軟體工程
(Software Engineering)
敏捷軟體工程：
敏捷方法、Scrum、 極限程式設計
(Agile Software Engineering:
Agile methods, Scrum, and Extreme Programming)

1101SE03
MBA, IM, NTPU (M6131) (Fall 2021)
Thu 11, 12, 13 (19:25-22:10) (209)

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2021-10-07

課程大綱 (Syllabus)

國立臺北大學 National Taipei University

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
1	2021/09/23	軟體工程概論 (Introduction to Software Engineering)
2	2021/09/30	軟體產品與專案管理：軟體產品管理，原型設計 (Software Products and Project Management: Software product management and prototyping)
3	2021/10/07	敏捷軟體工程：敏捷方法、Scrum、極限程式設計 (Agile Software Engineering: Agile methods, Scrum, and Extreme Programming)
4	2021/10/14	功能、場景和故事 (Features, Scenarios, and Stories)
5	2021/10/21	軟體工程個案研究 I (Case Study on Software Engineering I)
6	2021/10/28	軟體架構：架構設計、系統分解、分散式架構 (Software Architecture: Architectural design, System decomposition, and Distribution architecture)

課程大綱 (Syllabus)

國立臺北大學 National Taipei University

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
7	2021/11/04	基於雲的軟體：虛擬化和容器、軟體即服務 (Cloud-Based Software: Virtualization and containers, Everything as a service, Software as a service)
8	2021/11/11	期中報告 (Midterm Project Report)
9	2021/11/18	雲端運算與雲軟體架構 (Cloud Computing and Cloud Software Architecture)
10	2021/11/25	微服務架構：RESTful服務、服務部署 (Microservices Architecture, RESTful services, Service deployment)
11	2021/12/02	軟體工程產業實務 (Industry Practices of Software Engineering)
12	2021/12/09	軟體工程個案研究 II (Case Study on Software Engineering II)

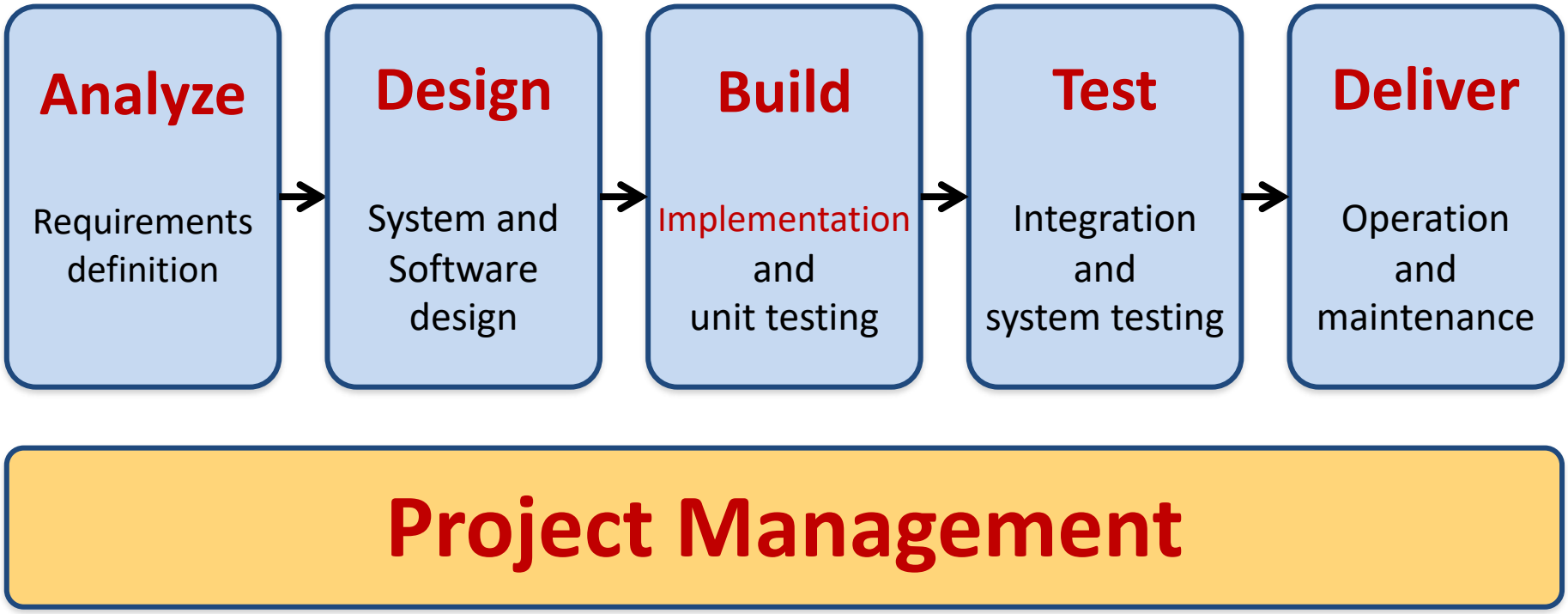
課程大綱 (Syllabus)

國立臺北大學 National Taipei University

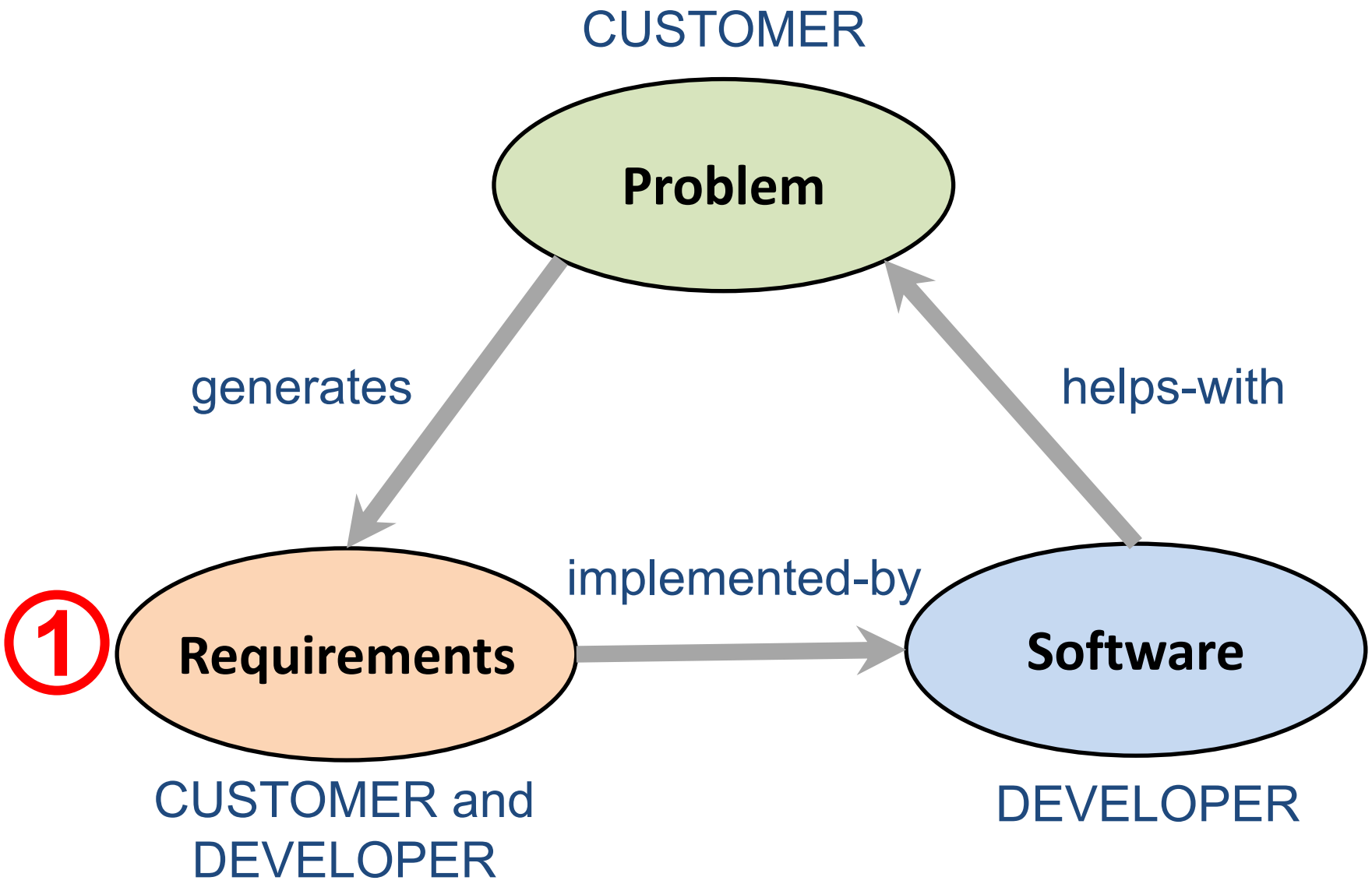
週次 (Week)	日期 (Date)	內容 (Subject/Topics)
13	2021/12/16	安全和隱私 (Security and Privacy); 可靠的程式設計 (Reliable Programming)
14	2021/12/23	測試：功能測試、測試自動化、 測試驅動的開發、程式碼審查 (Testing: Functional testing, Test automation, Test-driven development, and Code reviews); DevOps和程式碼管理：程式碼管理和DevOps自動化 (DevOps and Code Management: Code management and DevOps automation)
15	2021/12/30	期末報告 I (Final Project Report I)
16	2022/01/06	期末報告 II (Final Project Report II)
17	2022/01/13	學生自主學習 (Self-learning)
18	2022/01/20	學生自主學習 (Self-learning)

Agile Software Engineering

Software Engineering and Project Management

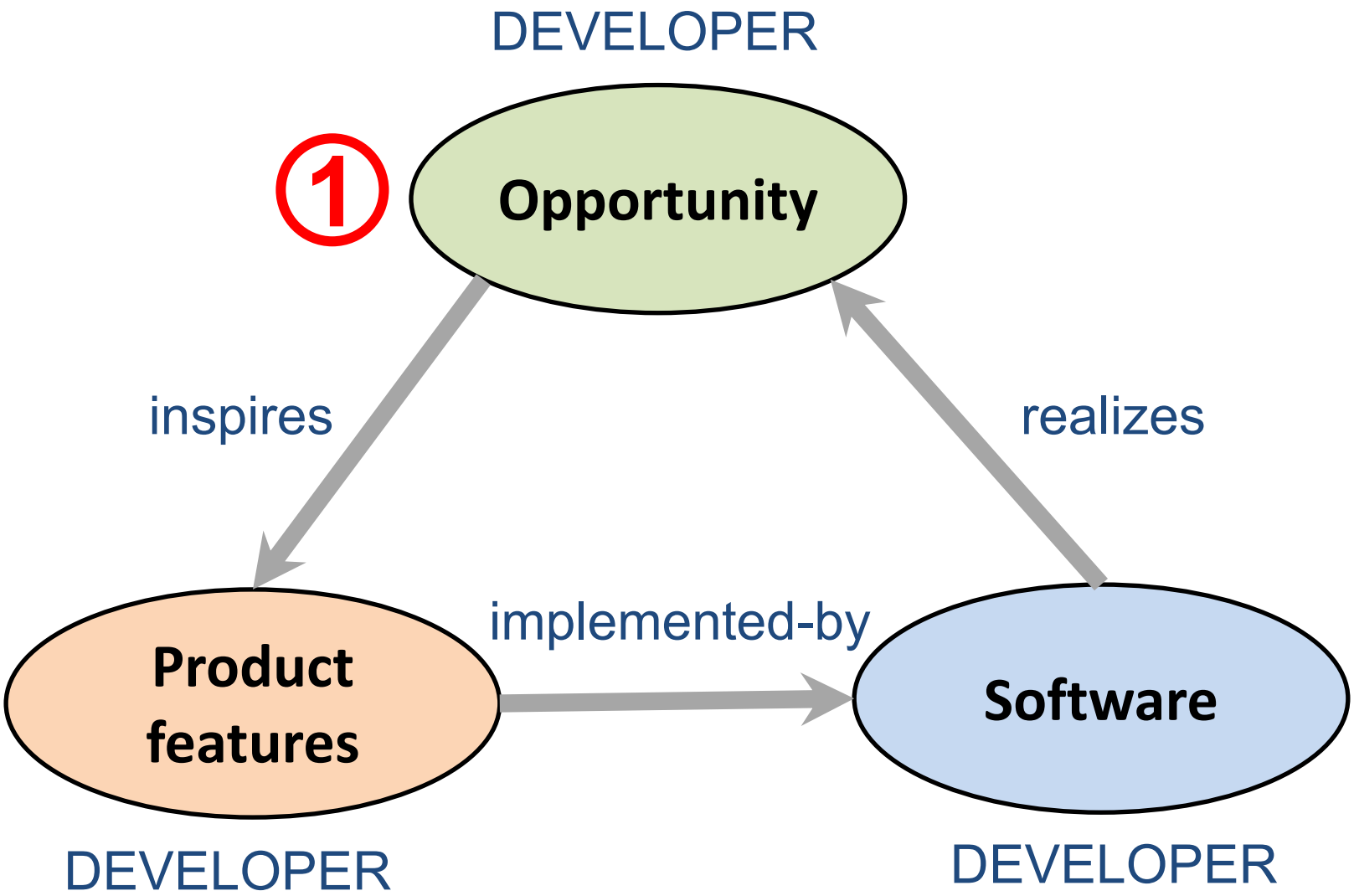


Project-based software engineering



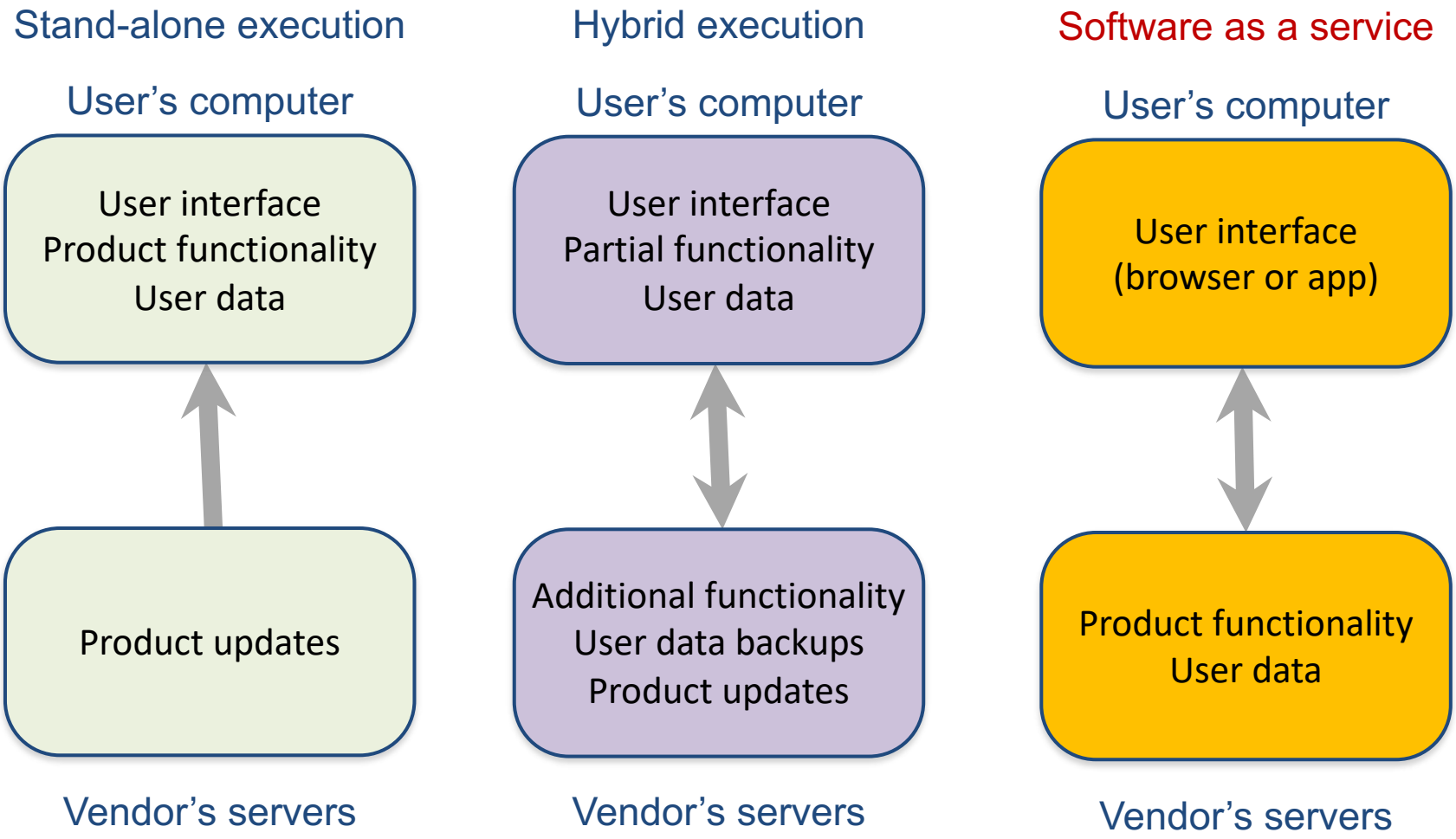
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Product software engineering



