UNIVERSITY OF MINHO

NEWCASTLE UNIVERSITY

HCSE 2010

The APEX framework: prototyping of ubiquitous environments based on Petri nets

José Luís Silva, Óscar R. Ribeiro, João M. Fernandes,
José C. Campos and Michael Harrison

October 2010

Supported by the Fundação para a Ciência e Tecnologia (FCT, Portugal)

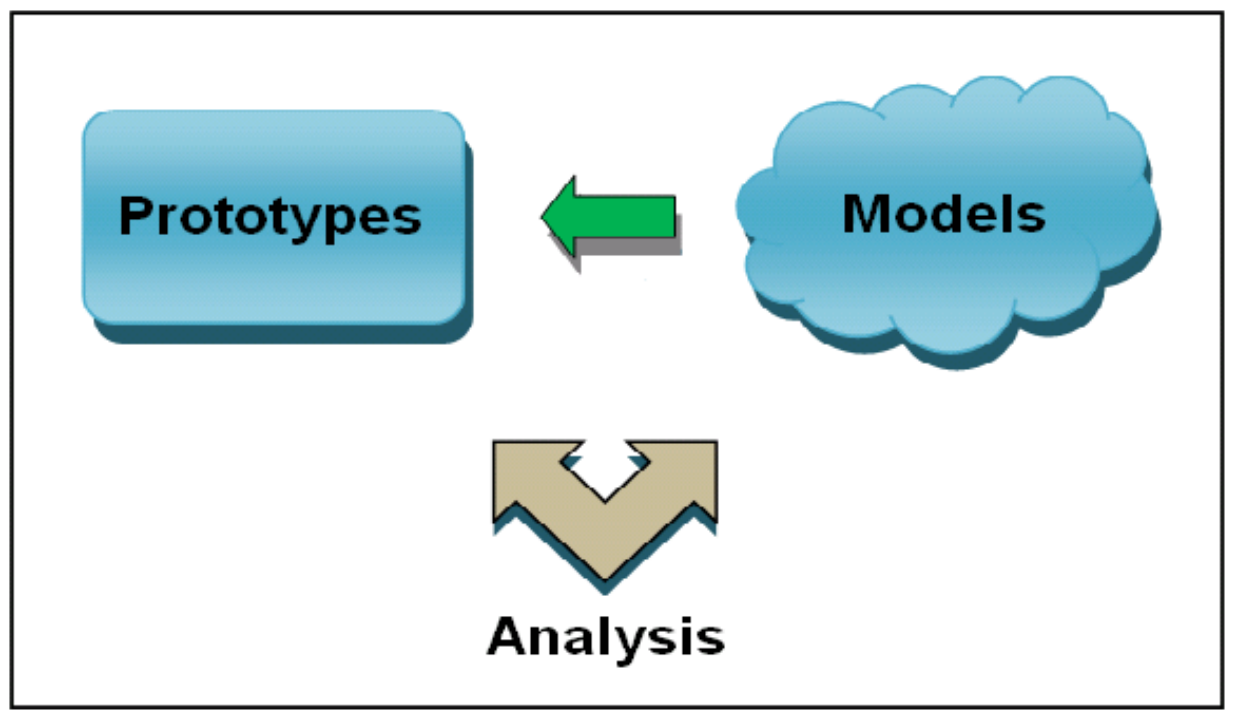
Summary

- Introduction and Objectives
- Background
- Proposed Approach
- Library Case Study
- Synopsis, Ongoing and Future Work

Introduction and Objectives

- Context-aware applications
  - Personalized services to users through the integration of environmental information (context)
  - spatially located using sensors
- New evaluation challenges
- Objectives
  - Rapid prototyping and evaluation of ambient intelligence systems through
    - Modelling
    - Simulation

