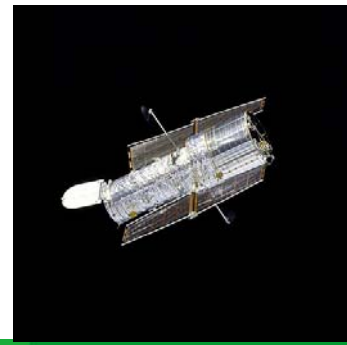
Hubble: An Advanced Dynamic Folder Technology for XML

Ning Li Joshua Hui Hui-I Hsiao Kevin Beyer

IBM Almaden Research Center
California, USA



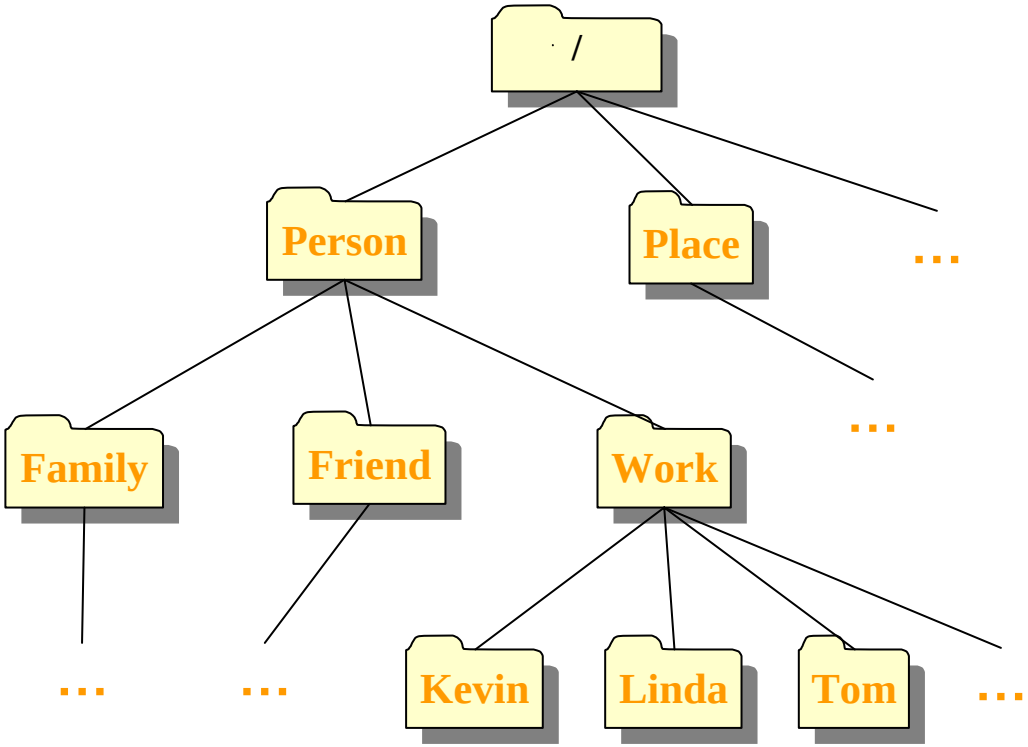
Background

- Folder/directory hierarchy
  - People are familiar and comfortable with it
- Amount of information grows faster than people can manage effectively
  - Challenge: organizing large document collections such that information can be found easily and quickly
- XML and XPath/XQuery
  - Large amount of XML documents and data collections generated everyday
  - XML documents are self describing
  - New challenge and new opportunity

Hubble Objective

- Fully exploit data model and semantics of XML
- Build and manage folders dynamically and efficiently
- Precise categorization and powerful features

