

Chapter 3:

Modeling Data in the Organization

Objectives

- Definition of terms
- Importance of data modeling
- Write good names and definitions for entities, relationships, and attributes
- Distinguish unary, binary, and ternary relationships
- Model different types of attributes, entities, relationships, and cardinalities
- Draw E-R diagrams for common business situations
- Convert many-to-many relationships to associative entities
- Model time-dependent data using time stamps

Business Rules

- Statements that define or constrain some aspect of the business
- Assert business structure
- Control/influence business behavior
- Expressed in terms familiar to end users
- Automated through DBMS software

A Good Business Rule Is:

- Declarative—what, not how
- Precise—clear, agreed-upon meaning
- Atomic—one statement
- Consistent—internally and externally
- Expressible—structured, natural language
- Distinct—non-redundant
- Business-oriented—understood by business people

A Good Data Name Is:

- Related to business, not technical, characteristics
- Meaningful and self-documenting
- Unique
- Readable
- Composed of words from an approved list
- Repeatable
- Follows standard syntax

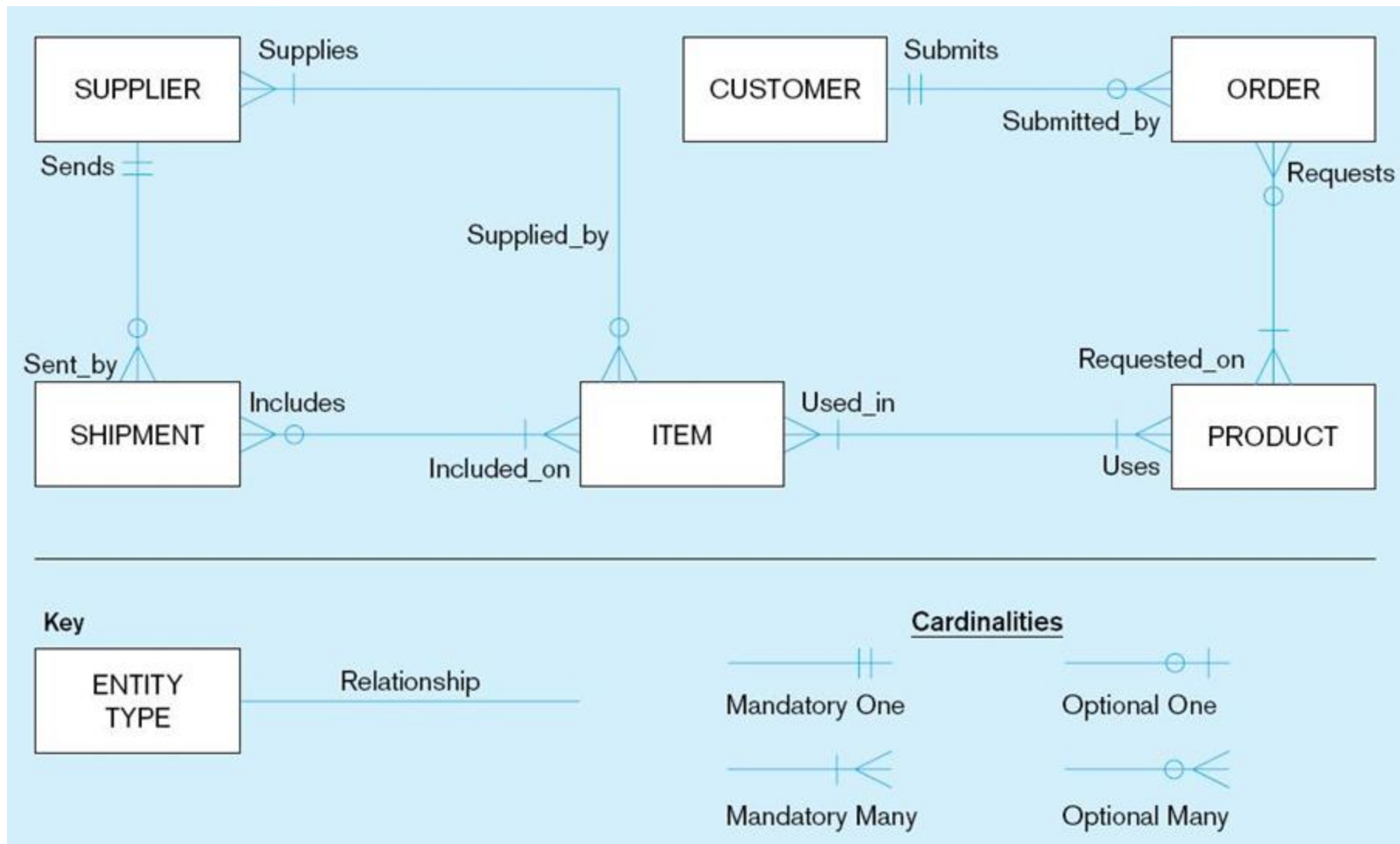
Data Definitions

- Explanation of a term or fact
 - Term—word or phrase with specific meaning
 - Fact—association between two or more terms
- Guidelines for good data definition
 - Gathered in conjunction with systems requirements
 - Accompanied by diagrams
 - Concise description of essential data meaning
 - Achieved by consensus, and iteratively refined

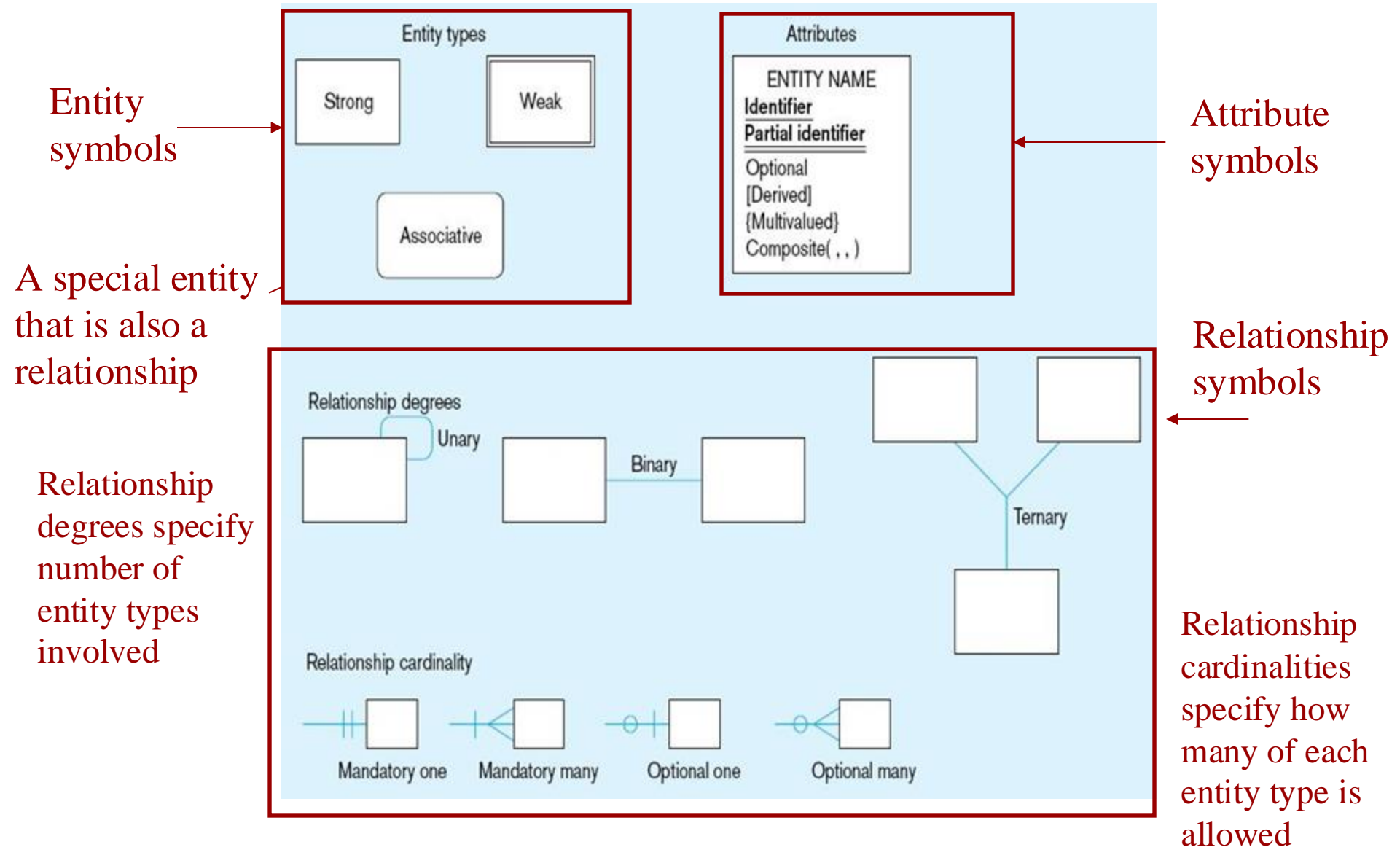
E-R Model Constructs

- Entities:
 - Entity instance—person, place, object, event, concept (often corresponds to a row in a table)
 - Entity Type—collection of entities (often corresponds to a table)
- Relationships:
 - Relationship instance—link between entities (corresponds to primary key-foreign key equivalencies in related tables)
 - Relationship type—category of relationship...link between entity types
- Attribute—property or characteristic of an entity or relationship type (often corresponds to a field in a table)

Sample E-R Diagram (Figure 3-1)



