

# Improvement of Agile Software Development Process Based on Automotive SPICE: A Case Study

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# Table of contents

Introduction

Background

Approach

Practical Examples of Process Improvement Effects

- Documentation and Traceability
- Problem resolution and change request management

Conclusions

# Introduction

# Profile of NEC Corporation

Company Name: NEC Corporation

Address: 7-1, Shiba 5-chome, Minato-ku, Tokyo, Japan

Established: July 17, 1899

Chairman of the Board: Nobuhiro Endo

President and CEO: Takashi Niino

Capital: ¥ 397.2 billion - As of Mar. 31, 2018 -

Consolidated Net Sales: ¥ 2,913 billion  
- Fiscal year ended Mar. 31, 2019 -

Operations of NEC Group: Public, Enterprise, Telecom Carrier,  
System Platform, Others

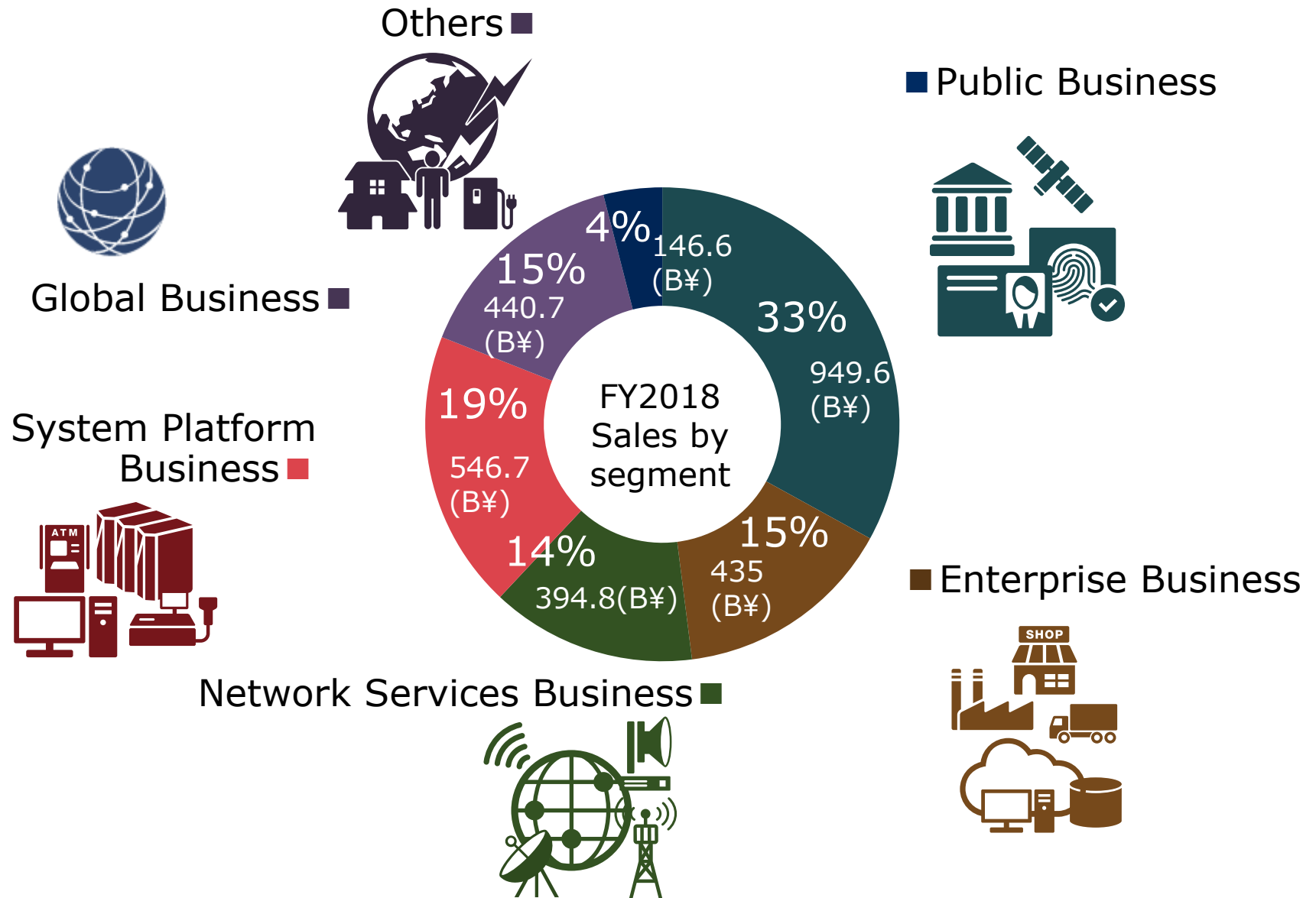
Employees: NEC Corporation

21,010 - As of Mar. 31, 2018 -

NEC Corporation and Consolidated Subsidiaries  
109,390 - As of Mar. 31, 2018 -

Consolidated Subsidiaries: 303 - As of Mar. 31, 2018 -

# Proportion of Sales (By Operating Segments)



# The seven themes for social value creation

Orchestrating a brighter world



Realizing the prosperous society and future through co-creation with customer and partner  
NEC will co-create the seven themes for social value creation.

# Quality and Process Improvement in NEC

- “Better Products, Better Services” is NEC’s corporate slogan since founded in 1899.
- NEC has taken initiative to utilize cutting-edge technologies for controlling and improving quality.
- NEC adopted model based process improvement for systems and software development in the 1980’s.
- NEC has accumulated experience and knowledge for effectively using process assessment models, such as CMMI and Automotive SPICE, and developed skilled people through in-house software process assessment and improvement.
- NEC has supported INCREMENT P to improve automotive software development processes based on the experience and knowledge since 2016.

