



RFID based monitoring the cold chain

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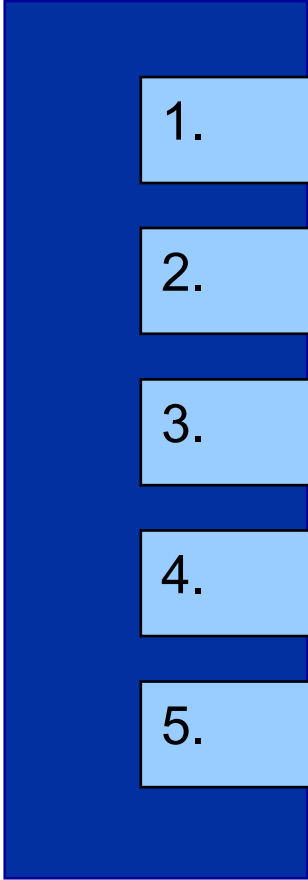
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**Cold Chain Management
2nd International Workshop Bonn, Germany**

8 - 9 May 2006

Overview

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1. Department of Logistics (UniDo)
 2. Basics of Radio Frequency Identification (RFID)
 3. Requirements of a cold chain integrity concept
 4. The concept of sensor based RFID (ISRFID)
 5. Results from Research Projekt „Trakü“



**Department of Logistics
University of Dortmund**

- **Retail and transportation Logistics**
- **Packaging Logistics**
- **Waste management Logistics**

Research and Development
on behalf of German Federal and
Federal State Authorities, EU, DfG,
Organisations, accredited laboratory of
der BVL, DVEU and the GVB

Test Laboratory for specific mechanical
and technological testing packaging and
packing materials
according to DIN EN ISO/IEC 17025



Test center for packaging of dangerous
goods on behalf of the German Federal
Institute for Materials Research and
Testing Berlin (BAM)



Electronic surveillance system
testing laboratory
according to VDI directives
VDI4470, VDI4471, VDI4473, VDI4475



Logistic Identification Laboratory

- Demonstration and test center of various RFID-Systems
- Ability to test and prove any RFID technology and influence factors



Department of Logistics (UniDo)



- Testlab

Application / Pilot Projects

under **Working / Environmental Conditions**

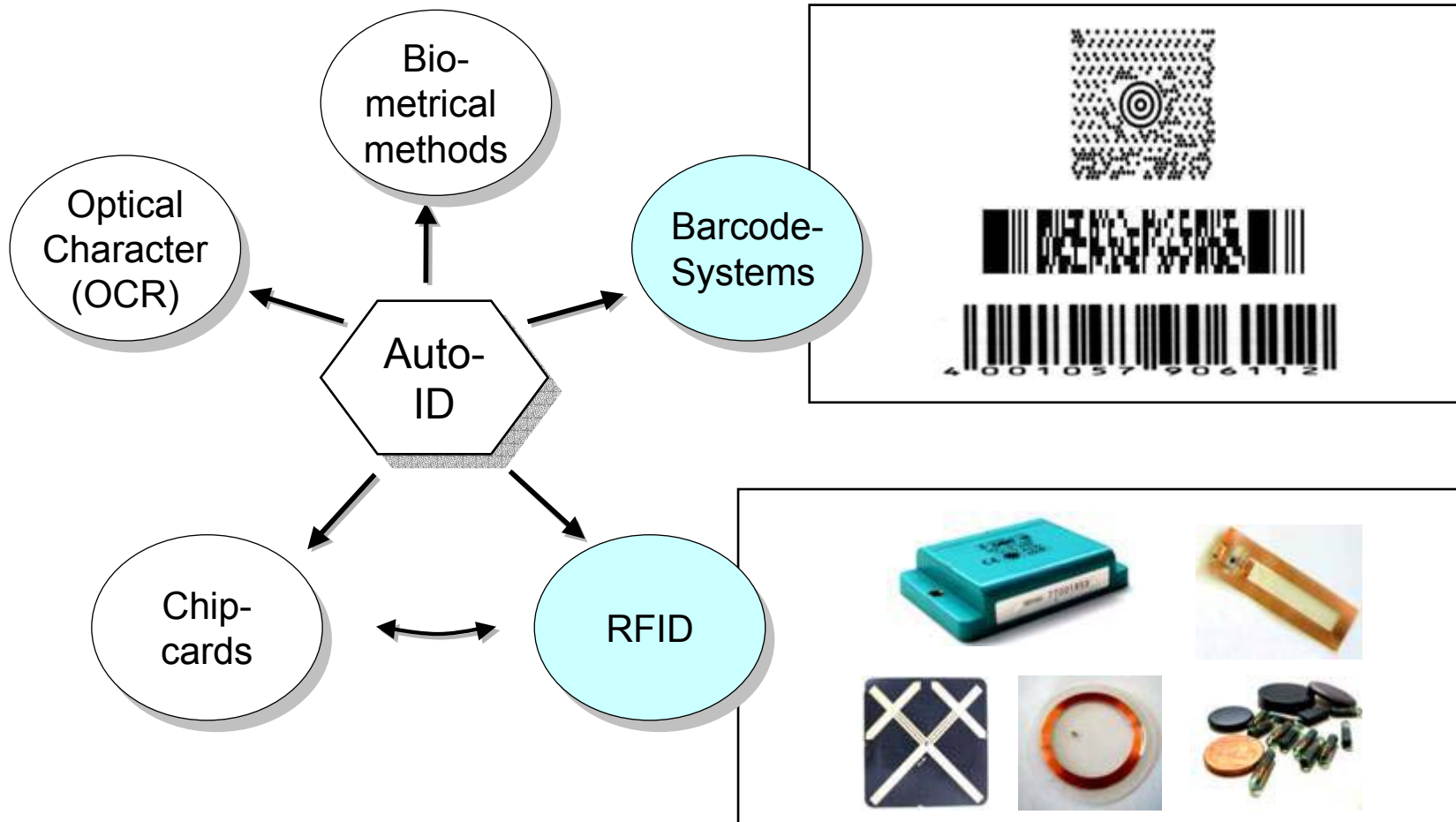
- Thermal Resistance / stress (climate-testing laboratory)
- Resistance against climate impacts
- Mechanical load (static / dynamic)
- Resistance against chemical substances

of the **Performance**

- Mounting Place / Substrate (metall, Liquids, etc.)
- Penetration trough material
- Ability to read transponder in a Bulk
- Read ranges
- Detection area of different antenna field patterns

to the **Electromagnetic Properties**

- Electrical and magnetical field strengths
- Evaluation of quality factor from inductive coupled RFID-Systems
- Bandwith and resonance frequency
- Minimal magnetic flux density at different frequencies for reading and writing



RFID: Radio Frequency Identification
(System to communicate between transponder and an interrogator)

internal Computer
Application

interrogator
and antenna

transponder
or tag

local
interface

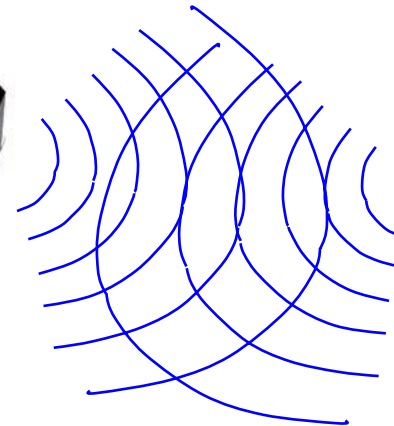
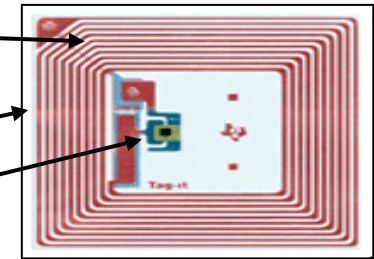
air
interface



