The TCO and Environmental Benefits of the Juniper Networks Cloud Metro Network Solutions

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EXECUTIVE SUMMARY

Cloud computing, edge computing, and metro networks are converging as network operators move to 5G networks and evolve to deliver new services. The emergence of disaggregation for the 5G vRAN and separation of the 5G core user and control plane to meet more ambitious service requirements are accelerating this trend. An ACG Research report [1] published in the first quarter of 2022 defined the characteristics, services, and requirements of cloud metro networks. Juniper Networks is leading this network transformation with a new generation of routing systems designed for modern cloud metro networks. Juniper's solution is comprehensive with improvements in router architecture, automation, AIOps, service assurance, and security. The cloud metro solution allows operators to flexibly deploy next-generation metro edge services while reducing network total cost of ownership (TCO), energy consumption, and CO_2 emissions.

This study presents a TCO model of a network of 10,000 cloud metro routers and compares the Juniper ACX7509 Cloud Metro router with a similar generation router from two competitors with significant global deployment. Specifically, we compare three routers:

- ACX7509 cloud metro router
- Competitor A (this is a current generation router from a leading vendor)
- Competitor B (this is an older generation router from a leading vendor with a large global installed base)

Our results show that the Juniper ACX7509 has a TCO benefit of 53% over Competitor A and 71% over Competitor B. Much of this benefit is due to reduced power, cooling, and space. The reduced power consumption of the Juniper ACX7509 in a network of 10,000 nodes results in a CO_2 emissions reduction of 69,765 metric tons compared to Competitor A and 145,063 metric tons of CO_2 emissions compared to Competitor B. The CO_2 savings compared to Competitor A is equivalent to 10.7 cars driven for one year or 6.2 home energy uses for one year. The CO_2 savings compared to Competitor B is equivalent to 22.2 cars driven for one year or 12.9 home energy uses for one year.

[1] https://www.acgcc.com/reports/next-generation-cloud-metro-network-requirements-a/

These savings become larger as the metro networks grow. The environmental efficiency of Juniper's ACX7509 helps drive both TCO savings and reduces greenhouse gas emissions. A summary of power and cooling, floorspace, CO_2, and total OpEx savings is presented in Table 1.

ACX7509 Savings	Competitor A	Competitor B
Power & Cooling	61%	77%
Floorspace	29%	64%
CO_2	61%	77%
Total OpEx Savings (Including Labor)	53%	71%

Table 1. Summary of ACX Savings over Competitor A and Competitor B

This report presents the key components of the cloud metro value proposition and the assumptions and results used in the TCO model.

Juniper's Cloud Metro Value Proposition

Juniper's cloud metro introduces a paradigm shift in how metro networks are designed, implemented, and operated. The new cloud metro networks are designed to scale modern 5G, edge, and multicloud services and provide a high-availability architecture. The key components of Juniper's cloud metro value proposition are:

- Sustainable high-performance metro networking systems
- Cloud-delivered Automation-as-a-Service (aaS)
- AIOps to improve network operations
- Embedded active service assurance
- Built-in zero-trust security
- Converged IP services fabric

The following subsections of this paper discuss each of these functions.

Sustainable High-Performance Metro Networking Systems

The ACX7000 Family of routers form the foundation of Juniper's cloud metro solutions and deliver significant TCO benefits:

- Advanced systems architecture
- AI enabled operations (AIOps)
- Cloud-delivered automation as a service

The ACX7000 family routers allow operators to deliver a rich variety of L2 and L3 services at the metro edge of the network:

- L3VPN
- L2VPN
- BNG
- MPLS
- Segment Routing
- Others

ACX7000 family routers have leveraged the latest generation chip-sets and system architecture design, resulting in lower power consumption and less rack space. In this study, we have chosen the ACX7509, part of the Juniper ACX7000 family, for the TCO and environmental benefit analysis. The systems architecture TCO benefits of the ACX7509 are primarily driven by the following (Figure 1):

