FruitFlyNet

A Location–aware System for Fruit Fly Monitoring and Pest Management Control

Architectural issues of a location-aware system applied in fruit fly e-monitoring and spraying control

Theodore Tsiligiridis Costas Pontikakos Dionysios Perdikis

Agricultural University of Athens

tsili@aua.gr

18th International Conference on Information Systems for Agriculture and Forestry

15th – 17th September 2014 in Jelgava, Latvia

This presentation has been produced with the financial assistance of the European Union under the ENPI CBC Mediterranean Sea Basin Programme. The contents of this presentation are the sole responsibility of the authors and can under no circumstances be regarded as reflecting the position of the European Union or of the Programme's management structures.

The 2007-2013 ENPI CBC Mediterranean Sea Basin Programme is a multilateral Cross-Border Cooperation initiative funded by the European Neighbourhood and Partnership Instrument (ENPI). The Programme objective is to promote the sustainable and harmonious cooperation process at the Mediterranean Basin level by dealing with the common challenges and enhancing its endogenous potential. It finances cooperation projects as a contribution to the economic, social, environmental and cultural development of the Mediterranean region. The following 14 countries participate in the Programme: Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Malta, Palestine, Portugal, Spain, Syria (participation currently suspended), Tunisia. The Joint Managing Authority (JMA) is the Autonomous Region of Sardinia (Italy). Official Programme languages are Arabic, English and French (www.enpicbcmed.eu).

The European Union is made up of 28 Member States who have decided to gradually link together their know-how, resources and destinies. Together, during a period of enlargement of 50 years, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms. The European Union is committed to sharing its achievements and its values with countries and peoples beyond its borders.

The project FruitFlyNet total budget is 1.662.872,32€ and it is financed, on an amount of 1.496.585,09€ (90 %), by the European Union (ENPI CBC Mediterranean Sea Basin Programme) through the European Neighbourhood and Partnership Instrument.

Editor(s): Theodore Tsiligiridis, tsili@aua.gr
Dionysis Perdikis, dperdikis@aua.gr
Costas Pontikakos, costas_pontikakos@yahoo.co.uk

FruitFlyNet: Project Information

Title: A Location–aware System for Fruit Fly Monitoring and Pest Management Control

Code: Standard II-B/2.1/0865/ENPI CBC MED/EU

Priority 2: Promotion of environmental sustainability at the basin level.

Measure 2.1: Prevention and reduction of risk factors for the environment and enhancement of natural common heritage.

Budget: € 1.662.872,32

Programme contribution (90%): € 1.496.585,09

Project co-financing (10%): € 166.287,23

Duration: 24 months

Start Day: 31.01.2013 End Day: 31.12.2015

Website: fruitflynet.aua.gr e-mail: fruitflynet@aua.gr

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION

ENPI CBCMED

FruitFlyNet: Project Partnership

1. **Beneficiary:**
   AUA: Agricultural University of Athens, Department of Agricultural Economy and Development, Informatics Laboratory, (Hellenic Republic: Attiki), EU.
2. **Partnership:**
   - PP1/ARO: Agricultural Research Organization (Israel: Arava, Negev), non-EU.
   - PP2/NCARE: National Center of Agricultural Research and Extension (Jordan: Al-Balqa), non-EU.
   - PP3/CRA-FRU: Agricultural Research Council, Fruit Tree Research Centre (Italy: Lazio), EU.
   - UIB: University of the Balearic Islands, Department of Biology (Spain: Baleares), EU.
   - UTH: University of Thessaly, Department of Entomology and Agricultural Zoology (Hellenic Republic: Thessaly), EU.

Contact person:
Mr. Theodore Tsiligiridis
Professor on Networking and ICT in Agriculture
Informatics Laboratory,
Agricultural University of Athens
e-mail: tsili[at]aua[dot]gr
tel: +30 (210) 529.4176, fax: +30 (210) 529.4176
skype: tsiligiridis.theodore

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION

ENPI CBCMED

Outline

1. *Introduction*
2. WMSN platforms: State-of-the-Art.
3. *FruitFlyNet* Architecture
4. Pilot scenarios - Test site
5. Conclusions

Project funded by the EUROPEAN UNION
ENPI CBCMED

Introduction: Goals

General Objective: To contribute to the development and implementation of environmentally effective e-monitoring and ground spraying control solutions based on prototypes, technological innovations, and knowledge transfer for specific key-pests in the Mediterranean, in order to increase the quality and quantity of available fruit to local consumers at lower prices.

Indicators:

1. One prototype developed per case to increase efficacy of sprays per pilot area by the end of the project.
2. Knowledge transfer to the final beneficiaries /target groups of good practices (reduce sprayings, better applications, etc.) developed by the outputs of the project activities.

