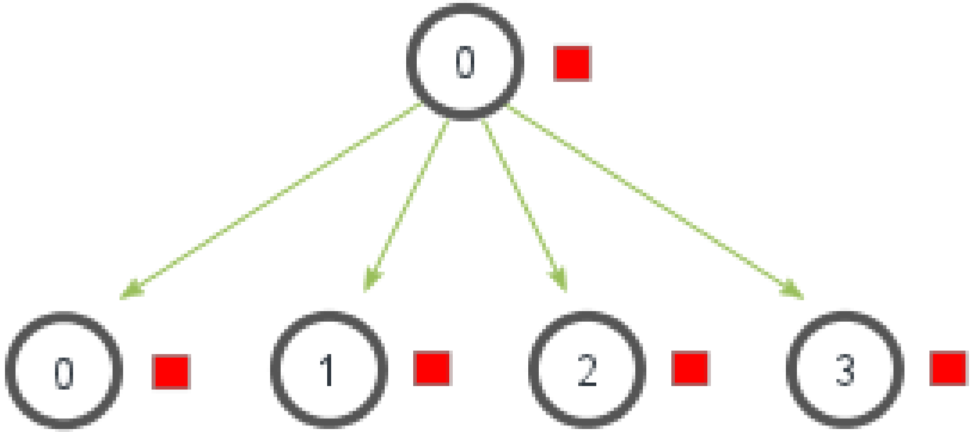
High Performance Computing Exercise 1

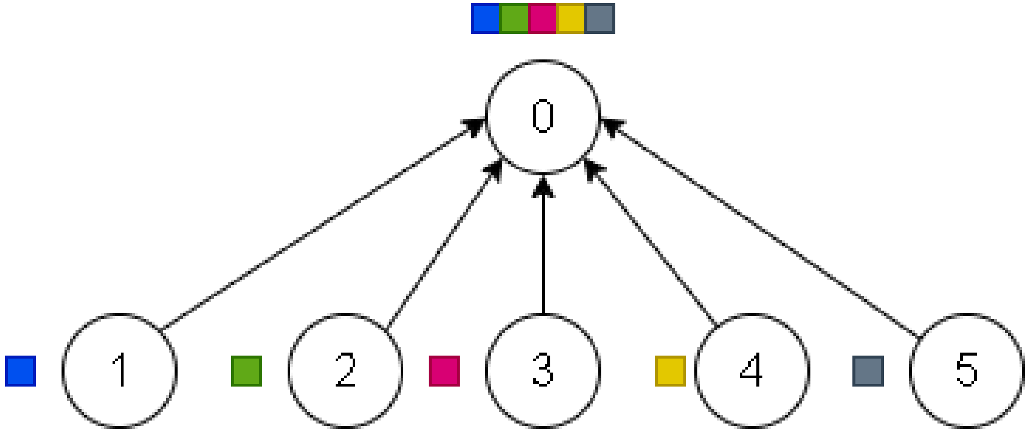
Alessandro Minutolo

Introduction

Broadcast



Gather



Settings

CLUSTER: ORFEO – EPYC AMD NODES

TOOL: OSU BENCHMARK

Data Collection

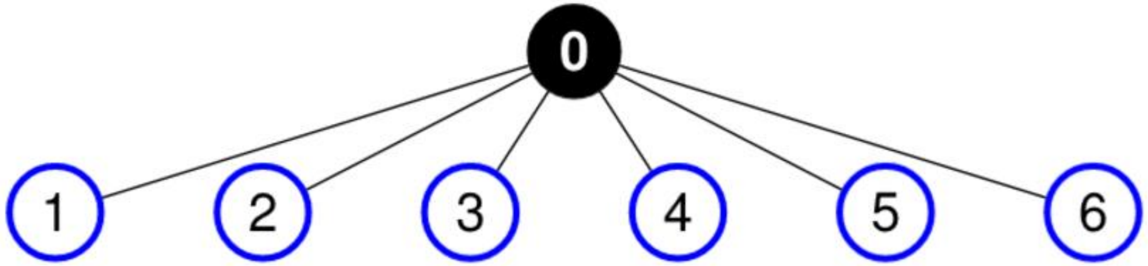
2 full EPYC nodes

Increasing number of processes (from 2 to 256)

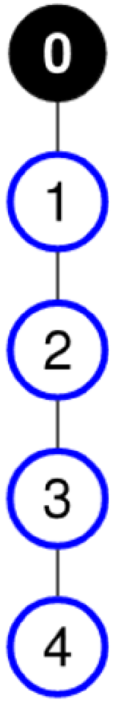
Increasing message size (from 2^0 to 2^{18})

