Real-world light sources and materials are brought to life with Iray.

Lightworks Iray+ Technical Overview

This document introduces NVIDIA's Iray rendering technology and Lightworks Iray+ integration SDK. Iray is a physically based, interactive ray trace rendering solution, that allows users to create high quality images and animated content using an intuitive real-world approach to material creation, lighting set-up and camera placement. All of which can be achieved in a fully interactive workflow.

All content is correct as of 11th November 2014.

If you have any questions about Iray, Iray+ or specific features detailed in this document, please contact one of the Iray+ team at iray@lightworkdesign.com

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What is NVIDIA Iray and Lightworks Iray+

Created by world leaders in visualisation-software development, NVIDIA ARC (Advanced Rendering Centre), Iray is a state-of-the-art rendering toolkit that provides visualisation solutions across all sectors and applications.

In 2013 Lightworks entered into a partnership with the NVIDIA ARC team to become the exclusive reseller of their Iray technology, broadening the reach of the technology and providing support to a growing set of Iray powered customers. As integration specialists Lightworks are able to take the technology to those that don't have the in-house resources, or expertise, to contemplate new technology adoption, tailoring the integration and support packages where appropriate.

Lightworks developed Iray+, a contemporary and easy-to-use C++ SDK layer to make the integration of Iray technology as easy, fast and simple to support as possible. Iray+ includes all the power of the NVIDIA Iray technology simply presented in an accessible form for inclusion within CAD software. It builds on the technology with an intuitive approach to building materials, a comprehensive library of predefined content and handy tools to save time during integration, especially if your team aren't experts in 3D visualisation.

Iray+ is a mature, fully-featured product that can be used for integration within a variety of products or applications. This ease of integration has been proven by the development of the Iray+ for 3ds Max plugin - Lightworks own end-user application.

Lightworks can support development with both Iray+ and NVIDIA Iray, but our starting point is always Iray+ as we know this will give the best experience, both now and in the future.

Iray+ differentiators:

- Modern, easy to follow, logically structured C++ APIs that minimise the requirement for code writing

- fully documented with a range of examples and use-case scenarios

- all objects are accessed in the same way, allowing easy UI build out

- unique approach to building materials using physically based components that represent the material creation process in the real world; NVIDIA MDL (Material Definition Language) is fully supported as standard

- the option to tailor the UI to your user requirements, hiding complexities where appropriate

- comprehensive material library and material components

- the ability to generate new materials and material thumbnails

- ready to use lighting options

- all objects are easily streamed in either xml or binary formats, so you can easily save data directly into your own CAD files

- integration support available at all stages, from hotline support and technical consultancy, through to product design and full turnkey implementation. Contact one of the Iray+ team to discuss all our support options iray@lightworkdesign.com

Lightworks Iray+ Fundamentals

Physically Based

Iray+ uses real-world material structures, lighting physics and photographic settings, allowing users to create images and animations that truly represent their product or design concept. Iray+ also presents the minimum necessary parameters needed to achieve this. A growing library of ready to render content enables fast render creation through simple drag-and-drop APIs .

Interactivity and Photorealism

The interactivity of Iray+ means you get real-time feedback on changes made to all settings including geometry, materials and lighting; allowing users to make decisions faster, saving time and money. Iray is well known for offering the highest level of realism on the market through its *Photoreal* render mode along with interactivity, and scalability, which mean users can create stunning visuals with a suite of render modes.

 Interactive render mode(s) offer a balance of quality and speed to suit any workflow requirements.

Interactive Fast: Using approximate ambient lighting effects with ray traced materials, this is the fastest interactive option available; enjoy real-time ray traced navigation and an experience that supercedes the best OpenGL rendering available.

Interactive Direct: Ideal for quickly creating initial design stills and animations, the Interactive Direct mode combines direct lighting effects, ray-traced ambient occlusions and diffused global illuminations.

