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

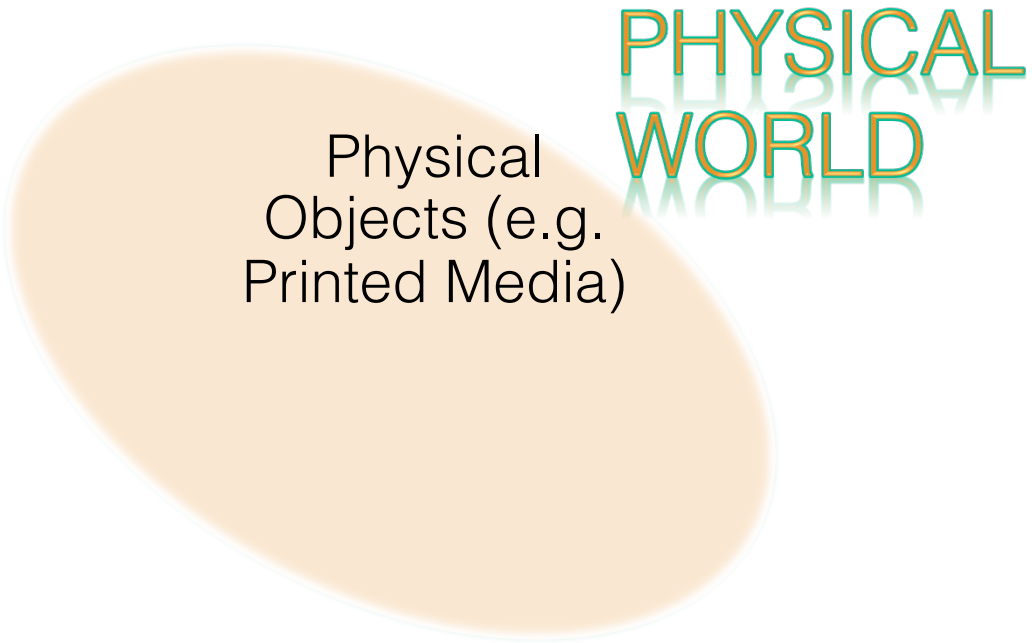
Augmented Reality
How can 802.15 contribute?

January 22, 2014

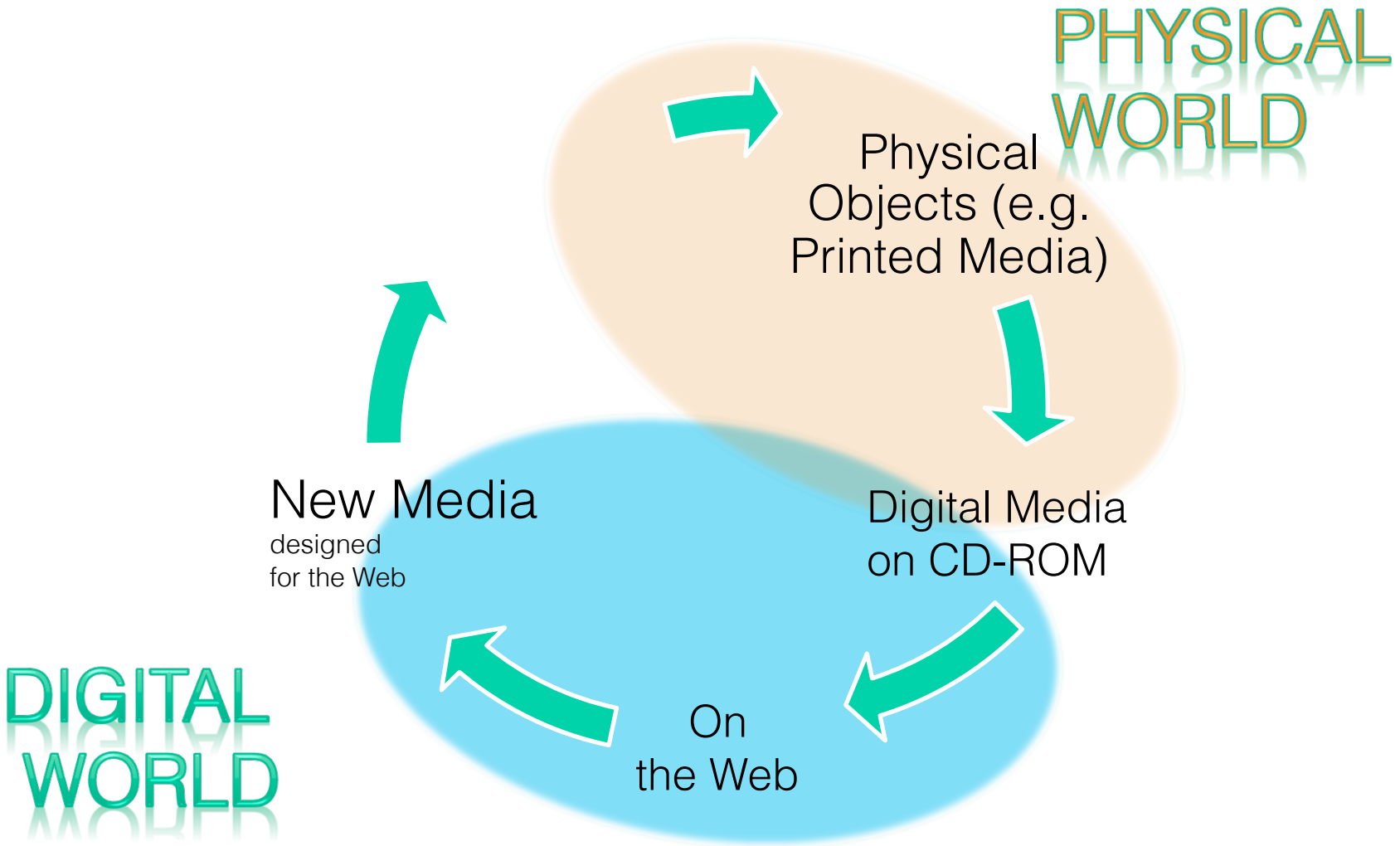
This Session will

- Prepare the "ground" for discussion with some terminology and frameworks
  - Enablers
  - 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

