SMART DROP

IoT based smart and efficient crop irrigation solution

Presentation of the preliminary baselines of the project

V20240108

EURO CLUSTERS

CircInWater
Supporting European SMEs to bring water-smart solutions to market

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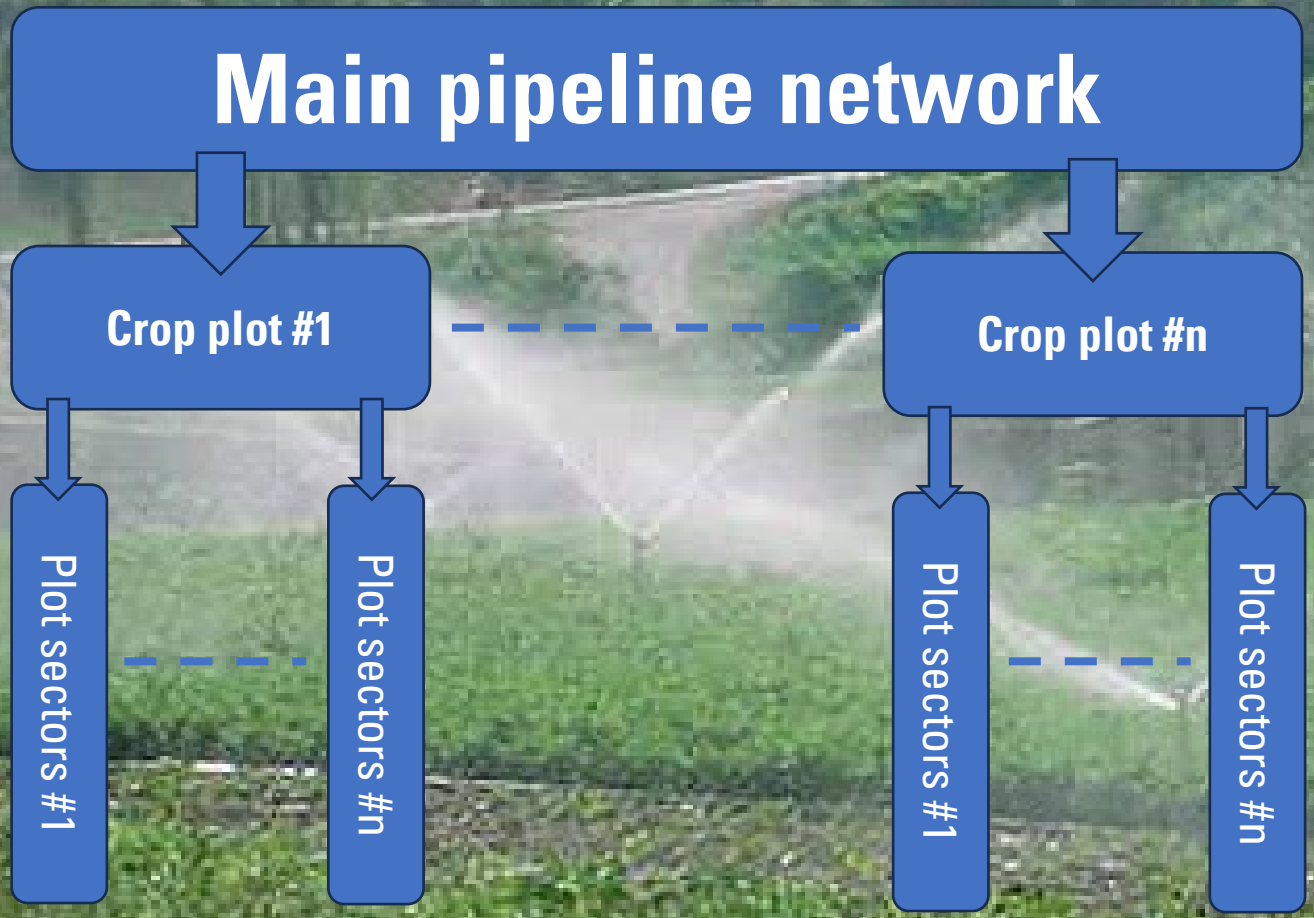
isurki Instrumentación·y·control

Version log of this document

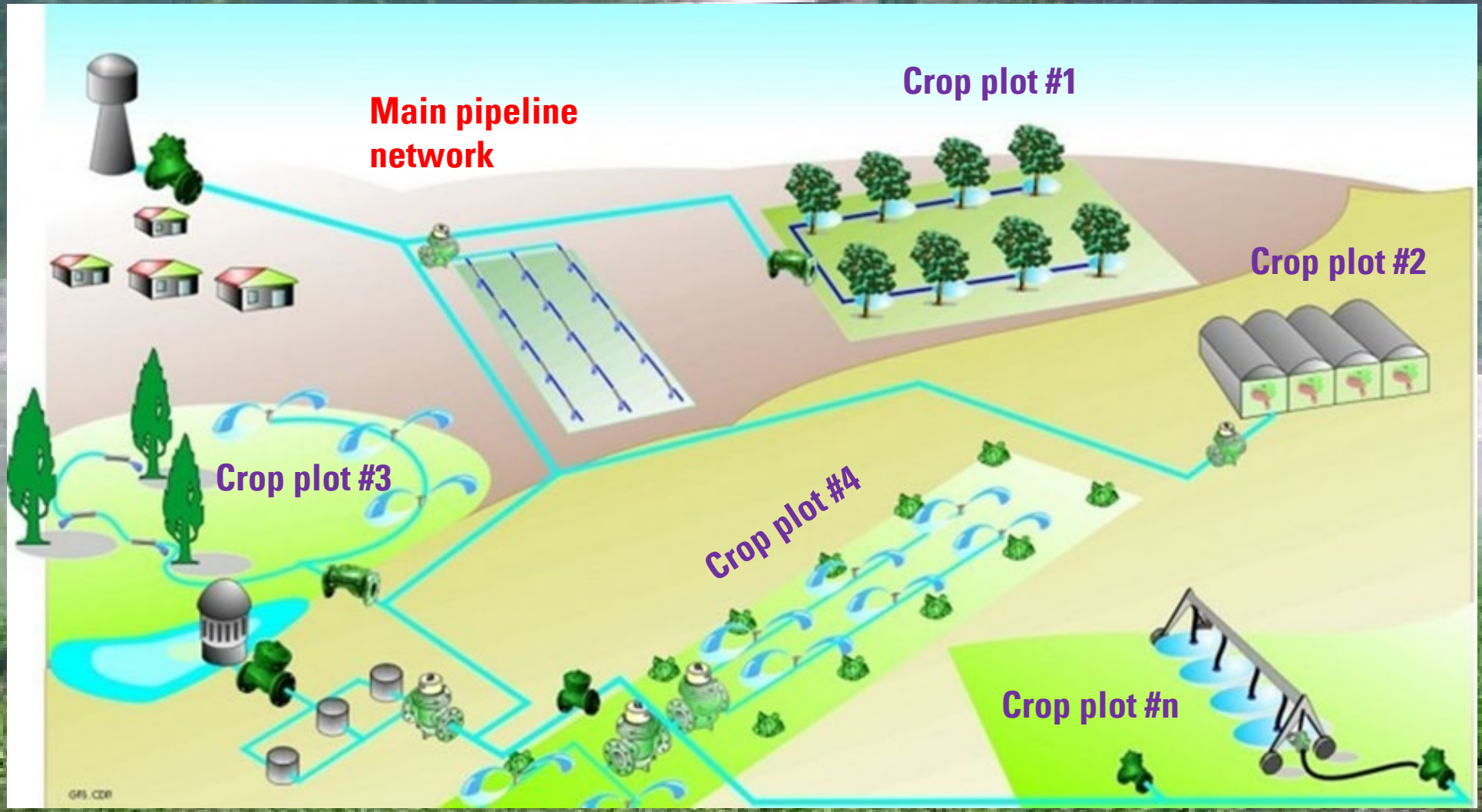
VERSION	AUTHOR	COMMENTS
20231210	IMV	First release
20231211	IMV	Adaptive Control section added at the end of the document
20231212	IMV	Soil moisture sensor is RS485 connected to the Isurlog data logger
20231227	IMV	On/off and proportional Flow/Pressure control valve operation added
20231228	IMV	Admin (Utility) level schematics added. Ecofertilizers tank level considered. Data logger trademark changed to SmartDrop. Introducing SmartDrop-SM (Soil Moisture LoRa data logger).
20231230	IMV	System management: Physical vs Management frameworks “Farmer” designation changed to “Landowner”
20240108	IMV	New design of the Configuration menu

