HYBRID CLIENT-SERVER AND P2P NETWORK FOR WEB-BASED COLLABORATIVE 3D DESIGN

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INTRODUCTION

Context

3D CVEs for design review (CAD, PLM, BIM)

Small teams (7/8 people) constraints:

- Mobility
- Real-time interactions in 3D
- Optimal ressources (rendering, storage, networking)

Need a light and efficient support for 3D distributed content accessible (almost) everywhere...

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What is the best suited architecture?

STATE OF THE ART

Architectures

Client-server [HLL+13] [MJ12] [GSWG13]

Client: rising of HTML5 -> WebGL.

Centralized data access and collaboration: Websocket.

Question

As a mimic of small team organization (people-to-people collaboration): why pass through an intermediary (server) ?

Architectures

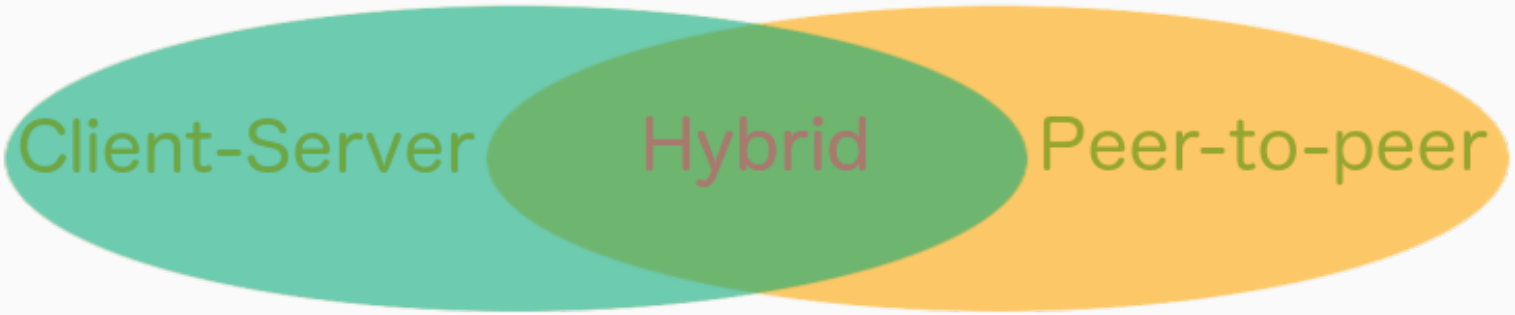
Peer-to-peer [CT07]

Direct data transmission. Distributed ressources.

Question

What if there is no seeder?

Architectures



Hybrid: Client(s)-Server and P2P [KVaD14], [CH14]

Persistence + direct data transmission between clients.

Flexibility and robustness.

OUR HYBRID MODEL

Overview

Hybrid : Persistence + collaboration

Users are working together on a scene where they can interact with 3D data.

