Venturing with ST2110 into uncharted territories

How a technology carried out of the studio-centric environment is now going to help save lives.

VidTrans19, Philippe Lemonnier

b com

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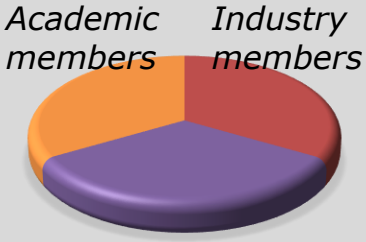
b<>com : who are we ?

1 of 8 such Institutes for Research & Technology in France

- Private, but bootstrapped by the french state in 2012
- Mission: Increase transfer from *Academic Research* to the *Industry*

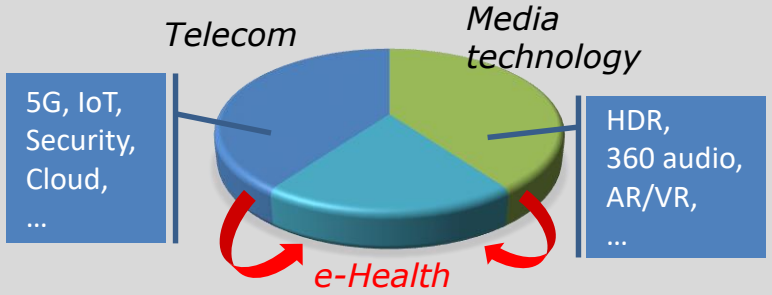


b<>com platforms + resident teams

300 people on 4 locations, ½ of which are member talents.

20 industry members

12 academic members



Key e-Health members & partnerships

INSTITUTE OF IMAGE-GUIDED SURGERY

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Video Interoperability in Operating Rooms

- The OR is core to the health business
  - 20% of hospital expenditures, 6% of health costs
  - 50 million procedures per year (U.S.)
- Important risks
  - 300,000 preventable severe adverse events / year (U.S.)
  - only ¼ of which are related to surgeon gesture
- Room for improvement
  - OR infrastructure mainly based on proprietary solutions
  - prohibitive purchase & operation costs
  - no shared resources among rooms

Uses of Real-Time Video in the OR

- Varied video sources (but not just visible light)
  - Endoscopy (gastroenterology, orthopedic surgery, Ear Nose & Throat)
  - Laparoscopy
  - Microscopy
  - Fluoroscopy / C-arm intraoperative imaging
  - Ultrasound
  - Angiography
  - Ophthalmology
  - General surgery: overhead camera
  - Dental surgery
  - Patient vitals displays

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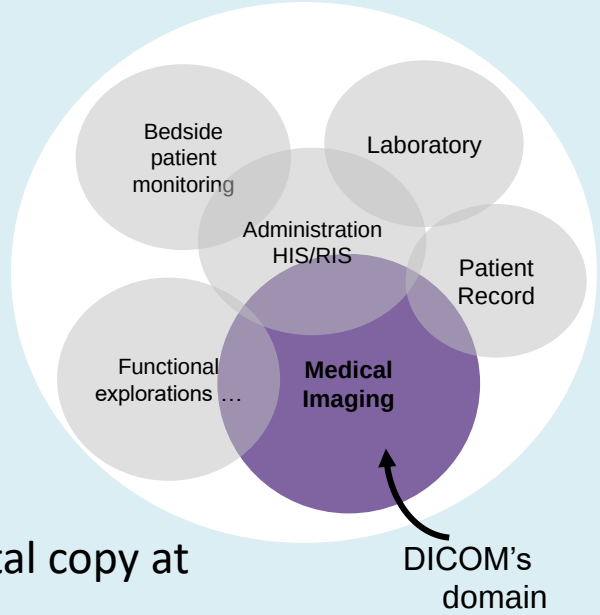
Standardization : a must for medical imaging

- Initially, communication between first CT scanners (1972, Dr. Hounsfield, EMI labs) and revue stations, printers…

- Streamline the exchange of images from acquisition to diagnostic or therapeutic usage, in a multi manufacturer environment.
- Harmonize the exchange of all kind of medical images (scanner, X-ray, ultrasounds, MRI, …., dermatology, endoscopy, surgery…)
- **Preserve <u>the context with the image</u>** (which patient, which operator, why, how) to avoid mistakes and make imaging useful
- Facilitate interfacing with the Electronic Health Record

Digital Imaging & COmmunications in Medicine

- Since 83, joint work between ACR[1] and NEMA[2]
  - ACR/NEMA V1.0 – 1985
  - ACR/NEMA V2.0 – 1988
  - Preliminary versions, rare implementations
- **DICOM 3.0 – 1993, now "DICOM"**
  - Constantly evolving since 1993
- Supplements & CP (Correction Proposals) integrated "yearly" in a global edition
- The standard is a set of 21 parts (>5,000 pages), free digital copy at http://dicomstandard.org.
  a.k.a *ISO standard 12052:2017 "Health informatics -- Digital imaging and communication in medicine (DICOM) including workflow and data management"*



1 : **A**merican **C**ollege of **R**adiology
2 : **N**ational **E**lectrical **M**anufacturers **A**ssociation

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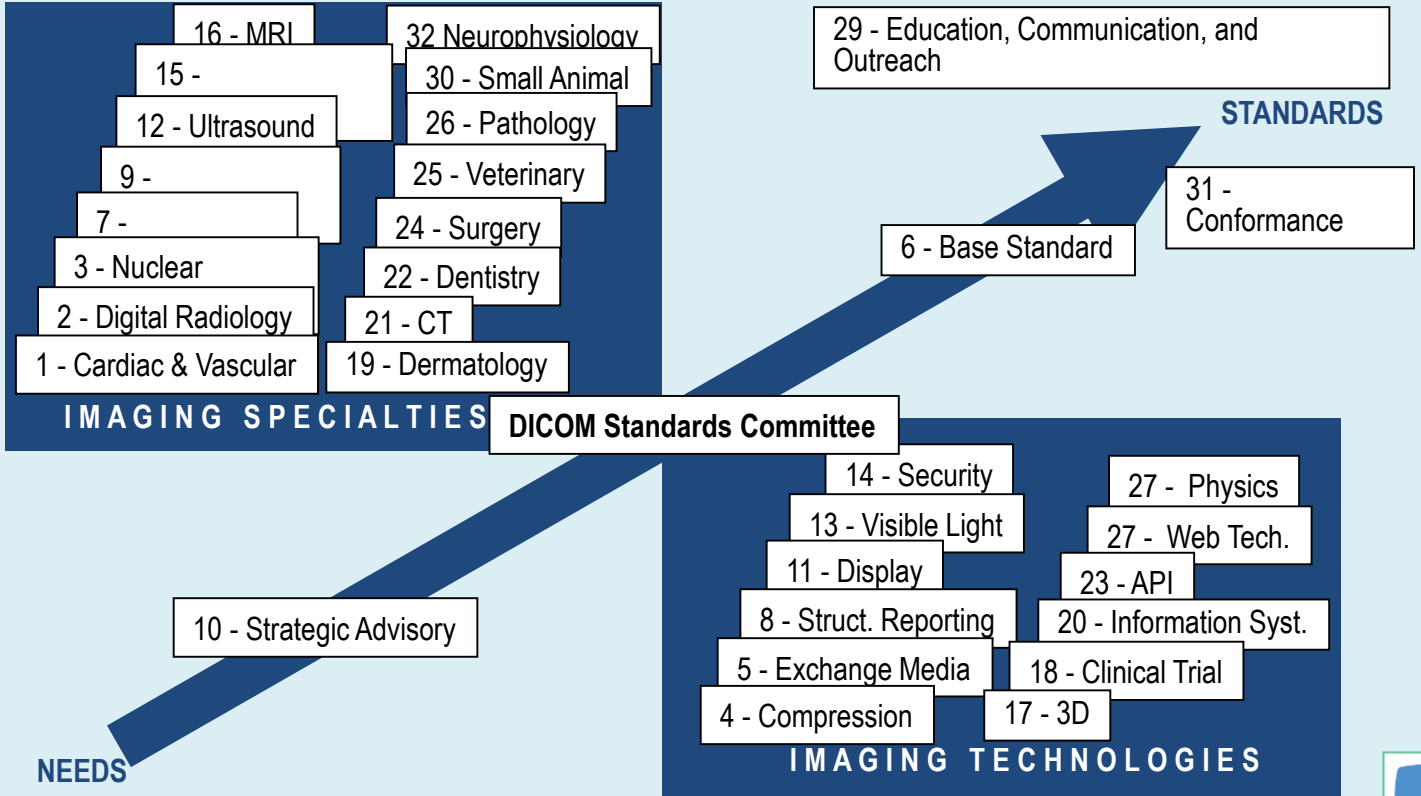
DICOM Organization



