Leaderless Consensus

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Introduction

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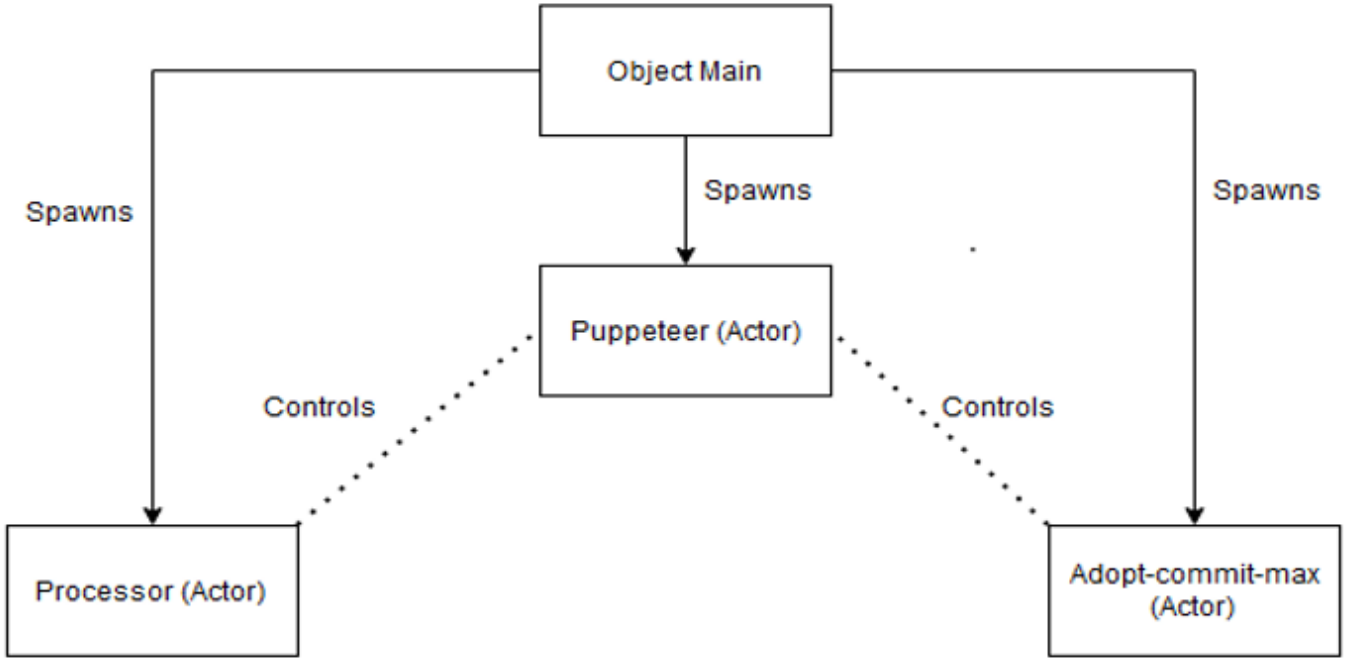
- Divided into rounds, processors/nodes propose values per-round
- Some nodes are disabled in a round
- We've also implemented a tougher adversary selection strategy for 2 processors

	1	2	3	4	5	6	7	8	9	10	11
p_1	$step(\mathcal{R}_5)_{p_1}$	X	$step(\mathcal{R}_2)_{p_1}$	$step(\mathcal{R}_6)_{p_1}$	$step(\mathcal{R}_3)_{p_1}$	X	$step(\mathcal{R}_3)_{p_1}$	$step(\mathcal{R}_2)_{p_1}$	$step(\mathcal{R}_1)_{p_1}$	$step(\mathcal{R}_4)_{p_1}$	$step(\mathcal{R}_1)_{p_1}$
p_2	$step(\mathcal{R}_2)_{p_2}$	$step(\mathcal{R}_4)_{p_2}$	X	X	X	$step(\mathcal{R}_2)_{p_2}$	$step(\mathcal{R}_1)_{p_2}$	X	X	X	X