Broadcast Algorithms

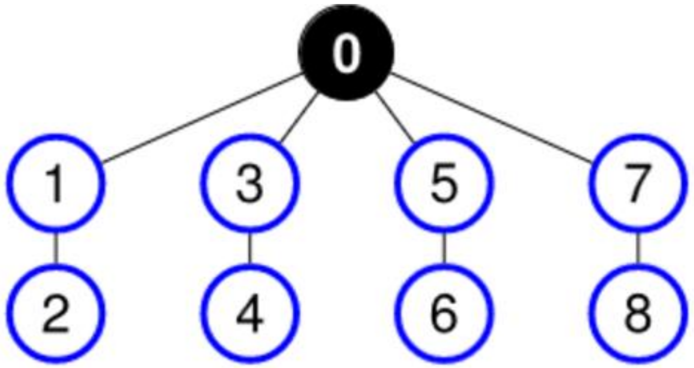
Basic linear



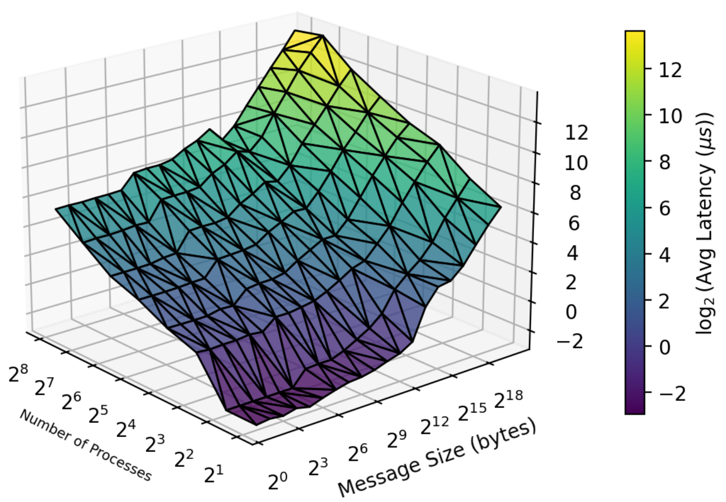
Pipeline



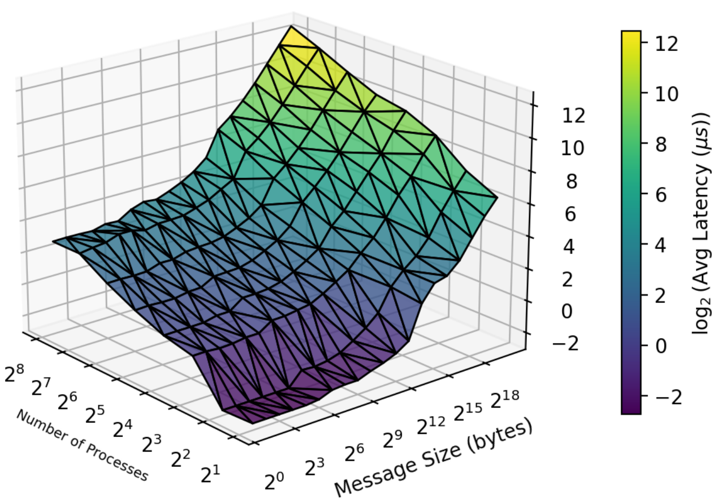
Chain



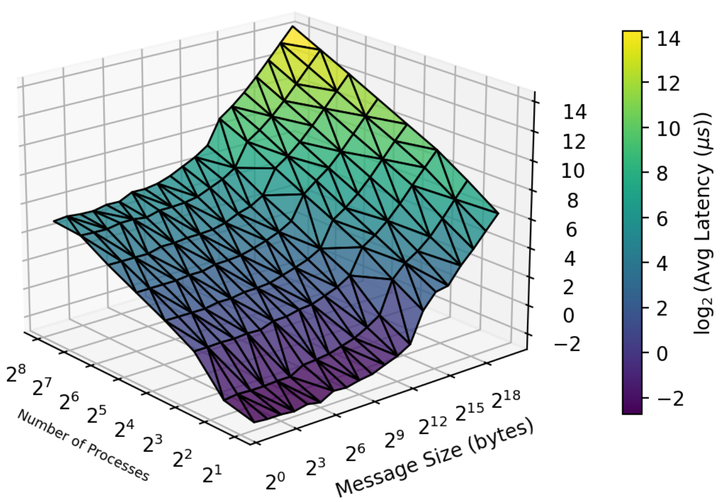
Basic Linear



Chain



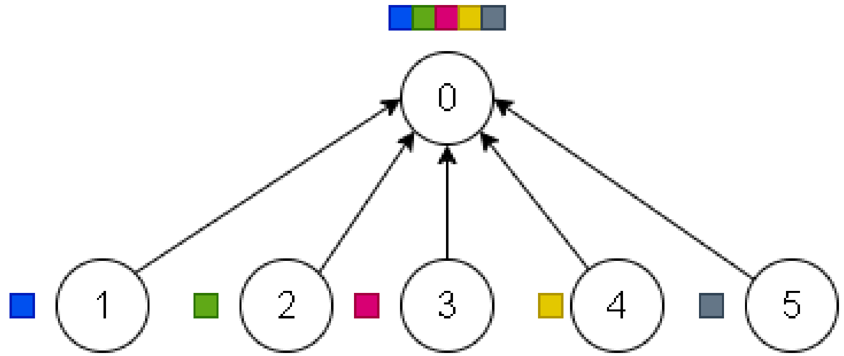
Pipeline



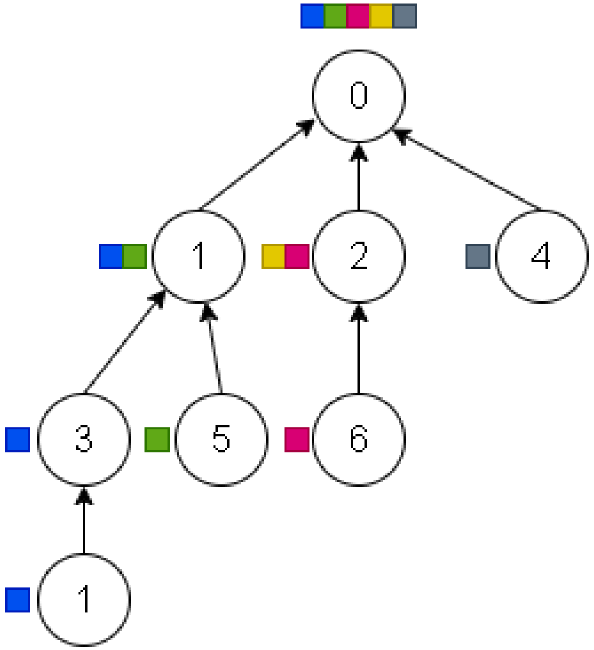
Performances of different broadcast algorithms

