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# Distributed Systems

Summer Term 2020

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## 4 Name Services



## Content

- ➔ Basics
- ➔ Example: JNDI

## Literature

- ➔ Tanenbaum, van Steen: Ch. 4.1
- ➔ Farley, Crawford, Flanagan: Ch. 7
- ➔ <http://docs.oracle.com/javase/tutorial/jndi/overview>

### Names, Addresses and IDs

- ➔ **Name**: character or bit sequence that refers to a unit
  - ➔ unit: e.g. computer, printer, file, user, website, ...
- ➔ **Address**: name of the entry point of a unit
  - ➔ entry point allows access to the unit
  - ➔ several entry points per unit are possible
  - ➔ entry point may change over time
- ➔ A **position-independent name** identifies a unit independently from its entry point
- ➔ **ID**: name with the following properties:
  - ➔ ID refers to at most one unit, unit has at most one ID
  - ➔ ID always refers to the same unit (not reused)



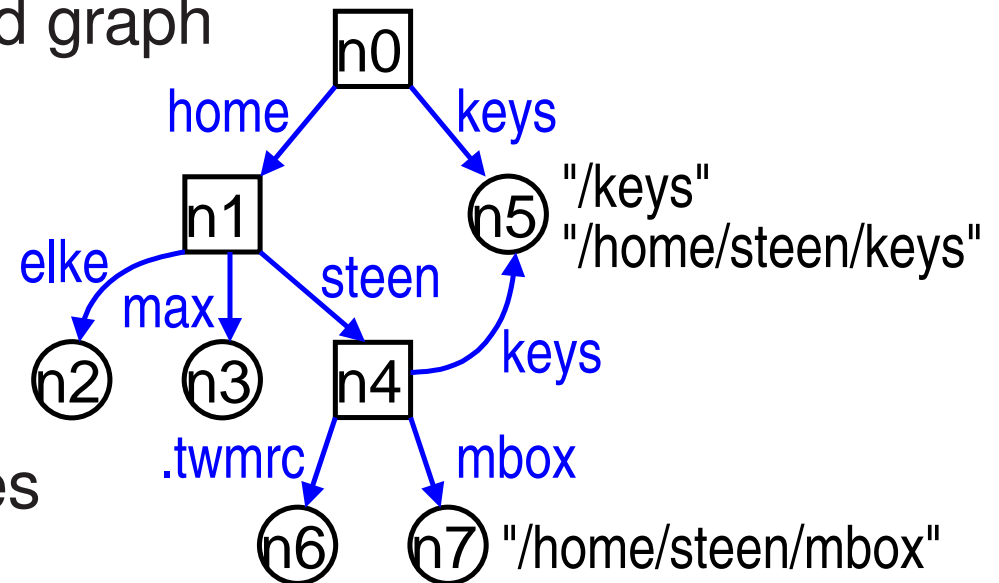
## Namespaces

→ represented by directed, labelled graph

→ leaf node: named unit, with information / status if required

→ inner node: directory node

→ edges are labeled with names



→ Units are named by paths in the graph:

*Start node: < Label-1, Label-2, ... >*

→ absolute path: starting from root (of namespace)

→ relative path: starting from any node

→ Example: names in the UNIX file system



### Aliasing and Linking

- ➔ **Alias**: alternative name for the same unit
- ➔ Possibilities for the realization of aliases:
  - ➔ allow several absolute pathnames for one unit
    - ➔ e.g. *hard link* in Unix
  - ➔ a (special) leaf node stores pathname of the unit
    - ➔ e.g. *symbolic link* in Unix
- ➔ Transparent linking of different namespaces:
  - ➔ a (special) directory node stores the ID of a directory node in another namespace
    - ➔ e.g. *mounted* file system in Unix



### Name Resolution

- ➔ Finding the node (or information) that corresponds to a name
  - ➔ start at the start node
  - ➔ look up first label in directory table
    - ⇒ ID of the next node
  - ➔ etc., until the path is completely processed
- ➔ **Conclusion mechanism**: determination of the start node
  - ➔ usually implicit
- ➔ **Global names**: resolution independent of specific context
- ➔ **Local names**: resolution is context-dependent
  - ➔ e.g. pathname relative to working directory in Unix



