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Information Systems 01PDWOV

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Books, notes are not allowed. Write only on these sheets.

Water network management

Company WATER provides water supply to buildings and houses. The company manages the network (water source, pipes, valves, actuators on valves, volume sensors, pressure sensors, points of delivery, meters at points of delivery) put in place to deliver water.
In a region like Piedmont the network is complex, with around 400K elements to be monitored and maintained.

Maintenance can be regular (inspection of an element at regular intervals) or exceptional (urgent intervention on an element with a failure, like water leakage or meter malfunction). Maintenance is made by a team of technicians (the team can be composed by one or more persons, depending on the maintenance task), and means accessing the element at its physical location, inspecting it, repairing or substituting it.

Maintenance is made by the maintenance office, and is triggered via two channels. The call center of WATER (calls from users who signal malfunctions), the maintenance office itself (regular maintenance interventions based on an annual schedule, and alarms from sensors on the network). In all cases maintenance is organized in maintenance tasks, typically lasting a few hours to few days, and implemented by a maintenance team, regarding one or more network elements.

A work order is a request of a maintenance task, is generated by the maintenance office and allocated to a maintenance team. At the end of the task the maintenance team produces a maintenance report that describes the work done, the elements involved (repaired or changed), the duration of the task.

AS IS process
The maintenance office is supported by an IT application that contains the representation of the network (all elements, their geographical position, the related technical documentation, their connections), the maintenance tasks, their scheduling over time, the work orders, the maintenance reports. Every day maintenance tasks of the day are sorted by priority and allocated to a team. The team receives a printed description of the maintenance task, printed technical documentation needed for the task. The team performs the task, then writes the report on paper and delivers it to the maintenance office. The office enters the report on the IT application.

TO BE process - paperless
Each maintenance team is equipped with a digital device (aka a laptop with SIM and internet access). Work orders are received on the device, technical documentation is accessible via the device, reports are entered on the device.

In the following model the TO BE situation.

1 Organizational model: list roles or organizational units involved

Water
Maintenance office

Maintenance team
Call center

User

Not mentioned in the text, some network elements are connected (Internet Of Things) to the maintenance office and trigger alarms themselves. In this case they would be active roles too.

