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Performance Optimization of Gaia Operational Simulator using PCOF & PDES Methodologies

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Outline

What are we going to see…

- Overview
- Parallel Discrete Event Simulation engine (PDES)
- Performance Control & Optimization Framework (PCOF)
- Test cases in Gaia
  - Benchmarking Evaluation
  - Parallelization
  - Code optimization

Why

Why all this…in a nutshell

- Reduce development risks
- Set development guidelines
- Monitor & proactively control performance
- Improve code implementation
- Achieve parallelization
- Enhance load-balancing
- Take advantage of modern CPUs
- Achieve architecture improvements

How

How do we achieve our goal…

Performance Control

- Identify use-cases
- Define performance metrics
- Perform measurements
- Correlate results
- Compose user-friendly report

How

How do we achieve our goal…

Performance Optimization

- Analyze results
- Evaluate performance
- Investigate code inefficiencies
- Focus on parallelization possibilities
- Implement optimizations

Solution

How do we achieve our goal…

Performance Control & Optimization Framework (PCOF)

Conservative Parallel Discrete Event Simulation Scheduler (C-PDES)

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PDES

Major Features…

- SIMSAT kernel component
- Compatibility with current scheduler
- Support for Master/Site kernel architecture
- Parallel execution: OS processes and threads
- Easily Configurable
- Open synchronization: user policies
- Optimized communication mechanisms (CORBA, shared memory)
- Causality error policies
- Real-time slip policies

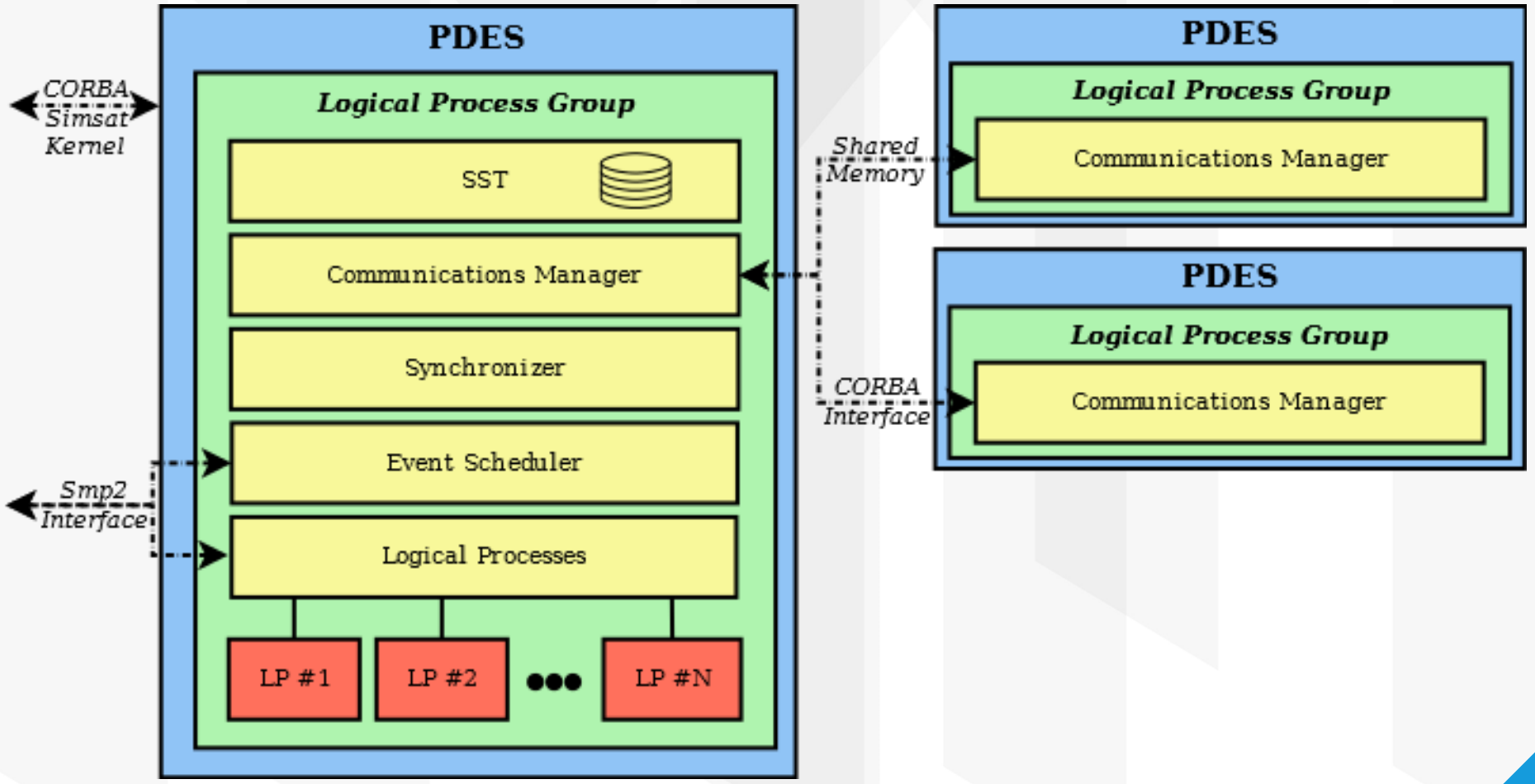
PDES

Components

- Logical Process Group (LPG)
- Logical Process (LP)
- Synchronizer (SYN)
- Event Scheduler (ES)
- Scheduling Scheme Table (SST)
- Communication Manager (CM)