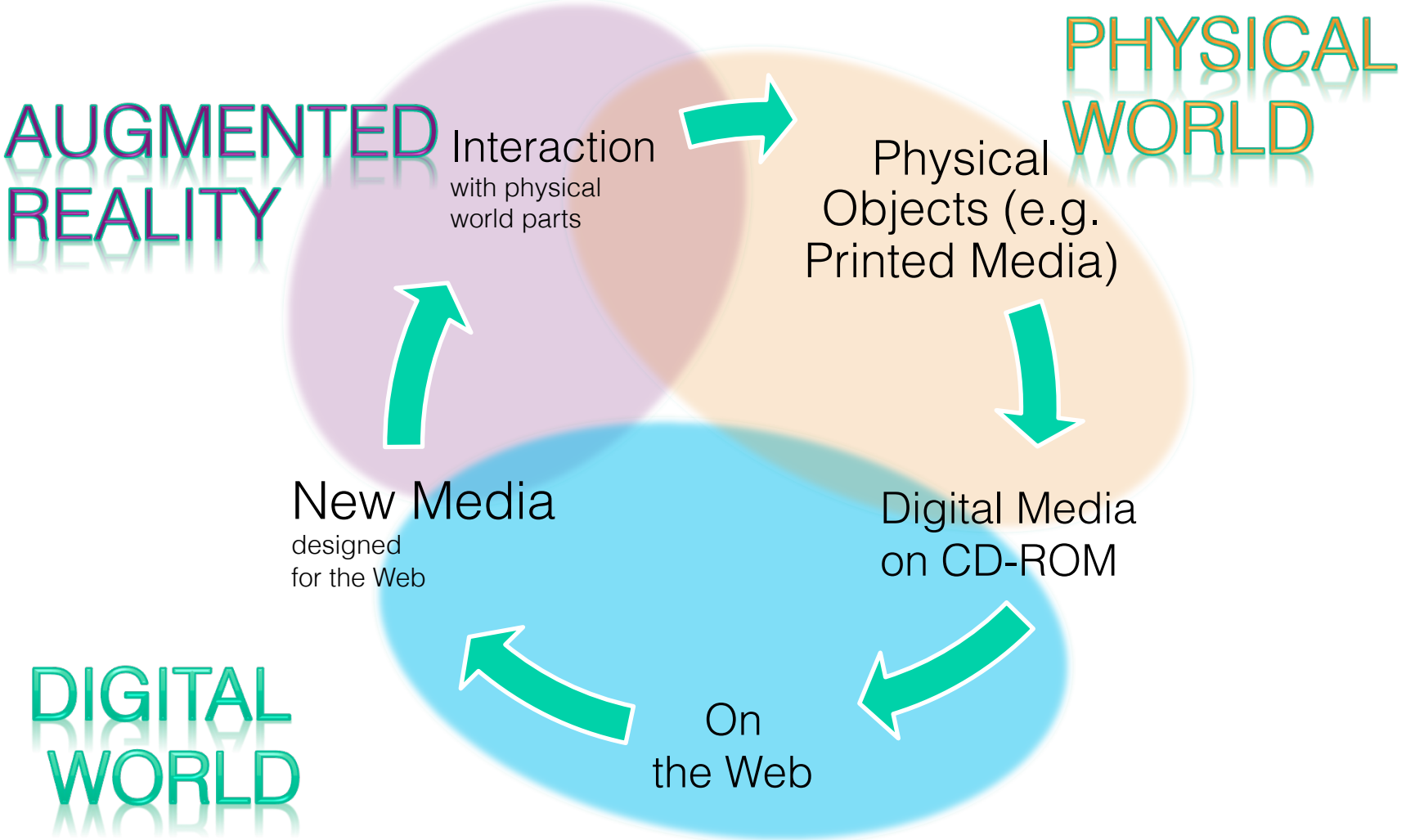
Information and Physical World



The Internet Came

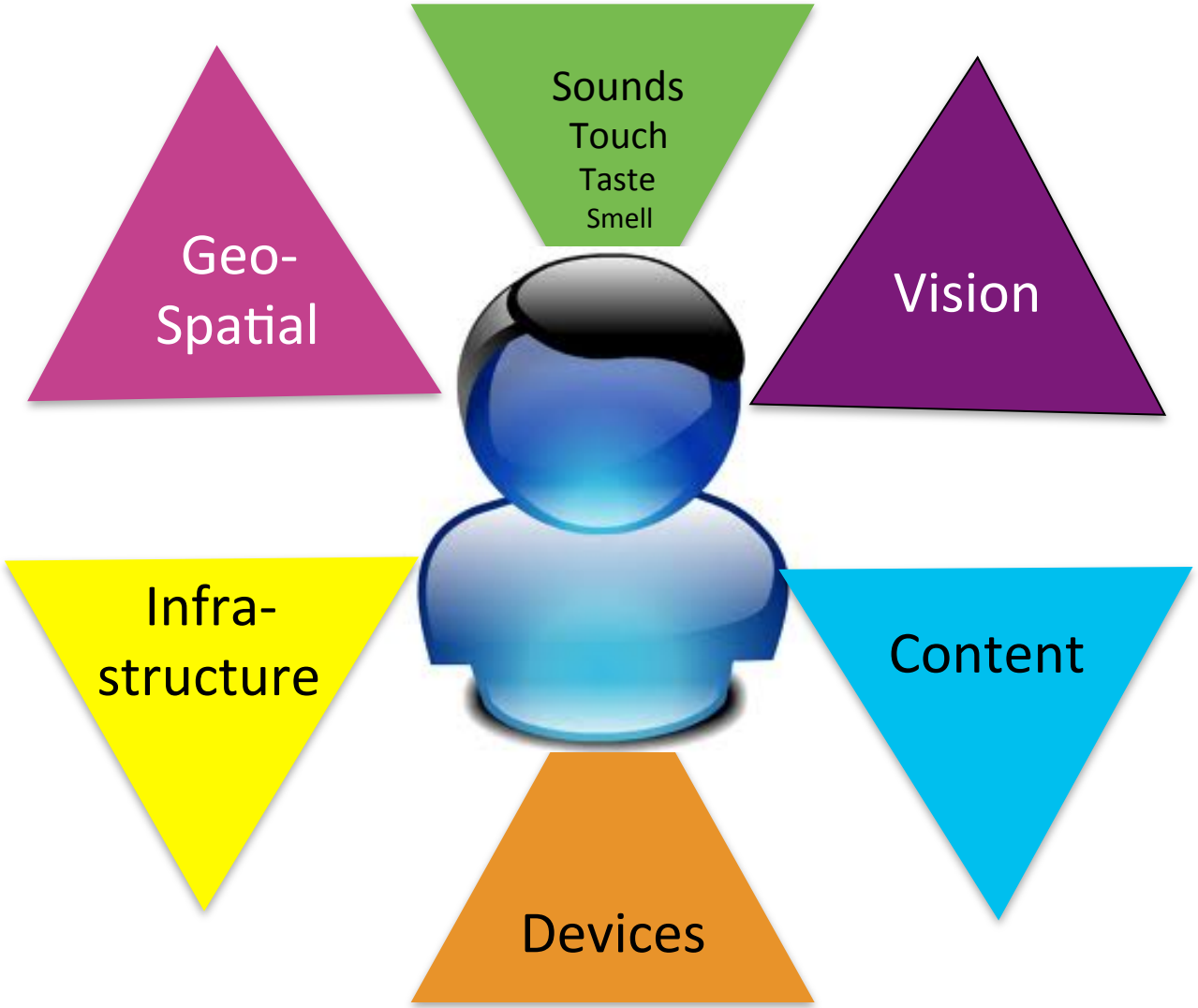


AR Continues what the Internet Began




Mont Blanc
Geneva
Lake Geneva
Overlay
(Text, images, graphics, 3D objects)
on the real world
Arriving in Montreux in 15 min
camera, GPS, compass, accelerometer, microphone
HELVETICS

AR Enhances User Experiences



Perceptions of reality altered using information *synchronized* with reality

