Mobile Augmented Reality Enabler

Candidate Version 1.0 – 29 Nov 2011

Open Mobile Alliance

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1. Scope

This Enabler Release (ER) document is a combined document that includes requirements and architecture of the Mobile Augmented Reality (MobAR) Enabler.

The MobAR Enabler provides an overall framework (mechanisms, functionalities, APIs, …) to enable mobile AR services.

The following areas will be covered as part of the scope of the enabler:

- AR Content and its management
- User interactivity and metrics
- Network and client APIs
- MobAR Enabler components functionalities
- Security and privacy aspects

MobAR Enabler will reuse as much as possible existing technologies.

2. References

2.1 Normative References

[RFC2119] "Key words for use in RFCs to Indicate Requirement Levels", S. Bradner, March 1997, URL:http://www.ietf.org/rfc/rfc2119.txt

[RFC4234] "Augmented BNF for Syntax Specifications: ABNF". D. Crocker, Ed., P. Overell. October 2005, URL:http://www.ietf.org/rfc/rfc4234.txt

[OSE] "OMA Service Environment", Open Mobile Alliance™, URL:http://www.openmobilealliance.org/

[SCRRULES] "SCR Rules and Procedures", Open Mobile Alliance™, OMA-ORG-SCR_Rules_and_Procedures, URL:http://www.openmobilealliance.org/

[OMA-MC] "Mobile Codes", Version 1.0, Open Mobile Alliance™, OMA-ERP-MC-V1_0

URL: http://www.openmobilealliance.org/

[OMA-SUPL] "Secure User Plane Location", Version 2.0, Open Mobile Alliance™, OMA-ERP-SUPL-V2_0

URL: http://www.openmobilealliance.org/

[OMA-DPE] "Device Profile Evolution", Version 1.0, Open Mobile Alliance™, OMA-ERP-DPE-V1_0

URL: http://www.openmobilealliance.org/

[OMA-MLS] "Mobile Location Service" Version 1.2, Open Mobile Alliance™, OMA-ERP-MLS-V1_2-20101006-C

URL: http://www.openmobilealliance.org/

[OMA-REST-NETAPI-TL] "RESTful Network API for Terminal Location", Version 1.0, Open Mobile Alliance™, URL: http://www.openmobilealliance.org/

[OMA-SEC-CF] "Application Layer Security Common Functions", Version 1.1, Open Mobile Alliance™, OMA-ERP-SEC-CF-V1_1

URL: http://www.openmobilealliance.org/

[OMA-Autho4API] "Authorization Framework for Network APIs", Version 1.0, Open Mobile Alliance™, OMA-ERP-AUTHO4API-V1_0

URL: http://www.openmobilealliance.org/

[OMA MSF] "Mobile Search Framework", Version 1.0, , Open Mobile Alliance™, OMA-ERP-MSrchFramework-V1_0-20101207-C

URL: http://www.openmobilealliance.org/

2.2 Informative References

[OMADICT] "Dictionary for OMA Specifications", Version 2.8, Open Mobile Alliance™, OMA-ORG-Dictionary-V2.8, URL:http://www.openmobilealliance.org/

3. Terminology and Conventions

3.1 Conventions

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in [RFC2119].

All sections and appendixes, except “Scope” and “Introduction”, are normative, unless they are explicitly indicated to be informative.

3.2 Definitions

AR Content	Any kind of multimedia object which can be used to augment/enhance the user’s sensory perception of the world such as: picture, video, text, 3D models, audio. Typically the AR Content relates to an AR Target
AR Marker	A digital object displayed on the screen that indicates the availability of AR Content about an AR Target.
AR Target	Any entity of the real world such as POI, product, person, vehicle, etc. that can have associated AR Content.
AR View	The view provided by AR application that supports user watching AR Content on the screen in overlay to the camera video stream.
Personalization	Processing of tailored AR Content based on a user's information; it can imply using static data to major extent and/or assumed about the User, that may be distributed in e.g., User profile, preferences etc.
Contextualization	Processing of tailored AR Content based on a given User Context, that can imply using dynamic data to major extent and/or assumed about the User Context, e.g.: location, device capabilities, etc.
User Context	A set of dynamic information that describes the current general status of the user and his/her nearby environment. This set of information can be retrieved from a variety of sources including OMA enablers
AR App	The AR App is an external entity resident on the device that requests and receives AR Content(s) from MobAR Client, and presents them to the user. AR App also report AR Metrics data to the MobAR Client.
MobAR Client	The MobAR Client is the device side functional component of the MobAR Enabler
Content Provider	See [OMADICT]
MobAR Server	The MobAR Server is the network side functional component of the MobAR Enabler

3.3 Abbreviations

OMA	Open Mobile Alliance
API	Application Programming Interface
AR	Augmented Reality
MobAR	Mobile Augmented Reality
POI	Point Of Interest
UGC	User Generated Content
DM	Data Matrix
QR	Quick Response

4. Introduction

Augmented Reality (AR) blends interactive media with the real world and then the view and the experience of the real world, mediated by an electronic device, are "augmented" by virtual digital objects.

The AR introduces a novel paradigm of interactivity, radically shifting the typical experience that the user perceives when getting (searching, retrieving) information. It really becomes interactive and digitally exploitable, meaningful and useful because the augmentation of the reality is in real-time and contextual.

Making use of position and the direction the camera of the mobile device is pointing at (determined e.g. by device resident location such as GPS, network-based location such OMA SUPL [OMA_SUPL], compass, accelerometer and various sensors of the mobile phones), the AR technology enables the above described scenario.

Figure 1 shows the actors mainly involved in the AR ecosystem.

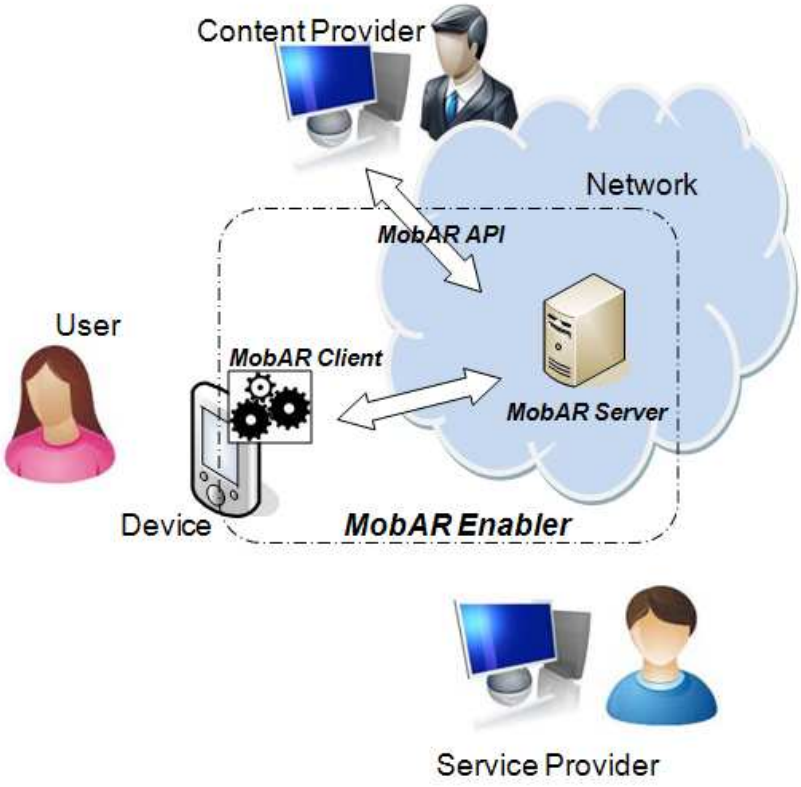

Figure 1 Actors involved in the AR ecosystem

All the depicted actors get benefits from this new AR paradigm.

