

### Executive Summary

In a previous whitepaper ACG Research described the business case for scaling the next-generation network with the Cisco ASR 9000 System (See <http://acgresearch.net/news/32.aspx>). This paper describes the extension of network virtualization (nV) technology across the edge, aggregation, and access networks. It also describes the extension of nV to converged services, including mobile and enterprise next generation and legacy services.

ACG Research has developed a business case analysis for Cisco's nV technology when deployed across the edge, aggregation and access networks that supports residential, enterprise and mobile services. The analysis captures the market's evolutionary change in the access network from E1/T1 to Ethernet-based technology. The model addresses this change for backhaul of 2G, 3G, and 4G radio technologies and for enterprise Internet access and L3 VPN services.

The business case analysis compares the cash flow and three-year cumulative total cost of ownership (TCO) of the Cisco nV technology with a leading competitor's converged services solution referred to as the "present mode of operations."

### Key Takeaways

The total cost of ownership, CapEx and OpEx of the Cisco network virtualization (nV) technology is more than 70% less than that of a leading competitor's solution.

Sources of savings include:

- Extending nV from edge to access using new Cisco 901/903 routers with converged services support.
- nV technology simplifies network operations.
- Single virtual entity management, one-click software upgrades, and integrated analytics reduce network care work.
- Support for multiple topologies, including ring, and hub and spoke.

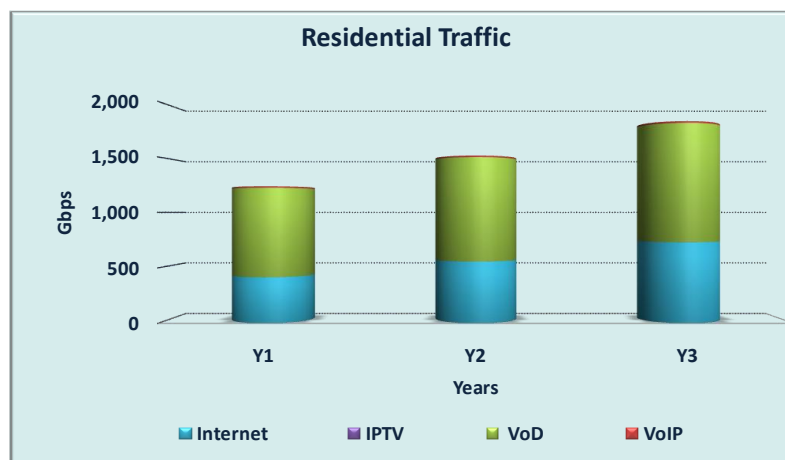
The analysis shows that the Cisco nV technology drives down TCO<sup>1</sup> by 74% as compared to the present mode of operations; CapEx is reduced by 74% and OpEx is reduced by 75%. ACG Research also developed a cash-flow analysis of the nV technology, allocating only 2% of the modeled service revenue to the access, aggregation and edge routing operation. The nV technology has a 10 month payback<sup>2</sup>.

## Model Network

The business case analysis models a network that represents the access, aggregation and edge networks using next-generation and legacy technologies and providing residential, enterprise, and mobile backhaul services. The network serves an addressable market consisting of 3.5 million households, 50,000 enterprise establishments and 7 million mobile users. The physical network consists of more than 2,000 access, aggregation, and edge sites; 400 fiber optic rings; and 10,000 cell sites.

### Residential Market Segment

The residential market segment assumes voice, video, and Internet access service delivered over IP/Ethernet access facilities. Figure 1 provides a traffic projection for the entire model network<sup>3</sup>.



**Figure 1. Residential Traffic**

Residential traffic increases throughout the entire study period. The growth is driven by the steady increase in market penetration of the IP/Ethernet service offerings and the increasing percentage of video content in Internet access service. Note that video on demand (VoD) and Internet access account for nearly all of the traffic.

