| Document Title | Specification of the AUTOSAR Network Management Protocol |
|---|---|
| **Document Category** | Protocol specification (PRS) |
| **Document UID** | 928 |
| **Document Status** | published |
| **Part of AUTOSAR Standard** | Foundation |
| **Part of Standard Release** | R26-11 |

| Document Change History | | | |
|---|---|---|---|
| **Date** | **Release** | **Changed by** | **Description** |
| 2026-11-26 | R26-11 | AUTOSAR Release Management | • Harmonized naming of PNC Request Bit Vector<br>• Moved use cases from discontinued RS NetworkManagement into this document |
| 2025-11-27 | R25-11 | AUTOSAR Release Management | • Added support for multiple network requests |
| 2024-11-27 | R24-11 | AUTOSAR Release Management | • No content changes |
| 2023-11-23 | R23-11 | AUTOSAR Release Management | • Updates for AP and CP NetworkManagement harmonization<br>• Reintroduced Use Cases chapter |
| 2022-11-24 | R22-11 | AUTOSAR Release Management | • Added definitions for network states<br>• Added definitions and clarifications for Partial Networking NM protocol |
| 2021-11-25 | R21-11 | AUTOSAR Release Management | • Updates for the rework of PNC related ComM and NM handling<br>• Updates for AP and CP NetworkManagement harmonization |
| 2020-11-30 | R20-11 | AUTOSAR Release Management | • Moved Use Cases chapter to FO RS NetworkManagement<br>• Added Partial Network Learning (PNL) bit in CBV<br>• Added PN Shutdown Request Bit (PNSR) bit in CBV |

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|---|---|---|---|
| 2019-11-28 | R19-11 | AUTOSAR Release Management | • Updated default positions for CBV and NID<br>• Changed Document Status from Final to published |
| 2019-03-29 | 1.5.1 | AUTOSAR Release Management | • No content changes |
| 2018-10-31 | 1.5.0 | AUTOSAR Release Management | • Initial release |

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# 1 Introduction and overview

This protocol specification specifies the format, message sequences and semantics of the AUTOSAR Network Management (NM) protocol.

NM is intended to work together with an underlying communication stack, independent of the physical layer of the communication system used.

The AUTOSAR Network Management is a hardware independent protocol (for limitations refer to chapter 1.2.2).

The following figure shows how the NM interfaces with an upper (see 1.3.3) and a lower (bus) layer.

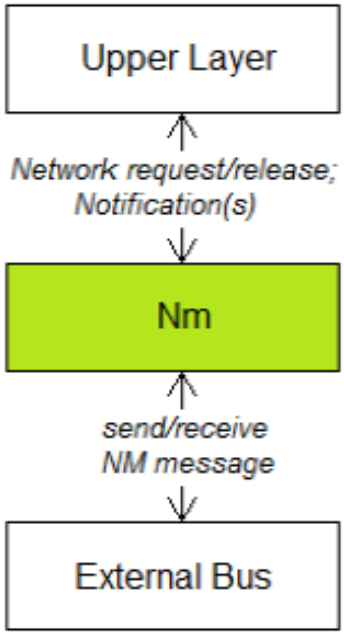



**Figure 1.1: NM interfaces**

## 1.1 Protocol purpose and objectives

Main purpose of the NM protocol is to coordinate one or more groups of ECUs to wake up and shutdown their communication stack synchronously.

The NM algorithm is based on periodic NM messages, which are received by all nodes in a NM cluster. Reception of NM messages indicates that sending nodes want to keep NM cluster awake. If any node does not need communication any more, it stops sending NM messages, but if NM messages from other nodes are received, it postpones transition to sleep mode. Finally, if a dedicated timer elapses because no NM messages are received anymore, every node initiates transition to the sleep mode, the NM node initiate the shutdown of the corresponding network.

If any node in the NM cluster requires bus-communication, it can keep the NM cluster awake by transmitting NM messages.

## 1.2 Applicability of the protocol

### 1.2.1 Constraints and assumptions

There may exist NM nodes in the network which follow the protocol without ever actively sending NM messages (called NM passive nodes).

### 1.2.2 Limitations

1. One NM instance is associated with only one NM cluster in one network. One NM cluster can have only one instance of Nm in one node.
2. The maximum size of the NM message is limited by the used communication bus.
3. The NM Coordinator is only used in the AUTOSAR Classic Platform. Details can be found in [1].

## 1.3 Dependencies

### 1.3.1 Dependencies to other protocol layers

NM algorithm uses services of the underlying communication stack modules to send and receive NM messages.

### 1.3.2 Dependencies to other standards and norms

N/A

### 1.3.3 Dependencies to the Application Layer

Upper layer (e.g. application) uses NM services to request or release a network i.e. to activate or deactivate sending of NM messages.

In addition, the upper layer/module may use the possibility to get informed about changes of the NM operational modes.

