Middleware Labs: Java RMI

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General Information

- Labs
  - Every other week
  - 5 labs total, 5 middleware technologies
  - Tuesday, 17.20 (SU1)
  - See calendar on the web

- Web
  - http://d3s.mff.cuni.cz/teaching/middleware/
    (also at http://d3s.mff.cuni.cz/mwy)

- Mailing list
  - mwy@d3s.mff.cuni.cz
  - https://d3s.mff.cuni.cz/mailman/listinfo/mwy
Requirements for Getting the Credits

- Details on the web page
- At least 7 points for the semester
- Standard tasks
  - “Hello World” in various technologies ;-)
- Alternative tasks
  - Less boring than the “Hello World” stuff ;-)
Standard Tasks

- 2 points for solving the task correctly and in time
- 1 point for incorrect submission in time
  - Fixed submission presented at next labs
- 1 point for missed deadline (max before next labs)
  - Must show at the labs
- 5 tasks together, each for 2 points
Alternative Tasks

– Only after previous consultation
  – Contact Petr Tůma for details (task, points, deadlines)
– Preferred way to get credit
– 2 to 6 points (depending on the difficulty)
– Deadline: end of summer examination period
  – Later only in special cases

Topics

– Benchmark (2), set of benchmarks (4 – 6)
– Your very own topic (?)
Be Original – No Cheating!

- This is not a mandatory subject
- Go cheat somewhere else
- You do not want to learn how to modify someone else’s code
- You want to learn middleware technologies
- If the tasks seems boring to you . . .
- . . . settle for an alternative.
Submission (generic notes)

- Working implementation
- Answer all the questions from the assignment
- By e-mail
  - Deadline is on the web
- Make sure it works in the lab downstairs
Submission (generic notes) II

– Documentation
  – README with key decisions overview
  – Notes on compiling/running

– The submission shall be easy to start
  – No need for Maven or Ant script
  – No need for packages etc.
  – Updated versions of the run-* scripts
  – Do not send stubs, compiled files or Eclipse .projects
Java RMI
public interface Searcher {
    public int getDistance(Node from, Node to);
}

public interface Node {
    Set<Node> getNeighbors();
    void addNeighbor(Node neighbor);
}
Local Implementation

- **Java version**
  - `java -version`
  - `java-config -s oracle-jdk-bin-1.7`
  - `java-config -s oracle-jdk-bin-1.8 (rmic deprecation)`
  - `java-config -s sun-jdk-1.6 (shall work as well)`

- **Eclipse**
  - All the eye-candy
  - Correct set-up of the run configuration
Local Implementation (cont.)

- Interfaces Node and Searcher
  - Classes NodeImpl and NodeSearcher
- Java main() is in the Main class
  - Measures the speed on a random graph
- Your implementation must be easy to start
  - Use the provided implementation
  - Do not add package etc.
  - Make sure it works in the labs downstairs
Implementation Notes

Extend single project, do not create 4 separate ones.

- Interface hides different implementations
  - Even Remote interface can be used locally
    - Just catch exceptions that would never occur
  - E.g. remote graph is just another array Node[]
    - Easy to have the same (logically) local and remote one
    - Similarly with Searcher

- Measure everything in one run to ease comparison
  - Just add measuring and a column to results in searchBenchmark()
Launching

- Use launchers from the Hello World
  - Important parameters
  - Simple Run as.../Application in Eclipse is not enough!
    - But can be set-up to work as well
- Read these slides
  - Avoid common problems
- Report problems
  - Well before submission
  - Use solely mailing list for questions
  - The same problem might affect more people
Launching (cont.)

- rmiregistry application – run in background
  - Port in use? – use different port number (> 1024)
    - Edit path in calls to [re]bind() and lookup()
    - localhost becomes localhost:1234
  - For simplicity – it has the same CLASSPATH
    - We want to avoid setting permissions for codebase etc.
- Starting the server – see run-server script
- Starting the client – see run-client script
Building – the make Script

- javac (with Eclipse unnecessary)
- rmic
  - Deprecated in Java 8
  - Creates stubs for remote objects
  - Parameters are class names implementing the remote objects
  - keep does not remove the generated stub sources
  - Sometimes unnecessary
    - Client can access the classes (yes in our task)
    - Classes inherit from UnicastRemoteObject
  - Subtle differences for generated stubs and proxies
    - equals()
Remote Searcher

- Extend Searcher interface (see Example)
  - Interface java.rmi.Remote
  - Exception of type java.rmi.RemoteException

- Remotely accessible object (see ExampleImpl)
  - Must be exported – 2 ways
  - Derive from java.rmi.server.UnicastRemoteObject
    - Export ensured by parent constructor
  - Call UnicastRemoteObject.exportObject(obj) manually
    - Does not handle semantics of hashCode(), equals(), toString() — not a problem with Searcher (just one instance)
Remote Searcher (cont.)

- Executable server (see ExampleServer)
  - Create instance (and export) of the remote object
  - Register with java.rmi.Naming.\[re\]bind()

- Extend Main with RMI (see ExampleClient)
  - Get reference to a remote Searcher
    - java.rmi.Naming.lookup(path)
  - Add call to remote Searcher.getDistance() with local objects NodeImpl in searchBenchmark() method
    - How the server access the neighbors of the passed nodes?
Remote Node Objects

- Extend interface Node with RMI (like Searcher)
- Class inherits from UnicastRemoteObject and implements Node
  - To allow for hashCode(), equals(), toString()
  - Copy/paste + edit is enough
    - We want that local Nodes from previous task still behaved locally
Remote Node Objects (cont.)

- How to create and return instances for client requests?
- Implement NodeFactory with method createNode()
  - Similar to remote Searcher – interface with RMI, implementing class, create and call Naming.bind() inside the existing server
  - Do not create a standalone server, we want just one for the 4\textsuperscript{th} variant

- Client gets the reference with lookup() and creates also the remote Node objects together with the local graph
- How does the local Searcher access the remote Nodes?
- What exactly returns NodeFactory to the client?
Remote Searcher on Remote Nodes

- Everything is ready, just add this variant to `searchBenchmark()` and compare the speed
- How does the Searcher on server access the Node objects on (the same) server?
Impact Of the Network

– So far, client and server were running on the same machine
  – Overhead of RMI communication, but no network latency

– Run on more machines
  – Server on the machine next to you, client on yours
  – Change paths in \[\text{re}bind()\] and \[\text{lookup()}\]
    – Remote machine name instead of \textit{localhost}
    – Modify to use \textit{args}[0]
  – Run \textit{rmiregistry} and \textit{Server} in SSH session on the remote machine
  – Run the client locally
  – Beware of \textit{CLASSPATH}
Passing by Value vs. Passing by Reference

- Previous tasks solves “extreme” cases
- How about combining both approaches?
- Idea: “batch” transfer of bigger parts of the graph
- `getTransitiveNeighbors(int distance)`
  - Returns all neighbors up to some distance
- Use the `getDistanceTransitive` method of the `Searcher` interface
  - In each step, requests neighbors up to the specified distance
- Try different values for the distance parameter
  - Compare measured times with previous variants
Submission

- Working implementation
- Documentation
  - Answer all the questions from the assignment
  - Describe measurement results
- By e-mail (deadline is on the web)
- Make sure it works in the lab downstairs
- The submission shall be easy to start
  - No need for Maven or Ant script
  - No need for packages etc.
  - Updated versions of the run-server scripts