Framework



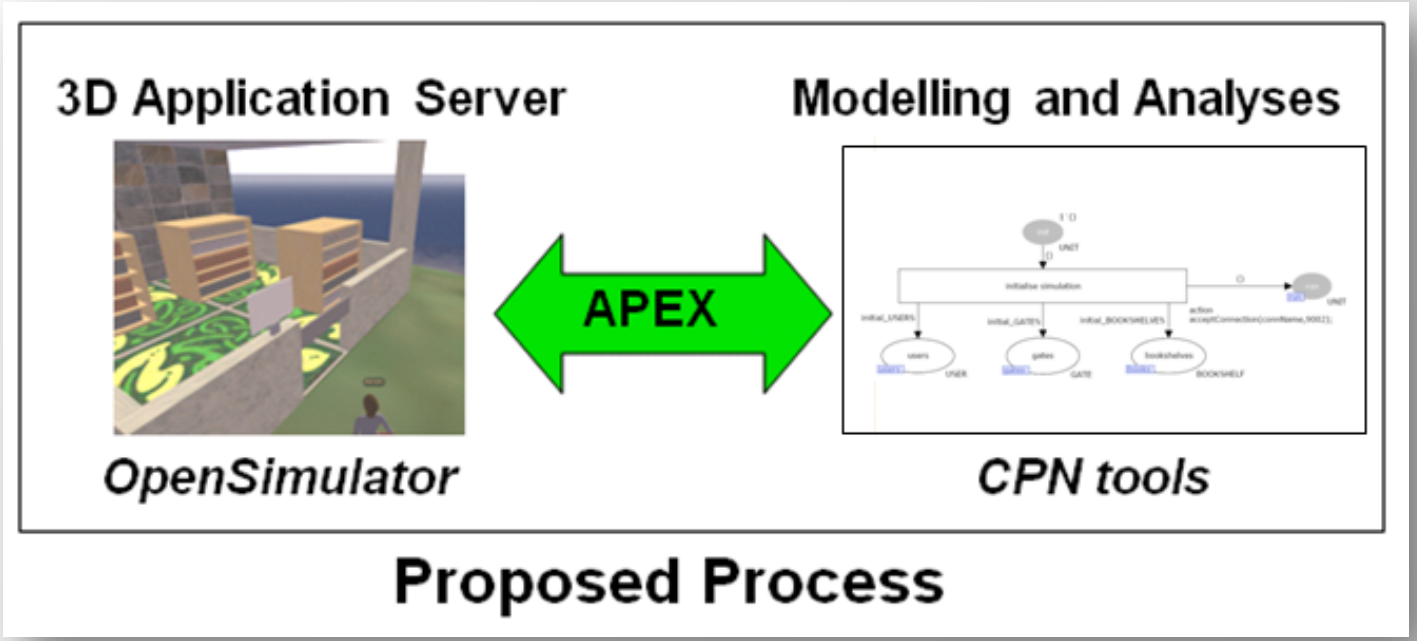
Modelling approach

- Focus on the interaction between the user and the system
  - Ubiquitous system models
  - Property checking and simulation
- **CPN (Colored Petri Nets)**
  - Other approaches possible

