# System Application Models

I2ISE

UCs are important!

# Application models – bridging the gap

- A lot of time has been spent on writing use cases and making domain models. Today, we cash in!
- We will use the UCs to bridge the gap between *what* the system must do (requirements) and *how* it must be done (design)
- In other words, we will use the UC's as *design drivers*
- So it would seem that :

**UCs are important!**

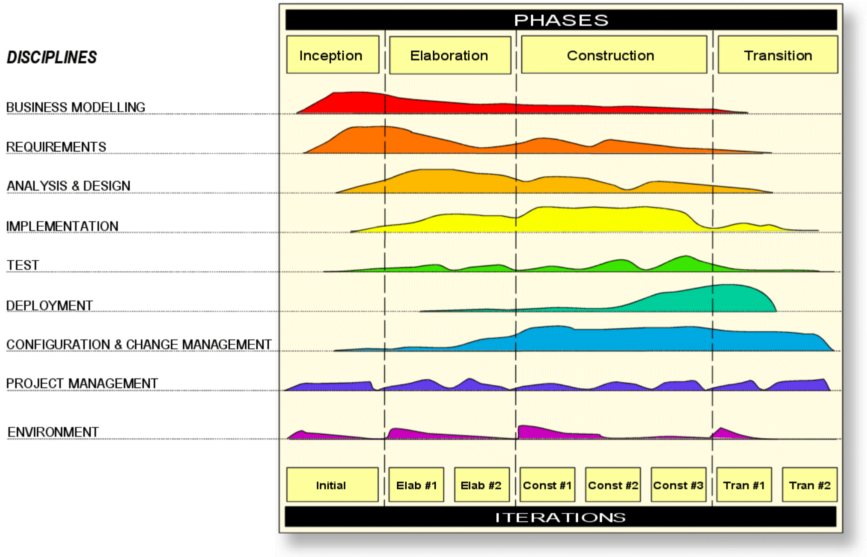
# What is a System Application Model?

- SAM is the first step of design!

- It will find relevant classes/modules to structure the design!

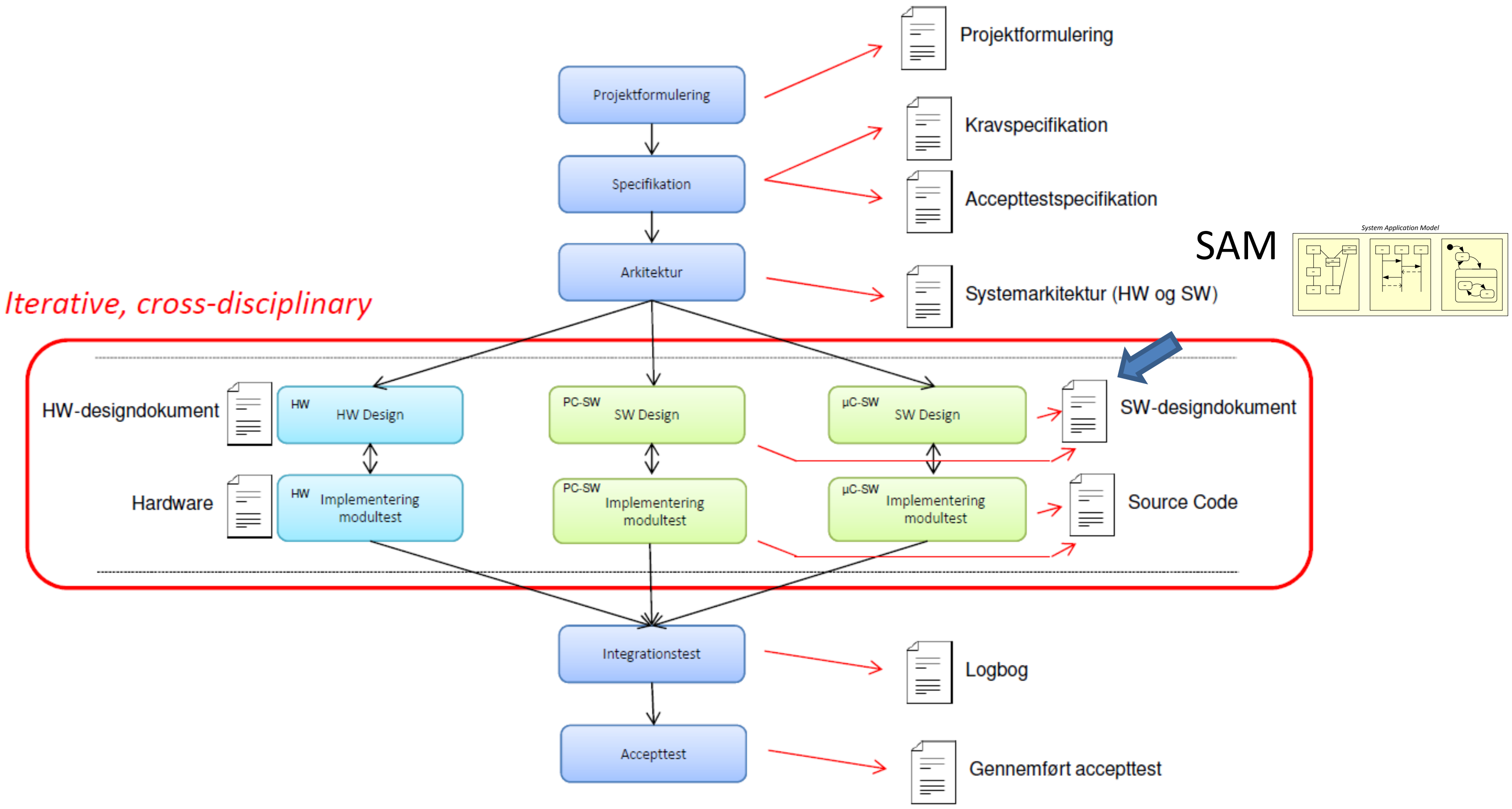
- It will describe how these interact!

- The *System Application model* is an artifact of design



# The SAM's place in the artefacts

## The ASE Process



Projektformulering

Specifikation

Arkitektur

*Iterative, cross-disciplinary*

HW HW Design

HW Implementering modultest

PC-SW SW Design

PC-SW Implementering modultest

µC-SW SW Design

µC-SW Implementering modultest

Integrationstest

Accepttest

Projektformulering

Kravspecifikation

Accepttestspecifikation

Systemarkitektur (HW og SW)

SAM

System Application Model

HW-designdokument

Hardware

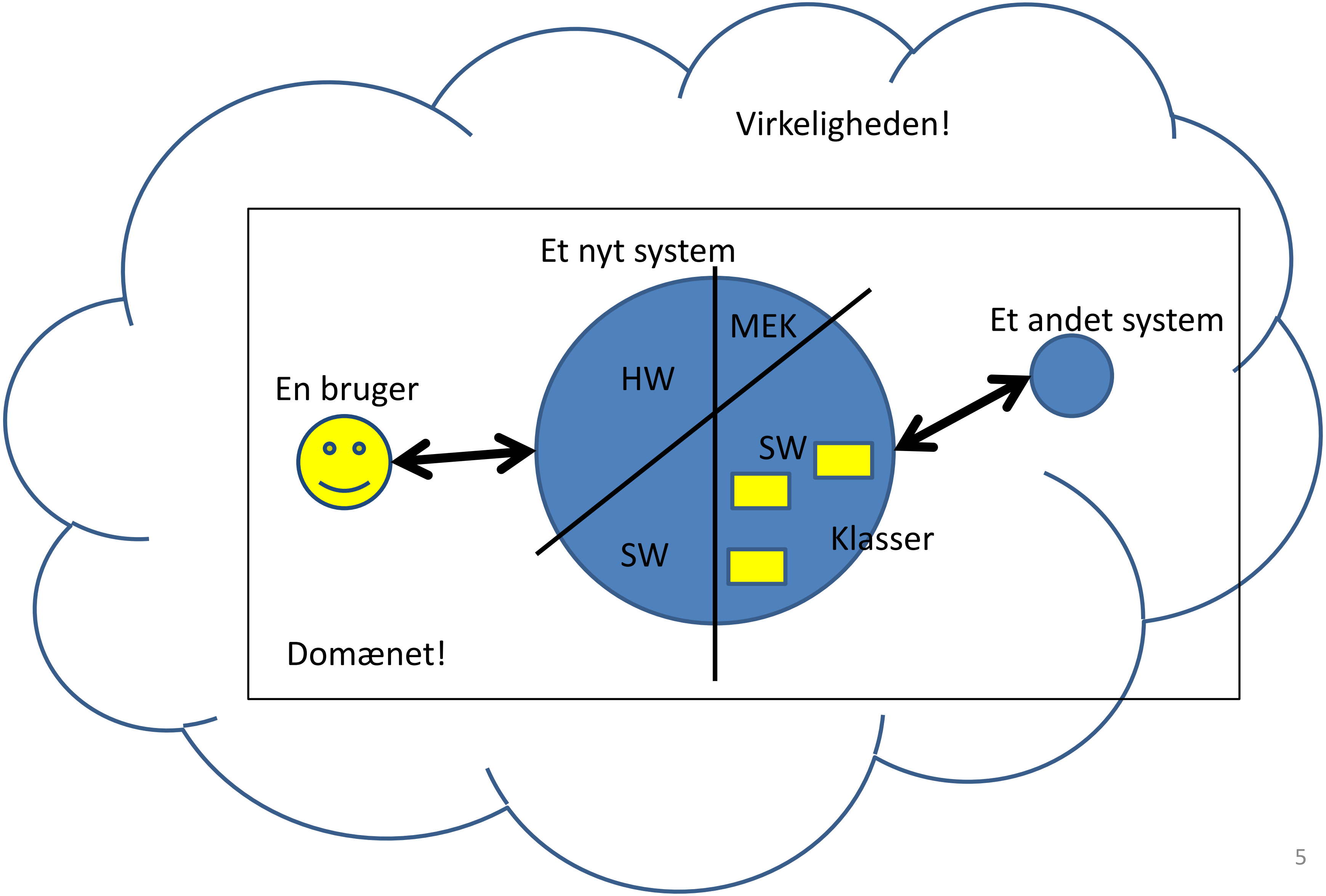
SW-designdokument

Source Code

Logbog

Gennemført accepttest

# Virkeligheden og systemet


Virkeligheden!

Et nyt system

MEK

HW

SW

SW

Klasser

En bruger

Et andet system

Domænet!

