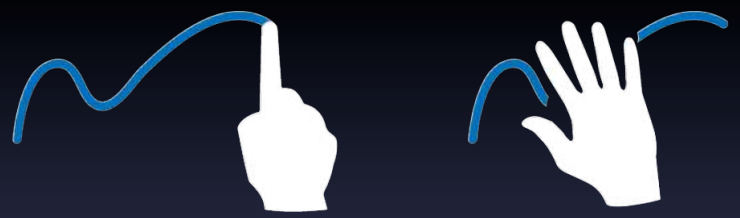
Motivations



Leverage Multi-touch overlays

More functions than a regular whiteboard

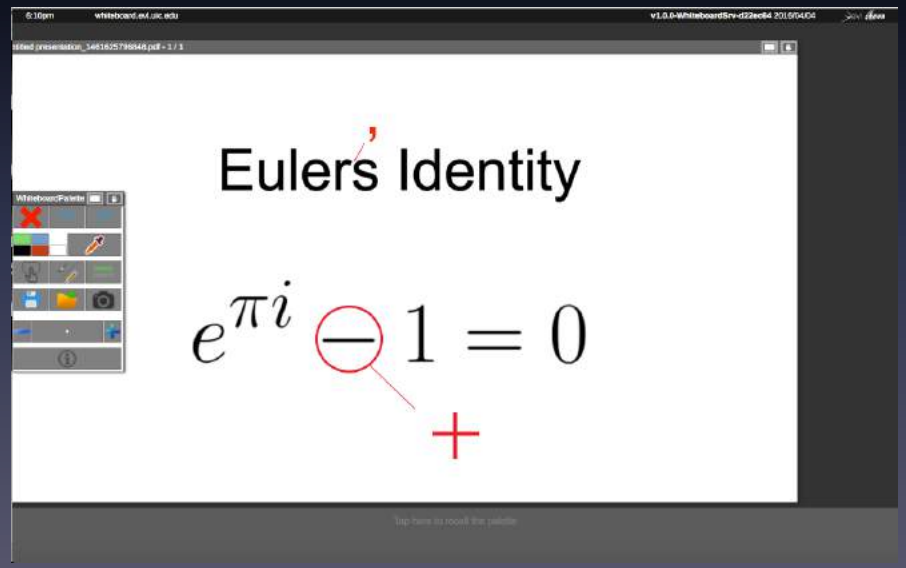
Share and annotate documents

Completely scalable

Easy to use

Enhance in-place and remote collaboration

More than a Whiteboard



Prepared material

Relocate and resize

Flawless erasing

Mirroring over different screens

Save and load sessions

Collaboration

Enhanced in-place collaboration

Remote collaboration available

Content sharing

Seamless environment

Demo

Demo

Related Works

First interactive whiteboards in the early 90s

Very active field in education

Studies demonstrate that engages children

Projector-based or touch based

Usually rely on dedicated input devices

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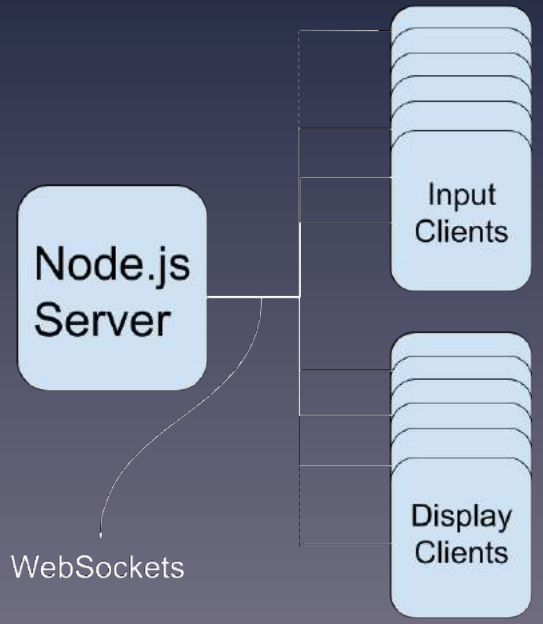
Background: SAGE2

http://sage2.sagecommons.org/project/introduction/



Collaborative Platform

Completely scalable to any size

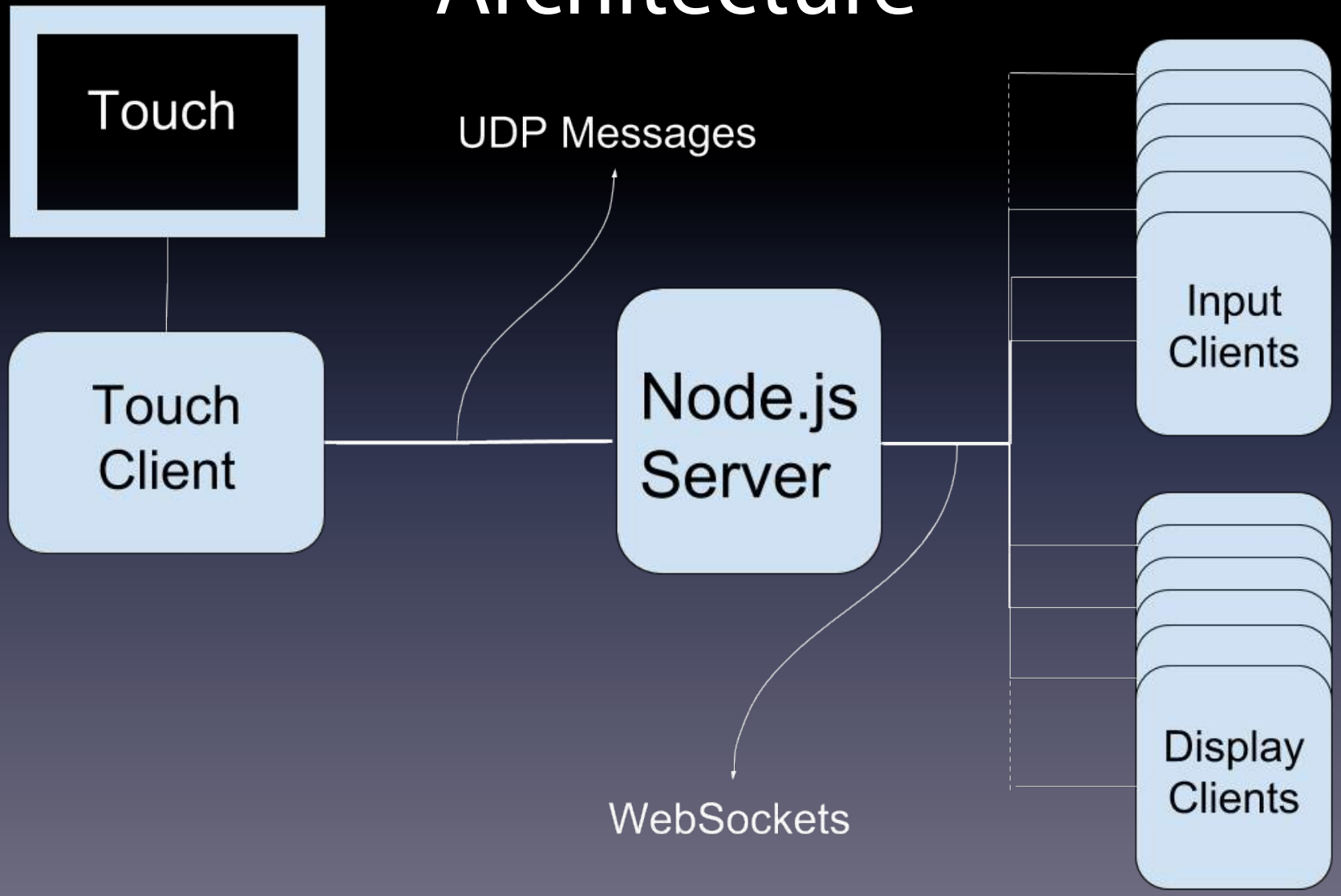
Users share a canvas that can be interacted with

