# VeloCloud Dynamic Multipath Optimization

This document discusses the key functionalities and benefits of VeloCloud Dynamic Multipath Optimization (DMPO) that assures enterprise and cloud application performance over Internet tend hybrid WAN.

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# Introduction

VeloCloud Cloud-delivered SD-WAN solution enables Enterprise and Service Provider to utilize multiple WAN transports simultaneously, maximize the bandwidth, while ensuring application performance. The unique Cloud-Delivered architecture offers these benefits for on-premise and cloud applications (SaaS/IaaS). This requires building overlay network, which consists of multiple tunnels, monitoring and adapting to the change in the underlying WAN transports in real time. To deliver a resilient overlay network that takes into account real-time performance of WAN links, VeloCloud has developed the Dynamic Multi-Path Optimization (DMPO). This document explains the key functionalities and benefits of DMPO.

# DMPO Key Functionalities

DMPO is used between all of the VeloCloud components that process and forward data traffic: VeloCloud Edge (VCE) and VeloCloud Gateway (VCG). For connectivity within Enterprise locations (branch-to-branch or branch-to-hub), the VCEs establish DMPO tunnels between themselves. For connectivity to Cloud applications, each VCE establishes DMPO tunnels with one or more VCGs. The four key DMPO functionalities are discussed below.

## Continuous Monitoring

### Automated Bandwidth Discovery

Once the WAN link is detected by the VCE, it establishes DMPO tunnels with one or more VCGs or Hubs and runs bandwidth test.

### Continuous Path Monitoring

DMPO performs continuous, uni-directional measurements of performance metrics — loss, latency and jitter of every packet on every tunnel between any two DMPO endpoints, VCE or VCG. VeloCloud's per-packet steering allows independent decisions in both uplink and downlink directions without introducing any asymmetric routing.

## Dynamic Application Steering

### Application-aware Per-packet Steering

DMPO identifies traffic using layer 2 to 7 attributes, e.g. VLAN, IP address, protocol, and applications. VeloCloud performs application aware per-packet steering based on Business Policy configurations and real-time link conditions. The Business Policy  contains out-of-the-box Smart Defaults that specifies the default steering behavior and priority of more than 2500 applications, which can be used immediately. Packets can be steered to onto one or more DMPO tunnels in the middle of communication with no impact to the flow. VeloCloud offers sub-second blackout (link down) and brown out (doesn't meet SLA) protection.

### MPLS Class of Service (CoS)

For a private link that has CoS agreement, DMPO can take CoS into account for both monitoring and application steering decisions. SP will guarantee a different SLA for each CoS on MPLS Link.

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## Bandwidth Aggregation

For applications that can benefit from more bandwidth, e.g. file transfer, DMPO performs per-packet load balancing, utilizing all available links to deliver all packets of a single flow to the destination.

# On-demand Remediation

In a scenario where it may not be possible to steer the traffic flow onto the better link, i.e., single link deployment, or multiple links having issues at the same time, the DMPO can enable error correction for the duration of the disruption. The type of error correction used depends on the type of applications and the type of errors.

## Real-time Applications

Real-time applications, such as voice and video flows, can benefit from Forward Error Correction (FEC) during periods of packet loss. DMPO automatically enables FEC on single or multiple links. With multiple links, DMPO will select up to two of best links at any given time for FEC. Duplicated packets are discarded and out-of-order packets are re-ordered at the receiving end before being delivered to the final destination. DMPO enables jitter buffer for the real-time applications when the WAN links experience jitter.

## TCP Application

TCP applications such as file transfer benefit from Negative Acknowledgement (NACK). Doing so protects end applications from detecting packet loss and maximizes TCP window and delivers high TCP throughput during lossy condition.

# Application Aware Overlay QoS

## QoS Scheduling

A Traffic Class is defined with a combination of Priority (High, Normal, or Low) and Service Class (Real-Time, Transactional, or Bulk) resulting into 3x3 matrix with 9 Traffic Classes. Application/category and scheduler weight can be mapped onto these Traffic Classes. All applications within a Traffic Class will be applied with the aggregate QoS treatment, including scheduling and policing.

## CoS Marking

When traffic arrives at the VCE, the Differentiated Service Code Point (DSCP) values marked by the customer can be left "as-is" or modified before sending out to the tunnel. The outer DSCP value on the tunnel header can also be modified or copied from the inner packet.



Default Application/Category and Traffic Class Mapping

Default Weight and Traffic Class Mapping

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### Policing MPLS CoS

For a private link that has CoS agreement with MPLS provider, SP will guarantee a different SLA for each CoS on MPLS Link. A policer can be defined for a MPLS CoS underlay to ensure Service Provider committed bandwidth SLAs are being honored by the customer.

