



Vrije Universiteit Brussel

**VOORBEREIDING BACHELOR PROEF**

**12/03/2014**

# CACHE SIMULATIE

Door: Lenaerts Sander

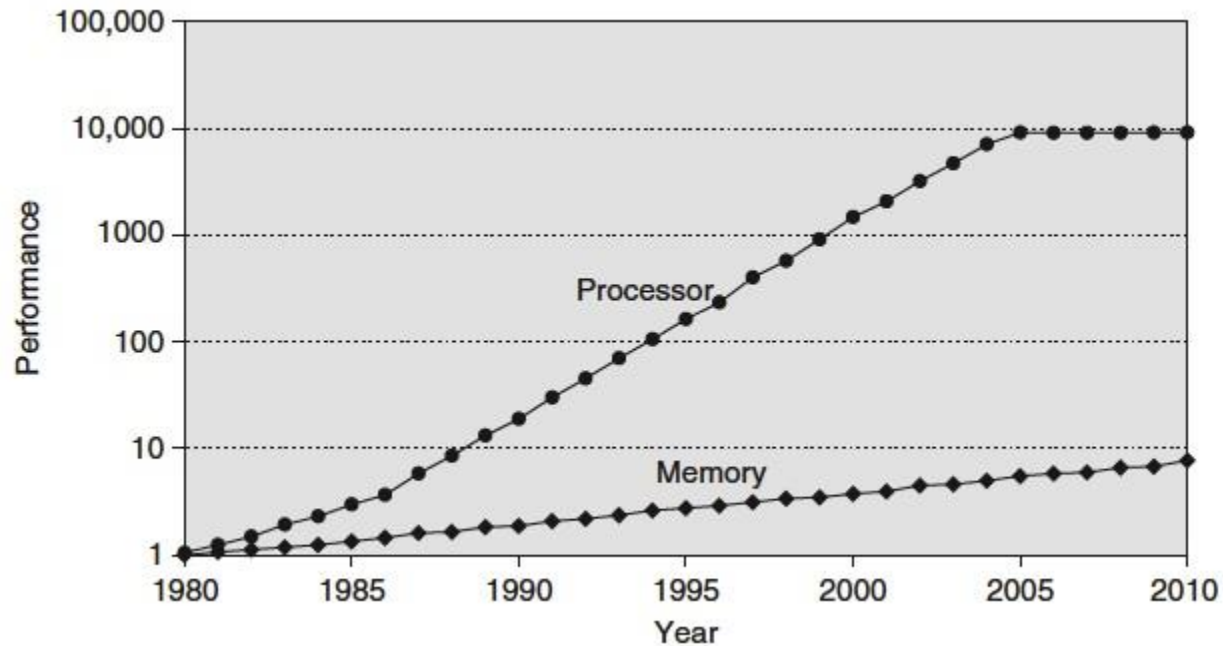
Begeleider: Mattias De Wael

Promotor: Jennifer Sartor

# Inhoud

- Doel van caches
- Wat zijn caches
- Waarom caches bestuderen
- Hoe werken caches
- Vier centrale vragen rond caches
- Coherency in multicore
- conclusie

# Doel



Processor: 0.3 - 0.5 ns

=> 160 tot 666 keer sneller

Main Memory: 80 -200 ns

# Wat zijn caches

- Hardware component
- Gereserveerd geheugen
- Link tussen CPU en main memory
- Bevat kopieën

# Waarom

- Hardware fabrikanten
- Zelf caches samenstellen
- Cache simulatie
- Caches bestuderen

# Locality

- (define (map lst function)  
 (unless (null? lst)  
 (function (car lst))  
 (map (cdr lst) function))))

