**IEEE P802.15**

**Wireless Personal Area Networks**

|  |  |  |
| --- | --- | --- |
| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | **D4 Comment resolution instructions** | |
| Date Submitted | 14 July 2021 | |
| Source | Bober, Kai Lennert Fraunhofer HHI | Voice: - Fax: - E-mail: bober@ieee.org |
| Re: | Comment resolution on D4 | |
| Abstract | This document contains proposed resolutions for CIDs on D4.0 | |
| Purpose | Aid comment resolution | |
| Notice | This document has been prepared to assist the IEEE P802.15. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein. | |
| Release | The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.15. | |

**Legend:**

* Arial size 13 indicates subsections for individual comments
* Red underlined text needs to be adapted during the comment implementation (e.g. because it is a reference).
* Bold italic text is an instruction to the editor to implement the text

CID A-19

***Remove the definition of HCM on page 20***

***Remove the following text from P27L28-31:***

, M-ary pulse amplitude modulation (PAM) with Hadamard-coded modulation (HCM) without the all-ones code

***Change P28L17-19 as follows:***

Binary pulse-amplitude modulation (2-PAM) with 8B10B line coding, as defined in 9.3.5 is supported. It is combined with Reed-Solomon (RS) forward error correction (FEC) to correct errors due to the noise.

***Remove HCM Allocation element from Table 4 Control frame subtypes.***

***Remove 6.6.17 HCM Allocation element and renumber the subsequent clauses.***

***Change 6.6.20 as follows:***

**6.6.20 PM-PHY MCS element**

The *PM-PHY MCS* element, shown in 0, holds a subset of supported MCS for the PM-PHY.

|  |
| --- |
| **1 Octet** |
| Clock Rates |

**PM-PHY MCS element**

**Clock Rates:** A bitmap indicating the set of supported clock rates. Reserved bits shall be set to zero. A one in the bitmap indicates that the given clock rate is supported. A zero indicates that the clock rate is not supported. 0 shows the bitmap structure.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | processed first | | | | processed  last | | | | |
| 1. **Bit in the bitmap:** | 0 | 1 | 2 | 3 | | 4 | 5 | 6 | 7 |
| 1. **Clock rate:** | 12.5 MHz | 25 MHz | 50 MHz | 100 MHz | | 200 MHz | reserved | reserved | reserved |

**Clock rate bitmap**

***Remove entry 13 HCM Allocation from table 12***

***Remove capHcm from table 37***

***Replace the sentence “PM-PHY enables moderate data rates from 1 Mb/s to some 100 Mb/s.” with:***

PM-PHY enables moderate data rates up to around 100 Mb/s.

***Change the sentences on P103L7-11 as follows:***

2-PAM with 8B10B line coding and RS FEC is used. The PM-PHY includes means to adapt the data rate of the link to varying channel conditions by varying the clock rate on a per PPDU basis.

***Change table 39 as follows:***

* ***Modulation: 2-PAM***
* ***Line Coding: 8B10B***
* ***Replace “Data rates with 2-PAM and 8b10b” with “Data rates”***
* ***Remove the “Min” column”***

***Replace the text on P103L15-16 with***

The base MCS for the PM-PHY use a 12.5 MHz clock rate.

***Change the sentence in P104L12 as follows:***

PPDU header fields that contain numbers shall be transmitted starting with the LSB of the number first to the MSB of the number last.

***Remove “independent of the clock rate” in P104L16.***

***Change P104L19 as follows:***

The second section is intended for channel estimation and synchronization. It enables cross- and autocorrelation with an appropriate window size.

NOTE – The general approach has been described by Schmidl and Cox [B12], Minn et al. [B3], Schellmann et al. [B10] and Goroshko et al. [B9].

For the preamble, the base sequence A8, a specific pseudo-noise sequence of length eight is used, as defined in B.2. A8 is repeated six times yielding a total sequence length of Each base sequence of length eight is multiplied with positive or negative sign as given below which is known to create a sharper peak after autocorrelation, compared to a double sequence of the same total length as described by Goroshko [B9]. The total preamble reads [A8 A8 A8 A8 A8 A8] where for elements of the sequence. The preamble is finally passed through the 2-PAM Modulator.