### Enterprise Market Segment

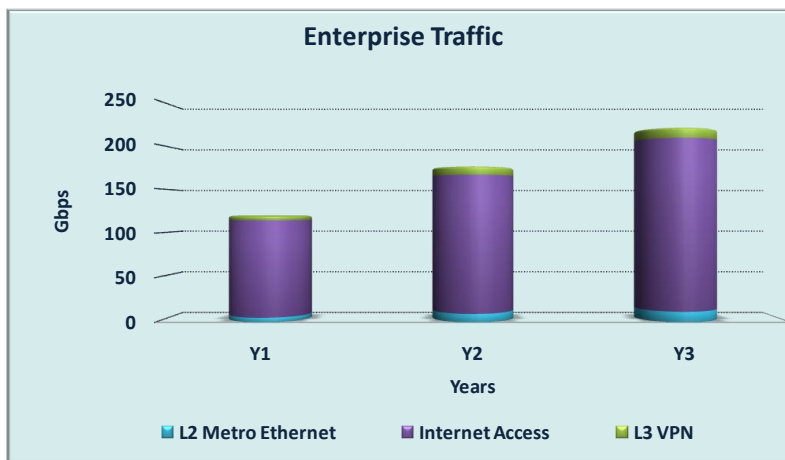
The enterprise market segment assumes Internet access, L3 VPN, and L2 Metro Ethernet services. Many Internet access and L3 VPN services are carried over E1/T1 circuits. However, the E1/T1 circuits are giving way to Carrier Ethernet transport services. The traffic forecast projects that E1/T1 transport is

<sup>1</sup> Total Cost of Ownership (TCO) is the sum of capital expense (CapEx) and operations expense (OpEx).

<sup>2</sup> Payback is the time required for project cumulative discounted net cash flow to reach the breakeven point.

<sup>3</sup> The Cisco Visual Networking Index (VNI) is used to generate all of the traffic projections in this report.

used for 66% of services today and that it will decline to 48% of services by Year 3. Figure 2 shows the overall enterprise traffic forecast.

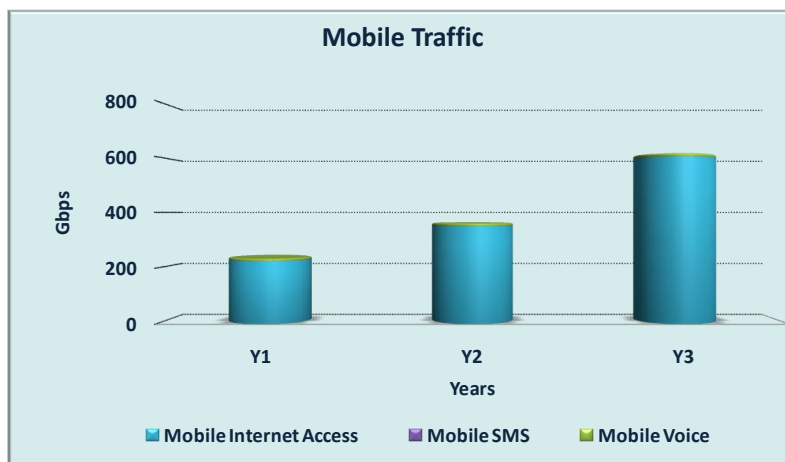


**Figure 2. Enterprise Traffic**

Enterprise Internet access service, which is a common need across large and small enterprises, is the dominant business service that is generating traffic demands on the network. In contrast, L3 VPN and L2 business Ethernet services are primarily used by large enterprises.

### Mobile Market Segment

The mobile market segment assumes voice, Internet and SMS services. Mobile operators are aggressively moving to carrier Ethernet-based backhaul. However, strong demand for mobile services will also drive requirements for E1/T1 backhaul. Service providers will take many years to convert the large installed base of 2G and 3G technology that employs E1/T1 backhaul circuits to more advanced technology. Consequently, a converged services solution is needed to economically deliver mobile backhaul services for both TDM and Ethernet. Figure 3 shows the mobile backhaul traffic projection.

