

Application Note

Monitor and Troubleshoot Teams Call Quality

Overview

Microsoft Teams has become a critical tool for many businesses, which rely on its video conferencing and voice calling features to keep employees connected and productive. As more companies adopt a hybrid work model that includes both on-site and remote employees, the importance of Teams increases—and so does the complexity of monitoring and supporting it. Your IT organization needs to ensure that Teams is available and performing well for your users, but supporting a cloud-based service has its challenges. You do not control the data center that is delivering the Teams service, and you have no control over the external network that you rely on to deliver the service. Employees who work from home offices may use different ISPs or may have a different level of internet service than what is available at your business site. All of these factors can affect the call quality that your users experience, so it is critical that you can quickly identify which factors are within your control.

This application note explains how you can use Vantage DX monitor the call quality experienced by your users and gain insight into the causes of poor call quality. It also describes how you can use Vantage DX to proactively monitor Teams call quality and address issues before they affect your users.

If you are new to Vantage DX, you may find it helpful to read *Understanding Vantage DX* for an overview of the solution and its modules. See the **Resources** section at the end of this document for more information.

About Microsoft CQD Data

The following sections describe the type of data that is available in Vantage DX through its integration with the Microsoft Call Quality Dashboard (CQD).

User data

A key feature of VDX Analytics is its ability to integrate with the Microsoft CQD to provide real-user monitoring. The Microsoft CQD is a tool that is available in the Teams Admin Center. It monitors all voice and video calls made in Teams and provides call quality metrics within 30 minutes of the end of a call.

You can use this integration to immediately correlate call quality data with factors that impact call quality, such as the ISP, the connection type, or the location of the user.

VDX Analytics retrieves the following types of data from the Microsoft CQD integration:

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Table 1: Data from the Microsoft CQD

Data Collected	Data Type in VDX Analytics	Description
Users	Object	<p>VDX Analytics provides information about the status of the user, such as its health state, the amount of uptime, and the number of incidents and alerts.</p> <p>Raw properties from Microsoft CQD are also available, such as:</p> <ul style="list-style-type: none"> • Display name • Email address • Department (if set in Azure AD) • Office location (if set in Azure AD)
User Devices	Object	<p>This object provides information about a user's experience from a specific location and network connection type. It is based on the geographical location of the device, the network connection type, the operating system, and the IP address. Because this object is based on multiple properties, VDX Analytics may display more than one object for each device. For example, if a user receives a Teams call on a mobile device over broadband while that device is also connected to WIFI in the office or at home, VDX Analytics creates two objects: one for the mobile connection and one for the WIFI connection.</p> <p>Each object includes information about the status of the device, such as its health state, the amount of uptime, and the number of incidents and alerts.</p> <p>Raw properties from Microsoft CQD are also available, such as:</p> <ul style="list-style-type: none"> • ISP and connection type • City and country • Setup information, such as the operating system and codecs • Call quality metrics for the device.

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Data Collected	Data Type in VDX Analytics	Description
Geographical locations	Groups	<p>Cities and countries display as groups. These groups are based on the location of user devices. VDX Analytics provides information about the status of the location, such as its health state, the amount of uptime, and the number of incidents and alerts.</p> <p>Raw properties from Microsoft CQD are also available, such as:</p> <ul style="list-style-type: none"> • The top 25 users for each location • The top 25 ISPs • Metrics about the number of devices and calls. • The group type (City or Country)
ISPs	Groups	<p>ISPs display as groups. The ISP group is based on the service provider information for user devices. VDX Analytics provides information about the status of the service provider, such as its health state, the amount of uptime, and the number of incidents and alerts.</p> <p>Raw properties from Microsoft CQD are also available, such as:</p> <ul style="list-style-type: none"> • The top 25 locations that use this ISP • The top 25 users • Metrics about the number of devices and calls • The group type (ISP)
Conference Calls	Groups	<p>Teams conference calls display as groups. The groups contain all of the user devices that were part of that meeting. You can view the group properties to see which users experienced poor call quality.</p>
Dynamic Offices	Groups	<p>A dynamic office is when three or more users participate in a call using the same IP address. VDX Analytics creates a group for that IP address.</p>
TCP Calls	Groups	<p>TCP call groups display all the users that make and receive TCP calls.</p>

