

An ADTRAN White Paper



Building a Network with ADTRAN

From Headend to Customer Premises

Building a Network with ADTRAN

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Gigabit deployments are unfolding at an incredible pace. Service providers, looking to transform the internet experience of consumers with life-changing hyper-speed connectivity, often have the arduous task of not just laying fiber but also planning, building, and installing the network within. Through this network, subscribers connect to the Internet and access to many applications and services, including voice, data, and video.

The goals of high-performance optimized networks require a holistic understanding of the end-to-end network and the many ways in which it can be deployed. The many skills needed to architect, design, and configure such a network are a premium and often needed temporarily to fulfill a specific project timeline. The skills needed to maintain the network are fewer and the tasks simpler. These skills are also in short supply, as we see an explosion in the number of Alternative Network Operators across Europe and a sharp rise in the demand for core and access network specialist skills. However, many of these demands are temporary. A service provider shouldn't have to incur heavy operating expenses to permanently hire very specialized resources when they can have access to these services through a trusted partner.

ADTRAN can help you build, plan, or extend your wired or wireless broadband network. We support a full spectrum of turn-key services related to field survey, planning, engineering, installation/turn-up, and provisioning. As a certified Juniper partner in the UK and Ireland, ADTRAN brings expertise to cover all aspects of network design, deployment, and maintenance. With over 35 years of designing, manufacturing, and deploying broadband solutions, ADTRAN has the services, technology, and operational expertise needed to successfully elevate your network, improve operations, and boost subscriber experience. Through our partnership with Juniper, we offer expertise across both core and access technologies, providing the necessary resources to you to ensure that you have access to experts when you need them, without exposing yourself to delays and burgeoning costs.

In this whitepaper, we will provide a set of principles and guidelines to inform a Service Provider and provide an overview on how to design an end-to-end network correctly.

ADTRAN- Juniper Partnership

At ADTRAN, we provide a complete portfolio of solutions for next generation fibre access systems and a suite of business and residential customer premises equipment (CPE) and residential gateways (RGs) with Wi-Fi 6 capabilities. Our turn-key systems integration services cover all aspects of design, integration, and field deployment of fibre access systems.

ADTRAN is a proud Juniper Networks partner for network gateway and aggregation at the core. As the routing and switching platform of choice for service providers, Juniper products complement ADTRAN's Broadband Access portfolio to provide a complete end-to-end best-in-class Service Provider network. ADTRAN's understanding of the access network requirements allow us to understand what is needed from the aggregation site all the way into building - a solid core network that can scale to meet ever-increasing demands.

ADTRAN became a Juniper Networks partner in 2019 and has already attained Select Partner and Service Provider Plus status. ADTRAN and Juniper have a shared philosophy on open networking. ADTRAN and Juniper together provide an end-to-end solution that is powerful, scalable, flexible, and reliable to meet service provider's needs of today and tomorrow.