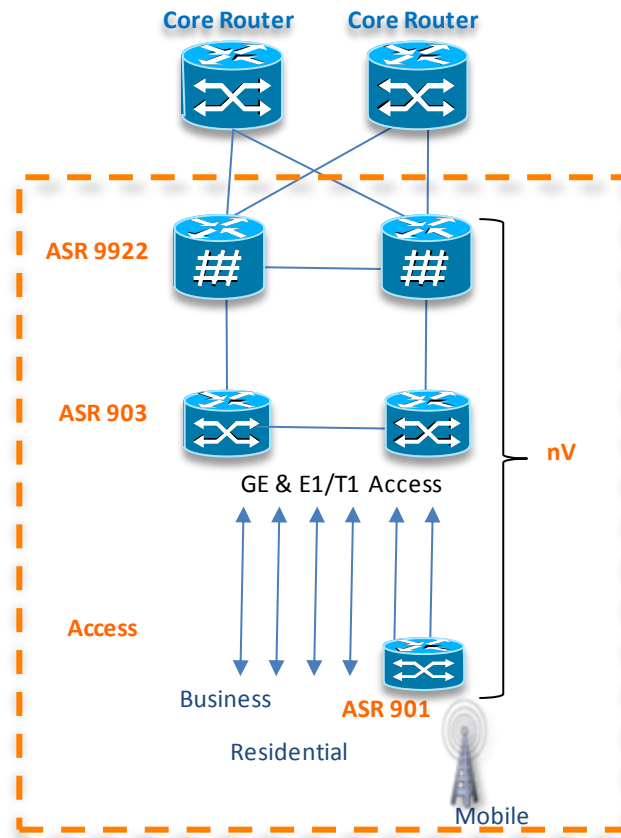


**Figure 3. Mobile Traffic**

Mobile Internet access is the fastest growing mobile service in terms of subscribers and bandwidth per subscriber. It dominates the other mobile services because subscribers are consuming an exploding proportion of video content with its high-bandwidth requirements.

## Cisco Network Virtualization (nV) Technology

Figure 4 shows a network schematic of the nV technology.



**Figure 4. nV Technology**

nV technology employs an ASR 9922 cluster as the edge/aggregation node with the ASR 903 as the pre-aggregation router and the ASR 901 as the cell site router. The ASR 901 and ASR 903 deliver full nV functionality within the ASR 9000 System and support both Ethernet and E1/T1 ports. The 901/903 routers have built-in redundancy and are environmentally hardened.

### nV Technology

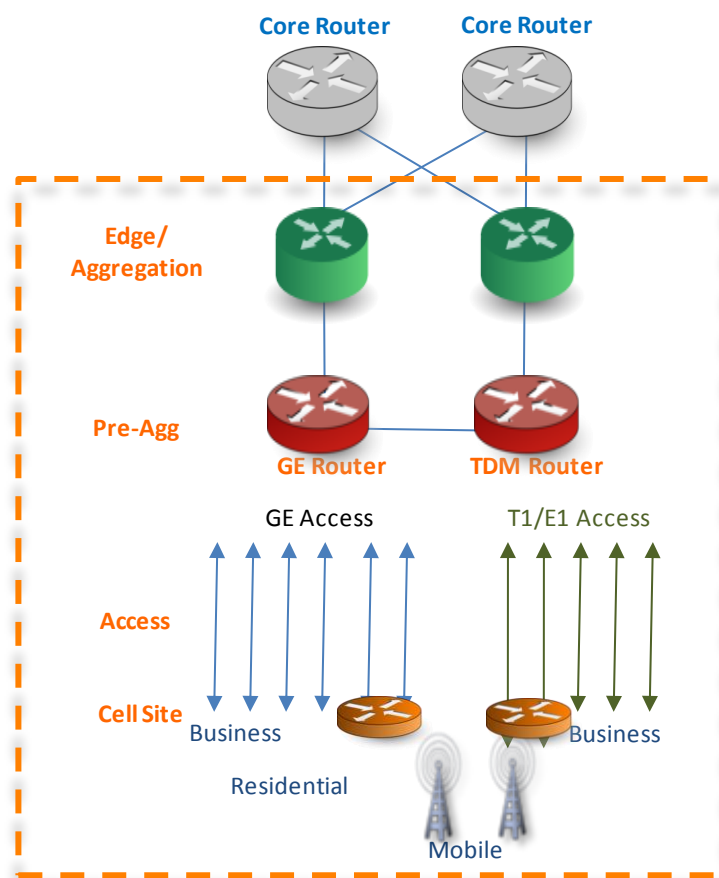
Cisco's nV technology enables the aggregation cluster and the access nodes to be treated as a single router. Its features include:

- Single virtual entity management
- Zero-touch deployment
- Integrated analytics
- One-click software upgrades

Network virtualization provides significant benefits by simplifying the network and delivering a more fully converged solution. Managing the solution as a single virtual entity requires less in-service operational support per element, enables service provisioning once across the network (versus provisioning on each network node), and reduces the configuration and deployment costs when adding devices to the network. Additionally, integrated traffic generation and analytics provide integrated throughput, loss, latency and jitter measurements to ensure service level agreements for newly provisioned services and to troubleshoot customers' issues without sending a truck and technician on site. nV technology supports multiple technologies, including ring and hub and spoke.

