Demo4: RESTViews and Transactions

Malcolm Crowe, 26 Oct 2022

Using SQL to access a REST service requires a little extra syntax. Pyrrho allows a modified CREATE VIEW syntax called RESTView:

CREATE VIEW id OF *rowtype* AS GET *url*

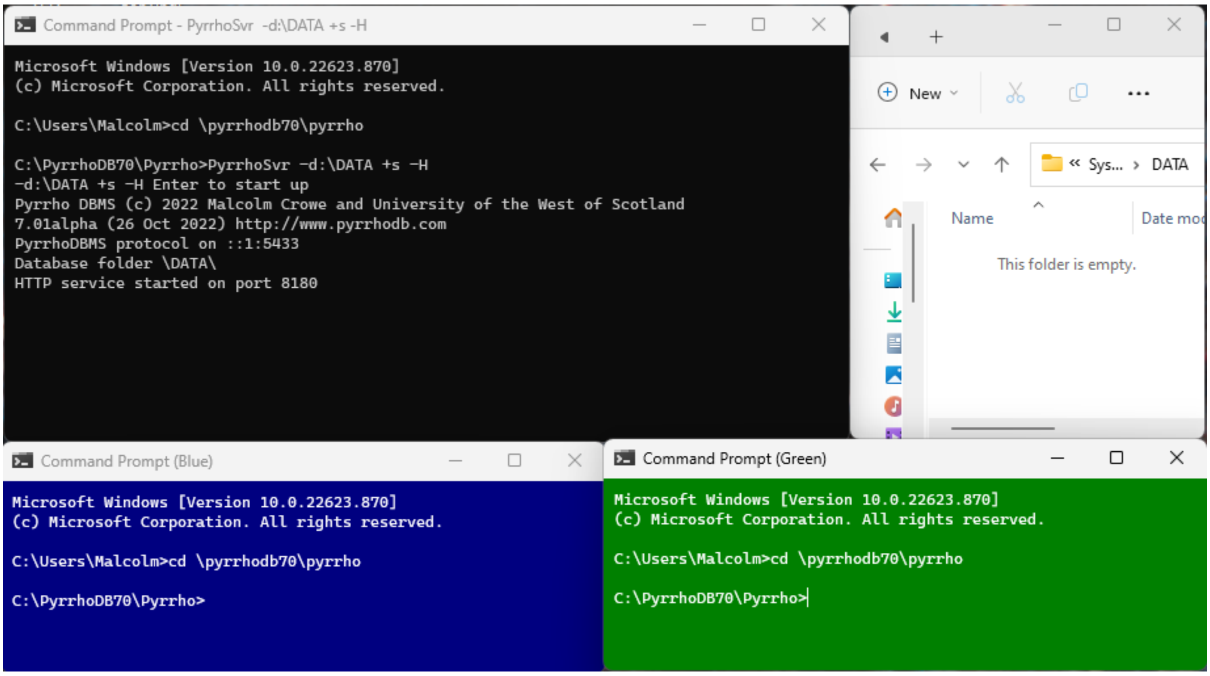
where rowtype is like a table definition, giving column names and domains. The url part can be a single-quoted string, but syntactically it is just Pyrrho-specific Metadata and various flags and additional items are possible for specifying mime types etc. Full details are in the Pyrrho manual, and we will see some examples in this demo.

To support transactions, we base our implementation on the use of entity-tags as in RFC 7232 (Fielding & Reschke, 2014). Very few actual REST services comply with this standard, so Pyrrho provides a suitable service. Then, as we will see, a REST round-trip is a branch transaction, that occurs at the main transaction commit point. The motivation for this example is the classic example of a transfer between two bank accounts, but here it is between two different banks, each with their own databases and need for serialized transactions. Communication between the banks will be over the Internet.

[158 @ 57:37]

This time the PyrrhoSvr needs to be started up with the command line shown to start the HTTP service (by default at localhost:8180) and provide some diagnostic feedback (type this line into the console window: do not paste from this document in case the minus signs are replaced by dashes):

PyrrhoSvr -d:\DATA +s -H



```
Microsoft Windows [Version 10.0.22623.870]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Malcolm>cd \pyrrhodb70\pyrrho

C:\PyrrhoDB70\Pyrrho>PyrrhoSvr -d:\DATA +s -H
-d:\DATA +s -H Enter to start up
Pyrrho DBMS (c) 2022 Malcolm Crowe and University of the West of Scotland
7.01alpha (26 Oct 2022) http://www.pyrrhodb.com
PyrrhoDBMS protocol on ::1:5433
Database folder \DATA\
HTTP service started on port 8180
```

```
Microsoft Windows [Version 10.0.22623.870]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Malcolm>cd \pyrrhodb70\pyrrho

C:\PyrrhoDB70\Pyrrho>
```

```
Microsoft Windows [Version 10.0.22623.870]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Malcolm>cd \pyrrhodb70\pyrrho

C:\PyrrhoDB70\Pyrrho>
```

Names of banks and accounts are kept short to fit on the presentation slides. In the blue window, give the command

PyrrhoCmd DB

to create the database for bank B. At the SQL> prompt set up an accounts table for bank B with the SQL statements

create table AB (id int, bal int)

insert into AB values (100,1000),(110,1400)