Commonly used for in-place collaboration, but remote is available too.

Arbitrary number of input clients and mirroring display clients.

SAGEBoard

Architecture



Data Flow

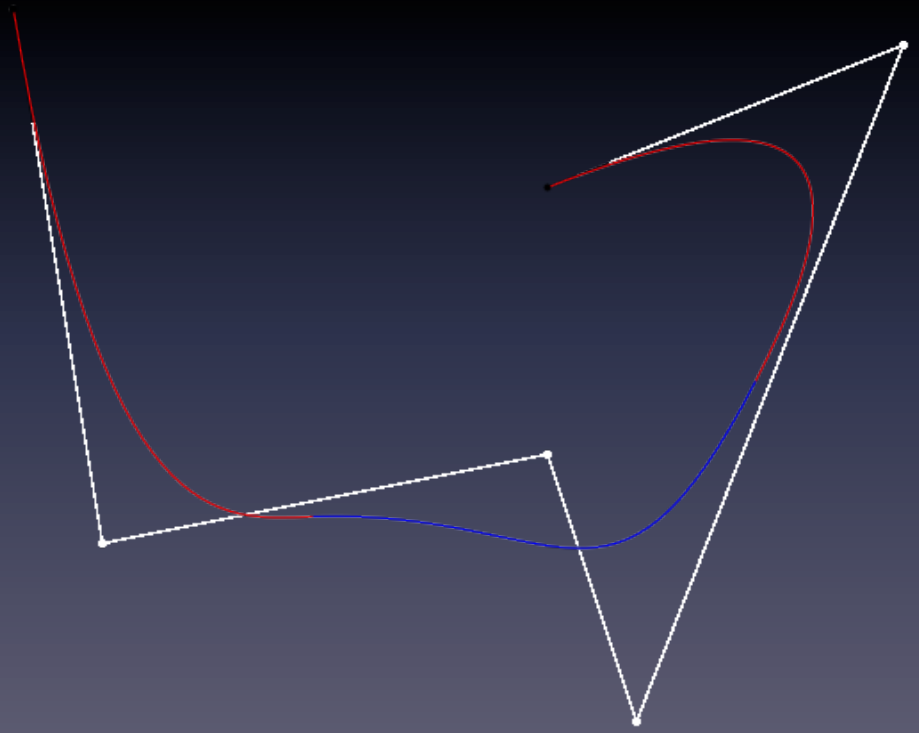
Raw Data

```
{ timestamp: 1459639231,
  sourceId: 1,
  serviceId: 1,
  serviceType: 0,
  type: 4,
  flags: 0,
  posx: 0.7031466960906982,
  posy: 0.2234227955341339,
  posz: 0,
  orw: 0,
  orx: 0,
  ory: 0,
  orz: 0,
  extraDataType: 0,
  extraDataItems: 0,
  extraDataMask: 0 }
```

