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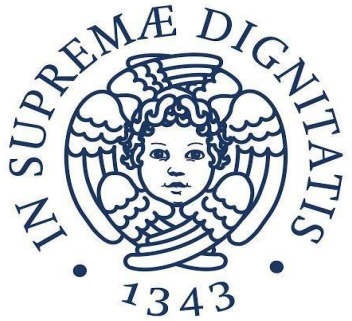

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PROGETTO BPM 2023/2024

Business Process Modeling

Data Science & Business Informatics

Author

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SUMMARY

1 INTRODUCTION

The present report illustrates the design of appropriate processes based on a specific case study concerning two friends who wish to organize a trip to go sea fishing during the summer.

The case involves a series of interactions between the two protagonists, Alex and Bob, who must agree on the date of the trip, the equipment to bring, and handle any unforeseen events during the process.

In particular, the report focuses on representing the process through an abstract model, namely the BPMN (Business Process Model and Notation), by applying the transformation techniques learned during the course. The proposed solutions, the analyses conducted, and the characteristics of the generated networks will be presented, including invariants, s-components, free-choice, well-handledness, and safety.

Furthermore, the report addresses the issue of soundness in the networks, verifying that the removal of the input/output interface places preserves the correctness of the process. In cases where it is not possible to design fully sound processes, the properties of weak soundness will be examined.

2 BPMN MODEL

The BPMN (Business Process Model and Notation) model was used to represent the process related to the scenario described in the “Fishing” case study.
The BPMN model provides an intuitive graphical notation to describe business processes, allowing for a clear and concise understanding of the activities, workflows, and interactions between participants.

The process was modeled using a pool with two lanes, where each lane represents one of the actors involved in the process: Alex and Bob.
This choice was made to clearly highlight the roles and responsibilities of the two participants within the process, thereby facilitating the understanding and management of the activities.

2.1 PROJECT DESCRIPTION

The process begins with Alex sending his list of availabilities to Bob.
Subsequently, Bob has several options: he can propose a date and a type of fishing equipment, leaving the final decision to Alex, or he can communicate that the meeting is not possible due to other commitments.
In the case of a proposal made by Bob, Alex can either accept it, suggest an alternative, or—if Bob has not made any proposal—Alex sends one himself.

2.2 FLOW OF EVENTS AND ACTIVITIES

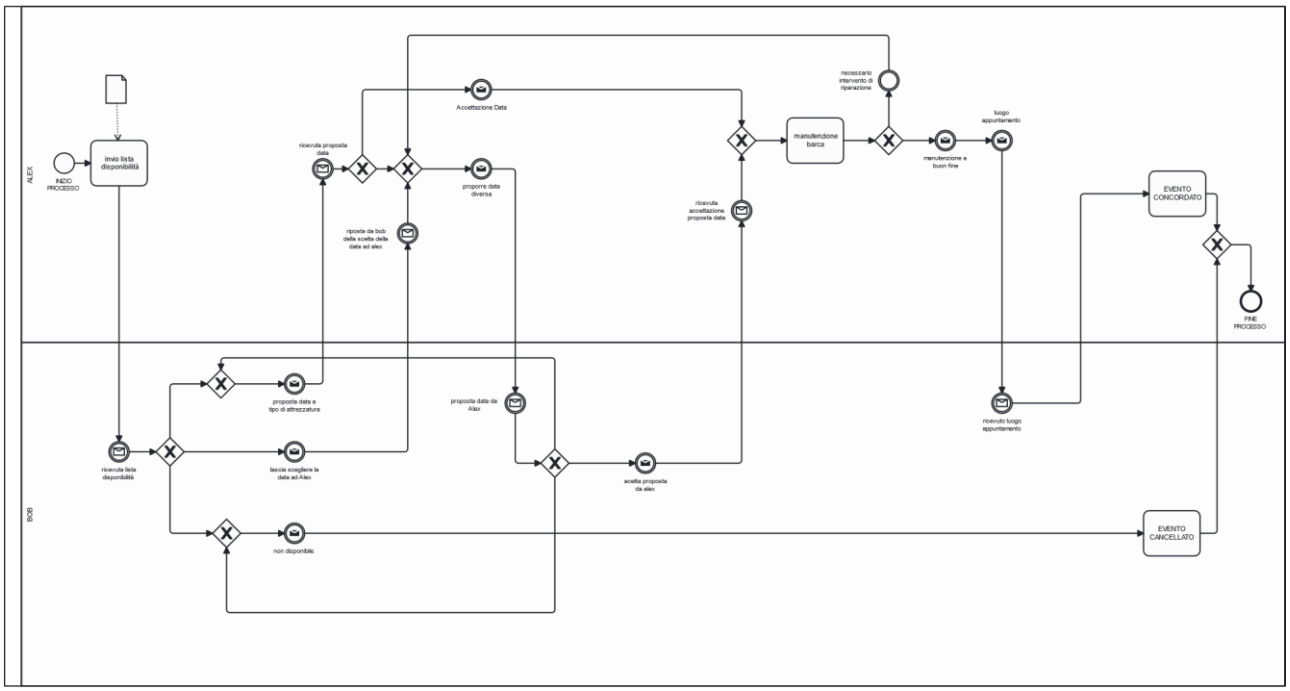
1. **Sending Availabilities:** Alex sends Bob his available dates to organize the boat trip.
2. **Bob’s Proposal:**
   - Bob proposes a date and a type of fishing equipment.
   - Bob leaves the choice up to Alex.
   - Bob communicates that the meeting is not possible.