# 2 Use Cases

This chapter describes the use cases which can be realized by an environment of an ECU which implements the Network Management Protocol.

| ID | Name | Description |
|---|---|---|
| 0001 | Synchronous Shutdown | If there is no communication need in a Nm cluster, the Nm protocol ensures that all Nm nodes synchronously enter sleep mode. |
| 0002 | Sub-networks Synchronous Shutdown | Support the coordinated shutdown of multiple sub-networks. This can be considered as an extension of the synchronous shutdown use case with the objective of synchronously shutting down multiple Nm clusters. |
| 0003 | Keep Nm Cluster Awake | If at least one Nm node in a Nm cluster needs communication, the Nm protocol ensures that all required Nm nodes remain awake. |
| 0004 | Partial Network | Support of partial network by defining communication/function domains to allow for turning off network communication across multiple ECUs in case their provided functions are not required under certain conditions. Other ECUs can continue to communicate on the same bus channels. Additionally use Nm messages to communicate the request/release information of a partial network cluster between the participating ECUs. |
| 0005 | Passive Mode | Nm node configured as Passive node is not able to initiate a start-up of a Nm cluster, however is able to be woken up if any other node initiates a start-up. This eliminates unnecessary communication and reduces bus and buffer overhead. Allowing shutdown to be controlled by a subset of the cluster's nodes enables the possibility that only fault tolerant nodes control shutdown. |
| 0006 | Partial Network Gateway | Since partial networks span over multiple buses, the network management protocol defines how the partial network information shall be gateway-ed between these buses, i.e. it shall be possible to forward request/release information to sub-networks thereby allowing gateway ECUs to act "on-behalf" of the original partial network requestor ECU. |
| 0007 | FlexRay Nm | Support the specific characteristics of the FlexRay bus and its HW Nm vector support. The network management protocol shall support alternatives for the FlexRay bus where the Network Management Vector of the FlexRay protocol specification can be used. |

**Table 2.1: Use Cases of Network Management**

# 3 Protocol Requirements

## 3.1 Requirements Traceability

| Requirement | Description | Satisfied by |
|---|---|---|
| No upstream requirements specified. | | |

**Table 3.1: Requirements Tracing**

# 4 Definition of terms and acronyms

## 4.1 Acronyms and abbreviations

The glossary below includes acronyms and abbreviations relevant to the Network Management specification that are not included in the [2, AUTOSAR glossary].

| Abbreviation / Acronym | Description |
|---|---|
| CBV | Control Bit Vector |
| FR | FlexRay |
| NM | Network Management |
| PN | Partial Network |
| PNC | Partial Network Cluster |
| PNI | Partial Network Information |
| PNL | Partial Network Learning |

**Table 4.1: Acronyms and abbreviations**

## 4.2 Definition of terms

| Term | Description |
|---|---|
| Network Mode | In this state the network is requested or active. |
| Prepare Bus-Sleep Mode | In this state the network is released or inactive. |
| Bus-Sleep Mode | In this state the network is released or inactive. In this state no NM message is sent |
| FlexRay communication cycle | Part of FlexRay communication schedule consisting of time slots (static or dynamic). Each FlexRay message is assigned to a specific time slot in one communication cycle. |
| NM cluster | Set of NM nodes coordinated with the use of the NM algorithm. |
| NM Message | Refers to the payload transmitted on the bus. It contains the User Data as well as the Control Bit Vector and may contain the Source Node Identifier. |
| Normal Operation | In this state the node is sending periodic NM messages in order to keep a NM cluster awake |
| Repeat Message State | This state ensures that transition, through a repetitive transmission of NM messages, to normal operation is visible for other nodes on the bus |
| Repeat Message Request | Request (received internally or externally via an NM message) to transition back to the Repeat Message State |
| NM Node | A ECU (electornic controll unit) which is connected to one or more NM clusters |
| NM instance | A NM instance represents the current status of one NM cluster inside one NM node |
| External Request | Communication request via received NM message |
| Internal Request | Communication request via a NM node internal (request by application / uppler layer) |
| Passive wakeup | A wakeup triggered by an external request |
| Active wakeup | A wakeup triggered by an internal request |
| PNC Request Bit Vector | Represent the Partial Network information in a NM frame |
| PNC Request Bit Vector Length | Represent the length of a Partial Network information in bytes |

| Term | Description |
|---|---|
| PNC bit | One bit with represent a particular Partial Network in the Partial Network Bit Vector Length |
| Top-level PNC coordinator | An ECU acts as top-level PNC coordinator for those PNCs which are actively coordinated on all assigned channels. This ECU has the PNC gateway functionality enabled. The top-level PNC coordinator triggers for those PNCs a synchronized PNC shutdown, if no other ECU in the network requests them and if the synchronized PNC shutdown is enabled. Note: For different PNCs it is possible to have different top-level PNC coordinators. |
| Intermediate PNC coordinator | An ECU acts as intermediate PNC coordinator for those PNCs which are passively coordinated on at least one channel. This ECU has the PNC gateway functionality enabled. The intermediate PNC coordinator forwards a synchronized PNC shutdown to active coordinated channels for PNCs which are passively coordinated, if the synchronized PNC shutdown is enabled. |
| PNC leaf node | A PNC leaf node is an ECU that act neither as top-level PNC coordinator nor as an intermediate PNC coordinator. It act as an ECU without a PNC gateway in the network and process PN shutdown message as usual NM messages. |
| PN shutdown message | A top-level PNC coordinator transmits the PN shutdown messages to indicate a synchronized PNC shutdown across the PN topology. A PN shutdown message is an NM message where the PNSR bit (resides in the control bit vector) and all PNC bits (reside in the PNC Request Bit Vector) which are indicated for a synchronized shutdown set to '1'.<br>An intermediate PNC coordinator which receives a PN shutdown message forwards the PNC Request Bit Vector as a PN shutdown message on the affected channels.<br><br>Note: An intermediate PNC coordinator has to forward the PNC Request Bit Vector of a received PN shutdown message as fast as possible to ensure a synchronized shutdown of the affected PNCs across the PN topology at nearly the same point in time. |
| PNC Gateway | A PNC Gateway is used to span (logical) partial network clusters across bus/communication channel boundaries, "gatewaying" PNC requests from one bus/network to the others. Therefore, a PNC gateway needs to be connected to multiple physical communication channels. The PNC gateway collects PNC requests from all of its multiple so-called "active" coordinated channels.<br>The PNC gateway sends the aggregated PNC state in the network to all its active channels, which causes all nodes to have the same view on the global PNC request state as the gateway. If the PNC gateway is not the topmost PNC gateway in the network hierarchy, the PNC gateway will also send the aggregated PNC request state of all subordinate nodes, plus its own internal request state, to its superior PNC coordinator, which is connected via the so-called "passive" coordinated channel. |
| Active coordinated channel | A PNC gateway has communication channels which must be coordinated regarding the PNC requests. A PNC gateway collects PNC requests from all of its active coordinated channels, aggregates them and forwards it to all channels (independent if active or passive coordinated). Active coordinated channels are actively kept awake by this PNC gateway. |

