1.1 ./Platform.Unsafe/ByteArrayExtensions.cs

```
using Platform.Exceptions;
using Platform.Collections;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Unsafe
{
    public unsafe static class ByteArrayExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static TStruct ToStructure<TStruct>(this byte[] bytes)
            where TStruct : struct
        {
            Ensure.OnDebug.ArgumentNotEmpty(bytes, nameof(bytes));
            var structureSize = System.Runtime.CompilerServices.Unsafe.SizeOf<TStruct>();
            Ensure.OnDebug.ArgumentMeetsCriteria(bytes, array => array.Length == structureSize,
            ↪  nameof(bytes), "Bytes array should be the same length as struct size.");
            TStruct structure = default;
            fixed (byte* pointer = bytes)
            {
                System.Runtime.CompilerServices.Unsafe.Copy(ref structure, pointer);
            }
            return structure;
        }
    }
}
```

1.2 ./Platform.Unsafe/IntPtr.cs

```
using System;
using System.Reflection;
using System.Runtime.InteropServices;
using Platform.Reflection;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Unsafe
{
    /// <remarks>
    /// Please use System.Runtime.CompilerServices.Unsafe instead.
    /// </remarks>
    public static class IntPtr<T>
    {
        public static readonly Func<IntPtr, T> GetValue;
        public static readonly Action<IntPtr, T> SetValue;

        static IntPtr()
        {
            GetValue = CompileGetValueDelegate();
            SetValue = CompileSetValueDelegate();
        }

        static private Func<IntPtr, T> CompileGetValueDelegate()
        {
            return DelegateHelpers.Compile<Func<IntPtr, T>>(emiter =>
            {
                if (NumericType<T>.IsNumeric)
                {
                    emiter.LoadArgument(0);
                    emiter.LoadIndirect<T>();
                    emiter.Return();
                }
                else
                {
                    emiter.LoadArguments(0);
                    emiter.Call(typeof(Marshal).GetGenericMethod(nameof(Marshal.PtrToStructure),
                    ↪  Types<T>.Array, Types<IntPtr, Type, bool>.Array));
                    emiter.Return();
                }
            });
        }

        static private Action<IntPtr, T> CompileSetValueDelegate()
        {
            return DelegateHelpers.Compile<Action<IntPtr, T>>(emiter =>
            {
                if (NumericType<T>.IsNumeric)
```

```
                {
                    emiter.LoadArguments(0, 1);
                    emiter.StoreIndirect<T>();
                    emiter.Return();
                }
                else
                {
                    emiter.LoadArguments(0, 1);
                    emiter.LoadConstant(true);
                    emiter.Call(typeof(Marshal).GetTypeInfo().GetMethod(nameof(Marshal.StructureToPtr), Types<object, IntPtr, bool>.Array));
                    emiter.Return();
                }
            });
        }
    }
}
```

