Web Based Education and Training Technologies for Learning Communities in the next Millenium

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http://www.npac.syr.edu/users/gcf/houstonwebedoct98

http://www.npac.syr.edu/tango

Geoffrey Fox

Syracuse University

NPAC

111 College Place

Syracuse NY 13244 4100

3154432163

Abstract of An Introduction to Web-based Education Presentation

- We start with an overview of web based education in asynchronous and synchronous modes -- we cover
  - Curricula design, authoring, management and delivery
- Then we describe Tango which can be downloaded and used Today
- It is quite reliable and one of most sophisticated "WebWindows" applications -- build systems entirely on top of Web clients and servers
- Overview of Tango Architecture, Capabilities and how to use it in education
- We stress the important role of both Asynchronous and Synchronous collaboration and the web and web-based collaboration allows one to implement it.

Challenge and Opportunity

- Pervasive Communication Infrastructure (The Internet) and powerful new software technologies and concepts
  - Distributed Multimedia information on the Web
  - Web-linked Databases, Distributed Objects
  - Collaborative Systems
- Can enable education and training with
  - Better curricula
  - New collaborative learning models
  - Different "business models" for universities and schools

The Ingredients of Web Based Education

- **Design of (possibly new as exploiting new possibilities) curricula**
- **Decide on Architecture of the curricula material**
- **Authoring of material in curricula**
- **Managing the material and students response to it including quizzes, grades and administration**
- **Delivery of the material in a mix of self-paced (asynchronous), traditional (synchronous) or collaborative (interactive)**
- **Good answers to all these components are pretty clear and these answers will match the evolution of web over next few years**
  - **The answers are not perfect but they will improve and they are already good enough and can be delivered at a distance**
- **So all we need is ……..**
- **Organizations with appropriate mission, resources and entrepreneurial spirit to do the grand experiments, succeed and blossom in the future ….**

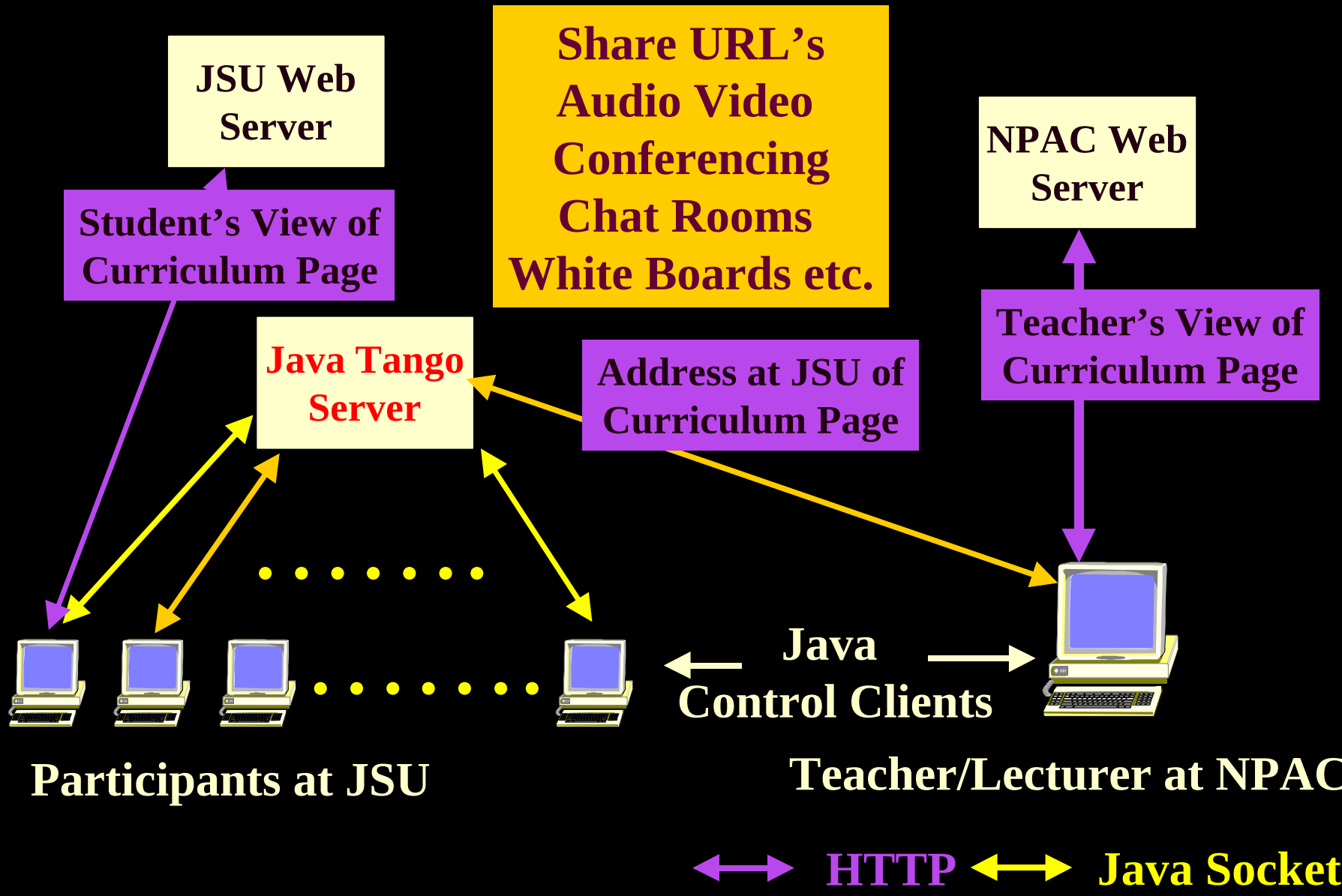
NPAC Education Curricula and Distance Delivery Activities

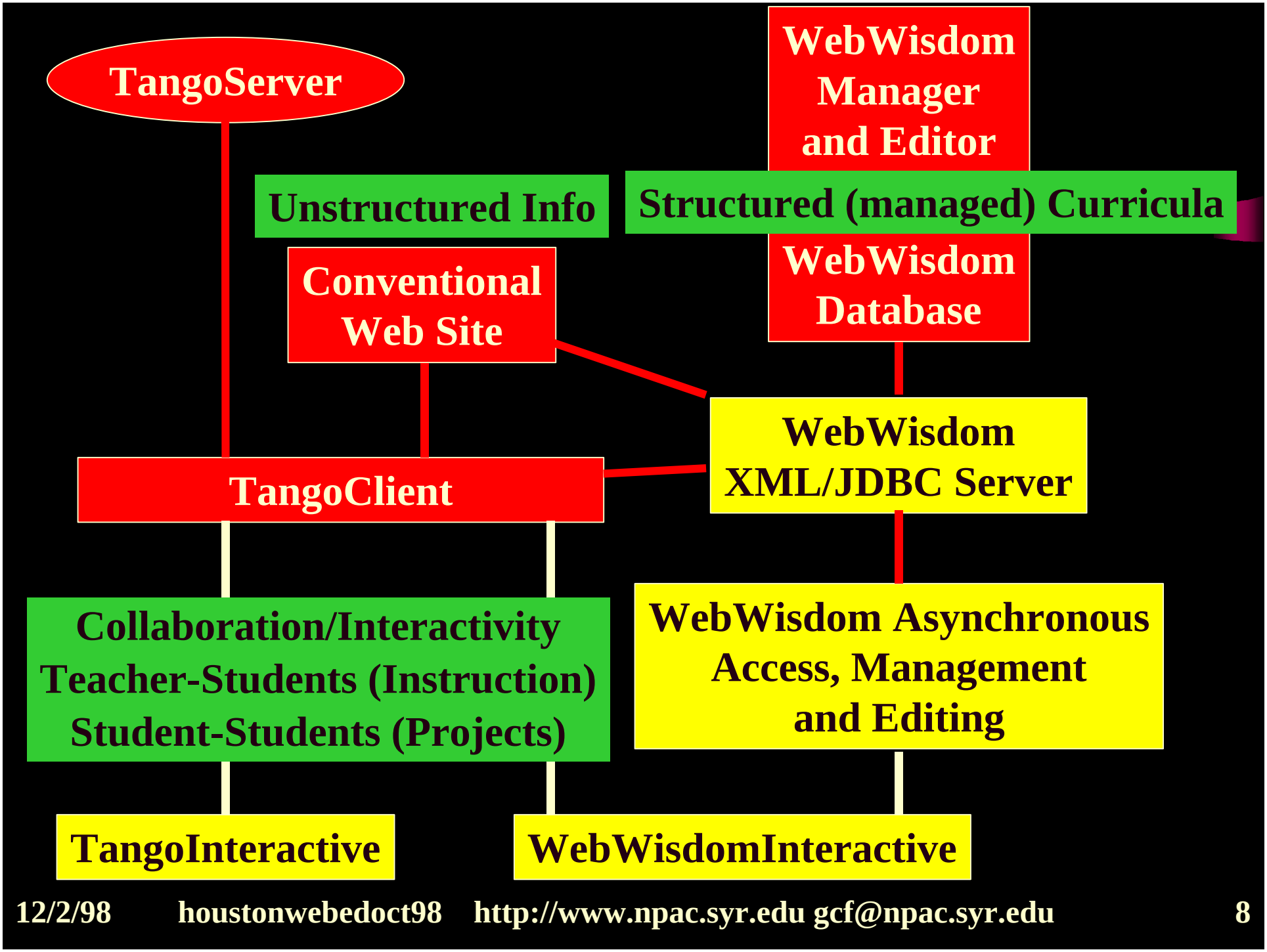
- Can offer "Certificates in Internetics or Computational Science" (Total of 4-6 or 1-2 semester classes respectively)
- Can offer internally *Web and Java* classes for K-12 level
- All these courses are in form suitable for synchronous/asynchronous delivery
- Taught two semesters from Syracuse over Internet a Senior Undergraduate Class in *Java for web applications* at Jackson State Mississippi using Tango collaboration system. This semester teaching graduate *computational science*
- Can combine with local CDROM of curricula material
- Have specialized programming laboratories for both Web and parallel programming -- Jackson students do ALL work from a PC at JSU accessing resources at Syracuse

