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Architecture of Nature-Based Smart City Introducing BaaS by Utilizing UAF

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Research trend on Smart City

- Smart city can enhance the quality of life of various stakeholders, including residents and local industries, by utilizing various cutting-edge technologies, such as IoT(Mall et al., 2023).
- Systems Engineering Vision 2035 emphasizes the necessity of designing balanced solutions, such as smart cities, to satisfy various stakeholder needs for capability, dependability, sustainability, social acceptability (INCOSE, 2021).
- The resilient smart city architecture perspective includes a focus on addressing risks, such as cascading failures, in terms of evolving needs, external context (INCOSE, 2023a).
- Considering that cities can exacerbate some of the world's most severe environmental and socioeconomic challenges, cities need to make peace with nature (UNEP, 2021)
- The acceleration of nature-based solutions (NbS) adoption can enhance urban resilience, mitigate urban heat island effects, improve air quality (UNEP, 2021)

Research trend can be seen in the previous research is that smart city aims at achieving sustainability by leveraging advanced technologies and the focus for considering nature appeared.

Literature Review of NbS

- The European Commission defines NbS as solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social, and economic benefits and help build resilience (The European Commission, 2022).
- These nature-based actions protect, sustainably manage, and restore ecosystems, effectively addressing societal challenges while benefiting both people and nature (IUCN, 2023).
- Multilevel governance and the removal of barriers to NbS expansion are critical, particularly the involvement of all stakeholder groups (UNEP, 2021).
- Aligning NbS with urban priorities, fostering partnerships among public, private, and nongovernmental organizations (NGOs), and creating intermediaries are key strategies required in smart cities (Xie et al., 2022).

Although NbS implement in smart city offers various benefits, the best way to use these benefits and the specific operations required to achieve them, remain unclear.

Biophilia as a Service (BaaS)

- Biophilia as a Service (BaaS), is defined as an integrated nature conservation service to protect natural environment. (Chen et al., 2024).
  - ➢ BaaS promotes nature safeguard action, while collaborating a range of stakeholders, based on the biophilia awareness.

What is biophilia?

- ➢ The innate tendency of humanity to focus on and to affiliate with nature, defined in the book *Biophilia*, by Edward O. Wilson, and he emphasizes the significance of biophilia for conservation and protection. (Wilson, 1984)

Research Motivations and Objectives

Motivations

We need to clarify how to realize these benefits based on local natural environment and how to collaborate with each stakeholder.

For sustainable smart city, it is significant to consider the entire picture in an integrated view, including which departments should play what roles, and which stakeholders should be collaborated with.

