Domain-specific Engineering

Overview

The Nature of a Conventional Process

Optimized for creating unique products

with complete, knowable, and fixed requirements

one at a time

- **Past solutions are irrelevant, by definition**
- **No provision is made for uncertain future change**
- **No allowance is made for requirements indecision**
- **Variations in need spawn multiple products or a single more complicated product**

The process does not prohibit these; they are unknown to it.

Problems of a Conventional Process

- Products are late, cost too much, or fail to meet actual customer needs
- Every project's success depends on the availability of the same few key people
- Every problem is solved by each project, resulting in redundant effort and less time to focus on new issues
- Different products solve similar problems in different ways, resulting in excessive maintenance costs
- Sales are based on typical, rather than actual, estimates of organizational capability and required effort.
- The organization's entire competence resides in peoples' heads.

Why a DsE Process is Better

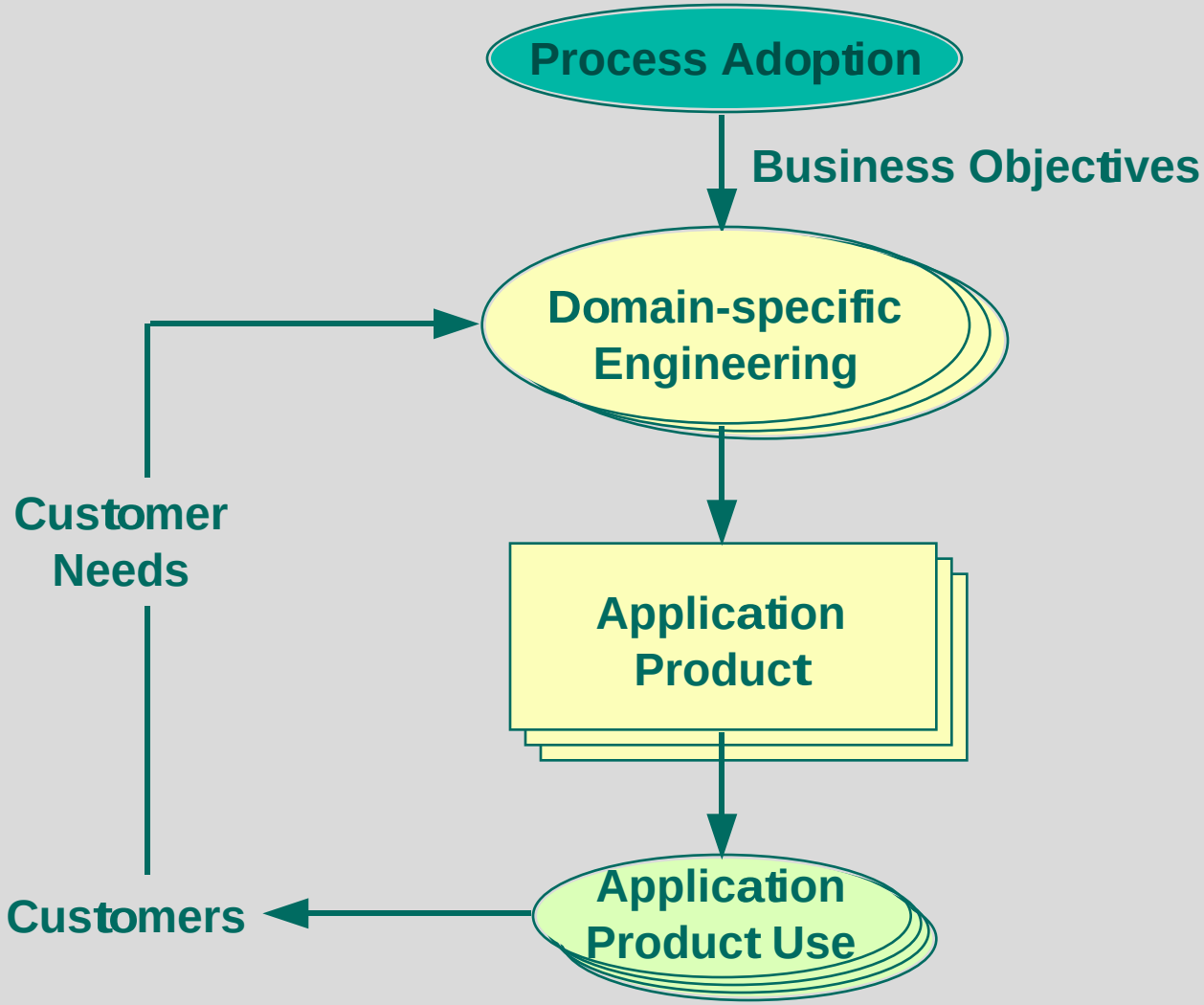
Optimized for creating similar products
with uncertain and changing requirements
many at a time

DsE asks:

- **How are products, now and future, similar and why?**
- **How can we use similarity to avoid unnecessary or redundant work?**
- **How can uncertainty and change be accommodated as normal and unavoidable?**

This is closer to what we actually do already, underneath a conventional process.

