An Attribute-Based Access Control Model for Secure Big Data Processing in Hadoop Ecosystem

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3rd ACM Workshop on Attribute-Based Access Control (ABAC'18)
Tempe, Arizona, USA, March 19-21, 2018

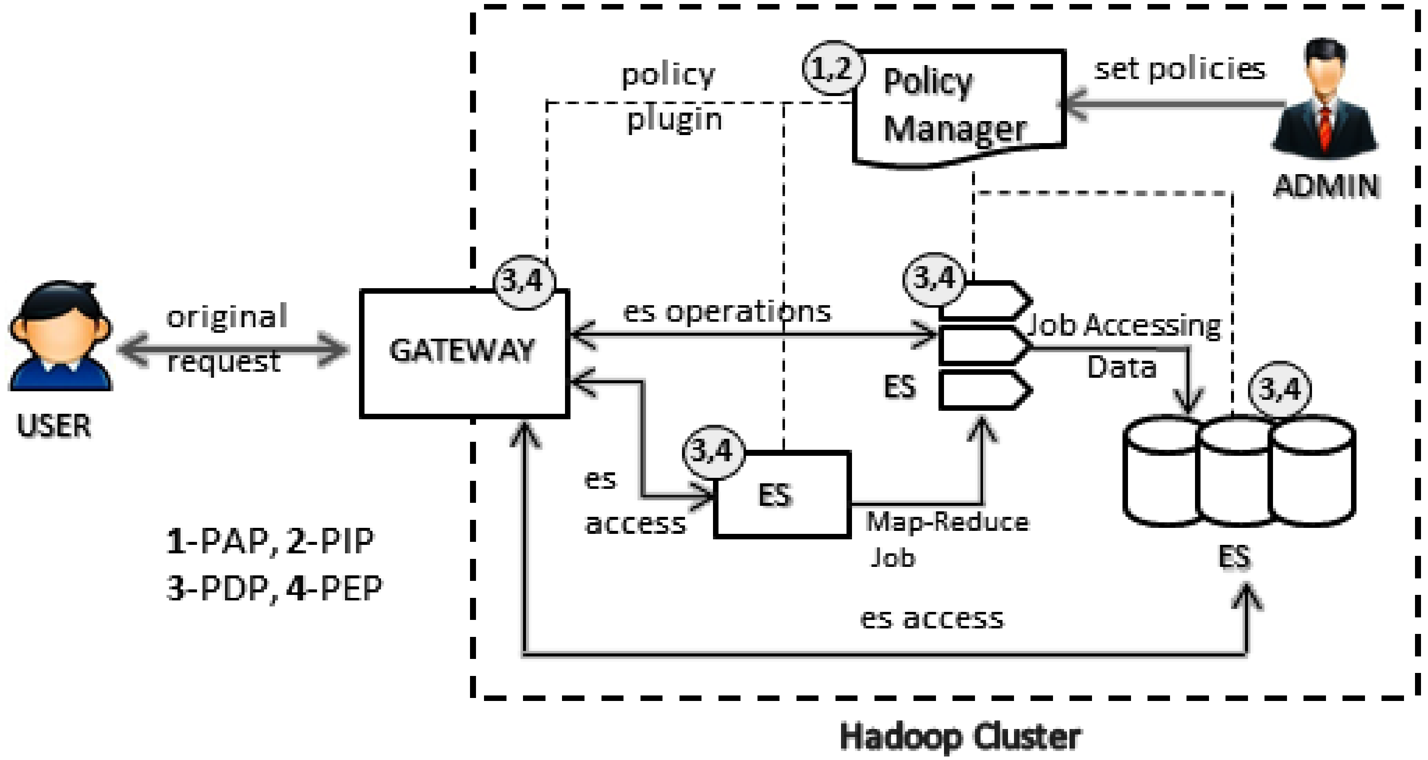
Outline

- Introduction and Motivation
- Multi-layer Hadoop Authorization Framework
- Object Tagged - RBAC Model
- HeABAC Model
- Implementation Approach
- Use Case