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Data Collected	Data Type in VDX Analytics	Description
Microsoft Data Center	Groups	When a Teams call is initiated, the location of the server that hosts the call is typically determined by the first user to join the call. The call is hosted by the Microsoft data center that is in the same region as the first user. VDX Analytics creates a group for each data center and displays the users who participated in calls hosted by that data center.
Call rating information	Groups	<p>The Call Rating is the score that users provide when they are prompted to rate the quality of a Teams call. The score is on a scale of 1 to 5 and it is optional for users to provide this rating. You can use this group to see which users are rating calls most frequently and how they are rating their experience.</p> <p>When you view the Raw Properties for the group, the Group Type is listed as CallRating.</p>



Note: If the IP address of a device changes during the data collection period, VDX Analytics creates a new device. In this version, you may see multiple instances of the same device if the IP address of a device is changed.

Metrics

VDX Analytics retrieves device-level metrics from the Microsoft CQD integration. The metrics are averaged over all the call streams for the device during the data collection window. Video frame rates are averaged separately for video sessions and for screen sharing sessions, and the highest average frame rate is displayed.

The following table lists the metrics that VDX Analytics display for each device.

Table 2: Call Quality Metrics

Metric	Description
Last call time	The time of the last call on this device.
Client forward jitter	The jitter from the client to the destination.

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Metric	Description
Client forward RTT	The round-trip time from the client to the destination.
Client forward video frame rate	The video frame rate from the client to the destination.
Client reverse jitter	The jitter from the destination to the client.
Client reverse RTT	The round-trip time from the destination to the client
Client reverse video frame rate	The video frame rate from the destination to the client.
Average MOS	A prediction of end-user audio quality experience. It is based on latency, the packet loss, jitter, and the codec used.
Call times	A list of calls, with their start and end times.
Number of poor calls	The number of calls with poor voice quality that occurred during the data collection period.
Poor call times	The start and end times of calls with poor voice quality.
Dropped streams call times	The start and end times when call streams were dropped. Calls do not necessarily fail when call streams are dropped. For example, the video stream may drop but the audio stream may continue.
Failed calls times	The start and end times when calls failed.

You can easily correlate these call quality metrics with specific users and business sites. VDX Analytics provides default boards that you can use to correlate key metrics with users, ISPs, and business locations. The boards are created automatically when you configure the integration with the Microsoft CQD.

Implementation

The following sections provide information about the default boards that display Microsoft CQD data, and provide examples of custom searches that you can use to create your own boards or business services.

Start with out-of-the-box data

To begin monitoring Teams, the first step is to configure the integration between VDX Analytics and the Microsoft CQD for your tenant. There are no agents or devices to install.

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Before you configure the integration with VDX Analytics, you must set up the Microsoft CQD and configure an Office 365 account that VDX Analytics can use to access the CQD. For more information about the account requirements, see the Resources section at the end of this document.

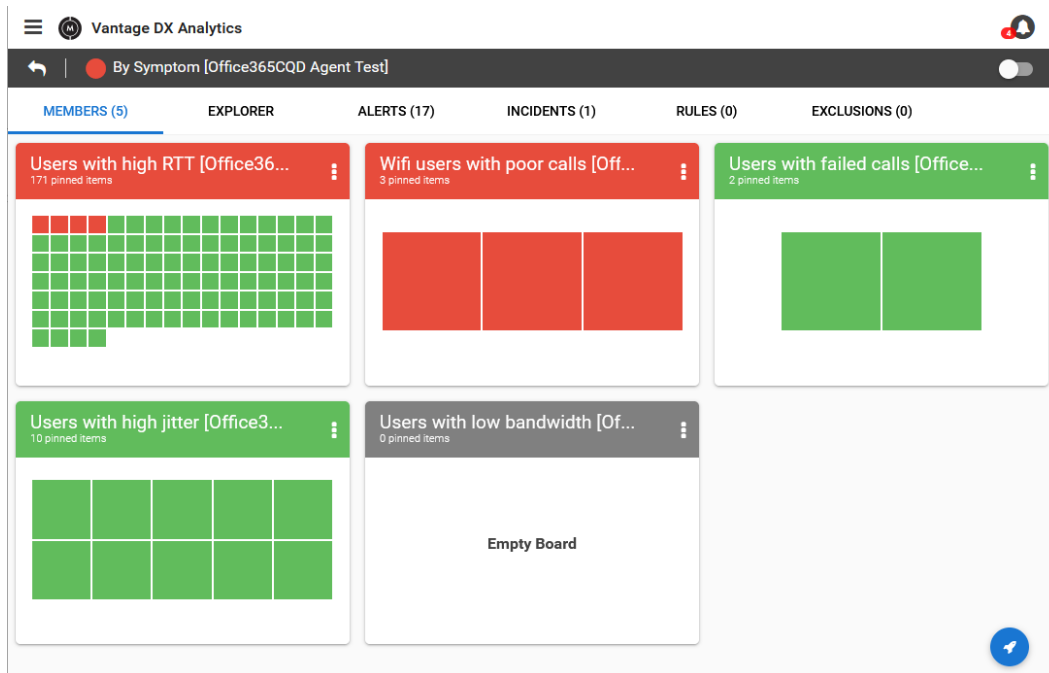
After you configure an integration between VDX Analytics and the Microsoft CDQ, VDX Analytics automatically creates a set of boards that contain Teams data for that specific Microsoft CQD integration. The following table lists the boards that VDX Analytics creates for each integration.

