Neighbourhood Collectives

Reusing this material

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Topology communicators

- Regular n-dimensional grid or torus topology
  - MPI_CART_CREATE
- General graph topology
  - MPI_GRAPH_CREATE
    - All processes specify all edges in the graph (not scalable)
- General graph topology (distributed version)
  - MPI_DIST_GRAPH_CREATE_ADJACENT
    - All processes specify their incoming and outgoing neighbours
  - MPI_DIST_GRAPH_CREATE
    - Any process can specify any edge in the graph (too general?)

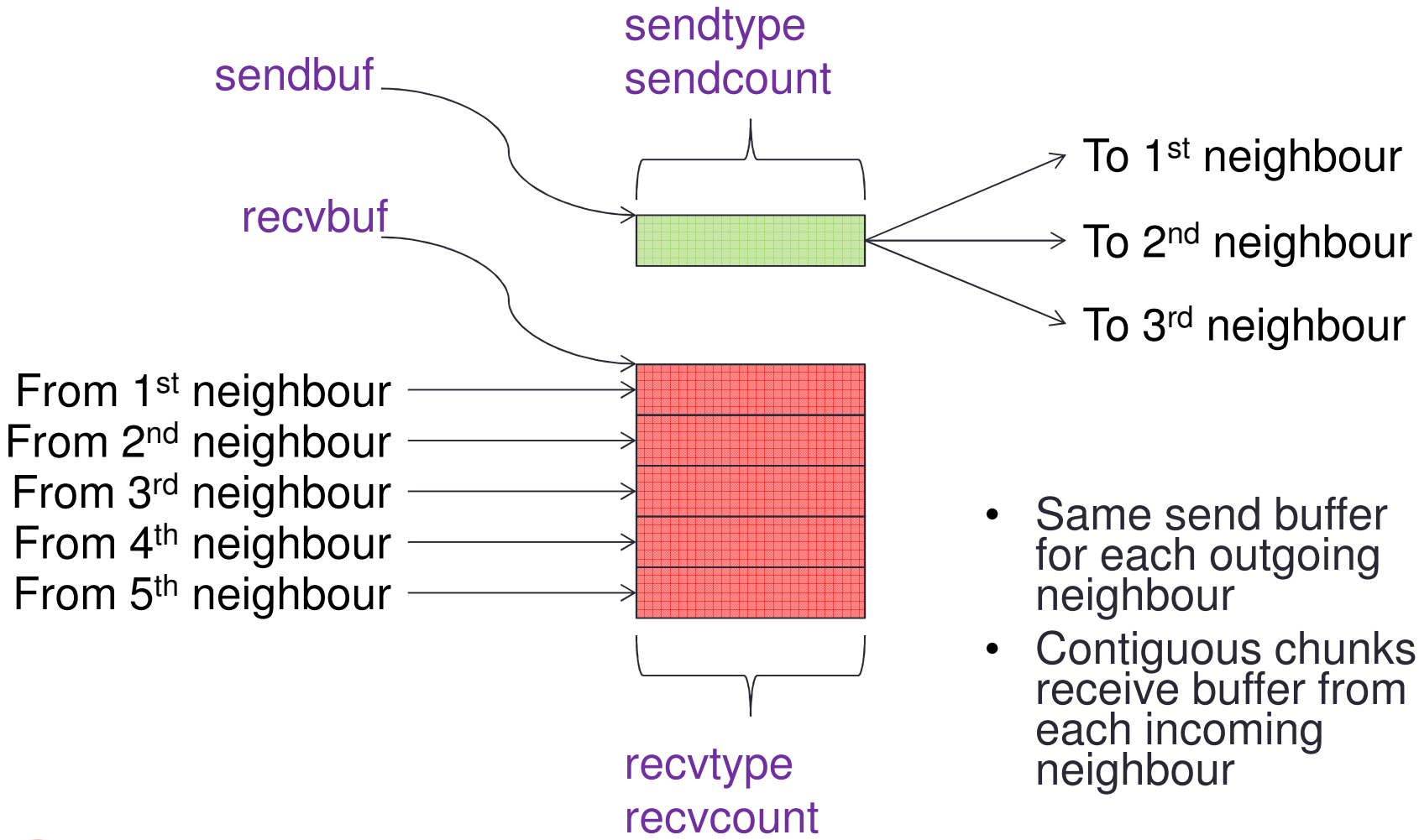
Topology communicators

- Testing the topology type associated with a communicator
  - MPI_TOPO_TEST
- Finding the neighbours for a process
  - MPI_CART_SHIFT
- Find out how many neighbours there are:
  - MPI_GRAPH_NEIGHBORS_COUNT
- Get the ranks of all neighbours:
  - MPI_GRAPH_NEIGHBORS
- Find out how many neighbours there are:
  - MPI_DIST_GRAPH_NEIGHBORS_COUNT
- Get the ranks of all neighbours:
  - MPI_DIST_GRAPH_NEIGHBORS

Neighbourhood collective operations

- See section 7.6 in MPI 3.0 for blocking functions
  - See section 7.7 in MPI 3.0 for non-blocking functions
  - See section 7.8 in MPI 3.0 for an example application
    - But beware of the mistake(s) in the example code!
- MPI_[N|In]eighbor_allgather[v]
  - Send one piece of data to all neighbours
  - Gather one piece of data from each neighbour
- MPI_[N|In]eighbor_alltoall[v|w]
  - Send different data to each neighbour
  - Receive different data from each neighbour
- Use-case: regular or irregular domain decomposition codes
  - Where the decomposition is static or changes infrequently
  - Because creating a topology communicator takes time

MPI_Neighbor_allgather



- Same send buffer for each outgoing neighbour
- Contiguous chunks in receive buffer from each incoming neighbour

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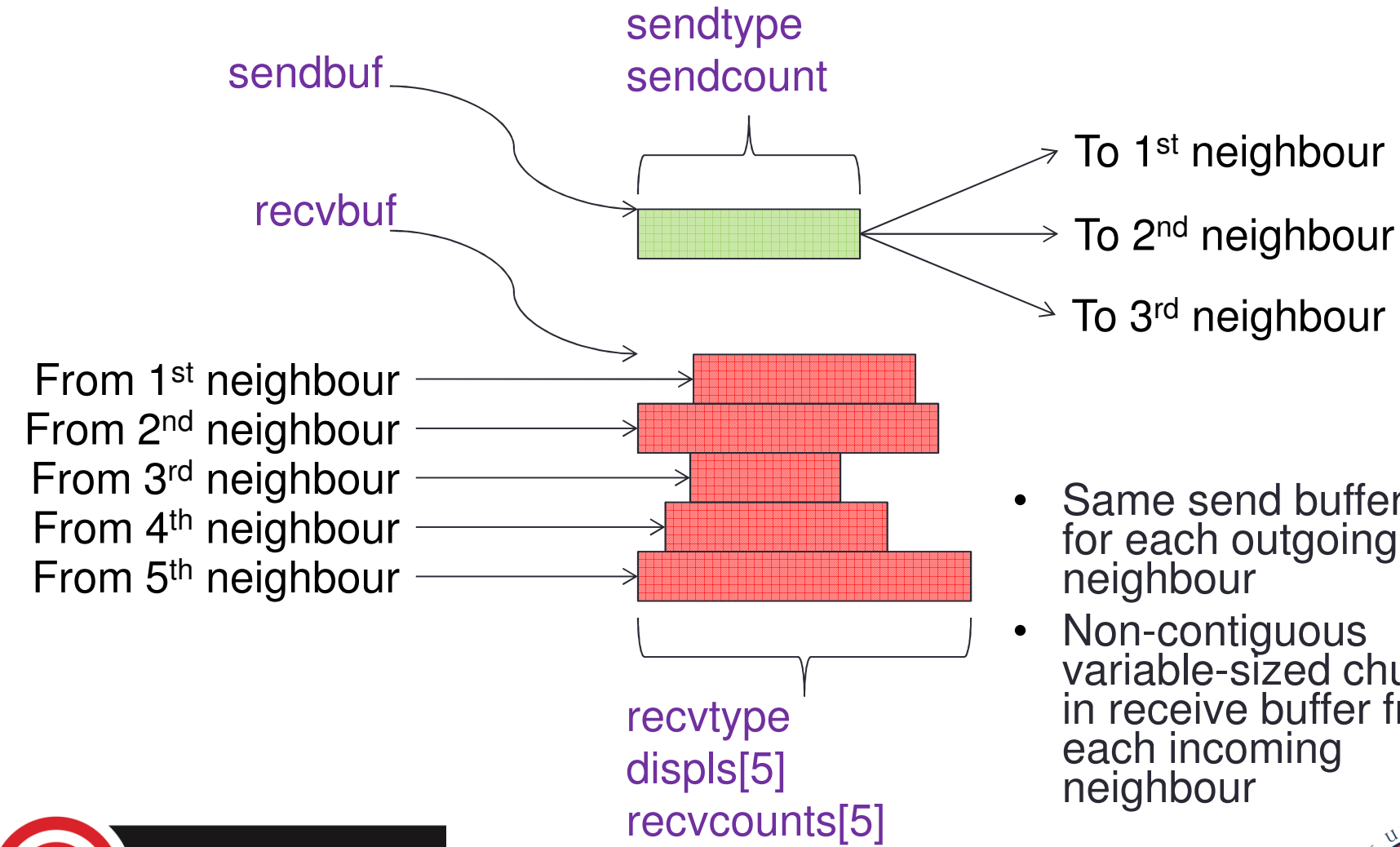
MPI_Neighbor_allgatherv