***Remove table 41.***

***Delete “data stream /” in P106L7***

***Remove “The MCS ID is composed as depicted in Figure 75.” in P107L12-13***

***Remove figure 75***

***Change text in P107L15-L20 as follows:***

MCSs are defined by the applied clock rate. The Clock Rate ID describes the used clock rate as defined in Table 43. The data rate for each MCS can be derived based on the corresponding clock rate and cyclic prefix duration. For instance, using RS(256,248) with 2-PAM, 8B10B and clock rate 12.5 MHz yields 9.6 Mb/s.

Table X ***(TE: adapt number)*** defines the relationship between MCS ID and clock rate.

***Insert a new table X at the end of subclause 9.2.5 as follows:***

***Create two columns MCS ID, Clock rate***

***Insert a row: MCS ID 0, Clock rate 12.5 MHz***

***Insert a row: MCS ID 1, Clock rate 25 MHz***

***Insert a row: MCS ID 2, Clock rate 50 MHz***

***Insert a row: MCS ID 3, Clock rate 100 MHz***

***Insert a row: MCS ID 4, Clock rate 200 MHz***

***Change “Channel estimation sequence, defined in B.2” to “Payload Channel estimation sequence, defined in B.2” in table 43.***

***Remove “For specific MCS, only a subset of the blocks may be used.” in P107L25.***

***Replace figure 76 with the following figure:***



***Change the text in P108L3-14 as follows:***

Header or payload data enters the transmitter and is scrambled in order to randomize uncoordinated interference. 8B10B line coding is applied as the second step. For FEC, the payload uses RS(256, 248) and the header uses RS(36, 24).

NOTE - According to Ivry [B4] and Boada [B5], a particular order of line and channel coding shown in Figure 76 achieves lowest error rates. After FEC, only the systematic part of the binary output code word (248 bits) is well balanced.

For maintaining a constant average light output, also the redundant part of the binary code word (360 – 240 = 120 bits in case of header data and 2560-2480 = 80 bits in case of payload data) passes through 8B10B line encoder. Both parts are concatenated again in a multiplexer. Subsequently, 2-PAM bit-to-symbol mapping is applied for the header.

***Remove the column Clock Rate ID in table 43***

***Remove P109L17-19.***

***Change text in P109L21-P110L2 as follows:***

The bit-to-symbol mapper is using PAM with two levels. For two levels, each input bit is mapped in one symbol. The symbols are mapped to levels as {0, 1} to {0, 1}, respectively.

***Remove table 44***

***Remove 9.3.7.***

***Remove Annex B.4***

***Remove Annex C.1***

CID I-13 / I-191 / I-9 / A-20

Replace figure 85 with the following graphic:



CID I-32 (PICS)

Insert the following new Annex:

Annex D

(normative)

Protocol implementation conformance statement (PICS) proforma

D.1 Introduction

This annex contains the PICS for IEEE Std 802.15.13. Its purpose is to provide a statement about the implemented capabilities and options in a given entity. Vendors shall complete the following PICS with respect to their entity claimed to comply with the IEEE Std 802.15.13.

D.2 Format and completion of the PICS

The PICS consists of multiple tables that list the available capabilities and options of the standard. Each Table contains functional modules of the standard and possible optional features of the respective module.

For each feature, an ID, item description and reference to the relevant clause in the standard document is given. The dependency column indicates other features that need to be implemented if the given feature is implemented. This is typically, because the given feature relies on functionality of other features.

D.3 Capabilities and options

Table D+1 Device types

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| DT1 | The entity is device-capable |  |  |  |  |  |
| DT2 | The entity is coordinator-capable. |  |  |  |  |  |

Table D+2 General device functions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| GDF1 | The entity is able to transmit an MPDU. |  |  |  |  |  |
| GDF2 | The entity is able to receive an MPDU. |  |  |  |  |  |
| GDF3 | The entity is able to handle generation and parsing of MPDU format version |  |  |  |  |  |
| GDF4 | The entity is able to perform an association request, parse an association response and retry the request when required. |  |  |  |  |  |
| GDF5 | Scanning for active OWPANs. |  |  |  |  |  |
| GDF6 | The entity is able to disassociate from an OWPAN. |  |  |  |  |  |

