Using UMLsec and Goal Trees for Secure Systems Development

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Motivation

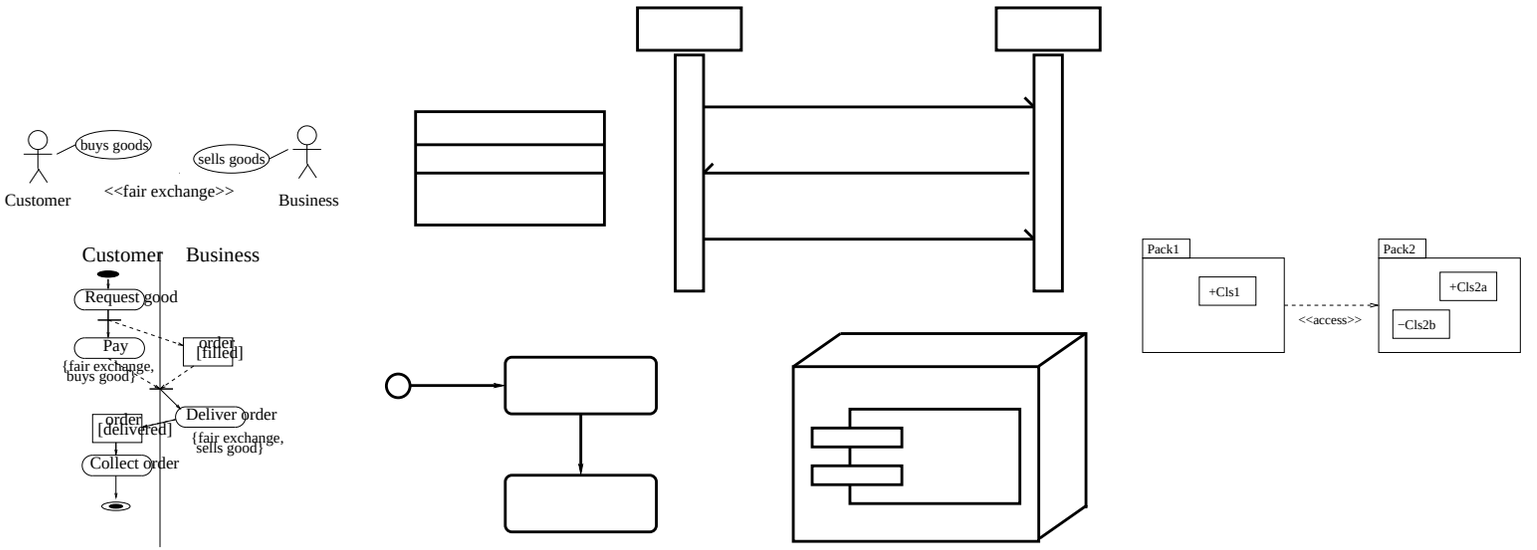
Computer security increasingly important (networks),
but designers often lack background in security.

Cannot use security mechanisms "blindly":
Security often compromised by circumventing
(rather than breaking) them.

Get security assurance into design process:

- Encourage and enable developers
  to consider security from early design phases.
- Encapsulate knowledge on prudent security engineering
  to aid secure systems development.
- Gain confidence on system security by verification.

UML



Unified Modeling Language (UML):
de-facto industry standard for object-oriented modelling.

Different kinds of diagrams for different views on the system.

Verification of behavioural properties: formal semantics.

UML diagrams

- Use case diagram: typical interaction between user and system
- Activity diagram: flow of control between system components
- Class diagram: class structure of the system
- Sequence diagram: interaction between components by message exchange
- Statechart diagram: dynamic component behaviour
- Package: collect system parts into groups
- Deployment diagram: Components in physical environment.

Distributed systems

Objects distributed over untrusted networks.

