Modeling the Contributions of Software Architecture to the Success of an Ecosystem

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The Big Idea

• The success of an organization that creates software-intensive products depends upon interactions with its collaborators, users, and competitors – its ecosystem.

• The software architectures that govern many of those interactions contribute to the success of the ecosystem.

• A model of the ecosystem supports strategic decision making including architecture decisions through broader, longer term views than traditional models.
Context

• An ecosystem is the environment surrounding an entity and includes its predators and prey.
• Every organization participates in one or more ecosystems whether they plan to or not.
• An organization can affect its ecosystem with strategically planned decisions.
• An ecosystem sometimes centers around a reference architecture that defines common services and core functionality.
Successful Ecosystem

• If you are
  – A platform owner/vendor – you want to attract product developers and users to the ecosystem to maximize the value of your platform.
  – App/product developer – you want low overhead, a platform with substantial functionality, and an environment attractive to the target audience.
  – End users - you want choices, low prices, high quality, and rapid availability.
STREAM - STRategic Ecosystem Analysis Method

- Business
  - Software suppliers
  - Existing business models

- Supply chains
  - Software architectures
  - Existing technologies

- Emerging business models
  - Emerging technologies
  - Innovation
STREAM - STRategic Ecosystem Analysis Method

Business
- Software suppliers
- Business models

Software Architecture's Impact

Supply chains
- Emerging business models

Software Architectures
- Emerging technologies

Software

Innovation
Business, Architecture, and Ecosystem

• An ecosystem will include organizations with conflicting business goals.
• The core of the architecture supports the business models of the dominant players but must allow variants to support a range of business goals.
• The quality and agility of the supply chain for products based on the architecture will impact the success of the ecosystem.
• Tools such as Porter’s 5 Forces structure the business information in the model.
Innovation, Architecture, and Ecosystem

• Innovations in architecture have driven the success of many ecosystems.
  – Plug-in architectures,
  – Dependency injection, and
  – Later binding times
have supported the evolving Eclipse business model.

• Innovations enable new products or properties which attract more producers and consumers to the ecosystem.

• Businessweek’s categories are: Product, Process, Business Model, and Customer Experience
Software, Architecture, and Ecosystem

• The architecture is clearly the key to success of the software and has a significant influence on all aspects of the ecosystem.
  – Flexibility
  – Scalability
  – Extensibility

• The architecture should make product building
  – Easy (relative the difficulty of the domain)
  – Collaborative (up to the point of differentiation)
  – Profitable (if sufficiently attractive to potential developers and users)

• Well chosen variation points attract new consumers and new producers

• Notations such as AADL capture architecture.
Dependency analysis

• Identify critical points in the implementation and the relationships that link them.
• Decision makers can’t examine 11,000 files but using betweenness centrality we can identify a small number.
Linking the business and software views

- Organizations and the Hadoop projects to which they contribute.
- The larger the contribution the larger the icons.
Modeling method

• Five practices by four phases by three views
• The needs of the client dictate the focal activities
Model Life Cycle

• This is a life cycle for the model not the ecosystem

• Each use of STREAM addresses specific questions so each phase is tailored for each use.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Actions</th>
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</thead>
<tbody>
<tr>
<td>Exploration</td>
<td>of how the information in the ecosystem should be classified, represented, and analyzed</td>
</tr>
<tr>
<td>Construction</td>
<td>of data representations and relationships</td>
</tr>
<tr>
<td>Exploitation</td>
<td>uses the relationships defined in the model to trace impacts and to predict the reactions to specific decisions</td>
</tr>
<tr>
<td>Evolution</td>
<td>of existing information and new information being added.</td>
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STREAM provides

• A structured representation for the information describing the ecosystem

• A set of views that makes implicit information explicit for the decision maker

• Analyses which identify important points so the decision maker is not overloaded

• A means of capturing in the present what has happened in the past to predict the future
Healthy ecosystem

• Ecosystem health criteria:
  – Robustness
  – Niche creation
  – Productivity

• Example: High performance computing environments
  Hadoop – Map/Reduce architecture specifically targets batch processing of BIG data
  – Robust – fault tolerant HPC architecture gaining widespread acceptance
  – Niche creation – Cloudera, HortonWorks, and MapR are leveraging the architecture to add value to the basic Hadoop distro for clients
  – Productivity – Hadoop is being integrated into other architectures to rapidly provide high performance computing features in many products
Lessons learned/Best practices

• The three views provide a comprehensive, but understandable model.
• The reference architectures in the ecosystem impact all three views in the model.
• The ecosystem architectures support coopetition through core architectures that provide greater flexibility and extensibility than typical product architectures.
• The ecosystem model is tailored to provide information appropriate to the strategic decision making needs of the organization.
Take-aways

• An ecosystem business strategy should include a complementary architecture strategy.

• Modeling the ecosystem extends the decision making vision beyond traditional boundaries.

• There are many tactics that can be used in the design of an architecture to impact the health of the ecosystem:
  – Robustness – modularity
  – Niche creation – variation points
  – Productivity – later binding times
Levels of specificity

• Architecture for a product
  – Single owner/objectives/business model

• Architecture for a product line
  – Single owner/differing objectives and models

• Architecture for an ecosystem
  – Multiple owners/objectives/business models
  – Coopetition – agree on a core architecture but provide greater flexibility than a product line architecture
Architecture in Ecosystem

- STREAM focuses on an architecture
  - Many variation points to support many variant products
  - Competing architectures co-exist in the ecosystem and may compete by having common file formats or translators

- Architectural integrity for the ecosystem is achieved by periodic refactorings of the focal architecture so evolution of the architecture is captured

- Architecture design in the ecosystem
  - Scope of the architecture
  - Fit with the business models
  - Selection of variation points
Technical Issues for the Software Architecture in an Ecosystem

• Interfaces act like magnets
  – Attract – open, public
  – Repel – closed, proprietary

• Evolution is an irregular, if not random, walk
  – Complexity builds up until it is noticed and refactored
  – Multiple directions such as multiple lines of deployment simultaneously

• Integration is anticipated but abstracted
  – Organizations are linked by common goals
  – Software modules are linked where the architecture provides a mechanism for it
Ecosystem metrics

- The software architecture promotes productivity as measured by the number of extensions, number of downloads, or number of developers creating extensions, e.g. plugins. Looking for trends.