SE3910 – REAL TIME SYSTEMS

Structured Design and Data Flow Diagrams

ROADMAP

- Today
  - Structured Design and Data Flow Diagrams
- Wednesday
  - Performance Analysis
- Friday
  - Queuing Theory

Math!

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OBJECTIVES

- Define Structured Design
- Explain the purpose for a data flow diagram
- Construct a dataflow diagram for a given problem
- Explain the purpose for a data-dictionary entry
- Explain how a data dictionary can be used to keep track of information in an embedded system
- Explain the types of defects that a data flow diagram could aid in detecting in software
- Compare and contrast Structured Analysis approaches versus Object Oriented Approaches toward designing software

DISCUSSION: HOW DO YOU REPRESENT DESIGN IN SDL?

With Laughter!

⇒ What Design?

⇒ the previous design?

DISCUSSION: HOW DO YOU REPRESENT DESIGN IN SDL?

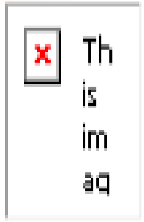
~~UML diagrams?~~

~~⇒ EA?~~

~~⇒ Rational Rose?~~

~~⇒ Visio?~~

No designs for SDL?



STRUCTURED DESIGN

- A Companion method to structured analysis — Big upfront design not good
- A systematic approach concerned with the specification of the software architecture and involves a number of strategies, techniques, and tools
- Easy to learn design approach — Just a couple of diagrams
- Primary artifacts are a data flow diagram (with data dictionary and mini-spec's), and entity relationship diagram

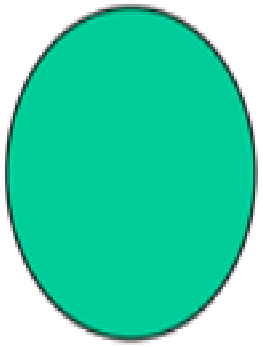
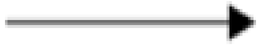
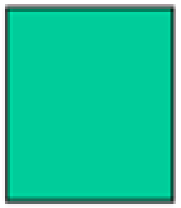
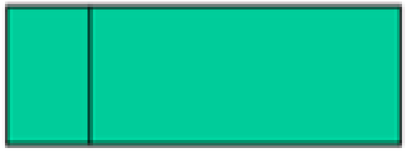
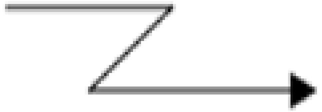
Shows how information moves in a system.

DATA FLOW DIAGRAMS

- Entity .
  - An entity is the source or destination of data.
  - The source in a DFD represents these entities that are outside the context of the system.

    outside of the scope.
  - Entities either provide data to the system (referred to as a source) or receive data from it (referred to as a sink). "Gstreamerish"
- Process
  - The process is the manipulation or work that transforms data, performing computations, making decisions (logic flow), or directing data flows based on business rules. [redacted]
- Data Store ⇒ Data structures
  - A data store is where a process stores data between processes for later usage by the same process or another process.
- Data Flow ⇒ motion of information.
  - Data flow is the movement of data between the entity, the process, and the data store. Data flow portrays the interface between the components of the DFD.

DATA FLOW DIAGRAM SYMBOLS

Symbol:	Meaning:	Description:
	Circle Process	A series of one or more steps that converts inputs to outputs. Each process is followed by a mini-spec ([redacted]) ↳ Defines manipulation
	Data Flow	Shows a data path (flow of data)
	Entity External Agent	A source or sink of data. Lies outside the system → Provider / User of data
	Data Store	Data at rest, usually a file or database table
	Real-time link	A communication link. This symbol added later. [redacted]

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CASE STUDY: TRAFFIC CONTROL

- We are going to walk through the design of a Traffic Control System
  - Starting with the needs of the system.
  - We want to talk about how data flows through the system.

