

IQRF Basics





IQRF Technical Support Leader

14 years in MICRORISC s.r.o.

Key projects

FI-IM4/034 Smart platform for wireless communication (2007-2010, MPO/FI)

FR-TI1/058 Intelligent house-open platform (2009-2012, MPO/FR)

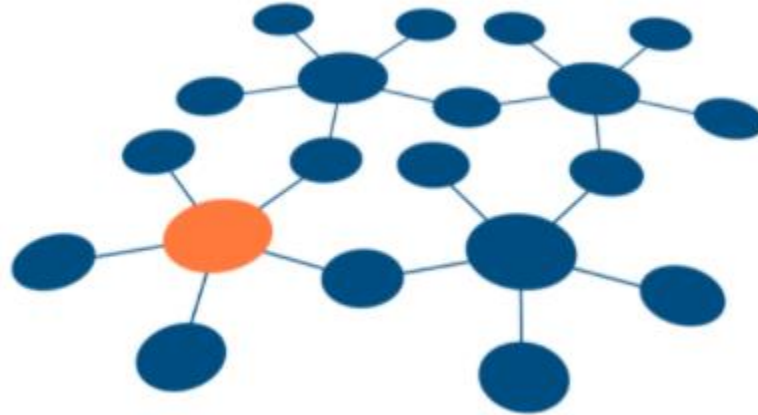
FR-TI3/254 Open platform for telemetry (2011-2014, MPO/FR)

FR-TI3/275 Open platform for smart cities (2011-2014, MPO/FR)

FV-40303 Communication infrastructure for battery powered devices (2018-2021, MPO/FV)



- What is IQRF
- Typical applications
- How to use IQRF
- Development tools
- IQMESH[®] network
- DPA protocol
- Transceiver modules
- How to start with IQRF



IQRF is complete wireless technology for ISM bands 868 MHz, 916 MHz and 433 MHz.

- Transceiver modules with built-in operating system.
- **MESH** networking (max. **240 hops**).
- Functionality depends on user application written in C language or ready-to-use DPA plug-in.
- RF range: tens of meters in buildings, hundreds of meters in open space.
- Extra low power (250 uA LP receiving, < 100 nA TR-76D deep sleep).
- Low data rate (19.836 kb/s).
- Packet oriented communication (max. **64 user bytes** / RF packet).
- No license fees.



- Transceiver modules
- Accessories
- HW / SW development tools
- Gateways, repeaters, end devices
- IQRF GW Daemon
- IQRF SDK
- Demo examples
- Support
- IQRF Alliance
- IQRF Repository



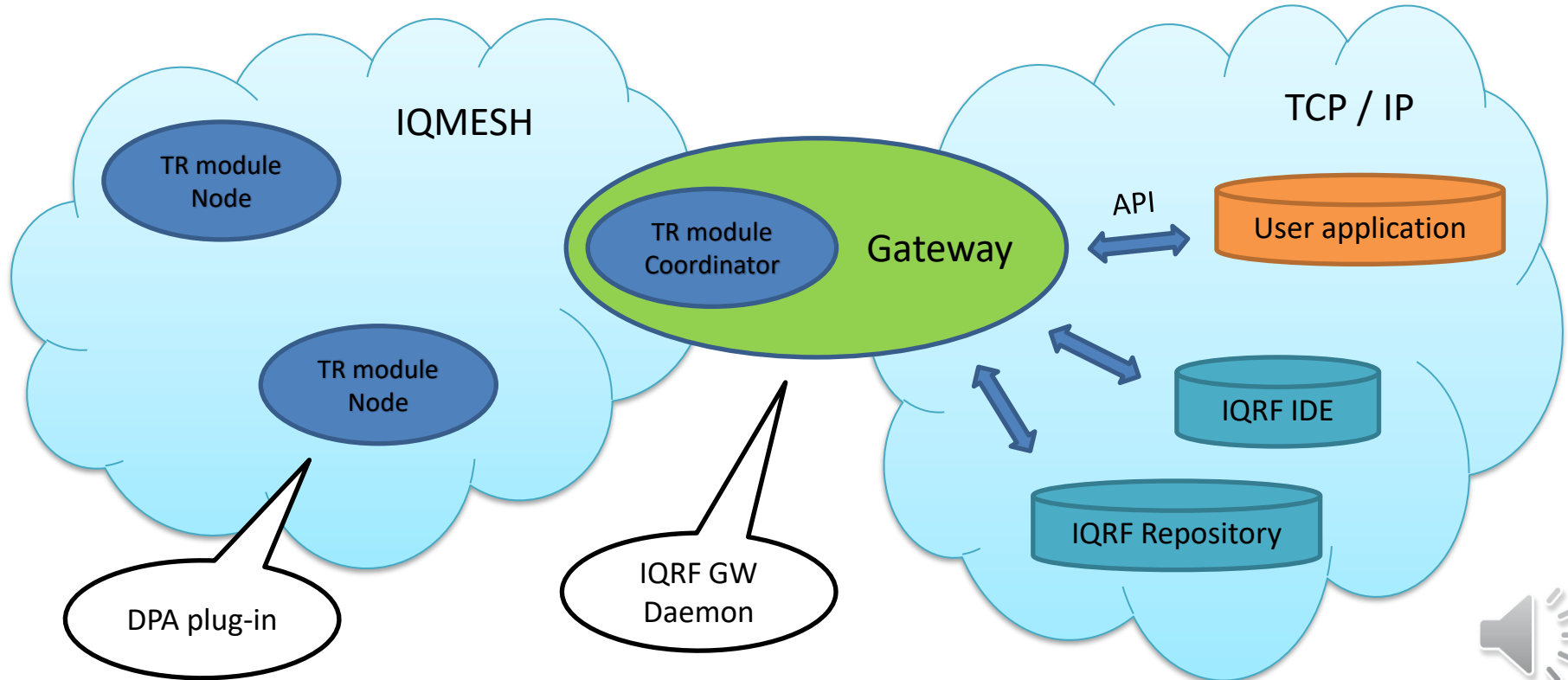
- Control systems
- Sensor networks
- Lighting applications
- Building automation
- Industrial automation
- Telemetry
- IoT



... our solution can be found in real applications



Typical Network Application



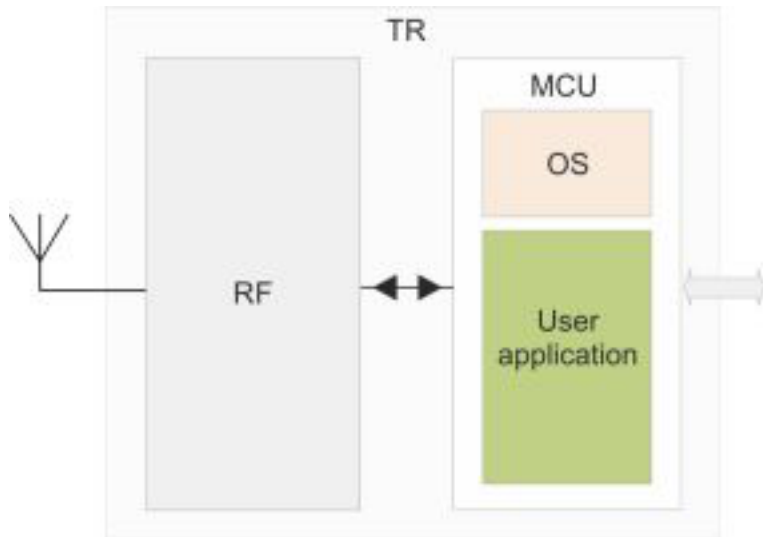
Two layers:

- Operating system
- User application

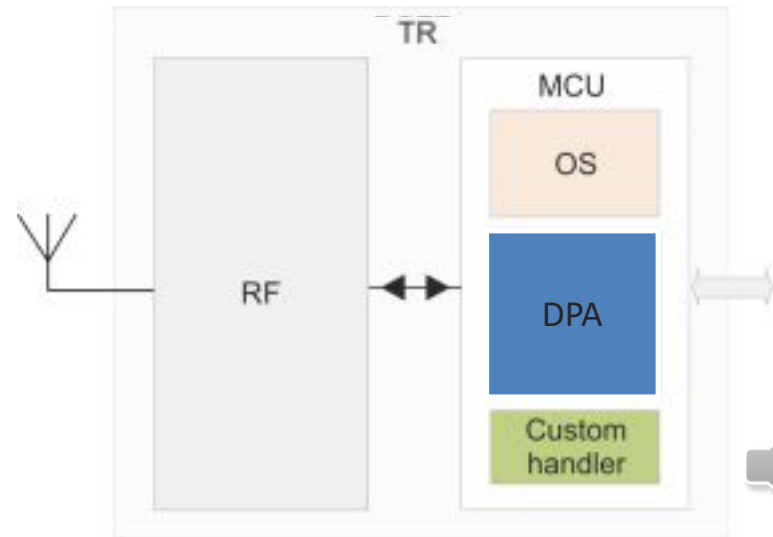


Two approaches

C programming



DPA plug-ins

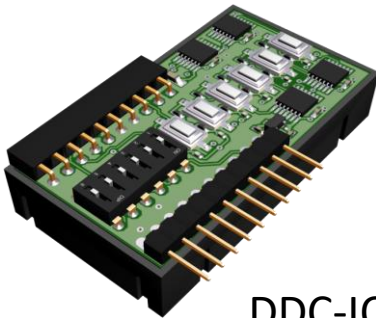




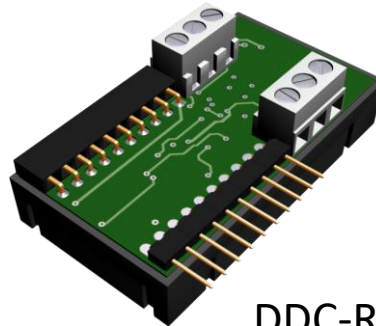
CK-USB-04A



DK-EVAL-04A



DDC-IO-01



DDC-RE-01



DDC-SF-01





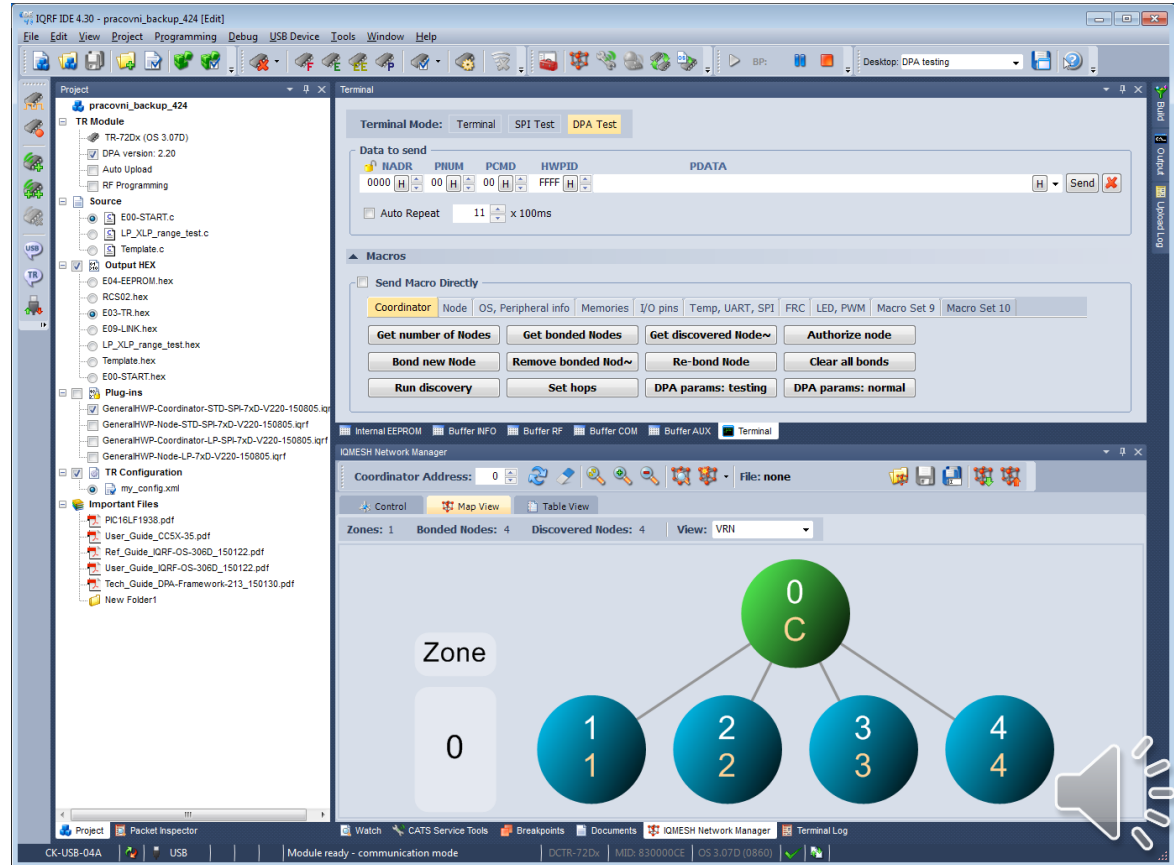
DS-START-04



DS-DPA-02



- Uploader
- Terminal
- Debugger
- IQMESH Network Manager
- CATS Service Tool
- Many other tools
- Free



IQRF IDE – TR Configuration

TR Configuration

File: my_config_v4

DPA version: 4.xx

OS

DPA

Security

Description

RF

RF band: 868 MHz

RF channel A: 30

RF channel B: 2

TR Peripherals

Thermometer

External EEPROM

RFPGM

Enable after reset

Termination after ~1 minute

Termination by MCU pin

Dual channel

LP mode

Incorrect upload

1 Value from 62 to 67 (868 MHz band) allowed only for TR-7xD.

2 Value from 189 to 255 (916 MHz band) allowed only for TR-7xD with IQRF OS 3.08D or above.

3 Value 16 (433 MHz band) allowed only for TR-7xD with IQRF OS 3.08D or above.

4 Used at RFPGM only.

5 Read only.

Default

Download

Upload

Close

TR Configuration

File: my_config_v4

DPA version: 4.xx

OS

DPA

Security

Description

Embedded peripherals

EEPROM

EEPROM

RAM

LEDR

LEDG

SPI

IO

THERMOMETER

UART

Other

Custom DPA Handler

DPA Peer-to-Peer

User peer-to-peer

Local FRC

IO Setup

Autoexec

Routing off

Stay awake when not bonded

UART baud rate: 57600 Bd

RF

Network type: STD+LP

TX power: 7

RX filter: 5

LP RX timeout: 6

Alternative DSM channel: 40

1 Valid only for DPA 3.03 or higher.

2 Valid only for DPA 4.10 or higher.

3 Valid only for DPA 4.15 or higher.

4 Valid only for DPA 4.14 or lower.

5 See OS tab note 1, 2, 3.

6 Used at Coordinator only.

7 Used at Node only.

8 For UART interface.
For UART peripheral at DPA 4.11 or higher.

Default

Download

Upload

Close

TR Configuration

File: my_config_v4

← 🔒 📁 📁 📁 📁 📁 DPA version: 4.xx

OS DPA Security Description

☒ Access Password

Format: ASCII

Value: 1

Password strength: Strong 15/16

☐ User Key

Format: ASCII

Value: 1

0/16

¹ Blank entry leaves the value default.
For upload only.

