Abstract

Many products today are developed for highly dynamic markets while the products and functions get more and more integrated. The product and service realization is based on fast changing technologies that come together in complex value chains. The challenge for modern companies in innovative domains is to survive in this dynamic world.

In this paper we explore the contribution of architecting and standardization to the company success. We look at the *why*, *when*, *who* and *how* questions of standardization and at the role of architecting in the standardization process.
Problem Statement

How to survive in innovative domains?

- Fast moving market
- Fast moving technology
- Complex value chains
- Increased integration
That is easy...

How to survive in innovative domains?
- fast moving market
- fast moving technology
- complex value chains
- increased integration

By being the fittest in your ecological (economical) niche!
1. employ skilled system architects
2. apply an agile system architecting process
3. determine the right subjects and moments for standardization
4. apply a sensible standardization process
How to survive in innovative domains?

standardization

what

why

how

when

who
How to survive in innovative domains?

standardization

why

when

what

how

who
Classification of Standardization Tactics

- System of systems
  - Provides
  - Interoperates with
  - Uses
  - Component
    - Focus on core value
    - Use of commodity components
    - Provide choice to customer
    - Compete on performance and functionality
    - Enlarge application potential
    - Customer value
Focus on Core; not on Key or Base Technology?

- Core
- Key
- Base

Technology life cycle:

- Own value IP
- Critical for final performance
- Commodity

Options:

- make
- outsource
- buy
- refer customer to 3rd party

Partnering

Total Product
How to survive in innovative domains?

standardization

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When to Standardize

too early ← right moment → too late

- problem is understood
- domain structure is clear
- broadening set of stakeholders
- technology is ripe

requirements unknown
- technological compromises
loss of competitive edge
insufficient and uncertain facts
wrong expectations
intuition not calibrated

captured in proprietary legacy
poor interoperability
customer demands standards
focus on key i.s.o. core
market does not take off
(Metcalfe's law)
Roadmapping as Tool

- Customer objectives
- Application
- Conceptual
- Realization

- time, ca 5 years

- drives, requires supports, enables

- standardization concern

- provides interoperability

- provides interoperability use of standards

- People
- Process
- Technology
- Products
- Market

- Customer needs
- expectations
- trends

- technology needs
- opportunities

- standardization process tactics deployment

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ECMAroadmapping
Purchased SW Requires Embedding

proprietary software

SW architecture

purchased OS

purchased software

embedding
Embedding Costs of Purchased SW

- Installation
- Configuration
- Customization
- Start up, shutdown
- Specifications
- Interface to application SW
- Exception handling
- Resource allocation and monitoring provision
- Resource tuning, see above
- Safety design
- Security design

- functional system design
- sw design
- add semantics level
- use of appropriate low level mechanisms
- match to high level mechanisms:
  - notification, scheduling
  - job requests, subscriptions

- System monitor
- Error propagation
- Logging
- CPU
- Memory
- Disk
Balance of Considerations and Trends

- Innovation from outside
- Focus on core technology
- Initial cost reduction
- Faster to market
- Interoperability
- Functional integration
- License costs
- Performance
- Resource use
- Flexibility
- Embedding
- Integration effort
- Release propagation
- Required know how
- Transition cost

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**Example of Lifecycle Reference Model**

<table>
<thead>
<tr>
<th>information handling</th>
<th>archiving</th>
</tr>
</thead>
<tbody>
<tr>
<td>entirely distributed</td>
<td>service business</td>
</tr>
<tr>
<td><em>wide</em> variation due to &quot;socio-geographics&quot;: psycho-social, political, cultural factors</td>
<td>not health care specific</td>
</tr>
<tr>
<td>distributed</td>
<td>extreme robust</td>
</tr>
<tr>
<td><em>limited</em> variation due to &quot;nature&quot;: human anatomy pathologies imaging physics</td>
<td>fire, earthquake, flood proof</td>
</tr>
<tr>
<td>base technology</td>
<td>life time</td>
</tr>
<tr>
<td>not health care specific</td>
<td>100 yrs (human life)</td>
</tr>
<tr>
<td>short life-cycles</td>
<td>rapid innovation</td>
</tr>
</tbody>
</table>

