The Magic Square of IoT

Thomas Rottach
Sales & Marketing
Siglent Germany

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E&A ELECTRONICS APPLICATIONS '23

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Agenda

- Introduction
- The Corners of the Square
- Inter-dependencies
- Example
- Summary

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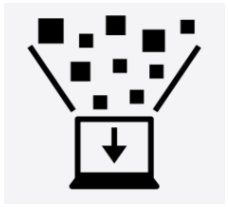
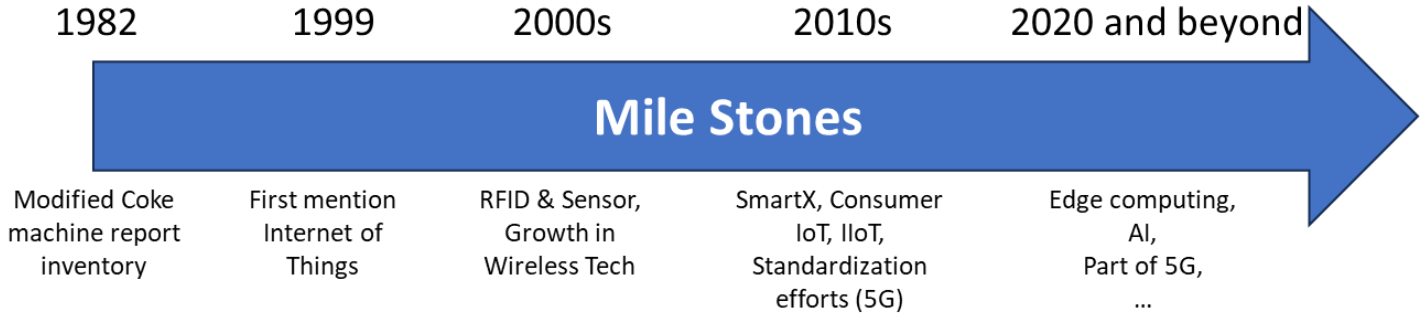
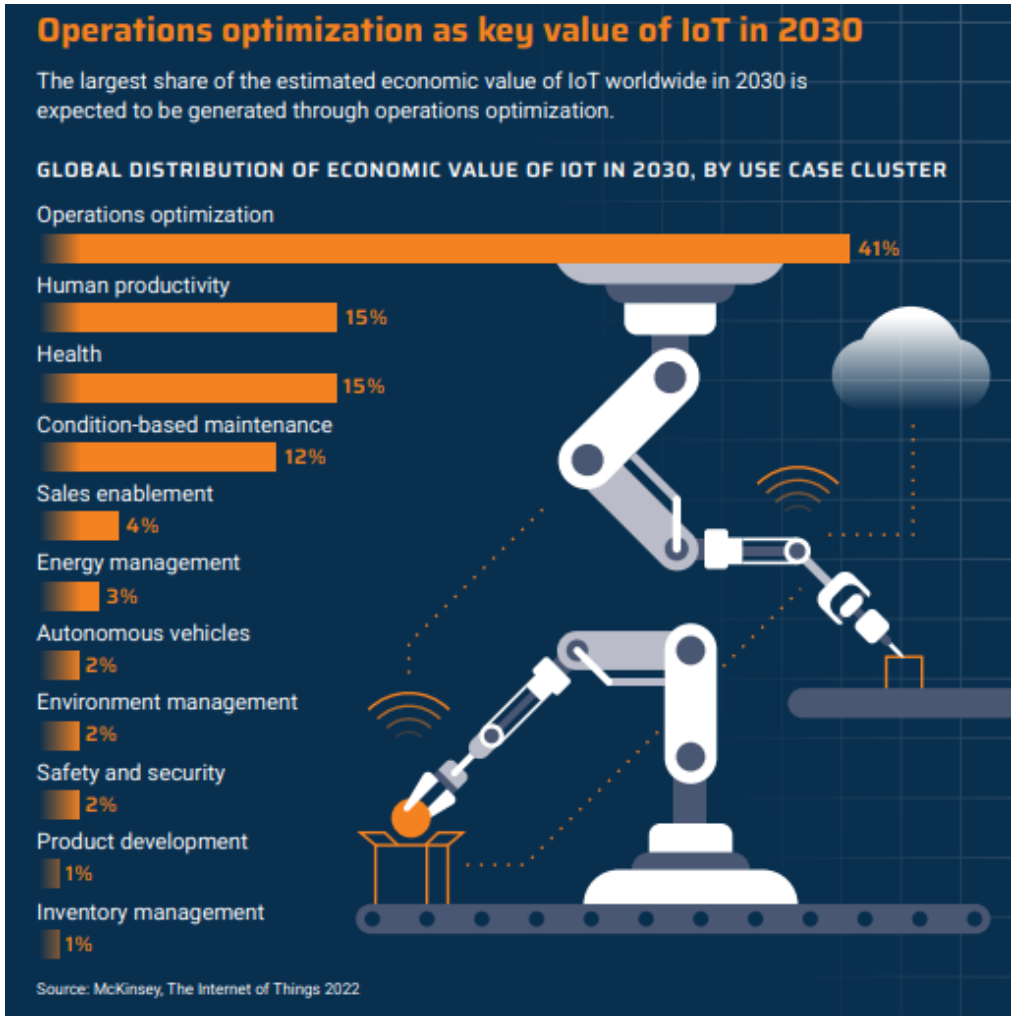
What is IoT?

