



# Spheres of isolation: adaptation of isolation levels to transactional workflow

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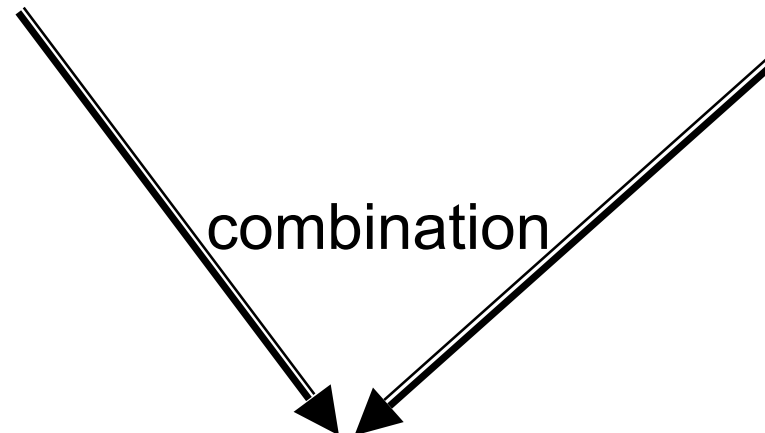
# Introduction

## **Workflow**

Advanced control of execution  
order of activities

## **Transaction management**

Atomicity of tasks : all or nothing  
Isolation : avoid incoherent data  
state

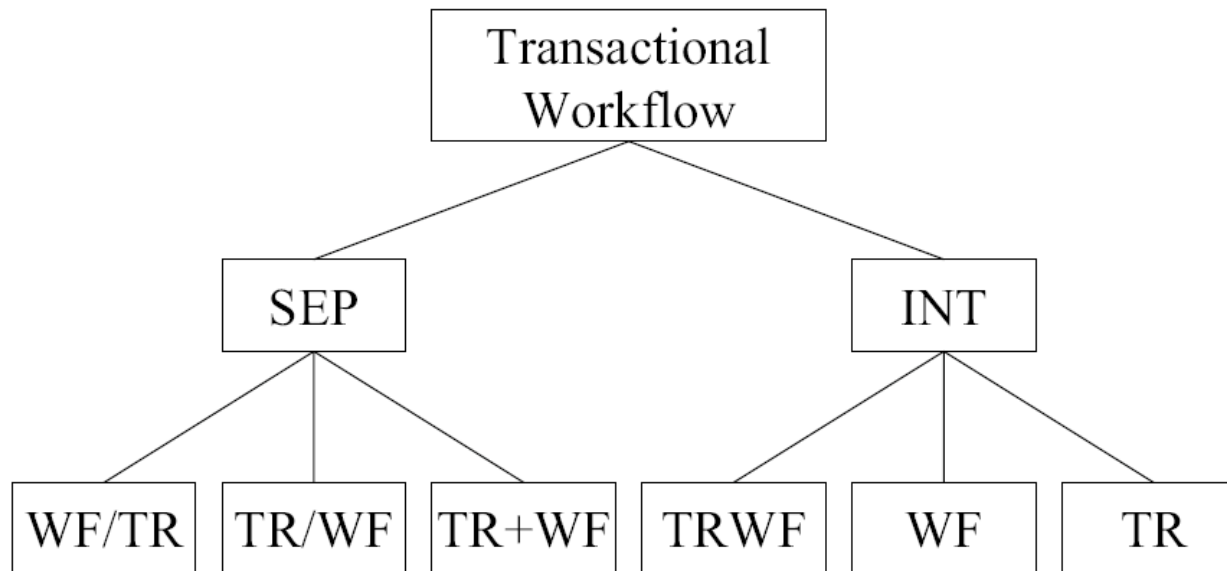


## **Transactional Workflow**

In order to ensure clear process semantics and robustness in process execution, data consistency and reliability

# SoA

- Approaches to implement this combination



Transactional Workflow Taxonomy  
( Grefen, 2002 )

Workflow over Transactions  
Transactions over Workflow  
Transaction and Workflow as peers  
Hybrid Transactional Workflow Model  
Transactions in Workflow  
Workflows in Transactions

# Context

- Isolation is taken into account at the activity level
- Atomicity is taken into account at the process and activity level
- It is difficult to take into account isolation at the process level
  - *Atomicity is used to the detriment of isolation*
    - ***all or nothing** is easier to understand in a workflow environment*
    - *isolation is seen like operative via atomicity*
  - *Isolation in TW is usually delegated to data bases*
    - *process aspects are not taken into account*
    - *data base approach is not adapted (definition of the transactional properties on the data)*

# Stakes of isolation in workflows : Data Visibility

Workflow data patterns (Russel et al., 2004)