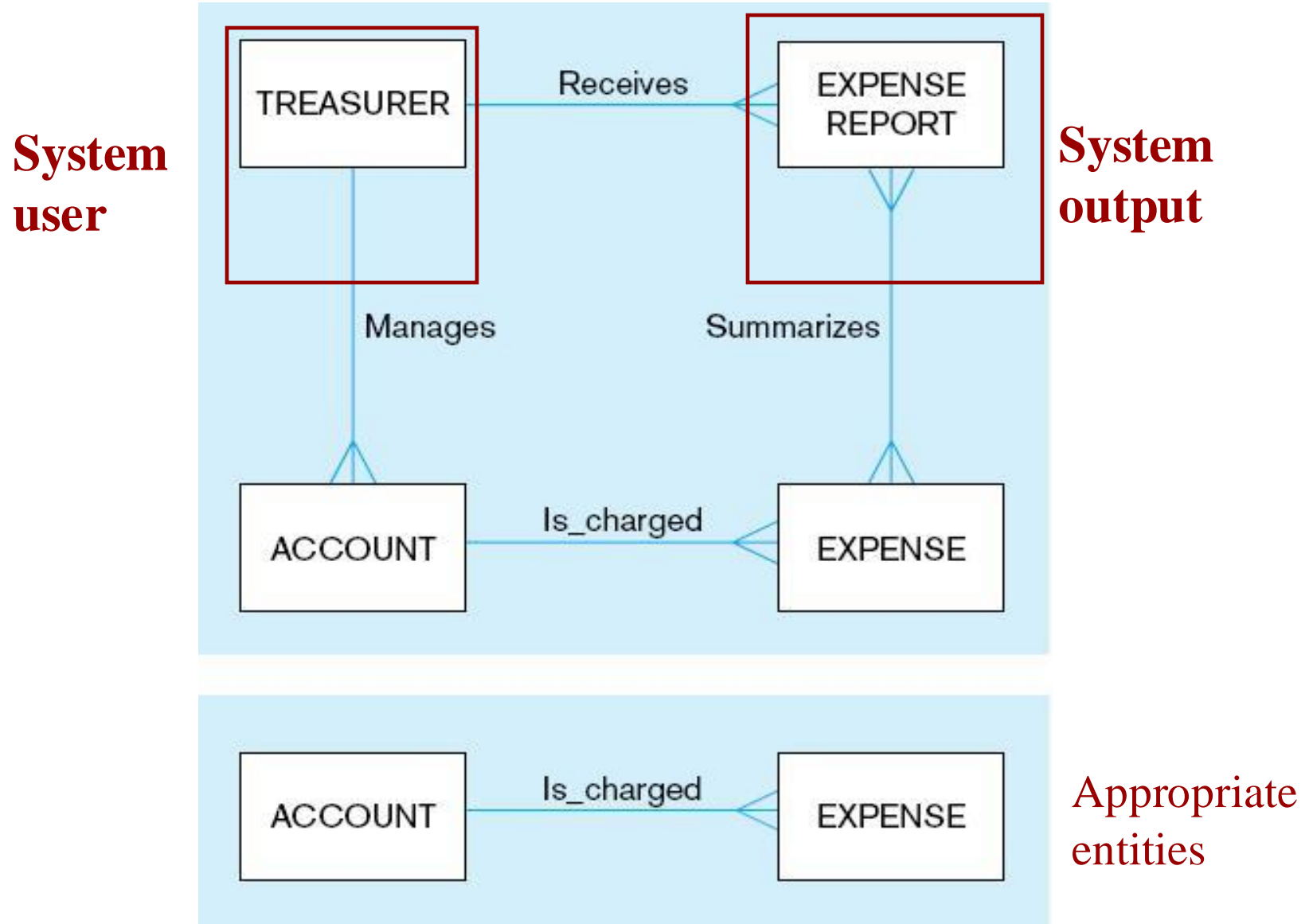
Basic E-R notation (Figure 3-2)



What Should an Entity Be?

- SHOULD BE:
 - An object that will have many instances in the database
 - An object that will be composed of multiple attributes
 - An object that we are trying to model
- SHOULD NOT BE:
 - A user of the database system
 - An output of the database system (e.g., a report)

Figure 3-4 Example of inappropriate entities



Attributes

- Attribute—property or characteristic of an entity or relationship type
- Classifications of attributes:
 - Required versus Optional Attributes
 - Simple versus Composite Attribute
 - Single-Valued versus Multivalued Attribute
 - Stored versus Derived Attributes
 - Identifier Attributes

Identifiers (Keys)

- Identifier (Key)—an attribute (or combination of attributes) that uniquely identifies individual instances of an entity type
- Simple versus Composite Identifier
- Candidate Identifier—an attribute that could be a key...satisfies the requirements for being an identifier

Characteristics of Identifiers

- Will not change in value
- Will not be null
- No intelligent identifiers (e.g., containing locations or people that might change)
- Substitute new, simple keys for long, composite keys

Figure 3-7 A **composite** attribute

**An attribute
broken into
component parts**

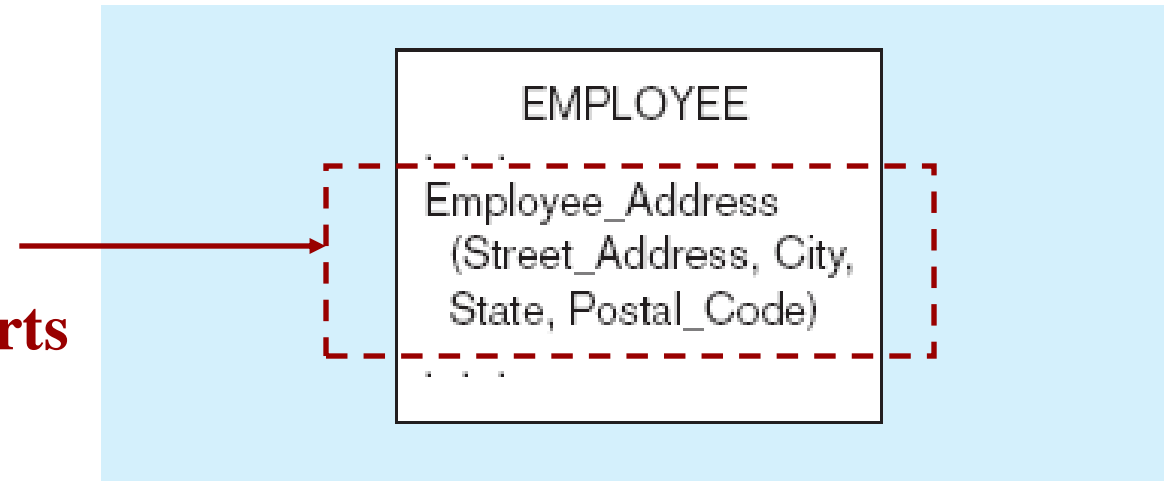
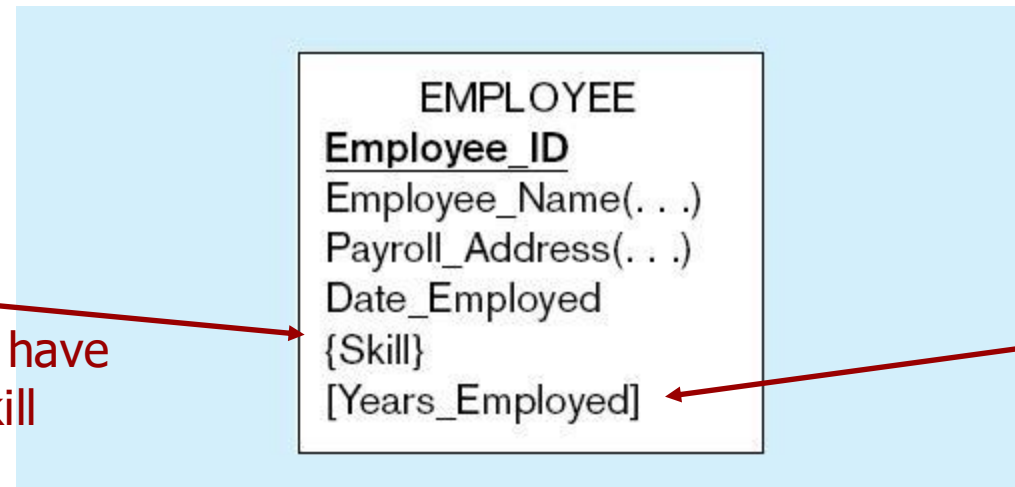


Figure 3-8 Entity with **multivalued** attribute (Skill) and **derived** attribute (Years_Employed)

