UNRAVELLING XC CONCEPTS

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[[COMBINE]],

20Aug2018

UNRAVELLING XC CONCEPTS

[[COMBINE]],
[[COMBINABLE]],

UNRAVELLING XC CONCEPTS

[[COMBINE]],

[[COMBINABLE]],

[[DISTRIBUTE]],

20Aug2018

UNRAVELLING XC CONCEPTS

[[COMBINE]],
[[COMBINABLE]],
[[DISTRIBUTE]],
[[DISTRIBUTABLE]] AND

20Aug2018

UNRAVELLING XC CONCEPTS

[[COMBINE]],
[[COMBINABLE]],
[[DISTRIBUTE]],
[[DISTRIBUTABLE]] AND
[[DISTRIBUTED(..)]] PLUS

UNRAVELLING XC CONCEPTS

[[COMBINE]],
[[COMBINABLE]],
[[DISTRIBUTE]],
[[DISTRIBUTABLE]] AND
[[DISTRIBUTED(..)] PLUS
PAR AND ON..

UNRAVELLING XC CONCEPTS

[[COMBINE]], [[COMBINABLE]], [[DISTRIBUTE]], [[DISTRIBUTABLE]] AND [[DISTRIBUTED(..)]] PLUS PAR AND ON..

CPA 2018 IN DRESDEN, GERMANY. AUGUST 19–22, 2018
COMMUNICATING PROCESS ARCHITECTURES[1]

UNRAVELLING XC CONCEPTS

[[COMBINE]], [[COMBINABLE]], [[DISTRIBUTE]], [[DISTRIBUTABLE]] AND [[DISTRIBUTED(..)]] PLUS PAR AND ON..

CPA 2018 IN DRESDEN, GERMANY. AUGUST 19–22, 2018
COMMUNICATING PROCESS ARCHITECTURES[1]

[1] http://wotug.cs.unlv.edu

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UNRAVELLING XC CONCEPTS [[COMBINE]], [[COMBINABLE]], [[DISTRIBUTE]], [[DISTRIBUTABLE]] AND [[DISTRIBUTED(..)]] PLUS PAR AND ON..

ØYVIND TEIG[2]
CODER AND BLOGGER

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[1] http://wotug.cs.unlv.edu

[2] http://www.teigfam.net/oyvind/home/ = *Aclassifier* with 40 years of embedded and safety-critical coding (including some years of occam). Home lab («retired») since June 2017

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CPA 2018 IN DRESDEN, GERMANY. AUGUST 19–22, 2018
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A FRINGE LECTURE

my 23rd WoTUG/CPA

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DISCLAIMER:

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..ONLY FUN AND EXPENSES

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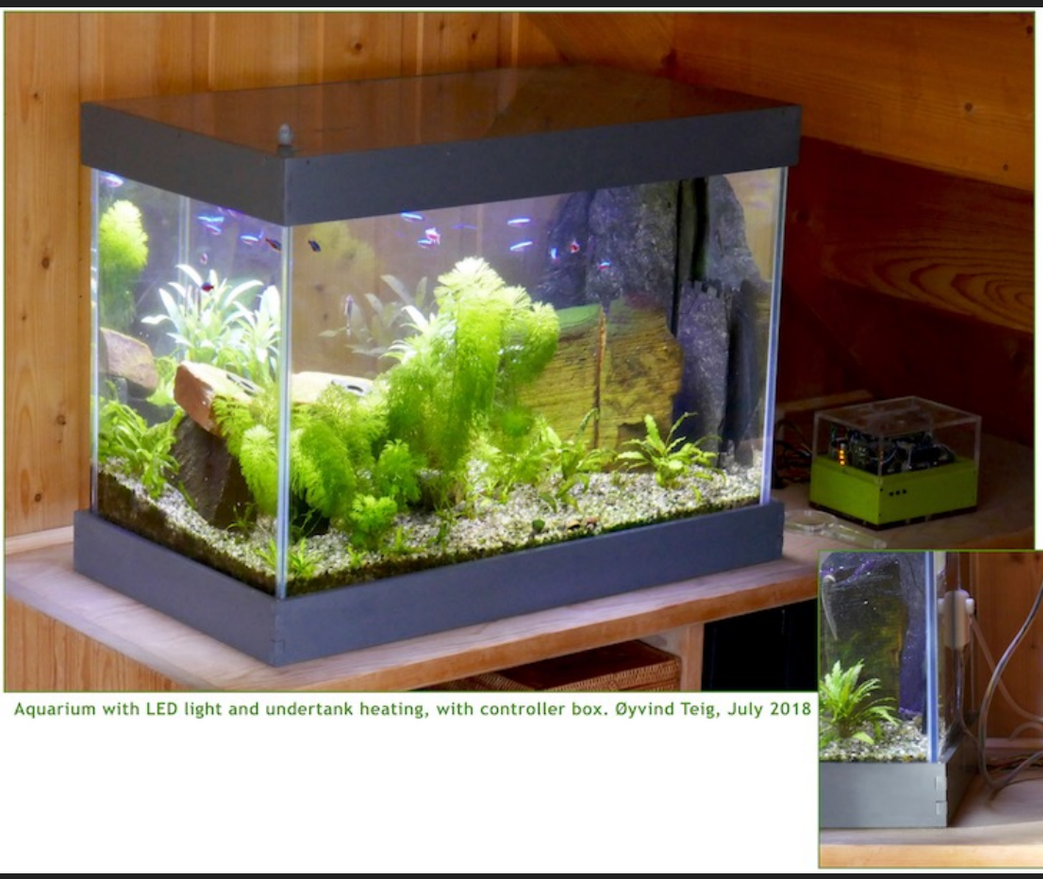

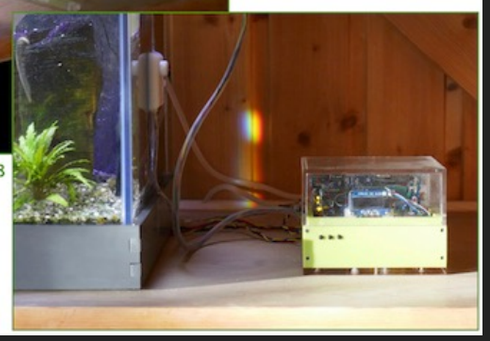

Aquarium with LED light and undertank heating, with controller box. Øyvind Teig, July 2018

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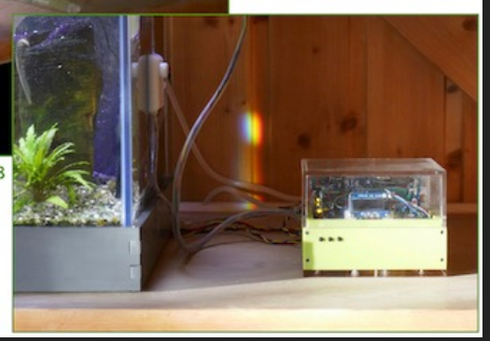

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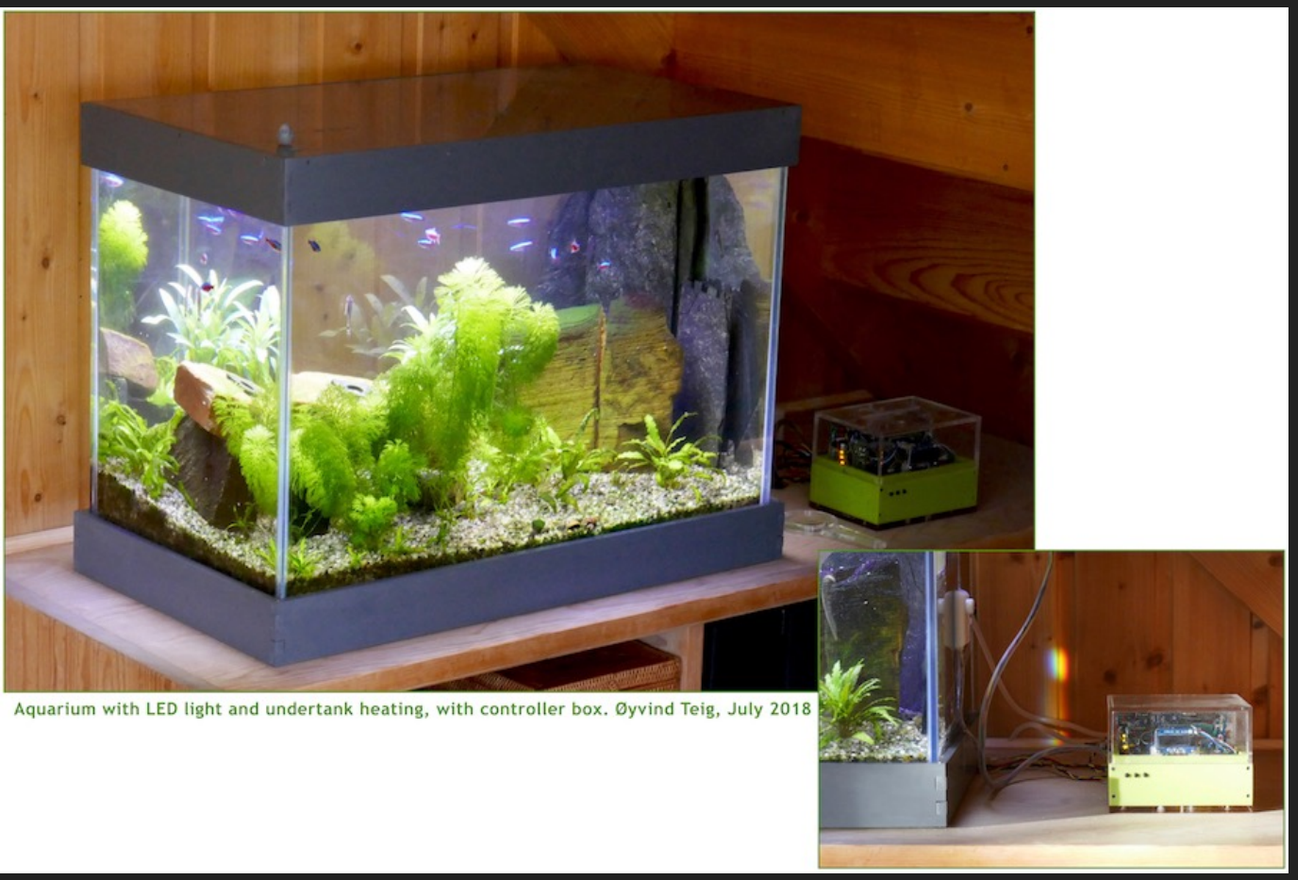

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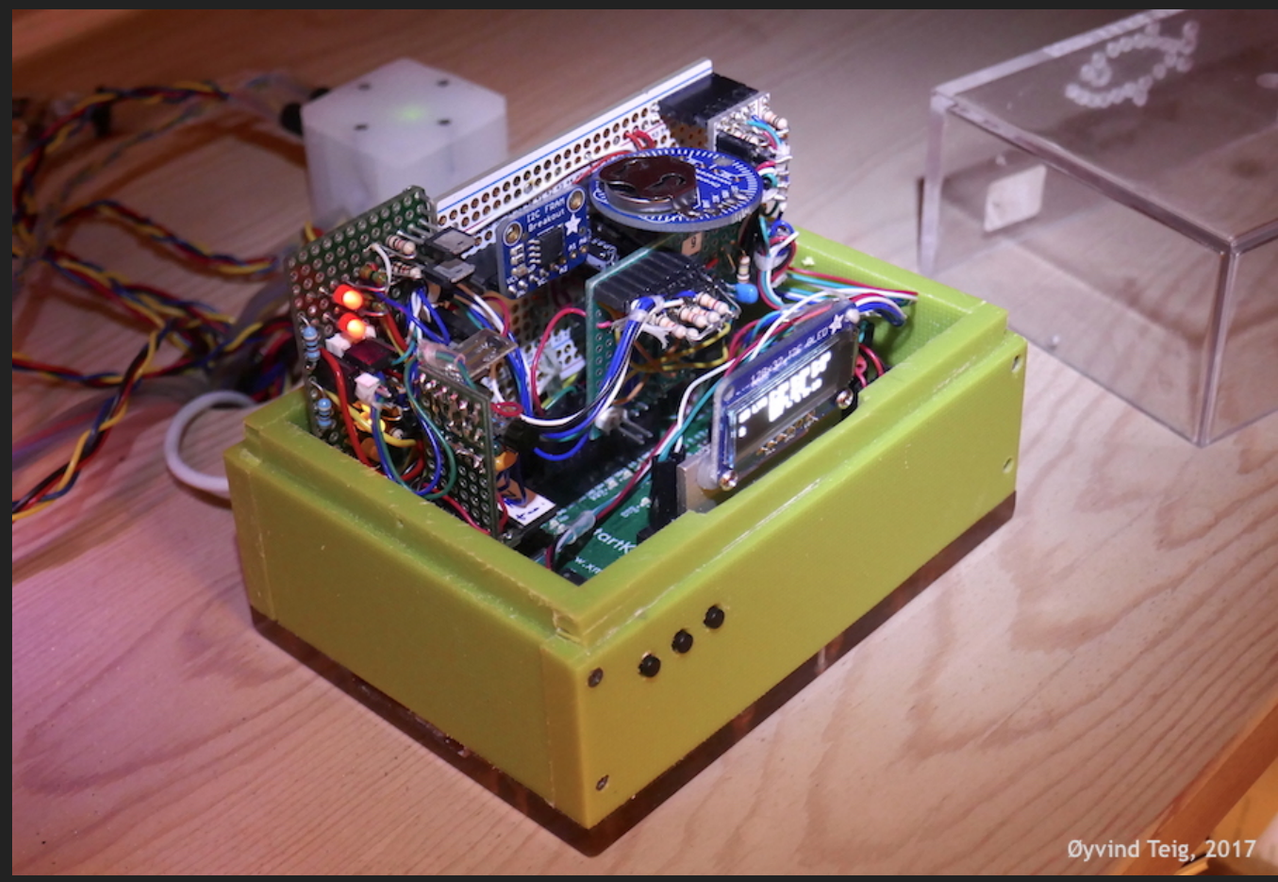

Øyvind Teig, 2017

BUT I DO USE XMOS BOARDS IN MY RATHER EXTENDED AQUARIUM PROJECT

AND AS A BACKGROUND FOR MY XMOS RELATED BLOGGING (SAME DISCLAIMER).