1.3 ./Platform.Unsafe/IntPtrExtensions.cs

```
using System;
using System.Runtime.CompilerServices;
using Platform.Numbers;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Unsafe
{
    /// <remarks>
    /// Please use System.Runtime.CompilerServices.Unsafe instead.
    /// </remarks>
    public unsafe static class IntPtrExtensions
    {
        [Obsolete("GetValue method is deprecated, please use System.Runtime.CompilerServices.Unsafe.Read method instead.")]
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static TElement GetValue<TElement>(this IntPtr pointer) => IntPtr<TElement>.GetValue(pointer);

        [Obsolete("SetValue method is deprecated, please use System.Runtime.CompilerServices.Unsafe.Write method instead.")]
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void SetValue<TElement>(this IntPtr pointer, TElement value) => IntPtr<TElement>.SetValue(pointer, value);

        [Obsolete("GetElement method is deprecated, please use System.Runtime.CompilerServices.Unsafe.Add method instead.")]
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static IntPtr GetElement(this IntPtr pointer, int elementSize, int index) => pointer + (elementSize * index);

        [Obsolete("GetElement method is deprecated, please use System.Runtime.CompilerServices.Unsafe.Add method instead.")]
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static IntPtr GetElement(this IntPtr pointer, long elementSize, long index) => new IntPtr((byte*)pointer.ToPointer() + (elementSize * index));

        [Obsolete("GetElement method is deprecated, please use System.Runtime.CompilerServices.Unsafe.Add method instead.")]
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static IntPtr GetElement<TIndex>(this IntPtr pointer, int elementSize, TIndex index) => pointer.GetElement((long)elementSize, (Integer)(Integer<TIndex>)index);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void WriteElementValue<TValue>(this IntPtr pointer, long index, TValue value) => System.Runtime.CompilerServices.Unsafe.Write((byte*)pointer + (System.Runtime.CompilerServices.Unsafe.SizeOf<TValue>() * index), value);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static TValue ReadElementValue<TValue>(this IntPtr pointer, long index) => System.Runtime.CompilerServices.Unsafe.Read<TValue>((byte*)pointer + (System.Runtime.CompilerServices.Unsafe.SizeOf<TValue>() * index));
    }
}
```

1.4 ./Platform.Unsafe/MemoryBlock.cs

```
using System.Collections.Concurrent;
using System.Threading.Tasks;
```

```

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Unsafe
{
    public static unsafe class MemoryBlock
    {
        public static void Zero(void* pointer, long capacity)
        {
            Parallel.ForEach(Partitioner.Create(0, capacity), range =>
            {
                var from = range.Item1;
                var offset = (void*)((byte*)pointer + from);
                var length = (uint)(range.Item2 - from);
                System.Runtime.CompilerServices.Unsafe.InitBlock(offset, 0, length);
            });
        }
    }
}
```

1.5 ./Platform.Unsafe/Structure.cs

```
using System;
using System.Runtime.InteropServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Unsafe
{
    public static class Structure<TStruct>
        where TStruct : struct
    {
        /// <summary>
        /// <para>
        /// Returns the size of an unmanaged type in bytes.
        /// This property do this without throwing exceptions for generic types as <see
        ↪  cref="Marshal.SizeOf{T}()"/> and <see cref="Marshal.SizeOf(Type)"/> do.
        /// </para>
        /// <para>
        /// Возвращает размер неуправляемого типа в байтах.
        /// Этот свойство делает это без выбрасывания исключений для универсальных типов, как
        ↪  это делают <see cref="Marshal.SizeOf{T}()"/> и <see cref="Marshal.SizeOf(Type)"/>.
        /// </para>
        /// </summary>
        public static int Size { get; } =
        ↪  System.Runtime.CompilerServices.Unsafe.SizeOf<TStruct>();
    }
}
```

1.6 ./Platform.Unsafe/StructureExtensions.cs

```
using System.Runtime.CompilerServices;
using Platform.Hardware.Cpu;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Unsafe
{
    public unsafe static class StructureExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static byte[] ToBytes<TStruct>(this ref TStruct obj)
            where TStruct : struct
        {
            var structureSize = System.Runtime.CompilerServices.Unsafe.SizeOf<TStruct>();
            var bytes = new byte[structureSize];
            fixed (byte* pointer = bytes)
            {
                obj.CopyTo(pointer, structureSize);
            }
            return bytes;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void CopyTo<TStruct>(this ref TStruct source, void* destination)
            where TStruct : struct
        {
            var size = System.Runtime.CompilerServices.Unsafe.SizeOf<TStruct>();
            CopyTo(ref source, destination, size);
        }

```

```
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void CopyTo<TStruct>(this ref TStruct source, void* destination, int size)
            where TStruct : struct
        {
            if (CacheLine.Size >= size)
            {
                System.Runtime.CompilerServices.Unsafe.Copy(destination, ref source);
            }
            else
            {
                System.Runtime.CompilerServices.Unsafe.CopyBlock(destination,
                ↪  System.Runtime.CompilerServices.Unsafe.AsPointer(ref source), (uint)size);
            }
        }
    }
}
```