- Centralized architecture with orthogonal design and no backplane
- No fabric cards because FEB cards provide both forwarding and fabric capabilities
- Common ports for 1-50GE (SFP)
- Common ports for 10-400GE (QSFP)
- Embeds Broadcom Jericho2c today, ready for Jericho3 for 800GE and beyond
- A smaller 5RU chassis reduces the number of fans required

These features lower TCO for the following reasons:

- ACX7509 supports future generation chip-sets, which extend system lifetime from 3–5 years to 7–12 years
- Extended system lifetime reduces the TCO because forklift upgrades are not required to upgrade router capacity and features with the next-generation chip-sets
- Eliminating fabric cards reduces both power and space
- Getting rid of fabric cards also improves life-cycle management because FEB cards can be upgraded without also needing to upgrade fabrics or forklift chassis
- Eliminating fabric cards decreases the number of components that can fail and therefore improves MTBF and increases service availability
- Common ports for both 1-50GE and 10-400GE allow service instantiation and changes to be done remotely, reducing truck rolls and manually changing hardware
- Lower power and smaller chassis cut down power, cooling, and floorspace expenses
- High-density interfaces and lower cost per port reduces TCO

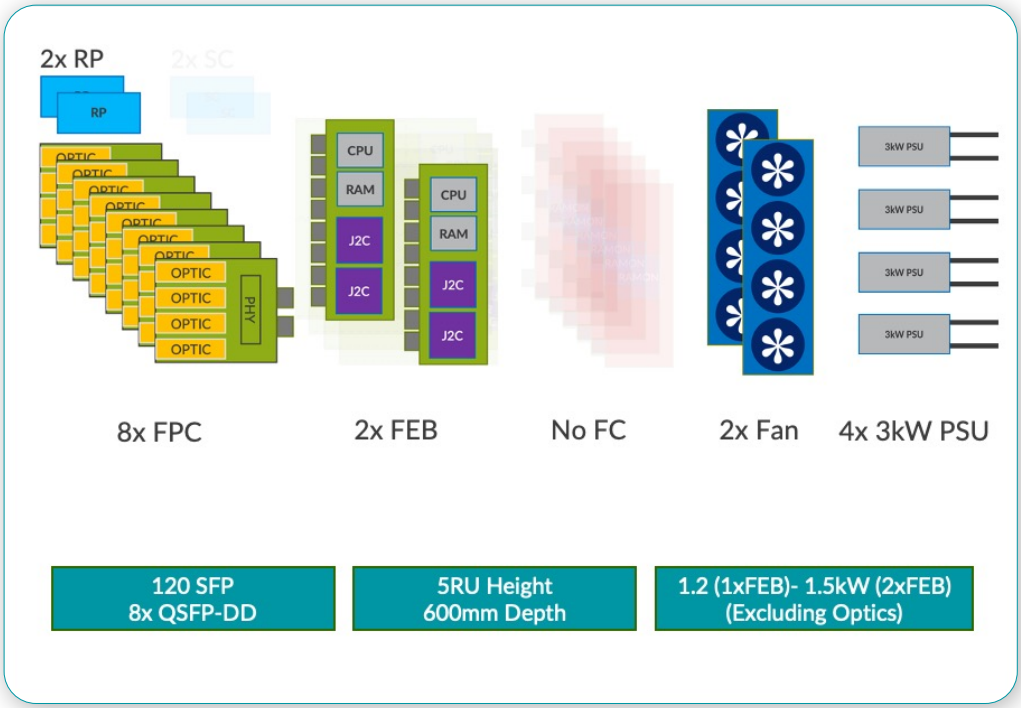

Figure 1. ACX7509 System Architecture

Paragon Automation as a Service

The goal of Paragon Automation as a Service is to provide a cloud-based service to operators providing network automation. Automation as a Service is a consumption-based SaaS service. Today, most operators are implementing multiple types of network automation, but there are challenges:

- CSPs must create and maintain scripts (Ansible, etc.)
- Automation requires knowledgeable staff to implement and maintain automation software and systems
- There is a gap in the marketplace for skilled network/automation staff; this was further increased by the great resignation

Juniper's cloud-delivered Paragon Automation as a Service provides:

- On-boarding new equipment
- Testing new equipment
- Service activation
- Ensuring security

Device onboarding is typically performed semi-automatically with few security and assurance

checks. It is a time consuming and error-prone process that requires significant manual effort. In many cases field technicians must have CLI knowledge, technical documentation, and experience testing network connectivity. The lack of automated oversight translates into costly errors and unacceptable times to market. To ensure secure, fast, error-free deployment at scale, communication service providers need to reimagine their device on-boarding process with automation.

Paragon Automation as a Service allows field engineering to perform on-boarding quickly, easily, and accurately through its mobile devices. In minutes hardware and software authenticity is validated, latest software is imaged, secure zero-touch configuration and provisioning is completed, additional device health checks and network performance tests are done before the inventory is updated, resulting in devices that are fully ready for service. This is more than ZTP. Traditional ZTP implementations are limited to automatic configuration while Paragon Automation as a Service provides secure ZTP, device trust validation, device health checks, and network connectivity and performance testing. These features are automated and do not require manual intervention.

The key benefits of Paragon Automation as a Service are:

- Accelerate time to revenue at global enterprise and CSP scale with instant device onboarding
- Ensure network trust with device integrity, compliance, and health checks
- Guarantee device performance and service quality
- Provide error-free deployment, avoiding costly mistakes by getting it right the first time
- Reduce the skill-sets required by technicians
- Decrease the labor expense required to install network devices

Given that there are tens of thousands of routers in a metro network these savings are significant.

AIOps

The Juniper AIOps uses a combination of artificial intelligence, machine learning, and data science techniques to optimize users' experiences and simplify operations. Data is ingested from network elements for end-to-end insight into users' experiences. Service quality, networks, and network elements are monitored to determine normal behavior and establish baselines. After establishing normal behavior, cloud-based AI/ML continues to monitor the network and automatically detects and diagnoses problems. Some problems can even be identified before the end user can detect them. AIOps also provides optional auto remediation. In some cases, operators will want auto remediation for some problems and manual remediation for other more complex problems and higher risk scenarios.

One of the main benefits of a SaaS based AIOps solution is that we can better train algorithms by using anonymized data from multiple situations. The benefit is a better AIOps solution for all.

Predictive maintenance is another benefit of AIOps. Predictive maintenance is a technique that uses data analysis tools and techniques to detect anomalies in operations and defects in equipment and processes so they can be fixed before they result in failure. Ideally, predictive maintenance allows the maintenance frequency to be as low as possible to prevent unplanned reactive maintenance without incurring costs associated with doing too much preventive maintenance.

The Juniper Paragon Automation AIOps solution is based on both device telemetry and active service assurance. Service assurance and customers' experiences are optimized by actively monitoring quality, not only focusing on device telemetry like most other solutions in the market today.

The key benefits of the Juniper Paragon Automation AIOps solution are:

- Change network management from reactive ops to proactive ops
- Reduce the required skill levels of engineers and technicians managing the network
- Shorten training times
- Decrease mean time to repair problems
- Improve network availability and performance
- Maintain customer service level agreements

Reducing labor expense while improving network availability and performance is the main TCO benefit of the Juniper Paragon Automation AIOps solution.

