

# Wireless Sensor Networks

## Important Features and Experience in Pharmaceutical Applications

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# Agenda

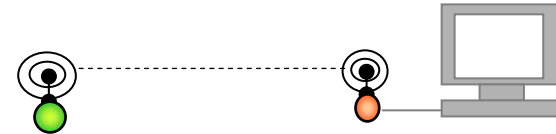
- Important Features
- Wireless Performance and Reliability
- Solution overview
- Typical Applications
- Experience in the Pharmaceutical Industry
- Conclusions

# Wireless Network Types

## Older, less flexible, less reliable technologies

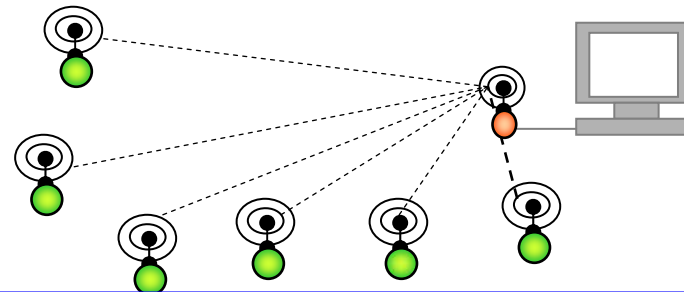
### Direct Connection

- Wire replacement
- Point to point, highly specific
- Engineered to suit application



### Star

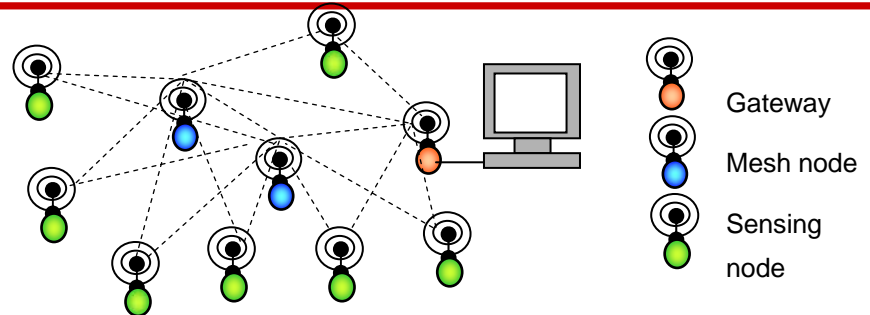
- One central routing and control point
- Single-hop - point to multi-point
- All data flows through central point



## Newer, more flexible, more reliable technology

### Mesh

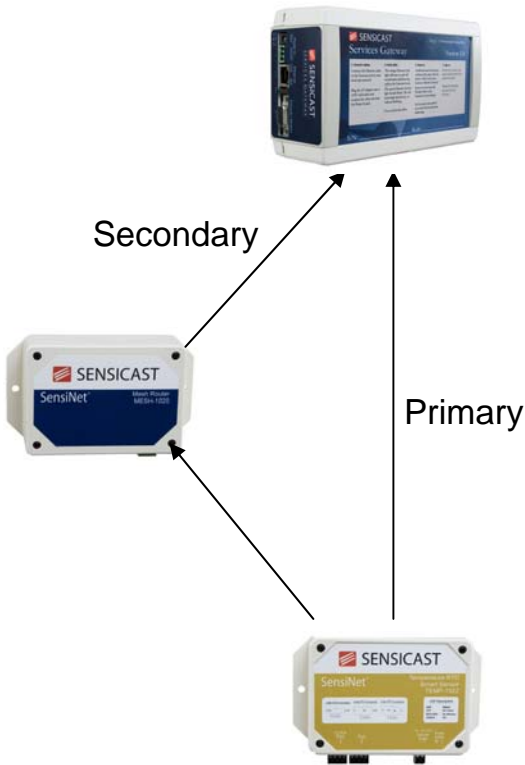
- Multiple data paths
- Multi-hop
- Can operate as star or hybrid star/mesh
- Self configuring, self healing
- Highly flexible, highly reliable