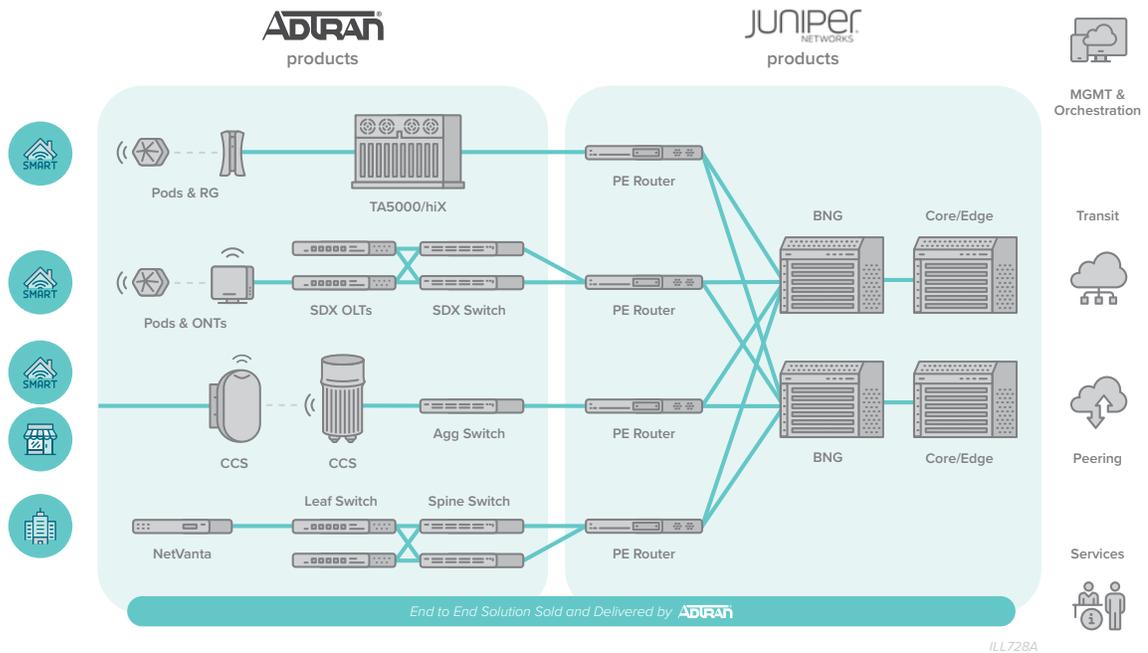
Benefits of the ADTRAN-Juniper Partnership:

- **Market Leadership Together**
ADTRAN and Juniper are a leading provider of complementary broadband access, aggregation, and core solutions in Europe.
- **Broadest Portfolio**
Complete end-to-end network solution from the subscriber edge to the core with leading innovations in disaggregated SDN-ready networks, 10G PON solutions, and powerful OS solutions with MOSAIC and JUNOS.
- **Reliability**
Proven solution for high availability, resilience, and performance with an open, standards-based approach
- **Trusted Partner**
Decades of operational expertise in design, manufacture, and deployment broadband solutions.

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Components of an End-to-End Network

An end-to-end Fibre-To-The-Premise (FTTP) network, in its simplest form, consists of a Layer 3 (L3) Broadband Network Gateway (BNG), aggregation switches, DHCP servers, RADIUS Servers, DNS servers, a Layer 2 (L2) Passive Optical Network (PON) access switch, an Optical Network Unit (ONU), a residential gateway with Wi-Fi routers at the subscriber premises, and a management platform for commissioning and control.



The BNG sits at the backbone or physical core of a network. It is a high-capacity device that serves as the gateway to the Wide Area Network (WAN) or the internet. A BNG architecture is designed to do the following:

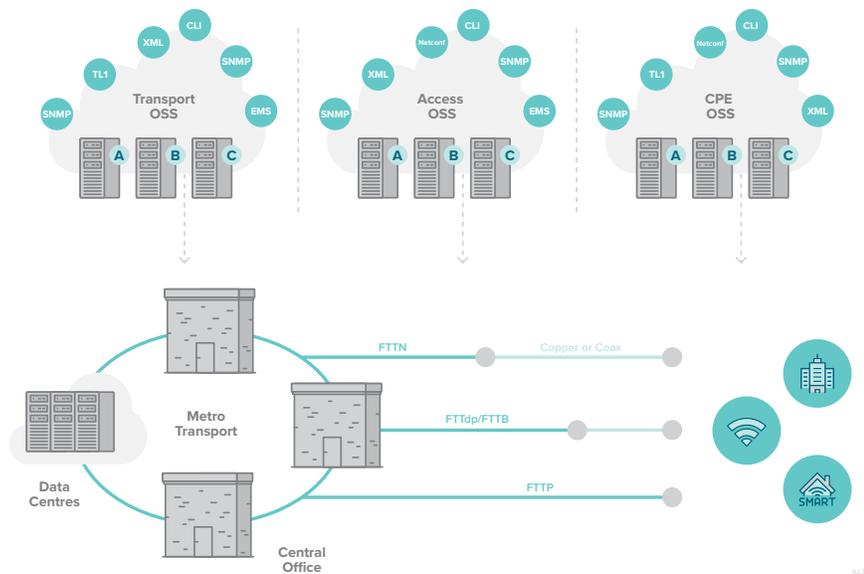
1. Connect with the Customer Premises Equipment (CPE) that needs to be served broadband services.
2. Establish subscriber sessions using IPoE or PPPoE protocols.
3. Interact with the RADIUS server that authenticates subscribers and keeps an account of subscriber sessions.
4. Interact with the DHCP server to provide IP addresses to clients.
5. DNS server resolves domains by mapping the name of the domain to the IP address.

