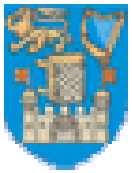
De-constructing and Re-constructing Aspect-Orientation



Bill Harrison
Department of Computer Science
Trinity College, Dublin

Presentation at FOAL 2008. For more comprehensive material see William Harrison, “De-constructing and Re-constructing Aspect-Orientation”, Proceedings of Seventh Annual Workshop on Foundations of Aspect Languages, pp. 43-50, ACM Digital Library, ISBN 978-1-60558-110-1/08/0004

This work is supported by a grant from Science Foundation, Ireland

AOSD Community: Themes

Treatment of Concerns as Independent Artifacts
Patterned Identification of Publishable Events
Identification of Intent / “Higher-Order” State
Concern Mining / Extraction

AOSD Community: Themes

Treatment of Concerns as Independent Artifacts

- Each Containing State, Behaviour, and Flow for Classes
- Join Points – Cooperative Method Call / Events - Creation, Call, Response
- Dispatch / Routing / Orchestration of Joined Methods
- Design / Code

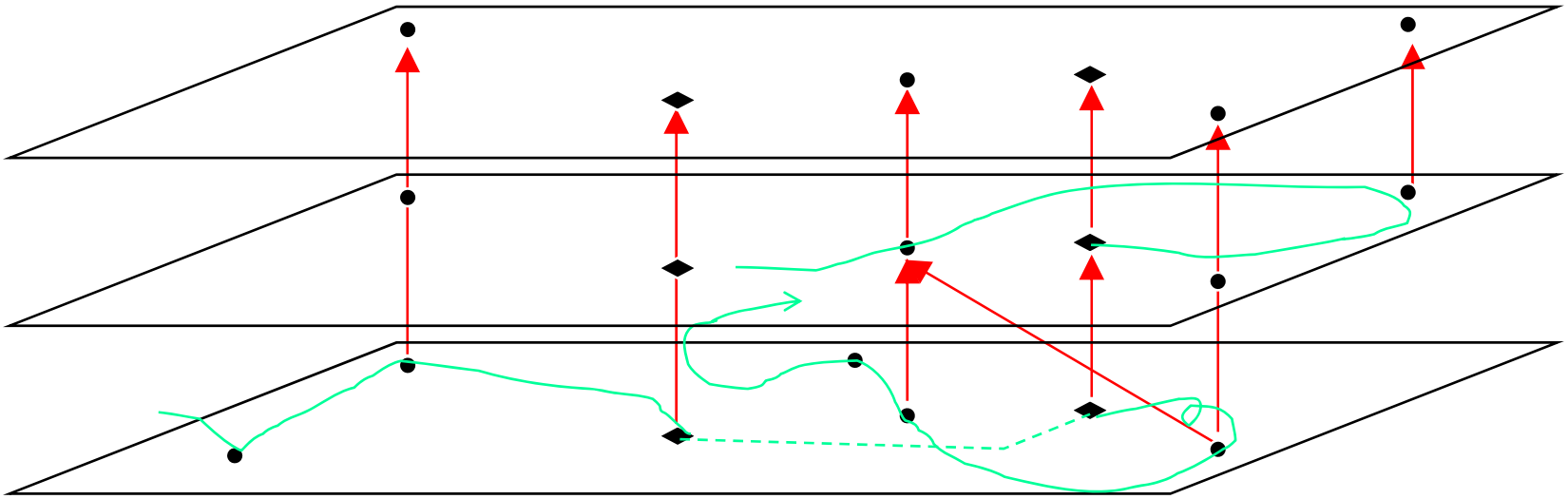
Patterned Identification of Publishable Events

