NOKIA

Critical code analysis with Observer pattern

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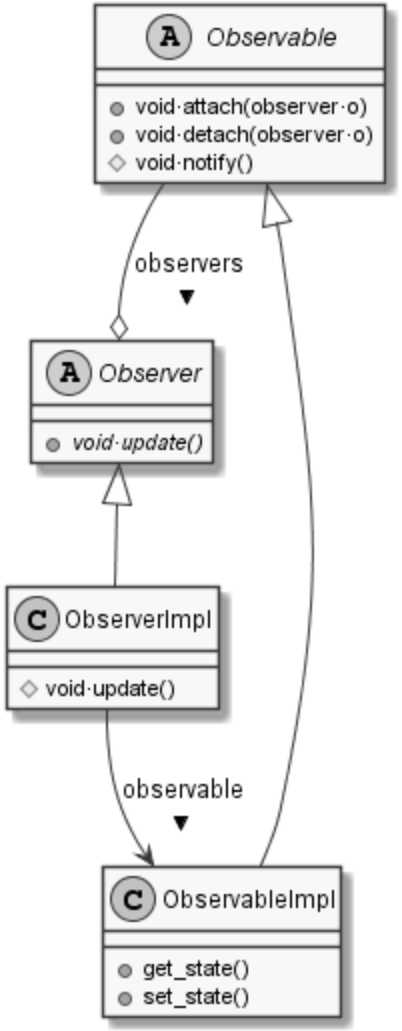
Agenda

1. Brief introduction to the pattern
2. Analysis of typical implementations
3. Conclusions from the implementations
4. Sneak peek at more complex aspects
5. Summary

The Observer pattern
Comes under many names

1. Observer/Observable (GOF, Java)
2. Listener & Events (Java)
3. Publish-Subscribe
4. Signals/Slots (Boost, Qt)

The Observer pattern
Gang of Four approach



The Observer pattern
Varies in implementations

- Single-threaded / Multithreaded
- Synchronous / Asynchronous
- Local / Distributed
- Inheritance / Composition

The Observer pattern
Varies in features

- Attaching and detaching
  - Attaching more than once

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- Notifying
  - Order
  - Observers attached while notifying
- Update
  - With source
  - With additional data

Implementation – 1st attempt
Classes

```
class observable {
public:
 virtual ~observable() = default;
 void attach(observer* o);
 void detach(observer* o);
protected:
 void notify();
private:
 std::vector<observer*> obss;
};
```

```
class observer {
public:
 virtual ~observer() = default;
 virtual void update() = 0;
};
```

Implementation – 1st attempt
Methods

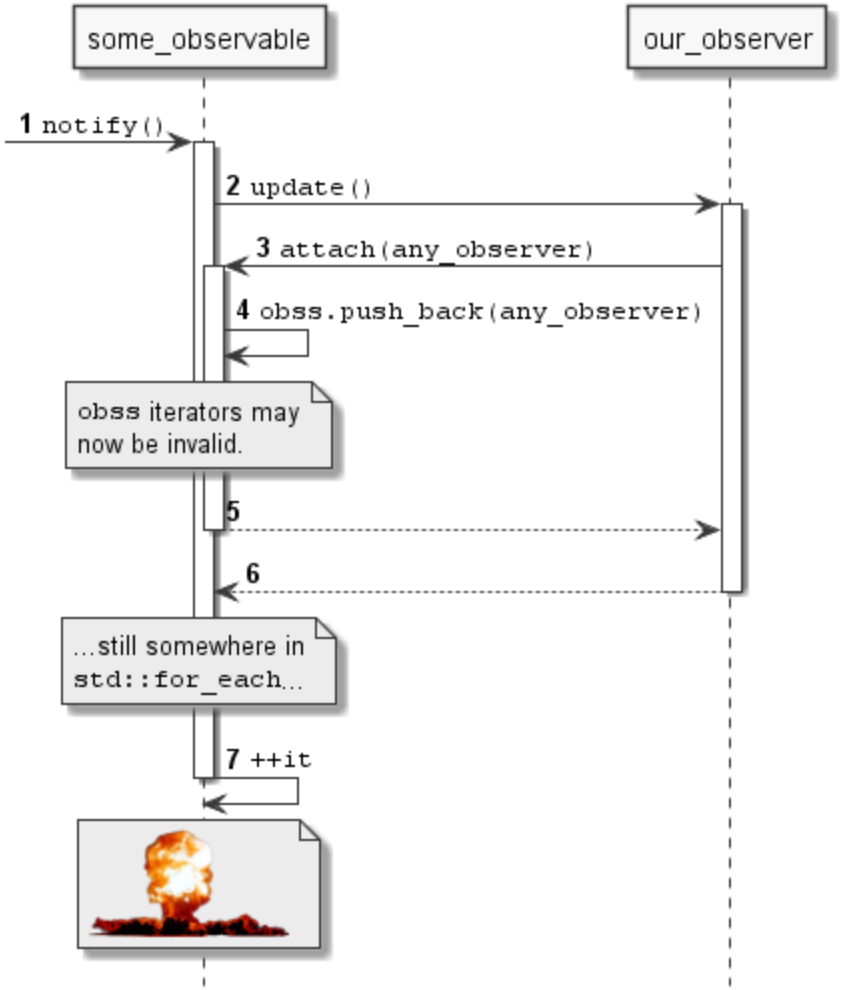
```
void notify() {
 std::for_each(
  obss.cbegin(), obss.cend(),
  [](observer* o) {
   o->update();
  }
 );
}
```

```
void attach(observer* o) {
 obss.push_back(o);
}

void detach(observer* o) {
 obss.erase(
  std::find(
   obss.cbegin(), obss.cend(), o
  )
 );
}
```

