IPA Information-technology Promotion Agency, Japan
京都大学 KYOTO UNIVERSITY
KILAP Kyoto University Center for Interdisciplinary Studies of Law and Policy

Rules (Laws and Standards) and Software Engineering in the Age of AI

Software-Defined Society(SDS)

Society is composed of rules
- Laws
- Rules
- Guidelines

Rules

Software

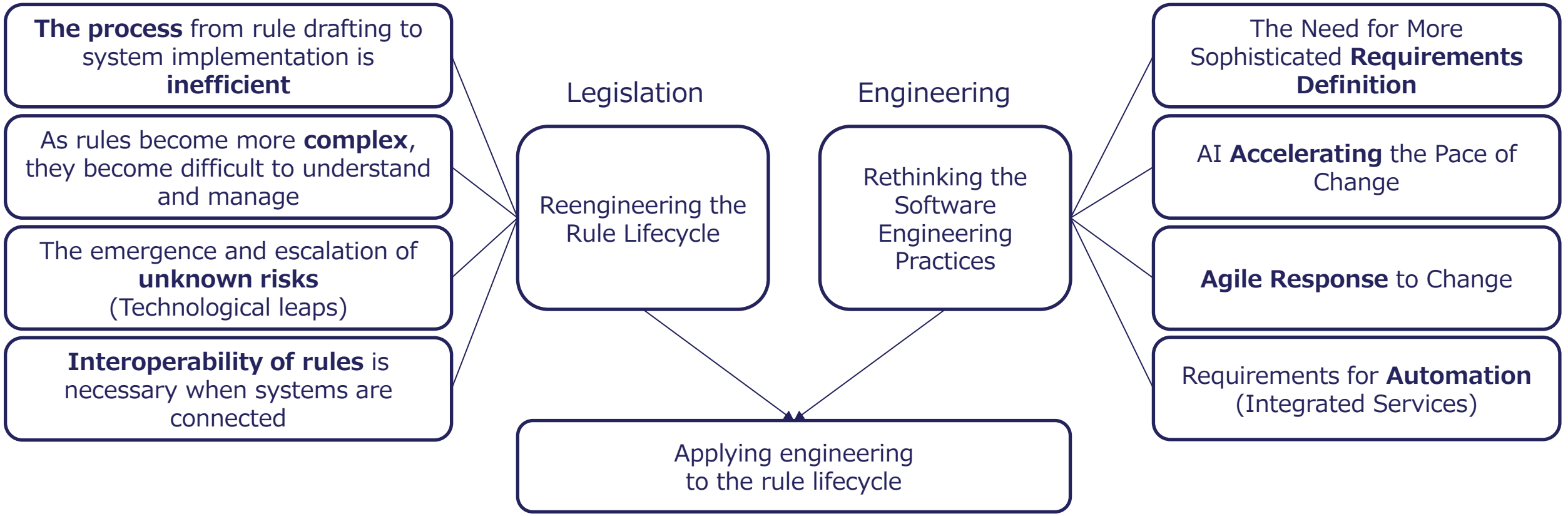
Data

Society is driven by data
- Activities
- Sensors
- Geospatial data

Society is composed of engineering
- Buildings
- Machines
- Systems

Society is accelerated by AI

Background: Traditional approaches are unable to keep pace with digital transformation



Note: Both rules and engineering are “systems of norms designed to achieve objectives” and share structural similarities.

Overview of the research

In this “**era of rapidly and continuously evolving AI**,” it is essential to appropriately enact, amend, implement, and enforce laws with clear accountability. However, existing legal systems and LegalTech have struggled to address these challenges.
Since both laws and software are critical components of social systems and share similar structures, we aimed to achieve a fundamental solution by introducing software engineering methodologies into the legal field.

Report

A report summarizing the background, objectives, and concept, as well as the initiatives undertaken by each specialized team.
(The Annex outlines the latest trends in LegalTech and provides an engineering perspective.)

