LDAP Stored Procedures and Triggers Arrive in ApacheDS

- Originally presented at ***ApacheCon US 2006*** in Austin, Texas
- Latest presentation materials are at ***http://people.apache.org/~ersiner***
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Agenda

- Stored Procedures
  - Why do we need them in LDAP?
  - Representing Stored Procedures
  - Executing Stored Procedures
- Triggers
  - Why do we need them in LDAP?
  - Model of LDAP Triggers
  - Integration with LDAP Stored Procedures
- Demos

Stored Procedures for LDAP (Why?)

- Bulk processing
- Controlled by user
- Extending server's capability *easily*

- LDAP Extended Operations?

Model of LDAP Stored Procedures

- Implementation technology
- Storage place
- Storage format
- Storage method
- Calling
  - Parameters
  - Return value
- Security

What's an LDAP stored procedure?

- A piece of code
- Implemented in any technology
- Stored in the Directory Information Tree
- Represented with schema elements
- Manipulated by standard LDAP operations (add, delete)

Stored Procedures in ApacheDS

- "Java" implementation of the generic model
- A "Java" LDAP stored procedure is
  - A public static method of a Java class
  - Represented by two attributes and an object class
  - Stored with its class (as expected) in compiled form (byte-code)

Calling a Stored Procedure

- Call from where?
  - Client side
  - Server side
- No standard SP Call operation
- For calling *any* LDAP stored procedure from client side
  - Use *Stored Procedure Execution (Extended) Operation*

Stored Procedure Execution (Extended) Operation

- Name of the stored procedure
- Where to find the stored procedure (optional)
  - A base search context (DistinguishedName)
  - Search scope: base, one, whole (Optional)
- Parameters (optional)
  - type information (optional)
  - value

DEMO 1

- Let's load a "Hello World" SP and call it!

```
public class Greeter
{
  public static void helloWorld()
  {
    System.out.println( "Hello World!" );
  }
}
```

DEMO 2 – SP Parameters and Return Values

```
public class Greeter
{
  public static String sayHello( String who, Integer times )
  {
    StringBuffer buffer = new StringBuffer();

    for ( int i = 0; i < times.intValue(); i++ )
    {
      buffer.append( "Hello " );
    }

    buffer.append( who );
    buffer.append( '!' );

    return buffer.toString();
  }
}
```

“Java” SP execution progress (A reflection story)

- Find the SP entry
  - Use the SP name (what) and search context (where)
- Extract class name from SP name
- Load the class
- Extract method name from SP name
- Find the method in the class
  - Use method name and check parameters for assignment compatibility
- Call the method supplying parameters
- Return back the result Object

A special SP parameter

- type: “ldapContext”
- value: A distinguished name (as a String object)

- ApacheDS supplies a JNDI context at the specified DN with the user’s credentials
- *Why do we need it?*

DEMO 4

- Let's do a real world example
- With *delete* operation only a single entry can be deleted at once
- It's a common requirement to delete a subtree at once
- There is a *delete operation control* for this but it is not adopted by the mainstream
- Let's write our own *deleteSubtree SP*, load and call it!

Security Issues

- Directory operations on stored procedures
  - Who can do what on stored procedures
- Permissions used during execution
  - Executor's verses owner's
- Authorization for executing stored procedures
- Stored procedures' capabilities within the server

Security Issues and ApacheDS

- Stored procedures
  - are standard user objects
  - any operation on them is possible
  - and subject to access control
- Stored procedures are executed with executor's permissions
- Currently, who is authorized to read an SP is also authorized to execute it
- Currently, execution is not sandboxed

Stored Procedures – Briefly

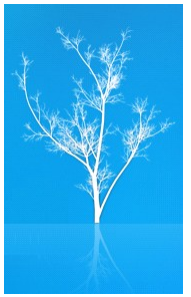
- LDAP stored procedures allow users to effectively define their own *extended operations* without requiring any server software extensions

Triggers for LDAP (Why?)

- Tracking DN references (referential integrity)
- Custom action needs upon some operations on some entries (logging, firing an external process)
- Existing solutions lacks some capabilities or are hard to use (e.g. requires server side plug-ins)

A Trigger

```
<Trigger Specification> :
    <Action Time>
        <Trigger Event>
            <Triggered Action>
```



An LDAP Trigger

- **Action Time**: AFTER
- **Trigger Event**: Change inducing LDAP operations
- **Triggered Action**: LDAP Stored Procedures!

