Karlsruhe Institute of Technology

Introduction into Subject Areas A & B

ErUM Data IDT - Collaboration Meeting

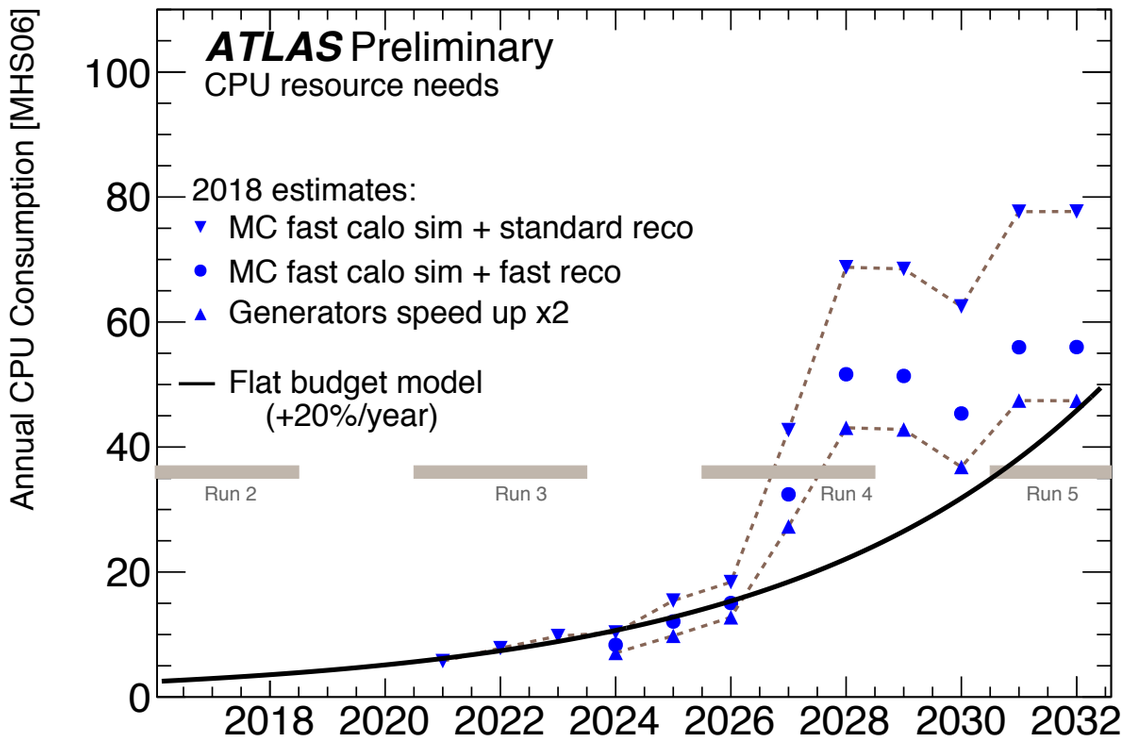
Manuel Giffels

Contributions from: Max Fischer and Günter Quast

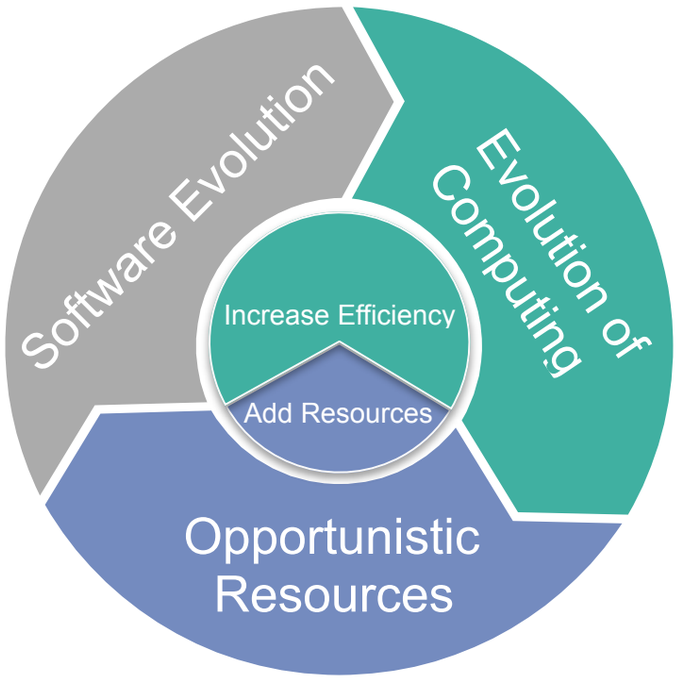
Institute for Particle Physics (ITP) & Steinbuch Centre for Computing (SCC)

Computing Challenge Ahead

https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ComputingandSoftwarePublicResults



- ATLAS/CMS CPU resource estimates
- Assuming flat budget and 20% technology advance per year
- CPU shortfall between needs and technology gains about factor 2-3 in 2027
- ➡ Critical conditions for HL-LHC (Run 4)

