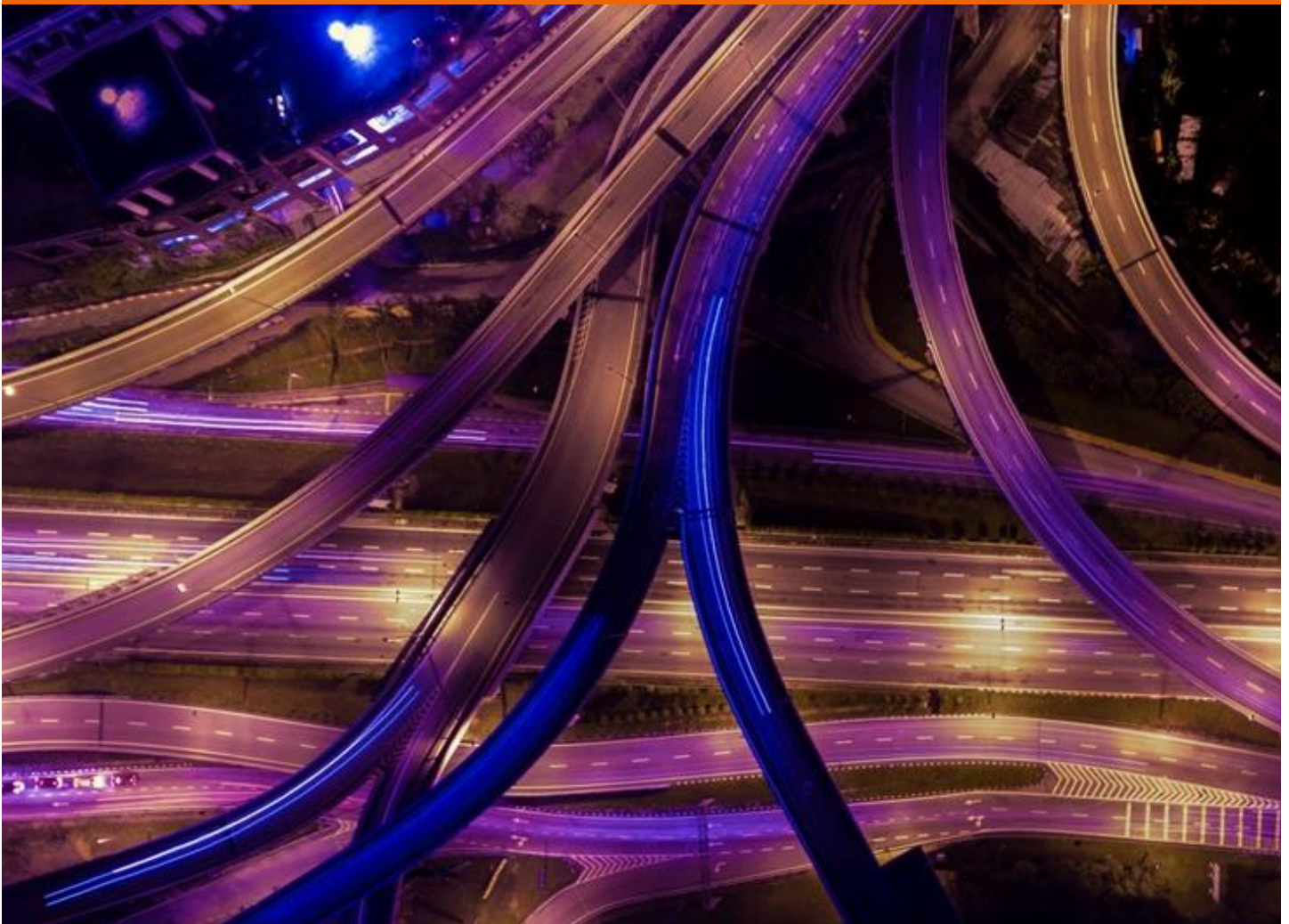October 2023

Juniper Paragon

Automation in the IP Domain

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INTRODUCTION

This solution profile is part of a series that accompanies our new [market outlook report](#) on automation in the transport domain. This research looks at the state of the art in automating transport networks and services. Our focus is on L2/L3 services, but with full observability of Layers 0/1. This profile focuses specifically on **Juniper Paragon** solution for transport domain(s) automation.

Our research on transport is part of Appledore's focus on the software, technology and processes that will be necessary to transform networks and services from their static and labor-intensive current state to a dynamic, often cloudified, and highly automated future state. We believe that the objective of automation must be far broader and more strategic than mere cost reduction. Rather, automation must also enable an increase in agility and cost-effective innovation in the emerging digital economy. Appledore is conducting complementary research in the areas of end-to-end service innovation, the automation of data centers in telco cloud infrastructure, and Open RAN. Critical to, and supporting all of these, is our [research stream in AIOps](#) and the application of machine learning (ML) to all domains.

Without transport domain automation, network slicing is impractical; service providers will forego significant new revenues in the enterprise WAN segment, and new innovative services will languish either because they are too difficult to design, too slow to introduce, or too costly to introduce and deliver.