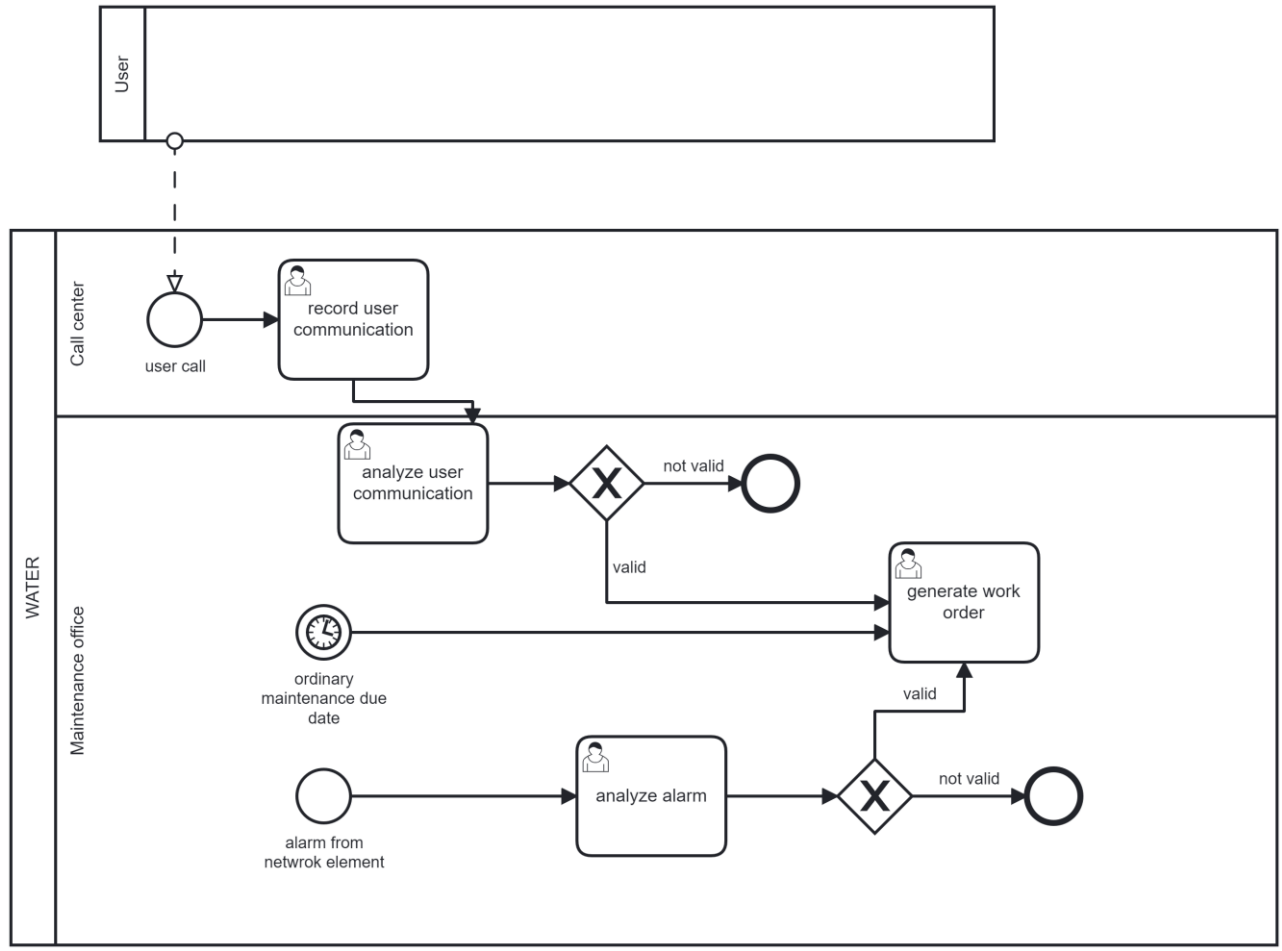
2aProcesses. List the key processes. For each process define name, input, output, description

Process name	Input	output	description	OU involved
Manage alarms and calls	User call to call center or maintenance trigger on element	Set of work orders to be processed		User, call center, maintenance office
Schedule work orders (daily)	Set of work orders to be processed	Ordered set of work orders, especially work orders for the day, allocated to maintenance teams		Maintenance office
Do work order	Work order	report		Maintenance team

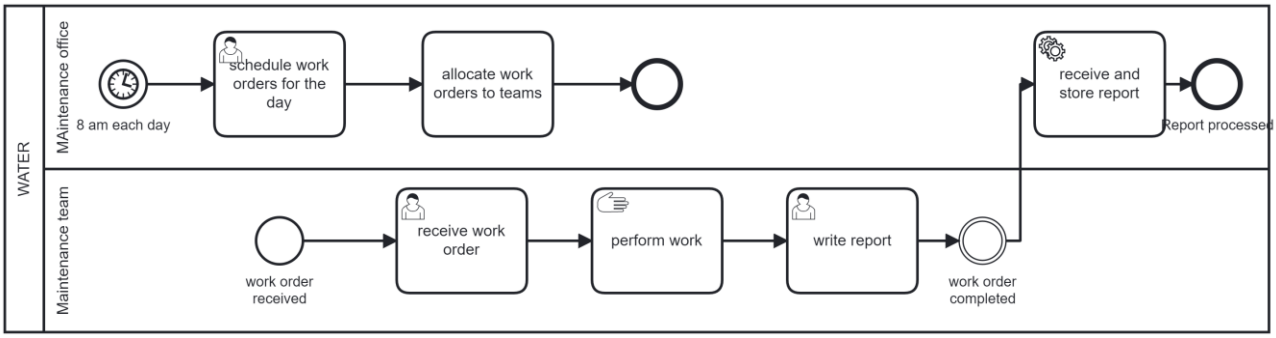
Schedule work orders could also be considered a simple task inside 'define work orders' process.