# Profile of INCREMENT P Corporation

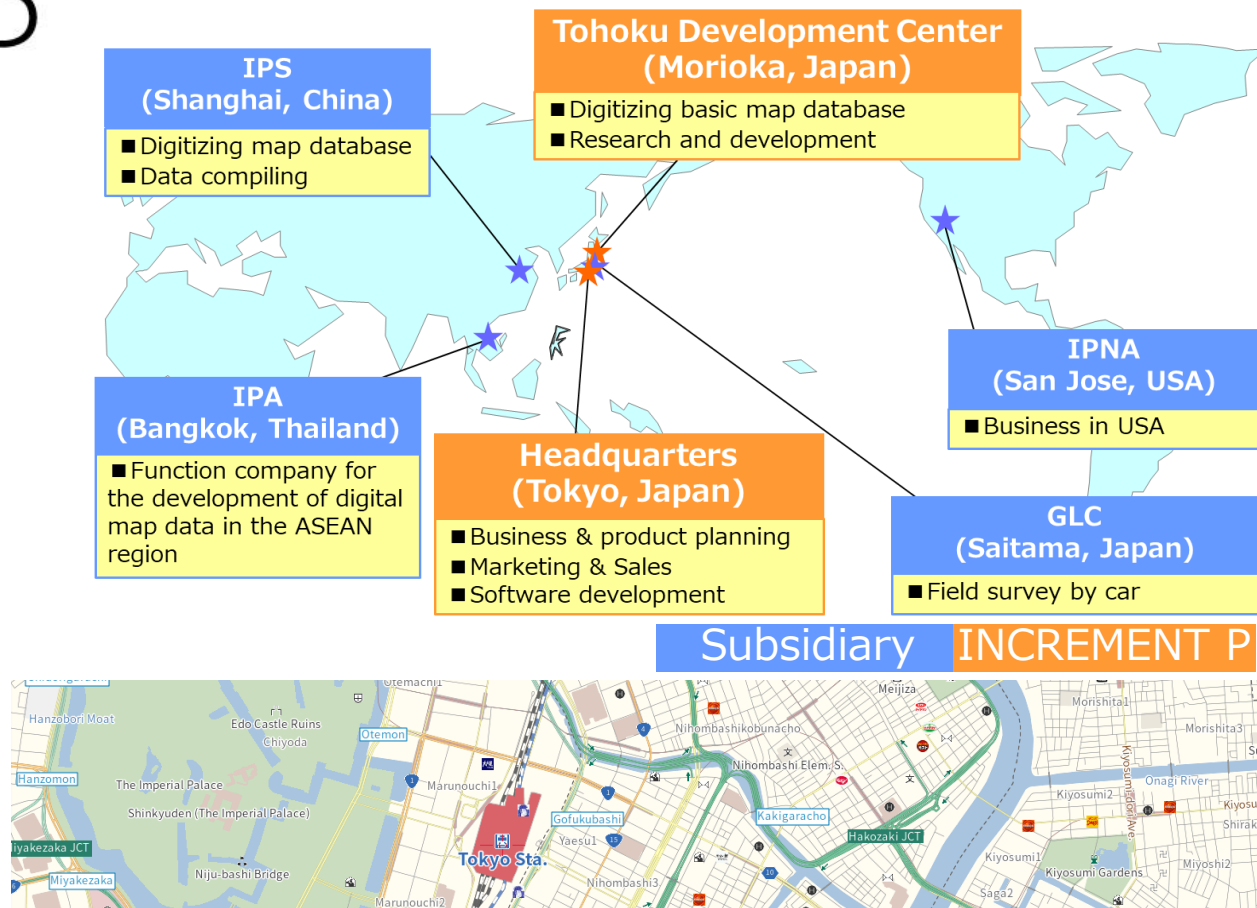
## Increment P

CEO/President:  
Takumi Jinguji

Establishment:  
May 1994

Capital:  
¥434.5 million

Employees:  
Approx. 500

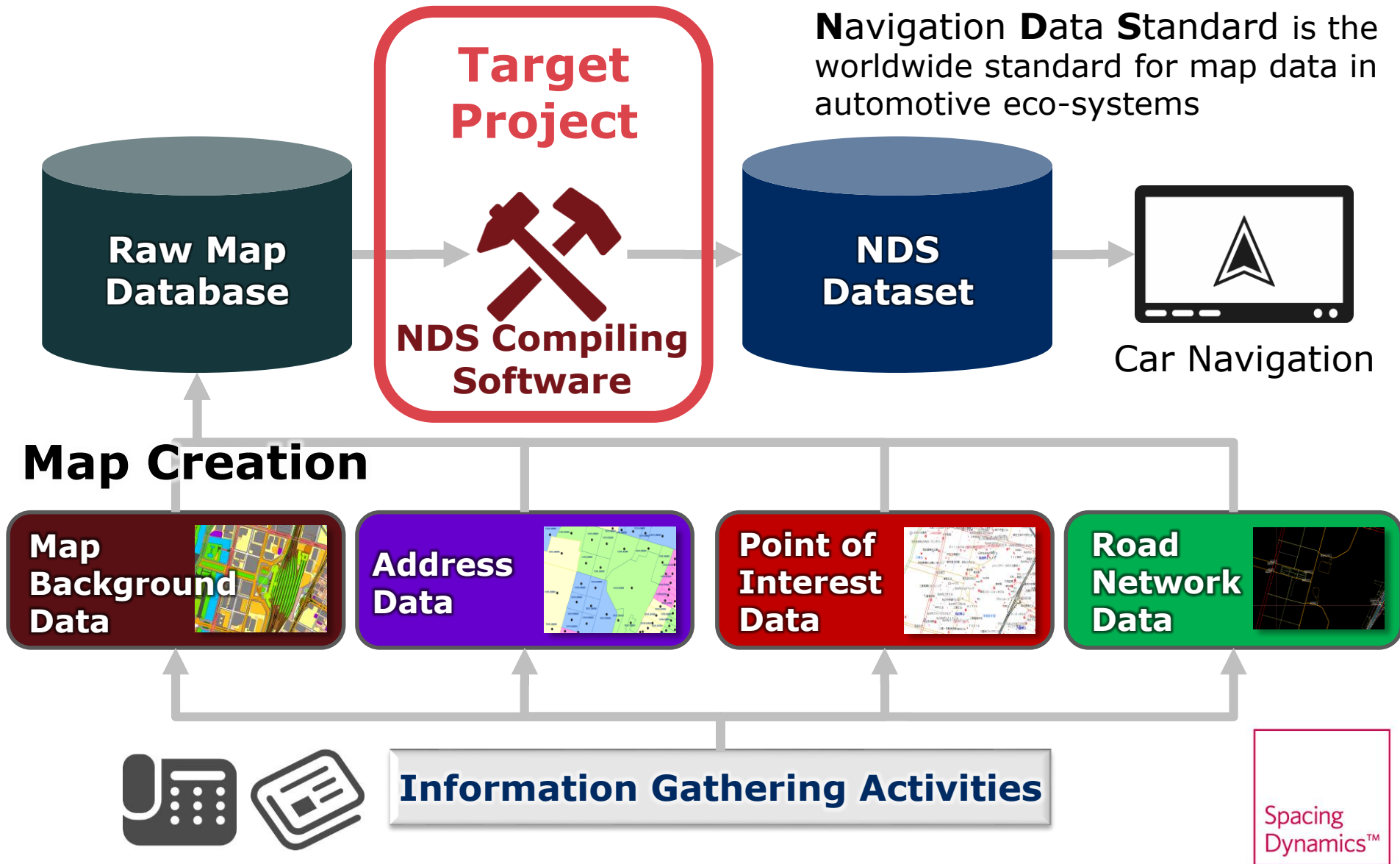


Commitment to digital maps is INCREMENT P's power to the future.  
We offer various map businesses.

<http://www.incrementp.co.jp/english/>



# Map Database Compiling Software for NDS



# Background

# Business Environment of INCREMENT P

- INCREMENT P has been developing map data for navigation systems, and currently develop it with the standard format: NDS.
- Quality and frequency is required to achieve market values of standardized map data, i.e. accuracy and currentness.
- INCREMENT P decide to adopt Automotive SPICE for quality and SCRUM for frequency.

## Past / Current

Various map data formats specific to applications and devices

Develop map data with waterfall to meet requirements and specifications for a target application and device



## Future

Standard format for map data was defined in the industry

Data can be traded independently with application and device

Accuracy and currentness are required.

Suitable development method is required to achieve high quality and frequency

Automotive SPICE and Agile will be useful for them, if well combined

# Overview of Automotive SPICE

An industry standard process assessment model that defines recommended practices for in-vehicle software development.

- the objectives are to evaluate process capability and to improve processes.

