

Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Augmented Reality standards, use cases and requirements: How can 802.15 contribute?

Date Submitted: January 21, 2014

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Abstract: Mobile Augmented Reality will be ubiquitous and put new requirements on mobile, personal networks. In this submission, we introduce the field, provide some requirements and recommend that mobile AR use cases and community members be involved in future 802.15 specs.

Purpose: Input for WNG discussion

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Augmented Reality

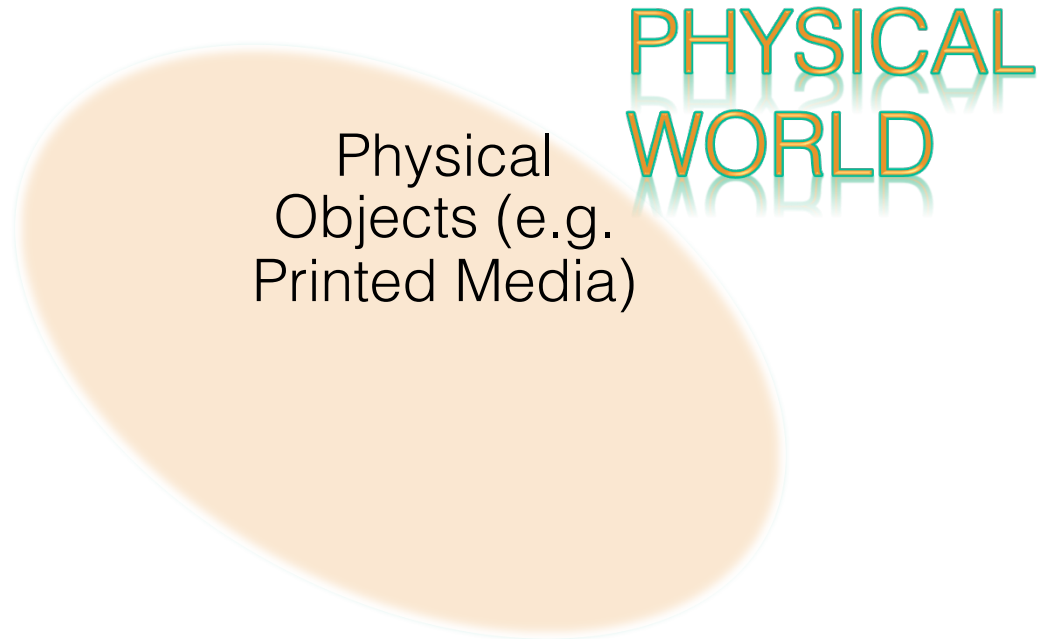
How can 802.15 contribute?

January 22, 2014

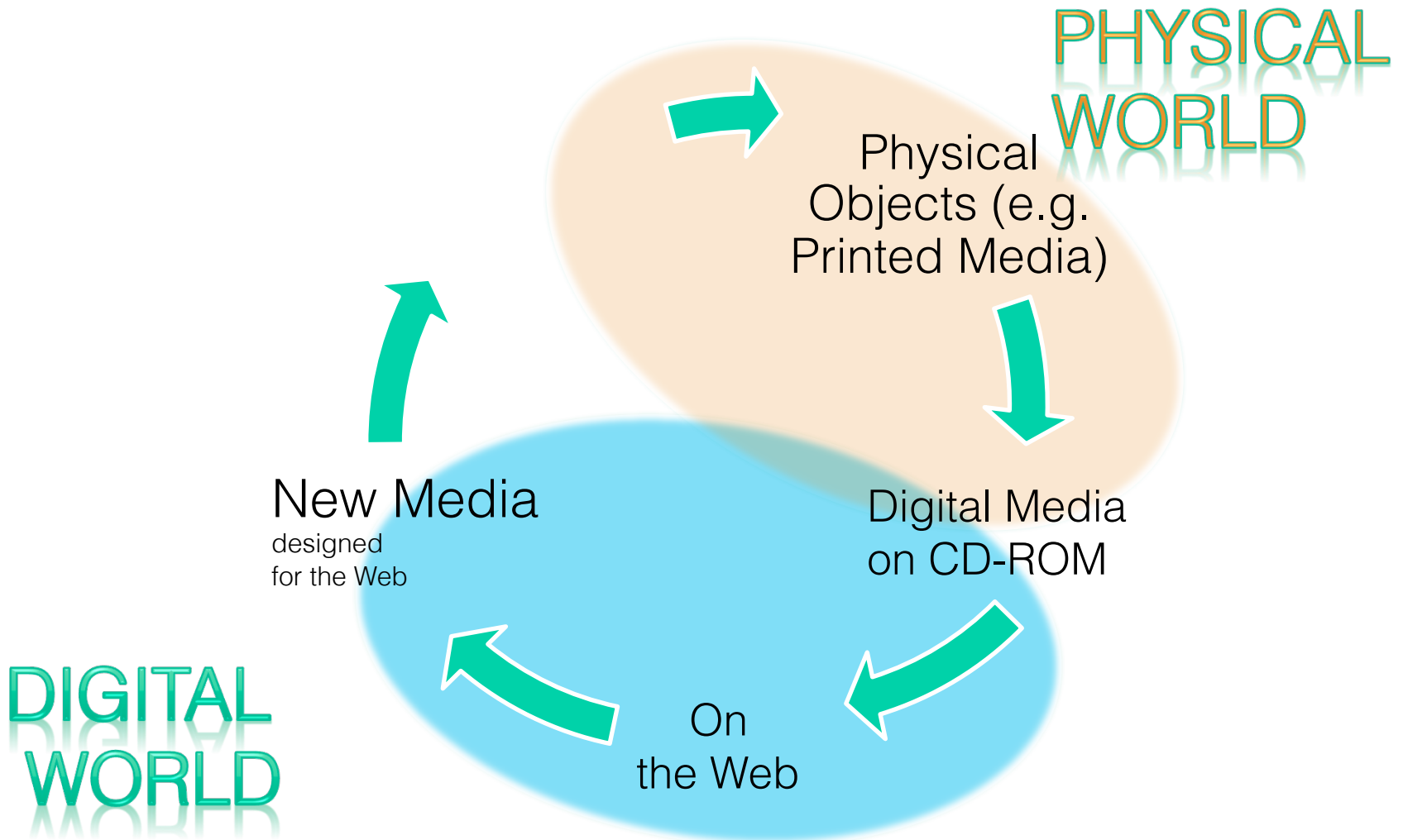
This Session will

- Prepare the “ground” for discussion with some terminology and frameworks
 - Define AR
 - Use Case Categories
 - Standards activities
- Provide some parameters that could be relevant to 802.15
- Recommend that AR use cases be part (or the focus of) future 802.15 work

