






Software-Defined Central Office Data Sheet

Includes the following products:

-  Access Leaf Router
-  Spine Router
-  Border Leaf Router

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1 Product Overview

RtBrick Full Stack (RBFS) is a set of software images that create containerized virtual form-factor routers, each purpose-built to address a specific role in the deployment. Together they deliver comprehensive Central Office functionality that can be delivered on a wide range of merchant silicon platforms. Access providers can use RBFS to build Software-Defined Central Offices (SDCO) to service Broadband Subscribers. RtBrick also provides a single-pane-of-glass management solution, the RtBrick Management System (RBMS), that acts as a single point of control for a deployment of RBFS across a whole network, simplifying network operations and service provisioning.

This data sheet includes information on three software image sets, which can be deployed together to create a carrier-scale central office:

-  Access Leaf Router
-  Spine Router
-  Border Leaf Router

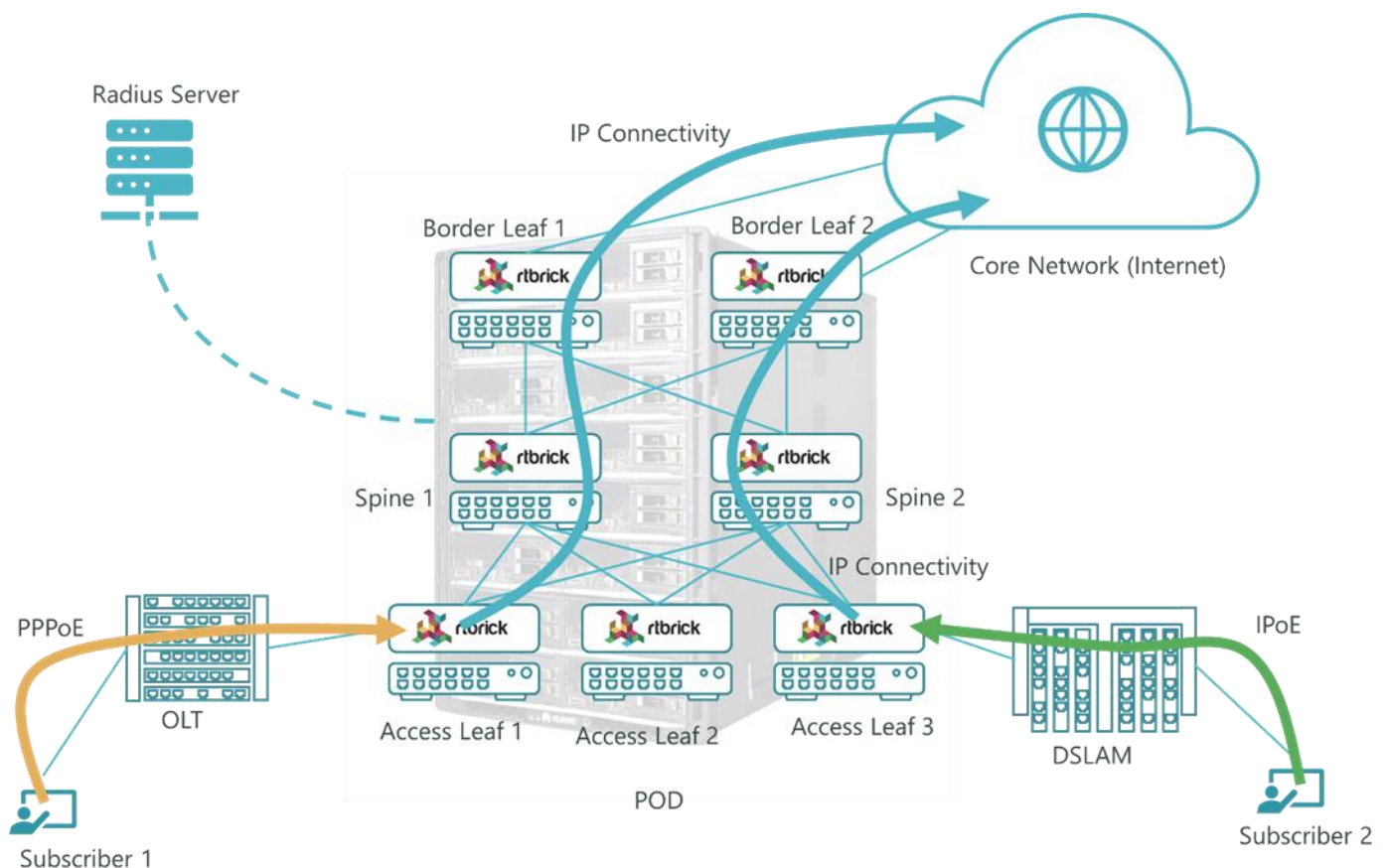


Figure 1: Subscriber Session Termination

Over recent years, 'cloud-native' service providers have developed ways to build and run massive data centers with a high degree of automation, using DevOps tools and technologies to reduce operational overheads and deliver levels of service agility beyond traditional carrier infrastructure. RtBrick Full Stack software brings these same benefits to carrier access networks, by using agile methodologies and the same battle-hardened cloud automation workflows that have been adopted by the world's biggest cloud providers.

