Zip Iterator

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abstract: The zip iterator provides the ability to parallel-iterate over several controlled sequences simultaneously. A zip iterator is constructed from a tuple of iterators. Moving the zip iterator moves all the iterators in parallel. Dereferencing the zip iterator returns a tuple that contains the results of dereferencing the individual iterators.

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`zip_iterator` synopsis

```
template<typename IteratorTuple>
class zip_iterator
{

public:
  typedef /* see below */ reference;
  typedef reference value_type;
  typedef value_type* pointer;
  typedef /* see below */ difference_type;
  typedef /* see below */ iterator_category;

  zip_iterator();
  zip_iterator(IteratorTuple iterator_tuple);

  template<typename OtherIteratorTuple>
  zip_iterator(
        const zip_iterator<OtherIteratorTuple>& other
      , typename enable_if_convertible<
              OtherIteratorTuple
            , IteratorTuple>::type* = 0     // exposition only
  );

  const IteratorTuple& get_iterator_tuple() const;

private:
  IteratorTuple m_iterator_tuple;     // exposition only
};
```

```
template<typename IteratorTuple>
zip_iterator<IteratorTuple>
make_zip_iterator(IteratorTuple t);
```

The `reference` member of `zip_iterator` is the type of the tuple made of the reference types of the iterator types in the `IteratorTuple` argument.

The `difference_type` member of `zip_iterator` is the `difference_type` of the first of the iterator types in the `IteratorTuple` argument.

The `iterator_category` member of `zip_iterator` is convertible to the minimum of the traversal categories of the iterator types in the `IteratorTuple` argument. For example, if the `zip_iterator` holds only vector iterators, then `iterator_category` is convertible to `boost::random_access_traversal_tag`. If you add a list iterator, then `iterator_category` will be convertible to `boost::bidirectional_traversal_tag`, but no longer to `boost::random_access_traversal_tag`.

`zip_iterator` requirements

All iterator types in the argument `IteratorTuple` shall model Readable Iterator.

`zip_iterator` models

The resulting `zip_iterator` models Readable Iterator.

The fact that the `zip_iterator` models only Readable Iterator does not prevent you from modifying the values that the individual iterators point to. The tuple returned by the `zip_iterator`'s `operator*` is a tuple constructed from the reference types of the individual iterators, not their value types. For example, if `zip_it` is a `zip_iterator` whose first member iterator is an `std::vector<double>::iterator`, then the following line will modify the value which the first member iterator of `zip_it` currently points to:

```
zip_it->get<0>() = 42.0;
```

Consider the set of standard traversal concepts obtained by taking the most refined standard traversal concept modeled by each individual iterator type in the `IteratorTuple` argument.The `zip_iterator` models the least refined standard traversal concept in this set.

`zip_iterator<IteratorTuple1>` is interoperable with `zip_iterator<IteratorTuple2>` if and only if `IteratorTuple1` is interoperable with `IteratorTuple2`.

`zip_iterator` operations

In addition to the operations required by the concepts modeled by `zip_iterator`, `zip_iterator` provides the following operations.

```
zip_iterator();
```

Returns: An instance of `zip_iterator` with `m_iterator_tuple` default constructed.

```
zip_iterator(IteratorTuple iterator_tuple);
```

Returns: An instance of `zip_iterator` with `m_iterator_tuple` initialized to `iterator_tuple`.

```
template<typename OtherIteratorTuple>
zip_iterator(
      const zip_iterator<OtherIteratorTuple>& other
    , typename enable_if_convertible<
            OtherIteratorTuple
          , IteratorTuple>::type* = 0     // exposition only
);
```

Returns: An instance of `zip_iterator` that is a copy of `other`.

Requires: `OtherIteratorTuple` is implicitly convertible to `IteratorTuple`.

```
const IteratorTuple& get_iterator_tuple() const;
```

Returns: `m_iterator_tuple`

```
reference operator*() const;
```

Returns: A tuple consisting of the results of dereferencing all iterators in `m_iterator_tuple`.

```
zip_iterator& operator++();
```

Effects: Increments each iterator in `m_iterator_tuple`.

