A generic solution for weaving business code into executable models

Eric Cariou, Olivier Le Goaer, Léa Brunschwig, Franck Barbier

University of Pau / LIUPPA, France

ECSEL Joint Undertaking

European Commission

Horizon 2020
European Union funding
for Research & Innovation

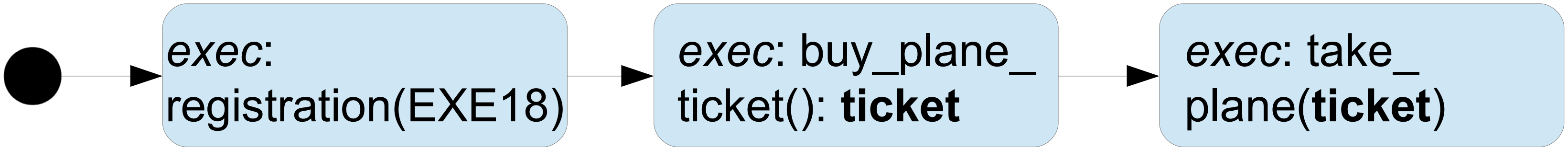
Introduction

- Interests of model execution
  - Clear separation between behavioral and business parts
- Business
  - What to do: call of a Web service, request on a data-base...
- Behavior
  - When and why doing something
  - Specified by a state machine, a Petri net, a workflow...
- Software implementation
  - Weaving business operations with a behavorial model

  → Technical/scientific problem

Challenges

- Developping an executable DSL and its execution engine
  - Well-known: Ecore, Java EMF, Kermeta, GEMOC …
- How to weave business operations with the executable model and its elements?
  - Java methods with various number and type of parameters with returned values becoming parameters of other methods
    - Need to manage a data flow
  - The execution engine is agnostic: independent of the content of the model to execute


exec: registration(EXE18)
exec: buy_plane_ticket(): **ticket**
exec: take_plane(**ticket**)