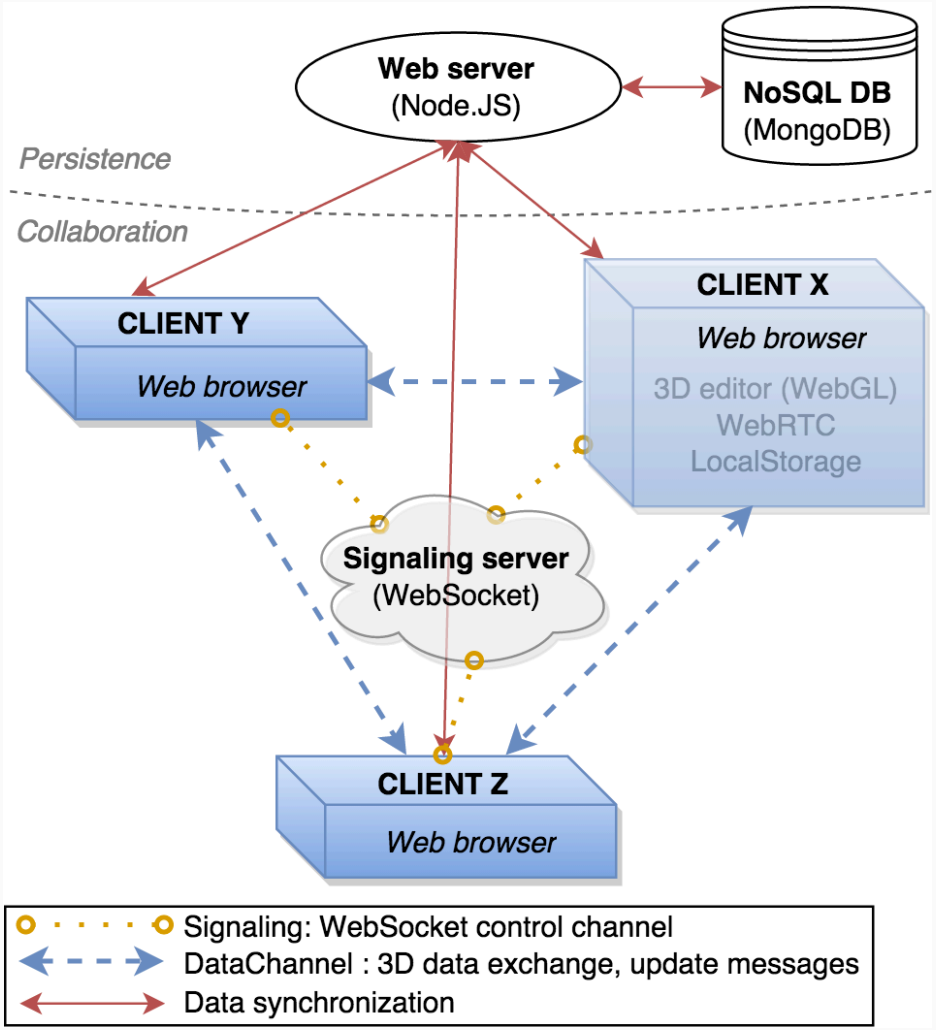
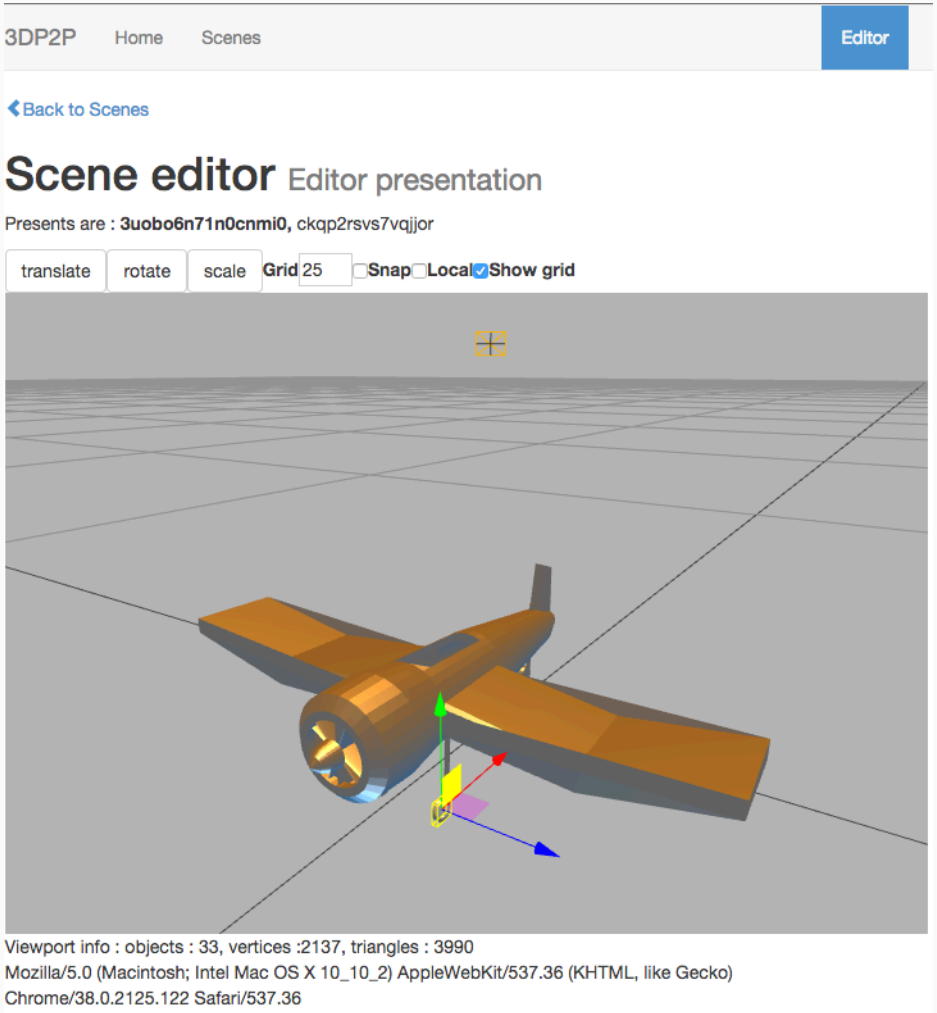


Figure: System overview

3D WEB EDITOR

Features

- **View, navigation** and **transformations tools**
- **Upload 3D models**, textures
- **Switch** point of view
- Referential modification
- Grid snap



Content access policy to avoid modification conflicts during the collaboration : lock/unlock

Persistence layer

NoSQL DB dynamic schema well supporting 3D data format (JSON), updatable on-the-fly.

