Modular Requirements Against Feature Interaction Problems

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"Naive" Feature-Oriented Description in Telephone Switching

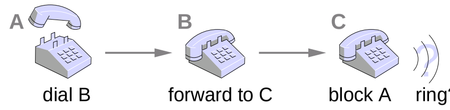
- base description plus separate feature descriptions
- attraction: behavioural "modularity"
  - easy change of system behaviour
  - make *any* change by just adding a new feature description
  - never change existing descriptions
- emphasizes individual features
  - makes them explicit
- de-emphasizes feature interactions
  - makes them implicit in the feature composition operator

Feature Interaction Problems in Telephone Switching

- features work separately, but not together
  - hundreds of (proprietary) features
  - combinations cannot be checked anymore
- telephone switching
  - users' expectation high

Feature Interaction Example: Call Forwarding & Terminating Call Screening

- CF
  - B forwards all calls to C
- TCS
  - when A is caller, C blocks him
- A calls B: can/should A reach C?



- notion of "caller" is crucial

My Approach: Families of Rigorous Requirements

- maintain all variants together
- reduce dependencies: information-hiding requirements modules
- document remaining dependencies

Requirements Module

- Definition:
  a set of properties that is likely to change together
  - likeliness of change: abstractness
  - abstractness: part of how many family members?
  - correlation of changes?

  "cohesion"
- groups properties
- groups property groups, recursively:
  hierarchy of modules
  - handle many "small" properties

Writing Requirements Modules in the Formalism Z

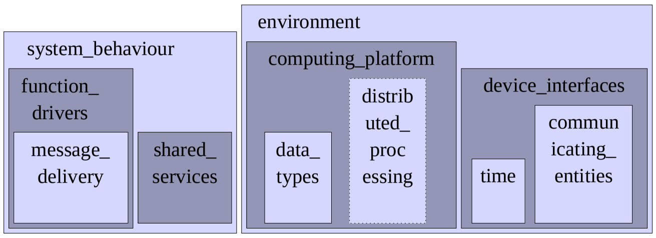
- formal grouping construct: "section" (in ISO-Z)
  + groups all kinds of formal paragraphs
  + dependencies explicit, via "parents" construct
- caveats:
  – not recursive
  – no interfaces
    ▷ no access control for changing parts

A Small Extension for Z

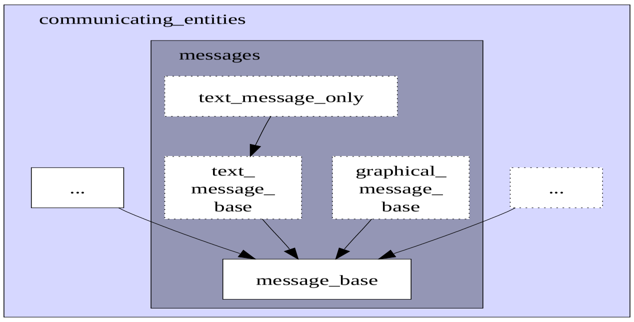
- "chapter": formal grouping of sections, and chapters
  - recursive
- interface for sections and chapters
  - restricts access to changing sections/chapters

Example for Grouping: a Family of LAN Message Services

top-level requirements module architecture:

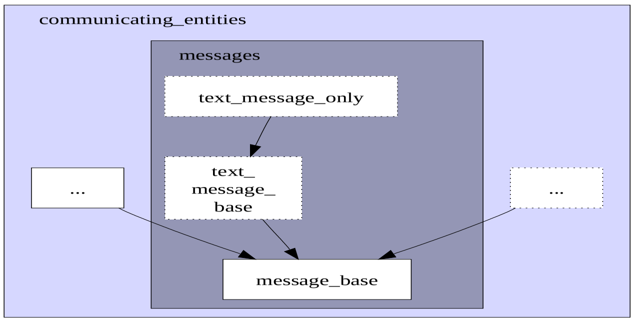


Example: Interfaces Restrict Access



legend: public private dependency

Example: Generating One Family Member



legend: public private dependency

References

[Bre04] Bredereke, J. *On feature orientation and on requirements encapsulation using families of requirements*. In Ryan, M. D., Meyer, J.-J. C., and Ehrich, H.-D., editors, "Objects, Agents, and Features", vol. 2975 of "LNCS", pp. 26–44. Springer (2004).

[Bre05] Bredereke, J. *Maintaining Families of Rigorous Requirements for Embedded Software Systems*. Habilitation thesis, University of Bremen, Germany (2005). *To appear.*

Reserve Slides

FI Example: Calling Card & Voice Mail

- #-button
  - (Bell) calling card: start new call without re-authorization
  - (Meridian) voice mail: end of mailbox number, end of password, . . .
- call voice mailbox using calling card??
  - either early disconnect, or
  - calling card feature crippled
- resolution by Bell
  - introduce new signal: "#-button pressed at least 2 sec."

FI Example: Call Waiting & Call Forward on Busy

- both activated simultaneously
  - in busy state
  - when another call arrives
- only one can get control
  - no resolution, except restrictions on features

FI Example: Originating Call Screening & Area Number Calling

- OCS
  - aborts calls to numbers in list
  - query Service Data Point (SDP) for list
- ANC
  - dialled number + area(calling number) → called number
  - example: Domino's Pizza
  - query SDP for called number

FI Example: Originating Call Screening & Area Number Calling (2)

- switch may restrict no. of queries
  - protection against infinite loops
  - e.g., one query per call
  - → OCS subscription prevents orders for pizza
- solution: one more query??

FI Example: Calling Number Delivery & Unlisted Number

- conflict of goals
  - CND reveals caller
  - UN prevents revealing caller
- resolution
  - weaken one feature
  - e.g.: CND delivers only 1-111-1111-1111 for unlisted number

Informal Feature Interaction Definition in Literature

- feature interaction:
  the behaviour of a feature is changed by another feature
- not all interactions are undesired
- not precisely clear what a feature actually is

Non-Monotonous Changes

- telephone switching:
  new features change the behaviour
  - of base system, or
  - of other features
- example: call forwarding
  - stops to connect to dialled number
    - ▷ restricts base system behaviour

    and
  - starts connecting to forwarded-to number
    - ▷ extends base system behaviour

The Tool genFamMem 2.0

- extracts specifications in plain CSP-OZ (not yet: ISO-Z) from a family document,
- detects feature interactions by
  - additional type checks for families
  - heuristic warnings
- helps avoiding feature interactions by generating documentation on the structure of the family.
- available freely