☐ Show passwords

?

Default Download Upload Close



Terminal

Terminal Mode: Terminal SPI Test **DPA Test**

Data to send

NADR

PNUM

PCMD

HWPID

PDATA

0001

H

06

H

00

H

FFFF

H

H

Send

[0/56]

☐ Auto Repeat

10

x 100ms

Macros

☐ Send Macro Directly

Coordinator

Node

OS, Peripheral info

Memories

I/O pins

Temp, UART, SPI

FRC

LED

network e

Set LEDR on

Set LEDG on

Pulse LEDR

M4

Set LEDR off

Set LEDG off

Pulse LEDG

M8

LEDR flashing

LEDG flashing

M11

M12

Internal EEPROM

Buffer INFO

Buffer RF

Buffer COM

Buffer AUX

User RAM

Communication Log

Terminal

Terminal Log

View: ☒ Auto Scroll

Separator: ☐ Horizontal ☒ Vertical

☒ Data Displaying

File: none

Line	ΔTime	Rx/Tx	Length	Data HEX	DPA Mess...	Error	NADR
1	N/A	Tx	6	01.00.06.01.FF.FF.	DPA Request		0x01 No
2	00:00:00.004	Rx	11	01.00.06.01.FF.FF.FF.27.07.08.07.	DPA Confirmation		0x01 No
3	00:00:00.735	Rx	8	01.00.06.81.00.00.00.27.	DPA Response		0x01 No
4	00:00:03.420	Tx	6	01.00.06.00.FF.FF.	DPA Request		0x01 No

Slide 16

Packet Inspector

Last Record: ☐ Any ☐ Tx ☐ Rx (☒ Ignore DPA Confirmation)

Mode: DPA, Line: 15, Tx

Protocol: DPA Request

NADR: 0x0005 00005 Node
 PNUM: 0x06 006 LEDR
 PCMD: 0x01 001 Set on
 HWPID: 0xFFFF 65535 Any
 PDATA[0]

Data: [6]

[0]	0x05	.	005	00000101	NADR Lo
[1]	0x00	.	000	00000000	NADR Hi
[2]	0x06	.	006	00000110	PNUM
[3]	0x01	.	001	00000001	PCMD
[4]	0xFF	.	255	11111111	HWPID Lo
[5]	0xFF	.	255	11111111	HWPID Hi

Packet Inspector

Last Record: ☐ Any ☐ Tx ☐ Rx (☒ Ignore DPA Confirmation)

Mode: DPA, Line: 17, Rx

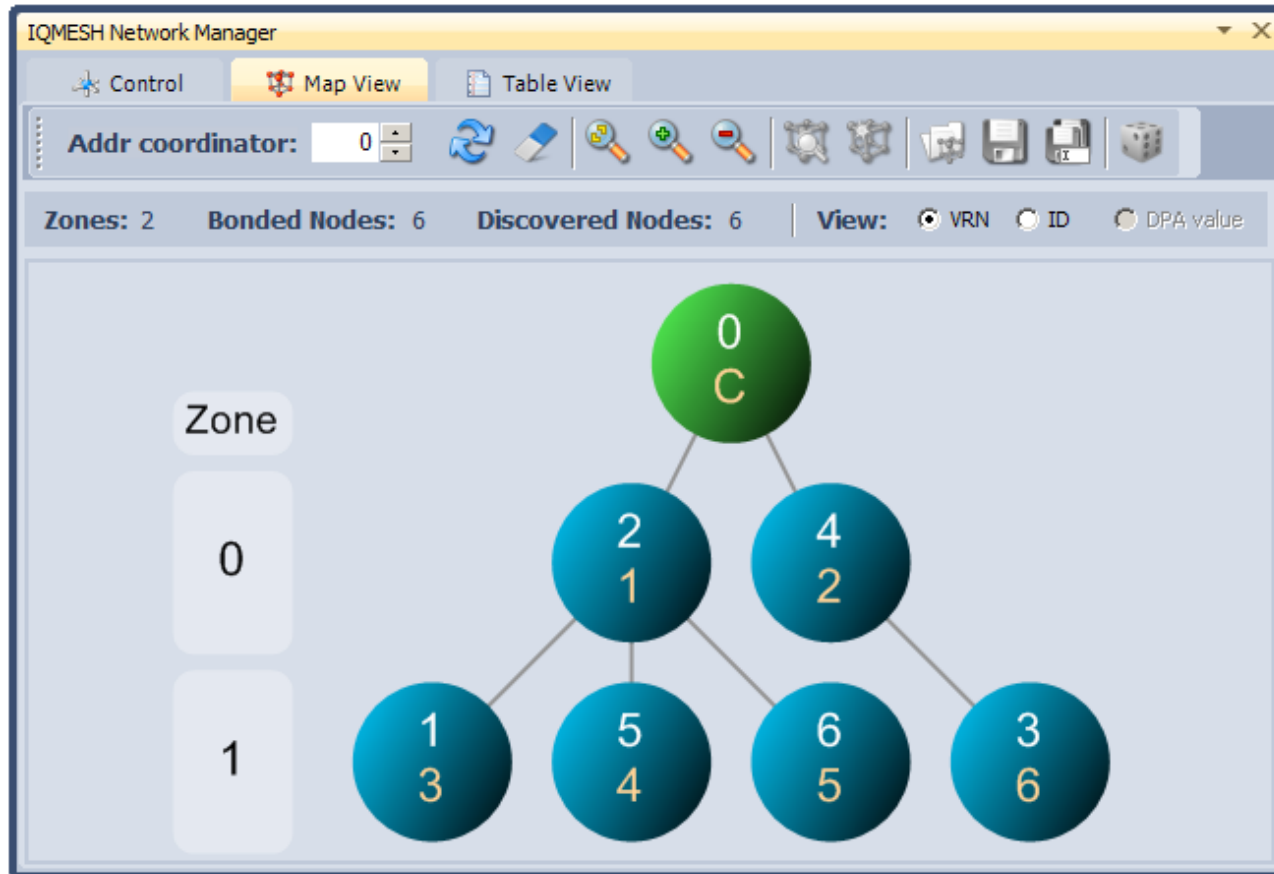
Protocol: DPA Response

NADR: 0x0005 00005 Node
 PNUM: 0x06 006 LEDR
 PCMD: 0x81 129 Set on
 HWPID: 0x0000 00000 General
 ErrN: 0x00 000 No error
 DPA value: 0x44 068
 PDATA[0]

Data: [8]

