Role of Systems Architecting in Innovation

by Gerrit Muller  University of South-Eastern Norway-NISE

e-mail: gaudisite@gmail.com

www.gaudisite.nl

Abstract

Distribution

This article or presentation is written as part of the Gaudí project. The Gaudí project philosophy is to improve by obtaining frequent feedback. Frequent feedback is pursued by an open creation process. This document is published as intermediate or nearly mature version to get feedback. Further distribution is allowed as long as the document remains complete and unchanged.
The Embedded Systems Domain

- chip
- television
- printer
- waferstepper
- MRI scanner
- cardio X-ray system
- GSM
- television
- printer
- waferstepper
Successful Innovation = Technological + Market

market innovations
- segments
- needs
- applications
- services

system

technological innovations
- materials
- circuits
- functions
- user interface

Role of Systems Architecting in Innovation
System Architect links technology and market

market innovations
  segments
  needs
  applications
  services

system

technological innovations
  materials
  circuits
  functions
  user interface

marketeers
  systems architect
  engineers
  inventors
Example: Easyvision serving three URF examination rooms

EasyVision: Medical Imaging Workstation

URF-systems

EasyVision: Medical Imaging Workstation

typical clinical image (intestines)
### X-ray rooms from examination to reading around 1990

<table>
<thead>
<tr>
<th>Examination Room</th>
<th>Control Room</th>
<th>Corridor or closet</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Examination Room" /></td>
<td><img src="image2" alt="Control Room" /></td>
<td><img src="image3" alt="Corridor or closet" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Examination Room</th>
<th>Control Room</th>
<th>Reading Room</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Examination Room" /></td>
<td><img src="image2" alt="Control Room" /></td>
<td><img src="image4" alt="Reading Room" /></td>
</tr>
</tbody>
</table>
Product Innovation: Easyvision applied as printserver

- Examination Room
- Control Room
- Corridor or closet
- Reading Room
- Printer
- Light box
- X-ray source
- Detector
- Console

Role of Systems Architecting in Innovation
8 Gerrit Muller
Market innovation: optimized film

old: screen copy  
new: SW formatting

20 to 50% less film needed
Technology innovation challenges

- **product policy:**
  - standard HW
  - SW "only"
  - 40 MHz CPU
  - 64 MByte memory
  - 10 MBit/s ethernet
  - 1 GByte disk

- **print throughput**
- **view response time**
- **image quality**
- **image processing**
- **tension**

- **ca 1 film / minute**
  - film = 4k*5k pixels

- **subsecond retrieve**
  - screen = 1k*1k

- **print throughput**
  - view response time

- **image quality**
  - image processing
Typical Growth of a System Architect

- Root technical knowledge
- Generalist technical knowledge
- Business, application insight
- Process insight
- Psychosocial skills

Role of Systems Architecting in Innovation

10 Gerrit Muller
Generalist versus Specialist

- **Specialist**
- **Generalist**
  - **Root knowledge**
  - **Breadth of knowledge**

**Role of Systems Architecting in Innovation**

11 Gerrit Muller
Generalists and Specialists are Complementary

Role of Systems Architecting in Innovation
12 Gerrit Muller
Spectrum from Specialist to System Architect

- All-round specialist
- Aspect architect
- Systems architect

Role of Systems Architecting in Innovation

Gerrit Muller

version: 0
September 9, 2018
MATfromSpecialistToSystemArchitect
More innovations in Medical Imaging

1992
RF 1.1
URF basis
RF 1.2
vascular import
RF 2.1
cardio
RF 2.2
Dicom
X 3.1
spine

1993

1994

1995

1996

Role of Systems Architecting in Innovation

version: 0
September 9, 2018
RllexampleMI
Key success factor 1: innovation by all parties

market innovations
- segments
- applications
- needs
- services

technological innovations
- materials
- circuits
- functions
- user interface

system

- system architect
- engineers
- inventors
- marketeers
The "CAFCR" model

What does Customer need in Product and Why?

Customer
What
Customer objectives

Customer
How
Application

Product
What
Functional

Product
How
Conceptual

Realization

drives, justifies, needs

enables, supports
What does Customer need in Product and Why?