# The System Application Model

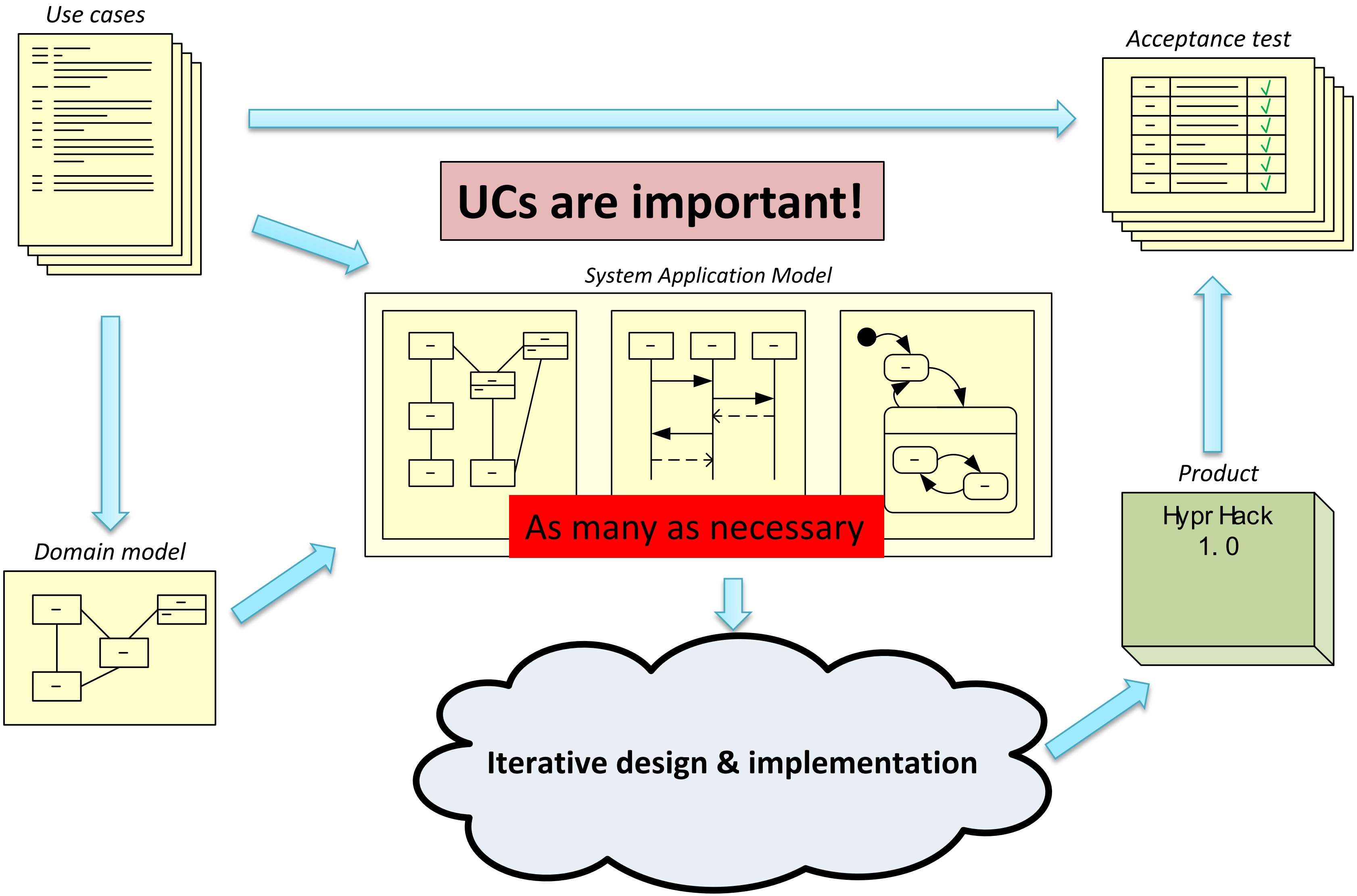
- The application model is a first, *incomplete* shot of a design –  the ”bridge”

- The application model is based on the system’s *use cases* and the *domain model*.
  - So, again:

**UCs are important!**

- The application model is built using three different types of diagrams
  - *Class diagram***s** for structure
  - *Sequence diagram**s*** and *state machine diagram**s*** for behaviour

# System Application Model in the big picture



*Use cases*

*Acceptance test*

**UCs are important!**

*System Application Model*

As many as necessary

*Domain model*

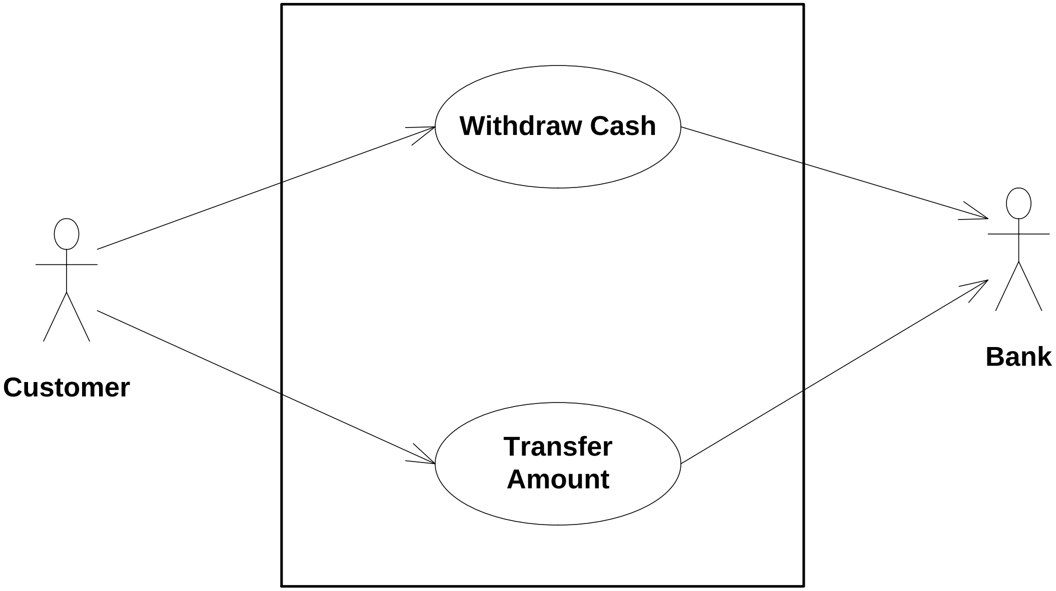
*Product*

Hypr Hack 1. 0

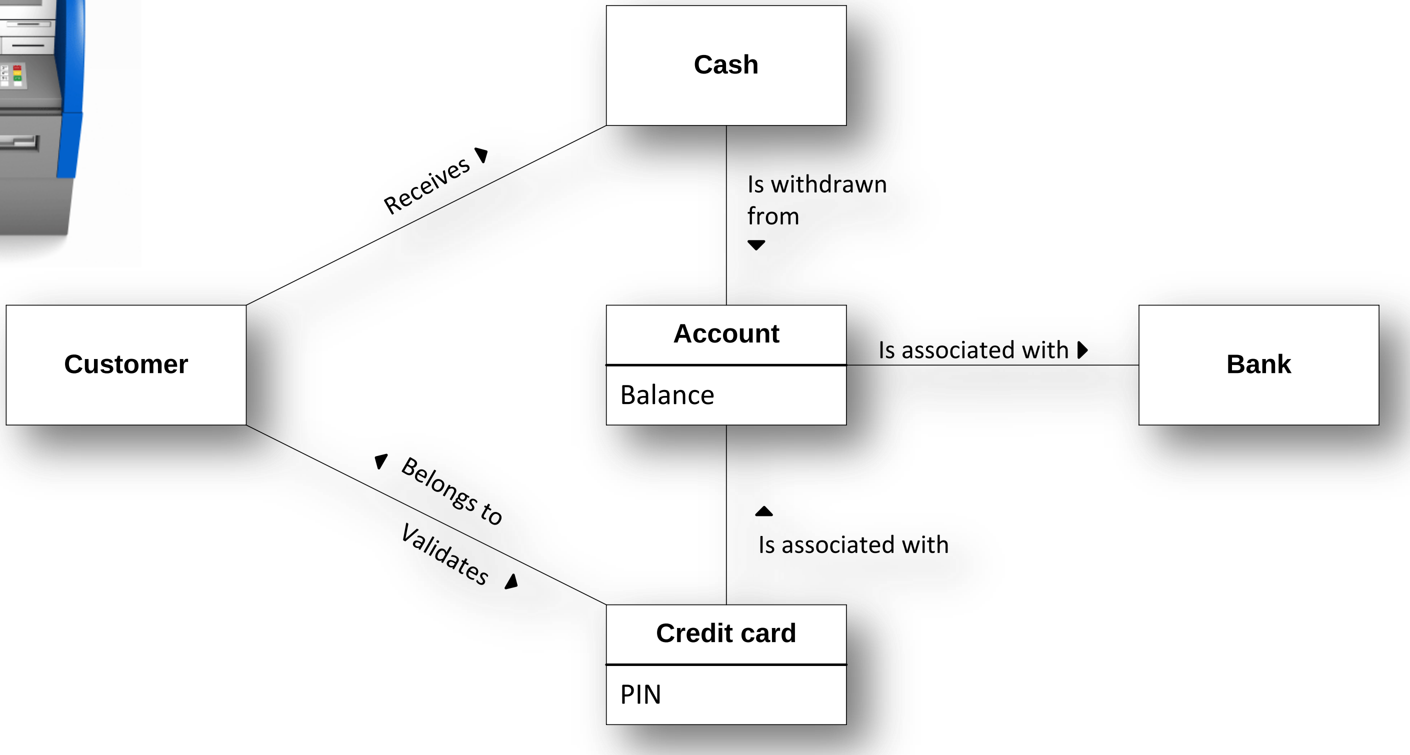
**Iterative design & implementation**

# Today’s example: The ATM

# ATM use cases



# ATM domain model



Cash

Receives ▶

Is withdrawn from ▼

Customer

Account

Balance

Is associated with ▶

Bank

◀ Belongs to

Validates ▶

▲ Is associated with

Credit card

PIN

# The System Application Model – Step 1

- The application model is constructed incrementally in units of use cases. So, apparently,

**UCs are important!**

Step 1.1: Select the next fully-dressed UC's to design for (how?)

