The Distributed Computing KB Project

Peter Clark
Artificial Intelligence Laboratory
Dept. of Computer Science, UT Austin

Goals of the Research Group

- Develop technologies for construction and use of large, multipurpose **knowledge-bases**.
- **Knowledge Delivery Systems:** general-purpose methods for accessing and exploiting KB.

Structure of a Knowledge Base

- Basic units ("building blocks") denote domain **concepts**
- Building blocks connected together with links denoting **relationships** in the domain.
- **Machine-accessible:** Software can retrieve and reason with domain information from KB.

The DCKB Project

- Sponsored by DEC and ATP
- Seven months into 2 years project

The Project's Goals

- Apply knowledge-base (KB) technology to DCE
- Help assist DCE system administrators by augmenting manuals with inferred answers to users' questions (the "dynamic manual"):
  1. Customize answers
     - to user's specific DCE network
     - to desired level of detail
  2. Answer unanticipated questions
  3. Generate answers involving reasoning (eg. planning)

Example Outputs: 1.

TOPIC: BINDING-PROCESS

```
QUESTION:
Describe binding-process in my cell, between
        the client PayDay running on Slowbox
        the server Oracle running on Firewheel

ANSWER:
  *  First, PayDay queries the Cell Directory Server for
     a machine running Oracle. It receives the network-id
     of FireWheel.

  *  Then, PayDay queries the endpoint mapper running on
     FireWheel for Oracle's endpoint.

  *  Now PayDay knows the full binding (network ID +
     endpoint) of Oracle.
```

Example Outputs: 2. Diagnosis

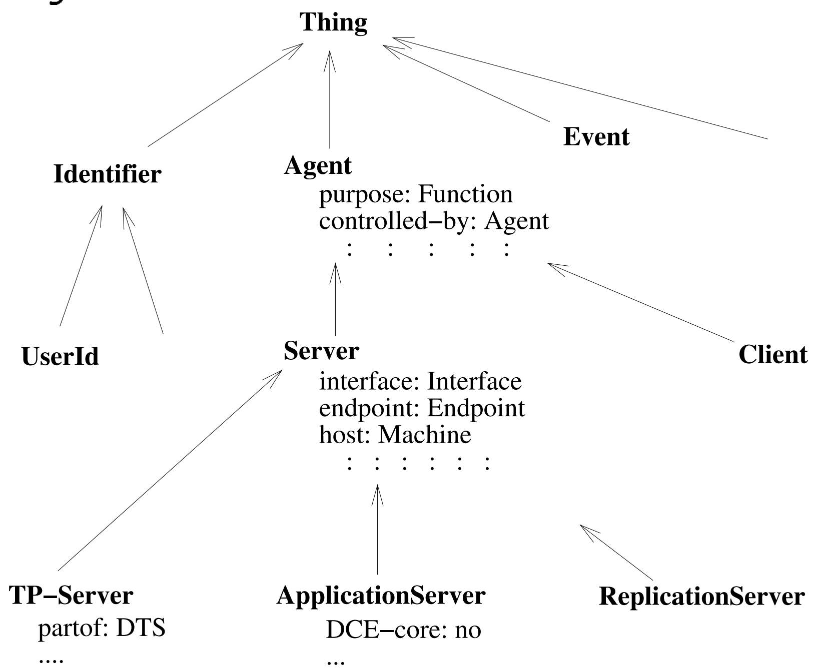
```
          TOPIC: ABORT-EVENT

QUESTION:
Diagnose cause of abort-event.

What where you doing when the problem occurred?

 1. Normal usage of a DCE application program.
 2. Adding data to the CDS namespace
 3. ...

Customise? y

What happens?

 1. PayDay aborts with a 'unable to locate server' error.
 2. PayDay aborts with a 'missing endpoint' error.
 3. ...

This could be because Oracle failed to register its
endpoint with the endpoint-mapper during server-startup.
To confirm this, ask the endpoint-mapper on Firewheel if
it has the server's endpoint registered in its database.
To fix it, restart Oracle.
```

