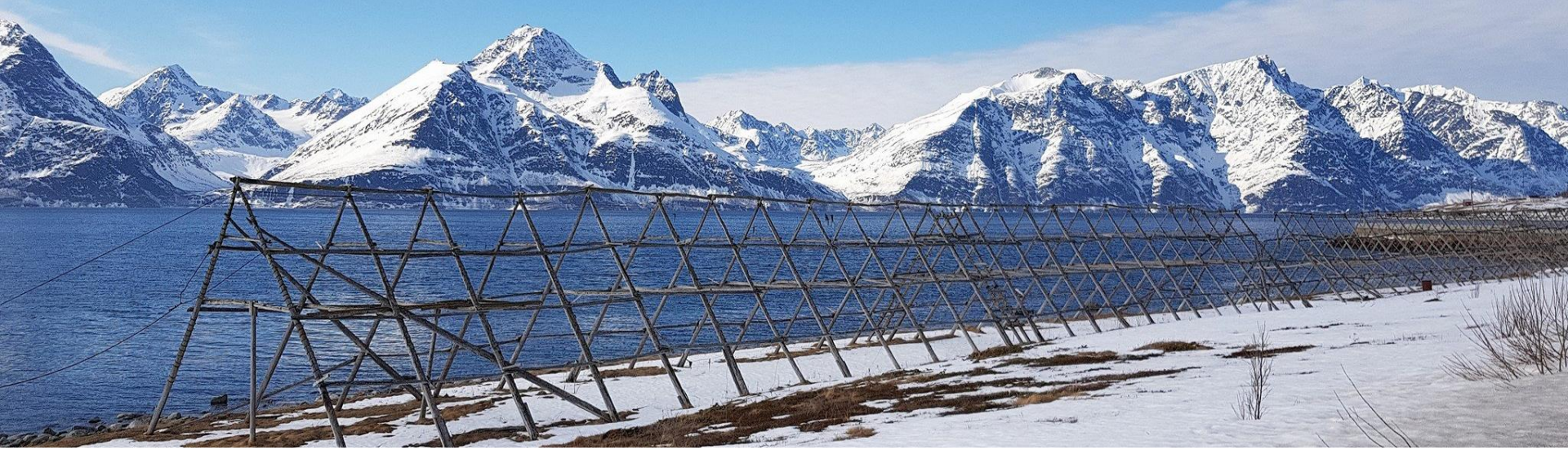

# Bluetooth 5: new opportunities for LE

## 蓝牙5：低功耗蓝牙的新“野心”

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Bluetooth Asia 2018

# Agenda

1 Bluetooth overview

2 First head in Bluetooth 5 new features

3 Bluetooth 5 new applications

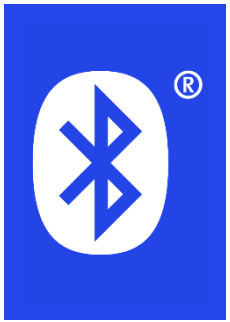
# Bluetooth technology feature

- Wireless
- Point to point communication
- Battery powered
- Phone/tablet/PC center
- Consumer electronics

# Bluetooth 5 background

- Internet of Things (IoT) arrives
  - Phone/PC/tablet beyond.
  - Consumer Electronics beyond.
  - New requirements. New challenges.
- Sophisticated Bluetooth ecosystem
  - >33,000 member companies
  - millions developers
  - Bluetooth SIG vision. Perfect and advance a flexible, reliable, and secure wireless communication solution that solves market challenges and helps realize a better future.
- When Bluetooth meets IoT, something big is destined

# Bluetooth revision landmark

| Bluetooth 1.0 | Bluetooth 2.0 | Bluetooth 3.0 | Bluetooth 4.0 |
|---|---|---|---|
|  |  |  |  |
| Bluetooth | EDR | HS/AMP | LE |

# Bluetooth 5 Landmark?

~~Bluetooth 5 has no connection with Bluetooth mesh for the present~~

# Bluetooth 5 Landmark


## Bluetooth IoT

蓝牙物联网

# Agenda

1 Bluetooth overview

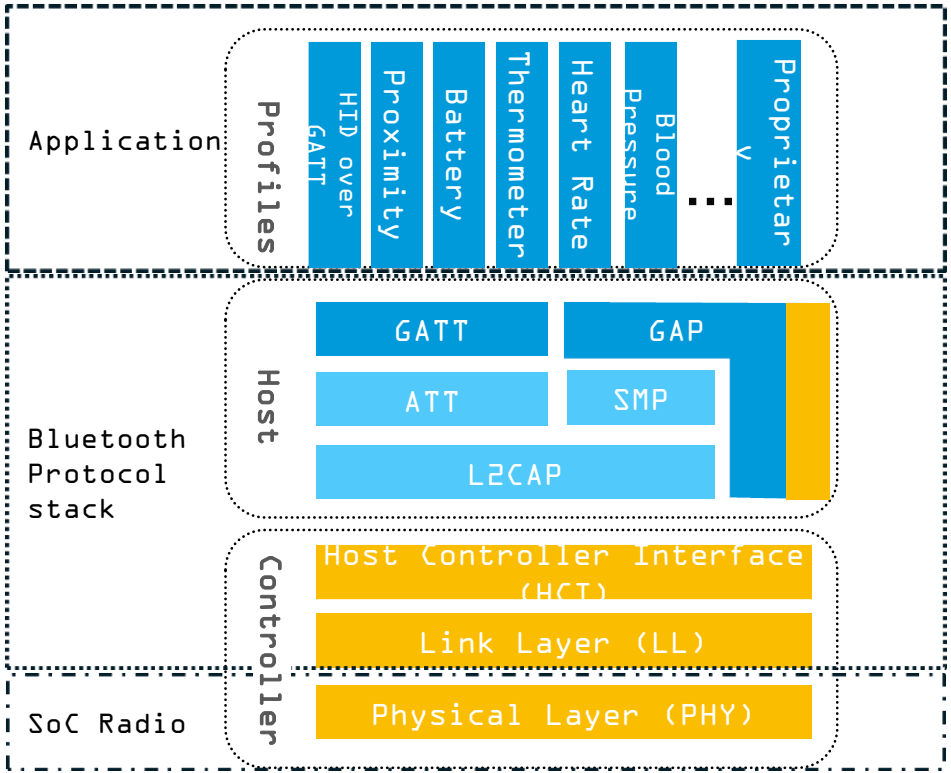
2 First head in Bluetooth 5 new features