Identification of Intent / “Higher-Order” State

Concern Mining / Extraction

=> Cooperative Method Call

- Events / Flow of Events
- Intention
- Generalized Dispatch



AOSD Community: Themes

Treatment of Concerns as Independent Artifacts

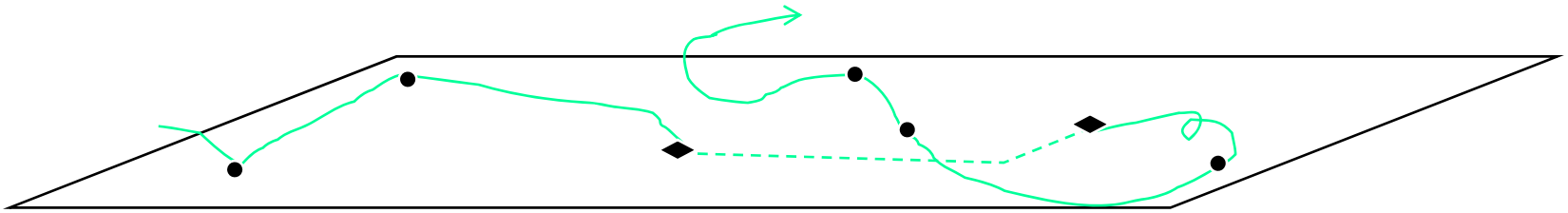
- Each Containing State and Behaviour for Classes
- Join Points – Cooperative Method Call / Events - Creation, Call, Response
- Dispatch / Routing / Orchestration of Joined Methods
- Design / Code

Patterned Identification of Publishable Events

- Expected Joinpoints : Method Calls
- Injected Joinpoints : Pointcuts – Obliviousness / Asymmetry

Identification of Intent / “Higher-Order” State

Concern Mining / Extraction



AOSD Community: Themes

Treatment of Concerns as Independent Artifacts

- Each Containing State and Behaviour for Classes
- Join Points – Cooperative Method Call / Events - Creation, Call, Response
- Dispatch / Routing / Orchestration of Joined Methods
- Design / Code

Patterned Identification of Publishable Events

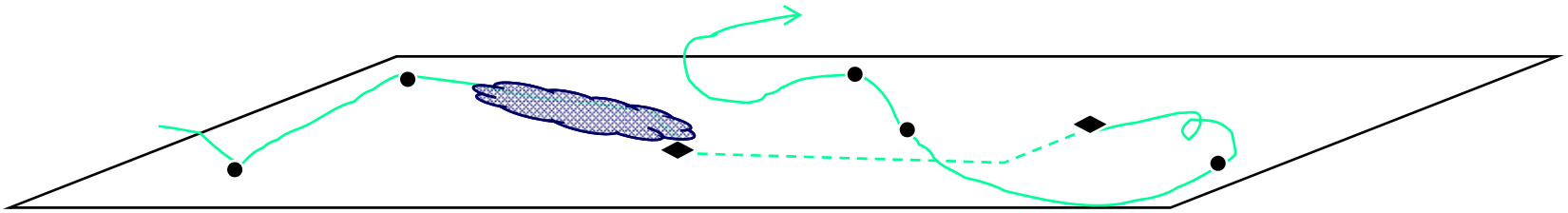
- Expected Joinpoints : Method Calls
- Injected Joinpoints : Pointcuts – Obliviousness / Asymmetry
- Joinpoint Shadows, Methoids
- Query Formulations, Exported Pointcuts – Expected Joinpoints

=> Pointcuts

- Exports / Supports

Identification of Intent / “Higher-Order” State

Concern Mining / Extraction



AOSD Community: Themes

Treatment of Concerns as Independent Artifacts

- Each Containing State and Behaviour for Classes
- Join Points – Cooperative Method Call / Events - Creation, Call, Response
- Dispatch / Routing / Orchestration of Joined Methods
- Design / Code

Patterned Identification of Publishable Events

- Method Calls: Expected Joinpoints
- Pointcuts: Injected Joinpoints – Obliviousness / Asymmetry
- Query Formulations, Exported Pointcuts – Expected Joinpoints
- Joinpoint Shadows, Methoids