- Same send buffer for each outgoing neighbour
- Non-contiguous variable-sized chunks in receive buffer from each incoming neighbour

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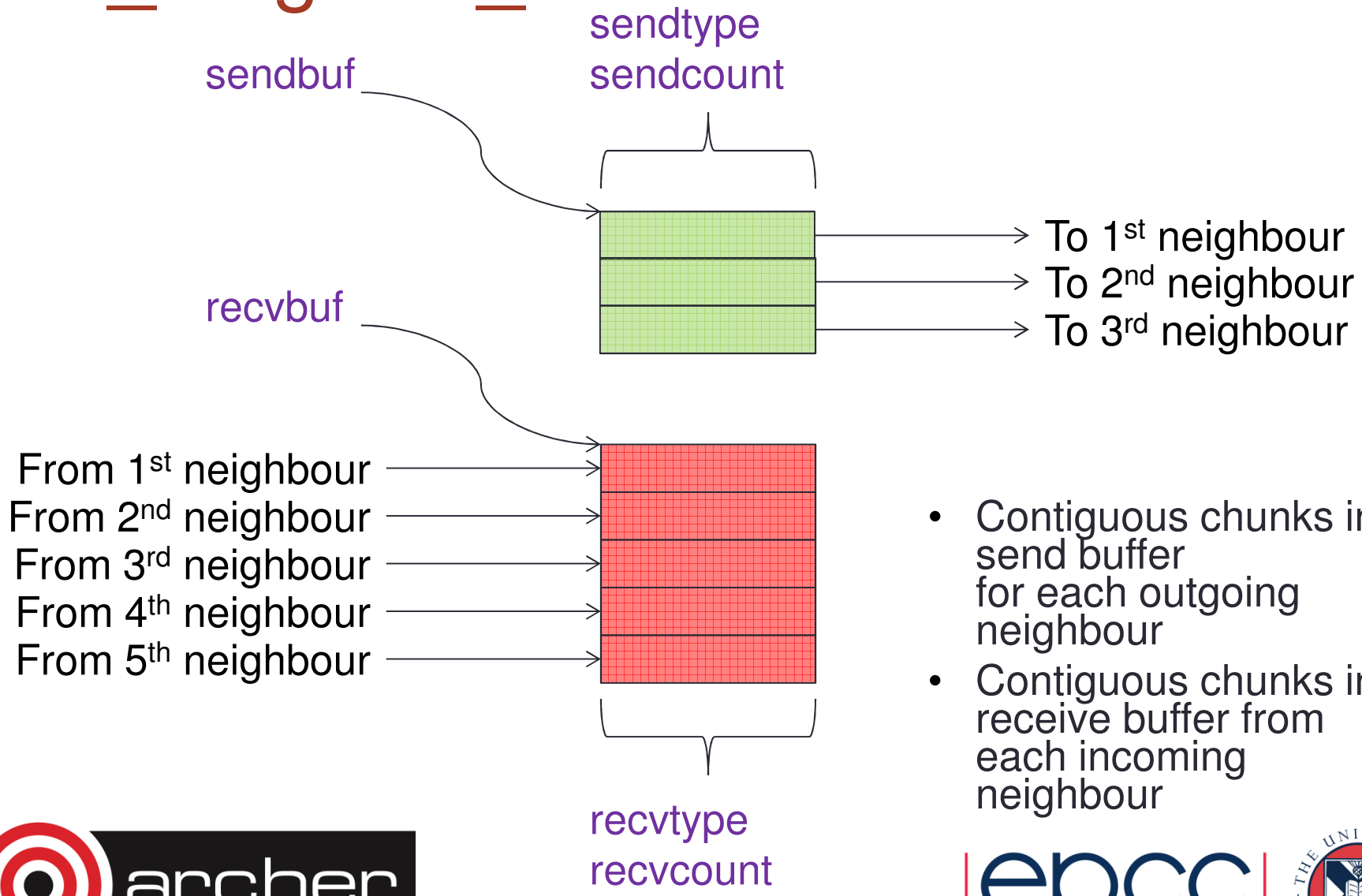
MPI_Neighbor_alltoall