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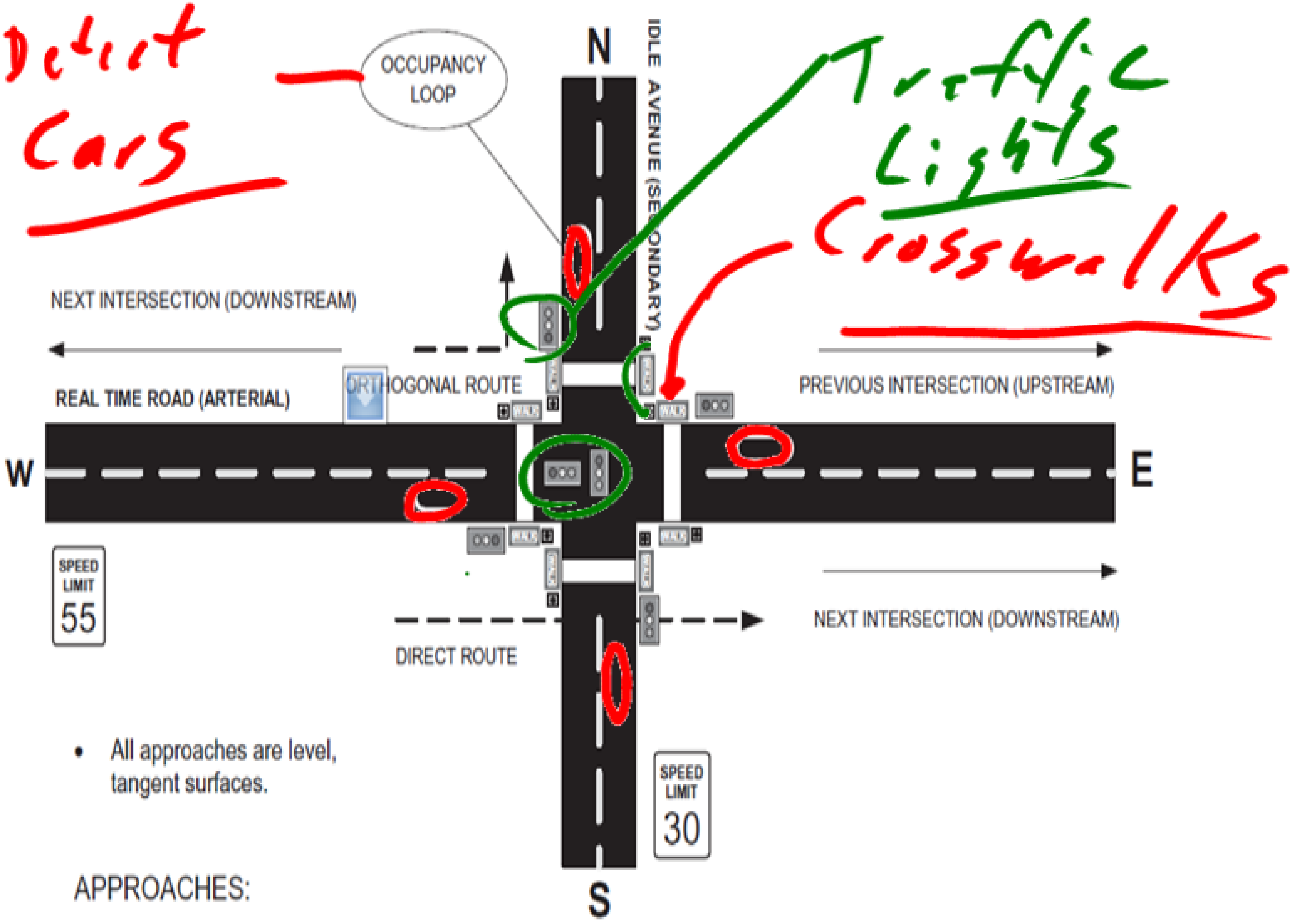
AN INTERSECTION SYSTEM



- All approaches are level, tangent surfaces.

APPROACHES:

W-E
E-W
N-S
S-N

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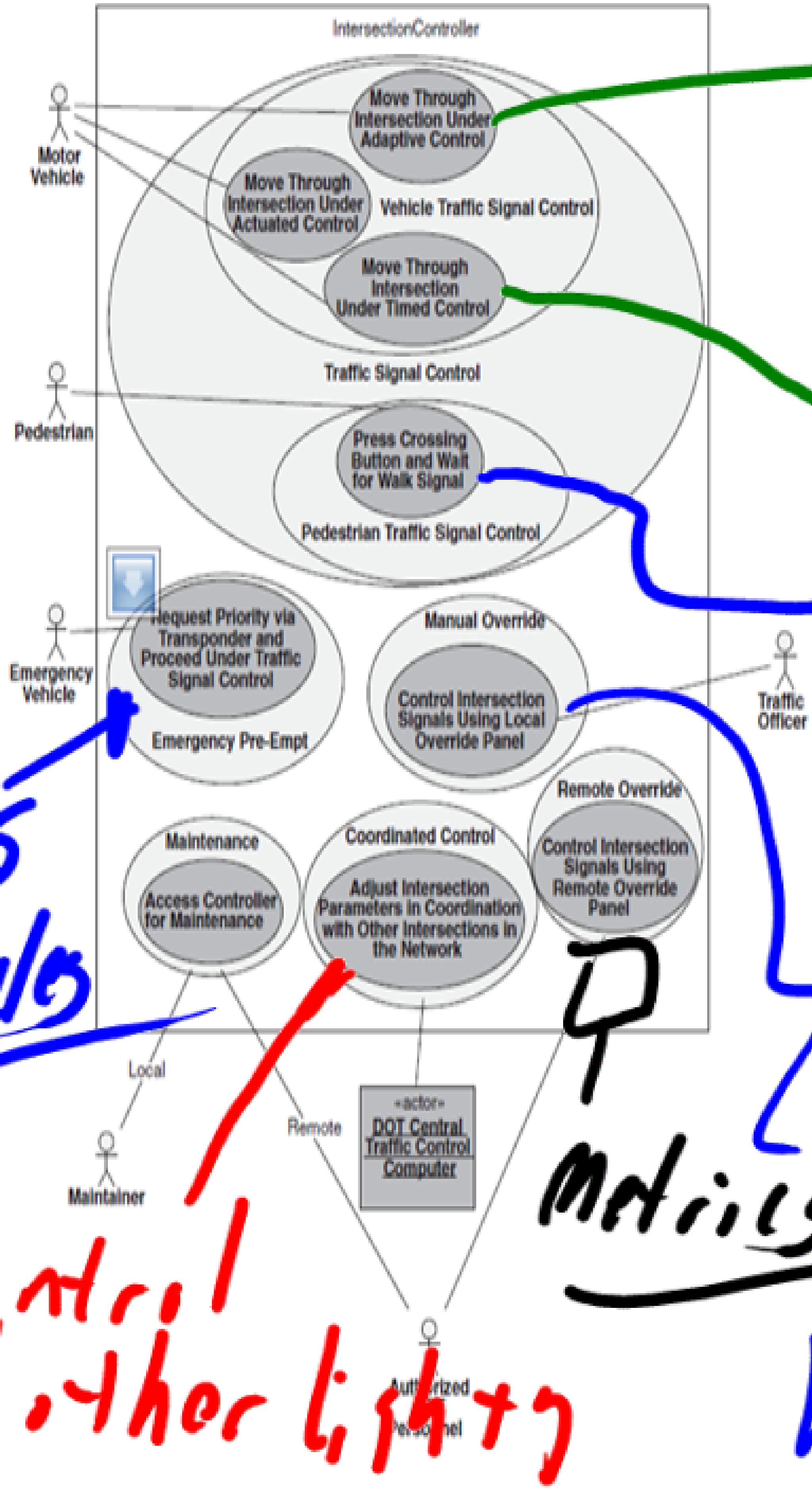
INTERSECTION CONTROL DIAGRAM


IntersectionController
Motor Vehicle
Move Through Intersection Under Adaptive Control
Move Through Intersection Under Actuated Control
Vehicle Traffic Signal Control
Move Through Intersection Under Timed Control
Traffic Signal Control
Pedestrian
Press Crossing Button and Wait for Walk Signal
Pedestrian Traffic Signal Control
Emergency Vehicle
Request Priority via Transponder and Proceed Under Traffic Signal Control
Emergency Pre-Empt
Manual Override
Control Intersection Signals Using Local Override Panel
Traffic Officer
Remote Override
Control Intersection Signals Using Remote Override Panel
Maintenance
Access Controller for Maintenance
Coordinated Control
Adjust Intersection Parameters in Coordination with Other Intersections in the Network
Local
Remote
Maintainer
«actor»
DOT Central Traffic Control Computer
Authorized Personnel

Adapt to traffic conditions

Fixed times

Crosswalk controls

EMS Vehicles

Control w/ other lights

Metrics

Let someone control by hand!

