Telecommunications and Information Exchange Between Systems

ISO/IEC JTC 1/SC 6

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G3 New Work Item Proposal

September 29,2009

PROPOSAL FOR A NEW WORK ITEM

Date of presentation of proposal: 2009-09-30	Proposer: National Body of Korea
Secretariat: KATS	**ISO/IEC JTC 1 N** XXXX ISO/IEC JTC 1/SC 06 N 14096

A proposal for a new work item shall be submitted to the secretariat of the ISO/IEC joint technical committee concerned with a copy to the ISO Central Secretariat.

Presentation of the proposal - to be completed by the proposer.

Title

Magnetic Field Area Network (MFAN)

Scope

This item defines the physical layer and the media access control layer protocols of a sensor-based wireless network using a magnetic field in a low-frequency band (30KHz~300KHz). Wireless communication in harsh environments is critically required in various industries. It is so difficult for a sensor node to transmit its data by radio frequency around metal, soil, and water with the existing standards of wireless communication. So, this item makes an alternative proposal that enables several sensor nodes inside metal, soil, and water to transfer their data to a coordinator outside using the characteristics of magnetic field.

The physical layer protocol is designed for the following scope:

- Low carrier frequency for large magnetic field area and reliable communication in harsh environments
- Simple and robust modulation for low cost implementation and low error probability
- Variable coding and bandwidth for adaptive link quality control

The media access control layer protocol is designed for the following scope:

- Simple and efficient network topology for low power consumption
- Variable superframe structure for compact and efficient data transmission
- Dynamic address assignment for small packet size and efficient address management

As shown in **Figure 1**, MFAN-N can be buried into the ground, and MFAN-C is on the ground. If MFAN-N receives the sensing data from the ground sensor, it sends the receiving data to MFAN-C using a Magnetic Field. MFAN-C sends the receiving data from MFAN-N to the monitoring center using the other wireless or wired communication for long distance.

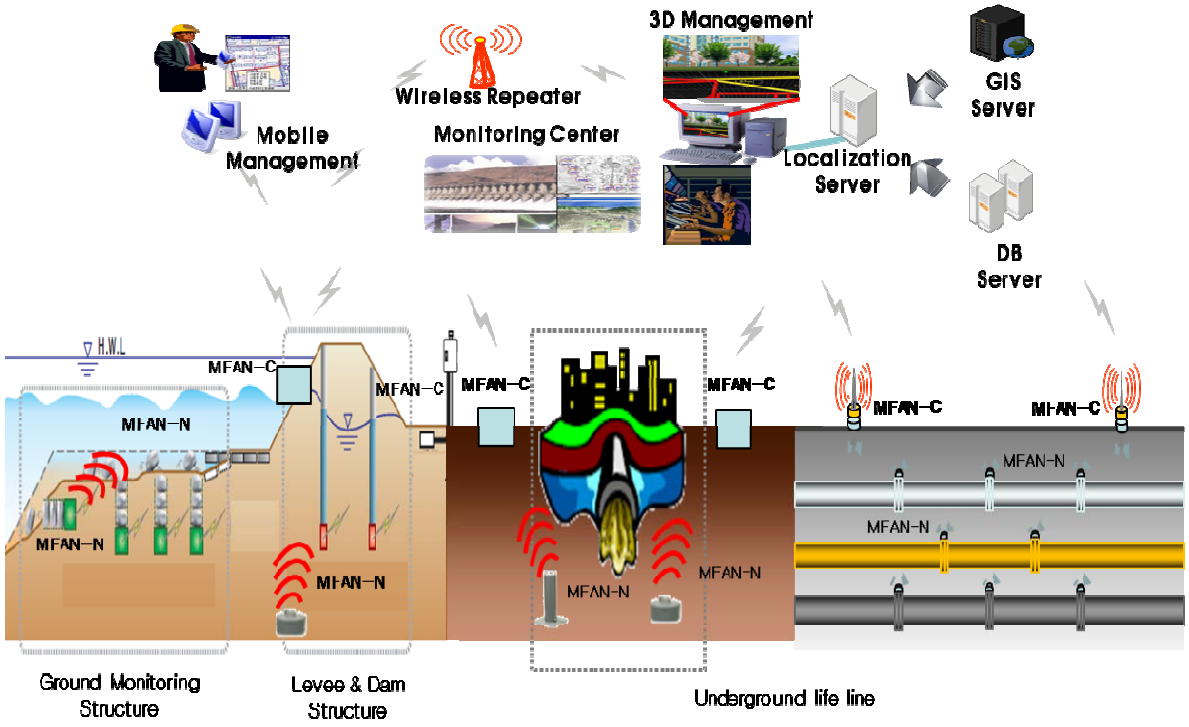

Figure 1 Underground Monitoring System

This item supports several kbps data transmission speed in wireless communication based on a formed network within a distance of several meters. And it can be applied to various services such as the following areas of application:

- Environmental industry to manage pollution levels in soil and water using wireless underground or underwater sensors
- Construction industry to monitor the integrity of buildings and bridges using wireless, inner-corrosion sensors
- Consumer-electronics industry to detect food spoilage in wet, airtight storage areas and transfer the sensing data from the inside to the outside
- Agricultural industry to manage the moisture level as well as mineral status in soil using wireless, buried sensors
- Transportation industry to manage road conditions and traffic information using wireless, underground sensors

Purpose and justification - attach a separate page as annex, if necessary.

