SAMARA UNIVERSITY

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STUDY OF THE APPLICABILITY OF THE EVENT LOG-BASED METHOD FOR THE IMPLEMENTATION OF FAULT-TOLERANT AND SELF-BALANCED COMPUTATIONS

1. **Motivation.**

2. **Architectural features of the studied distributed application:**
   - "traditional" many-task application architecture;
   - architecture for many-task computing based on the event log;
   - advantages of the studied architecture.

3. **Computational experiments:**
   - model problem;
   - simulation experiment using Templet SDK;
   - load test using Templet SDK and Everest platform.

4. **Conclusion, future work.**

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With the growth in the amount of computing (**AI, big data, computer simulation**), there is a need for programs that can be deployed on hybrid environments consisting of an arbitrary set of **non-dedicated** network computing resources.

❑ **Volunteer computers**, as in the BOINC project or other voluntary distributed computing projects.

❑ **Temporarily idle corporate computers** that are potentially available over the network to solve production problems.

❑ **Temporarily free computing nodes** of high performance supercomputer or cluster systems.

❑ **Free or low cost virtual machines** (spot VMs) from cloud providers.

Examples of considered network resources

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The use of **hybrid environments makes it possible to**

❑ **reduce the cost of computations,**
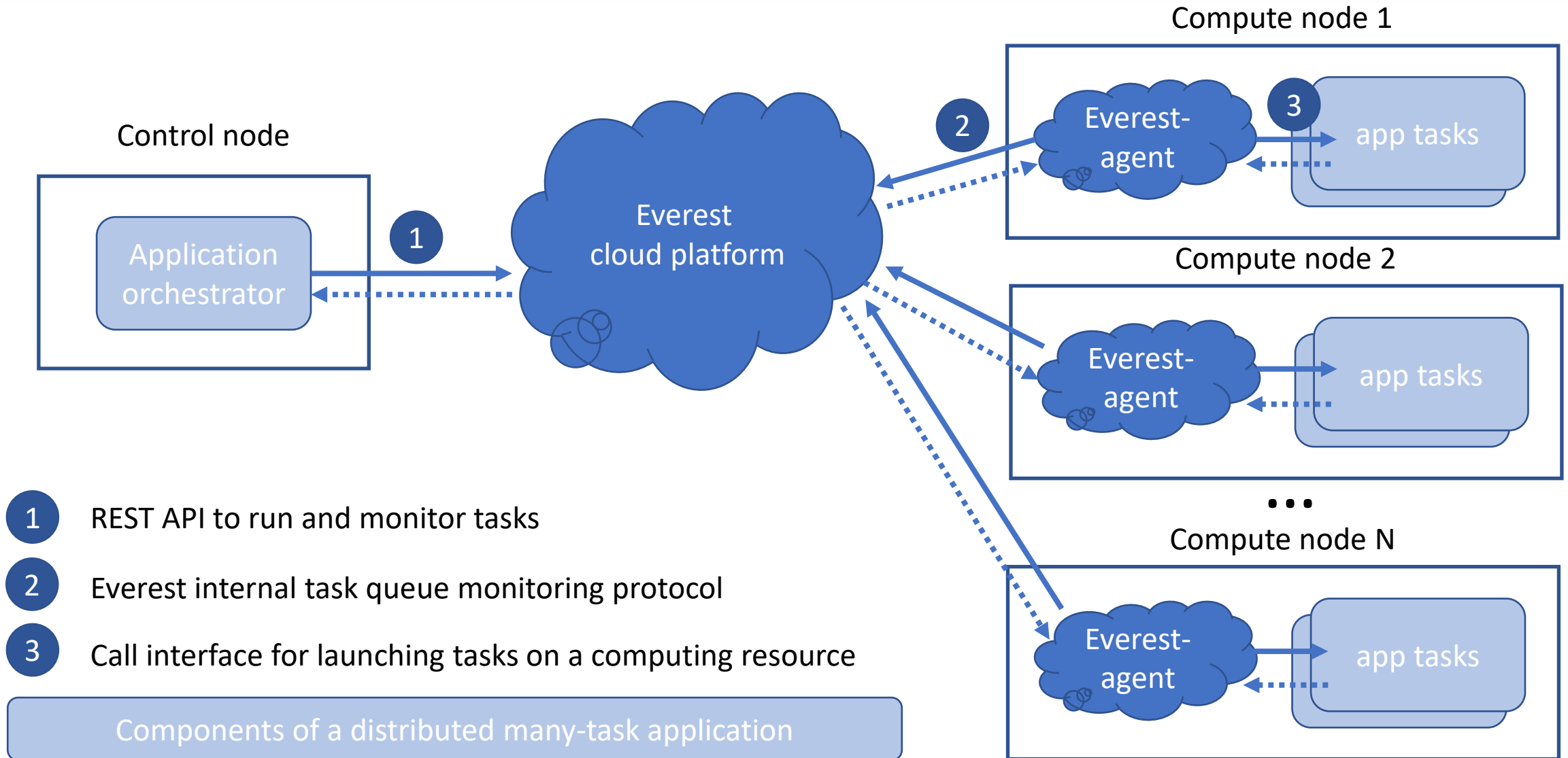
❑ **achieve their high performance.**