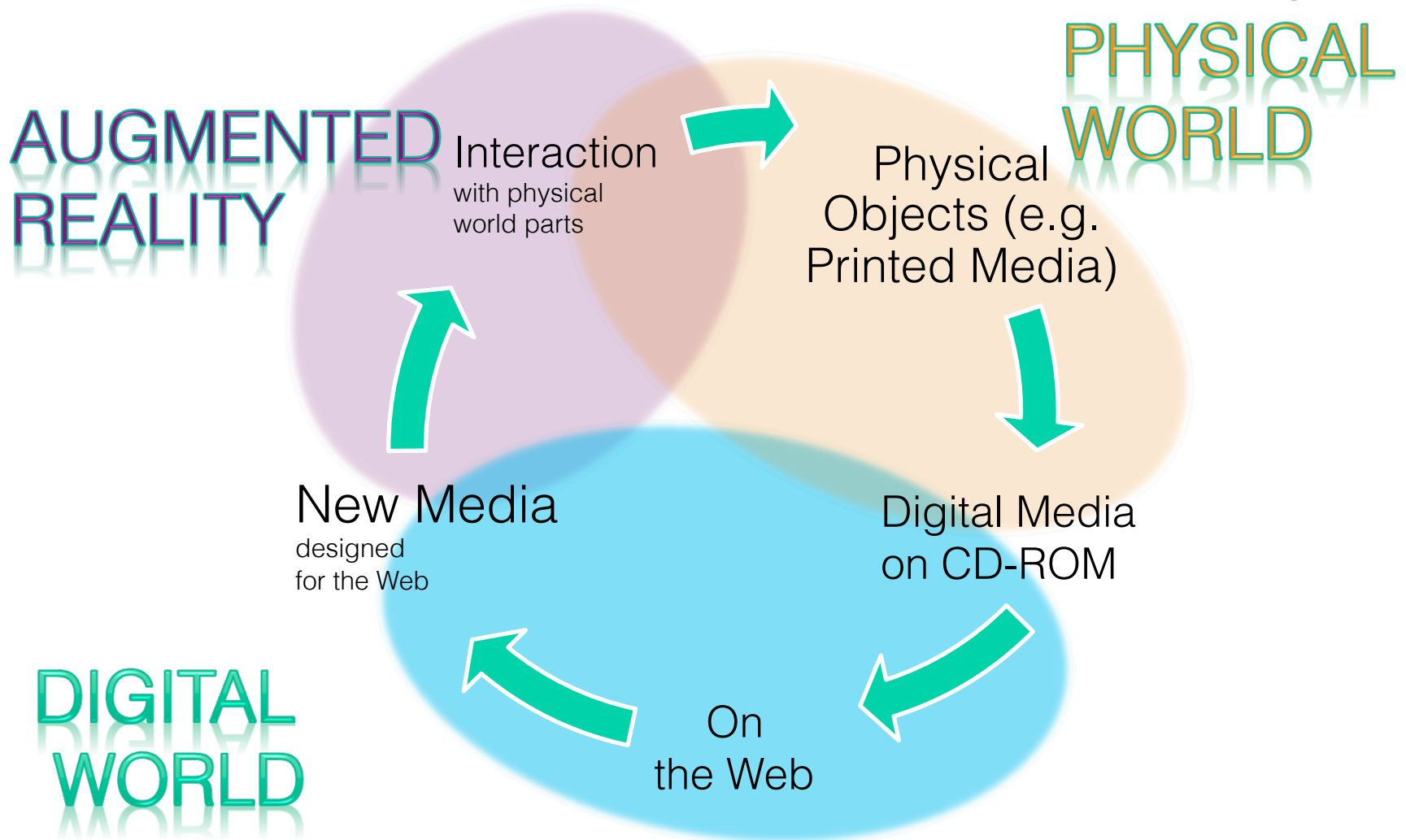
Information and Physical World



The Internet Came



AR Continues what the Internet Began



Mont Blanc

Geneva



Lake Geneva

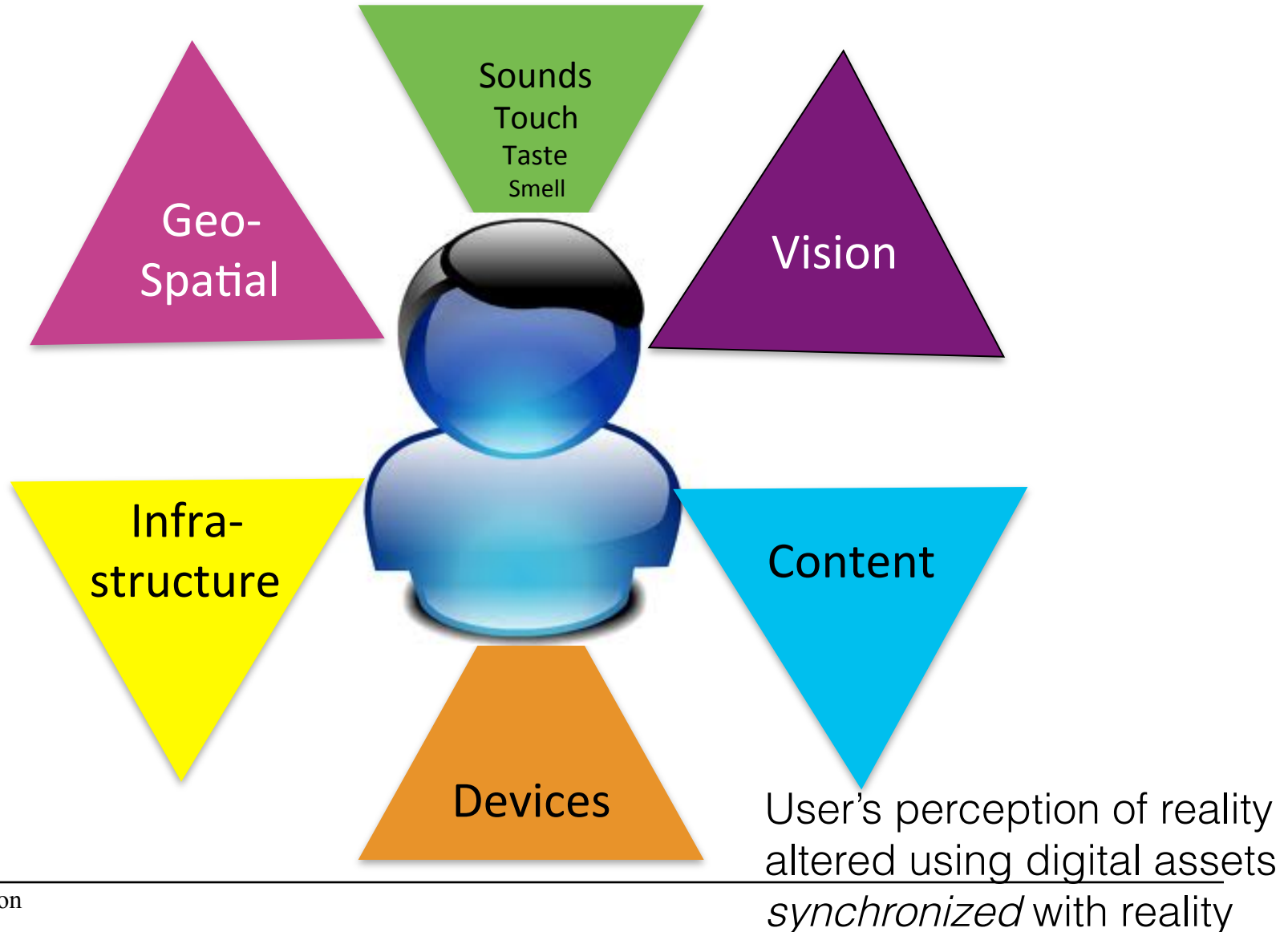
Arriving in
Montreux in
15 min



camera, GPS, compass,
accelerometer, microphone



AR Enhances User Experiences



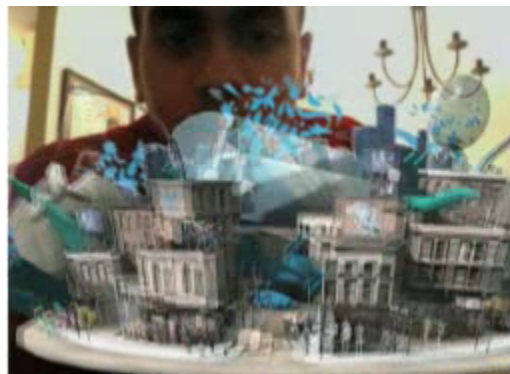
Retail Shopper



Tissot Watch
campaign on High Street in GQ and T3
<http://www.youtube.com/watch?v=sM70yME1OLk&>



