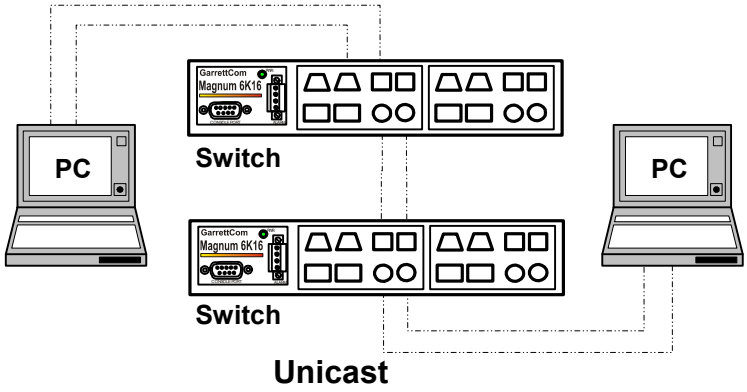
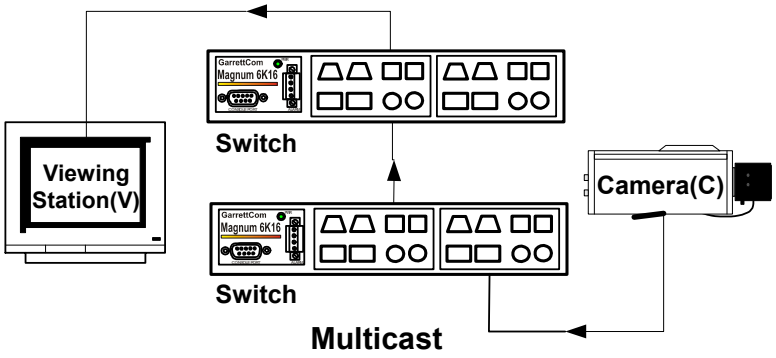
IGMP-L2 for Managing Ethernet Multicast Streams at Layer 2 . . . a Technical Brief

Ethernet LANs in industrial applications continue to evolve. Recently, multicast for streaming data has become increasingly important because video surveillance is increasingly important. This Technical Brief shows how multiple multicast streams of data can be efficiently managed using only Layer 2 Ethernet switches, simplifying many large LANs that serve applications with streaming data such as video surveillance. New "IGMP-L2™" technology (patent # 7,512,146) from GarrettCom, Inc. provides this capability, previously possible only with LANs incorporating complex Layer 3 switches and routers with IGMP (Internet Group Management Protocol).

Unicast vs. Multicast

Using unicast, a packet of data is sent from the source to one or potentially to many destinations, using Layer 1 repeaters (a.k.a. hubs) or Layer 2 switches. To send multiple copies of the data, multiple packets must be sent. Unicast transmission is still the predominant form of data transmission for LANs and within the Internet universe. All Ethernet LANs support the unicast transfer mode for bi-directional data flow, and most users are familiar with the standard unicast applications (e.g. http, ftp and telnet) which employ the TCP protocol.



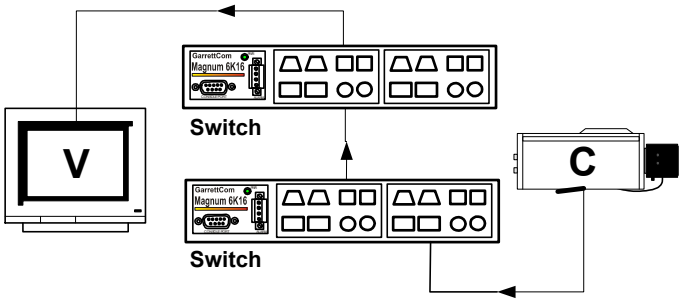


Using multicast, data is sent from the source only once and the network may reproduce and transmit the data to multiple destinations. Multicast is handled much like a broadcast of the packets. This is handy if several viewers want to see the same streaming data from one video camera, for example. IP multicast provides dynamic many-to-many connectivity between a set of senders and a group of receivers. The format of IP multicast packets is identical to that of unicast packets and is distinguished only by the use of a special class of destination address, called class D IP address, which denotes a specific multicast group. Multicast packets also take priority over unicast packets as they are processed through the LAN, which also makes streaming video benefit from multicasting. Since standard TCP supports only the unicast mode, multicast applications must use the UDP transport protocol. The majority of installed LANs including Ethernet are able to support the multicast transmission mode (UDP) and the unicast mode (TCP) at the same time.

