SUMMARY OF THE INVENTION

[0004] Embodiments of the present invention generally relate to communication systems using complex modulation techniques. More specially, embodiments of the present invention relate to distributed antenna systems that contain a microprocessor or other digital components, such as a Field Programmable Gate Array (FPGA) or Application Specific Integrated Circuit (ASIC). Timing synchronization in a Distributed Antenna system is sensitive to the data content that is transported on the network. Cellular data is prone to long periods of weak signals being present which can lead to long runs of zeros. A scrambler/descrambler is an effective technique to combat clock drift in a high data rate link. Embodiments of the present invention provide an efficient and effective method of insuring clock timing synchronization in a remote unit to which data has been transported over a digital link from a host unit to the remote unit.

[0005] Embodiments of the present invention provide systems and techniques that are based on performing scrambling on the transmitted downlink data at the Host unit and then descrambling on the received data at the remote unit. Likewise, scrambling and descrambling are used for the transmitted uplink data being transported between the Remote and the Host unit.

[0006] According to a first aspect of the present invention, there is provided a system for transporting data in a Distributed Antenna System, the system comprising: at least one Digital Access Unit (DAU); a plurality of Digital Remote Units (DRUs) coupled to the at least one DAU, wherein the plurality of DRUs are operable to transport signals between the plurality of DRUs and the at least one DAU; wherein the at least one DAU includes: a scheduler operable to allocate a first priority to payload I & Q data and a second priority to IP data; a data transport coder comprising: a framer, an encoder, a scrambler, and a serializer; and a data transport decoder comprising: a deserializer, a decoder, a descrambler, a frame synchronizer, and a deframer.

[0007] According to a second aspect of the present invention, there is provided a system for transporting data in a Distributed Antenna System, the system comprising: plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs; a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between the plurality of DRUs and the plurality of DAUs; wherein each of the plurality of DRUs includes: a data transport coder comprising: a framer, encoder, scrambler and serializer; a data transport decoder comprising: a deserializer, decoder, descrambler, frame synchronizer and deframer; and a scheduler/dispatcher, wherein the cheduler is operable to allocate a first priority to payload I & Q data and a second priority to IP data.

[0008] According to a third aspect of the present invention, there is provided a method of providing serialized data, the method comprising: receiving payload I & Q data; receiving IP data; allocating a first priority to the payload I & Q data; allocating a second priority to the IP data; transmitting the payload I & Q data and the IP data to a framer according to the first priority and the second priority; framing the payload I & Q data and the IP data; encoding the frame; scrambling the encoded frame to provide scrambled data; and serializing the scrambled data.

[0009] According to a fourth aspect of the present invention, there is provided a method of transmitting RF data and IP data, the method comprising: receiving the RF data at an RF port of a Digital Access Unit (DAU); receiving the IP data at an Ethernet port of the DAU; processing the RF data to provide digital payload I & Q data; allocating a first priority to the digital payload I & Q data; allocating a second priority to the IP data; transmitting the digital payload I & Q data and the IP data to a framer according to the first priority and the second priority; framing the digital payload I & Q data and the IP data to provide framed data; encoding the framed data; scrambling the encoded data; serializing the scrambled data; transmitting the serialized data through an optical fiber to a Digital Remote Unit (DRU); deserializing the serialized data; descrambling the deserialized data; extracting frame synchronization for the descrambled data; decoding the descrambled data; converting the decoded data to provide a representation of the RF data and the IP data; amplifying the representation of the RF data and the IP data; and transmitting the amplified RF data and IP data from an antenna associated with the DRU.

[0010] According to a specific embodiment of the present invention, a system for transporting data in a Distributed Antenna System is provided. The system includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs, a data transport coder comprising: a framer, encoder, scrambler and serializer, and a data transport decoder comprising: a deserializer, decoder, descrambler, frame synchronizer and deframer.

[0011] According to another specific embodiment of the present invention a, system for transporting data in a Distributed Antenna System is provided. The system includes a plurality of Digital Access Units (DAUs). The plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs, a data transport coder comprising: a framer, encoder, scrambler and serializer. The

system also includes a data transport decoder comprising: a deserializer, decoder, descrambler, frame synchronizer and deframer. The system further includes a scheduler and dispatcher.

[0012] According to yet another specific embodiment of the present invention, a system for transporting data in a Distributed Antenna System includes a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs. The system also includes a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between DRUs and DAUs and a plurality of Base Transceiver Stations (BTS). The system also includes a data transport coder comprising: a framer, encoder, scrambler and serializer, and a data transport decoder comprising: a deserializer, decoder, descrambler, frame synchronizer and deframer.