# Operational Advantages of Mesh

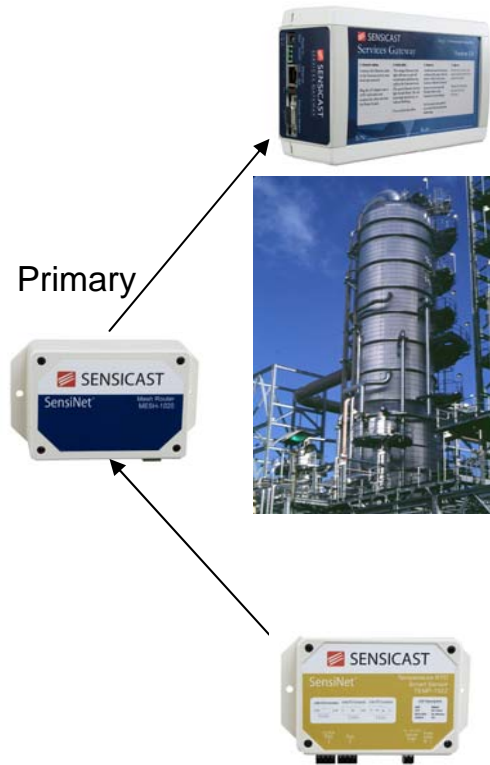
- **Multiple Pathways**

- Stronger connectivity
- Self-Healing, Self-Managing



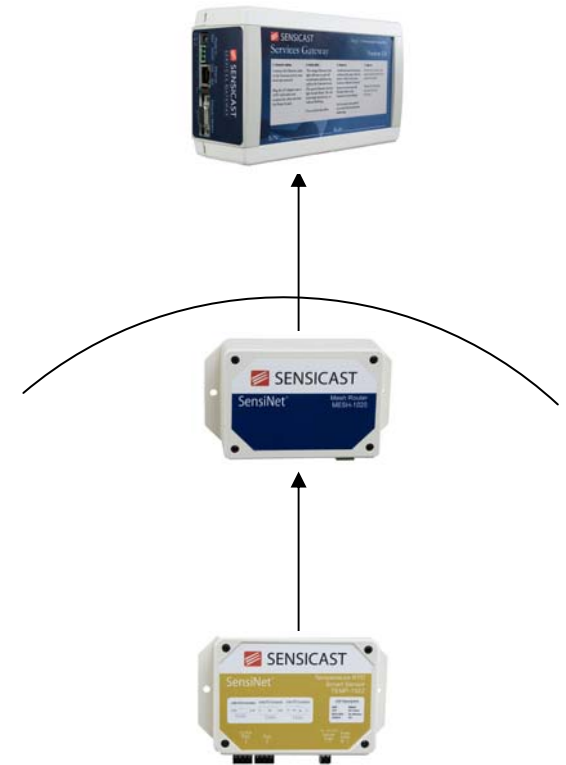
- **Transmit Around Equipment**

- More robust
- More flexible



- **Extend Network Range**

- More robust
- More capable



# Business Advantages

## Economic and operational advantages vs. wired sensors

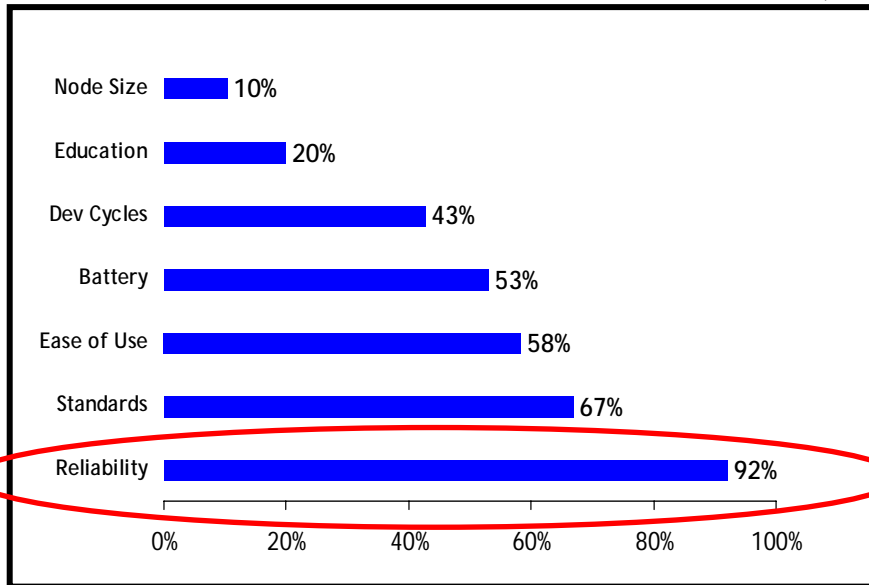
- Up to 90% lower installed costs
  - Lower cost of required equipment and supplies
  - Much quicker installation = less on-site time and less process disruption
- Monitor and control in:
  - harsh environments (lots of metal and interference)
  - “wire unfriendly” situations where wires are difficult or undesirable
- Monitors movable or rotating equipment
- Easy optimisation of sensor position in process for a better result
- Low cost and speedy retrofit to existing equipment and processes
- Cost-effective diagnostics in uncertain or temporary situations
- Multiple sensor types with standard wireless nodes on a single network
- Remote, ‘PC-less’, monitoring from anywhere on the internet

# Wireless Performance and Reliability

# Wireless Sensor Networks Adoption Inhibitors

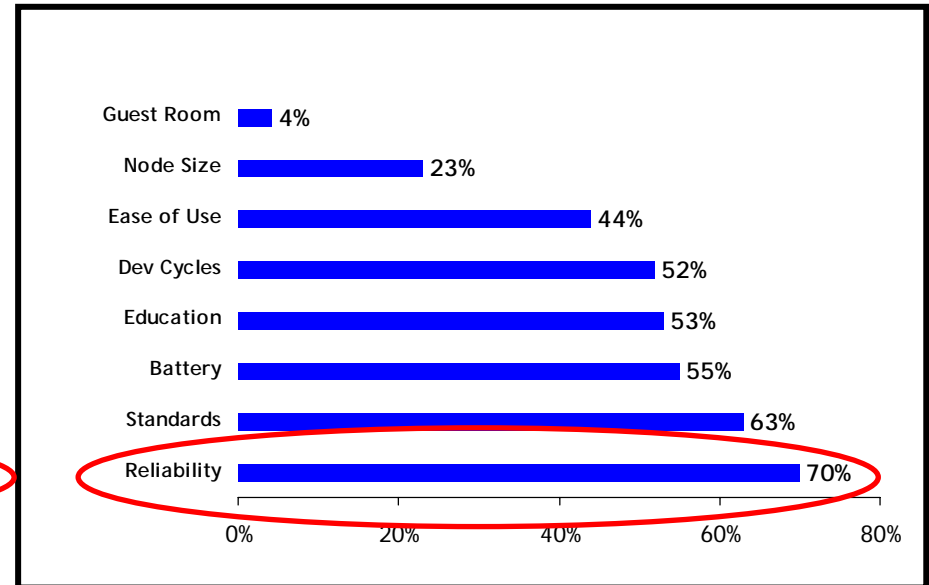
## Industrial OEM's

Source: ON World, Inc.



## Commercial Buildings

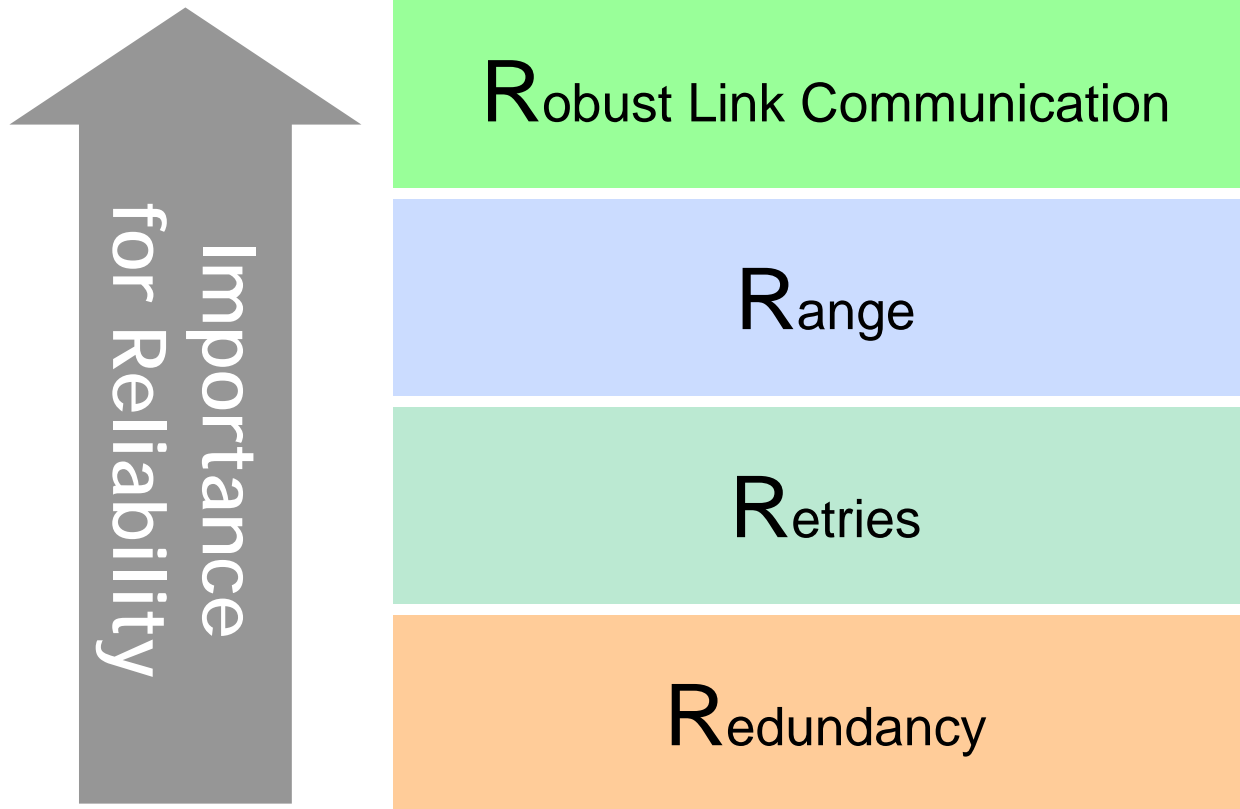
Source: ON World, Inc.



