

## Disaggregated BNG (Broadband Network Gateway)



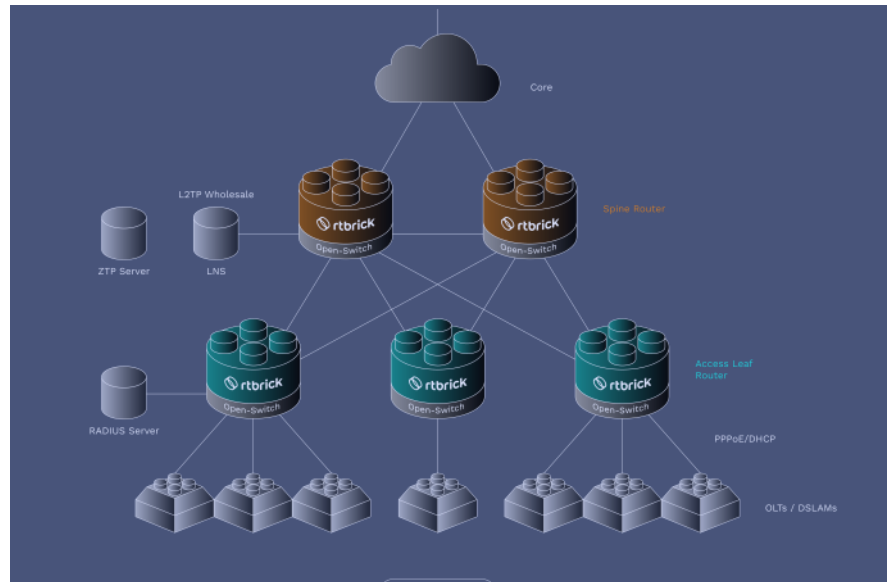
For smaller concentrations of subscribers, or deployment in more remote hardened environments, spine-leaf functionality can be collapsed onto a single switch as a **Consolidated BNG**, offering all the functionality on a single physical switch.

Broadband subscribers can be terminated on the Access Leaf Routers or tunneled to an LNS over L2TPv2. L2 Cross Connect (L2X) allows subscriber traffic to be tunneled out of the PoD at Layer 2, providing wholesale connectivity or connectivity for legacy services. This allows you to re-use your existing infrastructure to continue to provide lower volume legacy services, and optimize the rest of the network for the bulk of your traffic - providing large volumes of high bandwidth services at a lower cost-point with a web-scale operating environment.



Consolidated BNG

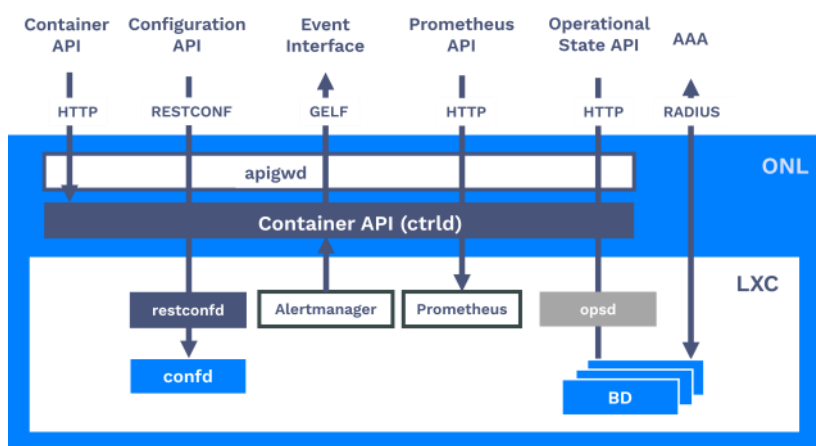
So your RtBrick BNG can also act as a service cross-connect, routing each subscriber to the appropriate network infra-



