How Reference Architectures support the evolution of Product Families; the Darwin research project

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Abstract

TBD

Distribution

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September 6, 2020

status: planned
version: 0.4
## High Level Problem Statement

<table>
<thead>
<tr>
<th>Installed Base Business</th>
<th>costly</th>
<th>diversity and # of configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Cycle Management</td>
<td>high effort</td>
<td></td>
</tr>
<tr>
<td>Development efficiency</td>
<td>costly</td>
<td>high effort</td>
</tr>
<tr>
<td>Innovation rate</td>
<td>too low</td>
<td>too late</td>
</tr>
<tr>
<td></td>
<td></td>
<td>too late</td>
</tr>
</tbody>
</table>

See next slides.
The Innovation Challenge

Challenge:
how to apply change locally for exploration of potential value and feasibility?

Postulate 1:
for effective exploration the following properties must be maintained
- patient throughput
- system responsiveness
- image quality
- safety
- reliability

Postulate 2:
a system architecture that supports this level of exploration also supports the next phases of innovation: scaling-up and engineering

Postulate 3:
a system architecture that supports this level of exploration also supports life cycle business over many generations

potential innovation: change

inherently complex system e.g. MR scanner
Evolvability Problem Statement

exploration is difficult  reliable realization is difficult  engineering is difficult

too much
time, effort, cost

from idea to tryout
too much
time, effort, cost

from tryout to realization

some new features
late relative to competition
too much
material and labor cost

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DERAproblemStatement
Evolvability Problem Analysis

**problems**

- *exploration is difficult*
  - too much
time, effort, cost
  - from idea to tryout

- *reliable realization is difficult*
  - too much
  - and unpredictable
development
time, effort, cost
  - from tryout to realization

- *engineering is difficult*
  - some new features
  - late relative to competition
too much
  - material and labor cost

**observed causes**

- 25 years of historical growth
- lack of overview
  - large amount of
detailed documentation
- size and complexity
  - of realization
- size and complexity
  - of organization
- inherent complexity of
  - system and context
- human and cultural factors
  - high level of expertise
  - conservatism

**suspected more specific root causes**

- coupling (dependencies)
  - higher than needed
- ineffective structure
  - (decomposition, interfaces)
- insufficient
  - underpinning of decisions
  - by value and cost
- unbalance in
  - core/key/base
- diversity of configurations

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DERAproblemAnalysis
Darwin Project Goal

- scientifically sound
- suitable for PhD

- specific methods, techniques and patterns
- to improve the evolvability
- of product families
- within industrial constraints
- and while maintaining other qualities

- faster to market
- less effort
- more predictable

- based on modeling and Reference Architectures

- market response to anticipated and unexpected changes

- very relevant for MR
- also relevant for others
- (partially) validated

- diverse products
- installed base diversity

- patient throughput
- system responsiveness
- image quality
- safety
- reliability

- people, process, project duration, and cost

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DERAprojectGoal
Darwin Research Model: Industry as Laboratory

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Philips MR scanner

Source of inspiration

Application playground

Industry

Challenging problems

Research

Hypothesis

Apply new engineering methods

Evaluate

Improve

Observe results
Sources of Change

customer context
- humans
- other systems
- legislation
- reimbursement

technical architecture
- clinical applications
- workflow applications
- domain specific technology
- generic technology

business architecture
- competition
- organization
- business model
Sources of Change

customer context
- humans
- other systems
- legislation
- reimbursement
- USA

technical architecture
- clinical applications
- workflow applications
- RF coils
- gradient amplifier
- domain specific technology
- generic technology
- Windows Vista
- PCI-X
- database

business architecture
- competition
- organization
- business model
- PMW
- PII
- PACS
- RIS
Darwin Research Questions

How to transform into an evolvable product family architecture?

How to support decision making?  
- business wise
- technological

How to create overview?  
- by visualization
- by high-level modeling

How to mine the realization for implicit know how?

What are practical guidelines?  
- for decomposition
- for interface definition

What are patterns that support evolvability?

related research areas

value analysis, e.g. real option
roadmapping

reference architecture
physical models, functional models,
budgeting, figures-of-merit,
state-diagrams, time-lines

repository meta-data analysis
dynamic dependency analysis
semantic analysis

reference architecture
physical models, functional models,
qualities, behavior models
clustering, structure, set-based design
RA = Business Arch. + Technical Arch. + Customer Context

customer context

technical architecture

requirements
black box view

customer enterprise
users

relations
guidance

business model
life cycle

design patterns
technology

business architecture

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SAFRAarchitectures
Technical Architecture

1. Functional Decomposition

2. Construction Decomposition

3. Allocation

4. Infrastructure

5. Choice of integrating concepts

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LWAArchitectureHow
Decomposition and Interfaces

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BWMAdecomposition
Interface much more than functions + parameters

*black box (interface) level:*
- protocols
- functions
- parameters
- formats
- behavior
- characteristics

*white box (implementation) level:*
- protocols
- functions
- parameters
- formats
- realizations
- limitations
- constraints
- opportunities
- behavior
- characteristics

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ECMAbackWhite
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ARMRIntegrationAndDiversity
Distribution Scenario’s

A "Thin Servers"

B "All-in-one" Combi's

C "All-in-one" server

D "Modular"

Clients

Network

Thin Servers

All-in-one Combi's

Network

All-in-one Server (PACS or HIS)

legend

acquisition

image handling

information handling

generic technology

Client

Client

Network

Server

Server

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ARMRproductScenarios
Simplistic Architecture

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ARMRsimplicityArchitecture
Future Simplistic Architecture

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Available Code Assets

>1000 my

cat

lab

>1000 my

HIS

RIS

>1000 my

PACS

work-
station

>1000 my

network

rest of world

MR scanner

operating system
database

print archive

communicate

image processing

acquisition

reconstruction

scan control

scan UI

view UI

view

image processing

print

archive

communicate

buy: >300 my

>500 my

>100 my

total buy: >1500 my

total make: >1000 my

total ROW: >3000 my

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ARMRcodeAssets
Example Long Term Vision

Long Term Vision: Reference Architecture + Sample implementation of Framework and Components

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ARlongTermVisionExample
Conclusion: Refactoring the Architecture is a must