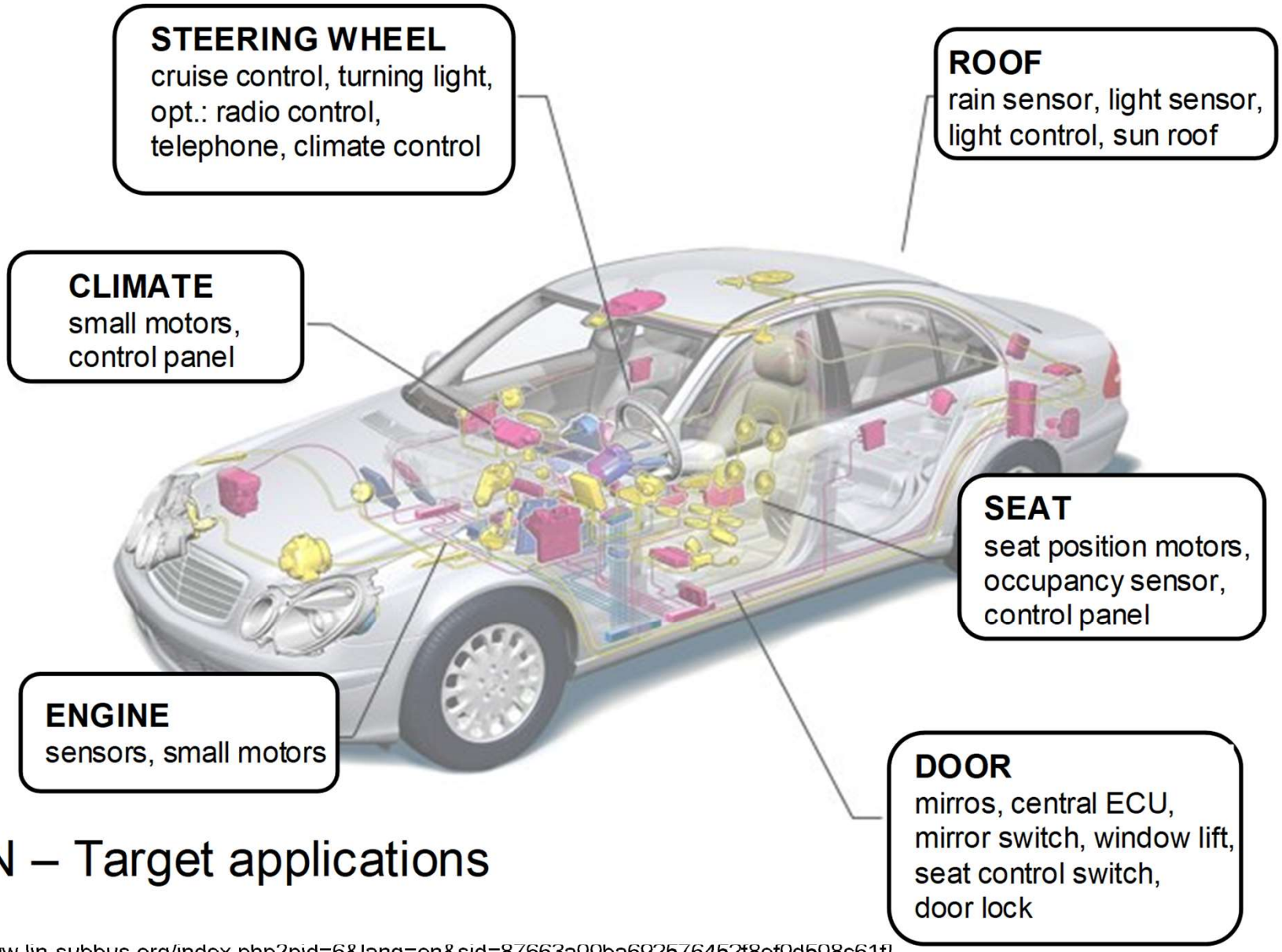
Local Interconnect Network

Méréstechnika és
Információs Rendszerek
Tanszék

Target applications



LIN – Target applications

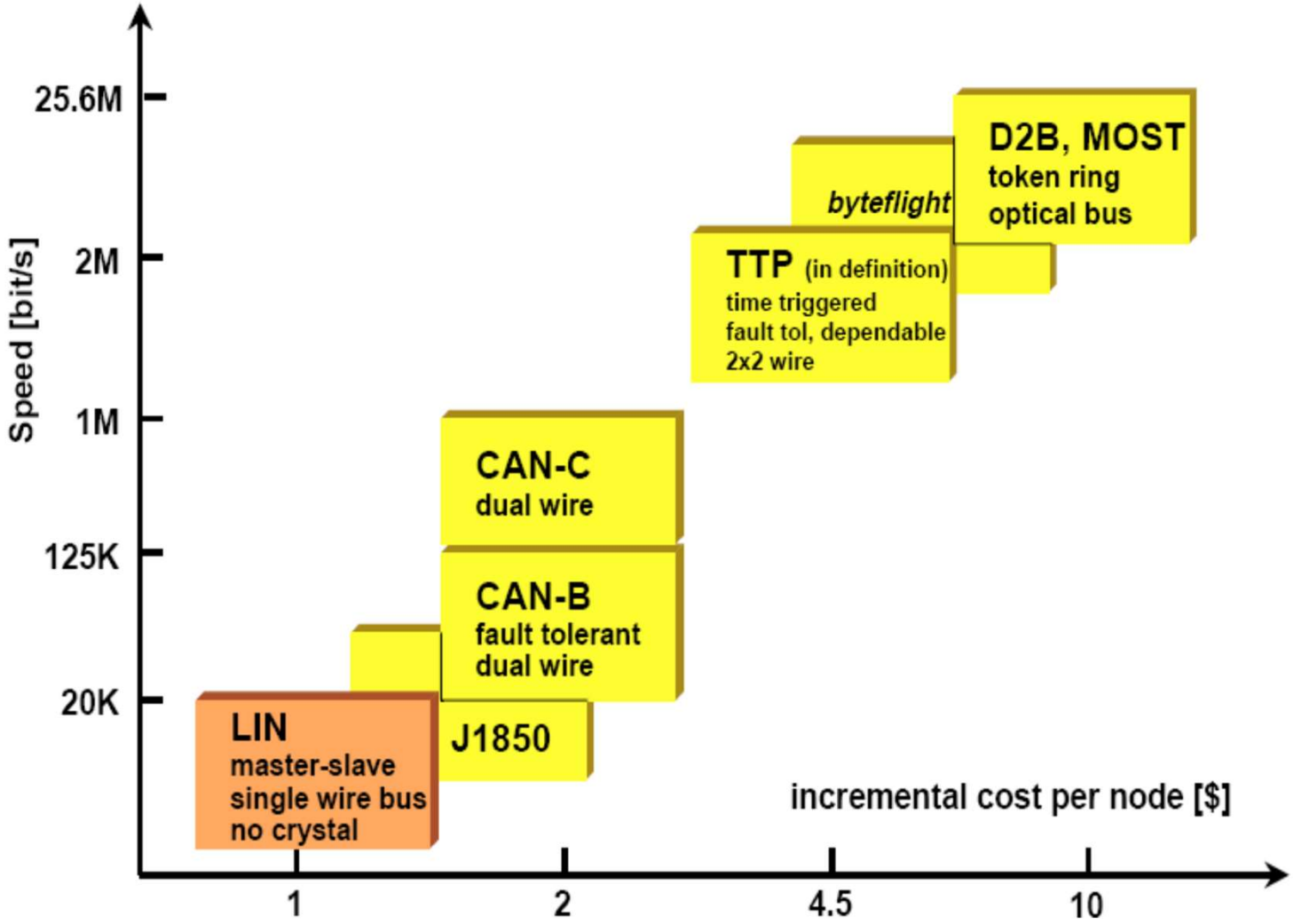
[http://www.lin-subbus.org/index.php?pid=6&lang=en&sid=87663a00ba69257645 2f8ef0d508c61f]

LIN – Local Interconnect Network

„LIN is a cost-competitive serial communication system designed for localized vehicle electrical networks.”

[http://www.lin-subbus.org/index.php?pid=3&lang=en&sid=87663a00ba692576452f8ef0d508c61f]

Néhány autós hálózat összehasonlítása



[Introduction to Local Interconnect Network (LIN)
Hans-Chr. v. d. Wense, Motorola, March 2000]

The key features of LIN

- Low cost single-wire implementation
- Enhanced ISO 9141, VBAT-based speed up to 20Kbit/s
- Acceptable speed for many applications (limited for EMI-reasons)
- Single Master / Multiple Slave concept
- No arbitration necessary
- Low cost silicon implementation based on common UART/SCI interface hardware
- Almost any microcontroller has necessary hardware on chip
- Self synchronization in the slave nodes without crystal or ceramics resonator
- Significant cost reduction of hardware platform
- Off-the-shelf slaves
- Flexibility because of configuration features
- Guaranteed latency times for signal transmission
- Predictable systems possible

[http://www.lin-subbus.org/index.php?pid=4&lang=en&sid=87663a00ba692576452f8ef0d508c61f]

A LIN története

- 1999 Motorola
- 2000 LIN Consortium
  - » Audi
  - » BMW
  - » Daimler Chrysler
  - » Volkswagen
  - » Volvo
- 2016 ISO 17987

LIN Consortium – Steering Committee

- **Audi AG**
- **BMW AG**
- **Daimler AG**
- **Freescale Halbleiter Deutschland GmbH**
- **Mentor Graphics Corporation**
- **Volkswagen AG**
- **Volvo Car Corporation**

LIN Consortium – Associated Members

- Kb. 80 tag (A-tól Z-ig):
  - AB Volvo
  - Adam Opel AG
  - Advanced Data Controls, Corp.
  - ...
  - ...
  - ...
  - Yazaki Europe Ltd.
  - Zentrum Mikroelektronik Dresden AG
  - ZF Lenksysteme GmbH

Supplier codes (Supplier ID)

- 0x0001 Audi
- 0x0002 BMW
- 0x0003 Daimler AG
- 0x0004 Motorola
- 0x0005 VCT / Mentor Graphics
- 0x0006 VW (VW-Group)
- 0x0007 Volvo Cars (Ford Group)
- 0x000B Freescale Semiconductor
- 0x0011 NXP Semiconductors
- 0x0012 ST Microelectronics
- 0x0013 Melexis
- 0x0014 Microchip
- 0x0015 CRF
- 0x0016 Renesas Technology Europe GmbH
- 0x0017 Atmel
- 0x0018 Magnet Marelli
- 0x0019 NEC
- 0x001A Fujitsu
- 0x001B Opel
- 0x001C Infineon
- 0x001D AMI Semiconductor
- 0x001E Vector Informatik
- stb.

A LIN specifikációk változatai

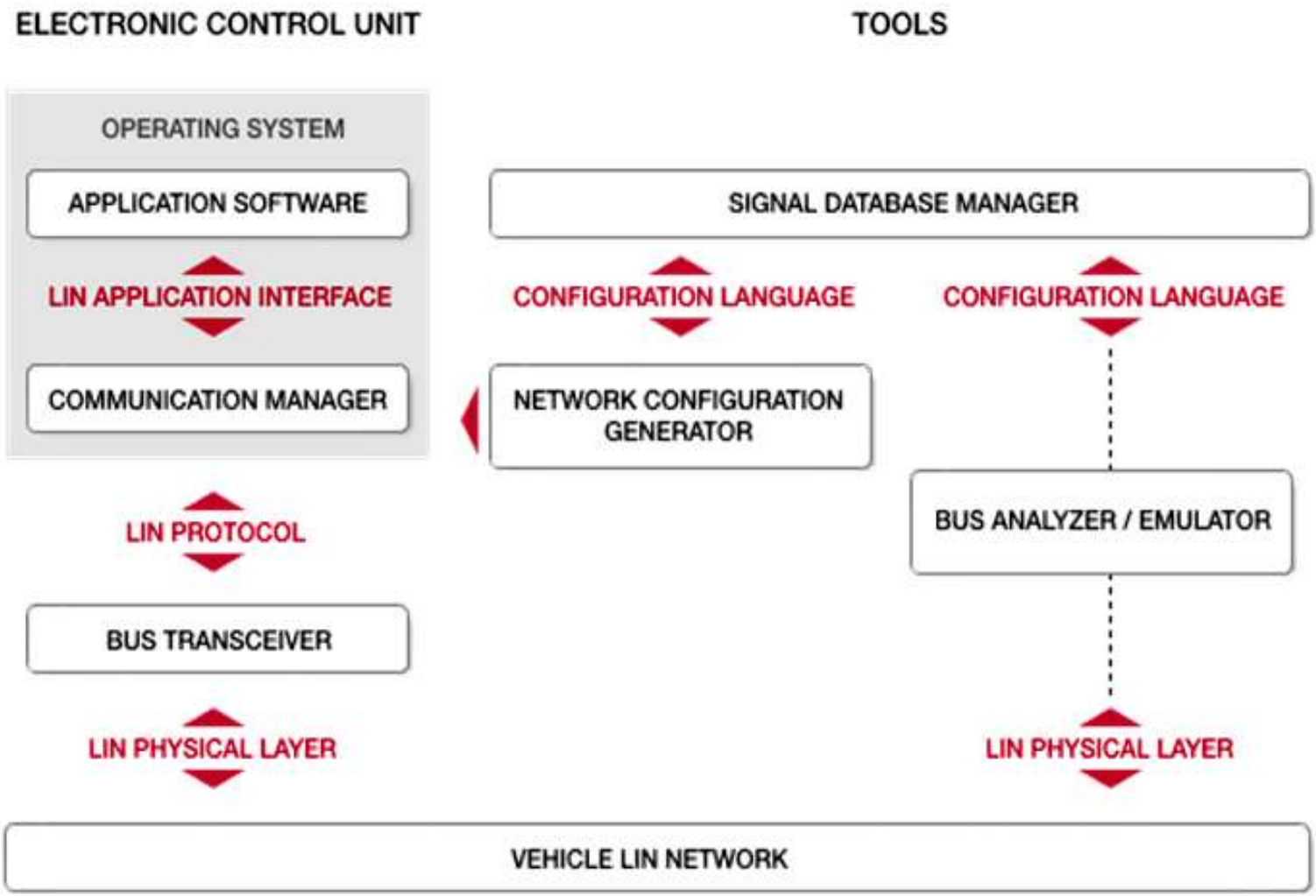
- LIN 1.0 (1999.07.01.) A LIN legelső változata.
- LIN 1.1 (2000.03.06.)
- **LIN 1.2** (2000.11.17.)
- **LIN 1.3** (2002.12.13.)
- **LIN 2.0** (2003.09.16.) Jelentős változtatás.
- **LIN 2.1** (2006.11.24.) Pontosítások, módosított konfigurálás, javítások a transzport rétegen, diagnosztika hozzáadása.
- **LIN 2.2** (2010.12.31.) LIN 2.1 Errata sheet 1.4 javításai; bitmintavétel specifikáció enyhítése
- **LIN 2.2A** (2010.12.31.) Jav. wakeup signal def. (2.6.2 fej.)

