COS 214 Project

War Engine

Project Report

RunTimeTerrorists()

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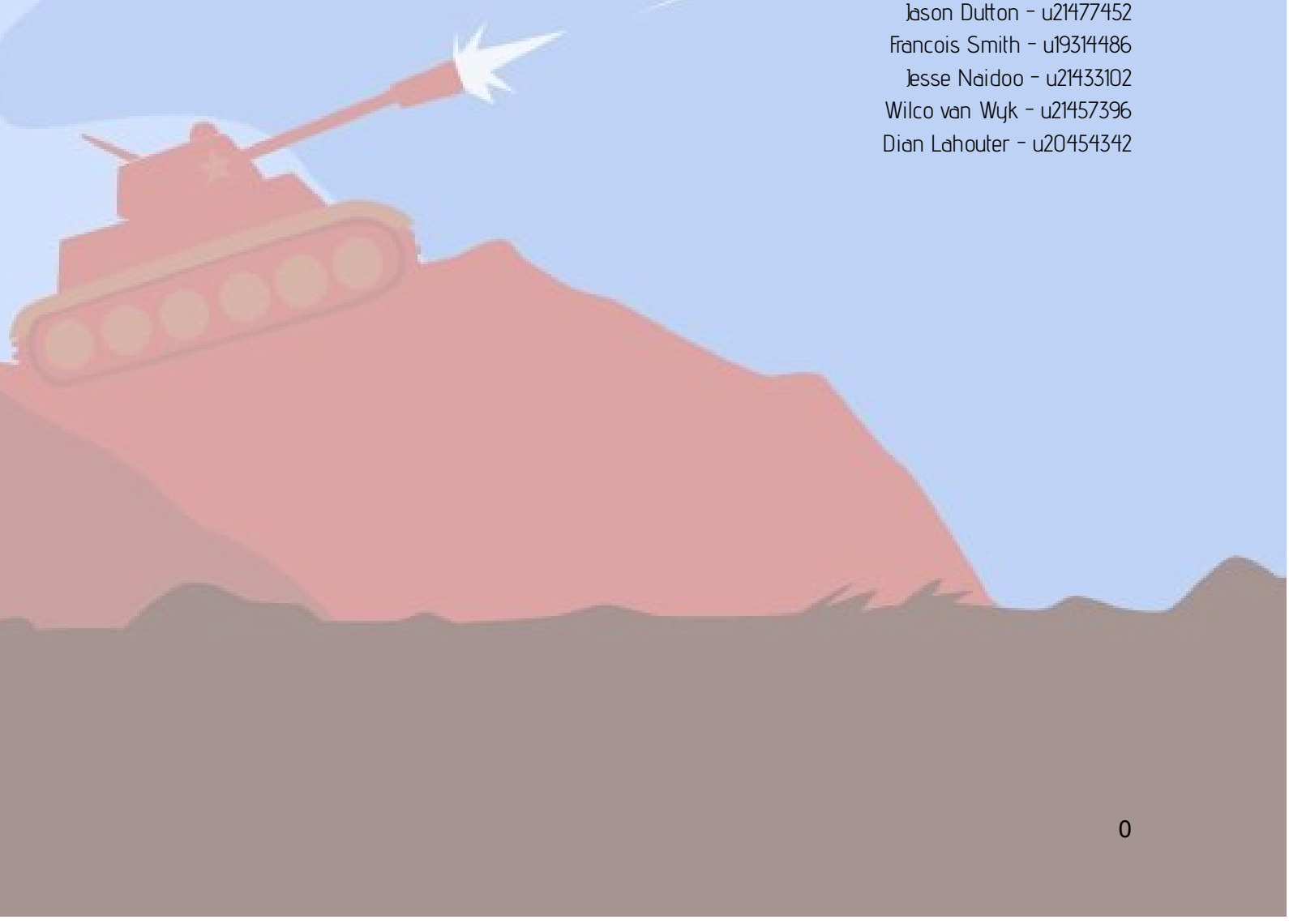

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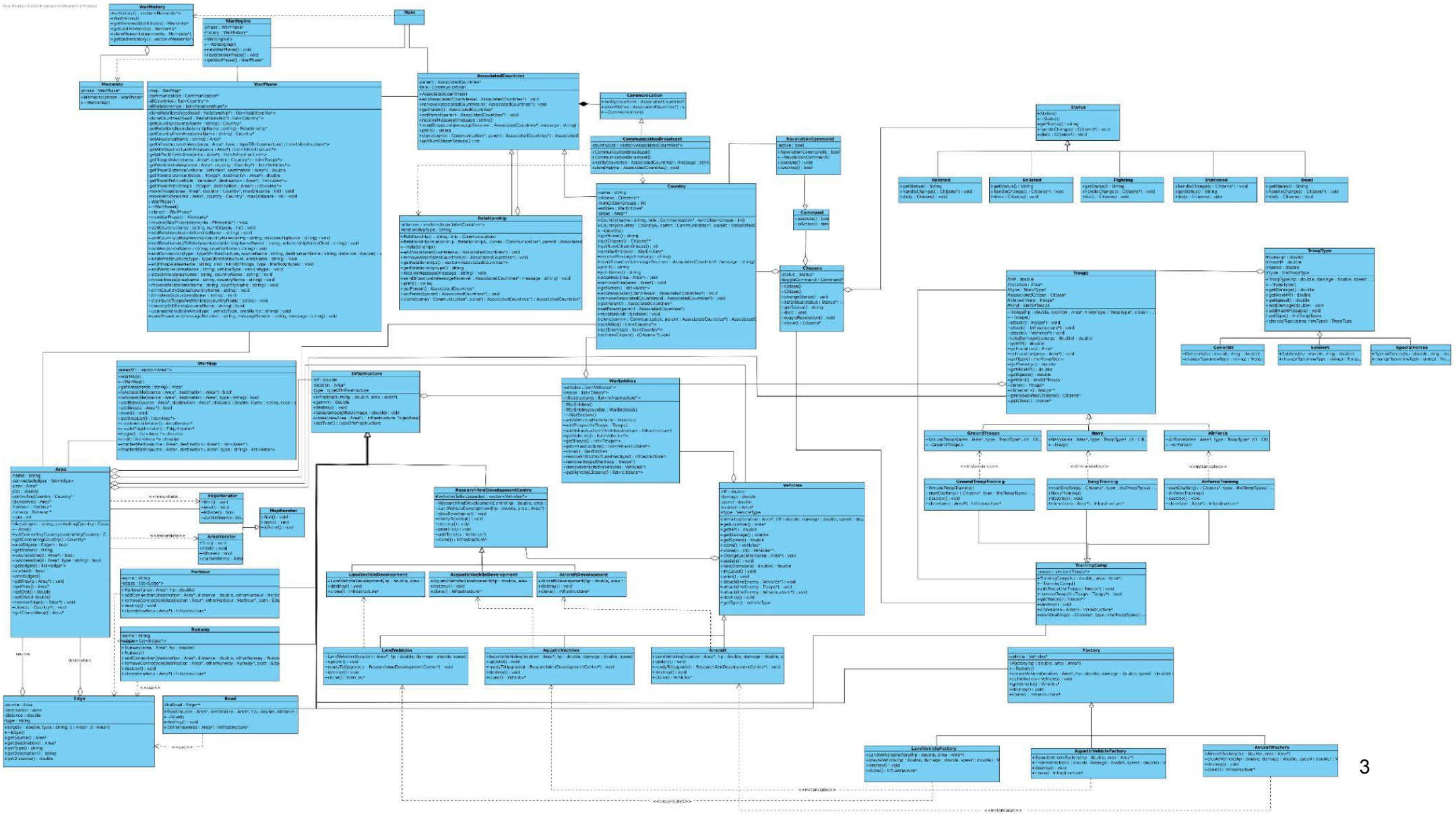
Introduction