Interactive Preview: Review design changes quickly and easily with the Interactive Preview mode that combines direct lighting and approximated global illumination models.

Photoreal: The Photoreal mode in Iray brings real-world materials and lighting behaviours to all applications. This high-performance mode generates photorealistic imagery, full global illumination, caustics and luminance distribution through progressive refinements for the highest quality final frame output, ideal for final image production.

Each mode shares the same material appearance giving you consistency of look within different workflows.

Interactive Fast

Interactive Direct

Interactive Preview

Photoreal

A key feature of the Interactive mode is to give fast feedback to material, lighting and geometry changes; quickly alter your geometry configurations, review light position and intensity, and reduce the time needed to preview materials.

Tip: Change the mode to suit different workflow requirements.

Interactive mode 'just got faster', and is now ready for inclusion in your CAD viewport; take your CAD application to the next level of realism by building in Iray Interactive rendering. Using Iray materials in your application means you can easily render Photoreal images directly from there.

> **Tip:** Anyone wanting to improve their viewport graphics should consider the Interactive mode, as you won't need to implement a full rendering solution to do so.

NEW: Interactive mode now comes with full CPU support, which builds on the fully multi-threaded CPU support, and GPU acceleration, available for the Photoreal mode. It is now possible for you and your users to make the most of all the Iray render modes regardless of your hardware infrastructure.

> **Tip:** CPU support for Interactive mode means you can be confident all your users will get a great experience.

Powerful

Iray is fully multi-threaded for CPU and automatically distributes rendering across all CPU resources. By adding one or more additional GPUs to a single machine you will experience near linear performance improvement with each card added. For information on the latest GPUs available, including specifications, please visit the NVIDIA site.

Off Machine Rendering using Local Area Network (LAN) or Cloud

Make the most of the compute power from either your Local Area Network, wider enterprise or 3rd party cloud resources. Any compute resource can be enabled as an Iray server and Iray+ makes accessing off machine rendering resources even easier. All render data can be automatically distributed, and incrementally updated, to single node or cluster based Iray servers, leaving your local machine resource free to concentrate on your design.

NVIDIA VCA

The NVIDIA® Iray® Visual Computing Appliance (VCA) combines hardware and software to greatly accelerate your Iray workflow. Each VCA consists of eight high-end NVIDIA GPUs each with 12GB of graphics memory. Accessible to anyone via your network, or through the cloud, multiple VCAs can be combined to increase rendering power on demand.

Tip: You can enable all of your machines with Iray Server and switch resources depending on which machines are free.

Asset Based

Iray technology appears in a multitude of products, which can all share content, in particular materials, with each other. This means MDL based materials and other elements can be used at every stage of a workflow from prototyping, review and simulation, to manufacture and collateral design. Design materials once, use them everywhere.

Quality and Flexibility

Iray technology is used by professionals in many industries including automotive, jewellery, architecture, product and interior design and many more to produce the highest quality visualisation on the market. An expansive material library provides the basis for creating virtually any material. MDL provides a powerful method for expressing and sharing any material created with other applications throughout the workflow.

Materials

Photorealistic materials are the key to getting great image results. Iray+ provides a range of pre-defined content to get you started, along with the most powerful material construction tools available. Using the base materials as a starting point, you can easily modify the material components. For example, start with a Car Paint material, change the colours and create any number of variations to suit your design needs. All materials work within a physically based system, performing consistently within any lighting scenario, without the need for adjustment.