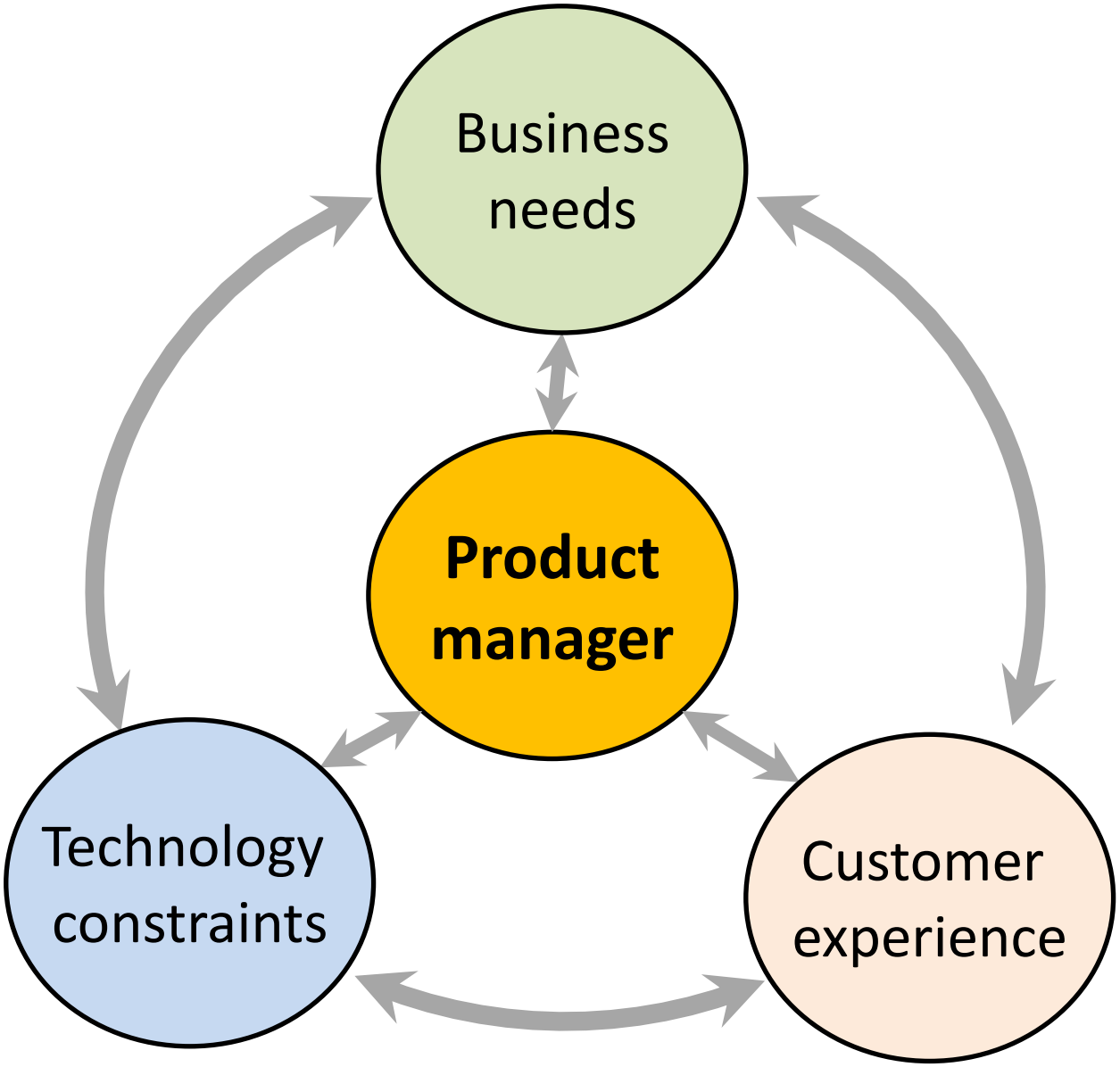
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Software execution models



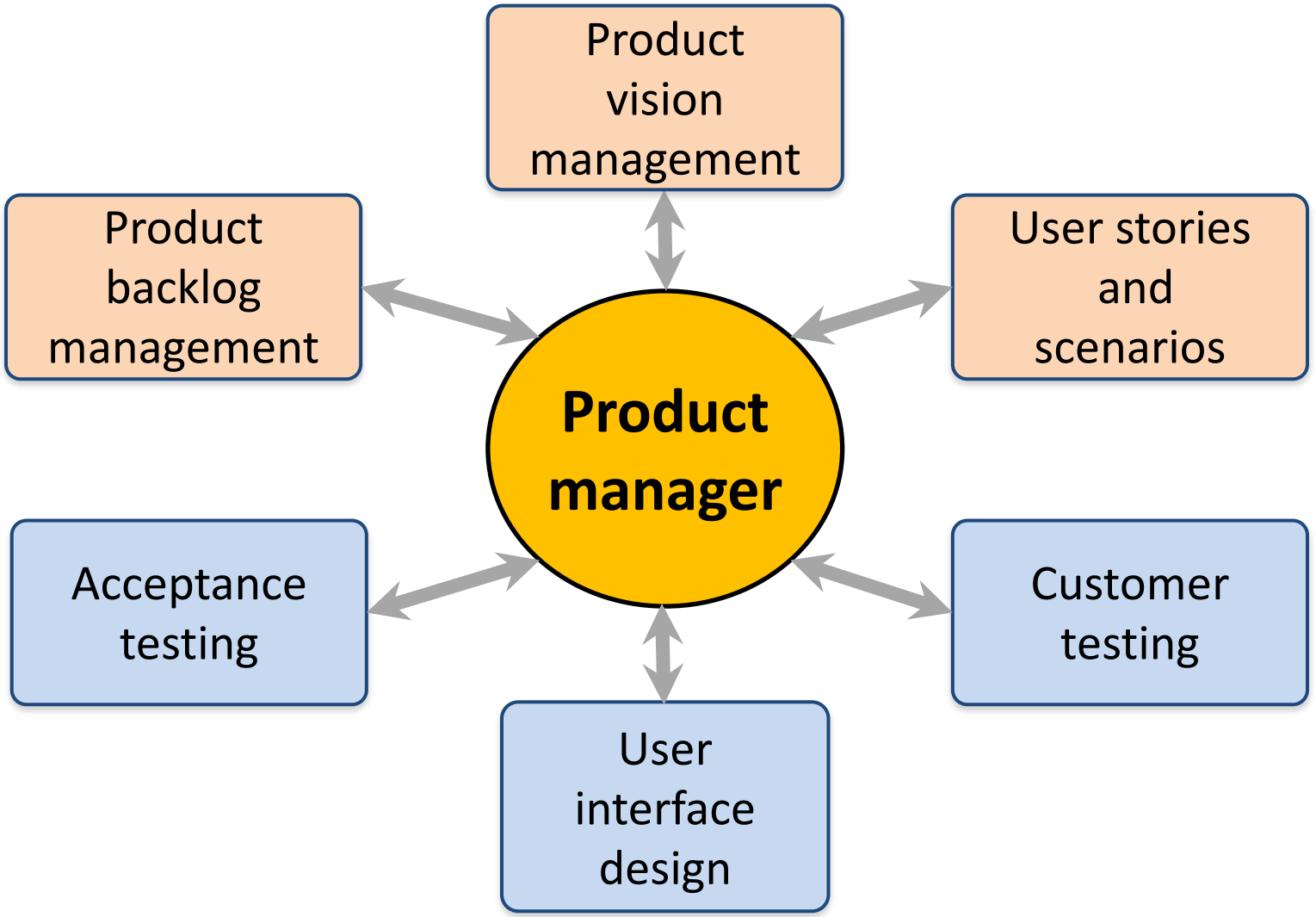
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Product management concerns



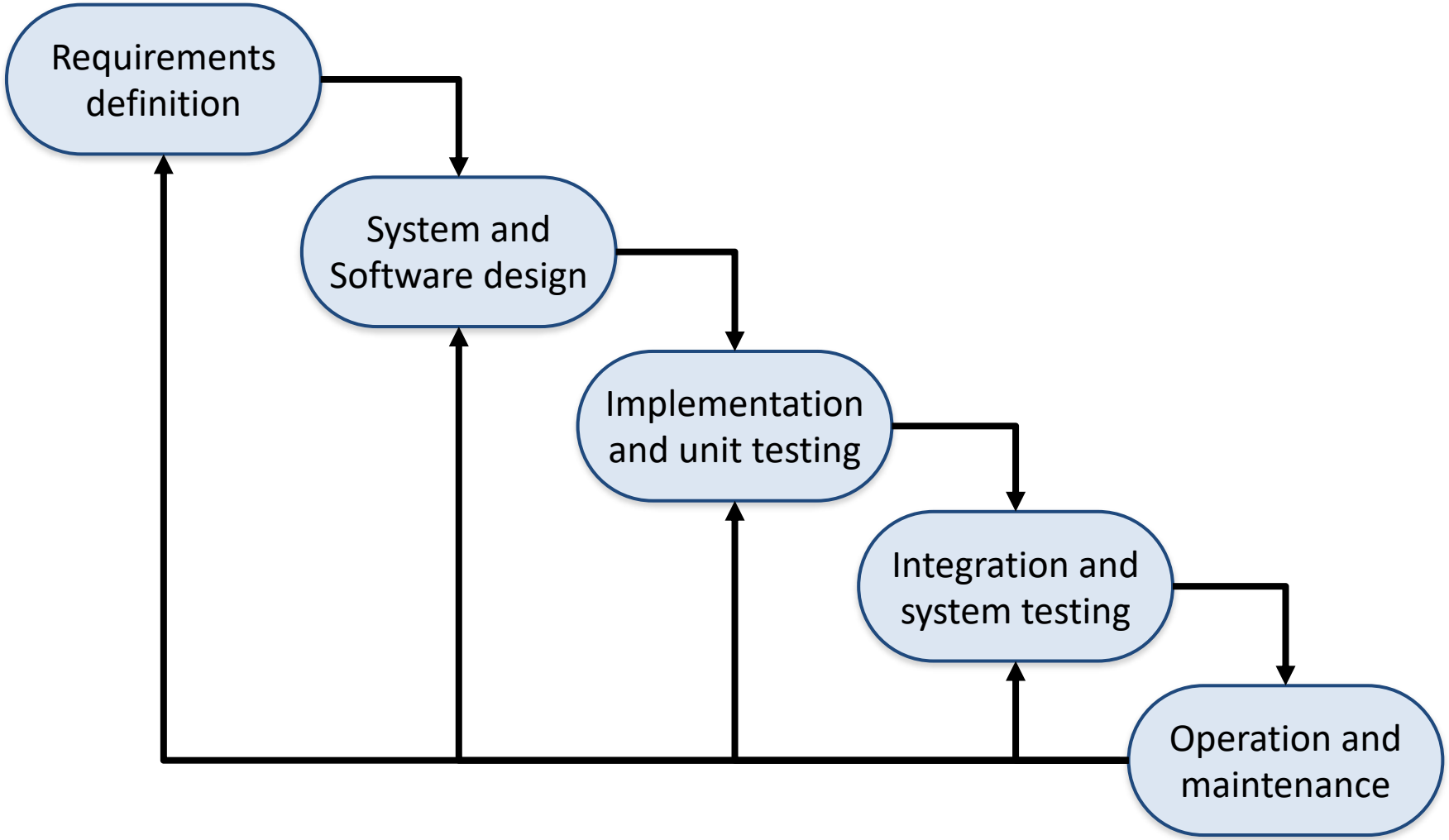
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Technical interactions of product managers



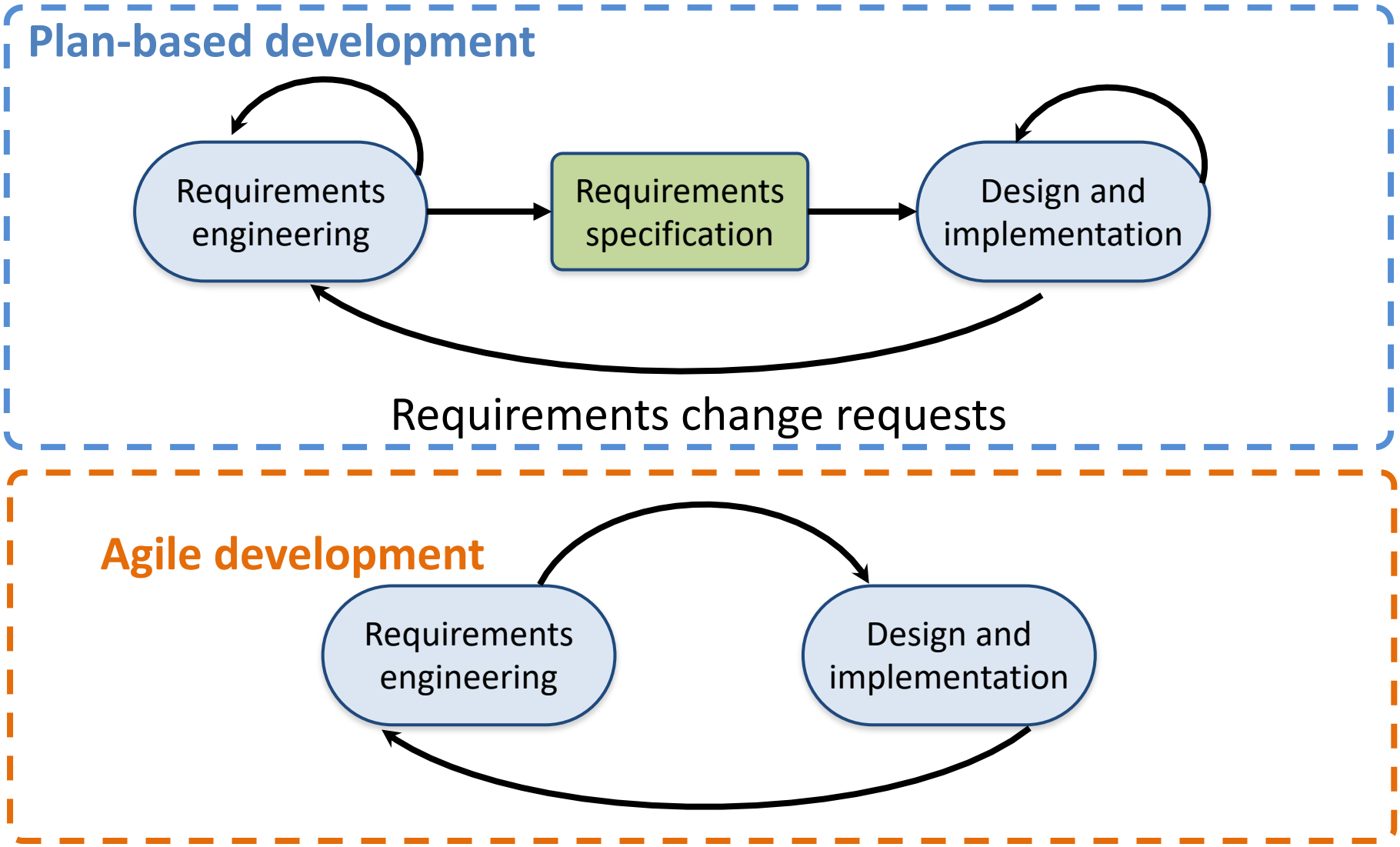
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Software Development Life Cycle (SDLC)
The waterfall model



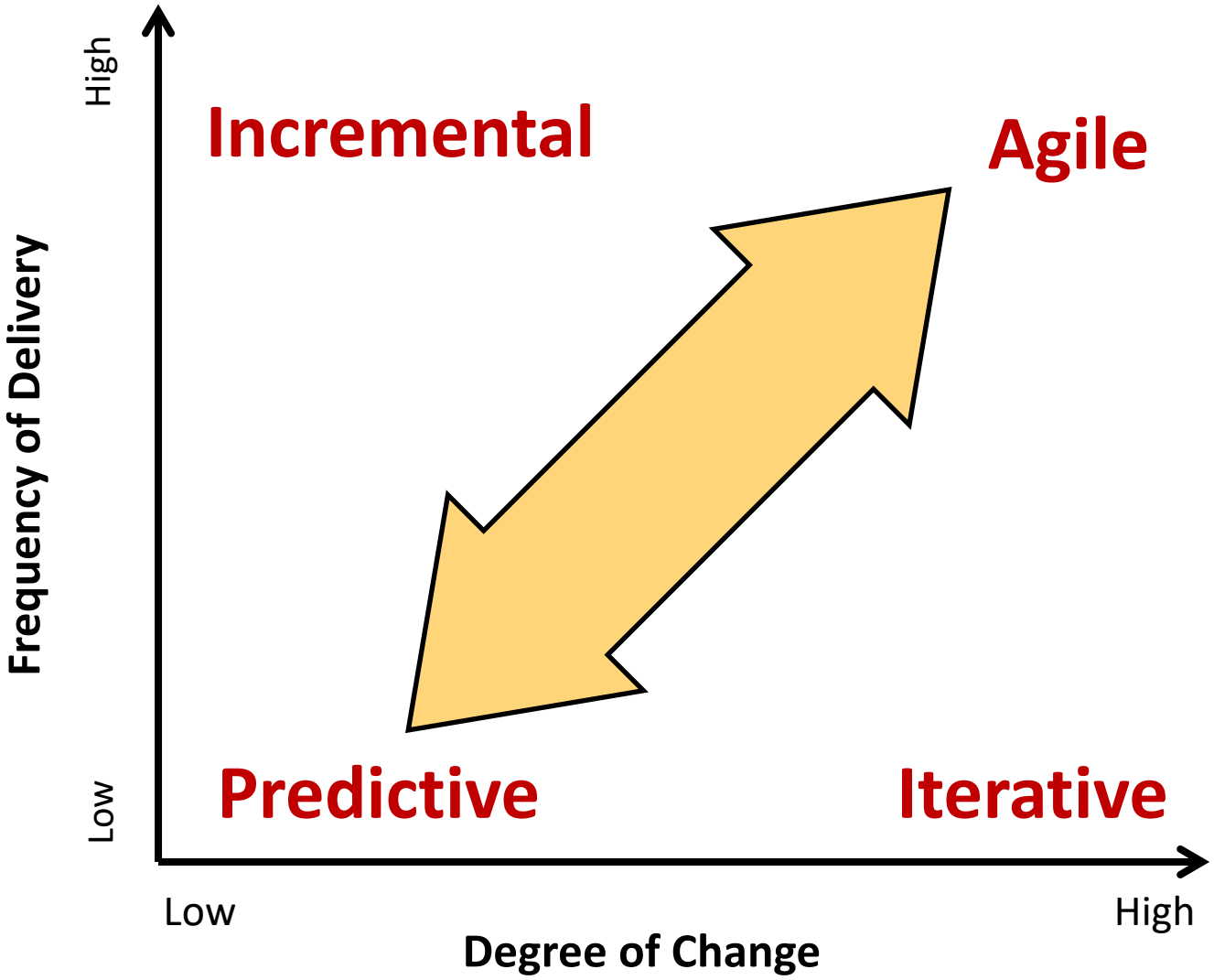
Source: Ian Sommerville (2015), Software Engineering, 10th Edition, Pearson.

