

Pervasive Systems

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Lecture 8: Pervasive Games



How Real Will Wearable Games Be?



What is a Pervasive Game?

- Idea been around for at least 20 years.
- A game that goes beyond the bounds of one screen.
- You play your game on your computer and then go out into the world with your PDA and keep playing.
- Your game would seep in to your life in a variety of ways and maybe even the boundaries of play and not-play would become illusive.
- While the target devices have maybe moved on from computers and PDAs to tablets and smartphones, the idea is alive and well.



Are there Success Stories?

- No.
- Why?
 - 1 Technology
 - pervasive game sounds good in theory,
 - in practice its meant getting a lot of different devices to play nice, and thats not easy.
 - 2 Expertise
 - Developing a game to work on one platform is hard,
 - never mind porting to similar platforms.
 - 3 Perception
 - the idea that players might move from screen to screen
 - sounds like a nice dream ...



Pervasive Space-trading Game	Augmented Reality Games
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- A Pervasive Game version of EVE Online
- Approach #1
 - Take EVE
 - Add some mobile features
- Approach #2
 - Rethink everything from the ground up
 - Maybe make a game that will always be much simpler than EVE

- Augmented Resistance
- Pervasive Game Concept: Conquer The Forest







Storytelling Games	Location-based Games
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- Trust Affair
- Pervasive Game Concept: Conquer The Forest

- 7 Candles Manchester
- Marshotron
- Hide and Seek Urban games



<div>Case Studies</div> <div>Mixed-reality Games</div> <div> <ul style="list-style-type: none"> • Can you see me now? • Momentum </div> <div>  </div>	<div>Case Studies</div> <div>Street Games</div> <div> <ul style="list-style-type: none"> • Athens Plaython • Tag Game • Fun-in-Numbers </div> <div>  </div>
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<div>Concept</div> <div>Technological Advancement - Sensors</div> <div> <p>Sensor networks are on the brink of becoming a truly ubiquitous technology</p> <ul style="list-style-type: none"> • embedded in many appliances and mobile phones • single/multi touch interfaces <p>combination provides huge potential for revolutionary services that interact with the physical world</p> </div> <div>  </div>	<div>Concept</div> <div>Technological Advancement - Global networks</div> <div> <p>Networking technologies have attracted a lot of research activity</p> <ul style="list-style-type: none"> • extremely small scale • low-power & wireless <p>allow the interconnection of daily objects at global scale</p> </div> <div>  </div>
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Fun in Numbers Vision

Combine technological advances to develop structured, collaborative and competitive activities that people undertake for enjoyment.

- Players interact by using **Movement and Presence**
- Players **cooperate or compete** with each other
- Players from **different cities** participate in the same game
- Indoor and/or Outdoor activities

The more the merrier



games using
human gestures and
motion



games using
human gestures and
motion



applications to
support education



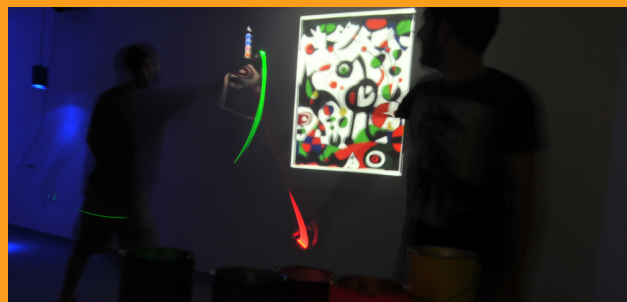
games using
human gestures and
motion



applications to
support education




interactive
installations in
exhibitions



Our Starting Point 2008

- Outdoor game
- Players carry special devices
- Interaction via motion and gestures
- Games are formed ad-hoc
- Simple-rules

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Hot Potato


Classic tagging game using virtual potatoes. Players pass the potatoes to nearby players. Potatoes have a count-down timers – when the potato goes “Boom” the carrying player loses.



Our Starting Point 2008


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- Indoor games
- Games require installation of a TV Display / Projector
- Players carry special devices
- Simple-rules
- Interaction via gestures



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Cazanov

Classic Hide and Seek game with 1 rabbit and many Hunters.



Gallery	2009: Visual Feedback	Gallery	2010: Smart Objects
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- Indoor games
- Games require installation of a TV Display / Projector
- Players carry special devices
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- Interaction via gestures



Tug of War

Perform the gestures indicated on the screen fast and accurately and wipe out your opponents.
In the end, your color should prevail covering each side of the cube.