Example Outputs: 3. Planning

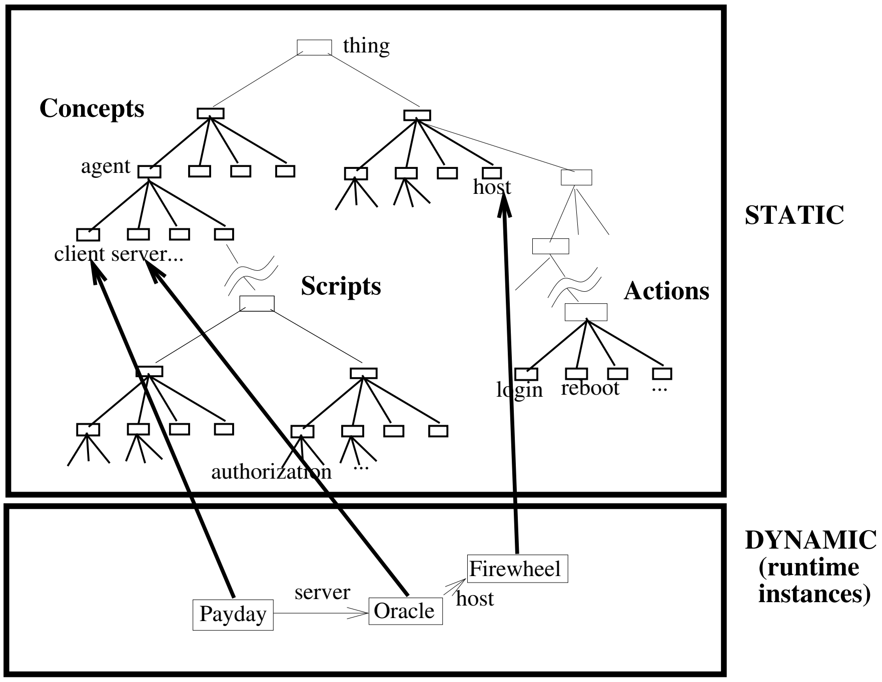
```
          TOPIC: PASSWORD-LIFESPAN

QUESTION:
How do I change password-lifespan?

Customise:
   For which organization: payroll
   New password lifespan: forever

Response:
        1. Log on as the cell administrator

                % dce_login cell_admin -dce-

        2. Start up the registry editor

                % rgy_edit

        3. Switch to the "organization" domain

                rgy_edit=> do org

        4. Change the attributes for the payroll organization:

                rgy_edit=> change payroll
                ...
                Enter account lifespan: forever
                rgy_edit=>
```

The Knowledge Base

- Extended frame-based representation language
- Each concept is a frame, organized in taxonomy



Structure of The KB



Concepts: building–blocks of DCE domain

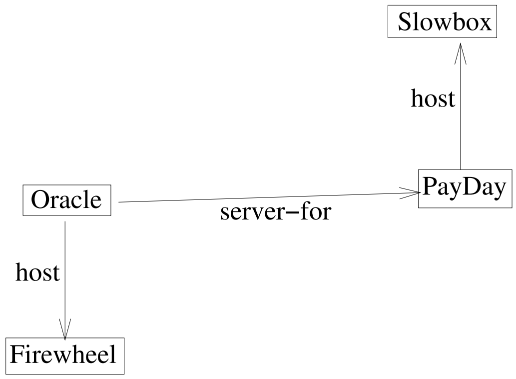
Scripts: stereotyped sequences of events

Actions: can change state of network

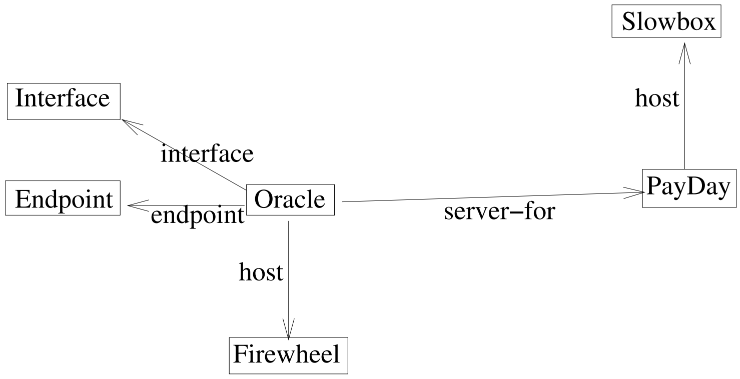
Elaboration of the run–time graph, using inheritance

From a "seed" description of the user's network, the KB can elaborate each component using inheritance to produce a full description of the user's DCE network.