Example Folder Hierarchy

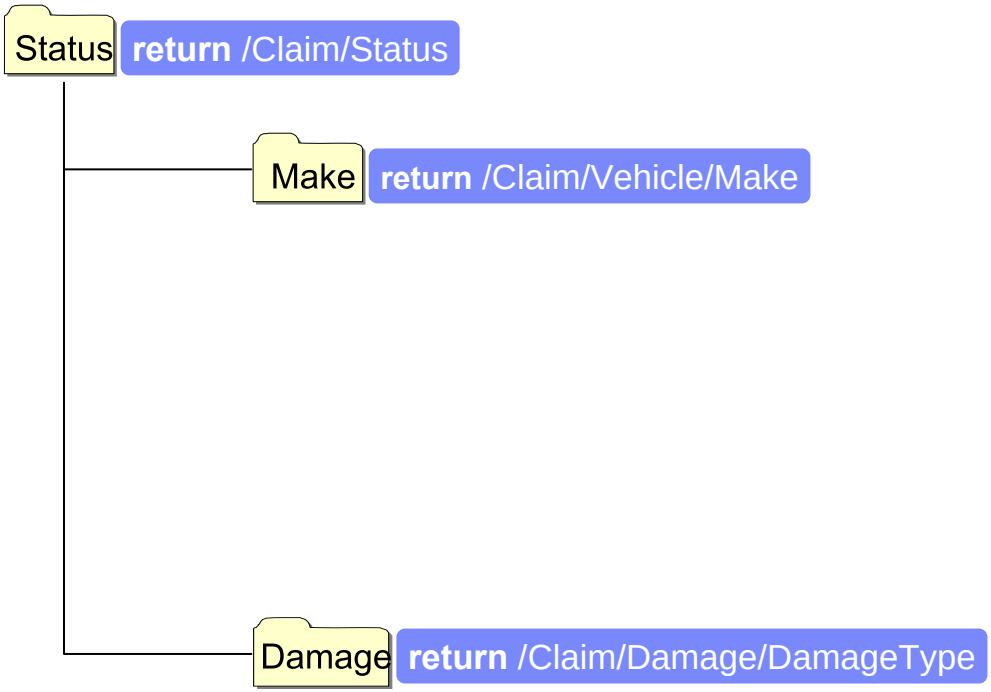


Hubble Core

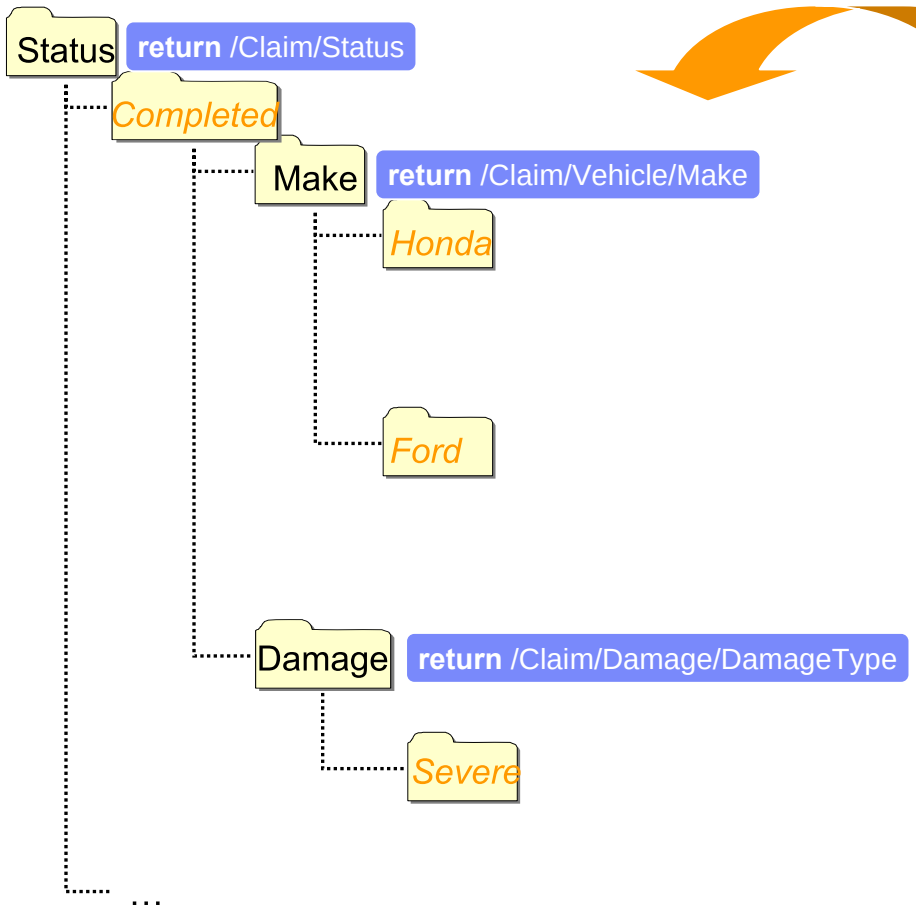
- Design-time folder *df* = (*dn*, *dq*)
  dn: name of the design-time folder
  dq: definition of the design-time folder specified in XQuery
  - Functions supported on *df*
    parentDf(df) returns the parent design-time folder of df
    childDfs(*df*) returns the set of child design-time folders of *df*

- Runtime folder *rf* = (*df*, *rv*)
  df: design-time folder that rf corresponds to
  rv: runtime value either defined in *df* or dynamically generated
  - Functions supported on *rf*
    parentRf(rf) returns the parent runtime folder of rf
    childRfs(rf) returns the set of child runtime folders of rf
    childDocs(*rf*) returns the set of documents contained in *rf*
    inRfs(*doc*) returns the set of runtime folders that contain *doc*

Design-time Folder Hierarchy



Runtime Folder Generation

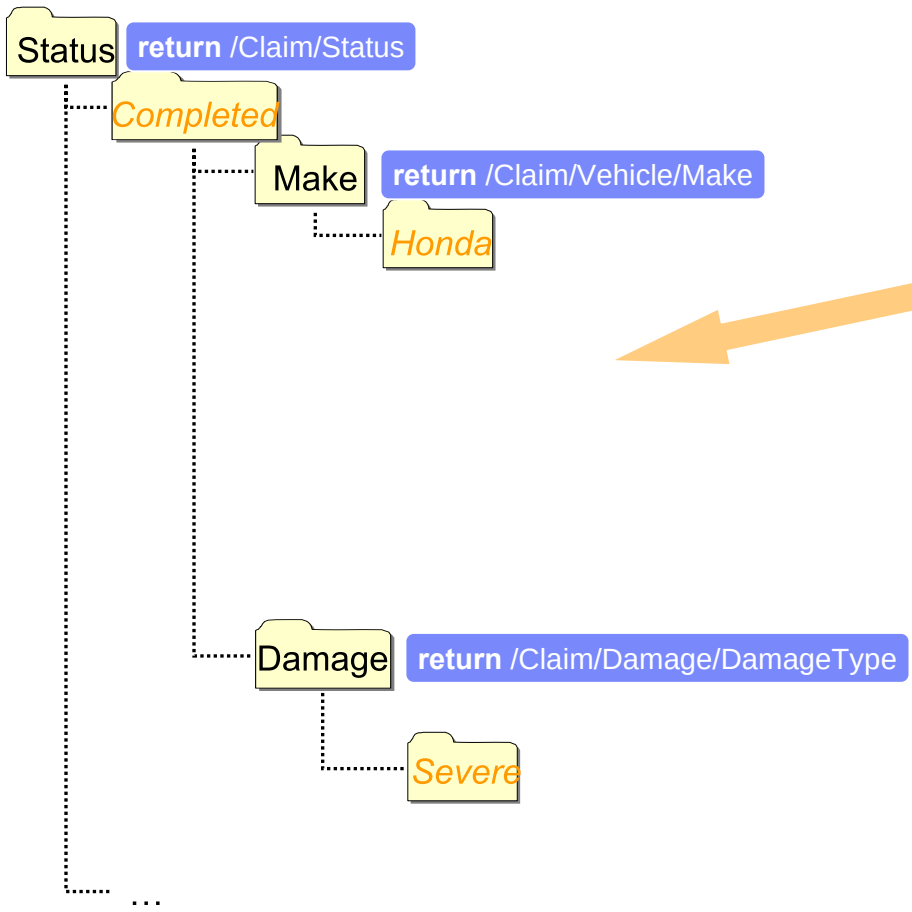



```
<Claim>
  <Status>Completed</Status>
  <Vehicle>
    <Make>Honda</Make>
    <Model>Accord</Model>
  </Vehicle>
  <Vehicle>
    <Make>Ford</Make>
    <Model>Focus</Model>
  </Vehicle>
  <Damage>
    <DamageType>Severe</DamageType>
   ...
  </Damage>
 ...
</Claim>
```

