Black Box Multicast Video-over-IP Solution

MediaCento™ IPX and LGB Series Ethernet Switches

In this application note, we examine IP multicast streaming of video content in an Ethernet network using the MediaCento IPX video appliance.

MediaCento IPX

The Black Box MediaCento IPX extends HDMI video over any IP network to as many as 250 distant screens—or to video walls. You can run the Black Box MediaCento IPX in unicast (one transmitter to one receiver) or multicast (one transmitter to many receivers) mode applications. The unit can also support a video wall, using multicast mode to output a single source video to a matrix of screens, so that you can project your HD content on a larger scale with one image divided over multiple video screens.

This Application Note will focus on the use of MediaCento IPX in multicast mode with Black Box Ethernet Switches. Real-world applications for this capability include:

- Video broadcast over a computer network (either one transmitter to many receivers or many transmitters to many receivers)
- Video wall applications
- Real-time news distribution

For MediaCento IPX multicasting applications it's very important to choose the right Ethernet switch, one that can handle the requirements to multicast data in your network without flooding your IP infrastructure. The recommended Black Box Ethernet switches for this application are the LGB Series of switches.

MediaCento IPX Units product numbers:

For Multicast and Multicast Video Walls	
Transmitter	VX-HDMI-IP-MTX
Receiver	VX-HDMI-IP-MRX
For Unicast	
Transmitter	VX-HDMI-IP-UTX
Receiver	VX-HDMI-IP-URX

General Ethernet Switch requirements to support MediaCento IPX for Multicasting:

You will need Ethernet switches with these minimum features:

- Gigabit (1000-Mbps) or faster Ethernet ports
- Support for IGMP v2 (or v3) snooping
- Support for Jumbo frames (packets) up to 9216-byte size—and you must enable Jumbo frames when configuring the switches
- High bandwidth connections between switches, preferably multi-Gigabit speed and or multiple slower links using Link Aggregation Control Protocol (LACP)

You should also:

- Look specifically for switches that perform their most difficult tasks (for example, IGMP Snooping) using multiple dedicated processors—that is, the tasks are carried out in custom ASIC hardware rather than software routines on a general processor.
- Check the maximum number of concurrent "snoopable groups" each switch can handle and make sure that they meet or exceed the number of MediaCento IPX transmitters that you will use to create multicast groups.
- Check the throughput speeds of the switch. Make sure that each port is full-duplex (that is, provides bidirectional communications) and that the up- and downstream data speeds for each port are 1 Gigabit per second (Gbps).
- Where possible, use the same switch manufacturer throughout a single subnet and, also if possible, the same model of switch— this will simplify configuration and lessen the chances of compatibility issues.
- When choosing Layer 3 switches for the network, at least one must be capable of operating as an IGMP requester.

IP Multicast

IP multicast is a technique for one-to-many communications using an IP infrastructure.

Unicast—one transmitter (red) transmits data to one receiver (green).

Multicast—one (or more) sender transmits data to more than one receiver.