Hostage Wear
<http://site.layar.com/company/blog/layer-of-the-week-shop-till-you-drop-in-the-new-hostage-virtual-shopping-layer>



Adidas Neighborhood
http://www.adidas.com/campaigns/originals_ss10/content/microsites/neighborhood/default.aspx

Entertainment/Game Applications



Sosro (Indonesia)



DNP Japan

<http://augmentedblog.wordpress.com/2010/04/09/metaio-and-dnp-japan-develop-first-augmented-reality-iphone-app-for-the-collectible-card-market/>



Acrossair Virus killer 360

<http://www.youtube.com/watch?v=qssUKAVN2kI>



Coke Zero and Avatar

<http://www.youtube.com/watch?v=APQ2OxgCNzE>

Overcoming barriers due to vision or language

Colorblind Vision

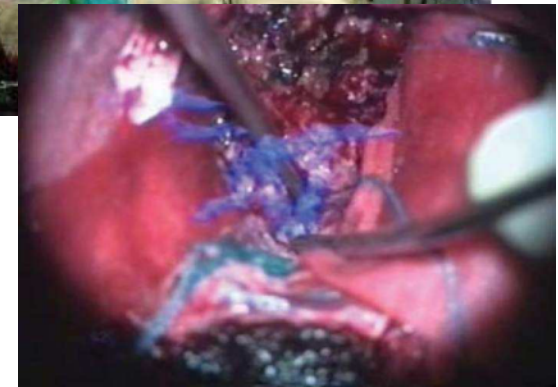
- Normal Vision**
Regular color vision
92% male - 99.5% female
- Deuteranopia**
Green weakness
5% male - 0.38% female
- Protanopia**
Red weakness
2.5% male - 0.02% female
- Tritanopia**
Blue weakness
0.5% male - 0.002% female
- Achromatopsia**
Inability to see color
0.005% of the population



<http://opcoders.com/#colorblind-vision>

<http://www.questvisual.com/us>

Medical/Healthcare



Above, operating room with the MAGI system. Below, enhanced view perceived by the surgeon with overlaid virtual anatomical structure in blue.

Source: Edwards et al. Guy's Hospital, London

http://www.readwriteweb.com/archives/how_augmented_reality_helps_doctors_save_lives.php

Design/Architecture



Novartis campus and the river
Urban Design and Planning Department
of Basel-Stadt and LifeClipper project

<http://www.lifeclipper.net/EN/general2.html>



iLiving application for furniture

<http://www.metaio.com/iliving/>
http://www.youtube.com/watch?v=pM_tXqH-vVM

Public Sector



Emergency response systems:

- fire fighting
- police
- natural disaster recovery

Public utilities (energy, water) using AR to aid with infrastructure deployment and maintenance

Bay Area Rapid Transit and metaio
Many others (e.g., Tokyo, Portland's Transit Agency)

AR-assisted Service



Mitsubishi Electric MeView
<https://www.youtube.com/watch?v=iz4yKmn3UR4>

Three Categories of AR Use Cases

Guide

- Simplest
- Largest

Publish

- AR married with Web 2.0 tools
- aka “Social AR”

Collaborate

- Complex
- Future of games

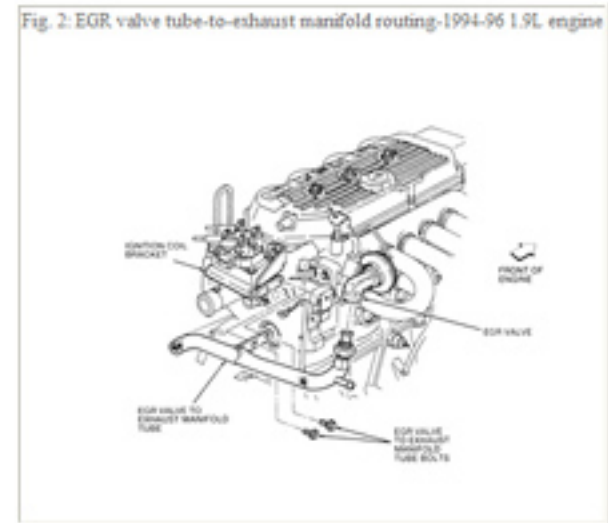
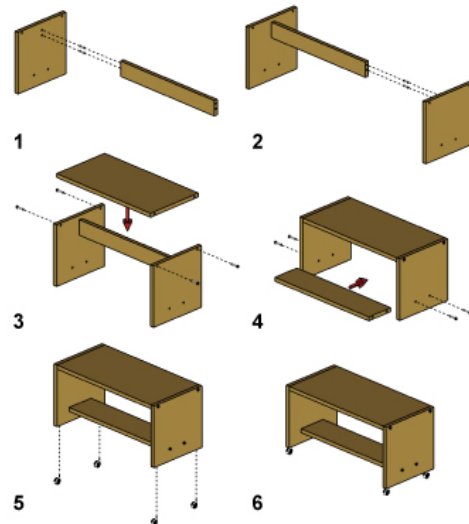
The “Guide” Use Cases

- System leads the user through a path or process in step-by-step (sequential) manner

1.9L Engine

See Figures 2 through 12

1. Disconnect the negative battery cable.
2. Remove the accessory drive belt.
3. Remove the alternator.
4. Remove the radiator cooling fan motor and the shroud assembly.
5. On 1991-93 models, remove the exhaust manifold heat shield.



The “Publish” Use Cases

- System furnishes the user the ability to attach or introduce (annotate) personal digital data in association with people, places and things in the real world