| Term | Description |
|---|---|
| Passive coordinated channel | A PNC gateway has communication channels which must be coordinated regarding the PNC requests. A PNC gateway collects PNC requests from all of its passive coordinated channels, aggregates them and forwards it to all active coordinated channels. Passive coordinated channels are remotely kept awake by another PNC gateway, which is connected to the same channel and actively coordinates this channel. |

**Table 4.2: Definition of terms**

# 5 Protocol specification

## 5.1 NM message format

**[PRS_Nm_00501] Contents of an Nm Message**

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⌈An Nm Message shall consist of the following elements:

- Control Bit Vector (CBV) of 1 Byte (optional)
- Source Node ID (SNI) of 1 Byte (optional)
- User Data of n Bytes (optional, may include PNInfo of n Bytes)

⌋

Note: There is an additional option to have a "Car Wakeup" bit.

**[PRS_Nm_00502] Format of an Nm Message**

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⌈User Data and/or PNInfo shall be located after CBV/SNI⌋

Note: UserData and PNInfo may overlap.

The following table shows an example layout of an NM message:

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| **Byte 0** | Control Bit Vector (default) | | | | | | | |
| **Byte 1** | Source Node Identifier (default) | | | | | | | |
| **Byte 2** | User data 0 | | | | | | | |
| **Byte 3** | User data 1 | | | | | | | |
| **Byte 4** | PNInfo byte 0 | | | | | | | |
| **Byte 5** | PNInfo byte 1 | | | | | | | |
| **Byte 6** | PNInfo byte 2 | | | | | | | |
| **Byte 7** | PNInfo byte 3 | | | | | | | |

**Table 5.1: NM message layout example**

**[PRS_Nm_00505]** ⌈The length of an NM message shall not exceed the MTU of the underlying physical transport layer.
⌋

**[PRS_Nm_00077]** ⌈The length (in bytes) of the NM message shall be configured by [NmMessageLength].⌋

### 5.1.1 Source Node Identifier

**[PRS_Nm_00074]** ⌈The location of the source node identifier shall be configurable to position Byte 0 or Byte 1 or Off (default: Byte 1). For FlexRay the source node identifier shall only be configurable to position Byte 1 or Off (default: Byte 1).⌋

**[PRS_Nm_00013]** ⌈The source node identifier shall be available (set to a configurable value) unless the location of the source node identifier is set to Off.⌋

### 5.1.2 Control Bit Vector

**[PRS_Nm_00075]** ⌈The location of the Control Bit Vector shall be configurable to position Byte 0 or Byte 1 or Off (default: Byte 0). For FlexRay the Control Bit Vector shall be non-configurable and always be set to position Byte 0.⌋

**[PRS_Nm_00045]** ⌈The Control Bit Vector shall consist of:

- Bit 0: Repeat Message Request

  0: Repeat Message State not requested

  1: Repeat Message State requested
- Bit 1: PN Shutdown Request Bit (PNSR)

  0: NM message does not contain synchronized Partial Network shutdown request

  1: NM message does contain synchronized Partial Network shutdown request for at least one PNC
- Bit 3: NM Coordinator Sleep Ready Bit

  0: Start of synchronized shutdown is not requested by main coordinator

  1: Start of synchronized shutdown is requested by main coordinator
- Bit 4: Active Wakeup Bit

  0: Node has not woken up the network (passive wakeup)

  1: Node has woken up the network (active wakeup)
- Bit 5: Partial Network Learning Bit (PNL)

  0: PNC learning is not requested

  1: PNC learning is requested
- Bit 6: Partial Network Information Bit (PNI)

  0: NM message contains no Partial Network request information

1: NM message contains Partial Network request information

- Bits 2,7 are reserved for future extensions

  0: Disabled/Reserved for future usage

⌋

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| **Byte 0/1** | Reserved | Partial Network Information | Partial Network Learning | Active Wakeup | NM Coordinator Sleep Ready | Reserved | PN Shutdown Request Bit | Repeat Message Request |

**Table 5.2: CBV layout**

Note: For FlexRay bit 7 is used as the Vote bit in certain schedule variants.
Note: Bit 1 and 2 were used in R3.2 as NM Coordinator ID (Low Bit)

### 5.1.3 User Data

User Data is considered all data not being part of CBV and NID.

**[PRS_Nm_00158]** ⌈It shall be possible to enable or disable the support of NM user data (NM user data is optional).⌋

Note: In AP UserData is configured with config parameter "nmUserDataLength".
Note: The length of the UserData in CP can be calculated from the `NmMessageLength` minus the amount of used NM system bytes and `PNInfo` bytes.