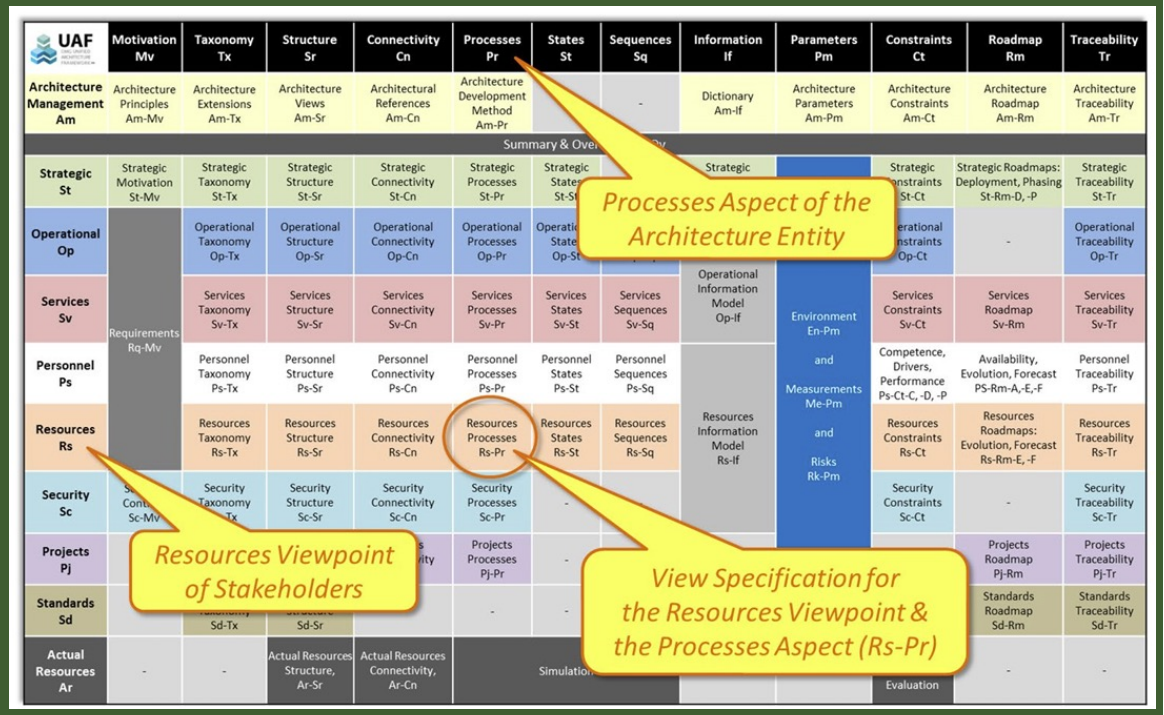
Objectives

We refer to sustainable and resilient smart city in harmony with nature as a nature-based smart city (NBSC) and define the architecture of NBSC introducing BaaS.

We consider NBSC introducing BaaS as an SoS and describe the architecture of NBSC introducing BaaS by utilizing the Unified Architecture Framework (UAF).

Model-UAF (Unified Architecture Framework)

- What is UAF?
  - UAF is a comprehensively integrated framework that is suitable to describe enterprise architecture as a System of Systems (SoS).
- Why choose UAF?
  - It provides a means to analyze architecture from the viewpoints of strategic, operation, services, resources, and others, to meet the needs of stakeholders from an integrated view.



Architecture of Nature-Based Smart City (NBSC) Introducing BaaS by Utilizing UAF

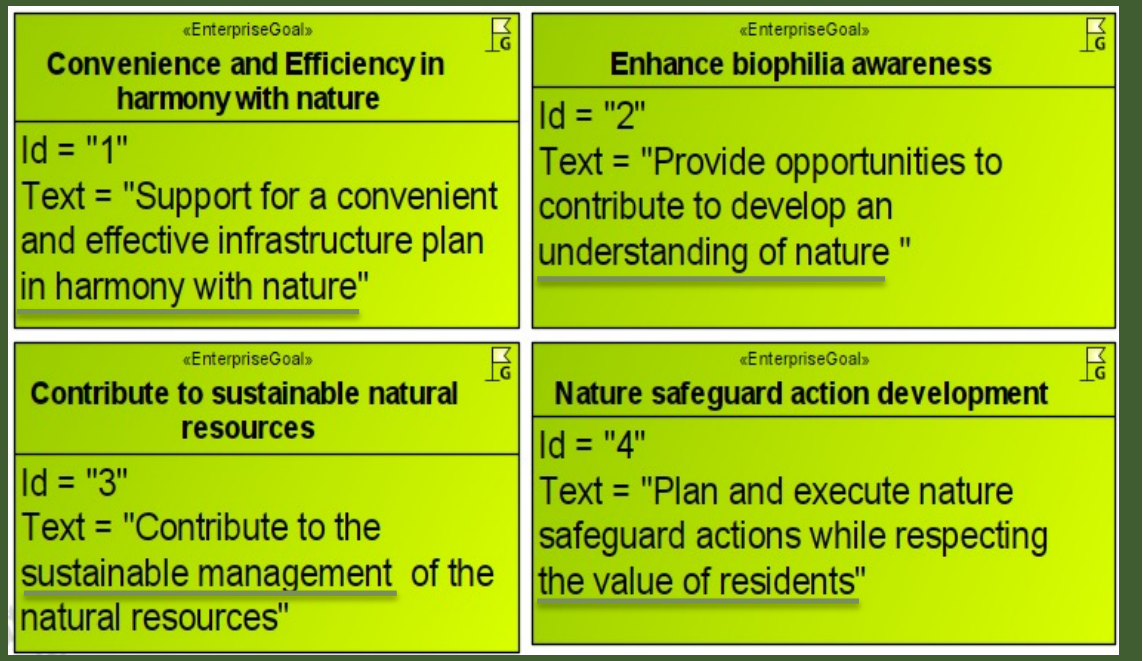
Strategic Structure for NBSC introducing BaaS

- Vision
  - The future state of NBSC Introducing BaaS is “Balanced benefits for humans and natural environment in NBSC”, by providing constantly nature conservation action.