In wireless sensor networks, reliability should be defined by receiving every transmitted message, every time



## The Four “R”s of Reliability in Sensor Networking





# Redundancy

The last line of defense in a wireless mesh sensor network

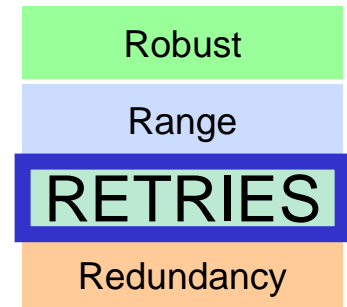


- Robust
- Range
- Retries
- REDUNDANCY**

# Retries

Minimise to optimise power consumption

- **Bi-directionality** is a fundamental feature
- Lack of transmission acknowledgement will trigger a **retry**
- Failures may be due to:
  - Out of range
  - Collisions
  - RF multi-path
  - External RF interference / jamming
- Retries are inversely proportional to battery life



Twice the number of transmissions will impact battery life  
Minimizing the number of required retries is very important

# Range

The louder you shout, the better you will be heard

## Shorter Range

- More routers required
  - Higher installed costs
  - Limited physical placement
- More "hops" to destination

## Longer Range

- Fewer routers required
  - Reduces costs
  - Flexible router placement
- Fewer "hops" to destination

Robust

**RANGE**

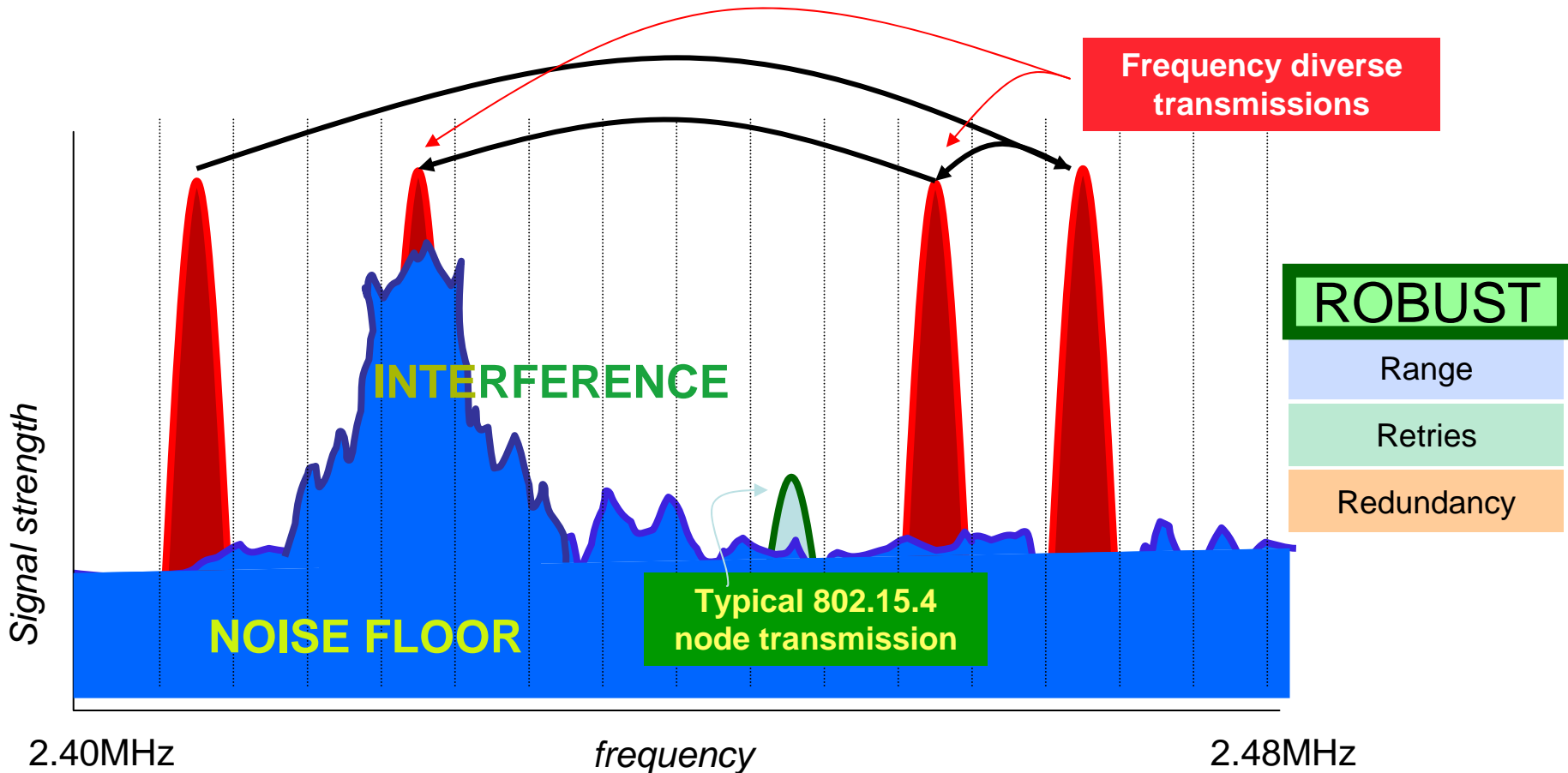
Retries

Redundancy

Without sufficient range significant retries or even communication failures are caused

