Metaverse
STANDARDS FORUM ™

Standards Cooperation for an Open and Inclusive Metaverse

metaverse-standards.org | @Metaverse_Forum

Photo: jason-blackeye on Unsplash

3D Web Interoperability

SIGGRAPH 2024

Domain Group Status Update

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Domain Group Overview

Our goal is to transform the web into a spatial, immersive realm that's
seamless, efficient, engaging and fun for all
and remain a core component of

the next iteration of the internet…

Our **goal** is: bringing the web to the open metaverse
Our **strategy** is: influencing the evolution of web standards
Our **tactics** include: use case analysis, gap analysis, driving consensus, creating tools
Our **priorities** are: seamless linked experiences, authoring, clients/servers

There is one **Web** :

composed of w multiple URL-addressable and linked interactive experiences

 Similarly, there is one **Metaverse**:

composed of multiple addressable and linked interactive and spatial experiences called virtual worlds
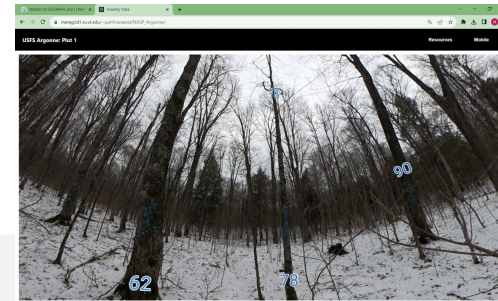
![Metaverse Standards Forum™ logo]

Use Cases & Requirements

Illustrate users' requirements:

- consistency of experience
- portable personal content
- metaverse bookmarks
- virtual field trips, and
- safety simulation
- …

Virginia Tech Visionarium Lab

Gap Analysis
-> Projects

Examine patterns across:

W3C, ISO, Web3D, Khronos, IEEE, OGC, MPEG, …

Standards Development Organizations (SDOs).

Project 1: Linked Experiences
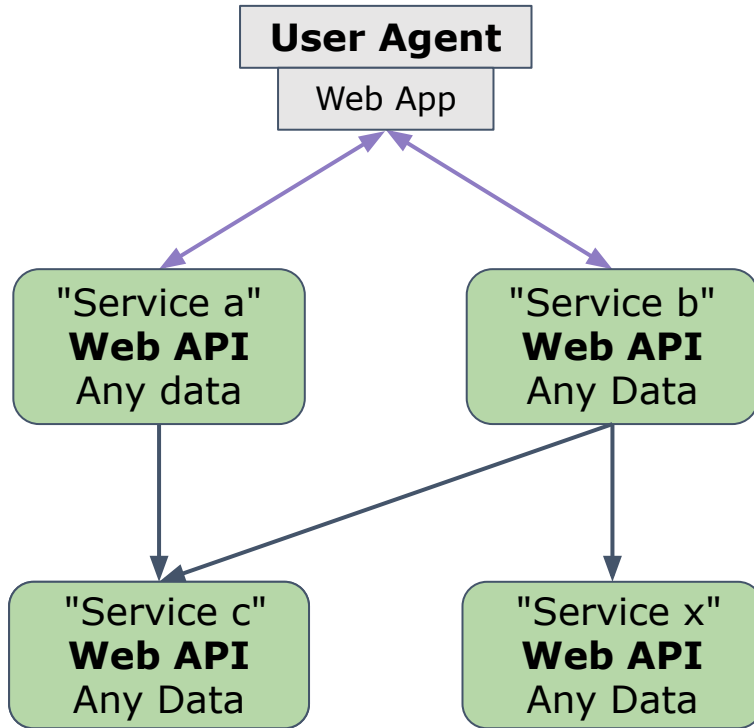
Mechanisms to link and reference virtual worlds and parts thereof

    a.   *Problem Statement:*

        Use cases demonstrate a wide variety of ways that virtual worlds and physical worlds and user information may be linked;