- Which entries is a trigger defined *on*?
  - A specific entry
  - *Trigger Execution Domains*

- All these information are stored as regular schema objects (so can be browsed, replicated, etc.)

Trigger Specification Examples

- **AFTER Delete**
  CALL "BackupUtilities.backupDeletedEntry"
  ($ldapContext(""),$name,$deletedEntry)

- **AFTER Add**
  CALL "Logger.logAddOperation"
  ($entry,$attributes,$operationPrincipal)

Stored Procedures – Triggers Integration

- SPs can be suplied parameters like:
  - operation specific standard request parameters ($entry for Add, $name for Delete, ...)
  - operation specific usefull parameters ($deletedEntry for Delete, ...)
  - generic parameters ($ldapContext, $operationPrincipal, ...)
- All available parameters have predefined corresponding Java types
- SP call options are supported as specified in the SP Execution Operation

DEMO 1

- Let's backup an entry when it's deleted

- Write a Java stored procedure and load it
- Put an `entryTriggerSpecification` attribute in an entry
  - **`AFTER Delete`**
  - **`CALL "BackupUtilities.backupDeletedEntry"`**
  - **`($ldapContext(""),$name,$deletedEntry)`**

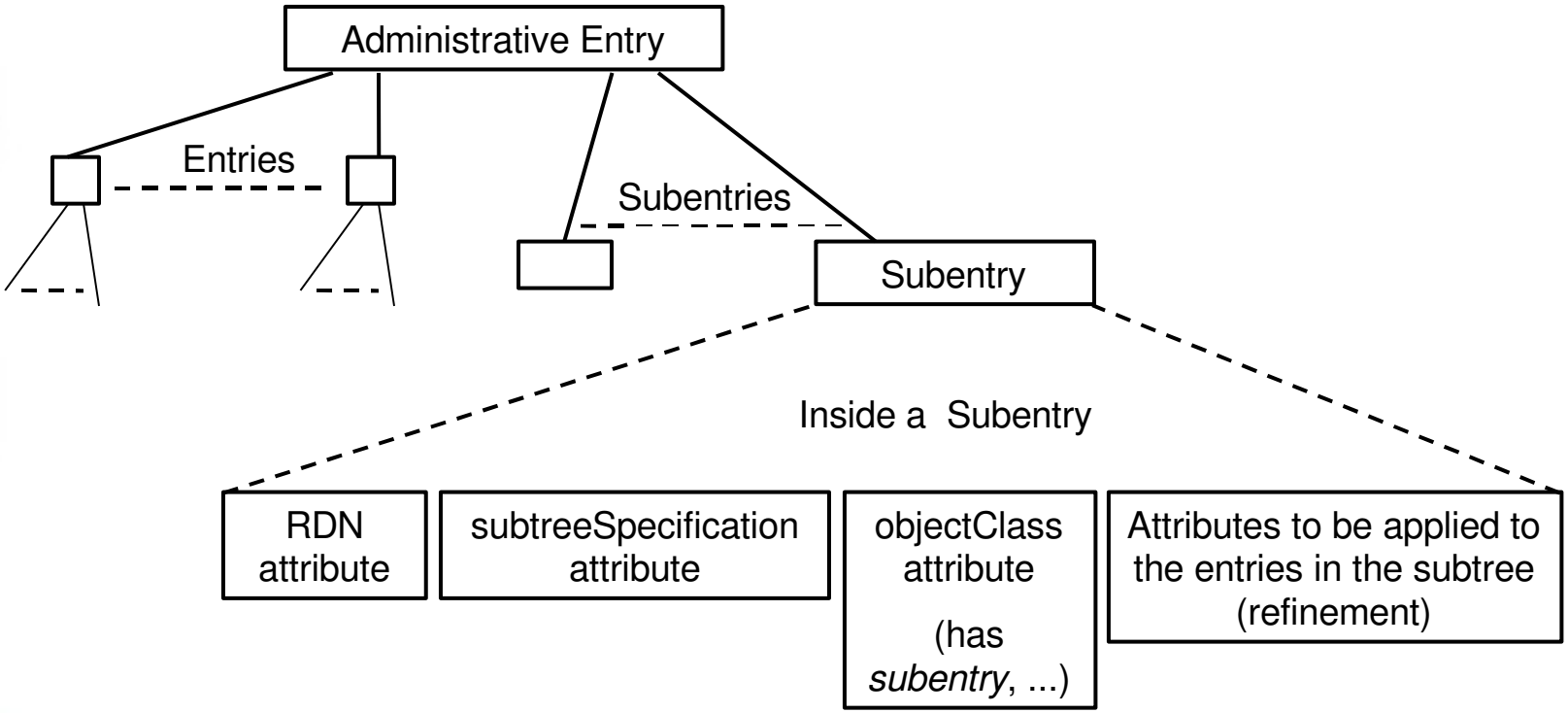
Was it impressive?

