Aalto-yliopisto
Teknillinen korkeakoulu

## Mat-2.4177 Operaatiotutkimuksen projektityöseminaari
## Research plan

# Modeling logistics network in a crisis situation

**Client: Puolustusvoimien Teknillinen Tutkimuslaitos (PVTT)**

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**Research team:**
**Forsberg, Tero**
**Kaikkonen, Ilkka**
**Kullberg, Niklas**
**Männistö, Toni k93646**

## Background

In a situation of crisis, it is important to provide help to people in trouble, and it is also extremely challenging to do that. After a serious catastrophe, like an earthquake, to get food, medicine and other relief supplies distributed to people in the area requires well-planned operations and lots of resources. Because resources in crisis areas are often very scarce, in order to reach as many people as possible, operations need to be efficient.

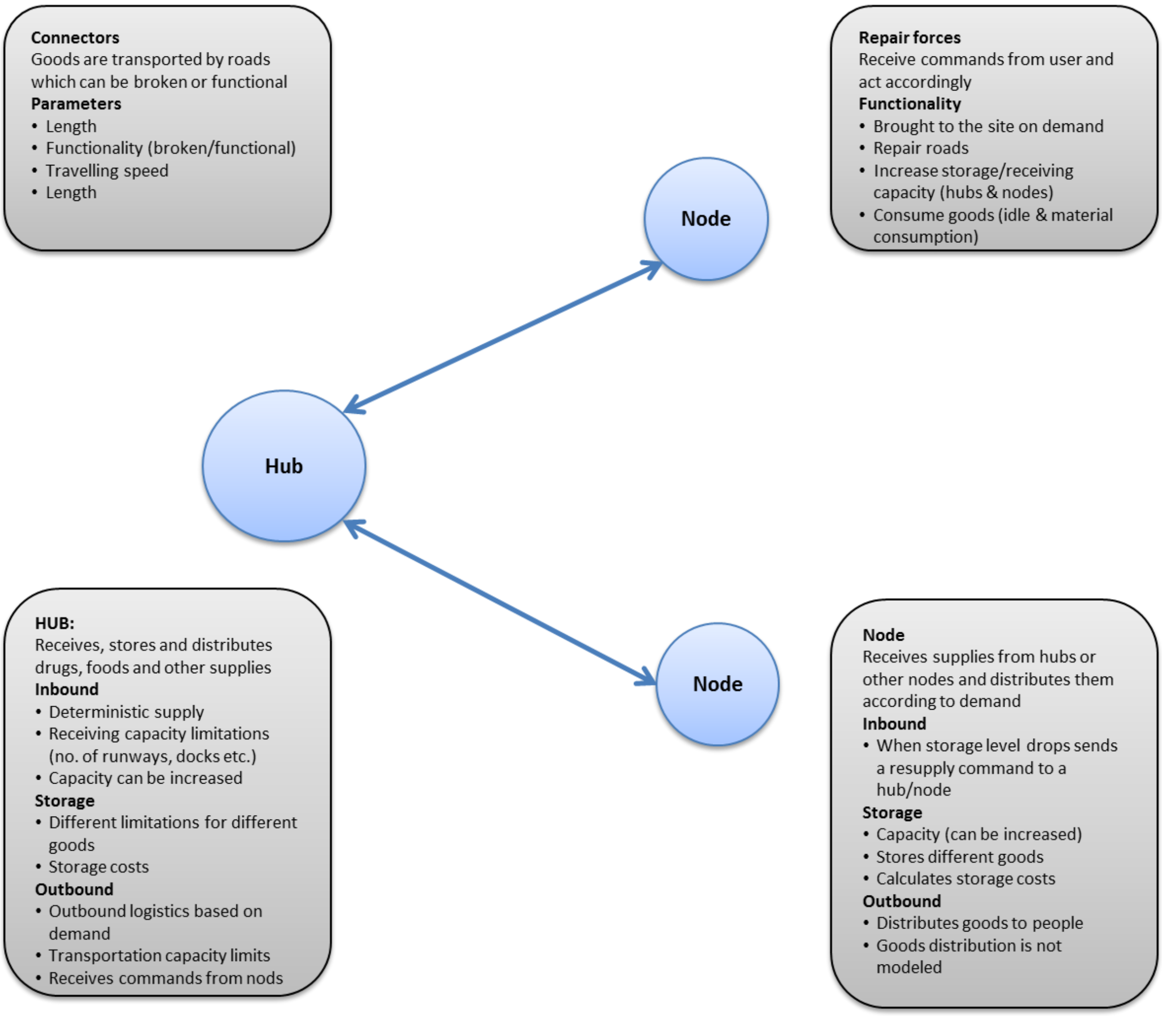
This work is inspired by the earthquake in Haiti in January 2010. The earthquake affected millions of people, and humanitarian operations on an island were massive. The case example that we are going to simulate takes place in an island state, like Haiti, where a serious earthquake happens destroying large part of the country's infrastructure and leaving people in trouble. Several countries and humanitarian organizations start immediately planning how to distribute relief supplies to the catastrophe area, and how to help as many people as possible. Because of damaged infrastructure, it is beneficial to send not only relief supplies, but also repair forces who can repair destroyed roads, food and medicine distribution facilities, harbors, airports and so on. For example, broken road connections can be repaired by the repair forces. This improves required infrastructure which is necessary in the distribution activities (e.g. more relief flights can land on a repaired airport).