Data processing
(backend)



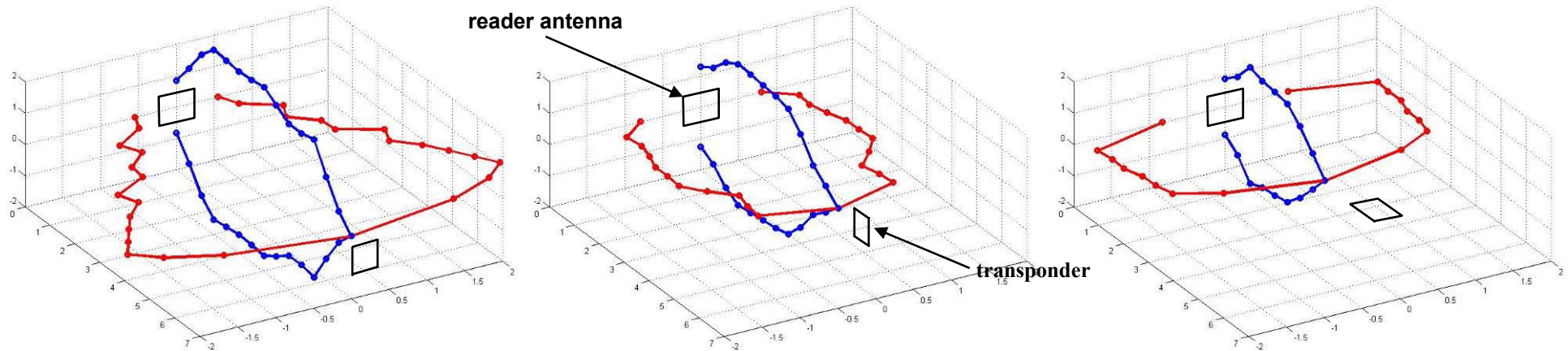
antenna/
inductive reactance
Housing
microchip



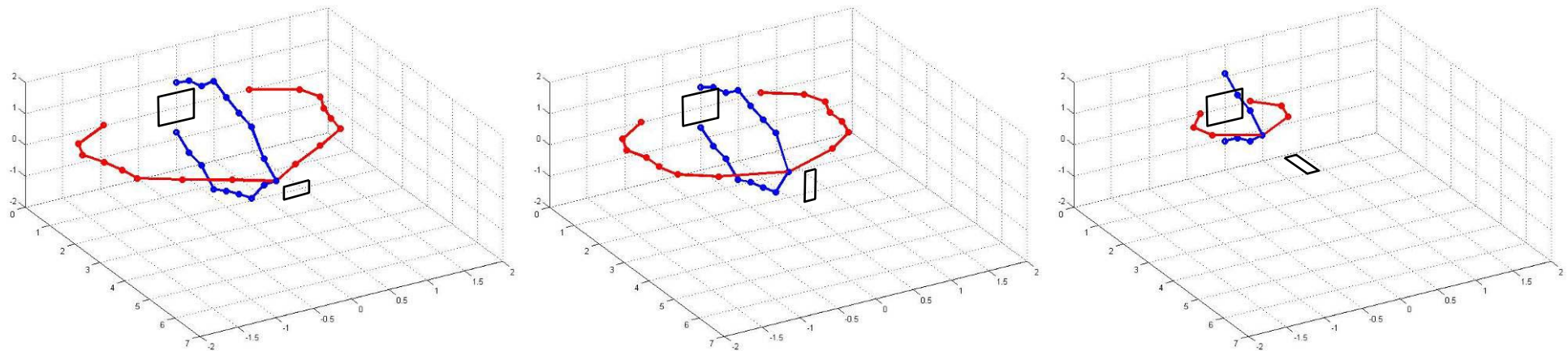
Magnetic field (inductive coupling)
or electromagnetic waves
(backscatter-coupling)



Transponder antenna (observer): 72mm x 72mm



Transponder antenna (observer): 97mm x 15mm



red: "horizontal layer"
blue: "vertical layer"

antenna detection pattern by changing the location of the transponder with respect to the reader antenna, 2 Watt (ERP), EPC 1.19, tests in LogIDLab®