Big Data and Big Challenges

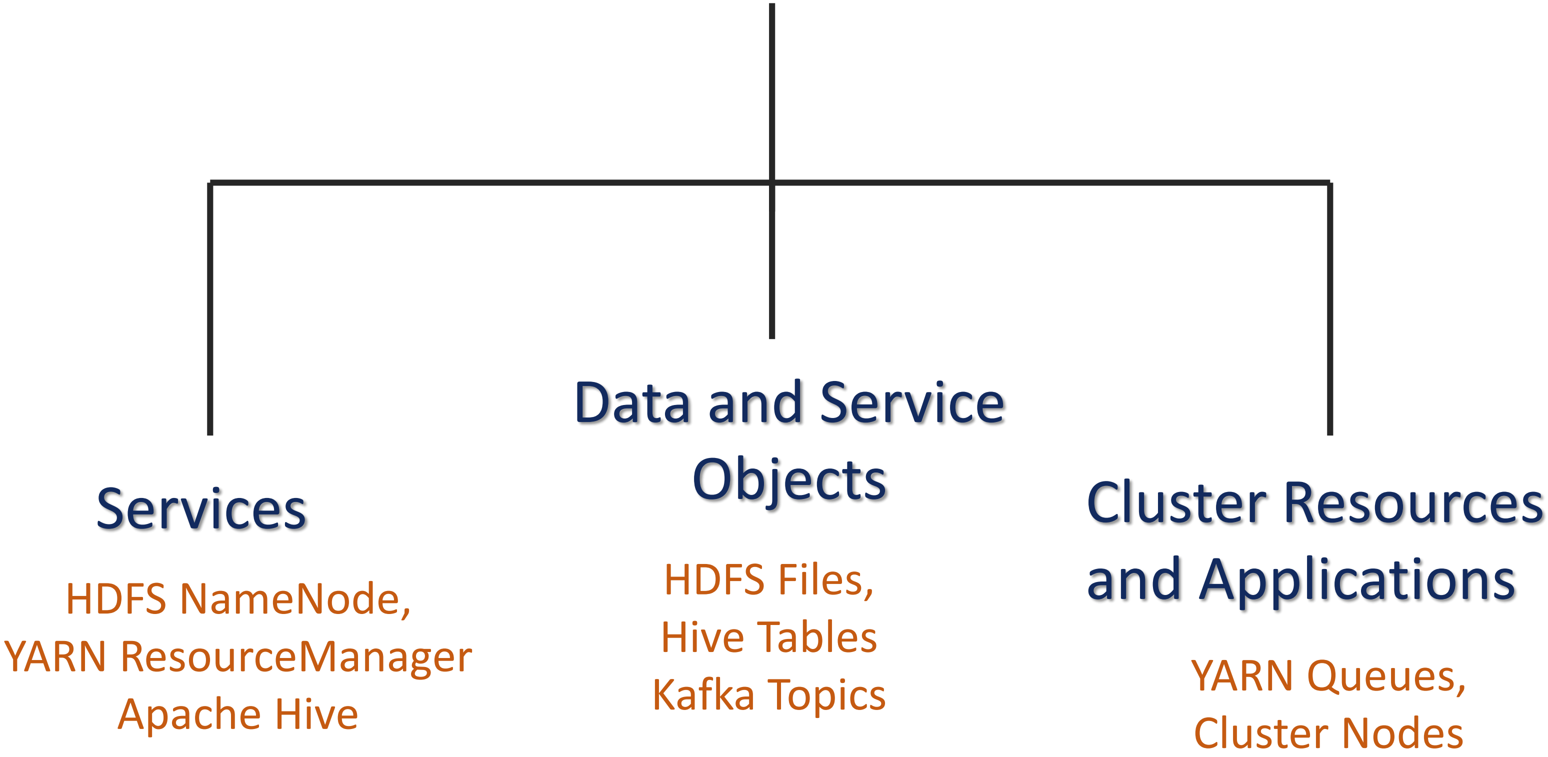
- IDC 2025 :
  - global "Datasphere" – 163 zettabytes
  - 10x than 2016
- Security:
  - Privacy Concerns (eg: HIPPA)
  - Fine granular access requirements
- Hadoop Ecosystem = Hadoop core + Open-Source Projects
- Hadoop Data Lake

Hadoop Ecosystem Authorization Architecture



Policy Manager : Apache Ranger, Apache Sentry
Gateway : Apache Knox
Ecosystem Service (ES) : Apache Hive, HDFS, Apache Storm, Apache Kafka, YARN