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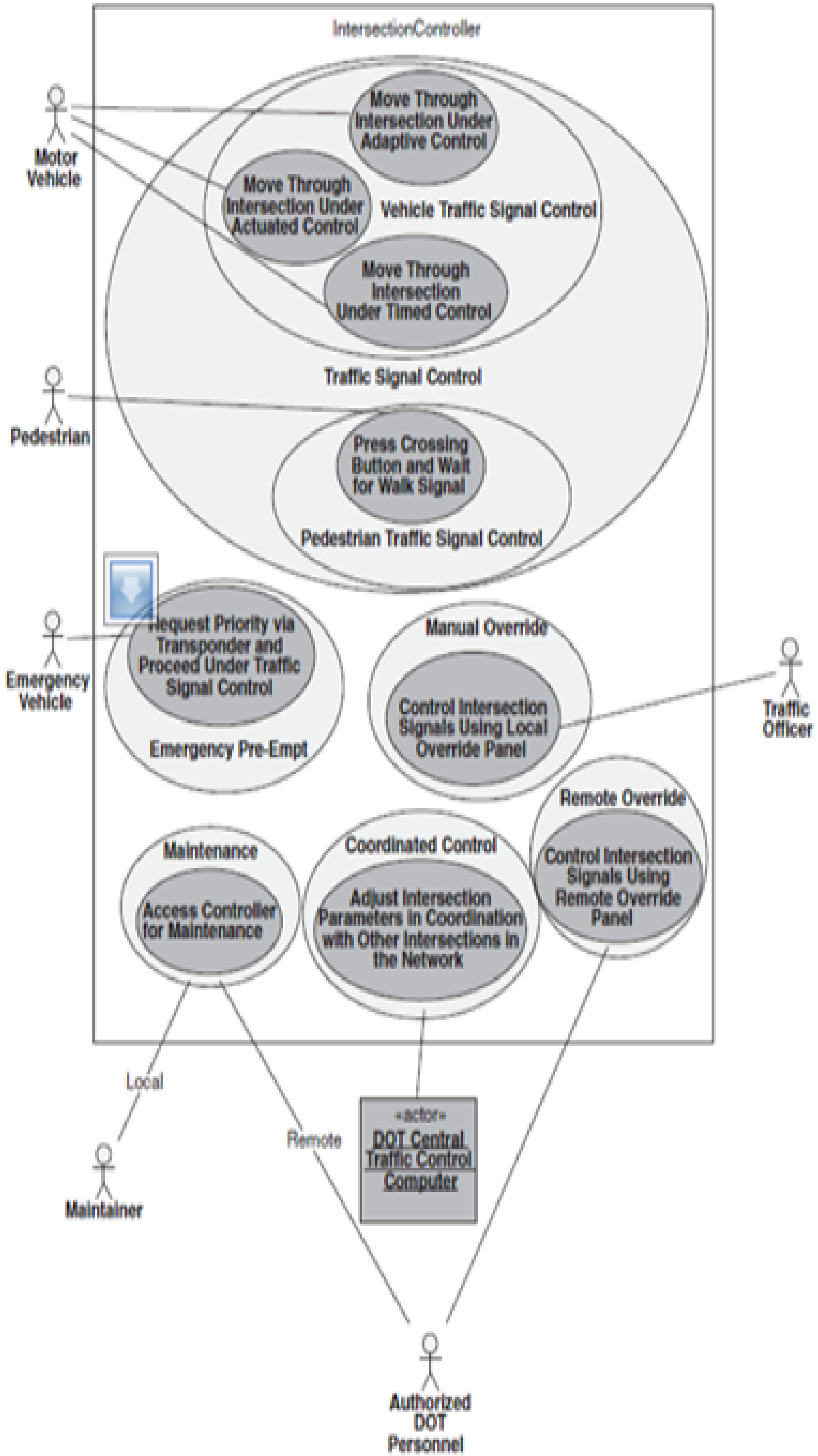
INTERSECTION CONTROL DIAGRAM


IntersectionController
Motor Vehicle
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Move Through Intersection Under Timed Control
Traffic Signal Control
Pedestrian
Press Crossing Button and Wait for Walk Signal
Pedestrian Traffic Signal Control
Emergency Vehicle
Request Priority via Transponder and Proceed Under Traffic Signal Control
Emergency Pre-Empt
Manual Override
Control Intersection Signals Using Local Override Panel
Traffic Officer
Remote Override
Control Intersection Signals Using Remote Override Panel
Maintenance
Access Controller for Maintenance
Coordinated Control
Adjust Intersection Parameters in Coordination with Other Intersections in the Network
Local
Remote
«actor»
DOT Central Traffic Control Computer
Maintainer
Authorized DOT Personnel

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DATAFLOW DIAGRAM

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DATA DICTIONARY

- An essential aspect of a structured design
  - Includes entries for data flows, control flows, data stores, buffers, etc.

Units

Uses

etc.

DATA DICTIONARY EXAMPLE

Example: A Sample Data-Dictionary Entry

For the elevator control system, one DD entry might appear as follows:

Name: Car call table ← what the data is called.

