
**Road vehicles — Open interface for
embedded automotive applications —**

**Part 5:
OSEK/VDX Network Management (NM)**

*Véhicules routiers — Interface ouverte pour applications automobiles
embarquées —*
(Partie 5: Gestion du réseau OSEK/VDX (NM))

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17356-5 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 17356 consists of the following parts, under the general title *Road vehicles — Open interface for embedded automotive applications*:

— Part 1: *General structure and terms, definitions and abbreviated terms*

— Part 2: *OSEK/VDX specifications for binding OS, COM and NM*

— Part 3: *OSEK/VDX Operating System (OS)*

— Part 4: *OSEK/VDX Communication (COM)*

— Part 5: *OSEK/VDX Network Management (NM)*

— Part 6: *OSEK/VDX Implementation Language (OIL)*

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0 Introduction

0.1 General

There is an increasing tendency for electronic control units (ECUs) made by different manufacturers to be networked within vehicles by serial data communication links.

Therefore, standardization of basic and non-competitive infrastructure in ECUs aims at avoiding the design of unnecessary variants and saving development time.

In the scope of OSEK/VDX cooperation, the Network Management system (NM) provides standardized features which ensure the functionality of inter-networking by standardized interfaces.

The essential task of NM is to ensure the safety and the reliability of a communication network for ECUs.

In a vehicle, a networked ECU is expected to provide certain features:

- each node accessible for authorized entities;
- maximum tolerance with regard to temporary failures; and
- support of network-related diagnostic features.

At a basic configuration stage, NM implementations complying with OSEK specifications are implemented in all networked nodes. This implies a solution for NM which can be implemented throughout the broad range of available hardware offered in today's ECUs.

Therefore, the status of the network is recorded and evaluated uniformly at all ECUs at intervals. Thus, each node features a determined behaviour as regards the network and the application concerned.

NM offers two alternative mechanisms for network monitoring:

- indirect monitoring by monitored application messages; and
- direct monitoring by dedicated NM communication using token principle.

However, the use of these mechanisms is up to the system responsible. Processing of information collected by these mechanisms is in accordance with requirements as regards to the entire networked system.

0.2 System status

In view of the application, NM comprises two standardized interfaces:

- Software: Application program <-> NM
- Network behaviour: Station <-> Communication medium

The resulting entire system is open. Thus, it can adapt to new requirements within the restrictions defined by the system design.

0.3 Remarks by the authors

This part of ISO 17356 describes the concept and the API of a Network Management, which can be used for ECUs in vehicles. It is not a product description which relates to a specific implementation.

General conventions, explanations of terms and abbreviations have been compiled in ISO 17356-1.

0.4 Summary

In order to achieve the essential task of a network monitoring, i.e. ensure safety and reliability of a communication network for ECUs, NM describes node-related (local) and network-related (global) management methods. The global NM component is optional. However, it requires a minimum local component to be operational.

Therefore, the following services are provided:

- initialization of ECU resources, e.g. network interface;
- start-up of network;
- providing network configuration;
- management of different mechanisms for node monitoring;
- detecting, processing and signalling of operating states for network and node;
- reading and setting of network- and node-specific parameters;
- coordination of global operation modes (e.g. network wide sleep mode); and
- support of diagnosis.

There are two main parts within the document: *Direct Network Management* described in Clause 2 and *Indirect Network Management* described in Clause 3. Both clauses describe the concepts, algorithms and behaviour.

Subclause 2.1, *Concept*, describes the fundamental aspects of the configuration management, the operating states and operating state management.

Subclause 3.3, *Algorithms and behaviour*, describes the protocol used for communication between nodes.

Clause 4 describes the *API (Application Programming Interface)* comprising the pure specification of the services offered for both direct and indirect NM. Input and output data, the functional description, particularities, etc. are described for each service. Furthermore, *System generation* services are described within this clause.

Clause 5 describes the impacts on the infrastructure of ISO 17356 and gives a brief description of all requirements for COM, OS and the data link layer for both direct and indirect NM.

Road vehicles — Open interface for embedded automotive applications —

Part 5: OSEK/VDX Network Management (NM)

1 Scope

1.1 Embedding of the Network Management (NM)

NM defines a set of services for node monitoring. Figure 1 shows how the NM is embedded into a system and that the NM shall be adapted to specific requirements of the bus system used or to the resources of the nodes.

