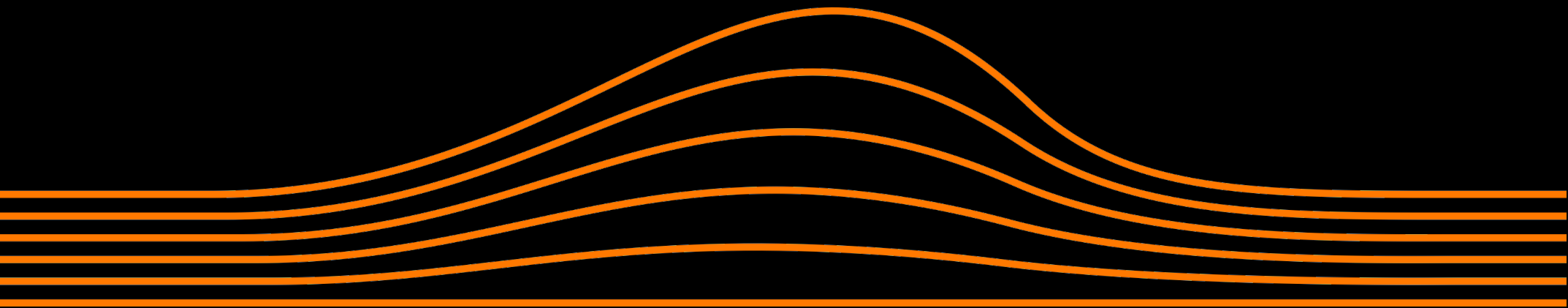


Towards Interoperable Spatial Anchoring for Augmented Reality

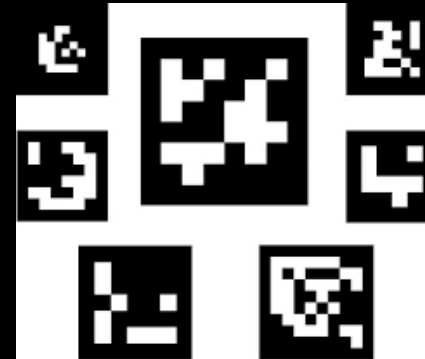
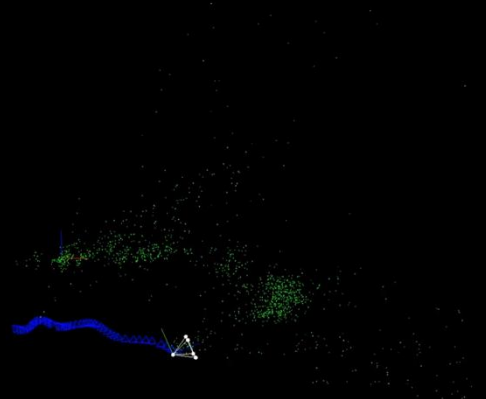
Jérémy Lacoche, **Guillaume Bataille**, Bruno Caby, Stephane Louis Dit Picard, Damien Mazeas, Gabor Soros (Nokia Bell Labs)



Augmented Reality and Spatial Anchoring

- Aligning virtual content with related real environment requires spatial anchoring

SolAR - Map Initialization



Camera *Tracking* through SLAM or Visual Odometry for instance (*video courtesy of IRT b<>com*)

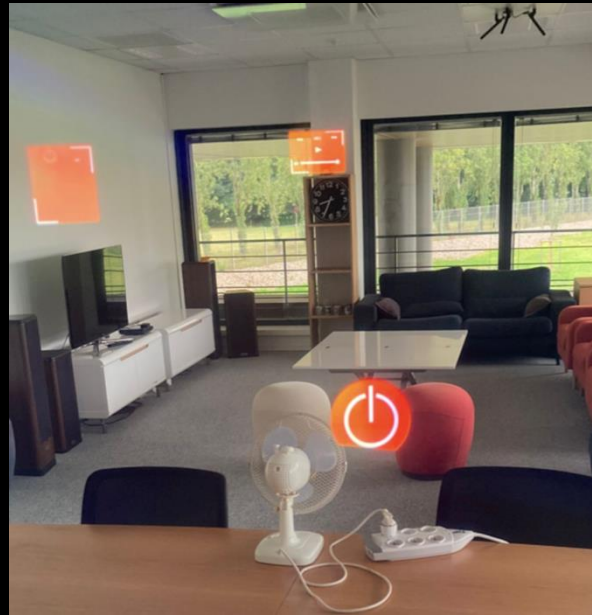
***Relocalization* based on spatial references from an existing real world representation**