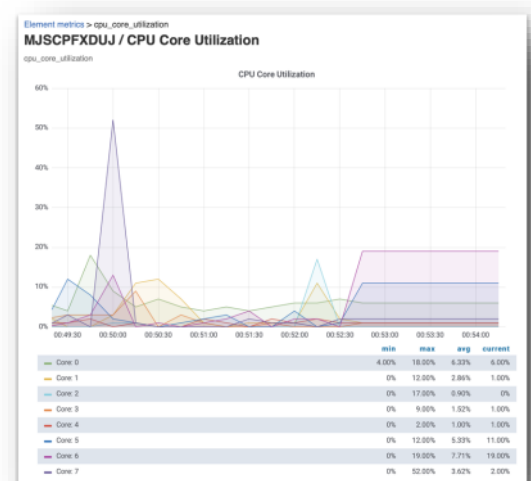
Spine-Leaf BNG

## Management and Operations

RtBrick's Management API has been designed to simplify the integration with your existing OSS and BSS systems. It reduces the amount of time and effort required to make your disaggregated network operational, and it leverages widely-adopted industry tools and programming languages. RtBrick's API is 'consumer-driven' – which means you can use the formats and languages of your choice, rather than have them imposed on you by a vendor. This allows you to build a client in Python, Go or Java, for example, as you prefer. And the APIs are all edited in Swagger, which is also a widely understood tool used by developers.



As an alternative to integrating directly into your own OSS system, you can use the RtBrick Management Suite (RBMS), which is an 'off-the-shelf' client that we have built using our own Management API. It is available to you as open-source software. It can be used as a standalone system for software management, ZTP (Zero-Touch-Provisioning) and switch inventory. Or you can use it as an open reference model to build your own client.



RtBrick API data extraction:  
example screenshots

## License and Support Options

RtBrick's BNG software is offered in two elements. There is a routing instance required per physical switch, plus a single network-wide BNG license, based on the total number of subscribers. The per-switch license varies depending on the type of switch it is linked to, for example switches using either Q2A or Q2C chips from Broadcom. The network-wide BNG license varies depending on feature-set required.

Instance-based licenses are perpetual, and linked to the hardware they were purchased on. Network-wide license are perpetual and migratable as the network grows.

All licenses require separate purchase of service and upgradability licenses on an annual, 3-year or 5-year basis. Service licenses entitle the operator to maintenance support for existing deployments as well as to receive release updates i.e. newer versions of the same functional release.

Subscription pricing is also available as an option, which includes support and upgrades.

## RtBrick BNG Features

| Feature                           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Base OS                           | <ul style="list-style-type: none"><li>RBFS LXC container based on Debian12</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Supported Hardware (Network role) | <ul style="list-style-type: none"><li>Edgecore: CSR320 (L2 Wholesale Leaf), CSR440 (Multiservice Edge Router), AGR400 (Spine), AGR420 (Multiservice Edge Router or Leaf)</li><li>UfiSpace: S9500-22XST (L2 Wholesale Leaf), S9510-28DC (Multiservice Edge Router), S9600-32X (Spine), S9600-72XC, S9600-102XC, S9610-46DX (Multiservice Edge Router or Leaf)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Access Protocols*                 | <ul style="list-style-type: none"><li>General - PPPoE, IPoE, L2BSA, L3BSA, co-existence of subscribers of different types, multiple subscriber profiles, RADIUS (AAA), Dual-Stack IPv4/IPv6, Double, Single, Untagged interfaces, Local/Remote Authentication, Local/Remote Address Allocation, Chained Address Pools, Ascend Data Filters, multiple RADIUS Servers, Change of Authorization (CoA), Volume and Time based Accounting, Access Line Attributes</li><li>PPPoE - LCP, IPCP, IP6CP, DHCPv6 for IPv6 support, Multiple address support (Framed-Address, frame-ipv6-prefix/IA-NA, delegated-IPv6-Prefix/IA-PD), N:1 and 1:1 VLAN support, PADO delay-based redundancy<br/>RFC 1332, 1334, 1516, 1661, 5072, 4679, 6320</li><li>IPoE - DHCP Server, DHCPv6 Server, DHCPv4/v6 Relay, 1:1 Hot-Standby Redundancy, Multiple address support (Framed-Address, frame-ipv6-prefix/IA-NA, Framed-Route, Framed-v6-Route, delegated-IPv6-Prefix/IA-PD), N:1 and 1:1 VLAN support<br/>RFC 951, 1542, 2131, 2132, 3046, 8415</li><li>RADIUS - Rich set of VSA's in addition to Standard Attributes, Session and Traffic Class Counters, Redundant Servers<br/>RFC 2865, 2869, 3162, 2866, 4372, 4679, 6320, draft-lihawi-ancp-protocol-access-extension-04</li><li>Lawful Intercept- support for PPPoE, IPoE, RBAC Security, Direction Selection</li><li>HQoS - multi-level Policing, Classification (Behavioral Aggregate, Multifield, IPv4/IPv6, Ethernet, MPLS), Remarking, Queuing, Shaping and Multi-Level Hierarchical Scheduling, Header Compensation, Priority Propagation, Programming Model that supports full capability of the underlying Chipset</li><li>L3BSA (L2TPv2) - LAC only, multiple LNS server support<br/>RFC 2661, 5515, 2868, 3145</li><li>L2BSA - A10-NSP interface for subscriber wholesale</li></ul> |