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DICOM Standards Committee Members

MANUFACTURERS (29)

- Accuray
- Agfa HealthCare
- Bayer Healthcare
- **b<>com**
- Brainlab
- Canon Medical Systems U.S.A
- Carestream Health
- Carl Zeiss Meditec
- Change Healthcare
- Corista
- Elekta
- Fujifilm Medical Systems U.S.A.
- GE Healthcare
- Hologic
- IBA
- Konica Minolta Medical Corporation
- Laitek
- Leica Biosystems
- Merge Healthcare
- Panasonic Healthcare
- Philips
- PixelMed
- Sectra Imtec AB
- Seno Medical Instruments
- Siemens Healthcare
- Sony
- SuperSonic Imagine
- Varian Medical Systems
- Visus

USERS (19)

- American Academy of Ophthalmology (AAO)
- American Academy of Oral and Maxillofacial Radiology (AAOMR)
- American Association of Orthodontists (AAO)
- American Association of Physicists in Medicine (AAPM)
- American College of Cardiology (ACC)
- American College of Radiology (ACR)
- American College of Veterinary Radiology (ACVR)
- American Dental Association (ADA)
- Brazilian College of Radiology (BCR)
- College of American Pathologists (CAP)
- Deutsche Ophthalmologische Gesellschaft (DOG)
- Deutsche Roentgengesellschaft
- European Federation of Organizations for Medical Physics (EFOMP)
- European Society of Cardiology (ESC)
- European Society of Radiology (ESR)
- Radiological Society of North America (RSNA)
- Medical Image Standards Association of Taiwan (MISAT)
- Society for Imaging Informatics in Medicine (SIIM)
- Spanish Health Informatics Society (SEIS)

GENERAL INTEREST (15)

- Brazil National Institute of Science & Technology for Digital Convergence
- Canada Health Infoway
- China Institute for Medical Imaging and Communication Standards (CIMICS)
- Chinese Center for Medical Device Standardization Administration (CFDA)
- FDA Center for Devices & Radiological Health
- India Centre for Development of Advanced Computing
- Japan Industries Association of Radiological Systems (JIRA)
- Japanese Association for Healthcare Information Systems (JAHIS)
- Japanese Society of Radiological Technology (JSRT)
- Logical Observation Identifiers Names and Codes (LOINC)
- Korean PACS Standards Committee
- Medical Imaging & Technology Alliance (MITA)
- National Cancer Institute (NCI)
- University of Arkansas for Medical Sciences
- Web3D Consortium

DICOM®
Digital Imaging and Communications in Medicine

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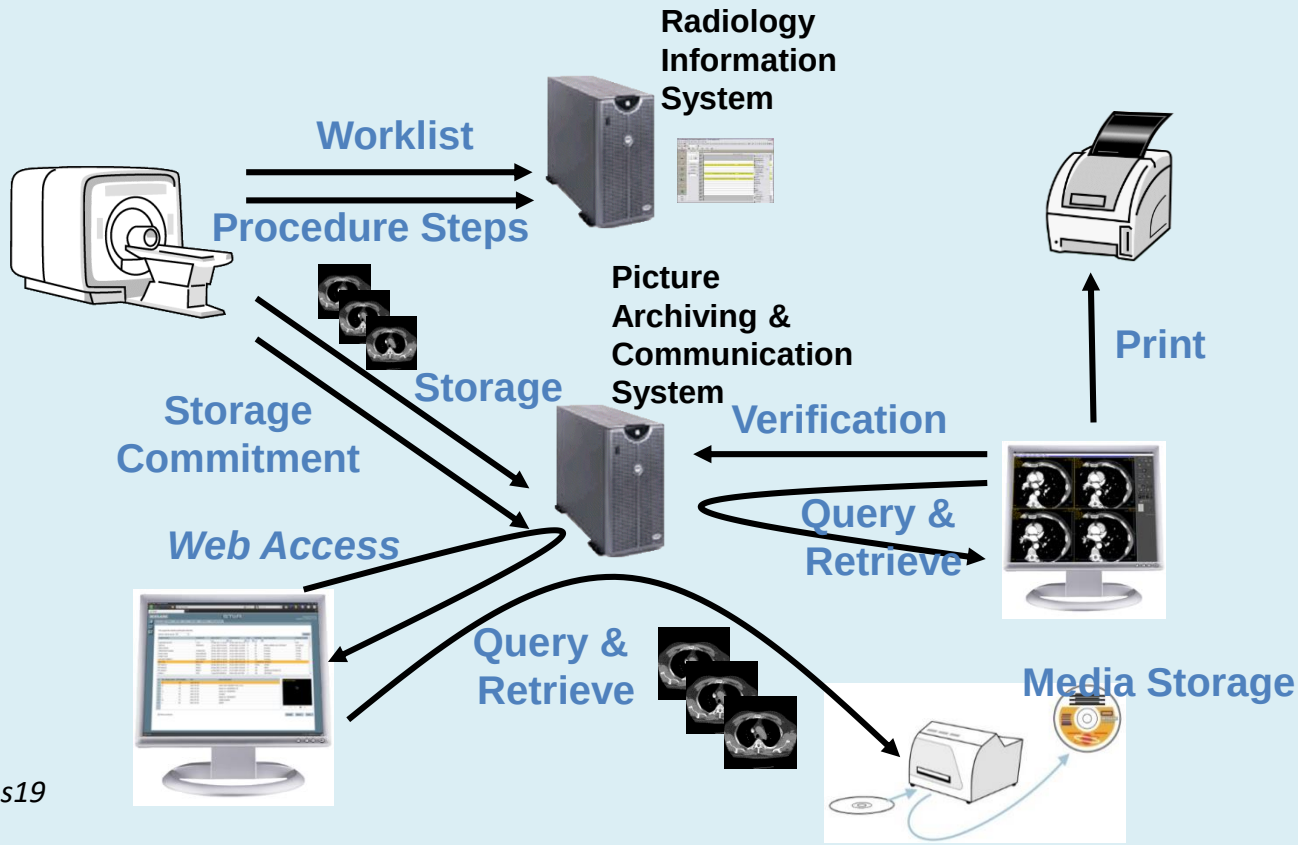
DICOM Services (*socket over TCP or Web*)



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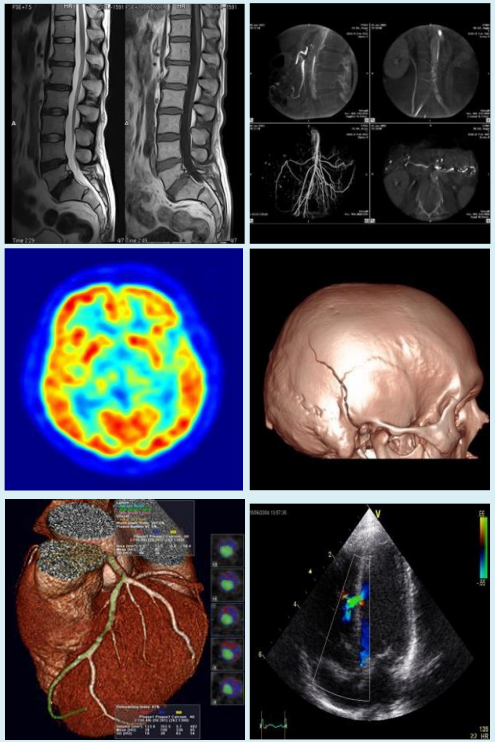
DICOM stores images…