Key **challenges in application programming** for hybrid environments:

❑ **fault tolerance,**

❑ **load balancing.**

Due to the specifics of the hybrid environment, the application, and not its computing environment (for example, the cloud due to hardware virtualization), must solve the listed problems.
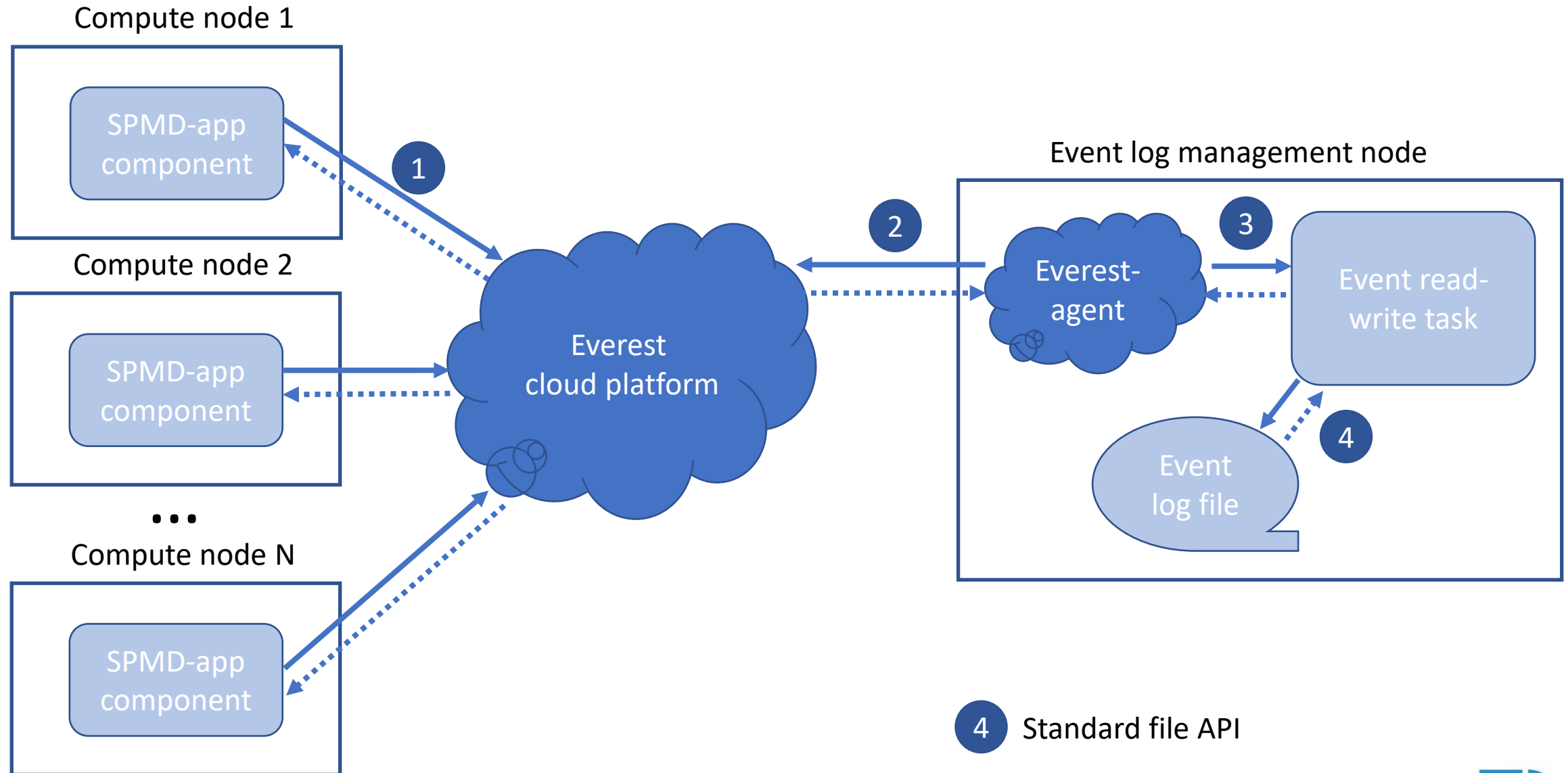
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1 REST API to run and monitor tasks

