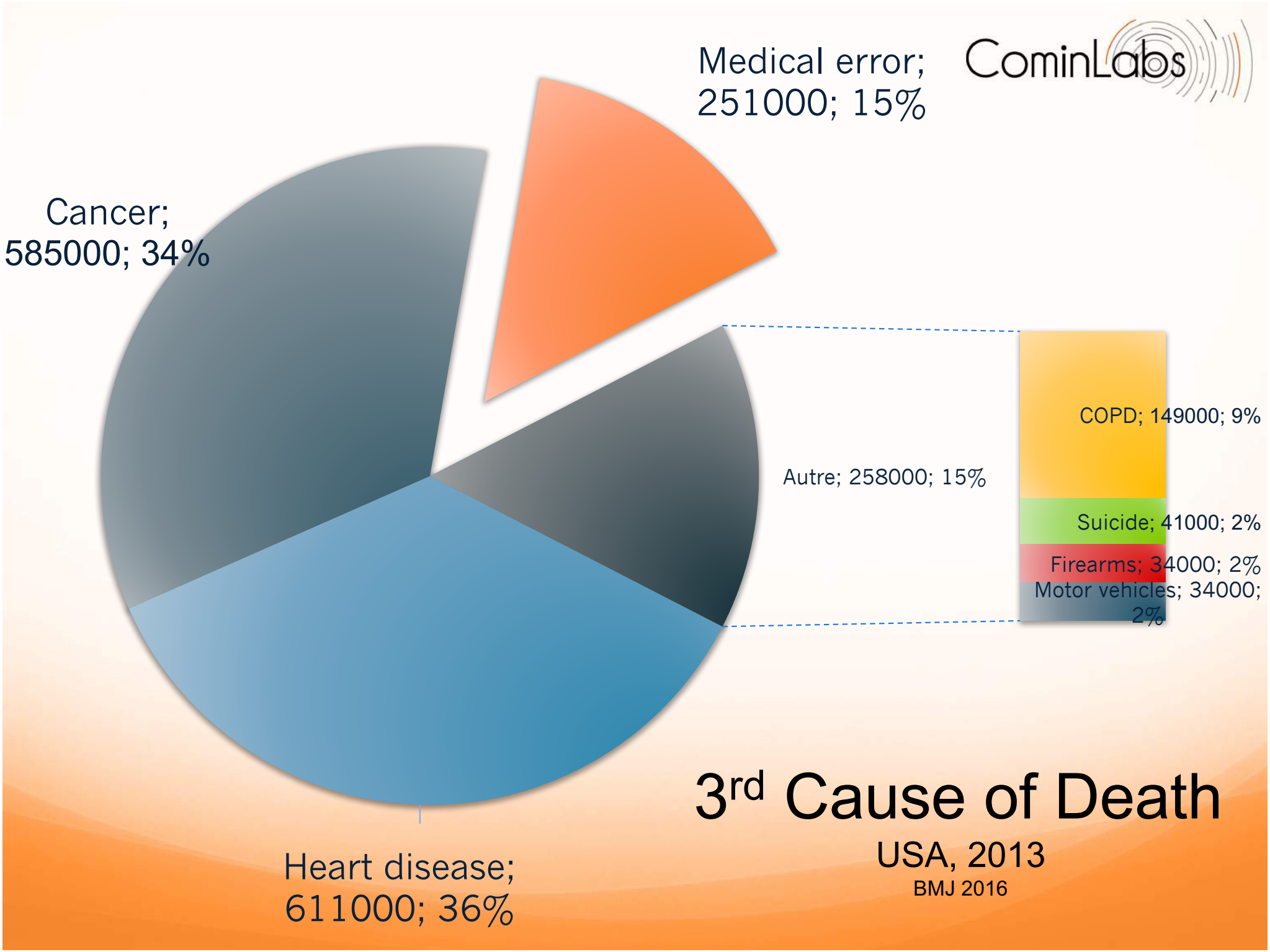
S3PM

Synthesis and Simulation of Surgical Process Models

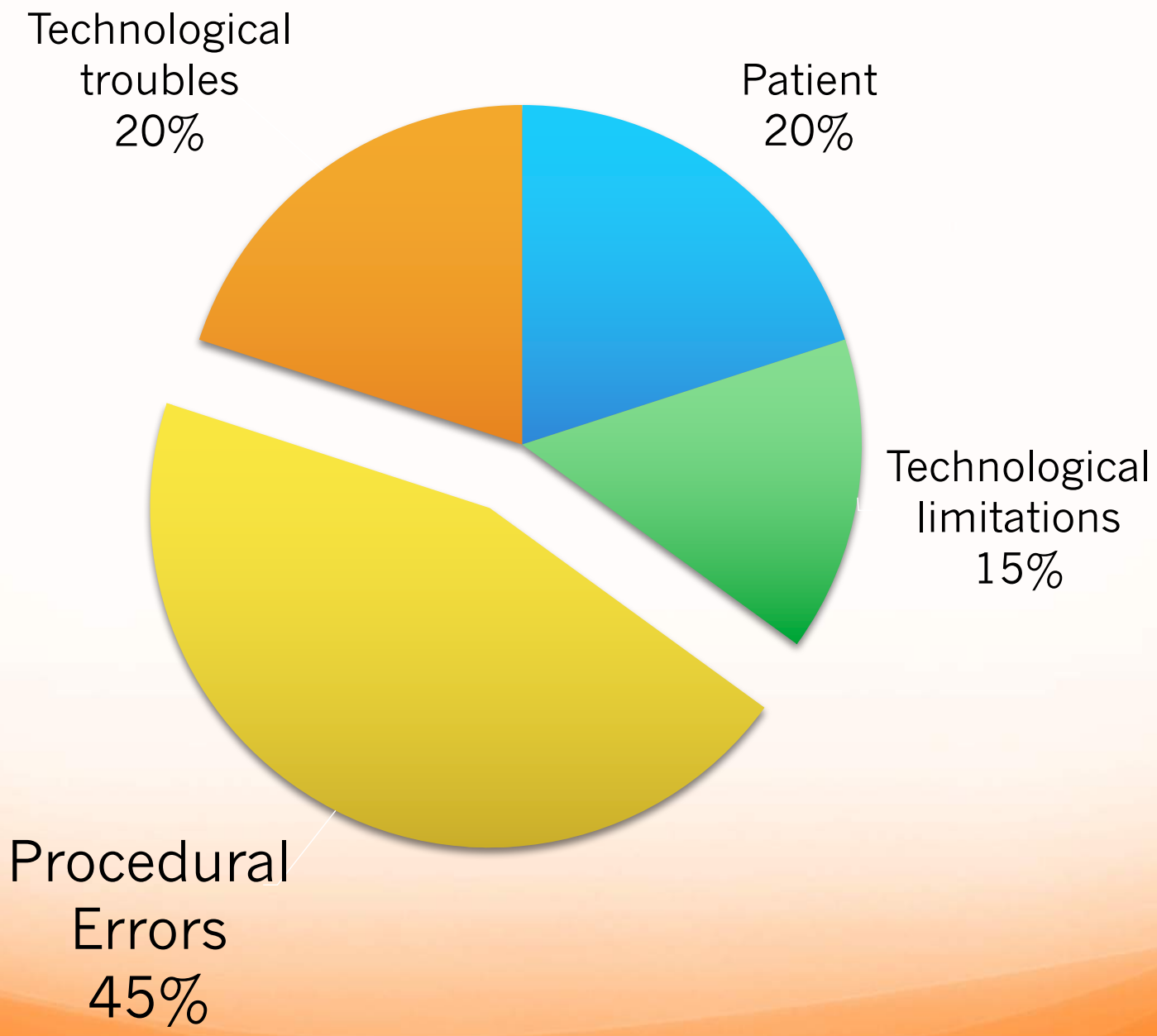
May 2013- April 2017



3rd Cause of Death

USA, 2013

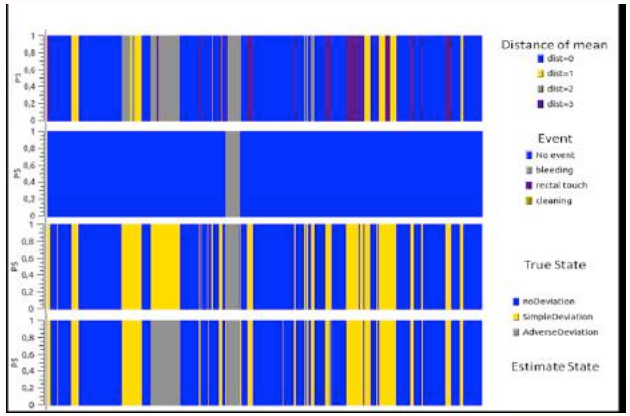
BMJ 2016


Technological troubles 20%
Patient 20%
Technological limitations 15%
Procedural Errors 45%

