

Table 15 – Placement of alignment padding in the binaries. We identified nine scenarios in which compilers emits alignment padding at different locations in the binary

#	Placement in Binary	Purpose and Location	Impact of Optimization	Align
1	Data interleaved in Code	inline data in .text section	increase with optimization	DB
2	Import Functions	before a branch instruction	decrease with optimization	NOP
3	Exception handling functions	aligned jump tables	less in MSVC & Clangcl, intense in ICC at O2, O3 [17]	NOP
4	Intrinsic functions	compiler’s inlined functions	expansion of function vary with compiler family & optimization [26]	NOP, DB
5	Function-entry alignment	before subroutine or EH function	align code and data	INT3, NOP
6	Common Runtime (CRT) routines	handcoded assembly routines	intense use of CRT at higher optimization	ZERO, DB
7	End-of-segment alignment	PE sections are aligned	decrease with higher optimization	ZERO, DB
8	Vector operations	128-bit multimedia operands are aligned	MMX and SSE (XMM) instructions aligned at 16 Byte address	NOP, DB
9	Branch Alignment	align branch target to a multiple of 16	increase with optimization	NOP

Table 16 – The selected C/C++ projects from Github in our dataset

Project	Description
ogg-vorbis	audio encoder/decoder for lossy compression
cmake	a cross-platform, open-source build system generator.
curl	library for data transfer with url syntax
doxygen	document generation tool from annotated C++ sources
eigen	C++ template library for linear algebra, matrices, vectors, numerical solvers, etc.
gflags	C++ library with command-line flags for strings, etc.
glm	C++ openGL Mathematics library for graphics
glog	C++ google logging (glog) module
libevent	a library that provides asynchronous event notifications.
llvm	an open source compiler and toolchain
onednn	oneAPI deep neural network library optimized for Intel and Xe architectures.
opencl	Open Computing Language for heterogeneous platforms like CPUs, GPUs, etc.
openssl	library to secure communications over computer networks against eavesdropping.
Microsoft library	C++ Standard Template Library (STL) for MSVC toolset and Visual Studio IDE.
sqlite	a relational database management system contained in a C library.
vtk	an image processing, 3D graphics, volume rendering, and visualization toolkit.
zlib	data compression library used in gzip file compression programs.