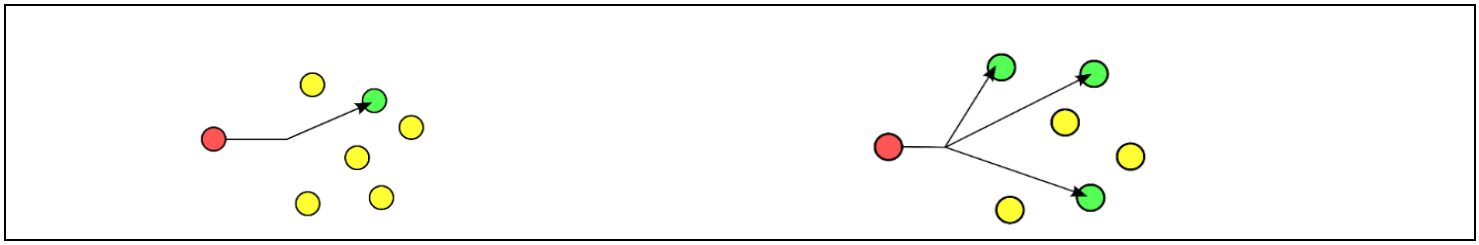

Figure 1: *Unicast versus Multicast.*

Multicast uses network infrastructure efficiently by requiring the sender to transmit a packet only once when it needs to be delivered to a large number of receivers. After the sender transmits, the network nodes take care of replicating the packet to reach multiple receivers as necessary. Multicast also scales to a large receiver population by not requiring the sender to have prior knowledge of who or how many receivers there are for a given multicast. The difference in bandwidth requirements can be seen on the next page in Figure 2.

IP multicasting is the “Internet abstraction” of LAN multicasting. Membership in a multicast group determines whether a host computer will receive datagrams sent to the multicast group. And on the receiving side, membership in an IP-multicast group is dynamic: a receiver may join or leave at any time and a receiver may be a member of an arbitrary number of multicast groups.

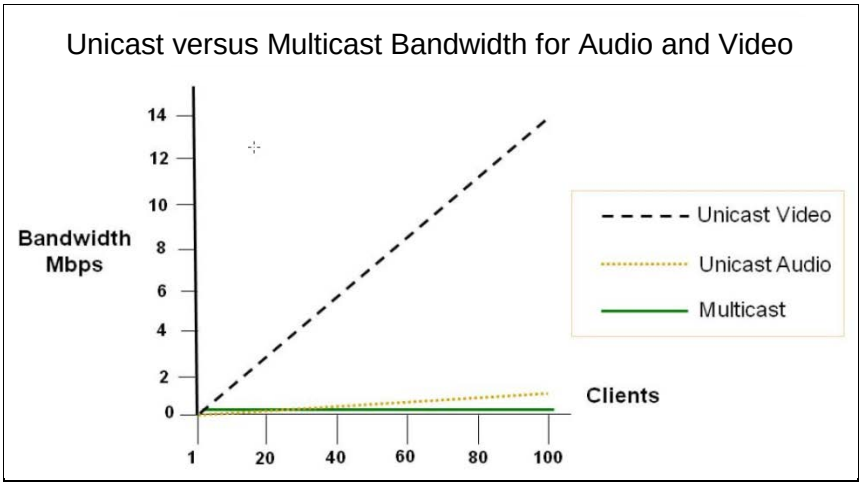

Figure 2: *While unicast communications scale linearly with the number of receivers/clients, multicast requires only one communication stream to be sent from the sender to the receivers—routers/gateways that have hosts wanting to receive the multicast then replicate the stream, thus greatly diminishing the bandwidth required for the multicast.*

The Challenge with Multicasting

While IP multicasting has many benefits, it also presents challenges. Multicasting delivers identical data to multiple receivers simultaneously *without maintaining individual links to those receivers*. So, when multicast data packets enter a subnet, the natural reaction of the switches that bind all the hosts together within the subnet is to send the multicast data to *all their ports*. This is referred to as “multicast flooding” and means that all the hosts in that subnet (or at least their network interfaces) are required to process that multicast data even if they are not members of that multicast. IGMP offers a partial solution.

IGMP (Internet Group Management Protocol) is the IP mechanism that enables routers to perform multicasting. IGMP was developed to help prevent network flooding by requiring individual hosts to opt into multicasts. It also provides a mechanism for routers to determine whether any hosts located within their subnet have opted in and want to receive a multicast. At the IP layer of the network, this affects only the router gateway to the subnet. So if one host within the subnet requests to receive a multicast, all hosts within the subnet will also receive it. As explained above, that will flood that subnet.

The Solution: IGMP Snooping

IGMP snooping “glues” together all the hosts within a subnet. IGMP snooping gives Layer 2 switches the ability to “peek” at the Layer 3 IGMP instructions that help routers to do their job. As a result, the switches can determine exactly which of their own hosts have requested to receive a multicast—*and only pass on multicast data to those hosts without flooding the whole subnet*.

