



*State of the Science Conference*  
*Tele-Exercise Breakout Panel*

# **Interface Technologies for Enhancing Universal Access Tele-Exercise**

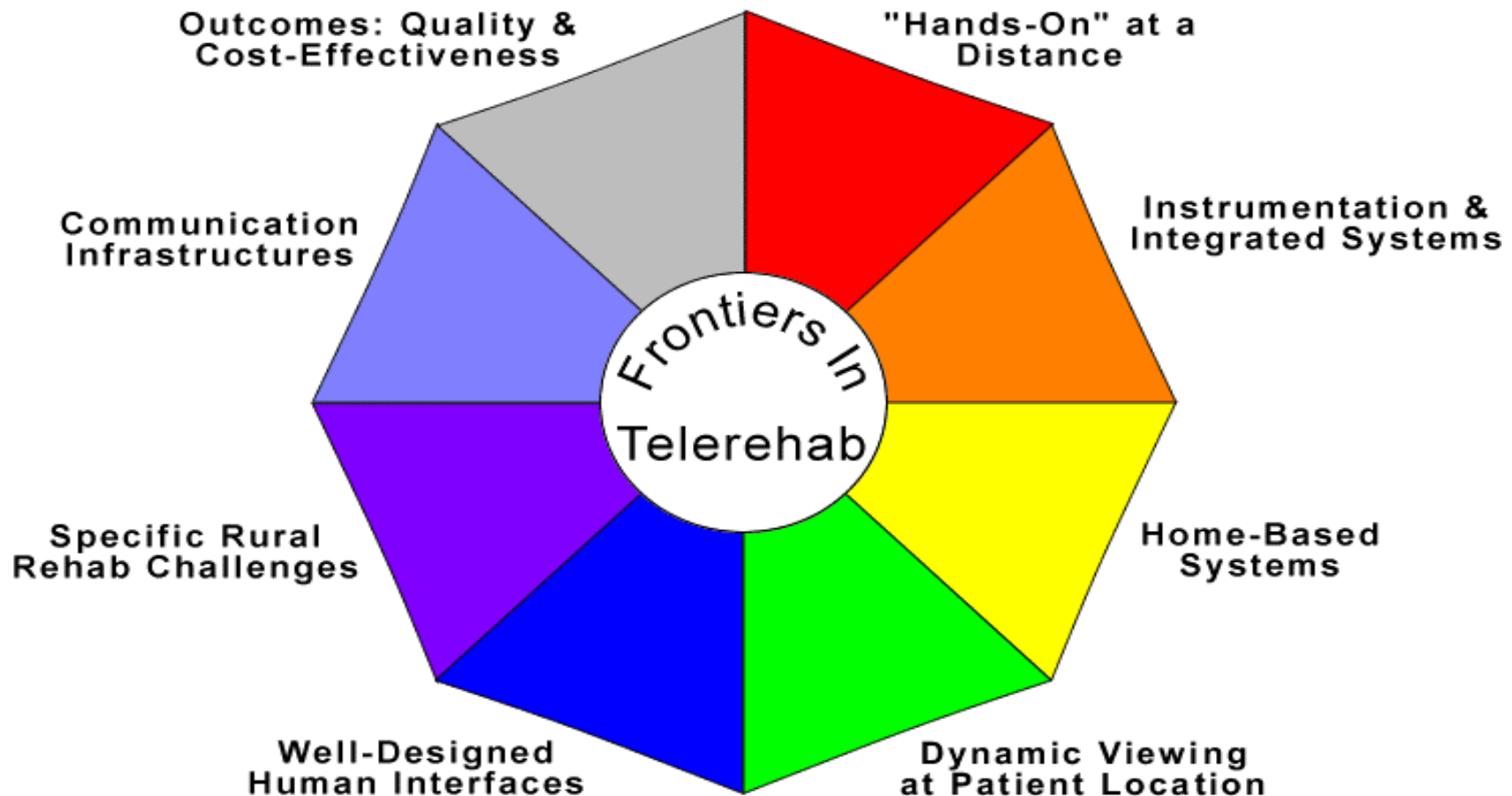
**Jack M. Winters, Ph.D.**

**Professor of Biomedical Engineering  
Director, RERC on Accessible Medical  
Instrumentation**

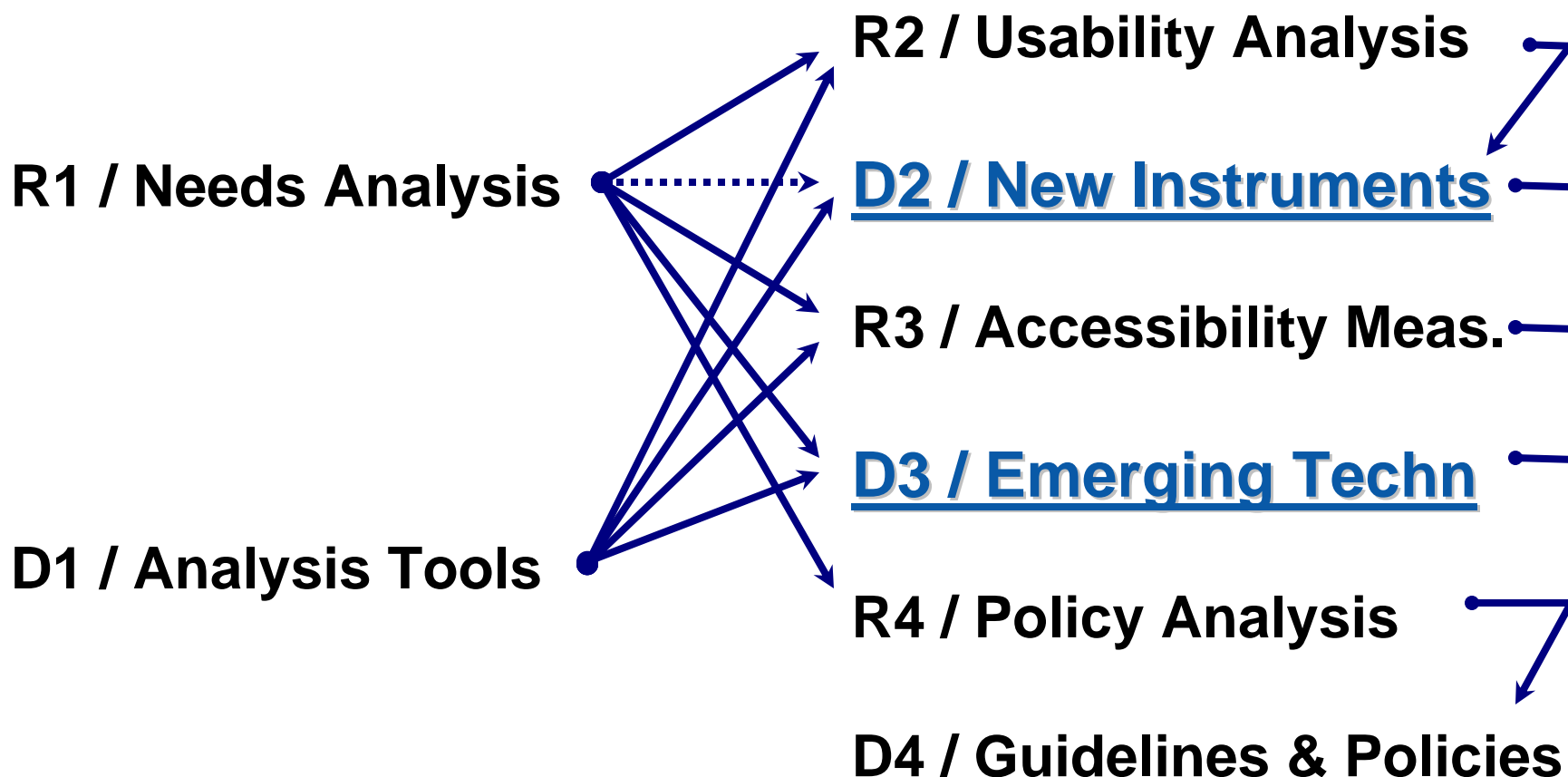
# Background Perspective

- **Background Experience**
  - Old RERC on Telerehab (1998-2003)
  - R&D in Homecare Technologies
  - RERC on Accessible Medical Instrum.
- **Foundation:**
  - RERC-AMI focus on Interfaces
  - Recent Chapter on Universal Access

# Tele-Exercise Challenges in Context of Home Telerehab Experiences



# Structure of RERC-AMI R&D Activities



## RERC-AMI Short-Term Outcome #2

As a result of developing and evaluating an innovative system (the Mobile Usability Lab), there is an improved ability by the RERC and other groups to conduct systematic accessibility analysis of medical devices through multi-site human subjects testing.

**Example: Elizabeth Omiatek's Talk** (during Wednesday afternoon breakout)

*Note: MU-Lab Technology can be made available to other groups*

## Short-Term Outcome #4

Effective demonstrations of accessible prototypes leading (as appropriate) to technology transfer of novel medical instrumentation or modifications to existing devices, or approaches to interfaces for classes of devices

**Example: MedURC** (universal remote console ANSI 389-393 standard) and User Profile Survey

**Example: UniTherapy** (computer-assisted personalized upper extremity tele-exercise)

## **Basis for Comments: Two Chapters from Book Related to RERC-AMI's SOS**

**Future Possibilities for Interface Technologies  
that Enhance Universal Access to Healthcare  
Devices and Services (Chapter 25, Winters)**

**Emerging Personalized Home Rehabilitation:  
Integrating Service with Interface (Chapter  
27, Feng & Winters)**

... Tele-Exercise, Access & Interfaces

# Tele-Exercise in 2010?

(the fine print - an example of future possibilities; Winters, 2006)