- Not very much!
- The trigger was effective only on a single entry
- And even our trigger specification has been deleted!

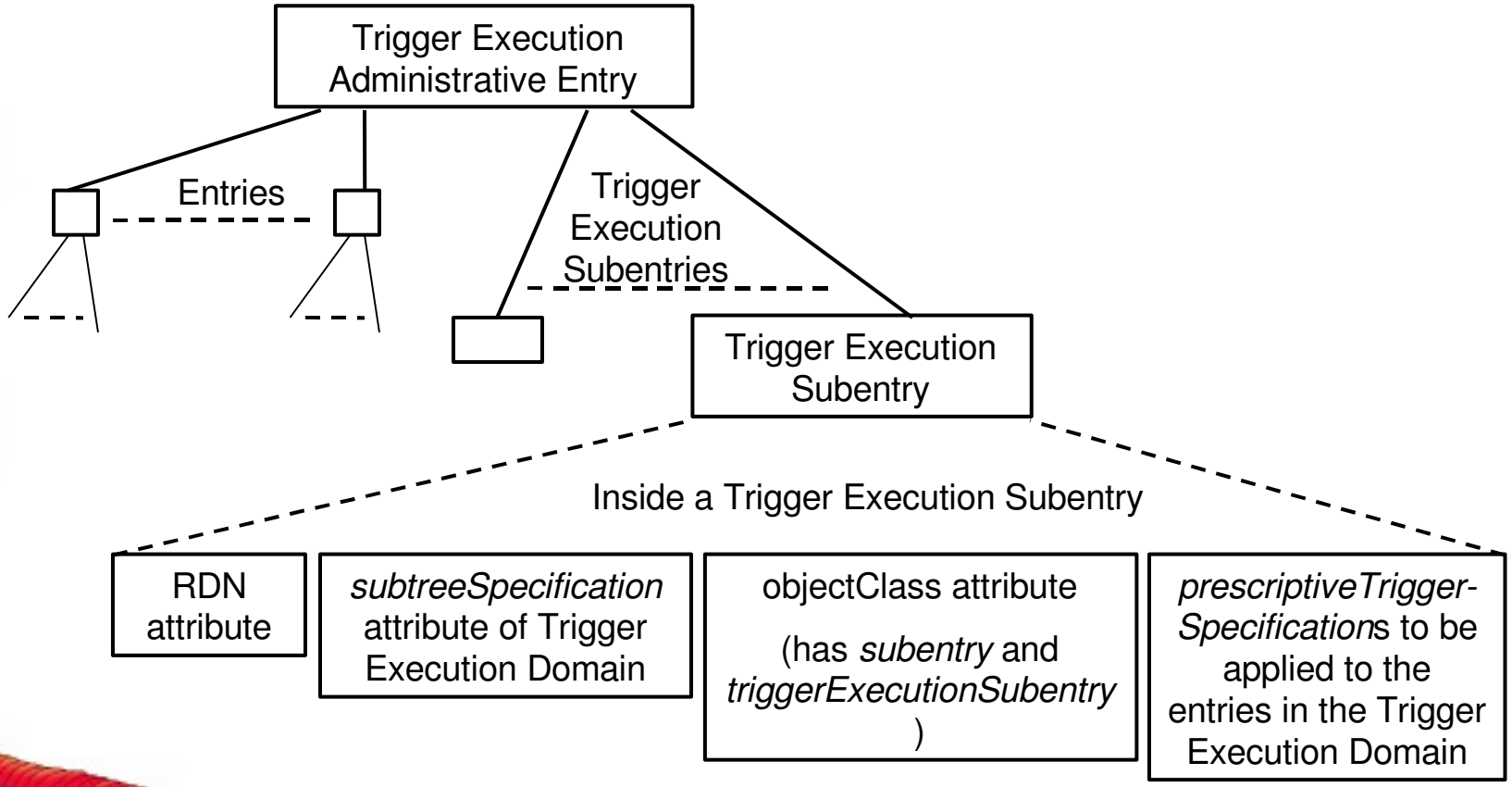
Trigger Execution Domains (TED)