1.



2.



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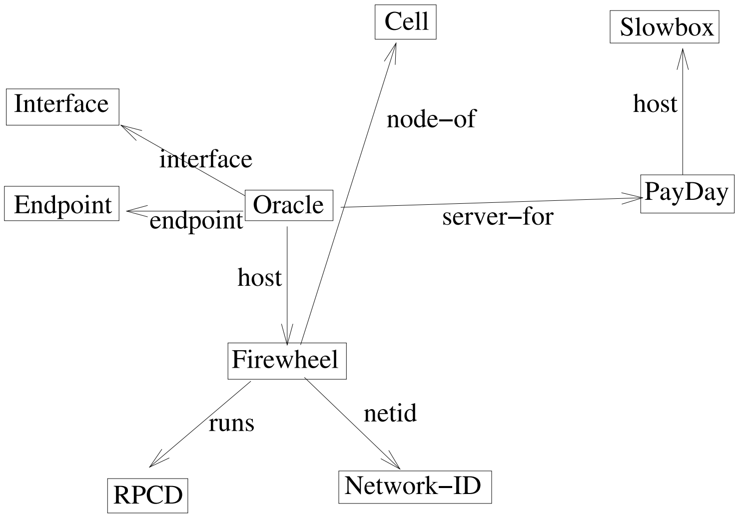
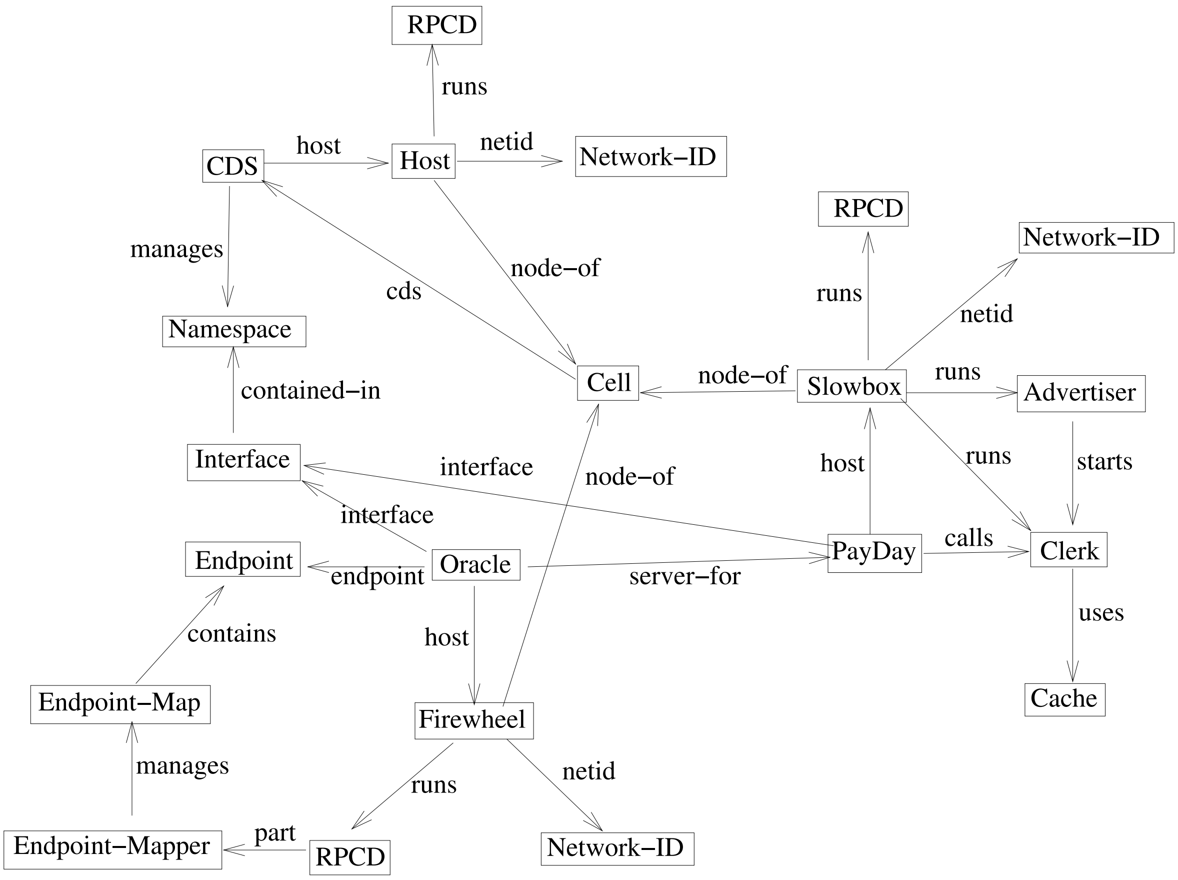
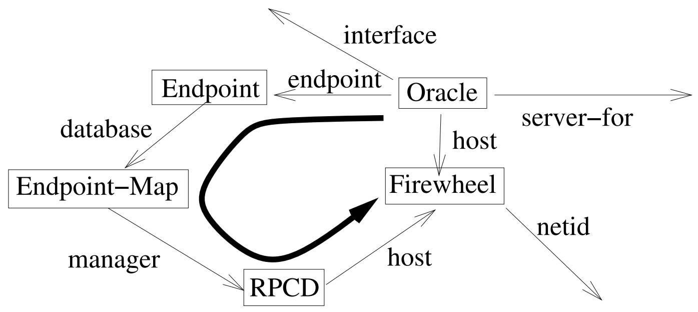