2b Processes. Define a BPMN process model for the process(es) listed in the previous question

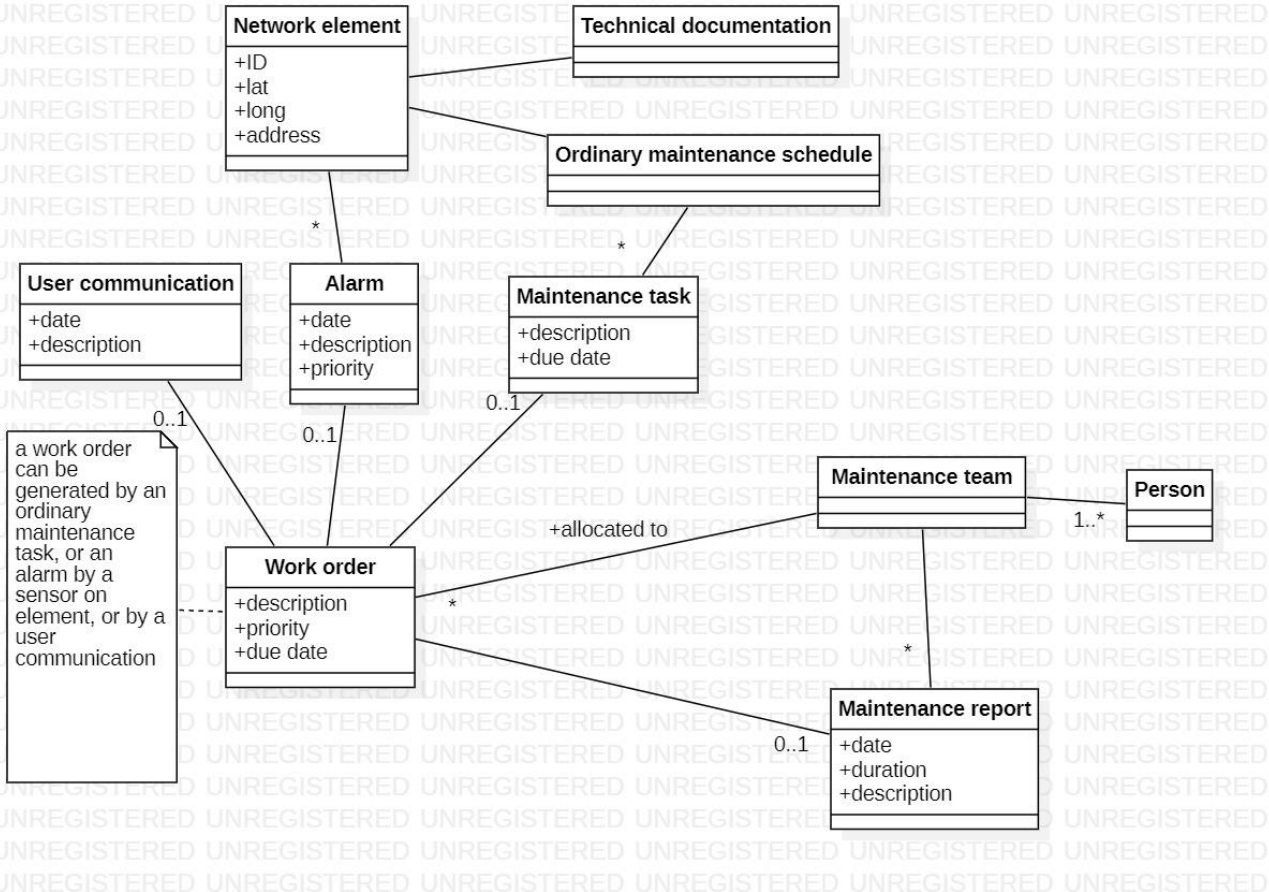
Manage alarms and calls



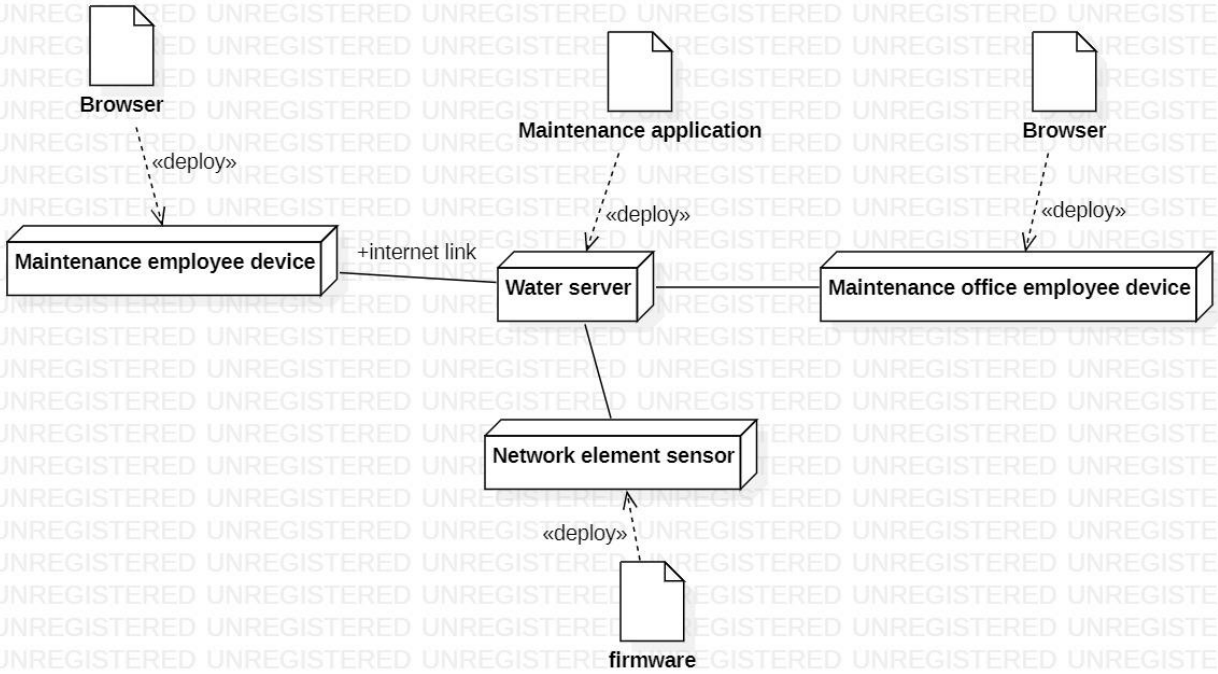
Schedule work orders, do work order



2c Conceptual model. Describe key concepts and their relationships using UML class diagram



3-a IT Model / Technological model: describe the hardware architecture of the system
(use **UML deployment diagram**)



3-b Business rule: define (in English, or formally) at least one business rule for the process

Network element X should be inspected at least every Y months
Cost of repair of an element <= 50% cost of element

5 Define the KPIs, considering these high level business goals (or CSF), CSF1 maximum availability of network (and water delivery), CSF2 cost effectiveness for WATER
If needed, define also indicators that are not KPIs.

Time range is 1 solar year for all measures

CSF name	KPI Category (General, cost ..)	KPI Name	KPI Description	Unit of measure
	GEneral	N_wo	N of work orders (includes ordinary and exceptional maintenance)	
			N of alarms N of network elements N of user communications N of maintenance tasks	
CSF2	Service	LT_wo	LT work order, from event 'work order received' to 'report processed'	Hours
CSF2	Efficiency	UC_wo	Unit cost to *manage* a work order = Human Effort (cost) of tasks 'receive work order', 'write report', 'receive and store report' + paper ink cost for report + pro rata cost of IT infrastructure (cost of task 'perform work', effort and materials must NOT be included here)	Euro
CSF2	Quality	R_Err	N work order reports with defects / N_wo Defects: wrong network element reported, wrong description, wrong times, lost report	%