**Workflow data visibility patterns : 7 patterns**

Multiple Instance data

Environment data

Workflow data

Case data

Scope data

Block data

Task data

**Importance of process dimension in isolation strategy**

**Maximum**



**Minimum**

**No isolation needs**

# Transactional needs in workflow environment

- Single activity is usually used as the transactional brick to use in transactional workflow
  - We need a **separation of concerns** between transactions and workflow notions

Solution : Transactional properties don't concerns only single activities but **groups of activities**

- Atomicity of groups of activities has been already used in the work of *Derks, 2002 (based on petri Net formalization)*
  - Isolation of group of activities has never been considered (to our knowledge)

# Inspiration

- spheres of control proposed in

**“data processing spheres of control “**

*Work Card Davies, Jr.*

- Spheres of atomicity proposed in

**“Customized atomicity specification for transactional workflows “**

*Derks, Dehnert, Grefen & Jonker*

- Isolation levels introduced in

**“ANSI SQL X3.135-1992“**

***and also in SQL 3***

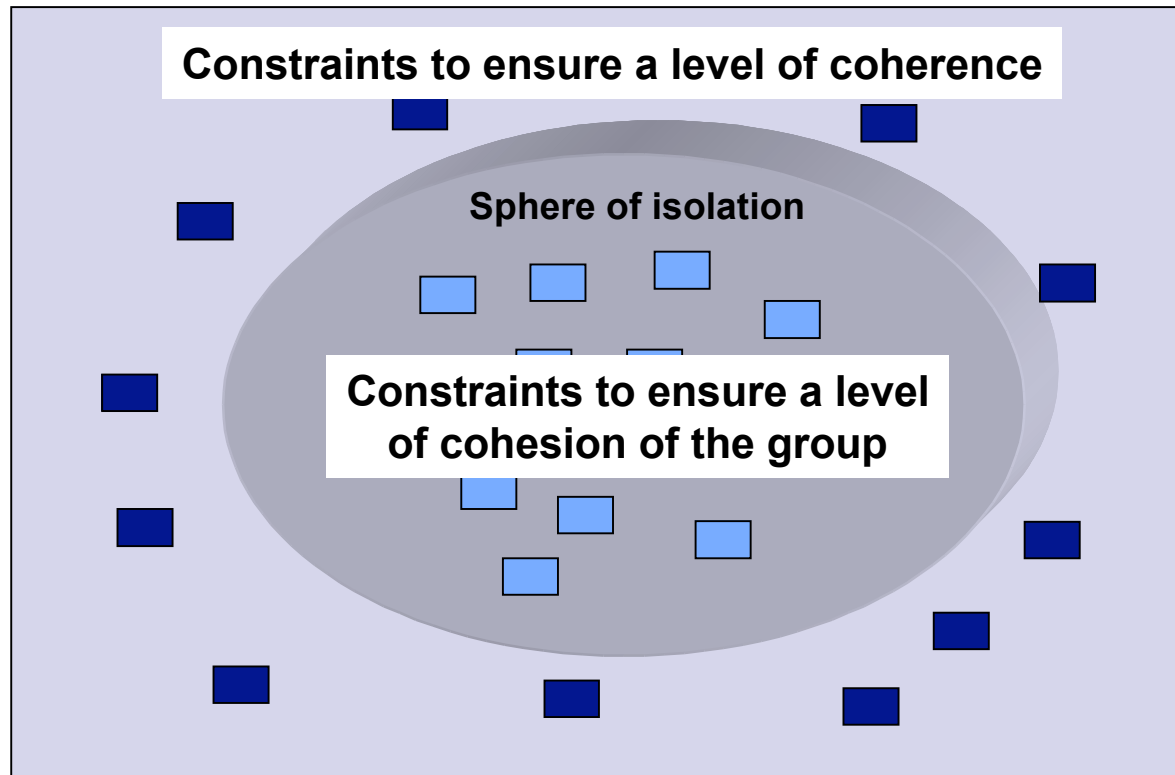
Main idea : identify isolation properties adapted to groups of activities

# Specific needs in workflow environment

- We need Cohesion :
  - A group of activity must have the same view on shared data (*collaborative work, distributed or composed e-services*)
- We need Coherence :
  - Once a group of activities finishes its execution, the information system must be in a coherent state

