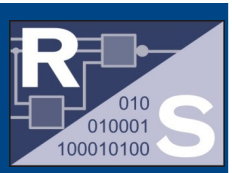
Hardware Support for Histogram-based Performance Analysis



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Agenda

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- **Motivation**
  - Measurement-based Execution Time Estimation
- **Online Generated Basic Block Histograms**
- **Working with Basic Block Histograms**
  - Probability Mass Functions
  - Operations for PMFs
  - Example

Execution Time Estimation

TECHNISCHE UNIVERSITÄT DARMSTADT

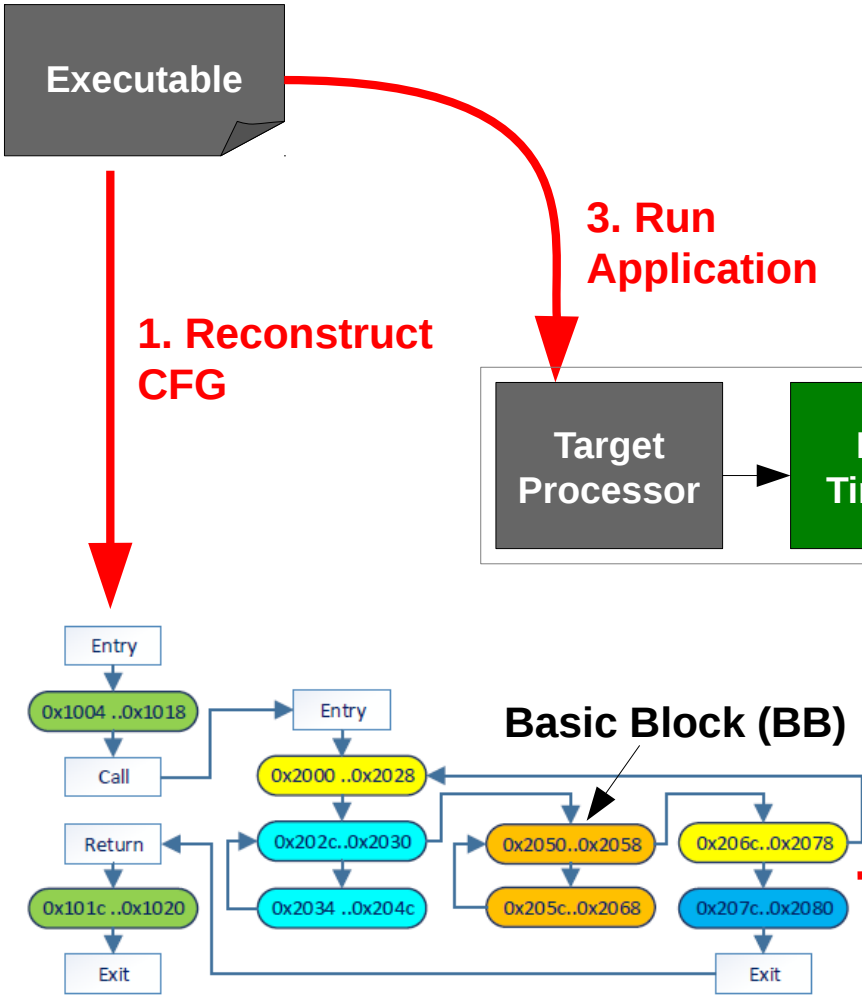
Boris Dreyer, Christian Hochberger, Simon Wegener, and Alexander Weiss.

Precise Continuous Non-Intrusive Measurement-Based Execution Time Estimation.

In Francisco J. Cazorla, editor, 15th International Workshop on Worst-Case Execution Time Analysis (WCET 2015), volume 47 of OpenAccess Series in Informatics (OASIcs), pages 45-54, Dagstuhl, Germany, 2015.

Schloss Dagstuhl—Leibniz-Zentrum für Informatik.

Execution Time Estimation - Idea



BB Address	Max First	Max Further
0x1004	8 us	0 us
0x2000	22 us	11 us
0x202c	16 us	8 us
0x2034	2 us	1 us
0x2050	12 us	8 us
0x205c	2 us	1 us
0x206c	8 us	4 us
0x207c	6 us	0 us
0x101c	6 us	0 us

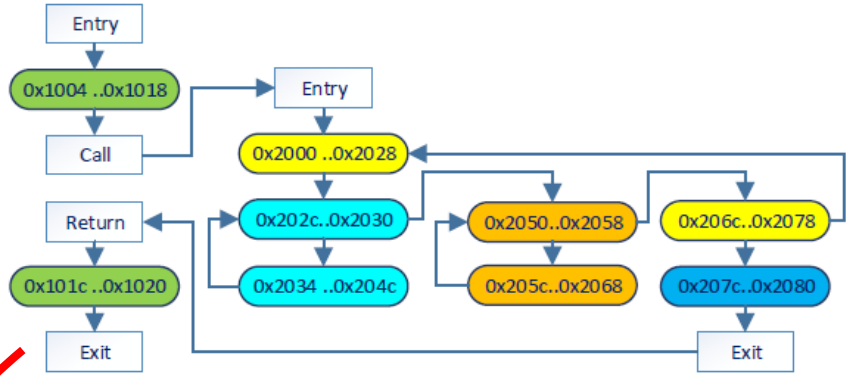
Context Sensitive BB Statistics

Execution Time Estimation - Idea

BB Address	Max First	Max Further
0x1004	8 us	0 us
0x2000	22 us	11 us
0x202c	16 us	8 us
0x2034	2 us	1 us
0x2050	12 us	8 us
0x205c	2 us	1 us
0x206c	8 us	4 us
0x207c	6 us	0 us
0x101c	6 us	0 us

