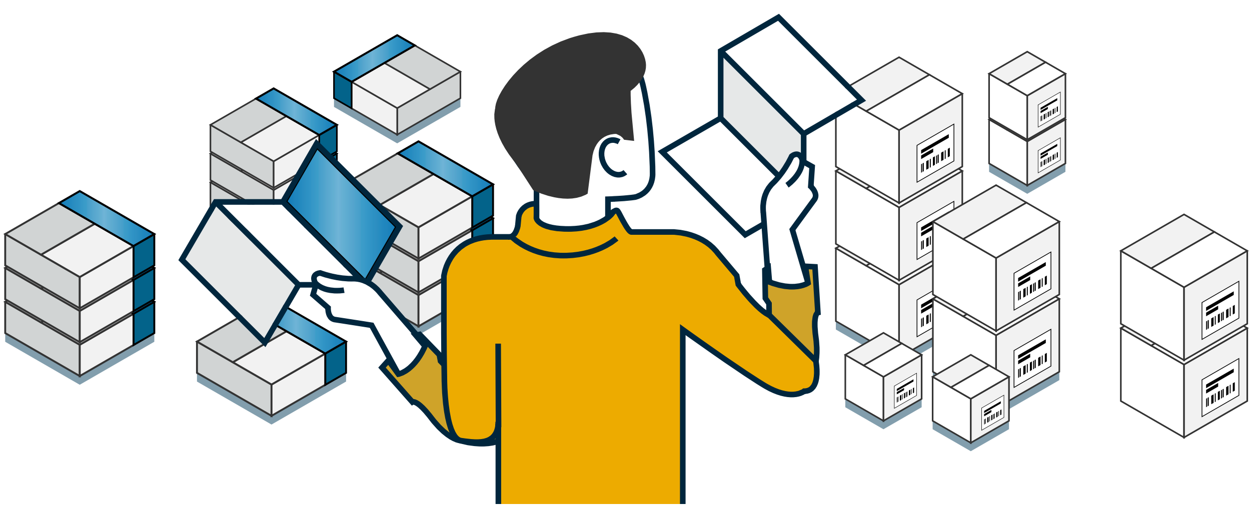
A standard network is composed of many separate hardware devices, each with a dedicated purpose. Some boxes focus on moving packets from place to place. Other boxes focus on analyzing or modifying the packets in order to optimize the network or deliver specialized services. A service provider's network will be filled with routers, load balancers, firewalls, WAN accelerators, intrusion prevention systems, deep packet inspectors, and network address translation equipment.

Adding a customer or activating a service often involves physically ordering, installing, and configuring new pieces of hardware within the data center. Certain services require a dedicated box per customer. Delivery of the equipment alone can take weeks. The network engineer must not only understand how to access the software on the box, but they must learn how to maintain the physical hardware, which varies from box to box. The entire process is inefficiently compartmentalized.

The current state of networks is not too different from a similar situation once faced by the general public. Only a decade ago, a person might have owned a simple cell phone, digital personal assistant, handheld gaming device, GPS navigator, digital camera, camcorder, and DVD player. These items of technology cluttered desks and filled drawers. Each item required maintenance and would quickly become obsolescent, having to be replaced with newer hardware versions.

Transformation through Network Function Virtualization

In 2007, Apple launched the iPhone and triggered a revolution. Smart phones were born and soon, all these separate items of hardware could be easily replaced by apps downloaded as desired onto the phone. This single hardware and operating system became the common platform able to support a diverse array of software functionality. Now the user only had to deal with one item of hardware and upgrading was far easier.



Network Function Virtualization (NFV) is somewhat comparable to the smart phone revolution. Although data centers have largely become virtualized, enabling them to efficiently support business applications, networking infrastructure has stubbornly remained locked in boxes. This means service providers are missing the synergies and knowledge that already exists within the data center side of their operations. NFV proposes to move network capabilities out of boxes and turn them into virtualized functions that reside within the shared server environment.

Transitioning to virtualized network functions requires being able to arrange service chaining. Whereas before, a box might be physically connected within the traffic pathway of a customer's network, a virtualized network function runs only when needed on a virtualized server somewhere within the data center. Smart routing must quickly direct the traffic to that location on demand. Since a customer's service package will often involve multiple functions, the functions must be linked together into a chain so the traffic passes through function by function.

