Multilateral voice transceiver using Sub-1GHz band

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Abstract—**In this paper, War situation, marine distress, mountain rescue, not available in the existing telecommunications infrastructure environment Propose multiparty Streaming real-time voice using 900MHz RF Module range with a radius of 1km. Without using separate infrastructure, using only Sub-1GHz RF (Radio Frequency) Module, to solve the problem in the loss of life is increasing non-communication area, such as ocean, mountain, etc.**

Keywords-Sub-1GHz; RF Module; multiparty; real-time; streaming; stransceiver; TDMA; TDD;

I. INTRODUCTION (HEADING 1)

Product demand and the need for effective multilateral group communication features is increased in recently outdoor leisure sport activities in rapidly increasing, disaster or emergency relief and recovery efforts in the disaster area, the describes in the museums, collaboration between Event proceeds agents at convention center.

Previously mentioned activities need not transfer large amounts of data, because the purpose of voice communication. There are also long distance communication features that should be possible. This point of consideration to this paper, 900MHz RF Module for use with a software-based TDMA (Time Division Multiple Access) / TDD (Time Division Duplex) technology for using multi-party voice transceivers developed over many special environments in the wireless communication a to be .

II. RELATED RESEARCH

A. 900MHz RF

RF communication of the 900MHz band has been used and studied in many fields. Typically an RFID. RFID technology refers to a technology for recognizing information from a distance using a radio wave.

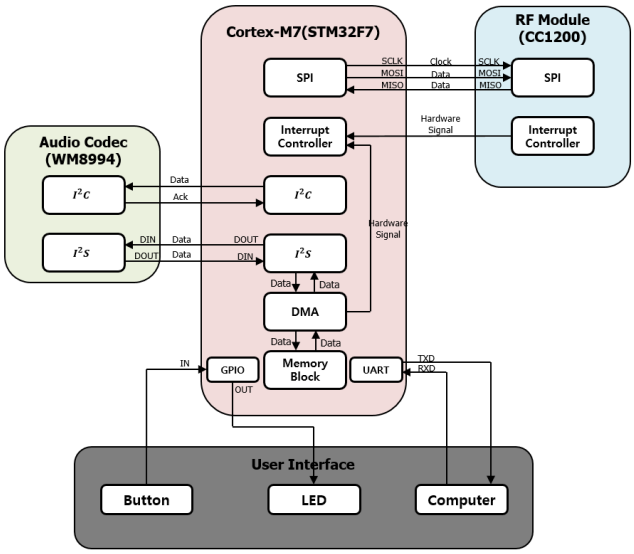
B. Audio Synchronization

When implementing a wireless protocol of the TDMA system Clock synchronization between each Node it is required. The reason is that each Node, and they know exactly what they need to be transferred to Time slot, we need to match the Clock synchronization between the Node does not overlap the Time slot. Between Node, Clock synchronization between the Node to enable their former Local Clock and, based on this exchange between the Node Local Clock synchronization is achieved.

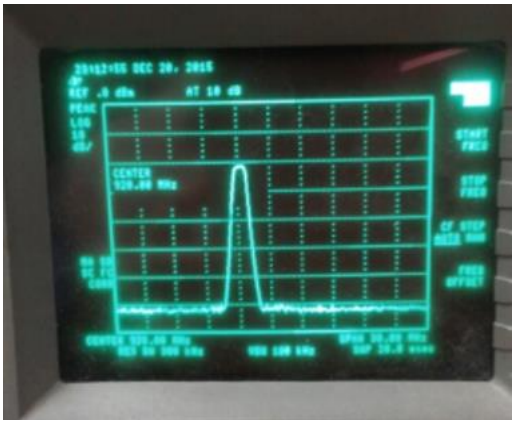
III. MAIN IDEA OF THIS WORK

A. 900MHz RF network configuration

900MHz RF wireless transmission function, and Texas instruments's CC1200 RF Chip STMicroelectronics Cortex-M7 Chip Company in the STM32F7 was used to verify, Audio codec include Wolfson's WM8994 Audio codec chip was used to. STM32F7 MCU from the SPI through the CC1200 RF chip and the control, Audio codec is the WM8994 I2C, I2S is controlled by the use. (Fig. 1) Hardware block diagram, and (Fig. 2) through the Spectrum can be seen that a signal is transmitted to a center frequency of 915MHz, in compliance with the wireless equipment rule for limiting to less than 200KHz significantly when using a frequency of 100MHz excess and operating a transmission rate of 150Kbps using a 185KHz bandwidth channel.



