



Hochschule Offenburg University of Applied Sciences

Reliable Wireless Communications for Health

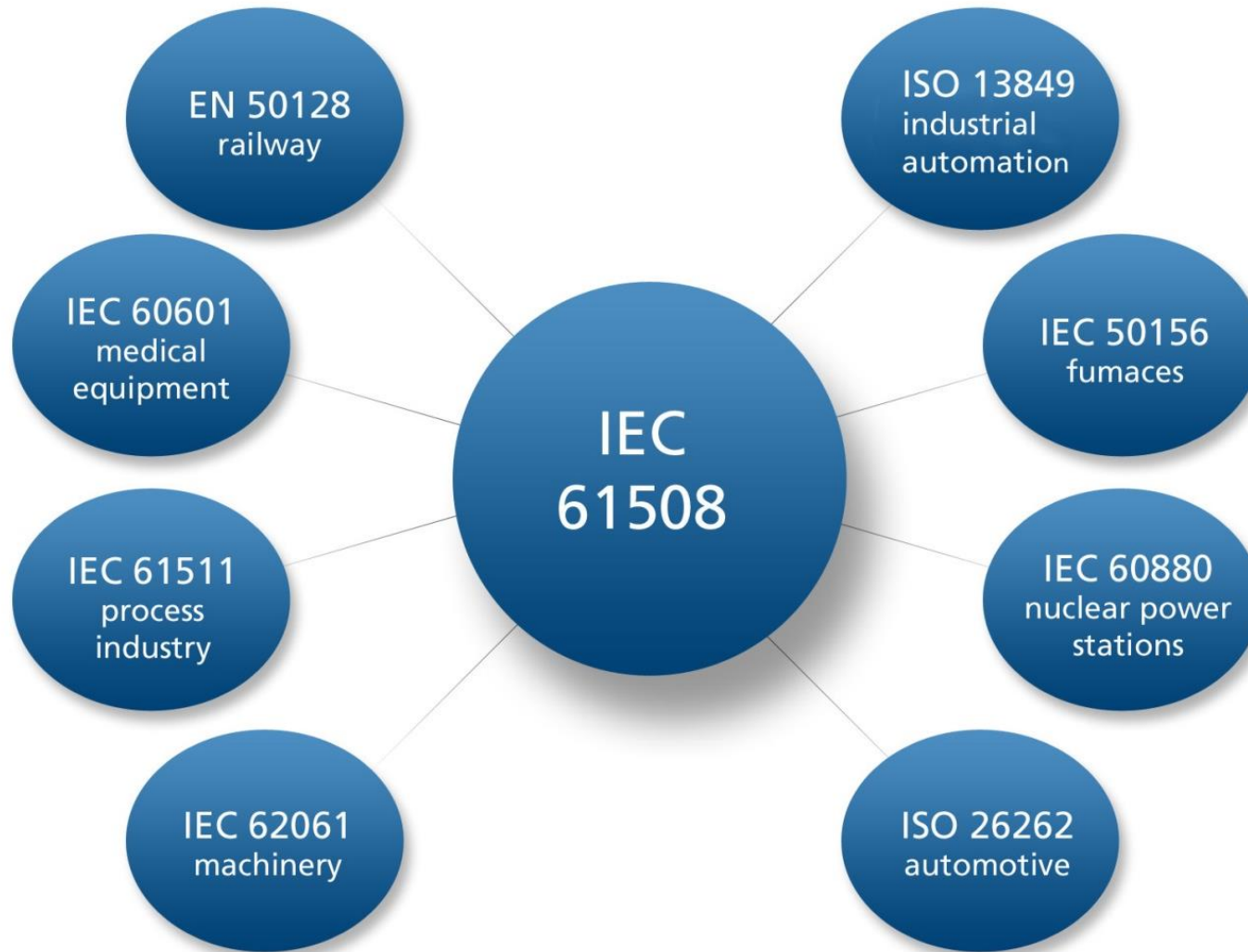
Prof. Dr.-Ing. Thomas M. Wendt

Golden Thread

Motivation
Functional Safety
Threats
Challenges
Concept
Summery



Motivation Functional Safety



Functional Safety

safety

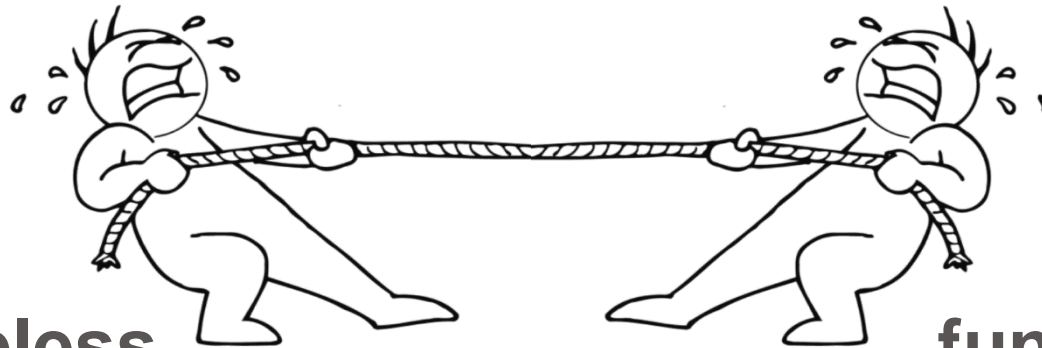
That a GPS navigation system is bouncing around in the passenger compartment during a crash is a problem of safety!

functional safety

That the same navigation system in conjunction with an advanced driver assistance systems is responsible for a hazardous situation due to a malfunction is a problem of functional safety!

Motivation Wireless and Functional Safety

Wireless and functional safety



**wireless
communication**

**functional
safety system**

Until today wireless is rather an issue of EMC for functional safety than a solution!