Implementation – 1st attempt
The bug

```
void update() {
  some_observable.attach(
    any_observer
  );
}
```



Implementation – 2nd attempt
Methods

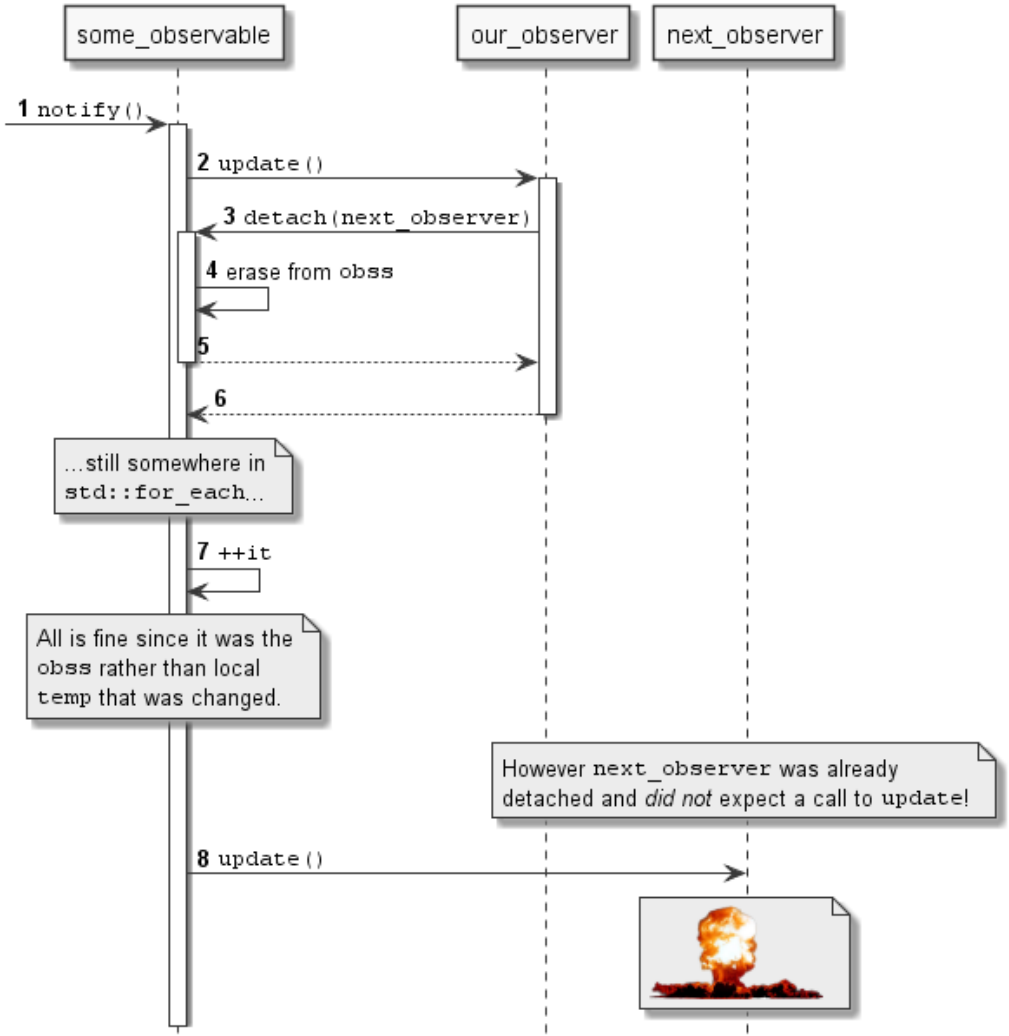
```
void notify() {
 auto const temp = obss;
 std::for_each(
  temp.cbegin(), temp.cend(),
  [](observer* o) {
   o->update();
  }
 );
}
```