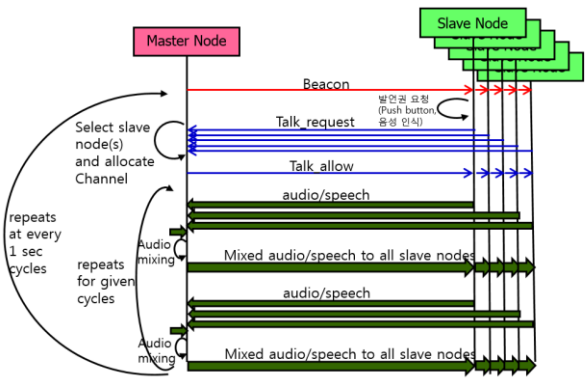
(Fig.1) Hardware block diagram



(Fig. 2) 915MHz Spectrum

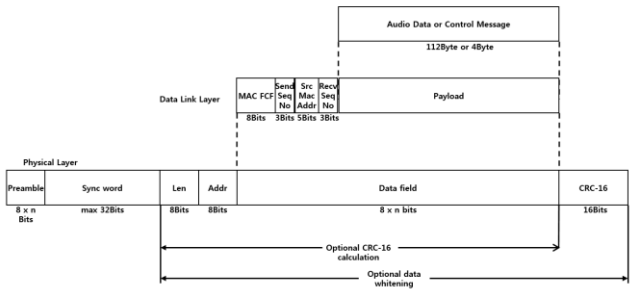
B. TDMA based multipoint transmission MAC Design and Implementation

Master node has a Sequence proceeds as a Beacon frame 1 second intervals broadcasting. The clock information of each Node is transmitted contained in the Beacon Message, Talk request frame, Talk allow frame synchronization to the Clock and Slave node Master node. Slave node if one is on Push button at the time of receiving the Beacon frame is transmitted to Talk request frame to the Master node. Talk request frame is received the Master node to say when permitted depending on whether the Frame Slave node structure that is to be sent, Master node priority in accordance with the accepted voice and Slave node to Talk allow frame transmission of a structure. Figure 3 is a Sequence of voice requests and Audio data transmission.



(Fig. 3)Audio data transmission Sequence

Slave node is likely to be a collision between the frame number request Talk Slave node when to transmit a Beacon frame received immediately Talk request message. Slave node Because each has its own after receiving the Beacon frame ID * 1.5ms after the Talk request message sent to the Mechanism with the Slave node-to Talk request frame of the collision was avoided. Talk time that Master receives the request was set to 28ms, which may be received without a collision Talk request frame from the theoretical 18 Slave node. Beacon, Talk request, Talk allow frame (Figure 4) and L2PDU (Layer 2 Protocol Data Unit) of the Payload of the 4Byte, it is possible to distinguish different Frame by FCF Field.

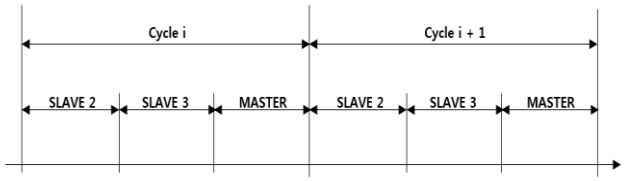


(Fig. 4) Frame structure

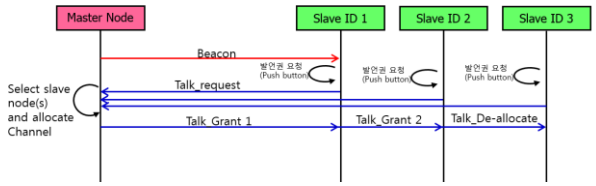
Each Slave node can know through the No audio collision-free transmission of an interval of 1.5ms Talk request frame (formula 1), and this time, the transmission rate of a 900MHz RF Module was calculated to 130Kbps.