Context Sensitive BB Statistics

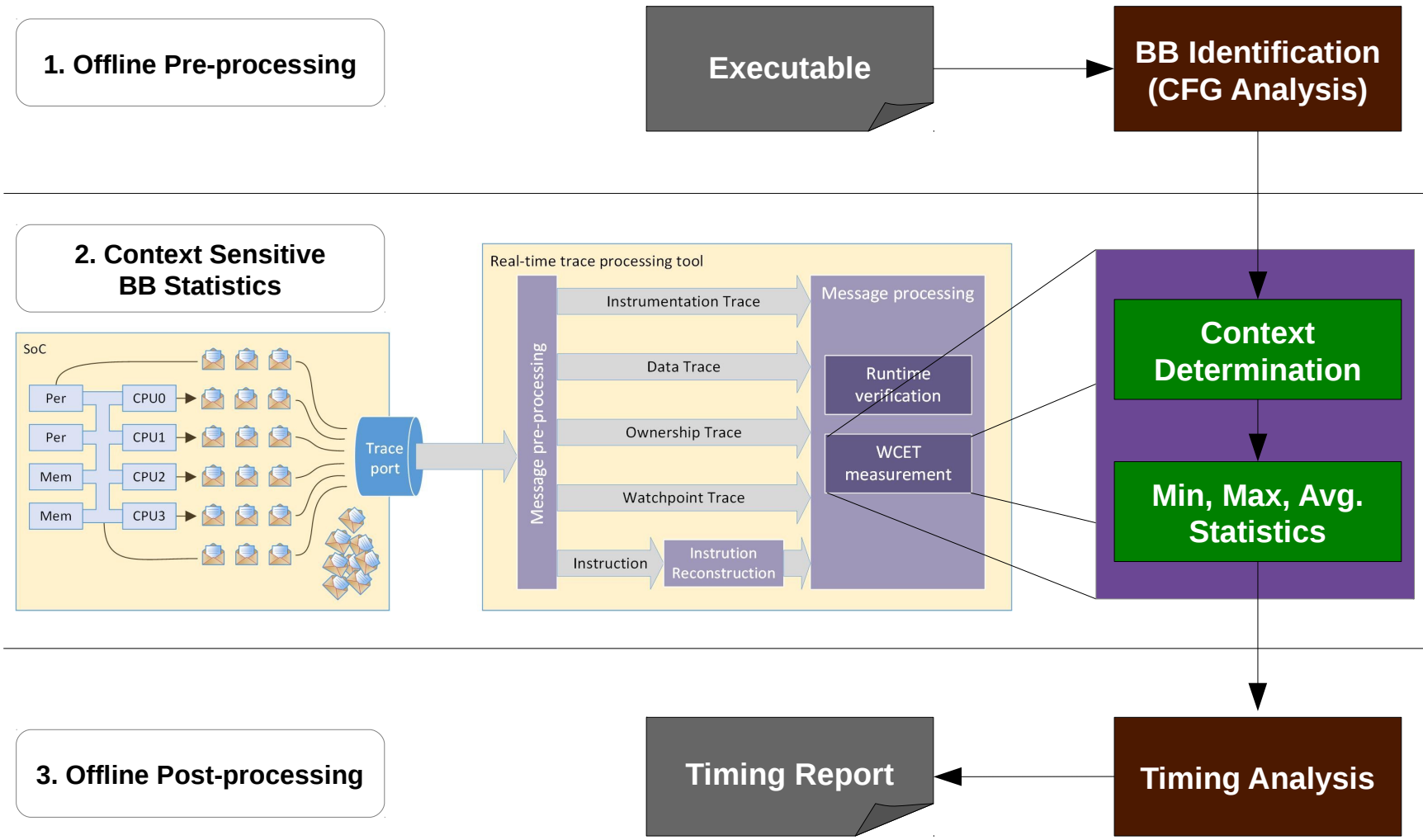
5. Annotate CFG



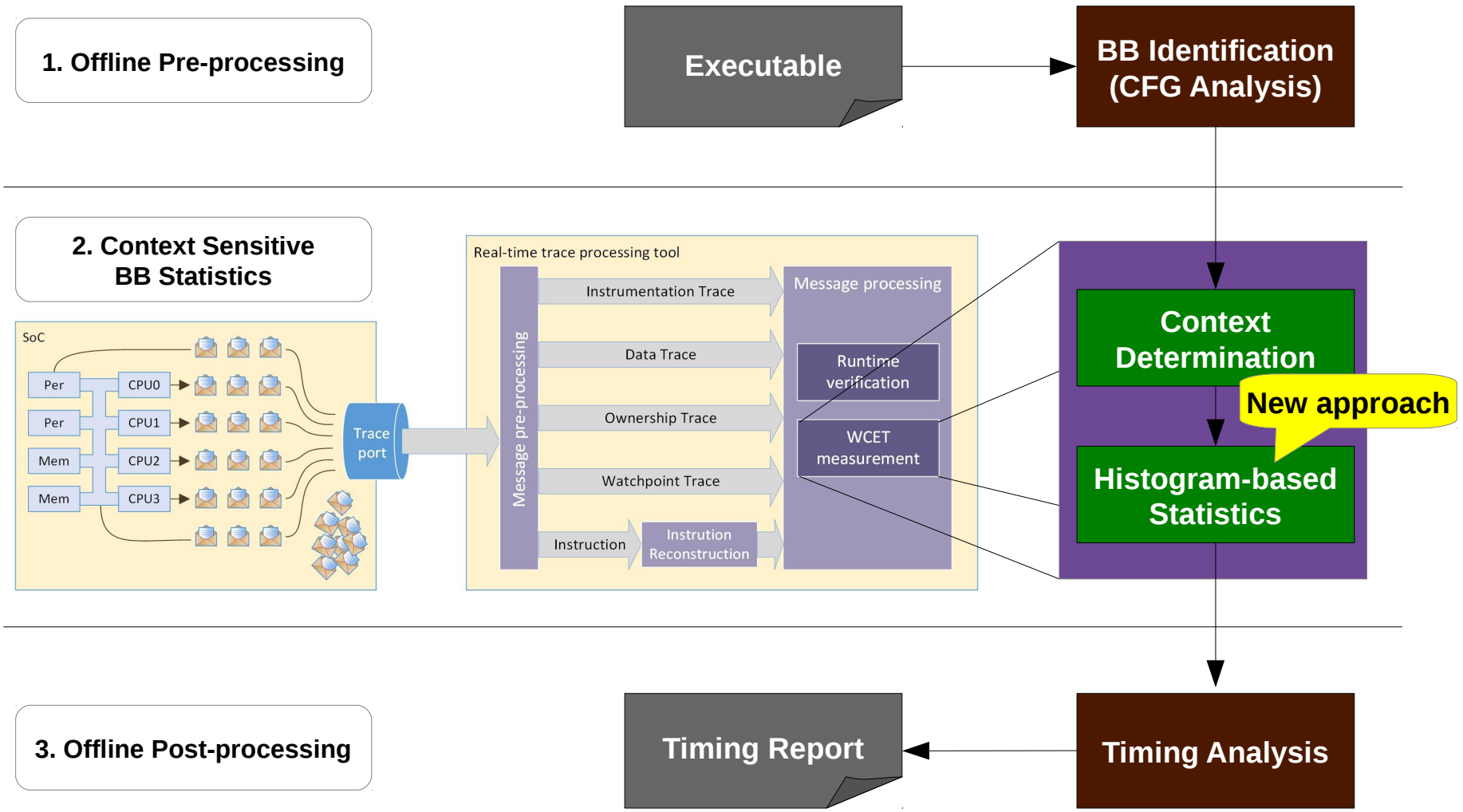
6. Find longest path (ILP based)