- X.500 Subentries and subtreeSpecification
  - A Subentry holds a subtreeSpecification attribute
  - subtreeSpecification allows specifying a *subtree of entries with chop specifications and refinements*
  - Other attributes in the Subentry are *applied* to the selection of entries
  - A building block of X.500 Administrative Model
  - RFC 3672 - Subentries in the Lightweight Directory Access Protocol
- Trigger Execution Domains
  - Instead of entryTriggerSpecification,
  - use *prescriptiveTriggerSpecification* in *triggerExecutionSubentry*
  - to define triggers on a set of entries

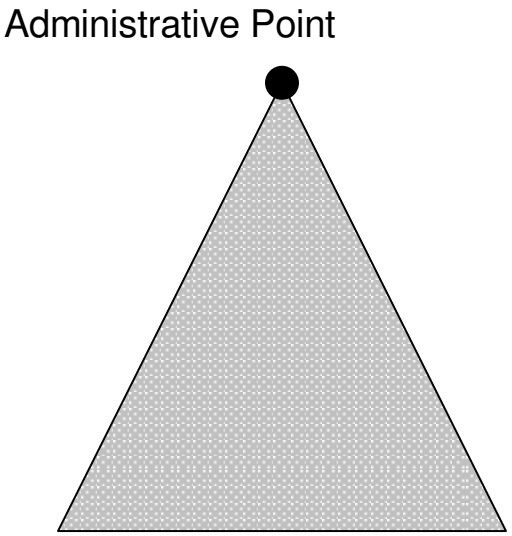
X.500 Administrative Model



X.500 Administrative Model – Trigger Execution Aspect

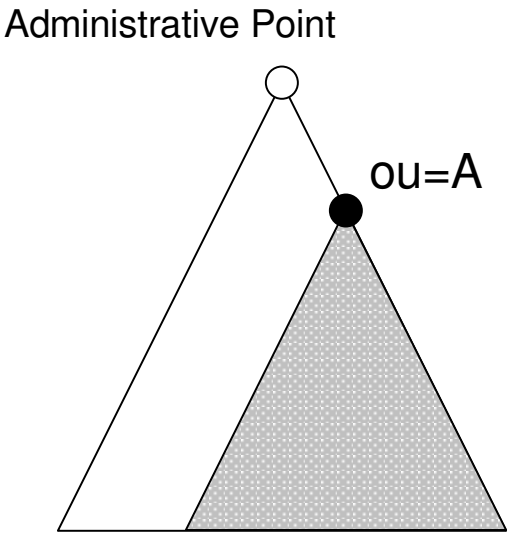


What can be specified *(How a TED can be specified)* with a subtreeSpecification ? (1)



subtreeSpecification=
{ }

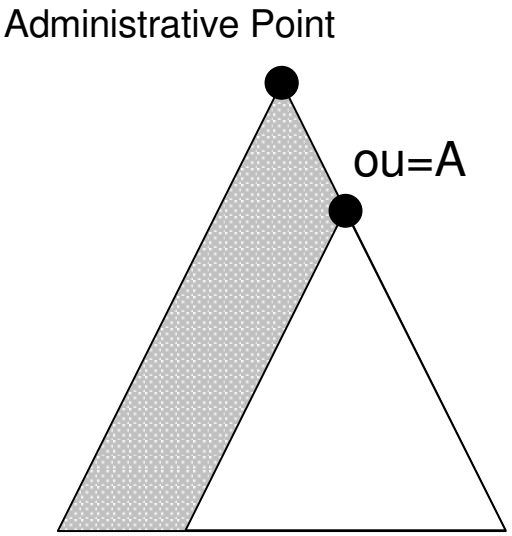
What can be specified *(How a TED can be specified)* with a subtreeSpecification ? (2)



subtreeSpecification=

{ base “ou=A” }

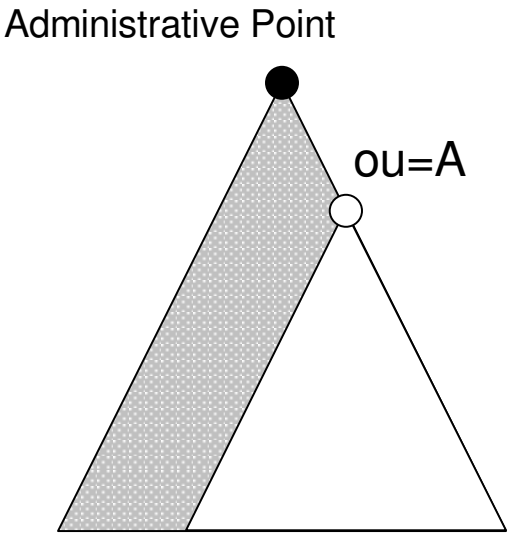
What can be specified *(How a TED can be specified)* with a subtreeSpecification ? (3)



