

HPC Training Standardization and Certification

HPC Certification Forum

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The **HPC** Certification Forum

Goals

- Fine-grained HPC knowledge representation \Rightarrow Competence Standard
 - ▶ What competences exist, how are they defined?
 - ▶ Puzzle of competences for everyone (practitioners, students, admins)
 - ▶ Supporting navigation and role-specific knowledge maps -> Learning pathways/baselines
- Establishing international certificates attesting knowledge

Scope of the forum

- Central authority for competence representation, certification, and support
- Purposeful limitations of the forum:
 - ▶ We do not compete with content providers
 - ▶ We do not create a curriculum (university/centers responsibility)

The **HPC** Certification Forum

Organization Details

- An independent international body
- Organized into
 - ▶ Steering board (elected)
 - ▶ Full members (with voting rights) - Contributors
 - ▶ Associate members (anyone and any institution)
 - ▶ Collaboration with e.g. EuroHPC JU projects HPC SPECTRA & EViTA

Activities

- Curating and maintaining the **Competence Standard**
- Providing tools and ecosystem around the competences

Organization

Organization of the members

- Webpage is the central hub (<https://www.hpc-certification.org>)
- Mailinglists (news, members, board)
- Monthly public meetings on our Slack channel
- Monthly meeting of the board
- Annual general assembly (BoF at ISC or independent workshop)

Data handling

- Everything is developed/available in the open
GitHub (<https://github.com/HPC-certification-forum>)
- Exception are examination questions

Outline

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HPC SPECTRA

- Funded by EuroHPC JU: 101136267
- Main deliverable: Training platform + Supporting IHPCSS



HPC SPECTRA

- International HPC Summer School (IHPCSS)
 - ▶ Organizing Summer School
 - ▶ Funding students
- Training platform: <https://events.hpc-portal.eu/>
 - ▶ Central database for courses across Europe
 - ▶ Browsable and bookable trainings
 - ▶ Interfacing with skill framework from HPC CF

EVITA

- Funded by EuroHPC JU: 101196394
- 4 year project and successor to HPC SPECTRA with 1 year overlap



EuroHPC Virtual Training Academy

EVITA

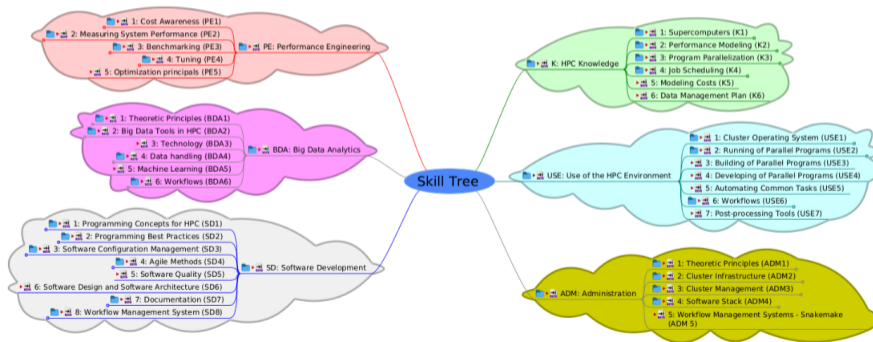
- Progressing the Training platform to include a material catalog
- Funding module creation with skill framework as basis
- Interfaces and advances the HPC CF Skill tree
- Establishing certificates for modules through examination framework
- Connecting certificates to ECTS and Micro-credentials

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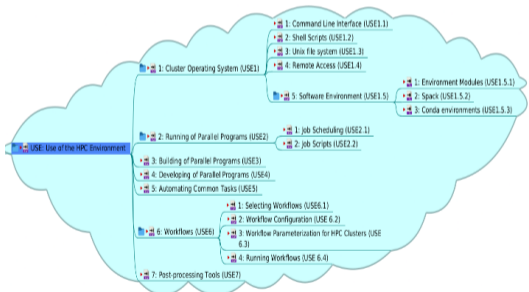
Classification of Competences

- A **skill** defines the contents to be learned and tested
- The **skill tree** organizes the competences as hierarchical skills
- Certificates bundle several skills into attestable unit



A Skill category in detail

- Using an HPC environment including Linux basics
- Organized into Node Skills, further Broken Down into Leaf Skills