Context for Reuse

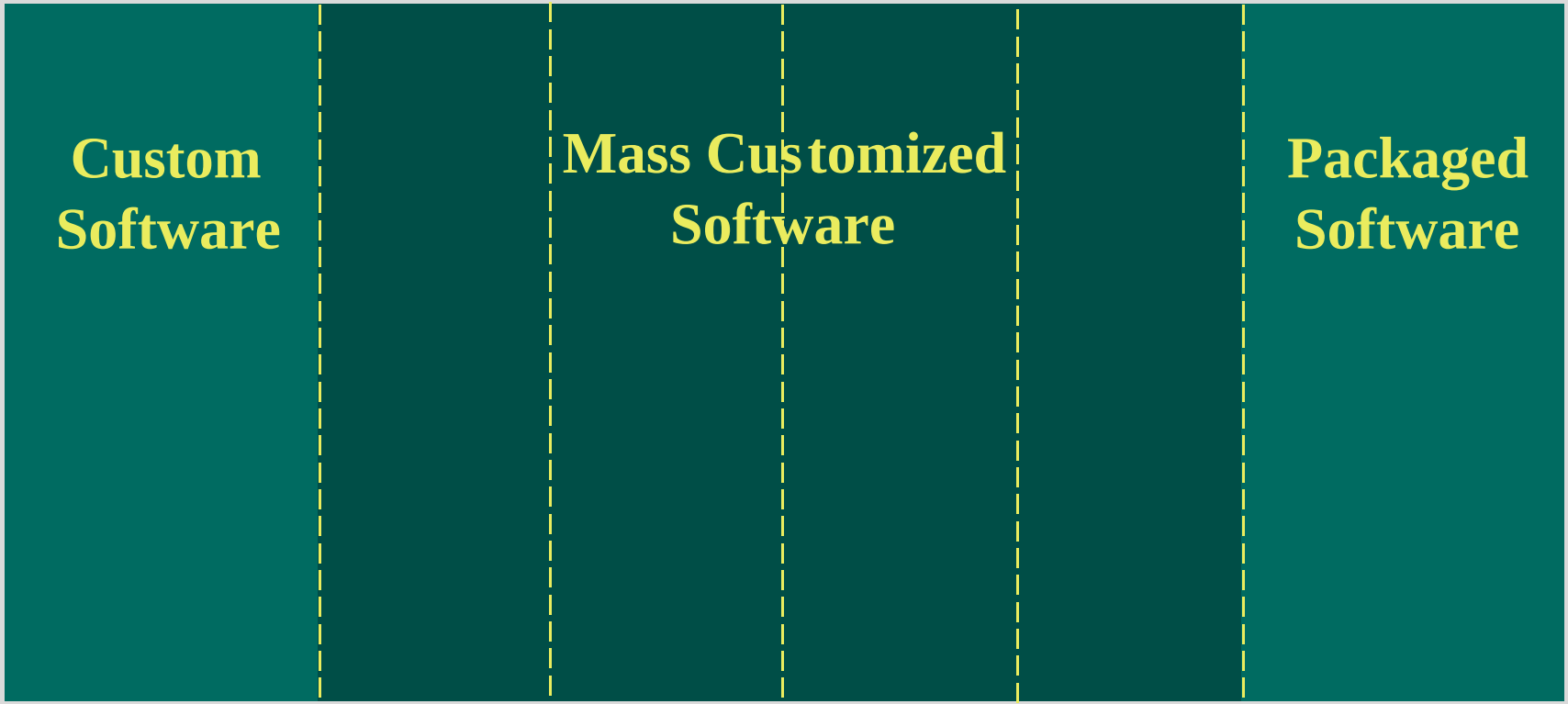


What is DsE?

Standardization of the most effective solutions to a class of similar problems

- **Identify a product line business area whose customers need similar products.**
- **Develop a shared understanding of how and why needed products are similar.**
- **Create a means to produce standardized, customized products rapidly.**
- **Transition systematically, with tailoring and incremental improvement.**
- **Evolve as market needs and technology change.**

The Scope of DsE



Goals of DsE

- Customized products in less time at lower cost
- A revised product rapidly when a customer's needs change
- Less redundant work, due to standardization and reuse, when creating similar products
- A shared understanding of problems and solutions
- A framework for disciplined engineering methods

Industrial Experience

- **Rockwell: message switching communications, global positioning receivers**
- **Boeing: flight training simulators**
- **Lockheed-Martin: satellite avionics, test equipment**
- **Thomson-CSF: air traffic control, training simulators, others *(corporate standard)***

Other similar:

- **Lucent: telephone switches**
- **Cummins Engine: diesel engine controls**
- **TenFold: financial, healthcare, and energy information systems**

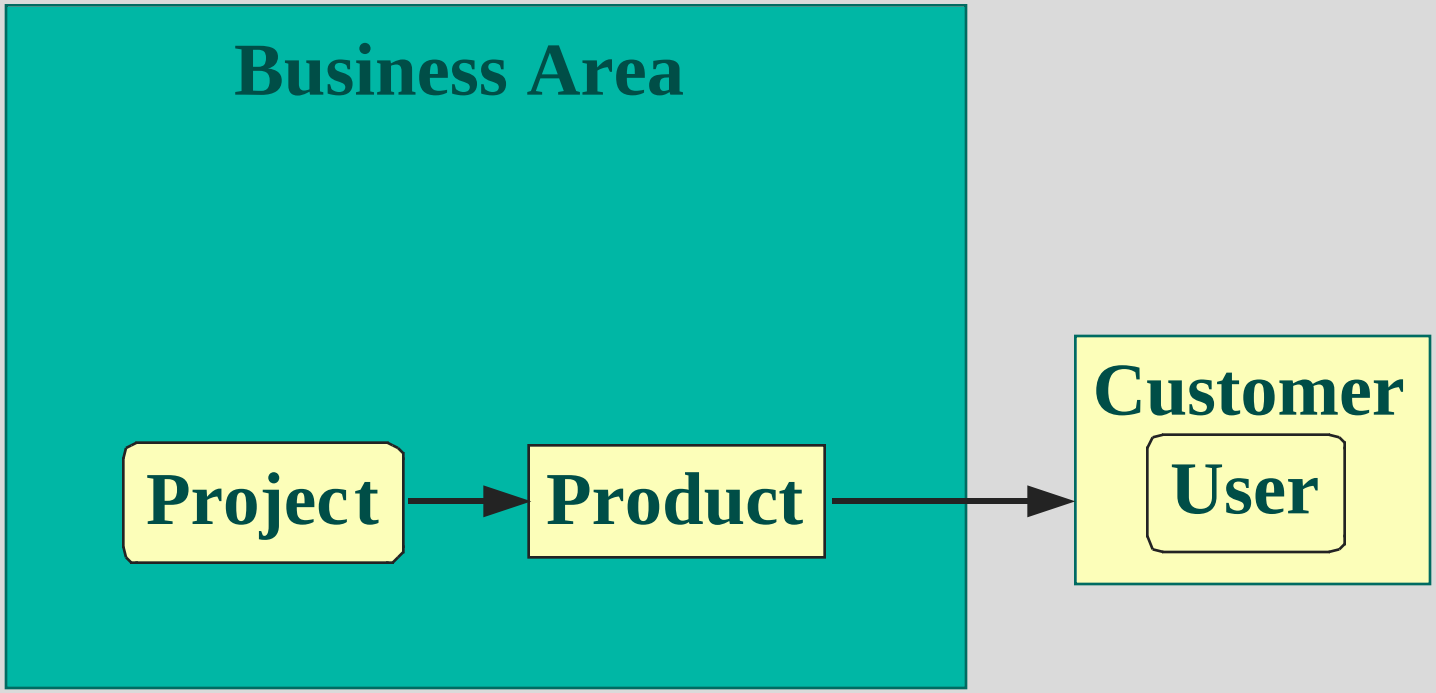
Definitions

- **Application: hardware, software, and procedures that are deployed to institute a system**
- **Product: an application and all associated work products**
- **Product line: a set of envisioned (current and future) products directed to a particular business area**
- **Business area: a coherent market of customers having similar needs**
- **Product family: a formalization of a product line according to similarities in the envisioned products**
- **Domain: (1) The knowledge (product family) and expertise (process) required to build a particular type of product; (2) a project responsible for developing a product family and associated process**