Plan-based and Agile development



Source: Ian Sommerville (2015), Software Engineering, 10th Edition, Pearson.

The Continuum of Life Cycles

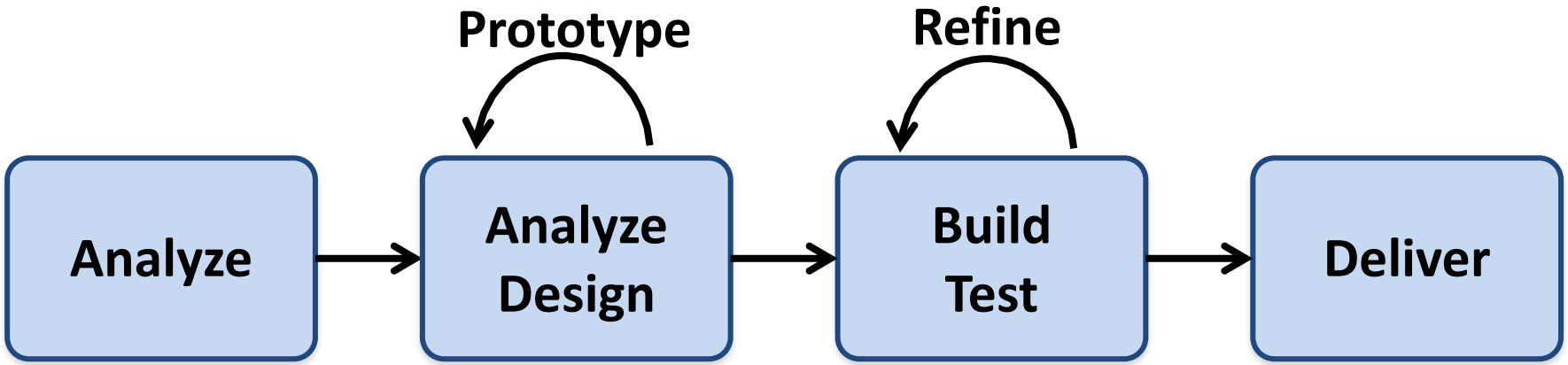


Source: Project Management Institute (2017), Agile Practice Guide, Project Management Institute

Predictive Life Cycle

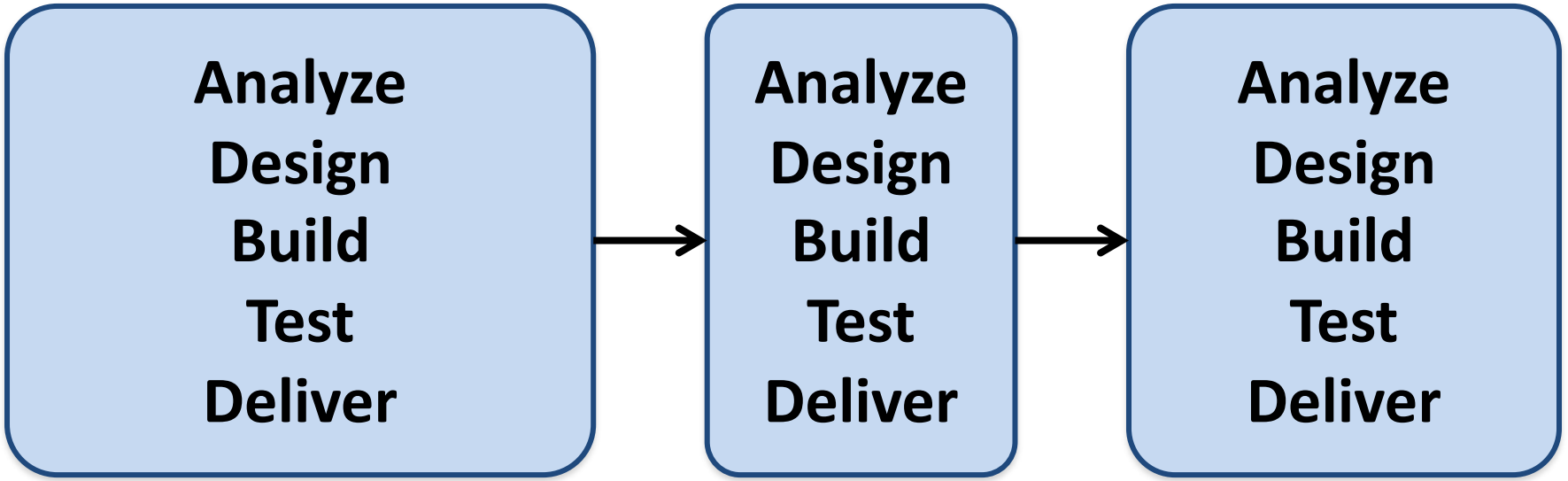
Source: Project Management Institute (2017), Agile Practice Guide, Project Management Institute

Iterative Life Cycle



Source: Project Management Institute (2017), Agile Practice Guide, Project Management Institute

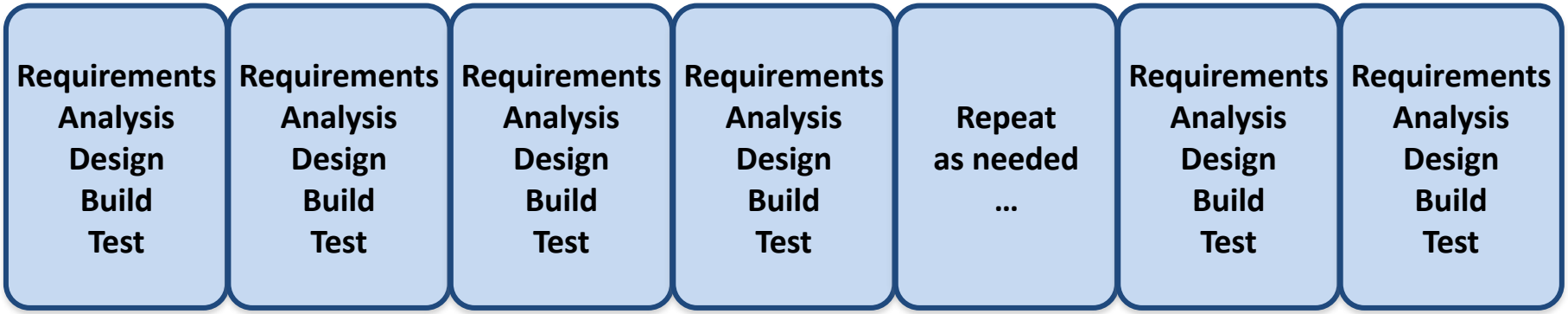
A Life Cycle of Varying-Sized Increments



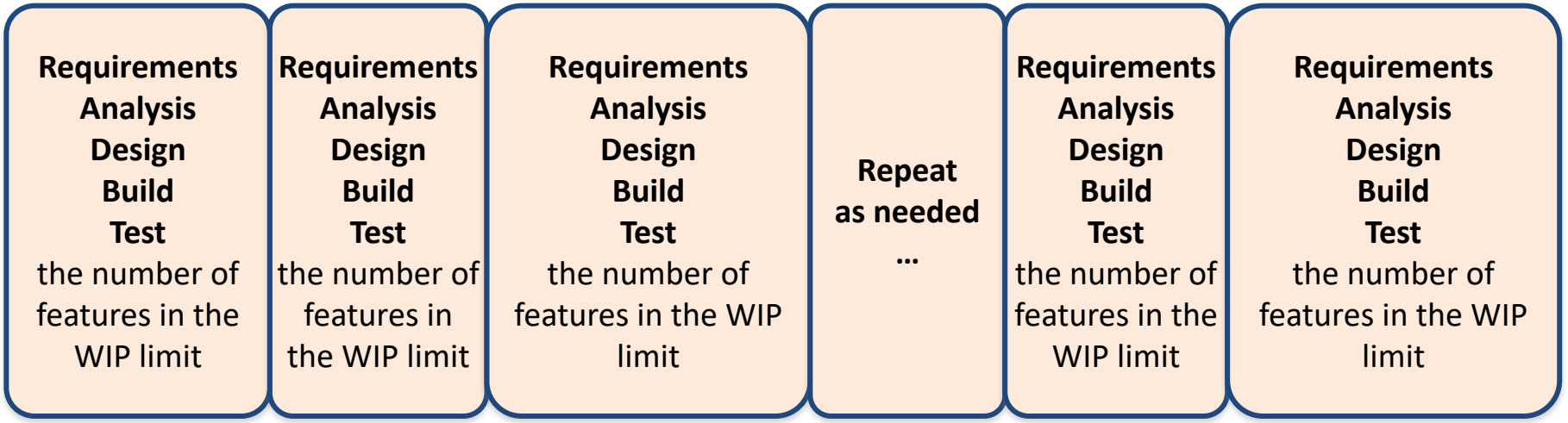
Source: Project Management Institute (2017), Agile Practice Guide, Project Management Institute

Iteration-Based and Flow-Based Agile Life Cycles

Iteration-Based Agile

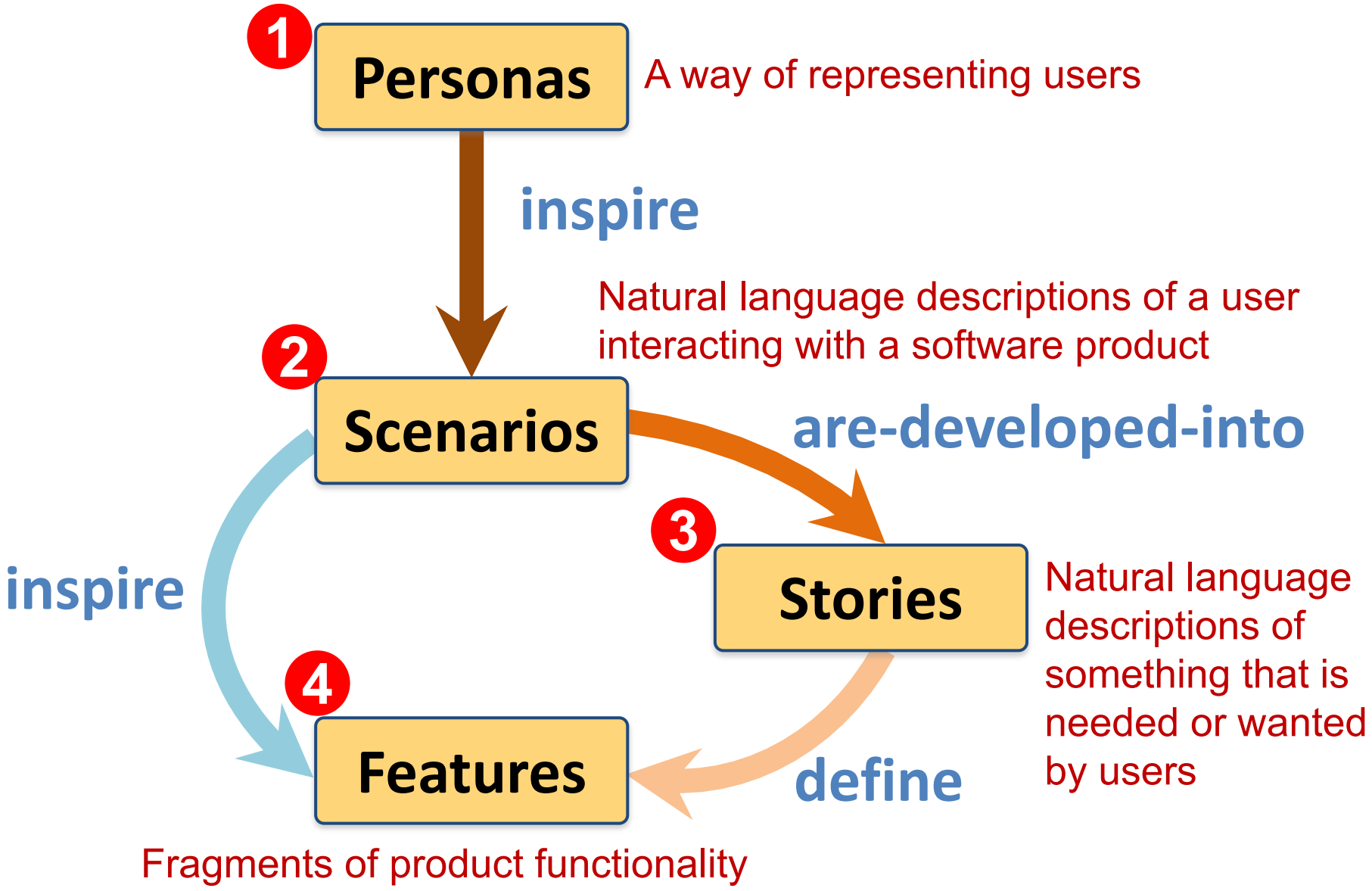


Flow-Based Agile



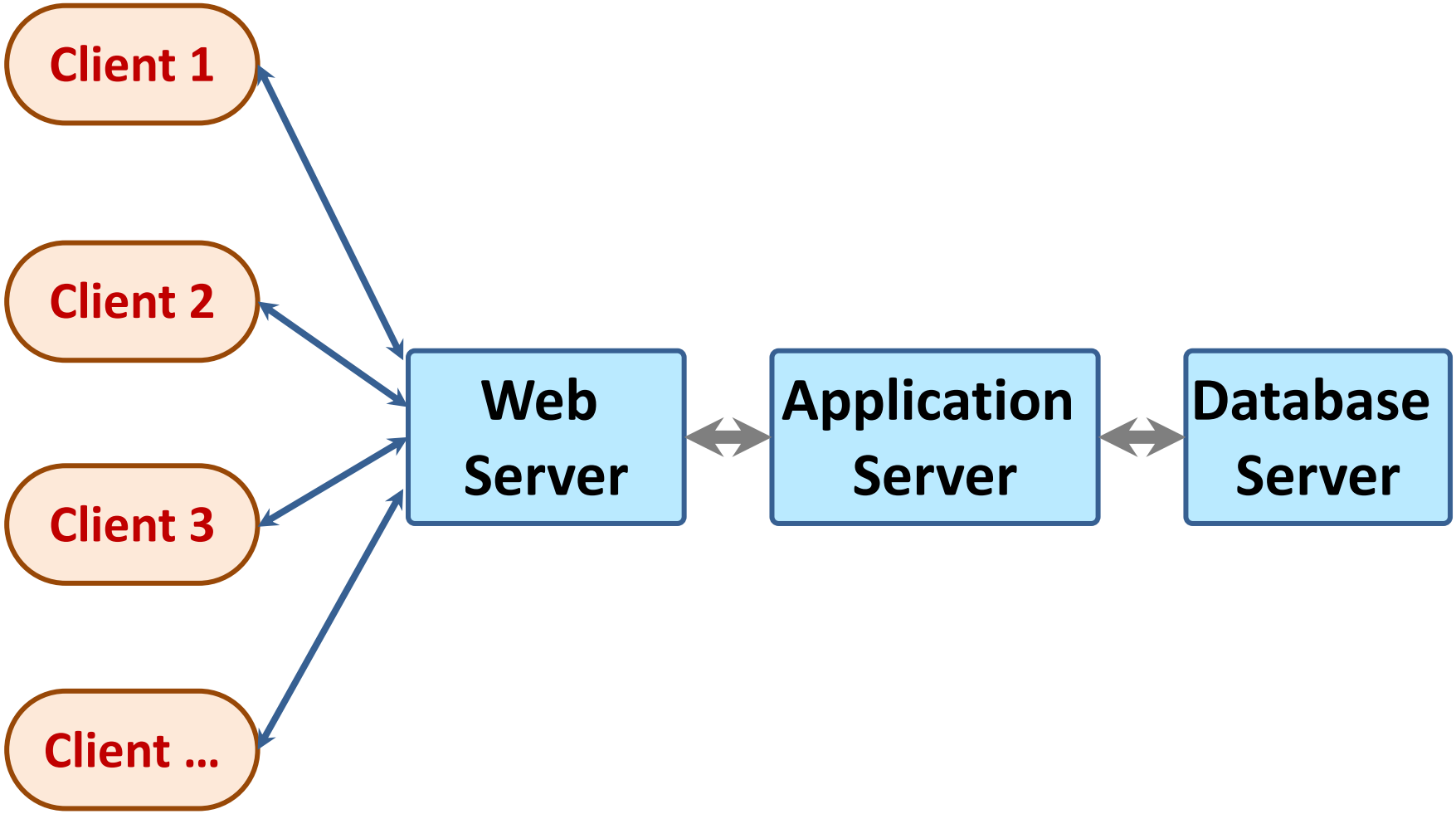
Source: Project Management Institute (2017), Agile Practice Guide, Project Management Institute

