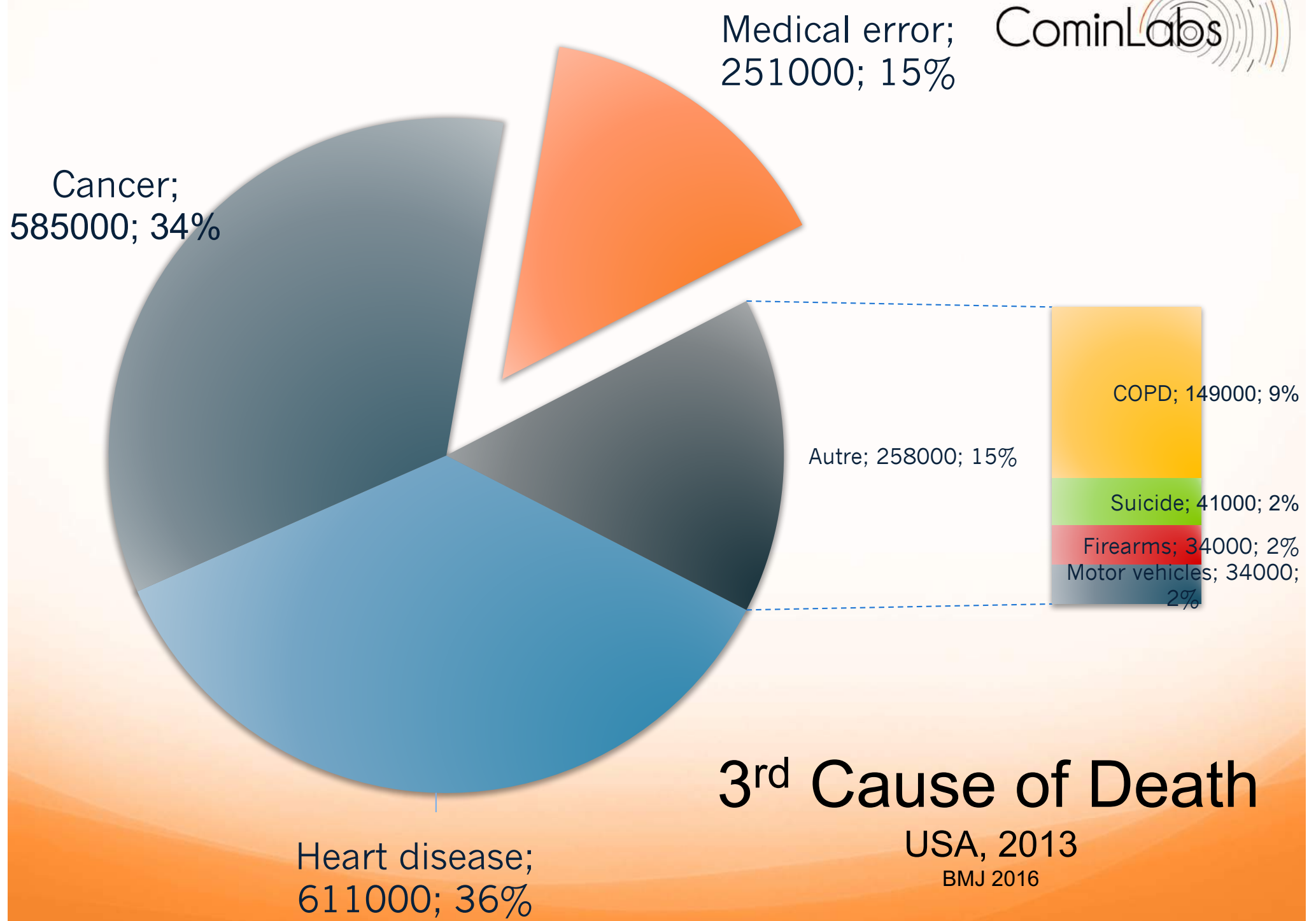


S3PM

Synthesis and Simulation of Surgical Process Models

May 2013- April 2017

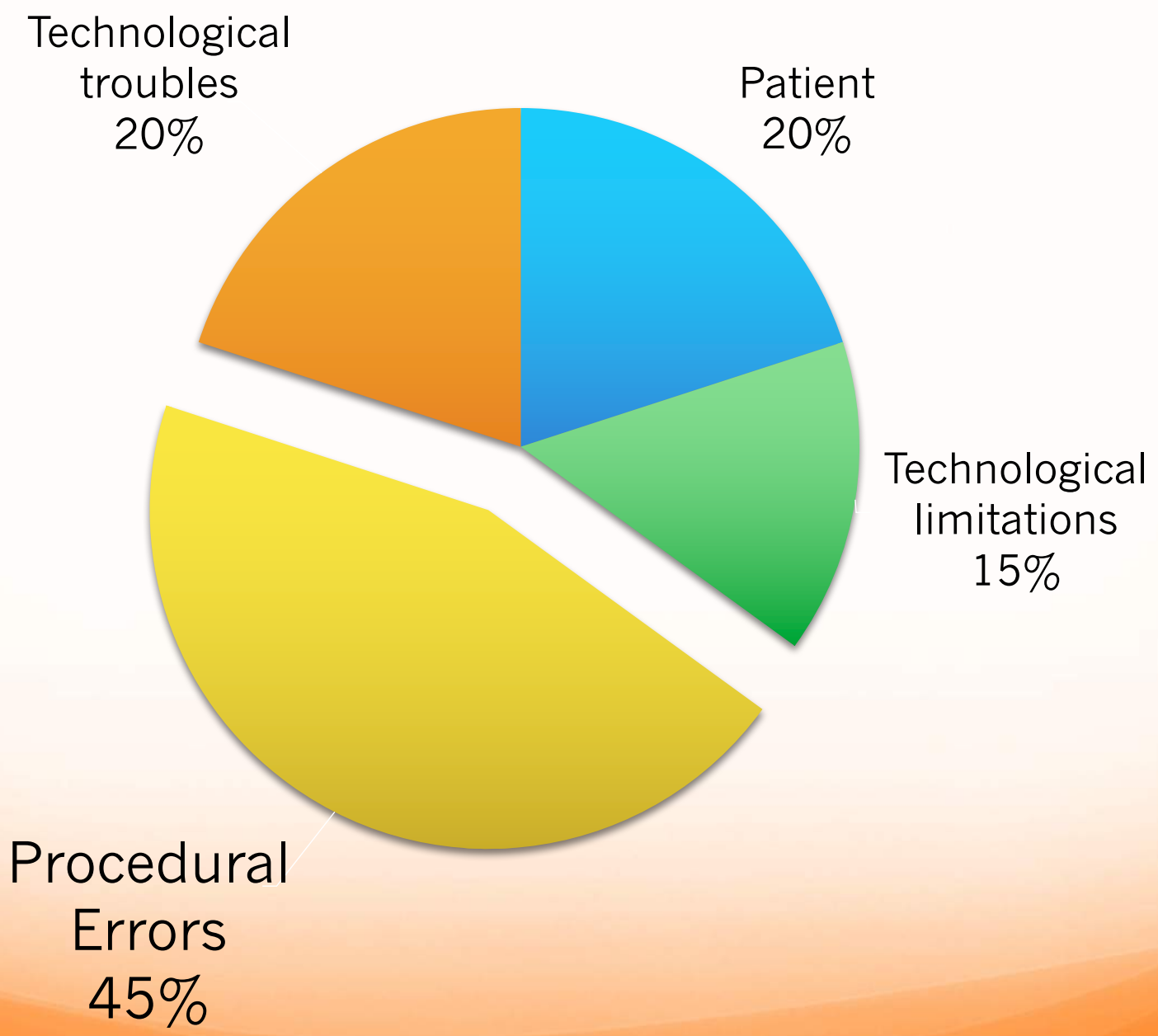




3rd Cause of Death

USA, 2013

BMJ 2016



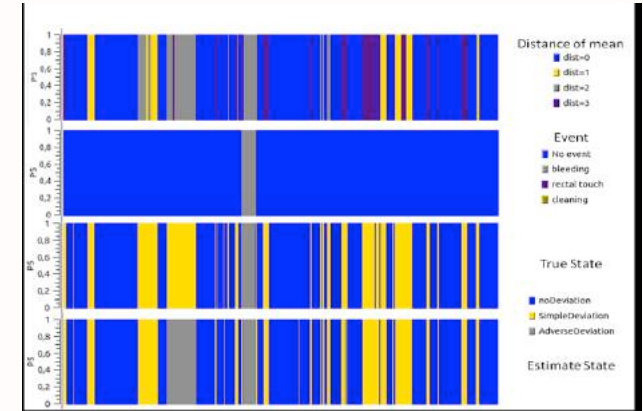
Assistance



OR Management Optimization



Automation



Traceability - Surgical QC

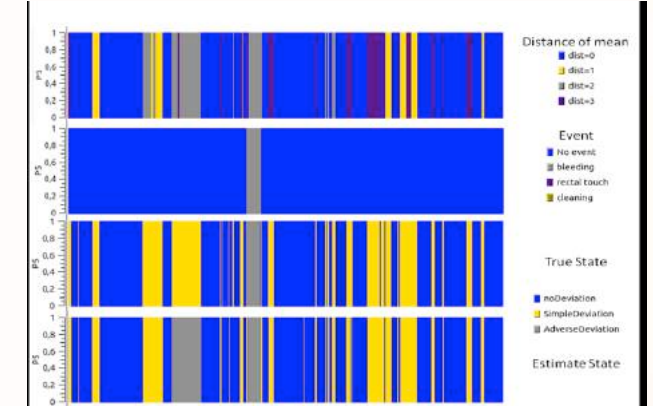
Assistance



OR Management Optimization

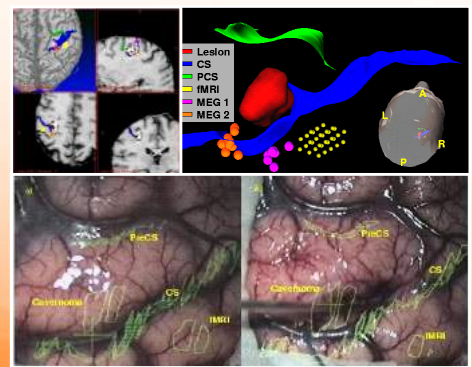


Automation



Traceability - Surgical QC

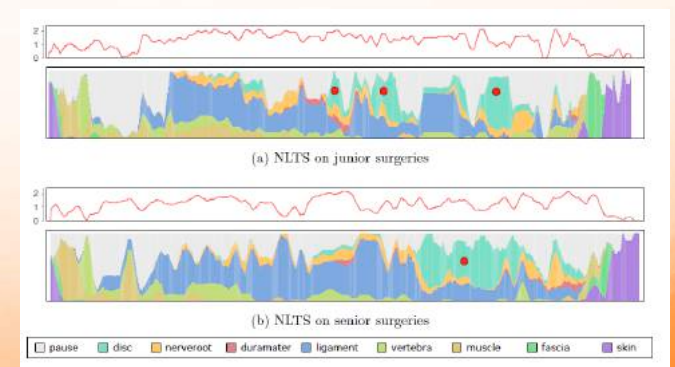
Training/Evaluation



Ergonomics



Learning



Assessment

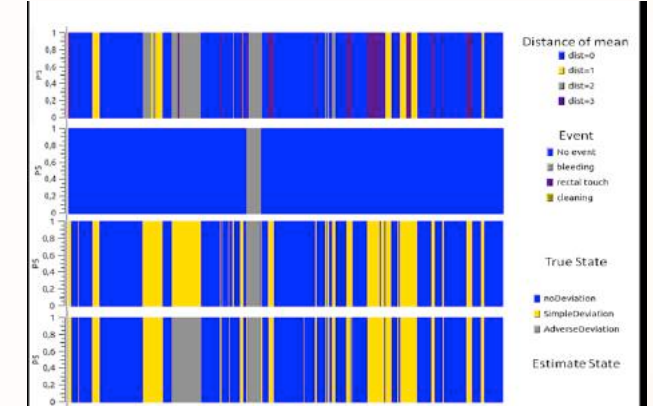
Assistance



OR Management Optimization

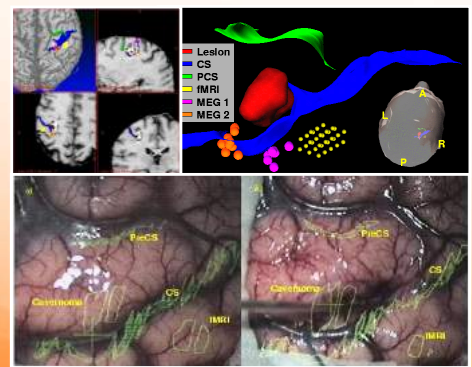


Automation



Traceability - Surgical QC

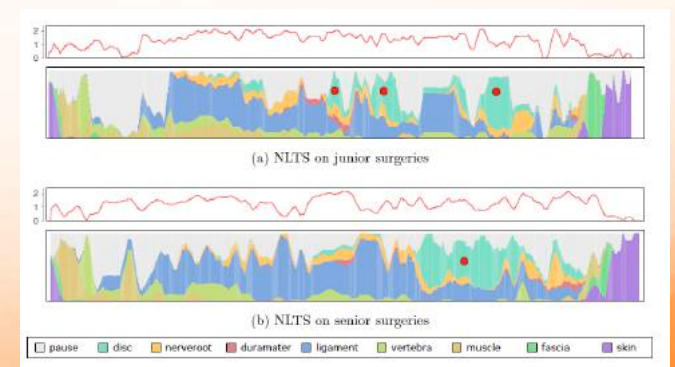
Training/Evaluation



Ergonomics



Learning

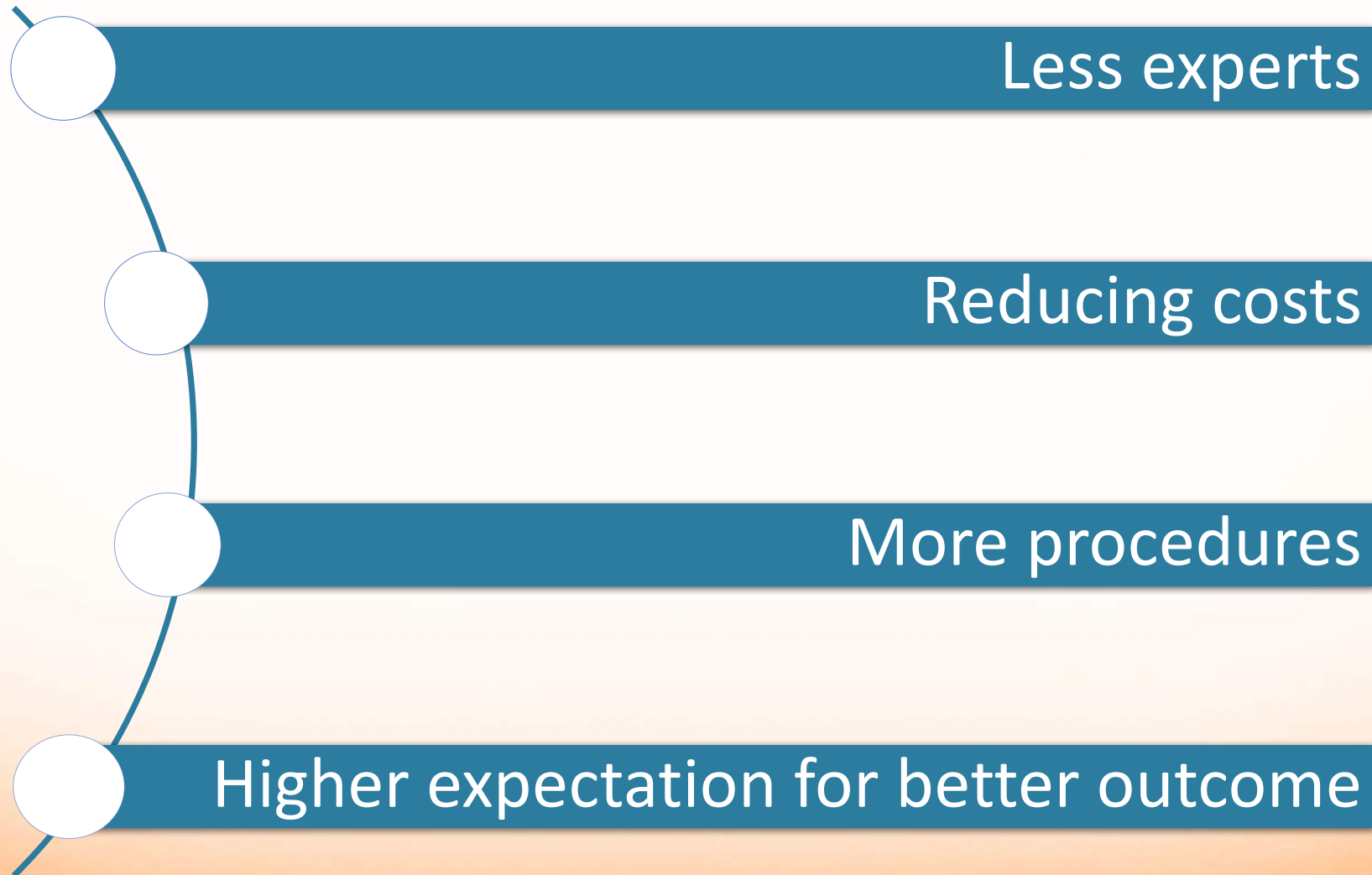


Assessment









Technical Skills

Non-Technical Skills

Motor Skills
/Dexterity

Conceptual
Knowledge

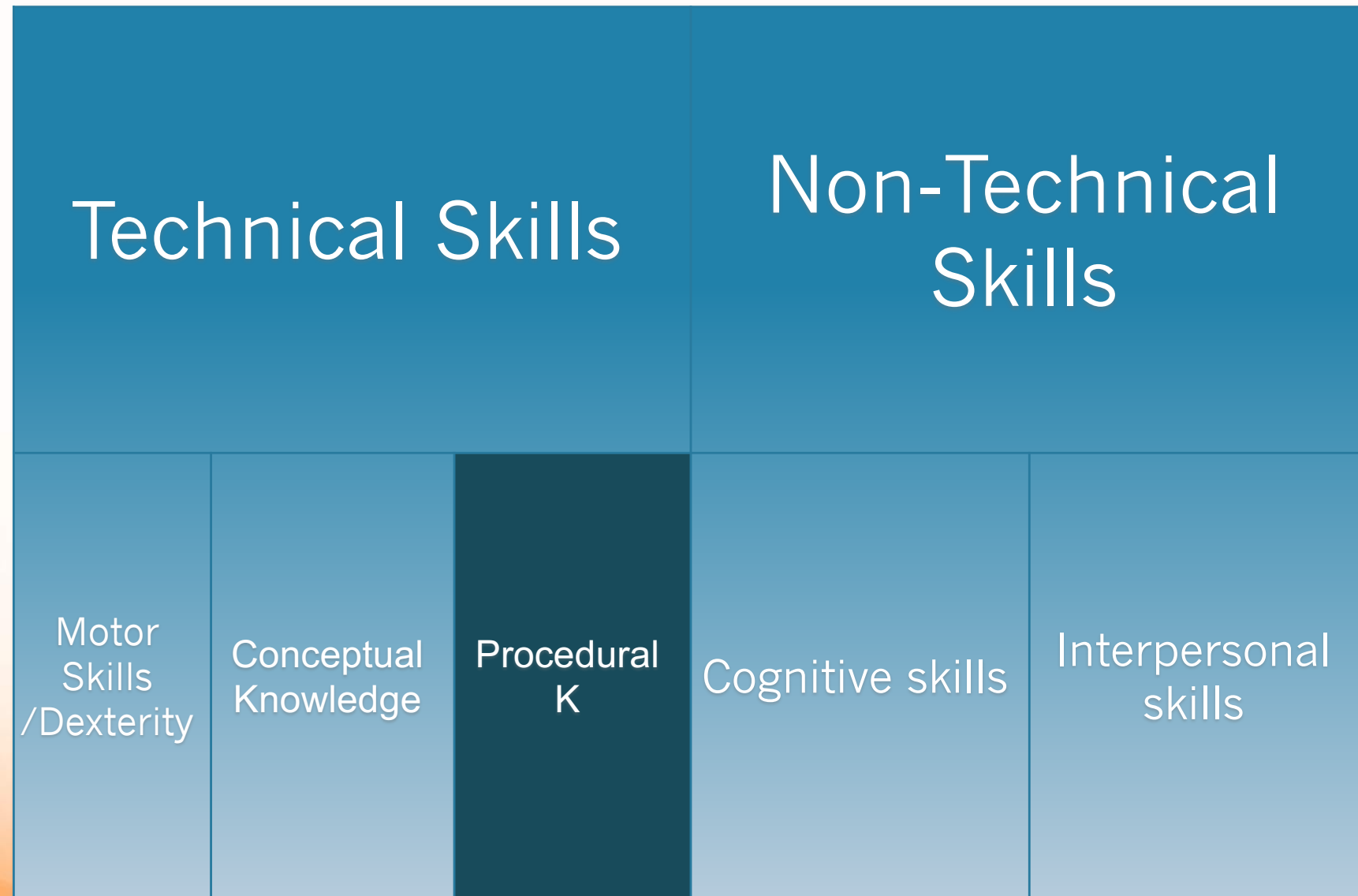
Procedural
K

Cognitive skills

Interpersonal
skills