subtreeSpecification=

{ specificExclusions { chopAfter: “ou=A” } }

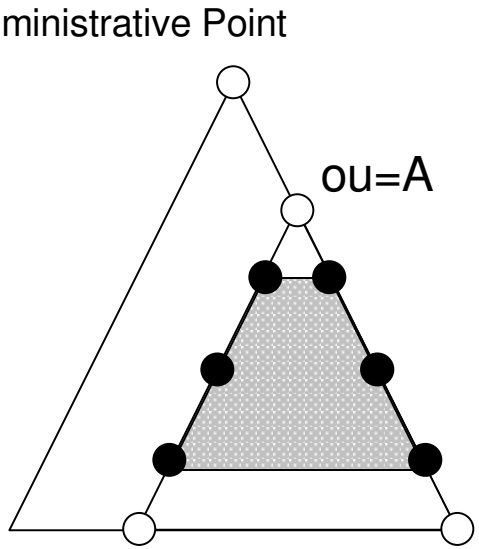
What can be specified *(How a TED can be specified)* with a subtreeSpecification ? (4)



subtreeSpecification=

{ specificExclusions { chopBefore: “ou=A” } }

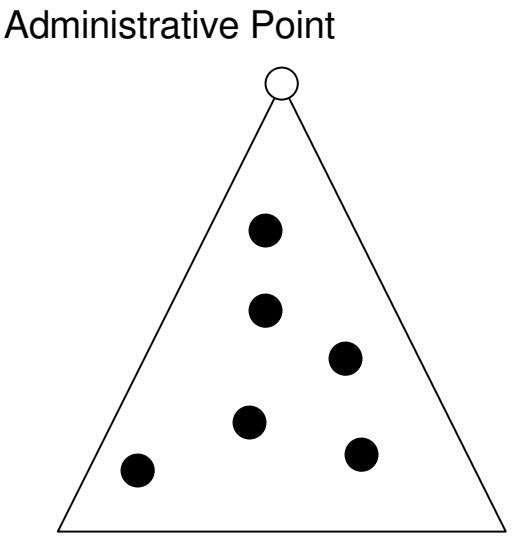
What can be specified *(How a TED can be specified)* with a subtreeSpecification ? (5)



subtreeSpecification=

{ base “ou=A”, minimum 1, maximum 3 }

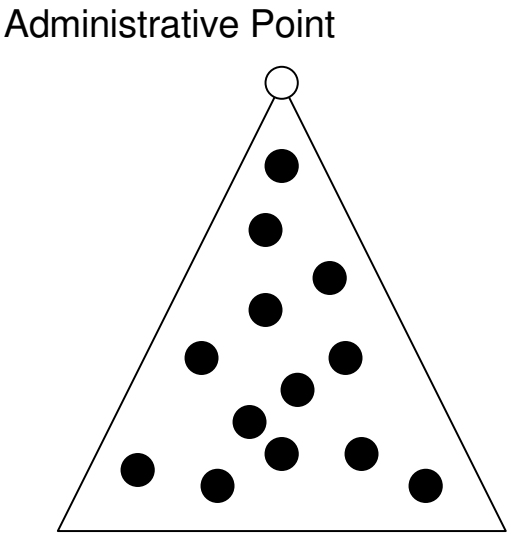
What can be specified *(How a TED can be specified)* with a subtreeSpecification ? (6)



subtreeSpecification=

{ specificationFilter item:student }

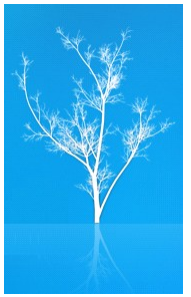
What can be specified *(How a TED can be specified)* with a subtreeSpecification ? (7)



subtreeSpecification=

{ specificationFilter or: { item:student,

item:faculty } }



DEMO 2

- Let's backup *any* entry when it's deleted

- triggerExecutionSubentry
  - **`subtreeSpecification`**
  - **`prescriptiveTriggerSpecification`**

What's coming next?

- BEFORE and INSTEADOF Triggers
- Search Operation Triggers
- Mutable parameters for Stored Procedures called from Triggers
- Fine grained security control

- and more: dev@directory.apache.org

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