Figure: Interaction in a synchronous-1 situation

High level view of components



Adopt-commit-max algorithm

- Every process p proposes a value

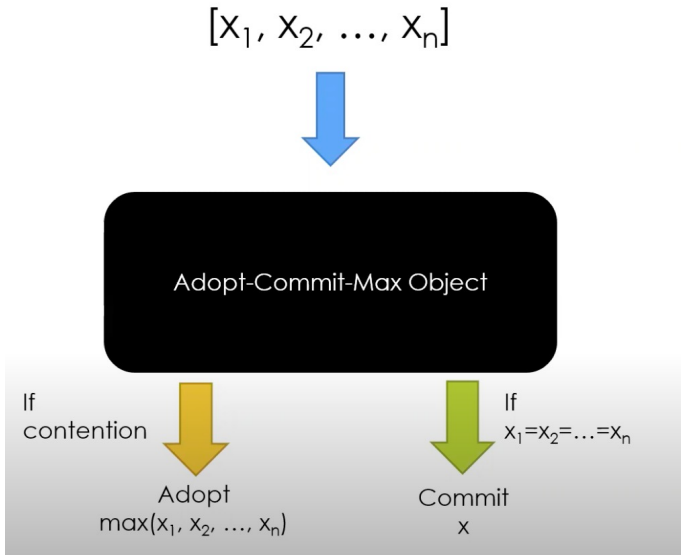
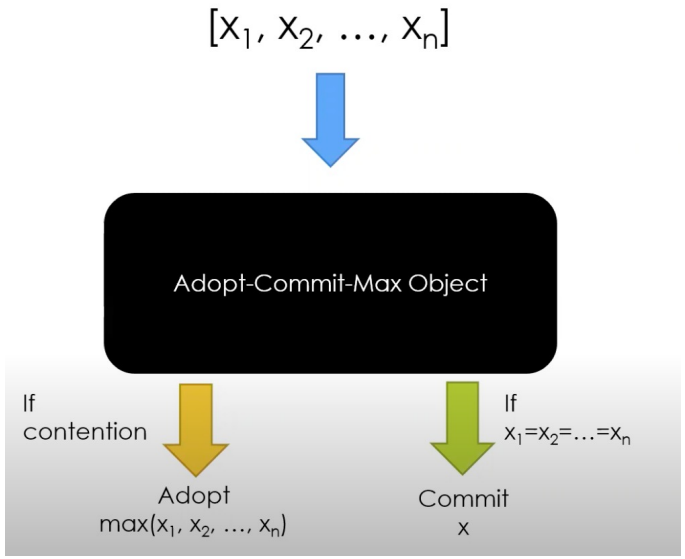


Figure: The manner in which the adopt-commit-max object behaves

Adopt-commit-max algorithm

- Every process p proposes a value
- The output is a pair $<d, p>$, where d is either *commit* or *adapt*



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Adopt-commit-max algorithm

- Every process p proposes a value
- The output is a pair $<d, p>$, where d is either *commit* or *adapt*
- Satisfies the following properties
  - CA-Validity
  - CA-Agreement
  - CA-Commitment
  - CA-Termination

