CP317A Software Engineering

Low-level design-part 1 – week 4-1

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Agenda

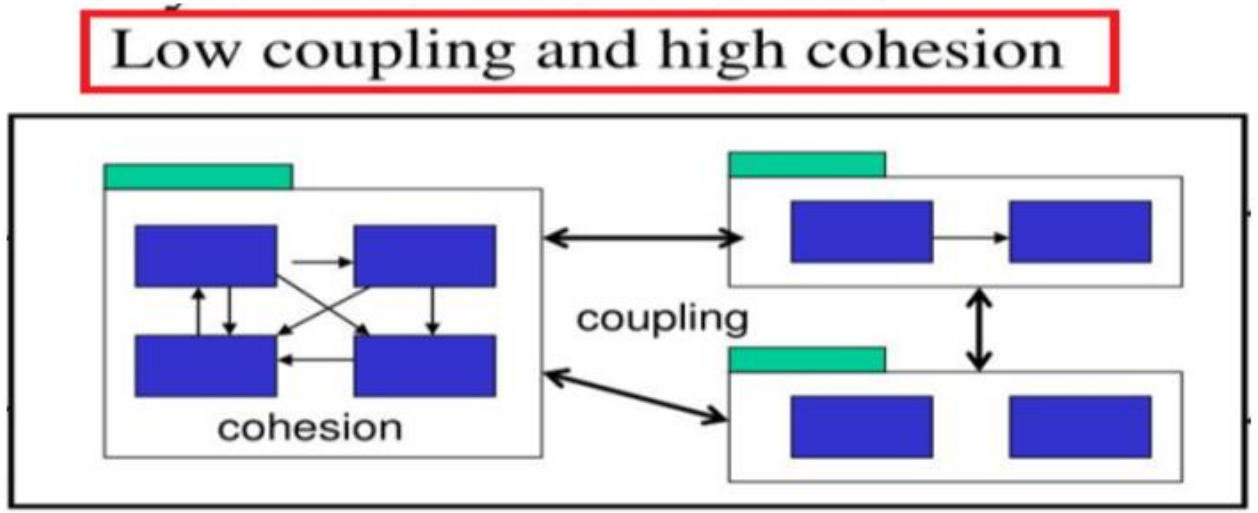
- Review architecture design
- Low-level (detailed) design
  - Concept
- Key tasks in low-level design
  - Understanding requirements, architecture and systems
  - Creating detailed design
    - **Interface design (internal and external)**
      - **Shared memory - concurrency**
    - **Graphical User interface (GUI) design**
      - **ASCII code**
    - **Internal component design (structure and behavioral)**
    - **Data design, data structure design**
  - Documenting detailed design
  - Evaluating detailed design
- Summary

Review week 3-2 topics

- Race condition
- Unified modeling language (UML)
- UML diagrams
  - Structure diagram
    - Class diagrams,
    - Component diagrams
  - Behavior diagram
    - Use case diagram,
    - State transition diagrams,
    - Sequence diagrams

Review week 3-2 topics – cont.

- Design principles (3 principles) – they also apply to detailed design
  - Decomposition
  - Cohesion
  - Coupling
- Cohesion and coupling apply to both architecture design and detailed design