Multi-Layer Access Control



Services

HDFS NameNode,
YARN ResourceManager
Apache Hive

Data and Service Objects

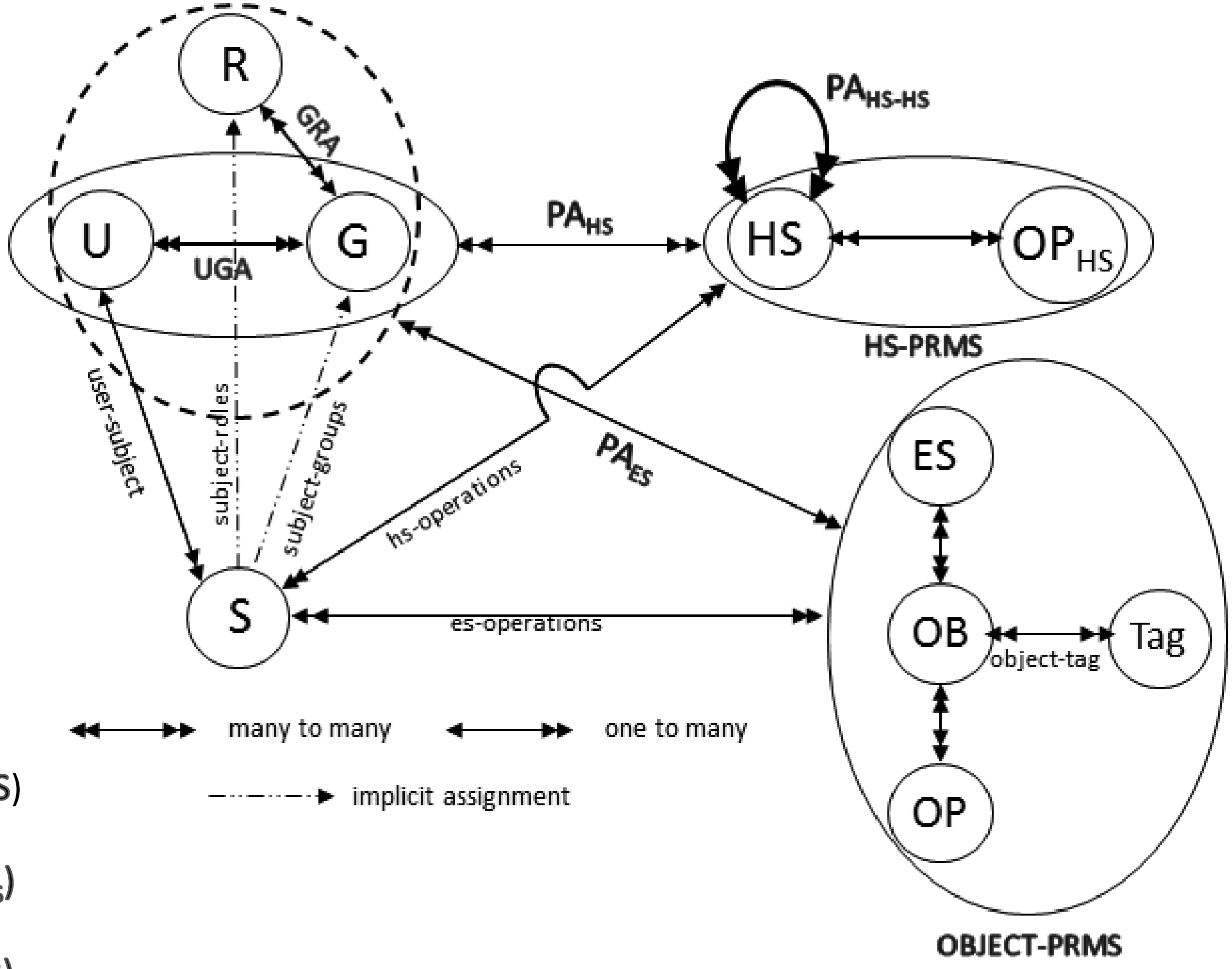
HDFS Files,
Hive Tables
Kafka Topics

Cluster Resources and Applications

YARN Queues,
Cluster Nodes

HeAC Model: Consolidated View

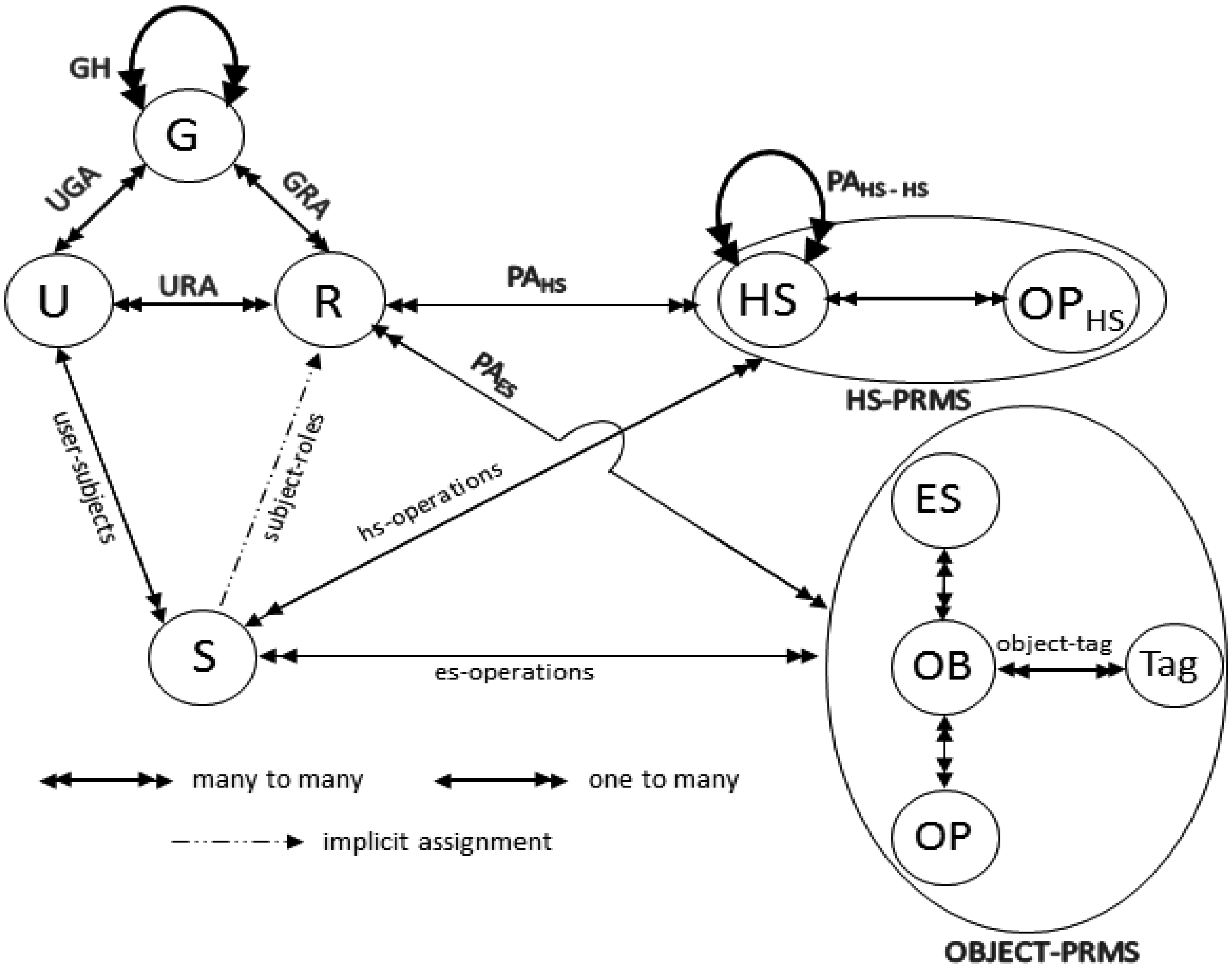
Hadoop Ecosystem Access Control Model



Users (U), Groups (G) , Subjects (S)
Hadoop Services (HS)
Hadoop Service Operations (OP_{HS})
Objects (OB), Operations (OP)
Ecosystem Service (ES), Objects (OB)
Operations (OP), Tag