Examples of applications

- Indoor and outdoor use cases
- Consumer and industrial scenarios



Security patrols in smart buildings



Augmented Smart home



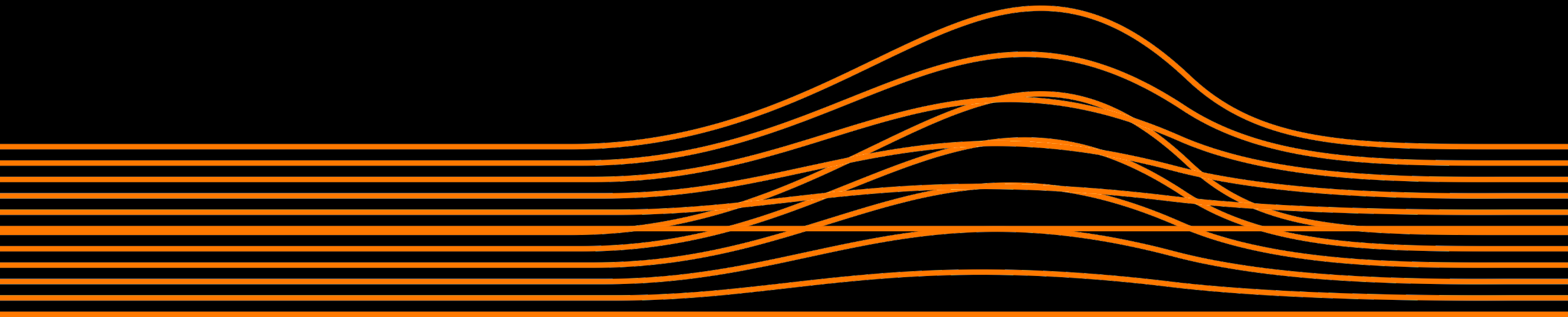
Visualization of underground infrastructure

Associated issues

- **AR Framework and ecosystems are fragmented across devices and platforms**
 - Heterogeneous tracking and anchoring capabilities
 - QRCode / Image tracking often the only common technology across platforms
 - Proprietary formats
 - Vendor specific cloud services
- **Rapid evolution over time**
 - New features
 - Platforms/SDKs/Services can disappear