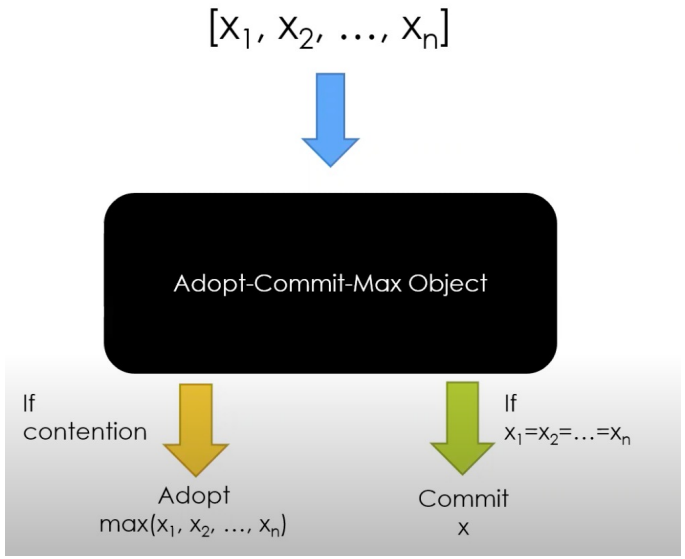

Figure: The manner in which the adopt-commit-max object behaves

Demo

Initial algorithm

Algorithm 4 Archipelago in message passing

```
1: Local State:
2:    i, the current adopt-commit-max object, initially 0
3:    R, a set of tuples, initially empty
4:    A[0, 1, ...], a sequence of sets, all initially empty
5:    B[0, 1, ...], a sequence of sets, all initially empty

6: procedure propose(v):
7:    while true do
8:       ⟨i, v'⟩ ← R-Step(v)
9:       ⟨flag, v''⟩ ← A-Step(v')
10:      ⟨control, val⟩ ← B-Step(flag, v'')
11:      if control = commit then return val
12:      else i ← i + 1

13: procedure R-Step(v):
14:   broadcast(R, i, v)
15:   wait until receive (R-response, i, R) from f + 1 proc.
16:   R ← R ∪ { union of all Rs received in previous line}
17:   ⟨i', v'⟩ ← max(R)
18:   return ⟨i', v'⟩

19: procedure A-Step(v):
20:   broadcast(A, i, v)
21:   wait until receive (A-response, i, A[i]) from f + 1 proc.
22:   S ← union of all A[i]s received
23:   if S contains only one value val then return ⟨true, val⟩
24:   else return ⟨false, max(S)⟩

25: procedure B-Step(flag, v):
26:   broadcast(B, i, flag, v)
27:   wait until receive (B-response, i, B[i]) from f + 1 proc.
28:   S ← union of all B[i]s received
29:   if S contains only ⟨true, val⟩ for some val then
30:      return ⟨commit, val⟩
31:   else if S contains some entry ⟨true, val⟩ then
32:      return ⟨adopt, val⟩
33:   else return ⟨adopt, max(S)⟩

34: upon reception of (R, j, v) from p:
35:   Add ⟨j, v⟩ to R
36:   send(R-response, j, R) to p

37: upon reception of (A, j, v) from p:
38:   Add v to A[j]
39:   send(A-response, j, A[j]) to p

40: upon reception of (B, j, flag, v) from p:
41:   Add ⟨flag, v⟩ to B[j]
42:   send(B-response, j, B[j]) to p
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- Good but not well suited for message passing

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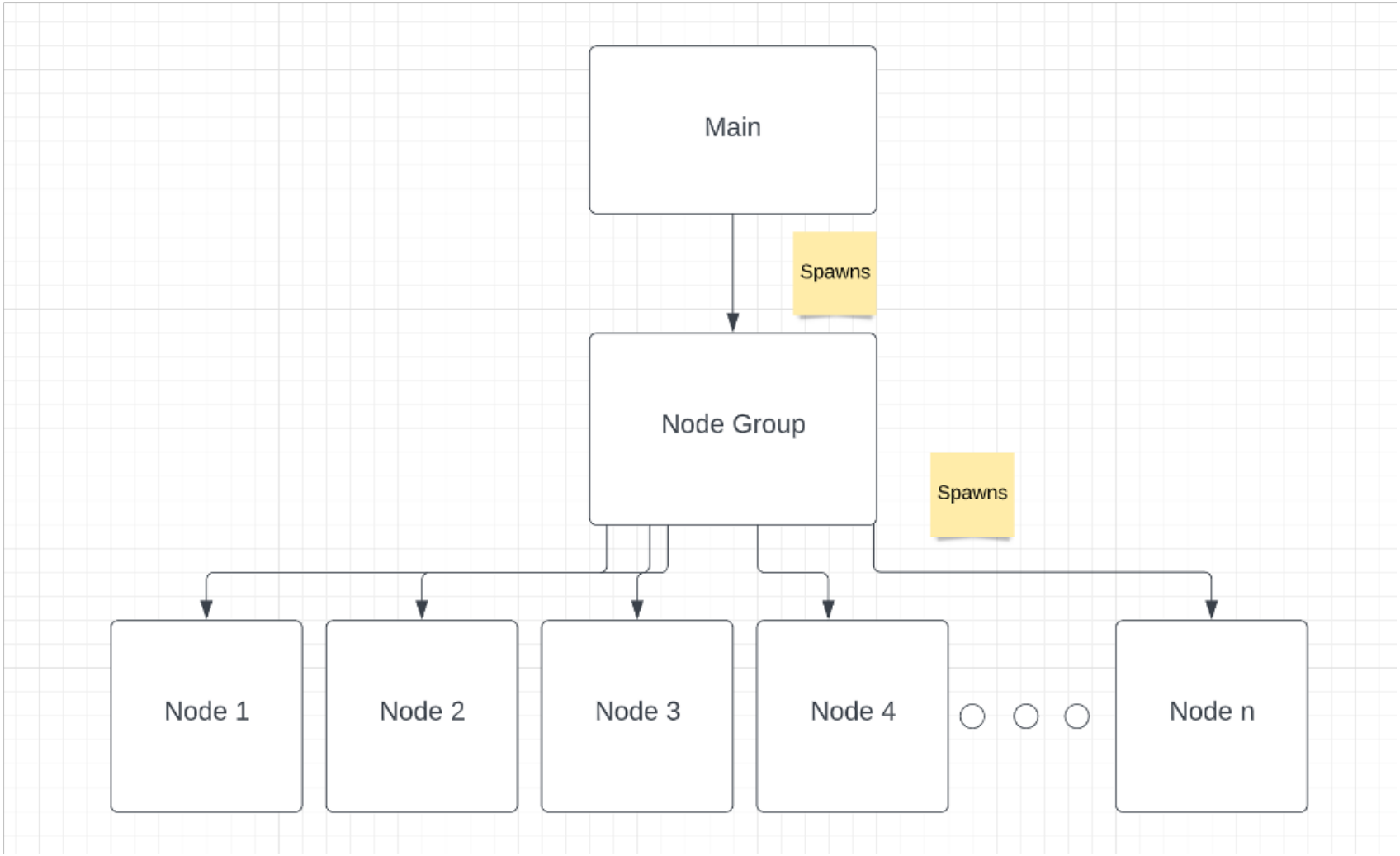
- Good but not well suited for message passing
- Waiting for responses seemed antithetical to the reactive, async style of doing thins

Archipelago with message passing



Main Actor

- Manages the Node Group

Main Actor

- Manages the Node Group
- Asks it to spawn nodes and start Archipelago

Node Group

