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# TIAMAT: A Multi-touch Tablet IDE for AmbientTalk

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# Chapter 1

## Introduction

### 1.1 Goal

This document is made to be a guide with the organisation, implementation and evaluation of the TIAMAT project. It will explain choices that have been made concerning the implementation and will evaluate the relevances of the chosen solution. To illustrate this all the specifications of this project will be listed and we will explain how these are implemented. Next to a reflection about how we implemented the project we will also provide some context. This being why the project is made, who will be using it and as last we will have a look at some related work. Next to the implementation we will have a social experiment with the application. We will distribute the app to several people and let them test the app. We will evaluate if the app is an improvement to the old apps which provide the possibility to create some AmbientTalk programs. Thanks to the implementation details the users of the application will be able to use this document as a reference to find what the possibilities of the app are. They can guide a user to use the app to its fullest potential.

### 1.2 Scope

The scope of this project is a third bachelor thesis at the Vrije Universiteit Brussel. The 3th bachelor thesis is given at third bachelor students computersciences. The goal of this bachelorthesis is to let the bachelorstudents participate in some actual research at the university. This has been chosen over giving the students a predefined task.

## 1.3 Definitions and Acronyms

VUB	Vrije Universiteit Brussel
IDE	Integreted Develepment Enviorment
AST	Abstract Syntax Tree
MANET	Mobile Ad-Hoc Network
OHA	Open Handset Alliance
App	Application. Programs on smartphones and tablets
MT4j	Multi-Touch for Java

## 1.4 Product Placement

This product is an IDE for AmbientTalk on Android devices. AmbientTalk is a programming language developed to mainly program within Mobile Ad-Hoc networks. MANETs are mostly used to program for mobile devices like smartphones and tablets. AmbientTalk is developed to be able to handle with possible disconnects within a MANET.

As AmbientTalk programs are made for Android devices one should be able to program on the Android device itself. Currently, on pc's, AmbientTalk is programmed in Eclipse. There are currently several apps which port Eclipse to Android. The only drawback is that these are not developed to be really useable on these devices. Most of them even assume that there is a keyboard connected to the tablet. Other drawbacks are that the screen of the pc version of Eclipse would not fit a much smaller tablet or smartphonescreen.

The goal of this product is to be a usefull alternative to program AmbientTalk code on an Android device. We won't make use of the existing technologies of Eclipse but instead we will develop an entire new technique based on the usage of the internal AST. We will manipulate the AST directly instead of creating a sequence of statements which will be mapped to an AST afterwards.

By manipulating the AST we can make use of predefined templates. This will help to create sourcecode without defining a sequence of statements. For every possible part of an AST a template is created which can be added to the current AST, making it possible to create an entire program.

## 1.5 Users

The goal of the Application is to be able to create programs on the Android devices. As AmbientTalk is programming language one should have basic knowledge of programming within the AmbientTalk environment. Without a knowledge

of the AmbientTalk language it is not easy to create a sound program. As AmbientTalk is developed at the university and momentarily is used as an example on different conferences the app can be helpful to create a small example of an AmbientTalk program instead of always need to use a computer.

## **1.6 Used Software**

### **1.6.1 AmbientTalk**

AmbientTalk is a programming language developed at the VUB in 2005. The goal of the language was to focus on making programs within Ad-Hoc networks. This means that AmbientTalk is developed mainly to create programs on mobile devices. AmbientTalk combines elements from other programming languages such like Scheme (closures), Smalltalk (pure OO), Self (prototypes and delegation) and some other languages.

AmbientTalk was originally a part of a doctorate study made by Jessie Dedecker. His goal was to create an extension to the already existing programming language Pic% (pic-oh-oh). Pic% itself was an extension of Pico. Pico was developed by professor Theo D'Hondt in 1996. Pico was developed merely to be used with an educational purposes. Pico is being used as a programming language to illustrate how programming languages are being made.

Pico got it's design principles and concepts from Scheme. The goal of Pico was to be a programming language based on simple rules, easy to extend. Thanks to the simplicity and extandability of Pico this language is often used to do some research to possible extensions and features for programming languages. This is the reason why a lot of offsprings of Pico are created, all with their own special attention to certain problems or extensions. When AmbientTalk was being developed special attention was given create distributed programs within ad-hoc networks. Momentarely AmbientTalk/2 is being used. It's the successor of the original AmbientTalk. Even though AmbientTalk/1 was already succesfull concerning the programmingfeatures for mobile Ad-Hoc networks it lacked some important features to create bigger software applications, such like exception handling,...