From personas to features



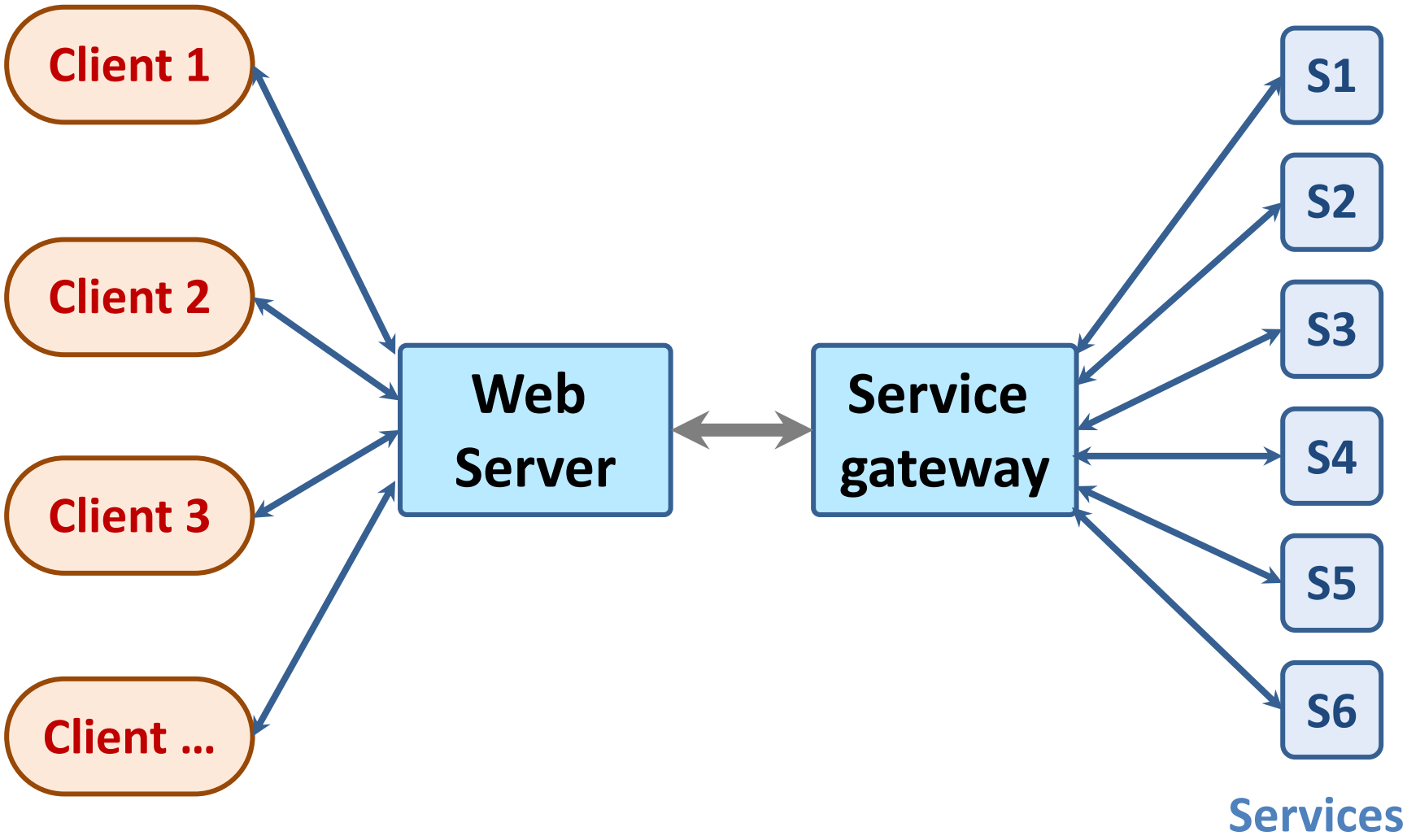
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Multi-tier client-server architecture

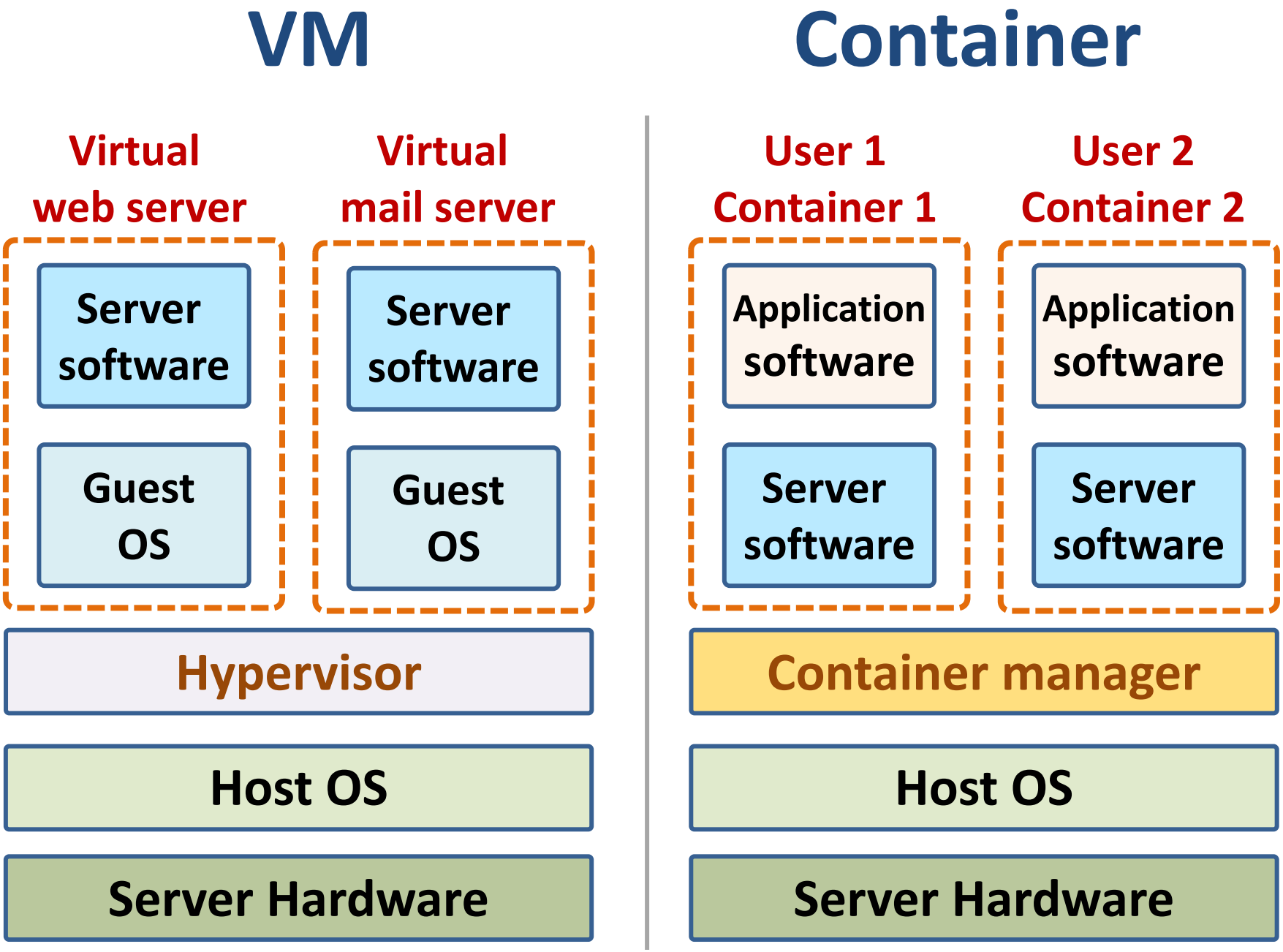


Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Service-oriented Architecture

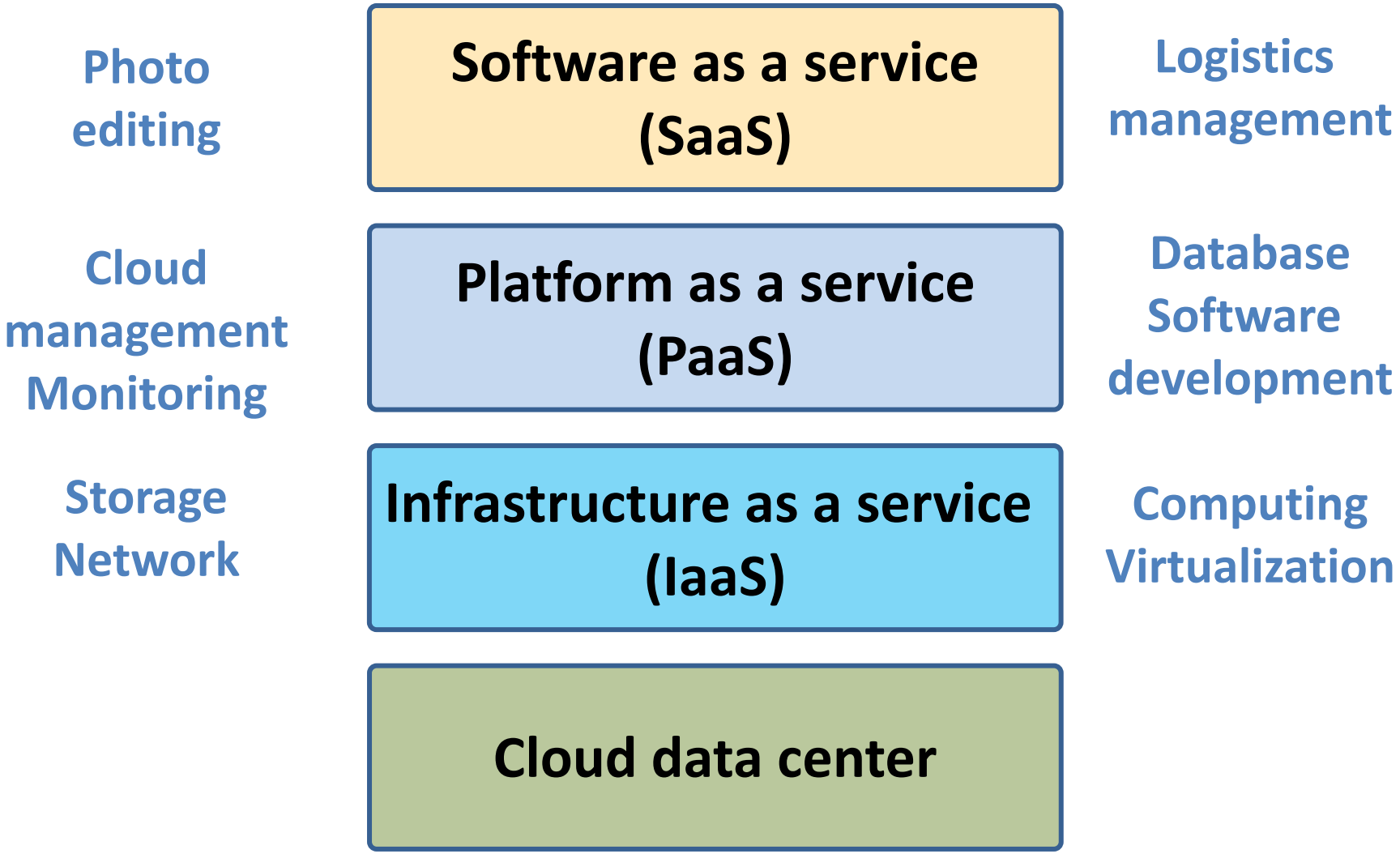


Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.



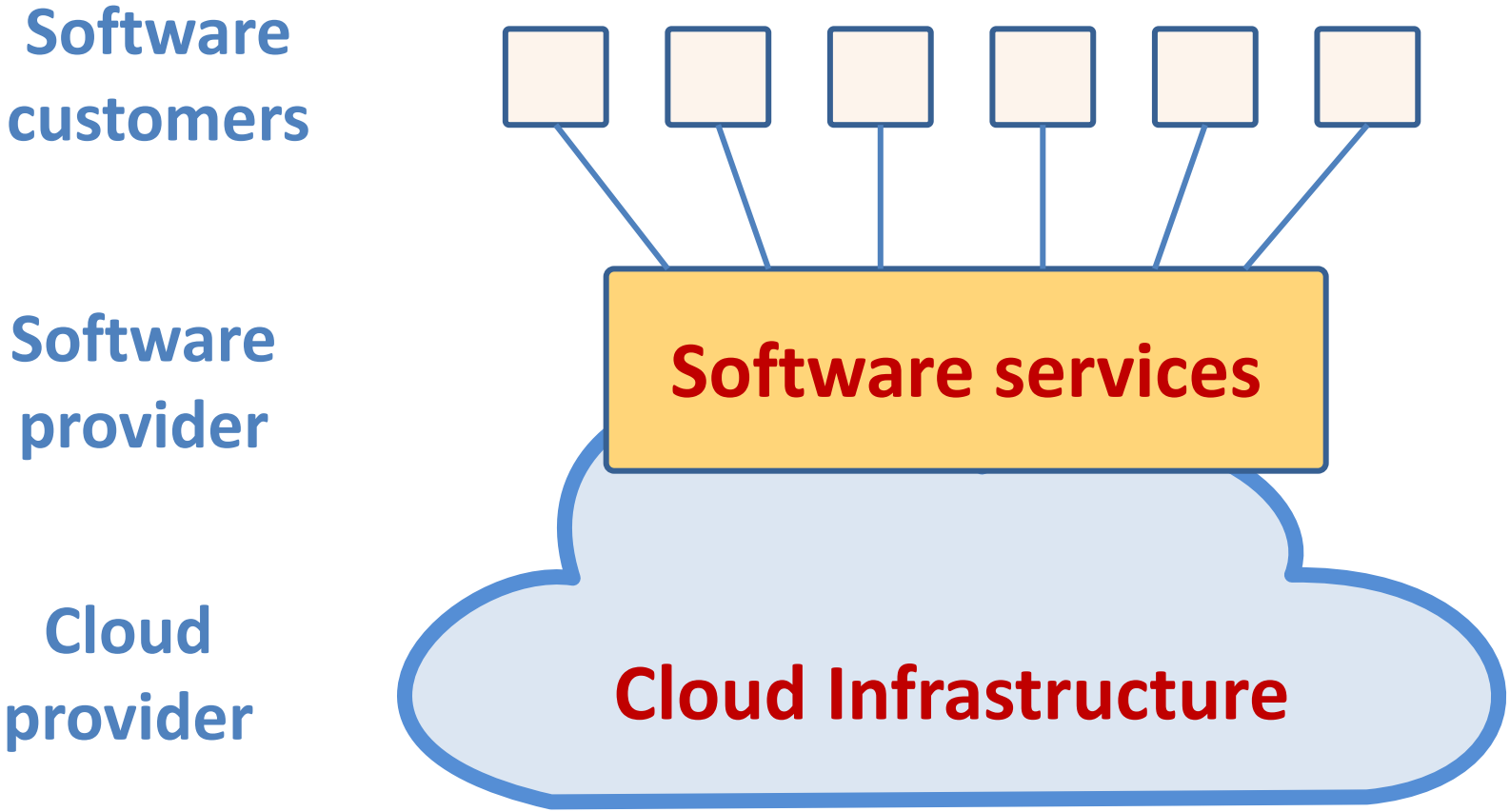
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Everything as a service



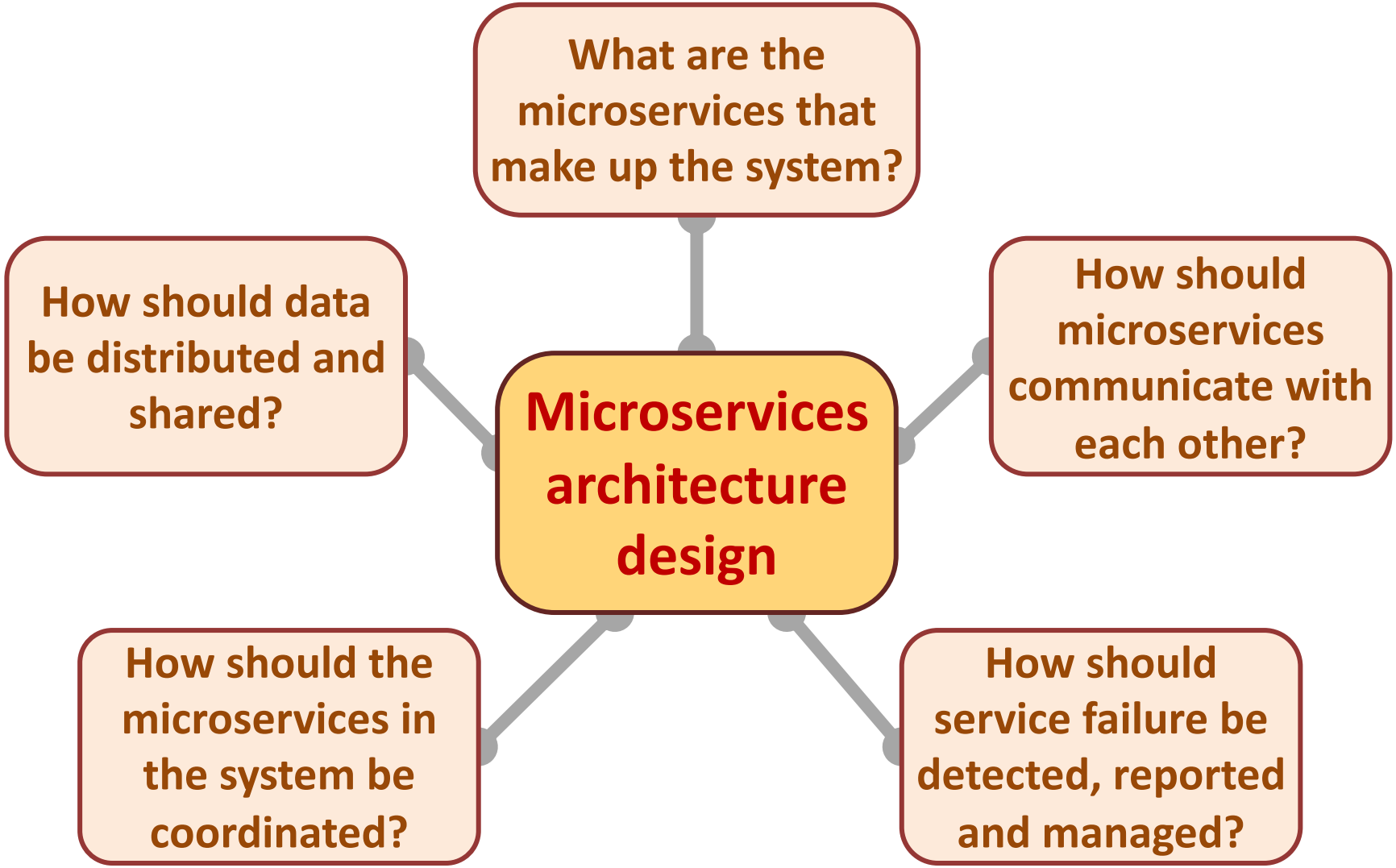
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Software as a service