## 5.2 Partial Networking

**[PRS_Nm_00405]** ⌈It shall be possible to enable or disable the PN support (PN feature is optional).⌋

**[PRS_Nm_00406]** ⌈It shall be possible to enable or disable the handling of synchronized PNC shutdown (handling is optional). If handling is enabled, then also PN support shall be enabled.⌋

**[PRS_Nm_00335]** ⌈If PN Support is enabled, the layout of the `PNC Request Bit Vector` within the NM message shall be pre-configured with `PnInfoOffset` and `PnInfoLength` (in bytes).⌋

Note:
Every bit (PNC bit) of the `PNC Request Bit Vector Length` represents one Partial Network. The following interpretation has to be considered:

- PNI bit ="'1"' and PNSR = "'0"': If the PNC bit is set to 1 the Partial Network is requested. If the bit is set to 0 there is no request for this PN.
- PNI bit ="'1"' and PNSR = "'1"' (received by a top-level PNC coordinator): ignore the PNSR bit and handle the message as a usual NM message. A top-level PNC coordinator should never receive a PN shutdown request. This is an error case, where an intermediate PNC coordinator or PNC leaf node sets the PNSR bit within the Nm message by accident.
- PNI bit ="'1"' and PNSR = "'1"' (received by an intermediate PNC coordinator): All the Partial Network were the corresponding PNC bits in the `PNC Request Bit Vector` are set to 1 are indicated to be released. The remaining Partial Network (the corresponding PNC bits are set to 0) are not affected.
- PNI bit ="'1"' and PNSR = "'1"' (received by a PNC leaf node): same as if PNI bit ="'1"' and PNSR = "'0"'.

Note: Each bit (PNC bit) of the `PNC Request Bit Vector` represent a particular PNC. The byteIndex and bitIndex within the `PNC Request Bit Vector` of a PNC bit can be determined as follows: byteIndex = (PncId div 8); bitIndex = (PncId mod 8).

**[PRS_Nm_00338]** ⌈If the PN Support is enabled, and if a message containing a PNC bit set to 1 is received, and the ECU is interested in this PNC, that PNC shall be considered "externally requested".⌋

**[PRS_Nm_00407]** ⌈If the PN Support is enabled, and if a message containing a PNC bit set to 0 is received, and the ECU is interested in this PNC, that PNC shall be considered "externally released".⌋

**[PRS_Nm_00339]** ⌈If the PN Support is enabled, and if one or more applications are requesting a PNC, and the ECU is interested in this PNC, this PNC shall be considered "internally requested".⌋

**[PRS_Nm_00408]** ⌈If the PN Support is enabled, and if no application of an ECU is requesting a PNC anymore, then this PNC shall be considered as "internally released".⌋

### 5.2.1 Handling of Rx NM messages

**[PRS_Nm_00328]** ⌈If PN support is disabled, then its NM shall ignore any partial networking information contained in the received message.⌋

**[PRS_Nm_00329]** ⌈If the PN support is enabled, and the PNI bit in the received NM message is 0, the node's NM shall ignore the partial networking information bytes of the message.⌋

**[PRS_Nm_00331]** ⌈If the PN support is enabled, the PNI bit is set to 1 and the PNSR bit is set to 0 in the received NM message, NM shall process the Partial Networking Information of the NM message.⌋

**[PRS_Nm_00409]** ⌈If synchronized PNC shutdown is enabled, a NM message is received in the role of a top-level PNC/intermediate PNC coordinator on an active coordinated channel and PNI bit and PNSR bit are set to 1, then NM shall ignore the PNSR bit and handle the message as a usual NM message.⌋

Note: A PN shutdown message (PNI bit = 1 and PNSR bit = 1) should never be received by a top-level/intermediate PNC coordinator on an active coordinated channel, because only a top-level PNC coordinator of a dedicated PNC could initiate a PN shutdown message. This is an error case where an intermediate PNC coordinator transmits a PN shutdown message by accident on an active coordinated channel. A receiving top-level/intermediate PNC coordinator should handle this message as a usual NM message.

**[PRS_Nm_00410]** ⌈If the PN synchronized shutdown error reaction is enabled and the received NM message is discarded due to [PRS_Nm_00409], then the top-level PNC coordinator shall immediately transmit an NM message with all "'internally requested"' and "'externally requested"' PNCs as Partial Network Information.⌋

**[PRS_Nm_00411]** ⌈If synchronized PNC shutdown is enabled, an NM message is received in the role of an intermediate PNC coordinator on a passive coordinated channel and PNI bit and PNSR bit are set to 1, then NM shall release the indicated PNCs (PNC bits which are set to 1 within the `PNC Request Bit Vector`), reset the PN reset timer and forward the received NM message with PNI bit and PNSR bit set to 1 and the according PNCs set to 1 to all subordinated ECUs.⌋

Note:

- An intermediate PNC coordinator has to forward the received NM message to all remaining communication channels.
- Subordinated ECUs could be either further intermediate PNC coordinators and/or PNC leaf nodes.
- A PNC leaf node has no special handling upon reception of a PN shutdown message. It just handles the received NM message as specified in [PRS_Nm_00331].

**[PRS_Nm_00340]** ⌈If the PN support is enabled, and if one PNC is not requested again (relevant PNC bit is not set to 1 again) within [`PnResetTime`] this PN shall be considered as "not requested".⌋

Note: `PnResetTime` is configured to a value greater than `NmMsgCycleTime`.

