



STEVENS
INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY®

An AI Based Sectionalized Semantic Traceability Framework for Policy Documents with Applications to Department of Defense Problems

Prof. Jose E. Ramirez-Marquez, Ph.D.





Towards a Unified Framework for Network Resilience

Jose Emmanuel Ramirez-Marquez¹ and Claudio M. Rocco²

¹Stevens Institute of Technology, School of Systems & Enterprises, Castle Point on Hudson, Hoboken, New Jersey, USA.

²Universidad Central de Venezuela, Facultad de Ingenieria, Caracas, Venezuela

jmarquez@stevens.edu, croccoucv@gmail.com

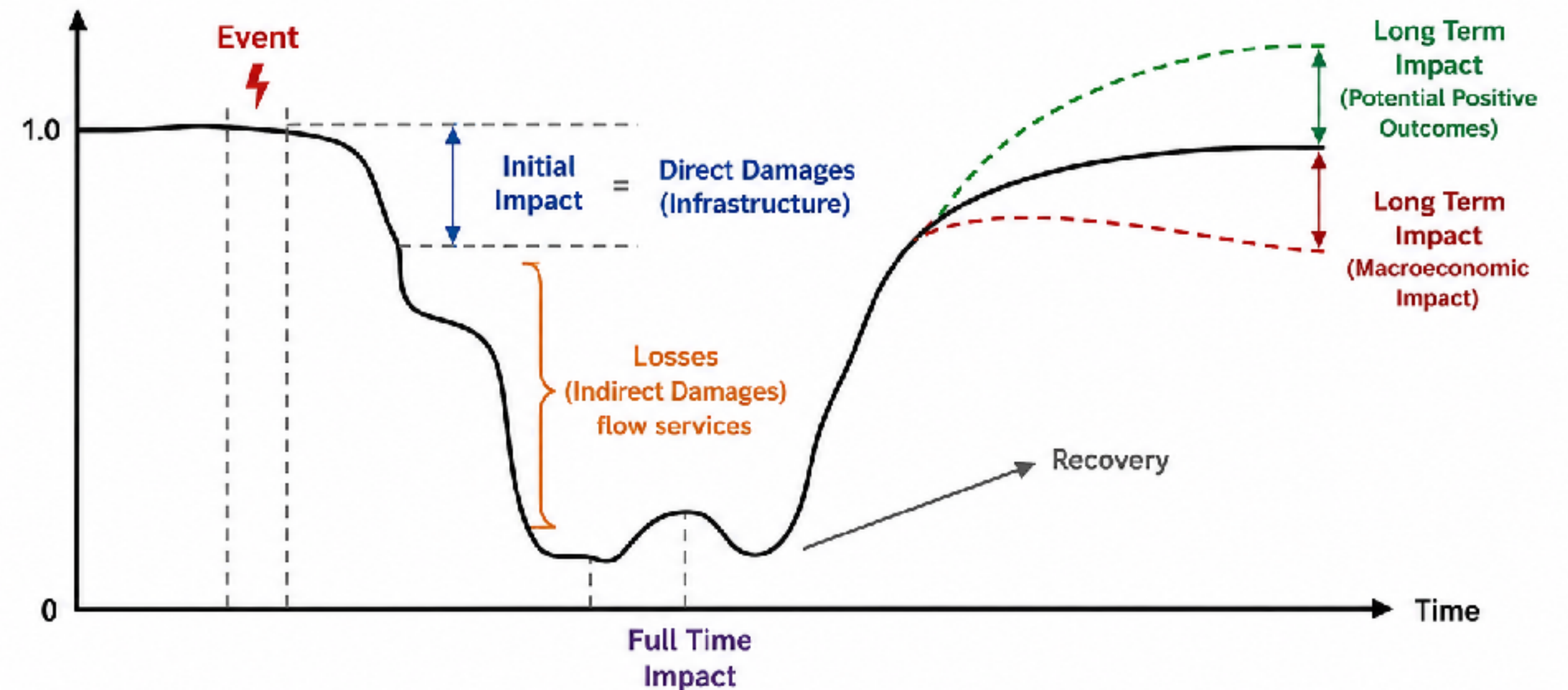
Abstract. The term “system resilience” by itself incites debate about its inherent concept and its computation. To clarify this concept, recent studies have proposed metrics to understand and to quantify the ability of systems to recover from an external disruptive event. Unfortunately, most of this research is focused on deterministic metrics. This presentation will introduce recent advances in the analysis of network resilience- via description of corresponding stochastic time dependent formulae for addressing the problem of quantifying network resilience. In specific the presentation will discuss: Time to Total Network Restoration, Time to Full Network Service Resilience and, Time to α %-Resilience. The presentation will unveil and discuss two optimization problems of stochastic order inherent to the resilience process when considering recovery activities: 1) minimize the time to full network service resilience and 2) minimum expected total cost of disruptive event. The presentation will highlight different issues regarding data collection and analysis for implementing a systems resilience framework in practice.

