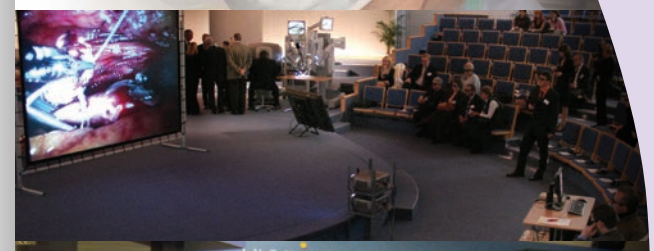
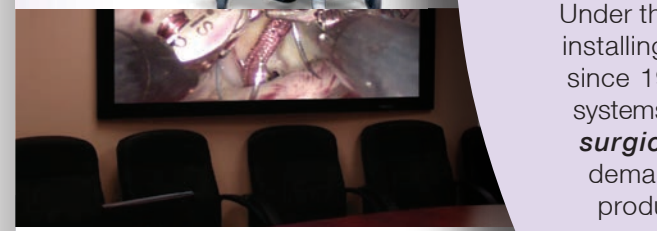
DepthQ®
STEREOSCOPIC

High Definition Stereoscopic Visualization Systems for Robotic Surgery

LightspeeD DESIGN

lightspeeddesign.com depthq.com





DepthQ® STEREOSCOPIC

ABOUT

Lightspeed Design and DepthQ® Stereoscopic

Lightspeed Design, Inc. has been a leader in stereo 3D for over twenty-two years, and is a trusted stereoscopic technology provider to the most discerning clientele, assisting in a wide range of disciplines within Fortune 500 companies, governments, major universities from Beijing to Munich, Hollywood's top filmmakers, and R&D labs across the globe.

DepthQ® is Lightspeed Design's industry-respected technology trademark, encompassing a range of innovative and powerful stereoscopic 3D products and services.

Lightspeed constantly tests new innovations and actively develops leading-edge 3D projection and software technologies in-house - from the world's first portable single lens stereoscopic DLP® projector, to the DepthQ® Mobile™ 3D Visualization Cart, to our high-end HD 3D capture, playback and broadcast software.

We are also ***custom systems integrators***, and authorized resellers of top-quality visualization products, including those from NEC, Christie Digital, Stewart Filmscreens, MacNaughton / Xpand, and Real D / Stereographics. We excel at identifying and integrating the best combination of components to solve any 3D visualization challenge.

Under the DepthQ® stereoscopic brand, Lightspeed has been engineering and installing custom industrial stereoscopic visualization centers and systems since 1997. Among those installations are a rapidly growing number of custom systems designed to visualize, record, and even broadcast live ***robotic surgical procedures*** in high-definition stereoscopic 3D. This clear demand has led us to develop and offer the following standardized set of products for the stereoscopic visualization of robotic surgery.

SELECT CLIENTS:

Intuitive Surgical Systems, Qatar Robotic Surgery Centre, Navy Medical Center New Jersey, Abbott Northwestern Hospital Minneapolis, Roswell Park Cancer Institute, St. Joseph's Hospital Atlanta, Clinique Générale-Beaulieu (Geneva), the First and Second Czech Congresses on Robotic Surgery (Hospimed), NASA Research Center, GE Research, Johnson & Johnson R&D, Pfizer Inc., F. Hoffmann-La Roche Ltd, Harvard and Stanford University...

DepthQ® High Definition Stereoscopic Visualization Systems for Robotic Surgery

OVERVIEW - Software and Hardware Components

There is no single solution when configuring a stereoscopic visualization system, especially for an operating room environment. DepthQ® Stereoscopic systems are therefore available in a variety of configurations, typically comprised of the following software and hardware components:

- A processing computer with robust hardware and powerful software to capture, process, monitor, record, and distribute/broadcast the incoming left & right video signals from the robot.
- A high-quality stereoscopic display.
- 3D eyewear: lightweight passive circular polarized.
- A mobile cart with lockable wheels and height-adjusting lift system to contain all the components and provide mobility & flexibility within the OR.

Software

DepthQ® Capture™ is Lightspeed's powerful software solution for the realtime capture, processing, monitoring and recording of stereo HD 3D video from two simultaneous camera inputs.

DepthQ® Player™ is our feature-rich digital media platform for receiving and decoding HD stereoscopic 3D video from live IP video streams, or for playing local 3D files.

DepthQ® Broadcast Server™ is our HD 3D video-over-IP broadcast server for encoding live video streams using standard video codec, transport stream, and Internet Protocol (IP) technologies.

Hardware Options

The DepthQ® HDs3D-1 3D Video Projector is Lightspeed's recommended high-definition stereoscopic display device when medium-sized projections of 4 to 7' diagonal are desired. Matched with image-enhancing screen technologies, these bright, 2700 Lumen DLP projectors can be utilized for either front or rear-screen projection.