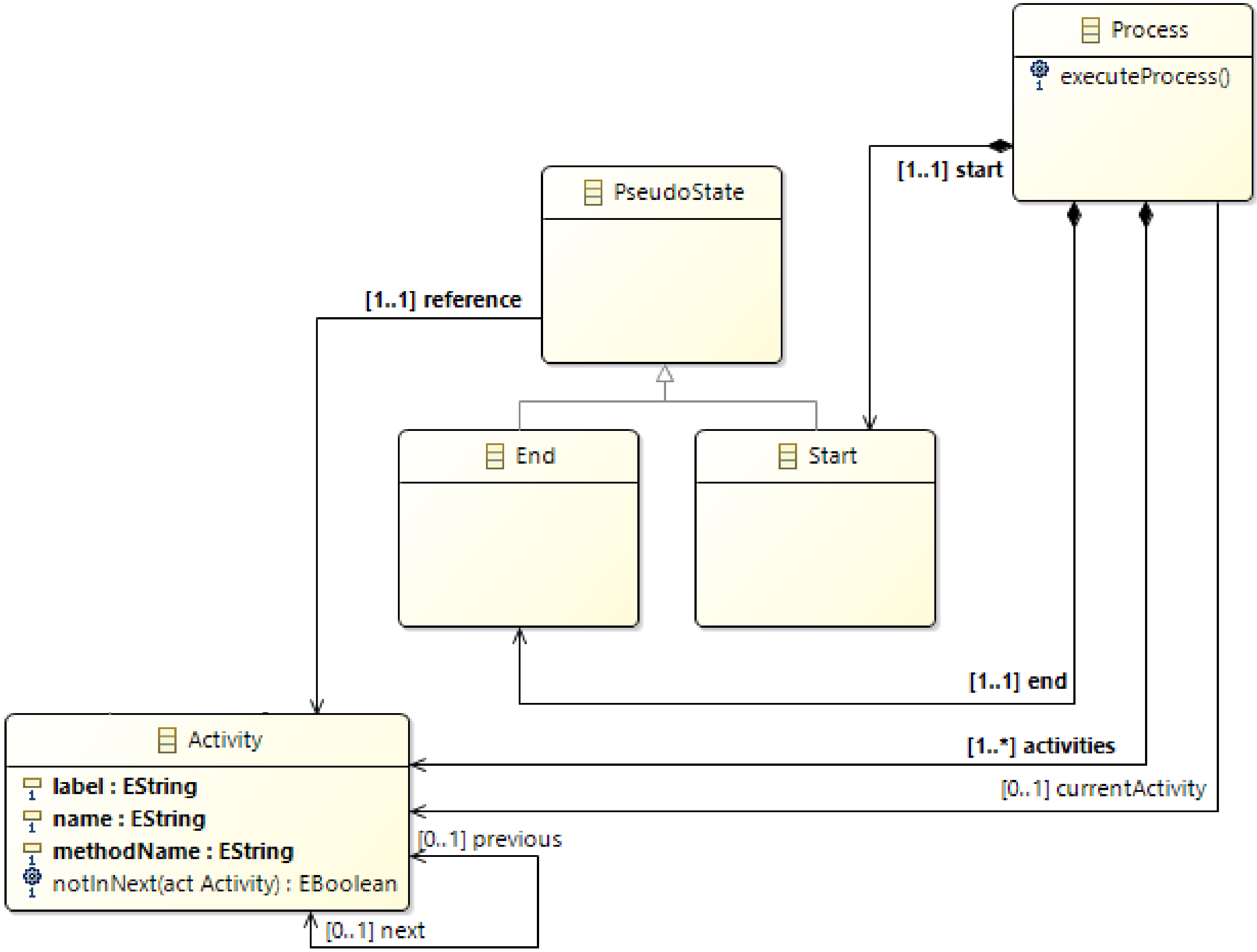
Challenges

- One solution
  - Developping the business parts in parallel of the model
  - Final application obtained by full code generation mixing executable elements and business methods
- Limits
  - Require to develop business code in an Eclipse/EMF-based tool
  - If you want or need to use another IDE or reuse legacy code?
    - How to developp an Android mobile app without Android Studio?
    - We must be able to escape the Eclipse/EMF world
- Proposition
  - Xmodeling Studio: a tool for defining executable DSL and execution engines usable in any Java development

