

Aufgabe 5.9 Im Unix-Teil der Vorlesung wurde die logische Struktur des Adressraums eines Unix-Prozesses vorgestellt. Die Bereiche innerhalb dieses Adressraums werden durch das Betriebssystem mittels geeigneter Datenstrukturen – analog zum Prozesssteuerblock – verwaltet.

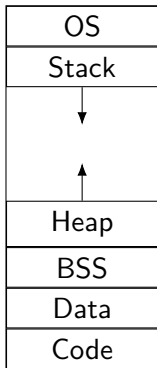
- (a) Geben Sie einen möglichen Aufbau einer solchen Datenstruktur in Form einer Tabelle an, die die Informationen enthält, die zur Beschreibung der einzelnen Bereiche erforderlich sind.
- (b) Bilden Sie die folgende Situation mit Hilfe dieser Datenstruktur ab: Die Größe des Text-, Daten- und BSS-Segments eines Prozesses betrage 20 KiByte, 6 KiByte bzw. 11 KiByte (jeweils aufgerundet). Ferner habe der Prozess während seiner Laufzeit ab Adresse 0x5009000 einen 24 KiByte großen Ausschnitt aus einer Datei schreibbar eingeblendet, beginnend ab dem Datei-Offset 0x7000. Der Stack (Keller) beansprucht aktuell eine Seite.

- (c) In diesem Adressraum sei auf folgende Adressen erfolgreich lesend zugegriffen worden und es gelte die nebenstehende Rahmenzuordnung. Schlagen Sie für die fehlenden Einträge geeignete Rahmen vor und konstruieren Sie die entsprechende einfache Seitentabelle.

virtuelle Adresse	physische Adresse
0x1000	0x340000
0x7000	0x32000
0x8000	
0xA000	
0x5009000	0x13000
0xBFFFF000	0x42000
0xC0000000	0
0xC0001000	0x1000

- (d) Was geschieht bei einem Lesezugriff auf die Adressen 0x3400, 0x500D100, 0xC0000040 und einem Schreibzugriff auf 0xA780, 0x3B060, 0xBFFFEDCB, wenn der Zugriff von einem normalen Nutzerprogramm aus erfolgt?

virt. AS



PD

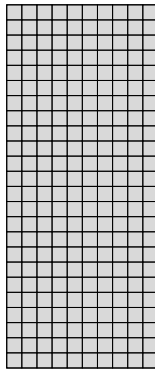
0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

PTs

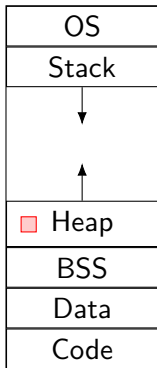
0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p

0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
...					

phys. AS



virt. AS



PD

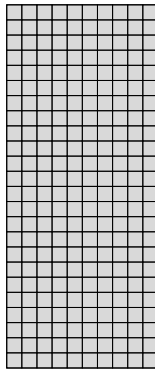
0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

PTs

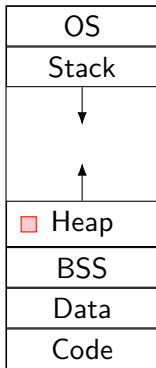
0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p

0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
...					

phys. AS



virt. AS



PD

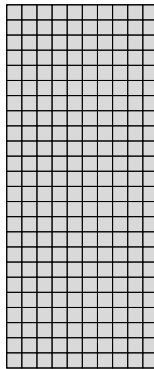
0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

PTs

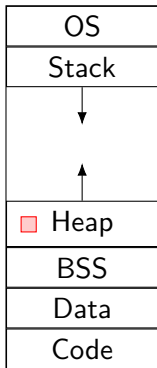
0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p

0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
...					

