Mobile Augmented Reality on the Web with X3D

Peter Schickel, Dipl.Inform.Univ
Vice President Web3D Consortium
CEO bitmanagement.com

The traditional way to embed a X3D augmented reality scene into a webpage is considered a plug-in that needs to be installed from the user by download from the website. On mobile devices where screen space needs to be maximized the 3D AR scene can be launched in full screen by clicking on a link or an image in a web-browser and be displayed by an appropriate viewer app, e.g. BS Contact from Bitmanagement on the iphone.

However the Web3D consortium that is preparing the X3D standard in close relation with HTML5 is now considering three basic approaches to display an X3D scene inside an HTML page without installation.

Figure 1: InterAR project: Overlay of 3D graphics based on X3D format over live video in the BS Contact viewer on a Nokia N900 device.
• (External reference) HTML page includes an object element tag that refers to an .x3d scene, implemented via an X3D plugin. Data might be passed within the page using DOM events.

• (X3D as XML in HTML) HTML page directly includes X3D source, likely with an XML namespace prefix, presumably implemented via an X3D plugin or the browser itself. Again data might be exchanged within the page using DOM events.

• (API access) HTML page includes some form of canvas (or maybe Canvas3D) element that allows programmatic access to the page, so that X3D Scene Access Interface (SAI) might draw a bitmap

Variations on these approaches are considered as part of X3D and HTML5 examples.

Figure 2: Web3d liaisons to other consortia and main interest of collaboration.

The Web3D consortium is a long term standardization group that has been producing and maintaining standards for ISO for more than 10 years. Today, the Web3D Consortium is utilizing its broad-based industry support to develop the X3D specification, for communicating 3D on the web, between applications and across distributed networks and web services. Through the well-coordinated efforts with the ISO and W3C, the Web3D Consortium is maintaining and extending its standardization activities.
Now the X3D Working Group of the Web3D Consortium www.web3d.org is contributing to the HTML Working Group for the purpose of best integrating X3D with HTML for Augmented Reality and other application domains.

The goal is to make the native authoring and use of declarative XML-based X3D scenes as natural and well-supported for HTML5 authors as the support provided for Scalable Vector Graphics (SVG) and Mathematical Markup Language (MathML). This effort has strategic importance for the take-up of augmented reality applications and indeed for all 3D graphics, since X3D is an interchange format for a wide variety of models.

Important new work includes the X3DOM suite by Fraunhofer, which shows native augmented reality in the X3D format within an HTML page, runnable in nightly builds for Chrome, Firefox and Safari. A second implementation is in progress, and similar solutions are being pursued for Internet Explorer and Opera.

Bitmanagement together with Fraunhofer Institute für Grafische Datenverarbeitung (IGD) jointly engages in the German BMWI funded project “InterAR – Augmented Reality in the Internet on mobile devices”. The X3D standard will be used in this project as interactive mobile content format. The aim is to develop a mobile augmented reality platform as a basis for creating application scenarios and products. Bitmanagement contributes to the project a scalable and mobile 3D-viewer for commercial and in mass markets available devices (e.g. Apple iPhones 3,4 and Ipad, Nokia phones and others).
The InterAR-Project at Bitmanagement aims to develop interactive 3D viewer software for a variety of mobile devices with content based on the X3D standard and a new server-based mobile tracking approach. The main challenge for AR on many applications today is the accuracy of the position data. Especially in urban areas with high buildings and skyscrapers the GPS signal on mobile devices is often not accurate enough. Here the new server based approach of the InterAR project can be helpful.

Figure 4: Bitmanagements X3D viewer BS Contact running on Apple’s product suite including iphone3, iphone4, ipod touch and mac as well as on PC and Linux.

Figure 5: InterAR project: Tracking of positions is supported over a network in order to reduce the computing necessities for the mobile client.
The tracking of position data in the InterAR project is done via a novel server based approach in order to reduce the calculation burden for image based tracking algorithms on the mobile client. The computational intensive matching algorithms, e.g. for marker less tracking are done on larger mainframe computers, while the found position is communicated via the internet to the mobile client. The video transmission over the internet works fine with the current UMTS and the coming LTE bandwidth constraints.

![Image](image_url)

**Figure 6:** InterAR: Serverbased tracking approach. Live Video from the mobile device is sent over the network, the server calculates the position and sends back the geocoded information to the client.

