R. Jedermann and W. Lang

Semi-passive RFID and beyond
Steps towards automated quality tracing in the food chain.

Microsystems Center Bremen
University of Bremen

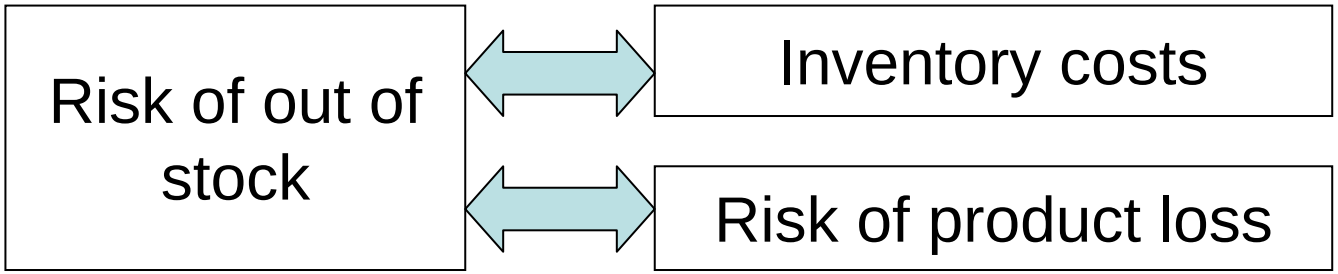
Outline

- Semi passive RFID
  - Measurement of spatial temperature profiles

- And beyond
  - Scales to assess effects of temperature deviations
  - Online access by wireless sensors
  - Automated data evaluation