1.7 ./Platform.Unsafe.Tests/IntPtrExtensionsTests.cs

```
using System;
using System.Runtime.InteropServices;
using Xunit;
using Xunit.Abstractions;
using Platform.Diagnostics;

namespace Platform.Unsafe.Tests
{
    public unsafe class IntPtrExtensionsTests
    {
        private const int N = 10000000;

        private readonly ITestOutputHelper _output;

        public IntPtrExtensionsTests(ITestOutputHelper output)
        {
            _output = output;
        }

        [Fact]
        public void ReadAndWriteOperationsForPointerValuesDelegatesTest()
        {
            var pointer = Marshal.AllocHGlobal(sizeof(ulong));
            ulong result = default;
            for (var i = 0; i < N; i++)
            {
                result = Delegates(pointer);
            }
            Assert.Equal(42UL, result);
            Marshal.FreeHGlobal(pointer);
        }

        private static ulong Delegates(IntPtr pointer)
        {
            ulong result;
            IntPtr<ulong>.SetValue(pointer, 42UL);
            result = IntPtr<ulong>.GetValue(pointer);
            return result;
        }

        [Fact]
        public void ReadAndWriteOperationsForPointerValuesExtensionMethodsTest()
        {
            var pointer = Marshal.AllocHGlobal(sizeof(ulong));
            ulong result = default;
            for (var i = 0; i < N; i++)
            {
                result = ExtensionMethods(pointer);
            }
            Assert.Equal(42UL, result);
            Marshal.FreeHGlobal(pointer);
        }

        private static ulong ExtensionMethods(IntPtr pointer)
        {
            ulong result;
            pointer.SetValue(42UL);
            result = pointer.GetValue<ulong>();
            return result;
        }

        [Fact]
```

```
63          public void ReadAndWriteOperationsForPointerValuesUnsafeClassMethodsTest()
64          {
65              void* pointer = (void*)Marshal.AllocHGlobal(sizeof(ulong));
66              ulong result = default;
67              for (var i = 0; i < N; i++)
68              {
69                  result = ReadAndWriteMethods(pointer);
70              }
71              Assert.Equal(42UL, result);
72              Marshal.FreeHGlobal((IntPtr)pointer);
73          }
74
75          private static ulong ReadAndWriteMethods(void* pointer)
76          {
77              ulong result;
78              System.Runtime.CompilerServices.Unsafe.Write(pointer, 42UL);
79              result = System.Runtime.CompilerServices.Unsafe.Read<ulong>(pointer);
80              return result;
81          }
82
83          [Fact]
84          public void ReadAndWriteOperationsComparisionTest()
85          {
86              var t1 = Performance.Measure(ReadAndWriteOperationsForPointerValuesDelegatesTest);
87              var t2 =
                ↪  Performance.Measure(ReadAndWriteOperationsForPointerValuesExtensionMethodsTest);
88              var t3 = Performance.Measure(ReadAndWriteOperationsForPointerValuesUnsafeClassMethod
                ↪  sTest);
89              var message = $"{t1} {t2} {t3}";
90              _output.WriteLine(message);
91          }
92
93          [Fact]
94          public void ElementOffsetOperationsForPointerValuesExtensionMethods()
95          {
96              var pointer = Marshal.AllocHGlobal(sizeof(ulong) * 10);
97              ulong result = default;
98              for (var i = 0; i < N; i++)
99              {
100                 result = GetElementExtensionMethods(pointer);
101             }
102             Assert.Equal(5UL * 8UL, result - (ulong)pointer);
103             Marshal.FreeHGlobal(pointer);
104         }
105
106         private static ulong GetElementExtensionMethods(IntPtr pointer)
107         {
108             ulong result;
109             result = (ulong)pointer.GetElement(8, 5);
110             return result;
111         }
112
113         [Fact]
114         public void ElementOffsetOperationsForPointerValuesUnsafeClassMethodsTest()
115         {
116             void* pointer = (void*)Marshal.AllocHGlobal(sizeof(ulong) * 10);
117             ulong result = default;
118             for (var i = 0; i < N; i++)
119             {
120                 result = GetElementMethods(pointer);
121             }
122             Assert.Equal(5UL * 8UL, result - (ulong)pointer);
123             Marshal.FreeHGlobal((IntPtr)pointer);
124         }
125
126         private static ulong GetElementMethods(void* pointer)
127         {
128             ulong result;
129             result = (ulong)System.Runtime.CompilerServices.Unsafe.Add<ulong>(pointer, 5);
130             return result;
131         }
132
133         [Fact]
134         public void GetElementOperationsComparisionTest()
135         {
136             var t1 =
                ↪  Performance.Measure(ElementOffsetOperationsForPointerValuesExtensionMethods);
137             var t2 = Performance.Measure(ElementOffsetOperationsForPointerValuesUnsafeClassMetho
                ↪  dsTest);
```

```
            var message = $"{t1} {t2}";
            _output.WriteLine(message);
        }
    }
}
```