PDES

Structure…



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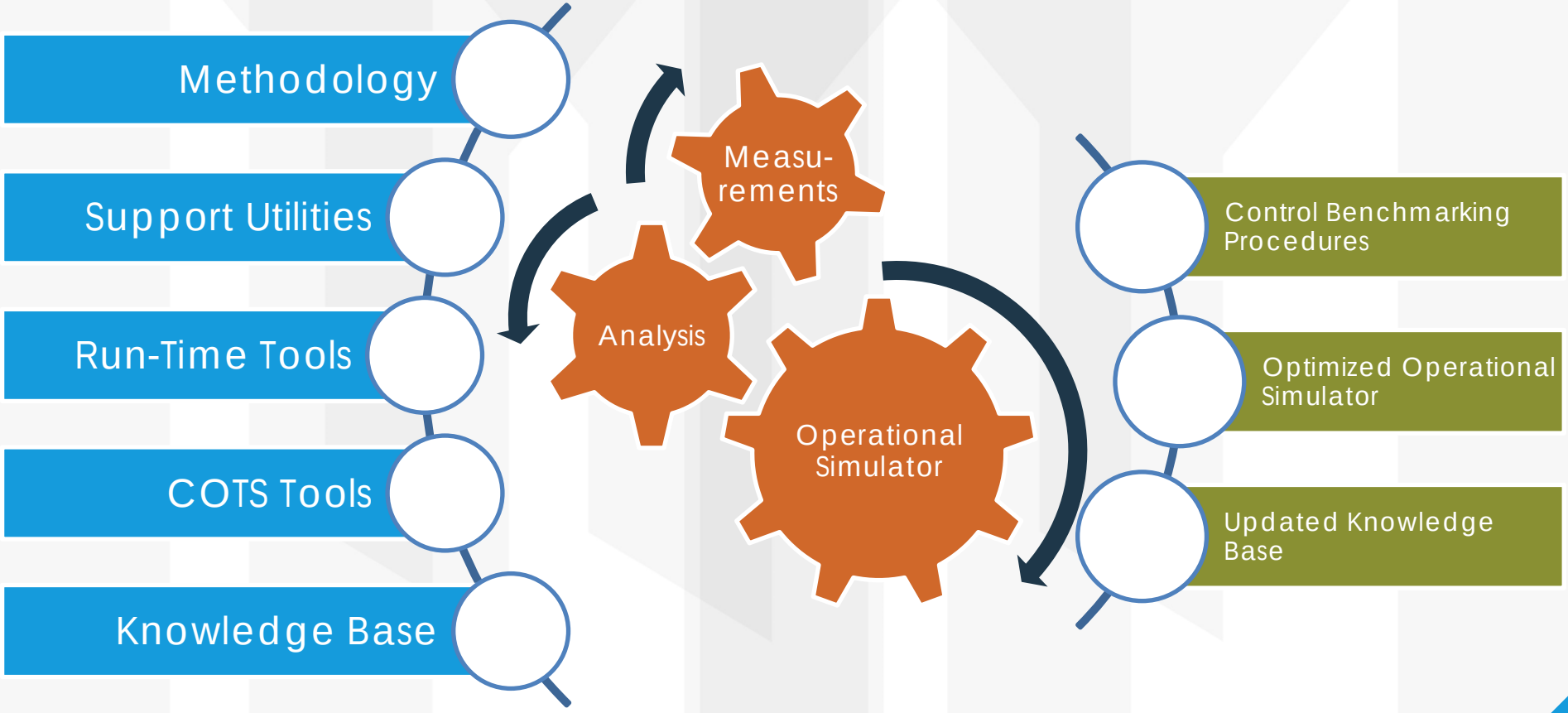
PCOF

Methodology: Components & Operations



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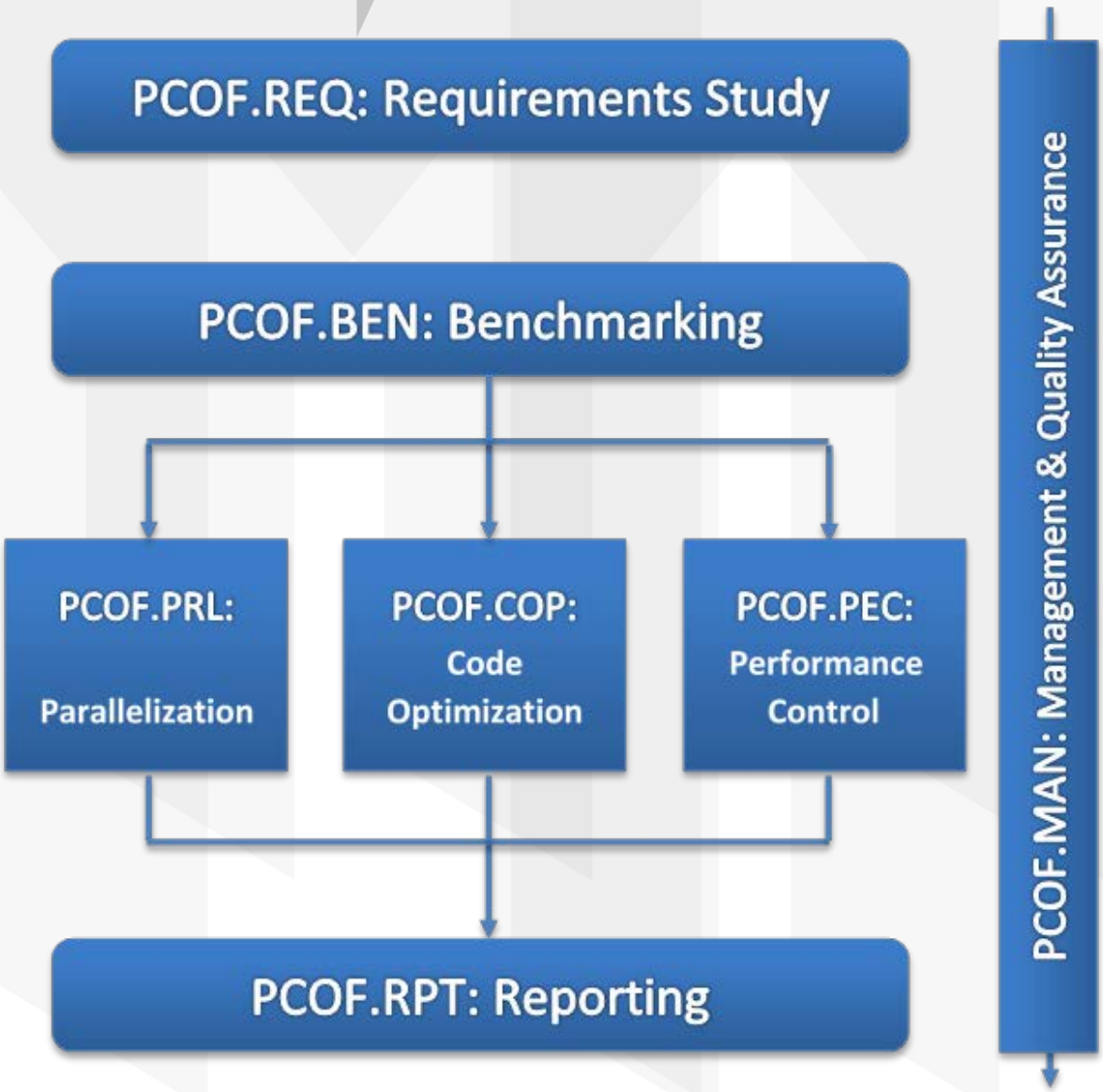
Methodology: Workflow