### Rate-Limiting an Application or Category

Rate limiting is offered in both inbound and outbound directions for a specific application. When a rate limit for the outbound/inbound traffic is applied, under congestion, the traffic will be queued and when the queue is full, the packets will be dropped.

### Multi-Source Inbound QoS

VeloCloud supports multi-source inbound QoS which proactively measures the bandwidth usage with multiple remote peers, and will begin to regulate the traffic before congestion.With a hub-spoke design, when dynamic edge to edge is enabled, the hub will not know the traffic between edges and keep sending low priority traffic until congestion occurs. With multi-source inbound QoS enabled, the edge will proactively inform the hub to slow down the low priority traffic.

### Business Priority Monitoring

Based on designated priority, the application traffic can be monitored in real-time, and historical data can be retrieved. It can be viewed in the format of Bytes Received and Sent, Packet Received and Sent, and Average Throughput.

# Business Policy Framework and Smart Defaults

IT administrator controls QoS, steering, and services to be applied to the application traffic through the Business Policy. Smart Defaults provides out-of-the-box Business Policy that supports over 2,500 applications. DMPO makes steering decision based application type, real-time link condition (congestion, latency, jitter, and packet loss), and the Business Policy.

Each application is assigned a category. Each category has default action, which is a combination of Traffic Class (Priority and Service Class), Network Service, and Link Steering. In addition to the default application list, customer applications can be defined manually. The following is an example of Business Policy.
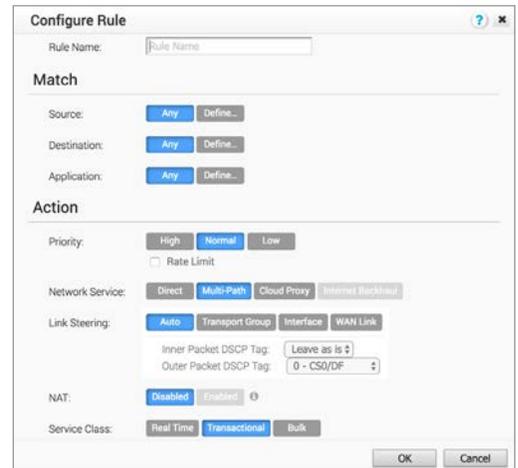


## Traffic Class (Priority and Service Class)

An application/category is assigned to Traffic Class based on the combination of Priority and Service Class and aggregated QoS treatment is applied to all the applications that fall into the same Traffic Class, including scheduling and policing (See the Application Aware Overlay QoS section for details).

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# Network Services

There are 4 types of Network Services – Direct, Multi-path, Cloud Proxy and Internet Backhaul. By default, an application is assigned one of the default Network Services, which can be modified by the user.

→ **Direct**: Typically used for non-critical, trusted Internet applications that should be sent directly, bypassing the DMPO tunnel. An example is Netflix, a service that is considered to be a non-business, high bandwidth application and should not be sent over the DMPO tunnels.

→ **Multi-Path**: Typically given to important applications.Multi-Path service assignment sends the Internet-based traffic to the VCG.

→ **Cloud-Proxy**: Redirects the application flow to a cloud proxy, such as WebSense (now ForcePoint).

→ **Internet Backhaul**: Redirects the Internet applications to the specified Enterprise location that may or may not have the VCE. The typical use case is to force important Internet applications through a site that has security devices such as firewall, IPS, and content filtering before the traffic is allowed to exit to the Internet.

# Link Steering

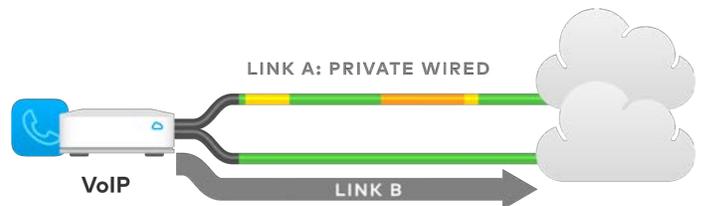There are three possible link steering options – *Preferred*, *Mandatory*, and *Available*.

**Mandatory
Link Steering**

Pin an application to a path even when the link fails. *Example: PCI*
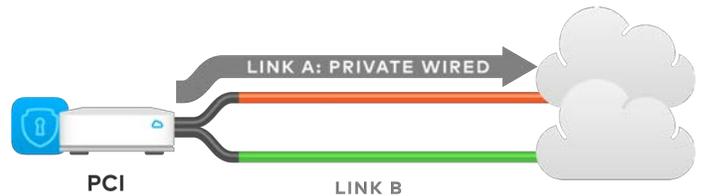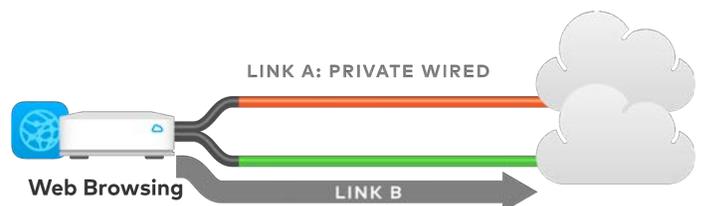