CSC499/615 at Jackson State

- Taught using Tango over Internet and defense high performance network DREN every Tuesday and Thursday from Syracuse
  - Course material based on Syracuse Senior Undergraduate class ECS406(Web Technologies) and graduate class CPS615(Base Computational science)
- Jackson State major HBC University with many computer science graduates
- Do not compete with base courses but offer addon courses with "leading edge" material (Web Technology, modern scientific computing) which give JSU (under)graduates skills that are important in their career
  - Job fair employers liked Java Programming!
- Needs guaranteed 30 (audio) to 100 (video) kilobits per second bandwidth assuming course material mirrored at JSU
  - Can be offered using CD-ROM's to homes with audio only (plus modest fram rate video) link and 28.8 kbaud modem

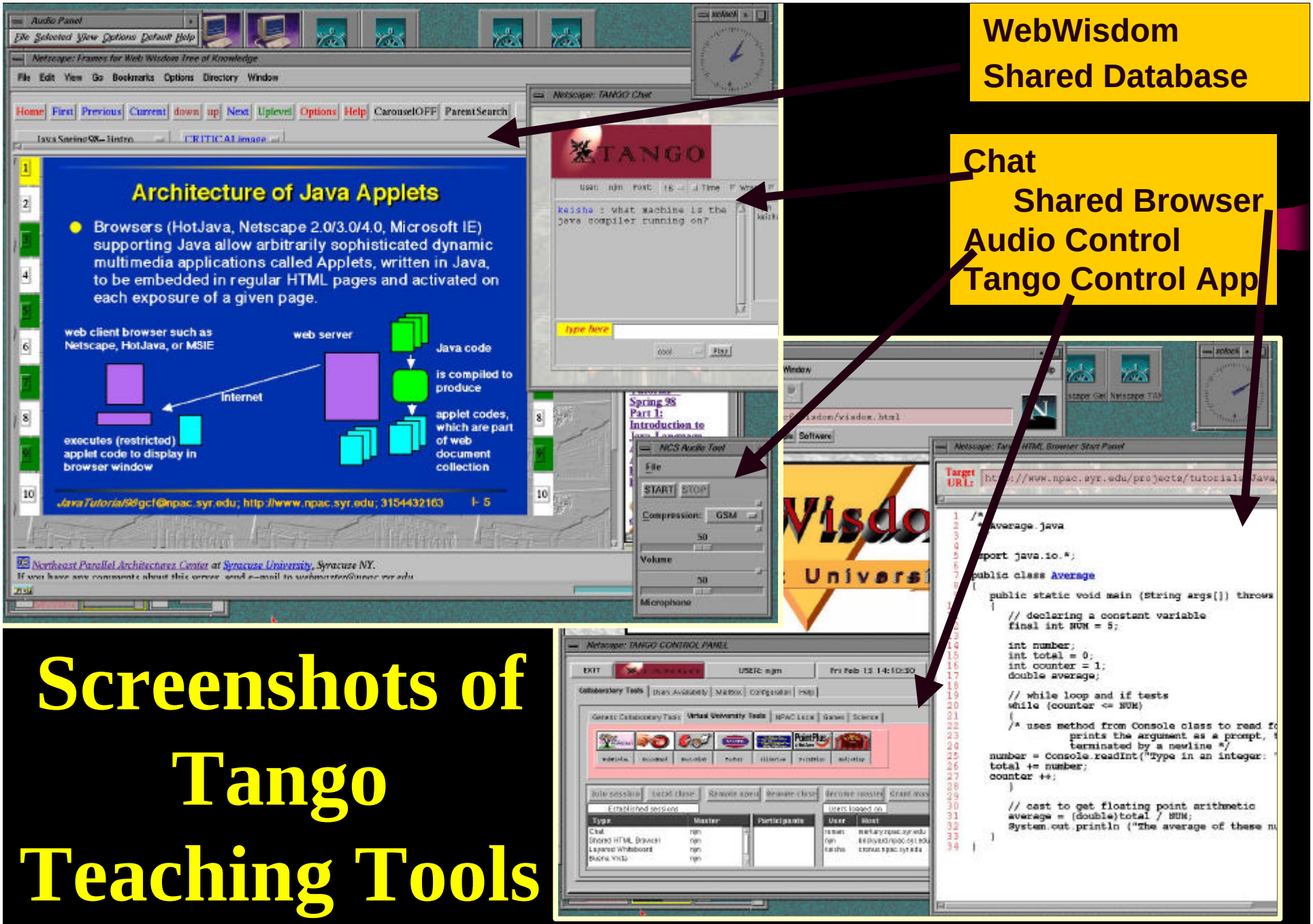
Architecture of Tango Distance Education




TangoServer
WebWisdom Manager and Editor
Unstructured Info
Structured (managed) Curricula
Conventional Web Site
WebWisdom Database
WebWisdom XML/JDBC Server
TangoClient
Collaboration/Interactivity
Teacher-Students (Instruction)
Student-Students (Projects)
WebWisdom Asynchronous Access, Management and Editing
TangoInteractive
WebWisdomInteractive

Some Definitions and Technology Notes

- **Collaboration = Sharing**
- **Asynchronous = Access to common Web and Database Information sources + simple tools (email, calendar)**
- **Synchronous = Real time/Interactive sharing of information that can also be accessed asynchronously**
- **An "object" is a "foil" or "screenful" -- natural unit of information that fits both computer screen and goal of focussed nuggets of knowledge**
- **Use Conventional Web Servers and databases (a.k.a object brokers) as information sources**
- **Server-side enhancements (Collaboration server, XML Curricula object processor) written in Java**
- **Client Side enhancements are a mix of Java applets (GUI), Java Applications (curriculum manager) and JavaScript (control web pages)**
- **Can collaborate with server or client side shared applications**



Screenshots of Tango Teaching Tools

Tango WebWisdom Model Collaborative Business model for Education

- **Universities "specialize" and deliver courses in areas of expertise**
  - **Provide all students *and faculty* with access to broader range of leading-edge courses**
- **JSU will lead HBCU wide deployment**
- **NPAC is studying use internationally**
- **Pilot for *distance training* for DoD**

Traditional Model of Instruction

Common Shared Books and Such Resources

Personal Lecture Material | **Personal Lecture Material** | **Personal Lecture Material**

Professors



Students



Done separately for each class at each university

Collaborative Model of Instruction

Class I is given by University 1) to students at 1,2,3)

Common Shared Books
Web based Lecture Material
and Similar Resources

Local Students

Professor from Univ. 1)

INTERNET

Outside Students

3)

2)

Each University teaches a given class to all Students
Universities divide classes up among themselves

Lessons from JSU Experiment

- Students liked the job relevant skills taught
- Important to have curricula mentor and technology expert at remote site; important to visit 2 or 3 times a semester
- Digital Audio/video less stressful to lecturer than speaker phone
- "Shy" students are helped by remote format as digital interactions are "personality neutral"
- Need to keep to the point -- digressions, which are often helpful in standard lectures, tend to lose students -- help with shared cursor
- Need to keep everything synchronized
- Chat stores up messages to answer at end of "current object"
- Teacher can browse ahead 1 or more foils as "thumbnails"
- Experiments were successful but conservative -- we deliberately tried to reproduce "time honored approach" -- we can expect there to be different optimal approach in distance case than in face to face case -- find by more experiments!

