WISI – Water Industrial Sector Initiative

Solutions for the water cycle

Irrigation management
A resource to be protected
Solutions for the complete water cycle
ABB solutions for the water cycle

Irrigation Networks

- Management of energy and water resources in agricultural applications
- Complete automation, from water plants to single hydrants
- Consumption and irrigation programs under wireless control

Canal de Zujar

21,000 hectares under control including open/close hydraulic valves, water counter reading, pressure reading, water consumption metering, volumetric and quota irrigation programs.
Irrigation demand around 70% of total fresh water worldwide, with more than 60% water lost, due to transportation evaporation, channels or pipes damages and inadequate use.

Irrigation is the main water activity to be develop and optimize, in order to define clear rules oriented to minimize water consumption.

Irrigation and agriculture is the heart of the worldwide food.

This industry gives work to more than 13% of total population.

Profitable farmer avoid urban migration.
ABB solutions for the water cycle
Irrigation automation

- Irrigation Automation
- Example 1: Canal de Zujar
- Example 2: Lorca
- Example 3: Carlet
- Business Opportunities

Main Control Room

Communications (Radio, Cable, GPRS)

Primary Network
(Transport Pipes/Channels, pumping, reservoirs)

Secondary Network
(Distribution pipes, counters, fertilization, irrigation valves)

Farmer Information
Farmer mobile phone
ABB solutions for the water cycle

Primary network

Primary Network: transport pipes/channels, pumping stations, reservoirs and filter stations

- Pumping / motor control
- Energy consumption optimization
- Valve control
- Pressure, Level, Flow Control
- Drives Control
- Cleaning filter station control
- Pre-fertilization
- Quality water measurements
  - Conductivity
  - pH
- Flow and water level measurements
- Alarms and events generation
  - Climatology automatic irrigation control
  - Leakage management
  - Intruder detection

Irrigation Automation

Example 1: Canal de Zújar
Example 2: Lorca
Example 3: Carlet

Business Opportunities
**Secondary Network: Irrigations Points**

- Open/close hydraulic valve control
- Water counter reading (pulses)
- Pressure and flow reading
- Flow integration
- Water quality reading
- Automatic Irrigation program
  - By hourly selection
  - By volume selection
  - By turn (Order priority)
  - By share (quota)
  - By hectare
  - By climatic trigger
  - Under farmer requirements
- Fertilization system
- Intruder detection

**Special remote control units needed**

**More Than 1.000 Units in each project**
ABB solutions for the water cycle
Irrigation management – communication technology

Sector I

Network
GPRS /EGDE

Sector 2

Routers ADSL

TFNO GPRS

Alarms

E. Control

E. Gestión

Reports

SAI

Main Control Room

Farmer

Message
SMS

Sector N
ABB solutions for the water cycle
Irrigation management – communication technology

The main problem for irrigation network control are communications for allowing coverage thousands of hectares

ABB has all technologies available:

- Only Cable
- Only radio
- Only GPRS
- Mix radio - cable
- Mix radio – GPRS
- Mix cable - GPRS
ABB solutions for the water cycle
Irrigation management – remote control units

- **Power Module:**
  - Power by cable (data + power over 2 twisted wires)
  - Solar panel + battery power
  - Battery long life power (Ion lithium batteries > 8 years)
  - AC Power 220 AC

- **Base Module:**
  - Main CPU
  - 4 Solenoid valve output, 4 counter input
  - 2 Analogue Inputs
  - 2 Digital Inputs
  - 1 Digital output (Latch relay)
  - 384 KB EEPROM. Data memory
  - 128 KB Flash Eprom. Program
  - 512 KB Memory RAM. Data

- **Communications Module:**
  - Radio Communications 10mW (400-500m)
  - Radio Synchronized Communications 50-500mW (4Km)
  - External Radio Communications 5W (20 Km)
  - Cable communications (2 wires - up to 12.5Km)
  - GPRS Modem Communications
  - RS232 Communications, M2M communication
ABB solutions for the water cycle
Irrigation management – remote control units

