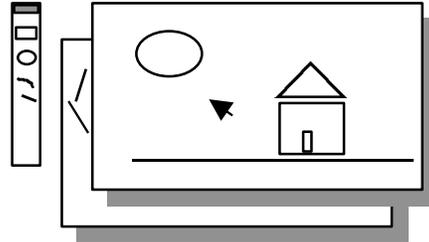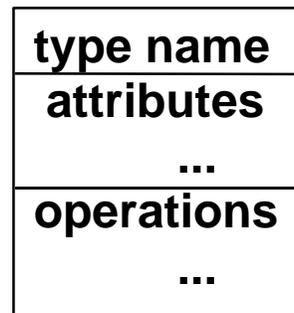# UML – Exercises (RT)

Exercise 1.1

- A software tool for editing drawings allows you to draw triangles, circles, and other simple shapes. What types would you expect to find in the program? Draw:

  - snapshots representing sample pictures;

type name
attributes
...
operations
...

  - a type diagram with types & associations.

- What operations could be performed by members of those types? Add them to the boxes in your diagram.

- Clever stuff: suppose now the tool allows you to treat a group of shapes as one (for moving, rotating, etc)....?

Mobile Phone Service

High-level Scenarios

Calls

Call out
Fred is stuck in traffic. He calls the destination office to tell them he will be late.

Conference
Sales team leader Sally is a regular in this traffic jam. All over the country, her team are in similar jams. The team make the best use of this time by holding their daily meeting in a conference call.

Call in – roaming
In the next car, Nikita, who has recently arrived from another country, is called by her office to give her details of her next assignment.

Travelling calls
Chris has been arguing with his girlfriend all the way from Stockton to Darlington; she meanwhile has progressed from Aix to Ghent.

Call waiting and callback
Kevin is calling his supplier to order goods. During the call, a customer calls who is desperate for some stuff. The phone gives an audible and visible indication of the other incoming call. Kevin switches to the customer and says he'll call back shortly. He completes negotiations with the supplier, and then calls back the customer with one or two keystrokes.

Diversion, answering service, and callback
Antoine is also from another country. His wife calls him from her office to find out where he is. Unfortunately, he is in a tunnel, so the network connects her to his answering service. She leaves a message. Not long after he emerges from the tunnel, his phone rings to give him the message. After listening to the message, he is able to call her back with one or two keystrokes.

Emergency guest user
Jennifer's yacht is sinking and the yacht's batteries are flooded – no VHF radio. She is also out of range of her usual mobile phone network. However, the phone finds another network which allows her to make an emergency call (112).

Provision of service

MobiNet is a mobile phone Network Operator. MobiNet covers much of the country, apart from the less populated and hilly parts. But they install new base stations regularly, both to extend their coverage, and to increase capacity in places with high usage.

NetMobile operate a similar service. Their coverage is geographically smaller than MobiNet's, but they have more capacity in high density areas, and so have fewer complaints about lack of service or dropped calls.

MobiNet and NetMobile don't normally sell phone service to users (though they do have some direct users, such as their own engineers).

GetConnected is a Billing Agency. All of their customers use MobiNet in UK, EireCall in Ireland, and any network in other countries. When you sign up with them, they give you an ID Chip to put in your phone (which you might have bought elsewhere), and bill you regularly. If you don't pay the bill, they disconnect you. There is a credit limit too: if you run up a big bill, you can't make more calls until you have paid (although people can call you).

The chip identifies the billing agency and the phone.

PhoneBox is another Billing Agency, which sells phones through newsagents. The phone runs on credit, which is displayed on the phone. When credit gets low, you can call PhoneBox and pay for more credit using Visa etc.

If a phone is stolen, you notify your Billing Agency.

Customers can ask for 'roaming' service, which means that if they are in a foreign country, they can still use their phones, and people can still call them. Network Operators have agreements to accept logins from foreign phones.

While in Germany, Fred (a UK MobiNet user) dials like anyone in the Germany: 091 … to call Bonn, +44 171 …to call home to London. But to call him, you dial his normal mobile number: his German colleagues would dial +44 422… and his London office would call 0422…. The caller pays for the part of the call to MobiNet's switching centre, and Fred pays for the connection via a German Network Operator.