The Service Provider builds and offers new attractive mobile AR services to Users via the MobAR Enabler.

The User enriches her experience on the move and is enabled to find easily entertaining and useful information about the surrounding reality.

The Content Provider has a new possibility to offer its content and information. Because of the information overloading phenomenon that affects the new digital era, there is the need to better classify, filter and aggregate content to simplify its access and consumption and to be sure that content is retrieved.

The MobAR Enabler defines an overall framework that can assure cross-platform exchange of AR Content and universal access to AR Content by providing new mechanisms for transport, filtering and personalization of AR Contents.

4.1 Version 1.0

The version 1.0 of the MobAR Enabler defines an overall framework that enables mobile Augmented Reality services.

The core functionalities exposed by the MobAR Enabler include: personalization and management of AR Content, user interactivity handling to AR Content, network and client APIs, security and privacy aspects.

5. Requirements (Normative)

The following subsections group the requirements in functional areas for the sake of document's readability. There is no architecture implication derived from the requirements grouping.

5.1 General: Functional requirements

The MobAR Enabler SHALL support mechanisms to allow user subscription/unsubscription for accessing premium content.

Note: These mechanisms may be used to allow the MobAR Service Provider to have accounts creation mechanisms for users, for accessing premium contents or just to control the number of users; the mechanisms may also be available directly to end user, where the end user can create their own account without intervention from the MobAR Service Provider.

The MobAR Enabler SHALL support methods to suspend and resume the ongoing content retrieval (e.g. put the AR session on hold).

The MobAR Enabler SHALL provide means to access and retrieve (e.g. for the purpose of caching) all the relevant AR Contents for AR Targets in the vicinity of the device both inside and outside of the camera view.

The MobAR Enabler SHALL support mechanisms to allow AR Content to be delivered via a pull mechanism.

The MobAR Enabler SHALL support mechanisms to allow AR Content to be delivered via a push mechanism based on the service conditions (e.g. user's subscription information, periodic, event based).

The MobAR Client SHALL support augmenting Real-world information with AR Content on the output device.

5.2 Personalization and Contextualization

The MobAR Client SHALL support retrieval of AR Content (e.g., marker) from MobAR Server, according to Personalization and Contextualization.

The MobAR Enabler SHALL support delivery of AR Content (e.g. marker) from MobAR Server, according to Personalization and Contextualization.

5.3 Content Management and Delivery

The MobAR Enabler SHALL support retrieval of AR Content based on the information from supported sensors on the device (e.g. the orientation of the dynamically changing camera-view).

The MobAR Enabler SHALL support usage of the preferences and account detail of users e.g. in order to access personalized AR Content.

The MobAR Enabler SHALL provide mechanisms to request AR Content from AR Content Provider and filter AR Content provided to the MobAR Client based on specific criteria such as (including but not limited to):

- User location
- Personalization and Contextualization
- User settings (e.g. search radius, search categories)
- Device capabilities (e.g. screen resolution)
- AR Target characteristics (e.g. opening time, price range)
- Multimedia content (e.g. image, video, audio)

When available, the MobAR Enabler SHALL support using information such as:

- Type of the AR Target (e.g. POI, person)
- Location information

When available, the MobAR Enabler SHOULD support using information associated to AR Targets such as:

- Category it belongs to (for a POI e.g. restaurant)
- Name
- Civil address
- URL(s) (e.g. web sites related to the AR Targets)
- Description
- AR Content Rating information
- Contact information (phone/fax number, email address etc)
- Relationships to other AR Targets (e.g. “contained-within”, “contains”, “adjacent-to”)
- Multimedia content: Image, video, audio etc

The MobAR Client SHALL provide mechanisms (under control/policy of the MobAR Enabler) to cache, use and maintain consistency of (e.g. to flush cached information when necessary) the cached downloaded AR Content. These mechanisms SHALL ensure consistency by allowing the Content Provider to invalidate out-of-date information or objects when appropriate.

The MobAR Enabler SHALL provide mechanisms to permit Content Providers to manage the caching policy (e.g., duration, security requirements).

The MobAR Enabler SHALL support open, interoperable protocols for naming, indexing, and retrieving AR Content (sometimes referred to as “syndicating”). These mechanisms SHOULD provide for the greatest degree of flexibility and extensibility possible in the description of information (e.g. mark-up language for AR) that is used to define what type of augmentation information is needed (e.g., based on geolocation or other position-based information, based on image or information extracted from images, based on end-user characteristics, identity, subscriptions, or other information, or based on other sensor information available to the MobAR Client device).

The MobAR Enabler SHOULD support alternative AR Content consumption styles on the device display besides AR View such as list (e.g. of nearby AR Targets), bird’s eye view (e.g. map view).

The MobAR Enabler SHALL provide mechanisms to aggregate AR Content based on several/multiple criteria (location, direction etc) and provide it to the MobAR Client to facilitate the displaying of a large amount of AR Markers.

The MobAR Client SHALL be able to handle (e.g.: retrieve, display) aggregated AR Content.

5.4 User Interaction and metrics

The MobAR Enabler SHALL support the user interaction with the displayed AR Marker and AR Content.

The MobAR Enabler SHALL provide the following interactive actions on the AR Marker and AR Content:

- Select an AR Marker or an AR Content
- Click to view details
- Provide directions towards the AR Target.
- Click to action (e.g. to make a call, to send an email, to send a short message)

The MobAR Enabler SHALL be able to collect metrics (e.g. on the MobAR Client and from it to the MobAR Server) such as:

- User interaction with displayed AR Content and AR Markers (e.g. selection and click to view details)
- AR Content access history (e.g. timestamp and attributes of the previously viewed AR Content including AR Target location, AR Content identifier).

MobAR enabler SHALL support collection and exposure of User's feedback such as ratings about AR Contents usage.

The MobAR Enabler SHALL support mechanisms to use the collected metrics data and User's feedback in the future AR Content selection process (e.g. prioritize AR Content retrieval and display for the most viewed contents).

The MobAR Enabler SHALL provide mechanisms for the User to specify and update settings and preferences such as (including but not limited to):

- Radius for AR Target and AR Content search;
- Categories of a specific AR Target type (e.g. for a POI it may be restaurant, theater);
- Push settings.

The MobAR Enabler SHALL be able to provide means to enable/disable all collection of metrics data and User's feedback in all AR Content instances based on User preferences and Service Provider policy (e.g. regulatory requirements).

The MobAR Enabler SHALL be able to provide means to enable/disable collection of metrics data and User's feedback per AR Content instance based on User preferences and Service Provider policy (e.g. regulatory requirements).

Note: for example the user may disable metrics data collection, or the user may be asked to allow metrics data collection case by case.

The MobAR Client SHOULD support creation and storage of a multimedia object based on the of AR View of user device augmented by AR Content (e.g. marker) retrieved from MobAR Server, according to the User's Personalization(e.g. type of multimedia to be stored) and Contextualization (e.g. not enough memory available) data.

