SATURN 2008
Pittsburgh, PA, USA

Identifying and Documenting Primary Concerns in Industrial Software Systems

30 April 2008

Roland Weiss **Pia Stoll**
Industrial Software Systems
ABB Corporate Research
Ladenburg, Germany Västerås, Sweden

© ABB DECRC - 1 - 13-Apr-08

Agenda

- Industrial software systems at ABB
- Case Study 1: Robotics system
- Case Study 2: Gauge system
- Summary & outlook

© ABB DECRC - 2 - 13-Apr-08

Industrial software systems at ABB

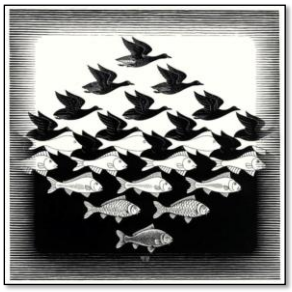
- ABB business relies on industrial software systems in all divisions
  - Domains differ: power, automation, robotics
  - See Pia's slides for more details or visit www.abb.com

- SW Systems share characteristics
  - Tightly coupled with hardware systems
  - Have to provide high reliability (24/7)
  - Split into engineering and operation parts
  - Live over a long period of time (>10 years)
- Maintaining and extending such systems pose interesting challenges due to
  - New business goals
  - Evolving technical environment
  - Changing stakeholders' concerns
  - Restructuring organization

© ABB DECRC - 3 - 13-Apr-08

Software evolution & migration

- Business and technology trends mandate evolution and migration projects for ABB's software systems
  - ABB has many running applications in conservative industries ➔ reuse of assets a must, downtimes have to be minimized
  - Stay feature complete & fulfill quality attributes
- Important quality attributes
  - Performance: real-time constraints
  - Reliability: critical systems with multi-decade lifetime
  - Scalability: from bakery to power plant
- Typical changes
  - Design changes
    - New functionality, bug fixes
  - Technology changes
    - C++ runtime (Unix, COM) ➔ .NET
    - GDI ➔ Windows Presentation Foundation
    - Proprietary protocols ➔ Web services



© ABB DECRC - 4 - 13-Apr-08

Identify & document primary concerns

- Typical situation at project start
  - No or limited architecture documentation available (UML not yet fully established, especially for embedded system development)
  - "Big picture" missing ➔ hard for new personnel to get on track
  - Need to document current *and* future architecture

- Identification
  - Analyze existing & understand future system with interviews, reading documentation, code inspection (manual and tool supported)
- Documentation
  - Create architecture documents: packaging, component interaction, deployment, communication, etc
- Goal: Prepare and enable evolution & migration projects

- Experience from two case studies
  - Gathering of use cases and quality attribute scenarios + specialties
  - Apply to existing systems and planned extensions
  - Case Study 1: Robotics system
  - Case Study 2: Gauge system

© ABB DECRC - 5 - 13-Apr-08

Case Study 1: Robotics system

Industries


Automotive


Foundry & Forging


Packaging & Palletizing


Plastics


Metal Fabrication

Application software


Arc welding


Die Casting
Easy-to-use software improves robot-based die casting productivity


Plastic


Press Automation


Assembly
Revolutionary new world of automated assembly

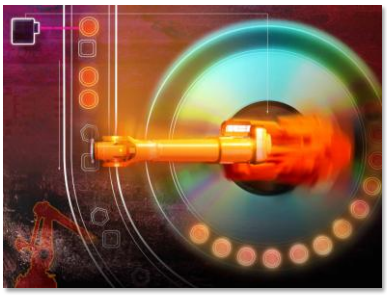

Packaging


Spot welding

Programming tools / Operator Interfaces


RobotStudio


Robot Application Builder



© ABB DECRC - 6 - 13-Apr-08

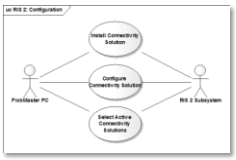
CS 1: Robotics system, contd.

- Robotics PC Application
  - Configurable, high-speed pick & place application
  - Vision integration, PC and controller communication
- Task: extended the remote interface of a Robotics software application
  - New functionality
    - Parameter tuning
    - Remote robot control
  - Integratability
    - Higher level systems, e.g. Distributed Control Systems, HMIs
    - Lower level systems, e.g. devices, PLCs
  - Standards compliance: OMAC, OPC

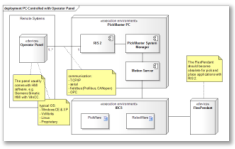
© ABB DECR
13-Apr-08

CS 1: Approach

- Gather use cases for capturing features
  - Worked very well
    - Easy to discuss with stakeholders
    - Easy to derive service interface from use cases



- Gather quality attributes scenarios
  - Excellent for discussing (relative) priorities with stakeholders, e.g. security vs. availability



