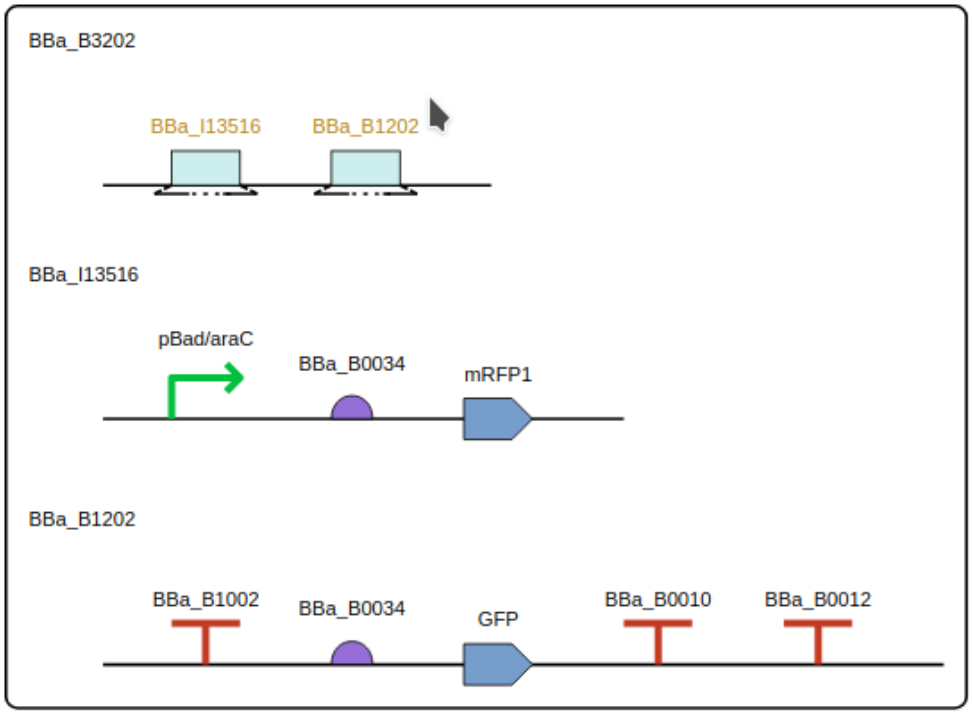
以BBa_B3202为例介绍通路图的存储

Example: BBa_B3202



对属性有疑问可查阅 https://sbolstandard.org/wp-content/uploads/2016/06/SBOL-data-model-2.2.1.pdf

DesignGraph

表示一个完整的通路图。基本属性为：

ATTRIBUTE	EXPLAIN
persistentIdentity	该通路图的唯一标识，须与其它通路图均不同。
article	该通路图的相关文献
description	该通路图的描述或备注

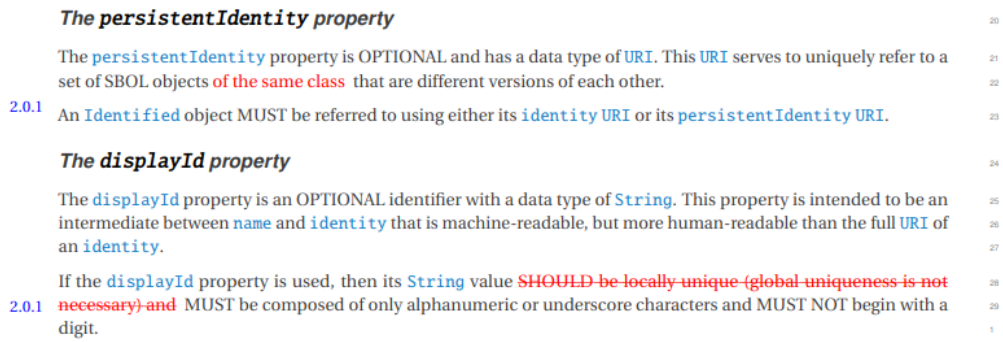
```
//BBa_B3202 DesignGraph
{
    "persistentIdentity": "BBa_B3202",
    "article": null,
    "description": null,
    // ....
}
```

Activity

一个DesignGraph中包含若干个Activity。

表示一个活动（比如，通路图的创建活动等）。基本属性为：

ATTRIBUTE	EXPLAIN
persistentIdentity	该活动的唯一标识，须与其它活动均不同。
displayId	
version	
title	同以下name的解释
description	
topLevel	可以简单理解为该实体的更高一层的物体
ownedBy	拥有者
creator	创建者
endedAtTime	



The `persistentIdentity` property

The `persistentIdentity` property is OPTIONAL and has a data type of `URI`. This `URI` serves to uniquely refer to a set of SBOL objects of the same class that are different versions of each other.