3 Bluetooth 5 new applications

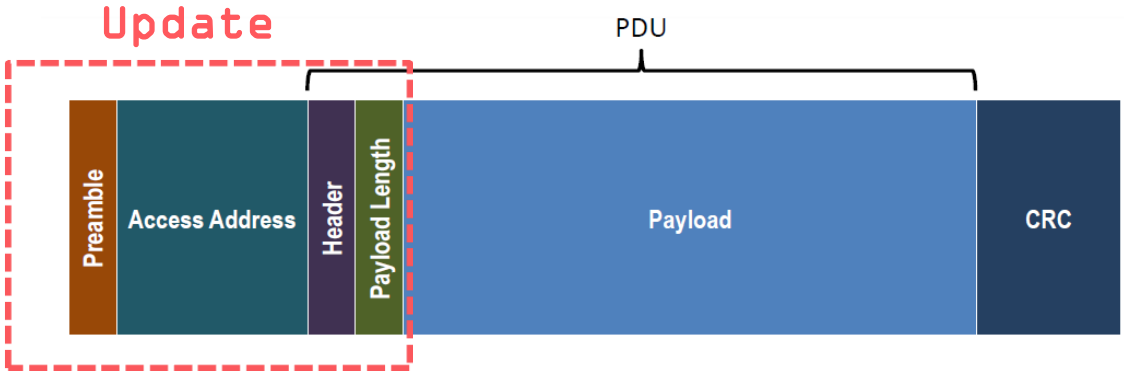
# Considerations for version upgrade

- Needs. History and challenge
- Backwards compatibility
- Forwards compatibility
- Interoperability
- Feasible
- …

