Configuring Members of a Family of Requirements Using Features

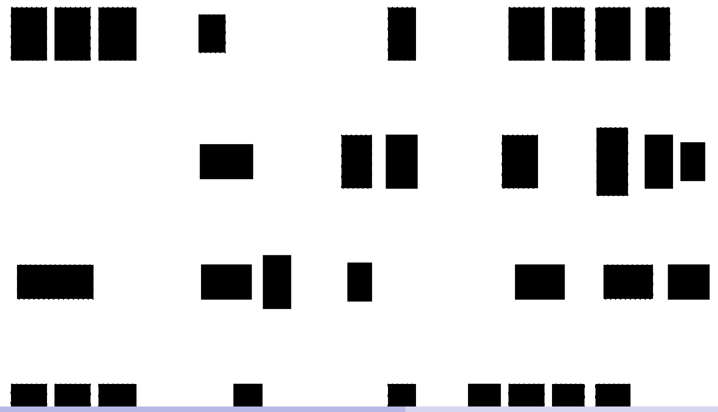
Jan Bredereke

Universität Bremen, Germany

June 29, 2005

Motivation: Family of Systems

first system:

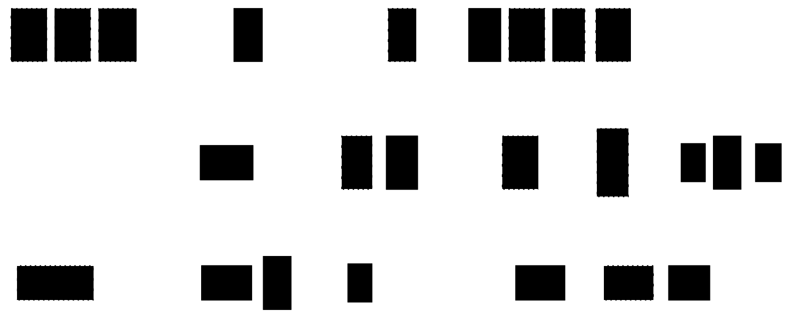


Motivation: Family of Systems

second system:

Motivation: Family of Systems

third system:



Outline

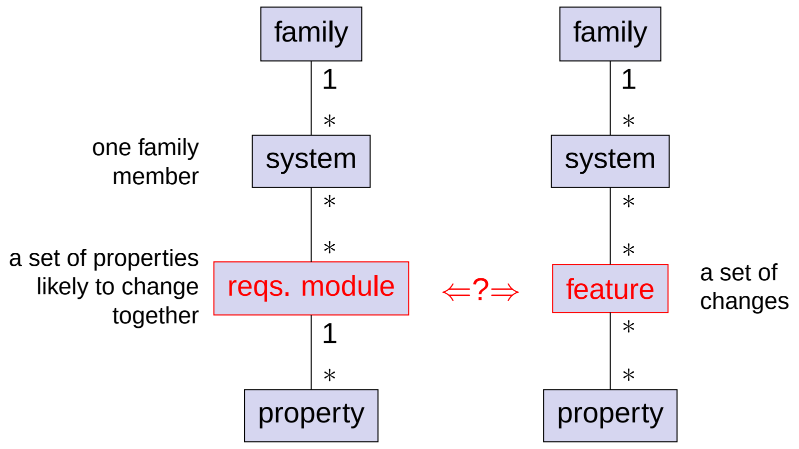
(Naive) Feature Orientation

- base system plus separate features as needed
- arbitrary increments
  - chosen from marketing perspective
  - marketing cannot care about structure of software or organization of requirements
- attractive!
- feature interaction problems
  - needed: organize requirements for change

Concentrate on Requirements

- all feature interaction problems: inherently present in requirements

Which Structure for Requirements?