### 5.2.2 Handling of Tx NM messages

**[PRS_Nm_00332]** ⌈If the PN support is enabled, its NM shall set the value of the transmitted PNI bit in the CBV to 1.⌋

**[PRS_Nm_00333]** ⌈If the PN support is disabled, its NM shall set the value of the transmitted PNI bit in the CBV to 0.⌋

**[PRS_Nm_00341]** ⌈If the PN support is enabled, for PNCs that are "internally requested" the corresponding bit in the `PNC Request Bit Vector` shall be set to 1 before sending the NM message.⌋

Constraint: The usage of the CBV is mandatory in case Partial Networking is used. This must be ensured by configuration in the respective platform.

**[PRS_Nm_00412]** ⌈If the PN support is enabled, for PNCs that are "'internally requested"' or "'externally requested"' the corresponding bit in the `PNC Request Bit Vector` shall be set to 1 before sending the NM message in the role of a top-level PNC coordinator or an intermediate PNC coordinator.⌋

**[PRS_Nm_00413]** ⌈If synchronized PNC shutdown is enabled and NM detect an transition of PNCs from "'requested"' to "'released"' (independent if externally or internally requested), the corresponding bit of those released PNCs shall be set to 1, the remaining shall be set 0 and the PNSR bit in CBV shall be set to 1 before sending the PN shutdown message.⌋

## 5.3 Timing behavior

### 5.3.1 Transition to Bus-Sleep Mode

When a NM node does not need the communication on a bus, it will not immediately shut down i.e. switch to Bus-Sleep Mode. Instead, it will first change to the so called Ready Sleep state. This state ensures that any NM node in the NM cluster waits to transition to the Bus-Sleep Mode as long as any other node keeps the NM cluster awake.

**[PRS_Nm_00103]** ⌈If bus communication is released, the NM algorithm shall perform transition to the Bus-Sleep Mode after a configurable amount of Ready Sleep Time has expired and no new communication request occurs in between and no NM Message has been received.⌋

Note: The Ready Sleep Time depends on the used network, refer to 5.4.

## 5.4 Networks specifics

### 5.4.1 CAN and Ethernet

On the transition path from Network to Bus-Sleep Mode, CAN NM and UDP NM introduce Prepare Bus Sleep Mode. The purpose of this state is to ensure that all nodes have time to stop their network activity before the Bus Sleep state is entered.

**[PRS_Nm_00506]**

*Status:* DRAFT

⌈If `NmStayInPbsEnabled` is disabled and bus communication in a NM cluster is released, and there are no Network Management PDUs on the bus for a configurable amount of time determined by NM Timeout Time (`NmTimeOutTime`) + Wait Bus-Sleep Time (`NmWaitBusSleepTime`) transition into the BusSleep Mode shall be performed.⌋

**[PRS_Nm_00115]** ⌈If `NmStayInPbsEnabled` is disabled the NM shall stay in the Prepare Bus-Sleep Mode for an amount of time determined by the Wait Bus-Sleep Time. After this time has expired, the Prepare Bus-Sleep Mode shall be left, and the Bus-Sleep Mode shall be entered.⌋

Note: Thus the Ready Sleep Time is extended by Wait Bus-Sleep Time (`NmWaitBusSleepTime`). The Ready Sleep Time on CAN and Ethernet starts when bus communication is released and it ends NM Timeout Time (`NmTimeOutTime`) after last NM messages was transmitted or received on the bus.

**[PRS_Nm_00504]**

*Status:* DRAFT

⌈When in Prepare Bus-Sleep Mode, and an NM message is received, or the NM is requested for communication, than NM shall enter Network Mode.⌋

**[PRS_Nm_00507] Handling multiple network requests**

*Status:* DRAFT

⌈If in Ready Sleep State, Normal Operation State or Repeat Message State and (`NmPnHandleMultipleNetworkRequests`) is set to true and the requested state of the channel/VLAN or an associated PNC changes, Repeat Message State shall be (re)entered.⌋

The following requirements concerns early shutdown. It does only apply to CAN and Ethernet, since on FlexRay always all messages have to be considered (FlexRay cannot shutdown earlier nodes):

**[PRS_Nm_00503]**

*Status:* DRAFT

⌈It shall be possible to enable or disable All Nm Messages Keep Awake functionality.⌋

**[PRS_Nm_00337]** ⌈If PN support is enabled, and All Nm Messages Keep Awake functionality is disabled, the NM algorithm shall only process messages if they contain at least one bit set to 1 in the PNC Request Bit Vector, that corresponds to a PNC which is relevant for the ECU.⌋

#### 5.4.1.1 Sending NM message

If communication on the bus is needed i.e. requested, NM messages are sent out. If no communication is needed i.e. released, sending of NM messages is stopped.

**[PRS_Nm_00237]** ⌈NM messages shall be sent periodically in states "Repeat Message" and "Normal Operation" using configured NM Message Cycle Time (NmMsgCycleTime).⌋

**[PRS_Nm_00005]** ⌈If the "Repeat Message" state is not entered beacuse of network request OR NM transmissions is zero (see NmImmediateNmTransmissions) the transmission of NM messages shall be delayed by NM Cycle Offset (see NmMsgCycleOffset) after entering the "Repeat Message" state.⌋

**[PRS_Nm_00334]** ⌈When the "Repeat Message" state is entered because of network request or repeat message request and configured number of immediate NM transmissions is greater than zero (see NmImmediateNmTransmissions), these immediate NM messages shall be transmitted using Immediate NM Cycle Time (see NmImmediateNmCycleTime). NM Cycle Offset (see NmMsgCycleOffset) shall not be applied in this case.⌋

### 5.4.2 FlexRay

In addition to NM message containing data (see Figure 5.1), the FlexRay NM specifies so-called NM-Vote messages.