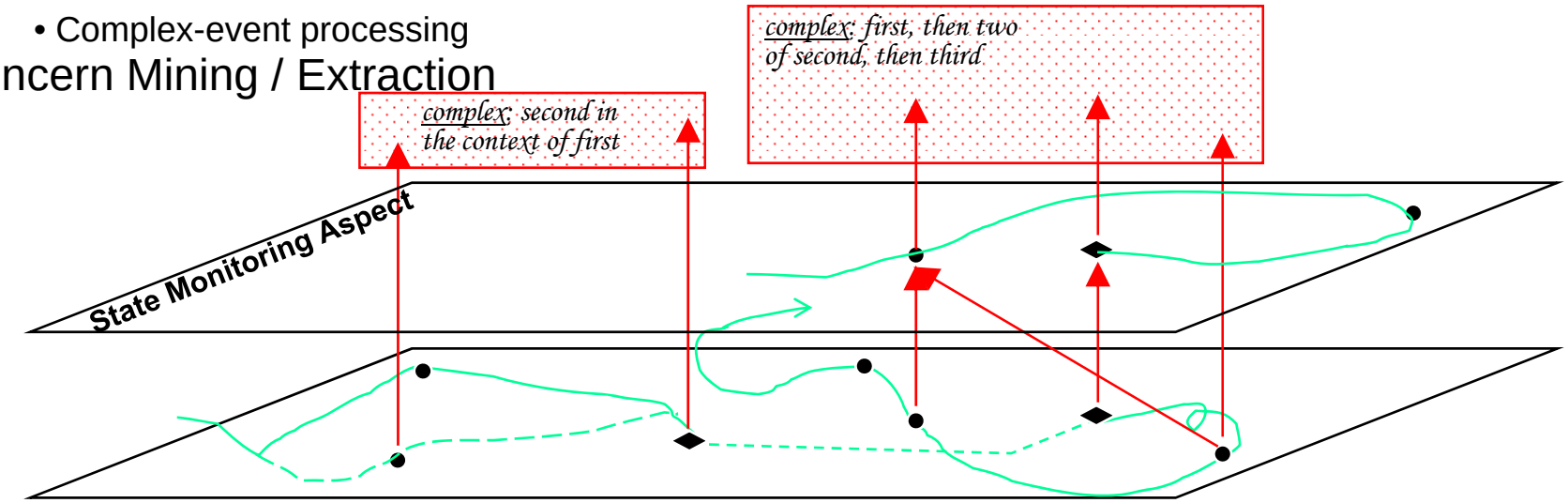
Identification of Intent / “Higher-Order” State

- Cflow
- Complex-event processing

Concern Mining / Extraction

=> Events / Concurrency

- Events / Flow of Events



AOSD Community: Themes

Treatment of Concerns as Independent Artifacts

- Each Containing State and Behaviour for Classes
- Join Points – Cooperative Method Call / Events - Creation, Call, Response
- Dispatch / Routing / Orchestration of Joined Methods
- Design / Code

Patterned Identification of Publishable Events

- Method Calls: Expected Joinpoints
- Pointcuts: Injected Joinpoints – Obliviousness / Asymmetry
- Query Formulations, Exported Pointcuts – Expected Joinpoints
- Joinpoint Shadows, Methoids, Generalized Artifacts