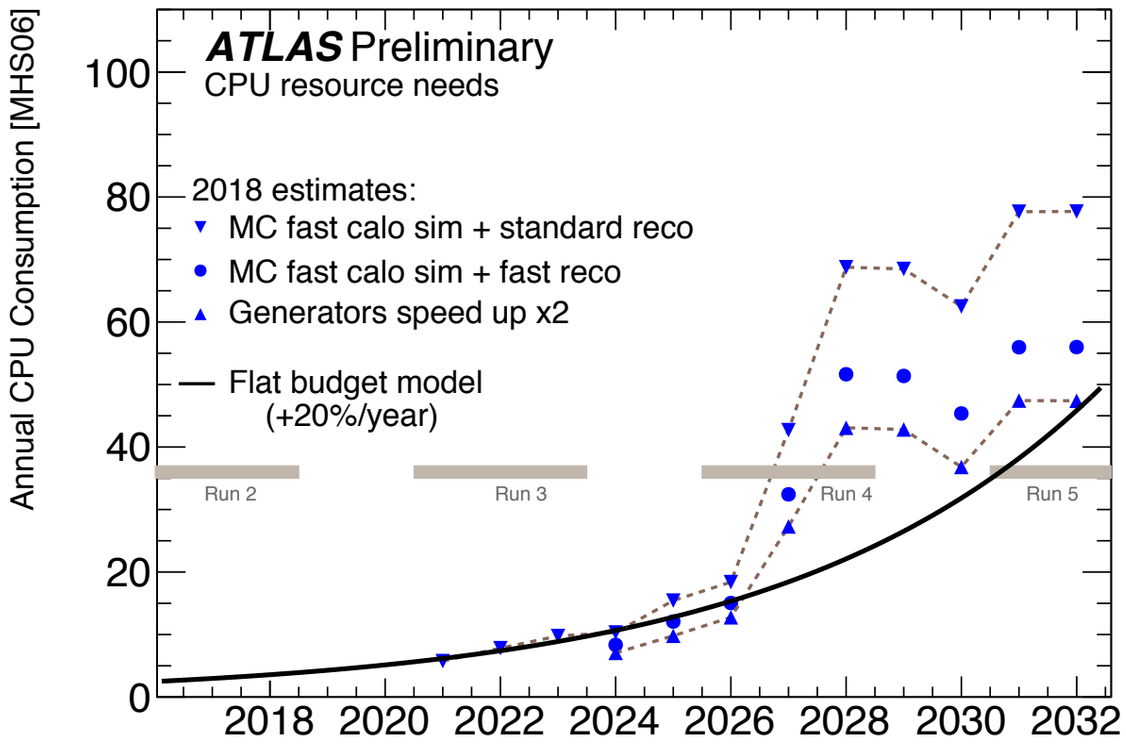


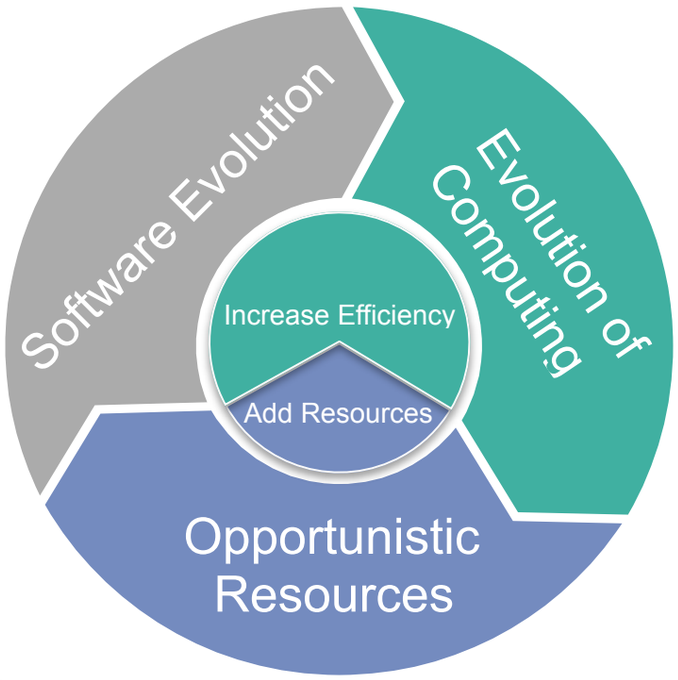
<u>New interesting research topics:</u>

- Exploitation of modern technologies
- Improvement of algorithms and utilization of ML
- Dynamic integration of opportunistic resources (HPC, cloud, volunteer computing, Tier 3s)
- Data lakes and data caching technologies

Computing Challenge Ahead

https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ComputingandSoftwarePublicResults





- ATLAS/CMS CPU resource estimates
- Assuming flat budget and 20% technology advance per year
- CPU shortfall between needs and technology gains about factor 2-3 in 2027
- ➡ Critical conditions for HL-LHC (Run 4)

New interes

Subject Areas A & B

- Exploitation of moder
- Improvement of algorithms and utilization of ML
- Dynamic integration of opportunistic resources (HPC, cloud, volunteer computing, Tier 3s)
- Data lakes and data caching technologies

What can we build on?

Illustration by Max Fischer (KIT)

What can we build on?

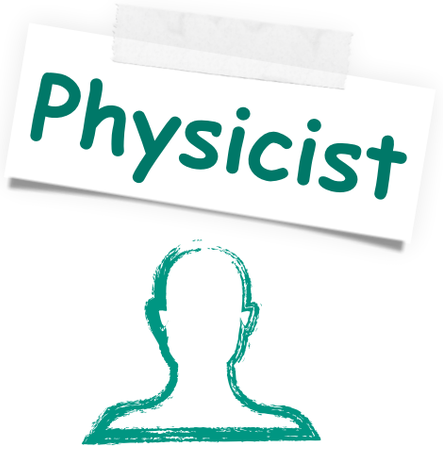
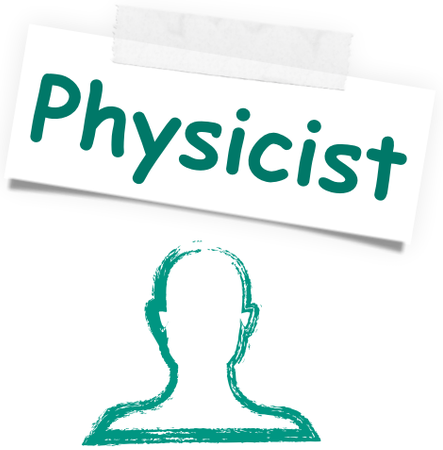


Illustration by Max Fischer (KIT)

What can we build on?



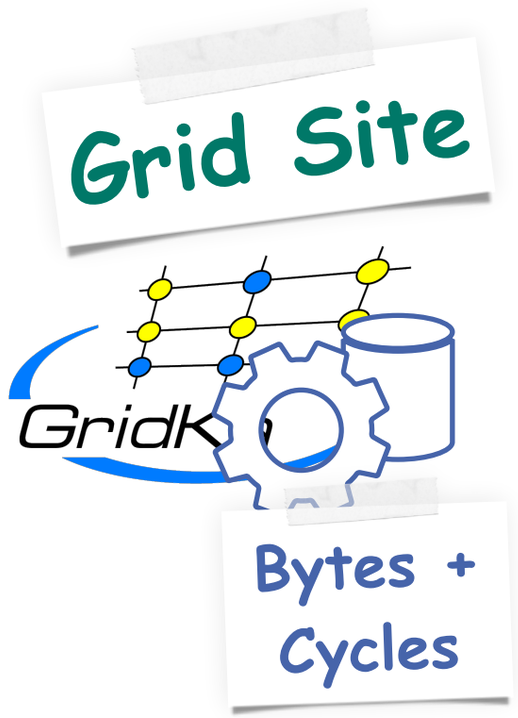


Illustration by Max Fischer (KIT)

What can we build on?

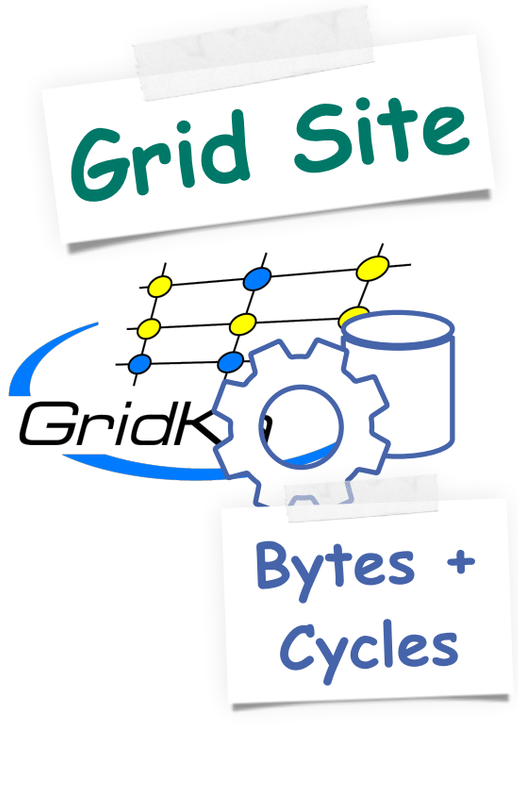


Illustration by Max Fischer (KIT)

What can we build on?