        How can we distinguish these different modes and their requirements?
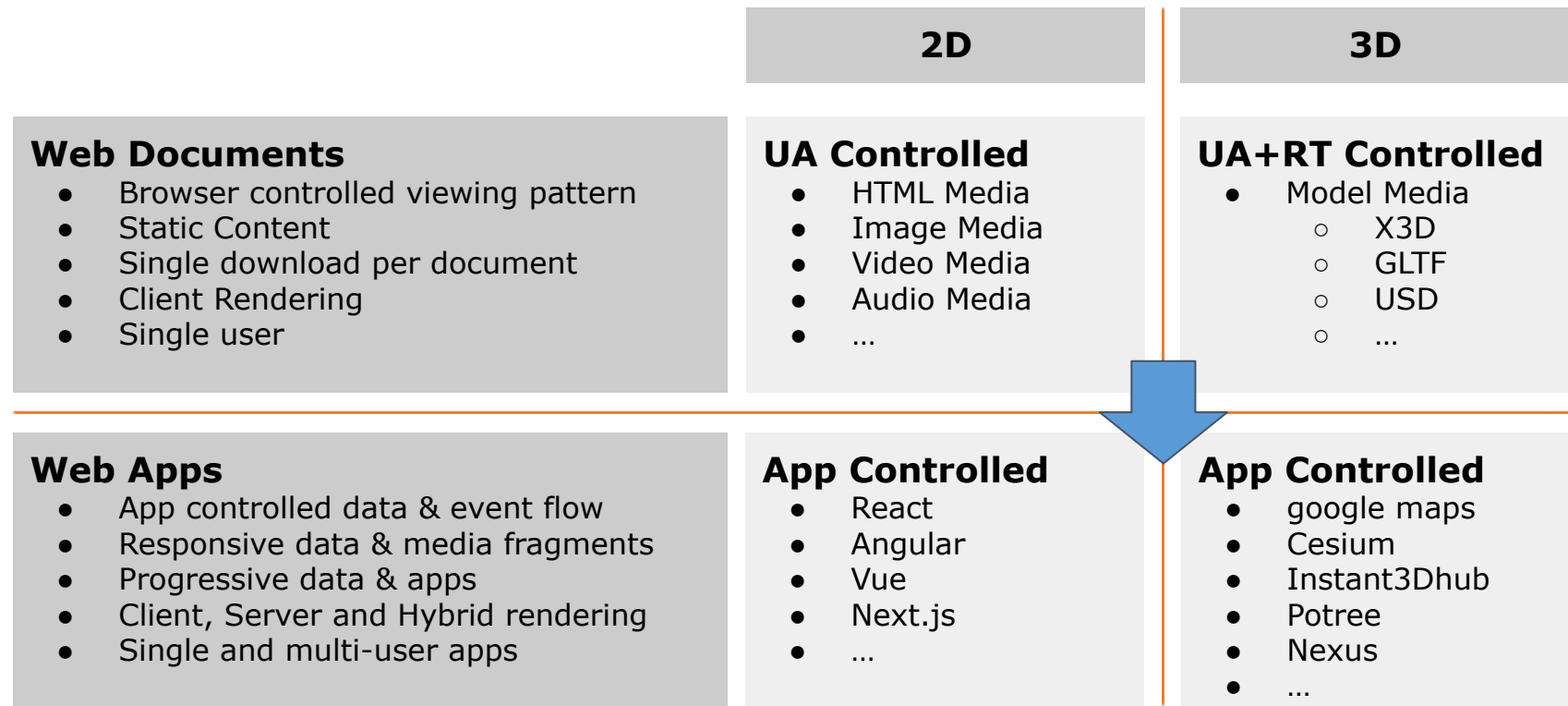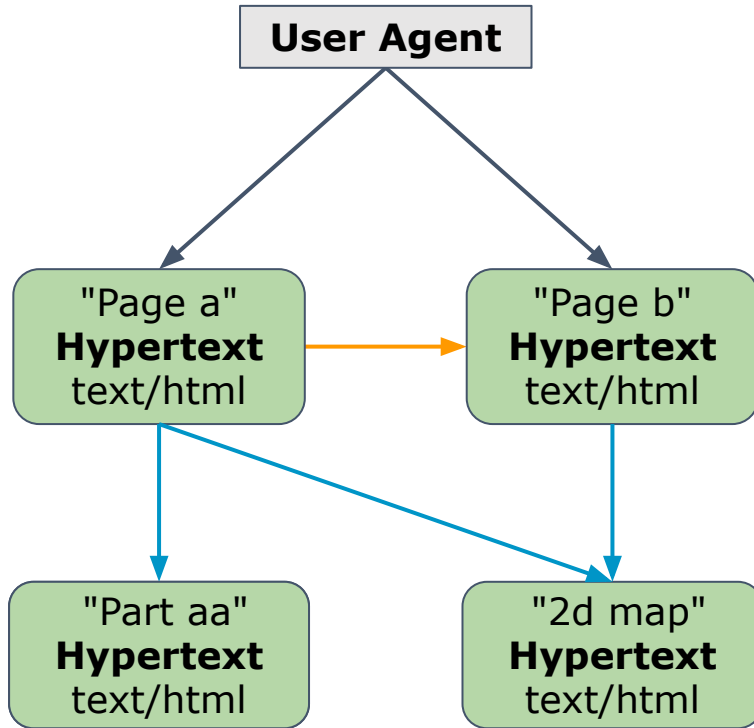
Scope: The (modern) Web

1. **From Web Documents to Web Apps**
   a. App controlled data & event flow
   b. Responsive data & media fragments
   c. Progressive data & apps
   d. Client, Server and Hybrid rendering
   e. Single and multi-user apps

2. **Fom Web Resources to API Endpoints**
   a. HTTP & WS data transmission
   b. 1To1 Content Negotiation and Encoding
      i. html/text
      ii. application/json
      iii. model/jt
      iv. ...
   c. Service agnostic authentication (e.g. SSO