Appledore's generic automation taxonomy specifically relies on autonomic and independent domains – linked together by capabilities such as componentized catalogs and E2E Service Orchestration. Each of these domains implements its own automation and typically orchestration – delivered by specialists in that particular domain (IP, optical, Radio/RAN, etc.). Juniper Networks Paragon supports Layers 1-3 with full correlation and therefore contextual life cycle management.

We encourage readers to first read our [Market Outlook on Transport Domain Automation](#).

JUNIPER NETWORKS CORPORATION

Company Background

Juniper Networks, headquartered in the USA, is one of the leading providers of IP networking gear globally with a comprehensive portfolio of routers, network appliances, SDWAN, and managed wifi. This profile focuses on their management/automation software portfolio which has received growing investment over the past few years, including both organic and through acquisition.

Traditionally, Juniper Networks' management software portfolio has augmented, and been closely associated with its network equipment sales. Juniper Networks, like others, recognizes the growing importance of automation software in our industry, as well as the growing demand for multi-vendor operations, and is strongly responding to both.

The focus and core of Juniper Networks' emerging Paragon Automation software business is support for that IP transport domain "in the large". Juniper Networks has now assembled a portfolio of modular software under the **Paragon** brand that aspires to drive a new level of automation into the Layers 1-3 domain. However, the capabilities of Paragon, and the scope of some of their proof-cases, show that this solution may take Juniper Networks well outside the WAN, as a stand-alone software vendor. We discuss the Paragon portfolio within the transport domain(s) in this profile, with a tight focus on creating, within CSPs, self-managing, automated domains.

Juniper Networks' acquisition of **Netrounds**, now branded [Paragon Active Assurance](#), in late 2020 has greatly expanded Juniper Networks' capabilities recently. Netrounds brought significant IP and testing/assurance capability into Juniper Networks, and forms one of Juniper Networks' differentiators.

Facts & Figures

Juniper Networks' annual revenues were approximately $5.3B USD globally in 2022, of which ~$3.5B USD was products and ~$1.8B USD were associated services. Juniper Networks, like many large firms[1], does not disclose revenues or P&L for all its product lines.

Appledore estimated that in 2022, Juniper Networks' revenues in next-generation "[Network Automation Software](#)" (non-legacy, relevant to Appledore's NAS taxonomy), were ~$70M USD, all in domain management. This number has likely grown since that market share document was published. Therefore, we believe that the majority of Juniper Networks' automation management software business falls into this domain, or closely adjacent domains such as SDWAN. Note this is "next generation" revenue, not total revenue. No doubt, as Paragon has progressed in capabilities and market recognition, Juniper Networks' NAS revenues have risen correspondingly.

Strategy

Juniper Networks is transitioning from being a network equipment provider (NEP), with bundled management software (EMS/NMS for its equipment), to, in Appledore's view, a pair of positionings: first as a supplier of automated complete solutions; and second as a semi-independent supplier of multi-vendor transport automation software. We should note that this is a significant, and recent development, driven both by acquisitions, partnership, and what appears to be significant internal investment in its Paragon portfolio. We note that Juniper Networks has significantly more professional depth in this field, with both market hires and experts that came on through the **Netrounds** acquisition.

Netrounds brings the perspective, use cases and capabilities of ISVs – specifically multi-vendor, and a view beyond the IP domain in which Juniper Networks is so strong. We believe that this may, over

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[1] Ciena, with their Blue Planet subsidiary is a notable exception, and speaks to Ciena's interest in promoting software as a stand-alone business.

time, help Juniper Networks overall expand beyond its existing strengths. In doing so, however, they will meet in the marketplace new, powerful competitors.

Juniper Networks focuses Paragon's differentiation on:

- **Multi-vendor capability** - via standards-based interfaces and models/characterization of third parties.

- **Use-case based** - use only what is needed and pay for only what is used. If CSPs only need to automate one use case to solve an immediate business problem – then that's where they start with Paragon Automation. There's no need to go "all-in," or "boil the ocean" by deploying and training legacy automation systems as one would with most vendor and DIY solutions. With Paragon, CSPs can start small, go fast. CSPs can choose their own adventure across the lifecycle of Plan, Orchestrate, Detect and Assure and Optimize use cases.

- **Active Assurance** – Paragon Active assurance, formerly Netrounds, brings the ability to perform a variety of active tests, both simulating the user experience, crossing domains and allowing for troubleshooting that goes beyond simple data collection and analysis. Active Assurance notably also brings capabilities at the end-to-end service level, and to actively assure (automatically test) technologies beyond the WAN.

- **Managing Complexity** – Through a combination of intent-based automation, domain knowledge baked into analytics, and the ability to perform active assurance. Juniper Networks notes that it is baking its many experts' knowledge into Paragon analytics – allowing those individuals and their experience to scale.

- **Intent-based Network Automation** – Intents are specified through Paragon Automation so that desired outcomes can be continually met. The intent-based network automation approach is taken across both high-level use-cases as well as with lower-level policies to ensure intents are met.

