COMPLEX CHALLENGES OF MONITORING AND MANAGING A GLOBAL COLD CHAIN

Complex challenges of monitoring and managing a global Cold Chain

Sensitech United, Argentina

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

Complex Challenges of Monitoring and Managing a Global Cold Chain

Temperature Recording Devices

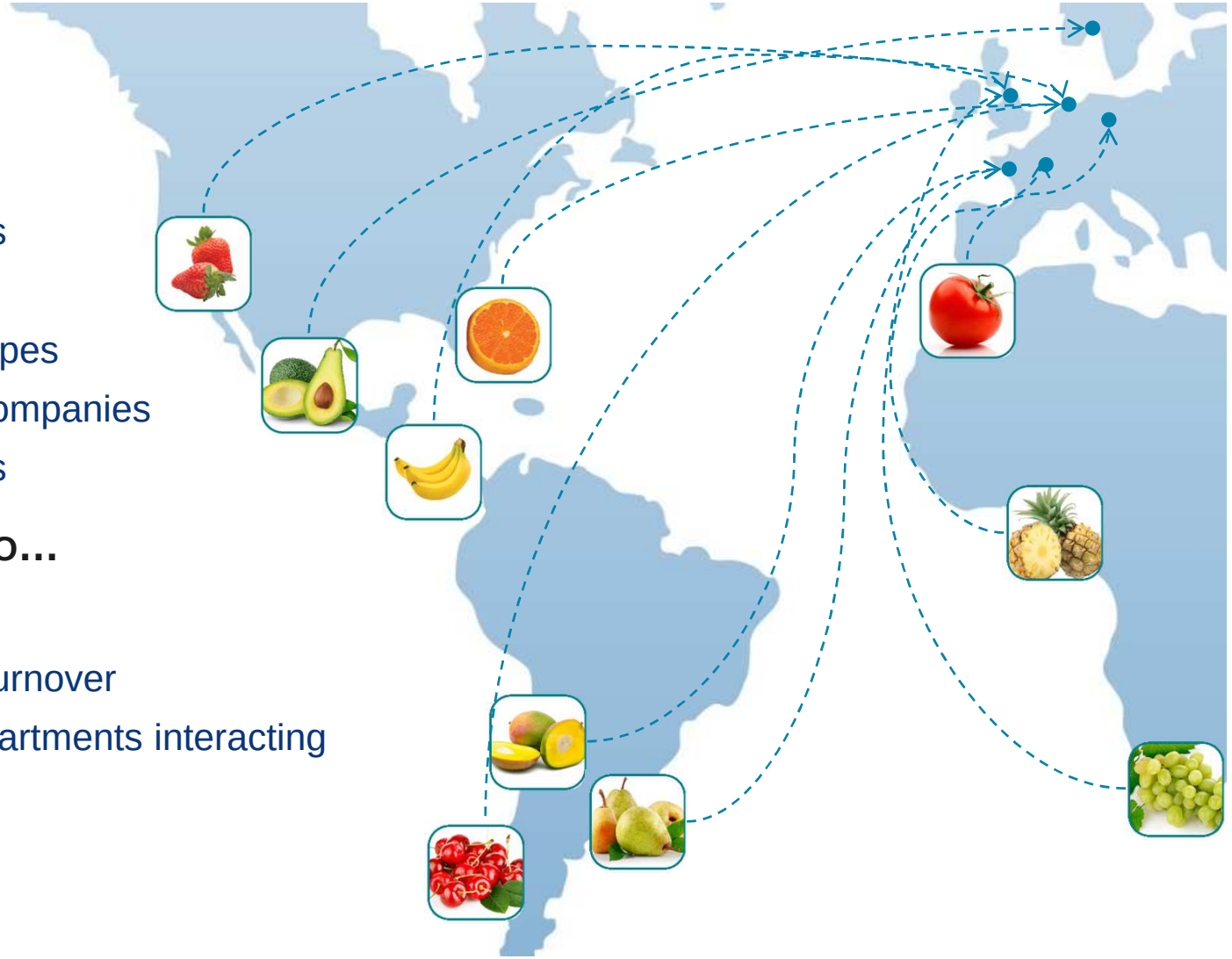
Complex Challenges of Monitoring and Managing a Global Cold Chain

NUMEROUS…

- Suppliers
- Origins
- Destinations
- Products
- Transport types
- Transport companies
- Destinations