3. **From Last mile to Service Networks**
   a. Deep service dependency stack (> 30)
   b. Microservice lead to smaller packages
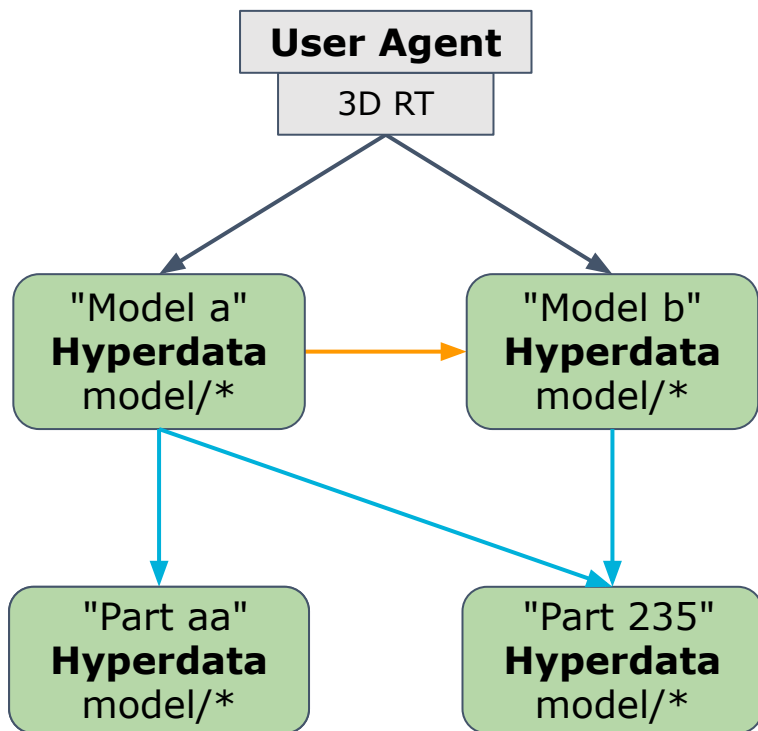   c. Native- and Web-Client symmetry

Scope: The modern 3D Web continuum

	2D	**3D**

Web Documents
- Browser controlled viewing pattern
- Static Content
- Single download per document
- Client Rendering
- Single user

UA Controlled
- HTML Media
- Image Media
- Video Media
- Audio Media
- …

UA+RT Controlled
- Model Media
  - X3D
  - GLTF
  - USD
  - …

Web Apps
- App controlled data & event flow
- Responsive data & media fragments
- Progressive data & apps
- Client, Server and Hybrid rendering
- Single and multi-user apps

App Controlled
- React
- Angular
- Vue
- Next.js
- …

App Controlled
- google maps
- Cesium
- Instant3Dhub
- Potree
- Nexus
- …

Scope: Connectivity of the (classic) 2D Web

User Agent

"Page a"
Hypertext
text/html

"Page b"
Hypertext
text/html

"Part aa"
Hypertext
text/html

"2d map"
Hypertext
text/html

- **URL** are pointer to **HTTP Resources** which can be of any **content** type ([http 1.0](#))

- **text/html** as **Hypertext** content
  - Is evaluated in the **User-Agent**
  - In domain URI references
    - <a> Links to new html-page
    - <iframe> Links to sub-page

Scope: Connectivity of the (classic) 3D Web

```
              ┌─────────────────────┐
              │     User Agent      │
              ├─────────────────────┤
              │       3D RT         │
              └─────────────────────┘
                    ↙        ↘
    ┌──────────────────┐    ┌──────────────────┐
    │   "Model a"      │ →  │   "Model b"      │
    │   Hyperdata      │    │   Hyperdata      │
    │   model/*        │    │   model/*        │
    └──────────────────┘    └──────────────────┘
           ↓        ↘           ↓
    ┌──────────────────┐    ┌──────────────────┐
    │   "Part aa"      │    │   "Part 235"     │
    │   Hyperdata      │    │   Hyperdata      │
    │   model/*        │    │   model/*        │
    └──────────────────┘    └──────────────────┘
```

- **URL** are pointer to **HTTP Resources** which can be of any **content** type ([http 1.0](#))

- **Any model/*** as **3D content** data
    - Is evaluated in a **3D Runtime (3DRT)**
        - **Browser Plugin**
        - **Javascript Frameworks**
            - **Three.js**
            - **X3DOM**
            - **...**
    - [RFC2077](#) **defines the model domain**
        - **Coordinate System**
        - In domain references
            - <...> Links to new scene
            - <...> Links to sub-data
    - >40 [IANA-Registered](#) types
        - model/gltf-binary
        - model/vnd.usda
        - model/x3d+xml
        - …

Scope: Connectivity of the (classic) 3D Web

- Links inside the model domain
 - Builds on existing HTTP standards
  - Implemented in existing standard
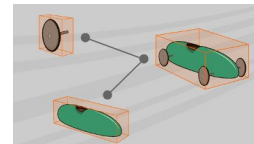
In Domain LInks	None	In-Format	Any-Format
Format	GLTF, obj, stl, …	USD, GLTFX, collada, plmxml, …	X3D, STEP, …

```
<X3D>
    <Transform>
        <Inline url='http://example.com/spatialpool/id/6i9454" >
    </Transform>
</X3D>
```

(Valid X3D example pointing to data endpoint with undefined format.
 The model format will be negotiated in the actual API call)