3 Main Characteristics:

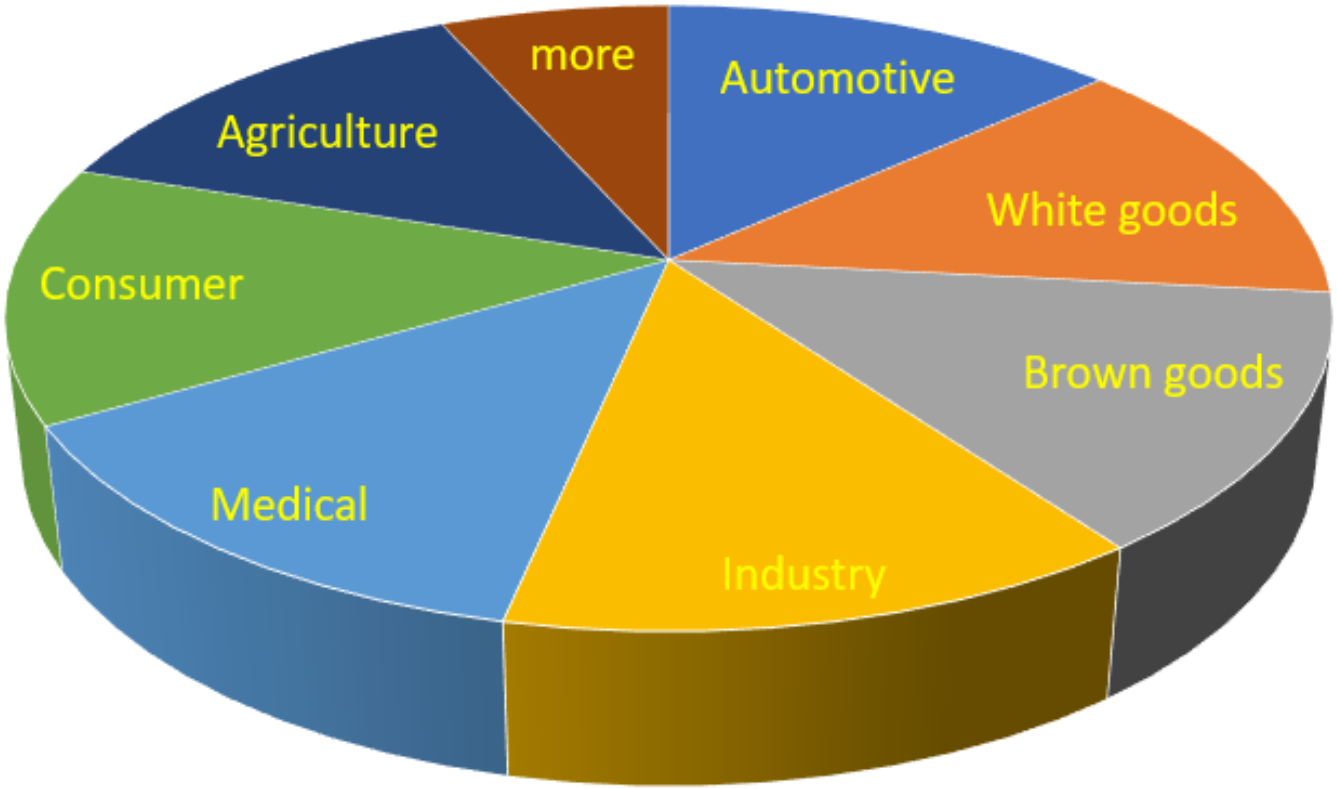
- **Connectivity**
- **Data Collection**
- **Data Processing**