CONSIDER ALSO…

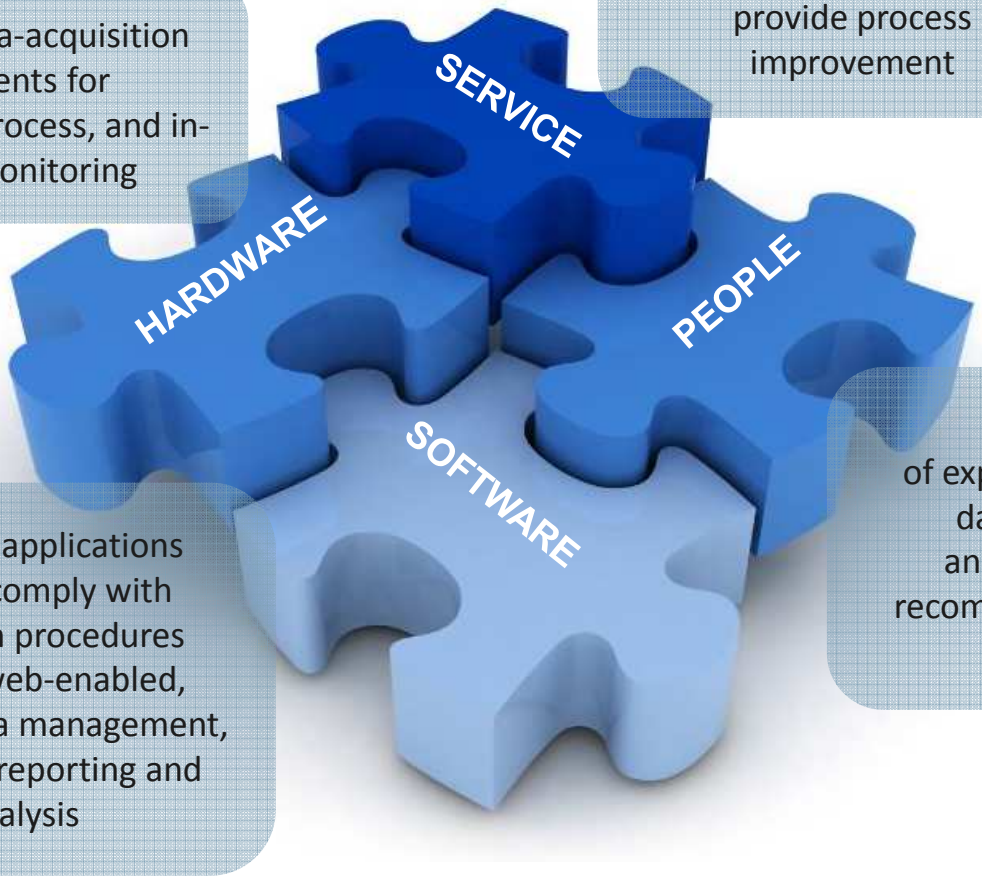
- Seasonality
- Personnel turnover
- Various departments interacting
- Languages



Sensitech's Components of Good Cold Chain Management

Measure critical control points, map and analyze complex cold chains, and provide process improvement

Validated data-acquisition instruments for in-transit, in-process, and in-storage monitoring



20+ years of experience providing data assessment and best practices recommendations to the food market

Software applications built to comply with validation procedures provide web-enabled, scalable data management, exception reporting and analysis

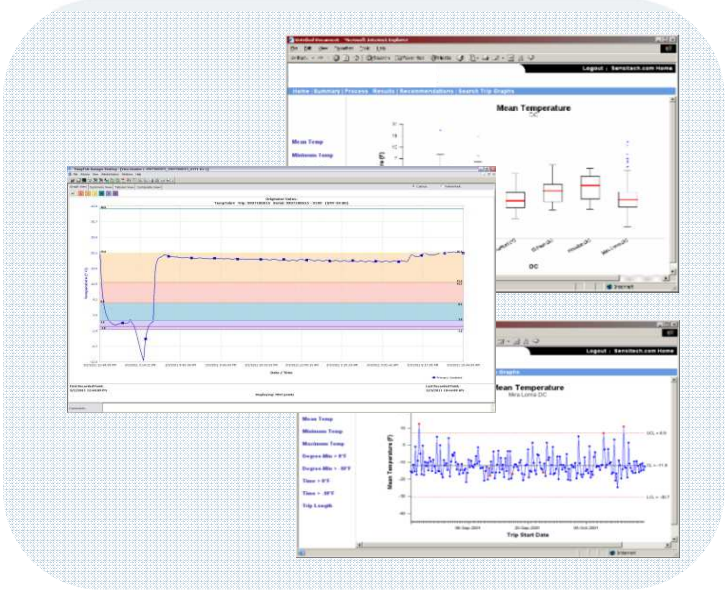
SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

Sensitech Products, Software and Services

Validated data-acquisition instruments for in-transit, in-process, and in-storage monitoring, collection and download

Software allows for cold chain data reporting and analysis

Professional services team helps to measure critical control points, map and analyze complex cold chains, and identify potential opportunities for process improvement.



SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

TempTale® Monitors

All TempTale monitors have the following specifications:

- Temperature resolution of 0.1°C/F over full temperature range
- Flexibility to program various time out of range, time and temperature alarms
- Start-up options of either manual push button or automatic launch
- Ability to scroll through the LCD without stopping the monitor to view:
  - Average temperature
  - Highest temperature recorded
  - Total time above high temperature limit
  - Lowest temperature recorded
  - Total time below low temperature limit
- LCD programmable options:
  - Display current temperature
  - Display temperature values in °C or °F
  - Enable flashing of start, stop and alarm icons
- Programmable high and low limits (single event or cumulative)
- Non-volatile memory
- NIST traceable; CE Mark by TUV; RoHS; WEE
- Fully validated - Each monitor comes with a Certificate of Validation

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

TempTale®4 Ambient

Temperature range of -30ºC to 70ºC

Temperature accuracy

- ±1.1ºC from -30ºC to -18ºC
- ±0.55ºC from -18ºC to 50ºC
- ±1.1ºC from 50ºC to 70ºC

Data sampling interval options of 10 seconds up to 2 hours

Start-up delay option of 0 seconds to 194 days

Maximum data storage capacity of 1,920 or 16,000 data points

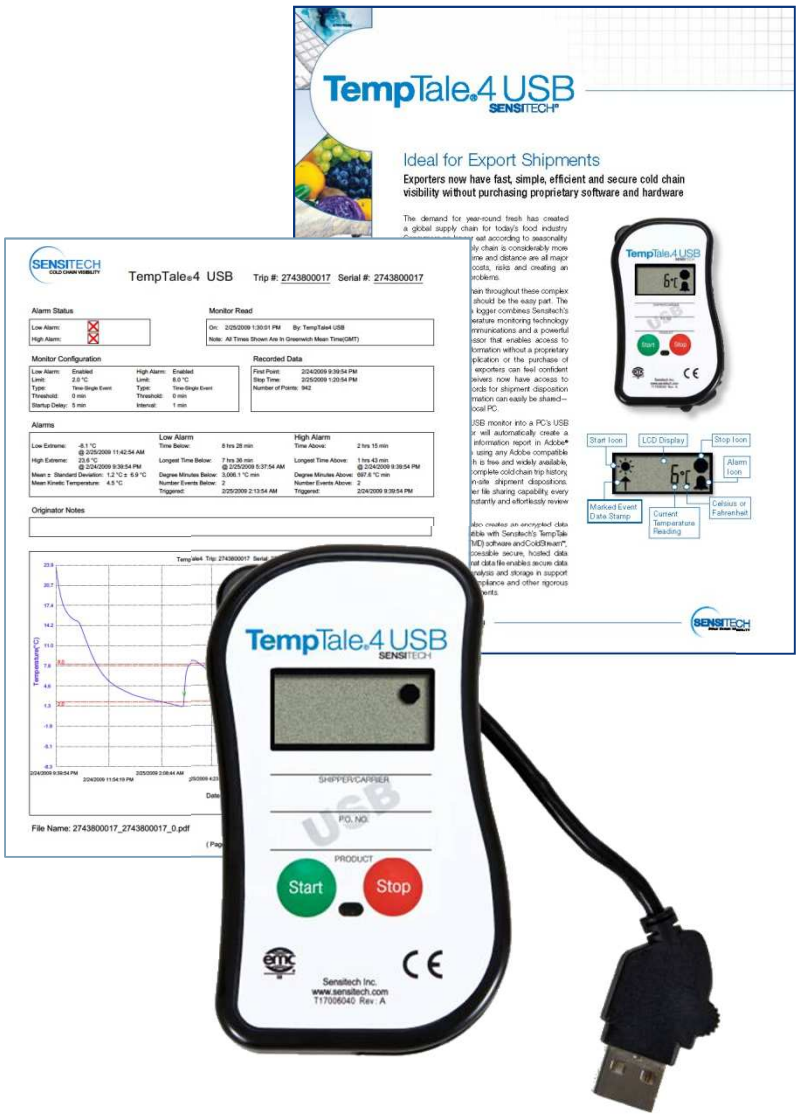
Compatible software platforms

- ColdStream®, TempTale Manager® Desktop

Available in Single-Use and Multi-Use

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

TempTale®4 USB



Temperature range of -30ºC to 70ºC

Temperature accuracy

- ±1.1ºC from -30ºC to -18ºC
- ±0.55ºC from -18ºC to 50ºC
- ±1.1ºC from 50ºC to 70ºC