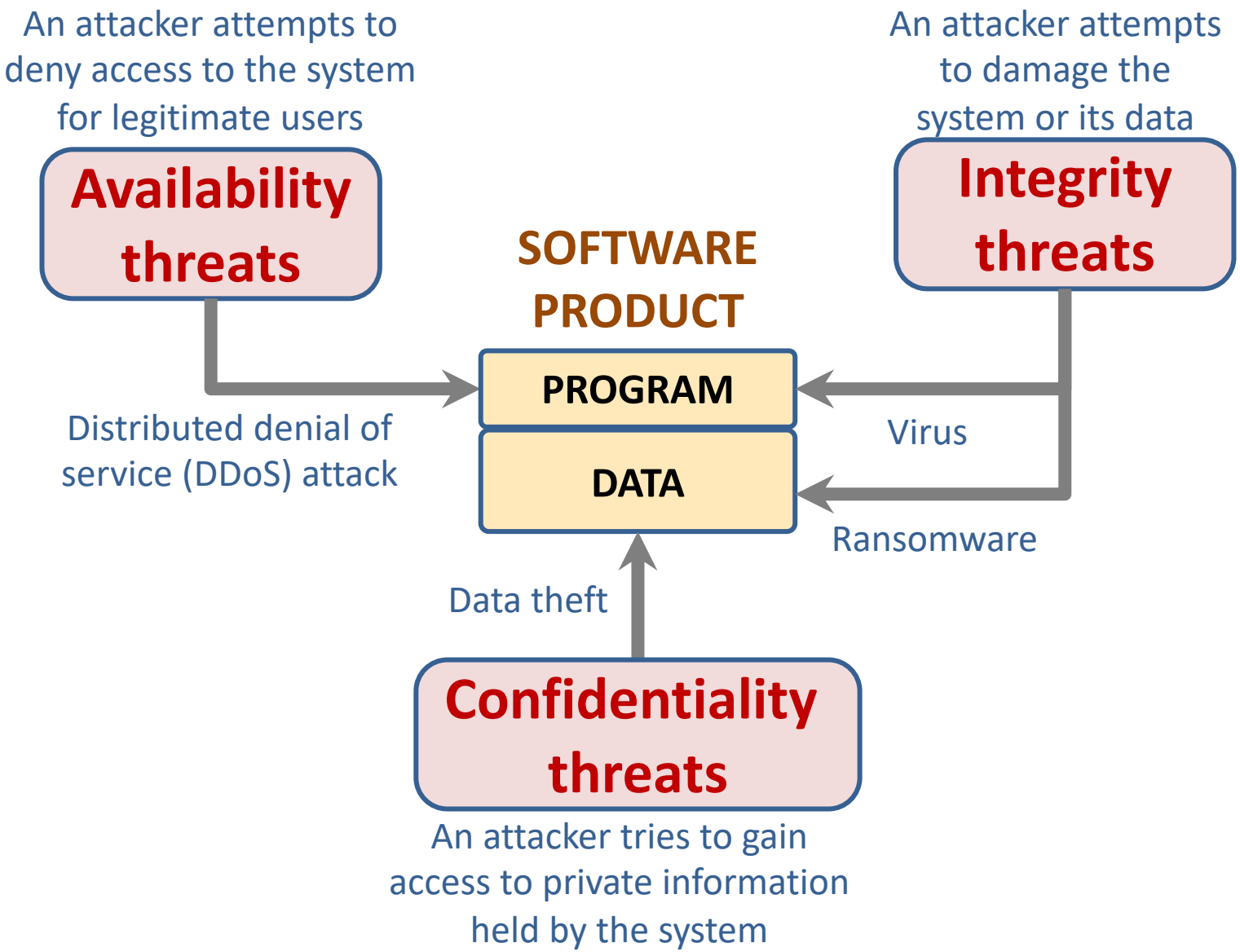
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Microservices architecture – key design questions



Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Types of security threat

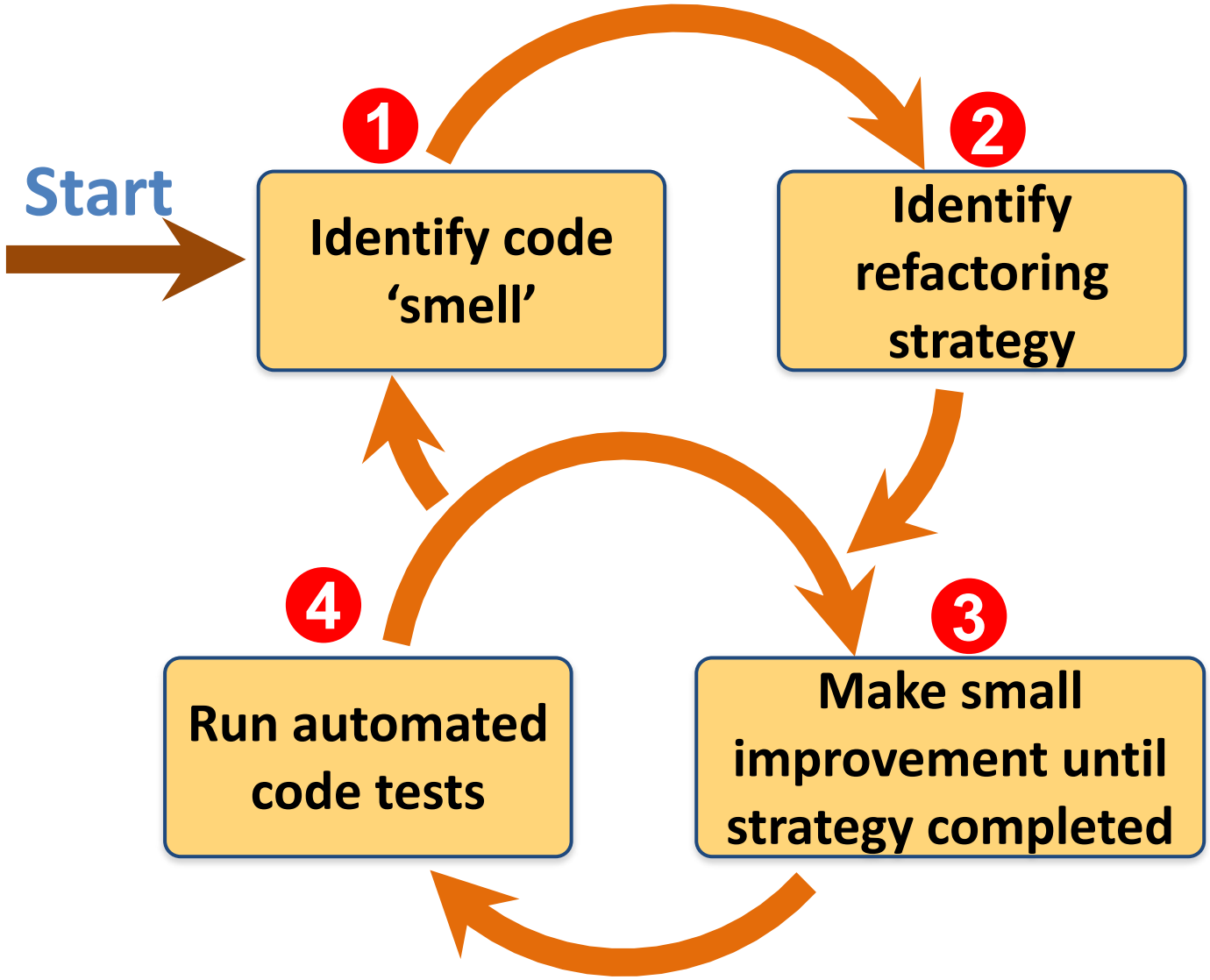


Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Software product quality attributes

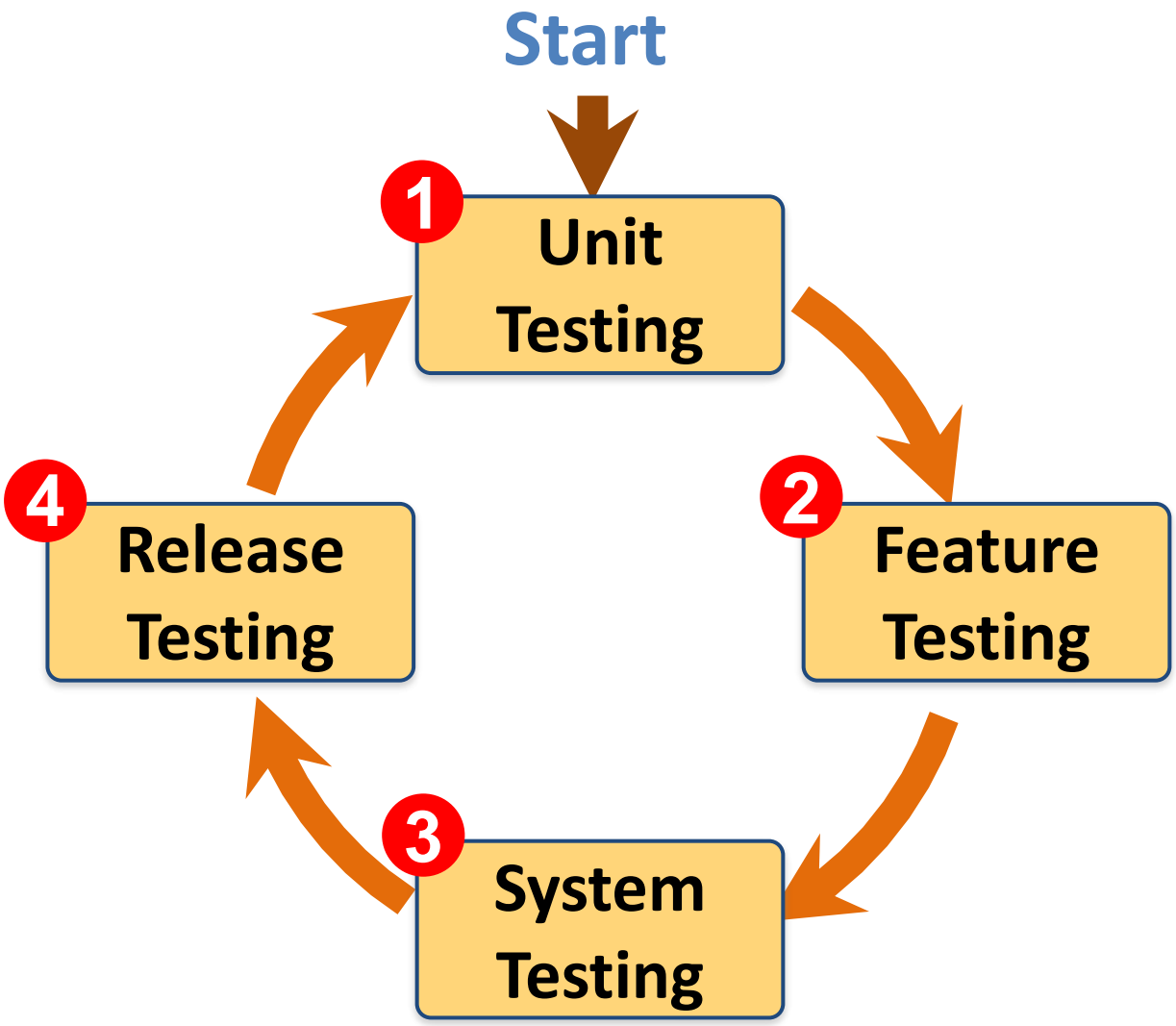
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

A refactoring process



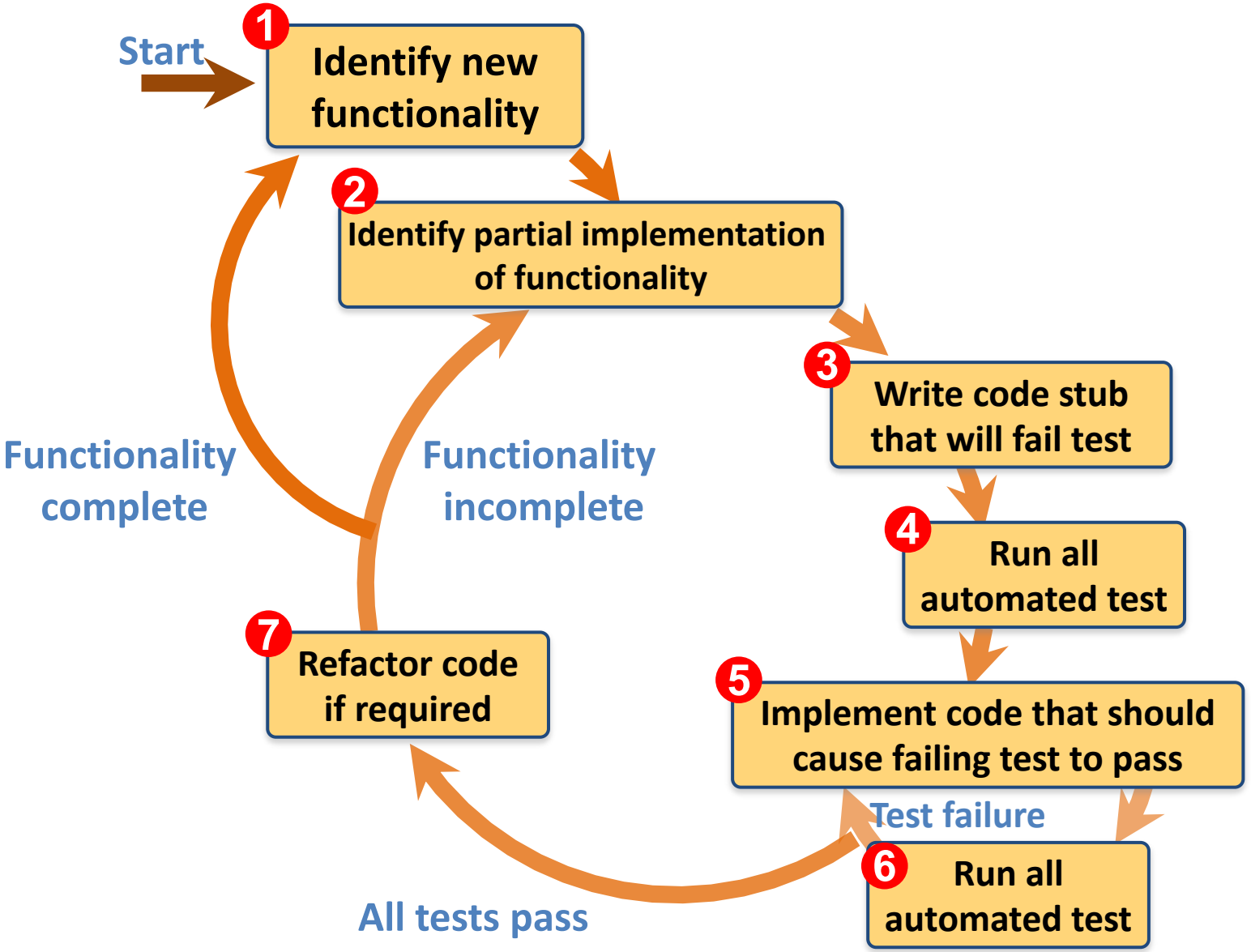
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Functional testing



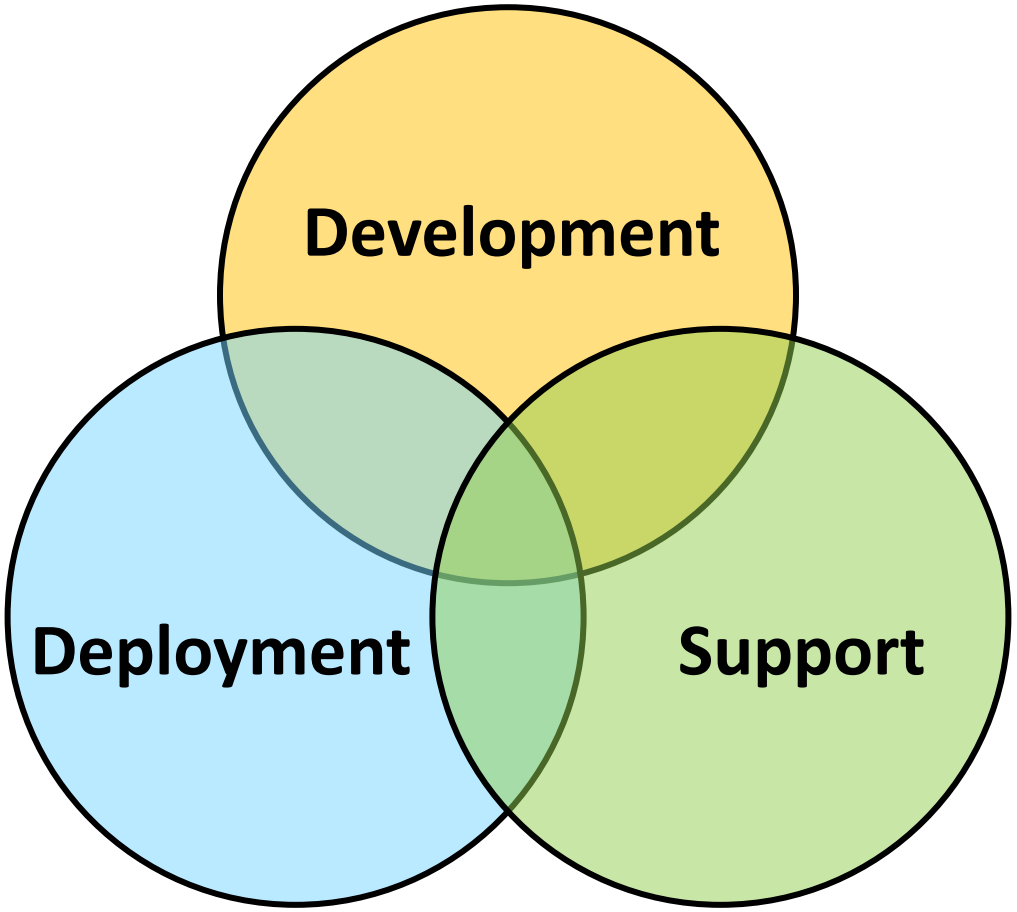
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Test-driven development (TDD)



Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

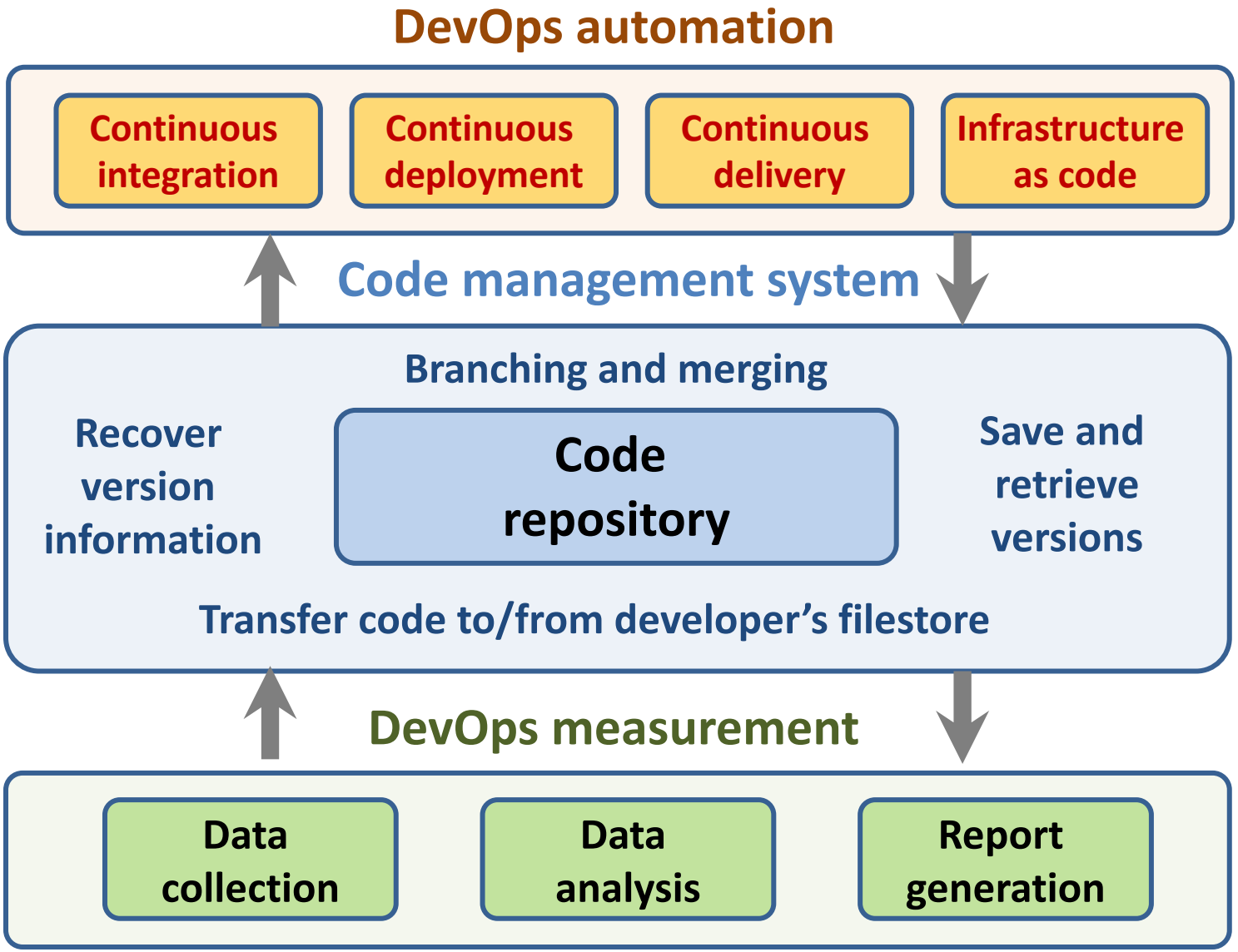
DevOps



Multi-skilled DevOps team

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Code management and DevOps



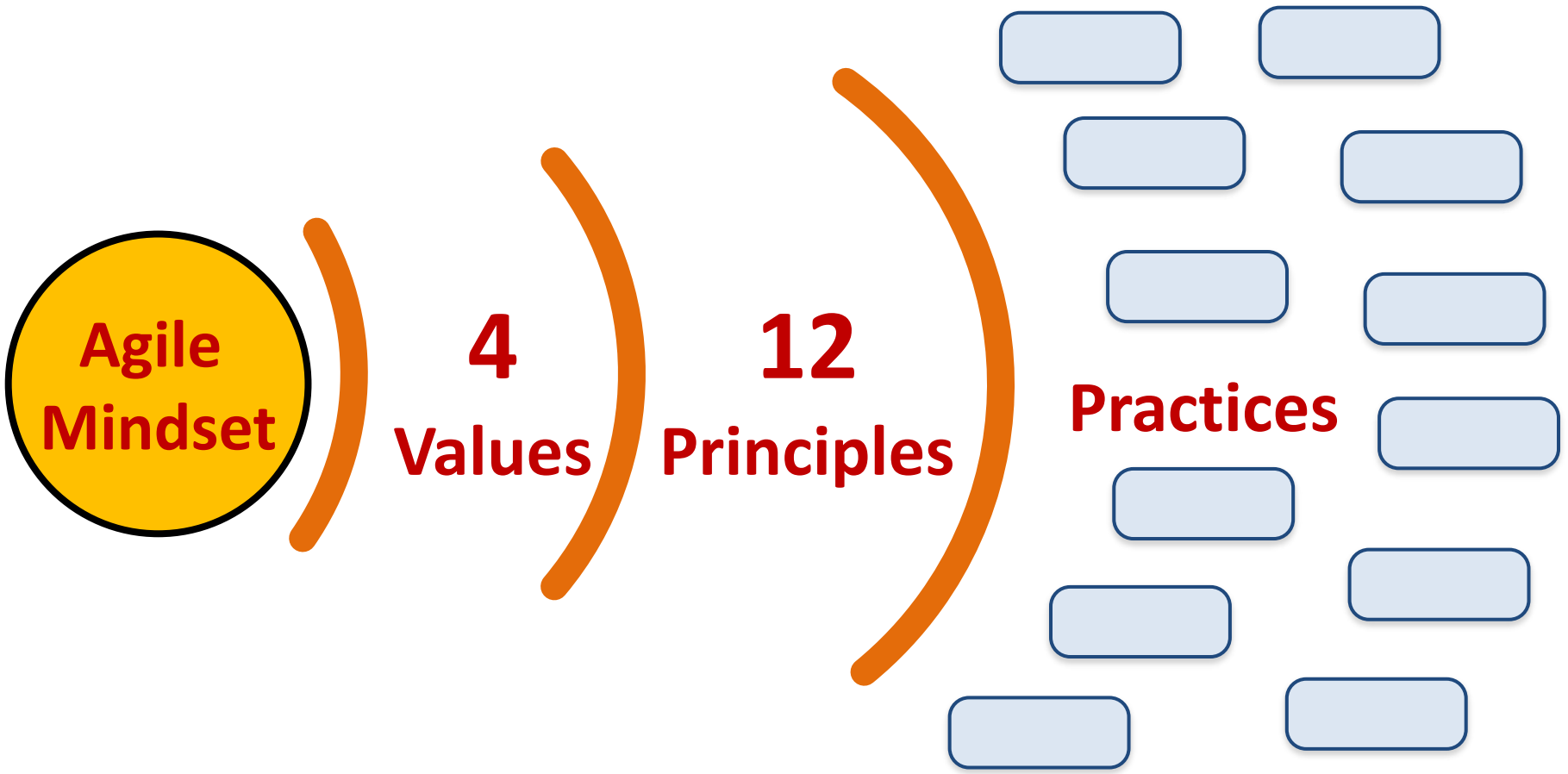
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Agile

Agile software engineering

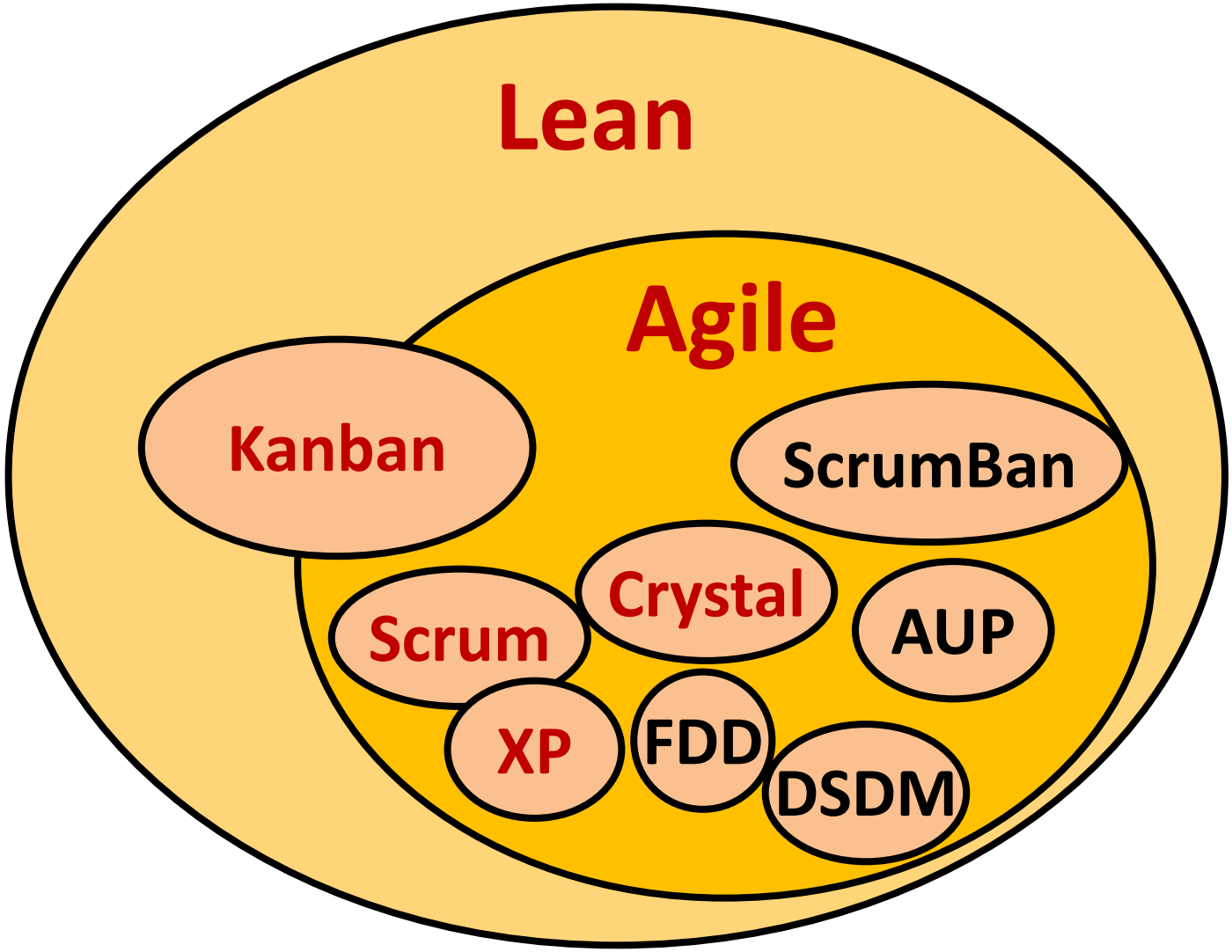
- Software products must be brought to market quickly so rapid software **development and delivery** is essential.
- Virtually all software products are now developed using an **agile approach**.
- **Agile** software engineering focuses on **delivering** functionality **quickly**, **responding** to **changing** product specifications and **minimizing** development **overheads**.

Agile Manifesto Values, Principles, and Common Practices



Source: Project Management Institute (2017), Agile Practice Guide, Project Management Institute

Agile is a Blanket Term for Many Approaches



Source: Project Management Institute (2017), Agile Practice Guide, Project Management Institute

Agile Manifesto and Mindset

Agile is a mindset defined by 4 values, guided by 12 principles, and manifested through many different practices.

Agile practitioners select practices based on their needs.

Source: Project Management Institute (2017), Agile Practice Guide, Project Management Institute

4
Agile Values

The Four Values of the Agile Manifesto

(Manifesto for Agile Software Development, 2001)

We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:

1. **individuals and interactions** over **processes and tools**
2. **working software** over **comprehensive documentation**
3. **customer collaboration** over **contract negotiation**
4. **responding to change** over **following a plan**

That is, while there is value in the items on the right, we value the items on the left more.

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

12
Agile Principles

The Twelve Principles Behind the Agile Manifesto

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.

2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.

3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

4. Business people and developers must work together daily throughout the project.

5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.

6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.

Source: Project Management Institute (2017), Agile Practice Guide, Project Management Institute

The Twelve Principles Behind the Agile Manifesto

7. Working software is the primary measure of progress.

8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.

9. Continuous attention to technical excellence and good design enhances agility.

10. Simplicity—the art of maximizing the amount of work not done—is essential.

11. The best architectures, requirements, and designs emerge from self-organizing teams.

12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Source: Project Management Institute (2017), Agile Practice Guide, Project Management Institute

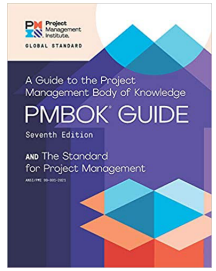
Agile Development Principles

- **Involve the customer**
  Involve customers closely with the software development team. Their role is to provide and prioritize new system requirements and to evaluate each increment of the system.
- **Embrace change**
  Expect the features of the product and the details of these features to change as the development team and the product manager learn more about it. Adapt the software to cope with changes as they are made.
- **Develop and deliver incrementally**
  Always develop software products in increments. Test and evaluate each increment as it is developed and feed back required changes to the development team.

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Agile Development Principles

- **Maintain simplicity**
  Focus on simplicity in both the software being developed and in the development process. Wherever possible, do what you can to eliminate complexity from the system.
- **Focus on people, not things**
  Trust the development team and do not expect everyone to always do the development processin the same way. Team members should be left to develop their own ways of working without being limited by prescriptive software processes.



12

Project Management Principles

Project Management Body of Knowledge (PMBOK Guide) PMBOK v6 vs. PMBOK v7

PMBOK Guide v6

Project Management Body of Knowledge:

- Introduction
- Project Environment
- Role of the Project Manager
- 10 Knowledge Areas
  - Integration
  - Scope
  - Schedule
  - Cost
  - Quality
  - Resources
  - Communications
  - Risk
  - Procurement
  - Stakeholders

The Standard for Project Management (5 Process Groups):

- Initiating
- Planning
- Executing
- Monitoring and Controlling
- Closing

PMBOK Guide v7

The Standard for Project Management :

- Introduction
- System for Value Delivery
- 12 Project Management Principles:
  - 1. Stewardship, 2. Team
  - 3. Stakeholders, 4. Value
  - 5. Systems Thinking, 5. Leadership
  - 7. Tailoring, 8. Quality
  - 9. Complexity, 10, Risk
  - 11. Adaptability and Resiliency
  - 12. Change

Project Management Body of Knowledge:

- 8 Project Performance Domains:
  - 1. Stakeholders, 2. Team,
  - 3. Development approach and Life Cycle
  - 4. Planning, 5. Project Work, 6. Delivery,
  - 7. Measurement, 8. Uncertainty
- Tailoring
- Models, Methods, and Artifacts

Source: Project Management Institute (2021), A Guide to the Project Management Body of Knowledge (PMBOK Guide) – Seventh Edition and The Standard for Project Management, PMI

Project Management Knowledge Areas

(PMBOK v6)

1. Project **Integration** Management
2. Project **Scope** Management
3. Project **Schedule** Management
4. Project **Cost** Management
5. Project **Quality** Management
6. Project **Resource** Management
7. Project **Communications** Management
8. Project **Risk** Management
9. Project **Procurement** Management
10. Project **Stakeholder** Management

Source: Project Management Institute (2017), A Guide to the Project Management Body of Knowledge (PMBOK Guide), Sixth Edition, PMI

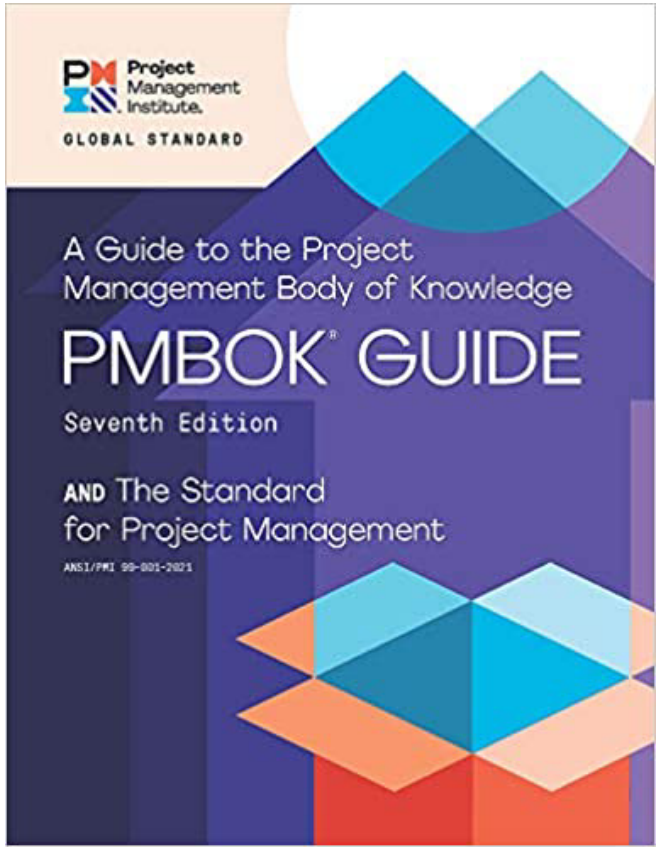
Project Management Process Groups
(PMBOK v6)