In order to do IGMP snooping, Layer 2 switches must be enabled to do something beyond typical Ethernet switching: they now must be able to decipher data packets at Layer 3 to read the logical addressing and multicast instructions. This requires considerably more processing power than their normal “day job” of reading physical MAC addresses at Layer 2.

Implementing IGMP snooping on a switch with a slow processor can cause severe performance problems when data is transmitted at high data rates and/or there are multiple IGMP groups to be monitored. If a switch cannot keep pace, it will cause backlogs where large numbers of data packets are arbitrarily discarded and/or it resorts to sending all multicasts to all ports— causing multicast flooding. Either way, this results in slow video updates and a poor user experience.

In recent years, the number of Layer 2 switches that support IGMP snooping has increased; but there is a wide variance in performance. For this reason, it's important to choose the right Ethernet switch for the job.

Testing MediaCento IPX and the Black Box LGB Series Ethernet Switches

In order to provide these recommendations, we conducted several tests with our Layer 2 switches and the MediaCento IPX.

1st Test: 1 transmitter to many receivers on one switch
2nd Test: 1 transmitter to many receivers on up to 2 switches
3rd Test: Many transmitters to many receivers on one switch
4th Test: Many transmitters to many receivers on up to 2 switches

Cabling: We used 24 AWG CAT5E/6 cables to connect the MediaCento IPX units to the switches and also for the connection between the switches over the configured trunkports.

Switch-Setups

- 1 tag-based VLAN for each transmitter.
- IGMP snooping enabled on all switches
- Port trunking (LACP) enabled

Video source: All tests were done with a Full HD Movie source (resolution 1920 x 1080). Each test was 24 hours. There were no delays or picture dropouts on the connected screens.