The wireless communication technology in harsh environments is urgently required. Sensor networks are vitally needed in the field of environmental, agricultural, transportation, construction industries, and also in the disaster prevention areas. The following are list of cases where wireless communication is much needed:

- Underground status monitoring to detect ground sinking and land sliding in the ground.
- Water pollution monitoring to manage the change of the temperature and the quality of water.
- Building and bridge management to detect inner corrosion and deterioration, or integrity of structures.
- Intelligent transportation information service to give drivers road conditions in harsh weather.
- Underground infrastructure management to detect malfunction and location of gas and water pipelines, electric wires, communication lines, and oil pipelines.

The desired characteristics of wireless communication in the above mentioned areas are as follows:

- Reliable communication in harsh environments
- Long shelf life of more than several years
- Low cost implementation and low power consumption
- Adaptive link quality control in changing wireless environments

To satisfy the rigorous requirement of these industries, we are proposing MFAN(Magnetic Field Area Network) technology, which enable reliable communication around metal, soil, and water. MFAN utilizes low-cost design using a simple modulation scheme and star network topology. In addition, utilizing adaptive link quality control using variable transmission speeds and coding methods according to wireless environments.
We anticipate that the international standardization of MFAN technology will contribute to accommodating the needs in the relevant industries with sharing related technologies among the countries, and encouraging international companies to participate. Moreover, developing the relevant service industries as well as wireless communication industries by presenting sensor-based wireless communication standard that is applicable to a variety of industrial usages.

Programme of work

If the proposed new work item is approved, which of the following document(s) is (are) expected to be developed?
_X__ a single International Standard
___ more than one International Standard (expected number: .....)

____ a multi-part International Standard consisting of ..... parts ____ an amendment or amendments to the following International Standard(s) ..... ____ a technical report , type ..... And which standard development track is recommended for the approved new work item? _X _a. Default Timeframe ____b. Accelerated Timeframe ____c. Extended Timeframe
Relevant documents to be considered
Co-operation and liaison
Preparatory work offered with target date(s)
Signature:
Will the service of a maintenance agency or registration authority be required? . No - If yes, have you identified a potential candidate? ..... - If yes, indicate name ..... Are there any known requirements for coding? No -If yes, please specify on a separate page Does the proposed standard concern known patented items? No - If yes, please provide full information in an annex Are there any known accessibility requirements and/or dependencies (see: http://www.jtc1access.org)?..No -If yes, please specify on a separate page Are there any known requirements for cultural and linguistic adaptability? No -If yes, please specify on a separate page

Comments and recommendations of the JTC 1 or SC XX Secretariat - attach a separate page as an annex, if necessary

Comments with respect to the proposal in general, and recommendations thereon: It is proposed to assign this new item to JTC 1/SC 06

Voting on the proposal - Each P-member of the ISO/IEC joint technical committee has an obligation to vote within the time limits laid down (normally three months after the date of circulation).

Date of circulation: 2009-09-30	Closing date for voting: 2009-12-30	Signature of Secretary: Jooran Lee

NEW WORK ITEM PROPOSAL -		

PROJECT ACCEPTANCE CRITERIA		
Criterion	**Validity**	**Explanation**
A. Business Requirement		
A.1 Market Requirement	Essential _X _ Desirable ___ Supportive ___	
B. Related Work		
B.1 Completion/Maintenance of current standards	Yes ___ No_X _	
B.2 Commitment to other organisation	Yes ___ No_X _	
B.3 Other Source of standards	Yes ___ No_X _	
C. Technical Status		
C.1 Mature Technology	Yes _X _ No___	
C.2 Prospective Technology	Yes ___ No_X _	
C.3 Models/Tools	Yes ___ No_X _	
D. Conformity Assessment and Interoperability		
D.1 Conformity Assessment	Yes ___ No_X _	
D.2 Interoperability	Yes ___ No_X _	
E. Adaptability to Culture, Language, Human Functioning and Context of Use		
E.1 Cultural and Linguistic Adaptability	Yes ___ No_X __	
E.2 Adaptability to Human Functioning and Context of Use	Yes ___ No_X __	
F. Other Justification		

Notes to Proforma

A. Business Relevance. That which identifies market place relevance in terms of what problem is being solved and or need being addressed.

A.1 Market Requirement. When submitting a NP, the proposer shall identify the nature of the Market Requirement, assessing the extent to which it is essential, desirable or merely supportive of some other project.

A.2 Technical Regulation. If a Regulatory requirement is deemed to exist - e.g. for an area of public concern e.g. Information Security, Data protection, potentially leading to regulatory/public interest action based on the use of this voluntary international standard - the proposer shall identify this here.

B. Related Work. Aspects of the relationship of this NP to other areas of standardisation work shall be identified in this section.

B.1 Competition/Maintenance. If this NP is concerned with completing or maintaining existing standards, those concerned shall be identified here.

B.2 External Commitment. Groups, bodies, or for a external to JTC 1 to which a commitment has been made by JTC for Co-operation and or collaboration on this NP shall be identified here.