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION
ENPI CBCMED

Introduction: Goals

- **Goal 1:** Create a control system that will harmonize management strategies for specific key-pests (Olive, Med, Cherry & some invasive species).
- **Goal 2:** Contribute to the development and implementation of environmentally effective e-monitoring & ground spraying control solutions, so as to increase the quality & quantity of available fruit to local consumers at lower prices.
- **Innovation:** Development, implementation, test and demonstration of an innovative, integrated, Location Aware System (LAS) for fruit fly e-monitoring and ground spraying control based on a Real –time Trapping & Insect Counting (ReTIC) system that can rationalize the use of insecticides.
- **Geospatial data delivery:** Implementation of 4 operational pilots in 5 Med countries to demonstrate the advantages of LAS compared with conventional methods.

Project funded by the EUROPEAN UNION
ENPI CBCMED

Introduction: Objectives

Specific Objective: To develop, implement, test, and demonstrate an innovative, integrated, Location Aware System (LAS) for fruit fly ground spraying control, by means of four (4) pilot prototypes in five (5) Med-countries aimed at developing prototypes, technological innovations and knowledge transfer.

Pilot Prototype	Pest	Country Eligible area
OliveFlyNet	*Bactrocera oleae*	Spain (Islas - Baleares)
		Jordan (Al-Balqa)
CherryFlyNet	*Rhagoletis cerasi*	Greece (Thessaly)
MedFlyNet	*C. capitata*	Italy (Lazio)
InvasiveFlyNet	*Bactrocera zonata* *Dacus ciliatus*	Israel (Arava)
Test site	*Bactrocera oleae*	Greece (Attiki)

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION
ENPI CBCMED

Introduction: Target groups

- Target Groups
  - Farmers, growers, landowners.
  - SMEs, Cooperative Unions.
  - Citizens.
  - Local communities living near spraying areas.
  - Phytosanitary inspectors.
  - Spraying operators.
- Final Beneficiaries
  - Pest-control operational industry.
  - National and/or International organizations dealing with the supervision of Tephritid control and their geographic expansion.
  - Agricultural, Environmental Protection, UN Food, UN FAO, IAEA Institutes and/or Organizations.

Project funded by the EUROPEAN UNION
ENPI CBCMED

Introduction: Outputs

Compared to common spray tactics against olive, cherry, med, and some invasive fruit flies population the project is expected to achieve:

1. An increase by 5% (?) of the efficacy of the sprays from ground.
2. A reduction by 5% (?) of the mean spray.
3. A reduction by 15% (?) of the mean spray duration of the spray applications.
4. A reduction by 20% (?) of the spraying volume.
5. A reduction by 30% (?) in the number of insecticide applications.

- Making sprayings more easier and effective
- Achieving fewer, locally applied and more effective sprayings.
- Creating a less polluted and healthier Med-basin Environment

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION
ENPI CBCMED

Outline

1. Introduction
2. *WMSN platforms: State-of-the-Art*
3. *FruitFlyNet* Architecture
4. Pilot scenarios - Test site
5. Conclusions

Project funded by the EUROPEAN UNION
ENPI CBCMED

WMSN platforms: State-of-the-Art
WMSN components

- Type of sensor nodes in WMSN:
  - ✓ **Scalar Sensors (SS):** These nodes sense scalar data and physical attributes like temperature, pressure, relative humidity and report the measured values. They are typically resource-constrained devices in terms of energy supply, storage capacity, and processing capability.
  - ✓ **Video and Audio Sensors (VAS):** These types of sensors capture sound and still or moving images of the sensed events. They can be arranged in a single-tier topology, or in a hierarchical manner.
  - ✓ **Multimedia Processing Hub (MPH):** These devices have comparatively large computational resources and are suitable for aggregating multimedia streams from individual sensor nodes. They are integral in reducing both the dimensionality and the volume of data conveyed to the sink and storage devices.
  - ✓ **Storage Hub (SH):** Depending on the application, the multimedia stream may be desired in real-time or after further processing. SHs allow data-mining and feature extraction algorithms to identify the important characteristics of the event, even before the data is sent to the end user.
  - ✓ **Sink Node (SN):** This node is responsible for packaging high-level user queries to network-specific directives and return filtered portions of the multimedia stream back to the user. Multiple sinks may be needed in large or heterogeneous networks.
  - ✓ **Gateway (GW):** This element serves as the last mile connectivity by bridging the sink to IP networks and is also the only IP-addressable component of the WMSN. It maintains a geographical estimate of the area covered under its sensing framework to allocate tasks to the appropriate sinks that forward sensed data through it.

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION
ENPI CBCMED

WMSN platforms: State-of-the-Art
WMSN components

- Wireless Multimedia Sensor Networks:
  - ✓ Networks of wirelessly interconnected devices
  - ✓ Sensor motes attached with a multimedia device
  - ✓ Allow retrieving video and audio streams, still images, and scalar sensor data.
- It is possible to ubiquitously capture multimedia content from the environment.
- Provides multiple point of view perception
- Current trends
  - ✓ Development of inexpensive hardware
    - o CMOS/CCD cameras
    - o Microphones

Project funded by the EUROPEAN UNION
ENPI CBCMED

WMSN platforms: State-of-the-Art
Design Issues

- Factors Influencing the Design of WMSNs
  - ✓ Power consumption
  - ✓ Flexible architecture to support heterogeneous applications
  - ✓ Multimedia coverage
  - ✓ Integration with Internet (IP) architecture
  - ✓ Integration with other wireless technologies