NM consists of the following:

- interface to interact with the Application Programming Interface (API);
- algorithm for node monitoring;
- internal interfaces (NM <-> COM, etc.);
- algorithm for transition into sleep mode; and
- NM protocol data unit (NMPDU).

1.2 Adaptation to bus protocol specific requirements

Adaptation to bus protocol specific requirements consists of the following:

- CAN, VAN, J1850, K-BUS, D2B, etc.;
- error handling, e.g. bus-off handling in a CAN, transmission line error handling; and
- interpretation of the status information, e.g. overrun or error active/passive in a CAN.

1.3 Adaptation to node resources

Adaptation to node resources consists of the following:

- scaling of the NM as a requirement of the node; and
- application-specific usage of the NM services.

1.4 Adaptation to hardware-specific requirements

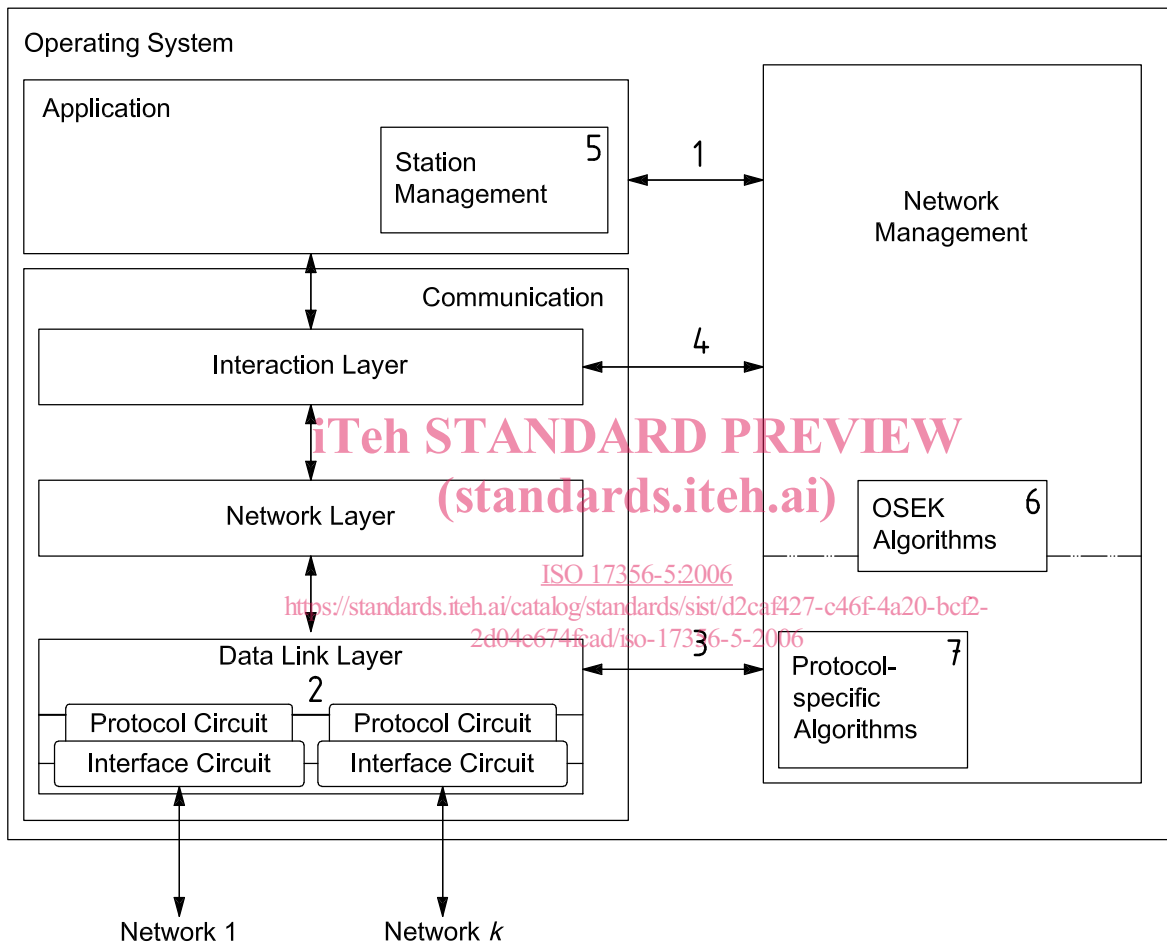
This consists of adaptation to a protocol circuit and a physical layer circuit, e.g. switching the bus hardware to one of the possible physically power save modes.