Overall execution time estimate
Our method: 191 us
Context insensitive: 258 us

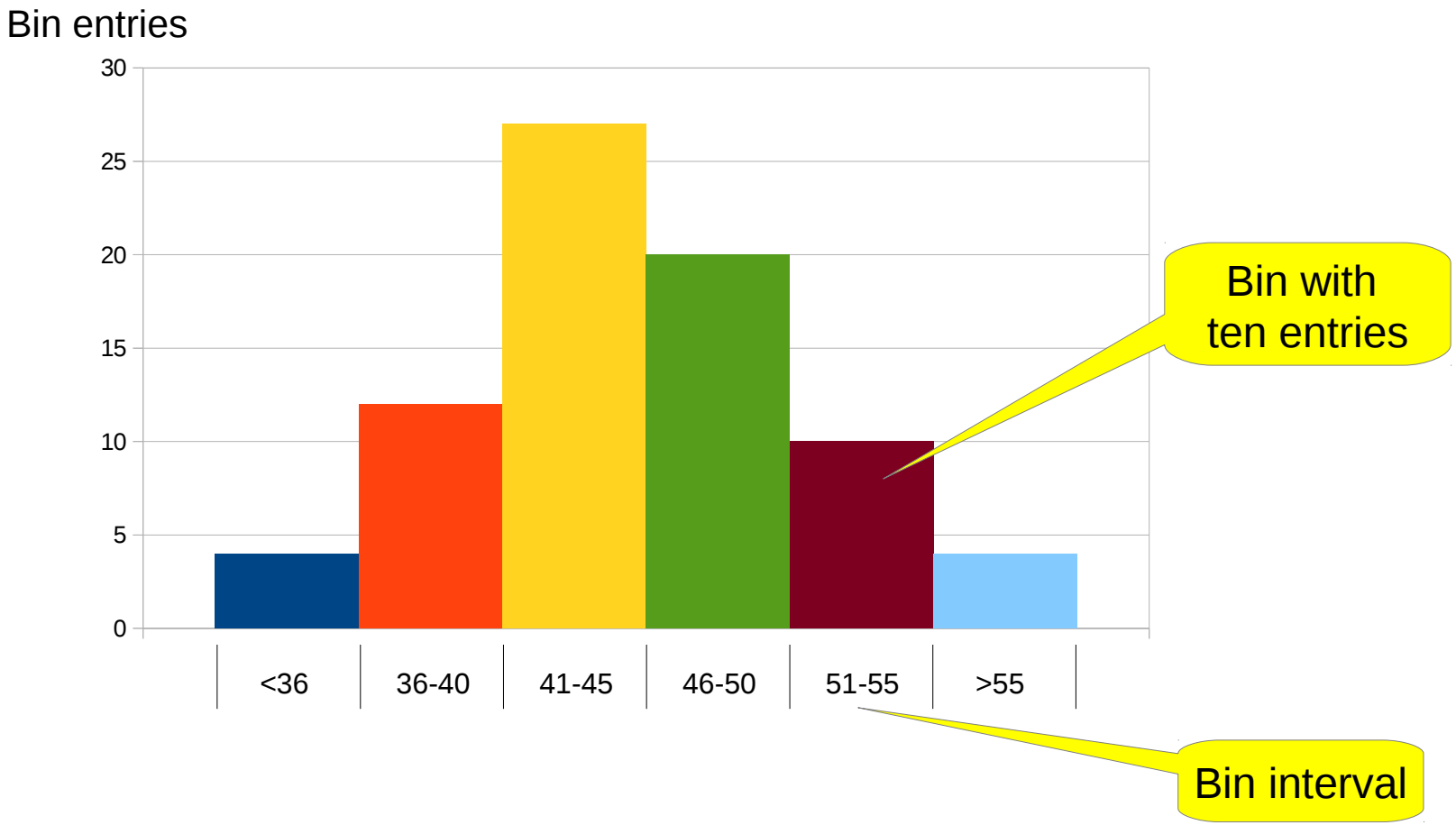
Execution Time Estimation - Architecture