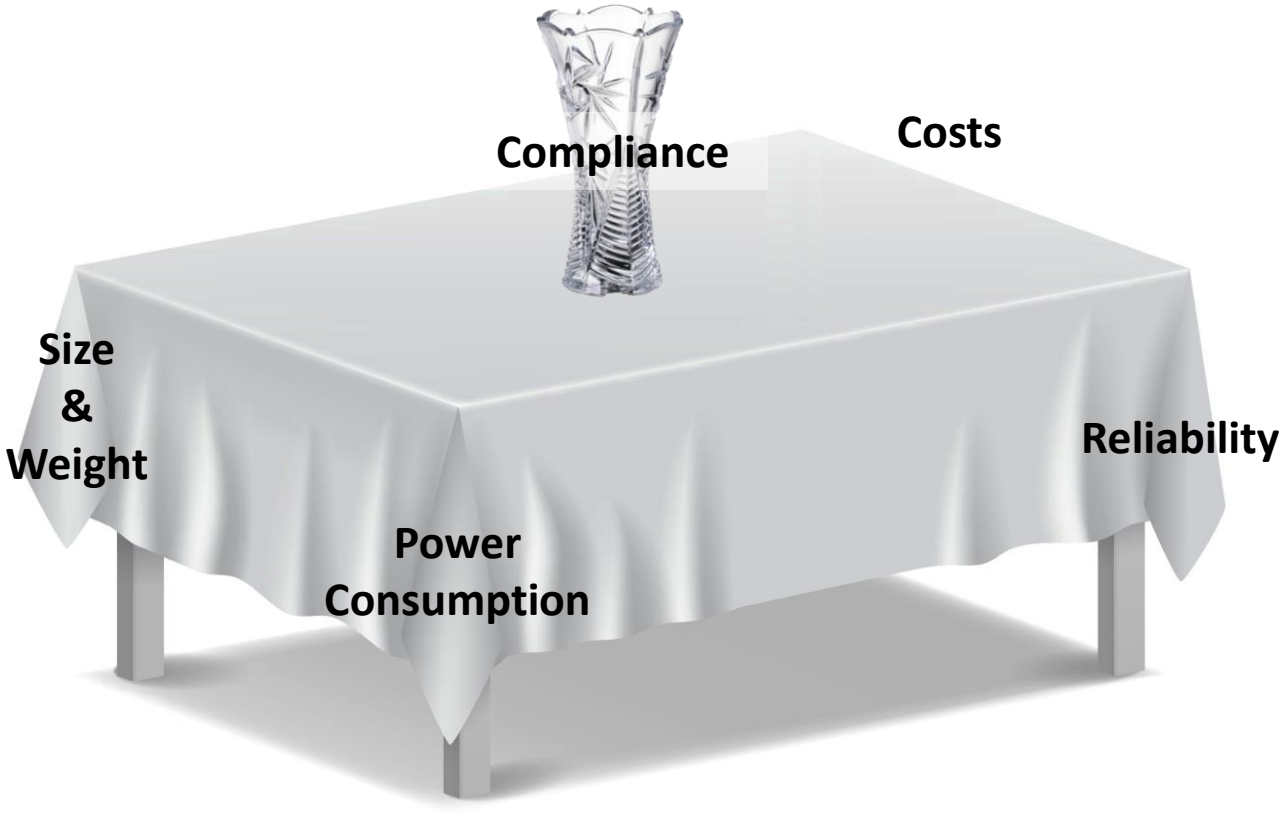
Focus Area for this Presentation



Focus on devices which have:

- **Wireless connectivity**
- **Limited availability of Power**
- **Requirement for Limited space and limited weight**
- **Cost pressure**

The Corners of the Square



- **Power Consumption**
  - **Battery powered devices**
- **Reliability**
  - **Critical Environment**
- **Size & Weight**
  - **Wearables**
- **Costs**
  - **Mass products**
- **Compliance**
  - **ALL areas**

Measures to improve Power Consumption

- Wireless Communication Standards
- Power Converter Efficiency
  - Selected Topology
  - Use of High-Quality Components
  - Optimize Switching Frequency
  - Implement advanced Semiconductors
- Microcontroller Operation
- Standby-Power / Deep-Sleep
- Temperature Control

Measures to improve Reliability

- Use of High-Quality Components
- Predictive Maintenance
- Battery Technology
- Energy Harvesting
- Type of connectivity