$$\frac{20Bytes*8}{130Kbps} = 1.23ms \qquad \text{(Eqa. 1)}$$

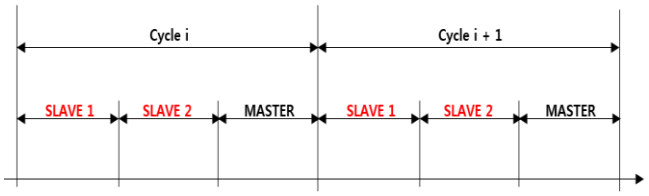
Master node is assigned a Time slot, as in accordance with the priorities of the Slave node is requested to give a voice to say with Talk allow frame (Fig. 4). In this paper, we prioritize according to Slave ID, Master node were to be fixed by the use of 3 Time slot assignment for Time slot No. 1 and 2 to the Slave node. Assign the first time slot Beacon frame 1 to the highest priority of the request for a say in the transmission cycle and the Slave Node priority is assigned to the following time slot to the Node First Time 2 ranking. Next Beacon frame transmission period of the current Time slot to use and which Slave node than the high-priority Node is a voice application will be if the current Time slot to use and that Node of the lowest priority Node's Time slot to unlock and high first, the structure of assigning the priority to the Node. (Fig. 5), while the Time slot is allocated, as shown in (Fig. 6) 1 has a higher priority, such as when a Slave node requests the floor (Fig. 7) and the Time slot changes as. (Fig. 5), the lowest priority voice of the Slave node 3 times with a ranking released and receive allocation of one Slave node is the first Time slot 1 of the highest priority, the second priority 2 Slave node of rank second Time in It is assigned a slot, through Talk allow frame is broadcast to each of the Node.



(Fig. 5) After application of voice Slave 2 Node and Slave 3 Node Time slot



(Fig.6) voice management in accordance with the priority of the Master

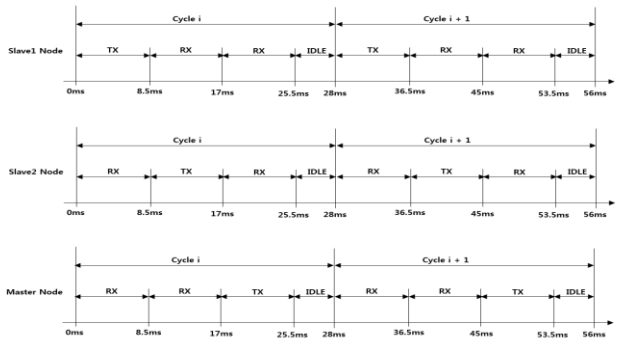


(Fig. 7) Time slot after the release of the Slave 3 Slave 1 Time slot allocation Cycle

C. *TDD based collision avoidance of a two-way audio transmission techniques Design and Implementation*

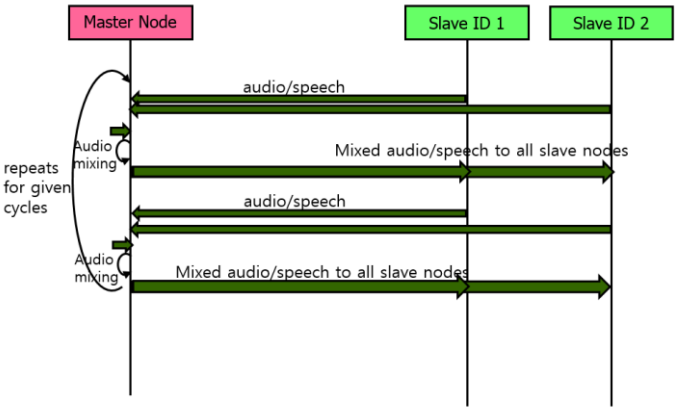
Audio is transmitted Cycle (Fig. 8) was equal to 28ms interval when operating the Audio Sample rate to 24KHz generated 84Byte of the Audio data. Frame size during wireless transmission can be obtained when operating a transmission rate of 130Kbps to RF Chip with 100Byte time it takes a Frame when transmission using the equation (2). After configuring the 28ms Audio data that is generated by the Cycle 84Byte this time, if the time of 6.15ms is 100Byte the transfer set in one slot makes it possible to Time Audio two-way transmission of the TDD scheme. But, CC1200 using a 900MHz RF Module RF Chip RF wireless transmission is made possible through the conversion of the TX / RX Mode in the State machine. In view of this, the Mode changes related to the presence of RF Chip Overhead was set to 8.5ms One Time slot.

$$\frac{100Bytes * 8}{130Kbps} = 6.154ms \qquad \text{(Eqa. 2)}$$



(Fig. 8) voice application for Slave 2 Node and Slave 3 Node After Time slot

Slave node can own a Microphone input Audio data will be sent to the Master node, node that will have a say in their own information and Audio data Audio data and information Mixing Slave node to the Broadcasting will be. (Fig. 9) is synthesized by relaying Sequence after receipt of the Audio data from the Master node Slave node.