phys. AS



virt. AS



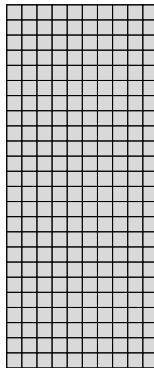
PD

0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

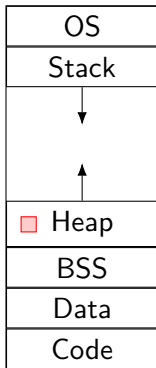
PTs

0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p
0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
...					

phys. AS



virt. AS



PD

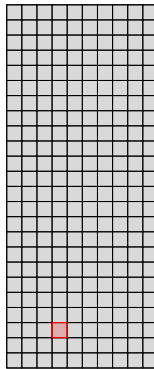
0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

PTs

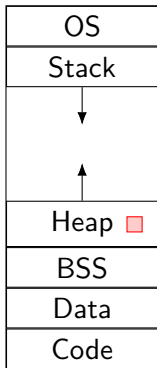
0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p

0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
...					

phys. AS



virt. AS



PD

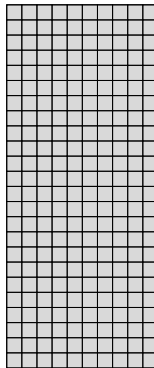
0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

PTs

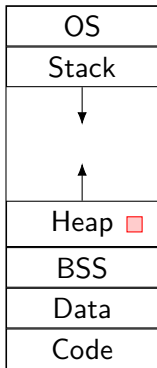
0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p

0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
...					

phys. AS



virt. AS



PD

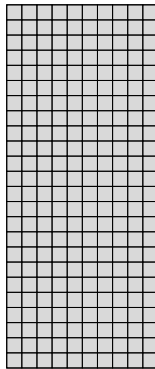
0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

PTs

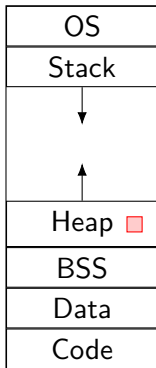
0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p

0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
...					

phys. AS



virt. AS



PD

0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

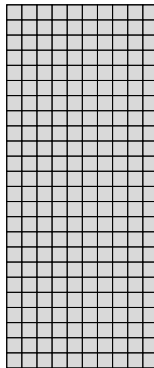
PTs

0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p

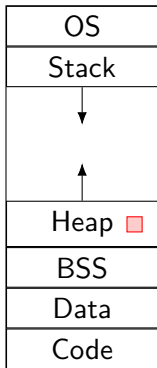
0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	p
A3	5		u	w	p
...					

→ PF

phys. AS



virt. AS



PD

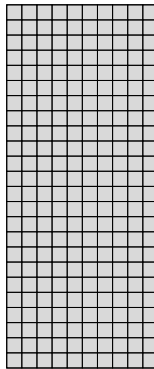
0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

PTs

0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p

0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
...					

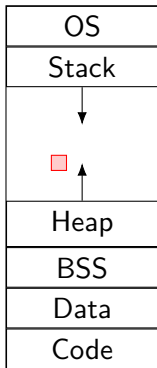
phys. AS



PF

⇒ demand paging
Heap Segment

virt. AS



PD

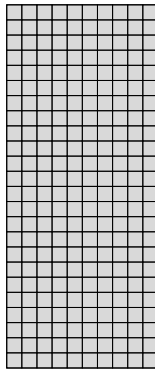
0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

PTs

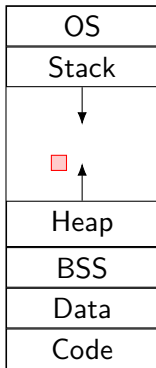
0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p

0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
...					