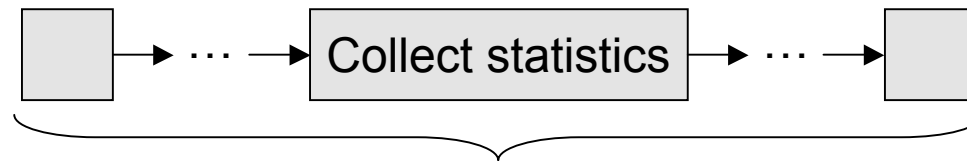
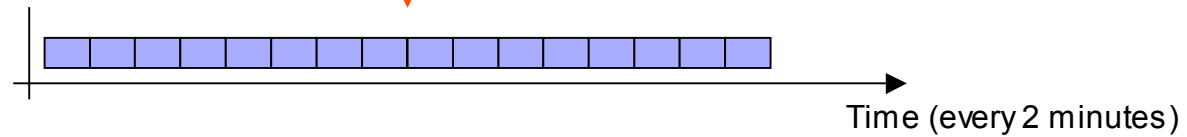
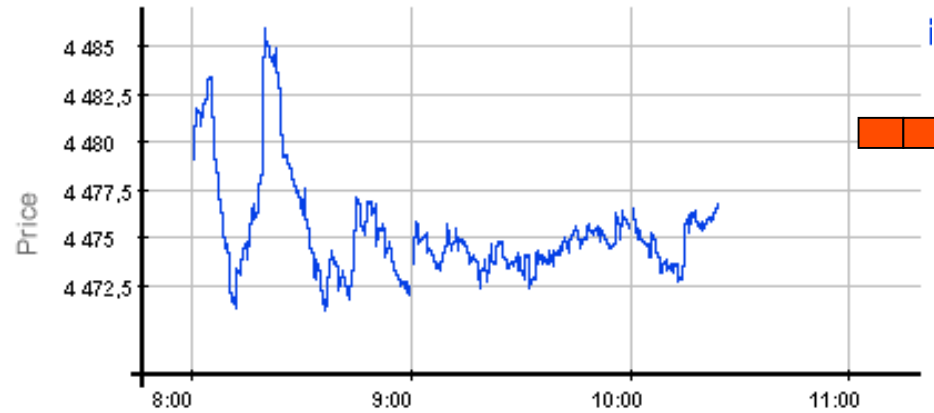


# Our approach: Sphere of isolation

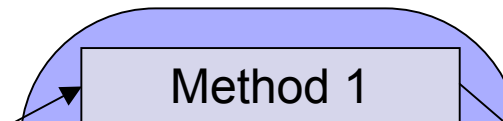


# An example : Cohesion of a group

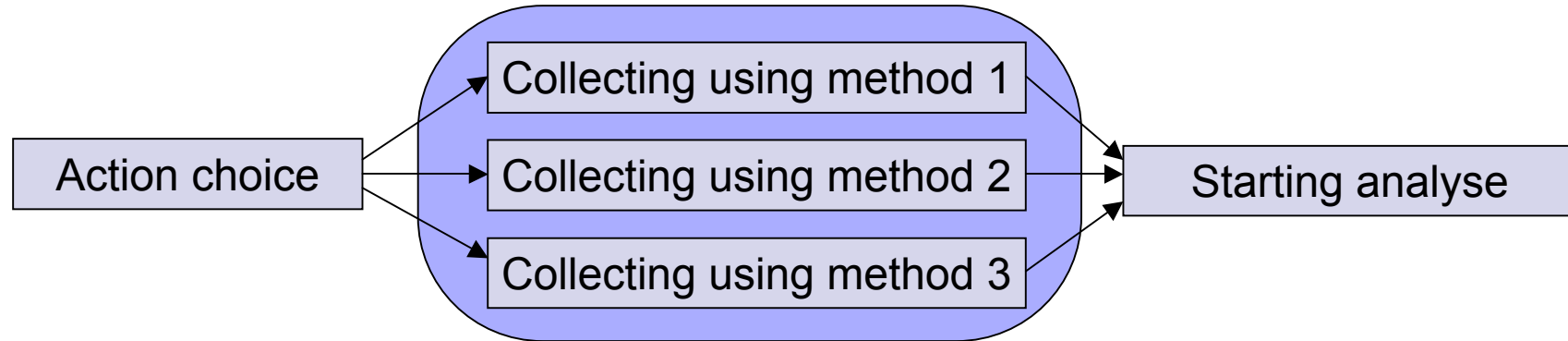
Stock exchange history : CAC40 action



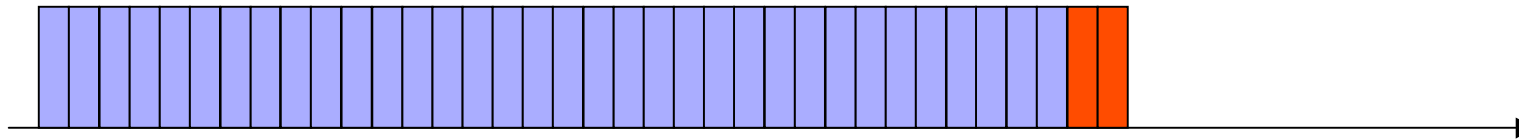
Mining process



# An example : Cohesion of a group



Collecting informations  
about stock exchange action



# Cohesion / Coherence

- We propose different levels of coherence and cohesion
- Sphere "behavior" depends on the combination of both levels