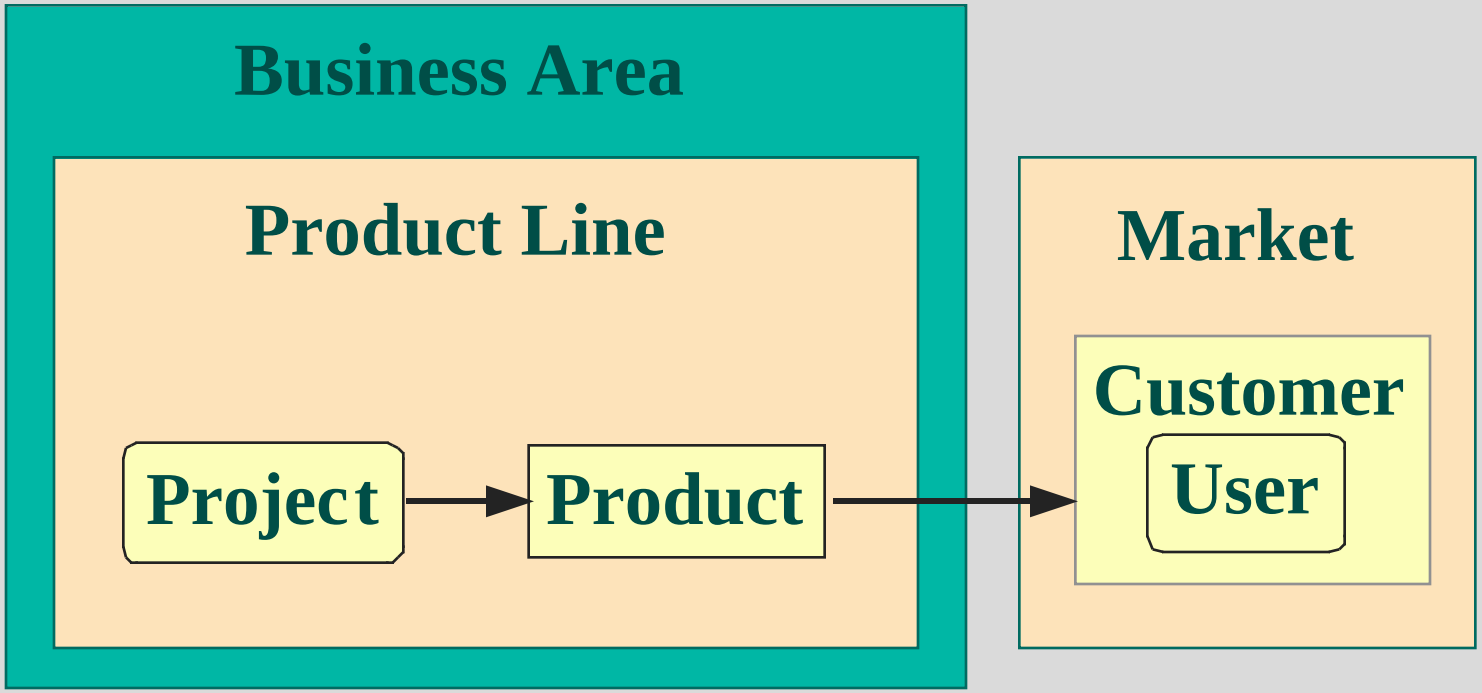
Mass Producing Customized Products

Domain-specific Engineering

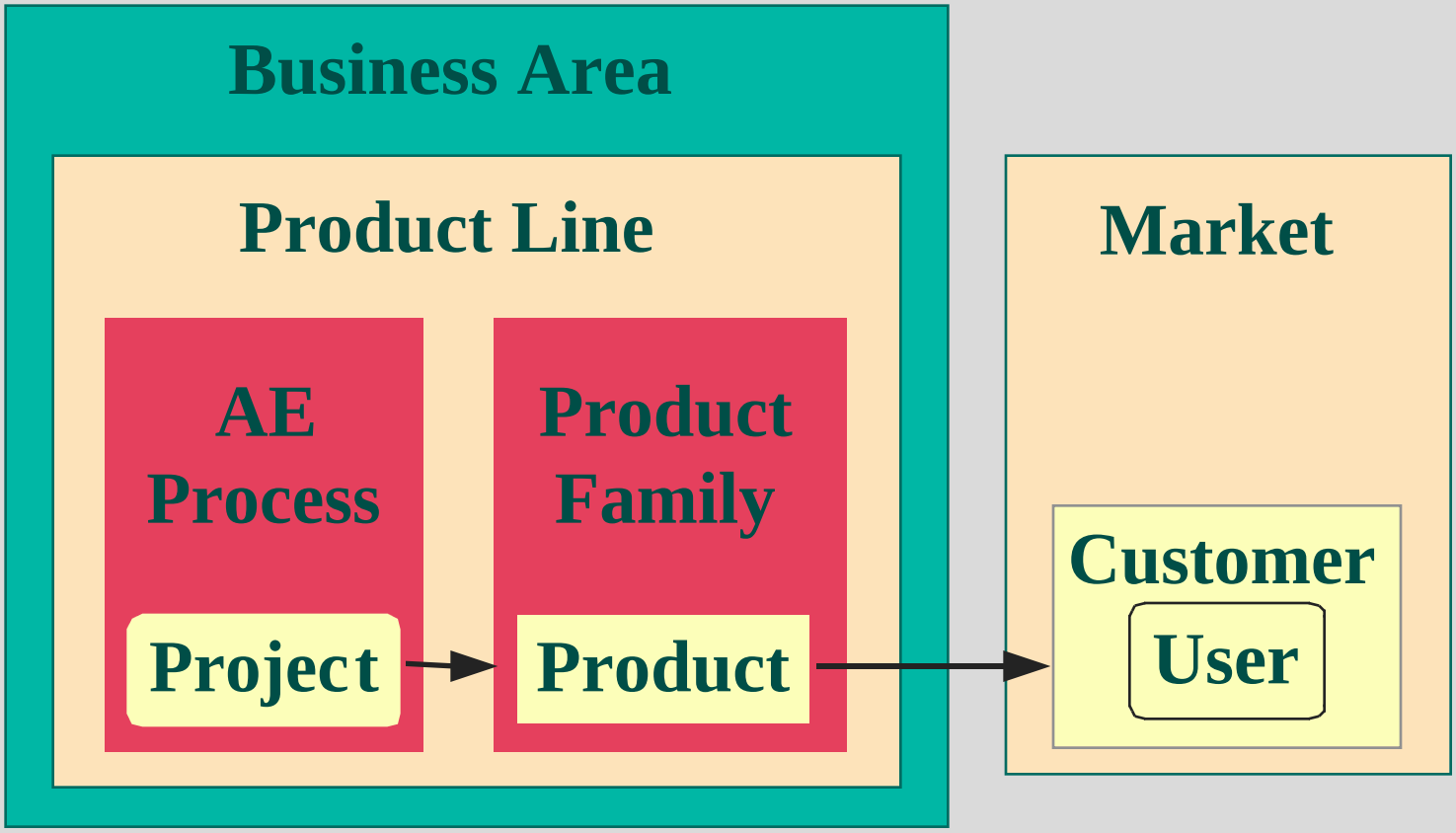
Conventional Organizational Model



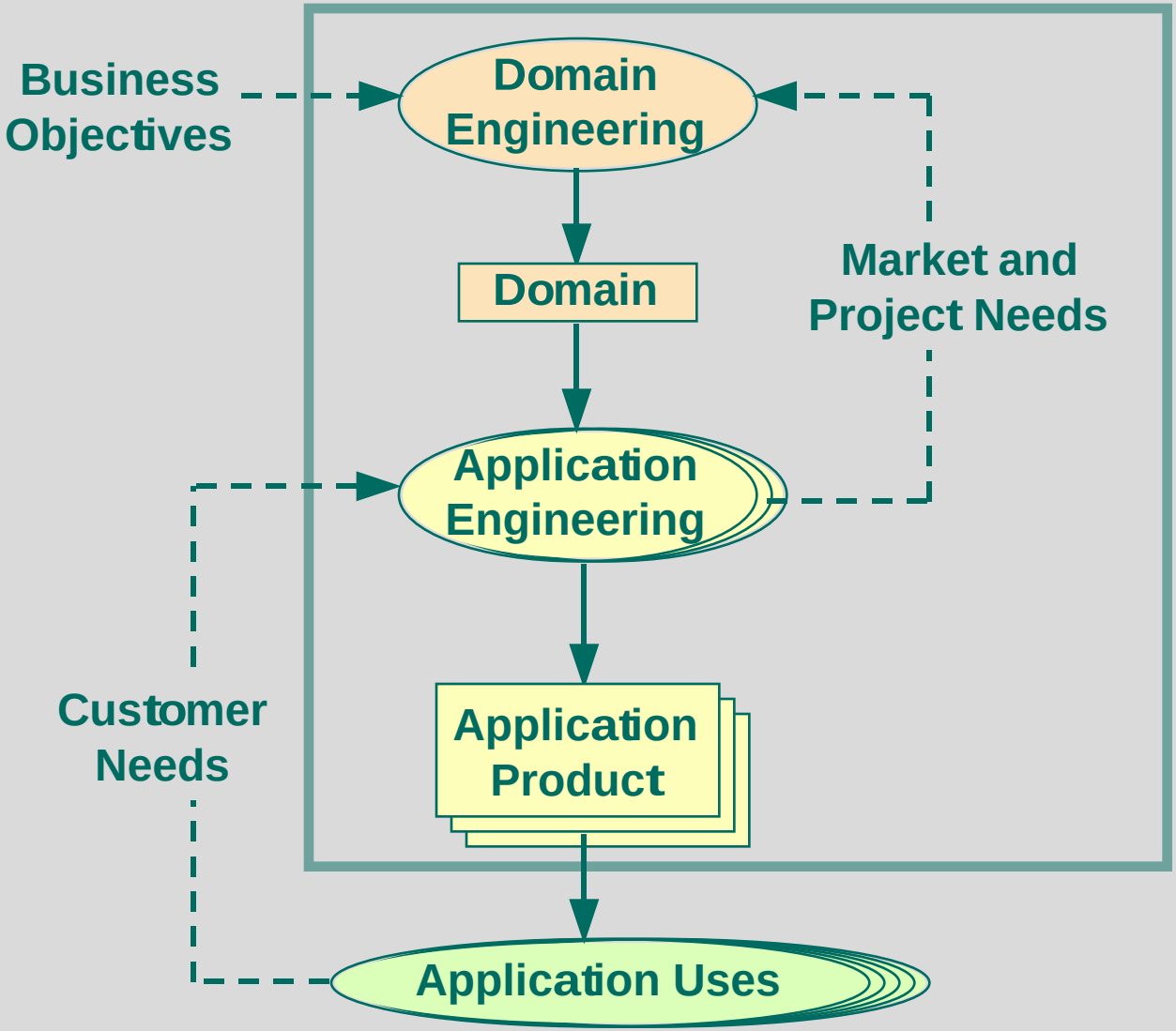
DsE Organizational Model