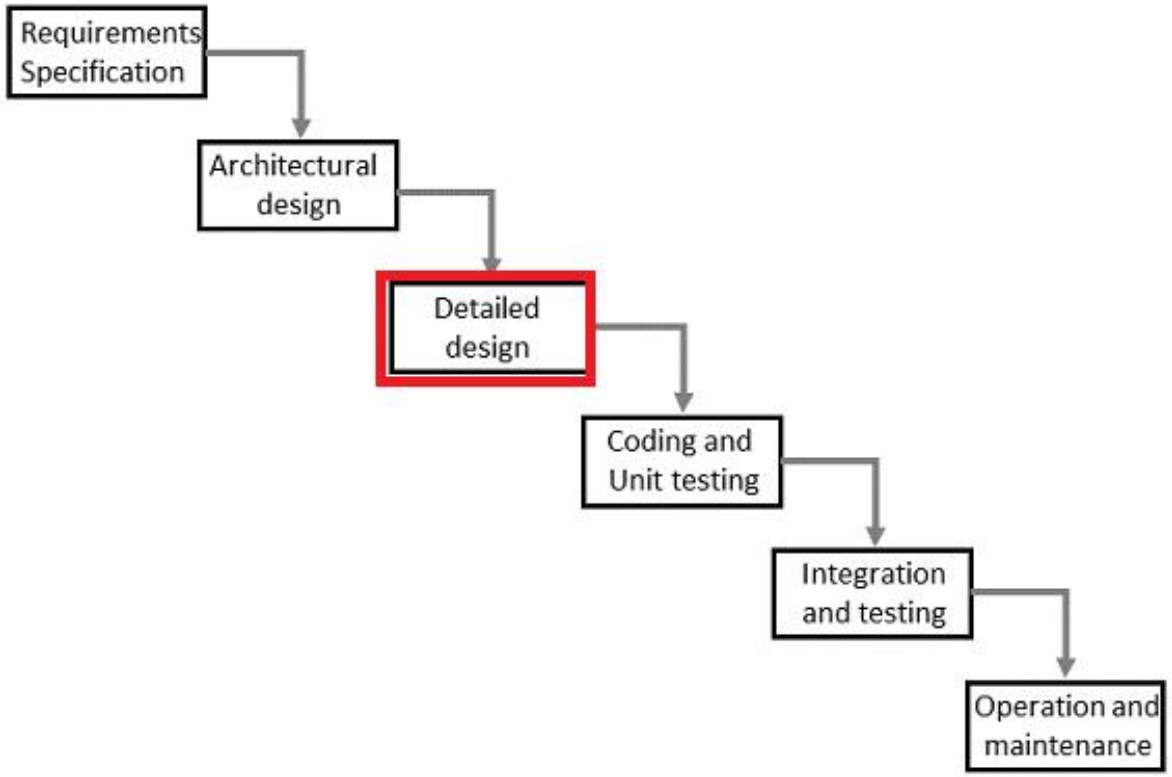
Introduction

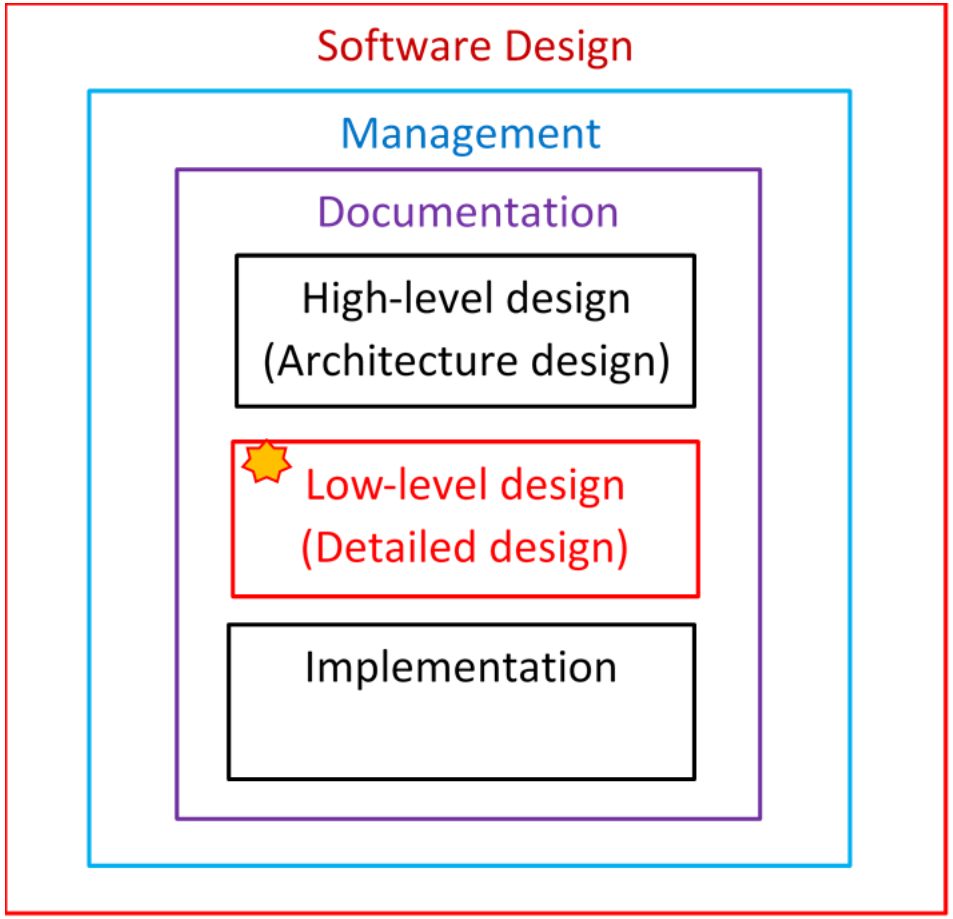
- Low-level (detailed) design
  - Low-level (detailed) design is the process of refining and expanding the software architecture of a system or component to the extent that the design is sufficiently complete to be implemented.
  - It is the specification of the internal elements of all major system components, their properties, relationships, processing, and often their algorithms and the data structures, data types.

