



## Project Management and Software Development for Medical Applications (PMSD)

# Needle tracking for ultrasound-guided biopsies with inside-out vision

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# Introduction & Motivation

## Project:

Software framework to track ultrasound transducer and needle  
Biopsy for cancer screening or neurology applications

## Problem:

Needle location uncertain in ultrasound image

## Solution:

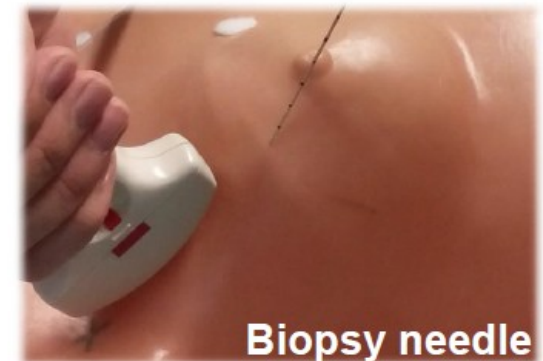
Needle and ultrasound tracking and visualization

## Motivation:

Less insertions, Analyse the right cells

## Partners:

Klinikum rechts der Isar, Framos GmbH





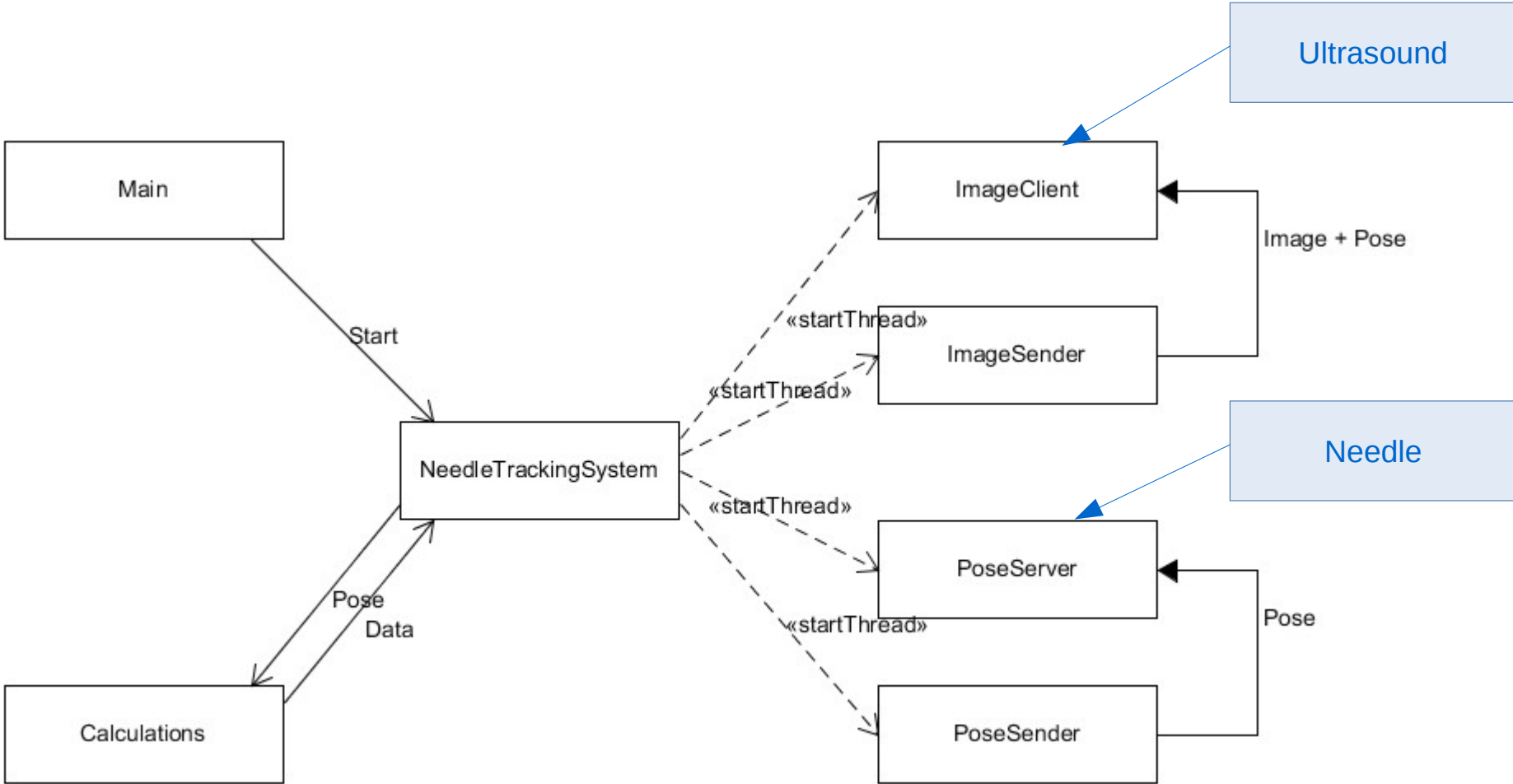


# State of the art

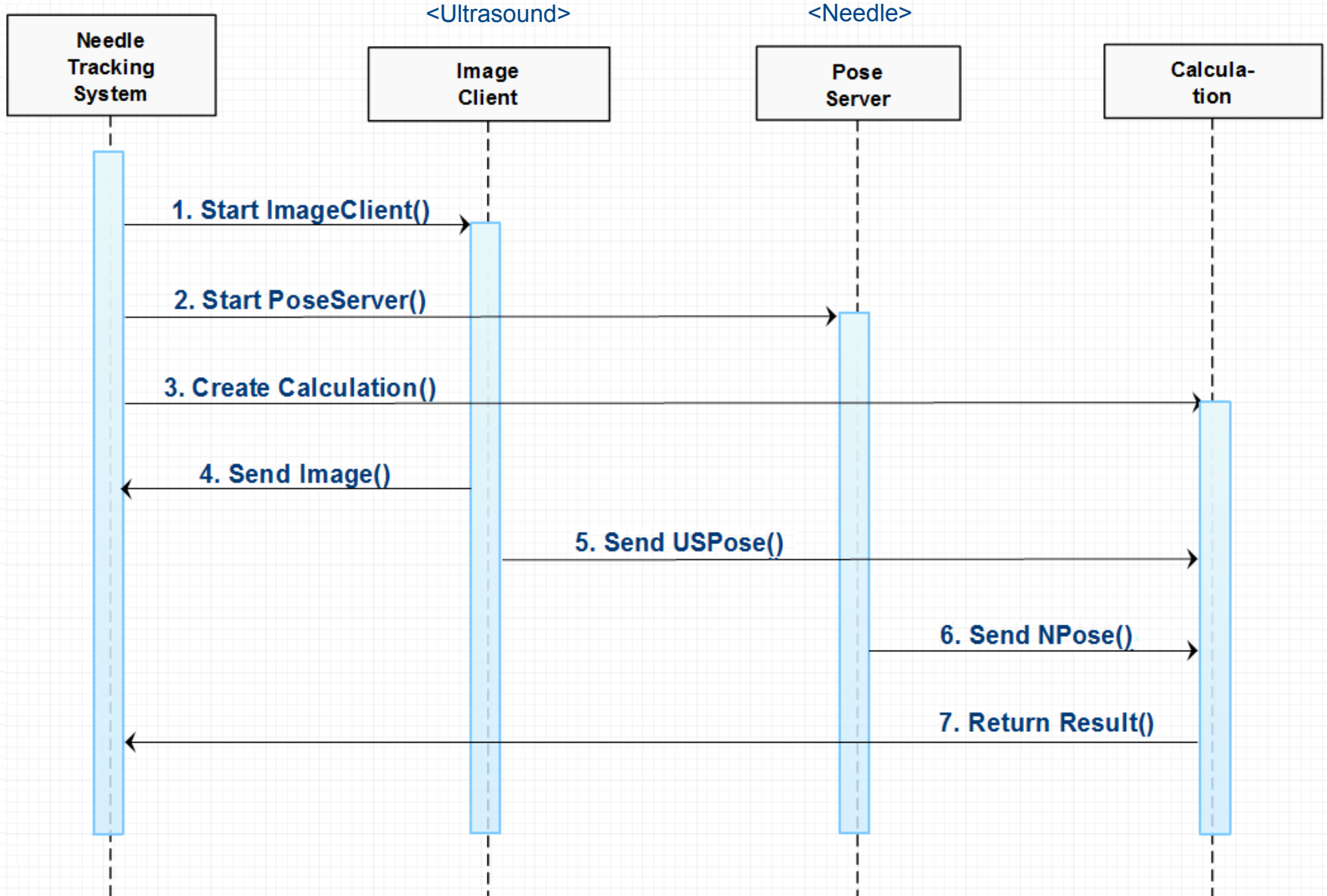
- Reading papers
- Ultrasound image is displayed
- Qt user interface created
- OpenIGTLink is included
- Software was tested with stub
- Features: Grid, Screenshots, Target, Distance
- Tests with transducer and needle to receive images and poses
- Improving class structure (Threads)
- Error fixing and optimization (signal slot)