RPCD
runs
CDS
host
Host
netid
Network−ID
manages
cds
node−of
RPCD
Network−ID
Namespace
runs
netid
contained−in
Cell
node−of
Slowbox
runs
Advertiser
Interface
interface
node−of
host
runs
starts
interface
Endpoint
endpoint
Oracle
server−for
PayDay
calls
Clerk
contains
host
uses
Endpoint−Map
Firewheel
Cache
manages
runs
netid
Endpoint−Mapper
part
RPCD
Network−ID

The Knowledge Server

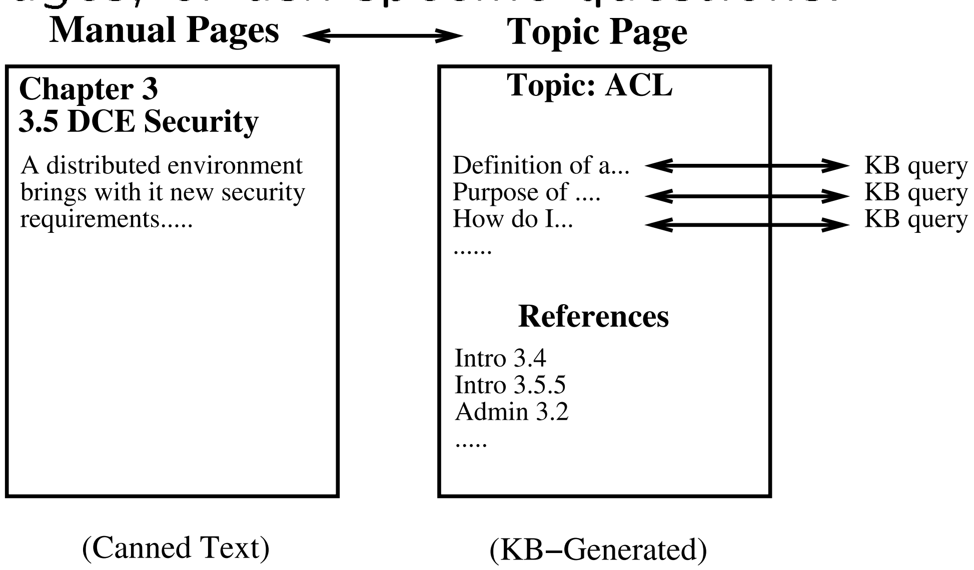
- KB acts as a "knowledge server" for applications.
- Low-level access via pseudo-English query language. Generates dynamic graph as needed.

```
DCKB> (the server)
Oracle
DCKB> (the host of (the manager of (the database of
               (the endpoint of (the server))))
Firewheel



DCKB> (the owner of (the key of (the ciphertext of
             (the ticket of (the client)))))
Oracle
DCKB> (the authorised-user of (the program with
                   (controls (certificate-lifetime)))
cell-administrator
```