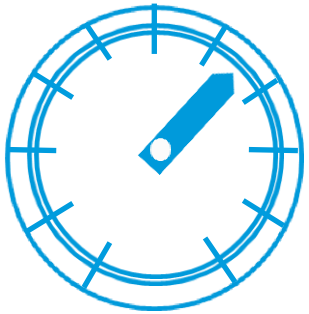
# Bluetooth LE Architecture



# Bluetooth LE Packet format



# The 4 feature pillars of Bluetooth 5



## 2x Speed

High speed 2Mbps mode

## 4x Range

Long range
500/125kbps modes

## 8x Broadcast capacity

Advertising extensions

## Better coexistence

Channel algorithm #2

# High Speed

Physical Layer

- 2 Msps modulation
- 370 kHz frequency deviation

Throughput increased to 1.4 Mbps

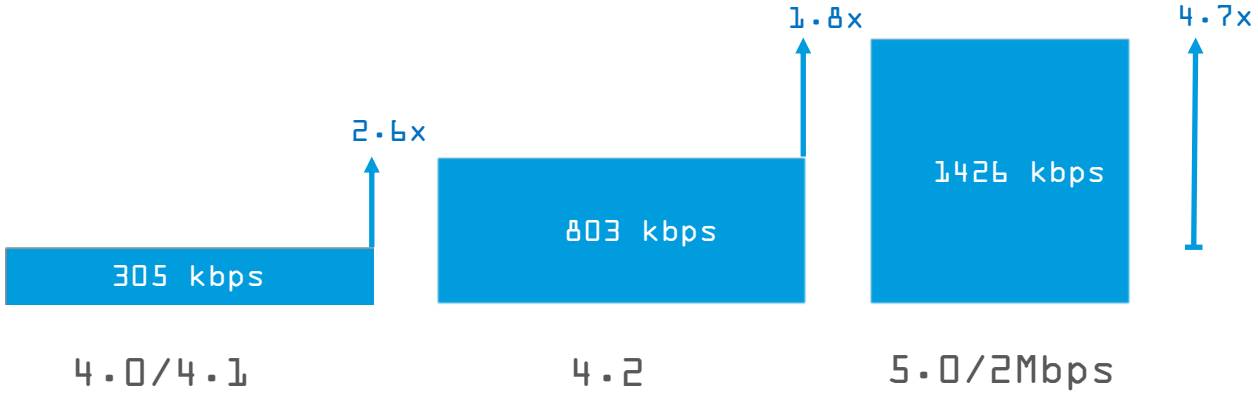
Link Layer Header

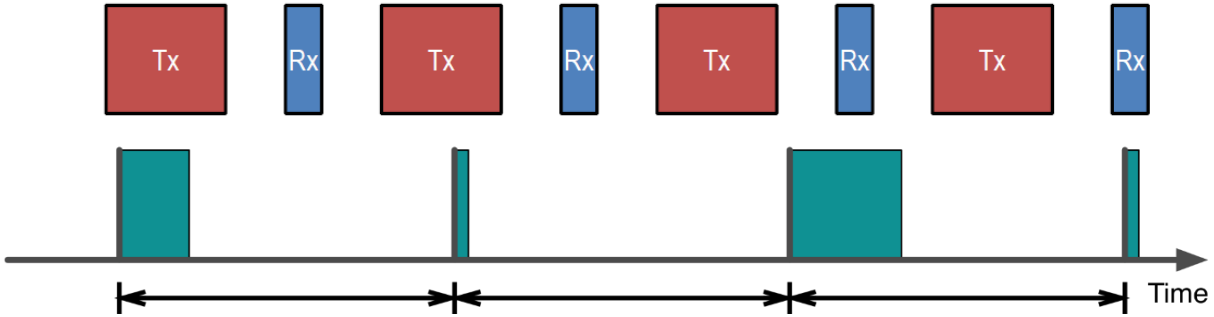
- 2 byte preamble

3 dB reduced sensitivity

- 29% range reduction

# Increased Throughput




Bluetooth 4.0/4.1

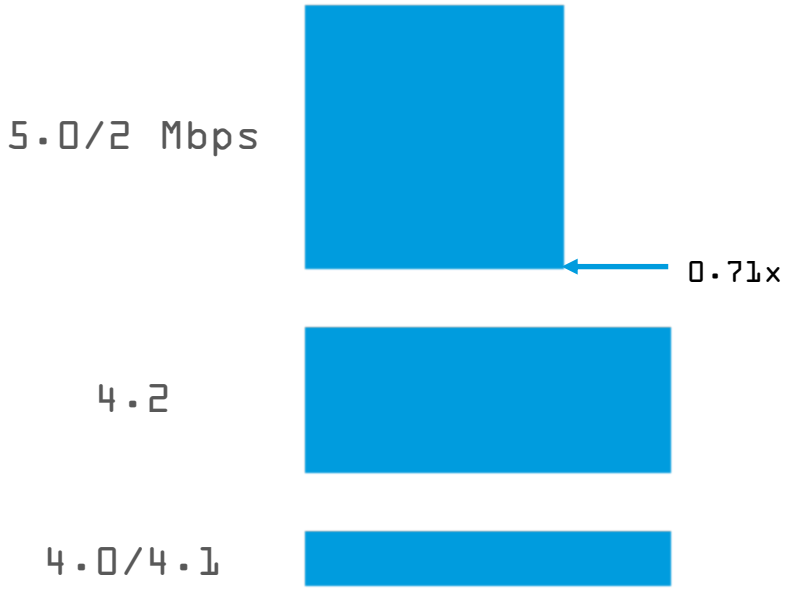
- 1 Mbps
- 27 byte payload

Bluetooth 4.2

- Data Length Extension
- 251 byte payload

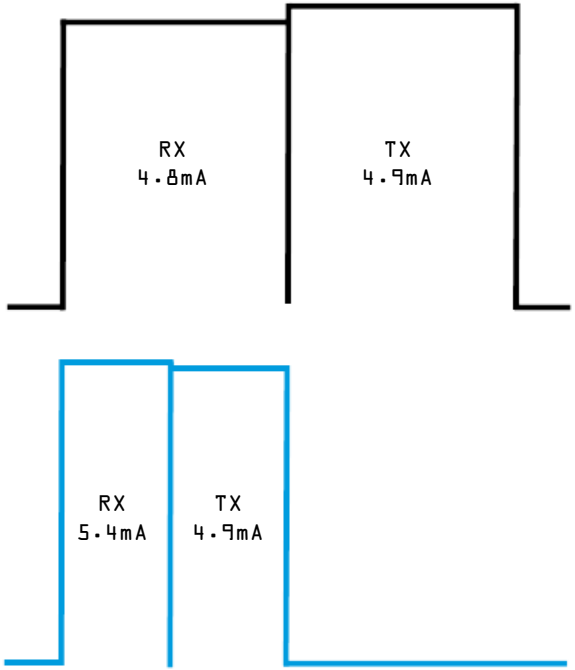
Bluetooth 5

