
Maintaining Global Integrity in Federated Relational Databases using Interactive Component Systems

Christopher Popfinger · Stefan Conrad

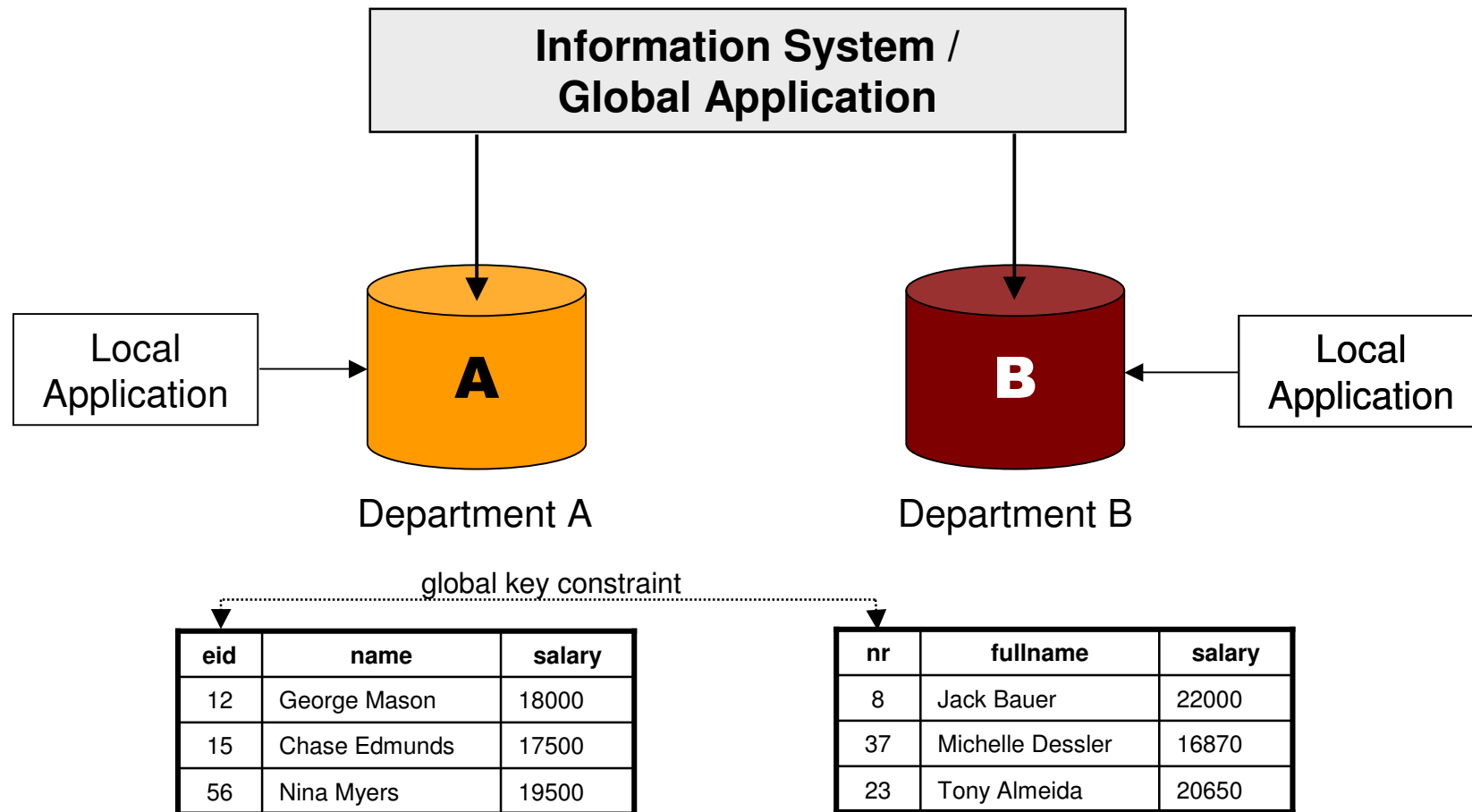
popfinger@cs.uni-duesseldorf.de

**Department of Computer Science
University of Düsseldorf, Germany**



- Application Scenario
- Active Component Database Systems
 - Enhanced Activity
 - External Program Calls
 - Architecture
- Global Integrity Maintenance
 - Partial Integrity Constraints
 - Checking Constraints
- Current and Future Work