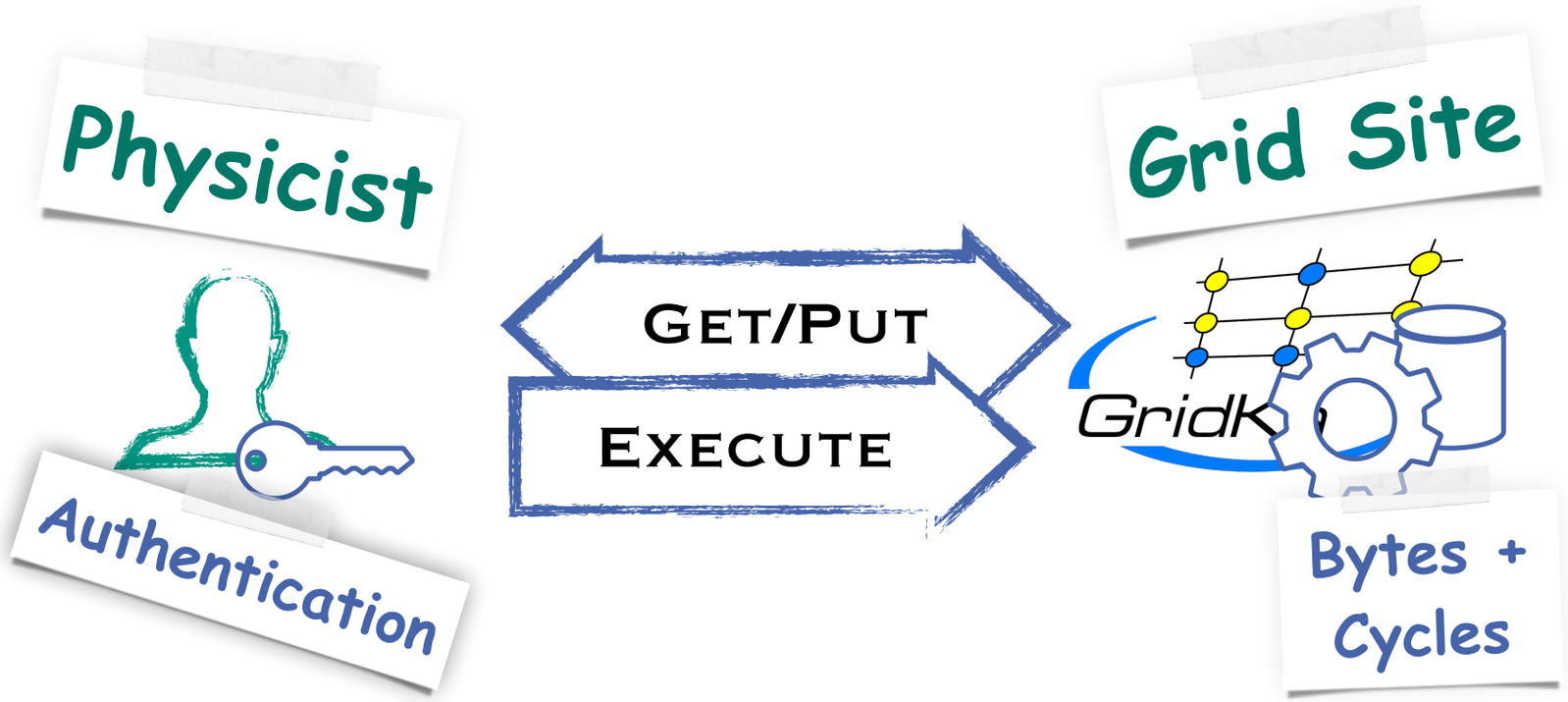
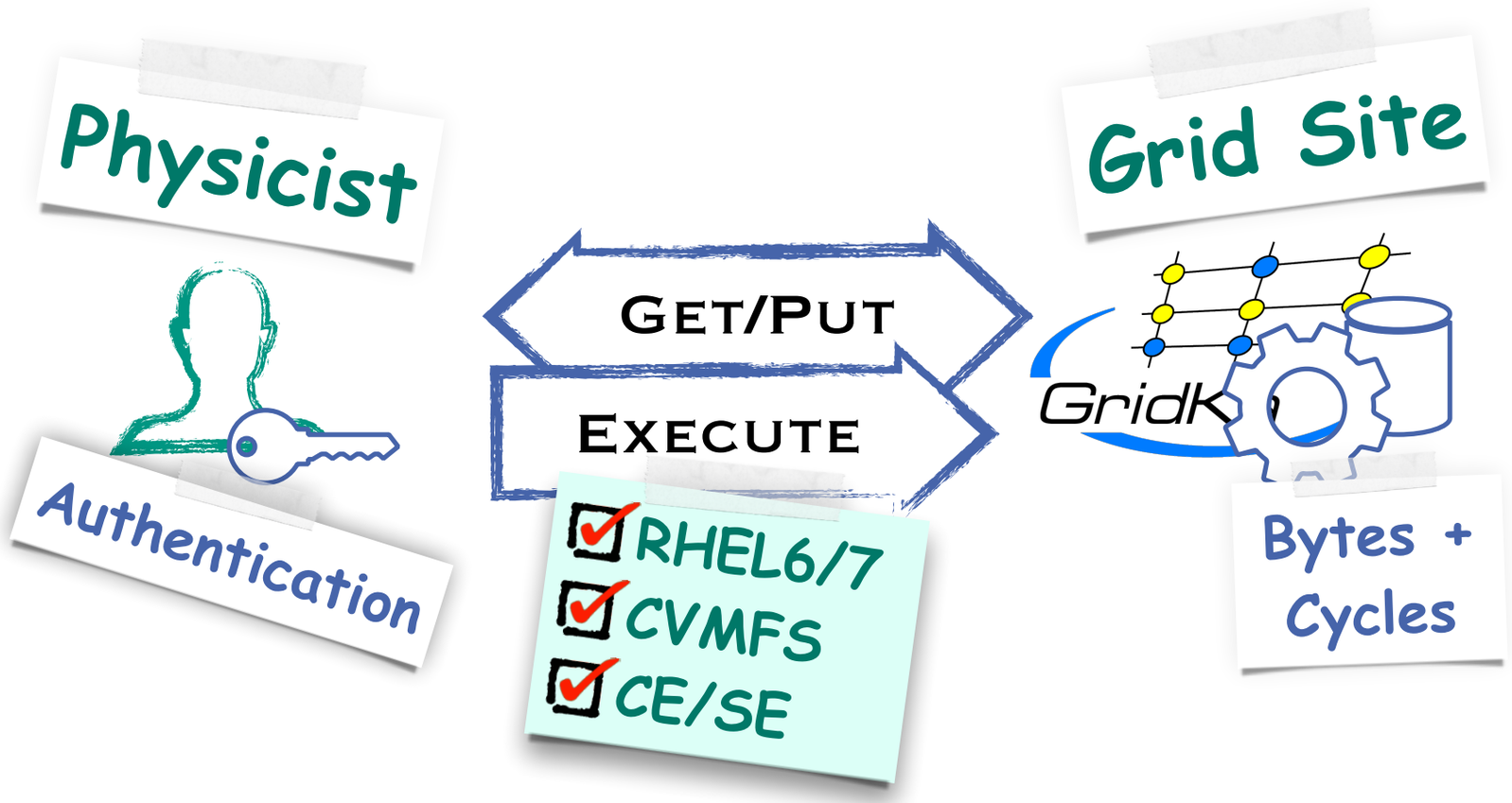