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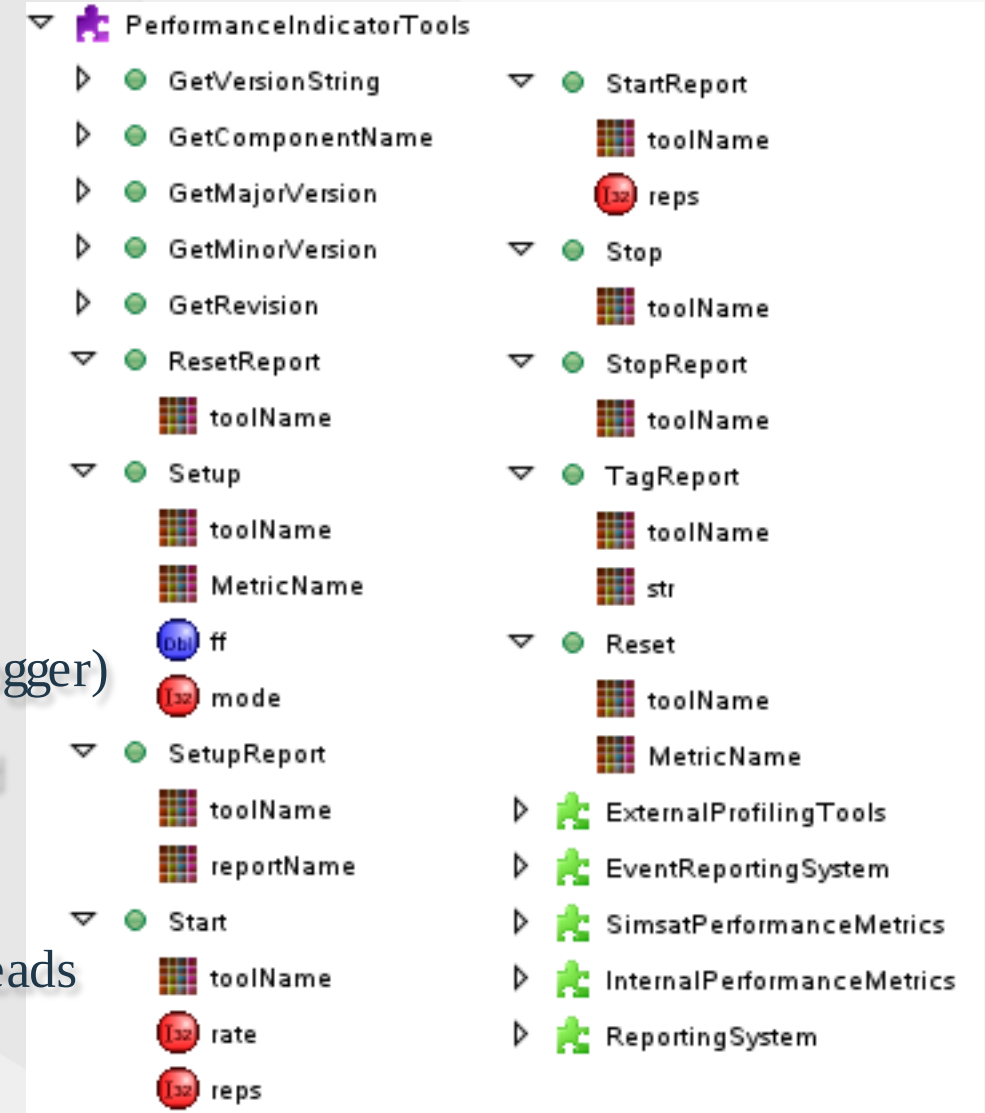
- External Profiling Tools (EPT)
- SIMSAT Performance Metrics (SPM)
- Internal Performance Metrics (IPM)
- Event Reporting System (ERS)
- Reporting System (RPT)

PCOF

Major Features…

- SIMSAT Integration
  - Visible in SIMSAT tree
  - Used from ScriptHost
  - Seamless communication with other SIMSAT components (e.g. Logger)
  - Measurements may be displayed in SIMSAT AND & GRID
- Running concurrently in different threads