```
sealed trait Command

final case class RequestTrackDevice(nodeId: String, replyTo: ActorRef[Main.Command])
final case class Start() extends Command
final case class Commit(value: Int, nodeId: String) extends Command
final case class BroadcastR(rBroadcast: Node.RBroadcast) extends Command
final case class BroadcastA(aBroadcast: Node.ABroadcast) extends Command
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- Keeps track of all nodes

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- Accepts final *commit*

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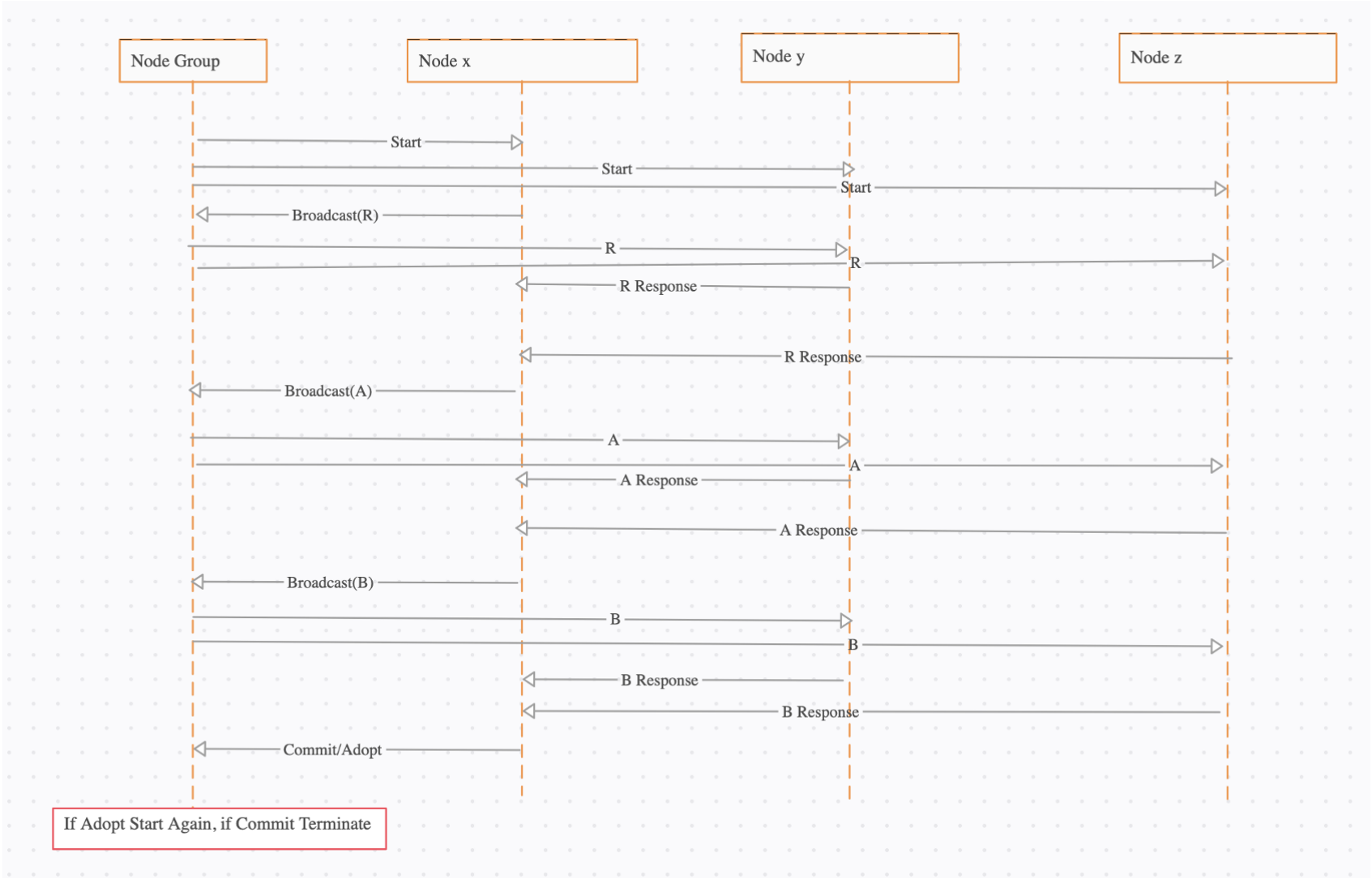
- Keeps track of all nodes
- Asks each node to start Archipelago inside them
- Accepts final *commit*
- Allows nodes to broadcast messages