The Aggregation Switch aggregates traffic from multiple OLT access switches. It links upwards to the core layer, and acts as a bridge between the core layer switch and the access layer switch. Aggregation switch ports tend to be less expensive than ports on a BNG. VLANs are distributed and prioritized using VLAN tags (typically S-Tags) and P-bits into the core network.

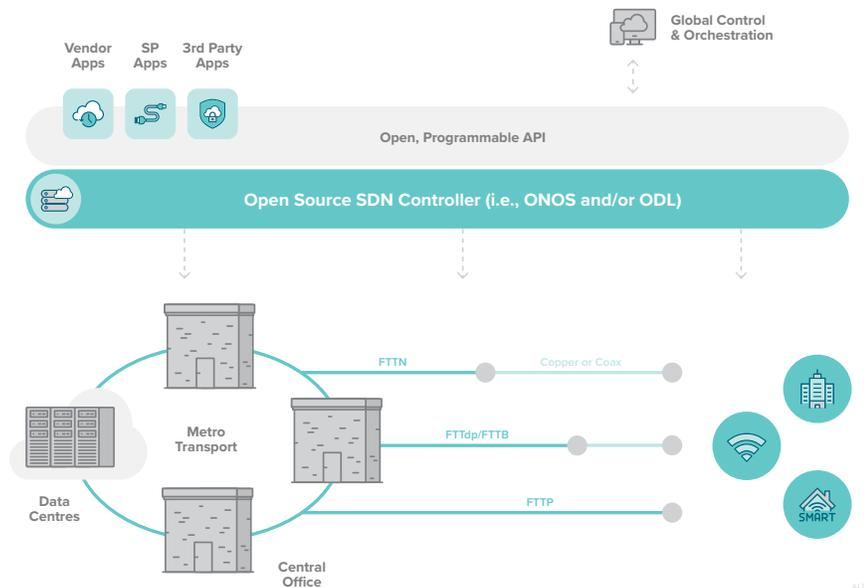
The OLT access switch is located at the access layer for connecting all subscribers to the network. It converts electrical signals into optical signals that are received and decoded by the ONU, which converts it back to Ethernet that is fed into the RG at a home or an enterprise.

Modern Disaggregated Networks

The image below illustrates a traditional telco environment with management silos that limit the ability to automate servers with vendor- and device-specific APIs.