Scope: Connectivity of the (classic) 3D Web

- Links inside the model domain and fragments of data

- URI Fragment standards allow to address sub-data
  E.g.: RFC7111 for "text/csv":
  "example.com/data.csv#row=3-5"
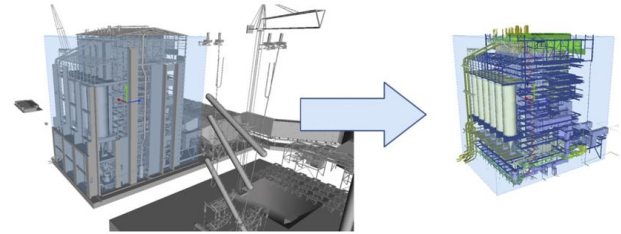
W3C Media Frament URI
  Spatially-, temporally- and structure-based addressing schema

  example.com/media/movie.mpg#xywh=100,100,10,10&t=10,20
  example.com/media/movie.mpg#id=cap

Open Opportunity: Missing "Model Fragment URI"
  Spatially-, temporally- and structure-based addressing

  E.g., example.com/model/434/#xyzwhz=100,100,100,20,20,20&t=10,20
  Object- and Object-set-based addressing schema
  example.com/model/434/#objects="/tire"

Vision: The web of worlds

Web
HTTP endpoint provides Site
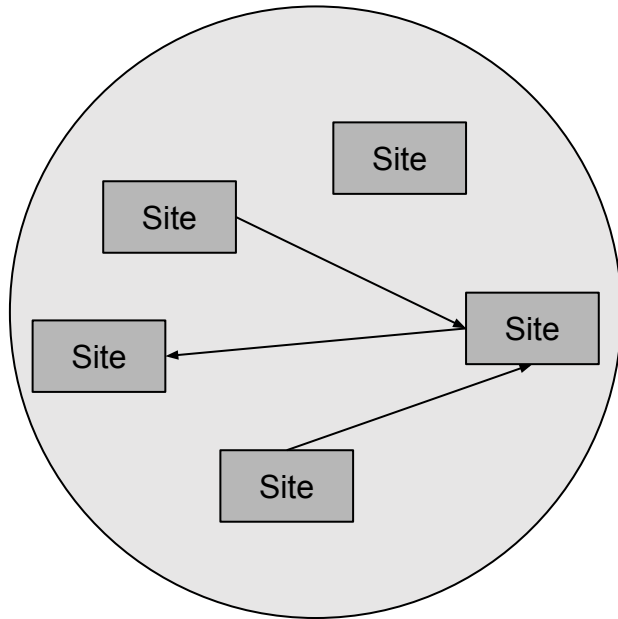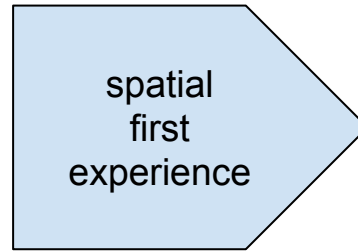
Metaverse
HTTP endpoint provides World

spatial
first
experience

Site

Site

Site

Site

Site

World
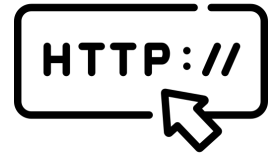
World

World

World

World

2D > 2D > 2D > 2D
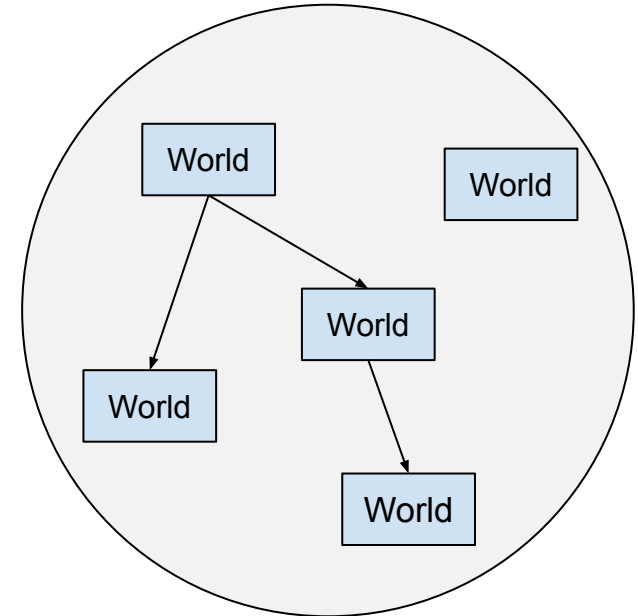
3D > 3D > 3D > 3D

Mission: Virtual Worlds on the modern web

1. **Single URI pointing to discrete virtual world**
   a. **Links between worlds** (e.g jumps/portals and inserts in spatial composition)
   b. **Persistent data references** in **linked data environments** (e.g. Digital twins, product configuration, …)
   c. **Storing** URI/URL for later use (e.g. Bookmarks, Ticket system, …)
   d. **Sharing** URI with second user (e.g. teams, …)