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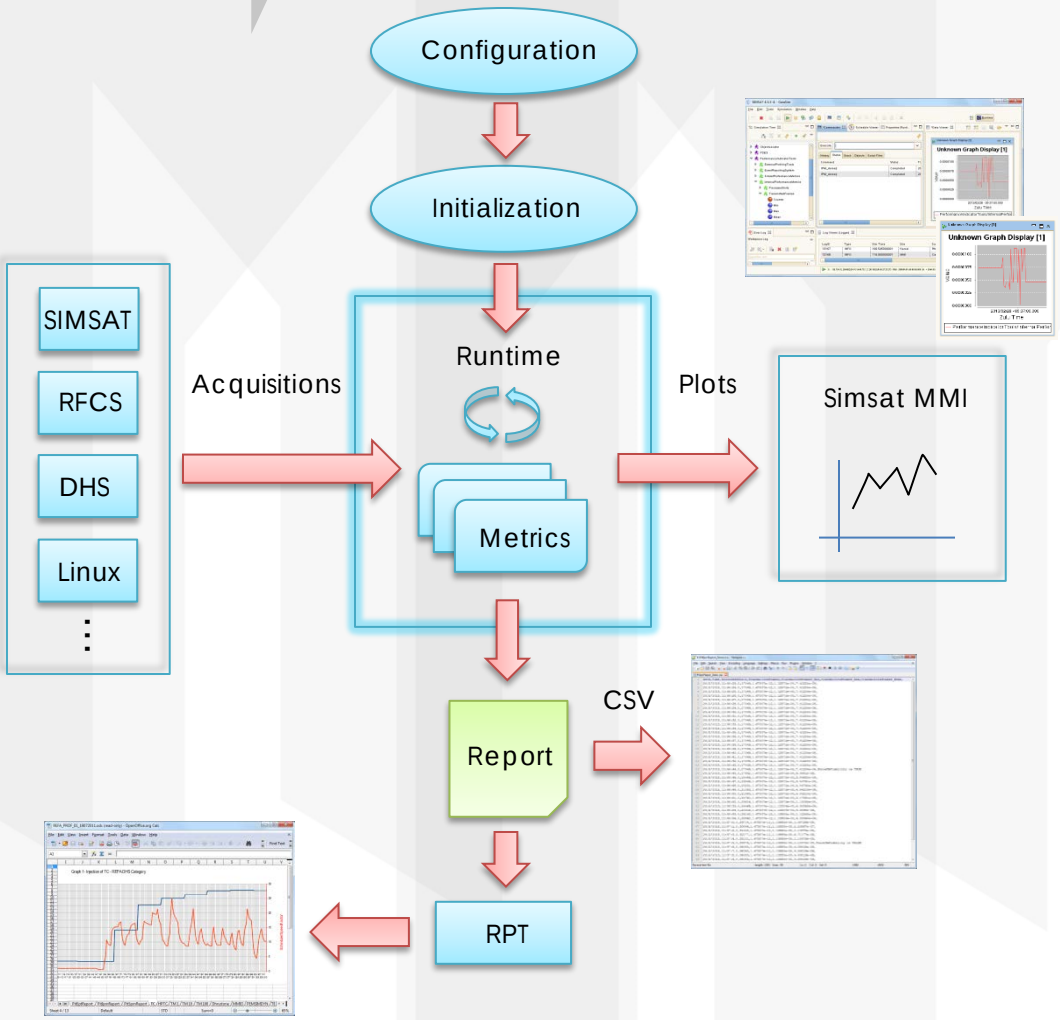
PCOF