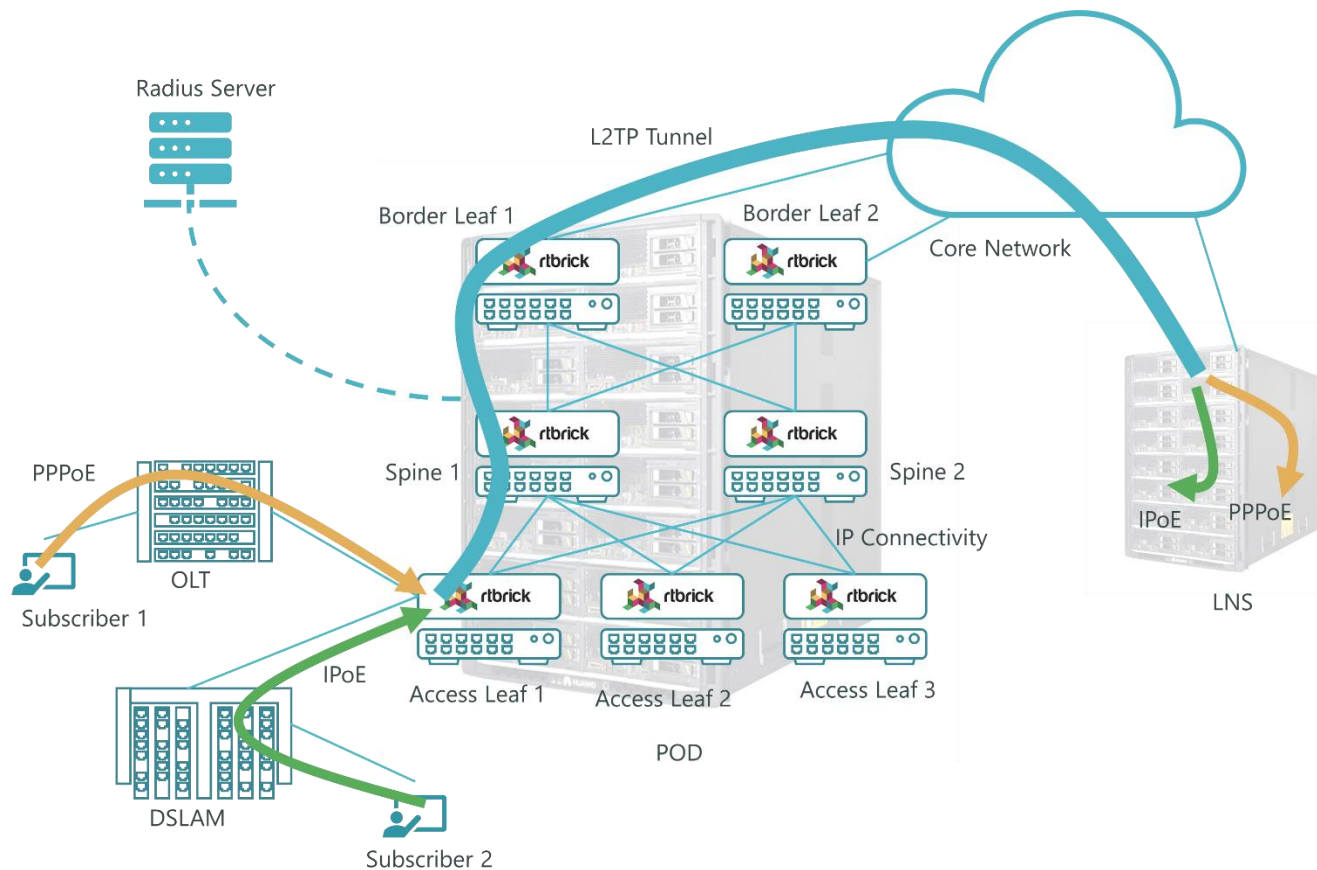


Figure 2: L2TP Tunneling

The Subscriber Management functionality is provided in a scale-out architecture through a unit of deployment called the Point-Of-Deployment (POD). A POD consists of Access Leaf Routers and Border Leaf Routers aggregated by a layer of Spine Leaf Routers in an auto-provisioned CLOS topology. The Access Leaves deliver Subscriber Management functionality and the Border Leaves provide connectivity to the core of the provider network. Both the sets of leaves can be scaled out to increase the number of Subscribers supported on the POD, providing a pay-as-you-grow architecture. Spine and Border Leaf functionality can be collapsed onto a single hardware platform, depending upon the hardware platform used. PPPoE 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.

2 Benefits

As carriers face ever more commercial pressures, running your Central Office on RtBrick Full Stack software brings some important benefits:

- 📦 Greater agility – add new services in weeks rather than years
- 📦 Reduce risk – no more vendor lock-in and a simpler, safer operating environment
- 📦 Cloud cost-levels – leverage low-cost merchant silicon and automate your operations

More agile

Deploying a Central Office with RBFS now only requires procurement of the relevant hardware platform(s) of choice and physically connecting them into the POD network. ZTP (Zero-Touch-Provisioning) ensures that such a box is booted, provisioned and made functional without requiring manual intervention. The box auto-provisions itself to join the underlay Packet Fabric. Service Orchestration on the underlay is done through RBMS which acts as the single point of interaction across the entire network. This, along with the lack of manual intervention, ensures that services are orchestrated on the hardware in a matter of minutes instead of days or even weeks. The software itself is developed using Agile and CI/CD methodologies which ensures that features are rapidly prototyped and implemented, reducing the time-to-market for new services.

Lower risk

RtBrick Full Stack software is compiled for your specific use-case, including only the features you need. With an order of magnitude fewer lines of code, and a single state database rather than hundreds, the whole system becomes less complex, less prone to bugs and has much faster restart times. It also allows you to pick and mix between the latest silicon and the best available software. RtBrick is part of an entire ecosystem consisting of TIP/OCP compliant chip vendors, OEMs and software providers, giving you choice as against being constrained to a single equipment provider until the next hardware upgrade cycle.

Cost optimized

Now you can take advantage of the low cost-points of merchant silicon on your choice of bare-metal switches, significantly reducing your capex bill. And opex costs can be reduced by automating your operations, using ZTP and the same Web2.0 operational tools that the 'cloud-natives' use to run their infrastructure.

3 Architecture

RBFS components, including the ones that program the NPU are written in UserLand and packaged inside a container. RBFS containers come packaged out-of-the-box with Open Network Linux (ONL) provided by the hardware SKU manufacturers, which handles peripherals such as LEDs, temperature sensors, and so on. There are no dependencies on either the kernel or the hardware platform components, so RBFS containers can be run on the Linux version of your choice. This allows the RBFS to be managed by the same DevOps tools that have been used to achieve a high degree of automation in massive cloud and data center deployments.

