Developing a Reference Model for Augmented Reality

5th International AR Standards Community Meeting
19 March 2012
What are uses of a Reference Model?

• Basis for coordination and understanding of the AR community and technology
• Provide insight into current state of AR
• Communications between acquirers and developers
• Input to component design and development
• Resource for defining application specific architectures.
• Allow coordinated development of standards relevant to AR
The Need for an ARC Reference Model

• An ARC reference model defines an authoritative basis that outlines the set of principles, terms and their precise definitions, a generic model of mixed/augmented reality system and its components and interfaces.

• We expect that the reference model will in turn provide the basis for deriving the MAR contents model (and file format), its proper abstraction level and required components.
Important Criteria for RM

• Independence from algorithms
  – Recognition/tracking, Rendering, …

• Independence from sensors used
  – Camera, RFID, Kinect, Marker based, Image patch based, …

• Independence from world capture device
  – Abstraction as a generic viewpoint/eye model

• Independence from computation platform
  – Desktop, Mobile, Server-client, …

• Independence from display device
  – HMD, Projection, Mobile, Holography, …

• Be able to describe a reasonable range of ARC applications
  – Use cases
Standards for defining Reference Model

• IEEE 1471
  – Architectural Description of Software-Intensive Systems
  – Requires viewpoints but does not define viewpoints

• RM-ODP
  – Reference Model for Open Distributed Processing
  – ISO/IEC 10746-1
  – 5 Viewpoints for separation of concerns

• OASIS Reference Model for Service Oriented Architecture
  – Focused on Services

• Others: DODAF, TOGAF, Zachman
Viewpoints in “Reference Model - Open Distributed Processing (RM-ODP)” ISO/IEC 10746
AR RM Foci

- **Engineering view – Business roles**
  - Identify major actors and roles
  - User Scenarios

- **Information view – Registration**
  - Coordinate Reference Systems
  - Geometry, Symbols, Feature types

- **Computational view – Behavior**
  - Use cases

- **Engineering view – Software**
  - Device stack/APIs
  - External networks: Internet, NFC
RM-ODP Viewpoints for AR Reference Model

Community Objectives
- Enterprise Viewpoint
  - Business aspects: purpose, scope and policies

Abstract/Design
- Information Viewpoint
  - Information sources and models
    - What is it about?
- Computational Viewpoint
  - Types of services and protocols
    - How does it work?

Implementation/Development
- Engineering Viewpoint
  - Solution types: distribution infrastructure
    - How do the components work together?
- Technology Viewpoint
  - Implementation system: hardware, software, distribution
    - With what?
Enterprise Viewpoint for AR-RM

• Viewpoint definition
  – Articulates a “business model” that should be understandable by all stakeholders;
  – Focuses on purpose, scope, and policies.
  – Community Objectives
  – Business aspects: purpose, scope and policies

• Topics in Viewpoint for AR
  – General Definition of AR
  – Components defined for enterprise objectives
  – Desirable Characteristics (top-level requirements)
Scope of AR RM

• Define full scope and then provide narrow scope
  – This RM adopts a specific scope for AR while allowing for expansion in future versions

• The scope of this AR RM is:
  – The users point of view is mobile
    • AR devices with fixed location are subset
  – Augmentation of the users live view of the real world with digital assets
    • Beginning with sight and other senses in future
    • Direct or indirect live view of the real world
  – Registration methods include geospatial and sensors
Enterprise View

AR Application
On-board Sensors
Spatial Registration

User

Content Provider

Networks

Network Operator

Networked Sensors
AR scenarios in user language (Enterprise Use Cases)

- **Guide**
  - Leads user through a process in real world

- **Create**
  - User contributes digital object on real world

- **Play**
  - bi-directional interaction between users and the real world
RM-ODP Viewpoints for AR Reference Model

Community Objectives
- Enterprise Viewpoint
  - Business aspects: purpose, scope and policies

Abstract/Design
- Information Viewpoint
  - Information sources and models
    - What is it about?
- Computational Viewpoint
  - Types of services and protocols
    - How does it work?

Implementation/Development
- Engineering Viewpoint
  - Solution types: distribution infrastructure
    - How do the components work together?
- Technology Viewpoint
  - Implementation system: hardware, software, distribution
    - With what?