Gather Algorithms

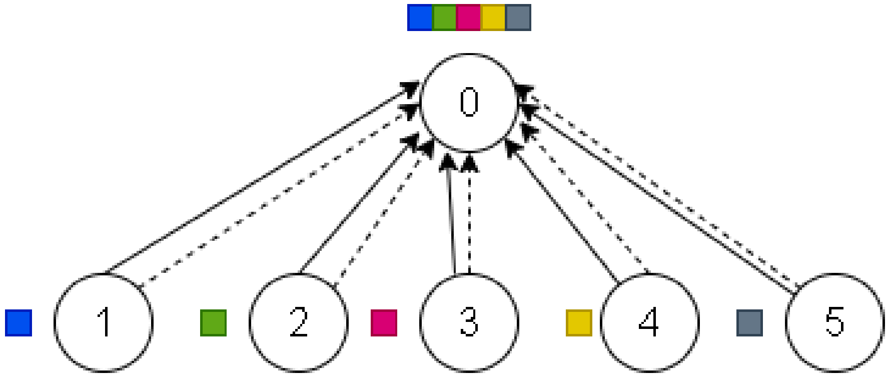
Basic linear

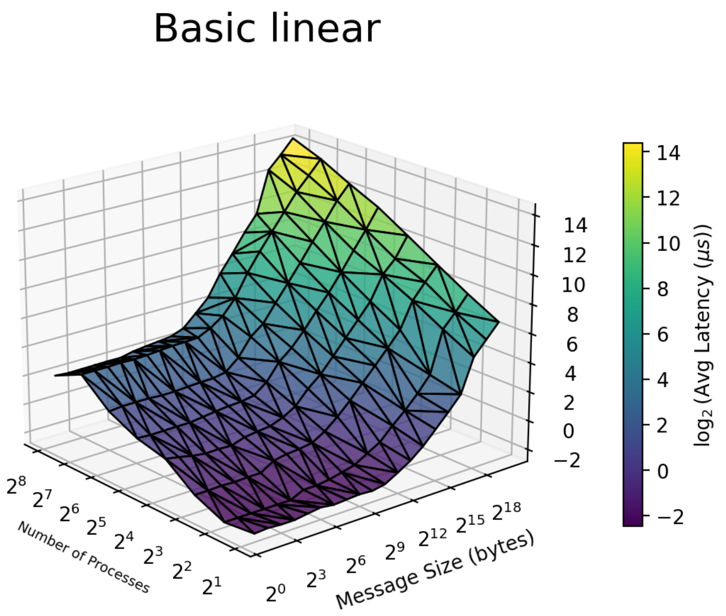


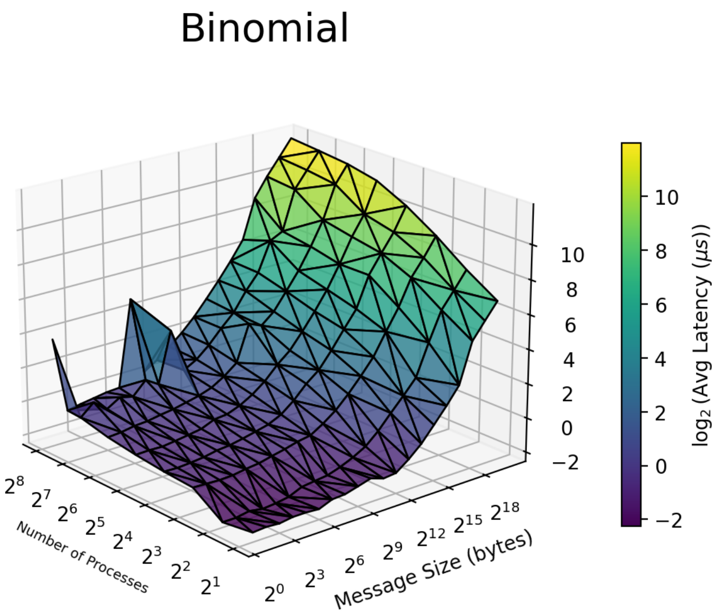
Binomial

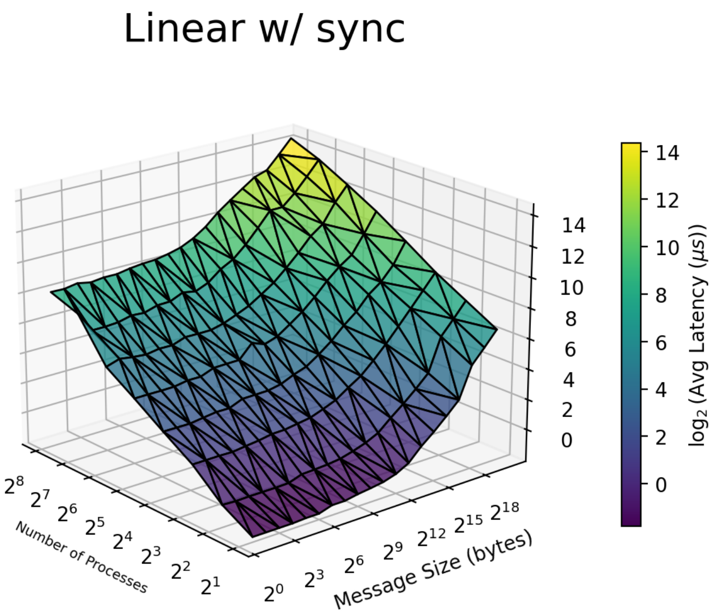


Linear w/ sync









Performances of different gather algorithms

Performance Models

- Data collected with a fixed size of the message (4byte)