LIKE IN THE NOTE « XC IS C PLUS X»[3]

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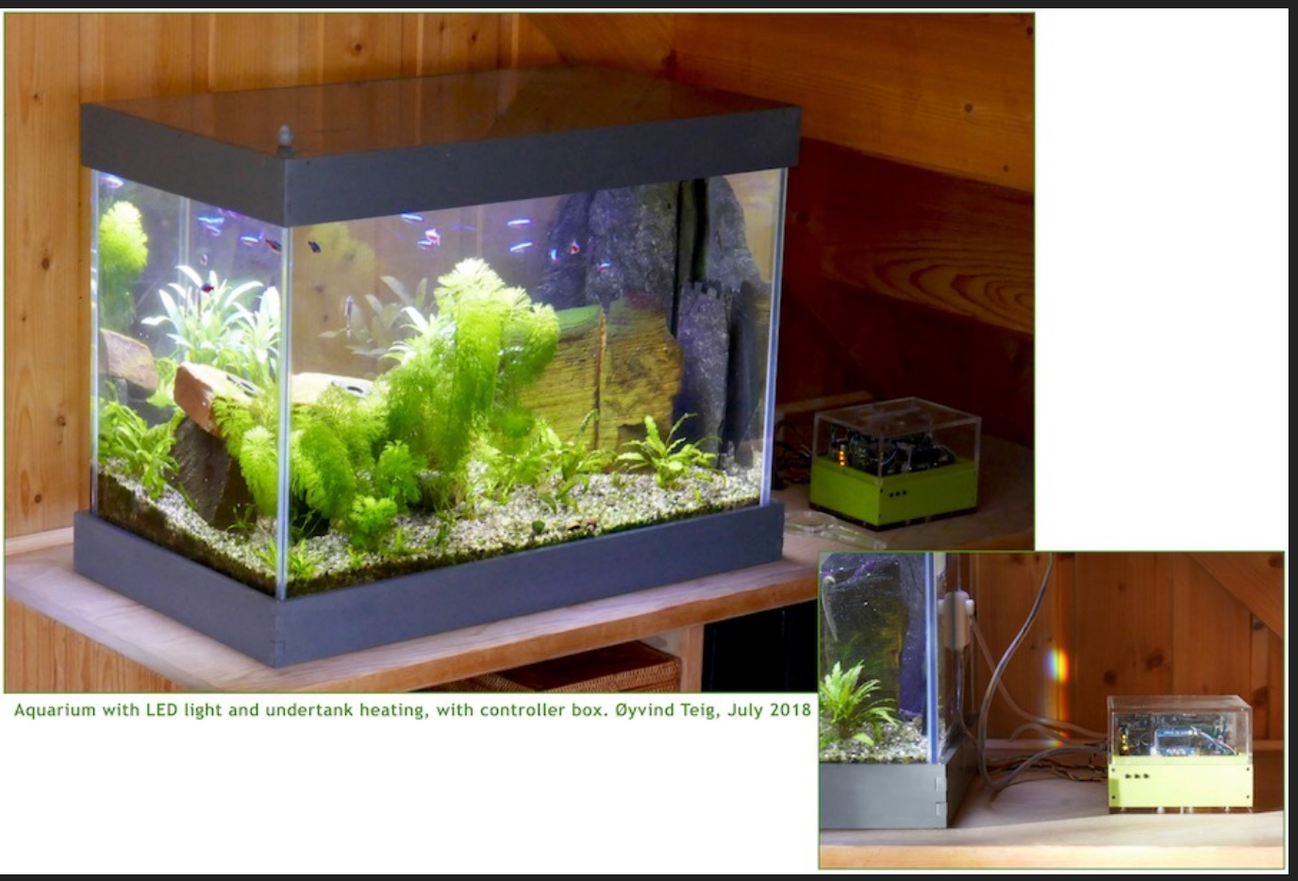

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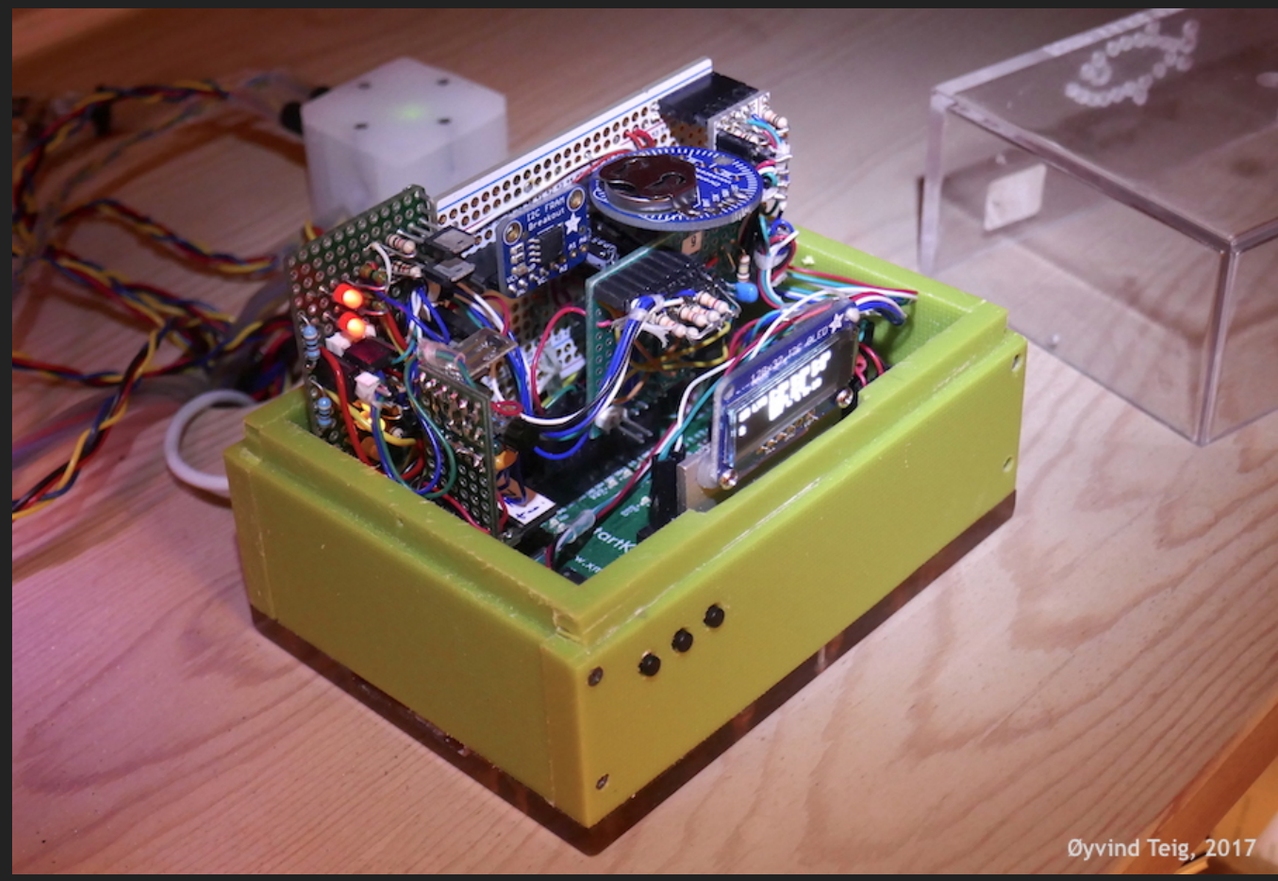

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---

[3] http://www.teigfam.net/oyvind/home/technology/141-xc-is-c-plus-x/

C PLUS ‘X’?

C PLUS 'X'?!

'X' THE UNKNOWN, NO QUESTION- MARK. BUT FUN

C PLUS ‘X’?!

‘X’ THE UNKNOWN, NO QUESTION-MARK. BUT FUN

Communicating Process Architectures 2018
K. Chalmers, J.B. Pedersen et al. (Eds.)
IOS Press, 2018

Unravelling `XC` concepts `[[combine]]`, `[[combinable]]`, `[[distribute]]`, `[[distributable]]` and `[[distributed(..)]]` plus `par` and `on`..

In search of understanding how some attributes, as present in XC code, by the compiler are treated weaker and more general and ultimately may be ignored altogether - in the runnable code for xCore multicore microcontrollers

Øyvind TEIG[1]
Coder and blogger

The XC programming language is designed to make runnable multitask programs for XMOS' xCore multicore microcontrollers, spread on *tiles* and *cores*. This presentation addresses only a few aspects of XC. What is a *combinable* and what is a *distributable* task, syntactically and semantically, but also resource wise and geographically on the chip? The xCore compiler handles the lowering of interfaces onto statically and dynamically allocated channel resources. The microcode and built-in scheduler also reflect them. Of the rather limited amount of resources, one must make it with 32 *chanends* per tile, with seemingly loose coupling between the XC code and the final number of chanends. Fiddling around, rather overwhelmed, with *[[combine]]*, *[[combinable]]*, *[[distribute]]*, *[[distributable]]* and *[[distributed(..)]]* plus *par* and *on* reveals a lot of how unchanged functionality spreads differently over cores or across tiles. Thus the same functional code may require anything from, like, six to *zero* chanends! The goal of this fringe presentation is to trigger interest, not provide answers. Or rather, only those answers that the author might presently have acquired by surrendering to this can of reserved words and observe what might possibly happen. Like, there must be an electric motor inside, because the sound of it is so pleasant.

Keywords. code lowering, placement, attribute decay, conversion, substitution, optimisation, channel, interface, critical region, lock, multicore, scheduler, scheduling.

[1] http://www.teigfam.net/oyvind/home/ and http://www.teigfam.net/oyvind/work/work.html, embedded and safety-critical coder, retired since June 2017

C PLUS 'X'?!

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C PLUS 'X'?!

'X' THE UNKNOWN, NO QUESTION-MARK. BUT FUN

can of reserved words and observe what might possibly happen. Like, there must be an electric motor inside, because the sound of it is so pleasant.

```
interface button_if_t {
    void but (int x);
};
```

```
interface button_if_t {
    void but (int x);
};

typedef enum {false,true} bool;
```

```
interface button_if_t {
    void but (int x);
};

typedef enum {false,true} bool;


void handle (server interface button_if_t i_but[3]) {
    int cnt = 0;
    timer tmr;
    int   time;
    bool  timeout = false;
    tmr :> time;
    while (1) {
        select {
            case i_but[int i].but (int ms) : {
                // Do something
                timeout = false;
                break;
            }
            case tmr when timerafter(time) :> void: {
                timeout = true;
                time += XS1_TIMER_HZ; // One second
                break;
            }
        }
        cnt++;
    }
}
```

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interface button_if_t {
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        }
        cnt++;
    }
}

int main (void) {
    interface button_if_t i_but[3];
    par {

        par {
             handle (i_but);
             button (i_but[0]);
             button (i_but[1]);
             button (i_but[2]);
         }

    }
    return 0;
}
```

```
01  interface button_if_t {
02      void but (int x);
03  };

04  typedef enum {false,true} bool;


05
06  void handle (server interface button_if_t i_but[3]) {
07      int cnt = 0;
08      timer tmr;
09      int   time;
10      bool  timeout = false;
11      tmr :> time;
12      while (1) {
13          select {
14              case i_but[int i].but (int ms) : {
15                  // Do something
16                  timeout = false;
17                  break;
18              }
19              case tmr when timerafter(time) :> void: {
20                  timeout = true;
21                  time += XS1_TIMER_HZ; // One second
22                  break;
23              }
24          }
25          cnt++;
26      }
27  }

28  int main (void) {
29      interface button_if_t i_but[3];
30      par {
31
32          par {
33               handle (i_but);
34               button (i_but[0]);
35               button (i_but[1]);
36               button (i_but[2]);
37           }
39
40      }
41      return 0;
42  }
```

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

```
interface button_if_t {
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[[combinable]]
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                break;
            }
        }
        // cnt++;
    }
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int main (void) {
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    par {

        par {
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             button (i_but[0]);
             button (i_but[1]);
             button (i_but[2]);
         }

    }
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}
```

XC

1

2

```
Constraint check for tile[0]:
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    tmr :> time;
    while (1) {
        select {
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                // Do something
                timeout = false;
                break;
            }
            case tmr when timerafter(time) :> void: {
                timeout = true;
                time += XS1_TIMER_HZ; // One second
                break;
            }
        }
        // cnt++;
    }
}

int main (void) {
    interface button_if_t i_but[3];
    par {
        [[combine]]
        par {
             handle (i_but);
             button (i_but[0]);
             button (i_but[1]);
             button (i_but[2]);
         }

    }
    return 0;
}
```

XC

1

2

```
Constraint check for tile[0]:
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  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
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};

typedef enum {false,true} bool;

[[combinable]]
void handle (server interface button_if_t i_but[3]) {
    // int cnt = 0;
    timer tmr;
    int   time;
    bool  timeout = false;
    tmr :> time;
    while (1) {
        select {
            case i_but[int i].but (int ms) : {
                // Do something
                timeout = false;
                break;
            }
            case tmr when timerafter(time) :> void: {
                timeout = true;
                time += XS1_TIMER_HZ; // One second
                break;
            }
        }
        // cnt++;
    }
}

int main (void) {
    interface button_if_t i_but[3];
    par {
        [[combine]]
        par {
             handle (i_but);
             button (i_but[0]);
             button (i_but[1]);
             button (i_but[2]);
         }

    }
    return 0;
}
```

XC

1

2

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)


Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

```
interface button_if_t {
    void but (int x);
};

typedef enum {false,true} bool;

[[combinable]]
void handle (server interface button_if_t i_but[3]) {
    // int cnt = 0;
    timer tmr;
    int   time;
    bool  timeout = false;
    tmr :> time;
    while (1) {
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                time += XS1_TIMER_HZ; // One second
                break;
            }
        }
        // cnt++;
    }
}

int main (void) {
    interface button_if_t i_but[3];
    par {
        [[combine]]
        par {
             handle (i_but);
             button (i_but[0]);
             button (i_but[1]);
             button (i_but[2]);
         }

    }
    return 0;
}
```

XC

1

2

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

```
interface button_if_t {
    void but (int x);
};

typedef enum {false,true} bool;

[[distributable]] // [[combinable]]
void handle (server interface button_if_t i_but[3]) {
    // int cnt = 0;
    timer tmr;
    int   time;
    bool  timeout = false;
    tmr :> time;
    while (1) {
        select {
            case i_but[int i].but (int ms) : {
                // Do something
                timeout = false;
                break;
            }
            case tmr when timerafter(time) :> void: {
                timeout = true;
                time += XS1_TIMER_HZ; // One second
                break;
            }
        }
        // cnt++;
    }
}

int main (void) {
    interface button_if_t i_but[3];
    par {
        [[combine]]
        par {
             handle (i_but);
             button (i_but[0]);
             button (i_but[1]);
             button (i_but[2]);
         }

    }
    return 0;
}
```

XC

1

2

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

```
interface button_if_t {
    void but (int x);
};

typedef enum {false,true} bool;

[[distributable]] // [[combinable]]
void handle (server interface button_if_t i_but[3]) {
    // int cnt = 0;
    // timer tmr;
    // int   time;
    // bool  timeout = false;
    // tmr :> time;
    while (1) {
        select {
            case i_but[int i].but (int ms) : {
                // Do something
                // timeout = false;
                break;
            }
            // case tmr when timerafter(time) :> void: {
            //     timeout = true;
            //     time += XS1_TIMER_HZ; // One second
            //     break;
            // }
        }
        // cnt++;
    }
}

int main (void) {
    interface button_if_t i_but[3];
    par {
        [[combine]]
        par {
             handle (i_but);
             button (i_but[0]);
             button (i_but[1]);
             button (i_but[2]);
         }

    }
    return 0;
}
```

XC

1

2

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

```
interface button_if_t {
    void but (int x);
};

typedef enum {false,true} bool;

[[distributable]] // [[combinable]]
void handle (server interface button_if_t i_but[3]) {
    // int cnt = 0;
    // timer tmr;
    // int   time;
    // bool  timeout = false;
    // tmr :> time;
    while (1) {
        select {
            case i_but[int i].but (int ms) : {
                // Do something
                // timeout = false;
                break;
            }
            // case tmr when timerafter(time) :> void: {
            //     timeout = true;
            //     time += XS1_TIMER_HZ; // One second
            //     break;
            // }
        }
        // cnt++;
    }
}

int main (void) {
    interface button_if_t i_but[3];
    par {
        [[combine]]
        par {
             handle (i_but);
             button (i_but[0]);
             button (i_but[1]);
             button (i_but[2]);
         }