Understanding the logistic network, that is used to distribute supplies to people in trouble, is important to make distribution system efficient. By simulating what happens in the network, it is possible to find out possible weak spots of the network, and figure out, on the one hand, which parts of the network work well, and which parts are in a need of improvements.

## Objectives

For an International Data Farming Workshop, a team of The Finnish Defence Forces is finding answers to the question how to get needed resources to the necessary locations to assist the victims of a catastrophe as soon as possible. To help them with that dilemma, our objective is to create a simulation model that can be used to simulate the logistic network in a catastrophe area, where resources are extremely limited, roads and facilities might be damaged and need of aid is immediate. Together with the customer, we will determine a research problem that is related to the research that customer's team does for the workshop mentioned above. Next, we will build the simulation model in a way that we can find answers to our research problem.

The basic structure of our simulation model is presented in picture 1. In other words, our goal is to build a deterministic model to simulate a logistic network. Network has several nodes and hubs, which represent either points where supplies are brought to the network, like airports and harbors, or points where supplies are stored and distributed to people. Every node is tied to a coordinate, and has on the one hand storing capacity, and on the other hand consumption rate that consume the supplies offered. When inventory level drops down to a certain level, resupply order is sent to another node or hub, where there are supplies available for sharing. Connections between nodes as well as facilities on nodes might be damaged, and for that reason there are repair forces that are able to repair and add capacities of facilities. Repair forces naturally consume the scarce resources, which also will be taken into account in our model.




**Picture 1: Graphic presentation of key features in the model**

Though we will use Haiti as a case example, objective is that this model can easily be modified. User of the model may determine the locations of the nodes, connections between the nodes as well as capacities of the nodes freely, so it can be used to simulate logistic networks in any other situation and in any other area as well.