Illustration by Max Fischer (KIT)

What can we build on?



Major achievements:

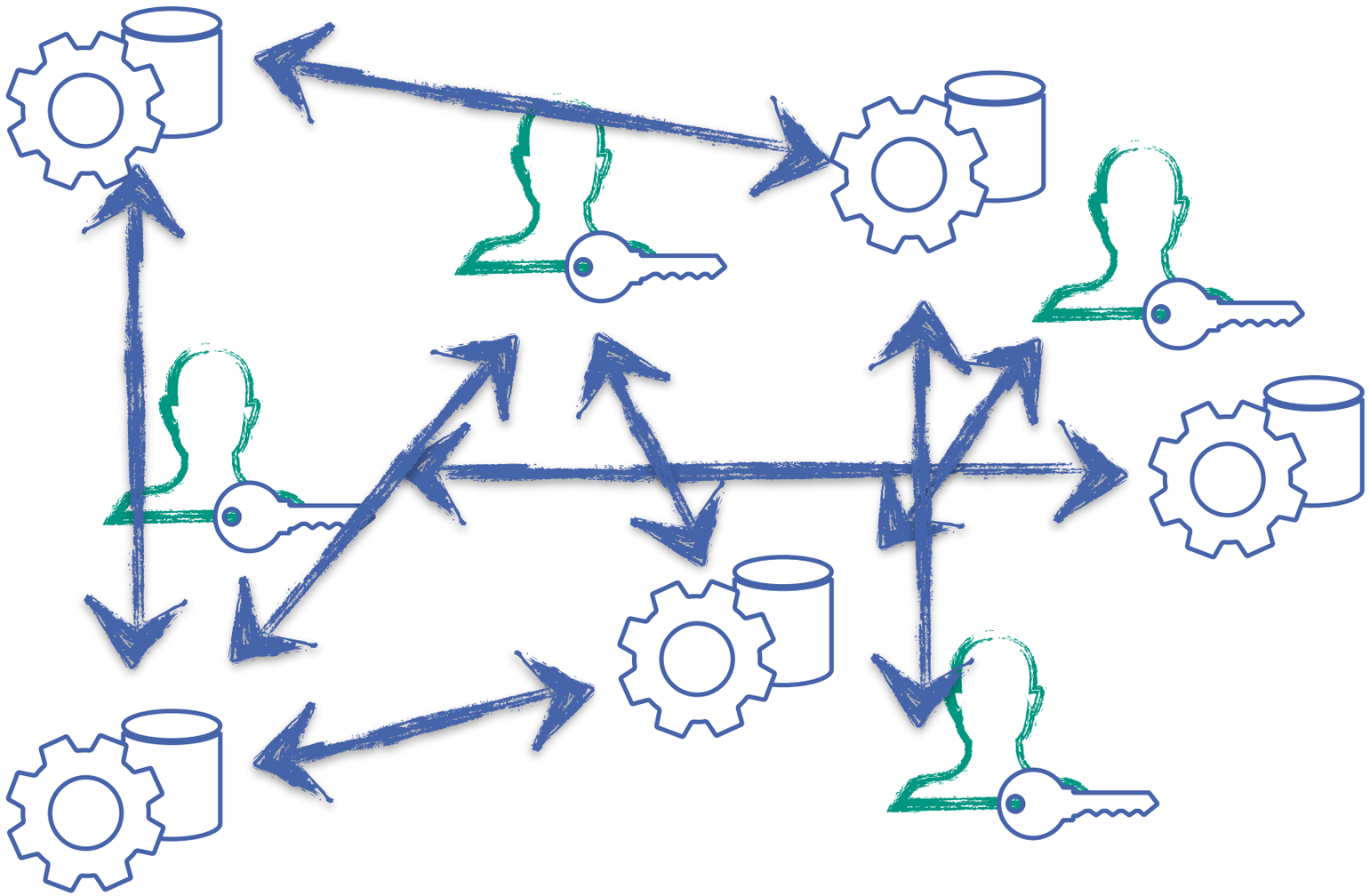
- Common authentication (X509 ➠ SciTokens?)
  - Global trust alliance (Grid CAs)
- “Homogeneous” resources on a global-scale
- Global standards (CVMFS, xrootd, FTS, …)

Illustration by Max Fischer (KIT)

What we can build on?