Design and Architecture of Curricula Material

- First we note that the web is evolving to the "object web" as "distributed object" and traditional web technologies merge. Whether Sun(Java), Microsoft(COM), W3C (Web Consortium) or OMG (Object Managent Group) win does not matter
  - At a high level they are all distributed objects accessible from the web
- So the architecture is that of distributed objects which are designed to be as modular as possible
  - Natural size of basic "educational object" is about a screenfull
- Initial design will be traditional -- include
  - Bunch of "foils" (electronic presentation)
  - Bunch of HTML pages (electronic book)
  - Bunch of multimedia dazzle (today's educational CDROM's)

Future Design and Current Status of Curricula Material

- Future design will include virtual environments and interactive simulations and these can only improve a situation that is already better than current teaching model because
  - Can teach at a distance more students than in a class.
  - Thus can invest more effort in curricula by the most appropriate developers and so get more up to date understandable curricula of a traditional type
  - distributed electronic object model allows for greater re-use than current system allowing development of customized courses for special audiences
  - Universal access technology will also allow optimization of delivery of given material to special groups of users
  - And of course distance education can reach users who otherwise would find it hard to attend quality classes

The Pragmatic Object Web I

- What about the four different object models swirling around in today's technology cauldron?
  - XML from W3C is easiest and great for documents
  - Java Jini/RMI from Sun is most elegant
  - CORBA from OMG is most powerful
  - COM from Microsoft is highest performance and best developed and Gates will soon crush us all …
- So don't settle on any one of these but put all your material in a database; host your database with a server (called a broker in CORBA) and use "middleware" (an Enterprise Javabean and JDBC - the Java Database Connectivity standard) to map between models
  - Do NOT author HTML pages
  - Can use Oracle or any standard "relational" database
  - Put up a token fight against Microsoft -- abhor Access

Pragmatic Object Web II

- Maybe we will complete our book "**Building Distributed Systems with the Pragmatic Object Web**" which describes the current cauldron using as example **JWORB** -- a server that understands all 4 object technologies …
- Alternatively take our "4 to 6 semester course" **Certificate in Internetics** offered using Web-based instruction!
- Alternatively learn into from your **children** who can also take (at a distance) our **1 to 2 semester Java Academy** designed for middle and high school students

Authoring the Curricula

- It would be good to use simulations and nifty animations and digital video if available
  - Simulations can be server side objects or client side (applets)
- But at the low end, use PowerPoint or HTML (with various levels of sophistication in editor)
  - Using COM can store individual foils of PowerPoint in a database
- At the high end, use Macromedia Director or equivalent technology
- Only use technologies that support web export
- Consider as objects that can be stored in a database and exported as HTML/XML using some template
- Store video and images in multi-resolution format to accommodate different curricula quality/network bandwidth tradeoffs
- Expect authoring tools to improve

4 Approaches to Authoring of Back End Resource I

- In order of increasing sophistication; cost; preparation time and presumably also in increasing learning value
- "Low-end" typified by simple HTML and PowerPoint. Of course hand written notes and postscript are even less sophisticated but these are getting less important.
- "Enhanced Low-end" typified by audio or video over web pages. Not clear how editing is possible/desirable
  - This can be viewed as a pragmatic way of capturing details from the busy lecturer who does not have the time to carefully prepare a more sophisticated resource.

4 Approaches to Authoring of Back End Resource II

- "Medium End" such as the Cornell Virtual Workshop where one provides overview material (as in traditional foils) as well as more detailed information. The former is used when you lecture and the asynchronous learner uses the details.
- "High End" such as the classic Multimedia CDROM (or its web equivalent) prepared by sophisticated authoring tools such as Macromedia Director and with possibly professionally produced videos.

Managing the Curricula

- So as we have stored all our material in a database, managing it is equivalent to building an administrative support system for the database
  - Administrative system is built in usual way as "business logic Javabean middleware" running on a server and accessed from some web client
- Web export from database should support Educom's IMS standard for metadata to allow convenient webwide searches of repositories
- One needs special modules that accommodate
  - PAPI or Personal and Performance Information
  - Submission of homework of diverse nature
  - Laboratories including both programming and science labs
  - Producing composite lectures from collections of base educational objects (re-use)
  - More research needed on assessment tools

Learning and Teaching the Curricula I

- So the students need to learn the material and they may need some sort of help from a teacher or mentor
- In self paced or asynchronous learning, student studies material in his or her own time and essence of this is a web site which may of course be generated from a back-end web-linked database
  - optimal for highly motivated mature students such as those in continuing education
  - electronic version of using a library
- In synchronous learning, teacher selects material from website and delivers it in electronic virtual class rooms
  - Homework is set from same website which remains a base asynchronous resource
  - Natural when teachers insight delivers motivation and clarification of key material to student
  - electronic version of traditional classes

Learning and Teaching the Curricula II

- In collaborative learning, teachers, assistants, students and the web resource interact in an electronic collaboration system
  - Seems particularly valuable in K-12 arena
  - Also natural model for collaborative research
- Note systems like Lotus Notes are "just web-linked object brokers" from this point of view
- All approaches use basic asynchronous tools such as electronic mail, bulletin boards and searchable repositories
- Can record synchronous sessions for later asynchronous replay
- One need not chose any one approach as can support all of them with a (preferably database back ended) web site linked to a suite of collaboration tools
- Note just as we can link asynchronous--synchronous--collaborative, we can also link education and training
  - Note modular educational objects naturally support smaller units of achievement certificates

