Connect Desktop and Cloud –
Free Your BIM Data!

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Class summary

- Connect desktop applications and BIM with cloud and mobile apps
- Architect a completely portable cloud-based data repository and geometry viewer
- Explore sample code and optimal use of the Autodesk Forge APIs in a BIM context
- Efficient use of open source tools, Node.js web server and MongoDB NoSQL database

Key learning objectives

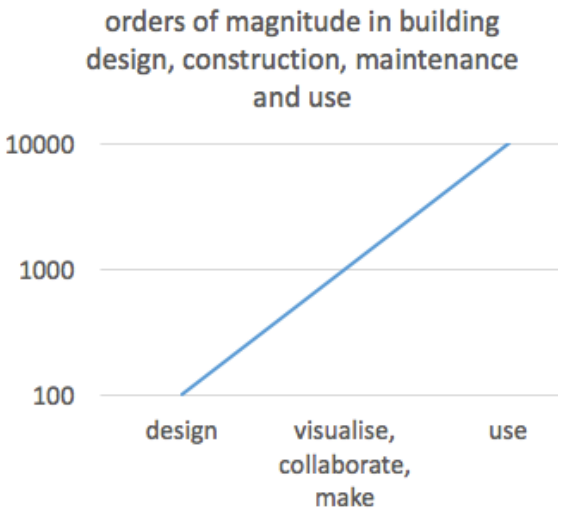
- Connect desktop applications and BIM with cloud and mobile apps
- Architect a completely portable cloud-based data repository and geometry viewer
- Explore sample code and optimal use of the Autodesk Forge APIs in a BIM context
- Efficient use of open source tools, Node.js web server and MongoDB NoSQL database

Agenda

- Free your BIM data – address all BIM participants!
- Why connect? What cloud? How about security?
- It's easy, and almost everything open source
- The 2D SVG cloud-based round-trip room editor
- NoSQL databases, CAP theorem, ACID versus BASE
- FireRating in the Cloud
- Forge overview
- Forge-based round-trip BIM editor
  - Roomedit3dv3

BIM Collaboration Roles

- Participant counts grow by orders of magnitude
- Building design, construction, maintenance, use
  - design - architect, engineer - Revit
  - visualise - client, everybody - Viewer
  - collaborate - management – Glue, Plan
  - make - construction – Field, Layout
  - use - inhabit, maintain, FM



Trends, Tools and Technologies

- Revit and BIM
  - Shrinking numbers of desktop computers
- A growing number of participants
  - Growing numbers of mobile devices
- Glue code, connected custom components
  - Internet, cloud
  - HTML5, SVG, WebGL
  - Forge

What Cloud? Private? Secure?

- Local and totally private
  - 2D room editor uses private CouchDB web server
- Global with Internet security
  - FireRatingCloud uses node.js web server on Heroku and MongoDB database on mongolab
- Forge OAuth
  - Roomedit3dv3 uses Forge OAuth

Keep It Simple!

- Simplify your data
  - Graphics? 2D? 3D? Properties?
  - Customise, optimal workflow, minimal complexity
  - Based on 'need to know'
- Use existing components
  - Minimise add-ins, custom components, glue code
  - Open source
  - Forge

Quotes on Three Fundamental Aspects

- Perfection
  - Perfection is achieved, not when there is nothing more to add, but when there is nothing left to take away – Antoine de Saint-Exupéry
- Lazy
  - … develop the three great virtues of a programmer: laziness, impatience, and hubris – Larry Wall
- Simple
  - Simplicity is the ultimate sophistication – Leonardo da Vinci
  - There is no greatness where there is no simplicity – Leo Tolstoy
- KISS