phys. AS



virt. AS



PD

0	C		u	w	p
1	57		u		p
2	12		u	w	
	...				
300	2			w	p
	...				

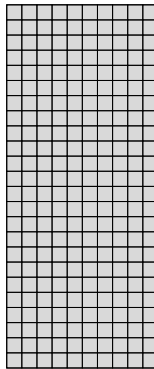
→ PF

PTs

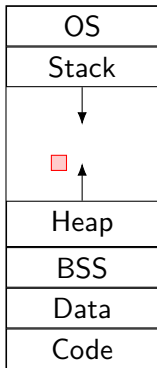
0	AB		u		p
	...				
A	30		u		
B	1		u	w	
	...				
3FF	0			w	p

0	AB		u	w	p
	...				
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
	...				

phys. AS



virt. AS



PD

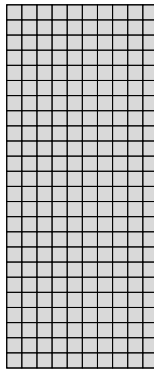
0	C		u	w	p
1	57		u		p
2	12		u	w	
	...				
300	2			w	p
	...				

PTs

0	AB		u		p
	...				
A	30		u		
B	1		u	w	
	...				
3FF	0			w	p

0	AB		u	w	p
	...				
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
	...				

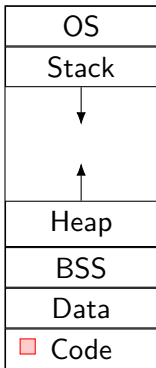
phys. AS



PF

⇒ SIGSEGV

virt. AS



PD

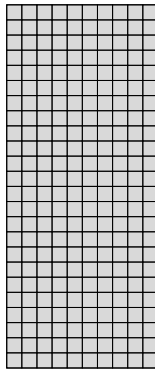
0	C		u	w	p
1	57		u		p
2	12		u	w	
			...		
300	2			w	p
			...		

PTs

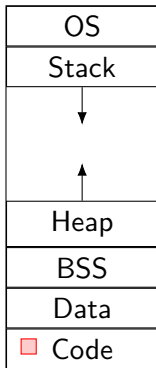
0	AB		u		p
			...		
A	30		u		
B	1		u	w	
			...		
3FF	0			w	p

0	AB		u	w	p
			...		
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
			...		

phys. AS



virt. AS



PD

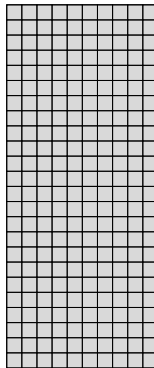
0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

PTs

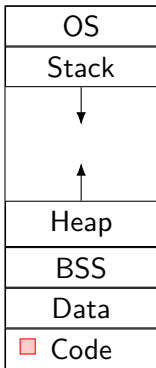
0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p

0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
...					

phys. AS



virt. AS



PD

0	C		u	w	p
1	57		u		p
2	12		u	w	
...					
300	2			w	p
...					

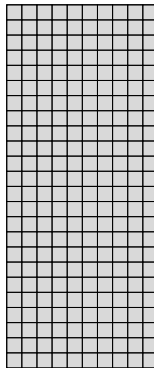
PTs

0	AB		u		p
...					
A	30		u		
B	1		u	w	
...					
3FF	0			w	p

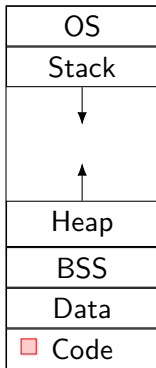
→ PF

0	AB		u	w	p
...					
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
...					

phys. AS



virt. AS



PD

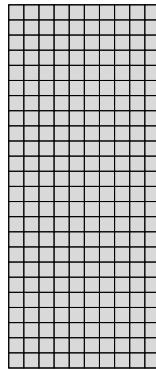
0	C		u	w	p
1	57		u		p
2	12		u	w	
			...		
300	2			w	p
			...		