  - During detailed design, software engineers go deep into each component to define its data structure and behavioral capabilities, and the resulting design leads to natural and efficient construction of software.

Introduction – cont.

- Where we are?
  - Waterfall model



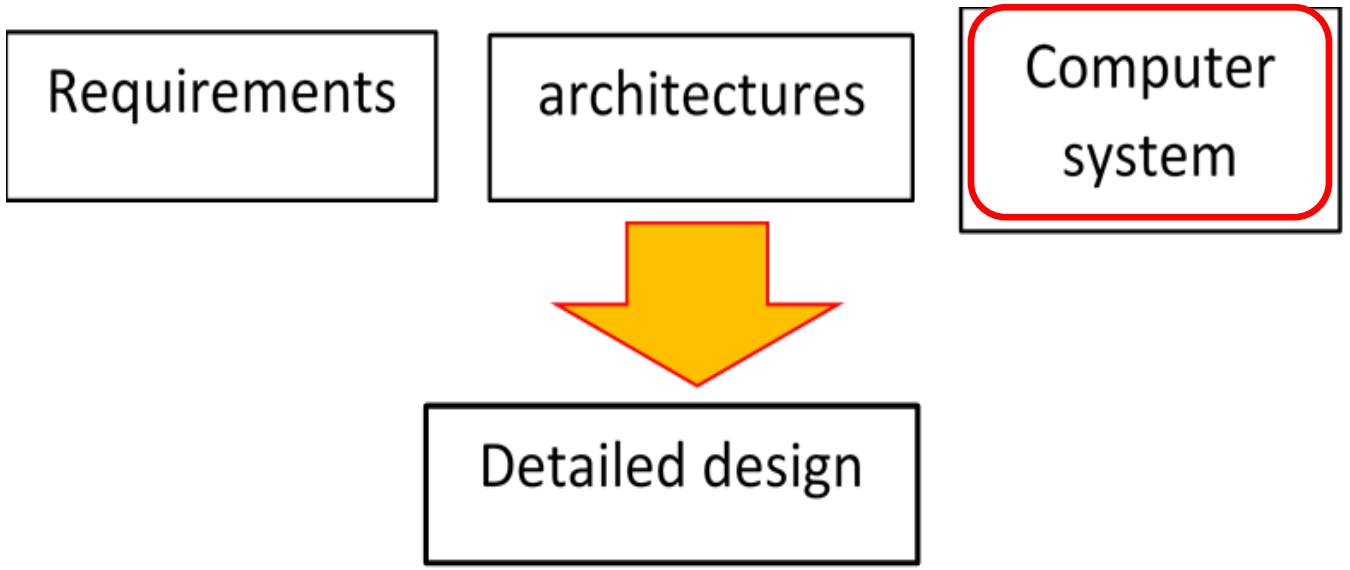


Fundamentals of low-level design

- Key tasks in detailed design
  - **Understanding architecture and requirements,**
  - **Creating detailed design**
  - **Documenting detailed design**
  - **Evaluating detailed design**
  - Managing implementation

