Predicting Event-Based Communication with Palladio

Palladio Days 2012, Paderborn
Benjamin Klatt, Christoph Rathfelder
Direct Communication
Point-to-Point Messaging

Send to Mailbox

Read Messages

Send to Mailbox

Send to Mailbox
Publish/Subscribe Communication

Dimensions of Decoupling
- Time
- Space
- Synchronization
Embedded Systems

Source: Nasa

Source: http://mhrg.if.uidaho.edu
Distributed Sensor Networks

Source: Georg Meister - pixelio.de
Industrial Control Systems

Source: Dieter Sch. tz - pixelio.de

Source: Viktor Mildenberger - pixelio.de
Logistics and Business Information Systems

Source: DHL

Source: Wikipedia.org
Benefits and Challenges

Benefits

- Scalability
- Handling of peak loads
- Adaptability and extendability

Challenges for Quality Evaluations

- Decoupled components and control flow
- Varying workloads
- System variations
- Many-to-many interactions
- Influence of communication middleware
Challenges for Quality Evaluations


Nasdaq CEO Blames Software For Delayed Facebook IPO Trading

By Nina Mehta - May 21, 2012 2:27 PM GMT+0200

Nasdaq OMX Group Inc. (NDAQ), under scrutiny after shares of Facebook Inc. were plagued by delays and mishandled orders on its first day of trading, blamed “poor design” in the software it uses for driving auctions in initial public offerings.

Computer systems used to establish the opening price were overwhelmed by order cancellations and updates during the “biggest IPO cross in the history of mankind,” Nasdaq Chief Executive Officer Robert Greifeld said yesterday in a conference call with reporters.
Palladio Extensions in a Nutshell

New Modelling Concepts
- Semantically correct modelling
- Many-to-Many connections and event channels

Platform Awareness
- Performance influences of middleware
- Separate exchangeable middleware model

Support of Existing Prediction Techniques
- Refinement maps to existing modelling elements
Modelling – Type Level

EventGroups as first class entity

- Containing multiple EventTypes
- In analogy to interfaces

Payload of events

- EventTypes refer to a DataTypes
- Values can be assigned to an event
Components emit and process events

- Event Source- and SinkRoles of Components
- EventHandlers for SinkRoles

**EventGroup**
- eventTypeA
- eventTypeB

**MyComponentSender**
- SEFF <doSth>
- PassiveResourceCompartment
- ComponentParameterCompartment

**MyComponentReceiver**
- SEFF <eventTypeA>
- SEFF <eventTypeB>
- PassiveResourceCompartment
- ComponentParameterCompartment

**EmitEventActions** to create and publish events
Modelling – Composition Level

Direct Event Connectors

• AssemblyEventConnector: 1-to-1
• Multiple connectors: m-to-n interactions
• Semantics:
  • Event is asynchronously and parallely sent to all connected components

\[
\text{<CompositeStructure>}
\]

\[
\text{defaultSystem}
\]

\[
\text{Sender1} \rightarrow \text{Receiver1}
\]

\[
\text{Sender2} \rightarrow \text{Receiver2}
\]
Modelling – Composition Level

Decoupled Publish/Subscribe

- EventChannels as intermediating element
- EventChannelSource- and EventChannelSinkConnectors
- Semantics
  - Event is asynchronously and parallely sent to all sink components connected with the EventChannel
Modelling – Composition Level

Filtering of events

• FilterRules in AssemblyEventConnectors and EventChannelSinkConnectors
• Connectors with Filters are Highlighted
• Semantics
  • Event is delivered if the StoEx evaluates to true

![Diagram of EventChannelSinkConnector with filters](image-url)

09.11.2012 © FZI Forschungszentrum Informatik
Explicit deployment of EventChannels

• AllocationContexts can reference AssemblyContext or EventChannel
Platform-aware QoS Prediction for Event-based Systems

Event-based System

Communication Middleware

Base ADL

Event-based Interactions

Software Model

Estimations/Measurements

Feedback/Optimization

Prediction Results

Model Analysis

Transformation

Annotated Software Model

Refinement Step

Refined Platform-independent Software Model

Transformations

Platform-specific Software Model

Merging Step

Middleware Repository

Automated and encapsulated in tooling
Generic event processing chain

Source
- send event to transmission system

Transmission System
- receive event
- replicate event and split control flow
- filtering/sink-specific processing
- send event to sink

Sink
- receive event
Two-step Refinement

Architecture-level

Refined platform-independent model

Platform-specific middleware model

Annot. Model

Refined

Middleware

Resulting Model
Middleware alternatives

Alternative 1

Alternative 2
Recent Case Studies

Traffic Monitoring System

- Distributed middleware (PIRATES)
- Resource intensive components
- Evaluation of different design alternatives
- Prediction error mostly < 20%
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Traffic Monitoring System

- ACIS
- LPR
- Location
- Scoot
- Bus Proximity
- Speeding
- Toll
Recent Case Studies

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Full SPECjms2007 Benchmark
- Supply-chain scenario
- Central MOM Server
- Complex mixture of
  - Point-to-Point und Pub/Sub
  - Different message types and sizes
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![Data flow and goods flow diagram](image)
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Industrial Control System
- External project
- Distributed system
- High interest in Pub/Sub modelling

Space Research Group Univ. Alcala
- Control system of solar orbiter
- Significant modelling reduction
Summary

Modelling and Prediction Support

- New modelling concepts
- Platform-aware performance predictions
- Support of existing prediction techniques

Fully Integrated in Palladio Release

- Validated in two real-world case studies
- Already used in industrial projects