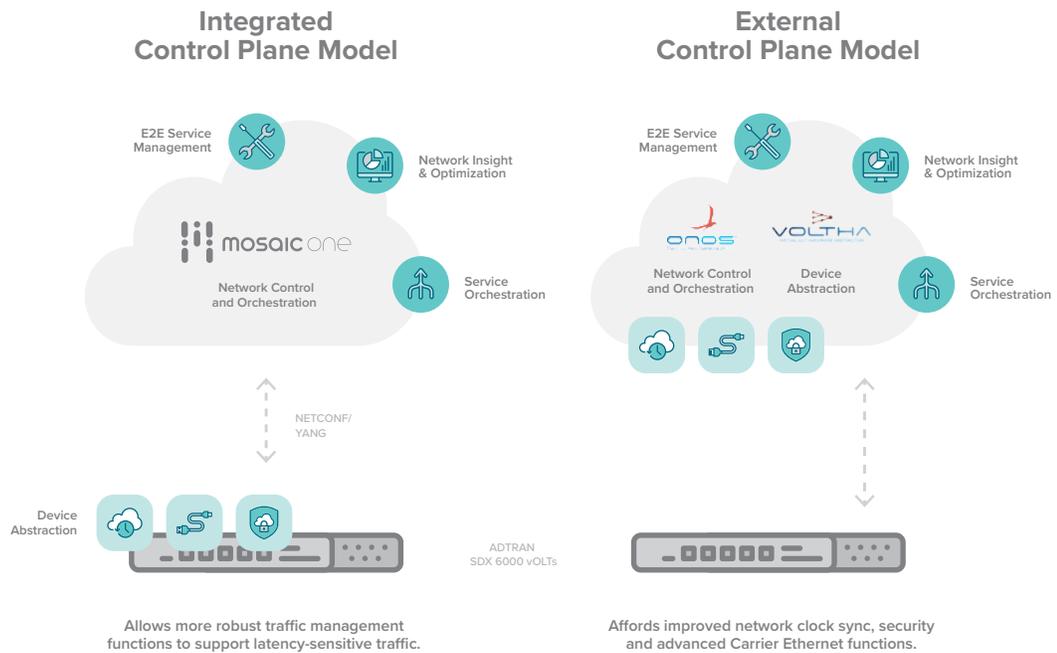


Networks of the future will see a shift from closed, vendor-locked systems to open, multi-vendor, multi-technology networks programmed via SDN controllers as shown in the image below.



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ADTRAN has been investing heavily in disaggregated fibre access systems. These next-generation fibre systems use the same data centre networking architectural principles that are being upheld by the Open Networking Foundation (ONF) with the SDN-Enabled Broadband Access (SEBA) Project and their reference designs. ADTRAN's SD-Access fibre system covers all types of PON access including GPON, XGS-PON, NGPON2, and 10G EPON, while also supporting 1/10/40/100G Ethernet aggregation and integrated subscriber management functions.



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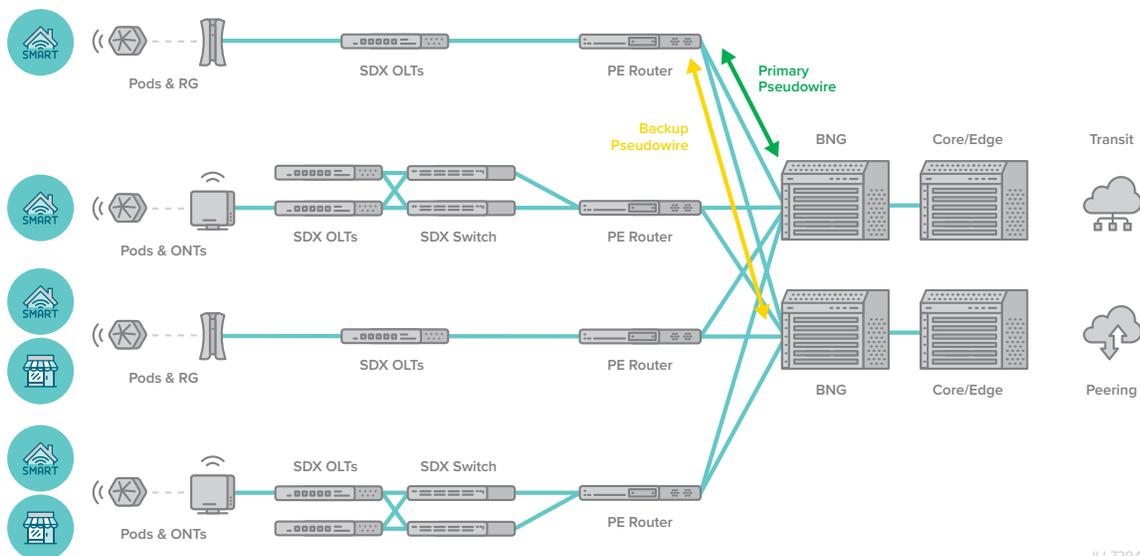
Building a solid network with ADTRAN and Juniper Networks

ADTRAN has worked with multiple service providers to provide end-to-end solutions using both ADTRAN and Juniper Networks equipment at the aggregation and core sites. There are many different approaches that can be taken depending on the layout of various networks.