3. **Alex's Response:**
   • Alex accepts Bob's proposal.
   • Alex suggests a different date.
4. **Confirmation or Modification:**
   • Bob confirms Alex's choice.
   • Bob proposes a change.
   • Bob cancels the appointment (in this case, the process ends).
5. **Boat Maintenance:**
   • If an agreement is reached, Alex performs the maintenance of the boat.
6. **Repair Intervention:**
   • In case of engine problems during maintenance, Alex and Bob must agree on a new date.
7. **Appointment Location Description:**
   • If the maintenance is successful, Alex sends Bob the location of the meeting.

2.3 BPMN ELEMENTS USED

• **Task:** Represents the activities performed by the participants during the process.
• **Events:** Indicate the triggering or completion of an activity within the process.
• **Gateway:** Used for splitting and joining workflow paths. In this case, only the **XOR gateway** was used.
• **Sequence Flow:** Defines the sequential order of activities within the process; in this case, it also represents the exchange of messages between the two actors.
• **Decorations:** Include **message catching and throwing events**, as well as a **data object reference** (specifically, the list of availabilities).

2.4 BPMN MODEL DIAGRAM



2.5 MODEL ANALYSIS

The developed BPMN model clearly and comprehensively reflects the process related to the scenario described in the case study.
The events and activities are well-defined and organized in a logical flow, allowing a clear understanding of the process by the participants involved.
The choice of using a **pool with two lanes** proved effective in outlining the roles and responsibilities of the participants in the process, contributing to its clear visualization and management.

3 PETRI NET

The transformation from BPMN models to **Petri Nets** is a fundamental process for analyzing and understanding business process behavior in greater depth.
In this section, we will examine the transformation procedure, illustrate the characteristics of the resulting Petri Nets, and conduct an analysis of the system's behavior.