Step 1.2: Identify all actors involved in the UC → *Boundary* classes

Step 1.3: Identify relevant classes in the domain model involved in the UC → *Domain* classes

**So are DM classes!**

Step 1.4: Identify the UC *controller* → *Controller* class

# Identify the what, the what and the what?!?

- Our application model consists of three different types of classes: *Boundary*, *domain*, and *controller* classes

- *Boundary* classes represent UC *actors*
  - They are the actors' interface to the system (UI, protocol, …)
  - They *present* the system but contain no business logic.
  - 1 per actor, shared between UCs
  - Optionally stereotyped «`boundary`»

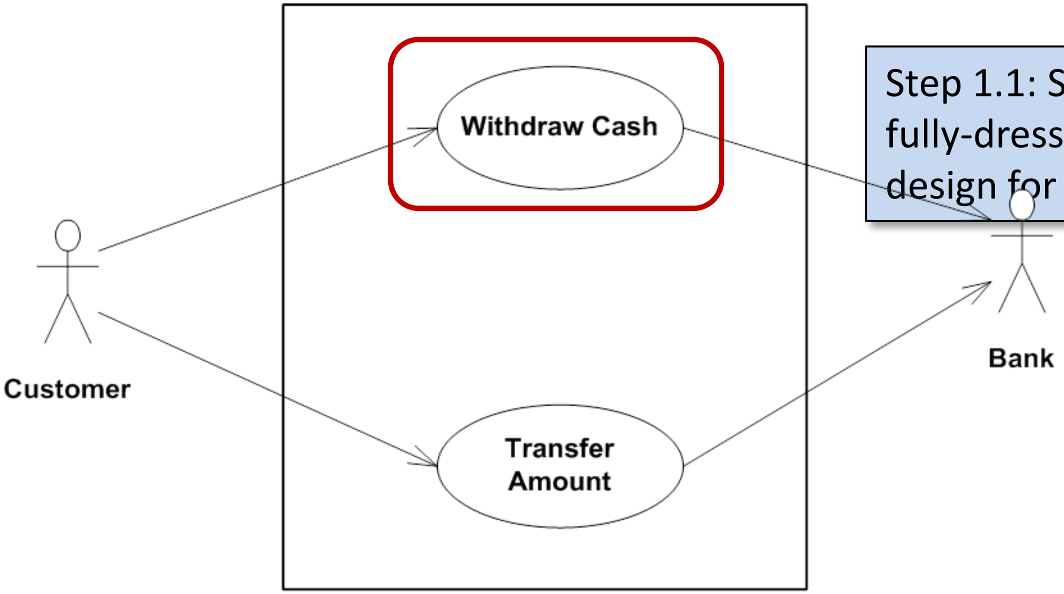
- *Domain* classes represent the system's *domain*
  - Memory, domain-specific knowledge, configuration, etc.
  - 1 or more, shared between several UCs

# Identify the what, the what and the what?!?

- Our application model consists of three different types of classes: *Boundary*, *domain*, and *controller* classes

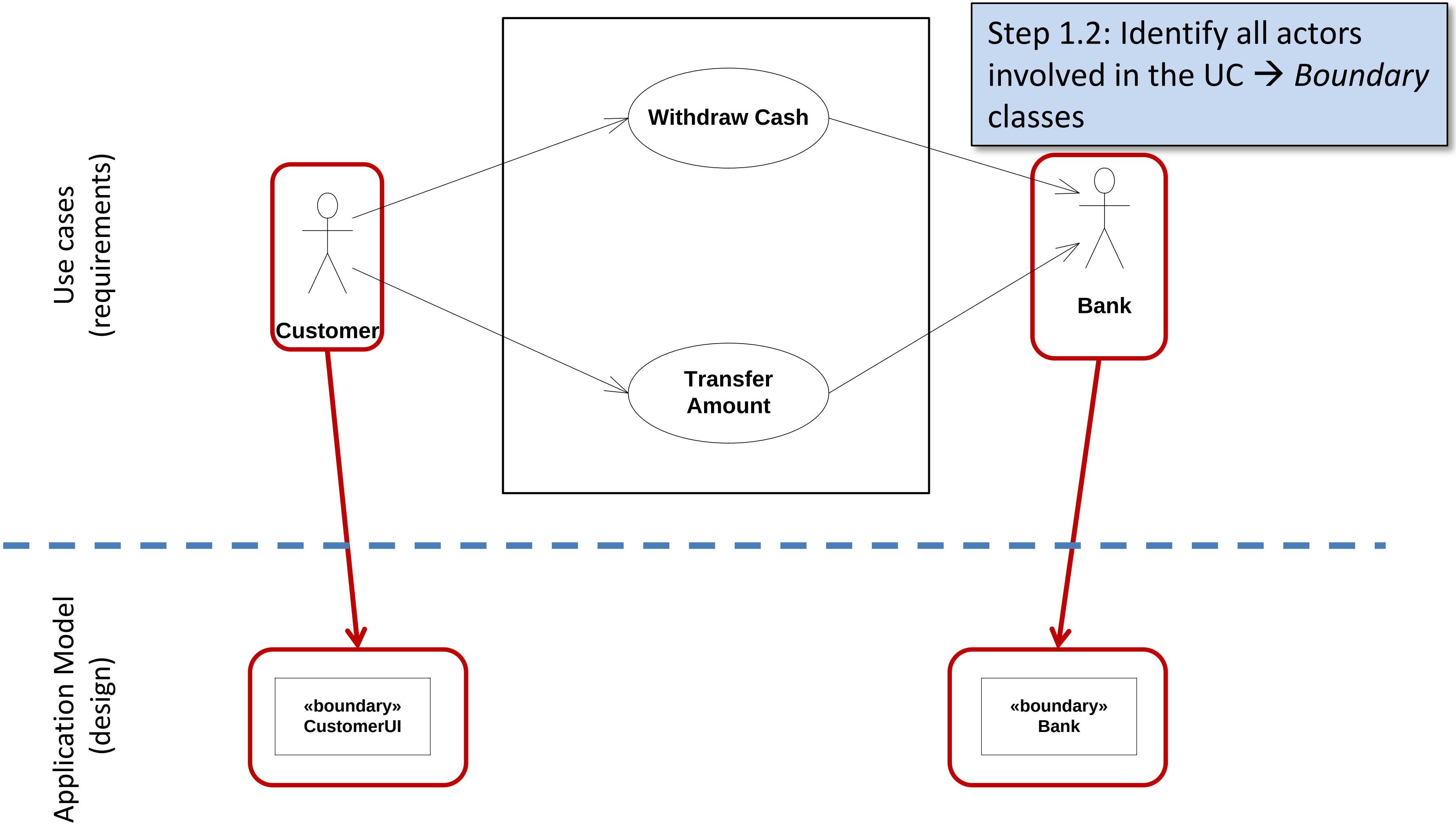
- The *Controller* class holds the UC business logic
  - It ”executes” the use case by interacting with the boundary and domain classes.
  - Named after the UC
  - Typically 1 per UC or 1 shared among a couple of UCs
  - Optionally stereotyped «`control`» or «`controller`»

# ATM step 1.1: Select next Use Case



Step 1.1: Select the next fully-dressed UC to design for

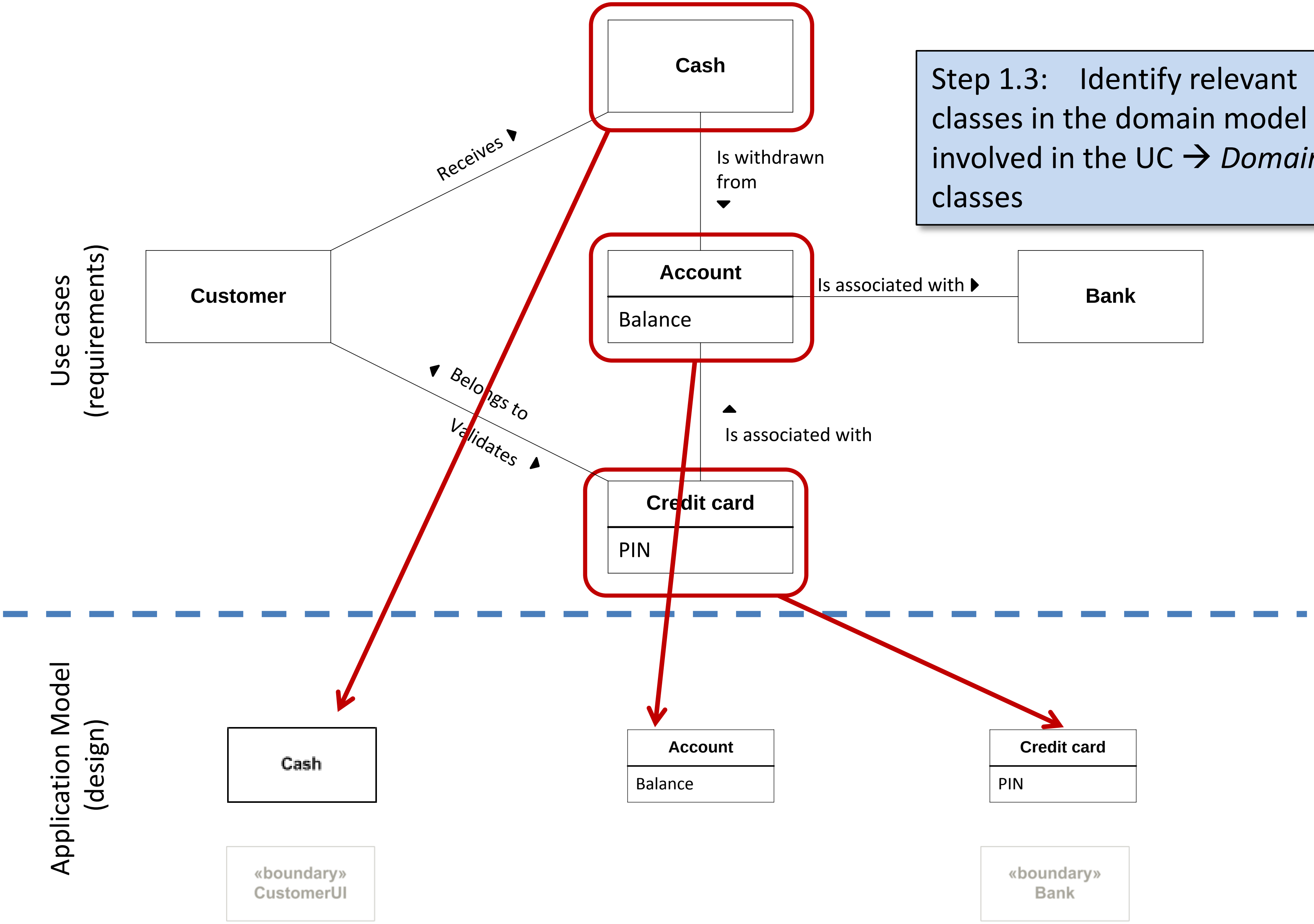
# ATM step 1.2: Actors -> boundary classes



Step 1.2: Identify all actors involved in the UC → *Boundary* classes

# ATM step 1.3: Domain classes

Step 1.3: Identify relevant classes in the domain model involved in the UC → *Domain* classes



Use cases (requirements)

Cash

Receives ▶

Is withdrawn from ▼

Customer

Account

Balance

Is associated with ▶

Bank

◀ Belongs to

Validates ▲

▲ Is associated with

Credit card

PIN

Application Model (design)

