

Process-Oriented Building Blocks

Adam Sampson

Institute of Arts, Media and Computer Games

University of Abertay Dundee

Threading Building Blocks

- Open-source C++ library from Intel
- Intended to replace OpenMP (more or less) in compute-heavy parallel applications – e.g. `parallel_for(0, 10, some_function);`
- ... but it's actually quite sophisticated underneath:
 - Built on non-preemptible **tasks**
 - Work-stealing multicore scheduler
 - API for submitting raw tasks, groups, etc.
 - Portable atomics, threads

Continuation-passing style

- You can abuse the scheduler to do **concurrent** (rather than **parallel**) programming...
- ... by writing in continuation-passing style
- So you can fairly easily knock up an implementation of channels on top of TBB...

```

PROC element (CHAN INT this?, next!) class Element {
  INITIAL INT token IS 1:
  WHILE token <> 0
    SEQ
      this ? token
      IF
        token > 0
          next ! (token + 1)
        TRUE
          next ! token
:
      }
    }
  }
  public:
  Element(pobb::channel<int>& cthis,
          pobb::channel<int>& cnext)
    : cthis_(cthis), cnext_(cnext),
      token_(1) {
  }
  tbb::task *start() {
    if (token_ != 0) {
      return cthis_.read(&token_,
        pobb::make_cont(*this,
          &Element::handle));
    } else {
      return 0;
    }
  }
  tbb::task *handle() {
    if (token_ > 0) {
      return cnext_.write(token_ + 1,
        pobb::make_cont(*this,
          &Element::start));
    } else {
      return cnext_.write(token_,
        pobb::make_cont(*this,
          &Element::start));
    }
  }
  }
  private:
  pobb::channel<int>& cthis_;
  pobb::channel<int>& cnext_;
  int token_;
};

```

```

PROC element (CHAN INT this?, next!)
  INITIAL INT token IS 1:
  WHILE token <> 0
    SEQ
      this ? token
    IF
      token > 0
        next ! (token + 1)
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        next ! token
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```

```

class Element {
public:
  Element(pobb::channel<int>& cthis,
          pobb::channel<int>& cnext)
    : cthis_(cthis), cnext_(cnext),
      token_(1) {
  }
  tbb::task *start() {
    if (token_ != 0) {
      return cthis_.read(&token_,
                        pobb::make_cont(*this,
                                        &Element::handle));
    } else {
      return 0;
    }
  }
  tbb::task *handle() {
    if (token_ > 0) {
      return cnext_.write(token_ + 1,
                          pobb::make_cont(*this,
                                        &Element::start));
    } else {
      return cnext_.write(token_,
                          pobb::make_cont(*this,
                                        &Element::start));
    }
  }
private:
  pobb::channel<int>& cthis_;
  pobb::channel<int>& cnext_;
  int token_;
};

```

Eww.

It works, but I
wouldn't want to
have to do this for
anything non-
trivial...

- This kind of translation is pretty mechanical... someone must have done this already, right?
 - (Pretty close to what SPoC does, in fact)
- Enter Gabriel Kerneis' **Continuation-Passing C**
 - Adds cps annotations to C: this function might be descheduled – so translate to CPS
 - Portable translator to ANSI C
 - Includes a very simple, single-core scheduler

```
cpc void server_process(int fd) {...}
```

```
cpc void main_loop() {  
    while (true) {  
        int fd = accept(sock);  
        cpc_spawn(server_process(fd));  
    }  
}
```

TBB + CPC + pobb.h = POBB

- I replaced CPC's scheduler with a wrapper around TBB's low-level interface
 - ... pretty straightforward
 - CPC's generated code is thread-safe, but many **applications** aren't – assume only one thread
- I reimplemented (some of!) KRoC's “CIF” library of process-oriented primitives – ChanOut, etc.
 - ... can just translate CCSP's algorithms


```

static struct cpc_continuation *element(struct cpc_continuation *cpc_cont ) ;
struct element_arglist {
    int this __attribute__((__aligned__(16))) ;
};
__inline static struct cpc_continuation *element_push(int this , struct cpc_continuation *cpc_cont_2732 ).
{
    struct element_arglist *cpc_arglist1 ;

    {
        cpc_arglist1 = (struct element_arglist *)cpc_alloc(& cpc_cont_2732, (int )sizeof(struct element_arglist )) ;
        cpc_arglist1->this = this ;
        cpc_cont_2732 = cpc_continuation_push(cpc_cont_2732, (cpc_function *)& element) ;
        return (cpc_cont_2732) ;
    }
}
struct cpc_continuation *__element_pc22(struct cpc_continuation *cpc_cont ) ;
struct __element_pc22_arglist {
    int next ;
    int this ;
    int *token __attribute__((__aligned__(16))) ;
};
__inline static struct cpc_continuation *__element_pc22_push(int next , int this ,
    int *token , struct cpc_continuation *cpc_cont_2737 ).
{
    struct __element_pc22_arglist *cpc_arglist1 ;

    {
        cpc_arglist1 = (struct __element_pc22_arglist *)cpc_alloc(& cpc_cont_2737, (int )sizeof(struct __element_pc22_arglist )) ;
        cpc_arglist1->next = next ;
        cpc_arglist1->this = this ;
        cpc_arglist1->token = token ;
        cpc_cont_2737 = cpc_continuation_push(cpc_cont_2737, (cpc_function *)& __element_pc22) ;
        return (cpc_cont_2737) ;
    }
}
struct cpc_continuation *__element_pc23(struct cpc_continuation *cpc_cont ) ;
struct __element_pc23_arglist {
    int next ;
    int this ;
    int *token __attribute__((__aligned__(16))) ;
};
// ... and so on

```

And it generates all this
for you...

```

PROC element (CHAN INT this?, next!) cps void element (Channel *this,
INITIAL INT token IS 1:                               Channel *next) {
WHILE token <> 0                                         int token = 1;
  SEQ
  this ? token
  IF
  token > 0
    next ! (token + 1)
  TRUE
    next ! token
:
}
}
}

```

That I can live
with...

I've ported over
most of the CCSP
benchmark suite –
including **agents**

Conclusions

- You can write concurrent programs in **portable C**
- Use TBB's multicore work-stealing scheduler
- Easy to add new synchronisation objects
- Combine with TBB's existing smart data-parallel functions
- Performance *seems* good – no proper analysis
 - ... which is why this is a fringe presentation!
- Minor downside: I ran into some problems with CPC's translator – but should be fixable
- If this sounds interesting, talk to me...