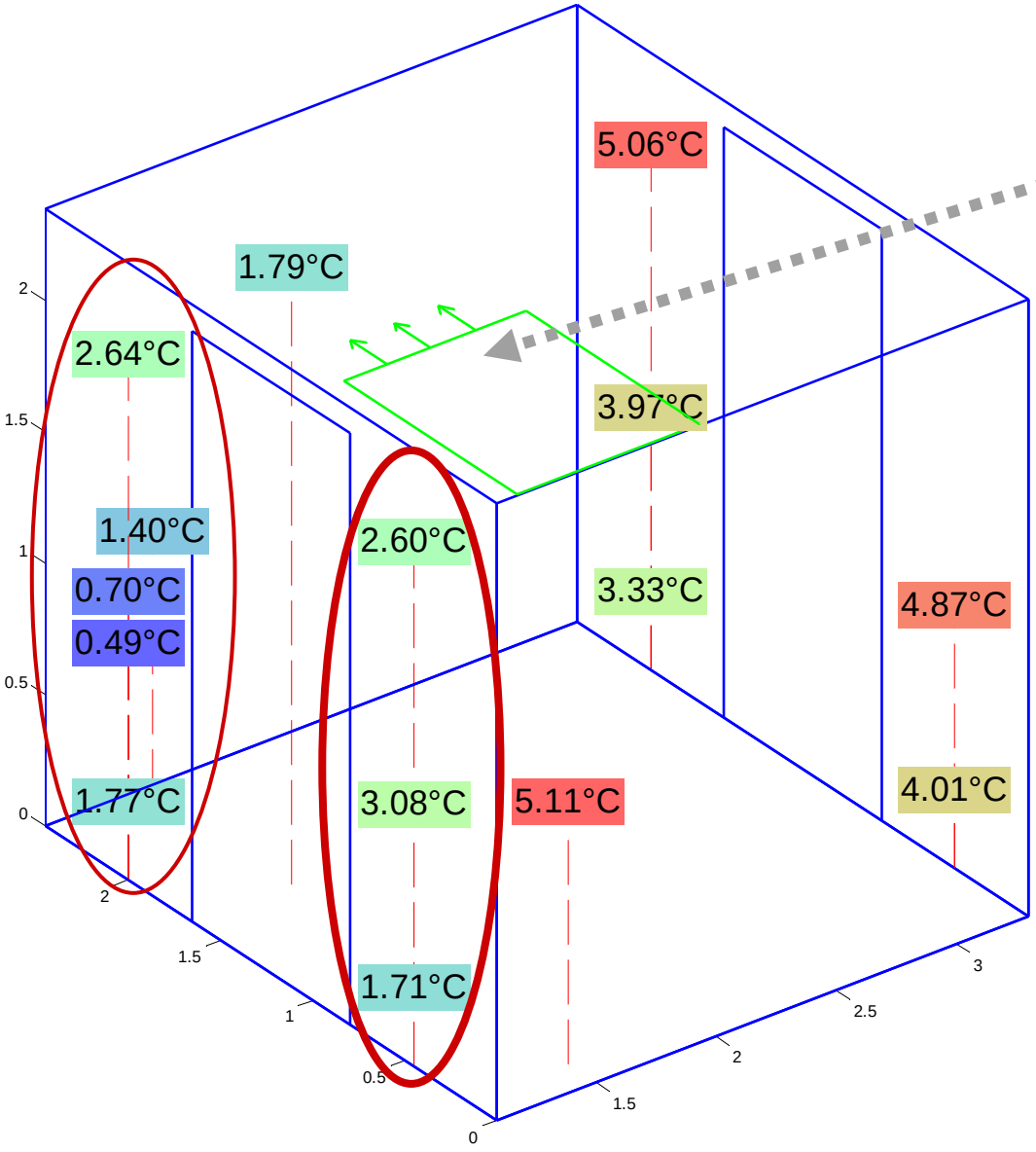
Challenges in food chain management

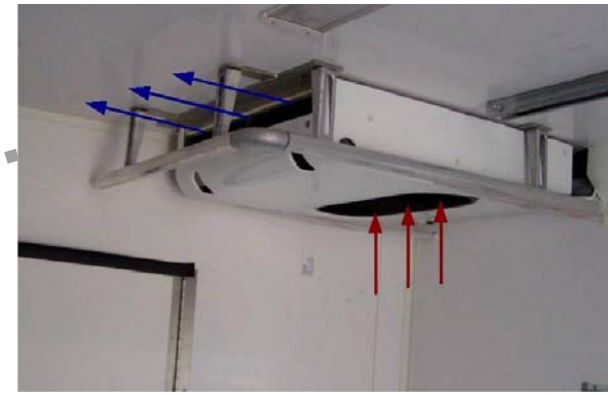
- **Beyond standard supply chain management**
  - Improvements by RFID (know where the good is)
  - Additional sensor tracking (know in what quality state it is)



- **Quality oriented tracking and tracing (QTT)**
  - FEFO First ***expires*** First out (F**E**FO)
  - Avoid unnecessary buffers in shelf life