Alderson, D., Developing expertise in surgery. Medical Teacher, 2011

Yule, S., et al., Non-technical skills for surgeons in the operating room: a review of the literature. Surgery, 2006





- Challenges
 - Complexity
 - Variability
 - Human factors



- S3PM Methodology
 1. Models
 2. Abstraction
 3. Synthesis
 4. Acceptability

S3PM Partners



- Permanents:

- Pierre Jannin
- Bernard Gibaud
- Valérie Gouranton
- Bruno Arnaldi
- Benoit Caillaud
- Pierre-Louis Henaux

- Recruited:

- Cédric Pénét
- Javier Rojas Balderrama
- Guillaume Claude

- External collaborators:

- University Hospital Rennes
 - Bénédicte Nogues
 - Emmanuelle Mondin



S3PM

Methods

Models:

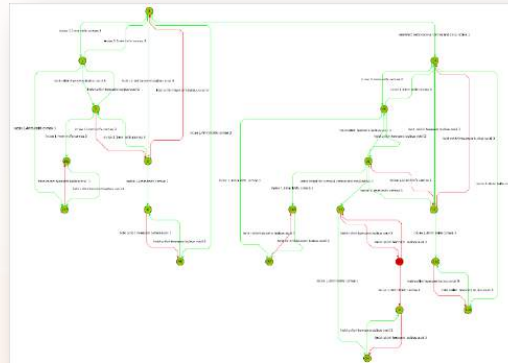
Acquisition of data as Surgical Process Model

Abstraction:

Derivation of Generic Surgical Process Model (gSPM)

Synthesis:

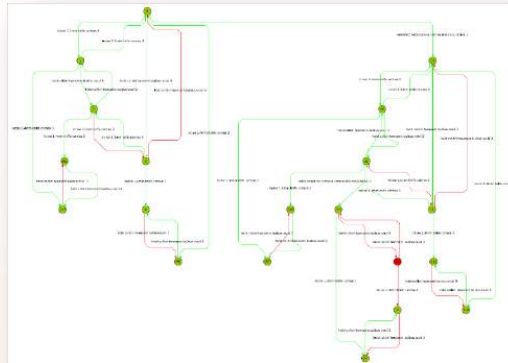
Integration of gSPM in a Collaborative Virtual Environment for Training

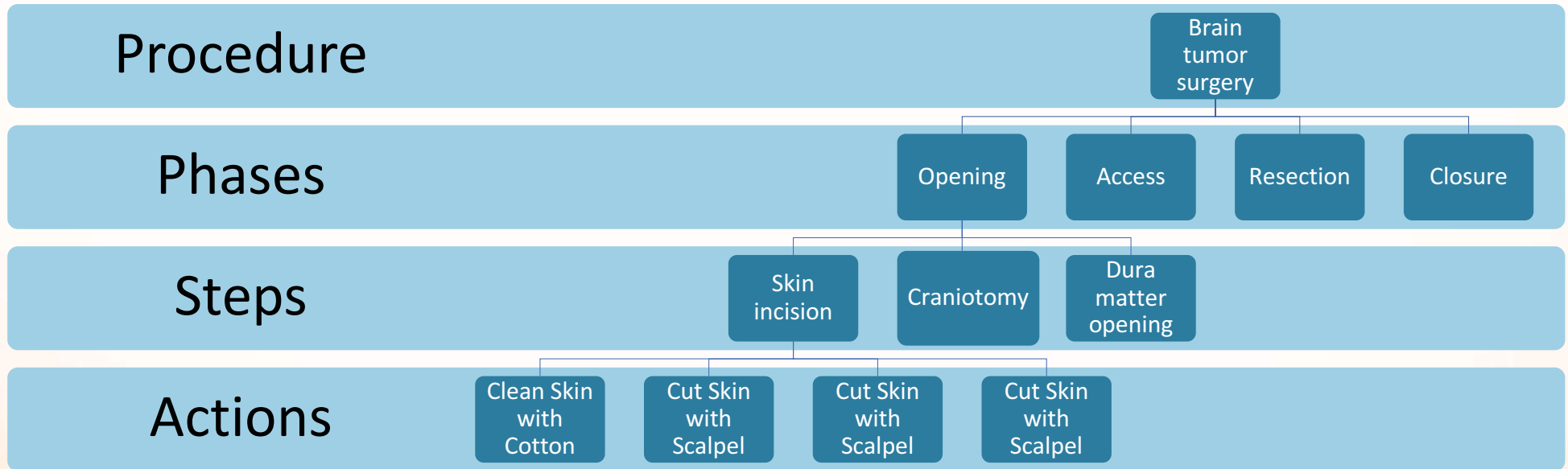


Models:
Acquisition of data as Surgical Process Model

Abstraction:
Derivation of Generic Surgical Process Model (gSPM)