- Point to point communication time between cores (OSU benchmark)
- Mathematical models for ideal performances

Broadcast Models

- Basic linear:

$$T = \max\left(T_{0,1}, T_{0,2}, \dots, T_{0,n}\right) + overhead$$

- Chain:

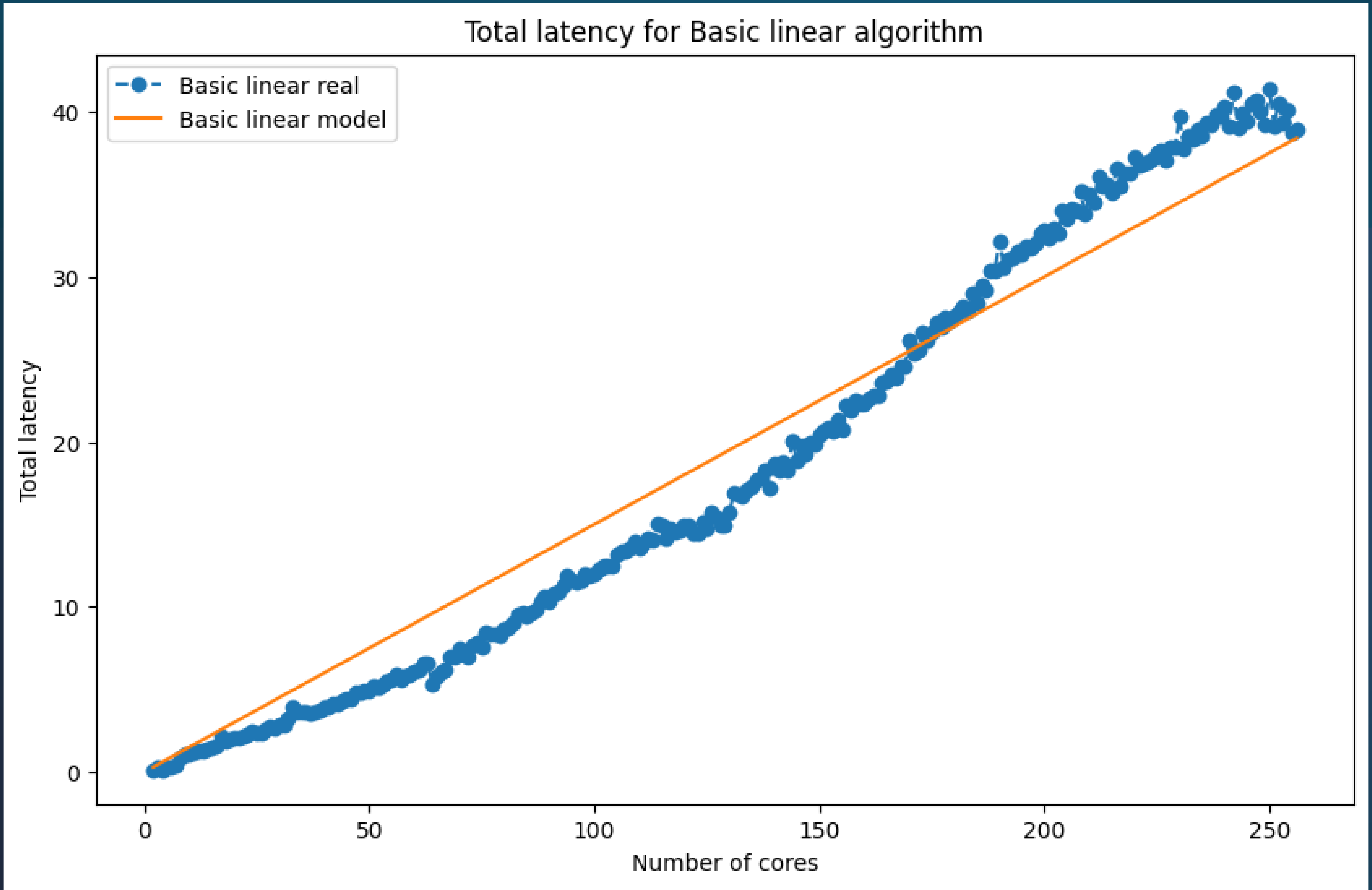
$$T = \max(T_1, \dots, T_k)\,, k = 1, \dots, 4$$