Key tasks in detailed design

- **Understanding architecture and requirements**
  - This is the first step, and it is paramount
  - Requirements are allocated to specific components – I/F
  - Always consider cohesion and coupling

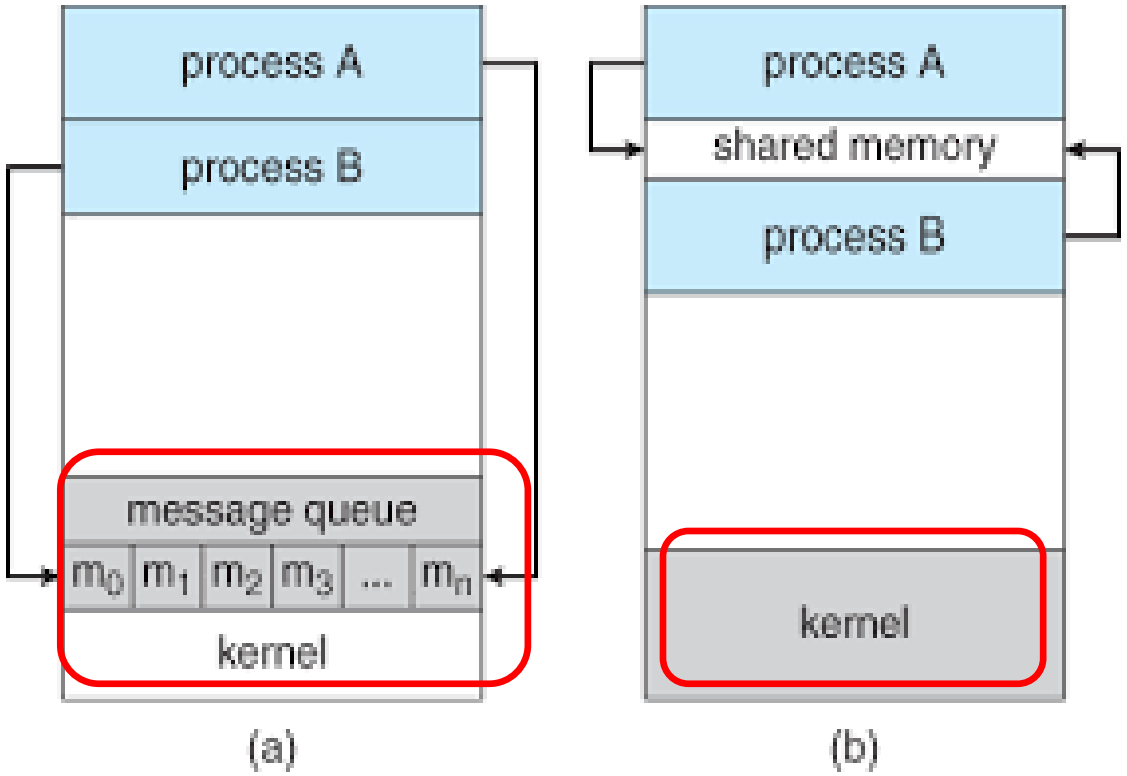


Key tasks in detailed design – cont.

- **Creating detailed design**
- When creating detailed design, focus is placed on the following:
  - **Interface design (internal)**
    - A software interface refers to a wide range of different types of interface at different levels.
  - **Interface design (external)**
  - **Graphical User interface (GUI) design**
  - **Internal component design (structure and behavioral)**
  - **Data design (database), data structure for communication**
    - **data types**

Key tasks in detailed design –cont.

