

# Energy efficiency with EAR

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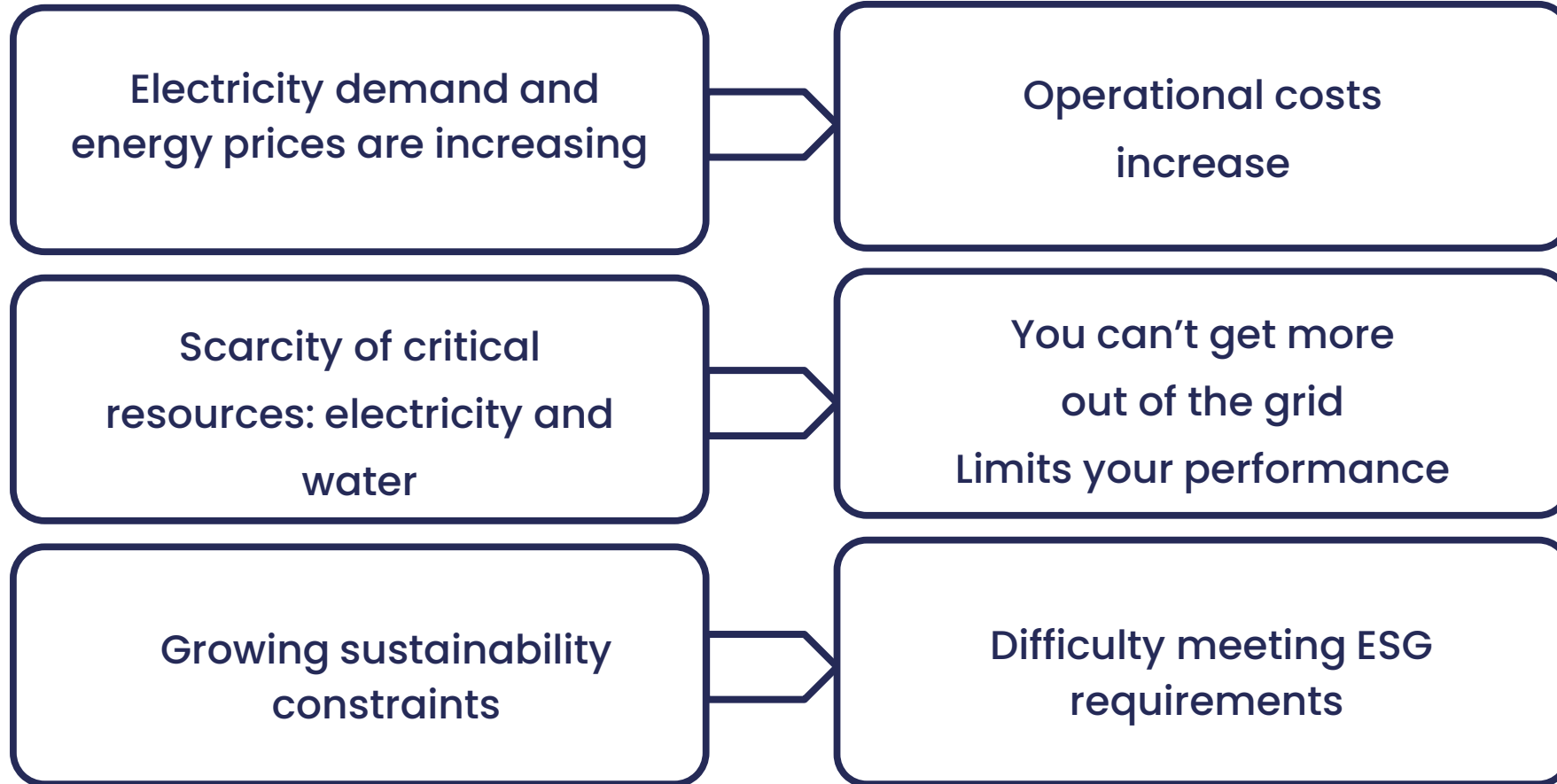
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# Outline

- Energy efficiency in Science
- The Science of EAR
- Energy Efficiency in Science with EAR

# Energy efficiency in Science

# Why energy efficiency is a scientific challenge?



# What energy-efficient science requires

EFFICIENT Data Center  
Key to the future  
Do more with less  
-20% energy OR +20% more jobs