PTs

0	AB		u		p
			...		
A	30		u		
B	1		u	w	
			...		
3FF	0			w	p

0	AB		u	w	p
			...		
A1	3	cow	u		p
A2	1		u	w	
A3	5		u	w	p
			...		

phys. AS



PF

⇒ demand paging
Code Segment

- (a) Geben Sie einen möglichen Aufbau einer solchen Datenstruktur in Form einer Tabelle an, die die Informationen enthält, die zur Beschreibung der einzelnen Bereiche erforderlich sind.

Die Region Map

Das Betriebssystem speichert für jeden Prozess alle Bereiche seines virtuellen Adressraums, die es verwendet.

Benötigte Informationen:

- Start und Größe/Ende des Bereiches
- Zugriffsberechtigungen (schreibend, ausführbar, ...)
- Spezielle Eigenschaften/Optionen (z.B. *grows downwards* (GD) für Stack)
- Verweis auf Inode und Offset (z.B. bei *eingebblendeten* Dateien)

Die Region Map

Das Betriebssystem speichert für jeden Prozess alle Bereiche seines virtuellen Adressraums, die es verwendet.

Benötigte Informationen:

- Start und Größe/Ende des Bereiches
- Zugriffsberechtigungen (schreibend, ausführbar, ...)
- Spezielle Eigenschaften/Optionen (z.B. *grows downwards* (GD) für Stack)
- Verweis auf Inode und Offset (z.B. bei *eingblendeten* Dateien)

Anhand dieser Informationen kann das Betriebssystem bei einem PF unterscheiden zwischen SIGSEGV und *demand paging*.

- (b) Bilden Sie die folgende Situation mit Hilfe dieser Datenstruktur ab: Die Größe des Text-, Daten- und BSS-Segments eines Prozesses betrage 20 KiByte, 6 KiByte bzw. 11 KiByte (jeweils aufgerundet). Ferner habe der Prozess während seiner Laufzeit ab Adresse 0x5009000 einen 24 KiByte großen Ausschnitt aus einer Datei schreibbar eingeblendet, beginnend ab dem Datei-Offset 0x7000. Der Stack (Keller) beansprucht aktuell eine Seite.

Die Region Map

Ein Beispiel

[illegible]

Die Region Map

Ein Beispiel

[illegible]

Die Region Map

Ein Beispiel

[illegible]

Die Region Map

Ein Beispiel

[illegible]

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data						

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF				

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u			

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS						

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF				

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File						

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack						

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack		0xBFFFFFFF				

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF				

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u			

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		

Die Region Map

Ein Beispiel

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

- (c) In diesem Adressraum sei auf folgende Adressen erfolgreich lesend zugegriffen worden und es gelte die nebenstehende Rahmenzuordnung. Schlagen Sie für die fehlenden Einträge geeignete Rahmen vor und konstruieren Sie die entsprechende einfache Seitentabelle.

virtuelle Adresse	physische Adresse
0x1000	0x340000
0x7000	0x32000
0x8000	
0xA000	
0x5009000	0x13000
0xBFFFF000	0x42000
0xC0000000	0
0xC0001000	0x1000

In Benutzung

Page Table

[illegible]

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Die Region Map

In Benutzung

Page Table

#	page	cow	nx	u	w	p
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
A						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x1000

⇒

physische Adresse

0x340000

In Benutzung

Page Table

[illegible]

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x1000

 $\Rightarrow$

physische Adresse

0x340000

In Benutzung

Page Table

[illegible]

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x1000

 $\Rightarrow$

physische Adresse

0x340000

In Benutzung

Page Table

[illegible]

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x1000

 $\Rightarrow$

physische Adresse

0x340000

In Benutzung

Page Table

[illegible]

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x7000

 $\Rightarrow$

physische Adresse

0x32000

In Benutzung

Page Table

[illegible]

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x7000

 $\Rightarrow$

physische Adresse

0x32000

In Benutzung

Page Table

[illegible]

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x7000

 $\Rightarrow$

physische Adresse

0x32000

Die Region Map

In Benutzung

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8						
9						
A						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x8000

⇒

physische Adresse

In Benutzung

Page Table

[illegible]