Strategic Structure for NBSC introducing BaaS

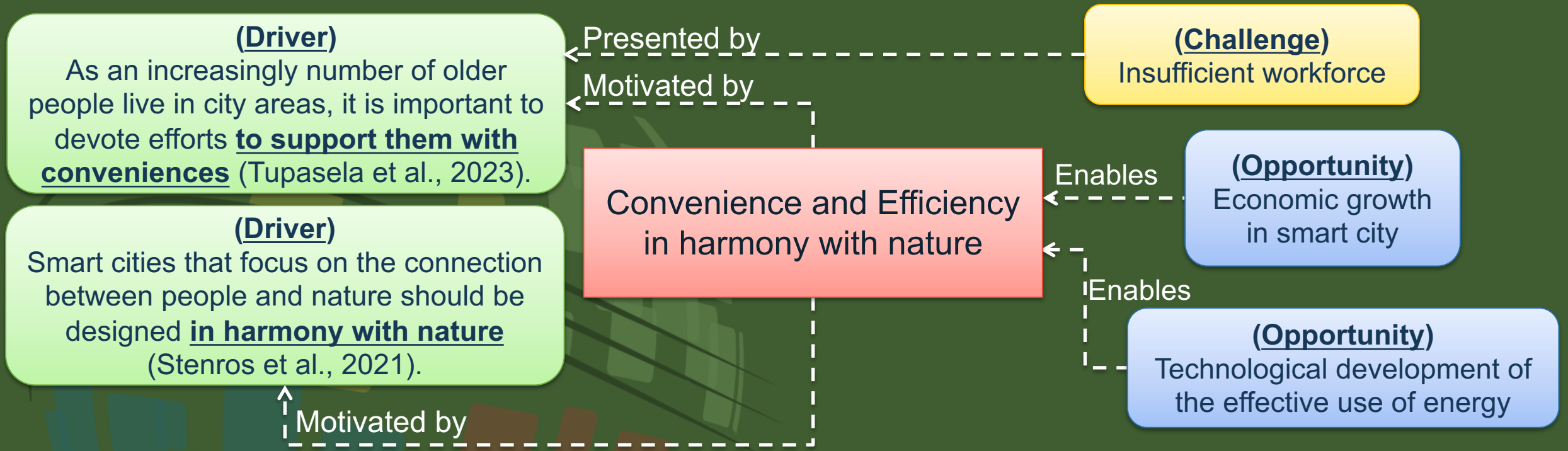
There are four goals which are defined based on the vision for NBSC, considering drivers, challenges and opportunities.

- Convenience and Efficiency in harmony with nature(Id=“1”)
  - Keep peace with nature
- Enhance biophilia awareness (Id=“2”)
  - Develop an understanding of nature
- Contribute to sustainable natural resources (Id=“3)
  - The contribution of sustainable management
- Nature safeguard action development (Id=“4”)
  - Respect the value of residents in NBSC



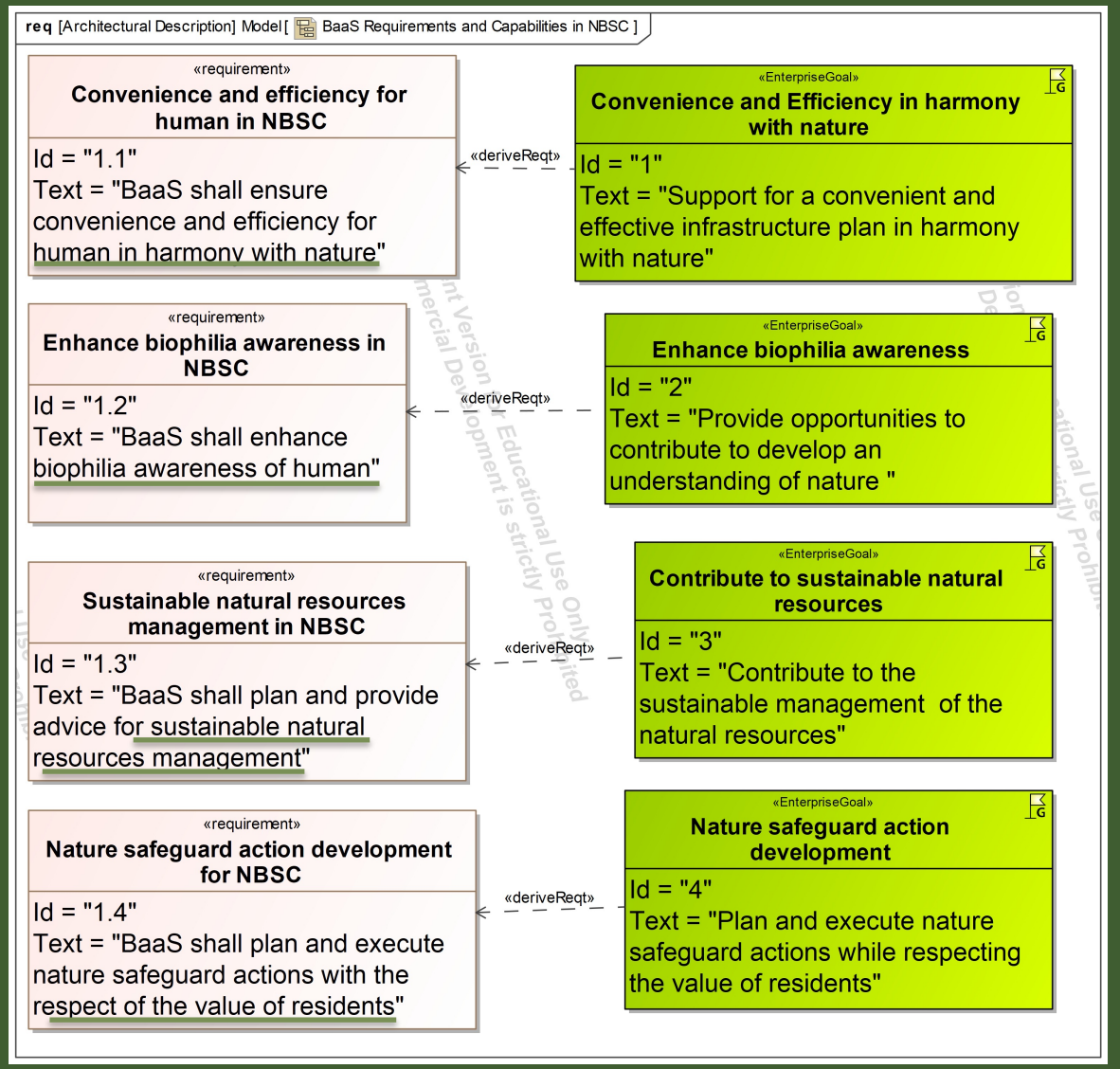
Strategic Motivation: Convenience and efficiency in harmony with nature