Cash

Account

Balance

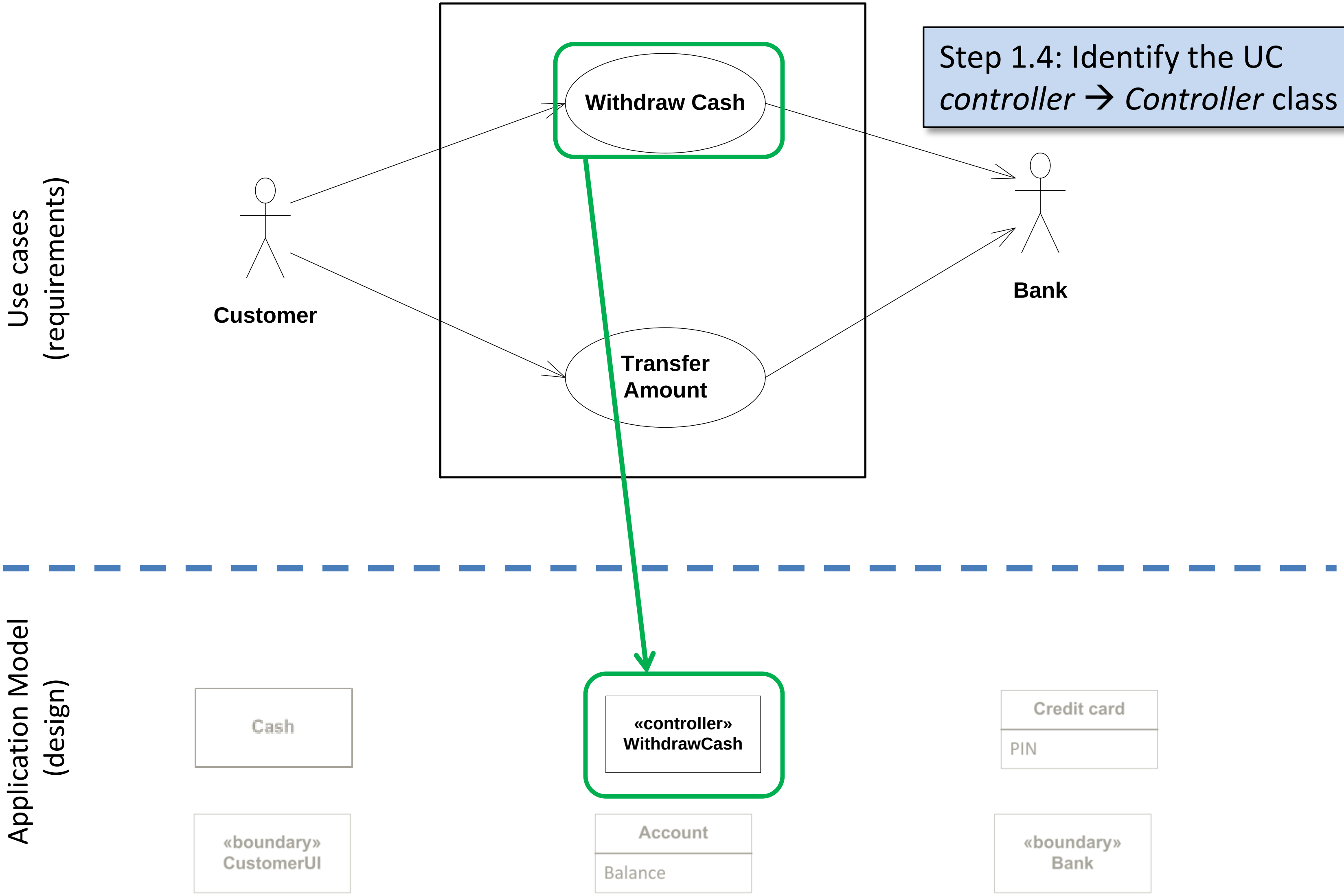
Credit card

PIN

«boundary» CustomerUI

«boundary» Bank

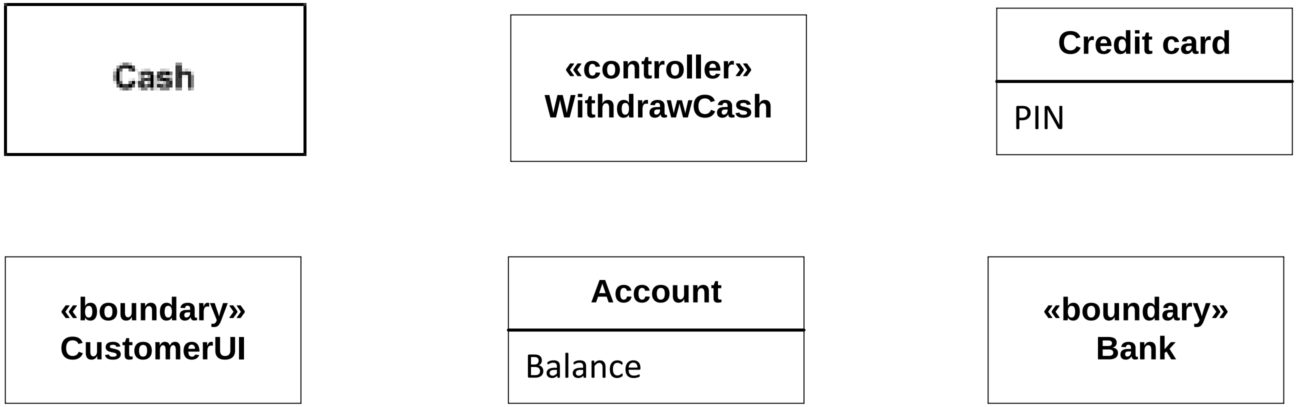
# ATM step 1.4
# Identify UC controller -> Controller class



Step 1.4: Identify the UC *controller* → *Controller* class

# Step 1 complete – so far, so good

- We have now completed Step 1 and identified 6 candidate SW classes for our initial design
- To do this, we used our *use cases* and our *domain model*



Cash

«controller»
WithdrawCash

Credit card
PIN

«boundary»
CustomerUI

Account
Balance

«boundary»
Bank

- We must now add *behaviour* to these classes – that's Step 2

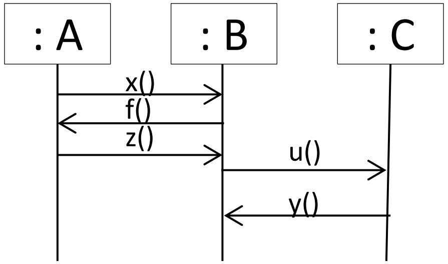
# Principle for step 2: Go through main scenario, update collaborations

***Sequence diagram:***

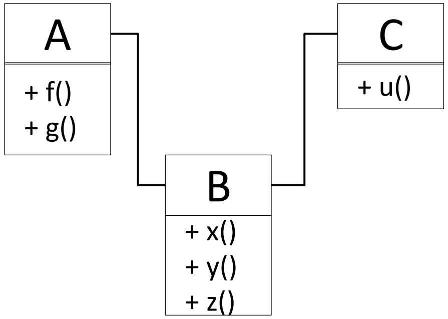
- Add sequence of calls to objects

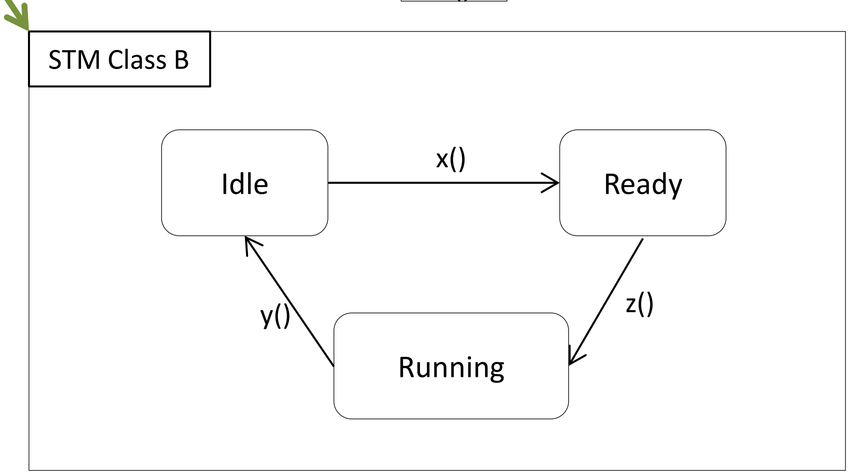
***Class diagram:***

- Add operations to classes
- Update associations



Updated simulta-neously





***State diagrams:***

- Add states to stateful classes
- Add actions (operations) that changes the state

# The System Application Model – Step 2

- The collaboration between the classes is now explored from the UC description – so, still,

**UCs are important!**

Step 2.1: Go through the UC main scenario step-by-step and identify collaborations (**actor- or system-initiated**)

Step 2.2: Update the application model's sequence and class diagrams to reflect the collaboration (relations, operations, attributes)

Step 2.3: Identify any classes with state-based behavior and update STMs for the classes (states, events, transitions) .

*(Step 2.3 is skipped if none classes with state-based behavior)*

Step 2.4: Verify that the diagrams adhere to the UC (descriptions, test)

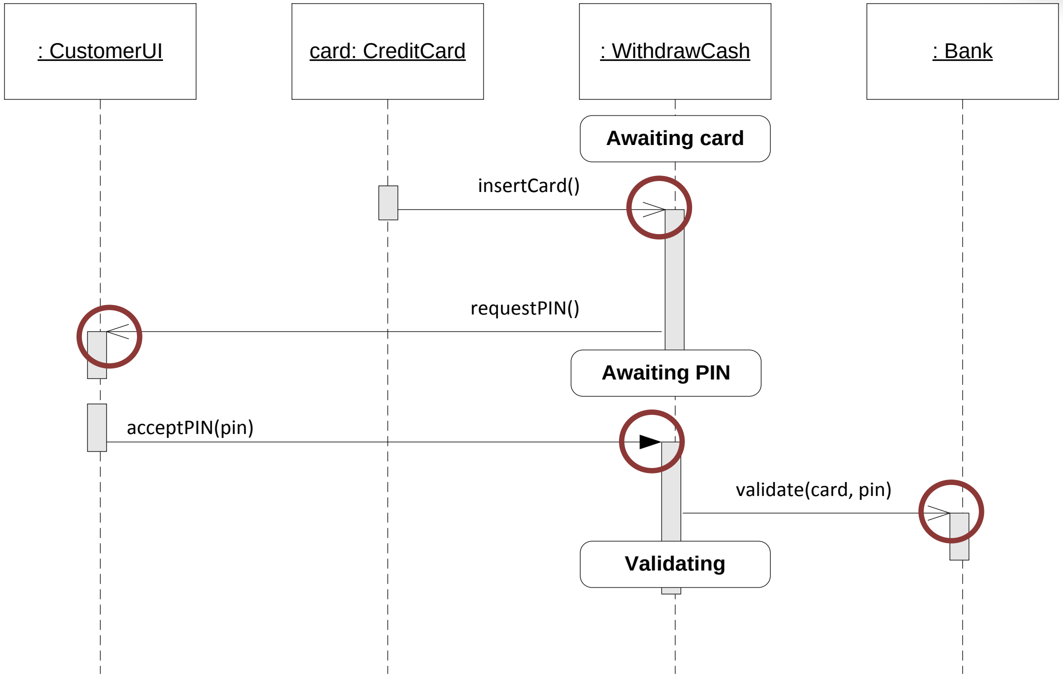
Step 2.5: Repeat 2.1 – 2.4 for all UC exceptions. Refine model.

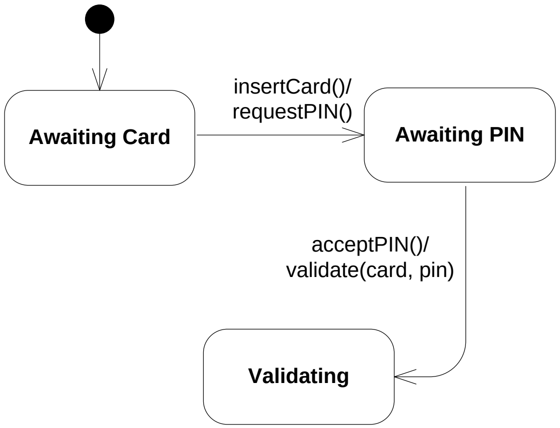
- Note: All 3 diagrams (class, SEQ, STM) are updated at the *same time* in this process.

