

# Rule Definition

```
template <typename Iterator, typename Context, typename Attribute_>
bool parse(Iterator& first, Iterator const& last
, Context const& context, Attribute_& attr) const
{
    rule_context<Attribute> r_context = { 0 };

    auto rule_ctx1 = make_context<rule_context_with_id_tag<ID>>(r_context, context);
    auto rule_ctx2 = make_context<rule_context_tag>(r_context, rule_ctx1);
    auto this_context = make_context<ID>(*this, rule_ctx2);

    return detail::parse_rule<attribute_type, ID>::call_rule_definition(
        rhs, name, first, last, this_context, attr, r_context.attr_ptr);
}
```

# call\_rule\_definition

```
template <typename RHS, typename Iterator, typename Context
    , typename ActualAttribute, typename AttributePtr>
static bool call_rule_definition(
    RHS const& rhs
    , char const* rule_name
    , Iterator& first, Iterator const& last
    , Context const& context, ActualAttribute& attr, AttributePtr*& attr_ptr)
{
    typedef traits::make_attribute<Attribute, ActualAttribute> make_attribute;

    // do down-stream transformation, provides attribute for
    // rhs parser
    typedef traits::transform_attribute<
        typename make_attribute::type, Attribute, parser_id>
    transform;
```

Continued...

# call\_rule\_definition

```
typedef typename make_attribute::value_type value_type;  
typedef typename transform::type transform_attr;  
value_type made_attr = make_attribute::call(attr);  
transform_attr attr_ = transform::pre(made_attr);
```

```
attr_pointer_scope<typename remove_reference<transform_attr>::type>
```

```
    attr_scope(attr_ptr, boost::addressof(attr_));
```

```
if (parse_rhs(rhs, first, last, context, attr_))
```

```
{
```

```
    // do up-stream transformation, this integrates the results
```

```
    // back into the original attribute value, if appropriate
```

```
    traits::post_transform(attr, attr_);
```

```
    return true;
```

```
}
```

```
return false;
```

```
}
```

# Rule

```
template <typename ID, typename Attribute = unused_type>
struct rule : parser<rule<ID, Attribute>>
{
    typedef ID id;
    typedef Attribute attribute_type;
    static bool const has_attribute = !is_same<Attribute, unused_type>::value;
    static bool const handles_container = traits::is_container<Attribute>::value;

    rule(char const* name = "unnamed") : name(name) {}

    template <typename RHS>
    rule_definition<ID, typename extension::as_parser<RHS>::value_type, Attribute>
    operator=(RHS const& rhs) const;

    template <typename Iterator, typename Context, typename Attribute_>
    bool parse(Iterator& first, Iterator const& last
        , Context const& context, Attribute_& attr) const;

    char const* name;
};
```

# Rule

```
template <typename RHS>
rule_definition<ID, typename extension::as_parser<RHS>::value_type, Attribute>
operator=(RHS const& rhs) const
{
    typedef rule_definition<
        ID, typename extension::as_parser<RHS>::value_type, Attribute>
        result_type;

    return result_type(as_parser(rhs), name);
}
```

# Rule

```
template <typename Iterator, typename Context, typename Attribute_>
bool parse(Iterator& first, Iterator const& last
, Context const& context, Attribute_& attr) const
{
    return detail::parse_rule<attribute_type, ID>::call_from_rule(
        spirit::get<ID>(context), name
        , first, last, context, attr
        , spirit::get<rule_context_with_id_tag<ID>>(context));
}
```

# Rule

```
template <typename RuleDef, typename Iterator, typename Context
    , typename ActualAttribute>
static bool call_from_rule(
    RuleDef const& rule_def
    , char const* rule_name
    , Iterator& first, Iterator const& last
    , Context const& context, ActualAttribute& attr, unused_type)
{
    // This is called when a rule-body has *not yet* been established.
    // The rule body is established by the rule_definition class, so
    // we call it to parse and establish the rule-body.

    return rule_def.parse(first, last, context, attr);
}
```

# Rule

```
template <typename RuleDef, typename Iterator, typename Context
    , typename ActualAttribute, typename AttributeContext>
static bool call_from_rule(
    RuleDef const& rule_def
    , char const* rule_name
    , Iterator& first, Iterator const& last
    , Context const& context, ActualAttribute& attr, AttributeContext& attr_ctx)
{
    // This is called when a rule-body has already been established.
    // The rule body is already established by the rule_definition class,
    // we will not do it again. We'll simply call the RHS by calling
    // call_rule_definition.

    return call_rule_definition(
        rule_def.rhs, rule_name, first, last
        , context, attr, attr_ctx.attr_ptr);
}
```



# X3 Calculator Grammar

```
////////////////////////////////////  
// The calculator grammar  
////////////////////////////////////  
namespace calculator_grammar  
{  
    using x3::uint_  
    using x3::char_  
  
    x3::rule<class expression, ast::program> const expression("expression");  
    x3::rule<class term, ast::program> const term("term");  
    x3::rule<class factor, ast::operand> const factor("factor");
```