Keywords. Resilience, Network Analysis, Vulnerability, Stochastic Optimization.

1 Introduction

As discussed in (Henry and Ramirez-Marquez, 2012), Figure 1 illustrates the general description of the process for understanding and analyzing system resilience. Accordingly, resilience of a system at time t , is exhibited if and only if there is an external disruptive event, e_j , that affects the original system state (depicted in Figure 1 as S_0). Once the system is disrupted at time t_e , a period of degradation, of length $(t_d - t_e)$, shifts the system from its original state, S_0 (with corresponding $F(t_0)$), to a disrupted state, S_d (with the corresponding $F(t_d)$). That is, the disruptive effect of such an event is quantified via the analysis of a function $F(t)$ describing the behavior of the system as a function of time. Examples of this function, henceforward called figure-of-merit (FOM), include system: delay, flow and, uptime, to name a few. After a period of time, of length $(t_s - t_d)$, the system restoration commences until it reaches a stable system state, S_f , with corresponding $F(t_f)$.

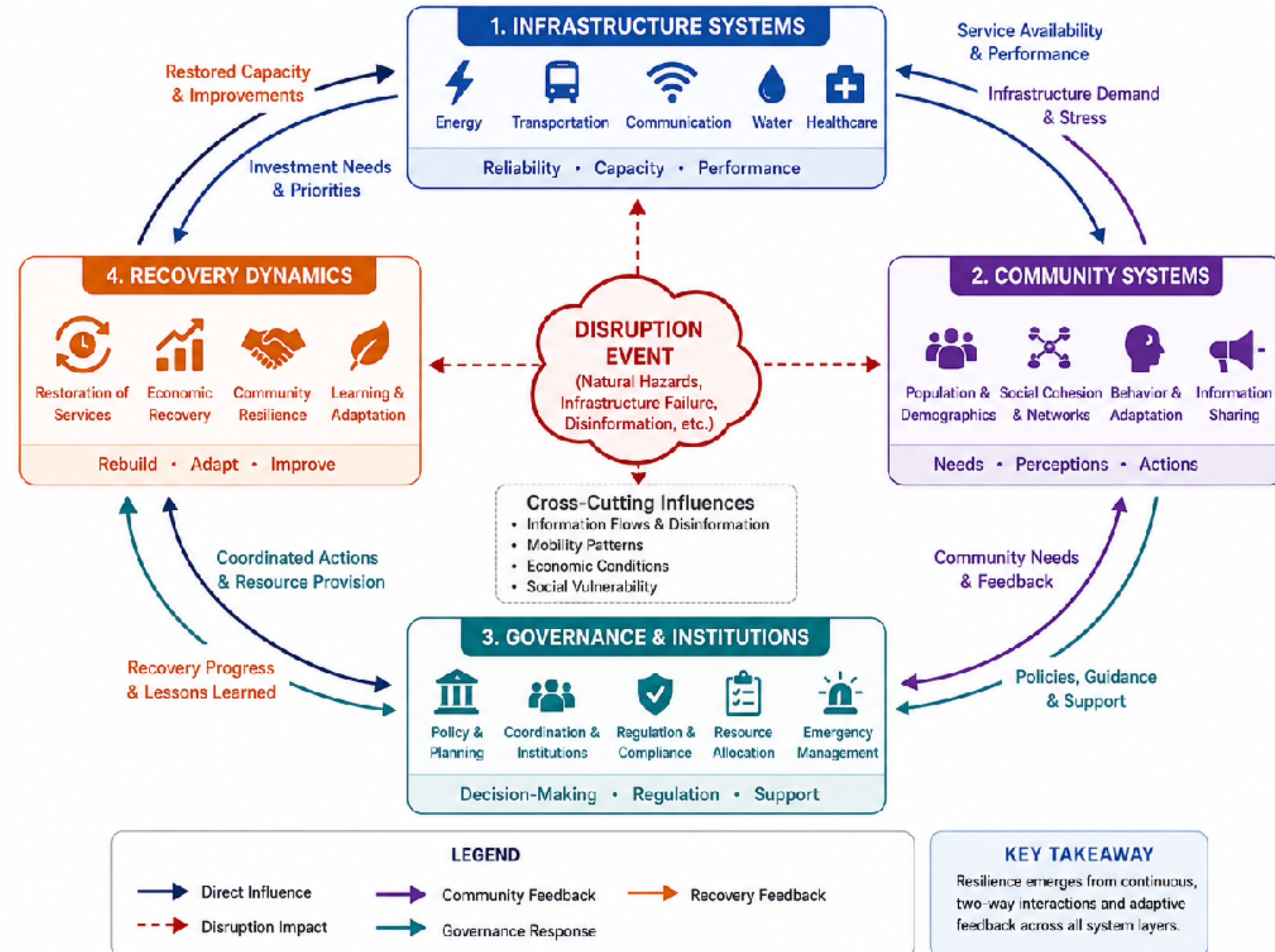
Performance (ϕ)