LIN konzorcium dokumentációs csomagja

- Physical Layer Specification
- Protocol Specification
- Transport Layer Specification
- Node Configuration and Identification Specification
- Diagnostic Specification
- Application Program Interface Specification
- Configuration Language Specification
- Node Capability Language Specification

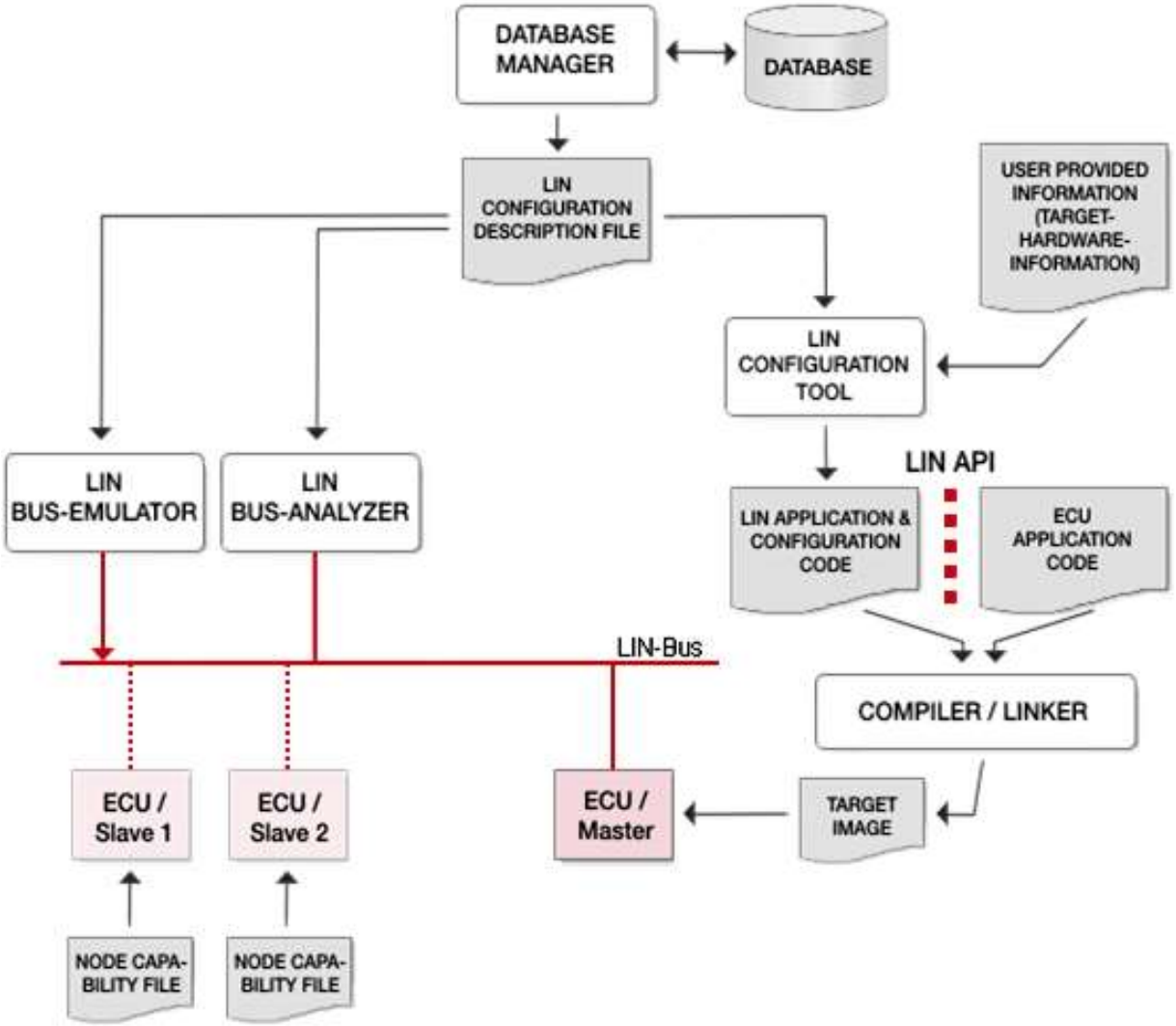
- (Már nem elérhetők.)

Scope of the LIN specifications



[http://www.lin-subbus.org/index.php?pid=7&lang=en&sid=87663a00ba692576452f8ef0d508c61f]

LIN tools



[http://www.lin-subbus.org/index.php?pid=19&lang=en&sid=87663a00ba692576452f8ef0d508c61f]

LIN szabvány: ISO 17987-1

ISO 17987-1:2016 (Published)

Road vehicles – Local Interconnect Network (LIN) –

Part 1: General information and use case definition

- ISO 17987-1:2016 gives an overview of the structure and the partitioning of ISO 17987 (all parts). In addition, it outlines the use case where the ISO 17987 (all parts) will be used. The terminology defined in ISO 17987-1:2016 is common for all LIN communication systems and is used throughout ISO 17987 (all parts).
- It has been established in order to define the use cases for LIN.

[https://www.iso.org/standard/61222.html]

LIN szabvány: ISO 17987-2

ISO 17987-2:2016 (Published)

Road vehicles – Local Interconnect Network (LIN) –

Part 2: Transport protocol and network layer services

- ISO 17987-2:2016 specifies a transport protocol and network layer services tailored to meet the requirements of LIN-based vehicle network systems on local interconnect networks. The protocol specifies an unconfirmed communication.
- The LIN protocol supports the standardized service primitive interface as specified in ISO 14229-2.
- ISO 17987-2:2016 provides the transport protocol and network layer services to support different application layer implementations like
  - normal communication messages, and
  - diagnostic communication messages.
- The transport layer defines transportation of data that is contained in one or more frames. The transport layer messages are transported by diagnostic frames. A standardized API is specified for the transport layer.
- Use of the transport layer is targeting systems where diagnostics are performed on the backbone bus (e.g. CAN) and where the system builder wants to use the same diagnostic capabilities on the LIN sub-bus clusters. The messages are in fact identical to the ISO 15765-2 and the PDUs carrying the messages are very similar.
- The goals of the transport layer are
  - low load on LIN master node,
  - to provide full (or a subset thereof) diagnostics directly on the LIN slave nodes, and
  - targeting clusters built with powerful LIN nodes (not the mainstream low cost).

[https://www.iso.org/standard/61223.html]

LIN szabvány: ISO 17987-3

ISO 17987-3:2016 (Published)

Road vehicles – Local Interconnect Network (LIN) –

Part 3: Protocol specification

- ISO 17987-3:2016 specifies the LIN protocol including the signal management, frame transfer, schedule table handling, task behaviour and status management and LIN master and slave node. It contains also OSI layer 5 properties according to ISO 14229-7 UDSonLIN-based node configuration and identification services (SID: B016 to B816) belonging to the core protocol specification.
- A node (normally a master node) that is connected to more than one LIN network is handled by higher layers (i.e. the application) not within the scope of ISO 17987-3:2016.

[https://www.iso.org/standard/61224.html]

LIN szabvány: ISO 17987-4

ISO 17987-4:2016 (Published)

Road vehicles – Local Interconnect Network (LIN) –

Part 4: Electrical physical layer (EPL) specification 12 V/24 V

- ISO 17987-4:2016 specifies the 12 V and 24 V electrical physical layers (EPL) of the LIN communications system.
- The electrical physical layer for LIN is designed for low-cost networks with bit rates up to 20 kbit/s to connect automotive electronic control units (ECUs). The medium that is used is a single wire for each receiver and transmitter with reference to ground.
- ISO 17987-4:2016 includes the definition of electrical characteristics of the transmission itself and also the documentation of basic functionality for bus driver devices.
- All parameters in this document are defined for the ambient temperature range from −40 °C to 125 °C.

[https://www.iso.org/standard/61225.html]

LIN szabvány: ISO 17987-5

ISO 17987-5:2016 (Published)

Road vehicles – Local Interconnect Network (LIN) –

Part 5: Application programmers interface (API)

- ISO/TR 17987-5:2016 has been established in order to define the LIN application programmers interface (API).

[https://www.iso.org/standard/69116.html]

LIN szabvány: ISO 17987-6

ISO 17987-6:2016 (Published)

Road vehicles – Local Interconnect Network (LIN) –

Part 6: Protocol conformance test specification

- ISO 17987-6:2016 specifies the LIN protocol conformance test. This test verifies the conformance of LIN communication controllers with respect to ISO 17987-2 and ISO 17987-3.
- ISO 17987-6:2016 provides all necessary technical information to ensure that test results are identical even on different test systems, provided that the particular test suite and the test system are compliant to the content of this document.

[https://www.iso.org/standard/61222.html]

LIN szabvány: ISO 17987-7

ISO 17987-7:2016 (Published)

Road vehicles – Local Interconnect Network (LIN) –

Part 7: Electrical Physical Layer (EPL) conformance test specification

- ISO 17987-7:2016 specifies the conformance test for the electrical physical layer (EPL) of the LIN communications system. It is part of this document to define a test that considers ISO 9646 and ISO 17987-4.
- The purpose of ISO 17987-7:2016 is to provide a standardized way to verify whether a LIN bus driver is compliant to ISO 17987-4. The primary motivation is to ensure a level of interoperability of LIN bus drivers from different sources in a system environment.
- ISO 17987-7:2016 provides all the necessary technical information to ensure that test results are consistent even on different test systems, provided that the particular test suite and the test system are compliant to the content of this document.

[https://www.iso.org/standard/61229.html]

LIN szabvány: ISO 17987-8

ISO/DIS 17987-8 (Under development)

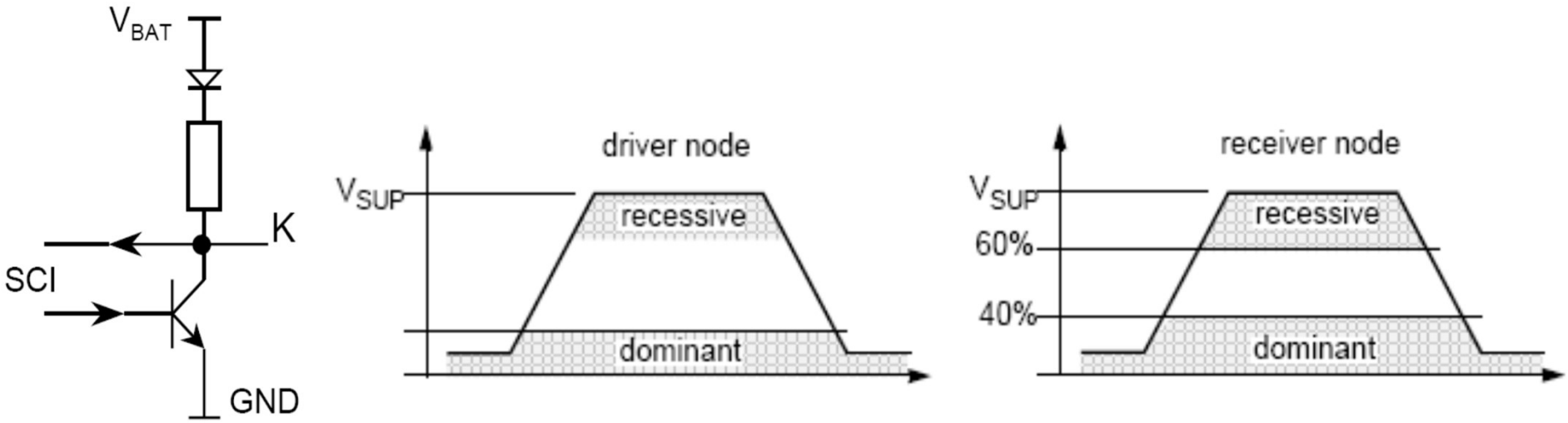
Road vehicles – Local Interconnect Network (LIN) –

Part 8: Electrical physical layer (EPL) specification: LIN over DC powerline (DC-LIN)

[https://www.iso.org/standard/71044.html]

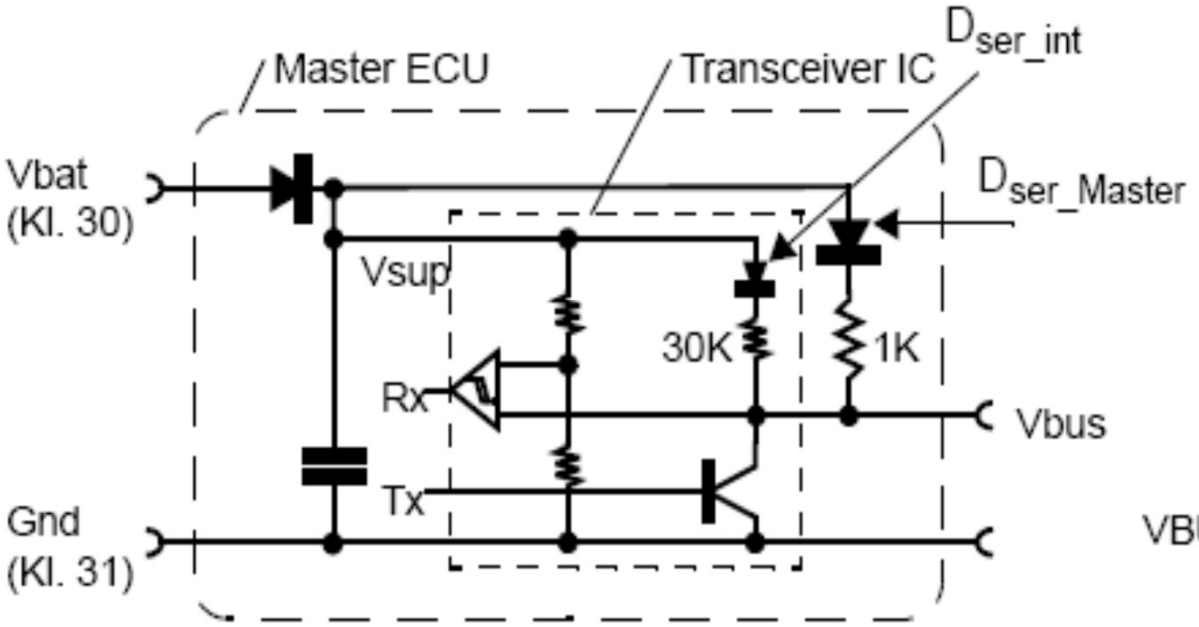
LIN – Fizikai réteg

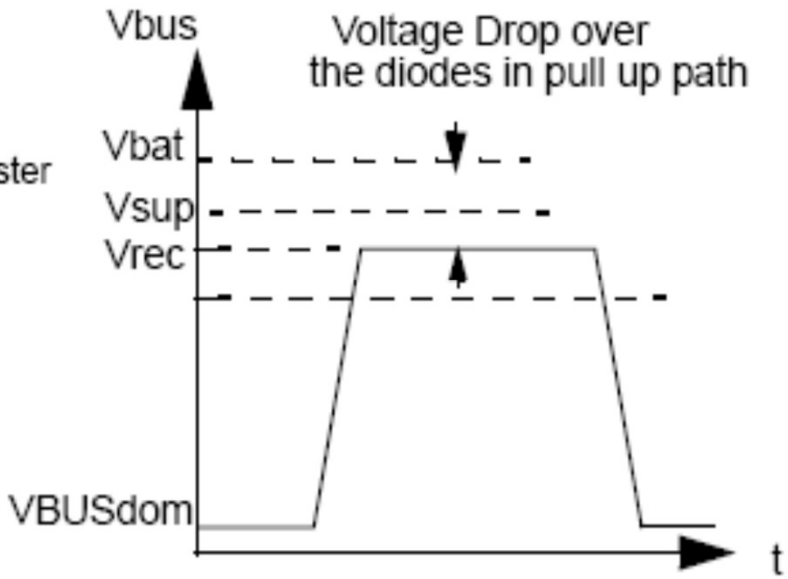
- Alapötlet: K-Line (ISO 9141)
- Open-collector
- Az autóakkumulátor szintjéhez (Vbat) igazodik.