In fact, the FlexRay NM algorithm is based on periodic NM-Vote messages received by all nodes in the cluster. Reception of a NM-Vote message indicates that the sending node wants to keep the NM cluster awake.

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| **Byte 0** | Vote | Set to "0" | | | | | | |

**Table 5.3: NM-Vote message layout**

**[PRS_Nm_00116]** ⌈The NM-Vote message format shall contain a Voting Bit (Vote) with the following meaning:

- 0 - vote against keeping awake
- 1 - vote for keeping awake

⌋

**[PRS_Nm_00117]** ⌈The FlexRay NM shall be able to separately transmit NM-Data and NM-Vote, or to combine them within one NM message (in either static or dynamic slot). Transmission format shall be configurable (Schedule Variant).⌋

When the NM-Vote and NM-Data are combined (by Bit OR-ing) within one NM message, the content of the NM-Vote will be combined with the content of the Control Bit Vector Byte.

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|
| **Byte 0** | Vote | Partial Network Information | Partial Network Learning | Active Wakeup | NM Coordinator Sleep Ready | Reserved | Reserved | Repeat Message Request |

**Table 5.4: Combined NM-Vote and CBV**

Each ECU, which participates in the FlexRay NM, is synchronized to a global time based on periodic repetition of the FlexRay communication cycle. To assure synchronous behaviour of all ECUs in a NM cluster, the FlexRay NM aligns the state changes to a NM Repetition Cycle, which is aligned to a FlexRay communication cycle.

Every transition is bound to repetition cycles (refer to configuration parameter NmRepetitionCycle). Therefore the Ready Sleep Time is defined as the time that starts when a new repetition cycle starts after bus communication has been released and ends `NmReadySleepCnt`+1 repetition cycles without any NM-Vote.

**[PRS_Nm_00118]** ⌈The FlexRay NM shall specify the following cycle configuration parameters:

- Voting Cycle - number of cycles needed to transmit NM-Vote of every node at least once
- Data Cycle - number of cycles needed to transmit the NM-Data of every node at least once
- Repetition Cycle - number of repetitions of Voting Cycle

⌋

Note: Further details can be found in the AUTOSAR SWS FlexRay specifications.