5.5 Security & Privacy

The MobAR Enabler SHALL not compromise the security level of the user device (e.g. by exposing the device to malware).

The MobAR Enabler SHALL ensure that the user related information (e.g. location information, user preference information) is exchanged, used and stored in a secure manner.

The MobAR Enabler SHALL support protection (e.g. by encryption) of:

- Feedback data collected from the user.;
- User information (identity, profile, preferences, User Context);
- Device identity;
- Metrics.

The MobAR Enabler SHALL provide or support means for the user to select relevant information (e.g. profile information, User Context information) to be available for AR Content selection in order to protect his/her privacy

5.5.1 Authentication

The MobAR Enabler SHALL support authentication mechanisms to authenticate requests among the MobAR Enabler components, e.g. between MobAR Client and Server, as well as other entities interacting with the MobAR Enabler.

5.6 Charging

The MobAR Enabler SHALL support the following charging events:

- Access to premium AR Content

The MobAR Enabler SHOULD support several charging mechanisms for the AR Content/service usage (e.g., premium, sponsored contents).

The MobAR Enabler SHOULD allow the User to receive an alert (e.g. advice of charge) in case the interactivity has some associated costs for it (e.g. a click to see a paid AR Content).

5.7 Administration & Configuration

The MobAR Enabler SHOULD support mechanisms to manage the policy for licensing, installation, configuration, enabling, disabling, removal, and access control for components that provide AR-related functionalities on the MobAR Client.

5.8 Access to Capabilities – Device & Network

The MobAR Enabler SHALL be able to access user location information in order to provide geolocalized content and information.

The MobAR Client SHALL access the device capabilities to check the supported features on the device.

The MobAR Client SHALL be able to access information from the supported sensors (on the device) e.g. the orientation provided by the accelerometer, gyroscope and compass.

The MobAR Enabler SHALL support usage of available information derived from external sources such as image or pattern recognition, code reader (e.g. DM or QR code reader [OMA-MC]), in order to facilitate the retrieval of suitable AR Content.

5.9 Interoperability

The MobAR Enabler SHALL support open, interoperable protocols for the exchange of information from various components that communicate over open IP network service. These protocols SHOULD be independent of differences in the MobAR Client execution environment, and MobAR Content Providers to the greatest extent possible.

5.10 Usability (Informative)

The MobAR Client shall support usability mechanisms (e.g. to avoid cluttering of user display).

5.11 Network and Client APIs

The MobAR Enabler SHALL provide APIs to permit applications using the MobAR Client to access AR Content (e.g. from cloud-based services) based on:

- Geographical or other location-based parameters.
- Visual search (e.g., images, extracted information from images, or other sensory inputs on the MobAR Client)

The MobAR Client SHALL provide an API for AR applications to access AR-related functionalities, including (but not limited to) target acquisition, target tracking, gesturing, visual search, and face recognition. To the greatest extent possible, these APIs should integrate seamlessly with other client APIs that could potentially be required concurrently by MobAR-based applications (e.g., OpenGL ES, OpenMAX, DirectX).

Note: it is recommended that the MobAR Client rely on a framework so that components implementing AR-related functionalities (that implement the MobAR APIs) can be added, removed and maintained within the MobAR Client execution environment.

Note: it is recommended that the MobAR Client provide an API from components implementing AR-related functionalities to components that provide hardware-specific optimization of critical AR functions (e.g., computationally complex functions that require hardware acceleration) on specific MobAR Client platforms (e.g., low-level computer vision acceleration functions, camera control, and overlay functions).

The MobAR Client SHALL provide APIs that allow MobAR applications to embed the augmentation of AR Content information (e.g., rendering or display of information retrieved from a cloud service) without requiring the use of a standalone "MobAR browser" application.

The MobAR Enabler SHALL provide a network API to the AR Content Provider to advertise the availability of AR Content.

The MobAR Enabler SHALL provide a network API to the AR Content Provider that supports the functionality of establishing or removal of association between AR Content and specific AR Target.

The MobAR Enabler SHALL provide a network API to the AR Content Provider that supports the functionality of specifying the deployment rules for AR Content such as (including but not limited to):

- Start time and duration of AR Content deployment;
- Different AR Content association with the same AR Target based on user or time;
- Access control to premium content.

The MobAR Enabler SHALL provide a network API to the AR Content Provider that supports the functionality of accessing anonymized feedback related to user interaction and metrics (e.g. for AR Content improvement).

The MobAR Enabler SHALL expose its functionalities as client and network APIs toward 3rd parties (e.g. applications on the device, Content Providers) to build and customize AR services and applications.

6. Architectural Model

In this section are described the architectural model and related aspects of the MobAR Enabler. The architecture contains only MobAR intrinsic functional components, functions, interfaces and APIs.

The architecture definition and functionalities are based on the requirements defined in the Section 5.

6.1 Dependencies

The MobAR Enabler does not have any dependency to other OMA Enablers. For deployment considerations on related Dependencies, please refer Appendix F.

6.2 Architectural Diagram

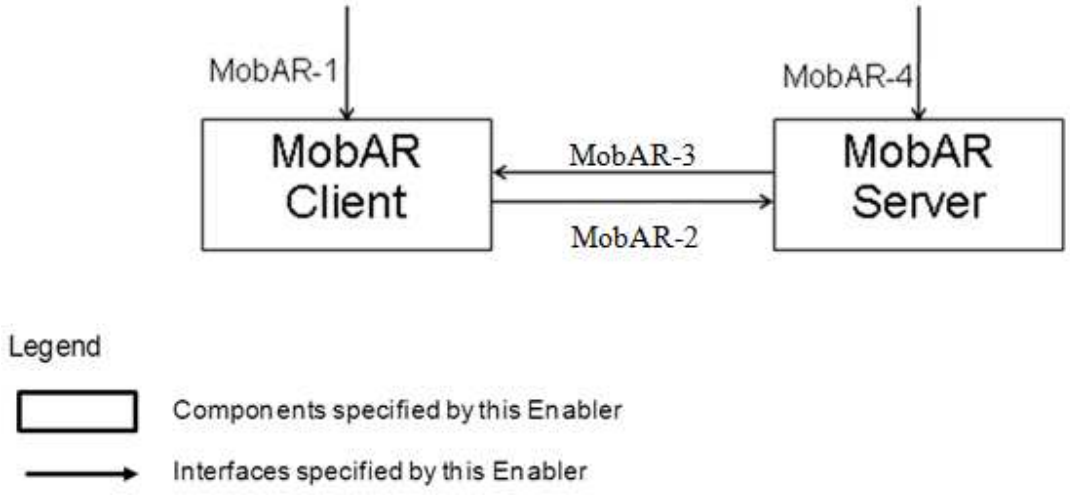

Figure 2 Architecture Diagram of MobAR Enabler

6.3 MobAR Enabler Functional Components and Interfaces definition

6.3.1 MobAR Server component

The MobAR Server is the functional component of MobAR Enabler resident in the network side that performs actions grouped in the following high-level functions:

- AR Content/AR Target selection function
- AR Content/AR Target delivery function
- AR Content/AR Target management function
- AR Metrics data handling function

- AR Content subscription function
- User feedback handling function
- AR Personalization / Contextualization function

6.3.1.1 AR Content /AR Target selection function

The AR Content /AR Target Selection function is responsible for the search of AR Target, selection and retrieval of AR Content based upon the receipt of requests from MobAR Client or push requests related to AR Target and/or AR Content delivery.