Multivalued
an employee can have
more than one skill



Derived
from date
employed and
current date

Figure 3-9 Simple and composite identifier attributes

The identifier is boldfaced and underlined

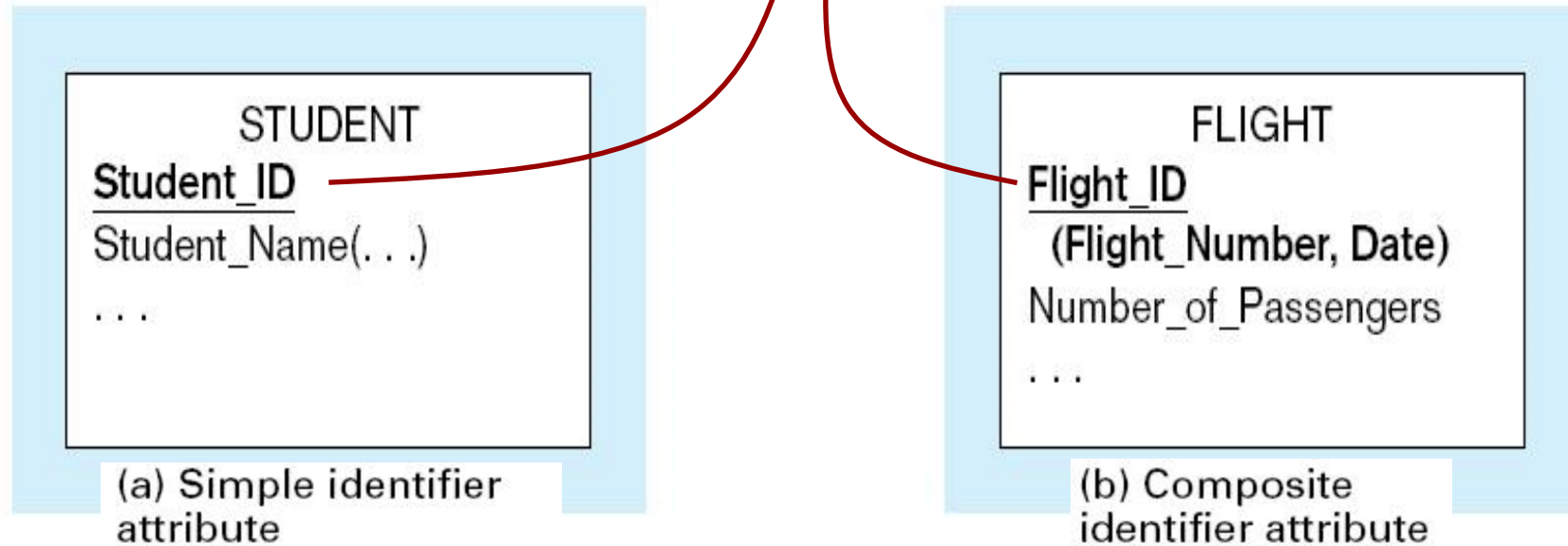
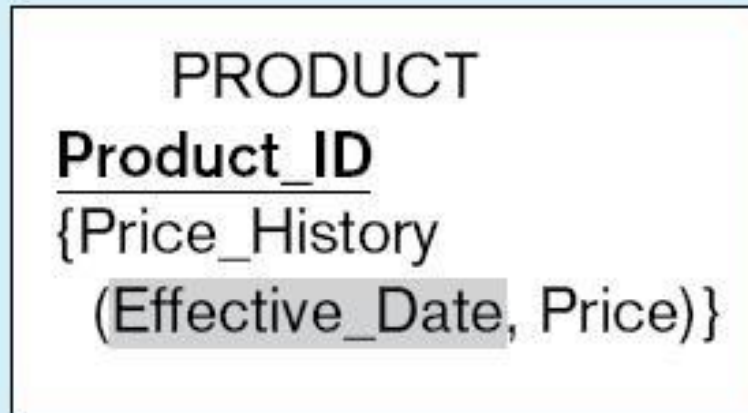


Figure 3-19 Simple example of time-stamping



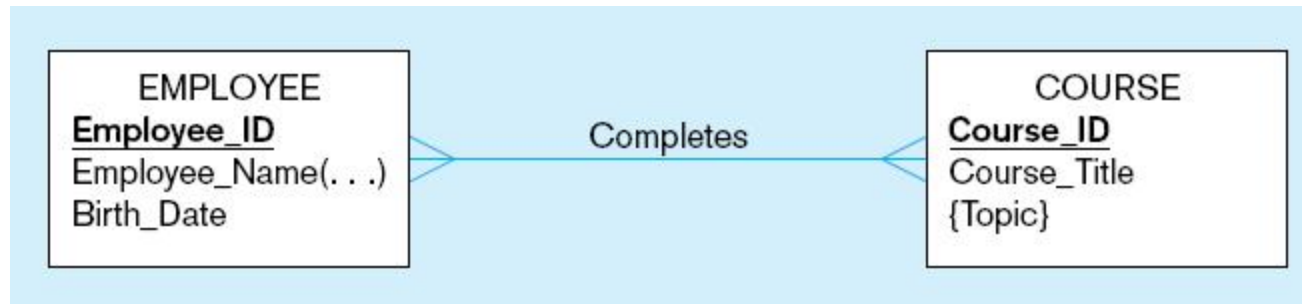
This attribute is
both
multivalued *and*
composite

More on Relationships

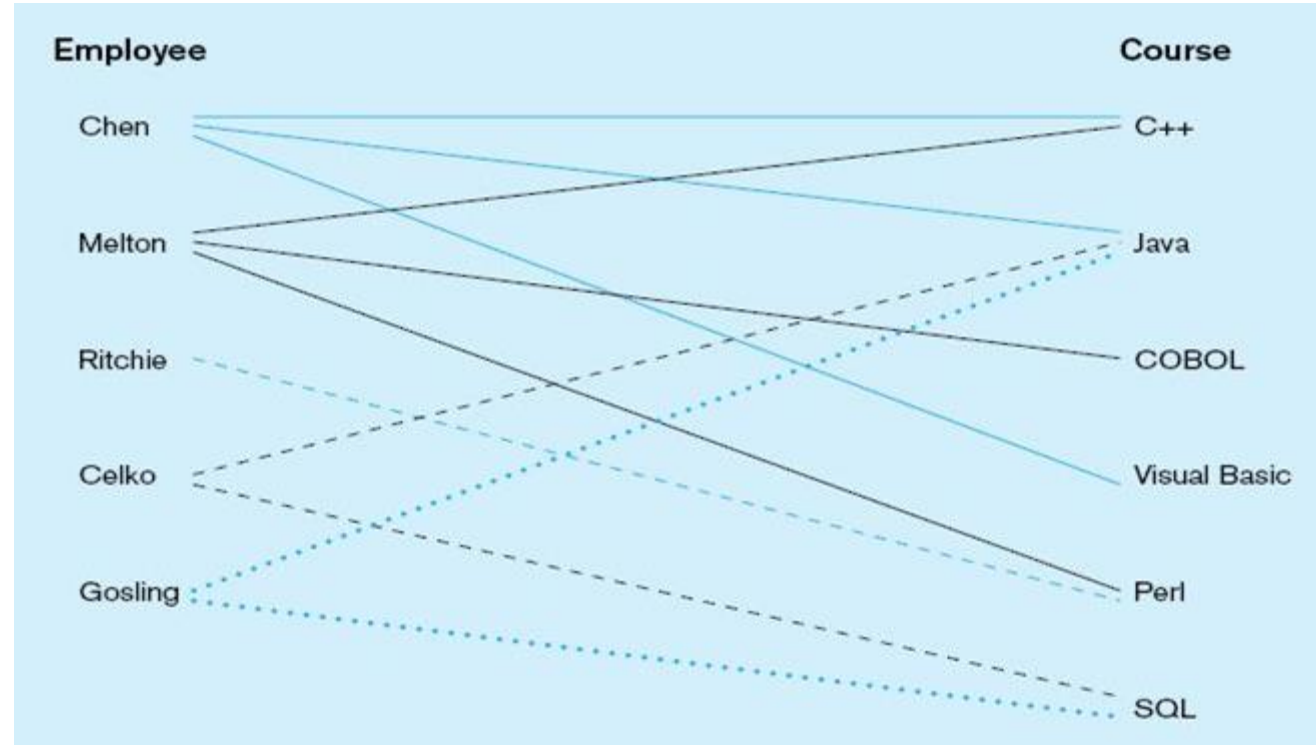
- Relationship Types vs. Relationship Instances
 - The relationship type is modeled as lines between entity types...the instance is between specific entity instances
- Relationships can have attributes
 - These describe features pertaining to the association between the entities in the relationship
- Two entities can have more than one type of relationship between them (multiple relationships)
- Associative Entity—combination of relationship and entity

Figure 3-10 Relationship types and instances

a) Relationship type



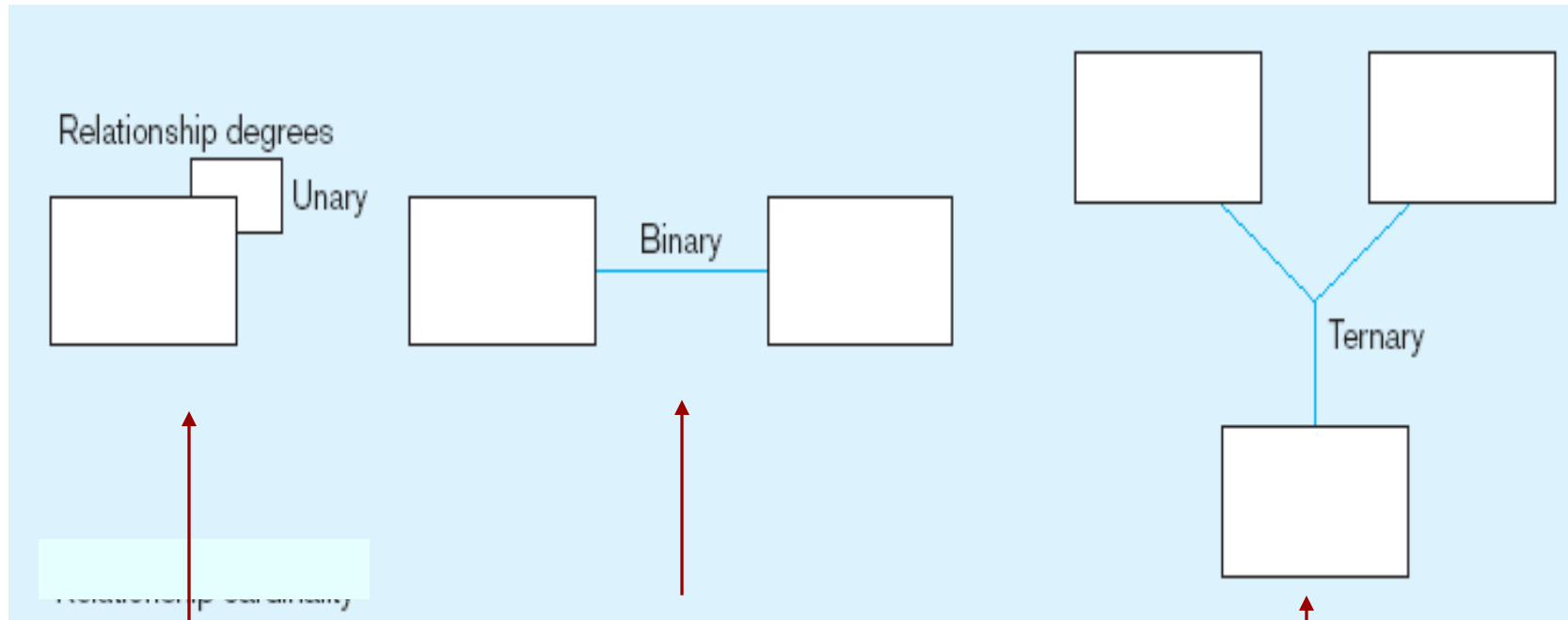
b) Relationship instances



Degree of Relationships

- Degree of a relationship is the number of entity types that participate in it
 - Unary Relationship
 - Binary Relationship
 - Ternary Relationship