B.3 External Std/Specification. If other activities creating standards or specifications in this topic area are known to exist or be planned, and which might be available to JTC 1 as PAS, they shall be identified here.

C. Technical Status. The proposer shall indicate here an assessment of the extent to which the proposed standard is supported by current technology.

C.1 Mature Technology. Indicate here the extent to which the technology is reasonably stable and ripe for standardisation.

C.2 Prospective Technology. If the NP is anticipatory in nature based on expected or forecasted need, this shall be indicated here.

C.3 Models/Tools. If the NP relates to the creation of supportive reference models or tools, this shall be indicated here.

D. Conformity Assessment and Interoperability Any other aspects of background information justifying this NP shall be indicated here.

D.1 Indicate here if Conformity Assessment is relevant to your project. If so, indicate how it is addressed in your project plan.

D.2 Indicate here if Interoperability is relevant to your project. If so, indicate how it is addressed in your project plan

E. Adaptability to Culture, Language, Human Functioning and Context of Use
NOTE: The following criteria do not mandate any feature for adaptability to culture, language, human functioning or context of use. The following criteria require that if any features are provided for adapting to culture, language, human functioning or context of use by the new Work Item proposal, then the proposer is required to identify these features.

E.1 Cultural and Linguistic Adaptability. Indicate here if cultural and natural language adaptability is applicable to your project. If so, indicate how it is addressed in your project plan.

ISO/IEC TR 19764 (Guidelines, methodology, and reference criteria for cultural and linguistic adaptability in information technology products) now defines it in a simplified way:

- "ability for a product, while keeping its portability and interoperability properties, to:
- be internationalized, that is, be adapted to the special characteristics of natural languages and the commonly accepted rules for their se, or of cultures in a given geographical region;
- take into account the usual needs of any category of users, with the exception of specific needs related to physical constraints

Examples of characteristics of natural languages are: national characters and associated elements (such as hyphens, dashes, and punctuation marks), writing systems, correct transformation of characters, dates and measures, sorting and searching rules, coding of national entities (such as country and currency codes), presentation of telephone numbers and keyboard layouts. Related terms are localization, jurisdiction and multilingualism.

E.2 Adaptability to Human Functioning and Context of Use. Indicate here whether the proposed standard takes into account diverse human functioning and diverse contexts of use. If so, indicate how it is addressed in your project plan.
NOTE:
1. Human functioning is defined by the World Health Organization at http://www3.who.int/icf/beginners/bg.pdf as: << In ICF (International Classification of Functioning, Disability and Health), the term functioning refers to all body functions, activities and participation. >>
2. Content of use is defined in ISO 9241-11:1998 (Ergonomic requirements for office work with visual display terminals (VDTs) Part 11: Guidance on usability) as: << Users, tasks, equipment (hardware, software and materials), and the physical and societal environments in which a product is used.>>
3. Guidance for Standard Developers to address the needs of older persons and persons

with disabilities).

F. Other Justification Any other aspects of background information justifying this NP shall be indicated here.

The Draft Specification of Magnetic Field Area Network

Contents

Page

1. Scope

This item defines the physical layer and the media access control layer protocols of a sensor-based wireless network using a magnetic field in a low-frequency band (30KHz~300KHz). Wireless communication in harsh environments is critically required in various industries. It is so difficult for a sensor node to transmit its data by radio frequency around metal, soil, and water with the existing standards of wireless communication. So, this item makes an alternative proposal that enables several sensor nodes inside metal, soil, and water to transfer their data to a coordinator outside using the characteristics of magnetic field.

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2. Symbols and Abbreviated Terms

The following acronyms are used in this document:

ARA	Association Response Acknowledgement
ARQ	Association Request
ARS	Association Response
ASC	Association Status Confirmation
ASRA	Association Status Response Acknowledgement
ASRQ	Association Status Request
ASRS	Association Status Response
CRC	Cyclic Redundancy Code
BPSK	Binary Phase Shift Keying
DA	Data Acknowledgement
DARA	Disassociation Response Acknowledgement
DARQ	Disassociation Request
DARS	Disassociation Response
DRQ	Data Request
DRRQ	Data Response Request
DRS	Data Response
FCS	Frame Check Sequence
GAIRA	Group Address Initialization Response Acknowledgement
HCS	Header Check Sequence
LSB	Least Significant Bit
MAC	Medium Access Control
MFAN	Magnetic Field Area Network
MFAN-C	Magnetic Field Area Network Coordinator
MFAN-N	Magnetic Field Area Network Node
NRZ-L	Non-Return-to-Zero Level
RA	Response Acknowledgement
RRQ	Response Request
SIFS	Short Interframe Space
TDMA	Time Division Multiple Access
UID	Unique Identifier

3. Overview

The MFAN(Magnetic Field Area Network) is a wireless communication network that can send and receive data using a magnetic field in low frequency band. The Wireless Communication using a Magnetic Field enable reliable communication and expanded communication area around metal, soil, and water. So, the MFAN's carrier center frequency is in a low frequency band (30KHz to 300KHz). It uses a simple and robust modulation method like BPSK for low cost implementation and low error probability, and a dynamic coding method like Manchester or NRZ-L coding for strongness against noise. It provides a data transmission speed of several kbps within a distance of several meters.