# X3 Calculator Grammar

```
auto const expression_def =
```

```
    term
```

```
    >>  *( (char_('+') >> term)
        | (char_('-') >> term)
        )
```

```
    ;
```

```
auto const term_def =
```

```
    factor
```

```
    >>  *( (char_('*') >> factor)
        | (char_('/') >> factor)
        )
```

```
    ;
```

```
auto const factor_def =
```

```
    uint_
```

```
    |    '(' >> expression >> ')'
    |    (char_('-') >> factor)
    |    (char_('+') >> factor)
```

```
    ;
```

# X3 Calculator Grammar

```
auto const calculator = x3::grammar(  
    "calculator"  
    , expression = expression_def  
    , term = term_def  
    , factor = factor_def  
    );
```

```
} // namespace calculator_grammar end
```

```
using calculator_grammar::calculator;
```

# Grammar

```
template <typename Elements>
struct grammar_parser : parser<grammar_parser<Elements>>
{
    typedef typename
        remove_reference<
            typename fusion::result_of::front<Elements>::type
        >::type::second_type
        start_rule;

    typedef typename start_rule::attribute_type attribute_type;
    static bool const has_attribute = start_rule::has_attribute;

    grammar_parser(char const* name, Elements const& elements)
        : name(name), elements(elements) {}
}
```

Continued...

# Grammar

```
template <typename Iterator, typename Context, typename Attribute_>  
bool parse(Iterator& first, Iterator const& last  
    , Context const& context, Attribute_& attr) const  
{  
    grammar_context<Elements, Context> our_context(elements, context);  
    return fusion::front(elements).second.parse(first, last, our_context, attr);  
}
```

```
char const* name;  
Elements elements;  
};
```

# Grammar

```
template <typename ...Elements>
grammar_parser<fusion::map<fusion::pair<typename Elements::id, Elements>...>>
grammar(char const* name, Elements const&... elements)
{
    typedef fusion::map<fusion::pair<typename Elements::id, Elements>...> sequence;
    return grammar_parser<sequence>(name,
        sequence(fusion::make_pair<typename Elements::id>(elements)...));
}
```

# Grammar Context

```
template <typename Elements, typename Next>
struct grammar_context
{
    grammar_context(Elements const& elements, Next const& next)
        : elements(elements), next(next) {}

    template <typename ID>
    struct get_result
    {
        typedef typename ID::type id_type;
        typedef typename mpl::eval_if<
            fusion::result_of::has_key<Elements const, id_type>
            , fusion::result_of::at_key<Elements const, id_type>
            , typename Next::template get_result<ID>>::type
        type;
    };
};
```

Continued...

# Grammar Context

```
template <typename ID>
typename get_result<ID>::type
get(ID id) const
{
    typedef typename ID::type id_type;
    typename fusion::result_of::has_key<Elements, id_type> has_key;
    return get_impl(id, has_key);
}
```

```
Elements const& elements;
Next const& next;
};
```

Continued...



# Grammar Context

```
template <typename ID>
typename get_result<ID>::type
get_impl(ID id, mpl::true_) const
{
    typedef typename ID::type id_type;
    return fusion::at_key<id_type>(elements);
}
```

```
template <typename ID>
typename get_result<ID>::type
get_impl(ID id, mpl::false_) const
{
    return next.get(id);
}
```

# Semantic Actions

```
template <typename Subject, typename Action>
struct action : unary_parser<Subject, action<Subject, Action>>
{
    typedef unary_parser<Subject, action<Subject, Action>> base_type;
    static bool const is_pass_through_unary = true;
    static bool const has_action = true;

    action(Subject const& subject, Action f)
        : base_type(subject), f(f) {}

    typedef typename traits::attribute_of<Subject>::type attribute_type;

    template <typename Iterator, typename Context, typename Attribute>
    bool parse(Iterator& first, Iterator const& last, Context const& context, Attribute& attr) const;

    template <typename Iterator, typename Context>
    bool parse(Iterator& first, Iterator const& last, Context const& context, unused_type) const;

    Action f;
};
```

# Semantic Actions

```
template <typename Iterator, typename Context>
bool parse(Iterator& first, Iterator const& last
, Context const& context, unused_type) const
{
    typedef traits::make_attribute<attribute_type, unused_type> make_attribute;
    typedef traits::transform_attribute<
        typename make_attribute::type, attribute_type, parser_id>
        transform;

    // synthesize the attribute since one is not supplied
    typename make_attribute::type made_attr = make_attribute::call(unused_type());
    typename transform::type attr = transform::pre(made_attr);
    return parse(first, last, context, attr);
}
```