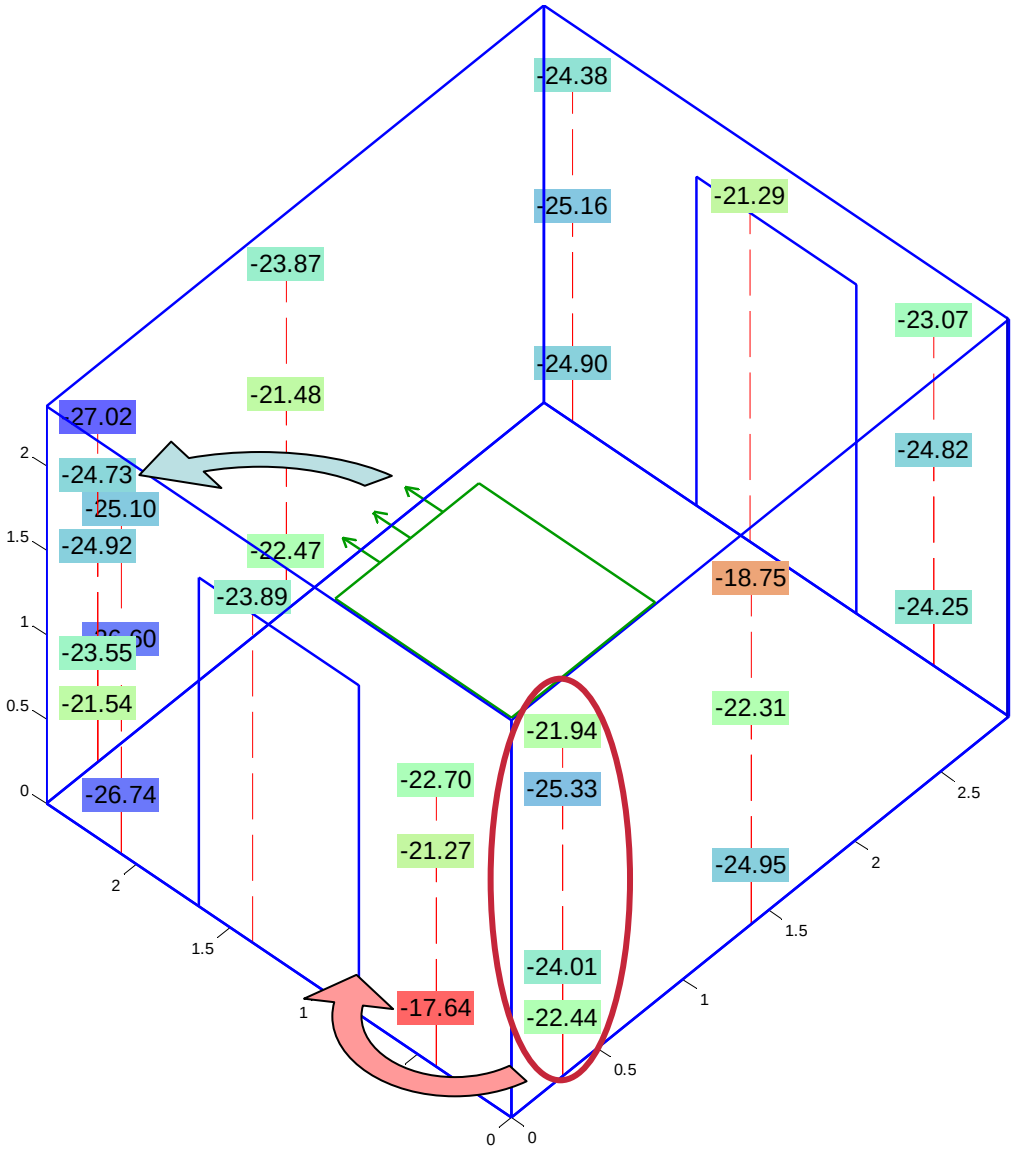
Temperature along the xyz-axis





- Average of reefer side ~2 °C colder than other side
- Single loggers behave 'chaotic'

Deep freezer after 5 hours cool down



How to define and measure quality?

What is quality?

- **Food Regulations:**