The MFAN uses a simple and efficient network topology like star topology for low power consumption. And it uses dynamic address assignment for small packet size and efficient address management. It uses an adaptive link quality control using variable transmission speeds and coding methods according to wireless environments. The participating devices in MFAN are divided according to their function into MFAN-C (MFAN-Coordinator) and MFAN-N (MFAN-Node). Only one MFAN-C exists within one MFAN network, and several MFAN-N devices form a network centered on MFAN-C. MFAN-C manages the connection and release of MFAN-N. MFAN uses the TDMA (Time Division Multiple Access) method for sending and receiving a data. When MFAN-N joins MFAN network managed by MFAN-C, MFAN-C allocates time-slot for MFAN-N's transmission according to MFAN-N's request and MFAN-C's judgment.

As shown in **Figure 1**, MFAN-N can be buried into the ground, and MFAN-C is on the ground. If MFAN-N receives the sensing data from the ground sensor, it sends the receiving data to MFAN-C using a Magnetic Field. MFAN-C sends the receiving data from MFAN-N to the monitoring center using the other wireless or wired communication for long distance.

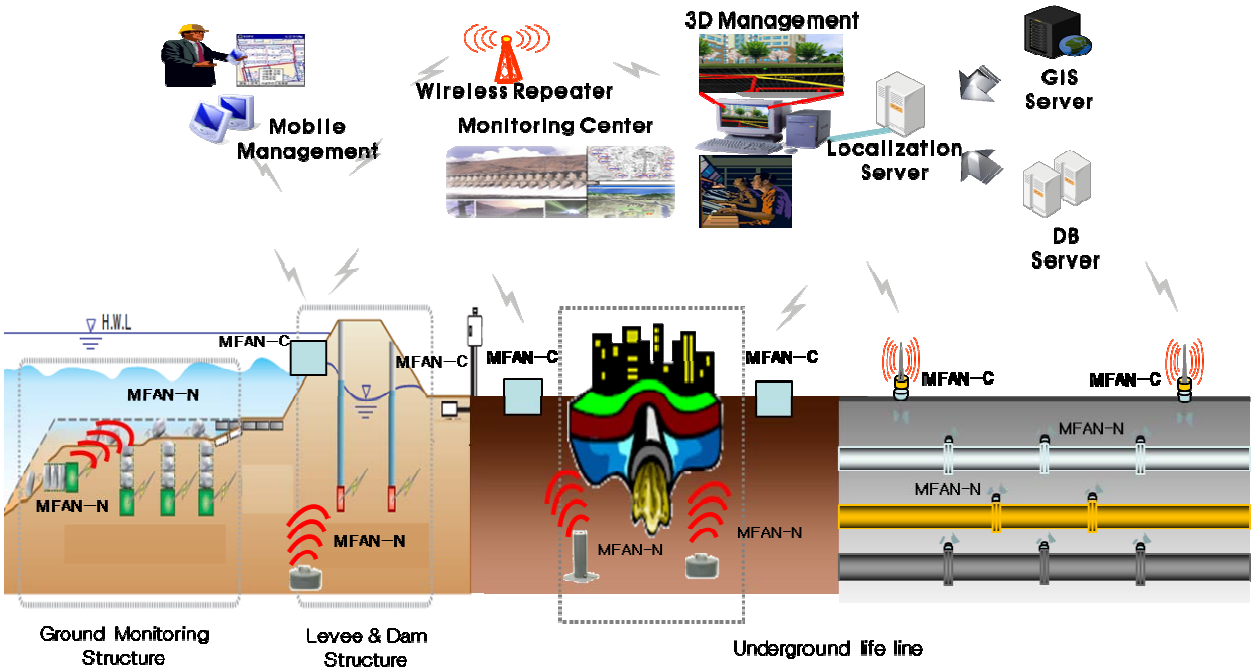

Figure 1 Underground Monitoring System

The wireless communication in harsh environments is critically required in various industries. It is so difficult for a sensor node to transmit its data by radio frequency around metal, soil, and water with the existing standards of wireless communication. So, MFAN makes an alternative proposal that enables several sensor nodes inside metal, soil, and water to transfer their data to a coordinator outside using the characteristics of magnetic field. And it can be applied to various services.

For example, in ground status management (**Figure 2**) the sensor nodes can be buried into the ground to sense the ground cave-in, ground sinking, land sliding, and so on. For the underground infrastructure management (**Figure 3**), we put the sensor nodes on pipes. With these nodes it is required to detect gas or water leaks and determine the location of those leaks. In building & bridge management (**Figure 4**) the sensor nodes can be placed on beams and columns to detect the crack of the structure. In pollution monitoring (**Figure 5**) the sensor nodes can detect the ground or the water quality. It is required to detect poisonous chemicals, PH and temperature by sensor nodes placed inside ground or water.