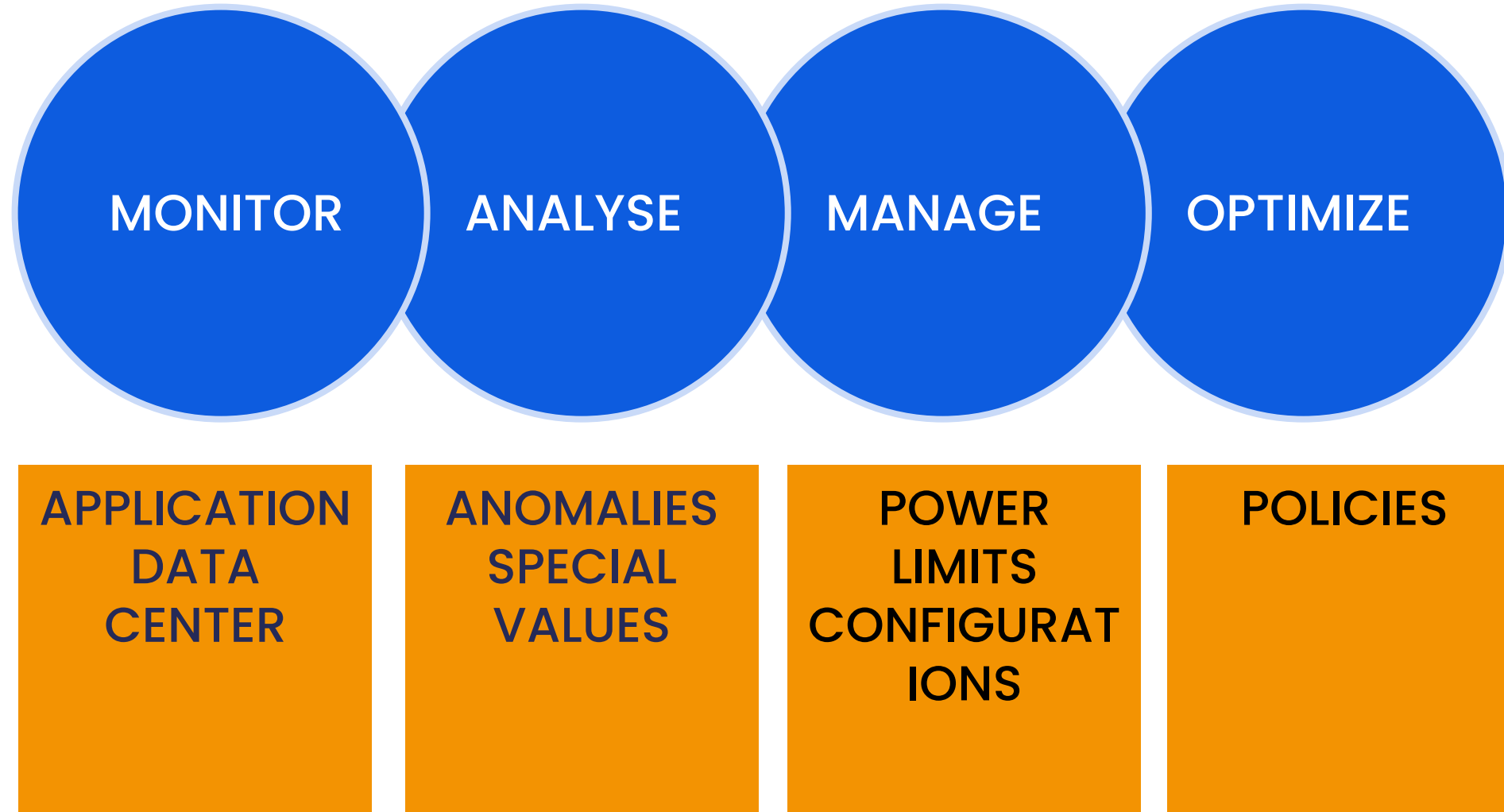
SUSTAINABLE Data Center  
Save -20% of CO2  
emission

