

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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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
 - Cause of fault that causes a system failure
- **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
 - System recovery

- **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