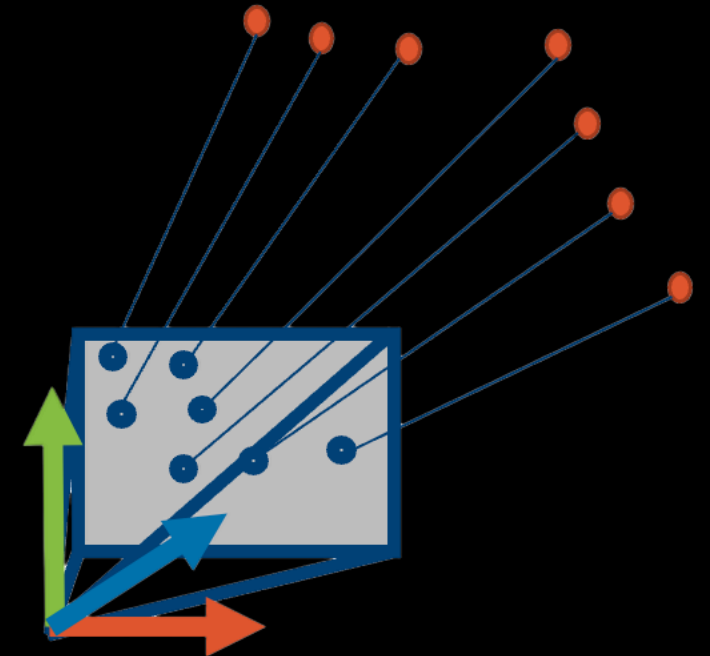


Technical Modalities for Spatial Anchoring



Relocalization and Trackables

- Relocalization matches current observations and real world representation
 - System recovery after interruption
 - Application restart
 - Change of user or devices
- a *Trackable* (3GPP) is a real world object that can be tracked
 - Defines a local reference space (cartesian, geodetic)
 - Based on computer vision techniques, GNSS,...



« Generic » Trackables

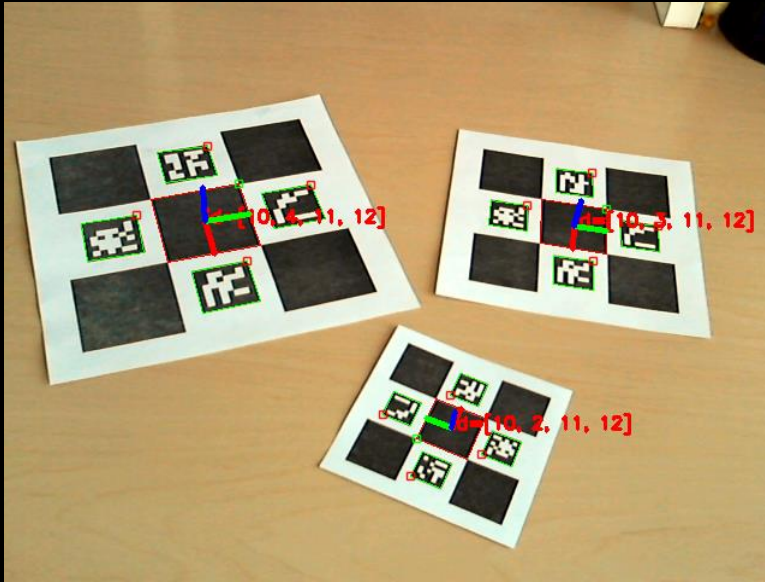
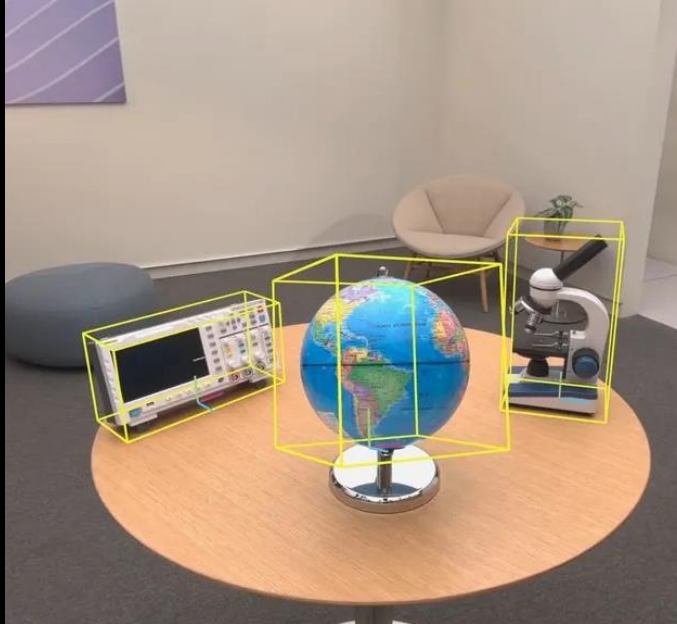