  Temperature thresholds

- Colour, Firm-ness, Bacterial growth ….
- Quality is what the consumer says

Quality scales

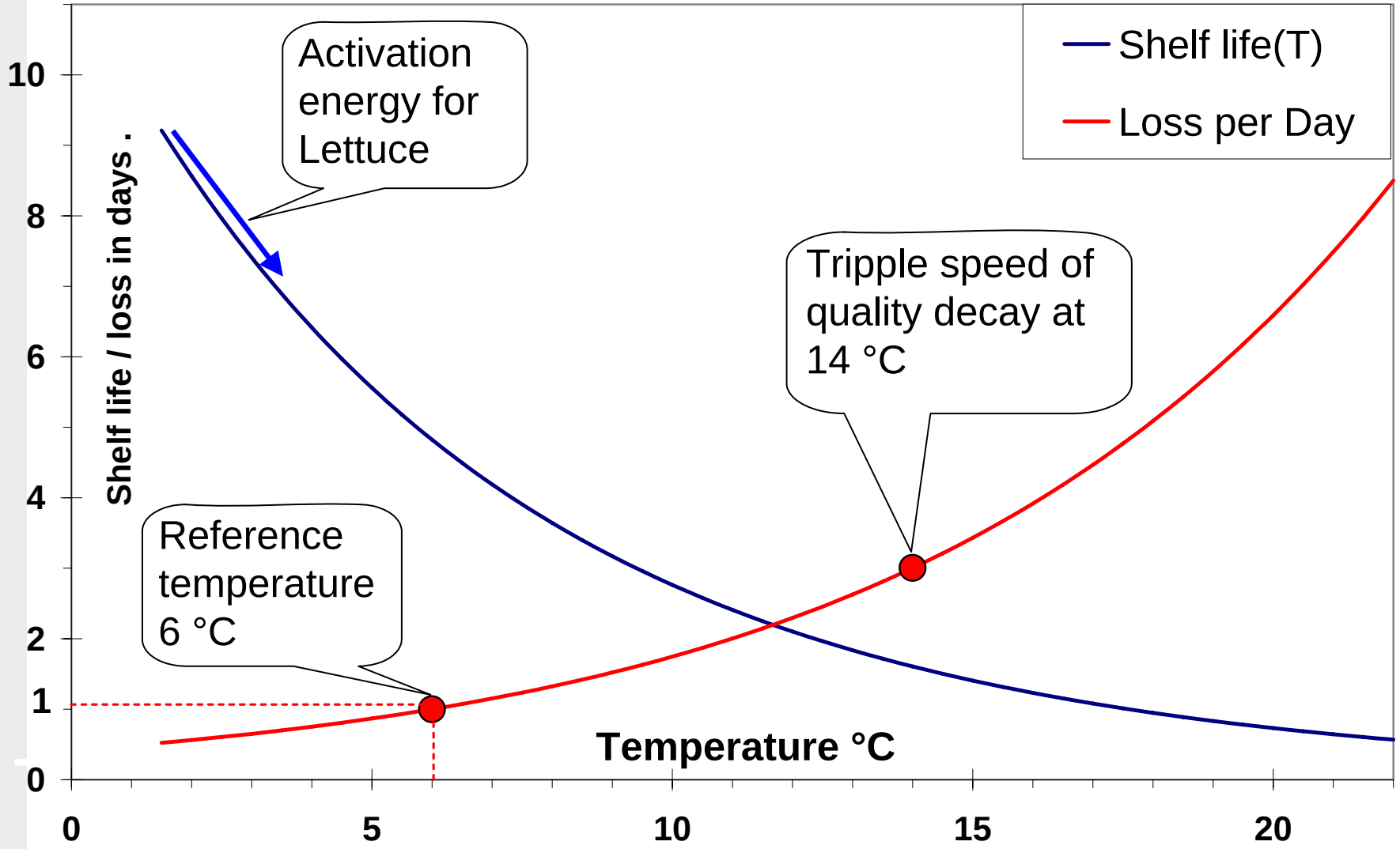
Yes / No Accept / Reject	**Continuous** / Percentage scale
Fixed (printed expiration date)	**Dynamic** (recalculated if temperature changes)