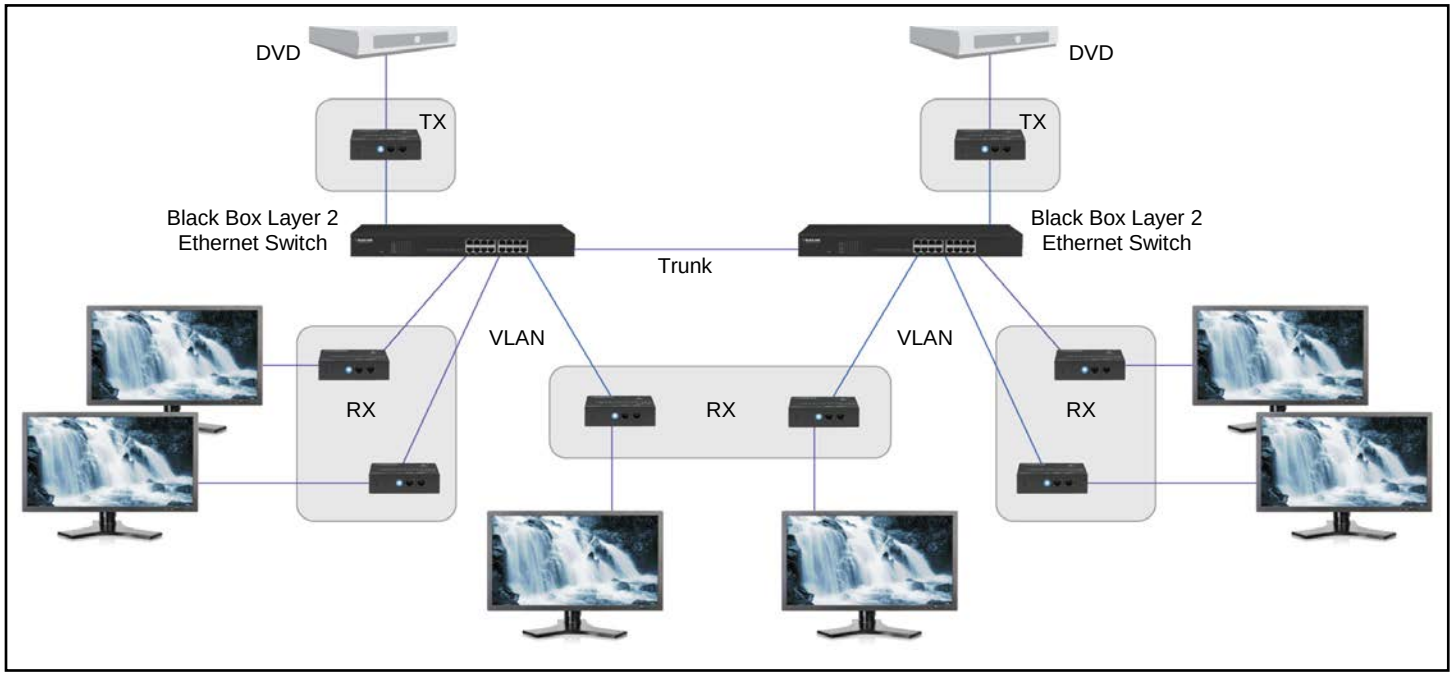

Figure 3

Black Box recommends using these switches with the following configurations:

For small- or medium-sized applications like the one shown in Figure 3, (up to two switches, three MediaCento IPX Transmitters and 10 MediaCento IPX receivers) Black Box recommends:

Product Number	Technical Specifications:
LGB1108A (8-Port)	MAC Addresses — 8 K Jumbo Frames — Frame sizes up to 9 KB supported on Gigabit interfaces Connectors —(8) 10-/100-/1000-Mbps RJ-45, (2) dual-media ports - each consisting of (1) 10-/100-/1000-Mbps RJ-45 and (1) SFP, (1) RJ-45 (serial console connection) Switch Capacity: 20 Gbps, Throughput: 14.9 Mpps
LGB616A (16-Port)	MAC Addresses — 32K Jumbo Frames — Frame sizes up to 9 KB supported on Gigabit interfaces Connectors —(16) RJ-45 (10/100/1000 Mbps); Switch Capacity: 32 Gbps , Throughput: 23.8 Mpps

For larger applications (up to two switches and 12 MediaCento Transmitters and 20 Receivers) as shown in Figure 4, Black Box recommends:

Product Number	Tech Specs:
LGB624A (24-Port)	MAC Addresses — 8K Jumbo Frames — 9.6 KB Connectors: (24) RJ-45 Switch Capacity: 48 Gbps , Throughput: 35.7 Mpps
LGB1148A (48-Port)	MAC Addresses — 32K Jumbo Frames — Frame sizes up to 9 KB supported on Gigabit interfaces Connectors —(44) RJ-45 (10/100/1000 Mbps); (4) dual-media ports, each consisting of (1) RJ-45 (100/1000 Mbps) and (1) SFP; (1) RJ-45 (serial console connection) Switch Capacity: 96 Gbps , Throughput: 71.4 Mpps
LGB5052A (48+4 Port)	MAC Addresses — 32 K Connectors —(44) 10/100/1000 Mbps RJ-45; (4) dual-media ports, each consisting of (1) 10/100/1000 Mbps RJ-45 and (1) SFP; (4) 10 Gbps SFP+ Switch Capacity: 176 Gbps , Throughput: 130.9 Mpps
LGB5028A (24+4 Port)	MAC Addresses — 32 K Connectors —(20) 10/100/1000 Mbps RJ-45; (4) dual-media ports, each consisting of (1) 10/100/1000 Mbps RJ-45 and (1) SFP; (4) 1/10 Gbps SFP+ Switch Capacity: 128 Gbps , Throughput: 95.2 Mpps