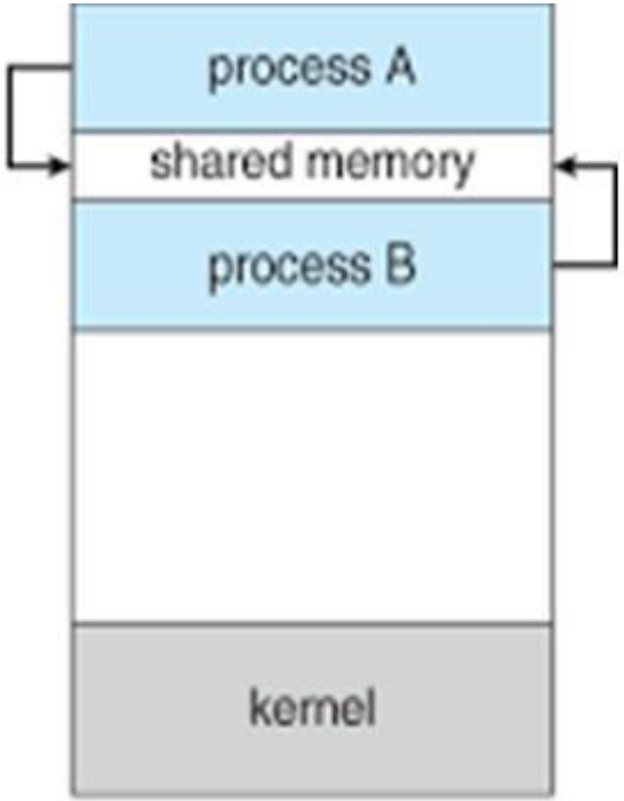
- **Creating detailed design**
  - **Interface design (internal)**
    - Interface among components (processes)
  - **Shared memory**
    - **Defined by software**
  - Message passing
    - Depend on OS
  - Inter-process communication (IPC)



- https://docs.microsoft.com/en-us/windows/win32/ipc/interprocess-communications

Key tasks in detailed design – cont.

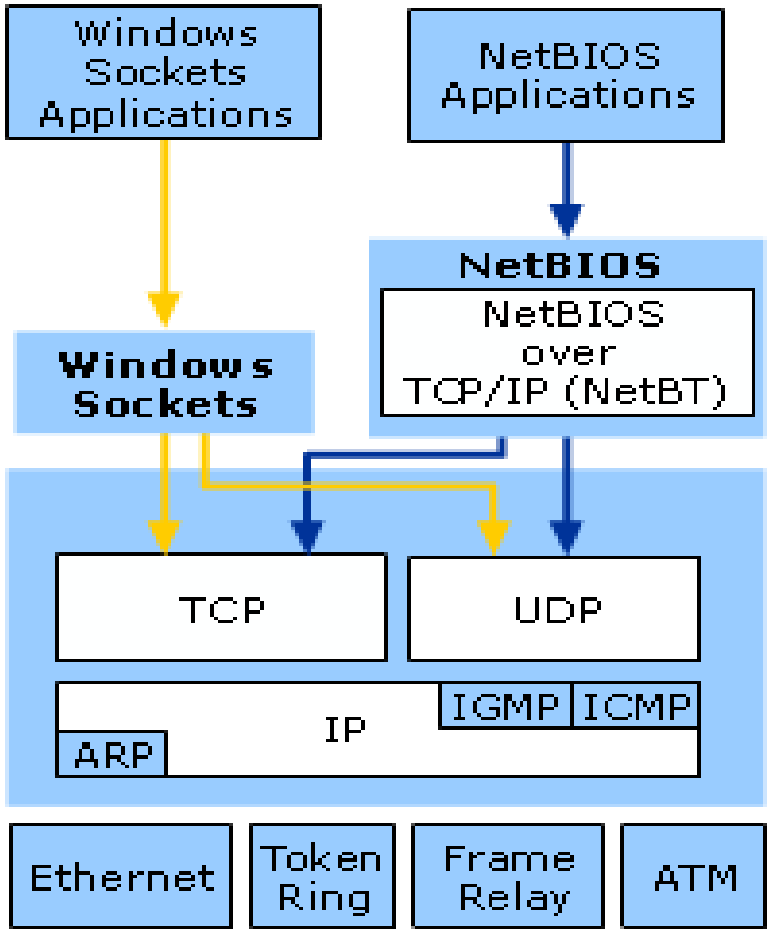
- **Creating detailed design**
  - **Interface design (internal) – cont.**
  - Shared memory
    - Shared memory is a type of memory that can be shared by multiple processes with the intent of providing inter-application communication. – defined by software
  - Concurrency: it is the executions of several instructions occur at the same time.
  - Advantages:
    - Less operating system dependency, has higher portability
  - Risk:
    - Race conditions:



Key tasks in detailed design – cont.

- **Creating detailed design**
  - **Interface design (external)**
    - Among devices and users
  - Involves data communication
    - Protocol + OS and CPU knowledges
      - TCP/IP or Serial (RS-232C)
    - Microcontroller
- Example: ATM, user – ATM – backend.
- Both internal and external interface design requires OS and CPU knowledges.

OS	Mobile	laptop/desk
Android	72.84%,	0%
Windows	< 1 %,	**87.56%**
MacOS/iOS	16.55%,	9.54%



Key tasks in detailed design – cont.

- **Creating detailed design**
  - **Interface design (external)**
  - Question?
  - Man-machine interface
    - **A**merican **S**tandard **C**ode for **I**nformation **I**nterchange (**ASCII**) table/code
- Question?

ASCII TABLE

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[ENG OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	[	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	|
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	]	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	^	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	_	127	7F	[DEL]

Key tasks in detailed design – cont.

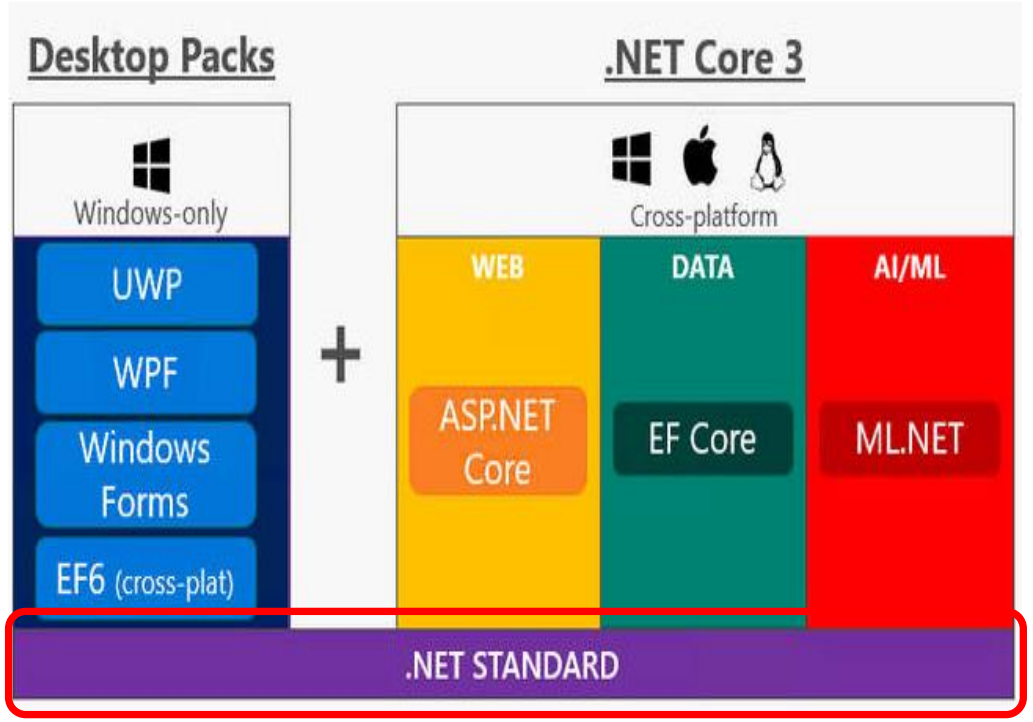
- Interface design (internal)
- Interface design (external)

- Think – Pair – Share
  - For the group project, which interface design is needed?