Integration with Manual Pages

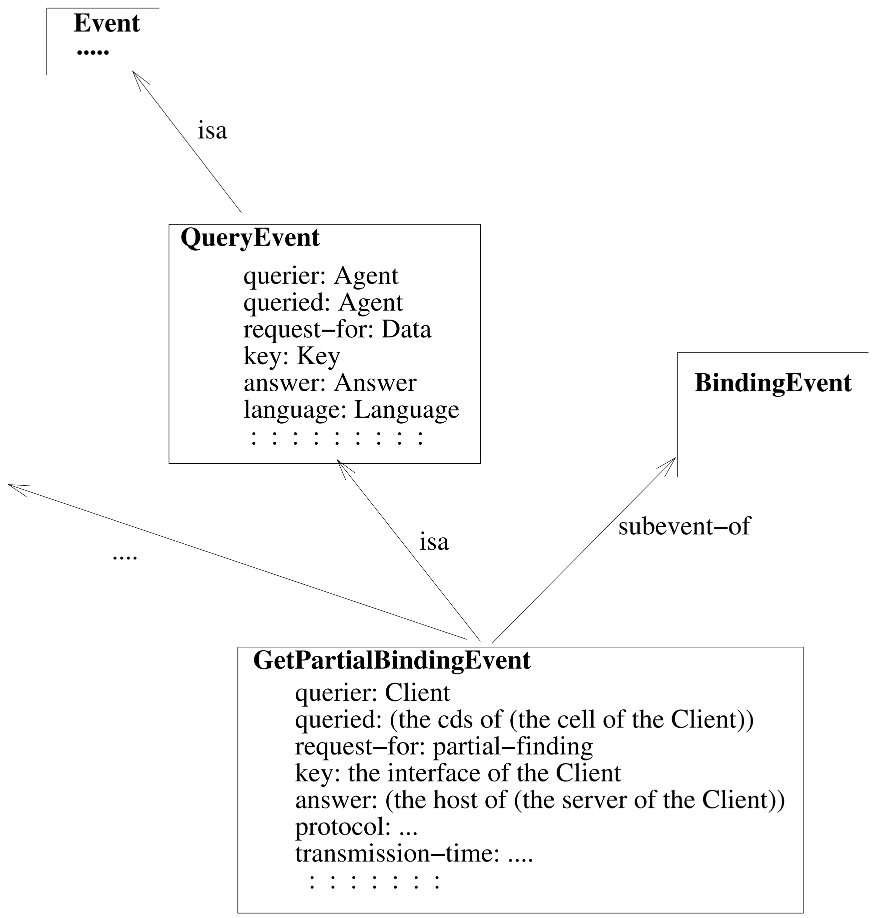
- Given concepts (and their English), can automatically hypertextize documents.
- 'hot-spots' take user to a page about a particular concept (the **topic**)
- From there, can index back to other man pages, or ask specific questions.