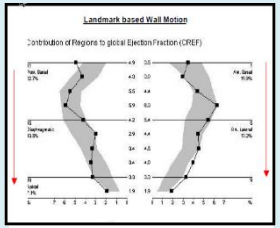
- … all kinds of images
  - CT, MR, X-Ray, Ultrasound, Angiography, Ophthalmology, Scanned Documents
  - Single & Multiframe; Volumes & Cines (sequences of frames); B&W & Color; Original & Processed
- DICOM helps manage Images
  - Not just pixels; Significant meta-data
  - **Patient identification** & demographics, the order, equipment, acquisition, workflow, …
  - PACS = database;



Other DICOM components

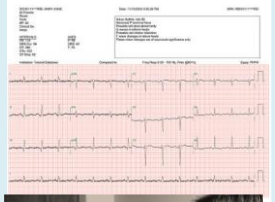
Store (Imaging) Data

fetal growth, cardiac output, tumor size, CAD findings, ECG Waveforms



Manage (Imaging) Workflow

Modality Worklists, Progress updates, Storage Commitment

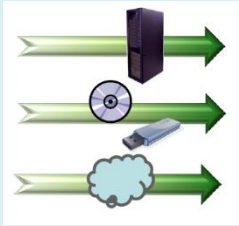


Display Images

Screen calibration, annotations, layouts, key image flagging

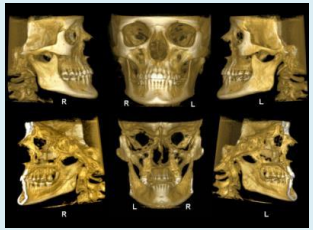
Distribute Images

Network push/pull, Media Transfer (CD, USB, Blu-ray…), Email Attachments, Web Protocols



Store Analysis Results

Registrations, Segmentations, Image Markup, 3D Print Models, …



Security

Audit Trails, De-identification Schemas, Encryption

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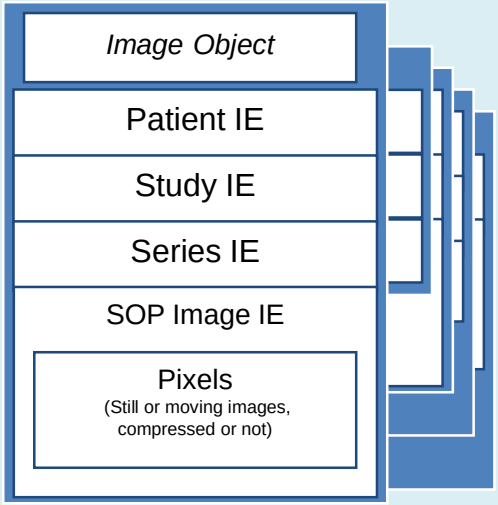
DICOM Models & Objects

Objects



IE: Information Entity

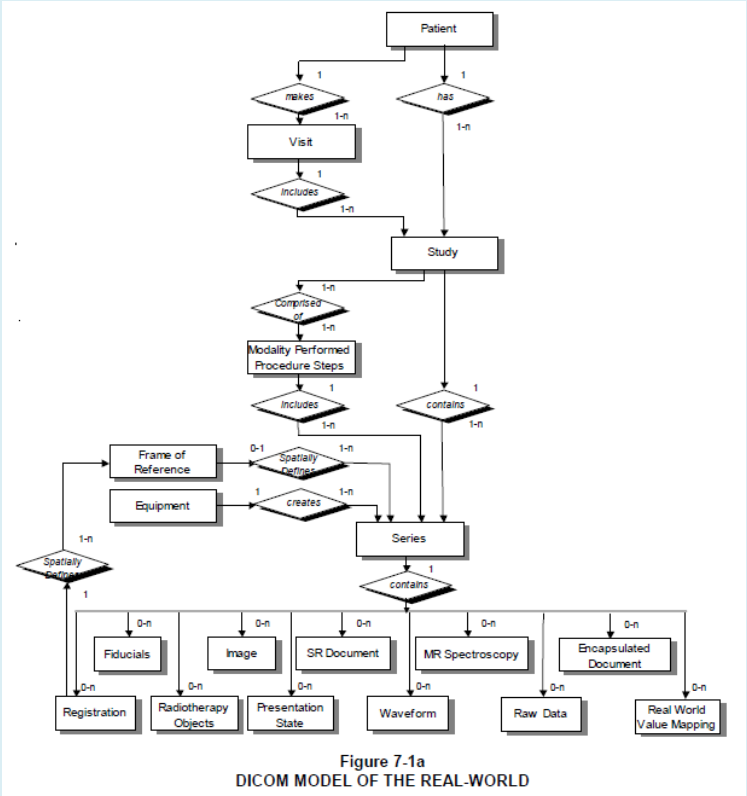


Figure 7-1a
DICOM MODEL OF THE REAL-WORLD

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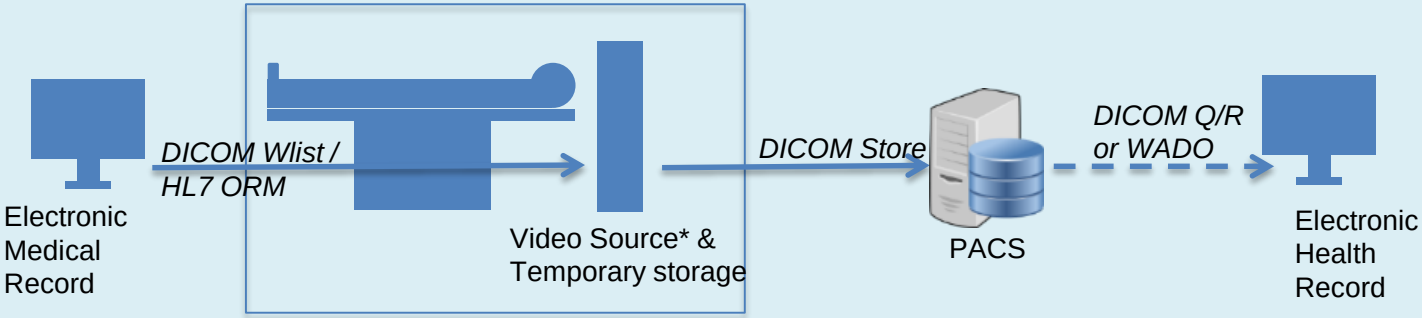
DICOM Video Storage today

For example, Operating Room to EHR via PACS

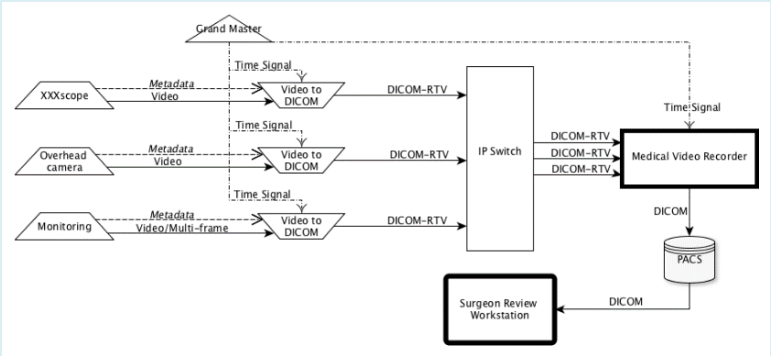
- Not real-time
- Patient information in metadata