The combined ADTRAN-Juniper approach is to avoid Layer 2 control protocols between the aggregation and core layers and instead adapt a Layer 3 approach from day one. As networks grow and scale, managing a complex Layer 2 network is problematic and fraught with danger. Simple changes in one section of the network can cascade wildly throughout the network resulting in outages and unhappy customers.

ADTRAN and Juniper believe that a better approach is to put Layer 3 devices at the aggregation layer and build a solid Layer 3 network that can handle multiple paths of different speeds and respond rapidly to changes in the network. Enabling an MPLS network on top of this brings a vast array of possibilities for providing multiple segregated services to residential or business, retail, or wholesale customers. Layer 2 functionality such as terminating DHCP/PPPoE customers on a BNG can be achieved by using Pseudowire, L2 VPNs, EVPNs etc., while offering EPLs and EVPLs to business customers. Advanced business services such as L3VPNs can also bring a real value-add to the network. All of this comes easily and naturally to an MPLS network, all while maintaining the segregation necessary when multiple services running on top of the network.

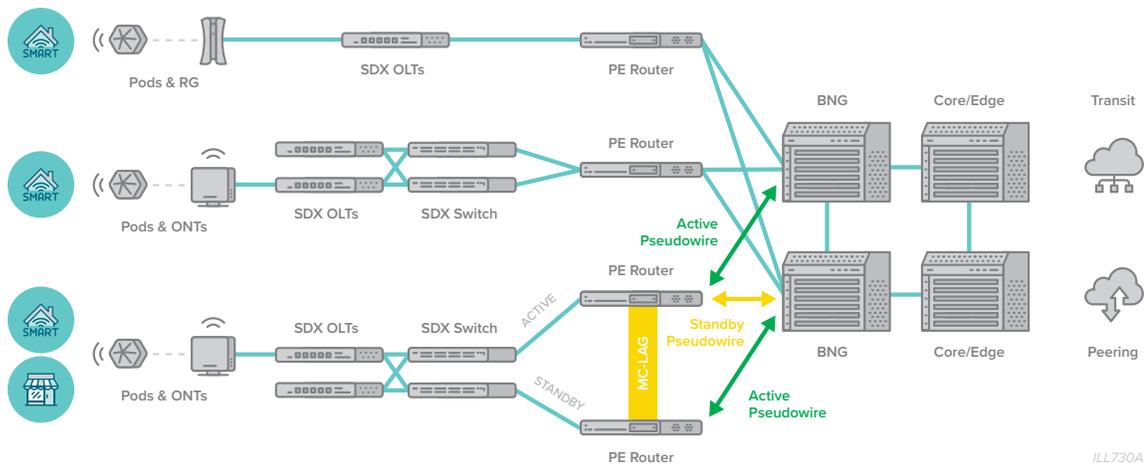
The diagram below illustrates our typical approach to a residential end-to-end network. PON devices such as OLTs, or pre-aggregation switches, can be aggregated onto a PE router such as a Juniper MX or ACX Series. From here, subscribers can be placed into a Layer 2 circuit and brought over the top of an IP/MPLS network to a centralised BNG. Following dynamic creation of the VLANs (single or double tagged) and successful authentication with AAA servers, the subscriber sessions are anchored on the BNG using Pseudowire Headend Termination (PWHT). In the event of a link failure, the circuit is simply routed another way across the network to the BNG, which keeps PPPoE sessions from dropping. To cover a complete loss of a BNG, a hot standby circuit routed to another BNG can be waiting to take over if the Layer 2 circuit drops.