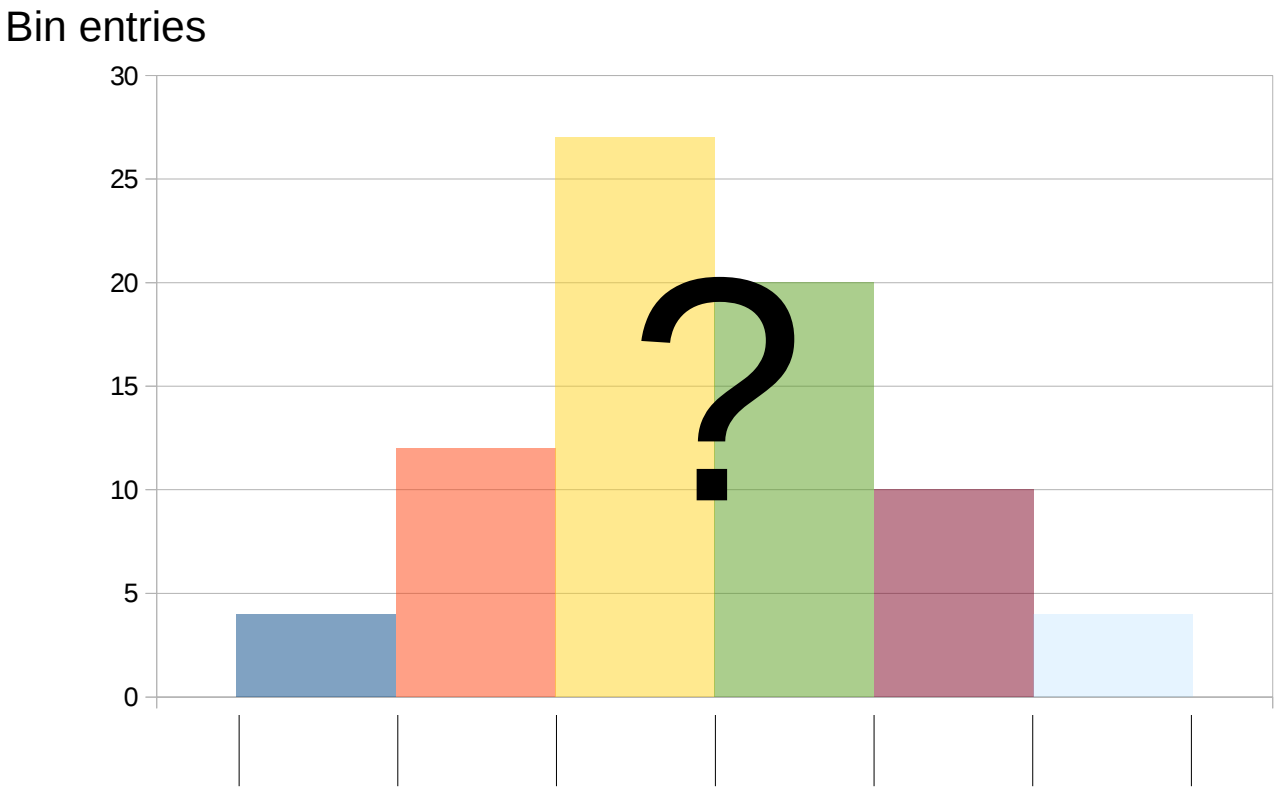
Execution Time Estimation - Architecture