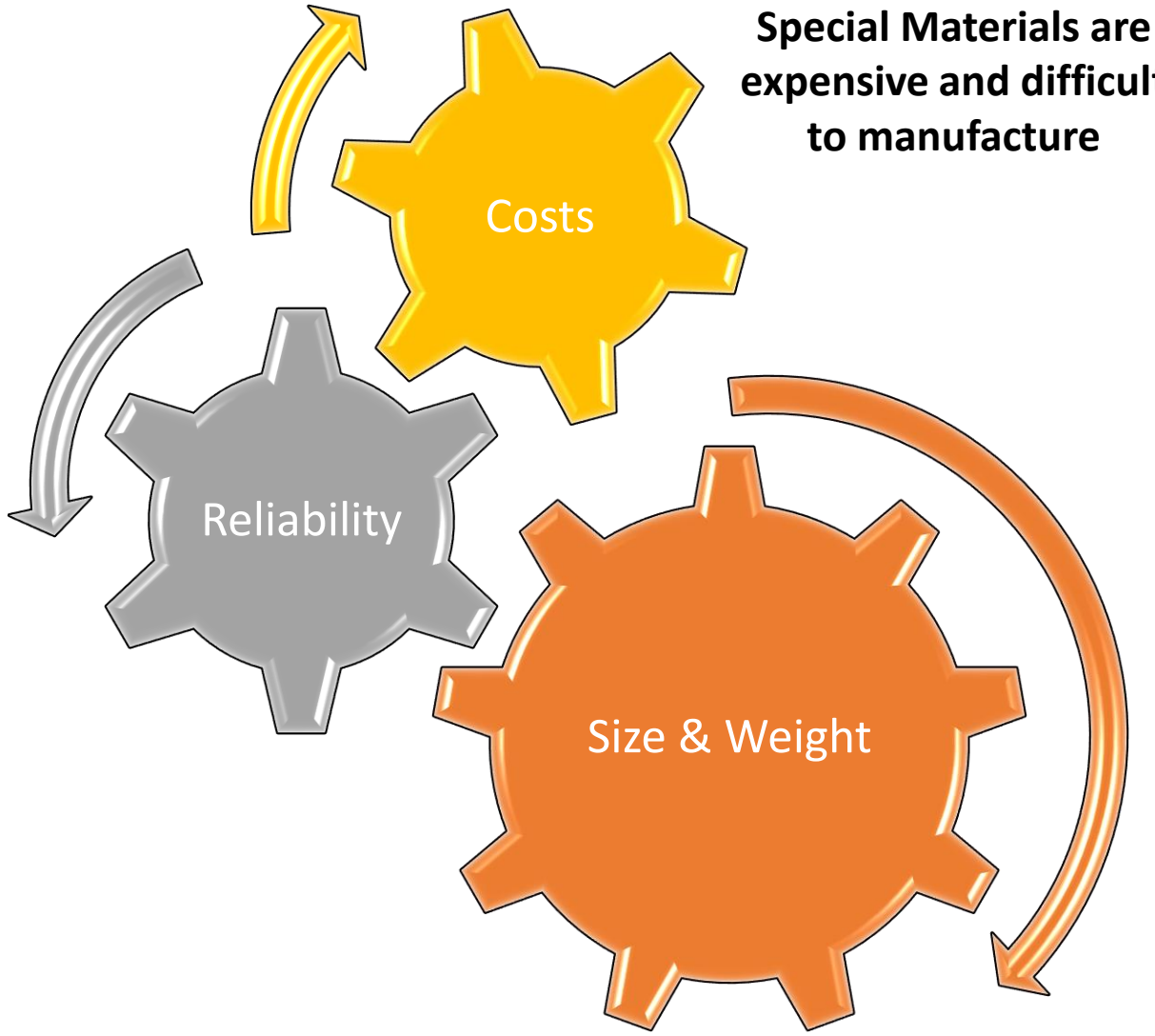
Measures to improve Size & Weight

- Smaller Components
- SoC (System on a Chip) / Stacked Components
- Thin-Film / Flexible Electronics
- Optimize Efficiency
- Smaller Heat sink
- Smaller Battery
- Energy Harvesting -> substitute battery
- Use advanced material
- External Antenna

Measures to improve Cost

- Cost optimized Component sourcing
- Cost optimized Technologies
- Housing (Metal vs. plastic)
- Standardization
- Production automation and outsourcing
- Modular Design for easy Scaling / Function adaption

Mutual Impact



Special Materials are expensive and difficult to manufacture

The probability of damages or breaking grow ➔ Reliability go down

