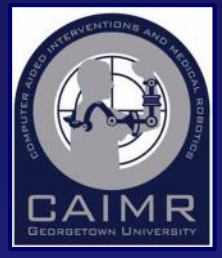

IGT System Design

Kevin Cleary, PhD

Imaging Science and Information Systems
(ISIS Center)

Department of Radiology

Georgetown University Medical Center

Washington, DC

cleary@georgetown.edu

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Take Home Message

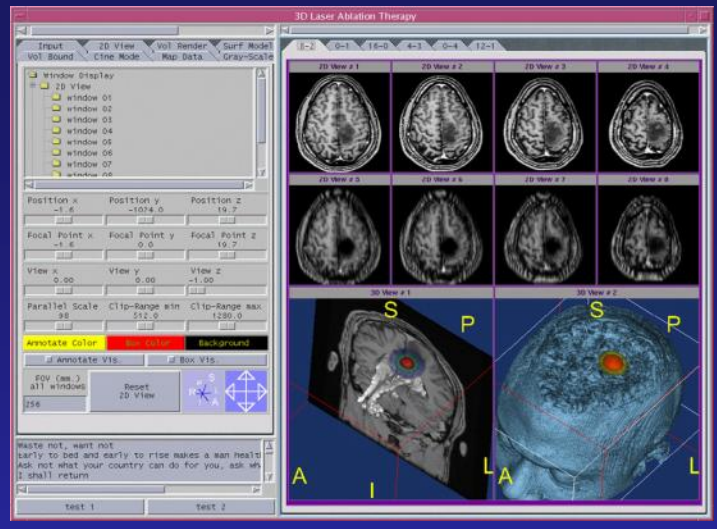
- IGT is a systems engineering problem
  - System design / requirements is first step
- Modularity is key
  - Component based approach
  - Timing is good as field is emerging
  - Science of image guidance
- NCIGT can help
  - Organization, infrastructure, prototype systems, and critical mass

Outline

- What is an IGT system?
- System design
  - Modularity
  - Design processes
- Components
  - Standards
  - Software
  - Trackers
  - Robots
  - Image-guided systems
- Challenges
- How can NCIGT help?

Courtesy of Accuray Inc.

Courtesy of Ferenc Jolesz, MD



OR2020 Examples (or2020.org)

Courtesy of Heinz Lemke, PhD

Courtesy of Mehran Anvari, MD

What is an IGT System?

- From Workshop web page: IGT systems
  - Integrated devices for therapy delivery
  - Incorporate intra-operative medical imaging, navigation, or robotics
- Compare this with the definition of a system
  - Set of interrelated components working together towards some common objective
  - Reference: Systems Engineering Principles and Practice, Kossiakoff and Sweet, Wiley, 2003, page 3
- Creating an IGT system
  - “Systems Engineering” job
  - Domain knowledge is critical

System Design Definition

- The process of defining the architecture, components, interfaces, and other characteristics of a system or component (page 434)
- Requirements are critical to this process
- Obtaining good requirements can be difficult
- Often a weak link in research projects (because of this difficulty)

System Design: Modularity

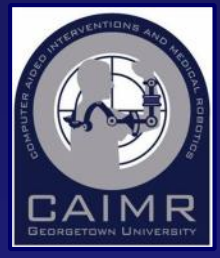
- Essential goal of systems engineering
  - High degree of modularity (page 10)
- Critical issue for our field
  - Where should we draw these interfaces?
  - Poor modularity makes it difficult to integrate components
  - Regulatory issues are important

Why Can't We Have Modularity for IGT (or can we?)

- Is the domain too complex?
  - Many different procedures
  - Physician practice varies
- Is the field too young?
  - Not enough critical mass
  - Science of IGT not mature
- Is it a regulatory problem?
- Or is the timing ripe?

One Possible Pathway

1. Identify clinically important problems where image-guided therapy may be useful
2. Workflow analysis of these procedures
3. Develop a requirements specification
4. Partition the systems into modules by determining where the interfaces lie
5. Implement and test system



System Design Processes

- Many traditional life cycle approaches
  - These are heavyweight processes
- We want an agile process
  - Can an agile process produce a quality product for the medical domain?
  - Agile does not imply unmanaged
  - Open source software tools may apply

Components of an IGT System

- Standards
- Software
- Trackers
- Robotics
- Commercial image-guided systems with accessible APIs

Standards: Accuracy Measurement

- ASTM Committee F04.05 on Computer Assisted Orthopaedic Surgical Systems
- WK5350 New Standard Practice for Accuracy Measurement in Computer-Assisted Orthopedic Surgery
- Scope
  - Clinically relevant assessment procedures
  - Focus on engineering performance of a system
- http://www.astm.org