Peer flow management auto (re)connect peers in a scene.

Mainly used for persistence of the world state and resilience.

Collaboration layer

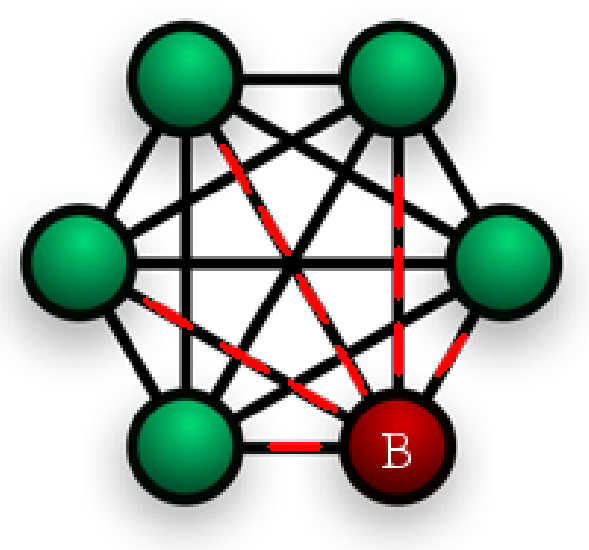


Figure: Message broadcasting inside a full mesh topology network.

Message broadcasting to direct peers and server DB.

Update rendering at message reception.

Granularity of the data transmission depends on the actions.

P2P CONNEXIONS

WebRTC: Web Real-Time Communication (W3C draft)

- allows DataChannel protocol for P2P connections between web browsers to exchange any raw data in real-time.

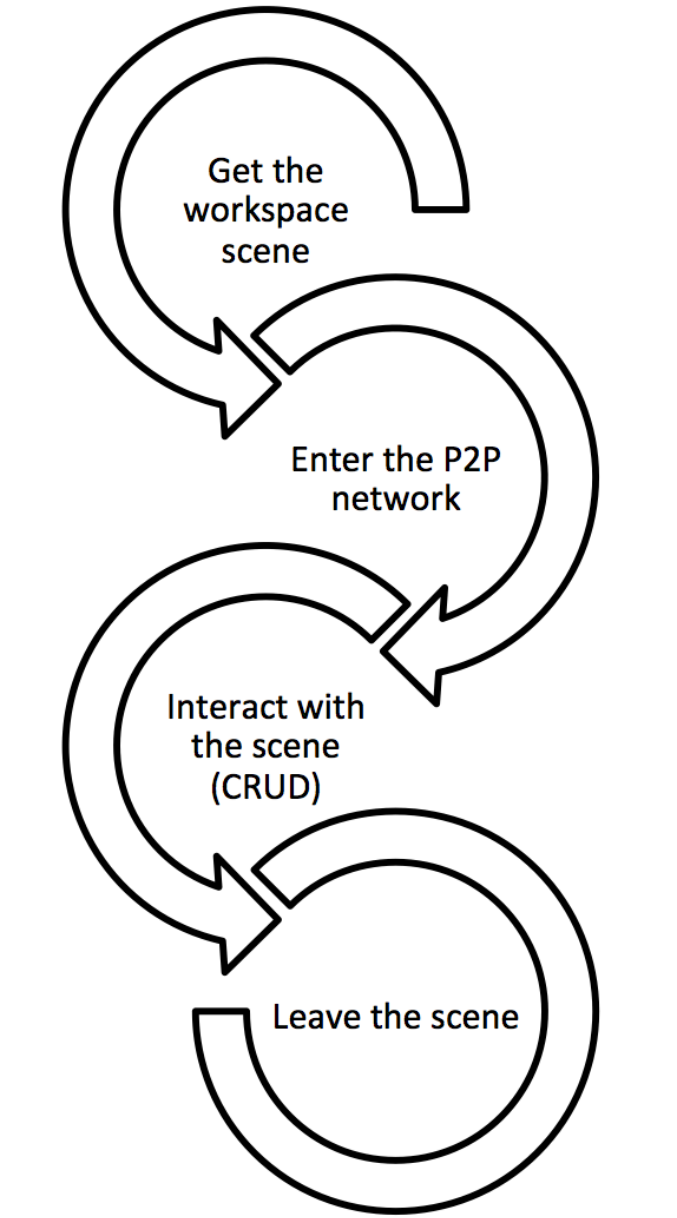
P2P connexions

WebRTC: Web Real-Time Communication (W3C draft)

- allows DataChannel protocol for P2P connections between web browsers to exchange any raw data in real-time.
- uses signaling mechanism (via WebSocket server) to manage peers, the network configuration and the media capabilities.