<table>
<thead>
<tr>
<th>PulsarPlus Model</th>
<th>Battery size</th>
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<tbody>
<tr>
<td>TLP-93x1x</td>
<td>19 Ah</td>
</tr>
<tr>
<td>TLP-93x2x</td>
<td>38 Ah</td>
</tr>
<tr>
<td>TLP-93x3x</td>
<td>67 Ah</td>
</tr>
<tr>
<td>TLP-93x4x</td>
<td>75 Ah</td>
</tr>
<tr>
<td>TLP-93x5x</td>
<td>85 Ah</td>
</tr>
<tr>
<td>TLP-93x6x</td>
<td>95 Ah</td>
</tr>
<tr>
<td>TLP-93x7x</td>
<td>114 Ah</td>
</tr>
<tr>
<td>TLP-93x8x</td>
<td>133 Ah</td>
</tr>
<tr>
<td>TLP-93x9x</td>
<td>152 Ah</td>
</tr>
<tr>
<td>TLP-93x10x</td>
<td>171 Ah</td>
</tr>
</tbody>
</table>

In sleeping mode, according with number of daily GPRS communications, the time duration of the long life batteries (Ion Lithium Batteries of 57 Ah) can be approximately:

- For 24 GPRS communications per day: > 6.7 years to replace
- For 12 GPRS communications per day: > 9.1 years to replace.
- For 6 GPRS communications per day: > 10.8 years to replace.
ABB solutions for the water cycle
Irrigation management – main control room and SCADA system
ABB Solutions for the water cycle
Irrigation management – main control room and SCADA system

Primary networks
ABB Solutions for the water cycle
Irrigation management – main control room and SCADA system

Secondary networks
Solutions for the water cycle
Irrigation project references
Canal de Zújar, Spain
Initial scenario

- 2 Dams (total capacity 3.532 Hm³)
- Irrigation distribution network
  - 21.141 hectares
  - 10 hydraulics sectors
  - 95 km open channel (capacity 27 m³/s)
  - 137 km pipelines (150-1500mm)
- Water plants
  - 6 Regulation Reservoirs (total capacity 2 Hm³)
  - 10 Pumping Stations (1 x sector)
  - 62 Pumps (total 26.750 kVA)
  - 2 x 45 kV lines, 10 substations.
  - Annual energy consumption: 23-25 GWh
- Old irrigation control system based on wired RTUs abandoned (high maintenance costs and lack of measurements reliability)
- N.2 water consumption calculations per year (for billing)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Surface (He)</th>
<th>No of Plots</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>1.028</td>
<td>622</td>
</tr>
<tr>
<td>II</td>
<td>2.691</td>
<td>2.620</td>
</tr>
<tr>
<td>III-IV</td>
<td>3.892</td>
<td>2.817</td>
</tr>
<tr>
<td>V-I</td>
<td>2.644</td>
<td>1.363</td>
</tr>
<tr>
<td>V-2</td>
<td>481</td>
<td>56</td>
</tr>
<tr>
<td>V-3</td>
<td>1.097</td>
<td>50</td>
</tr>
<tr>
<td>VII</td>
<td>1.323</td>
<td>403</td>
</tr>
<tr>
<td>VIII-1</td>
<td>3.875</td>
<td>1.037</td>
</tr>
<tr>
<td>VIII-2</td>
<td>1.120</td>
<td>304</td>
</tr>
<tr>
<td>IX-X</td>
<td>2.990</td>
<td>1.441</td>
</tr>
<tr>
<td>Total</td>
<td>21.141</td>
<td>10.715</td>
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<table>
<thead>
<tr>
<th>Crops</th>
<th>Maize</th>
<th>Tomato</th>
<th>Rice</th>
<th>Olive</th>
<th>Fruits</th>
<th>Asparagus</th>
<th>Tobacco</th>
<th>Sunflower</th>
<th>Various</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Surface</td>
<td>39</td>
<td>22</td>
<td>10</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>12</td>
</tr>
</tbody>
</table>
Canal de Zújar, Spain
ABB scope of supply