Jelgava Latvia, Sept. 15-17, 2014

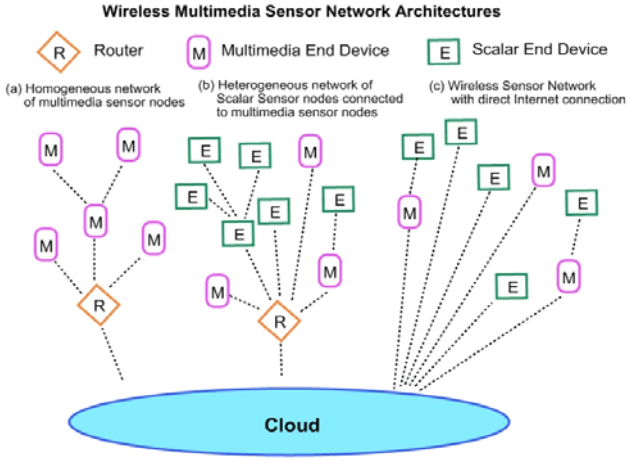
Project funded by the EUROPEAN UNION
ENPI CBCMED

WMSN platforms: State-of-the-Art Architectural Schemes

- Single-tier network architecture
  - ✓Flat homogenous
  - ✓Clustered heterogeneous
- Multi-tiered network architecture
  - ✓Clustered heterogeneous

Project funded by the EUROPEAN UNION
ENPI CBCMED

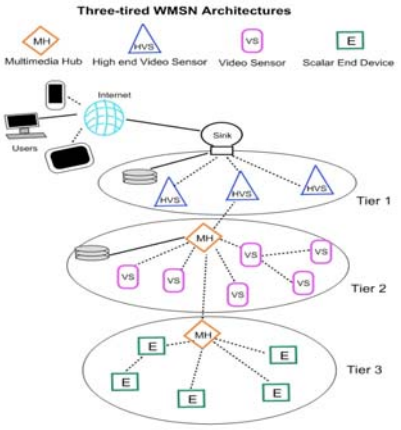
WMSN platforms: State-of-the-Art Single-tier Architectural Schemes



Project funded by the EUROPEAN UNION
ENPI CBCMED

WMSN platforms: State-of-the-Art
Multi-tier Architectural Schemes

- Heterogeneous sensors
  - ✓ Each tier is in charge of a subset of the functionalities.
  - ✓ Low-power scalar sensors are in charge of performing simpler tasks
  - ✓ High-power devices are responsible for more complex tasks.
  - ✓ Data processing and storage can be performed in a distributed fashion at each different tier.



Project funded by the EUROPEAN UNION
ENPI CBCMED

WMSN platforms: State-of-the-Art
Comparison of WSN platforms

Mote	Microcontroller	Data memory	Storage memory	Radio	Data rate
Mica2	ATmega128L (8-bit) 7.37 MHz	4 KB	512 KB	CC1000	38.4 Kbps
Mica2Dot	ATmega128L (8-bit) 4 MHz	4 KB	512 KB	CC1000	38.4 Kbps
MicaZ	ATmega128L (8-bit) 7.37 MHz	4 KB	128 KB	CC2420	250 Kbps
TelosB	MSP430F1611 (16-bit) 8MHz	10KB	48MB	CC2420	250 Kbps
Tmote Sky	MSP430F (16-bit) 8MHz	10 KB	1024 KB	CC2420	250 Kbps
Imote 2	PXA271ARM7 Xsale (32-bit) 13-416 MHz	11 KB	---	Zeevo TC2001	723.2 Kbps
Stargate	Intel PXA-255 XScale (32-bit) 400 MHz	64 MB	32 MB	IEEE 802.11b CC2420	1–11 Mbps 250 Kbps
XYZ	OKI ML67 Q5002 (32-bit)	32 KB + 2 MB	256 KB	CC2420	250 Kbps

Jelgava Latvia, Sept. 15-17, 2014

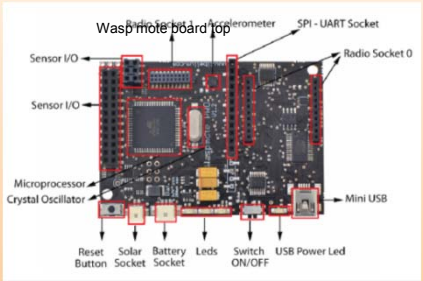
Project funded by the EUROPEAN UNION
ENPI CBCMED

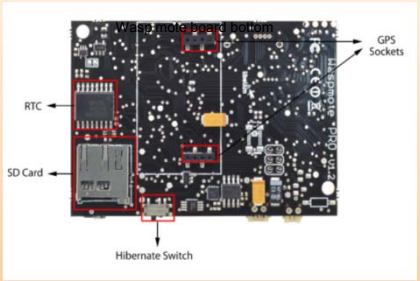
WMSN platforms: State-of-the-Art
Comparison of WMSN platforms