This gives us two bank accounts id=100 with balance 1000, and 110 with balance 1400. To enable access to this database over the network, at least one role and one user are required:

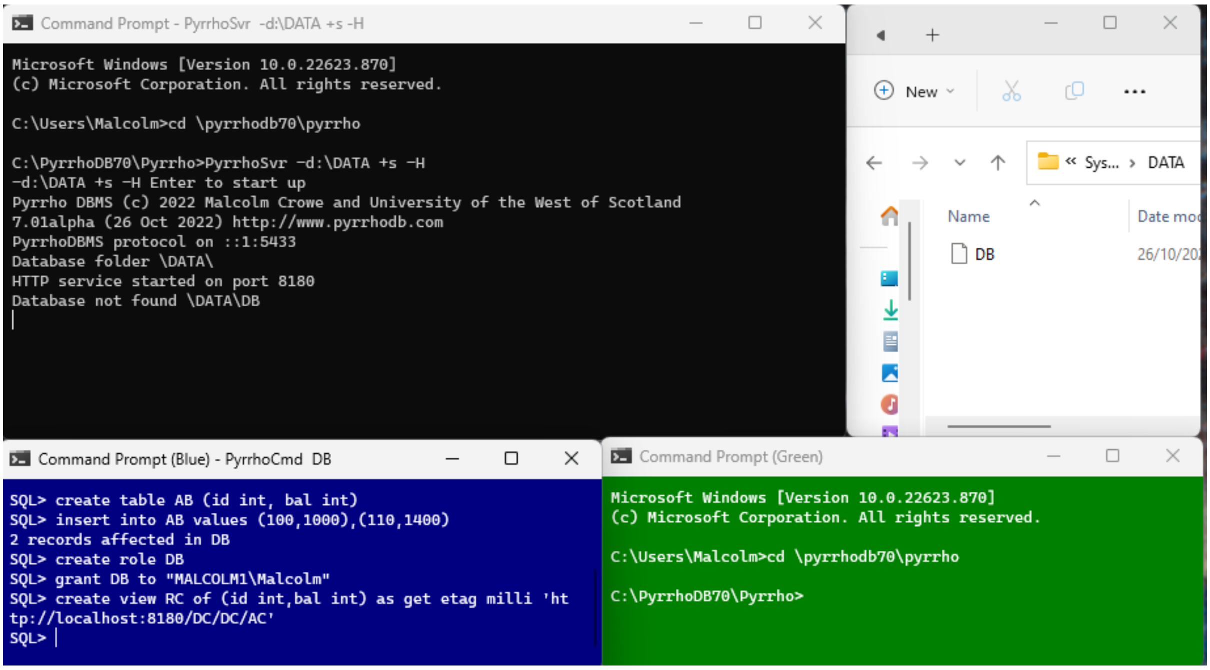
create role DB

grant DB to "*machine*\*user*"

where the current user identity is inserted surrounded by straight double-quotes. (You can find what this is with the command select user.) And we define a RESTView for bank C to use:

create view RC of (id int,bal int) as get etag milli 'http://localhost:8180/DC/DC/AC'

The url is enclosed in single-quotes as specified above, and the two metadata flags tell Pyrrho to enforce RFC 7232 with millisecond precision.



Command Prompt - PyrrhoSvr -d:\DATA +s -H

```
Microsoft Windows [Version 10.0.22623.870]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Malcolm>cd \pyrrhodb70\pyrrho

C:\PyrrhoDB70\Pyrrho>PyrrhoSvr -d:\DATA +s -H
-d:\DATA +s -H Enter to start up
Pyrrho DBMS (c) 2022 Malcolm Crowe and University of the West of Scotland
7.01alpha (26 Oct 2022) http://www.pyrrhodb.com
PyrrhoDBMS protocol on ::1:5433
Database folder \DATA\
HTTP service started on port 8180
Database not found \DATA\DB
```

Command Prompt (Blue) - PyrrhoCmd DB

```
SQL> create table AB (id int, bal int)
SQL> insert into AB values (100,1000),(110,1400)
2 records affected in DB
SQL> create role DB
SQL> grant DB to "MALCOLM1\Malcolm"
SQL> create view RC of (id int,bal int) as get etag milli 'ht
tp://localhost:8180/DC/DC/AC'
SQL>
```

Command Prompt (Green)

```
Microsoft Windows [Version 10.0.22623.870]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Malcolm>cd \pyrrhodb70\pyrrho

C:\PyrrhoDB70\Pyrrho>
```

[160] @ 59:47]

Do the same, mutatis mutandis, for bank C in the green window:

PyrrhoCmd DC

and then

create table AC (id int, bal int)