1.8 ./Platform.Unsafe.Tests/SizeOfTests.cs

```
using System.Runtime.InteropServices;
using Xunit;

namespace Platform.Unsafe.Tests
{
    public static class SizeOfTests
    {
        public struct X<T>
        {
            public readonly T F1;
            public readonly T F2;
        }

        [Fact]
        public static void UnsafeClassSizeOfTest()
        {
            var size = System.Runtime.CompilerServices.Unsafe.SizeOf<X<int>>();
            Assert.Equal(8, size);
        }

        [Fact]
        public static void MarshalSizeOfTest()
        {
            var size = Marshal.SizeOf(default(X<int>));
            Assert.Equal(8, size);
        }

        [Fact]
        public static void StructurePropertyTest()
        {
            var size = Structure<X<int>>.Size;
            Assert.Equal(8, size);
        }
    }
}
```

1.9 ./Platform.Unsafe.Tests/StructAndBytesConversionTests.cs

```
using Xunit;

namespace Platform.Unsafe.Tests
{
    public static class StructAndBytesConversionTests
    {
        [Fact]
        public static void StructToBytesTest()
        {
            ulong source = ulong.MaxValue;
            var result = source.ToBytes();
            for (int i = 0; i < result.Length; i++)
            {
                Assert.Equal(byte.MaxValue, result[i]);
            }
        }

        [Fact]
        public static void BytesToStructTest()
        {
            byte[] bytes = new[] { byte.MaxValue, byte.MaxValue, byte.MaxValue, byte.MaxValue,
            ↪  byte.MaxValue, byte.MaxValue, byte.MaxValue, byte.MaxValue };
            ulong result = bytes.ToStructure<ulong>();
            Assert.Equal(ulong.MaxValue, result);
        }
    }
}
```

1.10 ./Platform.Unsafe.Tests/ZeroMemoryTests.cs

```
using Xunit;

namespace Platform.Unsafe.Tests
{
    public static unsafe class ZeroMemoryTests
    {
```

```
7           [Fact]
8           public static void ZeroMemoryTest()
9           {
10              var bytes = new byte[1024];
11              for (int i = 0; i < bytes.Length; i++)
12              {
13                  bytes[i] = unchecked((byte)i);
14              }
15              fixed (byte* pointer = bytes)
16              {
17                  MemoryBlock.Zero(pointer, bytes.Length);
18              }
19              for (int i = 0; i < bytes.Length; i++)
20              {
21                  Assert.Equal(0, bytes[i]);
22              }
23          }
24      }
25  }
```

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