Image markers



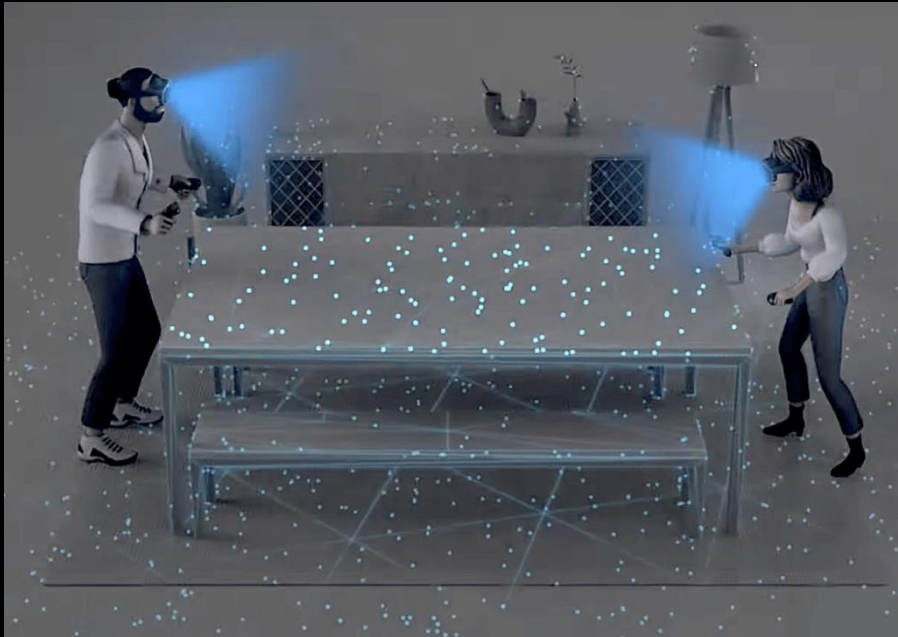
Mesh targets



Radio-based and
geospatial references

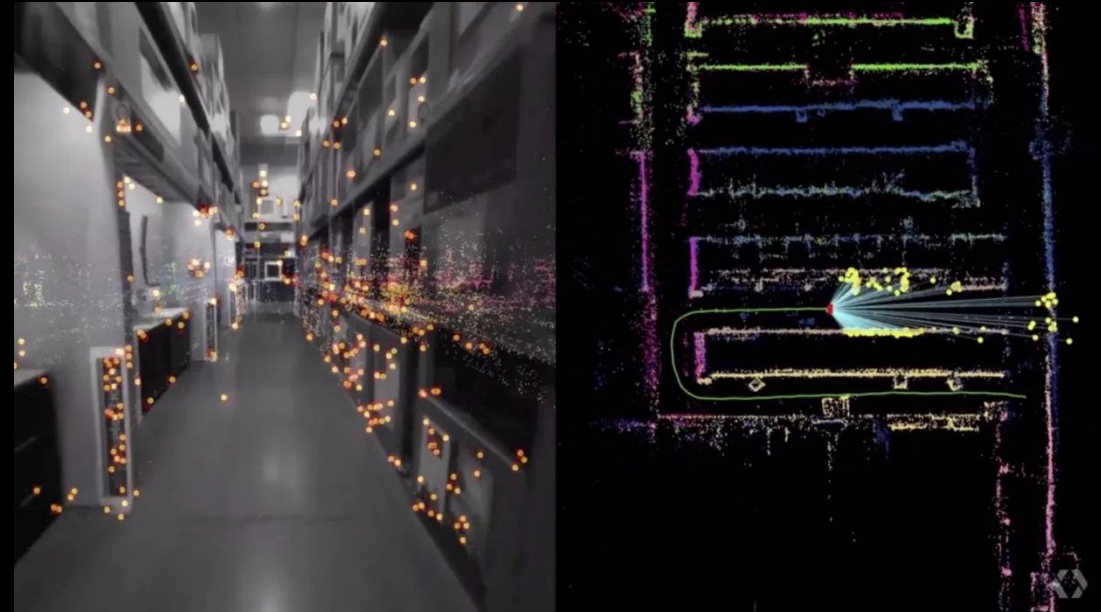
« Platform specific » Trackables

- Spatial maps for markerless