

# **An open-source and low-cost monitoring system for Precision Enology**

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## **MONITORING HIGH VARIABILITY IN WINEMAKING PROCESS**

**Winemaking is a complex and delicate process that requires attention and extreme care, in order to ensure the success of the enormous work carried out in vineyard.**

**During winemaking process, wine control becomes a priority due to many risk, such as microbiological problems and the production of undesirable or toxic compounds**

**Wine characteristic could be strongly different between products of the same vineyard and even among each wine vat, due to differences in the evolution of chemical-physical and microbiological processes transform grapes and must into wine.**

**This high variability means an increasing demand of control, process management and costs**

**Winemaking process requires a site-specific methodology, in order to optimize cellar practices management and quality production**



**PRECISION ENOLOGY**

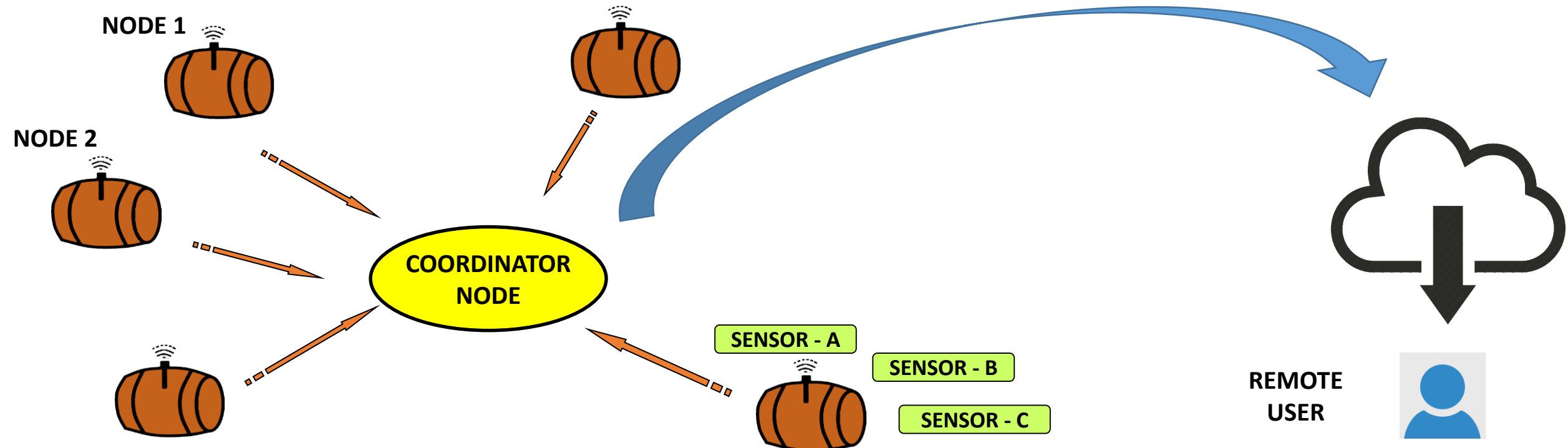
# PRECISION ENOLOGY



Development of monitoring technologies to support decision-making in the cellar variability management



A wireless sensor network (WSN) constituted by an autonomous series of nodes integrated in the barrel bungs equipped with sensors, able to monitor enological parameters and to cooperatively pass their data through the network to a main location, and next to a remote user (winemaker).