Node

```
sealed trait Command

final case class RBroadcast(i: Int, v: Int, replyTo: ActorRef[Node.Command]) extends Command
private final case class RResponse(i: Int, R: Set[(Int, Int)]) extends Command
final case class ABroadcast(i: Int, v: Int, replyTo: ActorRef[Node.Command]) extends Command
private final case class AResponse(i: Int, aJ: Set[Int]) extends Command
final case class BBroadcast(i: Int, flag: Boolean, v: Int, replyTo: ActorRef[Node.Command]) extends Command
private final case class BResponse(i: Int, bJ: Set[(Boolean, Int)]) extends Command
final case class Start(v: Int) extends Command
final case class Stop() extends Command
```

Sequential Diagram

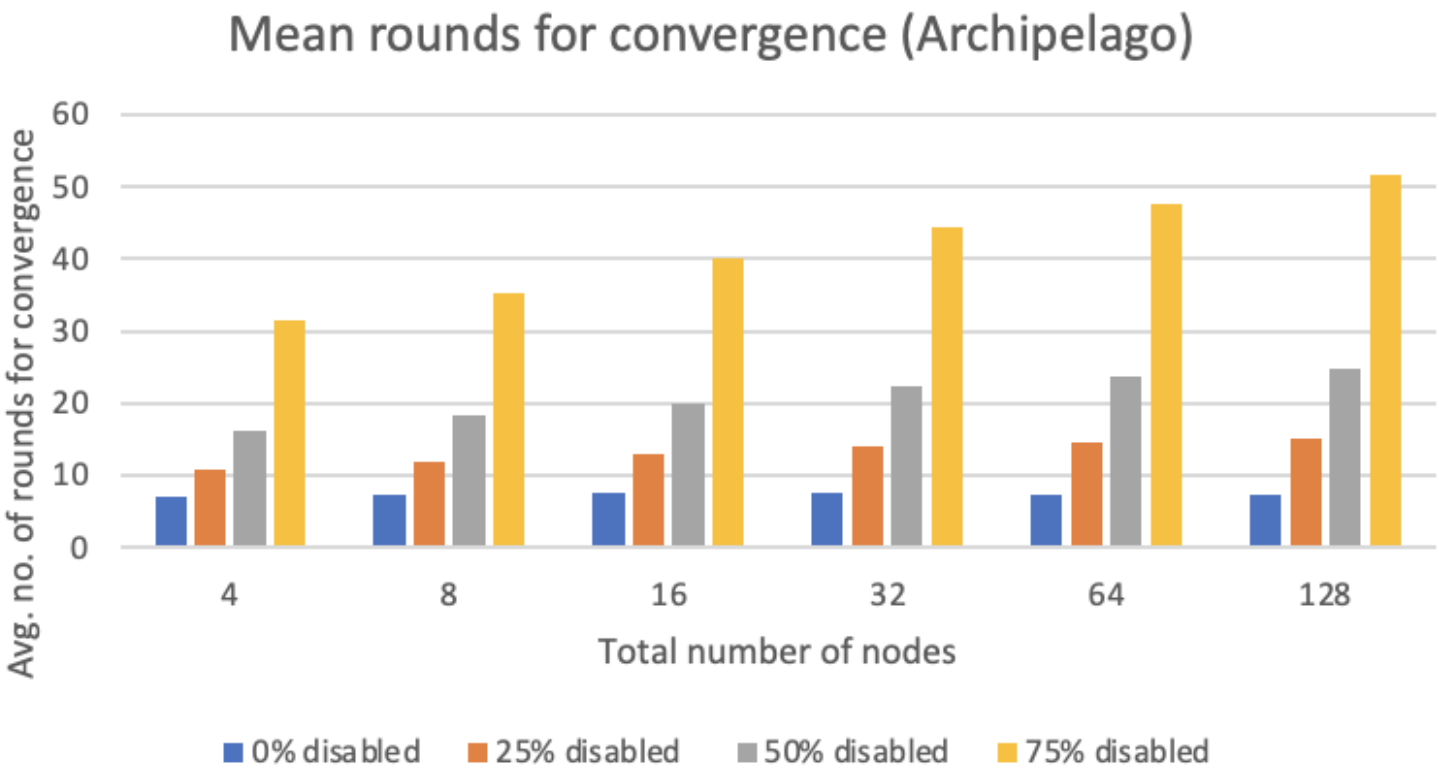


Archipelago with message passing

Demo

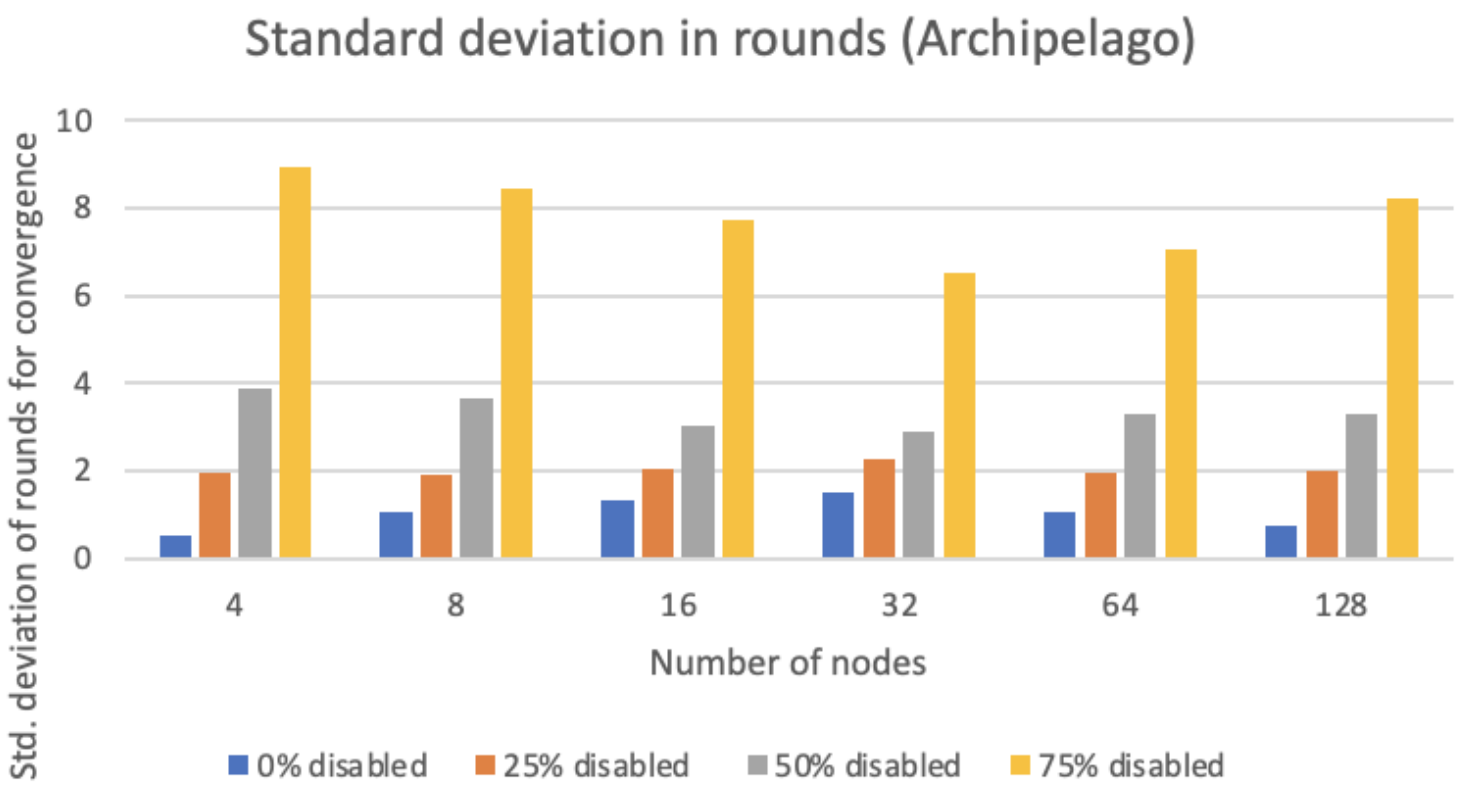
Experiments - Archipelago

Node Count	0% disabled	25% disabled	50% disabled	75% disabled
4	7.09	10.83	16.05	31.51
8	7.27	11.8	18.33	35.38
16	7.57	13.03	19.92	40.12
32	7.63	13.9	22.35	44.44
64	7.36	14.45	23.69	47.61
128	7.21	15.1	24.91	51.78