- Goal (Id="1") : Convenience and Efficiency in harmony with nature
  - It is crucial to ensure that NBSC residents are conveniently and effectively served to contribute to their well-being in harmony with nature.



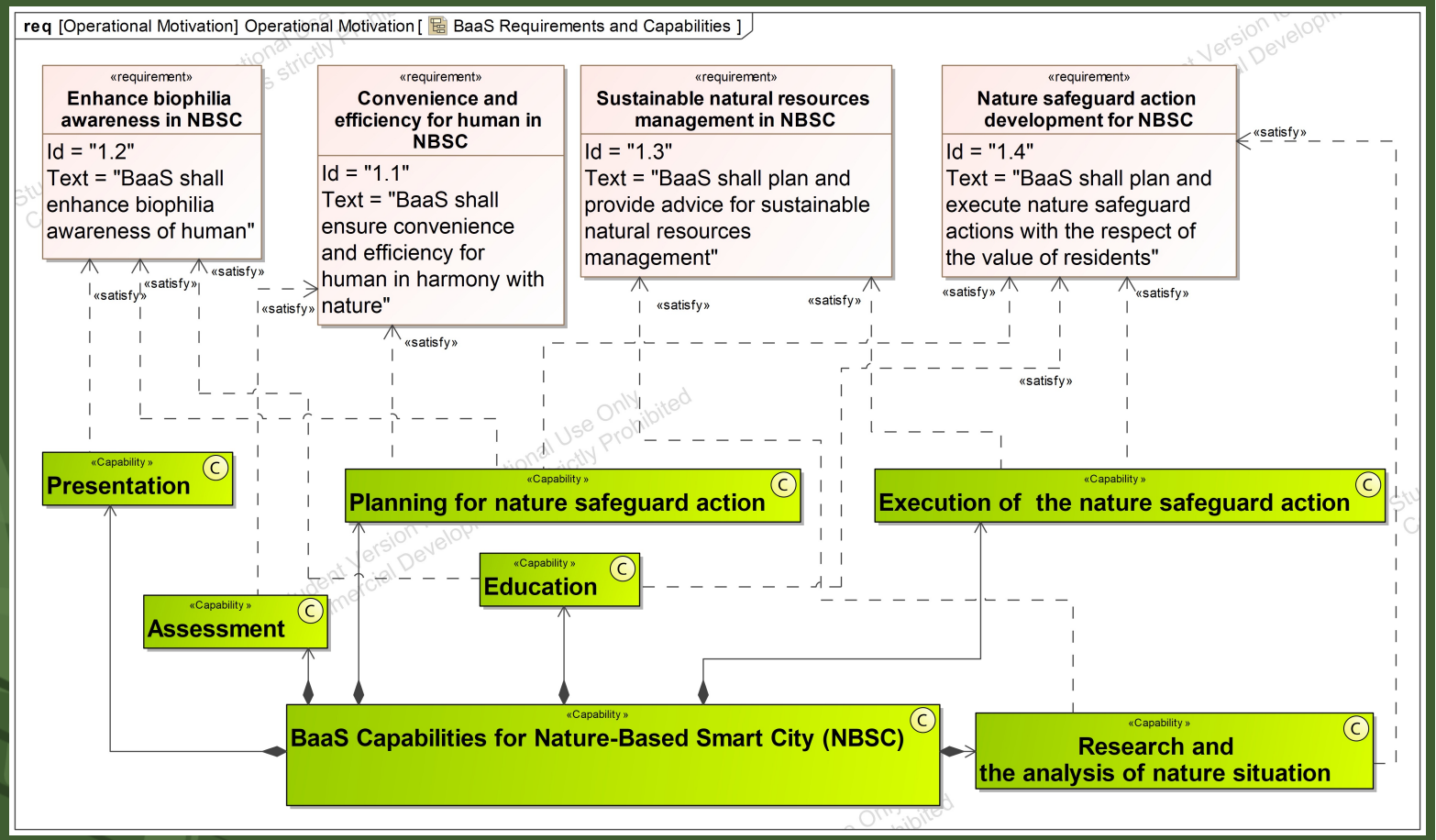
BaaS Requirements: Nature-centric convenience and efficiency for human

