Brocade vPGW and Brocade vSAE-GW

HIGHLIGHTS
- Minimizes packet core TCO by leveraging a highly optimized architecture that de-constructs the user plane as a high-performance, separately scalable entity
- Delivers full duplex 10 GbE line-rate performance with minimal virtualization overhead to cost-effectively meet the demand for high-throughput use cases
- Includes inline Layer 3, 4, and 7 DPI capabilities for enabling value-added services and analytics
- Incorporates GGSN support for interworking with 3G networks
- Supports low-latency use cases by enabling small form-factor user plane deployment at the network edge
- Provides a 5G-ready framework that allows for control plane and user plane separation
- Optimizes resource usage and increases business agility through on-demand scalability
- Provides granular scalability, preventing overprovisioning and allowing operators to grow at market speed
- Enables rich application integration using built-in data correlation and streaming capabilities

Software Networking-enabled Virtual Gateways
Brocade® Virtual Packet Data Network Gateway (vPGW) and Brocade Virtual SAE Gateway (vSAE-GW) are realizations of gateway functions on Brocade Virtual Core for Mobile (VCM) architecture. They provide a cost-effective, highly scalable alternative for Mobile Network Operators (MNOs) to expand an existing Evolved Packet Core (EPC) for new service delivery, or for Mobile Virtual Network Operators (MVNOs) to implement their own Internet connectivity gateways with a high service velocity.

Figure 1: Brocade VCM personalities.
BROCADE VIRTUAL CORE FOR MOBILE

Brocade Virtual Core for Mobile (VCM) architecture transforms mobile networks through a feature-rich and highly scalable virtualized Evolved Packet Core (EPC) implementation. This innovative architecture enables the platform to manifest itself not just as a collapsed all-inclusive EPC, but also as a virtualized P-GW or SAE-GW. In this manner, Brocade VCM architecture can be used to deliver user plane-focused distribution or expansion based on specific operator requirements.

The Brocade VCM product family consists of Brocade vEPC, Brocade vPGW, Brocade vSAE-GW, Brocade vHSS, and Brocade vC-SGN.

Key benefits include:
• Lower total cost of ownership
• Greater business agility
• Adaptiveness to multiple use cases (VoLTE service delivery, MVNO enablement, enterprise access)

Innovative Architecture

Brocade gateway products employ a service-based, horizontal architecture consisting of independent interface, service logic, database, and management modules (see Figure 1). This approach to functional virtualization optimizes performance and efficiency. Key aspects of delivering user plane services over a virtualized platform include overcoming the non-real-time nature of the x86 hardware processing pipeline and providing alternative solutions to traditional interrupt-driven packet processing approaches. By using batch-based packet processing models and poll-mode-based drivers, faster memory access and packet processing can be achieved. This allows operators to service a user plane that provides deterministic packet forwarding using a combination of synchronous run-to-completion and inline asynchronous threads, thereby maximizing throughput levels.

Brocade vPGW

Brocade vPGW is ideal for MNOs seeking to expand their networks to support new services (such as VoLTE, enterprise access) or to increase capacity. MVNOs that want to cost-effectively enable differentiated service offerings with greater agility can also deploy the Brocade vPGW as part of their own infrastructure. Combined with an optional subscriber management feature, Brocade vPGW can be integrated with Brocade Virtual Home Subscriber Server (vHSS) and can act as a full solution for MVNOs that want to better control how they manage their subscribers and traffic.

Brocade vSAE-GW

Brocade vSAE-GW provides combined S-GW and P-GW functionality in an optimal fashion without the overhead of double forwarding. Service providers can use Brocade vSAE-GW to augment and extend their existing gateway products while minimizing user plane latency. For example, service providers operating a private LTE network can place the gateway in a distributed and secure way, while improving the user experience with high throughput and low data latency.

Optimized User Plane Performance

Brocade vPGW and Brocade vSAE-GW have been optimized to enable packet core user plane functions on general purpose Intel x86-based servers. With their unique architecture, Brocade gateway products provide best-in-class performance and have been benchmarked for full duplex 10 GbE line-rate data processing and minimal data plane latencies. They utilize data plane acceleration technologies, such as Intel DPDK in PCI passthrough or SR-IOV mode, to ensure high performance in a virtualized environment.