Observation: Feature $\neq$ Requirements Module

1. type mismatch:

requirements module:	a set of properties	= 1 set
feature:	a set of changes = added & removed props.	= 2 sets

2. different grouping criterion for properties:

requirements module:	likeliness of change, averaged over entire family
feature:	marketing needs of single situation

Outline

Definition: Requirements Module

requirements module
a set of properties that are likely to change together

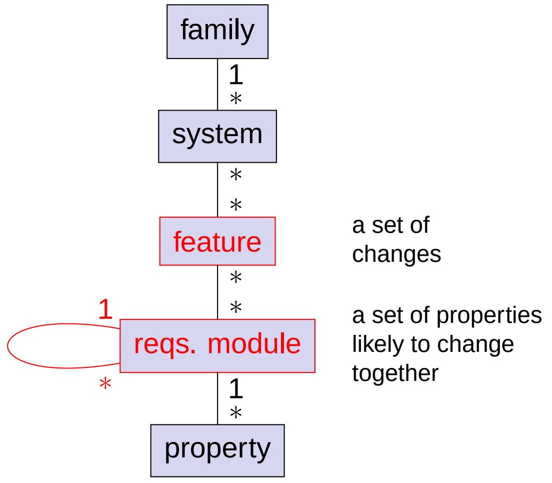
likeliness to change together

- properties hold / don’t hold for how many family members?

Hierarchy of Requirements Modules

- handle really huge number of properties?
  - configure many requirements conveniently?
  - find requirement in large document?
- group them again and again: recursive structure!
  - modules inside modules
  - top-level modules: most stable
  - leaf modules: most likely to change

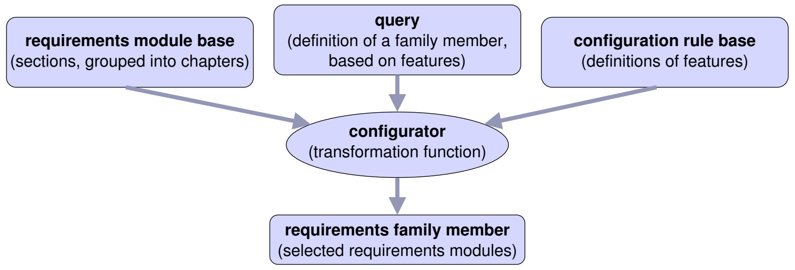
Features as Configuration Rules for Req. Modules



Z_F: A Requirements Module Construct and a Feature Construct for Z

- ▶ well-known formal language Z
- + explicit hierarchical modules
- + feature construct
- + type rules, for consistency
- + [explicit interfaces between requirements modules]

Configuring Requirements Modules Using Features in Z_F


requirements module base
(sections, grouped into chapters)
query
(definition of a family member, based on features)
configuration rule base
(definitions of features)
configurator
(transformation function)
requirements family member
(selected requirements modules)

Formal Definition of Z_F

- ▶ brief: in ICFI'05 paper
- ▶ in detail: in my book
  (is on my Web page: Habilitation thesis)

Outline

Example: A Family of LAN Message Services

idea

users on a LAN can send each other short messages

- example: “I cut birthday cake in 5 minutes”

less complex than full telephony

variabilities

- individual addressing
- message blocking
- message re-routing
- output on text console
- delayed messages
- . . .

The LAN Message Family Specification

1. chapter environment

1.1 chapter device_interfaces

1.1.1 chapter communicating_entities

1.1.1.1 private chapter user_interface

1.1.1.1.1 section user_base
parents comm_base

. . .

1.1.1.1.2 private chapter graphical_user_interface

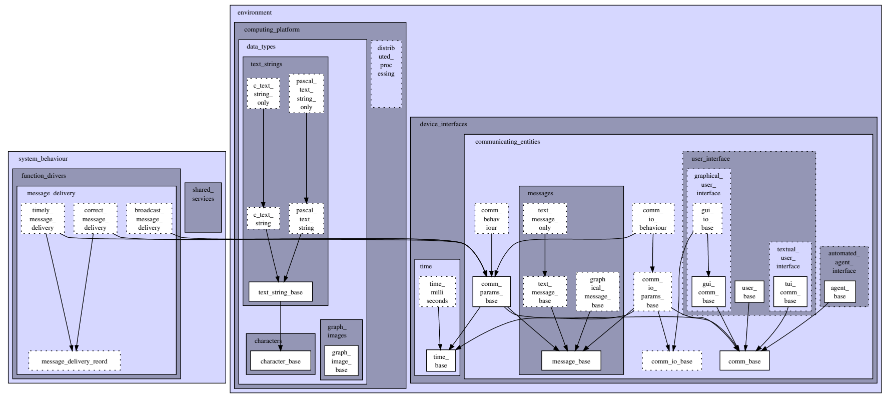
1.1.1.1.2.1 section gui_comm_base
parents comm_base

. . .

1.1.1.1.2.2 private section gui_io_base
parents gui_comm_base, comm_io_base

. . .