Synthesis:
Integration of gSPM in a Collaborative Virtual Environment for Training





OntoSPM Ontology

- ▼ ● **action**
 - ▼ ● **human-action**
 - ▶ ● **human-interaction**
 - ▶ ● **language-act**
 - ▶ ● **observation-by-human**
 - ▼ ● **physical-action-by-human**
 - ▼ ● **action-affecting-physical-object**
 - **cleaning-an-object**
 - **coagulating-a-bleeding-tissue**
 - ▶ ● **cutting-an-object**
 - ▶ ● **fixing-an-object**
 - ▶ ● **giving-an-object**
 - ▶ ● **grabbing-an-object**
 - ▶ ● **holding-an-object**
 - ▶ ● **holding-out-an-object**
 - ▶ ● **injecting-a-substance**
 - ▶ ● **moving-an-object**
 - ▶ ● **receiving-an-object**
 - ▶ ● **removing-an-object**
 - ▶ ● **sucking-an-object**
 - ▶ ● **suturing-an-object**
 - ▼ ● **medical-device-action**
 - **data-processing-action**
- **surgical-procedure-stage**
 - **installing-the-patient**
 - **performing-surgery**
 - **post-operative-cleaning-of-the-patient**
 - **provisioning-anesthesia**
 - **releasing-the-patient-from-the-surgical-room**
 - **sterilizing-the-patient**
 - **welcoming-the-patient-in-the-surgical-room**
- ▼ ● **role**
 - ▼ ● **affected-physical-object**
 - **injected-substance**
 - **injection-site**
 - ▼ ● **human-actor**
 - ▼ ● **healthcare-professional**
 - **anaesthesiologist**
 - **assistant**
 - ▼ ● **nurse**
 - **anesthesia-nurse**
 - **circulating-nurse**
 - **scrub-nurse**
 - **surgeon**
 - ▶ ● **interaction-role**
 - ▶ ● **patient**
 - **human-effector**
 - **input-data**
 - **instrument-effector**
 - **output-data**
- **blood_sucking_step**
- **bone_flap_elevation_step**
- **drapes_application_on_head_step**
- **dura_mater_detaching_step**
- **hemostasis_step_in_dura_mater_opening_phase**
- **hemostasis_step_in_skull_opening_phase**
- **instruments_clearance_after_opening_step**
- **instruments_preparation_before_opening_step**
- **periosteum_removal_step**
- **scalp_incision_step**
- **scalp_reflection_step**
- **skull_drilling_step**
- **skull_opening_step**
- **surgical_safety_checklist_step**
- **use_of_bone_wax_step**
- ▼ ● **material-entity**
 - ▼ ● **physical-object**
 - ▼ ● **amount-of-matter**
 - **amount-of-blood**
 - **bee-wax**
 - **bone-powder**
 - ▼ ● **physiological-saline-solution**
 - **Ringer-lactate-solution**
 - ▼ ● **body-part**
 - ▶ ● **anatomical-structure**
 - ▶ ● **biological-liquid**
 - ▶ ● **functional-structure**
 - **incision**
 - **human**
 - ▼ ● **medical-device**
 - **imaging-device**
 - ▼ ● **surgical-furniture**
 - **anesthesia-table**
 - **operating-table**
 - **operating-trolley**
 - **reserve-table**
 - ▶ ● **surgical-instrument**
 - ▶ ● **surgical-microscope**
 - ▶ ● **surgical-navigation-system**

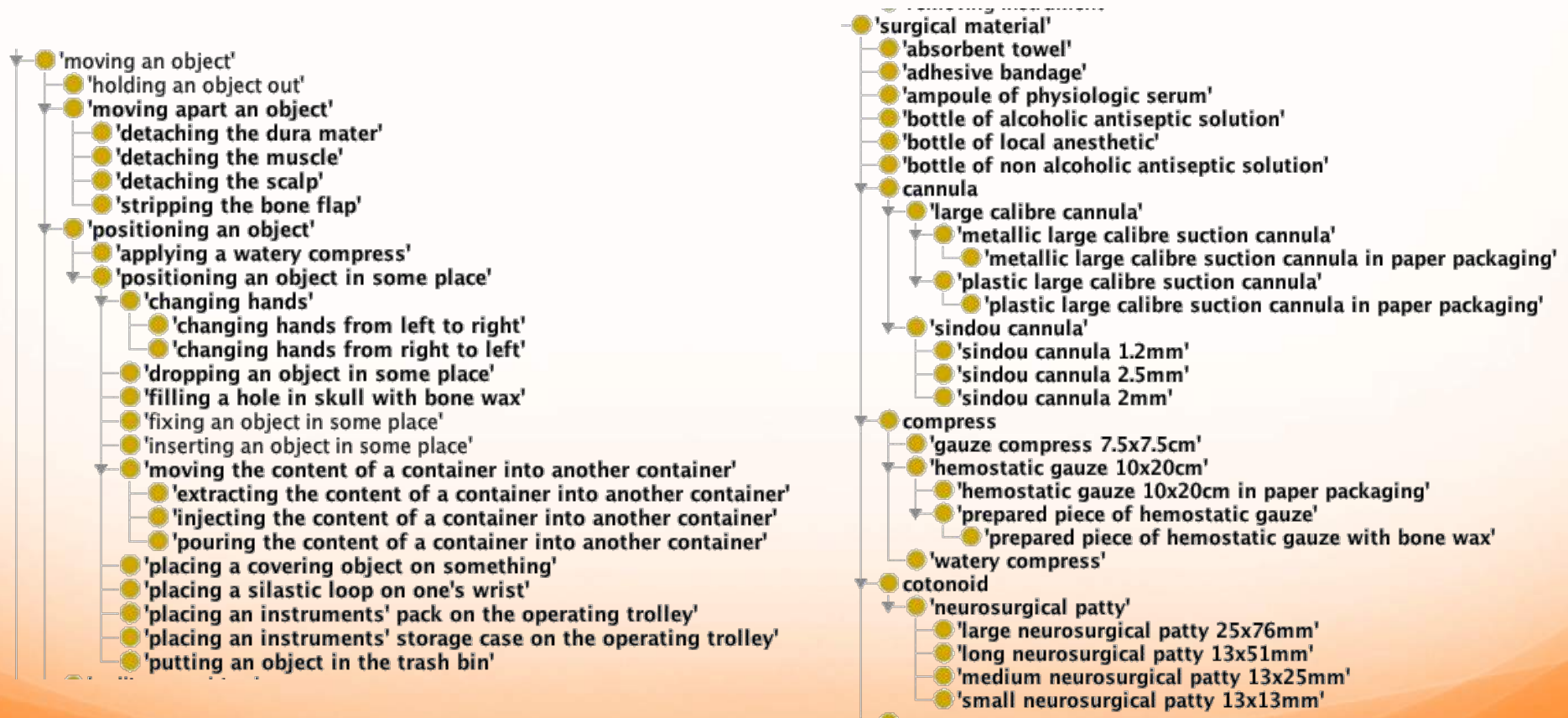
OntoSPM Collaborative Action

- Started in June 2016
- 15 european groups
- Collaboration action
 - Web site / wiki : <https://ontospm.univ-rennes1.fr>
 - Monthly Technical Committee meetings
 - Bi-Monthly Steering Committee meetings

Available at <http://ontospm.univ-rennes1.fr>

OntoS3PM Ontology

Extension of the core ontology to cover the needs of the different scenarios





Observation / cataract surgery

save

OPENING PHACOEMULSIFICATION IMPLANTATION CLOSURE

INCISION SCALP DETACHING IRRIGATION ASPIRATION CORNEAL HYDRATATION VISCOELASTIC GEL INJECTION FOR BAG DILATATION INTRAOCULAR LENS IMPLANTATION INTRAOCULAR LENS POSITION

STOP

ADD HAPPENING

OPENING

INCISION

Surgeon
Dr. Olivier Cesson

RIGHT HAND

Incise cornea keratome 2.2 mm

FAILED UNKNOWN SUCCEED

LEFT HAND

ACTION

Assistant
Christophe Seigné

Take scissors

RIGHT HAND

Sculpt grooves lens phacoemulsification tip

FAILED UNKNOWN SUCCEED

LEFT HAND

ACTION

Nurse
Émilie Rennes

1x

00h : 19m : 23s

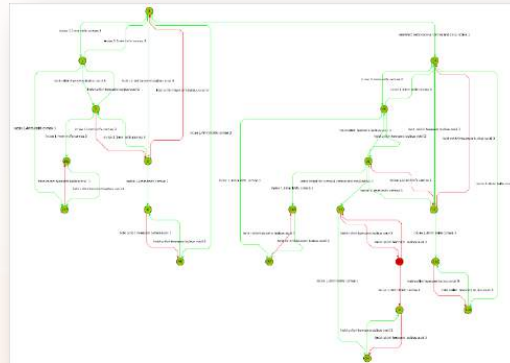
STOP OBSERVATION

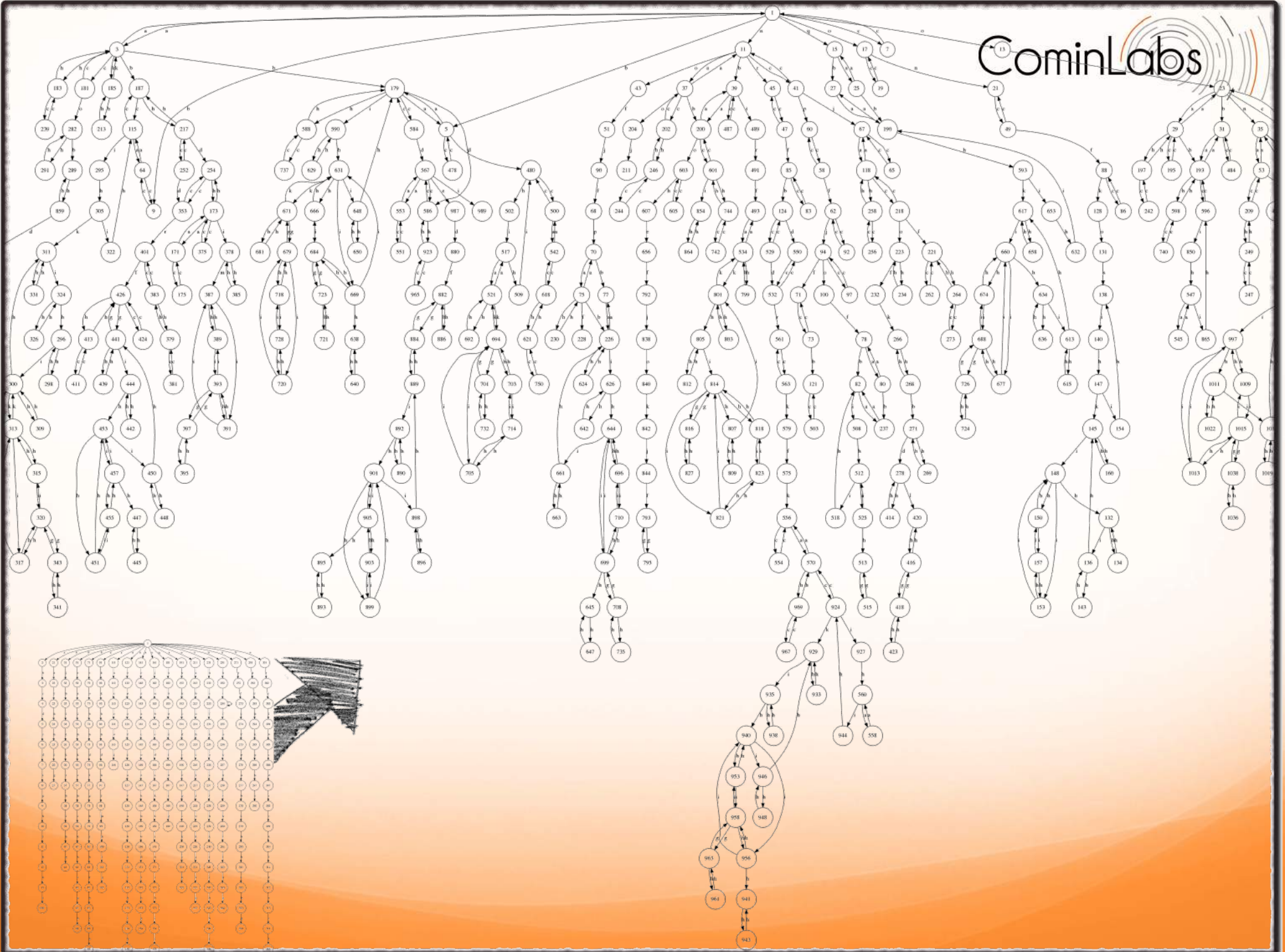
The screenshot displays the CominLabs Surge Track software interface. The top window title is "observation / craniotomy". The interface features a central timeline with various colored markers (green, red, yellow) indicating surgical events. On the right side, there is a vertical list of body parts: LEFT-HAND, RIGHT-HAND, BOTH-HANDS, LEFT-FOOT, RIGHT-FOOT, BOTH-FEET, and HEAD. Below the timeline, there is a video feed showing a surgical team performing a craniotomy in an operating room. The video feed includes a "Reference" label at the bottom. The bottom of the screenshot shows a Windows taskbar with the system clock at 09:17 AM on 11/11/2016, and a taskbar with icons for Start, Internet Explorer, and other applications.