From what we have seen of Juniper Networks' presentations, and discussion with their experts, the Paragon automation portfolio is relatively productized, rather than customized in the field. One notable example of this is the high degree of pre-built integration between the four Paragon modules, forming what they refer to as a "mesh" of integration. This in turn reduces the work that must be done in the field and provides relatively quick turn up of functionality that draws on data from one module further used in another. No doubt there is also a high degree of pre-integration with Juniper Networks' extensive equipment portfolio.

Another example is Juniper's investment in a Paragon Automation core module that handles the intent-driven operations with a proper, model-driven, intent method that unifies on a single method assurance (ingestion of intelligence) and configuration management/fulfilment (resolution actions). We expect to hear more on this capability as it matures and expands.

Figure 1: Paragon Automation integrates assets from across the NAS taxonomy
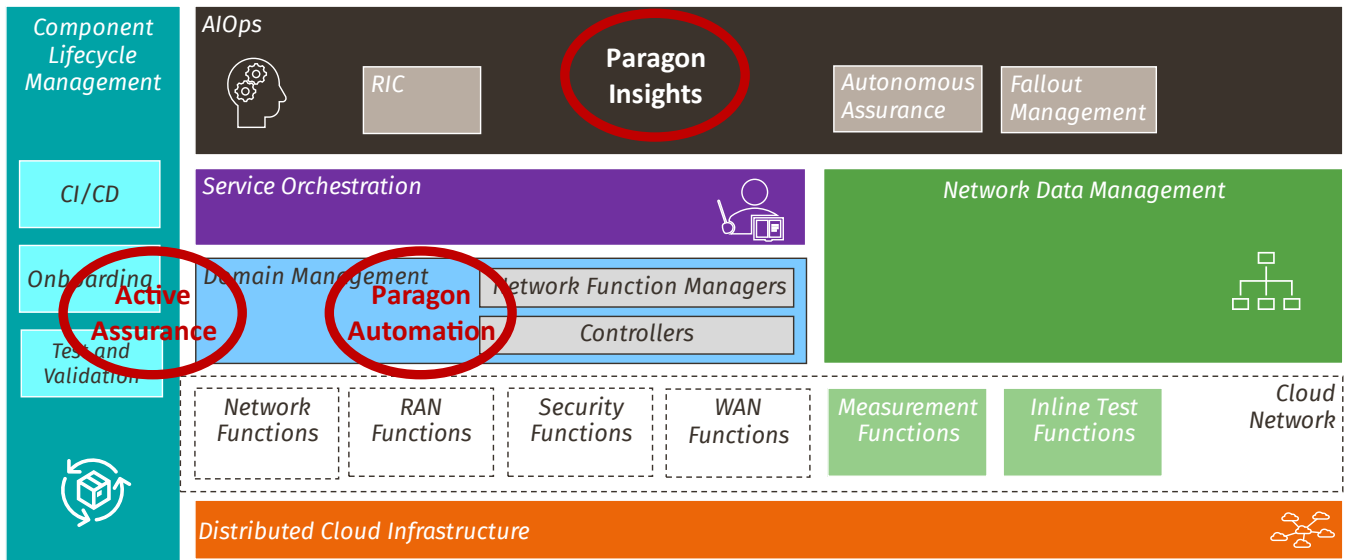
Source: Appledore Research

Above is Appledore's NAS taxonomy, with Juniper Networks Paragon Automation overlaid. While, as a solution for transport, it resides within Domain Management, Paragon integrates functionality that is often standalone within the AIOps (Paragon Insights) and Component Lifecycle Management (Paragon Active Assurance) segments.

SOLUTION DESCRIPTION

Juniper Networks' Paragon Automation suite is composed of four modules. All four are pre-integrated in what Juniper Networks refers to as a "mesh", a reference to multiple integrations such that each module can inform and work with each other module.

Intent is core to Paragon. From everything we have seen, intent is simply part of how Paragon works, and is documented both in Paragon's use cases and flows as well as lower down the "stack" where intent-based orchestration/operations methods must reside to effect a closed loop, or to take performance data and make optimized changes/corrections. Juniper's Intent-based Network Automation with Paragon has initial use-cases for Intent-based Service Orchestration along with Device Onboarding, Device Lifecycle Management, Network Trust and Compliance, Network Observability and Active Assurance.

Juniper is also partnered with **Itential** for method of procedure ("MOP") automation. Itential can also be used as a cross-domain orchestrator and/or for northbound exposure and IT integrations.

As seen in the following illustration, Paragon Automation focuses on allowing for an intuitive user experience through its simple user interface, being use-cased based and enabling AI.