Degree of relationships – from Figure 3-2



**One entity
related to
another of
the same
entity type**

**Entities of
two different
types related
to each other**

**Entities of three
different types
related to each
other**

Cardinality of Relationships

- One-to-One
 - Each entity in the relationship will have exactly one related entity
- One-to-Many
 - An entity on one side of the relationship can have many related entities, but an entity on the other side will have a maximum of one related entity
- Many-to-Many
 - Entities on both sides of the relationship can have many related entities on the other side

Cardinality Constraints

- Cardinality Constraints—the number of instances of one entity that can or must be associated with each instance of another entity
- Minimum Cardinality
 - If zero, then optional
 - If one or more, then mandatory
- Maximum Cardinality
 - The maximum number

Figure 3-12 Examples of relationships of different degrees

a) Unary relationships

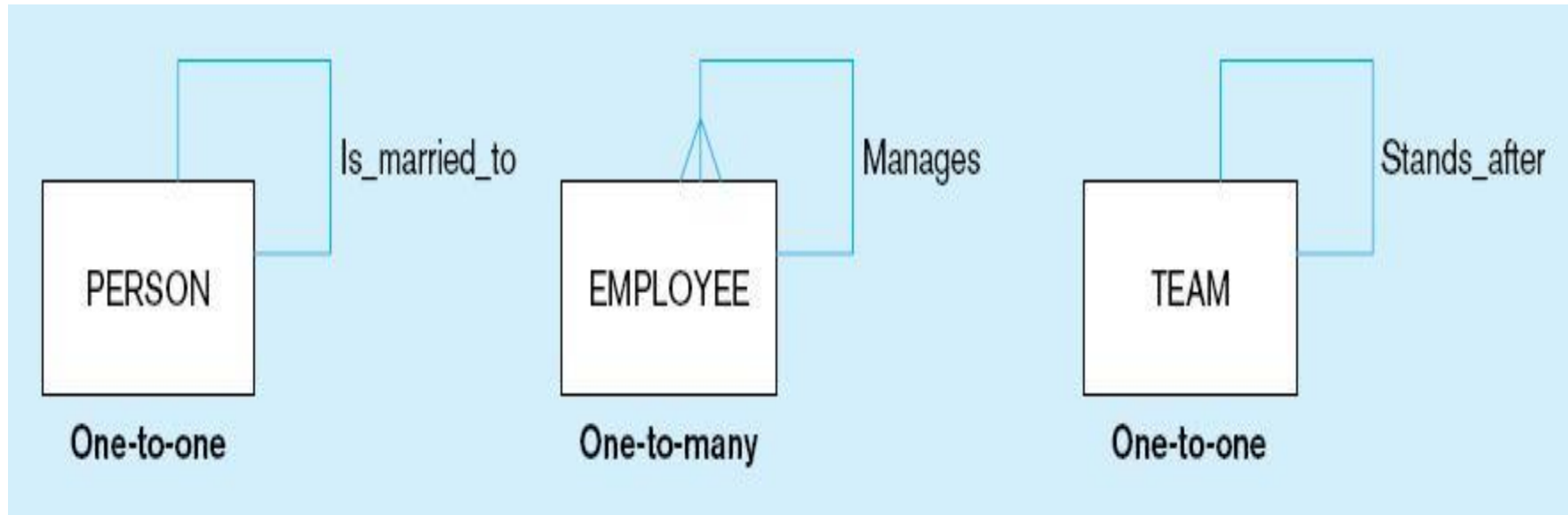


Figure 3-12 Examples of relationships of different degrees (cont.)

b) Binary relationships

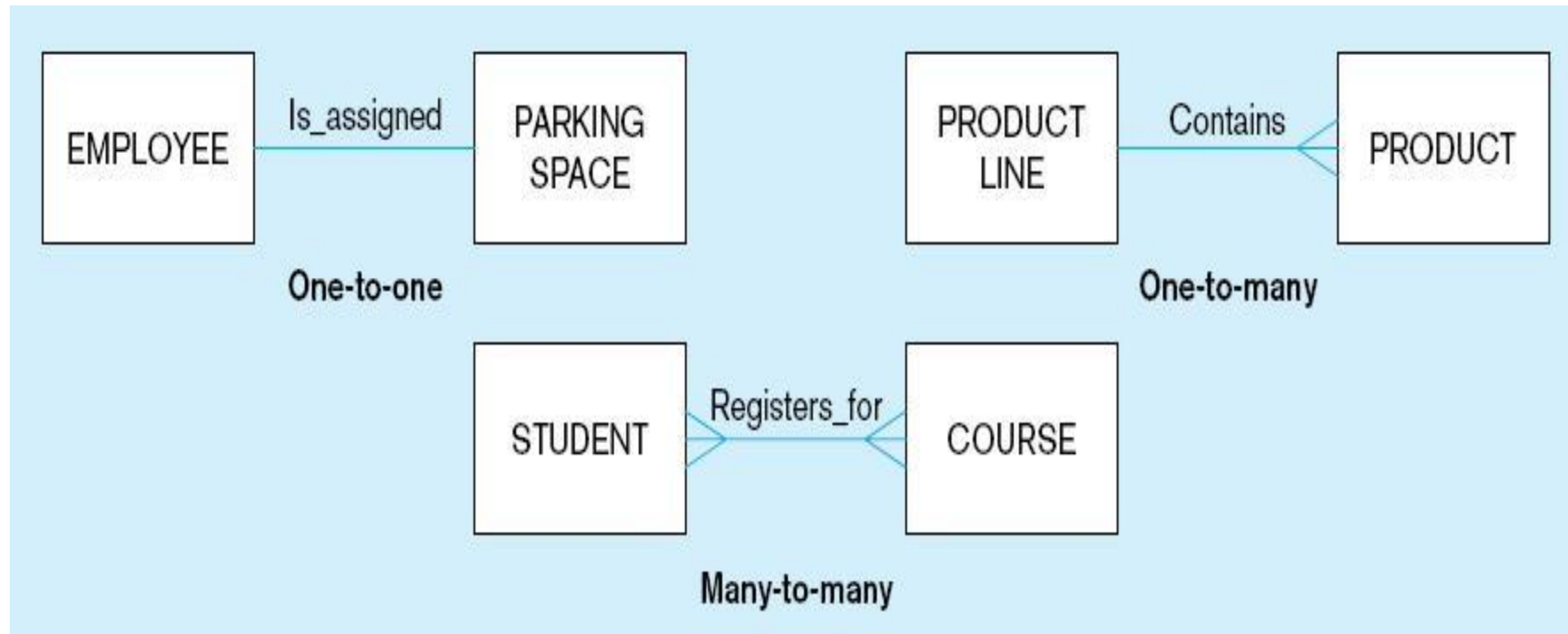
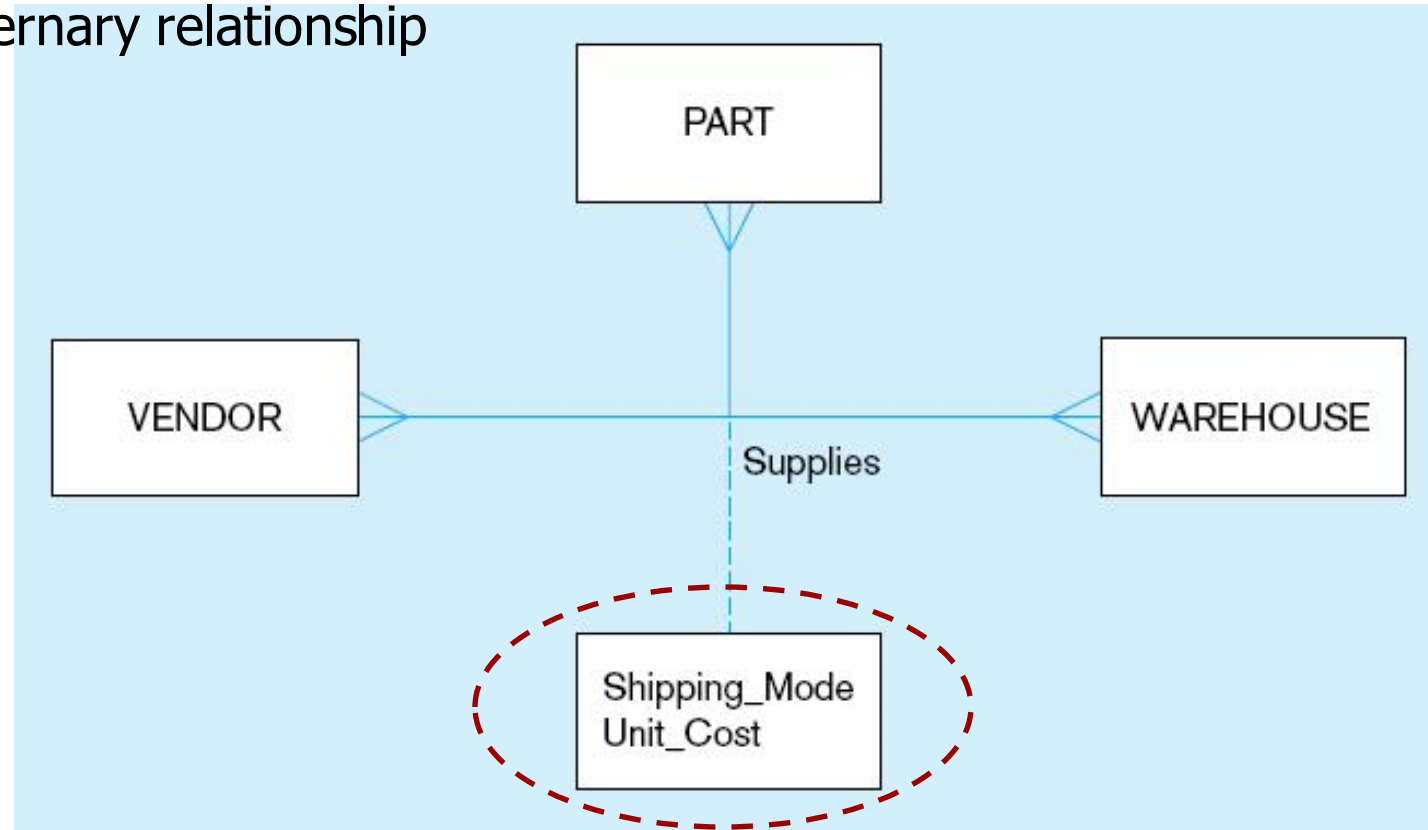