Three Categories of AR Use Cases

Guide

- Simplest
- Largest

Publish

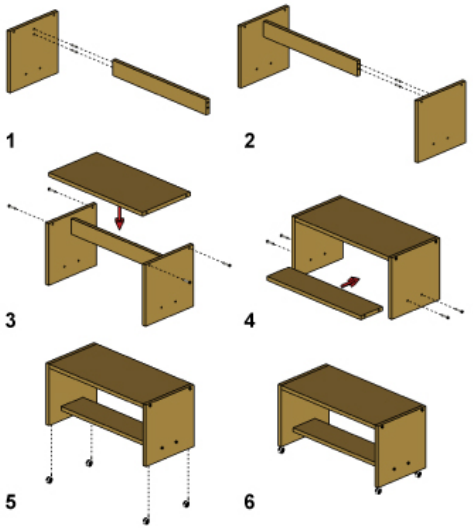
- AR married with Web 2.0 tools
- aka “Social AR”

Collaborate

- Complex
- Future of games

The “Guide” Use Cases

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

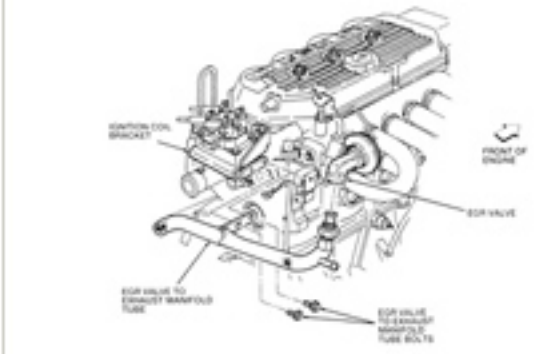


1.9L Engine

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.

