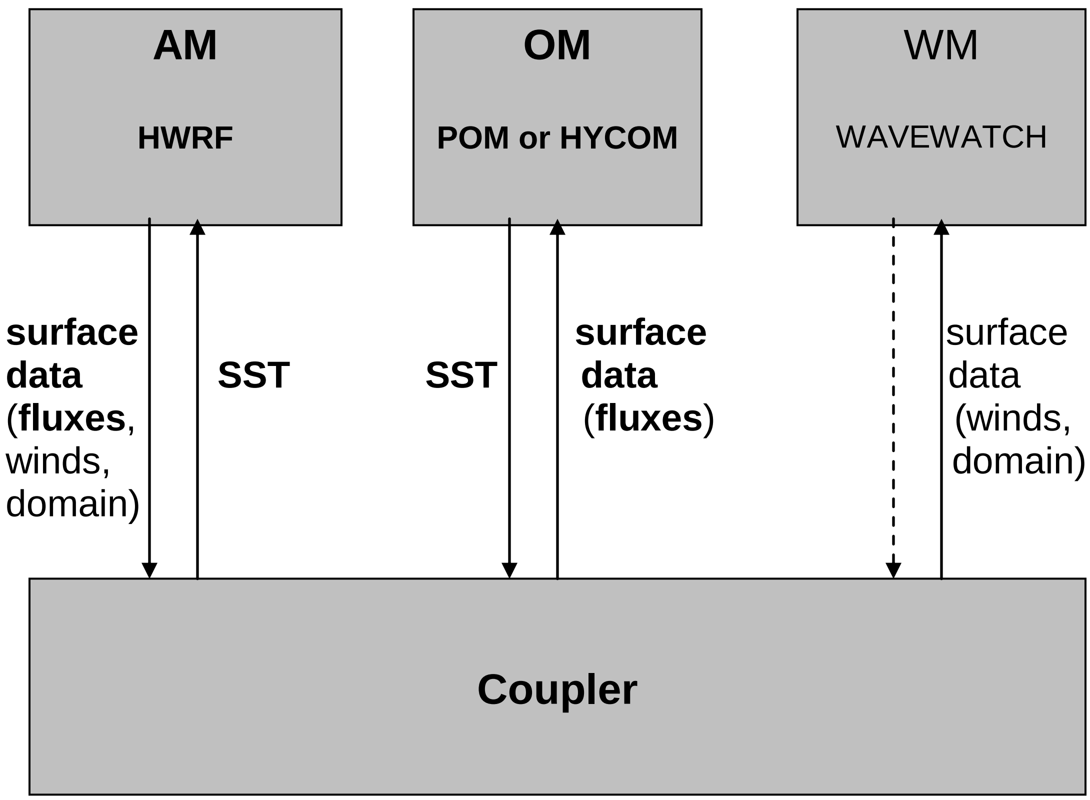
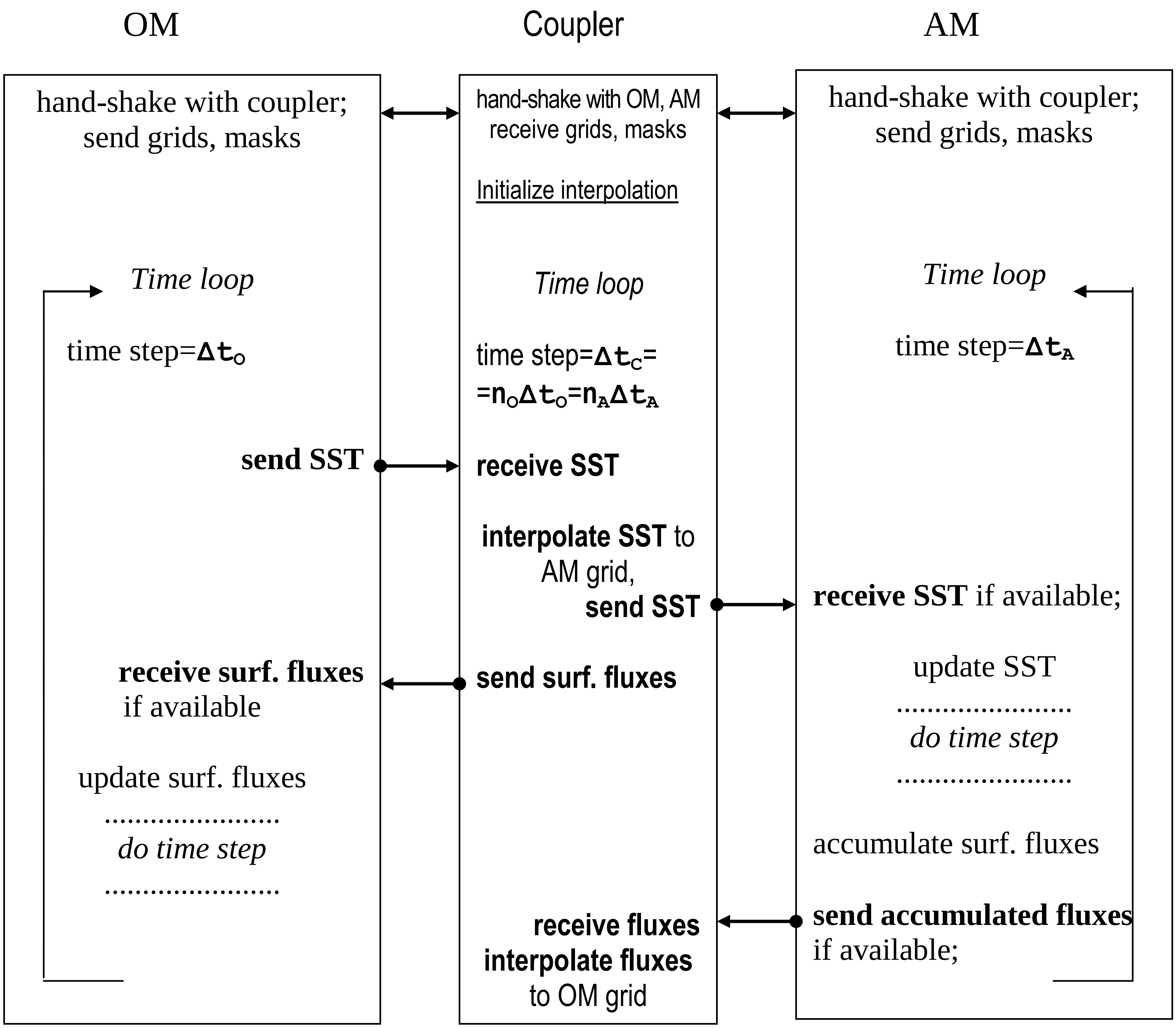
The Coupled System