# Range Reduction



# Less Time on Air

## ½ Energy Consumption




## More connections

## Improved coexistence

# Long Range


## Physical Layer

- Standard 1 Msps modulation

## 2 Coding Schemes

S=2: 4.5 dB increased sensitivity

- 68% range increase

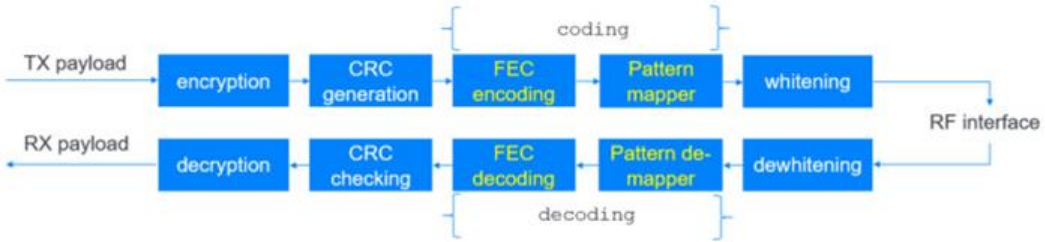
S=8: 12 dB increased sensitivity

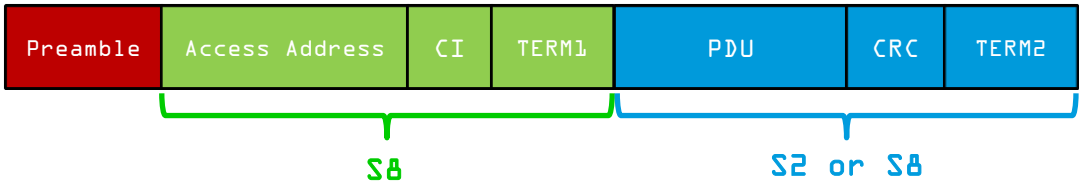
- 300% range increase

## Link Layer Header

- 1 extra byte

# Coding Schemes




## Forward Error Correction

- 2 bits for every input bit

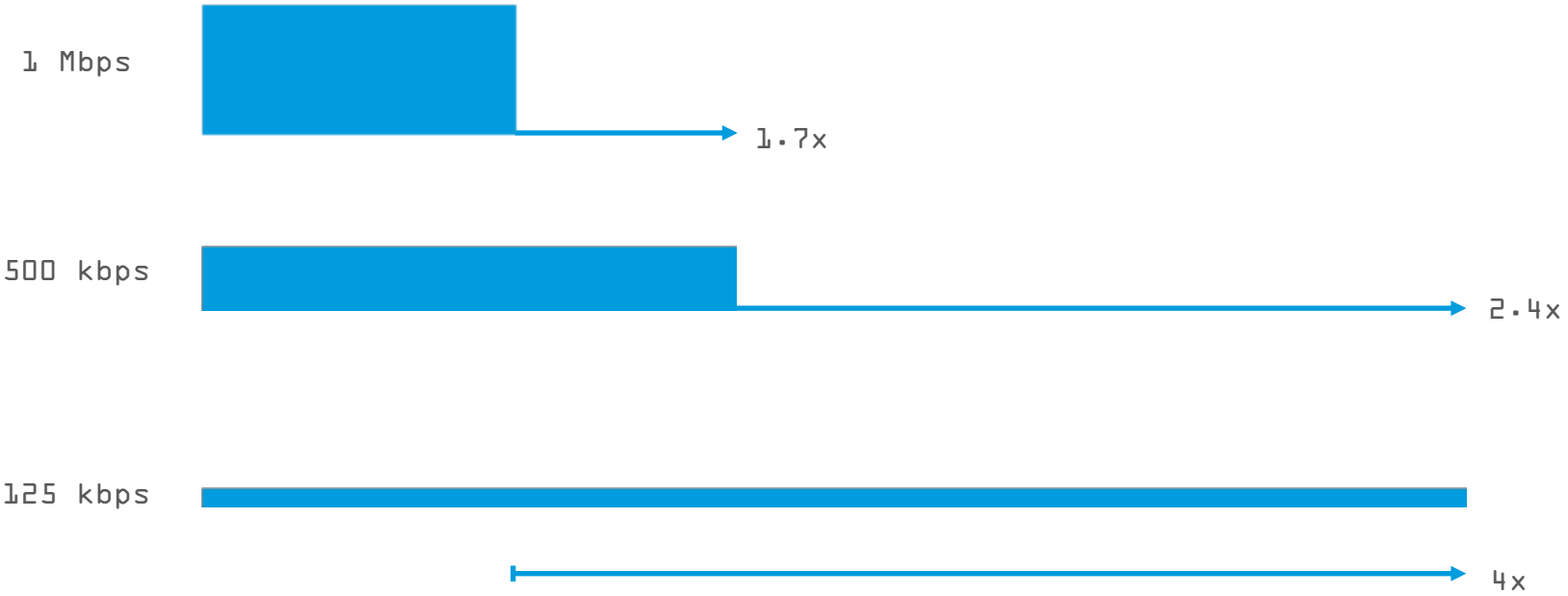
## Pattern Mapper

- S=2: 1 symbol per input bit
- S=8: 4 symbols per input bit

## S=2 - 2 symbols per bit

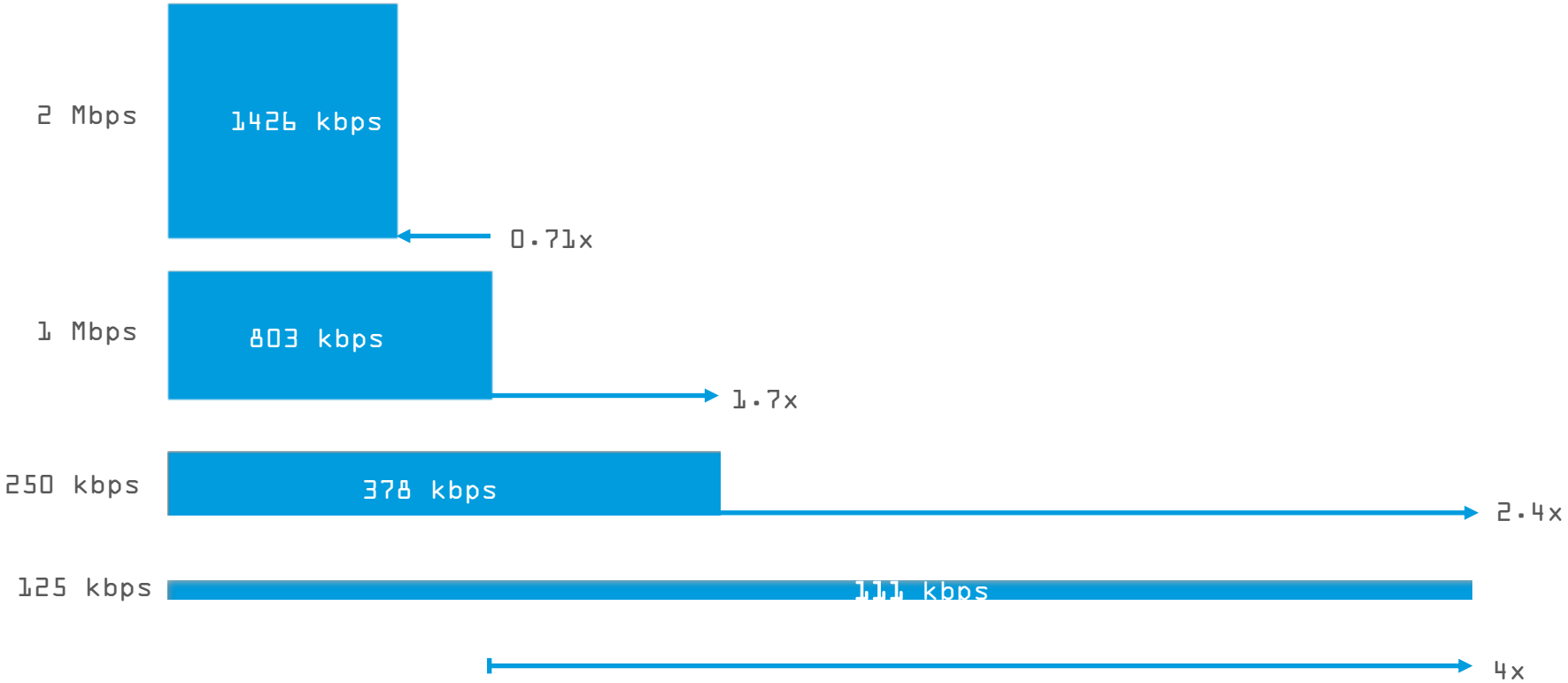
- 500 kbps

# Increased Range



# Reduced Throughput

# Flexibility for Bluetooth 5



# Advertising Extensions

- Increases advertising data length
- Allows advertising on data channels
  - Access address
  - Advertising channel for convention