- Contiguous chunks in send buffer for each outgoing neighbour
- Contiguous chunks in receive buffer from each incoming neighbour

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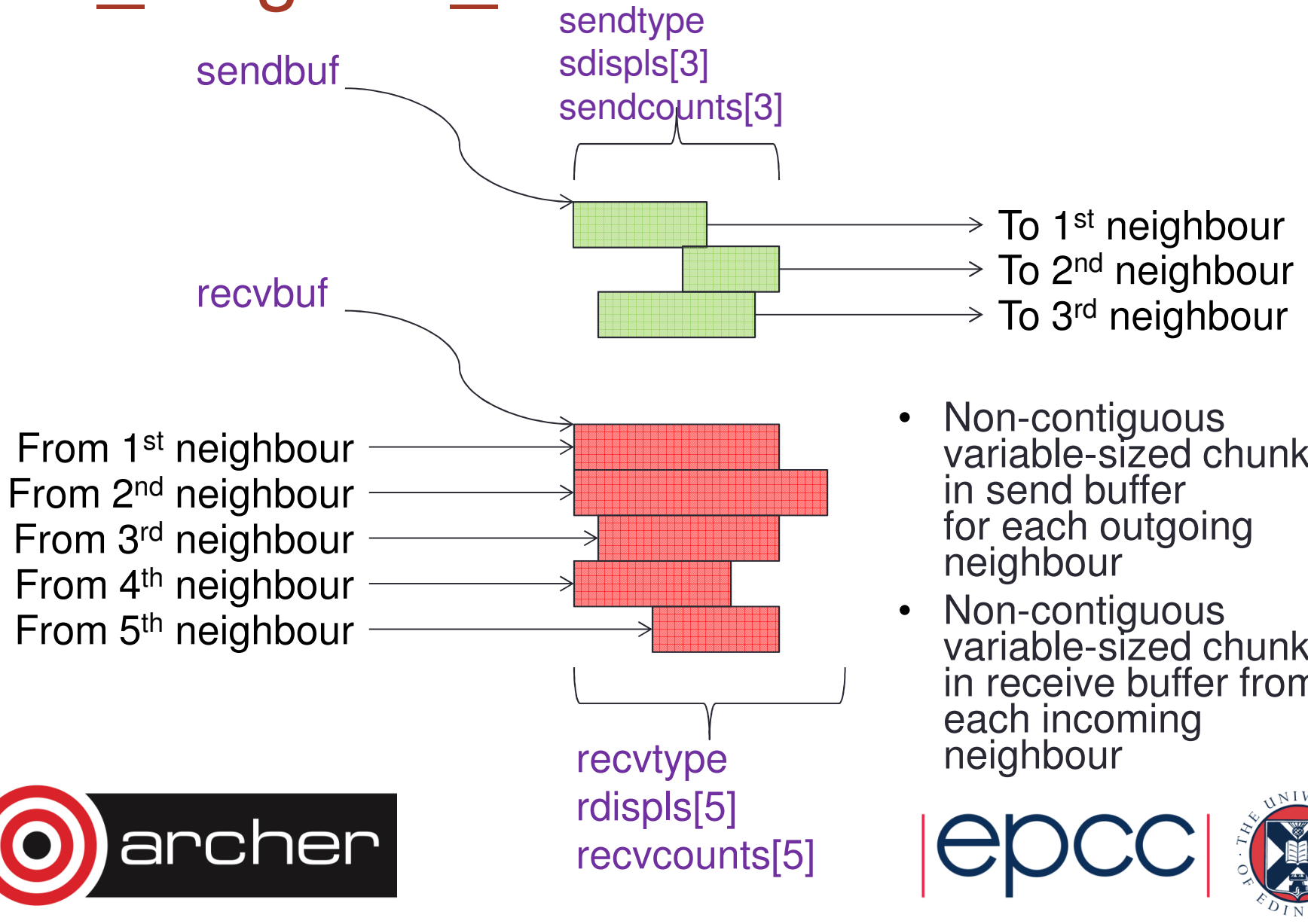
MPI_Neighbor_alltoallv