| Feature        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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| L3 Proto-cols* | <ul style="list-style-type: none"> <li>BGP - Multi-Protocol BGP (Families IPv4, IPv6, VPNv4, VPNv6, IPv4-LU, IPv6-LU, 6PE, MVPN, EVPN-VPWS, L2VPN, FlowSpec), L3VPN, Segment Routing, Enhanced Route Refresh, Authentication with TCP MD5/TCP AO, Route Reflection, Multipath, Addpath, 4-Byte AS, BGP Capability Advertisement, BGP Communities (Normal, Extended, Large), Revised Error Handling, Route Policy, Rib-in visibility, Hostname Capability, Segment Routing Underlay<br/>RFC 1997, 2385, 2545, 2918, 3107, 4271, 4360, 4364, 4456, 4486, 4659, 4760, 4798, 4893, 5492, 5549, 6513, 6608, 6793, 7313, 7606, 7911, 8092, 8669, draft-walton-bgp-hostname-capability-02, draft-kumar-idr-link-local-nexthop-02</li> <li>L3VPN - IPv4 and IPv6 overlay, IPv4 and IPv6 underlay, Route Policy, Multicast, BGP, OSPFv2, Static and PIM as PE-CE protocols,<br/>RFC 4364, 6513</li> <li>OSPFv2 and v3 - Refresh and Flooding Reduction, Route Policy, Segment Routing, Loop prevention in L3VPN, Multi-area Adjacency, Opaque LSA<br/>RFC 2328, 3137, 3509, 4136, 4576, 4577, 5185, 5250, draft-ietf-ospf-segment-routing-extensions-24</li> <li>ISIS - IPv4 and IPv6, Transient Blackhole Avoidance, Route Policy, Segment Routing, Hostname Exchange Support, Cryptographic Authentication, Restart Signaling, Extended IPv4 and IPv6 reachability, Pol TLV Support, Flood Filtering, Segment Routing Underlay<br/>RFC 1195, 3277, 5301, 5302, 5303, 5304, 5306, 5308, 6232, 7775, 7794, ietf-isis-segment-routing-09</li> <li>MPLS - LDP, Segment Routing (ISIS, OSPFv2/3, BGP)</li> <li>LDP - Authentication with TCP MD5/TCP AO, Support for IPv4/v6, Targeted-LDP, Route Policy—<br/>RFC 5036</li> </ul> |
| Security       | <ul style="list-style-type: none"> <li>Control Plane Policing, BGP Flowspec, Sflow, BGP RPKI Router, TCP MDS/AO support for BGP &amp; LDP, BGP GTSM - RFC 5036 8955, 8210, 5925, 5082, sflow.org/sflow_version_5.txt</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Multicast      | <ul style="list-style-type: none"> <li>Multicast - PIM-SSM, MVPN, IGMP v2/3 - RFC 2236, 3376, 4609, 3569, 6513</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| L2 Proto-cols* | <ul style="list-style-type: none"> <li>L2VPN - EVPN-VPWS, BGP-signaled L2VPN, Static Ethernet Pseudowire (L2X) local &amp; remote, ingress VLAN Operations, Uni &amp; Bi-directional, QoS support, incoming Traffic Match - RFC 8214, 6624, draft-ietf-l2vpn-vpls-bgp-02</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Timing         | <ul style="list-style-type: none"> <li>Precision Time Protocol (PTP) ITU-T G.8275.1 (PTP IEEE 1588-2008)</li> <li>Synchronous Ethernet/SyncE ITU-T G.8261 and ITU-T G.8264</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| CGNAT          | <ul style="list-style-type: none"> <li>NAT444</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| User Interface | <ul style="list-style-type: none"> <li>CLI</li> <li>RBFS REST API - authenticated access, finegrained access and control</li> <li>RESTCONF - abstracted model based configuration</li> <li>OpsD - Abstracted Model based Operational Commands</li> <li>SNMPv2C/v3</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

\*RFC and draft compliance partial except as specified

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