The Christie® Mirage™ HD6K-M is a high-definition stereoscopic video projector recommended for the brightest of environments, including large conference rooms and theaters. Due to their size, these powerful 6,000 Lumen projectors typically need to be permanently mounted to the ceiling.

The DepthQ® Polarization Modulator is combined with an active 3D projector and a silver screen to polarize the light for passive 3D eyewear.

DepthQ® Passive 3D Eyewear are lightweight and circular polarized.

DepthQ® Mobile™ Visualization Cart integrates the processing computer, medical-grade UPS and a high-quality passive 3D monitor into one compact, height-adjustable system, providing mobility and flexibility in an ever-changing operating room environment.

DepthQ® HDs3D2 Projector

Christie® Mirage HD6K-M 3D Projector

DepthQ® Polarization Modulator
(plus silver screen - not shown)

DepthQ® Passive Eyewear

DepthQ® Mobile™ Visualization Cart

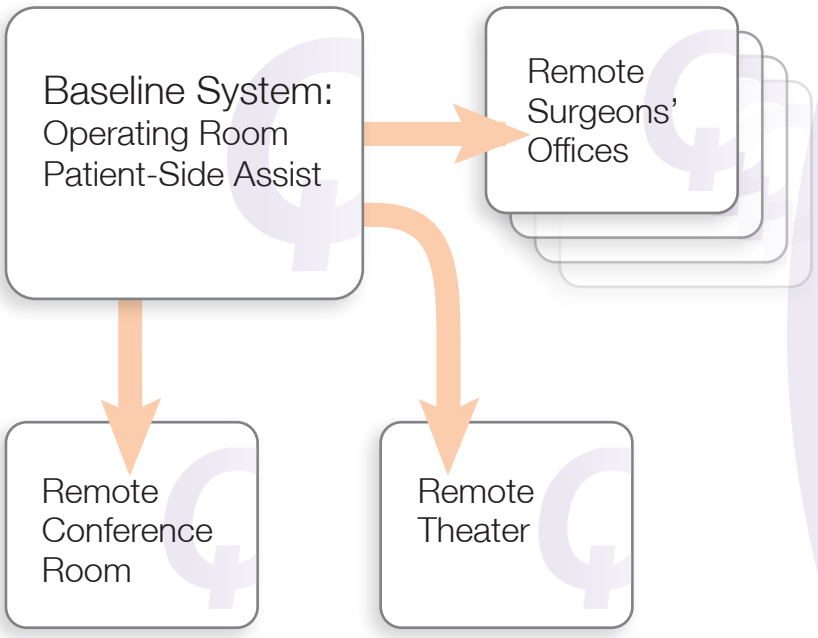
DepthQ® High Definition Stereoscopic Visualization Systems for Robotic Surgery