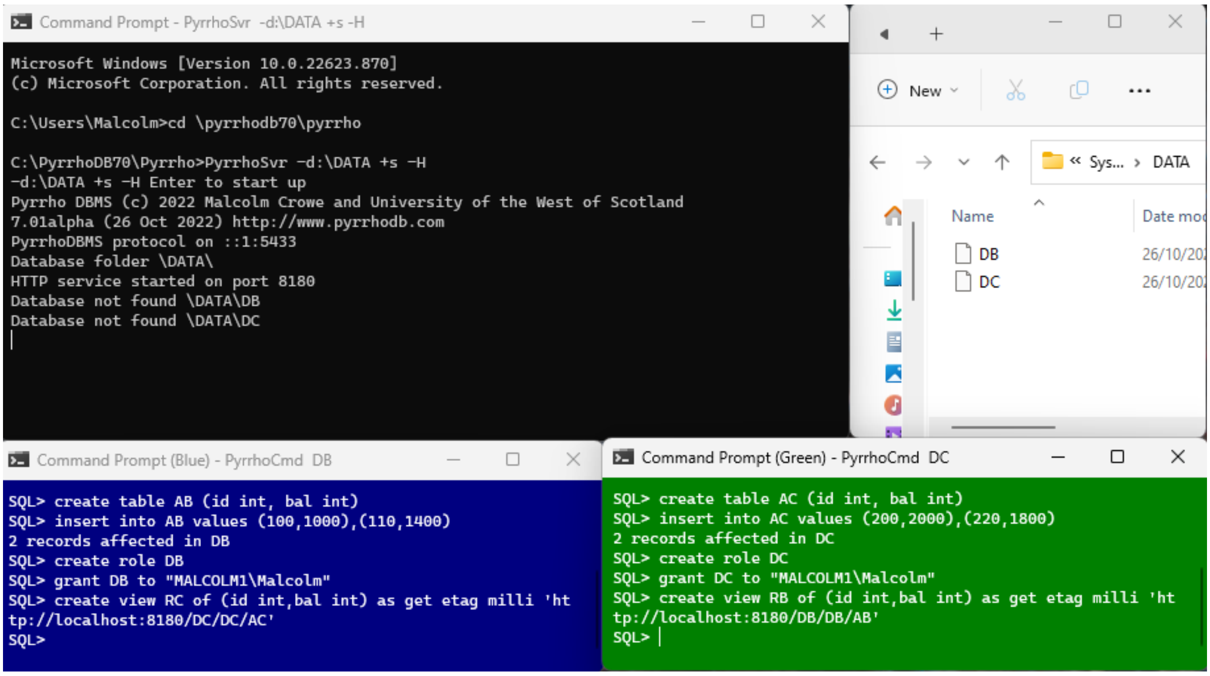
insert into AC values (200,2000),(220,1800)

create role DC

grant DC to "machine\user"

create view RB of (id int,bal int) as get etag milli 'http://localhost:8180/DB/DB/AB'

This gives us two bank accounts id=200 with balance 2000, and 220 with balance 1800.


Command Prompt - PyrrhoSvr -d:\DATA +s -H
New
Sys...
DATA
Name
Date mod
DB
26/10/20
DC
26/10/20
Command Prompt (Blue) - PyrrhoCmd DB
Command Prompt (Green) - PyrrhoCmd DC

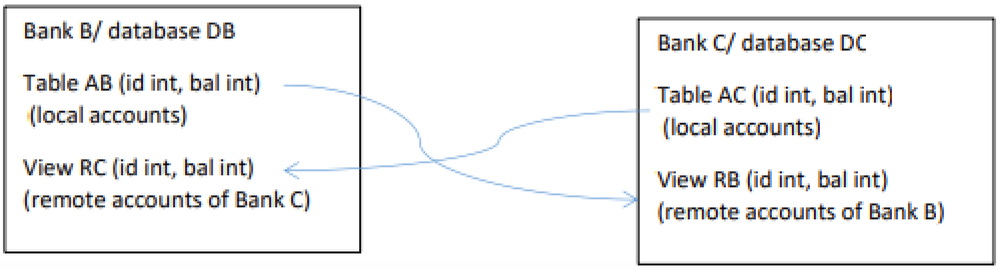
```
Microsoft Windows [Version 10.0.22623.870]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Malcolm>cd \pyrrhodb70\pyrrho

C:\PyrrhoDB70\Pyrrho>PyrrhoSvr -d:\DATA +s -H
-d:\DATA +s -H Enter to start up
Pyrrho DBMS (c) 2022 Malcolm Crowe and University of the West of Scotland
7.01alpha (26 Oct 2022) http://www.pyrrhodb.com
PyrrhoDBMS protocol on ::1:5433
Database folder \DATA\
HTTP service started on port 8180
Database not found \DATA\DB
Database not found \DATA\DC
```

```
SQL> create table AB (id int, bal int)
SQL> insert into AB values (100,1000),(110,1400)
2 records affected in DB
SQL> create role DB
SQL> grant DB to "MALCOLM1\Malcolm"
SQL> create view RC of (id int,bal int) as get etag milli 'ht
tp://localhost:8180/DC/DC/AC'
SQL>
```

```
SQL> create table AC (id int, bal int)
SQL> insert into AC values (200,2000),(220,1800)
2 records affected in DC
SQL> create role DC
SQL> grant DC to "MALCOLM1\Malcolm"
SQL> create view RB of (id int,bal int) as get etag milli 'ht
tp://localhost:8180/DB/DB/AB'
SQL>
```

[161 @ 1:01:27]

We refer to these windows as blue and green for clarity. We now have the following situation:



Bank B/ database DB

Table AB (id int, bal int)
(local accounts)