BROCADE vPGW AND BROCADE vSAE-GW: KEY FEATURES
• Carrier-grade high availability
• Linear scaling
• Stateless operation
• Intel DPDK-enabled data plane
• Full duplex 10 GbE line-rate performance
• Control plane and user plane separation
• Portable user plane deployable at the network edge
• Virtualization for multifacility
• VLAN tagging
• GGSN support
• Gx interface and PCEF support
• Online and offline charging
• RADIUS for Accounting and Authorization
• Cloud-ready, innovative design
• Multiple hypervisor support: VMware ESXi, KVM
• Integration with cloud tools: OpenStack, VMware vCenter, VMware vCloud Director, Cloudify TOSCA-based orchestration
• Commercial cloud-ready: AWS, GCE, Microsoft Azure
• Supported on Intel x86-based general purpose servers
• Management API support, including SNMP, REST, and XML
On-Demand, Granular Scalability
Brocade vPGW and Brocade vSAE-GW can scale according to the required capacity demand for a range of industry use cases. No barriers exist in terms of throughput or virtual resource minimums that must be deployed. Auto-scaling options allow for additional capacity to be added as a linear step function based on predefined thresholds. Such on-demand, granular scalability eliminates the need for long-range advance budget planning and expensive overprovisioning.

Open Interoperability
Brocade gateway products leverage proven industry tools, software, and best practices to provide an open and highly flexible solution. Using general purpose server hardware and standard operating systems (Linux), Brocade gateway products are designed for maximum interoperability, allowing seamless integration with third-party network elements and tools for extended functionality. All external interfaces are based on 3GPP specifications and have been demonstrated to interwork with adjacent network nodes from multiple third-party vendors (Figure 2).

QoS Enforcement
Brocade gateway products use a software-based hierarchical QoS scheduler to provide appropriate QoS for different traffic classes. This is accomplished without the use of any specialized hardware, such as a dedicated Network Processing Unit (NPU). The QoS scheduler leverages specialized algorithms to minimize latency and keep packet processing costs to a minimum. In addition, QCI-to-DSCP mapping and corresponding prioritization are performed to meet stringent packet loss error rates and packet delay budget restrictions.

Higher Service Velocity
Brocade vPGW and Brocade vSAE-GW can provide higher service velocity than traditional, physical node-based architectures, which are far more rigid and complex. Their service-based, modular design, combined with open API support, enables operators to quickly create and implement new feature frameworks for maximum business agility. Operators can add infrastructure to support new users or new services in just days, instead of months. The fully virtualized deployment allows operators to grow their mobile networks at market speed.

Built-in Load Balancing and Overload Control
Load balancers are an integral part of the cluster architecture in Brocade gateway products. For all core components, the cluster internally balances the load from the preceding layer using a smart proxy that is the client part of the cluster. The cluster allows various configurable load-balancing mechanisms, including load-factor-based, round-robin, weight-based, and server affinity.

With Brocade gateway products, the control plane Virtual Network Function Component (VNFC) runs in a stateless manner, and each control plane VM is only responsible for handling the GTP-C signaling for one procedure, such as session creation. Another control plane VM can be selected in a load-balanced manner for the next procedure, such as session modification. This makes it possible to have the load more equally distributed across multiple VMs, since the user and the component are not bound together. In addition, it prevents one component from serving users with numerous signaling activities, while another component serves users with very few signaling activities, resulting in an imbalance of load across VMs. It also enables VM overloading to be resolved faster, since the signaling load can be moved to another VM as soon as one procedure is completed, which is usually in less than 100 milliseconds.

Maximum Reliability
Each component within Brocade gateway products is designed for high availability and has no single point of failure. A well-distributed deployment of multiple instances of VNFC VMs at each tier allows clusters to detect a failure and

Figure 2: Brocade vPGW and Brocade vSAE-GW logical architecture and supported interfaces.
route subsequent requests to available instances. Brocade gateway products can detect and address a failure at the process, network interface, VM, and server level. Each VNFC VM is modeled to support 99.999 percent availability.

**High Performance**

Brocade vPGW and Brocade vSAE-GW are software-based, fully virtualized products and are not bound to any proprietary hardware. They utilize state-of-the-art technologies, such as DPDK, for fast packet processing in order to provide line-speed support for data plane processing functions. Also, they support linear scalability to meet any capacity and performance requirements of service providers (see Table 1).