Functional Safety

„Recognize“

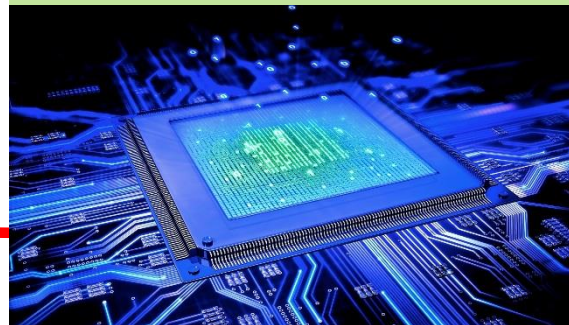
Measure



Sensor

„React“

Control



Control unit
(HW/SW)

„Do/Execute“

Operate



Actor

http://www.diashop.de/media/catalog/product/cache/1/image/9df78eab33525d08d6e5fb8d27136e95/3/1/31285252_1.jpg

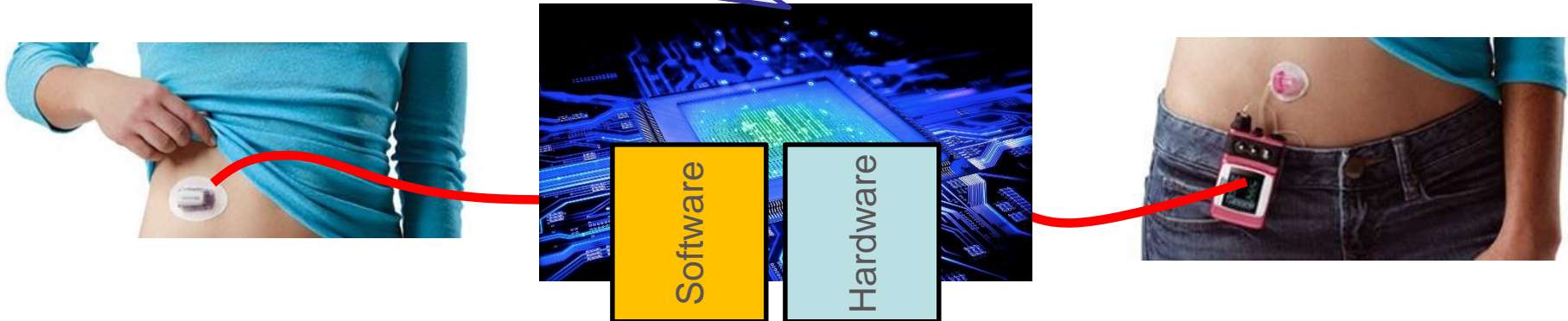
<http://www.4electron.com/wordpress/wp-content/uploads/2014/11/Comparison-between-Microprocessor-and-Microcontroller.jpg>

Functional Safety 1001 System

1001 means 1 out of 1

The simplest and most cost efficient type of system. There is no monitoring of the functional safety.

- Simple monitoring can be realized in software
- No functional safety features can be implemented.



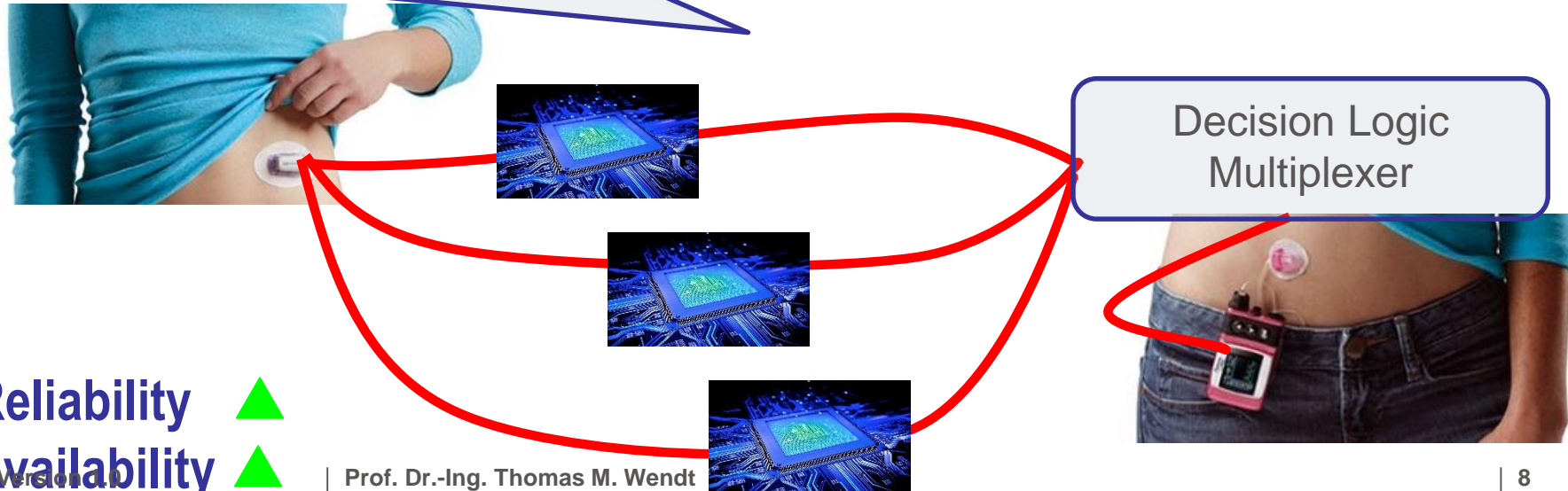
Reliability ▼
Availability ▼

Functional Safety 2oo3 System

2oo3 means 2 out of 3 (3 controller units plus decision logic),

Three independent hardware channels, of which two must deliver a consistent result in order to trigger a reaction. System remains functional in case a single unit fails. The decision logic monitors the controller units (diagnostics).

- Higher availability of the hardware due to three independent channels.
- High functional safety features can be implemented (e.g. Autopilot)
- Software monitoring is mandatory



Reliability ▲
Availability ▲



Gap!

What is Missing?

How to fix it?

