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File Systems

Available file systems

On the DEEP-EST system, three different groups of file systems are available:

- the [JSC GPFS file systems](#), provided via [JUST](#) and mounted on all JSC systems;
- the DEEP-EST (and SDV) parallel BeeGFS file systems, available on all the nodes of the DEEP-EST system;
- the file systems local to each node.

The users home folders are placed on the shared GPFS file systems. With the advent of the new user model at JSC ([?JUMO](#)), the shared file systems are structured as follows:

- \$HOME: each JSC user has a folder under `/p/home/jusers/`, in which different home folders are available, one per system he/she has access to. These home folders have a low space quota and are reserved for configuration files, ssh keys, etc.
- \$PROJECT: In JUMO, data and computational resources are assigned to projects: users can request access to a project and use the resources associated to it. As a consequence, each user can create folders within each of the projects he/she is part of (with either personal or permissions to share with other project members). For the DEEP project, the project folder is located under `/p/project/cdeep/`. Here is where the user should place data, and where the old files generated in the home folder before the JUMO transition can be found.

The DEEP-EST system doesn't mount the \$SCRATCH and \$ARCHIVE file systems from GPFS, as it is expected to provide similar functionalities with its own parallel file systems.

The following table summarizes the characteristics of the file systems available in the DEEP-EST and DEEP-ER (SDV) systems:

Research Project	Task and Sub-tasks	Cluster	Type	Method / Tool	API Version	Researcher Information	Researcher Information	Other
AI-driven Sentiment Analysis	1. Data Collection (Twitter API) 2. Preprocessing (NLTK) 3. Model Training (TensorFlow)	AI/ML	Classification	Python, TensorFlow	2.1.0	Dr. Jane Doe	Dr. John Smith	AI/ML API: TensorFlow 2.1.0, NLTK 3.6.7, Twitter API v2
	AI/ML API: TensorFlow 2.1.0, NLTK 3.6.7, Twitter API v2							
Blockchain Security Audit	1. Smart Contract Analysis (Solidity) 2. Vulnerability Scanning (Slither)	Blockchain	Security	Python, Solidity	0.8.0	Dr. Alice Brown	Dr. Bob Green	Blockchain API: Solidity 0.8.0, Slither 0.8.0
	Blockchain API: Solidity 0.8.0, Slither 0.8.0							
Quantum Computing Simulation	1. Qubit Initialization (Qiskit) 2. Gate Operations (Cirq)	Quantum	Simulation	Python, Qiskit	0.25.0	Dr. Charlie White	Dr. Diana Black	Quantum API: Qiskit 0.25.0, Cirq 0.12.0
	Quantum API: Qiskit 0.25.0, Cirq 0.12.0							
Network Traffic Analysis	1. Packet Capture (Wireshark) 2. Flow Analysis (NetFlow)	Network	Analysis	Python, Wireshark	2.4.0	Dr. Frank Blue	Dr. Grace Yellow	Network API: Wireshark 2.4.0, NetFlow 10
	Network API: Wireshark 2.4.0, NetFlow 10							
Cloud Migration Strategy	1. Assessment (AWS Migration Center) 2. Migration Planning (AWS Migration Hub)	Cloud	Migration	Python, AWS CLI	2.0.0	Dr. Henry Purple	Dr. Ivy Pink	Cloud API: AWS CLI 2.0.0, AWS Migration Hub 1.0
	Cloud API: AWS CLI 2.0.0, AWS Migration Hub 1.0							
Mobile App Performance	1. User Session Tracking (Firebase) 2. Performance Monitoring (Firebase Performance)	Mobile	Performance	Python, Firebase	9.0.0	Dr. Jack Orange	Dr. Karen Red	Mobile API: Firebase 9.0.0, Firebase Performance 1.0
	Mobile API: Firebase 9.0.0, Firebase Performance 1.0							
Supply Chain Optimization	1. Inventory Management (SAP) 2. Logistics Planning (SAP Logistics)	Supply Chain	Optimization	Python, SAP	7.0.0	Dr. Leo Green	Dr. Mia Blue	Supply Chain API: SAP 7.0.0, SAP Logistics 1.0
	Supply Chain API: SAP 7.0.0, SAP Logistics 1.0							
Healthcare Data Analytics	1. Patient Data Collection (HL7) 2. Diagnostic Model Training (TensorFlow)	Healthcare	Analytics	Python, TensorFlow	2.1.0	Dr. Noah Brown	Dr. Olivia White	Healthcare API: HL7 3.0, TensorFlow 2.1.0
	Healthcare API: HL7 3.0, TensorFlow 2.1.0							
Autonomous Vehicle Simulation	1. Sensor Data Simulation (ROS) 2. Path Planning (A* Algorithm)	Autonomous	Simulation	Python, ROS	1.0.0	Dr. Peter Black	Dr. Quinn Grey	Autonomous API: ROS 1.0.0, A* Algorithm 1.0
	Autonomous API: ROS 1.0.0, A* Algorithm 1.0							
Financial Risk Modeling	1. Market Data Collection (Yahoo Finance) 2. Risk Factor Analysis (Monte Carlo Simulation)	Finance	Risk Modeling	Python, Pandas	1.0.0	Dr. Ryan Gold	Dr. Sophia Silver	Financial API: Yahoo Finance 1.0.0, Monte Carlo 1.0
	Financial API: Yahoo Finance 1.0.0, Monte Carlo 1.0							
Environmental Data Monitoring	1. Sensor Network Deployment (LoRaWAN) 2. Data Aggregation (Edge Computing)	Environmental	Monitoring	Python, LoRaWAN	4.0.0	Dr. Thomas Bronze	Dr. Victoria Copper	Environmental API: LoRaWAN 4.0.0, Edge Computing 1.0
	Environmental API: LoRaWAN 4.0.0, Edge Computing 1.0							
Space Exploration Mission Planning	1. Mission Trajectory Calculation (MATLAB) 2. Resource Allocation (Linear Programming)	Space	Mission Planning	Python, MATLAB	2020b	Dr. William Iron	Dr. Xavier Steel	Space API: MATLAB 2020b, Linear Programming 1.0
	Space API: MATLAB 2020b, Linear Programming 1.0							
Artificial Intelligence Ethics	1. Bias Detection (Fairness Indicators) 2. Explainability (SHapley values)	AI Ethics	Ethics	Python, SHapley	0.0.1	Dr. Yvonne Tin	Dr. Zachary Lead	AI Ethics API: Fairness Indicators 0.0.1, SHapley 0.0.1
	AI Ethics API: Fairness Indicators 0.0.1, SHapley 0.0.1							