*over head camera, endoscope, microscope …

Example #1 : Post-procedure Review

- Senior surgeon watches a recorded procedure
  - Reviews to understand what happened
  - Decides whether the procedure is a success or needs re-operation
- Requires quality recording of all video (endoscopy, monitors, …) and associated metadata
- Requires accurate time synchronization between channels



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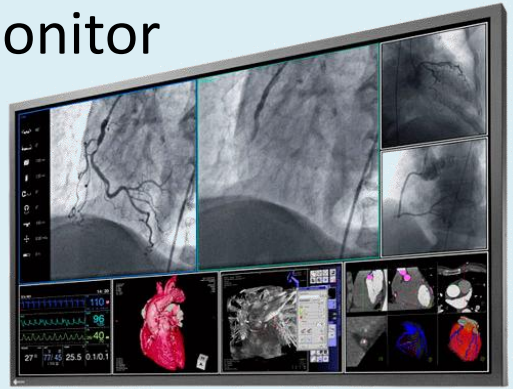
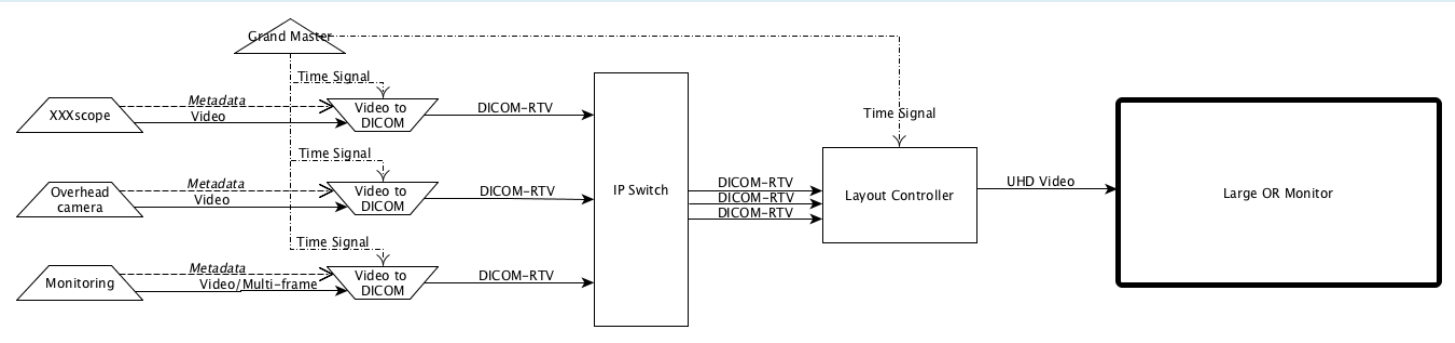
Example #2 : Automated OR Displays

- “Multi-displays” tile multiple videos on one monitor
- Tiling/Layout depends on the procedure step
- Need automated layout set-up
- Metadata drives layout automation





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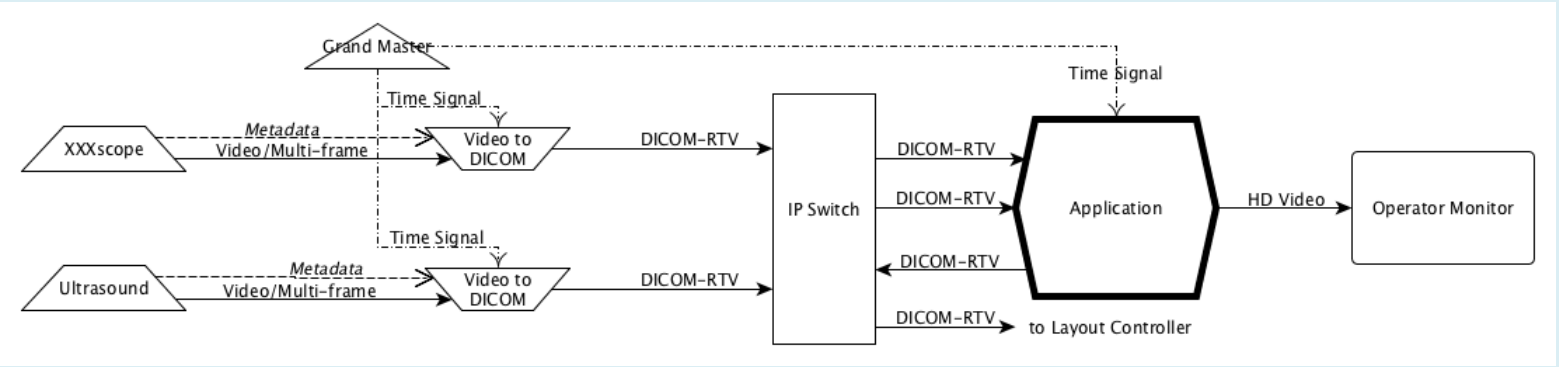
Example #3 : Augmented Reality

- Image-guidance improves interventional procedures
- Real-time display may be current feed(s), or combined with reference imaging (e.g., PET tumor location)
- Requires real-time video, metadata, and extremely good sync
- Minimizing latency improves safety and efficiency



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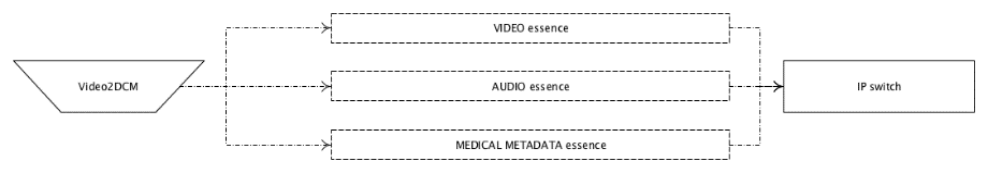
DICOM Real-Time Video in a nutshell

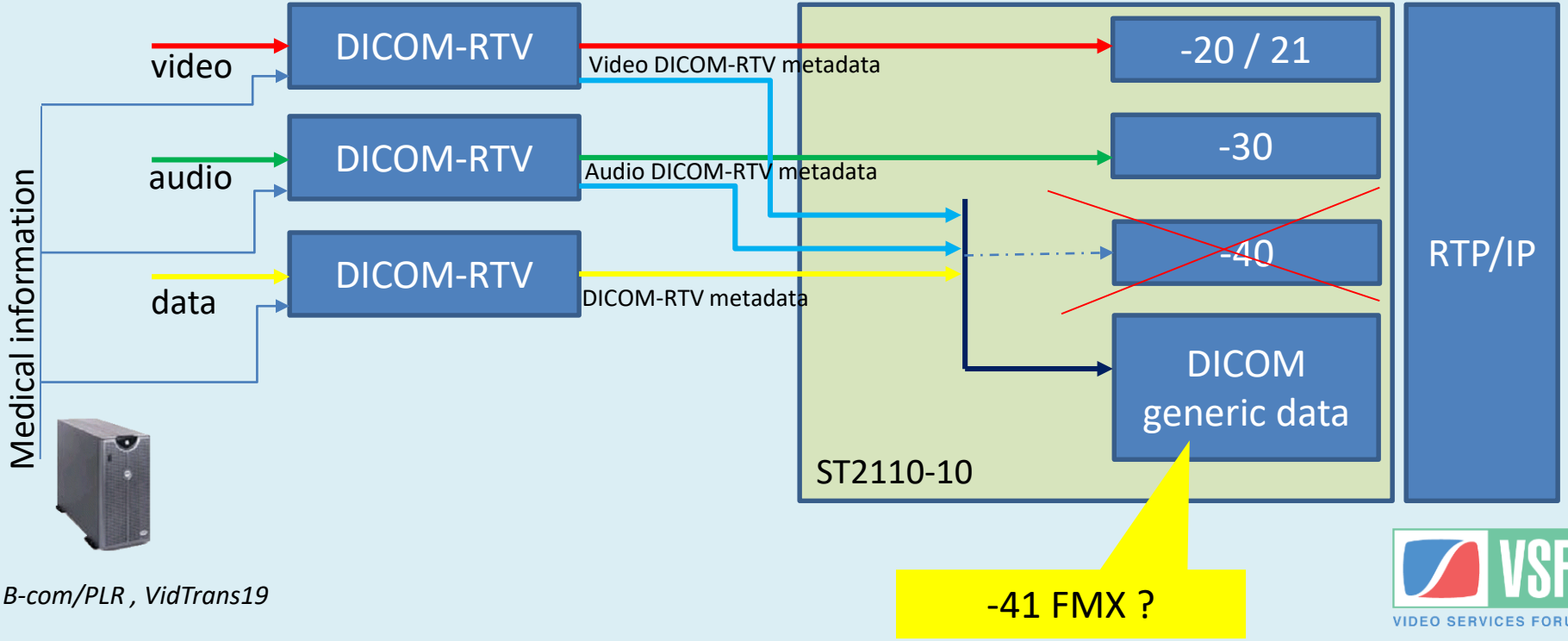
- b<>com started this activity in DICOM in 2016, educating the community on real time video technology, the TR03 principles and following up on 2110.
  DICOM Supplement 202: Real-Time Video work was started in early 2017, in DICOM Working Group 13 (Visible Light).
- DICOM-RTV data is comprised of video, audio and associated metadata essences, each transmitted as a multicast over an IP-based infrastructure