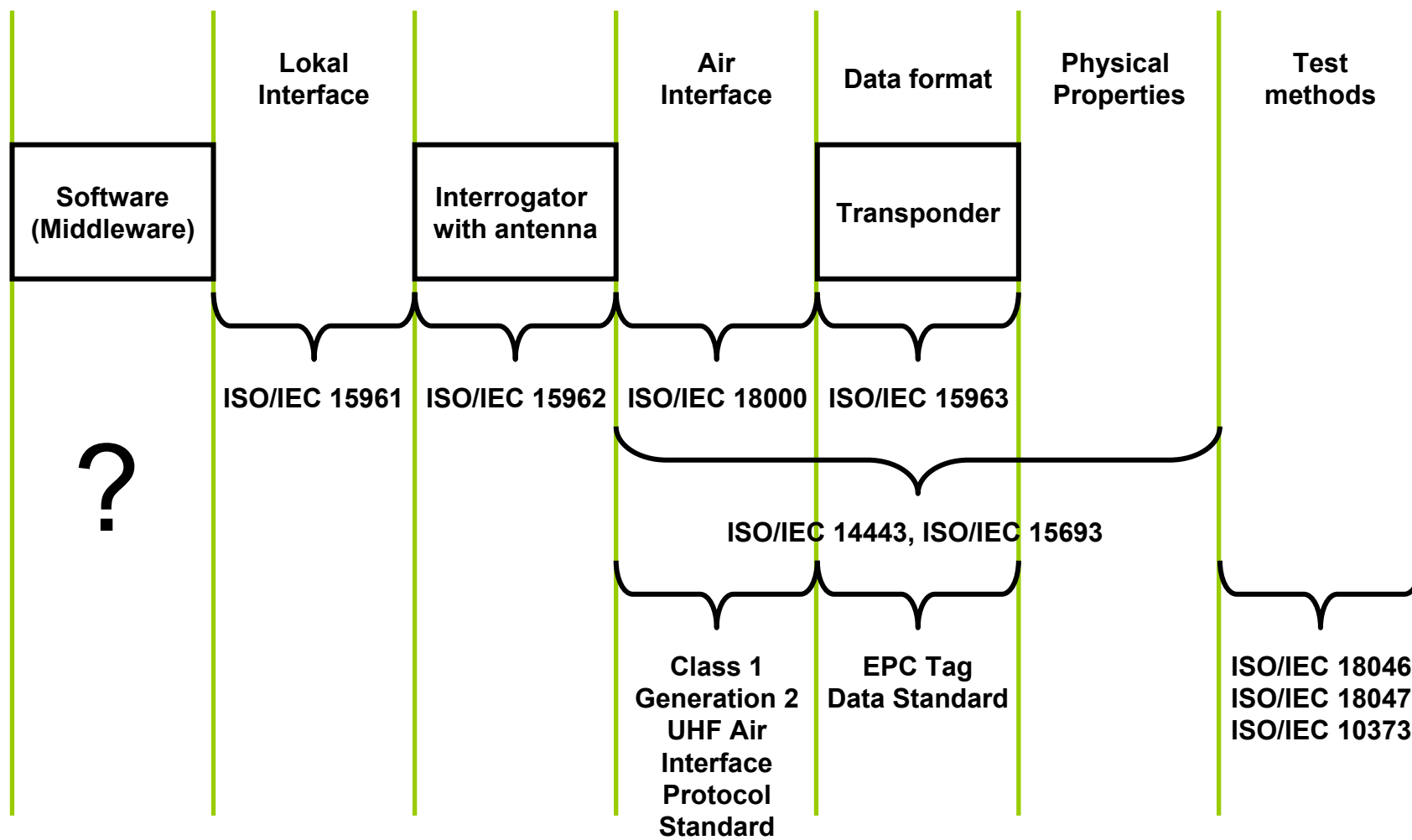


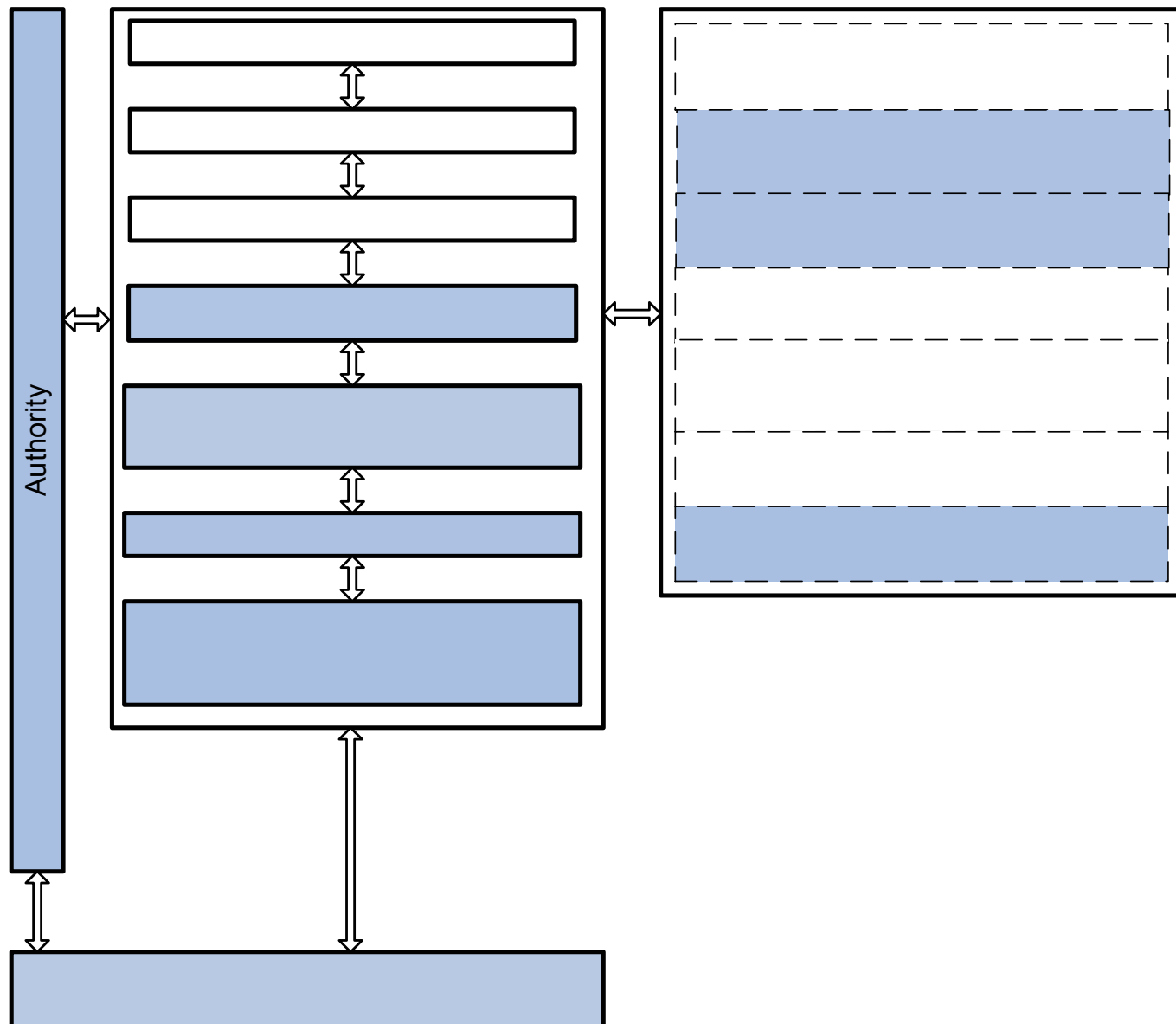
Comparison of different
detection pattern of UHF transponders

Working frequencies	100-135 kHz	13,56 MHz	868/915 MHz	2,45 GHz
Function principle	Inductive coupling		Backscatter coupling or electromagnetic waves	
Power supply	Passive	Passive and semi-active (battery for sensors)	Passive and active	
Data saving	Read-only und read/write (up to 2 kBit memory capacity)	Nearly only read/write (up to 2 kBit memory capacity)	Read-only und read/write (up to 256 kBit memory capacity for active systems)	
Range	Less than 1,0 m	Up to 1,7 m active (ca. 8-60 cm)	Up to. 6,0 m for passive systems; Up to 100 m for aktive systems	
Influence of metal	Weakening of magnetic field, disturbance of the resonance frequency, a ferrite layer or a ferrit core can lower metal influences		Reflections on metal surface; modification nescessary for direct application of the antanna on a metal surface	
Influence of liquids	Low		High	Very High
Bulk ability	Possible, but rarely realized	Possible (up to 100 pcs.)	Possible (up to 500 pcs.)	Possible (up to 500 pcs.)
Life span	EEPROM (passive read/write System) from 10.000 bis 100.000 write cycles, SRAM (aktive read/write System) nearly infinite amount of read/write cycles, active and semi-actice Systemen are depending on their batteries			
Data transmission rate	Low (approx. 4 KBit/s)	6.62 KBit/s (ISO 15693) 106 KBit/s (ISO 14443)	Very high (up to 848 KBit/s, ISO 18000-6) IQ-32T (115.2 KBit/s)	
Designs	Glass capsule, Stick, Nails	Label, Card	Label, Plastic Housing (IP 67)	
	Coin, Cart, Disc			
Approx. price [€]	0,50 - 1,00 passiv	0,40 - 0,70 passiv, 8,00 with sensor	0,40 - 0,70 passiv 60,00 with sensor	30,00 bis 50,00 aktiv



Technical Restrictions
overview verified by LogIDLab®





Market g

Feeding

Informations in a database

„Data-on-network“

Easy, cost-efficient transponder
Write-once-read-many transponder
Clear and unambiguous product
identification
Uniform standard
Central data storage

Informations in a transponder

„Data-on-tag“

Intelligent, but expensive transponders
Read-write transponder
Large quantity of Information
Additional features
Distributed data storage

>>Information<<

>>Control and Information <<

Information across
the process chain

Identification number (EPC) Instruction sheet
Ordering number Testing and supervising mark Number of items
Shipping notices source node destination node Transport number

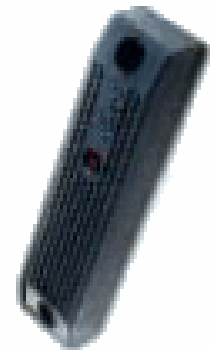


The concept of RFID based monitoring (ISRFID) –
data consolidation

Types of transponder: UHF-Transponder

Transponder (i-Q32T SL/EU):