OVERVIEW - Scope of Distribution and Baseline System

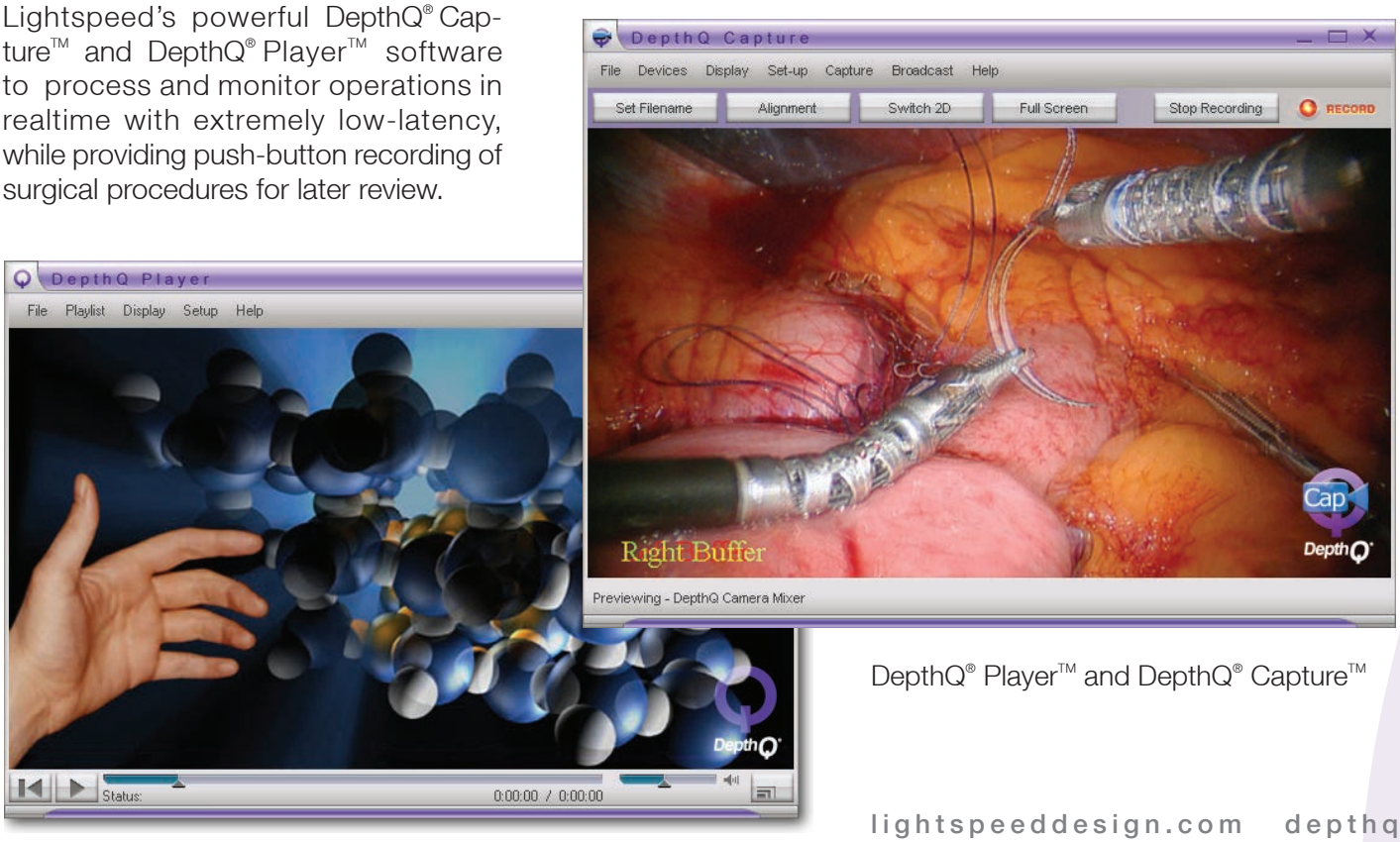
Stereoscopic visualization of surgical procedures is highly valuable not only in the OR itself, but ouside the OR for its effectiveness as a teaching tool. For this reason, many hospitals are installing DepthQ® systems not only in the operating room, but in remote conference rooms, offices, even theaters.

The baseline 3D DepthQ® system is designed to be a visual aid for patient-side assistance, and to improve communication in the OR, where it is directly connected to an Intuitive Surgical *da Vinci*® surgical robot. Satellite 3D systems are then brought online through the addition of optional components to the baseline system.

DepthQ® HD 3D stereoscopic visualization systems all incorporate Lightspeed's powerful DepthQ® Capture™ and DepthQ® Player™ software to process and monitor operations in realtime with extremely low-latency, while providing push-button recording of surgical procedures for later review.



Scope of Distribution for DepthQ® Stereoscopic Visualization Data



DepthQ® Player™ and DepthQ® Capture™

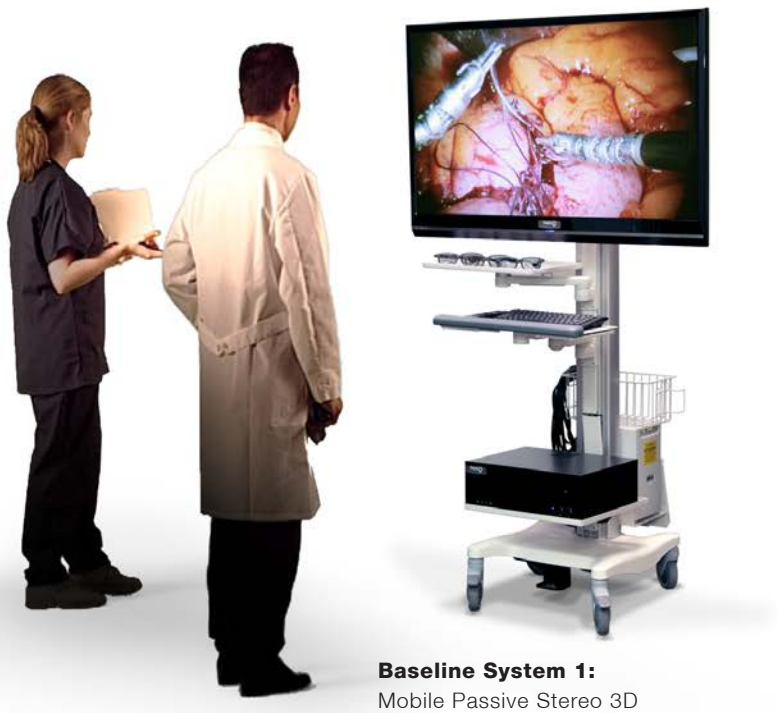
DepthQ® High Definition Stereoscopic Visualization Systems for Robotic Surgery

OVERVIEW - Baseline Systems

Baseline System 1:
Mobile Passive Stereo 3D

DepthQ® Mobile™ Stereoscopic Visualization Cart

Combines a large high-definition passive stereoscopic monitor and self-contained computer system running DepthQ®Capture™ software with the simplicity and convenience of a transportable lift system. Just press the foot pedal to raise or lower the system for optimized viewing – whether seated or standing.



