Script **generated by TTT**

Title: Seidl: Virtual_Machines (02.07.2013)

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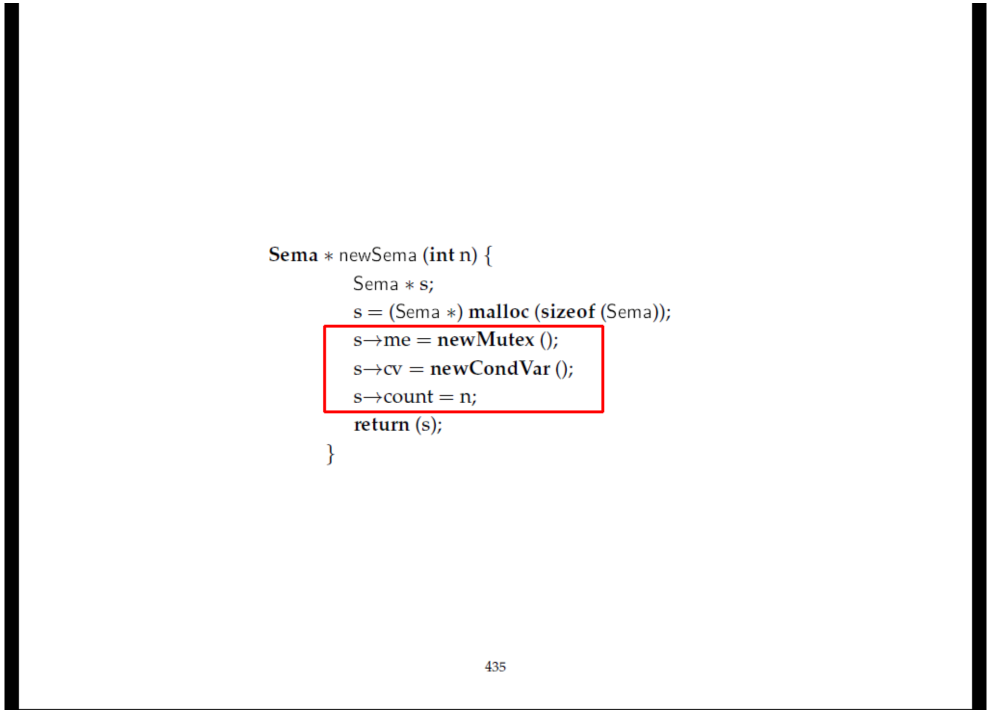
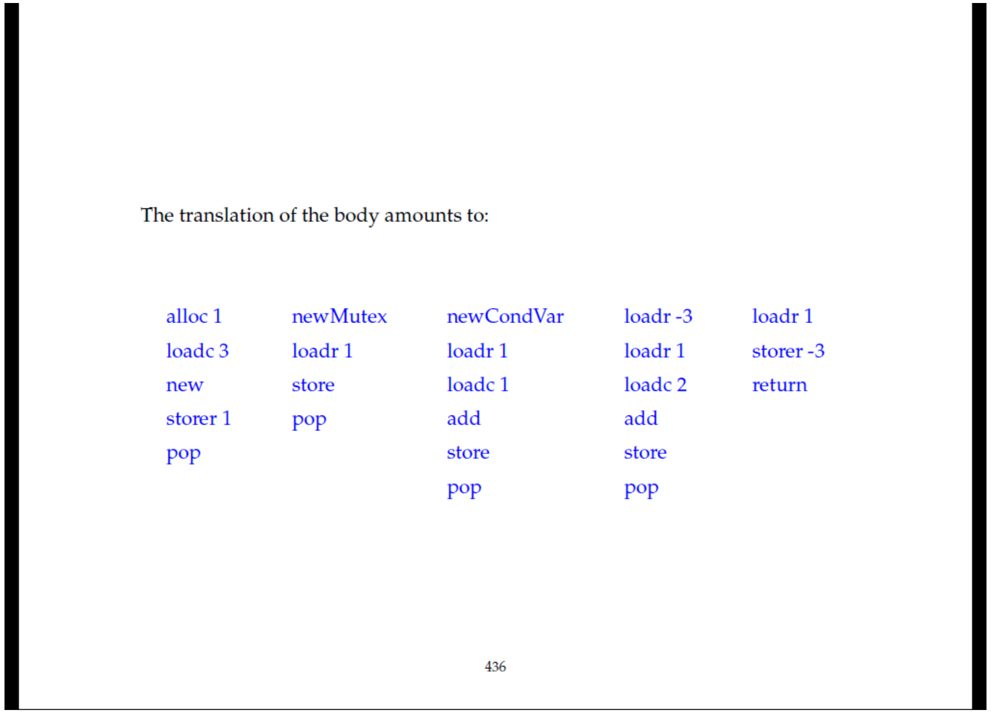
