narrow band radio waveforms, such as for communications. However, little work has been shown for wide band channelized transmit architectures.

[0005] Furthermore, waveforms (techniques) are often difficult to port between platforms due to platform dependent architectures. Usually a great deal of verification such as extensive testing on a simulator is necessary to verify the revised waveforms to be ported to a new platform. Most existing waveform generators are platform dependent and have to be modified to fit a certain channelization scheme or parallelization scheme. Many attempts have been made to write portable. The main set of attempts has been targeted at writing C code or other general purpose code. However, the problem with C code (and most other coding languages) is that these languages are not portable to field programmable gate arrays (FPGAs) and other programmable logic devices and thus is not applicable to many of FPGA-based platforms.

[0006] These problems become aggregated and even more challenging in a wide band channelized architecture that needs to be portable to different platforms.

SUMMARY

[0007] In some embodiments, the present invention is a method and apparatus for creating waveforms (techniques) using a metadata approach for waveform design. In some embodiments, the present invention is a system including a metadata interpreter circuit that interprets the metadata and generates a waveform corresponding to the metadata. The metadata-based waveform can then be ported to another (different) platform with little modification.

[0008] In some embodiments, the present invention is a method for generating channelized hardware-independent waveforms. The method includes: generating metadata associated with a waveform, the metadata including a frequency list, a phase list and amplitude information, wherein the metadata is generated independent of a number of channels; interpreting the metadata to generate channel select, frequency, phase and amplitude parameters; providing the frequency, phase and amplitude parameters to a direct digital synthesizer (DDS) to generate a digital signal; providing the channel select parameter to a channel selector to generate a plurality of channelized waveforms from the generated digital signal; and transmitting the plurality of channelized waveforms over a plurality of communication channels, wherein interpreting the metadata comprises dividing the frequency list by the number of channels to generate a quotient to be provided to the channel selector and a remainder to be provided to said DDS.

[0009] In some embodiments, the present invention is an apparatus for generating channelized hardware-independent waveforms. The apparatus includes: a meta data generator circuit for generating metadata associated with a waveform, the metadata including a frequency list, a phase list and amplitude information, wherein the metadata is generated independent of a number of channels; a meta data interpreter circuit for interpreting the metadata to generate channel select, frequency, phase and amplitude parameters; a direct

digital synthesizer (DDS) for inputting the frequency, phase and amplitude parameters to generate a digital signal; a channel selector circuit for inputting the channel select parameters to generate a plurality of channelized waveforms from the generated digital signal and transmitting the plurality of channelized waveforms over a plurality of communication channels; and a frequency divider for dividing the frequency list by the number of channels to generate a quotient to be provided to the channel selector circuit and a remainder to be provided to said DDS.

[0010] In some embodiments, the present invention is a method for generating parallelized hardware-independent waveforms. The method includes: generating metadata associated with a waveform, the metadata including a frequency list, a phase list and amplitude information, wherein the metadata is generated independent of a number of parallel waveform paths; interpreting the metadata to generate frequency and amplitude parameters, and a plurality of different phase parameters, each for a respective one of said parallel waveform paths; providing the frequency and amplitude parameters to a plurality of direct digital synthesizers (DDSs); providing said each of the plurality of different phase parameters to a respective DSS for generating a plurality of digital signals; and transmitting the plurality of digital signals over a plurality of communication channels, wherein interpreting the metadata comprises dividing the frequency list by the number of channels and providing the divided frequency list to each of the plurality of DDSs.

[0011] In some embodiments, the present invention is an apparatus for generating parallelized hardware-independent waveforms. The apparatus includes: a meta data generator circuit for generating metadata associated with a waveform, the metadata including a frequency list, a phase list and amplitude information, wherein the metadata is generated independent of a number of parallel waveform paths; a meta data interpreter circuit for interpreting the metadata to generate frequency and amplitude parameters, and a plurality of different phase parameters, each for a respective one of said parallel waveform paths; a plurality of direct digital synthesizers (DDSs) for inputting the frequency and amplitude parameters; a phase selector for providing each of the plurality of different phase parameters to a respective one of said plurality of DDSs for generating a plurality of digital signals to be transmitted over a plurality of communication channels; and a frequency divider for dividing the frequency list by the number of channels and providing the divided frequency list to each of the plurality of DDSs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 illustrates a block diagram of a wide band inverse channelization device.

[0013] FIG. 2 illustrates a block diagram of a waveform/technique generator that uses raw I/Q data, according to some embodiments of the present invention.

[0014] FIG. 3 is an exemplary block diagram of a channelized portable waveform generation circuit, according to some embodiments of the present invention.

[0015] FIG. 4 is an exemplary block diagram of a parallel portable waveform generation circuit, according to some embodiments of the present invention.

[0016] FIG. 5 is an exemplary process flow for a channelized portable waveform generation circuit, according to some embodiments of the present invention.