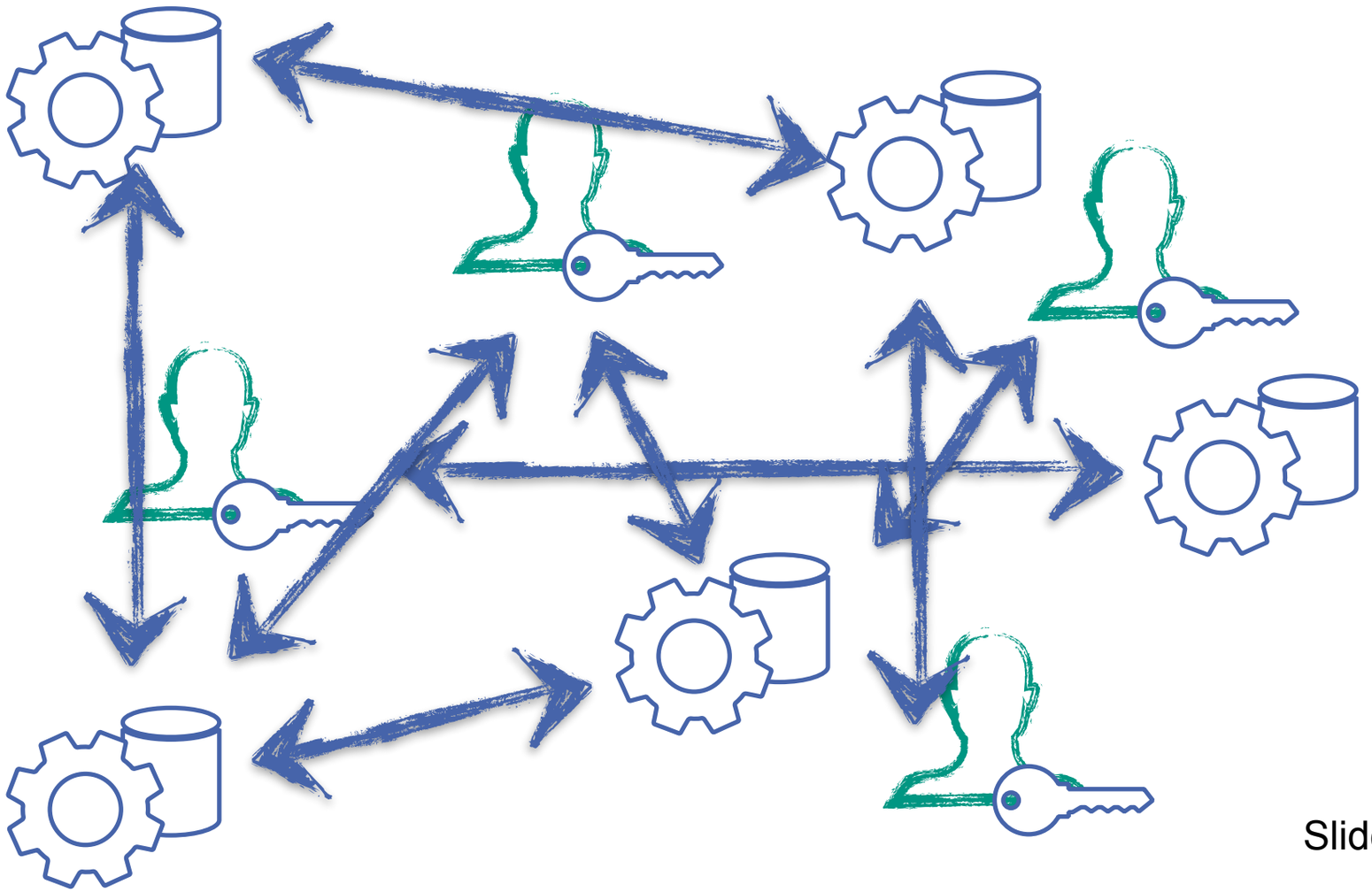
Slide by Max Fischer (KIT)

What we can build on?



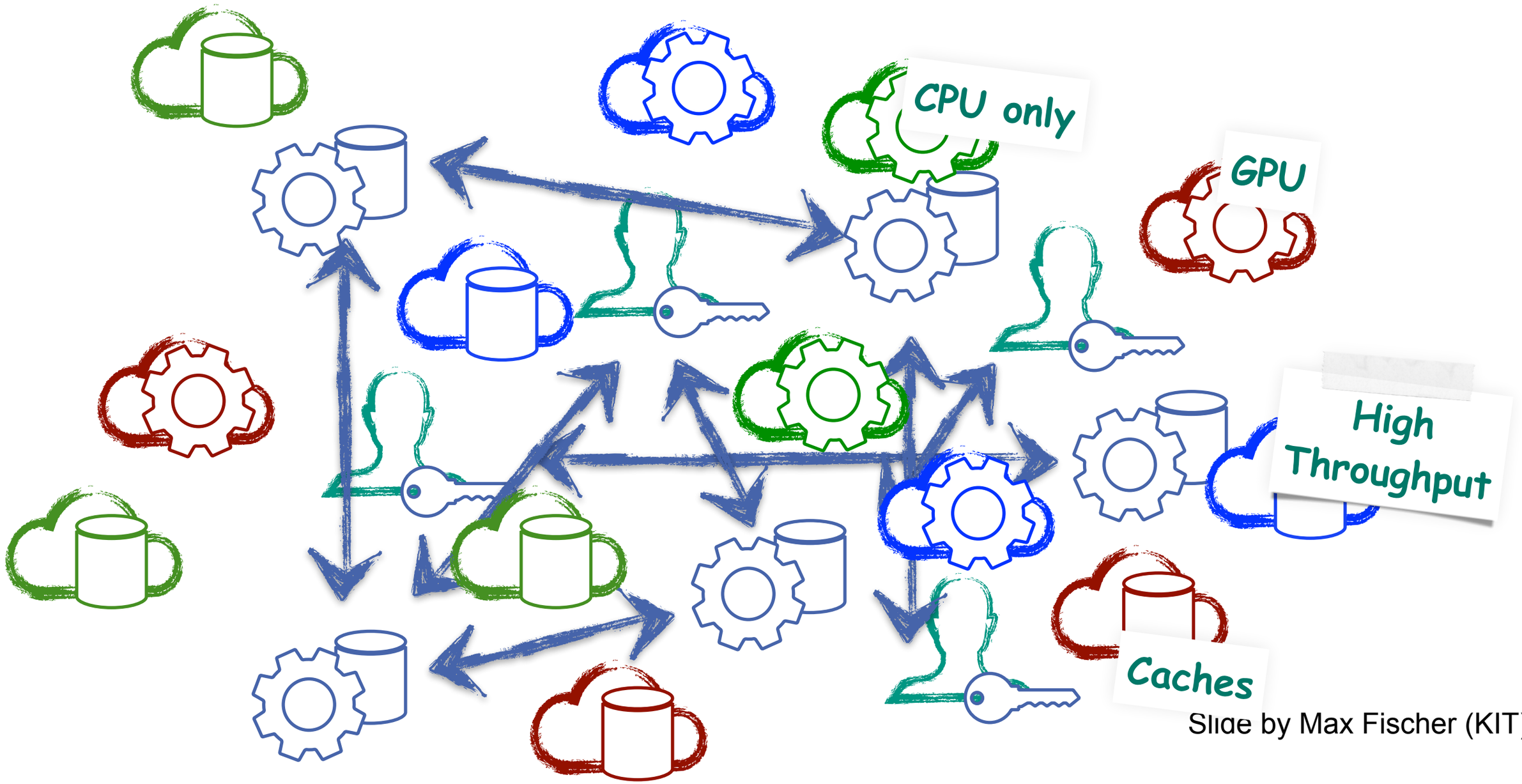
Slide by Max Fischer (KIT)

