Flexible Coupling for Performance

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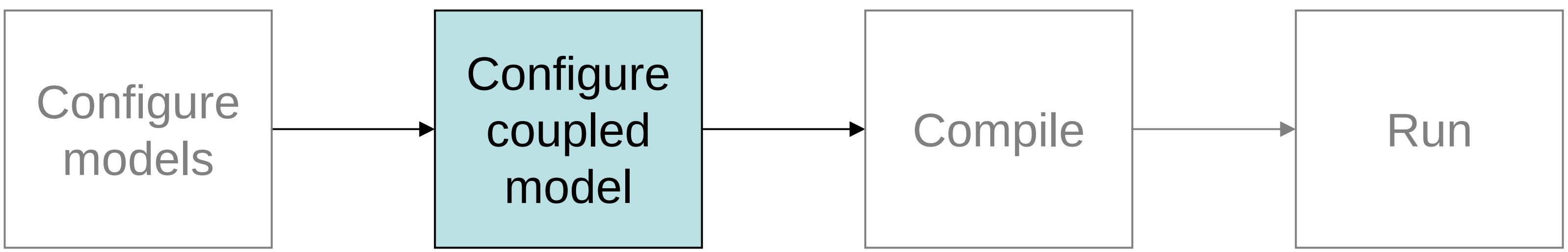
Overview

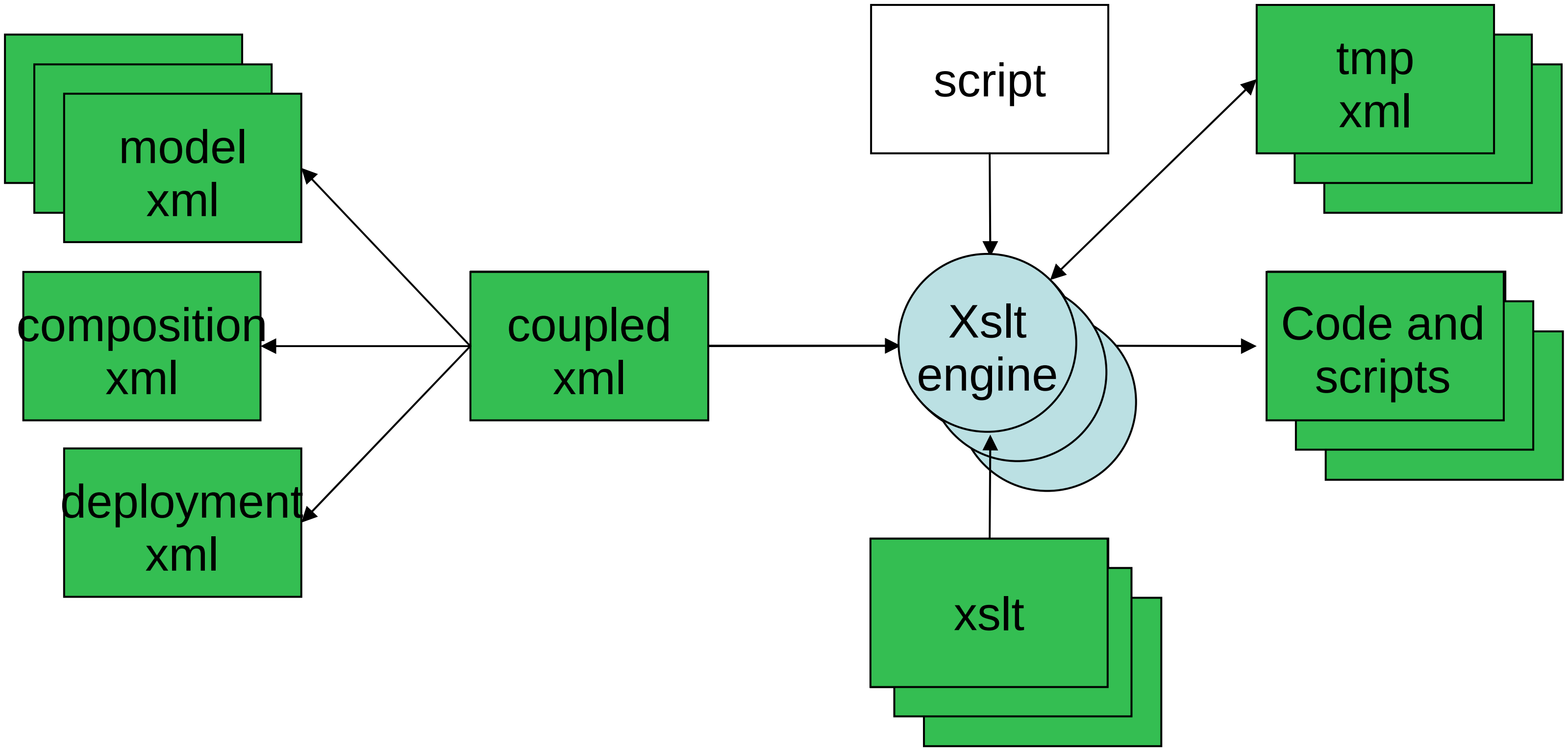
- Introduction
- Deployment flexibility (BFG1)
- Argument Passing (BFG2)
- GENIE results
- Conclusions