- Convenience and efficiency for human in NBSC (Id="1.1")
- Enhance biophilia awareness in NBSC (Id="1.2")
- Sustainable natural resources management in NBSC (Id="1.3")
- Nature safeguard action development for NBSC (Id="1.4")



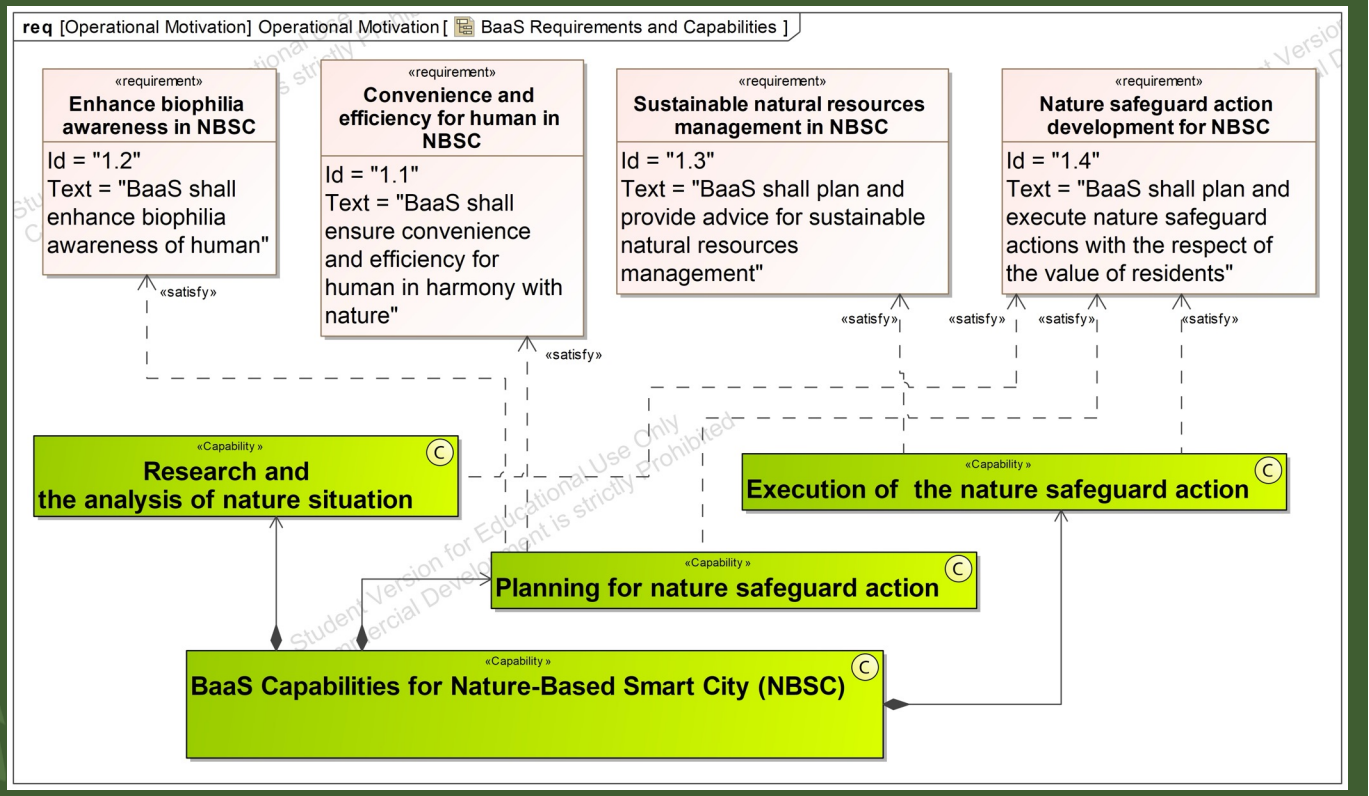
BaaS Capabilities: satisfy <nature-centric convenience and efficiency for human>(1/3)