Alias: Car_calls

Entry type: Data store ←

Description: An integer vector containing the car call status for each possible destination floor → Units

Permitted → *Values*: "1" corresponds to "car call registered" and "0" represents "no car call," whereas other values are illegal

Location: Level 2.1 DFD

0	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	0	1	1	1	1	1	1	1	0

DISCUSSION: WHICH SOFTWARE FAILURE WE HAVE TALKED ABOUT SHOULD HAVE BEEN CAUGHT USING THIS APPROACH?

Arianne 5 ⇒ floating point out of range

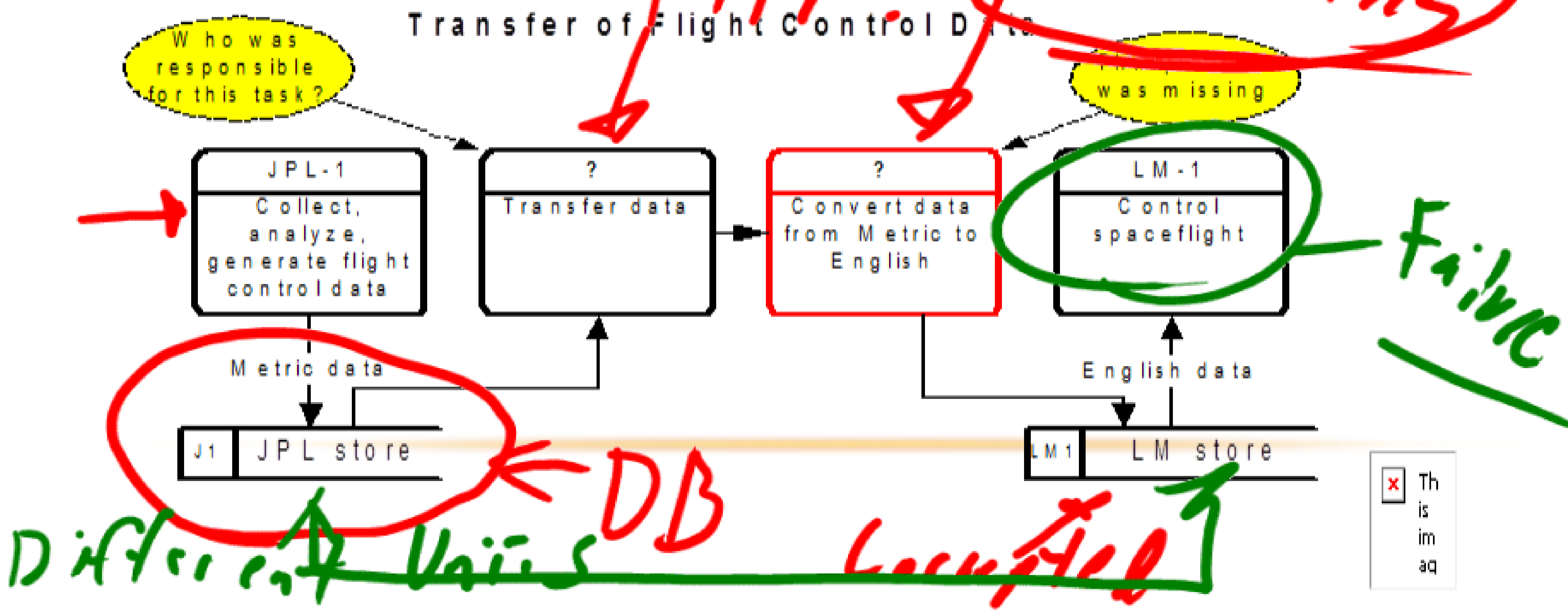
Mars Climate orbiter

DFD – PRACTICAL EXAMPLE

Launched Dec. 11, 1998, the Climate Orbiter plunged too steeply into the Martian atmosphere Sept. 23, 1999, and either burned up or crashed. In an initial failure report released Oct. 15, 2000 the review board blamed the navigation error on a communications foul-up between NASA's Jet Propulsion Laboratory and prime contractor Lockheed Martin.

FTP/?