Baseline System 1:
Mobile Passive Stereo 3D
DepthQ® Mobile™ Stereoscopic Visualization Cart

Baseline System 2:
Front-Projection Passive Stereo

DepthQ® Passive Stereoscopic Visualization with the DepthQ® HDs3D2 Video Projector.

This stereo 3D front (or rear) projection system combines the DepthQ® HDs3D2 video projector with a DepthQ® Polarization Modulator and a polarization-preserving screen to create a larger passive viewing experience.

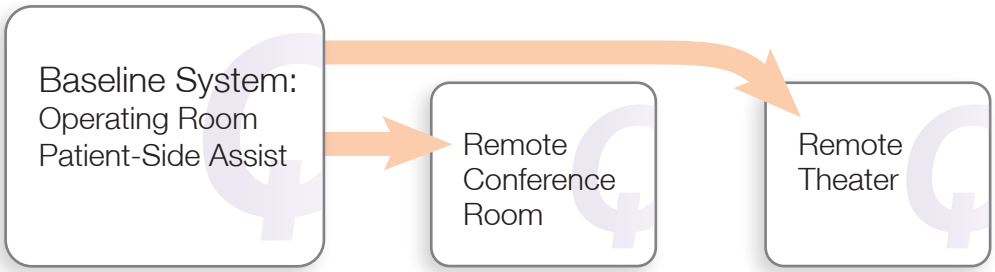
(Computer with DepthQ® Capture™, DepthQ® Player™ and UPS are housed in a separate cabinet, not pictured).

Baseline System 2:
Front Projection Passive Stereo 3D
with DepthQ® HDs3D2 Video Projector &
DepthQ® Polarization Modulator

DepthQ® High Definition Stereoscopic Visualization Systems for Robotic Surgery

STEREOSCOPIC DATA FLOW

Stereoscopic data from the surgical robot is processed and distributed in various formats, resolutions and frame rates, depending on the specific 3D display hardware being used as well as the type and extent of distribution required.



Operating Room
(see Data Flowchart A, next page)

Within the OR, the baseline DepthQ® visualization system receives two HD video signals from the Intuitive *da Vinci*® surgical system (a left and right image separately) either directly from the robot's cameras, or from the *da Vinci*® vision cart expansion card (incorporating the overlays provided to the surgeon's console).

DepthQ® Capture™ then ingests, concatenates, processes and serves the incoming stereo data as a single data stream to the 3D display device at the required resolution, frame rate, and encoding standard for that display. For instance, if the 3D display is the DepthQ® HDs3D2 3D video projector, it requires 1280x720 resolution input in a frame-sequential (L-R-L-R) HDMI format at 120 frames per second.

The entire process - from capture through processing and delivery is accomplished with extremely low latency for critical realtime monitoring.

Remote Conference Rooms and Theaters
(see Data Flowcharts B & C, pages 7 & 8)

When simultaneous stereoscopic visualization is desired in a single location outside the OR, for instance in a remote conference room or theater, the output signal from the OR can be transmitted directly to the remote system via fiber-optic cable.

If the remote display device is directly compatible with the 3D format employed in the OR, the combined LR video signal from the DepthQ® processing computer may be split and transmitted over a single fiber to the remote 3D device through high-speed fiber converter hardware.