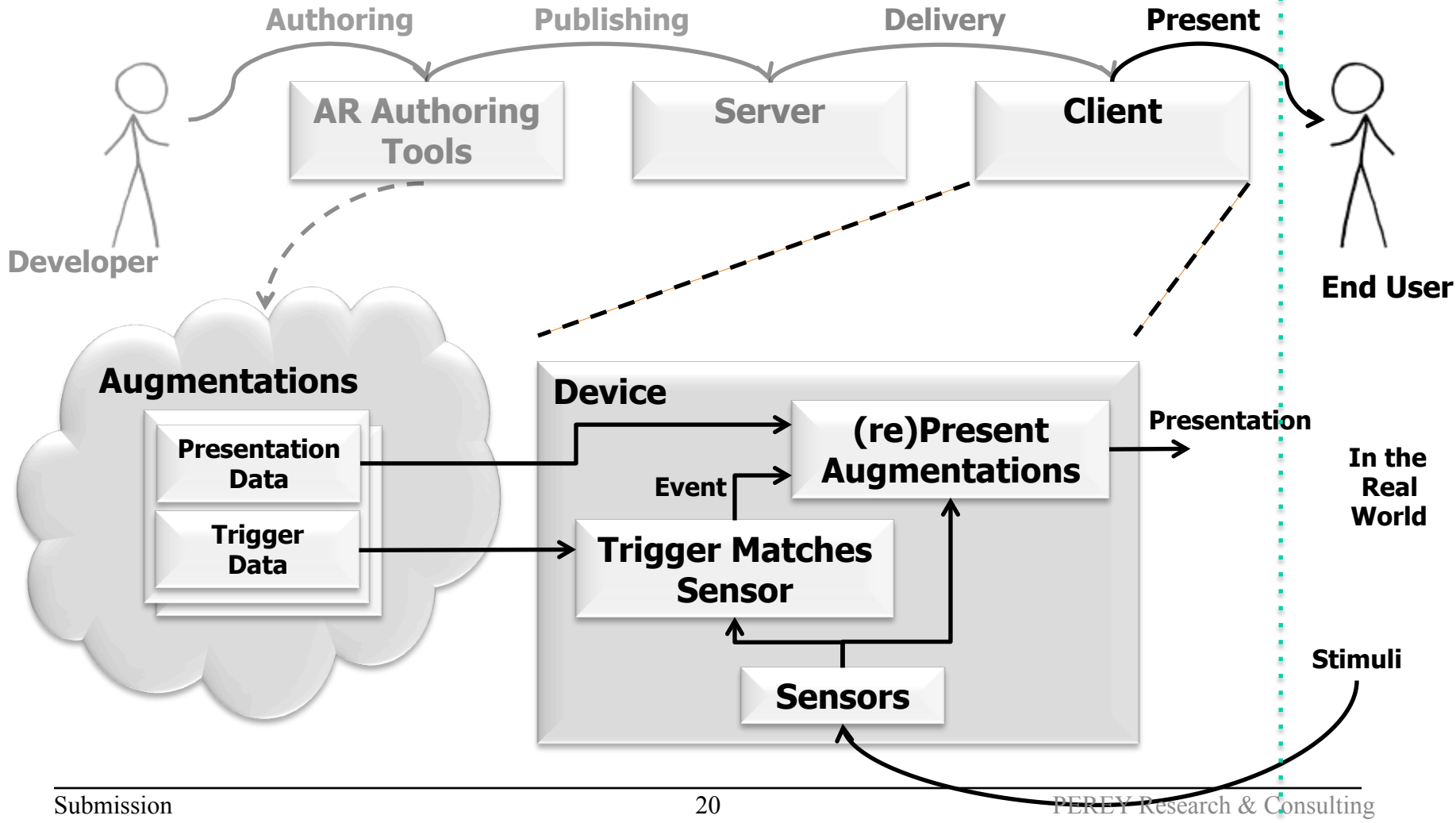
The “Collaborate” Use Cases

- System permits two or more people to interact with one another at a distance and some digital data in the real world in real time



https://www.youtube.com/watch?v=X-GXO_urMow (6min 30 sec)

Experience Presentation



Digitally Mapping User Context



Feature
Extraction

Capturing the unique features in the physical world as stimuli

Recognition

Looking for triggers (any pattern previously detected and stored in digital world)

Matching
digital asset

Retrieving the augmentation

Producing the AR Experience

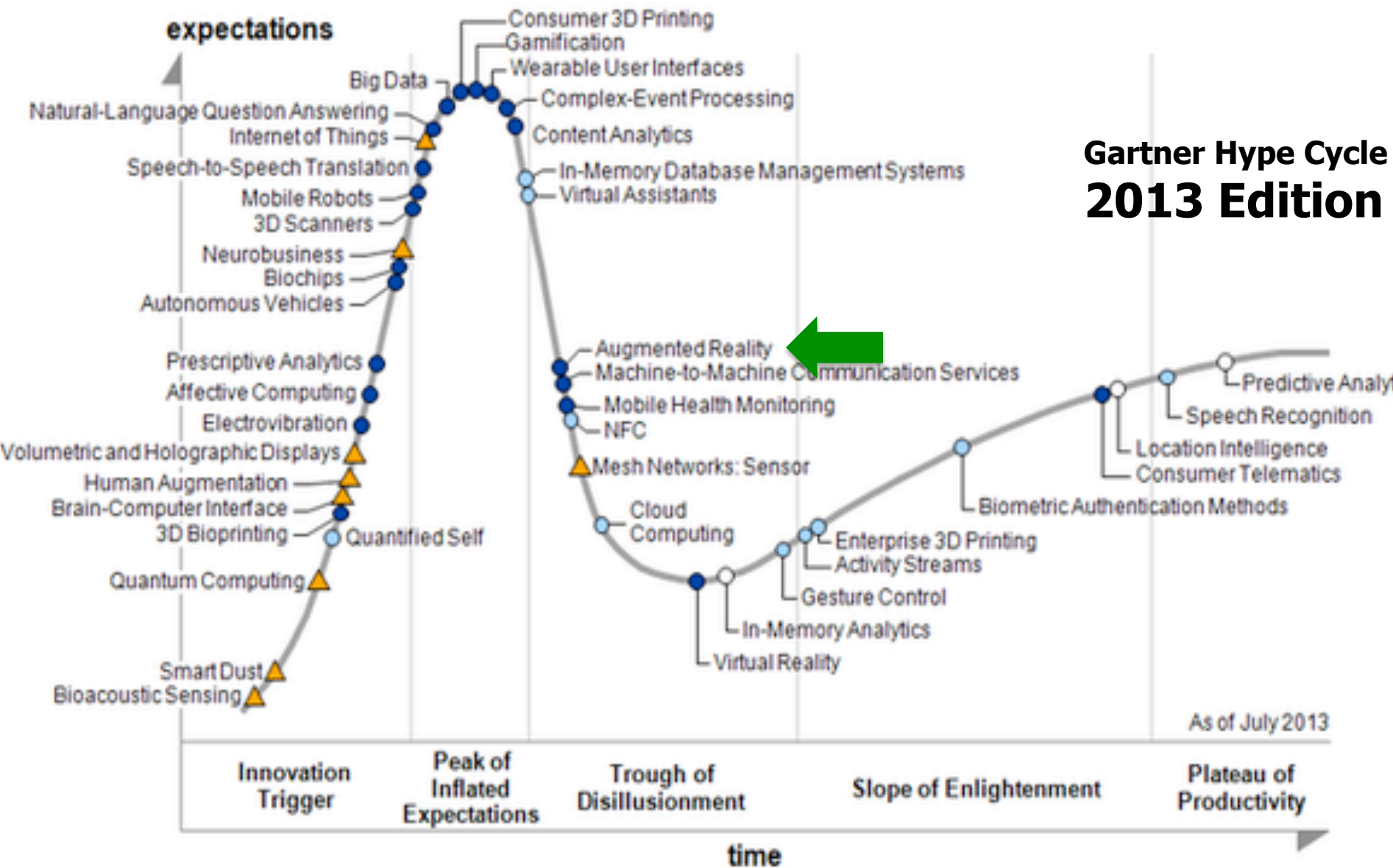


Matching features to digital asset

Accounting for distance, occlusions, light and other factors

Correcting, refreshing or “locking” the digital asset on physical world

Gartner Hype Cycle 2013 Edition



As of July 2013

Plateau will be reached in:

- less than 2 years
- 2 to 5 years
- 5 to 10 years
- ▲ more than 10 years
- ⊗ obsolete before plateau

Hype coefficient high since April 2012 (Google Glass)

Segment by End User Classes

| | Consumers | Professional Users |
|-----------------------|---------------------|--------------------|
| Tolerance for latency | Medium (500ms) | Low (300ms) |
| Need for precision | Depends on use case | Higher (<10 cm) |
| Willingness to pay | Cost sensitive | Based on ROI |

Segment by Delivery Platforms

Projection AR

Desktop & Kiosk AR

Mobile AR



Submission



24



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Mobile AR Segments



Geospatial-based AR

Uses built-in GPS and compass signals for position and orientation respectively



Computer Vision-based AR

Extracts “patterns” (also called “features”) of the real world from the live video signal (frames)

Both also use smartphone's built-in gyroscope and accelerometer

Key Mobile AR Enablers

- Low cost, high performance, low power
 - Sensors
 - Compute power (devices)
 - High speed networks
- Cloud and content management systems
- Personal and shared display technology
- Mobile application distribution platform (aka “the AppStore”)