Complete Module Hierarchy and Dependencies

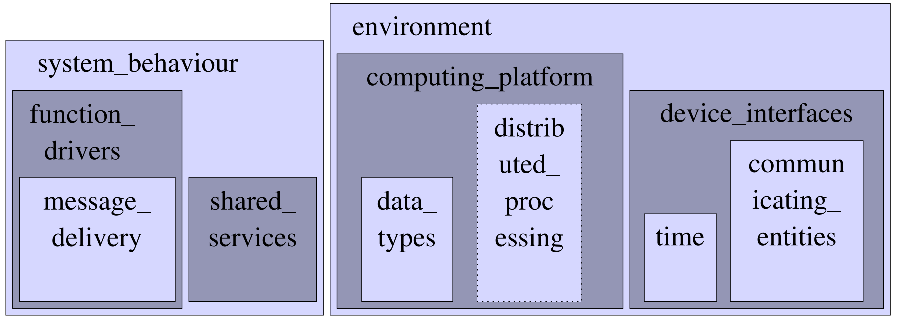


legend: x → y x depends on y

▭ public (i.e., interface) module or property

⬚ private (i.e., secret) module or property

Top-Level Requirements Modules



Features of the LAN Messages Family, in Z_F Syntax

feature note_to_all:
+ broadcast_message_delivery
+ text_message_base
(+) one_line_message

feature scroll_text_message:
+ multi_line_message
– one_line_message
(+) max_lines1000_message
+ graphical_user_interface
– textual_user_interface

feature birthday_cake_picture:
+ broadcast_message_delivery
+ graphical_message_base
– text_message_only
+ graphical_user_interface

feature lunch_alarm:
+ automated_agent_interface
+ broadcast_message_delivery
(+) text_message_base

feature deskPhoneXY_hardware:
– graphical_user_interface
+ textual_user_interface
+ max_lines2_message
+ pascal_text_string
+ pascal_text_string_only
– c_text_string

. . .

Family Members of the LAN Messages Family, in Z_F

The “Lunch Phone” system:

$\left.\begin{array}{l}\text{lunch\_alarm}\\ \text{deskPhoneXY\_hardware}\end{array}\right\}$ one input for configurator

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The “Classic PC” edition:

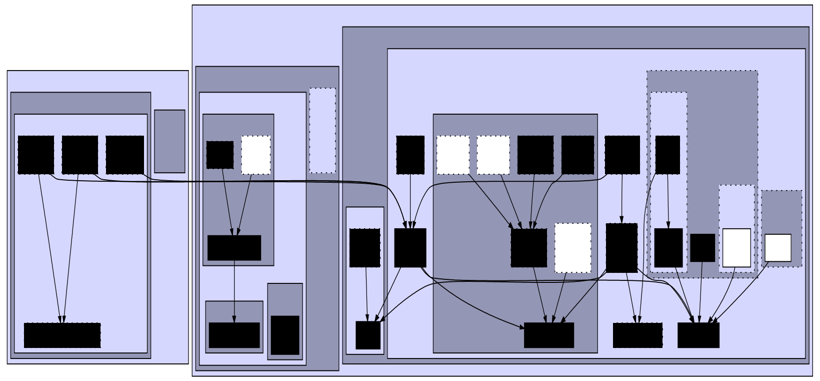
note_to_all
multi_line_text_message
standardPC_hardware

The “Deluxe PC” edition:

lunch_alarm
birthday_cake_picture
note_to_all
multi_line_text_message
scroll_text_message
standardPC_hardware

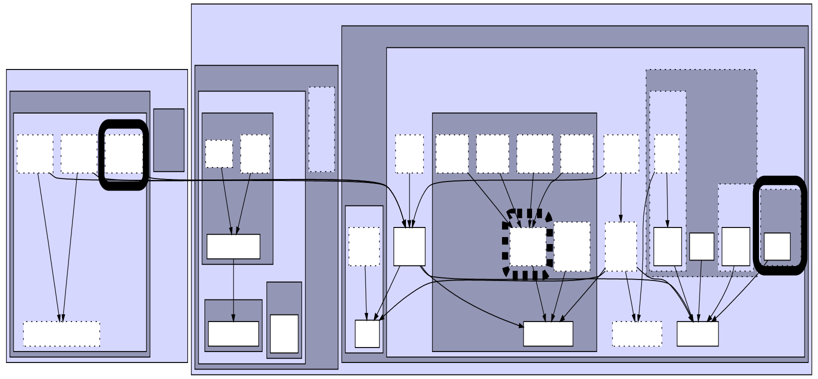
“Lunch Phone”: Base System + Two Features

base system:



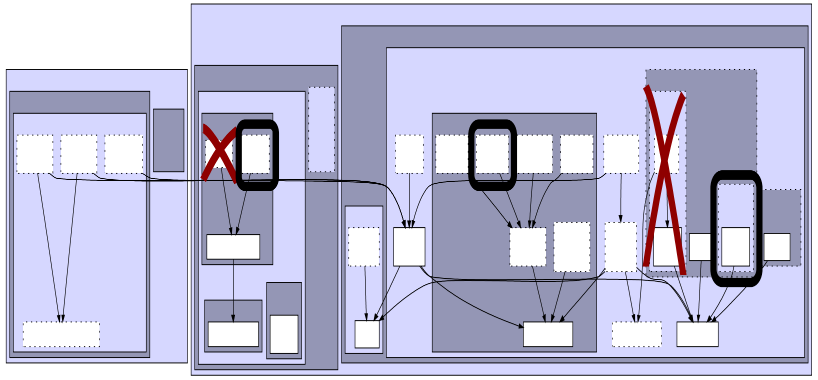
“Lunch Phone”: Base System + Two Features

feature lunch_alarm:



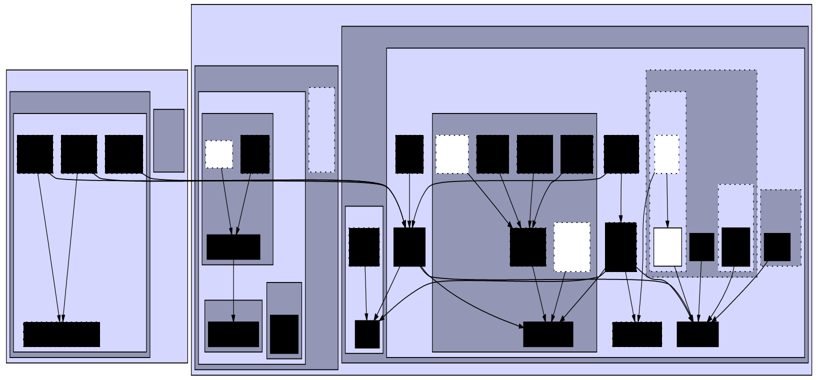
“Lunch Phone”: Base System + Two Features

feature deskphoneXY_hardware:



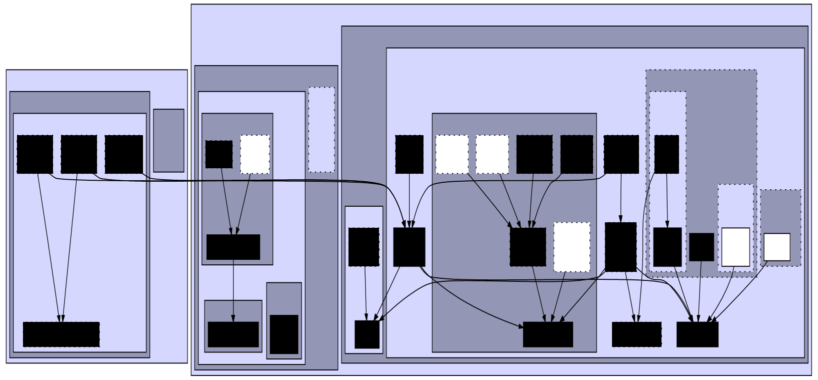
“Lunch Phone”: Base System + Two Features

lunch phone = base + lunch_alarm + deskphoneXY_hardware:



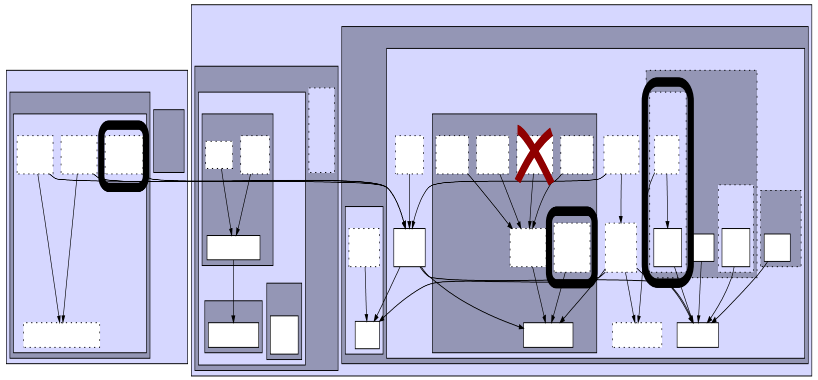
An Inconsistent Configuration: Type Error in Z_F

base system:



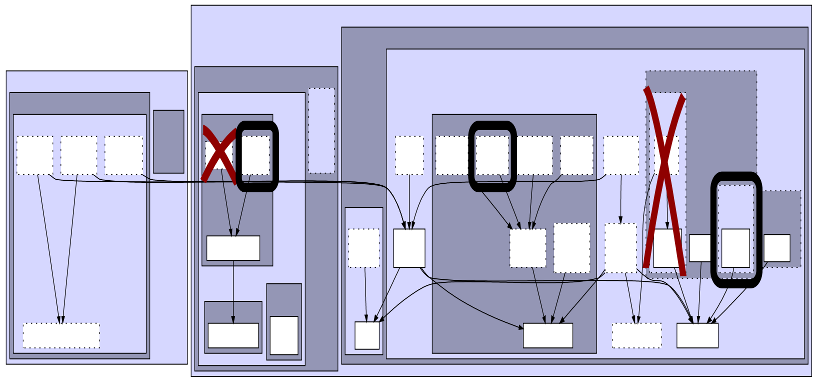
An Inconsistent Configuration: Type Error in Z_F

feature birthday_cake_picture:



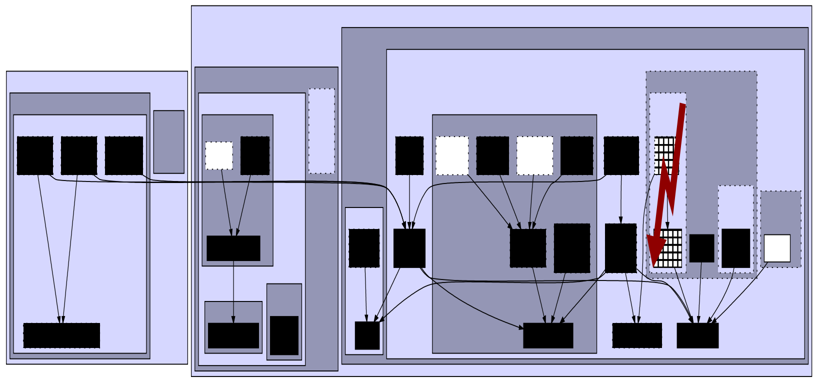
An Inconsistent Configuration: Type Error in Z_F

feature deskphoneXY_hardware:



An Inconsistent Configuration: Type Error in Z_F

base + birthday_cake_picture + deskphoneXY_hardware:



Detecting Inconsistent Configuration Rules / Features

- some inconsistencies are made type errors
- important case:
  include & exclude same property
- detect automatically

Summary

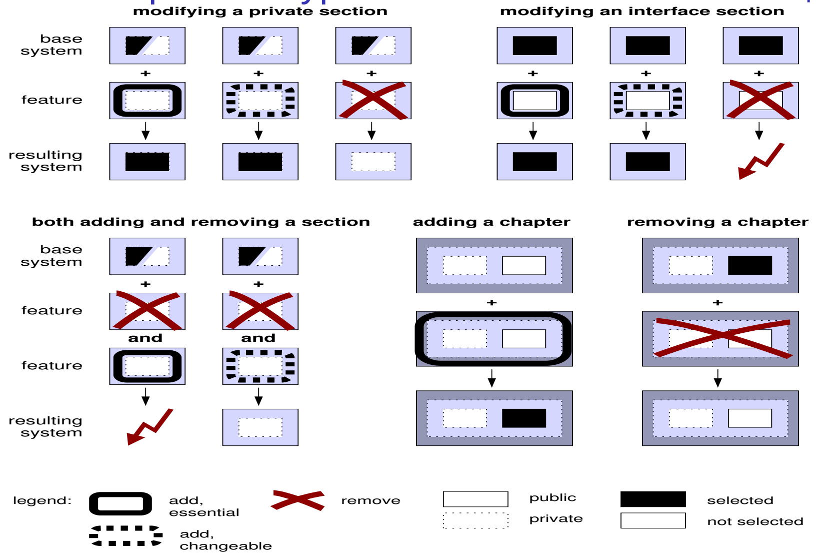
- feature $\neq$ requirements module

requirements module	*feature*
a set of properties	a set of changes
for long-lived family	for single situation (marketing)
provides an abstraction	a configuration rule