BIDIRECTIONAL INTERACTIONS DURING DISRUPTIONS

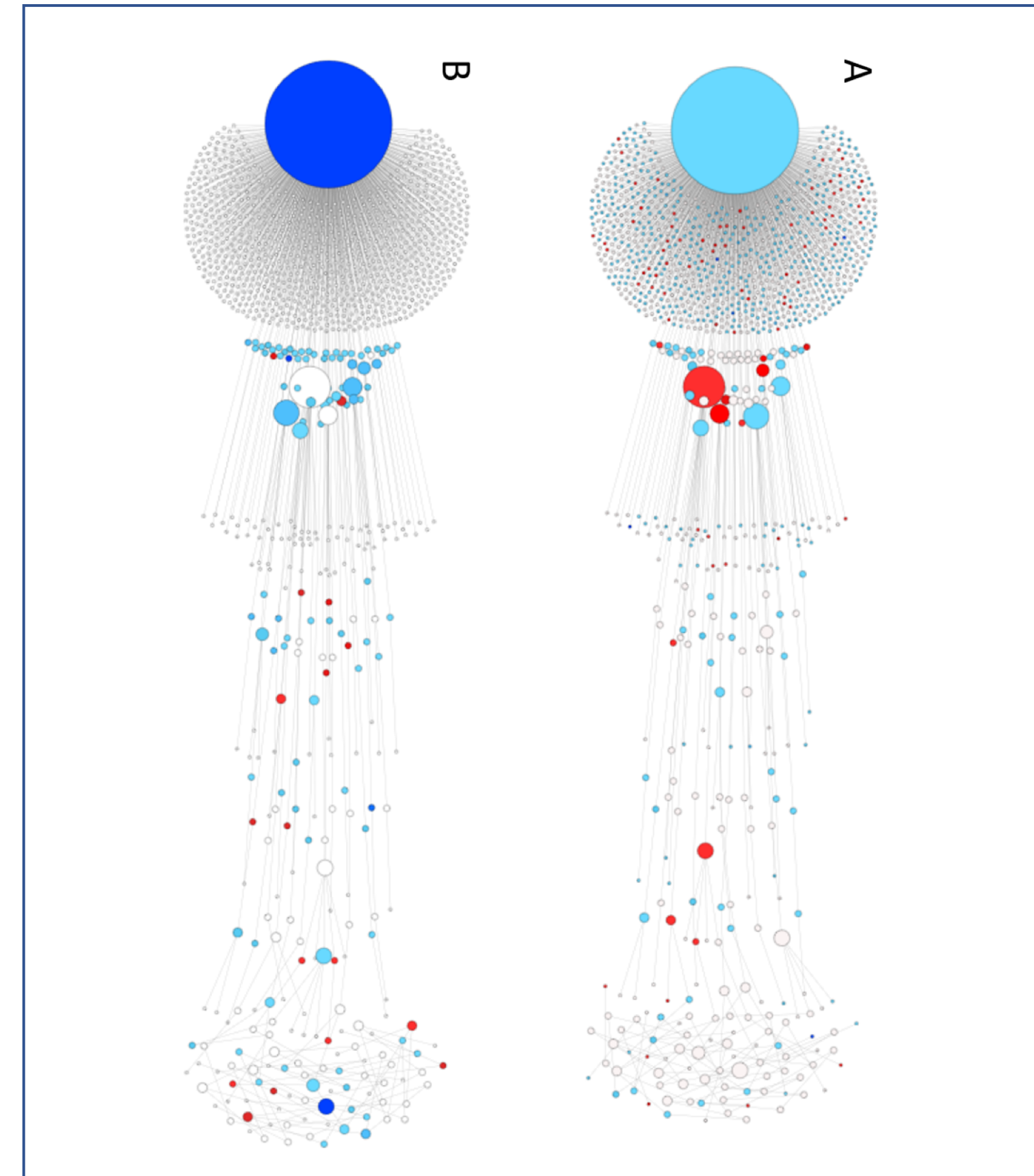