3.1 DESCRIPTION OF THE TRANSFORMATION PROCESS

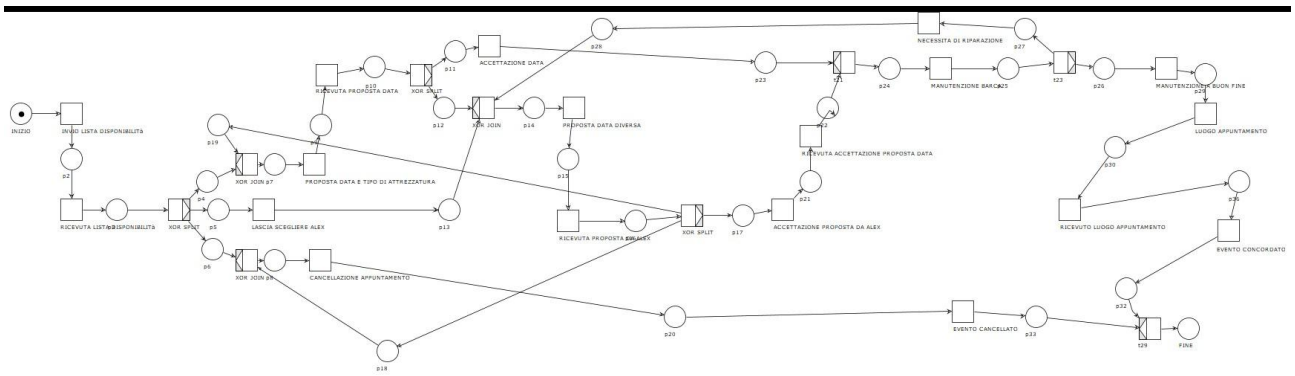
The transformation from BPMN to Petri Net involves several stages:

1. **Identification of Events and Activities:**
   The events and activities defined in the BPMN model are identified and represented as **transitions** in the Petri Net.

2. **Definition of Flows:**
   The sequence flows in the BPMN are translated into **places** and connected with directed arcs to the **transitions** (events and activities in the BPMN) within the Petri Net.

3. **Gateway Management:**
   The gateways in BPMN, such as **XOR gateways**, are mapped into **transitions** and **places** depending on the type of gateway (split or join) and are in turn connected to their respective **transitions** (events or activities).

3.2 PETRI NET MODEL DIAGRAM



3.3 ANALYSIS OF THE PETRI NET CHARACTERISTICS

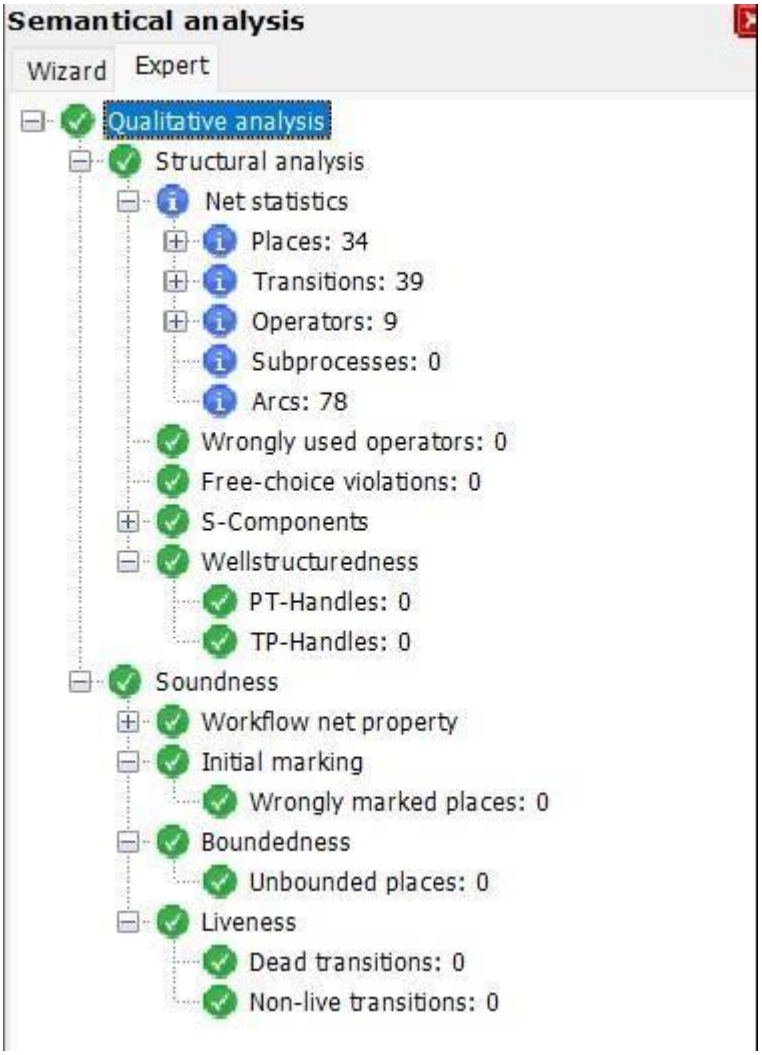
The Petri Net designed with WoPeD consists of 34 places, 39 transitions, 78 arcs, and 9 operators (XOR split and XOR join).
It should first be specified that there is one input place (START) and one output place (END); therefore, by definition, this is a workflow net.

