The Habanero CnC Framework: A Demonstration of CnC Unification

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Acknowledgements

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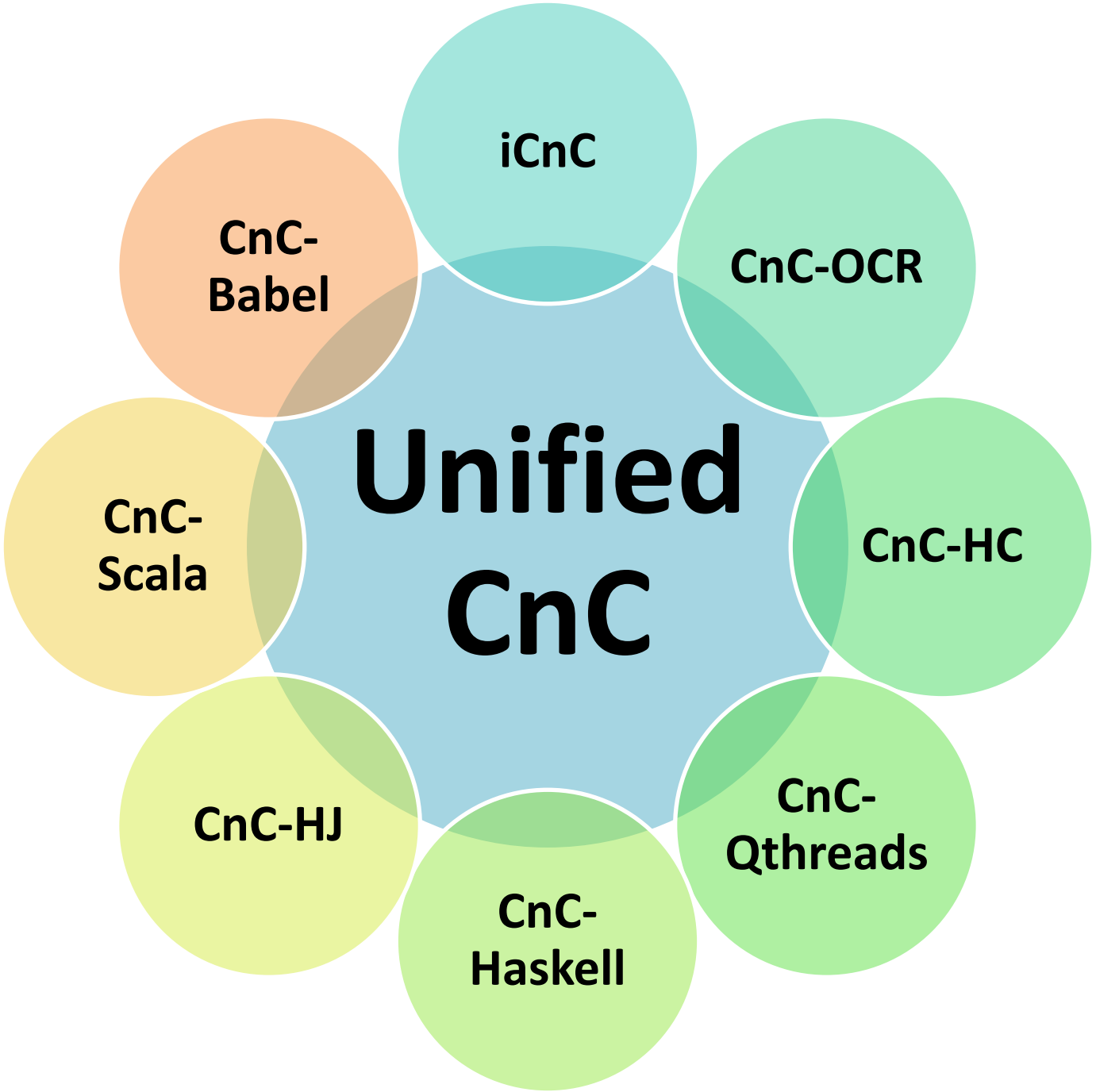
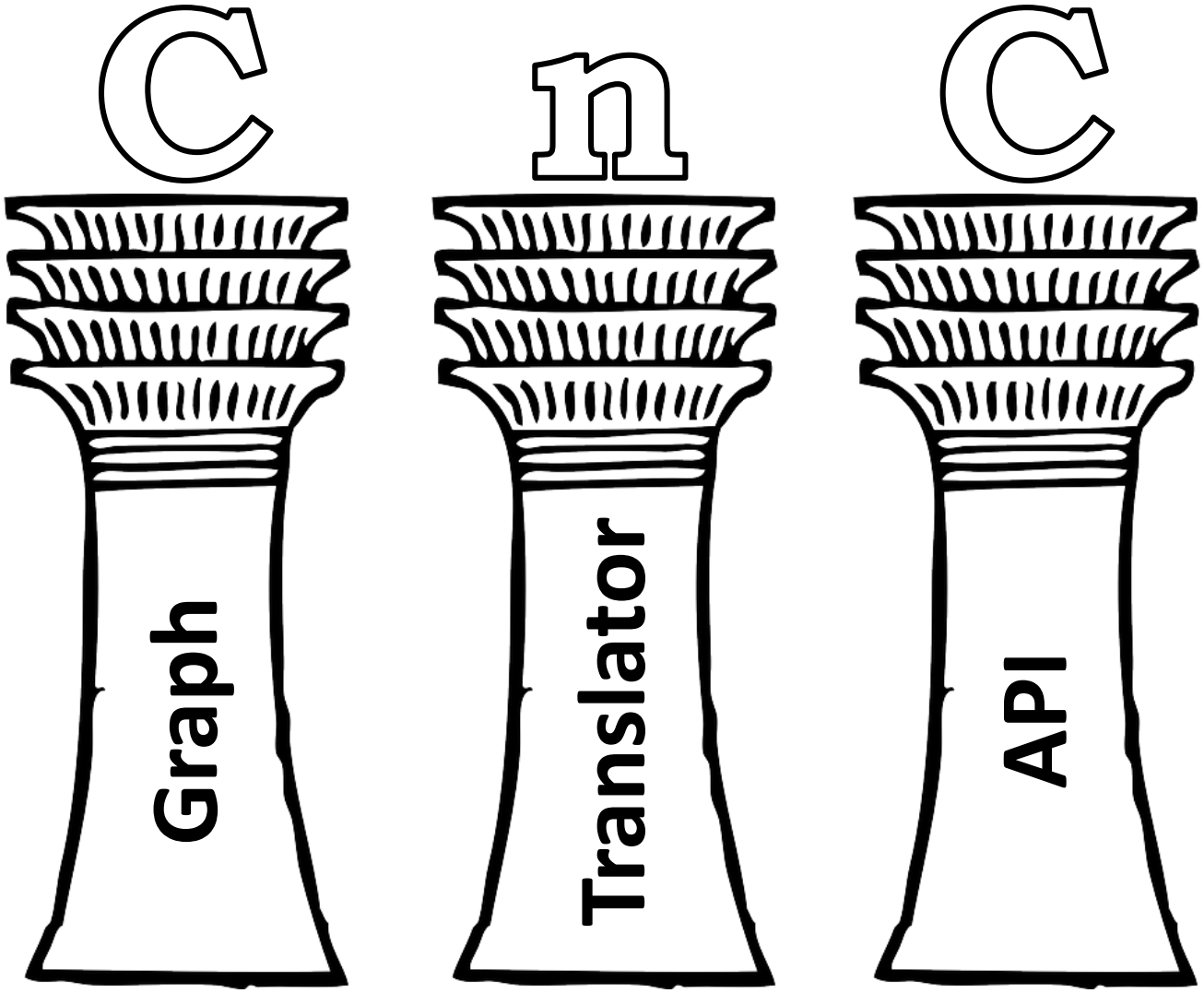
Frank Schlimbach, Kath Knobe, Zoran Budimlić, Alina Sbîrlea, Dragoş Sbîrlea, Gary Delp, and Ellen Porter.*