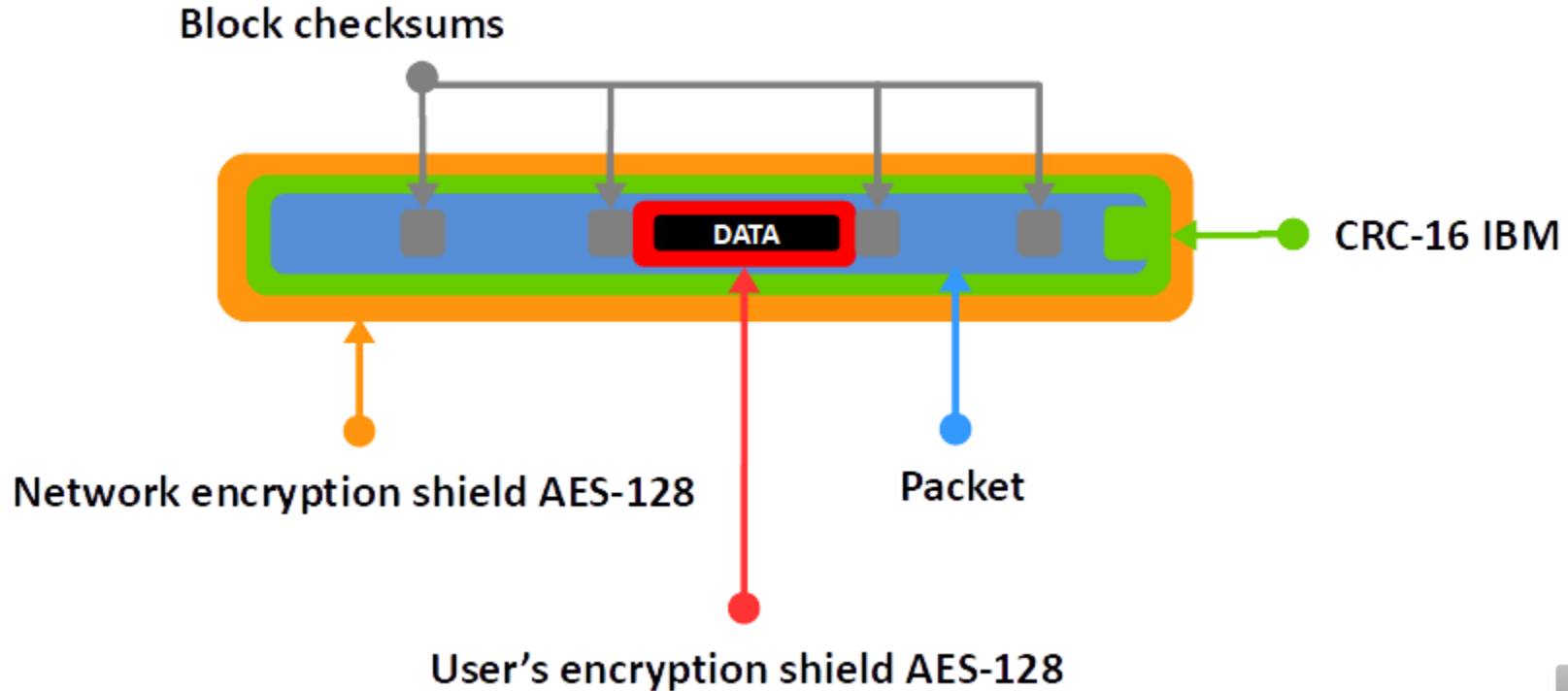
[0]	0x05	.	005	00000101	NADR Lo
[1]	0x00	.	000	00000000	NADR Hi
[2]	0x06	.	006	00000110	PNUM
[3]	0x81	.	129	10000001	PCMD
[4]	0x00	.	000	00000000	HWPID Lo
[5]	0x00	.	000	00000000	HWPID Hi
[6]	0x00	.	000	00000000	ErrN
[7]	0x44	.	068	01000100	DPA value





- **1 Coordinator** and up to **239 Nodes**
- Node type: **STD** or **LP** (specified by the uploaded DPA plug-in)
- Network type: **STD** or **STD + LP** (specified in the TR configuration of the Coordinator)
- Routing: up to **240 hops** (directional flooding and TDMA)
- **Synchronous communication**: request from Coordinator, response from Node
- **Beaming**: special asynchronous mode for sleeping (battery operated) Nodes
- Security: **AES-128**



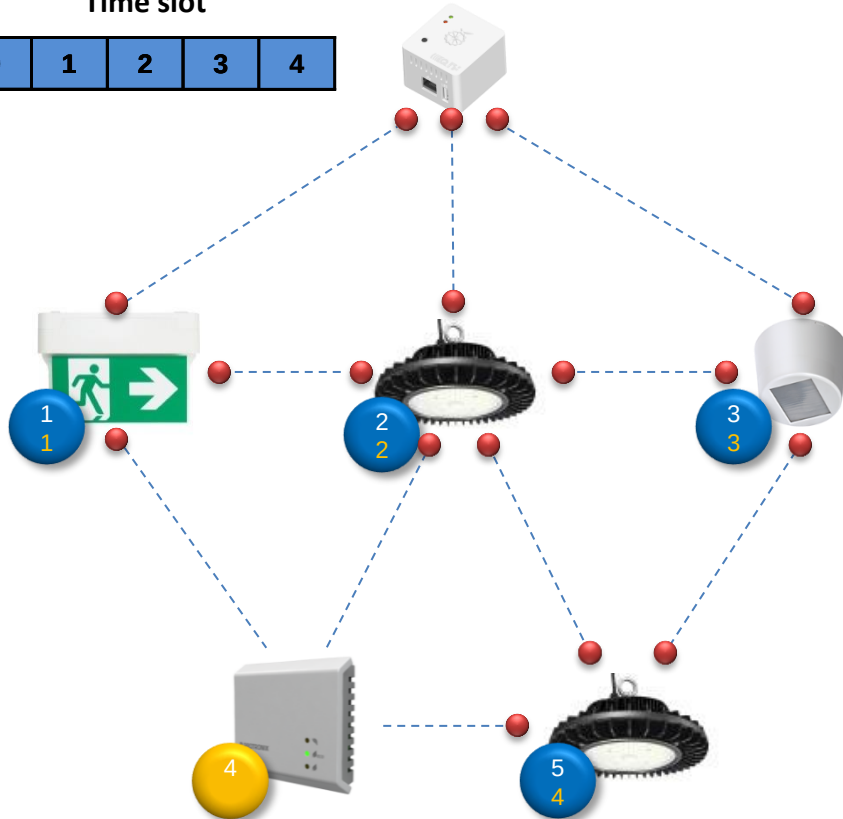


- Uploading the proper files into TRs (DPA plug-in, TR config., Custom DPA Handler)
- Including Nodes to the network (Coordinator) to assign the addresses – **Bonding** (local bonding, Smart Connect, IQUIP, Autonetwork)
- Installation of Nodes (placement)
 - **Redundancy** is required (every Node should be in range to more neighbours)
- Learning the network routing structure – **Discovery**
 - Only discovered Nodes can route packets
 - Routing Nodes should not be moved
 - Coordinator assigns VRNs to discovered Nodes
- Network testing and finalization (enumeration, backup)



Time slot

0	1	2	3	4
---	---	---	---	---



PURPOSE

Central control from coordinator

- Sending commands
- Collecting data

FEATURES

- Directed flooding mesh
- Redundant packet delivery
- No lost packets
- No need of self-healing
- Minimal latency after reset
- Predictable packet delivery time