# HOW MUCH TIME FOR WINE MONITORING ?

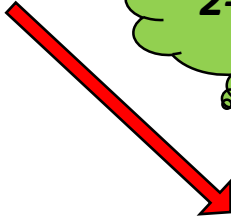
BARREL SAMPLING



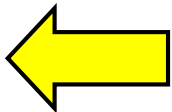
SAMPLES TRANSPORT



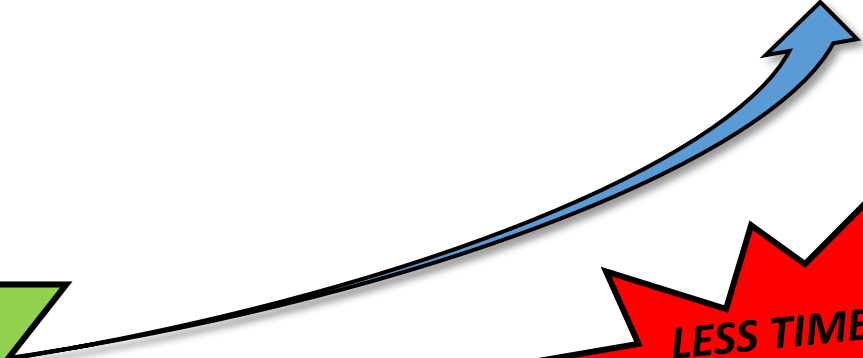
LABORATORY ANALYSIS



WINEMAKER



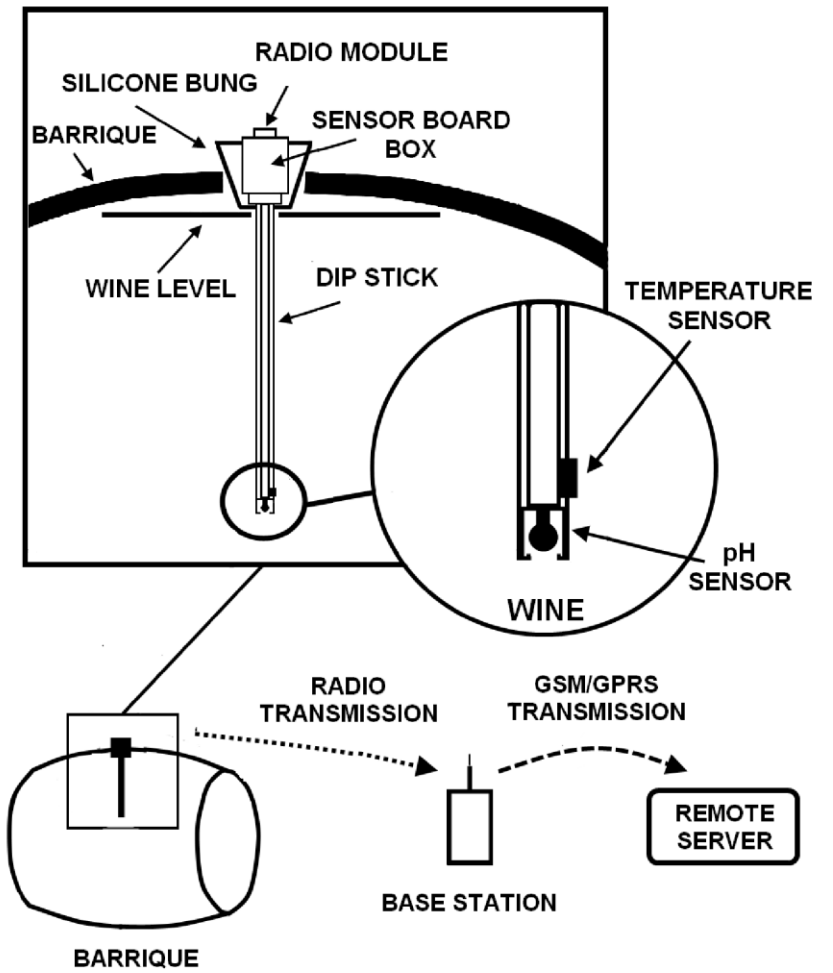