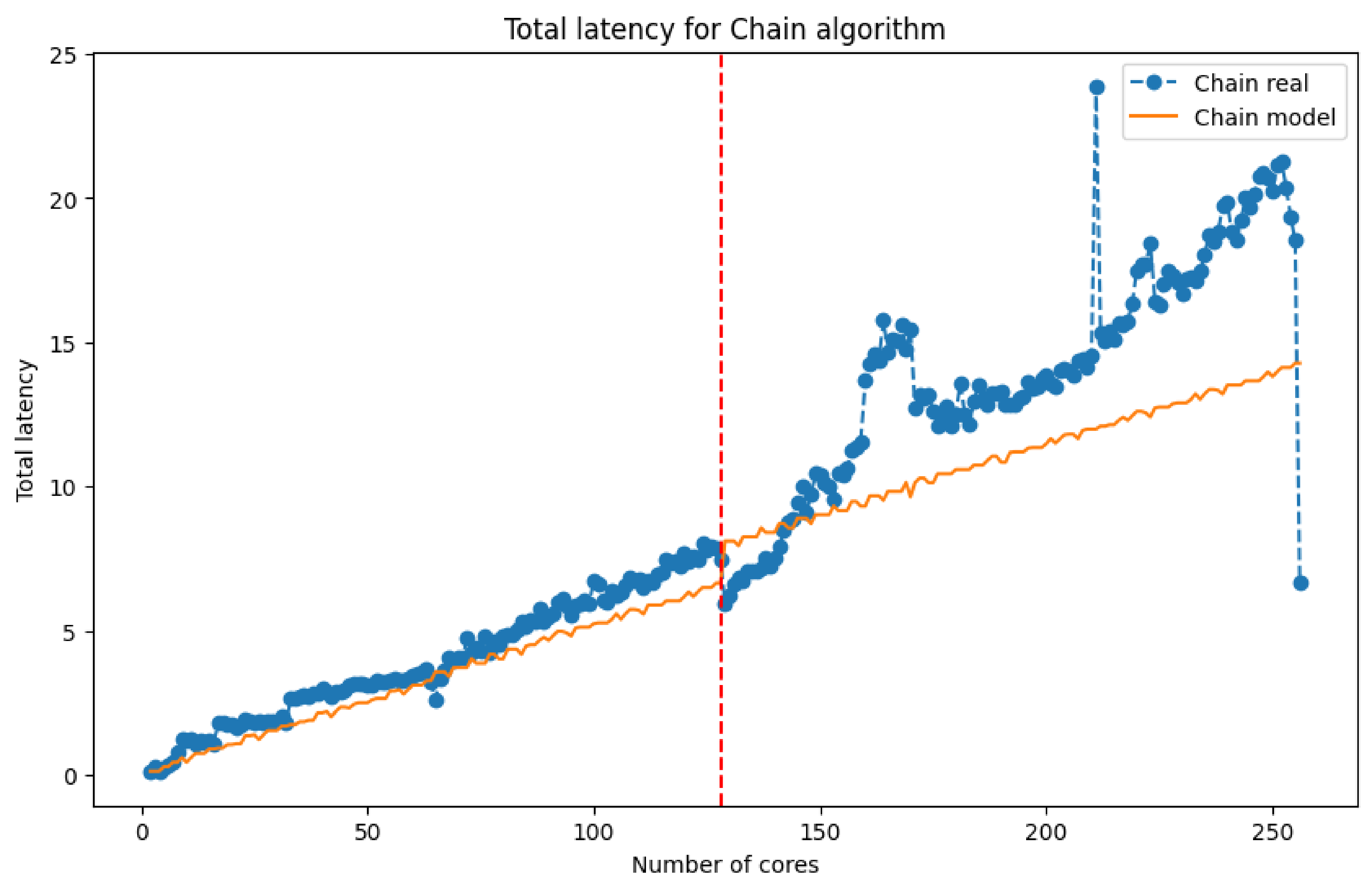
where T_k is the total time for the k-th chain: $T_k = T_{0,k_1} + \sum_{i=1}^{m_k-1} T_{k_i,k_{i+1}}$,