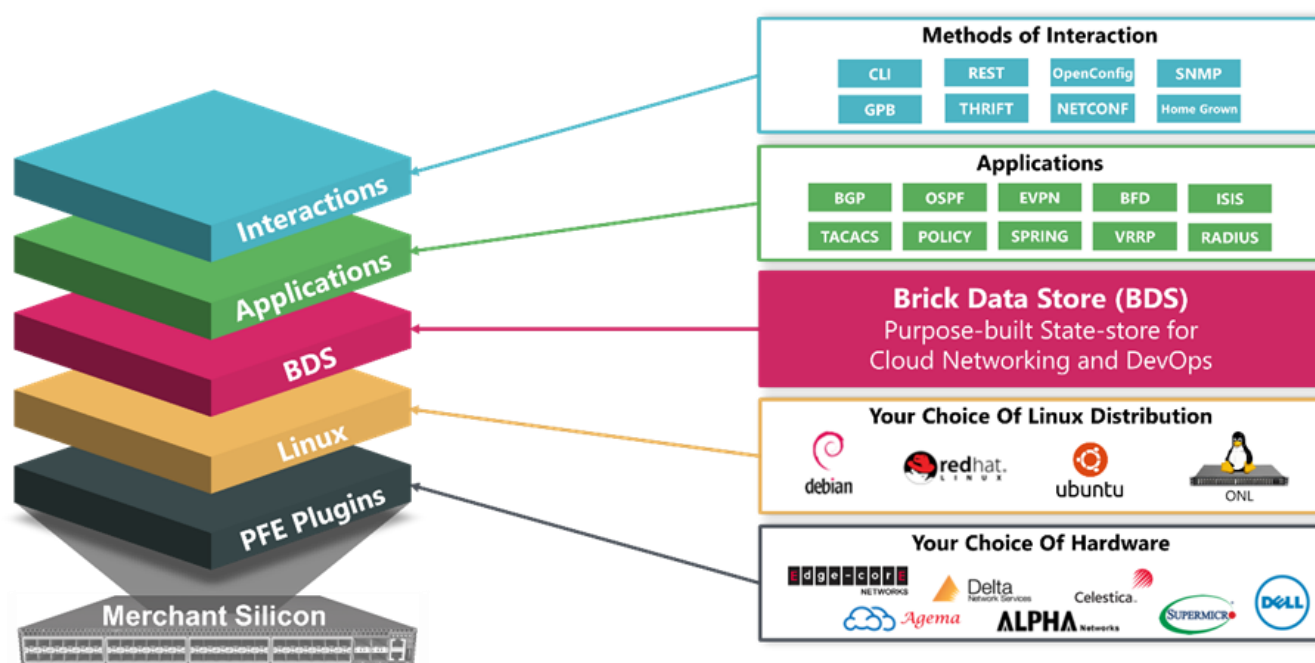


Figure 3: RBFS Architecture

At the core of RBFS is a patented, in-memory, distributed database called Brick Data Store (BDS) designed for routing applications at high-scale. BDS provides the primitives to create and share state across applications and facilitate interactions. Network protocols such as BGP, IGP and access protocols are modeled as applications and packaged as libraries, which are instantiated over BDS 'bricks' inside the RBFS container. A brick is a unit of execution akin to a Linux daemon that provides platform capabilities and can instantiate applications compiled into libraries to provide specific capabilities provided by the application instantiated. Since the router state is stored in BDS, custom applications can be written using generic BDS APIs, which reduces the learning curve for customization. The process is further facilitated by Adapters provided in multiple Languages such as C, C++, Python, Go, and so on.

Native applications are partitioned into IO bricks that handle the protocol aspects and neighbor interactions and APP Bricks that handle the topology visualization and route computations. This allows the bricks to be scaled-out independently to utilize more of the available compute power (CPU cores). In case multiple APP bricks are created, the routes are sharded to ensure consistent processing. RBFS natively support auto-provisioning of a CLOS network, which allows scaling out of service functionality. The service functionality is instantiated in an overlay in the Access Leaves on the CLOS network.

The forwarding plane has been designed with ease of porting as the primary objective, so RBFS can support a wide variety of merchant silicon platforms while keeping time-to-market at a minimum. This is achieved by abstracting the platform-independent forwarding logic in a separate brick and integrating the appropriate chipset plugin during packaging. RBFS supports Qumran-MX, Tofino and Intel DPDK based platforms today with others in the pipeline.