Imagine it's 2010. An elderly couple lives at home, the husband with stroke-induced disability and high blood pressure, and the wife with severe arthritis that affects hand function plus mild diabetes that includes a degree of visual impairment. He's a retired engineer and manager who is quite goal-directed, though seemingly more and more absent-minded. He follows a computer-assisted rehabilitation therapy that bears similarity to the vision described in Chapter 27 (Personalized Home Rehab). His "universal gym" of arm and leg exercise technologies adjust settings based on his recent history of performance as well as his mood and aims, as interpreted from his answers to several questions initiated by the system.

An interface is established when he's in their family room and says, "OK, healthy time." The picture-in-picture of his HDTV then functions as his health/performance monitor. In the primary picture he typically views the interactive game he's playing, a sports event (especially when doing more routine and "boring" aerobics), or occasionally his brother or daughter or his remote therapist or a nurse. Typically his interactive games are played remotely against his brother or daughter, with the sound off when he plays against his brother unless he wins, and the sound up and video available in the picture-in-picture when he plays against his daughter; this all adjusts automatically as a default. He also is prompted to record his resting heart rate and blood pressure each morning and evening, using a system that automatically stores and uploads this information, and even adjusts the dose of his blood pressure medication and sends reminders if he forgets to take the pills.

His wife uses a similar system, but typically chooses to use it in full talking mode. Her glucose monitor also talks with her, as well as transparently communicating with her personalized health record. Something (she's not sure what) sends reminders to her wristwatch to take blood glucose level measurements, and something else provides her with an appropriate dose of insulin that can be automatically administered without her needing to use her hands. She also uses her husband's exercise system to provide gentle stretching exercises to her hands and feet, and head-neck, typically during the commercials while she and her husband are watching TV. To her husband's chagrin, she also insists that all of the "wireless technology stuff" stay in the family room. The exception is when her daughter calls, during which the system automatically works everywhere within range; indeed, this even extends to carrying on 3-way hands-free conversations that often continue during walks, or 4-way when one of the grandkids is on.