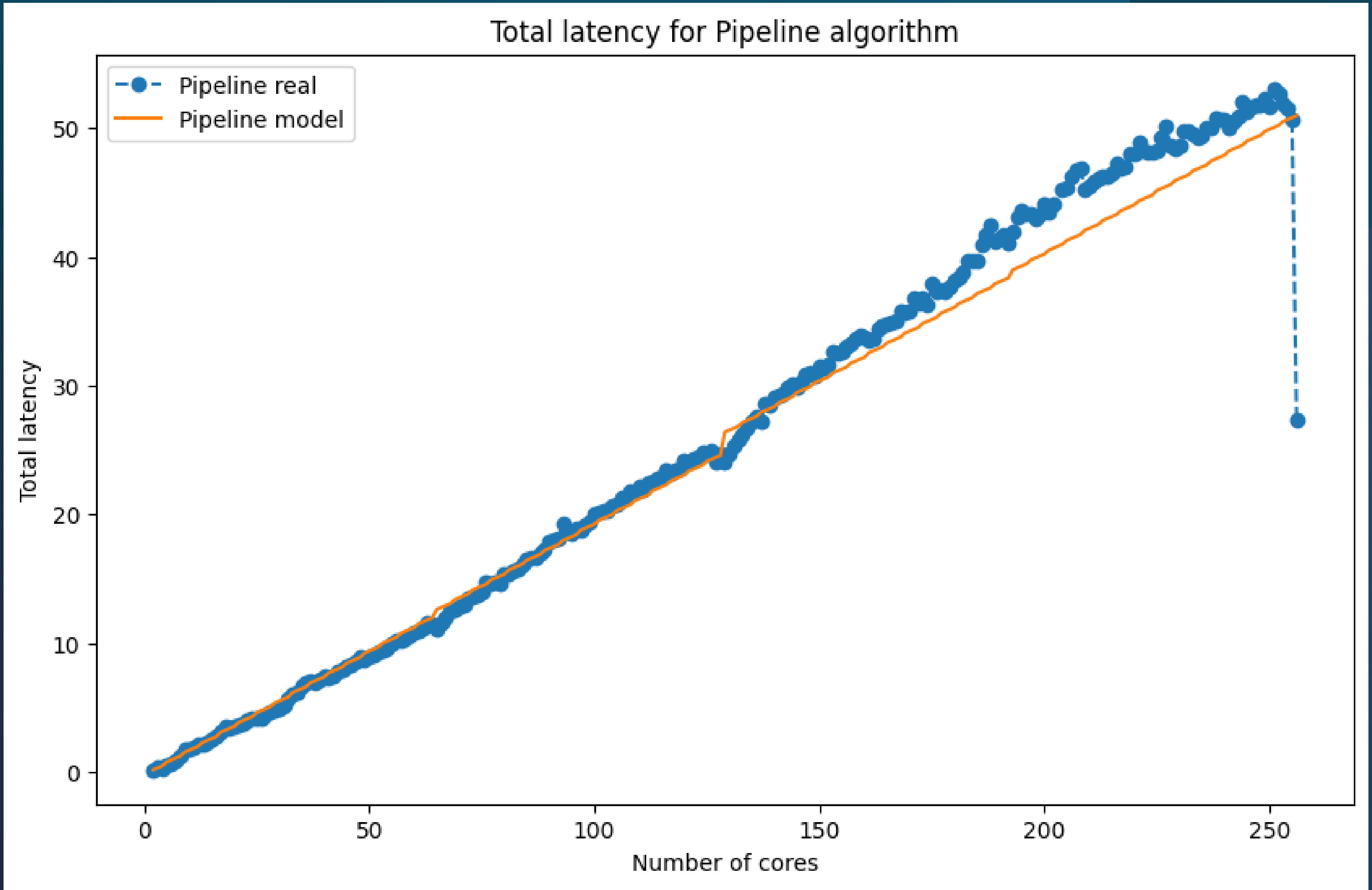
where T_{0,k_1} is the time to send the message from the root to the first process in the k-th chain and m_k is the total number of processes in the k-th chain