Maximum data storage capacity of 16,000 data points

Fully independent operation; no PC applications and no retained PS “footprint”

Easy “plug and play” operation with a USB 2.0, A-Type plug

Compatible software platforms

- Adobe Reader
- ColdStream®, TempTale Manager® Desktop

Available in Single-Use Only

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

TempTale®4 Humidity

Temperature range of -30ºC to 70ºC; relative humidity range of 10% to 100% RH

Temperature and humidity accuracy*

- ±1.1ºC from -30ºC to -18ºC
  ±0.55ºC from -18ºC to 50ºC
  ±1.1ºC from 50ºC to 70ºC
- ± 4% RH from 10% to 90%,
  ± 5% RH from 90% to 100%

**RH accuracy stated within temperature exposure range of 5ºC to 60ºC*

Data sampling interval options of 10 seconds up to 2 hours.

Start-up delay option of 0 seconds to 194 days

Maximum data storage capacity: 16,000 data points

- 8000 temperature data points,
  8000 relative humidity data points

Compatible software platforms

- ColdStream®, TempTale Manager® Desktop

Available in Single-Use and Multi-Use

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

TempTale®4 Probe

Available as a dual sensor

Temperature range of -30ºC to 70ºC (both sensors)

Temperature accuracy (both sensors)

- ±1.1ºC from -30ºC to -18ºC
- ±0.55ºC from -18ºC to 50ºC
- ±1.1ºC from 50ºC to 70ºC

Option of a 5-foot flexible or 5-inch stainless-steel probe

Data sampling interval options of 10 seconds up to 2 hours.

Start-up delay option of 0 seconds to 194 days

Maximum data storage capacity 16,000 data points

- Dual sensor: 8000 ambient data points, 8000 probe data points

Compatible software platforms

- ColdStream®, TempTale Manager® Desktop

Available in Single-Use and Multi-Use

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

TempTale®4 RF

Temperature range of -30ºC to 70ºC

Temperature accuracy

- ±1.1ºC from -30ºC to -18ºC
- ±0.55ºC from -18ºC to 50ºC
- ±1.1ºC from 50ºC to 70ºC

Operate within the 915 MHz or 868 MHz ISM band for efficient transmission in high water content product situations

Monitors never transmit until they are in the vicinity of an active ColdStream Infrastructure component (i.e., an operational TTRF Gateway and/or TTRF Repeater); this mode is required for air transit

Maximum data storage capacity
1,920 data points

Compatible software platforms

- ColdStream®

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

TempTale®4 RF (cont'd.)

TempTale RF Gateway

- AC powered reader attached to the network via an Ethernet connection.
- Wirelessly communicates with TTRF monitors directly or through TTRF Repeaters. When a TTRF Gateway is shipped, its operating frequency band is set by country. The TTRF Gateway automatically chooses a channel within the band based on the current signal-to-noise ratio measured in each channel.
- Contains a firmware-based Ethernet controller that is assigned an IP address.

TempTale RF Repeater

- AC powered unit used to extend the area that is covered by the network.
- Pass signals between the TTRF monitors, other TTRF Repeaters and the TTRF Gateway. When a TTRF Repeater is first installed, it searches for the presence of a TTRF Gateway and establishes communication on the same channel as the TTRF Gateway.

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

Critical Components

Based on regulatory audits evaluating documentation to ensure product quality, purity, safety, efficacy and potency, pharmaceutical, biologic and food manufacturers consider ***temperature monitoring devices*** and the ***systems*** used to ***manage the information*** collected as ***critical components*** of overall cold chain management

Reference: Bishara, R. H. , "The Application of Electronic Records and Data Analysis for Good Cold Chain Management Practices," American Pharmaceutical Outsourcing, 7(3), May/June 2006

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

Global Regulatory Expectations

Data is available to document risk levels

If a particular process was not documented, it did not happen

Qualification / Validation

Data needs to be available to prove that a specific cold chain element was within range

- Product quality, purity, efficacy, and potency were not negatively effected
- Ongoing monitoring and data analysis
- Applying process improvement to the temperature sensitive distribution

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

Validation and NIST Traceable Calibration

USP <1118> Monitoring Devices – Time, Temperature, and Humidity

- "Thermometers and hygrometers, used to provide data about the temperature and humidity exposure of a product, must be suitable for their intended use. Specifically, they must be appropriately validated."