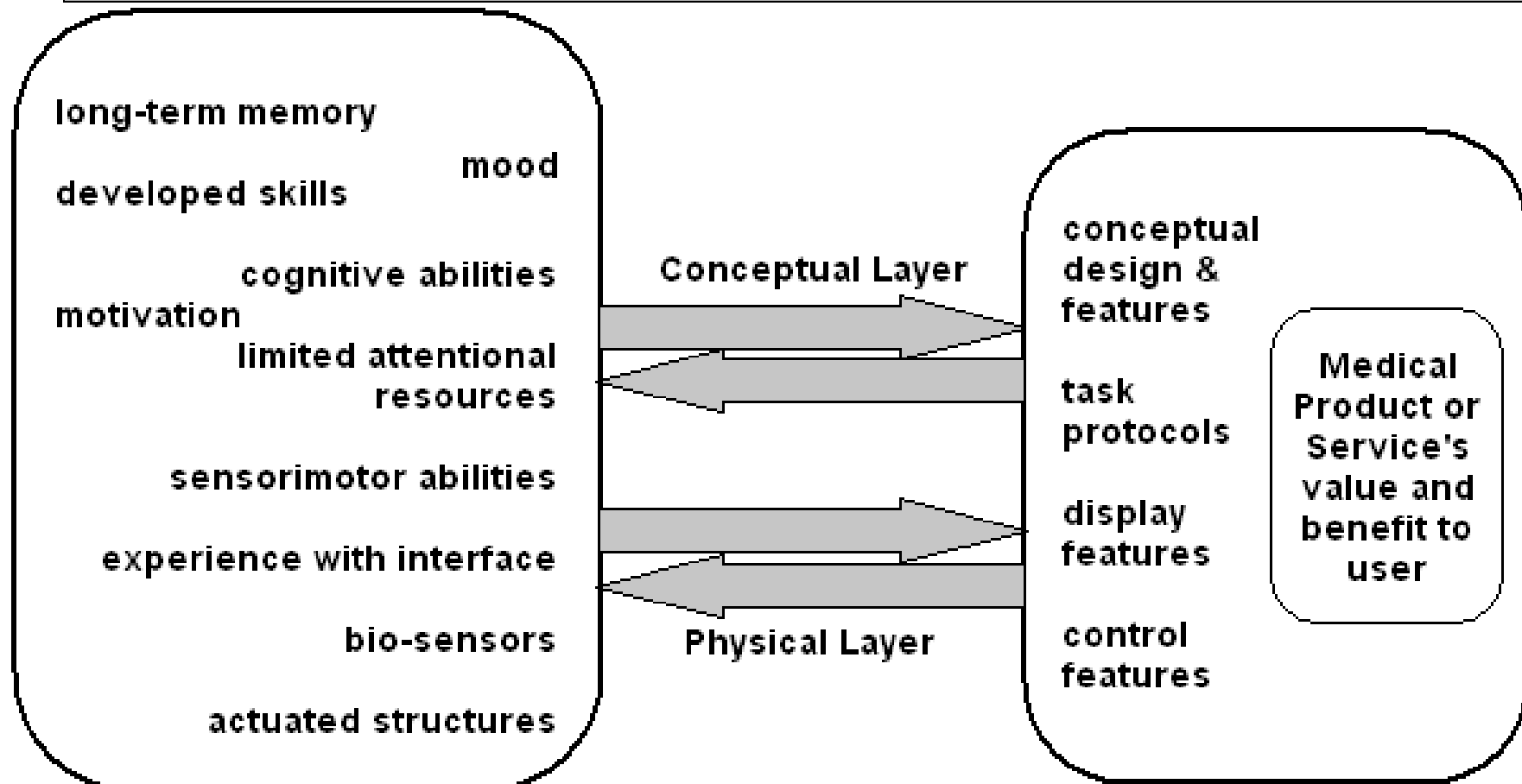
## Tele-Exercise Issue #1: Access that is as “Universal” and Inclusive as Possible

- ***Universal Access: “The ability to access a product or service by all who can benefit from the healthcare intervention or assessment, by overcoming barriers related to the accessibility of the interface, to distance and to cost.”***
- **Importance of accommodating diversity of abilities, preferences, aims**
- **Designing for ...Abilities**

# Universal Access Means More Than Universal Design, for Both RERC's

- **Universal Access addresses more Barriers**
  - **Accessibility of Interface**
  - **Access Barrier of Distance (e.g., Tele-Exercise)**
  - **Access Barrier of Cost**
- **Synergy Between our RERCs:**
  - **Addressing Barriers Thru Interface Design Features**
    - **Including Tele-Interface Design**
      - **Videoconferencing as multimodal interface**
  - **Personalized Interfaces**
    - **Strategy of Universal Design**
    - **Strategy of Multimodal Design (e.g., Section 508 Criteria)**
    - **Strategy of New Standards for Mapping to Personal Interface**