[Introduction to Local Interconnect Network (LIN)
Hans-Chr. v. d. Wense, Motorola, March 2000]

LIN – Fizikai réteg





[LIN Specification Package
Revision 2.1
November 24, 2006; Page 1]

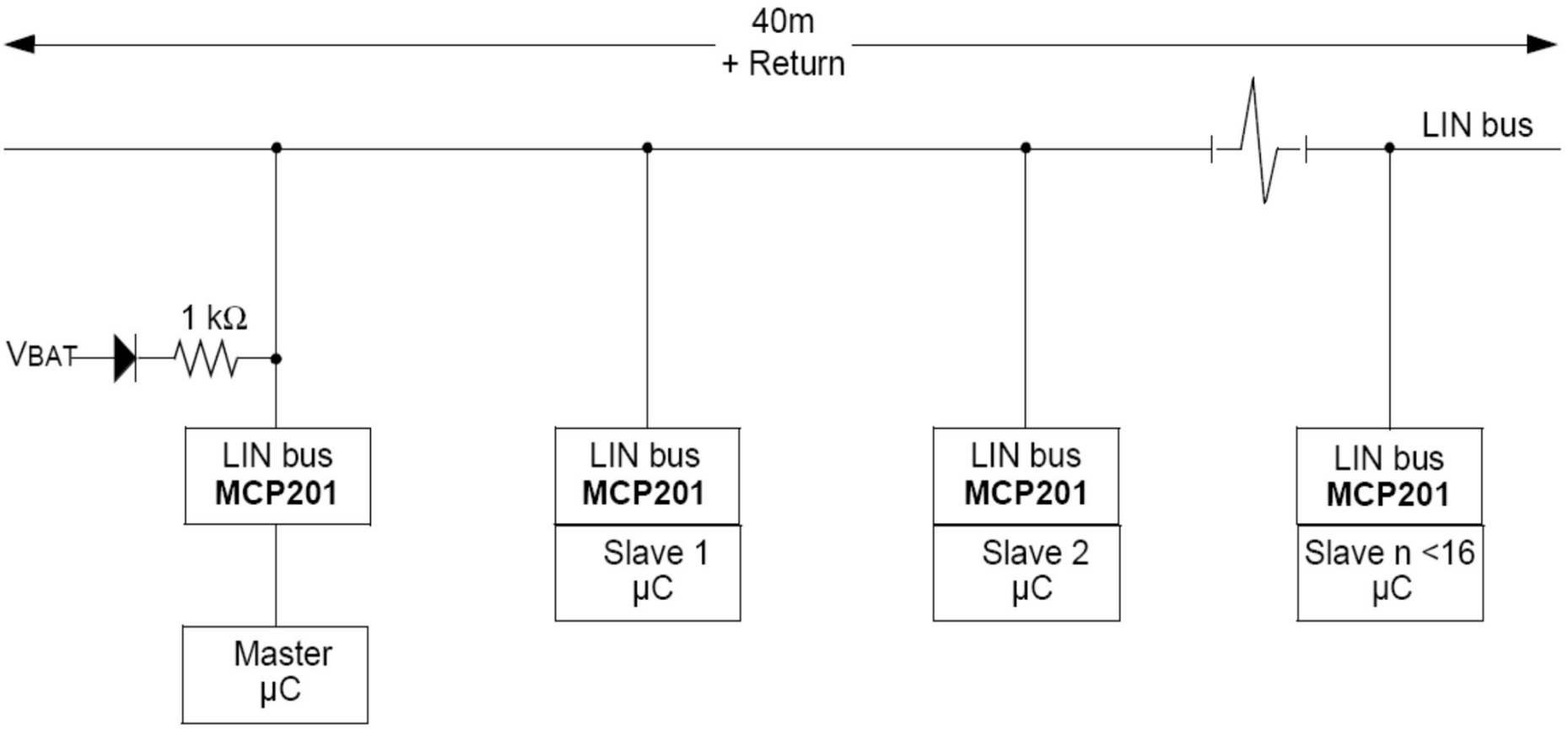
LIN – Fizikai réteg

- Kommunikációs sebesség: 1 kbit/s – 20 kbit/s
  - Standard UART bitsebességek
  - K-Line által használt 10,4 kbit/s
- Bitkódolás: NRZ (Non Return to Zero)
- A bitszintek:
  - domináns = 0 0 V
  - recessive = 1 7...17 V
- Slew rate: 1-2 V/µs
- Javasolt node szám: max. 16
- Vezetékhosszúság: max. 40 m
- Lezáró ellenállás: R_{master} = 1 kΩ, R_{slave} = 20-47 kΩ
- Terhelő kapacitás: $C_{master} >> C_{slave}$

Problémák

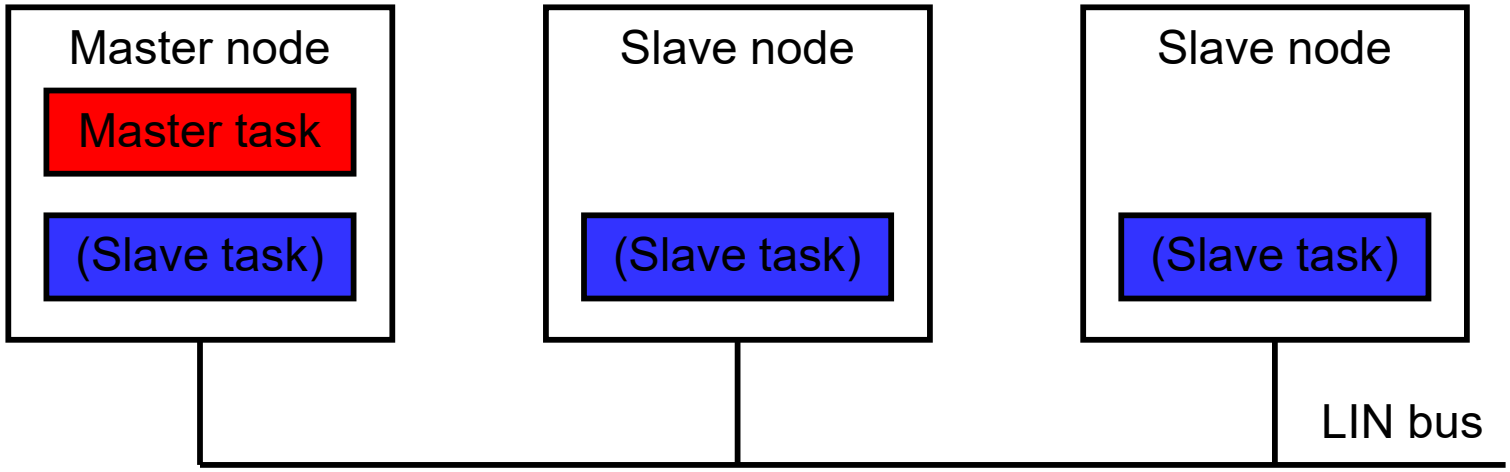
- A buszra kapcsolt kapacitás rontja a sebességet, de szükséges a rádiófrekvenciás zavarok kiszűrésére.
- Az egyes node-ok különböző kapacitív és rezisztív terhelései teljesen más felfutási időket eredményezhetnek node-onként.
- EMC problémák: egy 20 kbit/s-os LIN busz kb. akkora EMC terhelést okoz, mint egy 500 kbit/s-os CAN busz.

LIN busz (példa)

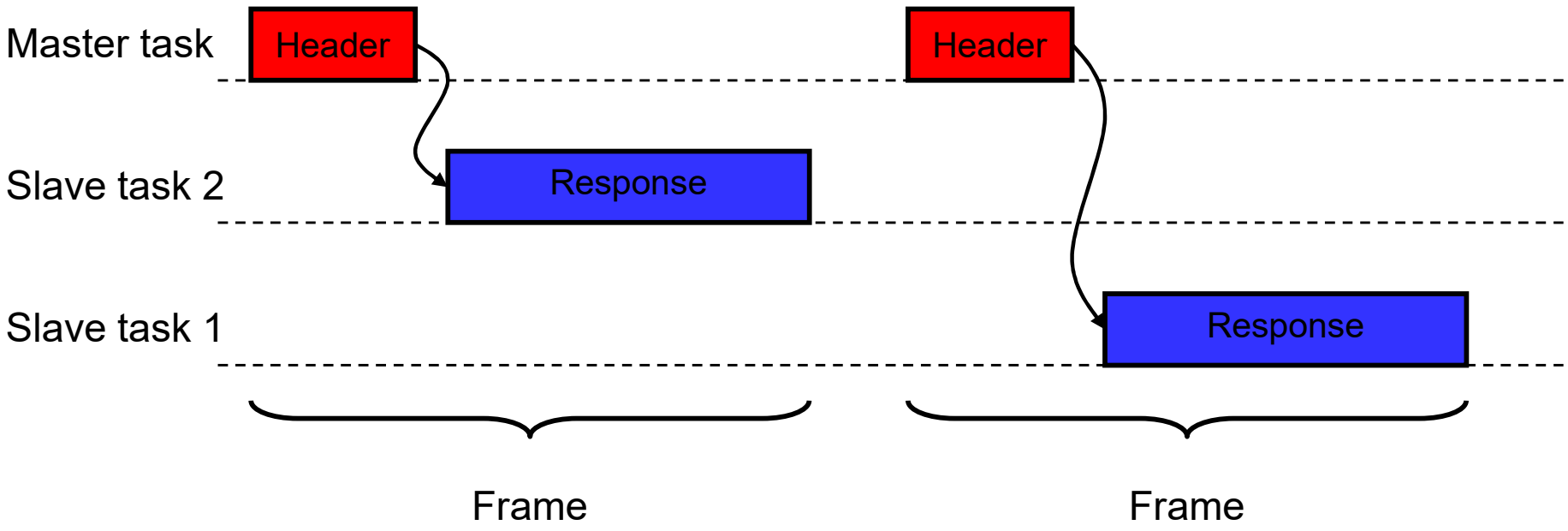


Microchip MCP201

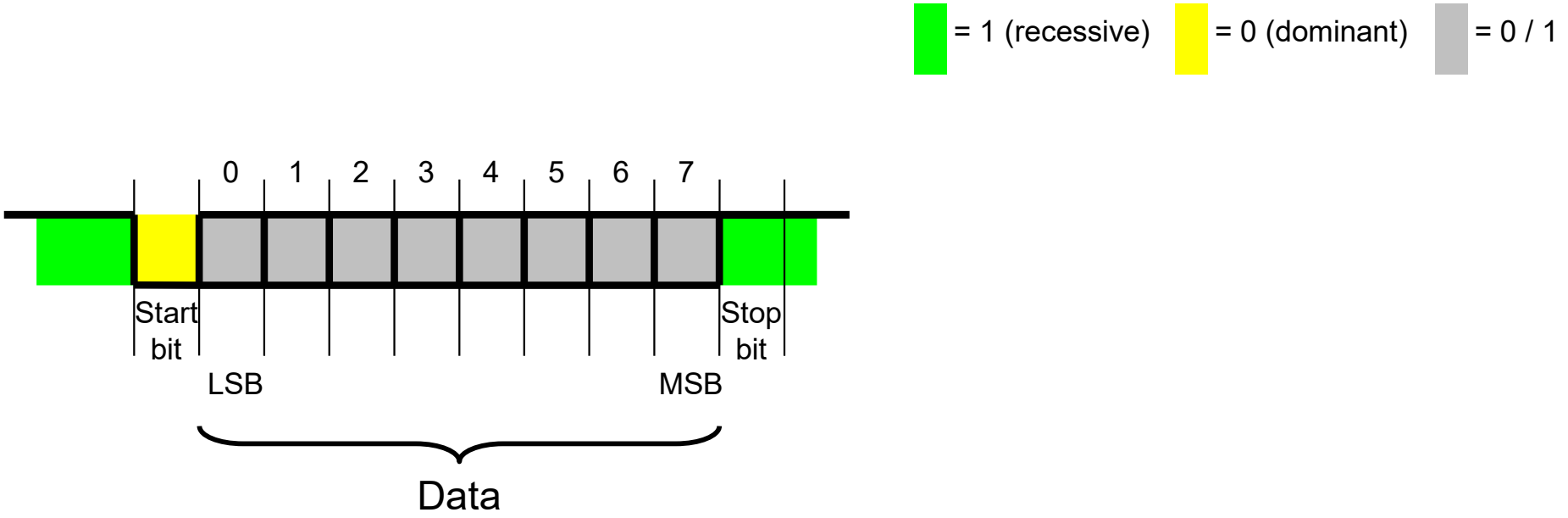
LIN – MAC réteg



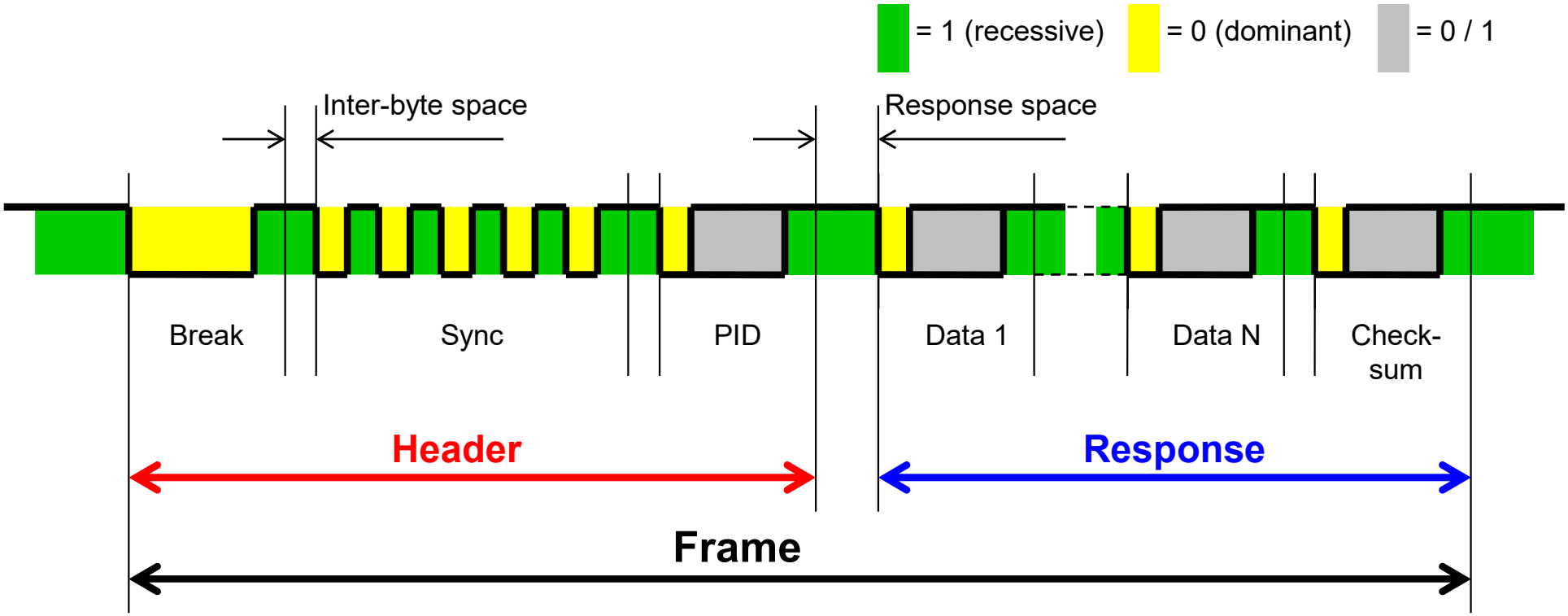
LIN – Master-slave kommunikáció



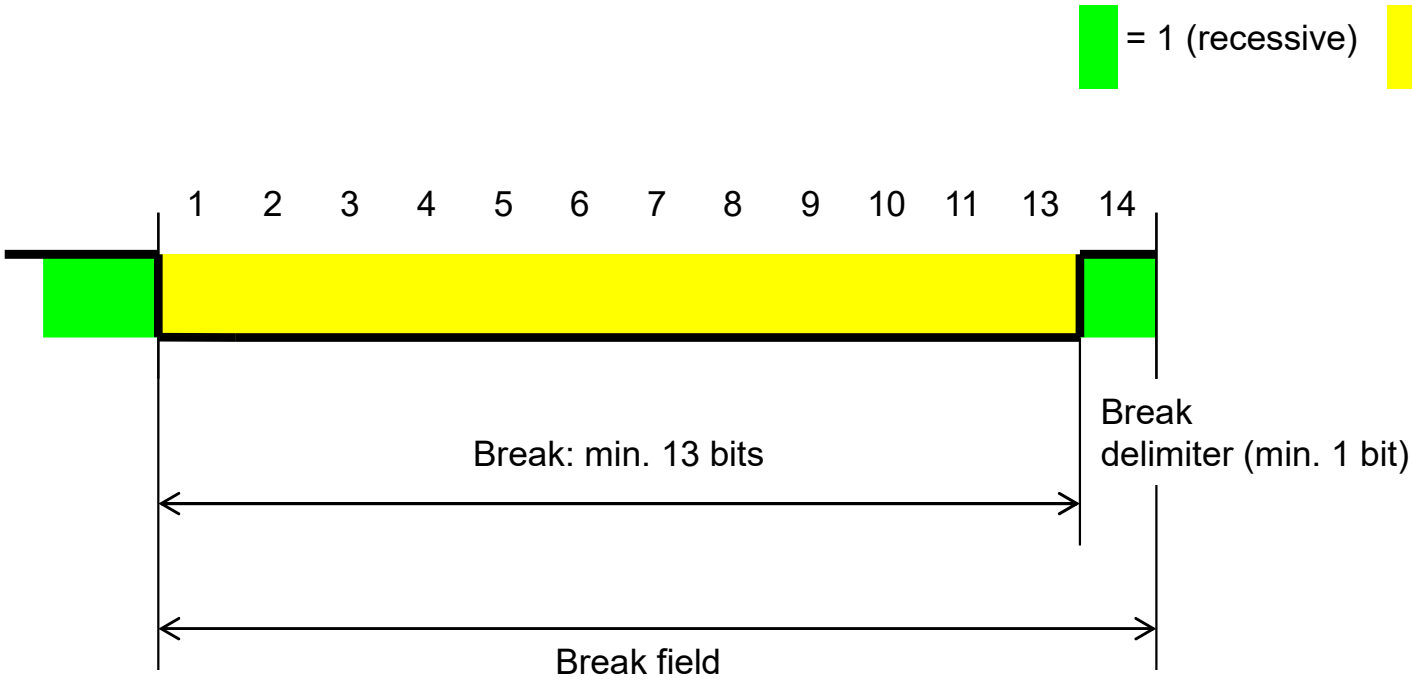
LIN – Aszinkron start-stop alapú komm.