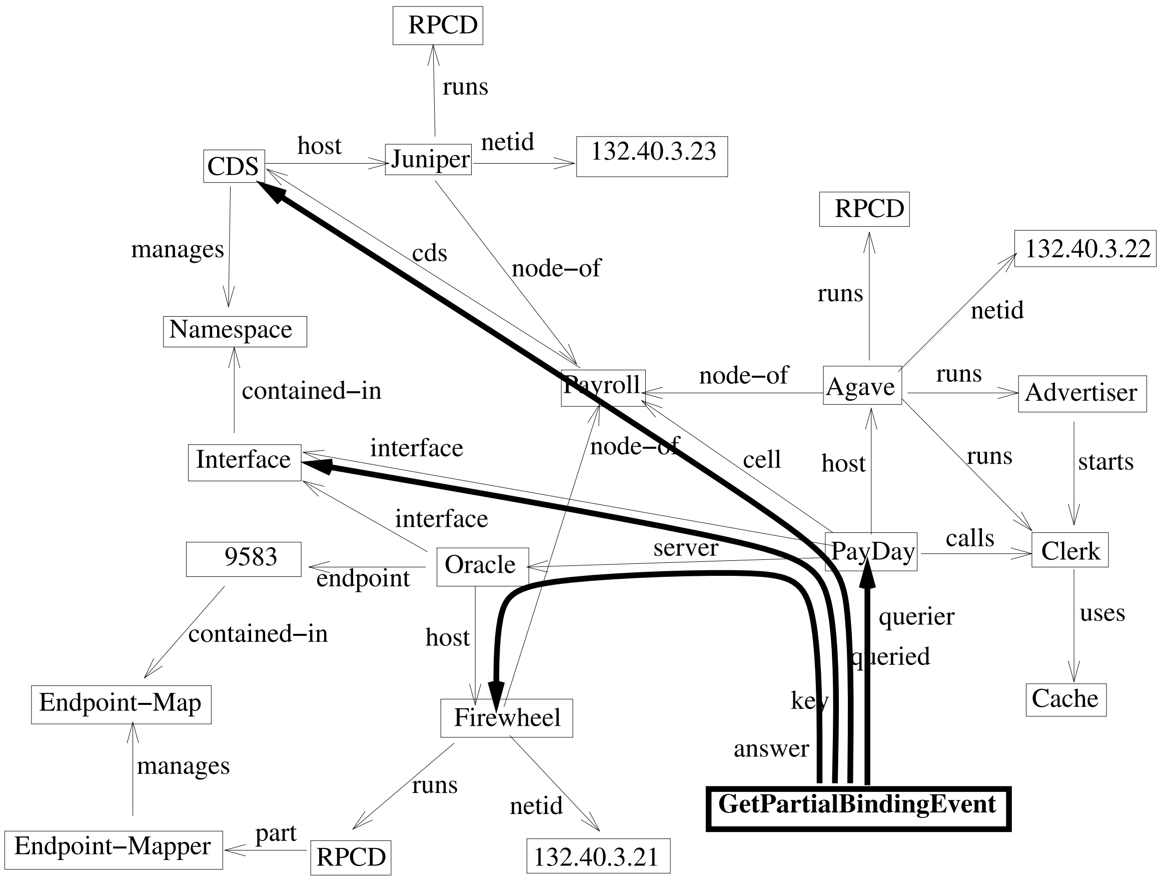
Knowledge Delivery Software

Knowledge Delivery Software feeds off the KB.

- Each question type has corresponding answer procedure.
- (Ideally) question types are **domain-general** (eg. "describe <event>", "define <object>")
- Answer procedures interface with KB using general terms (eg. "<querier> in <query-event>")
- In KB, expressions relates specific concepts/events to these general terms.