# Locality

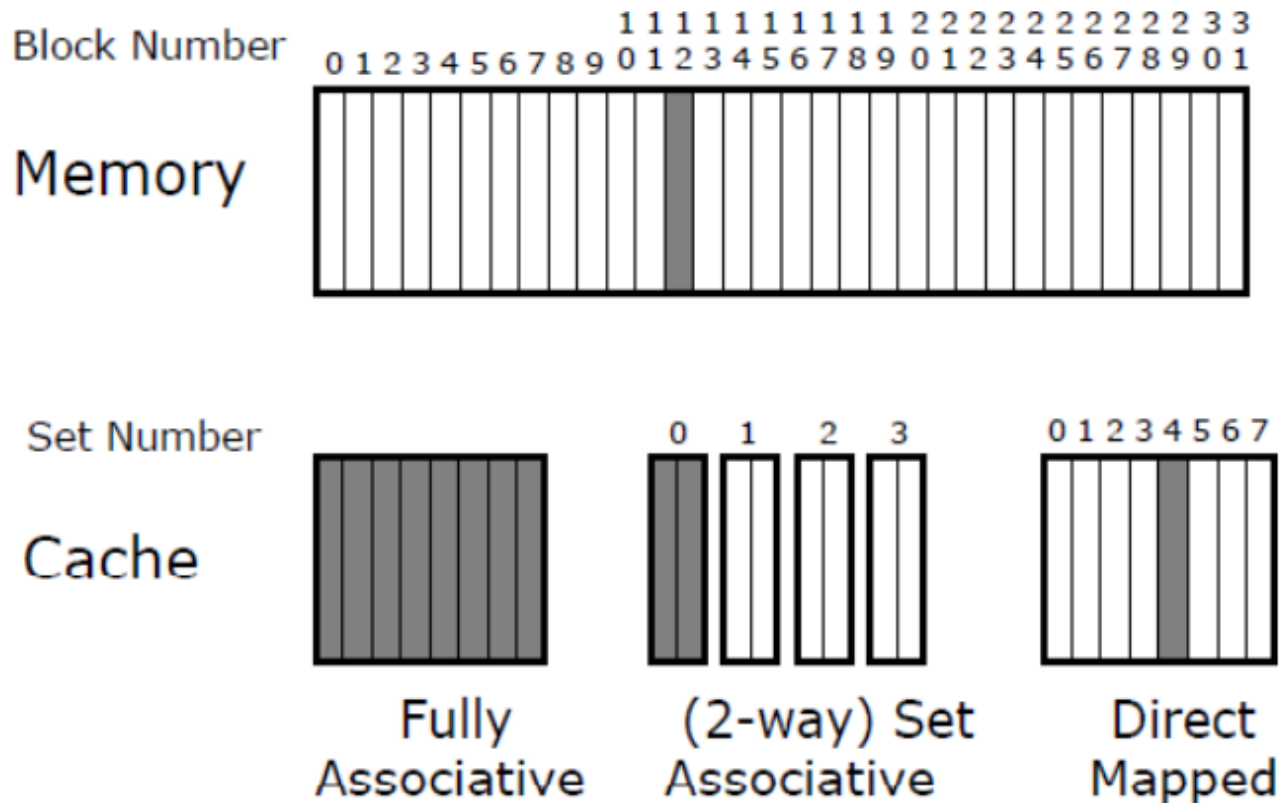
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 (unless (null? lst)  
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 (map (cdr lst) function))))



# Locality

- (define (map lst function)  
 (unless (null? lst)  
 (function (car lst))  
 (map (cdr lst) function))))