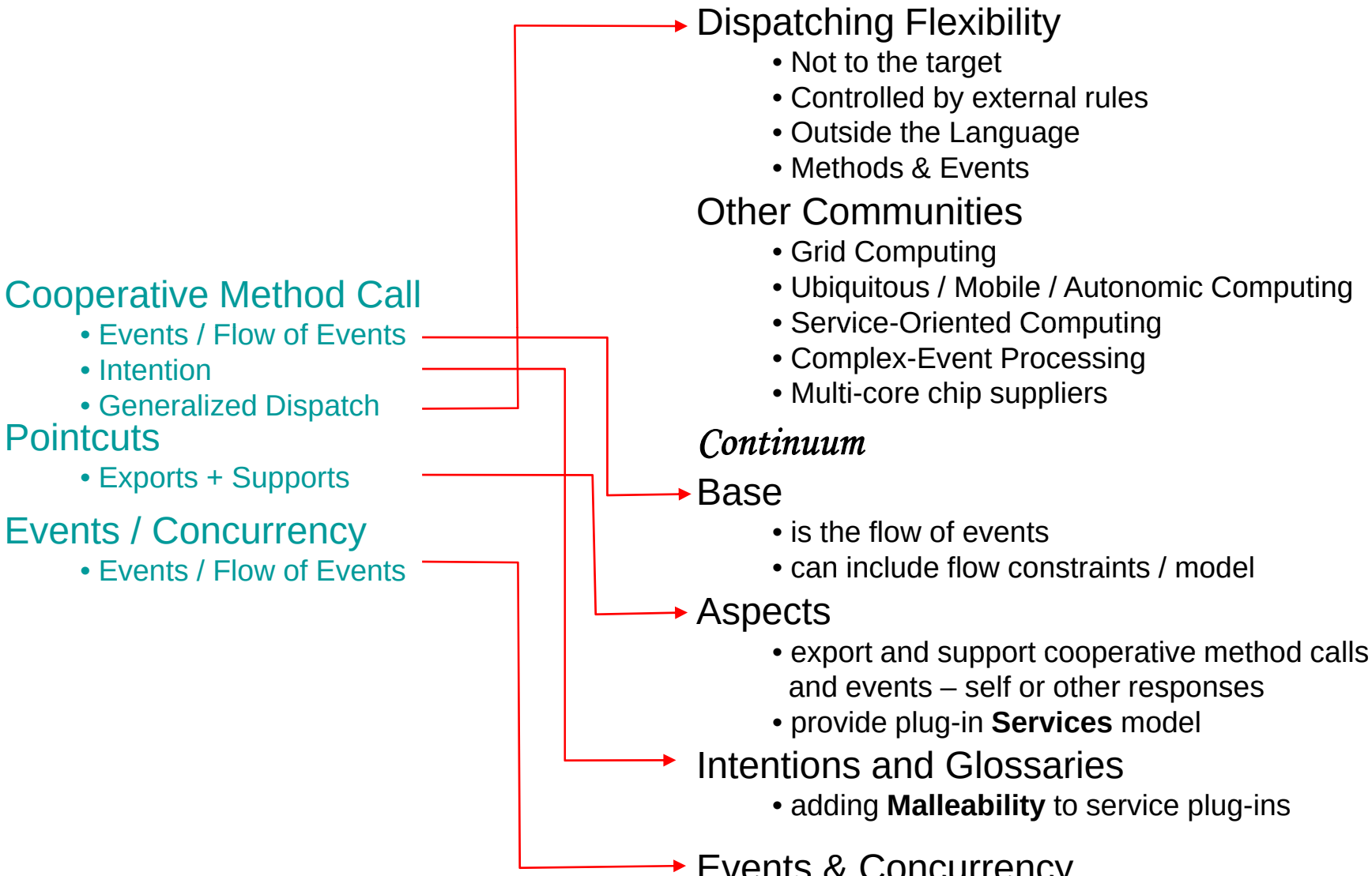
Identification of Intent / “Higher-Order” State

- Cflow
- Complex-event processing

Concern Mining / Extraction

- Program Slicing
- Extraction – Complex region methoids/shadows
- Design / Code / Generalized Artifacts

AOSD Community: Growth & Extension Issues



Environment

Communities Needing Flexible Routing

- Grid Computing
- Ubiquitous / Mobile / Autonomic Computing
- Service-Oriented Computing
- Complex-Event Processing
- Multi-core realisations