Platform	Processor	Memory RAM	Memory Flash	Camera & Resolution	Radio	Power Consum
Imote2 +Cam	PXA271 XScale proc 32-bit (Imote2)	256 KB (Imote2)	32 MB (Imote2)	IBM400 camera OmniVision OV7649 640x480 30fps	Integrated with CC2420 IEEE 802.15.4	322mW -1.8 mW
eCam	OV 528 serial bridge controller JPEG compression only	4 KB (Eco)	---	CoMedia C328-7640 (includes OV7640) 640x480 30fps	Interfaced with Eco Wireless mote nRF24E1 radio RF 2.4 GHz 1 Mbps	70 mA at 3.3V
MeshEye	ARM7TDMI based on ATMEL AT91SAM7S 32 bit 55MHz	64 KB	256 KB	Agient ADNS-3060 30x30 Agient ADCM-2700 640x480 10fps	Integrated with CC2420 IEEE 802.15.4	175.9 mV-1.78mW
Panotopes	PXA255 XScale CPU 32 bit 400MHz (Stargate)	64 KB (Stargate)	32 KB (Stargate)	Logitech 3000 USB 160x120 30fps 640x480 13fps	PCMCIA IEEE 802.11 wireless card	5.3 – 58mW
WiCa	Xetal II SIMD + 8051 ATMEL MCU 84 MHz	1.79 MB+ 128 KB DRAM	64 KB	VGA color camera 640x480 30 fps	Aquis Grain ZigBee IEEE 802.15.4	600 mW max
CITRIC	PXA270 XScale CPU 32 bit Intel 624 MHz	64 MB	16 NB	OmniVision OV9655 1280x1024 15fps 640x480 30fps	Interfaced with Tmote Sky mote IEEE 802.15.4	1 W max
Fox+Cam	LX416 Fox Board 100MHz	16 MB	4 MB	Labtec Webcam bro QuickCam Zoom 640x480	USB BT IEEE 802.15.4 100 m	1.5W at 5V

Project funded by the EUROPEAN UNION
ENPI CBCMED

WMSN platforms: State-of-the-Art
Sensors: Wasp mote





General data:
Microcontroller: ATmega1281
Frequency: 14.7456 MHz
SRAM: 8KB
EEPROM: 4KB
FLASH: 128KB
SD Card: 2GB
Weight: 20gr
Dimensions: 73.5 x 51 x 13 mm
Temperature Range: [-10ºC, +65ºC]
Clock: RTC (32KHz)

Inputs/Outputs:
7 Analog (I), 8 Digital (I/O), 1 PWM,
2 UART, 1 I2C, 1USB, 1SPI
Electrical data:
Battery voltage: 3.3 V - 4.2V
USB charging: 5 V - 100mA
Solar panel charging: 6 - 12 V - 280mA

Built-in sensors on the board:
Temperature (+/-): -40ºC , +85ºC. Accuracy: 0.25ºC
Accelerometer: ±2g (1024 LSb/g) / ±6g (340LSb/g)
40Hz/160Hz/640Hz/2560Hz

Consumption:
ON: 15mA
Sleep: 55µA
Deep Sleep: 55µA
Hibernate: 0.07µA
Operation without recharging: 1 year *

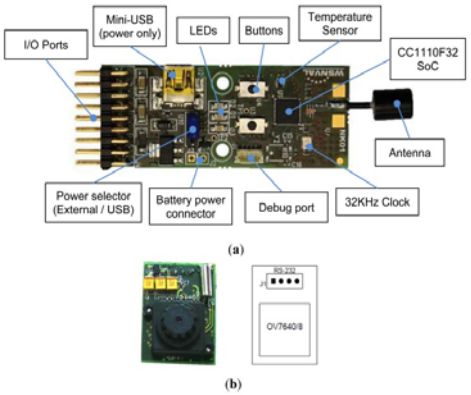
** Time obtained using the Hibernate mode as the energy saving mode*

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION
ENPI CBCMED

WMSN platforms: State-of-the-Art
Image sensor design

(a) Wireless sensor board based on CC1110F32 SoC and
(b) Camera module connected to sensor board through USART I/O ports.

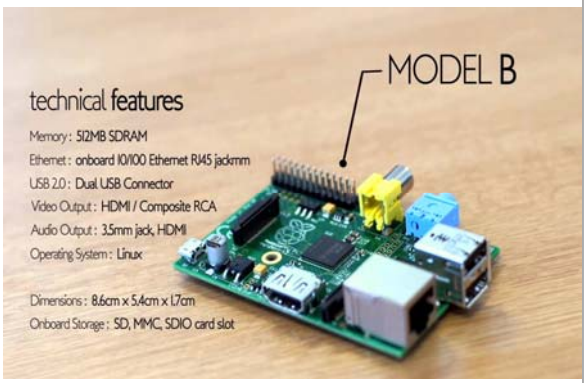


CC1110F32 SoC that includes:
- a 8051 enhanced microcontroller unit (MCU)
- the CC1101 radio transceiver module
- a set of peripherals:
  - 128-bit Advanced Encryption Standard (AES) security co-processor,
  - one USB 2.0 interface,
  - two USARTs (working also in SPI mode),
  - one I2S interface,
  - three 8 bit timers,
  - one 16 bit timer,
  - 7–12 bits ADC,
  - 21 GPIO pins.