The project brief required us, (the group - *RuntimeTerrorists()*) to design and build a “Generic War Simulator” that can simulate a war and model the different elements of war, by using an event loop that we refer to as the “war engine”.The simulator must be informed by the provided specifications in the brief as well as additional research on the various components of war.

This report covers the analysis of the designed simulation as well as the specifications that we implemented. It includes a brief description of all the design patterns used as well as the application of these patterns in our design and how it is used to simulate the war. The war in this project is roughly modelled around aspects of WWII and the simulation starts where two countries, France and Germany, are in disagreement with one another. These two countries and their allies represent similar political groupings to the Allied forces and Axis Powers as found in WWII. The dispute between the two forces increases and after a time of preparation the countries enter a phase of physical conflict . After the conflict the two forces assess the damage done and can decide to continue fighting, or settle the dispute and sign a peace treaty.

In the following report, we will elaborate on UML class diagrams, Design patterns and their application, and the research committed. The following section contains our UML Class Diagram followed by a short description of every design pattern used and how it is applied within our project.

UML Class Diagram



Design Patterns and Application

The following section describes each design pattern used in the project and all the classes associated with these design patterns.

1. Memento Design Pattern

Allows the current war phase to revert back to any previous phase by storing a history of all the warphases. Is used if users are not happy with an outcome and want to revert back to the previous state.

Participants:
Memento : Memento
Originator: WarEngine
Caretaker: WarHistory
State: WarPhase

2. Mediator design pattern

The Mediator pattern is used as a platform for communication between Country and Relationships (Colleagues). This is used when a country declares war against another country or even an alliance of countries and the it will let its own alliance know that they are now at war

Participants:
Mediator: Communication
ConcreteMediator: CommunicationBroadcast
Colleagues: Country, Relationship

3. Command Design Pattern

The Command Pattern is used to start or stop a revolution within a country (probably France). Only a group of Unlisted Citizens are able to invoke the RevolutionCommand and when a Revolution is active, then only the Stationed or Fighting Citizens can try to stop it. Thus, the Country (being the receiver) have fewer military troops when a revolution is active.

Participants:
Invoker: Citizens
Receiver: Country
Command: Command
ConcreteCommand: RevolutionCommand

4. Prototype Design Pattern

Return a prototype of either Aircraft, AquaticVechicles or LandVehicles by calling a clone function.
Participants:
Prototype: Vehicles
ConcretePrototype: Aircraft, AquaticVechicles and LandVehicles

5. Composite Design Pattern

The composite pattern is used to store all the countries that are in some way involved with the war, the ‘head’ node is a Relationship(Composite) node that will store more Relationship(Composite) nodes which represent a group of allies and store a number of Country(Leaf) nodes. The head node can also store Country (Leaf) nodes directly that are not allied with any other countries.

Participants:
Component: AssociatedCountries
Leaf: Country
Composite: Relationship

6. State Design Pattern

We used the State design pattern to alter the state of a group (object) of Citizens. These Citizens can either be in the states: Unlisted, Enlisted, Stationed,Fighting or Dead. The behaviour and general interactions with the rest of the systems differs, depending on which state a group of Citizens is in.

Participants:
State: Status
ConcreteState: Unlisted, Enlisted, Stationed, Fighting, Dead
Context: Citizens

7. Iterator Design Pattern

This design pattern is used to iterate over all the Area’s and Edge’s of the graph. Allowing you get every single Area and Edge one at a time.

Participants:
Iterator: MapIterator
ConcreteIterator: AreaIterator, EdgeIterator
Aggregate: WarMap

8. Observer Design Pattern

Used to notify and upgrade different types of vehicles

Participants:
Subject: ResearchAndDevelopmentCenre
ConcreteSubject: LandVehicleDevelopment, AquaticVehicleDevelopment, AircraftDevelopment
Observer: Vehicles
ConcreteObserver: LandVehicles, AquaticVehicles, Aircraft

9. Factory Method Design Pattern

Used to make different types of vehicles and troops in the war.

Participants:
Creator: Factory and TrainingCamp
ConcreteCreator: AircraftFactory, AquaticVehicleFactory, LandVehicleFactory, GroundTroopTraining, NavyTraining and AirforceTraining
Product: Vehicles and Troops
ConcreteProduct: Aircraft, AquaticVehcles, LandVehicles, GroundTroops, Navy and Airforce

10. Bridge Design Pattern

The Bridge pattern is used to define the Troops and the different TroopType. This allows us to easily create different variants of troops and create a cohesive Troop design.

Participants:
Abstraction: TroopType
RefinedAbstraction: Generals, Forces, SpecialForces
Implementor: Troops
ConcreteImplementor: GroundTroops, Navy, AirForce

UML Diagrams

After designing the system and determining the different design patterns that we are going to use, this section will focus on the behaviour of these classes and design patterns and how they interact with each other.

Object Diagrams:

The first diagram is a capture of the Red group and the airforce troops. The second diagram is a capture of the Blue group and their Soldiers and Land troops.

State Diagrams:

The first state diagram captures the state of a country when they are ready to go into battle. The second diagram captures the state of a country when they are preparing and reinforcing their troops and infrastructure.

Activity Diagrams:

The first activity diagram simulates the attack function. The second activity diagram simulates the process when a factory is created.