- applied to formalism Z
  - configure specifications in Z
  - detect inconsistent configurations as type errors
- Outlook
  - associate code fragments to requirements
  - policies and families
  - application to other formalisms

Reserve Slides

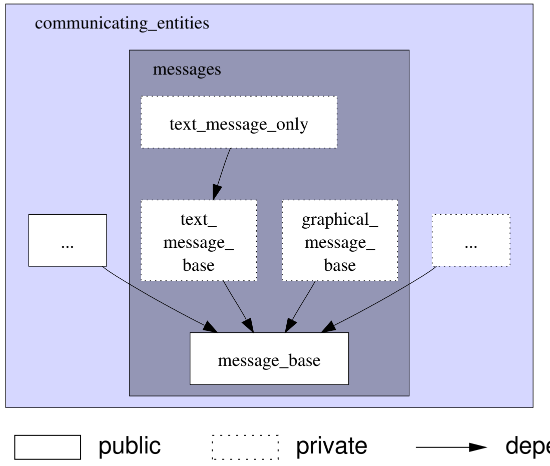
More Examples for Type Rules and Semantics of Z_F



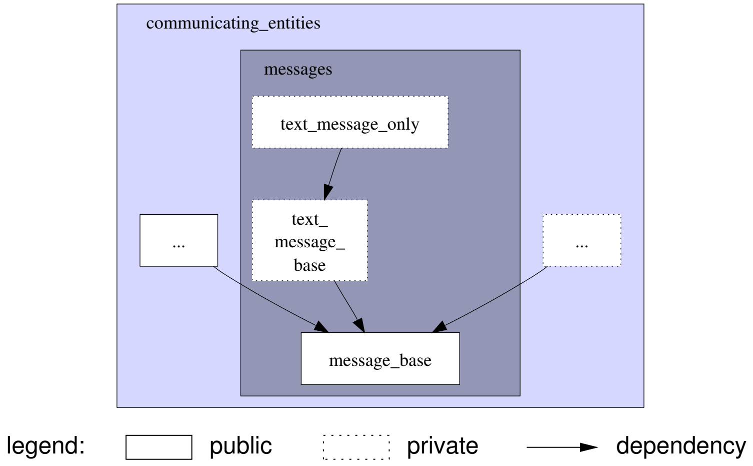
Resolving Inconsistent Configuration Rules

- reduce number of “hard” conflicts:
  differentiate the strictness of rules
  - essential property
  - changeable property
- classification by original specifier
- priority is per feature

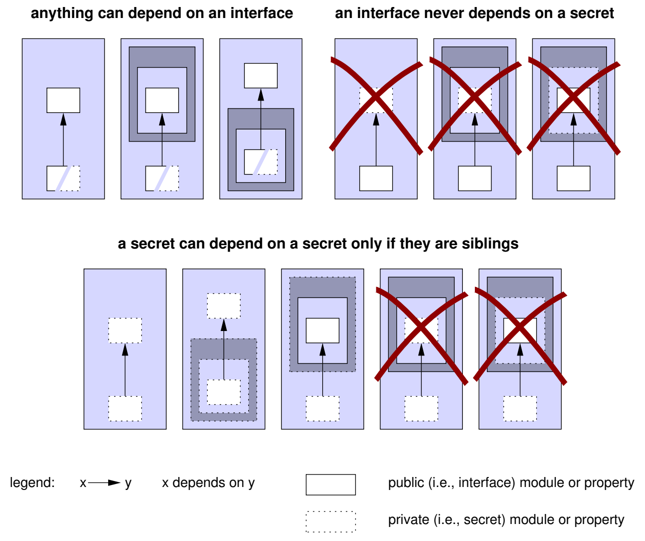
Interfaces Restrict Access



Generating One Family Member



The Access Rules for Modules in Z_F


anything can depend on an interface
an interface never depends on a secret
a secret can depend on a secret only if they are siblings
legend:
x → y
x depends on y
public (i.e., interface) module or property
private (i.e., secret) module or property