netidee PROJEKTE

1. Projektziel

Who are we? LEO Trek is a research and development project conducted at the Distributed Systems Group (DSG) at TU Wien. The project team is composed by Asst. Prof. Nastic, Cynthia Marcelino, and Thomas Pusztai. The goal is to provide open, reusable building blocks for computing across the Edge–Cloud–Space 3D continuum.

What is it? LEO Trek is an open-source toolkit for orchestrating, simulating, and optimizing serverless and AI workflows in the Edge–Cloud–Space 3D Continuum. It consists of several modular software components, including:

- **Stardust**: a scalable simulator for the 3D Continuum. Github: https://github.com/polaris-slo-cloud/stardust-go/
- **HyperDrive**: an SLO-aware serverless scheduler for the 3D Continuum.Github: https://github.com/polaris-slo-cloud/hyper-drive/
- **ChunkFunc**: a workflow resource optimizer that accounts for input size and cost–performance trade-offs. Github: https://github.com/polaris-slo-cloud/chunk-func/
- **FedCCL:** a Federated Learning Framework. Github: https://github.com/polaris-slo-cloud/fedccl
- **Databelt**: a state management framework for serverless workflows in the 3D Continuuum. Github: https://github.com/polaris-slo-cloud/databelt/
- **Gaia**: a serverless runtime for automated CPU/GPU selection for serverless AI. Github: https://github.com/polaris-slo-cloud/gaia/

Each module is self-sufficient, containing its own documentation. They can be used independently and combined as needed.

Who is it for and how does it help? LEO Trek is designed for researchers, platform engineers, and third-party developers working on distributed, serverless, and edge systems. It explains the system architecture, core components, and extension points, enabling reuse, evaluation, and further development of the open-source codebase.

How does it work? LEO Trek is composed of a set of modular components that enable simulation, scheduling, optimization, state management, and hardware acceleration in the 3D Continuum. The components can be used independently or combined, allowing both users to run simulations and evaluations and developers to extend or integrate the system. Each component is provided as a self-contained open-source repository that includes all information required to build, configure, use, and further develop the software.

2. Projektendergebnisse

1	*Projektzwischenbericht*	*CC BY 4.0*	*netidee.at/leo-trek*
2	*Projektendbericht*	*CC BY 4.0*	*netidee.at/leo-trek*
3	*Paper – Stardust: A Scalable and Extensible Simulator for the 3D Continuum*	*CC BY 4.0*	*netidee.at/leo-trek/stardust-scalable-and-extensible-simulator-3d-continuum &*

			https://arxiv.org/abs/2506.01513
4	Paper – HyperDrive: Scheduling Serverless Functions in the Edge-Cloud-Space 3D Continuum	CC BY 4.0	netidee.at/leo-trek & https://doi.org/10.1109/SEC62691.2024.00028
5	Paper – ChunkFunc: Dynamic SLO-Aware Configuration of Serverless Functions	CC BY 4.0	netidee.at/leo-trek/chunkfunc-serverless-workflow-resource-optimizer & https://ieeexplore.ieee.org/iel8/71/4359390/10959103.pdf
6	Paper – FedCCL: Federated Clustered Continual Learning Framework for Privacy-focused Energy Forecasting	CC BY 4.0	netidee.at/leo-trek & https://doi.org/10.1109/ICFEC65699.2025.00012
7	Paper – Cosmos: A Cost Model for Serverless Workflows in the 3D Compute Continuum	CC BY 4.0	netidee.at/leo-trek/cosmos-cost-model-serverless-workflows-3d-compute-continuum & https://arxiv.org/pdf/2504.20189
8	Paper – Databelt: A Continuous Data Path for Serverless Workflows in the 3D Compute Continuum	CC BY 4.0	netidee.at/leo-trek/databelt-continuous-data-path-serverless-workflows-3d-continuum & https://doi.org/10.1016/j.sysarc.2025.103577
9	Paper – Roadrunner: Accelerating Data Delivery to WebAssembly-based Serverless Functions	CC BY 4.0	netidee.at/leo-trek & https://dl.acm.org/doi/10.1145/3721462.3770777
10	Paper – Gaia: Hybrid Hardware Acceleration for Serverless AI in the 3D Compute Continuum	CC BY 4.0	netidee.at/leo-trek/gaia-hybrid-hardware-acceleration-serverless-ai-3d-compute-continuum & https://doi.org/10.1145/3773276.3774299
11	SW – Stardust 3D Continuum Simulator	Apache 2.0	netidee.at/leo-trek/stardust-scalable-and-extensible-simulator-3d-continuum & https://github.com/polaris-slo-cloud/stardust-go
12	SW – HyperDrive Serverless Scheduler	Apache 2.0	netidee.at/leo-trek & https://github.com/polaris-slo-cloud/hyper-drive

13	SW – ChunkFunc Serverless Workflow Optimizer	Apache 2.0	netidee.at/leo-trek/chunkfunc-serverless-workflow-resource-optimizer & https://github.com/polaris-slo-cloud/chunk-func/
14	SW – FedCCL Federated Learning Framework	Apache 2.0	netidee.at/leo-trek & https://github.com/polaris-slo-cloud/fedccl
15	SW – Databelt Serverless Function State Management	Apache 2.0	netidee.at/leo-trek/databelt-continuous-data-path-serverless-workflows-3d-continuum & https://github.com/polaris-slo-cloud/databelt/
16	SW – Gaia Hybrid Serverless Runtime for AI Workloads	Apache 2.0	netidee.at/leo-trek/gaia-hybrid-hardware-acceleration-serverless-ai-3d-compute-continuum & https://github.com/polaris-slo-cloud/gaia
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			https://github.com/polaris-slo-cloud/chunk-func https://github.com/polaris-slo-cloud/fedccl https://github.com/polaris-slo-cloud/databelt https://github.com/polaris-slo-cloud/gaia
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3. Geplante weiterführende Aktivitäten nach netidee-Projektende

After the conclusion of the netidee project, several follow-up activities are planned to ensure sustainability and further impact of the results. All developed software artifacts will continue to be maintained as open-source projects, including bug fixes, documentation improvements, and compatibility updates with evolving serverless platforms. The project results form the foundation for ongoing and future scientific work. The developed models, simulators, and systems will be extended and evaluated in larger-scale and longer-term experiments, including additional workload classes, hardware accelerators, and emerging Edge–Cloud–Space use case scenarios such as Serverless Compound AI. Several follow-up publications are planned, building on the existing results and addressing open research challenges identified during the project.

4. Anregungen für Weiterentwicklungen durch Dritte

The project results are modular and reusable, enabling further development by researchers, developers, and practitioners. Third parties can extend the simulator and system components to explore new routing, scheduling, optimization, state management, or hardware acceleration approaches, or integrate them into existing serverless platforms. The results can also serve as a reference architecture for designing serverless and AI-enabled systems in distributed and resource-constrained environments.