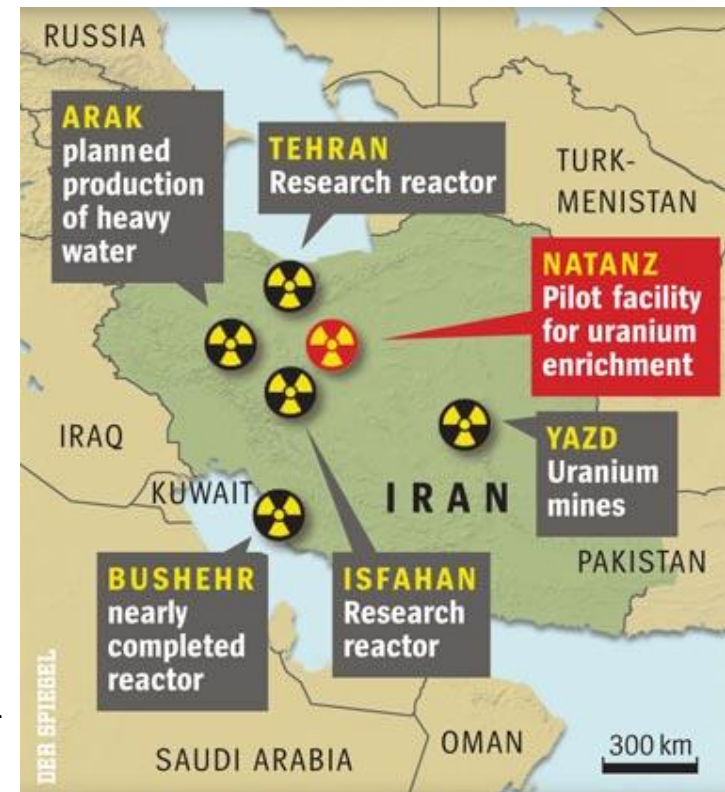
First become aware of it!



Stuxnet Worm

- **Very specific attack against the Iranian Nuclear Program**
- **Attacked only certain controlling devices from Siemens**
- **Was distributed via USB-Sticks**
- **Its creators are still unknown**

Chen, T. M. / Abu-Nimeh, S.: Lessons from Stuxnet, Computer, Volume 44, Issue 4, IEEE 2011



<http://www.iranreview.org/file/cms/files/iran-nuclear-facilities.jpg>

Security gap eCall System?

- Starting March 2018 every new car in the European Union has to have this emergency call system
- Voice and data is transmitted via cellular network in case of emergency
- One security gap was already shown where the authorization certificate was manipulated and eventually broke the authorization function
- Hackers gained access to the entire System!
- This eCall System is supposed to add safety to the car but instead it might open a gap in security of a car



<http://ec.europa.eu/transport/images/highlights/e-call.jpg>



<http://i.computer-bild.de/imgs/5/0/9/9/2/5/9/Logo-des-eCall-Projektes-in-der-EU-1024x576-3fc626d1a2894458.jpg>

Jeep Hack

Charlie Miller and Chris Valasek via cell phone

- Showed a picture of the hackers on the navigation screen
- Fooled around with the volume of the sound system
- Turned off the accelerator pedal
- Showed incorrect values on speedometer
- Took over steering of the car

<https://www.youtube.com/watch?v=MK0SrxBC1xs>

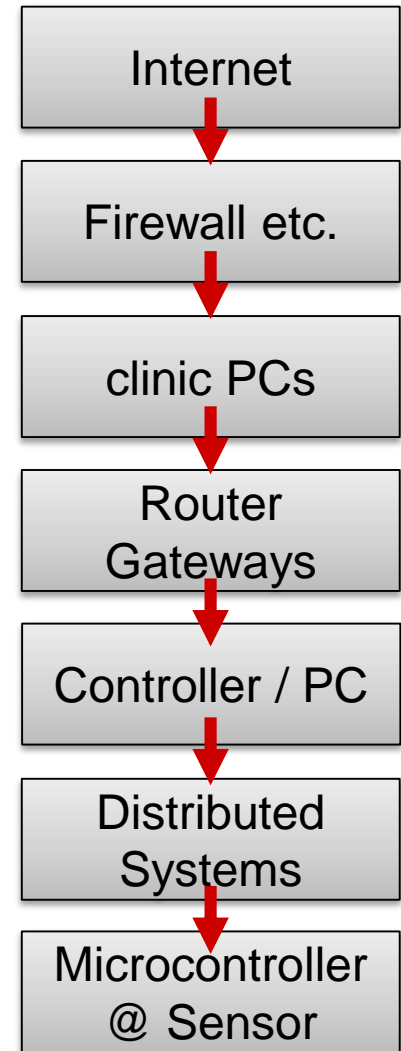
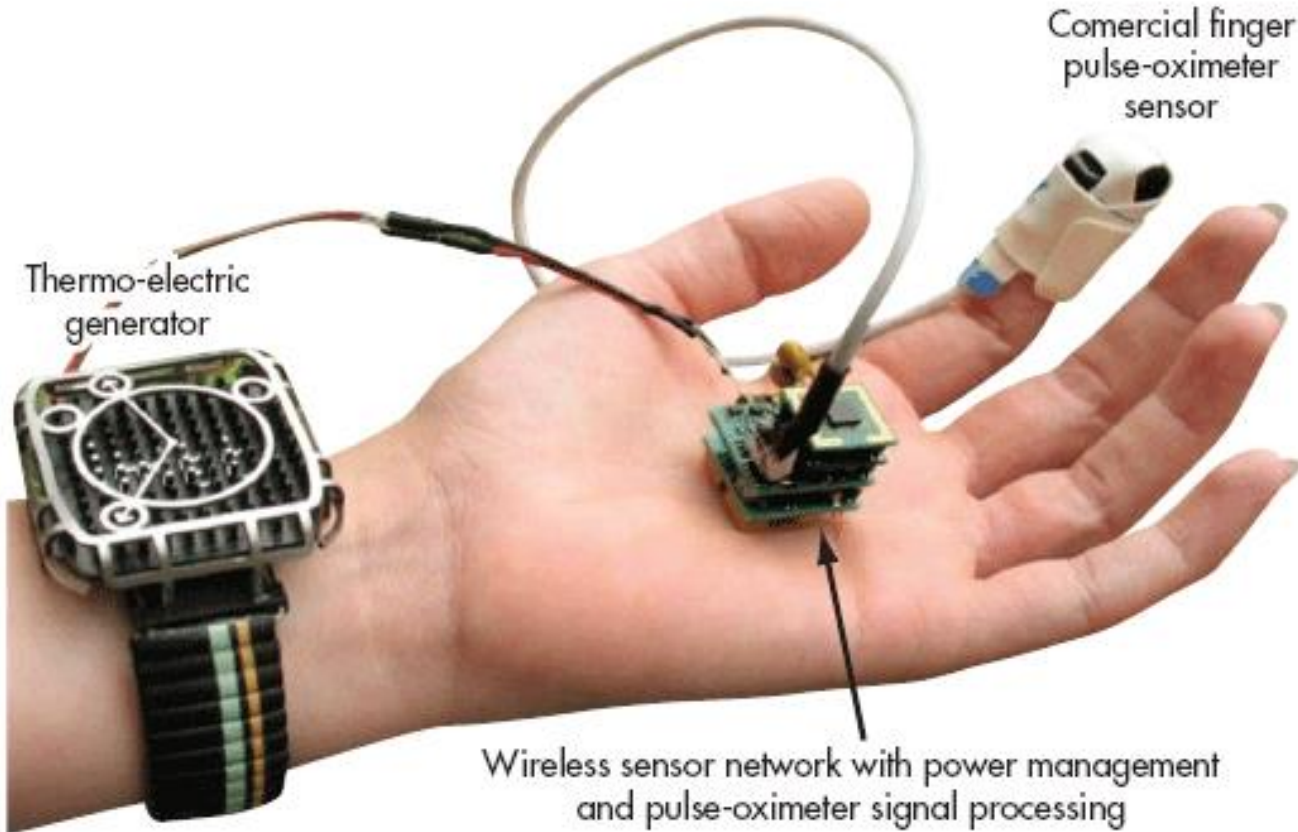