DsE Organizational Model



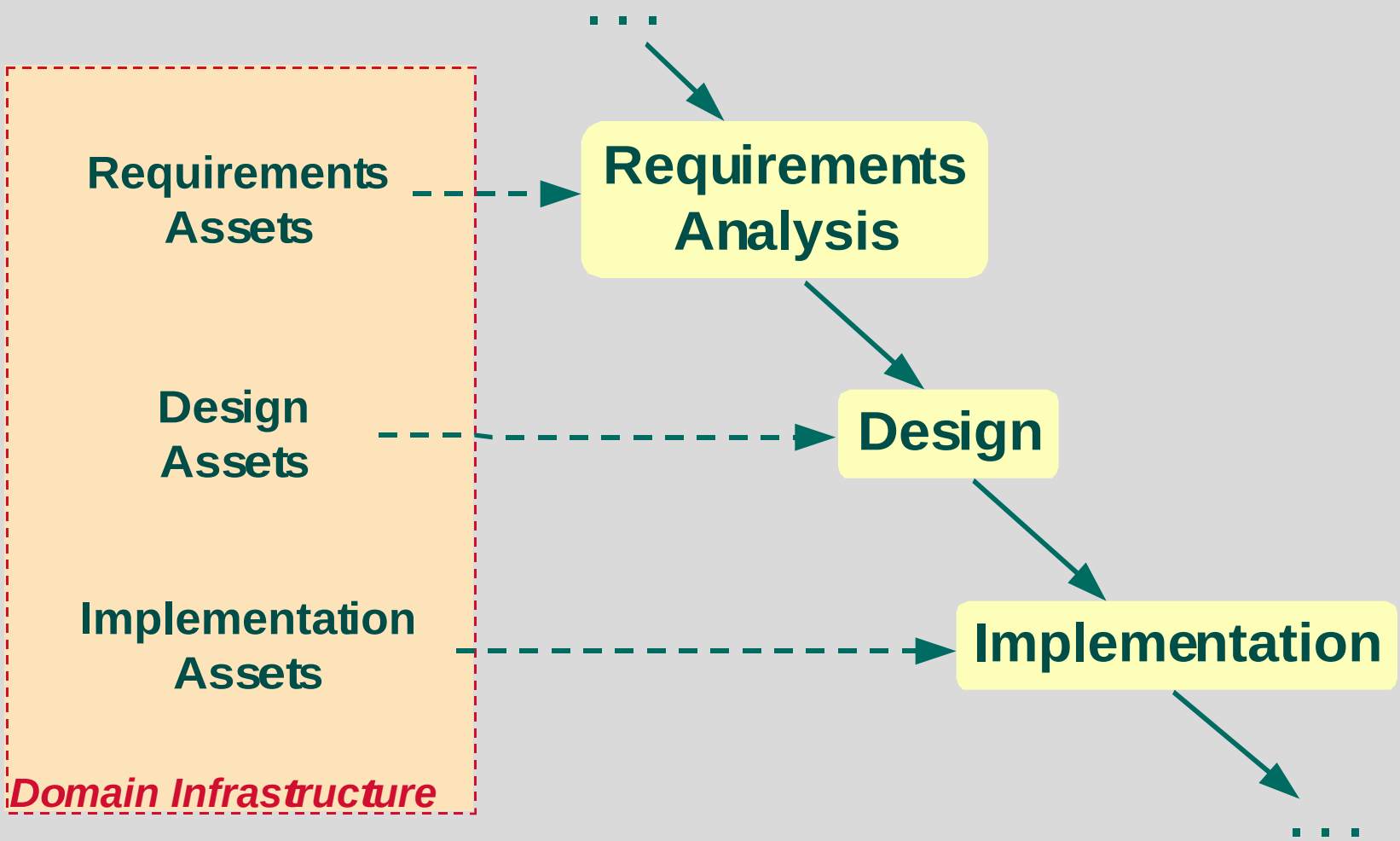
The DsE Process



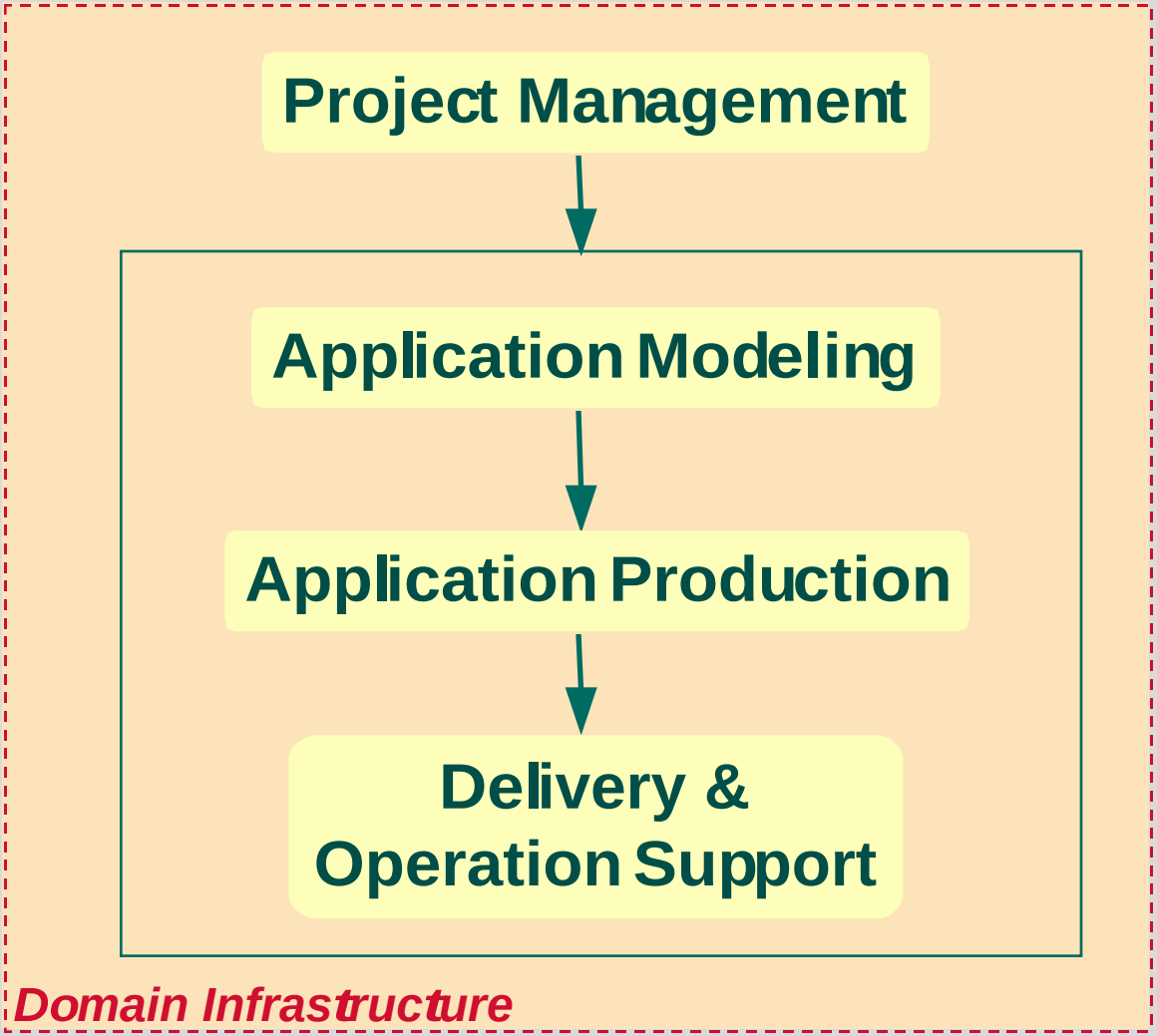
DsE Activities

- **Domain Engineering:**
  - **Standardize a product family, adaptable to deferred requirement and engineering decisions.**
  - **Establish a standard process for resolving deferred decisions.**
- **Application Engineering:**
  - **Resolve deferred decisions to match customer needs.**
  - **Mechanically produce a product, adapted to resolved decisions.**