The results of the qualitative analysis performed with WoPeD are reported in section 3.4, where it can be observed that the net is free-choice, since for every pair of transitions their presets and postsets are either equal or disjoint.
It is also an S-net, since the preset and postset of each transition consist of a single place (obviously, XOR operators are connected to multiple places, but when transformed into places and transitions, the same property still holds).
This implies that there are no deadlocks.

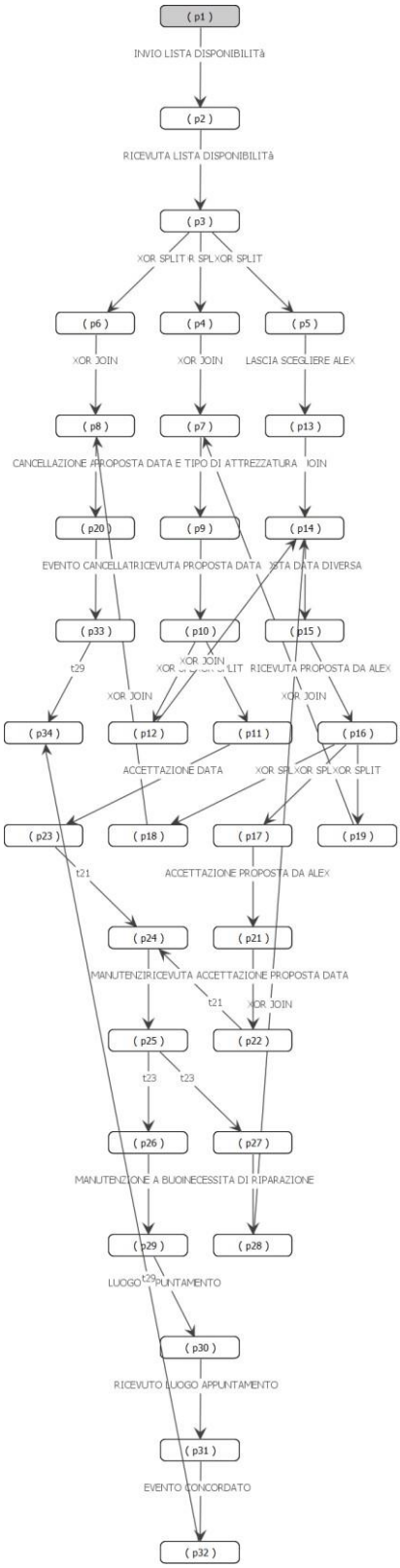
As a result, the software determines that the net is well-structured, meaning that the model is well-organized and can be decomposed into smaller subprocesses without causing ambiguity or conflict — in other words, no tp-handles or pt-handles are present.

The net is also sound, as there are no dead tasks (during execution, the token can pass through every place), there is a completion option (the token can reach the “END” place), and when the token is in the output place, all other places are empty.
The fact that the net is sound implies that it is also bounded and live.
The net is 1-bounded (meaning it cannot have more than one token simultaneously in each place), which also implies that the net is safe.