## Acquisition Process Group

ACQ.3  
Contract Agreement

ACQ.4  
Supplier Monitoring

ACQ.11  
Technical Requirements

ACQ.12  
Legal and Administrative  
Requirements

ACQ.13  
Project Requirements

ACQ.14  
Request for Proposals

ACQ.15  
Supplier Qualification

## Supply Process Group

SPL.1  
Supplier Tendering

SPL.2  
Product Release

## System Engineering Process Group

SYS.1  
Requirements Elicitation

SYS.2  
System Requirements  
Analysis

SYS.3  
System Architectural Design

SYS.5  
System Qualification Test

SYS.4  
System Integration and  
Integration Test

## Software Engineering Process Group

SWE.1  
Software Requirements  
Analysis

SWE.2  
Software Architectural  
Design

SWE.3  
Software Detailed Design  
and Unit Construction

SWE.6  
Software Qualification Test

SWE.5  
Software Integration and  
Integration Test

SWE.4  
Software Unit Verification

## Supporting Process Group

SUP.1  
Quality Assurance

SUP.2  
Verification

SUP.4  
Joint Review

SUP.7  
Documentation

SUP.8  
Configuration  
Management

SUP.9  
Problem Resolution  
Management

SUP.10  
Change Request  
Management

## Management Process Group

MAN.3  
Project Management

MAN.5  
Risk Management

MAN.6  
Measurement

## Reuse Process Group

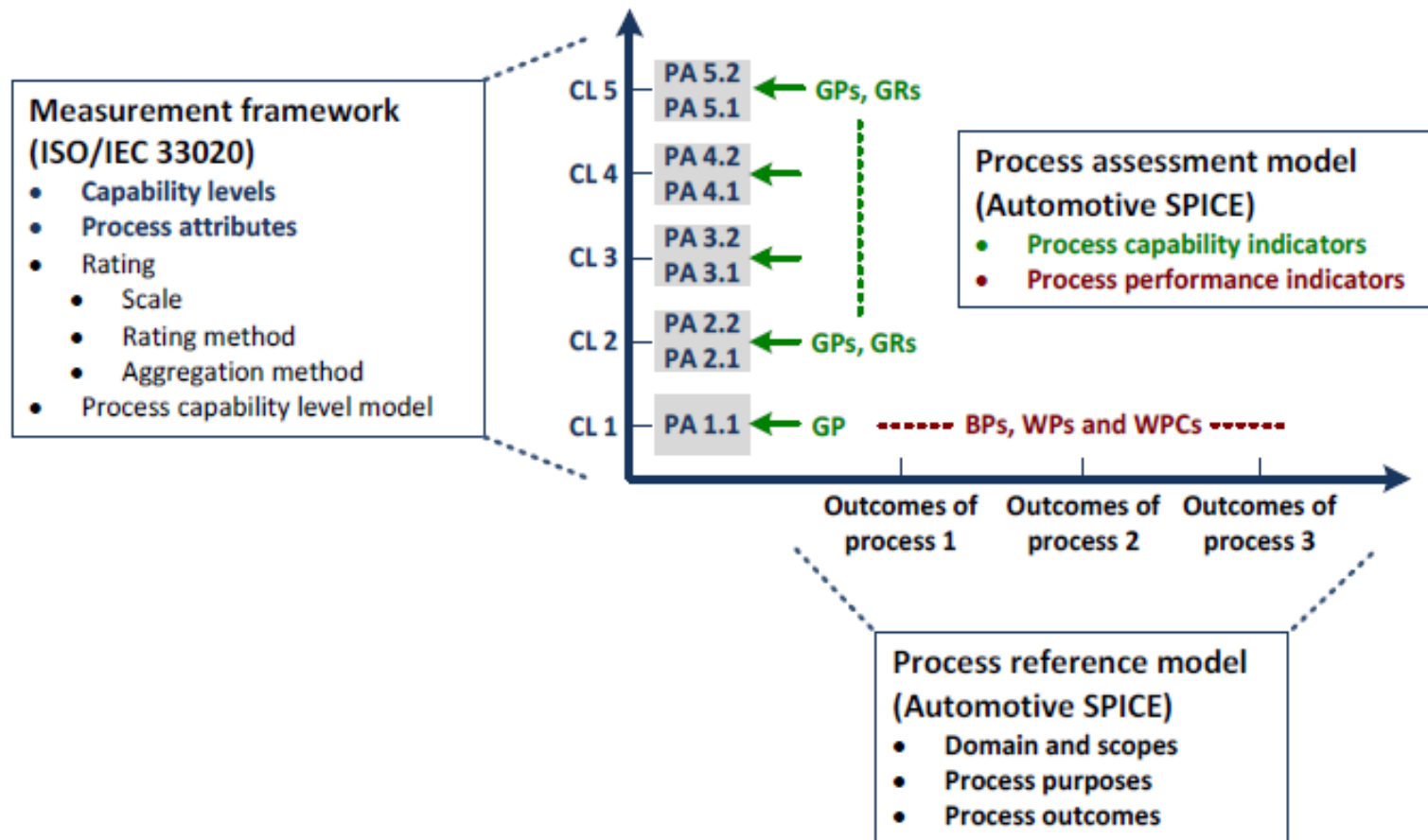
REU.2  
Reuse Program  
Management

## Process Improvement Process Group

RIM.3  
Process Improvement

# Process Assessment by Automotive SPICE

- Capability of each process is measured with degree of effective implementation of process capability indicators, i.e. GPs and GRs, and process performance indicators, i.e. BPs, WPs and WPCs.

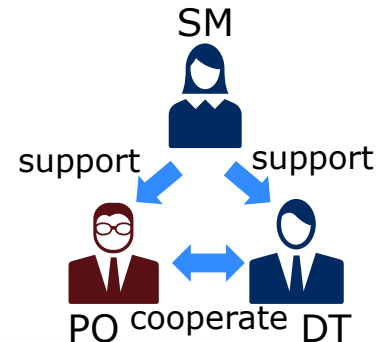


# Overview of SCRUM

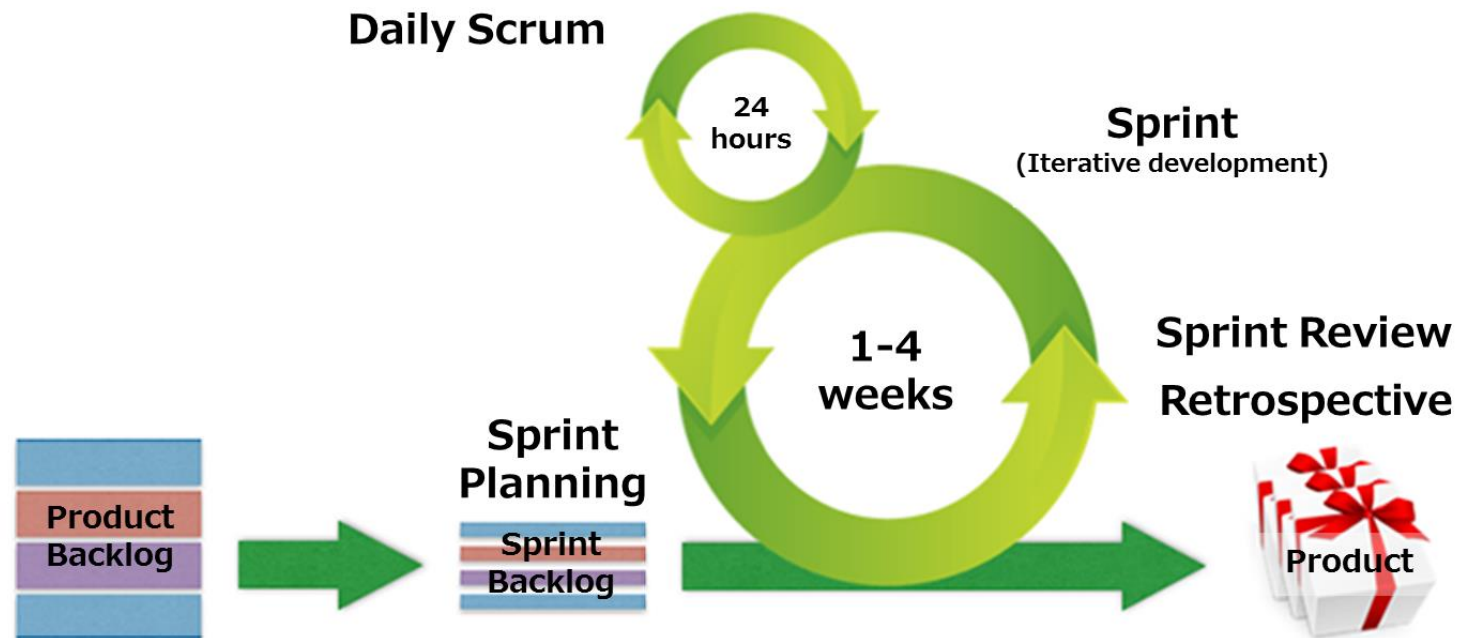
- Product requirements are prioritized and managed.
- Development is composed of short term development cycles.
- Higher priority requirements are realized with earlier development cycles.

## Team and roles

- Product Owner: Responsible for product. Decide priority of requirements.
- Development Team: Analyze requirements, design, implement and test. Responsible for quality. Composed of 3 to 9 members.
- Scrum Master: Support PO and DT to practice the SCRUM.