Part1 Law as the Integrated Implementation of Rules and Technology

Design, Implementation, and Operation of Legal Systems Based on Legal Interests

Part2 A Study of Structural Visualization Methods in LE4SDS

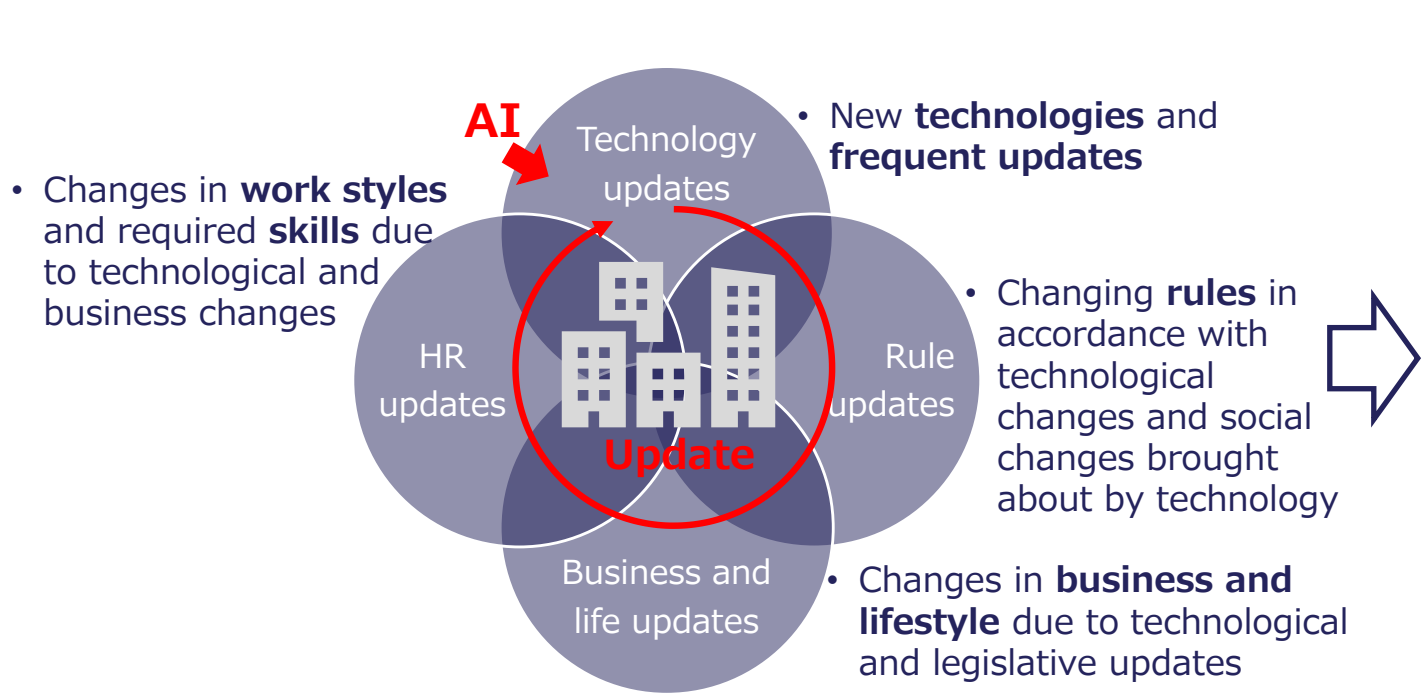
Verifying the usefulness of visualizing the structure of law based on legal interests using modeling techniques

