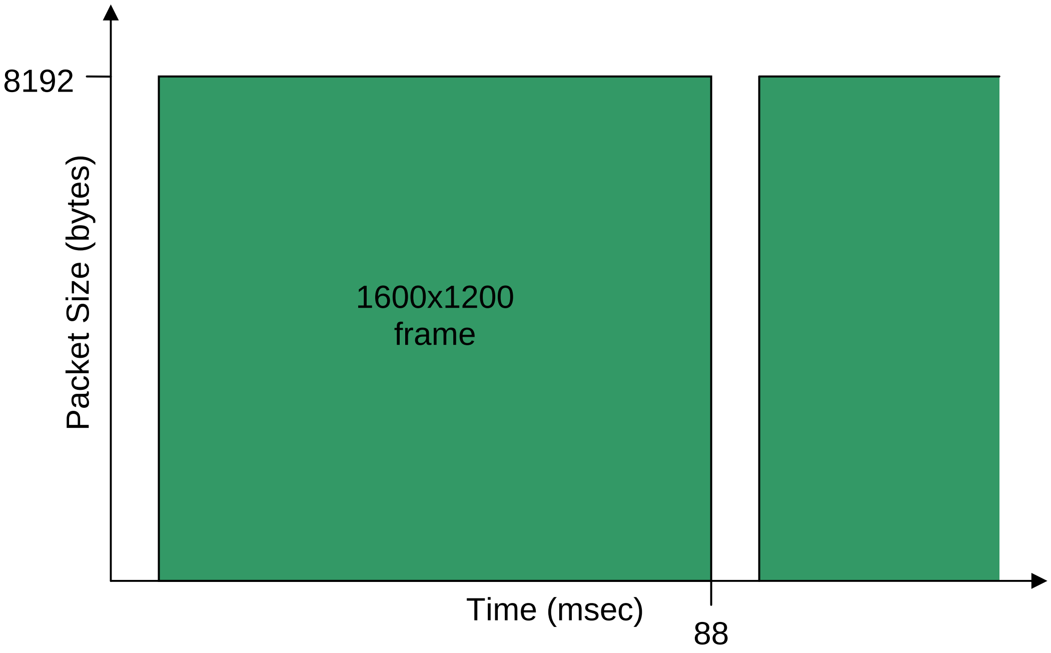
Overcoming the 8192 bytes isochronous packet limit

The problem

As mandated by the IEEE1394 specification, isochronous traffic is limited to having a packet size of up to 8192 bytes (at 800 mbps speed; at S400 the limit is 4096 bytes).
What does this practically mean? Let's look at an example: a camera captures and transmits frames at 1600x1200 resolution with RGB-24 color depth. The total size of each frame will be 1600x1200x3 = 5760000 bytes (3 bytes per pixel, 24 bits). This chunk of data is split and transmitted over the 1394 bus in packets, with each packet being transmitted on each isochronous cycle that is every 125 usec.

In order for the complete frame to be transmitted at 800 Mbps speed with the maximum allowed packet size of 8192 byte, then 5760000 / 8192 = 704 packets are needed[1]. A little bit of arithmetic shows that 704 * 125usec = 88 msec are needed for the transmission of a single frame at this resolution and color depth. That translates to about 11 frames per second[2]. This is what this traffic looks like at msec scale:



So what happens when we need a higher frame rate?