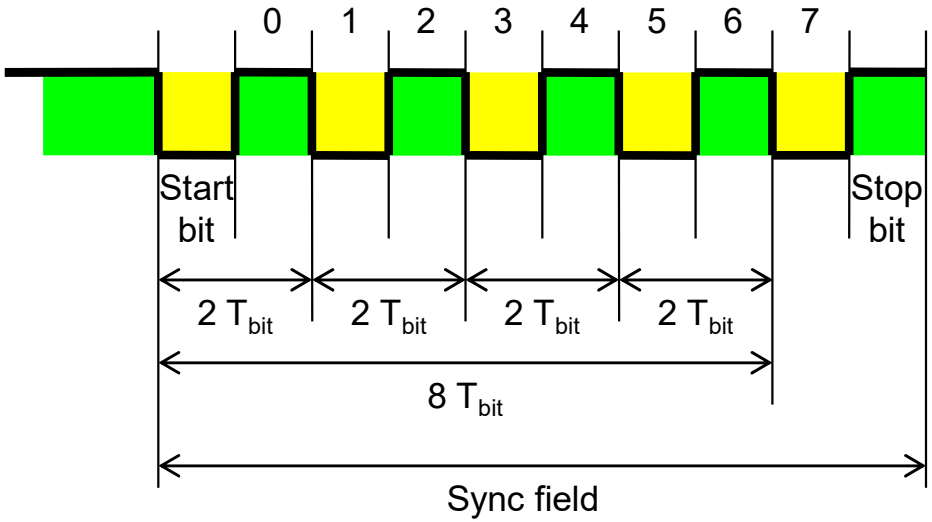
LIN – Keretformátum



LIN – Break field



LIN – Sync byte field



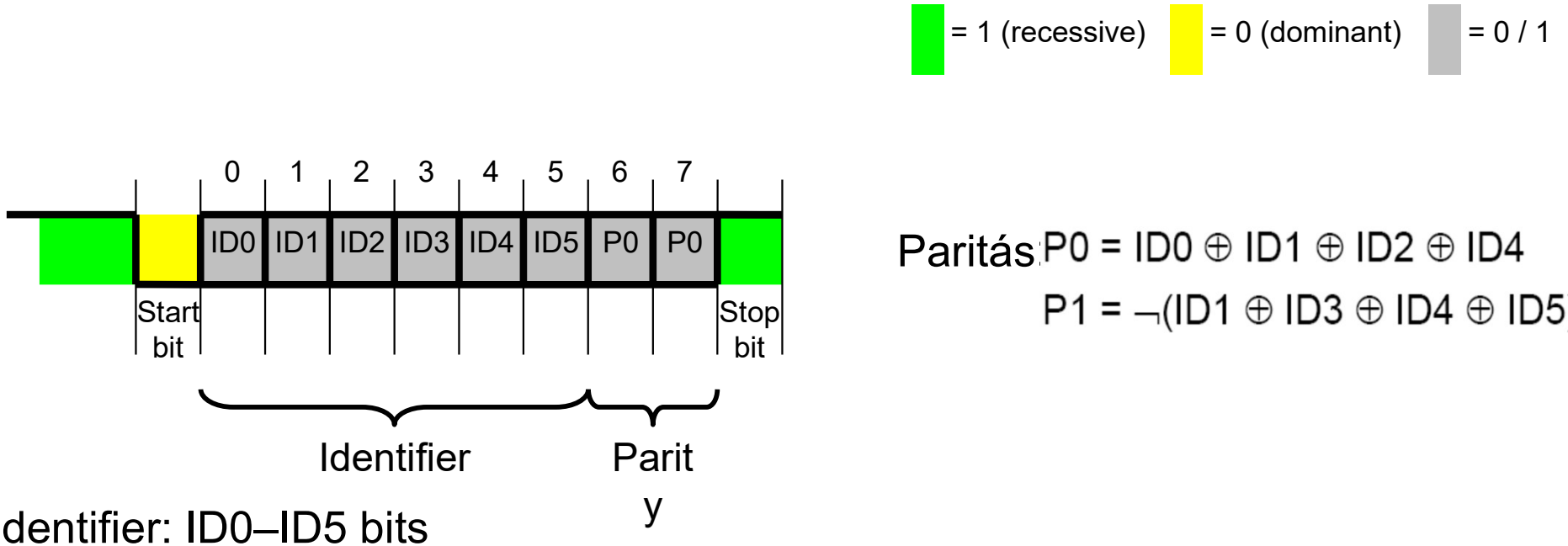
= 1 (recessive) = 0 (dominant) = 0 / 1

Sync = hex 0x55

A névleges bitsebességtől való megengedett eltérés:

- Master (kvarcoszcillátorral): $F_{TOL\_RES\_MASTER}$ < +/-0,5%
- Slave (kvarcoszcillátorral): $F_{TOL\_RES\_SLAVE}$ < +/-0,5% (szinkronizáció nélkül)
- Slave (kvarcoszcillátor nélkül) : F_{TOL_UNSYNC} < +/-14% (szinkronizáció előtt)
  F_{TOL_SYNC} < +/-2% (szinkronizáció után; a kommunikáció során ennyi a megengedett eltérés)

LIN – Protected identifier field (PID)



Paritás: $P0 = ID0 \oplus ID1 \oplus ID2 \oplus ID4$

$P1 = \neg(ID1 \oplus ID3 \oplus ID4 \oplus ID5)$

Identifier: ID0–ID5 bits

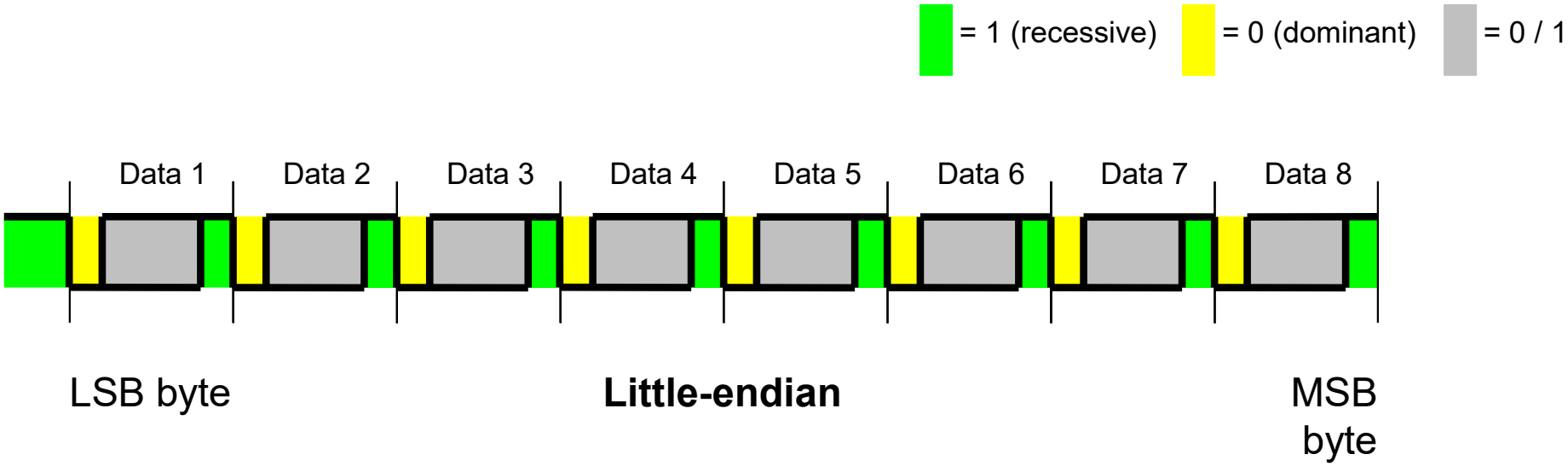
0 -59	(0x00 – 0x3B)	signalokat tartalmazó keretekhez unconditional, event triggered, sporadic frames
60, 61	(0x3C, 0x3D)	diagnosztikához és konfiguráláshoz (MRF, SRF)
62, 63	(0x3E, 0x3F)	későbbi bővítésre fenntartva

Az ID-k implicit vagy explicit módon meghatározzák az adatmező hosszát.

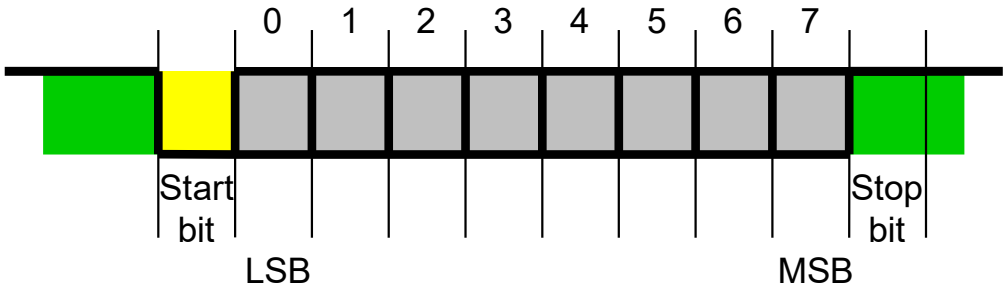
Explicit (LIN 1.3): ID0–ID3 identifier, ID4, ID5 data length (2, 4, 8 byte)

Implicit (LIN 2.0): ID0–ID5 identifier with implicit data length

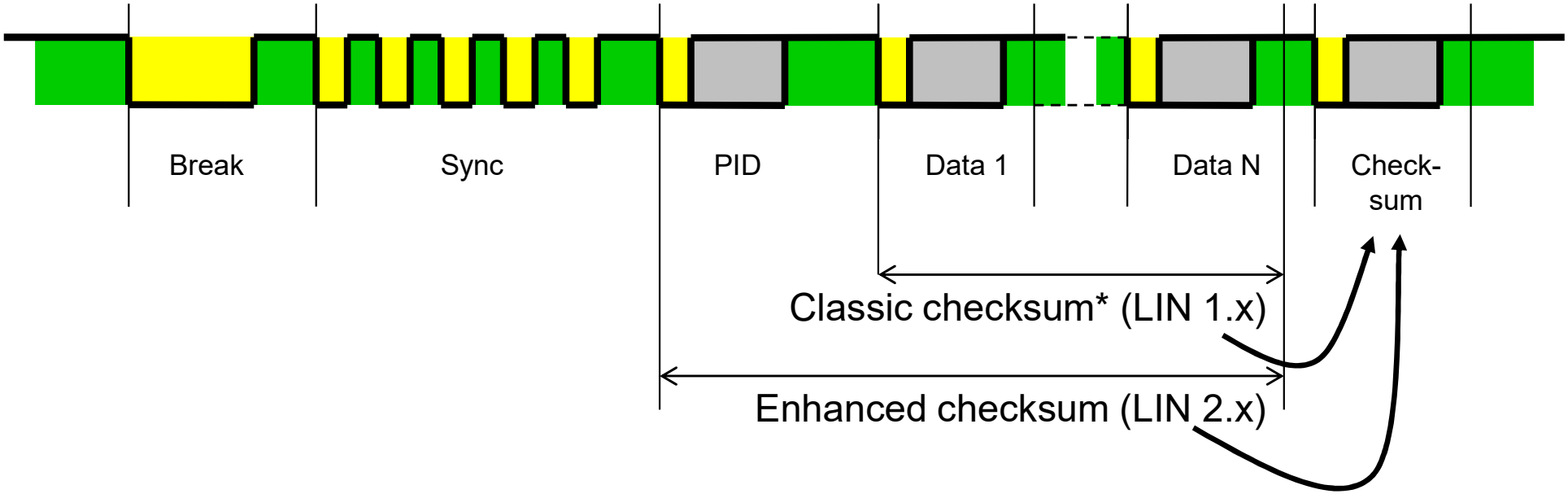
LIN – Data field



LIN – Checksum field (byte)



Checksum = a védett byte-ok előjeles összegének az inverze.



* ID = 60, 61-hez mindig classic checksum tartozik!

Kerettípusok

- Unconditional frame
- Event triggered frame
- Sporadic frame
- Diagnostic frame
- Reserved frame

Unconditional frame

Normál adatkeret

ID = 0..59 (0x00..0x3B)

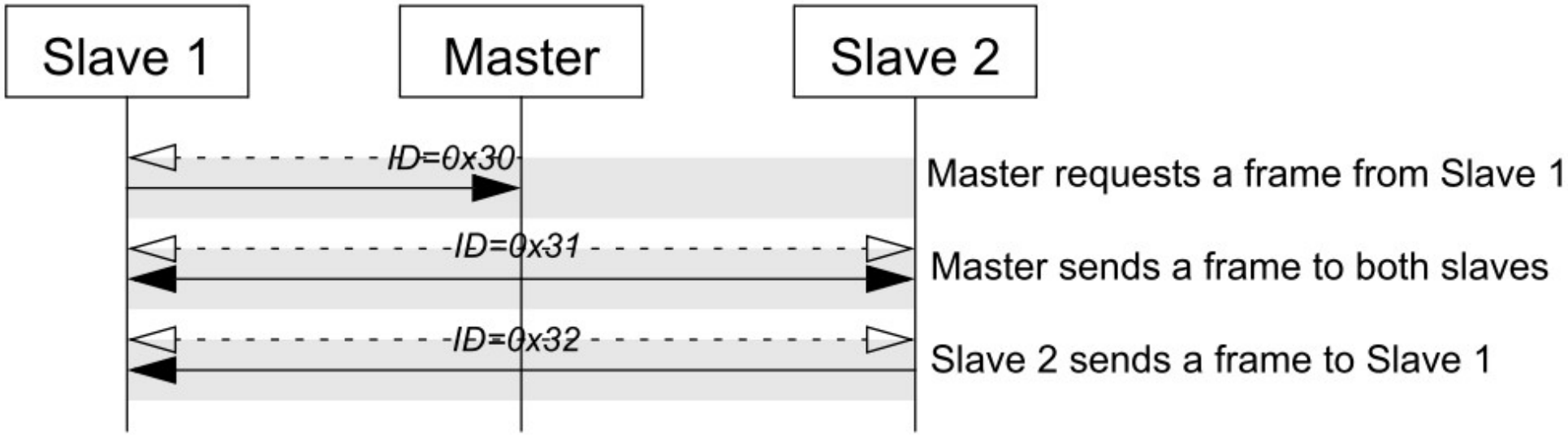


Figure 2.9: Three unconditional frame transfers.

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Event triggered frame

Ritka események hatékonyabb kezelésére

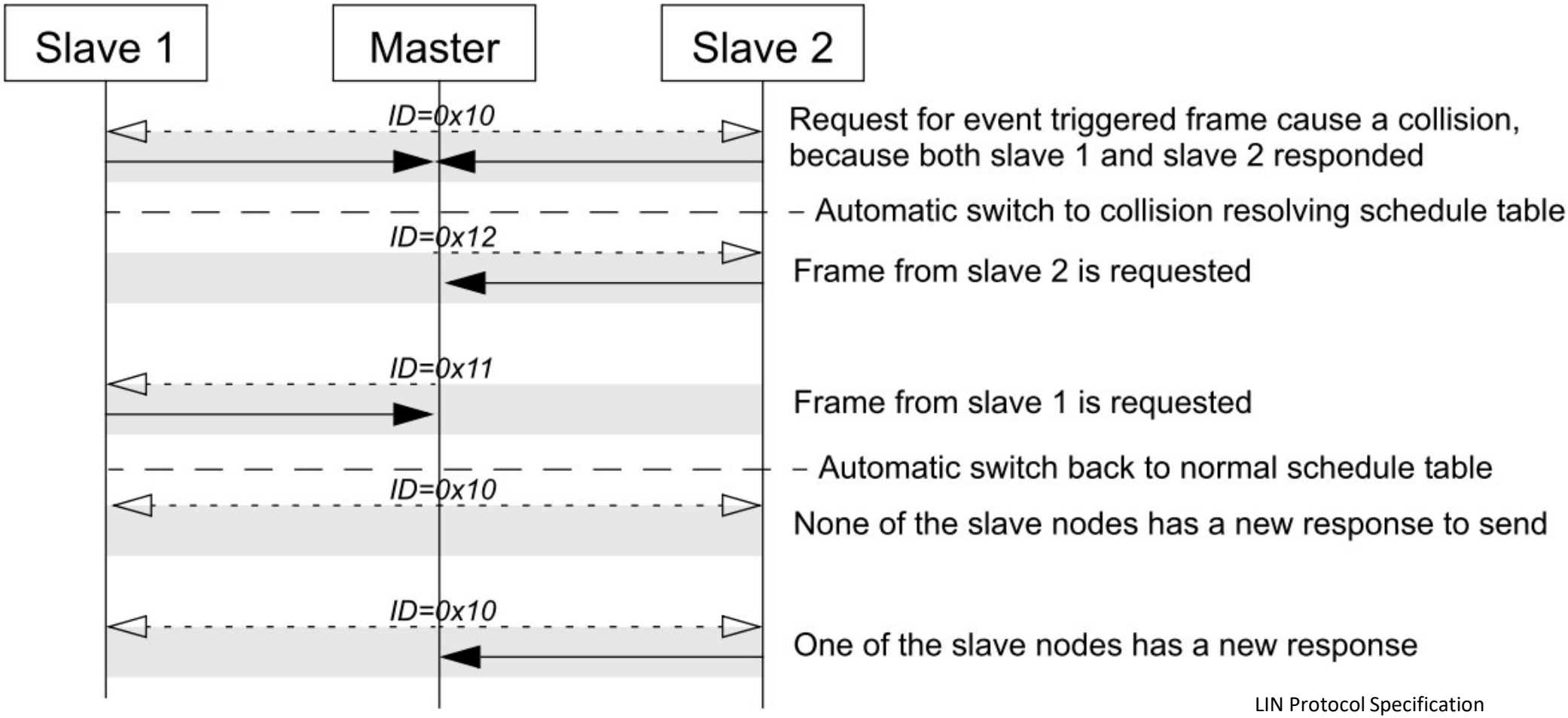

Figure 2.10: Event-triggered frame example.