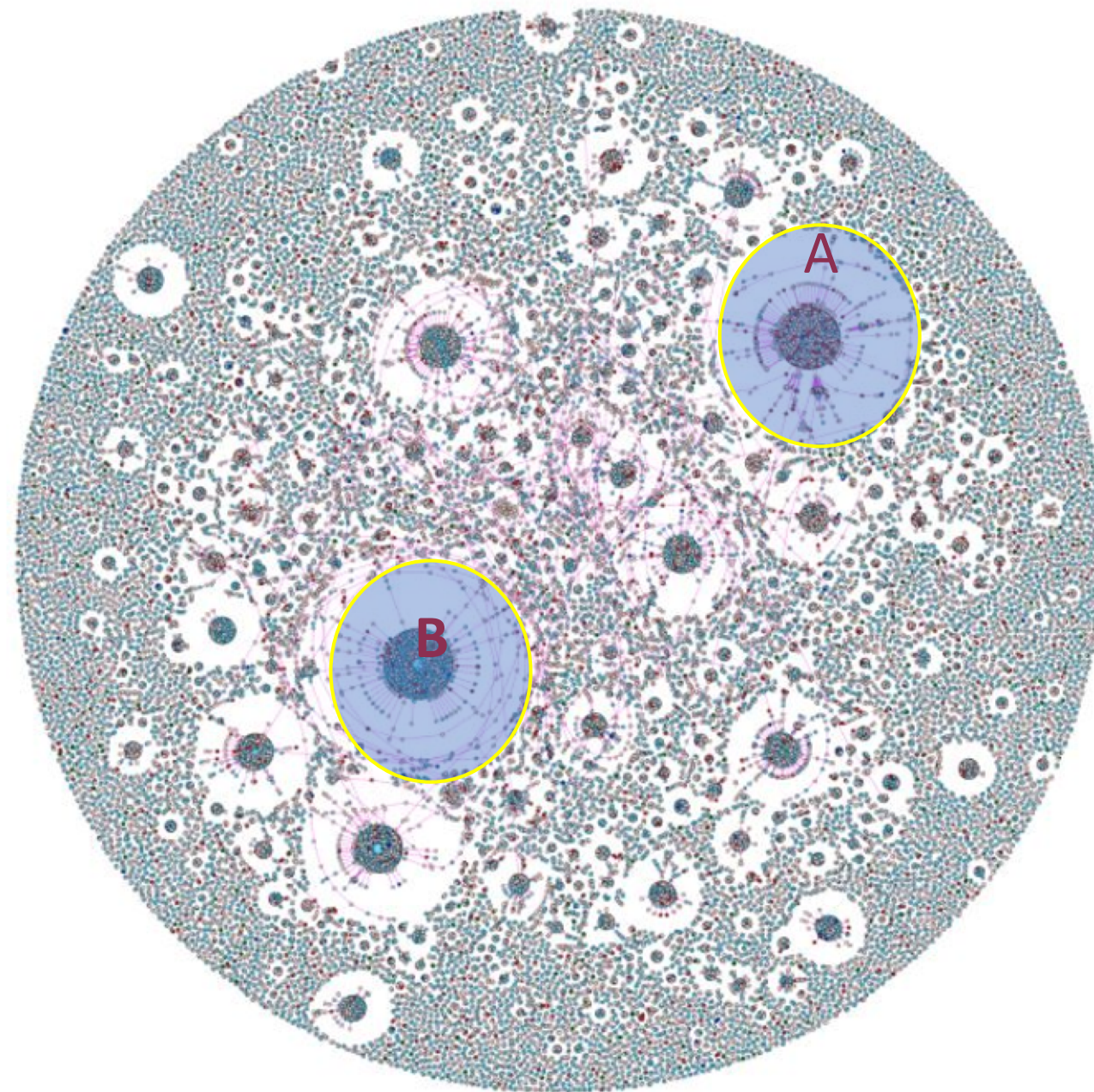
Infrastructure–Community–Governance Feedback Dynamics