The Grid, the Bad and the Ugly



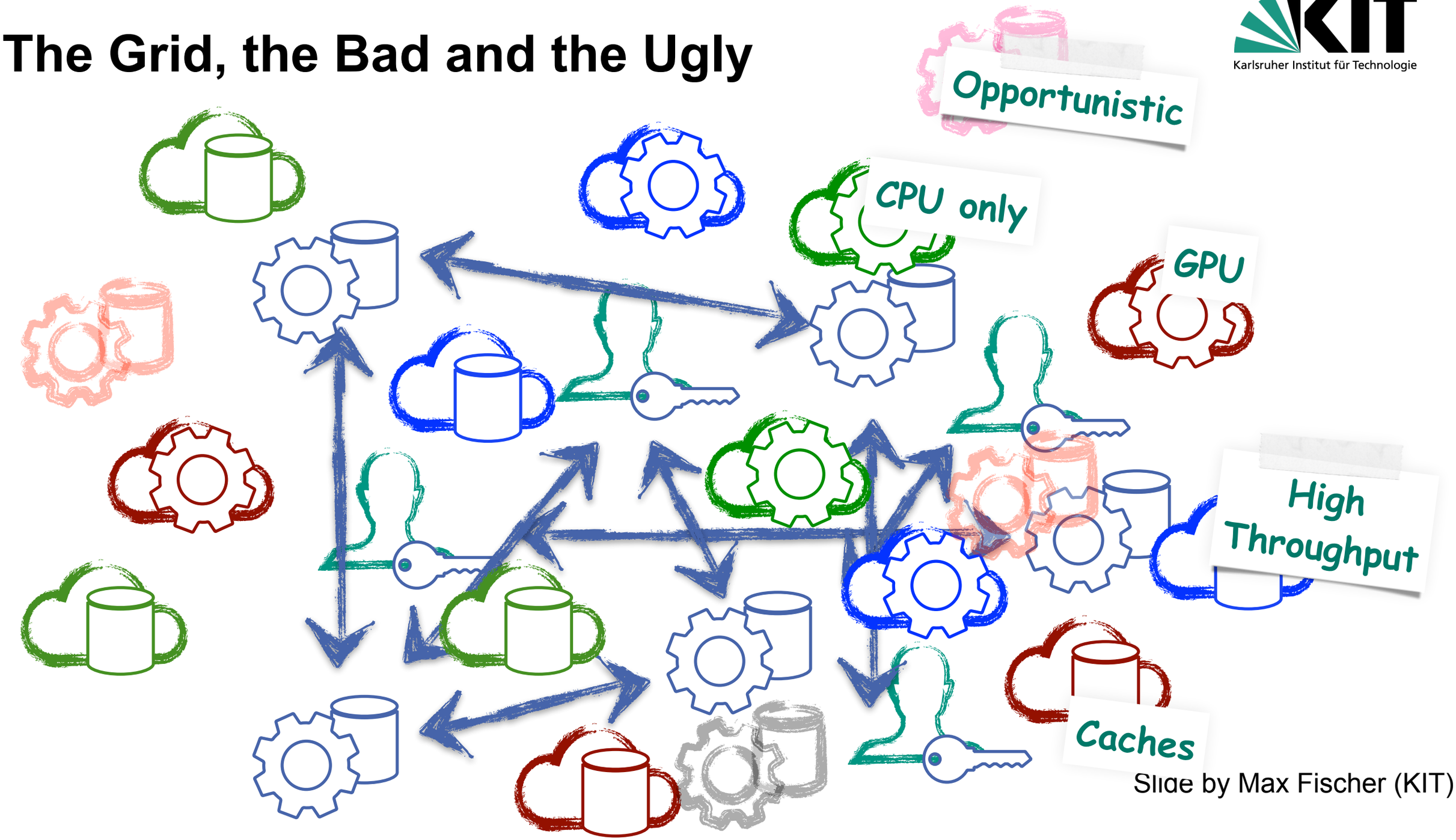
Slide by Max Fischer (KIT)

The Grid, the Bad and the Ugly



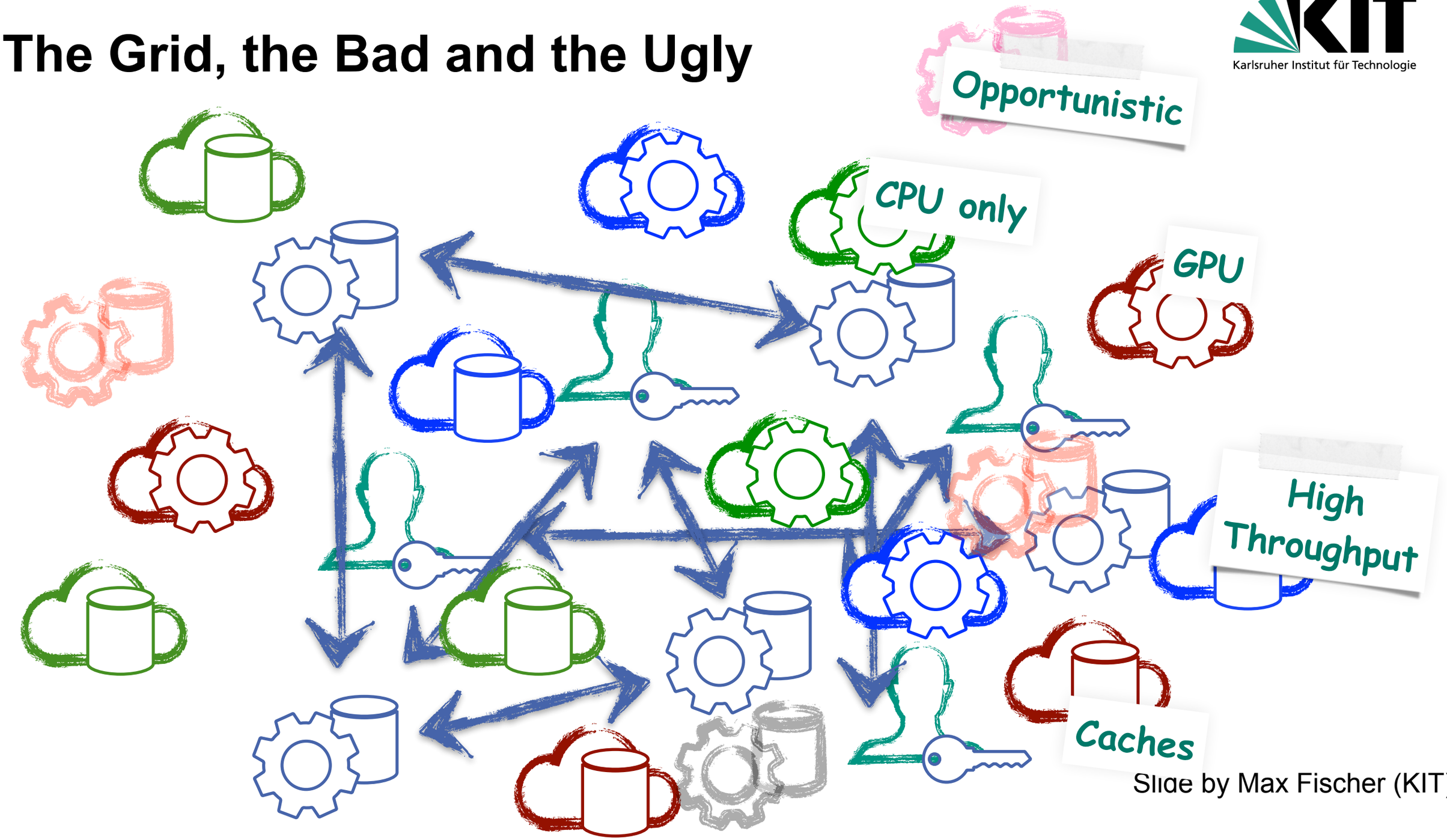
Slide by Max Fischer (KIT)