### Implementation of Naming Services

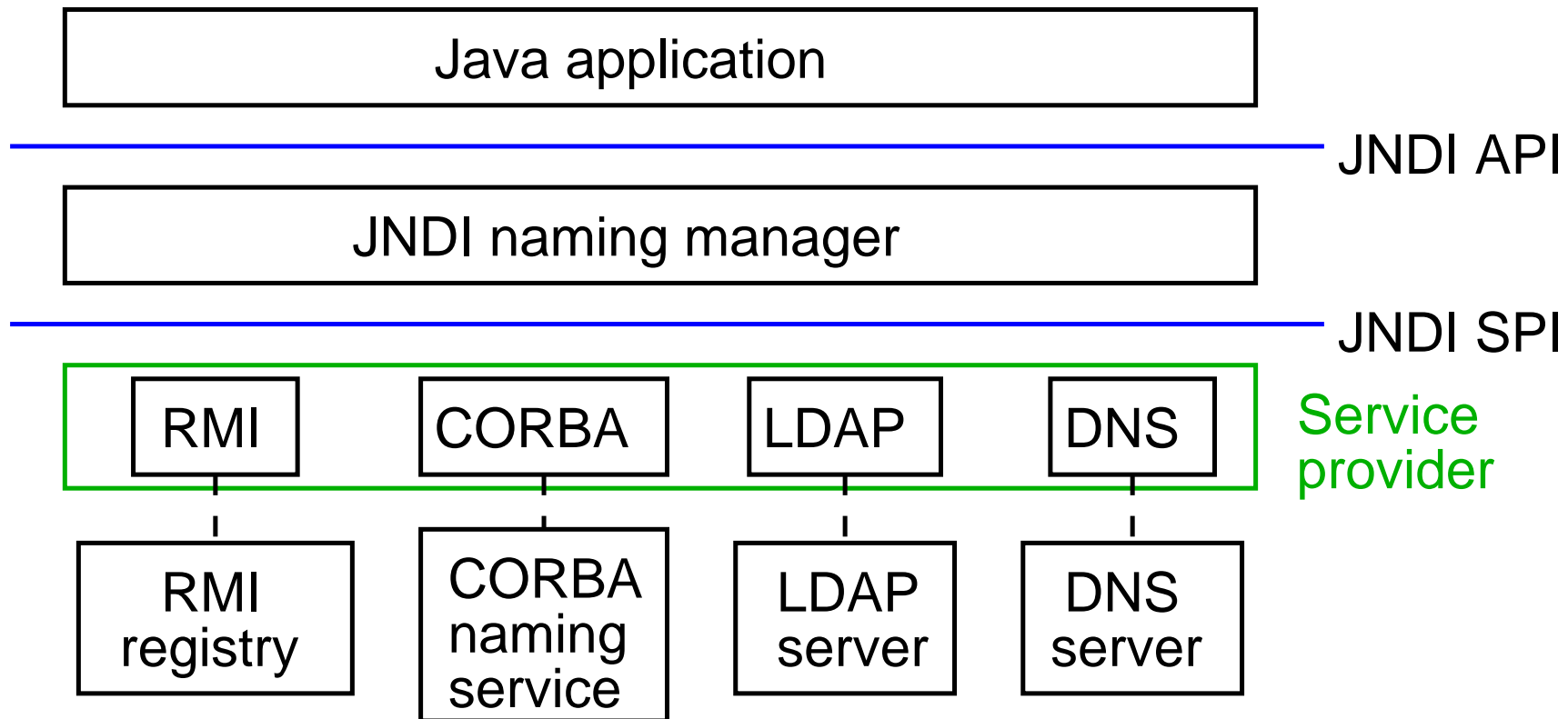
- ➔ Typical operations:
  - ➔ bind(name, address, attributes)
  - ➔ lookup(name, attributes)  $\Rightarrow$  address, attributes
  - ➔ unbind(name, address)
- ➔ In distributed systems:
  - ➔ namespace is stored distributed (usually hierarchically)
  - ➔ for high availability: additionally replicated storage
- ➔ Name resolution can be iterative or recursive
  - ➔ iterative: Server responds with address of next server
  - ➔ recursive: server requests even at next server
- ➔ Example: *Domain Name System* (👉 **RN\_I, 11.1**)