Key tasks in detailed design – cont.

- **Creating detailed design**
  - **Graphical User interface (GUI) design**

  - .NET used in Windows, Linux, or Mac OS, and etc.
  - C#
  - JavaScript, HTML
  - WPF: windows presentation foundation



Key tasks in detailed design – cont.

- **Internal component design (structure and behavioral)**
  - UML structure diagram
    - Class diagram
    - Component diagram
  - UML behavior diagram
    - Use case diagram
    - State transition diagram
    - Sequence diagram

Key tasks in detailed design – cont.

- **Data design, data structure design**
  - Data structures
    - Array
    - Stack: last-in–first-out (LIFO) data structure
    - Queue: first-in–first-out (FIFO) data structure
    - Linked list
      - Singly linked list
      - Double linked list
    - Define your own data structures based on requirements
  - Data type
    - Different between integer and unsigned integer
  - Incorrect data type definition can be problematic.
    - Example: students' grade should use unsigned integer or just integer

Key tasks in detailed design – cont.

- **Documenting detailed design**
  - Software design document (SDD)
  - Software design specification (SDS)
  - Software detailed design (SDD)

- **Think – Pair – Share**
  - What does the table of contents for the group project look like?

The sections of the SDD and sample table of contents:

Section	Description
Date of issue and status	Date of issue is the day on which the SDD has been formally released. Every time the SDD is updated and formally released, there should be a new date of issue.
Scope	Scope provides a high level overview of the intended purpose of the software. It sets a limit as to what the SDD will describe and defines the objectives of the software.
Issuing organization	Issuing organization is the company which produced the SDD.
Authorship	Authorship pertains to who wrote the SDD and certain copyright information.
References	References provide a list of all applicable documents that are referred to within the SDD. If there is a certain technology that is used within the design, it is important to refer to the corresponding documentation on that technology, so it may be referenced. When reading the referenced documents, stakeholders may uncover inconsistencies in how the technology should be used and how it is used in the software design.
Context	Description of the context of the SDD.
Body	Body is the main section of the SDD where the design is documented. This is where stakeholders look to understand the software and how it is to be constructed.
Summary	
Glossary	A glossary provides definitions for all software related terms and acronyms used in the SDD.
Change history	Change history is a brief description of the items added to, deleted from, or changed within the SDD.

Key tasks in detailed design – cont.

- **Documenting detailed design**
  - Software design document (SDD)
  - Software design specification (SDS)
  - Software detailed design (SDD)

- Example of Table of Contents of SDD
  - Just an example, you can add or remove items.

Contents example

Key tasks in detailed design – cont.

- **Evaluating detailed design**
  - The most popular technique for evaluating detailed design is technical reviews.
  - Keep in mind the following – be professional
    - Send a review notice with enough time
    - Include a technical expert
    - Include a member of software quality assurance and testing team
    - Present how your design helps meet system requirements
    - Document the review process – meeting note

Key tasks in detailed design – cont.

- Managing implementation (4 steps)
  - Prepare a good implementation plan
  - Create an implementation model
    - Learn later
  - Take care of the component implementation

Summary

- Low-level (detailed) design
  - Concept
- Key tasks in detailed design
  - Understanding requirements, architecture and systems
  - Creating detailed design
    - **Interface design (internal and external)**
      - **Shared memory - concurrency**
    - **Graphical User interface (GUI) design**
      - **ASCII code**
    - **Internal component design (structure and behavioral)**
    - **Data design, data structure design**
  - Documenting detailed design
    - **SDD, how to write a SDD**
  - Evaluating detailed design

Announcement

- 75% of you have a group. Please let me know if you need help.

- Oct. 8 (Tuesday) test 1 (60 minutes, cover week 1 - week 4). Please bring your laptop
  - Locations
    - BA208 (the first letter of family name from A-H (42))
    - BA211 (the first letter of family name from I-P (31))
    - BA112 (the first letter of family name from Q-Z (28))