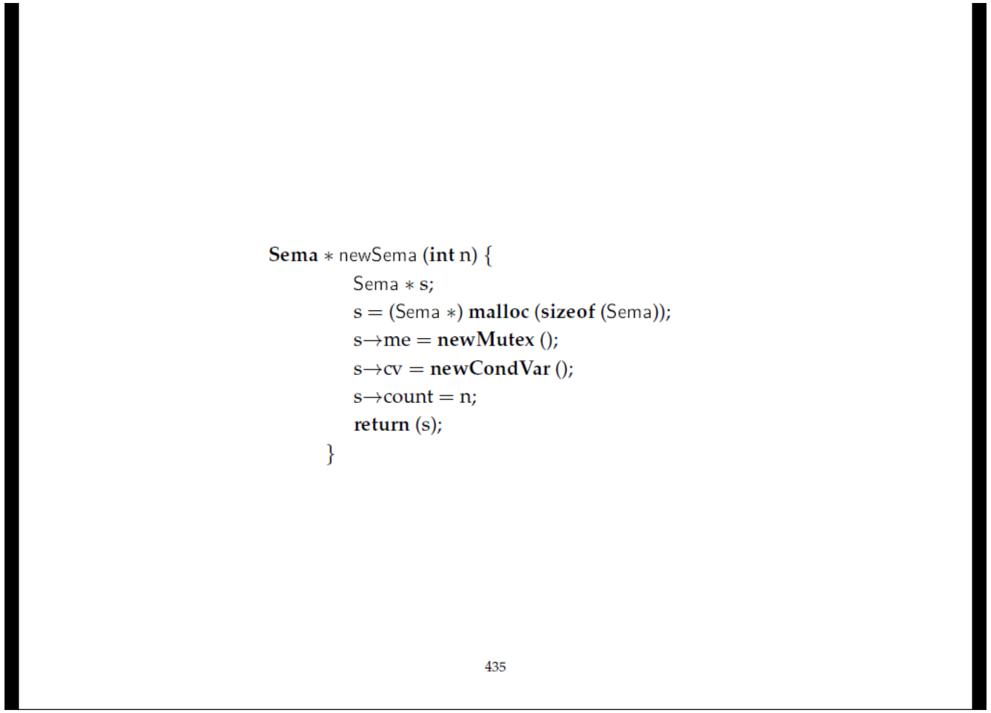


```
Sema ∗ newSema (int n) {
        Sema ∗ s;
        s = (Sema ∗) malloc (sizeof (Sema));
        s→me = newMutex ();
        s→cv = newCondVar ();
        s→count = n;
        return (s);
}
```