- Six Capabilities are defined that contribute to the achievement of the goals.
- BaaS capabilities for NBSC satisfy and support the nature-centric convenience and efficiency for human.



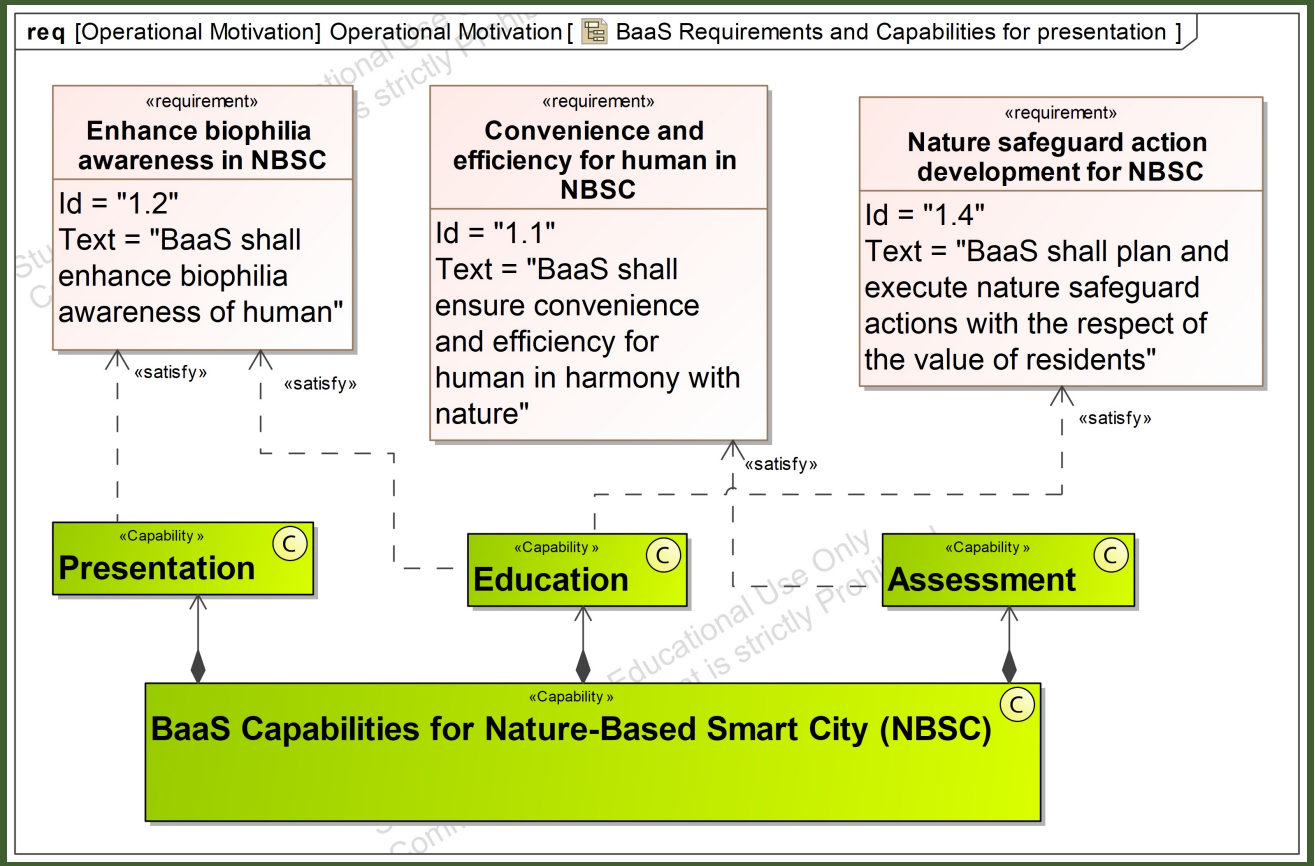
BaaS Capabilities: satisfy <nature-centric convenience and efficiency for human>(2/3)