Embedded Active Service Assurance

High-quality service assurance is a key success factor in every network. Although effective service assurance depends on effective fault management and AIOps, it is also important to actively monitor network performance to find problems before users or systems can detect them. Most service assurance monitoring uses either:

- Passive traffic monitoring
- Active probes inserted in the network to generate and monitor traffic and detect performance problems

Juniper's Paragon Active Assurance is embedded in the ACX7000 routers; an active probe is not required. It is a programmable, active test and monitoring solution for physical, hybrid, and virtual networks. Unlike passive monitoring approaches, it uses active, synthetic traffic to verify application and service performance. Service monitoring is delivered throughout the life of the service. Active Layer 2–7 service testing verifies that services are configured correctly the first time and ensures that service changes do not impact service quality. It provides detailed reports and alarms to alert operations of network performance problems. Because Paragon Active Assurance is embedded in the ACX7000 routers, there is no need for additional servers, probes or virtual machines (VMs) to install test agents. Where Juniper ACX7000 routers are not present, software test agents can still be deployed as VMs or as container applications or on bare-metal x86 hardware to meet multivendor testing needs. This reduces CapEx and cuts the cost of integrating and deploying agents. High-quality service assurance is critical because it improves customers' satisfaction and reduces churn.

Built-In Zero-Trust Security

Cloud Metro networks can have tens of thousands of routers deployed. There is a high risk of routers being compromised and the results can be catastrophic. The consequences of security breaches are high. Zero trust, the security principle of "never trust by default, always verify" has become a best practice across industries.

A recent report from Microsoft has quantified the economic impact of zero-trust solution. The following are some highlights from the report[2] :

- Three-year **92% return on investment** with a payback period of fewer than 6 months
- **50% lower chance of a data breach**
- Numerous **efficiency gains of 50% or higher** across security processes

The cost of security breaches is significant and implementing zero-trust security is critical to reducing the risk of network security breaches. All Juniper ACX7000 routers have built-in zero-trust security. DevID with TPM 2.0 hardware and software attestation validates the identity, authenticity, and integrity of each device. This is especially important in a cloud metro network that can have tens of thousands of devices deployed in unsafe locations such as street cabinets. It reduces the risk of counterfeit products or routers without proper software releases being deployed. In contrast, without these security capabilities, routers can be compromised and used to launch DDoS attacks as botnets. In addition to device security, it is also important to ensure data security, for example, protecting data-at-rest with native file encryption and data-in-transit with MACsec.

[2] https://www.microsoft.com/security/blog/2022/01/12/microsoft-zero-trust-solutions-deliver-92-percent-return-on-investment-says-new-forrester-study/

Converged IP Services Fabric

Cloud Metro reimagines today's siloed, point-to-point metro networks as a versatile IP services fabric that enables "Any Service, Any Place, Any Device" connectivity for distributed edge clouds and applications. It offers the ability to intelligently steer traffic not just to central data centers, but across multiple hubs (Edge Cloud), vaults and caches within the metro domain. These capabilities enable a more intelligent and future-ready metro with improved latency and bandwidth efficiency.

TCO Model Framework and Assumptions

The focus of this TCO model is on the OpEx benefits of the ACX7509 router. The objectives of the OpEx model:

- Compare power and space expense of the ACX7509 with two other industry-leading routers and show the OpEx benefits in a large cloud metro network
- In the same network show the OpEx benefits of AIOps as compared to a similar network without AIOps

In this model we compare three routers:

- ACX7509
- Competitor A (this is a current generation router similar to the ACX7509 from a leading vendor)
- Competitor B (this is an older generation router from a leading vendor with a large global installed base)

Table 2 depicts the power and space requirements for each router:

Router	Kwatts	RU	Monthly Power Expense	Monthly Cooling Expense	Monthly Space Expense
ACX 7509	1,167	5	118	47	90
Competitor A	3,008	7	303	121	126
Competitor B	4,995	14	503	201	252
ACX Savings vs Competitor A	61%	29%	61%	61%	29%
ACX Savings vs Competitor B	77%	64%	77%	77%	64%