Missing



Transfer of Flight Control Data
Who was responsible for this task?
was missing
JPL-1
Collect, analyze, generate flight control data
?
Transfer data
?
Convert data from Metric to English
LM-1
Control spaceflight
Metric data
English data
J1
JPL store
LM1
LM store
Failure
DB
Different Units
Corrupted
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SA/SD VERSUS OOAD

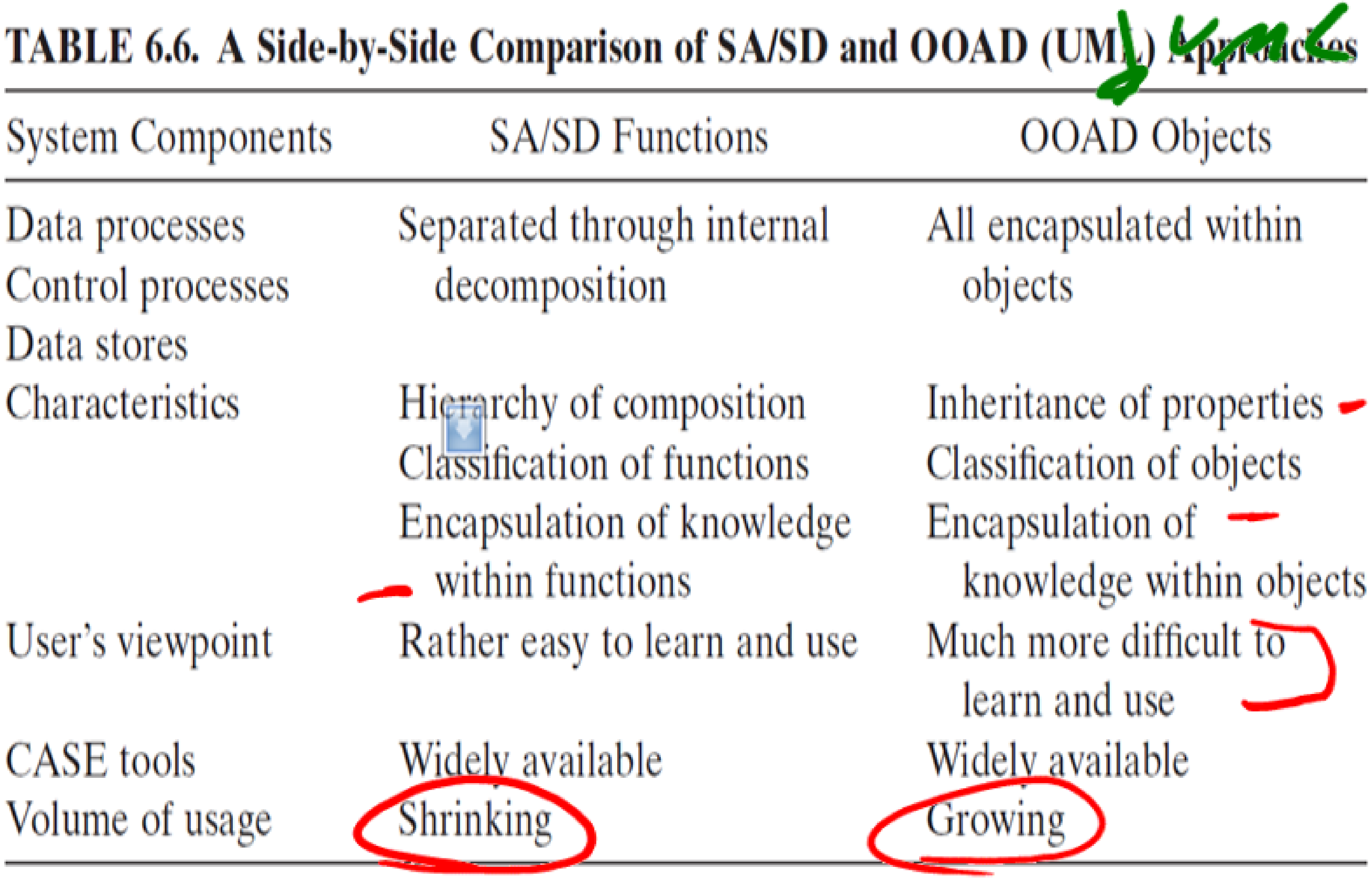

TABLE 6.6. A Side-by-Side Comparison of SA/SD and OOAD (UML) Approaches

uml

System Components	SA/SD Functions	OOAD Objects
Data processes Control processes Data stores	Separated through internal decomposition	All encapsulated within objects
Characteristics	Hierarchy of composition Classification of functions Encapsulation of knowledge within functions	Inheritance of properties Classification of objects Encapsulation of knowledge within objects
User's viewpoint	Rather easy to learn and use	Much more difficult to learn and use
CASE tools	Widely available	Widely available
Volume of usage	Shrinking	Growing