In unicasting, the individual point-to-point transmissions for multiple streams can multiply the packets needed to handle the traffic, consuming bandwidth at the source. In multicasting, a single virtual connection into a stream uses no more bandwidth at the source for thousands of users receiving a stream than it does for a single user. Usually, multicasting is more efficient for multimedia applications that use uni-directional streams of data. To see how various streaming applications are best handled, a few different situations illustrate the complexity of the requirements.

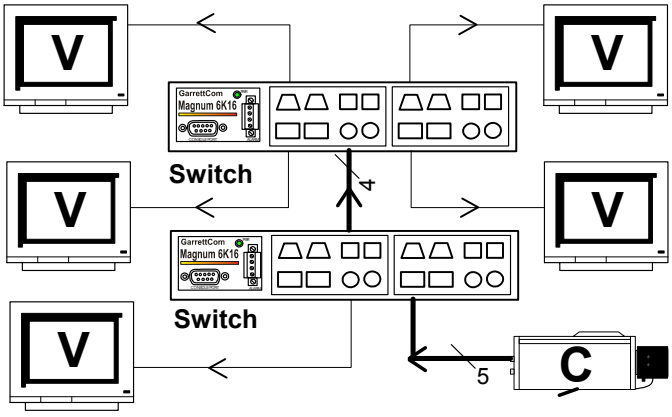
Multicasting one source to one destination

In a simple application, one video camera may need to be viewed by one viewing station. The bandwidth demands on the LAN are minimal, and such an application is easily handled by simple Layer 2 Ethernet switches. There may be a little or a lot of unicast traffic on the LAN serrving other applications and other connected unicast devices, it doesn't matter. The video traffic is sent from the camera in the multicat mode, providing priority over the normal unicast data used for packets between computers and SCADA devices in an induistrial LAN, and keeping the multicast packets in order for good picture quality without jitter. No need for complex Layer 3 switches here.



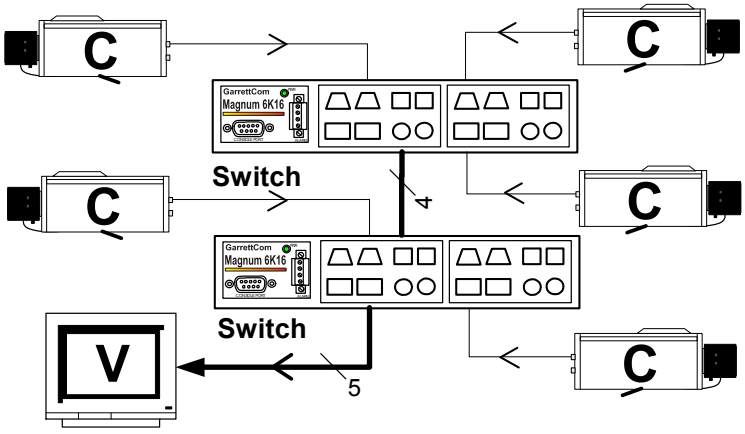
Multicasting one source to many destinations

In a somewhat more demanding application, one video camera may need to be viewed by multiple viewing stations. For example, several persons may want to simultaneously view the same video stream for training or for educational purposes. In this situation, the LAN can function properly when the video stream is multicast or broadcast to many viewing stations. The bandwidth consumed at some points in the LAN (for example, five streams coming out of the camera) with multicast is somewhat less than would be the case if the same application were handled with unicast packets. But, for modest numbers of viewing stations, the bandwidth even at only 100Mb Ethernet speed is plentiful and is not strained so that the difference is negligible. No need to introduce the complexity of Layer 3 switches here until the number of viewing stations gets to be, say, 8 to 10 or more.



