Buffer Under−run Protection & Its Value in Duplication

By John McGrath

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What is it?
It is known by many names, "BURN−Proof", "SafeBurn", and "lossless linking" to name but a few. Regardless of the name, they are all buffer under−run prevention strategies. In the dark days of CD−R recording, before we had BURN−Proof and the like, if a drive's on−board buffer became empty, the write would fail leaving an incomplete and unusable disc. The on−board buffer of the drive is analogous to the fuel tank on a military aircraft, which relies on periodic in−flight refuelings. If the jet's fuel runs out, the plane will crash. The host computer, or duplication controller, is the refueling aircraft. If it cannot supply DATA as fast as the drive consumes it, the write process will fail. Essentially, what buffer under−run prevention gives you is a means to pause while the host catches up.
Why do I need it for my PC?
Buffer under−run prevention was really a response from drive manufacturers to overcome limiting factors that were preventing drives from going to higher write speeds. Many PCs were, and still are, simply not up to the task of writing at these higher speeds. The burden of handling so many technical support calls was more than anyone was willing to deal with. The answer was simply to design the drives in a way whereby if the computer could not deliver the data as fast as the CD−R drive required, it would simply pause and wait for the PC to catch up. No coasters, no tech calls.
Why does it not make sense on a high performance duplication system?
A better analogy for CD−R writing when using buffer under−run prevention is that of a car. If a car runs out of fuel, you can simply fill up a gas can, add fuel, and continue on your way. No plane crashes here. Using the car analogy, what would be the down side if your tank was very small and you were embarking on a long drive whereby the distance between gas stations was greater than the fuel capacity allowed? Well, you would run out of gas frequently and find yourself walking along the road to fill your gas can only to walk back to your car, refill, and continue on your way, repeating this step as often as necessary. So in effect, if the host PC or duplication controller cannot provide data as fast as the CD−R drive writes, the drive will pause, wait for the buffer to refill, and then begin the write process again. The downside here is performance. This can take from one to several seconds per actuation of buffer under−run prevention. A one−drive 32x copier from one company might easily out−perform a 52x unit relying on buffer under−run prevention.
The MF Digital difference

MF Digital designs its duplication and publishing systems so that buffer under−run prevention strategies are not needed. This is achieved through MF Digital's own precision duplication controllers and software, and the use of high−speed hard drives, fast processors, and plenty of memory. When using MF Digital's PC based systems such as the Scribe, be sure to adhere to the minimum system requirements.

If you have any questions that might make an interesting TechNOTE or white paper, please do not hesitate to send them in. Please forward your questions or suggestions to John McGrath c/o MF Digital. 121 Carolyn Blvd., Farmingdale, NY. 11735, or email technotes@mfdigital.com, or http://www.mfdigital.com/

Buffer Underrun and Overrun Scenarios

By Stephen Bucaro

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Buffer underrun and buffer overrun are occurrences that can result in some very frustrating errors. This is not a "how−to" article about fixing buffer underrun and buffer overrun errors, but a basic description of what a buffer is, why we need buffers, and what causes buffer underrun and buffer overrun.

Buffer Underrun

The most common occurrence of buffer underrun is CD recorders. Let's imagine an example of a CD recording session. The computer has an ATA hard drive capable of transferring data at a rate of 8 MBps (Mega Bytes per second). The CD recorder has a recording rate of 8 MBps. Everything should work fine, right?

Note: The data transfer rates mentioned in this article do not apply to any specific device. They're just for purposes of discussion.

The 8 MBps specification for the hard drive is for "burst" mode. In other words, it can transfer data at a rate of 8 MBps for only a few seconds. Then the transfer rate drops much lower, and if the hard drive hasn't been maintained, for example it has not been defragmented recently, the transfer rate can drop even lower.

Whereas a hard drive can skip from cluster to cluster while reading and writing, a CD recorder must burn the data

track in a continuous stream without stopping. The design of a CD recorder requires a "sustained" transfer rate.

When two devices that operate at different transfer rates must communicate, we can make them work together by placing a buffer between them. A buffer is a block of memory, like a bucket for bytes. When you start the CD recording session, the hard drive begins filling the buffer. When the buffer is almost full, the CD recorder begins drawing bytes out of the buffer.

If everything goes smoothly, the hard drive will be able to keep enough bytes in the buffer so that the speedy CD recorder won't empty the buffer. If the buffer runs dry, the CD recorder has no data to burn into the CD, so it stops. Buffer underrun error.

We can reduce the chances of buffer underrun by configuring a larger buffer. Then the hard drive will be able to put more bytes in the bucket before the CD recorder starts drawing them out. However, sometimes you can't increase the size of the buffer because the computer doesn't have a large amount of RAM installed. When the computer needs more RAM, it uses "virtual" RAM. That is, it allocates part of the hard disk and pretends like that's RAM. Now, even though you've increased the size of the buffer, you have caused the hard drive to work even slower.

Buffer Underrun and Overrun Scenarios

Buffer Overrun

The most common occurrence of buffer overrun is video recorders. Let's imagine an example of a video camera connected to a computer. The video camera records at a data rate of 168 MBps. The computer monitor is capable of displaying data at a rate of only 60 MBps. We have a big problem, right?

Thanks to MPEG compression, we might not have as big a problem as first appears. With MPEG compression, the video camera does not have to send the entire image for every frame. It sends only the data for the part of the image that changed, and it compresses that part.

If the image doesn't change much, and the part that changed compresses well, the video camera might need to transfer at a rate of only a few MBps. But if the entire image changes every frame and the image does not compress well, the video camera might transfer data at a higher rate than the computer monitor is capable of displaying.

Again, we have two devices that operate at different transfer rates that must communicate. We can make them work together by placing a buffer between them. When you start recording video, the video recorder starts filing the buffer. The computer display immediately begins pulling data out of the buffer to compose display frames.

If everything goes smoothly, the computer display will be pulling data out of the buffer fast enough so that the buffer never completely fills. If the buffer fills up, the video camera can't put any more data in, so it stops. Buffer overrun error.

We can reduce the chances of buffer overrun by defining a larger buffer. Then the video camera will be able to put more bytes in the bucket before it fills up. Hopefully, the video camera will run into a few frames where the entire image doesn't change, reducing its data transfer rate enough so the computer display can catch up.

Underrun, Overrun Protection

Today, CD recorder buffer underrun is much less common. Computers come with much more RAM than they did before, and CD recorders have learned to monitor the buffer and reduce the recording speed if the buffer starts to run low.

Video camera buffer overrun is also less common. Video uses a program called a "codec" (for encode/decode). A smart codec can monitor the buffer and reconfigure itself when the buffer gets too full. It might for example automatically reduce the color depth of the video, or drop frames, until the computer display catches up.

Underrun and overrun Protection doesn't completely solve the problem. If underrun protection activates, a CD recording session will take much longer. If overrun protection activates, the video quality will be reduced. The only way to solve underrun and overrun problems, after increasing the size of the buffer, is to match the data transfer rates of the devices that need to communicate. You can upgrade to a faster hard drive, or install to a high performance video card.

Now, if you need to troubleshoot a buffer underrun or buffer overrun errors, at least you know what a buffer is,

why we need buffers, and what causes buffer underrun and buffer overrun errors.

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