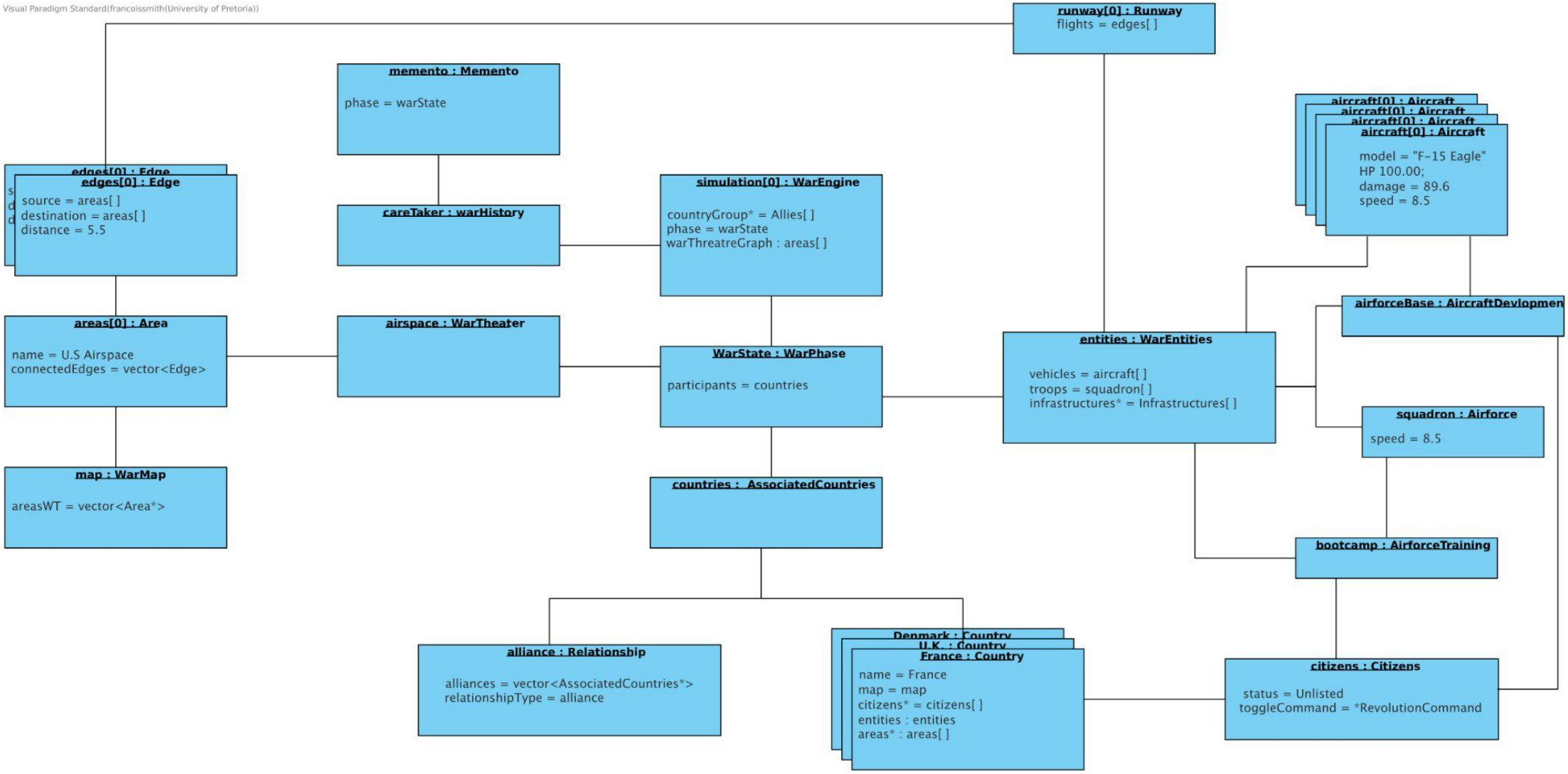
Sequence Diagrams:

The sequence diagram captures a large number of functions used by the main program running the simulation.

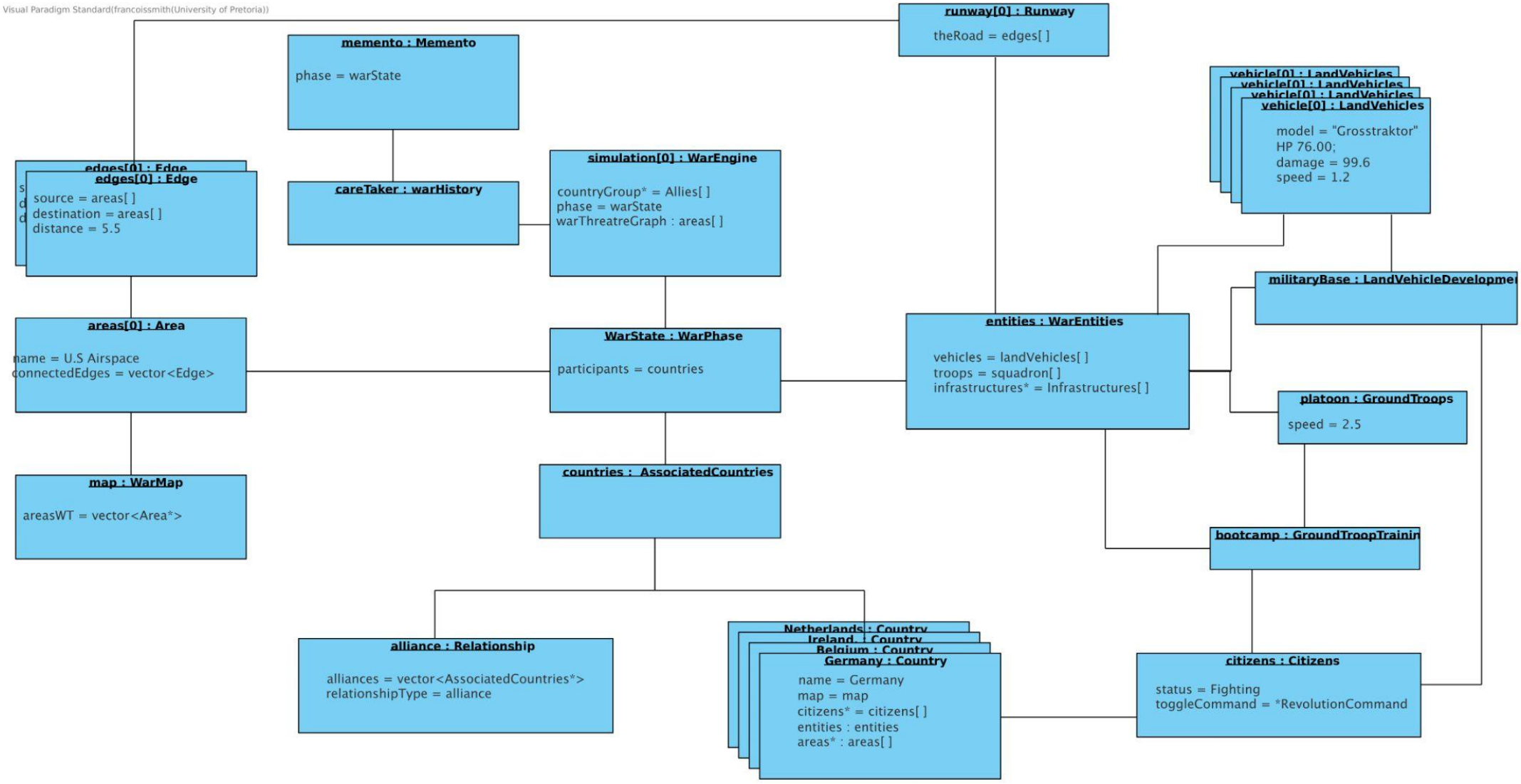
Communication Diagrams:

The communication diagram shows how a ResearchAndDevelopmentCentre interacts and upgrades different LandVehicles.