LIN Protocol Specification
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Event triggered frame

- Az event triggered keretekhez hozzárendelt unconditional keretek:
  - Azonos hosszúságúak.
  - Ugyanazt a checksum-modellt használják.
  - Az 1. adatbyte a saját ID.
  - Különböző slave node-ok továbbítják.
  - Külön ütemező táblázat az ütközések feloldására

Sporadic frame

- Master-slave irányú dinamikus adattovábbítás
- Prioritásos üzenetkezelés
- Nem borítja fel a determinisztikus viselkedést

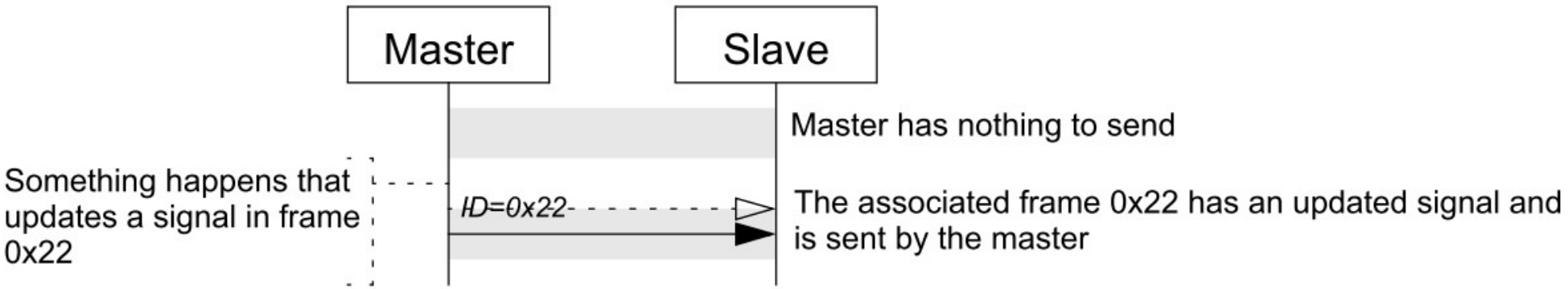

Figure 2.11: Sporadic frame example

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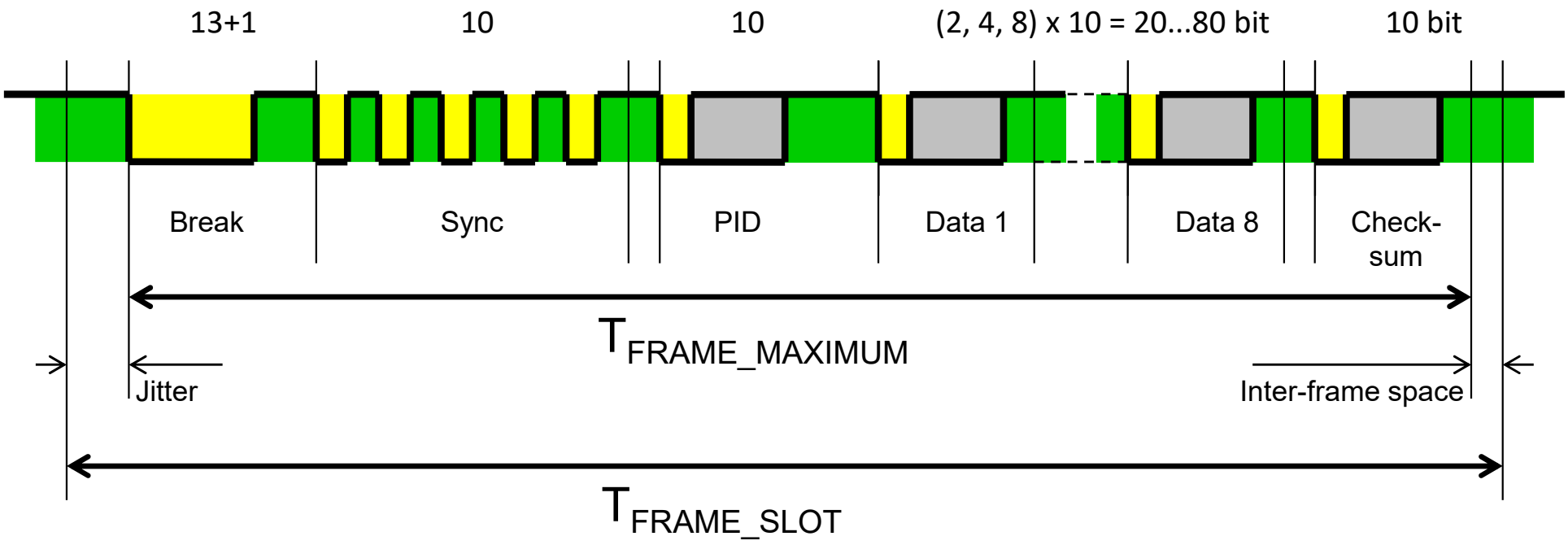
Diagnostic frame

- ID = 60 (0x3C) master request frame
- ID = 61 (0x3D) slave response frame
- A szállítási réteg adatainak továbbítására
  - Transport Layer Specification
- Mindig 8 adatbyte-ot tartalmaz
- Az adatok értelmezése:
  - Node configuration and Identification specification
  - Diagnostic specification

Reserved frame

- ID = 62 (0x3E), 63 (0x3F)
- Későbbi bővítésre fenntartva

Ütemezett adás – Időzítések



$T_{FRAME\_SLOT} = n * T_{BASE}$ (T_{BASE} tipikusan 5 ms vagy 10 ms)

$T_{FRAME\_SLOT} > Jitter + T_{FRAME\_MAXIMUM} + Inter\text{-}frame\ space$

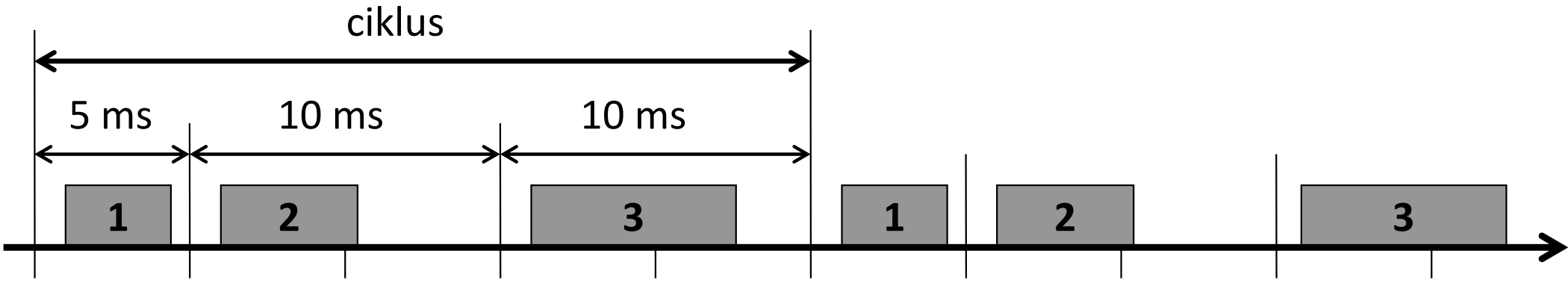
Ütemezett adás – Kerethosszak

	bit		
Break	14	14	14
Sync	10	10	10
PID	10	10	10
Data	**20**	**40**	**80**
Checksum	10	10	10
	64	**84**	**124**

		msec		
bit/s	**ms/bit**	**64 bit**	**84 bit**	**124 bit**
1200	0,83	53,3	70,0	103,3
2400	0,42	26,7	35,0	51,7
4800	0,21	13,3	17,5	25,8
9600	0,10	6,7	8,8	12,9
19200	0,05	3,3	4,4	6,5

+ 11 x Inter-frame space
+ Response space
+ Inter-frame space

Ütemezett adás



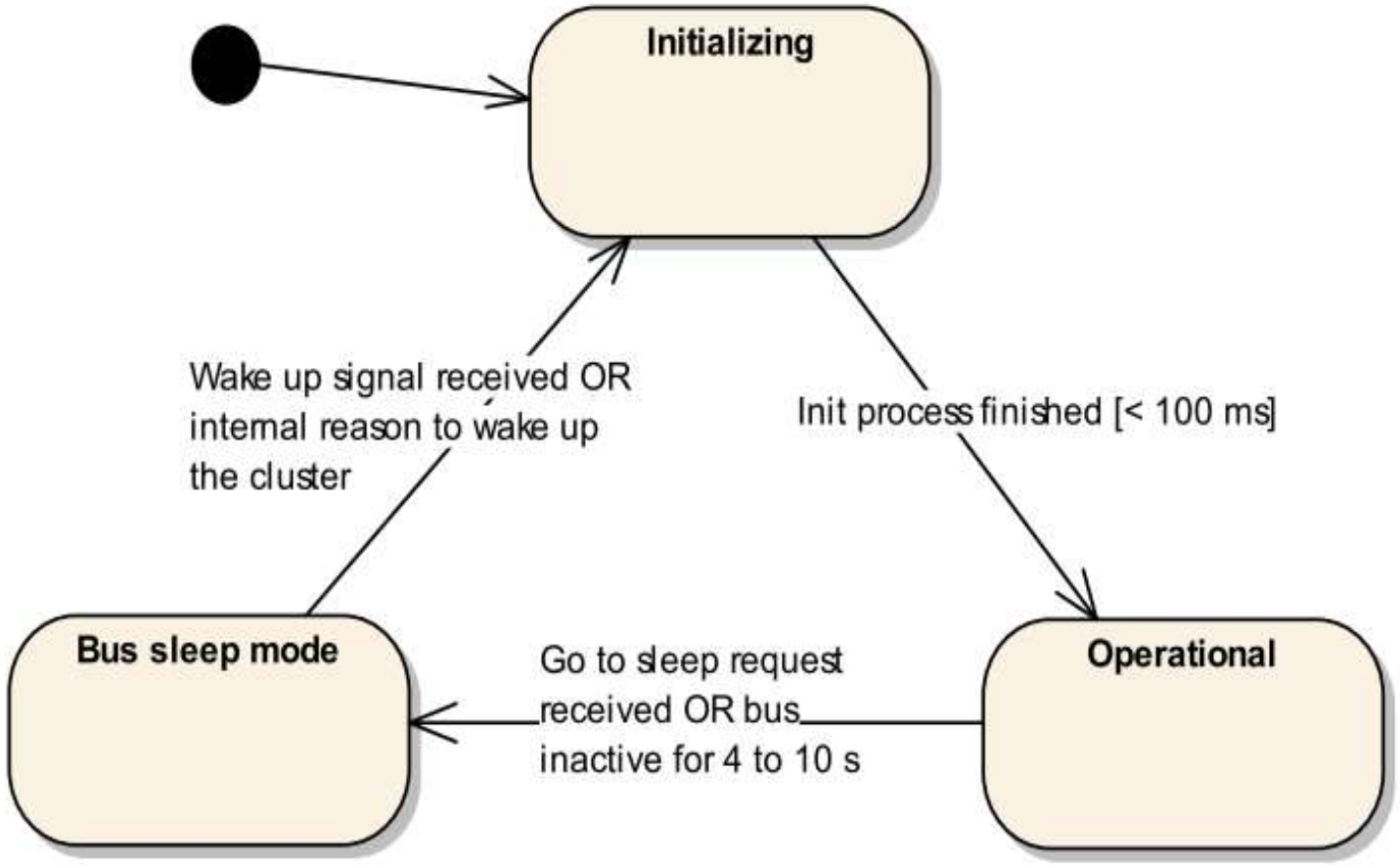

```
Normal_Schedule
{
   Frame1     delay 5 ms;
   Frame2     delay 10 ms;
   Frame3     delay 10 ms;
}
```

Ütemezett adás – Ütemező táblák

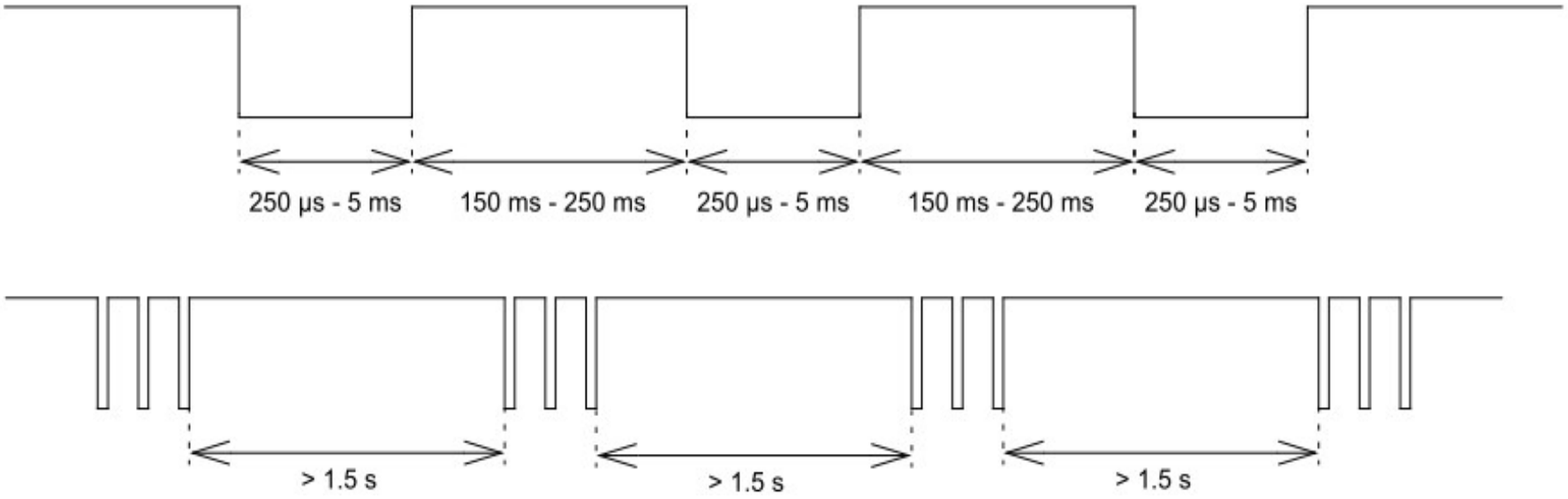
- A master kezeli
- A tervező állítja össze
- Determinisztikus működés
- Többféle ütemező tábla (schedule table)
  - Példa normál ütemezésre:

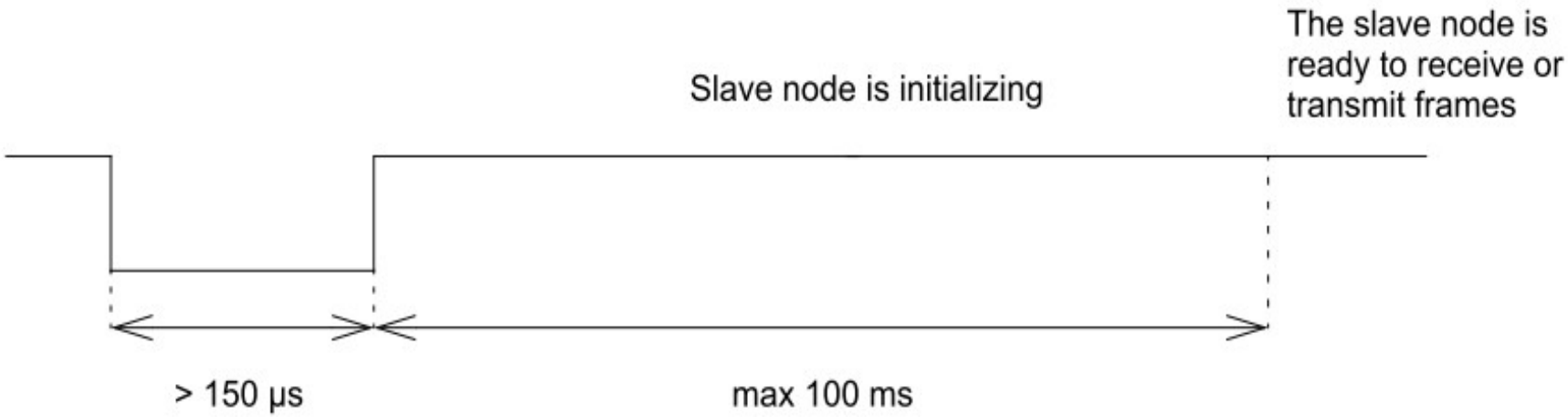
```
Normal_Schedule
{
   CEM_Frm1          delay 15 ms;
   LSM_Frm2          delay 15 ms;
   RSM_Frm2          delay 15 ms;
   Node_Status_Event delay 10 ms;
 }
```

Slave node communication state diagram



WAKE UP


250 µs - 5 ms
150 ms - 250 ms
250 µs - 5 ms
150 ms - 250 ms
250 µs - 5 ms
> 1.5 s
> 1.5 s
> 1.5 s


Slave node is initializing
The slave node is ready to receive or transmit frames
> 150 µs
max 100 ms

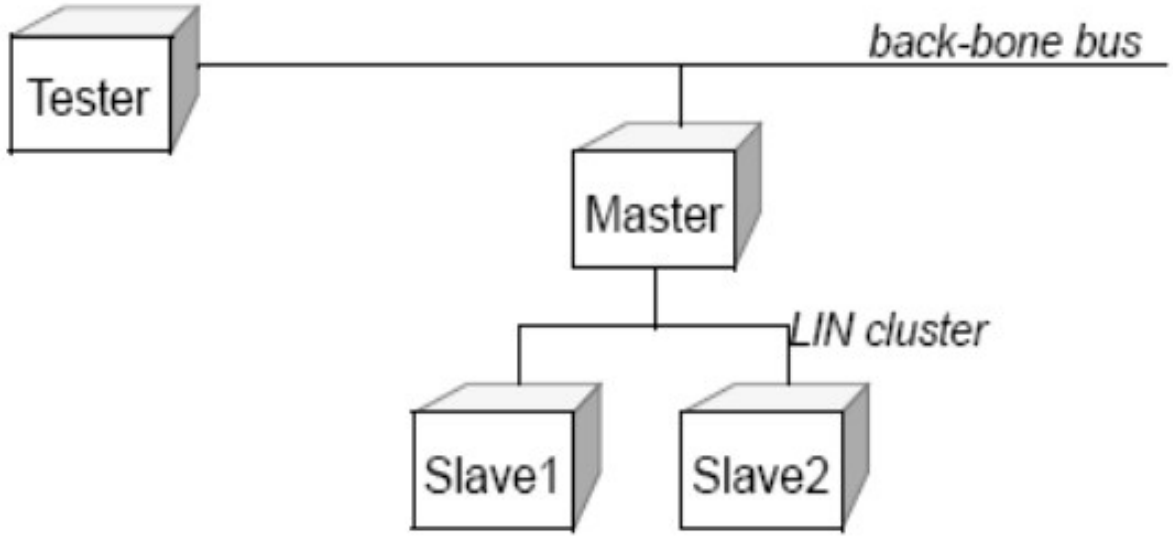
Go to sleep

data1	data2	data3	data4	data5	data6	data7	data8
0	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

LIN – Transport layer

Célja:

- Nagyobb adatmennyiség továbbítása diagnosztikai célokra.
- A CAN-nél megszokott diagnosztika használata a LIN-nél is. Példa:



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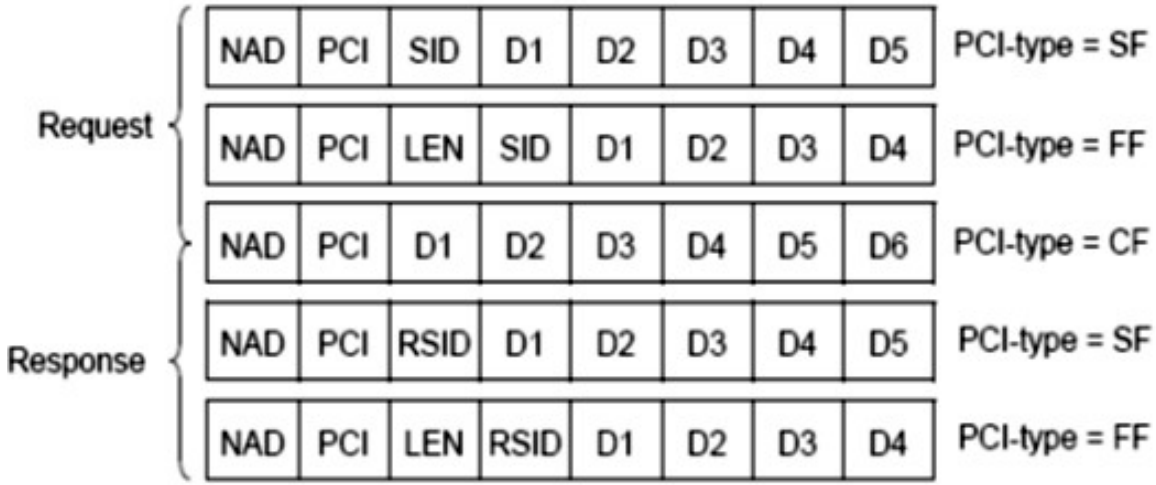
LIN – Transport layer



NAD = Node Address (csak a slave-nek van címe)
PCI = Protocol Control Information
SID = Service ID (0-0xAF, 0xB8-0xFE diagnosztika, 0xB0-0xB7 node konfig.)
RSID = Response SID
LEN = Length
SF = Single Frame
FF = First Frame
CF = Consecutive Frame

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LIN – Transport layer

Type	PCI type				Additional information			
	B7	B6	B5	B4	B3	B2	B1	B0
SF	0	0	0	0	Length			
FF	0	0	0	1	Length/256			
CF	0	0	1	0	Frame counter			

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Node configuration and identification

- A LIN node-ok konfigurálására és azonosítására
- **Product Identification:**
  - **Supplier ID** (16 bites, **0**xxxxxxx xxxxxxxx)
    A gyártóknak kiosztott egyedi cím.
    Az 1xxx... későbbi bővítésre van fenntartva.
  - **Functional ID** (16 bites): a gyártók által kiosztott cím.
    A teljesen azonos funkciót betöltő egységeknek ugyanaz a Functional ID-ja.
  - **Variant ID** (8 bites): Az azonos funkción belüli változatok megkülönböztetésére való.
  - **Serial number**: (32 bites)

Supplier codes (Supplier ID)

- 0x0001 Audi
- 0x0002 BMW
- 0x0003 Daimler AG
- 0x0004 Motorola
- 0x0005 VCT / Mentor Graphics
- 0x0006 VW (VW-Group)
- 0x0007 Volvo Cars (Ford Group)
- 0x000B Freescale Semiconductor
- 0x0011 NXP Semiconductors
- 0x0012 ST Microelectronics
- 0x0013 Melexis
- 0x0014 Microchip
- 0x0015 CRF
- 0x0016 Renesas Technology Europe GmbH
- 0x0017 Atmel
- 0x0018 Magnet Marelli
- 0x0019 NEC
- 0x001A Fujitsu
- 0x001B Opel
- 0x001C Infineon
- 0x001D AMI Semiconductor
- 0x001E Vector Informatik
- stb.

Wildcards

Property	Wildcard value
NAD	0x7F
Supplier ID	0x7FFF
Function ID	0xFFFF

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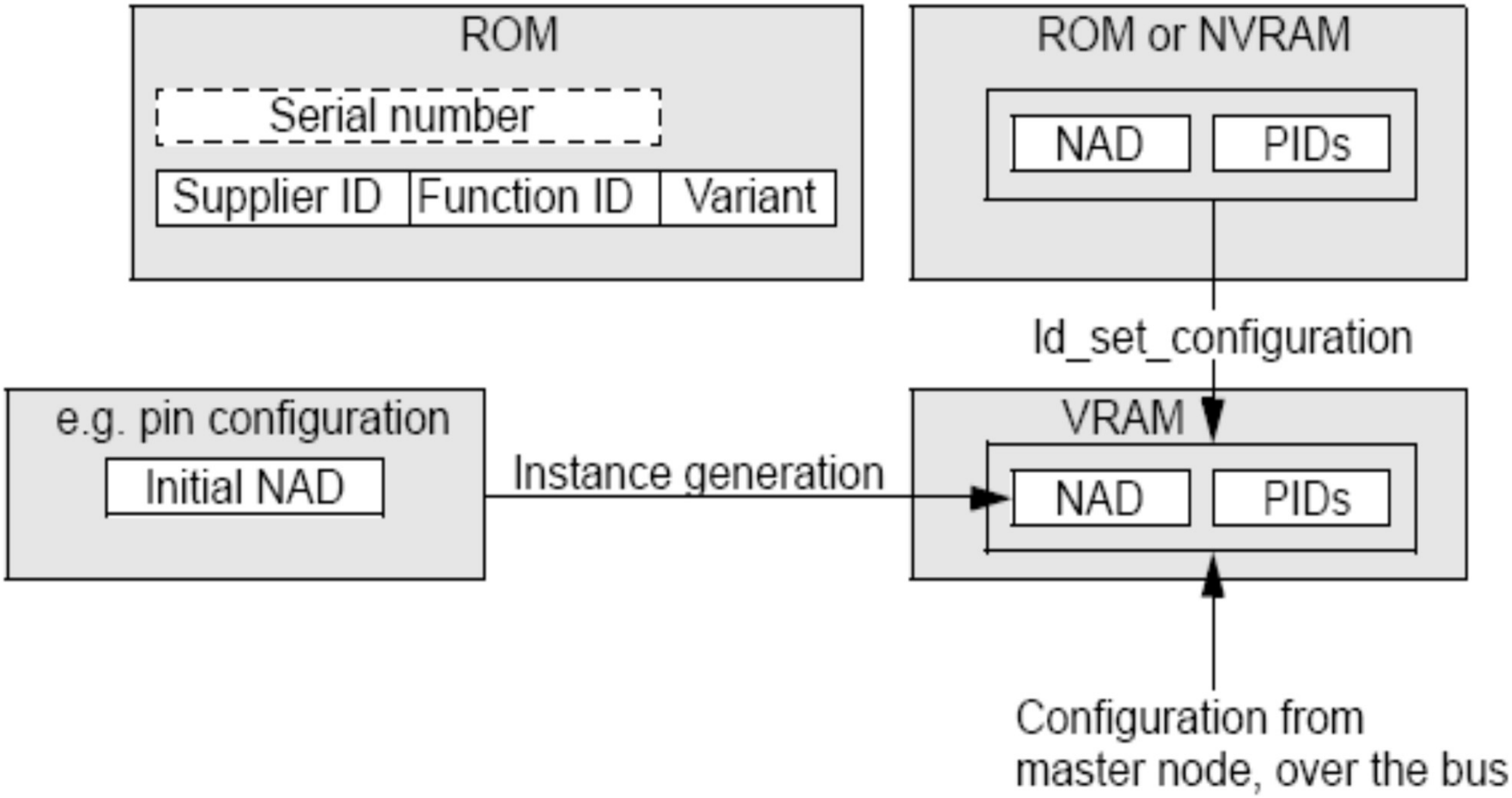
Slave node-ok konfigurálása



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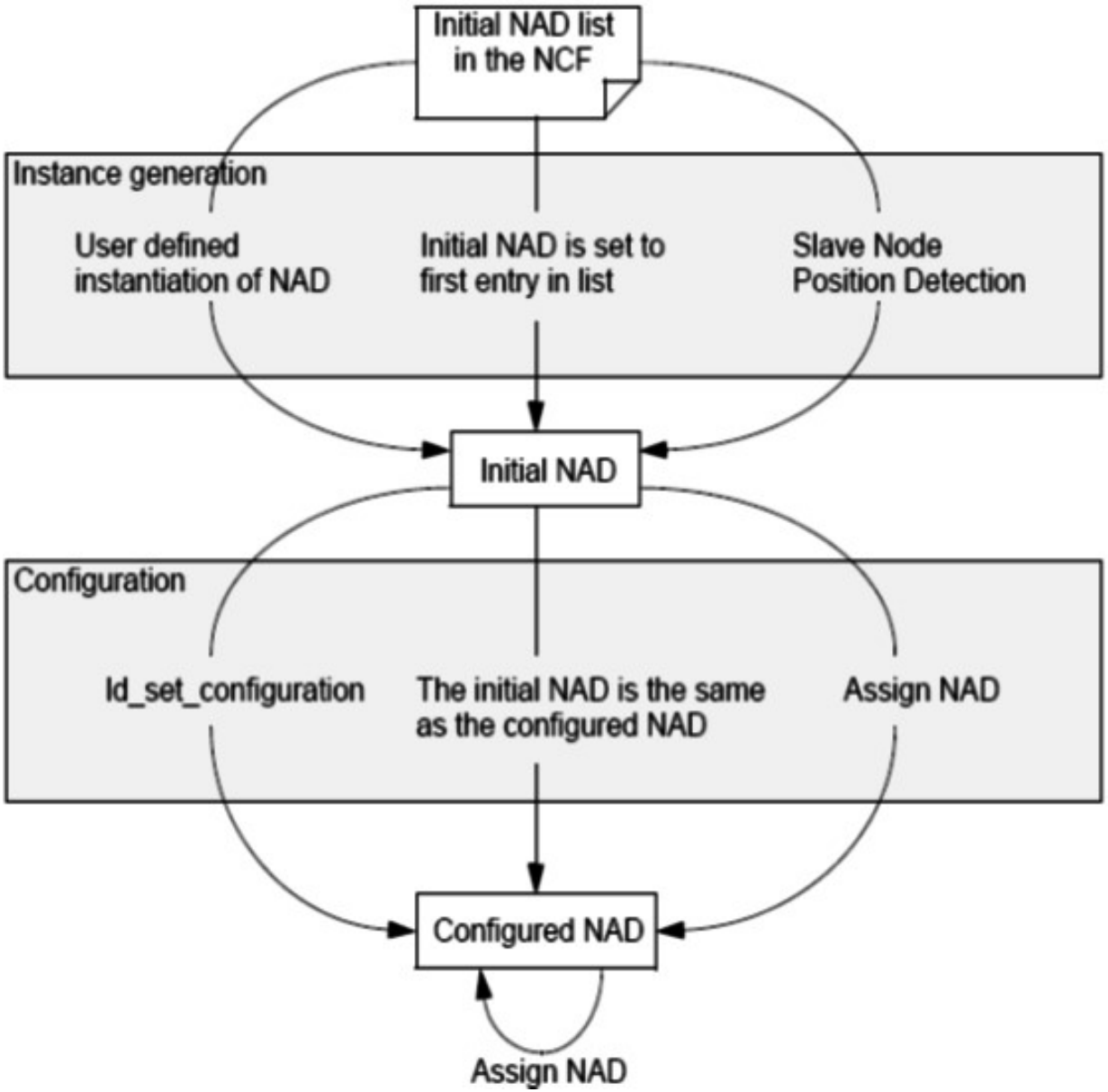
A slave node-ok kezdeti beállítása

- **Noconfigured** (nem konfigurált) slave node
  - A slave a konfigurációs adatokat RAM-ban tárolja.
  - Reset után nincs érvényes konfigurációja.
  - A masternek kell konfigurálnia a slave-et.
- **Preconfigured** (előre konfigurált) slave node
  - A slave ROM-ból tölti be az érvényes konfigurációját.
  - Reset után elvesznek az esetleges módosítások.
- **Full configured** (teljesen konfigurált) slave node
  - A slave a mindenkori aktuális konfigurációját NVRAM-ban tárolja.
  - Mindig van érvényes konfigurációja.