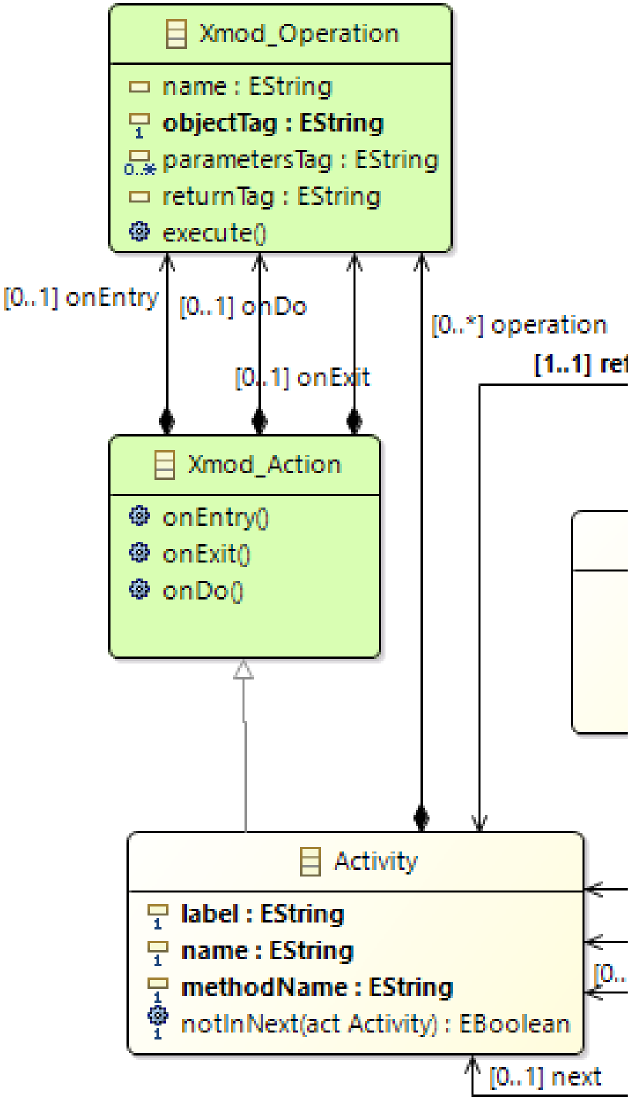
Xmodeling Studio

- EMF plugin for helping in the definition of executable DSL
- For the language engineer
  - Provide generic meta-classes for defining business operations that can be associated with meta-elements of any Ecore meta-model
  - Provide generic EMF Java code for automatically calling the business operations within the execution engine
    - By using the Java reflection mechanisms
- For the software engineer
  - Implement his/her Java business methods on one side
  - Specify his/her executable model on another side
  - Embed the execution engine and its executable model in any Java development, independently of Eclipse/EMF

Example: Process Definition Language (PDL)