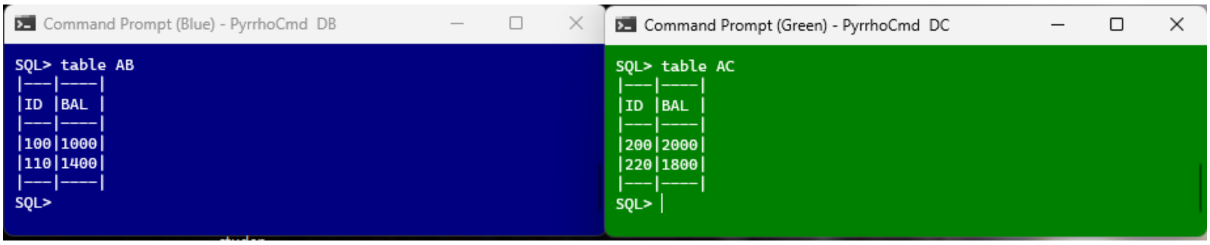
View RC (id int, bal int)
(remote accounts of Bank C)

Bank C/ database DC

Table AC (id int, bal int)
(local accounts)

View RB (id int, bal int)
(remote accounts of Bank B)

The current state of the account in the two banks can be verified by table AB in the blue window and table AC in the green window.


Command Prompt (Blue) - PyrrhoCmd DB
Command Prompt (Green) - PyrrhoCmd DC

```
SQL> table AB
|---|----|
|ID |BAL |
|---|----|
|100|1000|
|110|1400|
|---|----|
SQL>
```

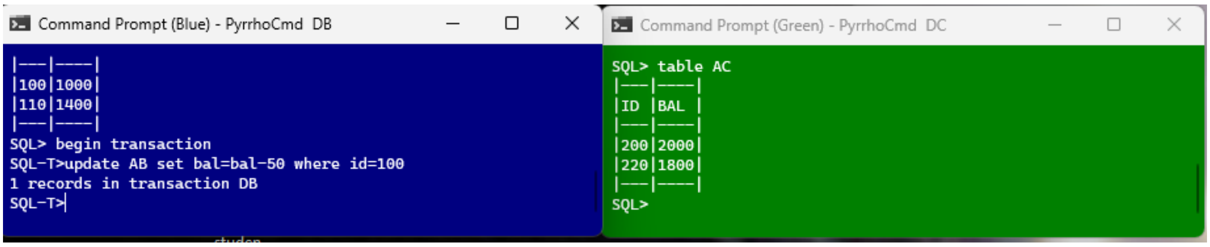
```
SQL> table AC
|---|----|
|ID |BAL |
|---|----|
|200|2000|
|220|1800|
|---|----|
SQL>
```

[162 @ 1:01:48]

Two overlapping transactions will conflict on account 200. In this slide, bank B starts a transaction and takes £50 from account 100 to be transferred. Nothing is written to disk yet.

begin transaction

update AB set bal=bal-50 where id=100


Command Prompt (Blue) - PyrrhoCmd DB
Command Prompt (Green) - PyrrhoCmd DC

```
|---|----|
|100|1000|
|110|1400|
|---|----|
SQL> begin transaction
SQL-T>update AB set bal=bal-50 where id=100
1 records in transaction DB
SQL-T>
```

```
SQL> table AC
|---|----|
|ID |BAL |
|---|----|
|200|2000|
|220|1800|
|---|----|
SQL>
```

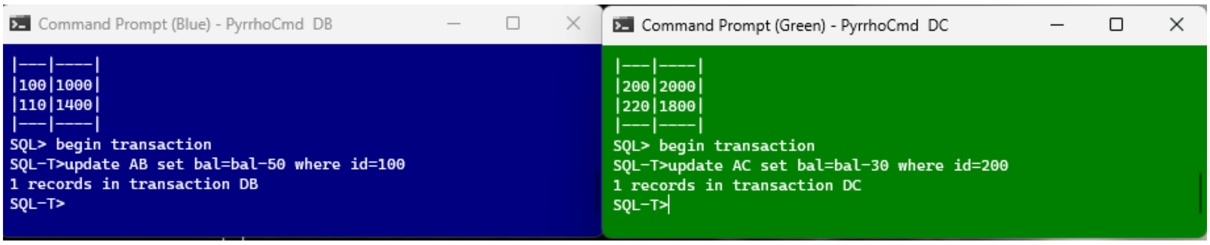
The report on the update makes the point that the new record is in the transaction, rather than the database.

[163 @ 1:02:12]

In the green window, someone in bank C starts a transaction to transfer money from account 200 to remote account 110.

begin transaction

update AC set bal=bal-30 where id=200


Command Prompt (Blue) - PyrrhoCmd DB
Command Prompt (Green) - PyrrhoCmd DC

```
|---|----|
|100|1000|
|110|1400|
|---|----|
SQL> begin transaction
SQL-T>update AB set bal=bal-50 where id=100
1 records in transaction DB
SQL-T>
```