NAD beállítás/konfigurálás



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NAD értékek

NAD value	Description
0	Reserved for go to sleep command, see Section 2.6.3
1 - 125 (0x7D)	Slave node addresses (NAD)
126 (0x7E)	Functional node address (functional NAD), only used for diagnostics (using the transport layer)
127 (0x7F)	Slave node address broadcast (broadcast NAD)
128 (0x80) - 255 (0xFF)	Free usage. Diagnostic frames with the first byte in the range 128 (0x80) to 255 (0xFF) are allocated for free usage since the LIN 1.2 standard. See user defined diagnostics Section 5.2.6.

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SID

SID	Service	type	Reference
0 - 0xAF	reserved	reserved	See ISO15765-3 [4]
0xB0	Assign NAD	Optional	Section 4.2.5.1
0xB1	Assign frame identifier	Obsolete	See LIN2.0 specification
0xB2	Read by Identifier	Mandatory	Section 4.2.6.1
0xB3	Conditional Change NAD	Optional	Section 4.2.5.2
0xB4	Data Dump	Optional	Section 4.2.5.3
0xB5	Assign NAD via SNPD	Reserved by SNPD	See Node Position Detection specification [2]
0xB6	Save Configuration	Optional	Section 4.2.5.4
0xB7	Assign frame identifier range	Mandatory	Section 4.2.5.5
0xB8 - 0xFF	reserved	reserved	See ISO15765-3

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NAD

NAD megváltoztatása (Initial NAD -> New NAD)

NAD	PCI	SID	D1	D2	D3	D4	D5
Initial NAD	0x06	0xB0	Supplier ID LSB	Supplier ID MSB	Function ID LSB	Function ID MSB	New NAD

Pozitív válasz

NAD	PCI	RSID	Unused				
Initial NAD	0x01	0xF0	0xFF	0xFF	0xFF	0xFF	0xFF

Conditional change NAD

NAD	PCI	SID	D1	D2	D3	D4	D5
NAD	0x06	0xb3	Id	Byte	Mask	Invert	New NAD

Pozitív válasz

NAD	PCI	RSID	Unused				
NAD	0x01	0xF3	0xFF	0xFF	0xFF	0xFF	0xFF

Egyéb parancsok:

- Data dump
- Save configuration
- Assign frame ID range
- Read by identifier

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LIN diagnosztika

- Diagnosztikai osztályok:
  - Class I (signal alapú)
  - Class II (Class I + node identification)
  - Class III (teljes funkcionalitású diagnosztika)

LIN diagnosztika

Slave Diagnostic Class	I	II	III	UDS service index [Hex]
Diagnostic Transport Protocol Requirements				
Single frame transport only	+			
Full transport protocol (multi-segment)		+	+	
Required Configuration Services				
Assign frame identifier range	+	+	+	0xB7
Read by identifier (0 = product id)	+	+	+	0xB2 0x00
Read by identifier (all others)	optional	optional	+	0xB2 0xXX
Assign NAD	optional	optional	optional	0xB0
Conditional change NAD	optional	optional	optional	0xB3
Positive response on supported configuration services	+	+	+	service + 0x40
Required UDS Services				
Read data by identifier:				0x22
- hardware and software version		+	+	0x22
- hardware part number (OEM specific)		+	+	0x22
- diagnostic version		+	+	0x22
Read by identifier (parameters)		+	+	0x22
Write by identifier (parameters)		if applicable	if applicable	0x2E

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LIN diagnosztika

Slave Diagnostic Class	I	II	III	UDS service index [Hex]
Session control			+	0x10
Read by identifier (sensor and actuator data)			+	0x22
I/O control by identifier			+	0x2F
Read and clear DTC (fault memory)			+	0x19, 0x14
Routine control			if applicable	0x31
Other diagnostic services			if applicable	...
Flash Reprogramming Services				
Flash programming services			optional	0xXX

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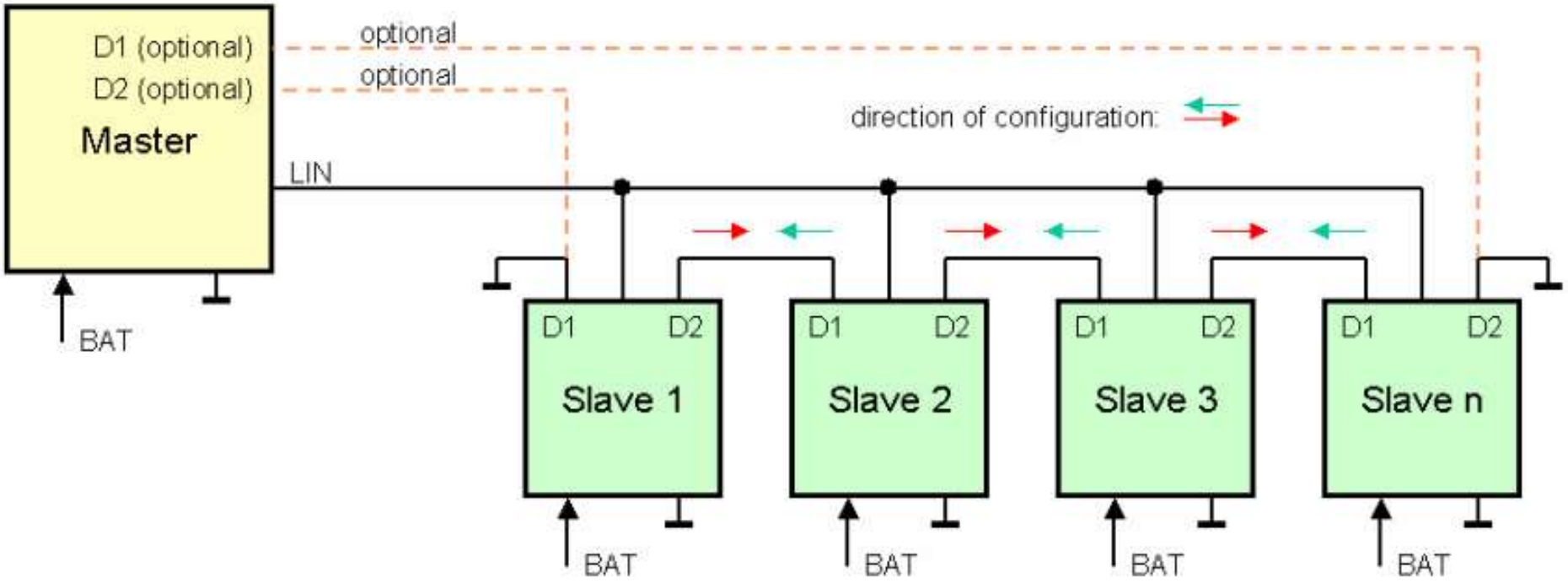
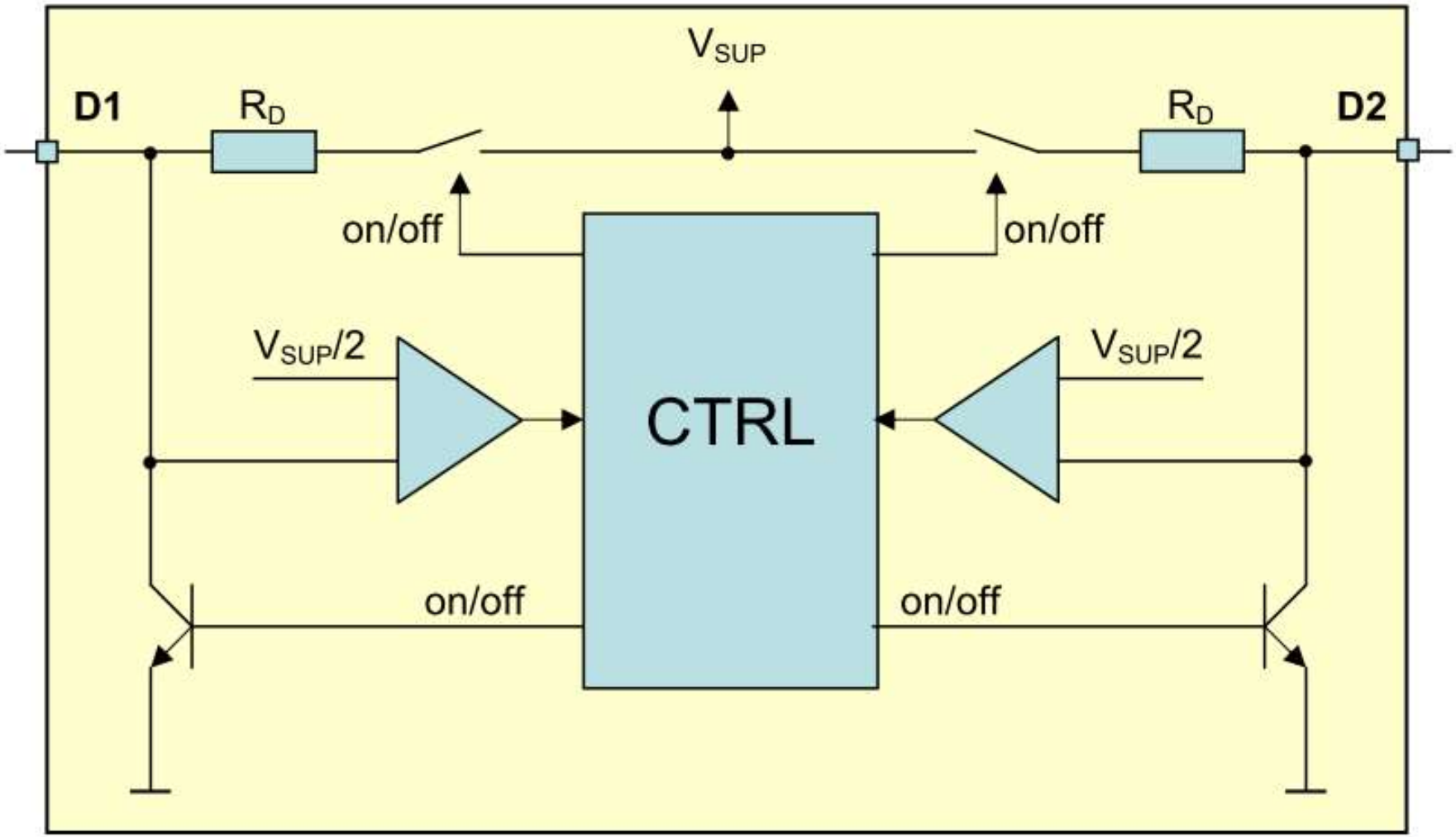
Slave Node Position Detection (SNPD)

- Extra Wire Daisy Chain (XWDC)
- LIN Switch Method (LSM)
- Bus Shunt Method (BSM)
- …

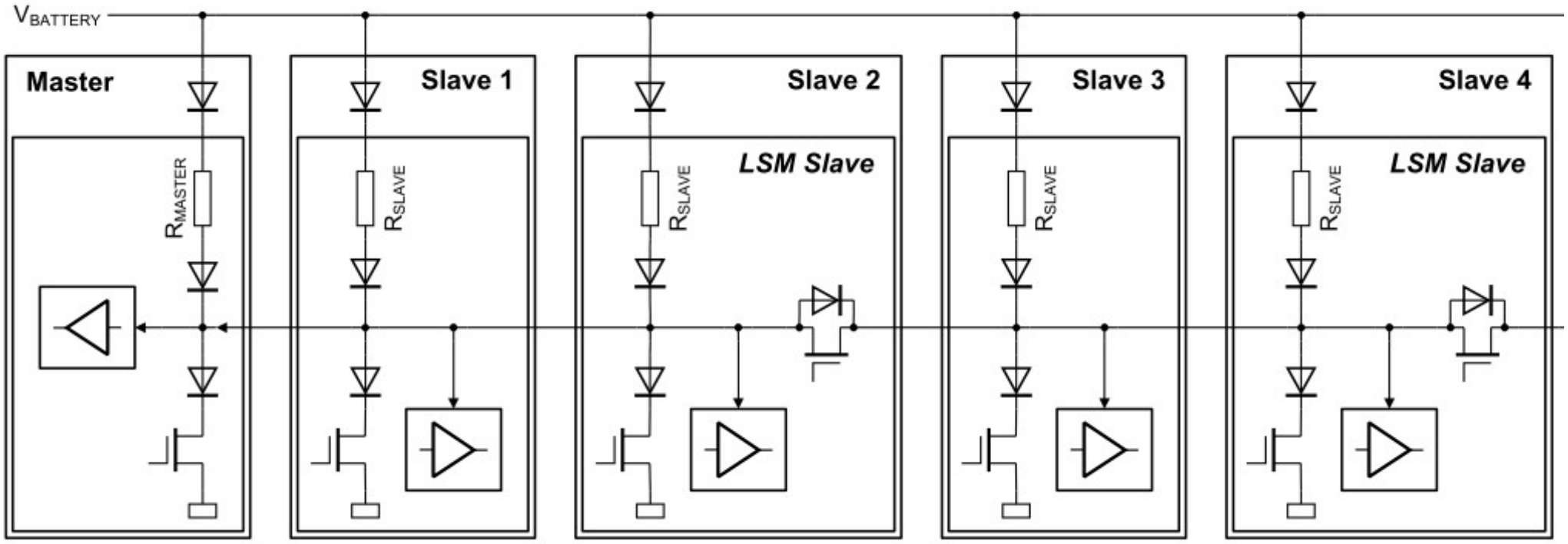
Extra Wire Daisy Chain (XWDC)



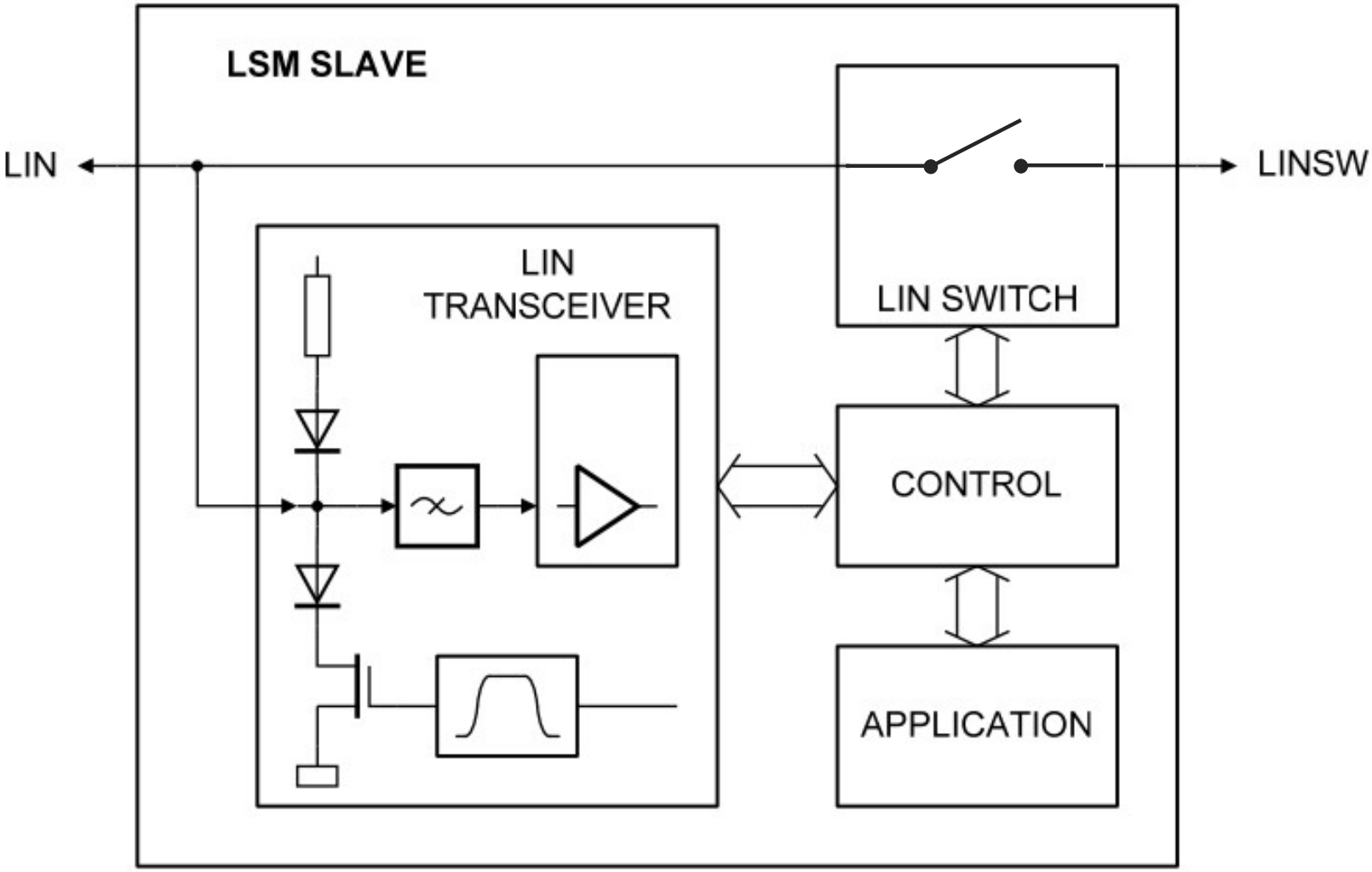
Extra Wire Daisy Chain (XWDC)