2. **Can be opened and joined in any browser directly**
   a. Shared interactive **spatial experience** and not 3D data (e.g x3d, gltf)
   b. **Web app** controlled user experience as dominant delivery model (e.g client data vs remote rendering)

3. **Rich user experience for any spatial data composition and size**
   a. **Static and dynamic spatial data composition**, billions of addressable spatial data states
   b. **High visual efficiency** and **fidelity**

4. **Shared multi user and multi device scenarios**
   a. Mixed and highly dynamic user and device configurations (e.g desktop, mobile, immersive)

5. **World agnostic user identification** and **data authentication** (e.g. SSO)
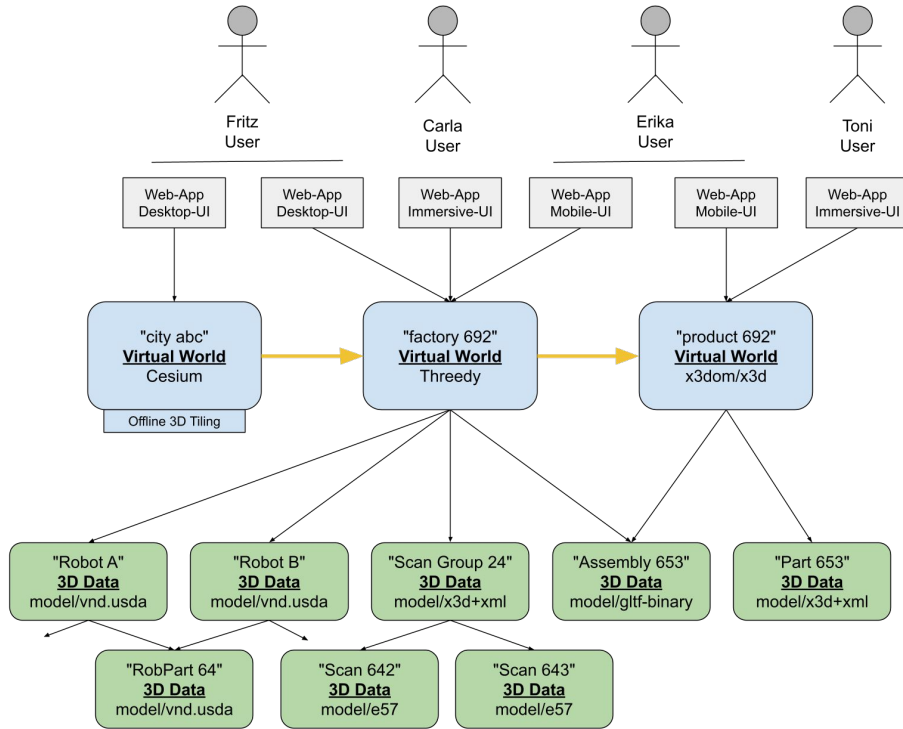
HTTP://

Opportunity: Uniform Web API standard for worlds

- Builds on existing **web and http stack and standards**

- Providing a **single URL endpoint** for each **addressable world**
  - **E.g.** http://example.com/superverse/395844

- **Open URL** in **UA** to **join** the **world** as **interactive experience**
  - **Automatic User ID** controlled **join/rejoin** management
  - **Web-App** controlled **IO/data/pixel flow**
    - E.g. Local data vs remote rendering
  - **Existing user & views** should be addressable
    - E.g. superverse/395844/user/983

- **Open URL** in **UA** to **preview** the world (optional)
  - No **additional user** but **user based authorization**
  - Web-App controlled IO/data/pixel flow
  - Existing userviews should be addressable

- **Scene** state as model data (optional)
  - Including external links, multi-standard (e.g. x3d, usd, gltf)