Run-time tools: Base of operation



Test cases

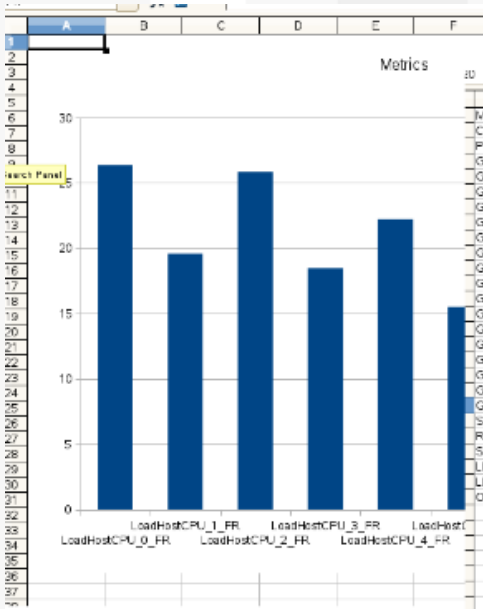
Application in Gaia…

- Benchmarking
- Parallelization
- Code optimization

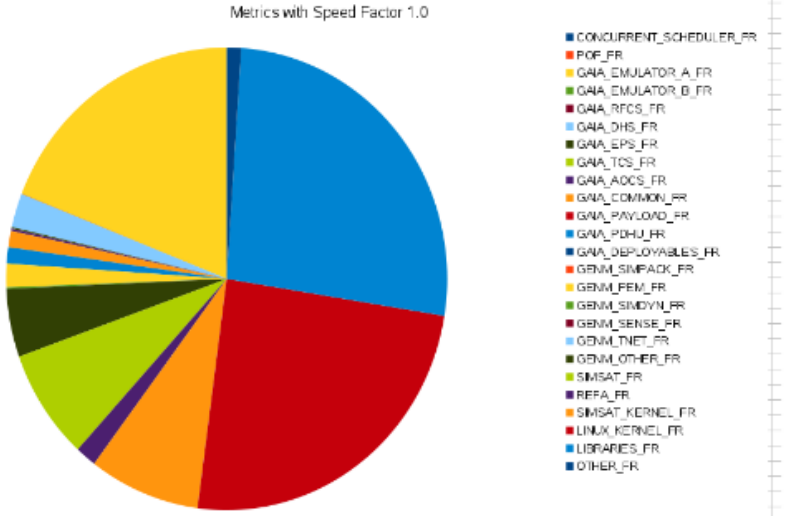
Use Case 1

Benchmark

- Initial Performance evaluation
- Tools used: EPT, RPT



Metric	Mean Value	Max	Sum	Mean	StdDev
CONCURRENT_SCHEDULER_FR	0	0	0	0	0
POF_FR	NaN	0	0	NaN	NaN
GAIA_EMULATOR_A_FR	16.4573881868	19.2466	2995.24465	16.4573881868	1.8680604218
GAIA_EMULATOR_B_FR	8.74450549450549E-006	0.0003183	0.0015915	8.74450549450549E-006	5.21714962876496E-005
GAIA_RFCS_FR	0.0186090902	0.0206885	3.3869526	0.0186090902	0.00149617
GAIA_DHS_FR	2.0555006044	2.34616	374.10111	2.0555006044	0.1674635196
GAIA_EPS_FR	0.083113211	0.104356	15.1266044	0.083113211	0.0109492624
GAIA_TCS_FR	0.0096594537	0.0139141	1.75802057	0.0096594537	0.0018101896
GAIA_AOCS_FR	0.1395960027	0.154487	25.4064725	0.1395960027	0.0132172045
GAIA_COMMON_FR	0.9827896868	1.11458	178.867723	0.9827896868	0.0857243592
GAIA_PAYLOAD_FR	0				
GAIA_PDHU_FR	0.9827896868				
GAIA_DEPLOYABLES_FR	0				
GENM_SIMPACK_FR	0				
GENM_PEM_FR	1.4210858242				
GENM_SIMDYN_FR	0.1004361896				
GENM_SENSE_FR	0				
GENM_TNET_FR	0				
GENM_OTHER_FR	4.1228012837				
SIMSAT_FR	6.6963315385				
REFA_FR	1.3298382143				
SIMSAT_KERNEL_FR	7.0591271978				
LINUX_KERNEL_FR	21.2506879121				
LIBRARIES_FR	22.9535626374				
OTHER_FR	0.9081131154				



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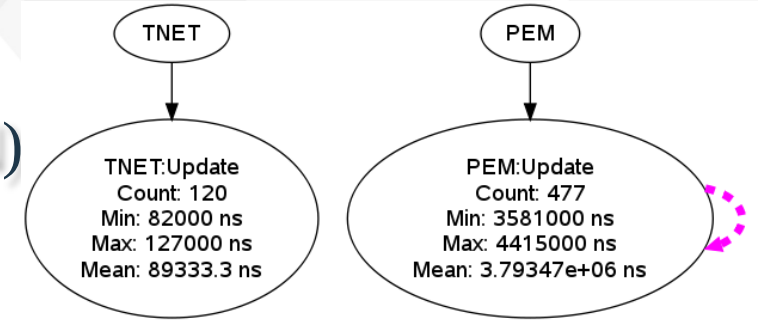
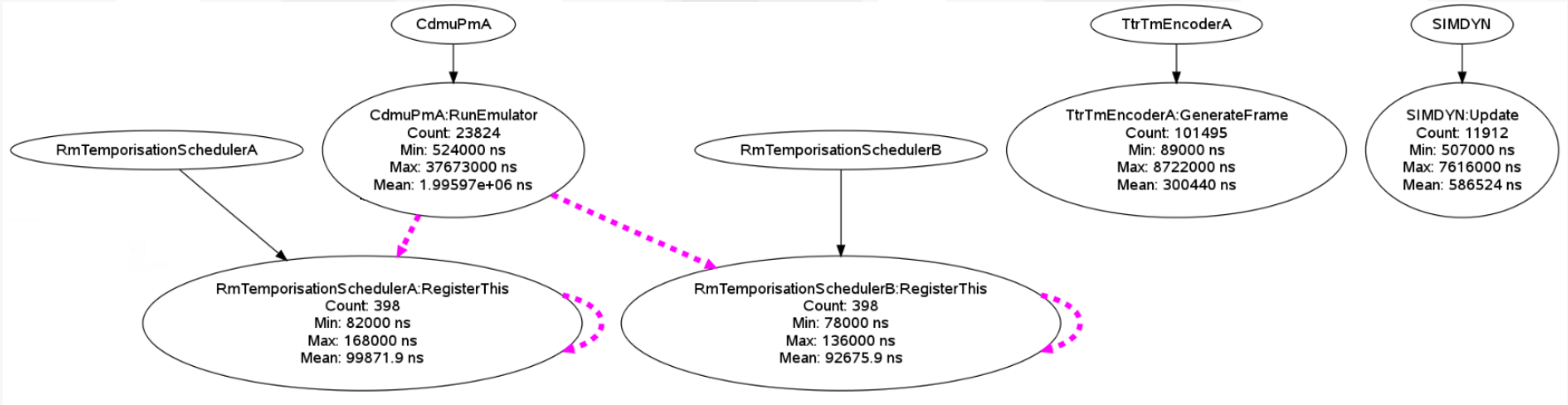
Use case 2