2 Everest internal task queue monitoring protocol

3 Call interface for launching tasks on a computing resource

Components of a distributed many-task application

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From the perspective of the organization of calculations

❑ Convenience of rapid deployment of SPMD application components on non-dedicated computing resources (**resource agent is not required**).

❑ Improved fault tolerance and ability to live migrate application code from one event log management node to another (**by copying the event log file**).

From the perspective of Templet project development

❑ Using the simpler and more common message broker logic from commercial applications instead of the task logic (**writing and reading the event log**).

❑ An architecture with an event log is more convenient for integration with third-party code.

❑ The architecture is "**blockchain compatible**".

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Given:

- ❑ arbitrary number of independent tasks (in experiments it varies from 10 to 50 with a step of 10), solved in 10 processes;
- ❑ for each process, a certain random order is defined in which it will solve problems;
- ❑ the calculation time of one task is determined (in experiments it changes from 10 to 50 seconds with a step of 10 seconds).

Find:

- ❑ how to solve each task in at least one process;
- ❑ how to ensure that all processes agree on a single order in which task solutions will be obtained (using the event log);
- ❑ estimation of the speedup of task calculation by 10 processes in the absence of communication trade-off;
- ❑ estimation of the speedup of task computations by 10 processes in the presence of communication trade-off.

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Simulation experiment.

- ❑ The simulation model is implemented using the **Templet SDK**.
- ❑ Programming language – **C++, Cling**.
- ❑ Development environment – **JupyterLab** notebook, cloud deployment using **Binder**.

Load experiment.

- ❑ Programming language – **C++**, **GCC**.
- ❑ Middleware – **Everest** platform, IITP RAS.
- ❑ Communication with the platform – **Templet SDK** (**libcurl**, **Everest REST API**).
- ❑ Deployment – a virtual spot machine (**OVHcloud**) using **Binder** service.

The event log process and computing processes are deployed on the same virtual machine to create the potentially largest load on the communication system.

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The duration of one task, sec	Number of tasks, pcs.				
	10	20	30	40	50
10 .. 50 – on the simulator	3.33333	4.0	5.0	5.71429	5.55556
10 - the best on the stand	1.69079	2.59185	4.38909	2.93101	3.2502
10 - the worst on the stand	1.23553	2.02957	3.34938	2.84712	3.19064
20 - the best on the stand	2.96925	4.35777	4.40018	5.8736	5.48895
20 - the worst on the stand	2.23945	3.44074	3.73296	4.97036	5.42627
30 - the best on the stand	3.09111	3.71213	5.48899	6.07871	5.70073
30 - the worst on the stand	3.0209	3.62881	4.55871	5.20853	5.09511
40 - the best on the stand	4.72322	4.63342	5.60457	6.16455	5.84823
40 - the worst on the stand	3.04433	3.71611	4.66365	5.29505	5.21234
50 - the best on the stand	3.18491	4.722	5.65974	6.32544	5.93804
50 - the worst on the stand	3.1375	3.77058	4.72567	5.40605	5.28163

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1) The study shows that the **method** of calculations based on the event log
   allows you to

- ❑ successfully solve the problem of fault tolerance,
- ❑ load balancing,
- ❑ and provides speedup of calculations.

Method limitation – excessive amount of calculations, which is not essential in case of availability and low cost of computing resources.

2) The considered **method** of organization of calculations **can be adapted for**

- ❑ applications with a dynamically generated set of dependent tasks,
- ❑ implementations based on blockchain technology.

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http://templet.ssau.ru/wiki - wiki and educational resources of the Templet project

https://github.com/the-templet-project - Templet SDK x3 - current version

https://github.com/the-templet-project/templet/tree/master/samples/blchsym
– code and experiment results

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THANK YOU FOR YOUR ATTENTION !

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