Introduction

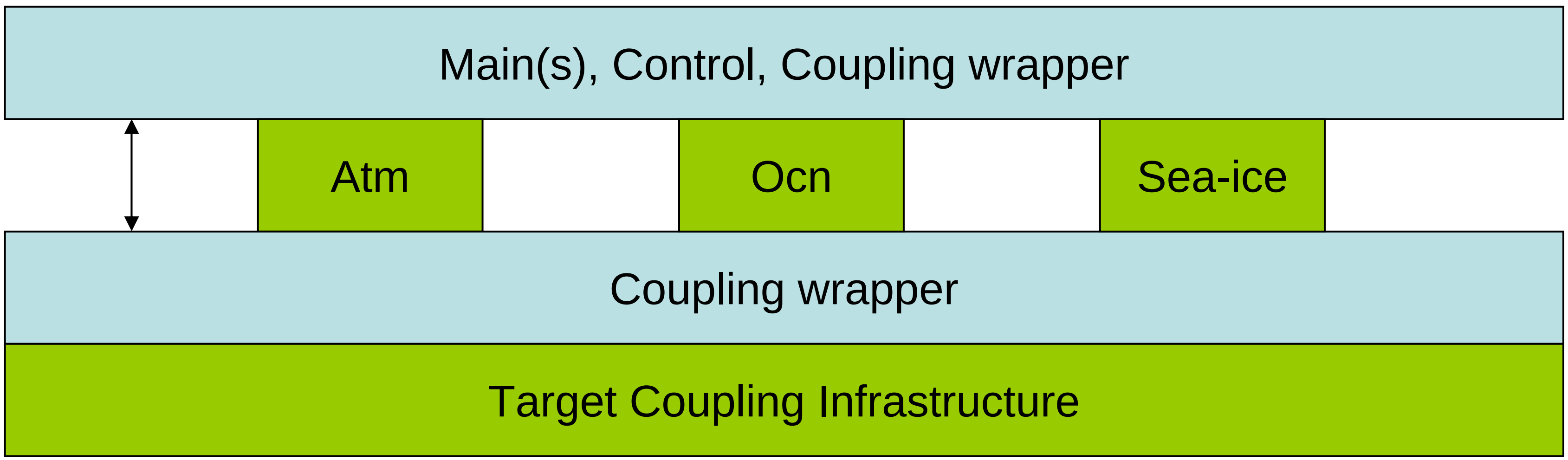
- Flexible Coupling Approach: metadata describing individual models (e.g. subroutines or methods), their composition into a coupled model and their deployment onto resources, and generate the required wrapper code (e.g. main(s) and communication code).
- BFG{1,2} are implementations of the above approach