X3D as a 3d content format shows many advantages over other technologies. In contrast to MPEG-4 for instance X3D is a royalty-free open standard file format. In contrast to Collada it is a run-time architecture to represent and communicate 3D scenes and objects using XML. It is an ISO ratified standard that provides a system for the storage, retrieval and playback of real time graphics content embedded in applications, all within an open architecture to support a wide array of domains and user scenarios. The development of real-time communication of 3D data across all applications and network applications has evolved from its beginnings as the Virtual Reality Modeling Language (VRML) to the considerably more mature and refined X3D standard.
The following features are already present in X3D

- **XML Integrated**: the key to integration with:
  - Web Services
  - Distributed Networks
  - Cross-platform, inter-application file and data transfer
- **Componentized**: allows lightweight core 3D runtime delivery engine
- **Extensible**: allows components to be added to extend functionality for vertical market applications and services
- **Profiled**: standardized sets of extensions to meet specific application needs
- **Evolutionary**: easy to update and preserve VRML97 content as X3D
- **Broadcast/Embedded Application Ready**: from mobile phones to supercomputers
- **Real-Time**: graphics are high quality, real-time, interactive, and include audio and video as well as 3D data.
- **Well-Specified**: makes it easier to build conformant, consistent and bug-free implementations
- **3D graphics and programmable shaders**: Polygonal geometry, parametric geometry, hierarchical transformations, lighting, materials, multi-pass/multi-stage texture mapping, pixel and vertex shaders, hardware acceleration
- **2D graphics**: Spatialized text; 2D vector graphics; 2D/3D compositing
- **CAD data**: Translation of CAD data to an open format for publishing and interactive media
- **Animation**: Timers and interpolators to drive continuous animations; humanoid animation and morphing
- **Spatialized audio and video**: Audio-visual sources mapped onto geometry in the scene
- **User interaction**: Mouse-based picking and dragging; keyboard input
- **Navigation**: Cameras; user movement within the 3D scene; collision, proximity and visibility detection
- **User-defined objects**: Ability to extend built-in browser functionality by creating user-defined data types
- **Scripting**: Ability to dynamically change the scene via programming and scripting languages
- **Networking**: Ability to compose a single X3D scene out of assets located on a network; hyperlinking of objects to other scenes or assets located on the World Wide Web
- **Physical simulation and real-time communication**: Humanoid animation; geospatial datasets; integration with Distributed Interactive Simulation (DIS) protocols
The modular architecture of X3D allows for layered "profiles" that can provide increased functionality for immersive environments and enhanced interactivity or focused data interchange formats for vertical market applications within a small downloadable footprint composed of modular blocks of functionality ("Components"), that can be easily understood and implemented by application and content developers.

Components can be individually extended or modified through adding new "levels", or new components can be added to introduce new features, such as streaming. Through this mechanism, advancements of the specification can move quickly because development in one area doesn't slow the specification as a whole. Importantly, the conformance requirements for a particular piece of content are unambiguously defined by indicating the profiles, components and levels required by that content.

- **Interchange** is the basic profile for communicating between applications. It support geometry, texturing, basic lighting, and animation. There is no run time model for rendering, making it very easy to use and integrate into any application.

- **Interactive** enables basic interaction with a 3D environment by adding various sensor nodes for user navigation and interaction (e.g., PlanseSensor, TouchSensor, etc.), enhanced timing, and additional lighting (Spotlight, PointLight).

- **Immersive** enables full 3D graphics and interaction, including audio support, collision, fog, and scripting.

- **Full** includes all defined nodes including NURBS, H-Anim and GeoSpatial components.

![Figure 7: X3D profiles help viewer implementers to choose the needed functionality for their device and application.](image-url)
A component-based architecture supports creation of different "profiles" which can be individually supported. Recently an AR study group has been established in the Web3D consortium that proposes to add an AR specific profile similar to the existing Interactive profile that also fulfills the requirements of HTML5 support.

This set of nodes and capabilities is implemented currently by Bitmanagement in the InterAR project in order to explore the application scenarios possible with this new set of functionality. The most interesting application scenarios for AR with the InterAR approach are expected in the sales and servicing domains as well as in the geospatial application domains.

Figure 8: Service and support applications for AR mobile

Mobile client-software represents contents of GIS applications on the mobile of the end user in real time, which means, the content is not rendered on servers. Due to the real time ability interactive concepts can be realized in which the client himself is engaged. The content can be explored in free space by the user, e.g. with new options like navigating through content or when exploring environments. The user can leave actively even prepared paths in a presentation, as well as he can e.g. regard and handle an object ad libitum. The user’s actions activate animations putting again new interaction possibilities in operation, like buttons, sliding controls or object behaviors.
Due to the computing at the mobile client the data sets for transmission on the Internet can be reduced down to partially a few KB in comparison to conventional video. Thereby the natural data volume does not any longer carry weight regarding downloading or streaming in the Internet. At the same time transmitting and disseminating applications in the Internet is simplified.

These are the reasons why X3D based software is used by customers in various concepts and products in many industries. The customer showcases in the links below offer an outline. The focus of X3D applications is visualization in CAD, GIS, Games, Stereoscopic Viewing and Augmented Reality.

X3D Customer Case studies:  

X3D Demos:  