Table 2. Power and Space Requirements for Each Router

ACG Research used its Business Analytics Engine (BAE)[3] to model and compare the OpEx of the ACX7509 with Competitor A and Competitor B routers. The BAE is a visual, cloud-based economic simulation engine that calculates TCO and return on investment for many IT and network use cases. Figure 2 presents the high-level input to the BAE. In this analysis we assume a large cloud metro network that starts with 2,000 edge service routers and grows to 10,000 routers over five years. We also consider the following categories of labor:

- Change management
- Hardware replacement
- Help desk
- Fault management
- Performance management
- Software upgrades

Table 3 presents these categories of labor and the savings. Most of the savings are due to AIOps network management automation; however, the hardware replacement savings are due to the ACX7509 architecture that has fewer physical components (no fabric cards) and flexible ports that can be configured by software. This leads to reduced truck rolls and hardware replacement costs.

FTE Name	ACX 7509 Savings	Notes
Change Management with Alops	10%	Due to AIOps
Hardware Replacement with Alops	20%	Due to reduced truck rolls result of HW architecture
Help Desk Trouble Tickets with Alops	60%	Due to AIOps
NOC Fault Management with Alops	70%	Due to AIOps
Performance Management with Alops	70%	Due to AIOps
Software Upgrades with Alops	10%	Due to AIOps