# Robust Link Communication

Frequency-hopping ensures the highest reliability



Frequency hopping also allows an amplified signal for greater range



# Performance you can rely on

## Robust Link Communication

- 100% link communication makes the other “R”s less important

## Range

- Adds flexibility and reduces cost

## Retries

- Unnecessary retries waste battery life and increase network overhead

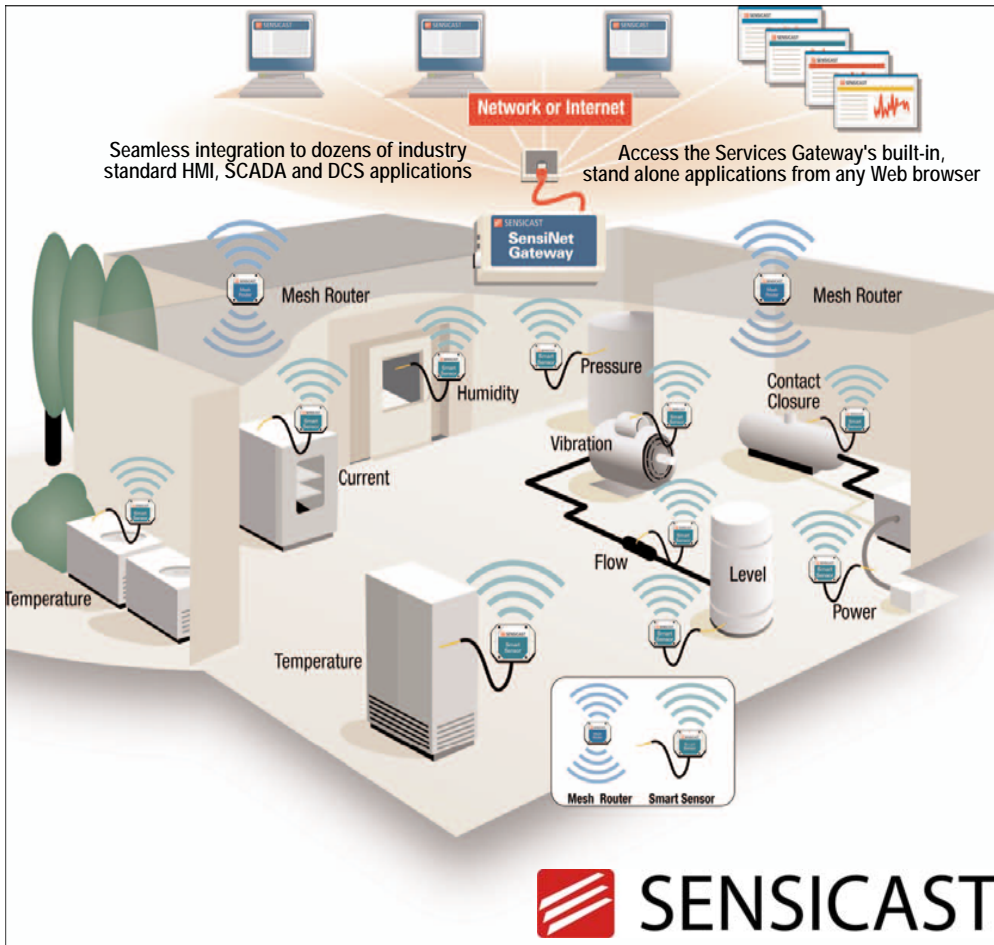
## Redundancy

- Provides a safety net

## SENSICAST Solution overview



# Wireless sensor network vendors should provide:



- An easy-to-use wireless network architecture
  - Auto configuring
  - Self healing
  - Self Managing
  - Highly reliable
  - Flexible
- A range of hardware options and ready-to-sense devices for end-user companies
- A range of capable and flexible application software for a complete solution

# SENSICAST SensiNet® Solution

**Services Gateway**

**Mesh Routers**

**Smart Sensors**

**Thousands of Third Party Probes**



- Temperature
- Humidity
- Touch
- Pressure
- Fluid Flow
- Vibration
- CO, CO<sub>2</sub>
- Voltage
- Current
- Relay
- Motion
- Light
- Biomaterials

Secure  
Browser Apps  
Modbus TCP  
OPC Server  
Web Services

**Industry Standard Interfaces**

**Popular Applications**



Cork – 12<sup>th</sup> September 2007

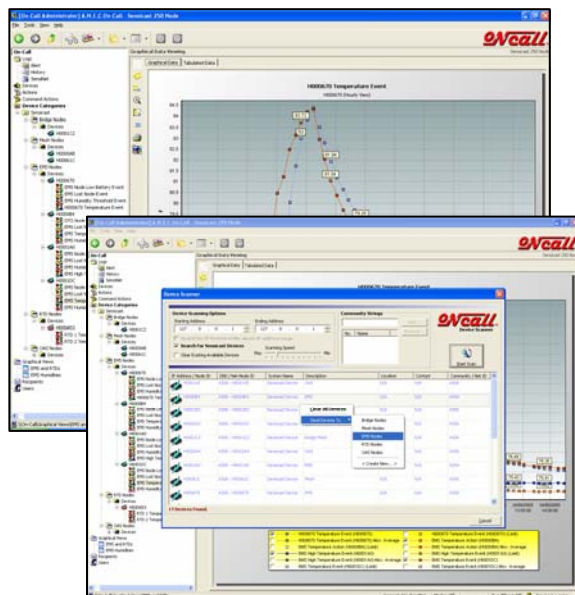


# Application Software

Flexible options =>  
To match varying needs:  
Compliance  
Wide area access  
Enterprise scalable

OnCall

Real-time monitoring  
Logging and archiving  
Charting  
Alerting  
E-mail  
SMS  
Klaxon / Strobe  
Web views



FMS 3.10 adds  
process  
insurability

GAMP4  
FDA 21 CFR pt 11  
Fully validated process  
Where compliance  
is a requirement