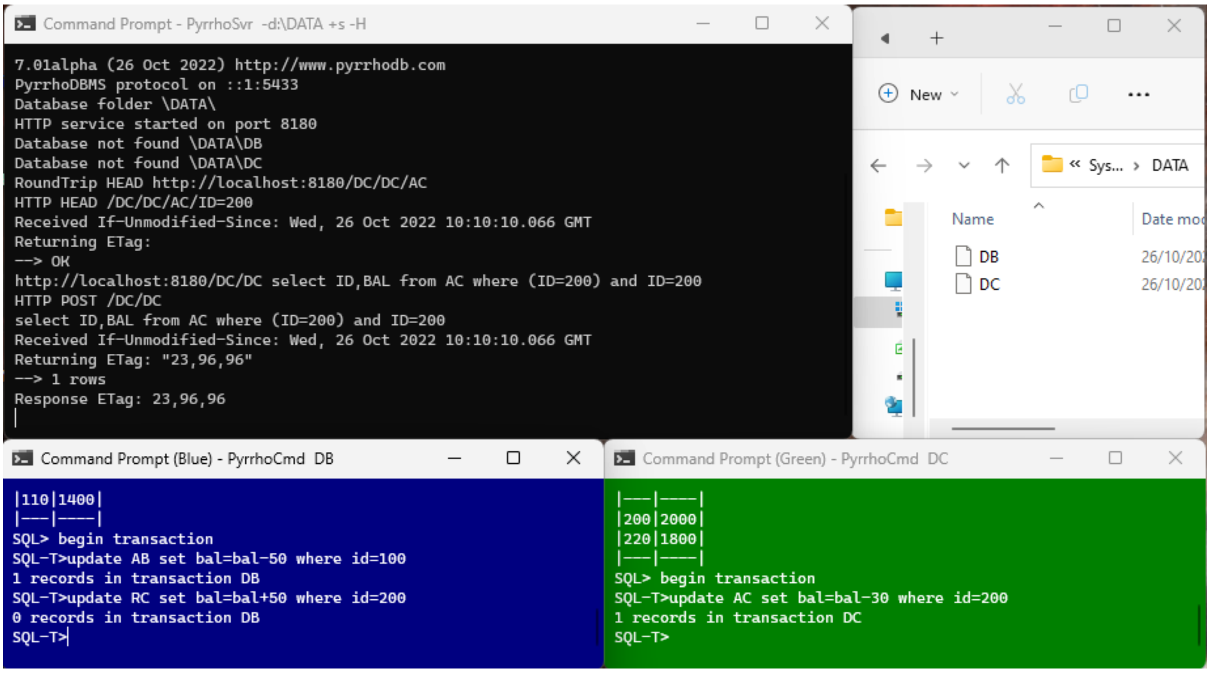
```
|---|----|
|200|2000|
|220|1800|
|---|----|
SQL> begin transaction
SQL-T>update AC set bal=bal-30 where id=200
1 records in transaction DC
SQL-T>
```

[164 @ 1:02:38]

Back in the blue window, bank C is taking the next step in its transaction, adding the £50 to remote account 200.

update RC set bal=bal+50 where id=200

This is still in the transaction, and nothing has been committed. The response on bank B indicates that the changes are not for the local bank.


Command Prompt - PyrrhoSvr -d:\DATA +s -H
New
« Sys... › DATA
Name
Date mod
DB
DC
26/10/20
26/10/20
Command Prompt (Blue) - PyrrhoCmd DB
Command Prompt (Green) - PyrrhoCmd DC

```
7.01alpha (26 Oct 2022) http://www.pyrrhodb.com
PyrrhoDBMS protocol on ::1:5433
Database folder \DATA\
HTTP service started on port 8180
Database not found \DATA\DB
Database not found \DATA\DC
RoundTrip HEAD http://localhost:8180/DC/DC/AC
HTTP HEAD /DC/DC/AC/ID=200
Received If-Unmodified-Since: Wed, 26 Oct 2022 10:10:10.066 GMT
Returning ETag:
--> OK
http://localhost:8180/DC/DC select ID,BAL from AC where (ID=200) and ID=200
HTTP POST /DC/DC
select ID,BAL from AC where (ID=200) and ID=200
Received If-Unmodified-Since: Wed, 26 Oct 2022 10:10:10.066 GMT
Returning ETag: "23,96,96"
--> 1 rows
Response ETag: 23,96,96
|
```

```
|110|1400|
|---|----|
SQL> begin transaction
SQL-T>update AB set bal=bal-50 where id=100
1 records in transaction DB
SQL-T>update RC set bal=bal+50 where id=200
0 records in transaction DB
SQL-T>|
```

```
|---|----|
|200|2000|
|220|1800|
|---|----|
SQL> begin transaction
SQL-T>update AC set bal=bal-30 where id=200
1 records in transaction DC
SQL-T>
```

But we can see in the server window that there has been some Internet activity. There are two round trips. First, bank B checks that 200 is a valid account number for bank C. Colour-coding to distinguish output from the blue and green server threads,

```
RoundTrip HEAD http://localhost:8180/DC/DC/AC
HTTP HEAD /DC/DC/AC/ID=200
Received If-Unmodified-Since: Wed, 26 Oct 2022 10:10:10.066 GMT
Returning ETag:
--> OK
```

Next, it gets an ETag for the current balance in account 200:

```
http://localhost:8180/DC/DC select ID,BAL from AC where (ID=200) and ID=200
HTTP POST /DC/DC
select ID,BAL from AC where (ID=200) and ID=200
Received If-Unmodified-Since: Wed, 26 Oct 2022 10:10:10.066 GMT
Returning ETag: "23,96,96"
--> 1 rows
Response ETag: 23,96,96
```