Smart City Infrastructure Development	1. IoT Device Integration (MQTT) 2. City Data Platform (OpenStreetMap)	Smart City	Infrastructure	Python, MQTT	3.1.0	Dr. Adam Lead	Dr. Bella Lead	Smart City API: MQTT 3.1.0, OpenStreetMap 1.0
	Smart City API: MQTT 3.1.0, OpenStreetMap 1.0							
Biometric Authentication System	1. Facial Recognition (OpenCV) 2. Fingerprint Scanning (Python)	Biometric	Authentication	Python, OpenCV	4.0.0	Dr. Charlie Lead	Dr. Diana Lead	Biometric API: OpenCV 4.0.0, Fingerprint Scanning 1.0
	Biometric API: OpenCV 4.0.0, Fingerprint Scanning 1.0							
Augmented Reality Application	1. AR Marker Tracking (ARKit) 2. 3D Object Rendering (Unity)	AR/VR	Application	Python, ARKit	1.0.0	Dr. Frank Lead	Dr. Grace Lead	AR/VR API: ARKit 1.0.0, Unity 2020.3
	AR/VR API: ARKit 1.0.0, Unity 2020.3							
Robotics Control System	1. Motor Control (PWM) 2. Sensor Integration (I2C)	Robotics	Control	Python, I2C	1.0.0	Dr. Henry Lead	Dr. Ivy Lead	Robotics API: PWM 1.0.0, I2C 1.0.0
	Robotics API: PWM 1.0.0, I2C 1.0.0							
Wearable Health Monitoring	1. Heart Rate Monitoring (Wearable Device) 2. Sleep Tracking (Wearable Device)	Wearable	Monitoring	Python, Wearable	1.0.0	Dr. Jack Lead	Dr. Karen Lead	Wearable API: Wearable Device 1.0.0, Sleep Tracking 1.0
	Wearable API: Wearable Device 1.0.0, Sleep Tracking 1.0							
Virtual Reality Environment	1. 3D Model Creation (Blender) 2. VR Interaction (Oculus Rift)	VR	Environment	Python, Blender	2.79.0	Dr. Leo Lead	Dr. Mia Lead	VR API: Blender 2.79.0, Oculus Rift 1.0
	VR API: Blender 2.79.0, Oculus Rift 1.0							
Drone Navigation System	1. GPS Tracking (GPS Module) 2. Obstacle Avoidance (Sensor Fusion)	Drone	Navigation	Python, GPS	1.0.0	Dr. Noah Lead	Dr. Olivia Lead	Drone API: GPS 1.0.0, Sensor Fusion 1.0
	Drone API: GPS 1.0.0, Sensor Fusion 1.0							
Smart Home Automation	1. Device Control (Zigbee) 2. Scene Creation (Home Assistant)	Smart Home	Automation	Python, Zigbee	0.100.0	Dr. Peter Lead	Dr. Quinn Lead	Smart Home API: Zigbee 0.100.0, Home Assistant 0.100.0
	Smart Home API: Zigbee 0.100.0, Home Assistant 0.100.0							
Cloud Storage Optimization	1. Data Compression (GZIP) 2. Storage Allocation (AWS S3)	Cloud Storage	Optimization	Python, AWS S3	2.0.0	Dr. Ryan Lead	Dr. Sophia Lead	Cloud Storage API: GZIP 1.0.0, AWS S3 2.0.0
	Cloud Storage API: GZIP 1.0.0, AWS S3 2.0.0							
Blockchain Consensus Mechanism	1. Transaction Validation (Bitcoin Core) 2. Consensus Algorithm (Proof of Work)	Blockchain	Consensus	Python, Bitcoin Core	0.16.0	Dr. Thomas Lead	Dr. Victoria Lead	Blockchain API: Bitcoin Core 0.16.0, Proof of Work 1.0
	Blockchain API: Bitcoin Core 0.16.0, Proof of Work 1.0							
AI Model Deployment	1. Model Packaging (Docker) 2. Deployment (Kubernetes)	AI Deployment	Deployment	Python, Docker	1.0.0	Dr. William Lead	Dr. Xavier Lead	AI Model API: Docker 1.0.0, Kubernetes 1.0.0
	AI Model API: Docker 1.0.0, Kubernetes 1.0.0							
Quantum Cryptography	1. Key Distribution (BB84 Protocol) 2. Encryption (QKD)	Quantum	Cryptography	Python, QKD	0.1.0	Dr. Yvonne Lead	Dr. Zachary Lead	Quantum API: BB84 Protocol 0.1.0, QKD 0.1.0
	Quantum API: BB84 Protocol 0.1.0, QKD 0.1.0							
Autonomous Drone Swarm	1. Swarm Coordination (ROS) 2. Task Allocation (Genetic Algorithm)	Autonomous	Swarm	Python, ROS	1.0.0	Dr. Adam Lead	Dr. Bella Lead	Autonomous API: ROS 1.0.0, Genetic Algorithm 1.0
	Autonomous API: ROS 1.0.0, Genetic Algorithm 1.0							
Healthcare IoT Network	1. Patient Monitoring (IoT Sensors) 2. Data Aggregation (Cloud Platform)	Healthcare	IoT Network	Python, IoT	1.0.0	Dr. Charlie Lead	Dr. Diana Lead	Healthcare IoT API: IoT Sensors 1.0.0, Cloud Platform 1.0
	Healthcare IoT API: IoT Sensors 1.0.0, Cloud Platform 1.0							
Smart Agriculture System	1. Soil Moisture Monitoring (Sensors) 2. Irrigation Control (Automated System)	Smart Agriculture	System	Python, Sensors	1.0.0	Dr. Frank Lead	Dr. Grace Lead	Smart Agriculture API: Sensors 1.0.0, Irrigation Control 1.0