Monitoring, control and management system of the irrigation network

- 9,500 volumetric valves (integrated hydraulic valve + counter), connection valve, installation
- 7,000 NEPTUNO GPRS RTUs integrated in volumetric valves (1 RTU controls for 1 or more valves), power supply using solar panels
- Main Control Centre, 4 Operator Stations, 2 Routers (ADSL, GPRS/UMTS/HSDPA)
- 1 Operator Station in a Secondary Control Centre
- WLAN between Primary and Secondary Control Centre

- Irrigation Automation
- Example 1: Canal de Zújar
- Example 2: Lorca
- Example 3: Carlet
- Business Opportunities

Control Center  Volumetric valve + NEPTUNO RTU (in transparent boxes to be shown)  Hydraulic solution
Canal de Zújar, Spain
System functions

- Irrigation Automation
- Example 1: Canal de Zújar
- Example 2: Lorca
- Example 3: Carlet
- Business Opportunities

**Process and consumption monitoring**
- Water counter reading (Pulses) and flow calculation
- Pressure, pH, conductivity measurement
- Continuous registration of volumes by hydrant, by area and total

**Irrigation control and management (remote)**
- Open/Close Valves (latch solenoid)
- Irrigation triggers by weather conditions or by farmer decision
- Irrigation programs with/without fertilization (by time, volume, or quota)

**Additional services**
- Link to “Information Management” and “Accounting” systems
- NEPTUNO SCADA Builder for engineering, tool to easily add/remove hydrants and RTUs
Canal de Zújar, Spain
System architecture

- Irrigation Automation
- Example 1: Canal de Zújar
- Example 2: Lorca
- Example 3: Carlet
- Business Opportunities
Canal de Zújar, Spain
Communication network

- Irrigation Automation
- Example 1: Canal de Zújar
- Example 2: Lorca
- Example 3: Carlet
- Business Opportunities

- RTU GPRS Remote access by 2 or more repeaters.
- High Security
- Availability > 96 %
- Communication speed 40 Kbps

- High speed ADSL
- Redundant ADSL / UMTS
- Redundant APN in two different sites
- Safety: Dual Tunnel IPSEC
- Availability > 96 %
- Speed 2,000 Kbps (50% guarantee)
Canal de Zújar, Spain
Intelligent RTU devices

- Store irrigation programs (up to 480 in total)
- Internal logic modules
- Connection to one or several control centers
- Connection to control center by RTU (by event/alarm or periodically)
- Working modes: active, sleep, and programmed by periods
- Several power supplies: solar panels, batteries, power lines
- Systems for charging batteries and avoiding power consumption
- Allow time based fares, because data volume is hour stored and sent
- Store of events, alarms, data samples, volumes, flows
- Reprogrammable via GPRS, even firmware and memory map
- Allow prepay systems such as SMS, mobipay

- Irrigation Automation
- Example 1: Canal de Zújar
- Example 2: Lorca
- Example 3: Carlet
- Business Opportunities

Complete assembled unit  RTU + Volumetric Valve  RTU module (inside)
Canal de Zújar, Spain

Project phases

- Irrigation Automation
- Example 1: Canal de Zújar
- Example 2: Lorca
- Example 3: Carlet
- Business Opportunities

Constructor tests of complete unit in field lab, pulses, valve operation and communication

Operation Test by WAP

Full RTU hardware + functional + communication tests in Factory

Assembling and test procedures

Communication Tests

Components Factory Test
Canal de Zújar, Spain
Customer benefits

Highlights
- Water Saving: 47Hm$^3$ / year
- Energy Saving: 30%
- Crops productivity increase: 25%
- Biggest irrigation control system in Spain

Farmer benefits
- Farmers can program and monitor instant data using WEB/WAP services
- Night irrigation using convenient electricity fares. Electricity bill cut
- No need to go to farm to irrigate. More free time, better quality of live
- Bills depending on the quantity of water used to irrigate, not to hectares

Irrigation consortia benefits
- Instant VS Bi-yearly consumption measurement (previous situation)
- Monthly VS Yearly bill (previous situation)
- Possible to cut water if farmers do not pay
- Easy to detect problems in pipes, thanks to pressure measurement
Canal de Zújar, Spain
Lessons learned