Assistance

OR Management Optimization

Automation

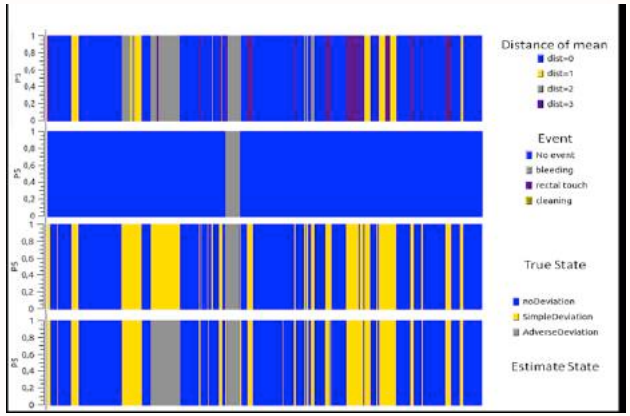


Traceability - Surgical QC

Assistance

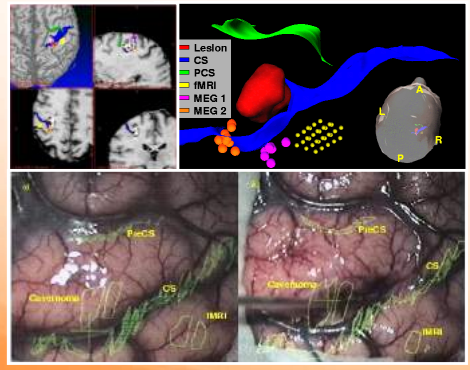
OR Management Optimization

Automation



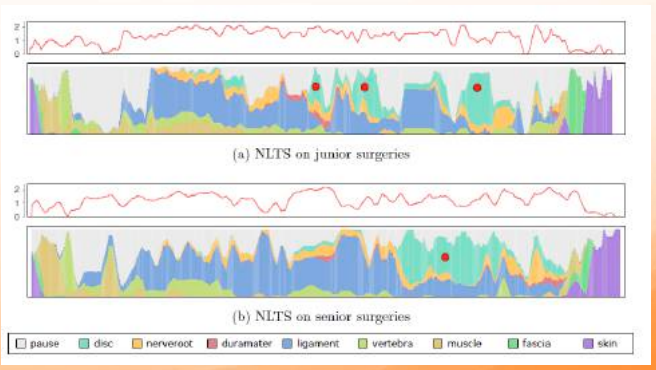
Traceability - Surgical QC

Training/Evaluation



Ergonomics

Learning

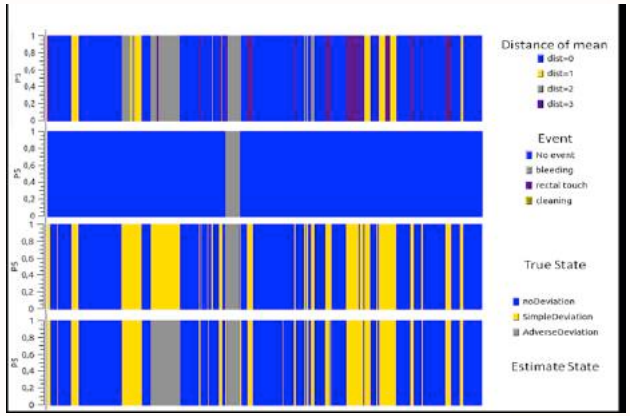


Assessment

Assistance

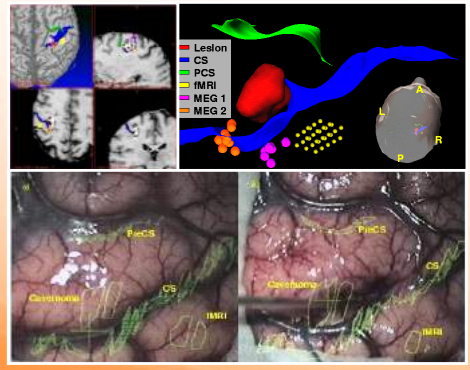
OR Management Optimization

Automation



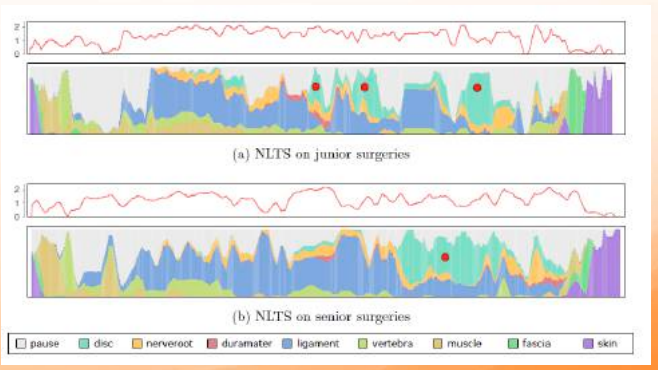
Traceability - Surgical QC

Training/Evaluation



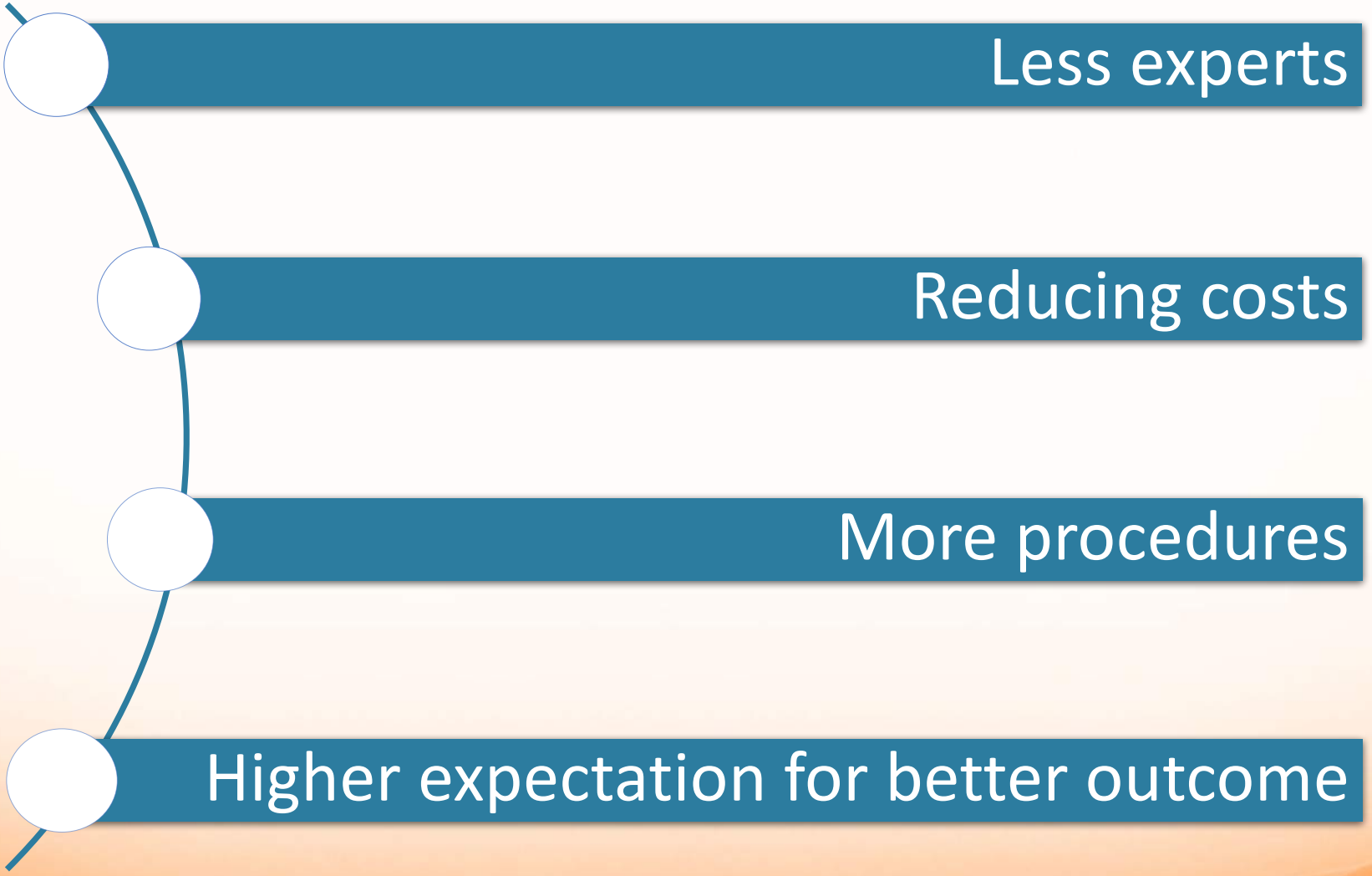
Ergonomics

Learning



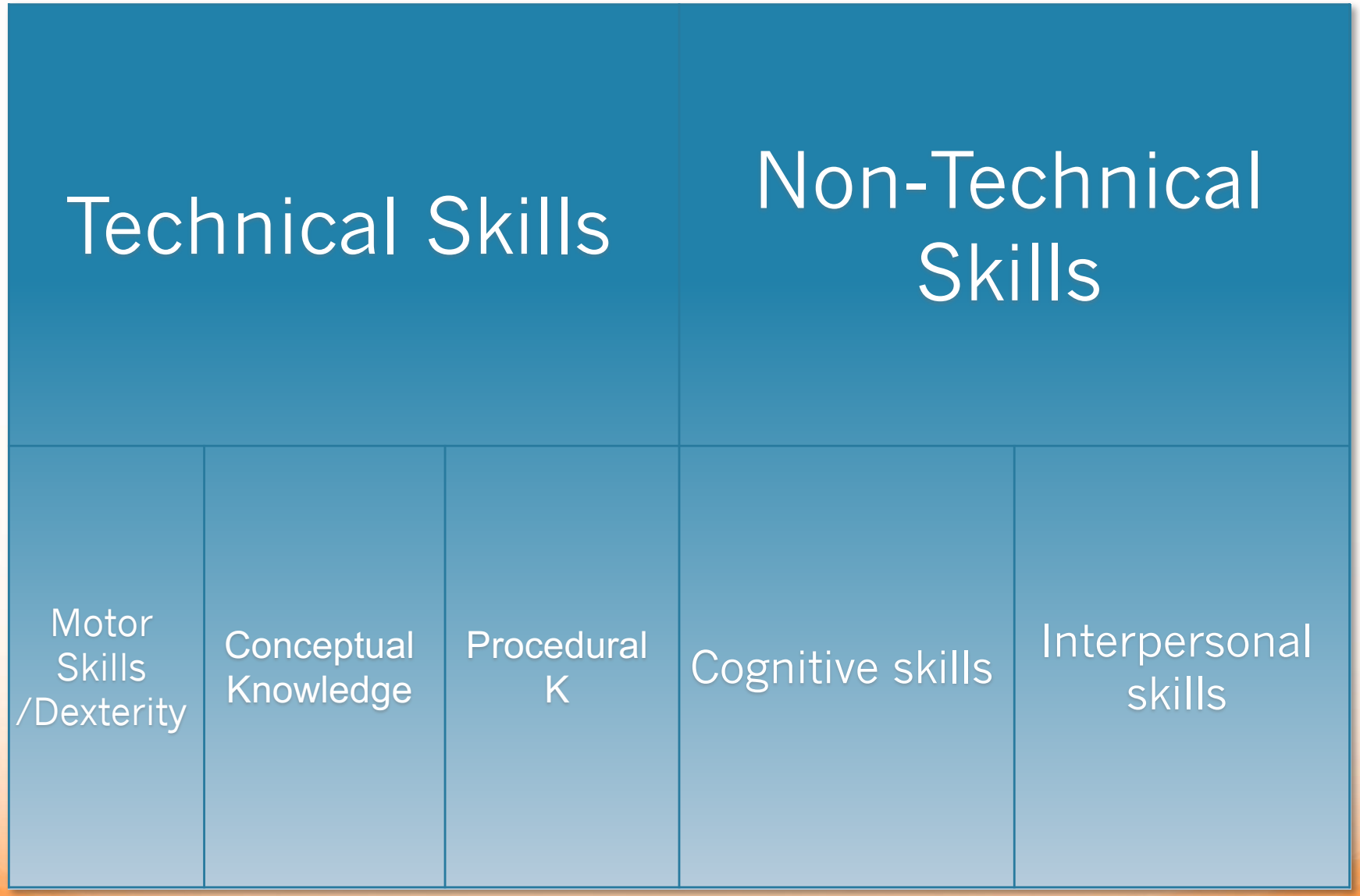
Assessment

ComInLabs



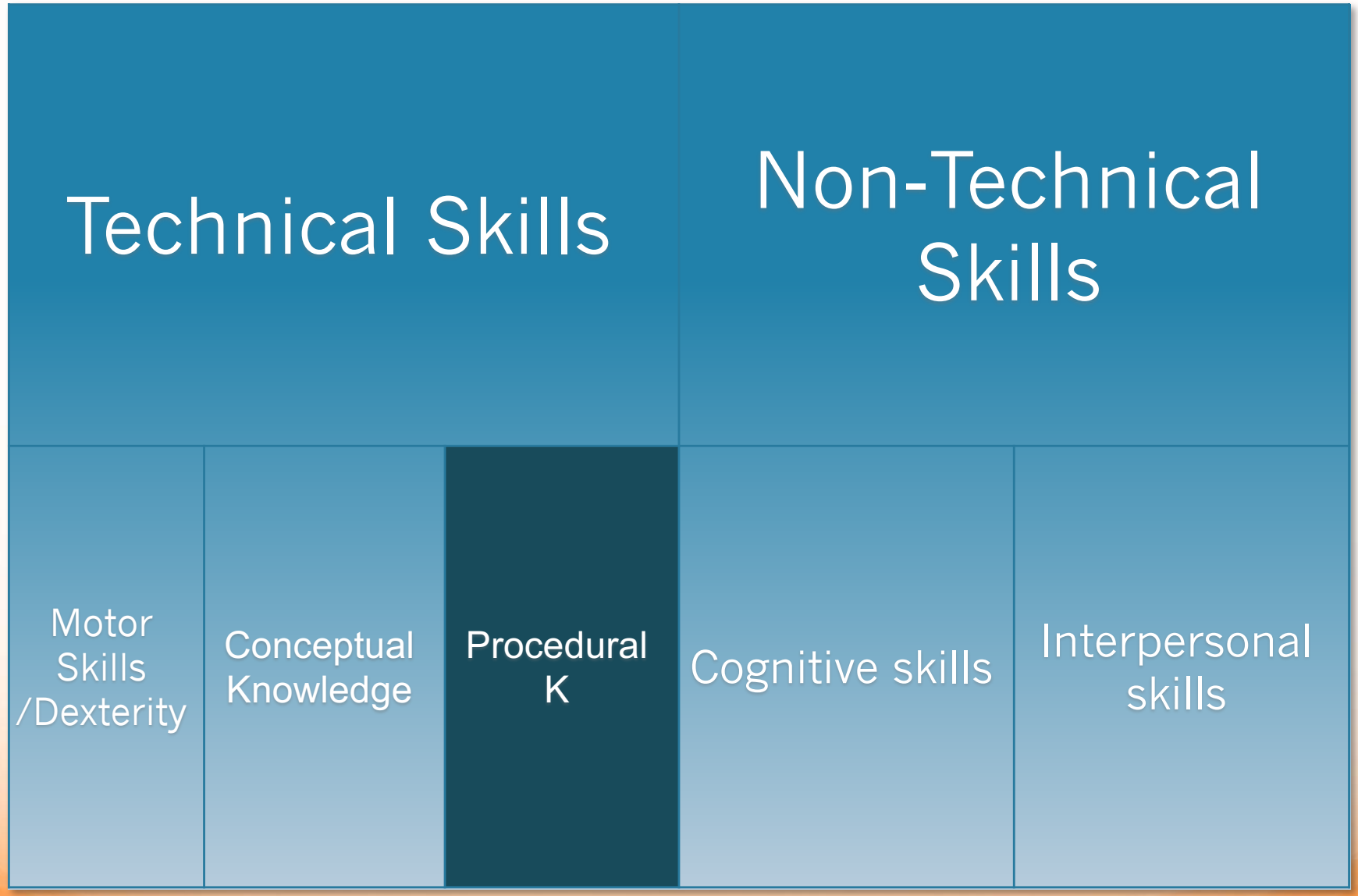
Gallagher, A. and G. O'Sullivan (2012). Fundamentals of Surgical Simulation: Principles and Practice, Springer London

ComInLabs



Alderson, D., Developping 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

ComInLabs



Alderson, D., Developping 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

CominLabs

S3PM

- Challenges
  - Complexity
  - Variability
  - Human factors

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

ComInLabs

S3PM Partners

- Permanents:
  - Pierre Jannin
  - Bernard Gibaud
  - Valérie Gouranton
  - Bruno Arnaldi
  - Benoit Caillaud
  - Pierre-Louis Henaux
- Recruited:
  - Cédric Pénet
  - Javier Rojas Balderrama
  - Guillaume Claude
- External collaborators:
  - University Hospital Rennes
    - Bénédicte Nogues
    - Emmanuelle Mondin

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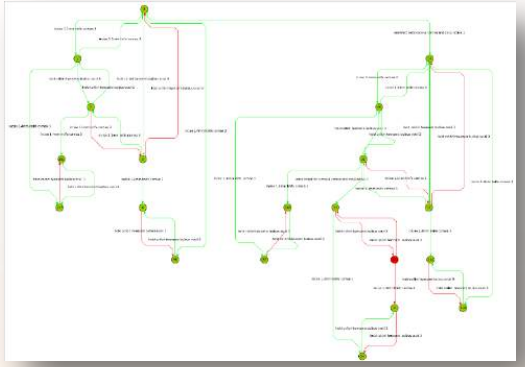
Methods

ComInLabs

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



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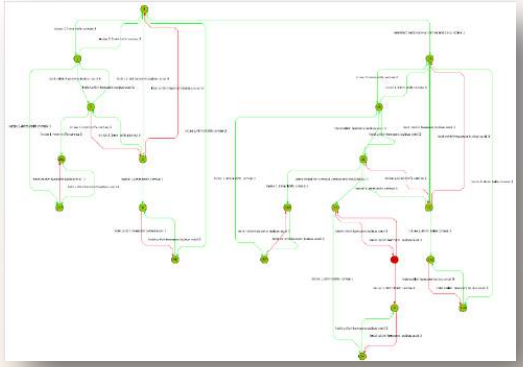