WINE MANAGEMENT DECISION



# Wireless real-time monitoring of malolactic fermentation in wine barrels: the Wireless Sensor Bung system

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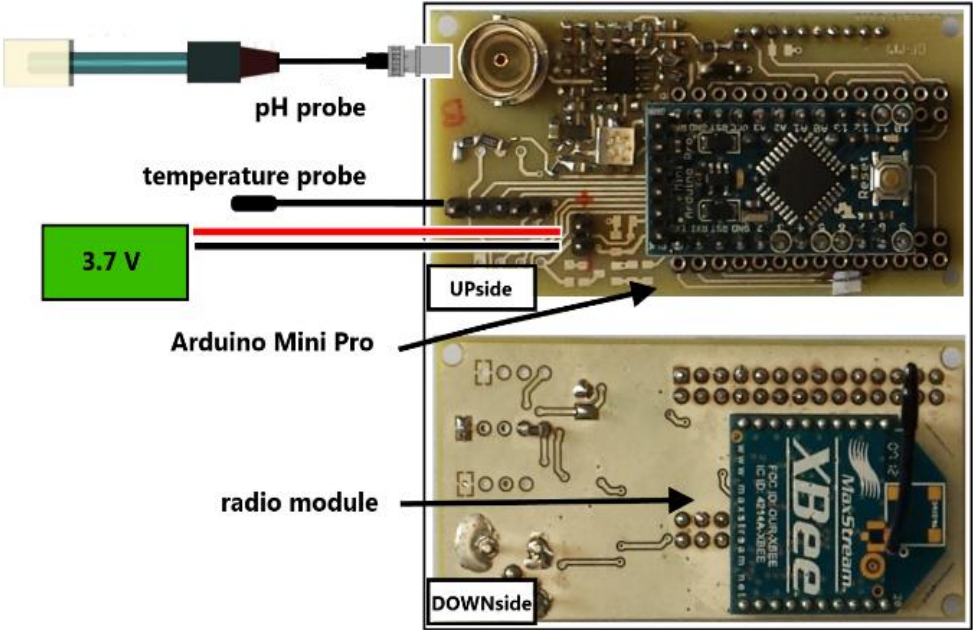
**FIRST PROTOTYPE (2011)**