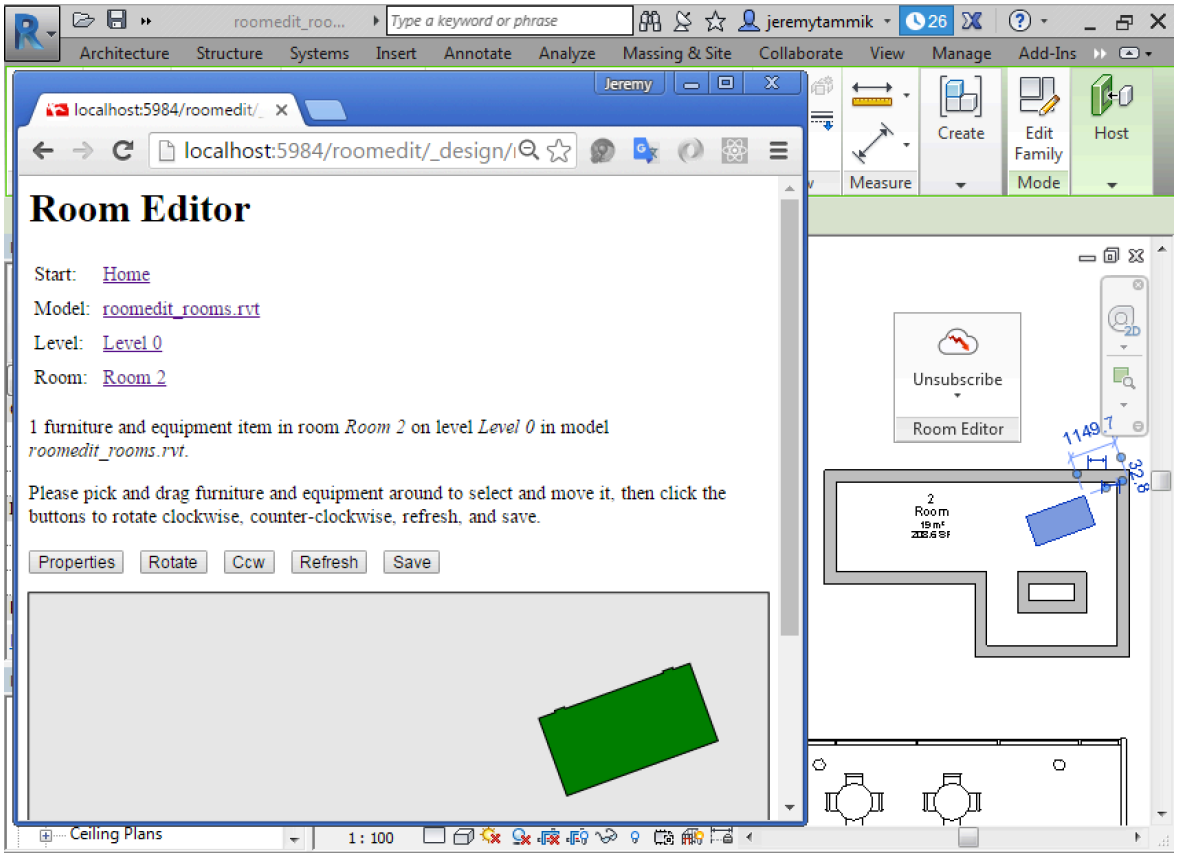
Sample Overview

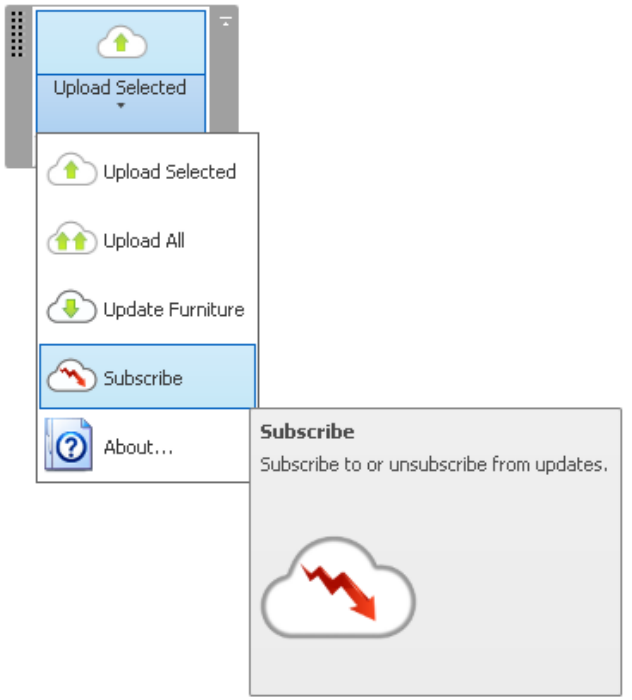
- Simplified 2D BIM room editor, SVG graphics
- FireRating in the Cloud, the simplest sample
- Roomedit3d, Forge based

Caveat

- I am not suggesting modelling in the web
- If you want to do so, talk with Autodesk
  - Revit I/O
  - http://thebuildingcoder.typepad.com/blog/about-the-author.html#5.28b