Service-Oriented: Real Black Boxes

Servicing implementations (classes) not chosen until execution time

- All selection criteria must be manifest (explicit at use-time), not latent (examined at development-time)
- Precise functions performed
- Side-effects
- Dependencies

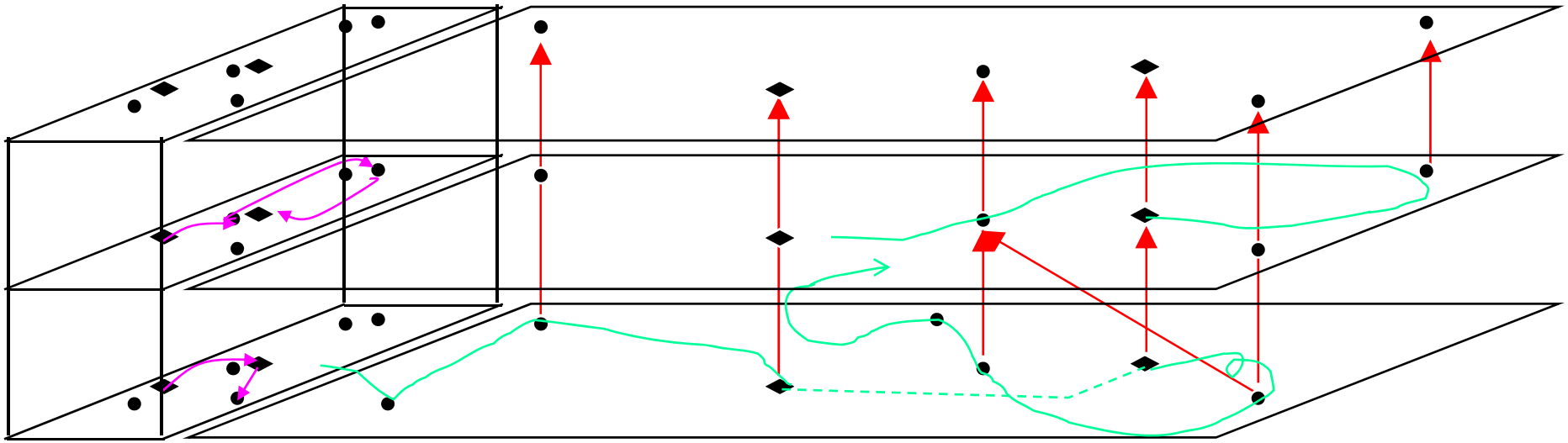
Emphasis on Concurrency

- Variable Latency - local / remote / delayed
- Physical limits on sequentially over-constrained behaviour
- Simplified expression of concurrent behavior