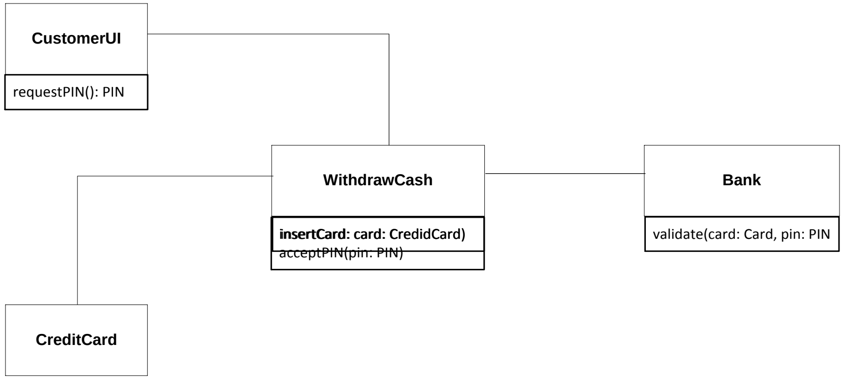
# Steps 2.1-2.4 for UC *Withdraw Money*

Main scenario:

1. Customer inserts credit card in System
2. System requests Customer's PIN code
3. Customer enters PIN code
4. System validates card info and PIN code with Bank

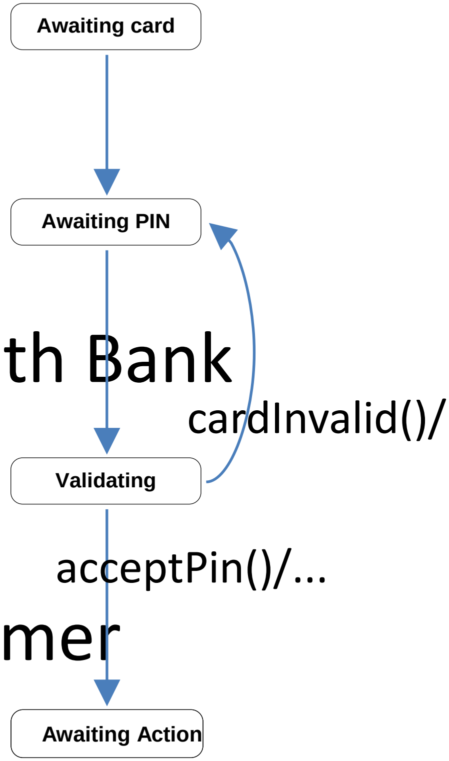






# Find the STM from the Scenario w/Extensions

1. Customer inserts credit card in System
2. System requests Customer’s PIN code
3. Customer enters PIN code
4. System validates card info and PIN code with Bank
5. Bank validates card
   [*Ext. 5.1: Invalid PIN entered*]
6. System requests desired action from customer
7. Customer selects “Withdraw Cash”
8. ...



# Your turn: Complete system application model for UC *Withdraw Cash*

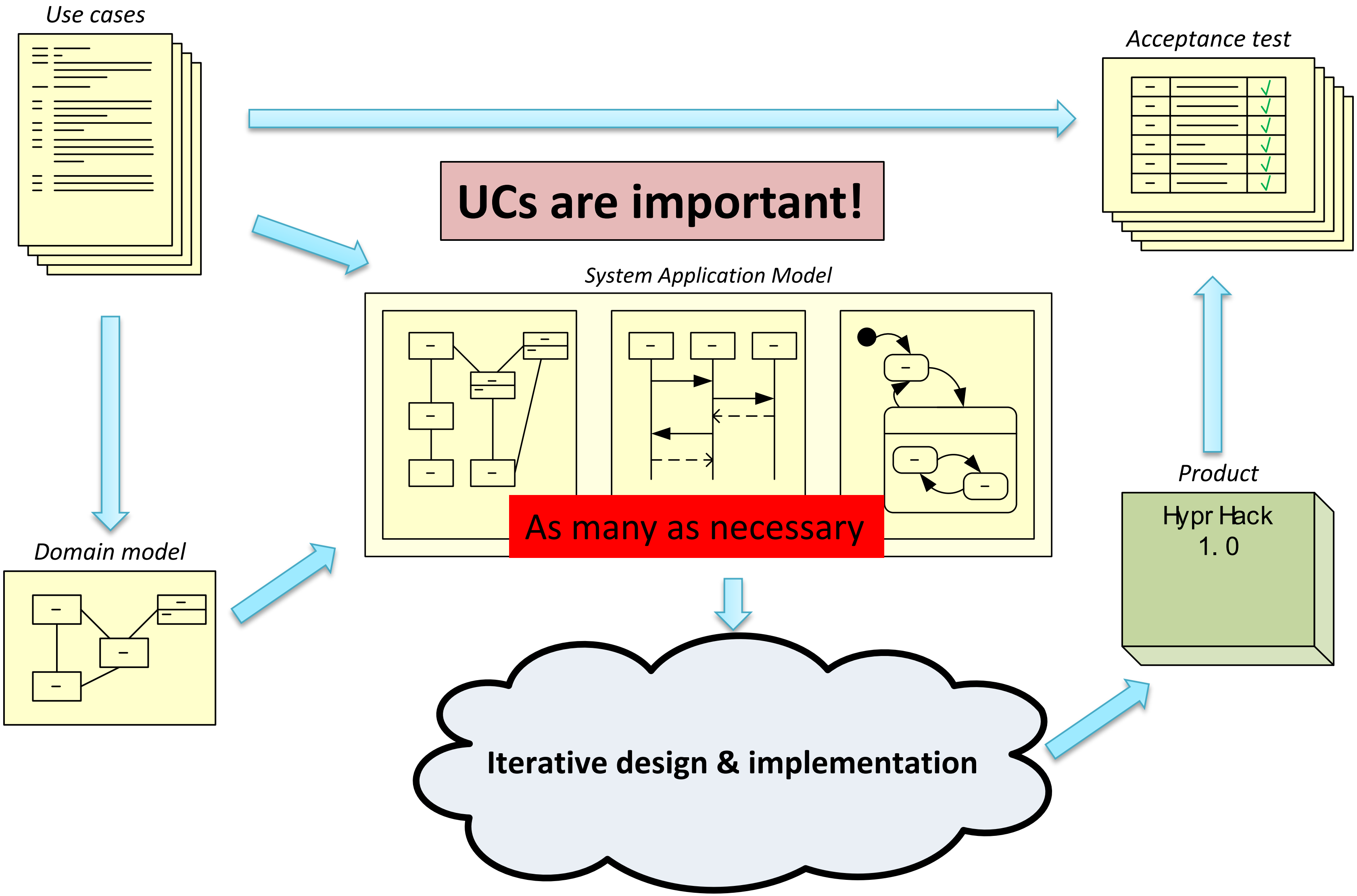
- The complete text for UC Withdraw Cash is on the BlackBoard. You have the following tasks:
  - Complete the System Application Model for the main scenario for the UC
  - Complete the System Application Model for all extensions for the UC
- Continue work with this in next lecture (L19)
- The remaining slides will be used for L20.

# The System Application Model – Step 3 and beyond

- As you add more UCs to the application model you will begin to discover *reuse* of the previous classes
  - Domain and boundary classes often repeat
  - Different domain classes may be so closely related that they might as well be ”collapsed” into one
  - Sometimes, even controllers ”collapse”

- At this time, experience must ensure the correct cut between reuse and new classes

# System Application Model in the big picture



Use cases

Acceptance test

UCs are important!

System Application Model

As many as necessary

Domain model

Product

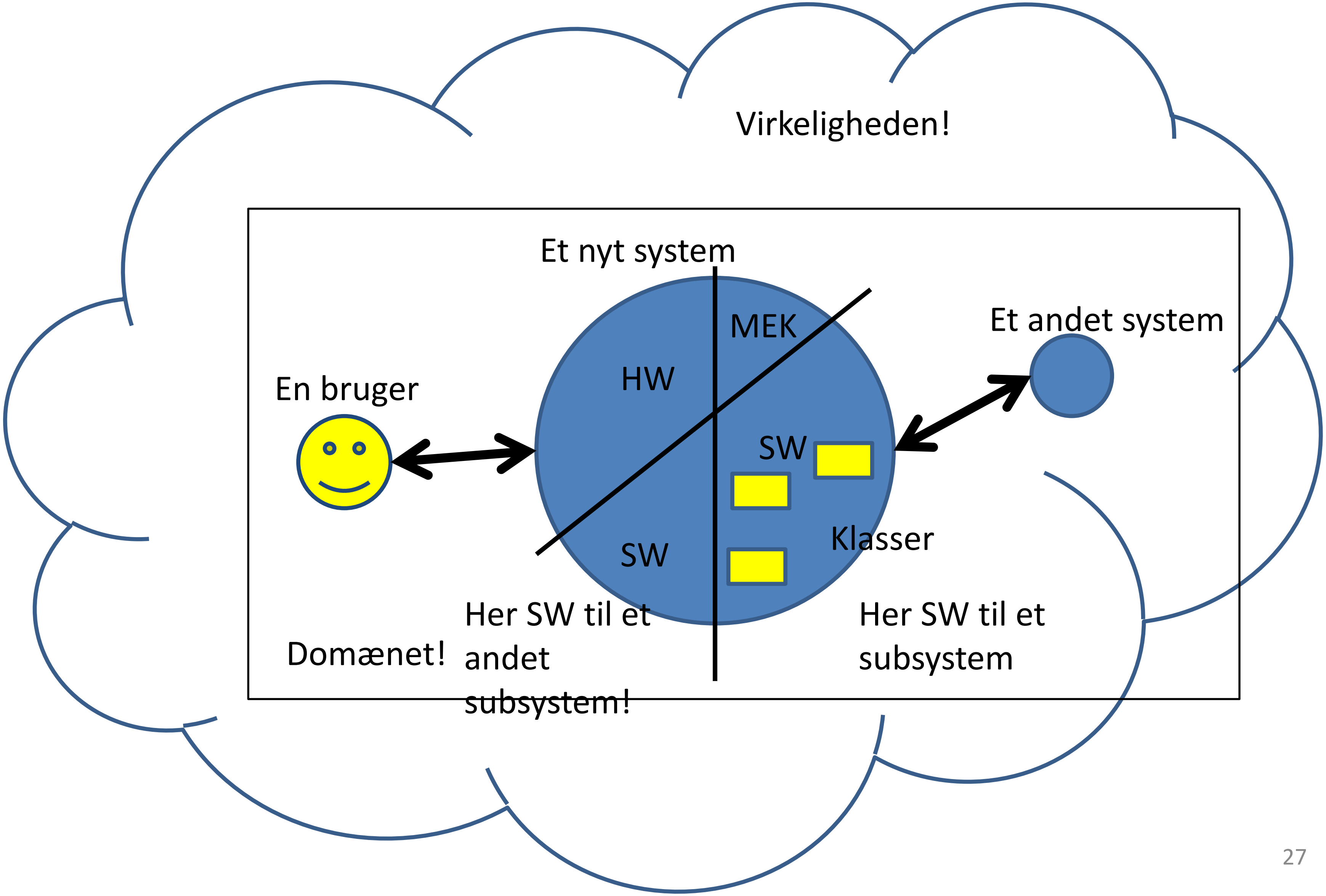
Hypr Hack
1. 0

Iterative design & implementation

# Application model and subsystems

- In case a system to be developed is composed by more computers an **application model is created for each subsystem** (computer)
- **Boundary classes** are identified for connections **between the subsystems and external units and actors**
- **Controller classes** are identified for **Use Cases where the subsystem is involved**
- **Domain classes** are taken from the domain model

# Virkeligheden og systemet



Virkeligheden!