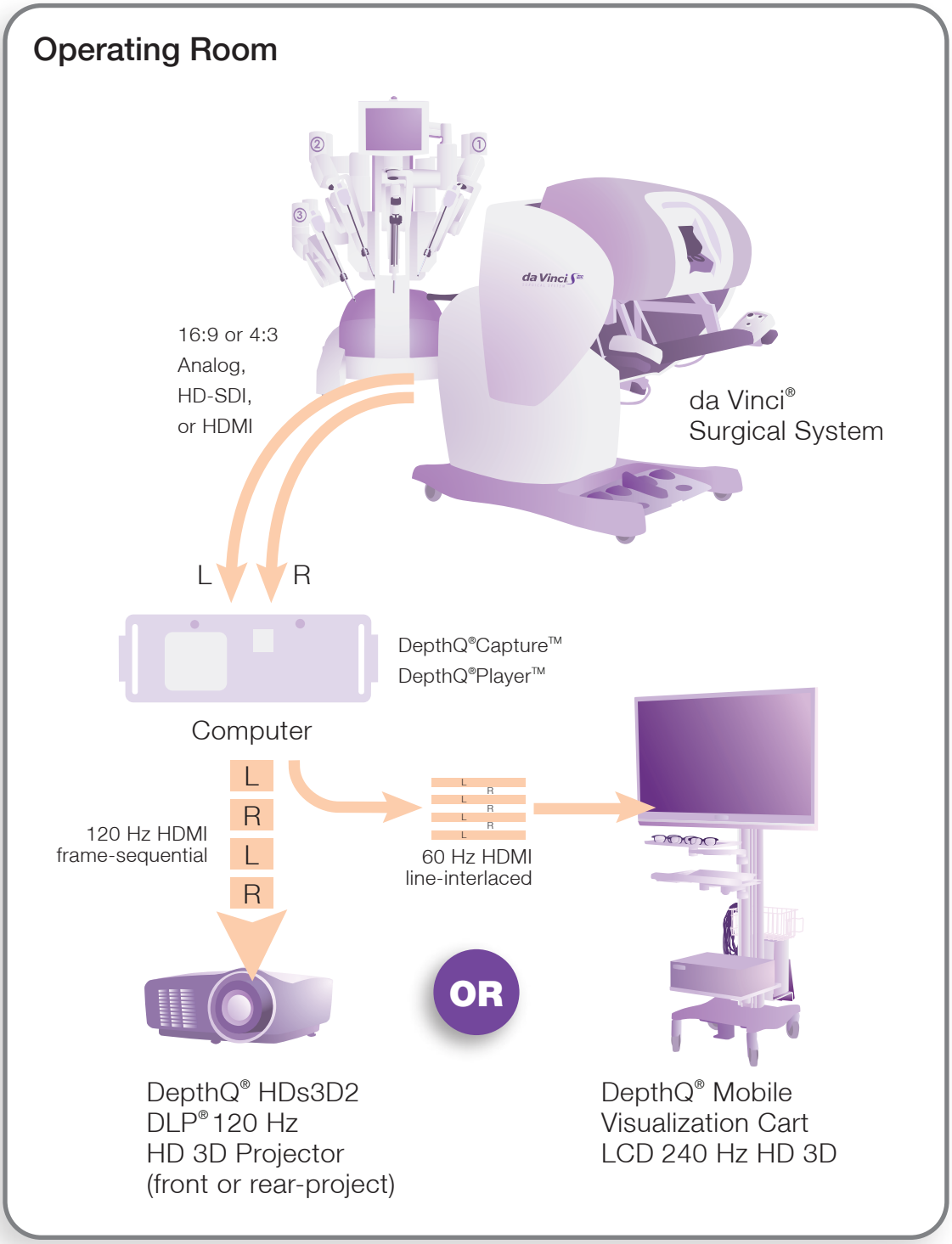
If the remote display device is *not* compatible with the 3D format in the OR (e.g. the Christie HD6K-M), the original individual left and right signals are transmitted unprocessed over two separate fibers to the remote site, where an additional DepthQ® processing computer is employed.

