Chapter 4: Multilevel Relational Data Models

DATABASE SECURITY

Granularity of Classification

- Classification could be at
  - the database level
  - the relation level
  - the attribute level
  - tuple level
  - Even at the element level
- Also, security levels could be assigned to
  - views
  - collections of attributes

Granularity of Classification

- Classifying databases

DATABASE D: Level = Secret

EMP

SS#	Ename	Salary	D#
1	John	20K	10
2	Paul	30K	20
3	Mary	40K	20

DEPT

D#	Dname	Mgr
10	Math	Smith
20	Physics	Jones

Granularity of Classification

- Classifying relations

EMP: Level = Secret

SS#	Ename	Salary	D#
1	John	20K	10
2	Paul	30K	20
3	Mary	40K	20

DEPT: Level = Unclassified

D#	Dname	Mgr
10	Math	Smith
20	Physics	Jones

Granularity of Classification

- Classifying attributes

EMP

SS#: S	Ename: U	Salary: S	D#: U
1	John	20K	10
2	Paul	30K	20
3	Mary	40K	20

DEPT

D#: U	Dname: U	Mgr: S
10	Math	Smith
20	Physics	Jones

U = Unclassified

S = Secret

Granularity of Classification

- Classifying tuples

EMP

SS#	Ename	Salary	D#	Level
1	John	20K	10	U
2	Paul	30K	20	S
3	Mary	40K	20	TS

DEPT

D#	Dname	Mgr	Level
10	Math	Smith	U
20	Physics	Jones	C

U = Unclassified
C = Confidential
S = Secret
TS = TopSecret

Granularity of Classification

- Classifying elements

EMP

SS#:	Ename:	Salary	D#:
1, S	John, U	20K, C	10, U
2, S	Paul, U	30K, S	20, U
3, S	Mary, U	40K, S	20, U

DEPT

D#: U	Dname: U	Mgr: S
10, U	Math, U	Smith, C
20, U	Physics, U	Jones, S

U = Unclassified

C = Confidential

S = Secret

Granularity of Classification

- Classifying views

EMP

SS#	Ename	Salary	D#
1	John	20K	10
2	Paul	30K	20
3	Mary	40K	20
4	Jane	20K	20
5	Bill	20K	10
6	Larry	20K	10
1	Michelle	30K	20

SECRET VIEW EMP (D# = 20)

SS#	Ename	Salary
2	Paul	30K
3	Mary	40K
4	Jane	20K
1	Michelle	30K

UNCLASSIFIED VIEW EMP (D# = 10)

SS#	Ename	Salary
1	John	20K
5	Bill	20K
6	Larry	20K

Granularity of Classification

- **Classifying metadata**
  - security level of the existence must be dominated by the security levels of the contents

Relation REL

Relation	Attribute	Level
EMP	SS#	Secret
EMP	Ename	Unclassified
EMP	Salary	Confidential
EMP	D#	Unclassified
DEPT	D#	Unclassified
DEPT	Dname	Unclassified
DEPT	Mgr	Confidential

Polyinstantiation

EMP

SS#	Ename	Salary	D#	Level
1	John	20K	10	U
2	Paul	30K	20	S
3	Mary	40K	20	TS
3	Mary	10K	20	U
3	Mary	30K	20	S
3	Mary	20K	20	C
2	Paul	15K	20	U

U = Unclassified
C = Confidential
S = Secret
TS = TopSecret

Polyinstantiation

- violates the properties of the relational data model.
    - In the relational model, every entity is represented uniquely.
    - But in the polyinstantiated model, an entity has multiple representations.
- why do we need polyinstantiation?
    - The main answer is to avoid signaling and covert channels

Polyinstantiation

- There are essentially two debates:
  - whether to have polyinstantiation?
  - the correct way to carry out polyinstantiation
- preferred approach has been to develop flexible systems.
  - the model must accurately reflect the real world.
    - if in the real world there are multiple representations of an entity
      - we cannot expect the database to hide this fact