Distributed Artificial Reality Environment
D.A.R.E

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Outline

- What is DARE ?
- Software packages description
- Communication paradigms
- Maintaining the dynamic shared state
- Interaction methods
- Conclusions & future work

What is DARE ?

- Software framework which implements Mixed Reality (MR) and Distributed Systems (DS) paradigms to:
  - improve development time for collaborative MR applications
  - provide a testbed for research in MR and 3D displays (e.g. data distribution, registration, calibration, virtual environment parameters assessment)

- Applications built using this framework:
  - are deployed in the Artificial Reality Center (ARC)
  - span the entire Virtuality Continuum
  - are visualized using HMDs (HMPD)

Software packages description (1)

Networking package provides

- a set of classes for fast development of scalable, real-time Mixed Reality applications on a LAN
- a novel paradigm for exchanging information through software objects
- a test-bed for development of real-time synchronization algorithms
- a test-bed in support of advanced coordination schemes for real-time networked environments

3D Display package

- provides an interface for three-dimensional displays.
- was designed around, and tested with optical see-through head mounted displays
- it interacts with several well known VR programming languages like OpenGL, SGI Performer and the Virtual Environment Software Sandbox (VESS).
- extensions of the package to account for deformable 3D objects are currently under implementation.

Sensors package

- provides a test-bed for interfacing devices that are used within MR environments.
- an application can receive device data without the need of a centralized device server
- currently, the package includes classes for optical trackers
- the package will be capable of providing device information in a variety of formats for registration and calibration in MR.

Software packages description (2)

Calibration package

- provides algorithms for determining the transformations necessary to accurately display virtual objects within an application
- the algorithms include eye-point determination, camera calibration, and optical distortion calculation
- the algorithms can be adapted for use with any two-channel stereoscopic display

Registration package

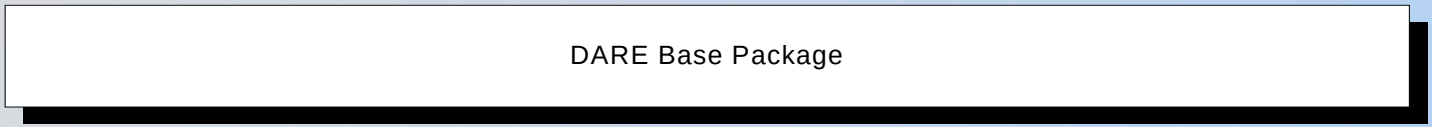
- provides algorithms for placing real and virtual objects into spatial coincidence (registration)
- provides algorithms for assessing the quality of registration

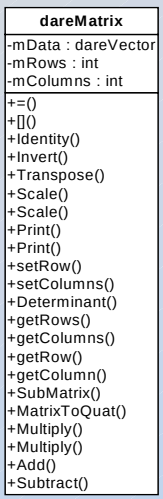
Assessment package

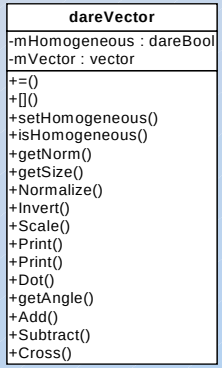
- includes visual perception tests aimed at assessing virtual environment system parameters
- currently includes a modified Landolt C Visual Acuity tests as well as a perceived contrast test
- will include tests witch allow mapping of the contrast sensitivity function for the HMPD display across all spatial frequency channels of the retina.

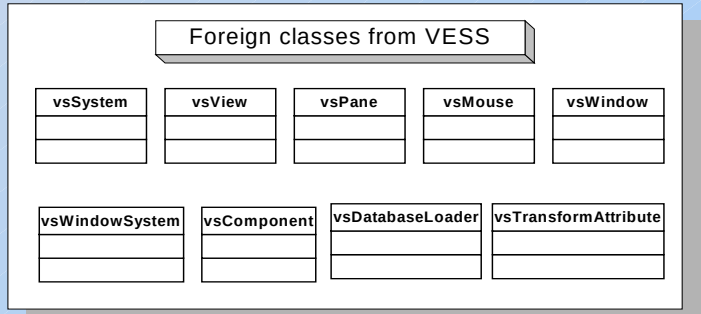
Software packages description (3)