Collaboration

Web Pages

Java

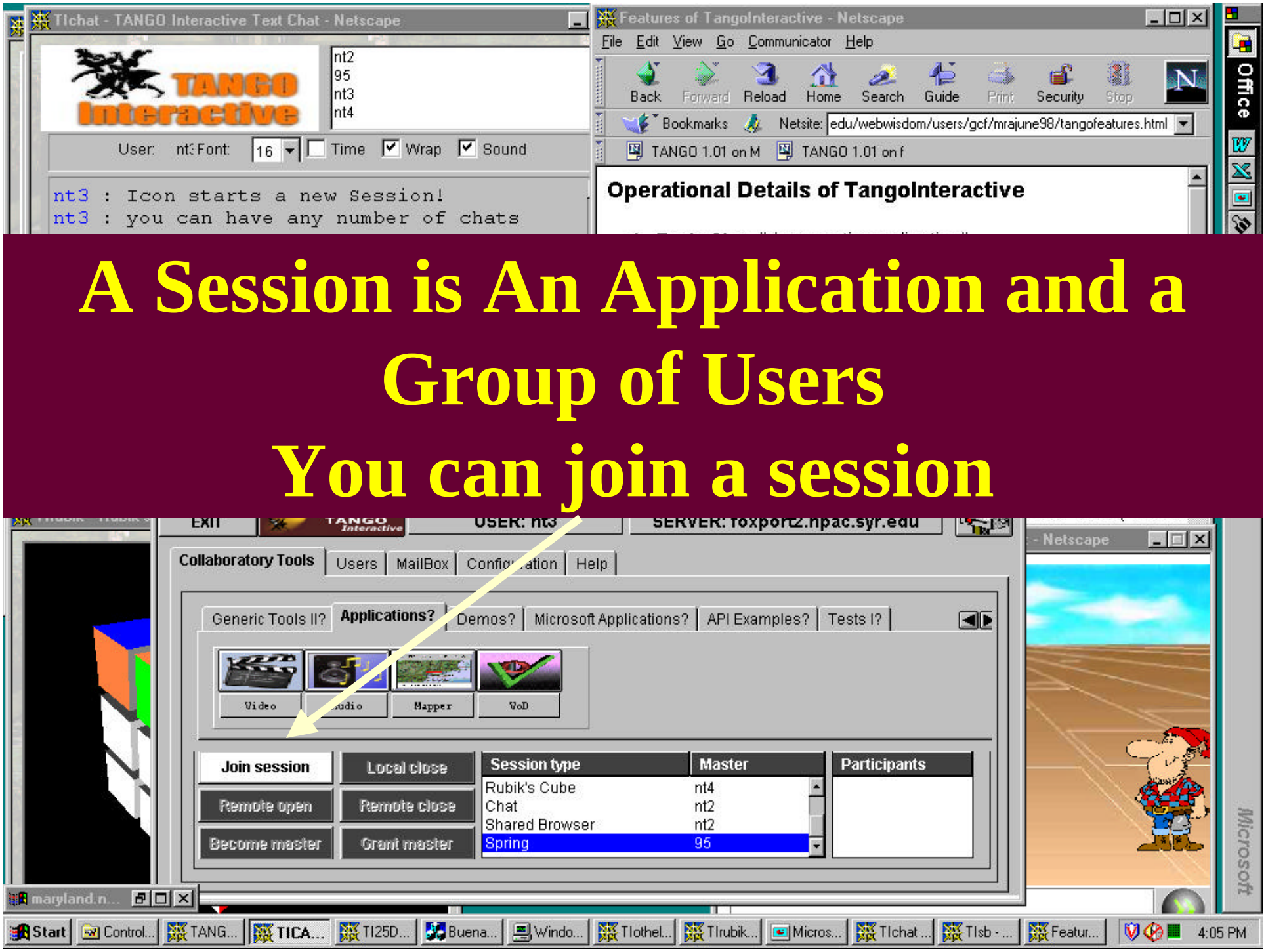
C++

Web Pages

Java

C++

TANGO - Interactive


TIchat - TANGO Interactive Text Chat - Netscape
TANGO Interactive
nt2
95
nt3
nt4
User: nt3 Font: 16 Time Wrap Sound
nt3 : Icon starts a new Session!
nt3 : you can have any number of chats
Features of TangoInteractive - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Guide Print Security Stop
Bookmarks Netsite: edu/webwisdom/users/gcf/mrajune98/tangofeatures.html
TANGO 1.01 on M TANGO 1.01 on f
Operational Details of TangoInteractive
Office
A Session is An Application and a Group of Users
You can join a session
EXIT
USER: nt3
SERVER: foxport2.npac.syr.edu
Collaboratory Tools
Users
MailBox
Help
Generic Tools II?
Applications?
Demos?
Microsoft Applications?
API Examples?
Tests I?
Video
Mapper
VoD
Join session
Local close
Remote open
Remote close
Become master
Grant master
Session type
Master
Participants
Rubik's Cube nt4
Chat nt2
Shared Browser nt2
Spring 95
- Netscape
Microsoft
maryland.n...
Start
Control...
TANG...
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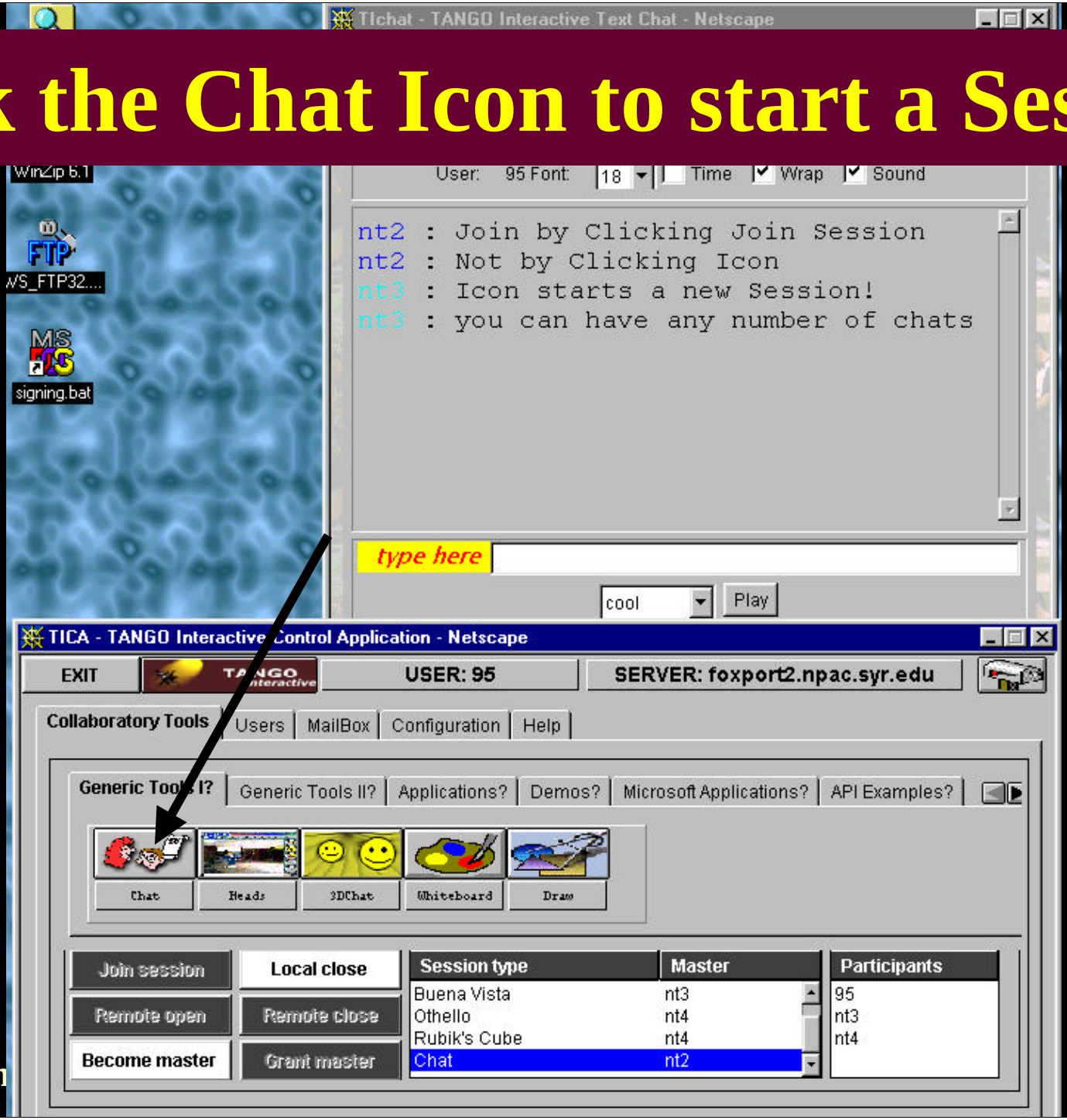
Windo...
TIothel...
TIrubik...
Micros...
TIchat ...
TIsb - ...
Featur...
4:05 PM