Latency Aware Points

Actual Drawing

Quality vs Latency



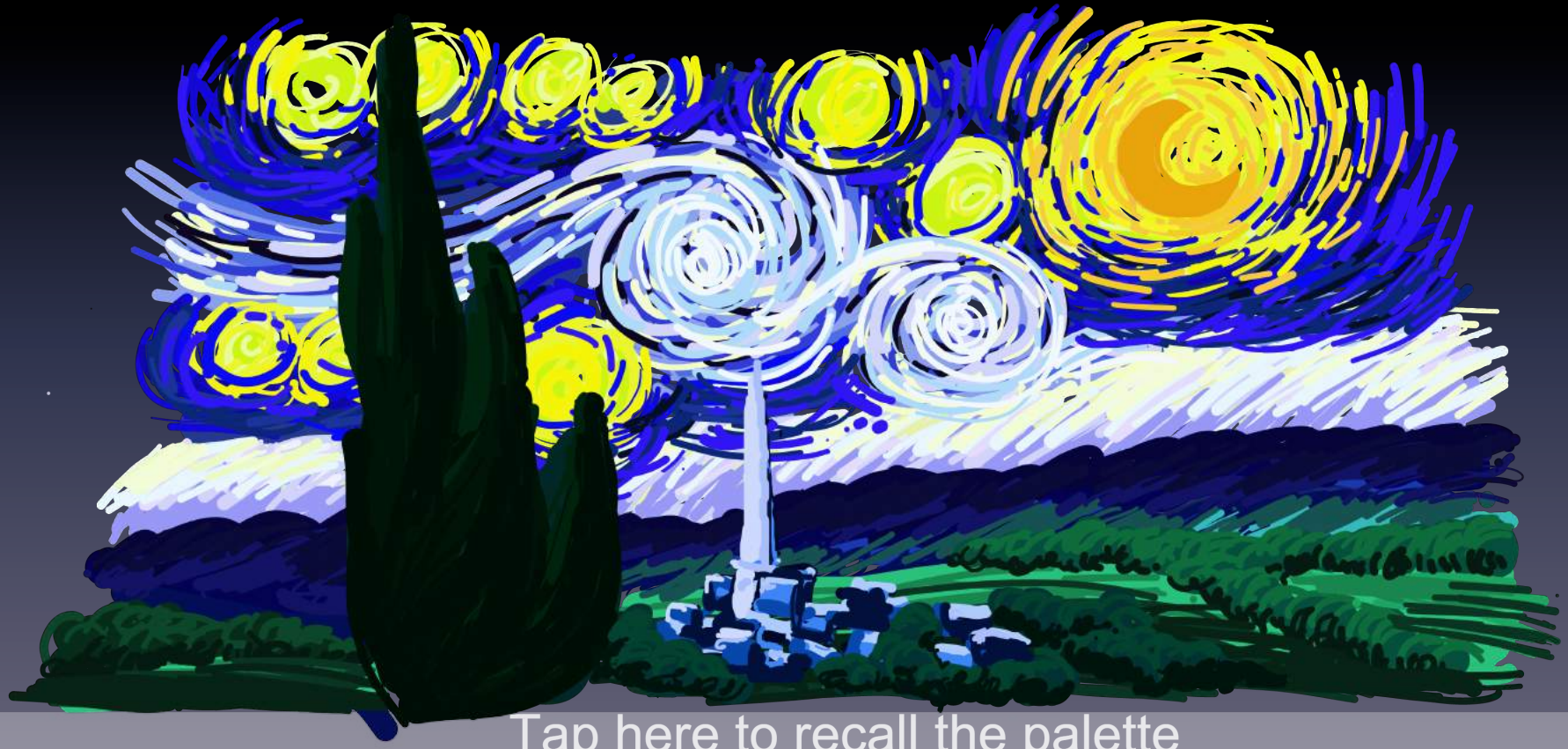
Only most important points sent

Deterministic B-spline interpolation

Same Result on every screen

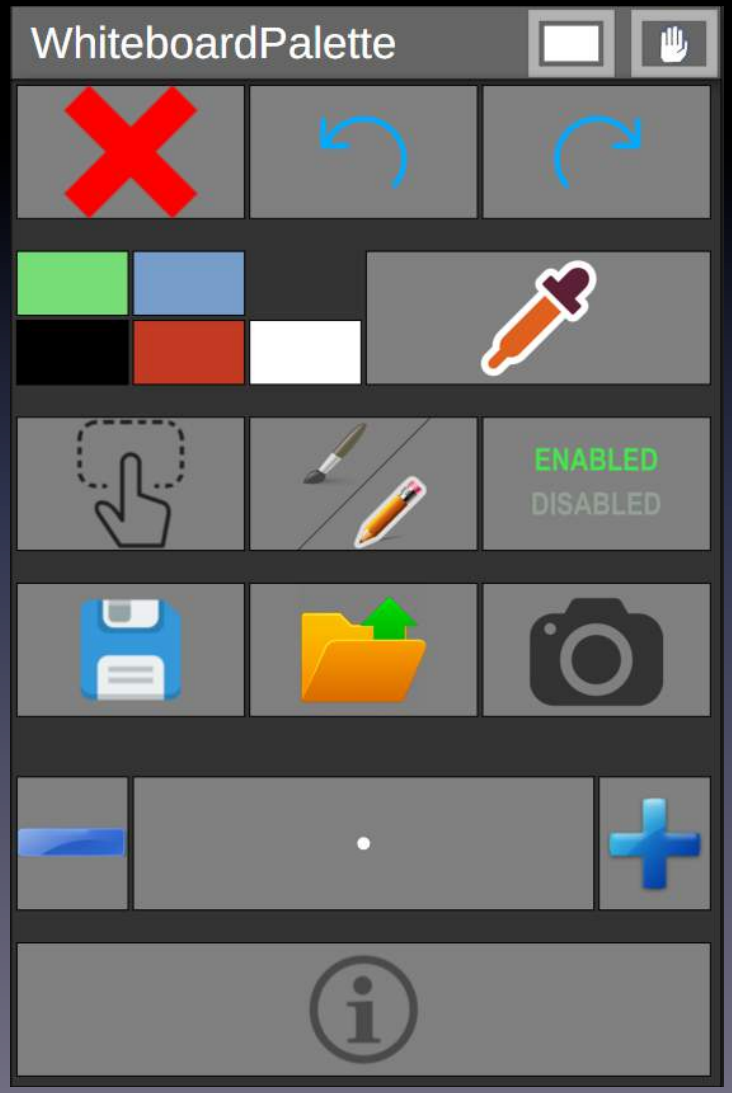
Drawing latency improved

Quality



Tap here to recall the palette

Palette



A Special SAGE2 Application

Always in front

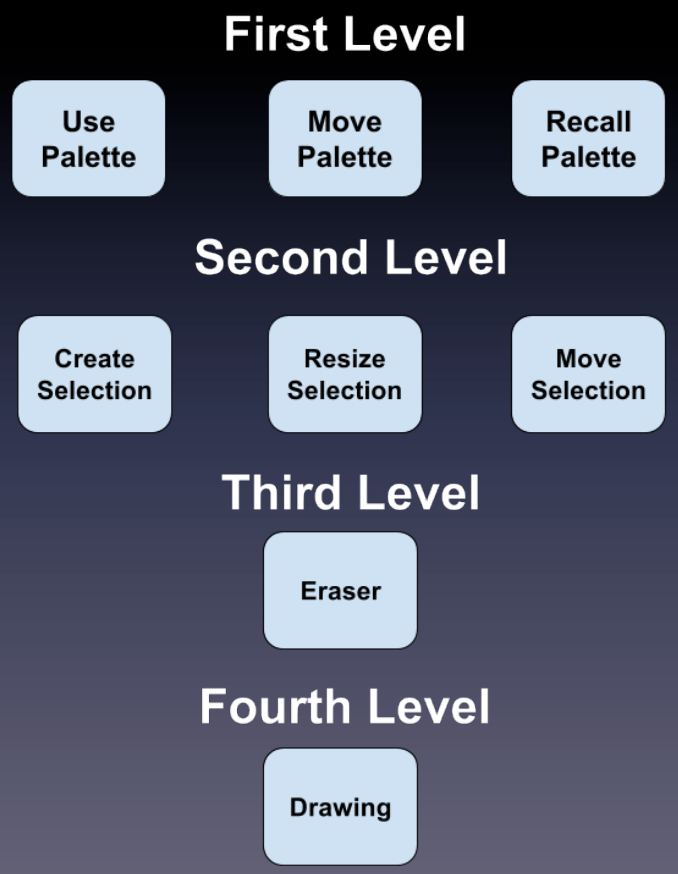
Square buttons, well separated

Stroke Preview

Tutorial button

Can be disabled

Multi-Touch Management



State Machine based approach

Priority Levels

Action decided at touch down

Can only change from drawing to eraser

Ignored State for shared resources

Extension: Mobile

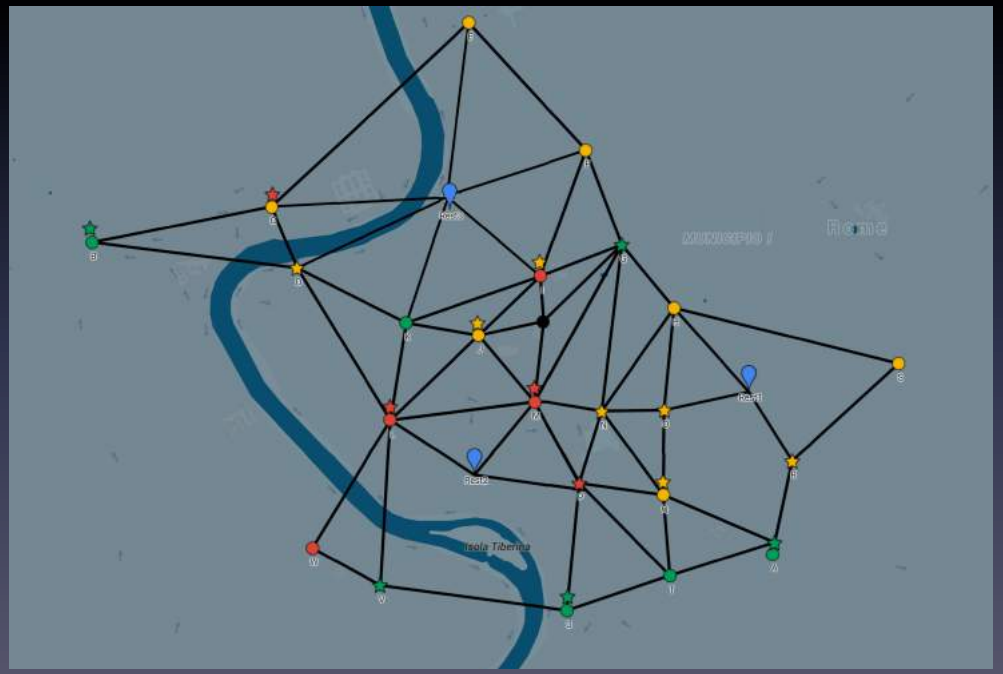
- Enables a different kind of collaboration
- Easy to develop thanks to architecture
- Treated as a normal touch input
- No scaling
- Leverage device precision

User Study

Goal

Understand how the collaborative behaviors change between using an electronic whiteboard such as our application and a more common single mouse input.