Prevent iterators invalidation while in **notify** by iterating over a local copy.

attach and **detach** no longer affect the container that is being iterated!

Implementation – 2nd attempt
The bug

```
void update() {
 some_observable.detach(
  next_observer
 );
}
```



Implementation – 3rd attempt
Classes

```
class observable {
public:
 virtual ~observable() = default;
 void attach(observer* o);
 void detach(observer* o);
 void notify();
private:
 std::vector<observer*> obss;
 std::vector<observer*> temp;
};
```

Then why not just have the `temp` as member variable and erase from it in `detach` but not add to it in `attach`?

This way `temp` will not reallocate and invalidate our iterators.

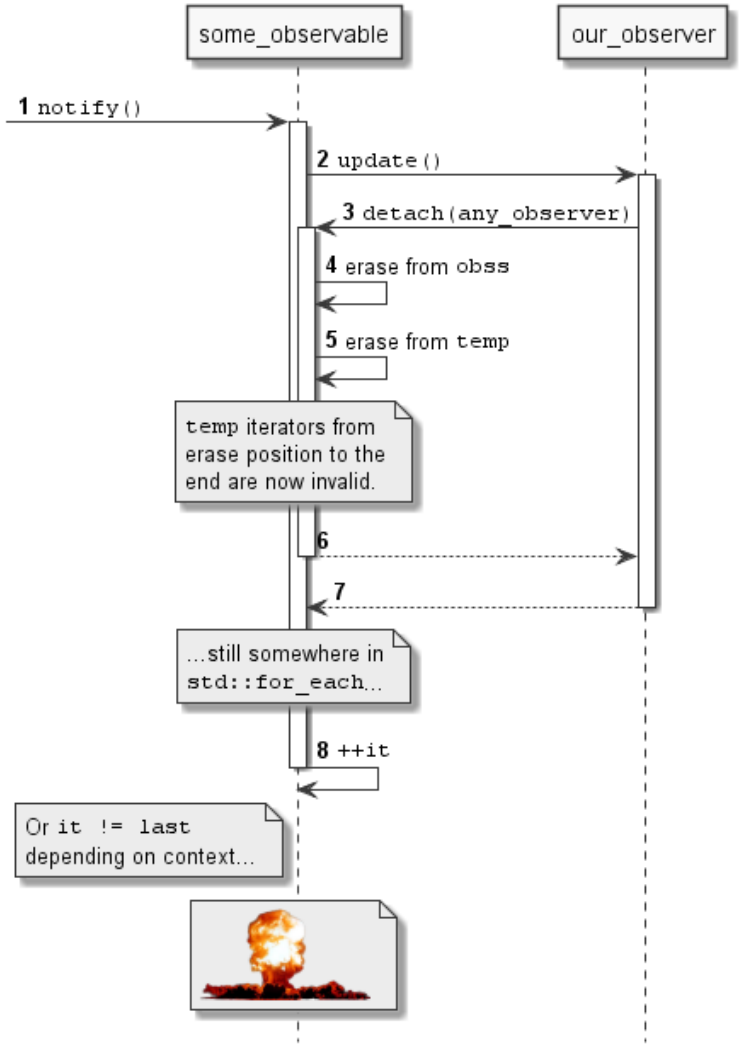
Implementation – 3rd attempt
Methods

```
void notify() {
 temp = obss;
 std::for_each(
  temp.cbegin(), temp.cend(),
  [](observer* o) {
   o->update();
  }
 );
}
```

```
void detach(observer* o) {
 auto const obss_it = std::find(
  obss.cbegin(), obss.cend(), o);
 auto const remove_index =
  obss_it - obss.cbegin();
 obss.erase(obss_it);
 temp.erase(
  temp.cbegin() + remove_index);
}
```

Implementation – 3rd attempt
The bug

```
void update() {
 some_observable.detach(
  any_observer
 );
}
```