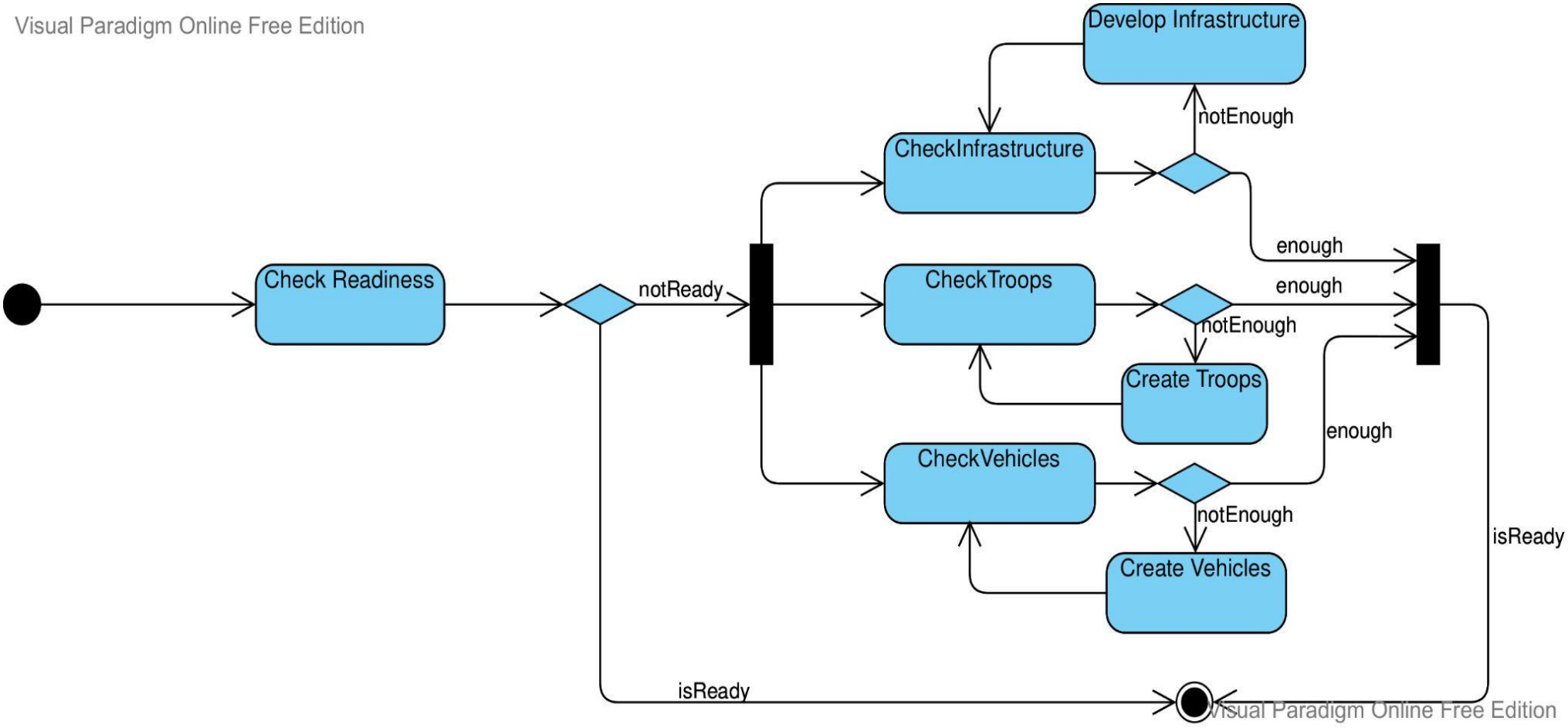
Object Diagrams 1:



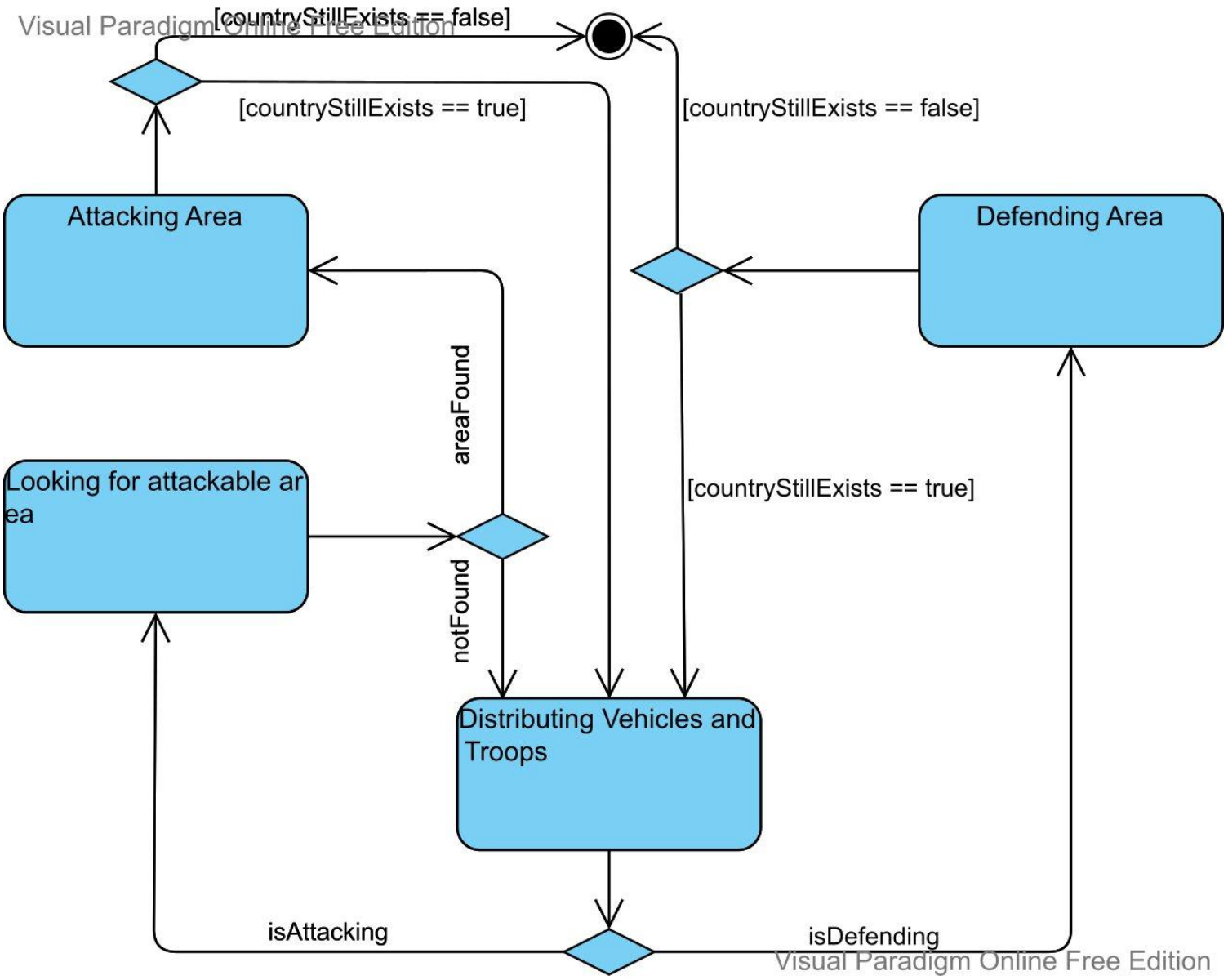
Object Diagrams 2:



State Diagram 1:



State Diagram 2:



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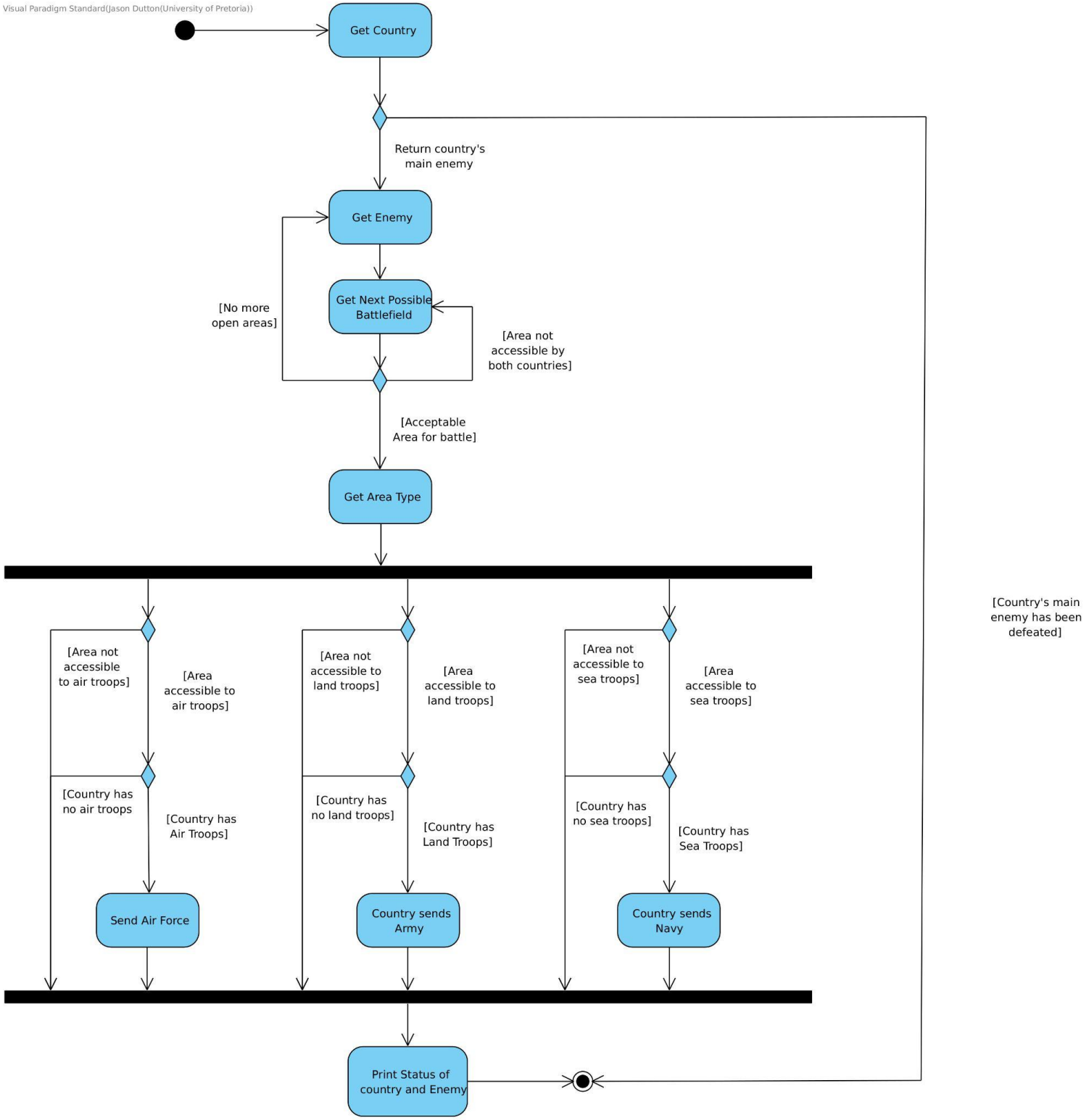
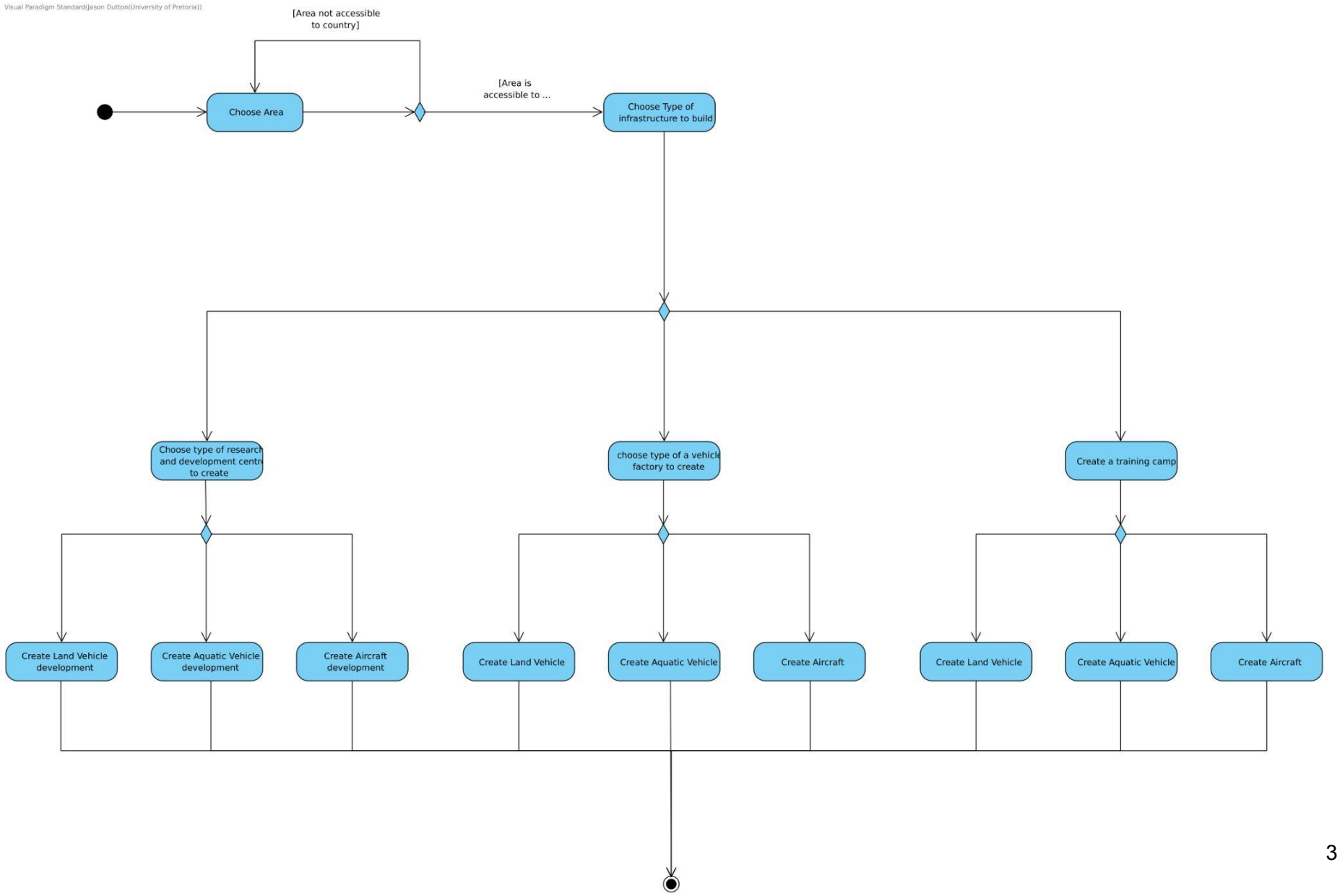
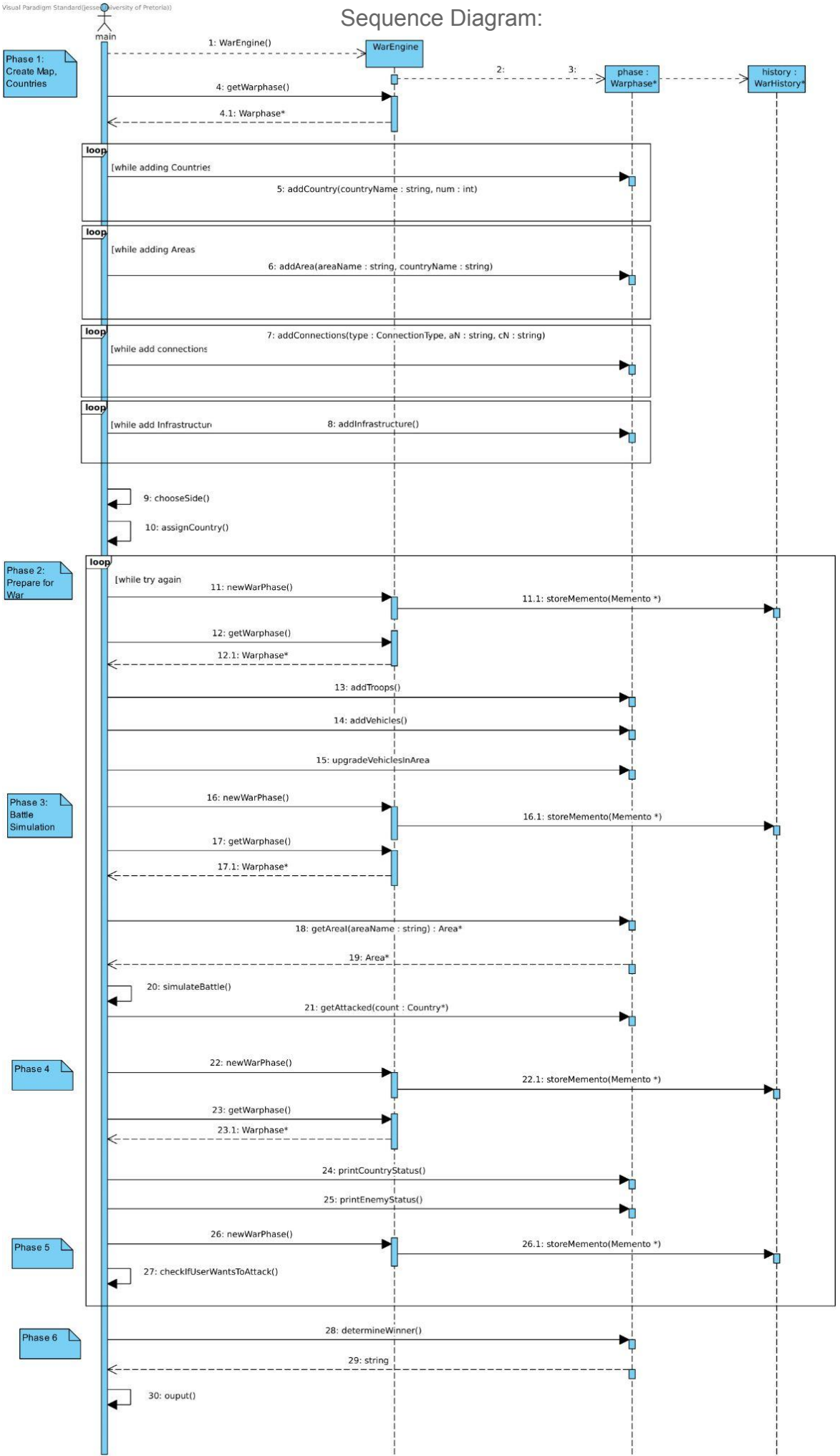
Activity Diagram1:



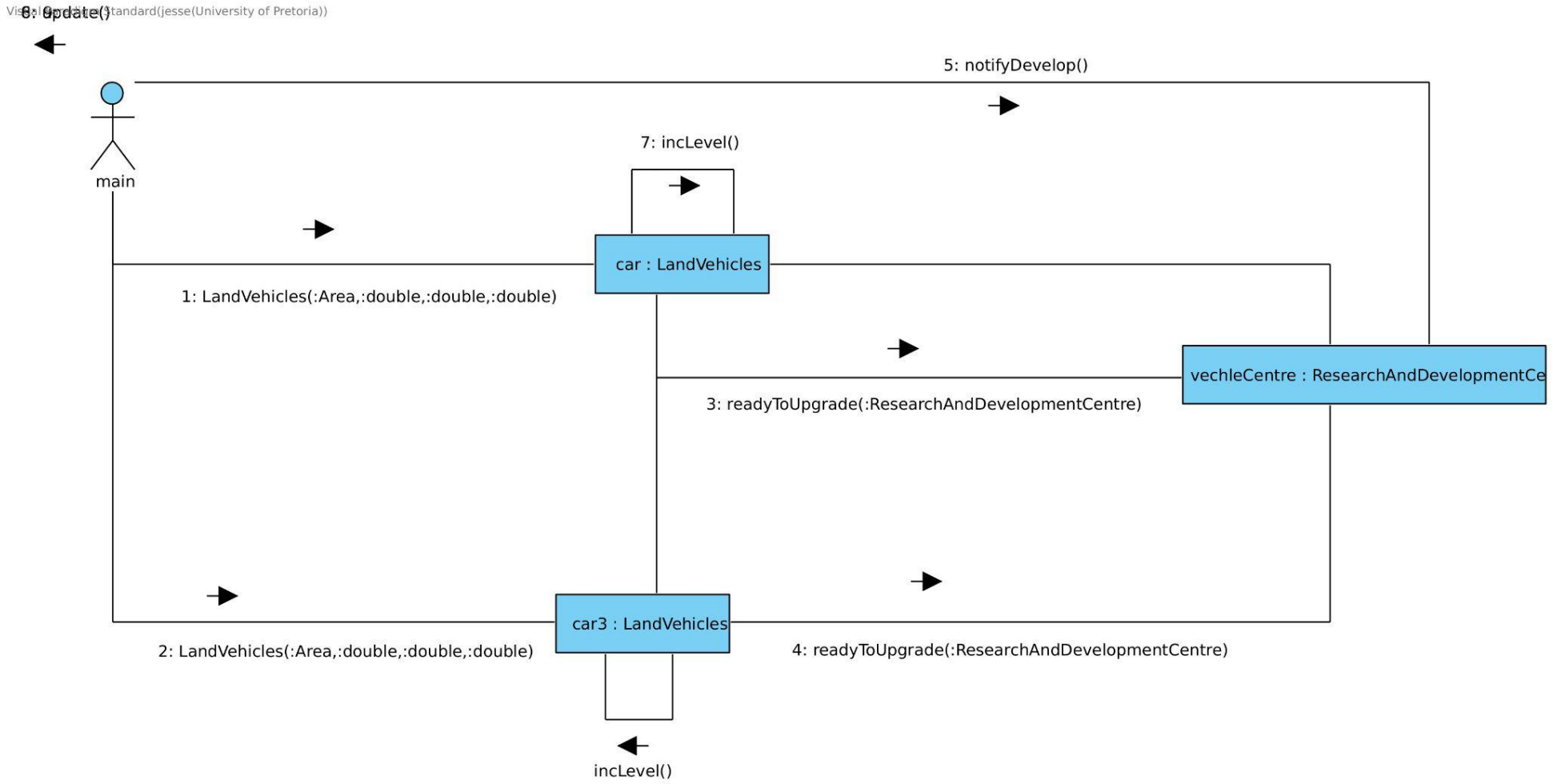
Activity Diagram 2:



Sequence Diagram:



Communication Diagrams:



Unit Testing

Designing a system as large as this one, it is crucial to write unit tests to test our code and prevent tiny errors and bugs that, in the greater scheme, will take forever to debug.

After a bit of research and some testing, we decided to use Doctest as our framework for writing unit tests.

We wrote 14 test cases that added up to 84 unit test that was used to test our code.
As seen in the file below the our code past all the test successfully.

```
g++ -c -std=c++11 -static *.cpp
g++ -std=c++11 -o main *.o
./main
==============================Start testing==============================
==============================End testing================================
[doctest] doctest version is "2.4.9"
[doctest] run with "--help" for options
=================Sending a message from UK to France================
United Kingdom is sending a message to France
France received a message:      Move all remaining troops to England
Germany is sending a message to Denmark
Denmark received a message:     No idea what message to do
=================Sending a message to ALL Blue Countries================
Germany is sending a message to Blue
Germany received a message:     This is a message to all the Countries
Netherlands received a message:         This is a message to all the Countries
Belgium received a message:     This is a message to all the Countries
Ireland received a message:     This is a message to all the Countries
==========Testing the ResearchAndDevelopmentCentre=============
France's citzens have started a revolution!!!
===============================================================================
[doctest] test cases: 14 | 14 passed | 0 failed | 0 skipped
[doctest] assertions: 84 | 84 passed | 0 failed |
[doctest] Status: SUCCESS!
```

Research

1. **Research introduction**

This section constitutes an overview of the textual research committed to inform the various aspects of war simulated through our war simulator .

These aspects include: War, War Entities, War Phases, War Theatre, Transportation, Components of Warfare
This project relies heavily on the work of General Carl von Clausewitz in his book *On War* (2006) to contextualise our approach to war and its various components.

1.1 War:

Starting with the most primary term, Levy and Thompson (2010: 5) defines ‘war’ as “a sustained, coordinated violence between political organisations”. Von Clausewitz (2006) breaks down his definition of war to its most elementary component as a “number of duals”. Von Clausewtiz (2006) contends that “war therefore is an act of violence intended to compel our opponent to fulfil our will”. According to this definition, the main aim of war is “to disarm the enemy” (Von Clausewitz, 2006). To do this, Von Clausewitz (2006) argues that the enemy must be put in a scenario that is “more oppressive to [them] than the sacrifice which [they] demand; but the disadvantages of this position must naturally not be of a transitory nature, at least in appearance, otherwise the enemy, instead of yielding, will hold out, in the prospect of a change for the better”.

The war simulated in this project will contain two conflicting countries. These countries will each have their own network of “allied” countries from whom they will receive military support and resources. The dispute between these countries will build up to a series of physical battles in an attempt to “disarm the enemy” (Von Clausewitz, 2006) that will either be won or lost. After every battle both countries will have to assess the damage that has been done. Based on the strengths and weaknesses of their ‘Troops’ and ‘Infrastructure’, countries will decide whether they will keep on fighting, or if they will surrender. If no one country chooses to surrender they will keep fighting until *the last man* is left standing. In the case where a country yields, a peace treaty will be drafted and signed through which the two warring countries will reach an agreement.

1.2 War Entities:

Warring entities refer to those agents, parties, forces or countries that are “ begin and engage in war (Moseley, [n.d.]) In the context of this project these entities include the countries that are involved in the war and the countries’ infrastructure. This will include everything from vehicles used for transportation, the troops that are fighting in battle, research development centres, training camps, even the citizens in the country involved in fighting the war.

The war entities are a critical part of warfare. In the simulation that we designed, the country that can best manage, distribute and maintain strong war entities, will most likely succeed in winning the war.

The entities involved in our simulation are France, UK and Denmark under the banner of the ‘Red Team’, and Germany, Ireland, Belgium and Netherlands as the ‘Blue Team’. These countries were chosen to fit and replicate a model similar to the principles found in WW2. with the Red Team simulating the Allied forces and the Blue Team, a group similar to the Axis powers.

1.3 War Phases:

According to Bloomfield (1997) there are six phases of war, including “dispute, conflict, hostilities, post-hostilities conflict, post-hostilities dispute and the settlement”, as is illustrated in figure 1 below. This section briefly explains each stage and elaborates on how it has been used to inform our project.