4 Management and Operations

Along with the traditional CLI and SNMP, more 'cloud-native' means of interactions are also supported, such as gNMI and Netconf. RtBrick's management system, RBMS, takes this a step further, by providing network level workflows such as Image Lifecycle Management, Network Upgrades and Event and Log Management. RBMS actions are available through REST APIs making them easy to integrate into existing OSS systems. RBMS provides a single point of interaction for operations staff – from provisioning and management to monitoring and debugging.

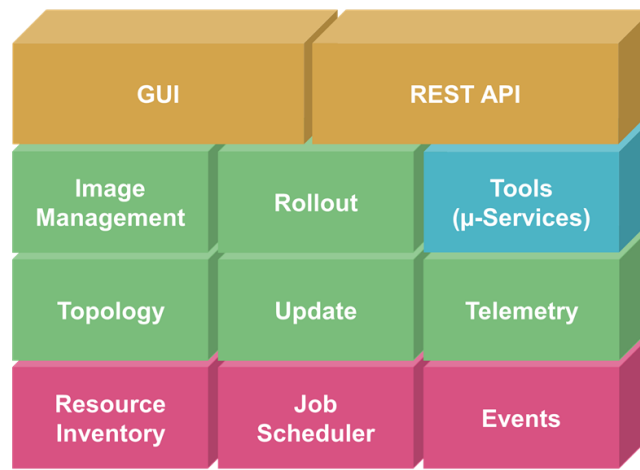


Figure 2: RBMS (RtBrick Management Suite)

The result is a network that can be managed using the latest Web2.0 tools through a 'single pane of glass', with Zero-Touch-Provisioning.

5 Product Specifications

This section lists the features offered in RBFS SDCO software products

Table 1: Product Features

Feature	Description
Base OS	ONL 4.1.109, Ubuntu 18.04
Supported Hardware	EC 5912 (leaf) EC 5916 (leaf, spine) EC 7712 (spine) Wedge 100BF-32X (leaf, spine)
Images	RBFS-Access-Leaf - applications: BGP, Access Protocols, MPLS, Python RBFS-Border-Leaf - applications: BGP, IGP, MPLS, Python RBFS-Spine - applications: BGP, MPLS, Python
Access Protocols*	PPPoE - RFC 1332, 1334, 1516, 1661, 5072 Radius - RFC 2865, 2868 - only 1 attribute, 3162, 2866, 4372 L2TPv2 - RFC 2661, LAC only, 5515
L3 Protocols*	BGP - RFC 1771, 2385, 2545, 2918, 3107, 4271, 4364, 4456, 4486, 4659, 4760, 4798, 4893, 5065, 5492, 5549, 6513, 6608, 6793, 7313, 7911, 8092, draft-walton-bgp-hostname-capability-02, draft-kumar-idr-link-local-nexthop-02, draft-ietf-idr-bgp-prefix-sid-27 OSPF - RFC 2328, 3137, 3509, 4136, 4576, 4577, 5185, 5250, draft-ietf-ospf-segment-routing-extensions-24 ISIS - RFC 1195, 10589 (ISO), 5301, 5302, 5303, 5304, 5304, 5305, 5306, 5308, 5309
UI	CLI SNMP RBMS gNMI
RBMS	Image Lifecycle Management ZTP Monitoring Log & Event Management http2 REST API

**RFC and draft compliance partial except as specified*

6 Ordering and Support Options

RBFS is offered in multiple consumption and licensing models. Three distinct images are available for different roles within the POD – the Access Leaf, the Spine and the Border Leaf. Once booted up, the images connect to the RtBrick Licensing Server and run with the relevant scale and functionality based on the license entitlement.

Licenses are available on a per deployed-instance basis or per subscriber basis, both with perpetual as well as subscription options. Perpetual licenses require separate purchase of service and upgradability licenses on an annual basis. The subscription licenses can be provided on a 3, 4 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. Upgradability licenses enable the operator to deploy newer releases as they become available. The following tables provide details of the licensing SKUs available.