### Table 1: Examples of Brocade gateway product performance with different numbers of physical cores.

<table>
<thead>
<tr>
<th>Performance</th>
<th>21 cores</th>
<th>36 cores</th>
<th>54 cores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Plane</td>
<td>Number of bearers</td>
<td>1.2 million</td>
<td>2.4 million</td>
</tr>
<tr>
<td>Session creation per second</td>
<td>3,500</td>
<td>7,000</td>
<td>10,500</td>
</tr>
<tr>
<td>Data Plane</td>
<td>Throughput (Gbps)</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

**Brocade vPGW and Brocade vSAE-GW Specifications**

<table>
<thead>
<tr>
<th><strong>General</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session management</strong></td>
</tr>
<tr>
<td>• Default bearer management</td>
</tr>
<tr>
<td>• Multiple EPS bearer support</td>
</tr>
<tr>
<td>• QCI to DSCP mapping</td>
</tr>
<tr>
<td>• UE-AMBR, APN-AMBR, GBR</td>
</tr>
<tr>
<td>• Dedicated bearer management</td>
</tr>
<tr>
<td>• Packet Filter Support</td>
</tr>
<tr>
<td>• Downlink Data Buffering</td>
</tr>
<tr>
<td>• GTPv1, v2</td>
</tr>
<tr>
<td><strong>APN support</strong></td>
</tr>
<tr>
<td>• Multiple APN support</td>
</tr>
<tr>
<td>• Static and dynamic IP address allocation</td>
</tr>
<tr>
<td>• UE IPv4 or IPv6 addressing support</td>
</tr>
<tr>
<td><strong>Roaming</strong></td>
</tr>
<tr>
<td>• Inbound and outbound roaming</td>
</tr>
<tr>
<td>• Gp</td>
</tr>
<tr>
<td>• S8</td>
</tr>
<tr>
<td><strong>Networking functions</strong></td>
</tr>
<tr>
<td>• Dual stack IPv4 and IPv6 support</td>
</tr>
<tr>
<td>• VLAN tagging</td>
</tr>
<tr>
<td>• Static routes</td>
</tr>
<tr>
<td>• IPv4 fragmentation and reassembly</td>
</tr>
<tr>
<td>• Jumbo frames</td>
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<tr>
<td>• NTP Synchronization</td>
</tr>
<tr>
<td><strong>Lawful intercept</strong></td>
</tr>
<tr>
<td>• 3GPP Release 12 Compliance</td>
</tr>
<tr>
<td>• X1_1 (administration)</td>
</tr>
<tr>
<td>• X2 (IRI)</td>
</tr>
<tr>
<td>• X3 (CC)</td>
</tr>
<tr>
<td><strong>Policy and charging</strong></td>
</tr>
<tr>
<td>• PCRF interworking: Gx</td>
</tr>
<tr>
<td>• Local Policy Control</td>
</tr>
<tr>
<td>• Time and volume CDR generation (ASN.1 format)</td>
</tr>
<tr>
<td>• GTP (GTP prime) support</td>
</tr>
<tr>
<td>• Online charging: DCCA, Gy</td>
</tr>
<tr>
<td>• Offline charging: Gz</td>
</tr>
<tr>
<td><strong>RADIUS</strong></td>
</tr>
<tr>
<td>• RADIUS authentication</td>
</tr>
<tr>
<td>• AAA server configuration</td>
</tr>
<tr>
<td>• RADIUS accounting</td>
</tr>
<tr>
<td>• RADIUS-based rate-limiting</td>
</tr>
<tr>
<td><strong>DPI</strong></td>
</tr>
<tr>
<td>• L3/L4 DPI</td>
</tr>
<tr>
<td>• S-tuple SDF detection</td>
</tr>
<tr>
<td>• URL filtering</td>
</tr>
<tr>
<td>• L7 DPI</td>
</tr>
<tr>
<td>• P2P protocol detection</td>
</tr>
<tr>
<td>• X-Header enrichment</td>
</tr>
<tr>
<td><strong>User plane performance</strong></td>
</tr>
<tr>
<td>• Intel DPDK-enabled</td>
</tr>
<tr>
<td>• PCI passthrough</td>
</tr>
<tr>
<td>• SR-IOV</td>
</tr>
</tbody>
</table>
### Brocade vPGW and Brocade vSAE-GW Specifications (continued)