An Augmented Application Engineering Process



A Streamlined Application Engineering Process



Planning & Coordination

Product Specification & Validation

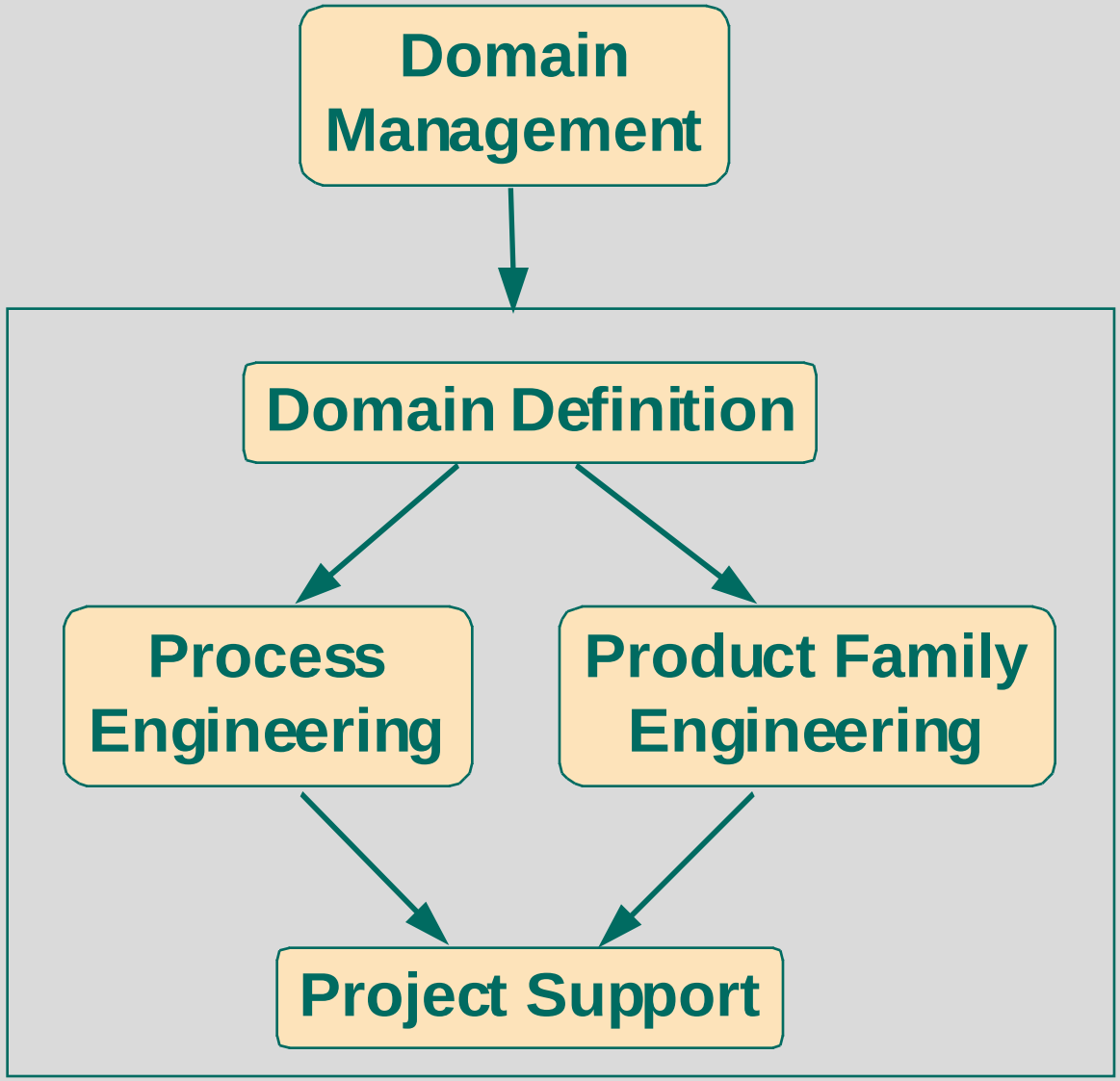
Product Generation & Verification

Product Distribution

Artifacts of a Domain

- **Domain Plan**
  - Market and product vision
  - Evolution strategy and plans
- **Domain Definition**
  - Terminology & assumptions
  - Decision model
- **Product Family**
  - Reusable components
  - Tailoring and composition tools
- **AE Process**
  - Tools & procedures
  - User documentation & training materials

Domain Engineering



Domain Engineering Activities

Domain Management

Organize, plan, and direct domain efforts to achieve business objectives

Domain Definition

Establish the focus and scope of the domain

Product Family Engineering

Develop assets and mechanisms for deriving tailored instances of a product family

Process Engineering

Define a standardized application engineering process and develop a supporting infrastructure

Project Support

Ensure that the domain meets business, project, and market needs

Side-Effects of DsE

- Expressing customer needs in a concise standardized form and terminology ensures clearer communication and earlier discovery of unsupported needs.
- Quality improvements in the product family improve the quality of all products.
- Process standardization fosters more predictable schedules and cost estimates.
- Process streamlining, based on a product family, reduces time and effort to deliver similar products.
- Problem and solution knowledge and expertise are more easily shared and extended.

DsE Tradeoffs

Pros

- Similar products are built without redundant effort.
- Each product is tailored to the specific needs of one customer.
- Product costs and schedules are more predictable.
- All products have a consistent level of quality.

Cons

- Flexibility requires investment.
- Product families are more complex than single products.
- Popular tools are not family friendly.
- Changing to a DsE mindset is hard.

Adopting DsE

Reuse-driven Process Improvement (PI_r)

Is DsE Right for You?

- Appropriate management and engineering expertise is available (and, usually, prior products)
- There is a viable future market for a line of similar products:
  - Multiple customers with differing needs
  - A single customer who needs multiple versions
  - Customer needs or supporting technologies that are likely to change
- Management is committed to the product line market as a cohesive business focus