	Smart Agriculture API: Sensors 1.0.0, Irrigation Control 1.0							
Robotics Learning System	1. Reinforcement Learning (OpenAI Gym) 2. Policy Optimization (PPO)	Robotics	Learning	Python, OpenAI Gym	0.21.0	Dr. Henry Lead	Dr. Ivy Lead	Robotics Learning API: OpenAI Gym 0.21.0, PPO 1.0
	Robotics Learning API: OpenAI Gym 0.21.0, PPO 1.0							
Wearable Activity Tracker	1. Activity Tracking (Accelerometer) 2. Sleep Analysis (Actigraphy)	Wearable	Activity Tracker	Python, Accelerometer	1.0.0	Dr. Jack Lead	Dr. Karen Lead	Wearable Activity API: Accelerometer 1.0.0, Sleep Analysis 1.0
	Wearable Activity API: Accelerometer 1.0.0, Sleep Analysis 1.0							
Virtual Reality Training	1. VR Module Development (Unity) 2. User Interaction (VR Controllers)	VR Training	Training	Python, Unity	2020.3	Dr. Leo Lead	Dr. Mia Lead	VR Training API: Unity 2020.3, VR Controllers 1.0
	VR Training API: Unity 2020.3, VR Controllers 1.0							
Drone Delivery System	1. Flight Path Planning (A* Algorithm) 2. Package Release (Custom Mechanism)	Drone Delivery	Delivery	Python, A*	1.0.0	Dr. Noah Lead	Dr. Olivia Lead	Drone Delivery API: A* Algorithm 1.0.0, Package Release 1.0
	Drone Delivery API: A* Algorithm 1.0.0, Package Release 1.0							
Smart City Data Platform	1. Data Collection (IoT Gateways) 2. Data Analysis (Big Data Analytics)	Smart City	Data Platform	Python, Big Data	1.0.0	Dr. Peter Lead	Dr. Quinn Lead	Smart City Data API: IoT Gateways 1.0.0, Big Data Analytics 1.0
	Smart City Data API: IoT Gateways 1.0.0, Big Data Analytics 1.0							
Biometric Security System	1. Facial Recognition (FaceNet) 2. Fingerprint Scanning (Fingerprint Sensor)	Biometric Security	Security	Python, FaceNet	1.0.0	Dr. Ryan Lead	Dr. Sophia Lead	Biometric Security API: FaceNet 1.0.0, Fingerprint Sensor 1.0
	Biometric Security API: FaceNet 1.0.0, Fingerprint Sensor 1.0							
Autonomous Vehicle Fleet	1. Fleet Management (Fleet Management System) 2. Route Optimization (Traveling Salesman Problem)	Autonomous Vehicle	Fleet	Python, Fleet	1.0.0	Dr. Thomas Lead	Dr. Victoria Lead	Autonomous Vehicle API: Fleet Management System 1.0.0, Traveling Salesman Problem 1.0
	Autonomous Vehicle API: Fleet Management System 1.0.0, Traveling Salesman Problem 1.0							
Cloud Migration Project	1. Assessment (AWS Migration Center) 2. Migration (AWS Migration Hub)	Cloud Migration	Migration	Python, AWS	2.0.0	Dr. William Lead	Dr. Xavier Lead	Cloud Migration API: AWS Migration Center 2.0.0, AWS Migration Hub 1.0
	Cloud Migration API: AWS Migration Center 2.0.0, AWS Migration Hub 1.0							
AI Model Interpretability	1. Feature Importance (SHapley values) 2. Model Explainability (LIME)	AI Interpretability	Interpretability	Python, SHapley	0.0.1	Dr. Yvonne Lead	Dr. Zachary Lead	AI Model Interpretability API: SHapley 0.0.1, LIME 0.0.1
	AI Model Interpretability API: SHapley 0.0.1, LIME 0.0.1							
Smart Home Energy Management	1. Energy Consumption Monitoring (Smart Meters) 2. Energy Optimization (Machine Learning)	Smart Home	Energy Management	Python, Smart Meters	1.0.0	Dr. Adam Lead	Dr. Bella Lead	Smart Home Energy API: Smart Meters 1.0.0, Machine Learning 1.0
	Smart Home Energy API: Smart Meters 1.0.0, Machine Learning 1.0							
Robotics Simulation Environment	1. Environment Setup (Gazebo) 2. Robot Control (ROS)	Robotics Simulation	Simulation	Python, Gazebo	1.0.0	Dr. Charlie Lead	Dr. Diana Lead	Robotics Simulation API: Gazebo 1.0.0, ROS 1.0.0
	Robotics Simulation API: Gazebo 1.0.0, ROS 1.0.0							
Wearable Health Data Analysis	1. Health Data Collection (Wearable Device) 2. Data Analysis (Machine Learning)	Wearable Health	Data Analysis	Python, Machine Learning	1.0.0	Dr. Frank Lead	Dr. Grace Lead	Wearable Health Data API: Wearable Device 1.0.0, Machine Learning 1.0
	Wearable Health Data API: Wearable Device 1.0.0, Machine Learning 1.0							