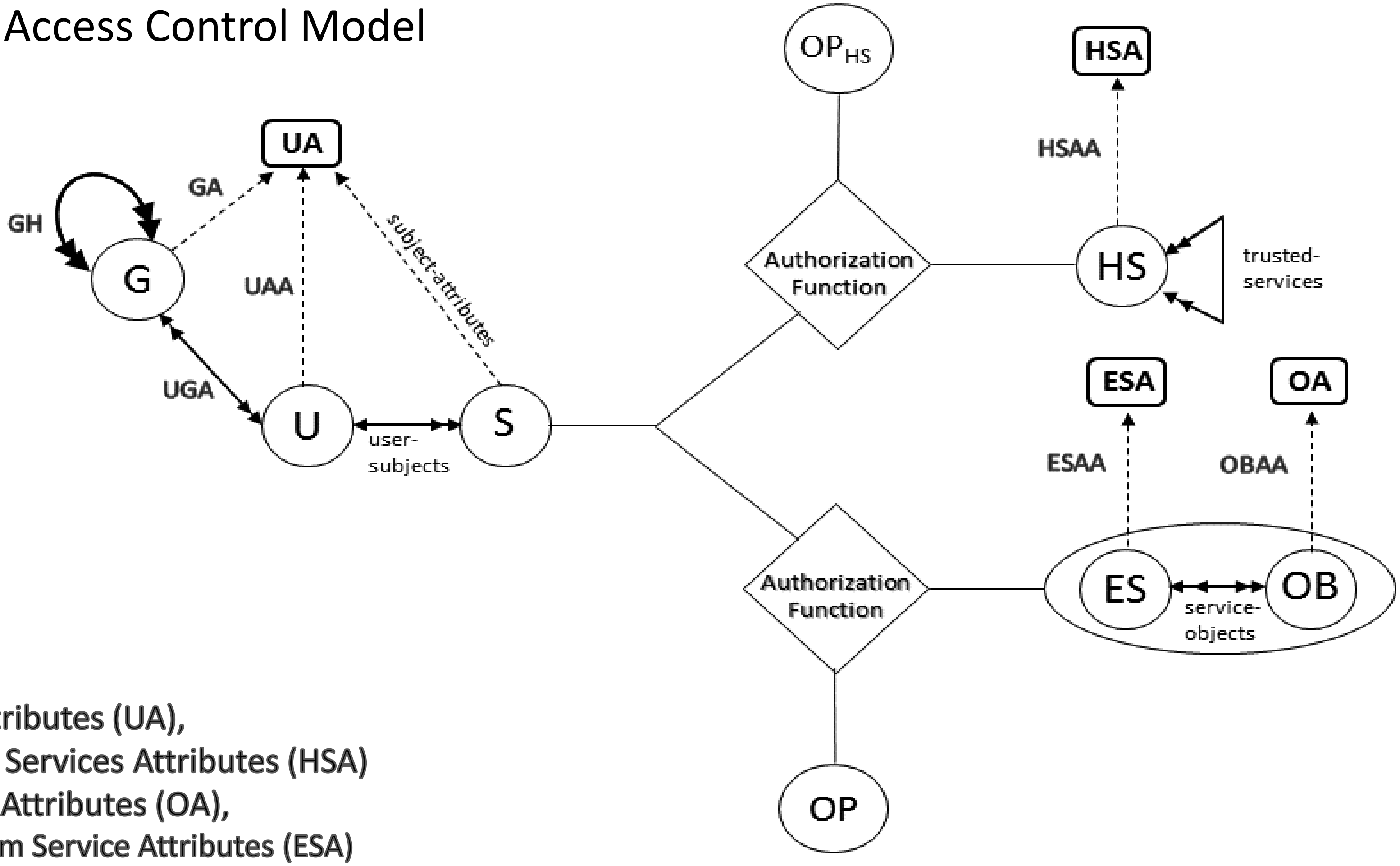
OT-RBAC Model

Object-Tagged RBAC



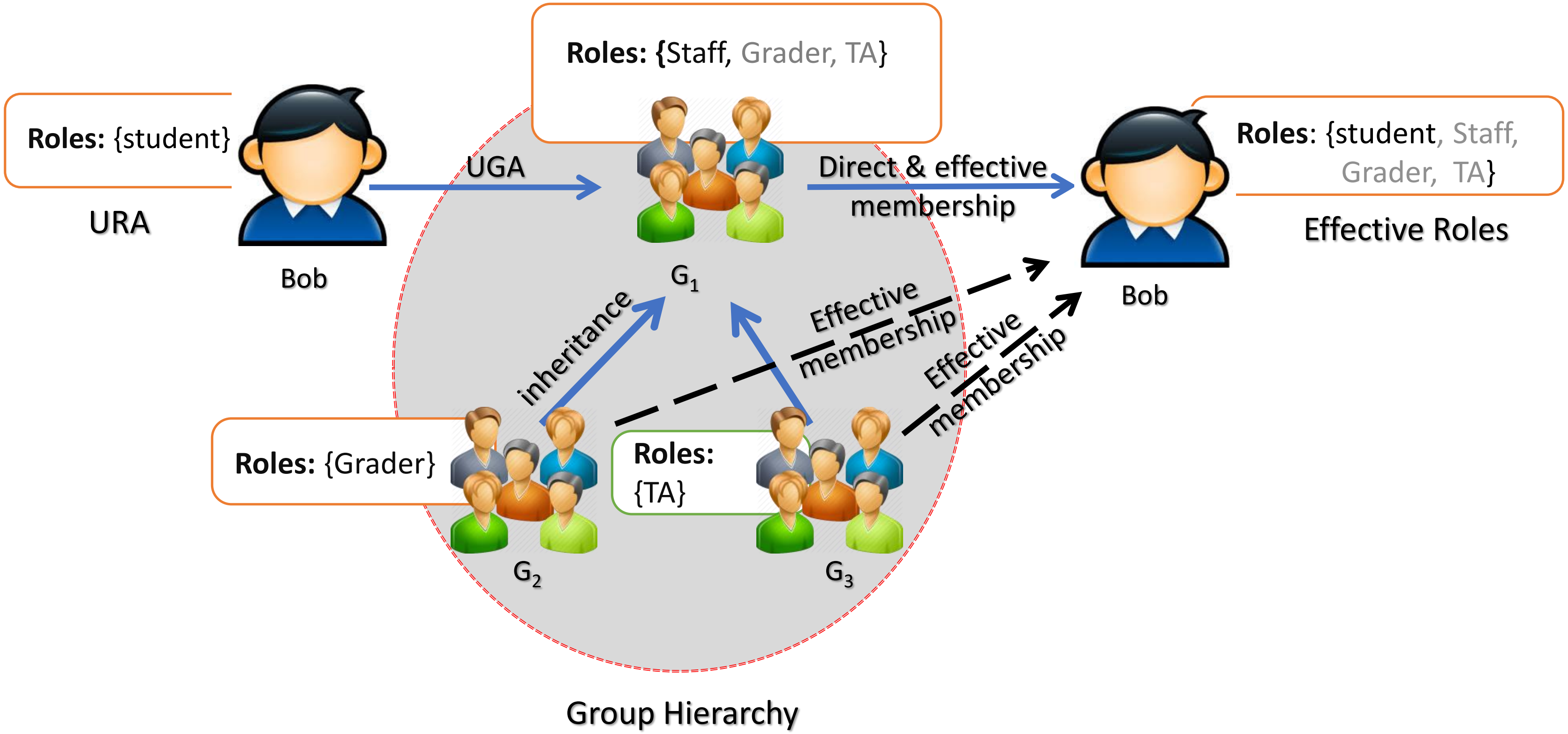
HeABAC Model

Hadoop Ecosystem Attribute-Based Access Control Model