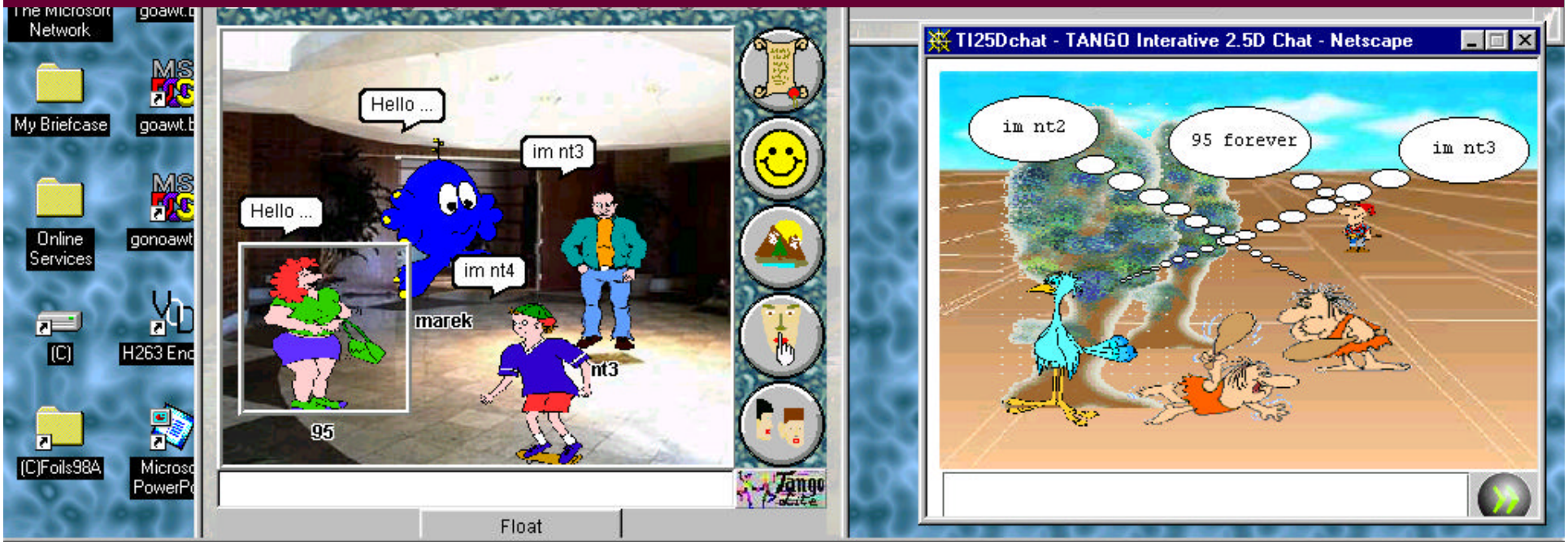
The current Capabilities of Tango -I

- Tango supports a synchronous shared event model of collaboration
- Tango supports (more than) enough (over 40) applications
- Core Collaboration Capabilities
  - Audio-Video Conferencing multicast between room participants
  - Text chat rooms with various tradeoffs between “coolness”, ease of use etc.
  - Shared Browser (Synchronized view of Web Pages)
  - Shared Web Search (becomes shared database query)
  - Slide Show
  - White Board
  - Shared Audio and Video Players (Java Applets and link to video on demand database)