# Layers of Tele-Interfaces



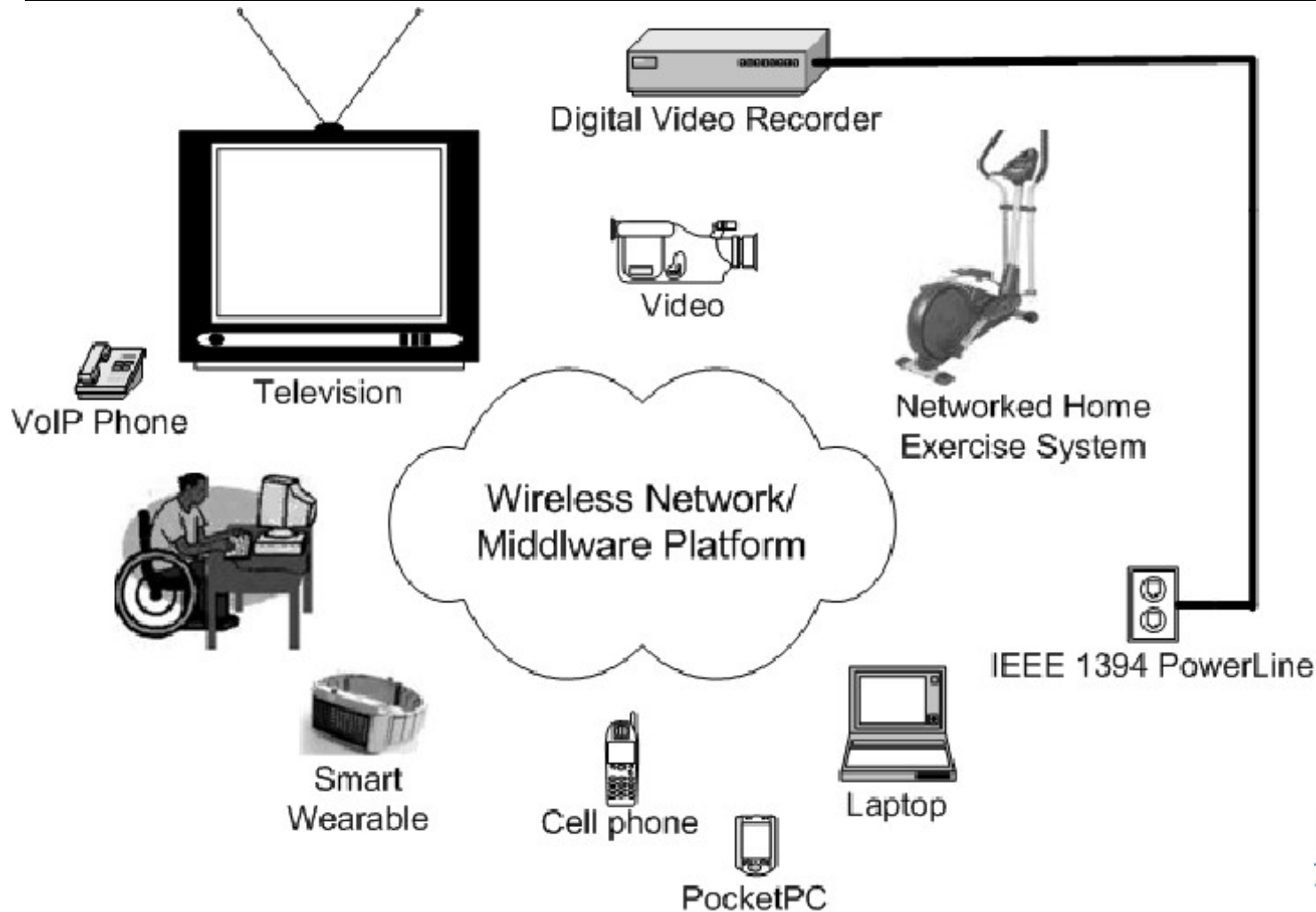
# Physical Interfaces

- **Two-way (physical) Interfaces**
  - **Power = Force\*Velocity**
  - **Extended Physiologic Proprioception**
- **One-way (display, control) interfaces**
  - **Trends in Displays**
    - **Visual (flat panel, LCD, heads-up, virtual enhancements)**
    - **Auditory (wireless, miniaturization, voice, codecs)**
    - **Kinesthetic (tactile/surface, force-feedback, vibration)**
  - **Trends in Controls**
    - **Manual (mouse/keyboards/joysticks/gamepads/gloves)**
    - **Speech, gesture, biometric**

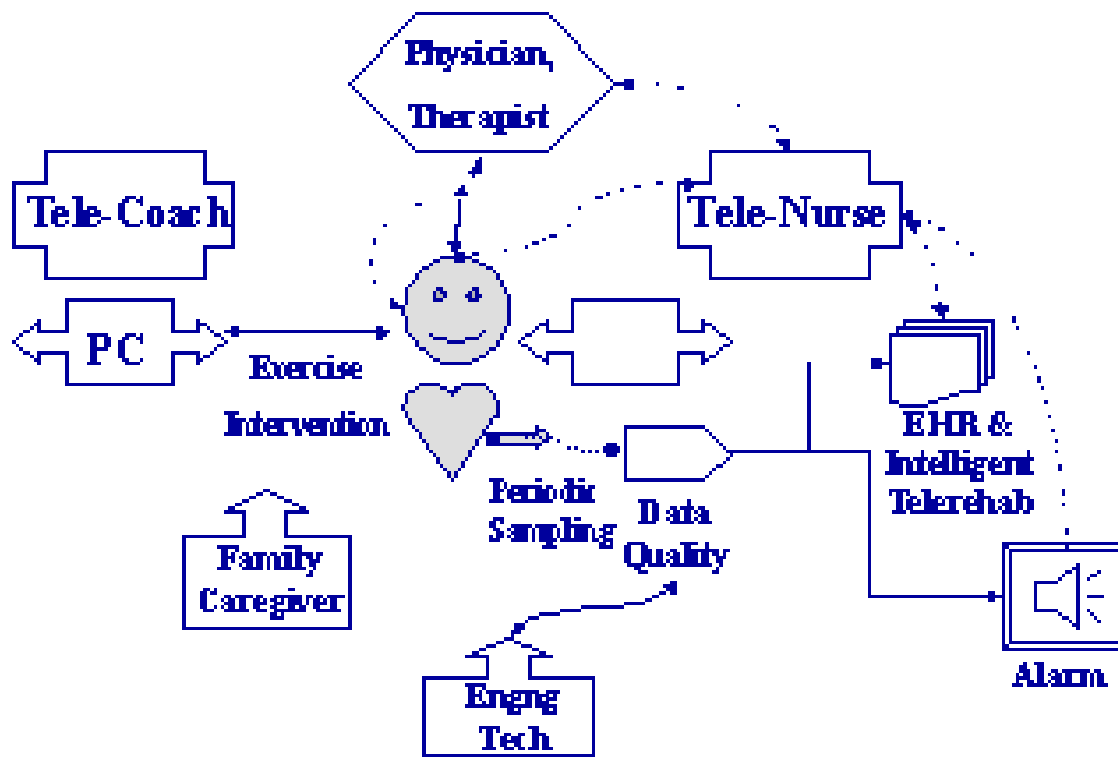
# Technical Trends Helping to Decouple Physical & Conceptual Interfaces

- **Modularized physical & middleware layers in IT tech standards**
  - promotes product interoperability, leverages investments
  - enables innovation at both physical & conceptual layers
- **Networking & interface standards promoting ubiquitous & distributed computing**
- **Emergence of XML as an international computing language for expressing structure and concepts**
  - Facilitates consensus protocols and guidelines that can be used by the technical community interested in accessibility
- **Emergence of the W3C's Semantic Web standard for structuring more natural interaction between human & machine**
- **Advances in intelligent systems**
  - Intelligent agents (act on user's behalf)
  - intelligent assistants (assist user)

# Personalized Home Tele-Exercise: Technology Interface Issues



# Personalized Home Tele-Exercise: People-Issues & Enabling ...Abilities



Telecoach (left) / Supportive Telecare (right) model

Degree of ...