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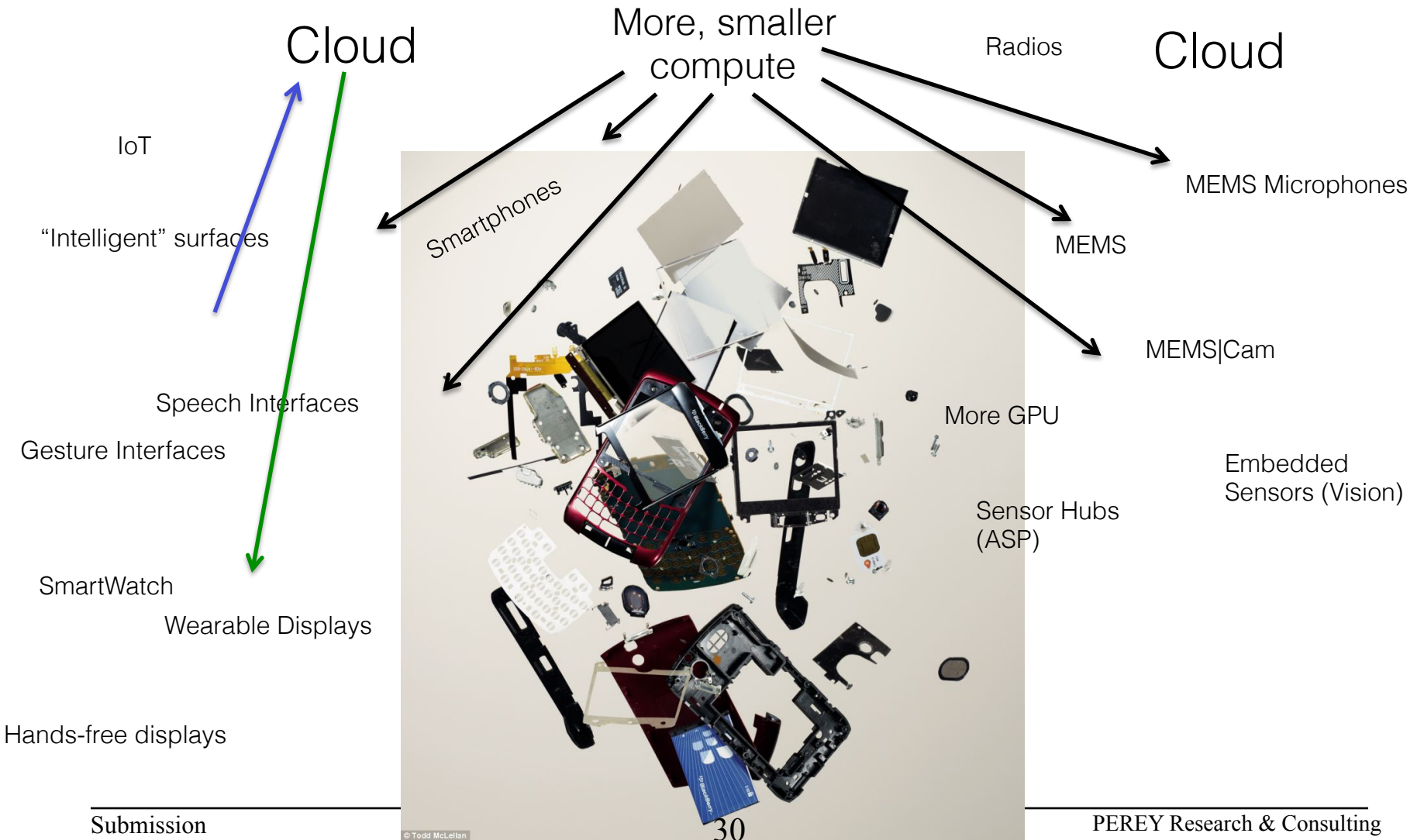
Mobile Handsets for AR

- Multi-core CPU smartphones with GPU acceleration are capable of
 - Tracking physical world in 3D
 - Rendering 3D digital assets in real time
- Problems remain with
 - Sensor quality, stability, reliability
 - Interference of natural world with sensors
 - User interaction
 - Power consumption (battery life)
 - Thermal threshold

Device + Network Requirement: Capture the Physical World

- Sensors (observation streams)
 - <400 ms latency (depends on the sensor)
 - In 3D (where possible)
 - More than just position (e.g., lighting)
- Leverage what is available from IoT

Mobile Computing is Fragmenting



Networks for AR

- Many AR platforms use cloud-based processing and data, via wireless networks
 - Mobile AR can also be developed for use “off line”
- Lack of value-added role for network operator reduces their motivation and does not address the user needs

Network Requirement: Deliver and Render Digital Assets

- Lowest latency
- In 3D (if available)
- Progressive (Adaptive)
- Caching likely

Displays for Mobile AR

- Personal
 - Wearable computing/technology
- Shared
 - Windows (car windshields, buildings)
 - Digital signage
 - Anything on which we can project digital assets (requires projector)

Known Smart Glasses Manufacturers



Defense Markets

- LiteEYE
- Lockheed Martin
- SBG Labs
- Rockwell Collins
- Osterhout Design Group
- Trex Enterprises
- MicroVision
- Six-15 Technologies
- Physical Optics Corp
- Innovega
- ARA
- Silicon Micro Display
- Thales Visionix



Commercial Markets

- Optinvent
- Kopin
- Epson
- Silicon Micro Display
- Google
- Microsoft
- Recon Instruments
- Scalar
- Brother
- Sony
- Oakley
- Laster Technologies
- EyeTap
- Canon
- Olympus
- eMagine
- Samsung
- MetaView
- Vuzix
- Innovega
- CastAR
- Lumus Vision
- GlassUp



High Diversity

Hardware

- Field of View
- Camera
- Adjustability of position (hinge)
- Gyro
- Brightness, transparency
- Focal plane
- Weight
- Industrial design
- Battery life

Software

- Each has unique SDK
- Very rudimentary
 - Not well integrated with AR authoring and SDKs
- Some companies are developing middleware and publishing platforms
 - Interface with radios and other shared resources
 - Generic control

User Control Interface Technologies

Software

- Gesture tracking
- Speech recognition
- Eye gaze

Hardware

- Tactile (“pad”)
- IR Pointer
- Depth sensing camera
- Video camera
- Microphone
- User focus (gaze)

Hands-Free Displays for AR

- Subsegments
 - Displays for information snacking (not “true” AR)
 - Displays designed to provide “True” AR
 - Accessories to mobile (+ cloud) system that does “the rest”
 - Sports
 - Defense
 - First Responders
 - Stand-alone, fully-integrated systems
 - Group
 - Automotive
 - Airplanes and helicopters
 - Personal and wearable *replacements for smartphones*

Personal Hands-free AR Display is often **confused with** Google Glass

- Google Glass is part of a new platform for information search, presentation (display) and capture
 - Information appears
 - Interaction
 - Capture
- When you turn or the real world context changes, information remains the same



What is Open and Interoperable AR?