#### Subscriber provisioning
- Optional subscriber provisioning framework (supported by co-deployment of Brocade vHSS)
- CLI-based subscriber provisioning
- Bulk provisioning
- APN and QoS templates

#### OAM aspects
- GUI-based EMS
- Follows ITU-T X.733
- Manages multiple Brocade VCM instances
- User management
- In-service software patching
- FCAPS
- SNMP, XML, REST
- CLI support
- Graphical display of VNFC topology
- Real-time resource usage charts

#### 3GPP interface support
- SGi
- Gy
- Gn/Gp
- S11 (Brocade vSAE-GW only)
- Gx
- Gz
- S5/S8
- S1-U (Brocade vSAE-GW only)

#### Standards Compliance

**3GPP**
- 3GPP TS 23.003: Numbering, addressing, and identification
- 3GPP TS 23.060: General Packet Radio Service (GPRS); Service description; Stage 2
- 3GPP TS 23.107: Quality of Service (QoS) concept and architecture
- 3GPP TS 23.203: Policy and charging control architecture
- 3GPP TS 23.207: End-to-end Quality of Service (QoS) concept and architecture
- 3GPP TS 23.401: General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access
- 3GPP TS 29.060: General Packet Radio Service (GPRS); GPRS Tunneling Protocol (GTP) across the Gn and Gp interface
- 3GPP TS 29.061: Interworking between the Public Land Mobile Network (PLMN) supporting packet-based services and Packet Data Networks (PDN)
- 3GPP TS 29.212: Policy and Charging Control (PCC); Reference points
- 3GPP TS 29.213: Policy and charging control signaling flows and Quality of Service (QoS) parameter mapping
- 3GPP TS 29.274: 3GPP Evolved Packet System (EPS); Evolved General Packet Radio Service (GPRS) Tunneling Protocol for Control plane (GTPv2-C); Stage 3
- 3GPP TS 29.281: General Packet Radio System (GPRS) Tunneling Protocol User Plane (GTPv1-U)
- 3GPP TS 32.215: Telecommunication management; Charging management; Packet Switched (PS) domain charging
- 3GPP TS 32.295: Telecommunication management; Charging management; Charging Data Record (CDR) transfer
- 3GPP TS 32.298: Telecommunication management; Charging management; Charging Data Record (CDR) parameter description
- 3GPP TS 33.106: 3G security; Lawful interception requirements
- 3GPP TS 33.107: 3G security; Lawful interception architecture and functions

**IETF**
- IETF RFC 2474: Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers
- IETF RFC 2865: Remote Authentication Dial-In User Service (RADIUS)
- IETF RFC 2866: RADIUS Accounting
- IETF RFC 2867: RADIUS Accounting Modifications for Tunnel Protocol Support
- IETF RFC 2868: RADIUS Attributes for Tunnel Protocol Support
- IETF RFC 2869: RADIUS Extensions
- IETF RFC 2882: Network Access Servers Requirements: Extended RADIUS Practices
- IETF RFC 4006: Diameter Credit-Control Application
- IETF RFC 4960: Stream Control Transmission Protocol
- IETF RFC 6733: Diameter Base Protocol
License Information
Brocade gateway products are available with simple, flexible, and scalable perpetual licensing options designed to support different use cases. Contact Brocade for more information about ordering and licensing.

Brocade Global Services
Brocade Global Services has the expertise to help organizations build scalable, efficient cloud infrastructures. Leveraging 20 years of expertise in storage, networking, and virtualization, Brocade Global Services delivers world-class professional services, technical support, and education services, enabling organizations to maximize their Brocade investments, accelerate new technology deployments, and optimize the performance of networking infrastructures.

Acquisition Options That Match Balance Sheet Objectives
Successful network deployments drive business forward, providing technical and financial agility. Brocade offers the broadest financing models, from traditional leasing to Brocade Network Subscription. Network-as-a-Service allows organizations to subscribe to network assets today then upgrade on demand, scale up or down, or return them with 60-day notification. Brocade Network Subscription plans can be structured to meet IASC guidelines for OpEx or CapEx treatment to align with financial goals. Learn more at www.nonetworkcapex.com.

Maximizing Investments
To help optimize technology investments, Brocade and its partners offer complete solutions that include professional services, technical support, and education. For more information, contact a Brocade sales partner or visit www.brocade.com.

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