

## Dual-Stack Lite Solution

Dual-Stack Lite (DS-Lite) is part of the Benu Networks' family of Virtual Service Edge (VSE) IPv4-IPv6 transition solutions that allows broadband service providers to transition to IPv6 without impacting existing subscribers' use of IPv4 Internet and applications. The Benu Networks' DS-Lite solution provides a standards-based Address Family Transition Router (AFTR) capability per IETF RFC6333 that can be deployed in a virtualized instance (VMware, OpenStack) or integrated with one of Benu Networks' high-performance compute nodes.



### THE IPV4 ADDRESS CHALLENGE

Technology consulting firm Gartner predicts the number of connected devices in use will reach 20.8 billion by 2020, up from 6.4 Billion in 2016. The growth of IP-connected devices has caused a rapid depletion of IPv4 addresses globally. On September 24, 2015, the American Registry for Internet Numbers ([www.ARIN.net](http://www.ARIN.net)) issued the final IPv4 addresses in their free pool. The other four Regional Internet Registries (RIR) are rapidly depleting their limited IPv4 pools. Globally, IPv4 remains the predominant Internet traffic protocol to IPv6, but IPv6 adoption is accelerating according to Akamai's Q3 2016 "State of the Internet" report. The same report also notes most advanced markets have a higher mix of IPv6 traffic than emerging markets, but IPv4 is still a greater percentage. IPv4 is not compatible with IPv6, and therefore most devices are required to support dual-stack (IPv4 and IPv6) clients to ensure that content can be accessed in both protocols. For some years now, Internet Service Providers (ISPs) have been allocating a public IPv4 address per subscriber, which is not sustainable due to the growth in broadband subscribers. Additionally, the upgrade and maintenance of a dual-stack (IPv4 and IPv6) network with continued traffic growth exceeding 50% CAGR, is too complex and CAPEX intensive. A transition to an all IPv6 solution is needed while supporting legacy IPv4 clients and IPv4 Internet.