World
- 3D User
- 3D View
- 3D Scene

External Data Provider (optional)
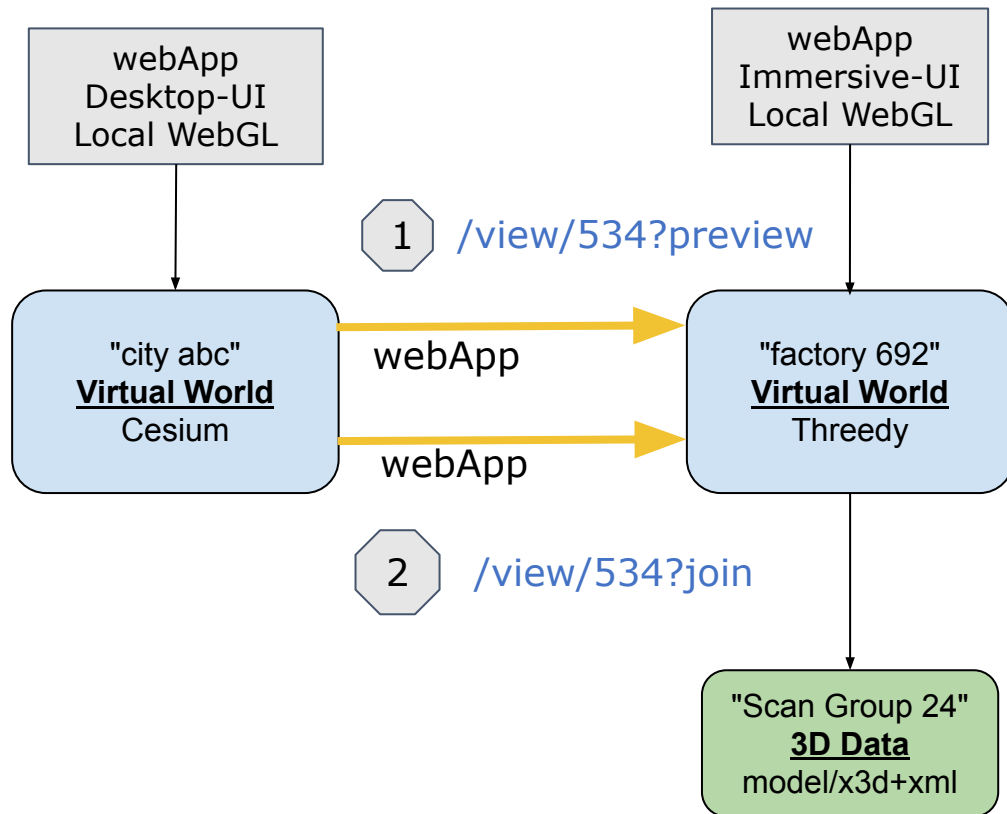- Avatar
- 3D Model
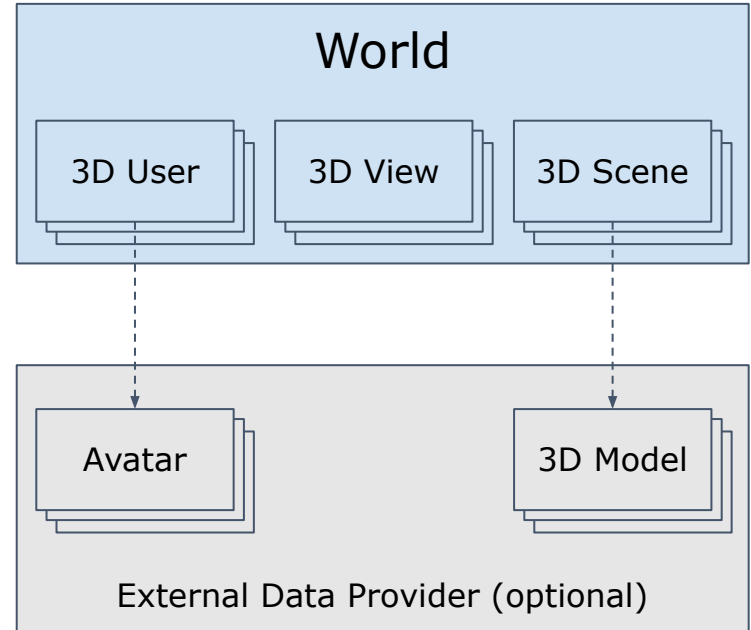
Use-Case 1/3: Shared links in multi-user/device setups

- **Fritz** clicks "city_abc" link in email
  - UA starts new Web-App with desktop-UI

- **Fritz** navigates to factory section

- **Fritz** clicks on "explore" button
  - UA starts new Web-App with desktop-UI

- **Fritz** shares "factory 692" link with Carla

- **Carla** Opens "factory 692" link on XR-Class
  - UA starts new Web-App with immersive-UI

- **Carla** shares link with Erika in teams

- **Erika** Open "factory 692" link on phone
  - UA starts new Web-App with mobile-UI