relocalization and persistent anchoring



Spatial Anchors

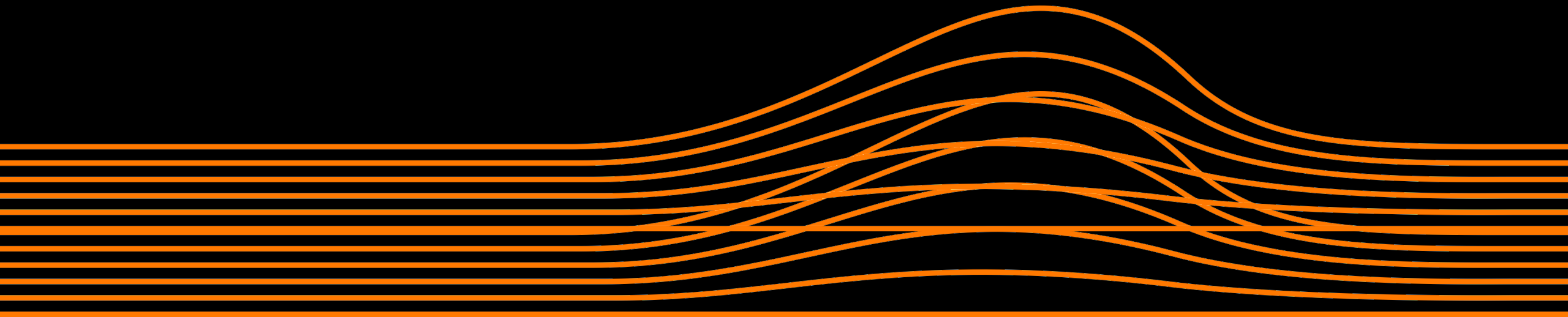
*application-level reference
points backed by spatial maps
(here : quest spatial anchors)*



Visual-Positoning Systems "VPS"