Example materials:

POLISHED ALUMINIUM	BRICKS	CERAMIC TILES	CONCRETE	BRUSHED COPPER
FROSTED GLASS	GRASS	LEAF	LEATHER	MARBLE
CAR PAINT	METAL PLATE	BRUSHED METAL	OCEAN	ROOF TILES
SKIN	SHOWER GEL	PERFORATED STEEL	STONE WALL	VARNISHED WOOD

Real-world structure
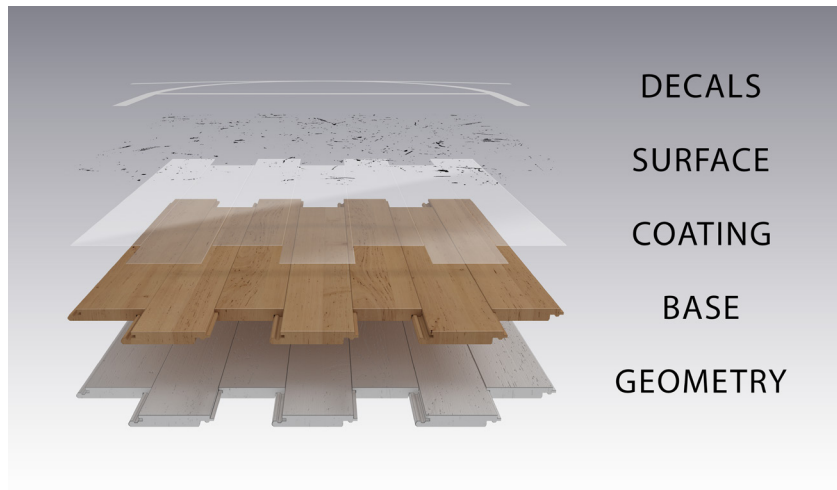
Iray+ materials follow an intuitive real-world layering system allowing you to create new materials in the same way they would be manufactured or found in nature. A painted, varnished wood for example follows this structure:

- **Decal:** Vinyl Sticker
- **Surface 2:** Scratches alpha channel
- **Surface 1:** Clear Coat Varnish
- **Coating:** Paint with diffuse colour
- **Base:** Pine Wood with bump map
- **Geometry:** Wood Geometry

These materials are created in a top down structure, with the core geometry at the bottom of the layer order, with additional layers built on top as required. Multiple layers of each type can be added, creating highly complex finishes, such as multi-layered paint peel, rust, chips and scratches.

Tip: Iray+ allows you to create your own custom material layers to present the perfect, tailored user interface to your users.

MDL: The standard for materials

The materials in Iray+ are based on NVIDIA's MDL (Material Definition Language) which uses material and environmental building blocks that can be combined in flexible ways. MDL is an open standard for describing materials and the interaction of light on their surfaces. Iray+ materials simulate the entire lighting equation; using measured data in your materials will result in simulation-grade accuracy.

In Iray+ you are presented with a wide variety of materials that can be adapted to represent almost any material with accuracy. These materials can be shared between other MDL-enabled applications ensuring everyone working on a project, no matter what point in the design workflow can use one set of materials.

> **Tip:** Iray+ also allows you to import other MDL materials, and then edit, for example, by adding layers.

Built with collaboration in mind

The real-world approach to material creation allows efficient re-use and sharing of each component between different materials. For example, you could take the Paint, Varnish and Decal from the Pine Wood base and add it to a Plaster or Concrete Base, creating a new material from these building blocks, without the arduous task of starting from scratch every time.

The large library of materials already available in Iray+ means that creating unique materials is a quick and easy process. And, the open nature of MDL allows sharing between communities and applications, removing the repetition usually involved in material creation.

Materials Properties

Material properties range from the surface colour, to reflection or refraction properties, light emission of surfaces, scattering and absorption properties of volumes, and even additional geometric properties of surfaces. These geometric properties - cut-outs, displacements, or bump-maps aren't commonly modelled in the primary geometric description.

The powerful, physically based, hierarchical layered material model relies on the following:

- Bidirectional Scattering Distribution Functions (BSDF)
- Emissive Distribution Functions (EDF)
- Volume Distribution Functions (VDF)

MDL describes what should be computed by Iray, and in turn uses this information to decide how to compute the image depending on the geometry, lighting and camera settings. Iray rendering takes full advantage of multiple importance sampling, which improves quality and speed, by using MDL as it separates the material properties from the rendering.