<http://www.motoroids.com/news/hackers-take-control-of-jeep-cherokee-through-internet-even-with-the-driver-at-wheel/>

Questions & Problems

- Focus on **“solving the technical issue”**
- Who is responsible?
 - Manufacturer
 - Software company
 - Seller / Distributor /
 - Owner
 - ...
- What is fully automated autonomous driving?
- Is there any standard talking about these issues?
- Included in Functional Safety or needs it's own standard?
- Are we (Manager, Engineers, Seller, QA, RA ...) aware of it?
- ...

What we do ...



Challenge I

- IOT
- Smart clinic
- Big Data
- Cyber physical system
- ...

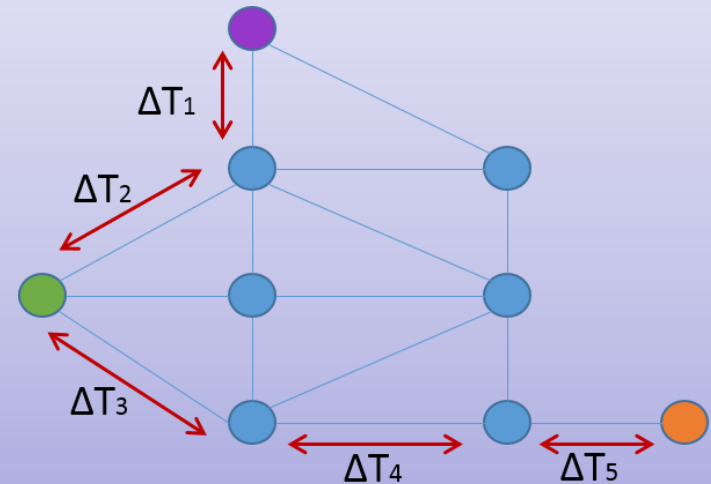
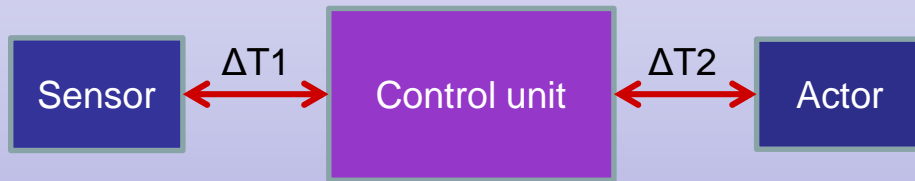
IEC EN DIN 61508

- Security
- Functional safety

http://www.coganpower.com/wp-content/uploads/2014/10/pOperatingRoom_Dollarphotoclub_26316918.jpg