Models:
Acquisition of data as Surgical Process Model

Abstraction:
Derivation of Generic Surgical Process Model (gSPM)

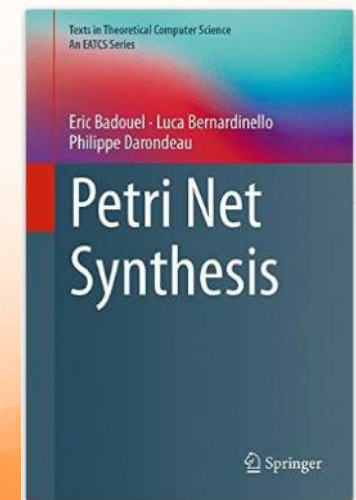
Synthesis:
Integration of gSPM in a Collaborative Virtual Environment for Training

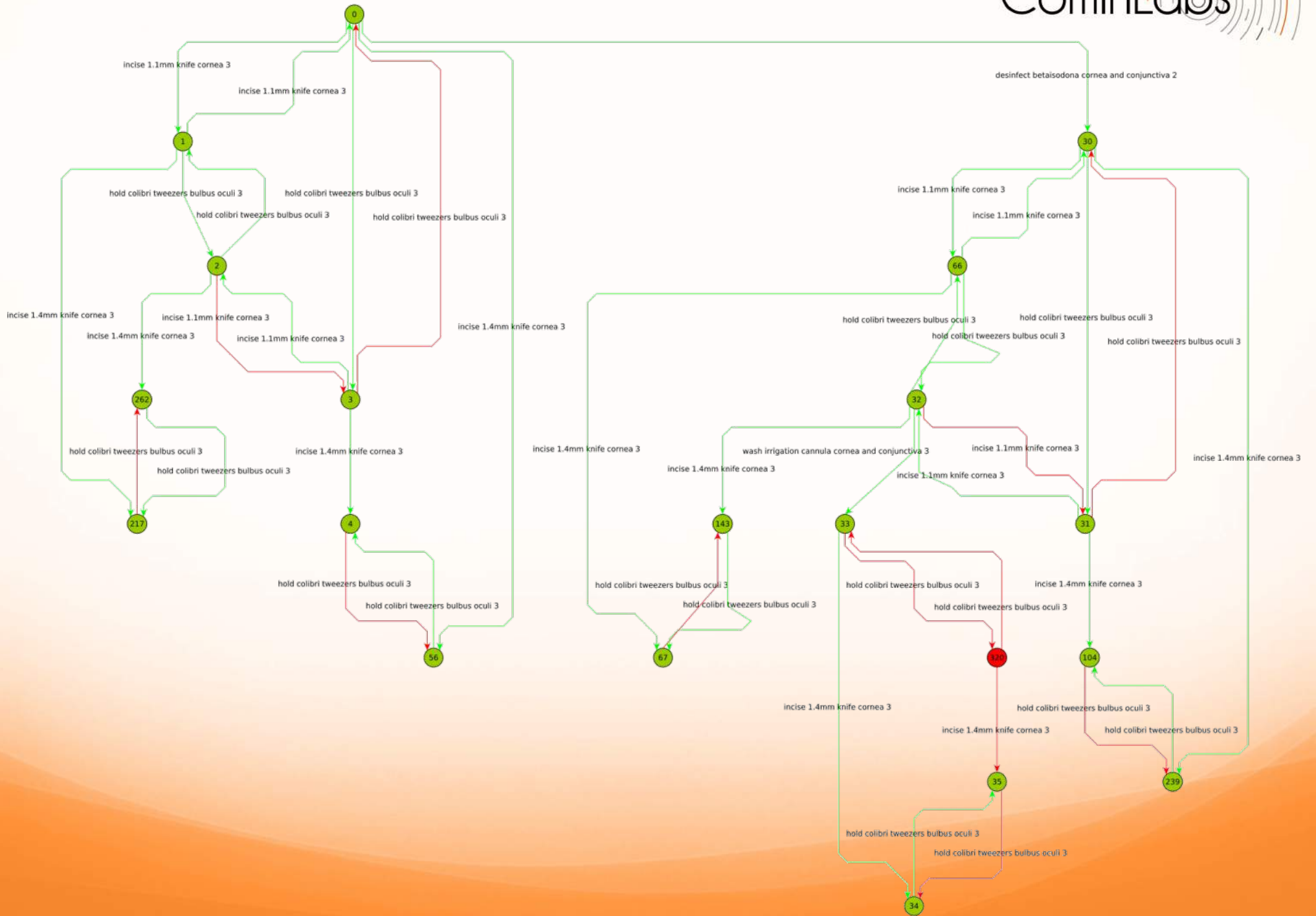


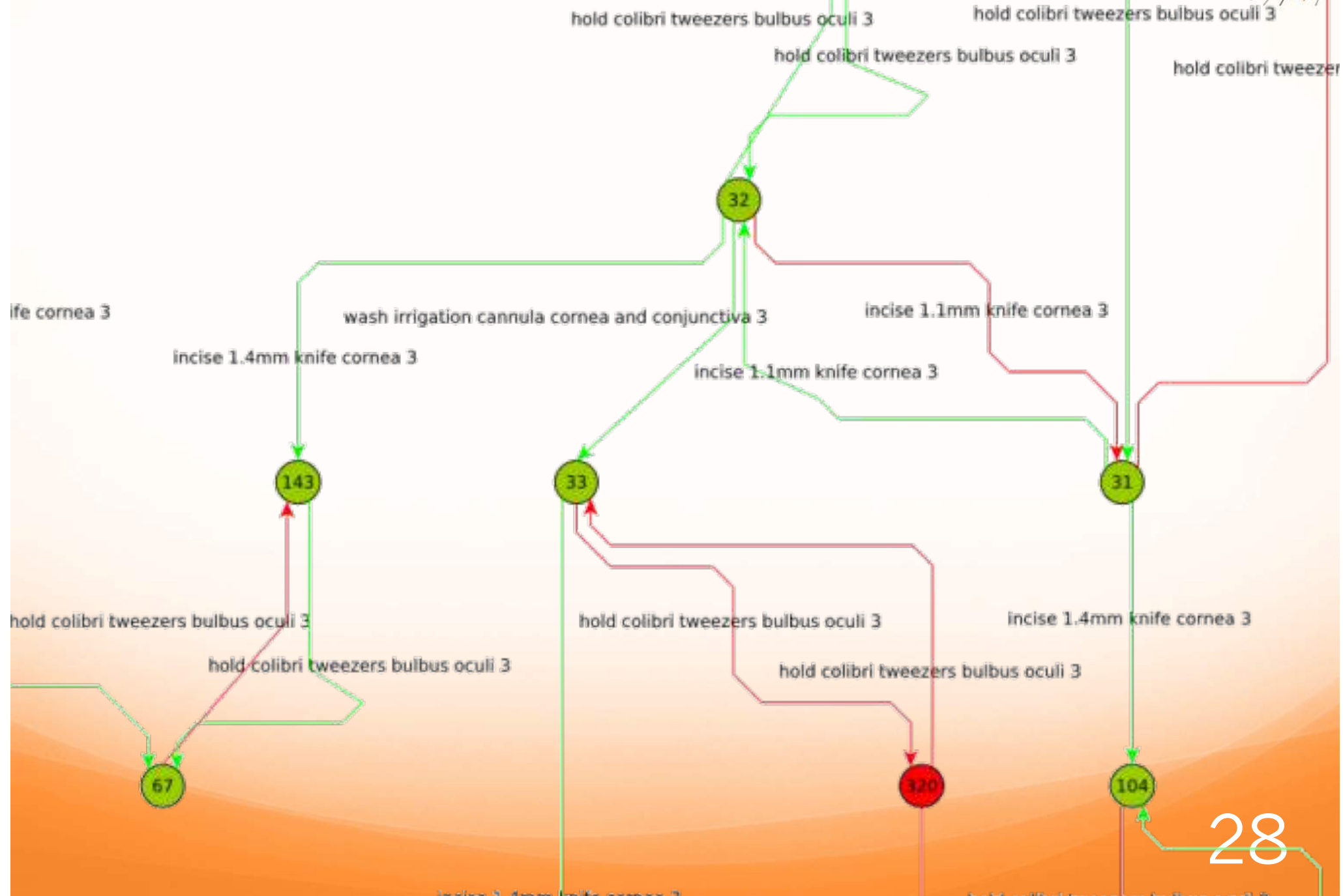


Surgical Process Mining

- Generic model representing the possible scenarios of the surgical procedure from observations
 - Test and Flip nets
 - Extension of Elementary Nets
 - Capture **causality**, **conflict** and **concurrency** between actions
 - **Generalize** from few observations



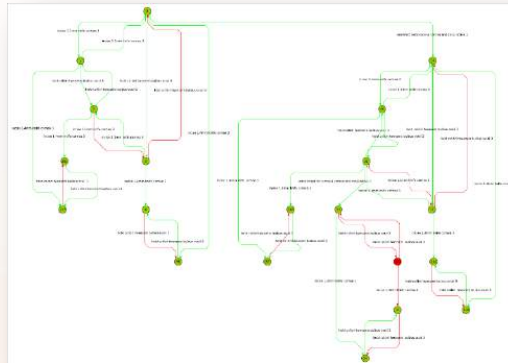




Models:
Acquisition of data as Surgical Process Model

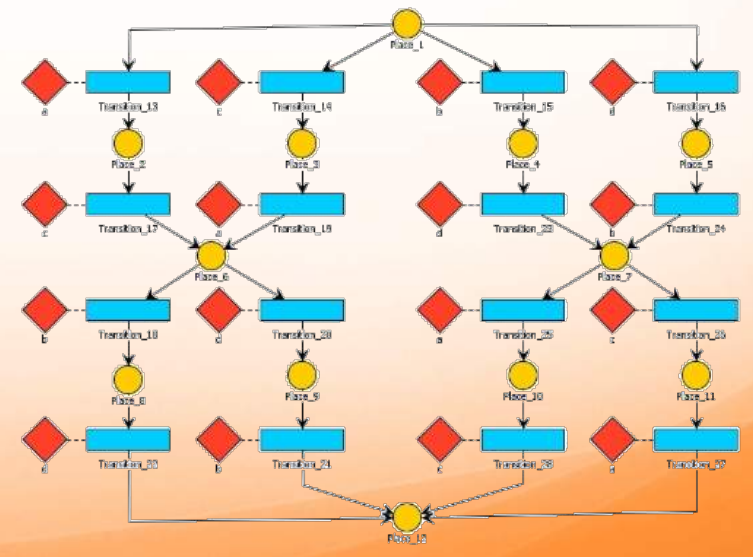
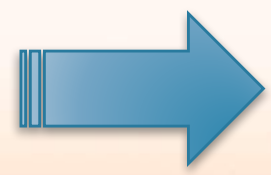
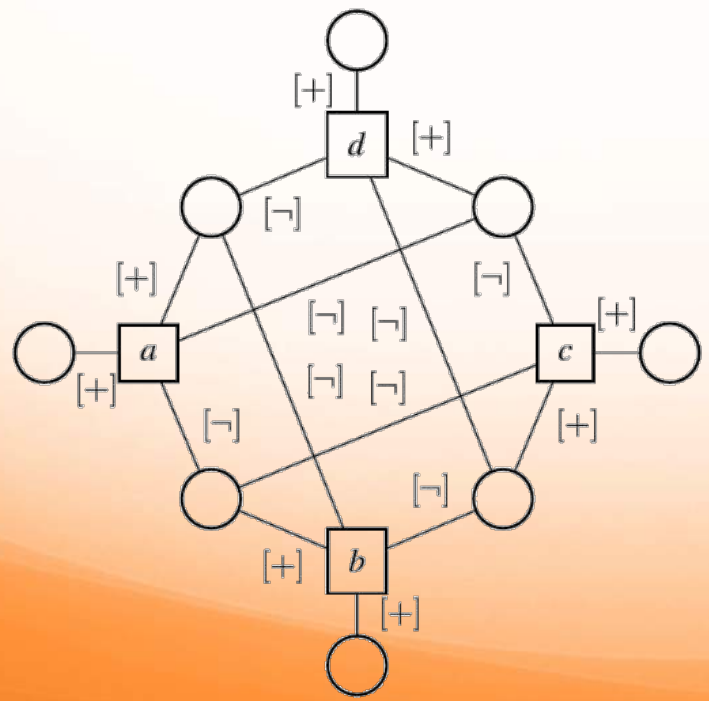
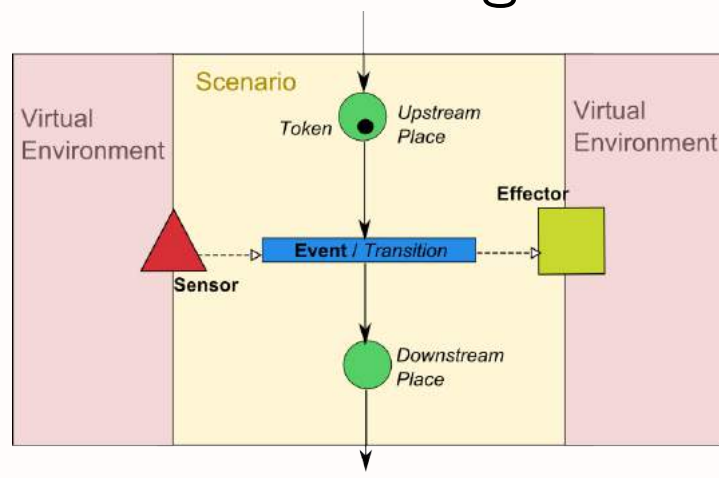
Abstraction:
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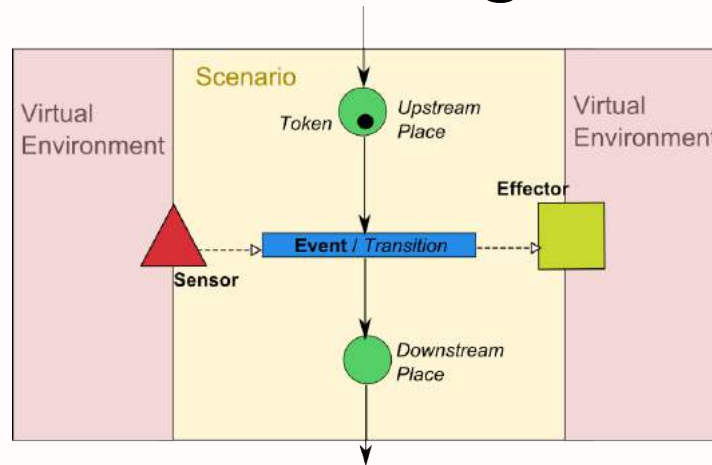


