Abstract

This module addresses tools and techniques available to the System Architect. It explains the basic CAFCR method and addresses story telling as method.
Basic Working Methods of a System Architect

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Abstract

The challenge for the architect is to cover a wide range of subjects, with many unknowns and uncertainties, while decisions are required all the time. The basic working methods, such as viewpoint hopping, modelling, handling uncertainties and WWHWW questions are described.

Distribution

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September 25, 2014
status: concept
version: 1.5
Many viewpoints

- Operator
- Ease of use
- Financial manager
- Cost of ownership
- Sales manager
- Differentiation
- Street price
- Data model
- Functions
- Adjustments
- Manufacturing
- Space
- Power tools
- RF engineer
- Timing
- FTE's
- Integration
- Architect
- Balance
- Project leader
- Security
- Problem
- Stakeholder concern
- Project leader
- Sales manager
- Financial manager
- RF engineer
- SW engineer
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- Ease of use
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BWMAmanyViewpoints
Viewpoint Hopping

- cost of ownership
  - street price
  - timing
  - functions
  - power
- integration
  - ease of use
  - differentiation
  - adjustments
  - data model
- security
  - fte's
  - space
  - balance
  - cost of ownership

- tools

- financial manager
- sales manager
- project leader
- SW engineer
- RF engineer
- architect
- operator
- manufacturing
- manager
- leader

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BWMAviewpointHopping
The seemingly random exploration path

thinking path of an architect during a few minutes up to 1 day
Scanning modes of the architect

open perceptive scanning

structured and judging

drunkard’s walk
the world is full of interesting needs, technologies, ...

scanning while structuring and judging

bad goal

good

bad

straight for the goal
ignore everything that is not contributing directly to the goal
Combined open perceptive and goal oriented scanning

- Room for open perceptive exploration
- Increasing goal orientation

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BWMAfromPerceptiveToGoalDriven
Coverage of problem and solution space

covered or touched by architects

subjects

covered by engineers and experts

level of detail
Decomposition, interfaces and integration
Successive quantification refinement

- Back of the envelope
- Benchmark, spreadsheet calculation
- Measure, analyze, simulate
- Cycle accurate

Order of magnitude

Guestimates

Calibrated estimates

Feasibility

Cycle accurate
Example evolution of quantification

- Incomplete understanding
- Calibration
- Input
- Design
- Robustness problem
- Performance degradation
- Measurement
- Estimate and uncertainty
- Specification
- Finished product

Better vs. worse over time.
Quantified understanding of wafer stepper overlay

- Process overlay: 80 nm
  - Matched machine: 60 nm
    - Process dependency sensor: 5 nm
  - Single machine: 30 nm
    - Matching accuracy: 5 nm
- Lens matching: 25 nm
- Stage overlay: 12 nm
  - Stage grid accuracy: 5 nm
  - Stage Al. pos. meas. accuracy: 4 nm
  - Alignment repro: 5 nm
- Position accuracy: 7 nm
- Global alignment accuracy: 6 nm
- Off axis pos. meas. accuracy: 4 nm
- Off axis Sensor repro: 3 nm
- Blue align sensor repro: 3 nm
- Interferometer stability: 1 nm
- Frame stability: 2.5 nm
- Tracking error WS: 2 nm
- Tracking error RS: 1 nm
- Tracking error X, Y: 2.5 nm
- Tracking error phi: 75 nrad
Architect focus on important issues

80% architecting time

20%

10% most important most critical issues

90%

new solved

spent on

spent on

all other issues

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BWMAArchitectingTime
Architect “worry” list

1. response time
   from key press until first image on display

2. cost price
   resource budgets

3. layering to separate
   separation of concerns
   self sustained
   life-cycle separation
   robust: paranoia validations

4. reliability of storage
5. database redesign
6. integration schedule
7. movement artefact
8. standby power
9. weak signal handling
10. location-based twiddle
A model is a simplified representation of part of the real world used for:

communication, documentation analysis, simulation, decision making, verification
Some examples of models