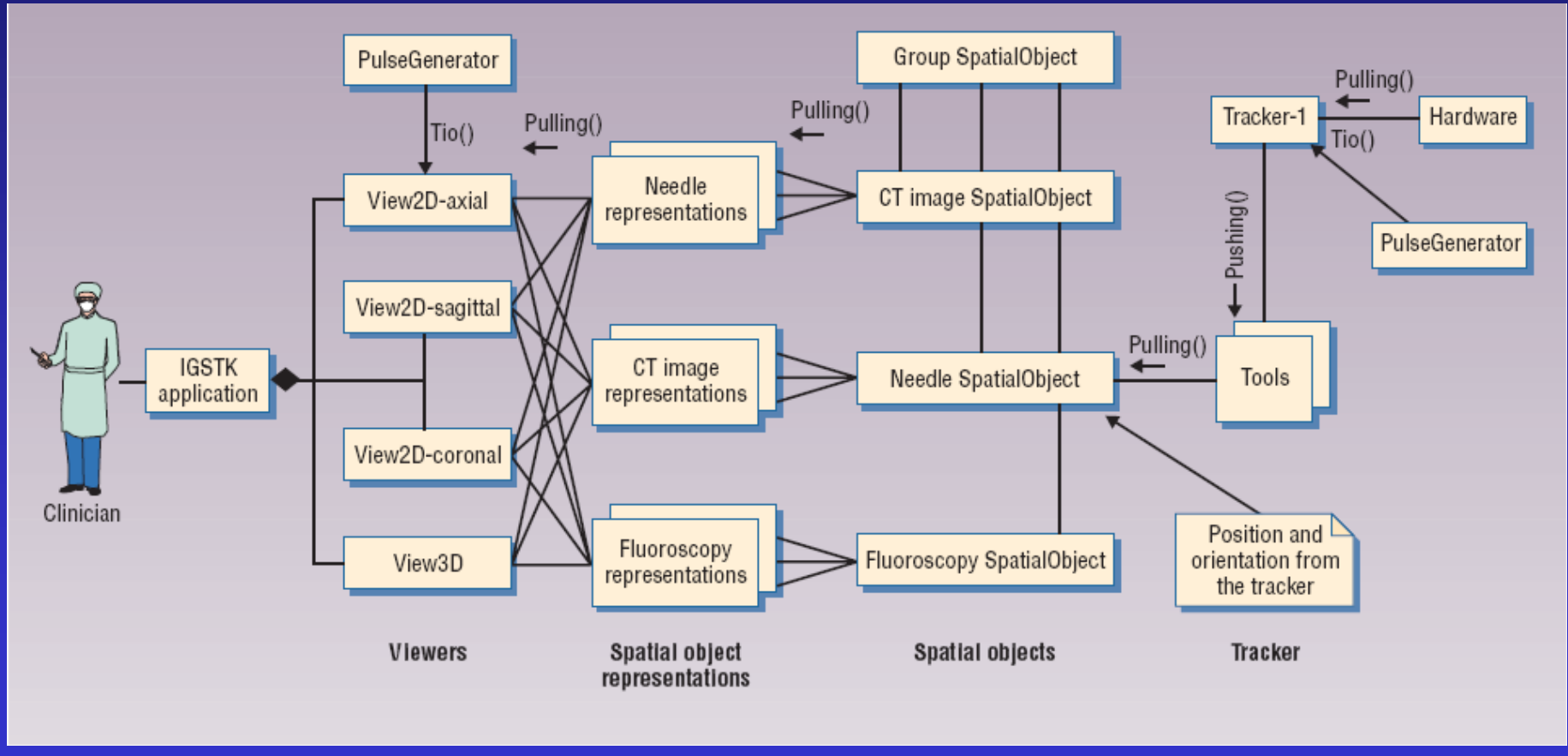
Standards: DICOM WG24

- Scope: To develop DICOM objects and services related to image guided surgery
- Roadmap
  - Representatives from surgical disciplines
  - Establish workflows
  - Propose DICOM services
- White paper in progress
- Chair: Heinz Lemke, PhD

Medical Device "Plug-and-Play" Interoperability Program

- Goal: standardizing medical device connectivity
- Based at CIMIT and Massachusetts General
- Standard under development
  - Integrated Clinical Environment Manager
  - Vendor neutral laboratory “sandbox”
- http://mdpnp.org/