The translation of the body amounts to:

```
alloc 1     newMutex    newCondVar    loadr -3    loadr 1
loadc 3     loadr 1     loadr 1       loadr 1     storer -3
new         store       loadc 1       loadc 2     return
storer 1    pop         add           add
pop                     store         store
                        pop           pop
```



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storer 1    pop         add           add
pop                     store         store
                        pop           pop
```

The function Down() decrements the counter.

If the counter becomes negative, **wait** is called:

```
void Down (Sema ∗ s) {
        Mutex ∗me;
        me = s→me;
        lock (me);
        s→count− −;
        if (s→count < 0)   wait (s→cv,me);
        unlock (me);
    }
```

The translation of the body amounts to:

```
alloc 1     loadc 2     add              loadc 1
loadr 1     add         store            add
load        load        loadc 0          load
storer 2    loadc 1     le               wait
lock        sub         jumpz A     A:   loadr 2
            loadr 1     loadr 2          unlock
loadr 1     loadc 2     loadr 1          return
```

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alloc 1     loadc 2     add              loadc 1
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            loadr 1     loadr 2          unlock
loadr 1     loadc 2     loadr 1          return
```

The function Down() decrements the counter.

If the counter becomes negative, **wait** is called:

```
void Down (Sema * s) {
        Mutex *me;
        me = s→me;
        lock (me);
        s→count– –;
        if (s→count < 0)   wait (s→cv,me);
        unlock (me);
    }
```

The translation of the body amounts to:

load adr < 0

```
alloc 1          loadc 2       add                 loadc 1
loadr ~~1~~ 2    add           store               add
load             load          loadc 0             load
storer ~~2~~ 1   loadc 1       less                wait
lock             sub           jumpz A      A:     loadr ~~2~~ 1
                 loadr ~~1~~ 1 loadr ~~2~~ 1       unlock
loadr ~~1~~ 1    loadc 2       loadr ~~-1~~ 1      return
```

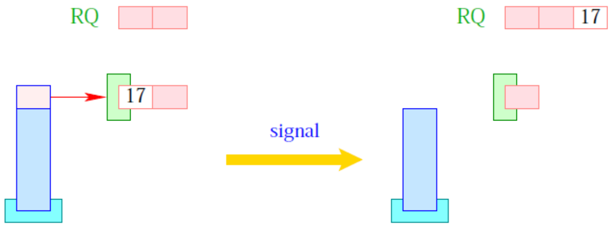
unlock next lo2 ←

The translation of the body amounts to:

```
alloc 1     newMutex    newCondVar    loadr -3    loadr 1
loadc 3     loadr 1     loadr 1       loadr 1     storer -3
new         store       loadc 1       loadc 2     return
storer 1    pop         add           add
pop                     store         store
                        pop           pop
```

Accordingly, we translate:

$$\text{code } \mathbf{signal}\ (e);\ \rho \quad = \quad \text{code}_R\ e\ \rho$$
signal



```
if (0 ≤ tid = dequeue ( S[SP]))
    enqueue ( RQ, tid );
SP--;
```

The function Up() increments the counter again.

If it is afterwards not yet positive, there still must exist waiting threads. One of these is sent a signal:

```
void Up (Sema * s) {
        Mutex *me;
        me = s→me;
        lock (me);
        s→count++;
        if (s→count ≤ 0)   signal (s→cv);
        unlock (me);
    }
```

The translation of the body amounts to:

```
alloc 1          loadc 2          add                 loadc 1
loadr ~~1~~ -2   add              store               add
load             load             loadc 0             load
storer ~~2~~ 1   loadc 1          leq                 signal
lock             add              jumpz A        A:   loadr ~~2~~ 1
                 loadr ~~1~~ -2                       unlock
loadr ~~1~~ -2   loadc 2          loadr ~~1~~ -2      return
```

55 Stack-Management

Problem:

- All threads live within the same storage.
- Every thread requires its own stack (at least conceptually).

1. Idea:

Allocate for each new thread a fixed amount of storage space.

$\Longrightarrow$

Then we implement:

```
void *newStack() { return malloc(M); }
void freeStack(void *adr) { free(adr); }
```

Problem:

- Some threads consume much, some only little stack space.
- The necessary space is statically typically unknown :-(

2. Idea:

- Maintain all stacks in one joint Frame-Heap FH :-)
- Take care that the space inside the stack frame is sufficient at least for the current function call.
- A global stack-pointer GSP points to the overall topmost stack cell ...

Problem:

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- The necessary space is statically typically unknown :-(

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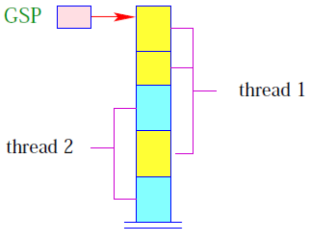
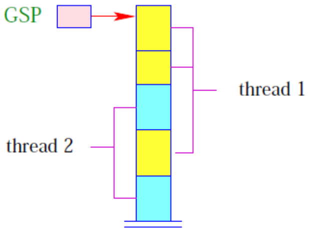
- Maintain all stacks in one joint Frame-Heap FH :-)
- Take care that the space inside the stack frame is sufficient at least for the current function call.
- A global stack-pointer GSP points to the overall topmost stack cell ...



