Title:	Mapping Channel Rays to Samples for System Simulations
File:	SCM-085_Ray_Mapping.doc
Source:	Motorola
Date:	December 19, 2002

1. SUMMARY

This contribution provides a method of mapping arbitrary channel rays to discrete samples for use in system simulations. This method is an alternative to the previously proposed ray splitting technique, which will be shown to have problems.

2. PROBLEMS WITH RAY SPLITTING TECHNIQUE

The ray splitting technique was proposed as a method of handling rays at arbitrary time offsets [1]. A single ray is split into two rays, one to the sample to the left and one to the sample to the right. The power of these new rays is such that the sum is equal to the original power, and the power of each of the new rays is proportional to the (1-normalised distance to the original ray). Finally, the power of all rays on one sample are added up and normalised to yield total channel power of 1. Consider the example shown in Figure 1. In this case a path of power P located between two delay samples (T_c = length of a chip in time) is split to two separate paths with power 0.75P at delay sample k and power 0.25P at delay sample k+1.

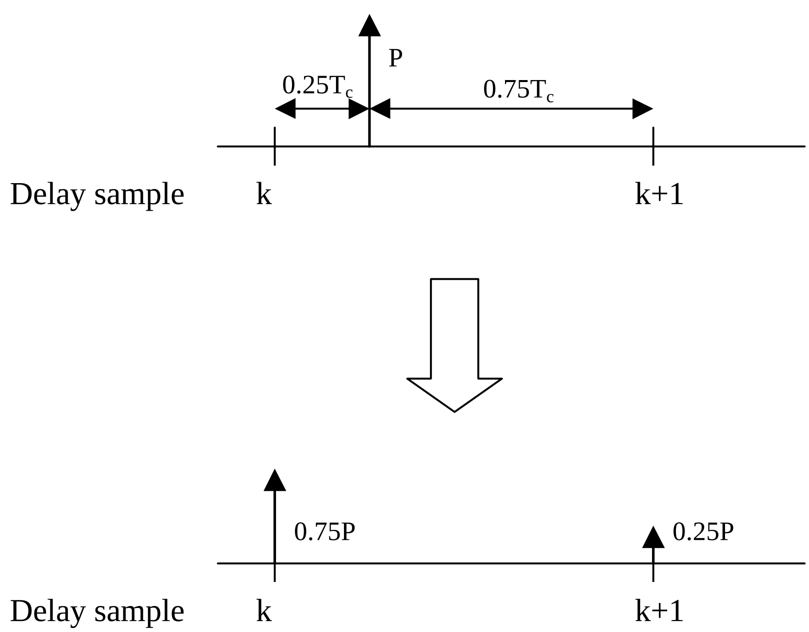

Figure 1. Ray splitting technique.

The technique seems to have issues with model accuracy and simulator computational complexity. A single-path channel becomes a two-path channel if the ray falls between two receiver sampling intervals. Consequently, significant variations in receiver performance can be produced by changing the ray's proximity to a sampling boundary. Another problem with the ray splitting technique is that it can double the number of rays in the channel, which can both increase the channel generation time of the simulator and increase the complexity of receiver algorithms.

3. RATE CHANGE BASED METHOD

The proposed method of ray mapping is based on quantizing the channel ray delays to the nearest 1/8 of a chip time interval. Adjusting a ray delay by at most 1/16 of a chip has an arguably insignificant effect on the nature of the channel and on receiver performance. After the channel has been quantized, it is straightforward to apply the transmit filter and to downsample the resulting signal to the chip rate or 2x chip rate (depending on receiver implementation). Also, the quantized channel is easy to represent since there are only six unique delays in the SCM model. Figure 2 shows a block diagram of the channel impulse response and the downsampling procedure.

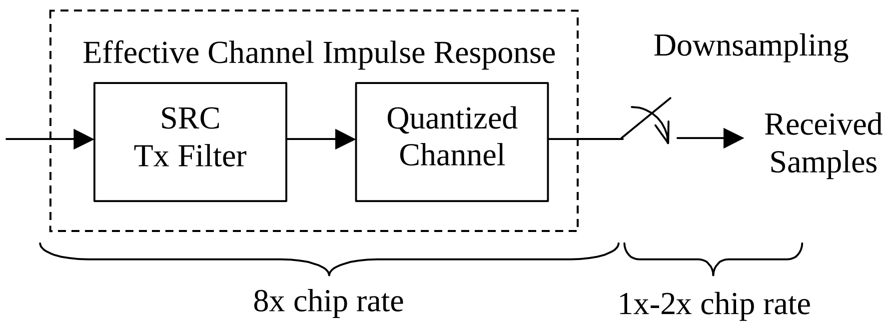

Figure 2. Channel impulse response with sampling.

The proposed method is generally less time consuming to run than the ray splitting method. The reason for this is that the ray splitting method can double the number of rays in the quantized channel impulse response. In the ray splitting method, each of the rays in the quantized channel must also be passed through the transmit filter shown in Figure 2. Using well-known signal processing techniques [2], the proposed method can be implemented with the same complexity per ray as the ray splitting method. Therefore, the ray splitting method can take up to twice the time to generate the received samples as the proposed method. The exception to this is when the channel contains all six rays within the same chip interval, but in different 1/8 chip intervals. In that case, the ray splitting will have only two rays while the proposed method will have six. However, the accuracy of that channel impulse response will be better preserved by the proposed method.

4. CONCLUSIONS

This contribution presented a sample rate change method of ray mapping that avoids the accuracy limitations and computational complexity issues felt to be associated with ray splitting.

5. REFERENCES

[1] Ericsson, “Modified ITU Channel Models,” Document distributed in SCM meeting, Quebec City, October 2002.

[2] R. Crochiere and L. Rabiner, “Multirate Digital Signal Processing,” Prentice-Hall, 1983.