Runtime Folder Management

- Automatic creation/deletion

Runtime Folder Maintenance

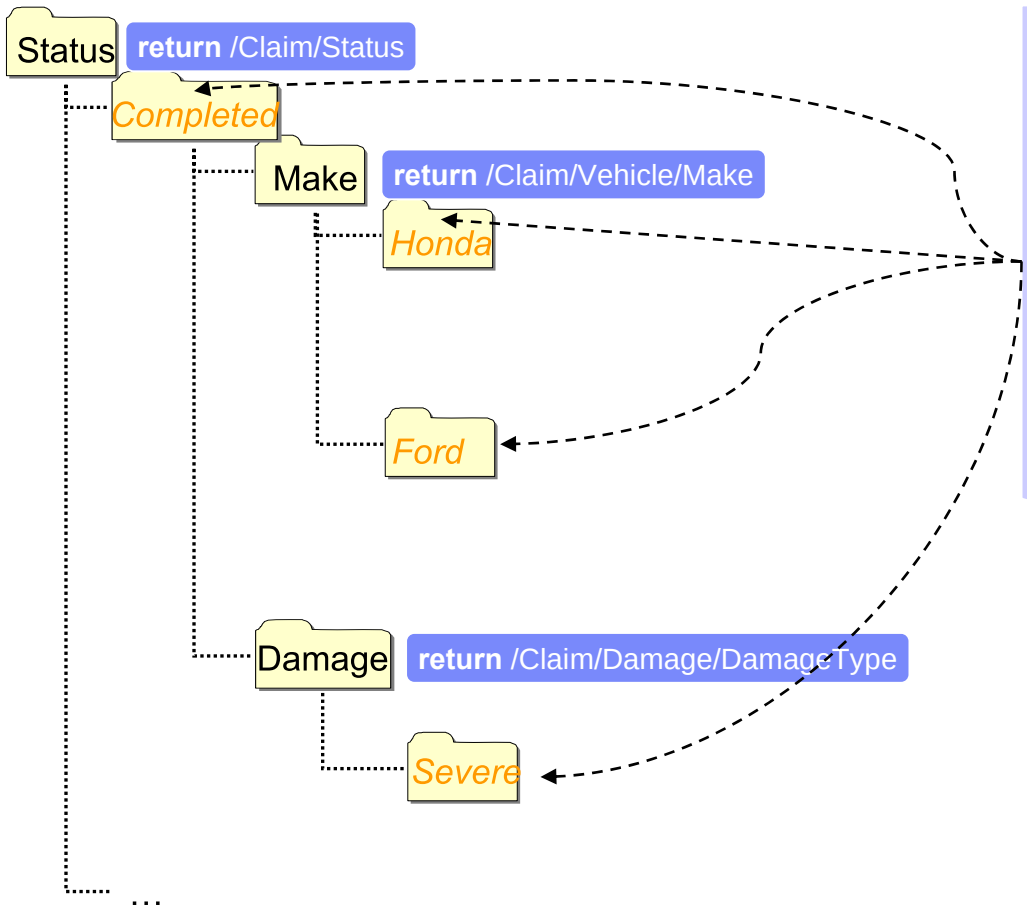



```
<Claim>
  <Status>Completed</Status>
  <Vehicle>
    <Make>Honda</Make>
    <Model>Accord</Model>
  </Vehicle>
  <Vehicle>
    <Make>Ford</Make>
    <Model>Focus</Model>
  </Vehicle>
  <Damage>
    <DamageType>Severe</DamageType>
    ...
  </Damage>
  ...
</Claim>
```

Runtime Folder Management

- Automatic creation/deletion

Reverse Navigation

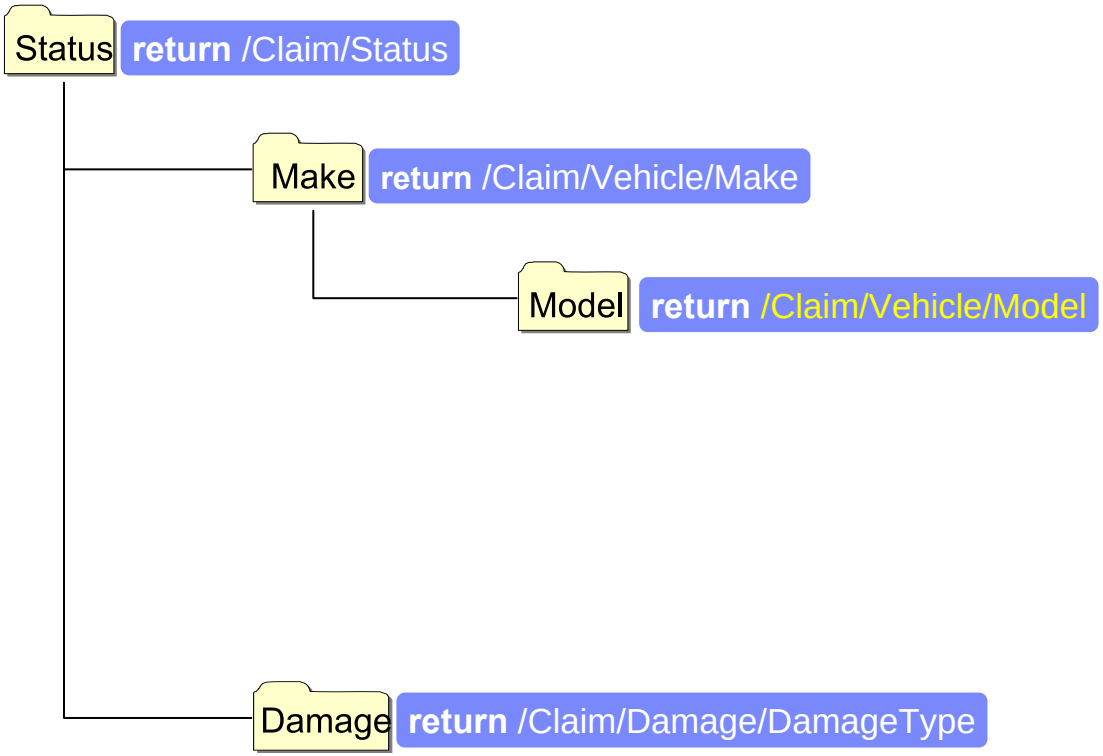



```
<Claim>
  <Status>Completed</Status>
  <Vehicle>
    <Make>Honda</Make>
    <Model>Accord</Model>
  </Vehicle>
  <Vehicle>
    <Make>Ford</Make>
    <Model>Focus</Model>
  </Vehicle>
  <Damage>
    <DamageType>Severe</DamageType>
   ...
  </Damage>
 ...
</Claim>
```