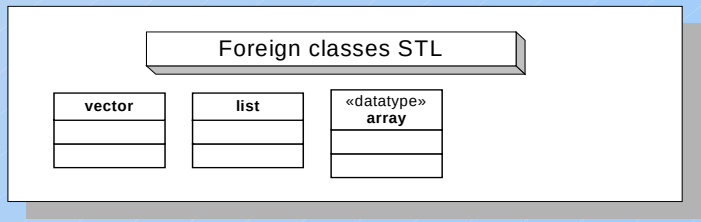
- The Base package
  - contains algebraic operation for matrices, vectors and quaternions

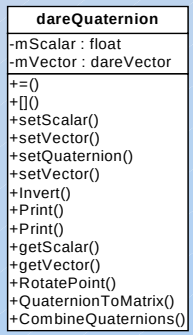


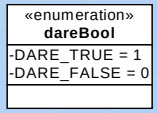












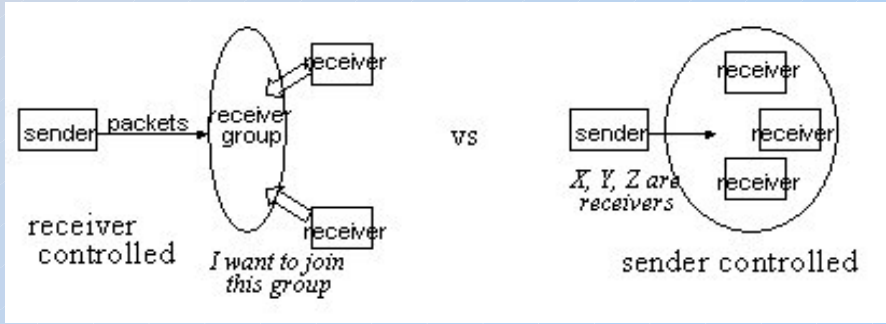
Communication (1)

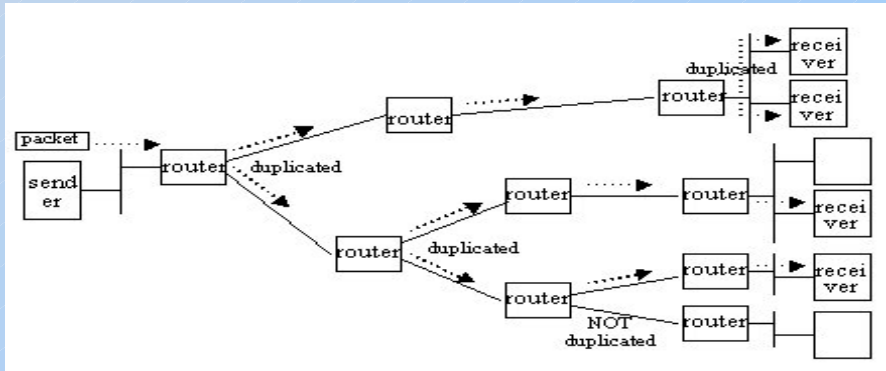
- The protocols used for network communication are:
  - TCP/IP
  - UDP/IP

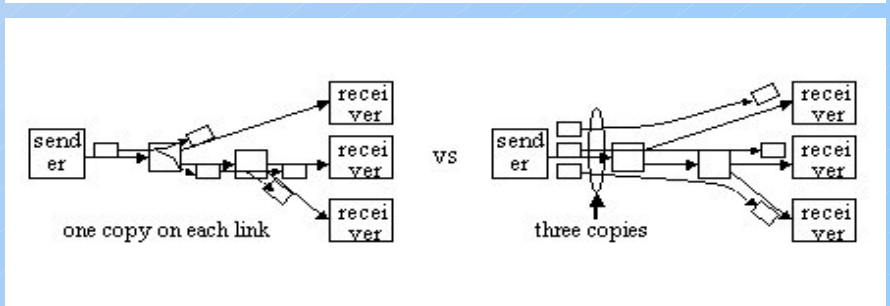
- Communication paradigms:
  - Connectionless (one-to-one) - unreliable/low delay
  - Connection oriented (one-to-one) - reliable/higher delay
  - Mass distribution (one-to-many):
    - broadcast/low delay/bandwidth intensive
    - multicast/low delay/bandwidth conservation