The AR Content /AR Target Selection function provide the following AR service：

- AR Target search based on specific criteria such as user location, user settings (e.g. search radius, search categories)
- AR Content selection and retrieval from Content Provider server or in local cache
- Filtering of AR Target and/or AR Content according to Personalization and Contextualization
- Aggregation of AR Target and/or AR Content based on specific criteria such as location, direction etc
- In conjunction with the MobAR Client, support for different consumption styles of the AR Content such as list (e.g. of nearby AR Targets), bird's eye view (e.g. map view)

6.3.1.2 AR Content /AR Target delivery function

The AR Content /AR Target delivery function is responsible of the delivery mechanisms used by the MobAR Enabler between MobAR Server and MobAR Client.

The mechanisms of AR Content /AR Target delivery allowed are both pull (from the MobAR Client to the MobAR Server) and push (from the MobAR Server to the MobAR Client).

The delivery mechanisms (push or pull) to be used can be based on:

- Service configuration such as applicable service delivery methods, e.g. push or pull, which can be user dependent
- User preferences such as preferred category
- Request from MobAR Client such as subscription, specific request
- Device capabilities, which can be used to select an appropriate delivery mechanism

In the case of pull mode, the AR Content /AR Target delivery function delivers AR Target information and/or AR Content in the response to the MobAR Client request.

In the case of push mode, the AR Content /AR Target delivery function invokes the delivery of AR Target information and/or AR Content to the MobAR Client.

According to the results of AR Content /AR Target selection function and user Personalization and Contextualization, the AR Content /AR Target delivery function may deliver one of the following to the MobAR Client:

- AR Target information and/or AR Content
- Reference(s)to AR Target information and/or AR Content (e.g. via URL)
- No result indication

6.3.1.3 AR Content /AR Target management function

The AR Content /AR Target management function is responsible for the storage and management of deployment information related to AR Target and associated AR Content.

The AR Content Management function provides the following mechanisms:

- Management of published AR Content information such as availability, visiting address, deployment rules, access control information, etc.
- Management of deployed AR Target information such as type, category, location, description, relationships to other AR Targets, etc.
- Management of caching policies.
- In conjunction with the MobAR Client, support for the management of AR Content that is cached in the MobAR Client.

6.3.1.4 AR Metrics data handling function

The primary responsibility of this function is to collect AR metrics from the MobAR Client related to the AR Content consumption.

This function consists of the following sub-functions:

- Collection of AR Metrics data about AR Contents and User's interactions with them (e.g. click the displayed AR Content/Marker). This information is collected from the MobAR Client.
- Optionally enhance the collected AR Metrics data with the data known to the AR Server (such as sources IDs, time-stamp, context etc).
- Process AR Metrics data, and all other related collected data into a consolidated report that may be used, e.g.:
    - As additional input for future AR Content selection
    - As chargeable event for the access to premium contents.

It also provides Network APIs to access the anonymized AR Metrics details.

6.3.1.5 AR Personalization / Contextualization function

The function is primarily responsible for collecting user related information, including user profile, user context (e.g. location, device capability) and user preferences, which may be obtained via interacting with other OMA Enablers or internally from this Enabler.

This collected information is used to provide the Personalization /Contextualization of the AR service.

6.3.1.6 AR Content Subscription function

This function is responsible for managing the subscription to allow subsequent AR Content push from MobAR server to MobAR Client.

The AR Content Subscription function includes the management of:

- Requests from the MobAR Client to subscribe/unsubscribe for being notified about AR Content.
- AR Content push settings specified by the user including triggering conditions and filtration criteria for AR Content push
    - Create or update push settings according to received subscribe request
    - Delete push settings according to received unsubscribe request or after the subscription expires

- Initiation of the AR Content push request according to triggering conditions and filtration criteria. Note that this may include downloading additional information such as AR Target information from the MobAR Server to the MobAR Client, etc.

The triggering conditions can be (non exhaustive): push interval (e.g. daily, week days …), User Context (location, presence).

The filtration criteria can be (non exhaustive): user preferences, AR Target details (category, type, characteristics).

Note that the subscription can also be done by out-of-scope mechanisms.

6.3.1.7 User Feedback handling function

The responsibility of this function is to collect user feedback from the MobAR Client related to the AR Content consumption and process it in order to be used as additional input for future AR Content selection.

It also provides Network APIs to access the anonymized user feedback information

6.3.2 MobAR Client component

The MobAR Client is the device side functional component of the MobAR Enabler. The AR Apps directly interact with the MobAR Client that offers the MobAR Enabler functionalities (e.g. User Interaction support, …) to them.

The MobAR Client SHALL access the available capabilities on the device (e.g. GPS, compass, accelerometer, gyroscope) in order to:

- retrieve the right AR Content from the MobAR Server
- make available the required information related to the capabilities to the AR Apps

The MobAR Client performs actions grouped in the following high-level functions:

- AR Content/AR Target retrieval function
- AR Content rendering function
- User Interaction support function
- AR Metrics data handling function
- User / Device data handling function
- User feedback handling function

6.3.2.1 AR Content / AR Target retrieval function

This functionality is responsible for the AR Content / AR Target retrieval from the MobAR Server.

This functionality allows the MobAR Client to request AR Content / AR Target using both pull and push mechanisms.

The AR Content / AR Target retrieval may be caused by

- Subscription requests
- Changes on the user settings (e.g. radius, category)
- Changes on value of the position and direction sensors (e.g. gyroscope, accelerometer, compass)
- User Interactions (e.g. click to get details)

- Request from AR App

This functionality enables also to retrieve aggregated content according to the criteria specified by the MobAR Client (e.g. position, category).

The AR Content / AR Target retrieval requests can be based also on specific consumption styles enabled such as:

- AR View: AR Target and AR Content are to be shown superimposed to the video stream
- Map view: optionally the AR Target and AR Content are to be shown on a map
- Listview: optionally the AR Target and AR Content are to be shown according to a list format

6.3.2.2 AR Content rendering function

The AR Content Rendering function is primarily responsible for providing the display mechanisms required by AR Apps to the user, based on the AR Contents, which are retrieved from the MobAR Server.
The AR Content rendering function consists of primarily the following sub-functions :

- Provide the real-time rendering of AR Contents; for this function existing multimedia rendering engines May be re-used or integrated when applicable. Example of multimedia rendering engines are: OpenGL ES®, DirectX®, OpenMAX™.
- Allows the display of aggregated AR Markers/Contents based on the Personalization and Contextualization criteria
- Allows the display of the Relationships (e.g. “contains”, “adjacent-to”) associated with AR Targets
- Supports the AR Contents to be displayed in either of alternate views such as:
    - AR View: AR Target and AR Content are to be shown superimposed to the video stream
    - Map view: optionally the AR Target and AR Content are to be shown on a map
    - List view: optionally the AR Target and AR Content are to be shown according to a list format

The AR Content rendering function provides mechanisms to reflect the updated displays based on user interactions (e.g. touch, highlight) with the displayed AR Contents/Markers.

While displaying the AR Contents / AR Markers, appropriate runtime execution environment (e.g. Media player, 3D Viewer) on the device may be launched.