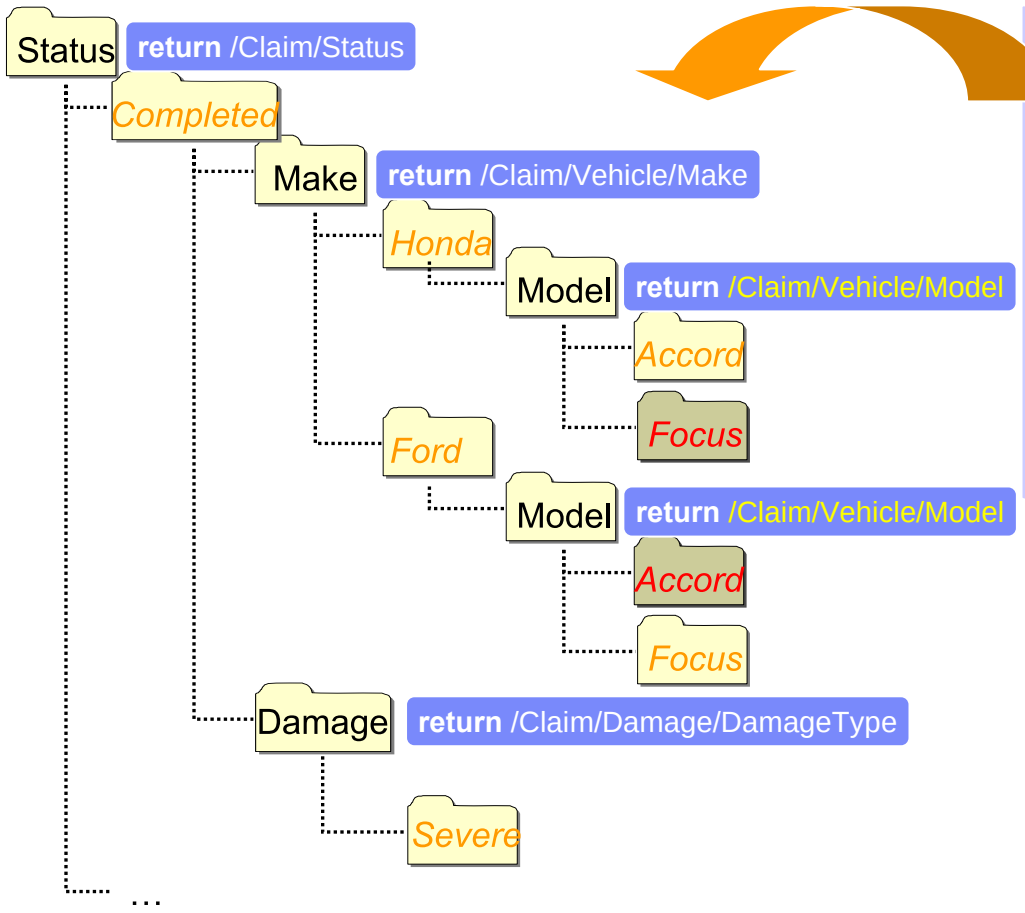
Runtime Folder Management

- Automatic creation/deletion
- Auto-identification of runtime folders that contain an item

Extend the Example

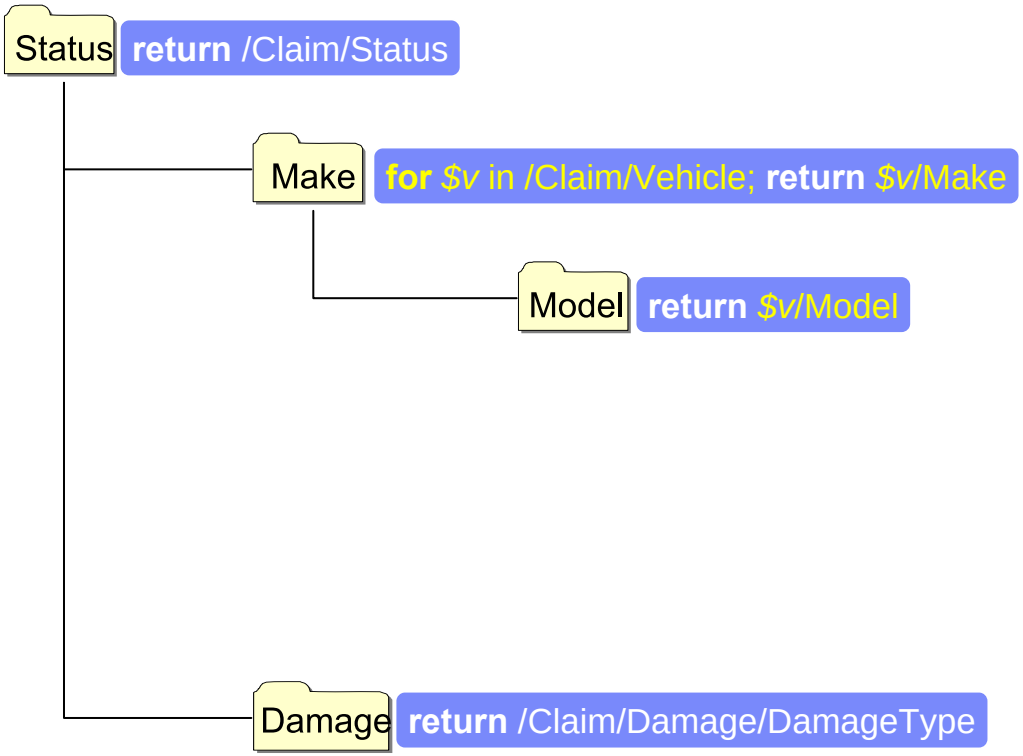


Extend the Example




```
<Claim>
  <Status>Completed</Status>
  <Vehicle>
    <Make>Honda</Make>
    <Model>Accord</Model>
  </Vehicle>
  <Vehicle>
    <Make>Ford</Make>
    <Model>Focus</Model>
  </Vehicle>
  <Damage>
    <DamageType>Severe</DamageType>
    ...
  </Damage>
  ...
</Claim>
```