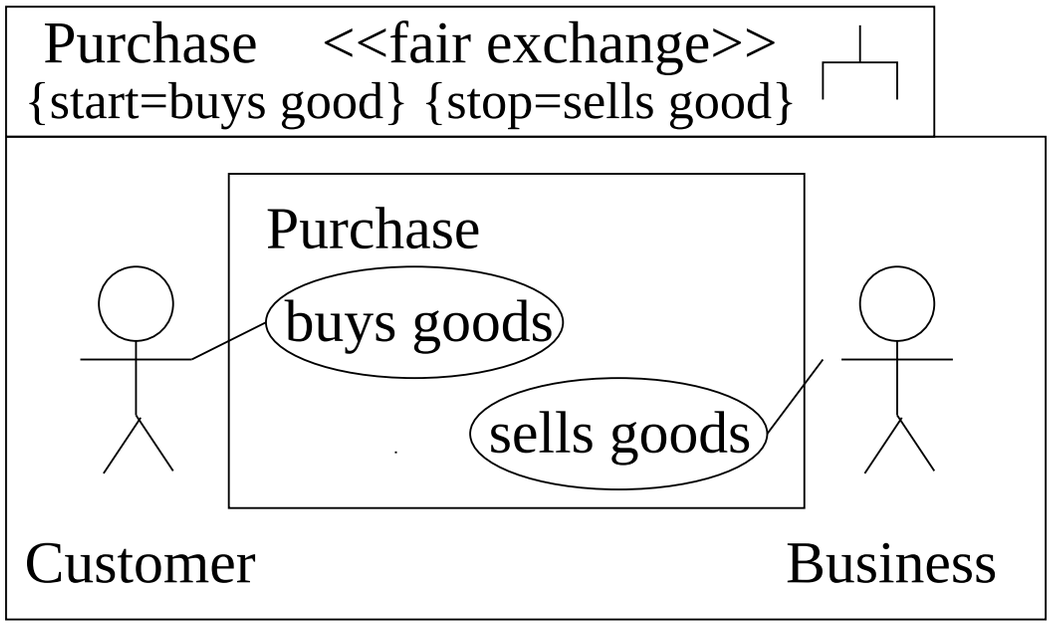
"Adversary" intercepts, modifies, deletes, inserts messages.

Cryptographic protocols to exchange session keys etc.

Vulnerabilities often at boundary between protocols and system.

Protocols in the context of system development with UML.

Requirements capture (use cases)