Part3 On Conformity Assessment in the Field of AI

Survey of Trends and Overview of Approaches in Conformity Assessment

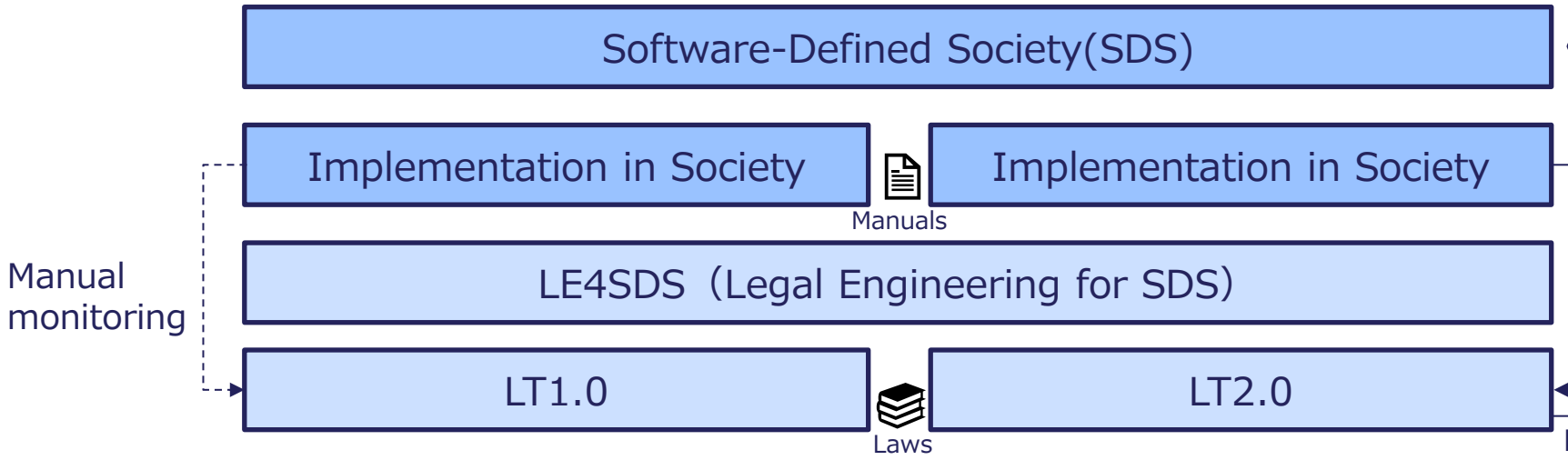
Report(Overview of the concept)

- AI is accelerating social change. The law must evolve at the same pace. The law must be simplified and made mission-oriented.
- Law and software are similar in that they are both logically and structurally organized to achieve specific objectives. This study introduces an engineering approach to legal studies and explores the development of a seamless framework.



Structure of the Joint Research

New Legal Framework for the Digital Age:**LE4SDS** (Legal Engineering for SDS)



Software Engineering
- Modeling for functions and processes
- Pre-validation and rapid implementation capabilities
- Feedback cycles

Implementation

Automatic monitoring

Detailed Specifications

Standards

Joint conformance certification (*1)
- Management
- Product

*1: Hereinafter referred to as the "Joint Certification"

	Traditional approach (Digital Tech. to Existing Laws and Regulations)	Proposed approach (New Legal Framework for the Digital Age)
Positioning of LegalTech	**Technical methods for efficiently performing current legal work**	**The integration of optimal norms and techniques to achieve the essential functions of the law**
Process	**Fulfillment of Legal Interests →Rule→Tech.+Process**	Requirements Analysis → **Fulfillment of Legal Interests →Function→Tech.+Process+Rule**
	Improvements based on functional analysis and process analysis	Pre- and post-implementation verification cycle

Easy for anyone to understand
Accountable
Easy to compare
No omissions or errors
Short lead times
Supports agile development
Data feedback can be integrated

Part1: Law as the Integrated Implementation of Rules and Technology

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Traditionally, mechanisms for protecting legal interests have been designed primarily as norms directed at humans. However, in the Software-Defined Society, technology itself becomes a tool that directly contributes to the protection of legal interests.
In this context, the role of rules evolves into a higher-level governance function: promoting the use of technology, evaluating its appropriateness, and designing operational methods tailored to the level of risk.

- Use Cases for Legal Design Based on Legal Interests
- Technologies that can replace or supplement the functions regulated by the Rule
- Framework and Operational Design to Promote the Use of Technology

