Script generated by TTT

Title: Seidl: Virtual Machines (30.06.2014)

Date: Mon Jun 30 10:25:02 CEST 2014

Duration: 64:50 min

Pages: 34

```
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 -2	loadr 1
loadc 3	loadr 1	loadr 1	loadr 1	storer -2
new	store	loadc 1	loadc 2	return
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);
    }
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The translation of the body amounts to:

pop
loadr -1

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

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

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The translation of the body amounts to:

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

56 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:

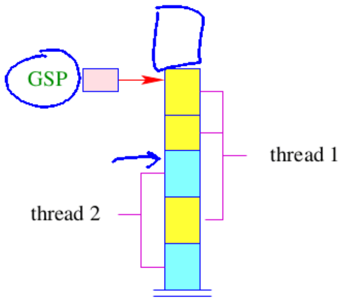
```
void *newStack() { return malloc(M); }
void freeStack(void *adr) { free(adr); }
```

Problem:

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

2. Idea:

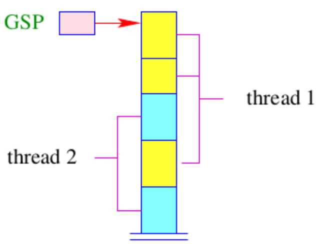
- Maintain all stacks in one joint Frame-Heap FH :-)
- Take care that the space inside the stack frame is sufficient at least for the current function call.
- A global stack-pointer GSP points to the overall topmost stack cell ...



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);
```

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

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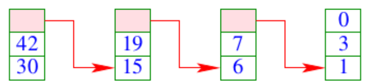


Warning:

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

$\Longrightarrow$

We maintain a list of freed stack blocks :-)

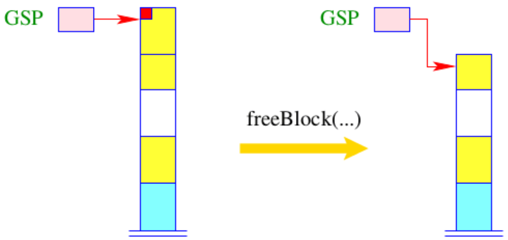


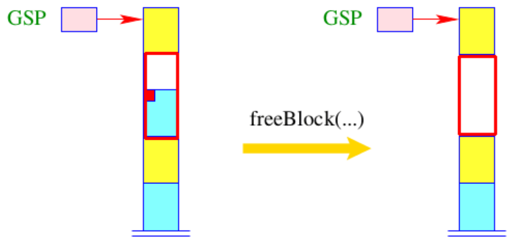
This list supports a function

```
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:





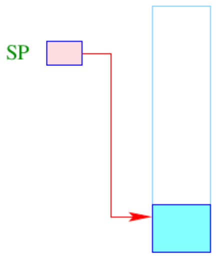
Approach:

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

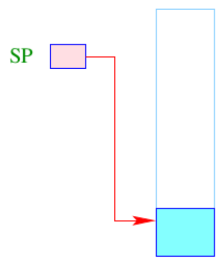
Problem:

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

$\Longrightarrow$ We order the new block after entering the function body!



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



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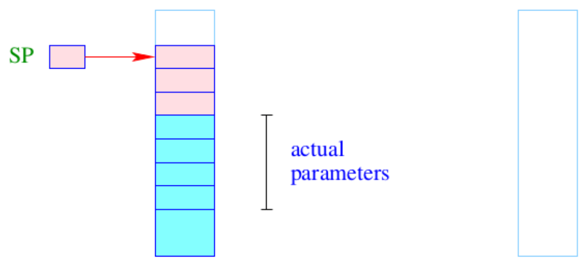
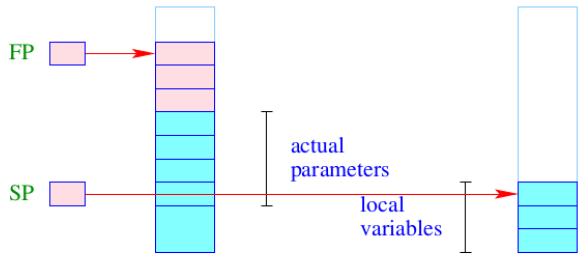


When entering the new function, we now allocate the new block ...



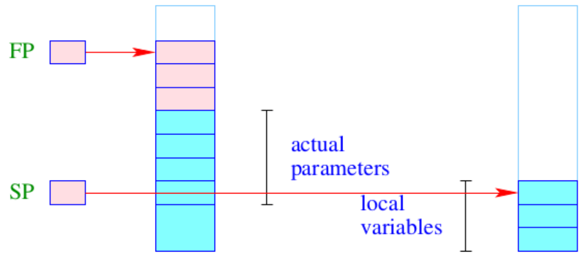
Inparticular, the local variables reside in the new block ...

⟹ 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 ... :-)



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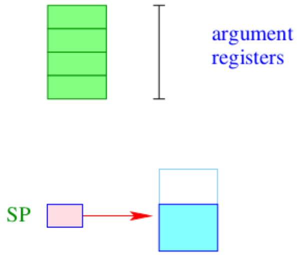
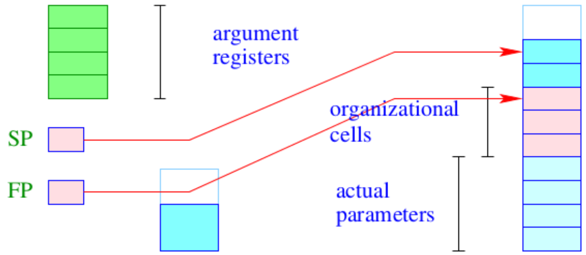
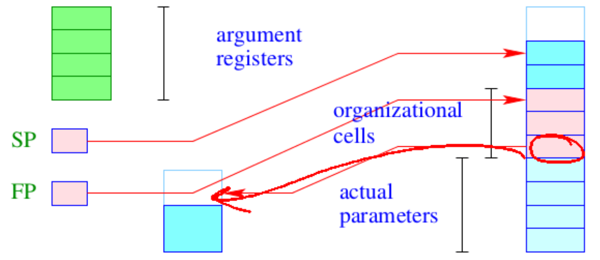


The values of the actual parameters are determined before allocation of the new stack frame.



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 :-))

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