Irrigation utility: Areas to be addressed



- Utility
- Landowner
- Farmer

Irrigation utility: Areas to be addressed



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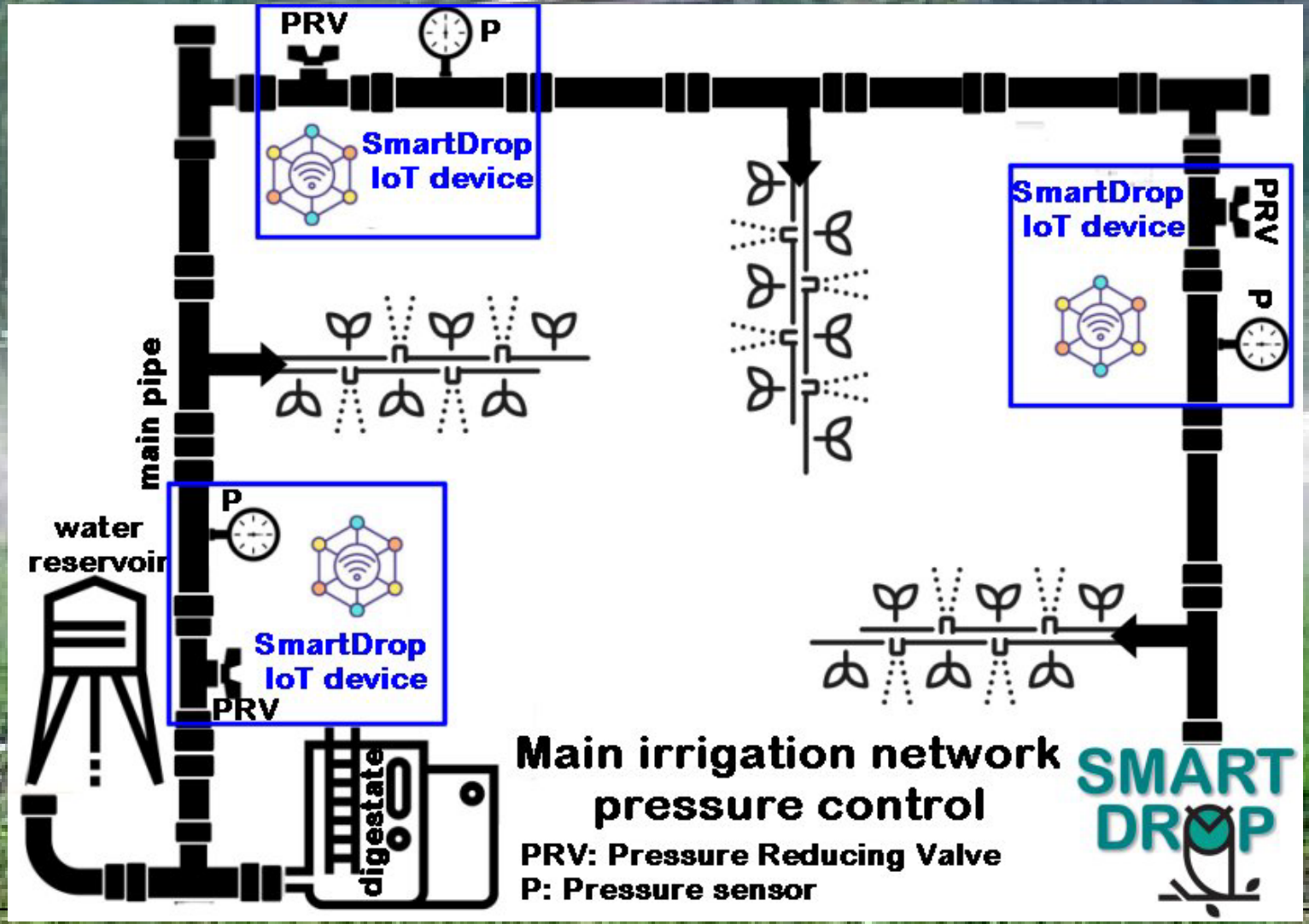
Field level: Main pipeline network pressure control



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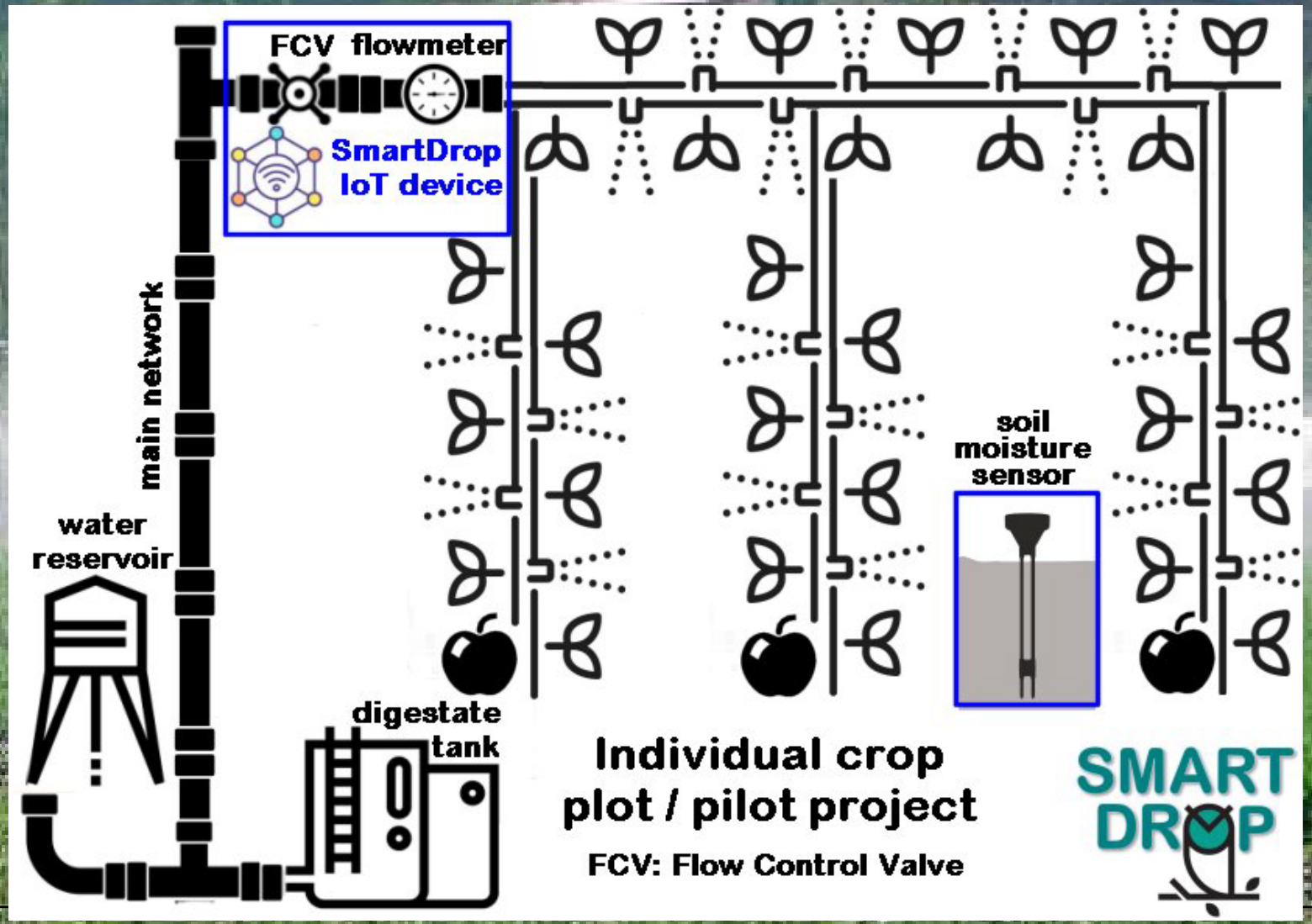
Field level: individual plots irrigation control