Table 3. Categories of Labor and ACX 7509 Labor Savings

[3] https://www.acgbae.com/

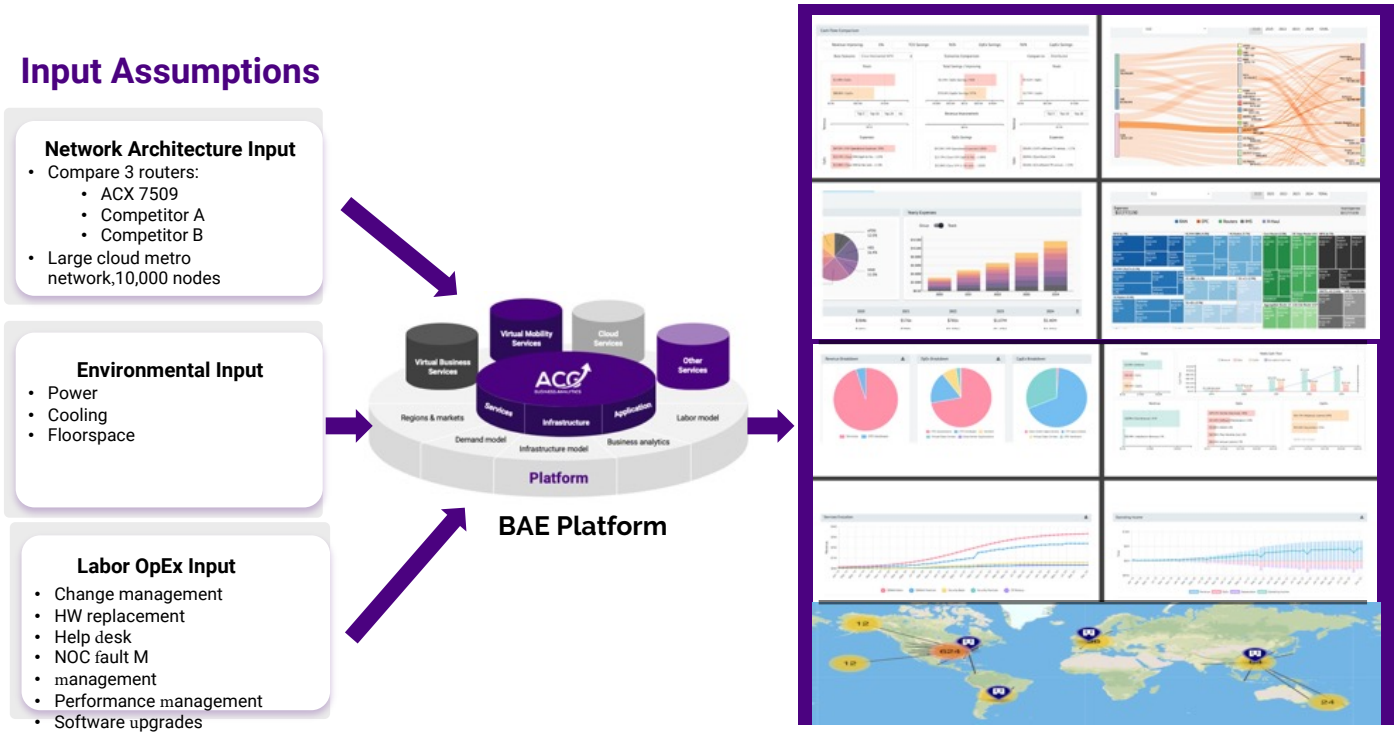

Figure 2. BAE Input Assumptions and Cloud-Based Economic Simulation

TCO Results

In this TCO analysis we consider OpEx for power, cooling, floorspace, and network management labor expenses. We also examine the environmental benefits of lowering power consumption to reduce CO_2 emissions. The results show that the ACX7509 significantly reduces both OpEx and CO_2 emissions compared to the competitive products. In a large metro network the reduction in environmental expenses associated with power, cooling, and floorspace are significant. Table 4 presents the cumulative five-year environmental OpEx for each alternative and shows the ACX7509 environmental expense savings.

	Five-Year Cumulative Environmental OpEx	ACX 7509 Savings
ACX7509	$90.9M	N/A
Competitor A	$196M	54%
Competitor B	$341M	73%

Table 4. Five-Year Cumulative Environmental OpEx with ACX Savings

In addition to the reduction in power, cooling, and floorspace expenses, AIOps reduces network operations labor expenses. Table 5 shows the five-year cumulative OpEx and the ACX 7509 savings. The savings are 53% when compared to a current generation router from a leading vendor and 71% when compared to a legacy platform from a leading vendor with a very large installed base. The benefits of the ACX 7509 architecture with reduced power consumption and lower footprint combined with the AIOps benefits are the drivers of these OpEx savings.

	Five-Year Cumulative OpEx	ACX 7509 Savings
ACX7509	$107M	N/A
Competitor A	$229M	53%
Competitor B	$347M	71%

Table 5. Five-Year Cumulative OpEx and ACX 7509 Savings

We compare the five-year annual OpEx spend for the ACX 7509, Competitor A, and Competitor B (Figure 3). The OpEx grows as the network increases from 2,000 routers to 10,000 routers. The key point is that as the network expands, the difference in OpEx expenses between the ACX7509 and the competitors becomes greater.