Application Scenario



Enhanced Active Database Systems

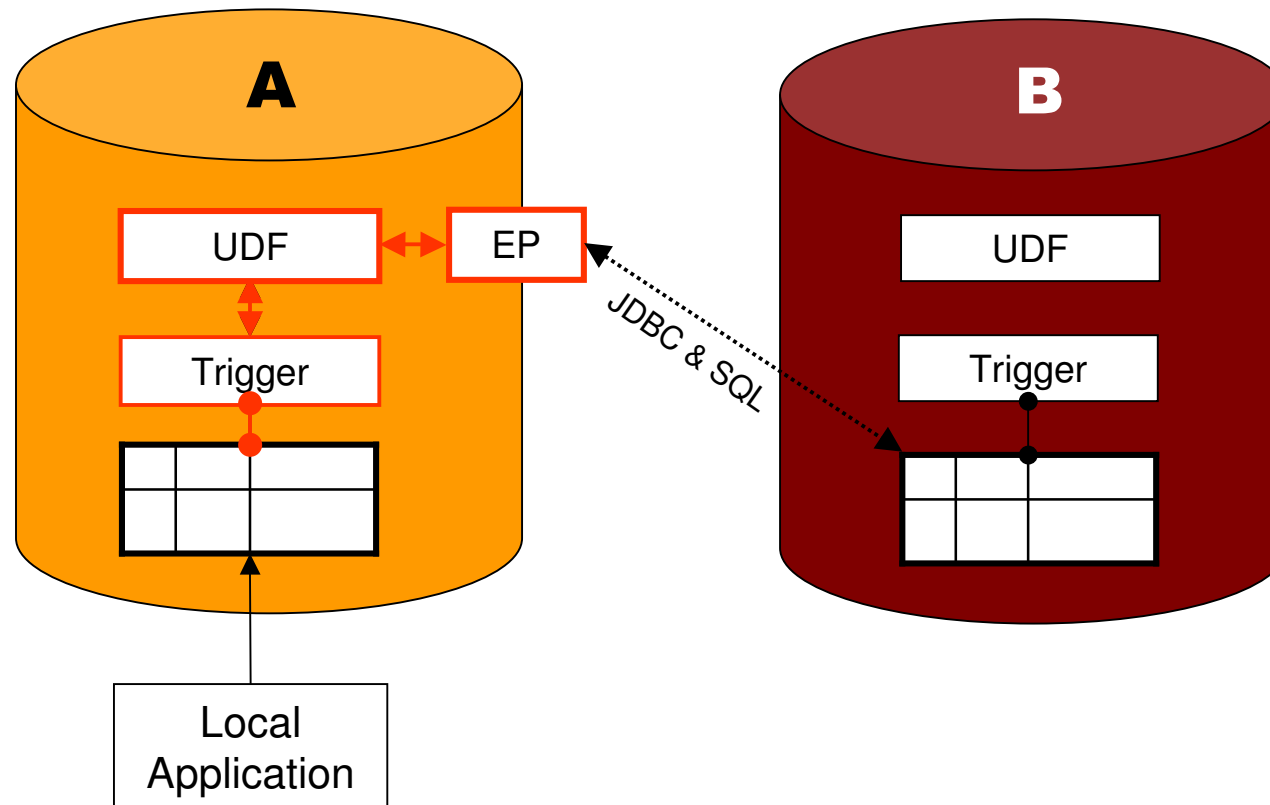
- Until recently: Scope of triggers and stored procedures limited to local system
- New developments: Execution of external programs from within DBMS
- Definition