Viewpoints in “Reference Model - Open Distributed Processing (RM-ODP)” ISO/IEC 10746
Information Viewpoint for AR-RM

• Viewpoint definition
  – Semantics of information and information processing
  – Describes the structure and content types of supporting data.
  – Information sources and models
  – Facilitates common understanding of AR content

• Topics in Viewpoint for AR
  – Information Content of Virtual Objects
  – Spatial Registration
  – Context Dependent Viewing
Some of this diagram is specific to video but would need to be generalized to other media, e.g. audio
Information Viewpoint

- Rob M. (lead), assisted by Hafez R., Martin L., Ben B
- (Update: Rob says he does not have the time to lead UML modeling.)
RM-ODP Viewpoints for AR Reference Model

Community Objectives

Enterprise Viewpoint

Business aspects: purpose, scope and policies

Abstract/Design

Information Viewpoint

Information sources and models
What is it about?

Computational Viewpoint

Types of services and protocols
How does it work?

Implementation/Development

Engineering Viewpoint

Solution types: distribution infrastructure
How do the components work together?

Technology Viewpoint

Implementation system: hardware, software, distribution
With what?

Viewpoints in “Reference Model - Open Distributed Processing (RM-ODP)” ISO/IEC 10746
Computational Viewpoint for AR-RM

• Viewpoint definition
  – Identify interfaces that allow for distribution
  – Types of services and protocols
  – How does the bits work together and a part?

• Topics in Viewpoint for AR
  – Use cases
  – Identify services and interfaces
Functional use cases
(Computational use cases)

• Determine Location and orientation
  – Determine location and orientation

• Object Detection/Identification
  – Processing of visual image from on-board camera to determine
  – Sensor processing

• Retrieve Digital Asset
  – Retrieve local/remote DA based on geographic location
  – Retrieve local/remote DA based on feature identification

• Present
  – Present visual digital assets registered to camera image
  – (Extend to other senses: audio, haptic, )

• Create Content
  – Content provider creates content and publishes
Objects in the world → Sensor → Recognition → Tracking → Spatial Mapping → Spatial Mapper → Spatial Mapping Description

“Sensor” Description

“Eye” Description

Camera / Video

MAR Contents

Event Description
Aug. Description

Scene Compositing / Simulation

Rendering

Display

Display Device Description

An ARC Ref. System Arch.
(G. J. Kim)

Slide from Gerry Kim, JTC 1/SC 24/WG 9
Computational View

• Timo Engelke is leading the modification of diagram
• Rob Manson and Lars Erik Bolstad to review
• Use cases will be in this Viewpoint
Community Objectives

Enterprise Viewpoint

- Business aspects: purpose, scope and policies

Abstract/Design

Information Viewpoint

- Information sources and models
  - *What is it about?*

Computational Viewpoint

- Types of services and protocols
  - *How does it work?*

Implementation/Development

Engineering Viewpoint

- Solution types: distribution infrastructure
  - *How do the components work together?*

Technology Viewpoint

- Implementation system: hardware, software, distribution
  - *With what?*
Engineering Viewpoint for AR-RM

• Viewpoint definition
  – Identification of component types
  – To support distributed interaction between the components.
  – How do the components work together?

• Topics in Viewpoint for AR
  – Engineering Components
  – Interfaces between components
  – Device Internal Interfaces
  – Encoding Formats
A proposal for a Web Standards based Augmented Reality Reference Model

ARStandards.org Basel 2011

Presented by Rob Manson (@nambor) http://mob-labs.com
Khronos AR Flow – Maximizing Acceleration

StreamInput working group is off and running well – aiming for shipment Sep 2012

Khronos considering OpenCV as standard – adding HAL acceleration layer

OpenMAX AL adopted by Android 4.0

OpenMAX AL working on advanced camera extensions – prototypes working

OpenGL ES Working Group close to selecting new generation texture compression standard – 1,2,4 bit per component with alpha
Standards implementation approach

WEB-View (HTML5 +JS)

DOM-Declarative

"AR ML"

Other application descriptions

Annotation Content

Context Registration

... 

SVG

X3D

A2ML

JavaScript

X3Dom

Sound

Vision

Sensors

Content

Native Interface

Generic Application (Instant mobileAR Browser)

Abstraction

Reachability for masses of developers

Individualization of App
• Timo (lead), Rob, Neil, Lars-Erik, Anita
• Component Devices figure may be merged or reconciled with Timo’s “orange blocks” data representations diagram
The Need for an ARC Reference Model

• An ARC reference model defines an authoritative basis that outlines the set of principles, terms and their precise definitions, a generic model of mixed/augmented reality system and its components and interfaces.

• We expect that the reference model will in turn provide the basis for deriving the MAR contents model (and file format), its proper abstraction level and required components.