6 Compare the previous and the current situation, using the KPIs defined above

KPI	AS IS	TO BE
All general kpis		No change
LT_wo		Decreases Task 'receive work order' faster Task 'perform work order' unchanged Task 'write report' same or faster Task 'receive and store report' much faster (zero time since automatic)
UC_wo	Receive work order manual Receive and store report manual	Decreases Receive work order automatic (no effort) Receive ad store report automatic (no effort)
R_err	Manual Data entry in 'write report' Repeated data entry in 'receive and store report'	Decreases. Same No more repeated data entry in 'receive and store report'

7 Considering the WATER company and the infrastructure it has to build or acquire for the TO BE, define the software functions needed

Process /Activity	**Software function(s) needed**
Receive work order	Send work order (IT application server side) Receive and show work order (application on device)
Write report	Write report (application on device) Check report (application on device)
Receive and store report	Send report (application on device) Store report (IT application server side)

8 Considering the comparison in point 6, summarize pros and cons for the actors in the TO BE situation (add actors if needed)

	PROS	CONS
WATER	No double data entry for reports (by maintenance team on paper, then by maintenance office in IT application) With improvement in UC_wo and R_err Easier communication between maintenance office and maintenance teams	Need to invest (see TCO later)
Maintenance team	Easier reception of work orders, easier access to technical documentation	Need to change work habit, learn using app on device
…		

9 Define the TCO for the WATER to shift to the TO BE situation

Phase	Cost	Capex or Opex
Construction selection	Development of software functions (see point 7), integration with existing IT application Acquisition of devices for teams Acquisition of SIMs	capex
Deployment	Install app on devices Training of teams	capex
Operation	Communication costs, electricity, operation of IT server application (prorata for new functions)	opex
Maintenance	Bug fixing, enhancements	Opex for bug fixing, capex for big enhancements
Retirement	Dismiss devices, data migration	opex

10 Considering a 5 years period, define costs and savings (ROI analysis) by adopting the TO BE situation

Year/ cost or saving	Year 1	Year2	Year3	Year4	Year5
Cost	Construction, selection, deployment costs	Op, maint	Op maint	Op maint	Op maint
saving		No double data entry No printouts	No double data entry No printouts	No double data entry No printouts	No double data entry No printouts
saving		No mistakes due to double data entry	No mistakes due to double data entry	No mistakes due to double data entry	No mistakes due to double data entry

11 What do you estimate? Will break even happen or not? Motivate your answer

Considering a company cost of 20 euro / hour, and 400 euro for a mobile device, 20 hours of effort saved would be needed to recover the cost. Considering just 10minutes saving per work order (no double data entry), the cost is recovered with 120 work orders (= 20 hours) – likely a team does at least a work order per day, 120 work orders would be made in half a year, time to break even on the devices slightly more than 6 months.
A point that was not clear in the text is the following. In AS IS, likely every team has to start the day from the main office to retrieve the paper work order. In TO BE the team could avoid this and

drive directly to the place where the work order has to be done. In this case the time savings could be much larger.

The computation for IT infrastructure is more complicated (fixed cost for all teams). Here the break even depends on the number of teams sharing the fixed cost, and the amount of the fixed cost. Assuming 50K cost, and 20 teams, each team needs to save 2.5K to break even. Assuming each team performs 300 work orders per year, 120 are need to recover the device cost, 180 are left = 1800 minutes saved = 30 hours = 600 euro, 4 years would be needed for break even.
This does not include savings by avoiding mistakes due to double data entry, and printing costs.

Overall break even should happen, but depends on many variables that should be precisely defined to compute it correctly.

12 Assume that WATER decides to outsource maintenance of the network. So now company MAINT is in charge of all maintenance work. Propose a few SLAs to monitor the outsourced maintenance.

UC_wo, LT_wo (as of point 5), reliability (tasks completed with problems within 2 months of task completion)

13 What are the main concepts of 'Agency theory'?

14 What has been the effect of the wider adoption of IT on agency costs?

15 Mention one cognitive bias and explain how it can affect decisions