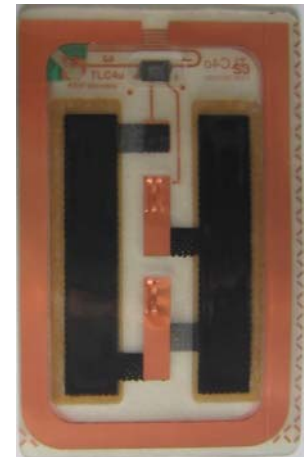
- Aktive transponder (with own batterie; life span up to six years)
- Read range up to approx. 100 m
- Working frequency: 868 MHz / 915 MHz
- Protection class: IP 65
- Memory capacity up to 13.312 temperature-timestamp values
- Measurement interval is arbitrary selectable
- Temperature bandwidth :-40°C up to +70°C
- Measurement accuracy: 0.5 °K
- A light-emitting diode (LED) can visualize different transponder states
- price: 69,80 € (1-500) ... 52,35 € (> 50.000 Stk.) (19.09.05, Baumer Ident)
- Dimensions: 131 × 28 × 21 mm (l × w × h)



Types of transponder: HF-Transponder

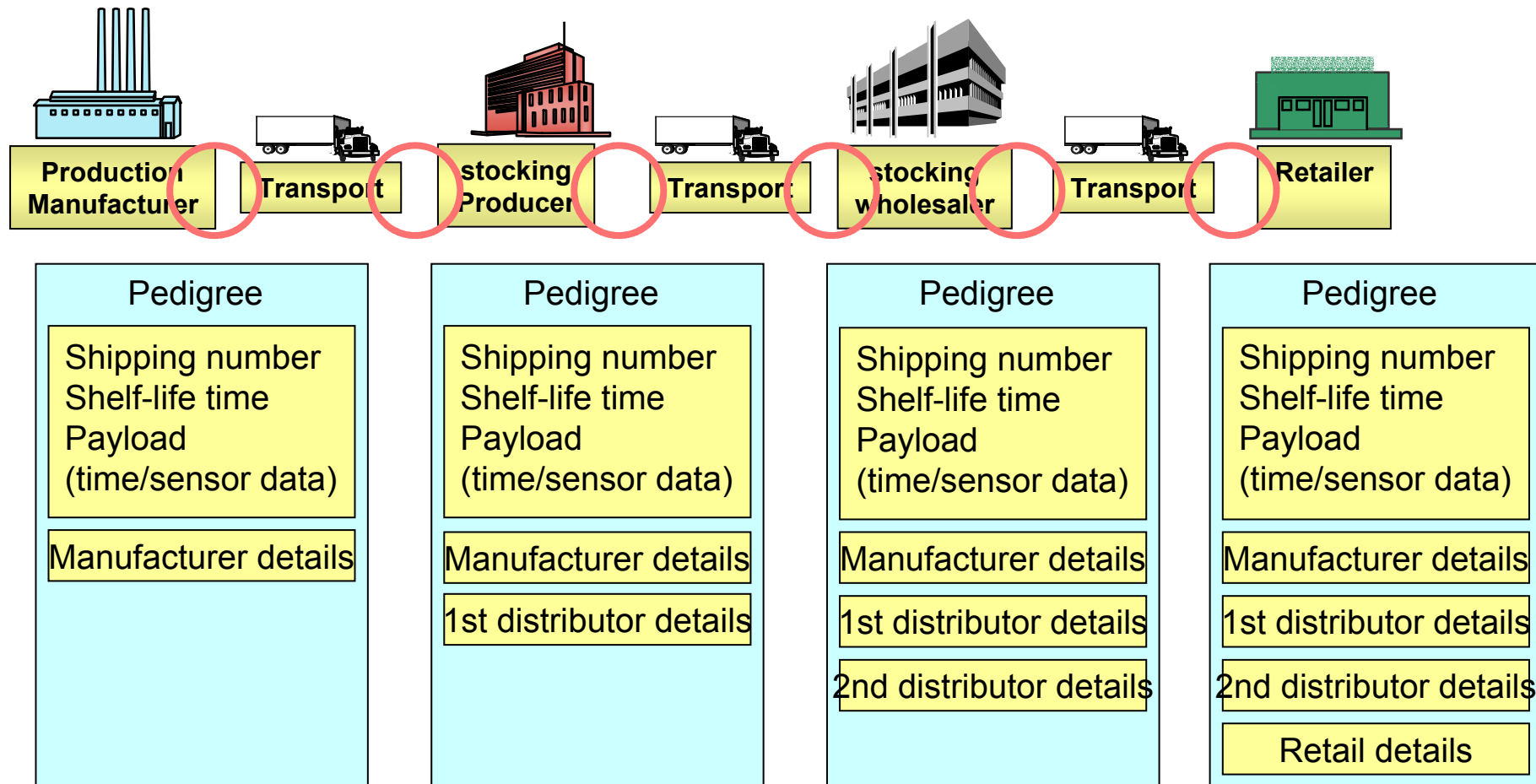
TETA – Transponder (TempSens®):

- semi-aktive transponder (batterie to support memory)
- Read range up to ca. 1 m
- Working frequency : 13.56 MHz
- Measurement accuracy: 0.5 °K
- Temperature bandwidth : -15°C up to +50°C
- Measurement interval : 10 sekunds up to 16 hours
- Memory capacity up to 64 time-temperature values
- price: 21,24 € (1-10)...6,30 € (100000) (09.06.2005, KSW microtec)
- Dimensions: 86 x 54 x 1,35 mm (l x w x h)
- Weight : 5,6 g.
- Data transmission speed: defined in DIN ISO 15693-3
- 6 Byte for Protection (access protection)