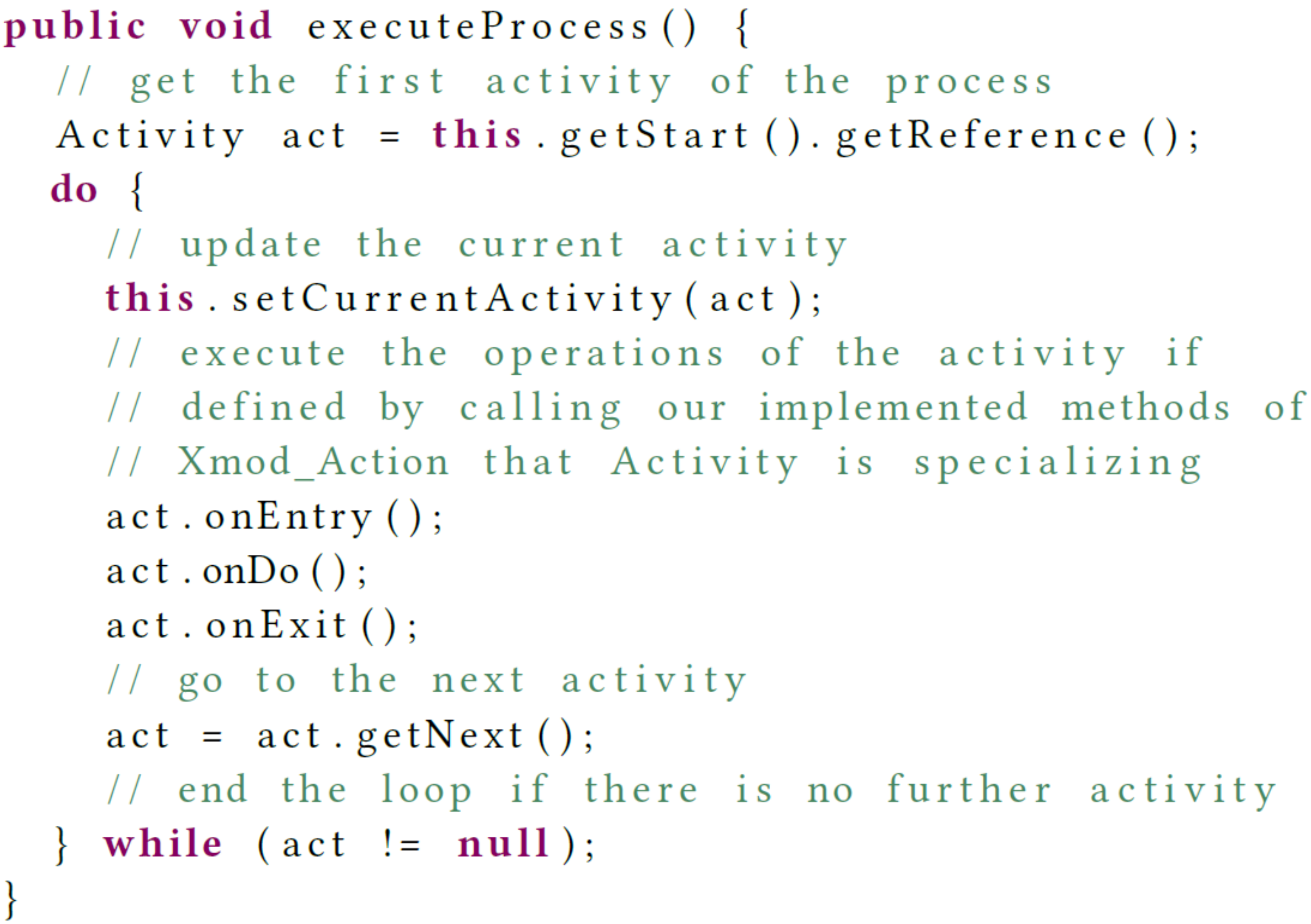
Extended PDL



- Meta-model transformation
  - Executable elements are annotated
  - Activity can now define operations
- An operation has
  - A name
  - An object name/tag on which the operation is called
  - Parameters through tags of objects
  - A returned value with a tag
- In the Java implementation
  - A map associates concrete objects with their names/tags
  - We profide generic code to execute the business operations and manage the data flow