Introduction: BFG Implementation



Introduction: Model Wrapping



- Existing code/library code
- BFG-generated wrapper code

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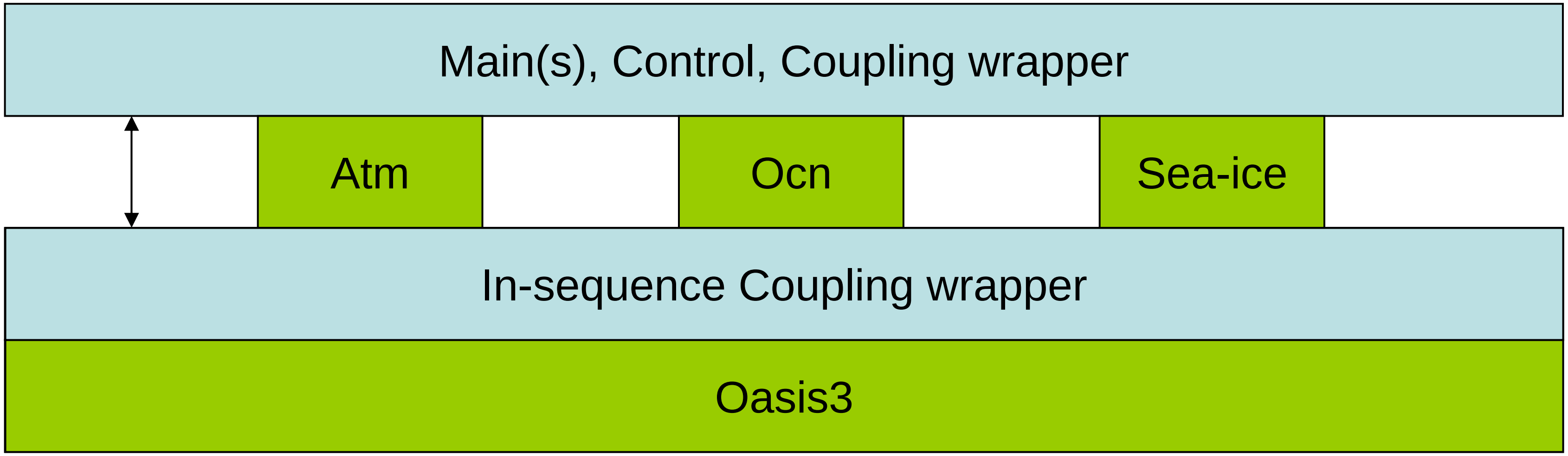
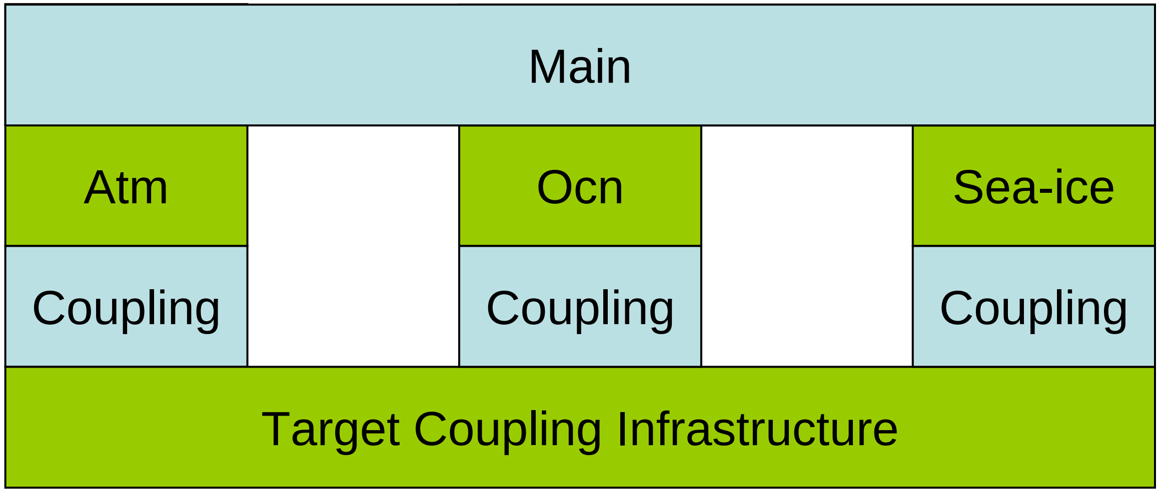
BFG1: Deployment Flexibility

- Support for many targets, therefore choose most appropriate:
  - in-sequence, mpi, Oasis3, tdt, web services
  - (Oasis4, esmf, …)
- No change to model code (or composition)



BFG1: Deployment Flexibility

- Ability to choose most appropriate mapping of models to executables, with no change to model code (or composition)



(f90) Models and In-Place Communication

```
module m1model
…
real :: a,x,y
…
subroutine m1init()
  ! Do things
  call put(a,3)
end subroutine m1init
…
subroutine m1()
  call get(x,6)
  ! Do things
  call put(y,3)
end subroutine m1
…
end module m1model
```

```
module m2model
…
real :: a,b,c
…
subroutine m2init()
  call get(c,2)
  ! Do things
end subroutine m2init
…
subroutine m2()
  call get(a,1)
  ! Do things
  call put(b,1)
end subroutine m2
…
end module m2model
```

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Running in Sequence?