## Present Mode of Operations

Figure 5 show the network schematic for the present mode of operations.

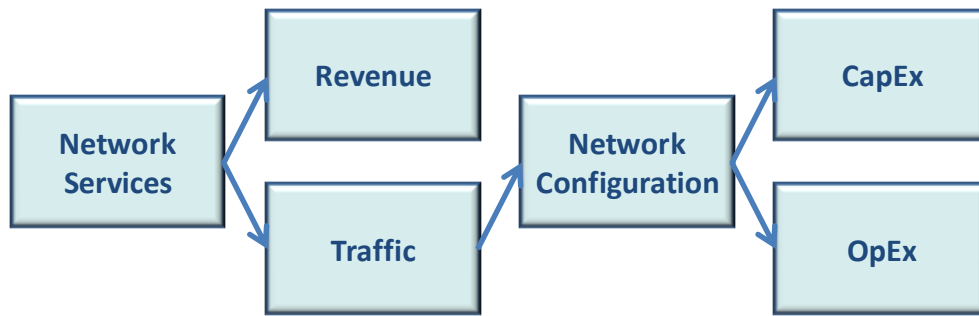


**Figure 5. Present Mode of Operations**

The present mode of operations is based on a leading competitor's converged services solution. With this solution service providers must configure each node separately and must provision new services individually across each node. In addition, the solution requires two separate routers at each pre-agg node for cost-effective scaling connectivity; one for E1/T1 ports and another for Ethernet ports.

## Business Case Modeling Approach

The business model analyzes TCO and cash flow for each alternative over a three-year period. Figure 6 summarizes the modeling approach.



**Figure 6. Modeling Approach**

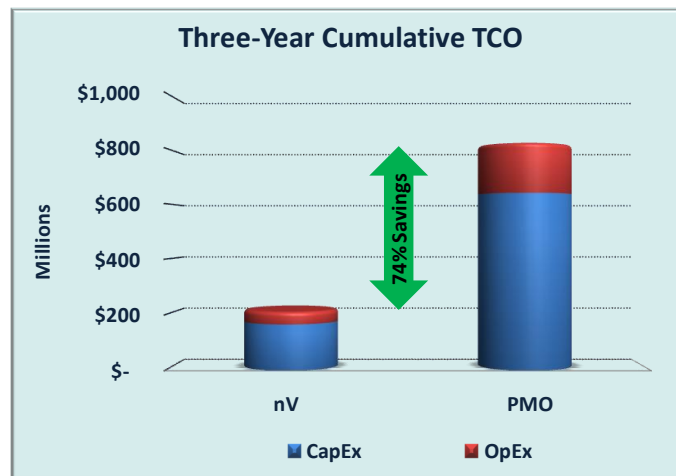
Network services drive traffic and revenue; network traffic drives equipment configurations, which drive CapEx and OpEx.

A detailed OpEx model employs a bottom-up analysis. The components of CapEx and OpEx considered are:

CapEx Categories	OpEx Categories
<ul style="list-style-type: none"> <li>• Average Selling Price (list price with discount)</li> <li>• Engineer, Furnish, and Install (EF&amp;I)</li> </ul>	<ul style="list-style-type: none"> <li>• Power</li> <li>• Cooling</li> <li>• Floor Space</li> <li>• Technical Support and Service</li> <li>• Network Care</li> </ul>

## Business Case Model Results

Figure 7 compares the three-year TCO of the nV technology with the present mode of operations.



**Figure 7. Three-Year Cumulative TCO Comparison**

The nV has 74% lower TCO than the present mode of operations. Both components of TCO (CapEx and OpEx) are lower for the nV technology. The sources of the savings include better port density for the ASR 9000 series, the converged services support of the ASR 901 and 903, and simplification of network operations and provisioning.