Figure 3-12 Examples of relationships of different degrees (cont.)

c) Ternary relationship



Note: a relationship can have attributes of its own

Figure 3-17 Examples of cardinality constraints

a) Mandatory cardinalities

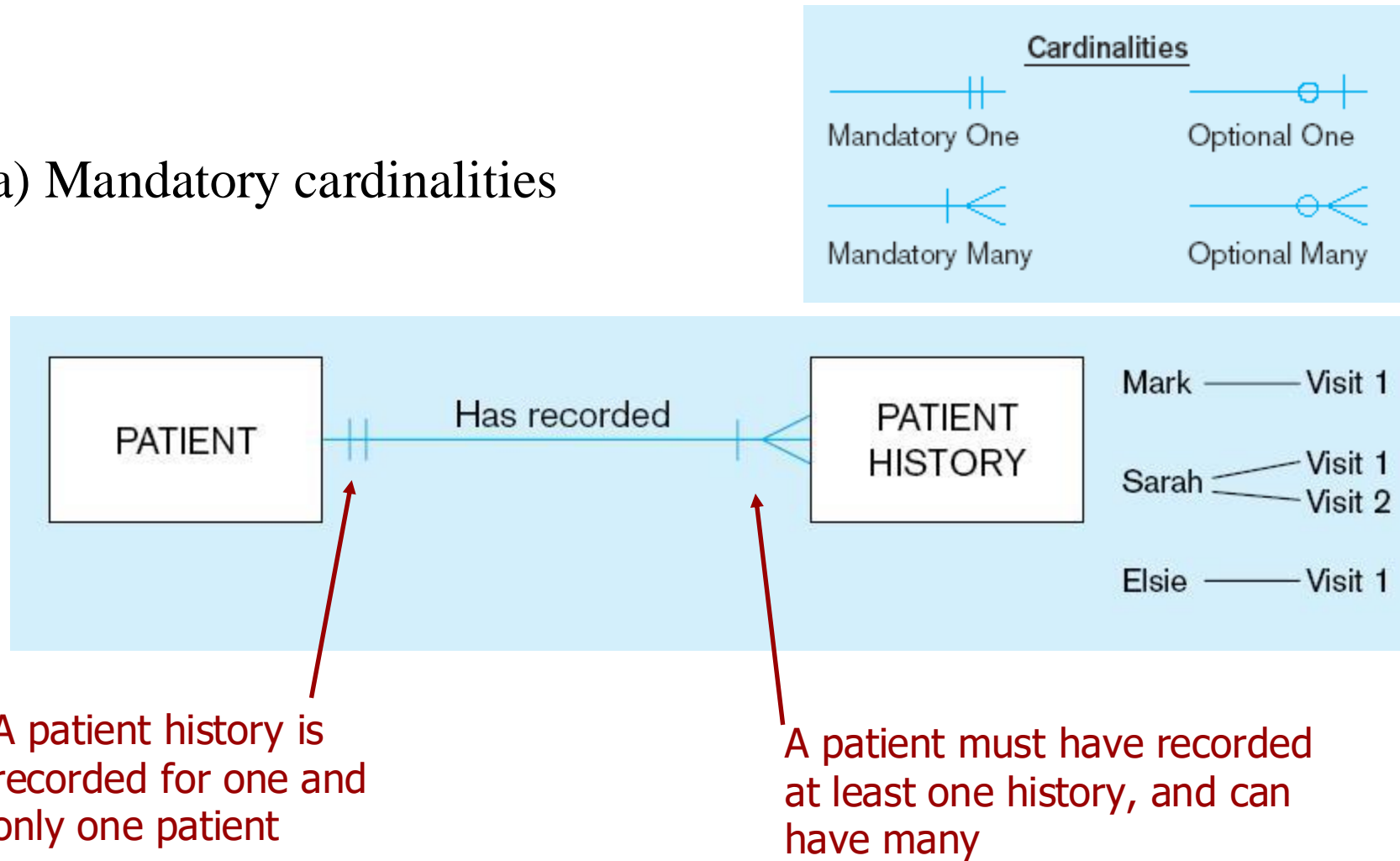


Figure 3-17 Examples of cardinality constraints (cont.)

b) One optional, one mandator

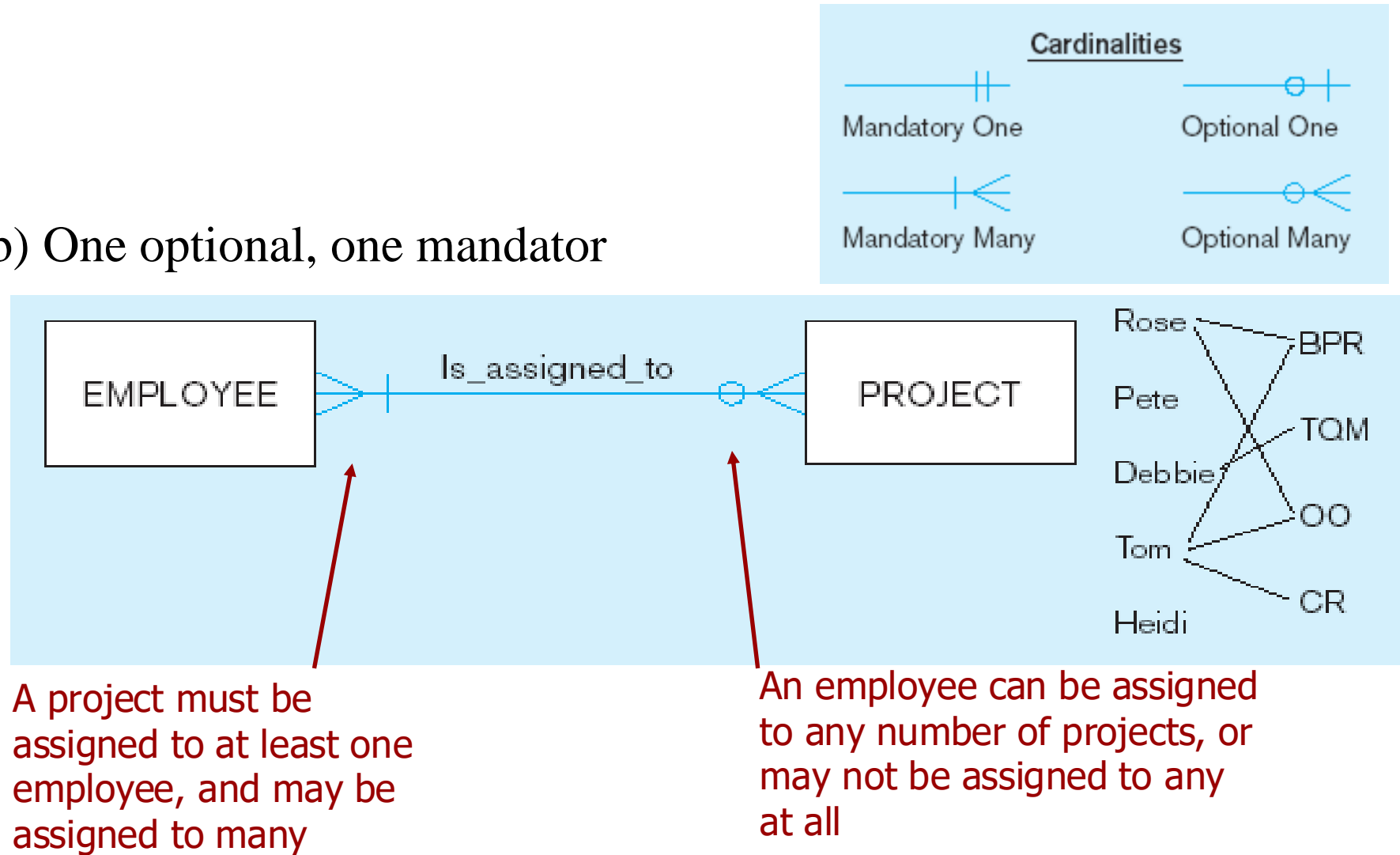
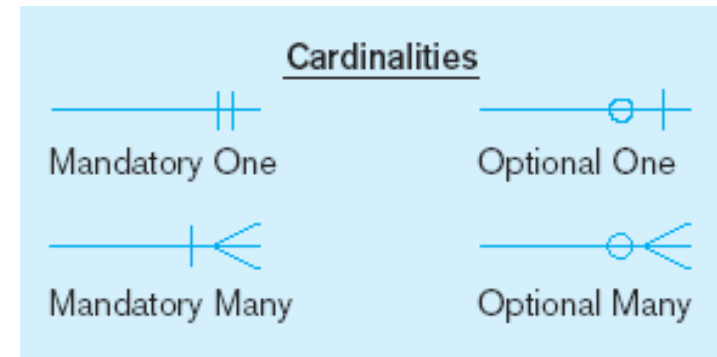


Figure 3-17 Examples of cardinality constraints (cont.)