Product How

Customer
What

Customer
How

Product
What

C (Customer objectives)

A (Application)

F (Functional)

C (Conceptual)

R (Realization)

context
understanding

intention

objective
driven

opportunity

constraint
awareness

knowledge
based

Role of Systems Architecting in Innovation
Gerrit Muller

version: 0
September 9, 2018
MSIntegratingCAFCR
CAFCR can be applied recursively

Consumer

Drives

Consumer

Drives

Customer's Business

Enables

Customer's Business

Enables

Value Chain

larger scope has smaller influence on architecture

System (producer)

Drives

Enables

Customer Business

Enables

Customer Business

Enables

Customer Business

Enables

Customer Business
## CAFCR applied on Security

<table>
<thead>
<tr>
<th>C (Customer objectives)</th>
<th>A (Application)</th>
<th>F (Functional)</th>
<th>C (Conceptual)</th>
<th>R (Realization)</th>
</tr>
</thead>
<tbody>
<tr>
<td>sensitive information</td>
<td>selection</td>
<td>functions</td>
<td>cryptography</td>
<td>specific</td>
</tr>
<tr>
<td>trusted</td>
<td>classification</td>
<td>for administration</td>
<td>firewall</td>
<td>algorithms</td>
</tr>
<tr>
<td></td>
<td>people</td>
<td>authentication</td>
<td>security zones</td>
<td>interfaces</td>
</tr>
<tr>
<td></td>
<td>information</td>
<td>intrusion</td>
<td>authentication</td>
<td>libraries</td>
</tr>
<tr>
<td></td>
<td>authentication</td>
<td>detection</td>
<td>registry</td>
<td>servers</td>
</tr>
<tr>
<td></td>
<td>badges</td>
<td>logging</td>
<td>logging</td>
<td>storage</td>
</tr>
<tr>
<td></td>
<td>passwords</td>
<td></td>
<td></td>
<td>protocols</td>
</tr>
<tr>
<td></td>
<td>locks / walls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>guards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>administrators</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**desired characteristics, specifications & mechanisms**

<table>
<thead>
<tr>
<th>not trusted</th>
<th>social contacts</th>
<th>missing functionality</th>
<th>holes between concepts</th>
<th>bugs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>open passwords</td>
<td>wrong</td>
<td></td>
<td>buffer overflow</td>
</tr>
<tr>
<td></td>
<td>blackmail</td>
<td>quantification</td>
<td></td>
<td>non encrypted</td>
</tr>
<tr>
<td></td>
<td>burglary</td>
<td></td>
<td></td>
<td>storage</td>
</tr>
<tr>
<td></td>
<td>fraud</td>
<td></td>
<td></td>
<td>poor exception</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>handling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>threats</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Role of Systems Architecting in Innovation

19 Gerrit Muller

version: 0
September 9, 2018
QNsecurityExample
Deliverables of the System Architect

Role of Systems Architecting in Innovation

20  Gerrit Muller

version: 0
September 9, 2018
RSAdeliverables
Responsibilities of the System Architect

Balance  Consistency  Decomposition  Integration  Overview

KISS  Elegance  Simple  Integrity  Fitting

Role of Systems Architecting in Innovation

21  Gerrit Muller
What does the System Architect do?

- Idea
  - think, analyze
  - listen, talk, walk around
  - design, brainstorm, explain
  - assist project leader with work breakdown, schedule, risks
  - present, meet, teach, discuss

- write, consolidate, browse
- test, integrate
- read, review
- travel to customer, supplier, conference
- provide vision and leadership

---

Role of Systems Architecting in Innovation

Gerrit Muller
From Detail to Overview

<table>
<thead>
<tr>
<th>consolidation in deliverables</th>
<th>meetings</th>
<th>informal contacts</th>
<th>sampling scanning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>driving views</strong></td>
<td>10</td>
<td>100 h</td>
<td></td>
</tr>
<tr>
<td><strong>shared issues</strong></td>
<td>$10^2$</td>
<td>1 h</td>
<td></td>
</tr>
<tr>
<td><strong>touched details</strong></td>
<td>$10^4$</td>
<td>0.5 – 10 min</td>
<td></td>
</tr>
<tr>
<td><strong>seen details</strong></td>
<td>$10^5 – 10^6$</td>
<td>0.1 – 1 sec</td>
<td></td>
</tr>
<tr>
<td><strong>product details</strong></td>
<td>$10^7 – 10^{10}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>real-world facts</strong></td>
<td>infinite</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Quantity per year (order-of-magnitude) | architect time per item

Role of Systems Architecting in Innovation

23 Gerrit Muller
Key Success Factor 2: highly iterative

Cost revisited in context of clinical needs and realization constraints; note: original threads are significantly simplified.
Key Success Factor 3: Architect as Integrator

team full of heroes

meddling architect
Innovation Challenges in Embedded Systems

- discover latent needs
- enable emergence
- where is the business

Creativity

Market dynamics

Globalization

Hype waves

Moore's law

Security

Privacy, DRM

Versus usability

Power consumption

Weight, cost, performance

Reliability

Complexity

Heterogeneity

#Engineers involved

Interoperability

Emerging behavior, future vs legacy

Heterogeneous vendors

Role of Systems Architecting in Innovation