**Imaging and Treatment**

- localised
- patient focus
- safety critical
- *limited* variation due to "nature":
  - human anatomy
  - pathologies
  - imaging physics

**Base Technology**

- not health care specific
- short life-cycles
- rapid innovation
Evolution from Proprietary to Standard

- High innovation rate
- Global standardization takes more than 5 years
- High interoperability

Legend:
- Applications
- Product family
- Vendor
- World standard

- ACR/NEMA
- DICOM
- Philips
- GE
- Siemens
- CT
- MRI
- Cardio vascular
- URF
- Medical imaging
- Cardio analyse
- Bolus chase
- Vascular analyse
- RF

Architecting and Standardization
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MICAInformationLayers
How to survive in innovative domains?

standardization

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Standards describe what

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

white box (implementation) level:
- protocols
  - realizations
  - limitations
  - constraints
  - opportunities
  - behavior
  - characteristics
Input from implementation know how

white box know how:

**current and future realization:**
- design choices
- technology capabilities
- domain concepts
- limitations
- constraints
- opportunities

what needs to be defined:
- functions
- parameters
- formats
- protocols
- behavior
- characteristics

realism/acceptance level:
- time
- effort
- cost
Towards a Standard

**market**
needs
expectations
concerns

**black box level:**
functions
parameters
formats
protocols
behavior
characteristics

**white box know how:**
current and future realization:
design choices
technology capabilities
domain concepts
limitations
constraints
opportunities

**future proof; room for innovation**
**market enabler; room for added value**
not locked into specific technology constraints
realistic and acceptable; time, cost, effort
What Should be in a Standard

**Standard: what**

requirements at conceptual level,

*no design or implementation*

the minimal set of (interface) requirements to:

1) ensure interoperability 
2) foster innovation and
3) maximise the room for added value.

as minimal as possible

ambitious but cautious
Embedding in a Reference Architecture

is this a standard?

reference architecture

context + system model:
  function allocation
  composition guidance
  emerging characteristics
  processes

framework for

standards

conform to

implementations
How to survive in innovative domains?
Flow of Standardization

**explore**
- market needs
- stakeholders (competitors, suppliers, partners, customers, ...)
- existing realizations
- implementation issues

**analyze**
- analyze
- explore
- market needs
- stakeholders (competitors, suppliers, partners, customers, ...)
- existing realizations
- implementation issues
- iterate
- manage and facilitate (heterogeneous stakeholders, create support and acceptance)
- write and debate (scoping, negotiation)
- prototype and validate

**standardize**
- decide
- publish
- provide reference implementation (optional)

**deploy**
- push
- manage compliance
- evolve standard
Who Contributes and Participates?

How to survive in innovative domains?

standardization

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Simplified Process Decomposition

customer

supplying business

strategy
process

customer oriented (sales, service, production) process

product creation
process

value

people, process and technology
management process

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RSPprocessDecomposition
Internal Standardization Process == Highly Strategic!

strategy
process
customer
supplying business
value
product creation
process
customer oriented (sales, service, production) process
people, process and technology
management process
Internal Standardization Process
Non technical aspects of standardization

- **Legal, IP oriented**
  - licenses
  - patents
  - copyright

- **Political**
  - decision power
  - who is in control?
  - (hidden) interests
  - coalitions
  - networks

- **Business**
  - value chains
  - business models
  - market development

- **Social**
  - privacy
  - social value

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**standardization**
Architect and Standards: Love-Hate Relationship

**love**
- no worries: concerns are taken care of
- focus on core problems
- facilitates interoperability

**hate**
- limits innovation (harness)
- limits solution space
- simplistic management orders
Conclusions

How to survive in innovative domains?

3. determine the right subjects and moments for *standardization*
4. apply a sensible *standardization* process

**standardization**

**why**
- unlock market (e.g. interoperability)
- focus on core assets
- optimize supply chain

**when**
- problem is understood
- domain structure is clear
- broadening set of stakeholders
- technology is ripe

**what**
- minimal, as little as possible requirements (not design or implementation)
- room for added value and innovation

**how**
- fast iteration
- make rationale explicit
- roadmapping

**who**
- strategic insight
- technology know how
- market know how
- social and political insight
- ambitious but cautious

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ECMAconclusion