Gallery	2010: Smart Objects	Gallery	2010: Smart Objects
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- Games require installation of smart objects
- Smart Objects can detect Players
- Smart Objects can control Lights ++
- Players carry special devices
- Players interact with Smart Objects via motion and gestures



Chromatize Images!

Reveal the famous painting works by filling with color the corresponding parts of the image.
Dip your brush in the color bucket and start!



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Magnetize Words

Interact in a virtual landscape made of words.
Move within a physical space to change the meanings of the words and give a new perspective on already known poems and texts.



<div>Gallery</div> <div>2011: Pervasive Education</div> <div> <ul style="list-style-type: none"> • Pervasive Education • Schoolsters • Boyscouts • Kinden-garden • Very simple-rules </div> <div></div>			<div>Gallery</div> <div>2011: Pervasive Education</div> <div> <ul style="list-style-type: none"> • Pervasive Education • Schoolsters • Boyscouts • Kinden-garden • Very simple-rules <div>  <div> Chromatize It! Come close to the screen and accept the challenge. You only have 3 colors on your inventory: Red Yellow Blue. Mix them properly and create the rainbow colors. </div> </div> </div> <div></div>		
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<div>Pervasive Games ○○○○○○○○○</div> <div>Fun in Numbers ○○○○○○●○○○○○○○○○○○○</div> <div>Projects ○○○○○</div>			<div>Pervasive Games ○○○○○○○○○</div> <div>Fun in Numbers ○○○○○○●○○○○○○○○○○○○</div> <div>Projects ○○○○○</div>		
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2012: Smart Phones

- Indoor/Outdoor games
- Players use their smart/mobile phones
- Simple-rules
- Interaction via Gestures



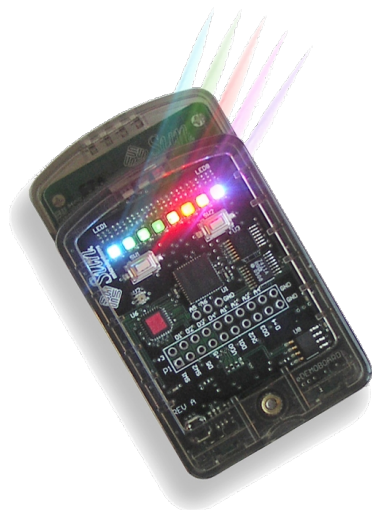
Tug of War

Perform the gestures indicated on the screen fast and accurately and wipe out your opponents.
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Sun's Small Programmable Object

- **180MHz** 32bit ARM920T processor
- **512MB** RAM / **4MB** Flash
- 2.4Ghz IEEE **802.15.4** radio CC2420 Chip
- 3.7V / 720mAh rechargeable lithium **battery**
- 3-axis **accelerometer**
- Temperature, Light **Sensors**
- 8 tri-color **LEDs**
- 6 analog **I/O pins**
- 2 switch **buttons**
- Java Squawk Virtual



Fun in Number

Platform for developing games with the following characteristics

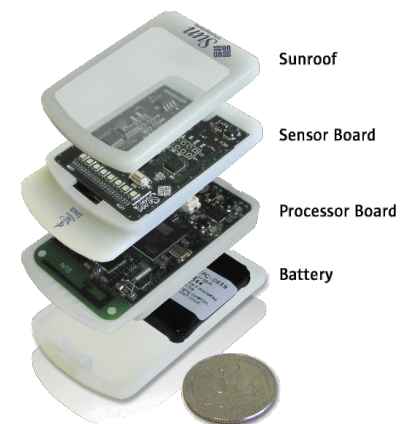
- Mobile devices
- Distributed architecture
- Sensors
- Wireless communication
- Social networking perspective

Large collection of games which include **motion**, **gesturing**, **interaction** with the physical environment and co-players:
Pervasive Games.



Sun's Small Programmable Object

- 3 Layers
 - 1 Battery
 - 2 Processor board & radio
 - 3 Sensor & interfaces board
- Squawk JVM is 100% Java Micro Edition compatible
- Programmable in Java with the provided SDK
- Flashed via USB using ant build scripts
- Solarium – Simulation's Environment with many capabilities
- Base Stations – Java Enterprise Edition




The platform

- Communication using datagrams
 - The radiostream protocol – reliable, buffered, stream-based communication
 - The radiogram protocol – datagram-based client-server protocol
- Multihop communication
- Each device can act as a mesh router
- Deployed, configured and programmed over the air

No low-level programming.
SPOTs are fully customizable using SDK libraries

- Change transmission power
- Change radio channel
- more

Libraries are open and can be modified (e.g. change the routing protocol).