(Fig.9) Master node and then relayed to the Sequence Audio data synthesis

IV. EVALUATIONS

A. *Simulation, Measurement, Test*

In this paper, we evaluate the speech quality by using a MOS (Mean Opinion Score). <Table 1> will showing an MOS evaluation table, <Table 2> illustrates the evaluation results are.

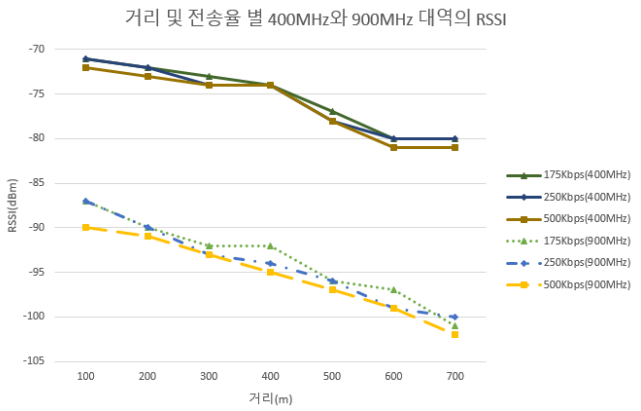
<Table.1> MOS table

MOS	Quality	Impairment
5	Excellent	Imperceptible
4	Good	Perceptible but not annoying
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying

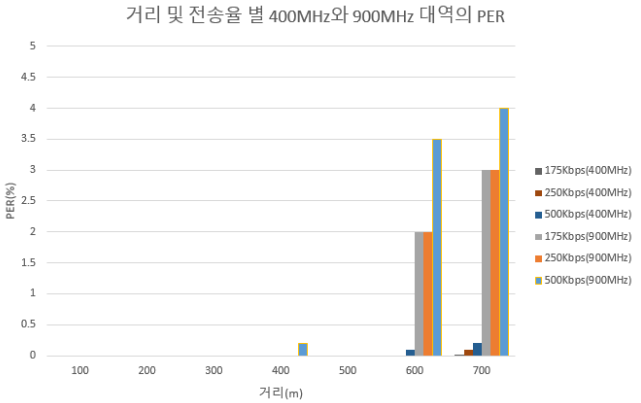
<Table.2> MOS Evaluation table

Speakers	MOS Average Score
2 people	4.1
3people	3.8

Sub-1GHz radio Node test Implementation and Performance test distance, the center frequency, the transmission rate in accordance with RSSI (Received Signal Strength Indicator), PER (Packet Error Rate) measurement was the result is (Fig. 10), (Fig. 11), and the like.



(Fig. 10) and the distance rate by 400 MHz, 900MHz of bandwidth RSSI



(Fig. 11) PER distance and 400 MHz, 900MHz bands rates

B. Analysis of the results

RF Module is a maximum transfer rate of 1Mbps. But the burden was confirmed, limiting the bandwidth 185KHz Data transmission and reception is made using a wireless RF channel to the transmission rate of 150kbps.

For Audio data Sample rate, Sample bit of 8KHz is then set to 16bit Channel was used for mono way. Sample size is 448Bytes and confirmed that produced one of the Audio sample intervals 28ms.

If the number of three-way voice transmission and reception delay difference between Node speaker had had a delay difference of less than 100ms, Clock Synchronization Also, if you set the resynchronization time of 5 seconds was confirmed that maintain less than 150us.

V. CONCLUSION

This paper can be utilized even be applied to the development of multi-party communication terminal equipment of commercial products used in the various multilateral group communication applications and real-time Multimedia Remote monitoring and remote control are available Internet of Things configuration and application services technology development of a variety of commercial equipment and is used as a collective tour guide, outdoor group activities (horseback riding, cycling, etc.), the police, the fire department, the Software available to various groups based communication applications that require soldiers, etc. TDMA / TDD two-way communications core technology group. If further service using the AD-hoc Network, Multi-hop Network to Cover can be more than 1km away.

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