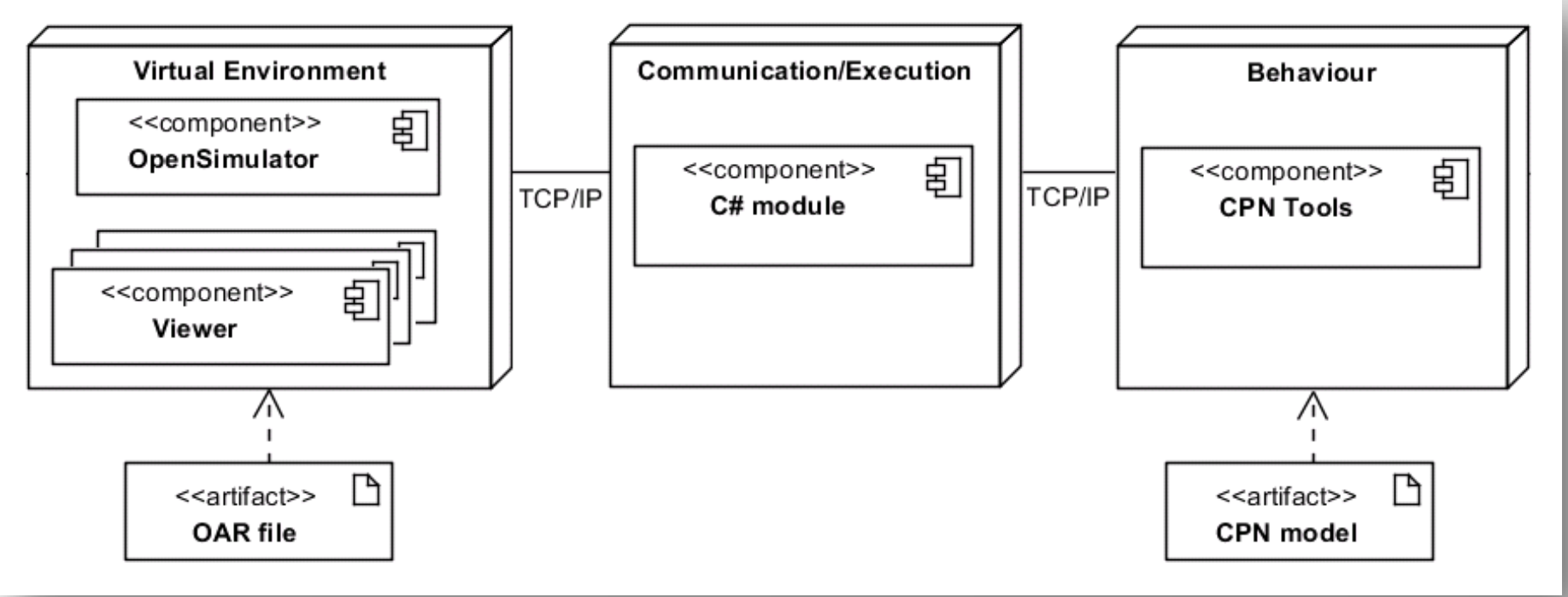
Prototyping approach

- Uses a 3D Application Server
  - **OpenSimulator (opensimulator.org)**
- Simulation
  - Models virtually a situation that can be studied to see how the system works
  - Explores the experience of using virtual systems as feedback about the proposed design
- Comparable with
  - Topiary
  - UbiWorld
  - 3DSim
  - work of O'Neill et al.
- Integrates formal analysis with experience of virtual environments