- Enables long range connection establishment

# Increases Advertising Data Length

## Legacy Advertising

- 2 bytes header
- 37 bytes payload
- 31 bytes advertising data


## Advertising extensions

- 2 bytes header
- 255 bytes payload

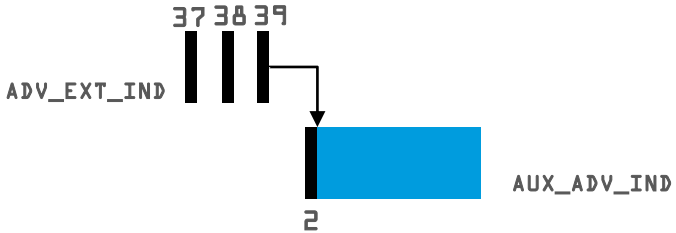
# Advertising on Data Channels

## Legacy Advertising

- Complete payload repeated on the advertising channels

## Advertising extensions

- Small packet is repeated on the advertising channels - primary advertising
- Payload is only transmitted once on a data channel - secondary advertising(Auxiliary)

# Advertising on Data Channels

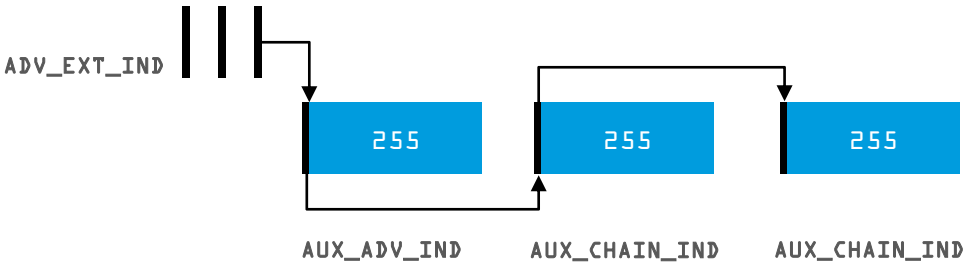
Longer packets for coded PHY

- Congested advertising channels

Reduces contention and duty cycle

# Chaining

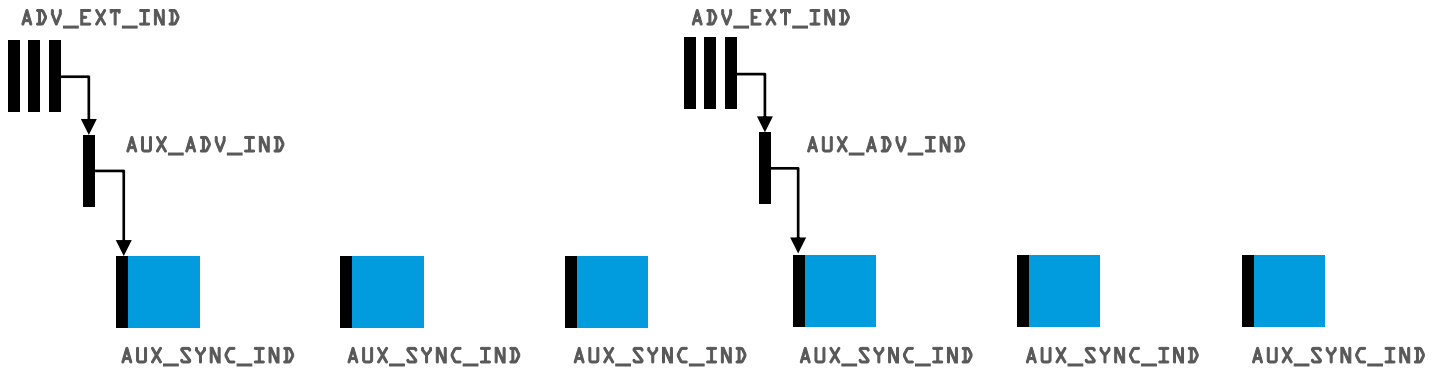
Advertisments can be chained together to extend the amount of advertising data