- Non-contiguous variable-sized chunks in send buffer for each outgoing neighbour
- Non-contiguous variable-sized chunks in receive buffer from each incoming neighbour

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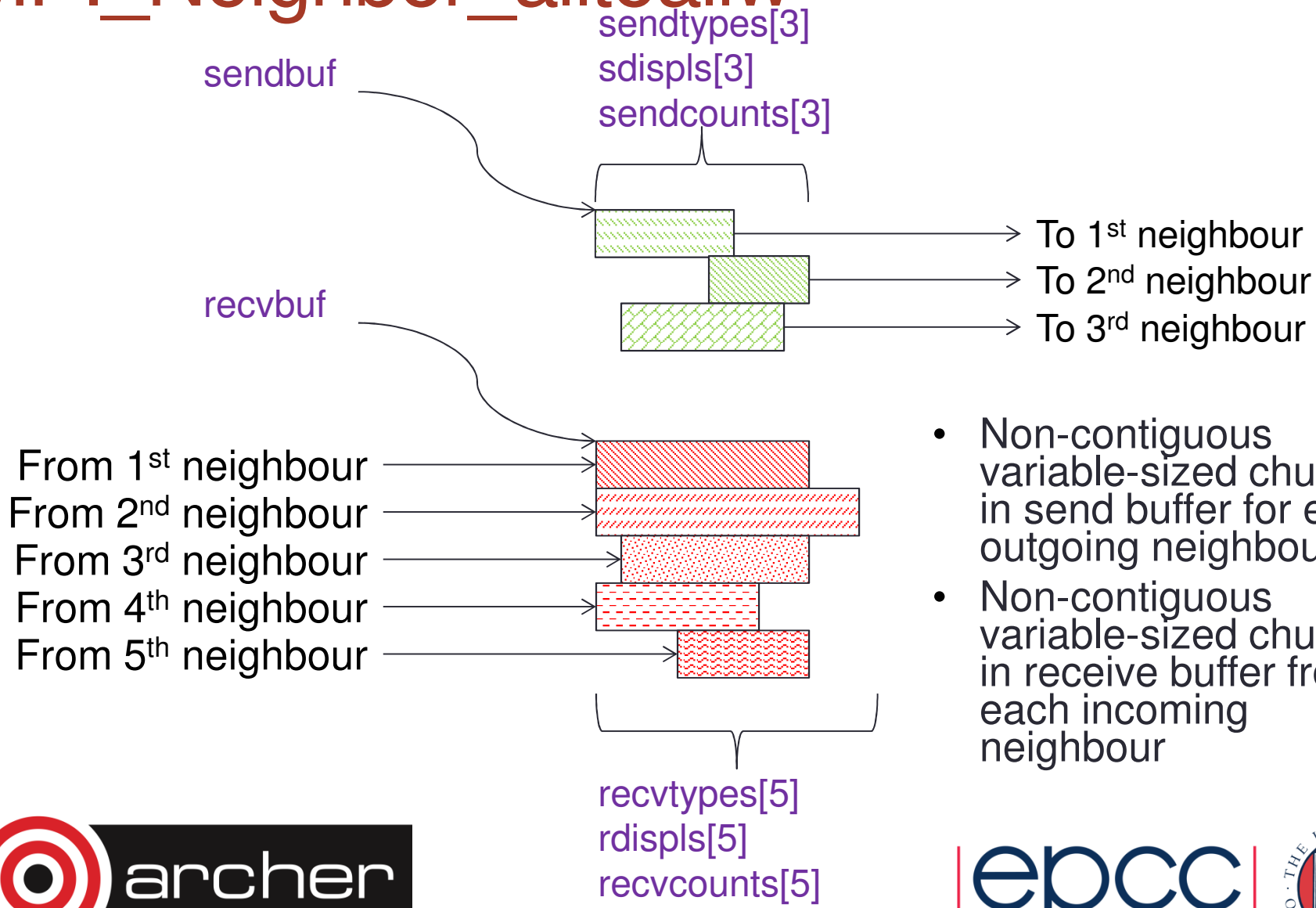
MPI_Neighbor_alltoallw