## Development Flow



# Approach

# Hybrid of SCRUM and Waterfall

## Goal

- introducing agile development conforming to A-SPICE

## Issue

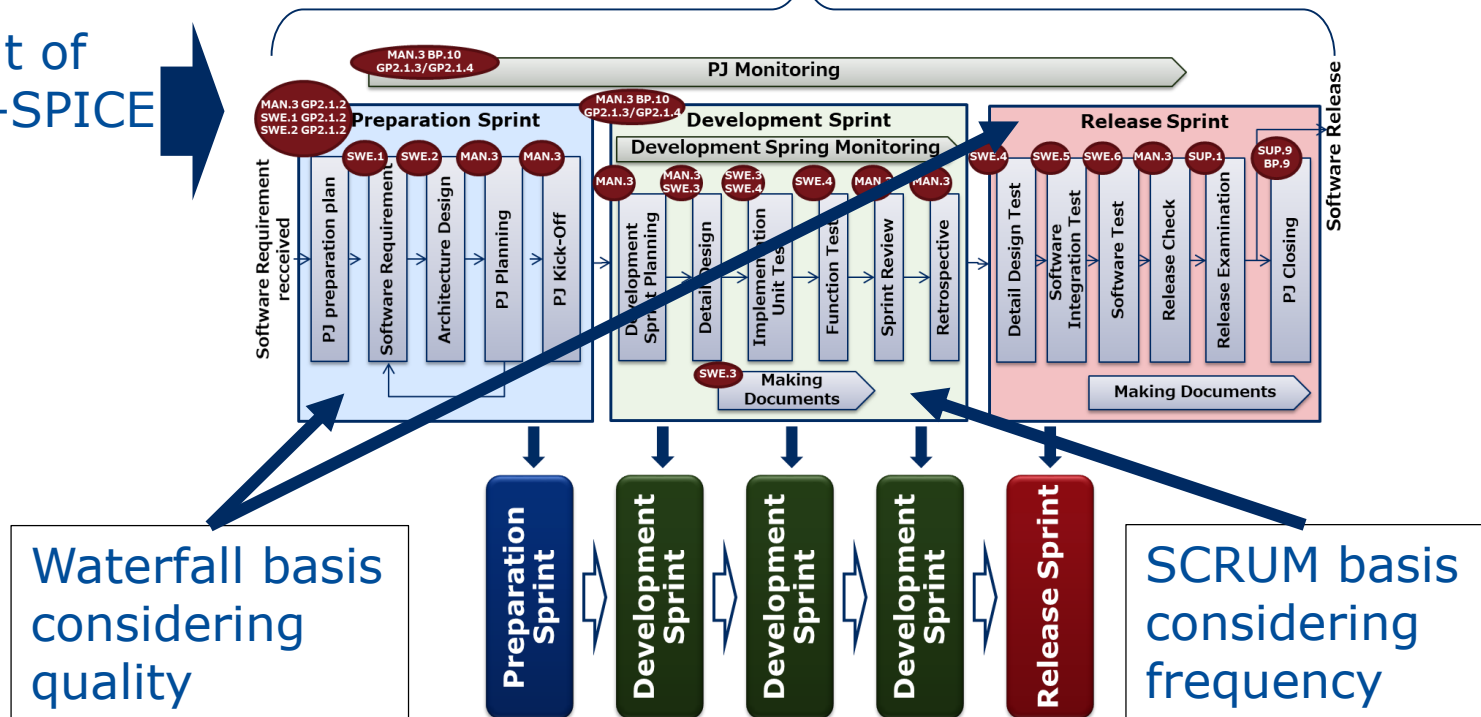
- Harmonization of SCRUM and A-SPICE by clarifying and resolving contradictory factors.

## Solution

- To define and hybrid processes embodying both agile and waterfall aspects

## Three types of sprints

Enhancement of tasks with A-SPICE practices





# Typical Issues to Adopt A-SPICE to Agile Development

Automotive SPICE processes	Issues in agile development
SPL.2 Product Release	- Organizational structure, procedures, and tools suitable for Agile development's short-term and repetitive product releases
SWE.1 Software Requirements Analysis ... SWE.6 Software Qualification Test	- Correspondence between Agile process and software engineering processes of automotive SPICE - Documentation in Agile development with emphasis on working software - Establishing and maintaining traceability among work products in Agile development that responds flexibly to changing requirements
SUP.1 Quality Assurance	- Organizational structure and procedures for ensuring the quality of activities and work products implemented by self-organizing teams - Setting of quality assurance criteria considering balance of agility and quality levels
SUP.8 Configuration Management	- Maintenance of consistency between work products across teams and sprints
SUP.9 Problem Resolution Management	- Sharing issues across teams and sprints, and clarifying impact and fixing all the affected work products
SUP.10 Change Request Management	- Mechanism of change request management that enables flexible response to change requests in agile
MAN.3 Project Management	- Realistically estimate and plan for each sprint - Monitor and control daily progress within sprint - Visualize progress towards project milestones and goals to foresee the achievement

# Approaches to Promote Process Improvement

## Target of improvement

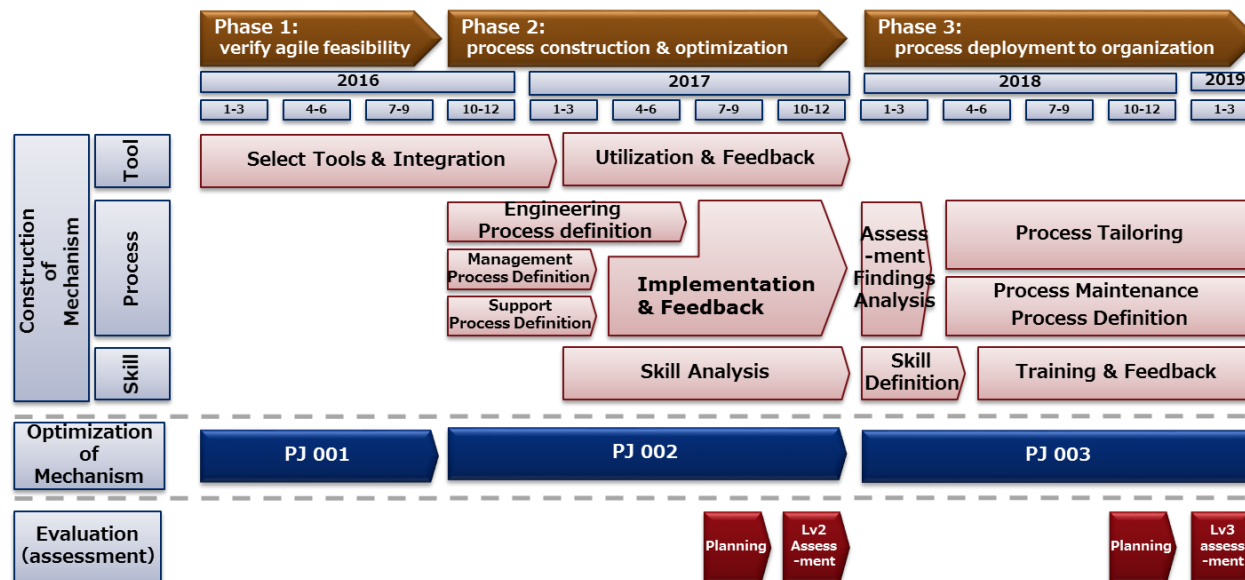
- Process, environment and developers' skill