Project funded by the EUROPEAN UNION
ENPI CBCMED

WMSN platforms: State-of-the-Art
Image sensor Design

- Single board pc – Raspberry Pi, Model B
- Digital Temperature and Humidity Sensor
- Raspberry Pi Infrared Camera Board.
- Mini USB WiFi 802.11b/g/n dongle
- XBee board + module
- 3G Modem
- Data SIM



Project funded by the EUROPEAN UNION
ENPI CBCMED

Outline

1. Introduction
2. WMSN platforms State-of-the-Art.
3. *FruitFlyNet* Architecture
4. Pilot scenarios - Test site
5. Conclusions

Project funded by the EUROPEAN UNION
ENPI CBCMED

FruitFlyNet Architecture Hardware Specifications

- The Task
  - ✓ will go in line with the four (4) basic scenarios definition and the corresponding analysis of requirements.
  - ✓ will provide the overall WMSN architecture and a reference device description.
  - ✓ will investigate several alternatives in the type of measuring variables.
  - ✓ will develop a feasible way of collecting useful data measurements.
- Sensing devices may contain
  - ✓ T, RH, Wind speed, Precipitation and Fluid level sensors.
  - ✓ Meteorological station
- Power
  - ✓ Solar Panels
  - ✓ Communication Devices
  - ✓ Low-power digital photography equipment.
    - o Image and/or video sensors (if possible) will be included in order to gather the multimedia information required.

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION
ENPI CBCMED

FruitFlyNet Architecture
Sensor node requirements

- The FruitFly sensor node should be capable to finish some on-line data processing.
  - ✓ format conversion,
  - ✓ data calculation and
  - ✓ value calibration
- The FruitFly sensor node should be capable of compressing the insect's image on-site.
  - ✓ The raw image needs to be compressed so as to be transmitted to the gateway node.
- The FruitFly sensor node should have an energy-efficient packet-processing unit.
  - ✓ In each measurement period, the large numbers of sensors generate bulky data. All data should be packetized, encapsulated and modulated to physical layer frame. Therefore the packet-processing unit is very important to overall performance.

Project funded by the EUROPEAN UNION
ENPI CBCMED

FruitFlyNet Architecture
Stand-along Trap Examples

***Market* Solutions** ***Experimental* solutions**

Modified Delta Trap

RPW trap

E-fly wach trap (McPhail type)

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION
ENPI CBCMED

Outline

1. Introduction
2. WMSN platforms State-of-the-Art.
3. FruitFlyNet Architecture
4. Pilot scenarios - Test site
5. Conclusions

Project funded by the EUROPEAN UNION
ENPI CBCMED

FruitFlyNet pilot scenarios - test site

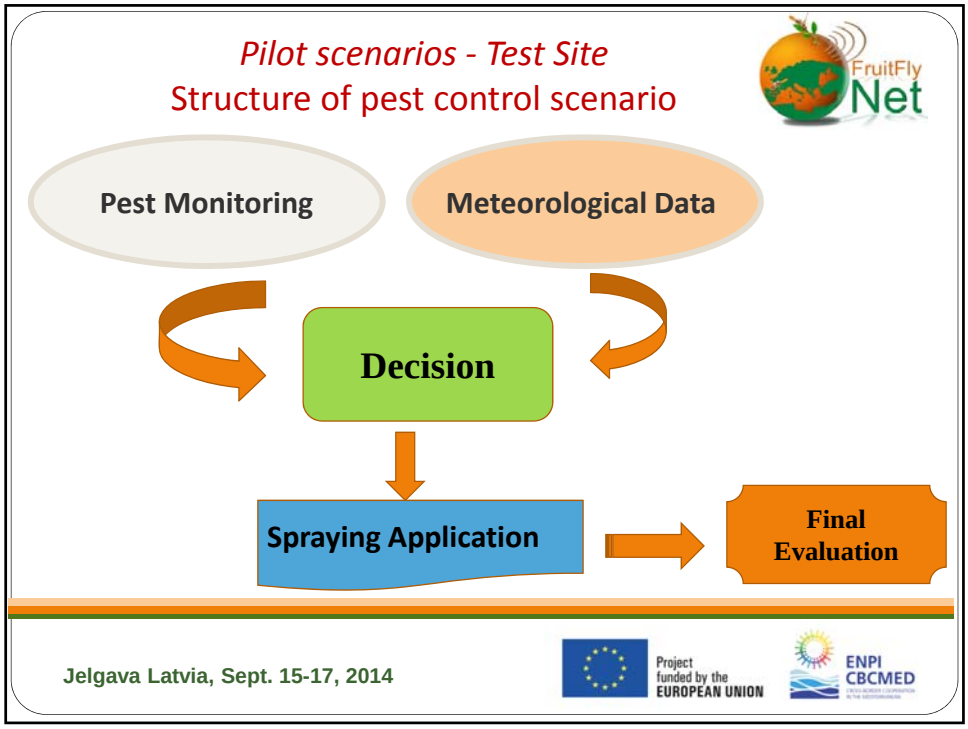
AIM: Compare the conventional and the proposed Location Aware System (LAS) method.