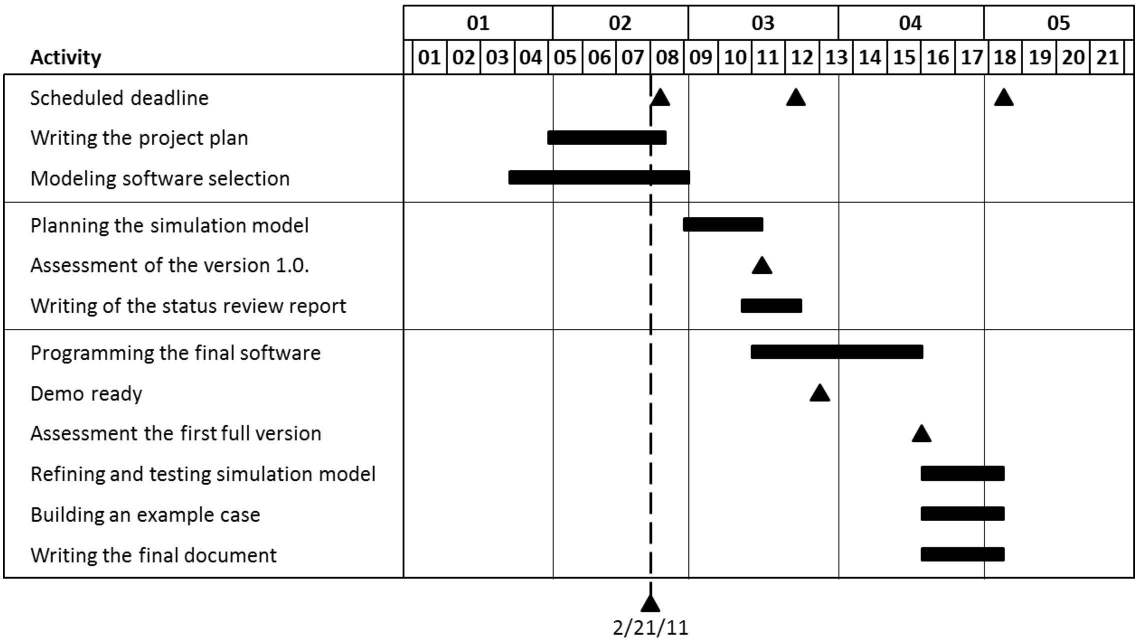
## Methodology

The project will be completed in three phases 1) Model definition 2) Model creation and 3) testing and implementation. We have broken these phases into tasks which can be seen from table 1.  Task list shows also work allocation. We have recognized that model definition as well as programming will be crucial to complete the project successfully which can be seen from work allocation. Our group doesn't have much programming experience so we must allocate enough time for learning in addition to programming.

Table 1: Key tasks and their description

| Task | Description | Labor allocation (h) |
|---|---|---|
| **T1 Kick-off meeting between the client and the project team** | Definition of objectives, scope, methods and schedule of the project | 20 |
| **T2 Writing of the project plan** | Documentation of the issues discussed and decided in the kick-off meeting | 50 |
| **T3 Selection of the modeling software** | Determination of criteria of the modeling software, short listing of potential alternatives. Selection of the software. | 25 |
| **T4 Planning the simulation model** | Creating a detailed blueprint of the model defining necessary bounder conditions and choosing the target of analysis | 100 |
| **T5 Assessment of the version 1.0.** | Critical review of the capabilities and weaknesses of the blueprint together with the customer | 10 |
| **T6 Writing of the status review report** | Writing the status review report in as described in course schedule | 25 |
| **T7 Programming the final software** | Implementing the plan | 150 |
| **T8 Writing of the final report** | Writing the final report in accordance with guidelines of the course and the client. | 50 |
| **Total** | | 430 |

The project team consists of four people. Ilkka Kaikkonen will act as the project manager and has the overall responsibility. As there are no special areas of expertise everybody must participate in all phases and we must function as a group. In order to reduce the risk of losing a group member every task must be performed by at least two people, so that no information bottlenecks gets created. We will control project advancement trough monitoring deliverables instead of hours. Thus each stream of the Gantt chart below (picture 2) has a predefined deliverable.




**Picture 2: Gantt-chart illustrating project execution timeline**

We have identified four risks which may have an impact on our ability to complete the project. We have also created ways to mitigate the risks to undermine the effects that the risks may have if they are realized. One system level defaults that our group has is lack of programming skills. The biggest risk is however the loss of one group member which we try to mitigate through information sharing. In case of loss the rest of the group must pick up the slacks and try to cope.  Model definition must also succeed since otherwise the workload and the quality of deliverables may suffer. The risks are summarized in table 2.

**Table 2: Summary of the identified project risks**

| Risk | Mitigation | Effect if occurs | Probability |
|---|---|---|---|
| A group member becomes disabled to complete his duties | • Working in groups<br>• Tight communication | • Time delays<br>• Quality may suffer<br>• Others must work harder | |
| Inability to learn programming | • Reserving enough time for learning | • Deliverables are of poor quality<br>• Workload increases | |
| The scope of the project is poorly defined | • Defining and assessing the simulation together with customer before programming | • Customer dissatisfaction<br>• Workload explodes | |
| The resulting model is too heavy or not relevant to customer | • Defining and understanding customer needs | • Customer dissatisfaction | |