Accessibility

Usability

Enjoy-ability

Adjustability/Flexibility

Reliability, Safe-ability

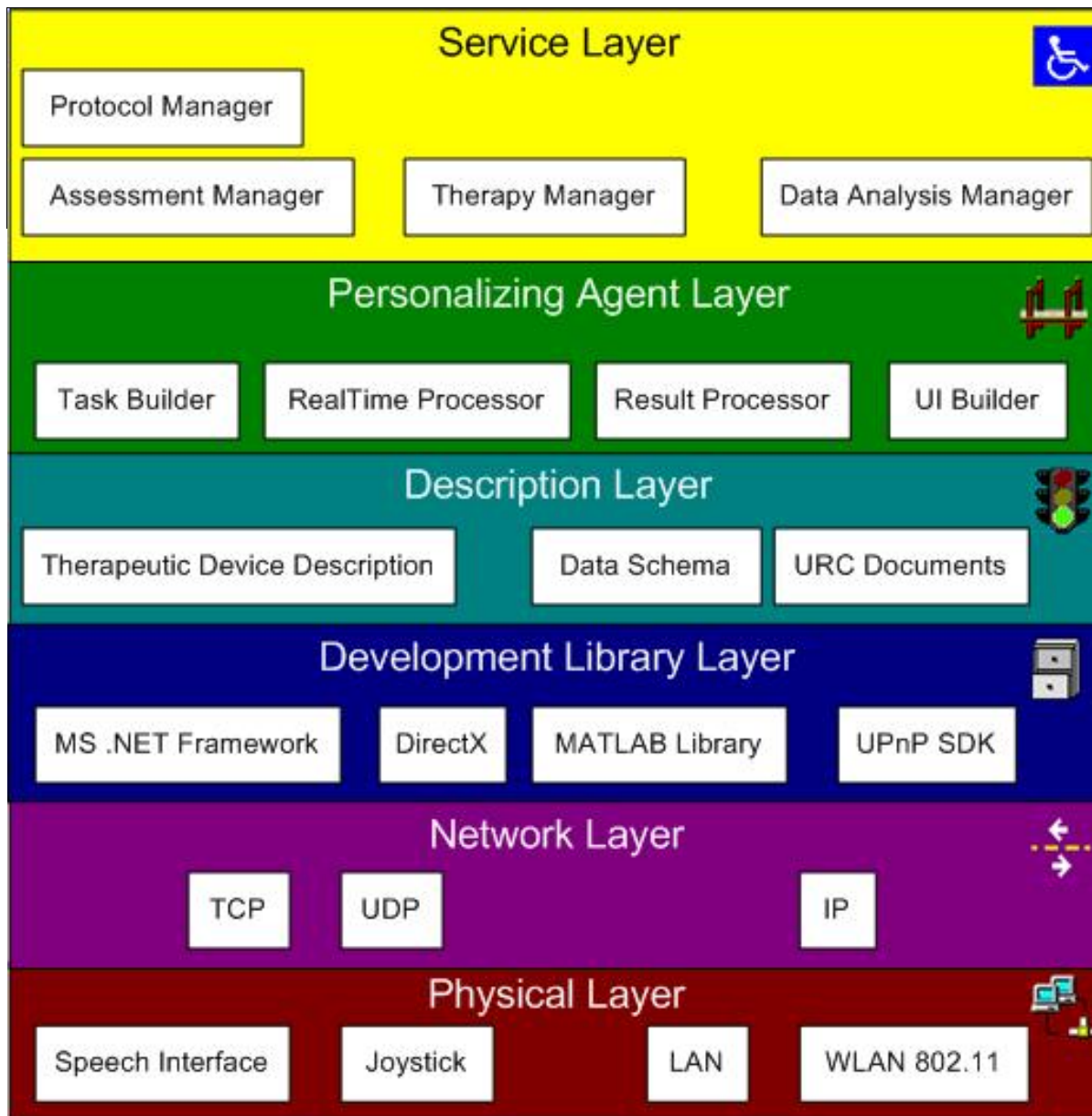
Supportability

Interoperability

Learn-ability

## **Emerging Personalized Home Rehabilitation: Integrating Service with Interface (Feng & Winters)**

- **Challenge - Lack of personalized healthcare services, including access to timely services or assessment data**
- ***Home Tele-Exercise Modes***
  - ***Teleconsultation***: “face-to-face” interactive conferencing
  - ***Telehomecare***: tele-nurse coordinated service delivery
  - ***Telemonitoring***: unobtrusive remote teleassessment
  - ***Teletherapy***: patient “exercises” in home, with tele-therapist able to change settings remotely based on patient’s performance
  - ***Tele-cooperation***: via telerehabilitation link, remote “trainer” can interactively participate (e.g., apply assistive forces)



## UniTherapy as Service

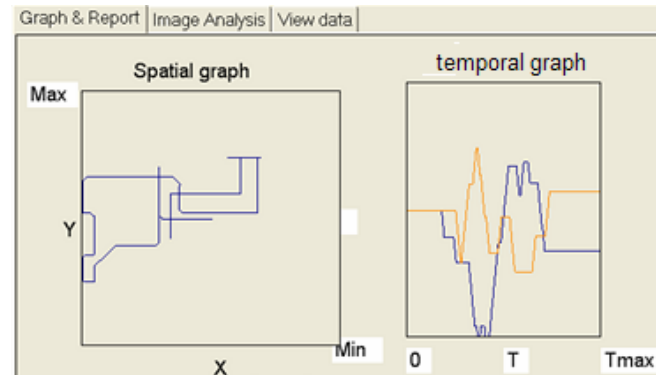
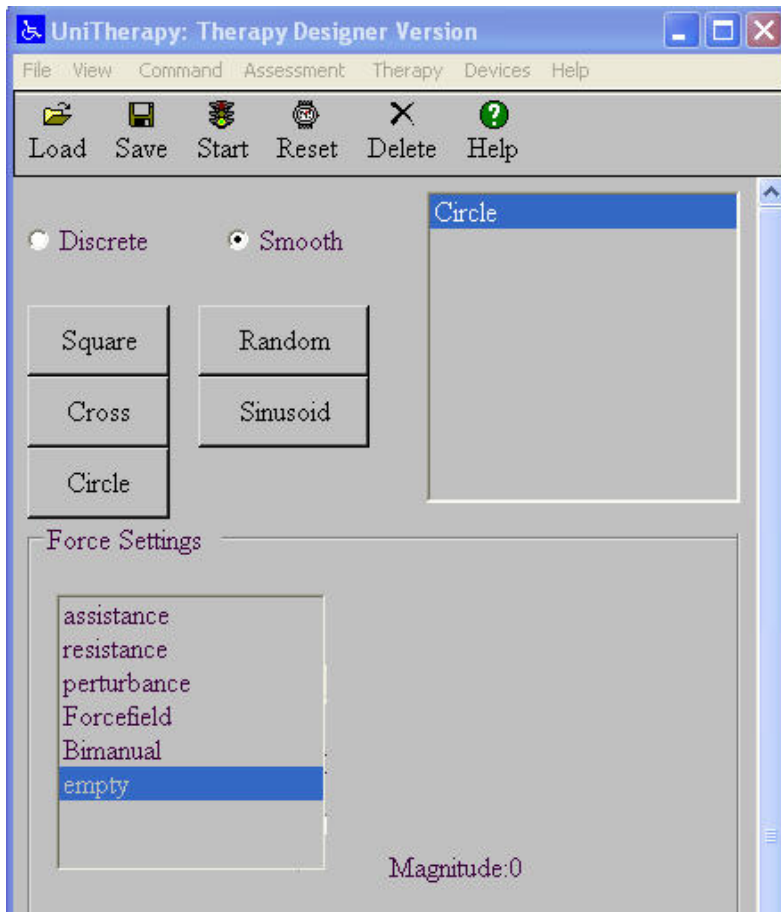
### Computer-Assisted Rehab