Parallelization

- Telemetry Module
- Generic Models (PEM, TNET, SIMDYN)
- Tools used: ERS, RPT





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Use case 2

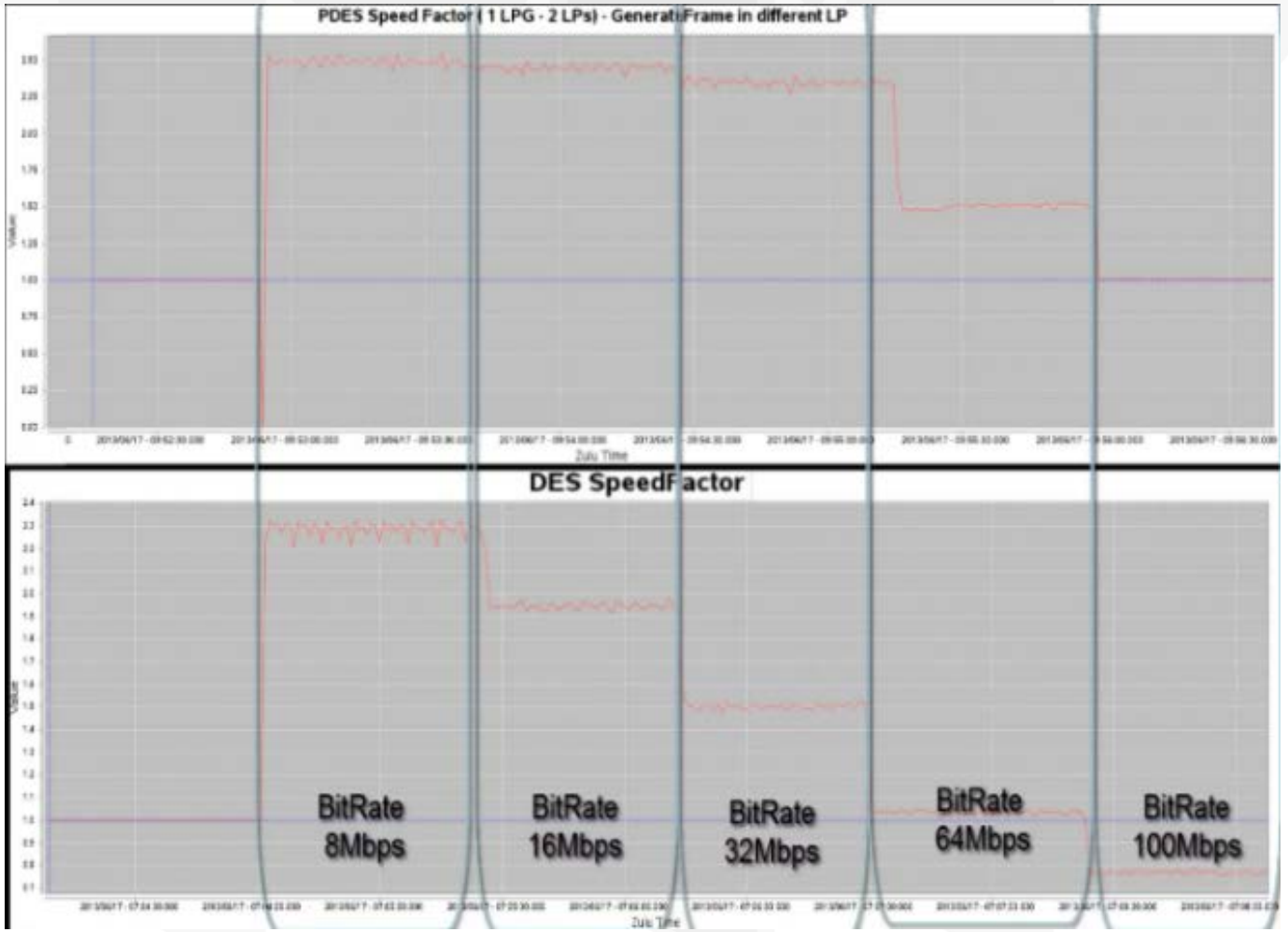
Parallelization

Configuration: SST.xml

```
<LPG>
    <Name>Master</Name>
    <Node>192.100.1.1:2709</Node>
    <LPS count="2">
        <LP>
            <Name>TestLP1</Name>
            <Events count="0">
            </Events>
        </LP>
        <LP>
            <Name>TestLP2</Name>
            <Events count="1">
                <Event>
                <Name>TtrTmEncoderA:GenerateFrame</Name>
                <ERP>REJECT</ERP>
                </Event>
            </Events>
        </LP>
</LPG>
```

