



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

John D. McGregor, Clemson University – USA

J. Yates Monteith, Clemson University - USA

Simone Amorim, University Federal of Bahia (UFBA) – Brazil

Eduardo Almeida, University Federal of Bahia (UFBA) - Brazil

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.

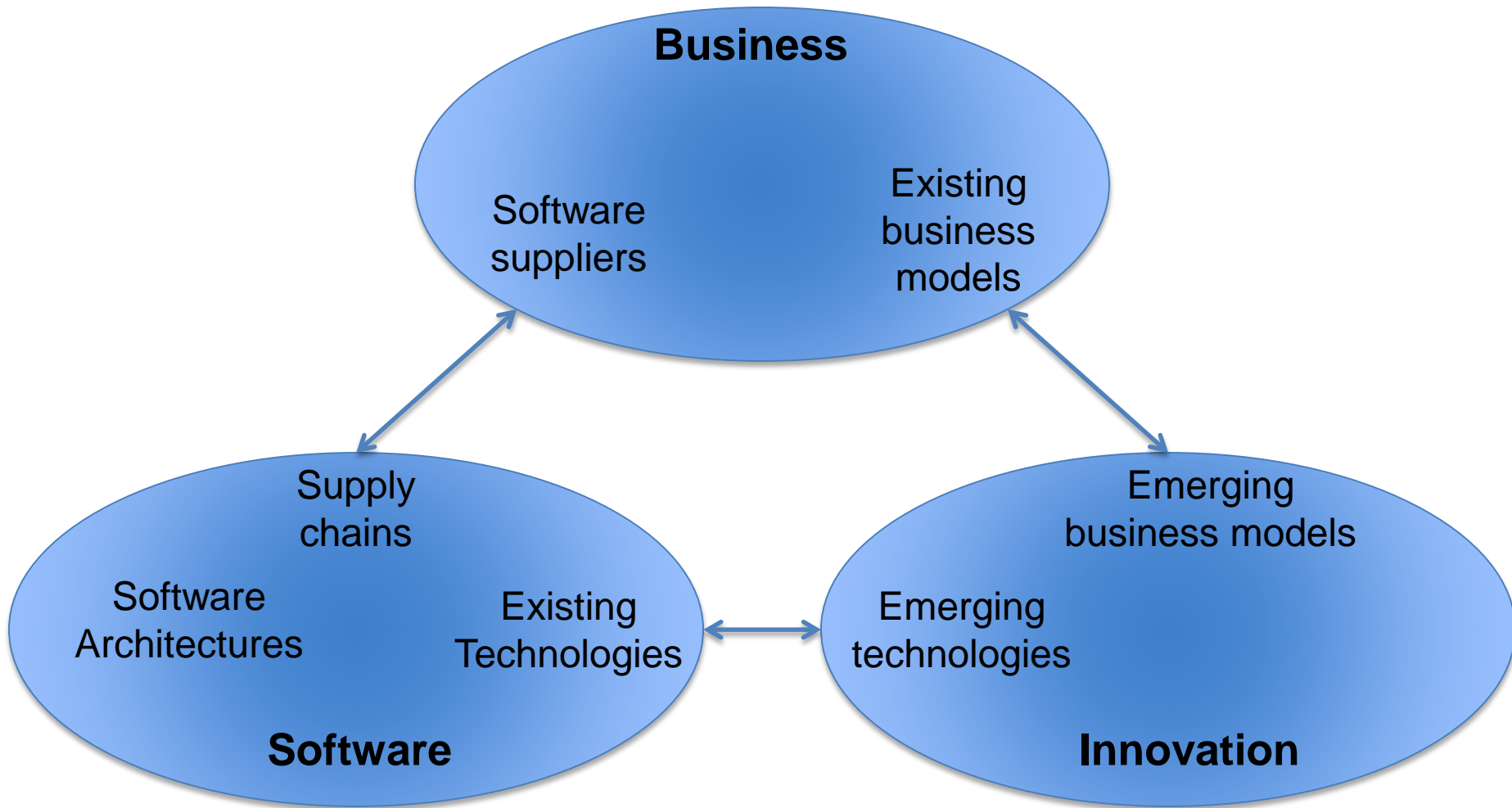
Context

- 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.