Editor’s note: formats for the above information types will be defined in TS phase.

6.3.2.3 User Interaction support function

The User Interaction Support function is responsible for enabling user interactions with the AR Target and the associated information such as AR Marker and AR Content on the device display.

- The User Interaction Support function enables at least the following user interactions: AR Targets interaction behaviour:
    - Selection of an AR Marker or an AR Content
    - Click to get details on the selected AR Marker or AR Content
    - Click to interact with the associated information (e.g. to make a call, to send an email, to send a short message, visit related web sites)
    - Filter AR Markers display e.g. using available AR Content Rating information
    - View Relationships to other AR Targets (e.g. “contained-within”, “contains”, “adjacent-to”) according to different display style

- Optionally create and store a multimedia object based on the AR View of user device augmented by the retrieved AR Content according to the User's Personalization and Contextualization, subject to the Service Provider and Content Provider's policy
- Enable/disable the collection of metrics data and User's feedback based on User preferences and Service Provider policy (e.g. regulatory requirements)
    - In all AR Content instances
    - Per AR Content instance
- Allow or disallow user relevant information (e.g. profile information, User Context information) to be available for AR Content selection
- Specify and update settings and preferences such as:
    - Radius for AR Target and AR Content search;
    - Categories of a specific AR Target type (e.g. for a POI it may be restaurant, theater);
    - Push settings for AR Content and/or AR Target delivery

6.3.2.4 AR Metrics data handling function

This function is responsible for the collection of user interaction with the AR Content and generates associated metrics related to the AR Content consumption.

It involves the reception of AR Metrics by MobAR Client from AR App and report the AR Metrics to the MobAR Server. Such metrics are generally intended for operation support purposes (e.g. personalization, usage history).

The AR Metrics data is generated based on the parameters such as:

- User interactivity details with AR Content and AR Markers
- Access history details of AR Contents

This functionality supports protection mechanisms for the collected AR Metrics.

6.3.2.5 User / Device data handling function

The User/ Device Data handling function is responsible for the collection and management of information related to user's service setting and device current status which is needed in the provision of client-side AR service.

The User/ Device data handling function consists of primarily the following sub-functions:

- Record and manage user's personalization data including:
    - The preference or setting for AR Target search such as search radius, search categories
    - The preference or setting for AR Content retrieval such as content type
    - The preference or setting for AR View-related multimedia object creation and storage such as type or size of multimedia to be stored
    - The preference or setting for AR Content \AR Target aggregation such as based on position or category
    - The preference or setting for AR Content consumption style such as map view or list view
- Gather and process device's status data including:
    - User geolocation information
    - User device static status e.g. hardware capabilities

User device dynamic status such as compass direction, accelerometers angles etc

The User/ Device data handling function also provides mechanisms to support User Context access:

- Collect the information related to User Context access including:
  - Different Device Capabilities (e.g. accessibility, current operational status)
  - Available supporting network service capabilities (e.g. OMA enablers)
- Determine the need and status of User Context access based on collected information and current AR service environment (e.g. requests from AR Applications to search for AR Targets based on user location or image recognition)
- Manage User Context access with the actions including:
  - Access to the appropriate Device Capabilities (e.g. camera, GPS, sensor etc)
  - Optimization of access to Device Capabilities (e.g. change device positioning accuracy or mode for saving terminal energy consumption)
  - Utilization of available network capabilities (e.g. convey dynamic device capabilities for better AR Contents adaptation)

Editor's Notes: How to optimize Device Capabilities access and how to utilize network capabilities is FFS.

6.3.2.6 User Feedback handling function

This function is responsible for the collection of user feedback on the AR Content about the AR Content consumption.

It involves the reception of User feedback by MobAR Client from AR App and report it to the MobAR Server.

The user feedback can consist of the rating (e.g. vote) or comment that the user can express on the AR Content that has been consumed.

This functionality supports protection mechanisms to ensure the privacy of the user.

If the OMA Mobile Search Framework Enabler is implemented and available for use, this function may interact with OMA Mobile Search Framework Enabler [OMA MSF], via MSF-1 interface, to support the User feedback collection.

6.3.3 MobAR-1 interface

MobAR-1 is an interface exposed by the MobAR Client to the AR App. The AR App uses this interface to request and obtain AR Content(s) from the MobAR Client, as well as to report AR Metrics data to the MobAR Client.

This interface is typically exposed in the form of APIs.

6.3.4 MobAR-2 interface

MobAR-2 is an interface exposed by the MobAR Server to the MobAR Client. The MobAR Client uses this interface to request and obtain AR Content(s) from the MobAR Server, as well as to report AR Metrics data to the MobAR Server.

In particular the supported functions of this interface include:

- Request of AR Contents /AR Targets based on several criteria such as: category, location information, search radius, orientation, consumption style, screen resolution, filters related e.g. to user preferences, AR Target details.
- Subscribe/Unsubscribe for AR Content push based on several criteria such as: category, location information, service conditions such as timer, event and other filters related e.g. to user preferences, AR Target details.
- Set/update of user preferences such as: search radius, category, push filters, collection of metrics (enable/disable).

- Send the appropriate AR Metrics collected and User's feedback(e.g., rating) to consider for future AR Content selection.

6.3.5 MobAR-3 interface

MobAR-3 is an interface exposed by the MobAR Client to the MobAR Server. The MobAR Client receives AR Content(s) over this interface from the MobAR Server via underlying push delivery mechanisms. It is also possible that the MobAR Server notifies the MobAR Client over this interface about information such as enable/disable metrics collection, etc.

In particular the supported functions of this interface include:

- Direct push delivery of AR Content for a subscription
- Indirect notify request of AR Content for a subscription

6.3.6 MobAR-4 interface

MobAR-4 is an interface exposed by the MobAR Server to the Content Provider. The Content Provider uses this interface to provide AR Content(s) to MobAR Server and access the functionalities provided by MobAR Server.

This interface is typically exposed in the form of APIs.

In particular the supported functions of this interface include:

- Request to publish the availability of AR contents
- Request to deploy AR Targets, and establish or remove the association between AR Content and specific AR Target
- Specify the deployment rules for AR Content such as (including but not limited to): start time and duration of AR Content deployment, different AR Content association with the same AR Target based on user or time, access control to premium content
- Access anonymized feedback related to user interaction and metrics (e.g. for AR Content improvement)