    }
    return 0;
}
```

XC

1

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

2

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1756 .  OKAY
    (Stack: 404, Code: 1132, Data: 220)
Constraints checks PASSED.
```

```
interface button_if_t {
    void but (int x);
};

typedef enum {false,true} bool;

[[distributable]] // [[combinable]]
void handle (server interface button_if_t i_but[3]) {
    // int cnt = 0;
    // timer tmr;
    // int   time;
    // bool  timeout = false;
    // tmr :> time;
    while (1) {
        select {
            case i_but[int i].but (int ms) : {
                // Do something
                // timeout = false;
                break;
            }
            // case tmr when timerafter(time) :> void: {
            //     timeout = true;
            //     time += XS1_TIMER_HZ; // One second
            //     break;
            // }
        }
        // cnt++;
    }
}

int main (void) {
    interface button_if_t i_but[3];
    par {
        [[combine]]
        par {
             handle (i_but);
             button (i_but[0]);
             button (i_but[1]);
             button (i_but[2]);
         }

    }
    return 0;
}
```

XC

1

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

2

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

4

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1756 .  OKAY
    (Stack: 404, Code: 1132, Data: 220)
Constraints checks PASSED.
```

```
01  interface button_if_t {
02      void but (int x);
03  };

04  typedef enum {false,true} bool;

05  [[distributable]] // [[combinable]]
06  void handle (server interface button_if_t i_but[3]) {
07      // int cnt = 0;
08      // timer tmr;
09      // int   time;
10      // bool  timeout = false;
11      // tmr :> time;
12      while (1) {
13          select {
14              case i_but[int i].but (int ms) : {
15                  // Do something
16                  // timeout = false;
17                  break;
18              }
19              // case tmr when timerafter(time) :> void: {
20              //     timeout = true;
21              //     time += XS1_TIMER_HZ; // One second
22              //     break;
23              // }
24          }
25          // cnt++;
26      }
27  }

28  int main (void) {
29      interface button_if_t i_but[3];
30      par {
31          [[combine]]
32          par {
33              handle (i_but);
34              button (i_but[0]);
35              button (i_but[1]);
36              button (i_but[2]);
37           }
39
40      }
41      return 0;
42  }
```

XC

1

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

2

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

4

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1756 .  OKAY
    (Stack: 404, Code: 1132, Data: 220)
Constraints checks PASSED.
```

```
01  interface button_if_t {
02      void but (int x);
03  };

04  typedef enum {false,true} bool;

05  [[distributable]] // [[combinable]]
06  void handle (server interface button_if_t i_but[3]) {
07      // int cnt = 0;
08      // timer tmr;
09      // int   time;
10      // bool  timeout = false;
11      // tmr :> time;
12      while (1) {
13          select {
14              case i_but[int i].but (int ms) : {
15                  // Do something
16                  // timeout = false;
17                  break;
18              }
19              // case tmr when timerafter(time) :> void: {
20              //     timeout = true;
21              //     time += XS1_TIMER_HZ; // One second
22              //     break;
23              // }
24          }
25          // cnt++;
26      }
27  }

28  int main (void) {
29      interface button_if_t i_but[3];
30      par {
31          [[combine]]                 [[combine]]
32          par {                       par (int j = 0; j < 3; j++) {
33              handle (i_but);             button (i_but[j]);
34              button (i_but[0]);      }
35              button (i_but[1]);      [[combine]]
36              button (i_but[2]);      par {
37           }                              handle (i_but);
39                                      }
40      }
41      return 0;
42  }
```

XC

1

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

2

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

4

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1756 .  OKAY
    (Stack: 404, Code: 1132, Data: 220)
Constraints checks PASSED.
```

```
01  interface button_if_t {
02      void but (int x);
03  };

04  typedef enum {false,true} bool;

05  [[distributable]] // [[combinable]]
06  void handle (server interface button_if_t i_but[3]) {
07      // int cnt = 0;
08      // timer tmr;
09      // int   time;
10      // bool  timeout = false;
11      // tmr :> time;
12      while (1) {
13          select {
14              case i_but[int i].but (int ms) : {
15                  // Do something
16                  // timeout = false;
17                  break;
18              }
19              // case tmr when timerafter(time) :> void: {
20              //     timeout = true;
21              //     time += XS1_TIMER_HZ; // One second
22              //     break;
23              // }
24          }
25          // cnt++;
26      }
27  }

28  int main (void) {
29      interface button_if_t i_but[3];
30      par {
31          [[combine]]                 [[combine]]
32          par {                       par (int j = 0; j < 3; j++) {
33              handle (i_but);             button (i_but[j]);
34              button (i_but[0]);      }
35              button (i_but[1]);      [[combine]]
36              button (i_but[2]);      par {
37          }                               handle (i_but);
39                                      }
40      }
41      return 0;
42  }
```

XC

1

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

2

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

4

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1756 .  OKAY
    (Stack: 404, Code: 1132, Data: 220)
Constraints checks PASSED.


Constraint check for tile[0]:
  Cores available:            8,   used:          2 .  OKAY
  Timers available:          10,   used:          2 .  OKAY
  Chanends available:        32,   used:          4 .  OKAY
  Memory available:       65536,   used:       1728 .  OKAY
    (Stack: 376, Code: 1090, Data: 262)
Constraints checks PASSED.
```

```
01  interface button_if_t {
02      void but (int x);
03  };

04  typedef enum {false,true} bool;

05  [[distributable]] // [[combinable]]
06  void handle (server interface button_if_t i_but[3]) {
07      // int cnt = 0;
08      // timer tmr;
09      // int   time;
10      // bool  timeout = false;
11      // tmr :> time;
12      while (1) {
13          select {
14              case i_but[int i].but (int ms) : {
15                  // Do something
16                  // timeout = false;
17                  break;
18              }
19              // case tmr when timerafter(time) :> void: {
20              //     timeout = true;
21              //     time += XS1_TIMER_HZ; // One second
22              //     break;
23              // }
24          }
25          // cnt++;
26      }
27  }


28  int main (void) {
29      interface button_if_t i_but[3];
30      par {
31          [[combine]]                 [[combine]]
32          par {                       par (int j = 0; j < 3; j++) {
33              handle (i_but);             button (i_but[j]);
34              button (i_but[0]);      }
35              button (i_but[1]);      [[combine]]
36              button (i_but[2]);      par {
37           }                              handle (i_but);
39                                      }
40      }
41      return 0;
42  }
```

XC

1

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

2

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

4

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1756 .  OKAY
    (Stack: 404, Code: 1132, Data: 220)
Constraints checks PASSED.
```

5

```
Constraint check for tile[0]:
  Cores available:            8,   used:          2 .  OKAY
  Timers available:          10,   used:          2 .  OKAY
  Chanends available:        32,   used:          4 .  OKAY
  Memory available:       65536,   used:       1728 .  OKAY
    (Stack: 376, Code: 1090, Data: 262)
Constraints checks PASSED.
```

```
01  interface button_if_t {
02      void but (int x);
03  };

04  typedef enum {false,true} bool;

05  [[distributable]] // [[combinable]]
06  void handle (server interface button_if_t i_but[3]) {
07      // int cnt = 0;
08      // timer tmr;
09      // int   time;
10      // bool  timeout = false;
11      // tmr :> time;
12      while (1) {
13          select {
14              case i_but[int i].but (int ms) : {
15                  // Do something
16                  // timeout = false;
17                  break;
18              }
19              // case tmr when timerafter(time) :> void: {
20              //     timeout = true;
21              //     time += XS1_TIMER_HZ; // One second
22              //     break;
23              // }
24          }
25          // cnt++;
26      }
27  }


28  int main (void) {
29      interface button_if_t i_but[3];
30      par {
31          [[combine]]                 [[combine]]
32          par {                       par (int j = 0; j < 3; j++) {
33              handle (i_but);             button (i_but[j]);
34              button (i_but[0]);      }
35              button (i_but[1]);     [[distribute]] // [[combine]]
36              button (i_but[2]);      par {
37          }                               handle (i_but);
39                                      }
40      }
41      return 0;
42  }
```

XC

1

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

2

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

4

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1756 .  OKAY
    (Stack: 404, Code: 1132, Data: 220)
Constraints checks PASSED.
```

5

```
Constraint check for tile[0]:
  Cores available:            8,   used:          2 .  OKAY
  Timers available:          10,   used:          2 .  OKAY
  Chanends available:        32,   used:          4 .  OKAY
  Memory available:       65536,   used:       1728 .  OKAY
    (Stack: 376, Code: 1090, Data: 262)
Constraints checks PASSED.
```

```
01  interface button_if_t {
02      void but (int x);
03  };

04  typedef enum {false,true} bool;

05  [[distributable]] // [[combinable]]
06  void handle (server interface button_if_t i_but[3]) {
07      // int cnt = 0;
08      // timer tmr;
09      // int   time;
10      // bool  timeout = false;
11      // tmr :> time;
12      while (1) {
13          select {
14              case i_but[int i].but (int ms) : {
15                  // Do something
16                  // timeout = false;
17                  break;
18              }
19              // case tmr when timerafter(time) :> void: {
20              //     timeout = true;
21              //     time += XS1_TIMER_HZ; // One second
22              //     break;
23              // }
24          }
25          // cnt++;
26      }
27  }


28  int main (void) {
29      interface button_if_t i_but[3];
30      par {
31          [[combine]]                 [[combine]]
32          par {                       par (int j = 0; j < 3; j++) {
33              handle (i_but);             button (i_but[j]);
34              button (i_but[0]);      }
35              button (i_but[1]);      [[distribute]] // [[combine]]
36              button (i_but[2]);      par {
37          }                               handle (i_but);
39                                      }
40      }
41      return 0;
42  }
```

XC

1

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

2

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

4

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1756 .  OKAY
    (Stack: 404, Code: 1132, Data: 220)
Constraints checks PASSED.
```

5

```
Constraint check for tile[0]:
  Cores available:            8,   used:          2 .  OKAY
  Timers available:          10,   used:          2 .  OKAY
  Chanends available:        32,   used:          4 .  OKAY
  Memory available:       65536,   used:       1728 .  OKAY
    (Stack: 376, Code: 1090, Data: 262)
Constraints checks PASSED.


../src/main.xc:366:1: error: distributed statement must be a call
                             to a distributable function
```

```
01  interface button_if_t {
02      void but (int x);
03  };

04  typedef enum {false,true} bool;

05  [[distributable]] // [[combinable]]
06  void handle (server interface button_if_t i_but[3]) {
07      // int cnt = 0;
08      // timer tmr;
09      // int   time;
10      // bool  timeout = false;
11      // tmr :> time;
12      while (1) {
13          select {
14              case i_but[int i].but (int ms) : {
15                  // Do something
16                  // timeout = false;
17                  break;
18              }
19              // case tmr when timerafter(time) :> void: {
20              //     timeout = true;
21              //     time += XS1_TIMER_HZ; // One second
22              //     break;
23              // }
24          }
25          // cnt++;
26      }
27  }


28  int main (void) {
29      interface button_if_t i_but[3];
30      par {
31          [[combine]]                 [[combine]]
32          par {                       par (int j = 0; j < 3; j++) {
33              handle (i_but);             button (i_but[j]);
34              button (i_but[0]);      }
35              button (i_but[1]);      [[distribute]] // [[combine]]
36              button (i_but[2]);      par {
37          }                               handle (i_but);
39                                      }
40      }
41      return 0;
42  }
```

XC

1

```
Constraint check for tile[0]:
  Cores available:            8,   used:          4 .  OKAY
  Timers available:          10,   used:          4 .  OKAY
  Chanends available:        32,   used:          6 .  OKAY
  Memory available:       65536,   used:       1464 .  OKAY
    (Stack: 372, Code: 882, Data: 210)
```

2

3

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1852 .  OKAY
    (Stack: 404, Code: 1228, Data: 220)
Constraints checks PASSED.
```

4

```
Constraint check for tile[0]:
  Cores available:            8,   used:          1 .  OKAY
  Timers available:          10,   used:          1 .  OKAY
  Chanends available:        32,   used:          0 .  OKAY
  Memory available:       65536,   used:       1756 .  OKAY
    (Stack: 404, Code: 1132, Data: 220)
Constraints checks PASSED.
```

5

```
Constraint check for tile[0]:
  Cores available:            8,   used:          2 .  OKAY
  Timers available:          10,   used:          2 .  OKAY
  Chanends available:        32,   used:          4 .  OKAY
  Memory available:       65536,   used:       1728 .  OKAY
    (Stack: 376, Code: 1090, Data: 262)
Constraints checks PASSED.
```

6 Wrong error message

```
../src/main.xc:366:1: error: distributed statement must be a call
                             to a distributable function
```