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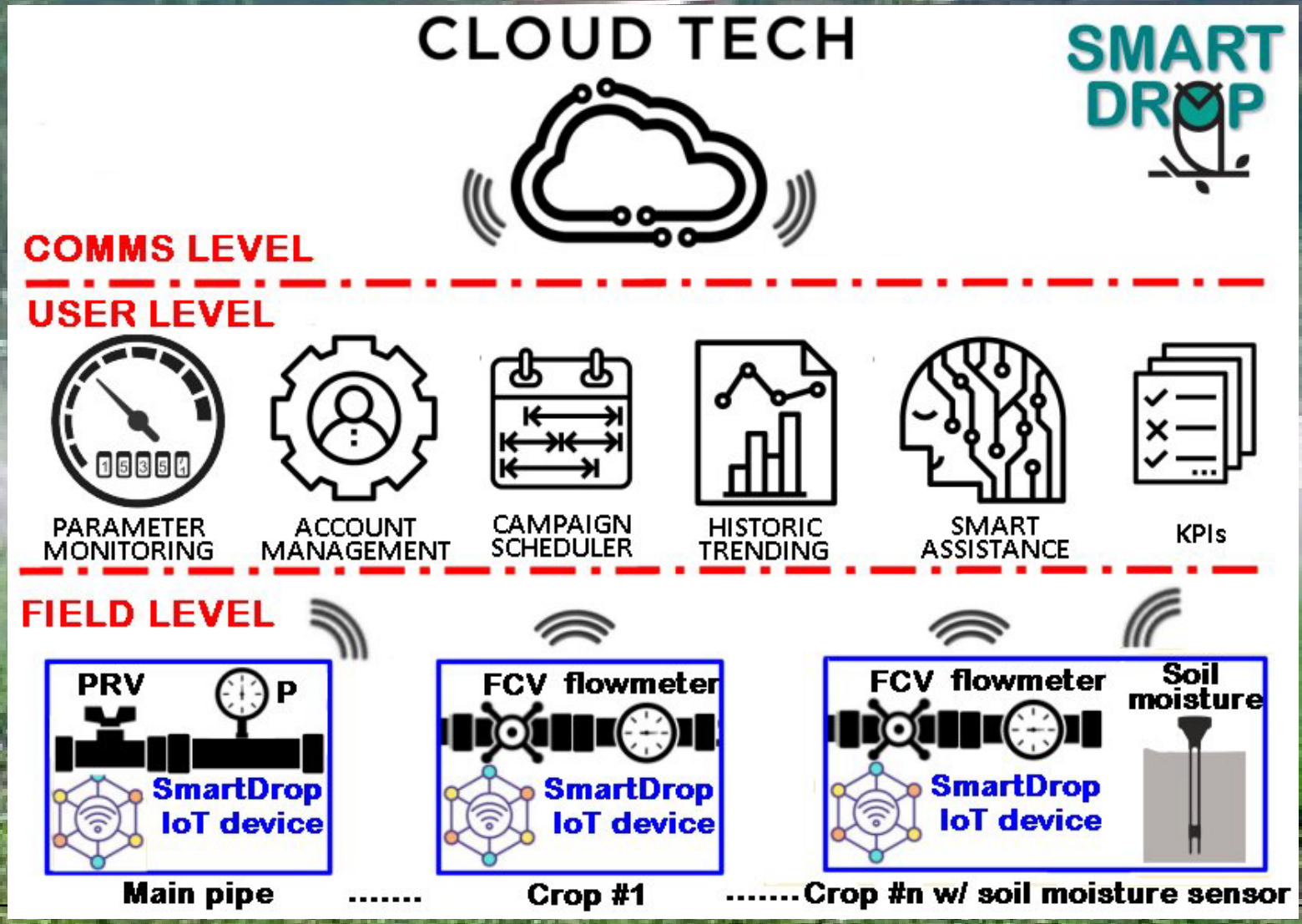
SMARTDROP General Schematics



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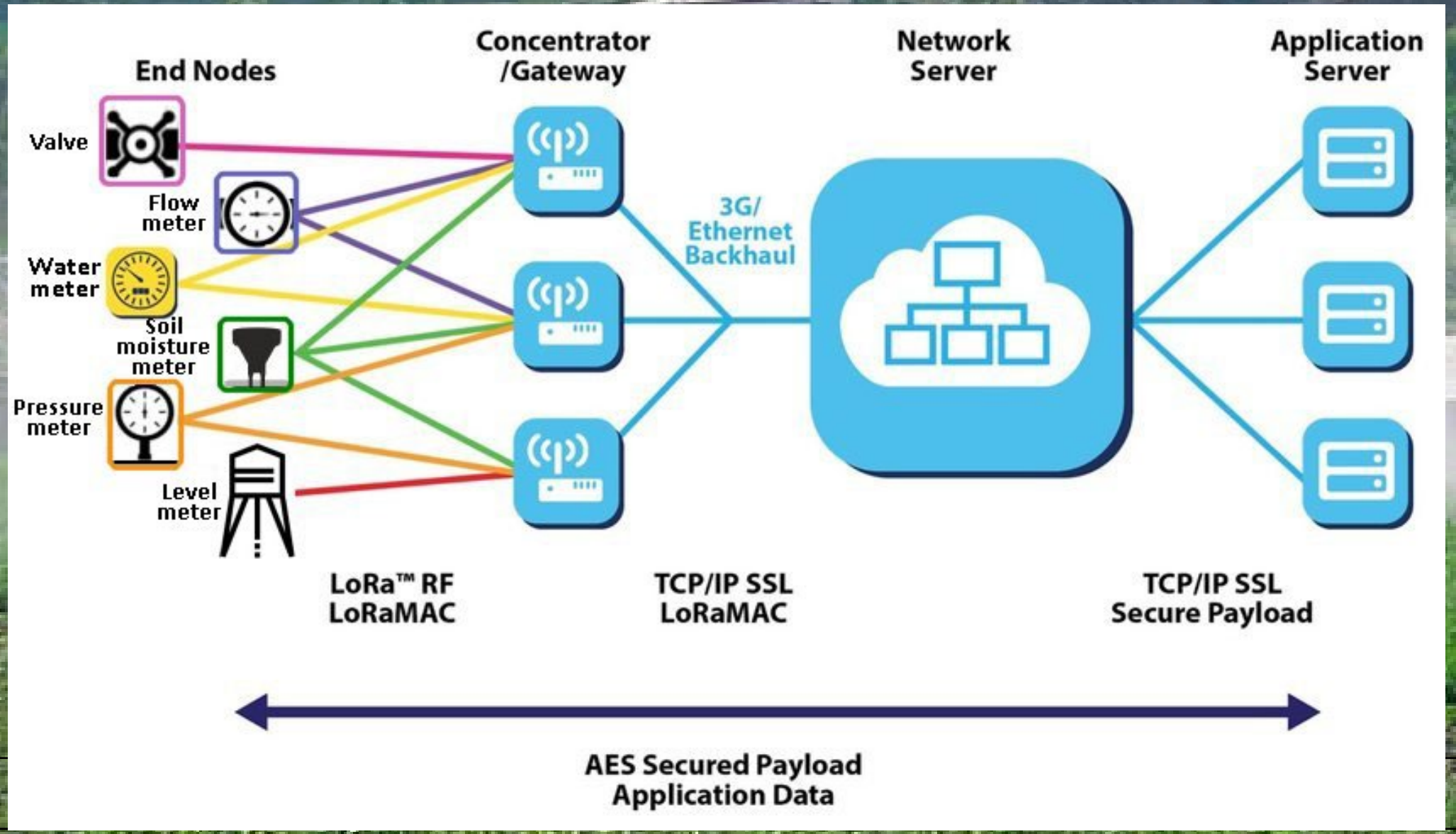
System Architecture



User level *Admin*: Advanced Management and Efficiency Improvement

Placing the farmer centre stage is the bedrock of the SmartDrop project.

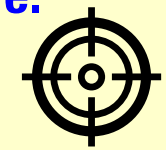
- Every single crop is unique and different from the rest.
- Nothing equals decades (when not centuries) of evidence-based human expertise.

but….

SmartDrop enriches the human factor providing
cutting-edge control and computing tools for decision-making assesment

in order to….

Make the irrigation more efficient and resilient against the effects of the climate change.
Save water and fertilizers.
Improve the gobernance and management of the utility to be more transparent.