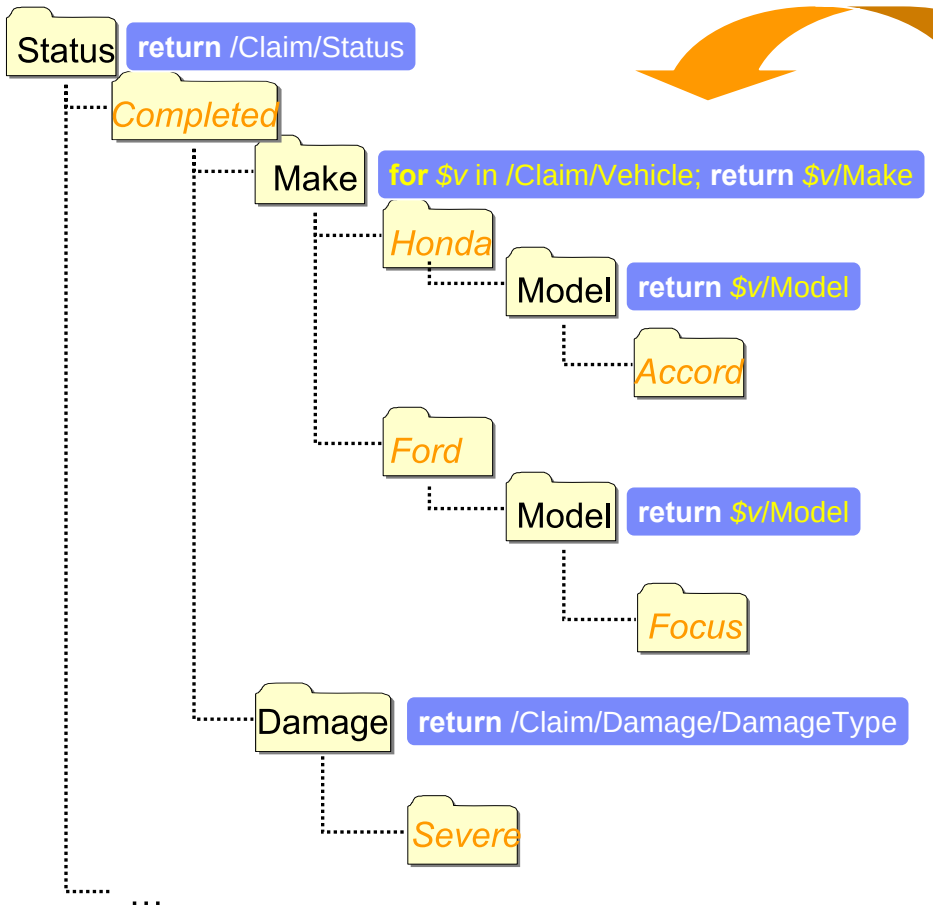
Variable Binding Mechanism



Extend definition of a design-time folder

- Variable bindings
  - Name of the variable
  - Definition of the variable specified in XQuery
- Query definition
  - Use variables defined in this folder or any ancestor folder

Example with Variable Binding

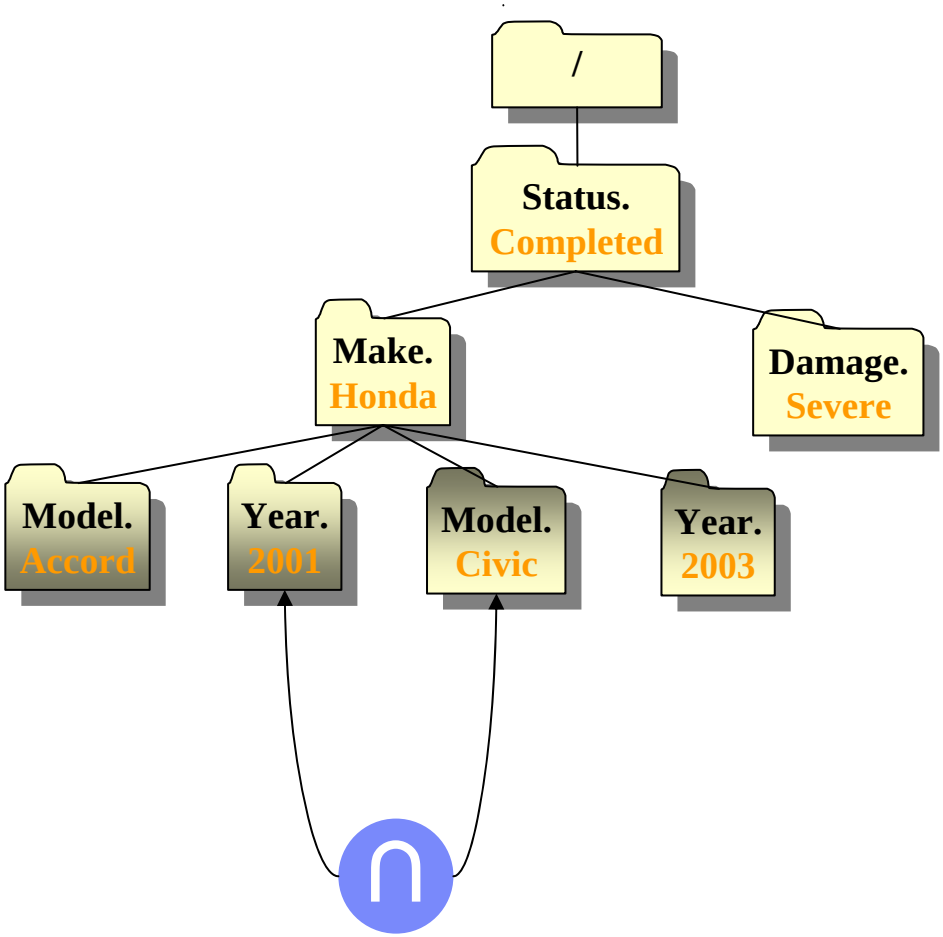



```
<Claim>
  <Status>Completed</Status>
  <Vehicle>
    <Make>Honda</Make>
    <Model>Accord</Model>
  </Vehicle>
  <Vehicle>
    <Make>Ford</Make>
    <Model>Focus</Model>
  </Vehicle>
  <Damage>
    <DamageType>Severe</DamageType>
    ...
  </Damage>
  ...
</Claim>
```