**Preferred
Link Steering**

Prefer application on a path but steer away if it cannot meet SLA. *Example: VoIP*



**Available
Link Steering**

Prefer application on a path but steer away if the link fails. *Example: Web Browsing*



# Secure Traffic Transmission

For private or internal traffic, DMPO encrypts both the payload, which contains the user traffic, and the tunnel header with IPSec transport mode end-to-end. DMPO supports AES128 and AES256 encryption standards and SHA2/SHA1 algorithms for integrity. IKEv2 is used for key management and PKI - for authentication. Both data and control traffic uses UDP port 2426.

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# DMPO Real World Results

## Scenario 1: Branch-to-Branch VoIP Call on Single Link

Results here demonstrate benefits of on-demand remediation using FEC and jitter remediation on a single Internet link with traditional WAN and VeloCloud SD-WAN.
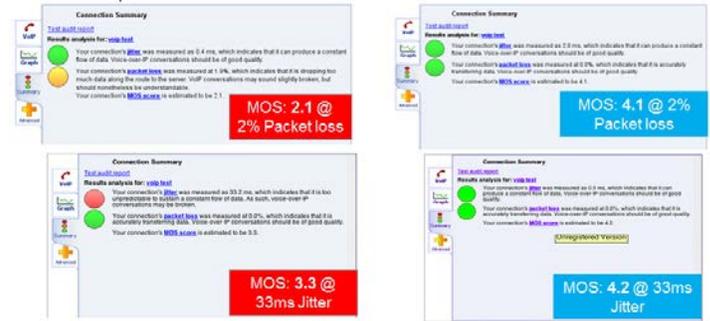


## Scenario 2: File Transfer from Box.com on Dual Links

Results here demonstrate benefits of bandwidth aggregation and on-demand remediation for a 50MB file download from Box.com on dual 20Mbps links with traditional WAN and VeloCloud SD-WAN.
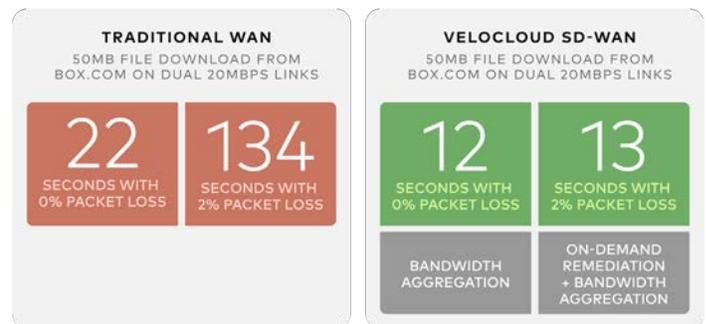


## Scenario 3: Branch-to-Branch Video Call on Dual Links

Results here demonstrate benefits of sub-second blackout protection by steering application flows onto Internet links and on-demand remediation at the same time on the Internet link with VeloCloud SD-WAN.
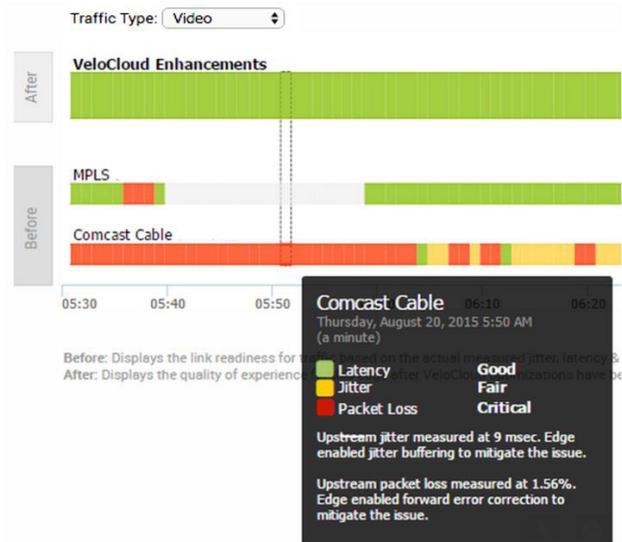


# Summary

VeloCloud Dynamic Multi-path Optimization (DMPO) enables application-aware dynamic per-packet steering, on-demand remediation and overlay Quality of Service; DMPO ensures optimal SD-WAN performance for the most demanding applications over any transport (Internet or Hybrid) and any destination (On-Premises or Cloud).