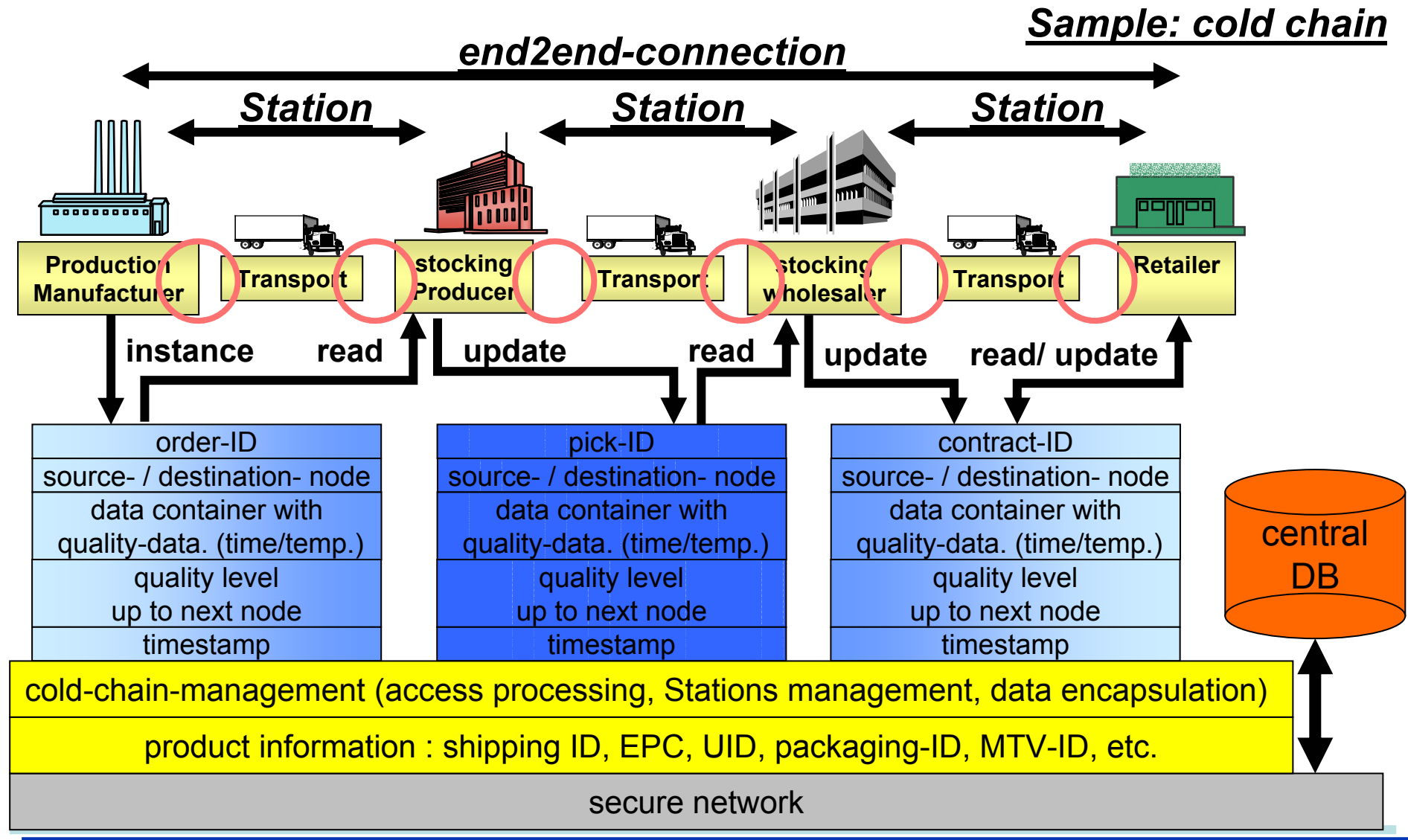


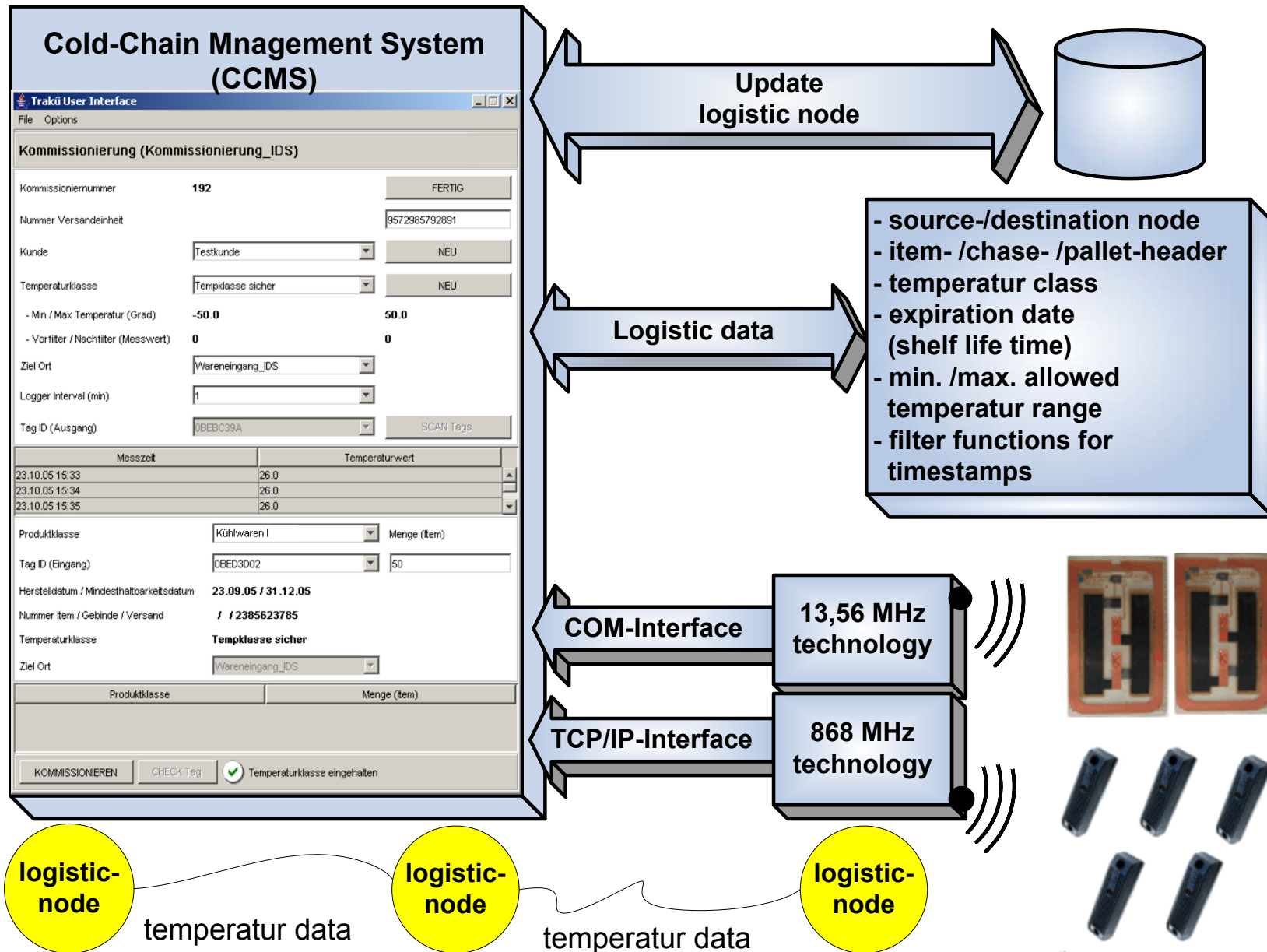
The procedure of the e-pedigree „Data-on-Tag“ method

Sample: Cold chain



The procedure of the „Data-on-Network“ method





Trakü User Interface

File Options

Produktion (Produktion 19-7) **Pilotanwendung D**

Auftrag **223** FERTIG

Nummer Item

Nummer Gebinde

Nummer Versandeinheit

Produktklasse NEU

Temperaturklasse NEU

Min Temperatur (Grad) **-30.0**

Max Temperatur (Grad) **20.0**

Vorfilter **0**

Nachfilter **0**

Ziel Ort

Menge **33**

Herstelldatum **09.12.05**

Mindesthaltbarkeitsdatum **08.04.05**

Logger Interval (min)

Transponder ID SCAN Tags

START Tag ✔ Daten gespeichert, Tag 0BED4F1E gestartet



stock temperatur (production) < -18 °C



goods issue inspection (production)



Trakü User Interface

File Options

Warenausgang (Warenausgang 19-7) Pilotanwendung D

Transponder ID:

Auftrag: **213**

Quelle Ort: **Produktion 19-7**

Kunde:

Produktklasse: **Burger**

Menge: **42**

Nummer Item:

Nummer Gebinde:

Nummer Versandeinheit: **340040745347438103**

Herstelldatum: **13.12.05**

Mindesthaltbarkeitsdatum: **12.04.05**

Ziel Ort:

Logger Interval (min):

Temperaturklasse:

- Min / Max Temperatur (Grad): **-40.0** **30.0**

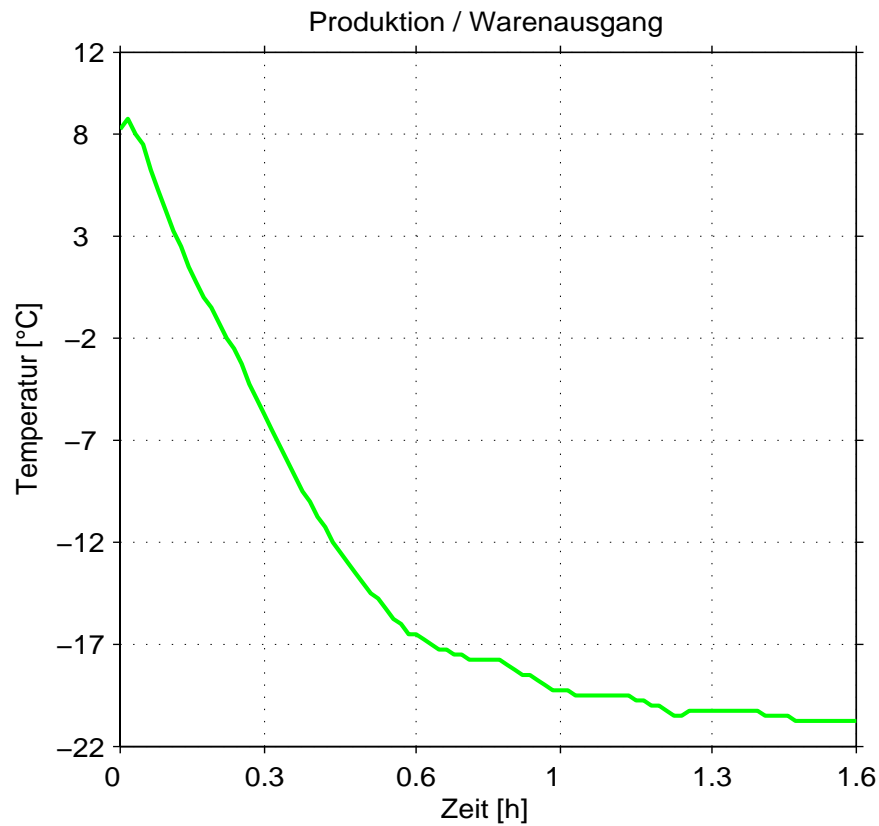
- Vorfilter / Nachfilter: **0** **0**

Messzeit	Temperaturwert
13.12.05 13:30	7.5
13.12.05 13:31	7.75
13.12.05 13:32	7.75
13.12.05 13:33	7.75
13.12.05 13:34	7.5
13.12.05 13:35	7.5
13.12.05 13:36	7.25
13.12.05 13:37	7.25
13.12.05 13:38	7.25

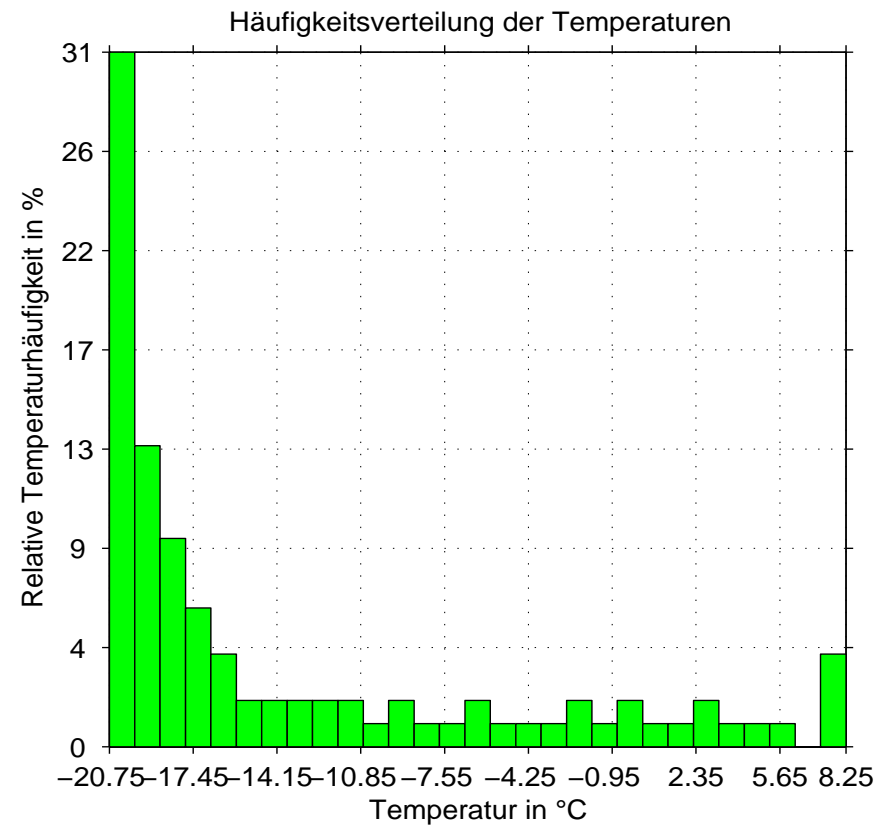
☒ Temperaturklasse eingehalten



production - goods issue inspection (temperature and histogram)



0BED4F1D



0BED4F1D

goods issue (production) - goods receipt inspection (stock) - transportation

Trakü User Interface

File Options

Wareneingang (Wareneingang TK-Lager) Pilotanwendung D

Transponder ID: 0BED4F1E SCAN Tags

Auftrag: 223

Quelle Ort: Warenausgang 19-7

Kunde:

Produktklasse: Burger

Menge: 33

Nummer Item:

Nummer Gebinde:

Nummer Versandeinheit: 340040745347438103

Herstelldatum: 09.12.05

Mindesthaltbarkeitsdatum: 08.04.06

Ziel Ort: Belieferung Restaurant B

Logger Interval (min): 1

Temperaturklasse: Burgertemperaturklasse Anlegen

- Min / Max Temperatur (Grad): -50.0 50.0

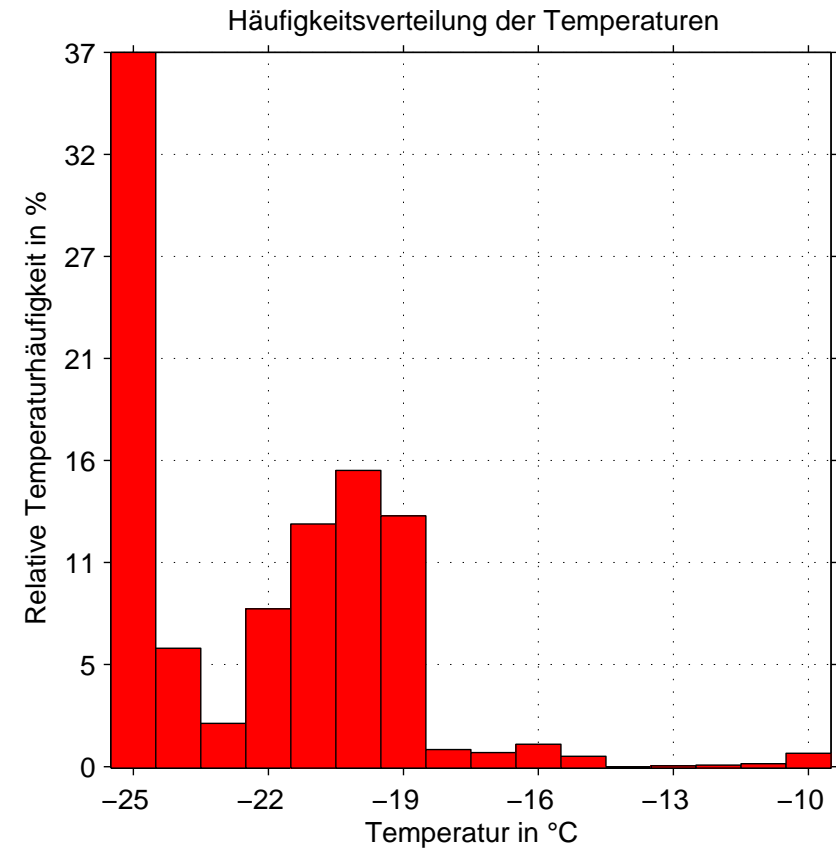
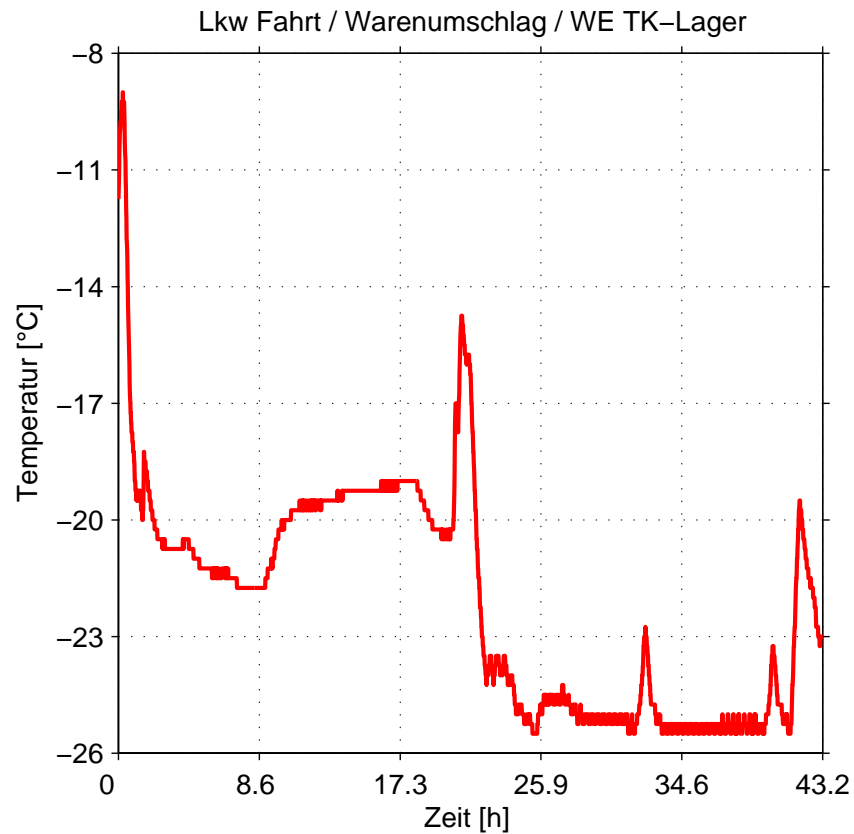
- Vorfilter / Nachfilter: 0 0

Messzeit	Temperaturwert
15.12.05 09:28	-20.25
15.12.05 09:29	-20.25
15.12.05 09:30	-20.5
15.12.05 09:31	-20.5
15.12.05 09:32	-20.5
15.12.05 09:33	-20.75
15.12.05 09:34	-20.75
15.12.05 09:35	-20.75
15.12.05 09:36	-20.75

NEU START Tag CHECK Tag ☒ Temperaturklasse eingehalten



goods issue (production) - goods receipt inspection (stocking) - transportation



goods issue (stock) - delivery (restaurant) - transportation

Trakü User Interface

File Options

Belieferung (Belieferung Restaurant B) Pilotanwendung D

Transponder ID:

Auftrag: 223

Quelle Ort: Wareneingang TK-Lager

Ziel Ort:

Kunde:

Produktklasse: **Burger**

Menge: 33

Nummer Item:

Nummer Gebinde:

Nummer Versandeinheit: 340040745347438103

HD: MHD: 09.12.05 08.04.06

Temperaturklasse: **Burgertemperaturklasse**

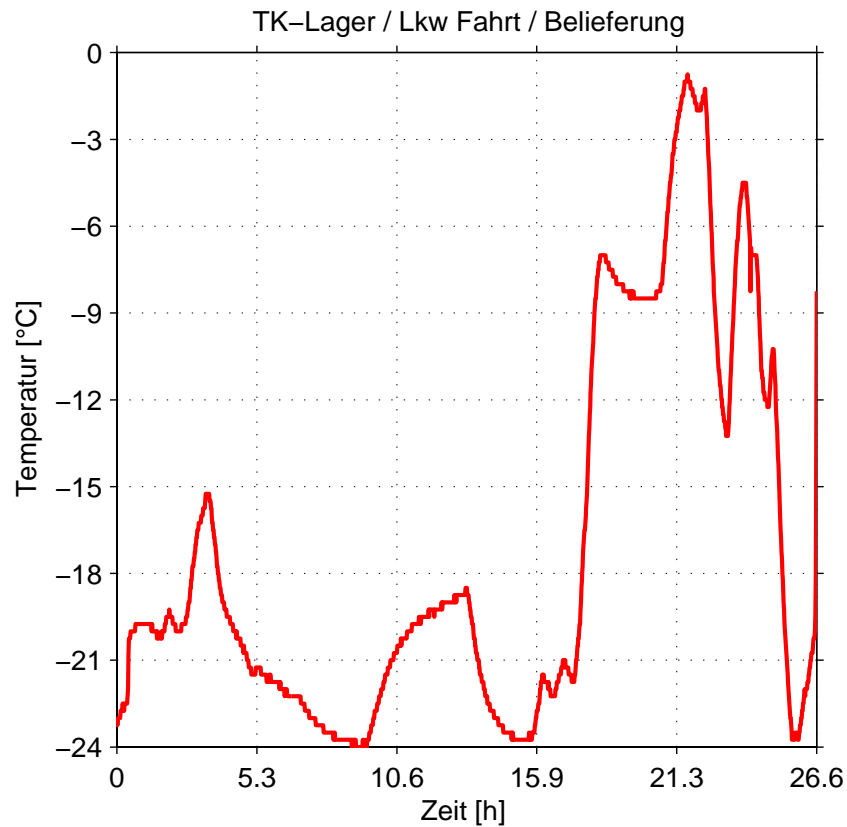
- Vor-/Nachfilter: Min/Max Temp: 0 / 0 -50.0 / 50.0

Messzeit	Temperaturwert
16.12.05 11:52	-20.25
16.12.05 11:53	-20.25
16.12.05 11:54	-20.0
16.12.05 11:55	-20.0
16.12.05 11:56	-20.0
16.12.05 11:57	-20.0
16.12.05 11:58	-19.75
16.12.05 11:59	-19.5
16.12.05 12:00	-19.25
16.12.05 12:01	-18.75
16.12.05 12:02	-18.5
16.12.05 12:03	-17.75
16.12.05 12:04	-17.0
16.12.05 12:05	-14.75
16.12.05 12:06	-10.75