# Experience in the Pharmaceutical Industry Using SENSICAST Solutions

# The Pharmaceutical Industry situation

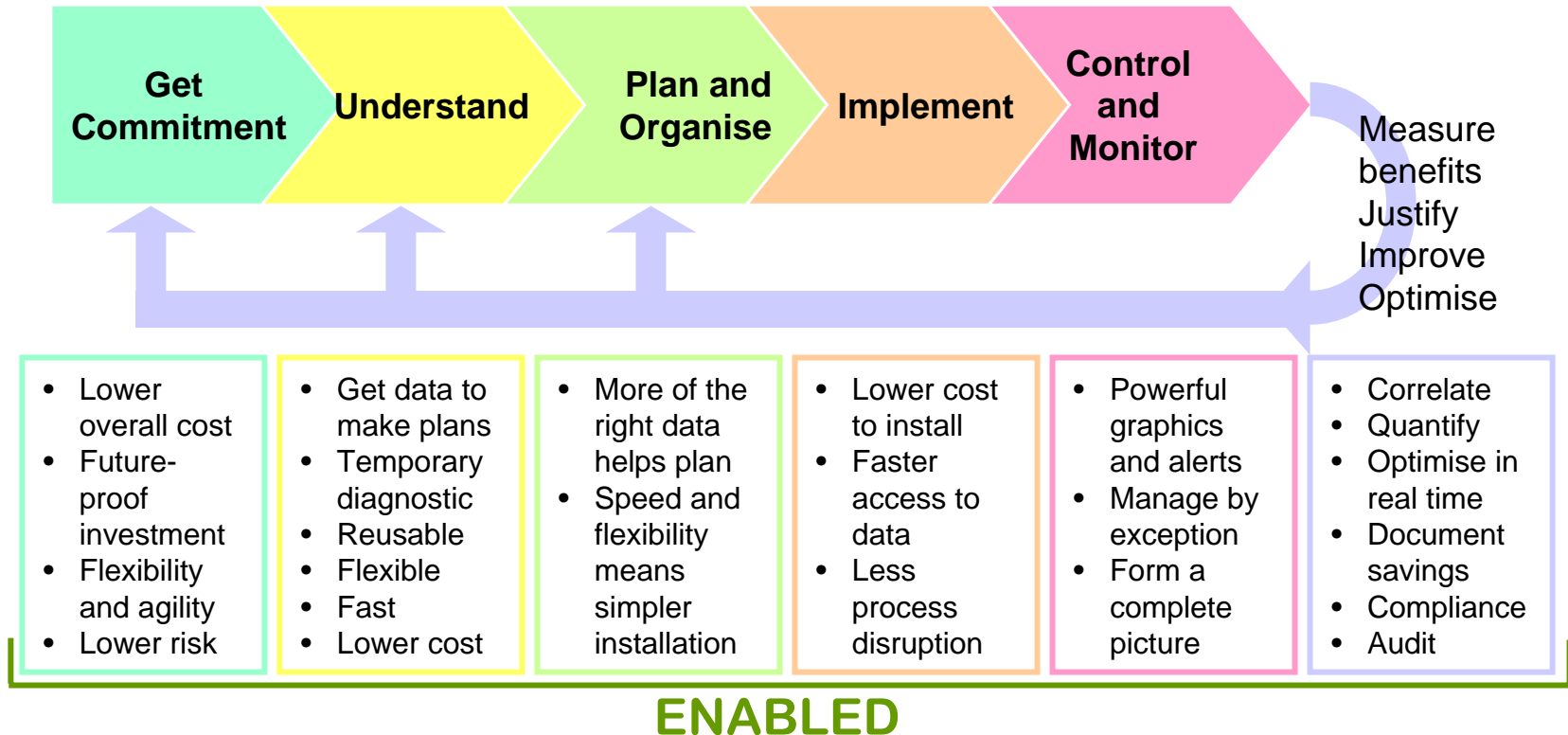
- Research and production processes are complex and highly regulated
- Equipment is often specific to the product or process – no ‘one-size fits all’ standard process monitoring solution.
- There is an ever-increasing requirement to:
  - Minimise production costs – energy increasingly important
  - Minimise product waste
  - Maximise product quality and conformity
  - Comply with emissions and other legislation and targets
  - Maintain traceability and audit trails
  - Increase Overall Equipment Effectiveness (OEE) by analysing root causes of problems
  - Make fact-based analysis and minimise risk of operational decisions
- Pharmaceutical process equipment is capital-intensive and equipment may need to be upgraded rather than replaced => retrofit is desirable.
- Much equipment is not adequately instrumented for current management needs.

## Areas of applicability in Pharmaceutical Plants

- Use Wireless Sensing for:
  - Environment Monitoring
    - Storage temperatures, Effluent condition / level, Compliance audits, etc
  - Plant condition and process monitoring:
    - Temperature, Vibration, Flow, Pressure, Level, etc.
  - Energy Monitoring
    - Sub-metering of oil, water, gas, electricity, steam, compressed air, etc
- Typical relevant plant:
  - Refrigeration plant and cold storage environments
  - Air Handling Units
  - Boilers
  - Compressed air systems
  - Large Electric motors
  - Rotating equipment, fans, pumps, mixers, etc

# Example - Energy Management Process

What does Wireless Enable?



# Some Examples of SENSICAST Pharmaceutical Installations



**Kaye LabWatch** uses only SensiNet devices in their wireless offering

- GE Kaye have installed and validated approximately 15 systems including KV Pharmaceutical, Cephalon and one at the FDA.

## Example - KV Pharmaceutical

**Problem:** Install FDA certified system quickly without downtime

**Solution:** 130 temp monitoring points in 3 buildings

**Features:** a) FDA 21 CFR Part 11 compatible and certified  
b) Integration with GE Intellution management software

**Payback:** Immediate with no plant downtime



# Example – Cephalon Pharmaceutical Life Sciences

## Perishables Storage

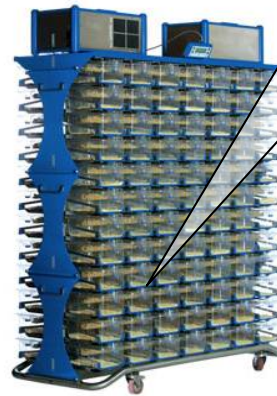
- Expensive genetically modified animals
- 2,000 live specimens
- Per-cage environment control

## Challenge

- High mortality rate due to ventilation system outages
- Rolling cage storage precludes use of wired sensor systems

## Solution

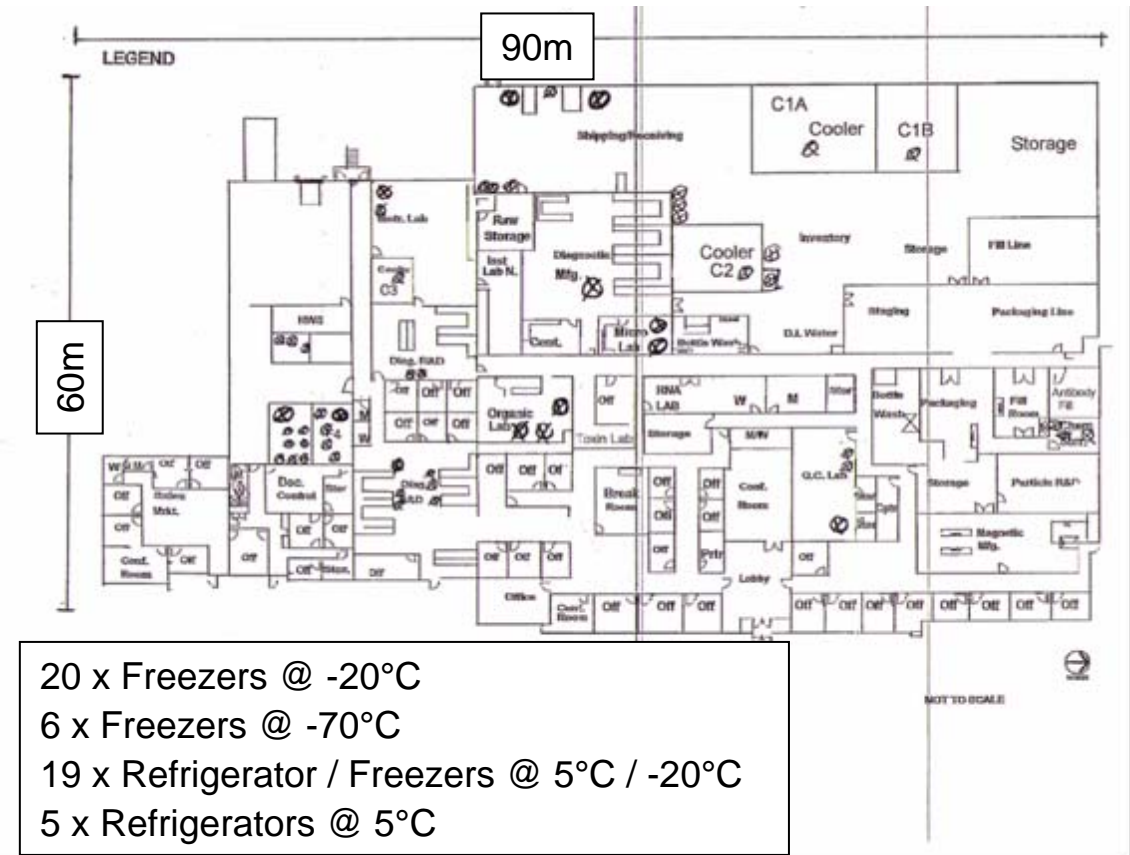
- SensiNet Storage Environment monitoring
- Automatic alarms and alerts provide immediate problem detection and correction



