Dynamic Adaptation to the Context in Grid Computing

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SUMARY

Central Objective

To design a mechanism for controlling the adaptations to the context of component-based applications in the Grid Computing, considering monitored informations, semantic informations and inferences from these same informations.

EXEHDA-DA: Overview

Collaborative Multi-level Adaptation

EXEHDA-DA has the following operational steps:

1. At the application level:
   - Development time:
     - definition and creation of ontologies for Policy of adaptation of the application and context of interest in the application (FWADAPT);
     - programming adaptive commands in the codes of the components;
   - Runtime:
     - activation of adaptive commands, through communication with the middleware EXEHDA.

2. Level of service EXEHDA-DA (middleware):
   inference and decision by type of adaptation to the context, at level of application component.

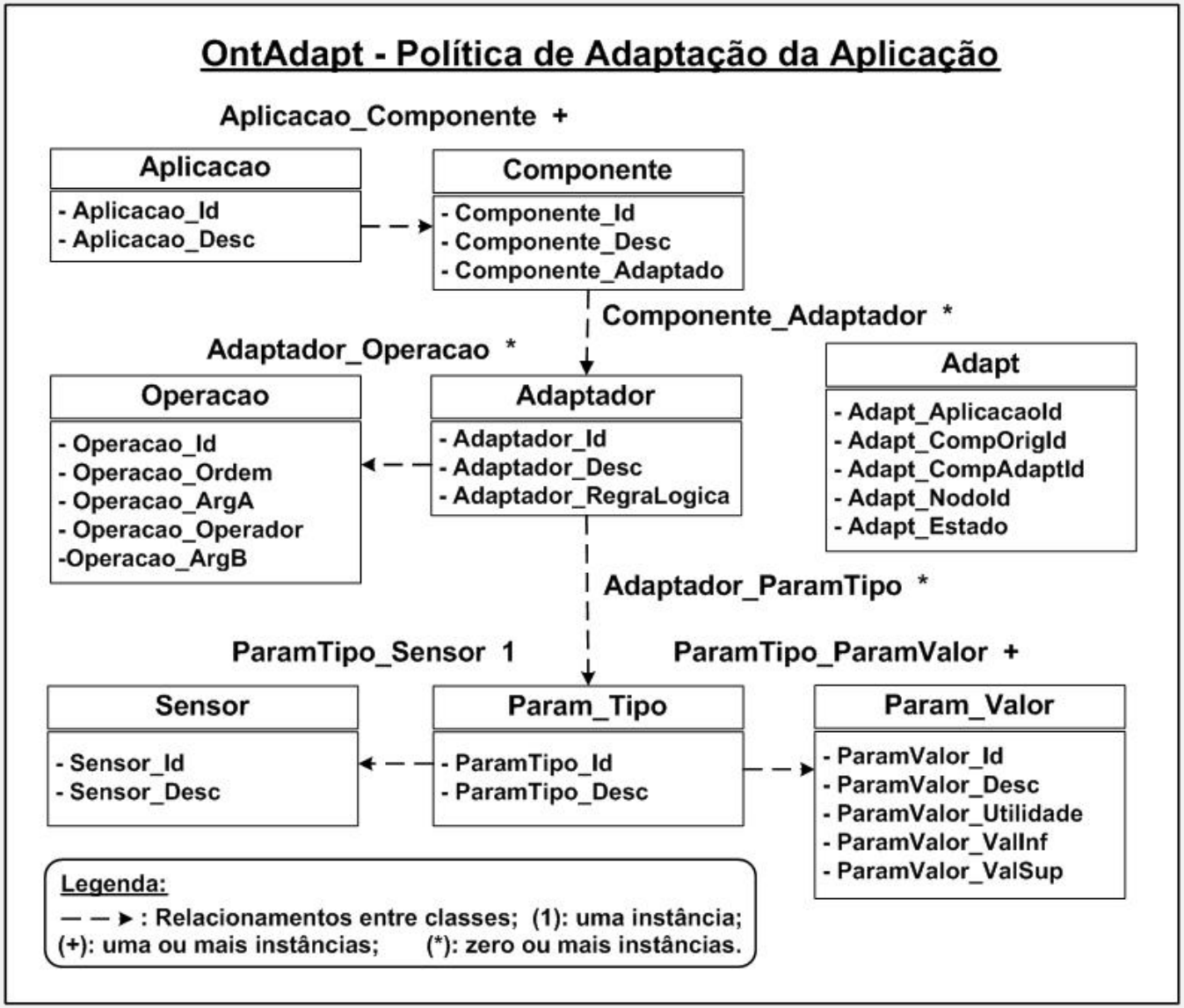
EXEHDA-DA: Overview - Main Features

- an adaptation mechanism used in runtime, for all applications and the middleware itself;
- support for functional and non-functional adaptations;
- individualized definition of adaptations to the components of application, using their context of interest;
- a semantic model for the defining the policy of adaptation of the application with the rules, parameters and utility functions for the adaptations;
- inference the adaptation decision using policy of adaptation of the application, context changes and user preferences;
- an incremental evolution of the specification of policies, rules, parameters and adaptation actions;
- reuse and customization of these specifications in the development of new adaptive applications.