Christie® Mirage HD6K-M 3D Projector

DepthQ® High Definition Stereoscopic Visualization Systems for Robotic Surgery

STEREOSCOPIC DATA FLOW

Data Flowchart A.
Baseline Patient-Side Assist



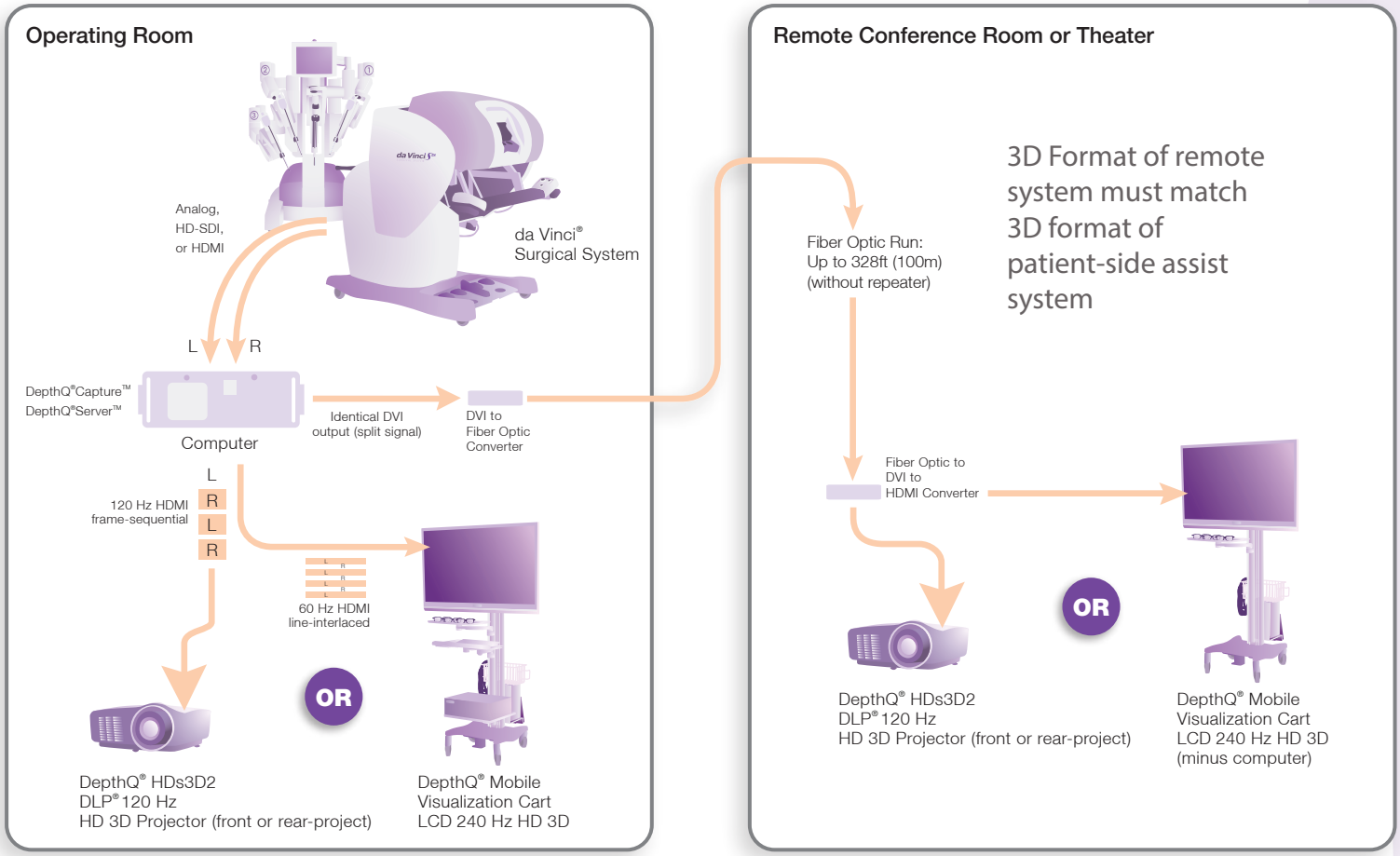
DepthQ® Mobile™ HD 3D Stereoscopic Visualization System Data Flow

DepthQ® High Definition Stereoscopic Visualization Systems for Robotic Surgery

STEREOSCOPIC DATA FLOW

Data Flowchart B.

Baseline Patient-Side Assist + 3D Format-Compatible Remote Conference Room or Theater



