

## Section 2.1 C++11

## constexpr Variables

```

k_SECONDS_PER_MINUTE = 60,    // UT might be long or long long.
k_MINUTES_PER_HOUR   = 60,
k_SECONDS_PER_HOUR   = 60*60,
// ...
k_USEC_PER_WEEK      = 1000L*1000*60*60*24*7 // same UT as all of the above
};
};

```

The original *values* will remain unchanged after the enumeration is extended, but the burden of all of the compiler warnings resulting from the change in UT and rippling throughout a large codebase could be expensive to repair.

We would like the original values to remain unchanged (e.g., remain as **int** if that’s what they were), and we want only those values that do *not* fit in an **int** to morph into a larger integral type. We might achieve this effect by placing each enumerator in its own separate anonymous enumeration:

```

struct TimeRatios3 // explicit scope for multiple classic anonymous enum types
{
    enum { k_SECONDS_PER_MINUTE = 60           }; // UT: int (likely)
    enum { k_MINUTES_PER_HOUR   = 60           }; // " " "
    enum { k_SECONDS_PER_HOUR   = 60*60       }; // " " "
    // ...
    enum { k_USEC_PER_SEC       = 1000*1000    }; // UT: int (likely)
    enum { k_USEC_PER_MIN       = 1000*1000*60 }; // " " "
    enum { k_USEC_PER_HOUR     = 1000U*1000*60*60 }; // UT: unsigned int
    enum { k_USEC_PER_DAY      = 1000L*1000*60*60*24 }; // UT: long or long long
    enum { k_USEC_PER_WEEK     = 1000L*1000*60*60*24*7 }; // UT: long or long long
};

```

In this case, the original values as well as their respective UTs will remain unchanged, and each new enumerated value will independently take on its own independent UT, which is ~~either implementation defined or else dictated~~ by the number of bits required to represent the value.

A modern alternative to having separate anonymous **enums** for each distinct value (or class of values) is to instead encode each ratio as an explicitly typed **constexpr** variable:

```

struct TimeRatios4
{
    static constexpr int k_SECONDS_PER_MINUTE    = 60;
    static constexpr int k_MINUTES_PER_HOUR     = 60;
    static constexpr int k_SECONDS_PER_HOUR     = k_MINUTES_PER_HOUR *
                                                k_SECONDS_PER_MINUTE;
    // ...
    static constexpr long long k_NANOS_PER_SECOND = 1000*1000*1000;
    static constexpr long long k_NANOS_PER_HOUR  = k_NANOS_PER_SECOND *
                                                k_SECONDS_PER_HOUR;
};

```