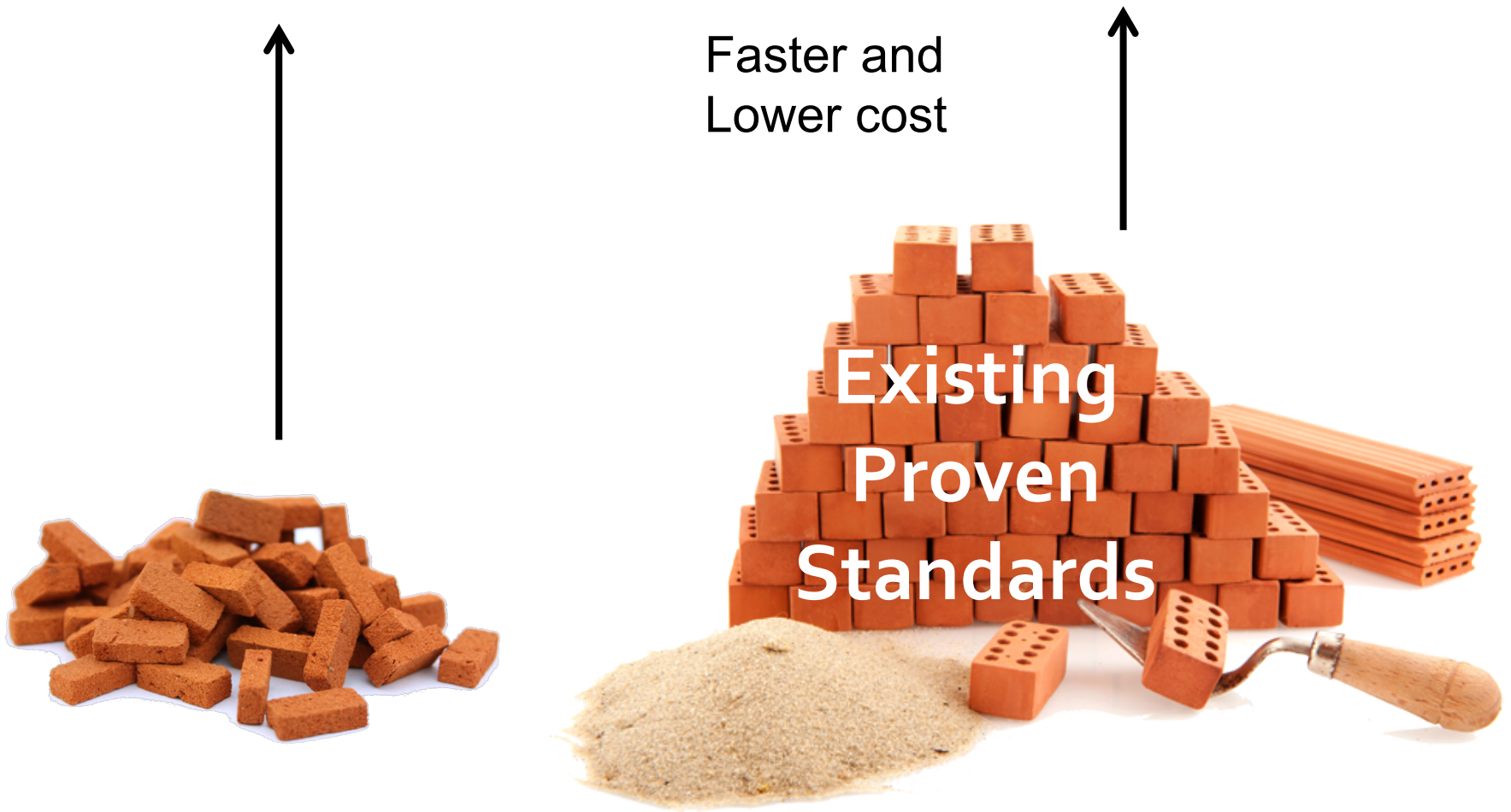
Complete end-to-end system in which
modular components can be supplied
by multiple vendors and still have the
same workflow and experience quality

(Hint: think of the Web)

In an ideal world AR Systems...

- Consistently receive reliable data (correct observations and/or calibrate sensors) about
 - User context and status
 - Focus of attention in the physical world
 - Position and orientation in the physical world
 - Other relevant physical world landmarks
 - Resources for producing/enhancing experiences
 - Data objects
 - Computational resources
 - Communication resources
 - Storage resources
 - Display/ presentation resources

Open and Interoperable AR



AR Standards Community

- Identify open interfaces and existing standards
- Assist, where standards are missing and needed, in their development
 - Collect and communicate AR developer and user requirements
 - Define industry- and technology-neutral use cases
- Foster and support the coordination of efforts across multiple Standards Development Organizations
- Detect the emergence of and provide a centralized place/forum for the expression of needs from the community including obstacles to the growth of AR

AR Standards Community

The numbers

4 years

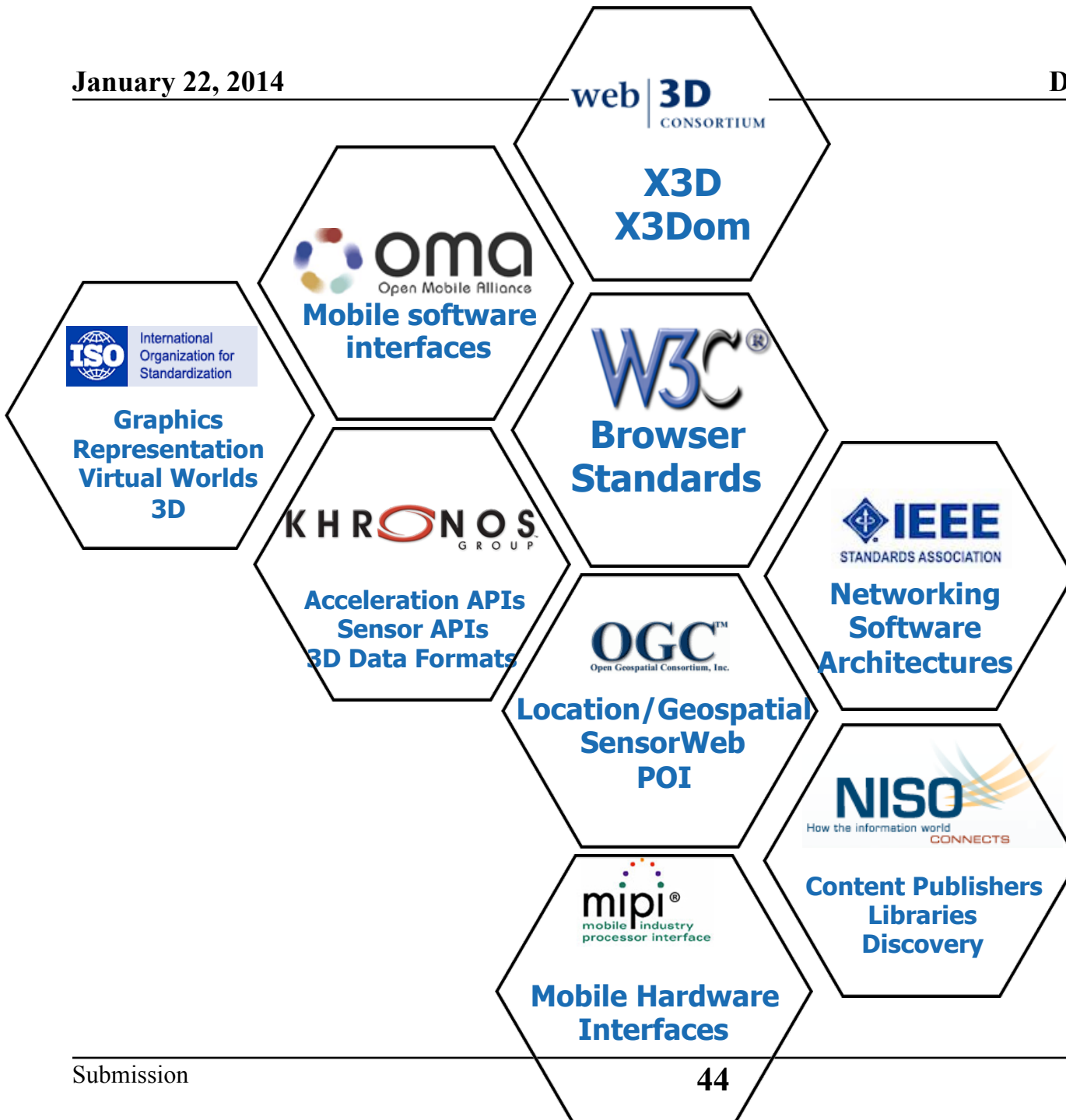
6 archived mailing lists

9 in-person meetings

>10 Standards Development Organizations
participating

>250 people

All resources are on the portal
<http://www.arstandards.org>



embedded
VISION
ALLIANCE

**Embedded
Vision
Algorithms**

web | **3D**
CONSORTIUM

**X3D
X3Dom**

Do  -vng0

I E T F
**Network
Protocols**

 **oma**
Open Mobile Alliance
**Mobile software
interfaces**

SAE
SAE
INTERNATIONAL®

**Automotive
Aviation**

 International
Organization for
Standardization

**Graphics
Representation
Virtual Worlds
3D**

W3C®
**Browser
Standards**

 **IEEE**
STANDARDS ASSOCIATION

HITSP
Healthcare

KHRONOS
GROUP

**Acceleration APIs
Sensor APIs
3D Data Formats**

OGC™
Open Geospatial Consortium, Inc.