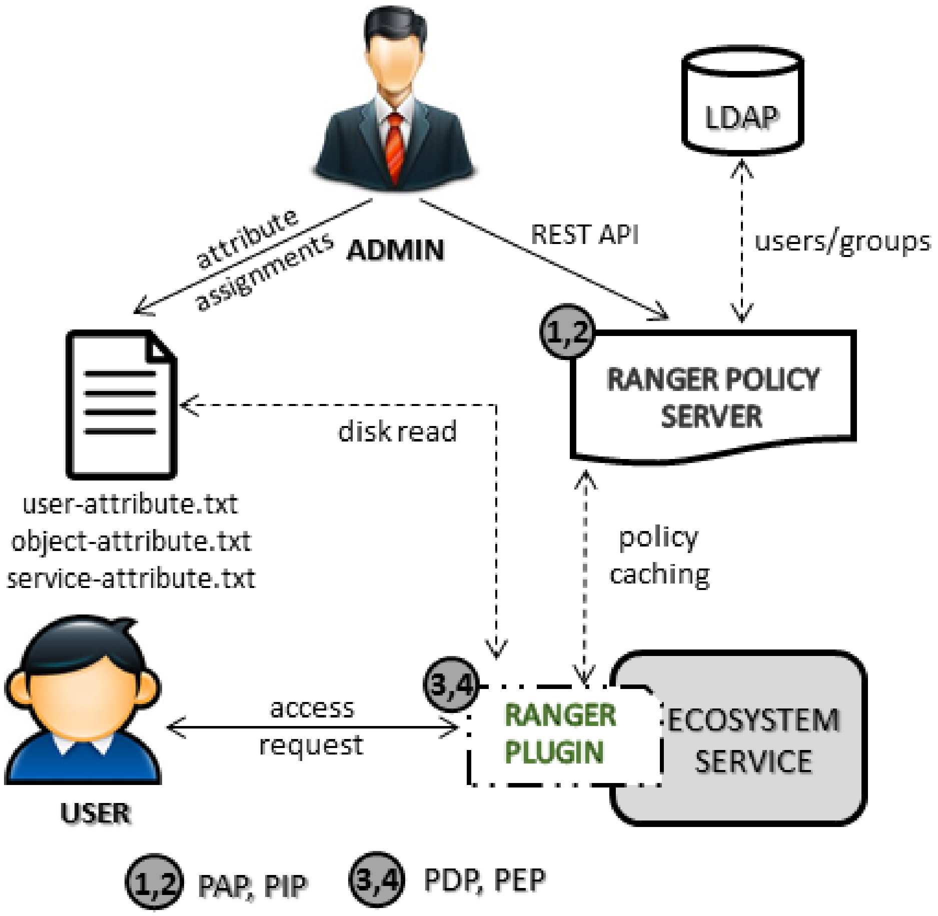
User Attributes (UA),
Hadoop Services Attributes (HSA)
Objects Attributes (OA),
Ecosystem Service Attributes (ESA)