- **Erika** navigates to product section

- **Erika** activates "product" objects
  - UA starts new Web-App with mobile-UI

- **Erika** shares the "product 692" link with Toni

- **Toni** open "Product 692" on AR-class
  - UA starts new Web-App with immersive-UI
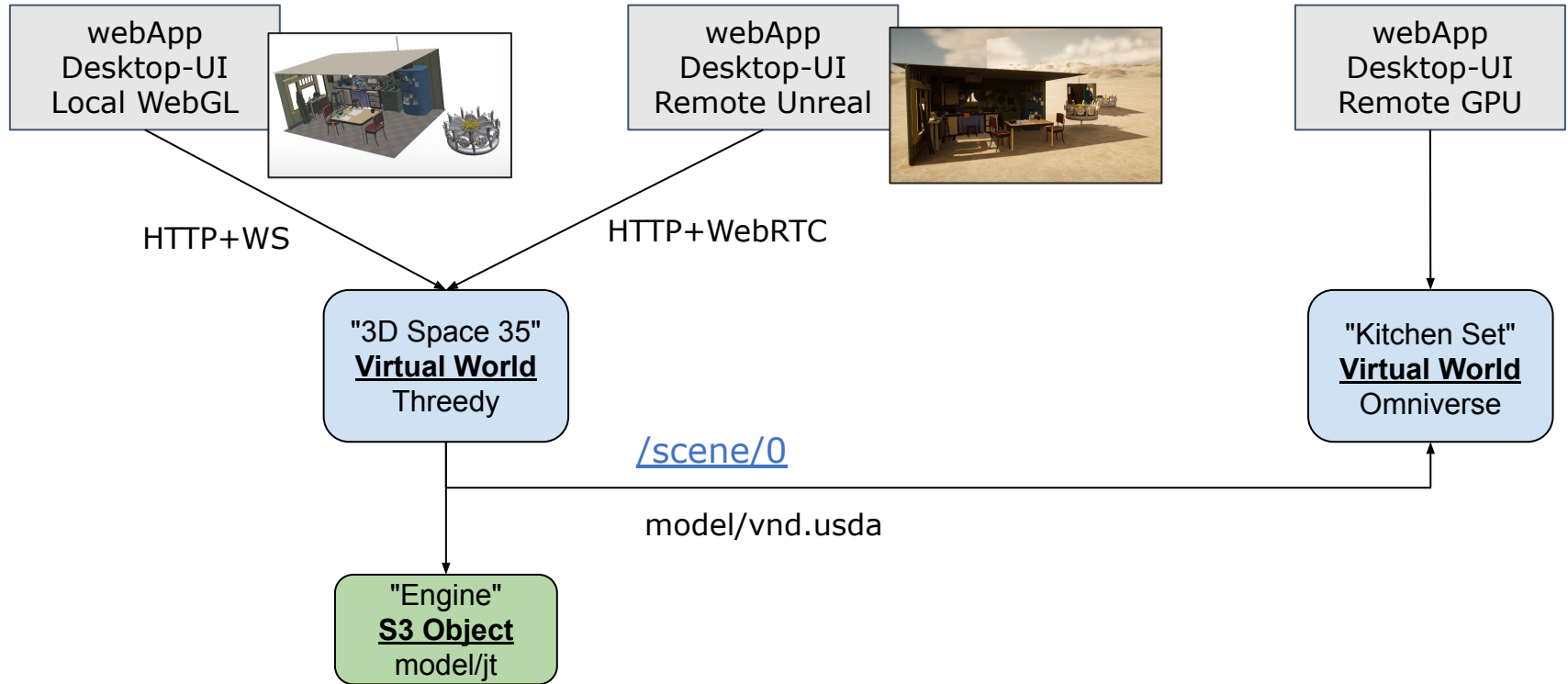
Use-Case 2/3: Previews and portals

webApp
Desktop-UI
Local WebGL

webApp
Immersive-UI
Local WebGL

1 /view/534?preview

"city abc"
Virtual World
Cesium

webApp

webApp

"factory 692"
Virtual World
Threedy

2 /view/534?join

"Scan Group 24"
3D Data
model/x3d+xml

Join us!

Use-Case 3/3: Compose scene state from second world

webApp
Desktop-UI
Local WebGL

webApp
Desktop-UI
Remote Unreal

webApp
Desktop-UI
Remote GPU

HTTP+WS

HTTP+WebRTC

"3D Space 35"
Virtual World
Threedy

"Kitchen Set"
Virtual World
Omniverse

/scene/0

model/vnd.usda

"Engine"
S3 Object
model/jt

Validation: [The Seven Rules of the Metaverse](#) check

1. There is only one Metaverse. ❓

2. The Metaverse is for everyone. ✅

3. Nobody controls the Metaverse. ✅

4. The Metaverse is open. ✅

5. The Metaverse is hardware-independent. ✅

6. The Metaverse is a Network. ✅

7. The Metaverse is the Internet. ❓

   . …

Next Steps

- Scope the proposed API

- Landing Page
    - Github
    - API spec

- Demo and test Continuous experiences
    - Desktop, mobile, XR device (Immersive)…

- Addition benefits for Previews and Portals
    - Use-Case match
        - Industrial Metaverse
        - …

Project 2: Functional Profiles

Functional profiles for Metaverse applications – content interoperability

a. *Problem Statement:* 3D scenes are built up from a variety of resources, from geometry and materials to lighting, sensors, and rich content models;

Can we define levels of 3D content interoperability that is useful for composing and traversing the Metaverse?

3D Web Content

3D: More than just geometry!

- Interactions
- Animations, Lights,
- WebAudio
- LODs
- Avatars
- Semantics of 3D content … ?

NB: Functional Profiles of Metaverse content?

