Radiocrafts
Embedded Wireless Solutions

PRESENTATION WILL START IN AT 10AM CEST

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Tips and tricks to achieve low power in radio networks
2019-10-24

Tips and tricks to achieve low power in radio networks, October 24th 2019

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House-keeping

- The seminar today is scheduled for 30 minutes with a 10-15 minutes Q&A afterwards.
- Please introduce yourselves in the chat window, so we know who is listening
- Post your questions in the chat window during the seminar, and we will answer as good as we can in the Q&A session.
- We will post a recorded version of the webinar on our website after the webinar, if you want to go back and see it again.

Agenda

- How to calculate power consumption/battery lifetime
  - The different contributors to power consumption
- How to increase battery lifetime
  - Tips and tricks
  - Trade-offs

What influences power consumption

- Receive
- Transmit
- Joining commissioning
- Processing
- Network maintenance
- Operating system
- Sleep current

Sleep current

- Process and technology dependent
- Typical in order 500 nA to 5 uA
  - Amount of flash
  - RTC crystal running
- Short range radio 0.5-3 uA
- NB-IoT 3-5 uA

Operating system

- Operating system can in some case give an extra power consumption
- This is caused by operating system performing updates, internal service maintenance every now and then
- For OS in MCU device it should be 0 uA to 2 uA

Network maintence

- Network maintenance is transmissions and reception used to let other devices now that its still present. There can also be some keep alive message
- More used in mesh network, but also used on star network
- With high data traffic the network maintenance traffic can be reduced

Processing

- All battery operated devices have a function in addition to send and receive data
- This can be to read a sensor or to control a device
- But it can also be to process data and to mist computing
  - This is specifically important in relationship with next slides on current transmit current consumption
- Example
  - If one monitor a chair usage and have a sensor to determine if it in in use or not.
  - This sensor is read every 2 minute. But to send 1 bit of information every 2 minutes is poor choice. Save up 30 samples and send every 1 hour. This will increase battery lifetime with 10x

Joining commisioning

- Joining process can take a lot of current as normally sleeping device are continuously listening
- Important design requirement → Make a mechanism to prevent device entering joining process during storage/transport.
  - Start joining on button, NFC etc.
  - Plastics strip to prevent battery connection
  - Etc.

Transmit

- The energy used to transmit data is

$$\frac{\text{TX-current x TX time}}{\text{Time between transmissions}}$$

- TX current is given by chipset and technical solution chosen
- TX time is given by

$$\frac{\text{Number of bytes to send + Overhead}}{\text{Data rate}}$$

TX current

- Here each developer must make tradeoffs vs application
- Long range→ TX current and/or TX time goes up
- High update rate, quick responsiveness→ Time between transmissions goes down
- Long range + high update rate = huge batteries.

TX current - Antenna

- By using a good external antenna, the output power can be reduced while maintaining range.
- Output power can be reduced as much as 50% with a good antenna vs a minimized internal antenna

TX current - Mesh

- By using a mesh backbone network the range from a battery-operated node to the next node can be made small, while the overall coverage is still large.
- This is a trade off between long battery lifetime and infrastructure cost

Transmit current consumption comparison

Technology	Bit rate [kb/s]	Time to send 20 bytes packet [ms]	TX current [mA]	Energy per packet Milliamp* millisecond [mAmS]
RIIoT (50 kb/s)	50	4.5	26	117
RIIoT Long range mode (5 kb/s)	5	45	26	1170
RIIM	50	9.35	26	243
LoRAWAN	0.298	1350	47	63450
Sigfox (EU)	0.100	1500	59	88500
169 MHz Wireless M-Bus	2.4	67	400	26800
868 MHz Wireless M-Bus	100	3.5	26	65
NB-IoT	6	177	220	38940

Typical RIIoT currents
- TX: 26.5 mA @14 dBm, RX: 6.2 mA,
- Sleep (RTC on) 0.7uA, Shutdown, 0.185uA

[1] CMWX1ZZABZ-078 from Murata
[2] RC1682-SIG from Radiocrafts
[3] Quectel B95 154 dB attenuation