Current Efforts - Citizens as Sensors

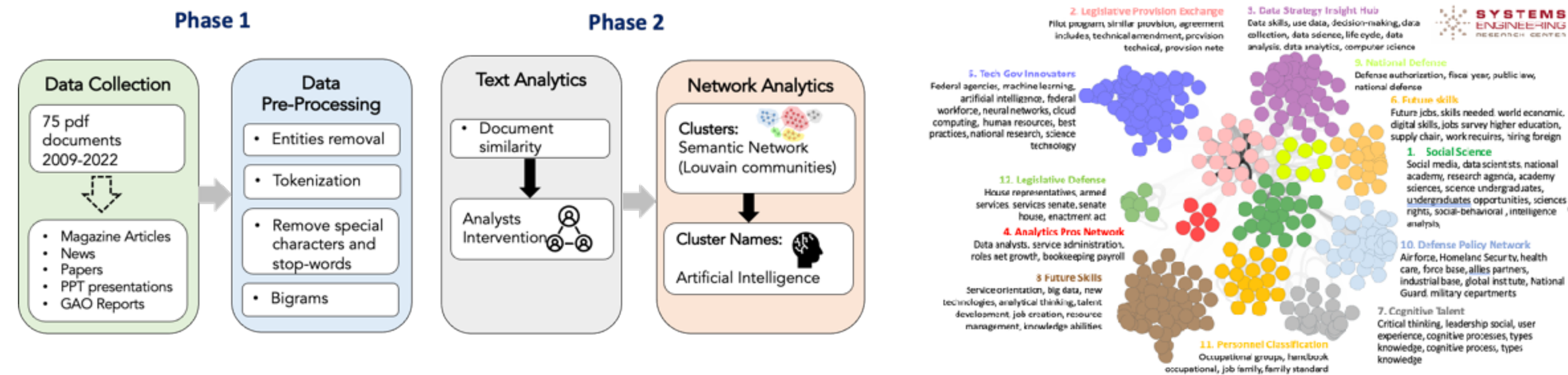


Sandy Tweet Galaxy

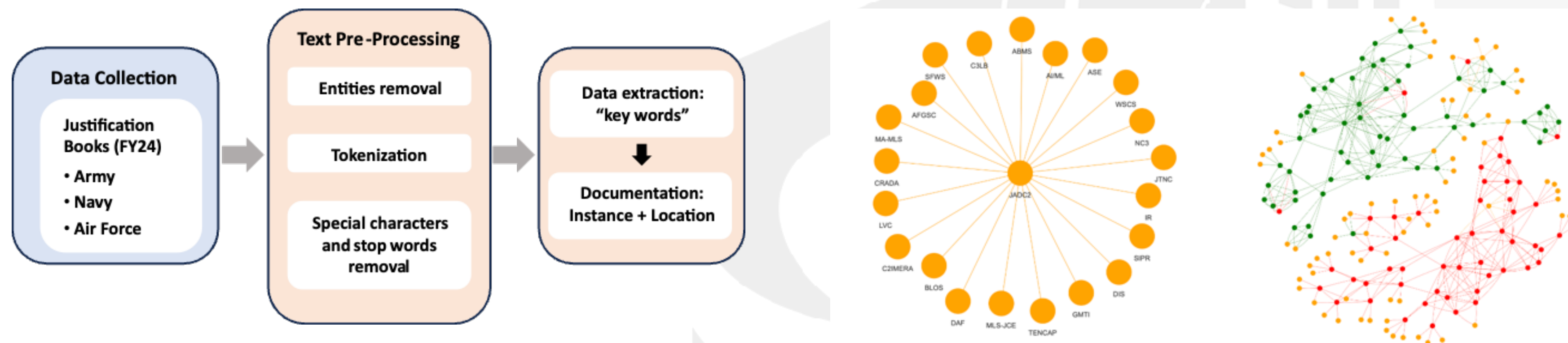




Leveraging NLP for Skill Identification and Talent Management in the Department of Defense, AIRC WRT-1080, 2023