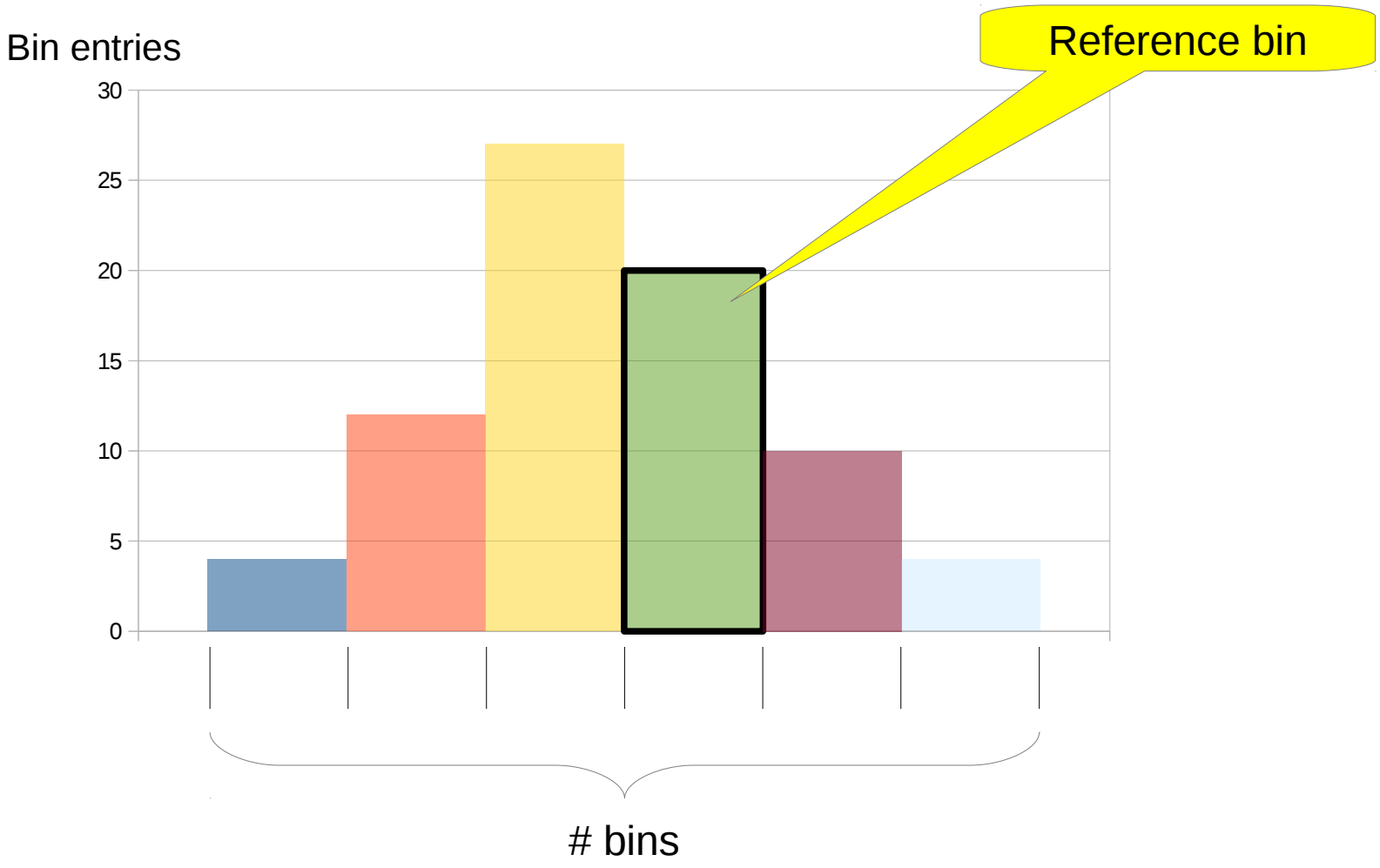
Histogram


Bin entries
30
25
20
15
10
5
0
<36
36-40
41-45
46-50
51-55
>55
Bin with ten entries
Bin interval