3.4 SEMANTICAL ANALYSIS WITH WoPeD



3.5 COVERABILITY GRAPH ANALYSIS

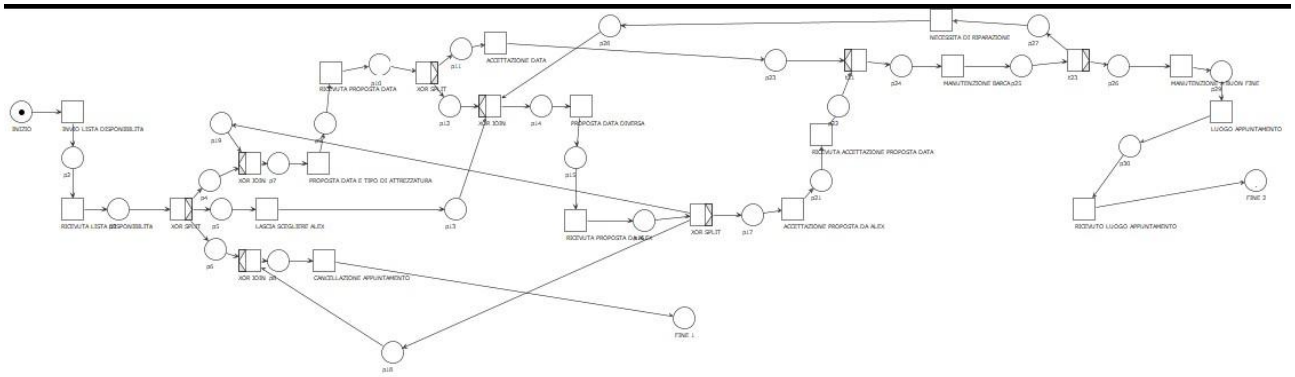


In this section, the coverability graph obtained with WoPeD is analyzed, which coincides with the reachability graph since the net is bounded.

This graph includes 78 arcs, 39 transitions, and 34 places.

The reason for creating this graph lies in its ability to accurately represent all the potential dynamics of the workflow net once it has been completed.

3.6 WORKFLOW MODULE



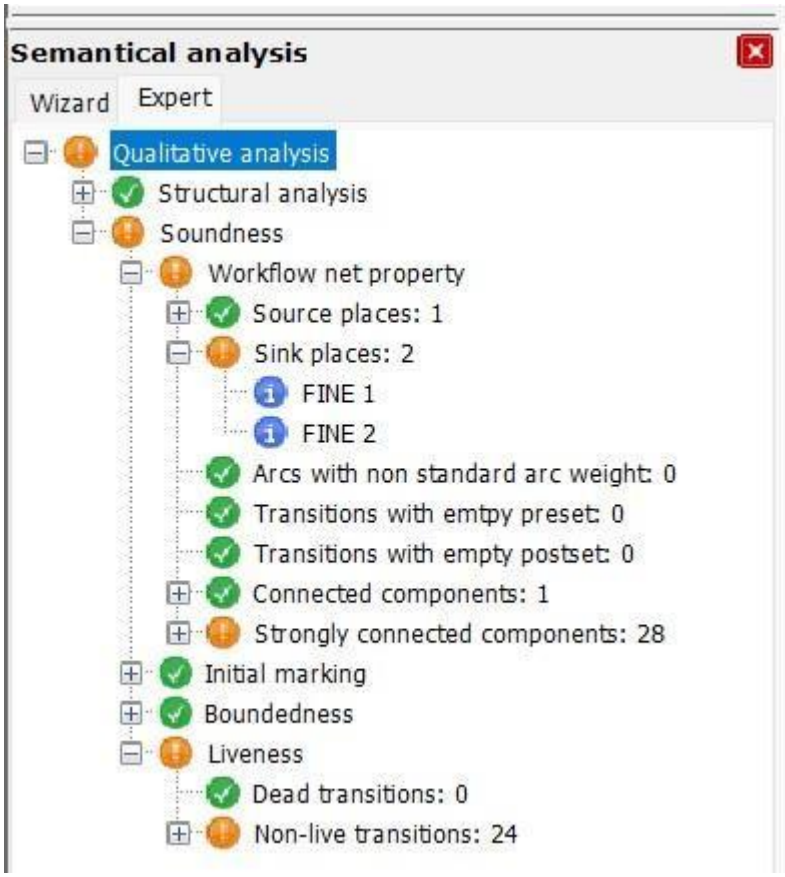
In this section, the workflow net is modified into a workflow module, with two output places instead of one:

- The first output place, “END 1”, represents the process ending with the appointment canceled.
- The second output place, “END 2”, represents the process ending with the appointment confirmed.

