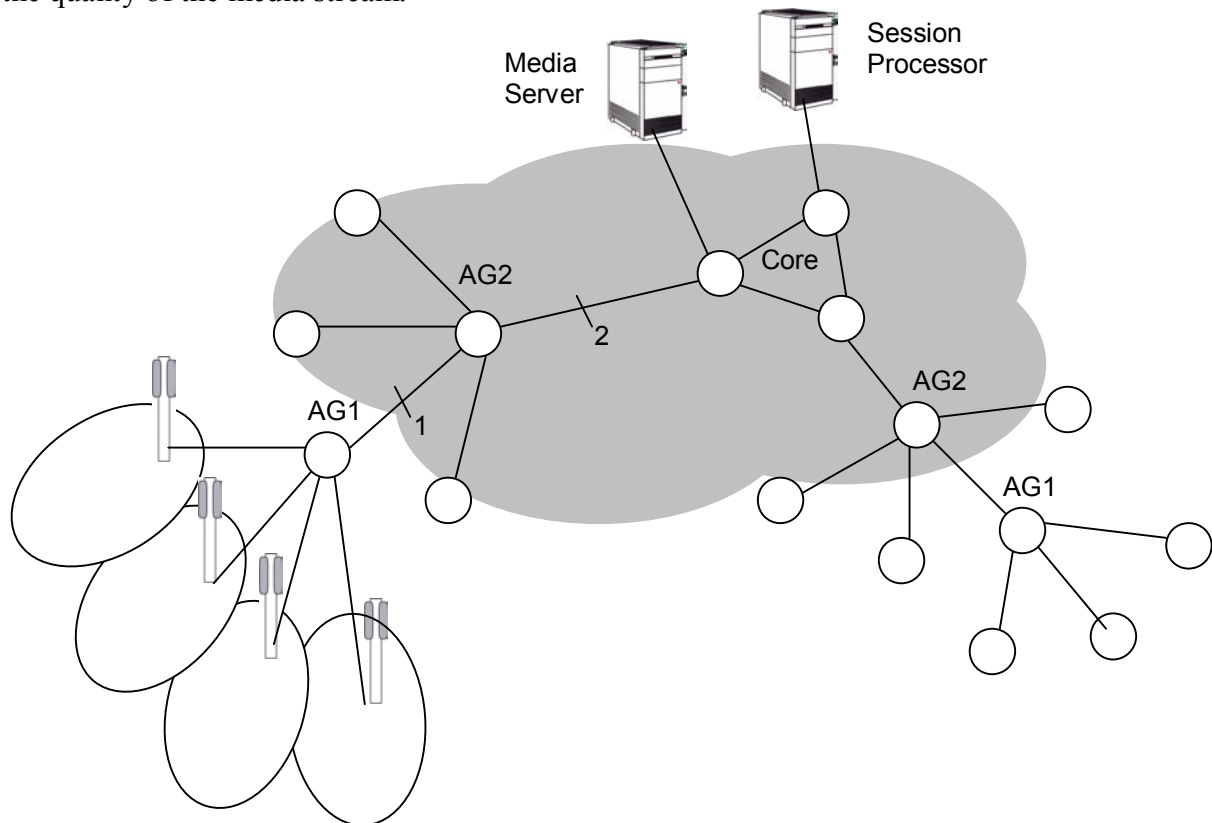


## Telecommunication Software Engineering

### Task 1 Voice over IP with Quality Enhancement

A Network Operator plans to offer Voice over IP Services. As service infrastructure, the network operator sets up a Session Processor to handle call transactions (call set-up, control and tear down), and a Media Server, which handles the voice traffic. The Media Server also uses digital signal processors to transcode and filter VoIP media streams in order to enhance the quality of the media stream.



#### Part 1

The Media Server can handle up to 15 million packets per second at 128 Bytes packet length (at 80% processor utilisation). Benchmarks show, that the Session Processor can handle up to 20.000 calls per second at 80% processor load. Each packet contains voice samples of 20 ms. According to the traffic model, there are 3.6 calls on average per subscriber in the busy hour, and each call has an average duration of 100 seconds.