Category	Risk Characteristics	Regulatory Design Approach	Reference Use Case	Institutional Design Challenges	Common Challenges across the Categories
Category A	**Tasks are limited, and risk scenarios can be enumerated**. Input data formats and quality requirements can be standardized, and pass/fail criteria can be expressed numerically.	Pre-standardization of quantitative performance criteria + approval system	Infrastructure Inspection (Singapore TR 78 Series)	Establishing Performance Standards and Institutionalizing the Evaluation Process	Dynamic Conformity Assessment Strengthening Regulatory Authorities' Technical Assessment Capabilities Institutionalizing Multi-Stakeholder Governance Participation in International Standard Harmonization
Category B	**Tasks are complex and the input space is infinite**, making it difficult to comprehensively cover all risk scenarios in advance. There are fundamental limitations to comprehensively standardizing performance criteria in advance.	A combination of preliminary evaluation based on safety principles and safety cases, and lifecycle-based continuous monitoring	Autonomous vehicles (UK Automated Vehicles Act 2024)	Dynamic Safety Assurance and the Redesign of Liability Attribution	
Category C	**The focus is on the protection of legal interests themselves**, rather than on alternatives to specific tasks. The legal interests to be protected are multifaceted, and risks depend on the technical context of the processing.	Risk-based, tiered regulatory framework premised on the formation of a social consensus regarding the acceptability of risks to legal interests	Personal data protection (GDPR, OECD PETs Report)	Building Social Consensus on the Acceptability of Risks to Legal Interests	

Part2: A Study of Structural Visualization Methods in LE4SDS

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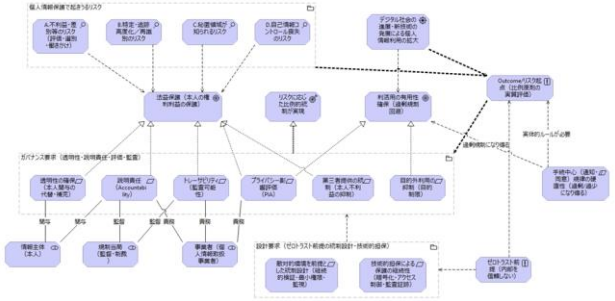
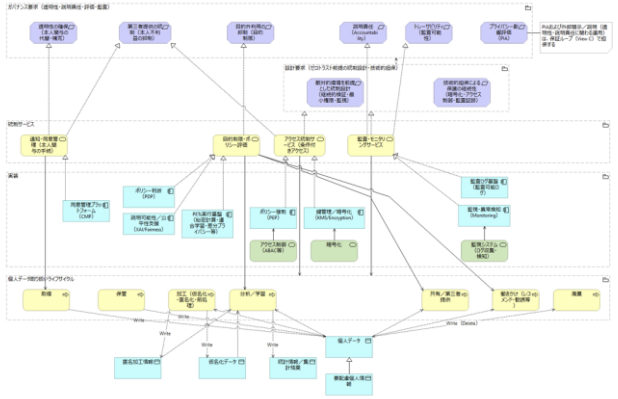
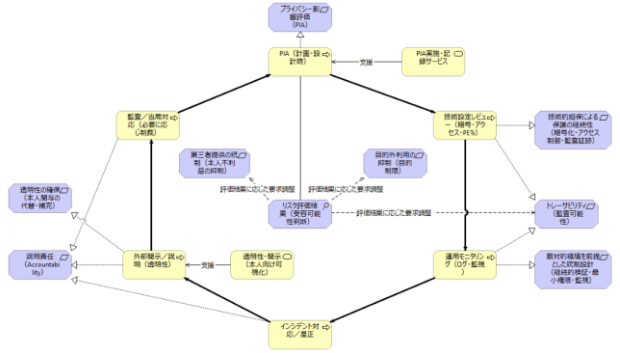
To ensure that everyone can understand and apply the law, it must be visualized. Previous research has described legal procedures using process modeling and verified their effectiveness and efficiency, including through simulation.
In this study, we attempt to apply requirements definition methods to the description of laws based on legal interests.
To visualize the law, we present the following elements at an easily readable level of detail:
(A) the basis for decision-making (risk origin), (B) implementation (deployment and realization),
and (C) operational effectiveness (assurance loop).
Collectively, these three views ensure traceability.
This confirmed that even non-legal experts can ensure governance and facilitate legislative revision.