*Remotely hosted spatial maps and
relocalization pipelines,*

Ecosystem Fragmentation Implementation Barriers



AR Hardware and Software



vuforia™



OS

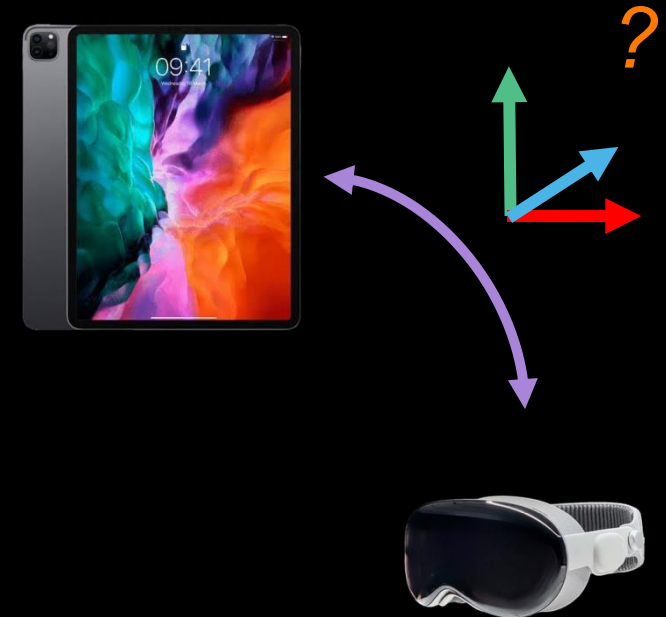
SDKs

Devices



Difficulties for developers

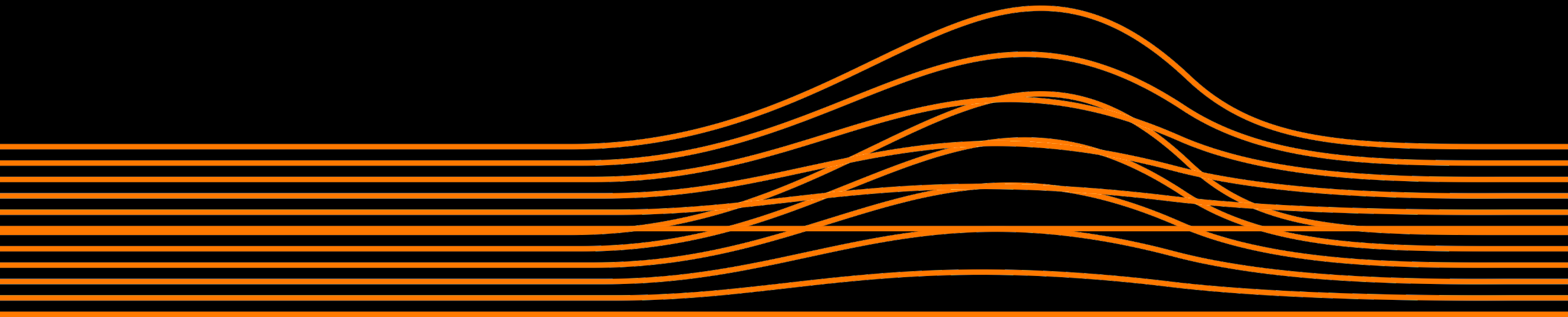
- Available tracking modalities across systems
- No cross platform spatial anchors system
 - Even within the same ecosystem:
 - Android vs Android XR
 - iOS vs VisionOS
- How to extend features with a limited access to data:
 - RGB
 - Depth
 - intrinsic and extrinsic camera parameters



Spatial anchoring Support Overview

Solution	Android	iOS	HMD support	Image tracking	Mesh tracking	Spatial Anchors	VPS
ARCore	Yes	Yes	Android XR Only	Yes	No	Yes (Cloud Anchors)	Yes (Google Geospatial)
ARKit	No	Yes	Vision Pro Only	Yes	Yes	Yes	Yes (ARGeoAnchor)
Horizon SDK	Quest Only	No	Quest Only	No	No	Yes	No
Vuforia	Yes	Yes	Yes	Yes	Yes	Yes	Yes (AreaTarget)
Niantic Spatial SDK	Yes	Yes	Quest 3 Only	No	No	Yes	Yes
Snap Lens Studio	Snap App Only	Snap App Only	Spectacles Only	Yes	No	Yes	Yes
Immersal	Yes	Yes	Yes	No	No	No	Yes
AR.js	Yes	Yes	No	Yes	No	No	GPS based only
artoolkitX	Yes	Yes	No	Yes	No	No	No

The path to Interoperability and Standardization



Abstraction layers

- **Cross vendor APIs for XR platforms and anchoring features:**
 - Khronos OpenXR: new spatial entity extension
 - W3C WebXR
 - **Abstraction layers available in game engines**
 - Unity ARFoundation
- **Facilitate applications portability**
- **Do not define a shared anchoring model across ecosystems**



Anchoring specification in scene formats

- **MPEG-I Scene Description x glTF**
 - **MPEG_Anchor** extension: associate a node/scene to a real world reference
 - Image, mesh, spatial anchor, ...
 - **Other formats such as ARML and X3D also propose such features**
- **Again : facilitate only content portability**