In 2006 Tom Van Cutsem and Stijn Mostinckx started developing AmbientTalk/2, the current version of AmbientTalk. The changes between AmbientTalk/1 and AmbientTalk/2 are quite big. There has been made an entire new design for most aspects of the language, including the syntax. The reason to change the syntax was to make AmbientTalk more accesible for people who don't have any experiance with Pico.

AmbientTalk is still mainly used by students at the VUB to do some research. But, slowly but surely, AmbientTalk became a usefull, handy programming lan-

guage which was usable to create some rather big programs. Because the focus of AmbientTalk lies within the distributed networks and this is still an area in which a lot of research is being done there aren't a lot of good alternatives. This made AmbientTalk a good alternative to create some real-life software.

The symbiosis with the underlaying Java Virtual Machine enables the possibility to use some parts of the Java programming languages within AmbientTalk, which makes it possible to combine both languages within one project.

The renewing element of AmbientTalk is so big that it became the main subject of the Distributed and Mobile Programming Paradigms course taught at the VUB.

## 1.6.2 Google Android

### General

Android is an open source platform, owned by Google, for mobile devices. Android is developed by Android Inc., a company bought by Google in 2005, which later placed it within the OHA.

It's an on Linux based operating system and is mainly programmed in C (core), Java (UI) and C++.

Android is originally created by Android Inc., a company founded by Andy Rubin, Rich Miner, Nick Sears and Chris White in 2003. Their goal was to create an operatingsystem for... smarter mobile devices that are more aware of its owner's location and preferences.

On october 17th 2005 Google bought Android Inc. and made it a part of their company. Even after Google bought the company founders Andy Rubin, Rich Miner and Chris White kept working for Android. Allready back then the goal of Google was to focus on the market of mobile devices with Android.

Only on december 9th 2009, together with the founding of OHA, the first product of Google concerning the market of the mobile devices was announced; Android. An on Linux kernel version 2.6 based platform for mobile devices.