Question 1: How many subscribers can the Session Processor support?

Question 2: How many parallel sessions can the Media Server support (Hint: one session represents one stream of voice packets.)?

Question 3: How many subscribers can the Media Processor support? What is the total number of subscribers that the server infrastructure can support? How can the performance of Media Server and Session Processor be balanced?

Question 4: What is the total throughput at the Media Server?

## **Part 2**

In the initial set-up, Session Processor and Media Processor connect to the core network. The core network connects to 10 subordinated networks at Aggregation Level 2 (AG2). Each AG2 collects traffic from 20 subordinated networks at Aggregation Level 1 (AG1). The network operator decides to place one Media Server (same capacity as before) into each of the AG2 networks (instead of one Media Server in the core).

Question 5: How much traffic is handled between AG1 and AG2 (interface 1) and how much traffic is handled between AG2 and the core (interface 2)?

Question 6: Each Media Server is composed of one Load Balancer, which receives incoming traffic and tunnels it to one of 12 processor blades within the Media Server corresponding to a suitable algorithm for load balancing. The processor blades then respond individually to the source of traffic. What is the throughput at the Load Balancer (traffic in, traffic out)?

## **Part 3**

Alice has 4 friends in her telephone directory. It is the busy hour of the day (same traffic model as in Part 1).

Question 7: What is the probability, that none of her friends is busy, when Alice tries calling one of them?

Question 8: What is the probability, that neither Alice of any of her friends is busy at the same time?

## ***Task 2 Universal Remote Control***

Equipment in home networks, such domestic appliances, equipment for entertainment and communication increasingly has interfaces to communicate over networks (such as Wireless LAN, Ethernet, Bluetooth, ...). This allows to monitor and control equipment over the network. In this task, one universal remote control is used to control two different types of TV sets.

### **Part 1**

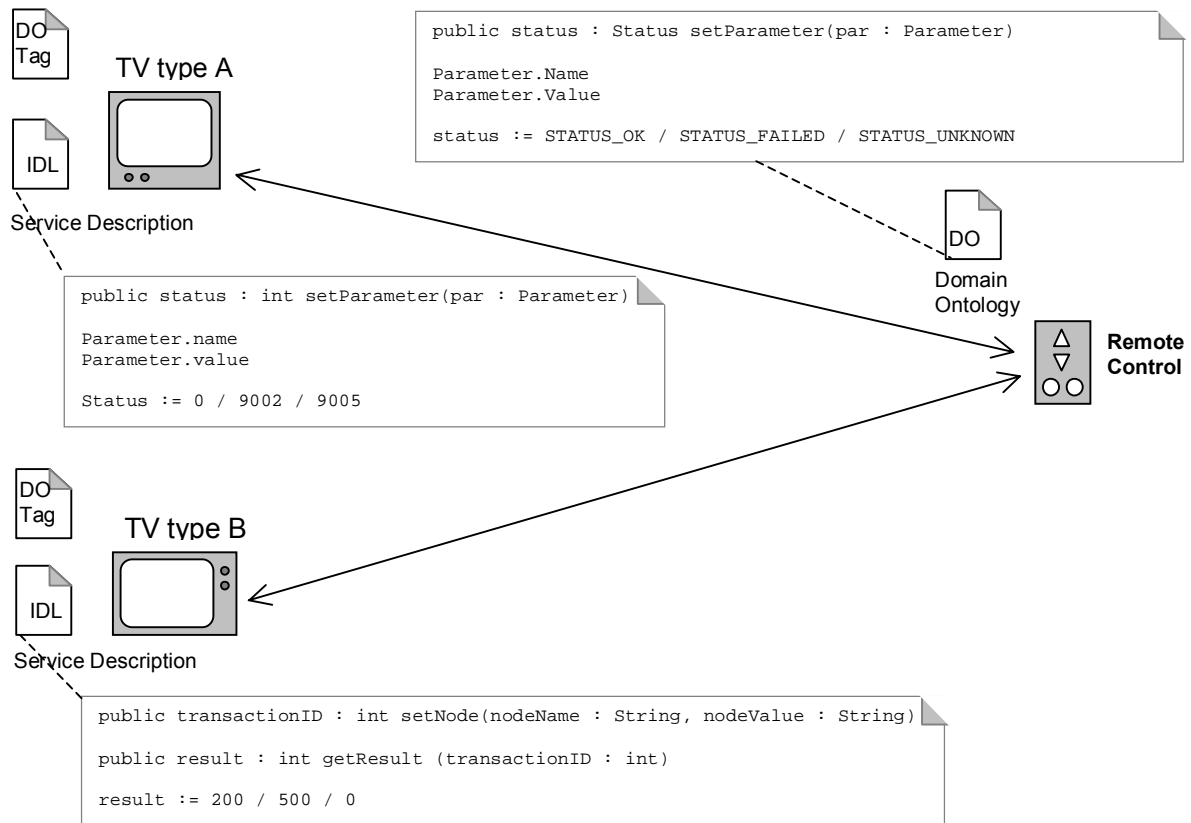
General questions on communication and interfaces.