Fig. 2: EGR valve tube-to-exhaust manifold routing-1994-96 1.9L engine

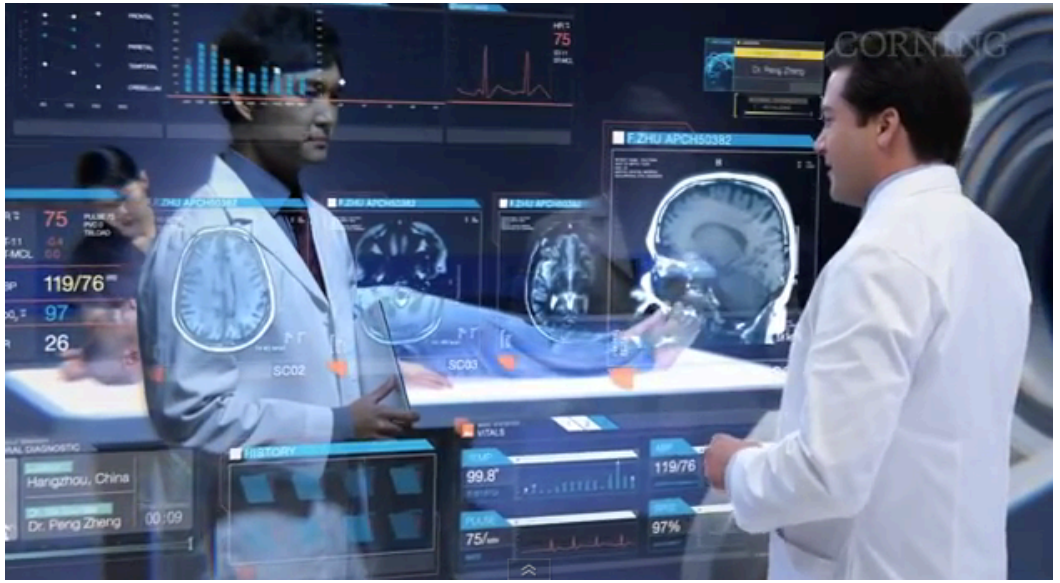


The “Publish” Use Cases

- 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

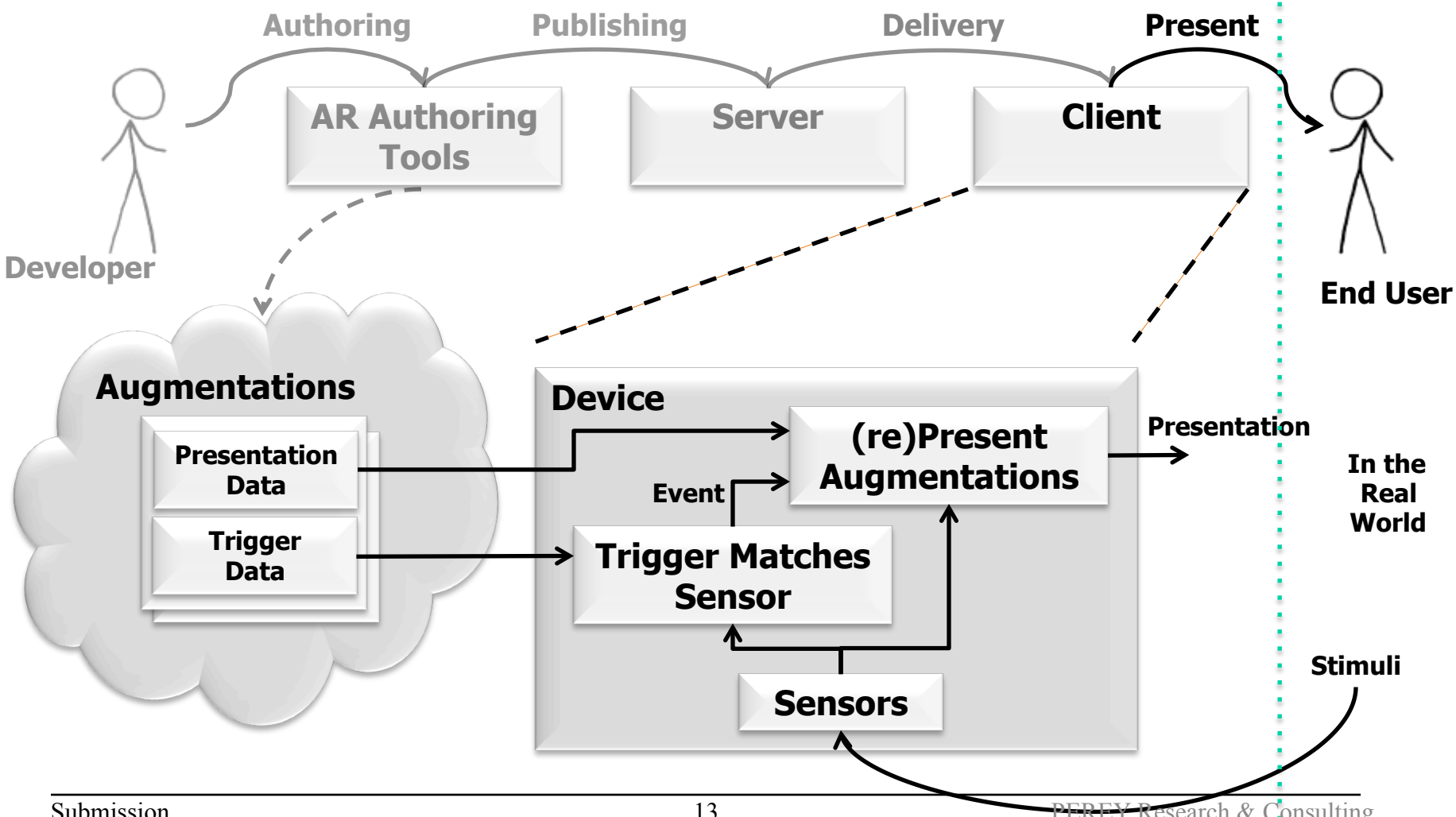
The “Collaborate” Use Cases

- 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

Capturing the unique features in the physical world as stimuli