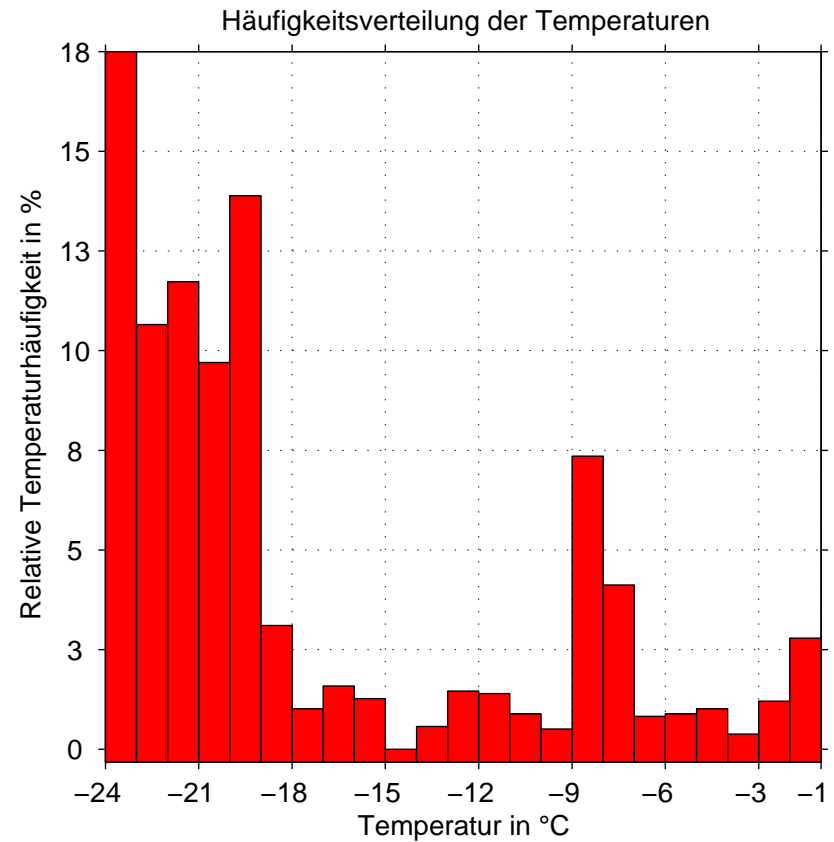
☒ Temperaturklasse eingehalten



goods issue (stocking) - delivery (restaurant) - transportation

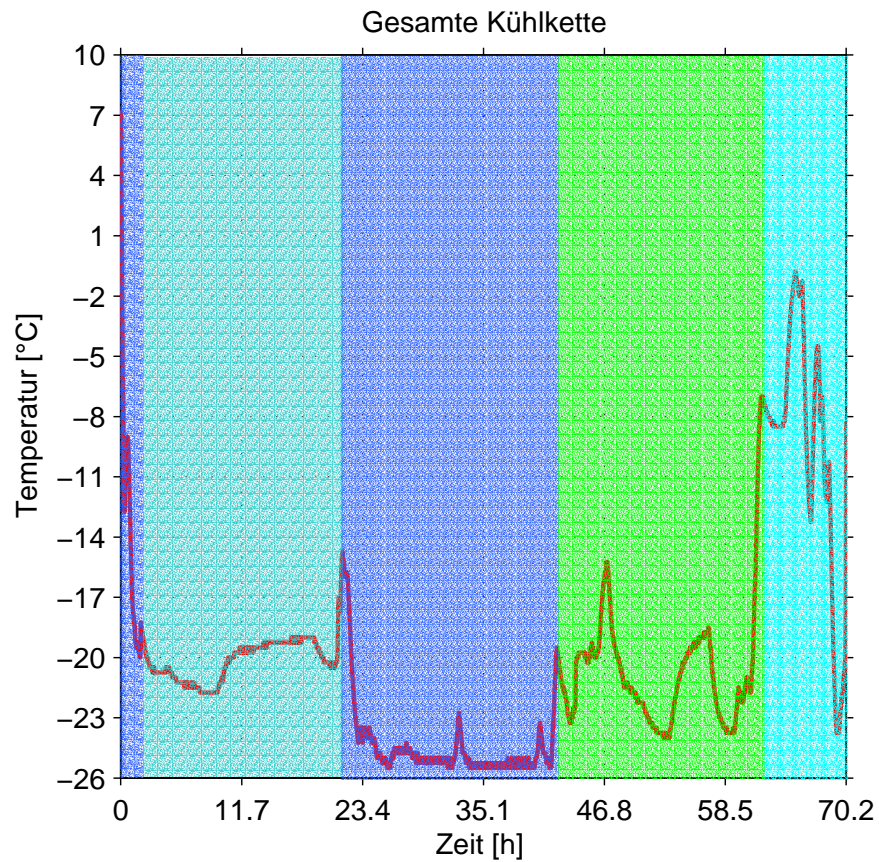


— 0BED4F1B

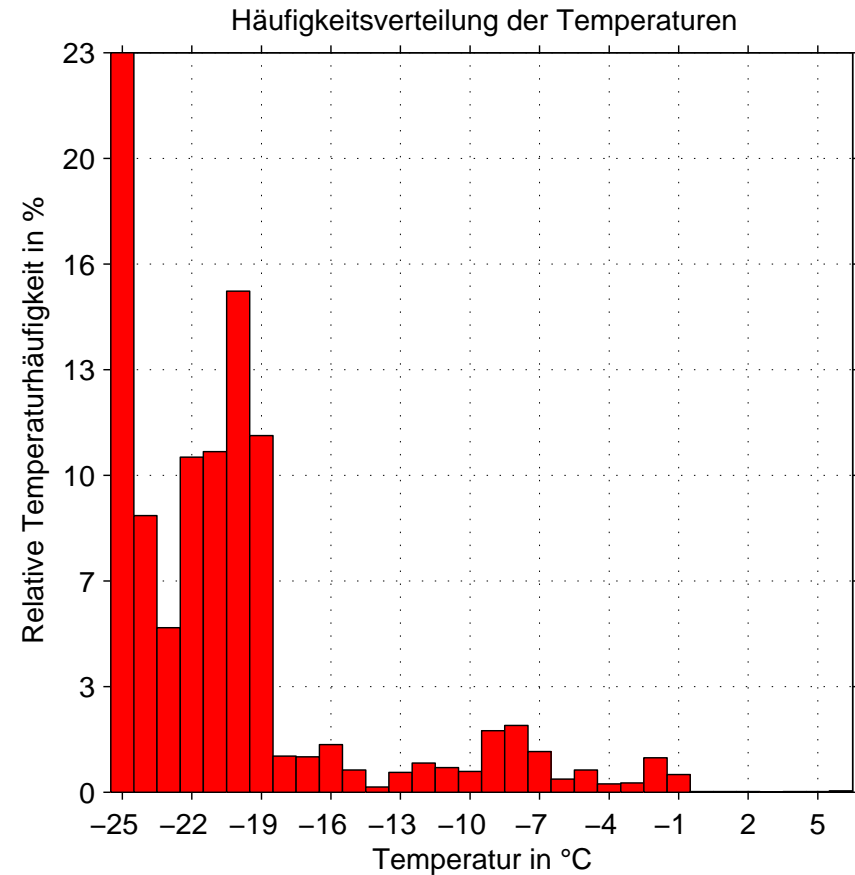


■ 0BED4F1C

RFID based monitoring the complete cold chain



— 0BED4F1B



■ 0BED4F1B

Conclusion:

- The RFID Technology has enormous potential to cope with the problems of automatical identification and context based sensor information across the supply chain.
- Businesses can speed up the processes of product identification.
- With RFID the shipment can be confirmed faster.
- No more time is needed for opening the packaging for visual confirmation.
- Even if there are some economical advantage (bulk ability, reading range) it is important not forget that equipping product, pallets or loading units with RFID transponder is restricted by the physics boundary conditions. Therefore on material mounted transponders could lead to different reading ranges.