- All ST2110-10 system requirements apply (SDP object describing each essence flow, timing system, etc). NMOS header extensions are used.
- DICOM-RTV is in *letter ballot* now,
  should be merged to the base standard around mid 2019

DICOM-RTV & ST2110

ST2110 is considered a bearer service for DICOM-RTV



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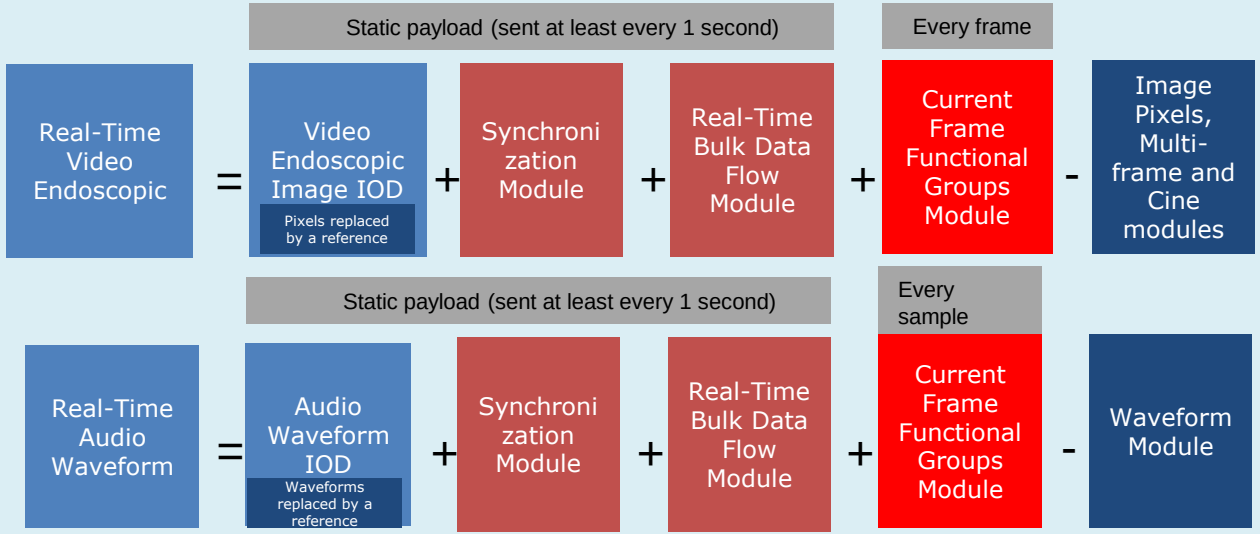
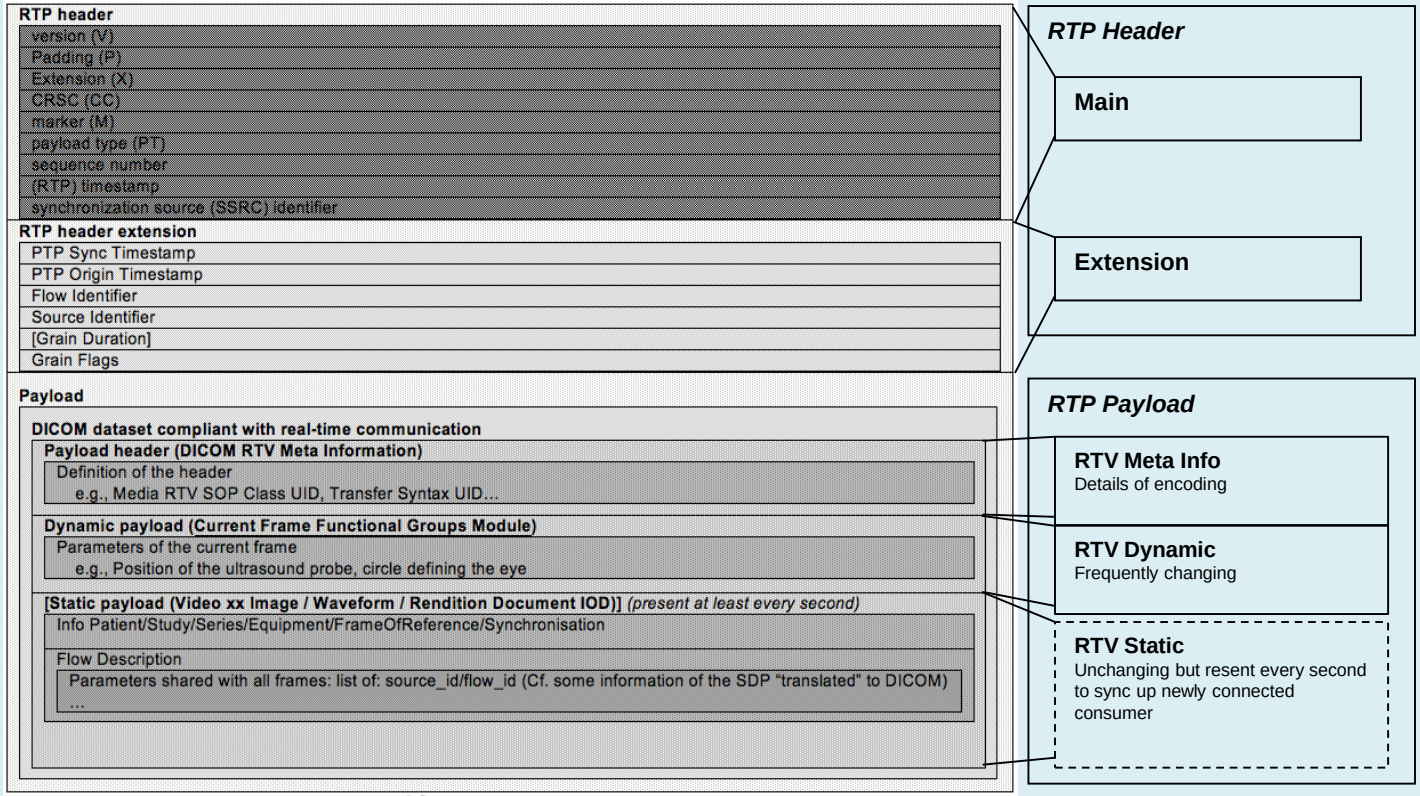
Metadata Flows