Advanced Operation

- Multi-path navigation
  - Operations
    - Intersection
    - Union
    - Difference
  - Semantics
    - Instance-based semantics – set operation on the documents contained in the runtime folders
    - Definition-based semantics – set operation on the query definitions

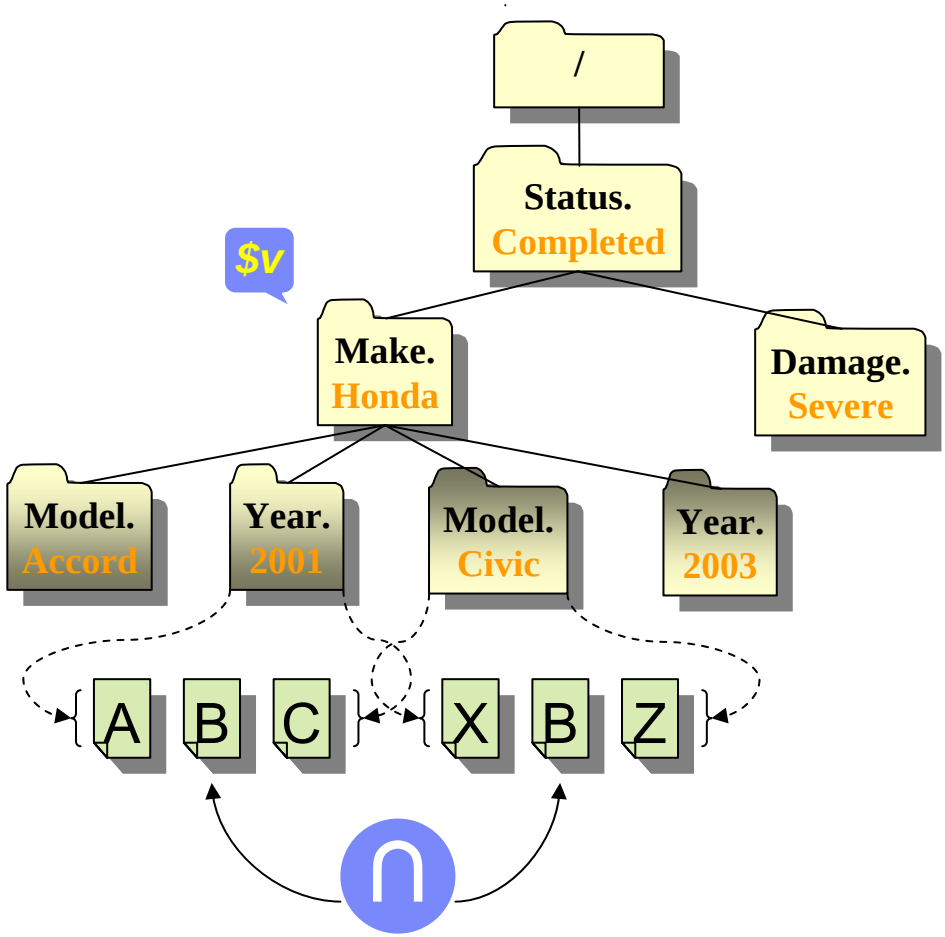
Multi-path Navigation Example



Add design-time folder Year

- Query: $v/Year

Instance-based Semantics

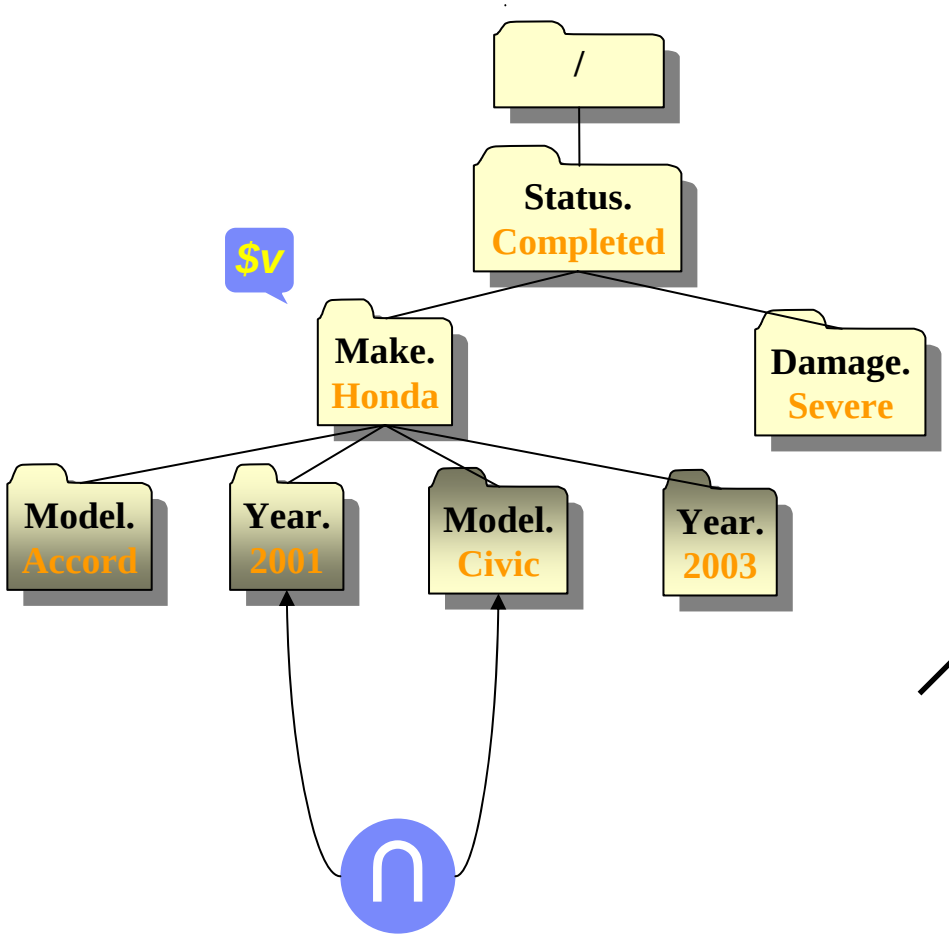



```
for $doc in context(),
    $v1 in $doc/Claim/Vehicle,
  where $doc/Claim/Status = “completed” and
    $v1/Make = “Honda” and
    $v1/Model = “Civic”
  return $doc
intersect
  for $doc in context(),
    $v2 in $doc/Claim/Vehicle
  where $doc/Claim/Status = “completed” and
    $v2/Make = “Honda” and
    $v2/Year = 2001
  return $doc
```