**Figure 2: Juniper Paragon Automation High Level View**
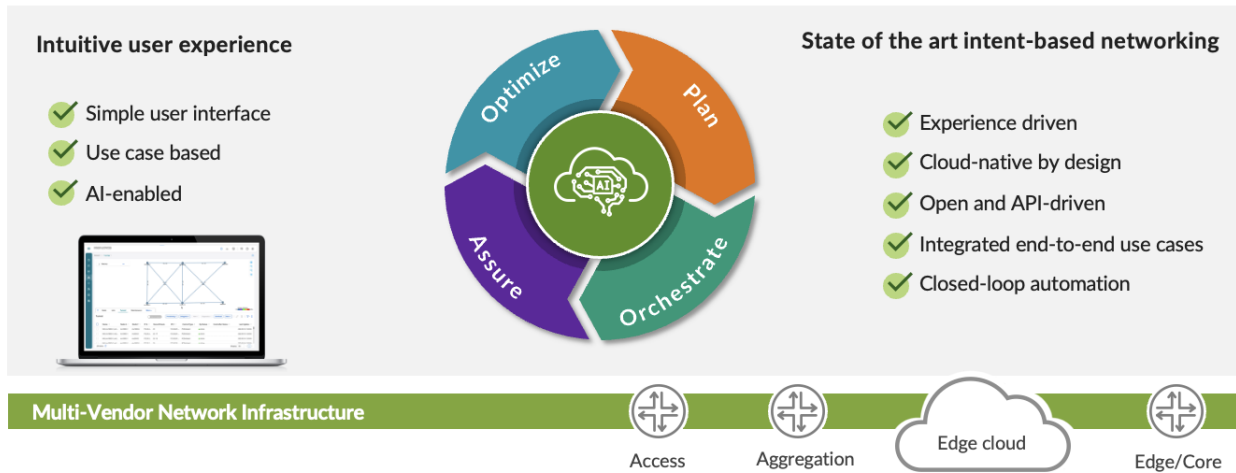
Courtesy: Juniper Networks

From the outside in, it is apparent that Juniper Networks has significantly stepped up its game in the last two years. Today they look far less like an equipment vendor, with supporting software, and more of a vendor of solutions that support modern and automated operations - with or without hardware. Three of the modules are organic Juniper Networks developments (Planner, Insights, and Pathfinder). A fourth, Active Assurance, is the rebranded Netrounds, acquired by Juniper Networks in 2020.

Juniper Networks is clearly focused on automation (it's part of the name of this suite), and similarly on the transport domain - after all, that is Juniper Networks' core business. Many of the use cases, proof points, and emphasized feature sets all point toward a serious, modern focus on automation. That said, Juniper Networks acknowledges that CSPs move cautiously and do not fully utilize all capabilities yet.

The graphic below, courtesy Juniper Networks, depicts the four Paragon Automation Applications. As shown, all share common infrastructure for telemetry, active measurement topology, data normalization, and so on. No doubt this simplifies the aforementioned mesh integration.

Figure 3: Paragon Automation Overview
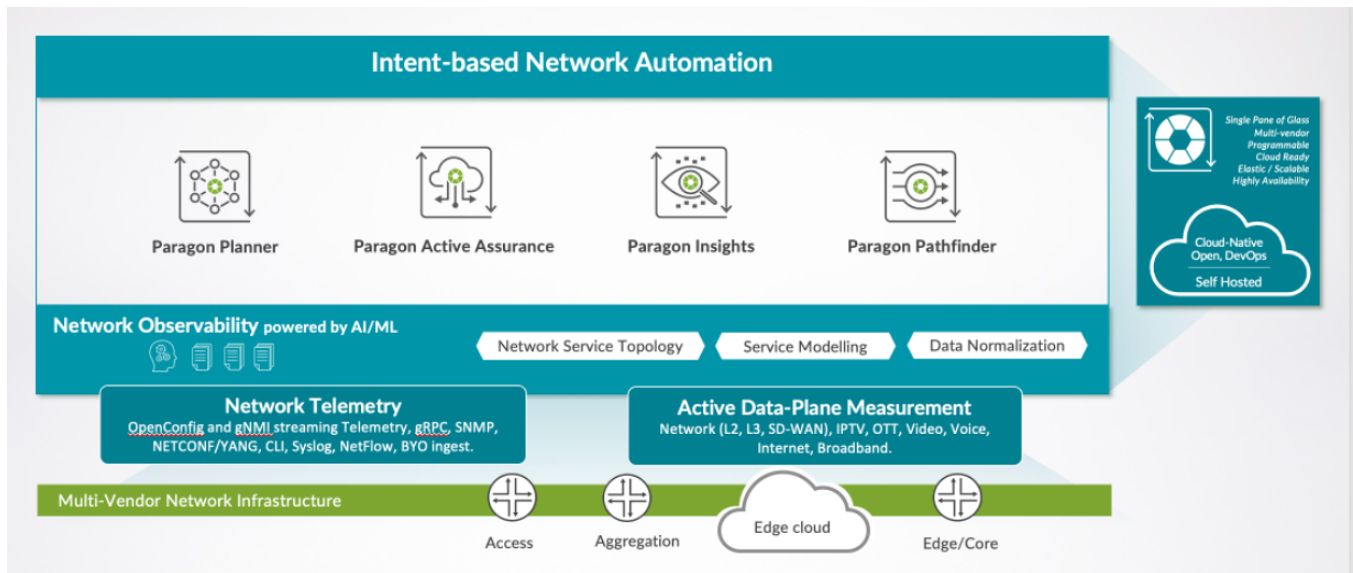
Source: Juniper Networks