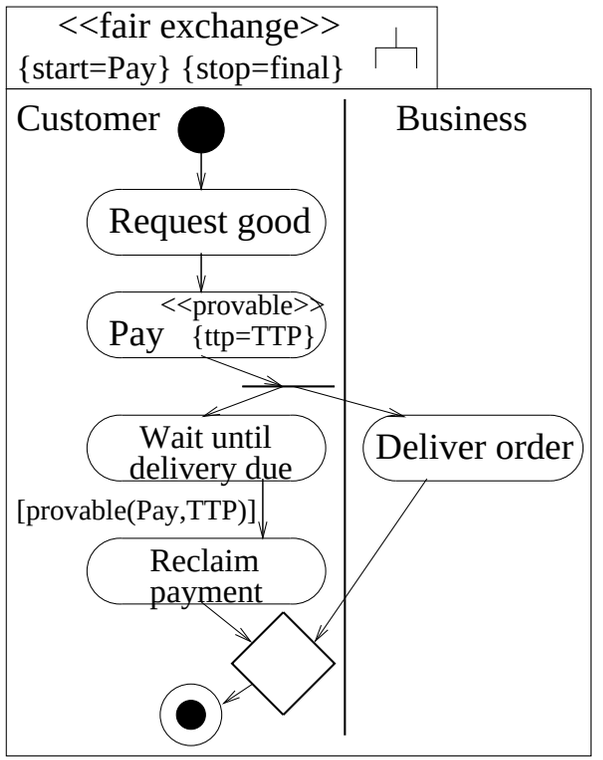
fair exchange

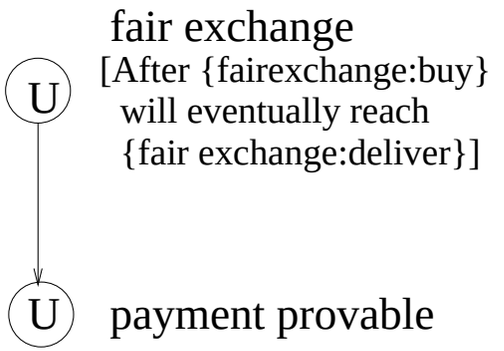
Goal tree

Formulate security requirements on use cases as
《 stereotypes 》.

《 fairexchange 》: if “buys good” then eventually “sells good”.

Analysis (activity diagrams)





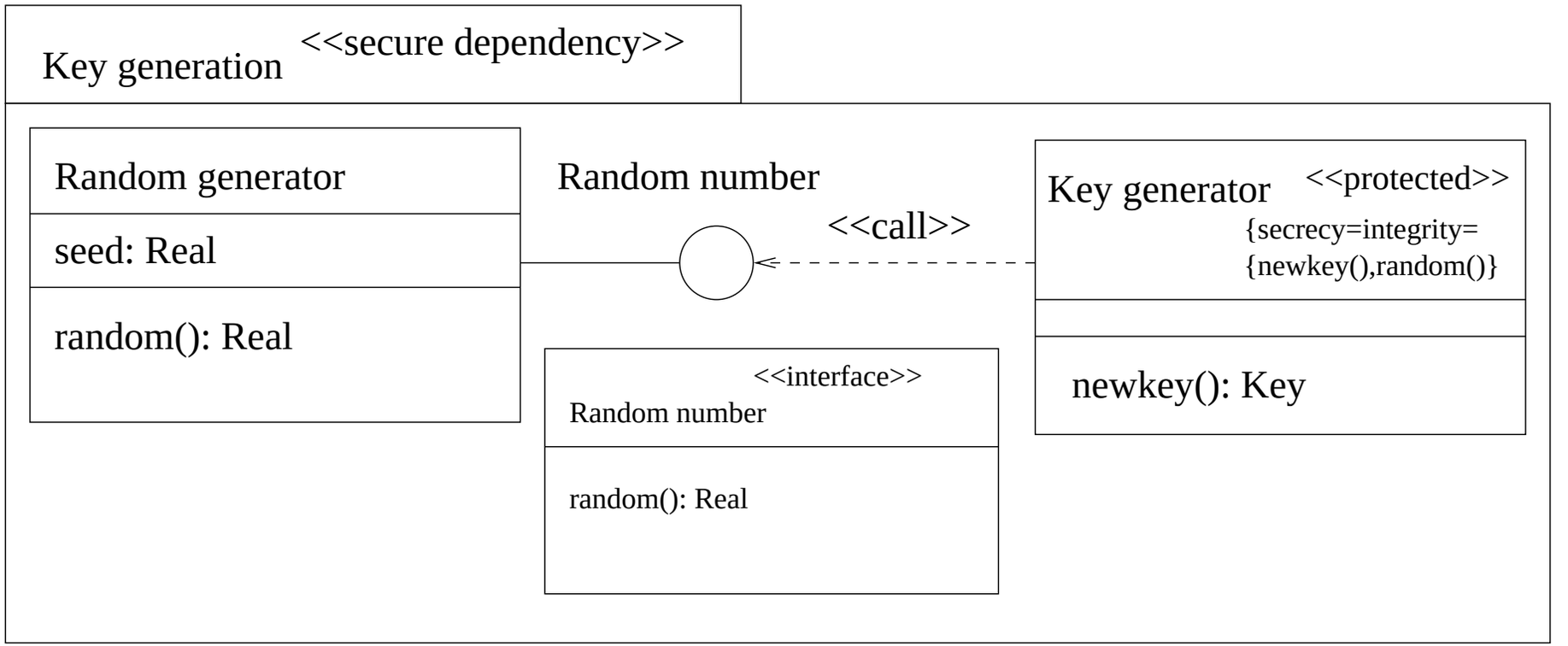
Goal tree

Ensure secure overall control flow (e.g. work-flow).