Table 3: Default Boards for Microsoft CDQ Integrations

Board Name	Description
By Symptom <integration name>	<p>The By Symptom board contains the following sub-boards:</p> <ul style="list-style-type: none"> • Users with high jitter <integration name>—Displays users whose forward jitter or reverse jitter exceeds 30 ms. Forward jitter is the jitter from the client to the destination; reverse jitter is the jitter from the destination to the client. • Users with high RTT <integration name>—Displays users whose forward or reverse round-trip time exceeds 100 ms. Forward RTT is the round-trip time from the client to the destination; reverse RTT is the round-trip time from the destination to the client. • Users with low bandwidth <integration name>—Displays users whose average available bandwidth is estimated as low. The estimate is calculated based on packet latency. • Users with failed calls <integration name>—Displays users who experienced more than four failed calls over the time period specified in the lookback period configured in the integration settings. • Wifi Users with poor calls <integration name>—Displays users who are connected through WIFI and who experienced calls with poor call quality over the time period specified in the lookback period configured in the integration settings.
Teams ISPs <integration name>	This board displays all of the ISPs that provide connectivity for users in the organization.
Teams Locations <integration name>	This board displays all of the countries where your users are connected.

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The following image shows an example of a board that was automatically created by VDX Analytics based on data from the Microsoft CQD.



Create Custom Searches

In addition to the default boards, you can also create custom boards based on other data. For example, you can create a search that identifies which users are using a specific audio codec, or a specific type of headset. You can identify which users are making or receiving TCP calls. Searching on audio devices allows you to see if a device that you supply to your users, such as an IP phone or headset, is impacting call quality. You can also use this information to see the audio devices in use, and then compare that to Microsoft's list of devices that are certified for use with Teams.

To monitor end users efficiently, we recommend that you create a saved search and then pin it to a board or business service. The saved search dynamically updates objects on a board or business service when the data changes. For example, if you create a saved search for all Teams users and pin that to a board, the objects on the board update dynamically when Teams users change.

Below are some suggested searches:

- **ISP and average MOS**—Determine whether poor voice quality is associated with a specific ISP. You can use this information to see whether degradation is related to bottlenecks at specific times, and determine whether your bandwidth is sufficient. The following search finds calls with degraded voice quality that were associated with a specific ISP:

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source.Office365CQD.ISP:"<ISP Name>" AND
 source.Office365CQD.AverageBandwidthEst:(>0 AND <1) AND
 source.Office365CQD.AverageMOS:(>0 AND <=3.6), where <ISP Name> is the name of a specific ISP, such as "Bell Canada."