The four modules are:

- **Paragon Planner**: Juniper Networks' planning environment provides a simulation environment that works on a snapshot of the network and its traffic, allowing "what if?" scenarios for build outs rearrangements and traffic re-routings. According to Juniper Networks it makes engineers vastly more productive. Appledore wonder when it might operate on a continuous basis in the background?[2]

- **Paragon Active Assurance:** Paragon's interactive and automated assurance platform, based on the effective extension of laboratory testing type technology. It uses a combination of test cases, automated test heads (which might be virtualized or agents within a network function) and automation controllers. Active Assurance has several advantages that complement traditional "data collection with post analytics". First it allows a true simulation of the service in question. Second it allows the deeper more specialized capabilities of test technology to be applied once an unusual situation has been identified. As noted above Active Assurance can be integrated with and triggered by orchestration by any chosen trigger at any point within a network or services lifecycle. While their agents are open, Juniper Networks notes that they are integrating these active agents into all Juniper Networks NFs to speed the practical adoption of automation and reduce complexity.

  Interested readers may wish to see another white paper that Appledore wrote for Juniper Networks in 2022, relevant to this topic, here.

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[2] Juniper Networks comment that this is technically possible today, but most customers are not yet at that point in the maturity curve.

- **Paragon Insights:** Juniper Networks' analytics platform. Insights uses a combination of technologies, including ML, to identify underlying causes, correlate problems with configuration errors and many other data-based findings. Of note, Juniper Networks emphasizes how much of Juniper Networks' "institutional expertise" – the knowledge of their many experts – has been codified into Insights.

  "The combined experience of our engineers gives Insights the ability to detect hard-to-identify 'gray' failures – and silent packet drops, etc." – Juniper Networks briefing to Appledore, Nov 2022

- **Paragon Pathfinder:** Formerly *NorthStar*, Pathfinder is the SDN controller and path computation engine, which works with full observability of the topologies at L1 and L2, and the configuration at L3, so that it can find optimal paths, find diverse paths, maintain data sovereignty, etc. Juniper Networks note that Pathfinder also calculates paths with "full observability of traffic, congestion and performance".

We note that Juniper Networks reports that Paragon automation is "growing by leaps and bounds" (according to Juniper Networks) relatively recently, as the solution gains critical mass, maturity and visibility. These things take time. Juniper Networks also notes that the market is now very receptive, with **automation moving from a nice goal to a real, near-term objective** (but still with cautious implementation). This plays to the Paragon story.

Juniper Networks, while an equipment supplier/NEP, strongly emphasizes their **multi-vendor capabilities** – and the fact that they are proven in the field. Juniper Networks Automation works both through models and normalization of various suppliers (using their NMSes) and, where available, through native standard interfaces.

Below is a functional, graphical representation of the Paragon Automation Applications, courtesy Juniper Networks. It illustrates the underlying functionality that is brought together, along with the rough relationships between them. Of particular note are that 1) Paragon exists as a domain solution, one layer below cross-domain service orchestration, and 2) the focus is on the WAN, as expected, and as relevant to this profile and market outlook report. This is very consistent with domain driven design – which Appledore is a huge fan of in concept. It also means that Juniper Networks is focusing its expertise where it can make the most difference, rather than trying to be everything to everyone and therefore spreading its investment thin.

Without contradicting ourselves, it is also important to emphasize how Juniper Networks is selling this **solution as a service-layer, active assurance solution – traversing the WAN, RAN, datacenter and other (e.g.: third-party) environments** to help first look truly end-to-end with a replication of the customer's experience, and then to dive into specific tests as necessary. This capability is fascinating, but largely beyond the scope of this profile and its associated transport domain market outlook report.