Et nyt system

MEK

HW

SW

SW

Klasser

En bruger

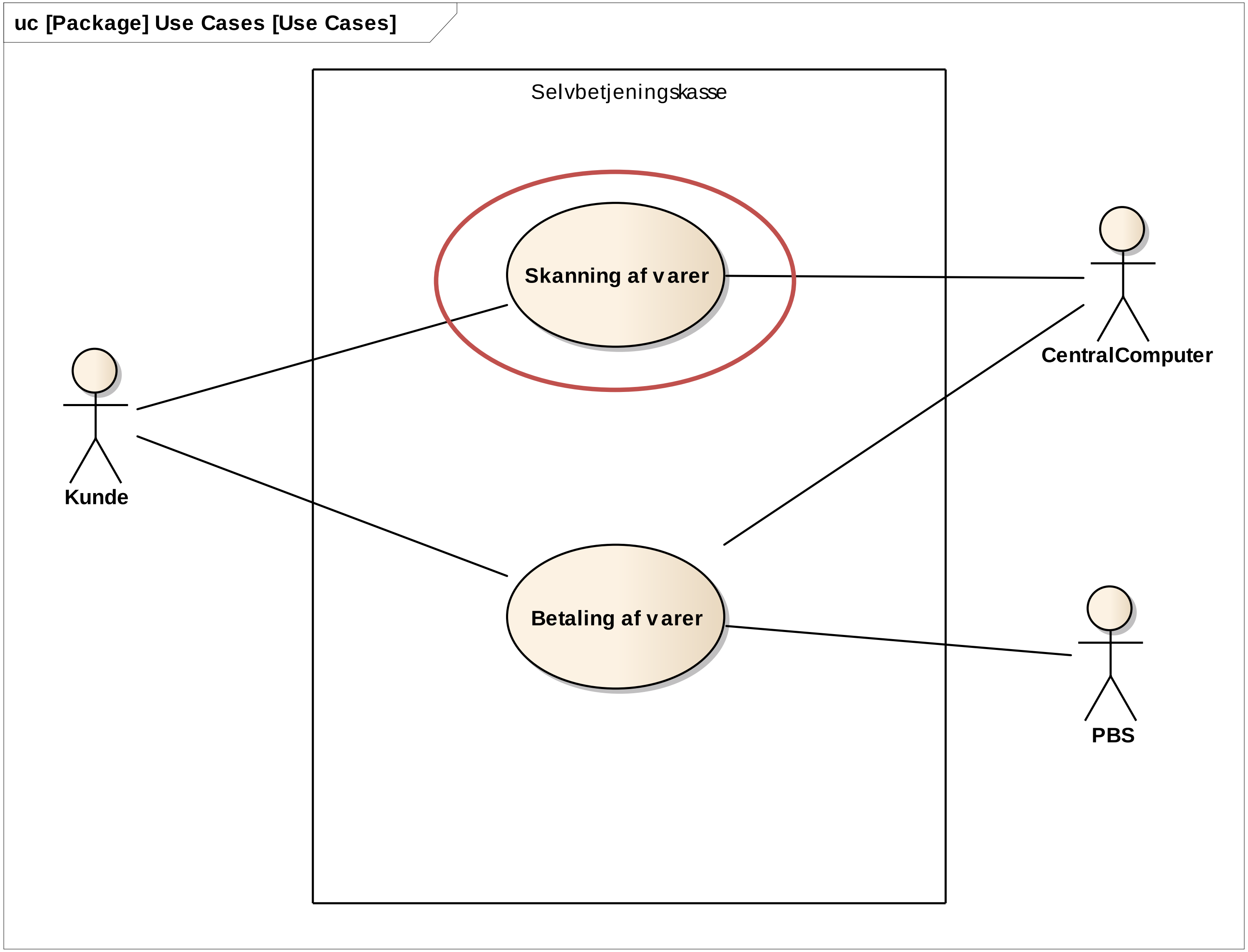
Et andet system

Domænet!

Her SW til et andet subsystem!

Her SW til et subsystem

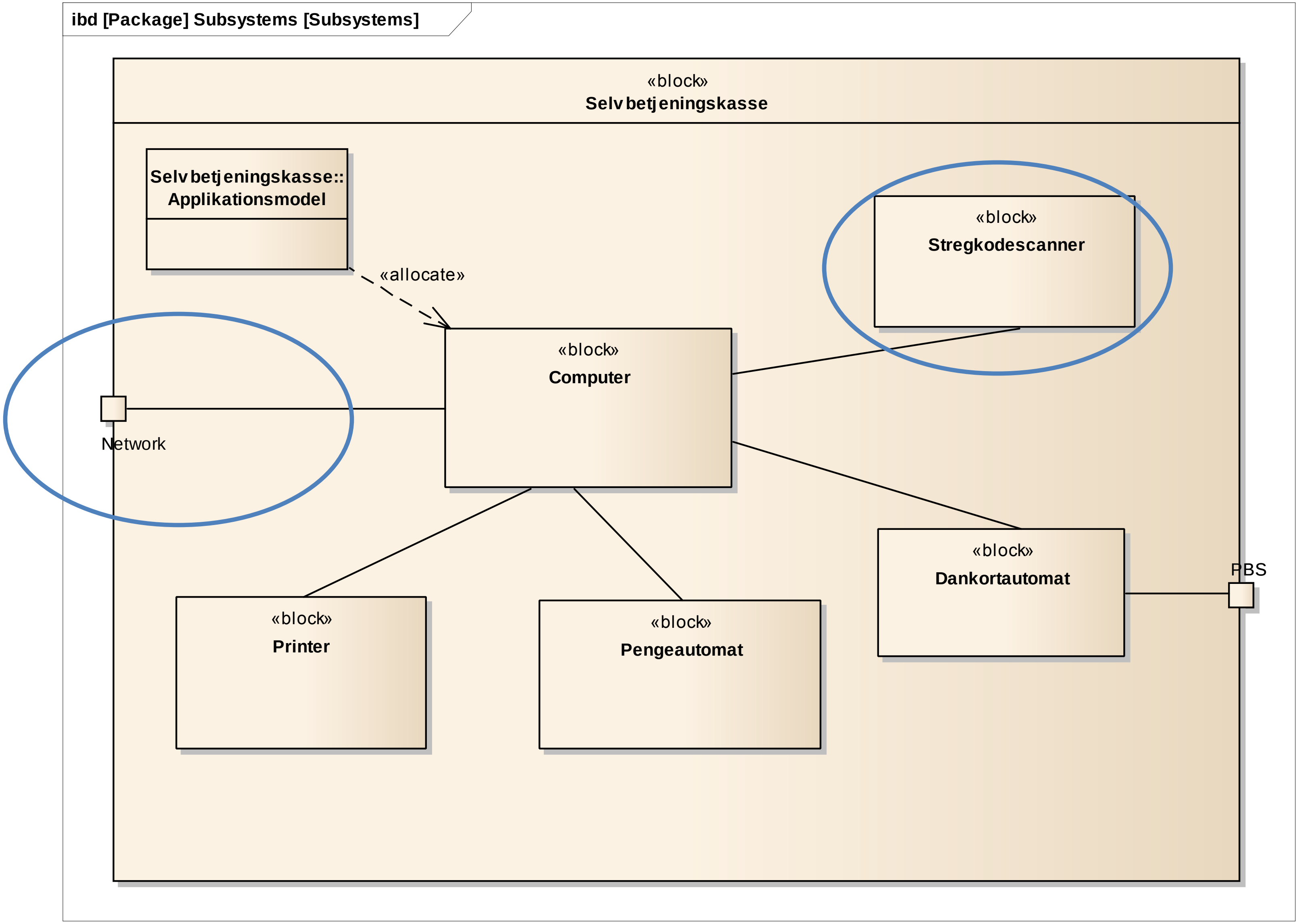
# Selvbetjeningskasse (2. eksempel)



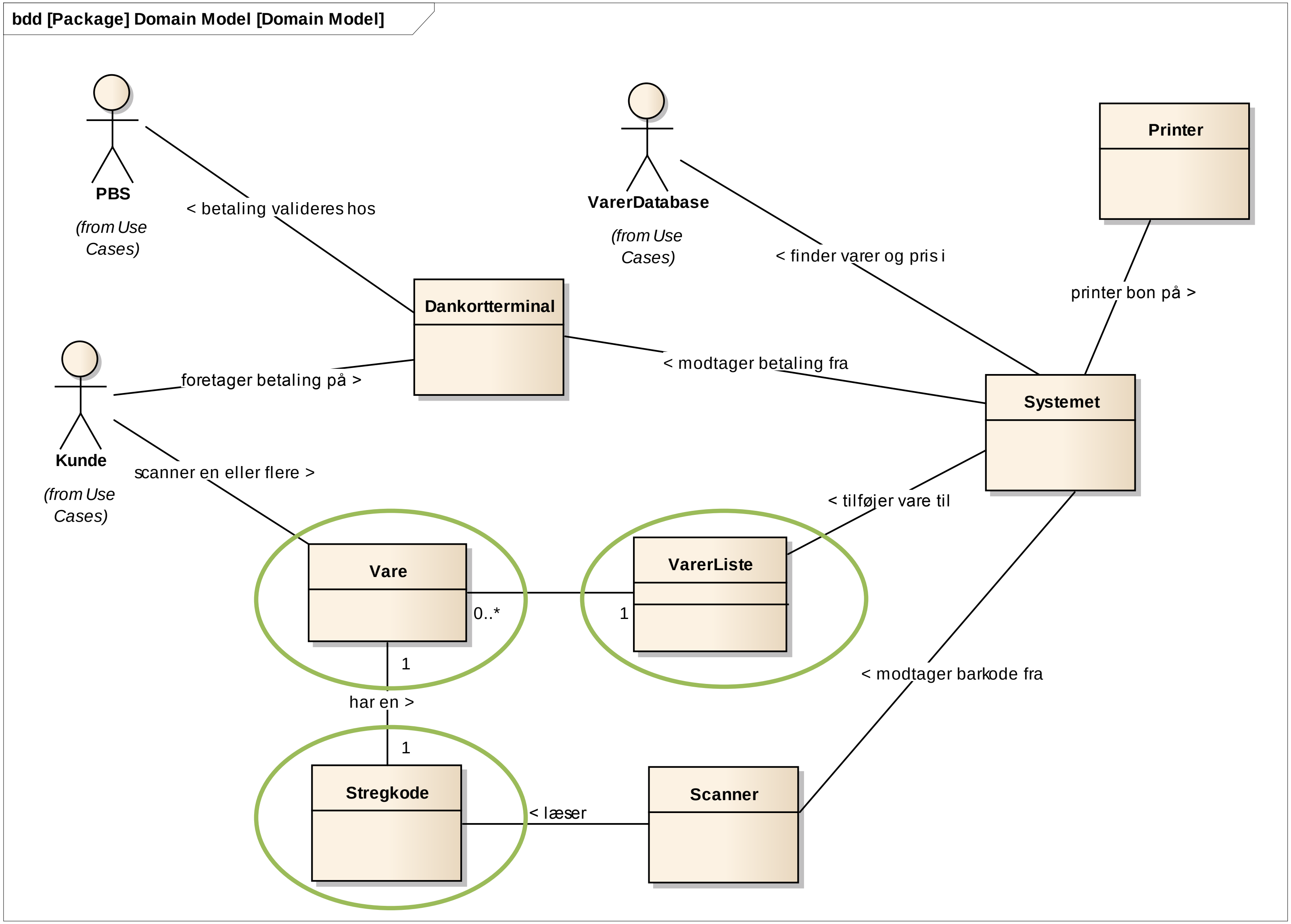
# Scanning af Vare (Hovedscenarie)