- **Power:** project started with Lithium Batteries; after 300 equipments installed change to solar panel + rechargeable battery due the need to send instant commands to RTUs
- **Solar Panel Position:** initially the hydrants were installed very closely to ground, and solar panels were 1,0-1,5m in altitude. In case of corn cultivation, it became much higher than solar panels which were no more able to charge batteries. Must were installed to solve the issue
- **Vales:** initial solenoid valves break due to pressure changes in pumping starting/stoping. Each solenoid valve replaced
- **Consumption:** total power consumption of NEPTUNO RTU is 4mA in Sleep Mode, and it cannot waste 1mA for each counter input.
Lorca, Spain
Initial scenario

Situation in 2001:

- 14,000 Hectares
- 8,500 Farmers
- Water is coming from irrigation channel and from wells
- 6 Reservoirs, 4 wells, and 2 pumping stations
- Traditional flood irrigation method, parts under pressure
- 6 Offices, more than 30 people and 15 cars managing opening/closing of valves/hatches for manual irrigation
Lorca, Spain
Modernization projects

Modernization Step 1 (2001-2005) – 4 sectors
- 1 Sector with new pipes, caskets, hydrants (4 for each casket), cables
- 3 Sector only with new valves in main pipes branches. Hydrants supplied and installed. Caskets and pipes not replaced.
- A ditch made for cable and 400 km of cable installed by constructor
- Management system with Internet connection

- New pipes, caskets, hydrants (4 each casket)
- New caskets + hydrants were installed on main pipes branches
Lorca, Spain
ABB scope of supply

Step 1
- 12 Radio RTUs based on AC800C PLCs, automation and remote radio control of reservoirs, wells, and pumping stations
- 3,000 Cable RTUs for each irrigation casket, controlling from 1 to 4 hydrants each
- 200 Cable RTUs for each main pipe branch, controlling water flow and emergency valve cut
- 200 Cable RTUs on each main pipes to measure Pressure
- 30 Cable Concentrators based on AC800C and radio+GSM
- 4 Sector Offices, with Central AC800M + radio + GSM, SCADA and SQL Data base, and communication by ADSL with Control Center
- 1 Control Centre in Main Office, SCADA+SQL (replication of 4 offices)
- Communication SQL Server with Customer Management System (irrigation programs and Volume measurements).
Lorca, Spain
ABB scope of supply

Step 2

- 2 New Sector Offices, new pipes, new 1270 new caskets with 4 hydrants each, 100 main pipes branch control
- 1370 NEPTUNO G4H RTUs (GPRS) with 4 hydrants control each, on caskets and main pipe branches.
- 100 Pressure transducers on Main Pipe Branches.
- 2 Testing equipments based on AC10 ABB Programmable Relay for pulse generation
- 1 Testing lab with 8 hydrants for RTUs testing
- 1 Control Centre with 3 Servers (SCADA, SQL, and Communications), and 8 Operator Stations (2 in Control Centre, 6 on Sectorial Offices)
Lorca, Spain
System architecture

- Irrigation Automation
- Example 1: Canal de Zujar
- Example 2: Lorca
- Example 3: Carlet
- Business Opportunities
Lorca, Spain
Lessons Learned

- In 2001 ABB available technology for irrigation control was only wired (no GPRS, Radio)
- One of the sectors was built from the scratch (new pipes, caskets, hydrants, RTUs). Communication cable was put in the same ditch as pipe was (1,5m in depth as minimum)
- For the other 3 sectors the pipes were not changed and cable was buried about 0,5m. Construction company did not do a good work.
- This area is very crowded. Population of Lorca is close to 100.000 inhabitants and 50% of population lives in fields close to town.
- We had one sector working properly, with the other 3 always having problems, due to use of wired solution. It was not only due to bad work by constructor, but also to other constructions works in this area going on during the next 5 years (houses, pipes, drinking and sewage water, roads). This caused many breaks in the 400 km cable and high maintenance cost
- Sector working properly is a small one (only 40-50 km cable), low level of population
- For cable problems we’re switching to other technologies (Radio and GPRS)