Generalized Scale:

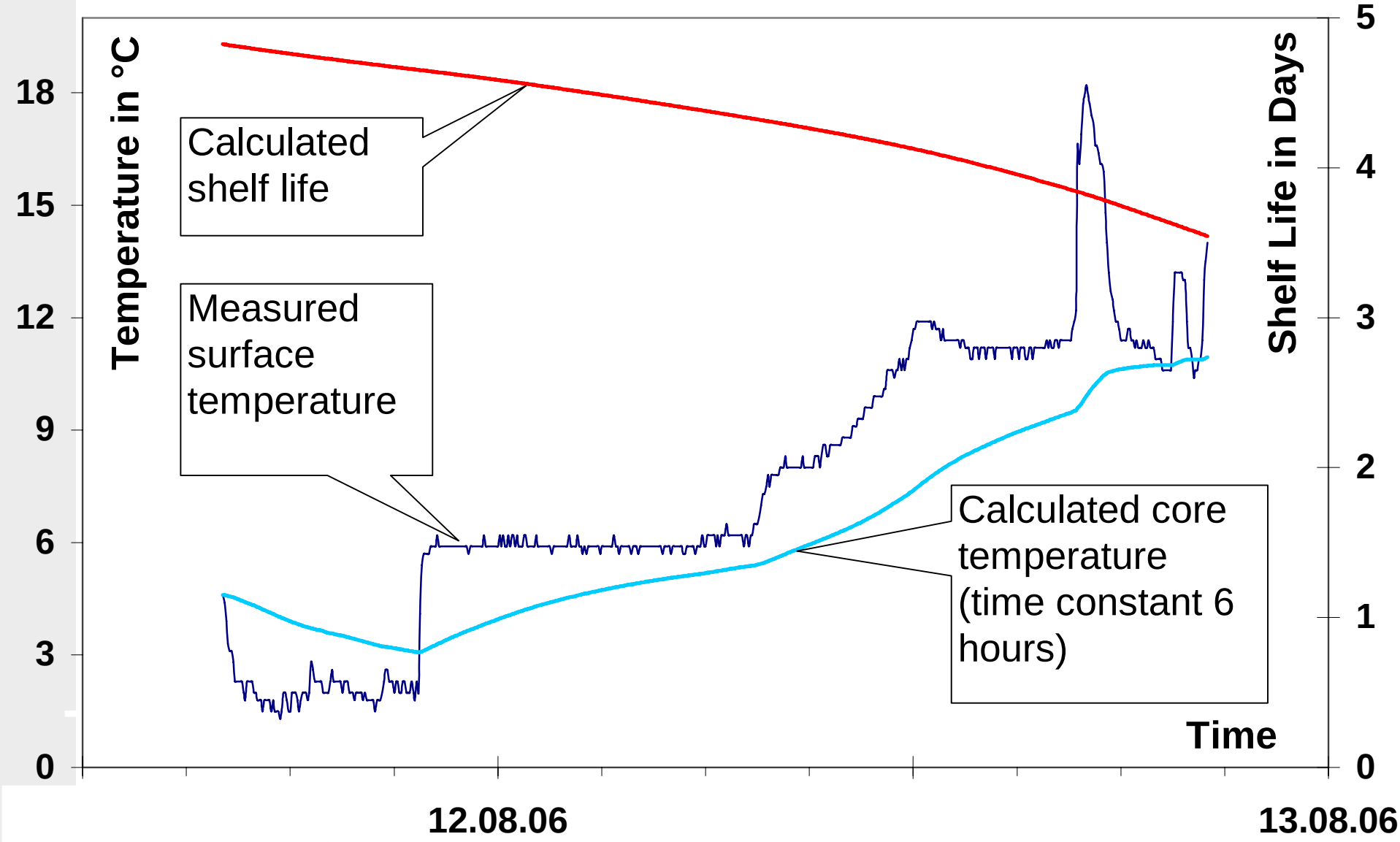
Keeping quality / Shelf life

Number of remaining days until a defined threshold will be passed (colour loss, bacteria limit, consumer acceptance …)

Example shelf life (Lettuce)