According to estimations in the second quarter of 2009 approximatly 2.8% of



Figure 1.1: Android logo

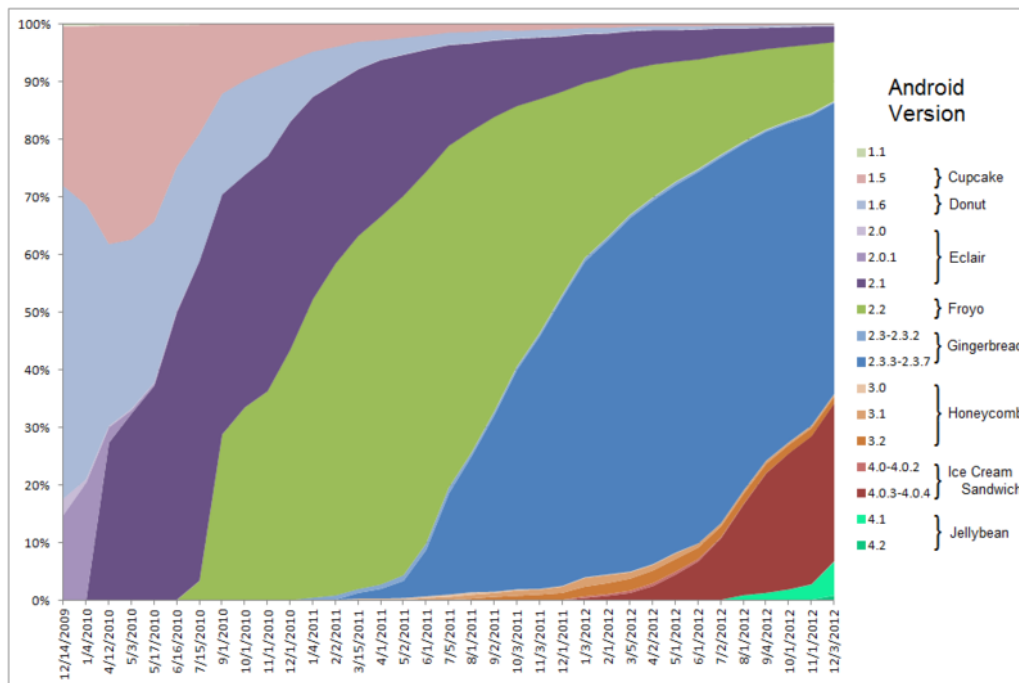


Figure 1.2: Android historical version distribution

new smartphones had Android as operating system. In the fourth quarter of 2010 this number was grown to 33% what made it the best selling smartphone platform. In the third quarter of 2011 this would already been grown to 52.5%. In february 2012 Andy Rubin said that Google activates 850000 smartphones or tablets on a daily basis.

## Versions

Through the years multiple versions of Android were released. In november 2007 there was a beta version released, but only on september 23th 2008 Android 1.0 was released. Android 1.0 was introduced on the HTC Dream. This version was already equipped with the Android Market, an application which gives you the option to download and update new applications, camera support, synchronisation with, and use of, most Google products, like Gmail, Google Calendar, Google Contacts, Google Search, Google Talk,... Also Wi-Fi and bluetooth were already supported, just like a Youtube media player.

After Android 1.0 in february 2009 Android 1.1 was released. After Android 1.1 a next version of Android, Android 1.5 which was given the name Cupcake was released followed by Android 1.6, called Donut. In october 2009 Android 2.0 got released. It was called Eclair. Eclair was followed by Froyo (2.2.x) and



later the popular Gingerbread (2.3.x) Next to the 2.x series in february 2011 the 3.x (Honeycomb) version got released. This version was created with focus on tablets and no longer on smartphones.

In october 2011 Android 4.0.1 (Ice Cream Sandwich) was presented. ICS was the version of Android which should combine the 2.x series and 3.x series to the 4.x series. This means that there will be no longer 2 parallel versions of Android, but only one working on both smartphones and tablets. This made it easier for Google, so they didn't need to keep two versions up to date but only one. On july 9th 2012 a new version of the Android 4.x series was released named Jelly Bean (4.1). In Figure 1.2 one can see a chart showing global Android version distribution from November 2009 to December 2012.

## **Design**

Android is based on a Linux kernel, with middleware, libraries and APIs written in C and application software in Java. In Figure 1.3 the architecture of Android is shown. The top layer of the figure; the Application Layer are the applications which are deployed on the phone when bought, like an SMS program, calendar, internet browser,... All these applications are written in Java. The application framework is made to create an open developing platform. Android gives developers the possibility to develop rich and innovative applications, by giving them the liberty to make use of all hardware, like location information, setting alarms, add notifications to the status bar,...

The libraries layer contains a number of C/C++ libraries which are being used in multiple layers of the Android system. Developers are able to explore these libraries through the Android Application framework for developers. Some of these libraries are SGL (a underlying 2D engine), FreeType (a bitmap and vector renderer), SQLite (a database engine),... The Android Runtime part are a number of core libraries which gives most Java functionalities. Last there is Linux kernel which provides safety, memory management, process management, network stacking and driver models. It also functions as abstraction layer between the hardware and the rest of the software.

## **Open Handset Alliance**

The Open Handset Alliance (OHA) is a consortium of 84 firms to develop open standards for mobile devices. Practically this translates in promoting Android. OHA is founded on november 5th 2007, with as main founding company Google, together with 34 other firms. These firms are active in creating software, creating mobile devices or creating chips. The main goal was to make Android a worthy



Figure 1.3: Android System Architecture

competitor of other mobile platforms like these developed by Apple, Microsoft, Nokia (Symbian), HP, Research in Motion and Barda.

Some of the company who aided founding OHA were, besides Google, HTC, Sony, Dell, Motorola, Qualcomm, Texas Instruments, Samsung Electronics, LG Electronics, T-Mobile, Nvidia,...

### **1.6.3 MT4j**

#### **General**

Multi-Touch for Java is developed to make it possible to create multitouch applications within the Java programming language. It's an open source Java Framework. It offers a GUI in which we can use shapes like rectangles, rounded rectangles, ellipses, polygons,... To each of these forms gestures can be attached. These can be in 2D or 3D. Next to the predefined shapes you can also make use of buttons, textareas, sliders and a multitouch keyboard.