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x8000

 $\Rightarrow$

physische Adresse

In Benutzung

Page Table

[illegible]

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x8000

 $\Rightarrow$

physische Adresse

0x69000

In Benutzung

Page Table

[illegible]

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x8000

 $\Rightarrow$

physische Adresse

0x69000

In Benutzung

Page Table

[illegible]

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0xA000

 $\Rightarrow$

physische Adresse

Die Region Map

In Benutzung

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0xA000

⇒

physische Adresse

<zero>

Die Region Map

In Benutzung

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x5009000

⇒

physische Adresse

0x13000

Die Region Map

In Benutzung

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0x5009000

⇒

physische Adresse

0x13000

Die Region Map

In Benutzung

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0xBFFFF000

⇒

physische Adresse

0x42000

Die Region Map

In Benutzung

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
BFFFF	42		nx	u	w	p

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0xBFFFF000

⇒

physische Adresse

0x42000

Die Region Map

In Benutzung

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
BFFFF	42		nx	u	w	p

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0xC0000000

⇒

physische Adresse

0x0000

Die Region Map

In Benutzung

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0xC0000000

⇒

physische Adresse

0x0000

Die Region Map

In Benutzung

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

virtuelle Adresse

0xC0001000

⇒

physische Adresse

0x1000

- (d) Was geschieht bei einem Lesezugriff auf die Adressen 0x3400, 0x500D100, 0xC0000040 und einem Schreibzugriff auf 0xA780, 0x3B060, 0xBFFFEDCB, wenn der Zugriff von einem normalen Nutzerprogramm aus erfolgt?

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

Ergebnis



Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3400

read

⇒

Ergebnis

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3400

read

⇒

Ergebnis

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3400

read

⇒

Ergebnis

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3400

read

⇒

Ergebnis

• PF

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3400

read

⇒

Ergebnis

- PF
- PFH → check RM

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3400

read

⇒

Ergebnis

- PF
- PFH → check RM

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

valid ← → PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3400

read

⇒

Ergebnis

- PF
- PFH → check RM → demand paging

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3						
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3400

read

⇒

Ergebnis

- PF
- PFH → check RM → demand paging
- Rahmen finden + füllen

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3400

read

⇒

Ergebnis

- PF
- PFH → check RM → demand paging
- Rahmen finden + füllen
- PT aktualisieren

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff
0x3400
read

⇒

Ergebnis

- PF
- PFH → check RM → demand paging
- Rahmen finden + füllen
- PT aktualisieren
- Prozess fortsetzen

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
...						
...						
...						
BFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

Ergebnis

0x500D100

⇒

read

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x500D100

read

⇒

Ergebnis

• PF

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x500D100

read

⇒

Ergebnis

- PF
- PFH → check RM

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

valid ←

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x500D100

read

⇒

Ergebnis

- PF
- PFH → check RM → demand paging

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D						
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x500D100

read

⇒

Ergebnis

- PF
- PFH → check RM → demand paging
- Rahmen finden + füllen

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x500D100

read

⇒

Ergebnis

- PF
- PFH → check RM → demand paging
- Rahmen finden + füllen
- PT aktualisieren

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x500D100

read

⇒

Ergebnis

- PF
- PFH → check RM → demand paging
- Rahmen finden + füllen
- PT aktualisieren
- Prozess fortsetzen

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

Ergebnis

0xC0000040 ⇒
read

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF (GPF)

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

Ergebnis

0xC0000040

⇒

• PF

read

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF (GPF)

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xC0000040

read

⇒

Ergebnis

- PF
- PFH → SIGSEGV

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xC0000040

read

⇒

Ergebnis

- PF
- PFH → SIGSEGV
- Prozess beenden

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xA780

write

⇒

Ergebnis

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xA780

write

⇒

Ergebnis

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF (WP)

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xA780

write

Ergebnis

⇒

• PF

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF (WP)