Challenges

- Integration of heterogeneous technologies
 - Compatibility issues through the different layers (Java ME → Java EE & Hibernate)
- Mobile & WS Networks issues
 - Variable transmission power
 - Operation on Disconnected Mode
- Resources Management

Powerful but not unlimited. Multiple threads can slow down processes significantly (e.g. Gesture recognition)
- Extensibility, Flexibility, Usability
 - Developer-Friendly Interface
 - Modular Design

Statistics

- ~20,700 lines of code
- over 80% JAVADOC coverage



The platform

Software - FinN platform

Started as a project for the *Distributed Systems II* course

- 15 undergraduate students were involved
- Divided in 5 sub-projects
- Continuous integration using collaboration tools
- Evolved beyond the purposes of the course (6 persons)

Technologies

- Java Enterprise Edition
- Java Micro Edition
- Java Remote Object (RMI)
- Java Server Pages
- Hibernate
- MySQL







Initial idea: a Massively Multiplayer Role Playing Game

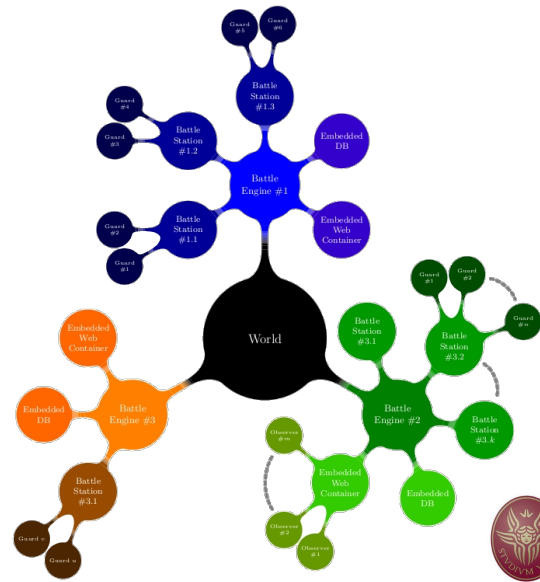



The FinN platform

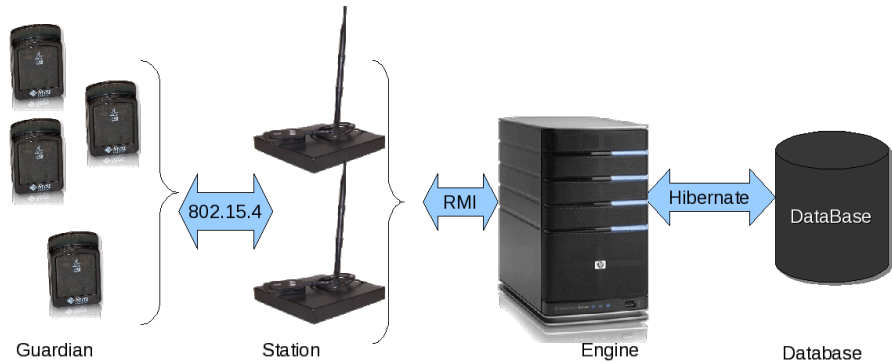
- Layer hierarchy consisting of peers
- Each layer has a distinctive role regarding the game

Peers vary

- Wireless Sensor device
Guardians
- Infrastructure nodes
Battle Stations, Mobile Stations
- PC Engines
Battle Engines
- Server PC
World