(A) “Why/What”
(Motivation, Evaluation, Principles, Requirements)



(B) “Where/How”
(Flow of the subject matter; control placement and implementation within processes)

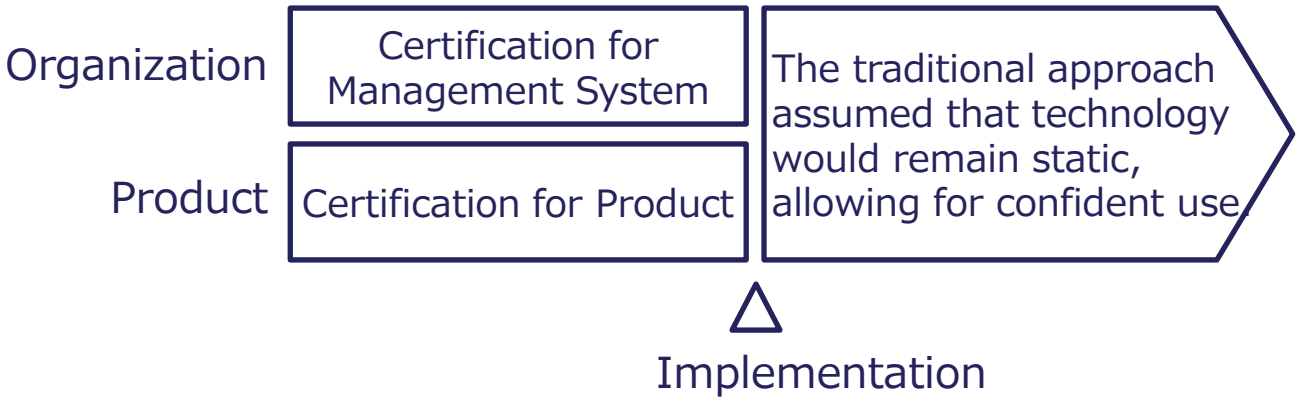


(C)“Can it be sustained?”
(The cycle of evaluation, monitoring, correction, disclosure, and audit)

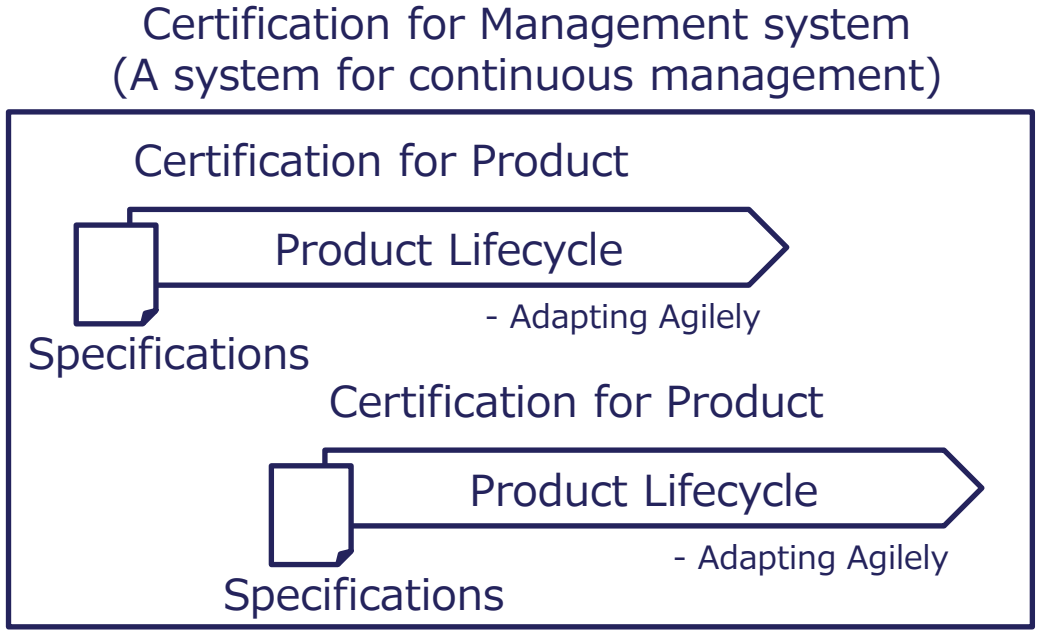
Part3: On Conformity Assessment in the Field of AI

Joint Certification is a new framework that integrates organizational management certification and product certification to simultaneously assess an organization's capacity for continuous improvement and the safety of its implementations. For technologies such as AI, which are inherently subject to updates, certification must focus on "processes and evidence" rather than on isolated "points." Joint Certification is the institutional framework that enables this approach.