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

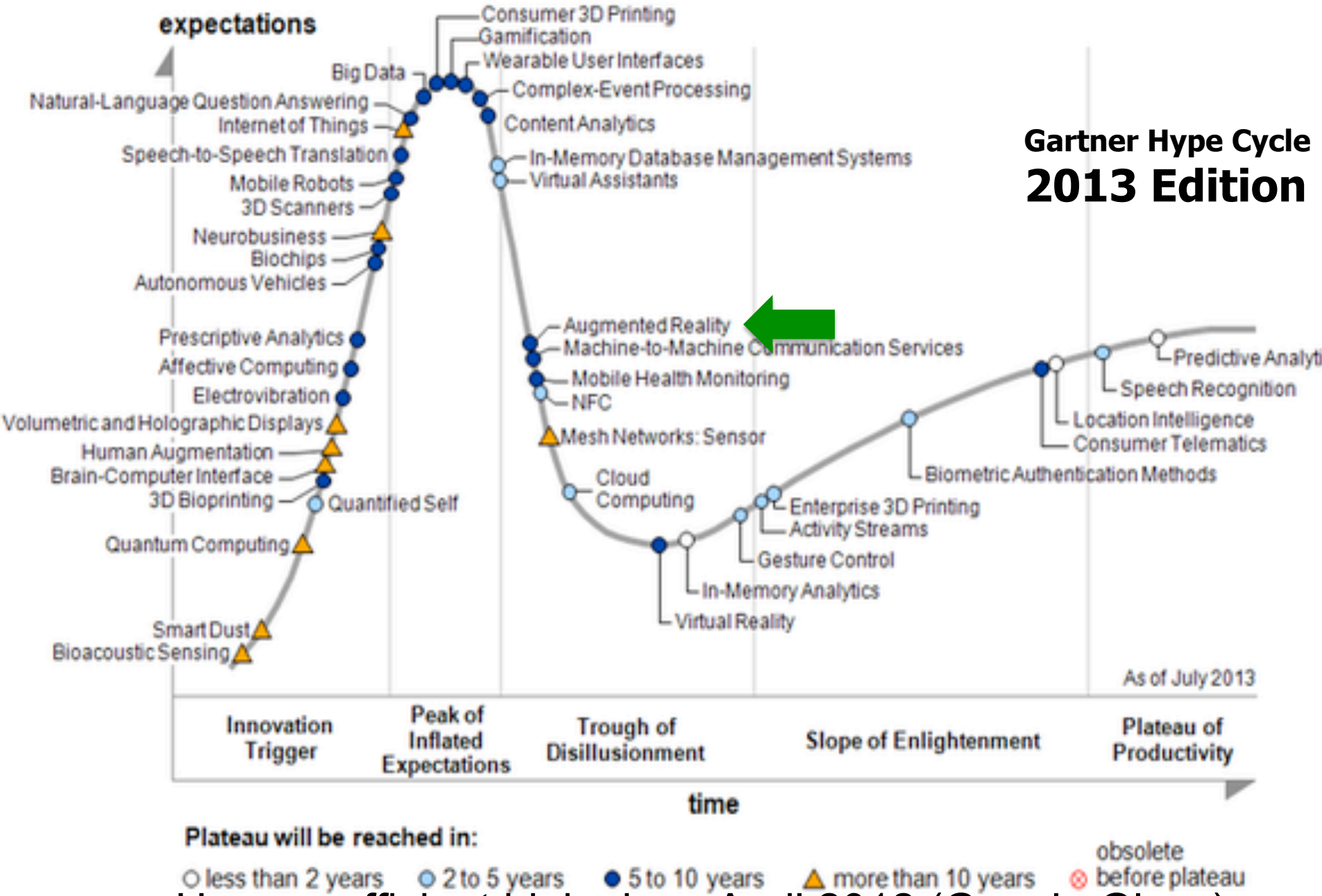
Retrieving the augmentation

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



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

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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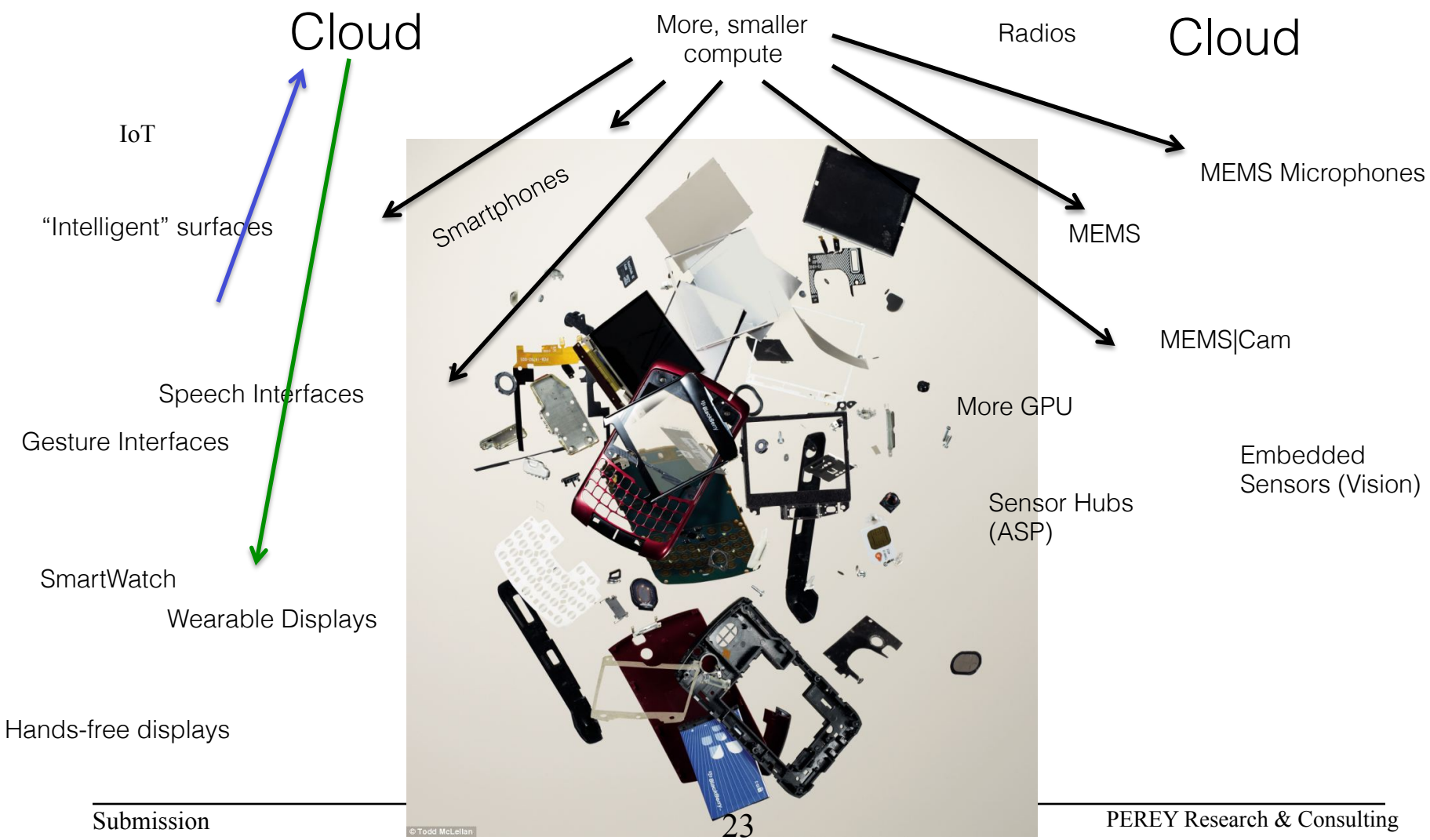
Mobile Handsets for AR