- Missing piece
  - Different deployment scenarios affect realizable functionality
    - High-end clients (HMI, DCS) vs. basic clients (PLC, simple I/O)
    - Deployments define use case subsets

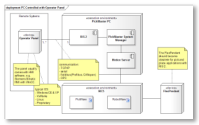
© ABB DECRC - 8 -
13-Apr-08

CS 1: Lessons learned

- ABB's global business structure requires a distributed approach to gathering use cases and quality attribute scenarios

- Combining use cases and quality attribute scenarios provides excellent base for documenting systems' primary concerns

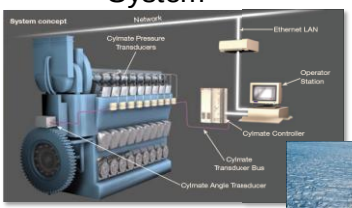
- Vital system characteristic is not covered by use cases and quality attribute scenarios: deployment

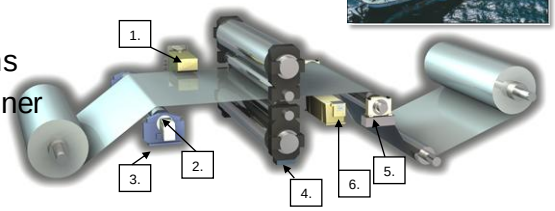


© ABB DECRC - 9 - 13-Apr-08

Case Study 2: Gauge system

- Gauge is a sensor with built-in intelligence.
- Roll force
  1. Millmate Thickness Gauging Systems
  2. Stressometer Systems
  3. Millmate Strip Tensiometer Systems
  4. Millmate Roll Force Systems
  5. PillowBlock Systems
  6. Millmate Strip Scanner Systems
- Cargo ships
  - Cylmate, Diesel Engine Performance Monitoring System





© ABB DECRC - 10 - 13-Apr-08

CS 2: Approach

- Task
  - Understand the most important software architectural drivers for the next generation gauge products
- Methods
  - Use cases
    - Worked well for illustrating functionality requirements, e.g. communication issues
    - Not so good for illustrating non-functionality issues, the “ilities”
  - Interviews (performed 7 interviews a 1-2 hours with architects, managers and developers)
    - Worked well for collecting stakeholders’ concerns regarding business goals, qualities, functionality
    - Drawback was that the stakeholders had many diverse concerns

© ABB DECRC - 11 - 13-Apr-08

CS 2: Approach, contd.

- Influencing Factors method*
  - Prioritize the concerns in line with prioritized business goals
- Quality Attribute Workshop (gathered 10 success-critical stakeholders for one day)
  - Worked well for getting a common understanding among stakeholders regarding their concerns.
  - Drawbacks
    - Stakeholder did not want to voice a common concern, since then his/hers own concern might be left out of the round-robin voicing of concerns. That is the stakeholders tended to use gaming tactics to get their individual concerns prioritized.
    - Most important concerns was not prioritized, especially the legacy concerns that everybody agreed upon were left out of the top-five list.
  - Solution; Requires psychology tactics of the QAW moderator to get the most important concerns prioritized.

© ABB DECRC - 12 - 13-Apr-08

*Stoll, P., Wall, A., Norström, C.: Guiding Architectural Decisions with the Influencing Factors Method. WICSA. IEEE, Vancouver (2008)

CS 2: Lessons learned

- The IF method used use cases, QAW results, and interview results to prioritize concerns ➔ high focus on usability: approved by the Steco
- QAW advantages
  - Gave a prioritization of stakeholders' conflicting *individual* concerns
  - Forced success-critical stakeholders to learn about scenarios and their impact on business goals and quality attributes
  - Forced success-critical stakeholders to listen to each others arguments
- QAW drawbacks
  - Did not prioritize the top-five most important architectural scenarios
  - The *perceived* pay-back of invested time for the success-critical stakeholders was low
- Future QAW
  - Set the stakeholders' expectations right from the beginning + communicate the QAW's goal better
  - Divide the scenario gathering into legacy concerns and additional concerns + vote twice: once for legacy concerns and once for the additional concerns
  - Give short presentation at the end of the roadmap for the design and how the QAW results fit in in the roadmap to increase the perceived pay-back of invested time

© ABB DECRC - 13 - 13-Apr-08

Summary & outlook

- Identification of a methodology to drive system development projects for industrial software systems
  - Application of use cases and QAWs enables deriving system architectures and service interfaces, respectively
  - IF method allows identifying the systems' primary concerns and prioritizing them in line with the business goal
  - Idiosyncrasies of the application domain have to be taken care of with specific techniques
- Combination of use cases and quality attribute scenarios proves very effective
  - Positive feedback from business units
- Provide reliable predictions for planning development & deployment
  - Architectural changes
  - Deployment variations

© ABB DECRC - 14 - 13-Apr-08

Power and productivity
for a better world™