Task



Find a common path for different interest

Actually very challenging

Find optimal path in undirected graph

Easier because common in real life

Collaborative but also competitive

Setup

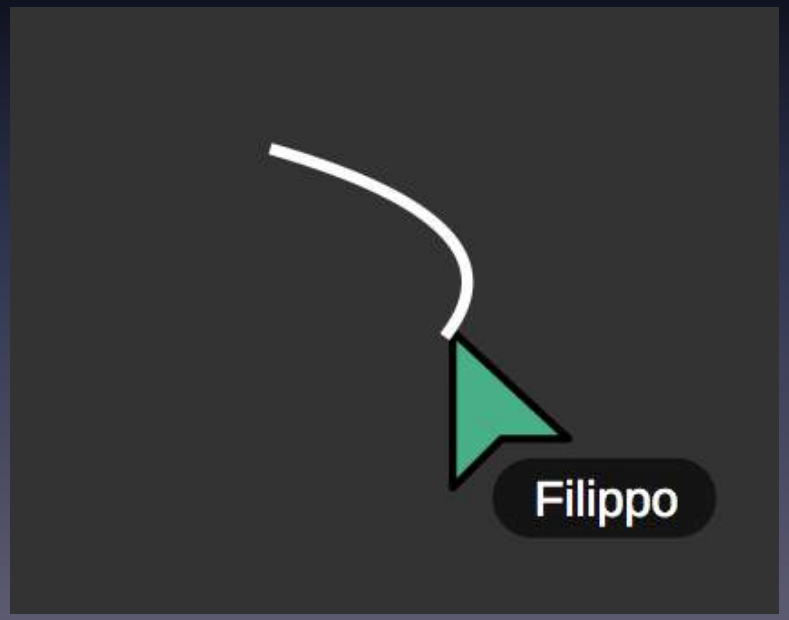
Performed in Cyber Commons classroom at EVL

SAGEBoard running on 20ft x 6ft screen (6m x 1.8m)

Perform the task singularly at first, to understand map and input bias.

Collaborate using both inputs, on different maps.

Drawing Input



SAGEBoard extended ad hoc for the task

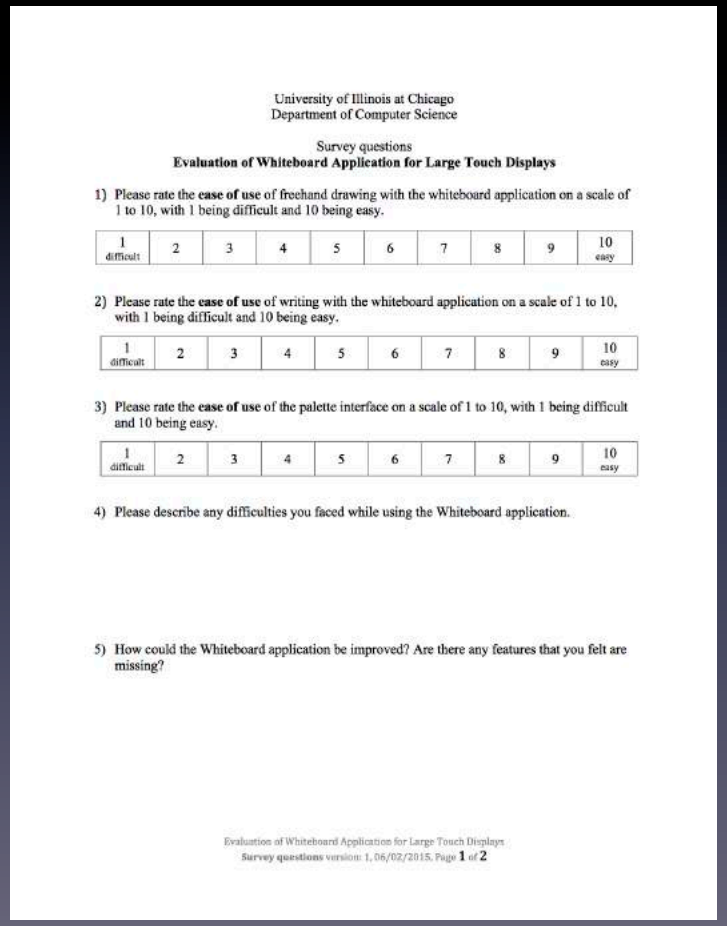
Working in the exact same environment

Comparable results

Mouse used to draw, right click eraser

Mouse emulates a touch input

Feedback



University of Illinois at Chicago
Department of Computer Science

Survey questions
Evaluation of Whiteboard Application for Large Touch Displays

1) Please rate the **ease of use** of freehand drawing with the whiteboard application on a scale of 1 to 10, with 1 being difficult and 10 being easy.