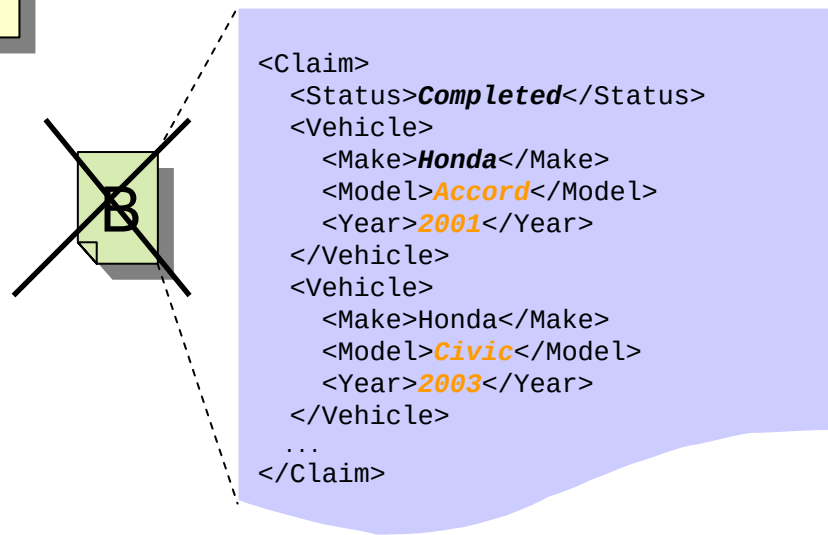
➔

```
for $doc in context(),
    $v1 in $doc/Claim/Vehicle,
    $v2 in $doc/Claim/Vehicle
  where $doc/Claim/Status = “completed” and
    ($v1/Make = “Honda” and
     $v1/Model = “Civic”) and
    ($v2/Make = “Honda” and
     $v2/Year = 2001)
  return $doc
```

Definition-based Semantics




```
for $doc in context(),
   $v in $doc/Claim/Vehicle
where $doc/Claim/Status = “completed” and
   $v/Make = “Honda” and
   ($v/Model = “Civic” and
    $v/Year = 2001)
return $doc
```



```
<Claim>
  <Status>Completed</Status>
  <Vehicle>
    <Make>Honda</Make>
    <Model>Accord</Model>
    <Year>2001</Year>
  </Vehicle>
  <Vehicle>
    <Make>Honda</Make>
    <Model>Civic</Model>
    <Year>2003</Year>
  </Vehicle>
  ...
</Claim>
```

Multi-collection Operation – Folder definition referencing documents in other collection