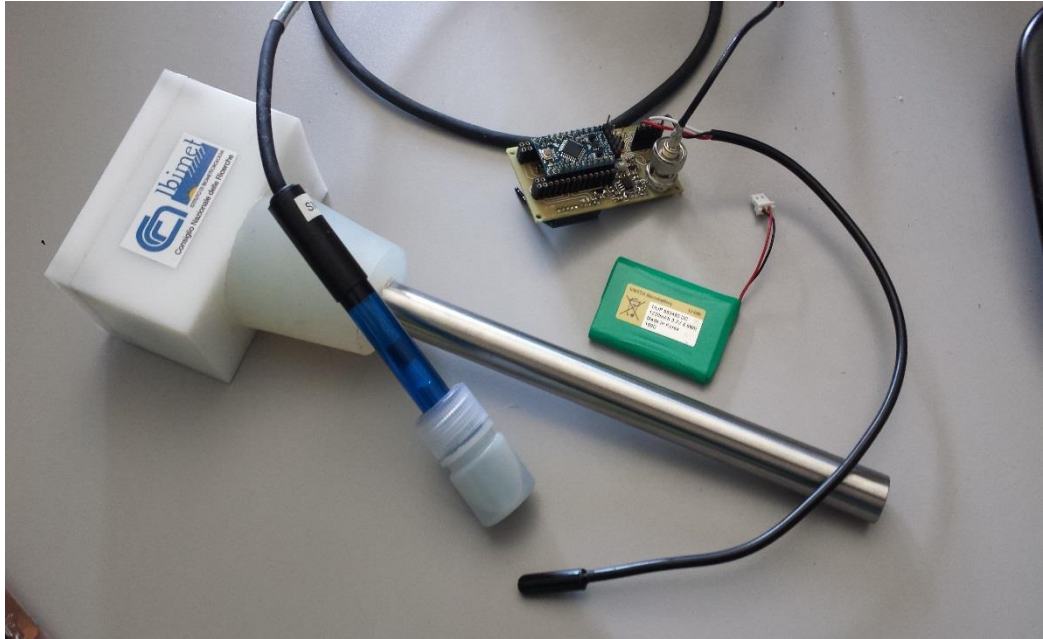
Remote user

# LOW-COST & OPEN SOURCE PERSPECTIVE

# WineDuino (2014)

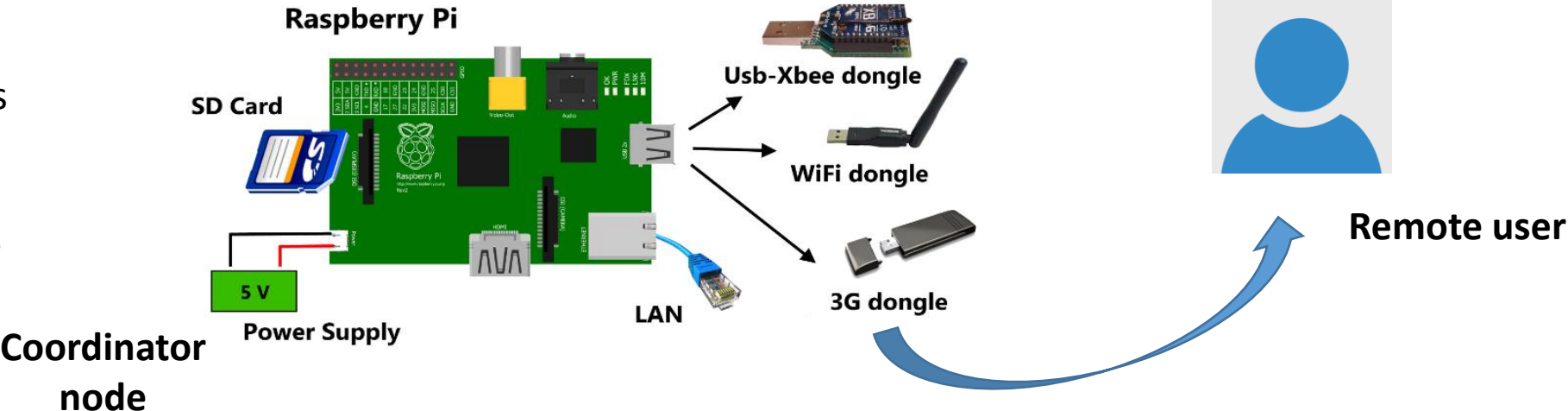


WineDuino node



## WineDuino IMPROVEMENT

- more channels for more sensors
- less cost
- more performance
- highly customizable and flexible
- open source technology
- ...