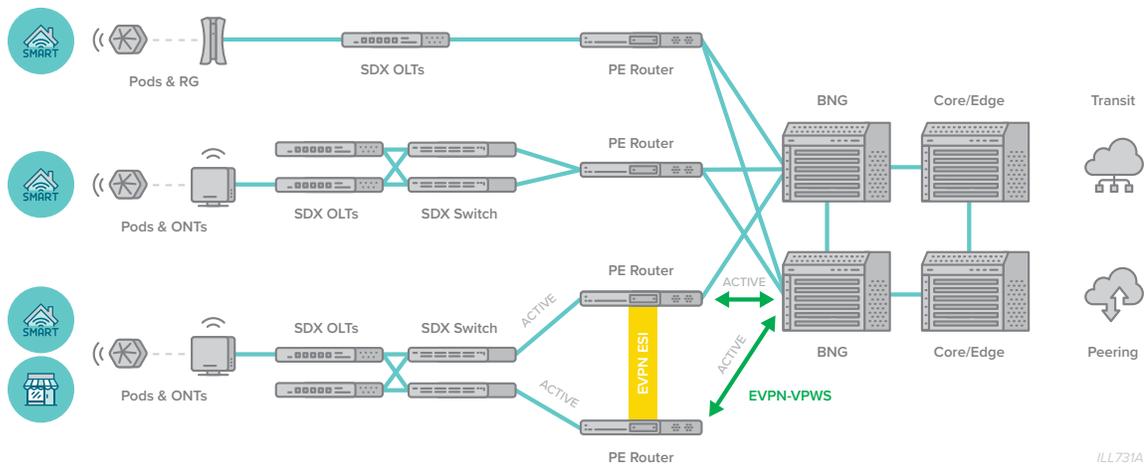
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Resiliency in the Aggregation Layer

If multiple paths are available from the PON network to the PE Aggregation layer, resiliency can be achieved in several ways. The first, as illustrated below is to use MC-LAG between the PE routers to have active / standby sessions to the PON equipment. On the uplink side you can then have your active / standby Pseudowire circuits in place.

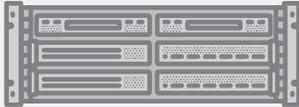


An alternative to MC-LAG, is to an EVPN-ESI which would allow an active/active connection downstream to the PON network. The connections to the BNG could then be built using an EVPN-VPWS service to provide an active / active connection to the BNG.



ADTRAN Recommendations for a Robust Network

SERVICE PROVIDER CORE



Juniper MX Platform

ADTRAN recommends Juniper Networks MX platform for Core Network routing needs. The MX is a robust portfolio of SDN-enabled routing platforms that provide industry-leading system capacity, density, security, and performance with unparalleled longevity. MX Series routers are the key to digital transformation for service providers.

The MX Series provides a vast range of products from small-I to very large-scale routing platforms that offer pay-as-you-grow flex licensing options. The MX Series has comprehensive Layer 3 routing features that allow it to run many different or combined functions within your network.

Recommended platforms:

- MX150
- MX204
- MX10003
- Virtual MX

Where CGNAT is a requirement the MX240, MX480, or MX960 with the powerful SPC3 card is recommended. The SPC3 card, along with CGNAT functionality can provide services like Stateful Firewall, Intrusion Detection (IDS), Traffic Load Balancer, DNS Request Filtering, and URL Filtering.

PROVIDER EDGE AGGREGATION



Juniper ACX Platform

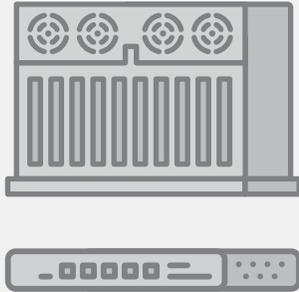
For aggregation sites, ADTRAN recommends the Juniper ACX Series of routers. The ACX MEF 2.0-compliant routers support use cases such as Ethernet business services, residential aggregation, mobile and industrial networks with solutions that extend from provider edge to access network.