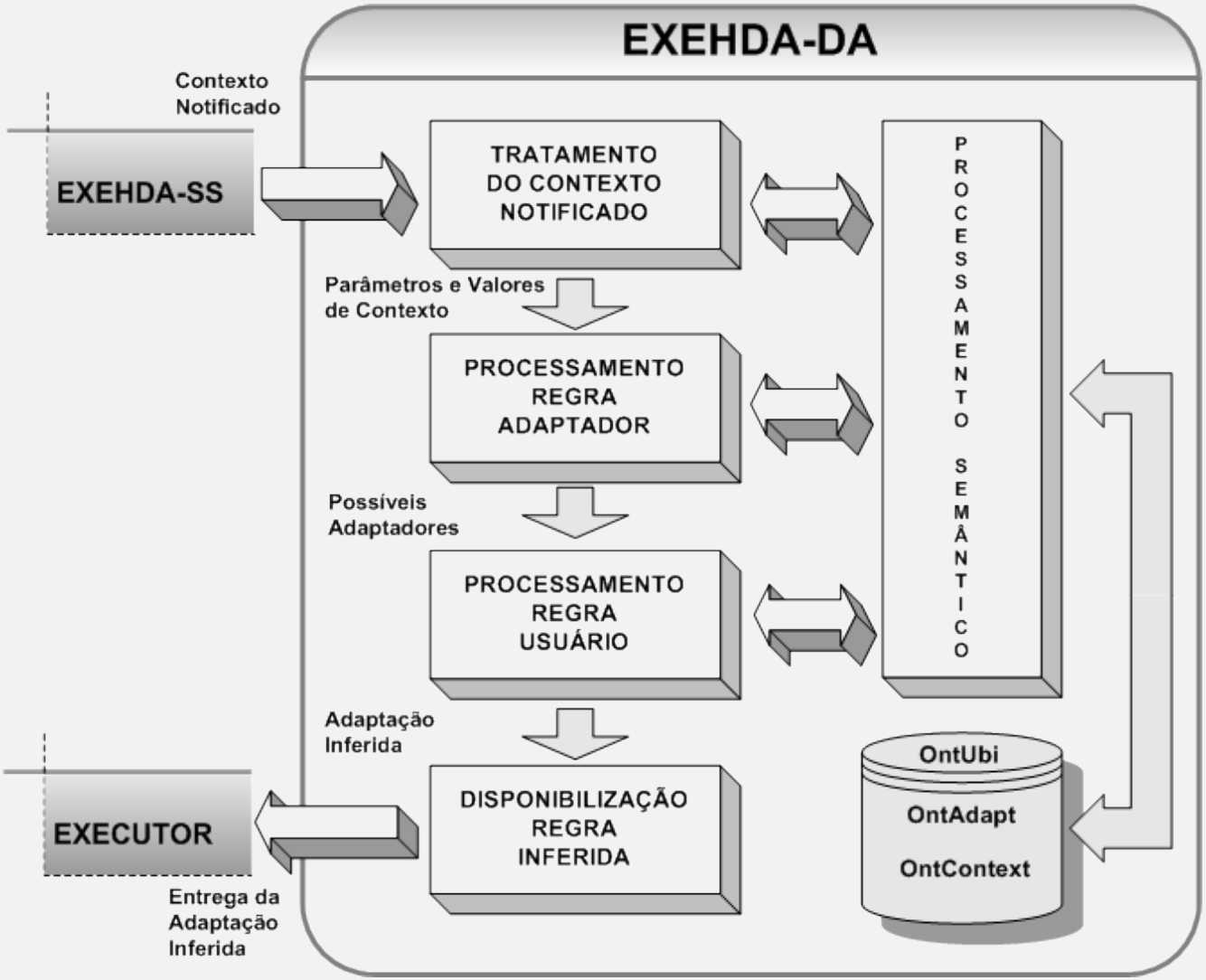
EXEHDA-DA: Modeling

Semantic Structure of Proposed Model

- **OntUbi** - The proposed Ontology for EXEHDA-DA. Entities (classes), attributes and relationships of the ubiquitous environment. The OntUbi also consists of:
  - **OntContext** - Ontology of Context Situation: contains collected contexts, reported contexts and contexts of interest to the application.
  - **OntAdapt** - Ontology of Adaptation: rules, parameters, operations and preferences, constraints and actions to adapt to the components of the applications.
  - **OntHistAdapt** - Ontology provided to records of decisions of adaptation, history of adaptations.