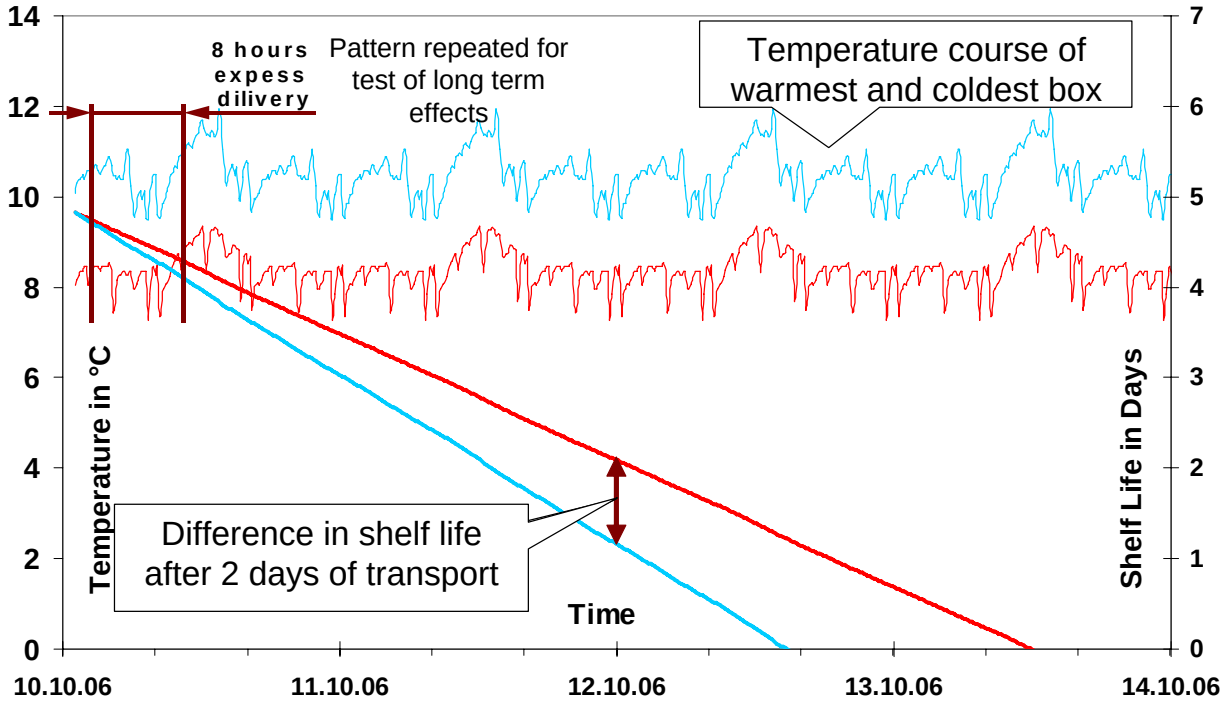


Effect of small temperature peaks on shelf life

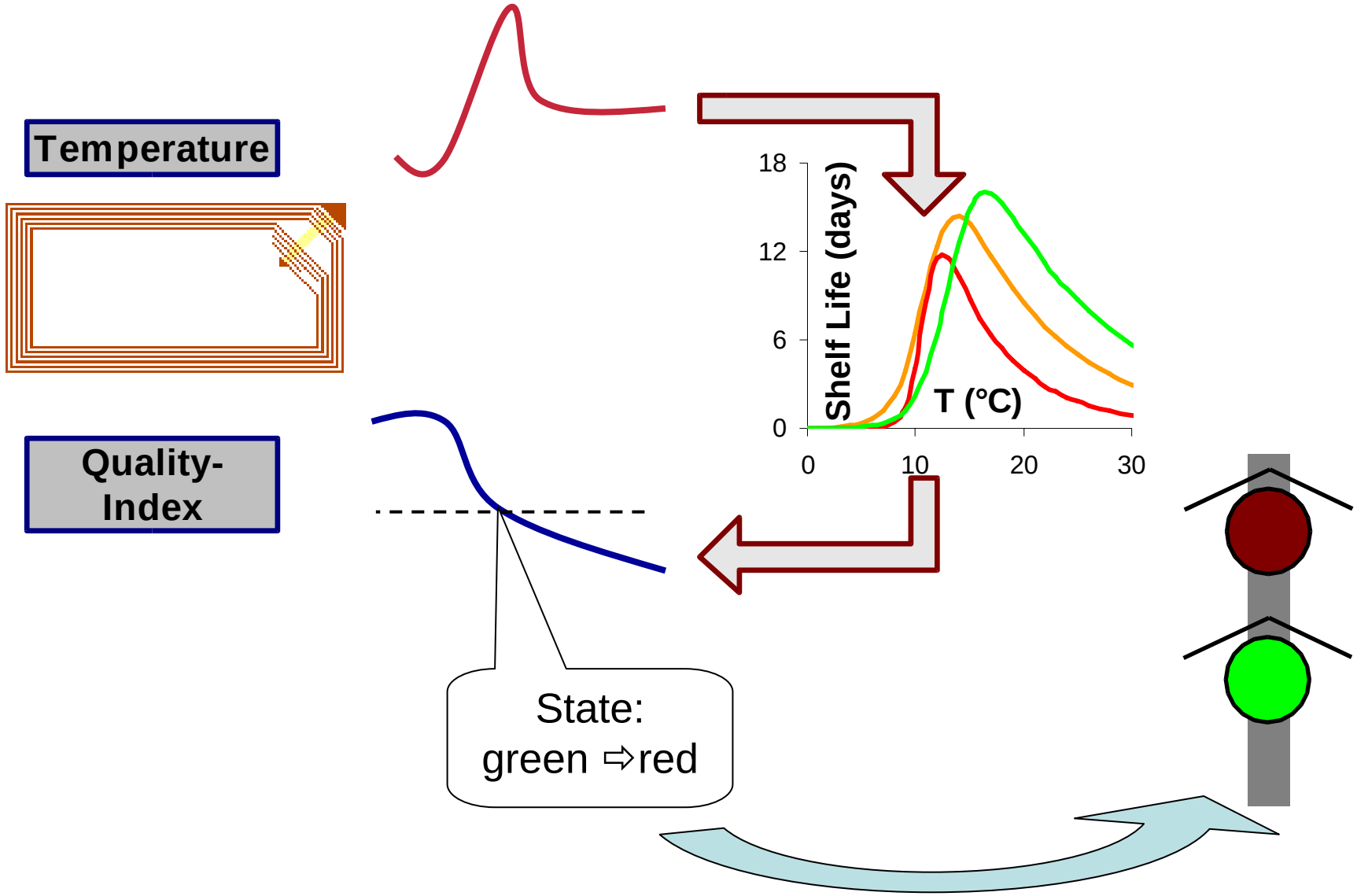


Application of shelf life model to recorded data

Box	Average Temperature	Zero Shelf life reached after
Coldest	8.21 °C	3.5 days
Warmest	10.31 °C	2.5 days