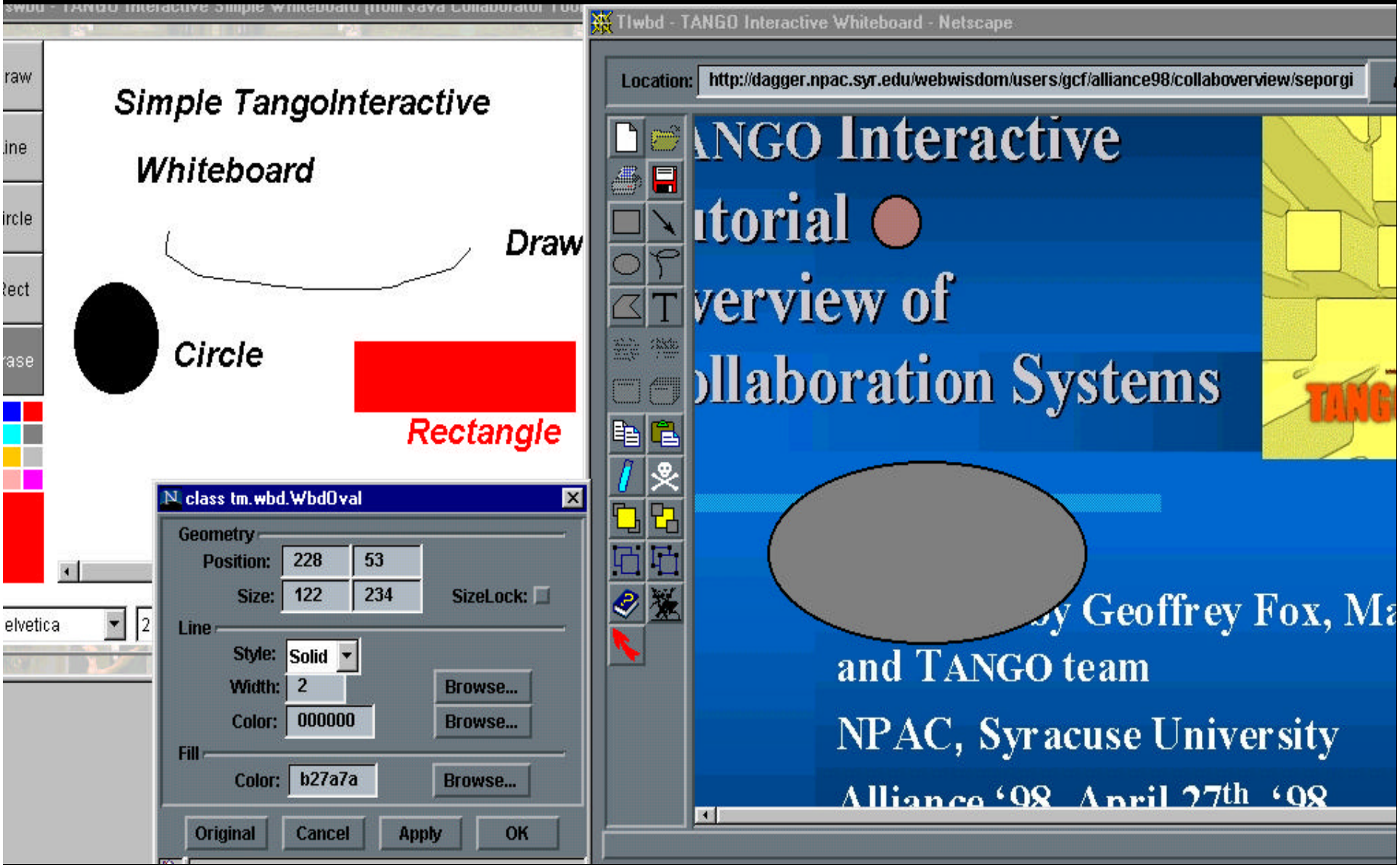
Click the Chat Icon to start a Session



TangoInteractive is a flexible framework -- 3 chats



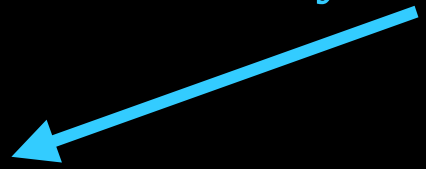
Tango Offers Two White Boards

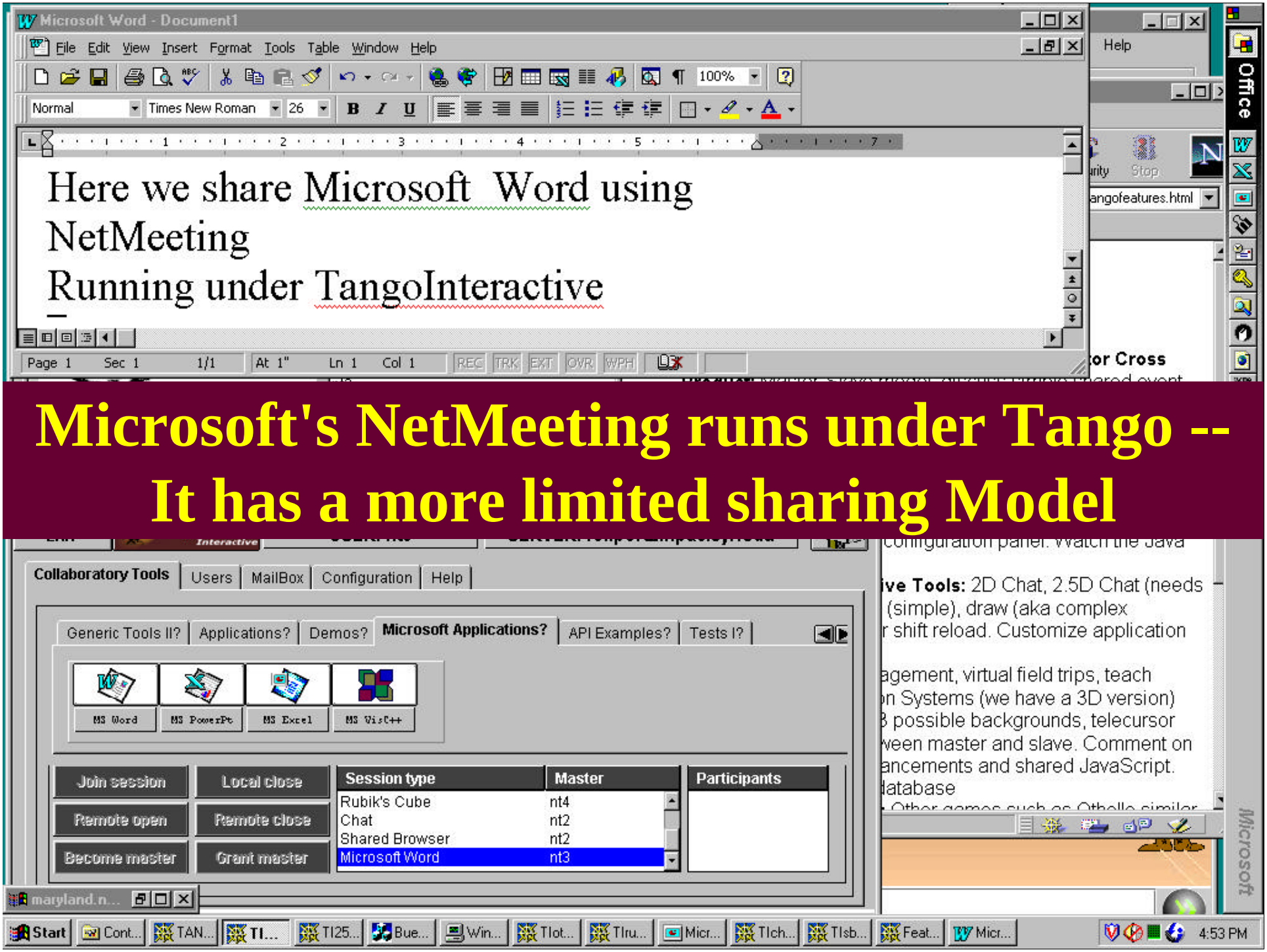


Capabilities of Tango -II

- **Databases Linkage (Under Development)**
  - **JDBC Link to WebWisdom Database**
  - **Lotus Notes Link to Asynchronous Collaboration**
- **Office and Authoring Tools**
  - **PowerPoint via shared display or shared Java viewer**
  - **Microsoft Excel using NetMeeting**
  - **Microsoft Word**
  - **shared visual C++ etc.**
  - **Combined Whiteboard / Java object based PowerPoint like authoring system**
  - **Shared emacs editor -- shared programming**

Very Useful for Education

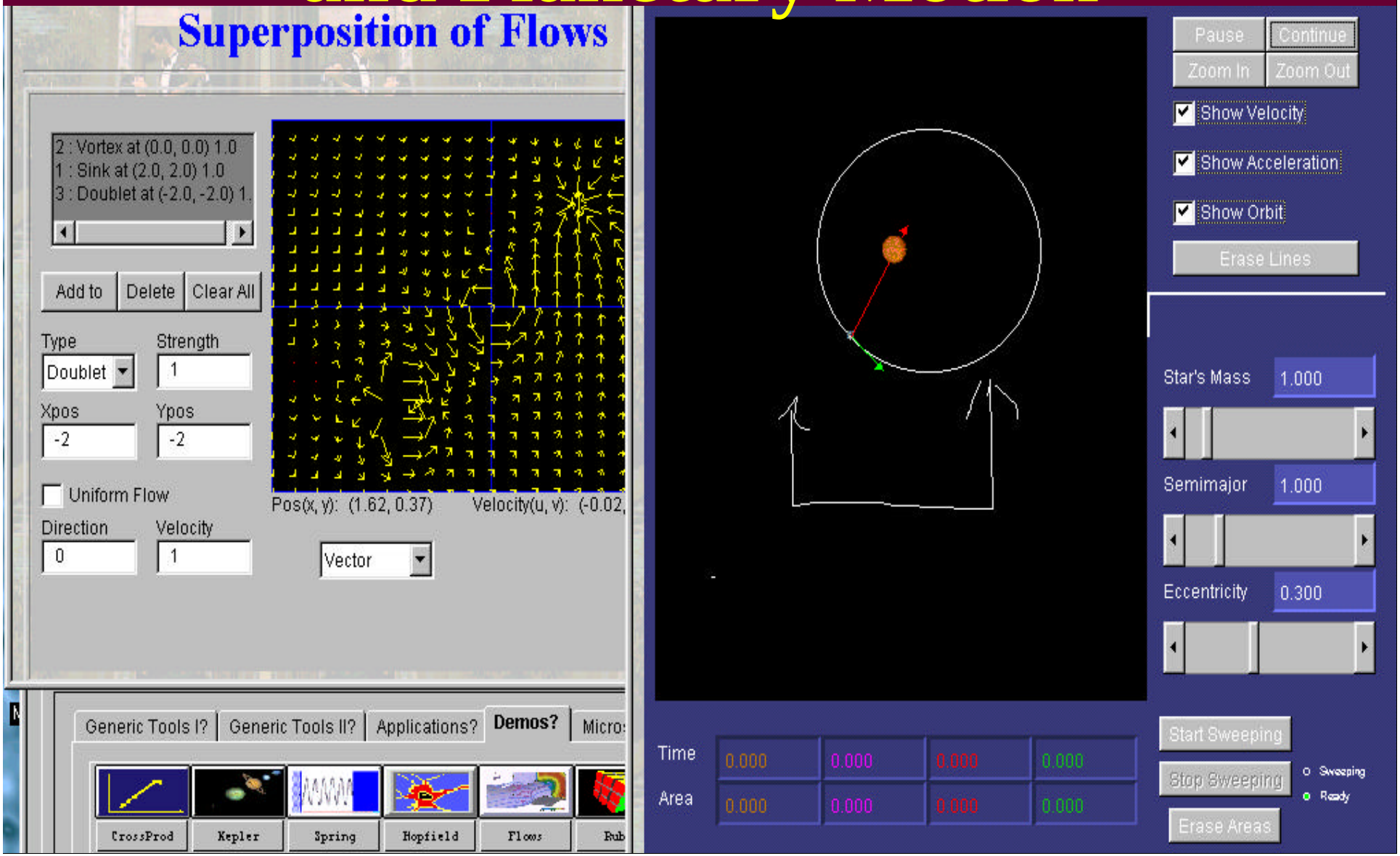



Microsoft Word - Document1
File Edit View Insert Format Tools Table Window Help
Normal Times New Roman 26
Here we share Microsoft Word using
NetMeeting
Running under TangoInteractive
Page 1 Sec 1 1/1 At 1" Ln 1 Col 1
Microsoft's NetMeeting runs under Tango --
It has a more limited sharing Model
Collaboratory Tools
Users
MailBox
Configuration
Help
Generic Tools II?
Applications?
Demos?
Microsoft Applications?
API Examples?
Tests I?
MS Word
MS PowerPt
MS Excel
MS VisC++
Join session
Local close
Remote open
Remote close
Become master
Grant master
Session type
Master
Participants
Rubik's Cube nt4
Chat nt2
Shared Browser nt2
Microsoft Word nt3
Start
4:53 PM

The current Capabilities of Tango -III

- General Virtual University Applications
  - Current WebWisdom hierarchical database system navigating through 25,000 foils and 650 foilsets
  - "Raise Hands" Applet to help teacher-student synchronous interaction
- Special Virtual University Applications
  - Shared Java applets to teach physics (spring, planets, vector cross product)
  - Shared visible human illustrates biology teaching
  - Shared Java Applets used to teach Java!
  - Shared SmartDesk system aimed at activities useful in special education with built in assessment