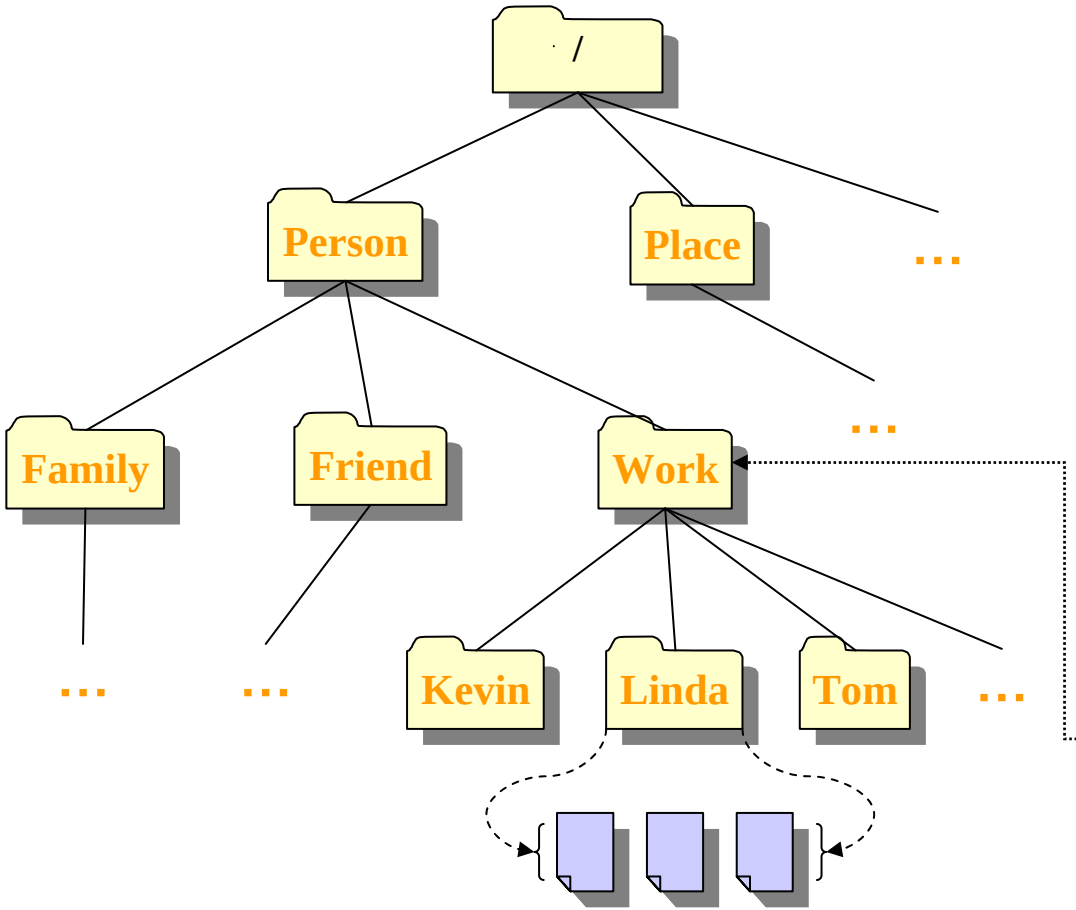


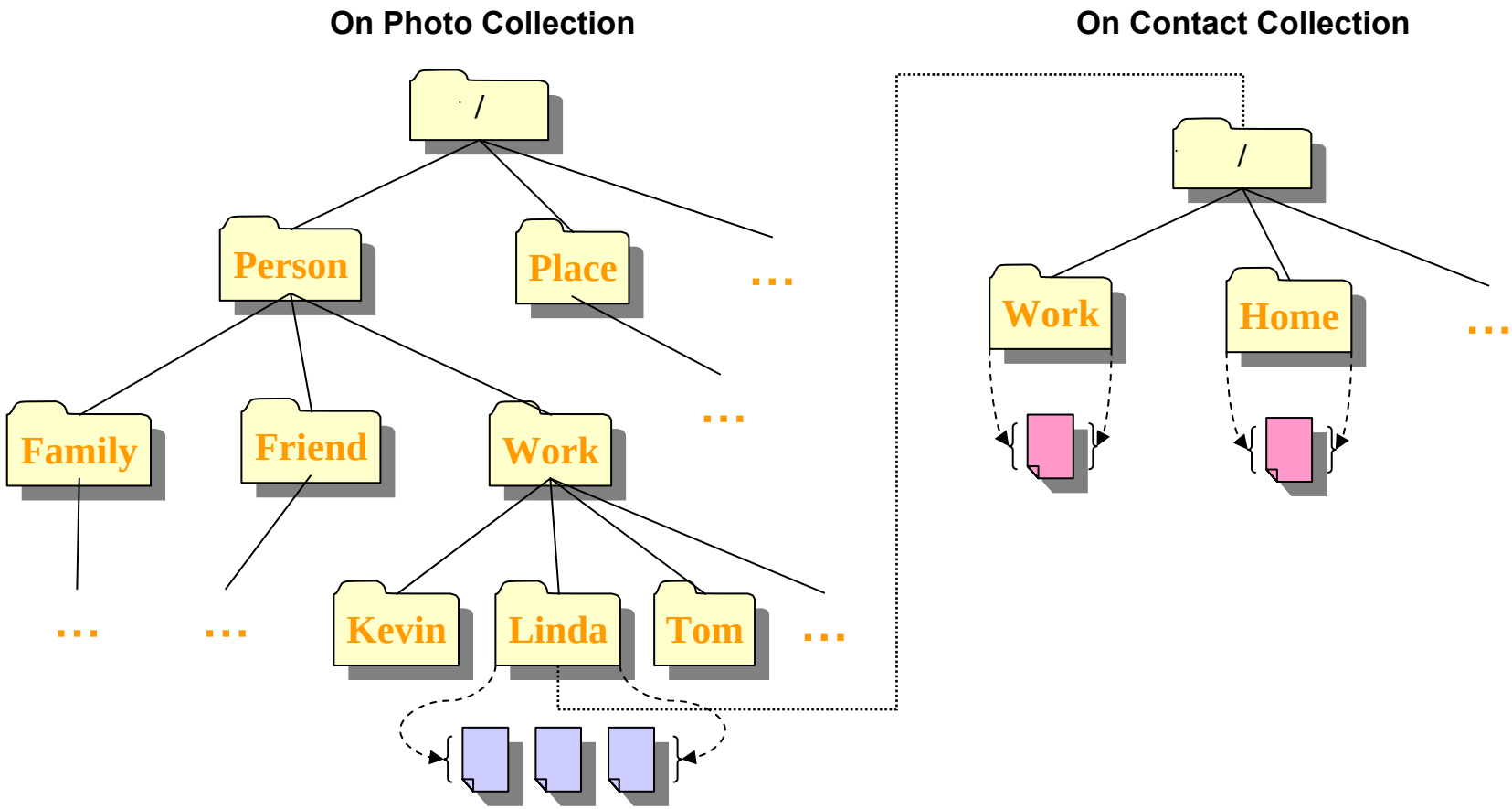
Photo Collection

```
<Photo>
  <Who>
    <Name>Linda</Name>
    <Name>Sandy</Name>
  </Who>
  <Where>
    <Park>Yosemite</Park>
    <State>CA</State>
  </Where>
  ...
</Photo>
```

Contact Collection

```
<Contact>
  <Name>Linda</Name>
  <Relation>Work</Relation>
  <Affiliation>IBM</Affiliation>
  ...
</Contact>
```

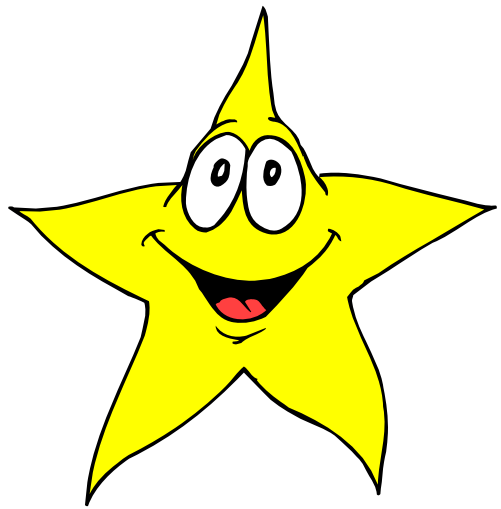
Multi-collection Operation – Folder traversal to folders/documents in other collections



Summary

- Hubble
  - Advanced dynamic folder technology
  - Peek deeply into the detail of XML documents
  - Effectively and precisely categorize XML document collections
  - Provide advanced functions
    - Variable binding technology
    - Multi-path navigation
    - Multi-collection search and navigation
  - Experiments show efficiency and scalability

Questions ?



Hubble in Outer Space