Generic Scenario Manager

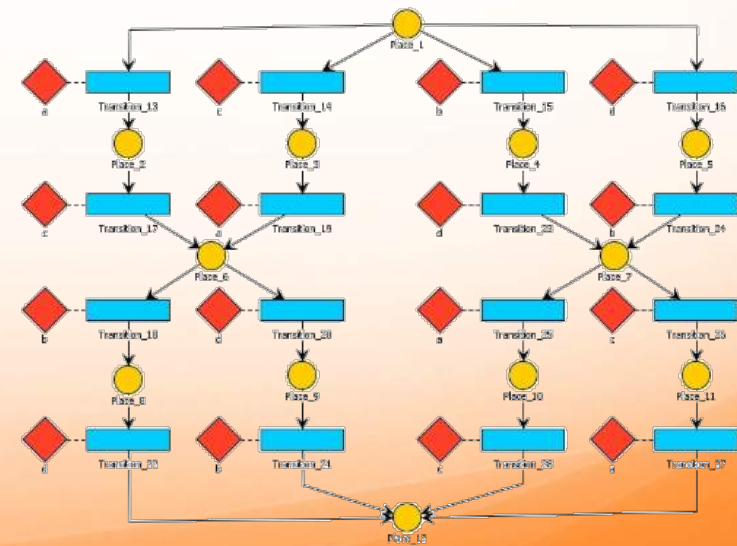
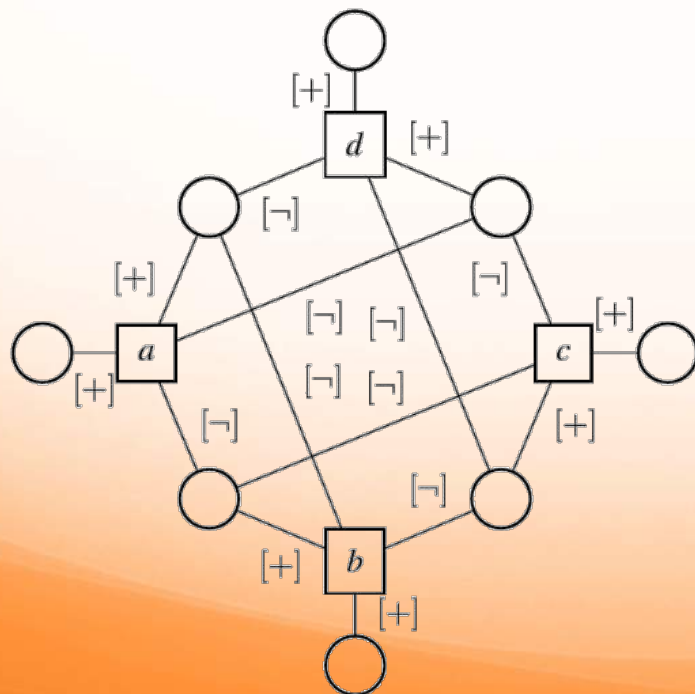
Scenario Engine

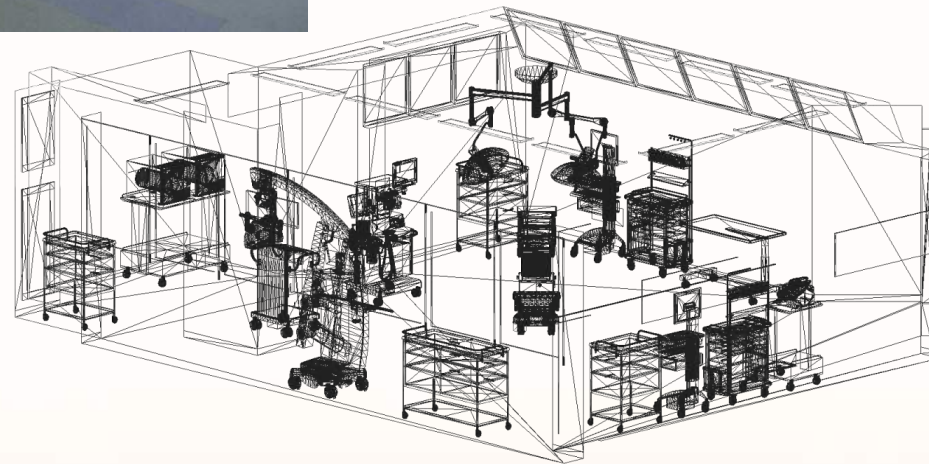


Generic Scenario Manager Scenario Engine



- **Collaboration** between actors (real and virtual)
- **Manage interaction**
- **Modularity**
- **Compatible with Test&Flip**

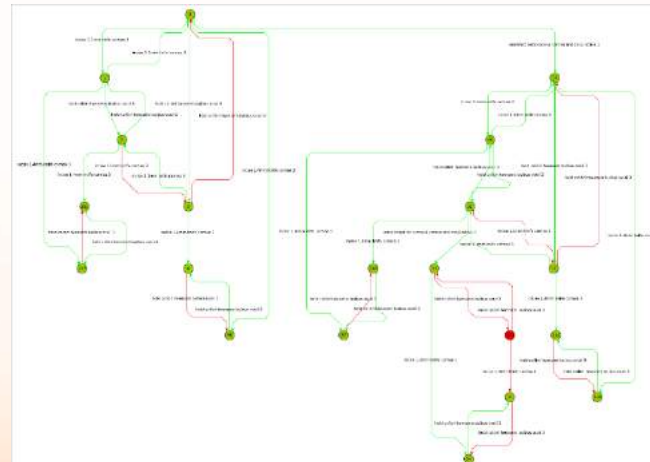




Acquisition of data as
Surgical Process
Model
(iSPM)

Derivation of
Generic Surgical
Process Model
(gSPM)

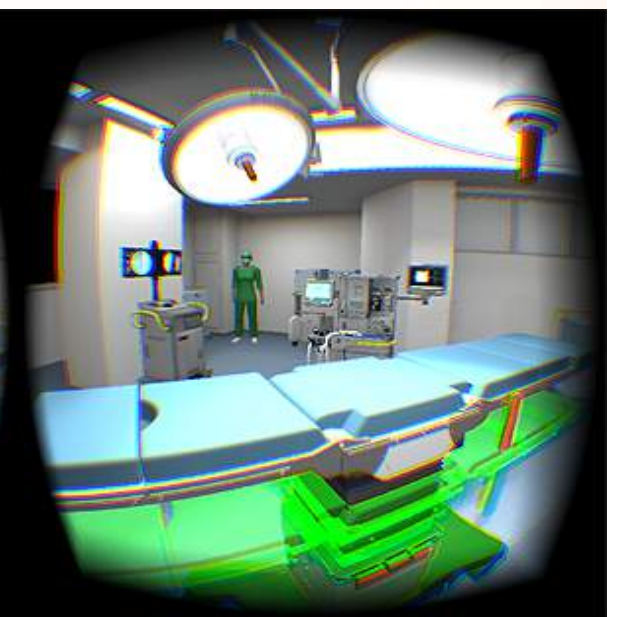
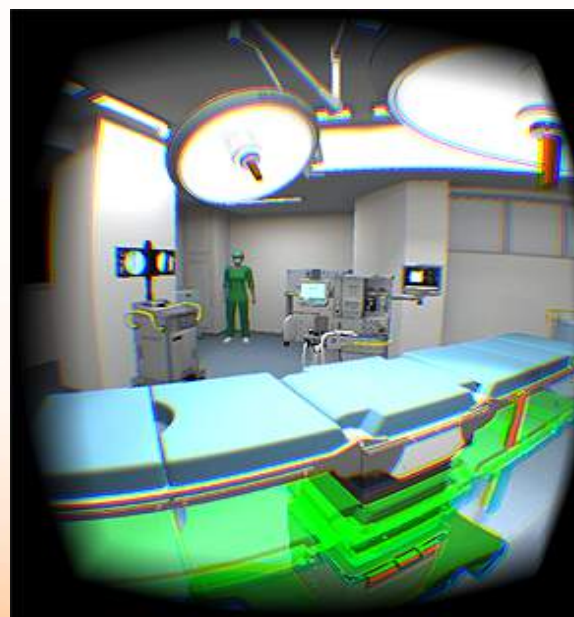
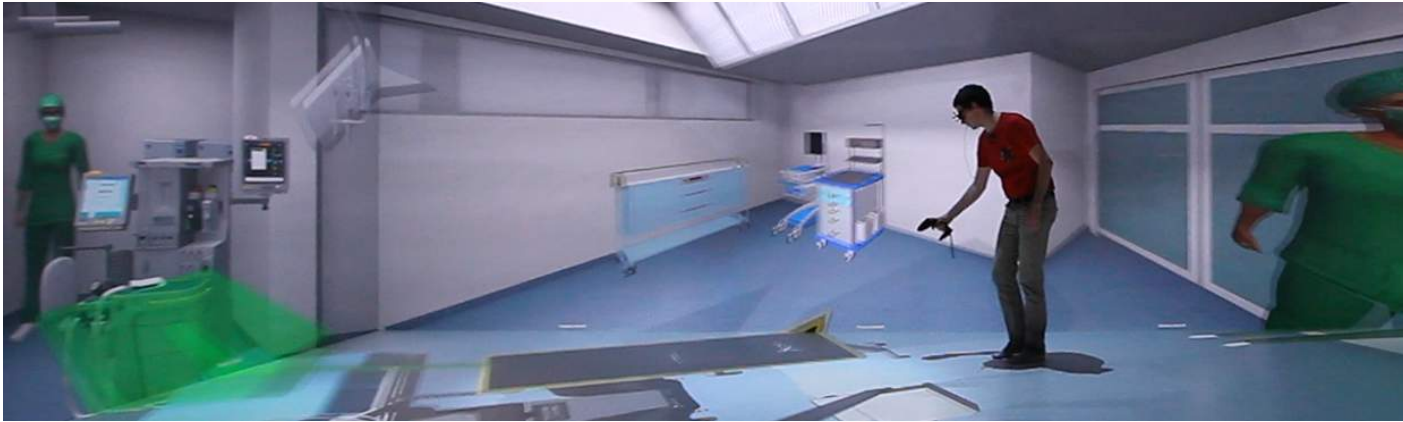
Integration of gSPM
in a Collaborative
Virtual Environment
for Training