Animal mortality eliminated  
3 month payback on system

# Example - Thermo Fisher Seradyn

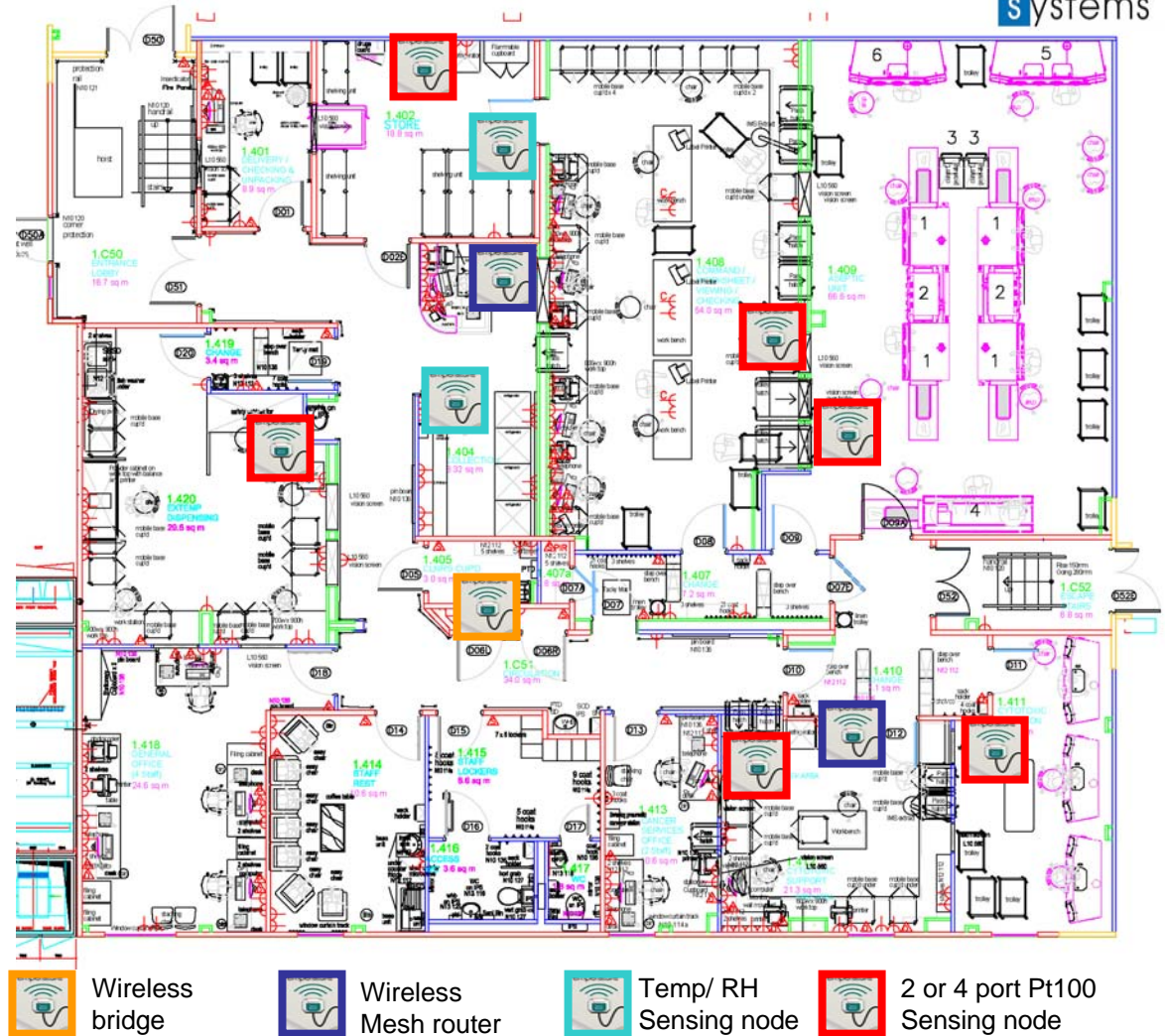
- Pharmaceutical Manufacturing Site
- FDA Validated Data Collection
- FDA 21 CFR Part 11 system certification achieved in March 2007.
- 60 SensiNet Monitoring Points in 1 Building
- Iconics Software connecting to SensiNet
- Sensicast-developed application





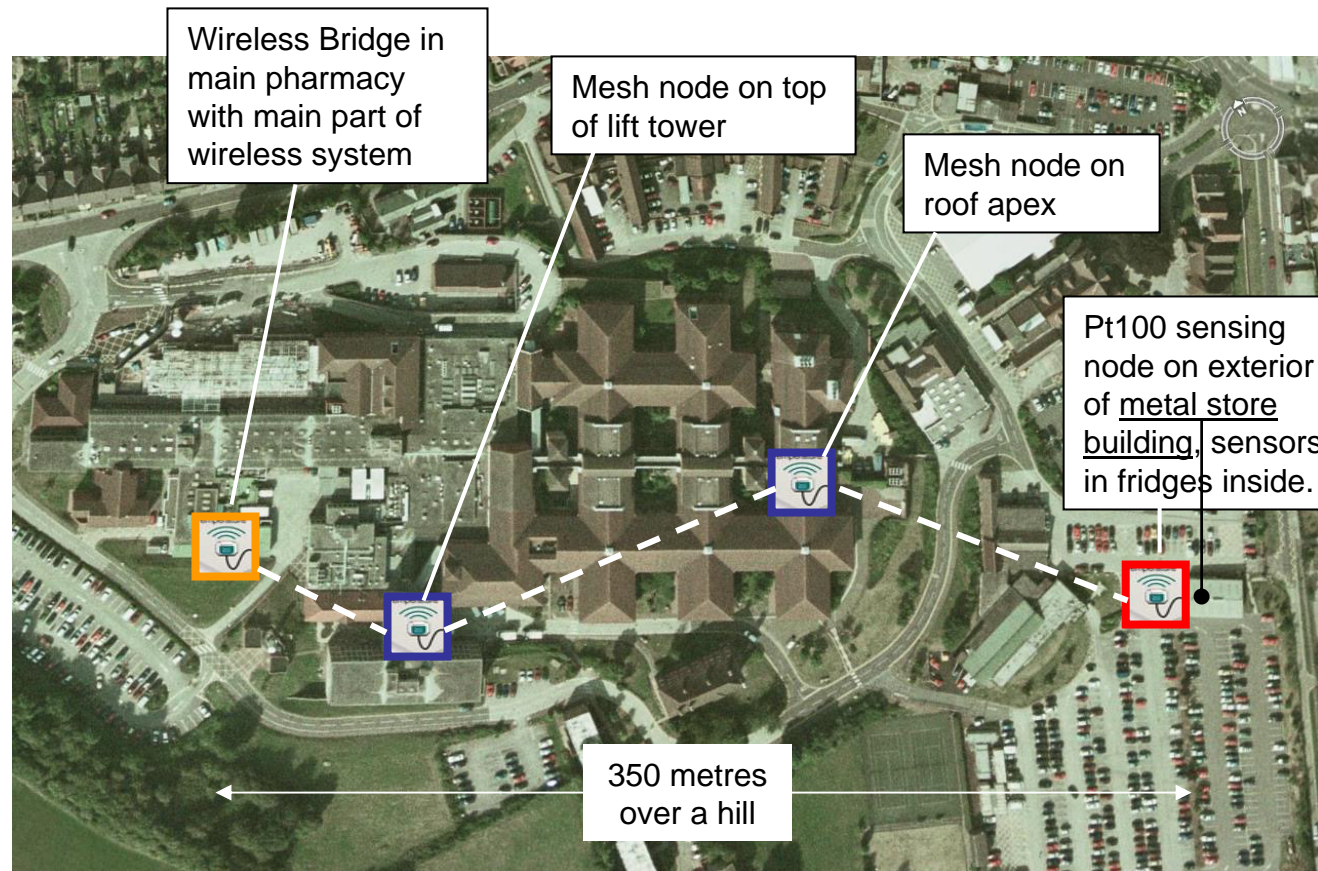
## Example – UK Hospital Pharmacy Clean Room