Implementation – 4th attempt
Methods

```
void notify() {
 for(
  decltype(obss.size()) i = 0;
  i < obss.size();
  ++i
 ) {
  obss[i]->update();
 }
}
```

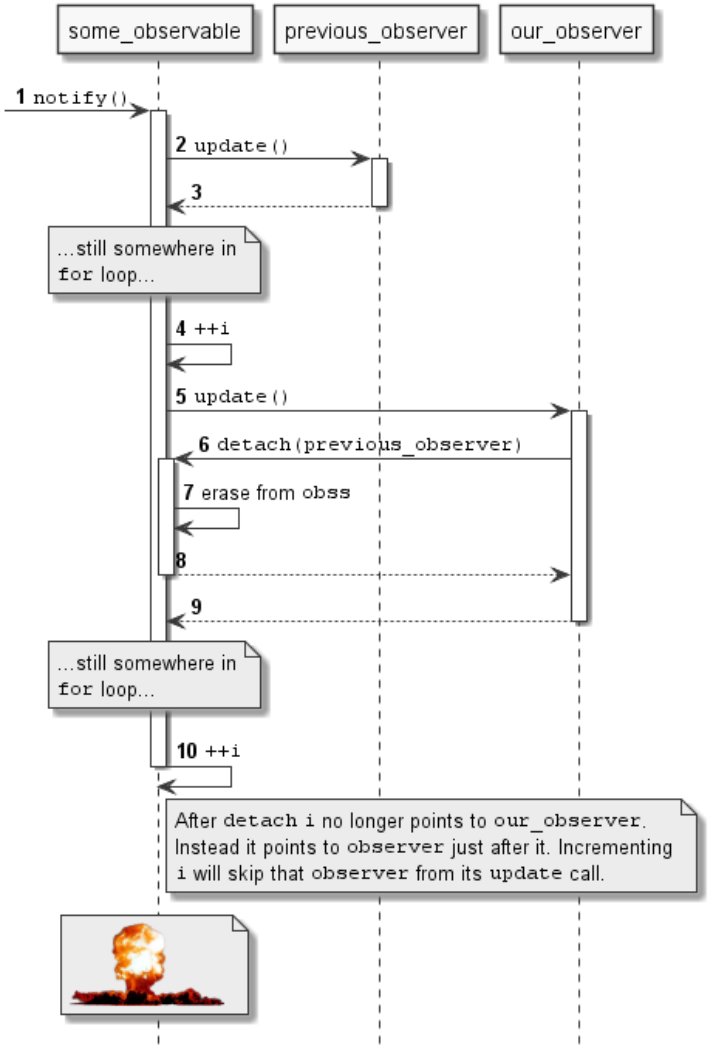
Since iterators keep making problems let's give up on them and use good old indexes.

No more **temp**, no more iterators, just indexes. They are never invalidated!

You can't go wrong with that – or can you?

Implementation – 4th attempt
The bug

```
void update() {
 some_observable.detach(
  previous_observer
 );
}
```



Implementation – 5th attempt
Classes

```
class observable {
public:
 virtual ~observable() = default;
 void attach(observer* o);
 void detach(observer* o);
 void notify();
private:
 using vector_type = std::vector<observer*>;
 vector_type obss;
 vector_type::size_type notify_index;
};
```

Implementation – 5th attempt
Methods

```
void notify() {
 for(
  notify_index = 0;
  notify_index < obss.size();
  ++notify_index
 ) {
  obss[notify_index]->update();
 }
}
```

```
void detach(observer* o) {
 auto const it = std::find(
  obss.cbegin(), obss.cend(), o);
 auto const remove_index =
  it - obss.cbegin();
 obss.erase(it);
 if(notify_index >= remove_index) {
  --notify_index;
 }
}
```

Implementation – 5th attempt
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- Quasi-multithreading

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- Destruction of `observable` while notifying
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  - Qt Signals requires `deleteLater`
- Asynchronous updates
  - Boost.Signals2 doesn't support it
  - Qt Signals use event loops
- Multithreading

Other aspects – Multithreading

By the optimist

```
/**
 * @todo Add thread safety.
 */
class observable
```


Other aspects – Multithreading

By the realist

```
/**
 * @warning Not thread safe!
 */
class observable
```

Best implementation

Avoid reinventing the wheel!

Summary

- Beware of quasi-multithreading
- Changing iterators to indexes doesn’t help much
- Neither does changing containers
- Avoid reinventing the wheel

Questions & Answers