BFG (In-place) style control

```
program mycoupledmodel

use m1model
use m2model

call m1init()
call m2init()

do i=1,nts
  call m1()
  call m2()
end do

end program mycoupledmodel
```

Hand-crafted Arg-passing comms (and data allocation)

```
program mycoupledmodel

use m1model
use m2model

real :: a,b,c

call m1init(a)
call m2init(a)

do i=1,nts
  call m1(b,c)
  call m2(b,c)
end do

end program mycoupledmodel
```

BFG2: (f90) Models and Arg-passing Communication

```
module m1model
…
real :: a,x,y
…
subroutine m1init()
  ! Do things
  call put(a,3)
end subroutine m1init
…
subroutine m1()
  call get(x,6)
  ! Do things
  call put(y,3)
end subroutine m1
…
end module m1model
```

```
module m1model

…

subroutine m1init(a)
  real, intent(out):: a
  ! Do things
end subroutine m1init
…
subroutine m1(x,y)
  real, intent(in) :: x
  real, intent(out):: y
  ! Do things
end subroutine m1
…
end module m1model
```

BFG2: Wrapping Arg-passing Communication

```
module m1model

…

subroutine m1init(a)
  real, intent(out):: a
  ! Do things
end subroutine m1init
…
subroutine m1(x,y)
  real, intent(in) :: x
  real, intent(out):: y
  ! Do things
end subroutine m1
…
end module m1model
```

```
module m1modelwrap
…
use m1model
…
real :: a,x,y
…
subroutine m1initwrap()
  call m1init(a)
  call put(a,3)
end subroutine m1initwrap
…
subroutine m1wrap()
  call get(x,6)
  call m1(x,y)
  call put(y,3)
end subroutine m1wrap
…
end module m1modelwrap
```

BFG2: Mixed Arg-passing/In-place Communication

- Choose most appropriate for model developer and for required use
- e.g. in-place for some diagnostics

```
module m1model
…
real :: y
…
subroutine m1init(a)
  real, intent(out):: a
  ! Do things
end subroutine m1init
…
subroutine m1(x)
  real, intent(in) :: x
  ! Do things
  call put(y,3)
end subroutine m1
…
end module m1model
```

BFG2: Mixed, concurrent/in-sequence

threads/processes

call atm(a)

call atm_chem(a)

call put(a,tag)

call ocn(a)

call ocn_chem(a)

mpi

(Oasis4)

threads/processes

call get(a,tag)