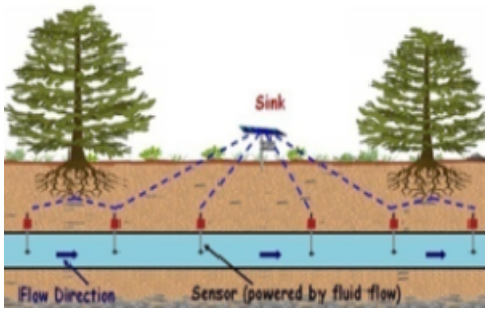

Figure 2 Ground status monitoring

Figure 3 Underground infrastructure management

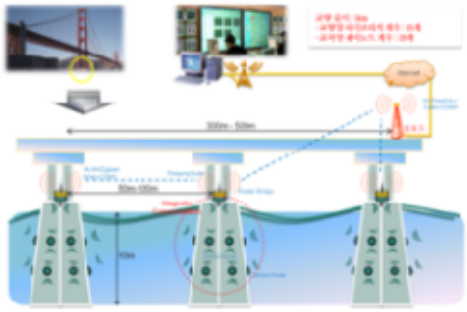

Figure 4 Building & Bridge Management

Figure 5 Pollution Monitoring

4. Network Elements

4.1. General

MFAN's main elements are divided into the time element and the physical element. The time element refers to the superframe consisting of a request period, a response period, and an inactive period, and the physical factor refers to the network consisting of MFAN-C and MFAN-N. The most basic element in the physical element is the node. Node types has MFAN-C to maanage the network and the network element MFAN-N to communicate with MFAN-C.

Figure 6 shows the structure of superframe(time element) and **Figure 7** shows the structure of network (physical element). The node that needs to be decided first in MFAN is MFAN-C, and MFAN's superframe begins with MFAN-C transmitting a request packet in the request period. MFAN-C takes the role of managing the association, disassociation, and release of MFAN-N's, and the sending or receiving scheduling within the communication area. Since MFAN can use one channel within the communication area, only one network exists. The rest of the nodes in MFAN excluding MFAN-C become MFAN-N. There is a 1:1 connection between MFAN-C and MFAN-N, and though the nodes participating in MFAN are divided into MFAN-C and MFAN-N according to their roles, all nodes can take the role of either MFAN-C or MFAN-N.

4.2. Time element

The time element that can be used in MFAN is the time slot of the Time Division Multiple Access method. MFAN-C manages the MFAN-N group that transmits data in the response period, and the time slot is independently managed by the MFAN-N's in the chosen MFAN group.

MFAN's superframe structure, as shown in **Figure 6**, consists of a request period, a response period, and an inactive period, and the request period and response period's lengths are variable. The superframe begins with MFAN-C transmitting a RRQ packet in the request period. The RRQ packet has information about MFAN-N's that can transmit response packets between response periods, and these MFAN-N's transmit the response packets between response periods by using the information in the RRQ packet.

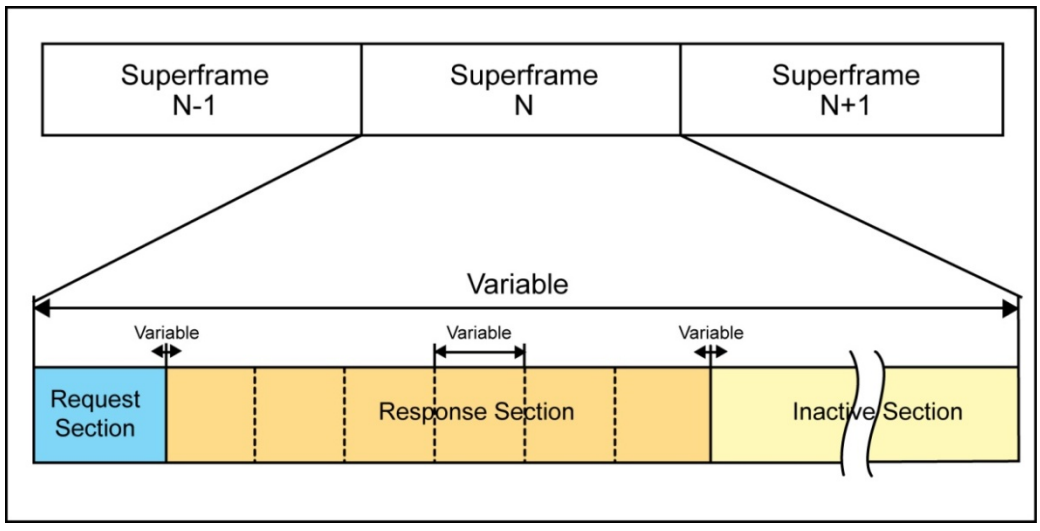

Figure 6 MFAN superframe structure

4.2.1. Request period

The request period transmits the RRQ frame that has the information about MFAN-N's in order for MFAN-C to send the response frame between response periods.

4.2.2. Response period

In the response period, MFAN-N can transmit response frames according to MFAN-C's RRQ, and may be divided into several time slots according to the number of MFAN-N's in MFAN. Each time slot length is variable according to the response frame length and acknowledgement frame length. The slot number is determined according to the order of the divided time slot, and the MFAN-N that is to be sent from each time slot is assigned by MFAN-C. MFAN-C assigns a response period to a particular group for the use of the response period, and the nodes in the assigned group independently transmit the data frame through the response period.

4.2.3. Inactive period

The inactive period begins when there is no node transmitting the response packet for a certain period of time, and here, nodes can transmit data even without MFAN-C's request. This period is maintained until MFAN-C transmits a response packet.