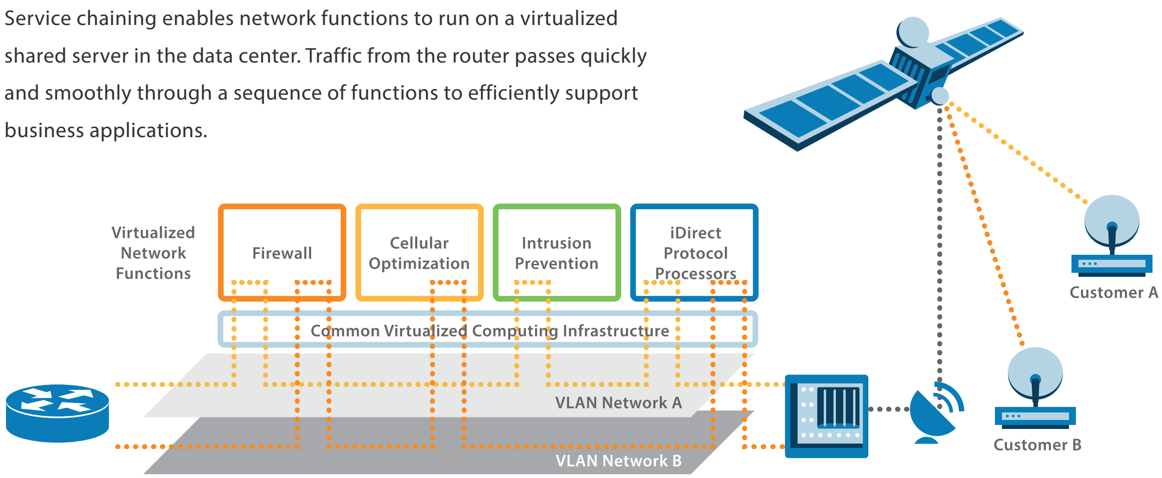
Customer Service Orchestration

Although SDN and NFV exist as separate concepts, they are complementary technologies that become more powerful when paired together. SDN's sophisticated routing makes large-scale NFV service chaining a realistic proposition. Likewise, since NFV breaks the network into virtualized packages, it facilitates SDN's grand vision of a network that is centrally controlled through software.

Service orchestration refers to the means by which customer services are provisioned. Service orchestration unites SDN and NFV in support of a business's service goals. A service orchestration controller is able to coordinate all the network components through a single user interface to make it easy to deploy services.

Figure C: Network Function Service Chaining

Service chaining enables network functions to run on a virtualized shared server in the data center. Traffic from the router passes quickly and smoothly through a sequence of functions to efficiently support business applications.



Making Dynamic Services a Reality

Satellite service providers are not far behind the trend toward network programmability. Terrestrial telecommunication companies have just recently completed lab trials and began to roll-out limited implementations of SDN and NFV on live networks. The largest satellite networks are keenly aware of the demand for value added services and rising operational costs, so they are starting to assess how to maintain a globally relevant presence.

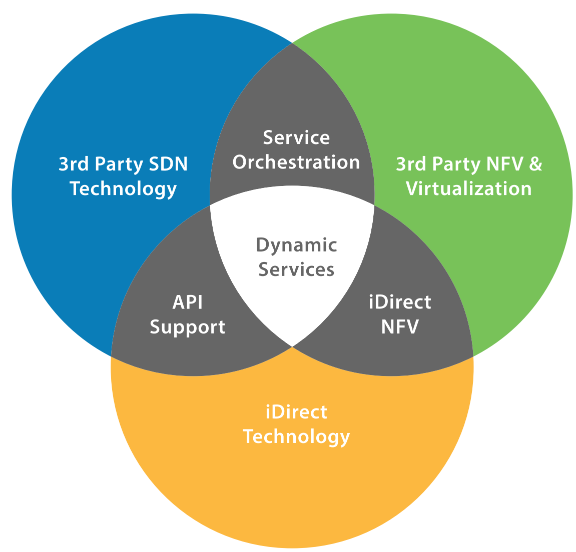
As SDN and NFV principles become more and more foundational, telecommunication companies will expect satellite communication to become part of this paradigm for easier integration. Larger satellite service providers will find that embracing these technologies will reduce their cost structures and align with a cloud services strategy. Smaller satellite service providers will discover emerging applications by which SDN and NFV gives them a competitive advantage.