Ability of a DBS to execute methods or programs from within its DBMS to interact with software or hardware components beyond its system border is called Enhanced Activity. A database with Enhanced Activity is an Enhanced Active Database System (EADBS)

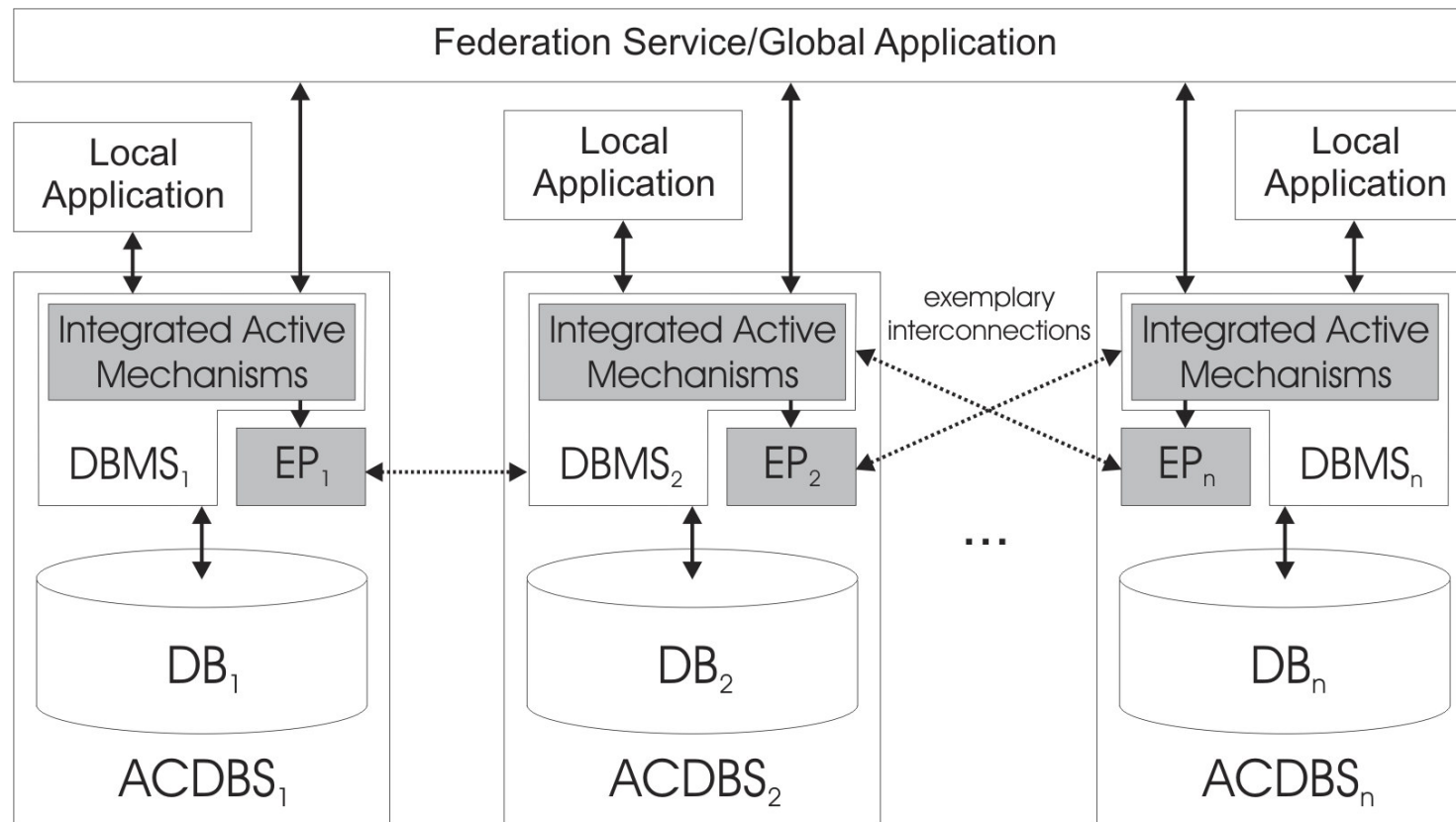
Enhanced Active Functionality

- Database Connectivity
 - Remote State Query: Querying the state of a remote data source *directly* during the execution of a trigger
 - Injected Transactions: Modifying a remote data stock *directly* during the execution of a trigger
- Server-Client Connections: The database is able to use external services from within triggers via
 - Sockets
 - Remote Method Invocations
 - ..
- ..