**Figure 4: Paragon Automation Applications: functions view in context of cross-domain service orchestration**
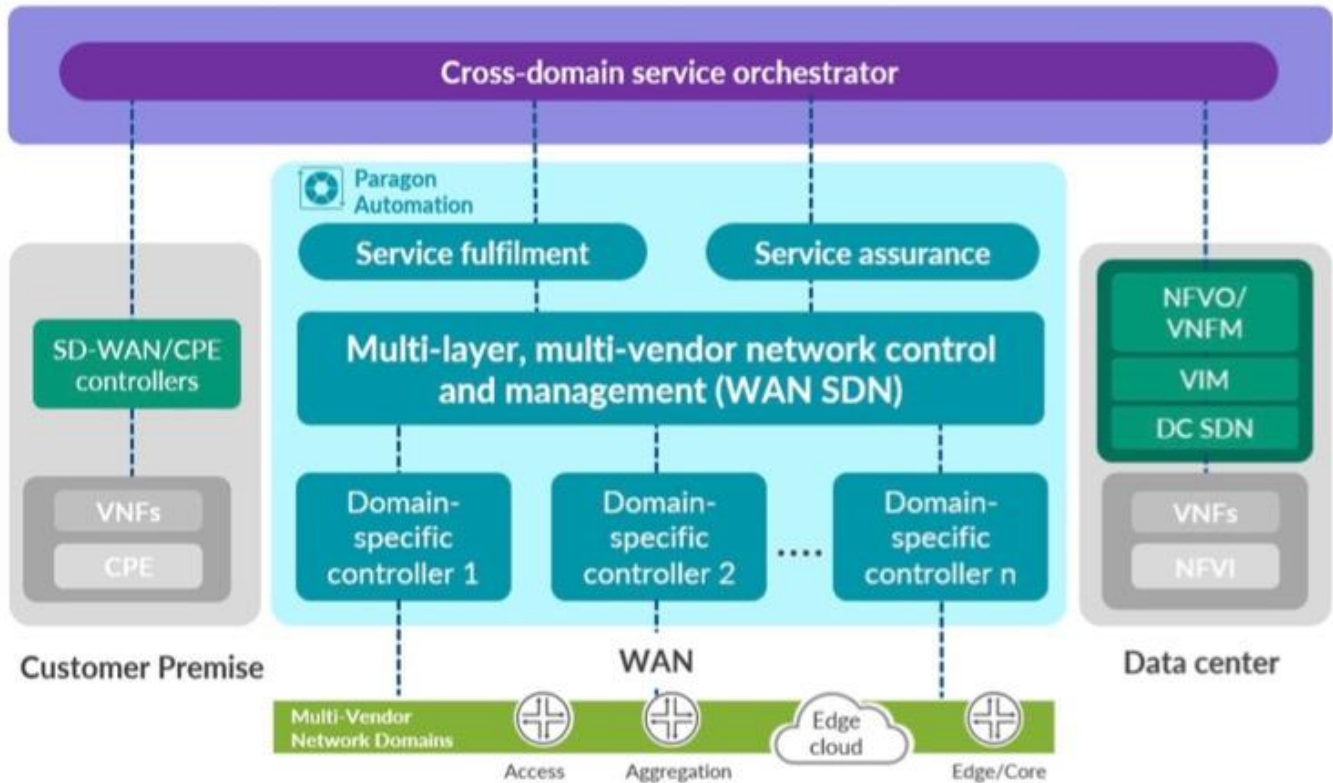
Source: Juniper Networks

Use Cases and Focus

Use cases stand at the heart of Juniper Networks' Paragon development, integration and packaging. Put simply, these use cases guide what and how they develop the Paragon modules, integrate them, and deliver them. The goal is to have concrete uses, pre-built (or at least structured for further customization) that can work out of the box, or shortly thereafter. If there was a box.

The diagram below shows Paragon's use cases, categorized by process area. Its shows that Paragon has flows/cases to automate, or help automate, most of the major activities from pre-Day Zero, through the lifecycle. It also calls out some key areas such as latency-based routing, pre-turn up testing, service-centric assurance (measuring the customer experience, rather than metrics with imperfect correlation), and "AI" (unspecified) based predictive analytics and RCA. What is unspoken here is all under the coordination of Paragon Orchestration, with pre-templated flows. For customers without Paragon Orchestration, Juniper Networks has notes that they have pre-built many automation use cases that can be "called" by any orchestrator.

Figure 5: Paragon Automation Applications (Use Cases)
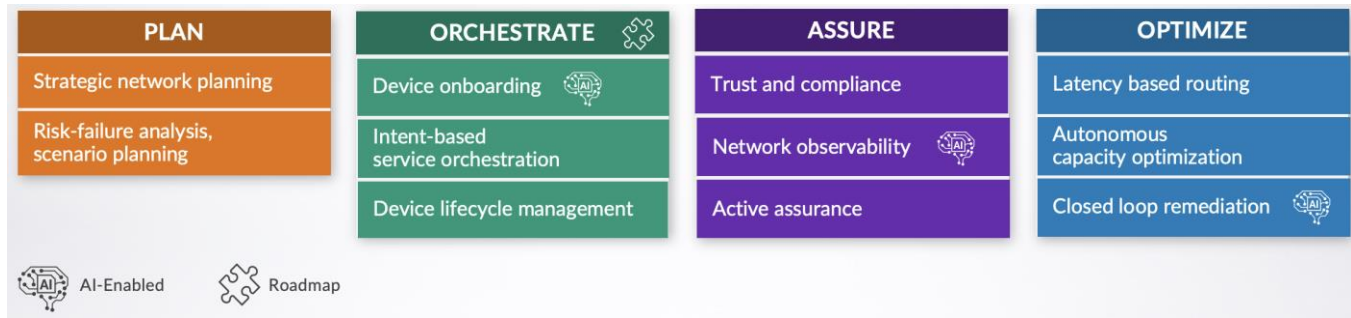
Source: Juniper Networks

Taking an orthogonal view of "use cases", below we look at the **CSP network services that are in Paragon Automation's sweet spot**. Note that this is not a list of all possible capabilities, but rather those that are common, and supported, network and customer services. It also specifically excludes the end-to-end orchestrated active assurance cases, whose permutations are too many to note, and scope is beyond this research stream:

- IP Broadband (access)
- IP core
- Network slicing (transport segments)
- MPLS
- IP-VPNs
- Bandwidth On Demand (dynamic bursting, adjusting)
- Automated Path Computation
- Metro Ethernet / MEF Use Cases
- X-Haul

Many more use cases could be supported with the proper reference data and workflows. Typically, the end service will include some components beyond the WAN/transport access, linked via service orchestration.