Use case 2

Parallelization



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Use case 2

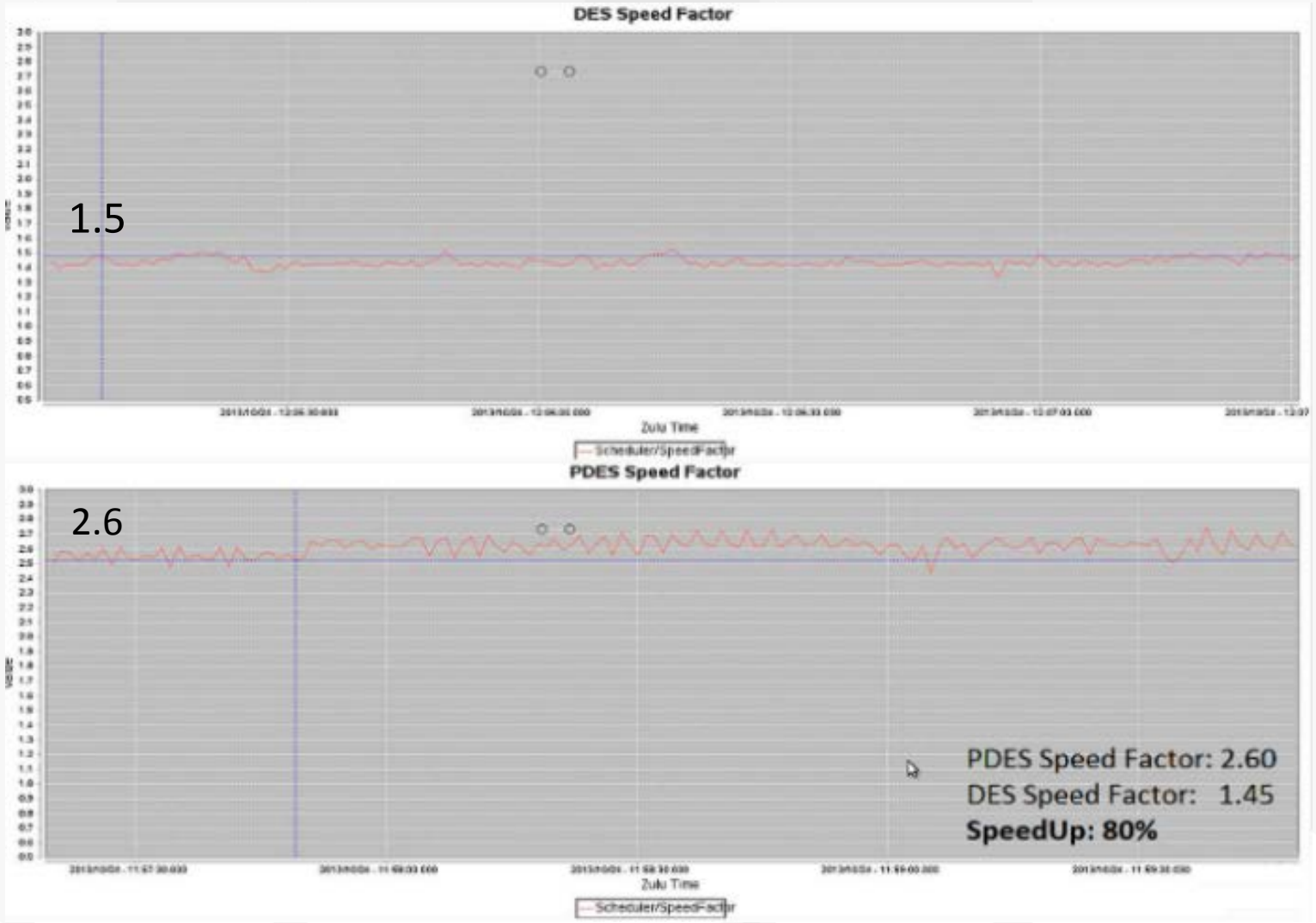
Parallelization

- Configuration: SST.xml

```
<LPG>
    <Name>Master</Name>
    <Node>192.100.1.1:2709</Node>
    <LPS count="3">
        <LP>
            <Name>TestLP1</Name>
            <Events count="0">
            </Events>
        </LP>
        <LP>
            <Name>TestLP2</Name>
            <Events count="1">
                <Event>
                <Name>TtrTmEncoderA:GenerateFrame</Name>
                <ERP>REJECT</ERP>
                </Event>
            </Events>
        </LP>
        <LP>
            <Name>TestLP3</Name>
            <Events count="3">
                <Event>
                    <Name>PEM:Update</Name>
                    <ERP>REJECT</ERP>
                </Event>
                <Event>
                    <Name>TNET:Update</Name>
                    <ERP>REJECT</ERP>
                </Event>
                <Event>
                    <Name>SIMDYN:Update</Name>
                    <ERP>REJECT</ERP>
                </Event>
            </Events>
        </LP>
</LPG>
```

Use case 2

Parallelization



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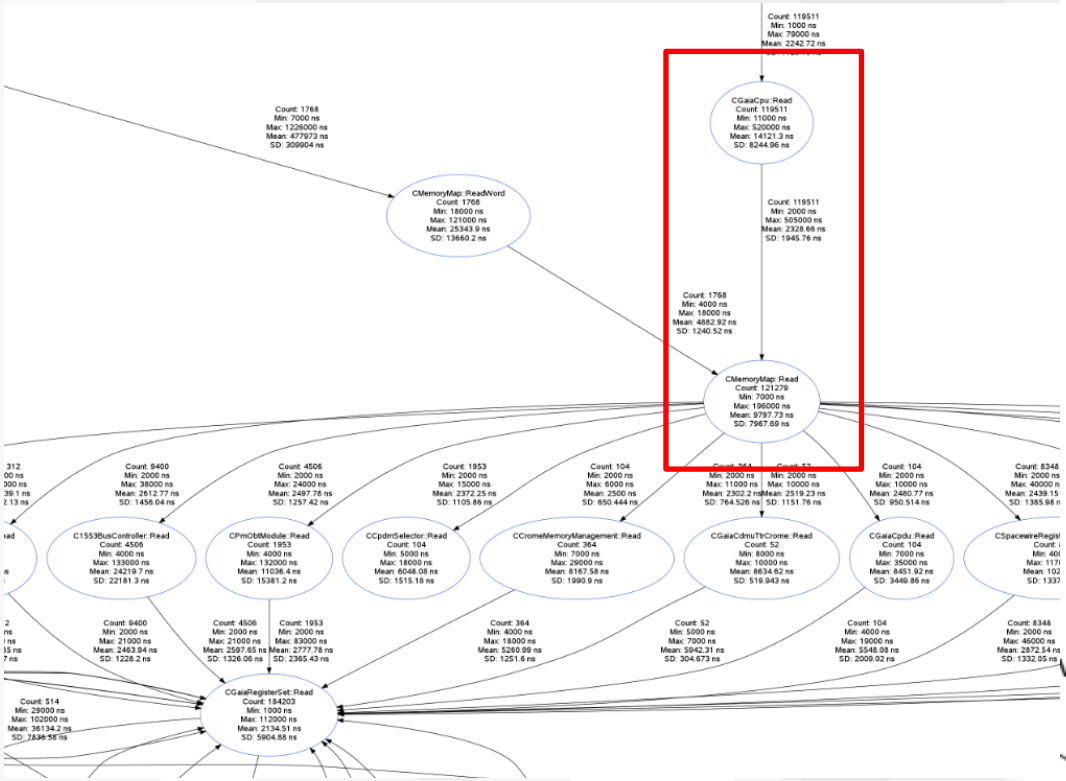
Use Case 3