- Pipeline:

$$T = \sum_{i=0}^{N-1} T_{i,i+1}$$


Total latency for Basic linear algorithm
Basic linear real
Basic linear model
Total latency
Number of cores
0
10
20
30
40
0
50
100
150
200
250


Total latency for Chain algorithm
Total latency
Number of cores
Chain real
Chain model
0
5
10
15
20
25
0
50
100
150
200
250


Total latency for Pipeline algorithm
Pipeline real
Pipeline model
Total latency
Number of cores
0
10
20
30
40
50
0
50
100
150
200
250

Gather Models

- Basic linear:

$$T = \max\left(T_{1,0}, T_{2,0}, \dots, T_{n,0}\right) + overhead$$

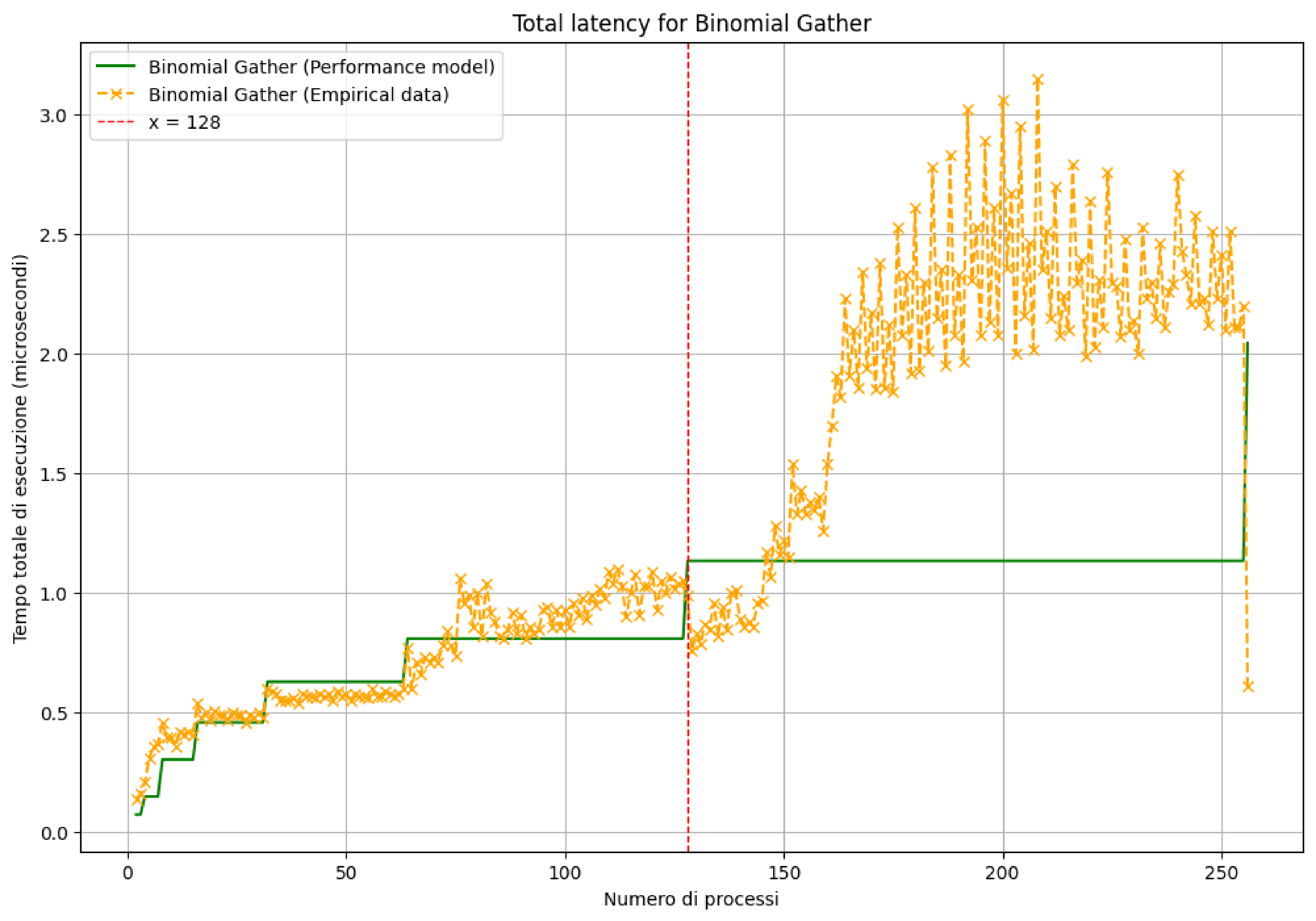
- Binomial:

$$T = \sum_{l=0}^{L-1} \max\{T_{i,i+2^l} | i \text{ } is \text{ } a \text{ } process \text{ } at \text{ } level \text{ } l\}$$