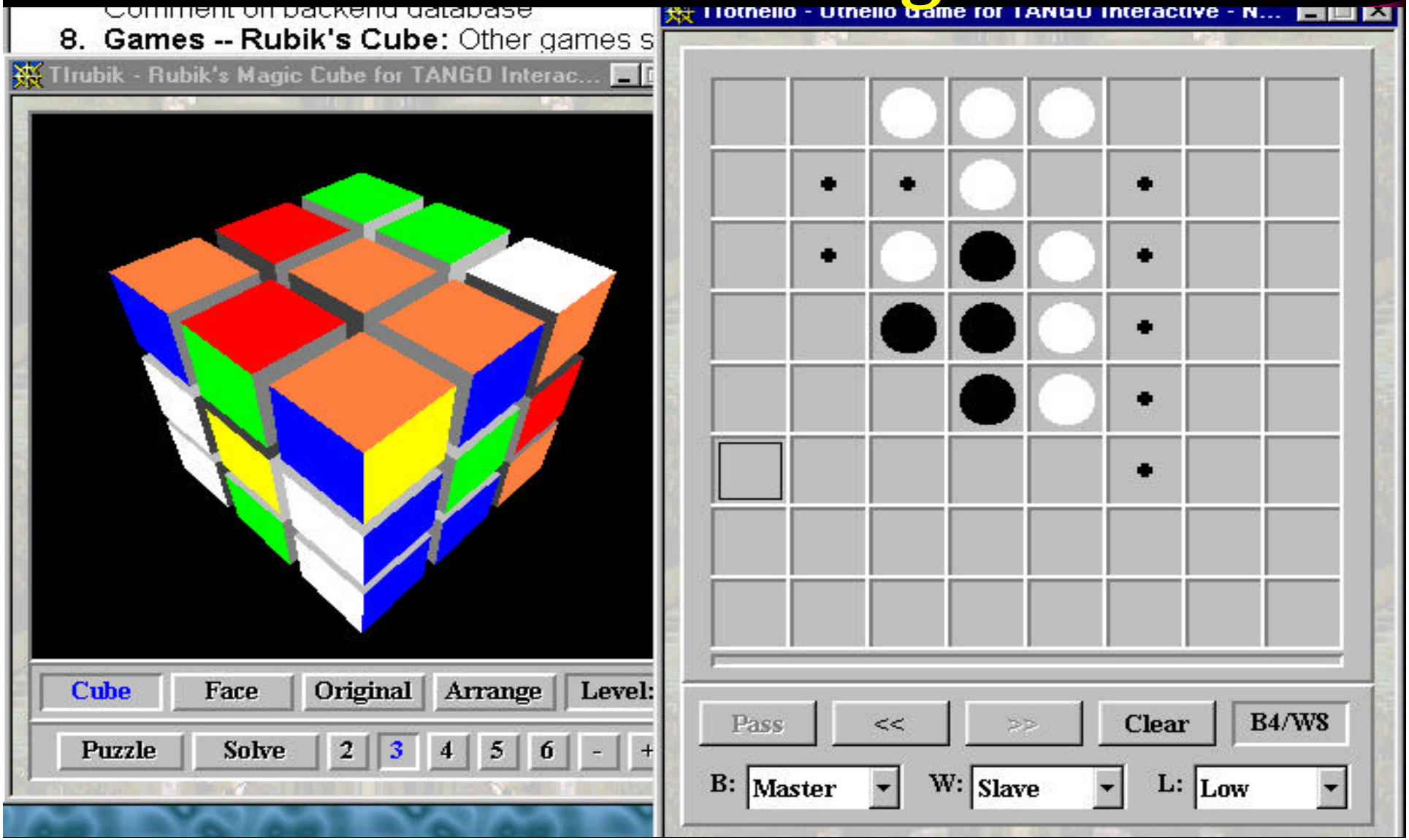
Shared Simulations -- Fluid Flow and Planetary Motion

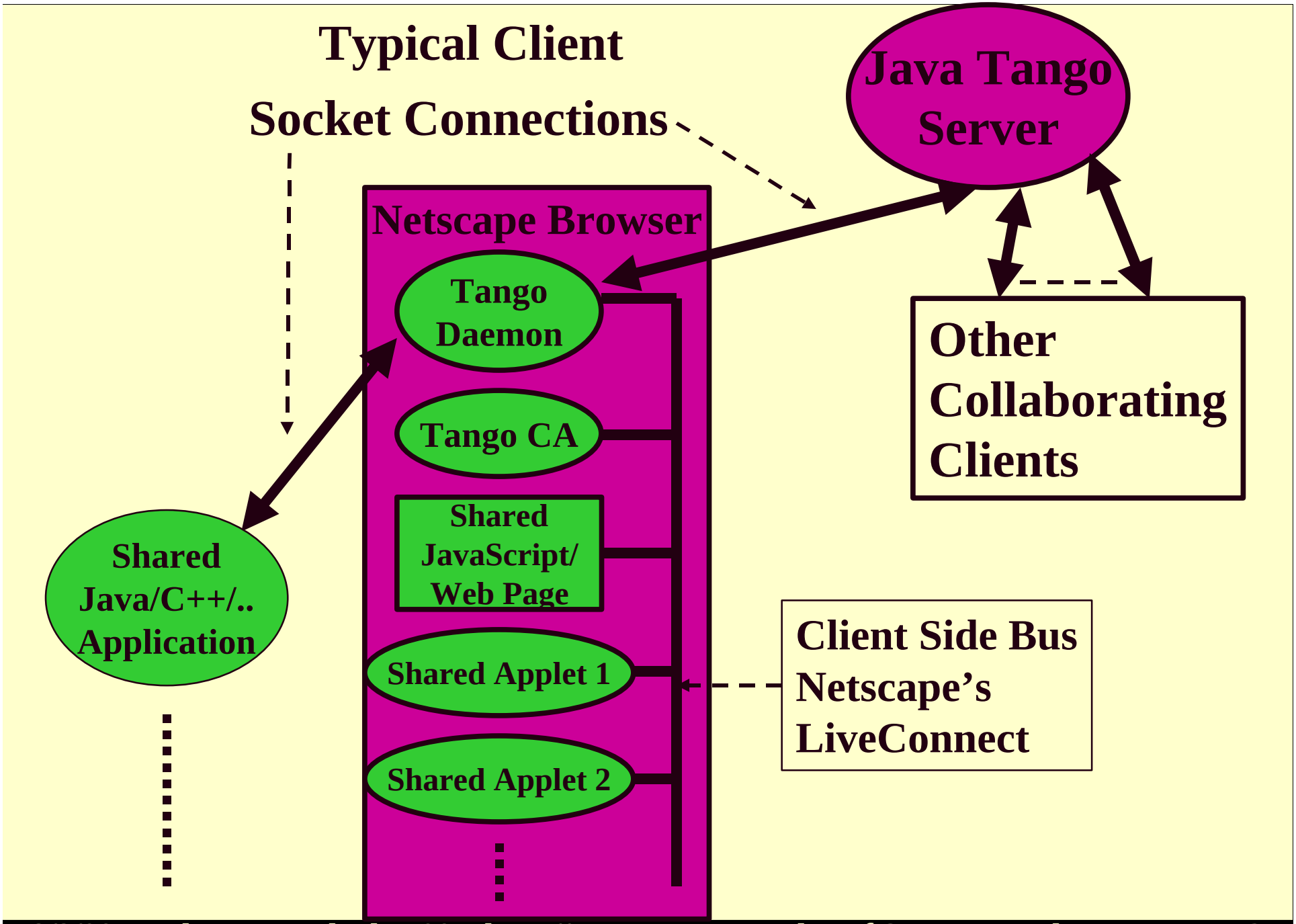


The current Capabilities of Tango -IV

- Have some fun with Multi-player games
  - VRML Chess
  - JavaScript Tetris
  - Java Othello and Rubic's Cube
  - snakes and ladders and could develop a bunch of similar "grid" games
- "Other" Applications
  - TANGOsim command and control system with shared tools (e.g. mapping, weather) to use in scripted crisis management
  - There is a very good shared mapper which is a Java whiteboard supporting map backends and general shared drawing
  - Shared Visualization and other programming tools under development

Games are Natural in Tango
Othello and the Magic Cube




Typical Client
Socket Connections
Java Tango Server
Netscape Browser
Tango Daemon
Tango CA
Shared JavaScript/ Web Page
Shared Applet 1
Shared Applet 2
Shared Java/C++/.. Application
Other Collaborating Clients
Client Side Bus Netscape's LiveConnect

How do you use Tango I?

- **Tango provides for any developer:**
  - **Session control among users**
  - **Access to broad range of general collaborative tools**
  - **API to JavaScript (Web Pages), Java Applet or Application, C and through C to any client side program (LISP, VRML)**
- **If you have a set of Web pages defined by their URL's -- then use today the Shared Browser and later on can store in WebWisdomNT database for a more powerful model**
- **If you have some enhanced Web Pages using Cookies and Forms (and wish say, to share form input), then we need to use shared JavaScript API -- we can provide this as general capability**
- **If you wish to share server side results as in Lotus Notes (or CGI Scripts), then exploit web export of these servers -- XML very powerful here -- with a variant of shared browser**

How do I use Tango II?