Materials in Iray+ are built from a range of individual bases - coating, surface and decal components - that are included as standard in the SDK and can be layered together to create new materials.

Subsurface scattering has up to 15x speed-up for sub-surface material performance increasing the overall Iray speed.

> **Tip:** Subsurface effects are great for skin, sea, milky plastics, gels, hair and vegetation.

A selection of some of the building block components:

CARBON FIBER	CLOTH	GLASS	LEATHER	MIRROR
METAL	RUBBER	VELVET	WAX	WOOD
SODIUM LIGHT	CLEARCOAT	SCRATCHES	DIRT	DUST
FLIP FLOP	GLOSS FINISH	RUST	SATIN	THIN FILM

Decals

Decals are a special feature that are used to apply materials to just a specific area of an object; for example, stickers and labels on products. Decals can be applied on top of, or inserted within, layers of a material.

Use a decal as part of a standard material, or create a special version that can be applied across multiple surfaces and different materials.

> **Tip:** The special decal is really useful to project, for example, a sticker across the whole length of a car on all body panels.

Matte Materials

Sometimes, when patching a model in a photographic backplate, it is desirable to have shadows appear on a ground plane, as well as on objects that are present in the backplate image. One method for enabling this is to model objects in the scene; place objects in the model and apply Matte Material, to that geometry. The geometry will be invisible, but will capture shadows and reflections.

Measured Materials

Measured data is becoming more popular across a range of industries, giving users a better representation of how light interacts with specific materials. Iray fully supports measured data and can be used as a full material or as the base layer of a material where coatings and stickers are added to create a new material.

Iray now directly supports X-Rite measured materials. Load XRite axf files into Iray, with its maps, in the same way as you'd work with an MDL material. In Iray+ these materials get treated as your base layer, so you are still at liberty to add further coatings and layers to create new material versions.

> **Tip:** At its heart Iray uses standard measured material distributions, so you are always using physically based materials; the ability to add measured data allows more specific control over these.

Lighting and Environment

Iray+ comes with a range of lighting types and options; add the values for your lights into the system and they will interact correctly with the physically based materials to produce true photorealistic visualisation, no matter what your configuration.

Lighting types included:

- **Physical sky and image-based lighting**: Wrap a standard physical sky model around your scene to perform sunlight studies or create a naturally lit scene. Any HDR image can be used to light your scene including photographic studio setups and HDR captures

- **standard point, spot, distant:** The usual standard light types can be included

- **area light sources**: A range of standard area light sources can be included to represent bulbs, ceiling lights, or other uniform-shaped emitters

- **emission materials**: A material that emits light can be attached to any object to producing interesting lighting effects. In addition, layers can be added to that material to represent not only the emission, but also characteristics of the emitting materials. For example, a glass filament

- **photometric sources**: Standard files for example, *.ies* can be used as a point source, area source or within an emission material, giving users full control to create manufacturer lighting and fittings.

Ground Shadows and Reflection Effects

Iray has a built-in ground plane allowing shadows and reflections to be captured from the model while still being able to see through [the ground] to the background or environment. Shadows are captured from all light types including the environment, while reflections are restricted to those cast from the model.

> **Tip:** Ground shadows are an easy way to make objects appear solid and attached to the floor.

Ready to use lighting

Iray+ provides ready to use materials and the lighting to match. Starting with the Physically correct Sky, a range of pre-calibrated HDR images are supplied for exterior, interior and studio-based environments. In addition, Iray has a range of material emissions and example goniometric lights preset to render - create your own custom profiles alongside these.

> **Tip:** Iray likes light, so interestingly, the more lights you add, the faster your images will converge.

