Millimeter-Wave Radio System

Mark Felipe
Sean Keys

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MILLIMETER-WAVE RADIO SYSTEM

ABSTRACT

A millimeter-wave radio system enables a need-based communication between a set of radios to improve performance metrics, such as signal strength/power performance, that impact the quality of service. The system monitors performance of a radio receiver using a software engine present within the radio receiver. Based on the monitored power performance, the system makes adjustments internally as a first course of action and then provides an update to a radio transmitter. Based on this update, the radio transmitter transmits a message to the radio receiver which acts as a second course of action for the receiver to optimize the power performance. The receiver determines the received power to be either too high or too low based on the received message and consequently communicates a Universal asynchronous receiver transmitter (UART) message to the transmitter to decrease or increase the power, respectively. The transmitter decodes the received UART message to process the embedded radio ID and payload information present in the message. The system will continue to perform these steps until the power level of the signal falls within an acceptable range.

PROBLEM STATEMENT

At present, multi-gigabit millimeter-wave radio systems lack the capability of making autonomous adjustments based on receiver requests. One of the primary reasons for this shortcoming is the lack of intelligent communication between the receiver and a transmitter. Currently, many systems use automatic transmit power control (ATPC) which focuses on
pre-analysis of the deployment area and is therefore non-universal. One other drawback of ATPC is that it is primarily used for boosting transmit power only for short durations of time. Thus there are numerous opportunities to have systems that make requests to both increase and decrease transmit power with no time constraints and constitute a need based communication between the receiver and the transmitter to improve the performance metrics.

**DETAILED DESCRIPTION**

The systems and techniques described in this disclosure relate to a millimeter-wave radio system that enables a need based communication between a set of radios to improve the performance metrics such as signal strength/power performance of the received signals. The system can be implemented in a variety of devices. It can be implemented on a radio transmitter of a first device and a radio receiver of a second device. It can be implemented as a standard and can be present on all the radio transmitters and radio receivers. The radio transmitter and receiver can be associated with any devices such as a mobile phone, a smartphone, a tablet computing device, a laptop computer, a coupling device, an electric or hybrid electric vehicle, an electric or hybrid electric automobile or car, a drone, a wireless electronic toy or game, a satellite, etc.

Fig. 1 illustrates an example method 100 that provides a way to monitor power performance associated with a radio transmitter and a radio receiver and ways to optimize the power performance.

The system monitors 110 power performance of a radio receiver using a software engine. The radio receiver can be any device capable of receiving RF signals and includes a software engine module that monitors the strength of signals received at the radio receiver. The software
engine module can include a processor, a memory, and a program code executable by the processor to make the required measurements. The software engine makes internal measurements and changes to the power level of the received signal in the radio receiver with certain limitations. The system uses Received signal strength indicator (RSSI) as a measurement of the signal strength or power present in the received signal which is represented in decibels or milliwatts.

If the monitored power is not optimal and does not fall into an acceptable range, the system makes adjustments to the power within the receiver as a first course of action for rectifying the power level. The software engine module compares the measured power level of the signal with an internally stored power level. The stored power level is a preferred range of power level for the received signal and can range from 0 DB to RSSI maximum based on the requirements of the system, external environment, and the current implementation of the system. This can be stored in a memory associated with the system. Based on this comparison, the software engine can adjust the received power level to bring it within the predefined optimal range. In one implementation, the software engine is able to completely adjust the power level of the received signal and consequently the method would only perform the next step and then stop. However, in another implementation, the software engine may not be able to successfully adjust the power level. In this scenario, the system will perform all the next steps.

The system provides an update to the radio transmitter after the first course of action has been exhausted. This update includes information about the power level which was measured at the receiver and the software engine’s attempt to adjust the power level. This update can also
include the level of adjustment made by the software engine and acts as a trigger for the transmitter to perform more steps in order to optimize the power performance.

Based on this update, the system receives a message at the receiver from the transmitter as a second course of action. The system utilizes this message to measure the power level of the received message and compare it with the stored range of preferred power level. Based on the comparison, if the received power is too high, the system sends a UART message to the transmitter to decrease the power level. On the other hand, if the received power is too low, the system sends a UART message to the transmitter to increase the power level.

The system then receives a UART message at the transmitter from the receiver over a signal airframe via a UART interface. The UART message takes bytes of data and transmits the individual bits in a sequential fashion. These bits are combined back into bytes at the destination. This message includes information about the power level and the adjustments to be made to the power level of the signals.

The system decodes this UART message to process the embedded radio ID and the payload information. This combination of embedded ID and the payload information helps the system to identify the radio receiver and the amount of power which needs to be increased or decreased in order to have an acceptable power level of the signal.

The system can repeat steps (140 to 150 to 153 or 156) until the RSSI falls within an acceptable range in order to have optimal power performance metrics for the system.

The subject matter described herein can be implemented in software and/or hardware (for example, computers, circuits, or processors). The subject matter can be implemented on a single device or across multiple devices (for example, a client device and a server device). Devices
implementing the subject matter can be connected through a wired and/or wireless network. Such devices can receive inputs from a user (for example, from a mouse, keyboard, or touchscreen) and produce an output to a user (for example, through a display and/or a speaker). Specific examples disclosed are provided for illustrative purposes and do not limit the scope of the disclosure.
Monitor power performance of a radio receiver using a software engine (1)

Make adjustments to the power within the receiver as a first course of action based on monitored power performance (2)

Provide update to the radio transmitter after the first course of action is exhausted (3)

Receive a message at the receiver from a radio transmitter as a second course of action (4)

Is the received power too high or too low? (5)

Too high: Send message to transmitter to decrease the power (6)

Too low: Send message to transmitter to increase the power (6)

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Receive a UART message at the transmitter from the receiver over a signal airframe via a UART interface (7)

Decode the UART message at the transmitter to process the embedded radio ID and payload information (8)

Steps 4 - 6 will continue until RSSI falls within an acceptable range (9)

Fig. 1