Returns: `*this`

```
zip_iterator& operator--();
```

Effects: Decrements each iterator in `m_iterator_tuple`.

Returns: `*this`

```
template<typename IteratorTuple>
zip_iterator<IteratorTuple>
make_zip_iterator(IteratorTuple t);
```

Returns: An instance of `zip_iterator<IteratorTuple>` with `m_iterator_tuple` initialized to `t`.

```
template<typename IteratorTuple>
zip_iterator<IteratorTuple>
make_zip_iterator(IteratorTuple t);
```

Returns: An instance of `zip_iterator<IteratorTuple>` with `m_iterator_tuple` initialized to `t`.

Examples

There are two main types of applications of the `zip_iterator`. The first one concerns runtime efficiency: If one has several controlled sequences of the same length that must be somehow processed, e.g., with the `for_each` algorithm, then it is more efficient to perform just one parallel-iteration rather than several individual iterations. For an example, assume that `vect_of_doubles` and `vect_of_ints` are two vectors of equal length containing doubles and ints, respectively, and consider the following two iterations:

```
std::vector<double>::const_iterator beg1 = vect_of_doubles.begin();
std::vector<double>::const_iterator end1 = vect_of_doubles.end();
std::vector<int>::const_iterator beg2 = vect_of_ints.begin();
std::vector<int>::const_iterator end2 = vect_of_ints.end();

std::for_each(beg1, end1, func_0());
std::for_each(beg2, end2, func_1());
```

These two iterations can now be replaced with a single one as follows:

```
std::for_each(
  boost::make_zip_iterator(
    boost::make_tuple(beg1, beg2)
    ),
  boost::make_zip_iterator(
    boost::make_tuple(end1, end2)
    ),
  zip_func()
  );
```

A non-generic implementation of `zip_func` could look as follows:

```
struct zip_func :
  public std::unary_function<const boost::tuple<const double&, const int&>&, void>
{
  void operator()(const boost::tuple<const double&, const int&>& t) const
  {
    m_f0(t.get<0>());
    m_f1(t.get<1>());
  }
```

```
private:
  func_0 m_f0;
  func_1 m_f1;
};
```

The second important application of the `zip_iterator` is as a building block to make combining iterators. A combining iterator is an iterator that parallel-iterates over several controlled sequences and, upon dereferencing, returns the result of applying a functor to the values of the sequences at the respective positions. This can now be achieved by using the `zip_iterator` in conjunction with the `transform_iterator`.

Suppose, for example, that you have two vectors of doubles, say `vect_1` and `vect_2`, and you need to expose to a client a controlled sequence containing the products of the elements of `vect_1` and `vect_2`. Rather than placing these products in a third vector, you can use a combining iterator that calculates the products on the fly. Let us assume that `tuple_multiplies` is a functor that works like `std::multiplies`, except that it takes its two arguments packaged in a tuple. Then the two iterators `it_begin` and `it_end` defined below delimit a controlled sequence containing the products of the elements of `vect_1` and `vect_2`:

```
typedef boost::tuple<
  std::vector<double>::const_iterator,
  std::vector<double>::const_iterator
  > the_iterator_tuple;

typedef boost::zip_iterator<
  the_iterator_tuple
  > the_zip_iterator;

typedef boost::transform_iterator<
  tuple_multiplies<double>,
  the_zip_iterator
  > the_transform_iterator;

the_transform_iterator it_begin(
  the_zip_iterator(
    the_iterator_tuple(
      vect_1.begin(),
      vect_2.begin()
      )
    ),
  tuple_multiplies<double>()
  );

the_transform_iterator it_end(
  the_zip_iterator(
    the_iterator_tuple(
      vect_1.end(),
      vect_2.end()
      )
    ),
  tuple_multiplies<double>()
  );
```

The source code for these examples can be found here.