c) Optional cardinalities



A person is
married to at most
one other person,
or may not be
married at all

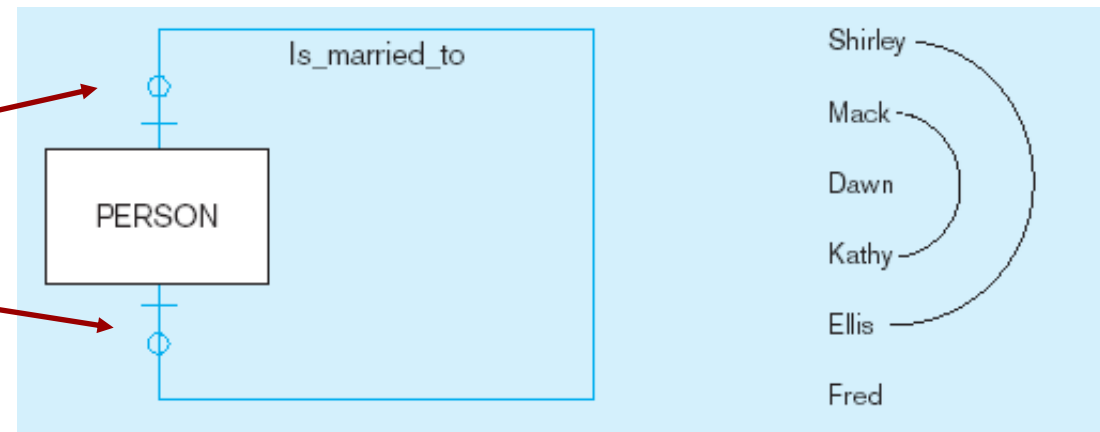
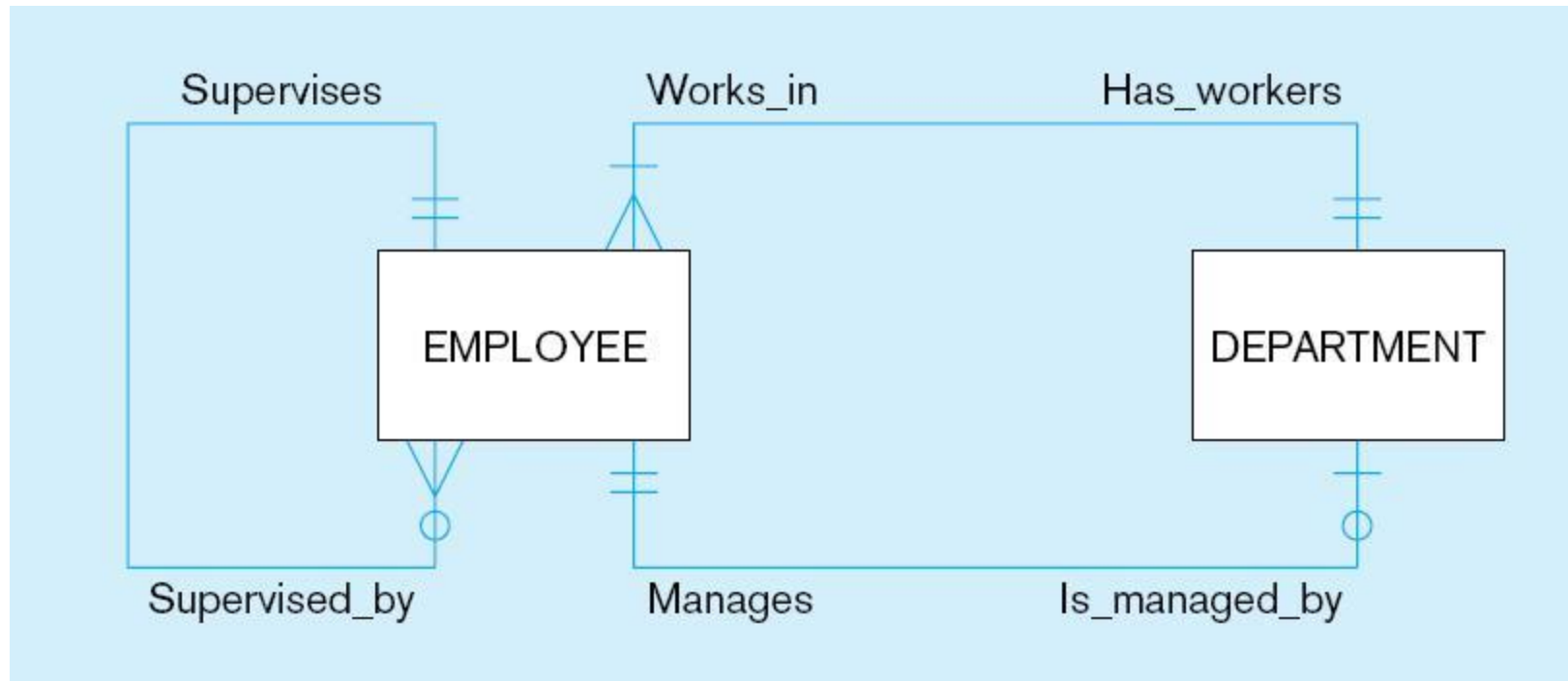


Figure 3-21 Examples of multiple relationships

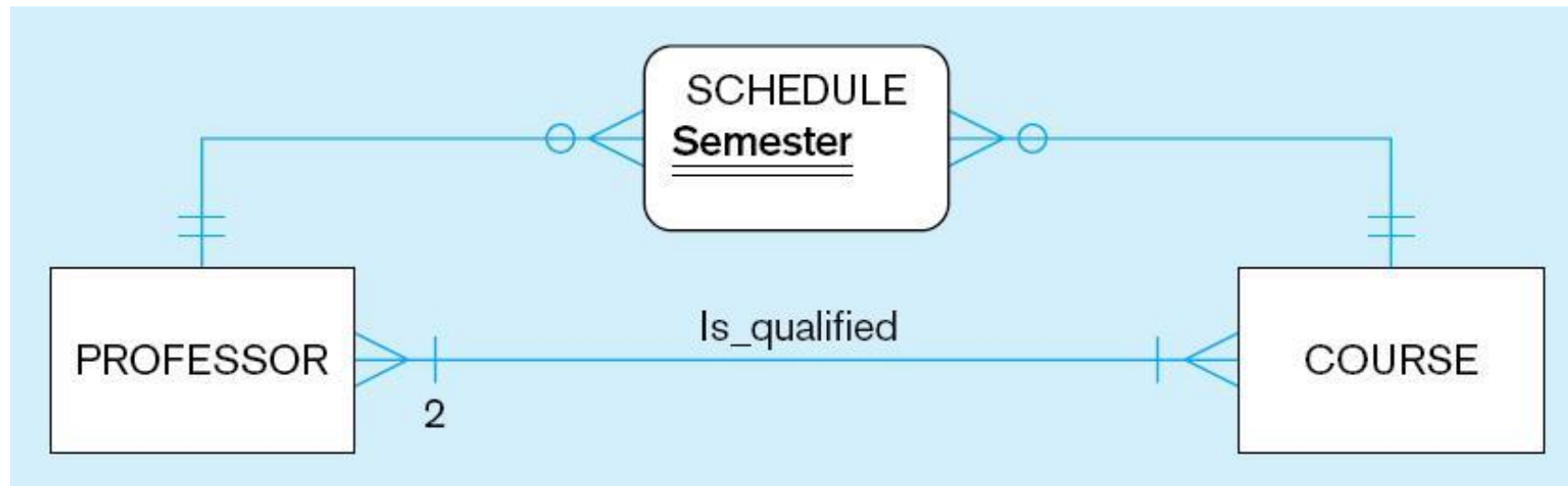
a) Employees and departments



Entities can be related to one another in more than one way

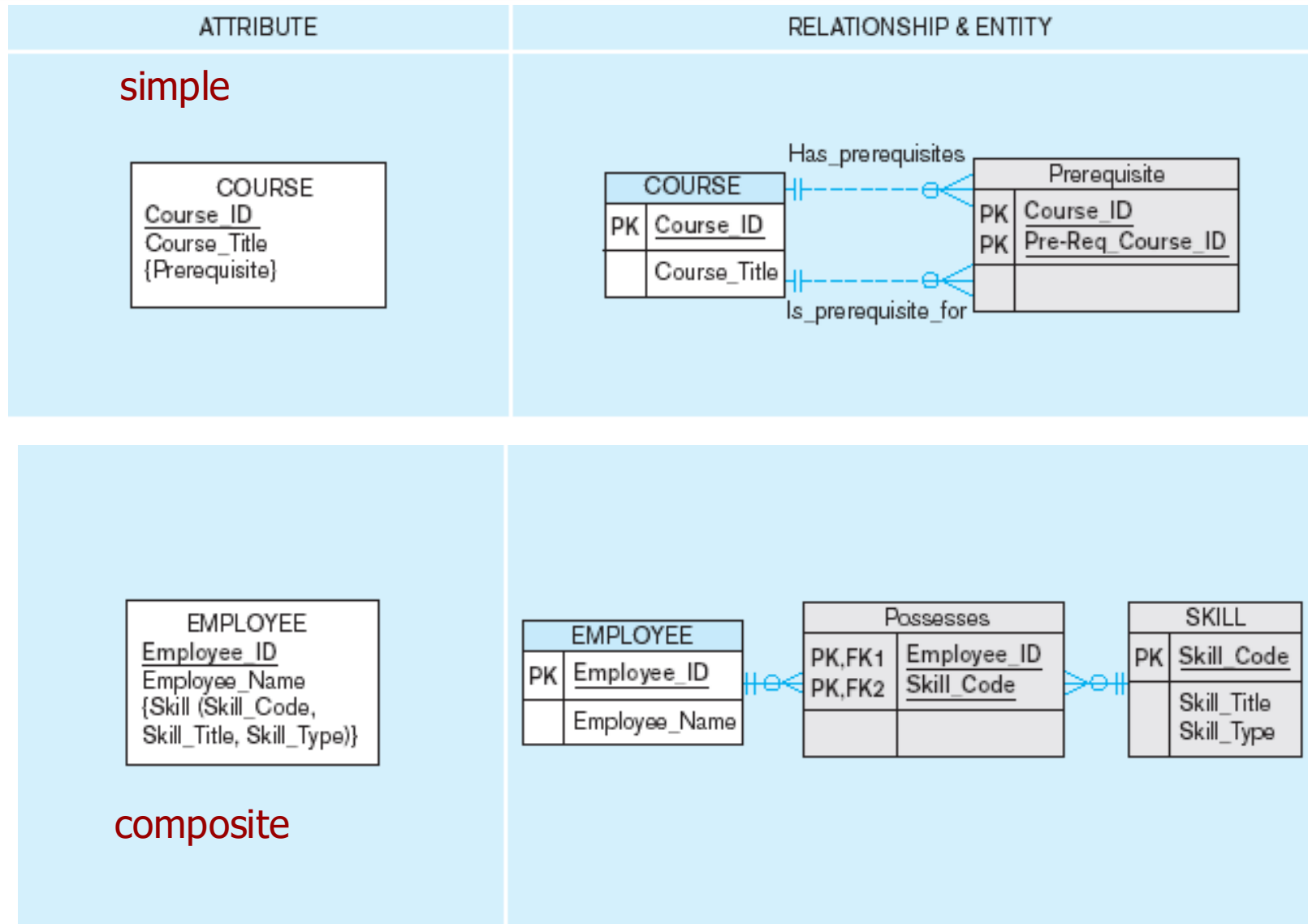
Figure 3-21 Examples of multiple relationships (cont.)