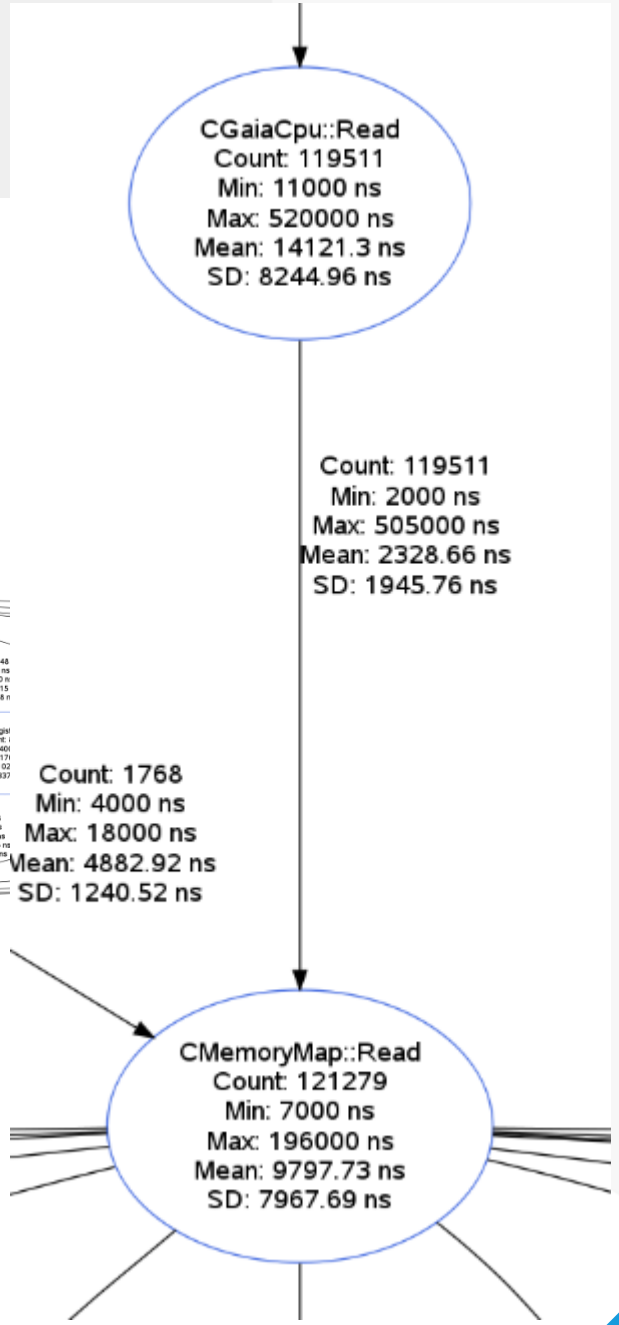
Code optimization

- Independent procedure
- Detect possible poor implementation
- Tools used: ERS, IPM, RPT
- Steps:
  - Define and implement IPM metric
  - Develop benchmark
  - Execute benchmark
  - Apply improvement
  - Execute benchmark again
  - Comparisons

Use Case 3

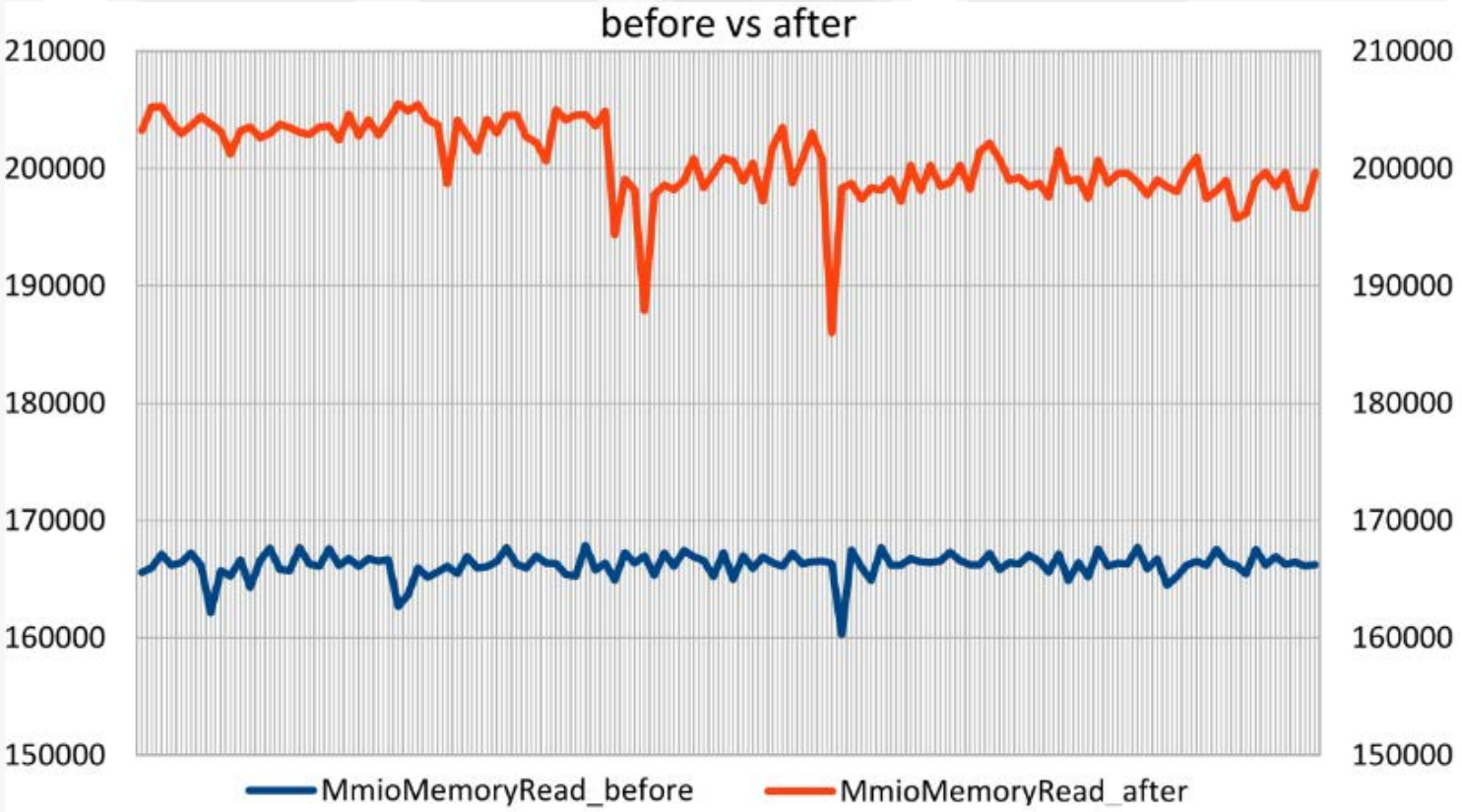
Code optimization





Use Case 3

Code optimization

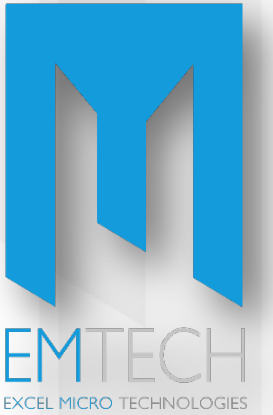


Conclusion

Summing up…

- PDES based on conservative approach
- PCOF procedure is independent
- PCOF utilization during actual operational simulator development

Thank you



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