Challenge II

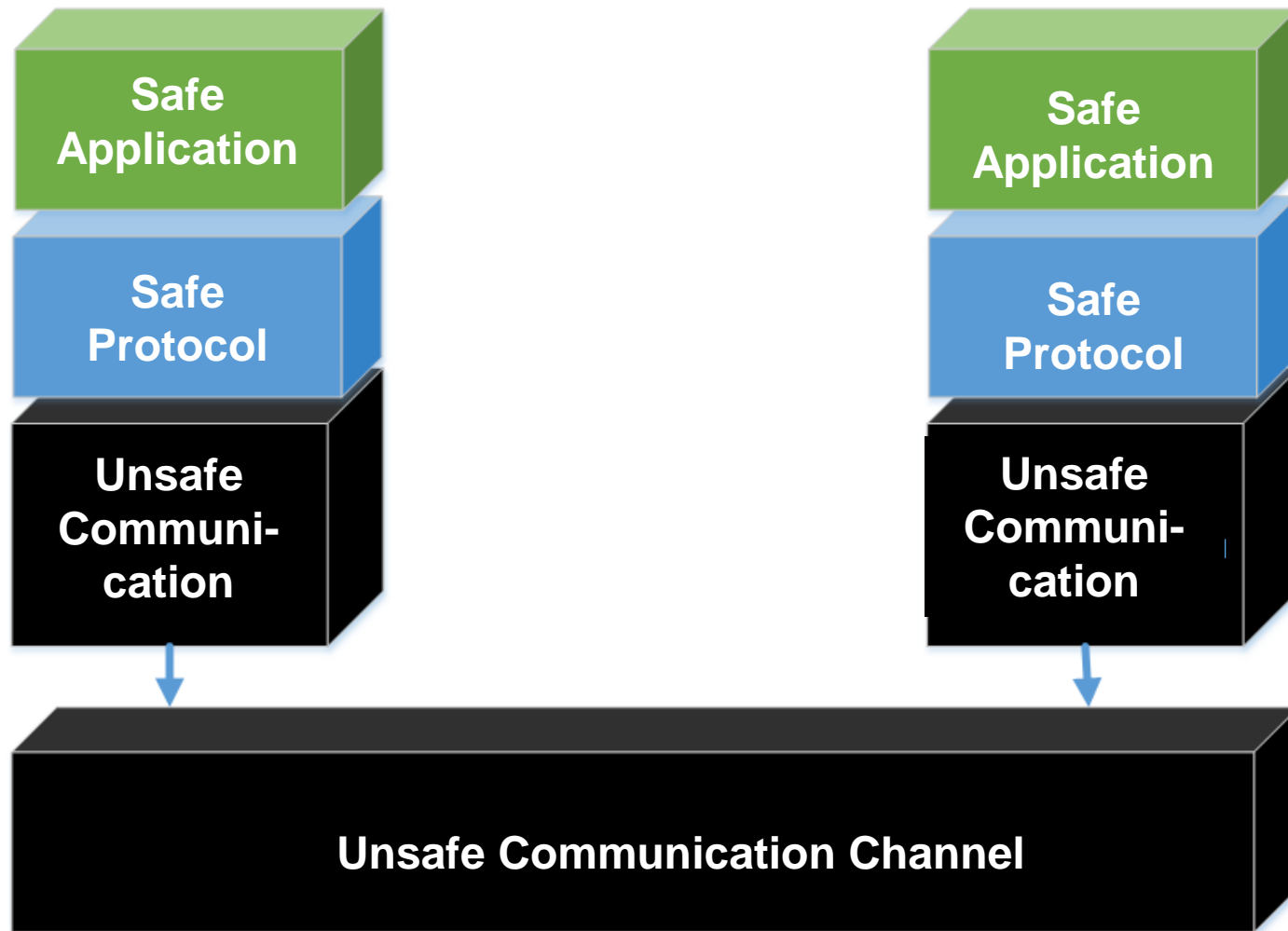
A late response is an incorrect answer, if it jeopardizes the security



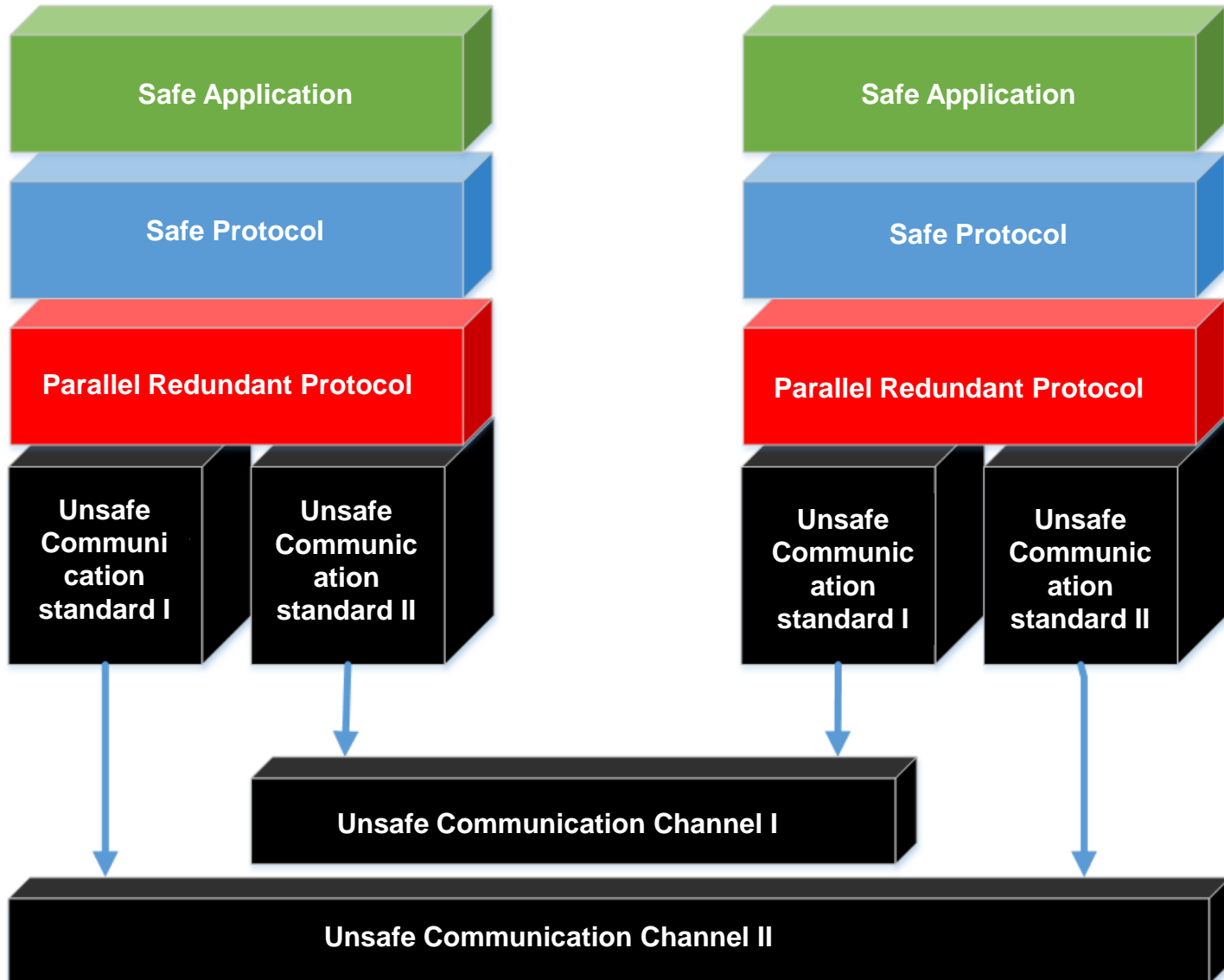
Information which is falsified must be recognized to ensure a functional safe system