SECURITY

- Network key
- AES-128



Coordinator



All or selected Nodes

30 B for DPA request

+

239 bit field for optional Node selection



2 bits from all **239 Nodes**

or

1 byte from max. **63 Nodes**

or

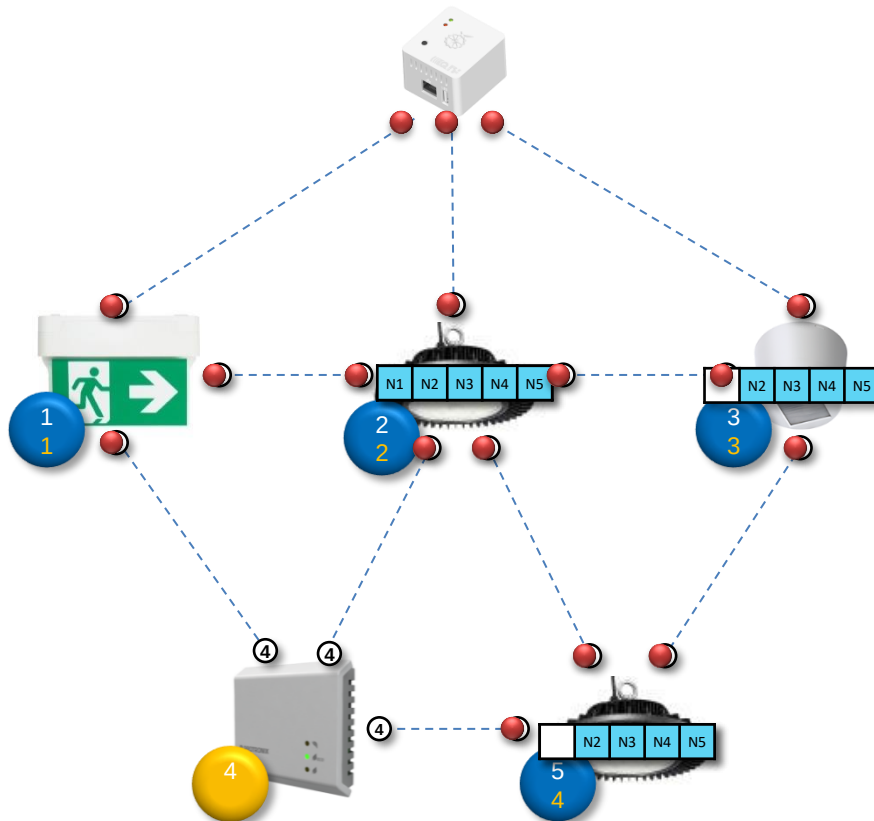
2 bytes from max. **31 Nodes**

or

4 bytes from max. **15 Nodes**



FRC® - Fast Response Command



PURPOSE

Data collection / acknowledged control of multiple nodes

PHASES

1. Broadcast FRC Request
2. Send FRC values locally
3. Collect FRC values on the way back

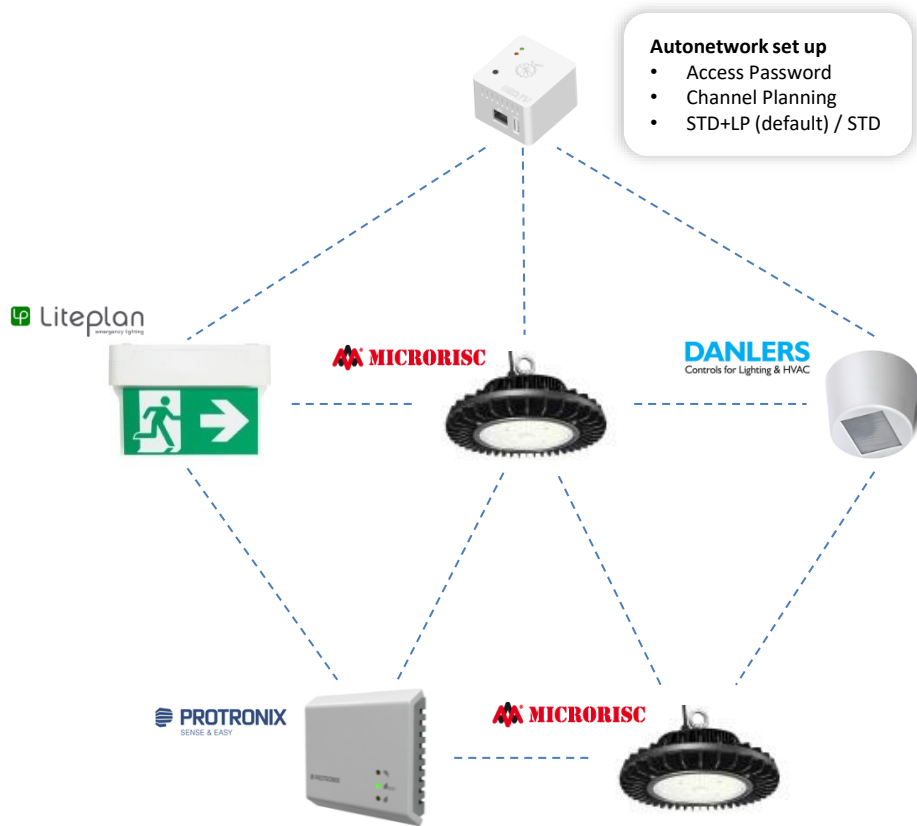
FEATURES

- Send up to 30 bytes
- Collect 2b, 1B, 2B or 4B FRC values
- Selective FRC
- Acknowledged broadcast

SECURITY

- Network key
- AES-128





AUTONETWORK

Wave 1

Prebonding

Reading MID

Authorisation - Assigning Logical Address

Nodes verification + Discovery

Wave 2

Prebonding

Reading MID

Authorisation - Assigning Logical Address

Nodes verification + Discovery

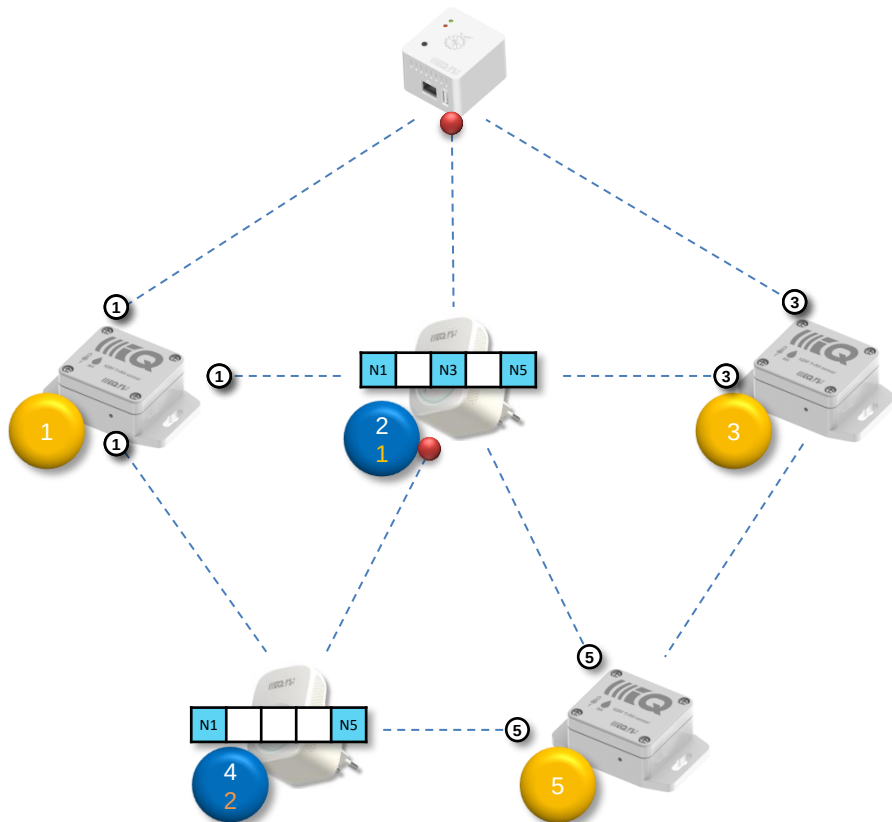
Wave ...