6.4 External Components (Informative)

6.4.1 Overall architecture diagram

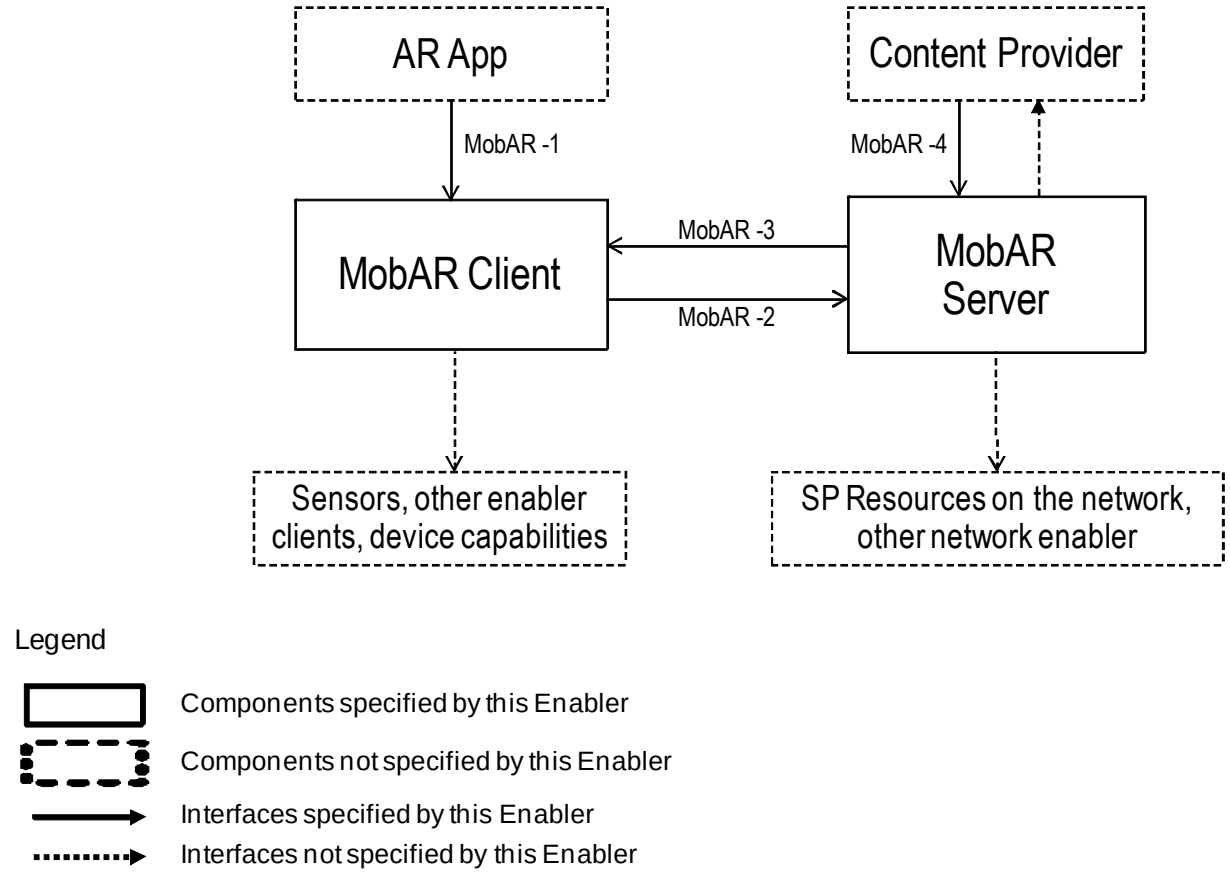

Figure 3 Architectural Diagram with external components

6.4.2 AR Content Provider

The AR Content Provider is an external entity that provides AR Contents to the MobAR Server.

Usually one MobAR Server interacts with multiple AR Content Providers.

6.4.3 AR App

See definition.

Examples of AR App can be AR-aware applications, web browser, gaming client that uses MobAR Client functionality exposed by the MobAR Client interface.

Usually one MobAR Client interacts with multiple AR Apps.

6.4.4 Sensors, Other Enabler Clients, Device Capabilities

Sensors, other enabler clients, and device capabilities are external entities available on the device that can support the MobAR Client on specific functions.

Sensors can be used to collect specific information, for example, compass for direction.

Device capabilities can be used to access the capabilities on the device, for example, camera.

Other enabler clients can be used to access the enabler functionalities, for example, Push Client to receive the pushed AR Contents from MobAR Server.

6.4.5 SP Resources on the Network and other network enablers

SP Resources on the network are external entities resident on the network, and may be accessed in order to provide any relevant information that may be useful for AR Content processing, for example, user profile information can be used to personalize AR Contents.

Other network enablers are external entities resident on the network, and may be accessed in order to provide any relevant enabler functionalities that may be useful for AR Content processing, for example, DPE (Device Profile Evolution) enabler can be used to adapt AR Contents.

6.5 Security Considerations

The MobAR Enabler implementation shall not compromise the security levels while protecting the user data(such as location, preferences, feedback, device details) by applying security mechanisms consistent with the applicable SP security policies (e.g. including transport security, user data privacy, data encryption, etc).

Security such as mutual authentication, authorisation, content encryption, transport security etc is subject to specific SP security policies. The possible mechanisms for mutual authentication, content encryption, transportation security can refer to [OMA SEC_CF]. The possible mechanisms for network API authorization can refer to [OMA Autho4API]. Also the client side API SHALL refer to authorization framework .

The CP-accessed network APIs shall consider security mechanisms to support anonymized feedback related to user interaction and metrics and/or the encryption of such personal information.

The security considerations mentioned in this section apply to the components involved in MobAR Enabler either internal or external. Any particular security mechanisms that are essential to the MobAR Enabler specification shall be addressed in the Technical Specifications.

Appendix A. Change History (Informative)

A.1 Approved Version History

Reference	Date	Description
n/a	n/a	No prior version –or- No previous version within OMA

A.2 Draft/Candidate Version 1.0 History

Document Identifier	Date	Sections	Description
Draft Versions OMA-ER-MobAR-V1_0	15 Nov 2010	all	Baseline definition
	18 Nov 2010	3, 4, 5, Appendix B	Incorporate CRs OMA-REQ-2010-0116R01, OMA-REQ-2010-0117R01
	22 Dec 2010	5, Appendix B	Incorporated CRs - OMA-REQ-MobAR-2010-0002R01, OMA-REQ-MobAR-2010-0004R03, OMA-REQ-MobAR-2010-0006R01, OMA-REQ-MobAR-2010-0007R01, OMA-REQ-MobAR-2010-0008R01
	21 Jan 2011	5, Appendix B	Updated as per CRs - OMA-REQ-MobAR-2010-0009R01, OMA-REQ-MobAR-2010-0003R02, OMA-REQ-MobAR-2011-0001
	01 Feb 2011	5, Appendix B	Integrated CR - OMA-REQ-MobAR-2011-0002R01
	15 Feb 2011	All	Update agreed CRs - OMA-REQ-MobAR-2011-0004R01, OMA-REQ-MobAR-2011-0005R01, OMA-REQ-MobAR-2011-0006R01, OMA-REQ-MobAR-2011-0007R02, OMA-REQ-MobAR-2011-0010R01, OMA-REQ-MobAR-2011-0012R02, OMA-REQ-MobAR-2011-0013R01, OMA-REQ-MobAR-2011-0017R01, OMA-REQ-MobAR-2011-0018R01,
	04 Mar 2011	5	Integrated CRs - OMA-REQ-MobAR-2011-0009R01, OMA-REQ-MobAR-2011-0011R01, OMA-REQ-MobAR-2011-0014R01
	11 Mar 2011	2,3,5	ER updated with readiness for RDRR - OMA-REQ-MobAR-2011-0016R01, OMA-REQ-MobAR-2011-0023R01
	31 Mar 2011	All	ER updated with the result of the review of the requirements part, i.e.: - OMA-REQ-MobAR-2011-0026-INP_Closure_Review_first_part - OMA-REQ-MobAR-2011-0027R01-INP_OMA_REQ_MobAR_2011_INP_Closure_Review_second_part - OMA-REQ-MobAR-2011-0028R01-INP_Closure_Revie_third_part
	09 May 2011	Sec 5.1, 6	Updated with CR# OMA-CD-MobAR-2011-0003R01, OMA-CD-MobAR-2011-0005, OMA-CD-MobAR-2011-0008
	08 Jun 2011	Sec 6.3	Updated with CRs - OMA-CD-MobAR-2011-0011R03, OMA-CD-MobAR-2011-0013, OMA-CD-MobAR-2011-0014R01
	29 Jun 2011	Sections 6.3, 6.4, Appendix C	Updated with CRs: OMA-CD-MobAR-2011-0010R02, 15R02, 17R02, 18R01, 19R01, 20R02, 21R02, 22R02, 23R02
	11 Jul 2011	Section 6.3	Integrated agreed CRs - OMA-CD-MobAR-2011-0026R01, OMA-CD-MobAR-2011-0027R01
	04 Aug 2011	Section 6.3	As per CRs: OMA-CD-MobAR-2011-0032R01, OMA-CD-MobAR-2011-0036R01
	17 Aug 2011	Sec 2, 6, Appendix F	Agreed CRs - OMA-CD-MobAR-2011-0030R03, OMA-CD-MobAR-2011-0033R01. OMA-CD-MobAR-2011-0037R02, OMA-CD-MobAR-2011-0039R01
	24 Aug 2011	Sec 6.3.1.3, 6.3.4	Corrected contents in subsections
	31 Aug 2011	Sec 6 and subsections	Incorporated 42R01, 31R02,
	17 Oct 2011	All	Incorporated changes agreed on 45R02, 44R01 and 43R01
	08 Nov 2011	All	Incorporated 49R02 and 50
Candidate Version OMA-ER-MobAR-V1_0	29 Nov 2011	All	Status changed to Candidate by TP: OMA-TP-2011-0418-INP_MobAR_V1_0_ERP_for_Candidate_Approval