1 difficult	2	3	4	5	6	7	8	9	10 easy

2) Please rate the **ease of use** of writing with the whiteboard application on a scale of 1 to 10, with 1 being difficult and 10 being easy.

1 difficult	2	3	4	5	6	7	8	9	10 easy

3) Please rate the **ease of use** of the palette interface on a scale of 1 to 10, with 1 being difficult and 10 being easy.

1 difficult	2	3	4	5	6	7	8	9	10 easy

4) Please describe any difficulties you faced while using the Whiteboard application.

5) How could the Whiteboard application be improved? Are there any features that you felt are missing?

Evaluation of Whiteboard Application for Large Touch Displays
Survey questions version: 1, 06/02/2015. Page **1** of **2**

We ask the users to rate various features

More focused on SAGEBoard evaluation

Last questions on collaborative experience

User Study Results

Premise

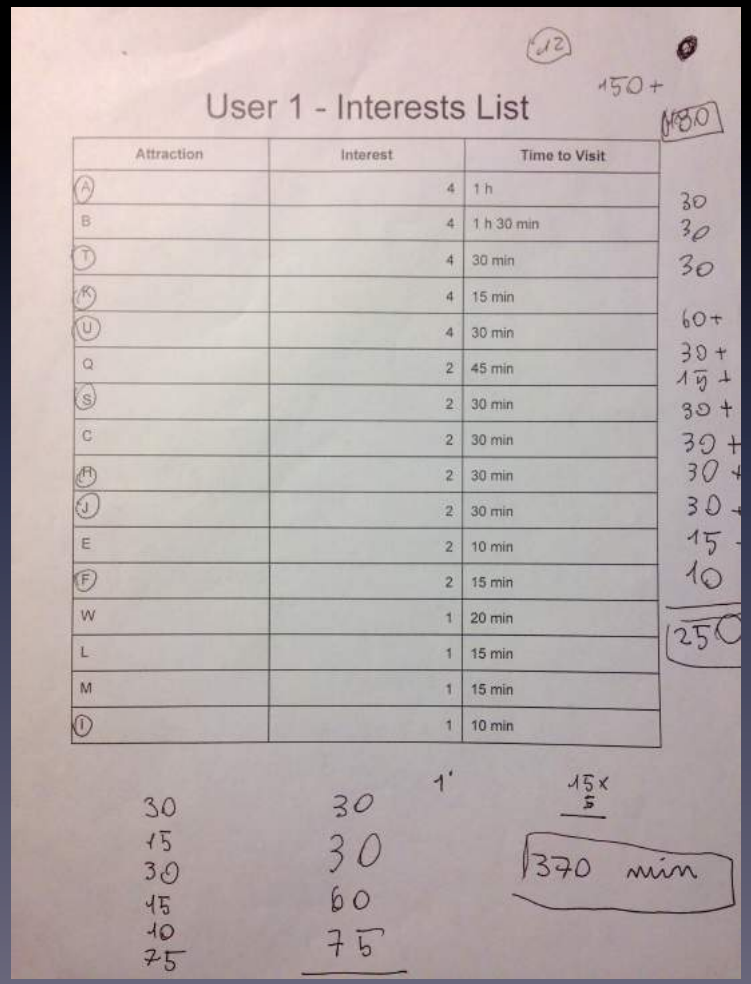
We do not really care about the actual scores

We are not testing the application on this particular problem

We are interested in the different behaviors with different inputs

Will the input dictate how the users collaborate?

Annotations



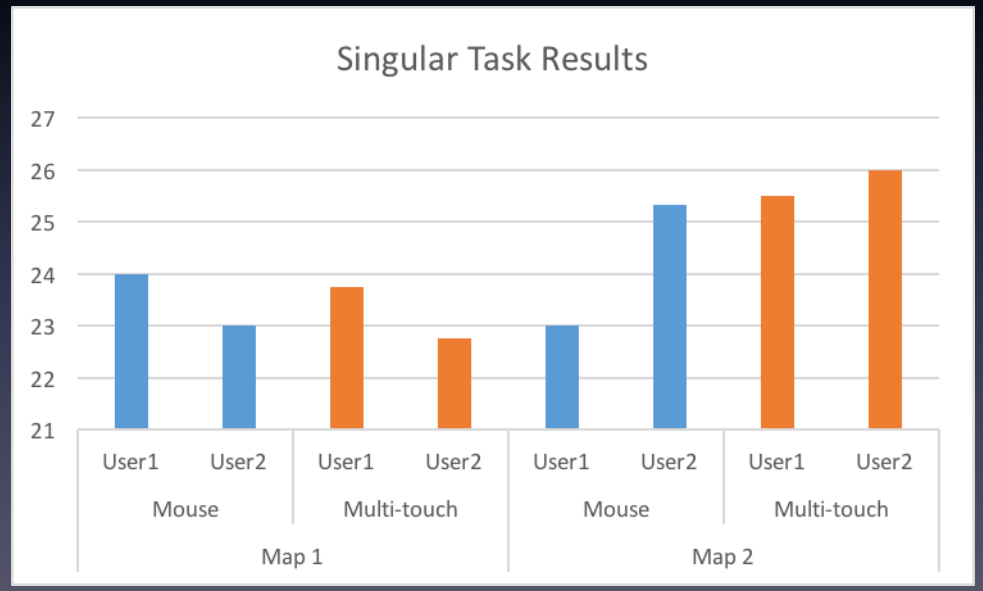
User 1 - Interests List

Attraction	Interest	Time to Visit
A	4	1 h
B	4	1 h 30 min
T	4	30 min
K	4	15 min
U	4	30 min
Q	2	45 min
S	2	30 min
C	2	30 min
H	2	30 min
J	2	30 min
E	2	10 min
F	2	15 min
W	1	20 min
L	1	15 min
M	1	15 min
I	1	10 min

- Users were given both styluses and pens
- It was up to them where to annotate
- Mostly on paper when using mouse
- Mostly on the screen with multi-touch
- Users did not even try annotating on screen with the mouse