“Base” Skeletal Flow of Events

Base

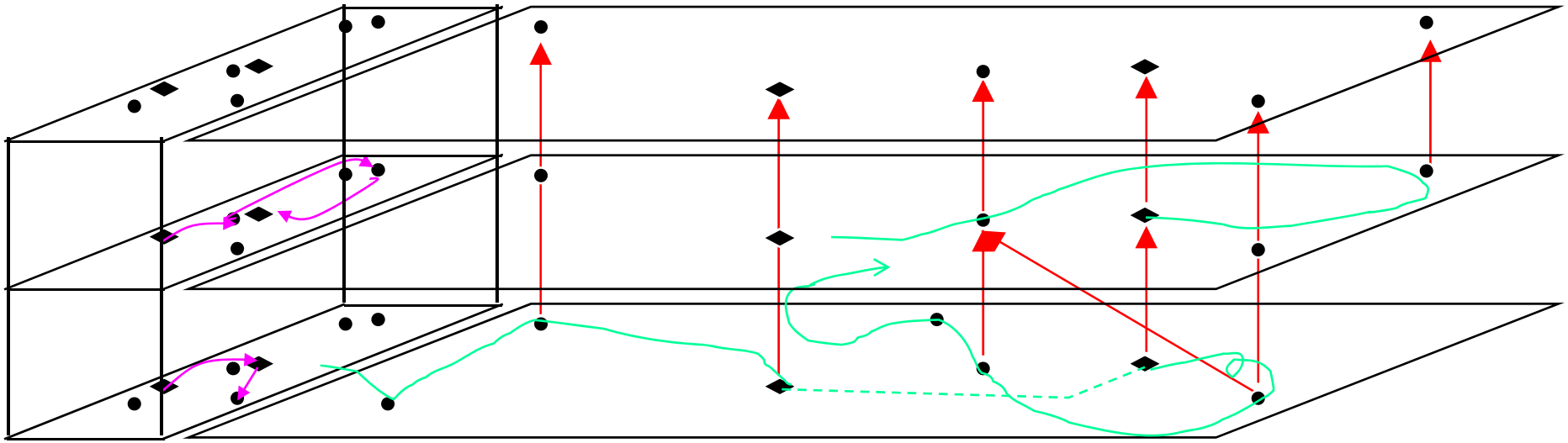
- is just the flow of events
  - can include flow constraints / model
    - “must occur before”
    - “must be seen before”
    - “must be followed by”
    - etc.
  - events derived from *community* of aspects “plugged-in”
    - directly (as cooperative method calls)
    - as exported pointcuts
    - or derived as part of a system architecture



“Base” Skeletal Flow of Events

Base

- is just the flow of events
  - can include flow constraints / model
    - “must occur before”
    - “must be seen before”
    - “must be followed by”
    - etc.
  - events derived from *community* of aspects “plugged-in”
    - directly (as cooperative method calls)
    - as exported pointcuts
    - or derived as part of a system architecture

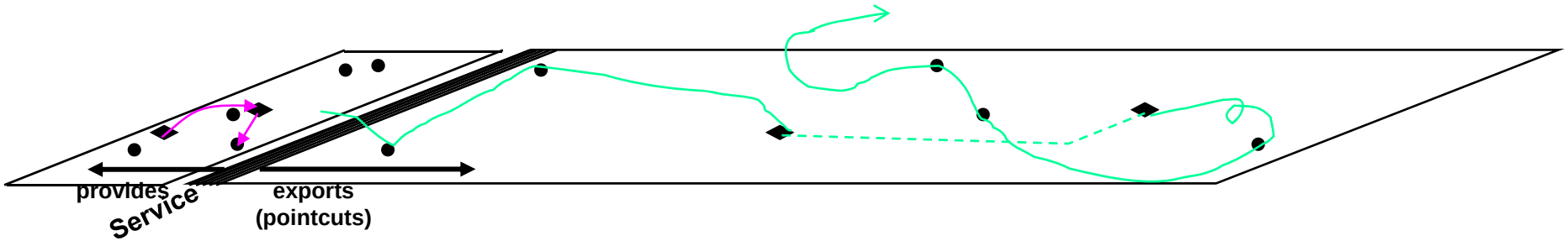


Base Aspects

Aspect /Service Integration

Aspects / Services

- exports pointcuts to support cooperative behaviour (method calls and events)
  - co-operators can be self or other responses
  - synchronous cooperative call or asynchronous (independent) events
- provide plug-in **Services** model
  - "*first-class*" linguistic element
  - stores "*persistent*" state for objects
  - provides reference decapsulation for methods to access object state
  - bounds definition of ambiguity
  - plugs into base (community)
    - dynamically
    - if consistent with base event model
    - when needed



Annotation for Intention / Malleability

Annotation

- supports run-time “service-finding” rather than development-time selection
  - must say much more about required, expected, and supplied behaviour
- adds greater flexibility to matching services with clients
  - multiple requirements satisfied by composite services
- documents what functions methods do or must do
  - replaces / supplements method name <reduces point of rigidly>
  - allows satisfaction by service composition
  - documents real intention of method use <pointcut annotation>

Glossary

- meets minimum requirements
- can be subject to direct matching
- glossaries are simplest of knowledge organizations, supertype of ontologies, etc.