- **Audio Devices**—This search allows you to see if a device that you supply to your users, such as an IP phone or headset, is impacting call quality. You can also use this information to see the audio devices in use, and then compare that to Microsoft's list of devices that are certified for use with Teams. The following search finds devices that have a MOS score of less than 3.6:
 source.Office365CQD.AudioDevices:"Built-In input" AND
 source.Office365CQD.AverageMOS:(>0 AND <=3.6)
- **Connection Type**—The following search allows you to see which users are connected through WiFi:
 source.Office365CQD.ConnectionType:"Wifi"
- **Data related to a specific ISP**—To find data for a specific ISP, create a saved search using the following search string: source.Office365CQD.ISPs:"<ISP Name>". You can create a saved search for each of your ISPs and compare their performance.
- **Geographical regions**—Find all Teams users in a specified geographical region, such as the following:
 - Europe:
 source.Office365CQD.groupType:Country AND
 (source.Office365CQD.Name:France OR
 source.Office365CQD.Name:Switzerland OR
 source.Office365CQD.Name:"United Kingdom" OR
 source.Office365CQD.Name:Netherlands OR
 source.Office365CQD.Name:Spain)
 - North America:
 source.Office365CQD.groupType:Country AND
 (source.Office365CQD.Name:"United States" OR
 source.Office365CQD.Name:Canada OR source.Office365CQD.Name:Mexico)
 - The Asia-Pacific region:
 source.Office365CQD.groupType:Country AND
 (source.Office365CQD.Name:India OR source.Office365CQD.Name:Australia
 OR source.Office365CQD.Name:Singapore)
- **Cities**—To find all the cities where Teams users are located, use the following search:
 source.Office365CQD.groupType:City
- **Meetings**—To see a list of all Teams meetings, including the number of participants, use the following search. You can call metrics for each meeting listed in the search results: source.Office365CQD.groupType:Meeting
- **Call ratings**—To list all components that have a call rating associated with them, use the following search: source.Office365CQD.groupType:callrating
- **PSTN trunk calls**—To see all Teams calls that were routed through a PSTN trunk, use the following search: source.Office365CQD.groupType:PSTNTrunk

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- **PSTN carriers**—To see all PSTN carriers associated with Teams calls, use the following search: `source.Office365CQD.groupType:PSTNCarrier`
- **Data centers**—To see all of the data centers associated with Teams calls, use the following search: `source.Office365CQD.groupType:MicrosoftDC`
- **Calls with low MOS**—To see all calls with low MOS, which is defined as a score of less than 3.8, use the following search: `source.Office365CQD.AverageMOS: <=3.8`
- **Meetings with low MOS**—To see meetings with low MOS, which is defined as a score of less than 3.8, use the following search:
`source.Office365CQD.groupType:Meeting AND source.Office365CQD.AverageMOS: <=3.8`

Search Example: TCP Connections

The following example explains how you can use Vantage DX to monitor calls that use TCP connections.

Packet loss and jitter are key factors in call quality. When packet loss occurs during a call that uses TCP as the connection protocol, TCP retransmits the broken packets. This retransmission causes a delay; in addition, voice packets may arrive in a different order from which they are sent. The packets are stored in a buffer and then reconstructed in the correct order. Jitter is a measure of the size of the buffer that is needed for this process. When jitter occurs, your end user experiences a lag in audio transmission.

TCP is more prone to jitter than UDP, because UDP does not retransmit broken packets. When a call uses UDP as the connection protocol, a dropped packet results in a brief silence, rather than a lag. If you want to identify and monitor calls that use TCP, you can do so by creating the following search:

```
source.Office365CQD.groupType:TCPCalls
```

The following image shows an example of the search results, where there is one group of TCP calls:

The screenshot shows the Vantage DX Analytics interface. The search bar contains the query `source.Office365CQD.groupType:TCPCalls`. The interface displays a table with the following columns: State, Name, Type, and Integration Type. A single result is shown: a green dot in the State column, 'TCP Calls' in the Name column, 'Group' in the Type column, and 'Microsoft Teams Call Quality' in the Integration Type column. The left sidebar shows various filter categories like Types, Integration Types, Integrations, Correlated Components, Consolidation Rules, and State.

State	Name	Type	Integration Type
●	TCP Calls	Group	Microsoft Teams Call Quality

You can open the group to view a wide range of raw properties, including:

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- The top 25 locations where calls occurred.
- The top 25 users.
- The top 25 ISPs.
- The number of devices and calls, as well as the number of poor calls.
- The operating systems associated with the calls.
- The top 5 user issues.
- The reasons for poor calls.
- The top network issue.
- Information about poor calls, dropped calls, and failed calls.

The following image shows an excerpt of information that is available for the TCP call group; it shows that the user issues were caused by packet loss and RTT.