Actions to Institute DsE

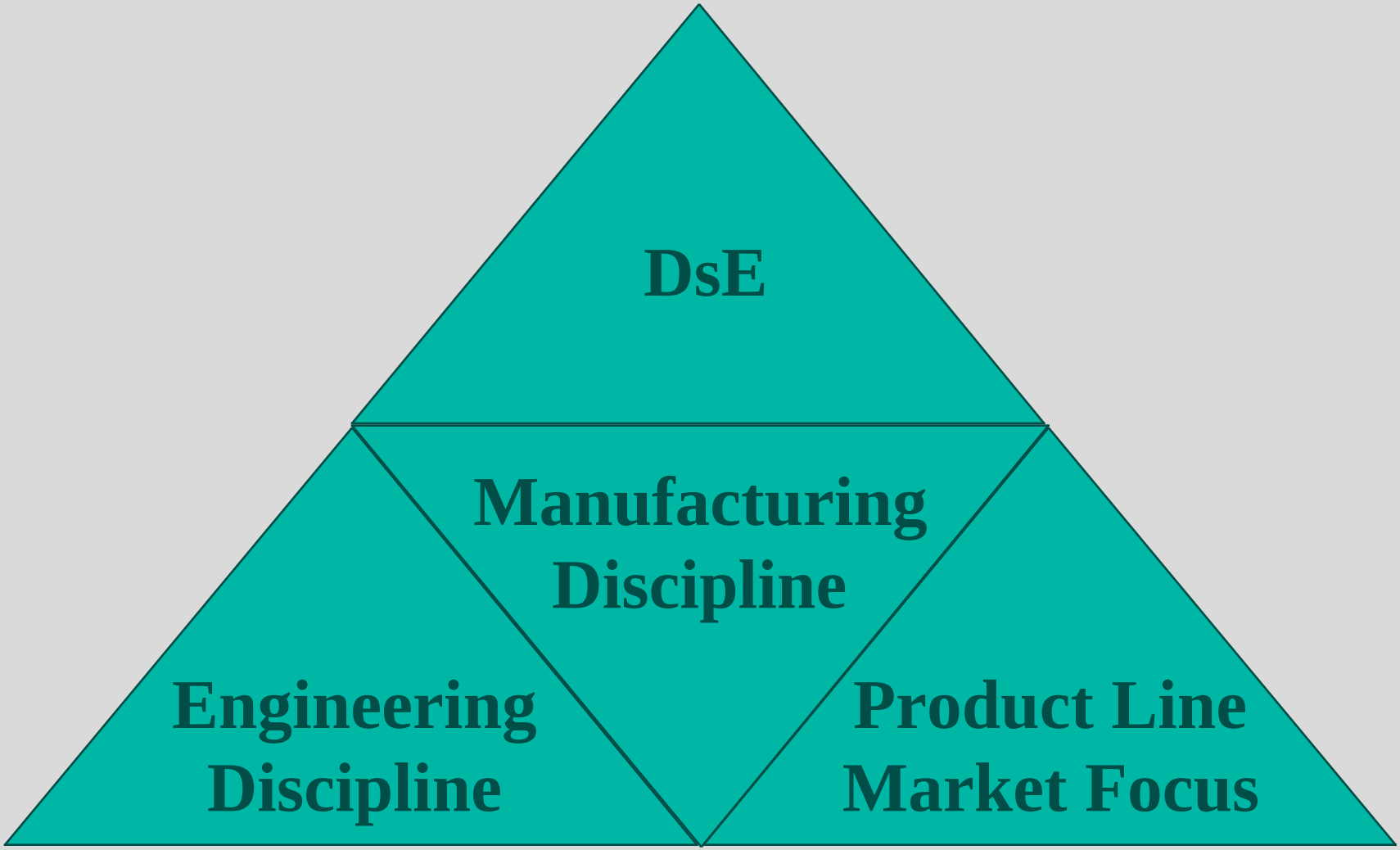
Organizational actions

- **Evaluate utility**
- **Initiate pilot efforts**
- **Provide training and support**

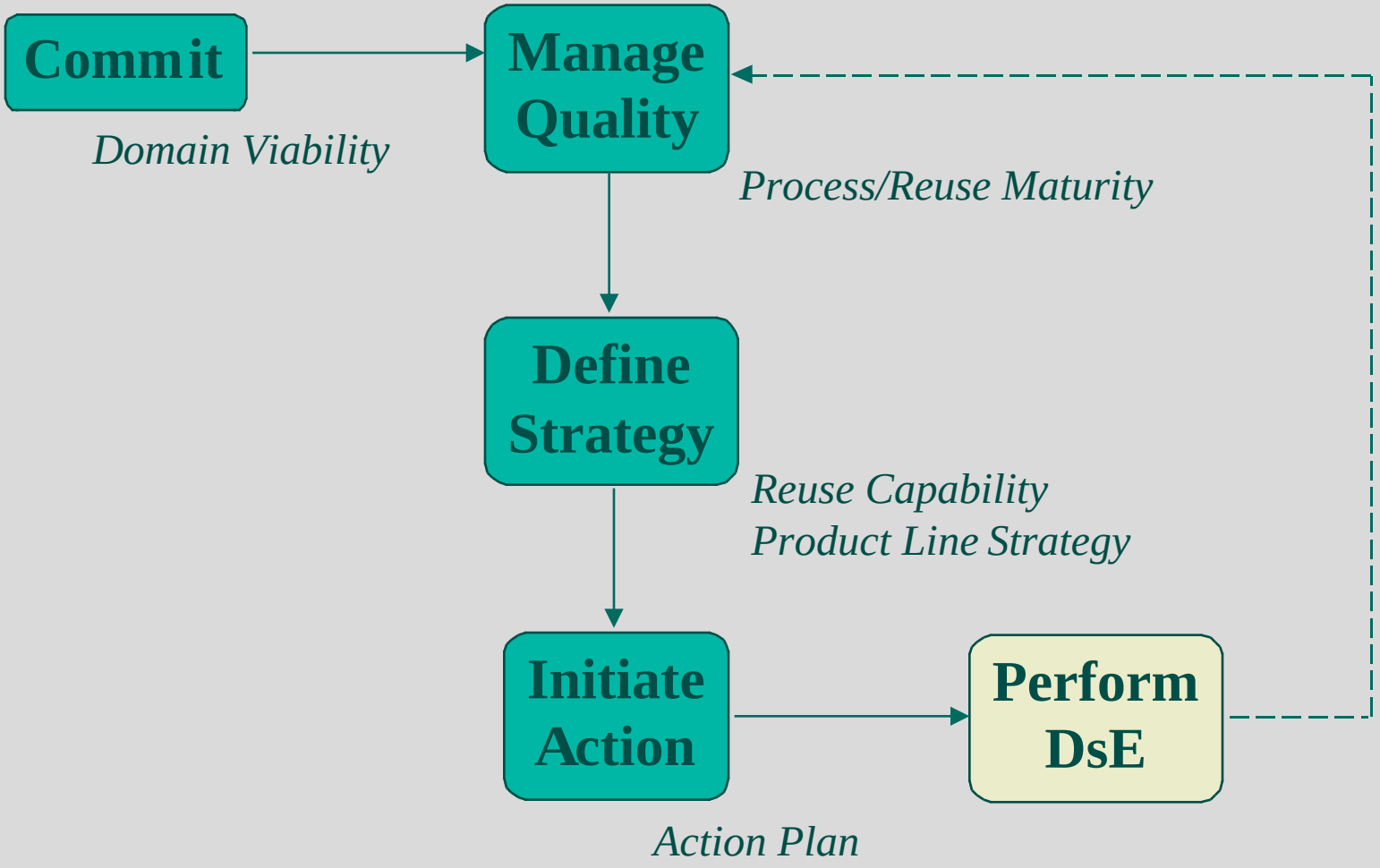
Domain-specific actions (3-4 month pilot efforts)

- **Define a preliminary product line focus**
- **Evaluate domain viability**
- **Analyze commonalities and variabilities**
- **Develop selected adaptable components**
- **Initiate the PI_r process**