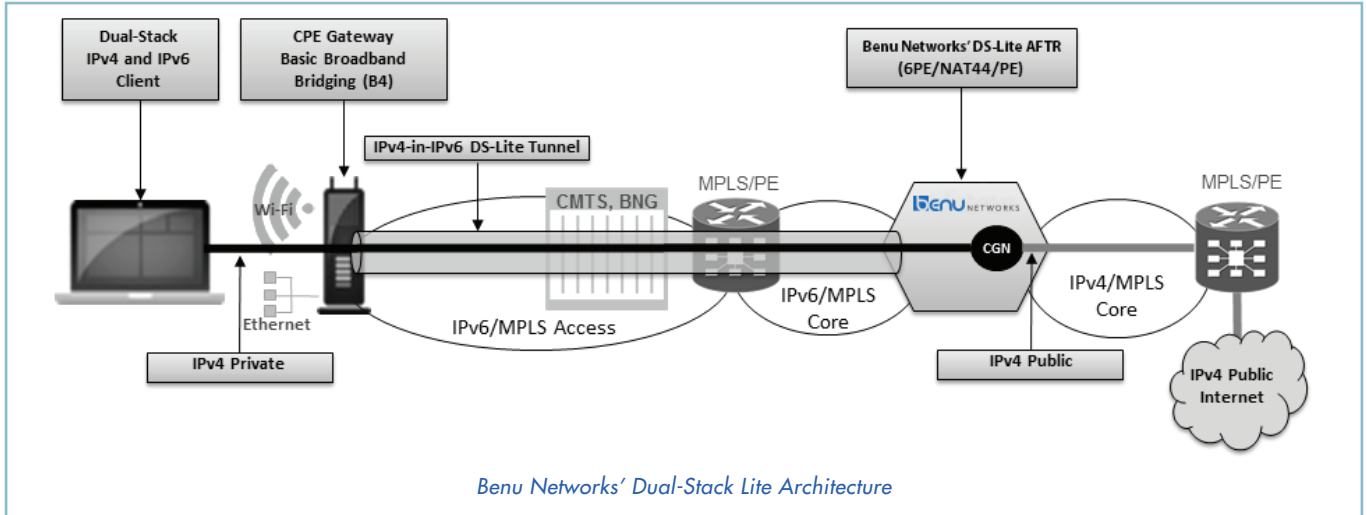
### DS-LITE OVERVIEW

DS-Lite is one of the IPv6 transition mechanisms implemented in Benu Networks' Virtual Service Edge (VSE) platform. DS-Lite is an IPv6 transition solution for ISPs with IPv6 infrastructure which allows them to connect their IPv4 subscribers to the IPv4 Internet. DS-Lite is a standards-based technology defined by the Internet Engineering Task Force (IETF) in the RFC6333 standard, and leverages two well-known technologies: IP in IP (IPv4-in-IPv6) and Carrier-Grade Network Address Translation (CGNAT). DS-Lite is implemented in the customer premise equipment (CPE) and in IP core network routers. The IP core network router is referred to as the "Address Family Transition Router (AFTR)". The DS-Lite function in the CPE is referred to as the "Basic Bridging Broadband (B4)" function. Important broadband standards organizations such as CableLabs (<http://www.cablelabs.com/>) and the Broadband Forum ([www.broadband-forum.org](http://www.broadband-forum.org)) regard DS-Lite as a favorable migration strategy for IPv4 to IPv6 transition. DS-Lite enables both the continued support for IPv4 services, and an easier transition to the deployment of IPv6.

### DS-LITE BENEFITS

- DS-Lite is a proven technology widely available in broadband customer premise equipment (e.g. cable modems, xDSL modems), and is readily available to Service Providers.
- DS-Lite provides dual-stack to users without requiring any public IPv4 address assigned to the CPE thus streamlining deployment and management of IPv4.
- DS-Lite uses IPv6 in the access network to ease the IPv4 exhaustion issue, resulting in simplified management of the access network.
- Native IPv6 traffic can be supported in the Service Provider's core network, thereby promoting the adoption of IPv6.

In the DS-Lite architecture, the CPE (B4) element encapsulates native IPv4 traffic in the IPv6 tunnel (soft-wire) which is terminated on the Benu Networks’ AFTR function. The AFTR function is an integrated part of Benu Networks’ operating system (BenuOS), which provides additional IP network services such as Provider Edge routing, MPLS, H-QoS, ACLs and other important functionality that is critical for large scale deployments. The AFTR function can be deployed in a virtual environment (VMware or OpenStack) or deployed on Benu Networks’ integrated x86 compute nodes. Benu Networks’ Virtual Service Edge platform supports carrier-class capabilities to meet the most demanding requirements.



Key highlights of Benu Networks’ DS-Lite Solution include:

- Large scale aggregation of IPv4-in-IPv6 soft-wires
- Carrier-Grade NAT (CGN) and CGN logging for deterministic NAT service delivery
- Advanced Provider Edge routing MP-BGP/6PE/MPLS for better network integration
- Advanced DPDK fast path capabilities for scale and performance
- Platform evolution to multiservice SDN architecture for next generation programmable network and service delivery

Benu Networks’ operating system, BenuOS, has been deployed at scale in some of the largest ISPs in the world. The BenuOS provides reliable and scalable IP subscriber management, carrier-grade NAT, policy enforcement, core routing and mobility. When deployed in a virtualized environment, the actual scale and performance will depend on the server platform and the specific virtualized environment. Optionally, Benu Networks provides pre-integrated and certified compute nodes to provide predictable scale and performance.

AFTR performance for integrated compute nodes solutions from Benu Networks are as follows:

xMEG MODEL NUMBER	PERFORMANCE GUIDELINE*
980-0011 980-0012	xMEG-100 Platform with 2x100GE QSFP28 Throughput: 200 Gb/s Capacity, 100 Gb/s Full Duplex Assuming 1 Mbps Full Duplex per B4 CPE Concurrent B4 DS-Lite Tunnels: 100,000 Concurrent IPv4 Sessions: 400,000 CGN Bindings: 204 Million
980-0009 980-0010	xMEG-100 Platform with 8x100GE SFP+ Throughput: 200 Gb/s Capacity, 100 Gb/s Full Duplex Assuming 1 Mbps Full Duplex per B4 CPE Concurrent B4 DS-Lite Tunnels: 100,000 Concurrent IPv4 Sessions: 400,000 CGN Bindings: 204 Million

\*Actual performance will vary depending on deployment environment and traffic model.

## BENUOS

The BenuOS, Benu Networks’ operating system, provides a carrier-grade IP networking feature set to solve today’s most complex IP service delivery challenges in order to maximize the customer lifetime value (CLV) of business, residential and mobile subscribers. In addition to key AFTR features, the BenuOS supports multiservice routing and gateway functions for fixed and mobile applications.