Gives fair exchange if payment 《provable》.

Proof using formal semantics.

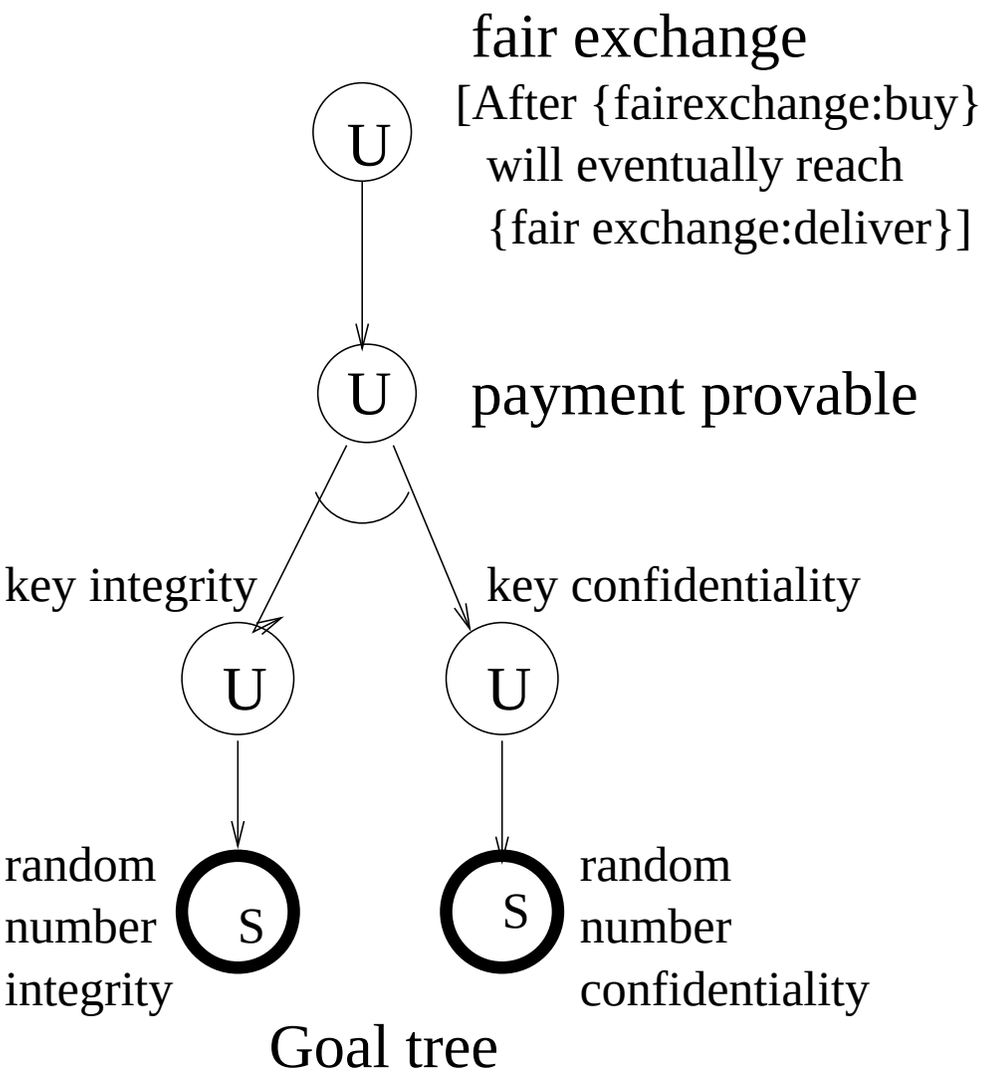
Design (class diagrams)