**formal analytical model**

\[ t_{\text{processing}} = t_{\text{overhead}} + n_{\text{rows}} \times t_{\text{row}} + n_{\text{row}} \times n_{\text{col}} \times t_{\text{pixel}} \]

**synchronization model**

- Req
- Ack
- Strobe

**feedback model**

feedback frequency: 4 kHz (0.25 msec)

**value chain model**

- consumer
- retailer
- box-maker
- semiconductor supplier
- service provider
- content provider

**mockup**

- wooden model

**model of coordinate system**

- 6 degrees of freedom

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# Types of models

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mathematical</td>
<td>visual</td>
</tr>
<tr>
<td>linguistic</td>
<td>visual</td>
</tr>
<tr>
<td>formal</td>
<td>informal</td>
</tr>
<tr>
<td>quantitative</td>
<td>qualitative</td>
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<td>detailed</td>
<td>global</td>
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<td>concrete</td>
<td>abstract</td>
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<tr>
<td>accurate</td>
<td>approximate</td>
</tr>
<tr>
<td>executable</td>
<td>read only</td>
</tr>
<tr>
<td>rational</td>
<td>intuitive</td>
</tr>
</tbody>
</table>
Questions

Why
What
How
Who
When
Where
Why broadens scope, How opens details

Why
What
How
Why
What
How
Why
What
How
system
context
subsystem

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Flow from problem to solution

1. Problem understanding by exploration and simple models

2. Analysis by
   + exploring multiple propositions (specification + design proposals)
   + exploring decision criteria (by evaluation of proposition feedback)
   + assessment of propositions against criteria

3. Decision by
   + review and agree on analysis
   + communicate and document

4. Monitor, verify, validate by
   + measurements and testing
   + assessment of other decisions

vague problem statement

conflicting other decision

insufficient data

no satisfying solution

invalidated solution

conflicting other decision

vague problem statement
## Multiple propositions

<table>
<thead>
<tr>
<th>Throughput</th>
<th>Cost</th>
<th>Safety</th>
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<tbody>
<tr>
<td>high-performance sensor</td>
<td>high-speed moves</td>
<td>additional pipelining</td>
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<tr>
<td>350 ns</td>
<td>9 m/s</td>
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### Low cost and performance 1

<table>
<thead>
<tr>
<th>Throughput</th>
<th>Cost</th>
<th>Safety</th>
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</thead>
<tbody>
<tr>
<td>high-performance sensor</td>
<td>high-speed moves</td>
<td>additional collision detector</td>
</tr>
<tr>
<td>300 ns</td>
<td>10 m/s</td>
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### Low cost and performance 2

<table>
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<th>Cost</th>
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<td>high-speed moves</td>
<td>additional collision detector</td>
</tr>
<tr>
<td>200 ns</td>
<td>12 m/s</td>
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## High cost and performance
## Assessment of propositions

<table>
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<th>high cost and performance</th>
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<td>future proof</td>
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<td>risk</td>
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<td>3</td>
<td>3</td>
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<tr>
<td>maintenance</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Recursive and concurrent application of flow

1. Problem understanding
2. Analysis
3. Decision
4. Monitor, verify, validate

Legend:
- decision flow
- analysis flow

System level
Subsystem level
Component level
Atomic level

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TORrecursion
Exploration by rapid iteration

system level \[\rightarrow\] detail level

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Abstract

A story is an easily accessible story or narrative to make an application live. A good story is highly specific and articulated entirely in the problem domain: the native world of the users. An important function of a story is to enable specific (quantified, relevant, explicit) discussions.
From story to design

What does Customer need in Product and Why?

Customer What

Customer How

Product What

Product How

Customer objectives

Application

Functional

Conceptual

Realization

market vision

story

a priori solution knowledge

analyze design

analyze design

design

case

analyze design
A day in the life of Bob

bla blah bla, rabarber music
bla blah composer bla bla
qwwwety 30 zeps.
nja nja njet njippie est quo vadis? Pjotr jaleski bla bla
bla bimee fgfg gsg hgrg
mmmm bas engel heeft een
interessant excuss. lex stelt
voor om vanavond door te
werken.

In the middle of the night he is awake and decides to change the world forever.