Irradiance Calculations

Iray has a special render pass mode that captures the irradiance from a scene, allowing measurement data to be taken which is based on real-world lighting values. This data can be used to check actual lighting levels for buildings; Iray is proven to accurately calculate irradiance at a point and directional view dependent luminance.
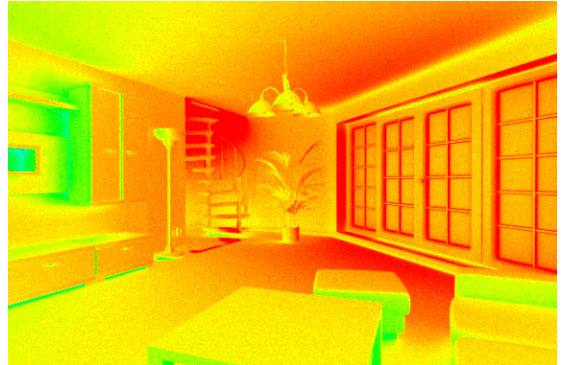
If you combine this mode with physically based materials and lighting Iray can accurately predict the visual appearance and the performance of your design at different times of the day, or under different lighting conditions. Access the results either through irradiance maps or as a full HDR export of your scene as a luminance map.

Tip: Great for architects and lighting engineers. Measure the light across offices, football stadiums and check for issues with glare from specific viewpoints.

Render Passes & Light Path Expressions

Iray is able to simultaneously render multiple render passes during a single image render; using Light Path Expressions (please see below) gives users incredible possibilities for post production effects.
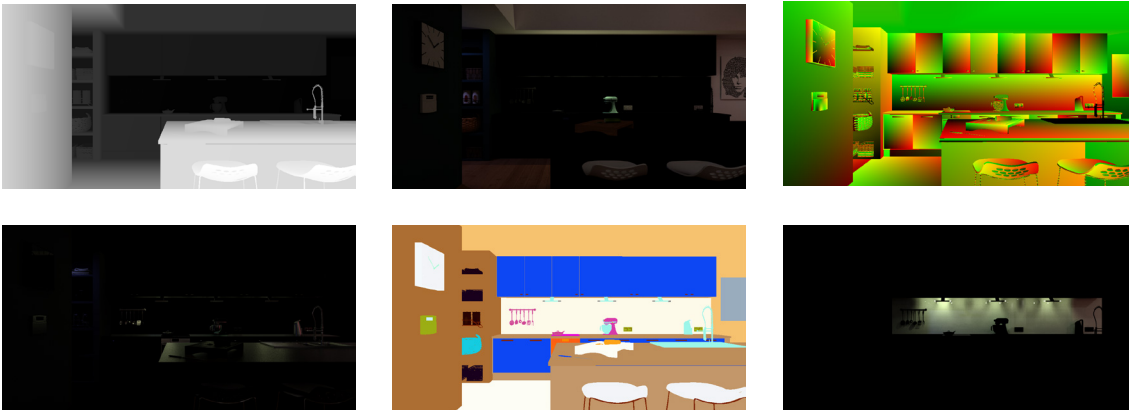
Standard Render Passes

- Beauty Pass
- Alpha
- Depth
- Distance
- Normal
- UVs
- Object ID
- Material ID
- Diffuse
- Specular
- Glossy
- Emission

Tip: Export these layers and import directly into your Photoshop pipeline ready for your post production work.

Light Path Expressions

In addition to the standard render passes, Light Path Expressions can be used to extract specific render layers. Up to 20 of these layers can be produced simultaneously with minimal impact on the render time, allowing you to build up great value with your final image for post processing or the creation of animated or dynamic customer presentations.

The following can be extracted:

- indirect lighting
- direct lighting
- individual lighting, or groups of lights, extracted and placed into a single layer
- global illumination from an object. For example, a wall - recolour and experiment with your image as appropriate.

Review NVIDIA's latest video on Composition Elements and Light Path Expressions here.

Tip: Use these layers to generate amazing user experiences; dynamically explore the lighting in your scene with your client .

Camera Effects

Iray+ works in the same way as a camera, with the same easy to use controls, settings and functions.