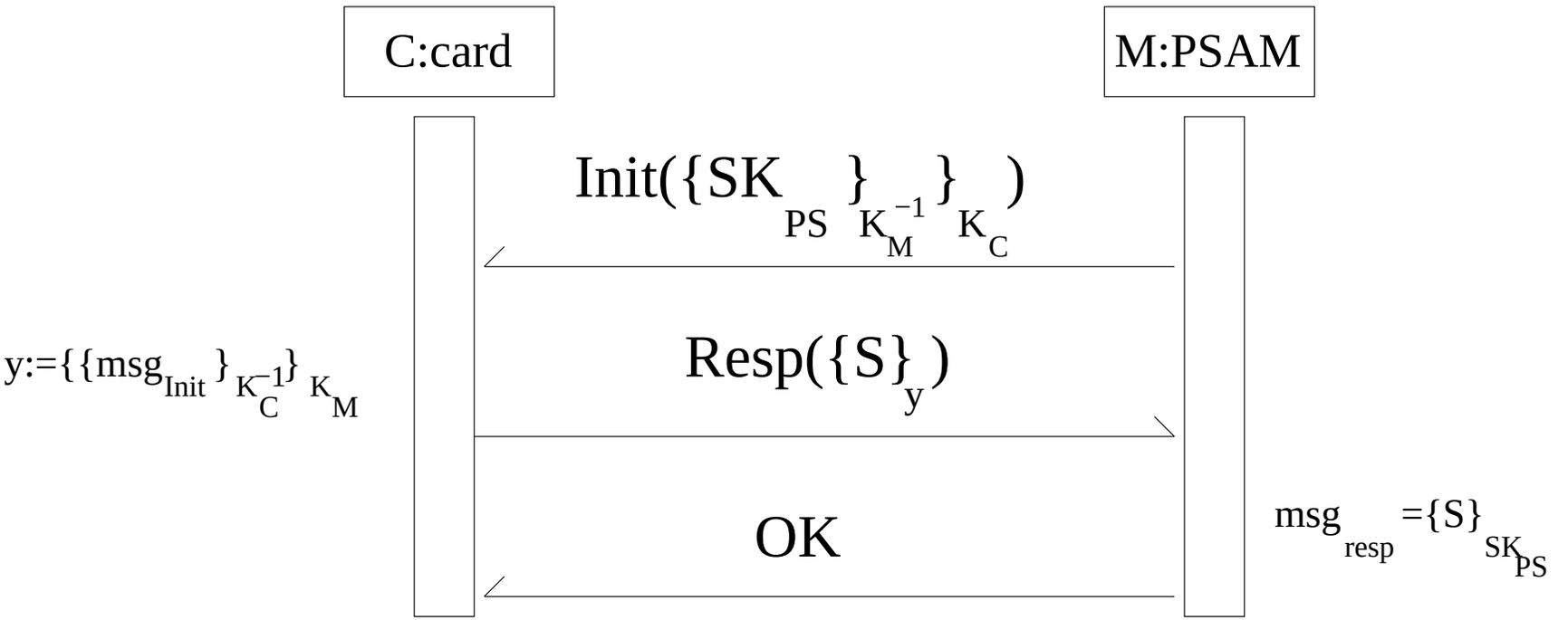
Ensure class structure provides data security.

Operation random() does not guarantee required security.