* I apologize if I left anyone out of this list!


iCnC
CnC-OCR
CnC-HC
CnC-Qthreads
CnC-Haskell
CnC-HJ
CnC-Scala
CnC-Babel
Unified CnC

Frank's 3 pillars of CnC unification



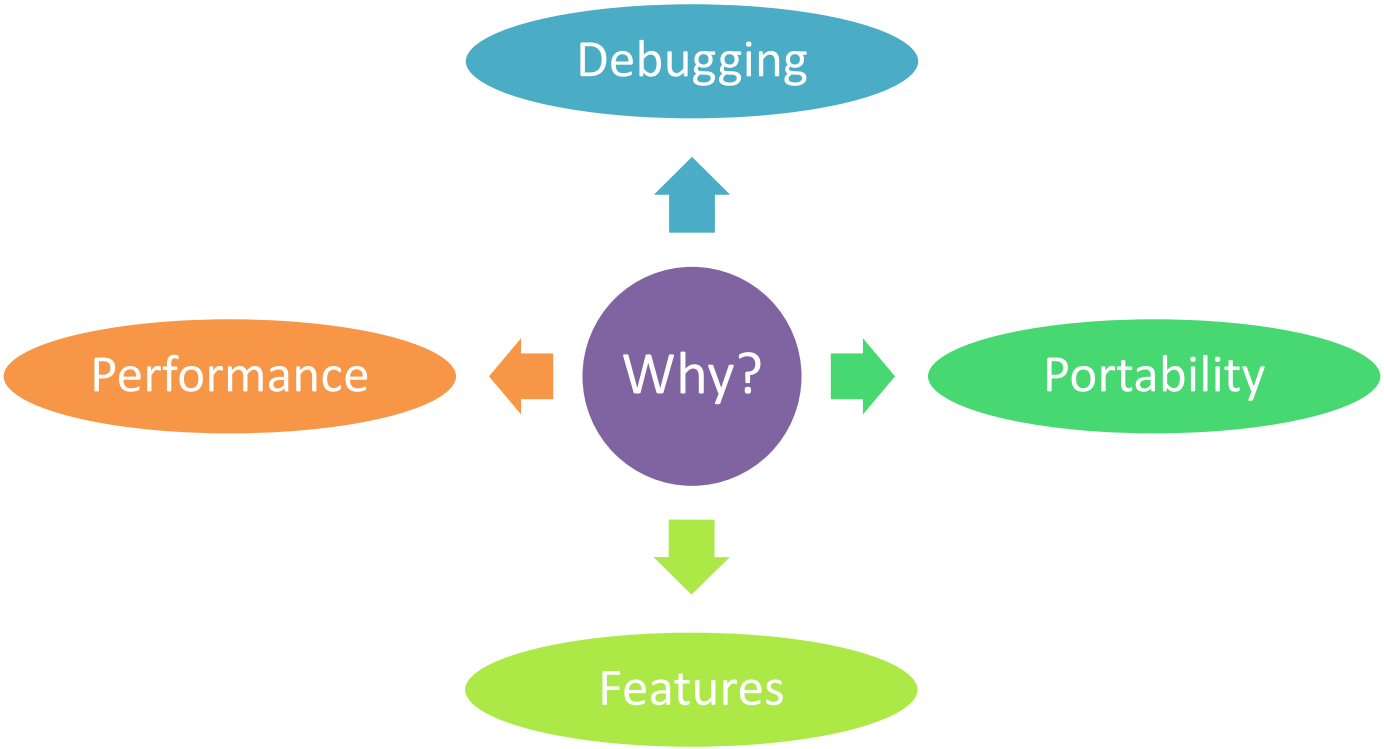
“Having a working demo does wonders for creating a consensus.”