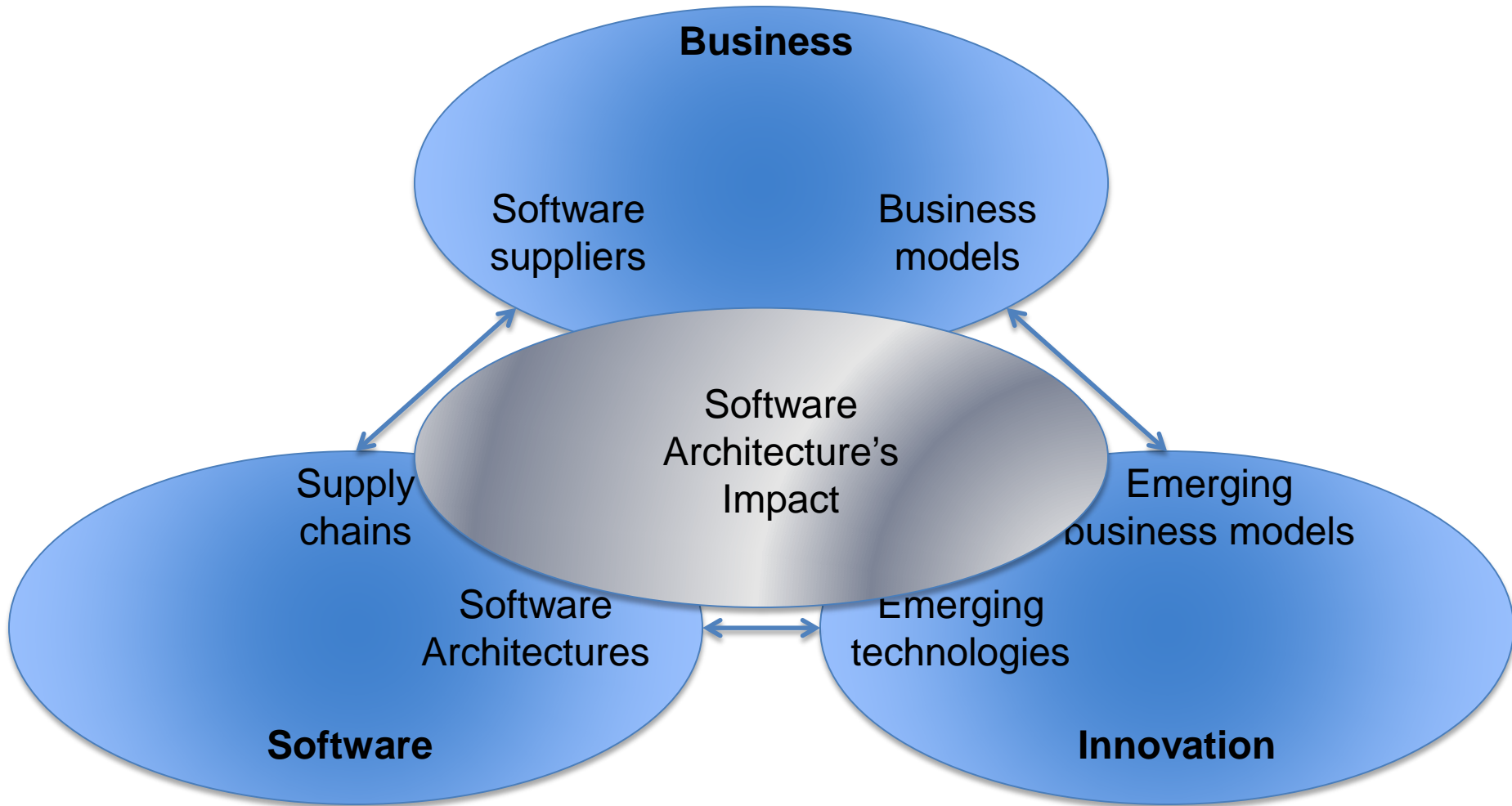
Successful Ecosystem

- 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

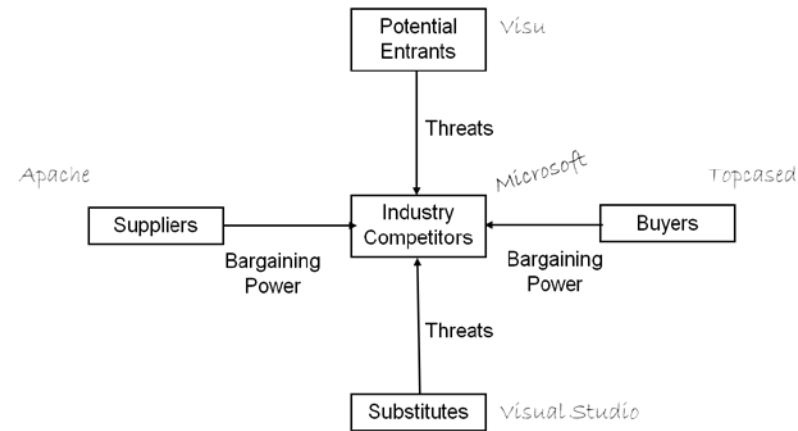


STREAM - STRategic Ecosystem Analysis Method



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.