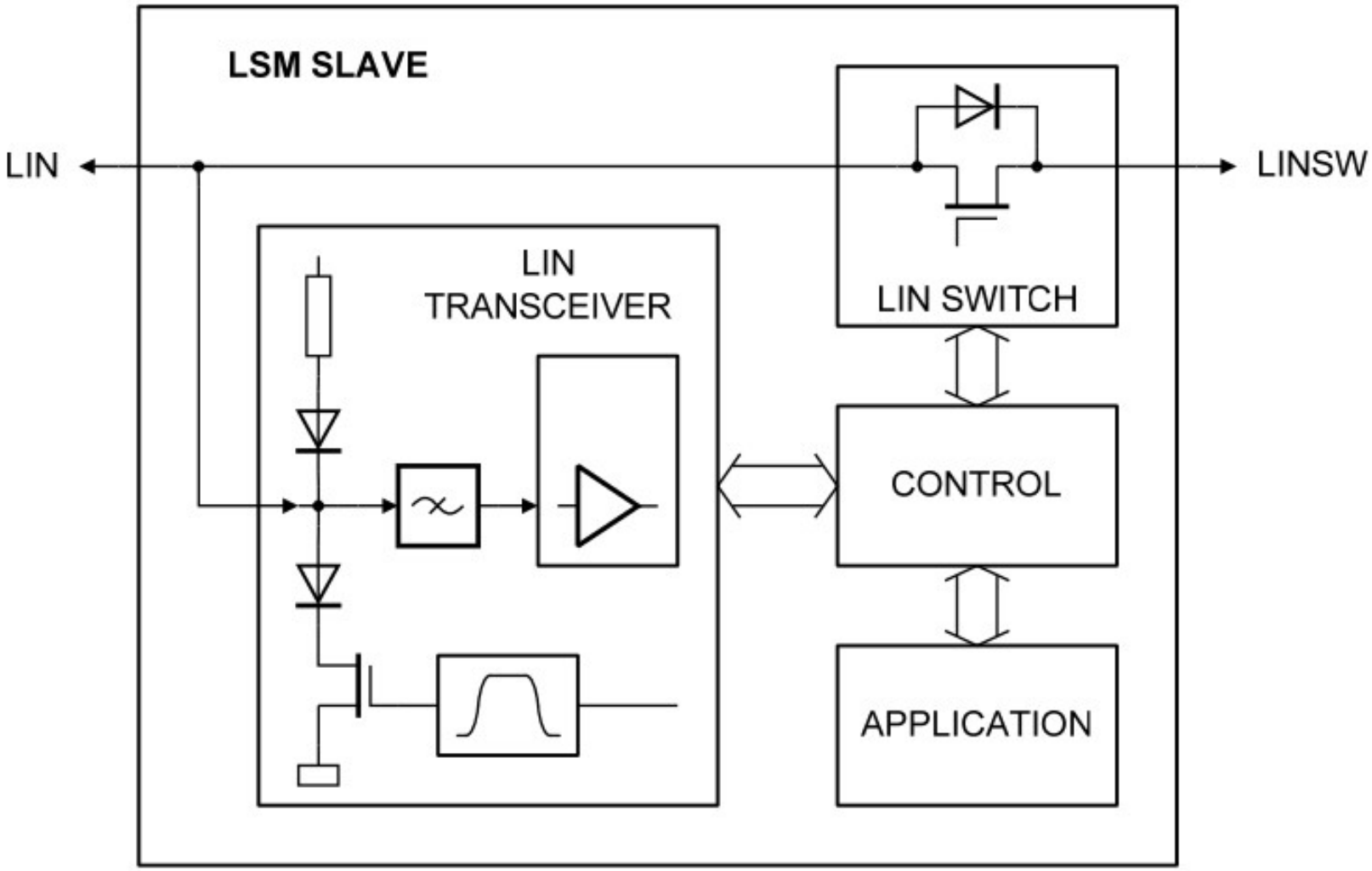
LIN Switch Method (LSM)



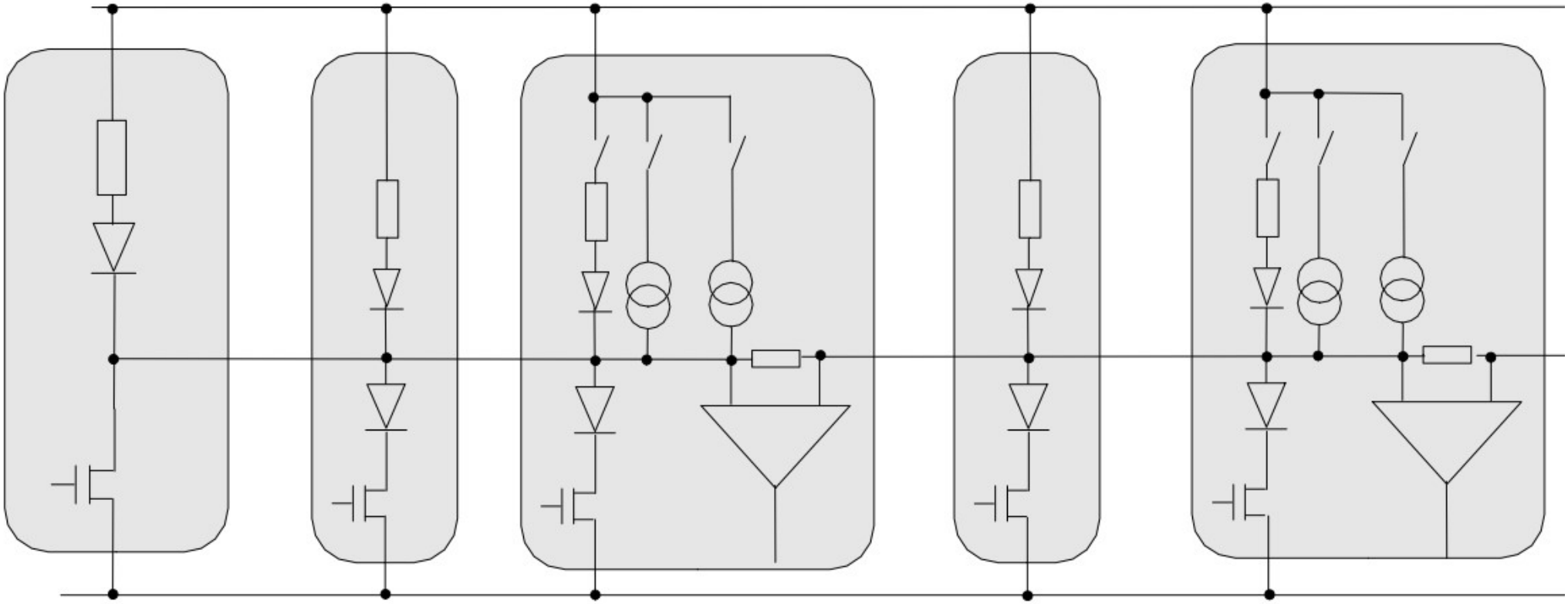
LIN Switch Method (LSM)



LIN Switch Method (LSM)

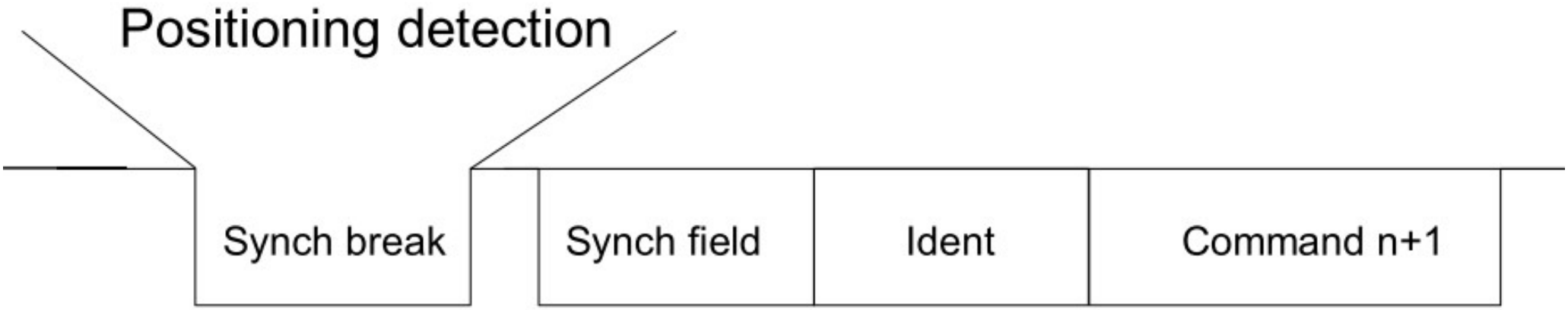


Bus Shunt Method (BSM)

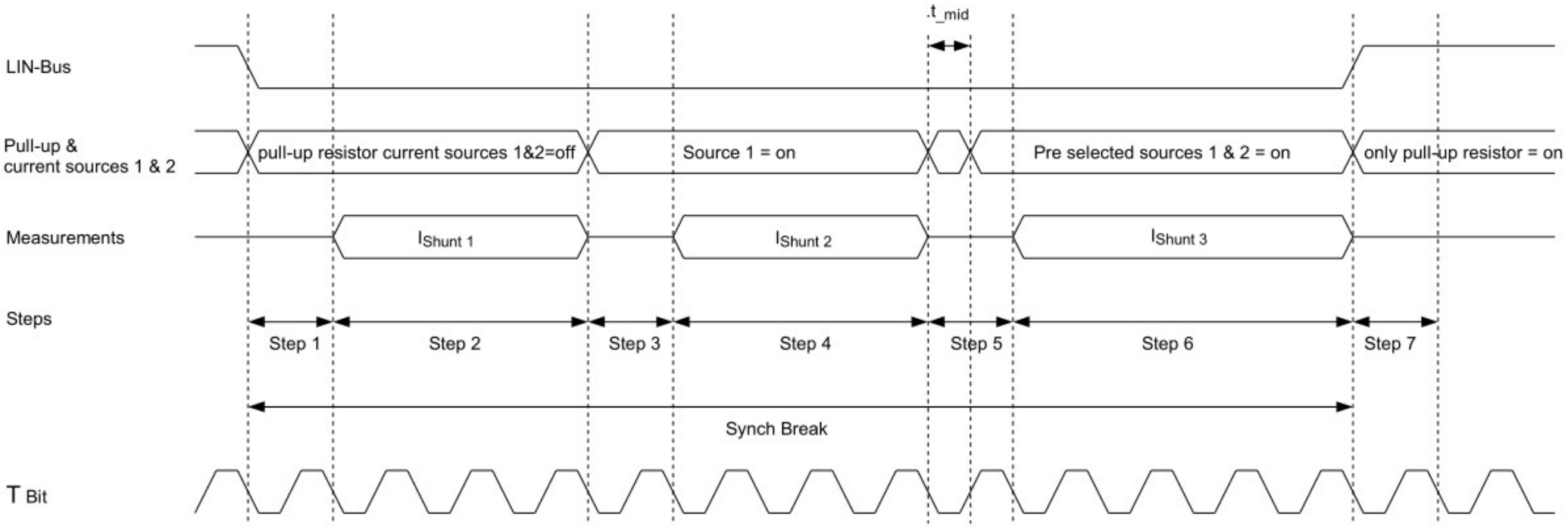


MASTER SLAVE 1 SNPD SLAVE 1 SLAVE 2 SNPD SLAVE 2

Bus Shunt Method (BSM)

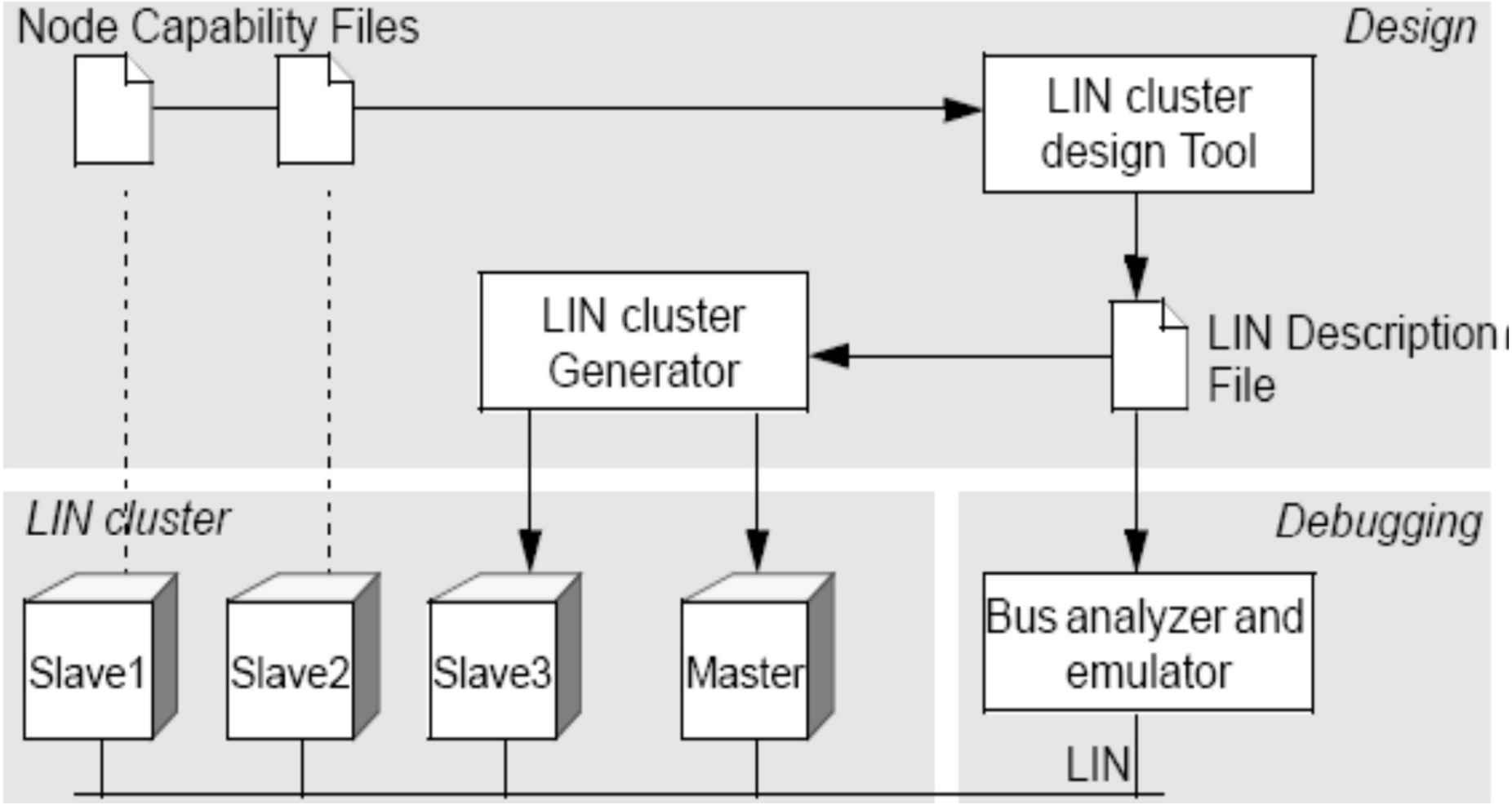


Bus Shunt Method (BSM)



LIN cluster development

Node Capability File, LIN Description File



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Vége