- Media Flows contain only Bulk Data (no metadata): regular ST2110 essence streams
- Metadata Flows reference the Media Flows but contain no media data
- Metadata Flows describe the Media Flows using (modified) modules from existing media Imaging Object Definitions (IODs)



DICOM Metadata Packet Structure



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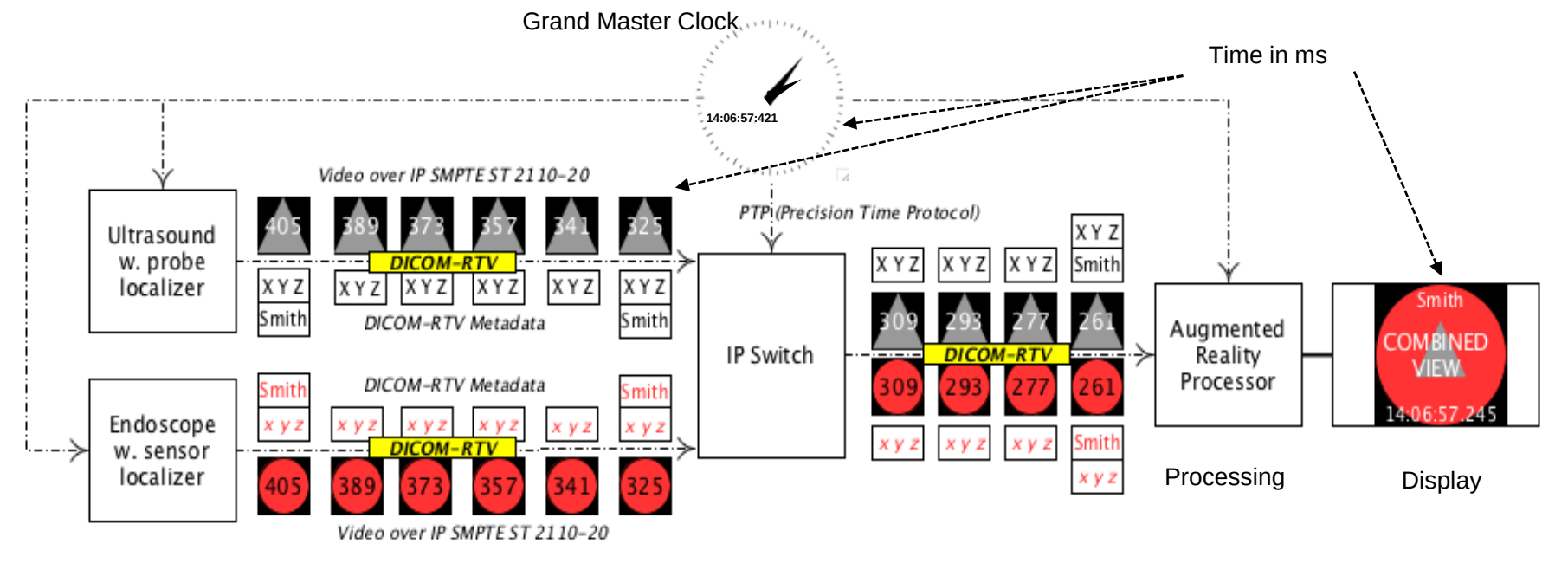
RTV Meta Information Header

Helps compliance with FMX Fast Metadata Payload Header

Attribute Name	Tag	Type	Attribute Description
Header Preamble	*No Tag or Length Fields*	1	A fixed 128 byte field available for Application Profile or implementation specified use. If not used by an Application Profile or a specific implementation, all bytes shall be set to 00H. Receivers shall not rely on the content of this Preamble to determine that this payload is or is not a DICOM payload.
DICOM Prefix	*No Tag or Length Fields*	1	Four bytes containing the character string "DICM". This Prefix is intended to be used to recognize that this payload is or is not a DICOM payload.
RTV Meta Information Group Length	(kkkk,ee01)	1	Number of bytes following this RTV Meta Element (end of the Value field) up to and including the last RTV Meta Element of the Group 2 RTV Meta Information
RTV Meta Information Version	(kkkk,ee02)	1	This is a two byte field where each bit identifies a version of this RTV Meta Information header. In version 1 the first byte value is 00H and the second byte value is 01H.
RTV Communication SOP Class UID	(kkkk,ee07)	1	Uniquely identifies the SOP Class associated with the Data Set. SOP Class UIDs allowed for RTV Communication are specified in section 7.2 STANDARD SOP CLASSES.
RTV Communication SOP Instance UID	(kkkk,ee08)	1	Uniquely identifies the SOP Instance associated with the Data Set placed in the RTP Payload and following the RTV Meta Information.
Transfer Syntax UID	(0002,0010)	1	Uniquely identifies the Transfer Syntax used to encode the referred bulk-data Flow. This Transfer Syntax does not apply to the RTV Metadata which is encoded using the Explicit VR Little Endian Transfer Syntax.
RTV Source Identifier	(kkkk,ee03)	1	The UUID of the RTP source that sends the RTV Metadata Flow.
RTV Flow Identifier	(kkkk,ee04)	1	The UUID of the RTV Metadata Flow.
RTP Sampling Rate	(kkkk,ee05)	1C	The rate of the dynamic part of the RTV Metadata Flow, the same as the bulk-data Flow rate. Required if RTV Metadata Flow includes a dynamic part.
RTV Flow Actual Frame Duration	(kkkk,ee06)	3	Duration of image capture in msec.
Private Information Creator UID	(0002,0100)	3	The UID of the creator of the private information (0002,0102).
Private Information	(0002,0102)	1C	Contains Private Information placed in the RTV Meta Information. The creator shall be identified in (0002,0100). Required if Private Information Creator UID (0002,0100) is present.

Summary: Example of Endoscopy/Ultrasound AR



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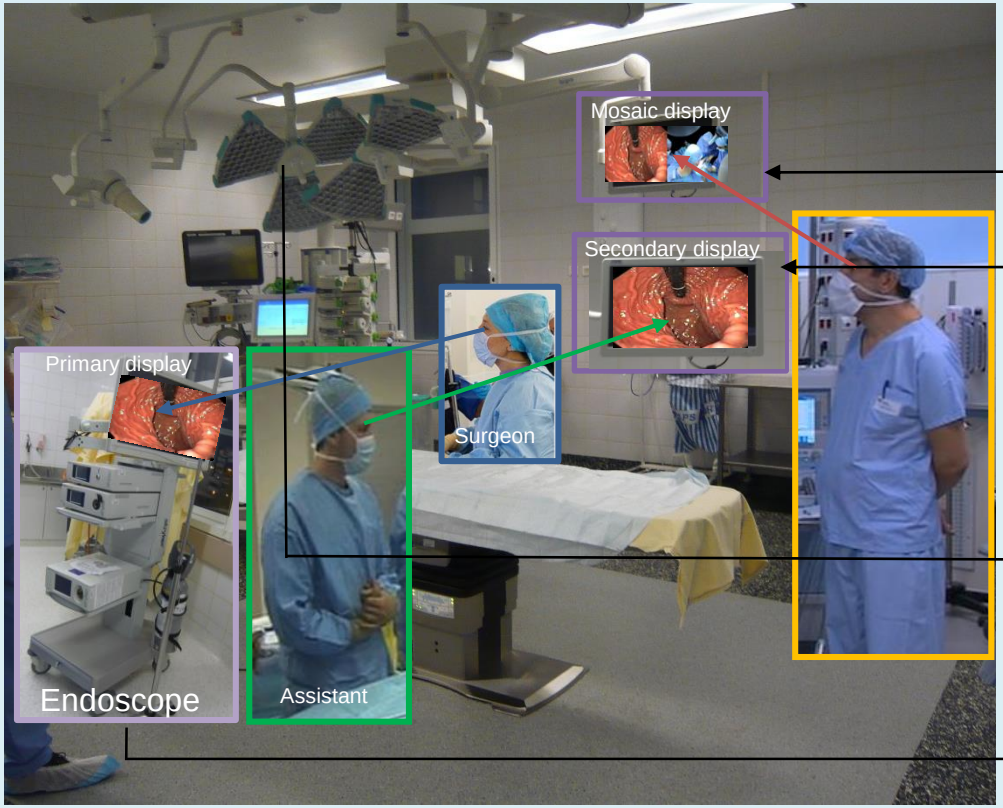
Now let’s go real …



Technical Room

Reference Clock

Video OUT

DICOM-RTV Configurator

DICOM-RTV Decoders

Video OUT

Ethernet Switch

Video IN

DICOM-RTV Encoders

Video IN

Operating Room Manager

Hospital Information System

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World premiere – January 16, 2019

Dr. Sébastien Vincendeau has been conducting a series of Photoselective Vaporization of the Prostate (PVP) surgery procedures using an imaging setup based on DICOM-RTV.