2.0.1 An `Identified` object MUST be referred to using either its `identity` `URI` or its `persistentIdentity` `URI`.

The `displayId` property

The `displayId` property is an OPTIONAL identifier with a data type of `String`. This property is intended to be an intermediate between `name` and `identity` that is machine-readable, but more human-readable than the full `URI` of an `identity`.

If the `displayId` property is used, then its `String` value ~~SHOULD be locally unique (global uniqueness is not necessary) and~~ MUST be composed of only alphanumeric or underscore characters and MUST NOT begin with a digit.

2.0.1

The `version` property

The `version` property is OPTIONAL and has a data type of `String`. This property can be used to compare two SBOL objects with the same `persistentIdentity`.

If the `version` property is used, then it is RECOMMENDED that version numbering follow the conventions of semantic versioning (`http://semver.org/`), particularly as implemented by Maven (`http://maven.apache.org/`). This convention represents versions as sequences of numbers and qualifiers that are separated by the characters "`.`" and "`-`" and are compared in lexicographical order (for example, 1 < 1.3.1 < 2.0-beta). For a full explanation, see the linked resources.

The `name` property

The `name` property is OPTIONAL and has a data type of `String`. This property is intended to be displayed to a human when visualizing an `Identified` object.

If an `Identified` object lacks a name, then software tools SHOULD instead display the object's `displayId` or `identity`. It is RECOMMENDED that software tools give users the ability to switch perspectives between `name` properties that are human-readable and `displayId` properties that are less human-readable, but are more likely to be unique.

The `description` property

The `description` property is OPTIONAL and has a data type of `String`. This property is intended to contain a more thorough text description of an `Identified` object.

7.5 TopLevel

`TopLevel` is an abstract class that is extended by any `Identified` class that can be found at the top level of an SBOL document or file. In other words, `TopLevel` objects are not nested inside any other object via a composite aggregation or black diamond arrow association property. Instead of nesting, composite `TopLevel` objects refer to subordinate `TopLevel` objects by their `URI`s using shared aggregation or white diamond arrow association properties. The `TopLevel` classes defined in this specification are `Sequence`, `ComponentDefinition`, `Model`, `ModuleDefinition`, `Collection`, `GenericTopLevel`, `CombinatorialDerivation`, and `Implementation`(Figure 5).

The `endedAtTime` property

The `endedAtTime` property is OPTIONAL and contains a DateTime (see section Section 12.7) value, indicating when the activity ended.

加上Activity后的BBa_B3202的DesignGraph表示：

```
//BBa_B3202 DesignGraph
{
    "persistentIdentity": "BBa_B3202",
    "article": null,
    "description": null,
    "Activity": [ // BBa_B3202只有一个Activity
        {
            "persistentIdentity":
"https://synbiohub.org/public/igem/igem2sbol",
            "displayId": "igem2sbol",
            "version": "1",
            "title": "iGEM to SBOL conversion",
            "description": "Conversion of the iGEM parts registry
to SBOL2.1",
            "topLevel":
"https://synbiohub.org/public/igem/igem2sbol/1",
            "ownedBy": "[\"https://synbiohub.org/user/james\",
\"https://synbiohub.org/user/myers\"]",
            "creator": "[\"Chris J. Myers\", \"James Alastair
McLaughlin\"]",
            "endedAtTime": "2017-03-06T15:00:00.000Z"
        }
```

```
    ],
}
```