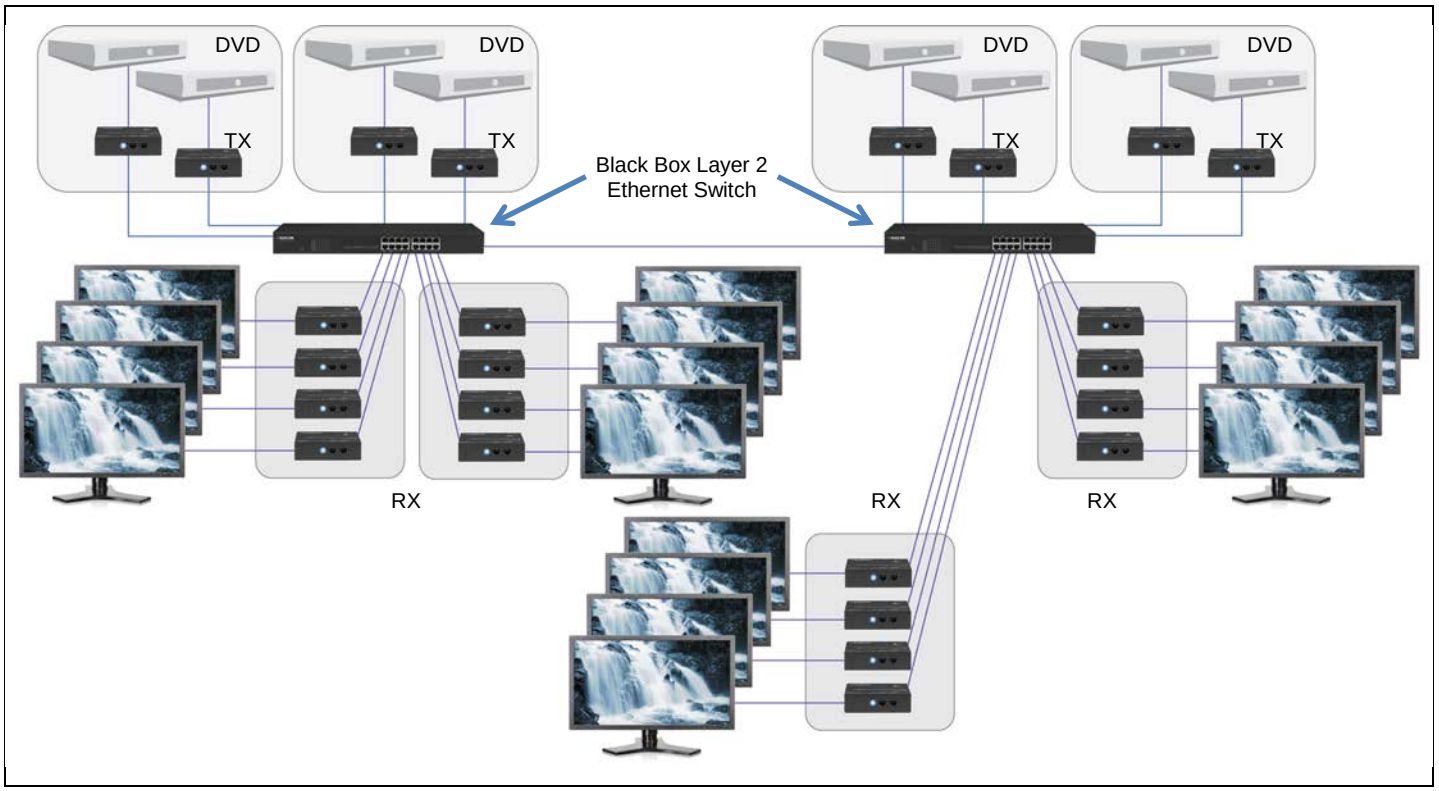

Figure 4

Testing Summary:

Regarding the different test setups used to establish this application note, here are the results in a pass/fail table.