## 5.5 Sequences

### 5.5.1 Communication request

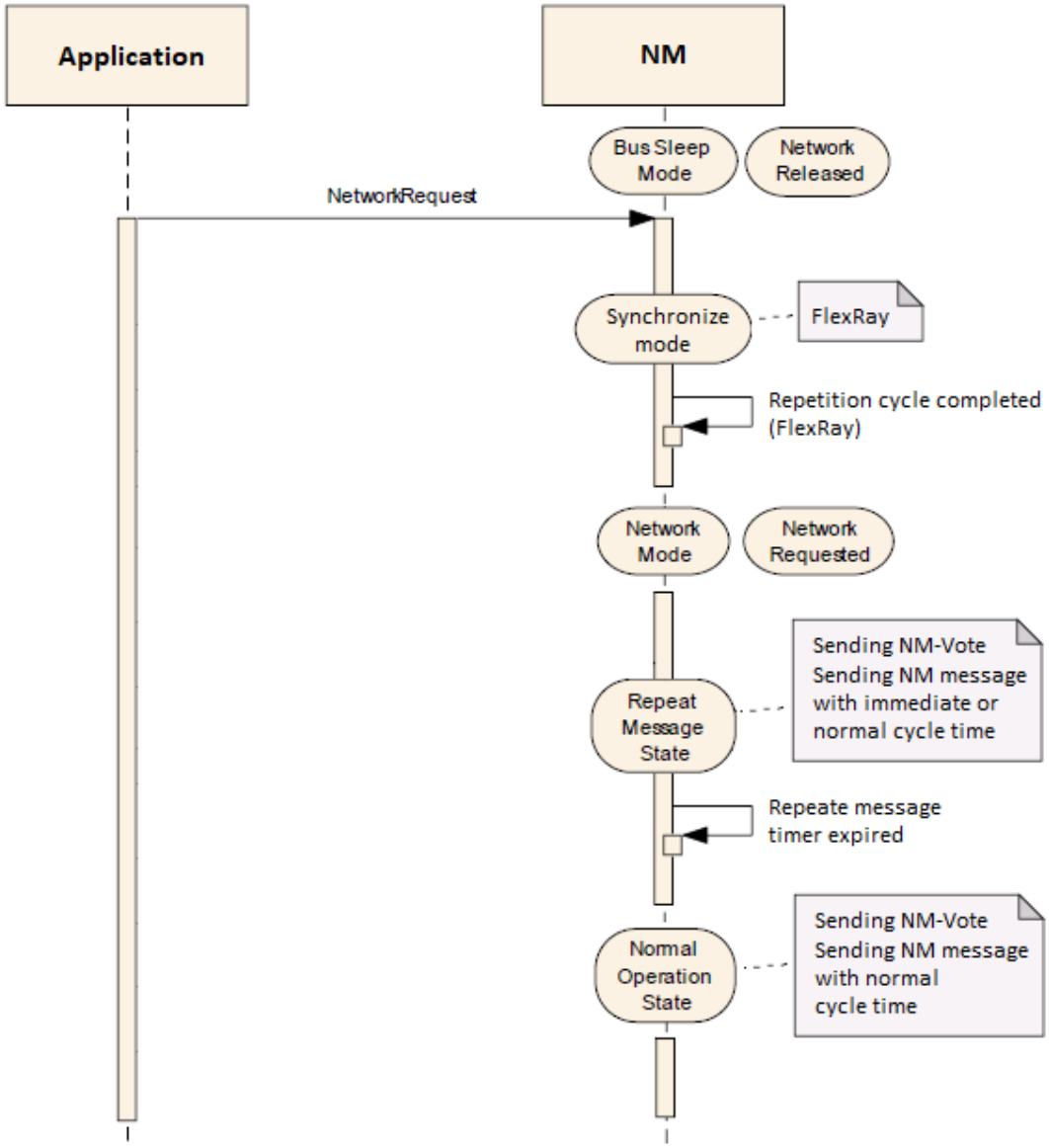



**Figure 5.1: Communication request**

### 5.5.2 Communication release

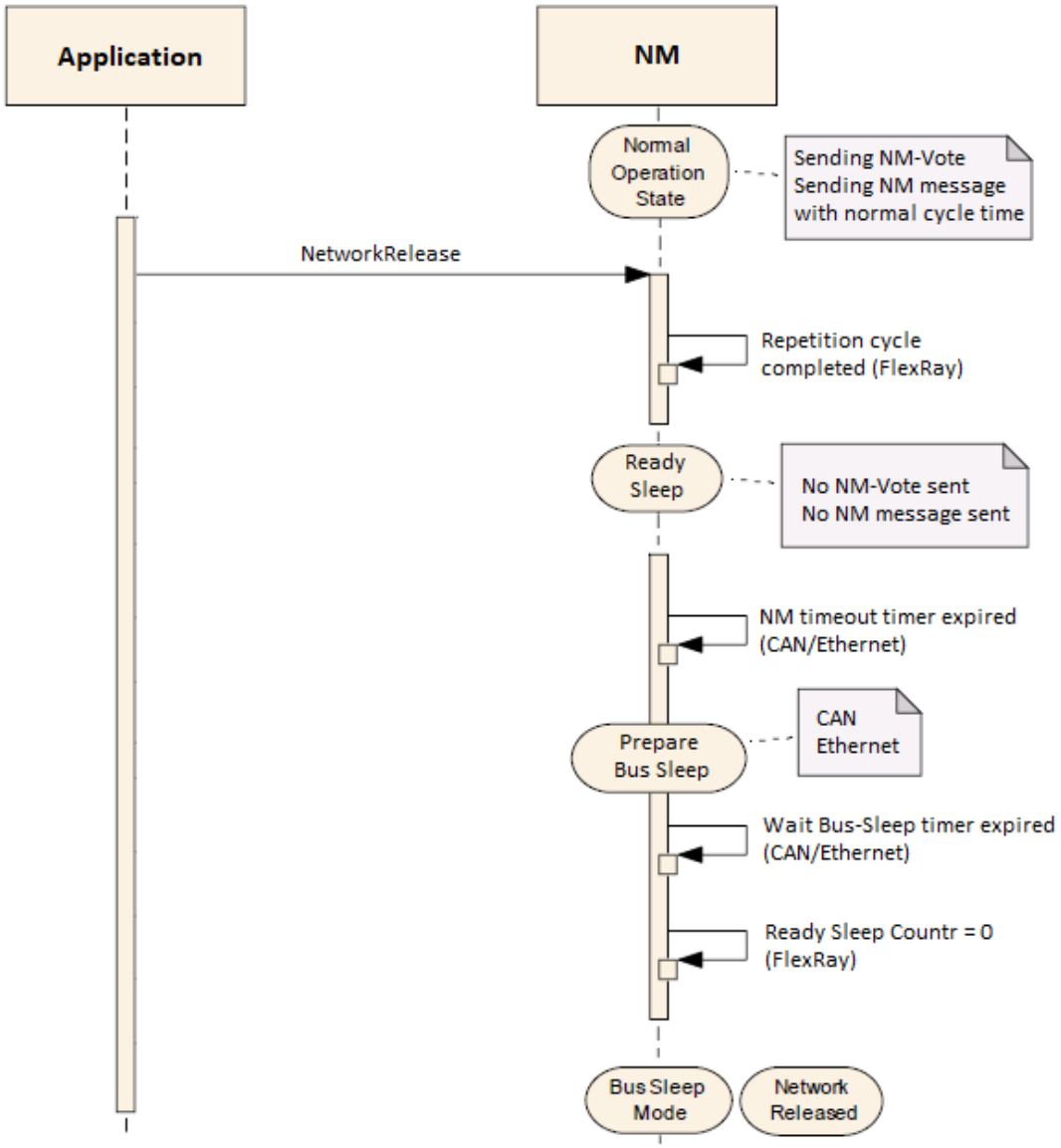



**Figure 5.2: Communication release**

# 6 Configuration parameters

This chapter lists all parameters the NM protocol uses.

## 6.1 NM Message Layout

| Parameter | Description |
|---|---|
| NmNidPosition | Defines the position of the source node identifier (if used) within the NM message |
| NodeId | Node identifier of local node |
| NmCbvPosition | Defines the position of the Control Bit Vector (if used) within the NM message |
| UserDataEnabled | Enables/disables user data support |
| NmMessageLength | Specifies the length (in bytes) of the NM message |
| PnEnabled | Enables/disables support of partial networking |
| PnInfoOffset | Offset of the PN request information in the NM message. The offset to the PNC data can only be configured to either be directly after the system bytes or after the user data. |
| PnInfoLength | Length of the PN request information in the NM message |

