

Implicit Lifetimes

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No Implicit Object Creation

```
#include <cstdlib>

void allocate()
{
    void *vp = std::malloc(sizeof(int)*1024);
    int *p = static_cast<int*>(vp);
    p[41] = 6*9;
    std::free(p);
}
```

- ▶ Writing to allocated memory of simple types is common practice
 - ▶ In 'C'-style legacy code malloc is often used
 - ▶ In idiomatic C++ this would utilise std::allocator
 - ▶ ...but either causes undefined behaviour; no `int` object was created
- ▶ R. Smith & V. Voutilainen note this longstanding defect in P0593
 - ▶ *Implicit creation of objects for low-level object manipulation*

No Implicit Object Creation

```
#include <memory>

constexpr void cpp_allocate()
{
    std::allocator<int> alloc;
    int *p = alloc.allocate(1024);
    p[41] = 6*9;
    alloc.deallocate(p,1024);
}
```

- ▶ Writing to allocated memory of simple types is common practice
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 - ▶ ...but either causes undefined behaviour; no `int` object was created
- ▶ R. Smith & V. Voutilainen note this longstanding defect in P0593
 - ▶ *Implicit creation of objects for low-level object manipulation*
- ▶ std::allocator::allocate became `constexpr` in C++20
- ▶ But the code above cannot be constant evaluated

No Implicit Object Creation

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```

- ▶ The adopted paper defines implicit lifetime types; types where:
 - ▶ Creating an instance of the type runs no code
 - ▶ Destroying an instance of the type runs no code
- ▶ Such types are (as of C++20) permitted such implicit creation
 - ▶ ...but not during constant evaluation (P0593 Section 3.5)
- ▶ P2674 introduced `std::is_implicit_lifetime` in C++23
 - ▶ ...alas no compiler has implemented it to date

A Hurdle for constexpr Programs

- ▶ Consequently, a suitable constructor must be called
- ▶ C++20's `std::construct_at` provides appropriate syntax
 - ▶ “Placement new” is still not **constexpr**
 - ▶ Barry Revzin's P2747 proposes it for C++26

```
#include <memory>

constexpr void cpp_allocate()
{
    std::allocator<int> alloc;
    int *p = alloc.allocate(1024);

    std::construct_at(&p[41]);

    p[41] = 6*9;
    alloc.deallocate(p, 1024);
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```
#include <memory>

constexpr void cpp_allocate()
{
    std::allocator<int> alloc;
    int *p = alloc.allocate(1024);

    if (std::is_constant_evaluated()) { // if consteval in C++23

        std::construct_at(&p[41]);
    }
    p[41] = 6*9;
    alloc.deallocate(p, 1024);
}
```

A Hurdle for constexpr Programs

- ▶ Typically require to construct all array elements after creation
- ▶ While respecting custom allocators via `std::allocator_traits`:

```
#include <memory>

constexpr void cpp_allocate()
{
    std::allocator<int> alloc;
    int *p = alloc.allocate(1024);
    using a_t = std::allocator_traits<decltype(alloc)>;
    if (std::is_constant_evaluated()) { // if consteval in C++23
        for (std::size_t i = 0; i < 1024; i++)
            a_t::construct(alloc, &p[i]);
    }
    p[41] = 6*9;
    alloc.deallocate(p, 1024);
}
```

A Hurdle for constexpr Programs

- ▶ P2674's `is_implicit_lifetime` trait should allow more precision
- ▶ Allow implicit object creation also during constant evaluation?
- ▶ Even just a `construct_n`? (akin to `destroy_n`)

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A Hurdle for constexpr Programs

- ▶ When porting programs to `constexpr` such details require care
- ▶ GCC and MSVC are lenient; only Clang throws an error

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