Design (class diagrams): Goal tree



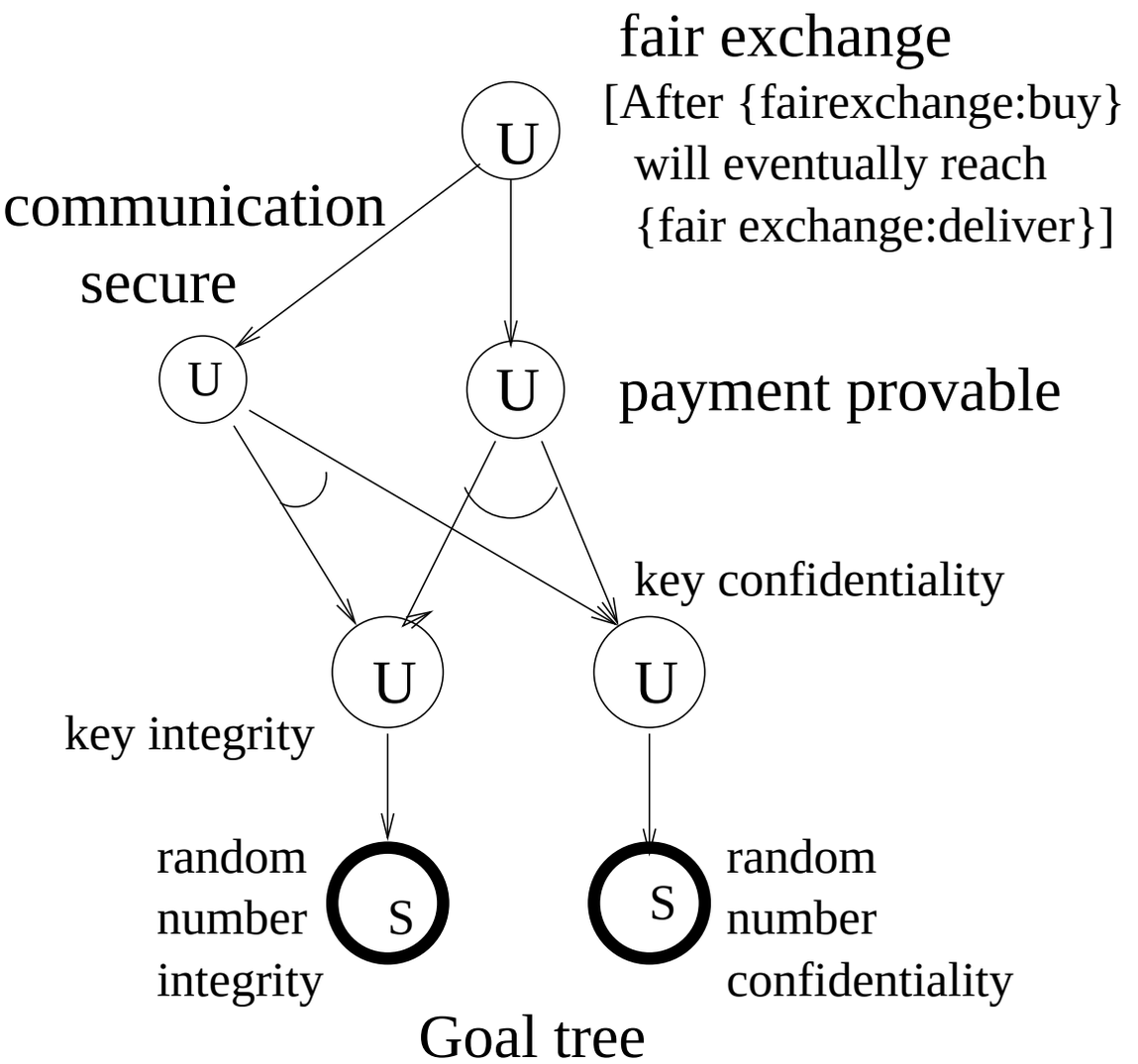
Design (sequence diagrams)