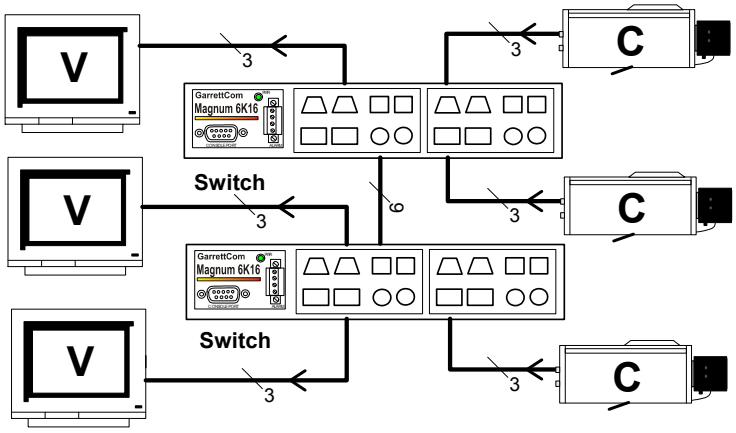
Multicasting many sources to one destination

In a small video surveillance or security monitoring application, several video cameras may need to be viewed by one viewing station. The traffic load on the network in this application is more interesting. All of the packet streams from all of the cameras need to be transported across the LAN to the viewing station, with all of those streams not viewed by the user at a given point in time discarded. Most of the bandwidth consumed to handle the LAN traffic is wasted. Still, the convenience to the viewer of being able to see any camera's data at any time is of value. Since all of the bandwidth was probably not going to be used, this application is satisfactorily handled by multicast (or even by unicast) at 100Mb Ethernet speed. No need to introduce the complexity of Layer 3 switches here as long as the number of cameras is no more than 8 to 10.



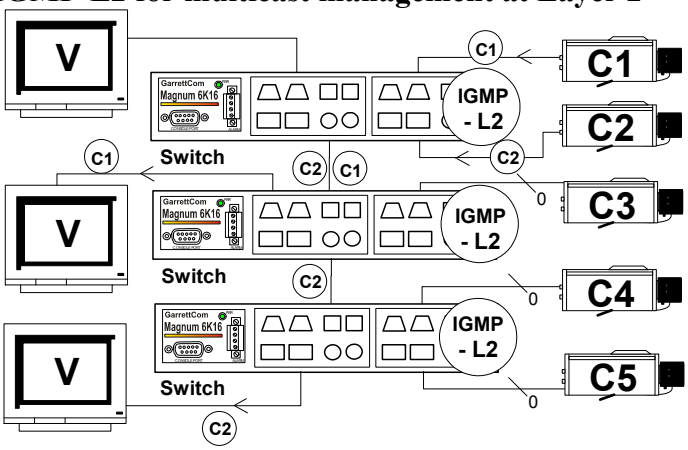
Multicasting many sources to many destinations

In a more typical video surveillance application, several video cameras may need to be viewed by multiple viewing stations. Users at the viewing stations may even need to view more than one camera at a time, in a split-screen fashion. The multiple traffic streams needed to handle this demand increases, and soon the combined streams for all cameras to send streaming data to all viewers (whether they want it or not) present a significant load on the LAN. Two or three cameras and viewing stations with combinatorial usage may be practical with ordinary unicast and multicast protocols, but what about growth? What's needed is an expandable way to handle several large groups of cameras and viewing stations, and to selectively manage the multicast traffic streams in any desired combinations.