MY XCORE-200 EXPLORERKIT BOARDS' PROCESSOR

MY XCORE-200 EXPLORERKIT BOARDS' PROCESSOR

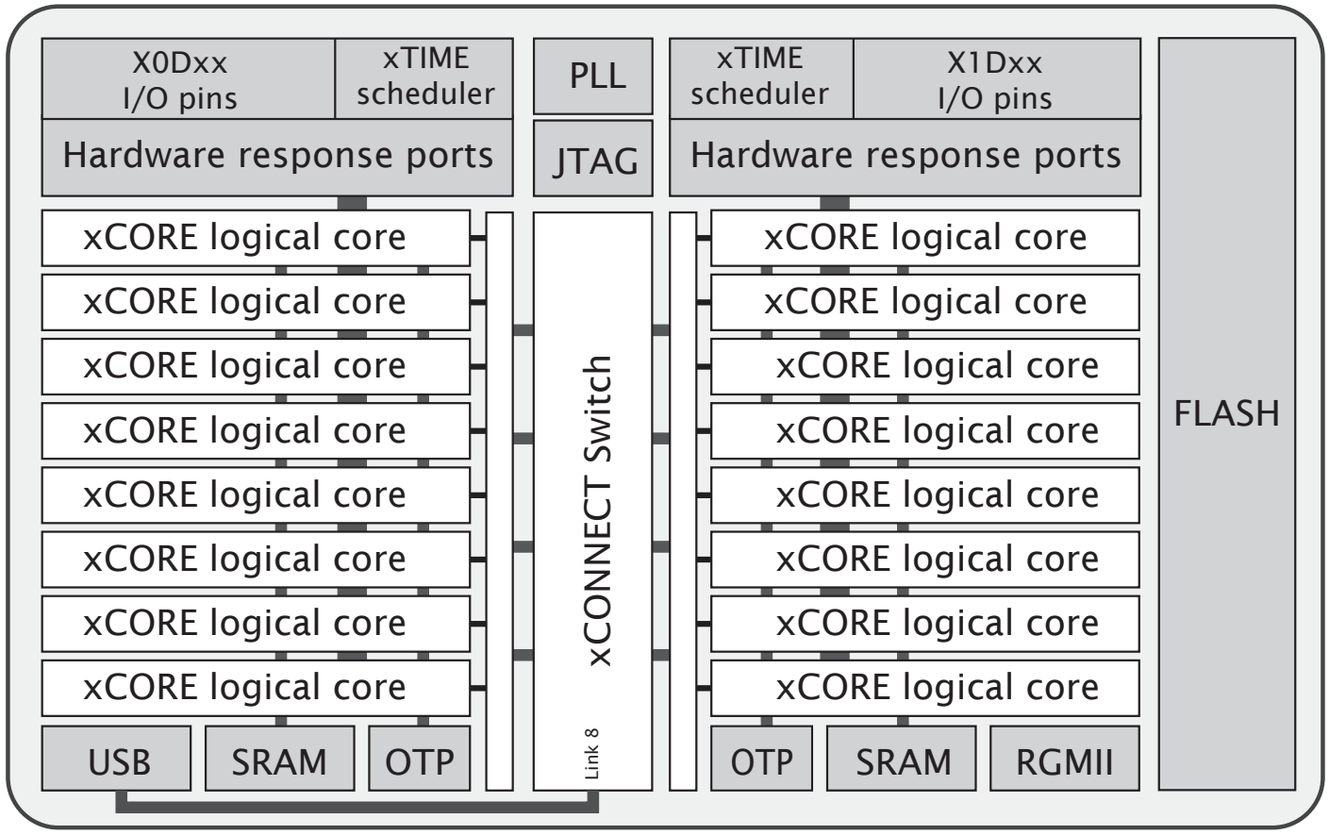
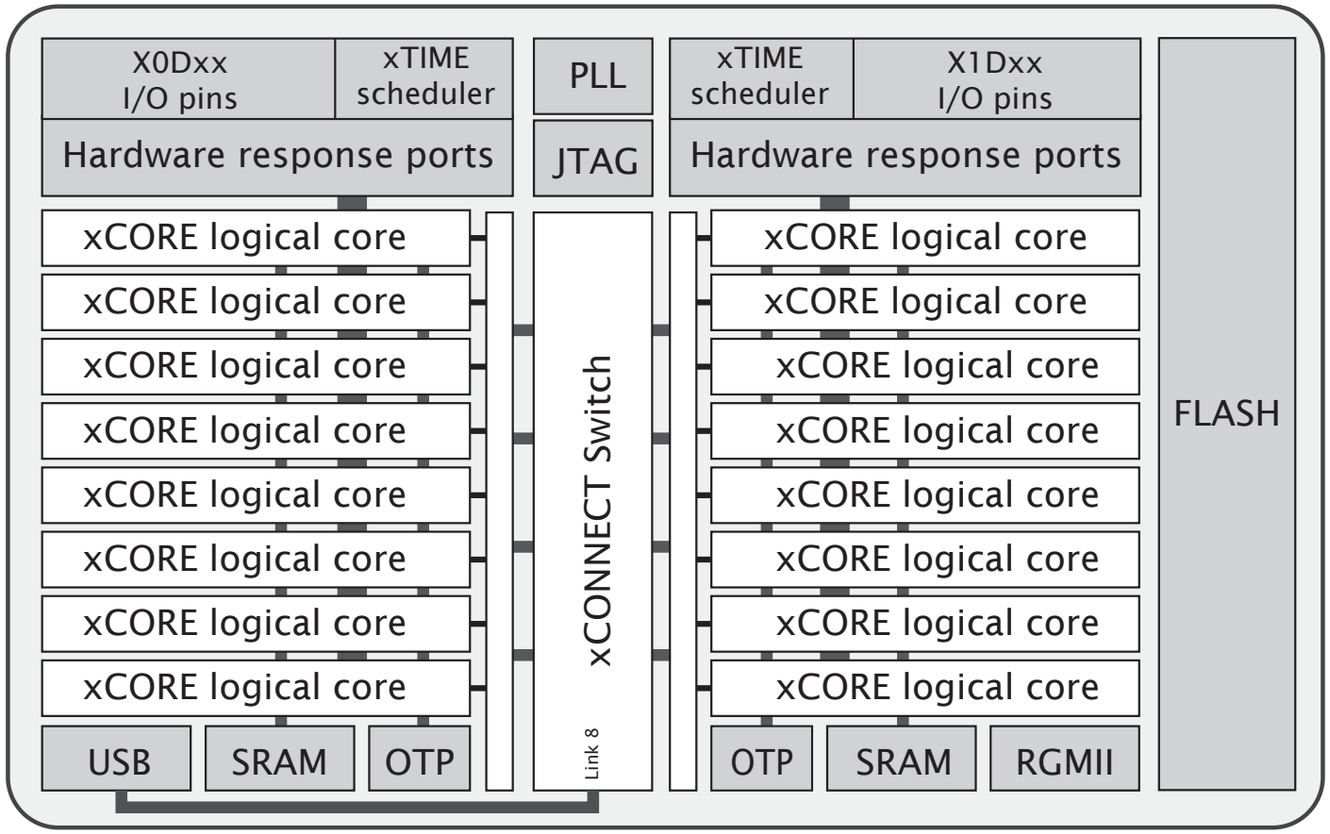


Figure 1: XEF216-512-TQ128 block diagram, from **XEF216-512-TQ128 Datasheet**. 2018/03/23
Document Number: X006990
http://www.xmos.com/download/private/XEF216-512-TQ128-Datasheet%281.15%29.pdf.
As used in the xCORE-200 eXplorerKIT.

MY XCORE-200 EXPLORERKIT BOARDS' PROCESSOR



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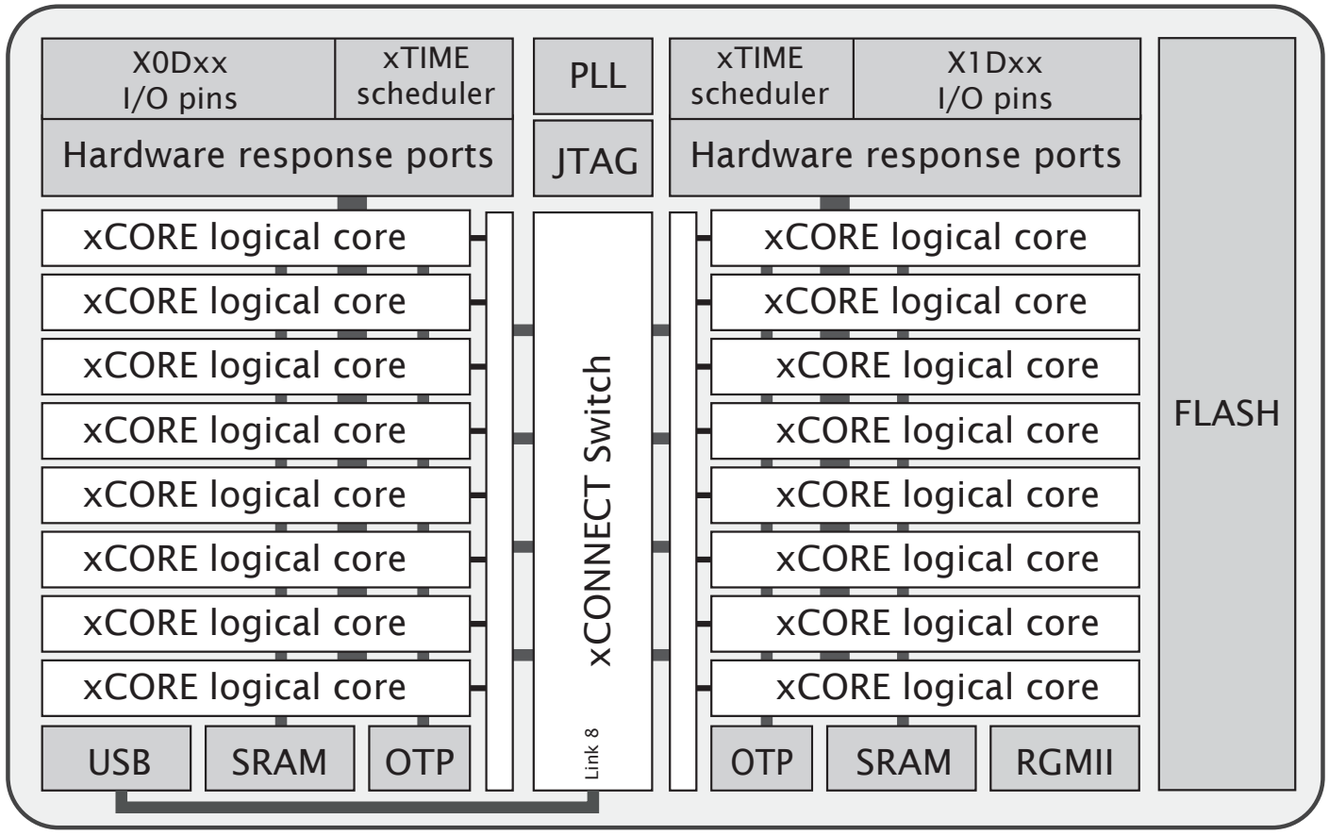
As used in the xCORE-200 eXplorerKIT.

- 2 tiles (500 MIPS per tile (or dual))

MY XCORE-200 EXPLORERKIT BOARDS' PROCESSOR



- 2 tiles (500 MIPS per tile (or dual))
- 8 cores per tile (=«Logical cores»)

Figure 1: XEF216-512-TQ128 block diagram, from **XEF216-512-TQ128 Datasheet**. 2018/03/23
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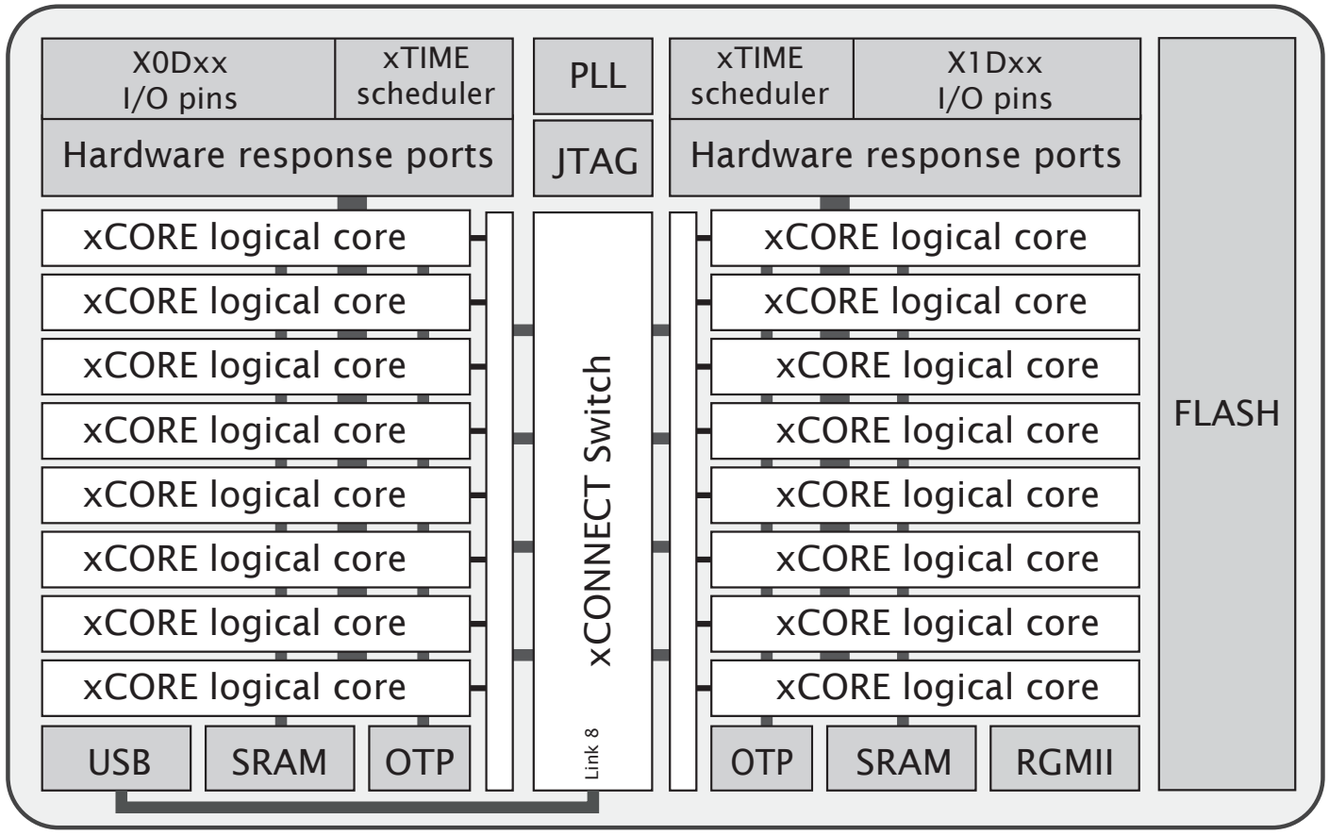
MY XCORE-200 EXPLORERKIT BOARDS' PROCESSOR



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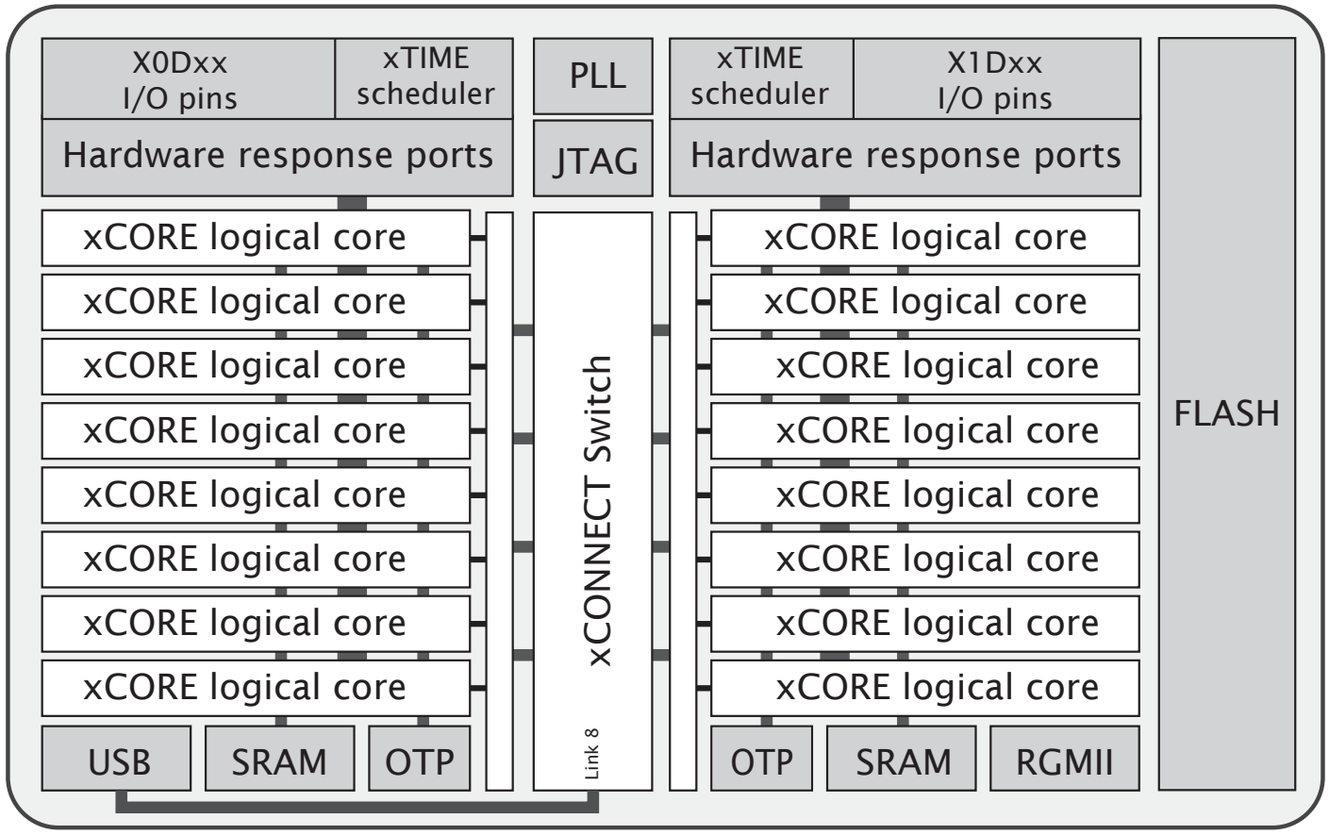
As used in the xCORE-200 eXplorerKIT.