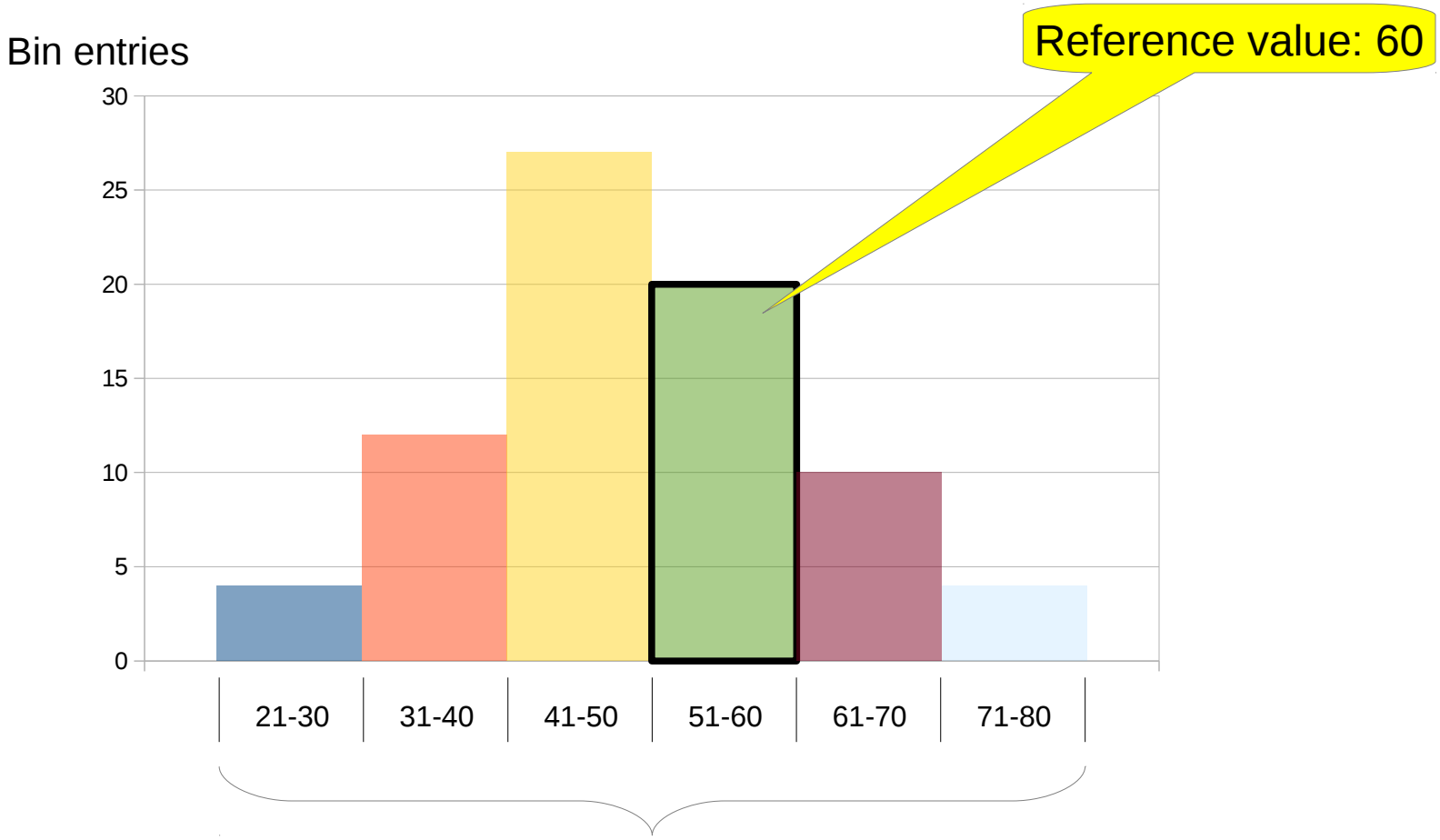
Histogram – Implementation



Histogram – Reference Bin

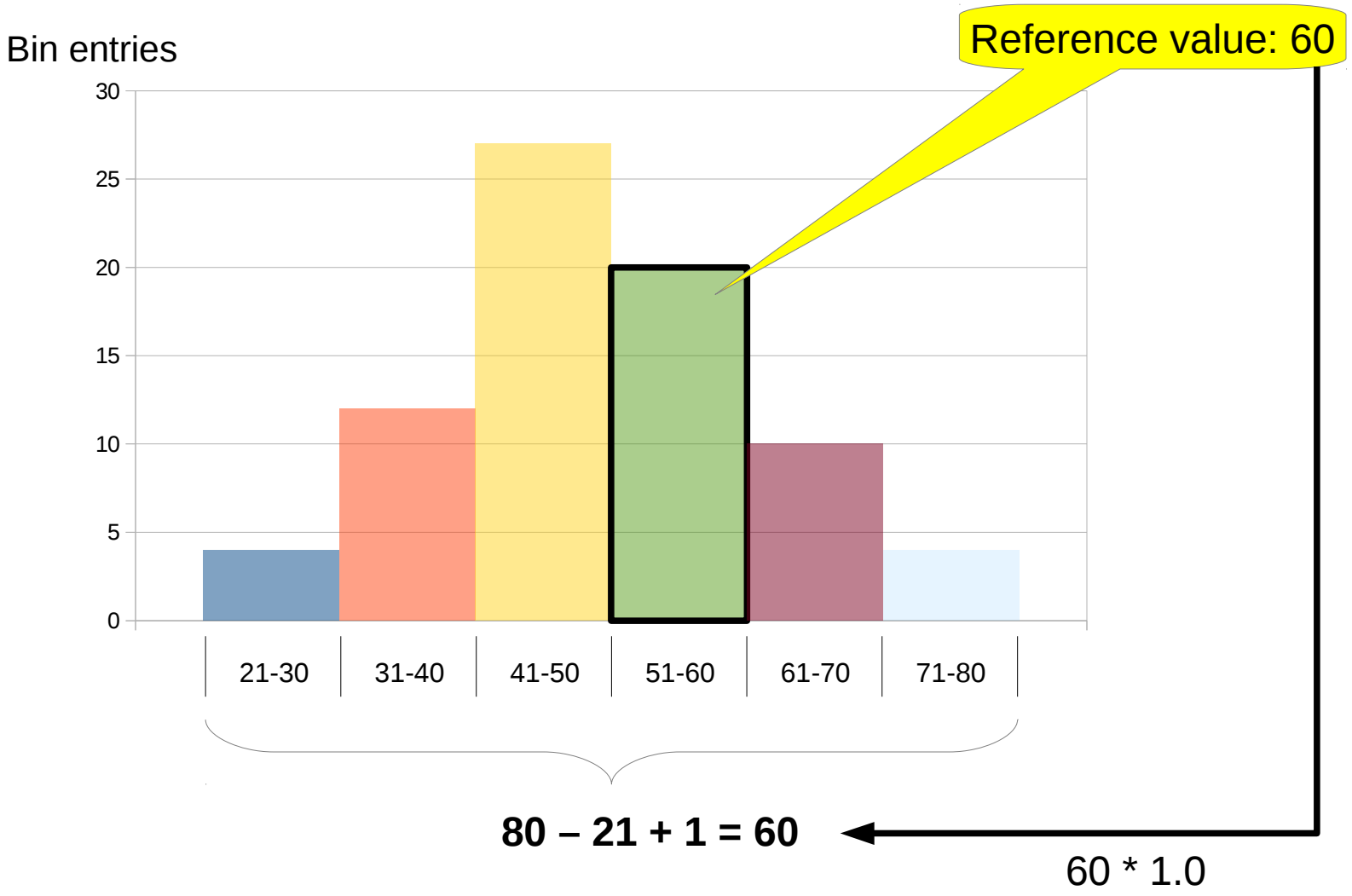


Histogram – Reference Value

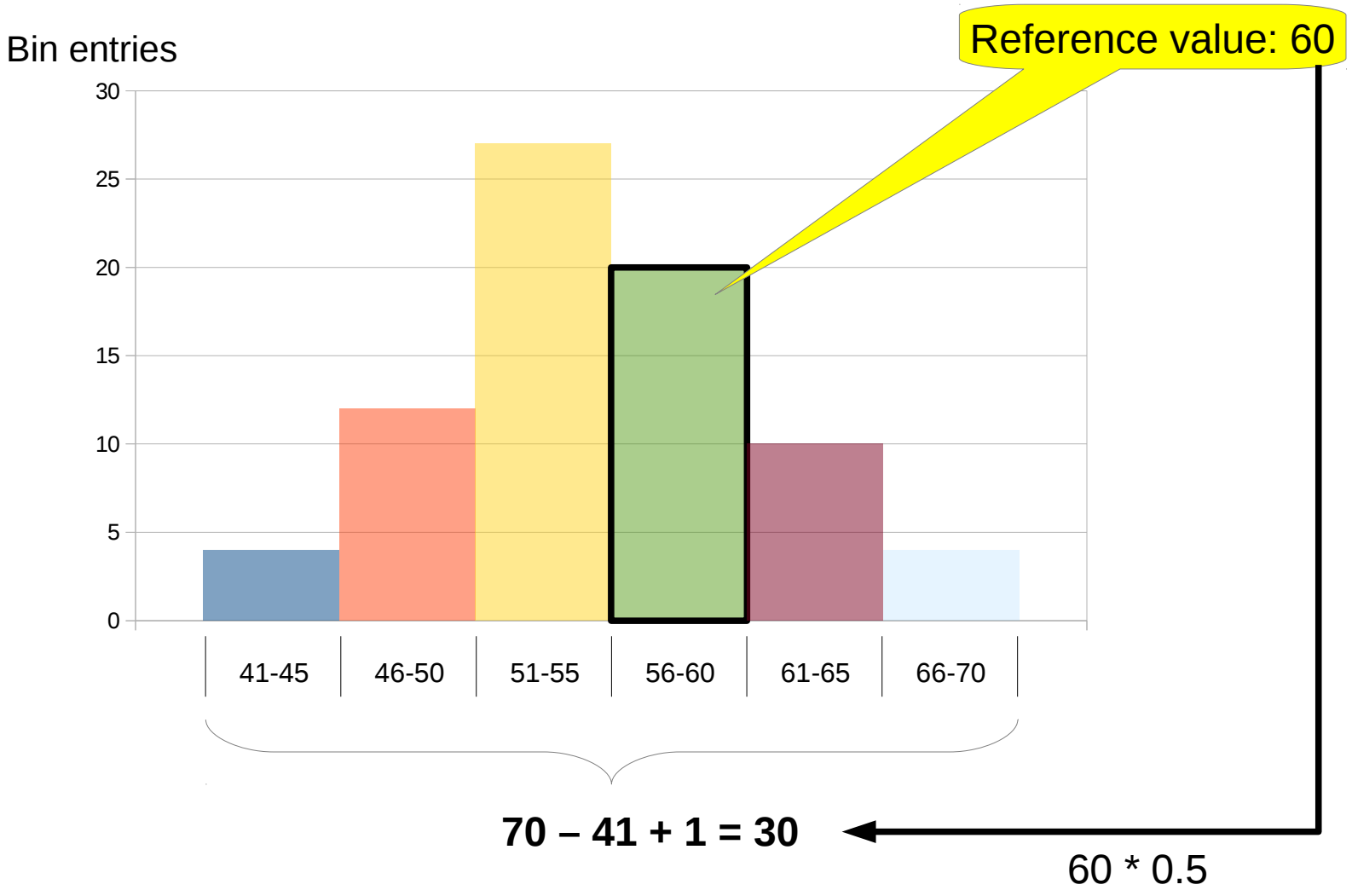


80 – 21 + 1 = 60

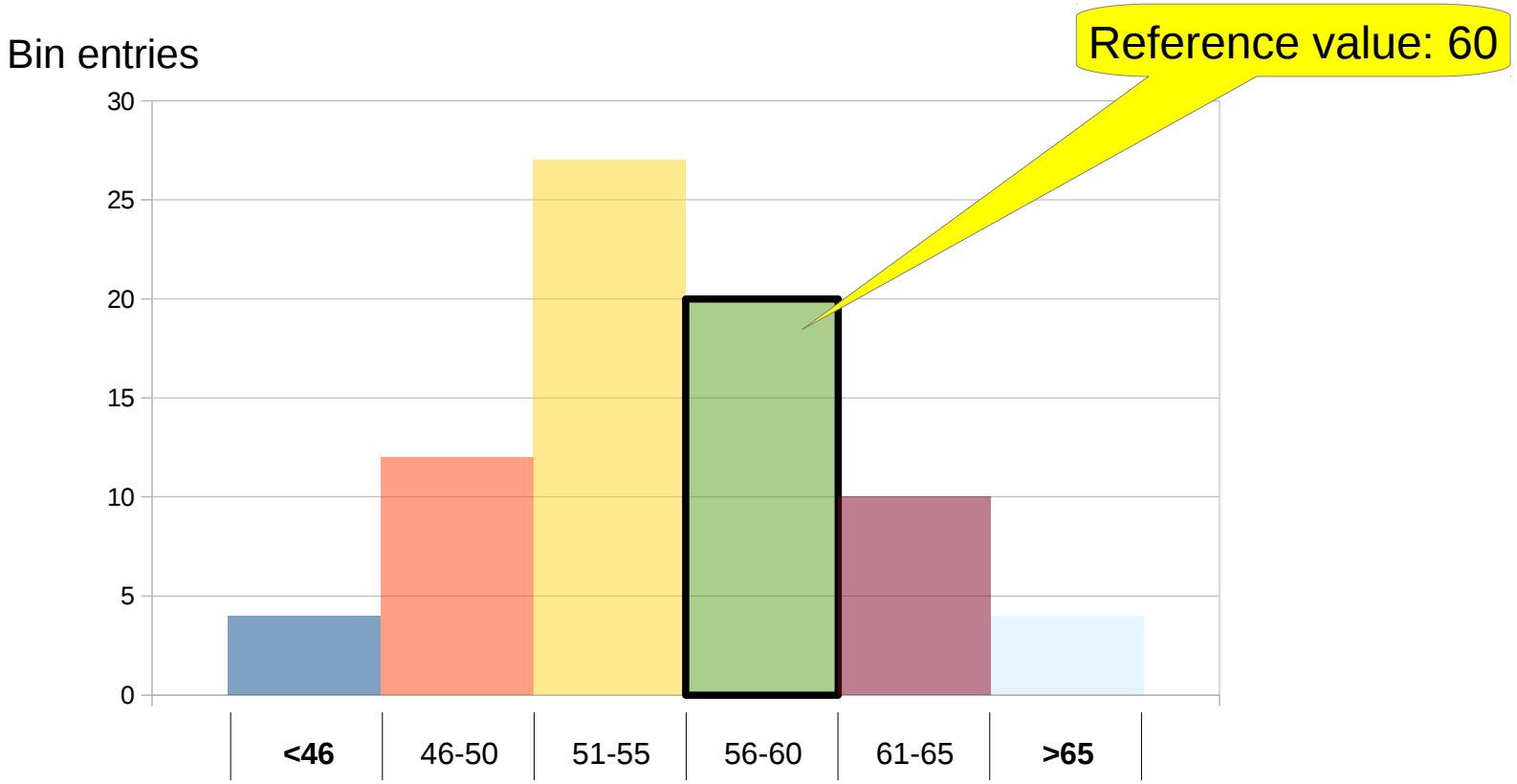