External Program Call



Architecture



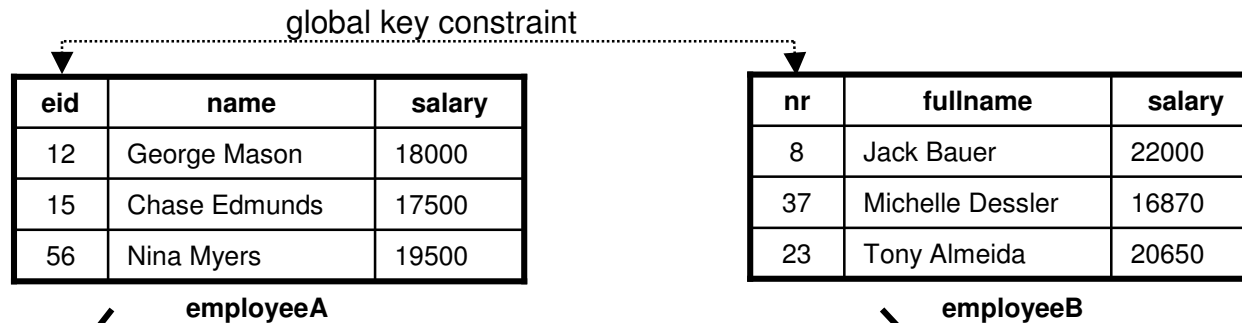
Checking Global Constraints

- Attribute Constraint: Sum of salary of all employees less than certain value **checked locally**
- Key Constraint: Global unique employee identifier
- Referential Integrity Constraints: Employee in B can only be inserted, if it also exists in A
- Aggregated Constraints: Sum of salary of all employees less than certain value

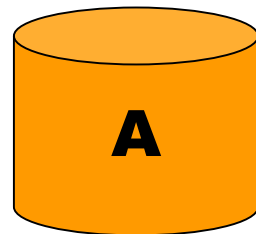
Partial Integrity Constraints

- Global constraints expressed over a a set of local schemata
- Global constraint is decomposed into a set of *partial integrity constraints* for all affected component systems
- A partial integrity constraint consists of:
 - a local integrity check
 - one or more remote constraint check on interrelated data
- Global constraint is assured, iff all affected component systems enforce their partial constraints

Partial Key Constraint - Example

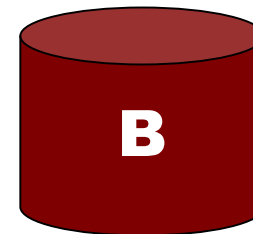


define rule *partialkeyA*
on *insert or update of employeeA*
if *checklocalkey yields false or*
 checkremotekey yields false
do *reject transaction*