MARKET IMPACT

While some players split their focus between service orchestration and various domain orchestration challenges, Juniper Networks focuses more squarely on automation within the WAN/access domain(s), so the majority of their large CSP deployments meet our criteria for relevance in this particular research stream. Note the caveats above with respect to automated assurance.

Juniper Networks claims over 350 deployments of Paragon Automation, and further note that *none* of these are the (prior) legacy EMS solution. Juniper Networks is very open that deployments vary from one of the modules (for example: Pathfinder or Active Assurance), through various combinations, with only a small number being the complete paragon portfolio. However, given the

breadth of Paragon, and the fact that it represents such a huge shift in Juniper Networks' portfolio in only a few years, this ought not be looked down on, but rather as an opportunity for expansion. Appledore further believes that a significant number may be active assurance but outside of the transport domain – on which this research stream focuses.   This is to be expected, and we narrow all of the supplier's numbers down to those that are representative of the capabilities that they represent, and implement the use cases/domain that we are covering.

All of this says that placing a single number on Paragon deployments begs the question "of what?" Therefore, it is reasonable to summarize that there are maybe a dozen broad-based lighthouse deployments, a much larger number that represent the potential of Paragon, and that the majority of the 350 represent a smaller subset, but all the modern characteristic represented to us by Juniper Networks. It's a significant list, especially for a relatively new player.

Below is a summary of the numbers, as well as highlighting a few customer use cases, abstracted for confidentiality.

Metric or Example Deployment	Notes
Paragon Automation Deployment, total	>300 across all components and industries. As explained above this represents a wide set of combinations – from small to complete – but all are claimed to be the current solution, as represented.
Transport Automation Full Deployments	Since Paragon does much more than transport automation, we are taking a slightly more "inclusive" stance here and referring readers to the explanation above, but accepting that all, at least in one segment, represent the current product and direction. CSP, competitor and enterprise discussions make us believe that many are Juniper Networks-only, at least for now.
Verizon Business	As discussed by **Verizon Business** in September 2023 at DTW Ignite in Copenhagen, Paragon Automation measures service quality with active assurance test automation, performs data normalization with analytics, and acts as a self-driving path computation engine for automating remediation through re-routing.
North American Tier 1 Wireless Provider	Automates provisioning of cell-site routers and local datacenters (15K sites in 50 cities). Paragon use cases: Paragon use cases 1) Device turn-up, 2) Zero-Touch Provisioning, 3) Device lifecycle management. Provides network visibility to operations from a single pane of glass (instead of 12 solutions). Lowered the time it takes to provision one cell site from 26 hours to 2 hours.
Tier 2 Global Business Services (Asia-Pacific)	Paragon use cases: 1) Latency based routing, 2) Autonomous capacity optimization, 3) Network observability.

| Metric or Example Deployment	Notes
Tier 1 Service Provider (EMEA)	Comprehensive lifecycle automation to provide broadband (business internet) services to ~10k customers and ~150k endpoints. This example appears to showcase much of Paragon's potential as a suite, covering: • Service-centric assurance. • Network observability. • AI-based network analytics, root-cause analysis. • AI-based predictive analytics. • Latency based routing. • Autonomous capacity optimization. • Closed loop automation.
TELUS	*Note: Telus is 5G-focused, but included since such a significant portion of 5G is x-haul.* Paragon is automating the test, validation, and certification of 5G, reduces service activation testing from weeks to days, and leading to greater customer satisfaction and retention.
Consortium GAAR	Speeds service deployment and automated lifecycle (closed loop) management of an educational broadband network across Italy. Includes workflows, software upgrades, device onboarding, inventory, network management, and configuration management.
DQE Communications	Paragon Pathfinder provides a (what appears to be single vendor) WAN automation solution to this rural/regional Pennsylvania service provider. Functions include simplification of traffic engineering and efficient management of strict transport service-level agreements through automated planning, provisioning, and proactive monitoring of large traffic loads.
Orange Egypt	Uses Paragon Active Assurance to maintain the quality of its mobile subscriber experience with service activation testing, quality monitoring, and troubleshooting. With a proof-of-concept test already in progress, the operations team took swift action to be able to put the solution into production in a matter of days. Again, we include this mobile-focused solution due to the significant transport component, and in the recognition of the value in testing services – across any medium – as the customer experiences it.
Consolidated Communications	Paragon Active Assurance tested and monitored network service performance as the CSP upgraded its core network. Automating testing moved Consolidated from a massive-touch process to a single-touch process.

APPLEDORE ANALYSIS

Network Automation Software Taxonomy position

Juniper Networks Paragon Automation portfolio is potentially much broader than transport domain management. This is not atypical: some vendors apply their "generic" orchestration and AIOps assets, along with WAN specific modules to a transport domain solution, and a similar set to other domains.