Appendix B. Use Cases (Informative)

B.1 Touristic Use Case

This use case describes the usage of the AR technology in a touristic scenario where the user is walking around the city and enjoying its beauty and cultural aspects.

B.1.1 Short Description

Isabel, a tourist, is visiting an ancient city. The Tourism Office, in accordance with the Service Provider, offers a new AR application to find touristic information (and much more) in an easy and entertaining new way. In particular, a 3D reconstruction of the city ruins is available.

Isabel loves to know everything about cultural places, so she used to carry several guides and make use of audio-guides. This time Isabel has downloaded on her mobile the AR application, so she doesn't have to carry heavy guides, as all cultural content and information available is easily accessible from her mobile.

When walking in the city centre, she starts the AR application to discover monuments and Points Of Interest (POI) in her proximity, as she doesn't want to miss any of them. The application makes use of Isabel's position in order to retrieve geolocalized content and information.

The application allows Isabel to set preferences (e.g. search radius, …) and select the type of content she wants to consume (e.g. category of POIs, …). Based on her preferences, or the choice made on the move, geolocalized multimedia contents are shown on the screen of her mobile.

Excited by the charm and beauty of the ancient city augmented by cultural content and information that AR application provides, Isabel wants to store these valuable views to review later. With a simple touch, Isabel successfully records what she is watching on her mobile screen

She is in front of a very original building and she frames it with her mobile. The scene is augmented with a mash-up of information and content about that building (e.g. POI name, its description, audio guide, related UGC content…): indeed her mobile screen displays AR Markers to highlight the availability of AR Content. AR Markers provide links to additional information sources and content related to that place. Isabel finds out that, among such content, the application also offers premium content: a 3D reconstruction of the ancient building. She decides to get it and starts interacting and virtually navigating the 3D model.

After that, Isabel decides to enjoy the beautiful scenery of this original building without outside interference, so she switches her mobile from AR view mode to camera-view mode to watch the building directly. For the convenience of following operations, this change does not need Isabel to shut down AR application.

B.1.2 Market benefits

This use case shows some benefits for User and Content Provider. The User can consume easily touristic information and entertaining content in an attractive way and in a single point of access: maps, basic information, multimedia content are all available through the AR application. Then the User is enabled to see their surrounding environment overlapped by enriched cultural multimedia content through the use of their mobile and intensify the user involvement by providing an interactive service.

The Content Providers (e.g. POI owners, …) are enabled to offer their content and information at the right moment, then their information is easily retrieved and consumed, allowing new business model.

B.2 Gaming Use Case

The use case described here focus on the rich experience offered by AR technology to the user actively involved in a Gaming scenario.

B.2.1 Short Description

Harry, an ardent gamer, is on visit to an adventurous and popular park Disney Park with its special effects and features. The Park, in conjunction with the local Service Provider, sets-up an AR gaming application version that offers amazing entertainment experience to the user. Harry downloads this AR app on his mobile to have fun in the park.

Through this application, Harry navigates his way through the park by following a map or trajectory that lets him know where the magical creatures live. Of course, this app is magical – as he moves past landmarks in the park the app tells him where to go next by showing on his mobile screen. Harry must solve puzzles and riddles on his way to the next destination. Clues to the answers can be found on the AR markers in the park on his camera view.

At each stage, Harry is shown the relevant content to proceed further in the game to accumulate points or coupons on his way out. These coupons can be redeemed for a discount on the purchase of any item in the park.

Following these directions, Harry may take photos of various landmarks. To his wonder, App's fantastical friends may appear in the photos – sometimes right next to him.

These photos are stored in a gallery to make his adventure unforgettable. The application typically may use all the features of the mobile to lead the user into a fantasy world of trolls, fairies and tree genies - right in their local park.

B.2.2 Market benefits

There is a win-win situation for both user and content provider in terms of usage and revenues. The user enjoy the gaming experience by downloading the application and consumes the resources (i.e. markers) overlaid on the real-time park environment. He also can utilize the discount coupons accumulated during the game play. The content provider is benefited by inviting more and more users by offering value-added services in their play-zone.

B.3 Authenticated Scenario Use Case

This use case describes the support to the authentication in order to enable the user to access special or personalized content.

B.3.1 Short Description

Alice is using is preferred AR application while visiting a touristic city.

She discovers that special contents are associated to a monument nearby. To access this content she needs to authenticate herself on the application.

By clicking on the AR marker, a window pops up allowing Alice to enter her credentials. After that she can enjoy the multimedia contents that show what the nearby area will look like after its renovation.

She discovers also some other special personalized contents that are provided based on her preferences and User Context.

B.3.2 Market benefits

This use case shows some benefits for the actors involved. The user through the authentication can consume a personalized service and access special contents reserved to her.

The Content Providers (e.g. POI owners, …) can offer contents that reach the right consumers.

The Service Provider can tailor the offered service based on its customers and differentiate its service offer.

B.4 Network and Client APIs Use Case

This use case describes how a MobAR Enabler implementation exposes its information and capabilities to third-party applications via (client and network) API.

B.4.1 Short Description

A big fashion brand company wants to provide its customers with an AR application that allows discovering all the shops selling its clothes.

The company makes a deal with the service provider that has deployed the MobAR Enabler and hires a developer to develop an applications able to access the exposed MobAR APIs accordingly to the appropriate authentication and authorization mechanisms.