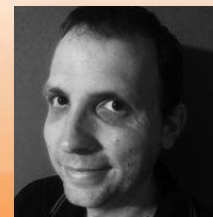
S3PM

Prototyping

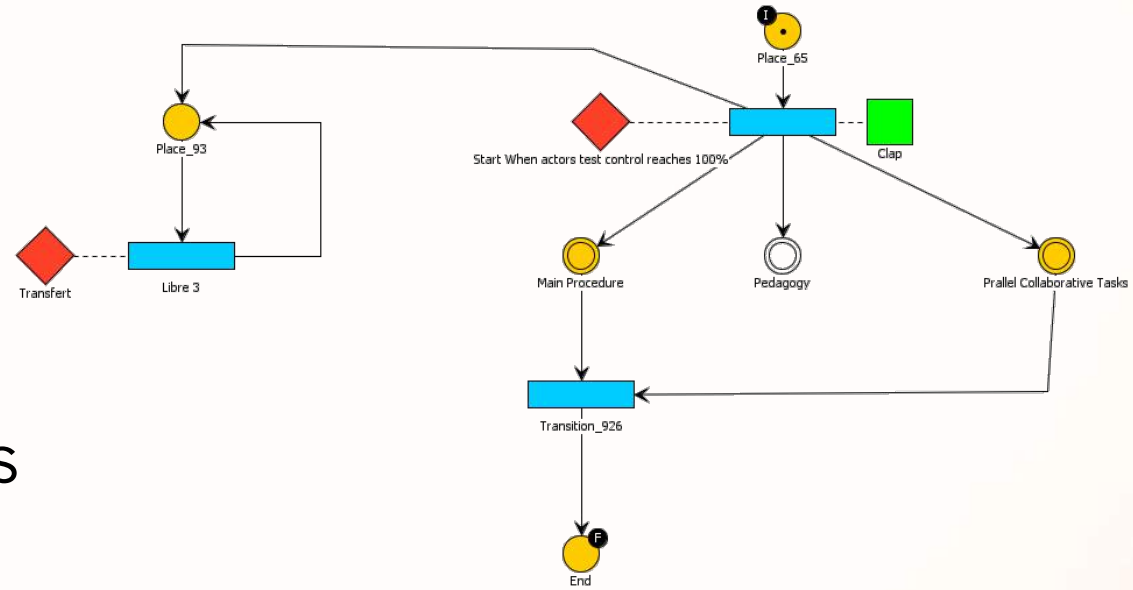


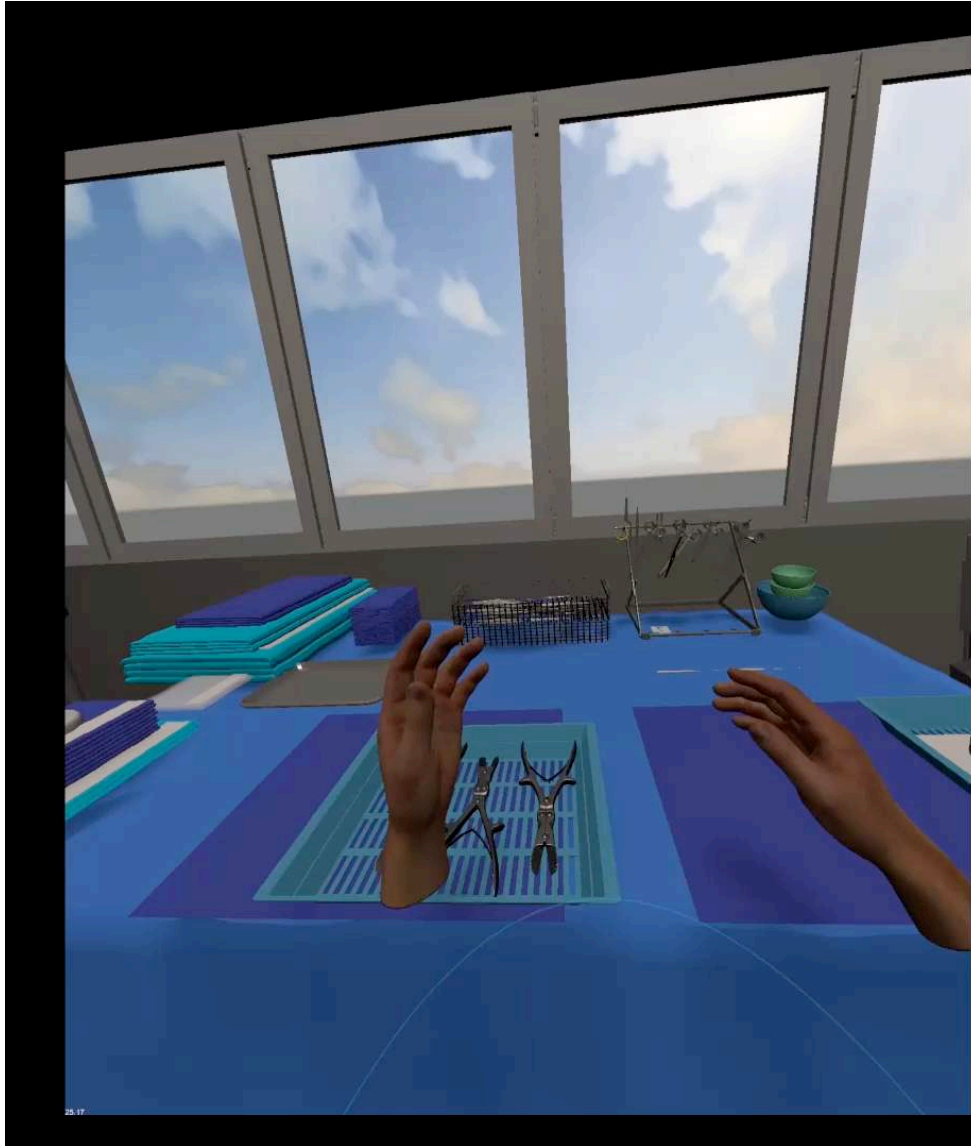
Vitrail

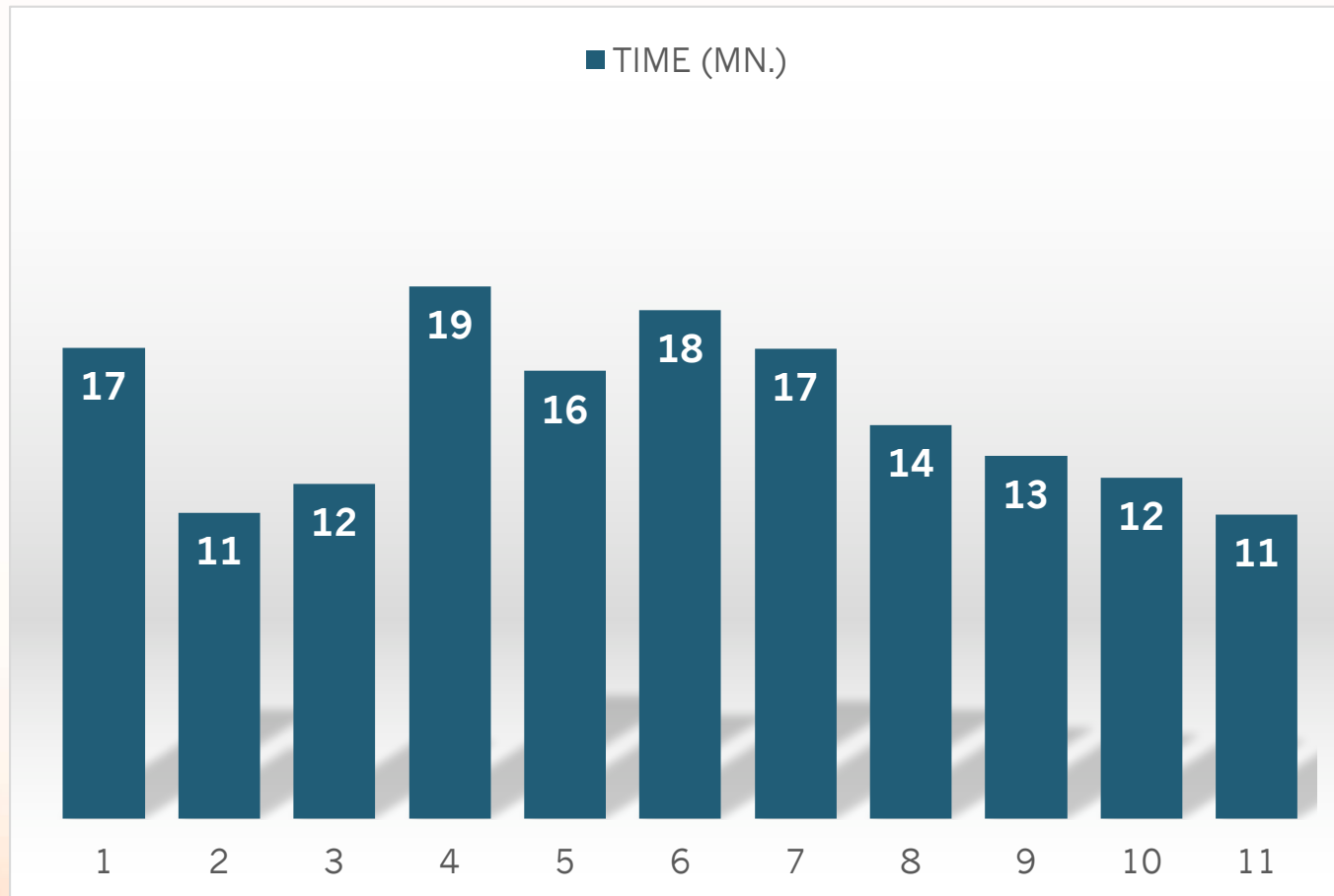
Virtual reality based **training** simulator
for Neurosurgical Scrub Nurse

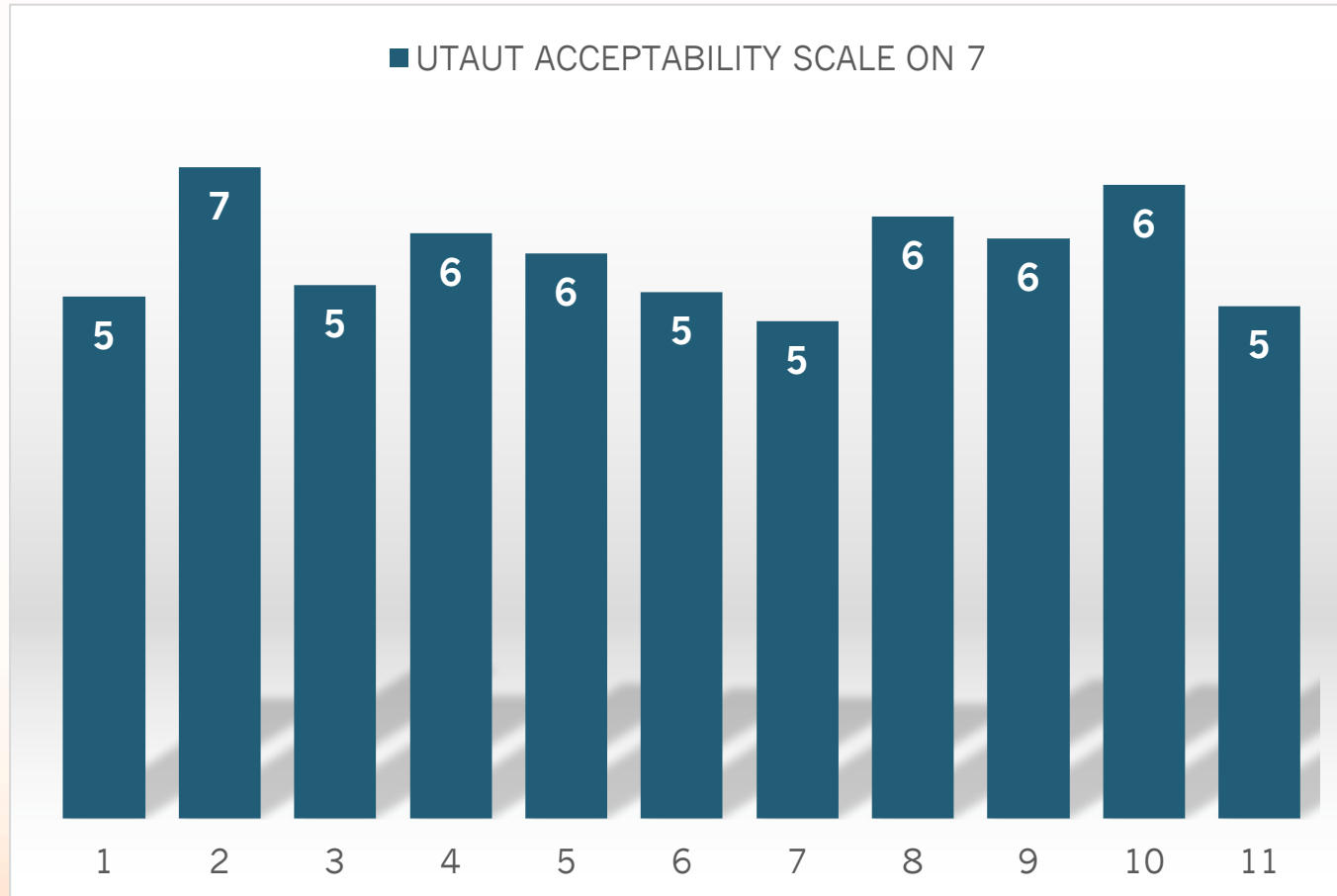


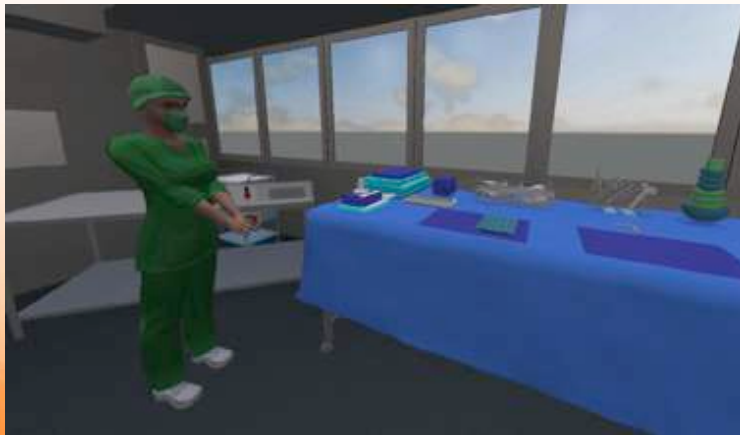
- Scene :
 - 388 objects
 - 138 usable
- Scenario
 - 944 places
 - 520 transitions