4.3. Physical element

The physical element forming MFAN is a node that includes MFAN-C from the MFAN-C-centered STAR topology network, and MFAN-N. MFAN is a network that can transmit data with each of the MFAN-N's centered on MFAN-C, and its basic element is the node. The node is divided into MFAN-C and MFAN-N according to its role. MFAN-C manages the whole MFAN and there must be only one MFAN-C per one network. MFAN-C, by broadcasting the RRQ packet to all MFAN-N's at once, controls MFAN-N. MFAN-N must transmit and receive response packets according to MFAN-C's control. MFAN can be formed as shown in Figure 6.

4.3.1. MFAN-C

MFAN-C is a node that manages MFAN; only one MFAN-C exists per one network, and it manages and controls MFAN-N using the RRQ packet.

4.3.2. MFAN-N

MFAN-N is a node that forms MFAN (excluding MFAN-C), and a maximum of 65,519 MFAN-N's can exist per one network. It transmits response packets according to the request packet transmitted by MFAN-C.

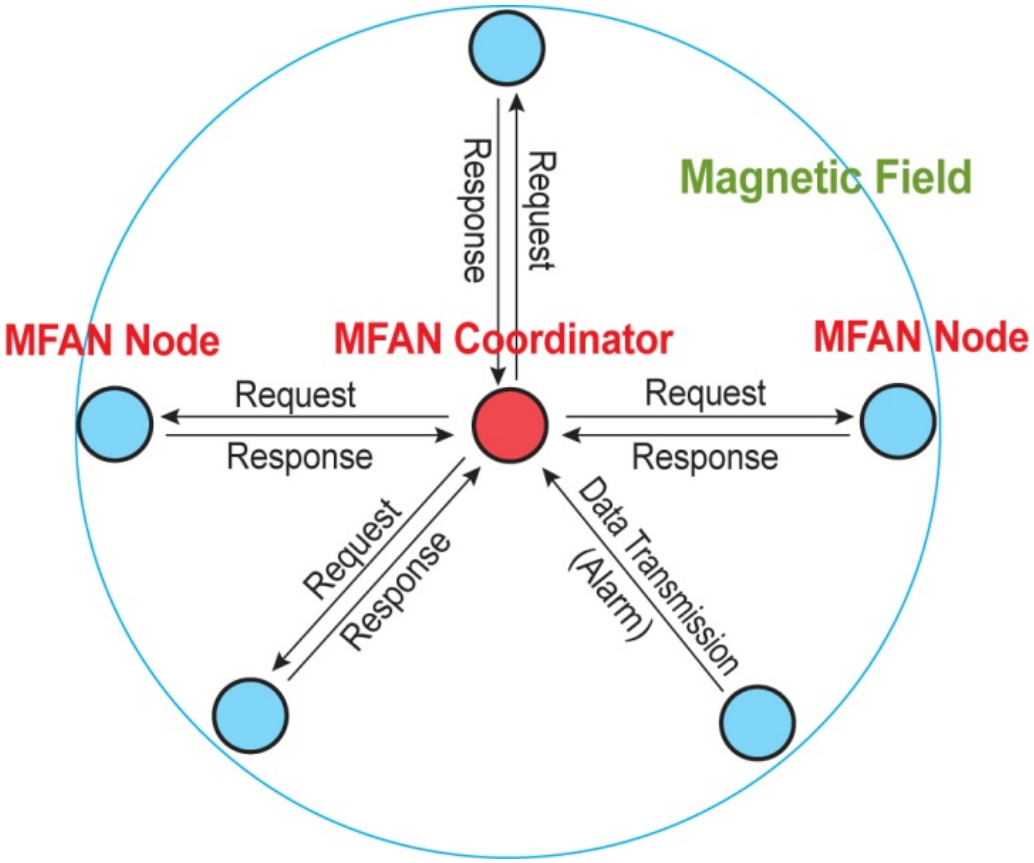

Figure 7 MFAN

4.4. Address element

In order to identify between each MFAN-N, MFAN uses the MFAN ID, UID, group address, node address, and other address systems.

4.4.1. MFAN ID

MFAN ID is a unique ID that identifies each MFAN from the others; the value is not duplicitous in other MFANs, and the value is maintained as long as MFAN continues to exist.

4.4.2. UID

UID is a unique identifier consisting of 64 bits; it consists of group address, IC producer code, and IC manufacturer's serial number. MFAN-N is identified by UID.

To be added

4.4.3. Group address

Group address is the identifier for the classified MFAN-N groups; as it can make data transmission requests by group unit during packet transmission, it is used in collision avoidance method.

To be added

4.4.4. Node addresses

Node address is an identifier used instead of UID to identify between each node, and is a 16 bit address assigned by MFAN-C.

To be added

5. Network Activation Introduction

5.1. General

MFAN's superframe is divided into a request period, a response period, and an inactive period, and MFAN's elements MFAN-C and MFAN-N operate in each period as follows.

5.2. Request packet transmission within the request period

In the request period, MFAN-C broadcasts a RRQ packet to all nodes. Based on this, the MFAN-N's that have received the RRQ packet decide whether to transmit response packets to the response period. MFAN-C can determine the MFAN-N group to transmit to the response period.

