

Do Communication Engineers Need Circuit Theory?

Do communication and information engineers get the physics right in their models? Do the basic model structures adequately translate physical reality? These are the central questions which will be addressed in this lecture.

The high level of abstraction taken by information theory makes it a very versatile and powerful tool for the analysis and optimization of communications systems. But information theory has no concept of the flow of energy that accompanies the flow of information. Therefore, some important aspects of communication systems such as transmit power or noise covariance can by no means be straightforwardly mapped from the information theoretic context to technical reality. An effective method will be presented to complement information theory with such a mapping by applying classical circuit theory. This allows correct assessment of the energy flow in a communication system and thereby enables an information theoretic analysis and optimization which is consistent with the underlying physics. After developing appropriate circuit theoretic channel models, the potential performance of multi-antenna communication systems will be analyzed and surprising new results and insights will be revealed. Besides the study of channel capacity, new limits for transmit and receive antenna array gain are also derived.

All the new results have been obtained with the application of classical circuit theory which extends the mathematical theory of communications to engineering science.