- Ambient and refrigerator temperature monitoring
- New build
- Integrated with wired FMS monitoring system using OPC
- Key factors - speed and flexibility of placement to optimise effective measurement
- Wireless RTD and integrated ambient temp / RH sensing nodes
- Installation meets FDA 21CFR part 11 compliance requirements
- Two other Sensicast wireless systems in other areas of this hospital are linked into the same software.



# Example – UK Hospital Pharmacy and Remote Store

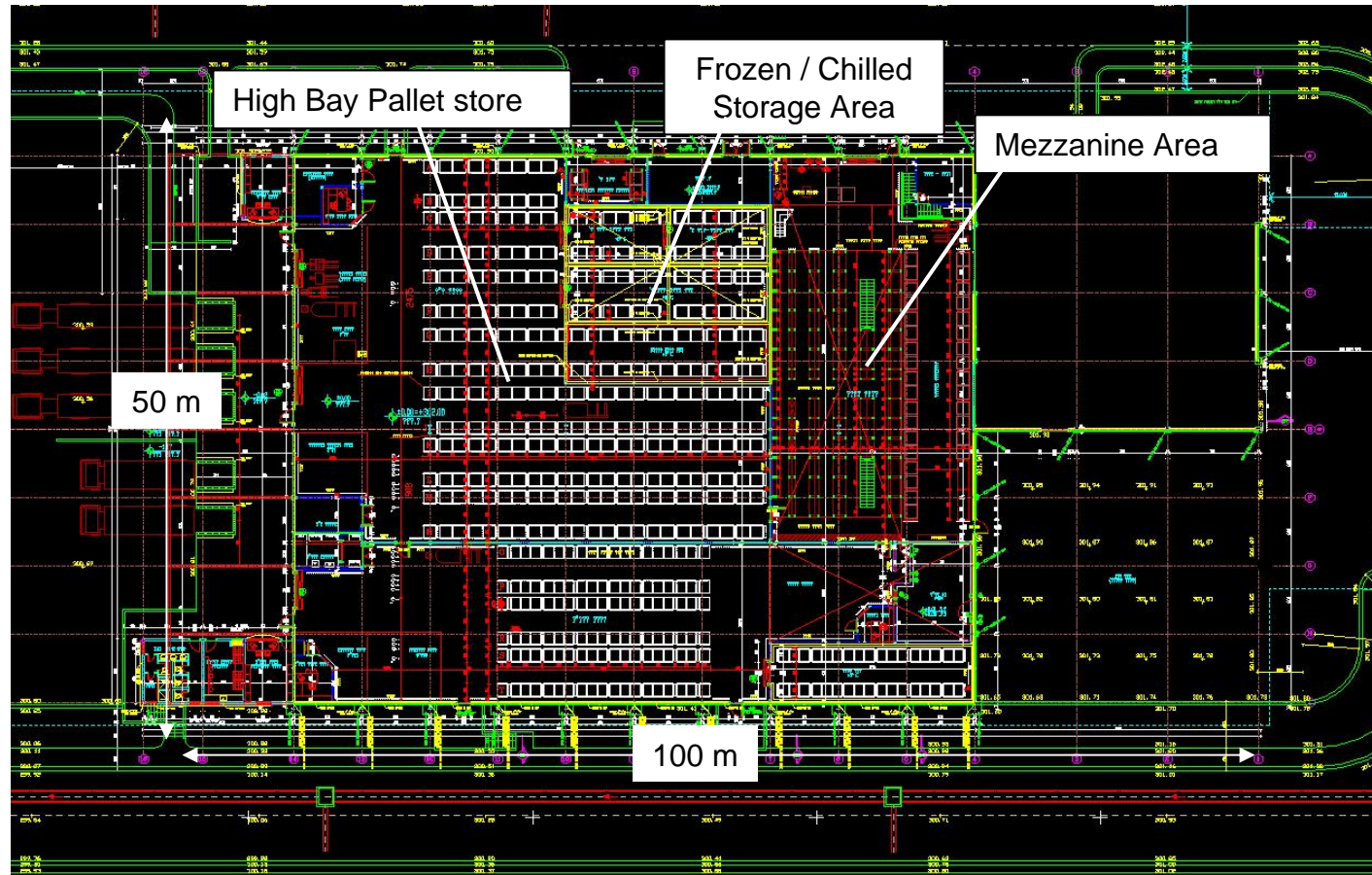
- Ambient and refrigerator temperature monitoring
- Main Pharmacy with 8 monitoring points
- Integrated with wired FMS monitoring system using OPC
- Key factors - speed and low cost of installed system with access to remote store
- Multi-hop mesh node connections provide up to 150m between nodes
- Installation meets FDA 21CFR part 11 compliance requirements