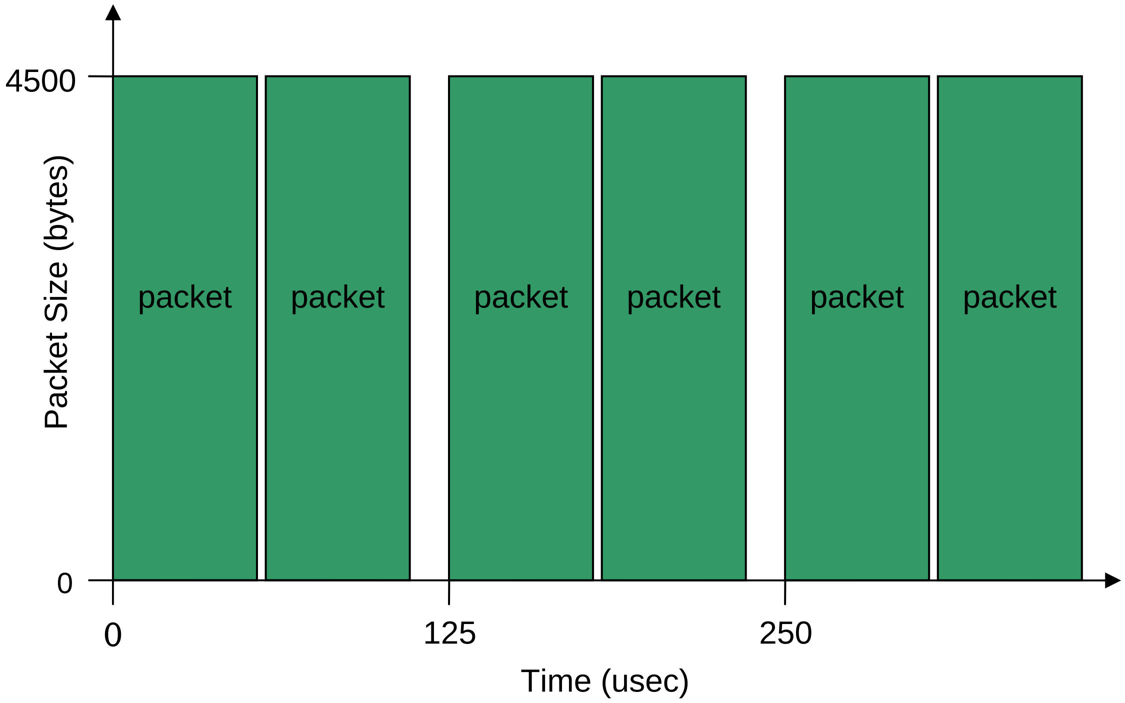
Possible solutions

The obvious way to improve on this limitation would be to use S1600 (or S3200 for that matter) instead of 800mbps. Unfortunately, adapters and cameras that operate at these speeds are currently unavailable. Camera manufacturers however, have tried to tackle this problem using methods that although typically violate the Firewire specifications, reduce the limitations by a significant margin.

[1] As of version 5.50.

The Point Grey Research approach (Two packets per cycle)

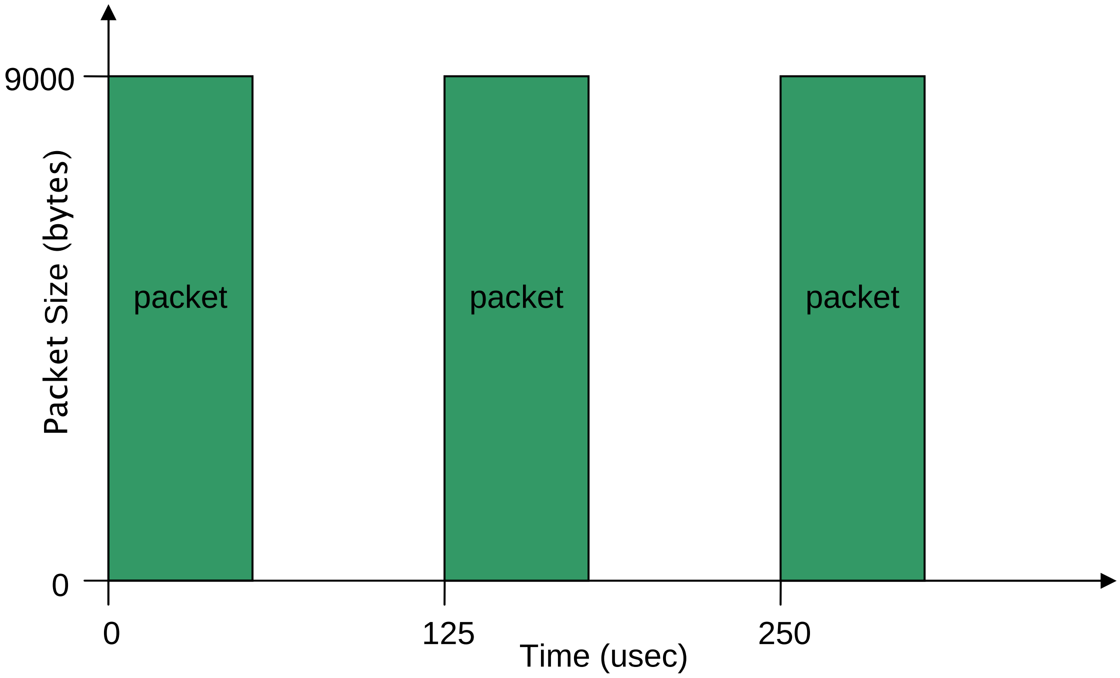
Point Grey Research (http://www.ptgrey.com), in its Grasshopper™ line of cameras, utilizes what is called "Dual Packet Mode". This works by splitting a packet that is larger than 8192 (say 9000) into two packets of 4500 instead of one of 9000, and having both packets transmitted in the same isochronous cycle. This is what this traffic looks like, in usec scale:



The main drawback of this approach is that the software doing the capture of the packets must support fully this mode of operation, otherwise corrupted frames will be received (best case scenario is the first of each pair of packets being received, resulting in a garbled image). It is also not 100% compliant to the IEEE1394 specification (besides being non-compliant to the IIDC specification) because the 1394 spec mandates that on each cycle all isochronous packets must use a unique *isochronous channel number*.