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff
0xA780
write

⇒

Ergebnis

- PF
- PFH → check PTE

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF (WP)

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff
0xA780
write

⇒

Ergebnis

- PF
- PFH → check PTE → COW

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	<zero>	cow	nx	u		p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF (WP)

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xA780

write

⇒

Ergebnis

- PF
- PFH → check PTE → COW
- Rahmen finden + Kopie

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xA780

write

⇒

Ergebnis

- PF
- PFH → check PTE → COW
- Rahmen finden + Kopie
- PT aktualisieren

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xA780

write

⇒

Ergebnis

- PF
- PFH → check PTE → COW
- Rahmen finden + Kopie
- PT aktualisieren
- Prozess fortsetzen

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

Ergebnis

0x3B060

⇒

write

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3B060

write

⇒

Ergebnis

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3B060

write

Ergebnis

⇒

• PF

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3B060

write

Ergebnis

⇒

- PF
- PFH → check RM

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3B060

write

⇒

Ergebnis

- PF
- PFH → check RM → SIGSEGV

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0x3B060

write

⇒

Ergebnis

- PF
- PFH → check RM → SIGSEGV
- Prozess beenden

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
...						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff
0xBFFFE DCB
write

⇒

Ergebnis

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
BFFFE						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

Ergebnis

0xBFFFE DCB
write

⇒

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
BFFE						
BFFF	42		nx	u	w	p
C000	0		?		?	p
C001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

Ergebnis

0xBFFEDCB

⇒

• PF

write

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
BFFE						
BFFF	42		nx	u	w	p
C000	0		?		?	p
C001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xBFFEDCB

write

⇒

Ergebnis

- PF
- PFH → check RM

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
BFFE						
BFFF	42		nx	u	w	p
C000	0		?		?	p
C001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFF000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

valid ←

Zugriff

0xBFFEDCB

write

⇒

Ergebnis

- PF
- PFH → check RM → demand paging

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
BFFFE						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFE000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xBFFFE000

write

⇒

Ergebnis

- PF
- PFH → check RM → demand paging
- RM aktualisieren

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
BFFFE						
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

→ PF

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFE000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xBFFFE000

write

⇒

Ergebnis

- PF
- PFH → check RM → demand paging
- RM aktualisieren
- Rahmen finden

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
BFFE	43		nx	u	w	p
BFFF	42		nx	u	w	p
C000	0		?		?	p
C001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFE000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xBFFFE000

write

⇒

Ergebnis

- PF
- PFH → check RM → demand paging
- RM aktualisieren
- Rahmen finden
- PT aktualisieren

Speicherverwaltung – With all its glory!

Page Table

#	page	cow	nx	u	w	p
0						
1	340		x	u		p
2						
3	342		x	u		p
4						
5						
6						
7	32		nx	u	w	p
8	69		nx	u	w	p
9						
A	ABC		nx	u	w	p
...						
5009	13		nx	u	w	p
...						
500D	5009		nx	u	w	p
...						
BFFFE	43		nx	u	w	p
BFFFF	42		nx	u	w	p
C0000	0		?		?	p
C0001	1		?		?	p
...						

Region Map

Name	Begin	End	Rights	Options	Inode	Offset
Text	0x1000	0x5FFF	ro, ex, u		binary	0x00??
Data	0x6000	0x7FFF	rw, u		binary	0x5???
BSS	0x8000	0xAFFF	rw, u			
File	0x5009000	0x500EFFF	rw, u		file	0x7000
Stack	0xBFFFE000	0xBFFFFFFF	rw, u	GD		
OS	0xC0000000	0xFFFFFFFF	rw, ex, s			

Zugriff

0xBFFFE^{write}DCB

write

⇒

Ergebnis

- PF
- PFH → check RM → demand paging
- RM aktualisieren
- Rahmen finden
- PT aktualisieren
- Prozess fortsetzen