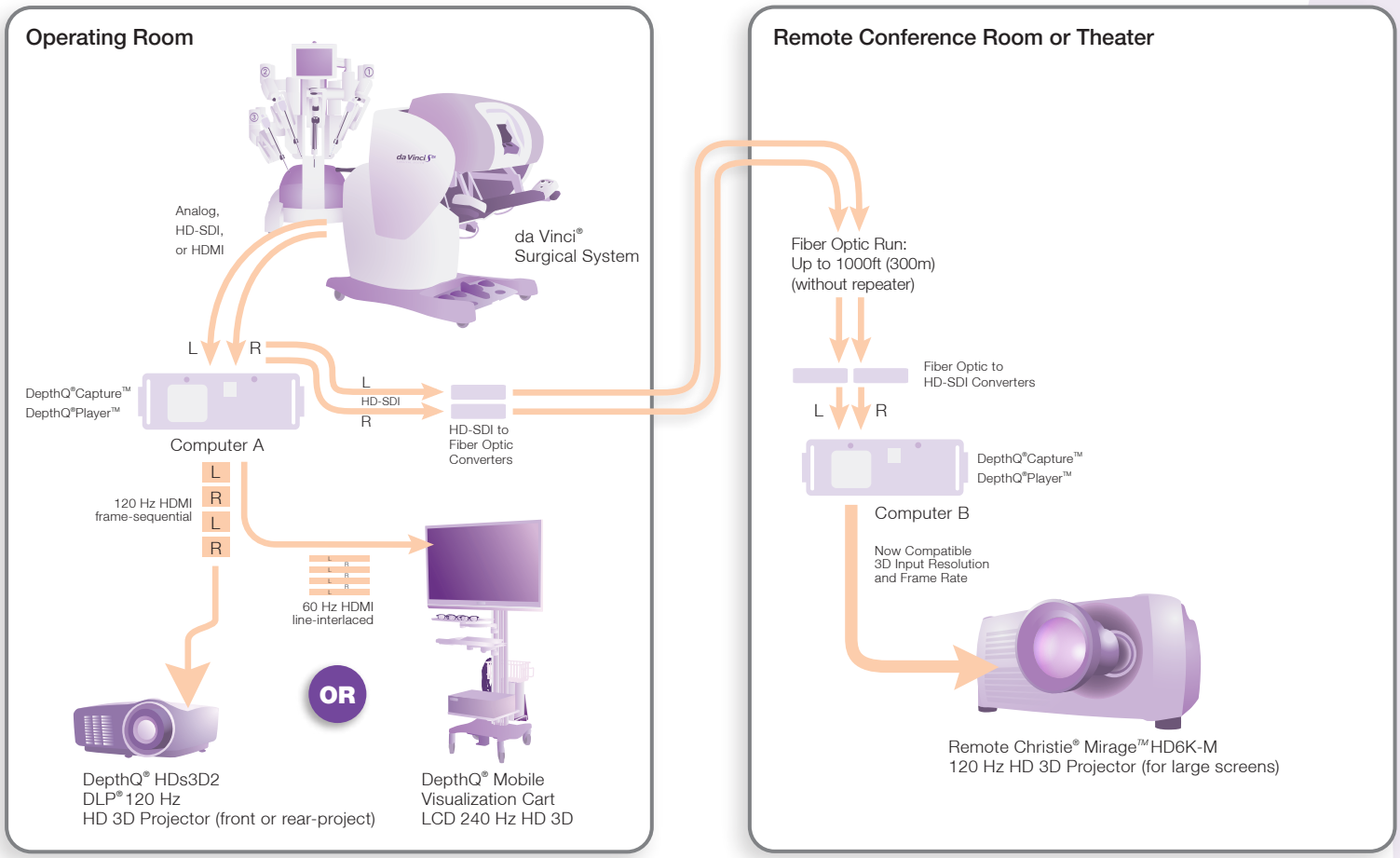
DepthQ® Mobile™ HD 3D Stereoscopic Visualization System Data Flow

DepthQ® High Definition Stereoscopic Visualization Systems for Robotic Surgery

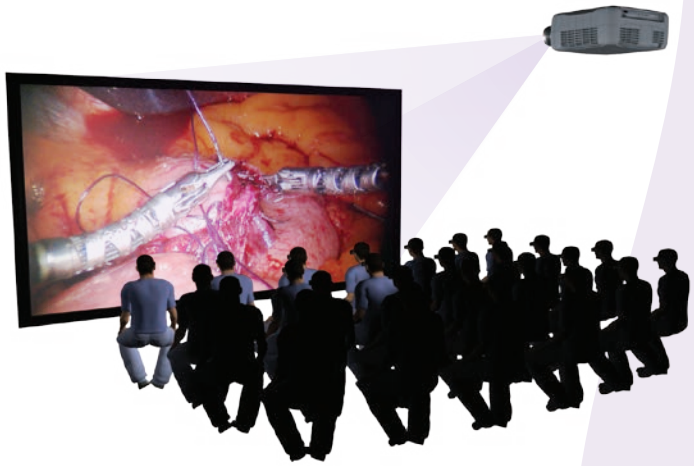
STEREOSCOPIC DATA FLOW

Data Flowchart C.

Baseline Patient-Side Assist + *Incompatible* 3D Format Remote Conference Room or Theater