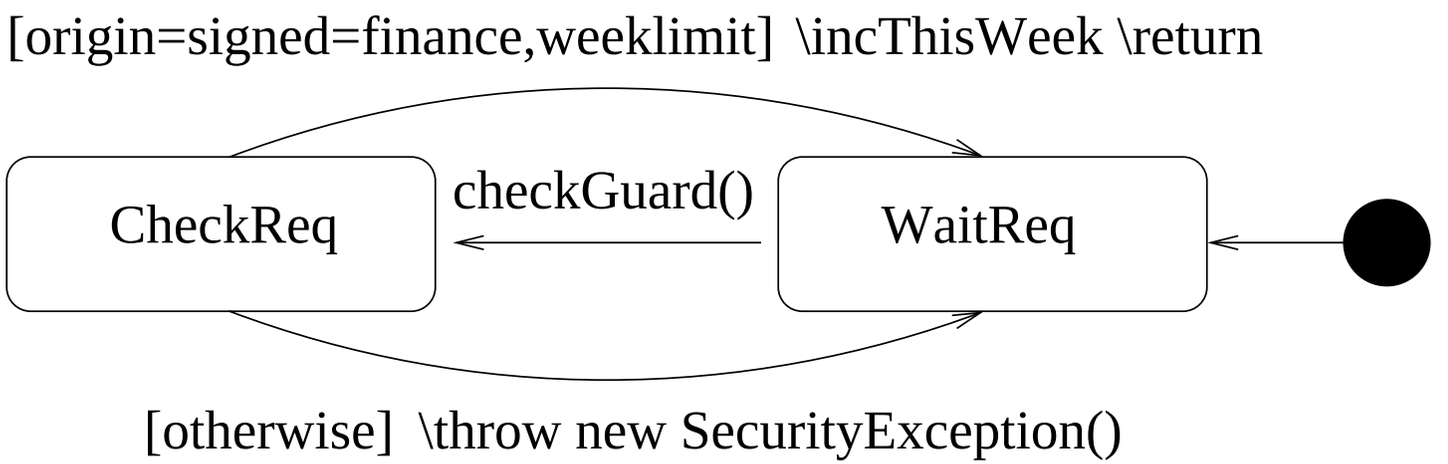
Use sequence diagrams to specify security protocols.

Translate to formal semantics; model-check or reason formally.

Design (sequence diagrams): Goal tree



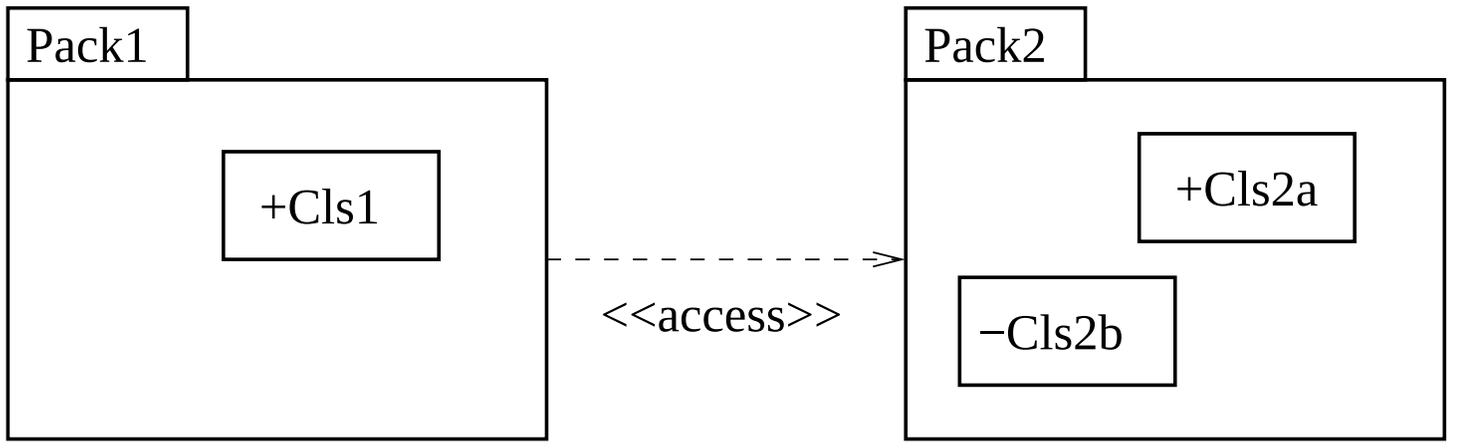
Design: statechart diagrams



Ensure secure behaviour within components/objects.