Traditional Approach for Conformity assessment



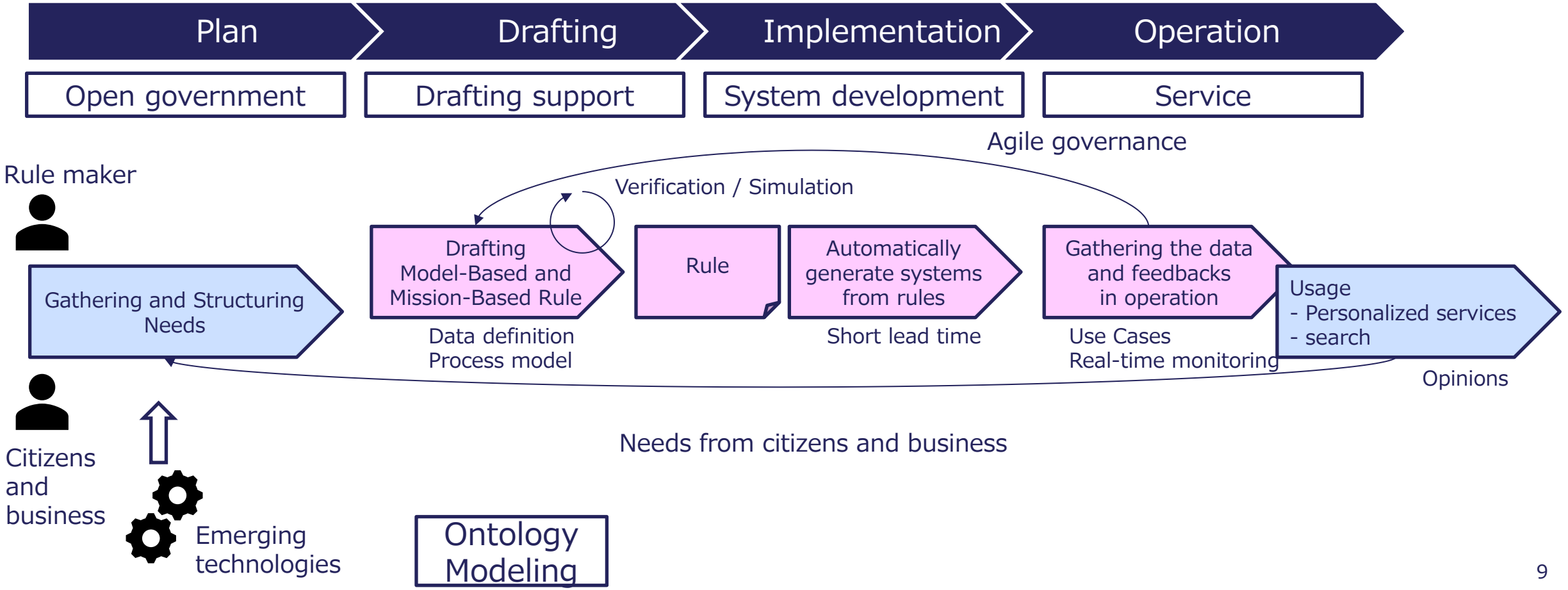
New Approach for CA in the Era of Updates