Using ThinFilm or Flexible Electronics to reduce S&W

Detailed Example Power Consumption

Optimizing Power consumption by increasing the converter efficiency.

1. Implement GaN-based switches

- Higher Energy efficiency (up to 80% lower losses)
- Higher Power density
- Higher Temperature sustainability
- Higher Switching speed

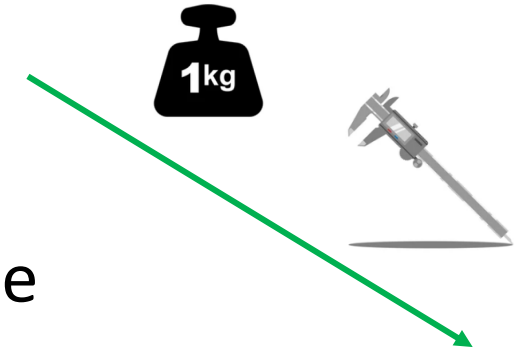
Impact on COST?

2. Select high quality Components

Direct impact on COST

Using GaN → Effect on Size & Weight

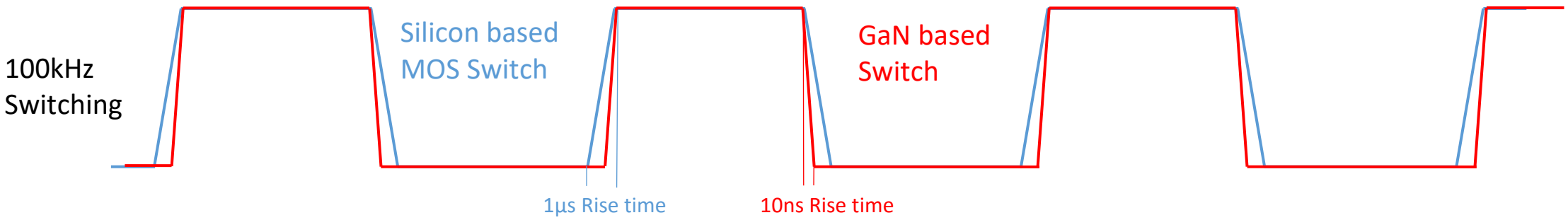
- Lower losses allow smaller heat sink
- Lower losses allow smaller battery
- Higher Power density allow do downsize switch device