# Block placement

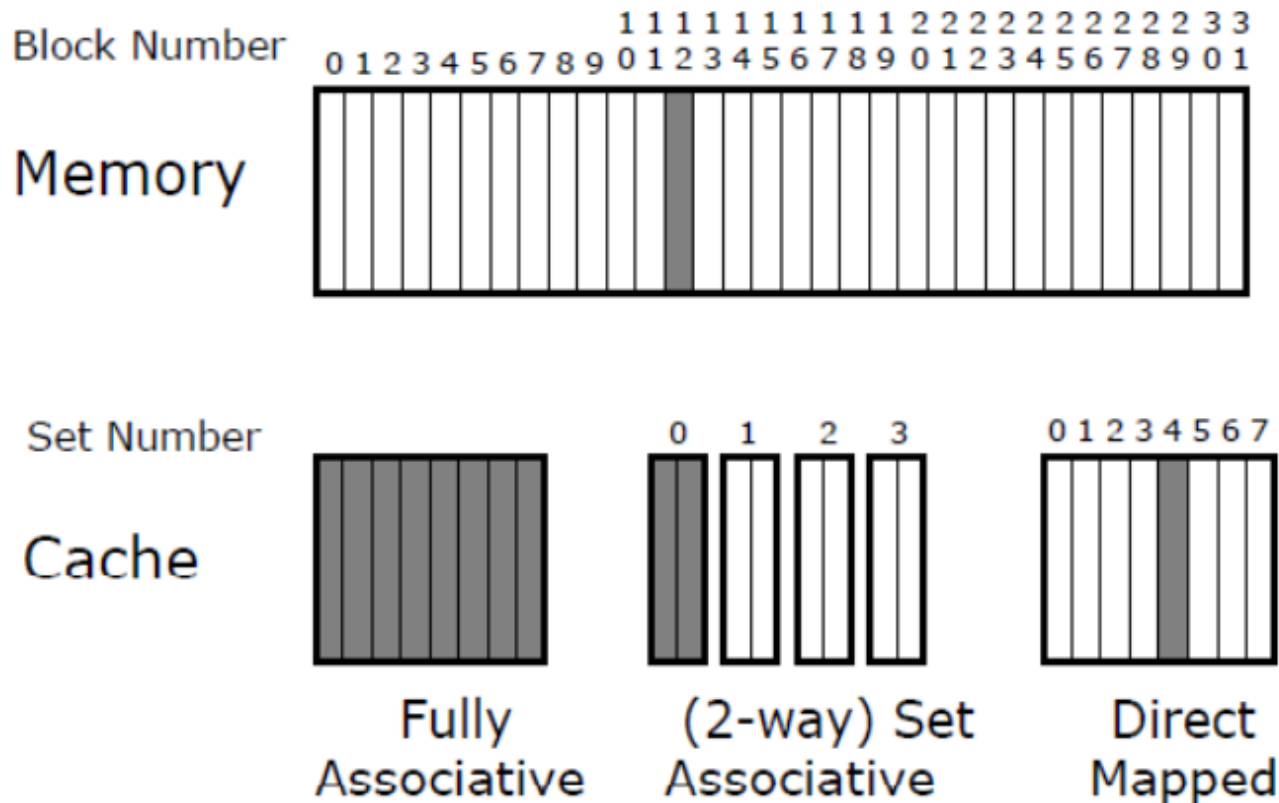


# Block identification

Read 5 / write 5 12



# Block replacement



# Write strategy

Write-through:      write 1 16

L1

	<b>1</b>	<b>42</b>		
--	----------	-----------	--	--

L2

	<b>1</b>	<b>42</b>						
--	----------	-----------	--	--	--	--	--	--

MM

	<b>42</b>														
--	-----------	--	--	--	--	--	--	--	--	--	--	--	--	--	--

# Write strategy

Write-through:      write 1 16

L1

	<b>1</b>	<b>16</b>		
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L2

	<b>1</b>	<b>42</b>						
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MM

	<b>42</b>														
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L1

	<b>1</b>	<b>16</b>		
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L2

	<b>1</b>	<b>16</b>						
--	----------	-----------	--	--	--	--	--	--

MM

	<b>42</b>														
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# Write strategy

Write-through:      write 1 16

L1

	<b>1</b>	<b>16</b>		
--	----------	-----------	--	--

L2

	<b>1</b>	<b>16</b>						
--	----------	-----------	--	--	--	--	--	--

MM

	<b>16</b>														
--	-----------	--	--	--	--	--	--	--	--	--	--	--	--	--	--



# Write strategy

Write-back:                      write 1 16

L1	<table><tr><td></td><td>1</td><td>C</td><td>42</td></tr></table>					1	C	42											
	1	C	42																
L2	<table><tr><td></td><td>1</td><td>C</td><td>42</td></tr></table>		1	C	42	<table><tr><td></td></tr></table>		<table><tr><td></td></tr></table>		<table><tr><td></td></tr></table>		<table><tr><td>5</td><td>C</td><td>15</td></tr></table>	5	C	15	<table><tr><td></td></tr></table>		<table><tr><td></td></tr></table>	
	1	C	42																
5	C	15																	
MM	<table><tr><td></td><td>42</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>		42																
	42																		