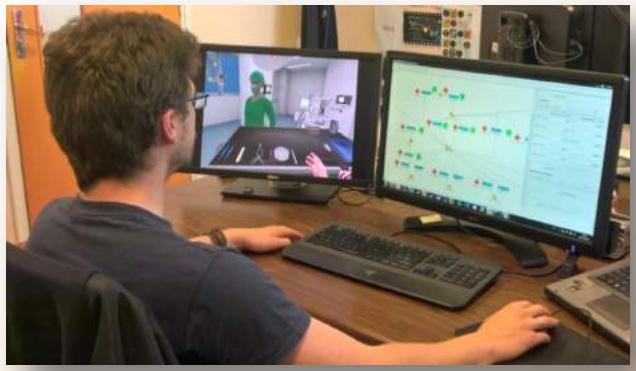

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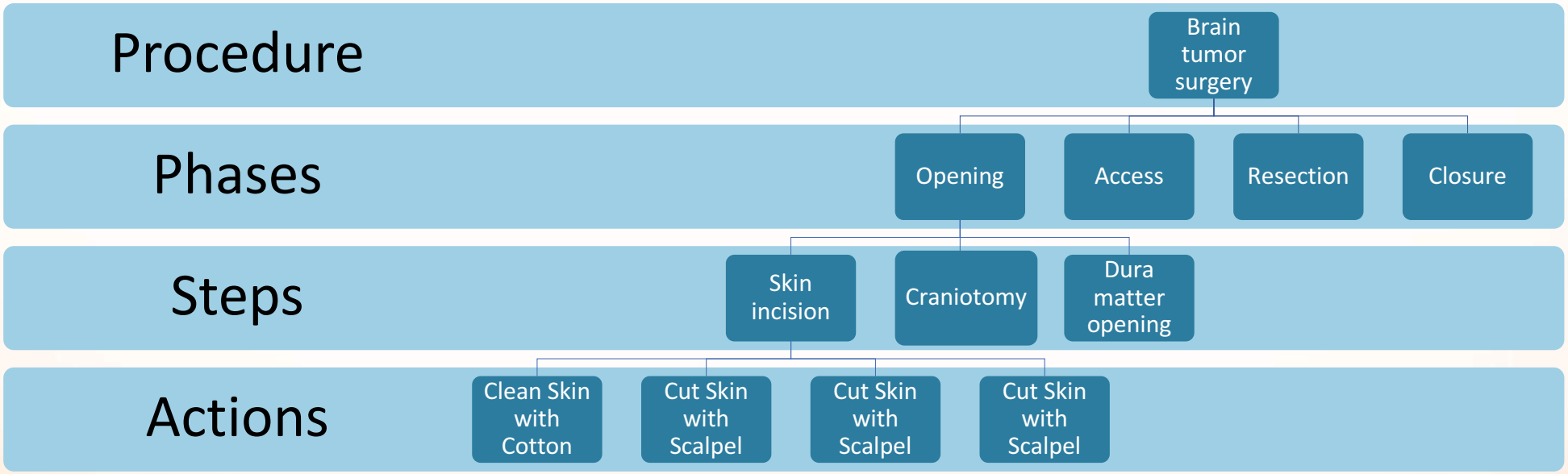
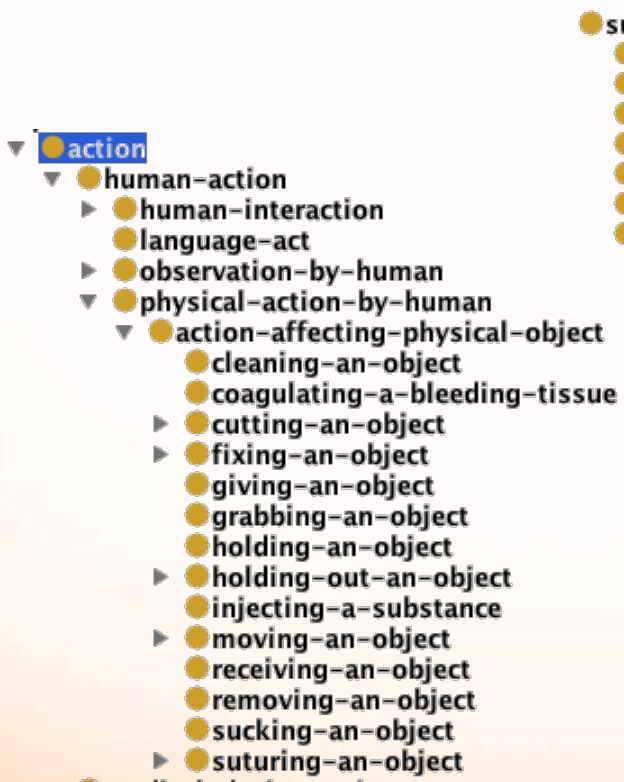
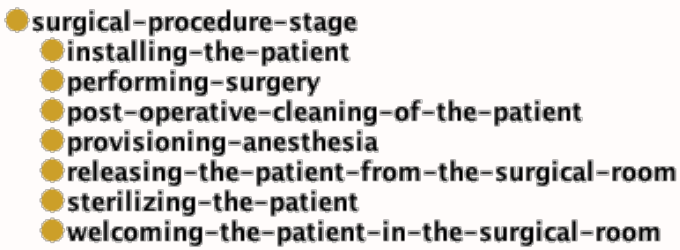
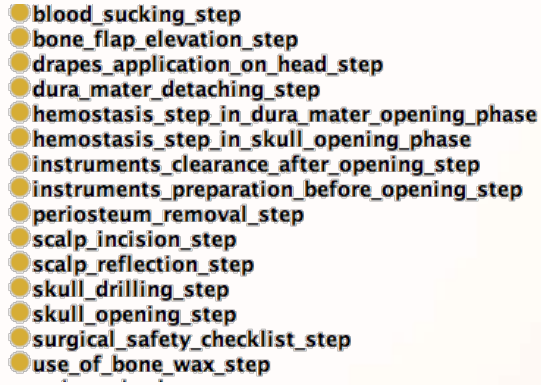

Procedure
Brain tumor surgery
Phases
Opening
Access
Resection
Closure
Steps
Skin incision
Craniotomy
Dura matter opening
Actions
Clean Skin with Cotton
Cut Skin with Scalpel
Cut Skin with Scalpel
Cut Skin with Scalpel

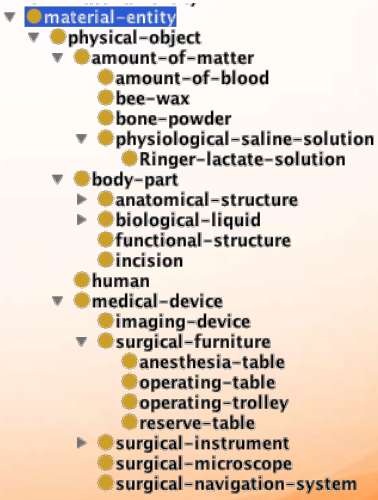
ComInLabs

OntoSPM Ontology









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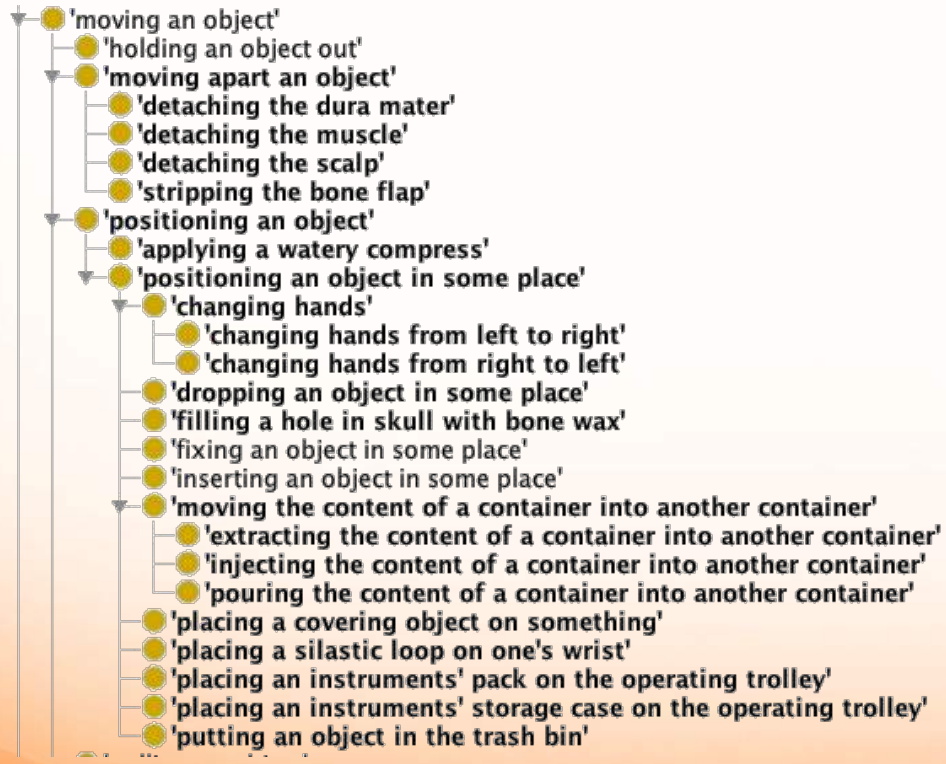
OntoSPM Collaborative Action

- 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



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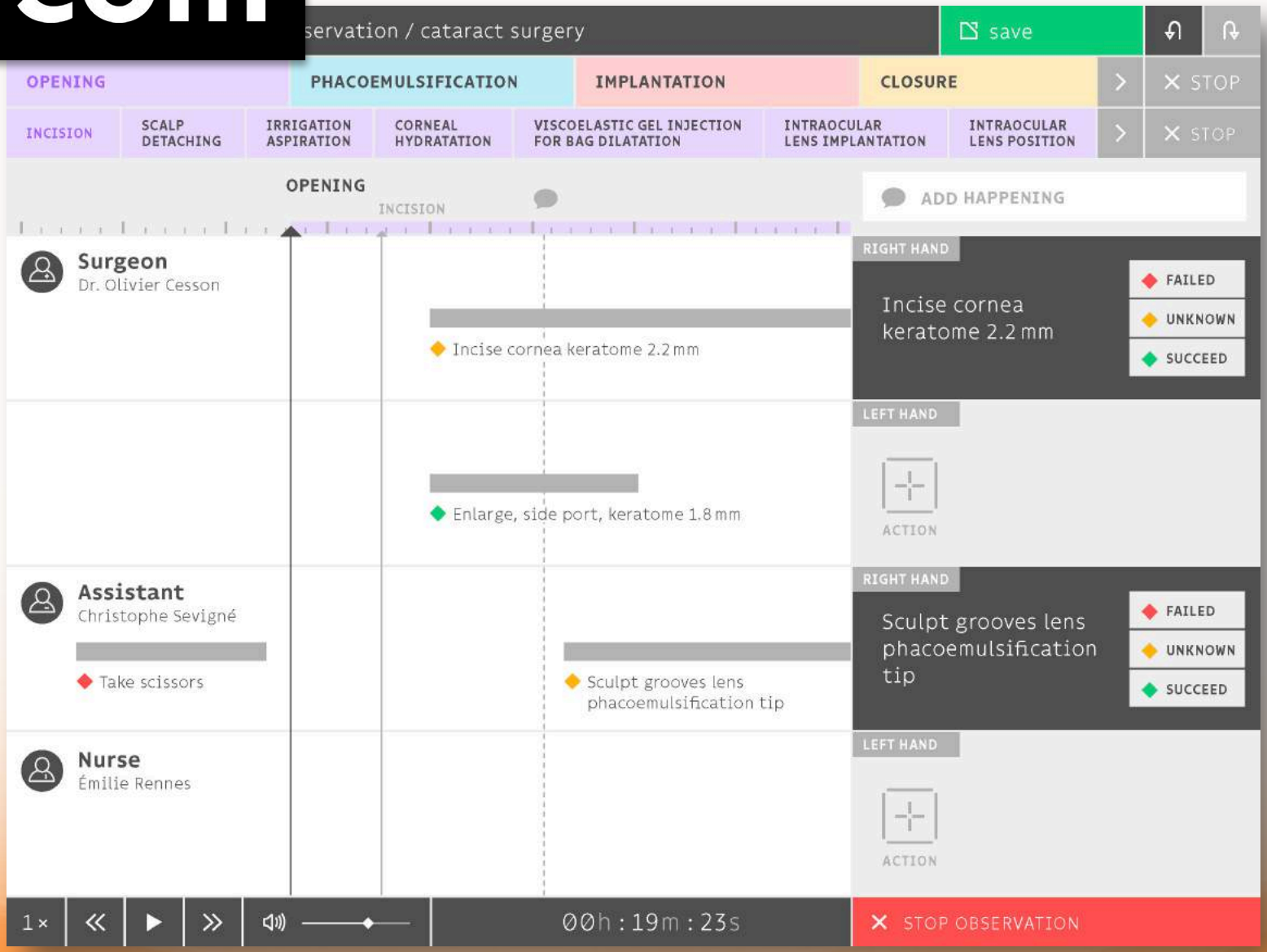