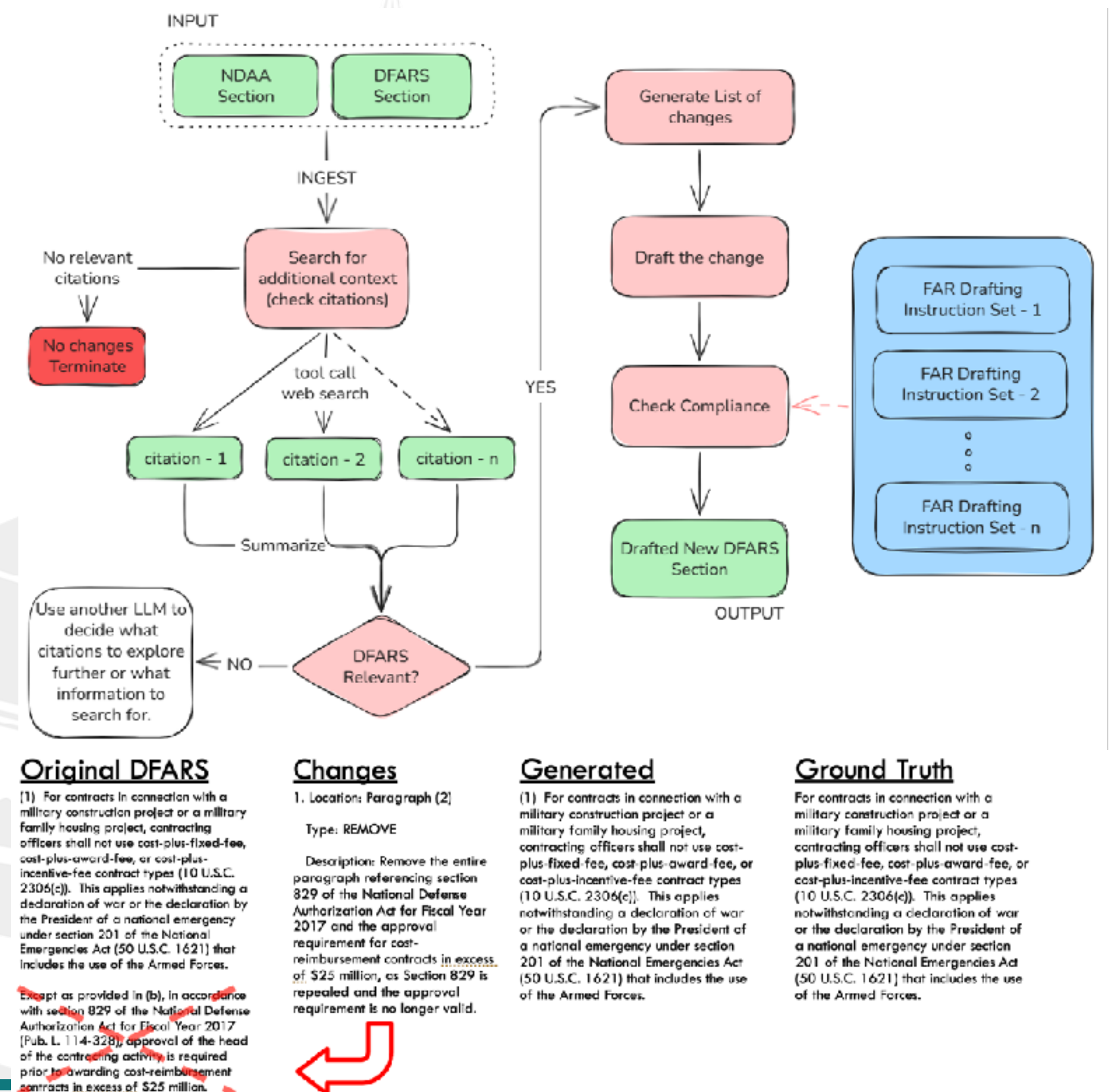


Demonstrating a J-Book Key Word Search Association Proof-of-Concept, AIRC, WRT-1079, 2023





AI-based DPCAP FAR/DFARS Change Support Tool, WRT-1097, 2025





Sectionalized NLP-Based Document Traceability Framework

An Integrated Workflow for Extracting, Analyzing, and Tracing Relationships Across Policy Documents