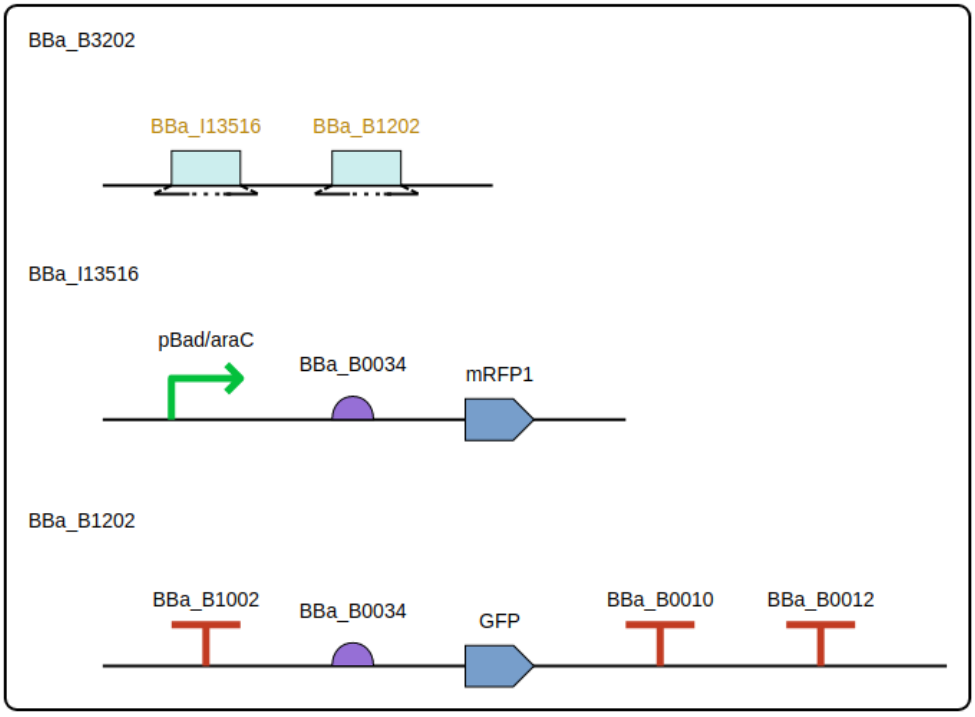
ComponentDefinition

表示单独的一个Device。

7.7 ComponentDefinition

The `ComponentDefinition` class represents the structural entities of a biological design. The primary usage of this class is to represent structural entities with designed sequences, such as DNA, RNA, and proteins, but it can also be used to represent any other entity that is part of a design, such as small molecules, molecular complexes, and light.

比如，下图中有名字的都是一个ComponentDefinition:



每一个ComponentDefinition的基本属性如下：

ATTR	EXPLAIN
persistentIdentity	独有ID
displayId	
version	
wasDerivedFrom	
wasGeneratedBy	
title	
description	
created	
modified	

ATTR	EXPLAIN
mutableProvenance	
topLevel	
mutableDescription	
mutableNotes	
creator	
type	
role	

The `wasDerivedFroms` property

2.2.0 The `wasDerivedFroms` property is OPTIONAL and MAY specify a set of `URI`s. An SBOL object with this property refers to one or more SBOL objects or non-SBOL resources from which this object was derived.

2.0.1 The `wasDerivedFroms` property of a `TopLevel` SBOL object is subject to the following rules. If any members of the `wasDerivedFroms` property of an SBOL object *A* that refers to an SBOL object *B* has an identical `persistentIdentity`, and both *A* and *B* have a `version`, then the `version` of *B* MUST precede that of *A*. In addition, an SBOL object MUST NOT refer to itself via its own `wasDerivedFroms` property or form a cyclical chain of references via its `wasDerivedFroms` property and those of other SBOL objects. For example, the reference chain "*A* was derived from *B* and *B* was derived from *A*" is cyclical.

Provenance semantics defined through `wasGeneratedBys` relationships are distinctly different from versioning semantics. Generation of a new object is defined by the W3C PROV-O specification as follows:

> ...the completion of production of a new entity by an activity. This entity did not exist before generation and becomes available for usage after this generation.

These semantics are somewhat different from the versioning semantics defined in section Section 7.4. The SBOL specification defines a new version of an object as an update of a previously published object (and therefore a previously existing object). Therefore, an SBOL object which is "generated" from another SHOULD BE regarded as a new entity rather than a new version of an existing entity. However, this distinction is somewhat subjective (see Theseus's paradox). Therefore, we RECOMMEND as a best practice that objects linked by Activities not be successive versions of each other, though this is left to the discretion of users and library developers.

The `types` property

The `types` property is a REQUIRED set of `URI`s that specifies the category of biochemical or physical entity (for example DNA, protein, or small molecule) that a `ComponentDefinition` object abstracts for the purpose of engineering design. For DNA or RNA entities, additional `types` fields are used to describe nucleic acid topology (circular / linear) and strandedness (double- or single-stranded).