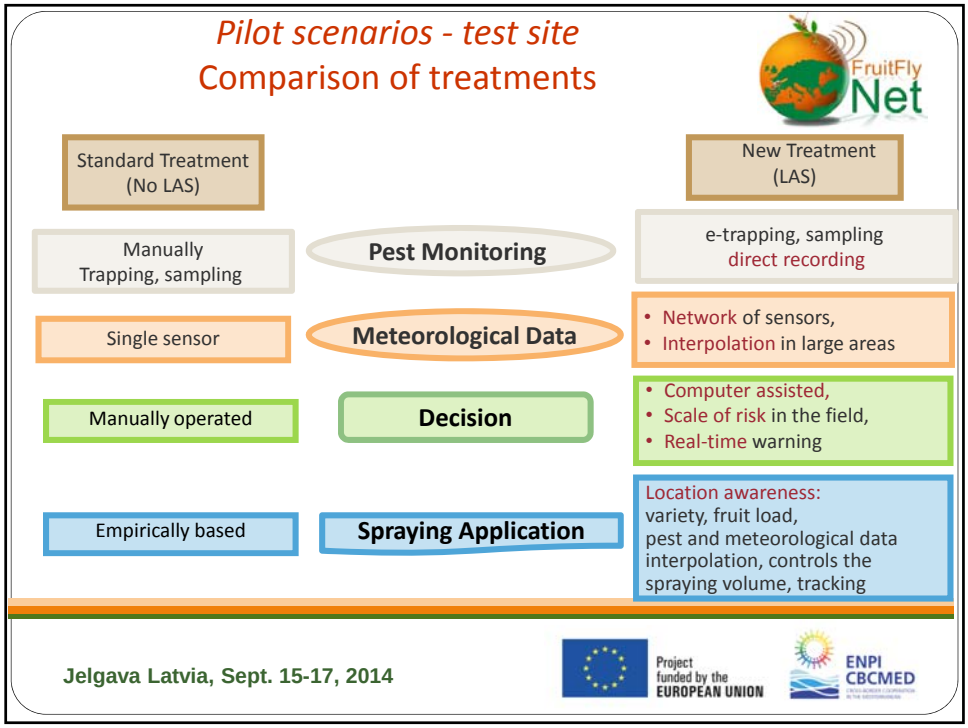
APPROACH: Follow scientifically sound procedures for each scenario.

IMPLEMENTATION: Apply randomized complete blocks (LAS, Standard, Control).

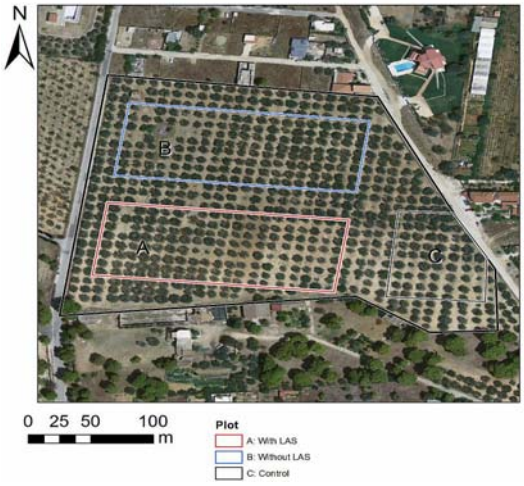
EVALUATE: Spraying - Indicators (spraying volume, number of spray applications etc).

Project funded by the EUROPEAN UNION
ENPI CBCMED


Pilot scenarios - Test Site
Structure of pest control scenario
FruitFly Net
Pest Monitoring
Meteorological Data
Decision
Spraying Application
Final Evaluation
Jelgava Latvia, Sept. 15-17, 2014
Project funded by the EUROPEAN UNION
ENPI CBCMED


Pilot scenarios - test site
Comparison of treatments
FruitFly Net
Standard Treatment (No LAS)
New Treatment (LAS)
Manually Trapping, sampling
Pest Monitoring
e-trapping, sampling direct recording
Single sensor
Meteorological Data
• Network of sensors,
• Interpolation in large areas
Manually operated
Decision
• Computer assisted,
• Scale of risk in the field,
• Real-time warning
Empirically based
Spraying Application
Location awareness: variety, fruit load, pest and meteorological data interpolation, controls the spraying volume, tracking
Jelgava Latvia, Sept. 15-17, 2014
Project funded by the EUROPEAN UNION
ENPI CBCMED

FruitFlyNet test site
Comparison of treatments: Design



Points to consider:

- ✓ AUA test (not pilot) site
- ✓ Same plot size/shape
- ✓ Equal trees number
- ✓ Buffer zone
- ✓ Plot orientation