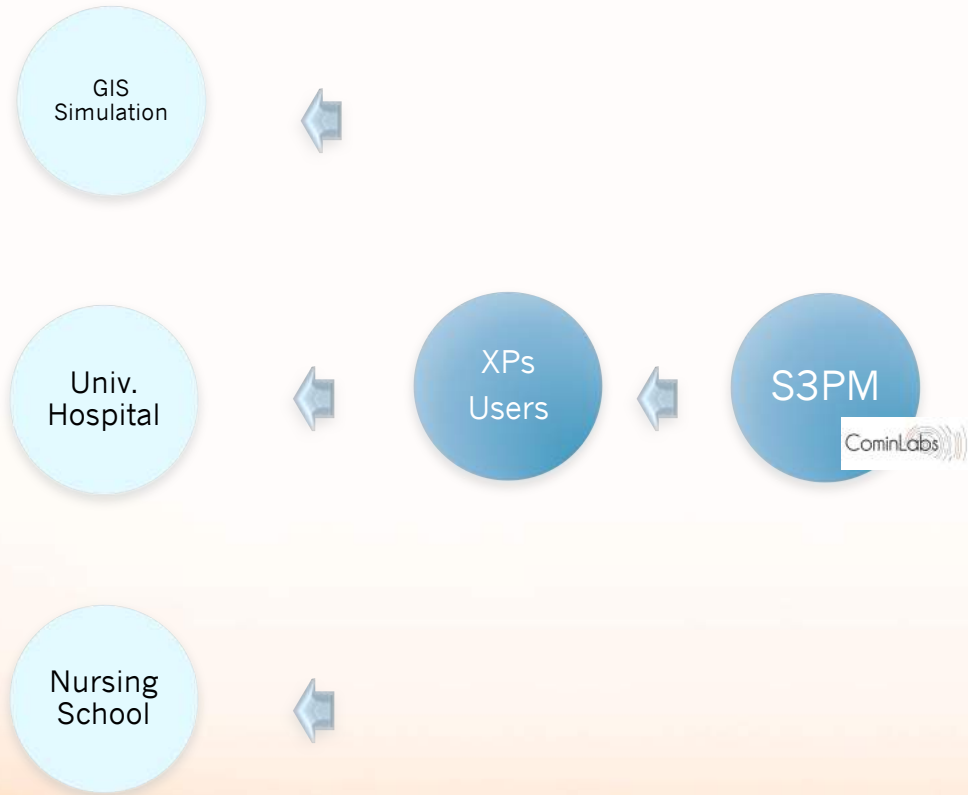


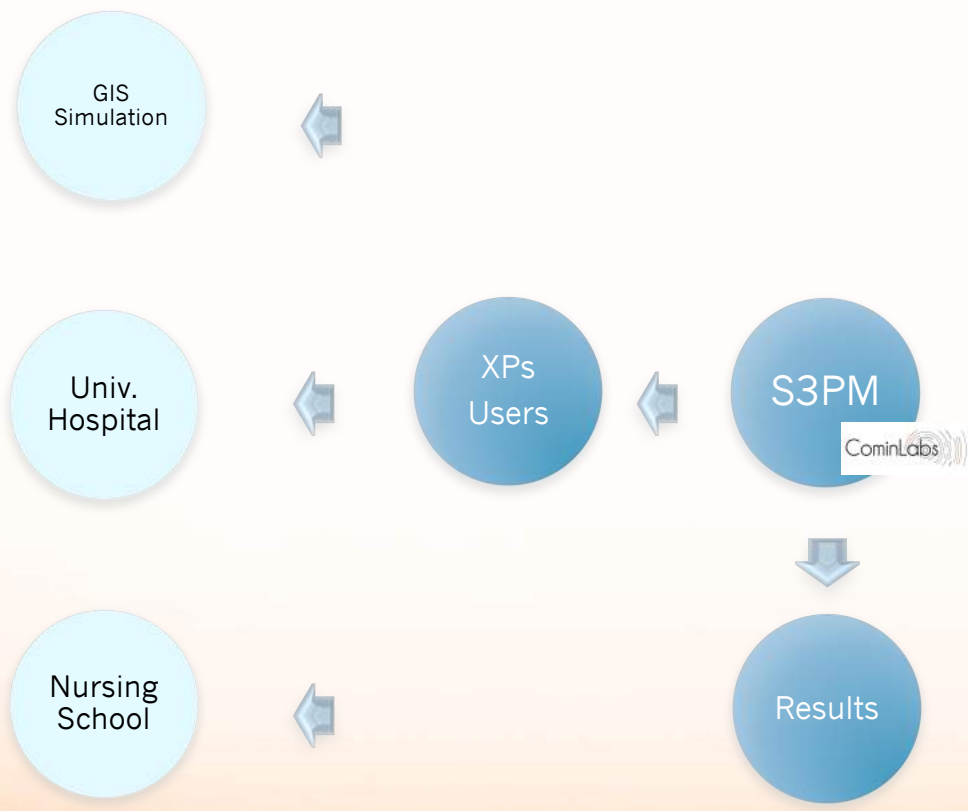


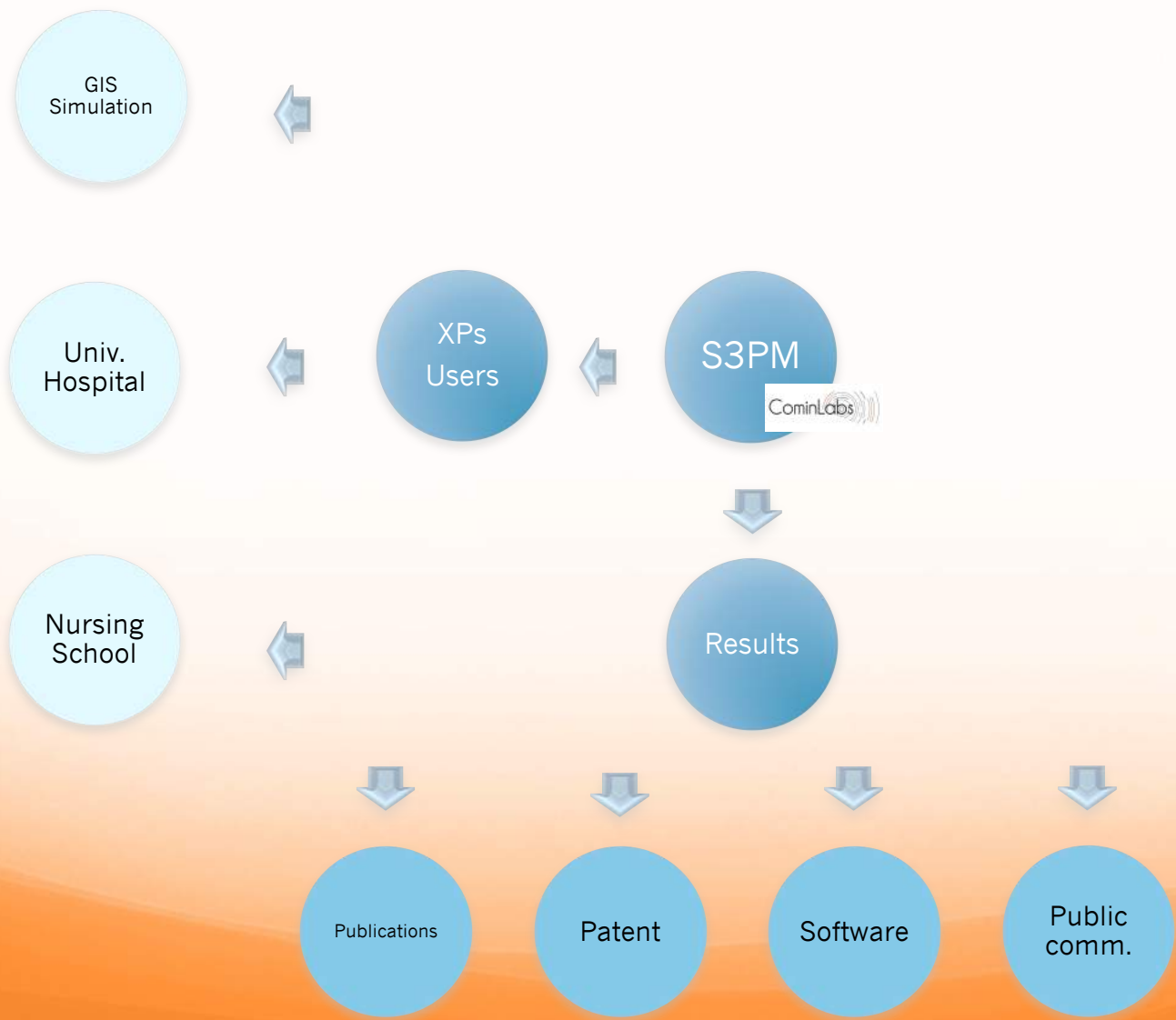


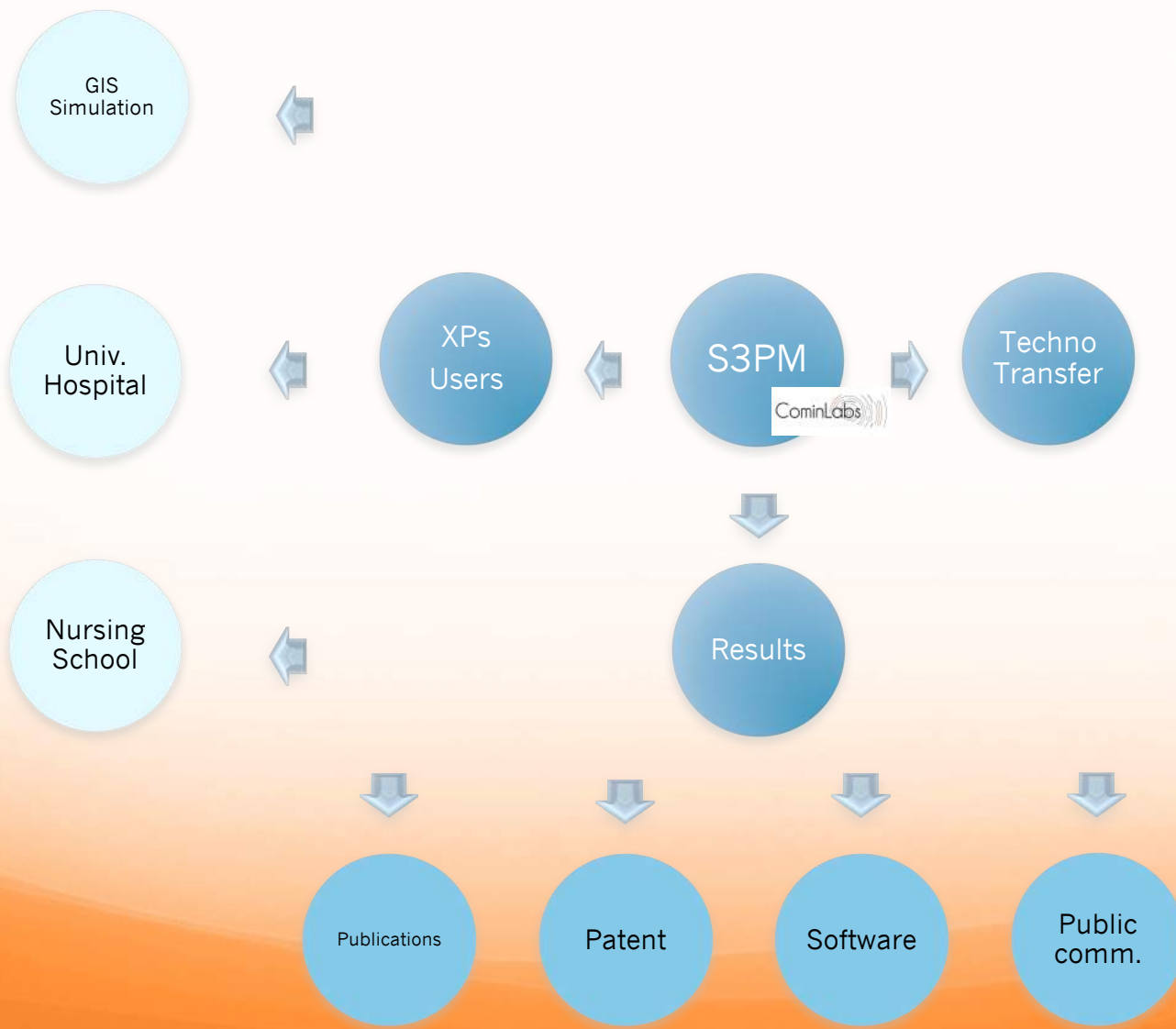