Histogram – Linear Compression = 1.0



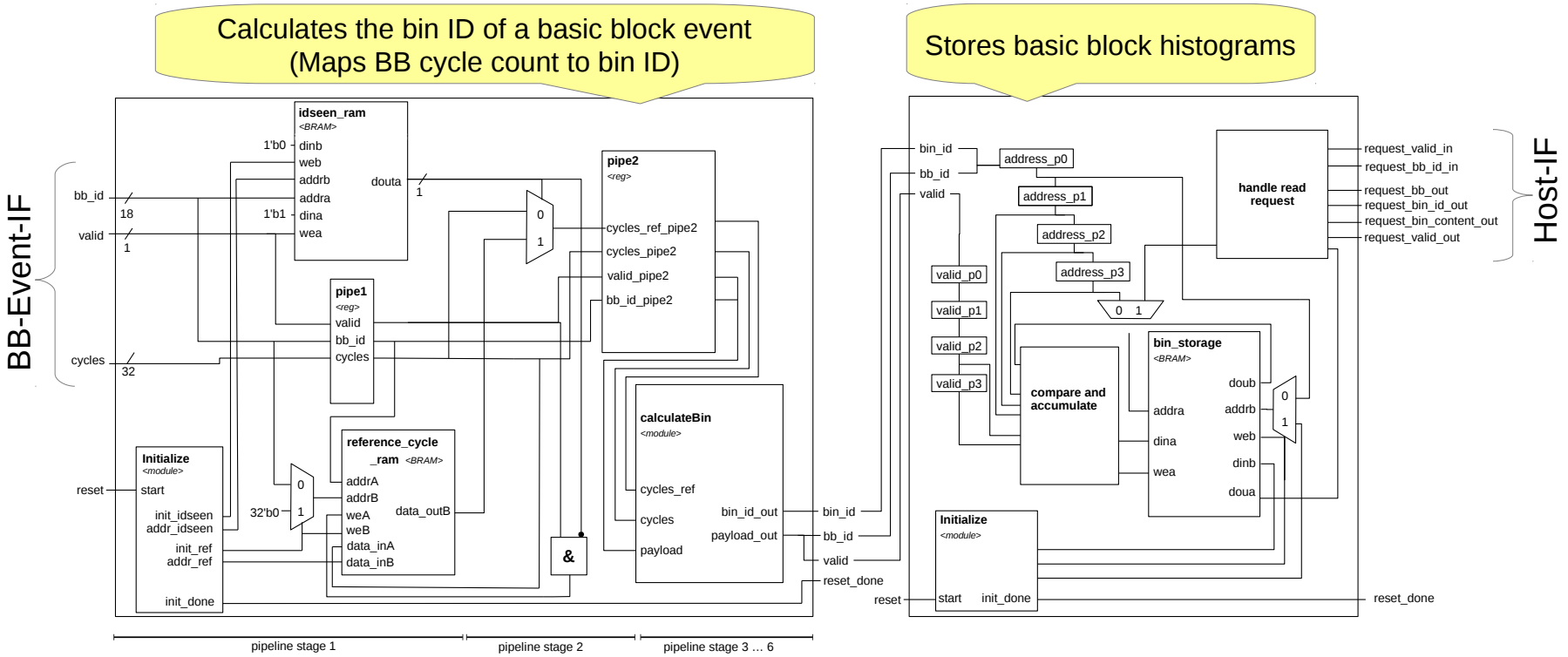
Histogram – Linear Compression = 0.5



Histogram – Catch-all Bins



Histogram Implementation



Bin finder module parameter

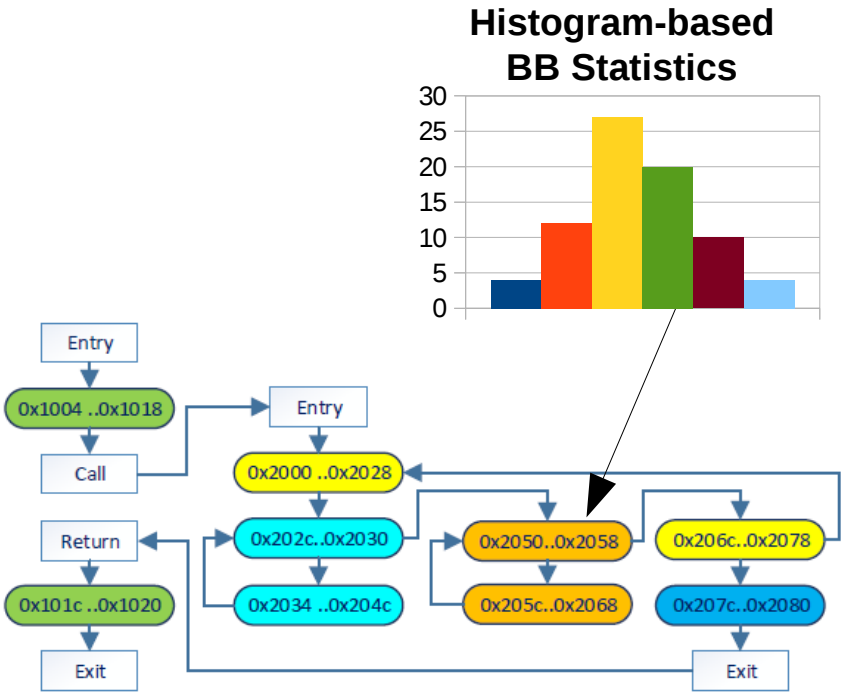
- # basic blocks
- # bins per basic block
- reference bin
- linear compression

Storage module parameter

- # basic blocks
- # bins per basic block

Determine resource consumption

Histogram-based BB Statistics



Histograms at Different Abstraction Levels