number, if it's the same as the second digit, implies no vertical subsampling of chroma. On the other hand, if it's a 0, there is 2:1 chroma subsampling between lines. Therefore, 4:4:4 implies that each pixel on every line has its own unique Y, Cr and Cb components.

Now, if we filter a 4:4:4 YCbCr signal by subsampling the chroma by a factor of two horizontally, we end up with 4:2:2 YCbCr. '4:2:2' implies that there are four luma values for every two chroma values on a given video line. Each (Y,Cb) or (Y,Cr) pair represents one pixel value. Another way to say this is that a chroma pair coincides spatially with every other luma value, as shown in Figure 6.6b. Believe it or not, 4:2:2 YCbCr qualitatively shows little loss in image quality compared with its 4:4:4 YCbCr source, even though it represents a savings of 33% in bandwidth over 4:4:4 YCbCr. As we'll discuss soon, 4:2:2 YCbCr is a foundation for the ITU-R BT.601 video recommendation, and it is the most common format for transferring digital video between subsystem components.

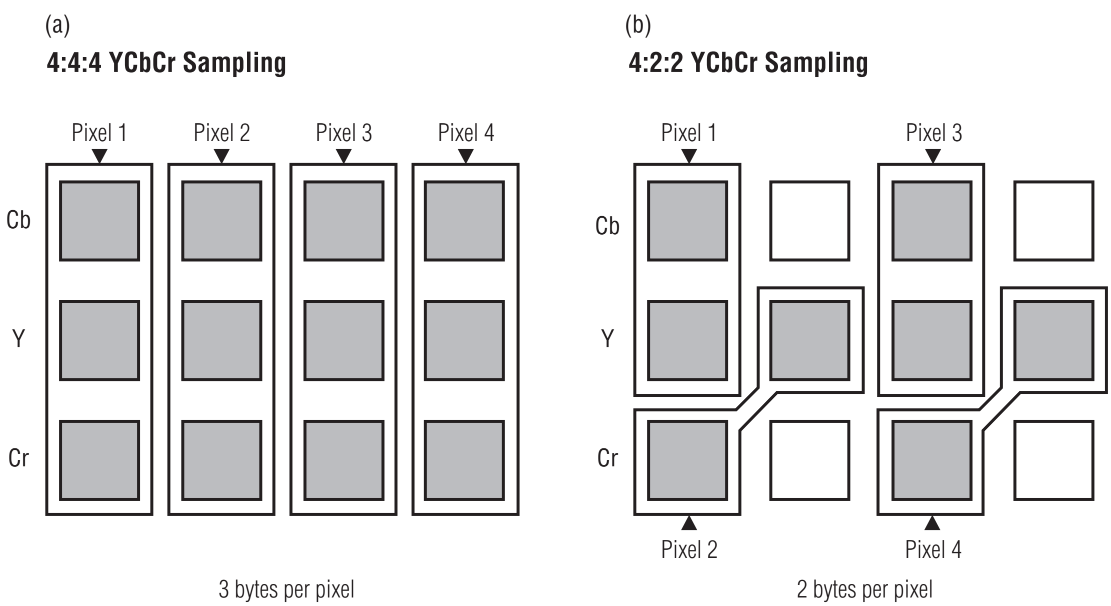

Figure 6.6 **(a) 4:4:4 vs. (b) 4:2:2 YCbCr pixel sampling**

Note that 4:2:2 is not the only chroma subsampling scheme. Figure 6.7 shows others in popular use. For instance, we could subsample the chroma of a 4:4:4 YCbCr stream by a factor of four horizontally, as shown in Figure 6.7c, to end up with a 4:1:1 YCbCr stream. Here, the chroma pairs are spatially coincident with every fourth luma value. This chroma filtering scheme results in a 50% bandwidth savings; 4:1:1 YCbCr is a popular format for inputs to video compression algorithms and outputs from video decompression algorithms.