#### **Architecture**

The architecture of MT4j is built in multiple layers which communicate with each other. Using events messages are sent from one layer to another. The different layers within MT4j are the Presentation Layer, Input Processing Layer, Input Hardware Abstraction Layer and the Input Hardware Layer.

#### **Input Hardware Layer**

By making use of the Input Hardware Abstraction Layer MT4j can give support to different kinds of input hardware, while only little alternations are needed within the Hardware Abstraction Layer. Within this layer all raw input gets reformed to unified input events. The only change needed when one wants to use a new form of input is to change the abstract superclass of all input sources and the specific input for this new part of hardware. MT4j already has a number of input methods which are supported, like a keyboard, mouse,... All input methods can be used synchronously and together without chances on conflicts.

#### **Input Processing Layer**

In MT4j the input processor gets used on two moments within the input event flow. The first moment is when input directly from the Input Hardware Abstraction Layers comes, the other moment is at the component level. This means one can recognize gestures which are ment for only one component.

#### **Presentation Layer**

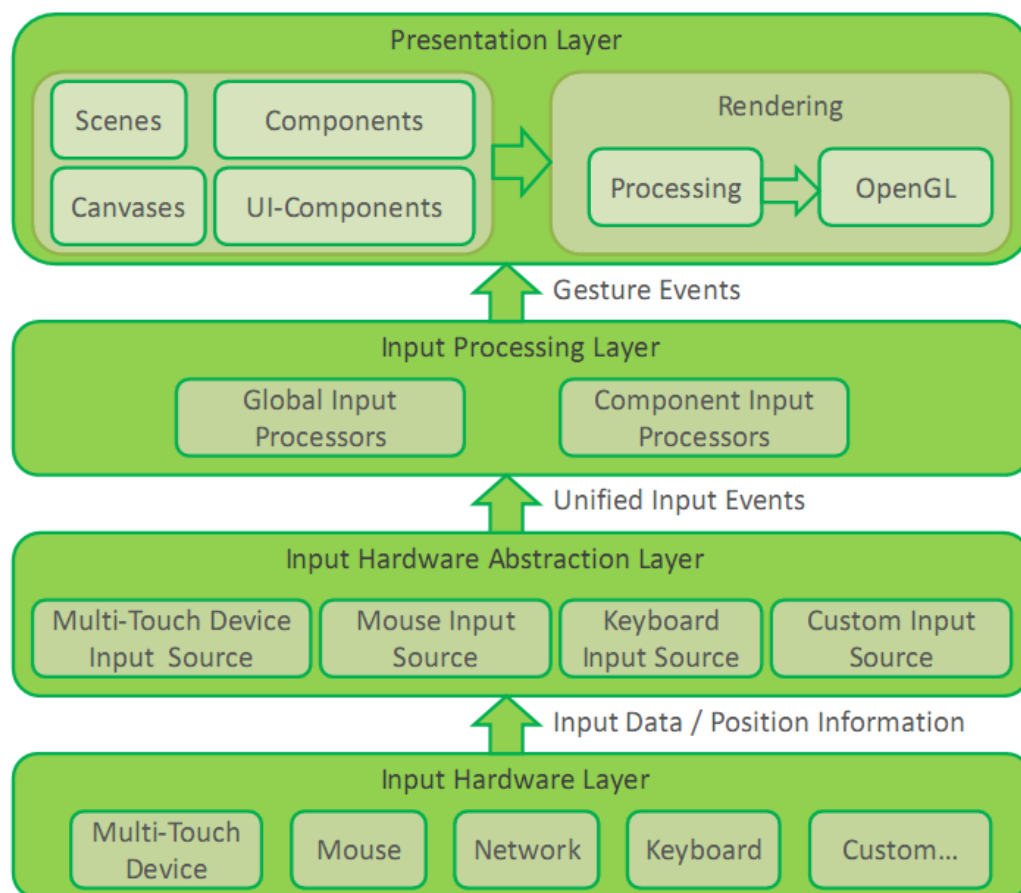


Figure 1.4: MT4j Architecture

The Presentation Layer within MT4j uses scenes. Scenes are made to be able to separate different aspects of a program, input and output, in a nice clean encapsulated manner. An example of multiple scenes could be a game where there's one scene to create the menu and an other scene in which the actual game is played.