Convenience

- applied in method definitions, not use – binds function to local name

```
“interface First {void one(int y) does(HardWork);}
 ((First) thing).one(6);”
```

Areas of application

- method name / function definition
- pointcut definition
- parameter matching / ordering

```
“void one(Object x for control, int y for size) does(HardWork);
```

Events and Concurrency

Stage 1 – Attachment of aspect behaviour in advices as events

- "**`event() p(int a) {...};`**"
- advice produces "fork without join"

Stage 2 – Explicit sending of events

- "**`send methodName(this, "hello");`**"

Events and Concurrency

Stage 1 – Attachment of aspect behaviour in advices as events

- "`event() p(int a) {...};`"
- advice produces "fork without join"

Stage 2 – Explicit sending of events

- "`send methodName(this, "hello");`"

Stage 3 – Events with future commitments

- "`void one(Object x, int y) sends two(Object x, real z)`"
- commits that if "one" is called, eventually "two" will be sent with same "x"
    - could be sent by "one"
    - could be sent by some event sent by "one"
    - assured by static type-checking
- needs the "services" model
    - hold the implementations for "two"
    - deal with failures

encourage use with convenience:

- "`send one(this, 6) expect two(MyClass this, int a) {...};`"
- avoids scattering and preserves local logic continuity

Events and Concurrency

Stage 1 – Attachment of aspect behaviour in advices as events

- "`event() p(int a) {...};`"
- advice produces "fork without join"

Stage 2 – Explicit sending of events

- "`send methodName(this, "hello");`"

Stage 3 – Events with future commitments

- "`void one(Object x, int y) sends two(Object x, real z)`"
- "`send one(this, 6) expect two(MyClass this, int a) {...};`"

Stage 4 – Errors in realising expectations

- failure to meet or assure future expectation results in failure message
- same name and arguments
- caught by catch blocks
- "`event two(Object x, real z) {...} catch(Error e) {... x ...}`"

Extended Malleability – Service-Orientation

Removed Some Barriers to Smooth Integration

- naming
  - use function annotation
- method bundling
  - use service composition
- method grouping
  - structural typing for interfaces
- parameter order
  - glossary (call-by-keyword)

Remaining Barriers:

Clients Know what Interfaces a Class Supports

Clients Know Where Implementations Are Located

- dynamic expectations
  - local knowledge of class capabilities
- static expectations
  - floating responsibility for assurance

Extended Malleability – Service-Orientation

Removed Some Barriers to Smooth Integration

- naming
  - use function annotation
- method bundling
  - use service composition
- method grouping
  - structural typing
- parameter order
  - glossary (call-by-keyword)

Remaining Barriers:

Clients Know what Interfaces a Class Supports

Clients Know Where Implementations Are Located

- dynamic expectations
  - local knowledge of class capabilities

```
void meth( Store{put(Store,Item)} store1, Store store2);

Store{put(Store,Item), boolean inStock(Item,Store)} more;

more = ({boolean inStock(Item,Store)}) store1;
more = store2;

boolean t = item.inStock(store2);
```

Extended Malleability – Service-Orientation

Unusual Characteristics

- Class (Store) and supported Interface {put(Store,Item)} can be asserted by client

```
void meth( Store{put(Store,Item)} store1, Store store2);

Store{put(Store,Item), boolean inStock(Item,Store)} more;

more = ({boolean inStock(Item,Store)}) store1;
more = store2;

boolean t = item.inStock(store2);
```

Extended Malleability – Service-Orientation

Unusual Characteristics

- Class (Store) and supported Interface {put(Store,Item)} can be asserted by client
- New facts {boolean inStock(Item,Store)} about classes (Store) “proven” by successful downcasts (flow-dependent)

```
void meth( Store{put(Store,Item)} store1, Store store2);

Store{put(Store,Item), boolean inStock(Item,Store)} more;

more = ({boolean inStock(Item,Store)}) store1;
more = store2;

boolean t = item.inStock(store2);
```