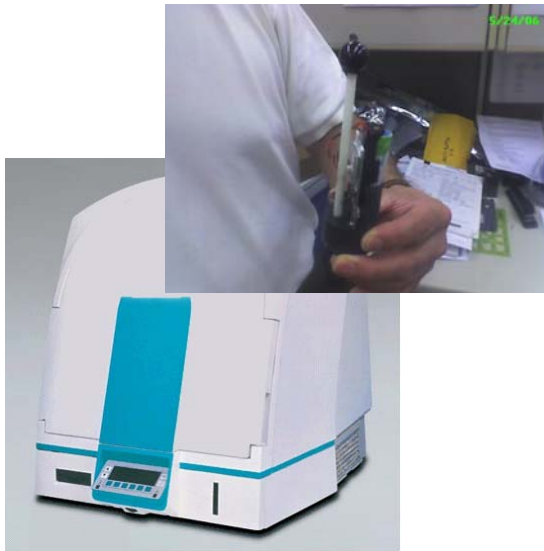


# Example – Middle Eastern Generic Drugs Manufacturer – Warehouse and Production

- New build plant and warehouse
- Three temperature zones -25°C freezer, 5°C chilled, 25°C main warehouse
- Integrated with GE Fanuc Simplicity using OPC or Modbus TCP
- Key factors - low cost of installed system. Flexibility to optimise sensor placement
- Mesh network coverage of whole facility is planned
- Installation to meet FDA 21CFR part 11 compliance requirements



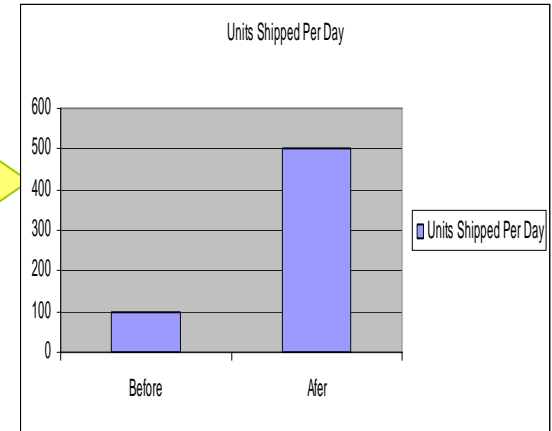
# Example – Becton, Dickinson



**Final Quality  
Temperature Test  
Performance  
Monitoring**

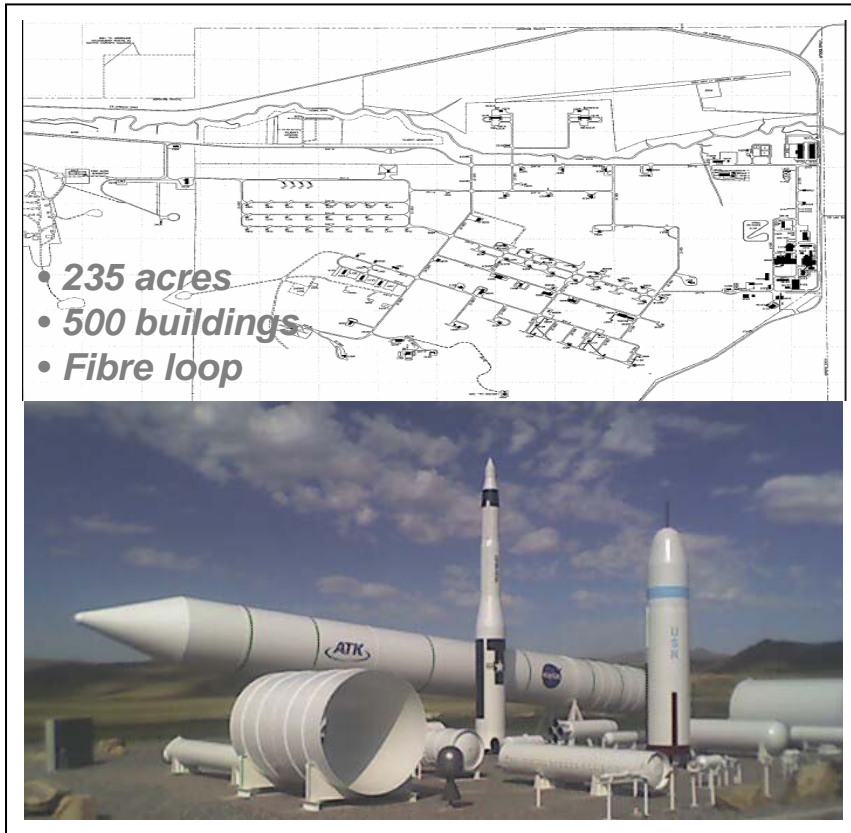


**Verification  
Of Correct  
Operation Prior  
To Shipment**

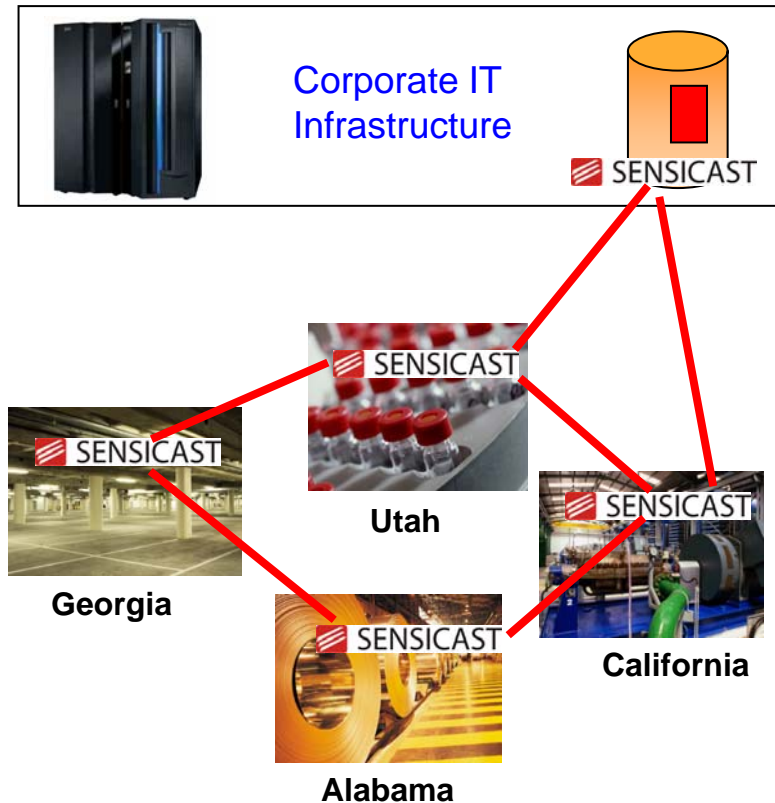


**Wireless In-process  
Monitoring Gives  
500% Throughput  
Increase**

# SENSICAST Enterprise Scale Sensor Networks



## M2M Integrated into IT Infrastructure



# Conclusions

- There are a wide range of valuable applications in pharmaceutical plants, laboratories and enterprises
- Implementable now with available wireless mesh technology
- Benefits of using wireless mesh sensor networks are:
  - Ease of retrofitting, uses standard sensors
  - Minimal wiring costs, minimal disruption
  - Ease of data analysis standalone or integrated with existing wired systems
  - Expandable for multiple applications on a single site or process
  - Flexible to move from process to process
- Value is in:
  - Having the data to prove compliance, identify opportunities for efficiency improvements, take decisions and monitor effects
  - Lowering risk when considering changes in processes and working practices
  - Freeing your people for more productive tasks
  - Contribution to intangible measures such as OEE through data enablement of programmes

# Thank-you

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