Empty wave → Autonetwork finished

ENUMERATION

HWPID, product, manufacturer, OS, DPA, module, peripherals,...





PURPOSE

Efficient data collection from battery operated sensors

PHASES

1. Beaming with a given period
2. Send FRC request
3. Collect FRC values on the way back

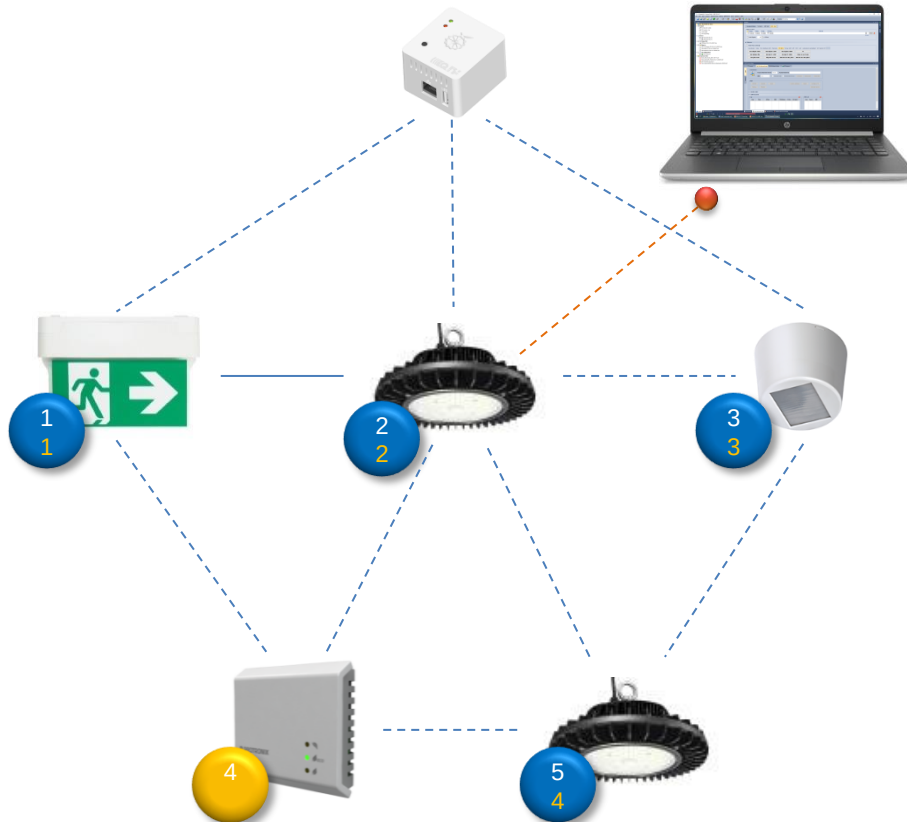
FEATURES

- Minimal power consumption of battery powered sensors
- Beaming of all sensor values
- FRC used for efficient data collection from aggregating repeaters

SECURITY

- Network key
- AES-128





PURPOSE

Local (last resort) maintenance of any IQRF module with DPA plug-in from IQRF IDE

- Low level service tool
- Configuration
- (Un)bonding, factory setting, local OTA

PHASES

1. Scanning
2. IQRF module reset
3. Connectivity set up – full control

FEATURES

- DSM (CATS service tool) available in IQRF IDE
- Special firmware on IQRF module
- Dedicated fixed service channel plus optional configurable one

SECURITY

- Access Password
- Only after device reset



DPA (Direct Peripheral Access) plug-in is ready to use application with embedded peripherals and services



No programming needed

Need to modify?



Custom DPA Handler

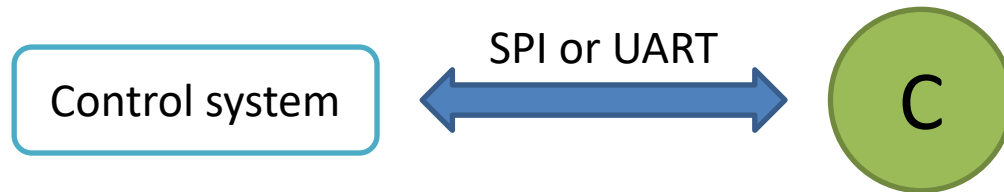


DPA plug-in can be controlled by a simple byte-oriented protocol that allows:

- Control peripherals and services of the Coordinator and all Nodes in IQMESH network
- Create and manage IQMESH network
- IQMESH network maintenance
- Over The Air (OTA) upgrade of OS and DPA

Interfaces:

- SPI
- UART



NADR	PNUM	PCMD	HWPID	PDATA
Ntw. Device Address	Peripheral Number	Peripheral Command	HW Profile Identification	Optional Data

NADR (2B) – specifies an address of a device in a network

PNUM (1B) – code of specific peripheral

PCMD (1B) – code of specific command of given peripheral

HWPID (2B) – uniquely specifies the type (functionality) of the device

PDATA (up to 56 B) – optional message data

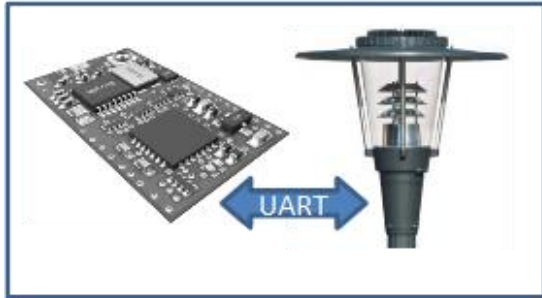


NADR	PNUM	PCMD
0x00 Coordinator	0x00 Coordinator	0x01 Get discovered Nodes 0x02 Get bonded Nodes ...
0x01 ... Nodes 0xEF	0x03 EEPROM	0x00 Read 0x01 Write ...
0xFF Broadcast	0x06 Red LED	0x00 Set off 0x01 Set on ...