b) Professors and courses (fixed lower limit constraint)



Here, min
cardinality
constraint is 2

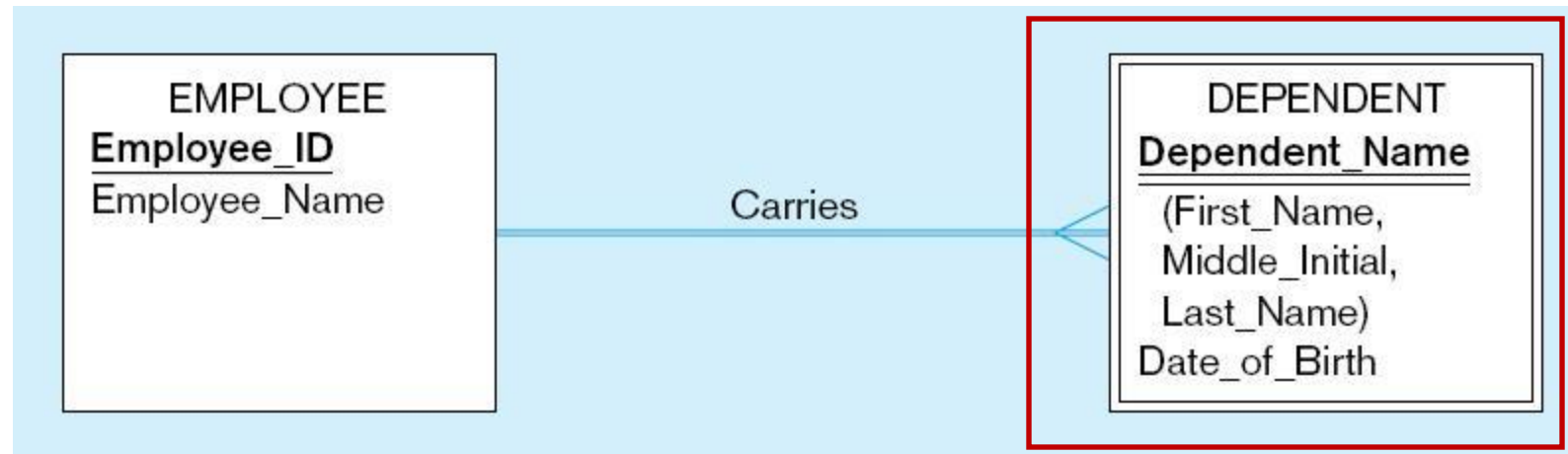
Figure 3-15a and 3-15b Multivalued attributes can be represented as relationships



Strong vs. Weak Entities, and Identifying Relationships

- Strong entities
 - exist independently of other types of entities
 - has its own unique identifier
 - identifier underlined with single line
- Weak entity
 - dependent on a strong entity (identifying owner)...cannot exist on its own
 - does not have a unique identifier (only a partial identifier)
 - partial identifier underlined with double line
 - entity box has double line
- Identifying relationship
 - links strong entities to weak entities

Identifying relationship (Figure 3-5)



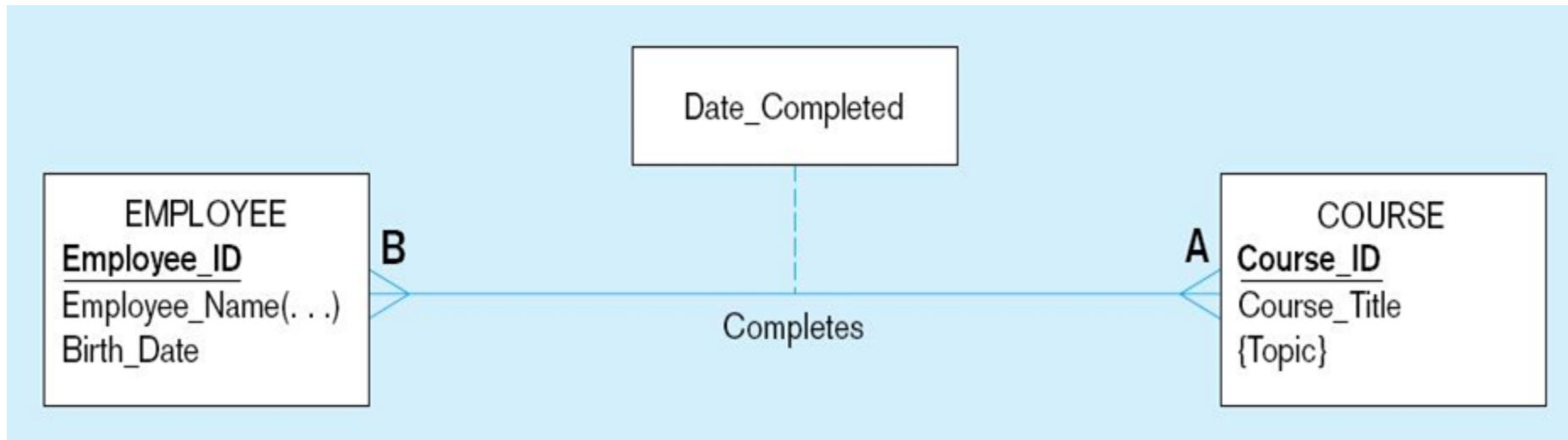
Strong entity

Weak entity

Associative Entities

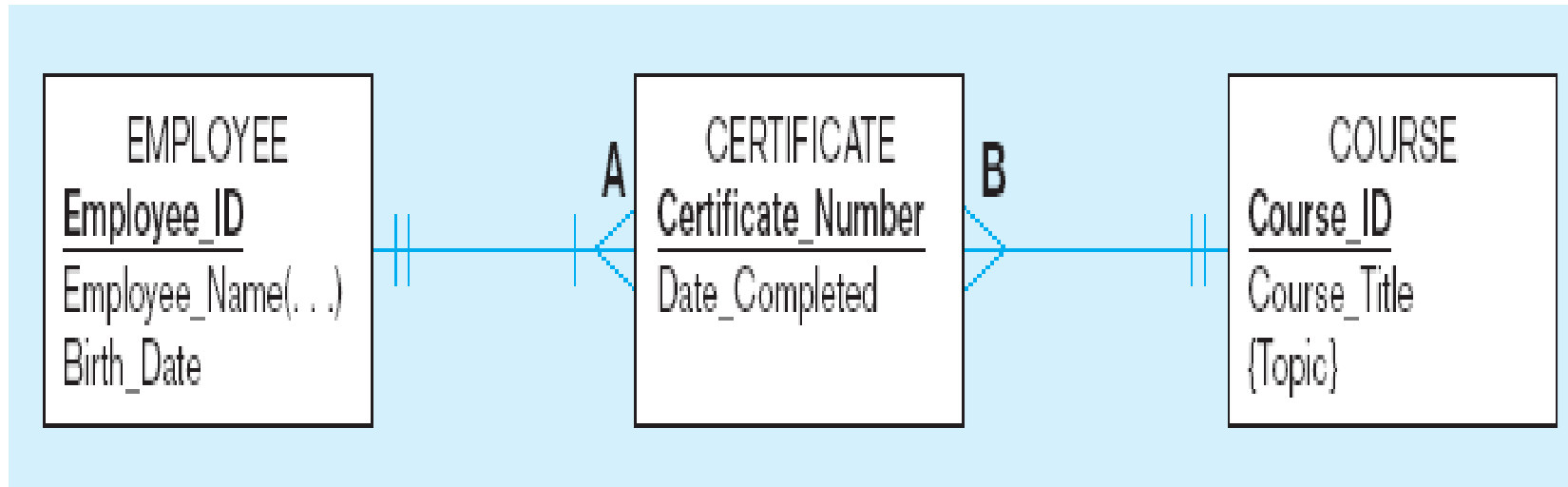
- An **entity**—has attributes
- A **relationship**—links entities together
- When should a *relationship with attributes* instead be an *associative entity*?
 - All relationships for the associative entity should be many
 - The associative entity could have meaning independent of the other entities
 - The associative entity preferably has a unique identifier, and should also have other attributes
 - The associative entity may participate in other relationships other than the entities of the associated relationship
 - Ternary relationships should be converted to associative entities

Figure 3-11a A binary relationship with an attribute



Here, the date completed attribute pertains specifically to the employee's completion of a course...it is an attribute of the *relationship*