1. **Initiating** Process Group
2. **Planning** Process Group
3. **Executing** Process Group
4. **Monitoring and Controlling** Process Group
5. **Closing** Process Group

Source: Project Management Institute (2017), A Guide to the Project Management Body of Knowledge (PMBOK Guide), Sixth Edition, PMI

Project Management 12 Principles
(PMBOK v7)

1. Stewardship
2. Team
3. Stakeholders
4. Value
5. Systems Thinking
6. Leadership
7. Tailoring
8. Quality
9. Complexity
10. Risk
11. Adaptability and Resiliency
12. Change



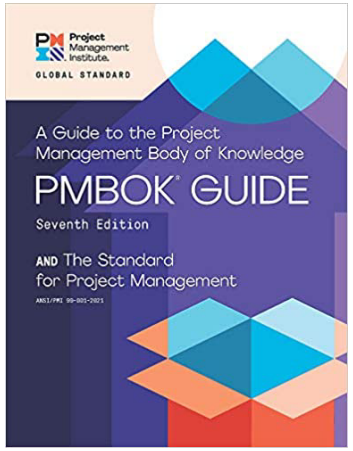
Source: Project Management Institute (2021), A Guide to the Project Management Body of Knowledge (PMBOK Guide) – Seventh Edition and The Standard for Project Management, PMI

Project Management

8 Project Performance Domains

(PMBOK v7)

1. **Stakeholders**
2. **Team**
3. Development Approach and Life Cycle
4. **Planning**
5. Project Work
6. **Delivery**
7. Measurement
8. Uncertainty



Source: Project Management Institute (2021), A Guide to the Project Management Body of Knowledge (PMBOK Guide) – Seventh Edition and The Standard for Project Management, PMI

Agile software engineering

- A large number of ‘agile methods’ have been developed.
  - There is no ‘best’ agile method or technique.
  - It depends on who is using the technique, the development team and the type of product being developed

Agile methods

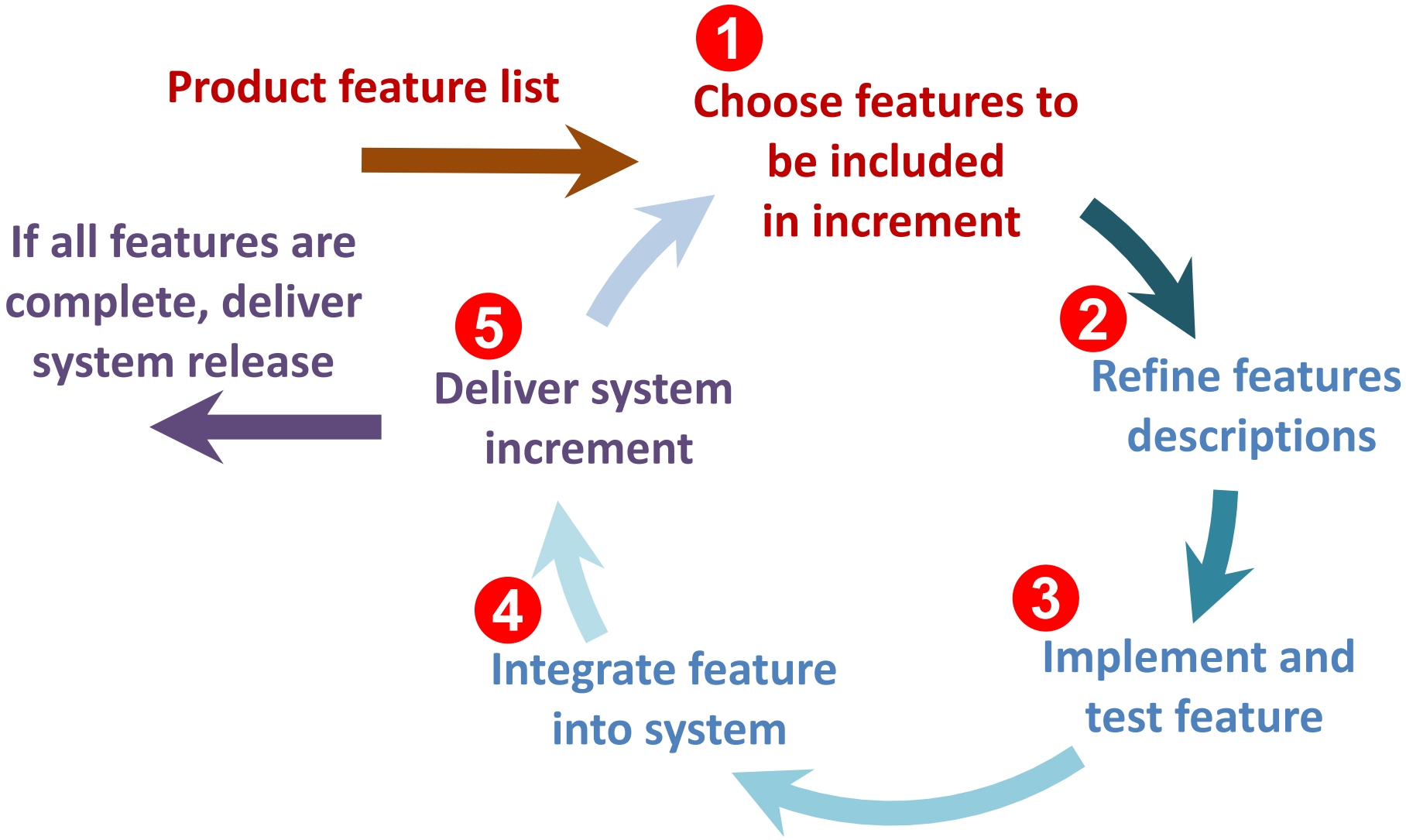
- **Plan-driven development** evolved to support the engineering of **large, long-lifetime systems**
  - This approach is based on controlled and rigorous software development processes that include detailed project planning, requirements specification and analysis and system modelling.
  - However, plan-driven development involves significant overheads and documentation and it does not support the **rapid development and delivery** of software.
- **Agile methods** were developed in the 1990s to address this problem.
  - These methods focus on the software rather than its documentation, develop software in a series of increments and aim to reduce process bureaucracy as much as possible.

Incremental development

- All **agile methods** are based around **incremental development and delivery**.
- Product development focuses on the software features, where a feature does something for the software user.
- With incremental development, you start by **prioritizing the features** so that the most important features are implemented first.
  - You only define the details of the feature being implemented in an increment.
  - That feature is then implemented and delivered.
- Users or surrogate users can try it out and provide feedback to the development team. You then go on to define and implement the next feature of the system.

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Incremental development



Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Incremental development activities

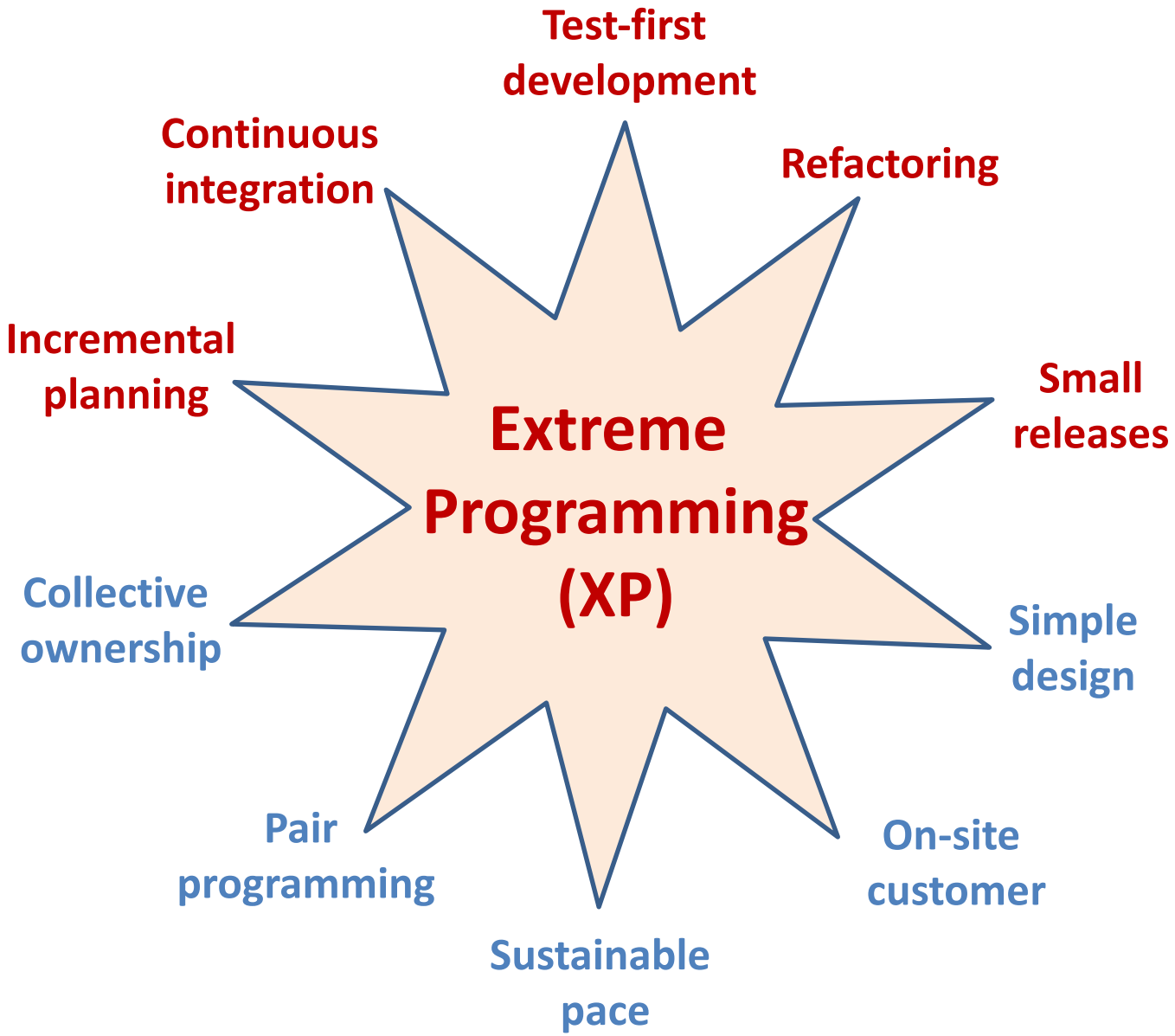
1. **Choose features to be included in an increment**
   Using the list of features in the planned product, select those features that can be implemented in the next product increment.
2. **Refine feature descriptions**
   Add detail to the feature descriptions so that the team have a common understanding of each feature and there is sufficient detail to begin implementation.
3. **Implement and test**
   Implement the feature and develop automated tests for that feature that show that its behaviour is consistent with its description.
4. **Integrate feature and test**
   Integrate the developed feature with the existing system and test it to check that it works in conjunction with other features.
5. **Deliver system increment**
   Deliver the system increment to the customer or product manager for checking and comments. If enough features have been implemented, release a version of the system for customer use.

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Extreme programming

- The most influential work that has changed software development culture was the development of **Extreme Programming (XP)**.
- The name was coined by **Kent Beck in 1998** because the approach was developed by pushing recognized good practice, such as iterative development, to 'extreme' levels.
- Extreme programming focused on 12 new development techniques that were geared to rapid, incremental software development, change and delivery.
- Some of these techniques are now widely used; others have been less popular.

Extreme Programming Practices



Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Widely adopted XP practices

- Incremental planning/user stories
  - There is no 'grand plan' for the system. Instead, what needs to be implemented (the requirements) in each increment are established in discussions with a customer representative.
  - The requirements are written as user stories.
  - The stories to be included in a release are determined by the time available and their relative priority.

Widely adopted XP practices

- Small releases
  - The minimal useful set of functionality that provides business value is developed first.
  - Releases of the system are frequent and incrementally add functionality to the previous release.

Widely adopted XP practices

- Test-driven development
  - Instead of writing code then tests for that code, developers write the tests first.
  - This helps clarify what the code should actually do and that there is always a ‘tested’ version of the code available.
  - An automated unit test framework is used to run the tests after every change.
  - New code should not ‘break’ code that has already been implemented.

Widely adopted XP practices

- Continuous integration
  - As soon as the work on a task is complete, it is integrated into the whole system and a new version of the system is created.
  - All unit tests from all developers are run automatically and must be successful before the new version of the system is accepted.

Widely adopted XP practices

- Refactoring
  - Refactoring means improving the structure, readability, efficiency and security of a program.
  - All developers are expected to refactor the code as soon as potential code improvements are found.
  - This keeps the code simple and maintainable.

Widely adopted XP practices

- Incremental planning/user stories
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Scrum

- Software company managers need information that will help them understand how much it costs to develop a software product, how long it will take and when the product can be brought to market.
- Plan-driven development provides this information through long-term development plans that identify deliverables - items the team will deliver and when these will be delivered.
- Plans always change so anything apart from short-term plans are unreliable.
- **Scrum is an agile method that provides a framework for agile project organization and planning**. It does not mandate any specific technical practices.

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Scrum Terminology

- **Scrum**
  A daily team meeting where progress is reviewed and work to be done that day as discussed and agreed.
- **Sprint**
  A short period, typically two to four weeks, when a product increment is developed.
- **ScrumMaster**
  A team coach who guides the team in the effective use of Scrum.

Scrum Terminology

- **Product**
  The software product that is being developed by the Scrum team.
- **Product owner**
  A team member who is responsible for identifying product features and attributes. They review work done and help to test the product.
- **Product backlog**
  A to-do list of items such as bugs, features and product improvements that the Scrum team have not yet completed.

Scrum Terminology

- **Development team**
  A small self-organising team of five to eight people who are responsible for developing the product.
- **Potentially shippable product increment**
  The output of a sprint which should be of high enough quality to be deployed for customer use.
- **Velocity**
  An estimate of how much work a team can do in a single sprint.

Key roles in Scrum

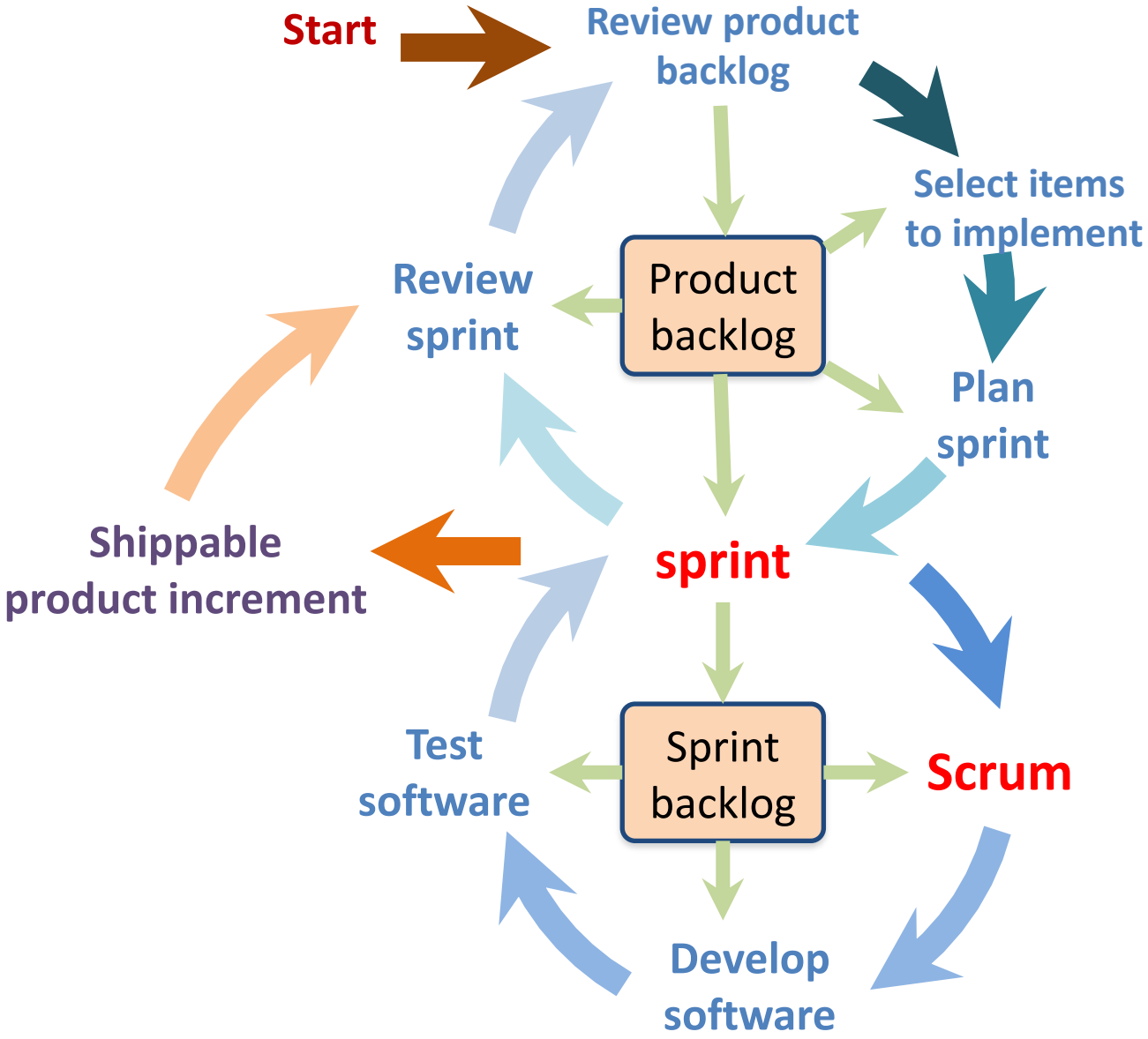
- **The Product Owner** is responsible for ensuring that the development team are always focused on the product they are building rather than diverted into technically interesting but less relevant work.
  - In product development, the product manager should normally take on the Product Owner role.
- **The ScrumMaster** is a Scrum expert whose job is to guide the team in the effective use of the Scrum method. The developers of Scrum emphasize that the ScrumMaster is not a conventional project manager but is a coach for the team. They have authority within the team on how Scrum is used.
  - In many companies that use Scrum, the ScrumMaster also has some project management responsibilities.