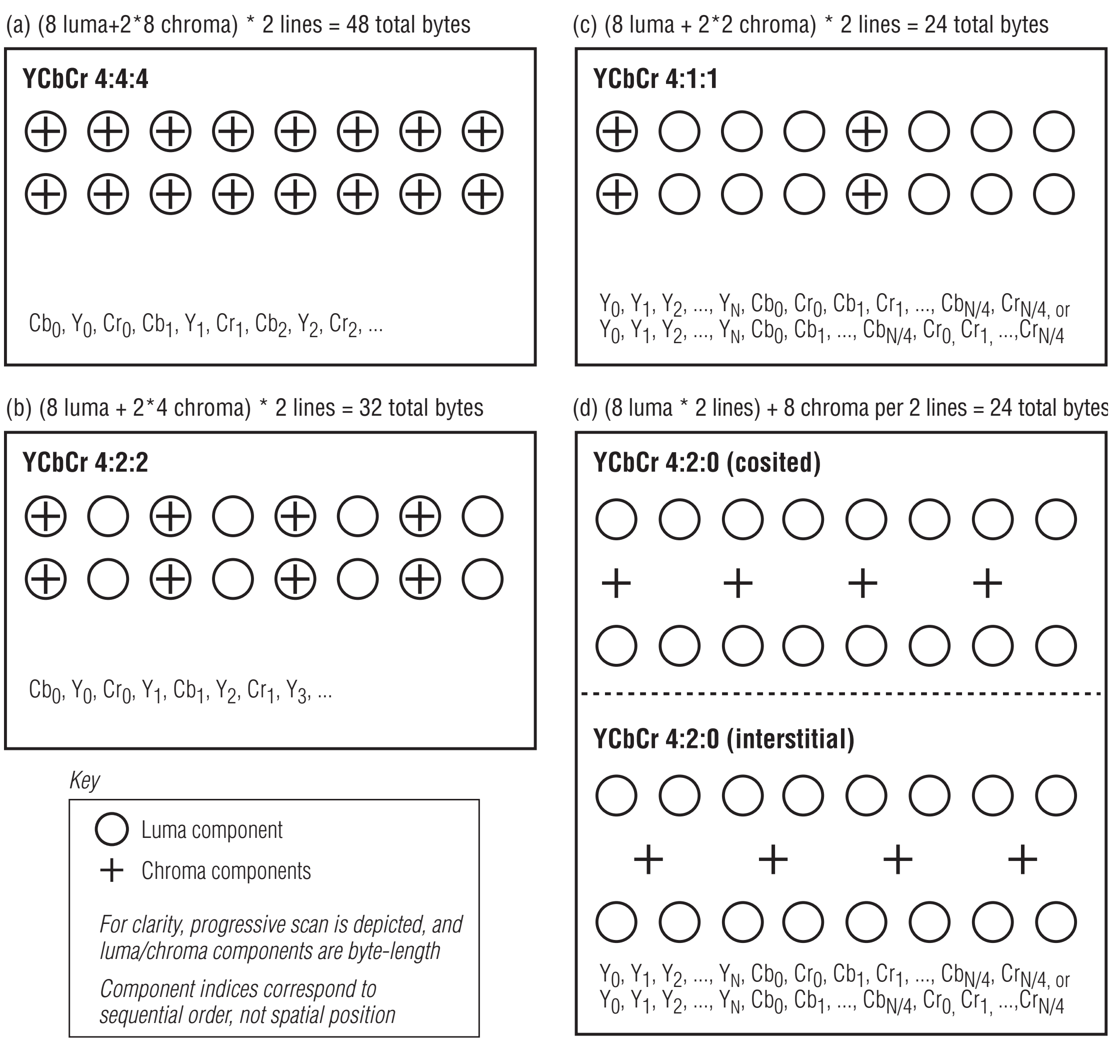

Figure 6.7 **(a) YCbCr 4:4:4 stream and its chroma-subsampled derivatives (b) 4:2:2 (c) 4:1:1 (d) 4:2:0**