IMPLEMENTATION

Workflow


Get the workspace scene
Enter the P2P network
Interact with the scene (CRUD)
Leave the scene

Technologies

3D rendering	Server + DB	P2P
three.js WebGL	node.js express mongoDB	PEERJS WebRTC WEBSOCKET

EVALUATION

Experiments

Objective

Demonstrate the feasibility of our model focusing on the user experience.

Experiment description

Assemble collaboratively multiple parts of a scene to match a given picture. Users are on the same network.

Qualitative criteria

- 3D modeling (interface)
- Collaboration (robustness, fluidity)

Table: Model descriptions for the experiments

Experiment	objects	size	users
Wind turbine	6	1.0 MB	2
Pick up	8	1.3 MB	4
Castle from *server*	35	1.3 MB	4
Castle from *peer*	35	1.3 MB	4

Results 1/2

Global evaluation Satisfied of the collaborative and visual results: goals are reached.

User interface Reports about a lack of visual feedbacks on collaborative object prehension.

Object manipulation Good evaluation except at the reception of a new model (not optimized).

User charge The variation (from 4 to 7 people) has not altered rendering and networking quality .

Results 2/2

The system offers a good robustness and resilience in case of browser's or server's crash.

The quality of the collaboration has been considered as real-time more than interactive.

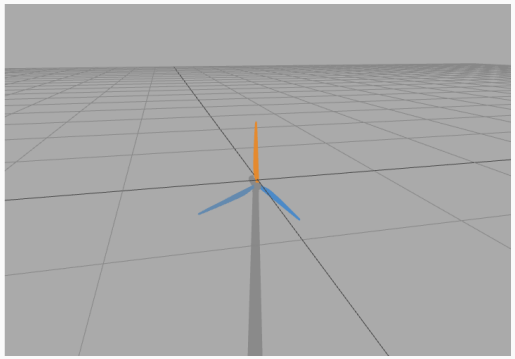
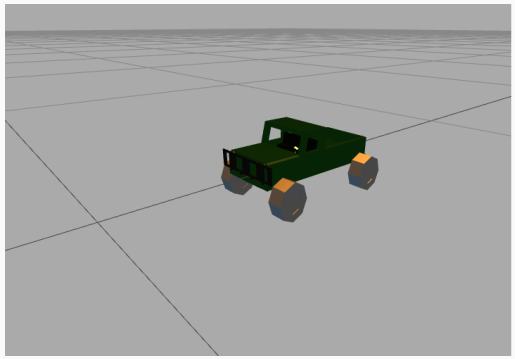
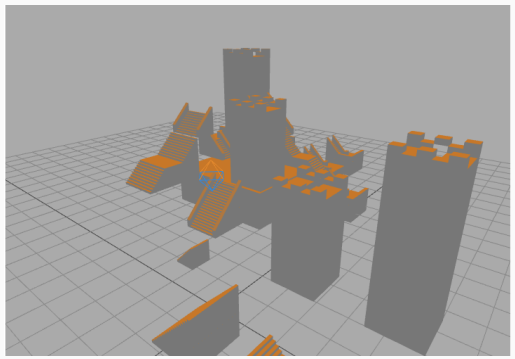




Figure: 3D editor's captures during experiments

CONCLUSION

Summary

Our hybrid model for 3D web-based collaborative modeling mixing Client-server (WebGL and NodeJS) and P2P (WebRTC) architecture is:

- exclusively based on web-browser ressources (cross-platform);
- supported by a functionnal prototype providing
  - 3D rendering with basic interactions,
  - real-time updates with persistence and granularity,
  - and transparent P2P collaboration;

Future work

- Quantitative evaluation (throughput, FPS...) for performance comparisons (WebRTC tools and web automation tools).
- Mesh processing for 3D streaming with distributed ressources
- Richer interface (feedbacks, versionning, plasticity)

Thank you for your attention

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