- 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)
  - 300-500 ms latency
  - In 3D (where possible)
  - Lighting
- Leverage what may be available from IoT

Mobile Computing is Fragmenting



Mobile Networks for AR

- Many AR platforms use cloud-based processing and data, via mobile 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

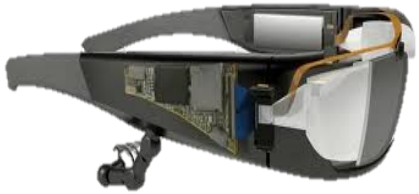
Network Requirement: Deliver and Render Digital Assets

- Low 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

Software

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

Hardware

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

User Control Interface Technologies

Software

- Gesture tracking
- Speech recognition

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

Faster and
Lower cost

AR Standards Community

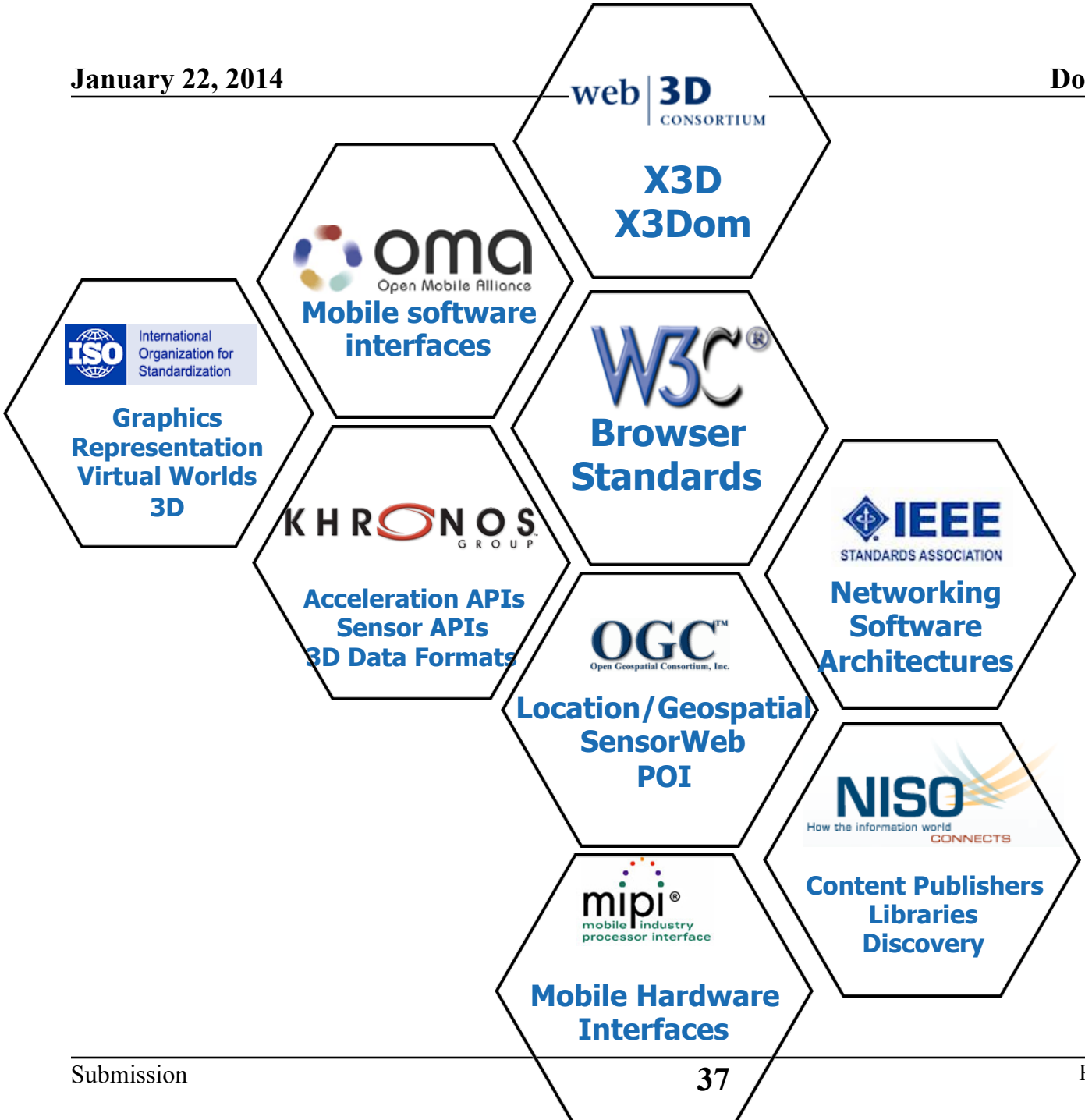
- Identify open interfaces and existing standards
- Assist, where standards are missing and needed, in their development
  - Collect and communicate AR developer and user requirements
  - Define industry- and technology-neutral use cases
- Foster and support the coordination of efforts across multiple 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