- **Research and analysis of nature situation**
  - The ability of conducting research and analyzing situation of nature while collaborating with other stakeholders
- **Planning for nature safeguard action**
  - The ability of planning for nature safeguard action
- **Execution of the nature safeguard action**
  - The ability of performing the action for safeguarding nature collaborating with other stakeholders



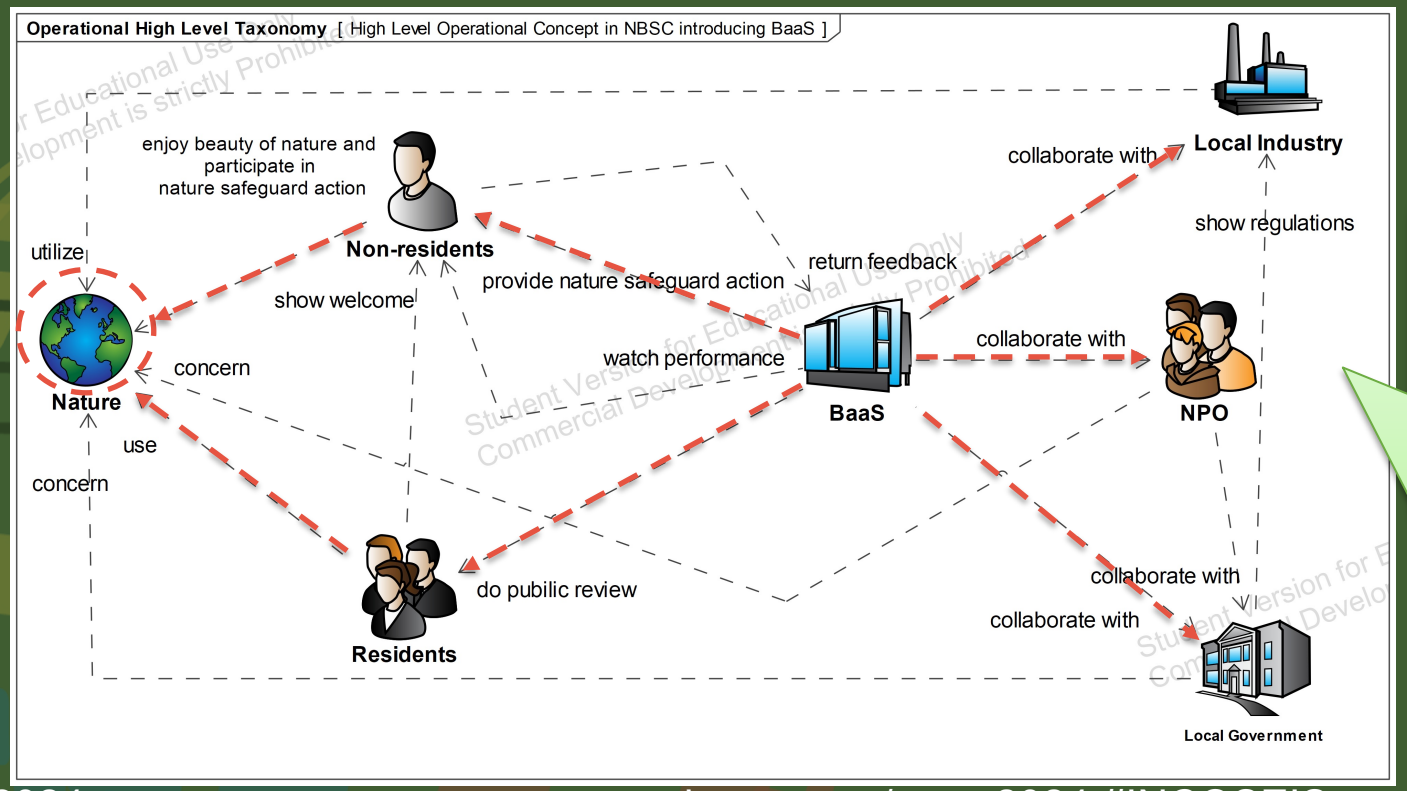
BaaS Capabilities: satisfy <nature-centric convenience and efficiency for human>(3/3)

- **Education**
  - The ability to help understand nature situation through educating residents or visitors
- **Presentation**
  - The ability of presenting the beauty of nature or challenges and safeguard action
- **Assessment**
  - The ability to assess performance of participants in nature safeguard action and improvements of nature