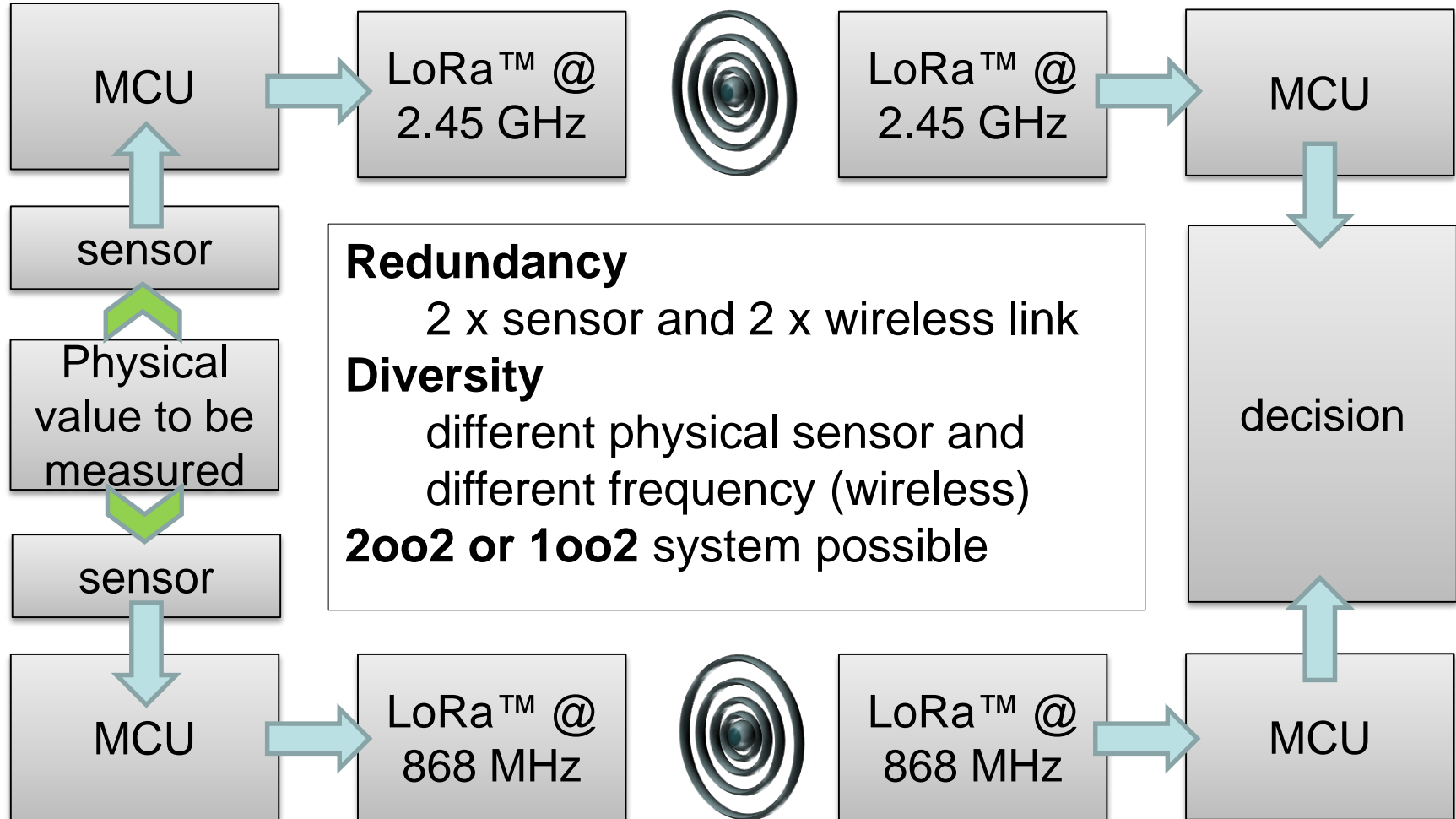
State of the Art → Black Channel Principle



New? → add Redundancy and Diversity



New? → add Redundancy and Diversity



Safe Wireless Applications

- **Leica Wireless Footswitch uses ISM bandwidth**
- **Animas® Vibe® Insulin Pump**



http://www.cyhc.com.tw/archive/upload/images/Leica%20M844_07.jpg



<https://www.animascorp.co.uk/vibe-insulin-pump>

Hardware → LoRa™ basics

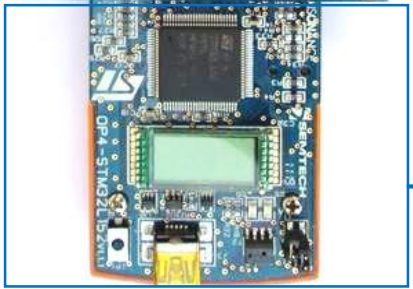
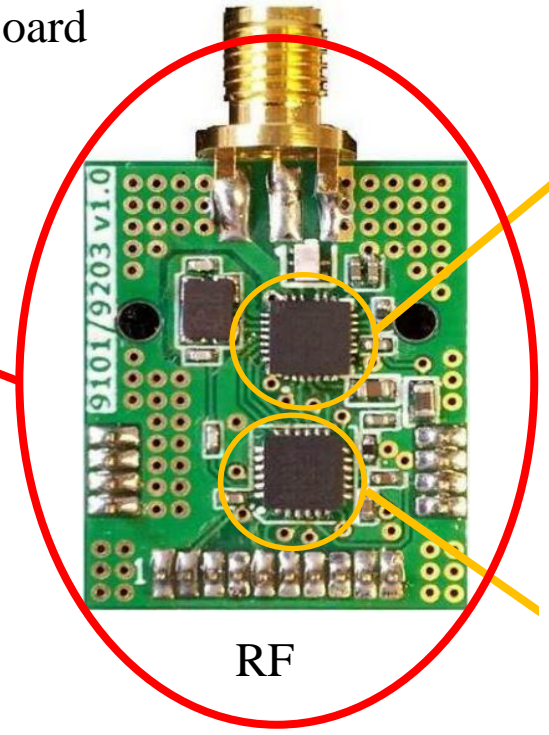
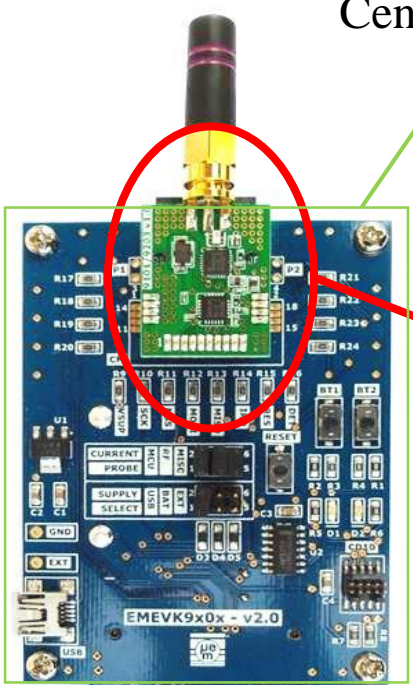
Central-Board