2D Room Editor





NoSQL

- "Not only SQL"
  - Next generation database paradigm
- Some characteristics
  - Non-relational, distributed, open-source, scalable, huge data
- Frequent other characteristics
  - Schema-free, easy replication support, simple API, eventually consistent, i.e., BASE, not ACID
    - http://nosql-database.org
    - https://en.wikipedia.org/wiki/NoSQL
    - http://www.mongodb.com/nosql-explained

CAP and ACID versus BASE

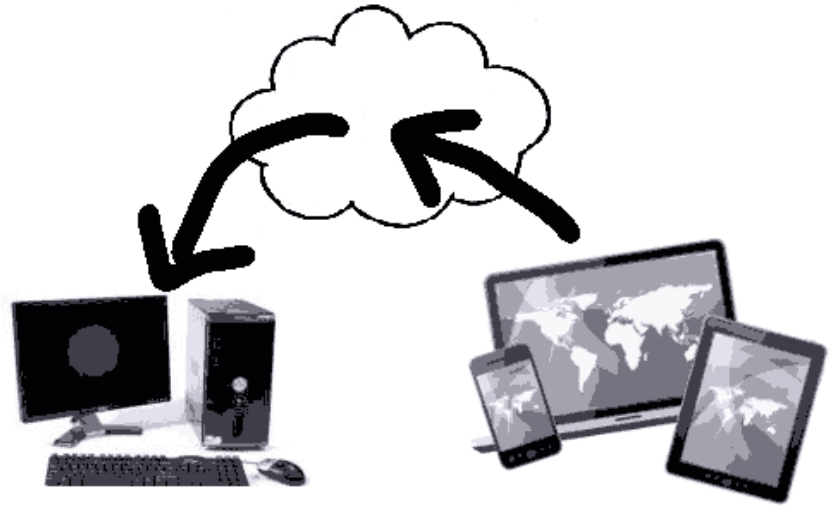
- ACID
  - Atomicity, Consistency, Isolation and Durability guarantee that database transactions are processed reliably
- CAP Theorem
  - The ACID paradigm cannot simultaneously guarantee consistency, availability and partition tolerance (distributed system)
- BASE
  - Basic Availability, Soft-state, Eventual consistency

http://thebuildingcoder.typepad.com/blog/2014/05/views-displaying-given-element-svg-and-nosql.html#5

Data Source, Repository and Consumer Client

- BIM – Building Information Model
- Cloud-based data repository
- 2D rendering on mobile device

Real-time Edit Triggers Database and BIM Update



- Graphical room editor on mobile device
- Update cloud database
- Reflect real-time changes in BIM

CouchDB Database Implementation

- Everything is a document
- All documents are JSON
- Every document has built-in id and revision
- The database design is also a document
- The design defines views and attachments

BIM Model

- Model – a RVT project file
- Level
- Room
- FamilyInstance – furniture or equipment
- FamilySymbol – geometry

BIM Object Graphics

- Room has boundary loops and can contain holes
- FamilySymbol has a single boundary loop
- FamilyInstance has a 2D placement
  - Translation
  - Rotation

BIM Object Relationships

- CouchDB ids are Revit unique ids
- Family instance → room → level → model
- Family instance → symbol

NoSQL Database Structure

- DbObj base class
- DbModel
- DbLevel
- DbRoom
- DbFurniture
- DbSymbol

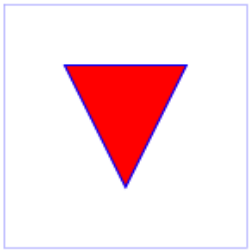
Database Object Relationships

- DbFurniture.symbolId → DbSymbol
- DbFurniture.roomId → DbRoom
- DbRoom.levelId → DbLevel
- DbLevel.modelId → DbModel

Database Object Graphics and Placement

- All graphics represented by SVG path element data

```
<svg width="4cm" height="4cm" viewBox="0 0 400 400"
     xmlns="http://www.w3.org/2000/svg" version="1.1">
  <rect x="1" y="1" width="398" height="398"
        fill="none" stroke="blue" />
  <path d="M 100 100 L 300 100 L 200 300 z"
        fill="red" stroke="blue" stroke-width="3" />
</svg>
```