[0013] Numerous benefits are achieved by way of the present invention over conventional techniques. For example, embodiments of the present invention provide improved clock timing synchronization utilized in the transmission of cellular data. Embodiments of the present invention are applicable to any communication system that transports cellular data over a medium. In some embodiments, a communication link is established between a local host unit and a remote unit. A Field Programmable Gate Array (FPGA) or Application Specific Integrated Circuit (ASIC) that incorporates a processor, such as a Power PC or Microblaze, can be used to control the data flow to and from the Remote Unit. These and other embodiments of the invention along with many of its advantages and features are described in more detail in conjunction with the text below and attached figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a block diagram showing a Distributed Antenna System (DAS), which includes one or more Digital Access Units (DAUs) and one or more Digital Remote Units (DRUs).

[0015] FIG. 2 is a block diagram of a Digital Access Unit (DAU).

[0016] FIG. 3 is a block diagram of a Digital Remote Unit (DRU).

[0017] FIG. 4 shows the mapping of the data frame structure used to communicate between the DAU and the DRUs.

CLAIMS:

1. A system for transporting data in a Distributed Antenna System, the system comprising:

at least one Digital Access Unit (DAU);

a plurality of Digital Remote Units (DRUs) coupled to the at least one DAU, wherein the plurality of DRUs are operable to transport signals between the plurality of DRUs and the at least one DAU;

wherein the at least one DAU includes:

a scheduler operable to allocate a first priority to payload I & Q data and a second priority to IP data;

a data transport coder comprising: a framer, an encoder, a scrambler, and a serializer; and

a data transport decoder comprising: a deserializer, a decoder, a descrambler, a frame synchronizer, and a deframer.

2. The system of claim 1 wherein the at least one DAU is coupled to the plurality of DRUs via at least one of Ethernet cable, Optical Fiber, Microwave Line of Sight Link, Wireless Link, or Satellite Link.

3. The system of claim 1 wherein the plurality of DRUs are connected in a daisy chain configuration.

4. The system of claim 1 wherein the plurality of DRUs are connected to the at least one DAU in a star configuration.

5. The system of claim 1 wherein a port of the at least one DAU is operable to connect to a Base Transceiver Station.

6. A system for transporting data in a Distributed Antenna System, the system comprising:

a plurality of Digital Access Units (DAUs), wherein the plurality of DAUs are coupled and operable to route signals between the plurality of DAUs;

a plurality of Digital Remote Units (DRUs) coupled to the plurality of DAUs and operable to transport signals between the plurality of DRUs and the plurality of DAUs;

wherein each of the plurality of DRUs includes:

a data transport coder comprising: a framer, encoder, scrambler and serializer;

a data transport decoder comprising: a deserializer, decoder, descrambler, frame synchronizer and deframer; and

a scheduler/dispatcher, wherein the scheduler is operable to allocate a first priority to payload I & Q data and a second priority to IP data.

7. The system of claim 6 further comprising a plurality of a plurality of Base Transceiver Stations (BTS).

8. The system of claim 6 wherein one or more elements of the data transport coder and data transport decoder are implemented in an FPGA.

9. The system of claim 6 wherein both payload I & Q data and IP data are processed by the data transport coder and data transport decoder.

10. A method of providing serialized data, the method comprising:

receiving payload I & Q data;

receiving IP data;

allocating a first priority to the payload I & Q data;

allocating a second priority to the IP data;

transmitting the payload I & Q data and the IP data to a framer according to the first priority and the second priority;

framing the payload I & Q data and the IP data;

encoding the frame;

scrambling the encoded frame to provide scrambled data; and

serializing the scrambled data.

11. The method of claim 10 further comprising:

receiving the serialized data;

deserializing the serialized data;

descrambling the deserialized data;

synchronizing the descrambled data;

decoding the descrambled data;

deframing the decoded data; and

providing the payload I & Q data and the IP data.

12. The method of claim 10 wherein the payload I & Q data is associated with RF cellular traffic.

13. The method of claim 10 wherein the IP data is independent of the payload I & Q data.

14. A method of transmitting RF data and IP data, the method comprising:

receiving the RF data at an RF port of a Digital Access Unit (DAU);

receiving the IP data at an Ethernet port of the DAU;

processing the RF data to provide digital payload I & Q data;

allocating a first priority to the digital payload I & Q data;

allocating a second priority to the IP data;

transmitting the digital payload I & Q data and the IP data to a framer according to the first priority and the second priority;

framing the digital payload I & Q data and the IP data to provide framed data;

encoding the framed data;

scrambling the encoded data;

serializing the scrambled data;

transmitting the serialized data through an optical fiber to a Digital Remote Unit (DRU);

deserializing the serialized data;

descrambling the deserialized data;

extracting frame synchronization for the descrambled data;

decoding the descrambled data;

converting the decoded data to provide a representation of the RF data and the IP data;

amplifying the representation of the RF data and the IP data; and

transmitting the amplified RF data and IP data from an antenna associated with the DRU.

15. The method of claim 14 wherein the RF data comprises analog RF data.

16. The method of claim 14 wherein the RF data comprises cellular data.

17. The method of claim 14 wherein the digital payload I & Q data and the IP data are framed as separate elements of the framed data.

18. The method of claim 14 wherein converting the decoded data comprises a digital to analog conversion process.