Group Based Attribute Inheritance

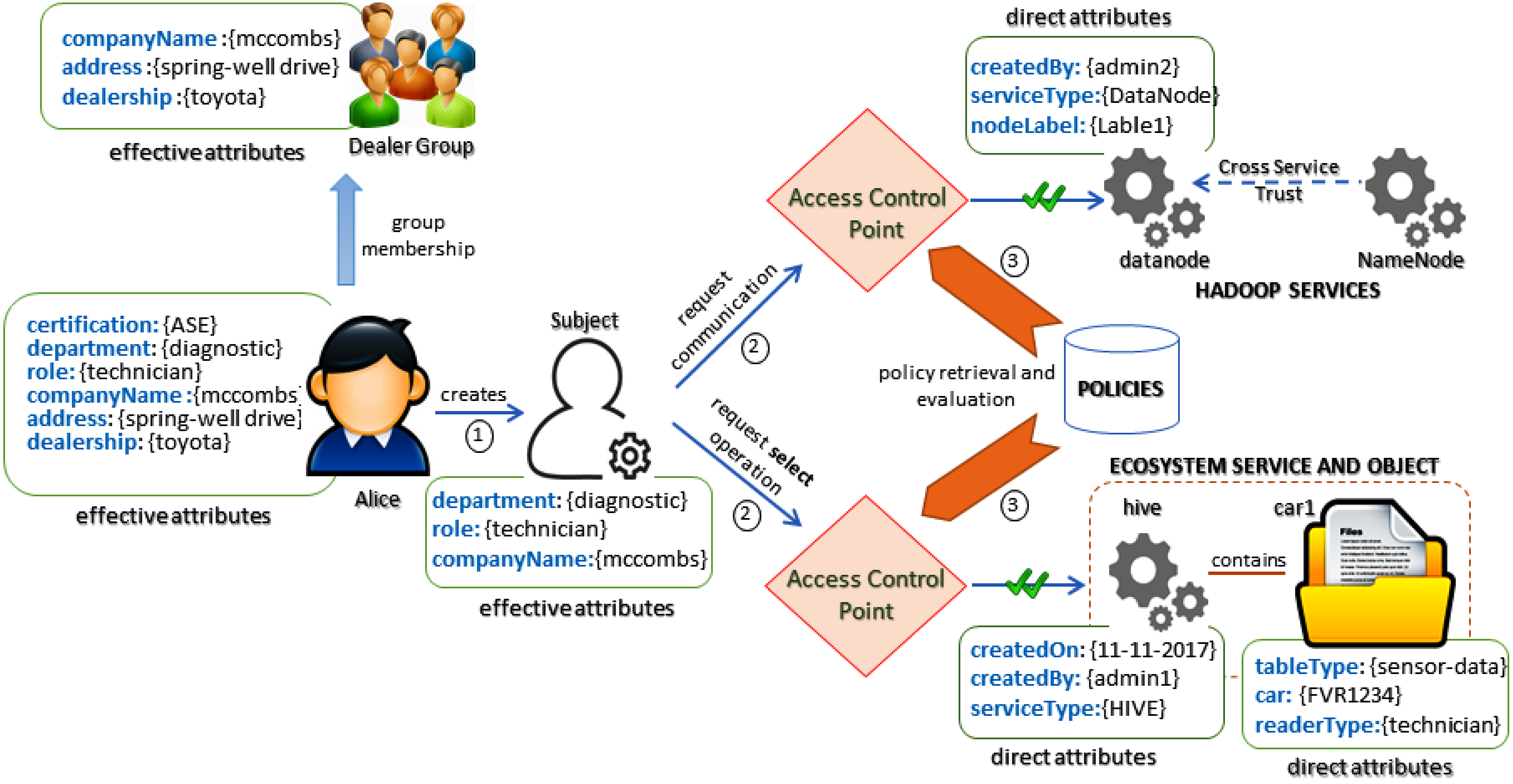


Major Benefits: Easy Administration where multiple roles can be assigned to user with single administrative operation.