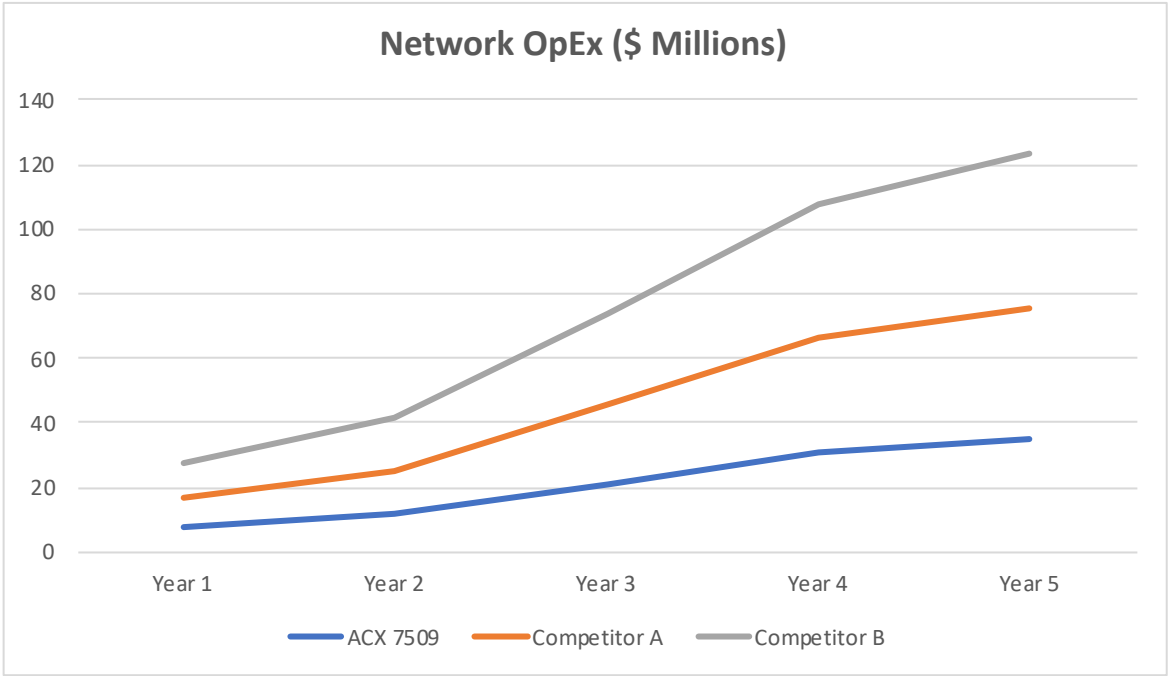

Figure 3. Five-Year Annual OpEx Spend for Each Alternative

Figure 4 shows the five-year cumulative OpEx savings comparing the ACX7509 with Competitor A, and a similar OpEx breakdown for Competitor B is presented in Figure 5. The diagrams show the savings both in absolute dollars and as a percentage. In both cases power, cooling, and floorspace account for most of the savings because we considered a large and growing metro network where environmental expenses are significant.