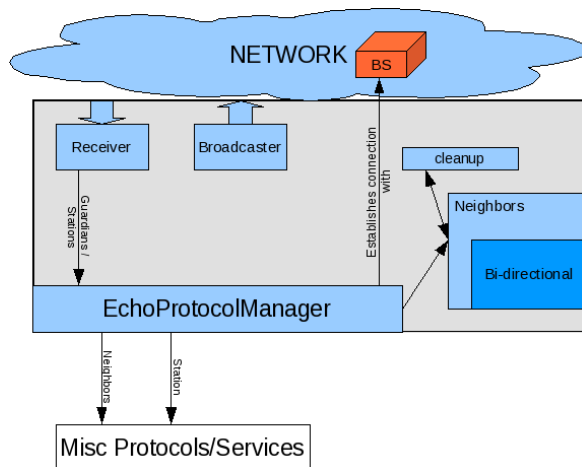



Architecture: 4 Layers



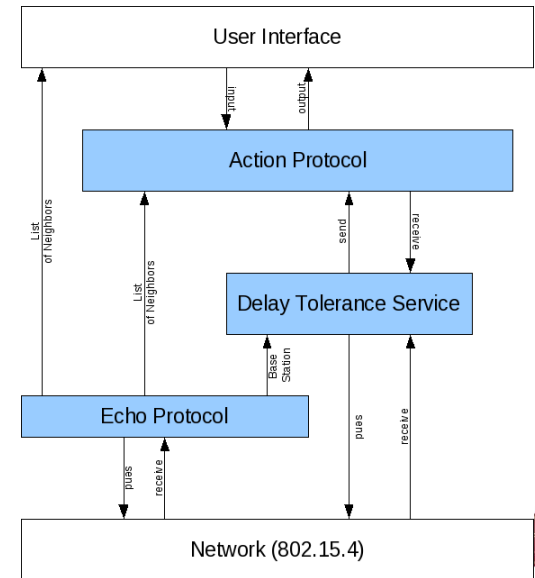
Echo Protocol – Basic Neighbor Discovery Protocol

- Broadcaster
 - Creates and transmits beacons according to the hosting device
 - Messages can be customized



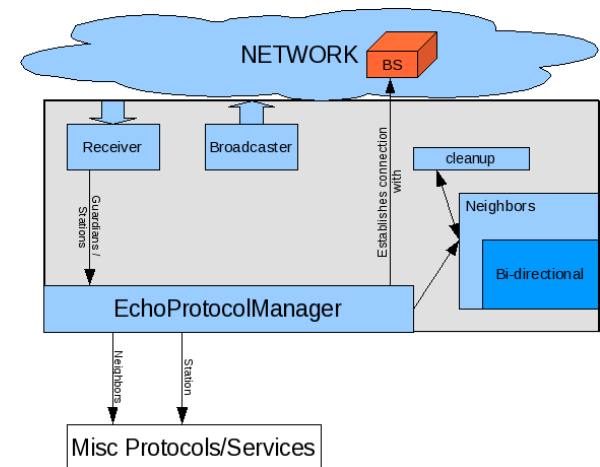
Protocols and Services Overview

- Initialization Service
- Echo Protocol
- Delay Tolerance Service
- Action Protocol
- Storage Service
- User Interface & Gesture recognition



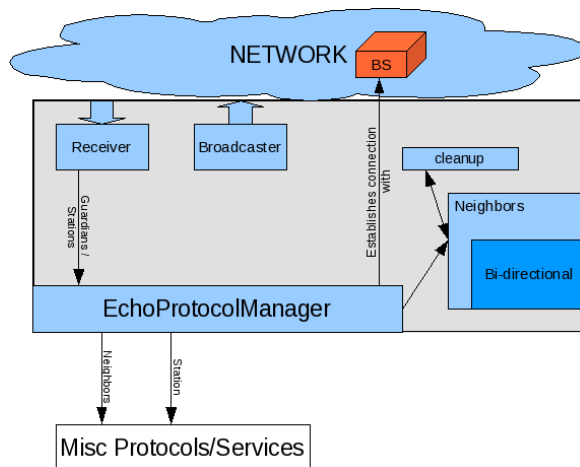
Echo Protocol – Basic Neighbor Discovery Protocol

- Receiver
 - Distinguishes different sources
 - Constructs temporary Objects for each received beacon
 - Forwards them to the Manager for processing



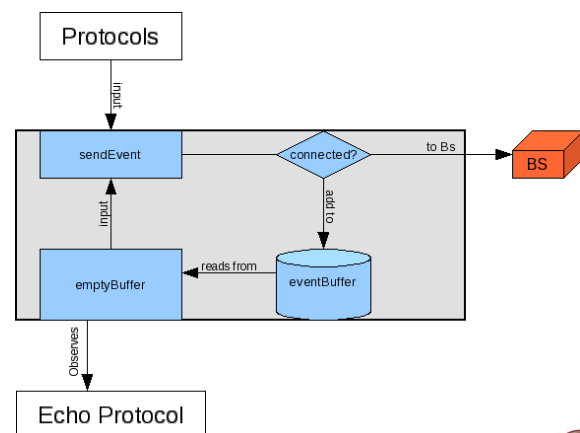
Echo Protocol – Basic Neighbor Discovery Protocol

- Manager
 - Updates the Neighbors' Hash Maps
 - Provides public interfaces for accessing the protocol