- Joysticks, Wheels
- Therapy tasks
- Assessment tasks

### Modes:

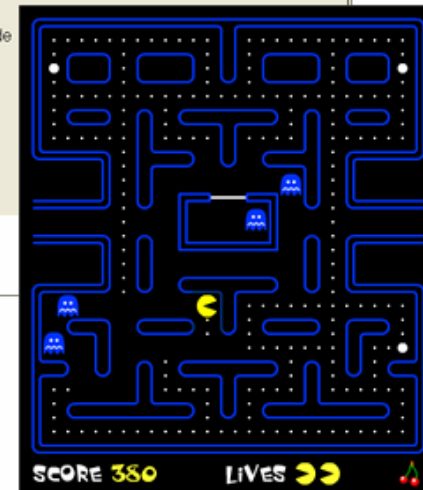
- Protocol Designer
- Tele-Practitioner
- Home Client

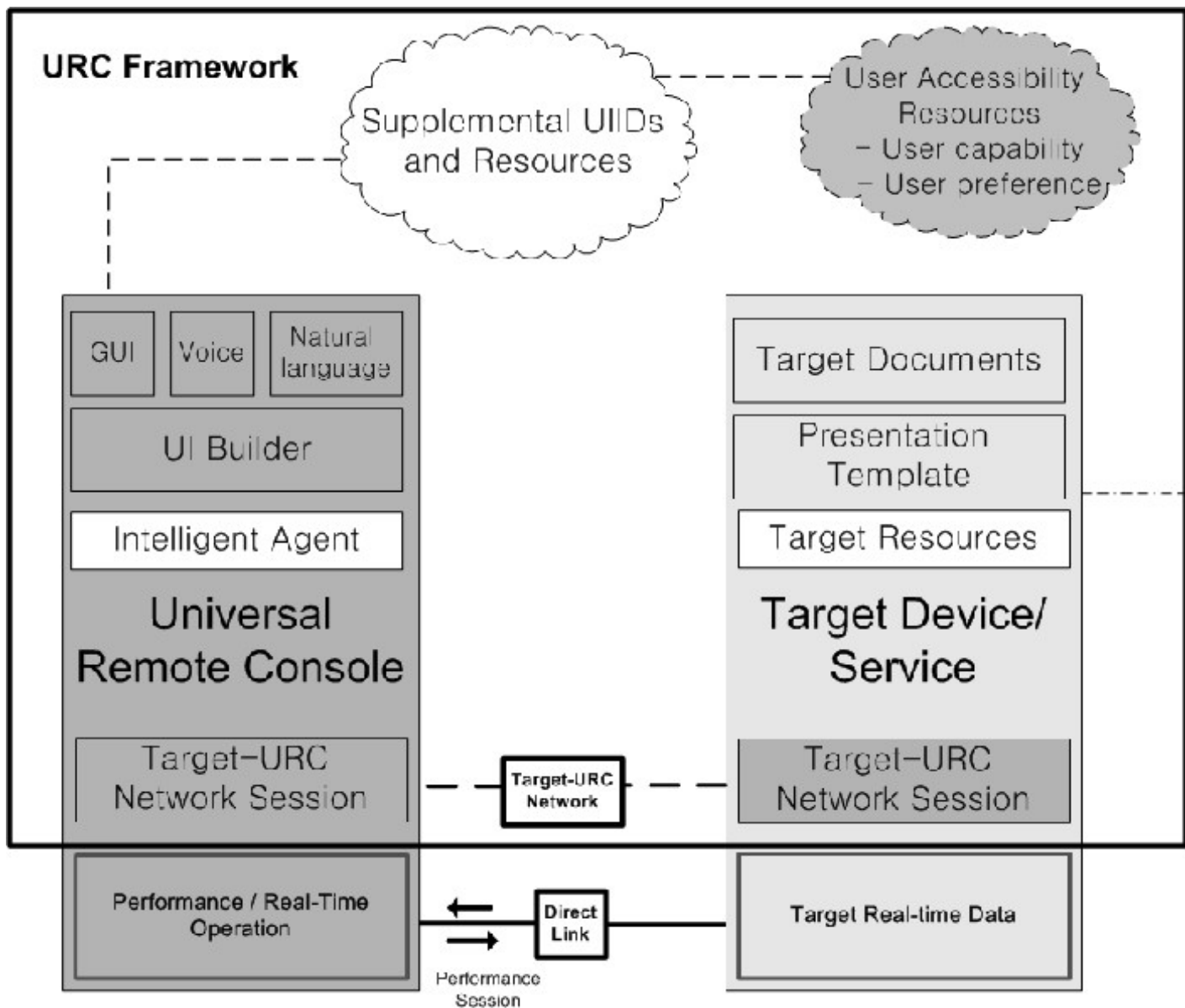
# UniTherapy Support for Creating Assessments, Documenting Therapy



Task summary

Task type:	Practice Mode
Ave. Speed (Window/second)	0.05
Max Speed (Window/second)	0.45