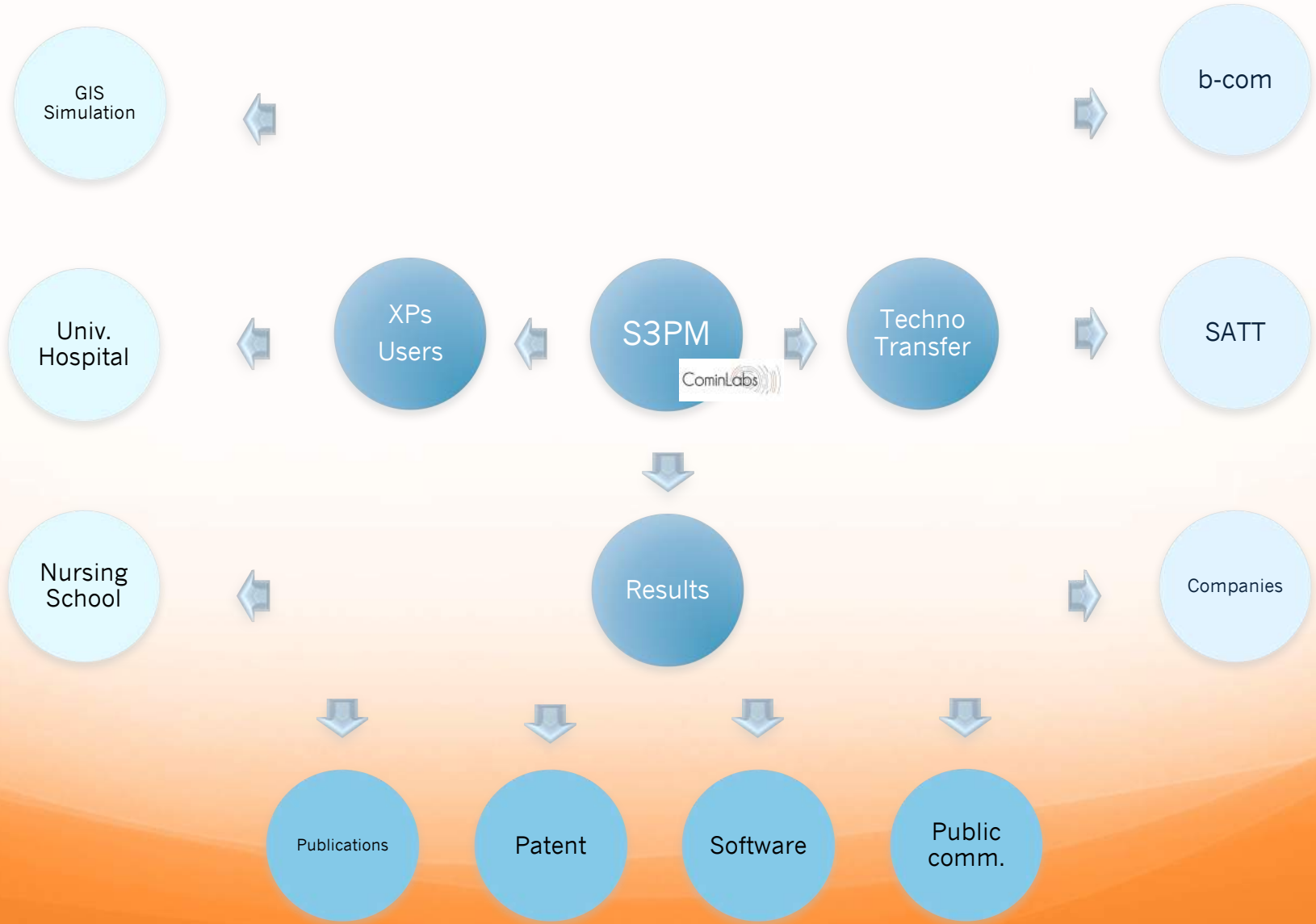


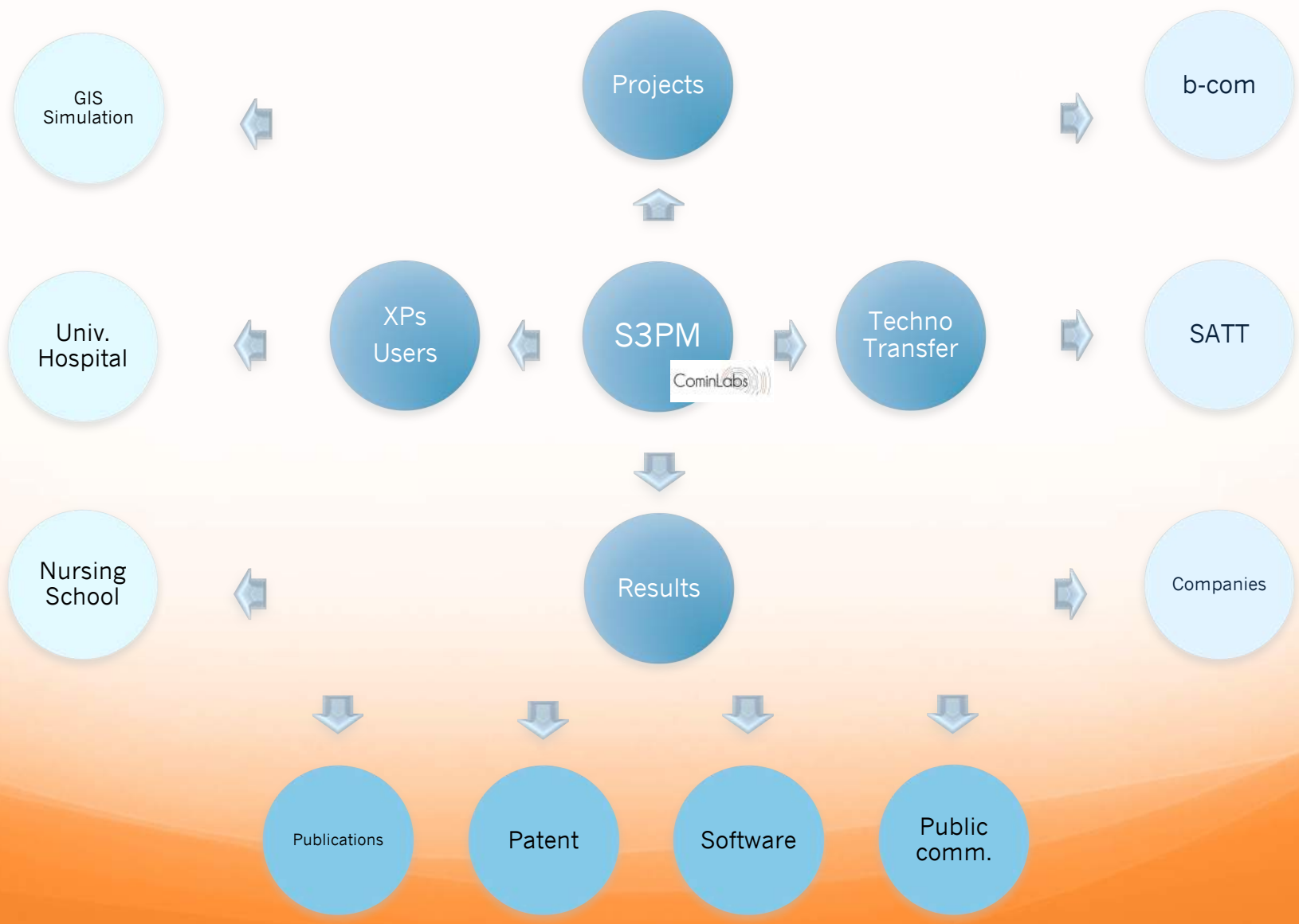


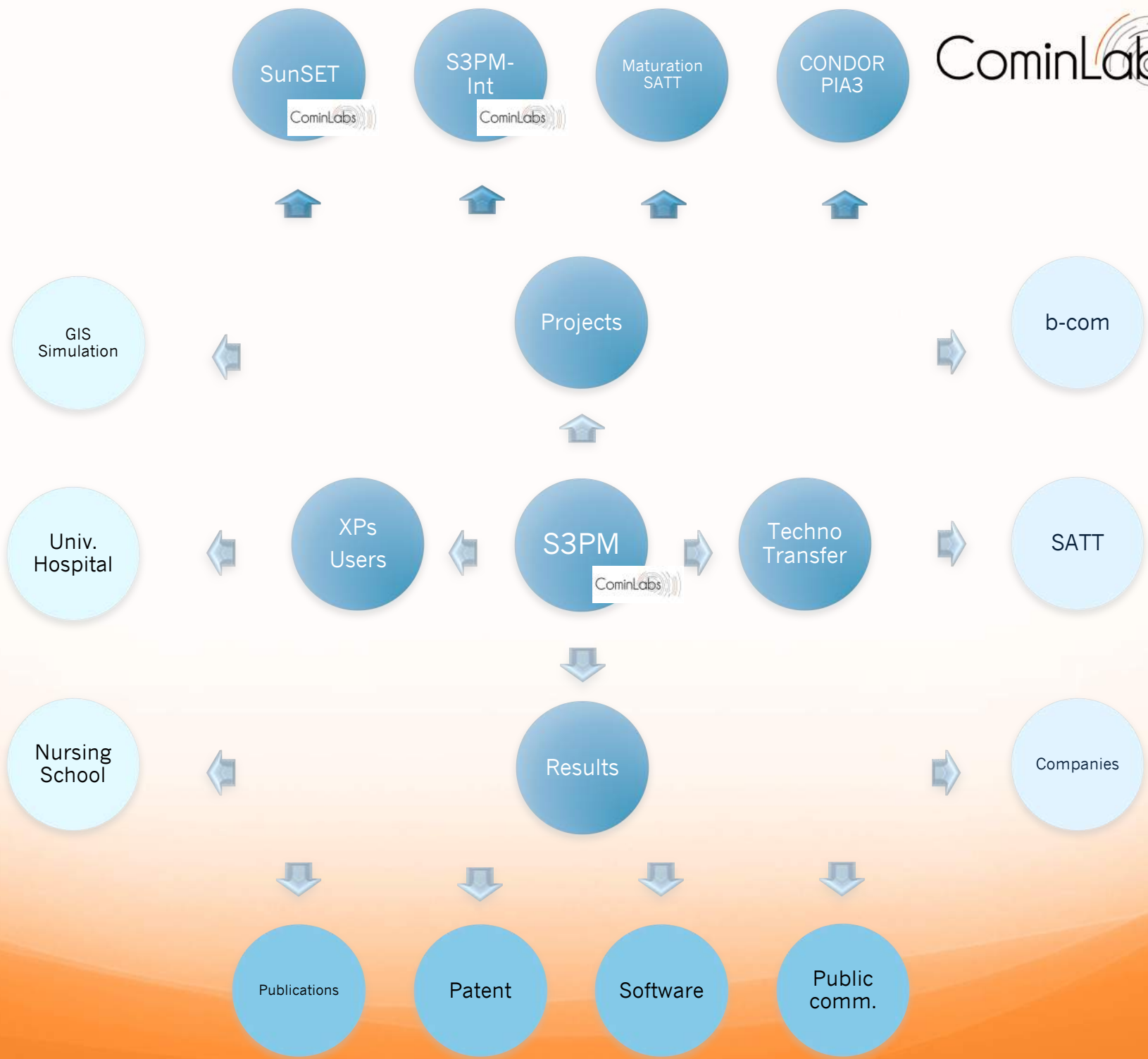














CominLabs