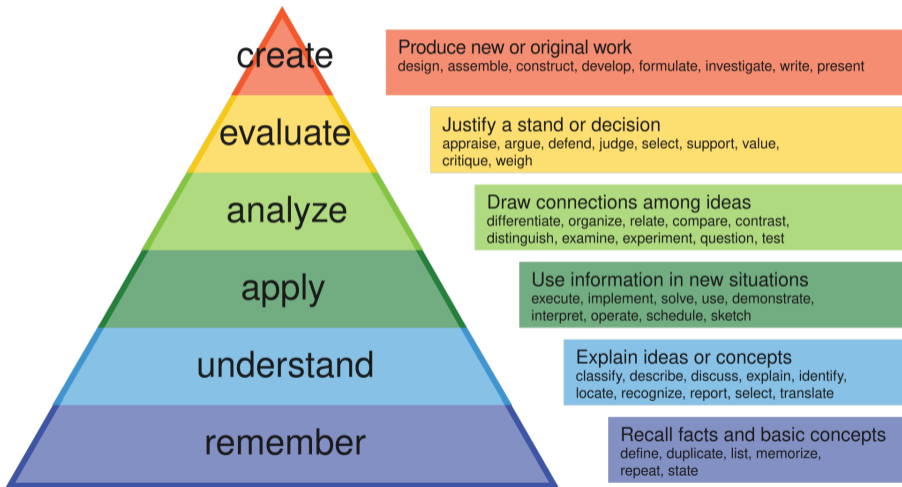
A Leaf Skill - Definition

- Single enclosed, universal unit of learning
- Contains several learning objectives
 - ▶ A leaf skill has content for 1 to 4 hours (including self-study time)
 - ▶ Framing of learning objectives follow: Bloom's taxonomy
- Has a unique identifier: for example USE1.5.1
- Can have requirements of other skills (either node or leaf)

A Node Skill - Definition

- An aggregate unit of learning
- Contains several learning objectives
 - ▶ 1-2 learning objectives distilled from skills immediately below it
 - ▶ Learning time set by skill below this node
 - ▶ Framing of learning objectives follow: Bloom's taxonomy
- Has a unique identifier: for example USE1.5
- Can have requirements of other skills (either node or leaf)

Bloom Taxonomy - Refresher



Source: https://en.wikipedia.org/wiki/Bloom%27s_taxonomy#/media/File:Bloom's_revised_taxonomy.svg from 21.06.2025

Example Skill (Excerpt)

- Name: Command Line Interface
- Id: USE1.1
(<https://www.hpc-certification.org/wiki/skill-tree/use/1/1/b>)
- Description: Using a CLI requires knowledge of the underlying system as well as the programs it can execute. It is important to learn about the functionality ...
- Learning Outcomes:
 - ▶ Utilize the bash shell to execute individual programs with arguments.
 - ▶ Describe the meaning of the exit code of a program.
 - ▶ Run multiple programs after another depending on the exit code `;`, `&&`, `||`.
 - ▶ List the set of basic programs and their tasks: `pwd`, `whoami`, `sleep`, ...

Classification of HPC Competences

■ Granularity of skill descriptions

- ▶ Too fine \Rightarrow content of a skill is predefined at leaf level
- ▶ Too coarse \Rightarrow no help for structuring the material
- ▶ Guiding principle: leaf node should be covered in 1-4 hour lecture/workshop

■ Organization of HPC skills

- ▶ A Skill topic contains multiple skills and topics building on each other
- ▶ Each Skill topic has an overview which can be referenced and contains all important information to be learned
- ▶ Requirements can be part of skill tree or external (i.e. basic programming knowledge)

■ Verification of skill tree and certification approach

- ▶ Feedback by the HPC community/practitioners justify the approaches
- ▶ Growing community in Europe working on using the Skill tree for courses

Status / Previous Activities

- Current version of the Competence Standard
 - ▶ Git managed Markdown files
 - ▶ Files are also available in a Wiki (for interaction)
- Supporting experts to adopt skills
 - ▶ Enable experts to curate skills that are in their field of expertise
 - ▶ Similar to code maintainer - various regular contributions
- Working on sponsoring
- Developed examination framework



This training covers (partially)
- K1.1 System architectures
- K1.2 Hardware architectures
See <https://hpc-certification.org/c/1.0>

All our developments are under open licenses (except the exam questions)

Contribution to the Skill-Tree High-Level Editing

How can members contribute?