JSON Symbol Database Document

- Family symbol
- Define geometry


```
{
   "_id": "11cc6e52-519e-49b2-9813-c9561b59a1fd-0005f5fc",
   "_rev": "1-d575ca095533db4ccbed9f7ab2607a12",
   "loop": "M-191 922 L190 922 216 862 190 859 -191 859 -216 862 -216 919Z",
   "type": "symbol",
   "description": "FamilySymbol Furniture <390652 Table ronde a chaises>",
   "name": "Table ronde avec chaises - 01"
}
```

JSON Instance Database Document

- Furniture doc represents family instance and defines
- Relationship to room and family symbol
- Placement = transform = translation + rotation


```
{
   "_id": "11cc6e52-519e-49b2-9813-c9561b59a1fd-0005f65b",
   "_rev": "1-c1b4fc969181267b55dab4c6857fc5d7",
   "roomId": "cbe571b0-0593-4350-a8e6-abf3c9239325-00061210",
   "symbolId": "11cc6e52-519e-49b2-9813-c9561b59a1fd-0005fe6d",
   "transform": "R-90T-10429,1020",
   "type": "furniture",
   "description": "FamilyInstance Furniture <390747 Canapé...
   "name": "Canapé 3 places"
}
```

CouchDB Views

- A view defines a map and optional reduce function
- The map produces key-value pairs
- Reduce produces an accumulation

```
exports.models = {
  map: function (doc) {
    if( 'model' == doc.type ) {
      emit(doc, null);
    }
  },
  reduce: function (key, values, rereduce) {
    return sum(values);
  }
}
```

Room Editor Views

- models
- levels
- rooms
- furniture
- symbols
- map_room_to_furniture
- map_level_to_room
- map_model_to_level

```
rooms = {
  map: function (doc) {
    if( 'room' == doc.type ) {
      emit(doc, null);
    }
  }
};
```

```
map_level_to_room = {
  map: function (doc) {
    if( 'room' == doc.type ) {
      emit(doc.levelId, doc);
    }
  }
};
```

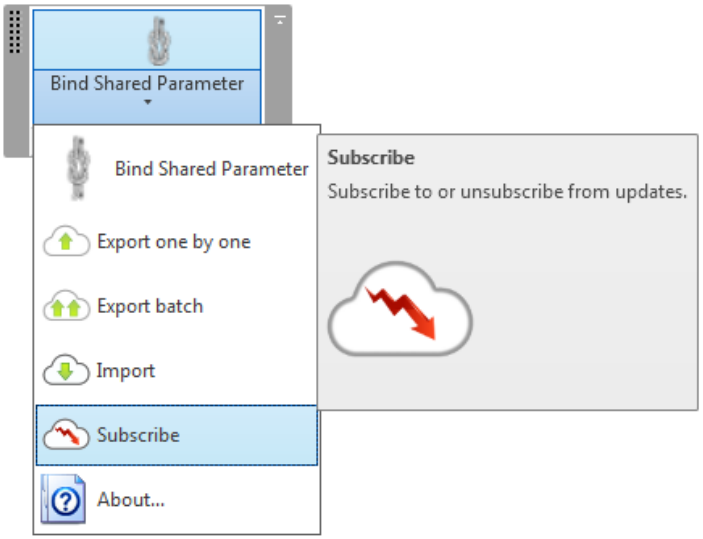
Minimal Predefined HTML Scaffolding

```
<h1>Room Editor</h1>

<div id="content"></div>

<ul id="navigatorlist"></ul>

<div id="editor"></div>

<p id="current_furniture"></p>

<script type="text/javascript" src="modules.js"></script>
<script type="text/javascript" src="raphael-min-jt.js"></script>
```