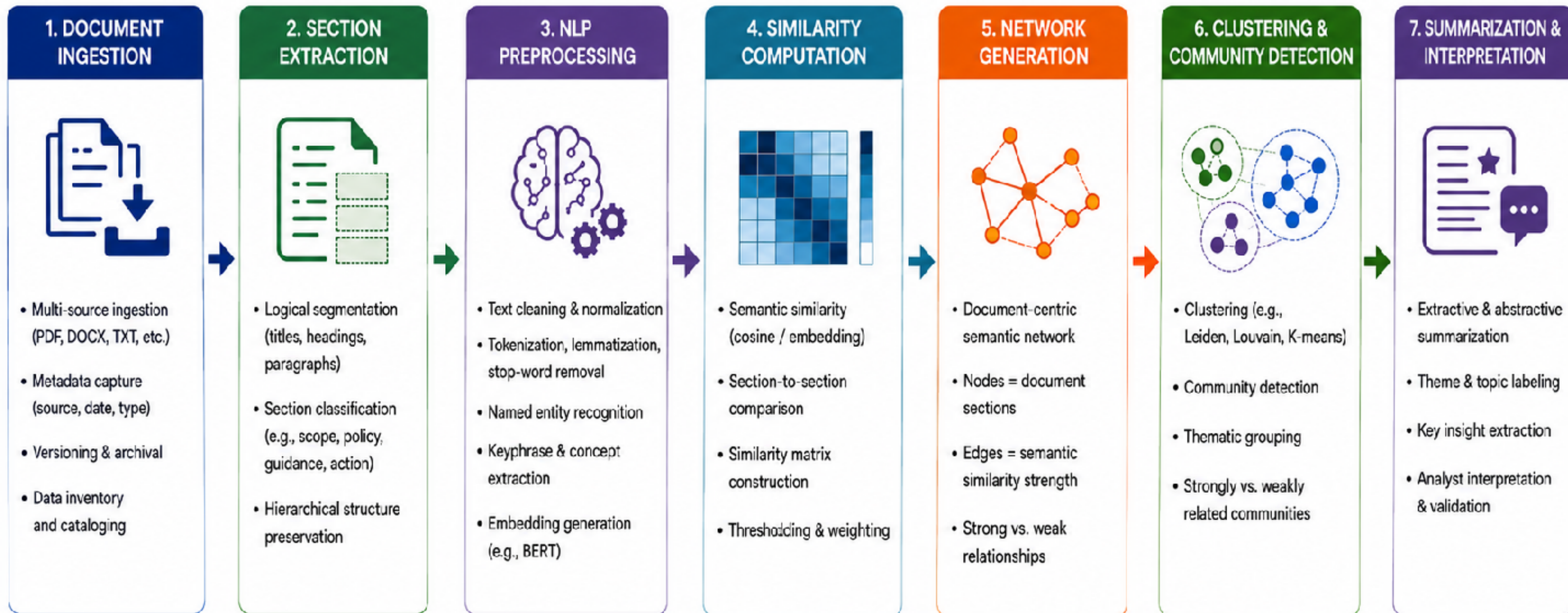


Figure 1: Sectionalized NLP-based document traceability workflow.

An AI Based Sectionalized Semantic Traceability Framework for Policy Documents with Applications to Department of Defense Problems

Jose Emmanuel Ramirez-Marquez, Ph.D.
Stevens Institute of Technology

The proposed framework begins by ingesting a collection of acquisition-related documents such as NDAA's, DFARS sections, GAO reports, J-Books, strategic memoranda, or acquisition reform studies. Rather than treating each document as a single analytical unit, the framework decomposes each document into sections or subsections that become individual semantic components. Each component retains metadata associated with the original document, including document identifiers, section numbers, titles, and thematic labels. Figure 1 summarizes the proposed analytical workflow.

Let the collection of uploaded documents be represented as:

$$D = \{d_1, d_2, \dots, d_n\}$$

where each document is decomposed into sectional components:

$$d_n = \{s_{n1}, s_{n2}, \dots, s_{nm_n}\}$$

Each section is transformed into an embedding representation using NLP vectorization techniques. Similarity between sections is then computed using cosine similarity measures:

where v_{si} and v_{sj} represent embedding vectors associated with sectional components s_{si} and s_{sj} .

Unlike traditional fully connected similarity networks, the proposed framework organizes semantic relationships around a central document node (i.e. a section). The central node represents the primary document section under analysis, while related documents and sections are spatially organized according to similarity strength. Strongly related sections and documents are positioned on the left side of the central document, while weakly related sections and documents are positioned on the right side. This creates a polarized semantic topology capable of distinguishing direct policy relationships from indirect thematic associations. Figure 2 illustrates the conceptual structure of the proposed framework.

Strong similarity relationships are defined as:

$$\mathcal{S}_{strong} = \{(s_i, s_j) : Sim(s_i, s_j) \geq \tau_s\}$$

while weak similarity relationships are defined as:

$$\mathcal{S}_{weak} = \{(s_i, s_j) : \tau_w < Sim(s_i, s_j) < \tau_s\}$$

where τ_s and τ_w represent strong and weak similarity thresholds respectively.