5.3. Response packet transmission within the response period

The MFAN-N chosen by MFAN-C can transmit response packet in the response period. When MFAN-N transmits the response packet through the response period, MFAN-C that has received the response packet transmits the RA packet. MFAN-N that has not received the RA packet continously transmits response packets every hour until it receives a RA packet from MFAN-C.

5.4. Data packet transmission in the inactive period

MFAN-N becomes an inactive period if it does not transmit any response packets for a certain period of time, and this period is maintained until MFAN-C transmits a response packet. As an exception, MFAN-N can transmit data without MFAN-C's request in an inactive period.

6. Network Status

6.1. General

In MFAN, MFAN-N acquires the active states of network formation, network association, response transmission, data transmission, master change, network disassociation, and network release.

6.2. Network formation

MFAN-C forms a network by transmitting a request packet to MFAN-N in the request period. MFAN ID is included in the request packet so that MFAN-N can identify the connecting network. Minimum network period means when only MFAN-C exists, and it consists of only the request period and the inactive period.

6.3. Network association

When MFAN-C sends an ARQ packet through the request period, MFAN-N judges the received packet and if it is the desired MFAN ARQ packet, transmits an ARS packet through the response period. MFAN-C, having received the ARS packet, transmits the ARA packet to MFAN-N. The network association of MFAN-N is completed upon receiving the ARA packet from MFAN-C.

6.4. Network disassociation

MFAN-N, associated with MFAN, can be disassociated either by MFAN-C's request or autonomously. MFAN-C can send a DARQ to MFAN-N according to the current network status or service type for a forced disassociation. In the case of spontaneous disassociation, MFAN-C can know the disassociation status of MFAN-N by the response's result of MFAN-C's ASRQ.

6.5. Data transfer

When MFAN-C sends a DRRQ packet through the request period from MFAN, MFAN-N requests MFAN-N, DRS packets to MFAN-C according to the type of requested data. Upon receiving the DRS packet, MFAN-C sends a DA packet, and MFAN-N, having received the DA packet, completes the data transmission.

6.6. Network release

MFAN release can be divided into normal release through MFAN-N's request, and abnormal release due to a sudden situation. Normal release refers to MFAN-C cancelling the network by deciding the release status and distributing the request to all MFAN-N's. Abnormal network release refers to when all participating MFAN-N's shut off as one or when MFAN-N goes outside MFAN's communication region simultaneously for network release.

6.7. MFAN device status

MFAN device status includes the MFAN-C status and the MFAN-N status. When the power switches on, MFAN-C passes from waiting in the inactive period into either the request period or the response period according to the packet response status. MFAN-N remains turned off until receiving the packet and turns on as it receives the packet. When the data transmission and reception are complete in one superframe, it turns off and returns to the reception waiting mode.

6.7.1. MFAN-C status

To be defined

6.7.2. MFAN-N status

To be defined

7. Physical Layer Requirement

7.1. Physical layer packet format

7.1.1. General

This chapter defines the physical layer packet format. Each physical layer packet consists of a preamble, a header, and a payload. The sending and receiving of packet begins at LSB.

7.1.2. Preamble field

To be defined

7.1.3. Header field

To be defined

7.1.4. Payload field

To be defined

7.1.5. FCS field

To be defined

7.2. Coding and modulation

7.2.1. Coding

To be defined

7.2.2. Modulation

To be defined

7.2.3. Coding and modulation process

To be defined

8. Frame Format of MAC Layer

8.1. General

MFAN's MAC frame format consists of a frame header and a frame body. The frame header is information for data exchange among MFAN-N's, and the frame body is the actual data exchanged among MFAN devices.

8.2. Frame format

All frame format of MAC consists of a frame header and a frame body as shown in **Figure 8**.

1) Frame header: Frame control information for data exchange among MFAN-N's, including source/destination address, frame sequence number and other control-related information. Frame type and the nodes that exchange the frame are differentiated using the information located in this part. Also, errors can be detected in the exchanged frame using this information to increase the frame's reliability.
2) Frame body: Consists of the payload that contains the actual data exchanged among the MFAN devices, and the FCS to check for error within the payload.

Unit: Byte

1	2	2	2	1	Variable	2
MFAN ID	Frame control	Source address	Destination address	Sequence number	Payload	Frame check sequence
Frame header					Frame body	

Figure 8 Frame format of medium access control

8.3. Frame type

The frame type is defined as a total of 4 types including a request frame, a response frame, a data frame, and an acknowledgement frame.

To be added

8.3.1. Request frame

The request frame is used when MFAN-C sends a request packet in the request period to a particular MFAN-N in MFAN, or broadcasts information to all MFAN-N's.

To be added

8.3.2. Response frame

The response frame is used when sending MFAN-N's response packet from the response period about MFAN-C's request. The appropriate MFAN-N sends the response packet between response periods within a specified number of times until it receives a acknowledgement packet.

To be added

8.3.3. Data frame

The data frame is used when MFAN-N transmits data to MFAN-C in the inactive period without MFAN-C's request.

To be added

8.3.4. Acknowledgement frame

The acknowledgement frame types include a RA frame and a DA frame. In the RA frame, when MFAN-C has transmitted a request frame, MFAN-N receives the request packet and transmits a response packet, and MFAN-C receives the response packet and transmits the RA packet. The RA data about the received response packet is recorded in the acknowledgement frame's payload. MFAN-C, having received the appropriate response frame, answers the transmitting MFAN-N by sending a RA frame after a short frame interval in the response period. DA frame is the acknowledgement frame about the received data packet. MFAN-C answers the MFAN-N that has transmitted the data packet by sending a DA frame after a short frame interval in the inactive period.