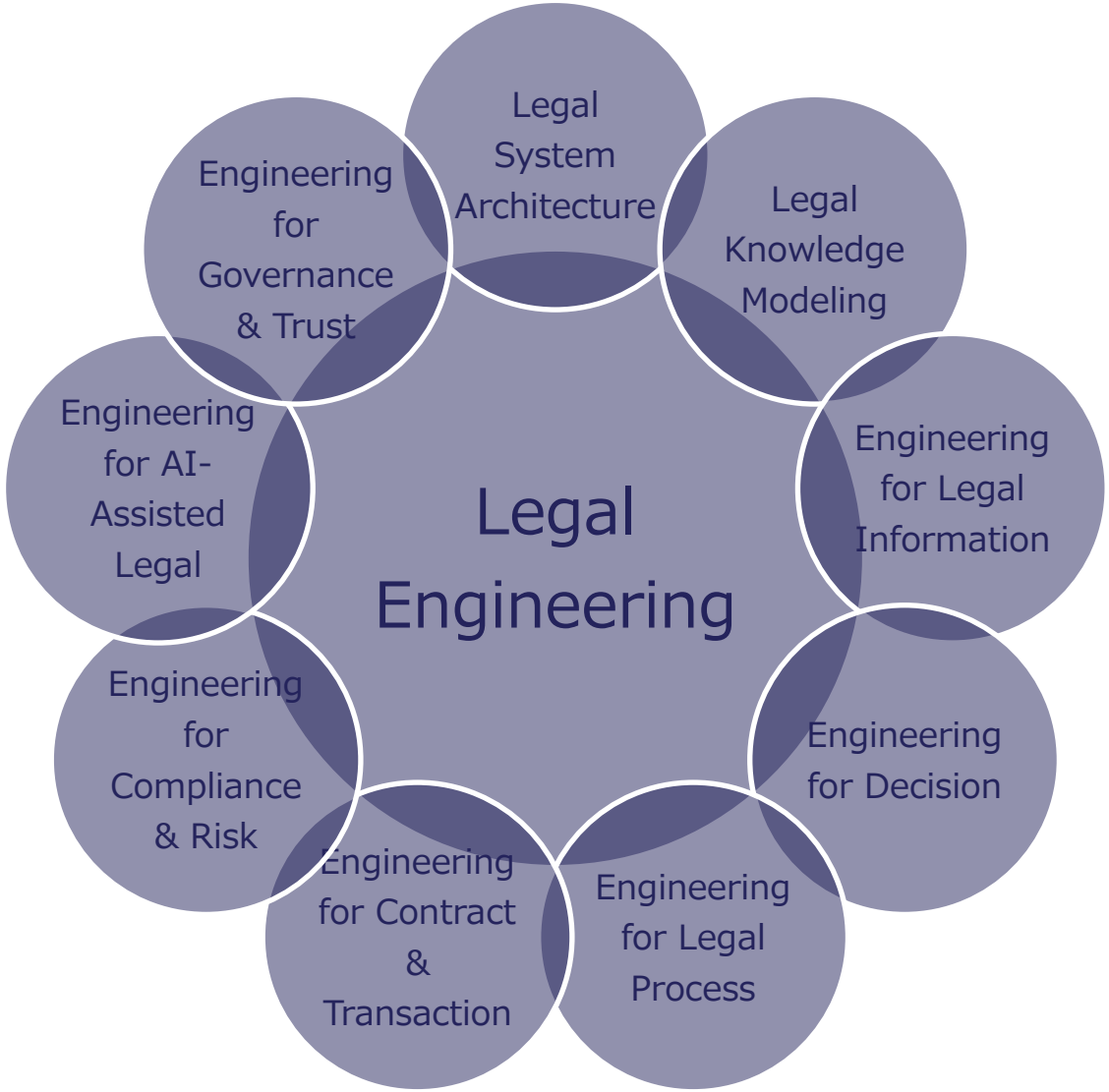
- What evidence to collect
- How to evaluate Conformity (Process)

Appendix A of the Report

From a lifecycle perspective, we clarified the role of legal engineering in each task and analyzed the current situation.



Appendix B of the Report



We analyzed the lifecycle of laws from an engineering perspective.

By applying an engineering framework, we aim to improve consistency, repeatability, verifiability, and ease of understanding and management.

Conclusion

- The core of this research is to theorize the transition from the **efficiency-driven phase** of LegalTech (LT1.0) to the **mission-oriented integrated design phase** (LT2.0), systematize this as LE4SDS, and present a framework for **embedding it into society through standards** (joint certification).
- This is not merely LegalTech research. This overarching structure constitutes an institutional design architecture for realizing SDS and can be described as a **redesign of the "social OS" for the AI era**.
- We will continue to refine this framework.