Event
.....
isa
QueryEvent
querier: Agent
queried: Agent
request–for: Data
key: Key
answer: Answer
language: Language
: : : : : : : : :
BindingEvent
....
isa
subevent–of
GetPartialBindingEvent
querier: Client
queried: (the cds of (the cell of the Client))
request–for: partial–finding
key: the interface of the Client
answer: (the host of (the server of the Client))
protocol: ...
transmission–time: ....
: : : : : : :


RPCD
runs
CDS
host
Juniper
netid
132.40.3.23
RPCD
132.40.3.22
manages
cds
node−of
runs
netid
Namespace
contained−in
Payroll
node−of
Agave
runs
Advertiser
interface
node−of
cell
host
runs
starts
Interface
interface
9583
server
Oracle
endpoint
PayDay
calls
Clerk
querier
uses
contained−in
host
queried
Endpoint−Map
key
Cache
Firewheel
answer
manages
runs
netid
GetPartialBindingEvent
Endpoint−Mapper
part
RPCD
132.40.3.21

1. Explanation Generation ("Describe..")

Three layers of specification:

1. **"Explanation Schemas":** Specify what the explanation should contain.
   - a targetted, ordered sequence of 'views'.
   - eg. for `process`:
     significance →overview →subevents.
2. **Views:** A coherent subset of facts about a concept.
   eg. `summary` view of `SEND-EVENT`: retreive its `sender`, `message`, and `receiver`.
3. **Facts:** Relationships in the domain.

```
* First, the client sends the ticket to the Privilege
  Server.
* Then, the Privilege Server returns the client's
  PAC back to the user.
* ...
```

Conversion to English

Concepts: All concepts have corresponding a lexical entry (= English word).

Views: have a corresponding TEXT-Skeleton.

eg. `summary` view of `SEND-EVENT`:

`<sender> ‘‘sends’’ <message> ‘‘to’’ <receiver> ‘‘.’’.`

Schemas: Concatenate view sentences, maybe with embelishments, eg. itemizing, line-breaks.

DCKB: Explanation Schemas

1. **Describe-Event:**

   Foreach subevent of event:

   a. summarize the subevent

   b. if there are recursively more subevents, alert the user

   c. if there are any known problems which can occur, alert the user

2. **Describe-Plan:**

   Foreach step in plan:

   a. describe the step

   b. describe the actions required to perform the step

3. **Describe-Problem:**

   a. describe symptoms

   b. describe possible causes of the problem

   c. describe any confirming tests

   d. describe any remedies

4. **Describe-Object:** ...

2. Diagnosis ("Diagnose cause of...")

KB contains:

- Description of **events** (and their subevents etc.)
- **Error conditions** associated with events (symptoms, possible causes, confirming tests)

Diagnostic search algorithm:

- list classes of situations of using DCE
- for the user-selected one:
  . for all types of event involved:
  . for all subevents of the event:
  . present possible error conditions.
- for the user-selected error condition: show cause, confirming-test, remedy

(Special case of interactive search of KB)

3. Planning ("How Do I...?")

Actions – effect a *change* in the graph representation.

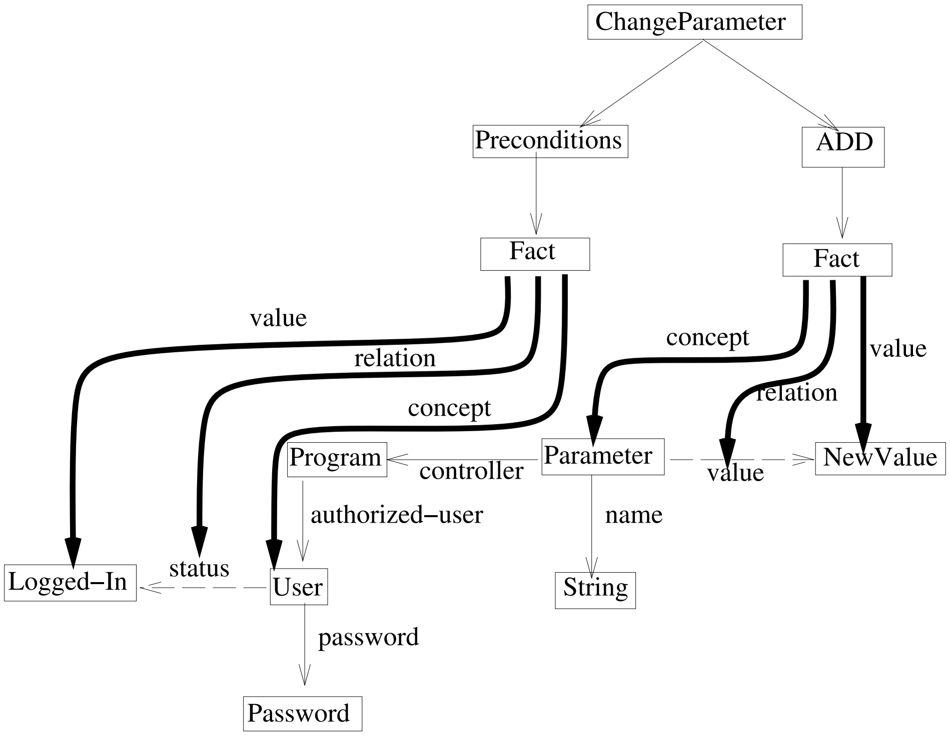
Again, is an extra layer on top of explanation generator.