Stephen Wong

(not an exact quote)

Nick's goal for unified CnC

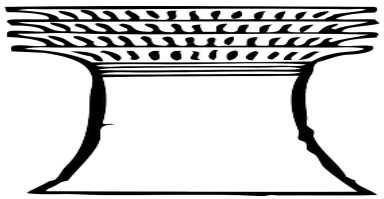
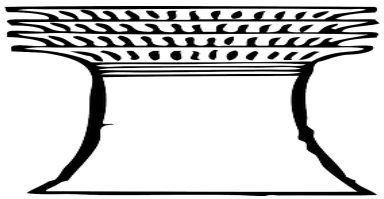
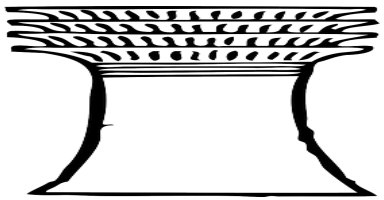
Run the same CnC app on both Intel CnC (MPI+TBB) and CnC-OCR



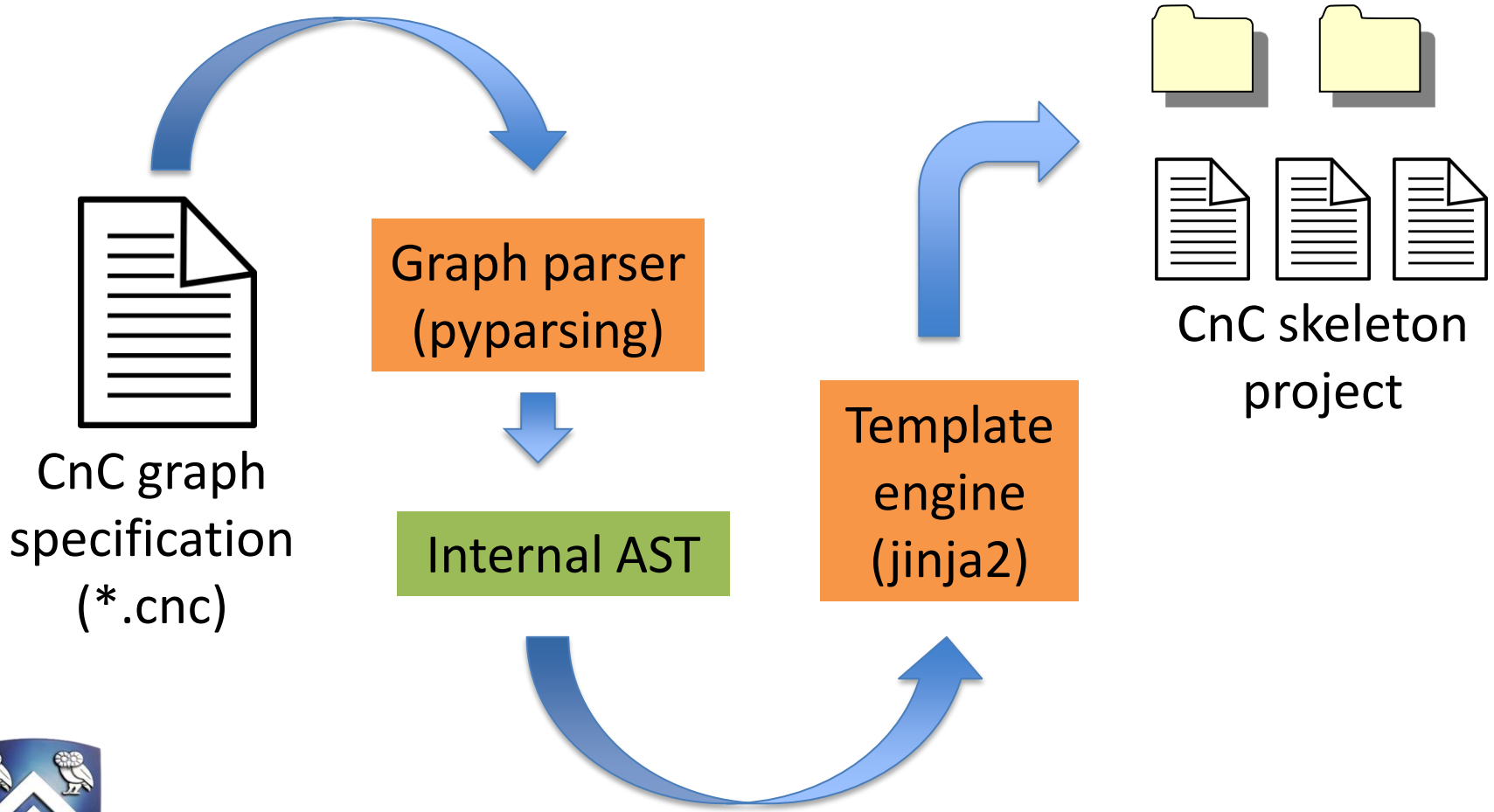
Nick's plan for unified CnC

Generalize the CnC-OCR Framework

- **Increase graph specification expressiveness**
- **Generate iCnC scaffolding**
- **Remove OCR abstractions from API**