B-com/PLR , VidTrans19 https://b-com.com/en/news/world-first-achievement-bcom-and-rennes-university-hospital

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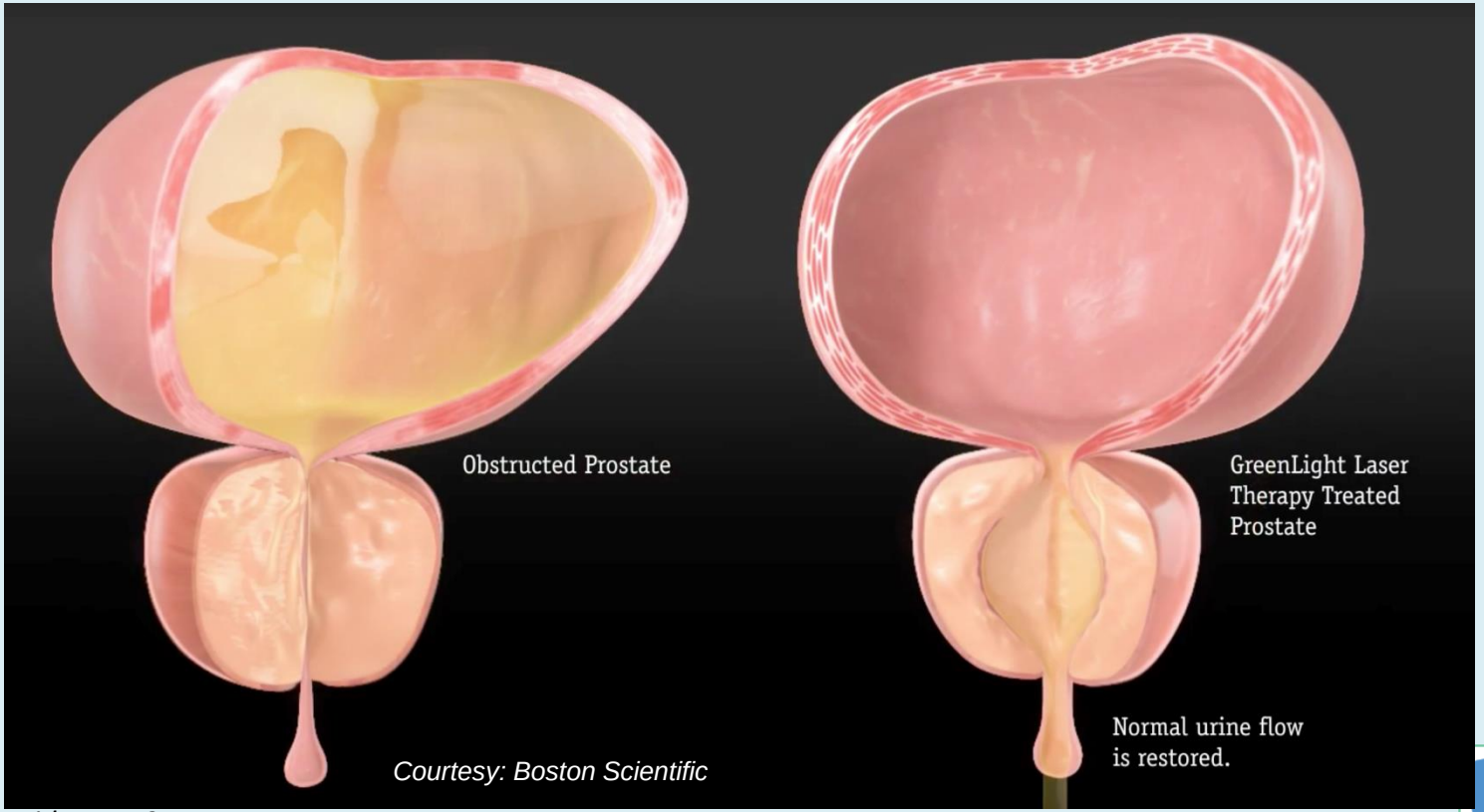
Objective: Restore urine path in the prostate



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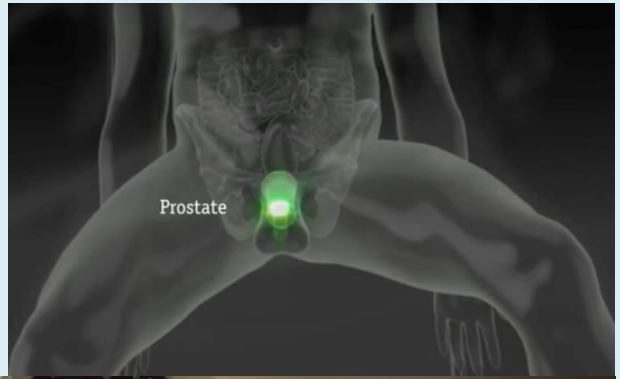
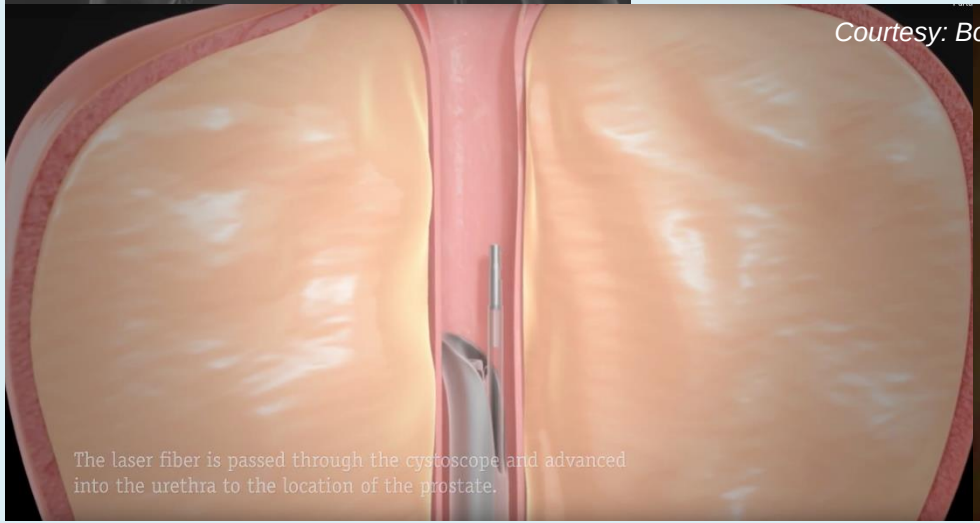
Photoselective Vaporization of the Prostate (PVP)



Courtesy: Boston Scientific



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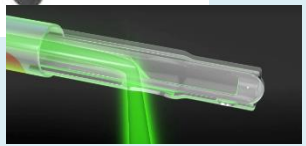
Equipment: Trans-rectal Ultrasounds, Flexible Endoscope and Laser