Communication (2) – *IP Multicast*

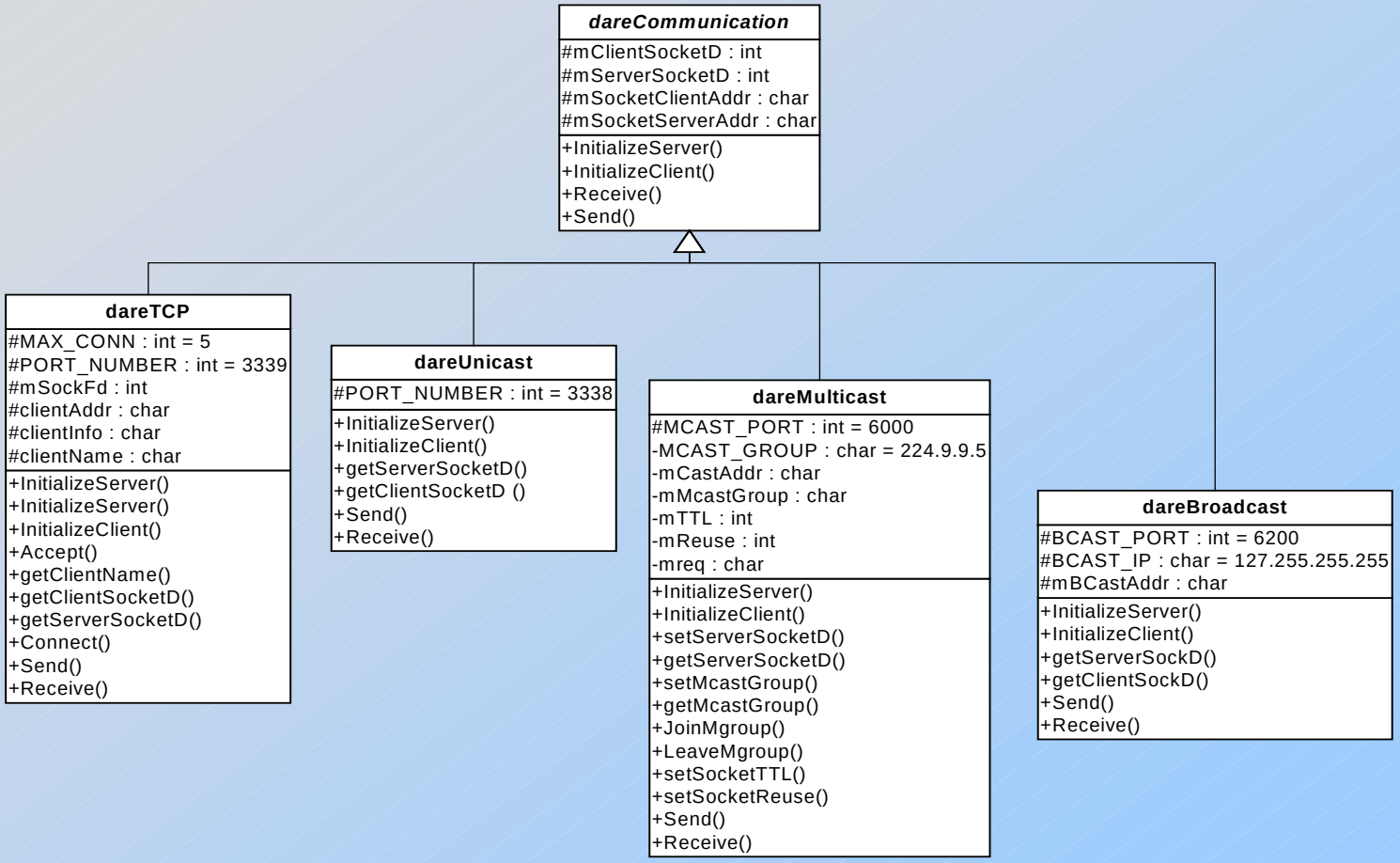
- Each Receiver joins a group (instead of Sender control)
- Anybody can join any group
  - TV-like ctrl~ tune on any TV station
- IP Multicast
  - Implements mcast in IP layer
  - Packets are duplicated ONLY when necessary.
  - Addressing ~ Group Address
  - Receivers to join a group, IGMP
  - Mcast routing protocols for inter-router control
  - Slow deployment, MBONE