Exercise 2.1 More detailed scenarios

Elaborate the Call scenarios above in more detail. Describe the interactions between the principal people, organisations, and their equipment: users, phones, networks, billing agencies. Omit detail of what goes on inside an organisation or network at this stage.

Draw sequence charts to explain the interactions.

Sketch snapshots to show the changing associations and attributes of relevant objects at each step. Include the effect of calls on users' bills.

Summarise the objects and associations you have used, in an initial draft of a type model.

Exercise 2.2 Use-cases

Beginning with 'make a call' and 'end a call', draw use-case diagrams to show the participants in these use-cases. Then draw other use-cases to say what other significant interactions these participants might have with each other, or with other parties.

Update the type model, if necessary.

Exercise 2.3 Use-case postconditions

Write postconditions for 'make a call' and 'end a call'. Use this procedure:

1. Write the postcondition informally, in users' terms.

2. Draw a before/after snapshot to illustrate the changes shown in your postcondition. Use an association or attribute to represent each fact referred to in the postcondition.

3. Write a definition of each attribute or association: 'when this association links objects A and B, it represents the fact that…'.

4. Restate the postcondition in terms of the changes illustrated in the snapshot.

5. If there are other possible outcomes, include these in the postcondition, with the help of another snapshot if necessary.

6. Write a precondition: what must be true for this use-case to occur?

7. Add timing requirements to the use-case, where appropriate.

8. Update the type model, if necessary.

Exercise 2.4: Statecharts

- Draw a statechart for a Phone. The transitions should be use-cases.

The states you associate with a Phone don't have to be information recorded within the Phone itself: for example, you might have a 'suspended' state for phones whose bills are unpaid. As analysts, we haven't yet decided where this information might be kept, but it's more likely to be in the Billing Agency than the Phone itself. Nevertheless, your statechart can include it because the information is associated with the phone somewhere in the world we're dealing with – and it certainly has an effect on the phone's behaviour. We'll decide at a later design stage, where to put the information.

Consider whether it might be more useful to draw a statechart for a Phone Service – that is, the service provided to a customer by various organisations through a phone. A Phone Service has similar states to a Phone; but a Phone Service may continue through the replacement of a broken Phone.

- For each state, write its definition (1) in natural language; (2) as a boolean function of other attributes and associations of Phone (or PhoneService) in your model. You may need to add new associations to the model for this purpose.

- If there are new use-cases you have found, add these to the model and draft pre/postconditions for them.

The Network

While the phone is switched on, it is normally logged into a particular network (run by a particular Network Operator). In home territory, this will usually be the home network. If this cannot be found, the phone will try to login to other networks.

Mobile Phones connect to Networks through Base Stations, which are positioned around the country on high buildings or on towers, or disguised as trees or streetlamps. The area covered by a base station (called a Cell) is typically a few square miles – more in open country, less in cities with many obstructions.

As a phone user moves around, the phone is handed over from one base station to another, allowing a call to continue without the user noticing anything. A call may be dropped if a user moves into a tunnel, or into a remote area where there is no base station, or into a cell where the base station is already handling as many calls as it can.

All calls go from the Base Station through a Regional Switch. This can connect a user to another mobile phone, or to a phone in another network, to tones and messages, or to answering services etc. A network with more than about 10000 users will usually have several Regional Switches. There are also Trunk Switches, which route traffic but have no base stations.

Tracking Phone Location (idle)

While switched on (not necessarily making a call), a phone is aware of which base stations are providing the best signal. As the user moves around, this will change. The phone keeps track of which is the favorite, and also the two next best. If the signal from the favorite gets too bad, one of the others is promoted.

Base Stations are organised into clusters of five or six. A phone that is switched on is usually registered with one cluster. When a phone moves from one cluster to another – that is, when its new favorite belongs to a different cluster – it conducts a short dialogue to re-register with the new favorite. In this way, the network knows where to find the phone when a call is made to it.

When a call is made to a phone, the network sends a calling signal from all the base stations in the phone's current cluster.

 The point of the clusters is to reduce the number of reregistration signals sent. For the same reason, the phone prefers to promote as favorite a base station in the same cluster.

Making a call

The phone tries to begin a call with the base stations it can hear, starting with the favorite. A base station has 32 channels, two of which are reserved for control signals. If a base station is already heavily loaded, it will not accept the call.