OntAdapt - Política de Adaptação da Aplicação
Aplicacao_Componente +
Aplicacao
- Aplicacao_Id
- Aplicacao_Desc
Componente
- Componente_Id
- Componente_Desc
- Componente_Adaptado
Componente_Adaptador *
Adaptador_Operacao *
Operacao
- Operacao_Id
- Operacao_Ordem
- Operacao_ArgA
- Operacao_Operador
-Operacao_ArgB
Adaptador
- Adaptador_Id
- Adaptador_Desc
- Adaptador_RegraLogica
Adapt
- Adapt_AplicacaoId
- Adapt_CompOrigId
- Adapt_CompAdaptId
- Adapt_NodoId
- Adapt_Estado
Adaptador_ParamTipo *
ParamTipo_Sensor 1
ParamTipo_ParamValor +
Sensor
- Sensor_Id
- Sensor_Desc
Param_Tipo
- ParamTipo_Id
- ParamTipo_Desc
Param_Valor
- ParamValor_Id
- ParamValor_Desc
- ParamValor_Utilidade
- ParamValor_ValInf
- ParamValor_ValSup
Legenda:
— — ▸ : Relacionamentos entre classes; (1): uma instância;
(+): uma ou mais instâncias; (*): zero ou mais instâncias.

EXEHDA-DA Software Architecture



Case Studies

1. Ubiquitous Monitoring of Patients - AUP: control the monitoring of patients who are not admitted to Intensive Care Unit (UTI).
   - Functional adaptation depending on the context data from sensors patient (vital signs), determining the software component used to display the alert level;
   - Functional adaptation in terms of device being used by the user by selecting the component with the most appropriate interface to the device.

2. Dynamic Resource Allocation - ADR: opportunistically exploit the computing resources in a distributed infrastructure. Selecting nodes with greater computational power and lower occupancy level processor and memory. (Non-Functional Adaptations).