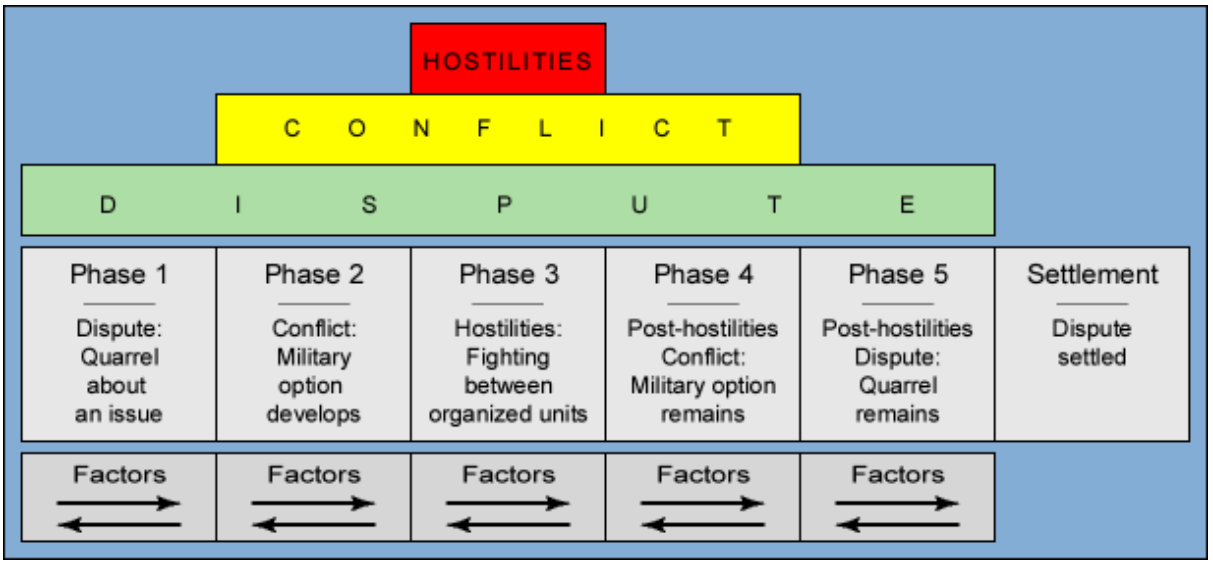


Figure 1: Bloomfield-Leiss Dynamic Phase Model of Conflict. (Bloomfield, 1997) Available from: https://web.mit.edu/cascon/warend.html

1.3.1 Dispute:

Refers to the existence of a dispute between entities before “significant military powers become relevant” (Bloomfield, 1997). In the context of our project, this constitutes the start of the simulation. France and Germany are in a disagreement, creating the two forces involved in the war. In this first phase the simulation will choose “a side” and start creating alliances with neighbouring countries (Germany with Ireland, Belgium and Netherlands, and France with the UK and Denmark), to help them in the war.

1.3.2 Conflict

The stage where military conflict seems probable and possible, and warring entities prepare by deploying military forces and weapons (Bloomfield, 1997). During this stage in our project, both parties (France and Germany) start to either create troops, create vehicles or upgrade their vehicles. This phase focuses on the preparation and reinforcement of war entities, (or military forces), progressing the entities into a state of full alert.

1.3.3 Hostilities

The hostile stage takes place when what has existed simply as a dispute so far crosses over into active “fighting” (Bloomfield, 1997). At this stage conflicting countries start attacking enemy areas, in an attempt to overthrow and take control of the area. If a country ceases to retain control of their areas the country is completely taken over and is no longer part of the war.

1.3.4 Post-hostilities Conflict

This phase refers to a temporary “armed-truce” (Bloomfield, 1997). However, there is no end in sight for the “conflict, let alone a settlement for the underlying dispute” (Bloomfield, 1997). After all the active “fighting”, all entities enter a phase of assessment. A report is generated containing the info of all remaining entities after the ‘hostilities phase’.

1.3.5 Post-hostilities Dispute

This phase refers to the extraction of military forces whereby all that is left of the conflict is the dispute itself (Bloomfield, 1997). This phase is applied in our project as a decision node. Based on the report received in phase four, countries can decide whether they want to keep fighting or continue to settle the dispute. If a country reaches this stage and their resources are completely depleted, it would be advised to draft a peace treaty and settle the dispute.

1.3.6 Settlements

The core of the conflict - the dispute- is settled (Bloomfield, 1997). During this stage in our simulation, one of the parties decides to resolve the dispute and come to an agreement.

1.4 War Theatre

As provided by the brief, ‘war theatres’ are defined by Von Clausewitz (2006) as: “a portion of the space over which war prevails” which has its “boundaries protected, and thus possesses a kind of independence”. Von Clasuewitz continues that “[s]uch a portion is not a mere piece of the whole, but a small whole complete in itself; and consequently it is more or less in such a condition that changes which take place at other points in the seat of war have only an indirect and no direct influence upon it”. Further defined in the *Department of Defense Dictionary of Military and Associated Terms* (2010: 242) as the “area of air, land, and water that is, or may become, directly involved in the conduct of major operations and campaigns involving combat”.

In our project the theatres of war include:

1.5 Transportation

When considering transportation during war we categorised transportation vehicles based on the departments or branches of the military. The *Department of Defense Dictionary of Military and Associated Terms* (2010: 247) defines a 'transportation system' as the " land, water, and air routes and transportation assets engaged in the movement of …forces and their supplies during military operations…" According to Redmond *et al.* (2013: 10) the military consists of five branches: "Air force, Army, Marine Corps, Navy, and Coastal Guard". We chose to use the following three branches in our project as they provided overarching categories (land, water and air - as per the definition of war theatres given above) in which to categorise different transportation vehicles.

The Air force:
Concerned with the protection of "air, space and cyberspace" by airmen (Redmond *et al.,* 2013: 11). When referring to "aircrafts" in the project it includes any and all military aircrafts.

The Navy:
Concerned with the maintenance, training and equipping of "combat ready naval forces" on sea (Redmond *et al.,* 2013: 11). When referring to "navy vehicles" in our project we include any and all military water-based naval vehicles.

Army:
Concerned with a range of "military operations" based on land (Redmond *et al.,* 2013: 11), providing "ground forces" to protect countries (US Department of Defense, (n.d.)). When referring to "Vehicles, LandVehicles" in the project we include any and all ground-based military vehicles.

Based on these military branches, we use the general categories of to encapsulate all vehicles included under these categorisations such as to be used in the war…

1.6 Revolution

When a country is at war, a lot of its resources and entities are vulnerable and susceptible to change. The citizens of a country are directly affected by their country being at war. These circumstances usually cause some groups of citizens to start a revolution.
"the weakness of the conservative groups, which may be caused by disputes among themselves, disaffection in the amy, international complications, or domestic crises" (Gottschalk, L., 1944)

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