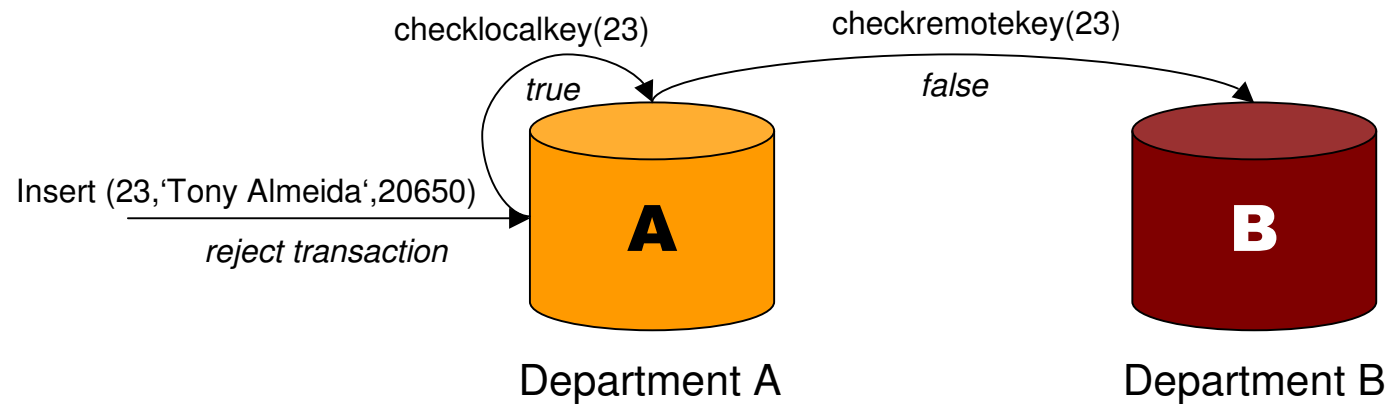
Department A

define rule *partialkeyB*
on *insert or update of employeeB*
if *checklocalkey yields false or*
 checkremotekey yields false
do *reject transaction*



Department B

Partial Key Constraint on Database A



global key constraint

eid	name	salary
12	George Mason	18000
15	Chase Edmunds	17500
56	Nina Myers	19500

nr	fullname	salary
8	Jack Bauer	22000
37	Michelle Dessler	16870
23	Tony Almeida	20650

Implementation

1. Create Java functions using JDBC to connect to remote database and execute queries
2. Load java archive into enhanced active database
3. Create external UDFs in database with mappings to the external Java functions
4. Create appropriate triggers on relations to be monitored that execute the corresponding UDFs

Concrete implementation depends on the capabilities and specific requirements of the data source

Trigger Definition in DB2 (example)

```
CREATE TRIGGER employInsert
AFTER INSERT ON employeeA
REFERENCING NEW AS n
FOR EACH ROW MODE DB2SQL
BEGIN ATOMIC
  local check {
    DECLARE numlocal INTEGER;
    SET numlocal = (select count(*) from employeeA where eid = n.eid);
    IF (numlocal > 1) THEN
      SIGNAL SQLSTATE '75000' SET MESSAGE_TEXT=
        'Global Key Constraint Violation: Key exists in local database';
    END IF;
  }
  remote check {
    IF(checkKey('B', 'employeeB', 'nr', n.id) = -1) THEN
      SIGNAL SQLSTATE '75000' SET MESSAGE_TEXT =
        'Global Key Constraint Violation: Key exists in remote database';
    END IF;
  }
END
```

Characteristics

- Implementation of Local Test Transaction (LTT) protocol (Grefen/Widom)
- Referential Integrity with/without cascading
- Generalization to more than two sites using non-transaction-based protocols (DRQ,TRQ)
- Synchronous and asynchronous protocols possible

Current and Future Work

- Current implementations
 - Global Constraint Toolkit
 - Tightly coupled wrappers with event detection subsystem¹⁾
 - P2P Information Sharing Environment (Dígame)²⁾
- Future Work
 - Heterogeneous data replication using Interactive Component Systems
 - External Mapping Manager

1. Popfinger,C., Conrad,S.: Tightly coupled Wrappers with event detection subsystem for Heterogeneous Information Systems. In: DEXA Workshop Proceedings, IEEE, 62-66, 2005
2. Pérez de Laborda,C., Popfinger,C., Conrad,S.: Dynamic Intra- and Inter-Enterprise Collaboration Using an Enhanced Multidatabase Architecture. In: DEXA Workshop Proceedings, IEEE, 626-631,2005.

**Thank you for
your attention!**

popfinger@cs.uni-duesseldorf.de