- If you have a client side program, then you need to know an API to it which allows one to get and set all the properties (or events which are change of properties)
- Most elegant interface is a TangoBean which implements shared Javabeans
  - A Javabean is a Java applet/application which has well defined visual and programmatic interface to its properties -- “design rules”
- In any case, you choose events to be shared; meaning of master/slave relationship (if any) and consequence of sharing on disparate machines
  - e.g. in shared physics simulation, one could share positions of particles or just start/stop commands
  - Then slower machines simulate less …..

Tango and Collaborative Versions of Other Large Scale Systems

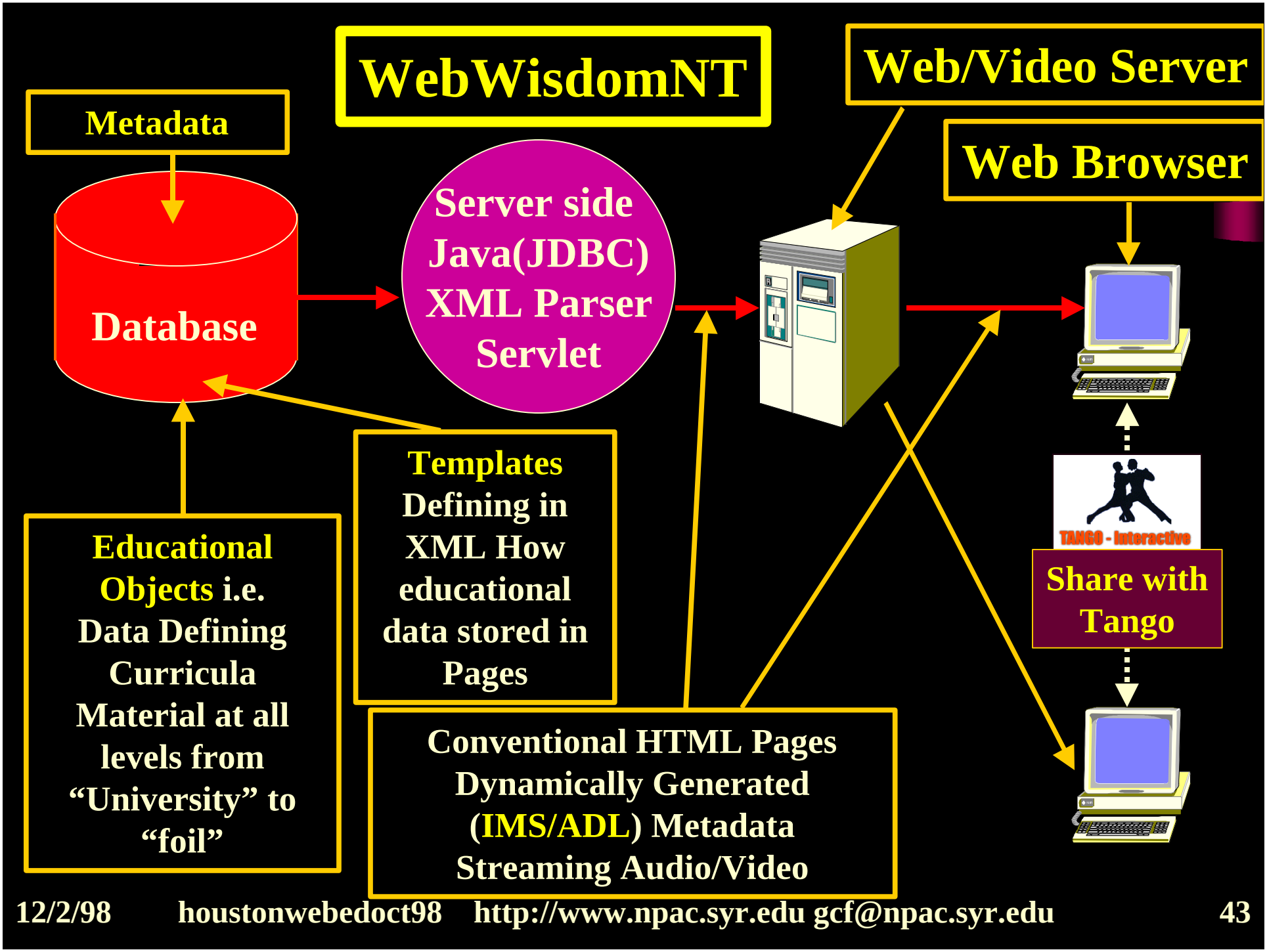
- Note that in Audio-Video Conferencing, Video on Demand, and Microsoft NetMeeting applications, Tango "just" provides session control to another application which provides itself all the necessary data distribution
  - This is also true in Shared Browser where Tango just provides a URL and lets Web Servers distribute information
  - So could in principle support many other such subsystems including other A/V conferencing tools such as MBONE

Asynchronous vs. Synchronous

- As primary Web function is asynchronous information publishing, Web-based collaboratories inherently link two models
  - Both modes focus on the basic concept of a "shared object"
  - Both modes can share presentation tools
  - Synchronous mode may create or persistently enhance/modify shared objects
- Web database linkage technology (based on JDBC/ Enterprise JavaBeans) promotes complex asynchronous collaboration by exposing rich data models of industrial-strength relational and OO DBMS's
- Need Both! Tango can be linked to Oracle, Lotus Notes and similar database systems -- XML is a powerful interface for such linkage
  - Tango offers "guided tour" sampling a large asynchronous web site, CDROM, database

Features of Database Backend

- Use a **database** to store material so as to
  - **Manage** large collections
  - **More easily adapt** to changing/different browsers by "just" changing templates
  - **Back-up, security** etc. well established capabilities
- Database has curricula material of all (4) levels of sophistication and **supports both synchronous** and **asynchronous learning**
  - database stores multimedia information -- video, audio and images
  - Also **administrative information**; organization of courses into programs; **grades**; **student/teacher** data


WebWisdomNT
Web/Video Server
Web Browser
Metadata
Database
Server side Java(JDBC) XML Parser Servlet
Templates Defining in XML How educational data stored in Pages
Educational Objects i.e. Data Defining Curricula Material at all levels from "University" to "foil"
Conventional HTML Pages Dynamically Generated (IMS/ADL) Metadata Streaming Audio/Video
TANGO - Interactive
Share with Tango

Leveraging Collaborative Tools

- At K-14 education level, dominant emphasis is "building learning communities" and tools to support collaborative learning
  - Fully interactive; semi-interactive (as in MOO model) or possibly asynchronous
  - Working through NCSA Alliance with NSF CILT center
  - 2.5D Chat is perhaps a nice tool here
- Web collaboration is central to many other applications
- Thus there are many leverage points
  - Synchronous teaching a good place for early deployment of collaborative tools as relatively structured and so less sensitive to immaturity of systems

Collaborative Web Applications with their Participants I

- We have discussed **Distance/Collaborative Learning Community Education** and training-- teachers and students (and administrators)
- Some important areas using related technologies are:
- **Forums and Chattering on the Web** -- the world!
- **(Tele)medicine** -- Doctors (primary and specialist referrals), Nurses, Patients and administrators
- **Business Enterprise** (strategic) Support as in Lotus Notes -- Employees of Business including especially managers

Collaborative Web Applications II

- **Crisis Management** and **Command and Control** or more generally distributed (tactical) **real-time decision support** -- decision makers and gatherers of information
- **Multidisciplinary Applications** including Collaborative design -- teams of up to 10,000 engineers
- **Collaborative Visualization/Data Analysis and Computational Steering** -- one or more computational scientist and visualization device
- **Consulting** and **shared software/systems** development
- In each case Collaboration involves support for **dynamic interactive shared distributed objects** and one needs both **synchronous** (as in Tango/Habanero) and **asynchronous** (basic Web/Lotus Notes/Email) support
- The **shared objects** are both **client** and **server** side

Some Tango Futures

- We intend enhancements to some applications -- such as full annotation (on the Java Whiteboard) with database access and archiving in WebWisdomNT
- We will evaluate Internet Explorer version (prototype available), Macintosh and AIX support
- Archive audio-video conferencing, text chat etc.
- Looking into a built in window manager, more automatic support for mirror (content) servers
- Link Tango user module with administrative (class) database -- link Tango and conventional mail
- Lots of interesting assessment opportunities
- Could build Collaboratory tools -- scientific visualization will be supported but also could do debuggers, performance visualizers etc.
- EOT PACI has identified NCSA Biology Workbench, BU Biology database, and for K-12 Belvedere annotation system