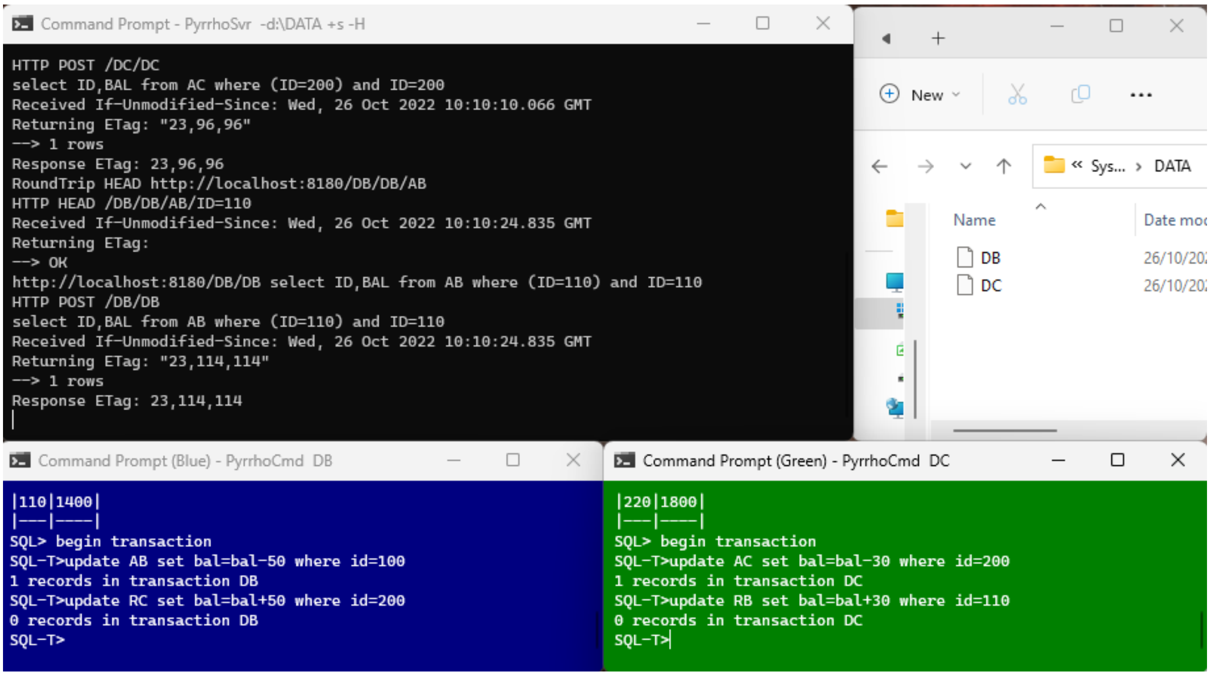
Bank B has noted this ETag.

[165 @ 1:02:52]

The green teller also starts a transfer, of their £30 from account 200, to account 110,

update RB set bal=bal+30 where id=110

and receives an ETag for remote account 110.


Command Prompt - PyrrhoSvr -d:\DATA +s -H
New
Sys... › DATA
Name
Date moc
DB
DC
26/10/202
26/10/202
Command Prompt (Blue) - PyrrhoCmd DB
Command Prompt (Green) - PyrrhoCmd DC

```
HTTP POST /DC/DC
select ID,BAL from AC where (ID=200) and ID=200
Received If-Unmodified-Since: Wed, 26 Oct 2022 10:10:10.066 GMT
Returning ETag: "23,96,96"
--> 1 rows
Response ETag: 23,96,96
RoundTrip HEAD http://localhost:8180/DB/DB/AB
HTTP HEAD /DB/DB/AB/ID=110
Received If-Unmodified-Since: Wed, 26 Oct 2022 10:10:24.835 GMT
Returning ETag:
--> OK
http://localhost:8180/DB/DB select ID,BAL from AB where (ID=110) and ID=110
HTTP POST /DB/DB
select ID,BAL from AB where (ID=110) and ID=110
Received If-Unmodified-Since: Wed, 26 Oct 2022 10:10:24.835 GMT
Returning ETag: "23,114,114"
--> 1 rows
Response ETag: 23,114,114
```

```
|110|1400|
|---|----|
SQL> begin transaction
SQL-T>update AB set bal=bal-50 where id=100
1 records in transaction DB
SQL-T>update RC set bal=bal+50 where id=200
0 records in transaction DB
SQL-T>
```