Next to scenes MT4j also uses components. Components are parts of a program which can be connected in a hierarchical manner. So one can use a basic component and add multiple components within this component. Here we can see as the basic component the background of the application, and within this component one or more other components are used.

The most basic component of MT4j is a canvas. A canvas is the link between multiple components and the input of the hardware. It can check what other components are on what place within the screen at a given time.

To render the MT4j components they use the Processing toolkit. Processing is an open source toolkit that is used to create data visualisation and interaction.

## **MT4Android**

MT4Android is an Android version of MT4j. Because MT4j lays the focus on multitouch and is made within Java it seemed a logical step to port MT4j to the Google Android platform. MT4Android is made by a coworker of MT4j. MT4Android still isn't a full version, but there is a beta version available.

# Chapter 2

## Implementation

### 2.1 ASTs

#### 2.1.1 Making ASTs

**Description:** Every piece of code used in the IDE will be directly linked to an AST. For this matter there has to be a possibility to create new ASTs from scratch. To create new AST trees we will need to implement the different parts of which an AST can exist. These different parts of an AST will be called a Node. We will start with a list of possible nodes with which basic programs can be made. Later extra kinds of nodes can be added to the AST. A superclass Node will be implemented which will organise the tree structure by providing operations like `getParent()`, which gets the parent of a Node, `setChild(oldChild, newChild)` which will set a child of a node and `getChildren()` to get the children of a Node. By using these operations new trees can be created. The types of nodes that will be implemented are: Placeholder, Begin, Block, Definition, Value, Argument List, Function, Function Call, Function Definition, Operation, Table, Table Call Table Definition.

**Priority:** High

**Status:** Within the `vub.ast` package the implementation of the Nodes can be found.

#### 2.1.2 Deleting ASTs

**Description:** When we have an existing AST and parts of this AST became irrelevant there should be a possibility to remove this AST. The removing of an AST, in total, or only a part of an AST will happen by replacing this AST by the Placeholder node. This possibility will be, as said in 1.1 implemented in the Node

class, by means of the `setChild(oldChild, newChild)` function.

**Priority:** High

**Status:** The possibility to set children of nodes of implemented in each node. This means that we can delete nodes by setting the node we want to delete to null in the parent node.

### 2.1.3 Replacing parts of ASTs

**Description:** When new Nodes will be created it's children, if there are any, will be made by Placeholders. When making a function for example, we'll implement the operation, but the two operands will be initialized with a Placeholder node. To be able to change these Placeholders to more relevant Nodes we should be able to replace existing Nodes by other Nodes, in this example maybe a Value, or another Operation. This can be done on a similar way as the deletion of ASTs, by making use of the `replaceChild(oldChild, newChild)` method.

**Priority:** High

**Status:** In the same way of deleting ASTs replacing parts of an AST can be done. We just set the child we want to change to the new node. These possibilities are implemented in the Node class.

### 2.1.4 Rendering ASTs to text

**Description:** To be able to pass the constructed code to the AmbientTalk interpreter we have to convert the AST to an understandable format for the interpreter. The interpreter works with a textfile containing AmbientTalk code. This means that the ASTs have to be converted to text. Converting an AST to a text should be a function within each Node, calling the same function recursively on all of its children.

**Priority:** High

**Status:** Every node can be rendered to text. There's a function foreseen in every subclass of the Node class, called `toString()`. Each of these call the `toString()` function on its children as well.

## 2.2 Templates

### 2.2.1 Templates creating ASTs

**Description:** For convenience we will make use of templates. Templates will be frequently used parts of code that will be saved. The way templates will be stored in the memory will be by an AST. Every time a template is used within the program a copy of this AST will be made and inserted into our current program. These templates can be frequently used functions, but mainly these will be the ASTs representing basic elements of the language like the if-then-else structure, when-discovered,...

**Priority:** High

**Status:**

### 2.2.2 Creating templates from XML

**Description:** To keep a clear view on what template functions we have, and make it easy for users to add templates, without having to know the implementation of the entire program we will keep the Templates in a separate XML file. When having an XML file containing the structure to create new Templates a function will be implemented that creates, from the XML file, a new AST, which can be used as a Template within the program.