During the analysis of this workflow module, some aspects emerged indicating a lack of soundness. The workflow module contains 24 non-live transitions, meaning transitions that cannot reach an active state during process execution, causing deadlocks that prevent the workflow from being completed.
Moreover, 28 non-strongly connected components were identified, which means there are subsets of transitions and places that are not tightly interconnected, compromising the continuity of the overall process.

The presence of non-live transitions and non-strongly connected components indicates the possibility of weak soundness, meaning that even though the process does not always get stuck during execution, there exist scenarios where workflow interruptions may occur, leading to inefficiencies or delays.

At the bottom, the qualitative analysis performed with WoPeD on the observed workflow module is shown.



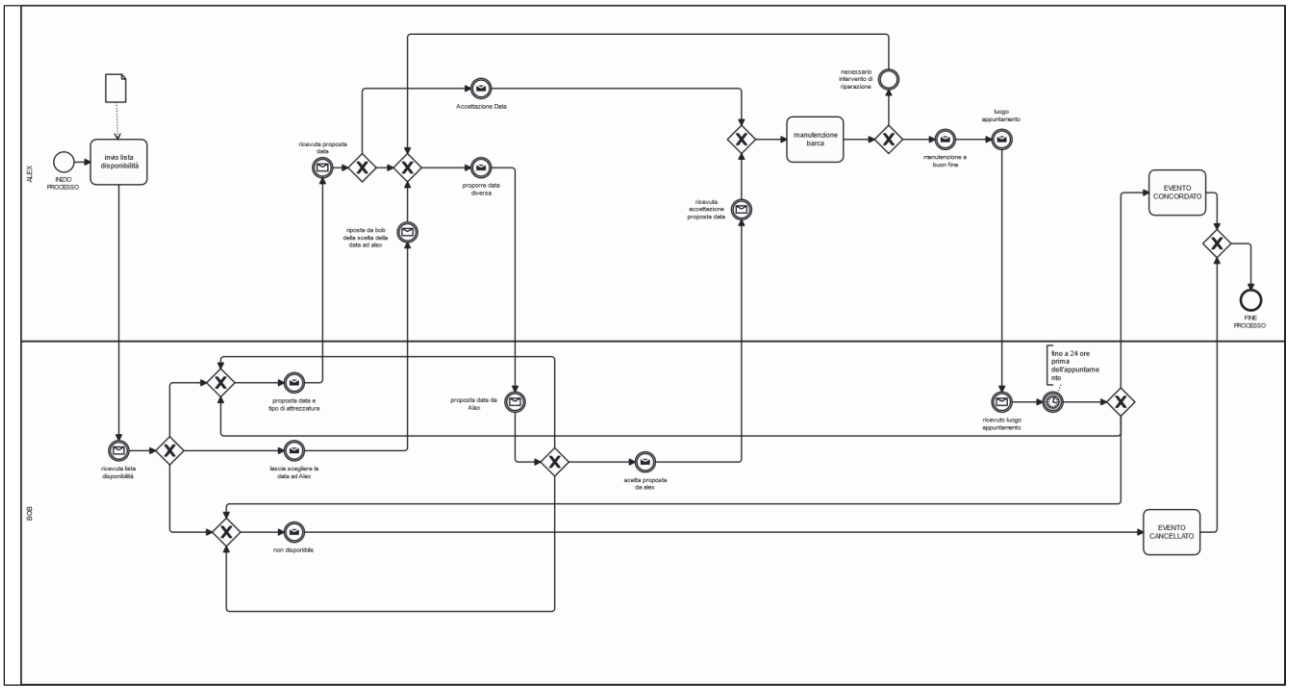
4 VARMODEL VARIANT

The extended process introduces an additional phase of interaction between Alex and Bob, allowing the latter to decide — up to 24 hours before the boat trip — whether to confirm, modify the date, or cancel the appointment.