User level *Admin*: Advanced Management and Efficiency Improvement

SMARTDROP is based on the DMAIC methodology

Define → **M**easure → **A**nalyze → **I**mprove → **C**ontrol

SMARTDROP facilitates the DMAIC implementation through its user-friendly menu

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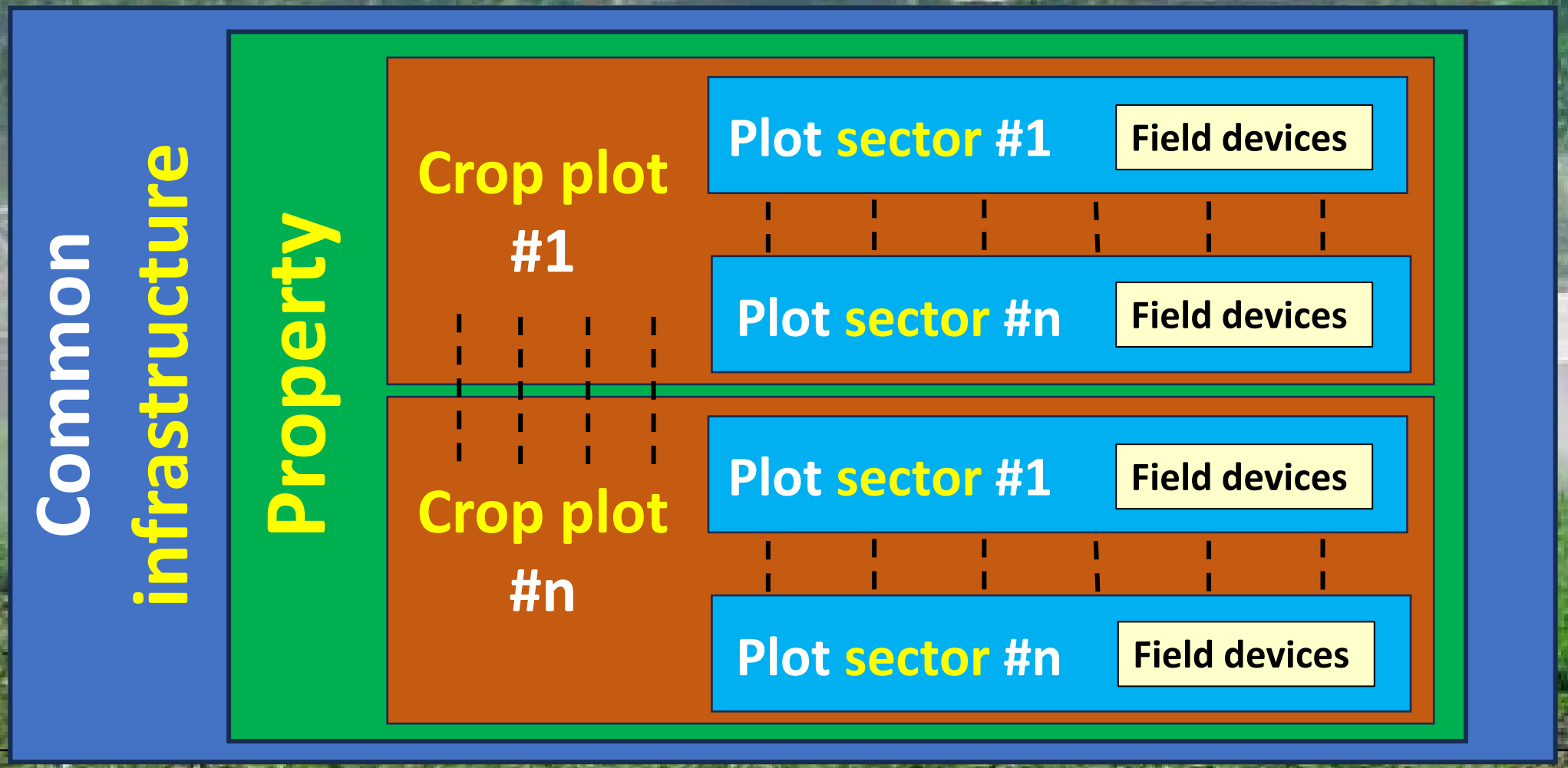
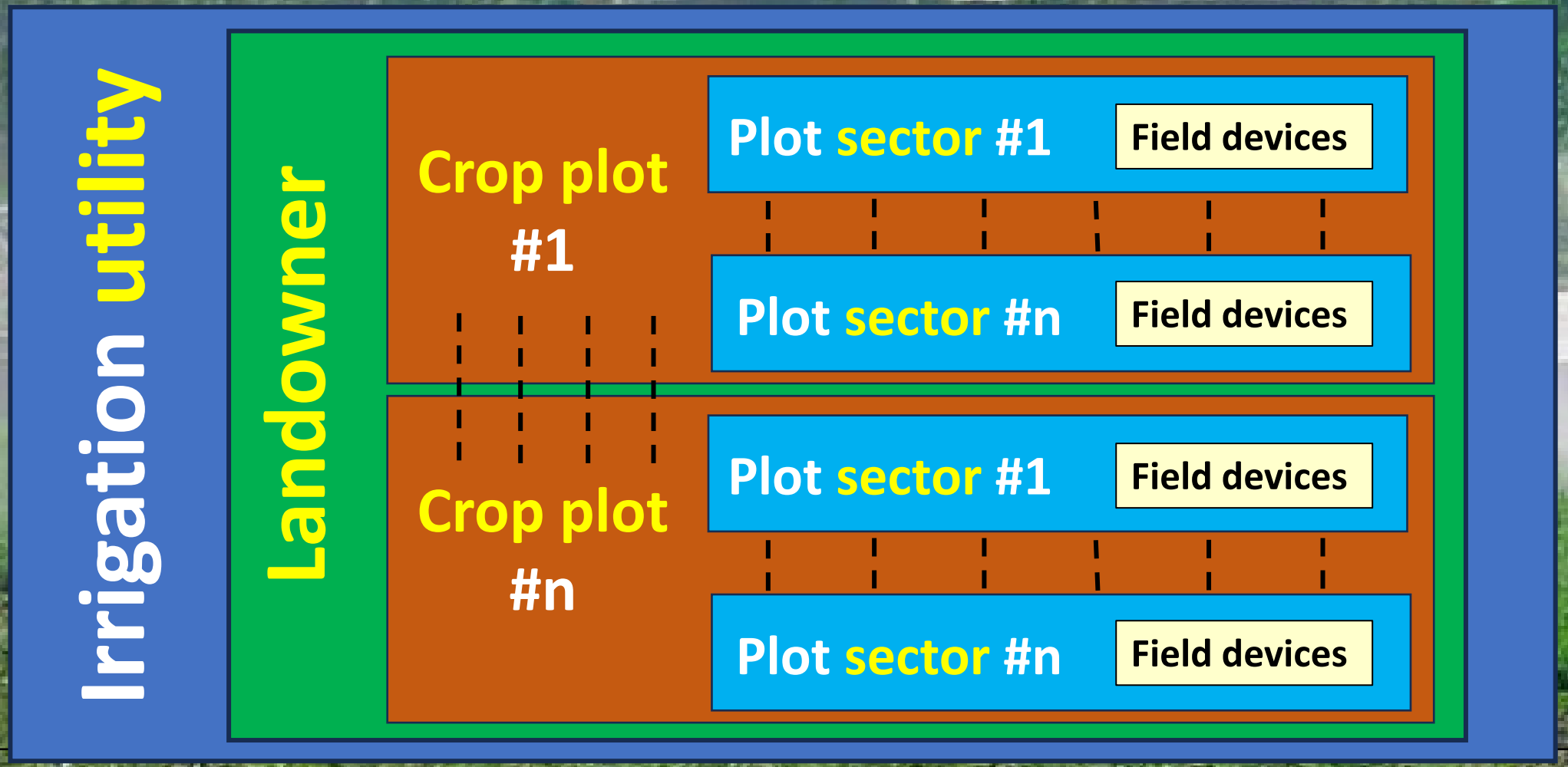
System management
Physical frameworks

