

**Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)**

**Submission Title:** Application Requirements about Fault Management in Manufacturing System

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**Source:** Tatsuji Munaka, Mitsubishi Electric Corporation

**Address** 5-1-1 Ofuna, Kamakura, Kanagawa, Japan

**Voice:** +81-467-41-2122, **FAX:** +81-467-41-2185, **E-Mail:**

Munaka.Tatsuji@ct.MitsubishiElectric.co.jp

**Re:** Application Requirements about Fault Management in Manufacturing System

**Abstract:** Application Requirements about fault detection, diagnosis and recovery

**Purpose:** Amendments to IEEE802.15.4e MAC

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## Objectives and backgrounds

- In the manufacturing system, it is indispensable to provide high reliability and RAS functions to end users.
- When a fault occurs, it firstly detects the fault, diagnoses the detected nodes or links in the system, and executes a recovery according to the pre-defined system service.
- Even though the system goes back to normal status, the system integrator has a responsibility to explain the cause of system fault and its proposal for relapse prevention.

# Motivation

- In general, fault detection and localization is handled by applications or network management system.
- However, current fault detection mechanisms are not sufficient to apply the wireless system to manufacturing systems.
- In this TG, we want to discuss which functions should be supported in MAC layer.

# Fault Management

- Fault detection
  - Localization of faults in a system
- Fault diagnosis
  - Diagnosis of the faults in the failure elements (nodes/sink/network) in a system
- Fault recovery
  - Removes the faults in a system and goes into degenerated mode
- Fault analysis
  - Reproduces of the faults and detect the cause of the faults

# Fault detection and diagnosis

- **Fault detection**
  - Localization
    - Sink, nodes or networks
    - Fault area which consists of some fault nodes
    - Source-cause of fault in a fault node
- **Fault diagnosis**
  - Fault level
    - Being able to know the fault level of node
    - Could be distinguished “active” and “non-active”.
  - Explicit and implicit
    - Explicit model
      - Sinks send a keep-alive packet to fault nodes
      - Fault nodes execute self-check procedure, and send the result to sinks
    - Implicit model
      - Neighbors of the fault nodes notify the link level logs to sinks instead of the fault node.

# Fault recovery and analysis

- **Fault recovery**
  - Data recovery
    - Out of scope (application matter)
  - Node recovery
    - Detach and attach of nodes
      - Nodes can join the system any time
      - Latency should be kept even if some nodes join the system
  
- **Fault analysis (offline support)**
  - Reproduce of the fault
    - To detect the fault, reproducibility is indispensable for the highly reliable system
    - Which functions should be supported in MAC layer?
  - Logs
    - Be able to accumulate error logs in sinks
      - Nodes do not have a resource accumulating logs
    - What data should be kept in the MAC and sent up to the upper layer?

# Types of errors

- **Types of errors**
  - Quality of data
    - Data corruption (ex., CRC errors)
    - Time out
  - Quantity of data
    - Amount of data
- **Localization**
  - Node peculiar fault
  - Network fault
    - A peculiar link between a node and a sink
    - Peculiar links between nodes and a sink
    - All links in a sink
- **Cause of errors**
  - Node's H/W or S/W failure
  - Electric wave trouble , etc.,

# Restrictions in manufacturing system

- Overhead
  - Additional command exchanges for fault detection may not be added into the system because it declines the performance
- Resources
  - There are many types of nodes in a system. Their resource constraint such as CPU, memory and other resources are varied