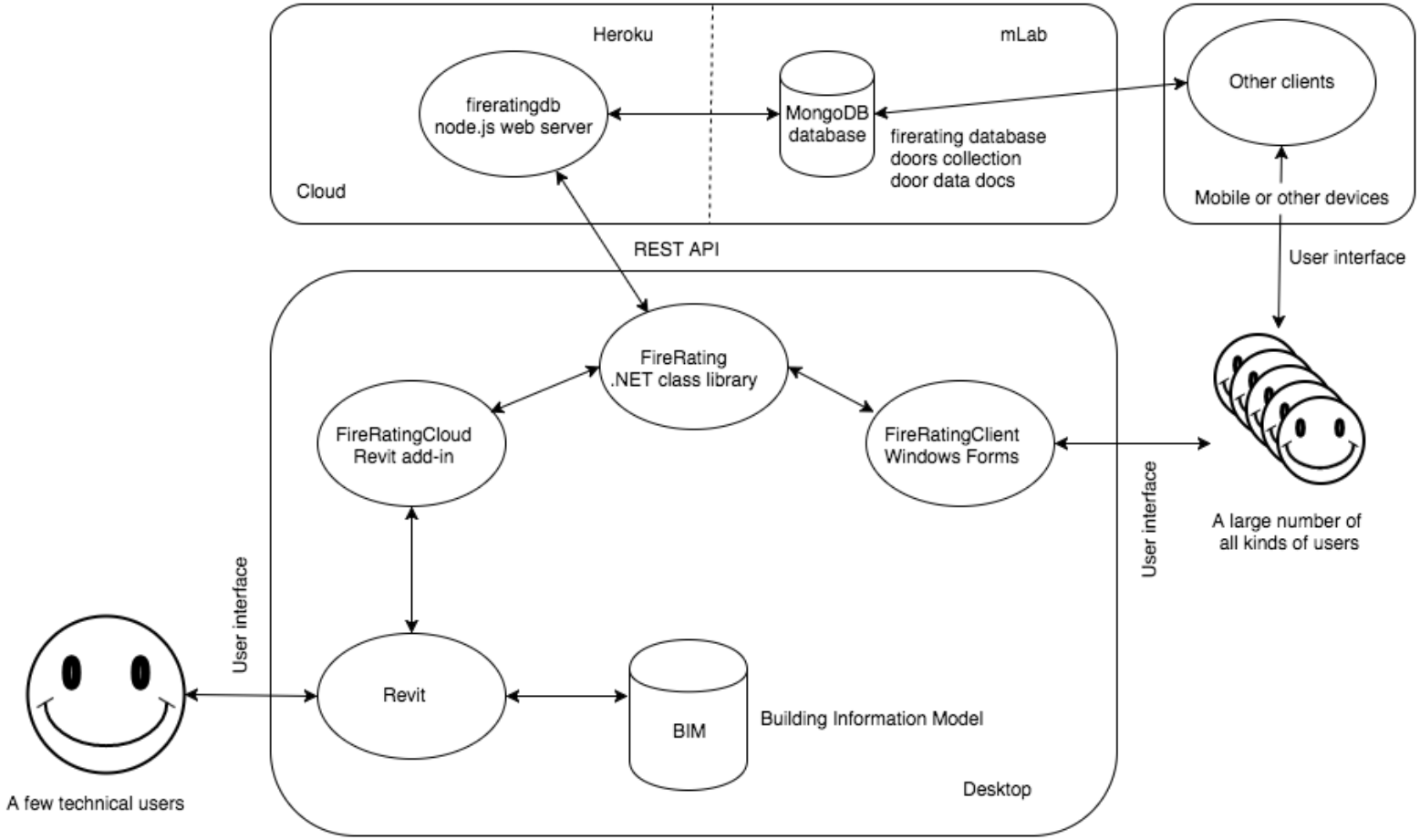
- Populated entirely using JavaScript adding HTML and SVG nodes using jquery, raphael and db for CouchDB queries

FireRating in the Cloud Commands

- Create the shared 'Fire Rating' parameter
- Export fire rating values for all doors
- Import the modified values back into BIM
- Store data for multiple projects
  - Cloud database, Revit UniqueId
- Subscribe to changes