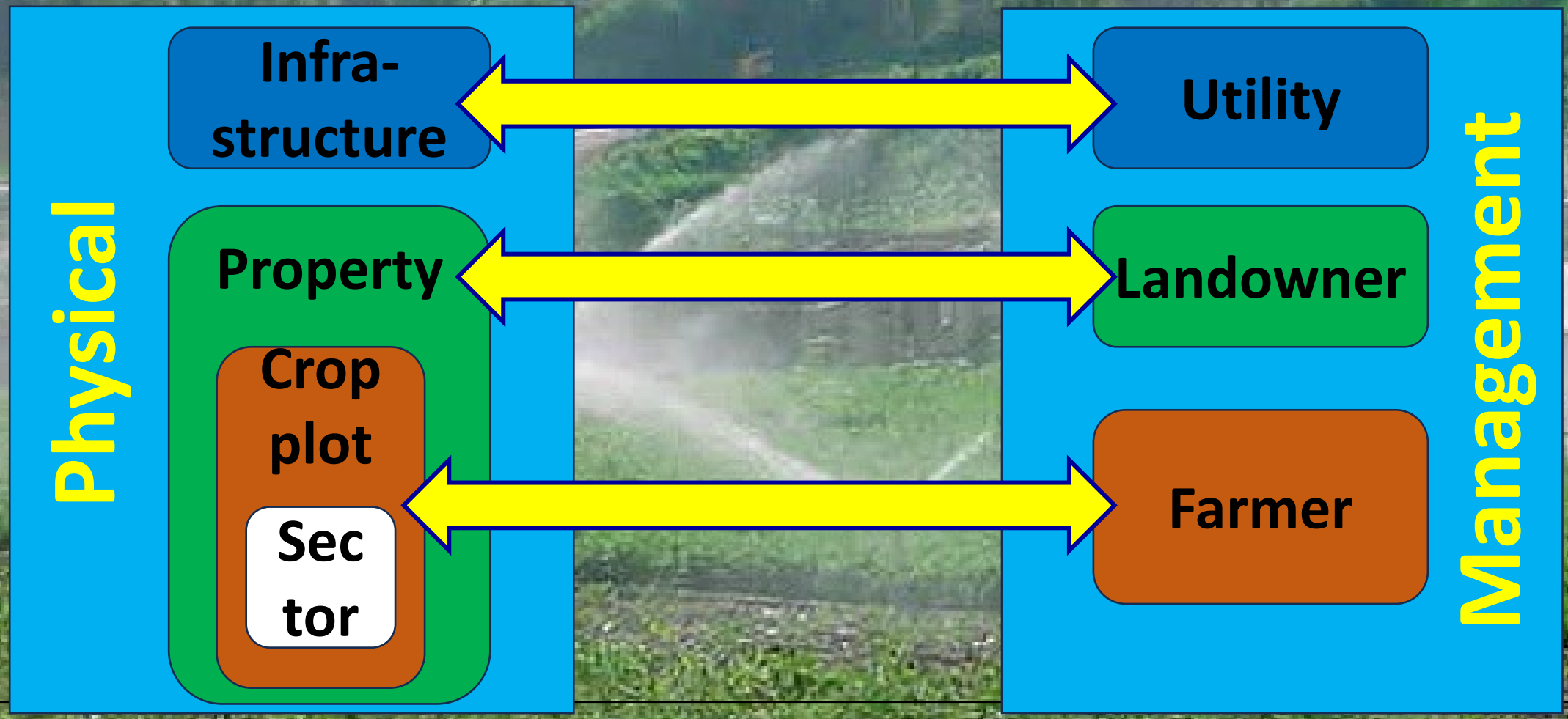


System management

Management frameworks



System management
Physical vs Management frameworks



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System management

Access levels

CONFIGURATION				
USER LEVEL	Infrastructure	Property	Crop	Sector
1 - Utility	☑	☝	☝	☝
2 - Landowner	☝	☑	☑	☑
3 - Farmer	☝	☝	☑	☑

MONITORING, RECORDING & CONTROL					
USER LEVEL	On-the-ground RT	RT weather	Weather Forecast	Historical Trending	Smart Assis. & Control
1 - Utility	☑	☑	☑	☑	☑
2 - Landowner	☑	☑	☑	☑	☑
3 - Farmer	☑	☑	☑	☑	☝

System control

Operating modes and submodes

mode	submode
Defines HOW the control is performed	Defines WHEN the control is performed
0x - Sleep	
1x – Data logging	x0 – At the user's discretion → The user defines, at its own discretion and responsability, both the starting and ending time of the operation mode
2x – P control	
3x – F control	x1 – Campaign → The user schedules a time-based-campaign, configuring both the starting and ending dates and other relevant parameters
4x – V control	

System control
Operating modes

		Required Valve type: On/off	Required Valve type: Proportional
0x - Sleep	• Minimum battery consumption scenario • Logging & Controls functionalities are OFF • Data logger beats every logging interval to confirm to the app its availability	✓	✓
1x – Data logging	• The data logger acquires, registers & uploads the measurements every logging interval	✓	✓
2x – P control	• Data logging mode 1 functionality is ON. • Pressure control functionality is ON. Rest of control modes are disabled	✗	✓
3x – F control	• Data logging mode 1 functionality is ON. • Flow control functionality is ON. Rest of control modes are disabled	✗	✓
4x – V control	• Data logging mode 1 functionality is ON. • Volume control functionality is ON. Rest of control modes are disabled	✓	✗

System control

Operating submodes

x0 - Manual

- The user activates the previously selected operating MODE by pushing the START button and confirming the order by its own.
- The app notifies the user whether the order has been successfully executed or not.

x1 – Campaign

- User can set up a timeframe-based irrigation campaign, configuring: time frame, irrigation hours, days of the week, campaign on/off, maximum regulation attempts, etc.

To quit any running P, F or V control mode (modes 2, 3 or 4 respectively), the user must return to modes 0 (sleep) or 1 (logging)

The APP must save and record for the next time all the user parameters configured for a particular control mode that has been successfully run.

System management
Operating modes

AVAILABLE OPERATING MODES DEPENDING ON THE ACCESS LEVEL						
Acces level	0 – Sleep	1 – Register only	2 – P control	3 – F control	4 – V control	5 - Campaign
Utility	☑	☑	☑	☑	☝	☝
Landowner	☑	☑	☑	☑	☑	☑

User level *Utility*: monitoring and control.
LoRa based ~~On-the-~~ground stuff

On-the-ground RT parameters

- Water volumen (m3)
- Water Pressure (gBar)
- Ecofertilizers tank level (m.w.c.)

Inputs

Data source

ISURDROP-CU
LoRa datalogger

Outputs

Pressure Control valve

Latency time

LoRa

5 to 1440 min

Comms layer

LoRa WAN gate way

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User level *Utility*: monitoring and control.
NB-IoT based ~~On-the-ground~~ stuff

On-the-ground RT parameters

- Water volumen (m3)
- Water Pressure (gBar)
- Ecofertilizers tank level (m.w.c.)

Inputs

Data source

ISURDROP-CU
LoRa datalogger

Outputs

Pressure Control valve

Latency time

NB-IoT

5 to 1440 min

Comms layer

Cellular network

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User level *Utility*: Proportional control.