- Higher Switching Frequency allow smaller components like Inductivity

→ **Direct impact on COST**

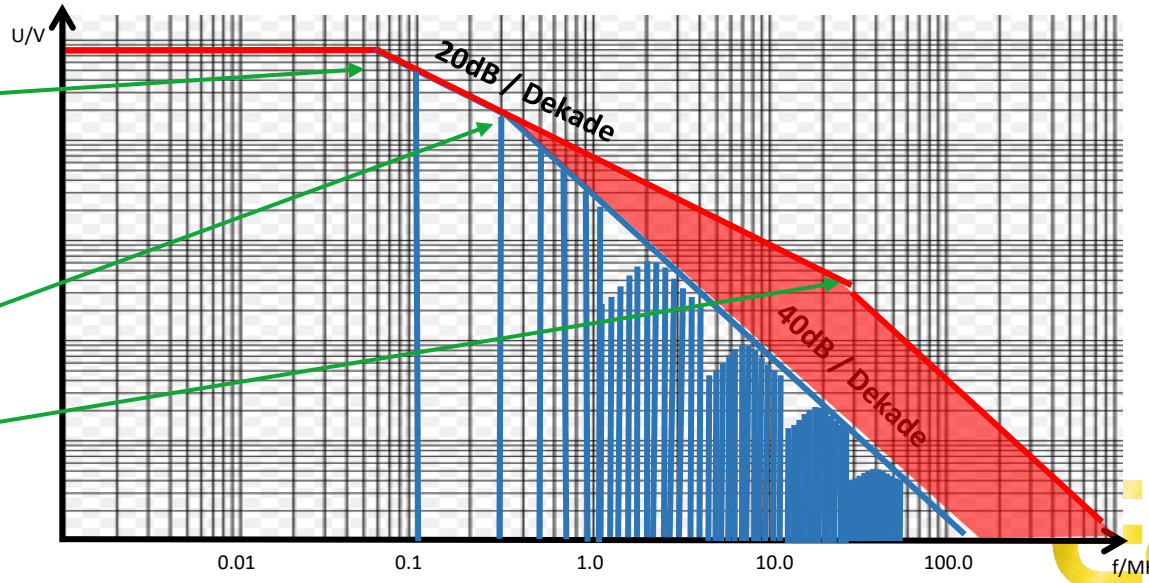
Possible Effect on Compliance



- **1st Frequency point = $\frac{2*fsw}{\Pi}$ (here = 63.7kHz)**
- **2nd Frequency point = $\frac{1}{\Pi*RiseTime}$**