Table D+3 Beacon-enabled channel access

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| BECA1 | The entity is able to generate and transmit beacon frames in a time-triggered manner. |  |  |  |  |  |
| BECA2 | The entity is able to generate superframe schedules and transmit CAP and GTS allocations to devices. |  |  |  |  |  |
| BECA2.1 | The entity is able to regard for guard intervals in the generation of a superframe schedule. |  |  |  |  |  |
| BECA3 | The entity is able to parse Beacon frames and handle the included information. |  |  |  |  |  |
| BECA4 | The entity is able to synchronize the local clock based on a received beacon frame. |  |  |  |  |  |
| BECA5 | The entity is able to perform channel access in the CAP, including backoff upon failure detection. |  |  |  |  |  |
| BECA6 | The entity is able to issue GTS requests. |  |  |  |  |  |
| BECA7 | The entity is able to parse GTS allocation elements. |  |  |  |  |  |
| BECA8 | The entity is able to perform timed medium access in the CFP in eligible superframe slots. |  |  |  |  |  |
| BECA8.1 | The entity is able to regard for the TAIFS when operating in half duplex mode. |  |  |  |  |  |

Table D+4 Non-beacon-enabled channel access

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| NBECA1 | The entity is able to transmit poll frames in order to advertise a maintained OWPAN and initiate the polling cycle. |  |  |  |  |  |
| NBECA1 | The entity is able to parse Poll frames, handle the included information, and perform transmissions in accordance with the polling-based medium access specification. |  |  |  |  |  |

Table D+5 Coordinator device functions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| CDF1 | The entity is able to start an OWPAN after receiving the relevant MLME primitive. |  |  |  |  |  |
| CDF1 | The entity is able to handle a request for association from an unassociated device. |  |  |  |  |  |

| Table D+6 MPDU fragmentation and reassembly | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| MPDUFR1 | The entity is able to fragment outgoing MSDUs according to the specification. |  |  |  |  |  |
| MPDUFR1 | The entity is able to reassemble received fragmented MSDUs |  |  |  |  |  |

Table D+7 MSDU aggregation

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| MSDUA1 | The entity is able to aggregate |  |  |  |  |  |
| MSDUA1 |  |  |  |  |  |  |

Table D+8 Attribute change procedure

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| ACP1 | The entity is able to initiate the setting of an attribute in an associated device. |  |  |  |  |  |
| ACP2 | The entity is able to process the request to change an attribute. |  |  |  |  |  |

Table D+9 Multi-rate transmission

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| AT1 | The entity transmits essential frames and elements with the PHYs base MCS. |  |  |  |  |  |
| AT2 | The entity is able to transmit an MCS request to a device. |  |  |  |  |  |
| AT2.1 | The entity is able to handle an MCS request for the PHY it supports. |  |  |  |  |  |

Table D+10 Interference detection

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| MID1 | The entity is able to detect interfering, non-decodable signals above an energy threshold. |  |  |  |  |  |
| MID2 | The entity is able to detect interfering transmissions by being able to parse MPDUs in case a supported PHY and MPDU version is used. |  |  |  |  |  |
| MID3 | The entity is able to issue an |  |  |  |  |  |

Table D+11 Adaptive MIMO transmission

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| MID1 | The entity is able to transmit a single PPDU over different connected OFEs. |  |  |  |  |  |
| MID2 | The entity is able to delay the transmission of a single PPDU on a per-OFE basis. |  |  |  |  |  |
| MID3 | The entity is able to transmit multiple different PPDUs over different connected OFEs. |  |  |  |  |  |
| MID4 | The entity is able to handle explicit MIMO channel feedback and adapt the transmission over different connected OFEs accordingly. |  |  |  |  |  |
| MID5 | The entity is able to handle CSI feedback obtained at the PHY and feed it back to another device. |  |  |  |  |  |

| **Table D+12 Protected transmission** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| MPT1 | The entity is able to assign sequence numbers to outgoing MPDUs. |  |  |  |  |  |
| MPT2 | The entity is able to retransmit an outgoing MPDU if an ACK was not received after a specified timeout. |  |  |  |  |  |
| MPT3 | The entity is able to handle sequence numbers of incoming MPDUs. |  |  |  |  |  |
| MPT3.1 | The entity is able to identify duplicate received MPDUs and not hand them to the higher layers. |  |  |  |  |  |
| MPT4 | The entity is able to transmit a single ACK to acknowledge the successful reception of an MPDU with ACK request set. |  |  |  |  |  |
| MPT5 | The entity is able to transmit a block ACK to acknowledge the reception of more than one successfully received MPDUs. |  |  |  |  |  |

Table D+13 MAC frames

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| MF1 | The entity is able to generate and parse non-optional fields of the general MPDU format. |  |  |  |  |  |
| MF2 | The entity is able to parse |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Table D+14 MAC data frame type