Singular Task

Different Maps

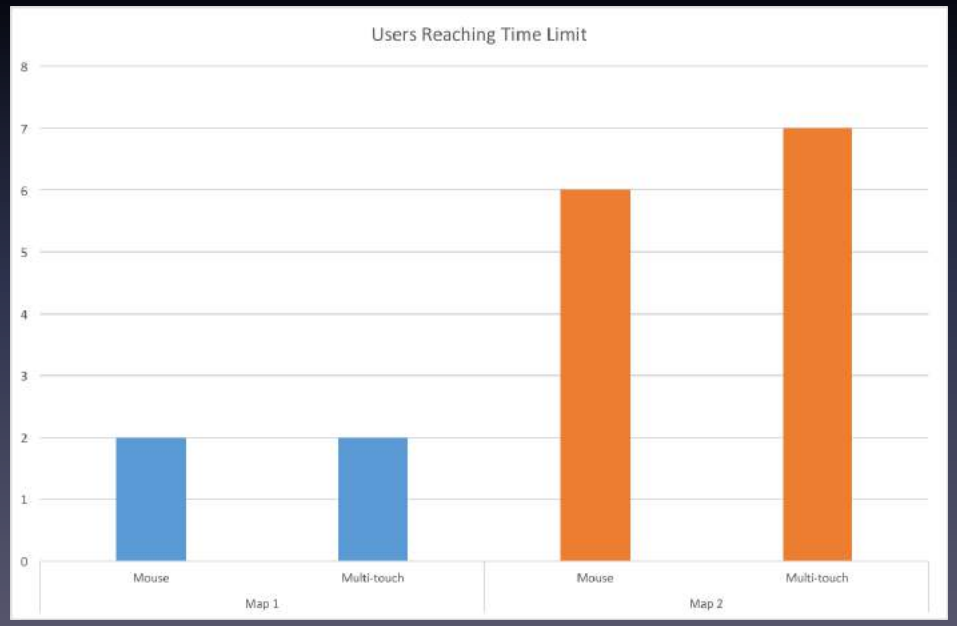


Problem very hard, difficult to find similar instances

Map 1 has lower scores than map 2

The input does not influence the singular score

Different Maps



Higher scores do not mean easier.