- Webpage with Markdown version controlled in Git
 - ▶ <https://www.hpc-certification.org/wiki/skill-tree/b>
 - ▶ GitHub: <https://github.com/HPC-certification-forum/skill-tree>
 - Pull requests, reviews, comments, ...
- Editing a MindMap, the structure of Skills
 - ▶ Synchronized with the skill tree in Git
 - ▶ Uses the OpenSource tool Freeplane
- Discussion on our Slack
- Documented in our processes section
- See our videos on YouTube

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Certification: Assessment

- User registers to test, receives email
- User takes test online (any time!), consists of
 - ▶ Scenario – SSH login in a browser to a Docker environment
 - ▶ Multiple choice exam (System selects number of questions (and responses) randomly from a pool)
- Results are submitted to the web server
- Automatic approval of response
- Automatic creation of certificate and returned by email
 - ▶ Permanent computer-verifiable proof that skill is created
 - Return a text version with GPG signature
 - Return a link that can be verified on hpc-certification.org
- Privacy: minimize information stored on servers, keep some for statistics
- Includes some measure to prevent cheating and brute forcing (e.g., delay)

Certification: Certificate

Text representation

```
-----BEGIN PGP SIGNED MESSAGE-----  
Hash: SHA512  
HPC Certification Forum Certificate  
This text confirms that "Jane Doe" has  
successfully obtained the certificate  
"HPC driving license" (id: 1) at 02/2019.  
Verification URL: https://hpc-certification.org/[...]  
-----BEGIN PGP SIGNATURE-----  
[...]  
-----END PGP SIGNATURE-----
```

Certificate



Examination Multiple choice - Demo

Examination for "*Linux basics: USE1.1-B Command Line Interface*"

This exam allows to obtain the certificate "*Linux basics: USE1.1-B Command Line Interface*" with the ID 1.

Deadline: 2025-02-21 18:15:44

Note that more than one answer may be correct for a question.

You must submit the test to the server via the button on the last page, otherwise the results are not saved!

Time remaining: 3002s

Question 1

Which command is used to close the vi editor?

Mark individual answers as correct or wrong.

unknown exit

unknown q

unknown quit

unknown <esc>ZZ

Question 2

Which command is used to close the vi editor without saving any changes?

Examination Scenario Start - Demo

Your scenario is ready, please follow the instructions to access it

The tasks are described in the following [PDF](#)

To access the sandbox, follow this [link](#).

Then enter the credentials

username: *user*

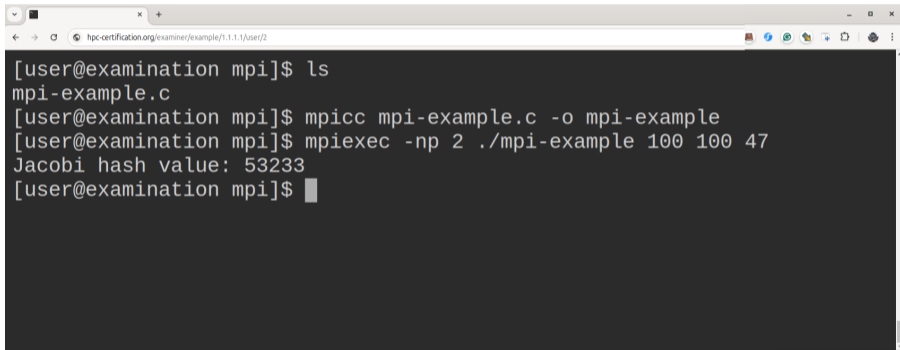
password: *9d53992919ee3091ff385f5bdd4f01c057b2b0ef*

Time is now: 2025-02-21 17:26:46

The deadline for the submission is: 2025-02-21 17:42:27

The scenario will automatically be submitted by the deadline!

Examination Scenario Session - Demo



```
[user@examination mpi]$ ls
mpi-example.c
[user@examination mpi]$ mpicc mpi-example.c -o mpi-example
[user@examination mpi]$ mpiexec -np 2 ./mpi-example 100 100 47
Jacobi hash value: 53233
[user@examination mpi]$
```

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ECTS - Connecting to University tracks

- Currently all universities manage their own set of courses.
- Universities are also only able to hand out ECTS.
- Some HPC centers are attached to universities and can also hand out ECTS for select courses.
- Similarly for Micro-credentials, which are industry centric
- Basic concept: One Skill 1 to 4 hours of work → About 5 to 7 Skills is one ECTS
- What we need? A solution that works across Europe and for all HPC centers.

Sustainability of the Standard

- Establishing this Standard as part of public and private education will ensure it's durability
- The EuroHPC JU wants the Skill tree as central concept in the Trainings and the Trainingplatform
- Future endeavors will dive deeper into further certifications and learning pathways

Summary

- The HPC CF curates a Skill Tree/framework and establishes a modular standard for tracking of competencies.
- Two EuroHPC JU funded projects, HPC SPECTRA and EViTA, are working on increasing the usage and uptake of the standard.
- An examination framework is being prepared and is able to certify verifiably that a skill has been acquired.
- Certificates can be connected to ECTS and/or Micro-credentials in the future.