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| MDFT1 | The entity is able to parse MDPUs with type data and subtype single MSDU. |  |  |  |  |  |
| MDFT2 | The entity is able parse MPDUs with type data and subtype Aggregated MSDU. |  |  |  |  |  |
| MDFT3 | The entity is able to parse MPDUs with type data and subtype Null Data. |  |  |  |  |  |

| **Table D+15 MAC management frame type** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| MMFT1 | The entity is able to parse MDPUs with type management and subtype Association Request. |  |  |  |  |  |
| MMFT2 | The entity is able to parse MDPUs with type management and subtype Association Response. |  |  |  |  |  |
| MMFT3 | The entity is able to parse MDPUs with type management and subtype Disassociation Notification. |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

Alien Signal

Poll

Poll request

Poll response - not implemented

Variable Element Container Element

Attribute Change Request

Attribute Change Response

| Table D+16 MAC control frame type | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| MCFT1 | The entity is able to parse MDPUs with type control and subtype ACK. |  |  |  |  |  |
| MCFT2 | Block ACK |  |  |  |  |  |
| MCFT3 | Block ACK Request |  |  |  |  |  |
|  | MCS Request |  |  |  |  |  |
|  | GTS Request |  |  |  |  |  |
|  | GTS Allocation |  |  |  |  |  |
|  | GTS Allocation List |  |  |  |  |  |
|  | Variable Element Container |  |  |  |  |  |
|  | Beacon |  |  |  |  |  |
|  | Random Access |  |  |  |  |  |
|  | BAT Request |  |  |  |  |  |
|  | Explicit MIMO Feedback |  |  |  |  |  |
|  | HCM Allocation |  |  |  |  |  |
|  | Vendor Specific Element |  |  |  |  |  |

**6.6**

Association Request Element

Association Response Element

Disassociation Notification Element

Superframe Descriptor Element

Capability List Element

GTS Descriptor List Element

GTS Descriptor Element

Explicit MIMO Feedback Element

MSDU Aggregation Element

ACK Element

Block ACK Request Element

Block ACK Element

MCS Request Element

BAT Request Element

GTS Request Element

HCM Allocation Element

Alien Signal Element

Supported MCS Element

PM-PHY MCS Element

LB-PHY MCS Element

HB-PHY MCS Element

Random Access Element

Attribute Change Request Element

Attribute Change Response Element

Variable Element Container Element

Vendor Specific Element

| Table D+17 MLME primitives | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| MCPSP1 | The entity provides an MCPS interface supporting the MCPS-DATA.request primitive. |  |  |  |  |  |
| MCPSP2 | The entity provides an MCPS interface supporting the MCPS-DATA.indication primitive. |  |  |  |  |  |

| Table D+18 MLME primitives | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| Item number | Item description | Reference | Status | Support | | |
| N/A | Yes | No |
| MLMEP1 | The entity is able to parse MDPUs with type control and subtype ACK. |  |  |  |  |  |
| MLMEP2 | MLME-Disassociate |  |  |  |  |  |
| MLMEP3 | MLME-GET |  |  |  |  |  |
| MLMEP4 | MLME-SET |  |  |  |  |  |
| MLMEP5 | MLME-SCAN |  |  |  |  |  |

MAC-PIB

MAC-Capabilities

CID I-306

Change the contents of 4.5.1 as follows:

The IEEE Std 802.15.13 architecture is defined in terms of layers. The standard includes a specification of the PHY and MAC sublayer and their exposed interfaces. Each layer is responsible for one part of the standard and offers its services to the next higher layer. Layers make use of service access points (SAPs) based on primitives, as described in the subclause 5.8 "Concept of primitives" in IEEE Std 802.15.4-2020. Figure 5X depicts the architecture of a single device. The MAC sublayer and the PHY are described in more detail in 5.5.3 and 5.5.2.



Figure 5X OWPAN device architecture

The IEEE Std 802.15.13 MAC sublayer controls access to the medium for all types of transfers. It provides the MCPS-SAP and MLME-SAP to the higher layers. Its MCPS-SAP allows the next higher protocol layer to transmit MSDUs between peer IEEE Std 802.15.13 devices. The higher layers are a network layer, which provides network configuration, manipulation, and message routing, and an application layer, which provides the intended function of the device. The definition of these higher layers is outside the scope of this standard.