1.5 Station management (system-specific algorithms)

There are a variety of additional tasks involved in coordinating a network. These are not described in ISO 17356, since they are system-dependent. Hence, these tasks are done by the application, e.g. by a module called station management.

1.6 Philosophy of node monitoring

Node monitoring is used to inform the application about the nodes on the network. Thus, the application can check with the appropriate service if all stations required for operation are present on the network.



Key

- 1 API
- 2 several buses connected to one μ Controller
- 3 interface to DLL, COM-specific, protocol-specific
- 4 interface to COM Interaction Layer
- 5 station management (outside the scope of ISO 17356)
- 6 algorithms
- 7 protocol-specific management algorithms

Figure 1 — Responsibility of interface and algorithms

2 Direct Network Management

2.1 Concept

2.1.1 Node monitoring

2.1.1.1 General

NM supports the direct node monitoring by dedicated NM communication. A node is a logical whole to which a communication access is possible. A microprocessor with two communication modules connected to two different communication media (e.g. low speed CAN and a high-speed CAN) represents two nodes from the NM point of view.

The rate of the NM communication is controlled across the network (minimization of bus load and consumption of resources) and the messages are synchronized (avoiding negative effects on application data by message bursts).

Every node is actively monitored by every other node in the network. For this purpose, the monitored node sends an NM message according to a dedicated and uniform algorithm.

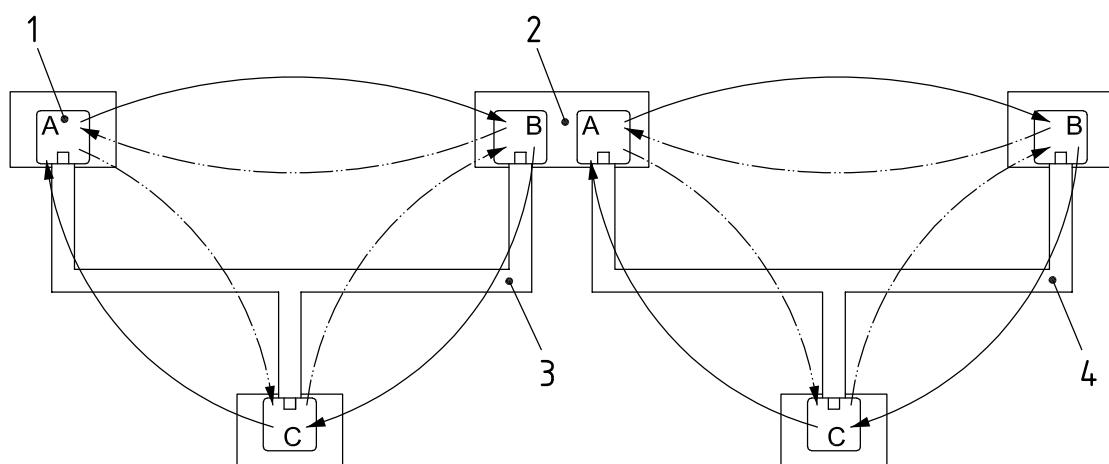
Direct node monitoring requires a network-wide synchronization of NM messages. For this purpose, a logical ring is used.

2.1.1.2 Logical ring

2.1.1.2.1 General

In a logical ring, the communication sequence is defined independently from the network structure. Therefore, each node is assigned a logical successor. The logically first node is the successor of the logically last node in the ring.

Thus, the decentralized control of the overall amount of NM messages is ensured and the bus load due to these messages is determined. The communication sequence of the logical ring synchronizes NM communication. Any node shall be able to send NM messages to all other nodes and receive messages from them.



Key

- 1 node
- 2 Electronic Communication Unit (ECU)
- 3 communication media 1
- 4 communication media 2

Figure 2 — Infrastructure of the NM (logical ring), example with two buses

2.1.1.2.2 Principle

The direct NM transmits and receives two types of messages to build the logical ring. An alive message introduces a new transmitter to the logical ring. A ring message is responsible for the synchronized running of the logical ring. It will be passed from one node to another (successor) node.

- Receive alive message: Interpretation as transmitter-related registration to the logical ring.
- Receive ring message: Interpretation as transmitter-specific alive signal and synchronization to initiate transmission of own NM message according to the logical ring algorithm.
- Time-out on ring message: Interpretation as transmitter-specific breakdown.