## FEATURE DETAILS\*

HIGH PERFORMANCE, SCALABLE PLATFORM	VIRTUALIZATION	NETWORKING
BenuOS (Operating System)	Virtual Appliance for VMware vSphere ESXi (5.5 and Later)	Routing – Static Routes, IS-IS (v4/v6), RIPv2, OSPF v2, BGP4/BGP6, IBGP
Multi-core Support		Virtual Router Function (VRF)
Linear Application Scaling		MP-BGP, MPLS, 6PE
Carrier Grade Linux	Virtual Appliance for Open-Stack (Liberty and Later)	VLAN Support
DPDK Data Plane		Access Control Lists (ACLs)
10GE or 100GE Interface Support		
DS-LITE AFTR FEATURES	MANAGEMENT	
Carrier Grade NAT (CGN/CGNAT), Large Scale NAT (LSN)	Dedicated Management Interface (Console, SSH, IPMI)	
Multiple Port-block Allocations	Industry Standard Command Line Interface (CLI)	
Fragmentation Support (Both IPv4 and IPv6)	SNMP, Syslog, Alerting	
CGN Logging	Port Mirroring	
CGN Logging to RADIUS	RADIUS Attributes in Logs	
	Policy from RADIUS	

\*Features may vary based on application and deployment model.

## PRODUCTS SUPPORTED

The virtual Multiservice Edge Gateway (vMEG) runs the BenuOS supported in a virtual solution environment with VMware or OpenStack.

vMEG Minimum Requirements:

vMEG MODEL NUMBER	DESCRIPTION
700-1310	vMEG BenuOS, VMware, 12 Core Capacity License
	Minimum Requirement: VMware vSphere ESXi 5.5 and later, 6 Core Intel
	Haswell-class CPU or greater, 24GB memory, 20GB of SSD.
700-1320	vMEG BenuOS, OpenStack, 12 Core Capacity License
	Minimum Requirement: OpenStack Liberty (or greater), 6 Core Intel
	Haswell-class CPU or greater, 24GB memory, 20GB SSD.

The x86 Multiservice Edge Gateway (xMEG) product is Benu Networks' integrated compute node offering for service providers that prefer to deploy a network appliance model. It supports the same BenuOS in a fully integrated and supported x86 compute platform.

xMEG Hardware Configurations:

xMEG MODEL NUMBER	DESCRIPTION
980-0012	xMEG100-DC: 2x100GE QSFP28, 2RU (19" Rack)
	Average Power: BTU 400W / 1,365 BTU/hr.
	Max Power: BTU 1,100W / 4,100 BTU/hr.
980-0011	xMEG100-AC: 2x100GE QSFP28, 2RU (19" Rack)
	Average Power: BTU 375W / 1,365 BTU/hr.
	Max Power: BTU 1,100W / 4,100 BTU/Hr.
980-0010	xMEG100-DC: 8x10GE SFP+ Ports, 2RU (19" Rack)
	Average Power: BTU 450W / 1,535 BTU/hr.
	Max Power: BTU 1,100W / 4,100 BTU/Hr.
980-0009	xMEG100-AC: 8x10GE SFP+ Ports, 2RU (19" Rack)
	Average Power: BTU 425W / 1,450 BTU/hr.
	Max Power: BTU 1,100W / 4,100 BTU/Hr.
980-0008	xMEG10-DC: 4x1GE Copper plus 2x10GE SFP+ Ports, 1 RU (19" Rack)
	Average Power: BTU 175W / 597 BTU/hr.
	Max Power: BTU 1,100W / 4,100 BTU/Hr.
980-0007	xMEG10-AC: 4x1GE Copper plus 2x10GE SFP+ Ports, 1 RU (19" Rack)
	Average Power: BTU 150W / 512 BTU/hr.
	Max Power: BTU 750W / 2,981 BTU/Hr.

[BENUNETWORKS.COM](http://BENUNETWORKS.COM)
[INFO@BENUNETWORKS.COM](mailto:INFO@BENUNETWORKS.COM)

**Corporate Headquarters**  
**Benu Networks**  
 300 Concord Road  
 Suite 110  
 Billerica, MA 01821  
 USA

**Benu Networks Ltd.**  
 Avenida de la Vega, 1  
 Building 3, 2nd Floor, Office 1  
 Alcobendas  
 28108 Madrid  
 Spain

**Benu Networks Packet Switch Pvt. LTD**  
 Vatika Business Center  
 A Wing, 2nd Floor, Suite 1  
 11 O'Shaughnessy Road,  
 Bangalore 560025  
 Kamataka, India