FireRating in the Cloud Architecture



FireRating in the Cloud C# REST Client

- Revit add-in
- Stand-alone

FireRating in the Cloud Node.js MongoDB Server

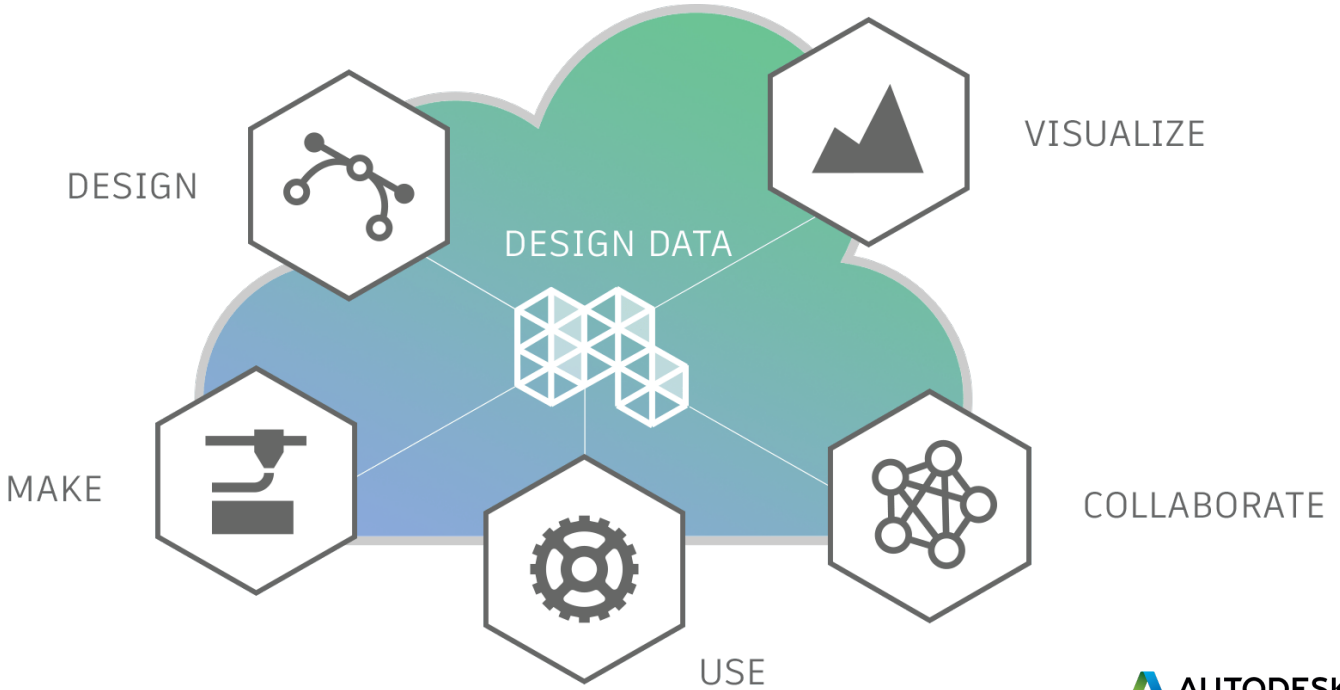
- /a/src/web/mongo/firerating/server.js

FireRating in the Cloud Mongolab Database

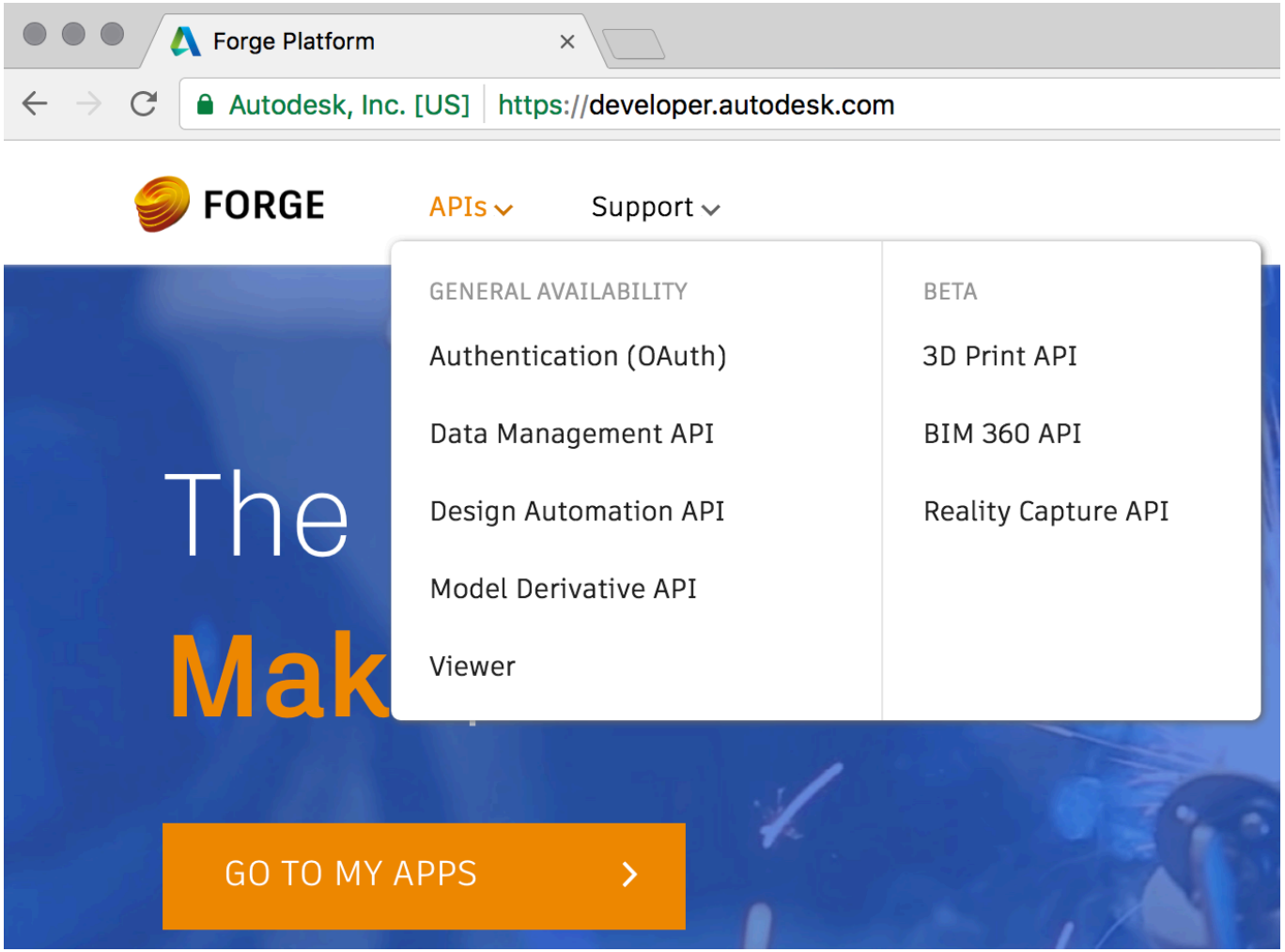
- https://mlab.com