		C o h e s i o n			
		Read uncommitted	Read committed	Repeatable read	Serialisable
C o h e r e n c e	Atomic coherence				
	Selective coherence				
	Global coherence				

# Formal definition

- Notation:

process  $\rho$ ,

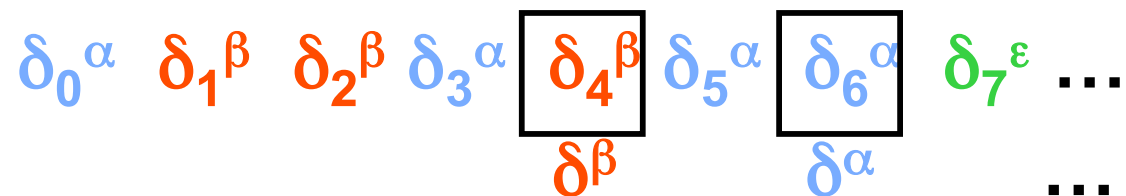
$A(\rho)$  are the activities of  $\rho$ ,

history of data  $\delta = \{ \delta_0, \delta_1, \dots, \delta_n \}$

corresponding to  $\{ t_0, t_1, \dots, t_n \}$ .

We note  $\delta_i^\alpha$  if  $\delta_i$  is written by activity  $\alpha \in A(\rho)$ .

We note  $\delta^\alpha$  the last value of  $\delta$  written by  $\alpha$  and representing the value committed by  $\alpha$ .



## Cohesion levels in a sphere

- **Read uncommitted** :  $\forall \delta \in \Delta\rho$  , if an activity of the sphere reads  $\delta$  , it can only read  $\delta_i^\alpha$  with  $\alpha \in \mathbf{A}(s)$
- **Read committed** :  $\forall \delta \in \Delta\rho$  , if an activity of the sphere reads  $\delta$  , it can only read  $\delta^\alpha$  with  $\alpha \in \mathbf{A}(s)$
- **Repeatable read** :  $\forall \delta \in \Delta\rho$  , if an activity  $\varepsilon$  of the sphere reads  $\delta$  , it can only read the last  $\delta^\alpha$  with  $\alpha \in \mathbf{A}(s)$  and  $\forall \delta_i^\beta$  coming between  $t(\delta^\alpha)$  and  $\mathbf{commit}(\varepsilon)$  with  $\beta \in \mathbf{A}(s)$ , then  $\delta_i^\beta \neq \delta^\beta$
- **Serialisable** : emulates an execution in series of the activities of the sphere independently of outside.

## Coherence levels

- **Atomic coherence** :  $\forall \delta \in \Delta \rho$  , if an activity  $\alpha$  of the sphere writes  $\delta$  , all  $\delta_i^\alpha$  are readable outside the sphere.
- **Selective coherence** :  $\forall \delta \in \Delta \rho$  , if an activity  $\alpha$  of the sphere writes  $\delta$  , only  $\delta^\alpha$  is readable outside the sphere.
- **Global coherence** :  $\forall \delta \in \Delta \rho$  , if activities of the sphere write  $\delta$  , only  $\delta^\alpha$  is readable outside the sphere,  $\alpha$  represents the last activity of the sphere writing  $\delta$

# Duality Cohesion / Coherence



# Significance of undesired phenomena in IS context

	Classic transaction $\chi$	Sphere of isolation
Dirty read	Read( $\delta_i^\alpha$ ) and rollback( $\alpha$ )	Read( $\delta_i^\alpha$ ) , $\alpha \notin A(s)$ and rollback( $\alpha$ )
Fuzzy read	Read( $\delta^\alpha$ ) , $\delta^\alpha < \delta_i^\beta < \delta^\chi$	Read( $\delta^\alpha$ ) , $\delta^\alpha < \delta_i^\beta < \delta^\chi$ , $\beta \notin A(s)$
Phantom	Read the result of a query and the insertion or the remove of a data during the execution of $\chi$ changes the result	Read the result of a query and the insertion or the remove of a data by an <b>external</b> activity during the execution of the sphere changes the result

# Imbrication of isolation spheres

- Nested cohesion similar to nested transactions
- Multi level of coherence

# Conclusion

- Isolation spheres make it possible
  - to make an entire separation of concerns between workflow and transaction design (Separate transaction and workflow models)
  - to enhance isolation flexibility through the duality Cohesion/Coherence and imbricated spheres
  - to enhance expressivity in transactional workflow

# Conclusion

- Future work :
  - Integration of isolation spheres with the WS-Transaction and the BPEL standards
  - Find correctness criteria referring to sphere imbrication, control flow, data dependencies and validate the model
  - Expand imbrication to possible overlapping spheres → alternative strategies and/or complementary strategies of isolation
  - Use isolation spheres to enhance cooperative processes

**Thank you for your attention**