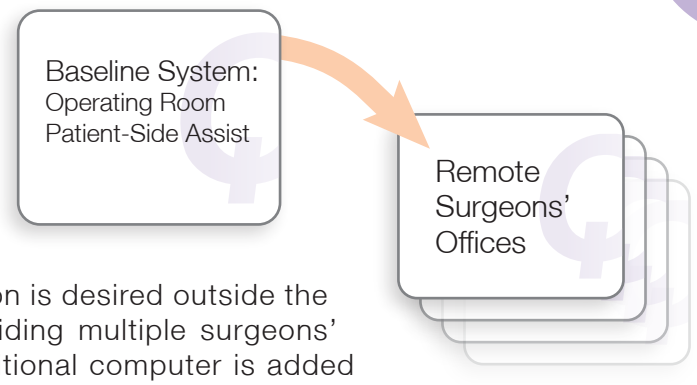


DepthQ® Mobile™ HD 3D Stereoscopic Visualization System Data Flow



DepthQ® High Definition Stereoscopic Visualization Systems for Robotic Surgery

ONGOING PRODUCT DEVELOPMENT - HD 3D IP Video Broadcasting

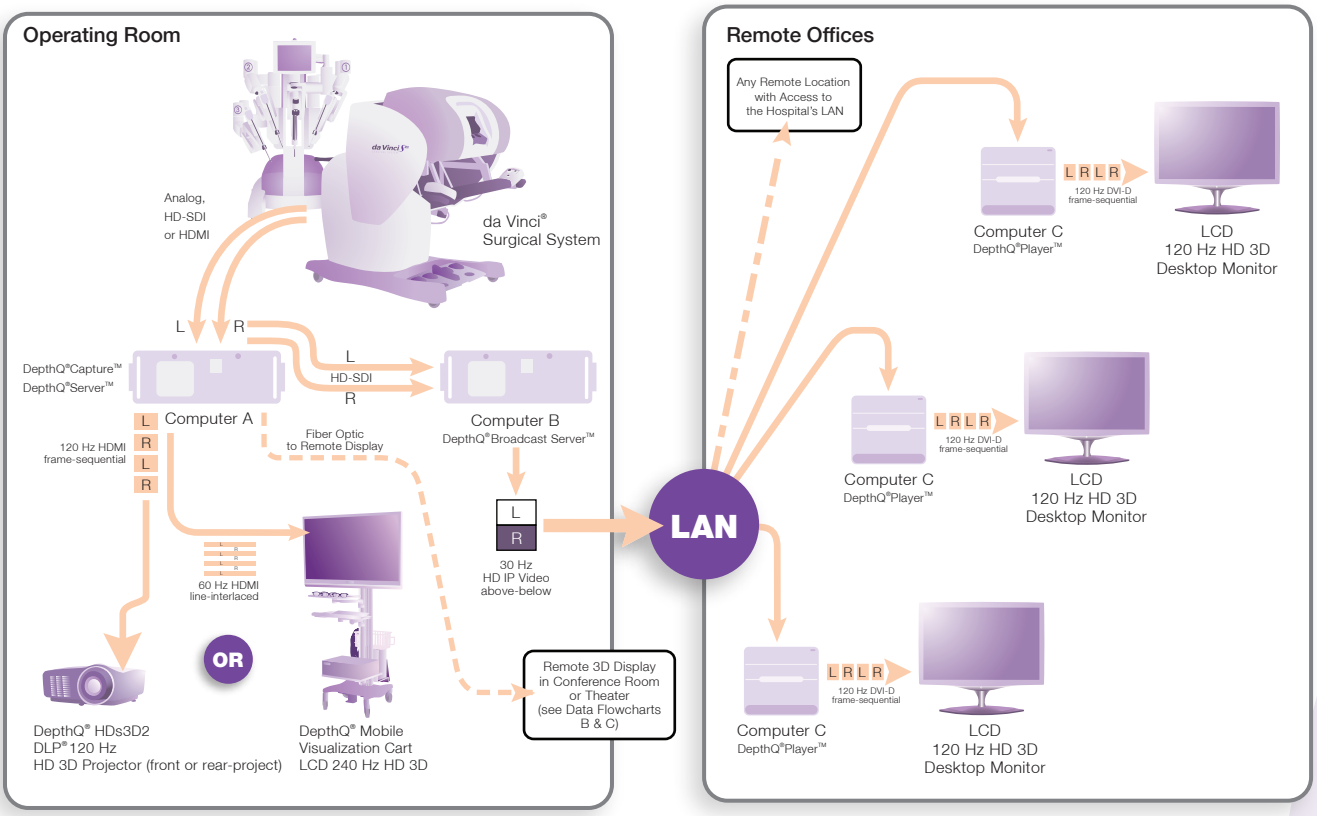


When simultaneous stereoscopic visualization is desired outside the OR, and in a *broad* capacity - such as providing multiple surgeons' offices with a live stereoscopic feed - an additional computer is added to the baseline system. This computer runs DepthQ® Broadcast Server™, an application in ongoing development which translates the OR output to a single concatenated above-below image at 30 frames per second, and serves this at varying bandwidths to the hospital's local area network (LAN) using standard video codec, transport stream, and Internet Protocol (IP) technologies. An additional desktop computer running DepthQ® Player™ then translates the streaming data to drive a personal 3D monitor anywhere that access to the network can be provided.

DepthQ® Broadcast Server™ is currently installed and running within the University of Minnesota's SimPORTAL program in Minneapolis, Mn., where it is being used for training and in support of two separate da Vinci® surgical systems.

Data Flowchart D.

Baseline Patient-Side Assist + HD 3D IP Video to LAN (does not preclude fiber to remote conf. room or theater)



DepthQ® Mobile™ HD 3D Stereoscopic Visualization System Data Flow

DepthQ® STEREOSCOPIC

High Definition Stereoscopic Visualization Systems for Robotic Surgery

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