**Networking
Software
Architectures**

Construction

SID
SOCIETY FOR INFORMATION DISPLAY

**Display
Technologies**

**Location/Geospatial
SensorWeb
POI**

NISO
How the information world
CONNECTS

 **buildingSMART**
International home of openBIM

**Building
Management**

 **Dublin Core Metadata Initiative**
Making it easier to find information

**Metadata
for Digital
Objects**

mipi®
mobile industry
processor interface

**Content Publishers
Libraries
Discovery**

**National
Standards
Organizations**

3GPP
A GLOBAL INITIATIVE

**Mobile Device
Radios and Com**

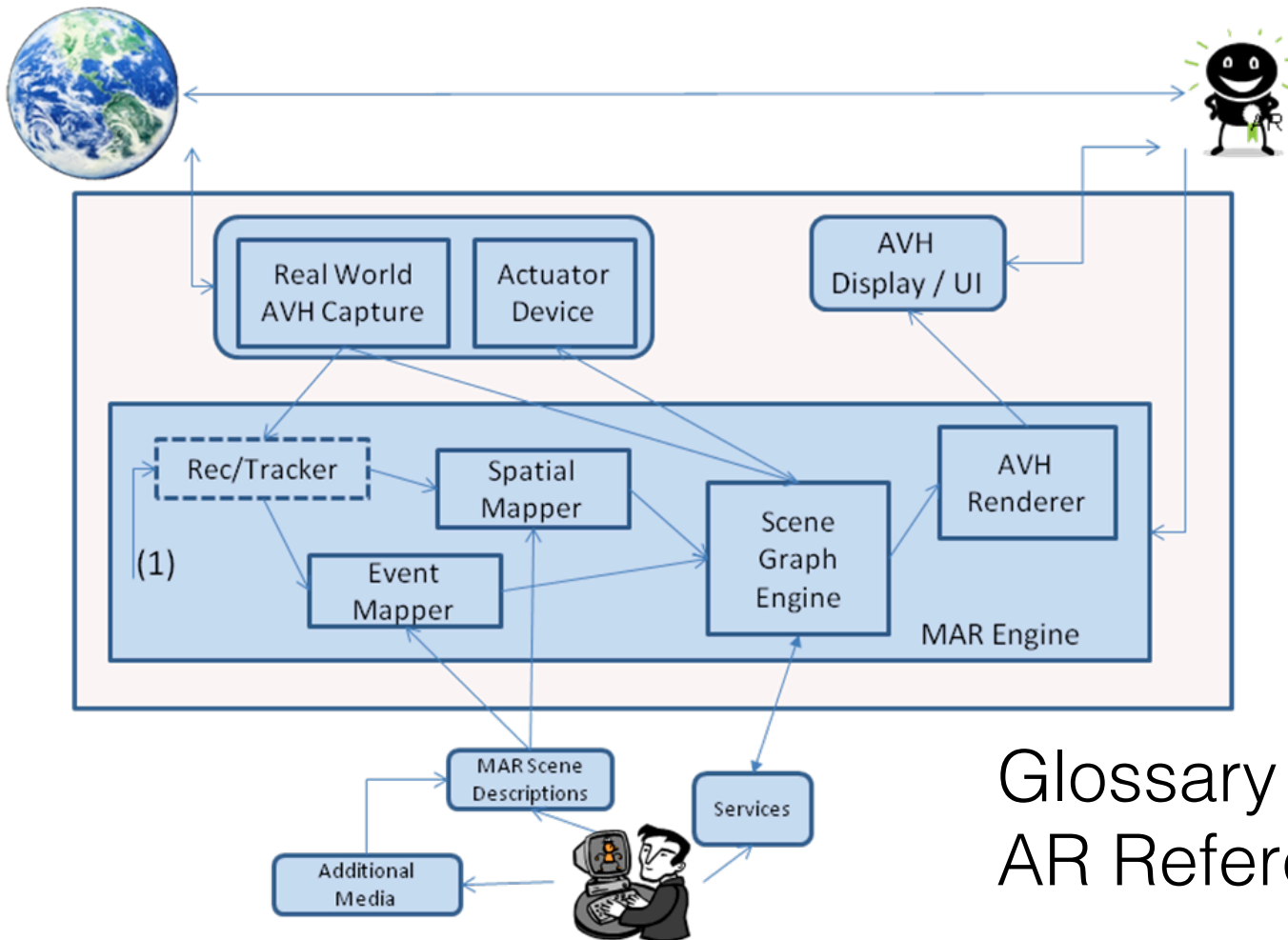
**Mobile Hardware
Interfaces**

Submission

 **GSMA**™

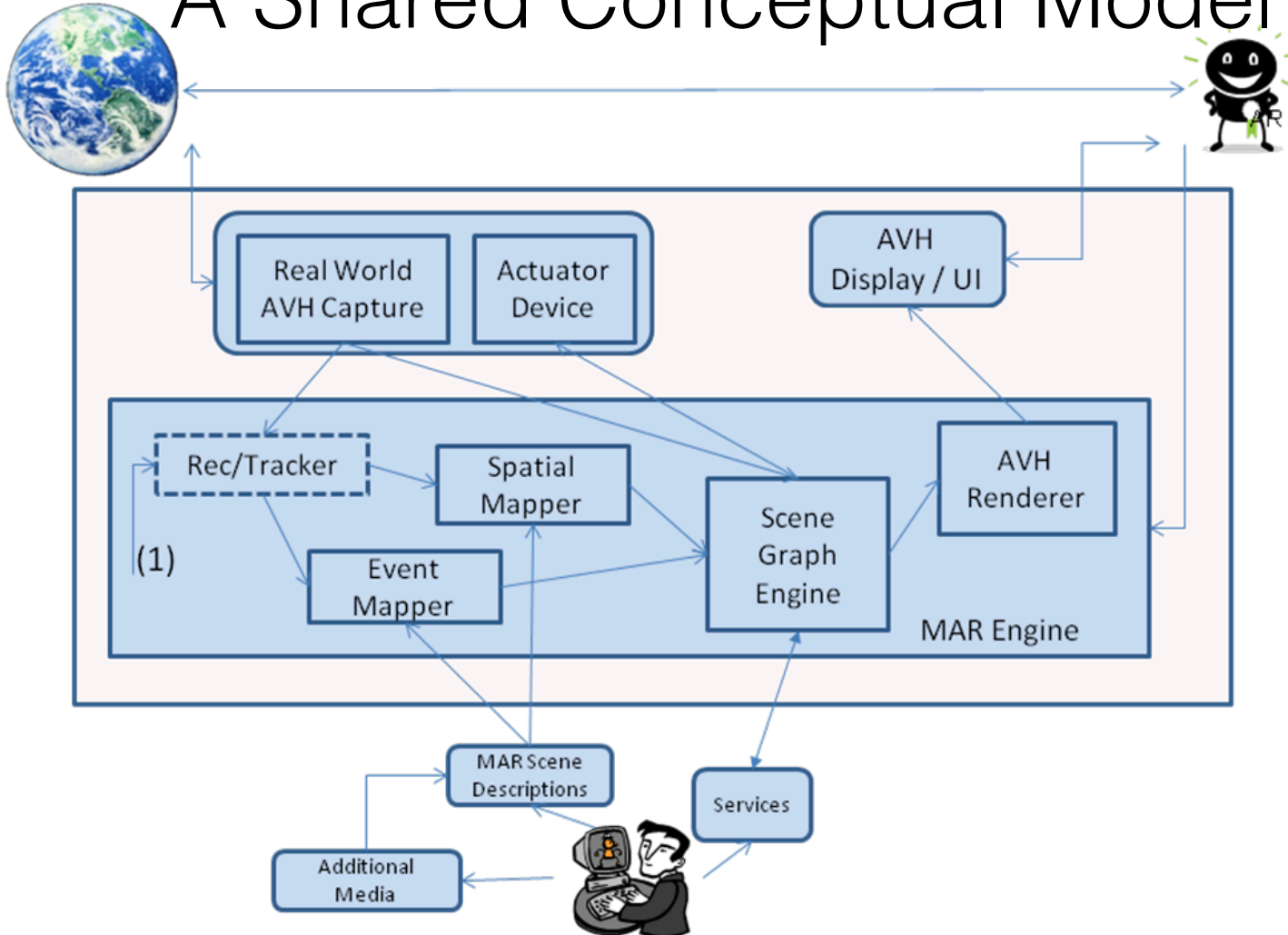
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Initiatives of AR Standards Community