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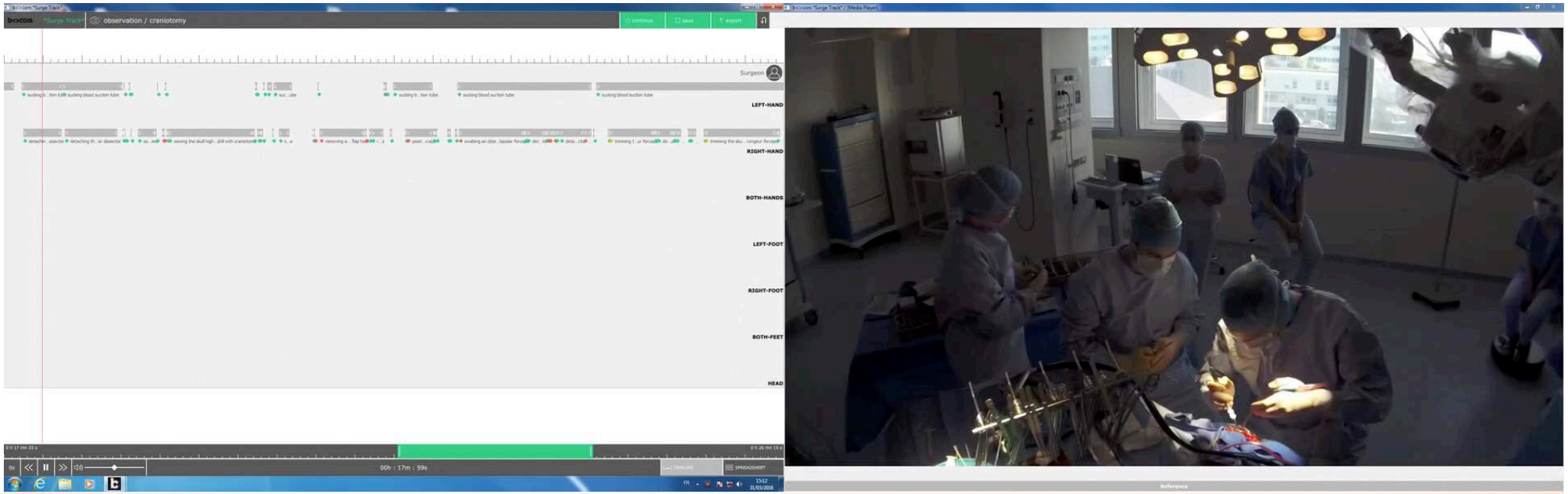
observation / craniotomy
continue
save
export
Surgeon
LEFT-HAND
RIGHT-HAND
BOTH-HANDS
LEFT-FOOT
RIGHT-FOOT
BOTH-FEET
HEAD
00h : 17m : 59s
TIMELINE
SPREADSHEET
Reference

ComInLabs

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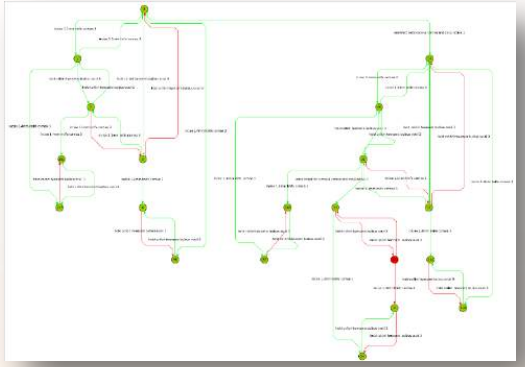

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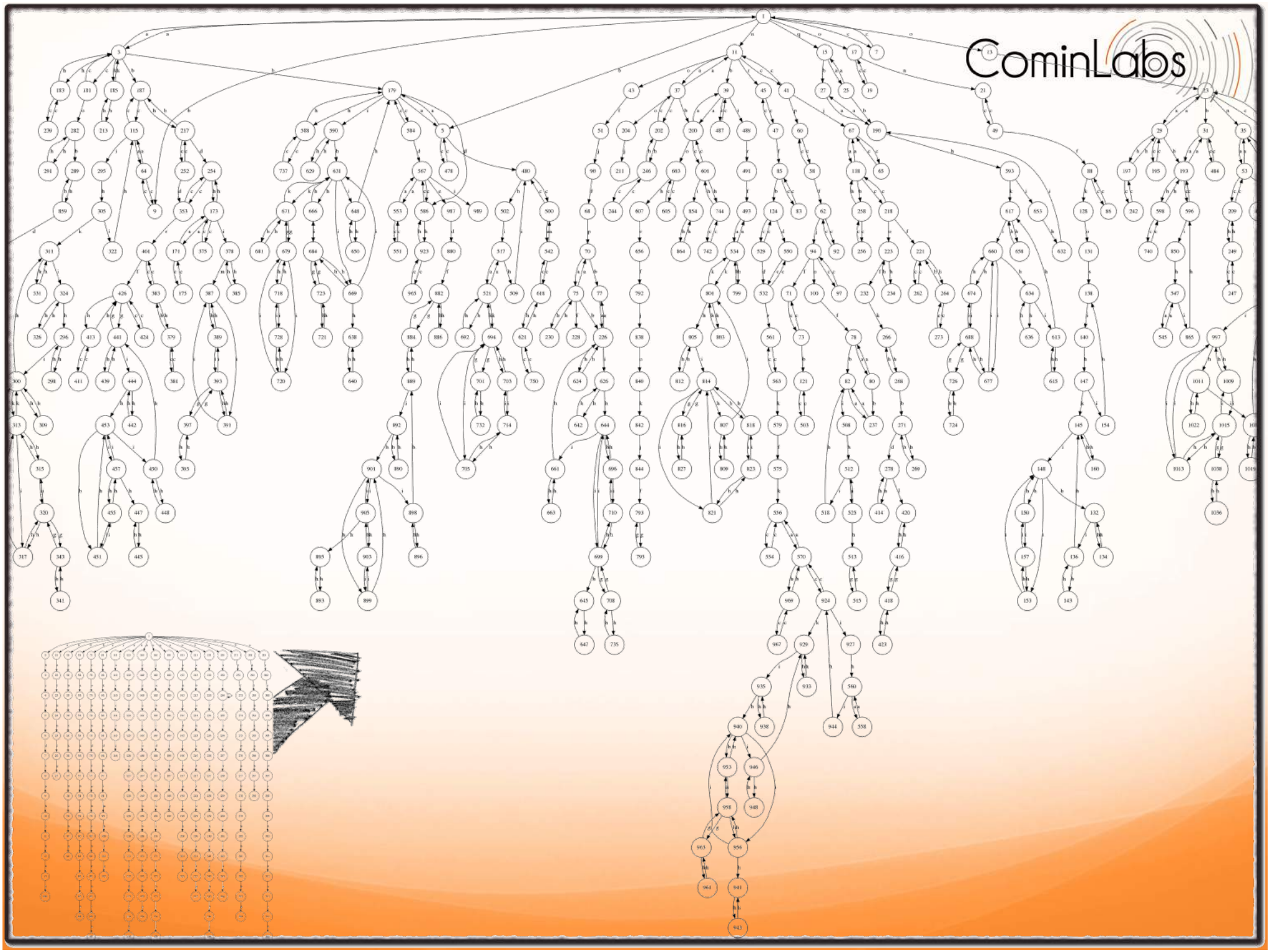
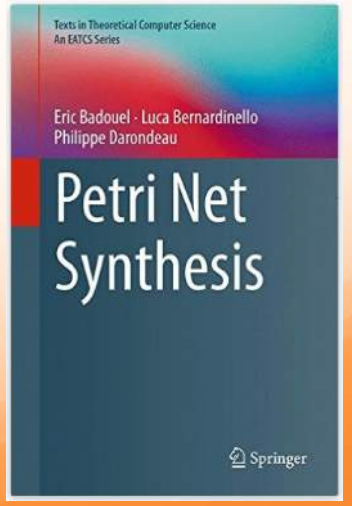
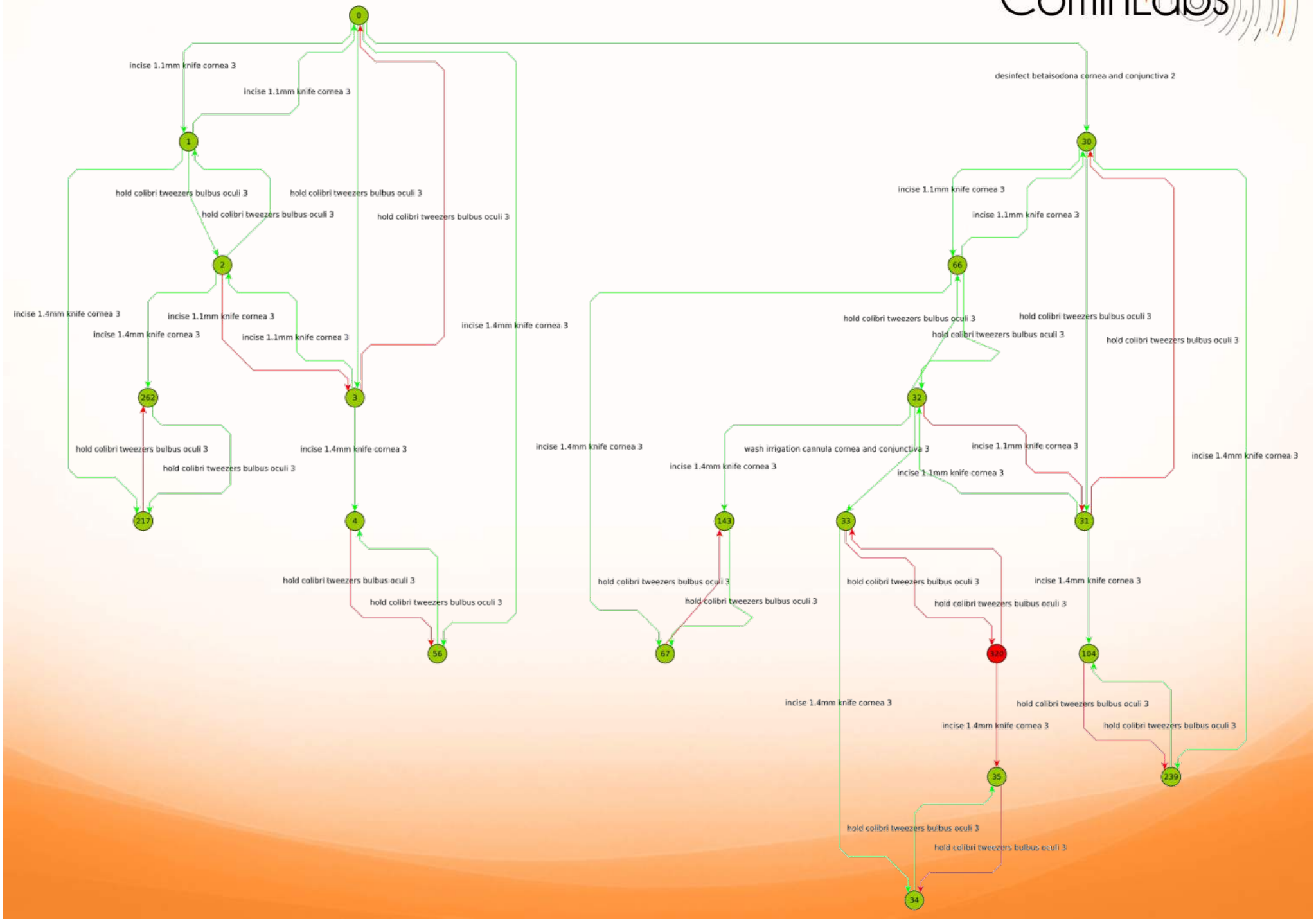