Unified CnC translator design



Fibonacci's unified graph spec

```
$context { int n; };

[ int *fib: i ];

( $initialize: () ) -> ( compute_fib: $rangeTo(0,#n) );

( compute_fib: i )
 <- [ x @ fib: i-2 ] $when(i>1),
    [ y @ fib: i-1 ] $when(i>1)
 -> [ z @ fib: i   ];

( $finalize: () ) <- [ fib: #n ];
```

iCnC Fibonacci

```
int fib_step::execute( const int & tag, fib_context & ctxt )
   const {
    switch( tag ) {
        case 0 : ctxt.m_fibs.put( tag, 0 ); break;
        case 1 : ctxt.m_fibs.put( tag, 1 ); break;
        default :
            // get previous 2 results
            fib_type f_1; ctxt.m_fibs.get( tag - 1, f_1 );
            fib_type f_2; ctxt.m_fibs.get( tag - 2, f_2 );
            // put our result
            ctxt.m_fibs.put( tag, f_1 + f_2 );
    }
    return CnC::CNC_Success;
}
```

Fibonacci's unified graph spec

```
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( compute_fib: i )
 <- [ x @ fib: i-2 ] $when(i>1),
    [ y @ fib: i-1 ] $when(i>1)
 -> [ z @ fib: i   ];

( $finalize: () ) <- [ fib: #n ];
```

Fibonacci's unified project

- cnc_support
  - x86
    - cncocr.h
    - cncocr.c
    - Fibonacci_internal.h
    - …
  - icnc
    - icnc.h
    - icnc.cpp
    - Fibonacci_internal.h
    - …
- Makefile.x86
- Makefile.icnc
- Makefile
- Fibonacci_defs.h
- Fibonacci.c
- Fibonacci_compute_fib.c
- Main.c
- build
- install

Fibonacci's unified step code

```
void Fibonacci_compute_fib(cncTag_t i,
        int *x, int *y, FibonacciCtx *ctx) {

    int *z = cncItemAlloc(sizeof(*z));
    *z = (i>1) ? *x + *y : i;
    cncPut_fib(z, n, ctx);

}
```

Unified CnC C API

```
int cncMain(int argc, char *argv[])

void G_S(cncTag_t t0, ..., cncTag_t tN, TX x, ..., TZ z, GCtx *ctx)
void G_cncInitialize(GArgs *args, GCtx *ctx)
void G_cncFinalize(cncTag_t t0, ..., cncTag_t tN, GCtx *ctx)

GCtx *G_create()
void G_destroy(GCtx *ctx)
void G_launch(GArgs *args, GCtx *ctx)
void G_await(cncTag_t t0, ..., cncTag_t tN, GCtx *ctx)

void cncPrescribe_S(cncTag_t t0, ..., cncTag_t tN, GCtx *ctx)

void *cncItemAlloc(size_t bytes)
void cncItemFree(void *item)
void cncPut_I(T *item, cncTag_t k0, ..., cncTag_t kN, GCtx *ctx)
```

Demo

https://youtu.be/R04HkX_97ww

Summary

- Realized 3 pillars of unification
  - Unified graph language
  - Unified graph translator toolchain
  - Unified developer API
- Proof of concept for iCnC and CnC-OCR
- Unified developer API is limited to C-compatible CnC runtime implementations

Future work

- Add additional back-end runtimes
  - CnC-HC via HC-Lib (+ MPI?)
- Add additional API targets
  - Intel CnC (C++ API)
  - JVM (HJ-Lib, Scala)
- Add JSON front-end support
  - Useful for JavaScript-based CnC designer

Go try it out!

https://github.com/habanero-rice/cnc-framework

https://xstack.exascale-tech.com/git/public/xstack.git

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