- 2 tiles (500 MIPS per tile (or dual))
- 8 cores per tile (=«Logical cores»)
- xTIME scheduler. If # cores active:
  - 1-4 cores: 1/4 cycles each
  - 5-8 cores: all cycles shared out
  - Deterministic thread execution
  - Thread safe
  - pragma for some deadlines

MY XCORE-200 EXPLORERKIT BOARDS' PROCESSOR



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- 2 tiles (500 MIPS per tile (or dual))
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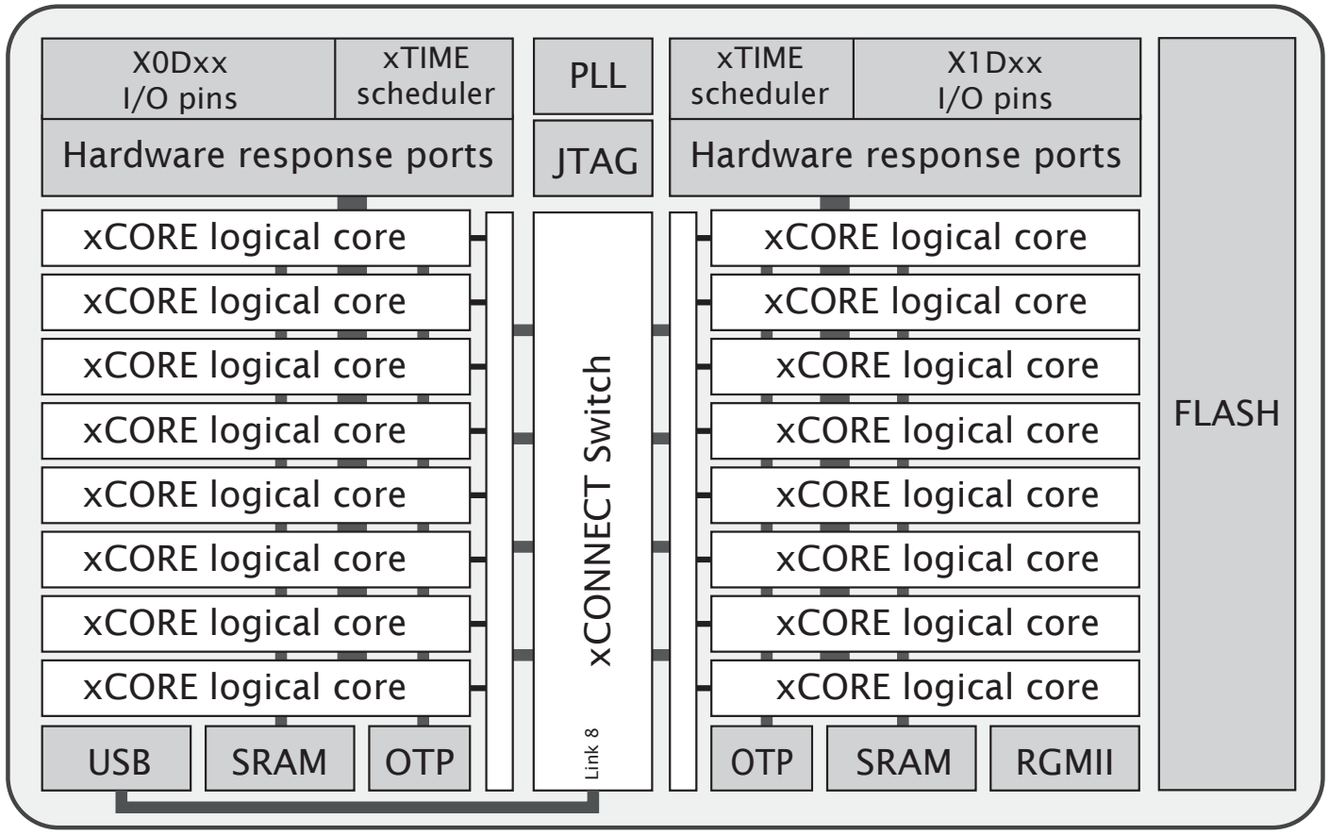
  - 1-4 cores: 1/4 cycles each
  - 5-8 cores: all cycles shared out
  - Deterministic thread execution
  - Thread safe
  - pragma for some deadlines
- Channels: untyped. Synch or asynch
  - XC `chanends` (32 per tile)
  - Not between tasks on the same core

MY XCORE-200 EXPLORERKIT BOARDS' PROCESSOR



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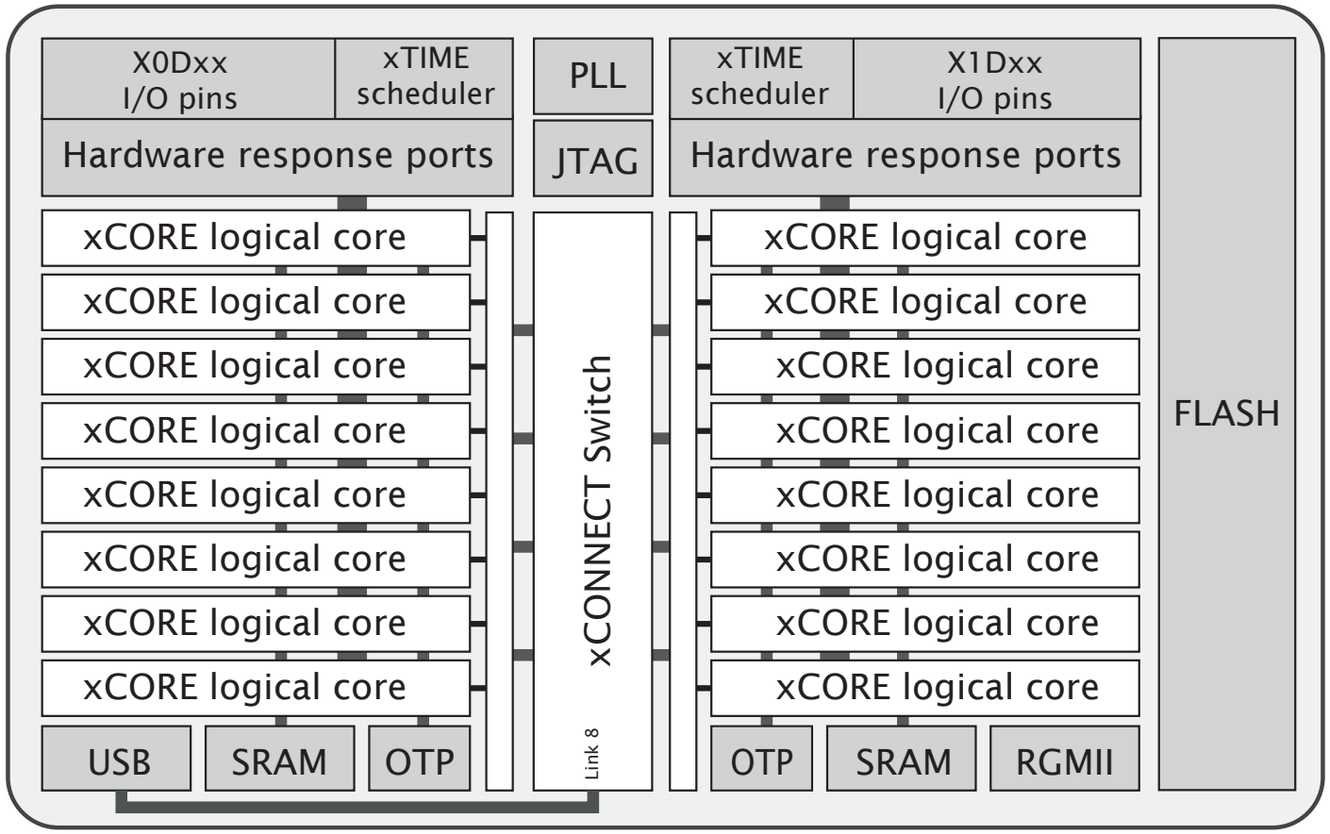
  - Deterministic thread execution
  - Thread safe
  - pragma for some deadlines
- Channels: untyped. Synch or asynch
  - XC `chanends` (32 per tile)
  - Not between tasks on the same core
- XC `interface` (typed and role/session)
  - *May* use `chanends` or locks or sharing of `select` or context (blocks of state data)

MY XCORE-200 EXPLORERKIT BOARDS' PROCESSOR



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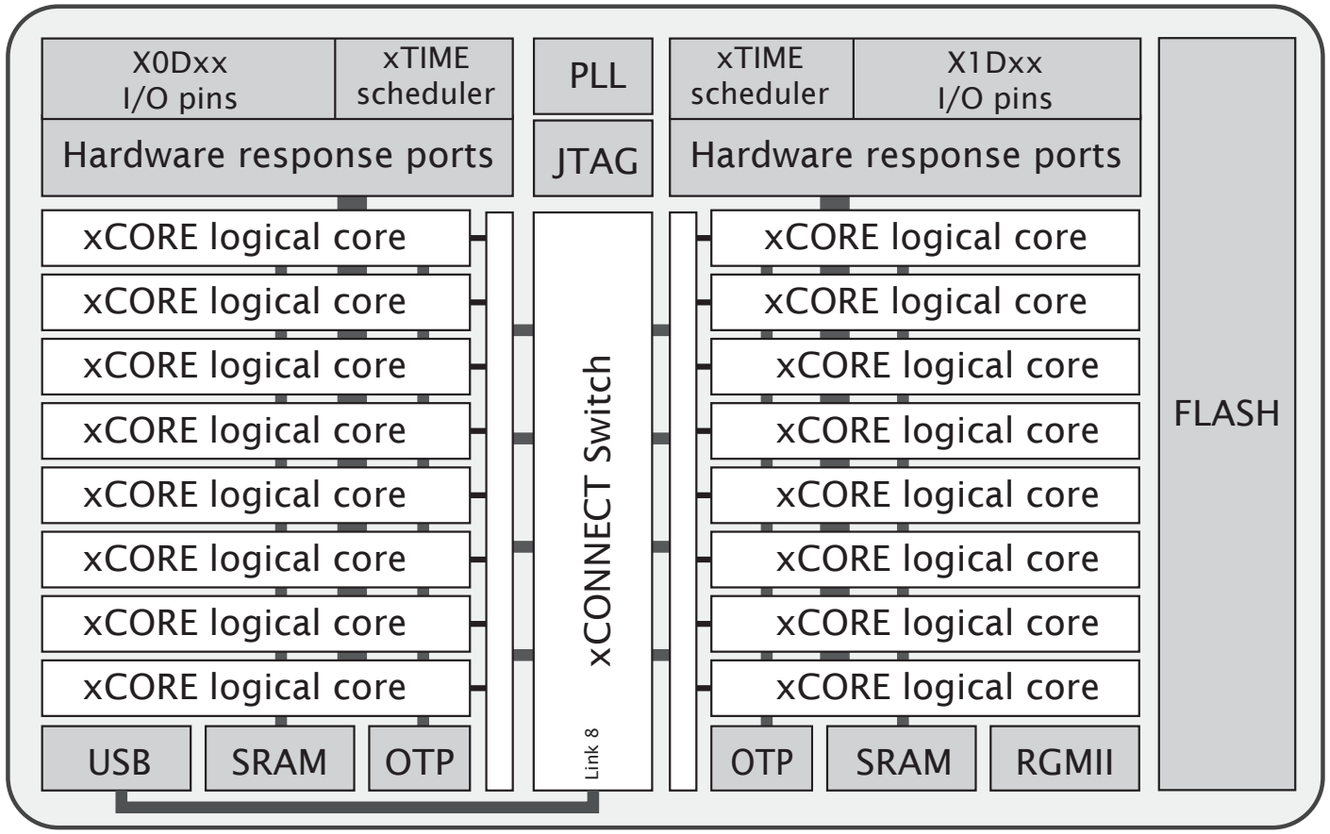
  - Thread safe
  - pragma for some deadlines
- Channels: untyped. Synch or asynch
  - XC `chanends` (32 per tile)
  - Not between tasks on the same core
- XC `interface` (typed and role/session)
  - *May* use `chanends` or locks or sharing of `select` or context (blocks of state data)
- Shared memory & no data bus contention
  - No cache
  - No DMA
  - I/O does not use memory bus

MY XCORE-200 EXPLORERKIT BOARDS' PROCESSOR



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  - Thread safe
  - pragma for some deadlines
- Channels: untyped. Synch or asynch
  - XC `chanends` (32 per tile)
  - Not between tasks on the same core
- XC `interface` (typed and role/session)
  - *May* use `chanends` or locks or sharing of `select` or context (blocks of state data)
- Shared memory & no data bus contention
  - No cache
  - No DMA
  - I/O does not use memory bus
- Also supported/used by XC
  - Locks (4 per tile). Runtime
  - I/O ports
  - Clock blocks (6 per tile)
  - Timers (10 pr tile)

XC real life @ Aquarium controller
On XMOS startKIT (I have several, after eol reached)

XC real life @ Aquarium controller
On XMOS startKIT (I have several, after eol reached)

```
int main() {
    ...  chan and interfaces

    chan c_analogue; // chans always untyped

    // interfaces:
    button_if                    i_buttons[BUTTONS_NUM_CLIENTS];
    spi_master_if                i_spi    [NUM_SPI_CLIENT_USERS];
    radio_if_t                   i_radio;
    irq_if_t                     i_irq;
    i2c_external_commands_if     i_i2c_external_commands [I2C_EXTERNAL_NUM_CLIENTS];
    i2c_internal_commands_if     i_i2c_internal_commands [I2C_INTERNAL_NUM_CLIENTS];
    startkit_adc_acquire_if      i_startkit_adc_acquire;
    lib_startkit_adc_commands_if i_lib_startkit_adc_commands  [ADC_STARTKIT_NUM_CLIENTS];
    port_heat_light_commands_if  i_port_heat_light_commands   [PORT_HEAT_LIGHT_SERVER_NUM_CLIENTS];
    temperature_heater_commands_if i_temperature_heater_commands[HEATER_CONTROLLER_NUM_CLIENTS];
    temperature_water_commands_if  i_temperature_water_commands;
    par {
        ... Placement of tasks
    }
    return 0;
}
```