2.1.1.2.3 State of a node

A monitoring node is able to distinguish two states of a monitored node:

- node present → specific NM message received (alive or ring);
- node absent → specific NM message not received during time-out.

A monitoring node is able to distinguish two states of itself:

- present or not mute → specific NM message transmitted (alive or ring);
- absent or mute → specific NM message not transmitted during time-out.

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2.1.2 Addressing

2.1.2.1 Status

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The status of nodes and of the network shall be acquired and evaluated uniformly at intervals. For this purpose, all nodes shall communicate via their NM.

The NM communication is independent of the underlying bus protocol. Each node can communicate unidirectionally and address-related with any other node of the network. Therefore, individual and group addressing of nodes is required.

2.1.2.2 Node addressing

2.1.2.2.1 General

Address-related communication takes into account receiver and emitter. Each node has a unique identification which is known in the network.

Each address-related communication message contains certain data, the emitter identification and the receiver identification. NM does not specify the encoding of these components into selected bus protocols.

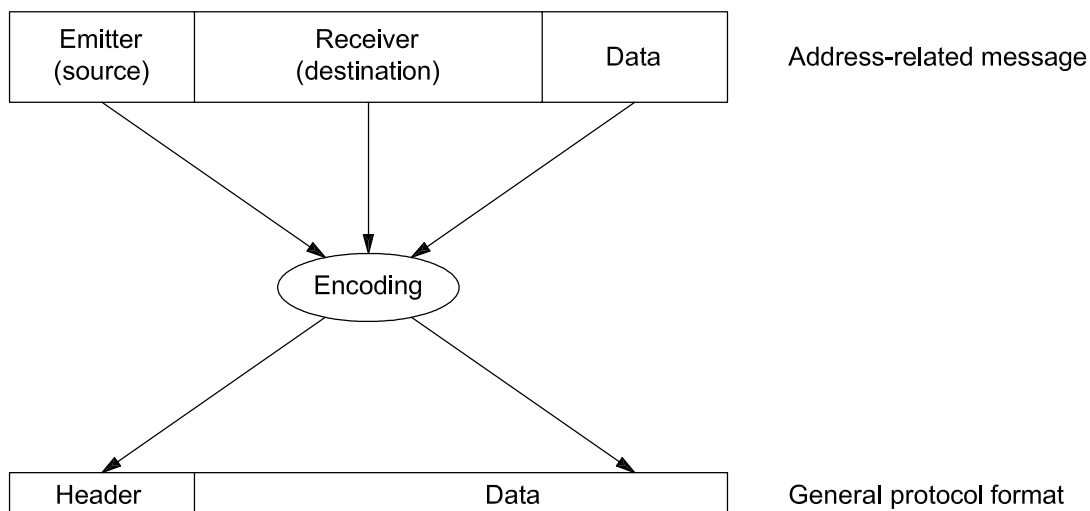


Figure 3 — Exemplary representation of encoding of an NM communication message onto a general protocol format

Individual addressing is implemented by node addressing using 1:1 connections. Group addressing is implemented by node addressing using 1:k connections ($k < \text{number of nodes in the network}$). For this purpose, groups of receivers join group addresses.

2.1.2.2.2 Features of node addressing

These include the following:

- Each node is assigned a unique identification known within the whole network.
- Emitter and receiver identifications are explicitly included in the message.
- 1:k connections are implemented using group addresses.
- All messages are broadcast.
- Integrating a new node in an existing network does not require notification of the existing nodes.

2.1.3 NM infrastructure for data exchange

The NM supports the transfer of application data via its infrastructure (the logical ring). During the time delay between the reception and the transmission of the ring message, the application is able to modify the data.

It is possible for the application to specify and implement management algorithms which are not provided by NM.