Table 2: Instance-based SDCO License SKUs

Role\Term	Perpetual	3-Yr Subscription	4-Yr Subscription	5-Yr Subscription
Access Leaf	RBFS-INST-ACCESS-P	RBFS-INST-ACCESS-3Y	RBFS-INST-ACCESS-4Y	RBFS-INST-ACCESS-5Y
Spine	RBFS-INST-SPINE-P	RBFS-INST-SPINE-3Y	RBFS-INST-SPINE-4Y	RBFS-INST-SPINE-5Y
Border Leaf	RBFS-INST-BORDER-P	RBFS-INST-BORDER-3Y	RBFS-INST-BORDER-4Y	RBFS-INST-BORDER-5Y

Table 3: SDCO Maintenance and Upgrade License SKUs

Role\Term	Annual Subscription	3-Yr Subscription	4-Yr Subscription	5-Yr Subscription
Maintenance (Access Leaf)	RBFS-SVC-ACCESS-1Y	RBFS-SVC-ACCESS-3Y	RBFS-SVC-ACCESS-4Y	RBFS-SVC-ACCESS-5Y
Upgradability (Access Leaf)	RBFS-UPG-ACCESS-1Y	RBFS-UPG-ACCESS-3Y	RBFS-UPG-ACCESS-4Y	RBFS-UPG-ACCESS-5Y
Maintenance (Spine)	RBFS-SVC-SPINE-1Y	RBFS-SVC-SPINE-3Y	RBFS-SVC-SPINE-4Y	RBFS-SVC-SPINE-5Y
Upgradability (Spine)	RBFS-UPG-SPINE-1Y	RBFS-UPG-SPINE-3Y	RBFS-UPG-SPINE-4Y	RBFS-UPG-SPINE-5Y
Maintenance (Access Leaf)	RBFS-SVC-BORDER-1Y	RBFS-SVC-BORDER-3Y	RBFS-SVC-BORDER-4Y	RBFS-SVC-BORDER-5Y
Upgradability (Access Leaf)	RBFS-UPG-BORDER-1Y	RBFS-UPG-BORDER-3Y	RBFS-UPG-BORDER-4Y	RBFS-UPG-BORDER-5Y

Table 4: SDCO Subscription License SKUs

Scale\Term	Perpetual	Annual	3-Yr	4-Yr	5-Yr
100K	RBFS-SUBS-SDCO-100K-P	RBFS-SUBS-SDCO-100K-1Y	RBFS-SUBS-SDCO-100K-3Y	RBFS-SUBS-SDCO-100K-4Y	RBFS-SUBS-SDCO-100K-5Y
200K	RBFS-SUBS-SDCO-200K-P	RBFS-SUBS-SDCO-200K-1Y	RBFS-SUBS-SDCO-200K-3Y	RBFS-SUBS-SDCO-200K-4Y	RBFS-SUBS-SDCO-200K-5Y
500K	RBFS-SUBS-SDCO-500K-P	RBFS-SUBS-SDCO-500K-1Y	RBFS-SUBS-SDCO-500K-3Y	RBFS-SUBS-SDCO-500K-4Y	RBFS-SUBS-SDCO-500K-5Y
1M	RBFS-SUBS-SDCO-1M-P	RBFS-SUBS-SDCO-1M-1Y	RBFS-SUBS-SDCO-1M-3Y	RBFS-SUBS-SDCO-1M-4Y	RBFS-SUBS-SDCO-1M-5Y
2M	RBFS-SUBS-SDCO-2M-P	RBFS-SUBS-SDCO-2M-1Y	RBFS-SUBS-SDCO-2M-3Y	RBFS-SUBS-SDCO-2M-4Y	RBFS-SUBS-SDCO-2M-5Y
5M	RBFS-SUBS-SDCO-5M-P	RBFS-SUBS-SDCO-5M-1Y	RBFS-SUBS-SDCO-5M-3Y	RBFS-SUBS-SDCO-5M-4Y	RBFS-SUBS-SDCO-5M-5Y
10M	RBFS-SUBS-SDCO-10M-P	RBFS-SUBS-SDCO-10M-1Y	RBFS-SUBS-SDCO-10M-3Y	RBFS-SUBS-SDCO-10M-4Y	RBFS-SUBS-SDCO-10M-5Y