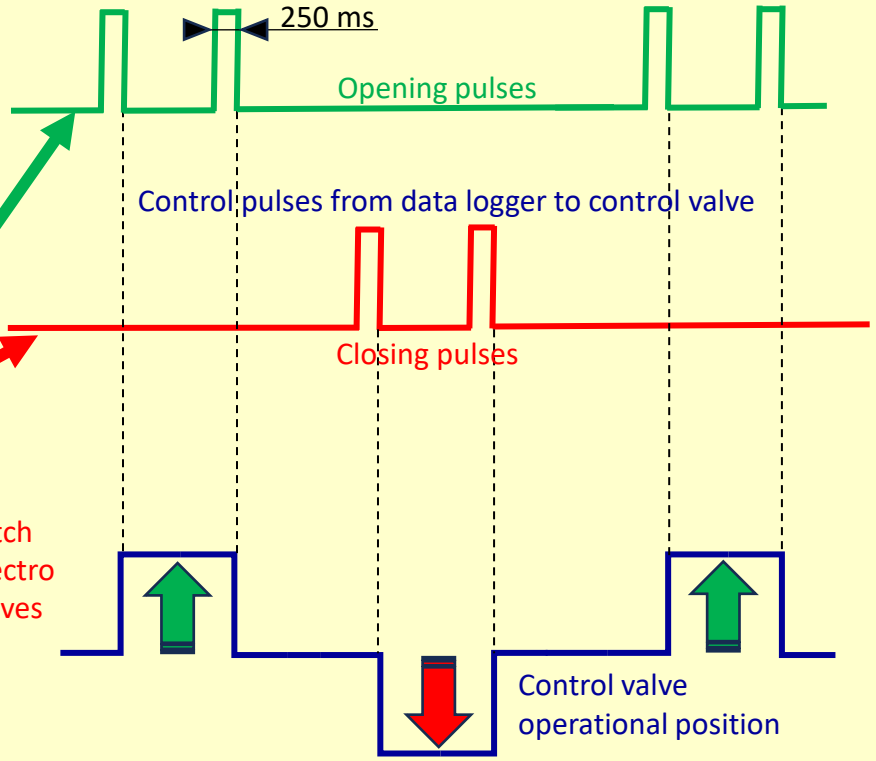
ISURDROP-CU data logger

pulses

Control valve

Latch electro valves

Flow



Latch electrovalves minimize electrical consumption since only a 250 mS pulse is necessary to switch the operational state of the valve (O/C) to a permanent working condition

For Flow and Pressure proportional control on the main pipeline, two electrovalves are necessary

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User level *Landowner*: monitoring and control.
LoRa based On-the-ground control devices

On-the-ground RT parameters

- Water volumen (m3)
- Water Flow (m3/h)
- Water Pressure (gBar)

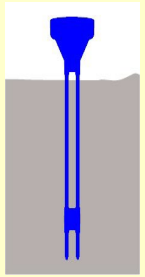
Inputs

Data source

ISURDROP-CU
LoRa datalogger

Outputs

ISURDROP-SM
Soil Moisture
LoRa Data logger



Control valve

proportional

On/off

Latency time

LoRa

5 to 1440 min

LoRa

Comms layer

LoRa WAN gate way

SMARTDROP: IoT based smart and efficient crop irrigation solution

User level *Landowner*: monitoring and control.
NB-IoT based ~~On-the-ground~~ stuff

SMART DROP

On-the-ground RT parameters

- Water volumen (m3)
- Water Flow (m3/h)
- Water Pressure (gBar)

Inputs

Data source

ISURDROP-CU
NB IoT datalogger

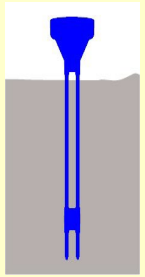
Outputs

Control valve

proportional

On/off

ISURDROP-SM
Soil Moisture
LoRa Data
logger



Latency time

NB IoT

5 to 1440 min

LoRa

Comms layer

Cellular network

LoRaWAN gateway

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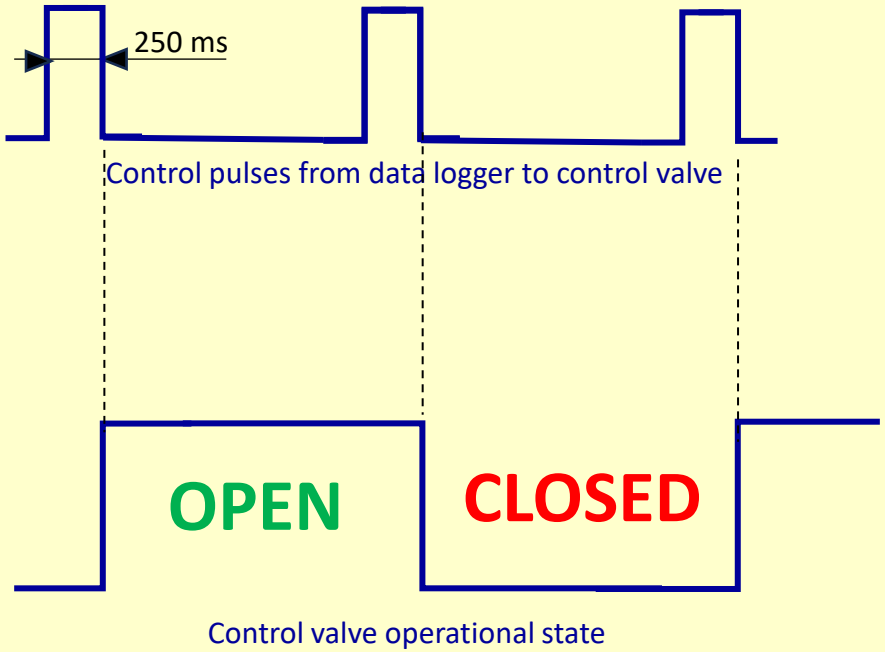
User level *Landowner (Plot)*: Irrigation ~~open~~/closed control.

ISURDROP-CU data logger



Latch electrovalves minimize electrical consumption since only a 250 mS pulse is necessary to switch the operational state of the valve (O/C) to a permanent working condition

For fully open/closed operation, only one electrovalve is necessary

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User level *Landowner*: Parameter monitoring and control. Data accessibility

ISURDROP data logger remote configuration: all the operative parameters can be configured online:

Latency (acquisition & uploading) is a user configurable parameter:
Interval: 5, 10, 15, 30 (minutes), 1, 2, 4, 6, 8, 12, 24 (hours).

Operating mode : Sleep, Data Logging, Pressure control, Flow control, Volumen control

Operating submode :

- Manual
- Campaign: Starting date & time, Ending date & time, days of the week, time-out.

Valve control mode : on/off – proportional

2 analog channels: zero, full scale, alarms (HH, Hi, Lo & LL thresholds)

- 1st channel (AI0) is exclusively assigned for PRESSURE GAUGE (mBarG) measurement.
- 2nt channel (AI1) is user configurable for either FLOW (l/s) or LEVEL (mwc) measurment.

User level *Landowner*: Parameter monitoring and control. Data accessibility

Field devices: different properties can be assigned to each field device

- Enabled/disabled.
- Manufacturer / model / serial number / installation date.
- Magnitude / eng. units / zero / full scale.

Alarming: independant alarm thresholds for each parameter can be user configured and linked to email and **Telegram** notifications:

- High value alarm setpoint (HH)
- High value prealarm setpoint (Hi)
- Low value prealarm setpoint (Lo)
- Low value alarm setpoint (LL)

User level *Farmer*: Parameter monitoring and control

Weather/meteo webs

REAL TIME WEATHER

WEATHER FORECAST

- Temperature (ºC)
- Humidity (%)
- Rain fall (mm)
- Wind speed (km/h)
- Wind direction (º)
- Atm. pressure (mBar)

