

Brane - introduction

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Background¹

Brane is the result of 6 years of research and development, first in the context of the EU project PROCESS² to enable exascale applications on distributed high performance computing centers³. Since 2020, Brane was developed further in the context of the EPI project⁴ to enable fast and secure computations across health institutions. The EPI project gave priority to improve the user experience and data privacy and security. As a result, the Brane was tuned to enables (data) scientists to perform data analyses without having worry about the underlying, distributed data processing execution. Brane's central design tenet is affording the separation of users' concerns, in accordance with their specialized roles namely: Domain-scientist, Software engineer, and Systems engineer⁵.

Unique Selling points: When automated systems compute and share data across organizational boundaries, user adoption is predicated on the system's reliable enforcement of their data policies. Intuitively, users are willing to share data but want to retain control of its use. Ultimately, policies control the system at an operational level, i.e., how data is read and written and processed. In the context of processing medical data, there is a further need for policies to capture normative concepts; these include various social policies, including organizational policies and legal regulations, such as the EU General Data Protection Regulation (GDPR). In EPI, we draw from the work on the eFLINT language, which aims to formalize many aspects of policy such that they have unambiguous interpretations, both legally and operationally⁶. At the network level the EPI platform enforces security and network low-level policies to secure data-sharing a dynamic service chain can be deployed at runtime through Virtual Network Functions⁷.

¹ [00 - Brane Overview](#) (animated Slides)

² <https://web.archive.org/web/20220521145136/https://www.process-project.eu/>

³ R. Cushing, et al. "Towards a New Paradigm for Programming Scientific Workflows," 2019 15th International Conference on eScience (eScience), San Diego, CA, USA, 2019, pp. 604-608, <https://doi.org/10.1109/eScience.2019.00083>.

⁴ <https://enablingpersonalizedinterventions.nl/>

⁵ O. Valkering, et al., "Brane: A Framework for Programmable Orchestration of Multi-Site Applications," 2021 IEEE 17th International Conference on eScience (eScience), 2021, pp. 277-282, <https://doi.org/10.1109/eScience51609.2021.00056>

⁶ L. T. van Binsbergen, et al. "Dynamic generation of access control policies from social policies," in The joined conference 12th EUSPN 2021), (ICTH-2021), Leuven, Belgium, November 1-4, 2021 : <https://doi.org/10.1016/j.procs.2021.12.221>

⁷ Kassem, J. A., et al. (2021). EPI framework: Approach for traffic redirection through containerised network functions. In Proceedings, IEEE 17th International Conference on eScience: e-Science 2021 : 20-23 September 2021, online event (pp. 80-89). IEEE Computer Society. <https://doi.org/10.1109/eScience51609.2021.00018>.

Brane Proof-of-concept: In collaboration with health organizations (St Antonius Ziekenhuis, UMC Utrecht, and Princes Maxima Centrum) a proof of concept to process patient data across resource distributed across the two hospitals and the national Dutch supercomputer centre SURF (Figure 1)

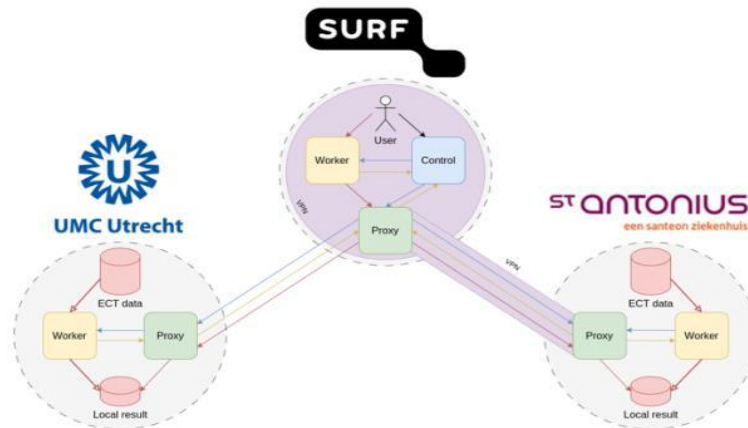


Figure 1: EPI proof of concept to secure the processing patients' data which is processed locally at Saint Antonius resources and all other data exchange with the computing resource at SURF is secured by the EPI framework (purple area)

The success of the Brane is based upon a secure and trustworthy distributed data infrastructure, combining data analytics, and health decision support algorithms to create new, actionable, and personalized insights for prevention, management, and intervention to providers and patients. The key feature of the EPI platform is to:

- **enable data processing across multiple organizations:** by providing (data) analysts, a high-level abstraction, hiding the complexities of utilizing the underlying, distributed resources. The complexity, inherent of such a system, is made possible by emphasizing the separation of concerns between cooperating (human) users and (automated) services.
- **Enforce of users' policies through service that apply data policies before and during the data processing.** Similar to Data analysts and policy experts need a high-level interface to define data policies and a service that is able to correctly interpret these policies and enforcement during the processing of the data

Brane Screencasts

- [1]. Brane-tutorials: Hello world workflow [[screencast](#)]
- [2]. Brane-tutorials: Hello world create package [[screencast](#)]
- [3]. Inter-package communication [[screencast](#)]
- [4]. Brane Posix Reasoner [[screencast](#)]
- [5] Brane-Policy-GUI [[screencast](#)]

Brane documentation (wiki, GitHub repo)

- [1]. Brane repository: <https://github.com/BraneFramework>

- [2]. Brane website: <https://braneframework.github.io>
- [3]. Brane manual: <https://braneframework.github.io/manual/>
- [4]. Brane Tutorials: <https://braneframework.github.io/tutorials/>
- [5]. Brane code doc: <https://braneframework.github.io/brane/unstable/overview/index.html>
- [6]. Brane specification: <https://braneframework.github.io/specification/>
- [7]. Brane-tutorials: Brane-tutorials <https://github.com/soreana/brane-tutorials>
- [8]. Brane resources and examples: <https://github.com/soreana/awesome-brane>

Brane related publications

- [1]. O. Valkering et al., "Brane: A framework for programmable orchestration of multi-site applications," in 17th IEEE International Conference on eScience, eScience 2021, Innsbruck, Austria, September 20-23, 2021. IEEE, 2021. [Online]. Available: <https://doi.org/10.1109/eScience51609.2021.0005>
- [2]. C. A. Esterhuysen, et al. "Exploring the Enforcement of Private, Dynamic Policies on Medical Workflow Execution," 2022 IEEE 18th International Conference on e-Science (e-Science), Salt Lake City, UT, USA, 2022, pp. 481-486, <https://doi.org/10.1109/eScience55777.2022.000>
- [3]. Kassem, J. et al. "EPI framework: Approach for traffic redirection through containerized network functions" 17th International Conference on eScience: 2021. doi: <https://doi.org/10.1109/eScience51609.2021.00018>
- [4]. Roadmap for enhancing Brane for Secure and Privacy-aware Distributed comm Healthcare <https://docs.google.com/document/d/1S615tBE-1RM9-PHRCAdCnLMiH1brZkjUPT29wWiV0o/edit?tab=t.0#heading=h.nvskn3qo372t>

Brane related students' projects: 2022-2023-2025

- [1]. PyTorch interface for Brane⁸
- [2]. Data Analyst job in Brane⁹
- [3]. Tweets Analysis in Brane^{10,11}[\[zenodo-entry\]](#)
- [4]. Titanic data processing in Brane¹²
- [5]. Sentiment Analysis in Brane^{13, 14}
- [6]. NLP getting Started in Brane^{15, 16}
- [7]. Brane Matplotlib package¹⁷
- [8]. ws-vaccine-tweets¹⁸
- [9]. Rossmann Store Sales project in Brane¹⁹
- [10]. Image processing with Brane²⁰

⁸ https://github.com/YAMWD/PyTorch_interface_for_Brane

⁹ <https://github.com/damla-jpg/brane-data-analyst-jobs>

¹⁰ <https://github.com/epi-project/brane-disaster-tweets-example>

¹¹ <https://github.com/marinoandrea/disaster-tweets-brane>

¹² <https://github.com/Web-Services-and-Cloud-Based-Systems-G9/brane-titanic-processing>

¹³ https://github.com/97Simej/wdps27_final

¹⁴ : <https://github.com/cmavlr/brane-sentiment-analysis>

¹⁵ <https://github.com/Ric0rdanza/nlp-disaster-for-brane>

¹⁶ <https://zenodo.org/record/6609830#.YuWayS8Rruw>

¹⁷ <https://github.com/tomwassing/brane-project>

¹⁸ <https://github.com/Asror-coder/ws-vaccine-tweets/tree/v1.0.0>

¹⁹ https://github.com/Rrrruin/Web_Service_G24

²⁰ <https://github.com/ManuDITA/Brane-Image-Processing>