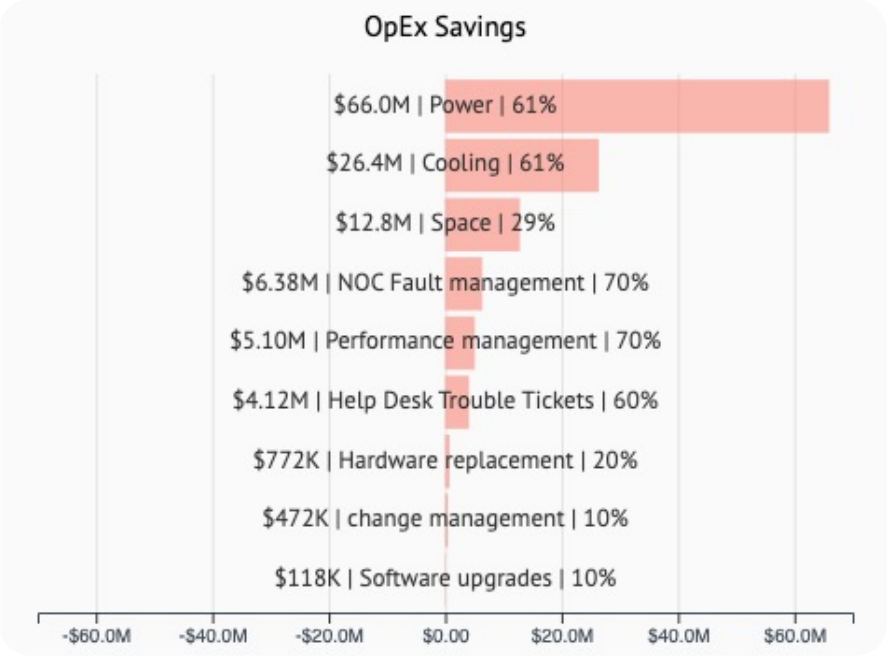

Figure 4. Five-Year Cumulative Breakdown of OpEx for Competitor A and ACX 7509

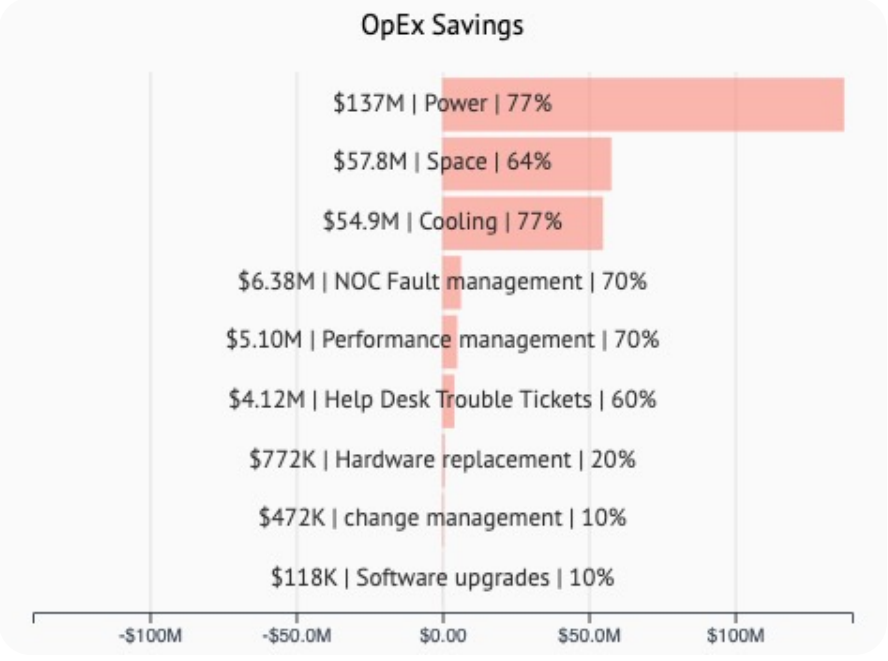

Figure 5. Five-Year Cumulative Breakdown of OpEx for Competitor B and ACX 7509

In addition to reducing OpEx, the decreased power consumption of the ACX7509 lowers CO_2 emissions. Table 6 shows the total power consumption, CO_2 emissions, and CO_2 savings for a network of 10,000 metro routers. The CO_2 savings compared to Competitor A is equivalent to 10.7 cars driven for one year or 6.2 home energy uses for one year. The CO_2 savings compared to Competitor B is equivalent to 22.2 cars driven for one year or 12.9 home energy uses for one year[4]. These savings become greater as the metro networks grow.

Router	Annual Kwatts/Hours	CO_2 Emissions Metric Tons	CO_2 Savings Metric Tons	Cars Driven for 1 Year	Homes Energy Use for 1 Year
ACX 7509	102,229,299	44,224	N/A		
Competitor A	263,500,800	113,989	69,765	10.7	6.2
Competitor B	437,562,000	189,287	145,063	22.2	12.9
ACX Savings vs Competitor A	61%	61%			
ACX Savings vs Competitor B	77%	77%			

Table 6. Power and Space Requirements for Each Router

The results of the TCO model show that the ACX7509 has significant OpEx benefits and CO_2 emissions savings over competitive platforms. The dollar value of these benefits becomes larger as the edge network grows. The environmental benefits also increase with the size of the network.

[4] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results

Conclusion

This report provides an overview of Juniper's cloud metro solution and value proposition. Juniper's cloud metro is a holistic solution providing:

- Sustainable high-performance systems
- Cloud delivered Automation-as-a-Service
- AIOps to improve network operations
- Embedded active service assurance
- Zero-trust security
- Converged IP service fabric

ACG Research developed a TCO model that showed significant TCO savings when compared with two competitive metro routers. The model showed significant reductions in CO_2 emissions because of power decreases in the network. As edge computing and cloud metro networks continue to increase, minimizing both TCO and CO_2 emissions is necessary to improving service profitability and decreasing the environmental impact of networks. This benefits people and the planet while increasing profits.

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