ClominLabs

ComInLabs

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




0
incise 1.1mm knife cornea 3
incise 1.1mm knife cornea 3
1
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
2
incise 1.4mm knife cornea 3
incise 1.1mm knife cornea 3
incise 1.4mm knife cornea 3
incise 1.1mm knife cornea 3
incise 1.4mm knife cornea 3
262
3
hold colibri tweezers bulbus oculi 3
incise 1.4mm knife cornea 3
hold colibri tweezers bulbus oculi 3
217
4
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
56
desinfect betaisodona cornea and conjunctiva 2
30
incise 1.1mm knife cornea 3
incise 1.1mm knife cornea 3
66
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
32
incise 1.4mm knife cornea 3
wash irrigation cannula cornea and conjunctiva 3
incise 1.1mm knife cornea 3
incise 1.4mm knife cornea 3
incise 1.1mm knife cornea 3
incise 1.4mm knife cornea 3
143
33
31
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
incise 1.4mm knife cornea 3
67
320
104
incise 1.4mm knife cornea 3
hold colibri tweezers bulbus oculi 3
incise 1.4mm knife cornea 3
hold colibri tweezers bulbus oculi 3
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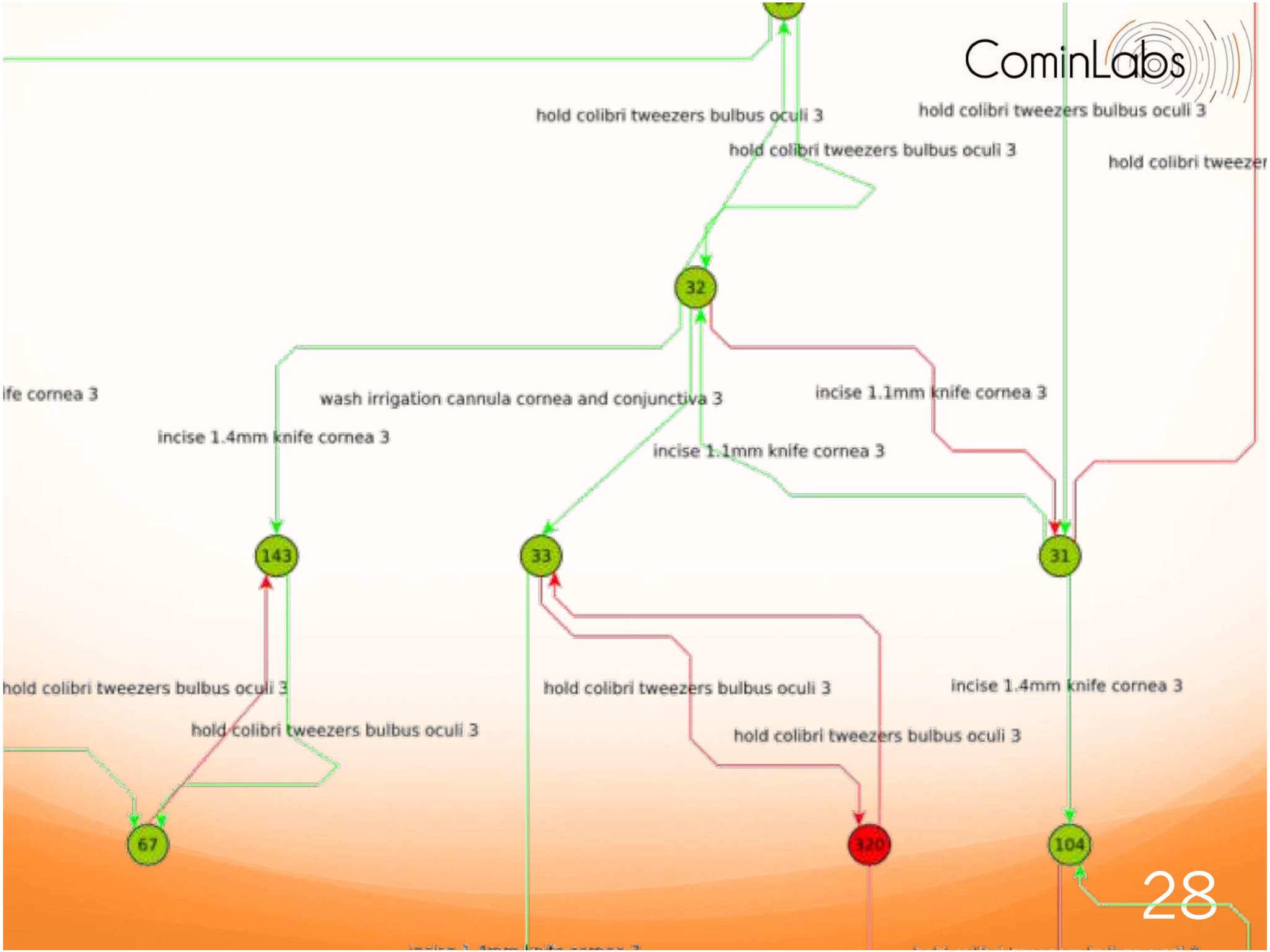
239
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
34


ComInLabs
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
hold colibri tweezer
32
ife cornea 3
wash irrigation cannula cornea and conjunctiva 3
incise 1.1mm knife cornea 3
incise 1.4mm knife cornea 3
incise 1.1mm knife cornea 3
143
33
31
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
hold colibri tweezers bulbus oculi 3
incise 1.4mm knife cornea 3
hold colibri tweezers bulbus oculi 3
67
320
104

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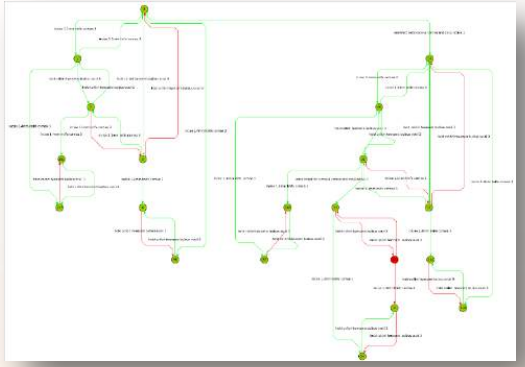

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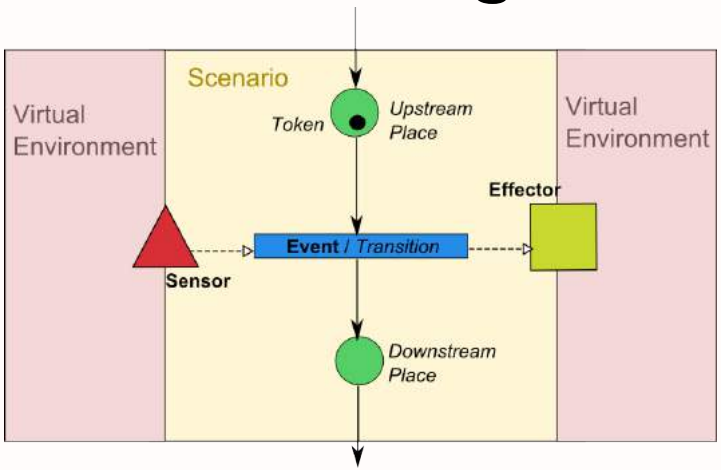
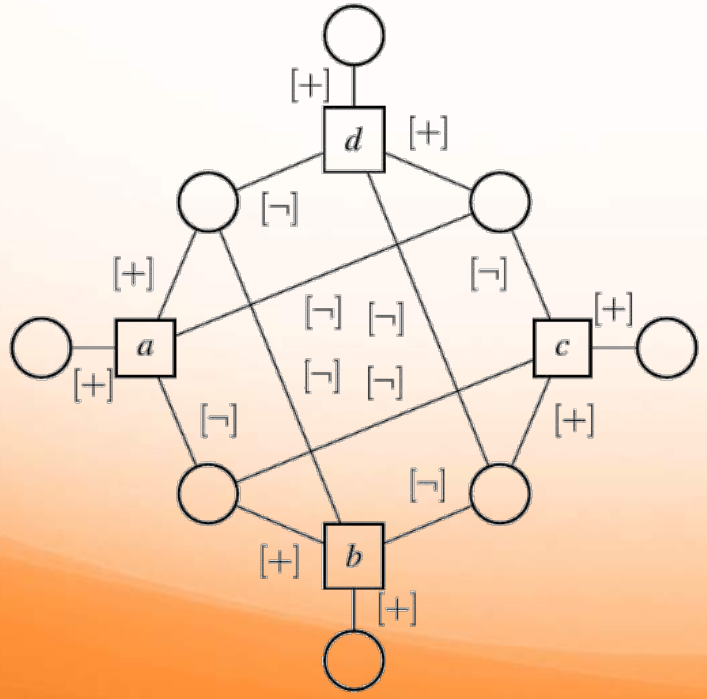
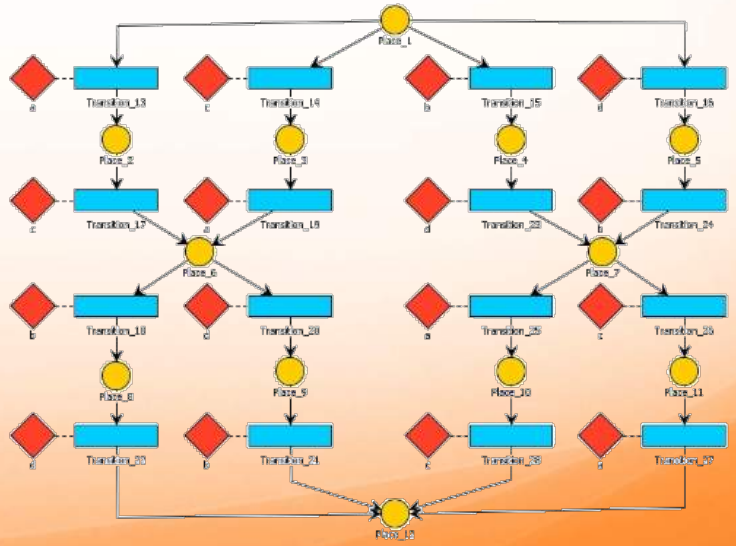
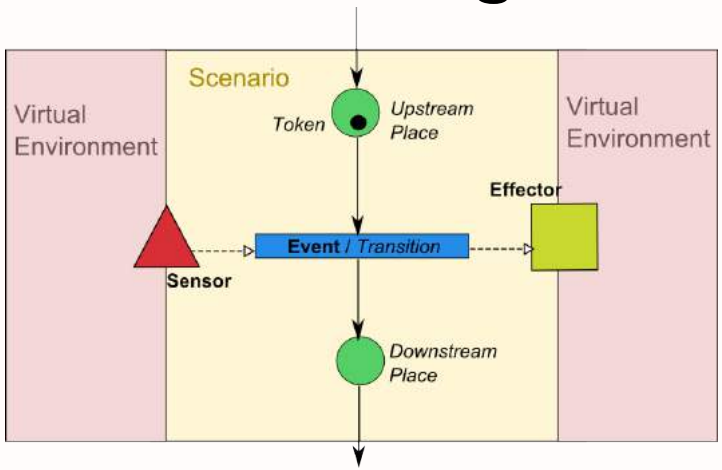
Generic Scenario Manager
Scenario Engine



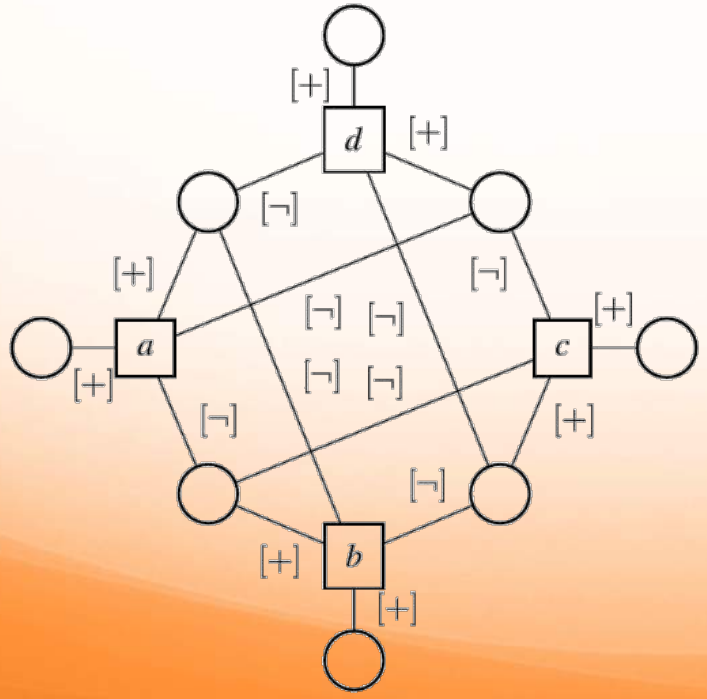


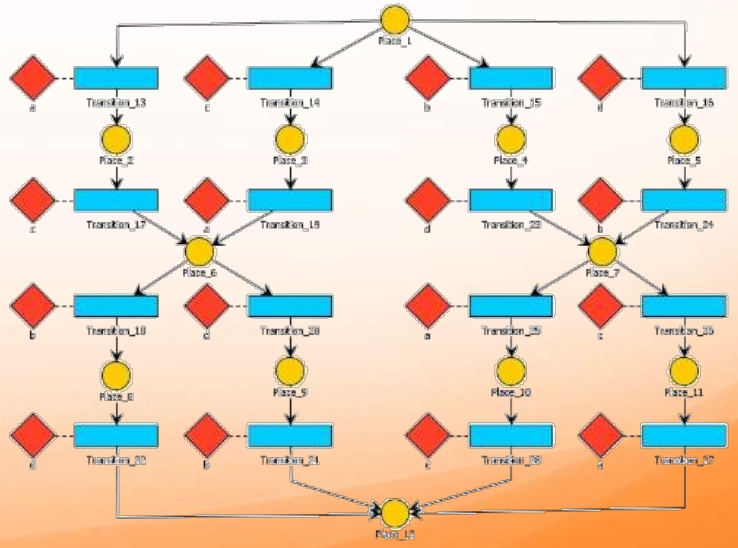


Generic Scenario Manager
Scenario Engine



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





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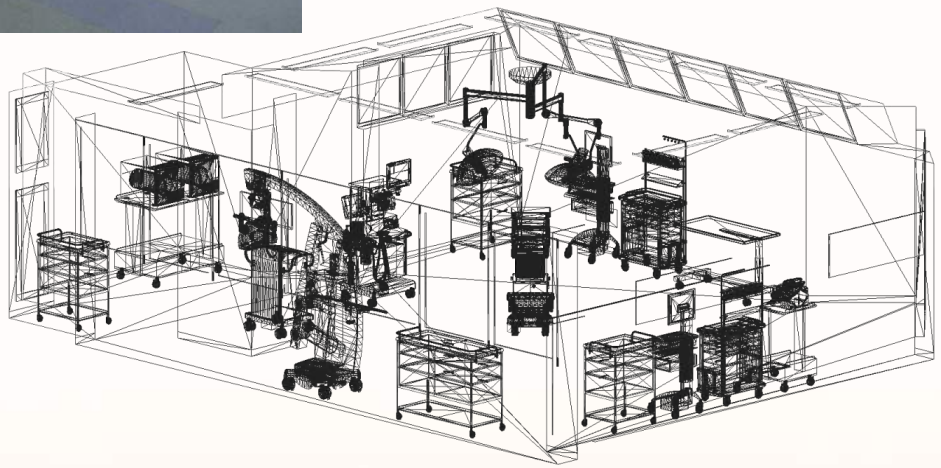
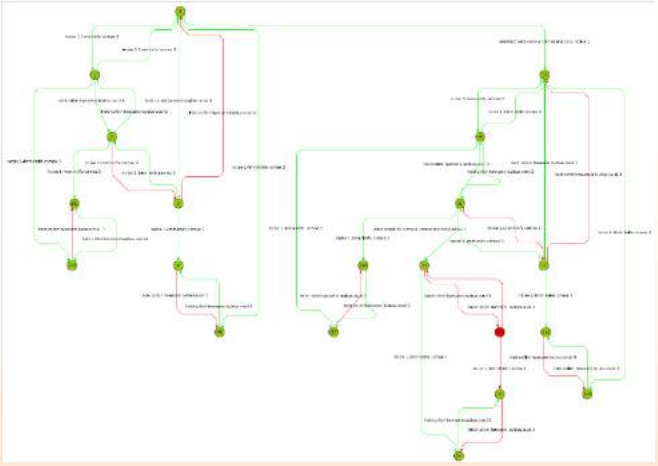