# Periodic Advertising

Enables synchronized broadcasting of advertising data

Happens at a deterministic interval allowing true connectionless broadcasting



# Nordic Bluetooth 5 example code snippet

```
static void advertising_init(void)
{
    ret_code_t             err_code;
    ble_advertising_init_t init;

    memset(&init, 0, sizeof(init));

    init.advdata.name_type                = BLE_ADVDATA_FULL_NAME;
    init.advdata.include_appearance       = true;
    init.advdata.flags                    = BLE_GAP_ADV_FLAGS_LE_ONLY_GENERAL_DISC_MODE;
    init.advdata.uuids_complete.uuid_cnt = sizeof(m_adv_uuids) / sizeof(m_adv_uuids[0]);
    init.advdata.uuids_complete.p_uuids  = m_adv_uuids;

    init.config.ble_adv_fast_enabled      = true;
    init.config.ble_adv_fast_interval     = APP_ADV_INTERVAL;
    init.config.ble_adv_fast_timeout      = APP_ADV_DURATION;

    init.config.ble_adv_primary_phy       = BLE_GAP_PHY_1MBPS;
    init.config.ble_adv_secondary_phy     = BLE_GAP_PHY_2MBPS;
    init.config.ble_adv_extended_enabled = true;

    init.evt_handler = on_adv_evt;

    err_code = ble_advertising_init(&m_advertising, &init);
    APP_ERROR_CHECK(err_code);
```

# Nordic Bluetooth 5 example code snippet

```
static ble_gap_scan_params_t m_scan_params =
{
    .active            = 0,
    .interval          = SCAN_INTERVAL,
    .window            = SCAN_WINDOW,
    .filter_policy     = BLE_GAP_SCAN_FP_ACCEPT_ALL,
    .filter_duplicates = BLE_GAP_SCAN_DUPLICATES_REPORT,
    .scan_phy          = BLE_GAP_PHY_CODED,
    .duration          = SCAN_TIMEOUT,
    .period            = 0x0000, // No period.
};
```

```
typedef struct
{
  ble_gap_adv_report_type_t type;                                /**< Advertising report type. See @ref b
  ble_gap_addr_t            peer_addr;                           /**< Bluetooth address of the peer devic
                                                                      and the address is the device's ide
  ble_gap_addr_t            direct_addr;                         /**< Set when the scanner is unable to r
                                                                      packet and the scanner has been ena
  uint8_t                   primary_phy;                         /**< Indicates the PHY on which the adve
  uint8_t                   secondary_phy;                       /**< Indicates the PHY on witch the adve
  uint16_t                  periodic_interval;                   /**< If periodic advertising exists, as
                                                                      in 1.25ms units. If set to 0, it in
  int8_t                    tx_power;                            /**< TX Power reported by the advertiser
  int8_t                    rssi;                                /**< Received Signal Strength Indication
  uint8_t                   set_id;                              /**< Set ID of received advertising repo
  uint8_t                   dlen;                                /**< Advertising or scan response data l
  uint8_t                   data[BLE_GAP_ADV_SR_MAX_LEN_DEFAULT]; /**< Advertising or scan response data.
} ble_gap_evt_adv_report_t;
```

# Nordic Bluetooth 5 example code snippet

```
case BLE_GAP_EVT_PHY_UPDATE:
{
    ble_gap_evt_phy_update_t const * p_phy_evt = &p_ble_evt->evt.gap_evt.params.phy_update;

    if (p_phy_evt->status == BLE_HCI_STATUS_CODE_LMP_ERROR_TRANSACTION_COLLISION)
    {
        // Ignore LL collisions.
        NRF_LOG_DEBUG("LL transaction collision during PHY update.");
        break;
    }

    m_phy_updated = true;

    ble_gap_phys_t phys = {0};
    phys.tx_phys = p_phy_evt->tx_phy;
    phys.rx_phys = p_phy_evt->rx_phy;
    NRF_LOG_INFO("PHY update %s. PHY set to %s.",
                 (p_phy_evt->status == BLE_HCI_STATUS_CODE_SUCCESS) ?
                 "accepted" : "rejected",
                 phy_str(phys));
} break;

case BLE_GAP_EVT_PHY_UPDATE_REQUEST:
{
    err_code = sd_ble_gap_phy_update(p_gap_evt->conn_handle, &m_test_params.phys);
    APP_ERROR_CHECK(err_code);
} break;
```

# Summary

- Bluetooth 5.0 backwards and forwards compatible with other Bluetooth revisions
- Bluetooth 5 certificate may be with or without Bluetooth 5 features
- Higher flexible
- More application use cases
- Bluetooth IoT. Bluetooth connectivity. Ubiquitous Bluetooth.