The idea of intelligent RFID



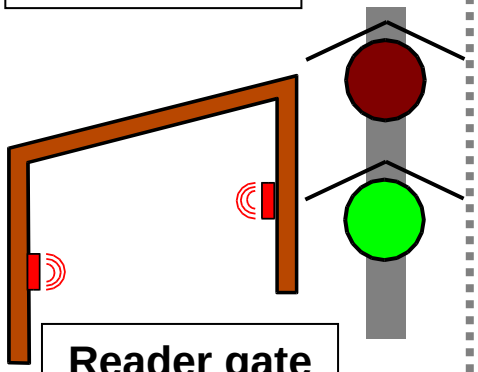
Chain supervision by intelligent RFID

Step 1: Configuration

Manufacturer

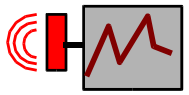
Step 2: Transport

Step 3: Arrival

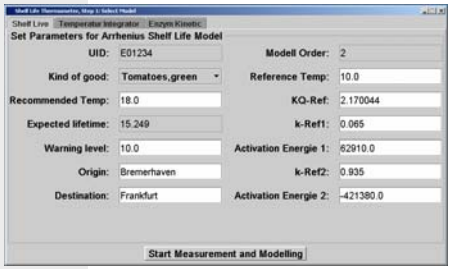


Reader gate

Step 4: Post control



Handheld Reader



Intelligent RFID

Measures and stores temperature

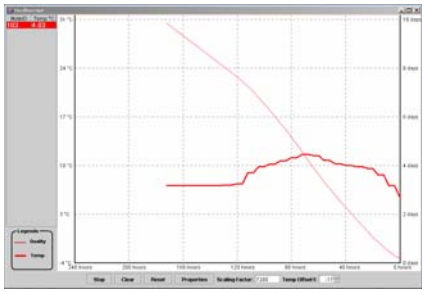
Calculates shelf life

Sets flag on low quality

List

- **Temperature**
- **Shelf life**
- **Transport Info**

Full temperature protocol



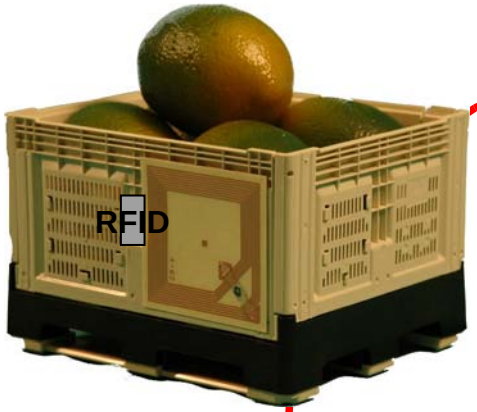
The need for online information

- If there is a quality problem, early information is of very high worth
  - Inform customer
  - Order / purchase replacement
  - Offer only goods to customer that will arrive in proper quality

  - Redirect truck as long as they are on the road

Intelligent Container

Logistical object
➔ Passive RFID-Label



Dynamic link

Intelligent Agent
➔ Transport- and handling-instruction
➔ Supervision in behalf of the owner

Truck requests agent at loading

Reading RFID at loading

Intelligent truck or container
➔ CPU platform
➔ Sensors
➔ RFID-Reader

Features and state of sensor tracing technologies

Technology	*Online accessibility*	*Local processing*	*Granu-larity*	*Current state*
Telemetric systems	✓	-	-	Available
RFID data loggers	-	-	✓	Short range available
Wireless sensors	✓	-	✓	Prototypes, pilot studies
Intelligent RFID	-	✓	✓	Concept
Intelligent Sensors	✓	✓	✓	Under development
Intelligent Container	✓	✓	✓	Demonstration system

Closing remarks

- Need for inter company data sharing
  - „… if every partner in the supply chain optimizes only his own profits and not the system and uses new technology only to blame others for product losses no one will win in the end“
- High need for extended UHF-RFID devices
  - Interface for external sensors
  - Free programmable processor / microcontroller

The End

Thanks for your attention

www.intelligentcontainer.com

Contact address
Dipl.-Ing. Reiner Jedermann
Universität Bremen, FB1 (IMSAS), Otto-Hahn-Allee NW1,
D-28359 Bremen, GERMANY
Phone +49 421 218 4908, Fax +49 421 218 4774

rjedermann@imsas.uni-bremen.de