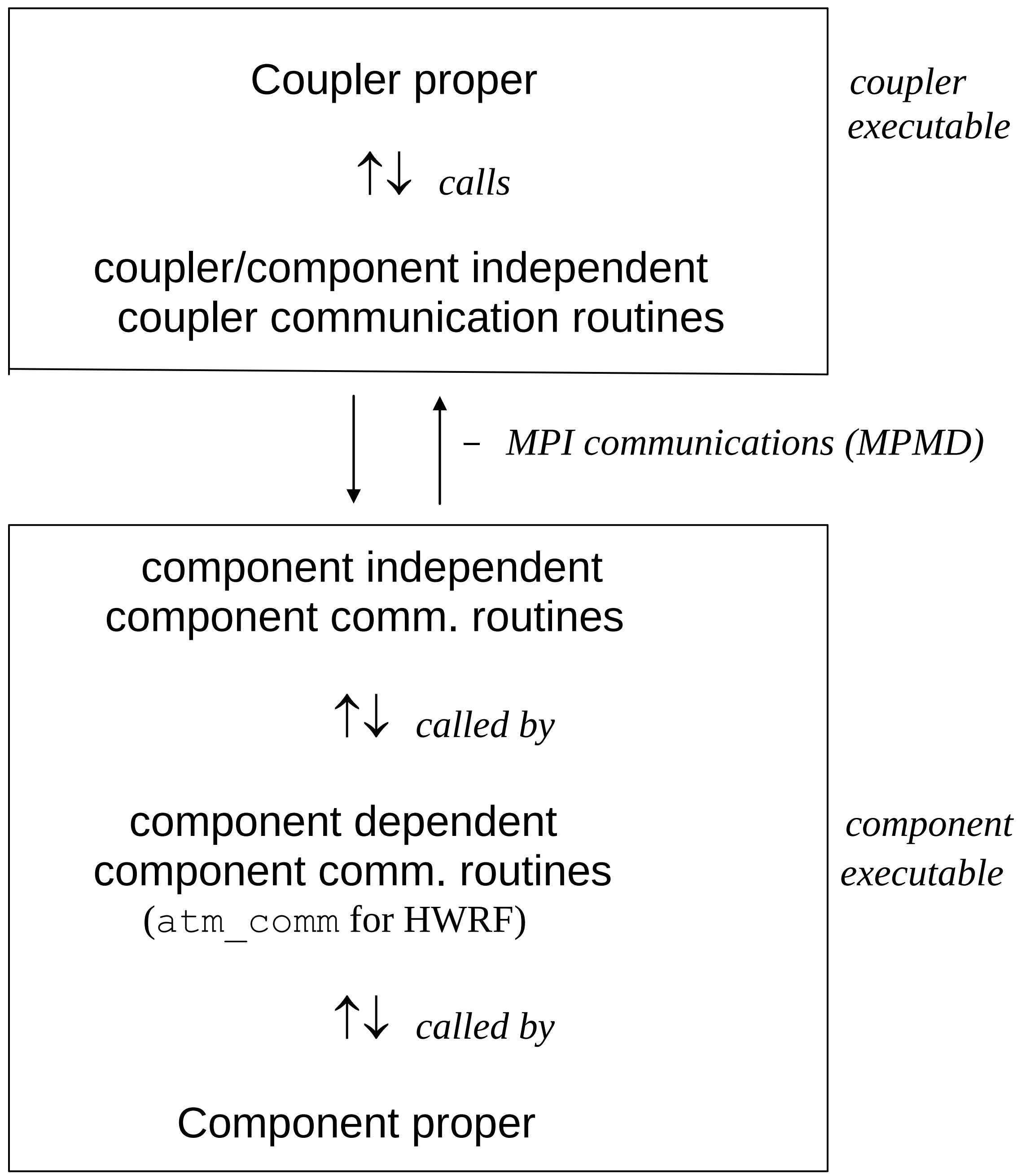


RUN-TIME COMMUNICATIONS



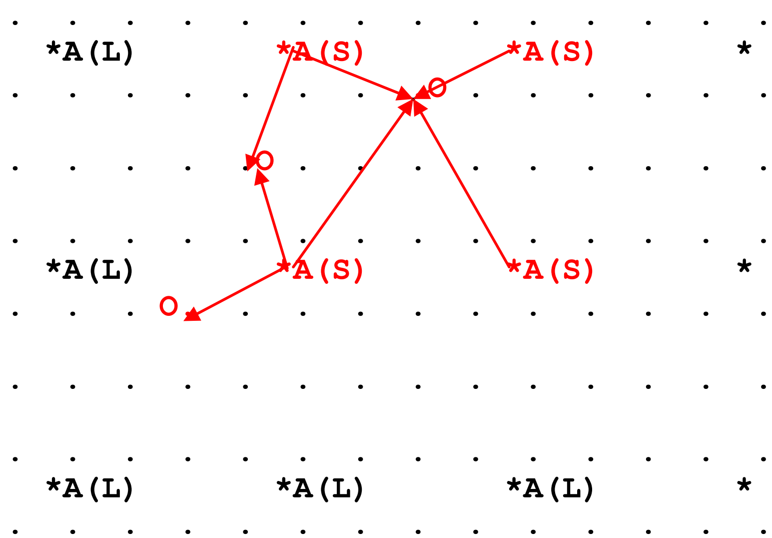
- if Component's GP is not an open sea GP, Component sends a special value, to be discarded by Coupler
- if there is no data at GP, Coupler sends a special value; when Component receives this value, it uses its background data instead
- **each Component can be run either in the coupled system or standalone, with the same code/executable; if Coupler is not detected, Component works standalone**

Coupler – Component interface



Coupler: data interpolation

• Interpolation: bilinear in elementary grid cells, sea points to sea points only



• Data not supplied by interpolation, due to domain and sea-land mask inconsistencies, are provided by:

▪ background (e. g. GFS) data

▪ extrapolation on domain's sea-point-connected component, for a specified number of grid steps, with (AM SST) or without (OM surface fluxes) relaxation to background data

Interpolation initialization: for each domain 2 gridpoint p_{ij} find domain 1 elementary grid cell C_{kl} such that p_{ij} lies inside C_{kl}

Data:

- the domains are not necessarily quadrilateral
- elementary grid cells C_{kl} are quadrilateral but not necessarily the elementary cell **(k,l)**, **(k+1,l)**, **(k+1,l+1)**, **(k,l+1)** in terms of indexing
- gridpoints are represented by their latitudes/longitudes (or other common coordinates); grids are general (not latitudinal/longitudinal)

Methods:

- direct search: $\sim N^4$ operations: inefficient. Cannot be pre-computed once and forever, as each forecast uses its own domains
- minimization search (e.g. searching for the nearest domain 1 gridpoint): $\sim N^2 * (\ln N)^2$ operations for robust algorithms. Not feasible because of local minima
- **current method**: $\sim N^3$ operations. Algorithm: go along a "continuous" path on grid 2; check if the current segment of the path crosses domain 1 boundary an odd number of times, thus determining if the current domain 2 gridpoint lies inside domain 1; if it does, search for the grid 1 cell using the one found for the previous domain 2 gridpoint as a 1st guess and if necessary continuing the search in expanding rectangles