The next hour the great event takes place:

This brilliant invention will change the world forever because it is so unique and valuable that nobody believes the feasibility. It is great and WOW at the same time, highly exciting.

Vtables are seen as the solution for an indirection problem. The invention of Bob will obsolete all of this in one incredible move, which will make him famous forever.

He opens his PDA, logs in and enters his private secure unique non trivial password, followed by a thorough authentication. The PDA asks for the fingerprint of this little left toe and to pronounce the word shit. After passing this test Bob can continue.
Points of attention

• purpose

• scope

• viewpoint, stakeholders

• visualization

• size (max 1 A4)

• recursive decomposition, refinement
### Criteria for a good story

- **accessible, understandable**
  - "Do you see it in front of you?"

- **valuable, appealing**
  - attractive, important
  - "Are customers queuing up for this?"

- **critical, challenging**
  - "What is difficult in the realization?"
  - "What do you learn w.r.t. the design?"

- **frequent, no exceptional niche**
  - "Does it add significantly to the bottom line?"

- **specific**
  - names, ages, amounts, durations, titles, ...

---

**Customer objectives**

- Application

**Conceptual**

- Realization

**Application**

- Functional
Betty is a 70-year-old woman who lives in Eindhoven. Three years ago her husband passed away and since then she lives in a home for the elderly. Her 2 children, Angela and Robert, come and visit her every weekend, often with Betty’s grandchildren Ashley and Christopher. As so many women of her age, Betty is reluctant to touch anything that has a technical appearance. She knows how to operate her television, but a VCR or even a DVD player is way to complex.

When Betty turned 60, she stopped working in a sewing studio. Her work in this noisy environment made her hard-of-hearing with a hearing-loss of 70dB around 2kHz. The rest of the frequency spectrum shows a loss of about 45dB. This is why she had problems understanding her grandchildren and why her children urged her to apply for hearing aids two years ago. Her technophobia (and her first hints or arthritis) inhibit her to change her hearing aids’ batteries. Fortunately her children can do this every weekend.

This Wednesday Betty visits the weekly Bingo afternoon in the meetingplace of the old-folk’s home. It’s summer now and the tables are outside. With all those people there it’s a lot of chatter and babble. Two years ago Betty would never go to the bingo: “I cannot hear a thing when everyone babbles and clatters with the coffee cups. How can I hear the winning numbers?!”. Now that she has her new digital hearing instruments, even in the bingo cacophony, she can understand everyone she looks at. Her social life has improved a lot and she even won the bingo a few times.

That same night, together with her friend Janet, she attends Mozart’s opera The Magic Flute. Two years earlier this would have been one big low rumbly mess, but now she even hears the sparkling high piccolos. Her other friend Carol never joins their visits to the theaters. Carol also has hearing aids, however hers only “work well” in normal conversations. “When I hear music it’s as if a butcher’s knife cuts through my head. It’s way too sharp!”. So Carol prefers to take her hearing aids out, missing most of the fun. Betty is so happy that her hearing instruments simply know where they are and adapt to their environment.
Value and Challenges in this story

Value proposition in this story:
quality of life:
  active participation in different social settings
usability for nontechnical elderly people:
  "intelligent" system is simple to use
  loading of batteries

Challenges in this story:
Intelligent hearing instrument
Battery life — at least 1 week
No buttons or other fancy user interface on the hearing instrument, other than a robust On/Off method
The user does not want a technical device but a solution for a problem
Instrument can be adapted to the hearing loss of the user
Directional sensitivity (to prevent the so-called cocktail party effect)
Recognition of sound environments and automatic adaptation (adaptive filtering)

source: Roland Mathijssen, Embedded Systems Institute, Eindhoven
Personal multi media appliance
Create a story for a personal multi media appliance.
Derive a case description from the story, with functions and quantitative requirements.
Architect Way of Working

Viewpoint Hopping

Perceptive vs Judging

Chaotic Path

Varying Depth
Some Architecting Means

Quantification and Margins

Focus on Key Issues

Phased Problem Solving

Story Telling

Exercise System Architect Toolkit
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