# Write strategy

Write-back:                      write 1 16

L1		1	D	16										
L2		1	C	42					5	C	15			
MM		42												

# Write strategy

Write-back:                      Read 5

L1				1	D	16									
L2			1	C	42						5	C	18		
MM		42													

# Write strategy

Write-back:                      Read 5

L1					1	C	16									
L2			1 D 16								5 C 18					
MM		42														

# Write strategy

Write-back:                      Read 5

L1

	<b>5</b>	<b>C</b>	<b>18</b>		
--	----------	----------	-----------	--	--

L2

	<b>1 D 16</b>				<b>5 C 18</b>		
--	---------------	--	--	--	---------------	--	--

MM

	<b>42</b>														
--	-----------	--	--	--	--	--	--	--	--	--	--	--	--	--	--

# Write strategy

Combo: write 1 16

L1

	<b>1</b>	<b>42</b>		
--	----------	-----------	--	--

L2

	<b>1</b>	<b>42</b>						
--	----------	-----------	--	--	--	--	--	--

L3

	<b>1</b>														
	<b>C</b>														
	<b>42</b>														

# Write strategy

Combo: write 1 16

L1

	<b>1</b>	<b>16</b>		
--	----------	-----------	--	--

L2

	<b>1</b>	<b>16</b>						
--	----------	-----------	--	--	--	--	--	--

L3

	<b>1</b>														
	<b>D</b>														
	<b>16</b>														

# Write strategy

Combo: write 1 16

L1

	1	C	42		
--	---	---	----	--	--

L2

	1	42				5	18		
--	---	----	--	--	--	---	----	--	--

L3

	1														
	C														
	42														



# Write strategy

Combo:

Read 5

L1

	<b>1</b>	<b>D</b>	<b>16</b>		
--	----------	----------	-----------	--	--

L2

	<b>1</b>	<b>42</b>				<b>5</b>	<b>18</b>		
--	----------	-----------	--	--	--	----------	-----------	--	--

L3

	<b>1</b>														
	<b>C</b>														
	<b>42</b>														

# Write strategy

Combo:

Read 5

L1

	<b>5</b>	<b>C</b>	<b>18</b>		
--	----------	----------	-----------	--	--

L2

	<b>1</b>	<b>16</b>				<b>5</b>	<b>18</b>		
--	----------	-----------	--	--	--	----------	-----------	--	--