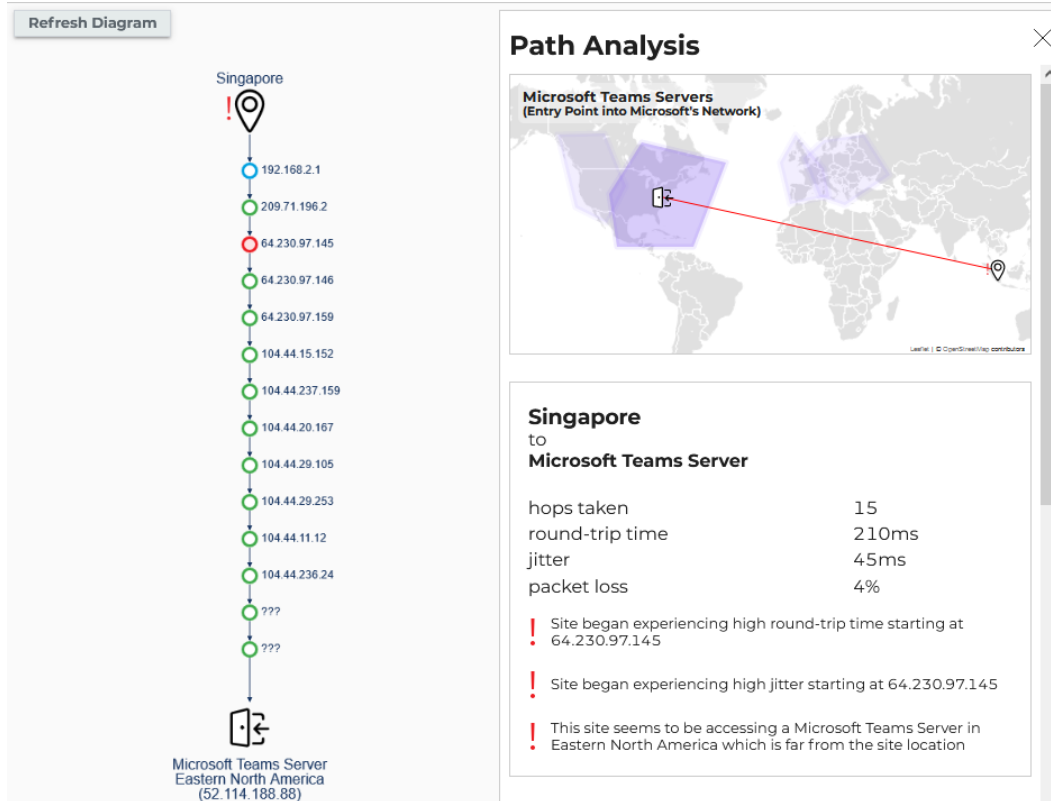
Top 5 User Issues	• User Display Name	Kimberly Barnes
	Number Of Poor Calls	1
	Top Issue	PacketLoss (1)
	• User Display Name	Rubie Farrell
	Number Of Poor Calls	1
	Top Issue	RoundTrip,Round Trip time Threshold (1)
Poor Call Reasons	• Issue	PacketLoss
	Number Of Calls	1
	• Issue	RoundTrip,Round Trip time Threshold
	Number Of Calls	1
Top Network Issue	Issue	PacketLoss
	Number Of Calls	1

Pinpoint Network Issues

With the real-user data provided in VDX Analytics, you can quickly identify users or locations that have recurring problems. The next step is to deploy Vantage DX Diagnostics probes to perform network tests from the problem area. Vantage DX Diagnostics uses My Traceroute (MTR)—which is a combination of traceroute and ping—to identify the segment of the network where the error occurs. For example, if a user or a location is experiencing high round-trip time (RTT), jitter, or packet loss, you can deploy a probe to determine the source of the problem. The test results will show whether the issue is occurring in the corporate network, the user's home network, the ISP's network, or the Microsoft network.