USP <1079> Good Storage and Shipping Practices

- "Validated, available temperature- and/or humidity-monitoring technologies can be used to monitor the overall effect on compendial articles during shipment and distribution."
- "All equipment used for recording, monitoring, and maintaining temperature and humidity conditions should be calibrated on a regular basis. This calibration should be based on NIST or international standards."

Reference: U.S. Pharmacopeia 29, General Chapter <1118> Monitoring Devices-Time, Temperature, and Humidity, " The U.S. Pharmacopeia Convention (Rockville, MD, 2005)

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

Temperature and Time Measurement Accuracy

USP <1118> Measurement Accuracy

- "For temperature and humidity monitoring devices, measurement accuracy refers to the closeness of the value obtained with a particular device to the true value being measured. In practice, this is determined by comparison with a device that has been calibrated against a standard that is obtained from or traceable to the National Institute of Standards and Technology (NIST)."

USP <1118> Time Accuracy

- "Most commonly, time accuracy is expressed as a ± percentage of total duration of the recording period. For pharmaceutical applications, a ±0.5% time accuracy is adequate."

Reference: U.S. Pharmacopeia 29, General Chapter <1118> Monitoring Devices-Time, Temperature, and Humidity, " The U.S. Pharmacopeia Convention (Rockville, MD, 2005)

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

Temperature Measurement Response

USP <1118> Temperature Measurement Responsiveness

"Any monitor takes time to respond to a change in the temperature or humidity. The more rapid the response, the clearer the picture of the environmental history of a monitored product will be.

Measurement responsiveness may be defined as the time, t½, required for a device to read a value of (x + y)/2 after an instantaneous change in the property being measured from x to y. Measurement responsiveness is typically defined for the operating range of a device.

Different levels of responsiveness are needed for different monitoring applications. For devices used to monitor storage locations, where the temperature and humidity are unlikely to change rapidly, a t½ 15 minutes may be appropriate. For devices used to monitor transport, where more rapid changes are possible, a t½ 5 minutes may be needed."

Reference: U.S. Pharmacopeia 29, General Chapter <1118> Monitoring Devices-Time, Temperature, and Humidity, " The U.S. Pharmacopeia Convention (Rockville, MD, 2005)

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

21 CFR Part 11 Guidance

Section 11.10 requires persons to “employ procedures and controls designed to **ensure the authenticity, integrity,** and, when appropriate, the **confidentiality of electronic records,** and to ensure that the signer cannot readily repudiate the signed record as not genuine.” To satisfy this requirement persons must, among other things, employ procedures and controls that include “validation of systems to ensure **accuracy, reliability, consistent intended performance,** and the **ability to discern invalid or altered records”**

“Commercial software used in electronic recordkeeping systems subject to part 11 **needs to be validated,** just as programs written by end users need to be validated.”

Reference: “Guidance for Industry 21 CFR Part 11; Electronic Records; Electronic Signatures Validation,” FDA, August 2011

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

cGMP – 21 CFR Part 211

"All **records** required under this part, or copies of such records, **shall be readily available** for authorized inspection during the retention period at the establishment where the activities described in such records occurred."

"Records that can be **immediately retrieved** from another location by computer or other electronic means shall be considered as **meeting the requirements** of this paragraph."

Reference: "21 Code of Federal regulations Parts 211 – Current Good Manufacturing Practice for Finished Pharmaceuticals," FDA

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

Case Study – Monitoring Temperature Treatment During Transportation

Background

A large New Zealand exporter ships a kiwi variety (gold) that requires temperature treatment during ocean transportation to trigger and then control the ripening process.

Problem

Without temperature devices placed directly on the product, the exporter only had available the temperature measurement taken at the departure and arrival points, or the data provided by the ocean carrier (if available).

Solution

The exporter has been placing temperature monitors (TempTales) in its shipments to monitor the temperature performance during transportation.

Solution

The exporter has been able to verify if the temperature of the container is modified as requested and evaluate the compliance of the service providers.

SENSITECH
United Technologies
SUPPLY CHAIN VISIBILITY

Case Study – Monitoring Temperature Treatment During Transportation (cont.)