There are several customization scenarios:

1) (Basic) Use of MobAR Network API: the application running in the content provider environment can customize AR contents based on the brands graphics; for example, the Nike company may provide AR contents for advertising Nike shops;
2) (Intermediate) Use of MobAR Client API: the AR application running on the device adds new functionalities to the ones provided by the MobAR Client; no customization is applied to the AR Content; for example, the Nike company may provide a dedicated MobAR application running on the device that customize the user interface (but not providing contents as in the previous case).
3) (Advanced) Use of MobAR Client API and MobAR Network API; the two cases described above apply. The developer can exploit both sets of APIs to implement a stunning AR application.

B.4.2 Market benefits

This use case shows some benefits for User, Service and Content Providers. The User can consume easily AR Content from her preferred clothes brand,

The Content Provider (e.g. brand company) is enabled to offer its own application and contents to its customers.

The Service Provider can monetize its deployment of the MobAR Enabler diversifying the users' portfolio (end users, enterprises, …)

Appendix C. Call Flows (Informative)

C.1 AR App Request AR Content Call Flow

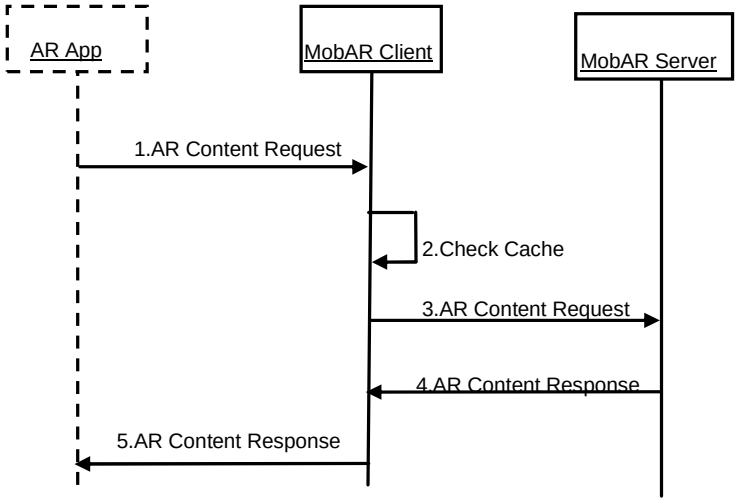

Figure 4 AR App Request AR Content Call Flow

This call flow is triggered by AR App's internal execution logic.

1. AR App requests AR Content from the MobAR Client.
2. The MobAR Client checks if there is available appropriate AR Content stored in the MobAR Client's cache. If there is no appropriate AR Content to satisfy the needs of the AR App, the MobAR Client may communicate with the MobAR Server, for the purpose of obtaining more AR Content, as specified in Step 3. Otherwise, goes to Step 5.
3. The MobAR Client sends AR Content retrieval request to MobAR Server, including the parameters from the request of AR App and additional parameters from MobAR Client.
4. The MobAR Server returns selected AR Content to MobAR Client. Note that the AR Content can be retrieved from AR Content Provider.
5. The MobAR Client returns AR Content to AR App.

C.2 AR App Report AR Metrics Data / User Feedback Call Flow

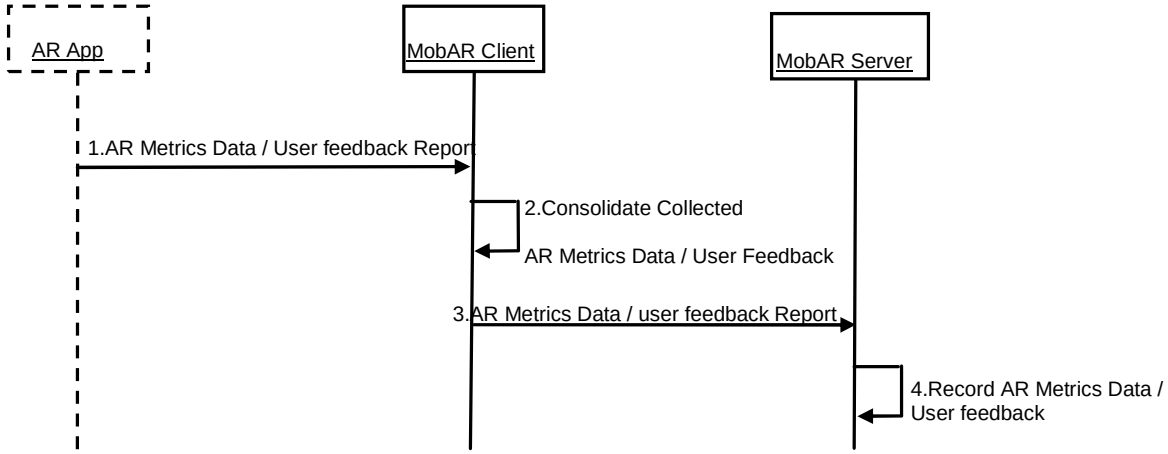

Figure 5: AR App Report AR Metrics Data / User Feedback Call Flow

This call flow is triggered by AR App's internal execution logic.

1. AR App reports AR Metrics data / User feedback to the MobAR Client.
2. The MobAR Client records the AR Metrics data / User feedback, and consolidates the collected AR Metrics data / User feedback, for example, combine several reports from AR App together until the completion of the reports. The MobAR Client may add related information known by the MobAR Client to the collected AR Metrics data / User feedback. This data can be further used to refine information for future AR Content selection process.
3. The MobAR Client reports the AR Metrics data / User feedback to the MobAR Server.
4. The MobAR Server records the reported AR Metrics data / User feedback.

C.3 Subscription Based AR Content Push Delivery Call Flow

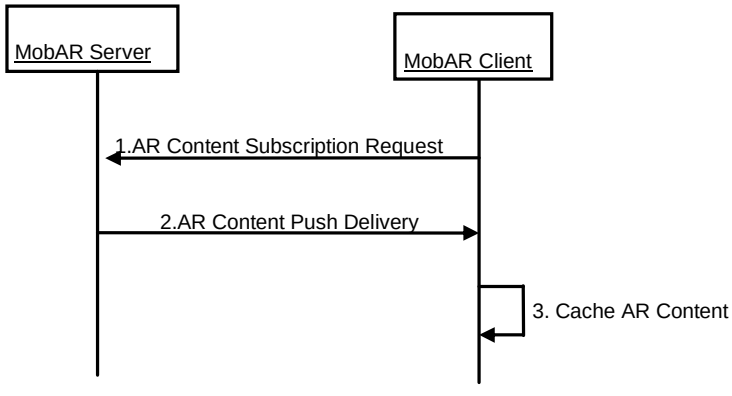

Figure 6: AR Content Push Delivery Call Flow

This call flow is triggered by MobAR Client's internal execution logic.

1. MobAR Client sends the subscription request to the MobAR Server for being notified about the AR Content. Note that there is no sequence relationship with the subscription and the push delivery.

2. The MobAR Server selects the appropriate AR Content, based on Personalization and Contextualization information, and sends the selected AR Contents to the MobAR Client, via a push delivery mechanism.

3. The MobAR Client caches the received AR Contents.

Appendix D. MobAR Enabler Deployment Considerations

MobAR Enabler deployment can be successful on the usage of other OMA Enablers and specifications, such as:

- Device Profile Evolution [OMA-DPE] that provides access to the device (under AR scenario) capabilities
- Location [OMA-MLS] or [OMA- OMA-REST-NETAPI-TL] that provides the user location details that is used in MobAR Enabler

Note: FFS on whether to consider the work done by W3C POI WG (data representations for AR Target).