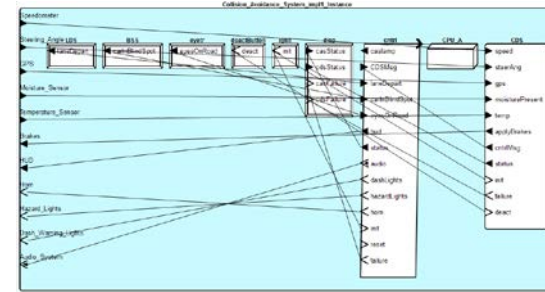


Innovation, Architecture, and Ecosystem

- Innovations in architecture have driven the success of many ecosystems.
 - Plug-in architectures,
 - Dependency injection, and
 - Later binding timeshave 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

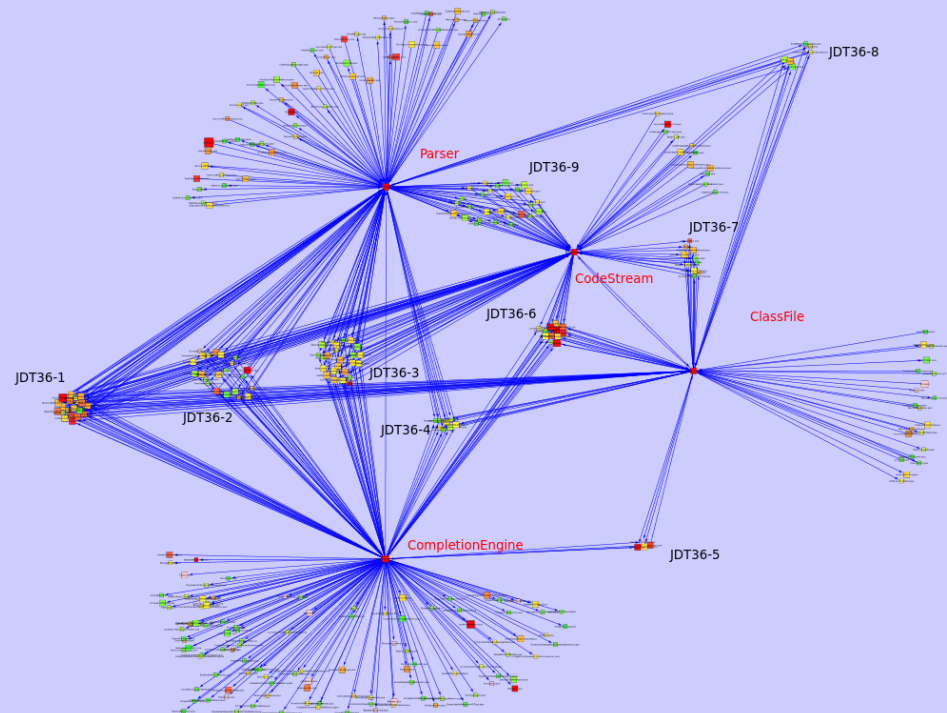
Software, Architecture, and Ecosystem

- 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.