Each device involves a device management entity (DME), responsible for managing the device and OWPAN. The DME invokes MAC layer management entity (MLME) functionality through the MLME service access point (MLME-SAP). The MLME-SAP defines a set of essential primitives for network operation. Further functionality may be provided by the MAC sublayer to the DME in an implementation-specific manner.

The PHY contains the optical wireless transceiver, which is responsible for turning a PSDU into a PPDU for transmission. Thus, a series of data bits from the MAC sublayer, is transformed into an analog signal through signal processing. PSDUs, i.e., MPDUs from the MAC sublayer, are transferred through the PD-SAP of the PHY. Management functions of the PHY are invoked through the PLME-SAP.

The relationship between data units of the different layers is depicted in Figure 6X.



Figure 6X Relationship between data units of the different layers

Ensure that acronyms in the aforementioned change are correctly expanded.

CID I-243

Replace figure 90 with the following graphic:



Replace figure 91 with the following graphic:



Replace figure 92 with the following graphic:



CID I-52

Change P37L13 as follows:

[0, 𝐶𝑊],

Replace figure 9 with the following graphic:



CID I-58

CID I-59

CID I-169

Replace “AttributeId” with “Attribute” in P92L11.

Replace “AttributeId” with “Attribute” in Table 25

Replace the valid range in table 25 with

Valid attributes as listed in table 35.

Replace the description in table 25 with

The attribute to get.

Replace “AttributeId” with “Attribute” in P92L20.

Replace “AttributeId” with “Attribute” in Table 26 column 2

Replace the valid range in table 26 column 2 with

Valid attributes as listed in table 35.

Replace the description in table 26 column 2 with

The attribute that was requested.

Replace the description in table 26 column 3 with

The value of the attribute that was requested.

Replace “AttributeId” with “Attribute” in P93L11.

Replace “AttributeId” with “Attribute” in Table 27 column 2

Replace the valid range in table 27 column 2 with

Valid attributes as listed in table 35.

Replace the description in table 27 column 2 with

The attribute to set.

Replace “AttributeId” with “Attribute” in P94L3.

Replace “AttributeId” with “Attribute” in Table 28 column 2

Replace the valid range in table 28 column 2 with

Valid attributes as listed in table 35.

Replace the description in table 28 column 2 with

The attribute that was requested to be set.

Replace the description in table 28 column 3 with

The value of the attribute that was requested to be set.

CID I-337

Replace figure 12 with the following graphic:



Replace figure 13 with the following graphic:



Replace figure 14 with the following graphic:



Replace figure 15 with the following graphic:



Replace figure 16 with the following graphic:



Replace figure 17 with the following graphic:



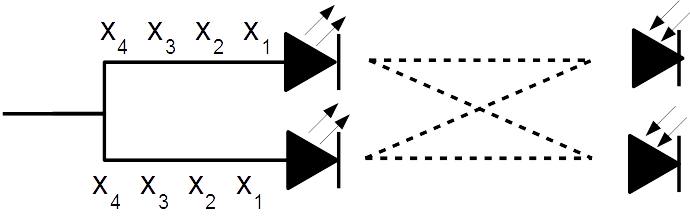
Replace figure 18 with the following graphic:



CID I-357 / I-10

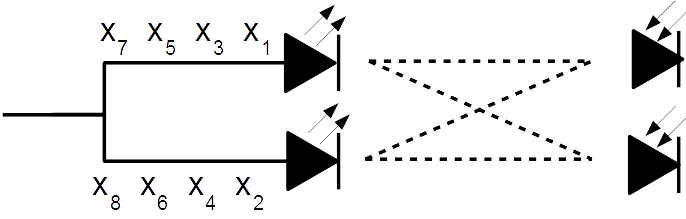
Replace line P58L33 to P59L6 with the following text and figures:

In the repetition coding, the same information is transmitted from all OFEs as shown in Figure 25. Solid lines indicate wires to the transmitter and dashed lines indicate light communication. Figure 25 depicts two light emitters at the left and two light receivers, i.e. photo diodes, at the right.



**Figure 25 Repetition coding for adaptive MIMO communication**

In the spatial multiplexing case, every OFE sends independent information as shown in Figure 26. The MCS of each OFE is provided separately. Solid lines indicate wires to the transmitter and dashed lines indicate light communication. Figure 26 depicts two light emitters at the left and two light receivers, i.e. photo diodes, at the right.



**Figure 26 Spatial multiplexing for adaptive MIMO communication**