### **CapEx Comparison**

Cumulative three-year CapEx is 74% lower for the nV technology as compared to the present mode of operations. The Cisco technology with access routers that accommodate both E1/T1 and Ethernet ports versus the present mode of operations' use of separate chassis contributes heavily to CapEx reductions. Cisco's nV zero-touch deployment feature also provides CapEx reductions by eliminating a substantial amount of engineer, furnish and install (EF&I) expense because features and services are only set up once on the virtual entity rather than for every network element, as required by the present mode of operations. Industry leading port density for the ASR 9922 also lowers CapEx investment.

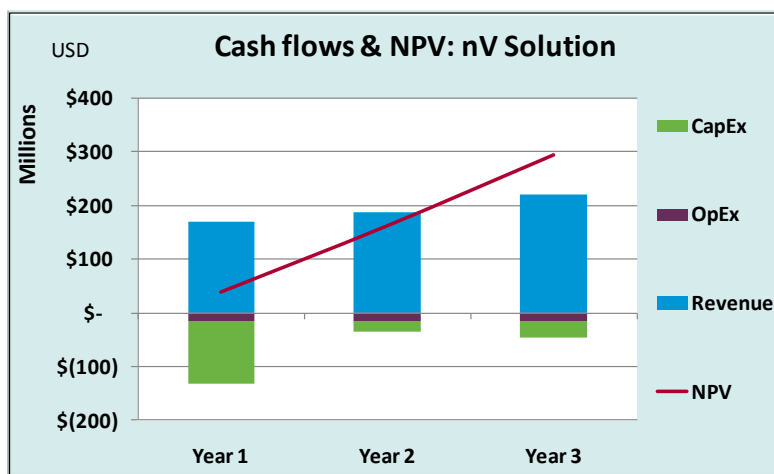
### **OpEx Comparison**

Cumulative three-year OpEx is 75% lower for the nV technology than for the present mode of operations. Technical support and service expense, the largest elements of OpEx, are 76% lower for the Cisco technology than for the present mode of operations. Since CapEx is lower for the nV technology, the technical support and service expenses (based on cost of installed network elements) are lower as well. Network care, the next largest component of OpEx, is 79% lower for the nV technology than for the present mode of operations. The nV technology has lower network care expenses partly because there are fewer chassis to manage and partly because nV simplifies network operations. Work is performed once on the virtual network node rather than repeatedly on each network element, reducing the cost of making network moves, adds and changes. One-click software upgrades ease the rollout of software patches and upgrades. Additionally, integrated analytics reduce troubleshooting and performance management efforts, improve reporting accuracy and enable providers to be more responsive to customers.

Environmental expenses, power, cooling, and floor space for heat dissipation, are all lower for the nV technology as compared to the present mode of operations. These expenses are determined by the power consumed by the installed network elements. The Cisco nV technology consumes 68% less power over three years, thus significantly lowering all environmental expenses.

### **Cash Flow Analysis**

Figure 8 shows a cash flow analysis for the nV technology. Annual net cash flow is computed as allocated revenue (only 2% of service revenue) less annual CapEx and OpEx. Discounting these flows (using a 10% rate) provides estimated project payback. For the Cisco nV network technology net cash flow is positive in the first year, and the investment is paid back in only 10 months.



**Figure 8. nV Technology Cash Flow Analysis**

## Conclusion

Extending nV from the edge to access reduces TCO 74% as compared to the present mode of operations. Integrated traffic analytics offer traffic generation and reporting capabilities without using an external platform. This saves service providers thousands of dollars per service turn-up. To support the massive growth in mobile devices nV technology is now topology agnostic and its latest addition provides support for both ring, and hub and spoke topologies.

CapEx is reduced by the support for converged services of the ASR 901 and ASR 903 routers, the high port density of the ASR 9000 series, and the zero-touch deployment of nV. Labor saving features of nV that lower OpEx include:

- Single virtual entity management
- One-click software upgrades
- Integrated analytics

Additional OpEx is realized by the lower power consumption of the nV technology, which dramatically decreases all environmental expenses.

Cisco has extended nV technology from the edge and aggregation network to the access network with support for residential, business, and mobile services. The nV architecture allows for effective scaling of converged services while maintaining operational simplicity.

## ACG Research

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