Project funded by the EUROPEAN UNION
ENPI CBCMED

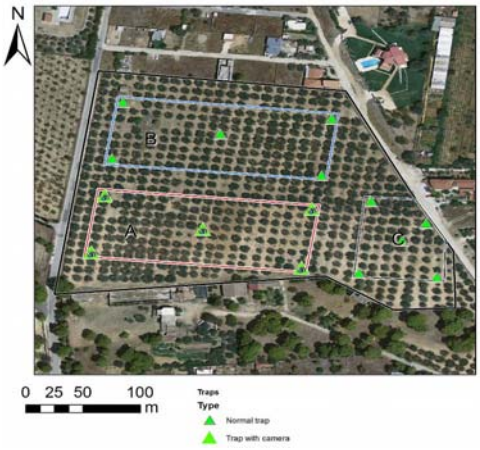
FruitFlyNet test site
Comparison of treatments: Orchard details

Points to consider:

- ✓ Single Variety (Manaki)
- ✓ Uniformity cultured:
  - o age,
  - o height,
  - o fertilization,
  - o irrigation, etc.

Project funded by the EUROPEAN UNION
ENPI CBCMED

FruitFlyNet test site
Comparison of treatments: Pest Monitoring



Points to consider:

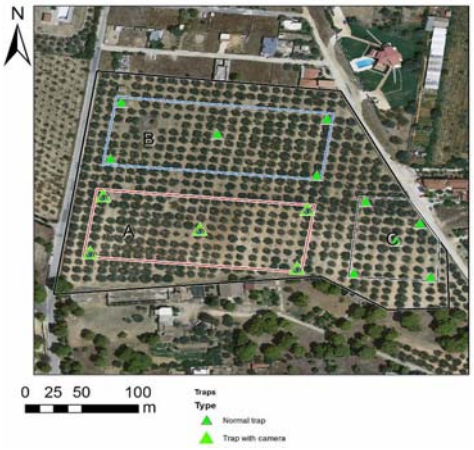
- ✓ Interpolation requirements
- ✓ Same trap number
- ✓ In LAS plot:
  - o McPhail with direct recording
  - o Validate ReTIC

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION

ENPI CBCMED

FruitFlyNet test site
Comparison of treatments: Meteo-data Monitoring



Points to consider:

- ✓ Data for decision to spray
- ✓ Data for decision of how to spray
- ✓ Interpolation requirements
- ✓ Sensors
  - o T: Temperature,
  - o RH: Relative humidity,
  - o W:Wind speed,
  - o P: Precipitation,
  - o F:Fluid level

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION

ENPI CBCMED

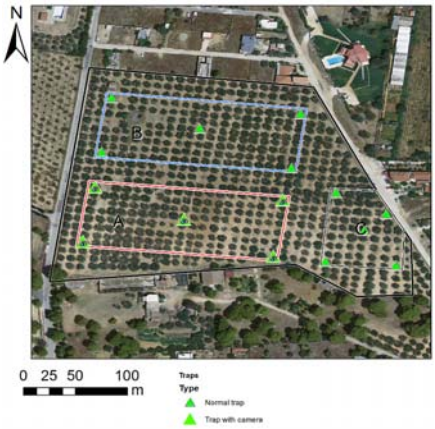
FruitFlyNet test site
Comparison of treatments: Equipment

Device	Number	WMSN Integrated	Height where device is deployed
Temperature Sensor	5	YES	1.5 – 2m
RH Sensor	1	YES	1.5 – 2m
Wind Speed Sensor	1	YES	1.5 – 2m
Precipitation Sensor	1	YES	1.5 – 2m
Fluid Level Sensor	1	YES	1.5 – 2m
Meteorological Station	0	NO	
Solar Panels	5	YES	
.....	0		

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION
ENPI CBCMED

FruitFlyNet test site
Comparison of treatments: Traps/Cameras



Points to consider:

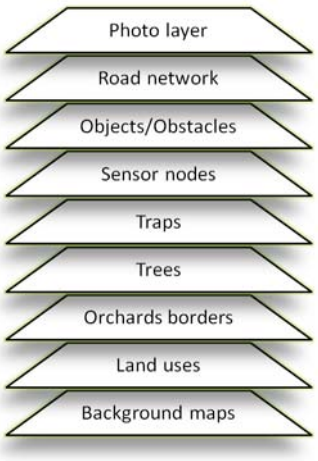
- ✓ 15 Traps, 5 of which will be with camera.
- ✓ Cameras may be standalone, not integrated with WSN.
- ✓ It may be required two (2) cameras for each trap.
- ✓ Other types of traps can be used that will be automated, meaning that they will not need to send images of the trap, but count readings of fruit flies.
- ✓ Column sensors may be used to mount on the cameras or the e-traps.
- ✓ The whole area is covered by 3G network.