For an action, can represent in KB:

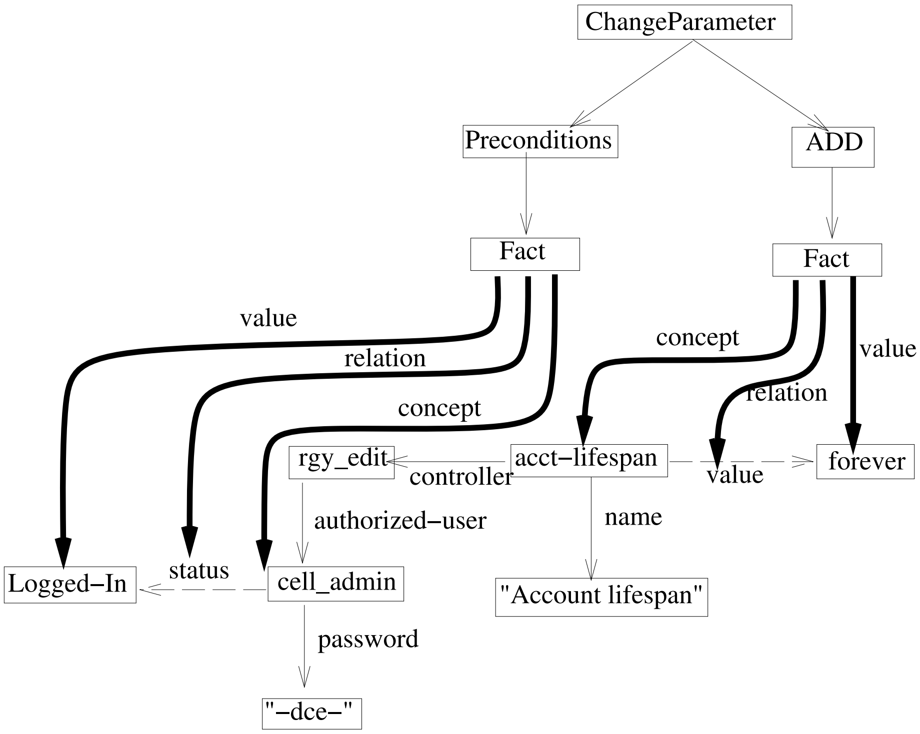
- The **changes** that the action will make in the graph
- The **preconditions** for the action to be applied

Use standard planning algorithm to find sequence of actions which will achieve desired goal.

Description of "ChangeParameter" action



Instantiation for changing acct−lifespan to "forever"



Discussion Items

Status: DCE glossary (500 concepts) as outline of the KB.

Scope: Some question types outside system's scope:

- Non-technical ("turf-related") questions
- Highly technical questions
- Cause/purpose questions difficult to formally represent

KB contains 'conceptual' not implementational model of DCE.

Research Issues and Plans

1. Scope: Develop KB on cell-admin subdomain (closure?)
2. Catalogue of Schemas and Viewpoint definitions
3. Coherent top-level of KB
   - Crucial foundation (extensibility, reusability)
4. KB Construction tools
   - Error detection
   - Data entry