Coordinator node

# ADVANTAGE OF A WIRELESS MONITORING SYSTEM IN CELLAR

WINE QUALITY GUARANTEE  
FROM RISK

LESS COST AND TIME FOR  
WINE SAMPLING, SAMPLES  
TRANSPORT AND  
LABORATORY ANALYSIS

REMOTE REAL-TIME  
MONITORING FOR  
FAST INFORMATION  
AVAILABILITY

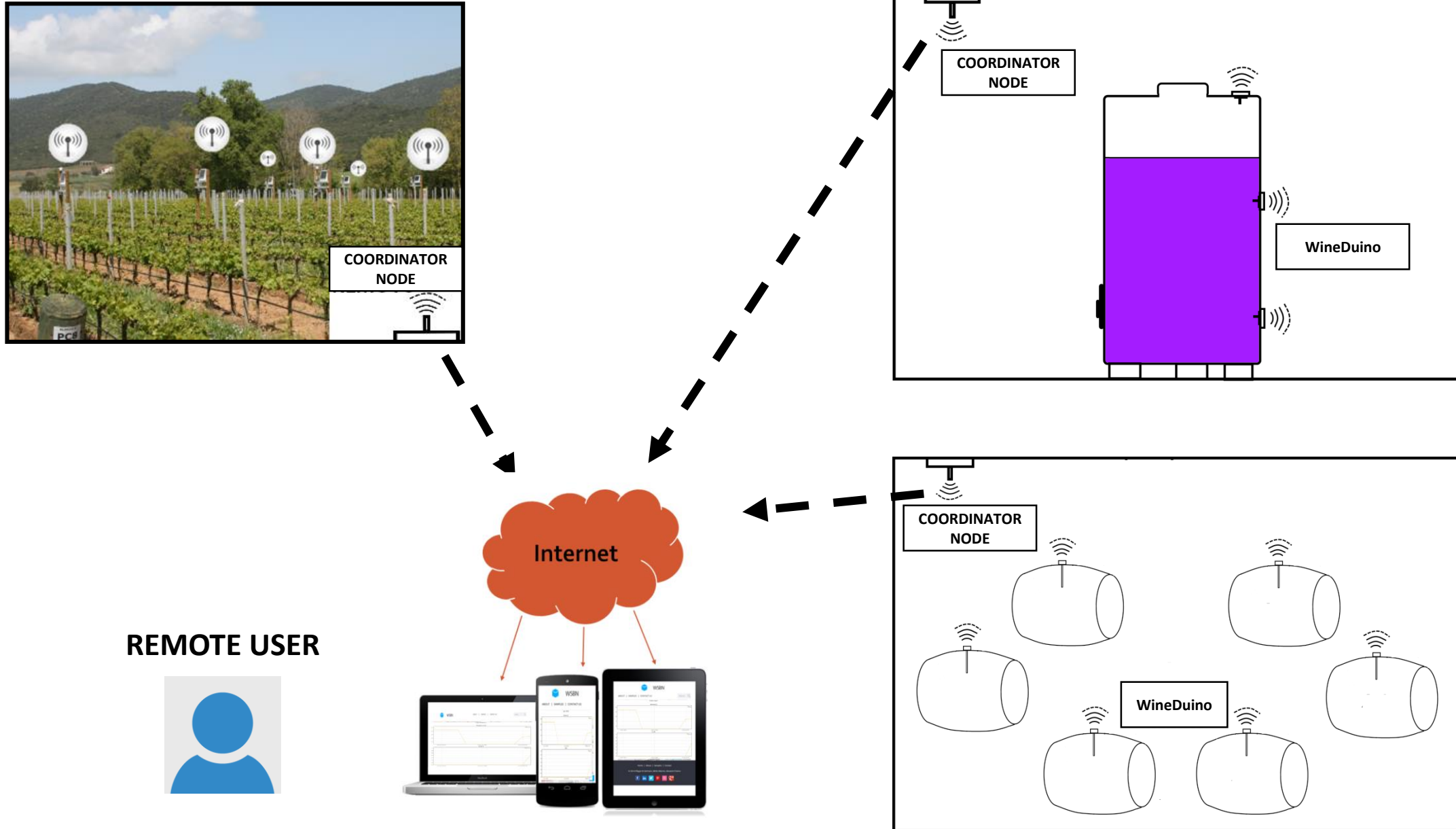


DECISION SUPPORT SYSTEM TO  
OPTIMIZE PLANNING CELLAR  
PRACTICES MANAGEMENT

NO OBSTACLE IN CELLAR  
THANKS TO WIRELESS  
TECHNOLOGY

SAFEGUARD THE CELLARMAN FROM WORKING  
HAZARDOUS CONDITION : CONFINED SPACES  
WITH HIGH HUMIDITY, LOW OXYGEN AND HIGH  
CARBON DIOXIDE LEVELS

# Multiscale monitoring approach for wine chain quality production





A close-up photograph of a wooden barrel, likely used for wine or spirits. The barrel is made of dark wood and has several metal hoops (staves) wrapped around it. A white plastic bung is visible at the top of the barrel. In the foreground, a black rectangular object is mounted on a white plastic base, which is also attached to the barrel. The background is a plain, light-colored wall.

**THANKS FOR YOUR ATTENTION**

**Salvatore Filippo Di Gennaro**