To be added

8.4. Payload format

The payload format is created differently according to the frame type including the request frame, response frame, data frame, acknowledgement frame, etc.

To be added

8.4.1. Request frame

To be defined

8.4.2. Response frame

To be defined

8.4.3. Data frame

To be defined

8.4.4. Acknowledgement frame

To be defined

9. MAC Layer Function

9.1. General

In MFAN's MAC layer, association, disassociation, and ASC process, etc are used to manage the MFAN network. Data transmission types include transmission from the response period and transmission from the inactive period. Also, the group address initialization function is provided for the management of MFAN-N groups.

9.2. Network association and disassociation

In order for MFAN-N to communicate with MFAN-C, it first needs to association with MFAN. As a given, each MFAN-N looks for a pre-formed MFAN; when it finds one, it associates with it, and when it does not find any becomes MFAN-C itself and creates a new MFAN. (Forming a new MFAN means transmitting a request packet periodically.) It does not, however, form the MFAN according to the function of the node itself but continues to remain as MFAN-N, or become an MFAN-C itself to form a new MFAN regardless of the existing MFAN's formation status. In this case, if there exists an MFAN that has been formed already, network formation is cancelled as there is only one frequency channel.

9.2.1. Association

When MFAN-C in the request period sends an ARQ packet to an MFAN-N that is not yet associated to MFAN, MFAN-N transmits a ARS packet to MFAN-C through the response period. MFAN-C decides the association

status of the appropriate MFAN-N to MFAN and tells the result through an ARA packet. When the association has been allowed, the assigned node address is included in the ARA packet, and when it has been rejected, the original node address 0xFFFE is recorded. When MFAN-C has not received an ARS packet or if MFAN-N cannot receive the ARA packet due to the ARA packet's data error, it sends an ARS packet continuously every hour until it receives the ARA packet. Association is complete when MFAN-N receives the ARA packet from MFAN-C.

9.2.2. Disassociation

When MFAN-C in the request period sends a DARS packet to an MFAN-N associated to MFAN, MFAN-N transmits a DARS packet to MFAN-C through the response period. MFAN-C decides the appropriate MFAN-N's disassociation status from MFAN and tells the result through a DARA packet. When the disassociation has been allowed, the node address on the DARA packet is recorded as the original node address 0xFFFE, and when the disassociation has been rejected the existing node address is recorded. When MFAN-C could not receive the DARS packet or has received it but if an MFAN-N trying to separate cannot receive the DARA packet due to the DARA packet's data error, it retransmits the DARS packet continuously every hour until it receives the DARA packet. Disassociation is complete when MFAN-N receives the DARA packet from MFAN-C.

9.2.3. Association status confirmation

When MFAN-C in the request period sends an ASRS request packet to an MFAN-N associated to MFAN, MFAN-N transmits the ASRS packet to MFAN-C through the response period. MFAN-C checks and transmits an ASRA packet about the appropriate MFAN-N's association status to MFAN. When MFAN-C has not received an ASRS packet, or when an MFAN-N trying to send an ASRS packet cannot receive the ASRA packet due to the ASRA packet's data error, it transmits the ASRS packet continuously every hour until it receives the ASRA packet. The ASRS is complete when MFAN-N receives the ASRA packet from MFAN-C.

9.3. Data transmission

Periods that can transmit data from MFAN are the response period and the inactive period. Data can be transmitted through MFAN-C's request in the response period, and data can be transmitted without MFAN-C's request in the inactive period.

9.3.1. Transmission in the response period

When MFAN-C in the request period sends DRRQ packet to an MFAN-N associated to MFAN, MFAN-N transmits DRS packet through the response period. MFAN-C receives the appropriate MFAN-N's data and transmits a DA packet. When MFAN-C could not received the DRS packet or if an MFAN-N trying to send a DRS packet cannot receive the acknowledgement packet due to the DA packet's data error, it transmits the DRS packet continuously every hour until it receives the DA packet. Data transmission is complete when MFAN-N receives the DA packet from MFAN-C.

9.3.2. Transmission in the inactive period

MFAN-N becomes an inactive period when it does not transmit response packets for a certain period of time, and this period is maintained until MFAN-C transmits the request packet. As an exception, MFAN-N can transmit data without MFAN-C's request during inactive period. When a system interruption occurs, it is possible for MFAN-N to transmit data without a request from MFAN-C. When MFAN-C cannot receive the data from MFAN-N, it retransmits data until it receives it. When MFAN-N's data reception is complete, MFAN-C sends the DA packet to MFAN-N and data transmission is complete when MFAN-N receives the DA packet.

9.4. Group address initialization

When MFAN-C in the request period sends a group address initialization RRQ packet to MFAN-N associated to MFAN, MFAN-N sends the group initialization response packet through the response period. MFAN-C checks the group address initialization status of the appropriate MFAN-N then transmits a GAIRA packet.

10. Air Interface

10.1. Frequency

To be defined

10.2. Signal waveform

To be defined