EM9203
transceiver chip

EM9101
modulation chip

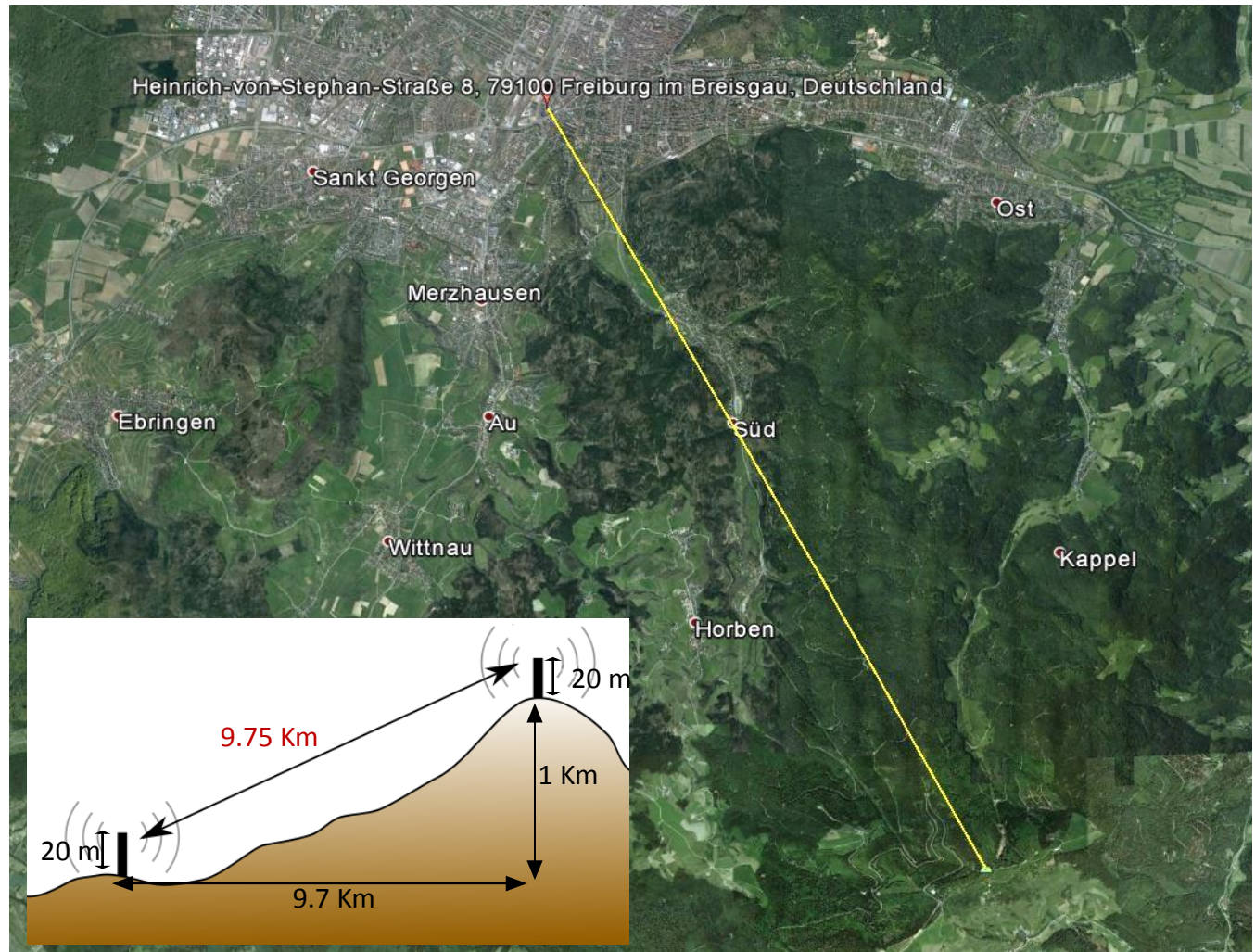
RF

Cortex-M3-Board STML125



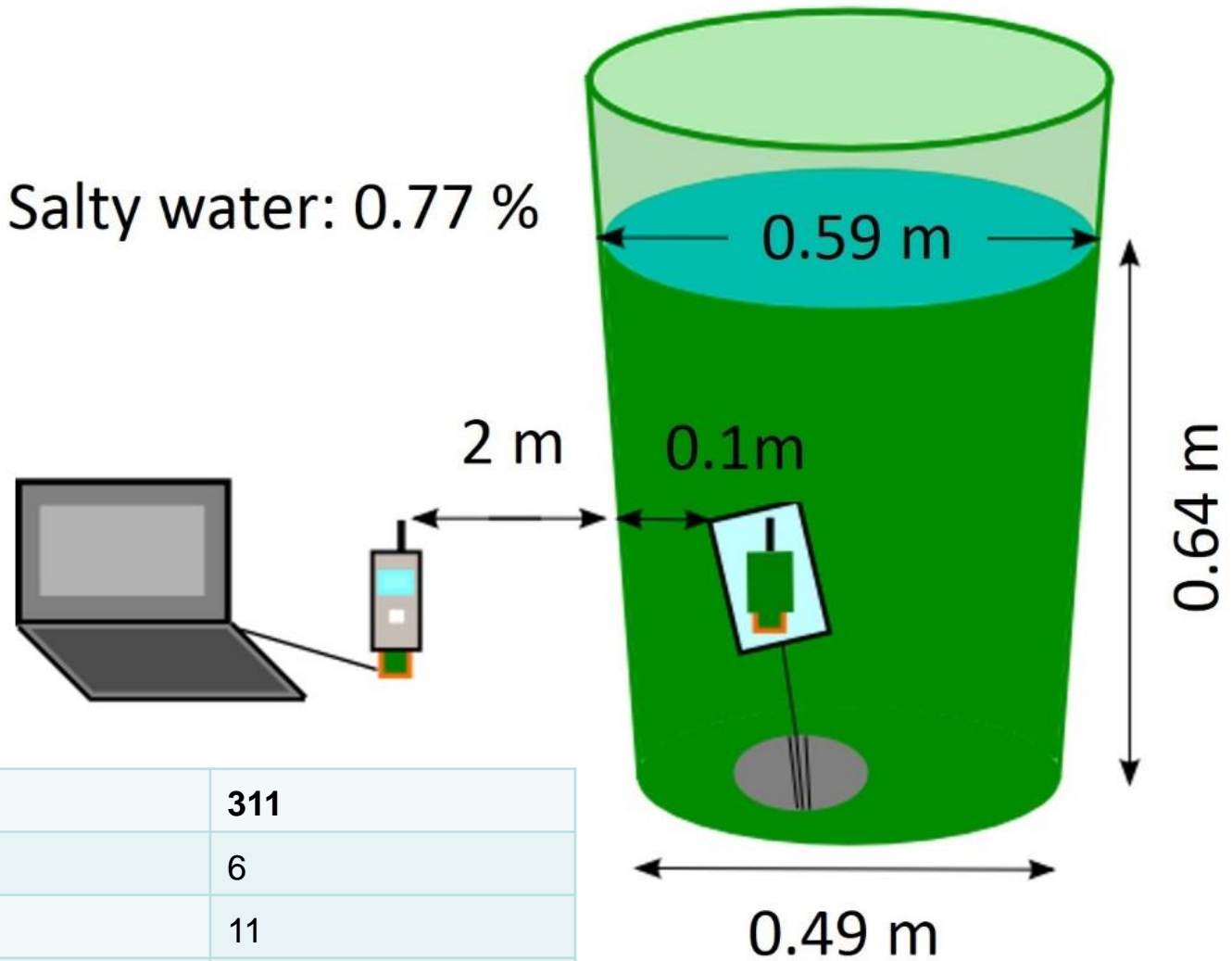
Measurements

	correct received /%
1	60.34
2	21.90
3	55.80
4	42.29
5	81.27
Ø	52.32



Measurements

Salty water: 0.77 %



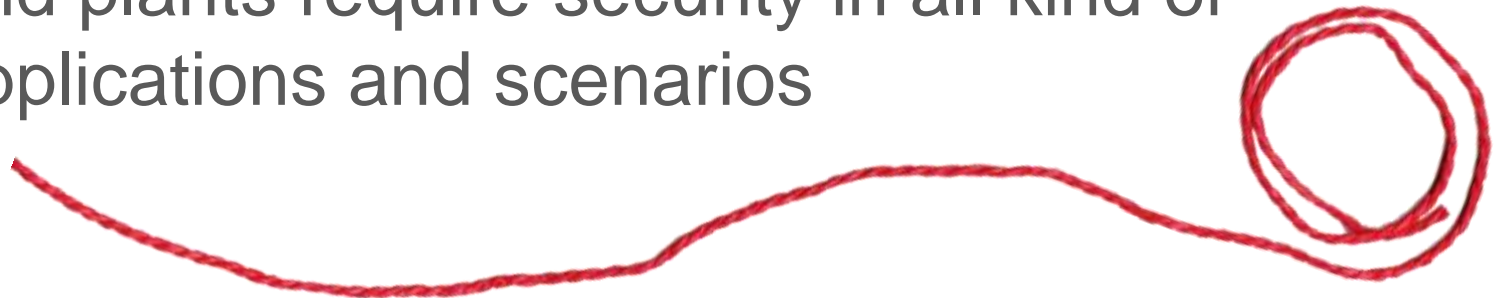
transmitted packets	311
“lost” packets	6
Error Rate	11
correct received rate	94.5%

Summary