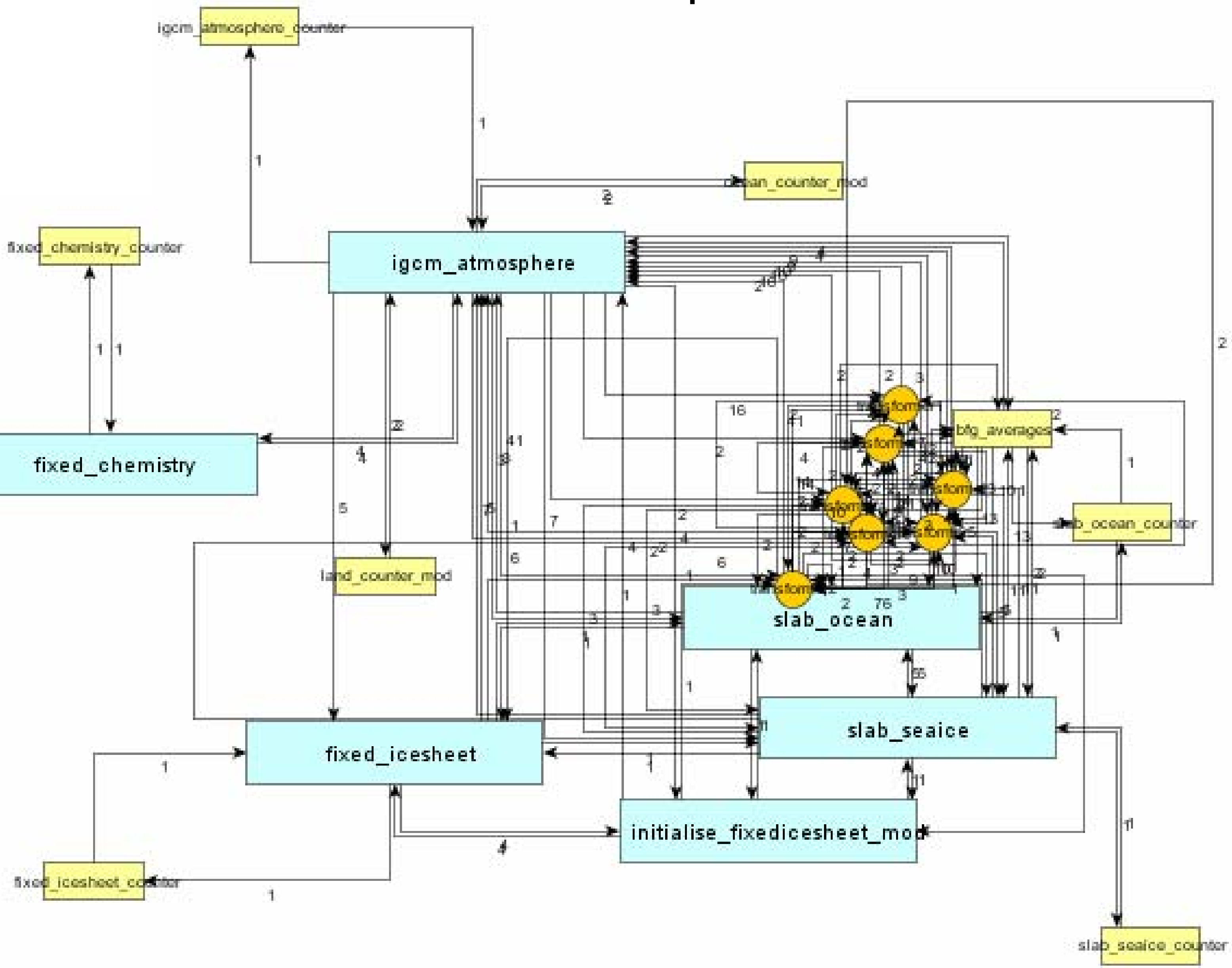
call ocn(a)

call ocn_chem(a)

GENIE example

- ESM system http://www.genie.ac.uk
- Models implemented with arg passing, all run in sequence, hand crafted control code (and data allocation)
- Made 4 genie models compliant and generate 2 configurations (ig_fi_sl, ig_sl_sl)
- Same performance as hand crafted implementations with slightly less memory use.

GENIE example



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FLUME, PRISM, BFG

- Graham and I are consultants to the Met Office on FLUME.
- BFG1 and BFG2 were originally implemented to test out the ideas being developed in FLUME.
- It is hoped that FLUME models will be compatible with BFG2. The current plan is to follow the same model coding rules and to ensure that the metadata describing models are at least compatible and hopefully the same.
- FLUME will use Oasis4 (the latest generation PRISM Coupler) to couple models concurrently (plan to use wrapping code approach).
- Oasis4 will be a BFG2 target

Conclusions

- Flexibility in deployment allows
  - choice of most efficient “target” infrastructure
  - choice of most efficient mapping of models to “main’s”
- Argument passing interface allows
  - as efficient generated code (in memory and time) as hand crafted code when running in sequence
  - all models to be run in-sequence, some models to be run in-sequence and some concurrently, all models to be run concurrently. Can choose most appropriate target and mapping to mains for concurrent models.
  - (potentially) More fine grain coupling without loss of performance
  - (potentially) Coupling for both NWP and ESM.

Thanks ...

http://www.cs.manchester.ac.uk/cnc/projects/bfg