The `types` property of every `ComponentDefinition` MUST contain one or more `URI`s that MUST identify terms from appropriate ontologies, such as the Biological Pathway Exchange (BioPAX) ontology **?** or the ontology of Chemical Entities of Biological Interest (ChEBI) **?**. Table 2 provides a list of possible ontology terms for the `types` property and their `URI`s. In order to maximize the compatibility of designs, the `types` property of a `ComponentDefinition` SHOULD contain a `URI` from Table 2, and any `ComponentDefinition` that can be well-described by one of the terms in Table 2 MUST use the `URI` for that term as one of its `types`. Finally, if the `types` property contains multiple `URI`s, then they MUST identify non-conflicting terms (otherwise, it might not be clear how to interpret them). For example, the BioPAX terms provided by Table 2 would conflict because they specify classes of biochemical entities with different molecular structures.

ComponentDefinition Type	URI for BioPAX Term
DNA	`http://www.biopax.org/release/biopax-level3.owl#DnaRegion`
RNA	`http://www.biopax.org/release/biopax-level3.owl#RnaRegion`
Protein	`http://www.biopax.org/release/biopax-level3.owl#Protein`
Small Molecule	`http://www.biopax.org/release/biopax-level3.owl#SmallMolecule`
Complex	`http://www.biopax.org/release/biopax-level3.owl#Complex`

Table 2: *BioPAX terms to specify the molecule type using the `types` property of a `ComponentDefinition`.*

The `roles` property

The `roles` property is an OPTIONAL set of `URI`s that clarifies the potential function of the entity represented by a `ComponentDefinition` in a biochemical or physical context.

The `roles` property of a `ComponentDefinition` MAY contain one or more `URI`s that MUST identify terms from ontologies that are consistent with the `types` property of the `ComponentDefinition`. For example, the `roles` property of a DNA or RNA `ComponentDefinition` could contain URIs identifying terms from the Sequence Ontology (SO). As a best practice, a DNA or RNA `ComponentDefinition` SHOULD contain exactly one `URI` that refers to a term from the sequence feature branch of the SO. Similarly, the roles property of a Protein and SmallMolecule `ComponentDefinition` SHOULD respectively contain `URI`s identifying terms from the `MolecularFunction` branch (`GO:0003674`) of the Gene Ontology (GO) and the `role` branch (`CHEBI:50906`) of the CHEBI ontology. Table 4 contains a list of possible ontology terms for the `roles` property and their `URI`s. These terms are organized by the type of `ComponentDefinition` to which they SHOULD apply (see Table 2). Any `ComponentDefinition` that can be well-described by one of the terms in Table 4 MUST use the `URI` for that term as one of its `roles`.

ComponentDefinition Role	URI for Ontology Term	ComponentDefinition Type
Promoter	http://identifiers.org/so/SO:0000167	DNA
RBS	http://identifiers.org/so/SO:0000139	DNA
CDS	http://identifiers.org/so/SO:0000316	DNA
Terminator	http://identifiers.org/so/SO:0000141	DNA
Gene	http://identifiers.org/so/SO:0000704	DNA
Operator	http://identifiers.org/so/SO:0000057	DNA
Engineered Gene	http://identifiers.org/so/SO:0000280	DNA
mRNA	http://identifiers.org/so/SO:0000234	RNA
Effector	http://identifiers.org/chebi/CHEBI:35224	Small Molecule
Transcription Factor	http://identifiers.org/go/GO:0003700	Protein

Table 4: *Ontology terms to specify the `roles` property of a `ComponentDefinition`, organized by the type of `ComponentDefinition` to which they are intended to apply (see Table 2).*

上图的ComponentDefinition中，BBa_B3202的具体表示如下：

```
//BBa_B3202 ComponentDefinition
{
    "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202",
    "displayId": "BBa_B3202",
    "version": "1",
    "wasDerivedFrom": "http://parts.igem.org/Part:BBa_B3202",
    "wasGeneratedBy":
"https://synbiohub.org/public/igem/igem2sbol/1",
    "title": "BBa_B3202",
    "description": null,
    "created": "2007-01-29T12:00:00Z",
    "modified": "2015-08-31T04:07:22Z",
    "mutableProvenance": "antiquity",
    "topLevel": "https://synbiohub.org/public/igem/BBa_B3202/1",
    "mutableDescription": "final construct for screening terminator
B1002",
    "mutableNotes": "final construct for screening terminators",
    "creator": "Haiyao Huang",
    "type": "http://www.biopax.org/release/biopax-
level3.owl#DnaRegion",
    "role": [
        "Composite",
        "engineered_region"
    ]
    //.....
}
```

Sequence

每个ComponentDefinition有若干个序列（在我们的情况下一般只有一个）。基本属性如下：

ATTR	EXPLAIN
persistentIdentity	
displayId	
version	
wasDerivedFrom	
wasGeneratedBy	
topLevel	
ownedBy	
elements	
encoding	

7.6 Sequence

The purpose of the Sequence class is to represent the primary structure of a ComponentDefinition object and the manner in which it is encoded. This representation is accomplished by means of the elements property and encoding property (Figure 6).