The Allied Vision Technologies approach (Large packets)

Allied Vision Technologies (http://www.alliedvisiontec.com/), in its Pike™ line of cameras, offers a “hidden” feature, whereas it is possible to increase the packet size as much as physically possible (about 11000 bytes at 800mbps speed). Using the previous example (9000 bytes packet size), this is what this kind of traffic would look like:

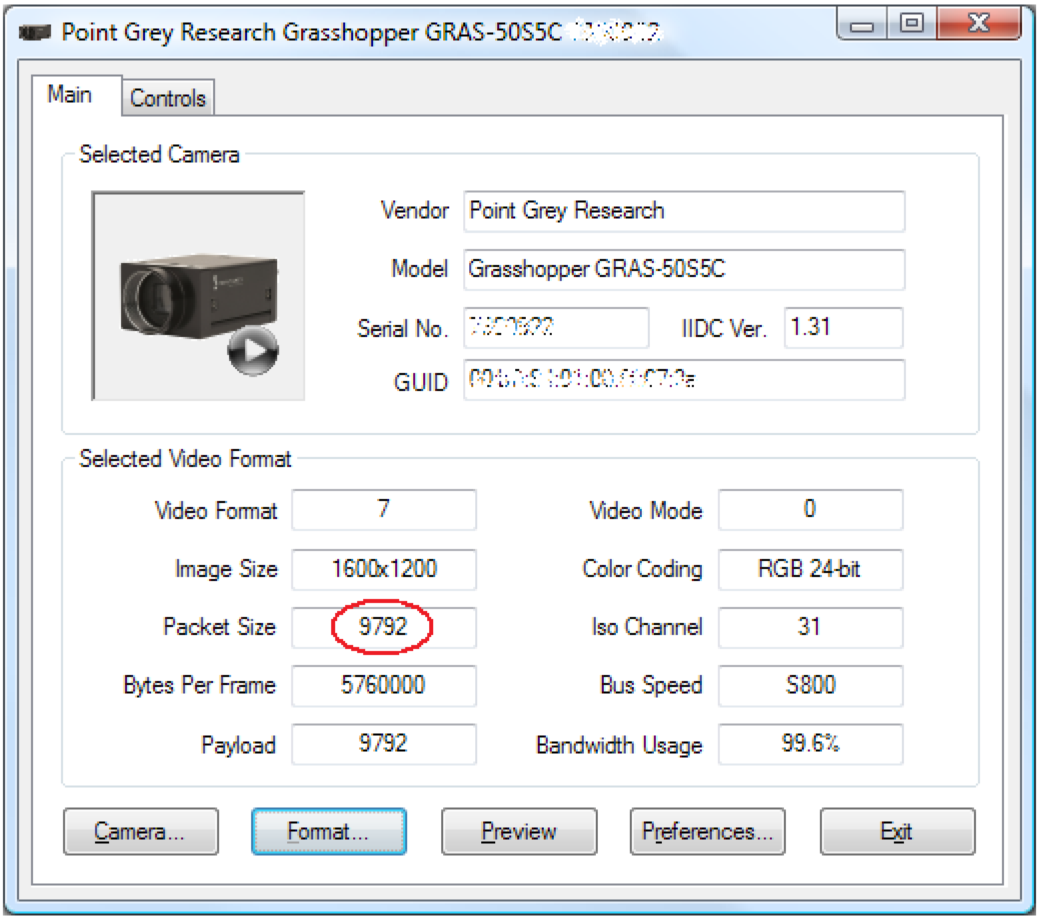


The main advantage of this approach against the Point Grey approach is that the software needs to do very little in order to be compatible – merely allow the large packets to be captured and remove the soft limit of the 8192 bytes. However, not all adapters can capture this kind of traffic reliably (it is out-of-spec after all).

[1] As of version 5.50.

Unibrain ubCore^{TM} support

Unibrain’s ubCoreTM and FireAPITM support both of these approaches fully1. The two different operations are automatically detected and enabled when available:



Point Grey Research Grasshopper GRAS-50S5C [redacted]

Selected Camera

Vendor: Point Grey Research

Model: Grasshopper GRAS-50S5C

Serial No.: [redacted]

IIDC Ver.: 1.31

GUID: [redacted]

Selected Video Format

Video Format	7	Video Mode	0
Image Size	1600x1200	Color Coding	RGB 24-bit
Packet Size	9792	Iso Channel	31
Bytes Per Frame	5760000	Bus Speed	S800
Payload	9792	Bandwidth Usage	99.6%

Further reading

- http://www.unibrain.com/Products/DriverAPI/FireAPI.html
- http://www.unibrain.com/Products/DriverAPI/ubcore.html
- http://www.alliedvisiontec.com/avt-products/cameras/pike.html
- http://www.ptgrey.com/products/grasshopper/index.asp
- http://www.ptgrey.com/support/kb/index.asp?a=4&q=276