1. Selvbetjeningskassen anmoder kunden om at skanne vare
2. Kunden placerer vare foran skanner
3. Systemet skanner varens stregkode
4. Systemet finder varens pris i varedatabasen
5. Vare med pris tilføjes til en vareliste
6. Kunden lægger vare i pose på bordet ved siden af skanner
7. Punkterne 1-6 gentages indtil alle varer er skannet
8. Kunden vælger afslut

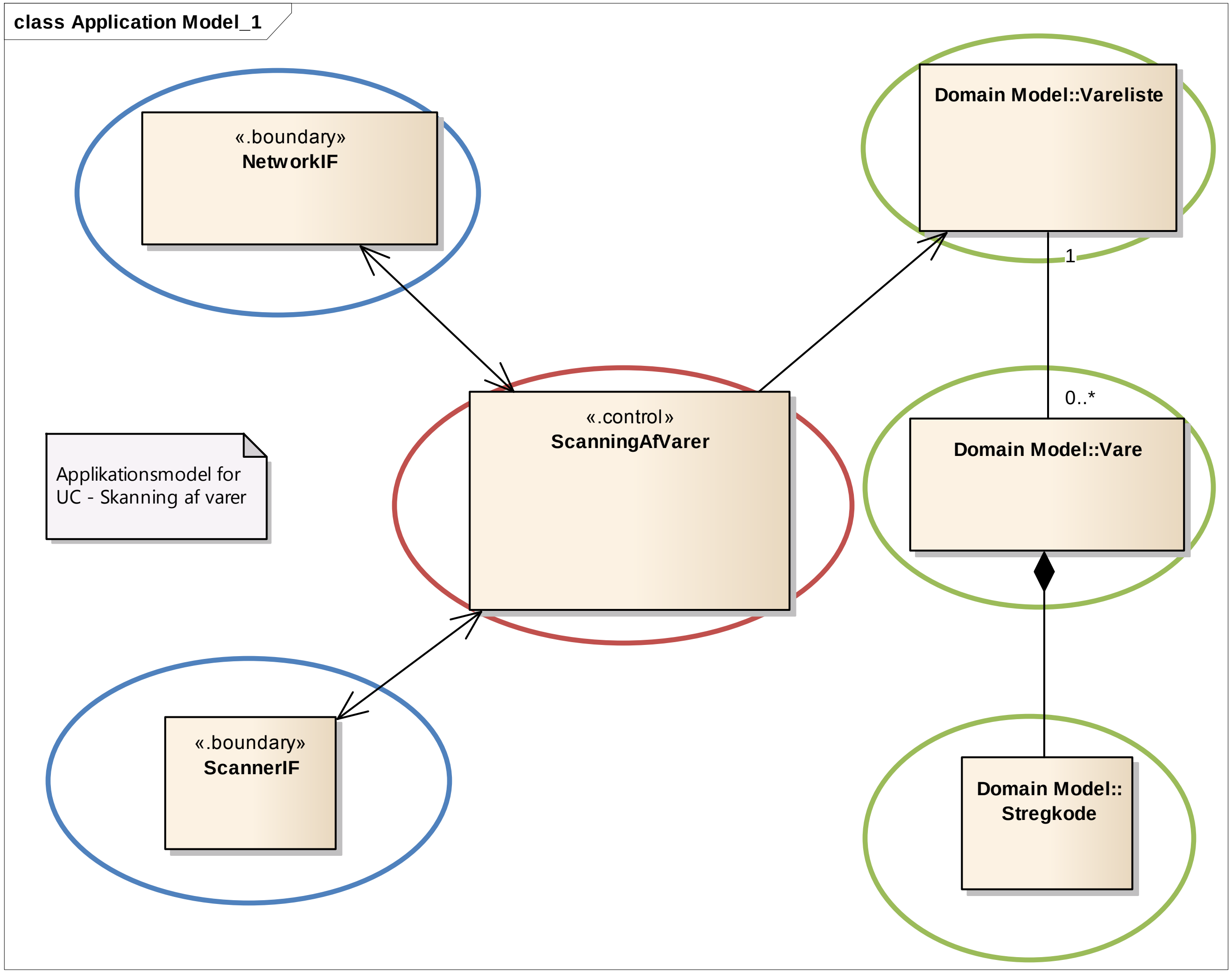
# Allokering – IBD Subsystem - Boundary



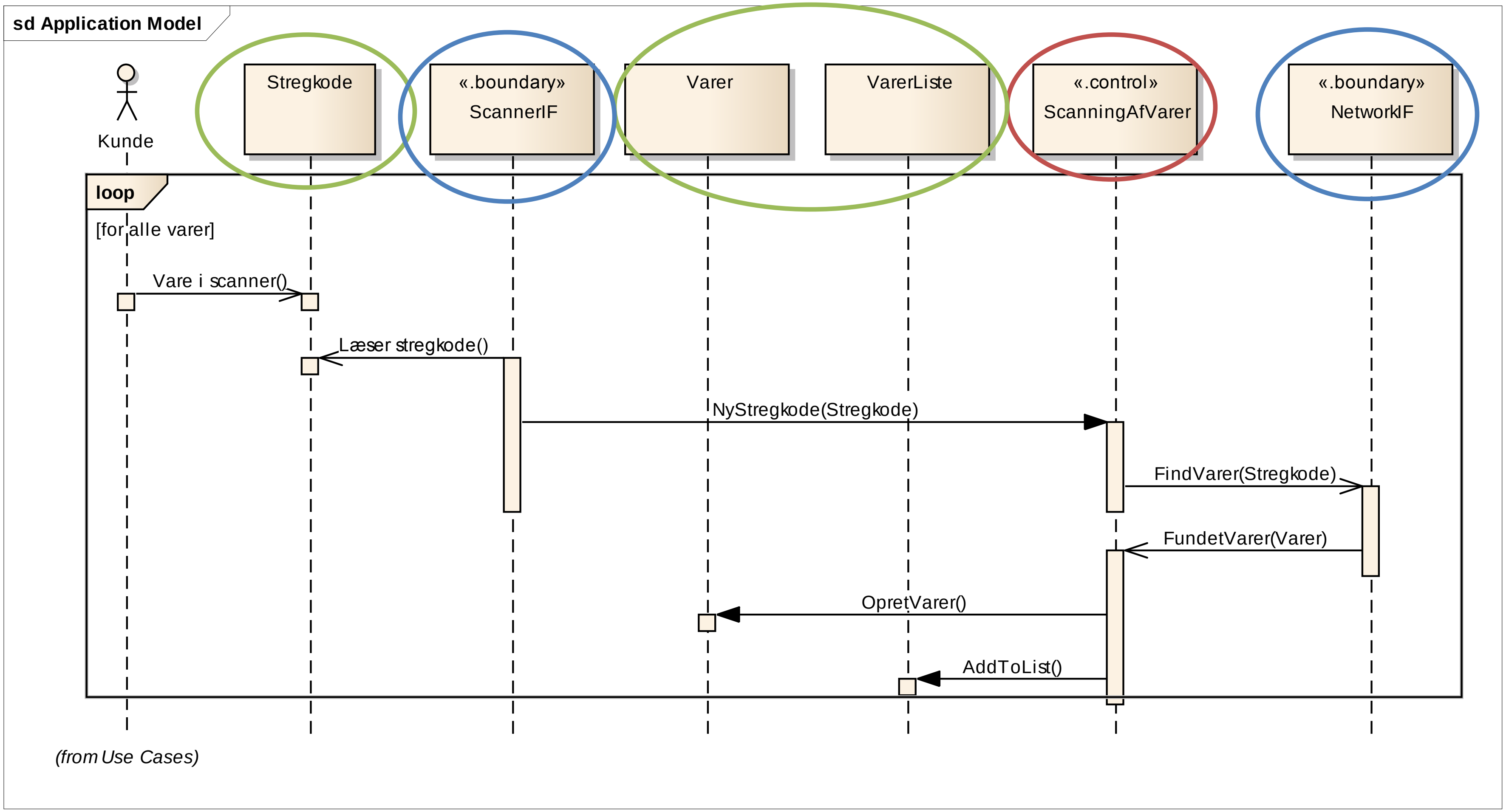
# Domain model



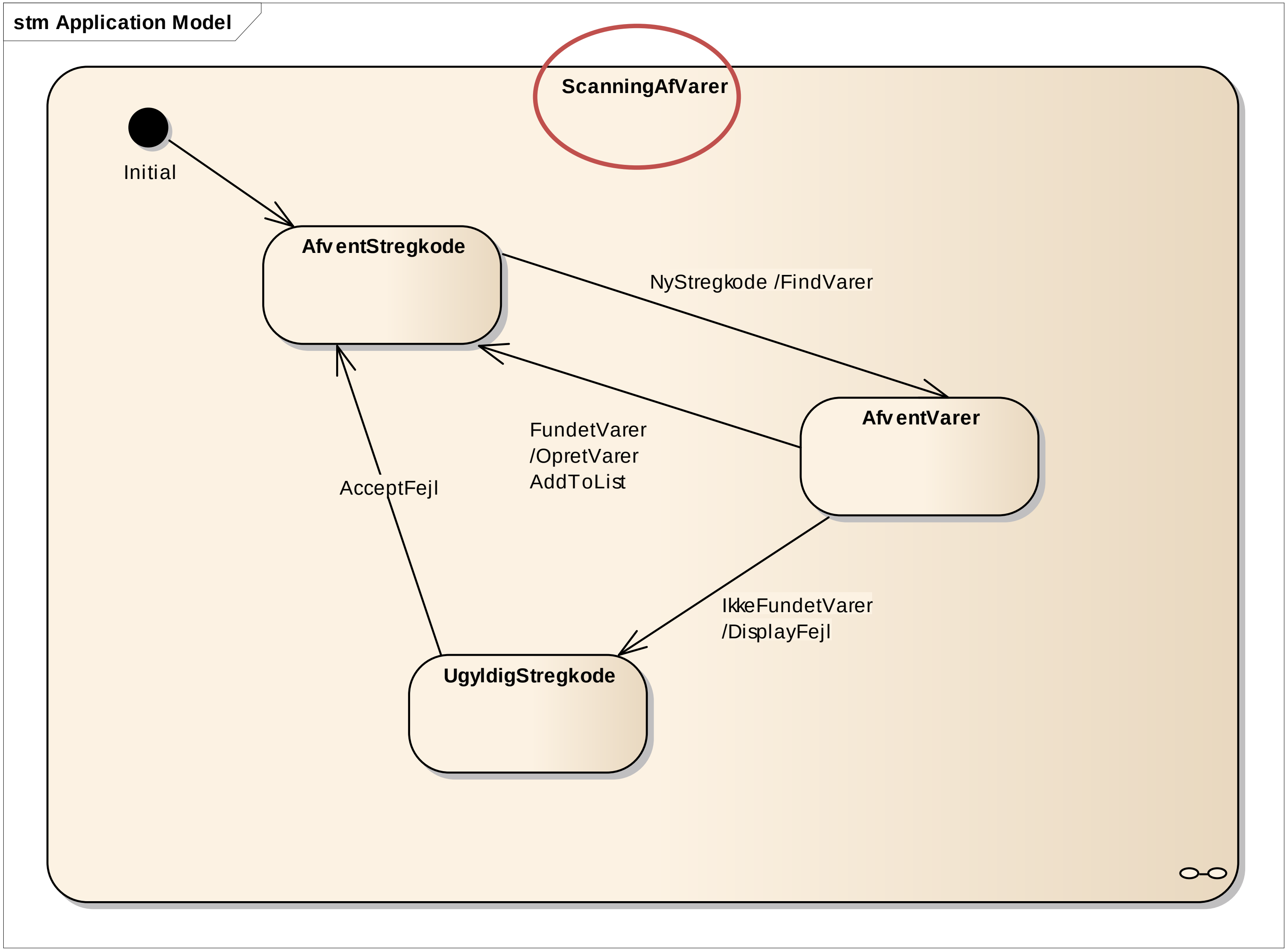
# Applikationsmodel (UC – Scanning af varer)



