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Building the World Wide Telescope

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Abstract. The vision of the World Wide Telescope 2.0 is to provide a common infrastructure so that multiple surveys, over time, can all share a common intuitive browsing platform that allows for seamless exploration of the universe augmented by the creation of narratives and paths through the virtual sky and underlying links to related source data.

1. Background

The World Wide Telescope began with a technical paper by Jim Gray (Microsoft Research) and Alex Szalay (Johns Hopkins) titled: *The World-Wide Telescope, an Archetype for Online Science in 2002* that federating astronomy databases will facilitate the creation of a world wide virtual telescope. Both of the authors were instrumental in the creation of SkyServer in 2002 to provide Internet access to the public Sloan Digital Sky Survey (SDSS) data for both astronomers and for science education. The Next Media Research Group assisted in that project by designing the web site but felt that the website was just a foundation for building a comprehensive learning environment of which the SkyServer would form an important foundation data layer.

In the fall of 2006, the Next Media Research group within Microsoft Research began building its vision for the World Wide Telescope with the following components:

1. **Rich Narrative layer** - Enable professional and amateurs to create rich media tours about topics in astronomy which are illustrated and linked into a virtual sky. Tours allow linking to specific objects in the sky as well as to other related tours for further study of specific topics. Initially a number of exemplar tours will be produced by astronomers and education outreach staff as a resource for all WWT users. Users can create their own tours and share those with others on an individual basis and later as a potential resource to all users.

2. **Virtual Sky** - WWT creates a virtual sky using a custom tiled multi-resolution image rendering engine (similar to Virtual Earth or Google Earth) which can seamlessly render multiple sky surveys (DPOSS, SDSS, 2MASS, etc) as well as multiple wavelength object surveys (Hubble, Chandra, Spitzer) etc. Users can go from a wide field multiple constellation view of the sky and seamlessly zoom into the details of a very high resolution space telescope image within a galaxy. Users can pan around the sky easily and switch between surveys seamlessly. Multiple surveys covering

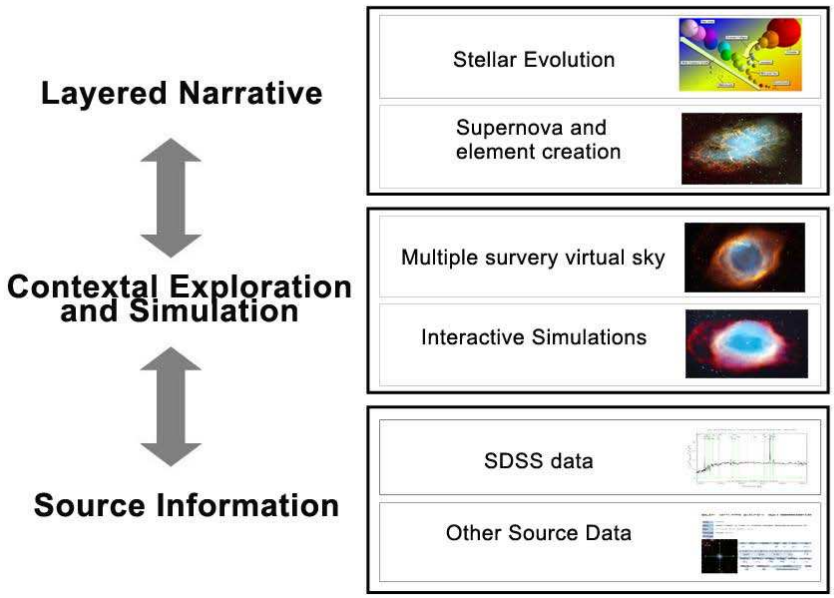

Figure 1. Interactive Linked Narrative Architecture

different wavelengths can be represented as well as time series surveys to allow spectral or temporal analysis of specific objects. Since all surveys are automatically registered in the virtual sky with WCS co-ordinates, any object or section of the sky could be examined in multiple wavelengths as well as multiple times to view space/time changes over a longer baseline of surveys. WWT is built using a custom 3-D engine so it is possible to view both multiple wavelength and temporal views of the sky as well as planets, moons and other spherical high resolution spherical image data sets. The Virtual Sky will also allow embedding rich media assets and links to simulations as a resource at a specific object or class of objects as needed.

3. **Source Data** - Objects as rendered in the virtual sky are linked to data sources based on WCS coordinates associated with objects. Data from sources like SIMBAD, SEDS and other astronomical web services sources are easily retrieved in context of the sky. These can be adapted for the audience or level of the users.

4. **ASCOM Integration** - WWT has integrated ASCOM telescope control so that examination of any area of the sky can be used to direct a local or remote physical telescope to slew to the same location in the sky.

2. The Vision

The vision of WWT is to provide a common infrastructure so that multiple surveys and studies from multiple sources, can all share a common intuitive browsing platform that allows for the creation of narratives, and paths through the virtual sky, which can assist a new user to effortlessly explore the universe though any wavelength and temporal period and understand what they are seeing. Contextual narratives linked to objects with connections to underlying data provide the user with multiple learning modalities from visual, audio, and interaction to develop and reinforce mental models of information about the sky to foster a deeper understanding of astronomy and science.

Kids who are interested in astronomy but don't have a telescope will learn from the linked narratives, understand what they are seeing and go as deep as they choose, exploring the virtual sky and accessing the source data underneath to potentially make discoveries of their own. Eventually anyone will be able to create and share their explorations though the virtual sky, thereby extending and empowering an ever-growing audience who want to know more about the universe.

Professional astronomers will be able to collaborate with others by creating annotations and call outs within the within the virtual sky and share that annotation with others taking advantage of all the resources of the aggregation of multiple large scale datasets.

Later versions of WWT will allow universities, museums and other communities to host their own localized version of the World Wide Telescope that benefit from the common resource pooling of multiple sky surveys and data while still layering on their own hosting of content specific to their interests. e.g. A University could host their own version of WWT which features annotated lectures and unique content specific to research areas of their own professors. Amateur astronomy organizations could host WWT featuring object images taken by their members as well as creating their own guided tours. Education communities could host their own curricular lessons while leveraging relevant tours from the WWT repository.

Microsoft Research will be releasing WWT as a free resource to the astronomy and science education community.

Acknowledgments. The World Wide Telescope is dedicated to Jim Gray.

References

Szalay, A. and Gray, J., in "The World-Wide Telescope, an Archetype for Online Science" , Microsoft Research Technical Report Technical Report MSR-TR-2002-75 (June 2002)