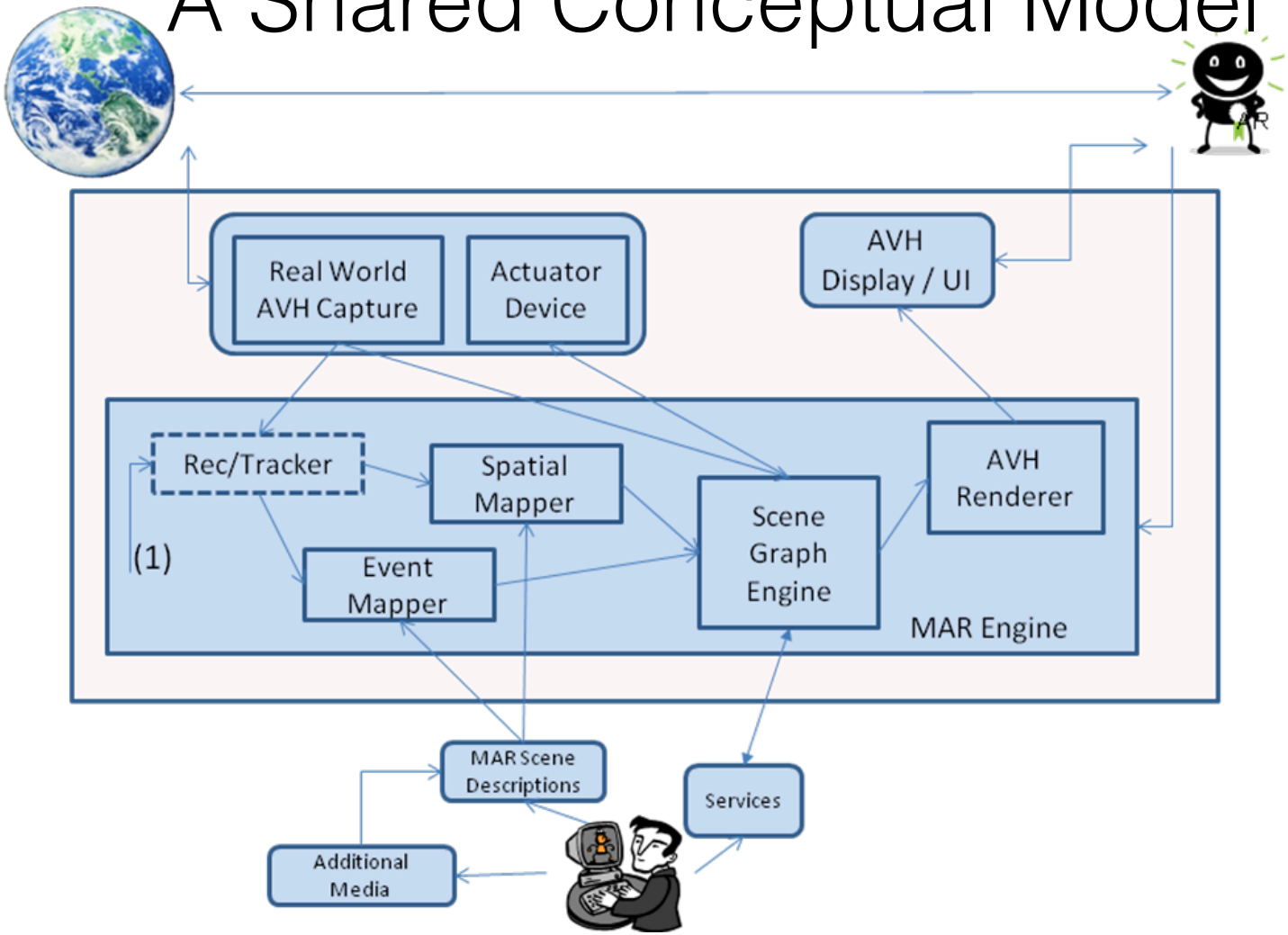

web 3D CONSORTIUM
X3D
X3Dom
oma
Open Mobile Alliance
Mobile software interfaces
International Organization for Standardization
Graphics
Representation
Virtual Worlds
3D
W3C®
Browser
Standards
KHRONOS GROUP
Acceleration APIs
Sensor APIs
3D Data Formats
IEEE
STANDARDS ASSOCIATION
Networking
Software
Architectures
OGC™
Open Geospatial Consortium, Inc.
Location/Geospatial
SensorWeb
POI
NISO
How the information world CONNECTS
Content Publishers
Libraries
Discovery
mipi®
mobile industry processor interface
Mobile Hardware
Interfaces


embedded VISION ALLIANCE
Embedded Vision Algorithms
web 3D CONSORTIUM
X3D X3Dom
IETF
Network Protocols
oma Open Mobile Alliance
Mobile software interfaces
SAE INTERNATIONAL
Automotive Aviation
ISO International Organization for Standardization
Graphics Representation Virtual Worlds 3D
W3C
Browser Standards
HITSP
Healthcare
KHRONOS GROUP
Acceleration APIs Sensor APIs 3D Data Formats
IEEE STANDARDS ASSOCIATION
Networking Software Architectures
SID SOCIETY FOR INFORMATION DISPLAY
Display Technologies
OGC Open Geospatial Consortium, Inc.
Location/Geospatial SensorWeb POI
Construction
buildingSMART International home of openBIM
Building Management
Dublin Core Metadata Initiative
Making it easier to find information
Metadata for Digital Objects
NISO How the information world CONNECTS
Content Publishers Libraries Discovery
3GPP A GLOBAL INITIATIVE
Mobile Device Radios and Com
mipi mobile industry processor interface
Mobile Hardware Interfaces
GSMA
National Standards Organizations