Objectives of PI_r



PI_r Process



Product Line Strategy

Market/products focus

Business model

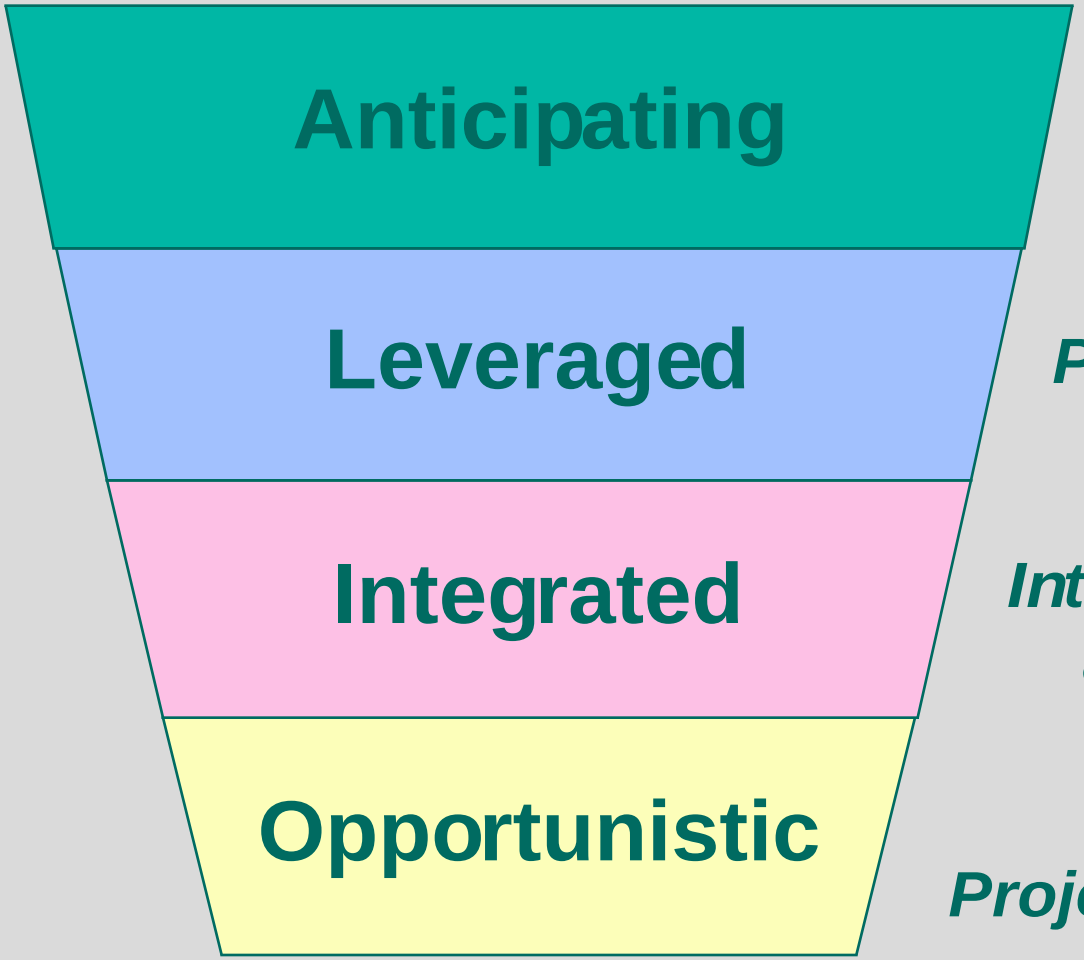
Tailored process model

Organizational structure

Support environment

Transition strategy

4 Levels of DsE Capability



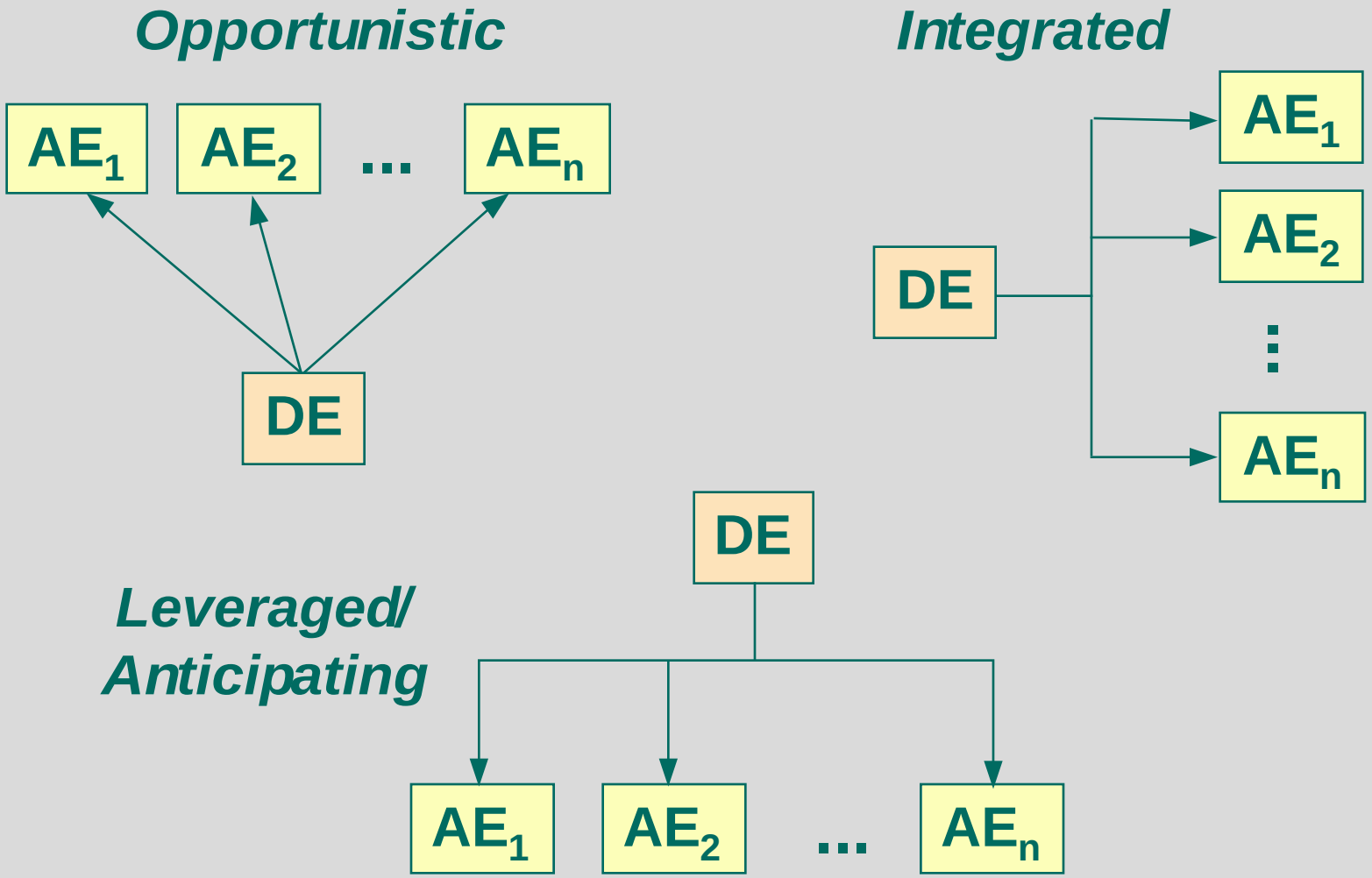
Domain-Market Coevolution

Products/Process Standardization

Integrated Products & Management

Enhanced Project-level Reuse

DsE Product Line Organizations



DsE Transition Strategies