ENERGY AWARE HPC & AI  
Monitor, manage and  
optimize

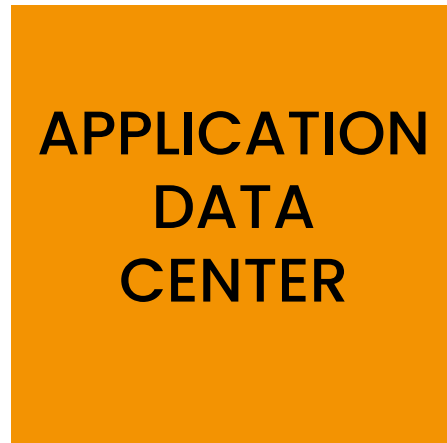
# The Science of EAR

How we do Energy monitoring, management and optimization easily and efficiently

# EAR overview: What do we do

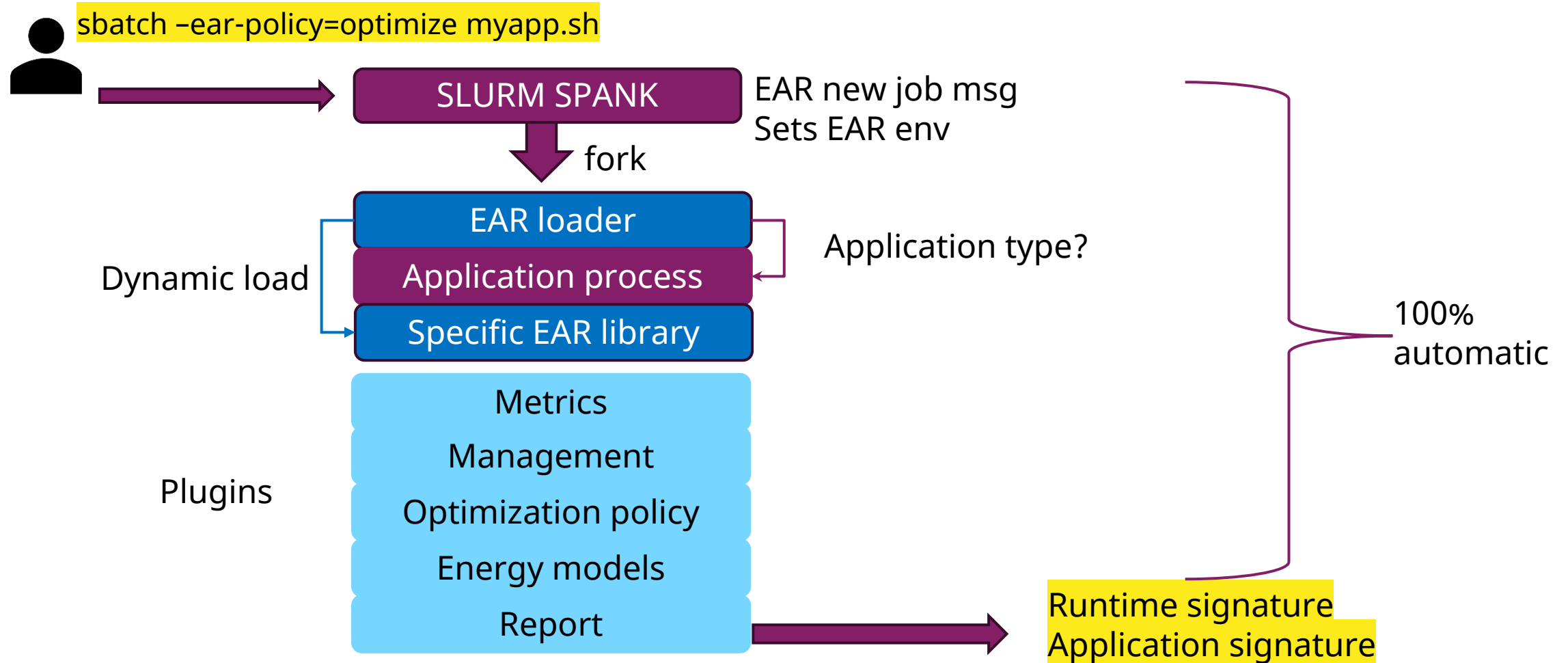


# MONITORING

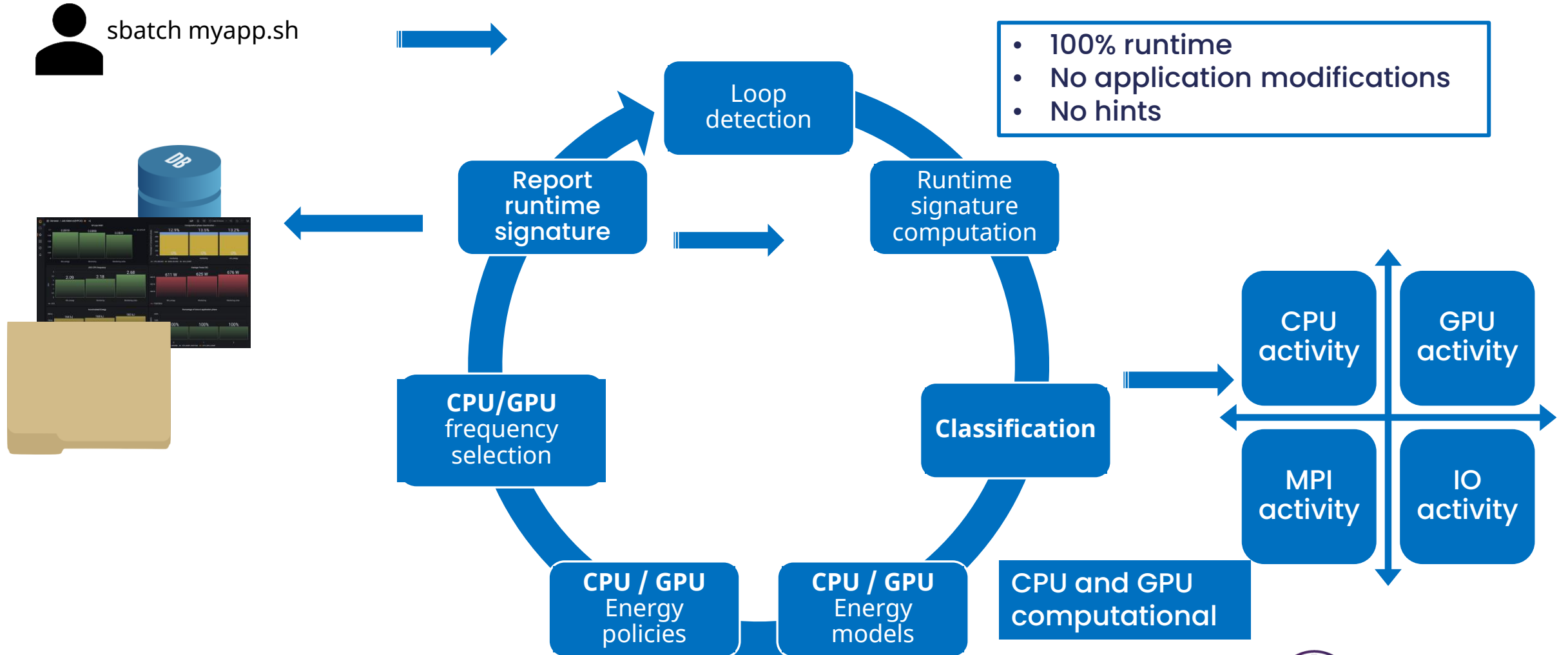


- Integracion with schedulers: SLURM, PBS-pro, K8 and own submitter (erun) for new use cases
- Homogeneous metrics, we do the effort for you
- Configurable reporting
  - Extensible
  - Lot of plugins already exist: logs, csv, mysql, pstgress, system file, etc
  - Easy to create new ones
  - Used by job, node and cluster monitoring

# Application monitoring



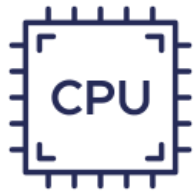
# Optimization loop



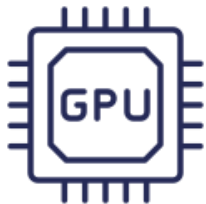
# Runtime characterization: utilization vs effective utilization

*From observation to optimization at runtime*

The key question is not whether the CPU or GPU is *used*, is **what is used for and how much energy it consumes** to do the job.... And EAR knows!