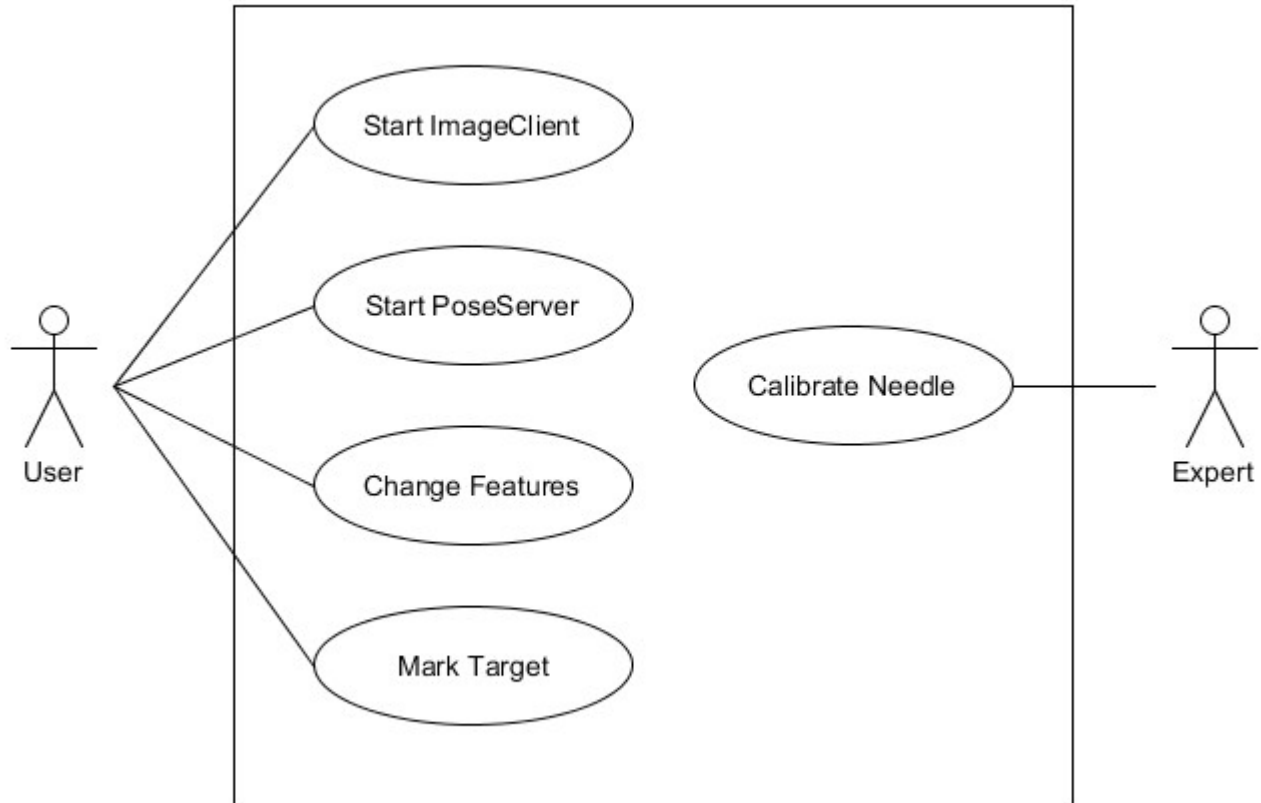
# Software structure



# Sequence Diagram



# Use Case Diagram





# Project status

## Current Tasks:

- Calculating transformation matrices  
(Pivot Calibration, Assembla Plus, recordings → transformation matrix  
Mouseclick in Image → transformation matrix to target)
- Calculations should be done in real-time  
(Transformation matrices, intersection point, shortest distance)
- Improving the user interface  
(Changing IP, Port, Grid, Colors and other Settings, Maybe 3D Vision)

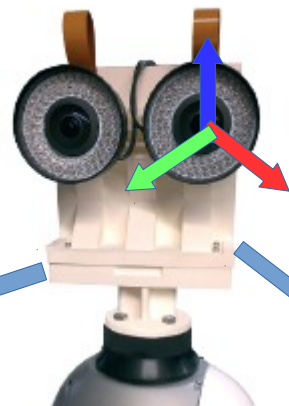
## Problems:

- Synchronisation problem  
(Mutex, Qt::QueuedConnection, Transfer object not the reference)
- Needle is flexible  
(Assumption: Needle is rigid → additional feature)

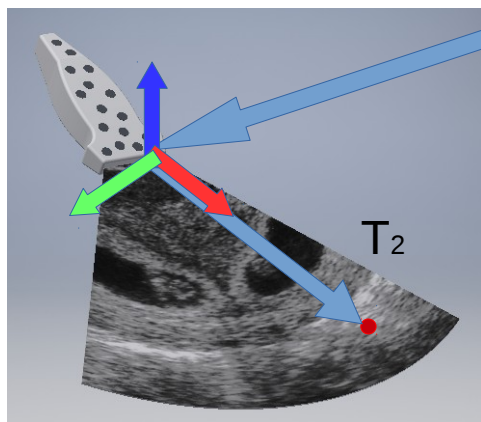




Optical Tracking System (OTS)