ComInLabs

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

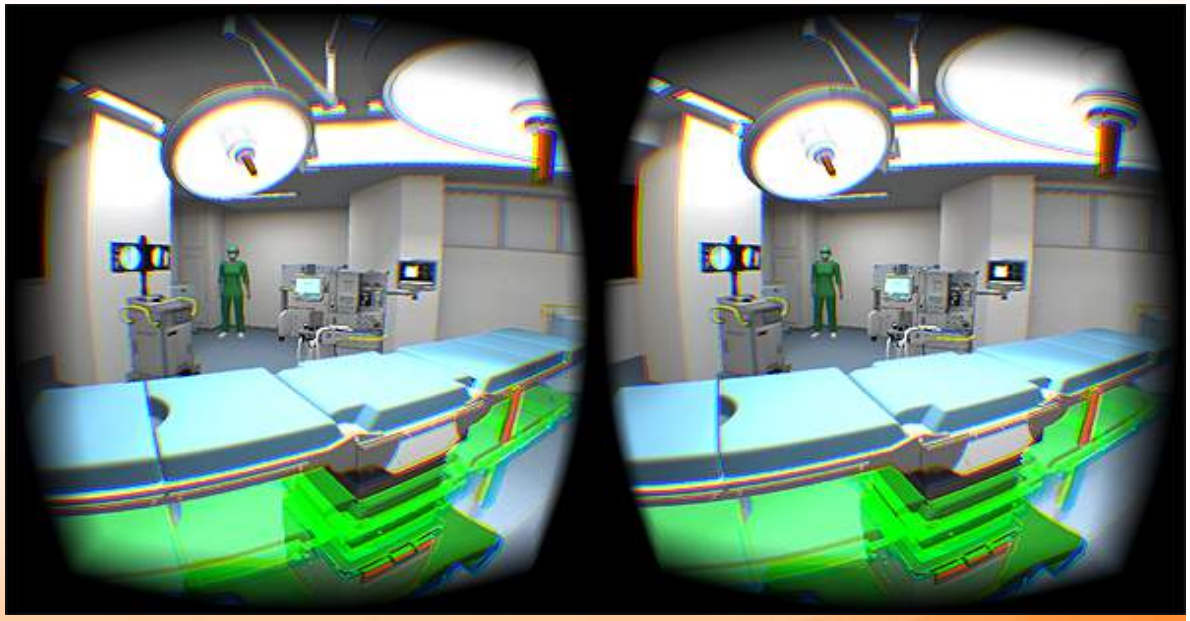


ComInLabs

S3PM

Prototyping

CominLabs



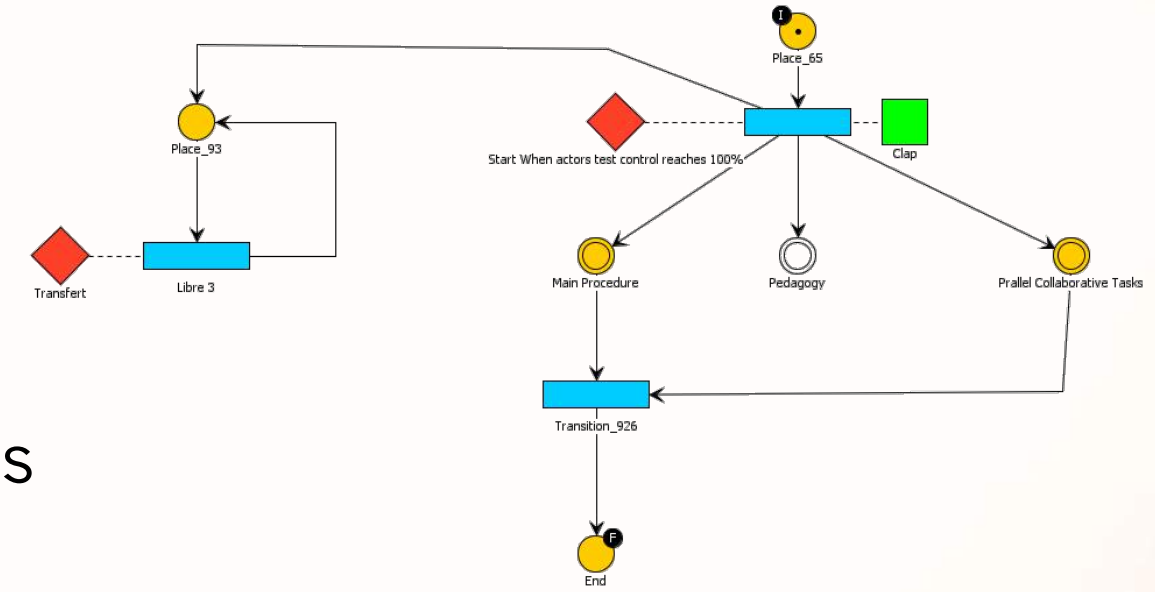
ComInLabs

Vitrail

Virtual reality based **trai**ning simulator for Neurosurgical Scrub Nurse

CHU Rennes

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



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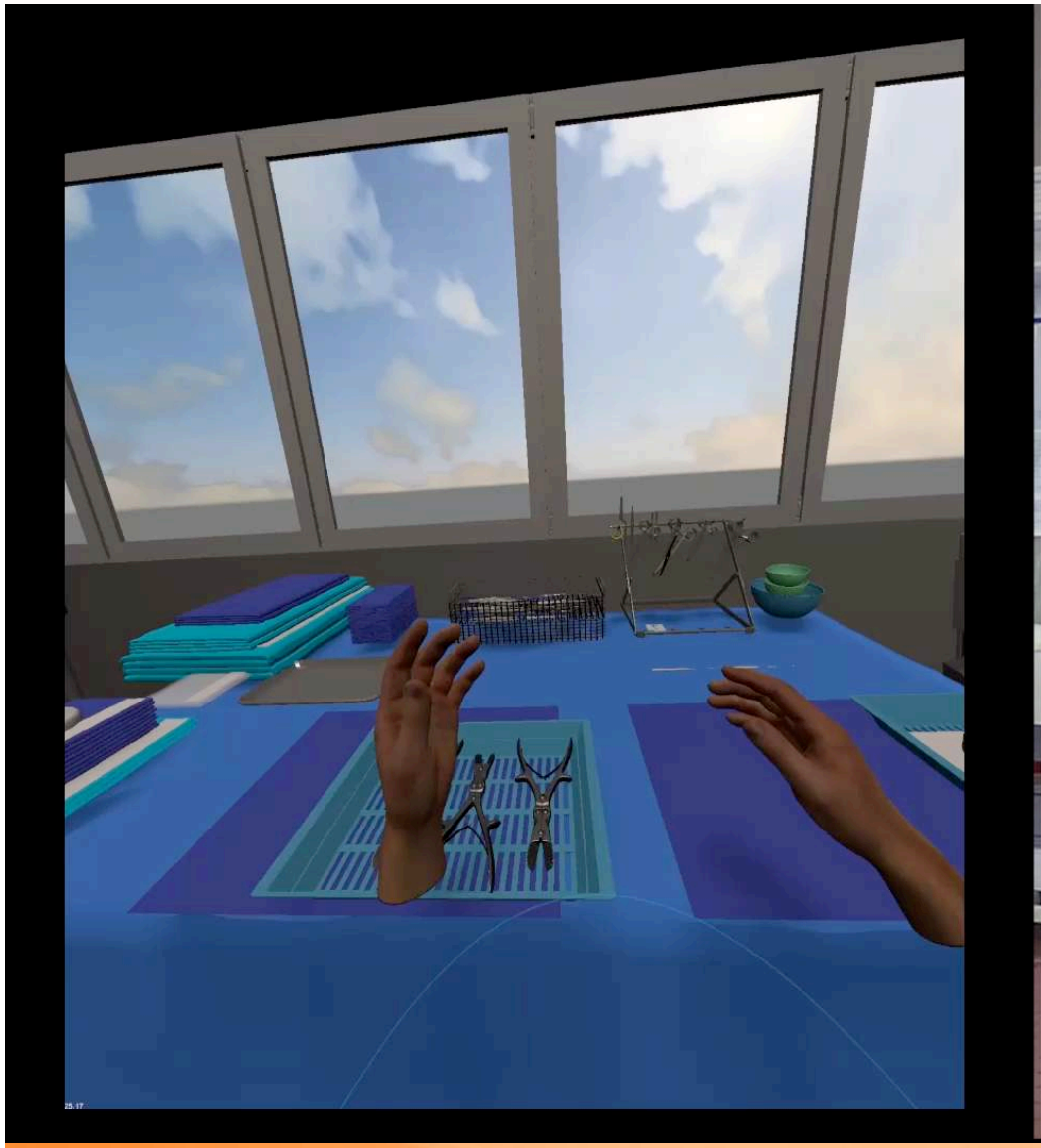