Extended Malleability – Service-Orientation

Unusual Characteristics

- Class (Store) and supported Interface {put(Store,Item)} can be asserted by client
- New facts {boolean inStock(Item,Store)} about classes (Store) “proven” by successful downcasts (flow-dependent)
- Facts about a class are true for all references to that class

```
void meth( Store{put(Store,Item)} store1, Store store2);

Store{put(Store,Item), boolean inStock(Item,Store)} more;

more = ({boolean inStock(Item,Store)}) store1;
more = store2;

boolean t = item.inStock(store2);
```

Extended Malleability – Service-Orientation

Unusual Characteristics

- Class (Store) and supported Interface {put(Store,Item)} can be asserted by client
- New facts {boolean inStock(Item,Store)} about classes (Store) “proven” by successful downcasts (flow-dependent)
- Facts about a class are true for all references to that class
- Facts may include knowledge about other classes

```
void meth( Store{put(Store,Item)} store1, Store store2);

Store{put(Store,Item), boolean inStock(Item,Store)} more;

more = ({boolean inStock(Item,Store)}) store1;
more = store2;

boolean t = item.inStock(store2);
```

Extended Malleability – Service-Orientation

Unusual Characteristics

- Class (Store) and supported Interface {put(Store,Item)} can be asserted by client
- New facts {boolean inStock(Item,Store)} about classes (Store) “proven” by successful downcasts (flow-dependent)
- Facts about a class are true for all references to that class
- Facts may include knowledge about other classes

- Facts can be transferred from one variable declaration to another (in the right flow circumstances)
- Classes are names without implied characteristics, but arranged in a type hierarchy
- Interfaces are structurally typed, their names are irrelevant

```
void meth( Store{put(Store,Item)} store1, Store store2);

Store{put(Store,Item), boolean inStock(Item,Store)} more;

more = ({boolean inStock(Item,Store)}) store1;
more = store2;

boolean t = item.inStock(store2);
```

Extended Malleability – Service-Orientation

oved Some Barriers to Smooth Integration

- naming
  - use function annotation
- function bundling in methods
  - use service composition
- method grouping
  - structural typing
- parameter order
  - glossary (call-by-keyword)

aining Barriers:

ents Know what Interfaces a Class Supports

nts Know Where Implementations Are Located

- dynamic expectations
  - local knowledge of class capabilities

Extended Malleability – Service-Orientation

oved Some Barriers to Smooth Integration

- naming
  - use function annotation
- function bundling in methods
  - use service composition
- method grouping
  - structural typing
- parameter order
  - glossary (call-by-keyword)

aining Barriers:

ents Know what Interfaces a Class Supports

nts Know Where Implementations Are Located

- dynamic expectations
  - local knowledge of class capabilities
- static expectations
  - floating responsibility for assurance

```
 meth( Store{put(Store,Item)} store1, Store store2);

e{put(Store,Item), boolean inStock(Item,Store)} more;

 = ({boolean inStock(Item,Store)}) store1;
 = store2;
```

AOSD Community: Themes

eatment of Concerns as Independent Artifacts
atterned Identification of Publishable Events
entification of Intent / “Higher-Order” State
oncern Mining / Extraction

SD Community: Growth & Extension Issues

rative Method Call
vents / Flow of Events
tention
eneralized Dispatch
uts
xports + Supports
/ Concurrency
vents / Flow of Events

Other Communities

- Grid
- Ubiquitous / Mobile / Autonomic
- Service-Oriented
- Complex-Event Processing
- Multi-core chips

Dispatching Flexibility

- Not to the target
- Controlled by external rules
- Outside the Language
- Methods & Events

Topics

- Base as Event Flow
- Aspects with Exported Pointcuts
- Aspects as Service Providers
- Intention & Annotation
- Malleability

Thank you!