Proposed Approach



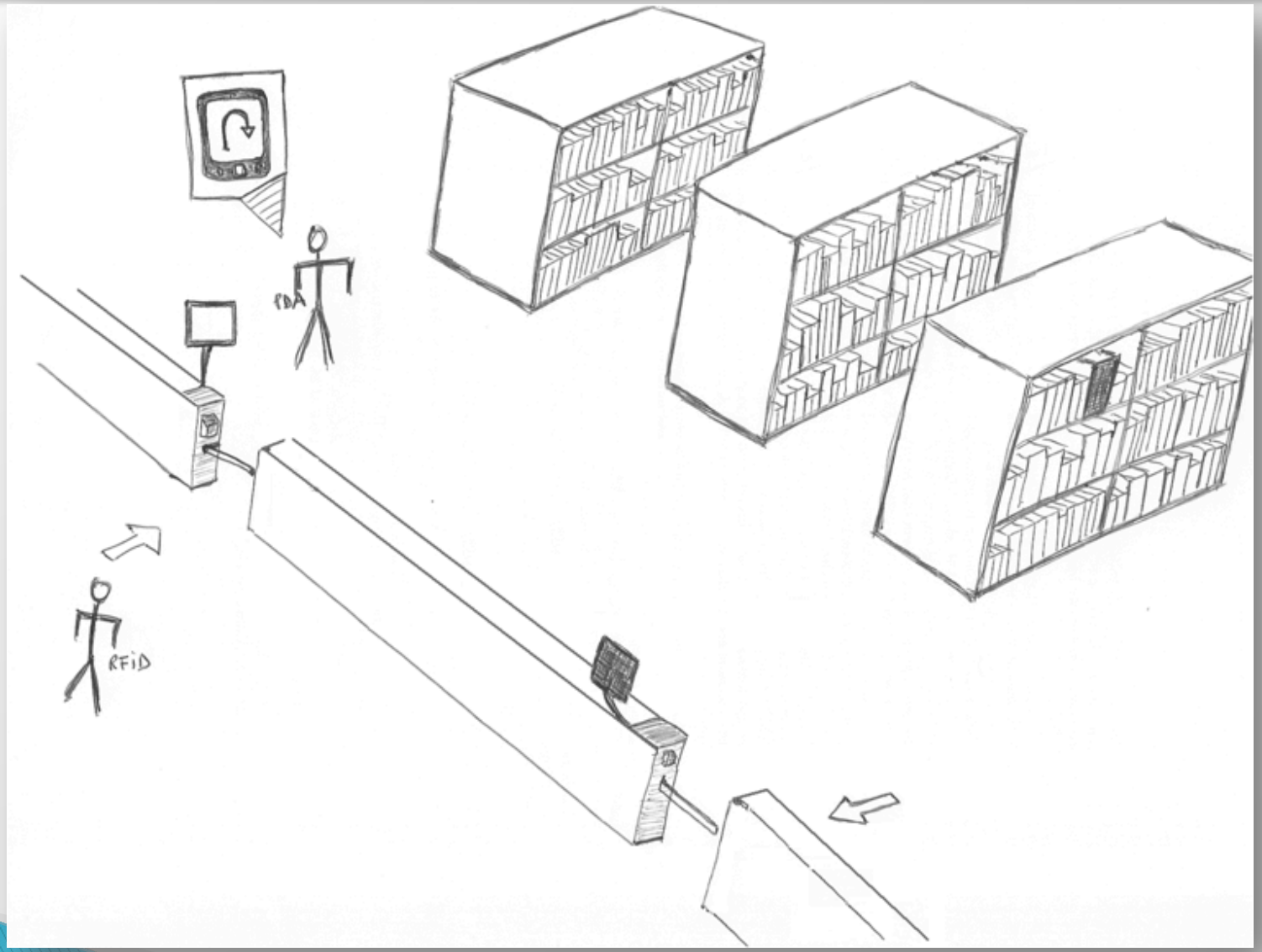
Architecture



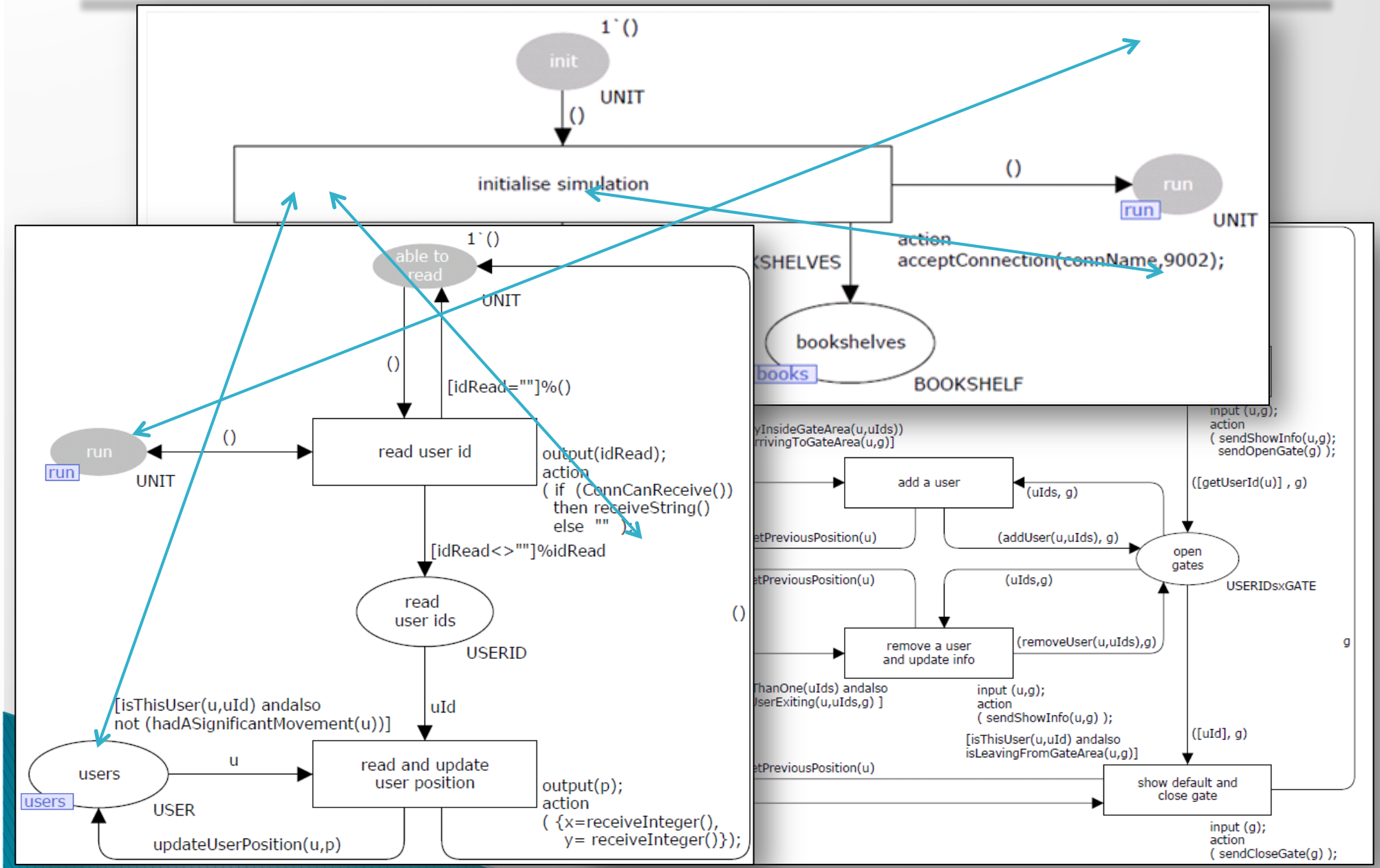
Architecture

- Approach to modelling
  - CPN model guideline
  - Easy to setup
- Virtual environment
  - Viewers
  - Easy to create
  - Many users

Library Case Study



Modelling


1`()
init
UNIT
()
initialise simulation
()
run
run
UNIT
action
acceptConnection(connName,9002);
bookshelves
books
BOOKSHELF
able to read
UNIT
()
[idRead=""]%()
run
run
UNIT
()
read user id
output(idRead);
action
(if (ConnCanReceive())
then receiveString()
else "");
[idRead<>""]%idRead
read user ids
USERID
uId
[isThisUser(u,uId) andalso
not (hadASignificantMovement(u))]
users
users
USER
u
read and update user position
output(p);
action
({x=receiveInteger(),
y= receiveInteger()});
updateUserPosition(u,p)
add a user
(uIds, g)
(addUser(u,uIds), g)
open gates
USERIDsxGATE
remove a user and update info
(removeUser(u,uIds),g)
input (u,g);
action
(sendShowInfo(u,g);
sendOpenGate(g));
([getUserId(u)] , g)
([uId], g)
show default and close gate
input (g);
action
(sendCloseGate(g));