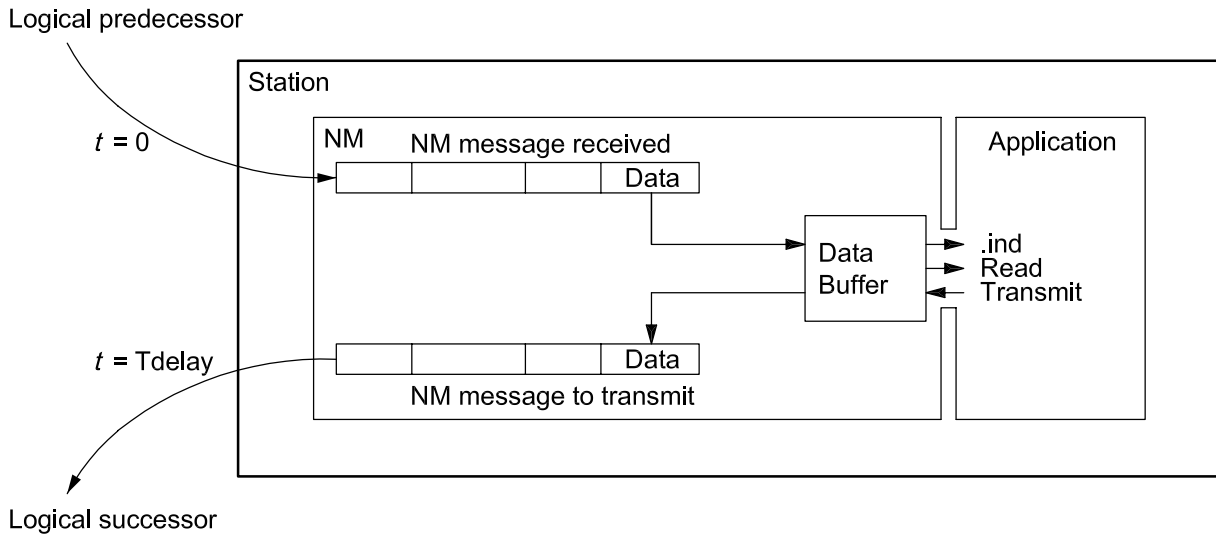


Figure 4 — Mechanism to transfer application data via the logical ring

2.1.4 Standard functionality

Initializations are performed with any system start (“cold start”), e.g. timer services required from the operating system or communication hardware via the data link layer interface.

Before the system is switched off, or switches off automatically, NM can be “shut down”, so that it can restore, e.g. to the previously known network history when the system is started up again.

The NM handles individual parameters, e.g. time-outs and node identifications and, if necessary, version numbers to identify hardware and software versions.

2.1.5 Configuration management

2.1.5.1 Network configurations

In the absence of any faults, the networked nodes are activated at different times, e.g.

- stations on terminal 30 (permanent power): Wake-up via external event;
- stations on terminal 15 (ignition): Switch ON via ignition key;
- stations with switch in supply line: switching ON and OFF at random, by driver.

However, the actual configuration is also altered by faulty nodes and by defects in the communication network. Consequently, different actual configurations can result for the individual nodes in the course of time, which are additionally subject to external influences, e.g. actions by the driver.

As a rule, each node wants to start its application as quickly as possible. In view of NM, this means that an actual configuration is made available to the applications as soon as possible. Finally, it is up to the application to decide whether to start communication immediately after it has become operable, or whether to wait until a minimum configuration is detected by NM.

NM distinguishes between:

- actual configuration: set of nodes to which access is possible; and
- limp home configuration: set of nodes which due to failure cannot participate in the logical ring.

Therefore, NM provides the following services:

- supply of the actual configuration;
- comparison of a configuration with a target configuration;
- indication of changed configuration.

2.1.5.2 Detection of a node in fault condition

2.1.5.2.1 Operability of a node

A node is considered operable, in terms of NM, if the node participates in the logical ring.

2.1.5.2.2 Detection of failures

Only a node which is expected to be operable on the network can be recognized as having failed. The application recognizes node failures by comparison to the previous knowledge regarding the target configuration. There are several possible ways by which the application can acquire this knowledge:

- the last stable state of the actual configuration;
- one or several programmed target configuration(s);
- the target/actual configuration determined by NM since system startup.

The NM recognizes its own node as having failed if it cannot send via the bus or if it cannot receive any messages from the bus, i.e. it is no longer operable.

Another node is considered as having failed if its NM message is not received or a NM message is received signalling an error state.

2.1.5.2.3 Reaction to a node failure

The NM of a node detecting a failure cannot distinguish whether the failed node is no longer able to communicate due to a line fault or due to a complete failure, without additional support. Any possible reactions, e.g. changeover to redundant physical paths, shall be specified together with entire system requirements.

2.1.5.3 Internal Network Management States

NM is specified in a hierarchical way. NM can enter the internal states listed below:

- NMOff: NM is shut off;
- NMON: NM is switched on;
- NMShutDown: Selective shutoff of NM entity.