Allocation and de-allocation of a stack frame makes use of the run-time functions:

```
int newFrame(int size) {
    int result = GSP;
    GSP = GSP+size;
    return result;
    }

void freeFrame(int sp, int size);
```



Allocation and de-allocation of a stack frame makes use of the run-time functions:

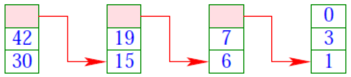
```
int newFrame(int size) {
    int result = GSP;
    GSP = GSP+size;
    return result;
    }

void freeFrame(int sp, int size);
```

Warning:

The de-allocated block may reside inside the stack :-(

⟹

We maintain a list of freed stack blocks :-)

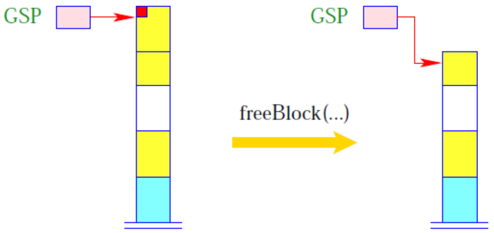


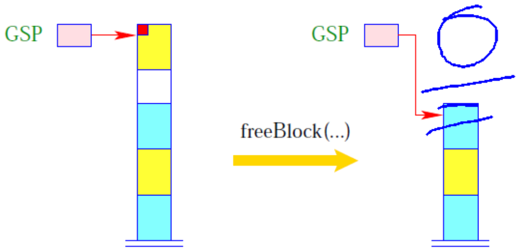
This list supports a function

```
void insertBlock(int max, int min)
```

which allows to free single blocks.

- If the block is on top of the stack, we pop the stack immediately;
- ... together with the blocks below – given that these have already been marked as de-allocated.
- If the block is inside the stack, we merge it with neighbored free blocks:





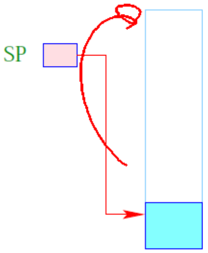
Approach:

We allocate a fresh block for every function call ...

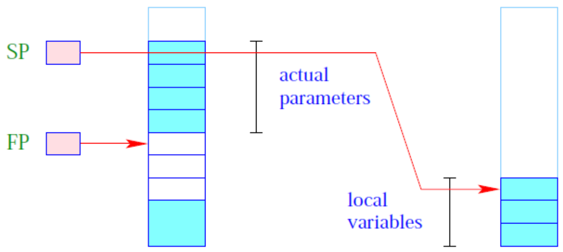
Problem:

When ordering the block before the call, we do not yet know the space consumption of the called function :-(

⟹ We order the new block after entering the function body!



Organisational cells as well as actual parameters must be allocated inside the old block ...



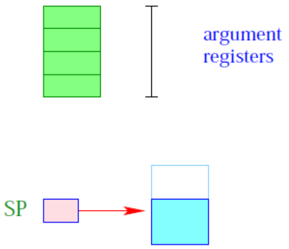
Inparticular, the local variables reside in the new block ...

⟹ We address ...

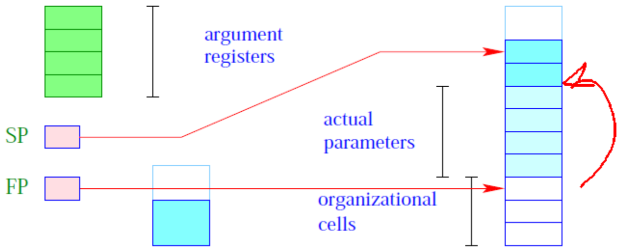
- the formal parameters relatively to the frame-pointer;
- the local variables relatively to the stack-pointer :-)

⟹ We must re-organize the complete code generation ... :-(

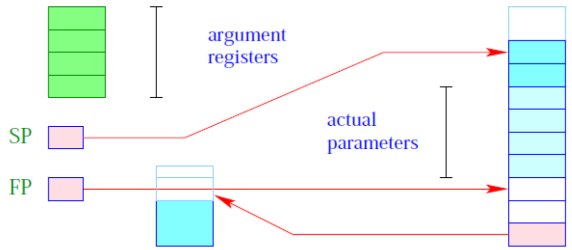
Alternative: Passing of parameters in registers ... :-)



The values of the actual parameters are determined before allocation of the new stack frame.



The complete frame is allocated inside the new block – plus the space for the current parameters.



Inside the new block, though, we must store the old SP (possibly +1) in order to correctly return the result ... :-)

3. Idea: Hybrid Solution

- For the first k threads, we allocate a separate stack area.
- For all further threads, we successively use one of the existing ones !!!

$\Longrightarrow$

- For few threads extremely simple and efficient;
- For many threads amortized storage usage :-))