Question 1: What is needed for two network entities to communicate to each other? What function does a network need to provide to make network entities aware of each other?

Question 2: In order to call functions on another device, e.g. to control the TV, the functional set of the device is described in a pre defined format, a so called IDL (Interface Definition Language). What does an IDL type of document need to contain? How can it be used by another device, e.g. the remote control?

## Part 2

As shown in the figure below, there are two different types of TV sets (type A and type B, e.g. from different manufacturers). Each device supports a service framework (such as UPNP, WSDL etc), i.e. it contains an IDL type of document for the services it provides.



Question 3: With reference the Service Descriptions in the figure above, explain the functions of both TV types and how they are used.

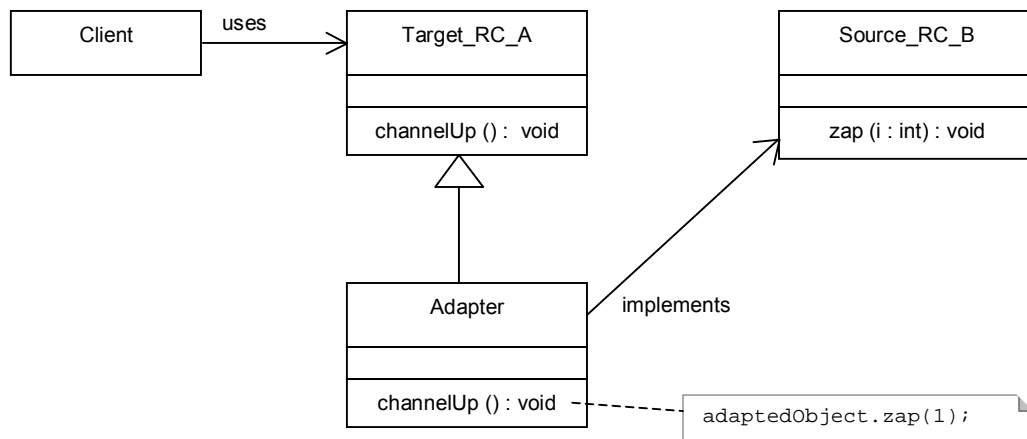
Question 4: The home network makes use of a Domain Ontology, which allows classifying the types of devices and describes their functions in a general way. Explain what the Domain Ontology in the figure above contains and how it can be used.

Question 5: Explain how the IDL type of definitions may be extended by DO Tags (Domain Ontology Tags) and how this Tags can be used by the Remote control.

Question 6: Describe a sequence of actions in order to (1) “zap” one TV channel up on TV A, and then (2) “zap” one channel up on TV B.

### Part 3

Another way to use one remote control is adaptation at syntactic level, i.e. by programming the device to adapting or translating commands. For a TV of type B, user Bob would like to use a Remote Control (RC) of type A. So, somehow, he will need to use type B commands on the type A Remote Control. The figure below illustrates the concept.



Question 7: Explain the components in the diagram and their relation.

Question 8: Explain how the components interact at runtime, e.g. in a sequence diagram.