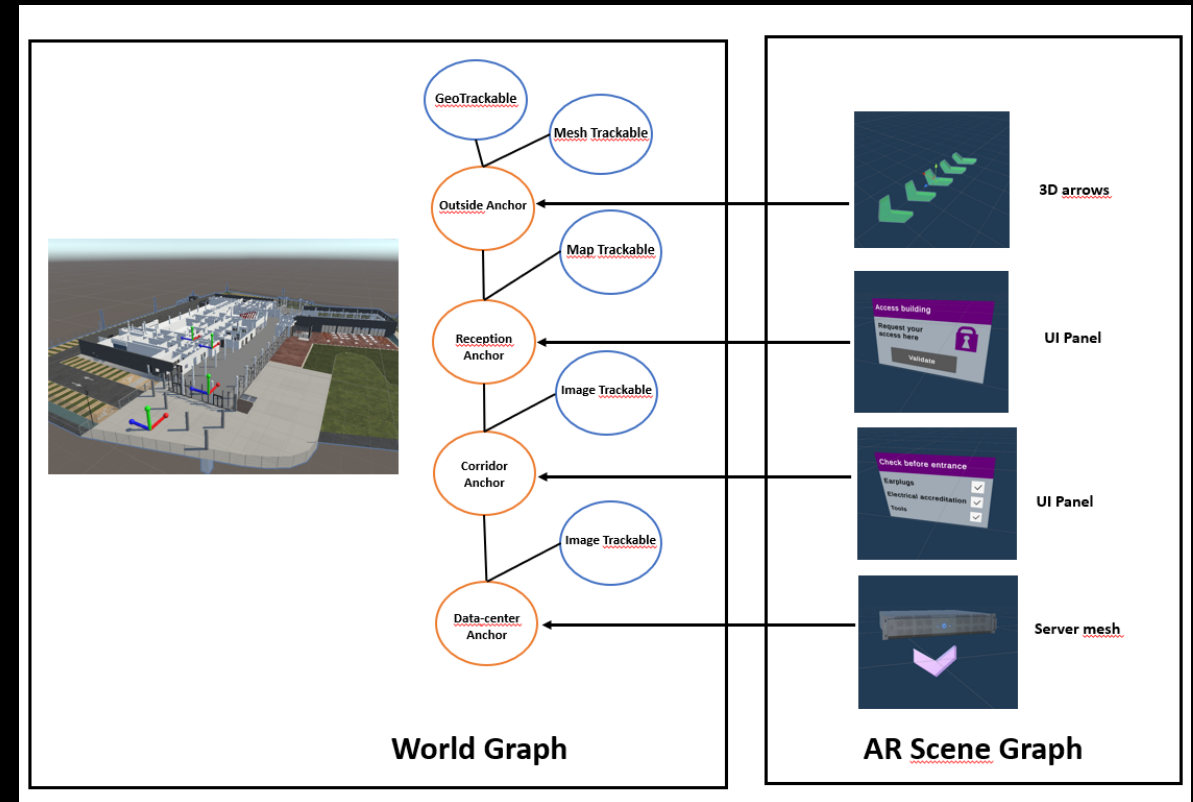


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    ]  
  }  
}
```

Example with a georeferenced anchor

Other initiatives : ETSI ARF

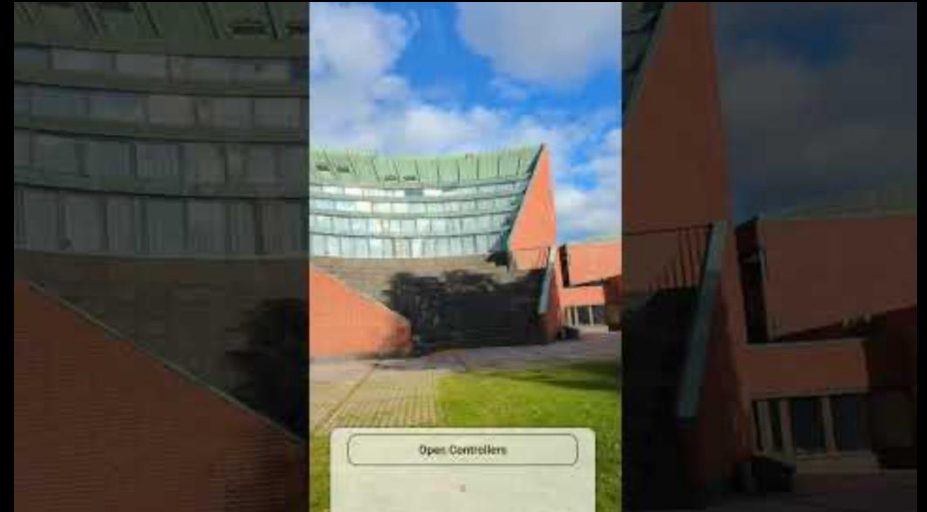
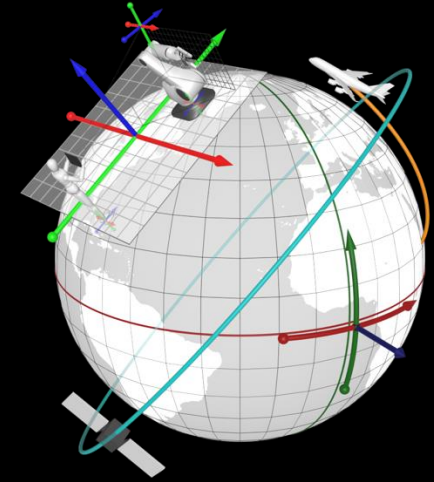
- **World Graph** representing the real world:
 - Several tracking technologies can support the positioning of a given asset
 - **World Analysis** places 3D content based on World Graph and identified trackables
 - Open source implementation available
 - ARKit/ARCore compatible
- Adoption remains limited
- Integration requires adaptations



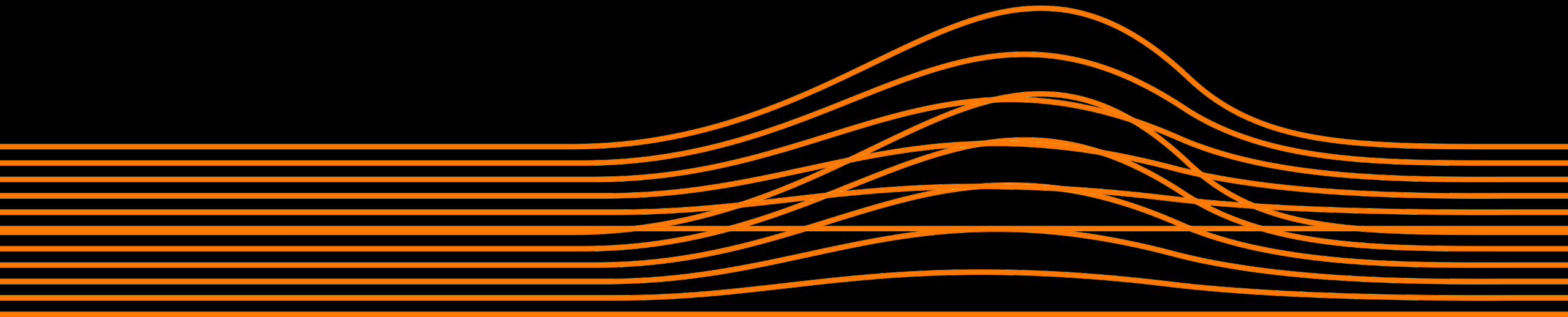
World graph is composed of
World Anchors and Trackables

Other initiatives : OGC and Open AR Cloud

- **OGC GeoPose: a common 6DoF representation of position and orientation in an Earth-fixed coordinate system.**
 - **Open AR Cloud: extensible client-server protocol for interoperable VPS based on GeoPose**
 - Image + metadata → GeoPose
 - **A reference VPS service and client implementations available as open source**
- Practical deployment can still depend on proprietary VPS backends



Perspectives



Perspectives for standardization organizations

- Push for stronger adoptions of standards
- Definition of common models/APIs for spatial anchoring/spatial maps/VPS
→ Not just abstractions
- Need for Open-source solutions
– framework, dataset, ...



AR perspectives

- Relocalization is not just an AR problem: robotics, digital twin, etc
- Gap between relocalization and authoring workflows: inspect/edit/reuse world representation during content creation
- Privacy, security, and governance issues deserve greater attention in future work



Thank you