Node 5: switch red LED on

NADR	PNUM	PCMD	HWPID	PDATA
0x05	0x06	0x01	0xFFFF	

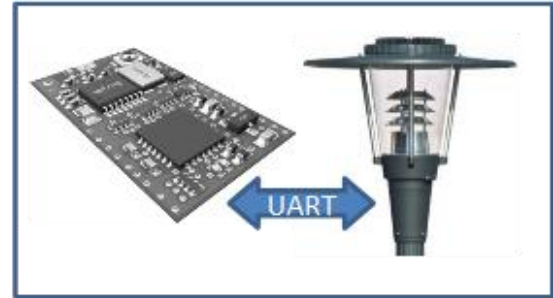




Node #1



Node #2



Node #3



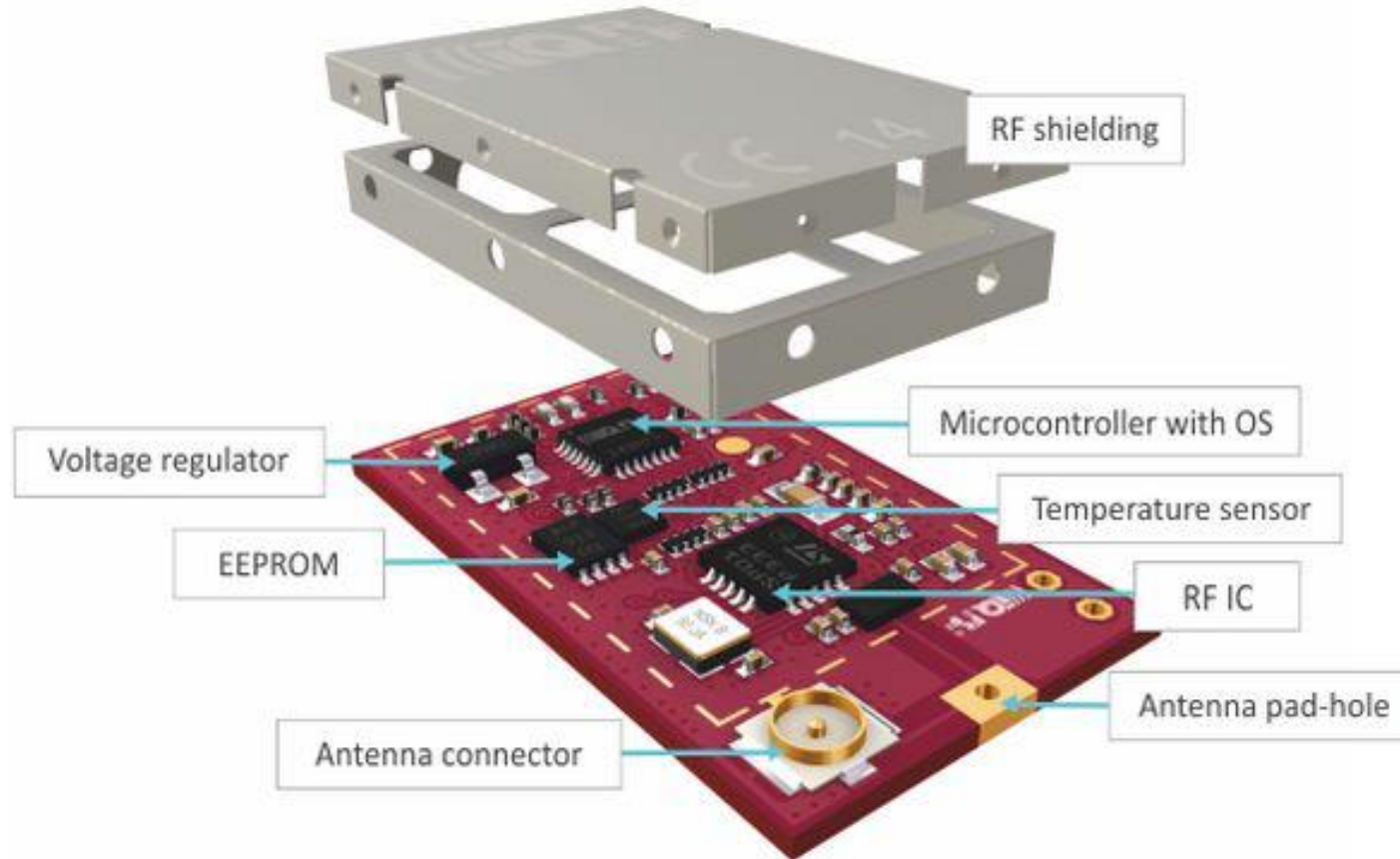
Raspberry PI

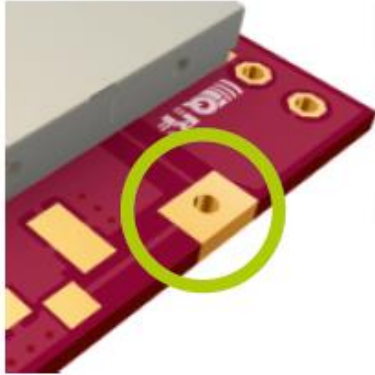
- + IQRF GW Daemon
- + KON-RASP-01 shield
- + TR module (Coordinator)



Integration of MESH networking has never been easier!