The resulting structure produces a document-centered semantic network capable of supporting multiple forms of acquisition analysis. Strongly related policy sections may reveal direct legislative traceability, recurring acquisition reform concepts, or regulatory dependencies. Weakly related sections may reveal indirect thematic relationships, emerging policy trends, or latent conceptual associations that would be difficult to identify manually. The framework supports multiple acquisition-related analytical applications, including NDAA-to-DFARS traceability, acquisition reform analysis, technology modernization tracking, and longitudinal policy evolution studies. More importantly, the framework provides a scalable methodology for representing acquisition ecosystems as interpretable semantic structures rather than isolated document collections.

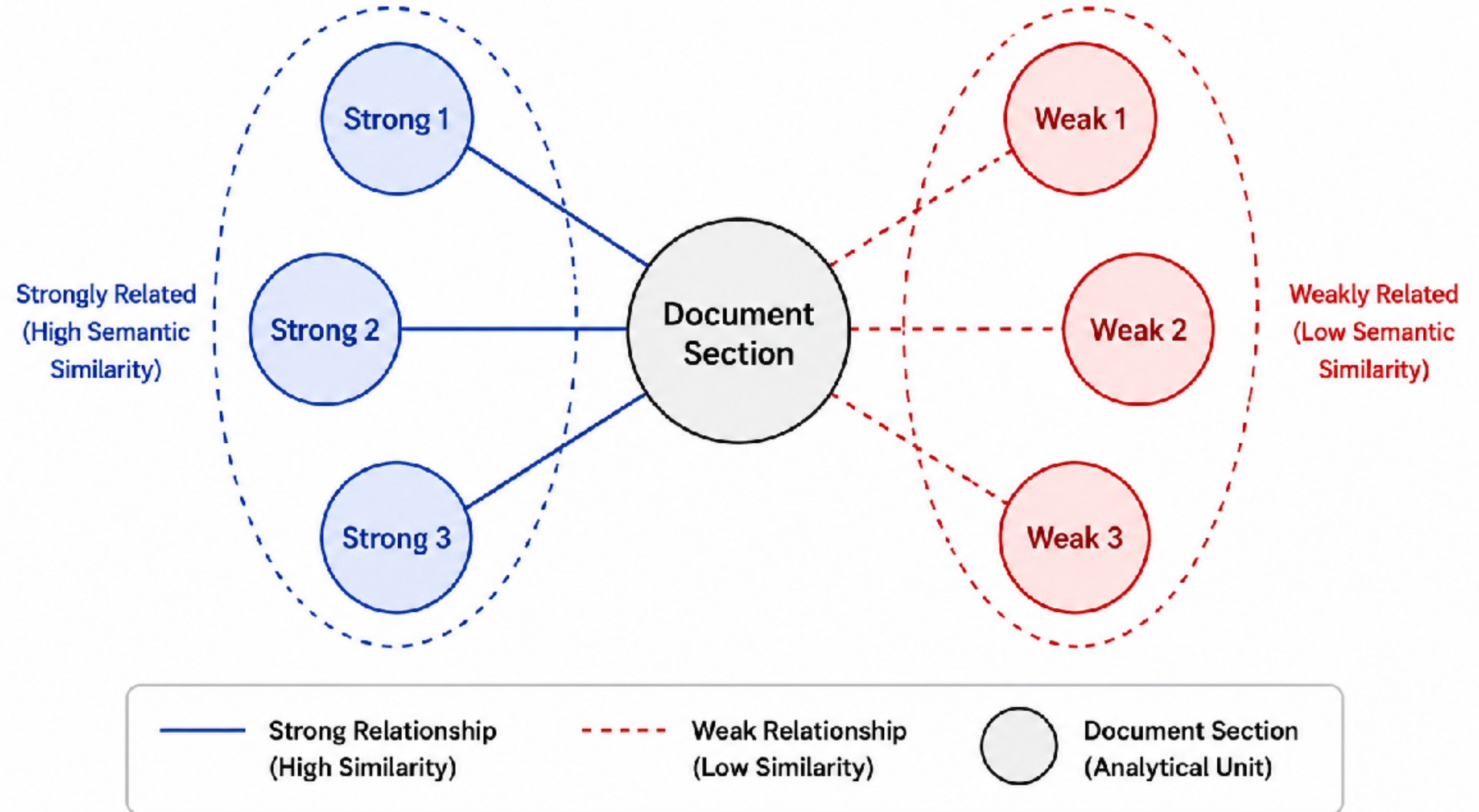


Figure 2: Conceptual representation of the proposed document-centric semantic network in which strongly related sections are organized separately from weakly related sections to support traceability and thematic interpretation.