Once the call is accepted by a base station, the Regional Switch will work out a route to the destination number. It will also check with the phone's Service Provider that the phone is authorised to make the call (no overdue bills, etc). The Service Provider may impose some limit on the length of the call. When the call is finished, the call details (source, destination, duration) will be sent to the Service Provider, who will add to the bill, reduce credit, etc.

Receiving a call

Each network has a central Registry that keeps a map of all the phones whose 'home' is this network, and also all the guest phones currently registered, whose home is elsewhere.

For each phone, the registry keeps the ID of the phone, the Billing Agency, and the current location. The location may be a Base Station Cluster or a foreign network.

The Registry is essential to the Network's operation, so there are two of them, operating on hot standby, geographically separated.

When a call is made to the phone, the registry is asked for its location. If it is a cluster within this Network, a calling signal is sent out on all the Base Stations in the cluster. If it

is available, the phone then calls back (as for Making a Call). The caller hears ring tone. If the phone is in foreign parts, the call will be routed through the host Network.

Handovers (during a call)
As a phone moves about, the base station sends it control information to make it adjust the strength and timing of its signals. If the signal gets too bad, the phone tries to find another base station that will accept the call. When a base station accepts it, the Regional Switch reroutes the call (possibly through a different Regional Switch) and tells the Phone to make the transfer.

Exercise 2.5: Use-case refinement

- *Replaces Bank AutoTeller example*.

'Up'. Looking at the use-cases you have already documented,

1. Are there interesting super-use-cases of which these form a part?

2. Are there other ways in which the postconditions of these 'larger' use-cases can be met?
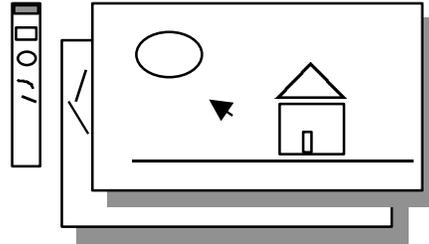
'Down.' Take a use-case such as making a call.

3. Describe in more detail how it breaks into smaller steps, using the above information about the Base Stations and Switches etc.

4. Draw sequence diagrams and/or statecharts to explain the sequence of events during a call.

5. Draft postconditions etc for the more detailed use-cases.

6. Extend the model with new associations/attributes as required.

Consider how the new more detailed picture affects the Phone[Service] statechart. Compare with the statechart of the Call.
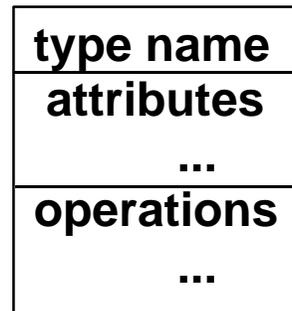
UML – Exercises (Biz)

Exercise 1.1

- A software tool for editing drawings allows you to draw triangles, circles, and other simple shapes. What types would you expect to find in the program? Draw:

    - snapshots representing sample pictures;

    ```
    ┌──────────────────┐
    │    type name     │
    ├──────────────────┤
    │    attributes    │
    │                  │
    │        ...       │
    ├──────────────────┤
    │    operations    │
    │                  │
    │        ...       │
    └──────────────────┘
    ```

    - a type diagram with types & associations.

- What operations could be performed by members of those types? Add them to the boxes in your diagram.

- Clever stuff: suppose now the tool allows you to treat a group of shapes as one (for moving, rotating, etc)....?

Library – general description

- The Library lends books to its members.

- Members can borrow several books at a time.

- Members and books are identified by attached bar-codes.

- If a book is not on the shelves, you can reserve it.

- When a reserved book is returned from loan, it is held under the counter until the reserver collects it, for up to a week. The reserver is notified when it becomes available.

- The stock-keeper keeps track of the relative popularities of the books. If a book is often reserved, more copies are procured.

- Books not returned for ages are written off the stock

Library scenario

- Chris borrows "Trainspotting".

- Pat borrows "Trainspotting"

- Jo tries to borrow "Trainspotting". It is not on the shelves. Jo reserves it.

- Steve returns "Planespotting for girls". It is put back on the shelves.

- Chris returns "Trainspotting"

- Jo is informed that "Trainspotting" is available for her to collect

- Jan tries to borrow "Trainspotting". It is not available.

- Jo comes to collect "Trainspotting"