Experiments - Archipelago

Node Count	0% disabled	25% disabled	50% disabled	75% disabled
4	0.509901951	1.949358869	3.866522986	8.958236434
8	1.053565375	1.892088793	3.66469644	8.444524853
16	1.326649916	2.061552813	3.016620626	7.745966692
32	1.493318452	2.289104628	2.875760769	6.547518614
64	1.067707825	1.977371993	3.292415527	7.084490102
128	0.768114575	2.0174241	3.281767816	8.223138087

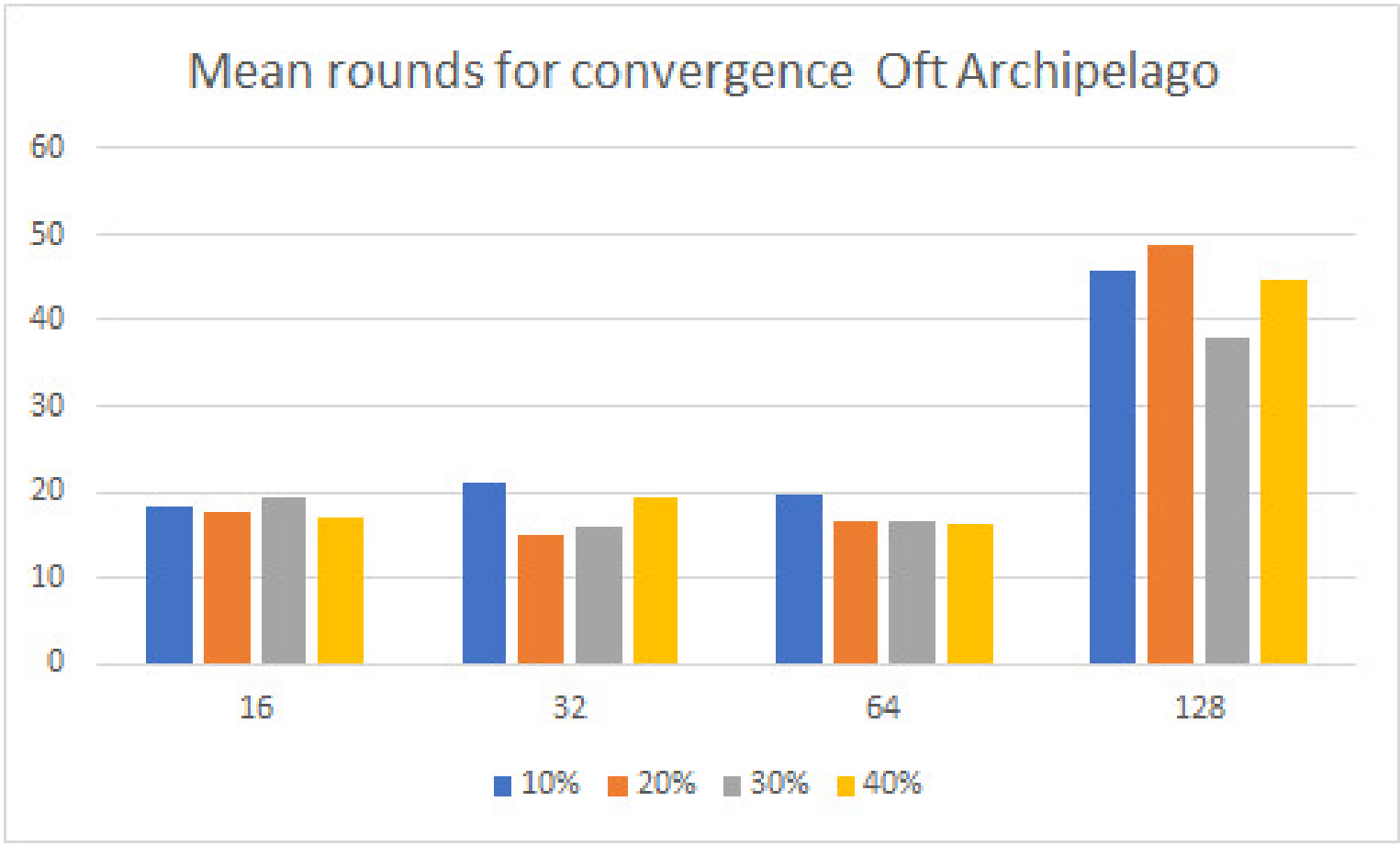


Experiments - Failure rate Archipelago adversary mode

Round limit	Convergence(Y/N)
10	N
100	N
1000	N

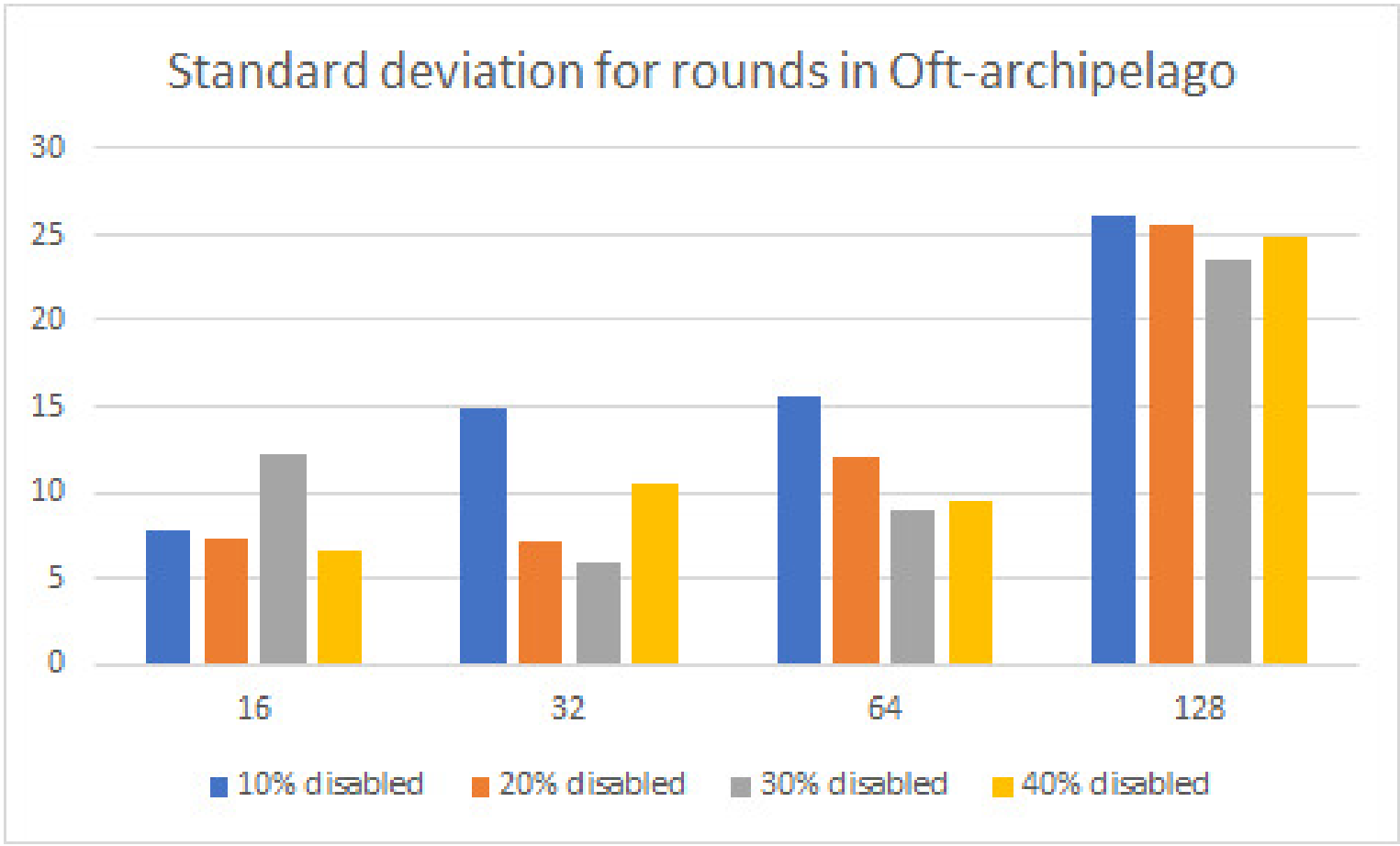
Experiments - Archipelago OFT

Node Count	10% disabled	20% disabled	30% disabled	40% disabled
16	18.24	17.8	19.34	16.8
32	21.05	14.91	15.78	19.5
64	19.69	16.52	16.48	16.16
128	45.92	48.75	37.82	44.69



Experiments - Archipelago OFT

Node Count	10% disabled	20% disabled	30% disabled	40% disabled
16	7.78	7.36	12.2	6.69
32	14.93	7.08	5.99	10.43
64	15.66	11.96	8.97	9.47
128	26.05	25.59	23.56	24.9



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- However, for large number of nodes (128) the mean and standard deviation increases significantly. Indicating that it takes longer to converge and that there is more volatility in rounds for convergence

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- However, for large number of nodes (128) the mean and standard deviation increases significantly. Indicating that it takes longer to converge and that there is more volatility in rounds for convergence
- Archipelago OFT obeys the O(n) theoretical limit for total rounds
- Once proposed limit

$$f = \frac{n-1}{2} \tag{1}$$

for disabled processes is reached, converging is not guaranteed.