L3

	<b>1</b>														
	<b>D</b>														
	<b>16</b>														

# Write strategy

Write 1 16

L1

	5	18		
--	---	----	--	--

L2

	1	42				5	18		
--	---	----	--	--	--	---	----	--	--

MM

	42														
--	----	--	--	--	--	--	--	--	--	--	--	--	--	--	--

# Write strategy

Write-through:      Write 1 16

L1

	5	18		
--	---	----	--	--

L2

	1	16				5	18		
--	---	----	--	--	--	---	----	--	--

MM

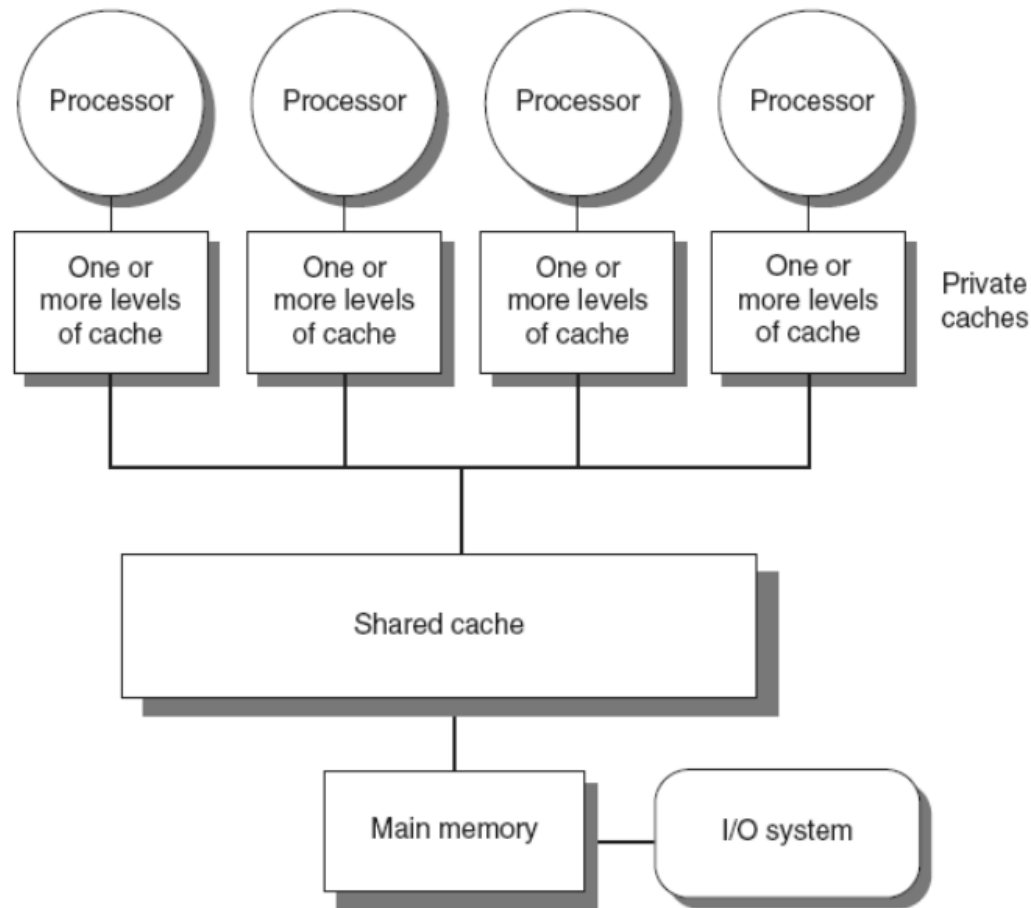
	16														
--	----	--	--	--	--	--	--	--	--	--	--	--	--	--	--