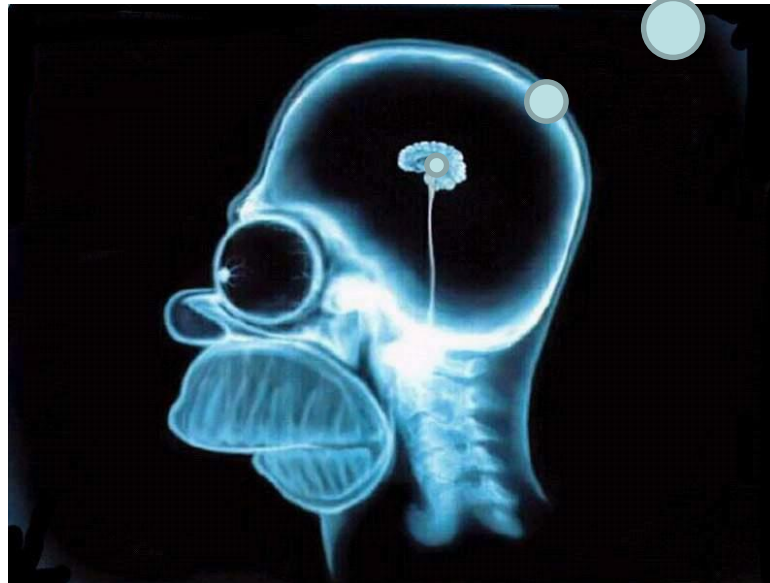
Overview of functional safety
Challenges of safety together with security
Examples of threats
Research areas

Conclusion

Functional safety systems as all other products and plants require security in all kind of applications and scenarios



thank you



“Everything should be made as simple as possible, but no simpler”!

[Albert Einstein \(14 March 1879 – 18 April 1955\)](#)