# Agenda

1 Bluetooth overview

2 First head in Bluetooth 5 new features

3 Bluetooth 5 new applications

# Smart home


- IoT router
- Smart speaker
- Full coverage
- More connected Bluetooth Devices

# Streaming

- Audio broadcasts in a museum or railway station
- Remote (ADPCM, SBC, Opus, BroadVoice32)
- Medical Box
- Faster OTA DFU

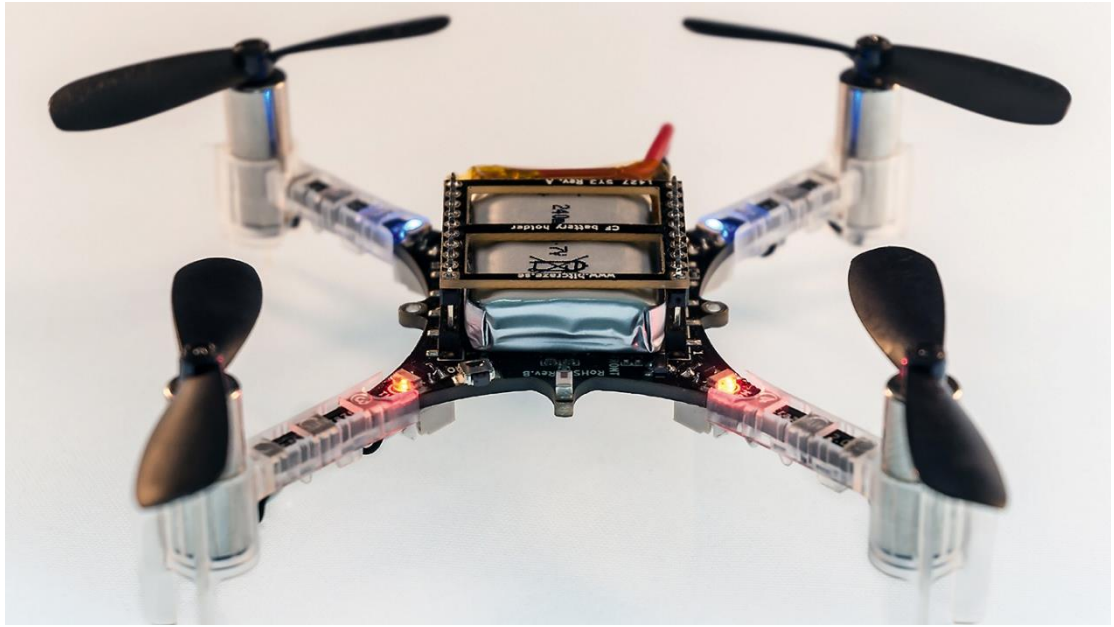
# Medical application


- Large margins on robustness
- Long range mode
- CSA#2

# Smart farming

- Long range mode to cover thousands square meters
- Beacon to monitor thousands animals

# Drone



- Long rang mode when flying
- High speed mode when offline
- Other toys

# Beacon application

- More data available
- Mall
- Railway station
- Airport

# Nordic Bluetooth 5 solution

- Full features
- Easy to use
- Fast Time to market
- Stable and reliable
- High flexible
- Strong support
- High added value