Data source

Accurate weather/meteo data

API

Smart Drop

Smart Drop server

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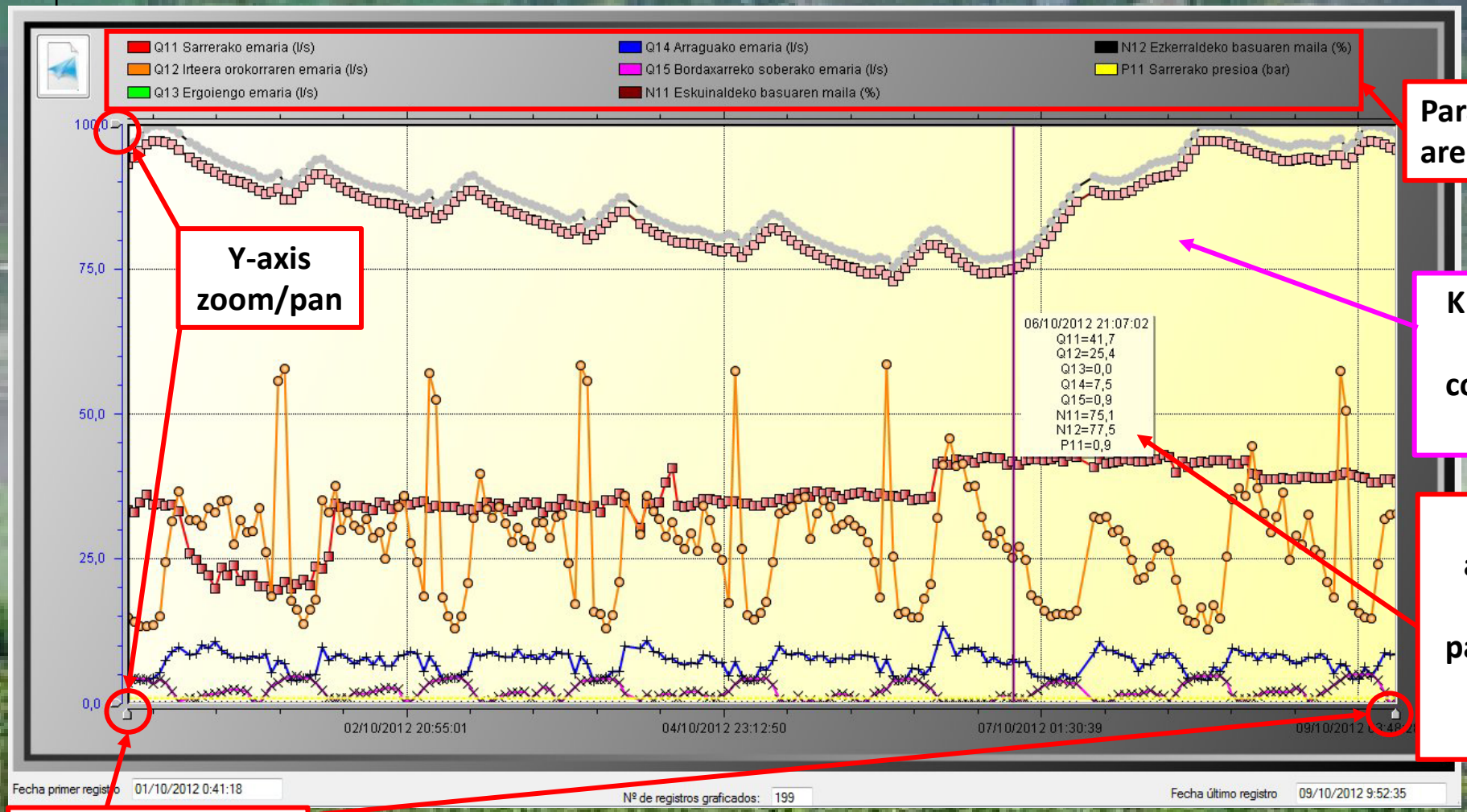
User level *Farmer*: Historic trending & KPIs



Parameters to be plotted are user selectable

Y-axis zoom/pan

KPIs can be defined to check the level of compliance of the real data

Dragging the cursor across the time base allows access to parameters readings at the selected time instant

user selectable X-axis time base

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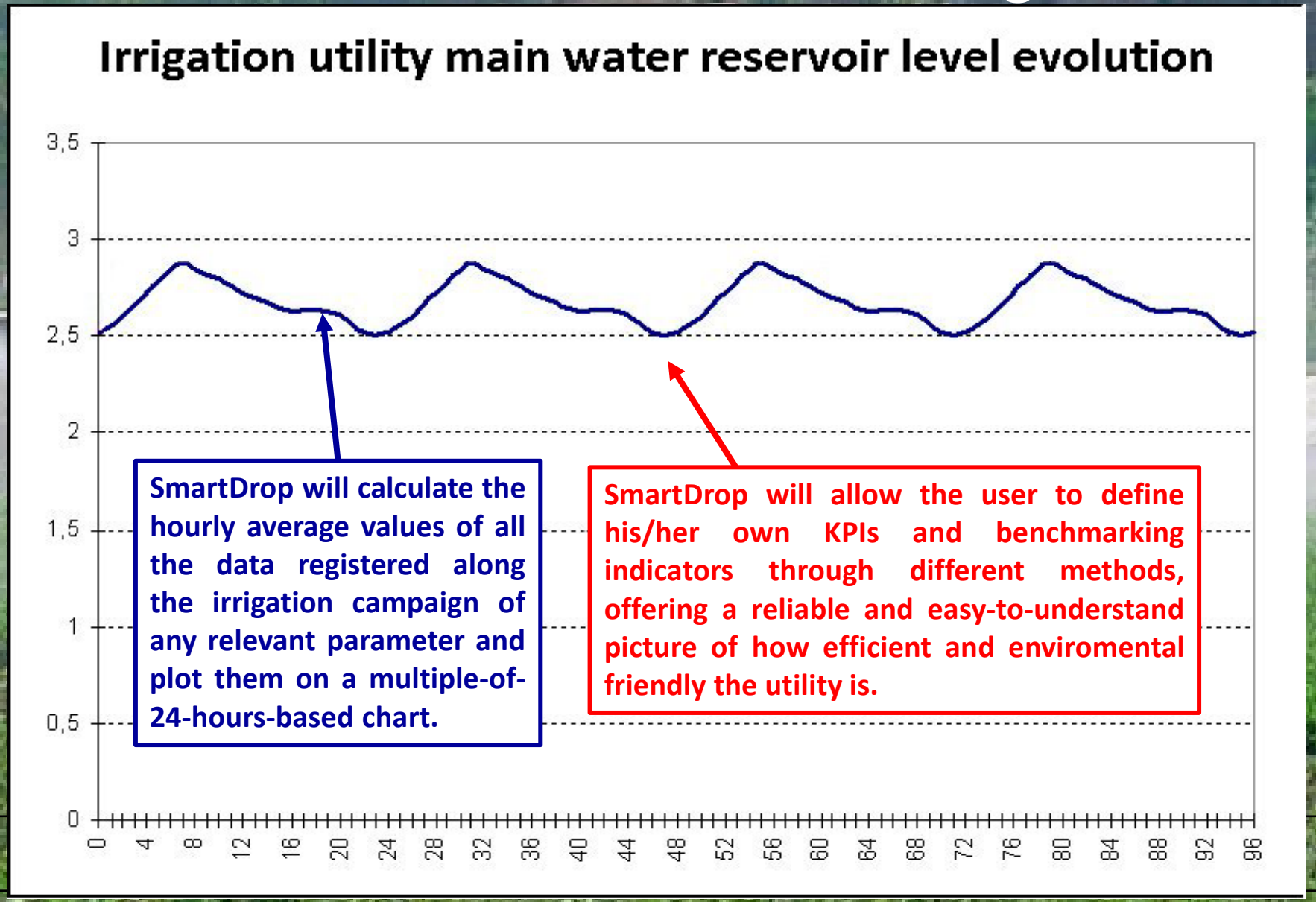
User level *Farmer* : Historic trending & KPIs



User level *Farmer* : Historic trending & KPIs

Data sources

Field logged values: Generate user configurable average plots based on the next choices:

- Campaign selection.
- Parameter selection.
- Time frame: Start and End dates.
- Day/s of the week to be considered from which the average values will be calculated.

Sunday	☐
Monday	☐
Tuesday	☐
Wednesday	☐
Thursday	☐
Friday	☐
Saturday	☐

KPIs & Benchmarking : SmartDrop provides the user with tools to create its own hourly-based daily indicators, plotting them in a chart correlated to Field logged values through the configuration of the next fields:

- Up to 3 **KPIs** can be assigned to each Field logged values
- Parameter selection (this is done automatically by the app since it must equal that one selected at the Field logged values section).
- 24 hourly values.
- Maximum percentage of discrepancy between simultaneous Field logged values and **KPIs**