Fortunately, this transition doesn't need to occur all at once. Even telcos with extensive resources such as AT&T expect it will take multiple years to migrate all functionality. Although service providers must plan holistically, they can minimize risk by dividing implementation into steps that offer incrementally progressive benefits.

Each satellite service provider will follow a unique path, but the broad steps entail:

1. Assess current operations and growth strategy
2. Identify the highest priority services to automate
3. Map network architecture, relationships, and dependencies
4. Select a virtualization platform for core network processing
5. Select third-party flow control and orchestration software
6. Complete baseline integration and testing of technology
7. Rollout first NFV-based service, followed by migration of additional services
8. Continue spiral integration that automates more and more network activities

Figure D: Dynamic Services Overview



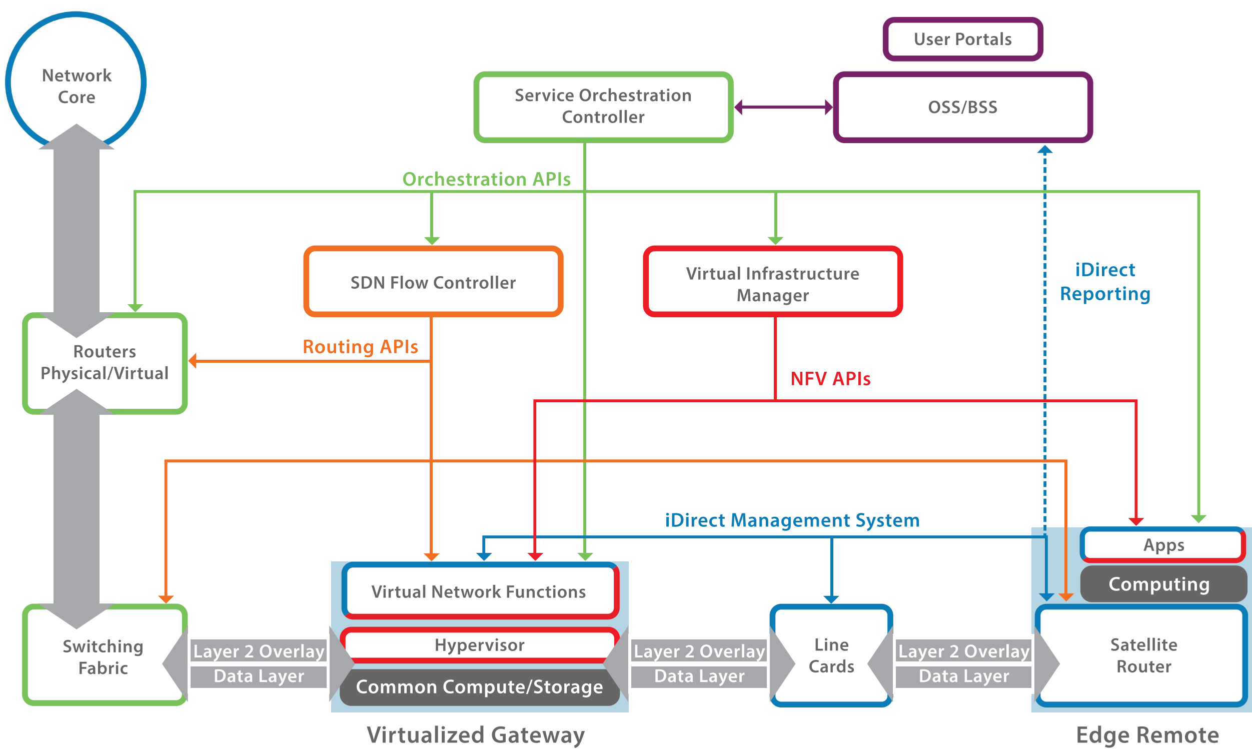
A Dynamic Services Architecture

A satellite network is an ideal candidate for network programmability because it is already a self-contained system with centralized protocol processing. And although there will always be distinct equipment devoted to transmitting and receiving, the entire suite of satellite network functions are transferrable to a virtualized environment.