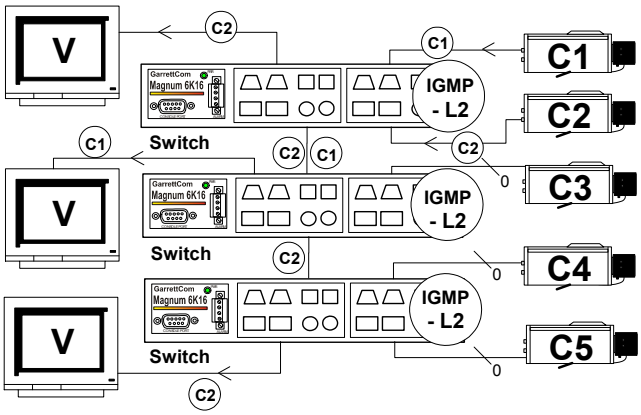
One way to do this in larger LANs is with IGMP at Layer 3. The various multicast streams are passed up to Layer 3 switches and routers which use standard IGMP logic to route the particular streams needed to their desired destinations. The Layer 2 switches "snoop" on the decisions made higher up at the Layer 3 level, and are told how to handle the multicast streams. To get the job done, complex and costly Layer 3 switches and routers enter the picture. Is there a different and better way?

IGMP-L2 for multicast management at Layer 2



IGMP-L2 can perform the same selective management of multiple multicast streams as IGMP plus Snooping, while operating only at Layer 2. It simplifies the network and minimizes wasted bandwidth consumption while still permitting large numbers of multicast data streams to be efficiently handled with traffic delivered to suit each viewing users needs.

Viewers send requests via IGMP-L2 to have selected multicast data streams sent to them for viewing. The IGMP-L2 software in MNS-6K processes the requests, shares it with other 6K switches in the LAN, and activates the selected data source to send multicast streaming data. The stream continues in operation until the viewer requests that it be turned off. *Note that, in the illustration shown here, nobody is viewing the traffic from cameras C3, C4 and C5, and no LAN bandwidth is consumed by the multicast traffic from them accordingly.*



If a viewer request for a particular multicast stream goes to a switch with IGMP-L2 running while that same multicast stream is already passing through it, that stream is copied at that point and directed to the additional viewer as well.

The logic of IGMP-L2 operates to move the desired multicast streams through the minimum number of switches, eliminating wasted streams that are transported through the LAN and then dropped. If a multicast stream source (such as a video camera) is not selected by anyone, all of its traffic will be dropped at the source and never move uselessly across the LAN. For IGMP-L2 to function properly across all possible streaming traffic paths, it must be installed and turned on in all of the inter-connected switches.

About MNS-6K software and IGMP-L2

Magnum MNS-6K software operates across the family of Magnum 6K switches. Innovative features of MNS-6K include Secure Web Management (SWM), cradle-to-grave GUI-based local and remote management, a choice of redundant LAN options including RSTP, LLL, S-Ring and RS-Ring; a comprehensive CLI, many ease-of-use features, industry-leading security features and options, and advanced support tools for configuration management. For additional Magnum MNS-6K product information, see the GarrettCom web site at http://www.garrettcom.com/6k_soft.htm.

IGMP-L2 is part of MNS-6K beginning at Release 3.5. It is configurable by the user of the 6K switch, and is useable separately and/or in conjunction with other MNS-6K features such as the security and redundancy capabilities. IGMP is supported for those users who may prefer to use it. For additional information on IGMP-L2, see the MNS-6K Technical Manuals Chapters on IGMP and IGMP-L2.

Summary

IGMP-L2 (patent # 7,512,146), a feature of MNS-6K software on Magnum 6K Switches released in June 2006, can perform the same selective management of multiple multicast streams as industry-standard IGMP plus Snooping, while operating only at Layer 2. It relieves the user of network topology constraints and the potential multicast flooding that can be experienced with standard Layer 3 IGMP and Snooping. It simplifies the network and eliminates wasted bandwidth consumption while still permitting large numbers of multicast data streams to be efficiently handled with traffic delivered to suit each viewing users needs.

Layer 3 switches and routers are not required when handling large multicasting applications with Magnum 6K switches. The IGMP-L2 advancement in software is particularly important for reducing the cost and complexity of video surveillance applications.

GarrettCom has a reputation for providing innovative Ethernet solutions to industrial, transportation, utility, and telecommunications applications. For more information, consult the GarrettCom website at www.GarrettCom.com or call 510-438-9071.

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GarrettCom, Inc.
47823 Westinghouse Drive • Fremont, CA 94539 • PH: (510) 438-9071
Email: mktg@garrettcom.com • Web: www.GarrettCom.com