Recommended platforms:

- ACX 710 Temperature-Hardened Router

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ACCESS AND AGGREGATION



ADTRAN Total Access5000 or SDX Platform

ADTRAN recommends either the SDX portfolio of products for a disaggregated network or the Total Access5000 portfolio of products for a chassis-based network. Both offer unique benefits that cater to the specific needs of a service provider – the choice between the two is one of preference.

Total Access 5000 is a Multi-Service Access and Aggregation Platform. It is among the most widely deployed platforms and supports most network topologies, including star, ring, and chain. It is a highly extensible platform that provides nonblocking multi-terabit architecture supported by resilient 100GE network interfaces.

Recommended chassis-based platform:

- TA5000 8-port Combo PON OLT
- TA5004 8-port Combo PON OLT

SDX 6300 Series OLTs are disaggregated OLT solution that belong to ADTRAN's SD-Access suite of devices. SD-Access takes an open, microservices architecture that affords service providers the freedom to choose best-of-breed elements that expedite the creation of new customer applications and broadband technology introductions while reducing overhead costs, network inefficiencies, and time- to-market delays.

Recommended disaggregated platform:

- SDX 6320-16 Combo PON OLT
- SDX 6312-4 Temperature-Hardened Combo PON OLT
- SDX 8210-54 Aggregation Switch or Leaf Switch
- SDX 8305-20 Aggregation Switch or Spine Switch

Growing your network

Using a combined ADTRAN-Juniper solution enables you to scale your network as network build and subscriber numbers increase.

The Juniper Networks MX platform has network-wide Subscriber Access licenses that you can purchase in increments of 1,000 or 10,000. Being network-wide, these licenses are agnostic to the configuration of MX routers as BNG or the location of subscriber connections – only the total number of subscribers matters. Hence, you don't have to over provision the licenses to cover failures in the network.

The Juniper ACX platform acts as a PE or Aggregation switch. It offers Flex licenses to allow you to start with restricted throughput and increase to a full throughput license when required. The licenses have a term of three- or five-years initially, with a one-year renewal term. The subscription costs also include the basic support costs for the term. You can optionally add hardware replacement support on top e.g., same day/next day.

The ADTRAN Fibre Access suite of products allows you to scale your network as you grow. You can start by having a single OLT uplinked into a PE /BNG. You can then continue to uplink OLTs into your PE until it reaches capacity. You can add aggregation switches to your central aggregation site. Aggregation ports are cheaper than ports on PE devices, so it makes sense to do this as you scale.

If an individual satellite site grows, an aggregation switch could also be added to “pre-aggregate” before hitting the main aggregation site.

When you reach a critical mass, you can then make the solution more resilient by having a Spine/Leaf architecture for aggregation. Adding a second PE router above this adds resilience back into the core network. This is achieved using MC-LAG or EVPN on the PE router.

There are multiple deployment methods that ADTRAN has investigated. Each deployment method is tailor-fit to the specific needs of a service provider. These include the deployment of OLTs in a ring using ERPs or, ELPs with one or two OLTs having a direct connection to the uplink device, as well as a modified daisy-chaining approach where multiple OLTs are connected in a star topology.

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Bringing it together

ADTRAN employees hold Juniper Networks Certifications in Sales, Pre-Sales, and Post-Sales, is a requirement for being a Select Juniper Networks Partner. It also brings a wealth of knowledge and experience in selecting, designing, installing, and commissioning Juniper Networks equipment. Our sales and engineering team boasts more than 15 years' experience working with Juniper Networks products and has the expertise to assist you in choosing the right product to suit your budget for current and future demand.

Past projects have seen us design and install several ADTRAN / Juniper Networks with EX and QFX switches, ACX, MX routers acting as MPLS Core routers and BNGs. We have also performed integration work in which our SDN platform Mosaic controls a Juniper MX router acting as BNG for end-end orchestration. The beauty of this is that the different families all run JUNOS, and all have powerful automation capabilities so operating Juniper Networks devices should hold no fear.

ADTRAN would be delighted to work with you to select, design and install an end-to-end network that will enable you to exceed your revenue and performance targets with an ADTRAN - Juniper Networks solution.



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