On the other hand, some vendors have built WAN-specific domain managers/orchestrators. In the past, in fact, Juniper Network's *NorthStar* (now Paragon Pathfinder) might well have fit the latter model, but today they are setting their sights higher – both within the transport domain and extending beyond it, especially to perform E2E active assurance and targeted active troubleshooting.

At this juncture it is worth repeating a diagram from above, overlaying some of the Juniper Networks assets on the Appledore NAS taxonomy. **This network automation software (NAS) taxonomy** defines a forward-looking set of market segments for automation software. These segments replace traditional "OSS" segments, which are obsolete, and in our opinion do not represent going forward market buying behaviors. Besides being highly modular, our taxonomy emphasizes the existence of many technology domains -- each of which should be self-managing including self-automating. Generally referred to as "domain driven design", this approach simplifies the addition of new vendors and technologies, and greatly simplified upgrades with minimal reintegration -- if any at all.

Figure 6: Paragon Automation, on the Appledore NAS Taxonomy. Note elements of AIOps and CLM.
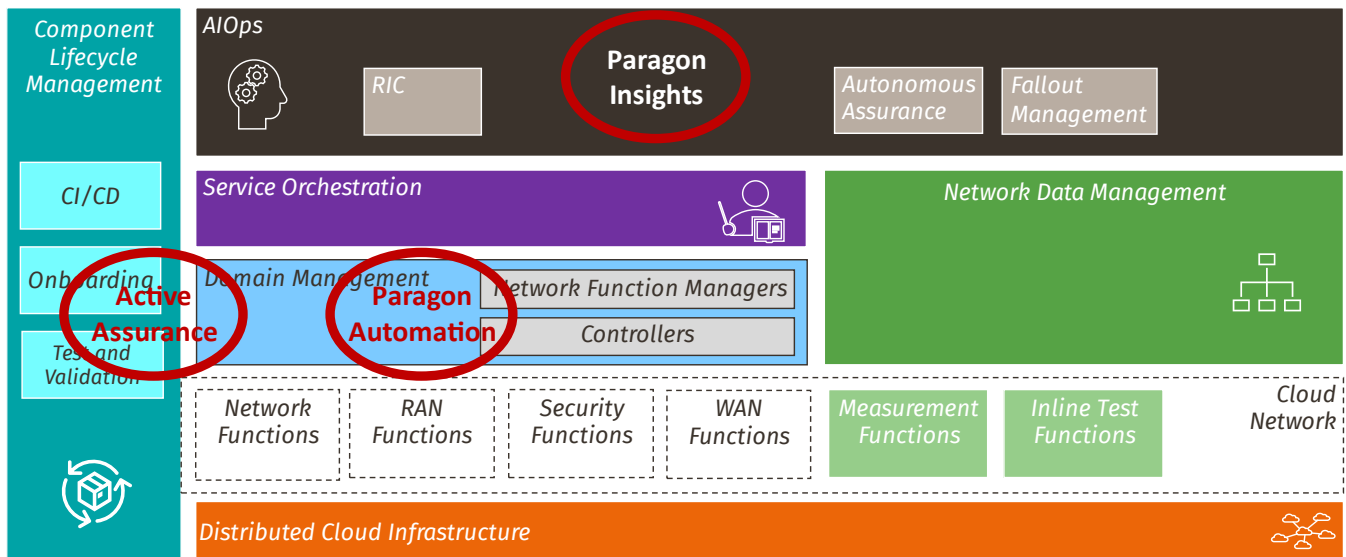
Source: Appledore Research

Juniper Networks' Paragon Automation can be applied to transport of these self-managing domains. It is shown above as one of many domains linked together by end-to-end service automation. Some of Paragon Automation's software modules appear in other parts of the taxonomy as well, illustrating their underlying capabilities and the fact that they can be applied beyond transport.

Active Assurance is the most obvious of these since one of its key attributes is end-to-end service simulation – which often extends beyond transport. Two years ago, this would not have been the case with Juniper Networks. How things change in two years.

Paragon Automation ticks all our operational and technology "best practices" boxes. It provides automation both of lifecycle phases, and also manages automation across layers (L1-3) within transport. It supports multiple vendors both natively and through adaptation to proprietary NMSes. It supports a wide range of both open in standards-based interfaces and APIs. Finally, it is a modern software (micro-services based, CI/CD operations, reference data driven, ...) design that simplifies going forward actions and is highly configurable. In particular, Juniper Networks went to great length to document their use case approach, and their core implementation of intent. They further shared some proof points from the market – some public, other which had to be abstracted but in fact represent some of the most impressive work.

These market evidence points show Juniper Networks' growing success and validate their claims for Paragon. While the "300 deployments" is likely a distraction, the growing number of significant recent wins in the CSP market show growing momentum, and satisfied customers.

We believe that the approaches taken within Paragon are solid, and in keeping with the direction that the industry is moving, and moreover, must go in the near future. Automation is essential. Paragon is built around automation and deserves attention.

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