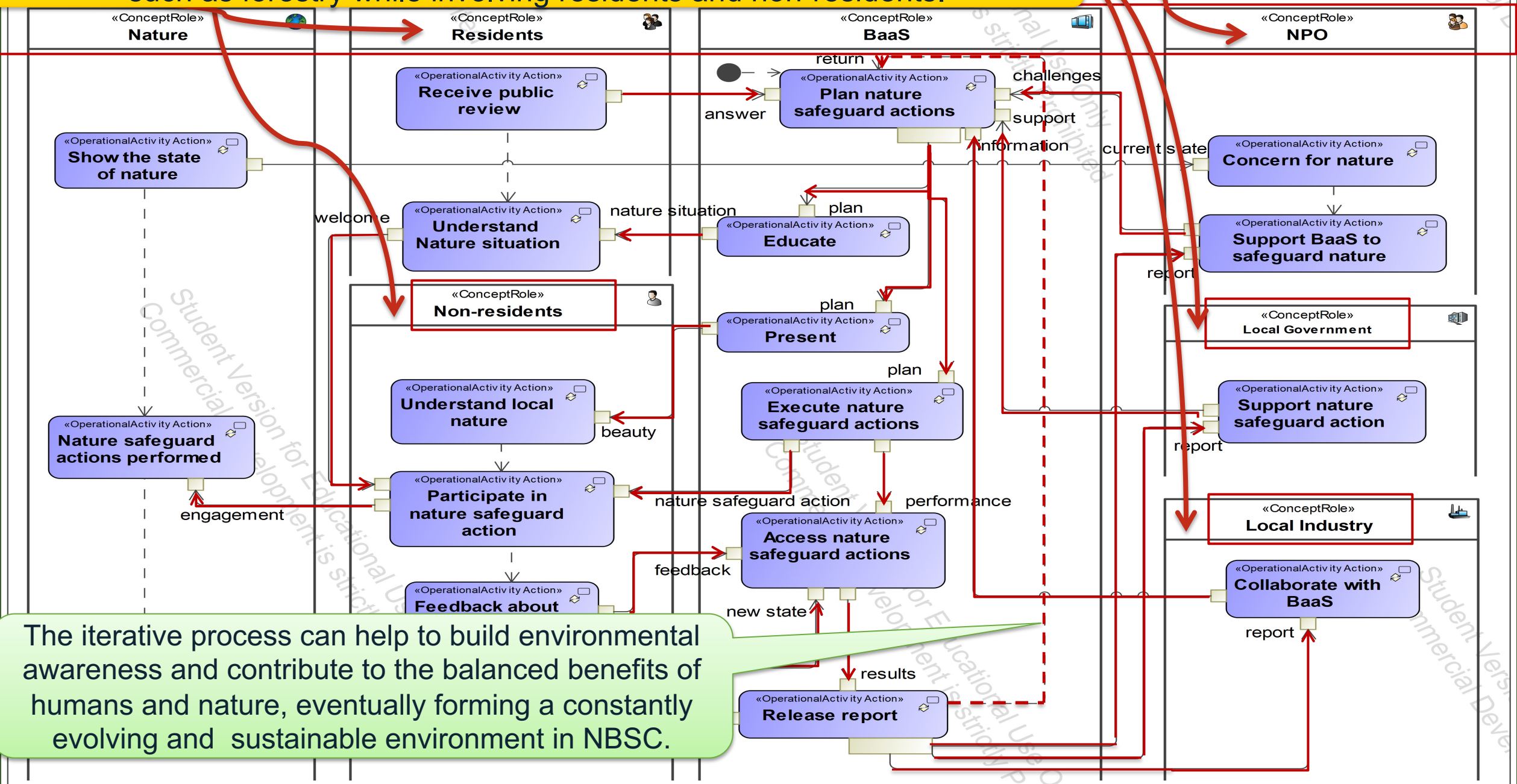
BaaS Operational Activity in NBSC introducing BaaS

- Based on the vison, goals, requirements, and capabilities that we defined, high-level operational activity is described to show a variety of stakeholders related to the NBSC introducing BaaS.



BaaS collaborating with related stakeholders and services as an integrated service, contributes to the balanced benefits of humans and nature in NBSC.

BaaS shapes a SoS, associating with local government, NPO, industries such as forestry while involving residents and non-residents.



The iterative process can help to build environmental awareness and contribute to the balanced benefits of humans and nature, eventually forming a constantly evolving and sustainable environment in NBSC.

Conclusion

We defined the architecture of NBSC introducing BaaS as a SoS by utilizing UAF, from strategic structure and operational activity view.

- ✓ By introducing BaaS to NBSC, we described an integrated service for nature conservation to promote safeguarding nature in NBSC.
- ✓ Operational process of BaaS in the context of NBSC were described, and we obtained the iterative operational process, contributing to spread and establish biophilia awareness in local area which benefits to humans and nature.

For future work, how BaaS collaborates with other services, such as forestry, effectively contributing to safeguarding natural environment as an integrated service, will be focused.

Thank you!

Q&A