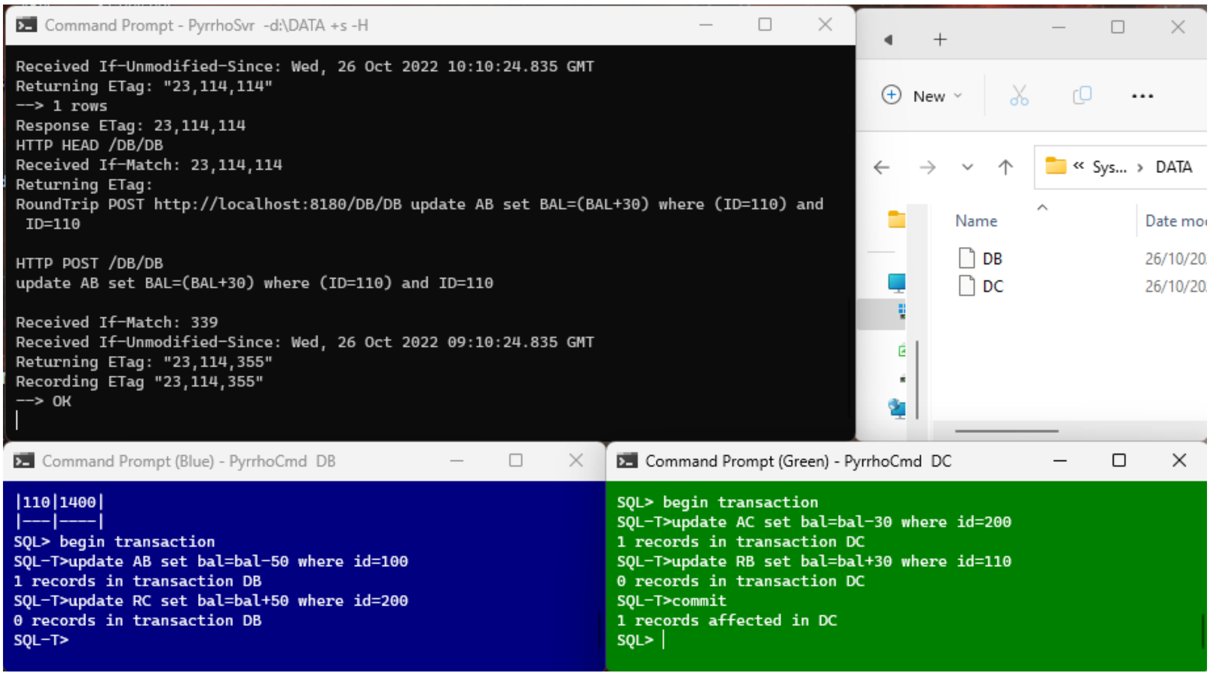
```
|220|1800|
|---|----|
SQL> begin transaction
SQL-T>update AC set bal=bal-30 where id=200
1 records in transaction DC
SQL-T>update RB set bal=bal+30 where id=110
0 records in transaction DC
SQL-T>
```

At this point both tellers are about to commit their transaction. The first to do so will succeed, but no changes have been made yet.

[166 @ 1:03:38]

The green teller gets there first, and commits their transaction.

commit


Command Prompt - PyrrhoSvr -d:\DATA +s -H
New
Sys... › DATA
Name
Date moc
DB
DC
26/10/20
26/10/20
Command Prompt (Blue) - PyrrhoCmd DB
Command Prompt (Green) - PyrrhoCmd DC

```
Received If-Unmodified-Since: Wed, 26 Oct 2022 10:10:24.835 GMT
Returning ETag: "23,114,114"
--> 1 rows
Response ETag: 23,114,114
HTTP HEAD /DB/DB
Received If-Match: 23,114,114
Returning ETag:
RoundTrip POST http://localhost:8180/DB/DB update AB set BAL=(BAL+30) where (ID=110) and
 ID=110

HTTP POST /DB/DB
update AB set BAL=(BAL+30) where (ID=110) and ID=110

Received If-Match: 339
Received If-Unmodified-Since: Wed, 26 Oct 2022 09:10:24.835 GMT
Returning ETag: "23,114,355"
Recording ETag "23,114,355"
--> OK
```

```
|110|1400|
|---|----|
SQL> begin transaction
SQL-T>update AB set bal=bal-50 where id=100
1 records in transaction DB
SQL-T>update RC set bal=bal+50 where id=200
0 records in transaction DB
SQL-T>
```

```
SQL> begin transaction
SQL-T>update AC set bal=bal-30 where id=200
1 records in transaction DC
SQL-T>update RB set bal=bal+30 where id=110
0 records in transaction DC
SQL-T>commit
1 records affected in DC
SQL>
```

Looking at the feedback in the server window:

```
HTTP HEAD /DB/DB
Received If-Match: 23,114,114
Returning ETag:
RoundTrip POST http://localhost:8180/DB/DB update AB set BAL=(BAL+30) where (ID=110) and ID=110
```

```
HTTP POST /DB/DB
update AB set BAL=(BAL+30) where (ID=110) and ID=110

Received If-Match: 339
Received If-Unmodified-Since: Wed, 26 Oct 2022 09:10:24.835 GMT
Returning ETag: "23,114,355"
Recording ETag "23,114,355"
--> OK
```

The first step is a HEAD request to verify the ETag sent to the green database is still valid. (It is.) Then the update is POSTed to bank B.

On receiving OK from the remote bank B, the change is committed to local account 200 in bank C. This will invalidate the ETag previously sent to the blue client.