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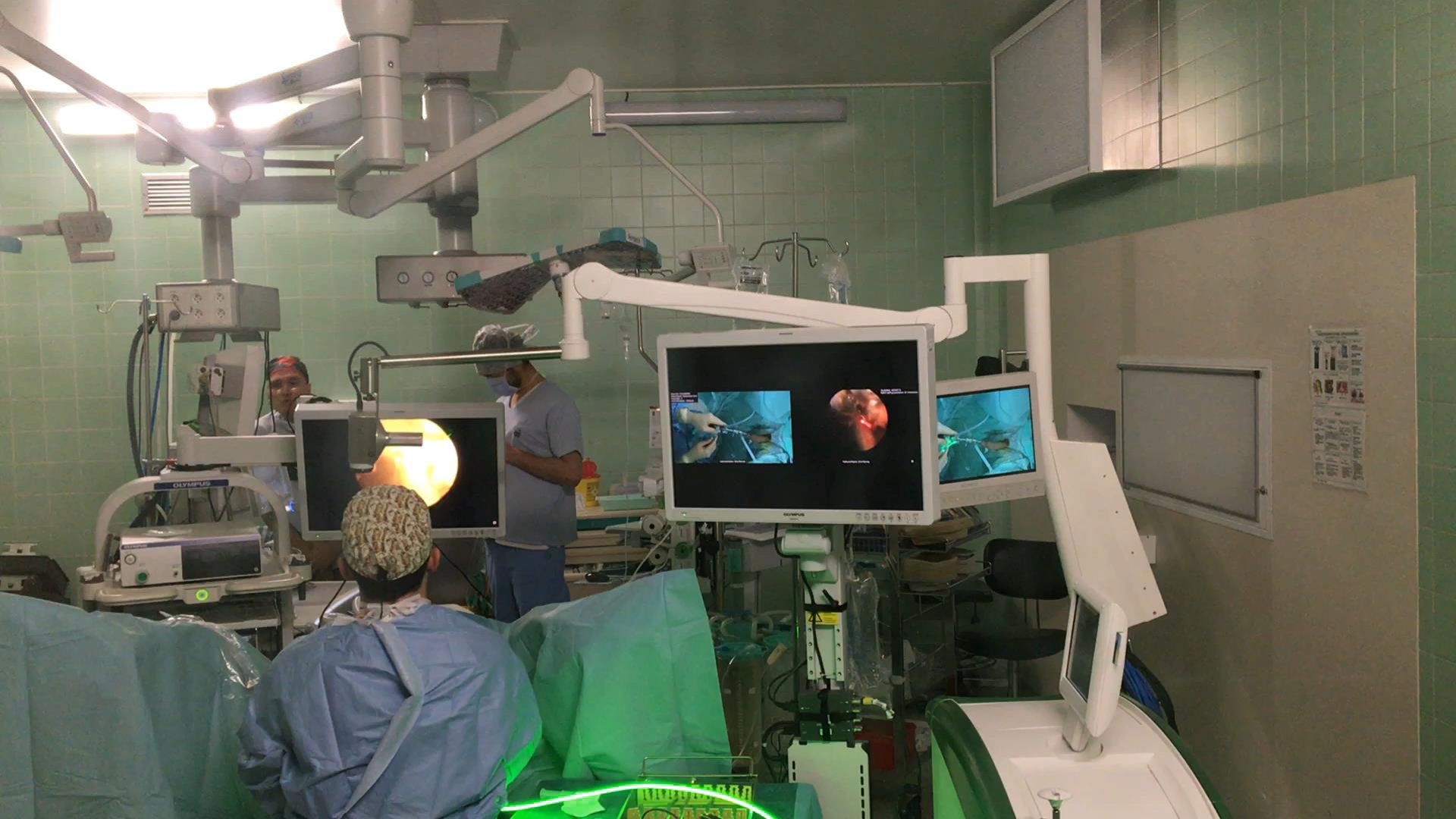
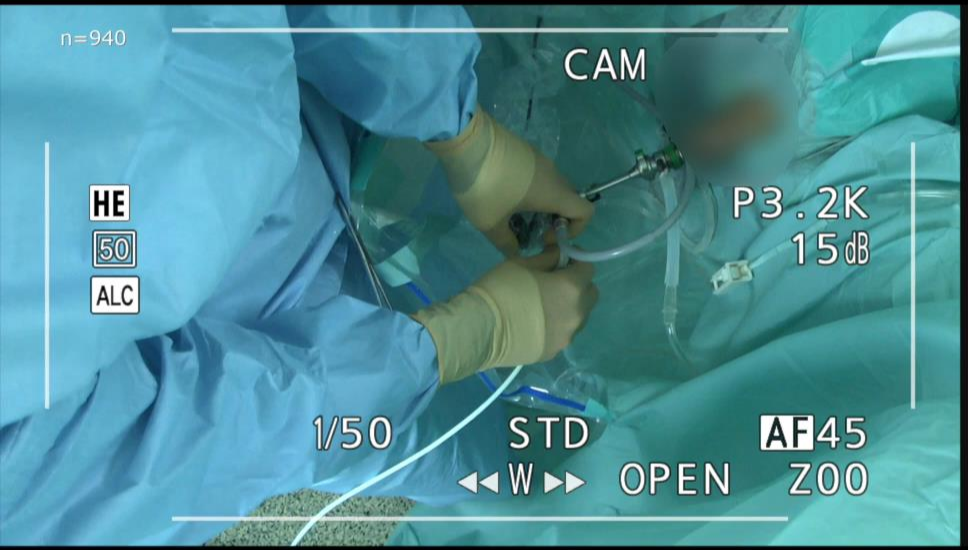
Video sequences

1. Operating room view

2. Overhead + Endoscope


OLYMPUS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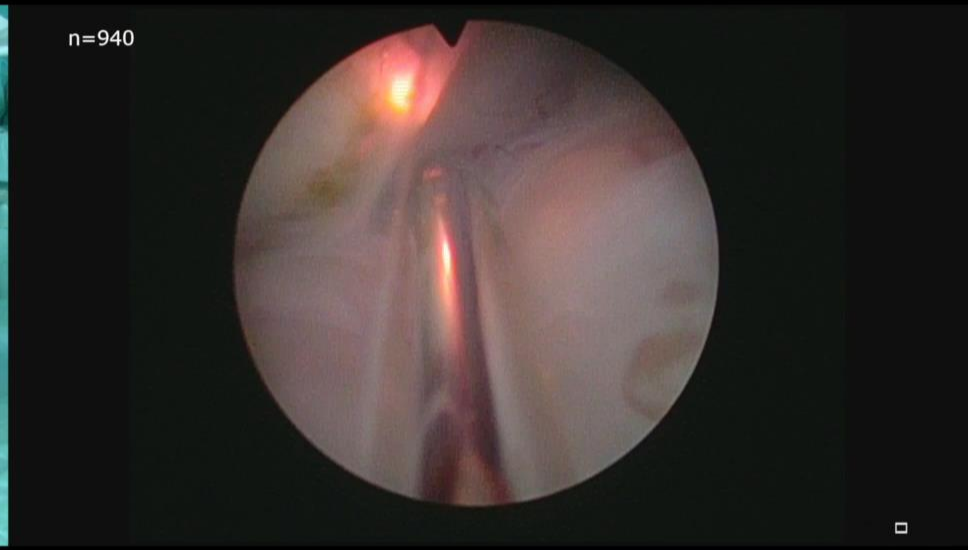
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Thank you for your attention!

Philippe Lemonnier – Engineering director – philippe.lemonnier@b-com.com

Some material included in this presentation was kindly provided
by Emmanuel Cordonnier – director, e-Health -- emmanuel.cordonnier@b-com.com

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