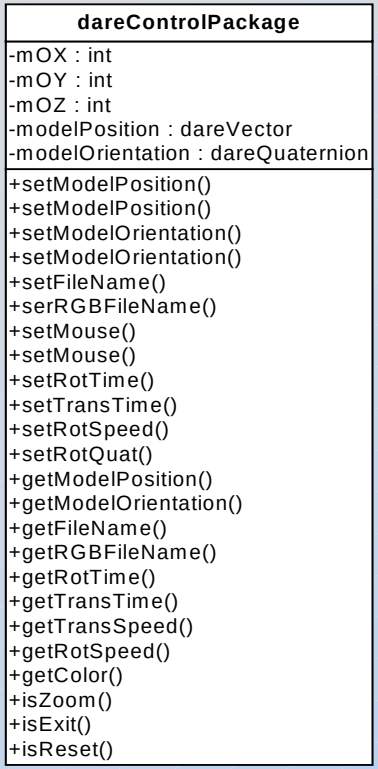


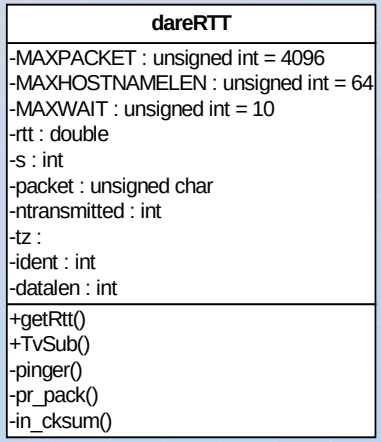


Network package classes (1)



Network package classes (2)





Maintaining the shared state

- The *ControlPackage* class allows instantiation of *ControlPackage* software objects

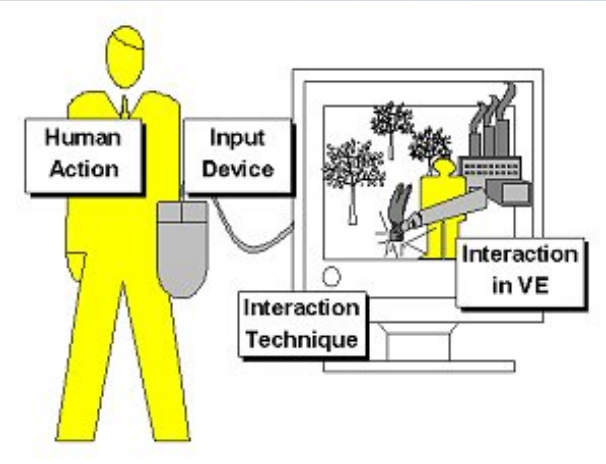
- The software objects contain information about the shared scene:
  - 3D objects position
  - 3D objects orientation
  - actions type (rotation/translation) applied on the objects
  - actions velocity
  - etc (open for sub-classing and aggregation)

- Objects can be transmitted through LAN using:
  - multicasting, broadcasting employing the client-server paradigm
  - tcp, Unicast(udp) employing peer-to-peer paradigm

Interaction methods (1)

- The definition of interaction differs according to research domain
- Human triggered interaction through a device (sensor) e.g.
  - mouse and a graphical user interface
  - position tracking sensor
  - speech recognition sensor, etc.
- Machine triggered interaction (programmed)
  - simulation loop
  - predetermined avatar behavior

Interaction methods (2) – *human triggered*



- Interaction sequence starts from human action
- Interaction is taken by means of an input device
- Executed interaction = the interaction that occurs within the virtual environment