Project 2: Functional Profiles

1. Recent example: glTF ++ extensions
2. [X3D Profiles and Components](#) provide a formal, validating basis for ISO-IEC Standard conformance that is flexible for many applications
   a. X3D Extensibility means that custom nodes can validate on top of conformant Profile and Components and can extend [the interface hierarchy](#)
   b. **X3D4** continues to evolve with glTF and WebAudio, MIDI, … support
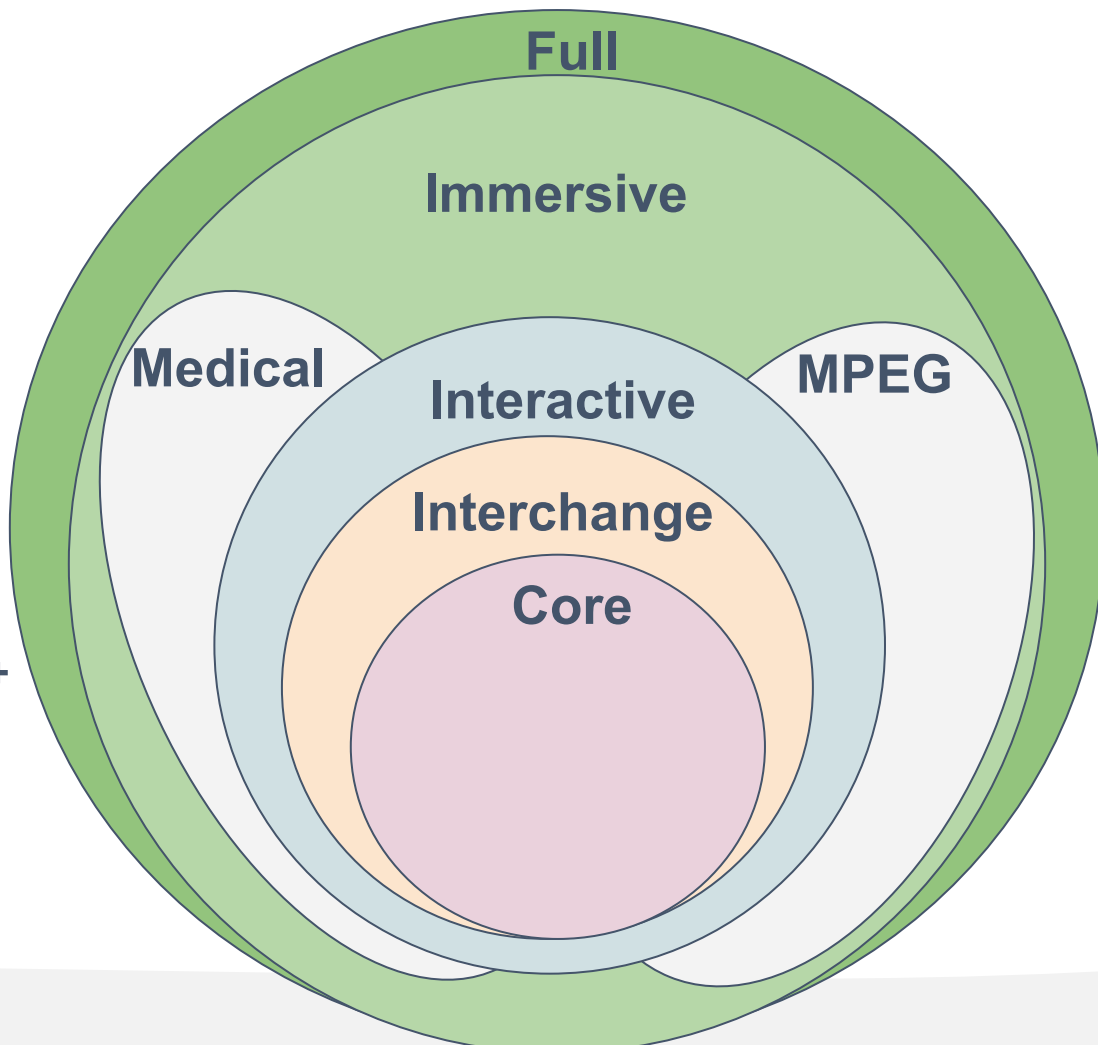3. Open source engines live the art of the possible

X3D Profiles

Node *Components* supported at *Levels*; declared in header

**NB:
In X3D4,
 support for**

**glTF 2.0 and PBR
Requires X3D:**
- **Interchange Profile +**
- **Networking Level 4**
- **Lighting Level 4**
- **Shape Level 2**

Proof and Pudding

- **X3DOM**.org : Javascript Engine - New Release 1.8.3

- **X_ITE** : Javascript Engine - New Release 10.0.5

- **Castle Game Engine**

- **FreeWRL** 6.1

Project 3: 3D UserAgent

3D UserAgent investigation

a. *Problem Statement:* The UserAgent is a piece of software that interprets a text string from a Web server on behalf of the user.

What capabilities could be added to the UserAgent (UA) to enable an accessible Metaverse?

Project 3: 3D UserAgent

Definition:

"A user agent is any software that retrieves, renders and facilitates end user interaction with Web content, or whose user interface is implemented using Web technologies."

Web Accessibility Initiative

- https://www.w3.org/WAI/standards-guidelines/

Consumer and producer protections

Web Content

1D: *Generally linear text (HTML, DOM) and layouts (CSS)*

- Provide text alternatives for accessibility

2D: *Tables have improved accessibility and CSS can be used*

- Images: alt text for images and SVG style semantics
- Videos: captions and transcripts
- Canvas: application has pixel control
  - Opaque to the UserAgent
  - WebGL, WebGPU

3D UserAgent

This proposal will improve the 3D semantics in the UserAgent

Join Us!

Metaverse Standards Forum: 3D Web Interoperability

Group information and Charter:

https://metaverse-standards.org/domain-groups/3d-web-interoperability/

YouTube Channel:

https://www.youtube.com/playlist?list=PL9H8jJb7mpbkOXlo_PxEsRGNSAOyq4gxK