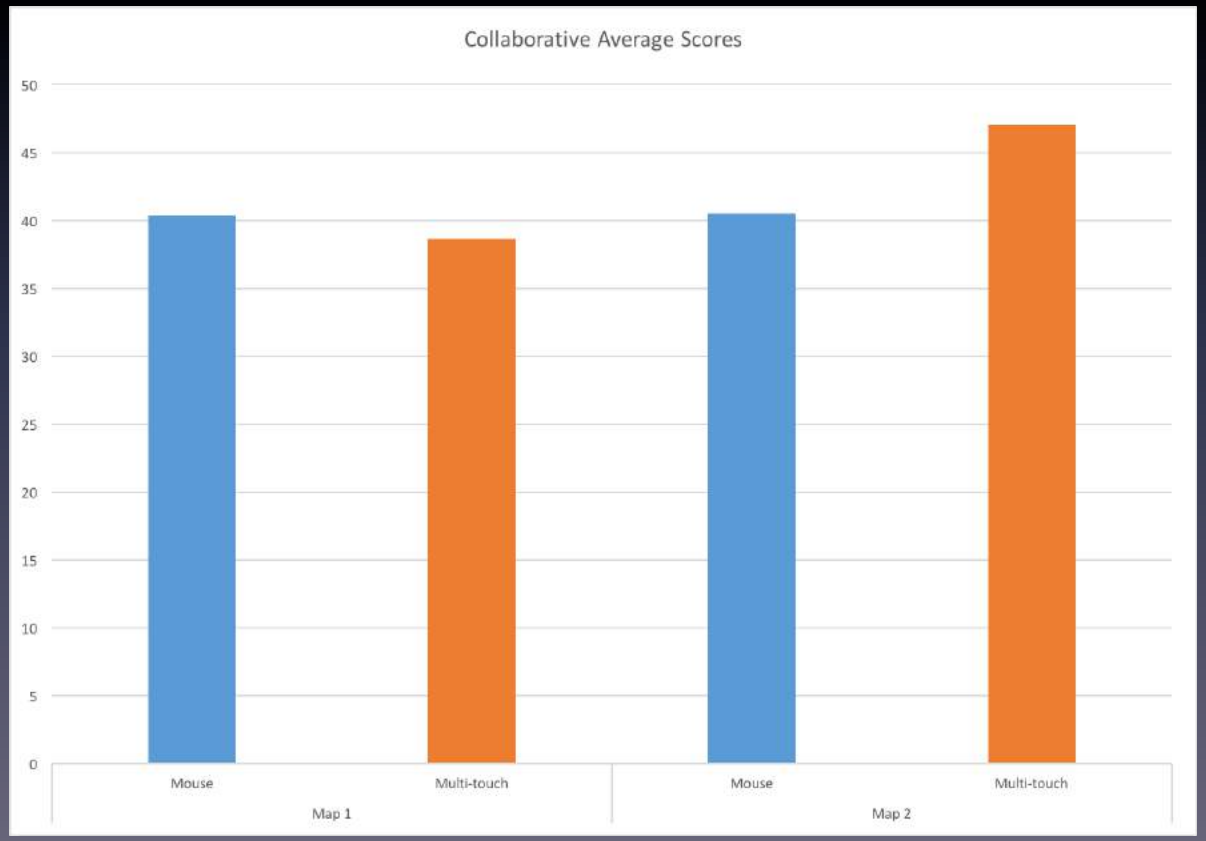
Users spent more time solving Map 2

Map 2 has higher scores because of a greater solution space

These results will help us analyze the Collaborative task

Collaborative Task

Collaborative Scores

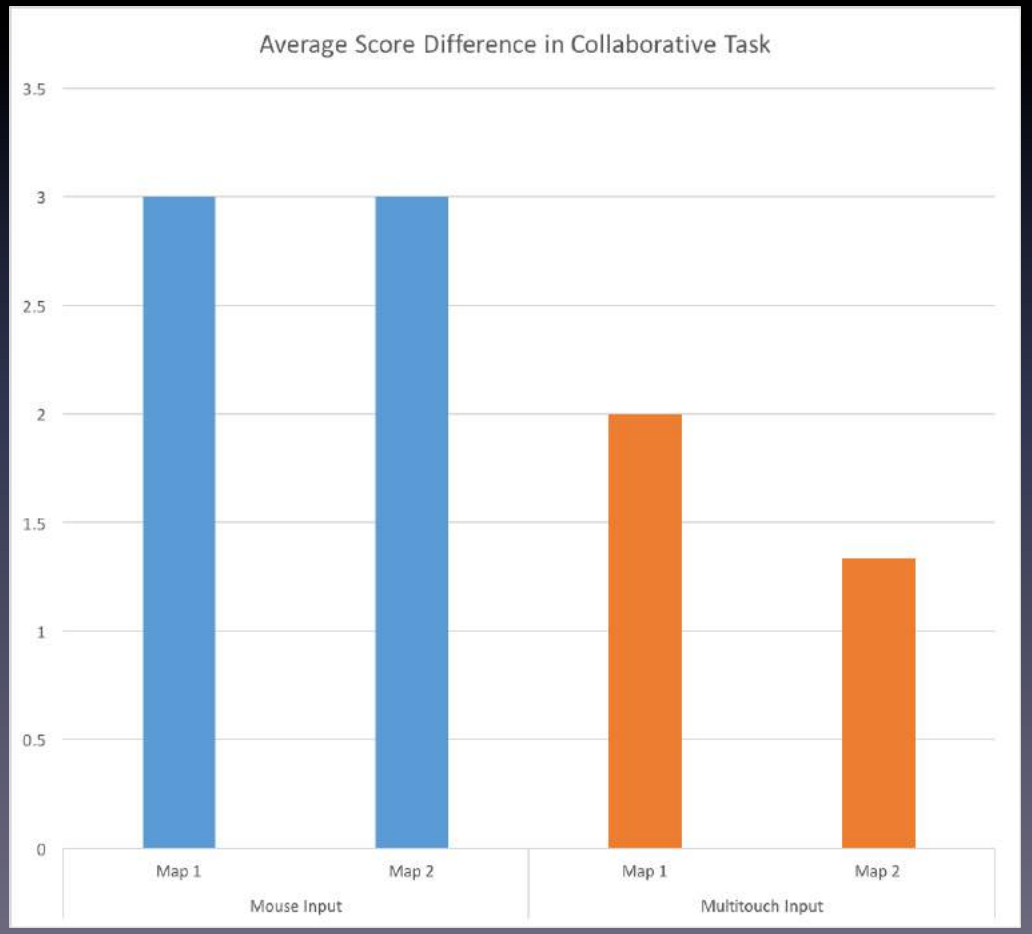


Scores more balanced

Input does not influence the result

Not what we are looking for

Collaborative Scores

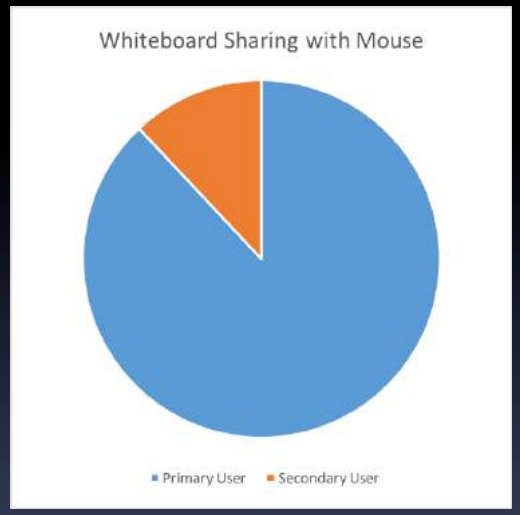


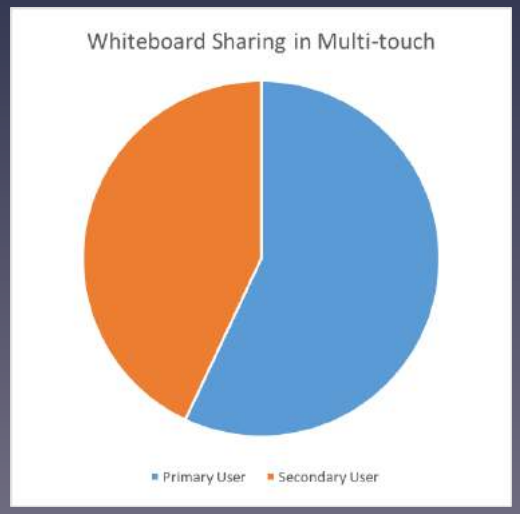
Using multi-touch less difference in singular scores