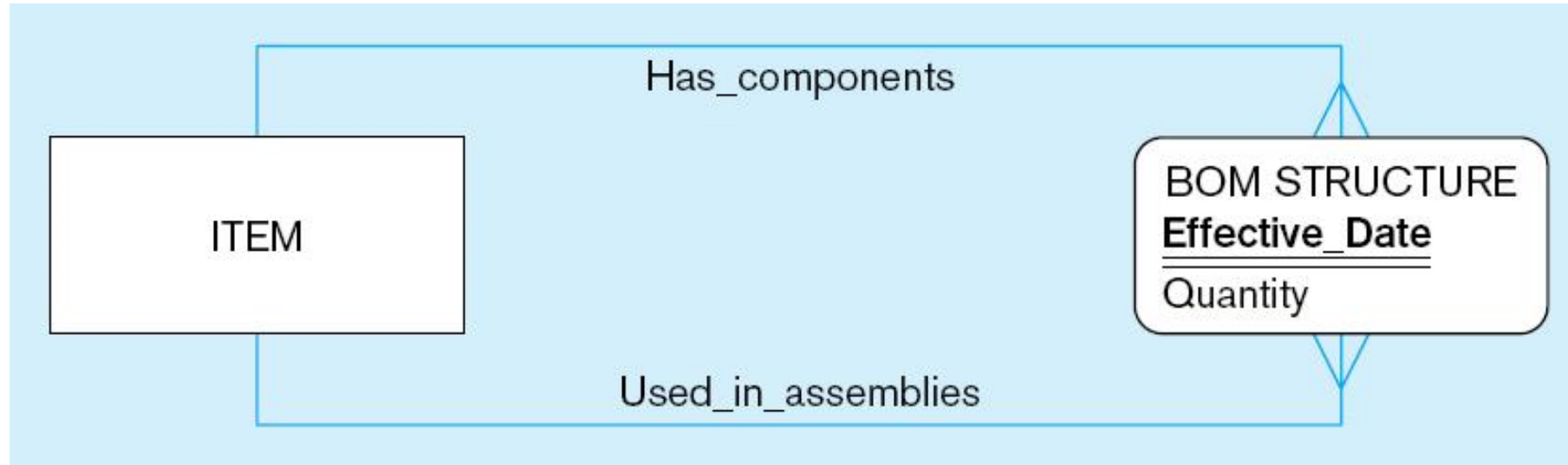
Figure 3-11b An associative entity (CERTIFICATE)



Associative entity is like a relationship with an attribute, but it is also considered to be an entity in its own right

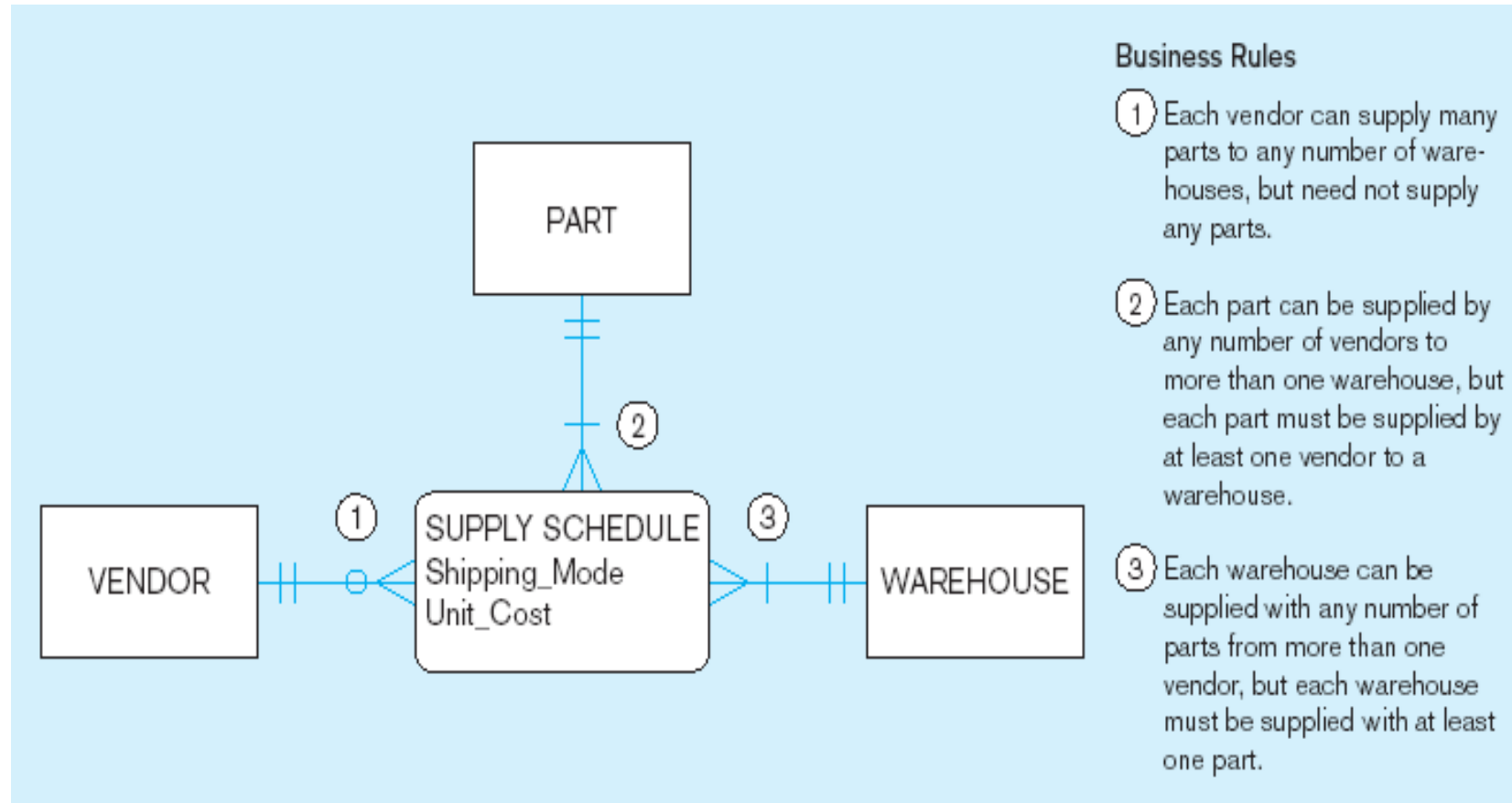
Note that the many-to-many cardinality between entities in Figure 3-11a has been replaced by two one-to-many relationships with the associative entity

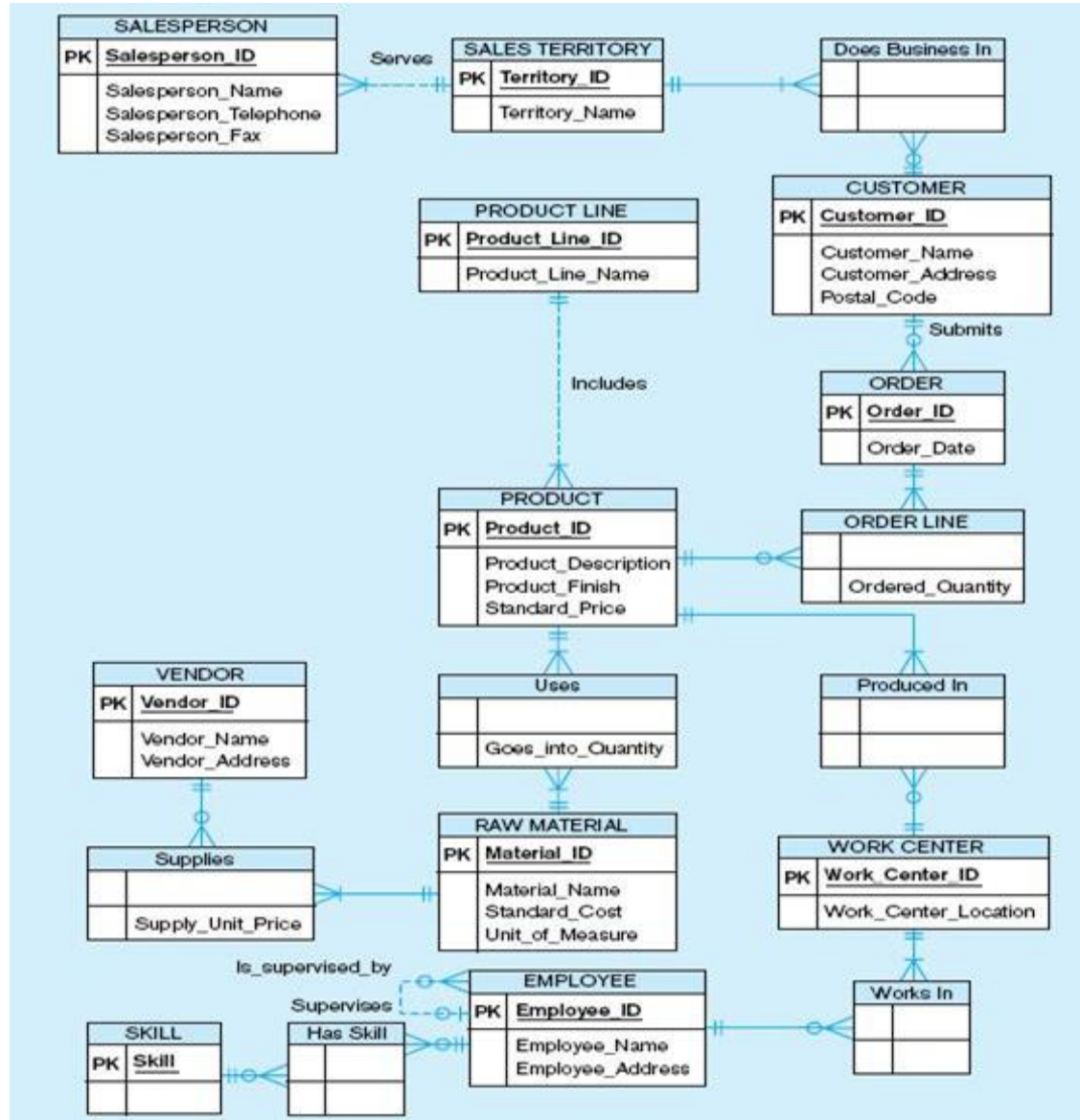
Figure 3-13c An associative entity – bill of materials structure



This could just be a relationship with attributes...it's a judgment call

Figure 3-18 Ternary relationship as an associative entity





Microsoft Visio Notation for Pine Valley Furniture E-R diagram

(Figure 3-22)

Different modeling
software tools may have
different notation for the
same constructs