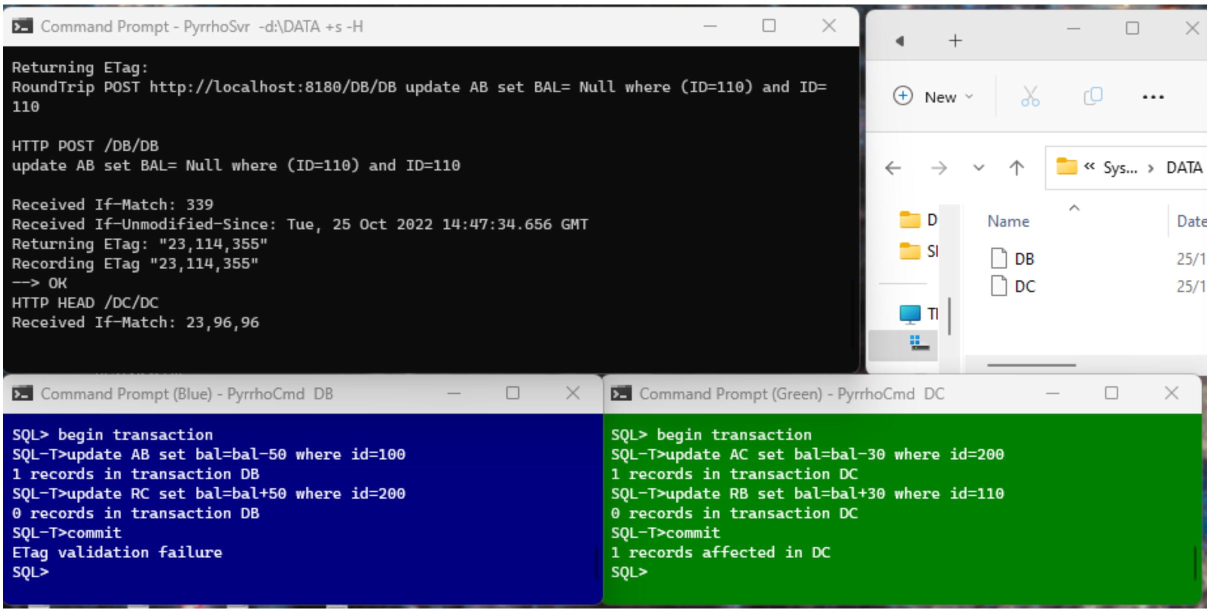
The response "1 records affected" to the commit indicates that the change to local account 200 is now recorded durably in the database.

[167 @ 1:04:20]

Sure enough, when the blue client attempts to commit,

commit

and sends its change to bank C, bank C reports that the ETag is invalid, and the transaction is aborted. The failure of this HEAD roundtrip rolls back the blue transaction entirely.


Command Prompt - PyrrhoSvr -d:\DATA +s -H
New
« Sys... › DATA
Name
Date
DB
DC
25/1
25/1
Command Prompt (Blue) - PyrrhoCmd DB
Command Prompt (Green) - PyrrhoCmd DC

```
Returning ETag:
RoundTrip POST http://localhost:8180/DB/DB update AB set BAL= Null where (ID=110) and ID=
110

HTTP POST /DB/DB
update AB set BAL= Null where (ID=110) and ID=110

Received If-Match: 339
Received If-Unmodified-Since: Tue, 25 Oct 2022 14:47:34.656 GMT
Returning ETag: "23,114,355"
Recording ETag "23,114,355"
--> OK
HTTP HEAD /DC/DC
Received If-Match: 23,96,96
```

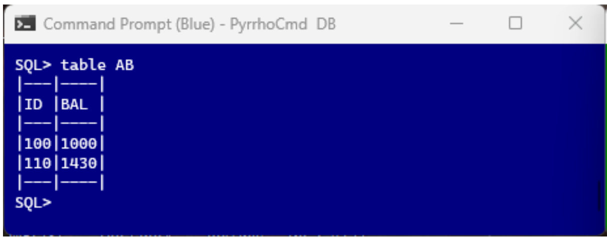
```
SQL> begin transaction
SQL-T>update AB set bal=bal-50 where id=100
1 records in transaction DB
SQL-T>update RC set bal=bal+50 where id=200
0 records in transaction DB
SQL-T>commit
ETag validation failure
SQL>
```

```
SQL> begin transaction
SQL-T>update AC set bal=bal-30 where id=200
1 records in transaction DC
SQL-T>update RB set bal=bal+30 where id=110
0 records in transaction DC
SQL-T>commit
1 records affected in DC
SQL>
```

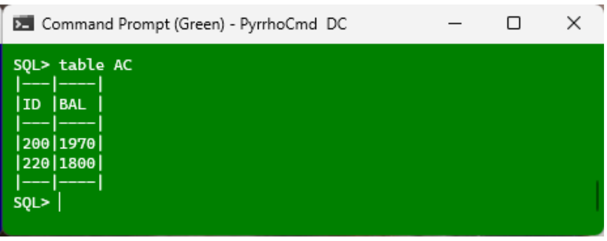
[168 @ 1:04:53]

The teller in bank B can verify that the transfer from account 100 has not occurred, while bank C's transaction transferring £30 has been committed in both databases.

[169 @ 11:05:11]



```
SQL> table AB
|---|----|
|ID |BAL |
|---|----|
|100|1000|
|110|1430|
|---|----|
SQL>
```



```
SQL> table AC
|---|----|
|ID |BAL |
|---|----|
|200|1970|
|220|1800|
|---|----|
SQL>
```

[For further examples, see section 6.10 in the SourceIntro document in the distribution.]