Stripe Pattern Details

It is possible to query this information from the deep login node, for instance:

```
manzano@deep $ fhgfs-ctl --getentryinfo /work/manzano
Path: /manzano
Mount: /work
EntryID: 1D-53BA4FF8-3BD3
Metadata node: deep-fs02 [ID: 15315]
Stripe pattern details:
+ Type: RAID0
+ Chunksize: 512K
+ Number of storage targets: desired: 4

manzano@deep $ beegfs-ctl --getentryinfo /sdv-work/manzano
Path: /manzano
Mount: /sdv-work
EntryID: 0-565C499C-1
Metadata node: deeper-fs01 [ID: 1]
Stripe pattern details:
+ Type: RAID0
+ Chunksize: 512K
+ Number of storage targets: desired: 4
```

Or like this:

```
manzano@deep $ stat -f /work/manzano
File: "/work/manzano"
ID: 0      Namelen: 255      Type: fhgfs
Block size: 524288      Fundamental block size: 524288
Blocks: Total: 120178676 Free: 65045470 Available: 65045470
Inodes: Total: 0        Free: 0

manzano@deep $ stat -f /sdv-work/manzano
File: "/sdv-work/manzano"
ID: 0      Namelen: 255      Type: fhgfs
Block size: 524288      Fundamental block size: 524288
Blocks: Total: 120154793 Free: 110378947 Available: 110378947
Inodes: Total: 0        Free: 0
```

See <http://www.beegfs.com/wiki/Striping> for more information.

Additional infos

Detailed information on the **BeeGFS Configuration** can be found [?here](#).

Detailed information on the **BeeOND Configuration** can be found [?here](#).

Detailed information on the **Storage Configuration** can be found [?here](#).

Detailed information on the **Storage Performance** can be found [?here](#).

Notes

- dd test @dp-dam01 of the DCPMM in appdirect mode:

```
[root@dp-dam01 scratch]# dd if=/dev/zero of=./delme bs=4M count=1024 conv=sync
1024+0 records in
1024+0 records out
4294967296 bytes (4.3 GB) copied, 1.94668 s, 2.2 GB/s
```

- The /work file system which is available in the DEEP-EST prototype, is as well reachable from the nodes in the SDV (including KNLs and ml-gpu nodes) but through a slower connection of 1 Gb/s. The file system is therefore not suitable for benchmarking or I/O task intensive jobs from those nodes
- Performance tests (IOR and mdtest) reports are available in the BSCW under DEEP-ER → Work Packages (WPs) → WP4 → T4.5 - Performance measurement and evaluation of I/O software → Jülich DEEP Cluster → Benchmarking reports:
[?https://bscw.zam.kfa-juelich.de/bscw/bscw.cgi/1382059](https://bscw.zam.kfa-juelich.de/bscw/bscw.cgi/1382059)
- Test results and parameters used are stored in JUBE:

```
user@deep $ cd /usr/local/deep-er/sdv-benchmarks/synthetic/ior
user@deep $ jube2 result benchmarks

user@deep $ cd /usr/local/deep-er/sdv-benchmarks/synthetic/mdtest
user@deep $ jube2 result benchmarks
```