A dynamic services architecture becomes the means by which service providers can maximize their High Throughput Satellite (HTS) opportunity. The ground segment must be able to bear the extreme processing requirements and gigabit throughput that future HTS networks will supply. A virtualized and scalable platform able to incorporate SDN and NFV is the first step toward getting ready for this technology future.

iDirect has developed a model to illustrate the key components of a dynamic services architecture and how those components relate to each other. The complete solution requires a mix of iDirect technology (blue components), third-party software and equipment (red, green, and orange components), and Application Programmable Interfaces (APIs) to bind everything together. Although not an exact model, this organizational framework is useful to facilitate thought and planning.

Figure E: Conceptual Model for a Dynamic Services Architecture



The important model components are briefly summarized:

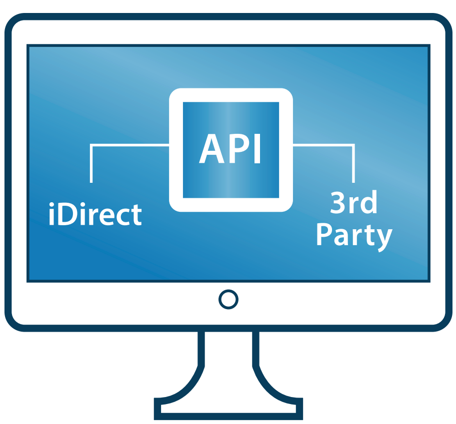
Simple Model for a Gateway

iDirect envisions consolidation of all network functions into a central, virtualized gateway that reduces infrastructure footprint, scales based on demand, lowers IT management costs, eases service enablement, and improves capability expansion. Elements of a virtualized gateway would include:

- Common Compute/Storage – A single modular server or private cloud that merges both computing and data storage into one platform.
- Hypervisor – A third-party operating system that creates the virtualized environment and abstracts the network functions from the underlying server hardware.
- Virtual Network Functions – Core functionality that powers the satellite network and delivers services, including protocol processing, throughput enhancement, and software applications that extend value added services.

Simple Model for Orchestration

iDirect envisions the use of open source APIs to make it easier to interface with third-party orchestration tools and integrate beyond the satellite segment of the network. This model for network orchestration would encompass:



- Application Programming Interfaces – Might involve a suite of network management and control APIs, such as OpenFlow, OpenConfig, NETCONF, YANG, and iDirect's own REST API.
- Service Orchestration Controller – This third-party master controller provides a single interface for service provisioning and automatically coordinates the Virtual Infrastructure Manager and the SDN Flow Controller, as well interfaces with the satellite network management system.
- Virtual Infrastructure Manager – This third-party manager allocates virtualized resources, activating virtual network functions and scaling the system to meet required service loads.
- SDN Flow Controller – This third-party controller pushes out routing tables to optimize traffic engineering and fulfill service chaining requirements.

Simple Model for an Edge Remote

While many network functions can be located at the center of the network, there will always be certain network functions that must reside at the customer edge to boost responsiveness. iDirect envisions remotes able to host value-added embedded software to consolidate customer premise equipment into a single device:

- Remote Computing – A powerful embedded processor that can host multiple applications for service optimization and customization.
- Remote Apps – Virtualized applications such as traffic acceleration, cellular backhaul, advanced end-point management, or service provider specific functions.

The Virtualized Teleport

The ultimate dream enabled by network programmability is to create virtualized teleports running virtualized networks and providing virtualized services, so operators can create and modify services with the push of a button. These software-based, overlay networks would exist transcendent, divorced from any particular item of physical hardware. Such a satellite network would easily blend into a telecommunication provider's private cloud, becoming a seamless extension of a carrier's access network.

As shown in this whitepaper, satellite service providers will not only benefit from SDN and NFV, they will discover network programmability to be necessary to sustain future growth. This is a chance to deliver greater value, operating more like a Telco and becoming highly responsive to customers. Service providers should seek a trusted partner to help develop a well-thought strategy that examines virtualization and the implementation of SDN and NFV principles.

iDirect has the networking expertise to assist providers as they begin evaluating technology options. iDirect has created the dynamic services model to portray the primary components for a SDN and NFV strategy and is evolving its satellite communications technology to support the step-by-step transition of satellite service providers toward this goal. First among these steps is the transition of core network processes onto a virtualized platform. As the satellite industry enters an era of unprecedented capacity and opportunity, iDirect will continue to provide a path forward for service providers to succeed.

End Notes

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