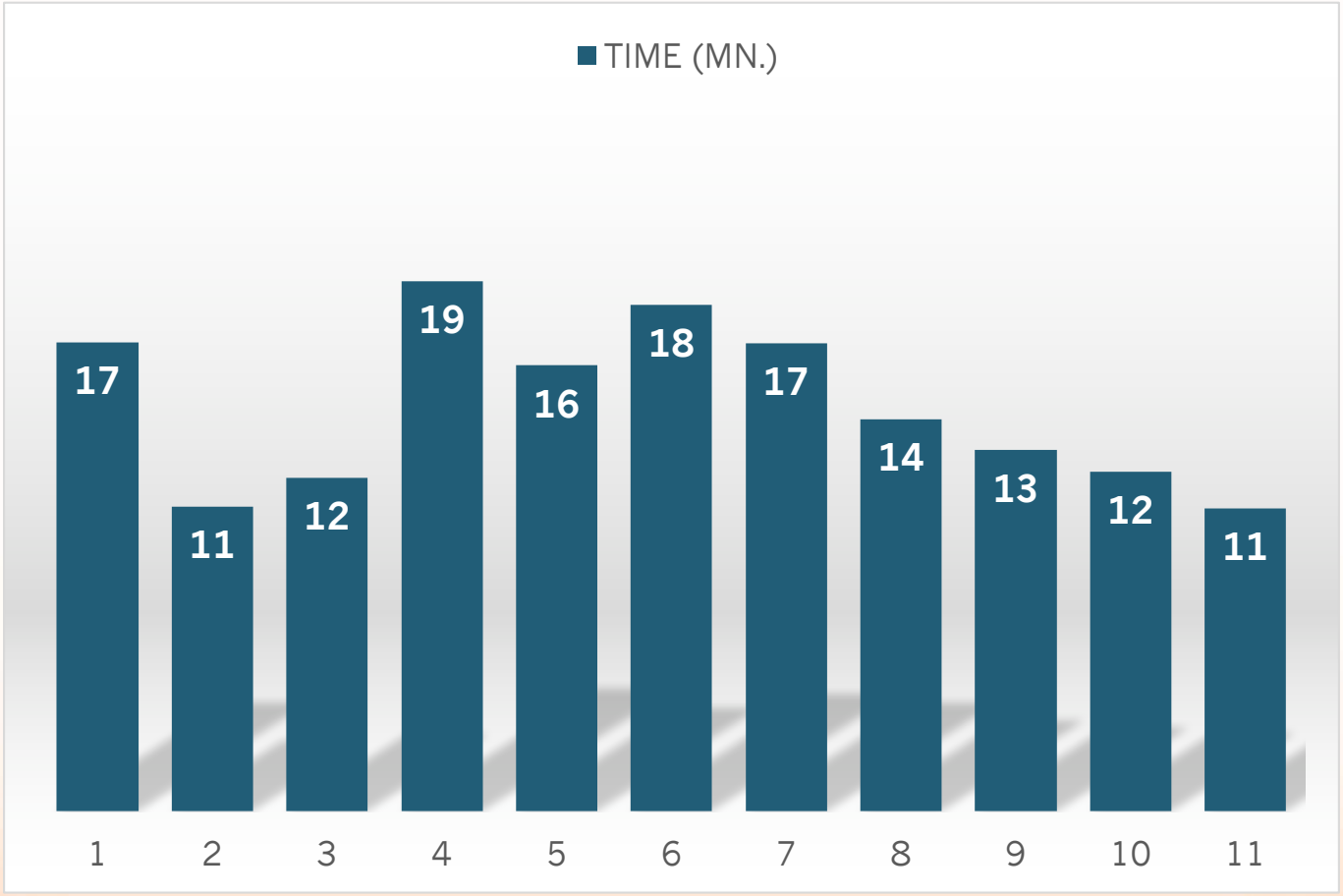
TIME (MN.)
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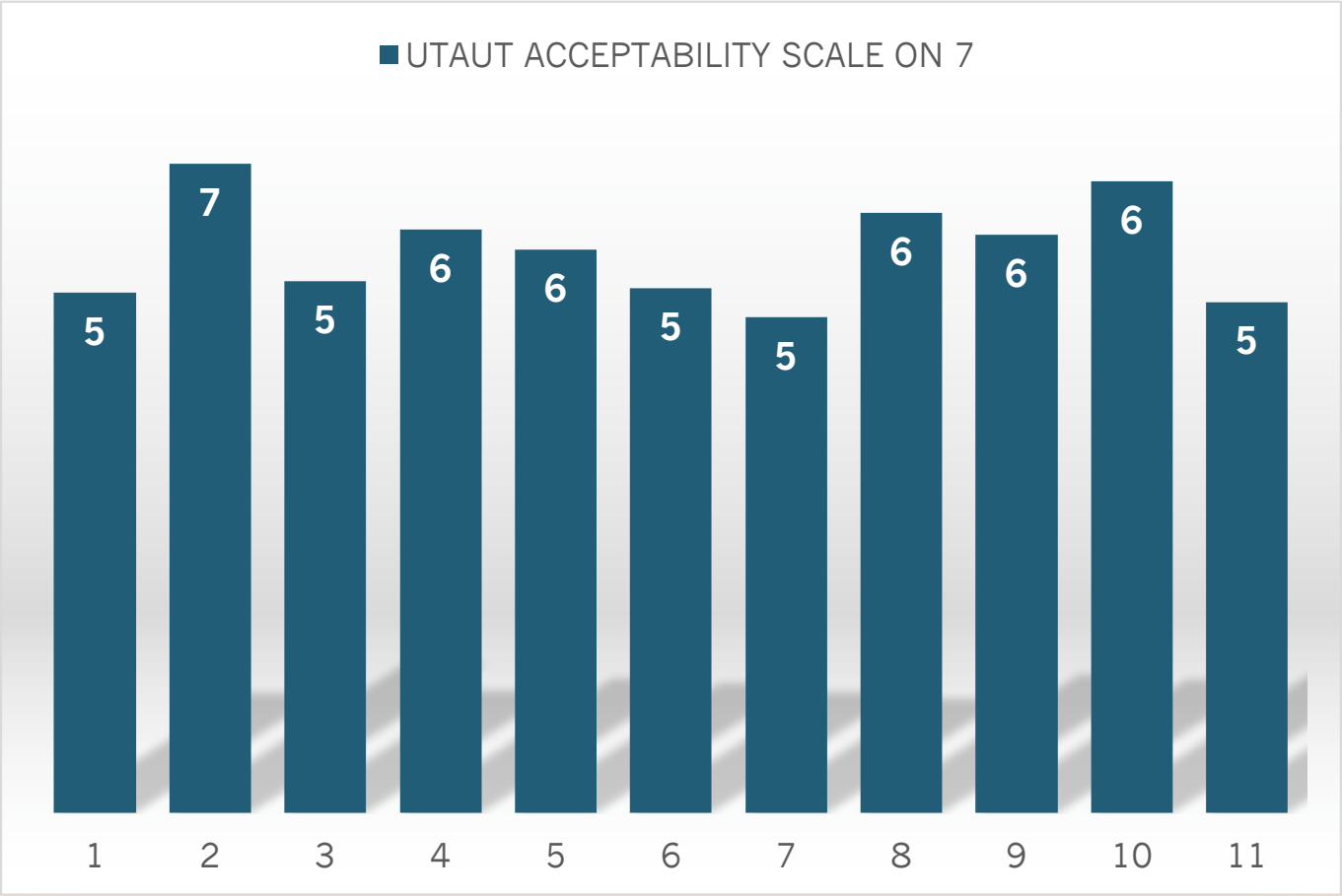
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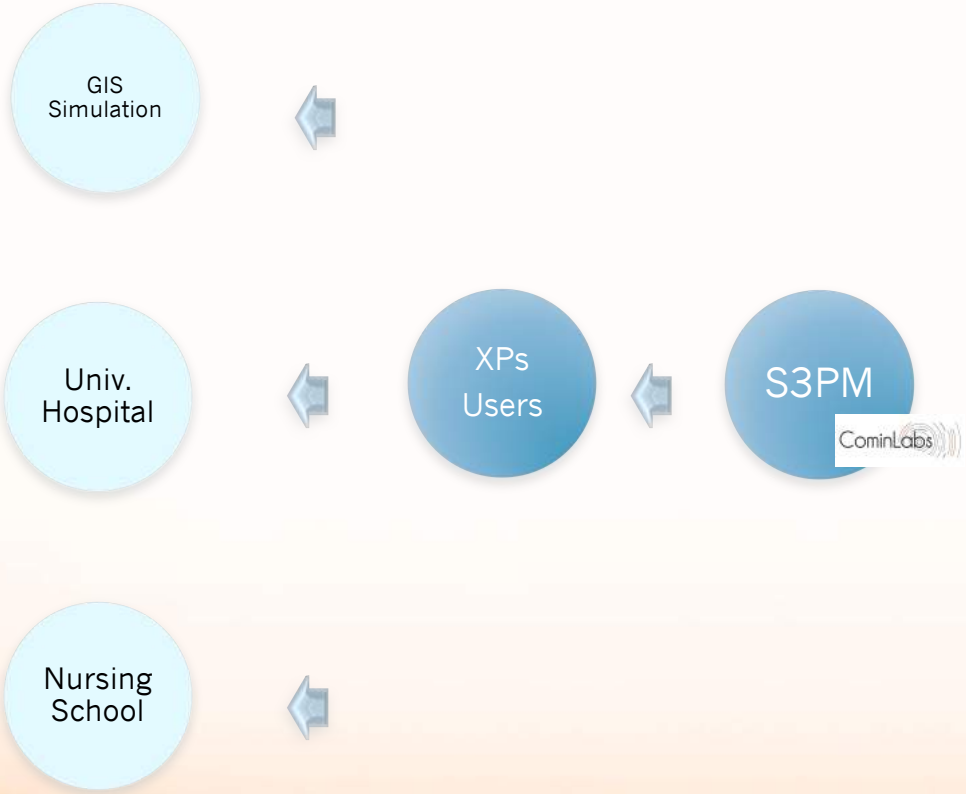
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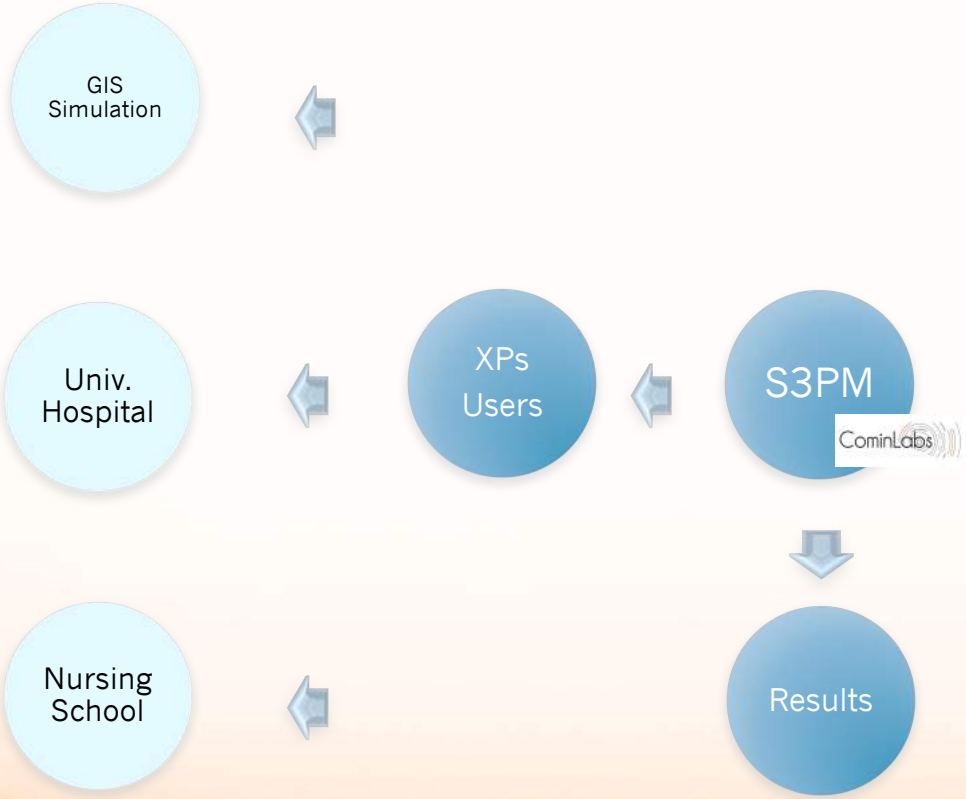
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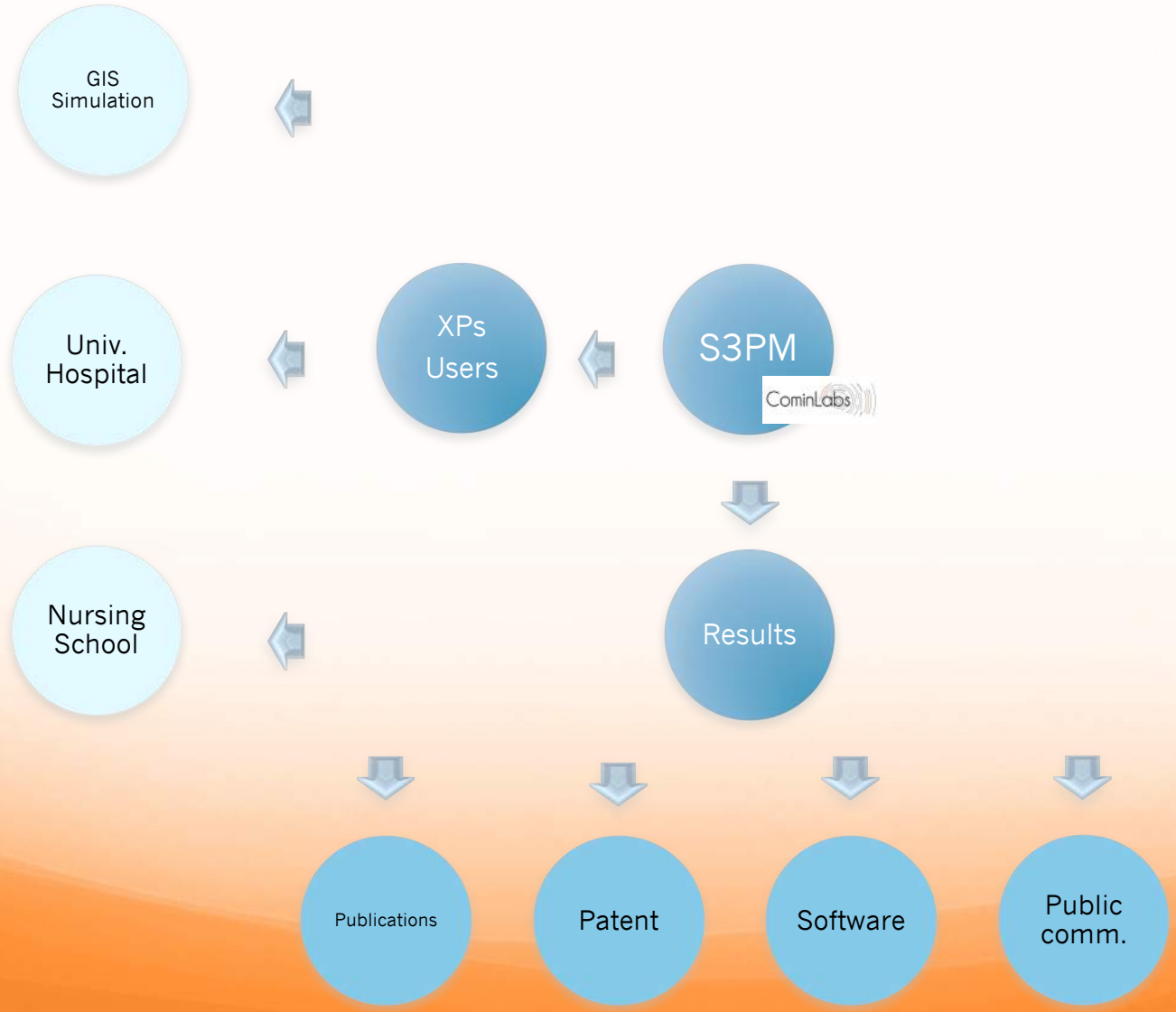