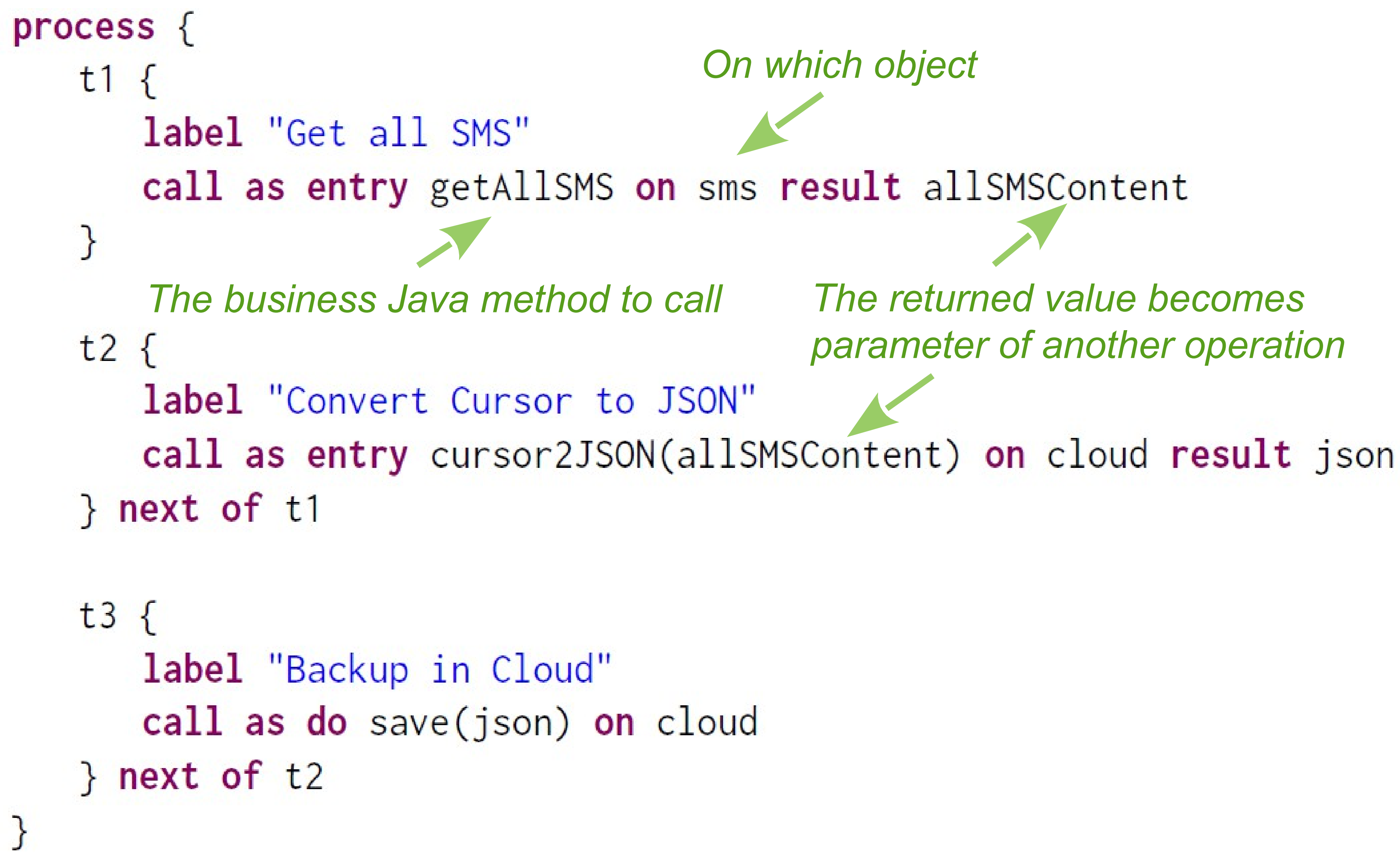
PDL Execution engine

- Main code of the engine: the executeProcess() operation of Process



```java
public void executeProcess() {
  // get the first activity of the process
  Activity act = this.getStart().getReference();
  do {
    // update the current activity
    this.setCurrentActivity(act);
    // execute the operations of the activity if
    // defined by calling our implemented methods of
    // Xmod_Action that Activity is specializing
    act.onEntry();
    act.onDo();
    act.onExit();
    // go to the next activity
    act = act.getNext();
    // end the loop if there is no further activity
  } while (act != null);
}
```