CABLE is a good solution only for small installations with new pipes, in areas not highly populated and not subject to ground works
Lorca, Spain
Customer benefits

Farmer benefits
- Agriculture is of high value in this area and to preserve it during drought period has been possible thanks to this modernization
- Agriculture productivity increased, due to more stable and intensive production (more crops with same water) and quality (drip systems)
- Farmers buy/sell water and program their irrigation through any Automatic Cashiers in Murcia area (more than 500 points), and they have instant data of the water volume they have used, and what is left of his quota
- Extra free time and cost saving for farmers (remote management)

Irrigation consortia benefits
- Electricity saving by pumping only during needed time window
- Maintenance cost saving: ½ people working on water distribution and reduction of number of vehicles and fuel costs
- Monitoring of water quality (conductivity, pH, pressure) and mixing water coming from different sources, in order to have optimal quality
- Possibility to detect problems in pipes and installations before farming is affected
- Possibility to cut water flows in case of pipes problems (press/flow measurement), hydrants (flow measurement) or in case farmers don’t pay
Irrigation network
- Irrigation with water coming from an open channel and wells
- Irrigation by channels, flood fields, and shifts
- Trees fields basically oranges, apricot, plums, peaches, khakis

Modernization goals
- Changing to pressure irrigation with drip systems
- 40 km of Pipes
- 2 Sectors, each one with a reservoir, pumping station, filtering, station, fertilization
- 3+1 and 2+1 pumps on each pumping station. Soft starters + one frequency converter for pressure regulation
- 163 distribution caskets for water distribution
- Each casket with up to 12 hydrants
- One cat butterfly valve, one filter and an general hydraulic valve with pressure regulation, air valve
- Each hydrant = hydraulic valve with pressure + flow regulation activated by a 12Vcc latch solenoid, and a water counter
Carlet, Spain
ABB Scope of supply

- 163 NEPTUNO G4H RTUs, with 12 hydrant control each and GPRS communication. One for each casket.
- 10 Pressure transducers connected to NEPTUNO G4H RTUs
- 2 AC500 PLCs on each pumping station controlling reservoir, pumps, filters, fertilization
- 2 Operator Panels, 10,4” LCD TFT colour touch screen, placed on the front side of the PLCs cabinet, in order to have local control
- A WLAN (Wireless LAN) among the 2 pumping stations and the Control Centre, based on 5,4GHz links 6Mbps bandwidth
- SMS alarm messages centre, Internet remote access
- Control Centre
Lithium batteries vs Solar Panels

- RTUs initially were powered by lithium batteries and were working in mixed mode.
- Mixed mode: RTUs are normally in sleep mode and every hour (time is selectable but battery life / costs depend on number of communications) RTU connects to control centre and sends data. This also happens automatically in case of important alarms.
- In mixed mode, lithium battery life was estimated to be more than 7 years.
- At the end, decision was taken to change to solar panels on top of the casket and rechargeable batteries because of:
  - Need to play with RTUs
  - Need to send instant commands to RTUs
  - AcPb batteries being cheaper and easier to find.

Lessons learned

- Irrigation Automation
- Example 1: Canal de Zujar
- Example 2: Lorca
- Example 3: Carlet
- Business Opportunities

Tadiran Ion Lithium battery + 5W 6Vpp solar panel + 6V 12Ah AGM AcPb Battery
Carlet, Spain
Customer benefits

**Farmers benefits**
- Less cost (transport, electricity, water consumption, fertilizations,…)
- More information about the field (water/fertilizer consumption)
- Better crops in quantity and quality, and more regular; healthier trees
- More free time (others are taking care of the fields)

**Irrigation consortia benefits**
- Change to drip means water savings
- Now wells (high conductivity) are not used, channel water is sufficient
- Water measurement/control. Now each farmer pays for the consumed water, every month. If a farmer doesn’t pay, water is cut instantly
- Central programming of water irrigation, and fertilization
- Alarm messages and operator station from anywhere
- Water irrigation by crops, shifts, electricity tariffs, weather conditions, and optimal agricultural public net recommendations.
Power and productivity for a better world™