Mouse has to be shared, it can only be owned by one user at a time

With mouse the users are no longer peers

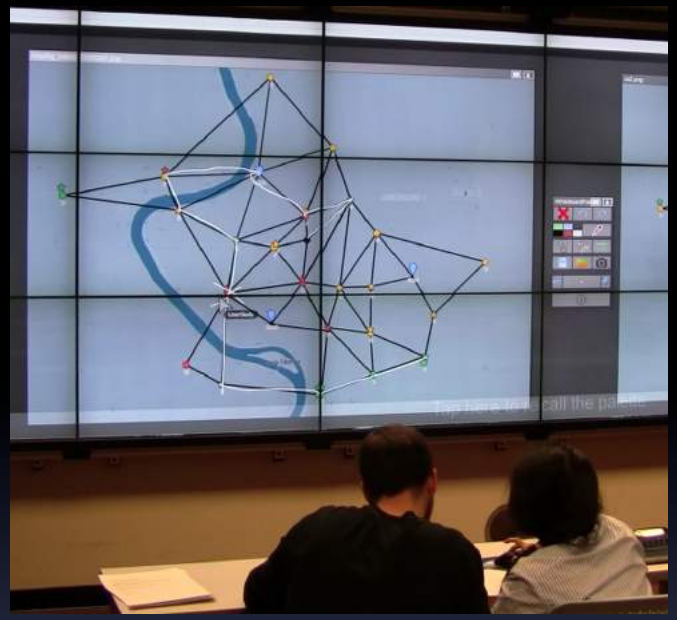
Sharing Ratio

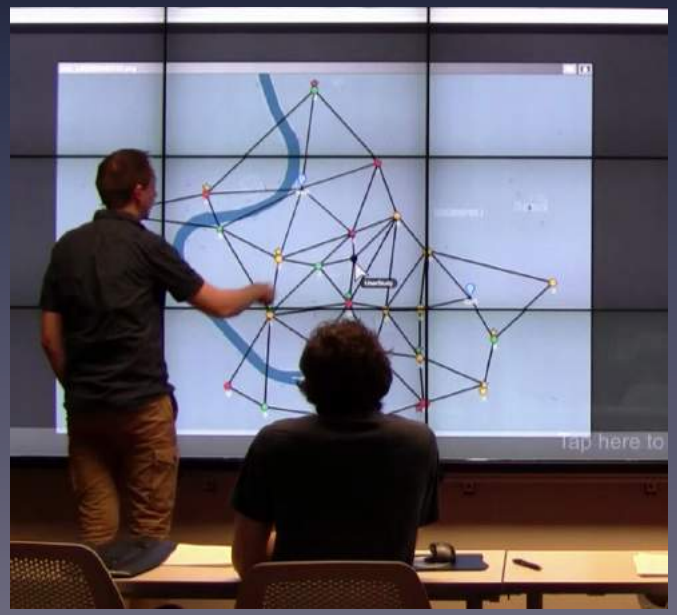




The users do not share the mouse, usually one is in charge of it

When using multi-touch the users share the application almost equally





Collaboration Settings

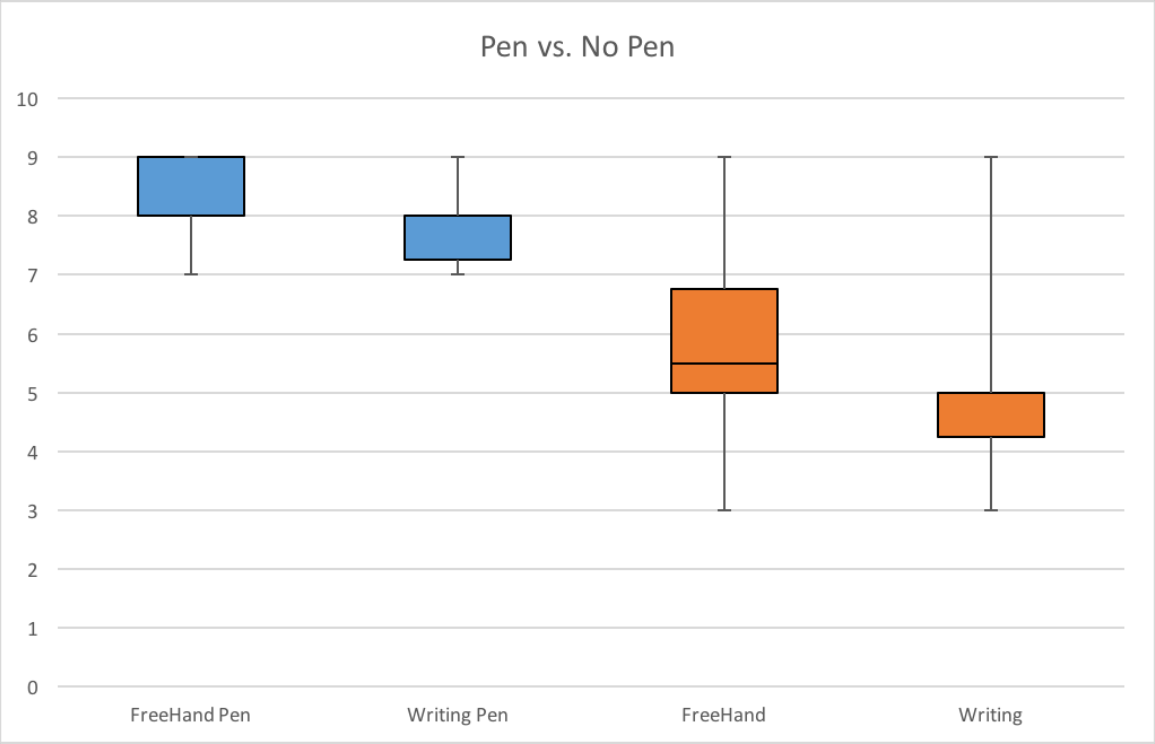
When using Multi-touch both the users are in front of the screen

When using the single mouse there are two settings, Pointer and draftsman, or draftsman and analyst.

Interestingly the role is not associated with the situation leadership.

Feedback

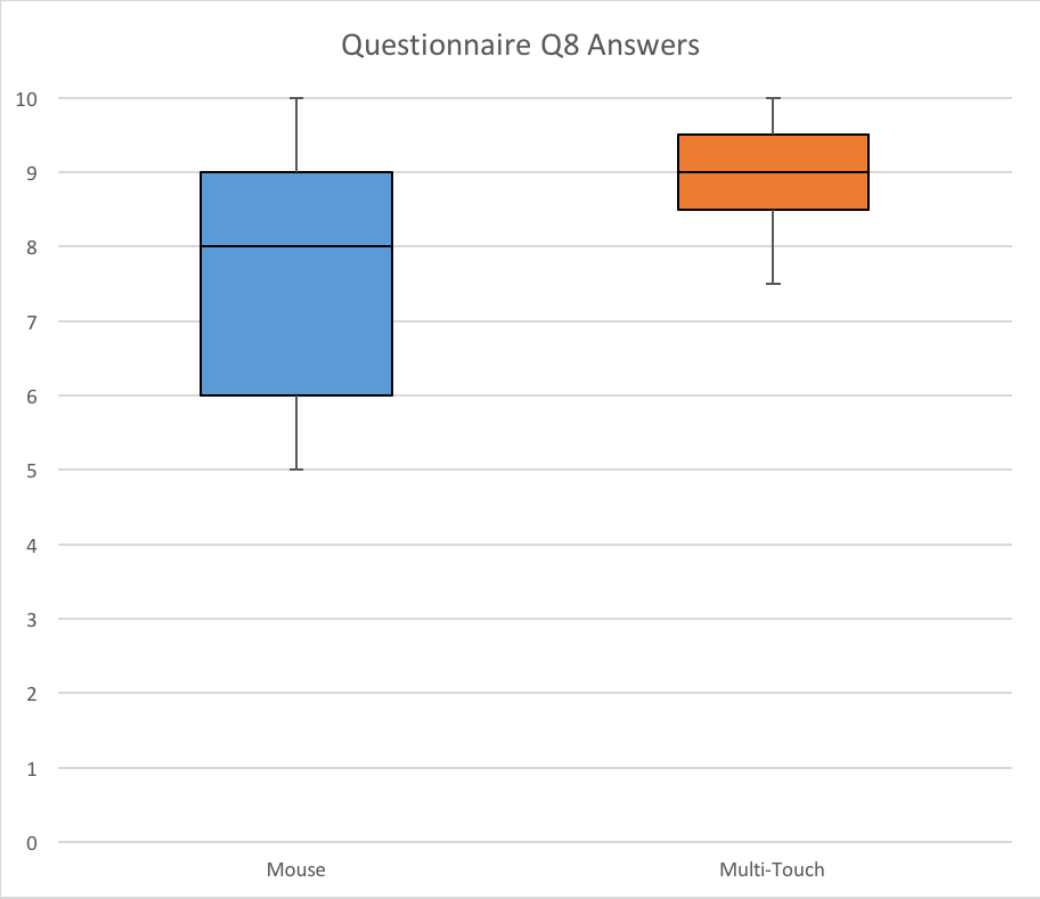
Usability Evaluation



Users that used a stylus in the multi-touch interaction gave much better evaluations.

The low scores are related the the low precision given by the touch overlay.

Inputs Evaluation



Users were globally satisfied with the application, regardless of the used input.

Users recognized that the multi-touch input is better for collaboration.

The preference question answers were almost always in favor of multi-touch

Conclusions

Conclusions

Developed an easy to use application that extends a simple whiteboard with more functionalities.

A scalable application that can be shared in real time between many clients.

Extended the application with a remote control function, using a tablet.

Tested the application and demonstrated its usability.

Noticed how the users are not willing to use a mouse for annotations

Conclusions

Showed how a single mouse input limits the collaboration.

Showed how the single mouse make the users feel like they are no longer peers.

Showed how this misbalance in the collaboration opens the floor to leadership by one of the two users, resulting in a higher difference in scores.

Noticed how the role played in the collaboration is not related to the leadership.

Noticed how the multi-touch input results in a more shared solution.

Thank You