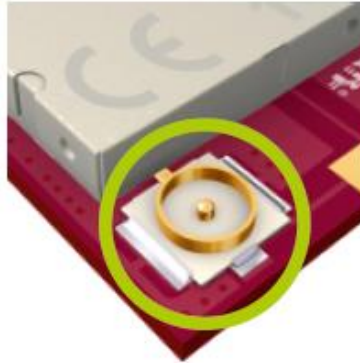






Soldering pad-hole

TR-7xD



U.F.L connector

TR-7xDC



Built-in PCB

TR-7xDA



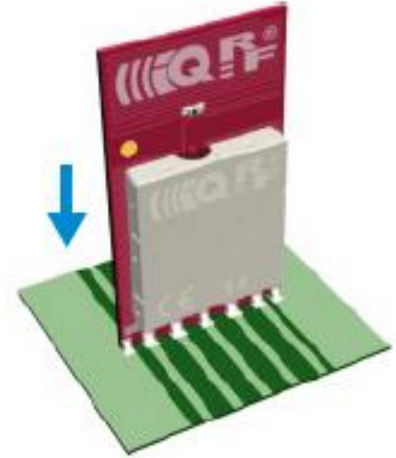
TR Module – Mounting Options



SIM connector
TR-72Dx



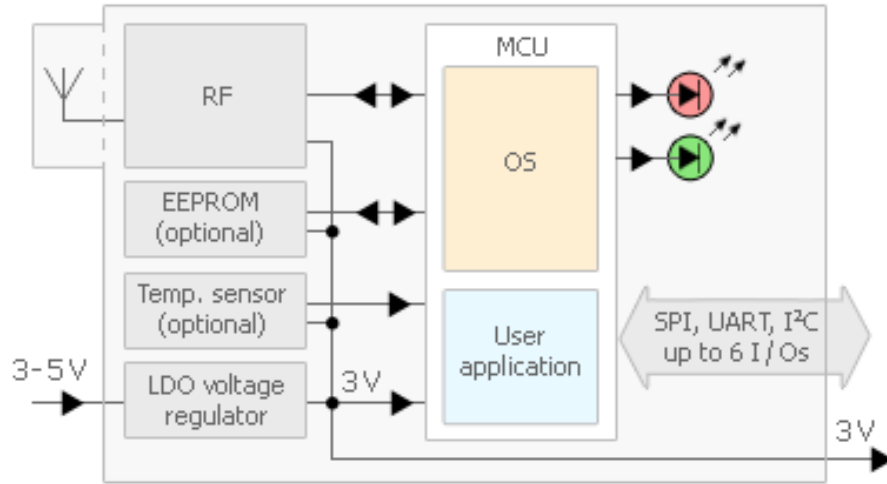
SMT
TR-76Dx



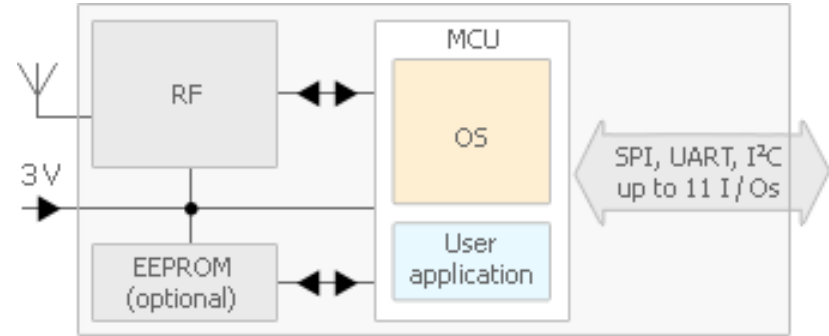
Vertical soldering
TR-75Dx



TR Module – Several Types



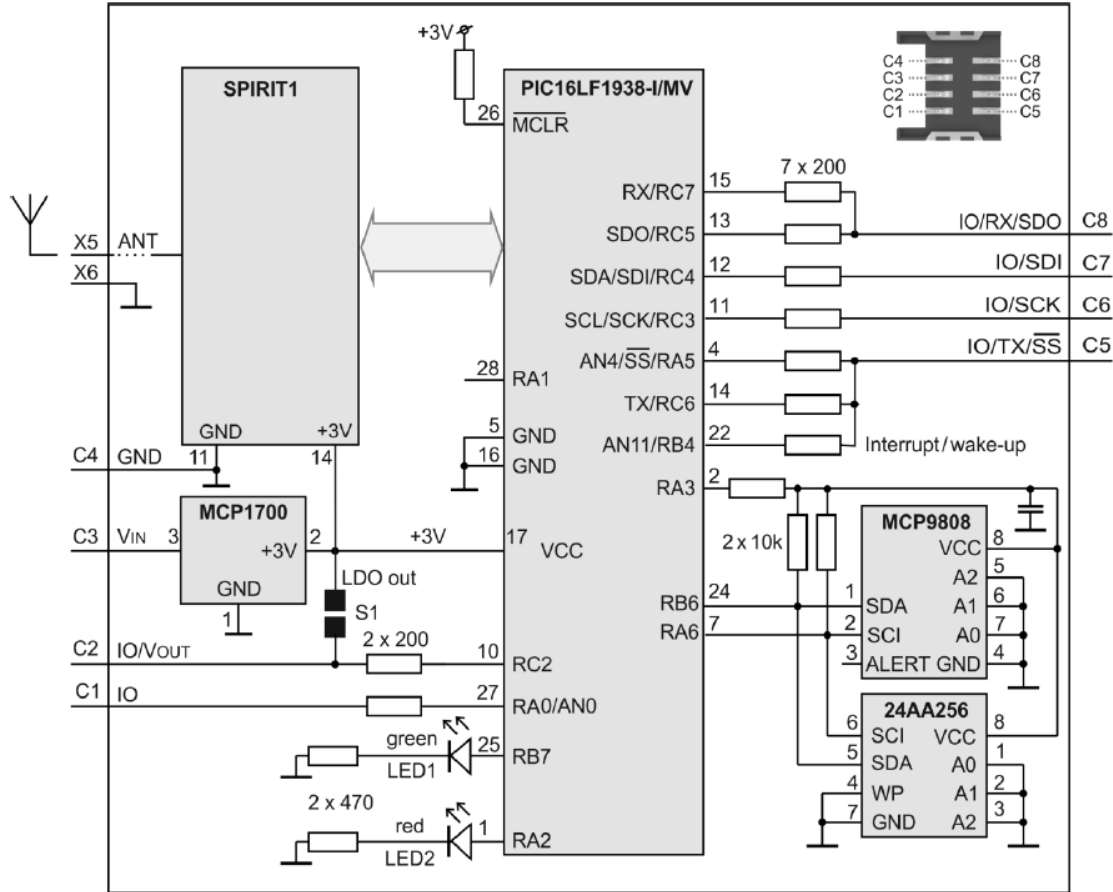
TR-72Dx



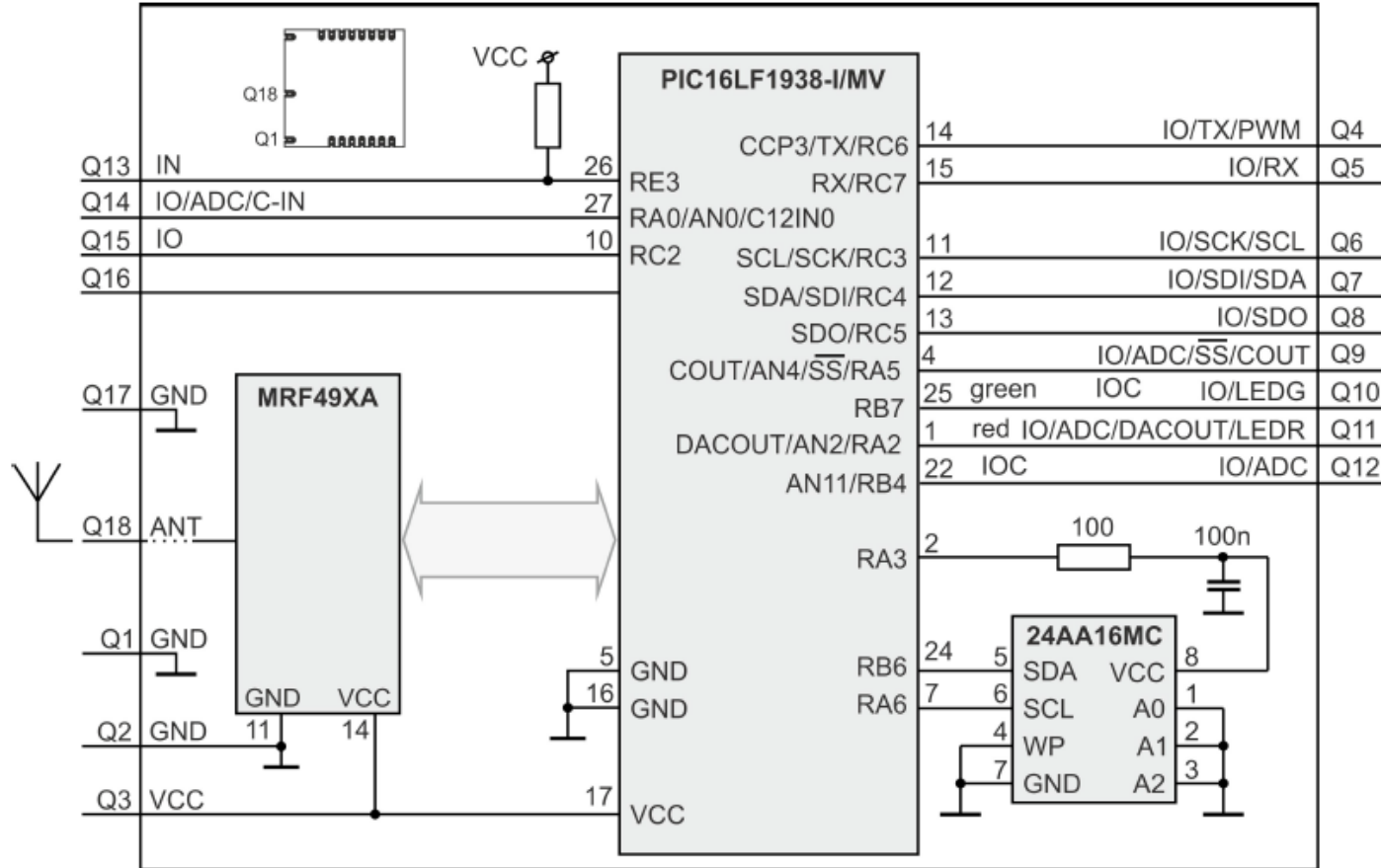
TR-76Dx



TR-72Dx Schematics



TR-76Dx Schematics



Hardware

One of IQRF development sets (DS-START-04 or DS-DPA-02)

Software

Free IQRF Startup Package (IQRF IDE, DPA plug-ins, examples, documentation)

Starting Point

www.iqrf.org/how-to-start (video tutorials, recommended reading)



www.iqrf.org

www.iqrfalliance.org

support@iqrf.org

sales@iqrf.org



Thank you!