The Grid, the Bad and the Ugly



Slide by Max Fischer (KIT)

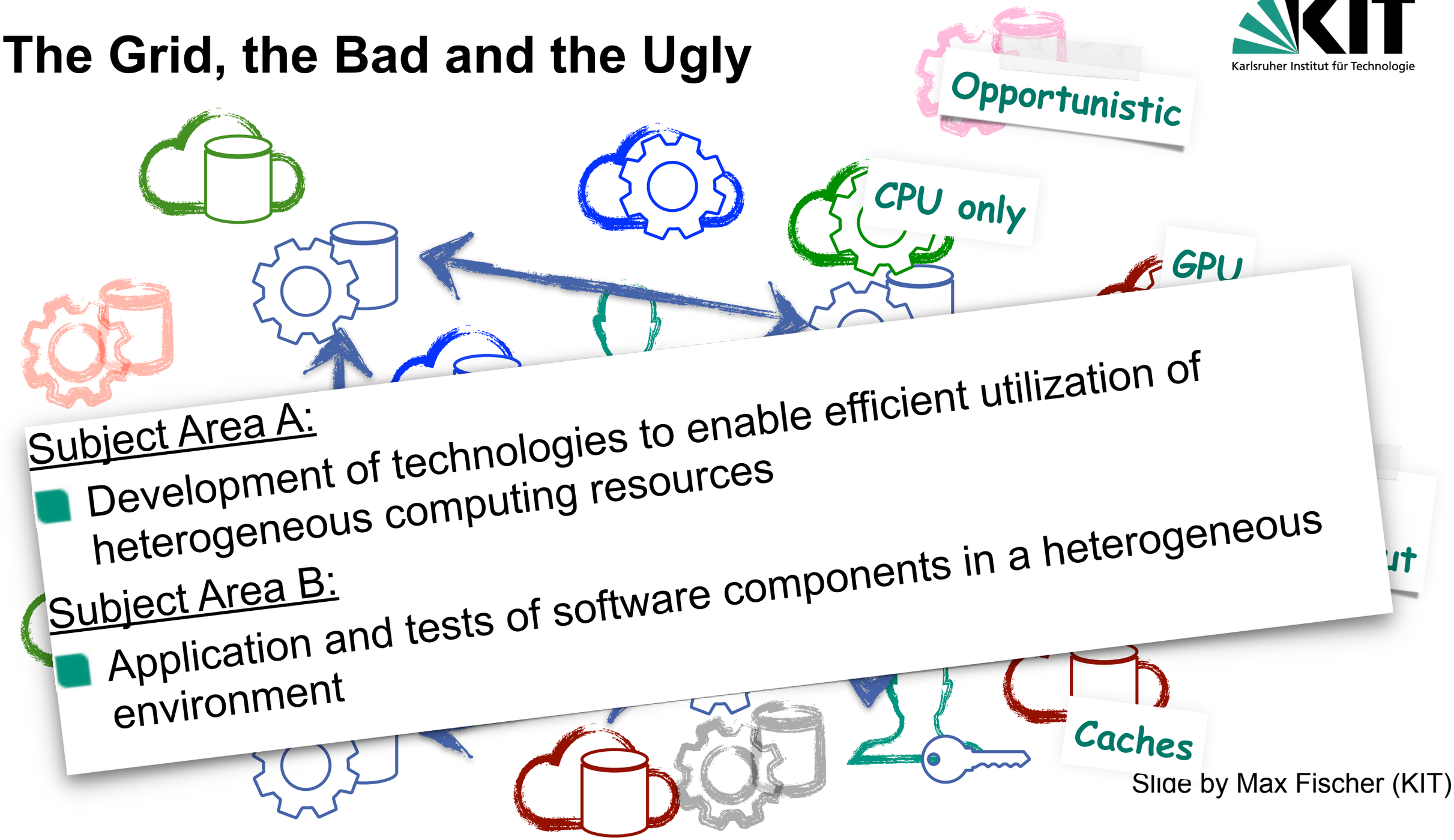
The Grid, the Bad and the Ugly



Slide by Max Fischer (KIT)

- Resources will be more heterogenous
- Huge challenge for computing operations of experiments and end users

The Grid, the Bad and the Ugly



Subject Area A:

- Development of technologies to enable efficient utilization of heterogeneous computing resources

Subject Area B:

- Application and tests of software components in a heterogeneous environment

Slide by Max Fischer (KIT)

➡ Resources will be more heterogenous

➡ Huge challenge for computing operations of experiments and end users

How could it look like?

Blueprint (?) for the German contribution to LHC computing >2025 ?