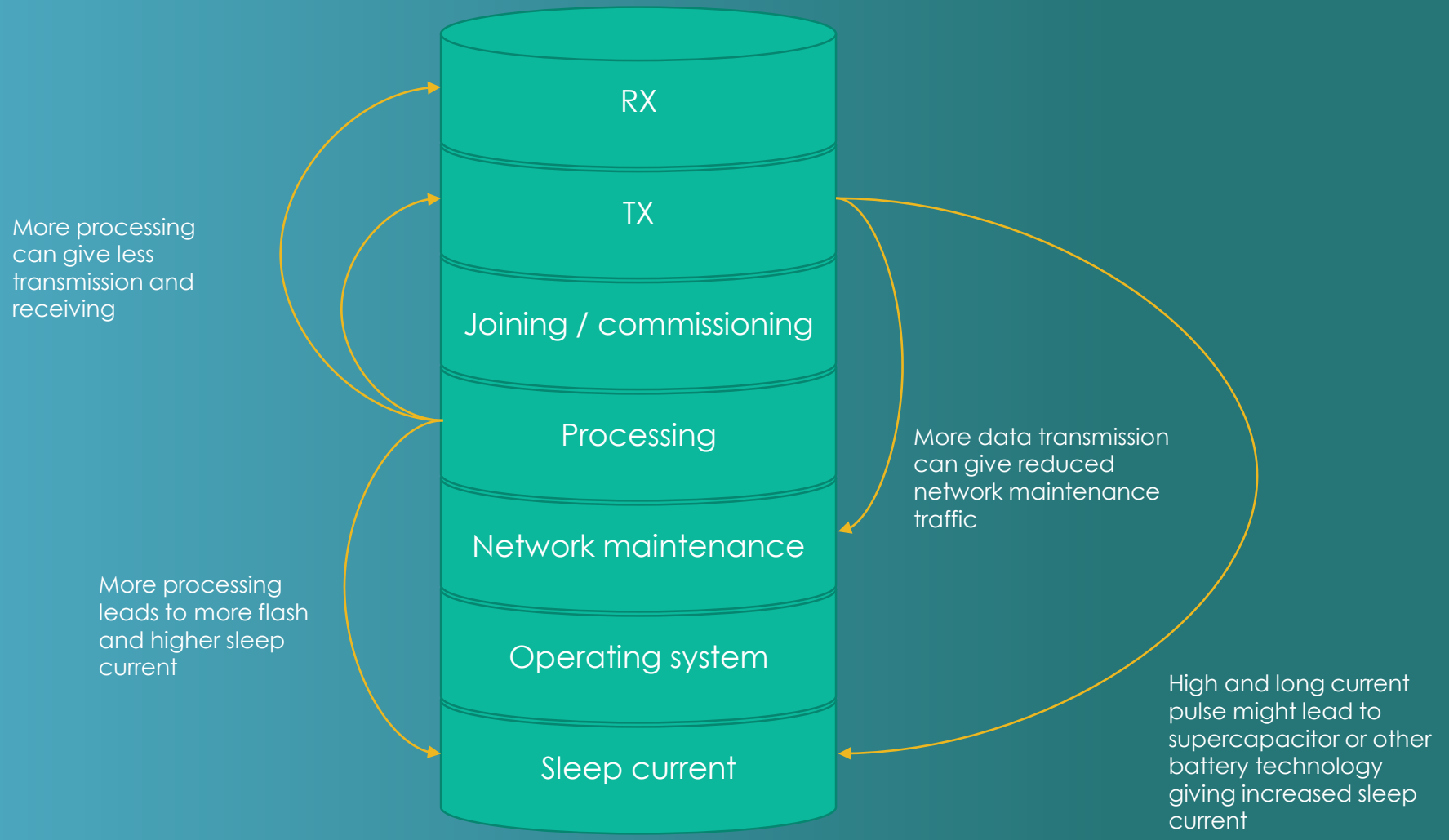
High peak current

- All battery have limitation in pulse current
  - Coincell < 20 mA
  - AA < 150 mA
- Using the batteries close to max pule give significant voltage drops
- Solution :Supercap/EDLC/HLC
  - Leakage ~1-4 uA
- Also applies to lower, but longer current peaks.

Receive current

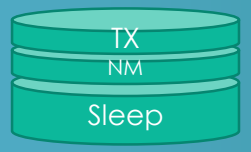
- LBT – Listen Before Talk
- ACK Acknowledgement
- (Retransmisson)
- Two way communication
- LoRAWAN/Sigfox and Wireless M-Bus normally avoid two way communication
  - Save current
  - Avoid capacity reduction in GW
  - Regulatory reasons
- NB-IoT spend more time in RX to syncronize than the other un-syncrone protocols

Confusing part – element effect each other

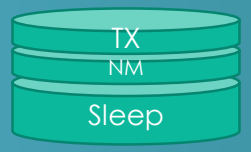


Current consumption example 1 transmission/hour

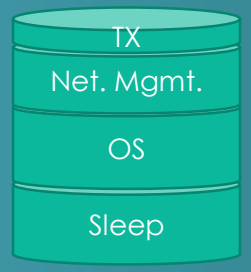
One AAA battery 5 years



RIIoT
50 kb/s



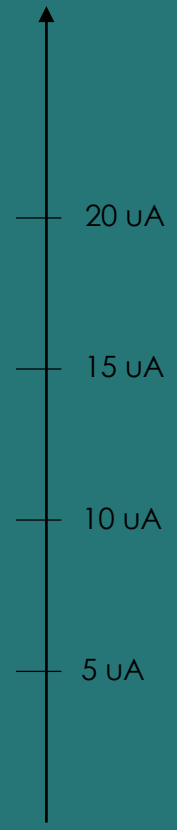
Wireless
M-Bus



RIIM

LoRAWAN
297 b/s

NB-IoT



Current consumption example 1 transmission/30 minutes

3 AAA battery 5 years

Summary – how to increase battery lifetime

- Send less data – TX current is normally the biggest contributor
  - Trade off vs. update rate
  - Store and send larger amount (30-60 bytes)
- Trade off vs. reliability
  - Do you need confirmation
  - Do you need retransmission
- Trade off vs. range
  - What is the actual range needed
  - Main powered mesh can give same coverage but less range for battery operated sensors
- Local processing can significantly reduce data traffic
- Use a good antenna and reduce output power
  - Trade off vs. design/size
- Mesh can combine large coverage and low power end devices
  - Trade off vs. infrastructure cost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Q&A

Thank you for the attention