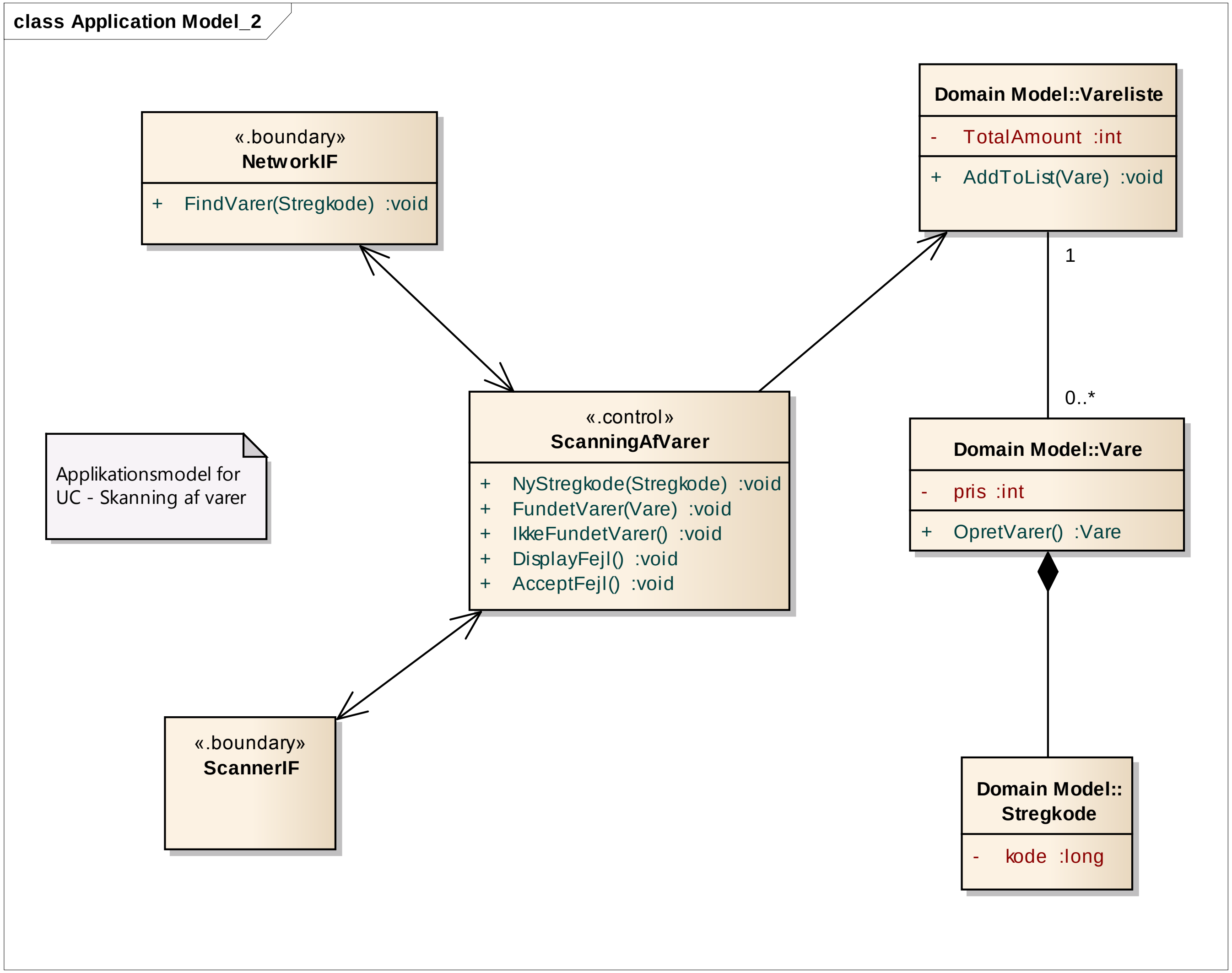
# Sekvensdiagram (Applikationsmodel)



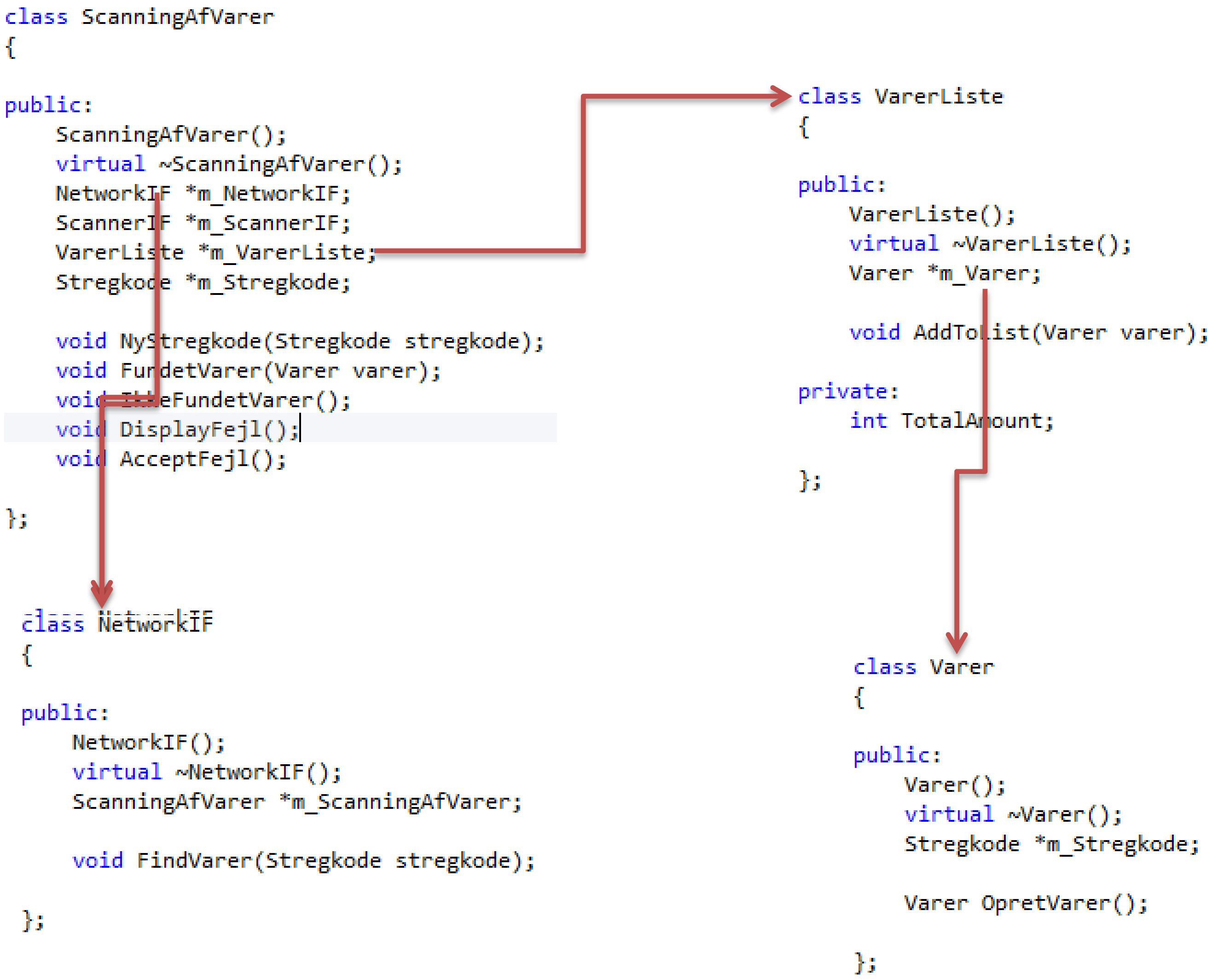
# Statediagram (Control class)



# Opdateret applikationsmodel



# C++-Kode – automatisk genereret



```
class ScanningAfVarer
{

public:
    ScanningAfVarer();
    virtual ~ScanningAfVarer();
    NetworkIF *m_NetworkIF;
    ScannerIF *m_ScannerIF;
    VarerListe *m_VarerListe;
    Stregkode *m_Stregkode;

    void NyStregkode(Stregkode stregkode);
    void FundetVarer(Varer varer);
    void IkkeFundetVarer();
    void DisplayFejl();
    void AcceptFejl();

};
```

```
class VarerListe
{

public:
    VarerListe();
    virtual ~VarerListe();
    Varer *m_Varer;

    void AddToList(Varer varer);

private:
    int TotalAmount;

};
```

```
class NetworkIF
{

public:
    NetworkIF();
    virtual ~NetworkIF();
    ScanningAfVarer *m_ScanningAfVarer;

    void FindVarer(Stregkode stregkode);

};
```

```
class Varer
{

public:
    Varer();
    virtual ~Varer();
    Stregkode *m_Stregkode;

    Varer OpretVarer();

};
```

# Næste skridt:<br>Denne skitse bruges i de egentlige SW designaktiviteter

# Your turn: System Application Model for Benzinstanderstyring – UC Optank Bil

- Complete the system application model for the Benzinstanderstyring – UC Optank Bil,
  taking into consideration what you know about the Hardware and other components of this system from the supplied bdd, ibd, Domain Model and initial class diagram.
  - Check if steps 1.1-1.4 have been completed for the supplied class diagram for the System Application Model
  - Complete steps 2.1-2.5 for the UC