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```
int main() {
    ...  chan and interfaces

    chan c_analogue; // chans always untyped

    // interfaces:
    button_if                    i_buttons[BUTTONS_NUM_CLIENTS];
    spi_master_if                i_spi    [NUM_SPI_CLIENT_USERS];
    radio_if_t                   i_radio;
    irq_if_t                     i_irq;
    i2c_external_commands_if     i_i2c_external_commands [I2C_EXTERNAL_NUM_CLIENTS];
    i2c_internal_commands_if     i_i2c_internal_commands [I2C_INTERNAL_NUM_CLIENTS];
    startkit_adc_acquire_if      i_startkit_adc_acquire;
    lib_startkit_adc_commands_if i_lib_startkit_adc_commands  [ADC_STARTKIT_NUM_CLIENTS];
    port_heat_light_commands_if  i_port_heat_light_commands   [PORT_HEAT_LIGHT_SERVER_NUM_CLIENTS];
    temperature_heater_commands_if i_temperature_heater_commands[HEATER_CONTROLLER_NUM_CLIENTS];
    temperature_water_commands_if  i_temperature_water_commands;
    par {
        ... Placement of tasks
    }
    return 0;
}
```

EXPERIMENT AND LEARN
mostly about XC but also
slalom with the compiler/mapper/linker

XC real life @ Aquarium controller
On XMOS startKIT (I have several, after eol reached)

```
int main() {
    ...  chan and interfaces
    par {
        on tile[0]: installExceptionHandler();
        par {
                        startkit_adc         (c_analogue);                                          // Is none since a "service"/hardware
            on tile[0]: My_startKIT_ADC_Task (i_startkit_adc_acquire, i_lib_startkit_adc_commands,   // Is none since contains a nested select
                                              NUM_STARTKIT_ADC_NEEDED_DATA_SETS);
            on tile[0]: System_Task          (i_i2c_internal_commands[0], i_i2c_external_commands[0], // Is none since contains a nested select
                                              i_lib_startkit_adc_commands[0], i_port_heat_light_commands[0],
                                              i_temperature_heater_commands[0], i_temperature_water_commands,
            /* tile[0].core[0] not now */     i_buttons, i_irq, i_radio);
            on tile[0]: adc_task             (i_startkit_adc_acquire, c_analogue,                   // [[combinable]]
                                              ADC_PERIOD_TIME_USEC_ZERO_IS_ONY_QUERY_BASED);
        }
        on tile[0]: {
            [[combine]]
            par {
                Button_Task (IOF_BUTTON_LEFT,   inP_button_left,   i_buttons[IOF_BUTTON_LEFT]);   // [[combinable]]
                Button_Task (IOF_BUTTON_CENTER, inP_button_center, i_buttons[IOF_BUTTON_CENTER]); // [[combinable]]
                Button_Task (IOF_BUTTON_RIGHT,  inP_button_right,  i_buttons[IOF_BUTTON_RIGHT]);  // [[combinable]]
            }
        }
        on tile[0]: {
            [[combine]]
            par {
                I2C_Internal_Task         (i_i2c_internal_commands);      // [[combinable]]
                I2C_External_Task         (i_i2c_external_commands);      // [[distributable]]
                Temperature_Heater_Task   (i_temperature_heater_commands, // [[combinable]]
                                           i_i2c_external_commands[1],
                                           i_port_heat_light_commands[1]);
                Temperature_Water_Task    (i_temperature_water_commands,  // [[combinable]]
                                           i_temperature_heater_commands[1]);
                Port_Pins_Heat_Light_Task (i_port_heat_light_commands);   // [[combinable]]
            }
        }
        on tile[0]: { // To avoid Error: lower bound could not be calculated (xTIMEcomposer 14.3.3)
            [[combine]]
            par {
                RFM69_driver    (i_radio, p_spi_aux, i_spi[SPI_CLIENT_0], SPI_CLIENT_0);             // [[distributable]]
                spi_master_2    (i_spi, NUM_SPI_CLIENT_USERS, p_sclk, p_mosi, p_miso,                // [[distributable]]
                                 SPI_CLOCK, p_spi_cs_en, maskof_spi_and_probe_pins, NUM_SPI_CS_SETS);
                IRQ_detect_task (i_irq, p_spi_irq, probe_config, null, 0);                           // [[combinable]]
            }
        }
    }
    return 0;
}
```

XC real life @ Aquarium controller
On XMOS startKIT (I have several, after eol reached)

```
int main() {
    ...  chan and interfaces
    par {
        on tile[0]: installExceptionHandler();
        par {
                        startkit_adc         (c_analogue);                                          // Is none since a "service"/hardware
            on tile[0]: My_startKIT_ADC_Task (i_startkit_adc_acquire, i_lib_startkit_adc_commands,   // Is none since contains a nested select
                                              NUM_STARTKIT_ADC_NEEDED_DATA_SETS);
            on tile[0]: System_Task          (i_i2c_internal_commands[0], i_i2c_external_commands[0], // Is none since contains a nested select
                                              i_lib_startkit_adc_commands[0], i_port_heat_light_commands[0],
                                              i_temperature_heater_commands[0], i_temperature_water_commands,
            /* tile[0].core[0] not now */     i_buttons, i_irq, i_radio);
            on tile[0]: adc_task             (i_startkit_adc_acquire, c_analogue,                   // [[combinable]]
                                              ADC_PERIOD_TIME_USEC_ZERO_IS_ONY_QUERY_BASED);
        }
        on tile[0]: {
            [[combine]]
            par {
                Button_Task (IOF_BUTTON_LEFT,   inP_button_left,   i_buttons[IOF_BUTTON_LEFT]);   // [[combinable]]
                Button_Task (IOF_BUTTON_CENTER, inP_button_center, i_buttons[IOF_BUTTON_CENTER]); // [[combinable]]
                Button_Task (IOF_BUTTON_RIGHT,  inP_button_right,  i_buttons[IOF_BUTTON_RIGHT]);  // [[combinable]]
            }
        }
        on tile[0]: {
            [[combine]]
            par {
                I2C_Internal_Task         (i_i2c_internal_commands);      // [[combinable]]
                I2C_External_Task         (i_i2c_external_commands);      // [[distributable]]
                Temperature_Heater_Task   (i_temperature_heater_commands, // [[combinable]]
                                           i_i2c_external_commands[1],
                                           i_port_heat_light_commands[1]);
                Temperature_Water_Task    (i_temperature_water_commands,  // [[combinable]]
                                           i_temperature_heater_commands[1]);
                Port_Pins_Heat_Light_Task (i_port_heat_light_commands);   // [[combinable]]
            }
        }
        on tile[0]: { // To avoid Error: lower bound could not be calculated (xTIMEcomposer 14.3.3)
            [[combine]]
            par {
                RFM69_driver    (i_radio, p_spi_aux, i_spi[SPI_CLIENT_0], SPI_CLIENT_0);             // [[distributable]]
                spi_master_2    (i_spi, NUM_SPI_CLIENT_USERS, p_sclk, p_mosi, p_miso,                // [[distributable]]
                                 SPI_CLOCK, p_spi_cs_en, maskof_spi_and_probe_pins, NUM_SPI_CS_SETS);
                IRQ_detect_task (i_irq, p_spi_irq, probe_config, null, 0);                           // [[combinable]]
            }
        }
    }
    return 0;
}
```

```
Constraint check for tile[0]:
  Cores available:            8,   used:          7 .  OKAY
  Timers available:          10,   used:          8 .  OKAY
  Chanends available:        32,   used:         26 .  OKAY
  Memory available:       65536,   used:      61620 .  OKAY
    (Stack: 6472, Code: 49386, Data: 5762)
Constraints checks PASSED.
```

XC real life @ Aquarium controller
On XMOS startKIT (I have several, after eol reached)

```
int main() {
    ...  chan and interfaces
    par {
        on tile[0]: installExceptionHandler();
        par {
                        startkit_adc         (c_analogue);                                          // Is none since a "service"/hardware
            on tile[0]: My_startKIT_ADC_Task (i_startkit_adc_acquire, i_lib_startkit_adc_commands,   // Is none since contains a nested select
                                              NUM_STARTKIT_ADC_NEEDED_DATA_SETS);
            on tile[0]: System_Task          (i_i2c_internal_commands[0], i_i2c_external_commands[0], // Is none since contains a nested select
                                              i_lib_startkit_adc_commands[0], i_port_heat_light_commands[0],
                                              i_temperature_heater_commands[0], i_temperature_water_commands,
            /* tile[0].core[0] not now */     i_buttons, i_irq, i_radio);
            on tile[0]: adc_task             (i_startkit_adc_acquire, c_analogue,                   // [[combinable]]
                                              ADC_PERIOD_TIME_USEC_ZERO_IS_ONY_QUERY_BASED);
        }
        on tile[0]: {
            [[combine]]
            par {
                Button_Task (IOF_BUTTON_LEFT,   inP_button_left,   i_buttons[IOF_BUTTON_LEFT]);   // [[combinable]]
                Button_Task (IOF_BUTTON_CENTER, inP_button_center, i_buttons[IOF_BUTTON_CENTER]); // [[combinable]]
                Button_Task (IOF_BUTTON_RIGHT,  inP_button_right,  i_buttons[IOF_BUTTON_RIGHT]);  // [[combinable]]
            }
        }
        on tile[0]: {
            [[combine]]
            par {
                I2C_Internal_Task         (i_i2c_internal_commands);      // [[combinable]]
                I2C_External_Task         (i_i2c_external_commands);      // [[distributable]]
                Temperature_Heater_Task   (i_temperature_heater_commands, // [[combinable]]
                                           i_i2c_external_commands[1],
                                           i_port_heat_light_commands[1]);
                Temperature_Water_Task    (i_temperature_water_commands,  // [[combinable]]
                                           i_temperature_heater_commands[1]);
                Port_Pins_Heat_Light_Task (i_port_heat_light_commands);   // [[combinable]]
            }
        }
        on tile[0]: { // To avoid Error: lower bound could not be calculated (xTIMEcomposer 14.3.3)
            [[combine]]
            par {
                RFM69_driver    (i_radio, p_spi_aux, i_spi[SPI_CLIENT_0], SPI_CLIENT_0);             // [[distributable]]
                spi_master_2    (i_spi, NUM_SPI_CLIENT_USERS, p_sclk, p_mosi, p_miso,                // [[distributable]]
                                 SPI_CLOCK, p_spi_cs_en, maskof_spi_and_probe_pins, NUM_SPI_CS_SETS);
                IRQ_detect_task (i_irq, p_spi_irq, probe_config, null, 0);                           // [[combinable]]
            }
        }
    }
    return 0;
}
```

```
...  chan and interfaces
   // interfaces:
   button_if                     i_buttons[3];
   spi_master_if                 i_spi    [1];
   radio_if_t                    i_radio;
   irq_if_t                      i_irq;
   i2c_external_commands_if      i_i2c_external_commands [2];
   i2c_internal_commands_if      i_i2c_internal_commands [1];
   startkit_adc_acquire_if       i_startkit_adc_acquire;
   lib_startkit_adc_commands_if  i_lib_startkit_adc_commands  [1];
   port_heat_light_commands_if   i_port_heat_light_commands   [2];
   temperature_heater_commands_if i_temperature_heater_commands[2];
   temperature_water_commands_if  i_temperature_water_commands;
```

```
Constraint check for tile[0]:
  Cores available:            8,   used:          7 .  OKAY
  Timers available:          10,   used:          8 .  OKAY
  Chanends available:        32,   used:         26 .  OKAY
  Memory available:       65536,   used:      61620 .  OKAY
    (Stack: 6472, Code: 49386, Data: 5762)
Constraints checks PASSED.
```

- Common term for `[[combine]]`, `[[combinable]]`, `[[distribute]]`, `[[distributable]]` and `[[distributed(..)]]` does not seem to exist

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- Not all shown here. More on «XC is C plus X»

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- `chan` and `interface` code compared side by side (next page, small text, just for reference) (It also shows where the tool fails for some usages)

- Common term for `[[combine]]`, `[[combinable]]`, `[[distribute]]`, `[[distributable]]` and `[[distributed(..)]]` does not seem to exist
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- `chan` and `interface` code compared side by side (next page, small text, just for reference) (It also shows where the tool fails for some usages)
- The XC reference I use the most[1]

[1] **XMOS Programming Guide**
as of 14Aug2018: 2015/9/21 version F, 2015/9/18 in the document,
https://www.xmos.com/published/xmos-programming-guide

- Common term for `[[combine]]`, `[[combinable]]`, `[[distribute]]`, `[[distributable]]` and `[[distributed(..)]]` does not seem to exist
- Not all shown here. More on «XC is C plus X»
- `chan` and `interface` code compared side by side (next page, small text, just for reference) (It also shows where the tool fails for some usages)
- The XC reference I use the most[1]
- Plus the XCORE Exchange community forum[2]

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[1] **XMOS Programming Guide**
as of 14Aug2018: 2015/9/21 version F, 2015/9/18 in the document,
https://www.xmos.com/published/xmos-programming-guide

[2] https://www.xcore.com

chan

interface

XC code, see http://www.teigfam.net/oyvind/home/technology/141-xc-is-c-plus-x/

XC is C plus X, The combined code: 6 to zero channels by Øyvind Teig (6Jul2018)

```
#if defined TEST_CHAN_AND_COMBINE_TEST

    #include <platform.h>
    #include <stdio.h>
    #include <timer.h> // XS1_TIMER_HZ etc

    #define DEBUG_PRINT_TEST 0
    #if (DEBUG_PRINT_TEST == 1)
        // Uses 1 timer and one chanend (not counted below)
        #define debug_print(fmt, ...) do \
            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
    #else
        #define debug_print(fmt, ...)
    #endif
```

chan

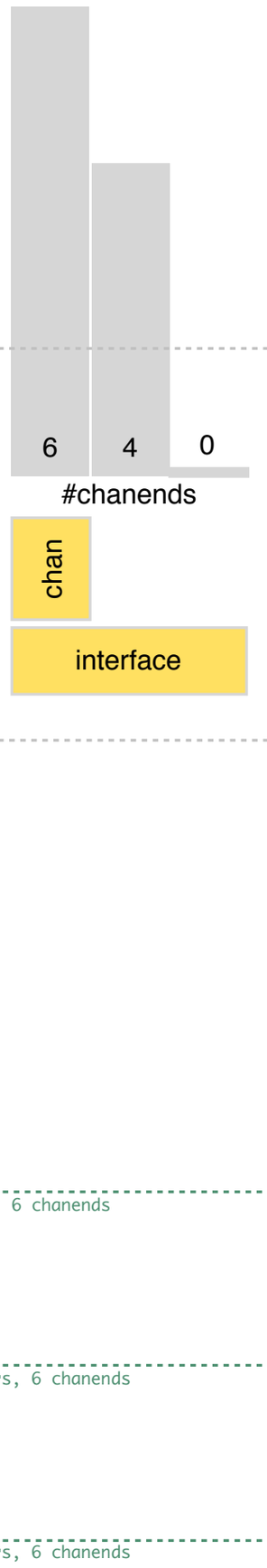
```
    [[combinable]]
    void button (chanend c_out) {
        timer t;
        int s;
        t :> s;
        while (1) {
            select {
                case t when timerafter(s) :> void: {
                    c_out <: (s/XS1_TIMER_KHZ); // ms
                    s += XS1_TIMER_HZ;
                    break;
                }
            }
        }
    }
```

```
    [[combinable]]
    void handle (chanend c_but[3]) {
        int val;
        while (1) {
            select {
                case c_but[int i] :> val: {
                    debug_print ("handle: from %d val %u\n", i, val);
                    break;
                }
            }
        }
    }