## PDCA basis

- P: Construction => D: Implementation => C: Evaluation => A: Improvement  
P: Construction => D: Implementation => ...
- Assessments are performed for an evaluation

## Stepwise deployment

- Phase 1: feasibility verification in trial project
- Phase 2: implementation of constructed processes in established environment by trained developers, and evaluation and improvement in actual project
- Phase 3: organizational deployment



# Practical Examples of Process Improvement

## Documentation and Traceability

# Documentation suit both for SCRUM and A-SPICE

## Analysis to find minimum required documents

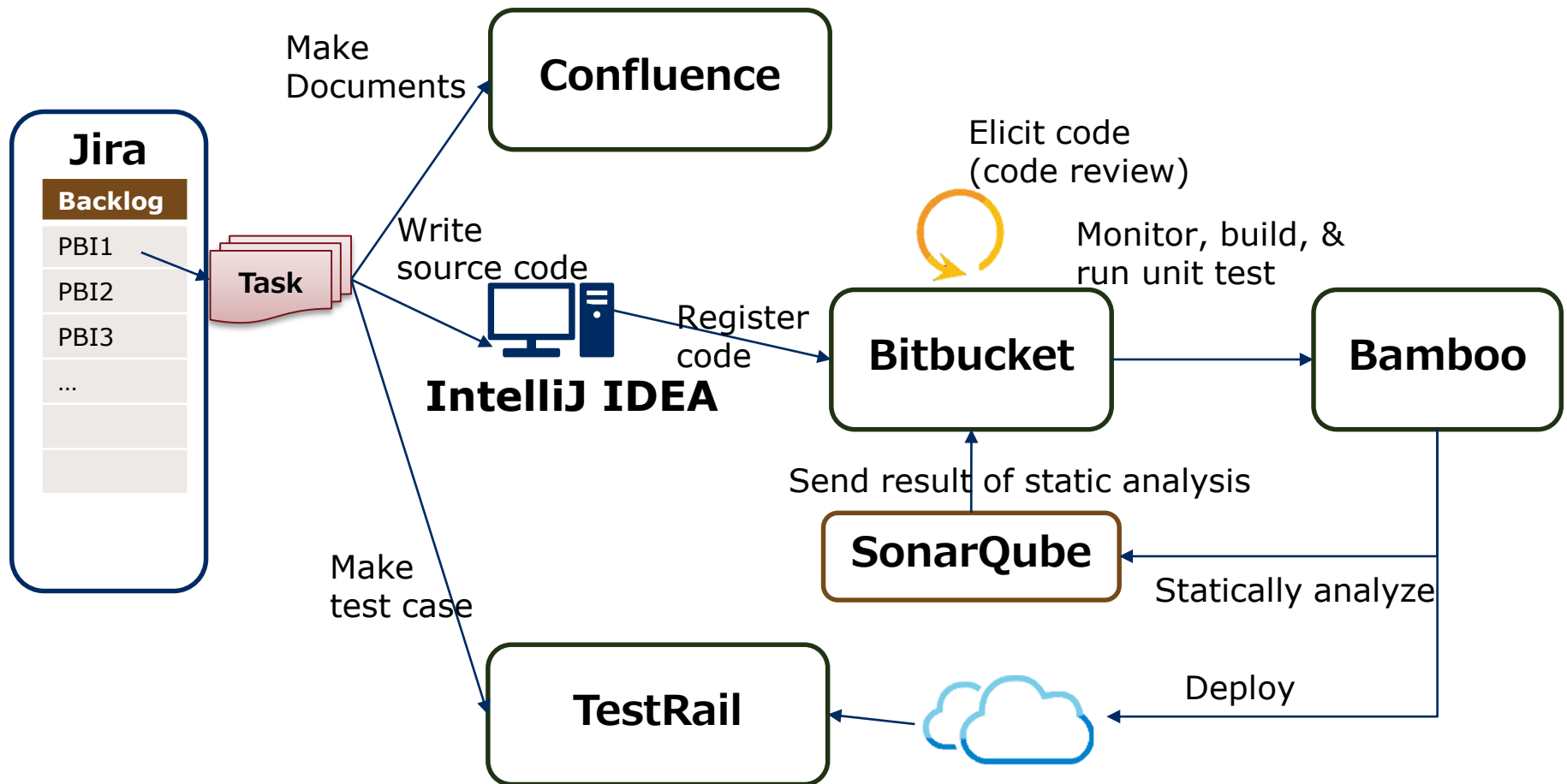
- Rationale for documentation was clarified.