Initiatives of AR Standards Community

- Glossary and AR Reference Model

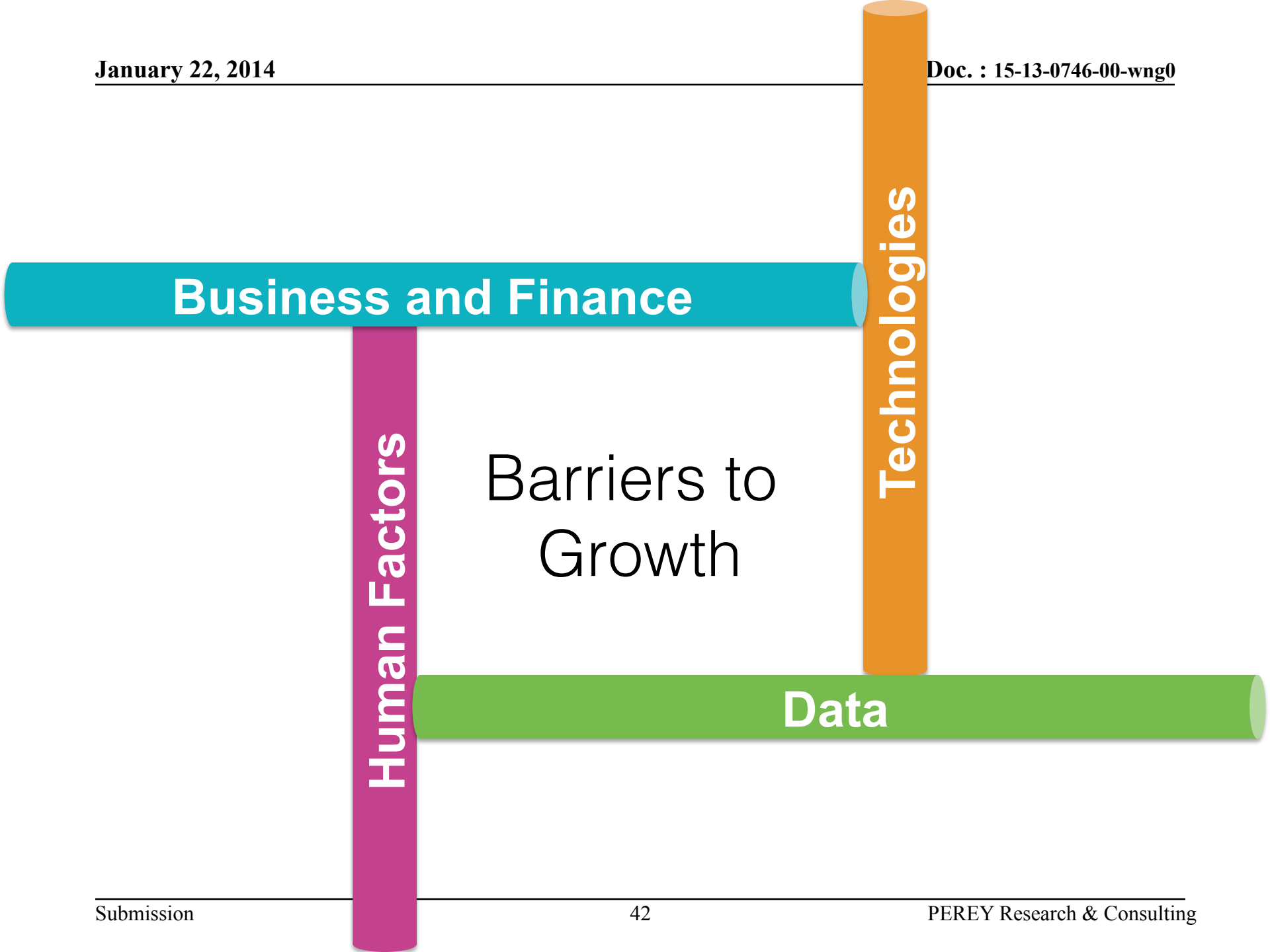
A Shared Conceptual Model



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	• Low awareness or need • Burned once, avoid the risk • Habits
Presentation Systems	• Positioning the display with respect to perception • Fixed focal distances • Weight • Fashion
Interactivity	• Too many steps • Too many assumptions • No support for “peripheral” vision • No conventions for gestures

Human Factors

Category	How to Breakthrough
Inherent Human Traits	• Raise Awareness of benefits of AR visualization • Don't promise what can't be delivered • Use widely-accepted AR terminology
Presentation Systems	• 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	• 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	• Many sources of interference
	  • Urban canyons
	  • Reflective surfaces
	• Focus of user attention is not part of the experience
	• Sensor data streams unsynchronized

Tracking	• Intermittent especially in highly dynamic environment • High power consumption
Display/ presentation	• Loss of calibration, flicker • Interference of bright and natural light sources • Rendered assets do not appear realistic
Others	• Weight • No support for “peripheral” vision • No conventions for gestures

Technologies

Category	How to Breakthrough

User Context Acquisition/Focus of Attention	• Develop methods to reduce interference
	  • Alternative positioning technologies (PDR)
	  • Distinguish reality from reflection
	• Increase viewing angle to include focus of attention
	• Synchronize sensor data streams

Tracking	• Improve in highly dynamic environment • Reduce power consumption or use alternate power
Display/ presentation	• Re-calibrate automatically and invisibly • Use technology tolerant of bright/natural light sources • Develop hardware acceleration for realistic
Others	• Reduce weight • Support greater “peripheral” vision • Develop conventions for gestures

Data

Category	Obstacles
Source	• Which data? • Creating high quality digital assets and developing experiences is time consuming and expensive • No portability/interoperability
Transmission	• Delay • Network service interruption may prevent access
Storage	• Limited memory • Management of updates
Usage	• Lack of policies with respect to interaction (use) records • Voting/rating feedback

Data

Category	How to Breakthrough
Source	• Improve data and metadata discovery • Reduce cost and time of developing high quality digital assets • Adopt standards for data portability/interoperability
Transmission	• Reduce delay • Reduce network service interruption
Storage	• Improve memory management systems • Adopt Learning management system solutions
Usage	• Develop policies for interaction (use) records • Support user voting/rating feedback • Voting/rating feedback

Business and Finance

Category	Obstacles

Policy	• Absence of policy
	• Liabilities
	  • Injuries
	  • Unintentional capture of identities
	• Risk with respect to data security

Costs	• Creating high quality digital assets and developing experiences is time consuming and cost unknown (assumed to be expensive) • Purchase of delivery platforms • Maintenance
Benefits	• To be measured and proven
Business Models	• Many available • Specifics yet to be proven

Business and Finance

Category	How to Breakthrough

Policy	• Develop policies for safety, security and quality
	• Reduce liabilities
	  • Injuries
	  • Unintentional capture of identities
	• Develop secure data display solutions

Costs	• 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	• Measure and prove, then document, share
Business Models	• Explore best business models • Prove new business models

IEEE SA Taking Leadership Role

- IEEE SA is developing assets for education and 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 SA 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 IEEE SA, the AR Community and AREA
  - Obtain and develop specifications that will meet mobile AR requirements

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