Interaction methods (3) - *actions*

- High frequency vs. Low frequency actions
  - depends of the input device

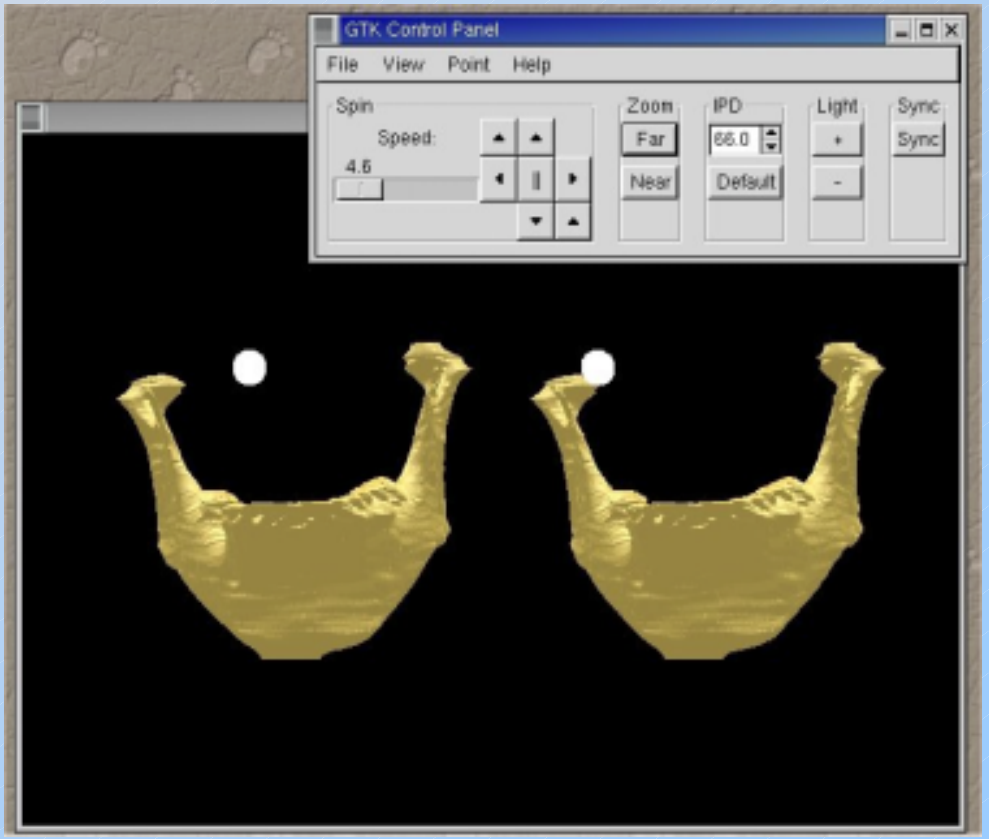
    (action freq. triggered from a mouse: www.cs.ucf.edu/~fhamza/html/MouseClicking.html)

- Predictable vs. unpredictable actions
  - depends on the environment (static vs. dynamic)
  - direct manipulation [*Shneiderman, 82*] interfaces
    - Continuous representation of the object of interest
    - Physical actions instead of complex syntax
    - Impact on the object of interest is immediately visible

(!) Direct manipulation interfaces are easy to use, moreover, it also reduces the cognitive load.

Interaction methods - *DARE 3D pointer*

- Small spherical pointer
- Connected to mouse device
- Left/right OZ axis
- Stereoscopic appearance



Conclusions

- DARE is an open framework, freely distributed for research in MR environments and for promoting applications for 3D displays.
- Hopefully DARE will unite the development efforts of the ODALab team members.
- DARE project will be used as reference to pursue research initiatives and to obtain financing for the research initiatives.
- DARE_V1.0_alpha released to ODALab members mid June,03.
- DARE_V1.0_beta released to ODALab members mid July,03.

Future

- DARE_V1.0 will be released soon (we all hope) and can by publicly advertised.
- More applications will start using the framework classes.

Web Page

http://odalab.creol.ucf.edu/dare

suggestions and comments are welcomed