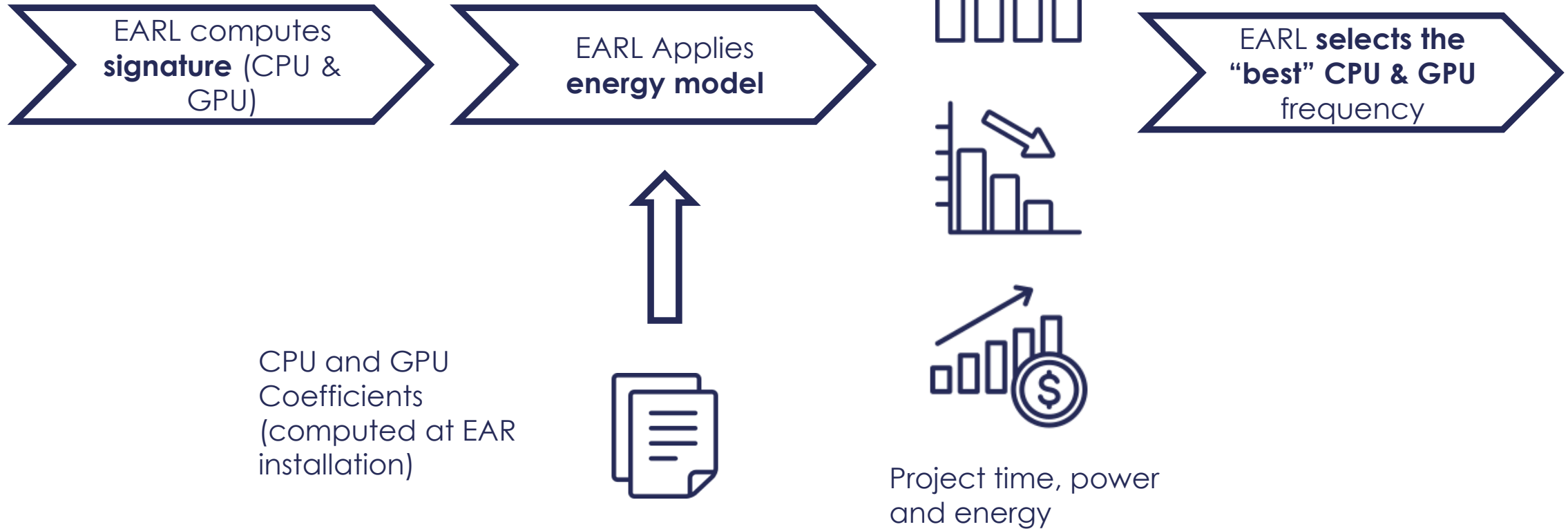


CPU activity : CPI, Memory BW, GFlops, IO, MPI  
statistics  
Power consumption: DC node power, DRAM and CPU  
power



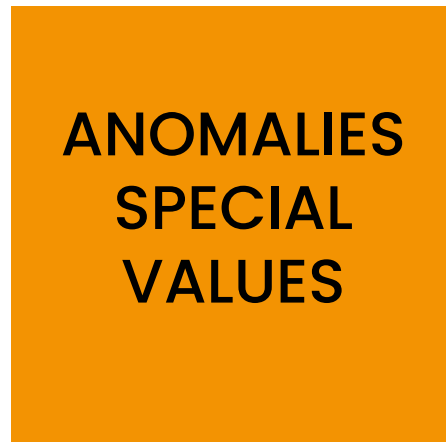
GPU activity : GPU and memory utilization, GPU  
flops (NVIDIA)  
Power consumption: DC node power, GPU power

# Energy dynamic optimization



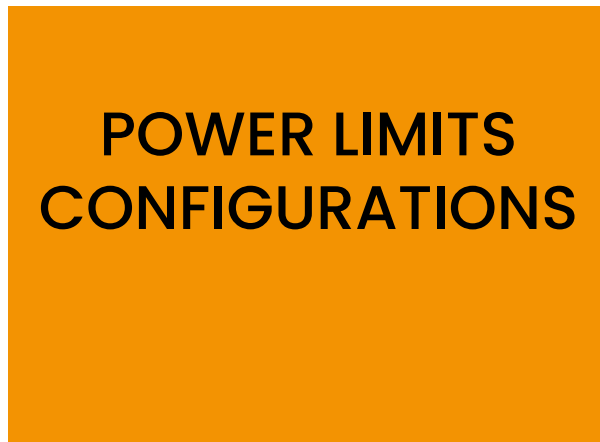
**Min\_energy\_to\_solution policy (CPU and GPU):** Minimizes the **energy with a maximum performance (time) penalty defined as threshold**