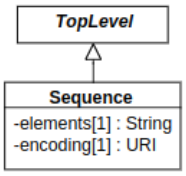


Figure 6: Diagram of the Sequence class and its associated properties.

The elements property

The elements property is a REQUIRED String of characters that represents the constituents of a biological or chemical molecule. For example, these characters could represent the nucleotide bases of a molecule of DNA, the amino acid residues of a protein, or the atoms and chemical bonds of a small molecule.

The encoding property

The encoding property is REQUIRED and has a data type of URI. This property MUST indicate how the elements property of a Sequence MUST be formed and interpreted.

For example, the elements property of a Sequence with an `IUPAC DNA` encoding property MUST contain characters that represent nucleotide bases, such as `a`, `t`, `c`, and `g`. The elements property of a Sequence with a `Simplified Molecular-Input Line-Entry System (SMILES)` encoding, on the other hand, MUST contain characters that represent atoms and chemical bonds, such as `C`, `N`, `O`, and `=`.

Table 1 provides a list of possible URI values for the encoding property. The terms in Table 1 are organized by the type of ComponentDefinition (see Table 2) that typically refer to a Sequence with such an encoding. It is RECOMMENDED that the encoding property of a Sequence contains a URI from Table 1. When the encoding of a Sequence is well described by one of the URIs in Table 1, it MUST contain that URI.

Encoding	URI	ComponentDefinition Type
IUPAC DNA, RNA	http://www.chem.qmul.ac.uk/iubmb/misc/naseq.html	DNA, RNA
IUPAC Protein	http://www.chem.qmul.ac.uk/iupac/AminoAcid/	Protein
SMILES	http://www.opensmiles.org/opensmiles.html	SmallMolecule