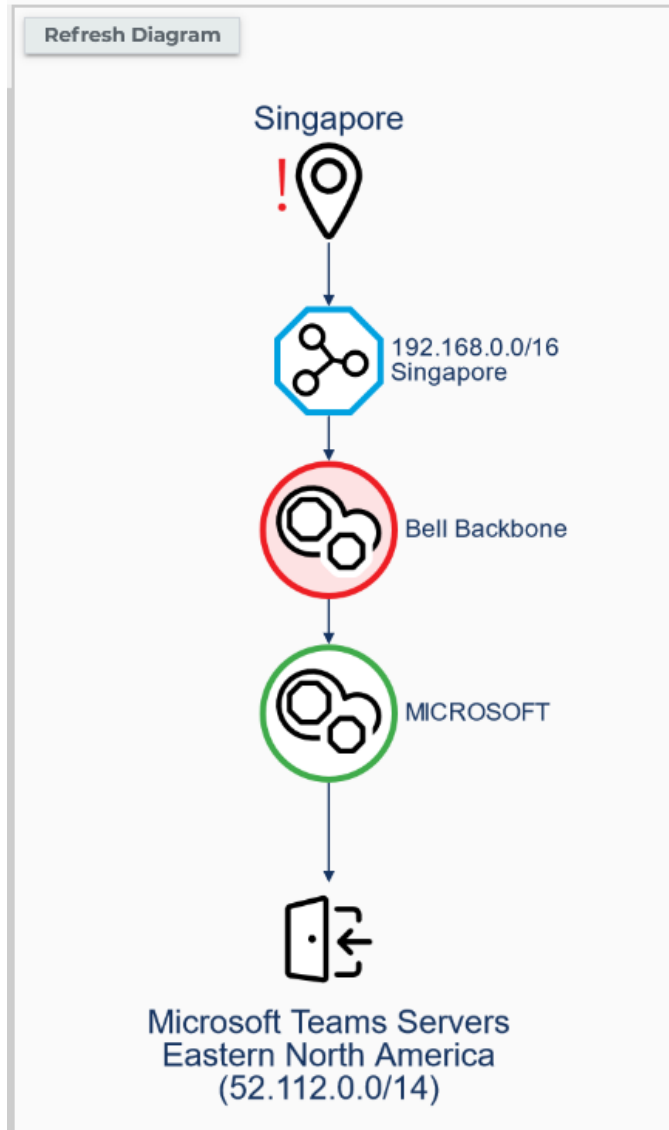
The following image shows an example of a network path diagram in Vantage DX Diagnostics. In this example, the path between the Singapore office and the Teams web service experienced high RTT and a high level of jitter. The site is also accessing the Teams web server from a geographically distant location, which could be caused by the use of a VPN:

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You can use the Grouping option to view the hops by network owner. As the following image shows, the hops that contributed to high RTT and jitter occurred in the segment of the network owned by the ISP:

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You can use this information to focus your troubleshooting efforts.

Identify Problems Proactively

After you have used the real-user data and the network path data to identify and troubleshoot problems, you can use Vantage DX Monitoring robots to proactively monitor the network conditions that affect call quality.

Vantage DX Monitoring collects a range of metrics for the Teams workload, but the following metrics are key predictors of call quality:

- **Jitter**—The recommended average is < 30 ms during any 15-second interval.

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- **Packet loss**—Microsoft recommends a packet loss rate of 1% during a 15-second interval. A packet loss rate between 3% and 7% causes a noticeable impact to call quality. A rate of more than 7% severely impacts the call quality.
- **Round Trip Latency**—The recommended target is < 100 ms.
- **Average bandwidth**—The recommended targets are:
 - Voice calls: > 100 KBPS
 - Video calls: > 300 KBPS
- **Packet reorder ratio**—The recommended target is < 0.05%.
- **Network MOS**—The recommended target is > 4.

Vantage DX Monitoring robots continually test these metrics from your business sites. When test results indicate that a performance threshold has been breached, the health status of the workload changes to either Warning or Critical, depending on the test. This continual monitoring means that you can be notified of performance degradation immediately, and address it before it impacts your end users. You can also use this information to proactively notify your users about known issues.

Resources

For more information, see the following documents:

- For an overview of the Vantage DX solution and its capabilities, see the *Understanding Vantage DX* Application Note.
- For a comprehensive overview of the Vantage DX solution, see the *Vantage DX Deployment Guide*.
- For detailed information about integrating the Microsoft Teams Call Quality Dashboard with Vantage DX, see *Real User Monitoring with Vantage DX Analytics*.
- See the following Application Notes for information and examples about key features in VDX Analytics:
 - *Business Services and SLA Performance Data on VDX Analytics*.
 - *Manage Complex Data in VDX Analytics*

All documentation is available on the Martello website at:

<https://martellotech.com/documentation/vantage-dx/>

About Martello Technologies

Martello Technologies Group Inc. (TSXV: MTLO) is a technology company that provides digital experience monitoring (DEM) solutions. The company develops products and solutions that provide monitoring and analytics on the performance of real-time applications on networks, while giving IT teams and service providers control and visibility of their entire IT infrastructure. Martello's products include unified communications performance analytics software and IT analytics software.

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