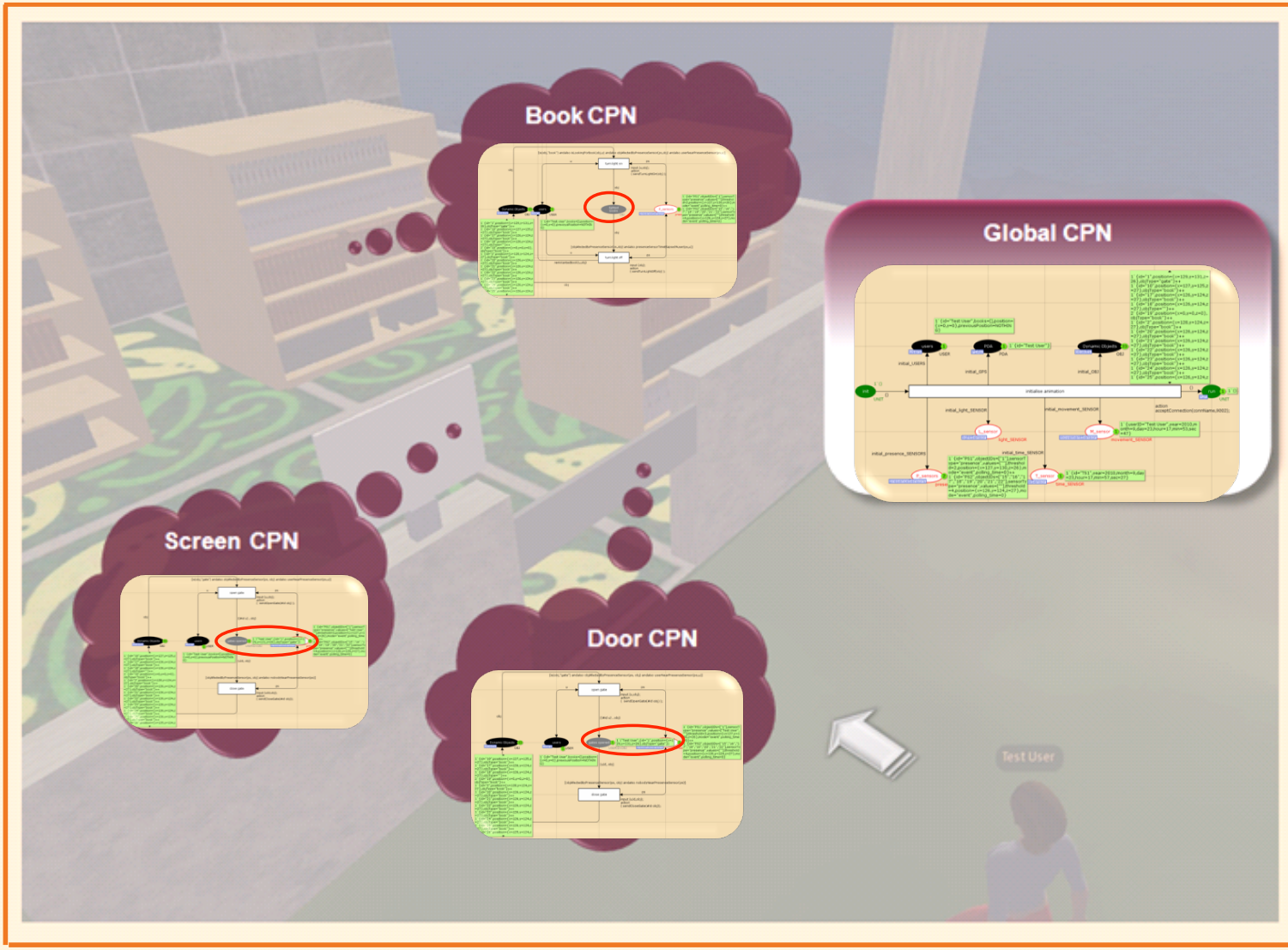
APEX framework

A - user outside library

B – user near entry gate

C – user taking wanted book

APEX framework

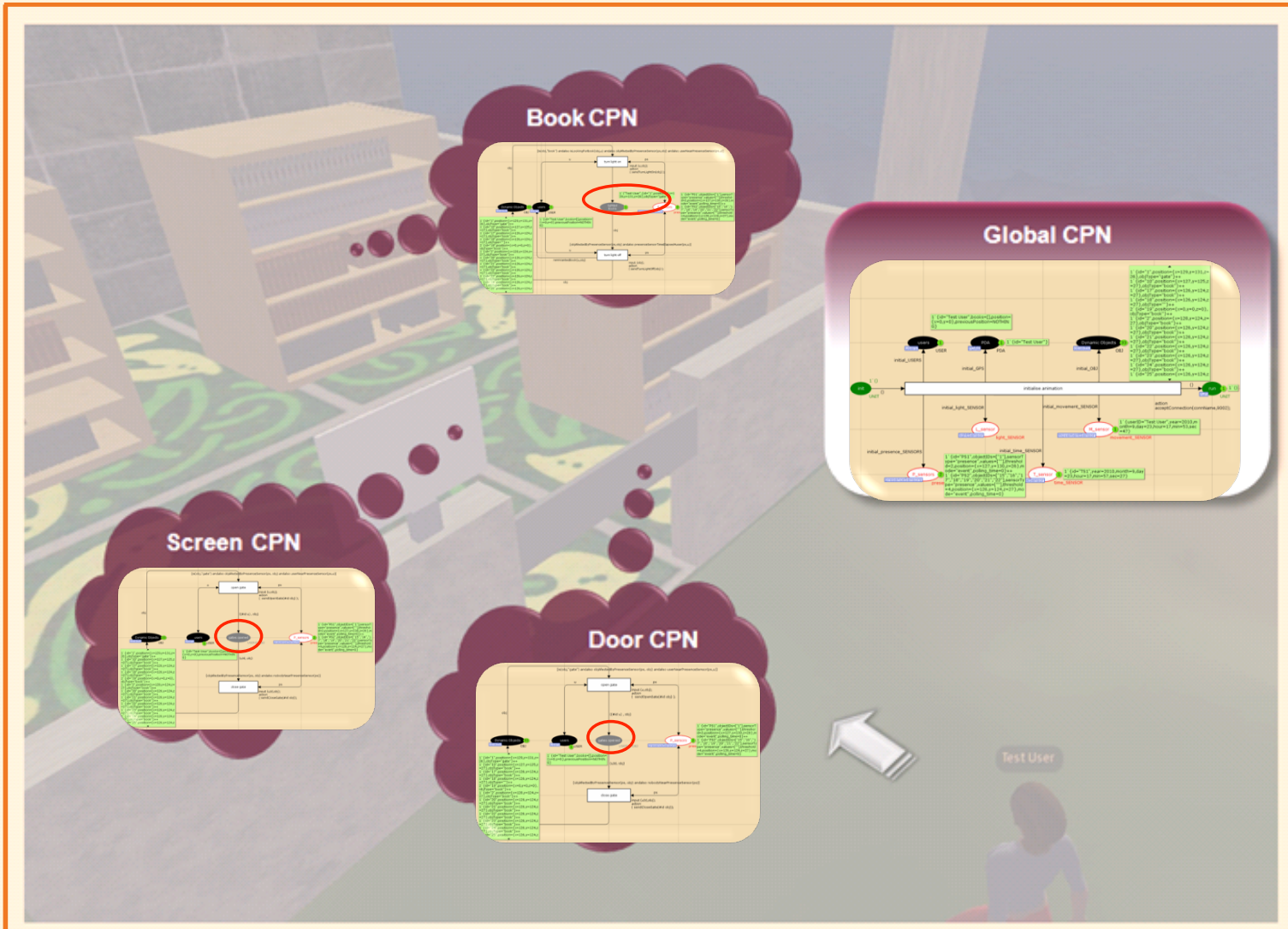


A - user outside library

B – user near entry gate

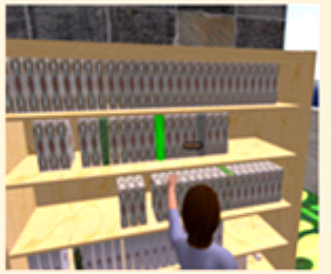
C – user taking wanted book

APEX framework



A - user outside library

B – user near entry gate



C – user taking wanted book

Summary

- An environment for ubiquitous systems analysis and simulation
  - Simulation allows navigation, and interaction, both explicitly and implicitly, with (virtual) devices
  - Analysis using *CPN tools*
- Supports evaluation of usability and social impact of the design

Ongoing and Future work

- Support for plug and play construction of virtual environments
- Perform usability studies
- Interchanging the physical and the virtual
  - mobile devices
  - Human users vs. autonomous users
- Link to a CAVE (Cave Automatic Virtual Environment)

Questions

Thank you!