Documents to be developed	Corresponding Automotive SPICE BPs	Rationale of documentation
Software requirement specification	SWE.1 BP.1	Scrum develops software based on product backlog, but the product to be developed had to consider the features provided with the platform in addition to the functions provided with the application to work on it. Therefore, it is expected to develop product backlog considering as much functional and non-functional requirements as possible in early stage. So, it was decided to clarify the path to derive the product backlog from the requirements with software requirement specification. The requirements are specified considering overall software architecture described in architectural design specification.
Software architectural design specification	SWE.2 BP.1	
Software functional specification	SWE.3 BP.1	Due to the nature of software, there was a need to implement multiple functions in one element. Since the functions are assigned to different product backlogs, implementation of them may be across multiple sprints. In order to prevent degrade, the design assets in a sprint are documented as software functional specification to be referable in subsequent sprints.
Software functional test specification and report	SWE.4 BP.2 SWE.4 BP.4	To ensure software components to work as described in the software functional specification.
Software integration test specification and report	SWE.5 BP.3 SWE.5 BP.6	To ensure integrated software items to work as described in the software architectural design specification.
Software qualification test specification and report	SWE.6 BP.2 SWE.5 BP.4	To ensure software product developed in a development sprint to fulfill the requirements described in the software requirement specification.

# Tool Chain for Document Management

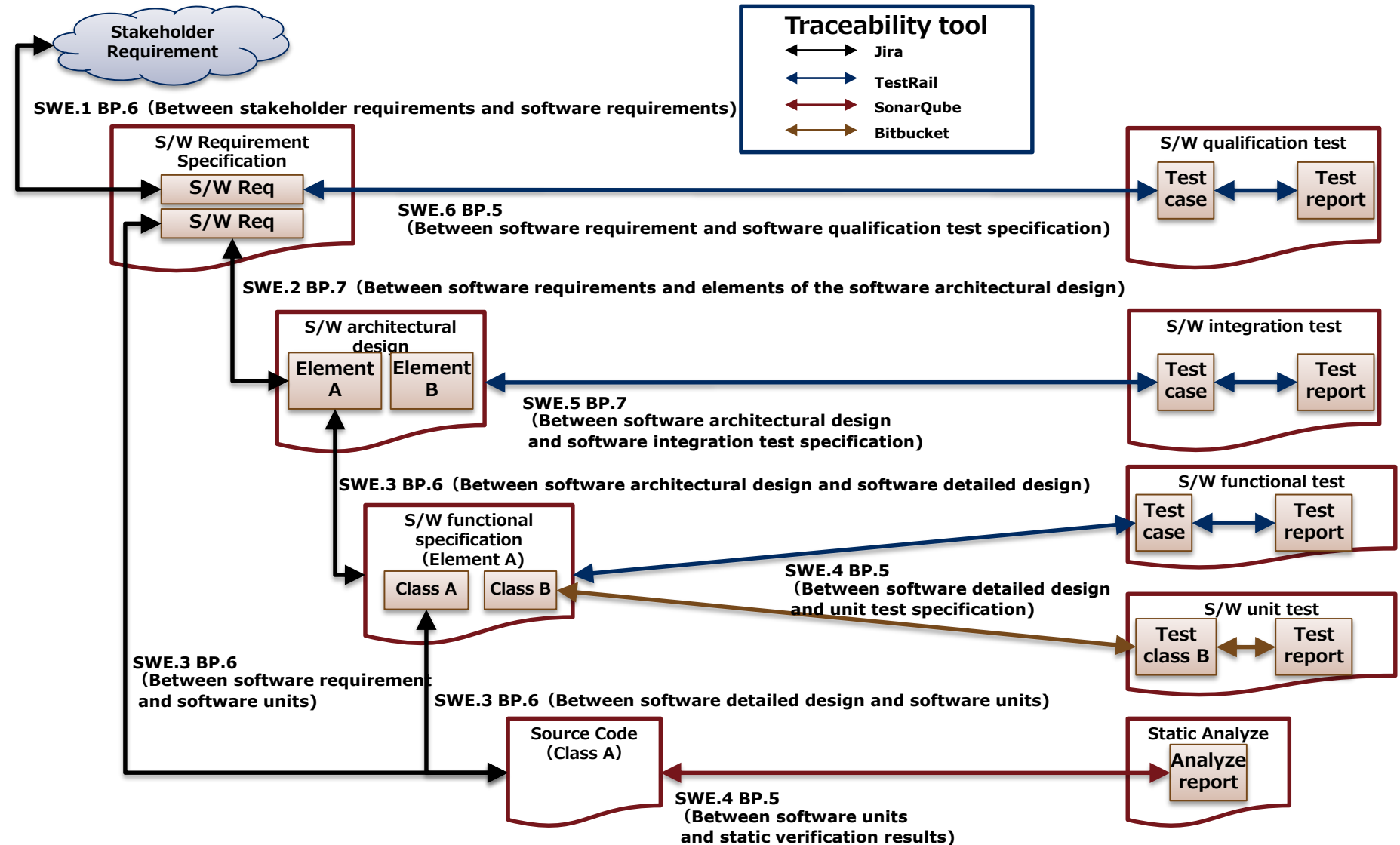
Efficient document management using tools.

- Work products development was assigned as a Jira task.
- Confluence is used for requirements and designs, Bitbucket for source codes, TestRail for test cases and test results.



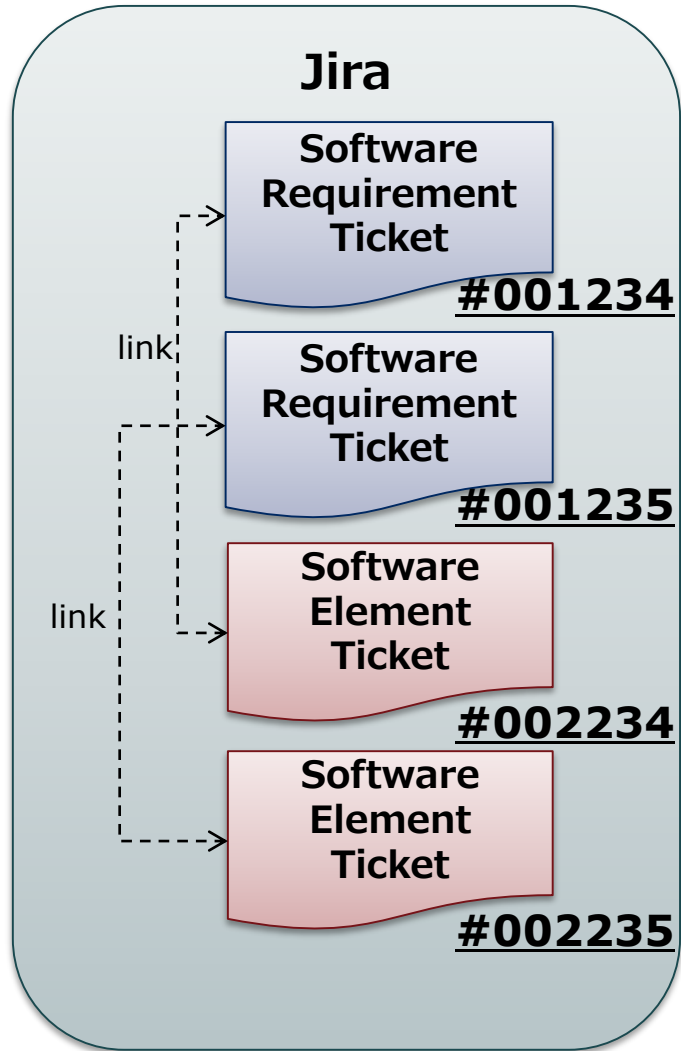
# Establishment of Bidirectional Traceability