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION
ENPI CBCMED

FruitFlyNet test site

Comparison of treatments: Digitization



Points to consider:

- ✓ Items to be digitized
- ✓ Traps unit load
- ✓ Sensors
- ✓ Variety distribution
- ✓ Fruit loan
- ✓ Tree location - to the level required
- ✓ Obstacles

Project funded by the EUROPEAN UNION
ENPI CBCMED

FruitFlyNet test site

Comparison of treatments: Spraying decision

1.	Capture threshold	*A critical number is 2-5 flies per trap in 5 days for the first spraying in July, later it can be more than 5*
2.	Damage threshold on the fruits during the season	*For the first spraying it is the first recording of fertile punctures on the fruits, for the next sprayings is the alive infestation (eggs, larvae and pupae) 1-2 or 3-5% depending on the variety and generation.*
3.	Fruit color or other characteristic	*Hardening of fruit kernel important for first spraying in July*
4.	Critical climatic conditions	*Temperature (lower than 14ºC, 35ºC or higher)*
5.	Risk scale description and respective measures (i.e. ratio of trees to be sprayed for bait sprayings)	*This will be related to the captures, the damage level and the meteorological conditions.*

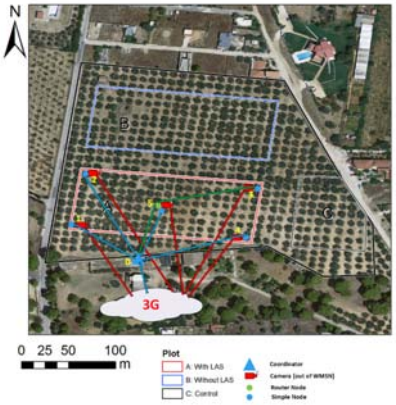
Points to consider:

- ✓ Trapping and sampling data
- ✓ Scale of risk in LAS

Project funded by the EUROPEAN UNION
ENPI CBCMED

FruitFlyNet test site
Comparison of treatments: WMSN

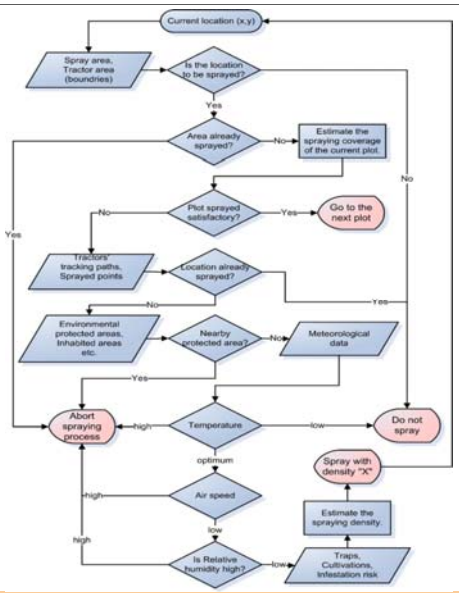
- Number of cameras to be used: 5.
- The coordinator is placed in point “0” (Power supply).
- Simple nodes (scalar sensors) are denoted with blue circles
- Routers are denoted with green circles. Router nodes have the ability to mount sensors on them.
- The topology is cluster tree.
- Node antennas range: 700m.
- Communication Protocol: 802.15.4 compliant
- In point 5 we have to take 5 measurements (excluding the camera), which are
- T: Temperature, RH: Relative humidity, W: Wind speed, P: Precipitation, F: Fluid level.
- It is possible that not all these sensors can be mounted on one node so to be safe we used two. One of these two will act also as a router for point 3, which is the furthest one from the Coordinator. The later maybe is not necessary, but is used as a precaution measure in case that the antenna is proved to have less range than specified.



Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION

ENPI CBCMED



FruitFlyNet test site
Comparison of treatments: Spraying Application

Points to consider:

- ✓ Type of spray: bait
- ✓ Weather conditions
- ✓ Adjust tractor tracking and areas to be sprayed according to: interpolation of pest incidence, variety, fruit load, obstacles.

Rome, 10-11 July, 2014

5-17, 2014

Project funded by the EUROPEAN UNION

ENPI CBCMED

Outline

1. Introduction
2. WMSN platforms State-of-the-Art.
3. *FruitFlyNet* Architecture
4. Pilot scenarios - Test site
5. Conclusions

Project funded by the EUROPEAN UNION
ENPI CBCMED

Conclusions

- Working towards to
  - ✓ develop a control system that will harmonize management strategies for specific key-pests (Olive, Med, Cherry & some invasive species).
  - ✓ Contribute and promote the development and implementation of environmentally effective e-monitoring & ground spraying control solutions.
  - ✓ Develop, implement, test and demonstrate an innovative, integrated, Location Aware System (LAS) for fruit fly e-monitoring and ground spraying control based on a Real –time Trapping & Insect Counting (ReTIC) system that can rationalize the use of insecticides.

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION
ENPI CBCMED

Conclusions

- Making sprayings more easier and effective
- Achieving fewer, locally applied and more effective sprayings.
- Creating a less polluted and healthier Med-basin Environment

Jelgava Latvia, Sept. 15-17, 2014

Project funded by the EUROPEAN UNION

ENPI CBCMED

Thank you!!!

County Month, Year

Project funded by the EUROPEAN UNION

ENPI CBCMED