Implementation Approach



HeABAC Use-Case



companyName :{mccombs}
address :{spring-well drive}
dealership :{toyota}

effective attributes

Dealer Group

group membership

certification: {ASE}
department: {diagnostic}
role: {technician}
companyName :{mccombs}
address: {spring-well drive}
dealership: {toyota}

effective attributes

Alice

creates

1

Subject

department: {diagnostic}
role: {technician}
companyName:{mccombs}

effective attributes

request communication

2

request select operation

2

Access Control Point

Access Control Point

policy retrieval and evaluation

3

3

POLICIES

direct attributes

createdBy: {admin2}
serviceType:{DataNode}
nodeLabel: {Lable1}

Cross Service Trust

datanode

NameNode

HADOOP SERVICES

ECOSYSTEM SERVICE AND OBJECT

hive

car1

contains

createdOn: {11-11-2017}
createdBy: {admin1}
serviceType:{HIVE}

direct attributes

tableType: {sensor-data}
car: {FVR1234}
readerType:{technician}

direct attributes

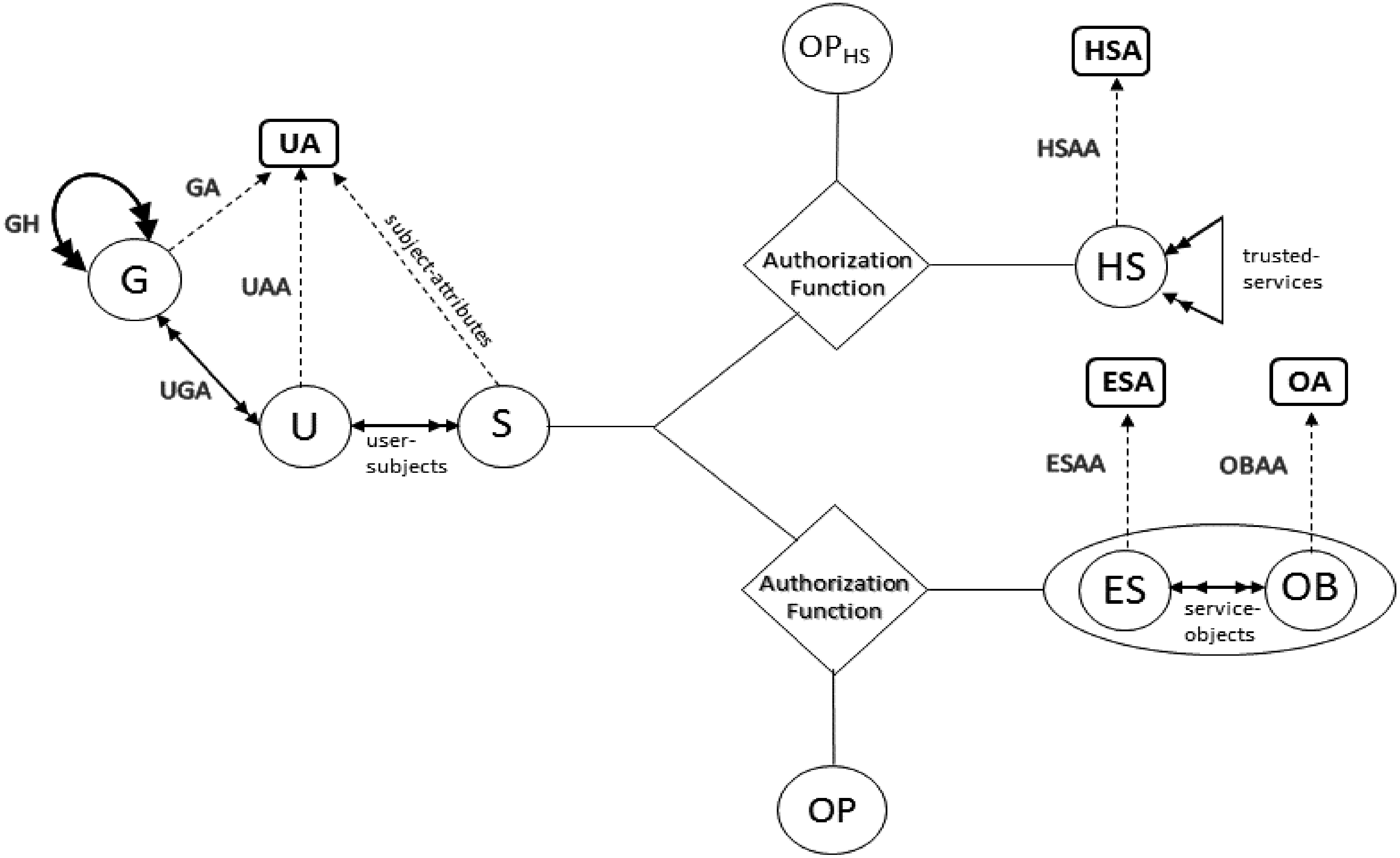
HeABAC Example Policies

1. $\text{Authorization}_{\text{access}}(\text{s:S}, \text{es:ES}) \equiv \text{diagnostic} \in \text{effective}_{\text{department}}(\text{s}) \wedge \text{technician} \in \text{effective}_{\text{role}}(\text{s}) \wedge \text{serviceType}(\text{es}) = \text{HIVE} \wedge \text{createdBy}(\text{es}) = \text{admin1}$.