# ANALYSIS



- DATA CENTER and NODE anomaly and special detection at runtime
- Highly coupled in current architecture

# MANAGEMENT



- Highly configurable services
- Node powercap management based on plugins
- Powerful econtrol (EAR control) CLI
  - Status
  - Power monitoring
  - Power management
  - Frequency configuration
  - Policies

# OPTIMIZATION



- Optimization policies based on policy plugins (Not easy to extend but doable)
- Energy models based on plugins
  - CPU
  - GPU

# Energy Efficiency in Science with EAR

The roadmap to help Science to be more energy efficient

# MONITORING



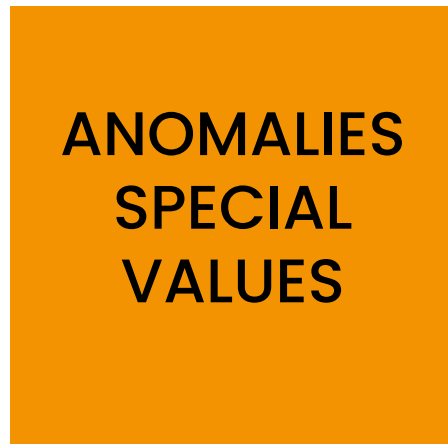
APPLICATION  
DATA CENTER

- CPU and GPU homogeneous and automatic monitoring for your applications
- Supported at user level
- Limited features for user-level only runs (no services) but still valid for homogeneous evaluation

## ROADMAP:

- New/Update API to create external tools based on EAR monitoring and management for workflow/applications monitoring (and management, optimization)
- More scenarios (for example ) applications and workflows with “submitters”

# ANALYSIS



- Highly coupled in current EAR architecture inside EAR services

## ROADMAP:

- Use EDCMON service (EAR Data Center Monitoring service)
- Reporting is already very flexible
- Extend the approach used in Cluster power monitoring to other metrics and scopes
  - Metric
  - Values
  - Actions

# MANAGEMENT



POWER LIMITS  
CONFIGURATIONS

- Current architecture is powerful but very complex to modify or extend because it is encoded in the service itself

## ROADMAP:

- System power policies based on plugins
- Node power policies based on plugins
- Move also to EDCMON new service

# OPTIMIZATION



- Maintain the optimization loop
  - Monitoring → Understanding → Optimize
- Move from the highly couple current solution to a more configurable and extensible solution
- **ROADMAP**
  - Maintain the philosophy
  - Move to external third party tools
    - Monitoring API
    - Management API

## Just try it.....

```
git clone git@github.com:eas4dc/  
cd EAR  
export CONFIG_SITE=ear.site  
autoreconf -i  
./configure && make full && sudo  
etc.install && sudo make doc.ins  
installed"
```


```
#!/bin/bash  
export EAR_VERSION=6.0.odissee  
export INSTALL_ROOT=/opt/EAR  
export INS_PATH=$INSTALL_ROOT/ear$EAR_VERSION  
export EAR_TMP=/var/ear  
export EAR_ETC=$INS_PATH/etc  
prefix=$INS_PATH  
docdir=$INS_PATH/doc  
CC=gcc  
CFLAGS="-Wall -O1 -g"  
MPICC=mpicc  
OMPI_CC=gcc  
OMPI_CFLAGS="-Wall -O1 -g"  
with_slurm=no  
enable_mpi=no  
USER=ear  
GROUP=ear
```

```
erun --ear=on --ear-verbose=1 -ear-user-db=my_metrics --program="./bt.C.x"
```



**ODISSEE**

Online Data Intensive Solutions  
for Science in the Exabytes Era

 [Odissee-project.eu](http://Odissee-project.eu)

 [ODISSEE Project](#)