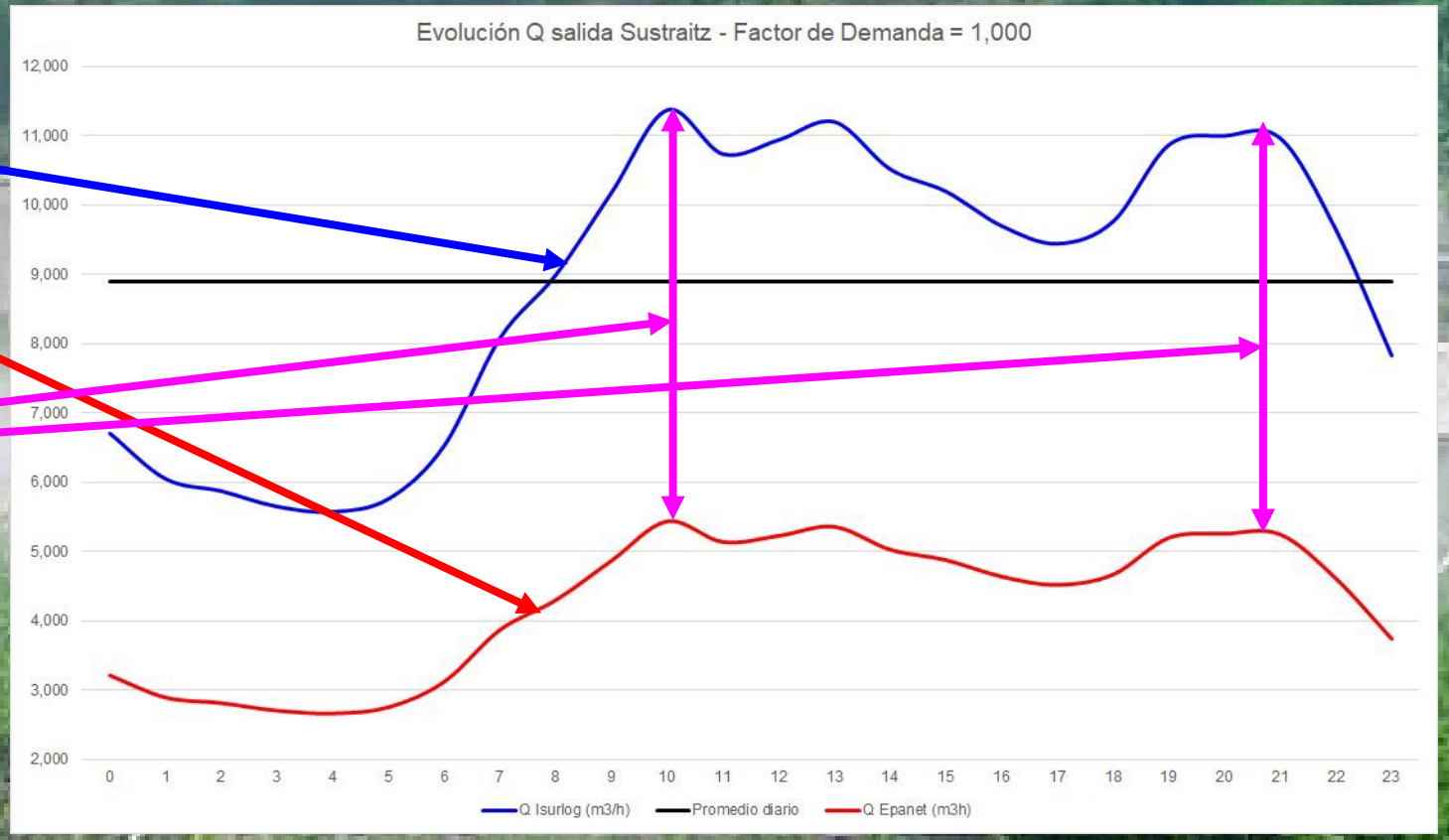
User level *Farmer* : Historic trending & KPIs

Outcomes

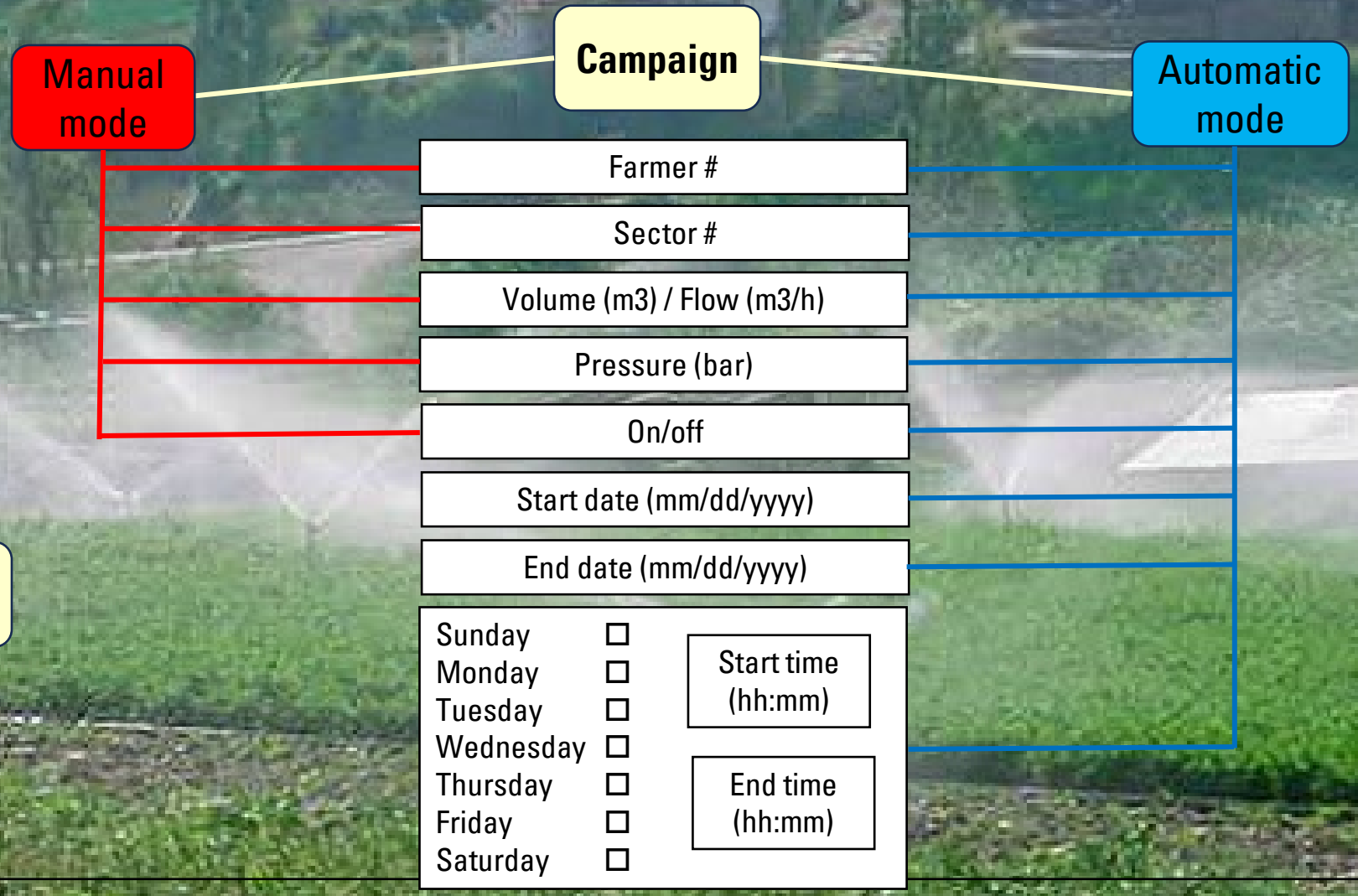
Shows comparative chart of **Field logged values** vs user-defined **KPIs**

Highlights those moments in chart in which configured discrepancy has been exceeded.

Identifies and provides a better understanding of the irrigation process shortcomings and helps in the improvement of the design of future campaings.



User level *Landowner*: Campaign scheduling



Overall

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User level *Landowner*: Adaptive control

SmartDrop can automatically adapt the operational irrigation parameters of a currently running campaign according to unexpected variations in the field variables (soil moisture, RT and forecasted weather parameters, hydraulic parameters,…), thus assuring an automatic adaptation and response to unpredictable scenarios.

The adaptive control tool can be configured according to the next concepts:

- On-the-ground RT parameters: water volume/Q/pressure & ecofertilizers tank level & soil moisture
- RT weather parameters: wind speed/direction, air temp., pluviometry, atm. pressure.
- Weather forecast parameters: same as above.
- Logic functions and statements: IF/THEN - AND – OR - > - < - ≥ - ≤
- Command, control and alarming: start / stop / flow control

User level *Landowner:* Adaptive control

An adaptive control example:

Logic	Parameter	Logic		Parameter	Logic
IF		≥ HH ≥ Hi ≤ Lo ≤ LL	AND OR		≥ HH ≥ Hi ≤ Lo ≤ LL

Logic	Action on the irrigation process
THEN	STOP START Flow/Volume/Pressure setpoint adjustment
	Alarming

Up to 4 comparative conditions can be linked to an "if…then" statement

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