# Write strategy

Write-back:      Write 1 16

L1				1	D	16									
L2			1	C	42						5	C	18		
MM		42													

# Multicore processoren



# Coherency protocols

**Processor 1**  
**Write 2 9**

**Processor 2**

**L1**

2	5	
---	---	--

2

5

2	5	
---	---	--

**L2**

		2 5	
--	--	-----	--

		2 5	
--	--	-----	--

**L3**

		2 5						
--	--	-----	--	--	--	--	--	--

# Coherency protocols

**Processor 1**

**Processor 2**  
**Write 2 7**

**L1**

2	9	
---	---	--

2	7	
---	---	--

**L2**

		2 9	
--	--	-----	--

		2 7	
--	--	-----	--

**L3**

		2 7						
--	--	-----	--	--	--	--	--	--



# Coherency protocols

**Processor 1**

**Processor 2**  
**Write 2 7**

**L1**

2	9	
---	---	--

2	5	
---	---	--

**L2**

		2 9	
--	--	-----	--

		2 5	
--	--	-----	--

**L3**

		2 9						
--	--	-----	--	--	--	--	--	--

# Coherency protocols

**Processor 1**

**Processor 2**  
**Write 2 7**

**L1**

#f	9	
----	---	--

2	7	
---	---	--

**L2**

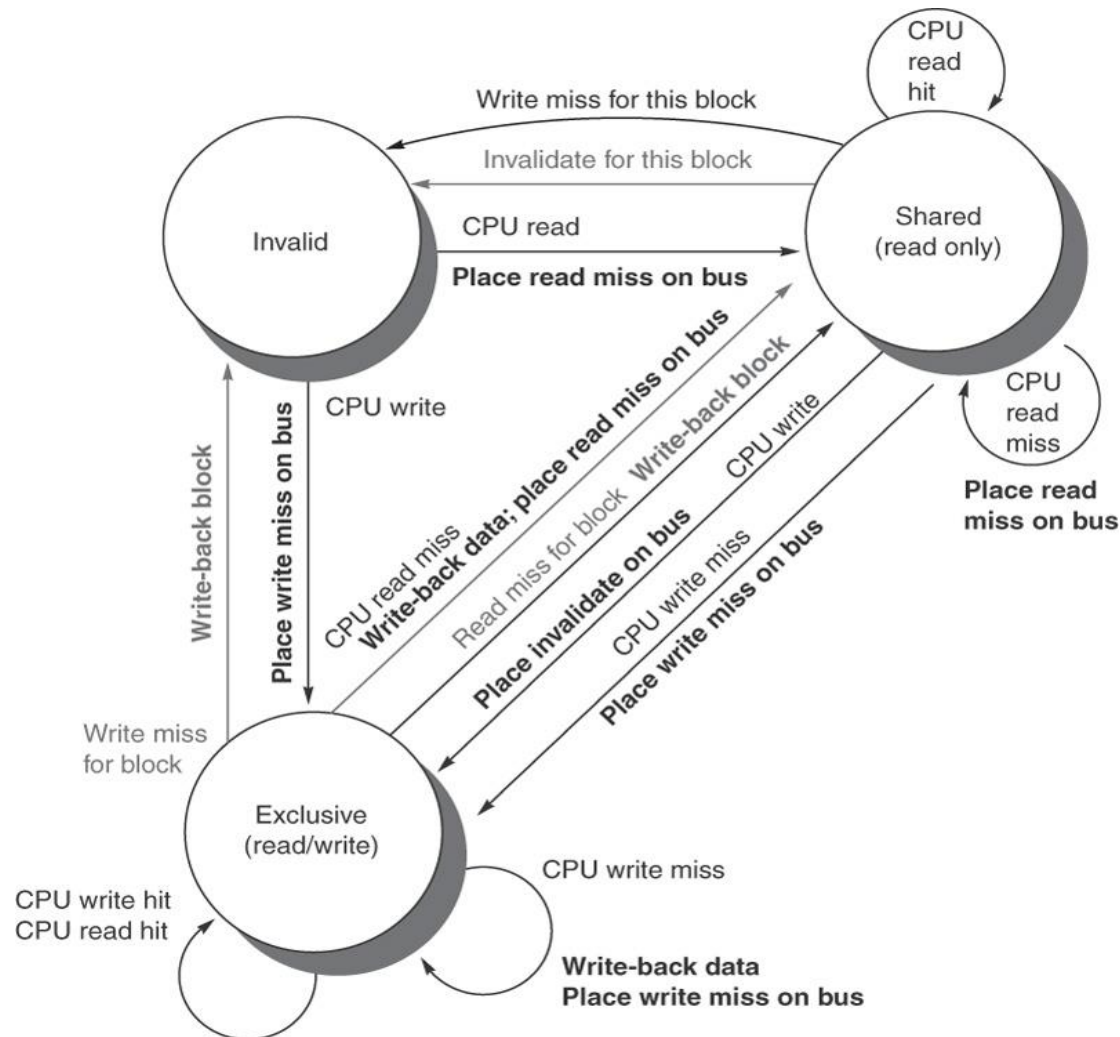
		#f 9	
--	--	------	--

		2 7	
--	--	-----	--

**L3**

		2 7						
--	--	-----	--	--	--	--	--	--

# Coherency protocols



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# Conclusie

- *Drie methoden*
  - *Read*
  - *Write*
  - *Invalidate*

# Conclusie

- variatie punten
    - Blok placement: 3
    - Replacement strategie: 4
    - Write strategie: 4
    - Coherence protocolen: 5
    - Multilevel in/exclusion: 2
    - Read boven write: 2
    - Prefetching/pipelining/way-prediction: 3
    - Single / non-blocking caches: 2
- => 4320

# Conclusie

- Zes knoppen
  - Cache creatie
  - Vind set adres
  - Vind blok
  - Na cache operatie
  - Replacement strategy
  - Write strategy