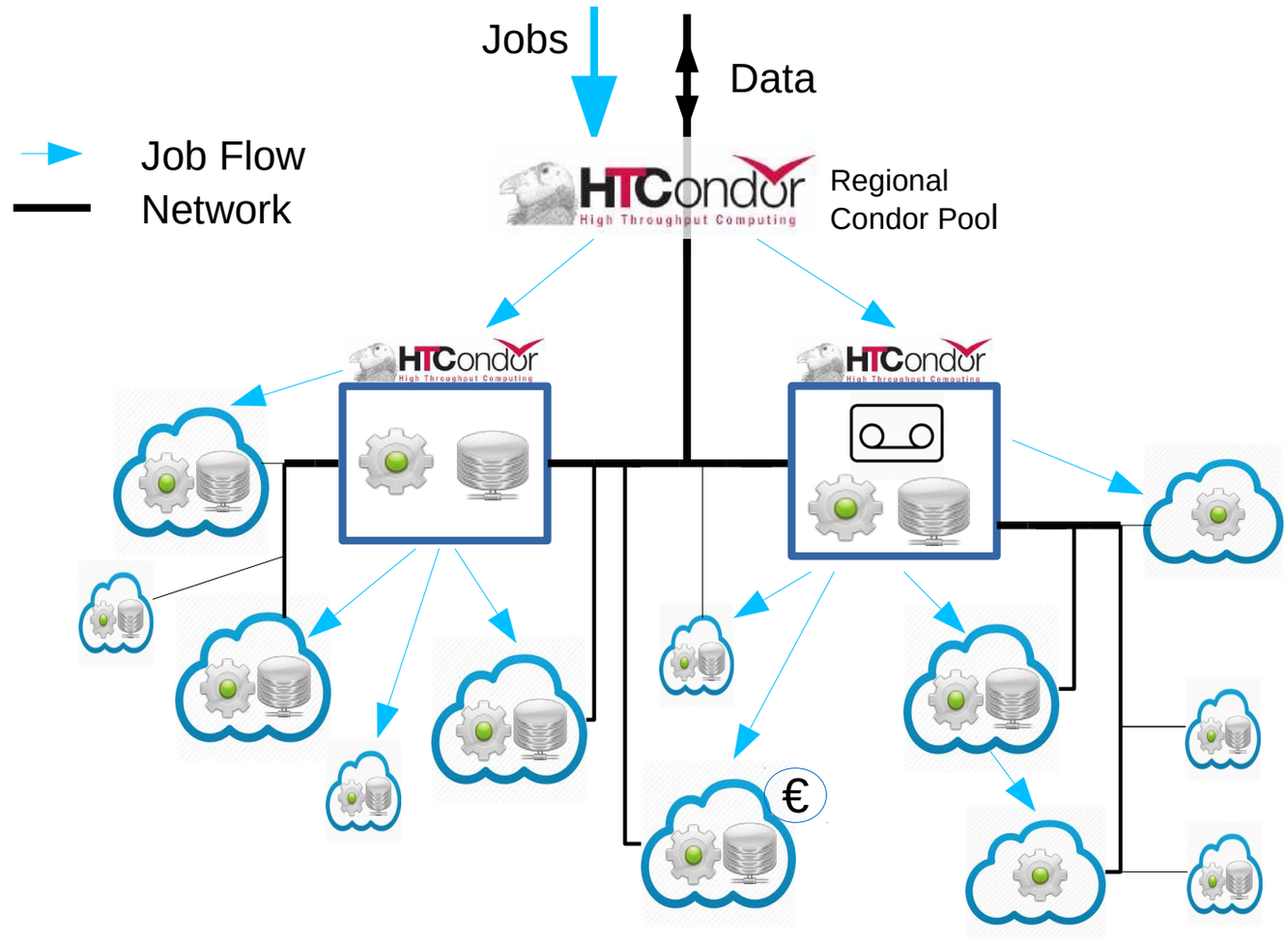


Illustration by G. Quast

- Complexity abstraction by dedicated point(s) of entry
- Jobs can be distributed using inside knowledge about integrated resource
- Possible scenario for the combined test [B4]

Subject Area A

Development of technologies to enable utilization of heterogeneous computing resources

AP 1) Werkzeuge zur Einbindung • Scheduling von Cloud - Jobs • Container - Technologien • Checkpointing • Zugang zu Experiment-Datenbanken	**AP 2) Effiziente Nutzung** • Steigerung der Effizienz von daten-intensiven Anwendungen auf hetero-genen Ressourcen mittels „on the fly“ Datencaches
AP 3) Workflow Steuerung • Identifikation und Steuerung • In - Pilot Job Monitoring • Accounting • Optimierung durch data - mining	

Contributions to Subject Area A

Aachen (associated partner):

- T2_DE_RWTH can be used for dynamic resource management tests [A1]

Bonn (associated partner):

- Dynamic resource management of T3 resources using (COBalD/TARDIS) [A1]
- Interests to join: developments and evaluation of coordinated distributed caching solutions [A2]

DESY (associated partner):

- Smart caching in WLCG data federation using dCache [A2]

Frankfurt/GSI:

- Singularity Containers to include HPC resources into Grid computing (e.g. ALICE T2@GSI) [A1]
- Developments of XRootD based coordinated distributed caching solutions [A2]

Freiburg:

- Dynamic resource management developments (COBalD/TARDIS) [A1]
- Contribute to the coordinated distributed caching solutions [A2]
- Development of monitoring, accounting tools and benchmarks [A3]

Karlsruhe:

- Development of the opportunistic resource manager COBalD/TARDIS [A1]
- Workflow management in heterogenous environments [A1]
- Development of a coordinated distributed caching solution using XRootD [A2]

München:

- Job log files analysis by using ML (anomaly detection) [A3]
- Development of XRootD based disk caching (XCache) [A2]

Wuppertal:

- Containerization of user jobs and services (VOMS, DB access, monitoring) focussing on lightweight solutions [A1, A3]

Subject Area B

Application and tests of software components in a heterogeneous environment

1) Tests der Technologiekomponenten Implementierung und Tests auf verschiedenen Plattformen von • Speicher- und Cachinglösungen und • virtualisierter Dienste (Datenbanken, Monitoring, Accounting).	**2) Job- und Ressourcenmanagement** Jobverteilung und Überwachung in der Umgebung heterogener Computingressourcen unter Einbeziehung von Containervirtualisierung.
3) Virtualisierung von Nutzerjobs • Erfassung der Anforderungen, • Bestimmung und Erzeugung der Laufzeitumgebung, • Erstellung des Containers und von Metadaten und • Checkpointing von Containervirtualisierung.	**4) Kombinierte Tests** Testen von Gesamtsystemen (Speicher, Dienste, Ressourcemanagement) auf verschiedenen Plattformen in Bezug auf • Installations- und Wartungsaufwand, • Performance, • Skalierbarkeit und • Robustheit.

Contributions to Subject Area B

Aachen (associated partner):

- Combined tests can use T2_DE_RWTH [B4]

CERN (associated partner):

- Test with RUCIO in context with Cloud/HPC and other experiments (CMS/Belle II) [B4]

DESY (associated partner):

- Tests with dCache [B4]

Frankfurt:

- Testing and documentation
  - Singularity containers for Grid jobs [B1]
  - Coordinated distributed caching [B1]
  - Combined test containers and caching [B4]

Freiburg:

- Optimize job orchestration for different combinations of heterogeneous resources [B2]
- Test complete workflow based on tools for monitoring, benchmarking and accounting [B4]

GridKa (associated partner):

- Testing dynamic resource management and disk caching solutions [B4]

München:

- Testing
  - XCache for ATLAS [B1]
  - Job log file analysis in the context of Belle II [B1, B3, B4]

Wuppertal:

- Testing container technologies
  - on different systems (T2, HPC, Cloud) [B1]
  - for virtualization of user jobs [B3]
  - in terms of reliability, scalability and performance [B4]

Overview of FTEs

Standort	A1	A2	A3	FTE	B1	B2	B3	B4	FTE
Aachen								X	-
Bonn	X			-		X	X	X	0/1
CERN								X	-
DESY		X		-				X	-
Frankfurt FIAS	X	X		0,75/1	X			X	0,5
Frankfurt IRI			X	0/0,5					
Freiburg	X	X	X	1/1,5		X		X	0,5
Göttingen								X	0/1
GSI	X	X		-				X	-
KIT/Quast	X	X	X	1/1,5	X	X		X	-
KIT/GridKa								X	-
KIT/Haungs	X			0/0,5					
München		X	X	0,5	X		X	X	0,7
Wuppertal	X		X	0,5	X		X	X	0,5/1

Subject Area A: 3,75 FTE

Subject Area B: 2,2 FTE