Interactive Tone Mapping

Tone mapping effects are fully dynamic as your image is progressing, so you don't have to initially decide on the exact look you want.

It is possible to change the overall brightness and control highlights and shadow regions, while focusing saturation or white-points on specific areas, combined with a vignette effect and gamma to get the perfect result.

Tip: For interiors you'll often find that the light grows in the scene later in the process; tweak the original settings or change the options at any point.

Filters

Iray has a number of special filters that can be applied to the image. For example, the bloom filter applies a post process effect.

In Camera Depth-of-Field

Depth-of- field can be fully controlled within the camera. This control applies to the environment and backplates and works in all render modes in Iray.

Tip: Help your customers by implementing an auto focus - create a selection point within the model and automatically focus the camera on that region, then simply adjust the level of focus.

NEW: Motion Blur

When you are taking a photograph with your camera, anything that moves causes a blurring effect in the photo. This Motion Blur can be caused by objects moving within the frame, or camera movement across the frame. Iray can generate this effect by applying special animated transforms to objects, or the camera, that describe the movement during the shot.

Geometry

Iray+ supports polygonal and NURBS based geometry input enabling your full scene hierarchy to be represented directly. Transforms can be applied at any level; link your scene graph directly to Iray+ and maintain it during modelling operations, or transfer the entire scene for rendering and mark-up.

Instancing Support

Iray now comes with full instancing support, unlocking the true potential for Iray on GPU. Iray was built around instancing support in the scene graph, however when accelerating on GPU it didn't benefit from memory acceleration - now scenes can be filled with trillions of polygons - without incurring adverse memory acceleration problems.

Tip: Instancing support is great for presenting product variations alongside each other, while still maintaining interactivity. Add clutter items to your architectural models, such as vegetation, cars, people etc..

Dynamic Section Planes

Multiple section planes can be added to Iray; users can decide whether or not to preserve lighting effects. Dynamic Section Planes can be applied to anything from cars, with see-through panels showing the engine detail, to the walls of a building that allow a full view of the architectural interior, while preserving the full lighting effect.

Tip: Use this for views of your building that can't be achieved with the camera function, whilst leaving the lighting unaffected. Inspect mechanical models - look inside engines or complex machinery.

Hiding Geometry

The same kind of effect as those in Section Planes can be achieved by 'hiding' geometry. It is possible to flag an object as hidden, while interacting with the scene. For example, you could hide the windows of a car to get a clearer look inside.

You can also easily just hide geometry and let the light come into the scene depending on the effect you want.
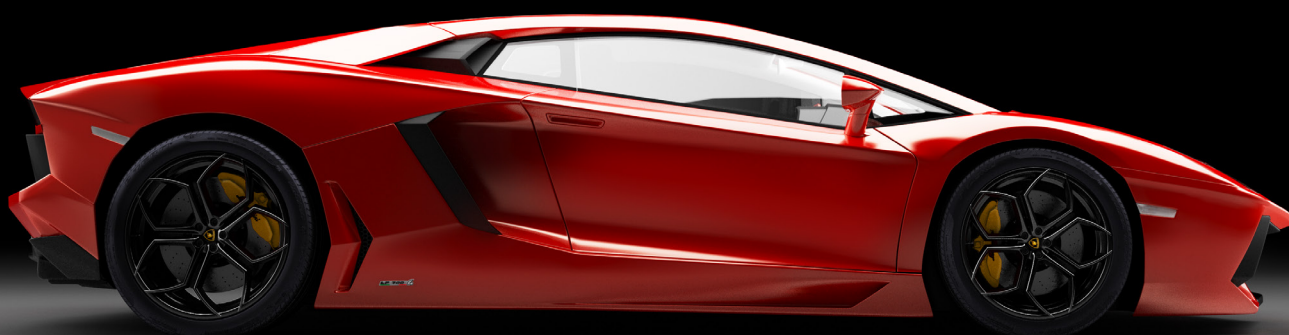
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