4.1 BPMN MODEL

In this BPMN process, after Bob receives the meeting location from Alex, a timer event has been added, set to trigger up to 24 hours before the appointment.
This event is connected to an XOR split gateway, which leads to:

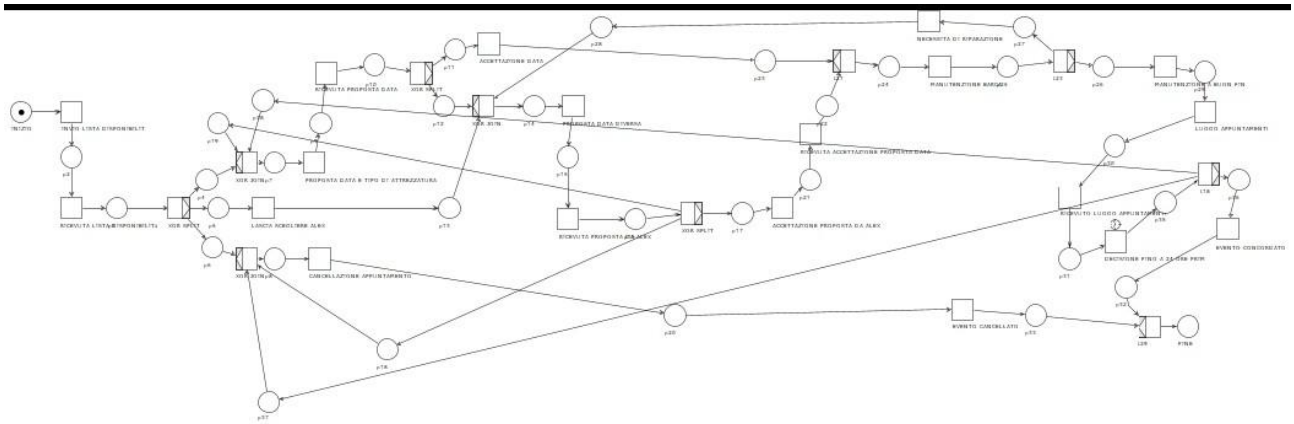
- An activity titled “AGREED EVENT”
- A join gateway connected to the event “Not available”
- A join gateway connected to the event “Proposal of date and type of equipment”



4.2 TRANSFORMATION INTO PETRI NET

The variant model (graphically illustrated at the end of section 4.1) was transformed into a Petri Net using the same rules described in section 2, with the addition of a timer transition.
This transition is connected to an XOR split transition via an arc and a place, which in turn are linked to their respective XOR joins, enabling the continuation of the process — either by finding a new mutually convenient date, canceling the meeting, or confirming the appointment.