## 4.2 Example: JNDI



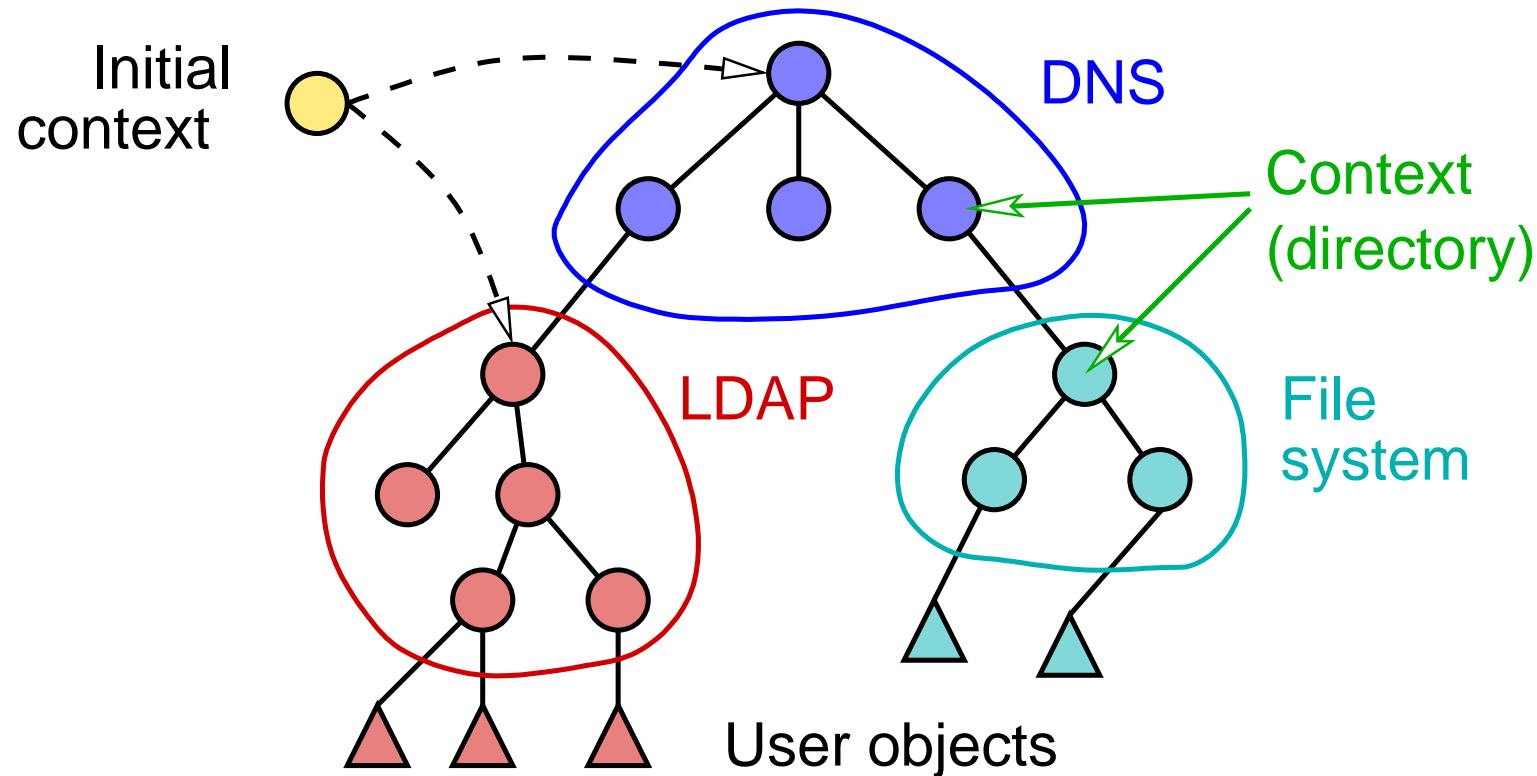
- ➔ JNDI: *Java Naming and Directory Interface*
- ➔ API for access to different name and directory services
  - ➔ directory service also stores attributes of objects



## 4.2 Example: JNDI ...



- ➔ JNDI supports compound namespaces
  - ➔ managed by various name or directory services



- ➔ Directories are called “contexts”
  - ➔ objects are bound to names within a context



### The Interface `javax.naming.Context` for Naming Contexts

➔ Important methods:

- ➔ `bind()`, `rebind()` : bind objects to names
  - ➔ `bind()` throws exception if name already exists
- ➔ `unbind()` : remove names
- ➔ `rename()` : rename
- ➔ `lookup()` : resolve name to object
- ➔ `listBindings()` : list of all bindings
- ➔ `createSubcontext()` : create sub-context
- ➔ `destroySubcontext()` : delete sub-context



### The Interface `javax.naming.Context` for Naming Contexts ...

- ➔ Implementation class `InitialContext`
  - ➔ for initial context (depending on the concrete name service)
    - ➔ `Context iC = new InitialContext(properties);`
  - ➔ configuration via `Properties` object (`Hashtable`), among others:
    - ➔ `"java.naming.factory.initial"`
      - ➔ factory for `InitialContext`
    - ➔ `"java.naming.provider.url"`
      - ➔ contact information for service provider
    - ➔ `"java.naming.security.principal"` and `"java.naming.security.credentials"`
      - ➔ user name and password for authentication



### Example: Accessing the RMI Registry

```
import javax.naming.*;
```

```
...
```

```
Properties props = new Properties();  
props.put("java.naming.factory.initial",  
    "com.sun.jndi.rmi.registry.RegistryContextFactory");  
props.put("java.naming.provider.url",  
    "rmi://localhost:1099");  
Context ctx = new InitialContext(props);  
  
obj = (Hello)ctx.lookup("Hello-Server");  
  
message = obj.sayHello();
```



### Example: Accessing a Local File System

```
import javax.naming.*;
```

```
....
```

```
Properties props = new Properties();  
props.put("java.naming.factory.initial",  
         "com.sun.jndi.fscontext.RefFSContextFactory");  
Context ctx = new InitialContext(props);
```

```
for (int i=0; i<args.length-1; i++)  
    ctx = (Context)ctx.lookup(args[i]);  
NamingEnumeration<Binding> list  
    = ctx.listBindings(args[args.length-1]);  
while (list.hasMore()) {  
    Binding b = list.next();  
    System.out.println(b.getName()+" : "+b.getClassName());  
}
```