Results of the 1st Test: 1 transmitter to many receivers on 1 switch

Connected Receivers	Black Box Switches					
	LGB1108A	LGB616A	LGB624A	LGB5028A	LGB1148A	LGB5052A
5	Pass					
10		Pass				
15			Pass			
20				Pass	Pass	Pass

Results of the 2nd Test: 1 transmitter to many receivers on up to 2 switches

Connected Receivers	Black Box Switches					
	LGB1108A	LGB616A	LGB624A	LGB5028A	LGB1148A	LGB5052A
5	Pass					
10	Pass					
15		Pass	Pass			
20				Pass	Pass	Pass

Results of the 3rd Test: Many transmitters to many receivers on 1 switch

Connected Transmitters (Tx) and Receivers (Rx)	Black Box Switches					
	LGB1108A	LGB616A	LGB624A	LGB5028A	LGB1148A	LGB5052A
2 Tx and 5 Rx	Pass					
3 Tx and 10 Rx		Pass	Pass	Pass		
5 Tx and 10 Rx		Fail	Pass	Pass	Pass	Pass
10 Tx and 20 Rx					Pass	Pass

Results of the 4th Test: Many transmitters to many receivers on up to 2 switches

Connected Transmitters (Tx) and Receivers (Rx)	Black Box Switches					
	LGB1108A	LGB616A	LGB624A	LGB5028A	LGB1148A	LGB5052A
2 Tx and 5 Rx	Pass					
3 Tx and 10 Rx	Pass	Pass	Pass	Pass		
5 Tx and 10 Rx		Fail	Pass	Pass	Pass	Pass
10 Tx and 20 Rx			Fail	Pass	Pass	Pass

Figures 5 and 6. The bandwidth of multiple receivers and transmitters during the testing.

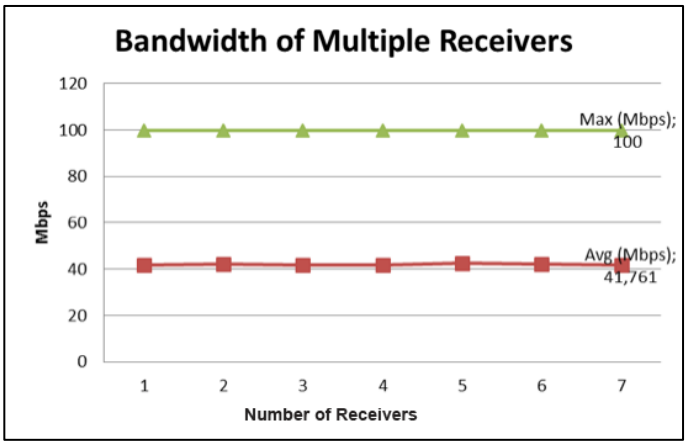

Figure 5

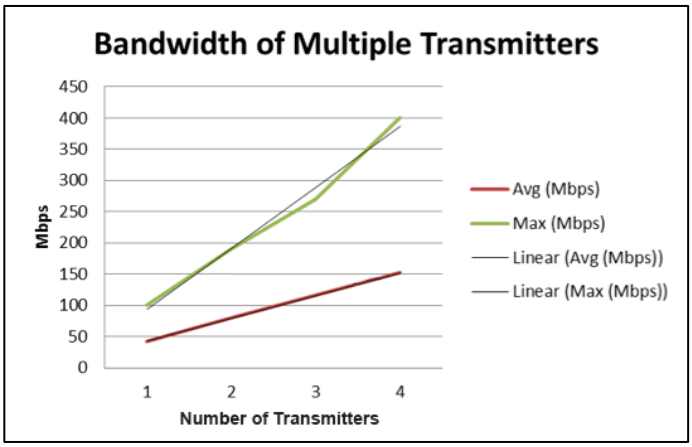

Figure 6

About Black Box

Black Box provides an extensive range of networking and infrastructure products. You'll find everything from cabinets and racks and power and surge protection products to media converters and Ethernet switches all supported by free, live 24/7 Tech support available in 60 seconds or less.

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