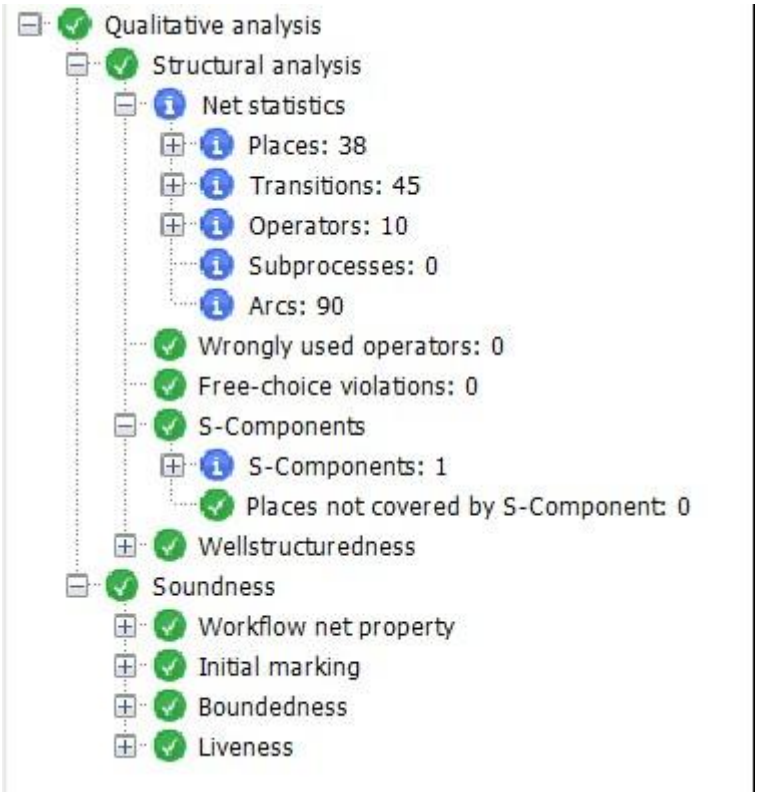
Afterward, the Petri Net of the variant model is presented.



4.2 PETRI NET ANALYSIS

Performing the semantic analysis with WoPeD, it was observed that this model is also sound.
It follows the properties of Petri Nets and maintains the characteristics of boundedness and liveness.
The net has a single s-component covering the entire structure, is well-structured (no tp-handles or pt-handles are present), and is free-choice.

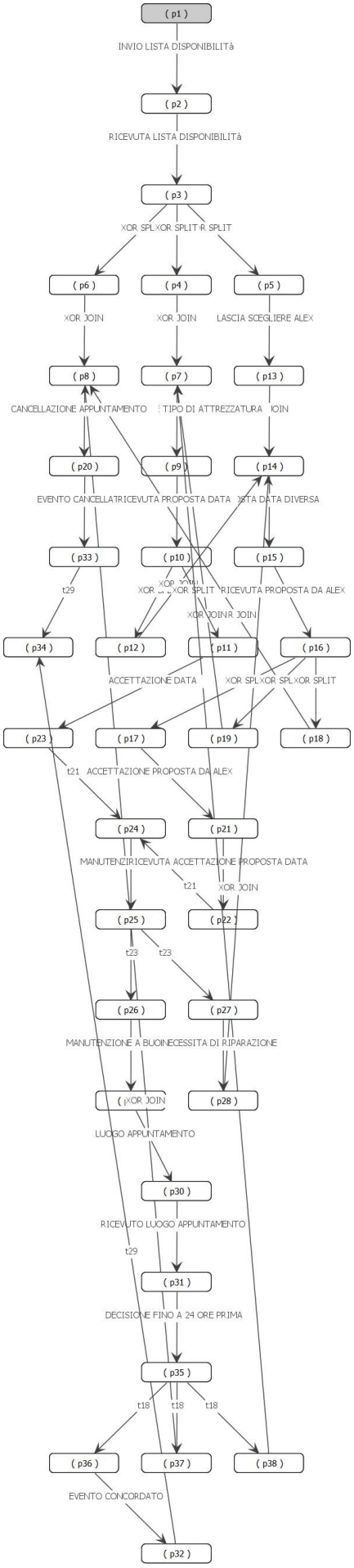
Compared to the previous model, it includes 38 places, 45 transitions, 10 operators (XOR split and join), and 90 arcs — data that reflect the modification allowing Bob to make a decision regarding the appointment up to 24 hours before the meeting.



4.3 REACHABILITY GRAPH

The coverability graph of the variant (which also coincides with the reachability graph, since this net is also bounded) highlights the system's ability to represent all possible configurations that can be reached during process execution — including intermediate states that arise from handling changes to the appointment.

Subsequently, the coverability graph of the variant model created with WoPeD is presented.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