- Implication for the case of AM moving nested grid: initialization performed for a "total" grid covering the entire static domain and including all possible positions of the moving grid as sub-grids. Alternative: dynamic (run-time) initialization

COUPLER EFFICIENCY

T_1 – WCT of Component 1

T_2 – WCT of Component 2

T_C – WCT of Coupler

T – WCT of Coupled System

Definition of Ideal Coupler: for given T_1, T_2, T_C T is a minimum (neither Component waits for the other Component). Ideal Coupler does NOT mean that $T_C=0$; however, if $T_C=0$ then for Ideal Coupler $T=\max(T_1,T_2)$.

Theorem: for an Ideal Coupler,

$$T=\max(\min(T_1,T_2)+T_C,\max(T_1,T_2))$$

I.e. if $T_1 \geq T_2$ then

$$T=\max(T_2+T_C,T_1)$$

Formula $T=max(T_1,T_2)$, which works for GFS+MOM and HWRF+POM, is only valid when $|T_1-T_2|\geq T_C$.

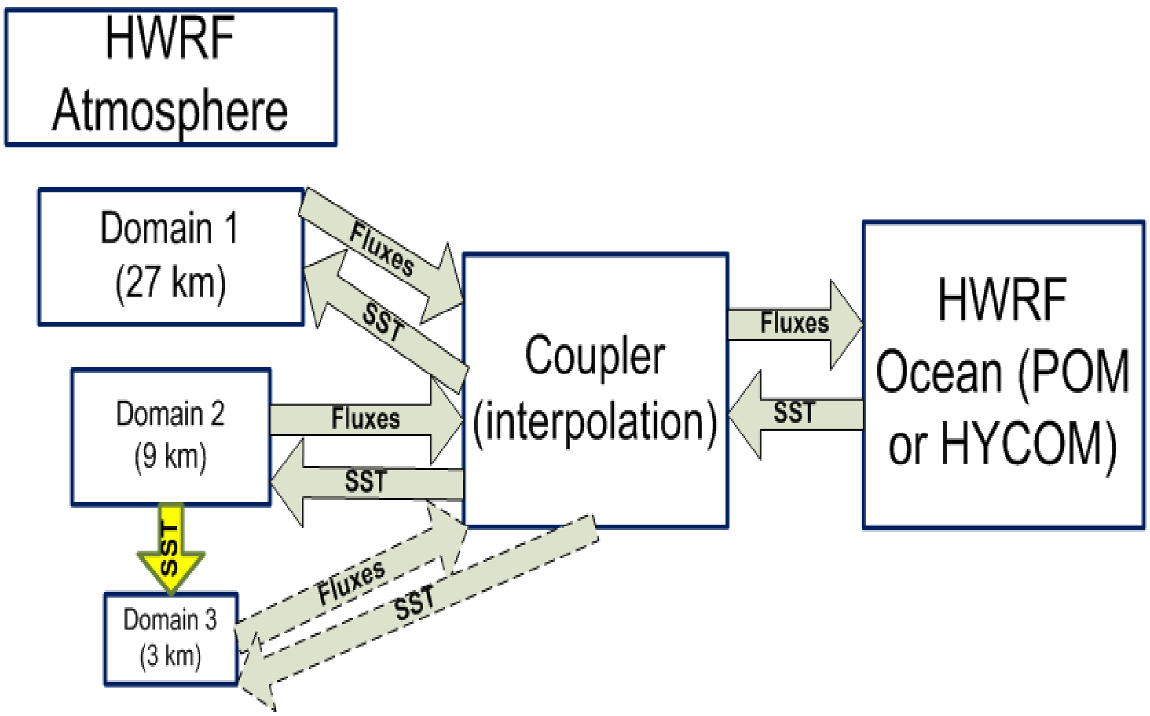
In Progress: Dynamic Initialization of Interpolation

Method: Initialization for moving grids' leading edges at every coupling time step

Expected: Memory/efficiency savings that would facilitate full-fledged coupling for triple nested HWRF and running a coupled HWRF with higher resolutions in the horizontal

(currently, the resources required for the once-per-forecast static initialization of interpolation with a "big fine grid" are insignificant)

Coupler for Third Nest



Extension of 2-way interactive NCEP coupler
(dashed lines represent future development)