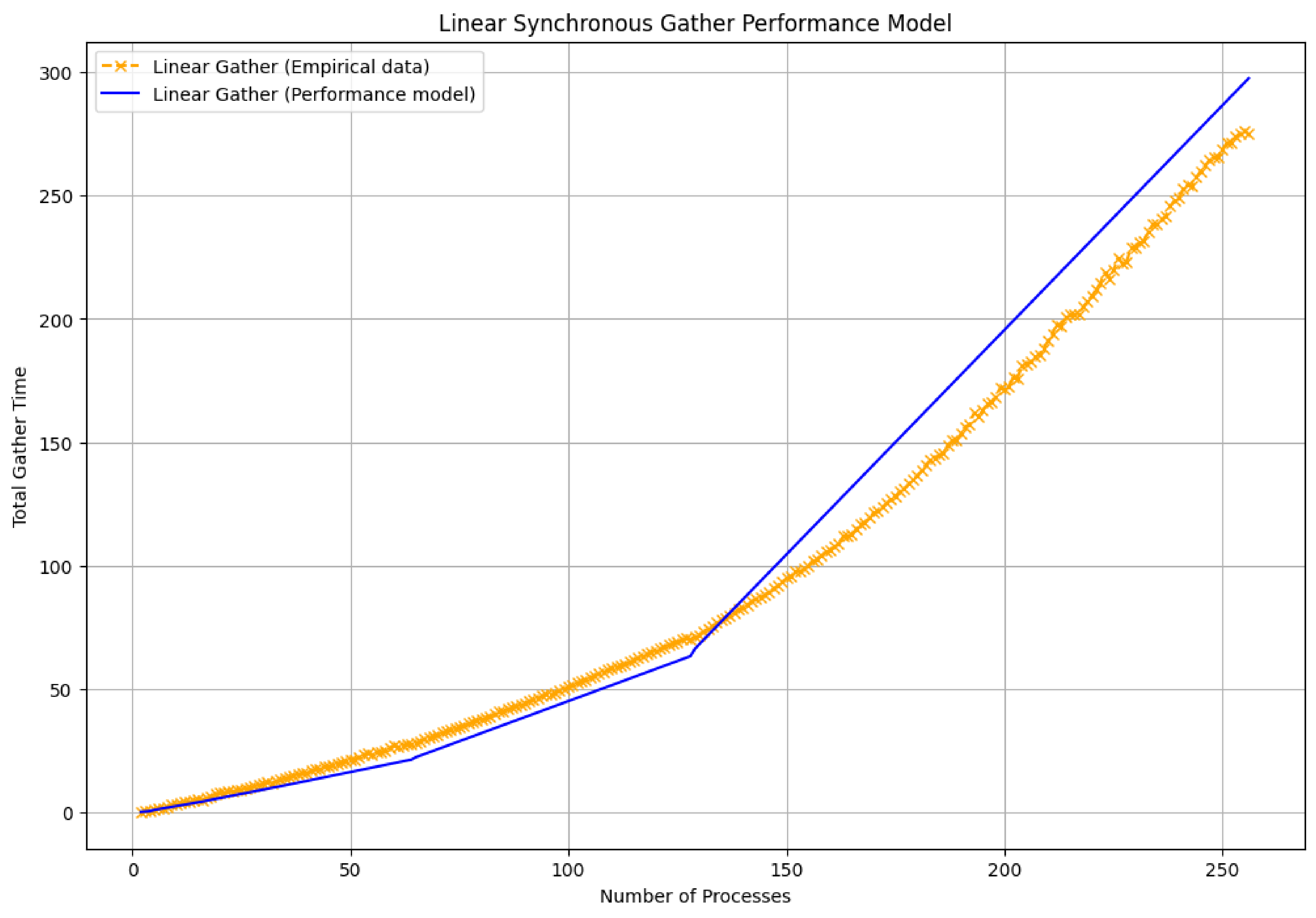
- Linear w/ sync:

$$T = \sum_{i=1}^{N} T^{1st}{}_{i,0} + \max\left(T^{2nd}{}_{i,0}, \dots, T^{2nd}{}_{n,0}\right)$$

Total latency for Basic Linear Gather
Basic Linear Gather (Model)
Basic Linear Gather (Empirical data)
x = 128
Tempo totale di esecuzione (microsecondi)
Numero di processi
0
2
4
6
8
10
12
0
50
100
150
200
250



Total latency for Binomial Gather
Binomial Gather (Performance model)
Binomial Gather (Empirical data)
x = 128
Tempo totale di esecuzione (microsecondi)
Numero di processi
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
50
100
150
200
250


Linear Synchronous Gather Performance Model
Linear Gather (Empirical data)
Linear Gather (Performance model)
Total Gather Time
Number of Processes
0
50
100
150
200
250
300