Glossary and AR Reference Model

A Shared Conceptual Model



Initiatives of AR Standards Community

- Glossary and AR Reference Model
- 3D Transmission and Compression
- 3D tiling and 4D data for mobile AR
- Mobile AR Browser Interoperability

NEXT INITIATIVE?

Business and Finance

Technologies

Human Factors

Barriers to Growth

Data

Human Factors

| Category | Obstacles |
|-----------------------|--|
| Inherent Human Traits | <ul style="list-style-type: none">• Low awareness or need• Burned once, avoid the risk• Habits |
| Presentation Systems | <ul style="list-style-type: none">• Positioning the display with respect to perception• Fixed focal distances• Weight• Fashion |
| Interactivity | <ul style="list-style-type: none">• Too many steps• Too many assumptions• No support for “peripheral” vision• No conventions for gestures |

Human Factors

| Category | How to Breakthrough |
|-----------------------|--|
| Inherent Human Traits | <ul style="list-style-type: none">• Raise Awareness of benefits of AR visualization• Don't promise what can't be delivered• Use widely-accepted AR terminology |
| Presentation Systems | <ul style="list-style-type: none">• Use eyewear and stationary displays in environment• Support variable focal length systems• Reduce weight by reducing battery size• Provide "invisible" or fashion-friendly displays |
| Interactivity | <ul style="list-style-type: none">• Automate decision• Prompt the user to set up preferences• Support for "peripheral" vision• Develop conventions for gestures |

Technologies

| Category | Obstacles |
|---|---|
| User Context Acquisition/ Focus of Attention | <ul style="list-style-type: none"> • Many sources of interference <ul style="list-style-type: none"> • Urban canyons • Reflective surfaces • Focus of user attention is not part of the experience |
| | <ul style="list-style-type: none"> • Sensor data streams unsynchronized |
| Tracking | <ul style="list-style-type: none"> • Intermittent especially in highly dynamic environment • High power consumption |
| Display/ presentation | <ul style="list-style-type: none"> • Loss of calibration, flicker • Interference of bright and natural light sources • Rendered assets do not appear realistic |
| Others | <ul style="list-style-type: none"> • Weight • No support for “peripheral” vision • No conventions for gestures |

Technologies

| Category | How to Breakthrough |
|---|---|
| User Context Acquisition/Focus of Attention | <ul style="list-style-type: none"> • Develop methods to reduce interference <ul style="list-style-type: none"> • Alternative positioning technologies (PDR) • Distinguish reality from reflection • Increase viewing angle to include focus of attention |
| | <ul style="list-style-type: none"> • Synchronize sensor data streams |
| Tracking | <ul style="list-style-type: none"> • Improve in highly dynamic environment • Reduce power consumption or use alternate power |
| Display/presentation | <ul style="list-style-type: none"> • Re-calibrate automatically and invisibly • Use technology tolerant of bright/natural light sources • Develop hardware acceleration for realistic |
| Others | <ul style="list-style-type: none"> • Reduce weight • Support greater “peripheral” vision • Develop conventions for gestures |

Data

| Category | Obstacles |
|--------------|---|
| Source | <ul style="list-style-type: none">• Which data?• Creating high quality digital assets and developing experiences is time consuming and expensive• No portability/interoperability |
| Transmission | <ul style="list-style-type: none">• Delay• Network service interruption may prevent access |
| Storage | <ul style="list-style-type: none">• Limited memory• Management of updates |
| Usage | <ul style="list-style-type: none">• Lack of policies with respect to interaction (use) records• Voting/rating feedback |

Data

| Category | How to Breakthrough |
|--------------|--|
| Source | <ul style="list-style-type: none">• Improve data and metadata discovery• Reduce cost and time of developing high quality digital assets• Adopt standards for data portability/interoperability |
| Transmission | <ul style="list-style-type: none">• Reduce delay• Reduce network service interruption |
| Storage | <ul style="list-style-type: none">• Improve memory management systems• Adopt Learning management system solutions |
| Usage | <ul style="list-style-type: none">• Develop policies for interaction (use) records• Support user voting/rating feedback• Voting/rating feedback |

Business and Finance

| Category | Obstacles |
|-----------------|---|
| Policy | <ul style="list-style-type: none"> • Absence of policy • Liabilities <ul style="list-style-type: none"> • Injuries • Unintentional capture of identities • Risk with respect to data security |
| Costs | <ul style="list-style-type: none"> • Creating high quality digital assets and developing experiences is time consuming and cost unknown (assumed to be expensive) • Purchase of delivery platforms • Maintenance |
| Benefits | <ul style="list-style-type: none"> • To be measured and proven |
| Business Models | <ul style="list-style-type: none"> • Many available • Specifics yet to be proven |

Business and Finance

| Category | How to Breakthrough |
|-----------------|---|
| Policy | <ul style="list-style-type: none"> • Develop policies for safety, security and quality • Reduce liabilities <ul style="list-style-type: none"> • Injuries • Unintentional capture of identities • Develop secure data display solutions |
| Costs | <ul style="list-style-type: none"> • Reduce cost and time required for high quality digital asset and AR experience design • Reduce cost of delivery platforms through healthy competition based on standards • Increase maintenance at lower cost |
| Benefits | <ul style="list-style-type: none"> • Measure and prove, then document, share |
| Business Models | <ul style="list-style-type: none"> • Explore best business models • Prove new business models |

IEEE SA Role in Augmented Reality

- IEEE SA is developing assets for market education and awareness programs
- IEEE SA seeks, where applicable, to engage with WG chairs to increase the support for AR in existing and future IEEE standards
- IEEE SA is leading AR awareness across IEEE societies and members

IEEE SA Emerging Technologies

- Will publish
 - Information about how IEEE specifications can advance AR
 - Domain specific uses for AR
- Organize
 - Information and demonstration events
 - Community and expert discussions

Proposals

- Explore
 - Evaluate where 802.15 may add value
 - Mobile AR use cases in future work
- Collaborate with SDOs (including IEEE SA), the AR Community and AREA
 - Obtain and develop specifications that will meet mobile AR requirements

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