# Semantic Actions

```
template <typename Iterator, typename Context, typename Attribute>
bool parse(Iterator& first, Iterator const& last
, Context const& context, Attribute& attr) const
{
    Iterator save = first;
    if (this->subject.parse(first, last, context, attr))
    {
        // call the function, passing the enclosing rule's context
        // and the subject's attribute.
        f(context, attr);
        return true;

        // reset iterators if semantic action failed the match
        // retrospectively
        first = save;
    }
    return false;
}
```

# Rule Context

```
template <typename Attribute>
struct rule_context
{
    Attribute& val() const
    {
        BOOST_ASSERT(attr_ptr);
        return *attr_ptr;
    }

    Attribute* attr_ptr;
};
```

```
struct rule_context_tag;
```

```
template <typename ID>
struct rule_context_with_id_tag;
```

# Semantic Actions

```
struct f
{
    template <typename Context>
    void operator()(Context const& ctx, char c) const
    {
        _val(ctx) += c;    // get<rule_context_tag>(ctx).val() += c;
    }
};
```

```
std::string s;
typedef rule<class r, std::string> rule_type;
```

```
auto rdef = rule_type()
    = alpha    [f()]
    ;
```

```
BOOST_TEST(test_attr("abcdef", +rdef, s));
BOOST_TEST(s == "abcdef");
```

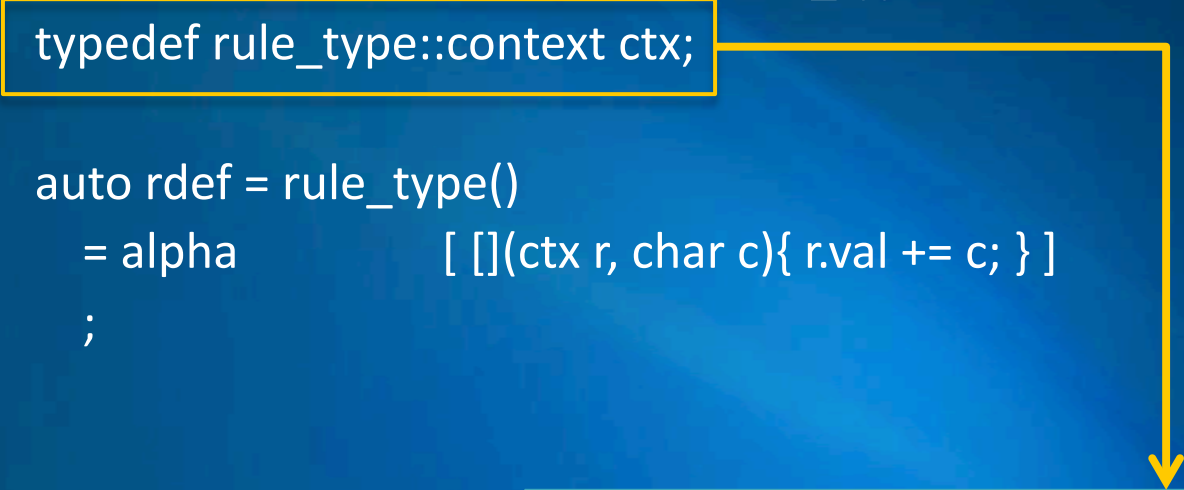
# Semantic Actions

```
std::string s;  
typedef rule<class r, std::string> rule_type;  
  
auto rdef = rule_type()  
    = alpha      [ [] (auto& ctx, char c) { _val(ctx) += c; } ]  
    ;
```

Generic Lambda: C++14 ?

# Semantic Actions

```
std::string s;  
typedef rule<class r, std::string> rule_type;  
typedef rule_type::context ctx;
```



```
auto rdef = rule_type()  
    = alpha      [ [] (ctx r, char c) { r.val += c; } ]  
    ;
```

```
template <typename Attribute>  
struct rule_context_proxy  
{  
    template <typename Context>  
    rule_context_proxy(Context& context)  
        : val(_val(context)) {}  
    Attribute& val;  
};
```



# Semantic Actions (Phoenix)

```
std::string s;  
typedef rule<class r, std::string> rule_type;  
  
auto rdef = rule_type()  
    = alpha      [ _val += c ]  
    ;
```

# Semantic Actions (Alternative Idea)

```
class r_id {};  
std::string s;  
typedef rule<r_id, std::string> rule_type;  
  
auto rdef = rule_type()  
    = alpha  
    ;  
  
/* ... */  
  
template <typename Context, typename RHS>  
void on_success(r_id, Context const& ctx, char c)  
{  
    _val(ctx) += c;  
}
```

# Wrapping Up

- Spirit X3 is Evolving
- [https://github.com/djowel/spirit\\_x3](https://github.com/djowel/spirit_x3)
- Contributors! We need you!
  - Documentation / Tutorials
  - Porting Karma
  - Porting Lex
  - Testing, Benchmarks
  - Fun stuff! (Experimental Research)

THANK YOU!!!