- Non-contiguous variable-sized chunks in send buffer for each outgoing neighbour
- Non-contiguous variable-sized chunks in receive buffer from each incoming neighbour

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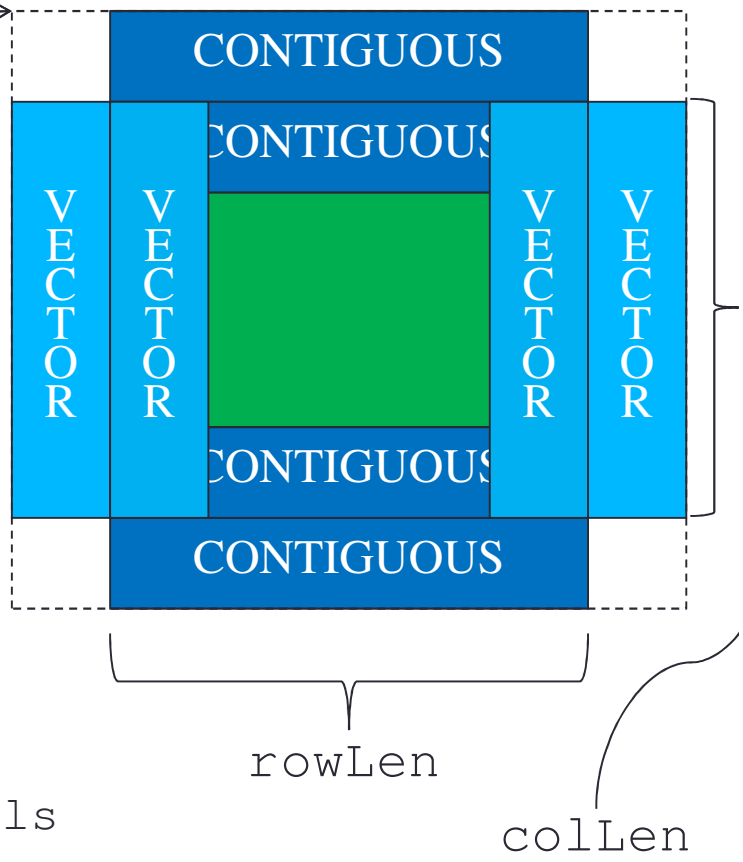
MPI_Neighbor_alltoallw

```
for (int i=0;i<4;++i) {sendbuf
    sendcounts[i] = 1;
    recvcounts[i] = 1; recvbuf
}
sendtypes[0] = contigType;
senddispls[0] = colLen*(rowLen+2)+1;
sendtypes[1] = contigType;
senddispls[1] = 1*(rowLen+2)+1;
sendtypes[2] = vectorType;
senddispls[2] = 1*(rowLen+2)+1;
sendtypes[3] = vectorType;
senddispls[3] = 2*(rowLen+2)-2;
// similarly for recvtypes and recvdispls
```




```
MPI_Neighbor_alltoallw(sendbuf, sendcounts, senddispls,
sendtypes,recvbuf, recvcounts, recvdsipls, recvtypes,
comm);
```

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Summary

- Regular or irregular domain decomposition codes
  - Where the decomposition is static or changes infrequently
- Should investigate replacing point-to-point communication
  - E.g. halo-exchange communication
- With neighbourhood collective communication
  - Probably MPI_Ineighbor_alltoallw
- So that MPI can optimise the whole pattern of messages
  - Rather than trying to optimise each message individually
- And so your application code is simpler and easier to read