**Priority:** High

**Status:**

### 2.2.3 Create templates from functions

**Description:** When a newly created function is often used by the user and he wants to save this function, the possibility to write this function, in correct XML, to the existing XML file will be provided. This means that whenever the program is terminated functions can be stored inside the XML file.

**Priority:** High

**Status:**



## 2.3 Interface

### 2.3.1 Rendering of nodes

**Description:** Each type of node has to have a screen representation. For each node we need a function that displays the Node on the screen, and that recursively calls the display function of all children of this node. We won't implement these displays within the separate types of nodes, discribed in 1.1, but for each node we will implement a separate display function. This with as goal that we can re-use our AST implementation without having to dead with the program specific display possibilities.

**Priority:** High

**Status:** Within the vub.templates package ther's a templateReader class. This class will read all templates defined in the templates.xml file within the assets folder.

### 2.3.2 Lay-out engine

**Description:** We will make a render manager, this manager will render all nodes and make sure they are organised on a ordered way. The render mananger will use indetion to organise nodes across the screen. **Priority:** High

**Status:** Witin the vub.rendering package we have the RenderManager class. This class gives you the possibility to render nodes by sending MTRectangles to them, and tell the class how to render them. This being next to the previous node or under the previous node. The is also to option to indent the next function. This for when one want to show a new node under the previous one, but indented.

### 2.3.3 Creating functions on the spot

**Description:** Whenever a new function (or variable) is created within the program a link to call this function will be added to the menu's. This means that we can easily re-use a made variable or have an easy way to call an earlier created function.

**Priority:** High

**Status:** Newly created functions will have a automatically have a functionCall made. This will be added to the list of possible functioncalls.

## 2.3.4 Buttons

### Menu's

**Description:** To keep track of all templates or calls that can be made we will need a menu that gives us the possibility to insert templates in to the code. We will use one a menu with some submenu's, devided for each kind of templates. These can be provided functions self implemented function, used variables,...

**Priority:** High

**Status:**

### Run button

**Description:** Thanks to requirements 4.2 we can evaluate made code with an external AmbientTalk app. To do this we'll add a button to the main screen which will first make sure requirement 1.4 is done, the creation of a textfile with the current code, and later on run the AmbientTalk app, as described in requirement 4.2.

**Priority:** High

**Status:**

### Delete button

**Description:** To be able to delete some code, as described in 1.2 we need a way to select what code will be deleted. Herefore we will implement a delete button on the screen, which deletes the current selected piece of code. This can be done by pressing this button or by dragging the selected code to this place. **Priority:** High

**Status:**

## 2.3.5 Views

### Colorcoding keywords

**Description:** As in many languages the use of colorcoding should be done here aswell. We will try to achieve the same colorcoding as being used in the official AmbientTalk IDE in Eclipse.

**Priority:** Low

**Status:** The implementation of MT4j does not allow us to make use of colorcoding. Because of a bug within the code it is impossible to change the color of only

1 word. This is on the other not the problem when one to change the background color of a `MTTextArea`.

### **Colorcoding types**

**Description:** Next to the colorcoding of keywords we will implement colorcoding on the types of words. This means that we will give Placeholders different colors, just like `VariableNames`,...

**Priority:** Low

**Status:** Unlike the colorcoding of keywords the backgroundcolor of `MTTextAreas` can be edited.

### **Codefolding**

**Description:** The use of AST should gives us the possibility to easily fold in certain parts (read piece of the AST) of our code. This can be done by just not rendering certain nodes, and it's children, of the AST.

**Priority:** Low

**Status:**

### **Move code**

**Description:** By using the possibility of deleting parts of ASTs and saving parts of ASTs a copy-pasty system, or even moving of code to places that make sense belongs to the possibilities.

**Priority:** Low

**Status:**

## **2.3.6 Gestures**

### **Selection of code**

**Description:** To be able to replace, delete, move,... code we need a possibility to select certain parts of the code. This will be done by a tap or doubletap gesture. The selected code will be marked and it will be possible to makes changes to this code.

**Priority:** High

**Status:**

### **Pinch-to-zoom**

**Description:** When starting on a piece of code by using the pinch-to-zoom function the selected part of code should be extended. This can be done by enlarging the selected area from the current AST to the parent of this AST.

**Priority:** High

**Status:**

### **90 degrees turning for comments**

**Description:** When a piece of code is selected, and afterwards this piece of code gets turned around for 90 degrees, this piece of code should be commented out. Commented code should not be written to the textfile when this is called on this AST.

