4. **Java RMI and Alternative Communication Mechanisms**

4.1. Name the main advantages of remote method invocation compared with remote procedure call.

4.2. An object for the management of the warehouse provides a method for removing items (removeItem) with a given product ID (long productId) and number of items (int itemNumber) from the warehouse which is called during the order processing from the ordering system. The method sends a status message (String statusMessage) as output parameter.

   a) Model through Java futures the parallel removal of three items by the ordering system from the warehouse. Sketch the main artifacts to be implemented.
   b) Discuss, how threads can be used in contrast to invoke and handle parallel calls.
   c) Discuss the advantages and disadvantages of futures and threads for the implementation of parallel RPC calls.

4.3. Publish/subscribe is an alternative interaction scheme to request/response used for RPC.

   a) Explain the roles of the communication partners and the message exchange for publish/subscribe.
   b) Explain the principles of a message channel and a message queue.
   c) Which advantages and disadvantages result from the use of message based systems in comparison to RPC systems.

4.4. Which phases can be differentiated in stream based communication and what purpose do they serve?

4.5. The communication mechanisms discussed so far are based on different protocols. Sketch the protocol stacks according to the ISO/OSI model for RPC, Web services, AJAX, message-based and stream-based communication.

**Homework:** Fully implement the scenario described in question 4.2 based on Java Standard Edition (Java SE) and Java RMI.