NMON:

- NMInit: NM initialization;
- NMAwake: Active state of the NM;
- NMBusSleep: NM in sleep mode;
- NMActive: NM communication enabled;
- NMPassive: NM communication disabled.

NMAwake:

- NMReset: The operability of the own node determined;
- NMNormal: Processing of direct node monitoring;
- NMLimpHome: Handling of failure in own node.

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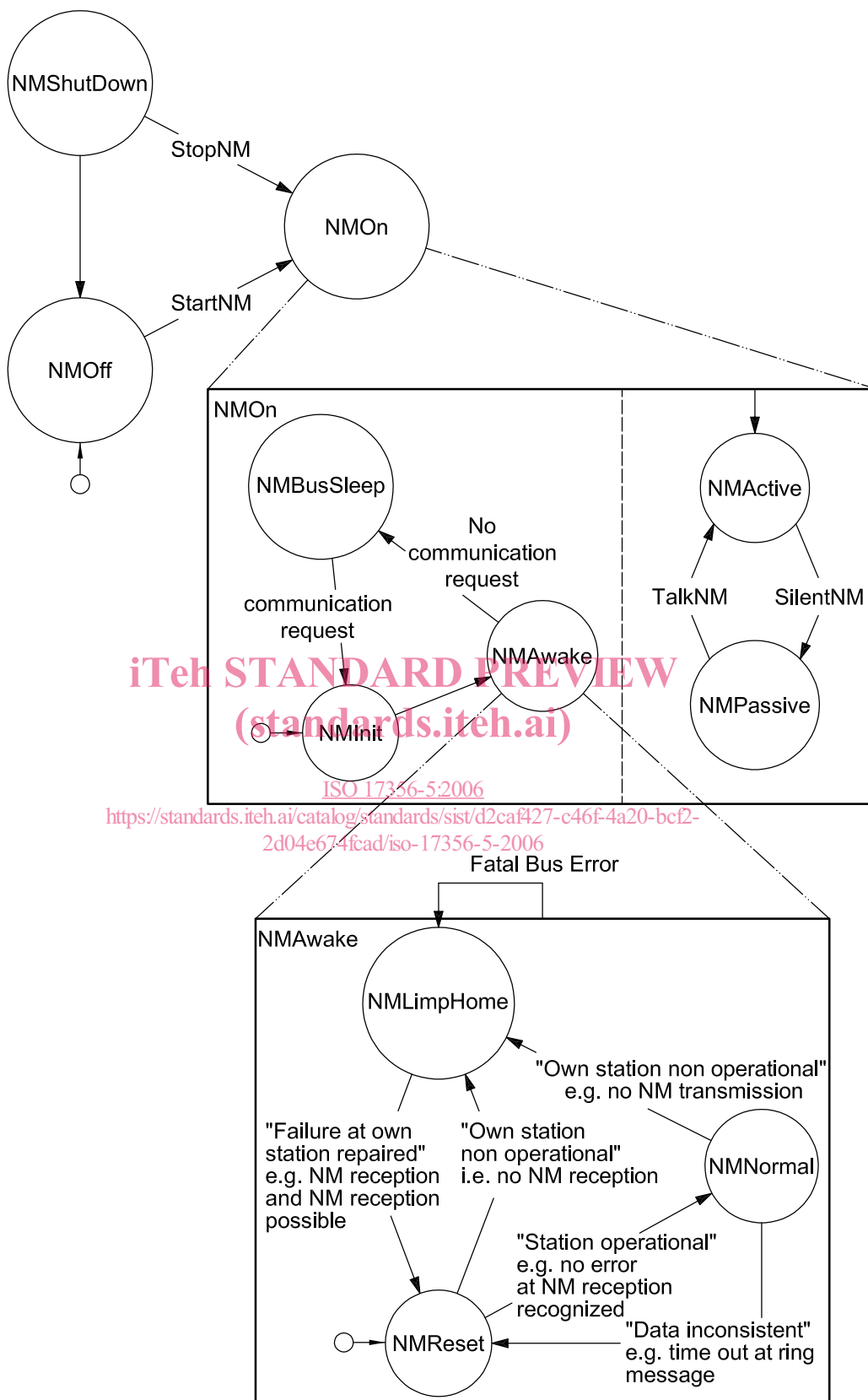


Figure 5 — Simplified state transition diagram of the direct NM