- https://mlab.com/databases/firerating
- https://mlab.com/databases/firerating/collections/doors ?q=%7B%22tag%22%3A%22jeremy%22%7D

Forge Platform Empowers Developers

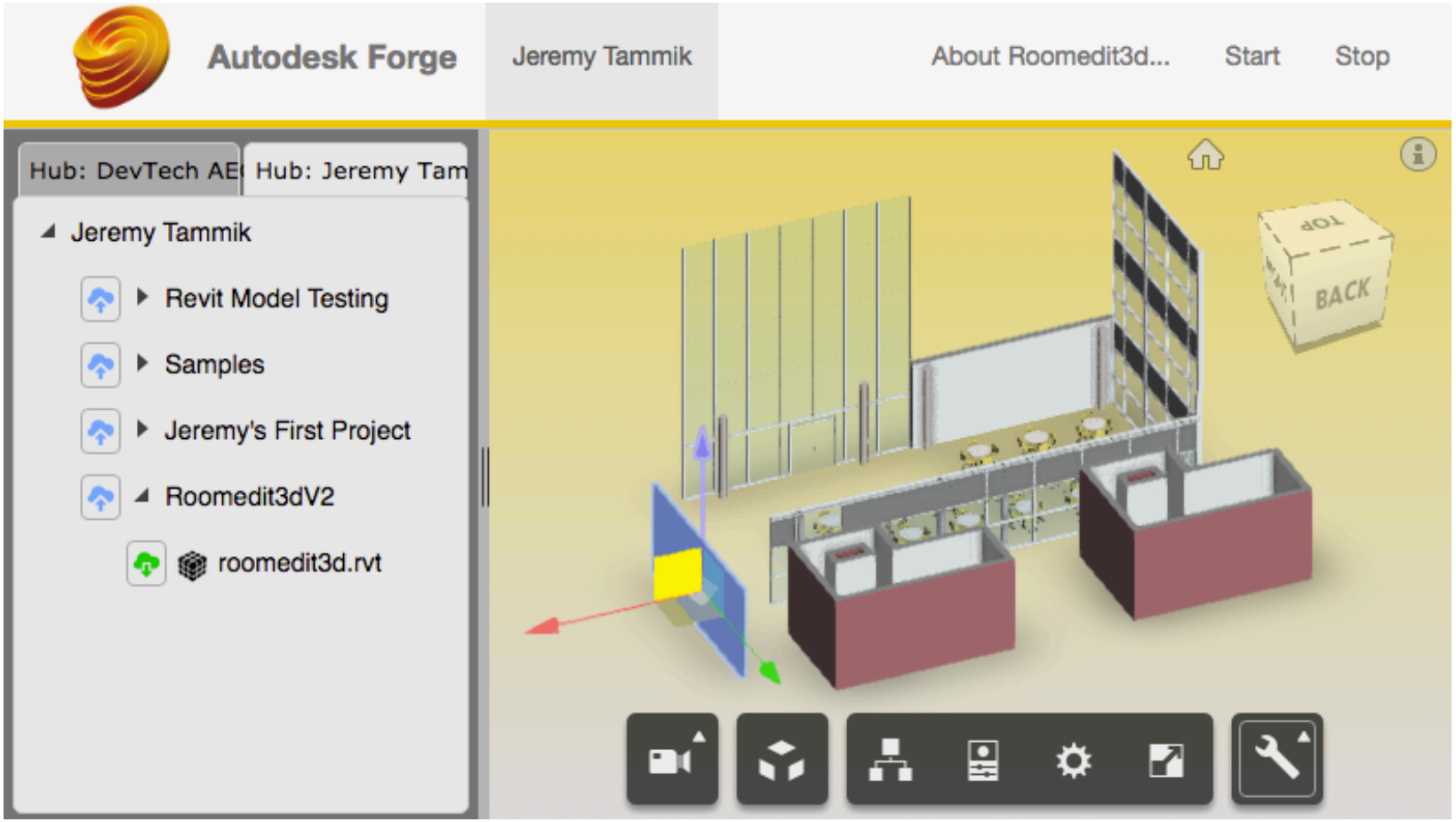
- Forge is a platform to empower developers
- They can in turn empower their users
  - design
  - visualise
  - collaborate
  - make
  - use