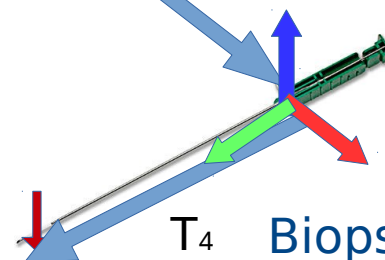


Ultrasound Transducer



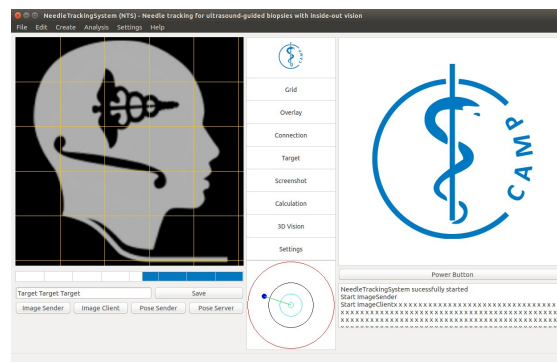
T<sub>1</sub>

T<sub>3</sub>



T<sub>4</sub>

Biopsy Needle



Needle Tracking System



# Calculation of transformation matrix

$$R_X R_Y R_Z$$

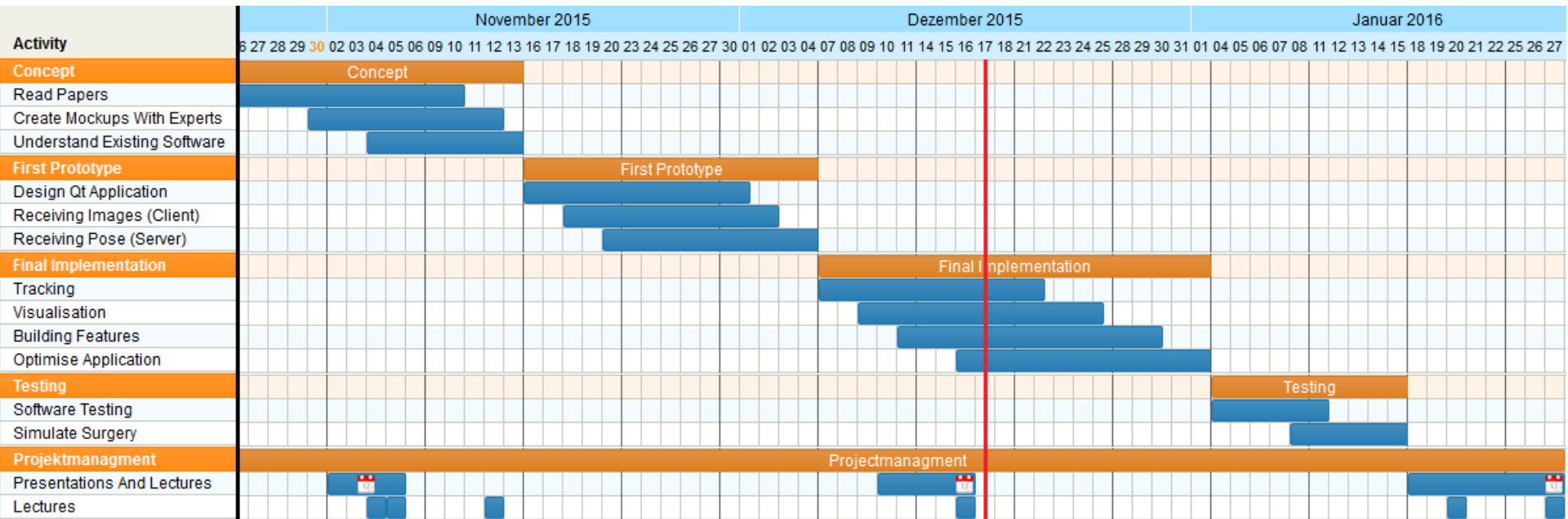
$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos A & -\sin A \\ 0 & \sin A & \cos A \end{bmatrix} \begin{bmatrix} \cos B & 0 & \sin B \\ 0 & 1 & 0 \\ -\sin B & 0 & \cos B \end{bmatrix} \begin{bmatrix} \cos C & -\sin C & 0 \\ \sin C & \cos C & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} \cos B \cos C & -\cos B \sin C & \sin B \\ \sin A \sin B \cos C + \cos A \sin C & -\sin A \sin B \sin C + \cos A \cos C & -\sin A \cos B \\ -\cos A \sin B \cos C + \sin A \sin C & \cos A \sin B \sin C + \sin A \cos C & \cos A \cos B \end{bmatrix}$$

$$\begin{bmatrix} -0.411886 & -0.709998 & 0.571185 & -1.45998 \\ 0.709998 & 0.142857 & 0.689561 & 49.9787 \\ -0.571185 & 0.689561 & 0.445257 & -1.45998 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$



# Gantt Chart



# References

References for the slides:

- Images from FRAMOS GmbH
- Gantt Chart: <http://www.tomsplanner.de>
- UMLet for Use Case Diagram and Class structure
- Sequence Diagram: <http://creately.com>
- Latex for formulas
- Blender for 3D Images



Thank you for your attention!

Do you have any questions?