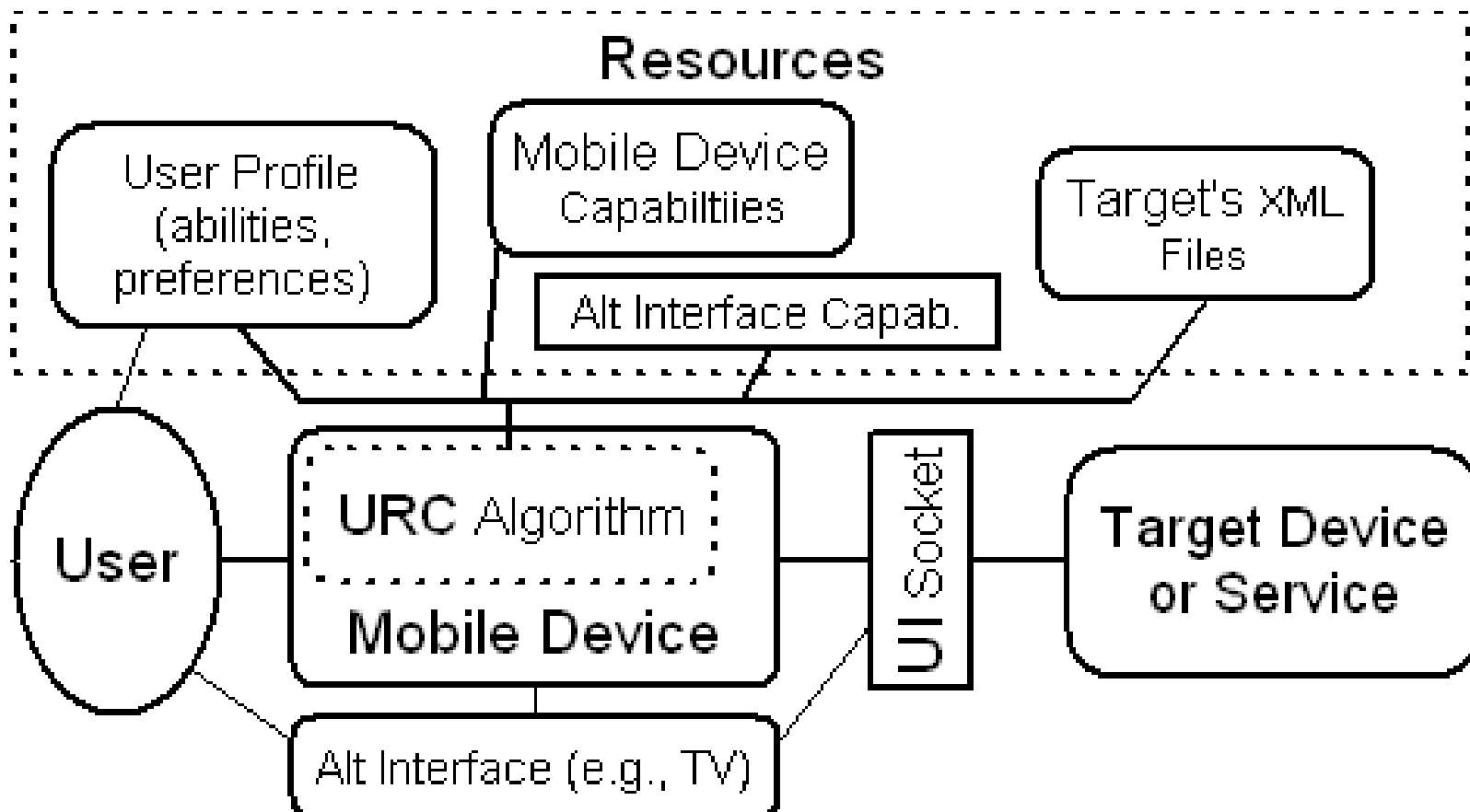




## UniTherapy & URC

- UniTherapy is UI-Socket/URC “target service” for Home Client
- Supports UPnP (Univ Plug n Play)
- Personalizing the interface might be especially helpful while exercising

# Personalized Tele-Interfaces for Tele-Supported Exercise Programs?



## Project D3.2 & UI-Socket/URC Standard: Personalized Controls/Displays Interfaces

Dr. Sarma Danturthi - Medical **device** “targets”:

- Vital signs; Tables/chairs; Ergometers

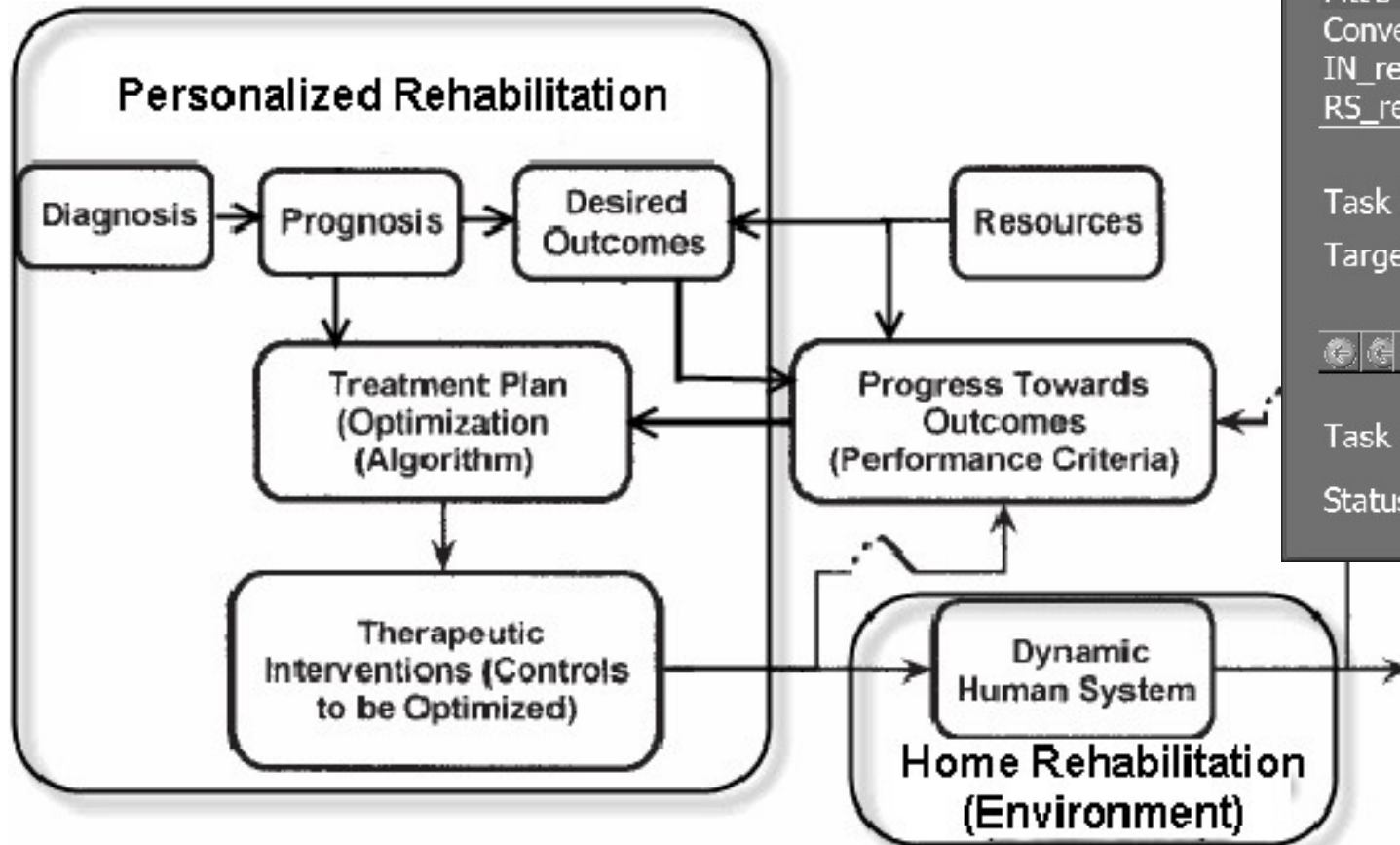
Xin Feng: UniTherapy telerehab **service**:

- Support force-reflecting joysticks, mice, etc.
- Assessment, therapy
- Accessibility & interoperability/telehealth features
- Suite of Web Services

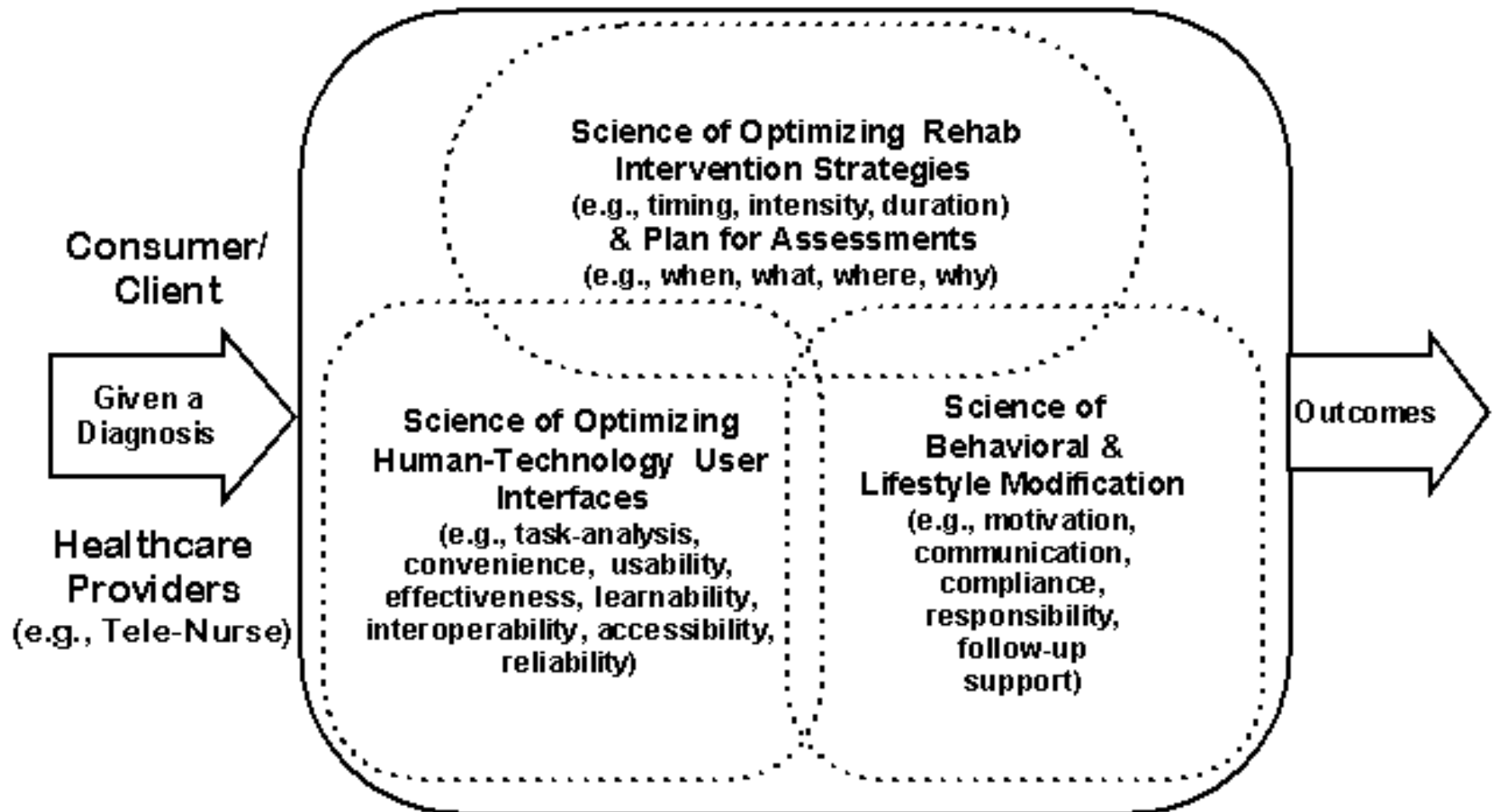
Pawan Schroff: Personalized **URC generation**

- URC interface based on user abilities and preferences, and target descriptions

# Aim: Personalized Rehab Protocol Plus Personalized Interface



# Possible Scientific Framework for Addressing Issues in Tele-Exercise



(Winters & Winters, 2002)

# RERC-AMI Intermediate-Term Outcome #1 ... Tele-Exercise?

Systems change in product design practice through effective use of guidelines for designing more accessible medical instrumentation

Tele-Exercise, integrated with Home-Based Tele-Supported Healthcare, fits well with this desired RERC-AMI outcome

- R&D Projects
- Standards/guidelines activities