    #define DO_PLACED 1 // 1-4 works

    int main (void) {
        chan c_but[3]; // Using 6 chanends always
        par {
            #if (DO_PLACED == 1) // Works, also with interface. Uses 4 cores, 4 timers, 6 chanends
                on tile[0].core[0]: handle (c_but);
                par {
                    on tile[0].core[2]: button (c_but[0]);
                    on tile[0].core[3]: button (c_but[1]);
                    on tile[0].core[4]: button (c_but[2]);
                }
            #elif (DO_PLACED == 2) // Works, also with interface. Uses 2 cores, 2 timers, 6 chanends
                on tile[0].core[0]: handle (c_but);
                par {
                    on tile[0].core[1]: button (c_but[0]);
                    on tile[0].core[1]: button (c_but[1]);
                    on tile[0].core[1]: button (c_but[2]);
                }
            #elif (DO_PLACED == 3) // Works, also with interface. Uses 4 cores, 4 timers, 6 chanends
```

chan



interface

XC code, see http://www.teigfam.net/oyvind/home/technology/141-xc-is-c-plus-x/

XC is C plus X, The combined code: 6 to zero channels by Øyvind Teig (6Jul2018)

```
#if defined TEST_CHAN_AND_COMBINE_TEST

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    #define DEBUG_PRINT_TEST 0
    #if (DEBUG_PRINT_TEST == 1)
        // Uses 1 timer and one chanend (not counted below)
        #define debug_print(fmt, ...) do \
            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
    #else
        #define debug_print(fmt, ...)
    #endif
```

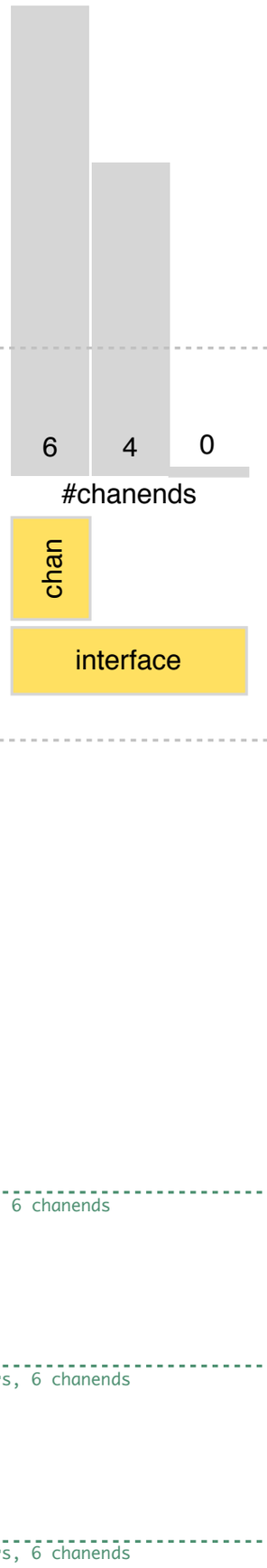
chan

```
    [[combinable]]
    void button (chanend c_out) {
       timer t;
       int s;
       t :> s;
       while (1) {
           select {
               case t when timerafter(s) :> void: {
                   c_out <: (s/XS1_TIMER_KHZ); // ms
                   s += XS1_TIMER_HZ;
                   break;
               }
           }
       }
    }

    [[combinable]]
    void handle (chanend c_but[3]) {
        int val;
        while (1) {
            select {
                case c_but[int i] :> val: {
                    debug_print ("handle: from %d val %u\n", i, val);
                    break;
                }
            }
        }
    }

    #define DO_PLACED 1 // 1-4 works

    int main (void) {
        chan c_but[3]; // Using 6 chanends always
        par {
            #if (DO_PLACED == 1) // Works, also with interface. Uses 4 cores, 4 timers, 6 chanends
                on tile[0].core[0]: handle (c_but);
                par {
                    on tile[0].core[2]: button (c_but[0]);
                    on tile[0].core[3]: button (c_but[1]);
                    on tile[0].core[4]: button (c_but[2]);
                }
            #elif (DO_PLACED == 2) // Works, also with interface. Uses 2 cores, 2 timers, 6 chanends
                on tile[0].core[0]: handle (c_but);
                par {
                    on tile[0].core[1]: button (c_but[0]);
                    on tile[0].core[1]: button (c_but[1]);
                    on tile[0].core[1]: button (c_but[2]);
                }
            #elif (DO_PLACED == 3) // Works, also with interface. Uses 4 cores, 4 timers, 6 chanends
```




```
#elif defined TEST_INTERFACE_AND_COMBINE_TEST

    #include <platform.h>
    #include <stdio.h>
    #include <timer.h> // XS1_TIMER_HZ etc

    #define DEBUG_PRINT_TEST 1
    #if (DEBUG_PRINT_TEST == 1)
        // Uses 1 timer and one chanend (not counted below)
        #define debug_print(fmt, ...) do \
            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
    #else
        #define debug_print(fmt, ...)
    #endif
```

interface

```
    interface ifa {
        void but (int x);
    };

    [[combinable]]
    void button (client interface ifa i_but) {
       timer t;
       int s;
       t :> s;
       while (1) {
           select {
               case t when timerafter(s) :> void: {
                   i_but.but(s/XS1_TIMER_KHZ); // ms
                   s += XS1_TIMER_HZ;
                   break;
               }
           }
       }
    }

    [[combinable]]
    void handle (server interface ifa i_but[3]) {
        while (1) {
            select {
                case i_but[int i].but (int val) : {
                    debug_print ("handle: from %d val %u\n", i, val);
                    break;
                }
            }
        }
    }

    #define DO_PLACED 6 // 1-6 works

    int main (void) {
        interface ifa i_but[3]; // 6 to zero chanends
        par {
            #if (DO_PLACED == 1) // Works, also with chan. Uses 4 cores, 4 timers, 6 chanends
                on tile[0].core[0]: handle (i_but);
                par {
                    on tile[0].core[2]: button (i_but[0]);
                    on tile[0].core[3]: button (i_but[1]);
                    on tile[0].core[4]: button (i_but[2]);
                }
            #elif (DO_PLACED == 2) // Works, also with chan. Uses 2 cores, 2 timers, 4 chanends
                on tile[0].core[0]: handle (i_but);
                par {
                    on tile[0].core[1]: button (i_but[0]);
                    on tile[0].core[1]: button (i_but[1]);
                    on tile[0].core[1]: button (i_but[2]);
                }
            #elif (DO_PLACED == 3) // Works, also with chan. Uses 4 cores, 4 timers, 6 chanends
```

interface

XC code, see http://www.teigfam.net/oyvind/home/technology/141-xc-is-c-plus-x/

XC is C plus X, The combined code: 6 to zero channels by Øyvind Teig (6Jul2018)

```
#if defined TEST_CHAN_AND_COMBINE_TEST

    #include <platform.h>
    #include <stdio.h>
    #include <timer.h> // XS1_TIMER_HZ etc

    #define DEBUG_PRINT_TEST 0
    #if (DEBUG_PRINT_TEST == 1)
        // Uses 1 timer and one chanend (not counted below)
        #define debug_print(fmt, ...) do \
            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
    #else
        #define debug_print(fmt, ...)
    #endif
```

chan

```
    [[combinable]]
    void button (chanend c_out) {
       timer t;
       int s;
       t :> s;
       while (1) {
           select {
               case t when timerafter(s) :> void: {
                   c_out <: (s/XS1_TIMER_KHZ); // ms
                   s += XS1_TIMER_HZ;
                   break;
               }
           }
       }
    }
```

```
    [[combinable]]
    void handle (chanend c_but[3]) {
        int val;
        while (1) {
            select {
                case c_but[int i] :> val: {
                    debug_print ("handle: from %d val %u\n", i, val);
                    break;
                }
            }
        }
    }

    #define DO_PLACED 1 // 1-4 works

    int main (void) {
        chan c_but[3]; // Using 6 chanends always
        par {
            #if (DO_PLACED == 1) // Works, also with interface. Uses 4 cores, 4 timers, 6 chanends
                on tile[0].core[0]: handle (c_but);
                par {
                    on tile[0].core[2]: button (c_but[0]);
                    on tile[0].core[3]: button (c_but[1]);
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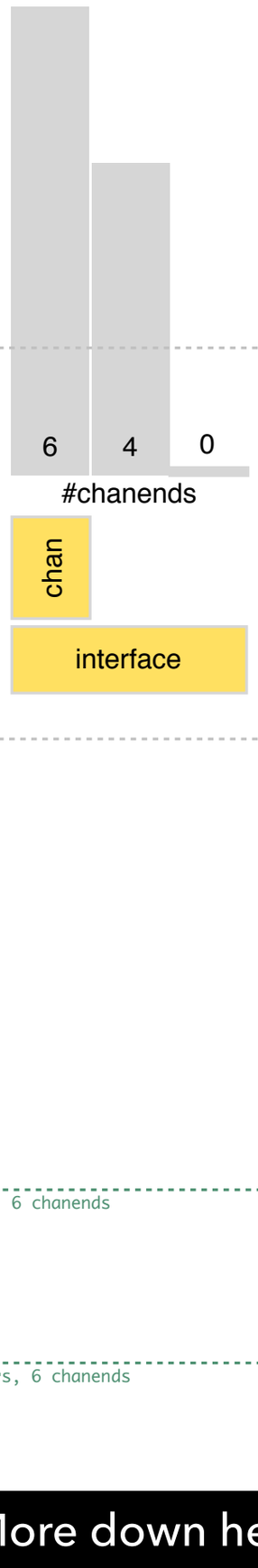
                }
            #elif (DO_PLACED == 2) // Works, also with interface. Uses 2 cores, 2 timers, 6 chanends
                on tile[0].core[0]: handle (c_but);
                par {
                    on tile[0].core[1]: button (c_but[0]);
                    on tile[0].core[1]: button (c_but[1]);
                    on tile[0].core[1]: button (c_but[2]);
                }
            #elif (DO_PLACED == 3) // Works, also with interface. Uses 4 cores, 4 t
```




```
#elif defined TEST_INTERFACE_AND_COMBINE_TEST

    #include <platform.h>
    #include <stdio.h>
    #include <timer.h> // XS1_TIMER_HZ etc

    #define DEBUG_PRINT_TEST 1
    #if (DEBUG_PRINT_TEST == 1)
        // Uses 1 timer and one chanend (not counted below)
        #define debug_print(fmt, ...) do \
            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
    #else
        #define debug_print(fmt, ...)
    #endif
```

interface

```
    interface ifa {
        void but (int x);
    };
```

```
    [[combinable]]
    void button (client interface ifa i_but) {
       timer t;
       int s;
       t :> s;
       while (1) {
           select {
               case t when timerafter(s) :> void: {
                   i_but.but(s/XS1_TIMER_KHZ); // ms
                   s += XS1_TIMER_HZ;
                   break;
               }
           }
       }
    }
```

```
    [[combinable]]
    void handle (server interface ifa i_but[3]) {
        while (1) {
            select {
                case i_but[int i].but (int val) : {
                    debug_print ("handle: from %d val %u\n", i, val);
                    break;
                }
            }
        }
    }

    #define DO_PLACED 6 // 1-6 works

    int main (void) {
        interface ifa i_but[3]; // 6 to zero chanends
        par {
            #if (DO_PLACED == 1) // Works, also with chan. Uses 4 cores, 4 timers, 6 chanends
                on tile[0].core[0]: handle (i_but);
                par {
                    on tile[0].core[2]: button (i_but[0]);
                    on tile[0].core[3]: button (i_but[1]);
                    on tile[0].core[4]: button (i_but[2]);
                }
            #elif (DO_PLACED == 2) // Works, also with chan. Uses 2 cores, 2 timers, 4 chanends
                on tile[0].core[0]: handle (i_but);
                par {
                    on tile[0].core[1]: button (i_but[0]);
                    on tile[0].core[1]: button (i_but[1]);
                    on tile[0].core[1]: button (i_but[2]);
```

interface

More down here in blog note

```
            #elif (DO_PLACED == 3) // Works, also with chan. Uses 4 cores, 4 timers, 6 chanends
```

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    #include <platform.h>
    #include <stdio.h>
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    #define DEBUG_PRINT_TEST 0
    #if (DEBUG_PRINT_TEST == 1)
        // Uses 1 timer and one chanend (not counted below)
        #define debug_print(fmt, ...) do \
            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
    #else
        #define debug_print(fmt, ...)
    #endif
```

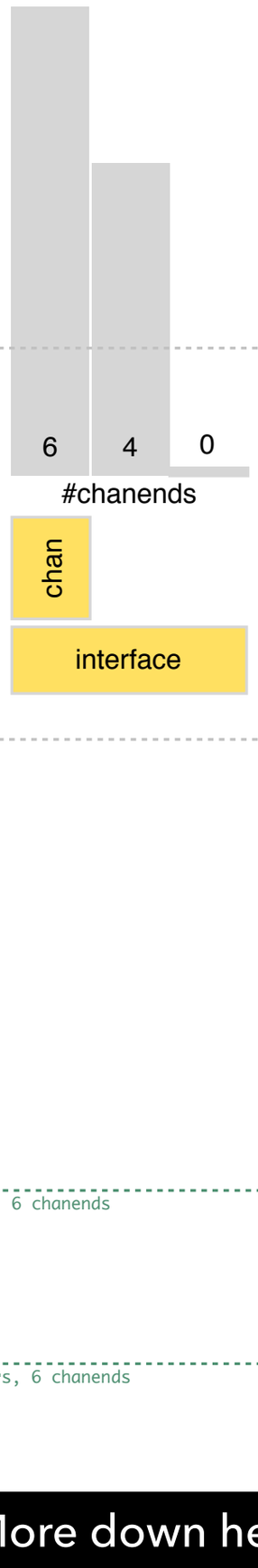
chan

```
    [[combinable]]
    void button (chanend c_out) {
        timer t;
        int s;
        t :> s;
        while (1) {
            select {
                case t when timerafter(s) :> void: {
                    c_out <: (s/XS1_TIMER_KHZ); // ms
                    s += XS1_TIMER_HZ;
                    break;
                }
            }
        }
```

```
[[combinable]]
void handle (chanend c_but[3]) {
    int val;
    while (1) {
        select {
            case c_but[int i] :> val: {
                debug_print ("handle: from %d val %u\n", i, val);
                break;
            }
        }
    }
}

#define DO_PLACED 1 // 1-4 works

int main (void) {
    chan c_but[3]; // Using 6 chanends always
    par {
        #if (DO_PLACED == 1) // Works, also with interface. Uses 4 cores, 4 timers, 6 chanends
            on tile[0].core[0]: handle (c_but);
            par {
                on tile[0].core[2]: button (c_but[0]);
                on tile[0].core[3]: button (c_but[1]);
                on tile[0].core[4]: button (c_but[2]);
            }
        #elif (DO_PLACED == 2) // Works, also with interface. Uses 2 cores, 2 timers, 6 chanends
            on tile[0].core[0]: handle (c_but);
            par {
                on tile[0].core[1]: button (c_but[0]);
                on tile[0].core[1]: button (c_but[1]);
                on tile[0].core[1]: button (c_but[2]);
            }
        #elif (DO_PLACED == 3) // Works, also with interface. Uses 4 cores, 4 t
```




```
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    #if (DEBUG_PRINT_TEST == 1)
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            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
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    #endif
```

interface

```
    interface ifa {
        void but (int x);
    };
```

```
    [[combinable]]
    void button (client interface ifa i_but) {
       timer t;
       int s;
       t :> s;
       while (1) {
           select {
               case t when timerafter(s) :> void: {
                   i_but.but(s/XS1_TIMER_KHZ); // ms
                   s += XS1_TIMER_HZ;
                   break;
               }
           }
       }
```

```
[[combinable]]
void handle (server interface ifa i_but[3]) {
    while (1) {
        select {
            case i_but[int i].but (int val) : {
                debug_print ("handle: from %d val %u\n", i, val);
                break;
            }
        }
    }
}

#define DO_PLACED 6 // 1-6 works


int main (void) {
    interface ifa i_but[3]; // 6 to zero chanends
    par {
        #if (DO_PLACED == 1) // Works, also with chan. Uses 4 cores, 4 timers, 6 chanends
            on tile[0].core[0]: handle (i_but);
            par {
                on tile[0].core[2]: button (i_but[0]);
                on tile[0].core[3]: button (i_but[1]);
                on tile[0].core[4]: button (i_but[2]);
            }
        #elif (DO_PLACED == 2) // Works, also with chan. Uses 2 cores, 2 timers, 4 chanends
            on tile[0].core[0]: handle (i_but);
            par {
                on tile[0].core[1]: button (i_but[0]);
                on tile[0].core[1]: button (i_but[1]);
                0].core[1]: button (i_but[2]);
```

interface

More down here in blog note

```
            == 3) // Works, also with chan. Uses 4 cores, 4 timers, 6 chanends
```