What Is Claimed Is:

1. A method for generating channelized hardware-independent waveforms, the method comprising:

generating metadata associated with a waveform, the metadata including a frequency list, a phase list and amplitude information, wherein the metadata is generated independent of a number of channels;

interpreting the metadata to generate channel select, frequency, phase and amplitude parameters;

providing the frequency, phase and amplitude parameters to a direct digital synthesizer (DDS) to generate a digital signal;

providing the channel select parameter to a channel selector to generate a plurality of channelized waveforms from the generated digital signal; and

transmitting the plurality of channelized waveforms over a plurality of communication channels,

wherein interpreting the metadata comprises dividing the frequency list by the number of channels to generate a quotient to be provided to the channel selector and a remainder to be provided to said DDS.

2. The method of claim 1, further comprising inverse channelizing the transmitted plurality of channelized waveforms to generate a digital signal and converting the digital signal to an analog signal.

3. The method of claim 1, wherein said interpreting the metadata further comprises selecting a single phase for all the channels to be provided to said DDS.

4. The method of claim 1, further comprising:

generating metadata associated with a plurality of different waveforms;

multiplexing the metadata for each of the plurality of different waveforms; and

generating a plurality of different digital signals to be transmitted over said plurality of channels.

5. The method of claim 1, further comprising modifying only the number of channels for porting the waveform generation to a different platform having a different number of channels.

6. An apparatus for generating channelized hardware-independent waveforms comprising:

a meta data generator circuit for generating metadata associated with a waveform, the metadata including a frequency list, a phase list and amplitude information, wherein the metadata is generated independent of a number of channels;

a meta data interpreter circuit for interpreting the metadata to generate channel select, frequency, phase and amplitude parameters;

a direct digital synthesizer (DDS) for inputting the frequency, phase and amplitude parameters to generate a digital signal;

a channel selector circuit for inputting the channel select parameters to generate a plurality of channelized waveforms from the generated digital signal and transmitting the plurality of channelized waveforms over a plurality of communication channels; and

a frequency divider for dividing the frequency list by the number of channels to generate a quotient to be provided to the channel selector circuit and a remainder to be provided to said DDS.

7. The apparatus of claim 6, further comprising an inverse channelizer circuit for inverse channelizing the transmitted plurality of channelized waveforms to generate a digital signal and a digital-to-analog converter (DAC) for converting the digital signal to an analog signal.

8. The apparatus of claim 6, wherein one or more of said meta data generator circuit, said meta data interpreter circuit, said DDS, and said channel selector circuit are implemented in one or more field programmable gate arrays (FPGAs).

9. The apparatus of claim 6, wherein said meta data interpreter circuit further comprises a phase selector for selecting a single phase for all the channels to be provided to said DDS.

10. A method for generating parallelized hardware-independent waveforms, the method comprising:

generating metadata associated with a waveform, the metadata including a frequency list, a phase list and amplitude information, wherein the metadata is generated independent of a number of parallel waveform paths;

interpreting the metadata to generate frequency and amplitude parameters, and a plurality of different phase parameters, each for a respective one of said parallel waveform paths;

providing the frequency and amplitude parameters to a plurality of direct digital synthesizers (DDSs);

providing said each of the plurality of different phase parameters to a respective DSS for generating a plurality of digital signals; and

transmitting the plurality of digital signals over a plurality of communication channels,

wherein interpreting the metadata comprises dividing the frequency list by the number of channels and providing the divided frequency list to each of the plurality of DDSs.

11. The method of claim 10, further comprising multiplexing the transmitted plurality of digital signals to generate a digital signal and converting the digital signal to an analog signal.

12. The method of claim 10, wherein said interpreting the metadata further comprises generating the plurality of different phase parameters (POA) according to:

POA for DDS(M-1)=(M-1)*(Fout/Fs), where M is an integer number of parallel channels, Fs is a clock frequency of the parallel channels, and Fout is the divided frequency list for each of the plurality of DDSs.

13. The method of claim 10, further comprising:

generating metadata associated with a plurality of different waveforms;

multiplexing the metadata for each of the plurality of different waveforms; and

generating a plurality of different digital signals to be transmitted over said plurality of parallel channels.

14. An apparatus for generating parallelized hardware-independent waveforms comprising:

a meta data generator circuit for generating metadata associated with a waveform, the metadata including a frequency list, a phase list and amplitude information, wherein the metadata is generated independent of a number of parallel waveform paths;

a meta data interpreter circuit for interpreting the metadata to generate frequency and amplitude parameters, and a plurality of different phase parameters, each for a respective one of said parallel waveform paths;

a plurality of direct digital synthesizers (DDSs) for inputting the frequency and amplitude parameters;

a phase selector for providing each of the plurality of different phase parameters to a respective one of said plurality of DDSs for generating a plurality of digital signals to be transmitted over a plurality of communication channels; and

a frequency divider for dividing the frequency list by the number of channels and providing the divided frequency list to each of the plurality of DDSs.