**Priority:** Low

**Status:**

### **Fast scrolldown**

**Description:** When we want to scroll down a longer piece of code we can use the scroll with two fingers gestures to get us scroll faster.

**Priority:** Low

**Status:**

## **2.4 Evaluating code**

### **2.4.1 Writing code to textfile**

**Description:** To make use of the AmbientTalk app we need a textfile with the AmbientTalk code. We can make use of the toText() function of each node to translate our current AST to plain text, and afterwards we will need to write this text, into a textfile.

**Priority:** High

**Status:**

## **2.4.2 Call external AmbientTalk app**

**Description:** The external AmbientTalk app, which makes use of the textfile from the previous - insert number- should be called. To get this app called we will implement a button on the screen, which first gets the textfile created and afterwards calls the AmbientTalk app.

**Priority:** High

**Status:**

## **2.4.3 Return to TIAMAt after evaluating code**

**Description:** The AmbientTalk app will evaluate the program. After the evaluation of this program and returning the result we should get back the our application to create the possibility to edit our current program

**Priority:** High

**Status:**

## **2.5 Features**

### **2.5.1 Extra interface for comments**

**Description:** An extra interface can be created in which we can store extra comments. This interface should only be called on object which could get any use of extra comments.

**Priority:** Low

**Status:**

### **2.5.2 Speaking comments**

**Description:** A nice feature is to add spoken comments to our program. The possibility to add spoken comments will be integrated in the extra interface for spoken comments, announced in requirement 5.1. There will be added extra buttons to record comments and play these comments.

**Priority:** Low

**Status:**

### 2.5.3 Selector for Java classes

**Description:** Within the AmbientTalk language it's possible to make use of a Java class selector. Adding this feature to this implementation will make sure that our project becomes a better alternative to the pc one.

**Priority:** Low

**Status:**

### 2.5.4 Multiple tabs

**Description:** If we want to make bigger programs it would be easy to be able to have multiple tabs. Certainly when big programs exist of multiple files. To make this possible we would need to save multiple AST trees and implement a possibility to switch between the different tabs.

**Priority:** Low

**Status:**

### 2.5.5 Saving files

**Description:** As we will implement a write to XML to save new Template into an XML file we could use this procedure to save an entire program in XML, and later rebuild our AST and on this way reconstruct our program.

**Priority:** Low

**Status:**

# Chapter 3

## Related work

### 3.1 TouchDevelop

TouchDevelop is a programming environment made for Windows phones. TouchDevelop allows you to create some simple applications for your phone and add these later to the Windows Phone Marketplace. Because TouchDevelop is made to create applications for the device on which they are developed they can make use of really powerful templates. TouchDevelop offers you the possibility to make use of most of the built in sensors and files upon your device, such like media files, web cloud, network, gps,... This makes it possible to develop apps which only react when one shakes the phone or only when the phone is faced up or down.

TouchDevelop is ment for students and people who like to program in their free time, and not for professional developers. It makes the making of own applications so easy that everyone with a basic knowledge of programming can start making his own applications. Different than with TIAMAT these applications are being made within an entire new programming language. This language is made from scratch to be work with Windows Phones, while AmbientTalk was developed to work on plural platforms.

The goal of TouchDevelop was not to be an IDE for an existing programming language, like TIAMAT, but to develop an entire way to create some application on the device for which the application is ment to run.

### 3.2 Touch Scheme

Touch Scheme is developed by a programmer who wanted to program during his vacation on his iPad. To be able to do so he developed an app. His main idea was to edit the parse tree within the app.

### **3.3 Editing Haskell as AST rather than text**

Christopher Done has created 'A concept for editing Haskell as an AST rather than text'. This works in a similar way as Tiamat. The idea here is to change certain parts of the AST to the piece of code we want. In the video made by Chistopher Done you can see how he edits his Haskell program by clicking on the places where new parts of the code should come. He fills in the parts of the AST by clicking on them and choosing from a list (of templates) what should be entered on this spot. This idea is very similar to TIAMAT where we work with Placeholders which can be replaced with actual nodes within the AST of the program.



# **Chapter 4**

## **Evaluation**

## **Chapter 5**

## **Conclusion**