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Scrum and sprints

- In Scrum, software is developed in sprints, which are fixed-length periods (2 - 4 weeks) in which software features are developed and delivered.
- During a sprint, the team has daily meetings (Scrums) to review progress and to update the list of work items that are incomplete.
- Sprints should produce a 'shippable product increment'. This means that the developed software should be complete and ready to deploy.

Scrum cycles



Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Key Scrum practices

- **Product backlog**
  This is a to-do list of items to be implemented that is reviewed and updated before each sprint.
- **Timeboxed sprints**
  Fixed-time (2-4 week) periods in which items from the product backlog are implemented,
- **Self-organizing teams**
  Self-organizing teams make their own decisions and work by discussing issues and making decisions by consensus.

Product backlogs

- The product backlog is a list of what needs to be done to complete the development of the product.
- The items on this list are called product backlog items (PBIs).
- The product backlog may include a variety of different items such as product features to be implemented, user requests, essential development activities and desirable engineering improvements.
- The product backlog should always be prioritized so that the items that be implemented first are at the top of the list.

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Examples of product backlog items (PBIs)

1. As a teacher, I want to be able to configure the group of tools that are available to individual classes. (feature)
2. As a parent, I want to be able to view my childrens' work and the assessments made by their teachers. (feature)
3. As a teacher of young children, I want a pictorial interface for children with limited reading ability. (user request)
4. Establish criteria for the assessment of open source software that might be used as a basis for parts of this system. (development activity)
5. Refactor user interface code to improve understandability and performance. (engineering improvement)
6. Implement encryption for all personal user data. (engineering improvement)

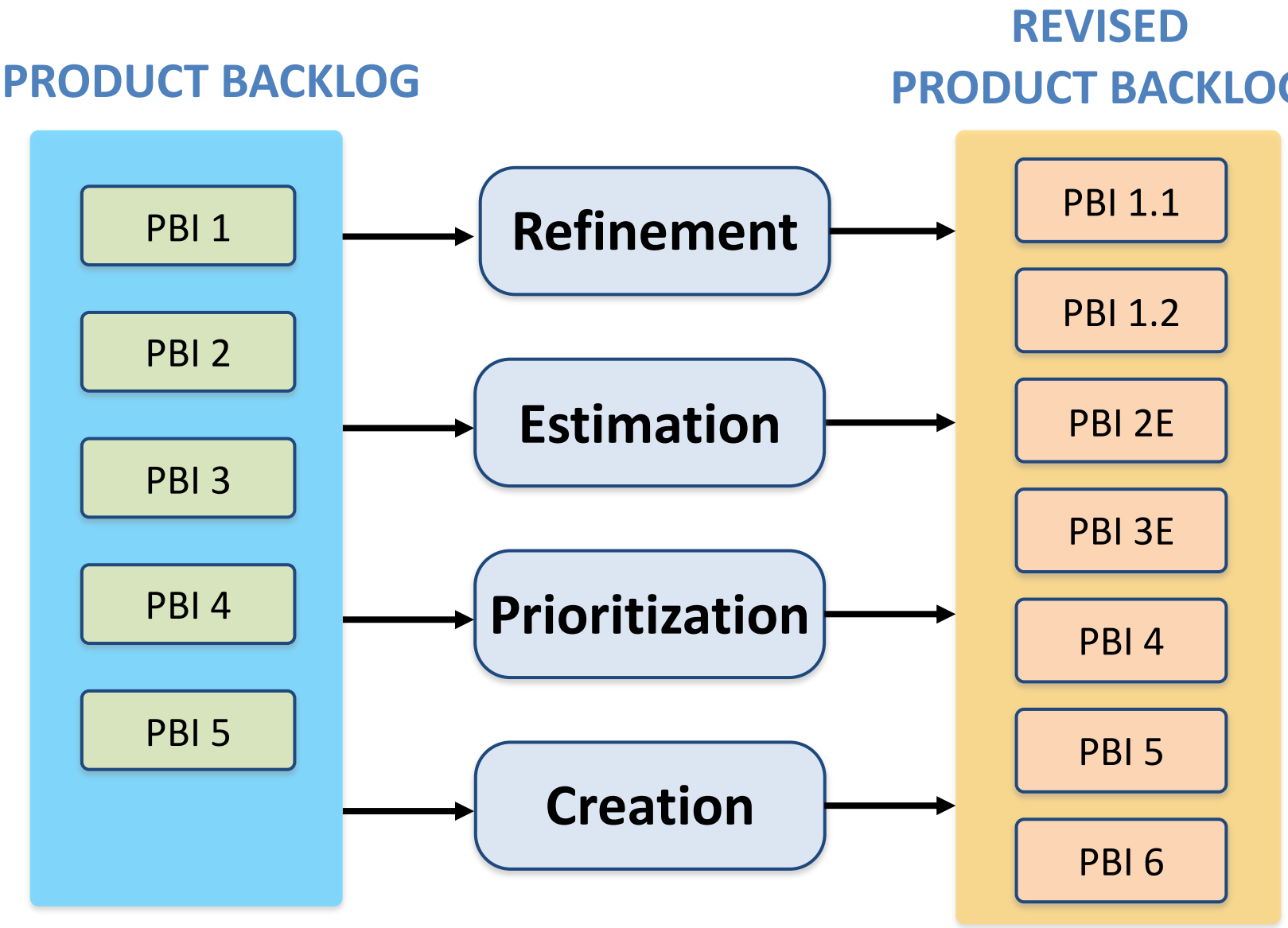
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Product backlog item states

- **Ready for consideration**
  These are high-level ideas and feature descriptions that will be considered for inclusion in the product. They are tentative so may radically change or may not be included in the final product.
- **Ready for refinement**
  The team has agreed that this is an important item that should be implemented as part of the current development. There is a reasonably clear definition of what is required. However, work is needed to understand and refine the item.
- **Ready for implementation**
  The PBI has enough detail for the team to estimate the effort involved and to implement the item. Dependencies on other items have been identified.

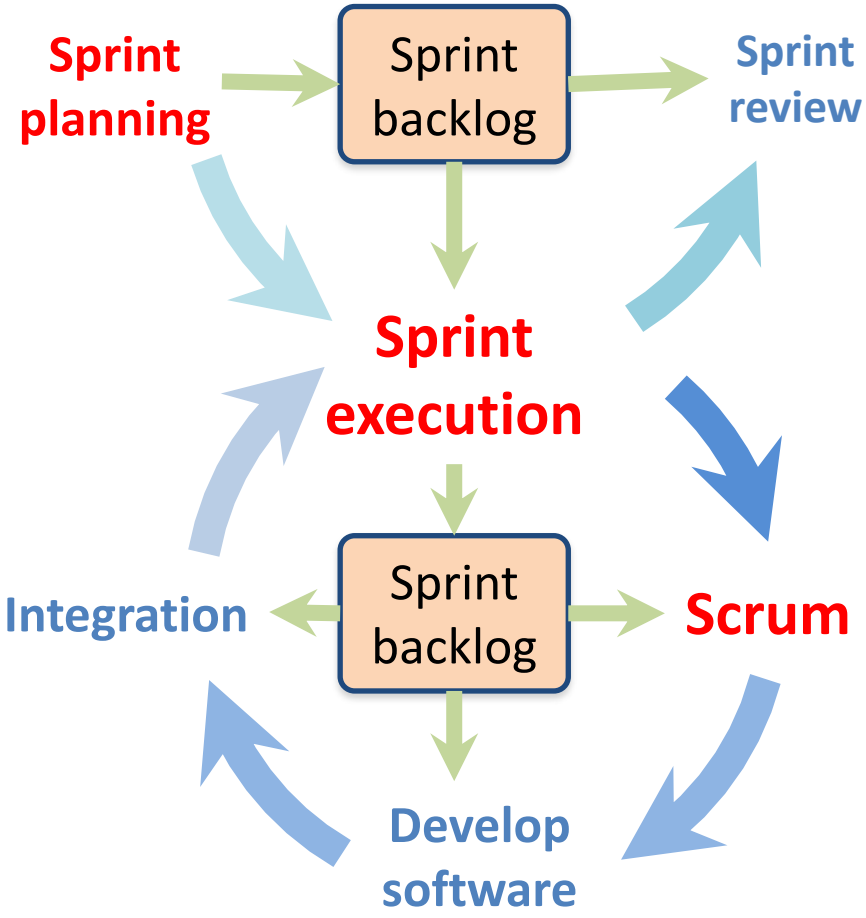
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Product backlog activities



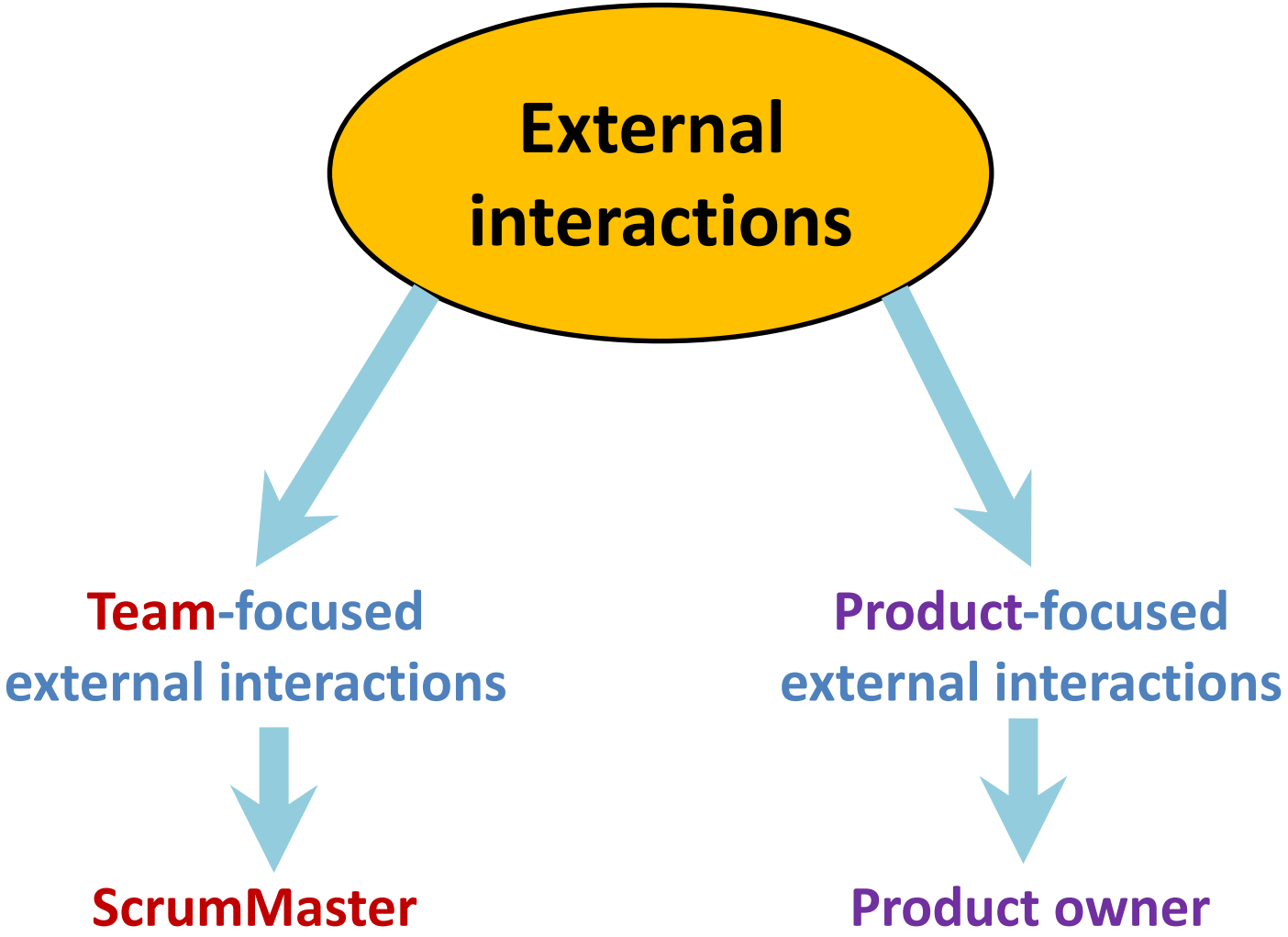
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Sprint activities



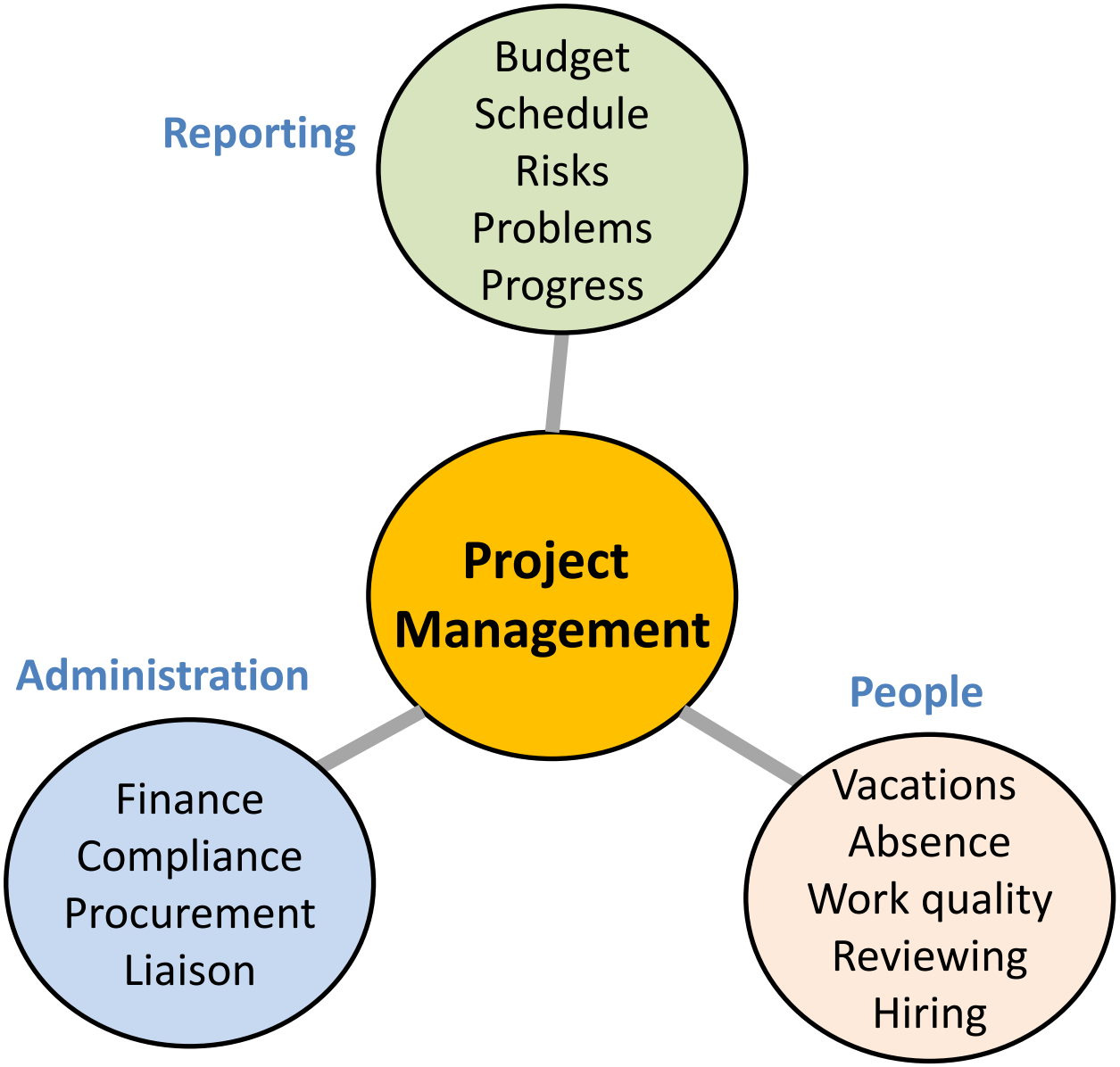
Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Managing External Interactions



Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Project Management Responsibilities



Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Summary

- The best way to develop software products is to use agile software engineering methods that are geared to rapid product development and delivery.
- Agile methods are based around iterative development and the minimization of overheads during the development process.
- Extreme programming (XP) is an influential agile method that introduced agile development practices such as user stories, test-first development and continuous integration. These are now mainstream software development activities.

Summary

- Scrum is an agile method that focuses on agile planning and management. Unlike XP, it does not define the engineering practices to be used. The development team may use any technical practices that they believe are appropriate for the product being developed.
- In Scrum, work to be done is maintained in a product backlog – a list of work items to be completed. Each increment of the software implements some of the work items from the product backlog.

Summary

- Sprints are fixed-time activities (usually 2–4 weeks) where a product increment is developed. Increments should be 'potentially shippable' i.e. they should not need further work before they are delivered.
- A self-organizing team is a development team that organizes the work to be done by discussion and agreement amongst team members.
- Scrum practices such as the product backlog, sprints and self-organizing teams can be used in any agile development process, even if other aspects of Scrum are not used.

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