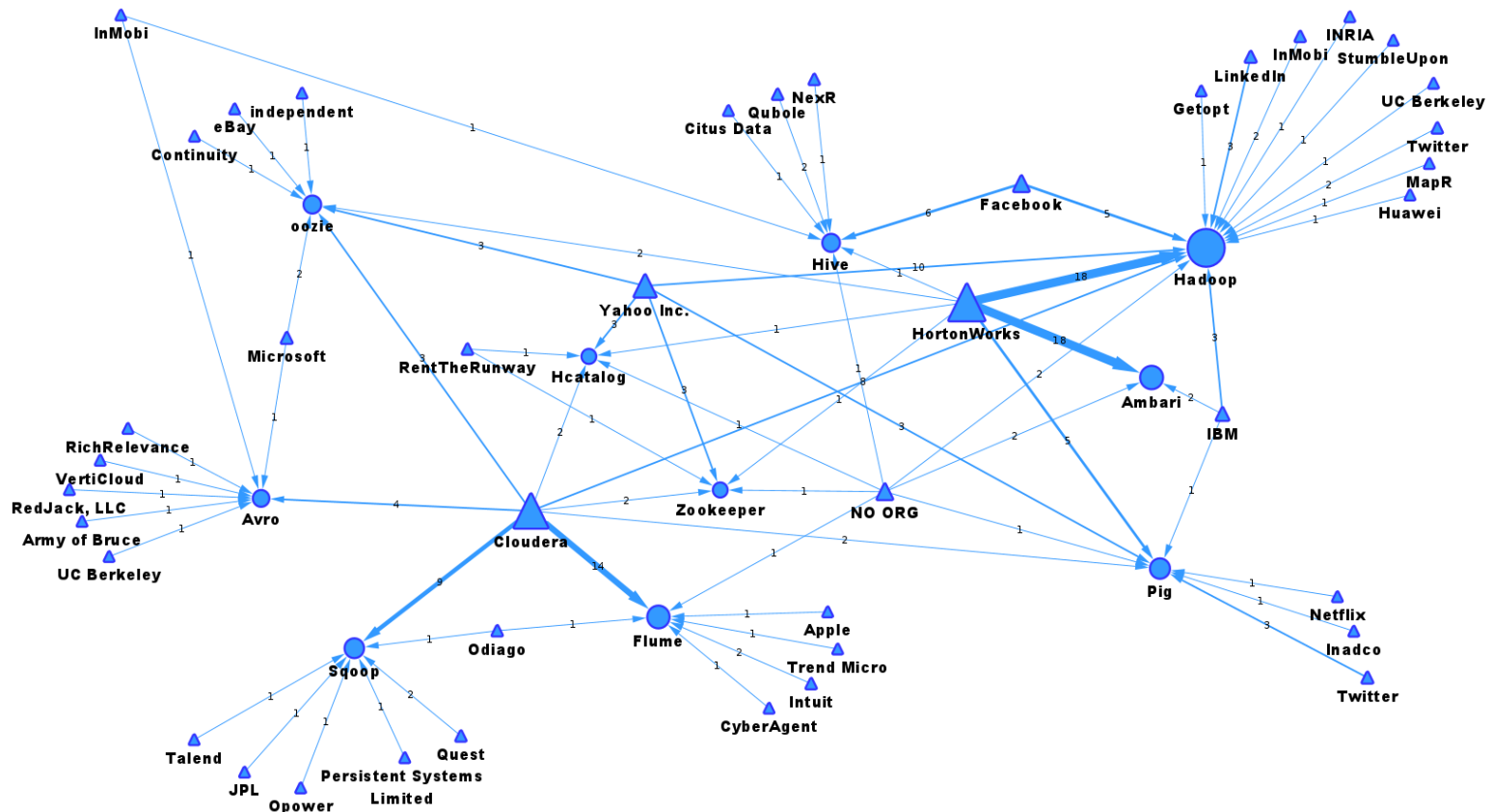
Dependency analysis

- 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.



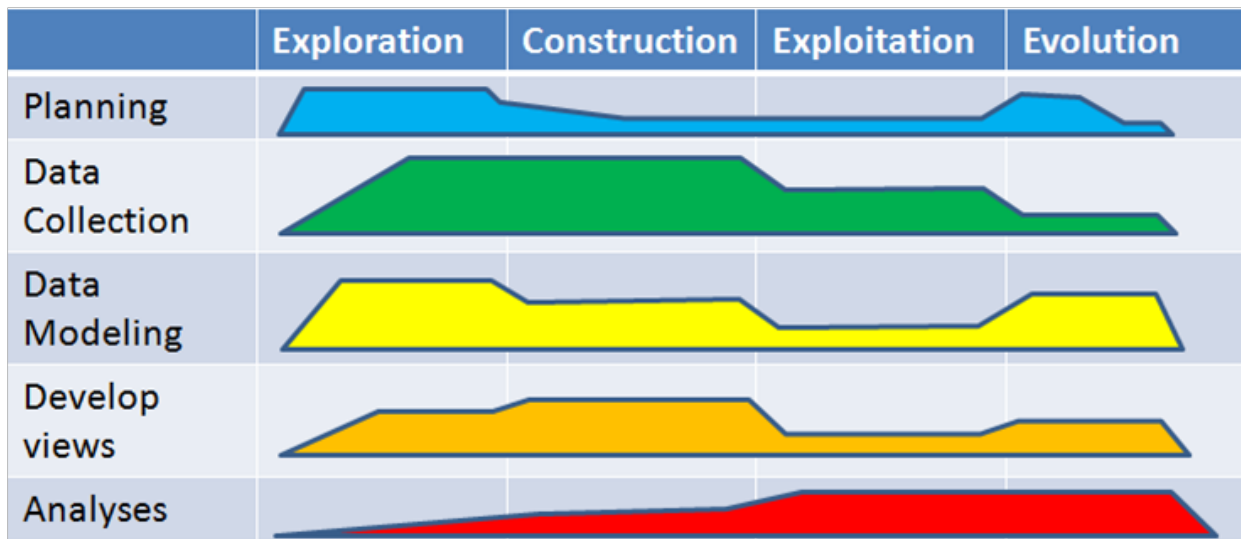
Linking the business and software views

- 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.

Phase	Actions
Exploration	of how the information in the ecosystem should be classified, represented, and analyzed
Construction	of data representations and relationships
Exploitation	uses the relationships defined in the model to trace impacts and to predict the reactions to specific decisions
Evolution	of existing information and new information being added.

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. plug-ins. Looking for trends.