Forge Components



Forge Based BIM Editor



Roomedit3dv3 Evolution

- Roomedit3d pre-DevCon – hard-coded
- Roomedit3dv2 for DevCon – A360, deprecated
- Roomedit3dv3 – boilerplate + a dozen lines
  - https://roomedit3dv3.herokuapp.com

Advantages of a Forge Based App

- Realistic model rendering in both 2D and 3D, optionally linked
- Complete access to all BIM data, geometry, structure, properties
- Not bound to any specific model
- Secure authenticated access
- Embedded in a full ecosystem of mature CAD related web services
- Minimal amount of coding based on boilerplate sample code

Sample Repositories

- 2D RoomEditorApp and roomeditdb

  https://github.com/jeremytammik/RoomEditorApp

  https://github.com/jeremytammik/roomedit
- Properties FireRatingCloud and fireratingdb

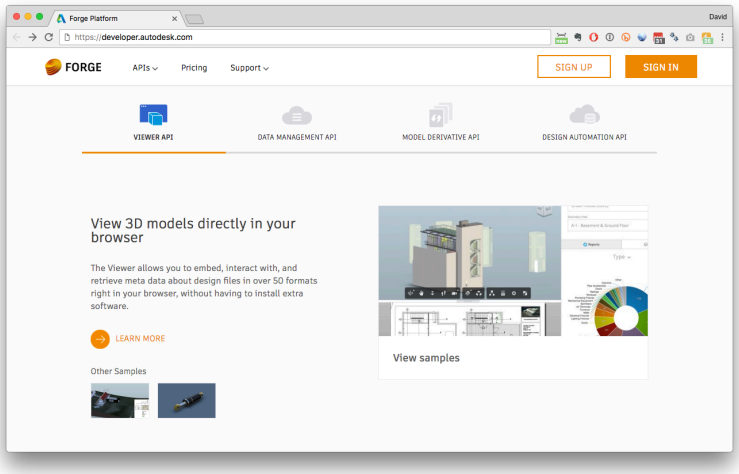
  https://github.com/jeremytammik/FireRatingCloud

  https://github.com/jeremytammik/firerating
- Forge Roomedit3dApp, roomedit3d and roomedit3dv3

  https://github.com/jeremytammik/Roomedit3dApp

  https://github.com/jeremytammik/roomedit3d

  https://github.com/Autodesk-Forge/
  forge- boilers.nodejs/tree/roomedit3d



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