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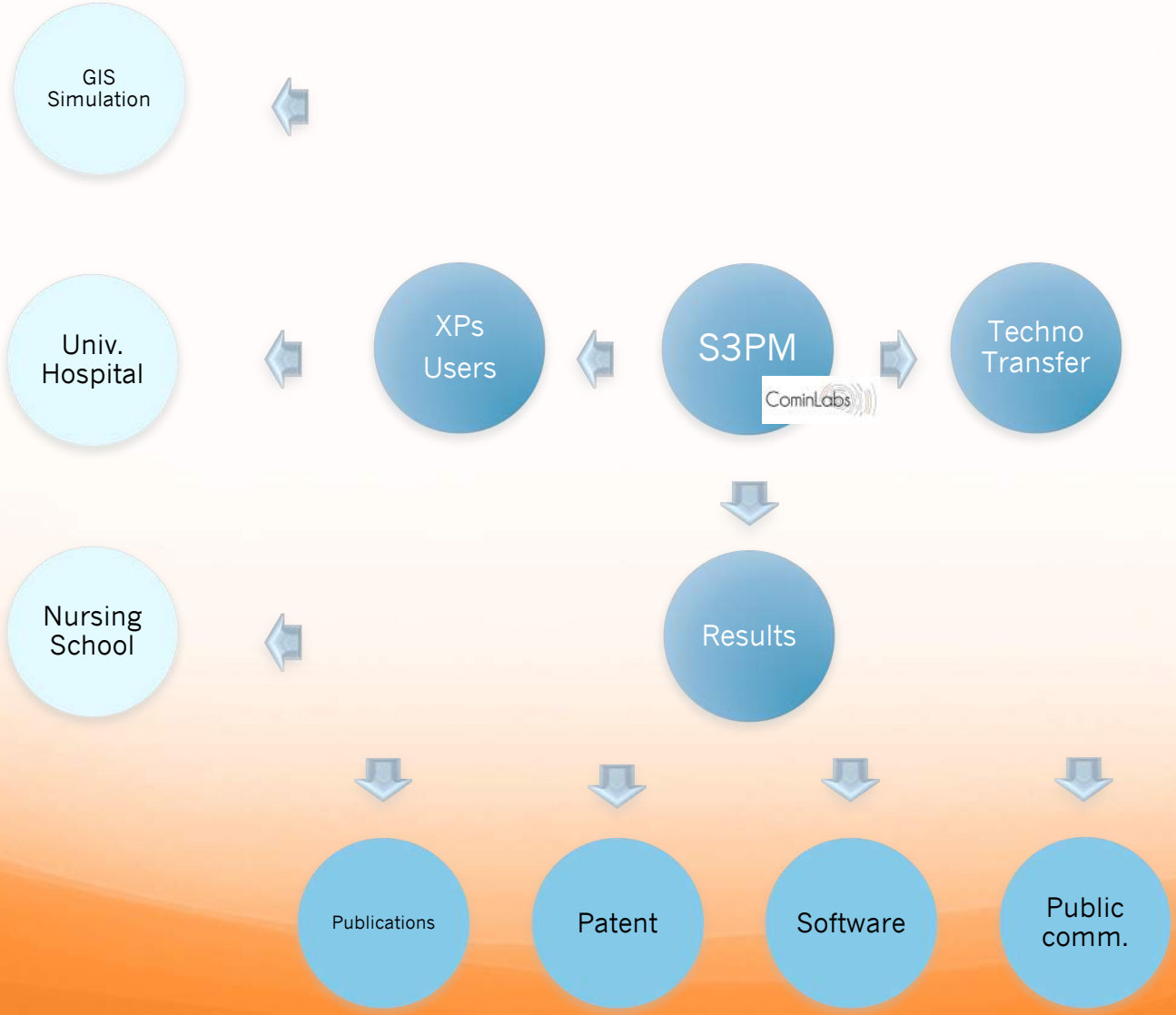
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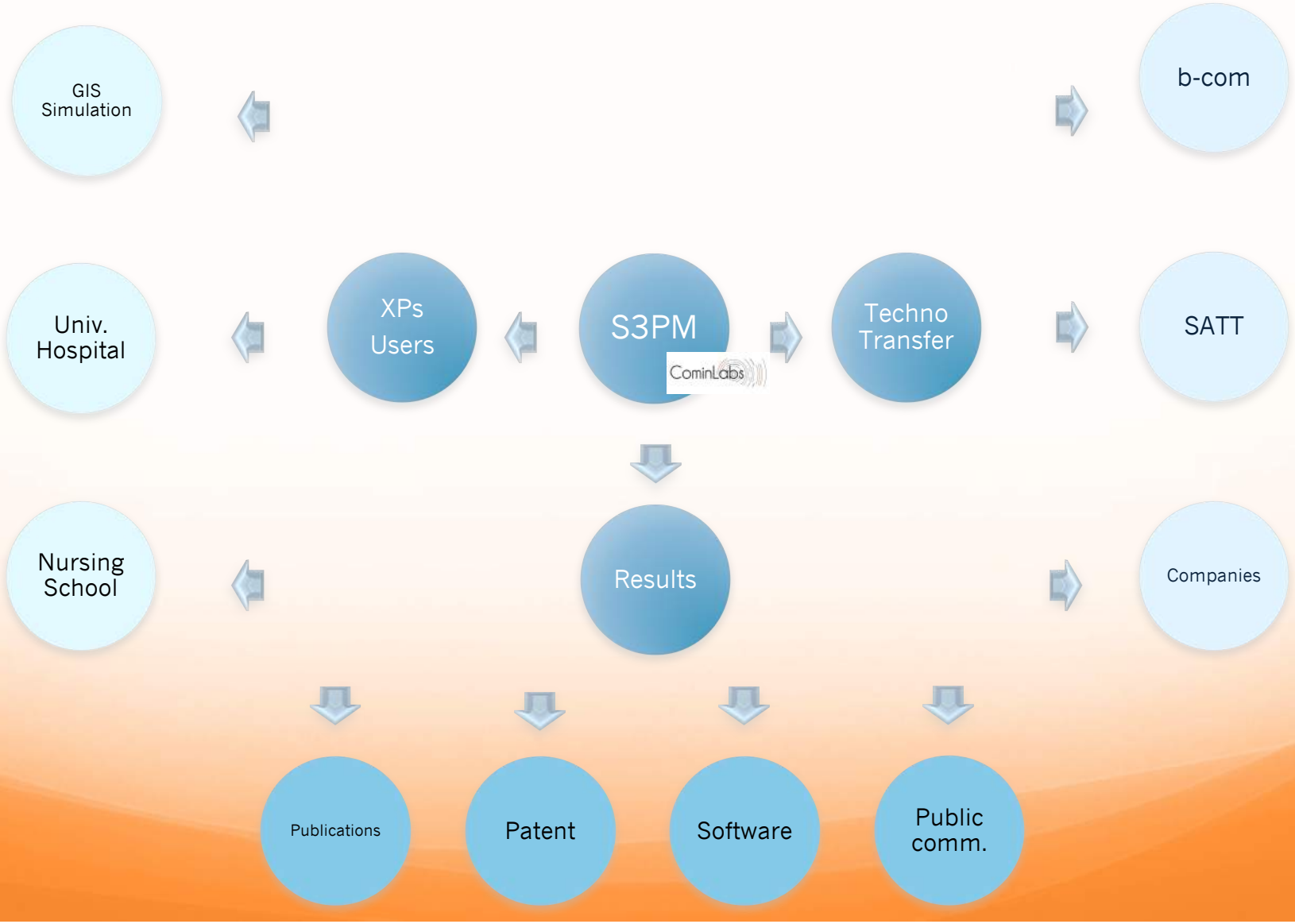
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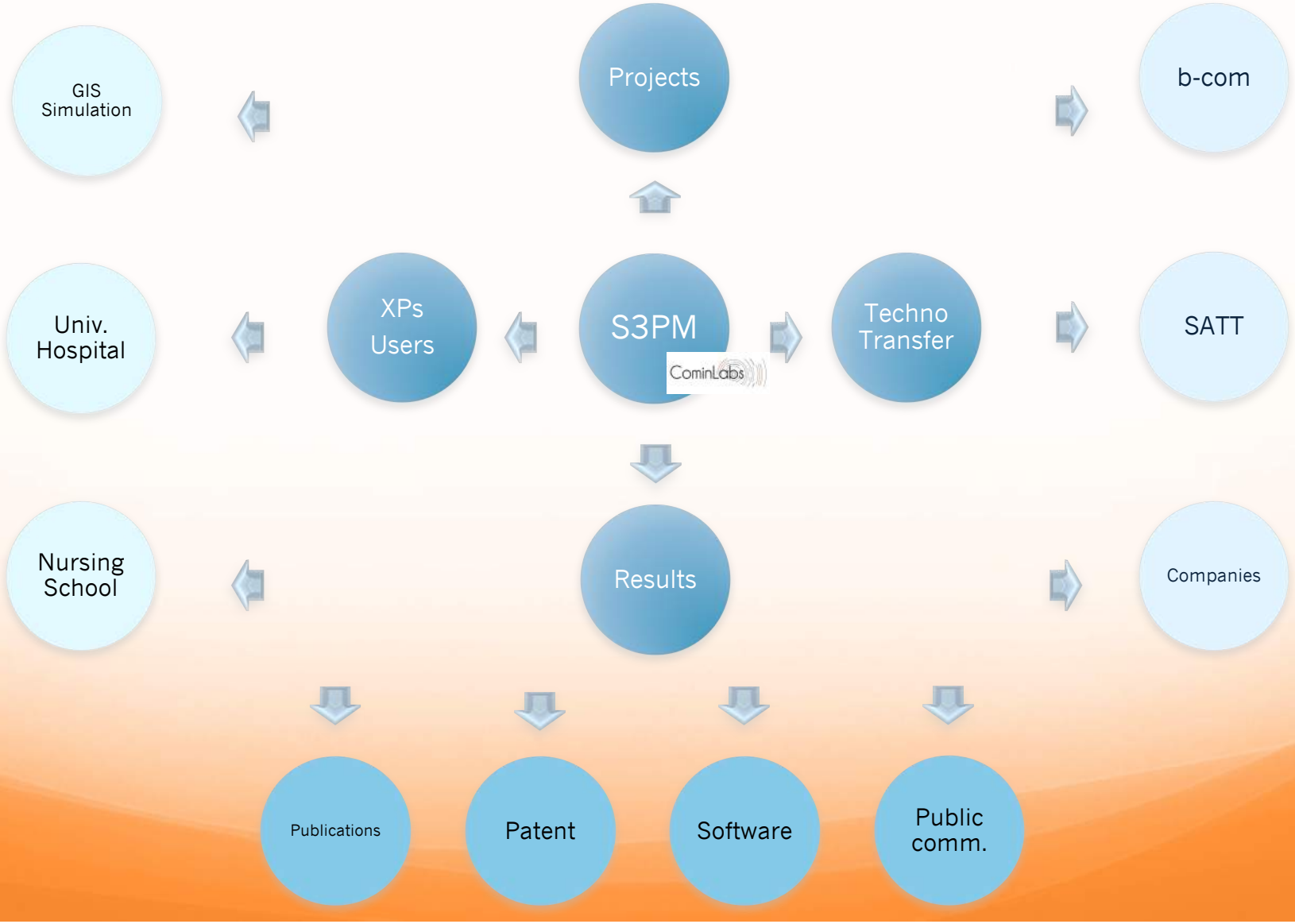
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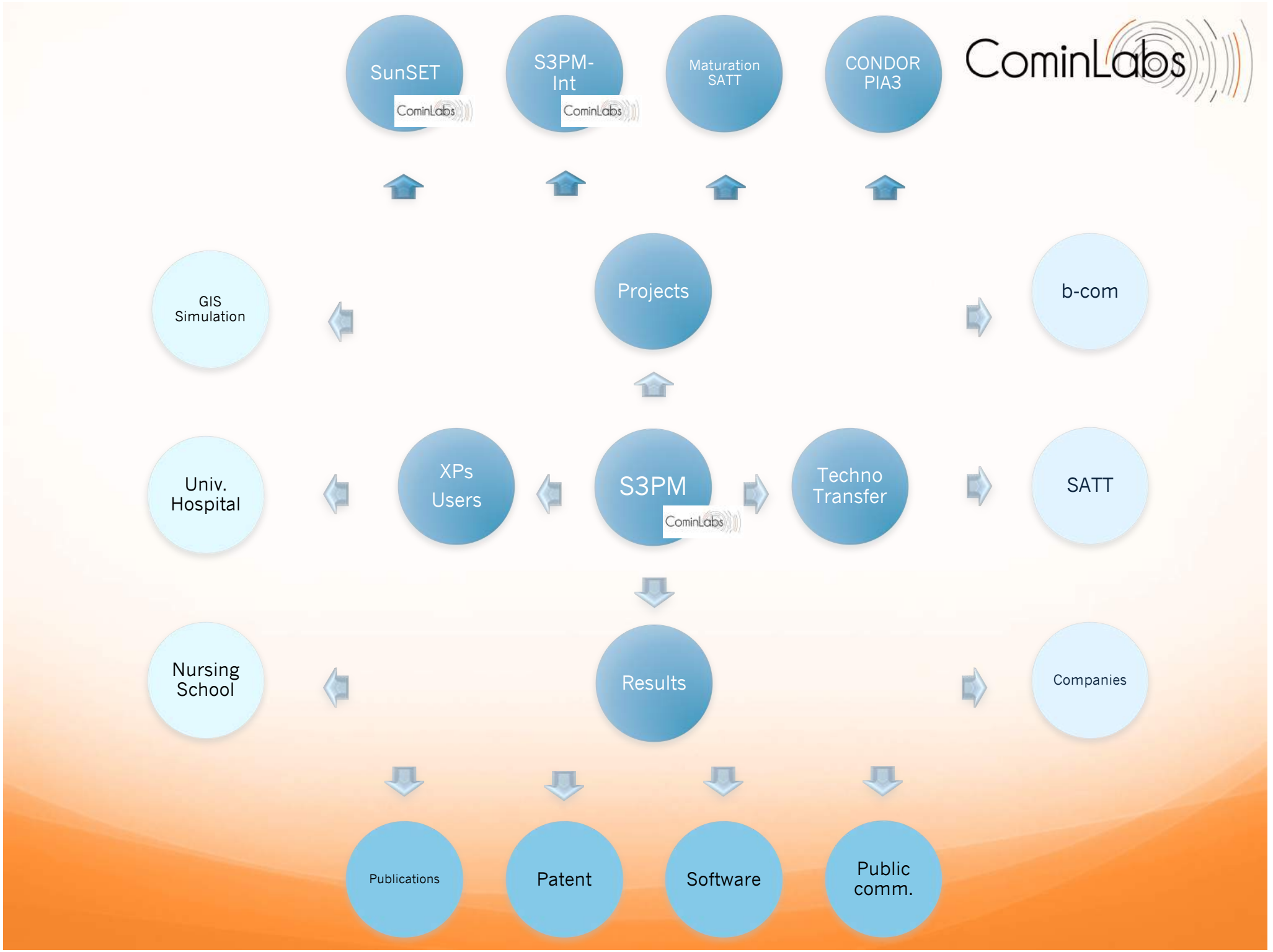
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