Access control, database security, information flow, . . .

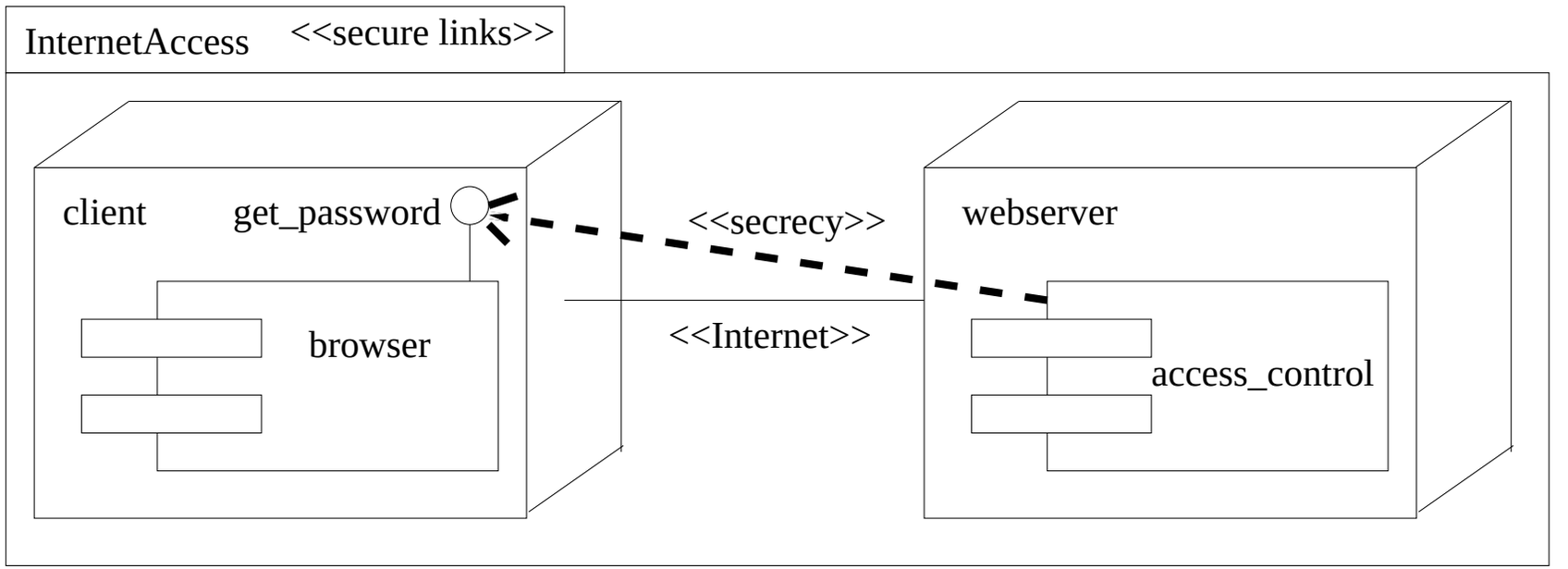
Design: package diagrams



Component-based reasoning using package diagrams.

Uses visibility of parts within packages.

Implementation: deployment diagrams



Express security assumptions on physical layer of the system (security of communication links, hardware security, tamper resistance . . .)

Conclusion

Secure systems development with UML.

Security by design:

- start in early design phases
- encapsulate security knowledge
- make verification more usable in practice
- reduce cost of certification (reuse UML specs)

Combination of use-case driven and goal-directed process.

Further work

- developing secure Java systems using UML
  (signing/sealing/guarding objects...)
- modelling and analysis of
  Common Eletronic Purse Specifications with UML

Future work

- tool support (UML tool via XMI to AutoFocus)

Resources

Slides, papers etc.:

http://www4.in.tum.de/~umlsec

Homepage:

http://www.jurjens.de/jan

Thanks for your attention !