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XC is C plus X, The combined code: 6 to zero channels by Øyvind Teig (6Jul2018)

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    #define DEBUG_PRINT_TEST 0
    #if (DEBUG_PRINT_TEST == 1)
        // Uses 1 timer and one chanend (not counted below)
        #define debug_print(fmt, ...) do \
            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
    #else
        #define debug_print(fmt, ...)
    #endif
```

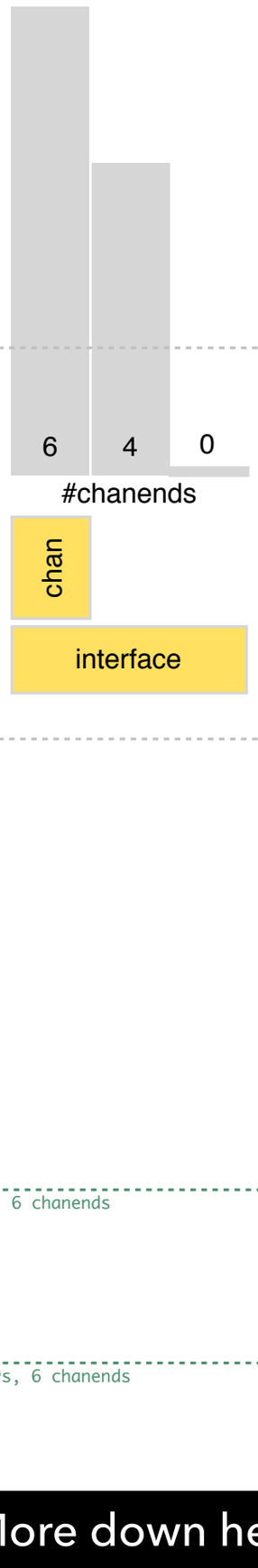
chan

```
    [[combinable]]
    void button (chanend c_out) {
       timer t;
       int s;
       t :> s;
       while (1) {
           select {
               case t when timerafter(s) :> void: {
                   c_out <: (s/XS1_TIMER_KHZ); // ms
                   s += XS1_TIMER_HZ;
                   break;
               }
           }
       }
    }
```

```
    [[combinable]]
    void handle (chanend c_but[3]) {
        int val;
        while (1) {
            select {
                case c_but[int i] :> val: {
                    debug_print ("handle: from %d val %u\n", i, val);
                    break;
                }
            }
        }
    }

    #define DO_PLACED 1 // 1-4 works

    int main (void) {
        chan c_but[3]; // Using 6 chanends always
        par {
            #if (DO_PLACED == 1) // Works, also with interface. Uses 4 cores, 4 timers, 6 chanends
                on tile[0].core[0]: handle (c_but);
                par {
                    on tile[0].core[2]: button (c_but[0]);
                    on tile[0].core[3]: button (c_but[1]);
                    on tile[0].core[4]: button (c_but[2]);
                }
            #elif (DO_PLACED == 2) // Works, also with interface. Uses 2 cores, 2 timers, 6 chanends
                on tile[0].core[0]: handle (c_but);
                par {
                    on tile[0].core[1]: button (c_but[0]);
                    on tile[0].core[1]: button (c_but[1]);
                    on tile[0].core[1]: button (c_but[2]);
                }
            #elif (DO_PLACED == 3) // Works, also with interface. Uses 4 cores, 4 t
```




```
#elif defined TEST_INTERFACE_AND_COMBINE_TEST

    #include <platform.h>
    #include <stdio.h>
    #include <timer.h> // XS1_TIMER_HZ etc

    #define DEBUG_PRINT_TEST 1
    #if (DEBUG_PRINT_TEST == 1)
        // Uses 1 timer and one chanend (not counted below)
        #define debug_print(fmt, ...) do \
            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
    #else
        #define debug_print(fmt, ...)
    #endif
```

interface

```
    interface ifa {
        void but (int x);
    };
```

```
    [[combinable]]
    void button (client interface ifa i_but) {
       timer t;
       int s;
       t :> s;
       while (1) {
           select {
               case t when timerafter(s) :> void: {
                   i_but.but(s/XS1_TIMER_KHZ); // ms
                   s += XS1_TIMER_HZ;
                   break;
               }
           }
       }
    }
```

```
    [[combinable]]
    void handle (server interface ifa i_but[3]) {
        while (1) {
            select {
                case i_but[int i].but (int val) : {
                    debug_print ("handle: from %d val %u\n", i, val);
                    break;
                }
            }
        }
    }

    #define DO_PLACED 6 // 1-6 works

    int main (void) {
        interface ifa i_but[3]; // 6 to zero chanends
        par {
            #if (DO_PLACED == 1) // Works, also with chan. Uses 4 cores, 4 timers, 6 chanends
                on tile[0].core[0]: handle (i_but);
                par {
                    on tile[0].core[2]: button (i_but[0]);
                    on tile[0].core[3]: button (i_but[1]);
                    on tile[0].core[4]: button (i_but[2]);
                }
            #elif (DO_PLACED == 2) // Works, also with chan. Uses 2 cores, 2 timers, 4 chanends
                on tile[0].core[0]: handle (i_but);
                par {
                    on tile[0].core[1]: button (i_but[0]);
                    on tile[0].core[1]: button (i_but[1]);
                    on tile[0].core[1]: button (i_but[2]);
```

interface

More down here in blog note

```
            == 3) // Works, also with chan. Uses 4 cores, 4 timers, 6 chanends
```

XC code, see http://www.teigfam.net/oyvind/home/technology/141-xc-is-c-plus-x/

XC is C plus X, The combined code: 6 to zero channels by Øyvind Teig (6Jul2018)

```
#if defined TEST_CHAN_AND_COMBINE_TEST

    #include <platform.h>
    #include <stdio.h>
    #include <timer.h> // XS1_TIMER_HZ etc

    #define DEBUG_PRINT_TEST 0
    #if (DEBUG_PRINT_TEST == 1)
        // Uses 1 timer and one chanend (not counted below)
        #define debug_print(fmt, ...) do \
            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
    #else
        #define debug_print(fmt, ...)
    #endif
```

chan

```
    [[combinable]]
    void button (chanend c_out) {
       timer t;
       int s;
       t :> s;
       while (1) {
           select {
               case t when timerafter(s) :> void: {
                   c_out <: (s/XS1_TIMER_KHZ); // ms
                   s += XS1_TIMER_HZ;
                   break;
               }
           }
       }
    }
```

```
    [[combinable]]
    void handle (chanend c_but[3]) {
        int val;
        while (1) {
            select {
                case c_but[int i] :> val: {
                    debug_print ("handle: from %d val %u\n", i, val);
                    break;
                }
            }
        }
    }

    #define DO_PLACED 1 // 1-4 works

    int main (void) {
        chan c_but[3]; // Using 6 chanends always
        par {
            #if (DO_PLACED == 1) // Works, also with interface. Uses 4 cores, 4 timers, 6 chanends
                on tile[0].core[0]: handle (c_but);
                par {
                    on tile[0].core[2]: button (c_but[0]);
                    on tile[0].core[3]: button (c_but[1]);
                    on tile[0].core[4]: button (c_but[2]);
                }
            #elif (DO_PLACED == 2) // Works, also with interface. Uses 2 cores, 2 timers, 6 chanends
                on tile[0].core[0]: handle (c_but);
                par {
                    on tile[0].core[1]: button (c_but[0]);
                    on tile[0].core[1]: button (c_but[1]);
                    on tile[0].core[1]: button (c_but[2]);
                }
            #elif (DO_PLACED == 3) // Works, also with interface. Uses 4 cores, 4 t
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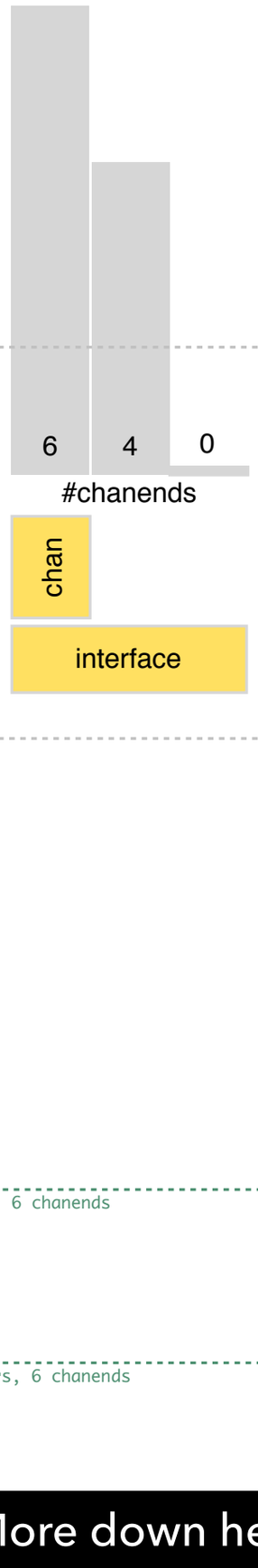


```
#elif defined TEST_INTERFACE_AND_COMBINE_TEST

    #include <platform.h>
    #include <stdio.h>
    #include <timer.h> // XS1_TIMER_HZ etc

    #define DEBUG_PRINT_TEST 1
    #if (DEBUG_PRINT_TEST == 1)
        // Uses 1 timer and one chanend (not counted below)
        #define debug_print(fmt, ...) do \
            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
    #else
        #define debug_print(fmt, ...)
    #endif
```

interface

```
    interface ifa {
        void but (int x);
    };
```

```
    [[combinable]]
    void button (client interface ifa i_but) {
       timer t;
       int s;
       t :> s;
       while (1) {
           select {
               case t when timerafter(s) :> void: {
                   i_but.but(s/XS1_TIMER_KHZ); // ms
                   s += XS1_TIMER_HZ;
                   break;
               }
           }
       }
    }
```

```
    [[combinable]]
    void handle (server interface ifa i_but[3]) {
        while (1) {
            select {
                case i_but[int i].but (int val) : {
                    debug_print ("handle: from %d val %u\n", i, val);
                    break;
                }
            }
        }
    }

    #define DO_PLACED 6 // 1-6 works

    int main (void) {
        interface ifa i_but[3]; // 6 to zero chanends
        par {
            #if (DO_PLACED == 1) // Works, also with chan. Uses 4 cores, 4 timers, 6 chanends
                on tile[0].core[0]: handle (i_but);
                par {
                    on tile[0].core[2]: button (i_but[0]);
                    on tile[0].core[3]: button (i_but[1]);
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            #elif (DO_PLACED == 2) // Works, also with chan. Uses 2 cores, 2 timers, 4 chanends
                on tile[0].core[0]: handle (i_but);
                par {
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interface

More down here in blog note

```
            == 3) // Works, also with chan. Uses 4 cores, 4 timers, 6 chanends
```

XC code, see http://www.teigfam.net/oyvind/home/technology/141-xc-is-c-plus-x/

XC is C plus X, The combined code: 6 to zero channels by Øyvind Teig (6Jul2018)

chan

```
#if defined TEST_CHAN_AND_COMBINE_TEST

    #include <platform.h>
    #include <stdio.h>
    #include <timer.h> // XS1_TIMER_HZ etc

    #define DEBUG_PRINT_TEST 0
    #if (DEBUG_PRINT_TEST == 1)
        // Uses 1 timer and one chanend (not counted below)
        #define debug_print(fmt, ...) do \
            { if(DEBUG_PRINT_TEST) printf(fmt, __VA_ARGS__); } while (0)
    #else
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    #endif
```

```
    [[combinable]]
    void button (chanend c_out) {
        timer t;
        int s;
        t :> s;
        while (1) {
            select {
                case t when timerafter(s) :> void: {
                    c_out <: (s/XS1_TIMER_KHZ); // ms
                    s += XS1_TIMER_HZ;
                    break;
                }
            }
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```
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void handle (chanend c_but[3]) {
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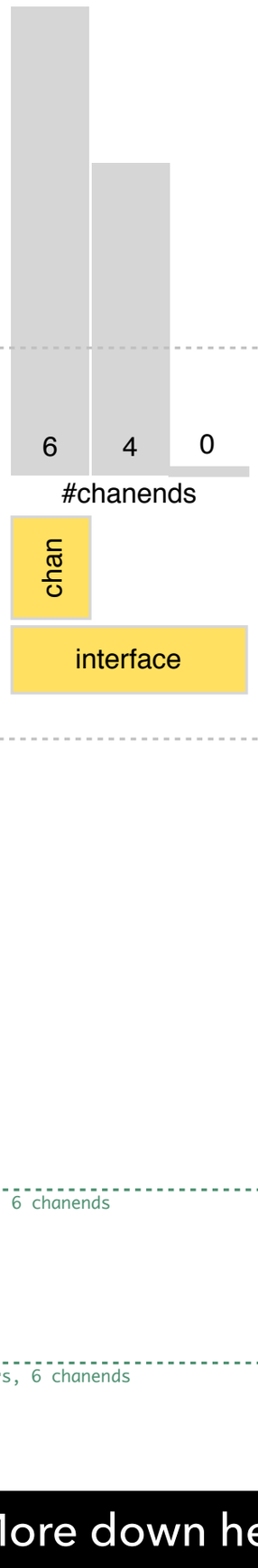

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- The linker runs, linking together the object code, and throwing away unused (non specialised) functions
- In an .s-file there would be duplicate content but with different boiler plating regarding how chanends and blocks of state data (holding chanends) are used

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Austrått manor

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  - Shared with full code and tasks for heat control, clock/calendar, day/night, soft light control, «cloud on the sky», display, buttons, I2C + SPI libraries and a radio client (`main` shown here)
- There probably is no electric motor inside the xCore machines. But to me it sounds like one!

Austrått manor

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Thank you!

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This and more at http://www.teigfam.net/oyvind/home/technology/175-cpa-2018-fringe/

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2 extra summary pages?

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Normal	Tasks run on a logical core and run independently to other tasks. The tasks have predictable running time and can respond very efficiently to external events.
Combinable	Combinable tasks can be combined to have several tasks running on the same logical core. The core swaps context based on cooperative multitasking between the tasks driven by the compiler.
Distributable	Distributable tasks can run over several cores, running when required by the tasks connected to them.

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