Software
IGSTK: Image-Guided Surgical Toolkit



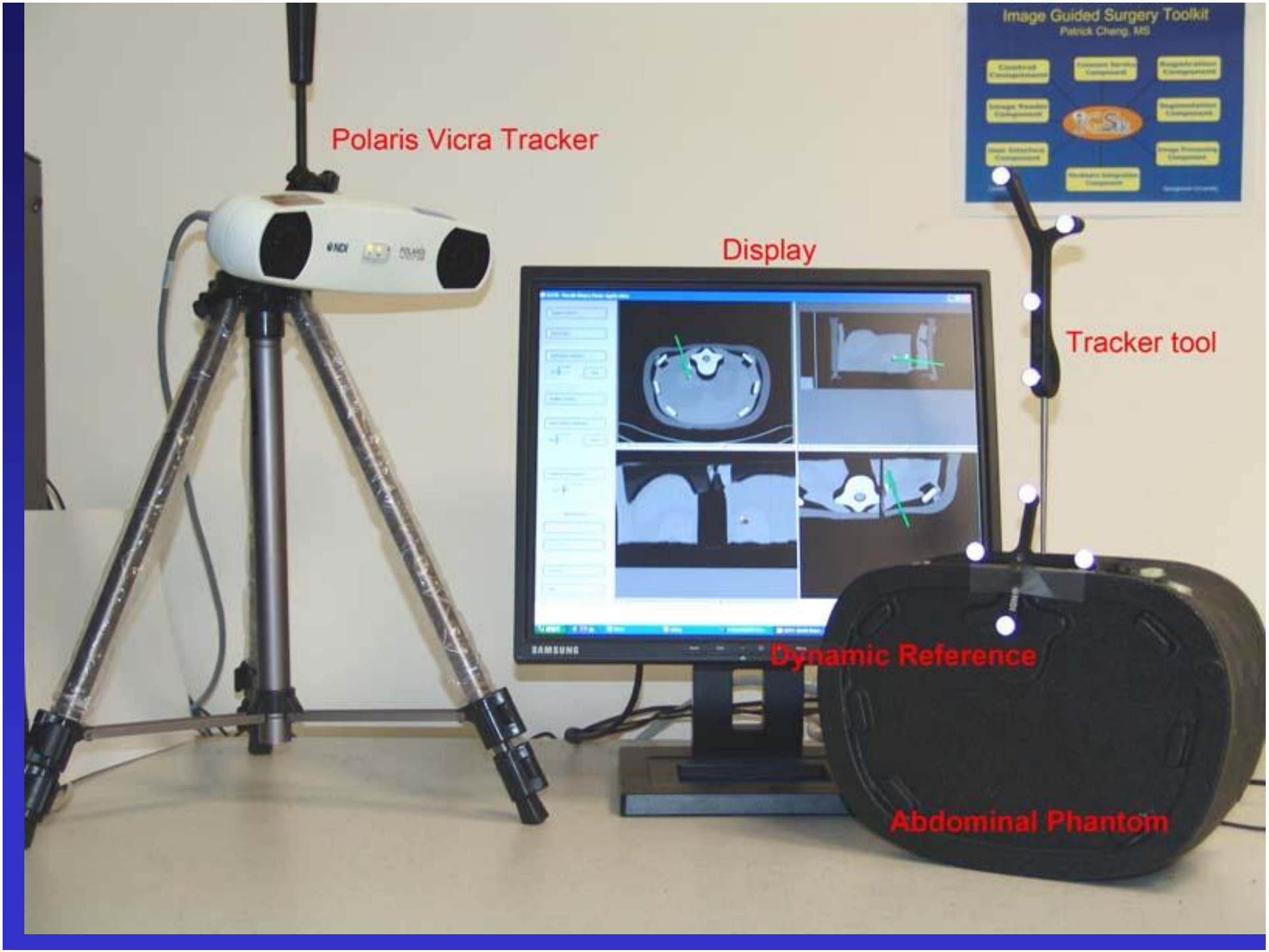
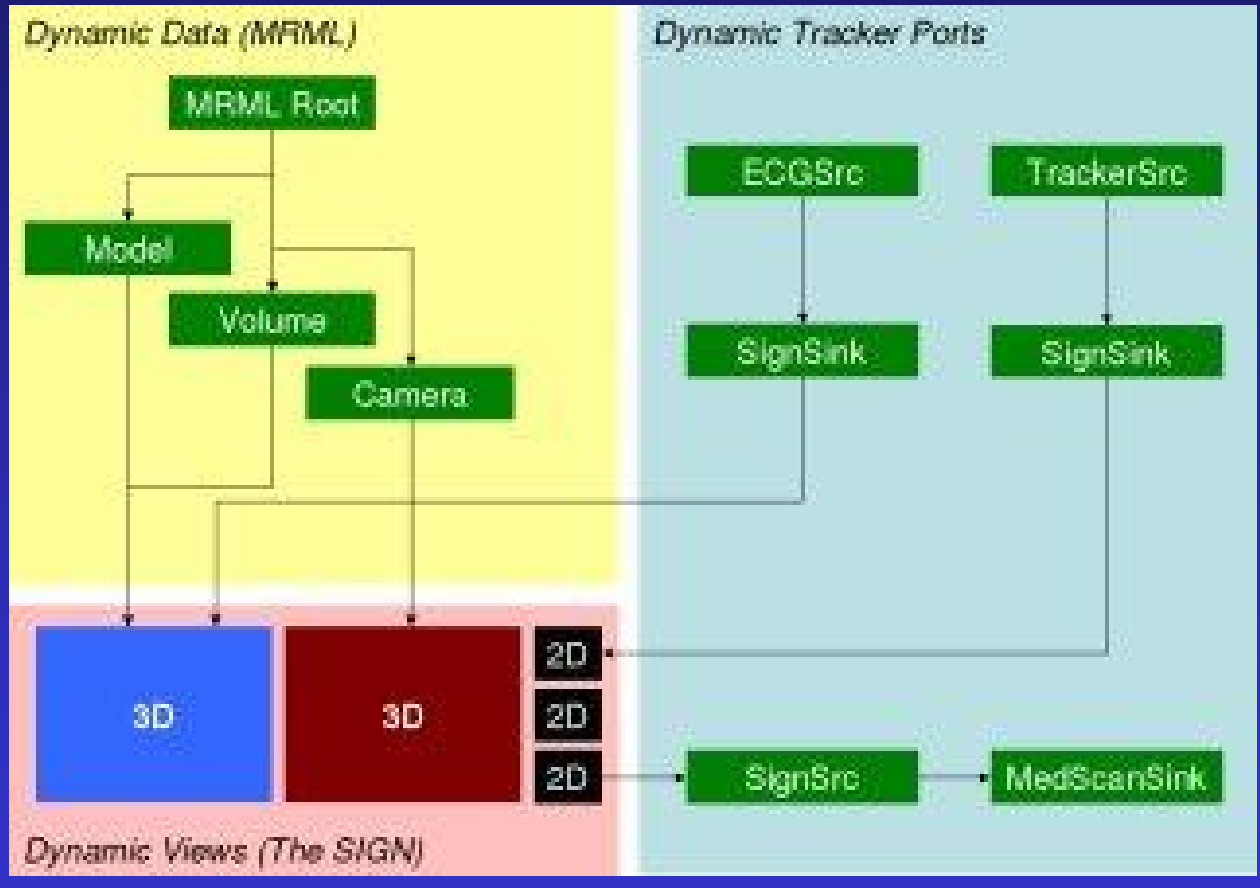