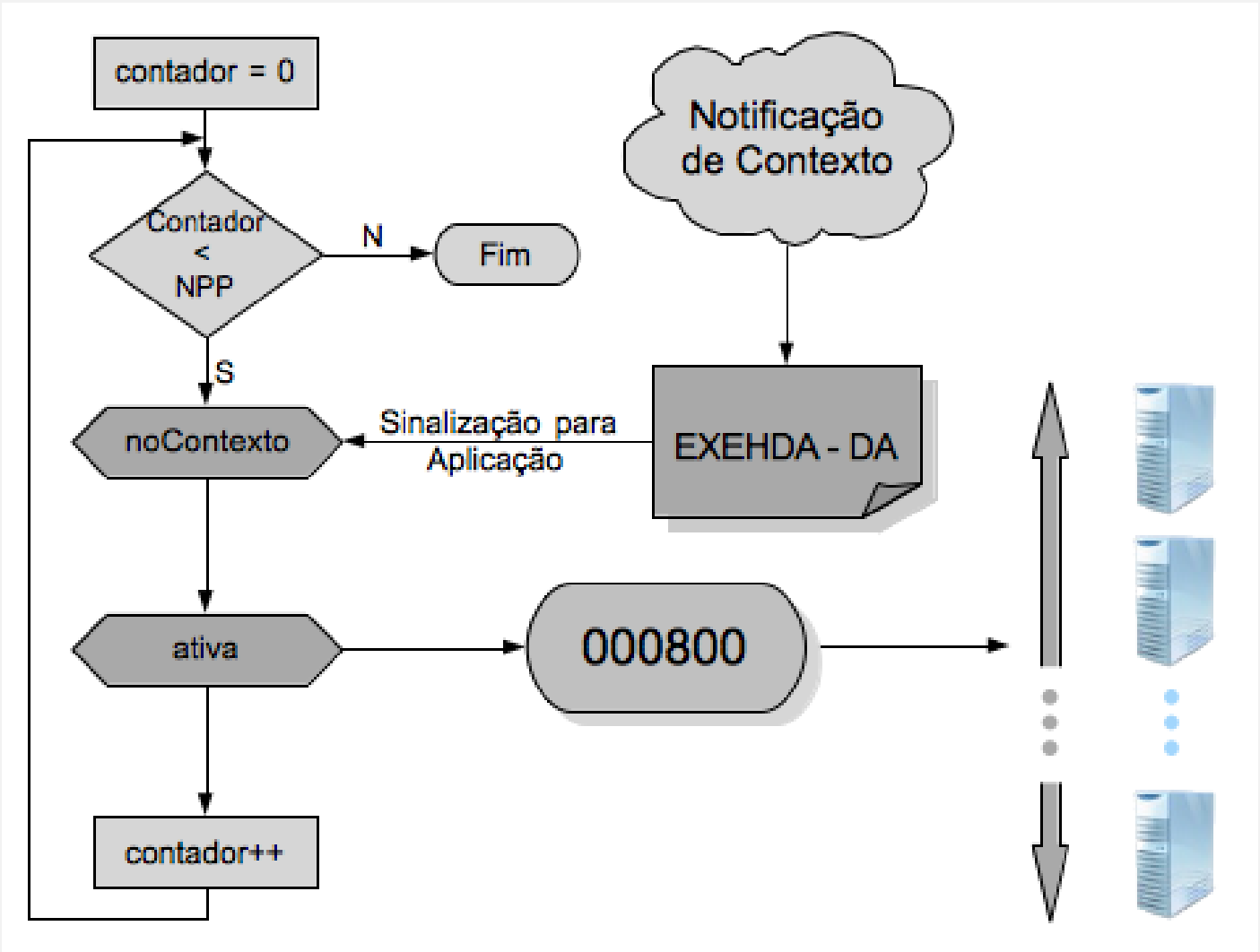
A D R - Softwares

- **parallel application CalcPi** - bag-of-tasks - calculate the number π using the method of Monte Carlo;
- **application CpuSteal** - load generator, based on an distribution of exponential property. Operates in cycles of activation and deactivation. Are generated floating-point operations occupying the processor.
- **application LoadGen** - produce a descriptor of computational load. Generates the time of activation and deactivation of processor;
- **application MemSteal** - promotes memory occupancy. This application produces an instantiation of arrays to generate demand for memory in the processor nodes.

A D R - Main Objectives

- be able to select the most appropriate computational resource, according to a criterion of adaptation, among all currently available;
- allow the distribution of computations can be started, regardless of whether the availability of processors to accommodate all parallel tasks planned;
- provide decision-making scheduling on two levels: (i) considering the state in the computing infrastructure and (ii) user preferences regarding the origin of the resource;
- model the application to provide an adequate granularity for processing in computational grids;

A D R - Execution Flow



MODELS	01	02	03	04	05	06	07	08
CARISMA	+		+		+	+	+	+
CHISEL		+	+				+	
QUO	+		+			+		
RAINBOW	+		+			+	+	
MADAM	+	+	+		+		+	+
PROTEUS	+		+	+			+	
SECAS	+		+		+		+	
EXEHDA-DA	+	+	+	+	+	+	+	+

1 - Functional adaptations of the application and/or middleware;
2 - Non-functional adaptations;
3 - Control of Adaptation is external to the application;
4 - Semantic Modeling for the Policy of adaptation of application;
5 - Mobiles Devices;
6 - Reuse policies from a catalog;
7 - Treatment autonomic of adaptation based in rules;
8 - Utility Function.

Main Comments on the Related Works:

- The utility functions provide a better fit for adaptation and a better match user needs, not considered in most projects;
- The EXEHDA-DA allows the application developer to include new adaptations, new conditions due to the policy of application be maintained externally;
- Some studies address only one type of adaptation, functional or non-functional;
- Others will not provide the possibility of maintenance, incremental or not, in the rules and policies of applications;
- With the use of semantic model, for its expressiveness and reusability and standardization, we believe that providing greater ease in defining of the application profile.

Final Considerations - Major Contributions

- participation in the creation of ontology ONTUBI, which represents the ubiquitous environment managed by the middleware EXEHDA (ontological model for G3PD);
- defining a software architecture for EXEHDA-DA, the adaptation rules-based and customizable to application;
- designing an integrated interface to other middleware services;
- identification of the adaptive commands to be used by the developer;
- proactive management of decision to adapt, which can be executed at any time and without user intervention, in response to changes in context. Important for emergencies;

Final Considerations - Major Contributions

- allows to explore any measurable dependence on context;
- promotes the development of adaptive applications, through the independence of the application;
- possibility of logical inferences based on semantics for decision-making for adaptation;
- use of the concept of utility as a way to expand the decision alternatives generated by the adaptation policy;
- ease maintenance and reuse of adapters, rules for adaptation, its parameters and operations, described and instantiated in high-level language.

Future Works

- dynamic adjust of adaptation rules (self-adaptation);
- new funcionalities for FWADAPT framework;
- alternatives for operations used in the rules;
- considering the use of adaptation history in the EXEHDA-DA;
- implementation in Green Houses (Embrapa Clima Temperado).

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