Delay Tolerance Service

- Players can move arbitrary outside the infrastructure range
- Transparent Layer
 - Connected mode: Events are forwarded to the infrastructure
 - Disconnected mode: Events are stored and forwarded when connection is established
- Observes the Echo Protocol



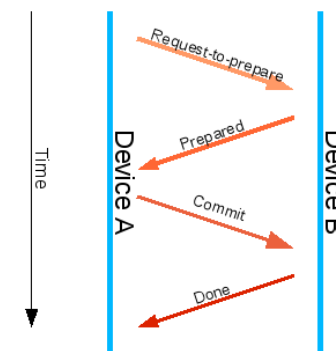
Echo Protocol



- Protocol efficiency vs. Network density
 - Collision of beacons when the network has more than 7-8 nodes
- Bi-Directional vs One-Way links
 - Different transmission power \Rightarrow one-way links
 - Nodes broadcast their one-way neighbors MAC addresses
 - Other nodes look for their own MAC in this broadcast
- Hash map lookups vs. Vector Iterations
 - Hash Maps used for Neighbors and One-Way neighbors storage $\langle \text{MAC} \rangle, \langle \text{Neighbor Object} \rangle$
 - Fast timestamps update
- Implements the Observable/Observer design pattern
 - When changes occur Echo Protocol Observers get updated (e.g. when connection to some Station has been established)
 - Decreases the number of running Threads





Action Protocol

- Two Phase commit protocol implementation
- Players Interaction
- Consistency
 - Roll-back option on partly or full action failure
 - Reduce the possibility of unexpected or malicious player behavior



The platform	The platform
<h2>Action Protocol</h2> <ul style="list-style-type: none"> Each Action consists of 2 parts <ul style="list-style-type: none"> Part A – Shoot the Ray gun Part B – Shot by the Ray gun All nodes participating in the games are loaded with the same <i>Actions</i> Node A initiates the procedure and sends the <i>Request-to-prepare</i> message to all the target nodes Target nodes reply <i>Prepared</i> When all target nodes have replied, node A sends the actual Action and executes part A Target nodes execute part B and send back an acknowledgment message 	<h2>Other Services</h2> <ul style="list-style-type: none"> Initialization Service <ul style="list-style-type: none"> Transmits the proper data for each player Automated procedure All 4 layers take part Storage Service <ul style="list-style-type: none"> Use the 4MB of flash memory Implemented using Java ME recordstores Increases reliability – <i>reset-proof</i> games Gesture Recognition <ul style="list-style-type: none"> Simple gestures due to limited computational strength Possible enrichment using the wiigee library World Portal <ul style="list-style-type: none"> Create new games, participate in existing ones, watch ongoing events. Community portal 
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General information	General information
<h2>General Information</h2> <ul style="list-style-type: none"> Group-based Projects <ul style="list-style-type: none"> 2-3 students Complete cycle <ol style="list-style-type: none"> Design – architecture, component diagram, interfaces, protocols Development – agile tools Experimentation – real-world evaluation 	<h2>Delivarables</h2> <ol style="list-style-type: none"> Project Presentation <ul style="list-style-type: none"> Youtube video Slideshare presentation Open-source Code <ol style="list-style-type: none"> Git-hub Documentation of code (e.g., javadoc) Instructions on how to compile / run Google-play Technical report <ol style="list-style-type: none"> Problem State of the art Design Implementation details Experimental findings Conclusions & future work 
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Timeline

- ① April, 1st (Wednesday)
 - Presentation of Team + Idea
- ② April, 22nd (Wednesday)
 - Presentation of Design
- ③ May, 6th (Wednesday)
 - Presentation of MVP
 - Presentation of Plans for Experiments
- ④ June
 - Presentation of Experiments
 - Presentation of Final Version



Pervasive Learning

- Provide tools
 - Participation of Students for a bottom-up learning
 - Monitor attention of students (physical, thoughts)
 - Correlate attention of students with lecturer's voice/pitch
 - ...
- Technical issues
 - ① User Interaction
 - ② Physical Activity
 - ③ Visualization



Participatory Sensing

- Monitor the conditions in DIAG
 - Student participation in lecture rooms,
 - Noise/Temperature/Light conditions in lecture rooms,
 - ...
- Technical issues
 - ① Sensors
 - ② Localization
 - ③ Visualization
 - ④ DTN



Pervasive Game

- A Pervasive Game Scenario
- Technical issues
 - ① Coordination
 - ② Localization
 - ③ Visualization
 - ④ DTN