An Android-based PDL model



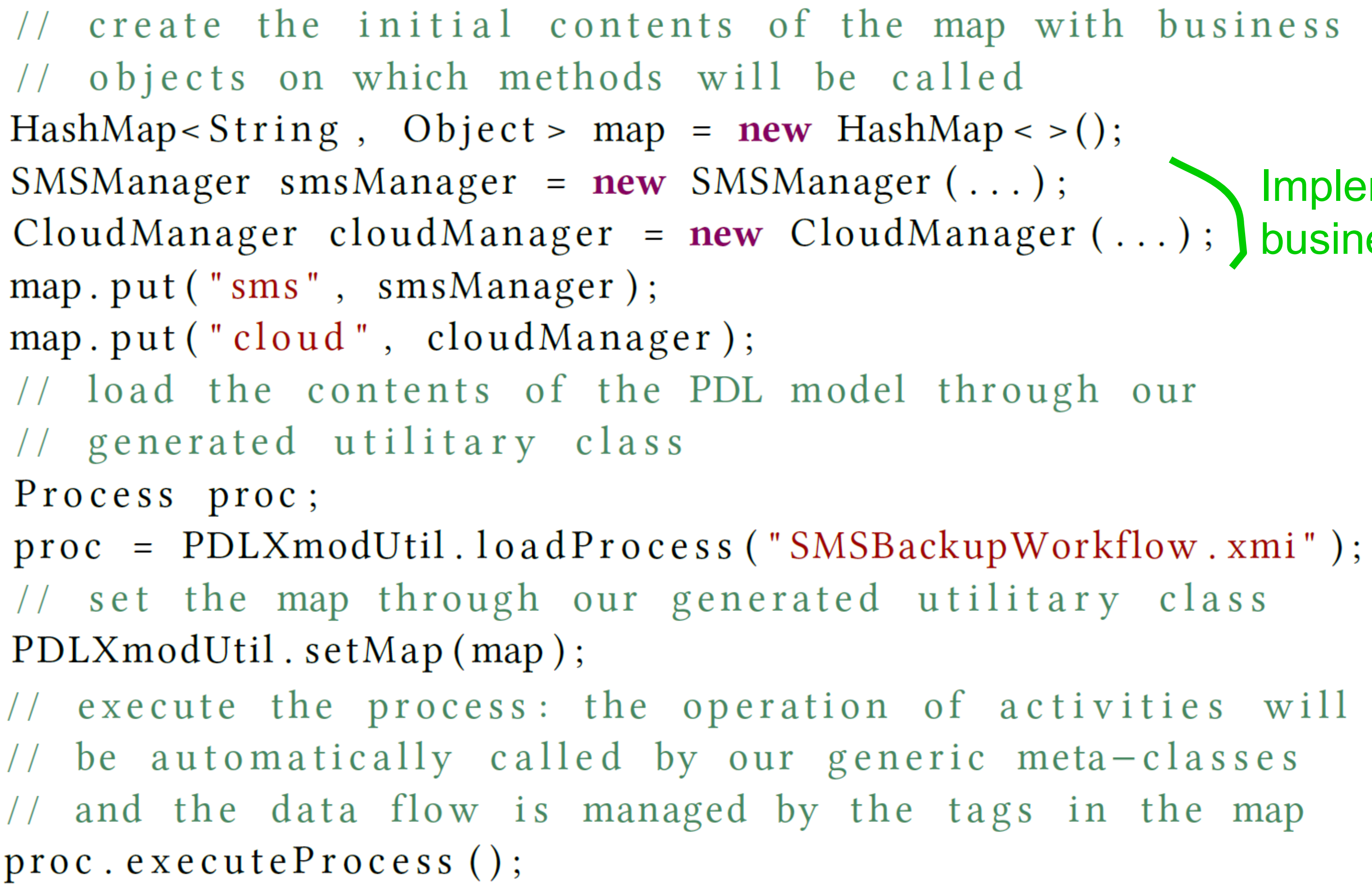
```
process {
    t1 {
        label "Get all SMS"
        call as entry getAllSMS on sms result allSMSContent
    }

    t2 {
        label "Convert Cursor to JSON"
        call as entry cursor2JSON(allSMSContent) on cloud result json
    } next of t1

    t3 {
        label "Backup in Cloud"
        call as do save(json) on cloud
    } next of t2
}
```

On which object

The business Java method to call

The returned value becomes parameter of another operation

Software engineer: app. implementation



```
// create the initial contents of the map with business
// objects on which methods will be called
HashMap<String, Object> map = new HashMap<>();
SMSManager smsManager = new SMSManager(...);
CloudManager cloudManager = new CloudManager(...);
map.put("sms", smsManager);
map.put("cloud", cloudManager);
// load the contents of the PDL model through our
// generated utilitary class
Process proc;
proc = PDLXmodUtil.loadProcess("SMSBackupWorkflow.xmi");
// set the map through our generated utilitary class
PDLXmodUtil.setMap(map);
// execute the process: the operation of activities will
// be automatically called by our generic meta-classes
// and the data flow is managed by the tags in the map
proc.executeProcess();
```

Implement the business methods

Conclusion

- As a proof of concept: an Android mobile app
  - Add 3 .jar files of EMF in the Android Studio project (size of 2 MB)
  - Add the .jar file of the EMF PDL project
  - Add the .xmi model to execute
  - Succesfull deployment and execution on an Android smartphone
- Critics
  - Strange way and perhaps not efficient way of programming
    - Not yet tested for developping large applications
  - Intrinsic problem of executable models due to the complete separation of behavioral and business parts?
- To test it: http://www.pauware.com → Technology