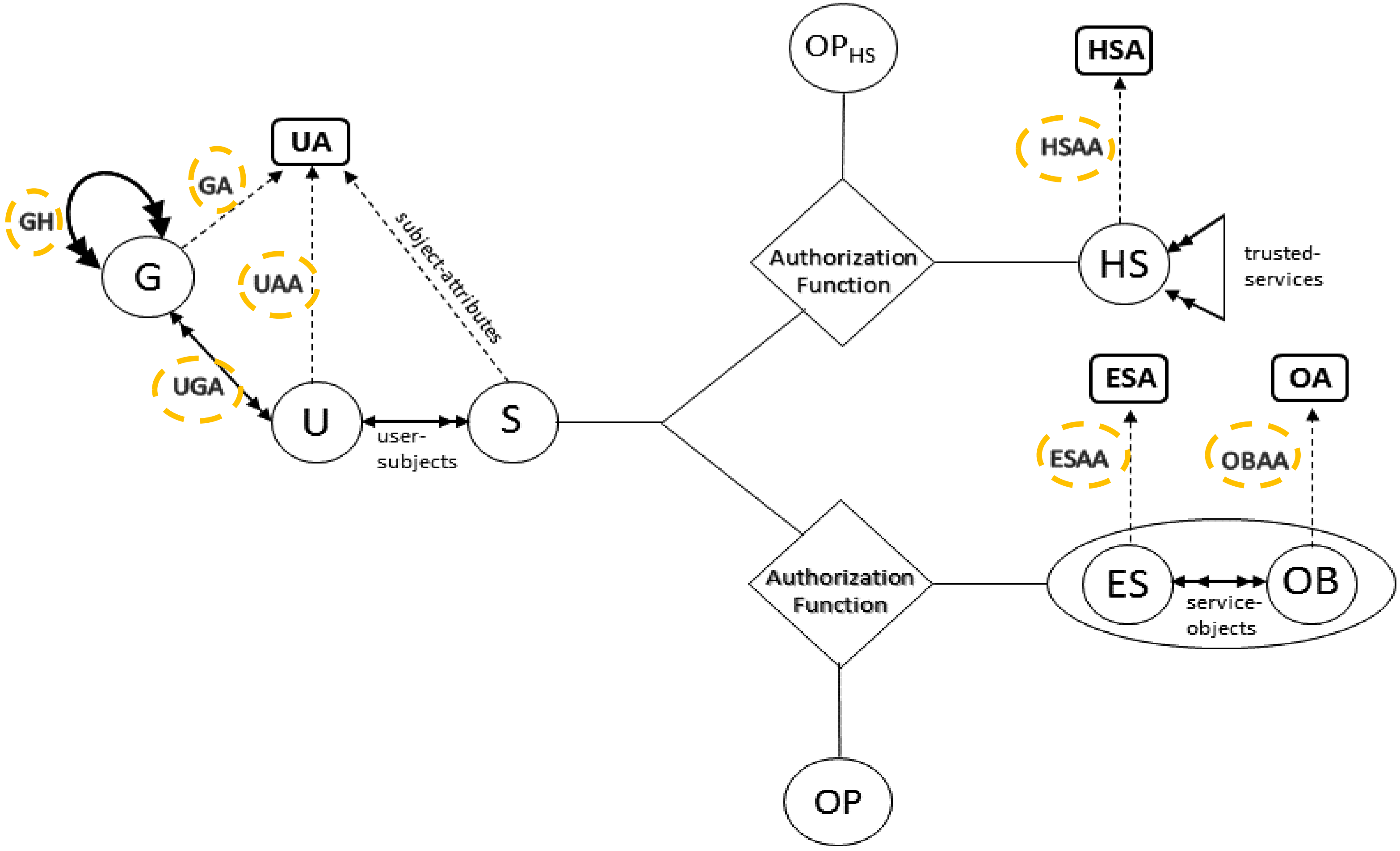
2. $\text{Authorization}_{\text{select}}(\text{s:S}, \text{es:ES}, \text{ob:OB}) \equiv \text{Authorization}_{\text{access}}(\text{s:S}, \text{es:ES}) = \text{True} \wedge \text{diagnostic} \in \text{effective}_{\text{department}}(\text{s}) \wedge \text{effective}_{\text{role}}(\text{s}) \in \text{readerType}(\text{ob}) \wedge \text{tableType}(\text{ob}) = \text{sensor-data} \wedge \text{car}(\text{ob}) = \text{FVR1234}$.

3. $\text{Authorization}_{\text{access}}(\text{s:S}, \text{hs:HS}) \equiv \text{diagnostic} \in \text{effective}_{\text{department}}(\text{s}) \wedge \text{technician} \in \text{effective}_{\text{role}}(\text{s}) \wedge \text{serviceType}(\text{hs}) = \text{DataNode} \wedge \text{createdBy}(\text{hs}) = \text{admin2}$

HeABAC Administrative Realms



HeABAC Administrative Realms



ARBAC inspired GURA, GURA$_G$ models are required.

Conclusion and Future Work

- Hadoop Authorization Layers
- Object-Tagged-RBAC Model
- Formalized Attributes based HeABAC Model

Some Future Goals:

- Introduce Data ingestion security
- Privacy concerns and finer grained approaches in multi-tenant Hadoop Lake