1µs Rise Time => 318,3kHz

10ns Rise Time => 31,83MHz



Possible Effect on Compliance

2MHz Switching

GaN based Switch

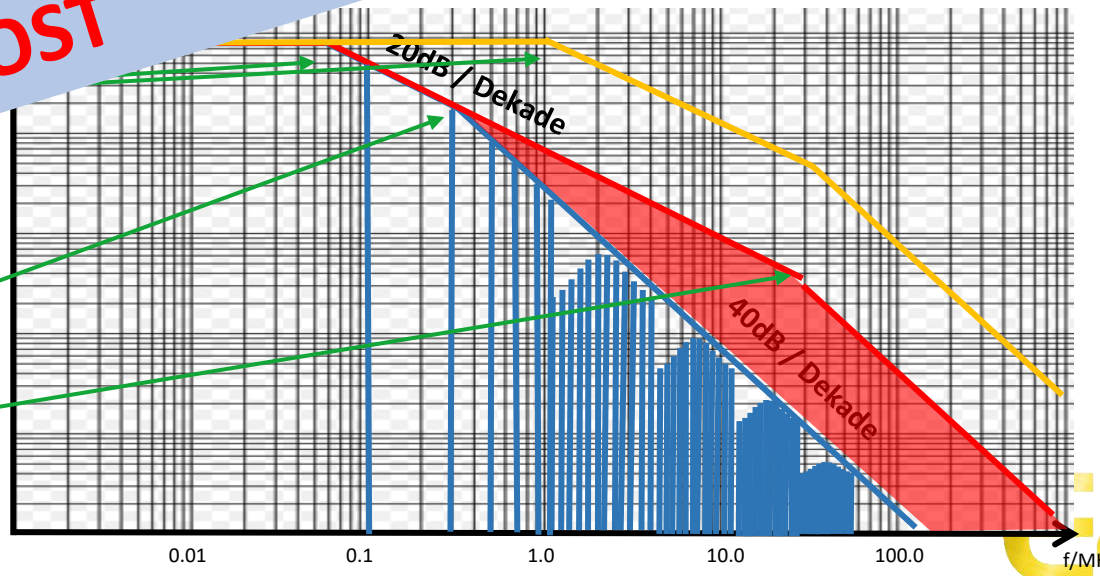
Dealing with this issue cost time and possibly new Filter

➔ **Effect on COST**

- **1st Frequency point = $\frac{2}{\Pi * RiseTime}$ (here = 63,78kHz)**
- **2nd Frequency point = $\frac{}{\Pi * RiseTime}$**

1µs Rise Time => 318,3kHz

10ns Rise Time => 31,83MHz



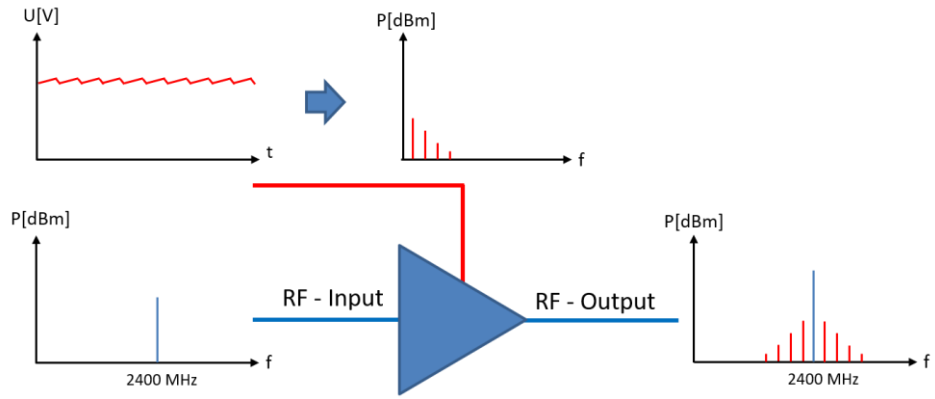
Effect on Reliability

- GaN devices increase reliability
- Lower power consumption -> extend lifetime

Direct impact on COST

- Improper design can harm RF performance
  - EMI interference with Carrier
  - Ripple introduced interference

Direct impact on COST



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Summary Effect on Cost

- Higher quality component increase cost
- GaN is still a bit more expensive than Silicon
- Optimizing effort adds labour cost
- Working with GaN requires higher performance T&M equipment

- Smaller heat sinks are cheaper
- Higher Efficiency allows smaller battery
- Higher Reliability lowers Service costs

- Compliance is non negotiable
- There are 4 Core Requirements
- Every Area of Application has different priorities on requirements
- Any change on any of these 4 Requirement impact the other 3 (positive & negative)
- Keep an eye on each Parameter

Thank you!

Booth Number: 7F050

Tooltronics B.V.
+31 88 291 66 55
info@tooltronics.nl
www.tooltronics.nl

Siglent Technologies Germany GmbH
+49 821 666 0 111 0
info@siglenteu.com
www.siglenteu.com