**Table 6.1: NM Message Layout**

## 6.2 Timeout Parameters

| Parameter | Description |
|---|---|
| NmTimeOutTime | The time for a node between the reception of the last NM message keeping it awake to the transition to Bus Sleep |
| NmMsgCycleTime | The transmission periodicity of an NM message by a node |
| NmMsgCycleOffset | The start delay of a transmission of Nm messages in Repeat Message State |
| NmRepeatMessageTime | The time for a node to remain in Repeat Message State |
| NmWaitBusSleepTime | Timeout for bus calm down phase. It denotes the time in seconds how long the NM shall stay in the Prepare Bus-Sleep Mode before transition into Bus-Sleep Mode (CAN NM, UDP NM only). |
| NmReadySleepCnt | Ready sleep counter. After NmReadySleepCnt+1 repetition cycles without any NM-Vote, NM enters Bus-Sleep (FR NM only). |
| NmImmediateNmCycleTime | Defines the immediate NM message cycle time in seconds used in Repeat Message state (CAN NM, UDP NM only) |
| NmImmediateNmTransmissions | Number of immediate NM messages which shall be transmitted in Repeat Message state (CAN NM, UDP NM only) |
| NmDataCycle | Number of FlexRay Schedule Cycles needed to transmit NM-Data of all ECUs (FR NM only) |
| NmVotingCycle | Number of FlexRay Schedule Cycles needed to transmit NM-Vote of all ECUs (FR NM only) |
| NmRepetitionCycle | Number of NM voting cycles where no change of voting behavior is possible (FR NM only) |
| NmScheduleVariant | Defines the transmission scheduling variant for sending NM-Vote and NM-Data (FR NM only) |

| Parameter | Description |
|---|---|
| PnResetTime | Time a PNC is considered reqested externally after the last message containing the corresponding bit set to one has been received |

**Table 6.2: Timeout Parameters**

## 6.3 NM local configuration

| Parameter | Description |
|---|---|
| SynchronizedPncShutdownEnabled | Enable/Disable a synchronized PNC shutdown |
| NmStayInPbsEnabled | If this parameter is disabled Prepare Bus-Sleep Mode is left after NmWaitBusSleep Time. If this parameter is enabled Prepare Bus-Sleep Mode can only be left if ECU is powered off or any restart reason applies. |
| NmPnHandleMultipleNetworkRequests | If enabled, an additional transition from Network Mode to Repeat Message State shall be performed, if the requested state of the channel/VLAN or an associated PNC changes. |

**Table 6.3: NM local configuration**

# 7 Protocol usage and guidelines

No additional guidelines or How-To instructions for implementer.
All relevant information already provided in previous chapters.

# 8 References

[1] Specification of Network Management Interface
AUTOSAR_CP_SWS_NetworkManagementInterface

[2] Glossary
AUTOSAR_FO_TR_Glossary

# A Change history of AUTOSAR traceable items

Please note that the lists in this chapter also include traceable items that have been removed from the specification in a later version. These items do not appear as hyperlinks in the document.

## A.1 Traceable item history of this document according to AUTOSAR Release R26-11

### A.1.1 Added Specification Items in R26-11

none

### A.1.2 Changed Specification Items in R26-11

| Number | Heading |
|---|---|
| [PRS_Nm_00335] | |
| [PRS_Nm_00411] | |
| [PRS_Nm_00501] | Contents of an Nm Message |
| [PRS_Nm_00502] | Format of an Nm Message |

**Table A.1: Changed Specification Items in R26-11**

### A.1.3 Deleted Specification Items in R26-11

none

## A.2 Traceable item history of this document according to AUTOSAR Release R25-11

### A.2.1 Added Specification Items in R25-11

| Number | Heading |
|---|---|
| [PRS_Nm_00507] | Handling multiple network requests |

**Table A.2: Added Specification Items in R25-11**

### A.2.2 Changed Specification Items in R25-11

none

### A.2.3 Deleted Specification Items in R25-11

none

## A.3 Traceable item history of this document according to AUTOSAR Release R24-11

### A.3.1 Added Specification Items in R24-11

none

### A.3.2 Changed Specification Items in R24-11

none

### A.3.3 Deleted Specification Items in R24-11

none

## A.4 Traceable item history of this document according to AUTOSAR Release R23-11

### A.4.1 Added Specification Items in R23-11

| Number | Heading |
|---|---|
| [PRS_Nm_00005] | |
| [PRS_Nm_00505] | |
| [PRS_Nm_00506] | |

**Table A.3: Added Specification Items in R23-11**

### A.4.2 Changed Specification Items in R23-11

| Number | Heading |
|---|---|
| [PRS_Nm_00115] | |
| [PRS_Nm_00334] | |

**Table A.4: Changed Specification Items in R23-11**

### A.4.3 Deleted Specification Items in R23-11

none

## A.5 Traceable item history of this document according to AUTOSAR Release R22-11

### A.5.1 Added Specification Items in R22-11

none

### A.5.2 Changed Specification Items in R22-11

| Number | Heading |
|---|---|
| [PRS_Nm_00335] | |
| [PRS_Nm_00337] | |
| [PRS_Nm_00341] | |
| [PRS_Nm_00406] | |
| [PRS_Nm_00407] | |
| [PRS_Nm_00408] | |
| [PRS_Nm_00409] | |
| [PRS_Nm_00410] | |
| [PRS_Nm_00411] | |
| [PRS_Nm_00412] | |
| [PRS_Nm_00413] | |

**Table A.5: Changed Specification Items in R22-11**

### A.5.3 Deleted Specification Items in R22-11

| Number | Heading |
|---|---|
| [PRS_Nm_00102] | |

**Table A.6: Deleted Specification Items in R22-11**