Implemented Using Multiple tools, i.e. Jira, TestRail, SonarQube and Bitbucket .



# Visibility of Traceability Using Jira's Function

Traceability can be visualized as matrix or tree structure

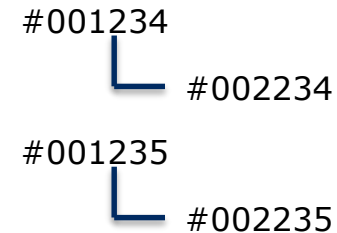


Matrix View

	#001234	#001235
#002234	X	
#002235		X



Tree View



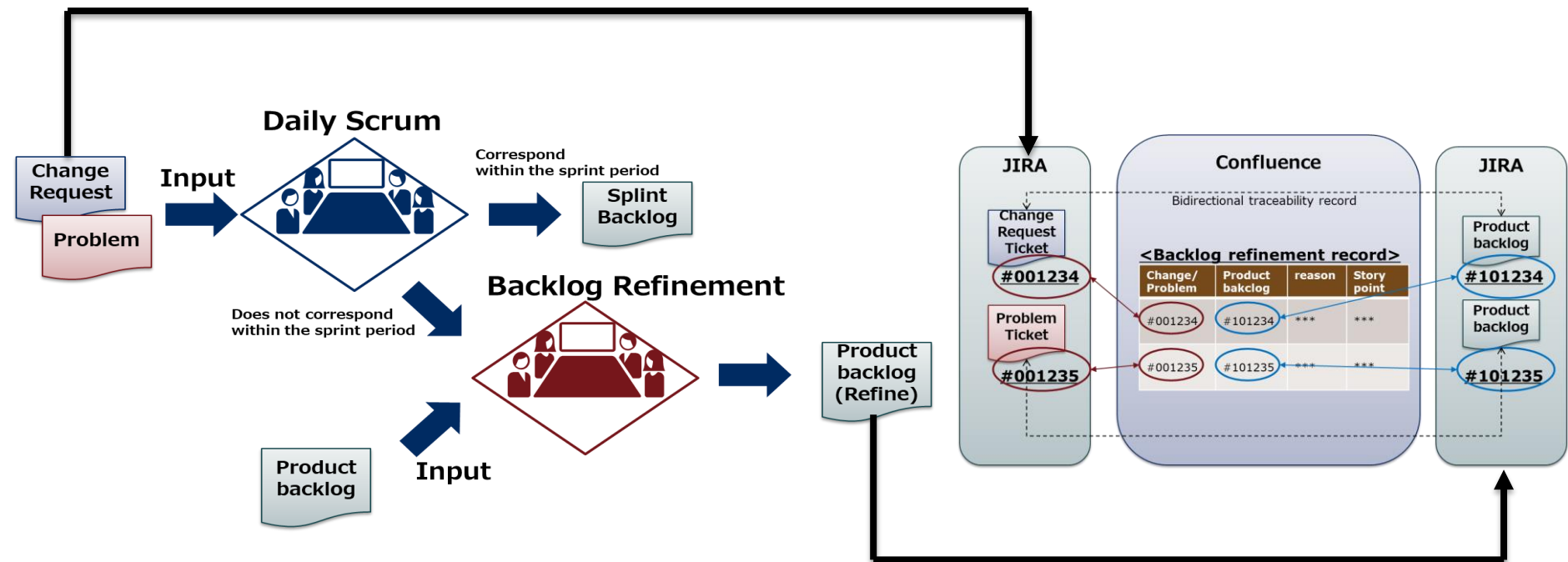
# Practical Examples of Process Improvement

Problem resolution and change request management



# Problem resolution and change request management in Agile

- Problem and change request in agile, and workflow to manage them are defined.
- The workflow is supported by tools
  - Product backlogs, problems, change requests were classified as Jira ticket types according to the definitions.
  - Backlog refinement records were stored in Confluence and linked to the related product backlog, problem, and change request to make it possible to trace discussions on it.



# Effects

# Effects of Process Improvement

## Qualitative Effects

- Achieved capability level 2 in Phase 2 and level 3 in Phase 3

## Quantitative Effects

- Productivity
  - Increased 50% from Phase 1 to 3
  - Measured in velocity (amount of story points that one scrum team can implement per sprint).
- Quality
  - Improved 30% from Phase 2 to 3
  - Measured in number of defects found after release per project scale (person-months).

	Phase1:Project 001	Phase2: Project 002	Phase3: Project 003
Productivity	9	11.8	13.5
Quality	-	0.18	0.14

# Conclusions

# Conclusions

■ The following are explained;

- A Hybrid development method of agile and waterfall, which implements A-SPICE practices,
- Stepwise process improvement from the view of process, people and technology,
- Practical example to implement A-SPICE practices related to bidirectional traceability and problem and change request management in agile development.

■ Effects of the process improvement approach are verified on productivity and quality.

■ We will deploy the established processes to other area, collect and analyze data, verify effects further, and improve the processes continuously.

Thank you very much  
for your kind attention!

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**NEC**