Image Guided Surgery Toolkit
Patrick Cheng, MS
Polaris Vicra Tracker
Display
Tracker tool
Dynamic Reference
Abdominal Phantom
SAMSUNG

Software
SIGN: Slicer Image-Guided Navigator



- Source: http://www.ncigt.org/sign/documentation/index.html

Trackers
State of the Art

- APIs are available
  - Optical trackers
  - Electromagnetic trackers
- Software libraries are available
  - Open tracker
- Can be easily integrated

Robots
State of the Art

- Situation is more complicated
- No commercial robot for medical market exists with a defined API
- Robotic systems tend to change clinical procedure more than image guidance
- This is a challenge for the future

Image-Guided Systems Medtronic Stealthlink

- Network interface
- Allows data flow from image-guided system Stealthstation to your application in real-time
- Provides an application program interface (API)
- Contact: leslie.holton@medtronic.com

Image-Guided Systems Brainlab VectorVision Link

- Network interface
- Allows data flow
- Provides an API
  - Based on VTK
- Can create custom views and display on VectorVision workstation
- Contact: robert.lucht@brainlab.com

Summary of Components

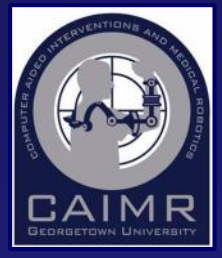
- Components are becoming available
- More standardization is needed
- Analysis of clinical procedures would be useful to determine commonality (back to requirements definition)
- Architecture and interfaces are key
- This group could help!

Three challenges

- Do a better job at defining the requirements
  - Image-guided systems can be complex
  - Should we define multiple types of systems based on difficult clinical requirements?
  - This should help define components and architecture
- Providing a rationale to convince manufacturers that they should always provide an API (like DICOM is now standard for images)
- Creating standards (can be difficult and time consuming)

How can NCIGT help?

- By providing a forum where researchers can discuss these issues
- By developing a testbed or prototype system that multiple researchers can contribute to
- By developing an open architecture and modular components



Thank you for your attention!