Secure | https://launchstudio.bluetooth.com/Listings/Search

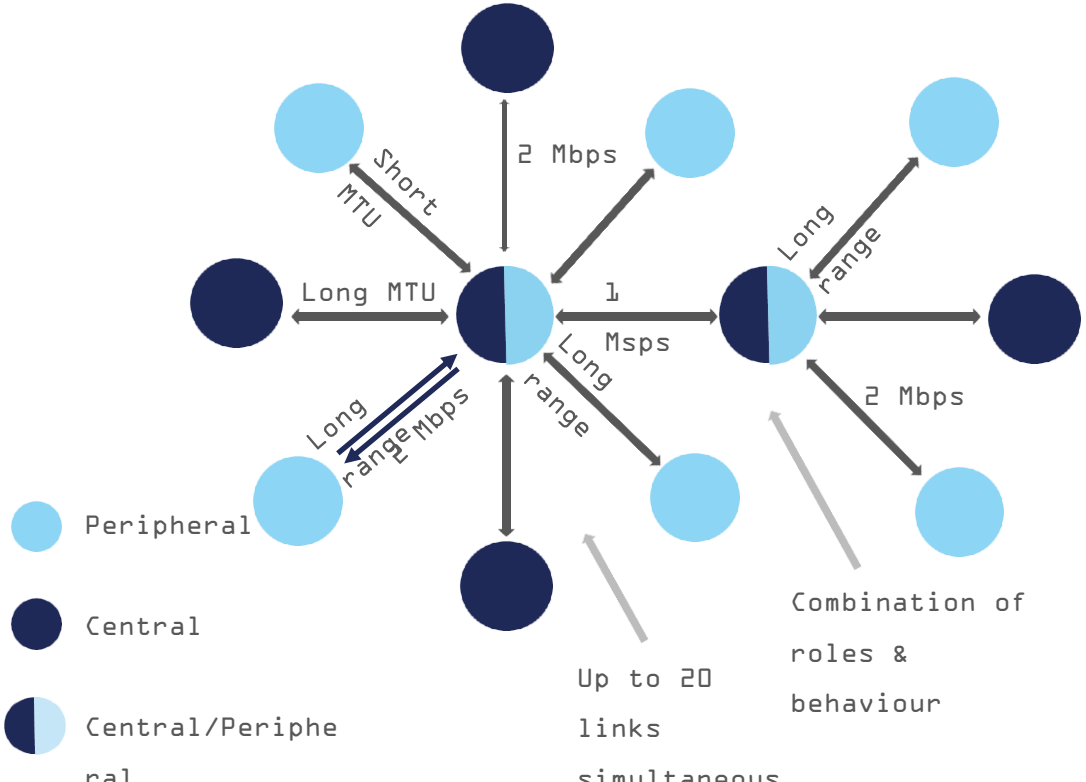
Nordic Semiconductor ASA

Reset

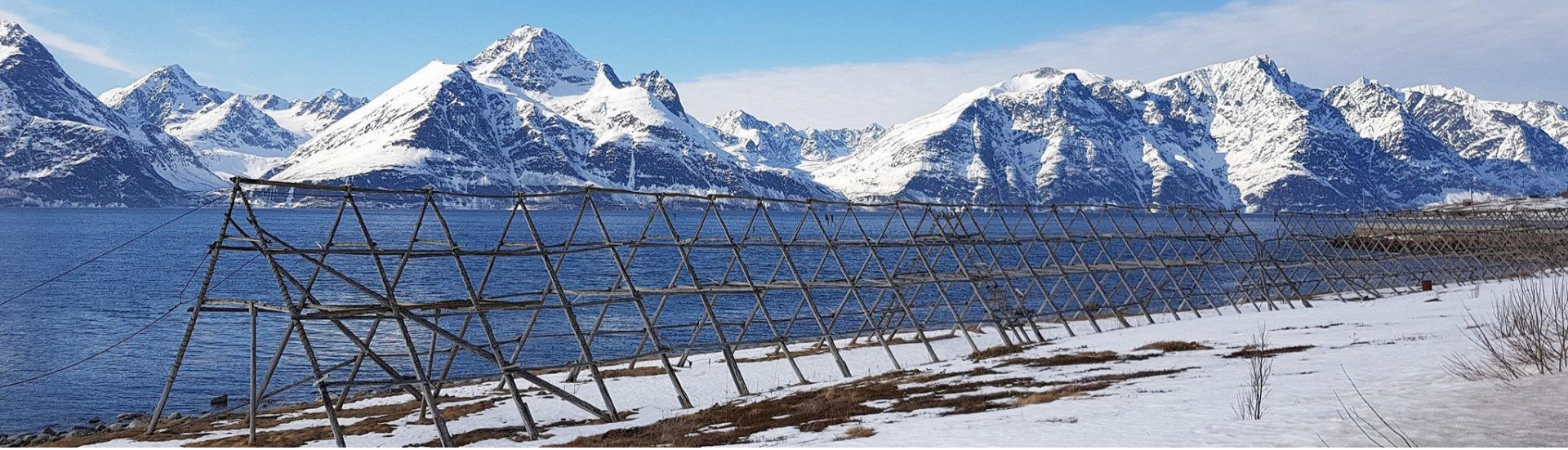
| Declaration ID | QDID(s) | Company | Products | Specification Name | Listing Date |
|---|---|---|---|---|---|
| D039781 | 111537 - Profile Subsystem | Nordic Semiconductor ASA | nRF5 SDK for MESH, nRF5 SDK for Mesh v2.0.1 | N/A | 2018-05-02 |
| D038621 | 108621 - End Product | Nordic Semiconductor ASA | nRF52840 with S140 v6.0.0, nRF52840 | 5.0 | 2018-03-02 |
| D038622 | 106845 - Component (Tested) | Nordic Semiconductor ASA | Host layer for SoftDevice S140, nRF52 Host v6.0.0 | 5.0 | 2018-02-23 |
| D038623 | 108232 - Component (Tested) | Nordic Semiconductor ASA | S140 v6.0.0 Link Layer component, S140 Link Layer v6.0.0 | 5.0 | 2018-02-21 |
| D038125 | 104470 - Component (Tested) | Nordic Semiconductor ASA | nRF52840, nRF52840 AQFN73 | 5.0 | 2018-02-01 |
| D037973 | 103875 - End Product | Nordic Semiconductor ASA | nRF52832 with S132 v5.1.0, nRF52832 S132 v5.1.0 | 5.0 | 2017-11-29 |
| D037974 | 102543 - Component (Tested) | Nordic Semiconductor ASA | S132 v5.1.0 link layer component, S132 Link Layer v5.1.x | 5.0 | 2017-11-27 |
| D037750 | 102861 - End Product | Nordic Semiconductor ASA | nRF52810 with S112 v5.1.x, nRF52810 S112 5.1.0 | 5.0 | 2017-11-08 |
| D036908 | 100330 - Component (Tested) | Nordic Semiconductor ASA | Link Layer for SoftDevice S112, S112 Link Layer 5.1 | 5.0 | 2017-10-31 |
| D036907 | 99792 - Component (Tested) | Nordic Semiconductor ASA | Host Layer for SoftDevice S112, S112 Host 5.1.0 | 5.0 | 2017-10-27 |
| D036987 | 101395 - Controller Subsystem | Nordic Semiconductor ASA | Zephyr BLE controller, nRF52 controller | 5.0 | 2017-10-24 |
| D036906 | 98252 - Component (Tested) | Nordic Semiconductor ASA | Nordic nRF52810, nRF52810 | 5.0 | 2017-10-19 |
| D036591 | 100032 - Profile Subsystem | Nordic Semiconductor ASA | nRF52 DK, nRF52 DK - IPSP | 5.0 | 2017-09-04 |
| D034946 | 97989 - End Product | Nordic Semiconductor ASA | nRF52832 with S132 v5.0.0, nRF52832 S132 v5.0.0 | 5.0 | 2017-07-05 |
| D034753 | 94418 - Component (Tested) | Nordic Semiconductor ASA | Host layer for SoftDevice S132, S132 Host 5.0.0 | 5.0 | 2017-06-21 |

80 listing(s) found

# Bluetooth 5 Multilink Inspires Innovation




- 20 simultaneous links or more
- Concurrent roles
- Configurable bandwidth for each link
- A “low power” option compared to Mesh



# Bluetooth 5: new opportunities for LE

蓝牙5：低功耗蓝牙的新“野心”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- 5/30/2018