Table 1: URIs for specifying the encoding property of a Sequence, organized by the type of ComponentDefinition (see Table 2) that typically refer to a Sequence with such an encoding.

```
//BBa_B3202 ComponentDefinition 加入了Sequence
{
```

```
    "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202",
    "displayId": "BBa_B3202",
    "version": "1",
    "wasDerivedFrom": "http://parts.igem.org/Part:BBa_B3202",
    "wasGeneratedBy":
"https://synbiohub.org/public/igem/igem2sbol/1",
    "title": "BBa_B3202",
    "description": null,
    "created": "2007-01-29T12:00:00Z",
    "modified": "2015-08-31T04:07:22Z",
    "mutableProvenance": "antiquity",
    "topLevel": "https://synbiohub.org/public/igem/BBa_B3202/1",
    "mutableDescription": "final construct for screening terminator
B1002",
    "mutableNotes": "final construct for screening terminators",
    "creator": "Haiyao Huang",
    "type": "http://www.biopax.org/release/biopax-
level3.owl#DnaRegion",
    "role": [
        "Composite",
        "engineered_region"
    ],
    "Sequence": [
        {
            "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202_sequence",
            "displayId": "BBa_B3202_sequence",
            "version": "1",
            "wasDerivedFrom":
"http://parts.igem.org/Part:BBa_B3202",
            "wasGeneratedBy":
"https://synbiohub.org/public/igem/igem2sbol/1",
            "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202_sequence/1",
            "ownedBy": "[\"https://synbiohub.org/user/james\",
\"https://synbiohub.org/user/myers\"]",
```

```
            "elements":
"ttatgacaacttgacggctacatcattcacttttttcttcacaaccggcacggaactcgctcgggct
ggccccggtgcatttttttaaataccgcgagaaatagagttgatcgtcaaaaccaacattgcgaccg
acggtggcgataggcatccgggtggtgctcaaaagcagcttcgcctggctgatacgttggtcctcgc
gccagcttaagacgctaatccctaactgctggcggaaaagatgtgacagacgcgacggcgacaagca
aacatgctgtgcgacgctggcgatatcaaaattgctgtctgccaggtgatcgctgatgtactgacaa
gcctcgcgtacccgattatccatcggtggatggagcgactcgttaatcgcttccatgcgccgcagta
acaattgctcaagcagatttatcgccagcagctccgaatagcgcccttccccttgcccggcgttaat
gatttgcccaaacaggtcgctgaaatgcggctggtgcgcttcatccgggcgaaagaaccccgtattg
gcaaatattgacggccagttaagccattcatgccagtaggcgcgcggacgaaagtaaacccactggt
gataccattcgcgagcctccggatgacgaccgtagtgatgaatctctcctggcgggaacagcaaaat
atcacccggtcggcaaacaaattctcgtccctgatttttcaccaccccctgaccgcgaatggtgaga
ttgagaatataacctttcattcccagcggtcggtcgataaaaaaaatcgagataaccgttggcctcaa
tcggcgttaaacccgccaccagatgggcattaaacgagtatcccggcagcaggggatcattttgcgc
ttcagccatacttttcatactcccgccattcagagaagaaaccaattgtccatattgcatcagacat
tgccgtcactgcgtcttttactggctcttctcgctaaccaaaccggtaaccccgcttattaaaagca
ttctgtaacaaagcgggaccaaagccatgacaaaaacgcgtaacaaaagtgtctataatcacggcag
aaaagtccacattgattatttgcacggcgtcacactttgctatgccatagcatttttatccataaga
ttagcggatcctacctgacgctttttatcgcaactctctactgtttctccatacccgtttttttggg
ctagctactagagaaagaggagaaatactagatggcttcctccgaagacgttatcaaagagttcatg
cgtttcaaagttcgtatggaaggttccgttaacggtcacgagttcgaaatcgaaggtgaaggtgaag
gtcgtccgtacgaaggtacccagaccgctaaactgaaagttaccaaaggtggtccgctgccgttcgc
ttgggacatcctgtccccgcagttccagtacggttccaaagcttacgttaaacacccggctgacatc
ccggactacctgaaactgtccttcccggaaggtttcaaatgggaacgtgttatgaacttcgaagacg
gtggtgttgttaccgttacccaggactcctccctgcaagacggtgagttcatctacaaagttaaact
gcgtggtaccaacttcccgtccgacggtccggttatgcagaaaaaaaaccatgggttgggaagcttcc
accgaacgtatgtacccggaagacggtgctctgaaaggtgaaatcaaaatgcgtctgaaactgaaag
acggtggtcactacgacgctgaagttaaaaccacctacatggctaaaaaaccggttcagctgccggg
tgcttacaaaaccgacatcaaactggacatcacctcccacaacgaagactacaccatcgttgaacag
tacgaacgtgctgaaggtcgtcactccaccggtgcttaataacgctgatagtgctagtgtagatcgc
tactagagcgcaaaaaaccccgcttcggcggggttttttcgctactagagaaagaggagaaatacta
gatgcgtaaaggagaagaacttttcactggagttgtcccaattcttgttgaattagatggtgatgtt
aatgggcacaaattttctgtcagtggagagggtgaaggtgatgcaacatacggaaaacttaccctta
aatttatttgcactactggaaaactacctgttccatggccaacacttgtcactactttcggttatgg
tgttcaatgctttgcgagatacccagatcatatgaaacagcatgacttttcaagagtgccatgccc
gaaggttatgtacaggaaagaactatatttttcaaagatgacgggaactacaagacacgtgctgaag
tcaagtttgaaggtgataccttgttaatagaatcgagttaaaaggtattgattttaaagaagatgg
aaacattcttggacacaaattggaatacaactataactcacacaatgtatacatcatggcagacaaa
caaaagaatggaatcaaagttaacttcaaaattagacacaacattgaagatggaagcgttcaactag
cagaccattatcaacaaaatactccaattggcgatggccctgtccttttaccagacaaccattacct
gtccacacaatctgccctttcgaaagatcccaacgaaaagagagaccacatggtccttcttgagttt
gtaacagctgctgggattacacatggcatggatgaactatacaaataataatactagagccaggcat
caaataaaacgaaaggctcagtcgaaagactgggcctttcgttttatctgttgtttgtcggtgaacg
ctctctactagagtcacactggctcaccttcgggtgggcctttctgcgtttata",
            "encoding":
"http://www.chem.qmul.ac.uk/iubmb/misc/naseq.html",
            "father_id":
"https://synbiohub.org/public/igem/BBa_B3202"
        }
    ],
    // ...
}
```

Component

每个ComponentDefinition有若干个子ComponentDefinition，由Component连接。

比如，上述BBa_B3202有两个子ComponentDefinition，分别为BBa_I13516和BBa_B1202。

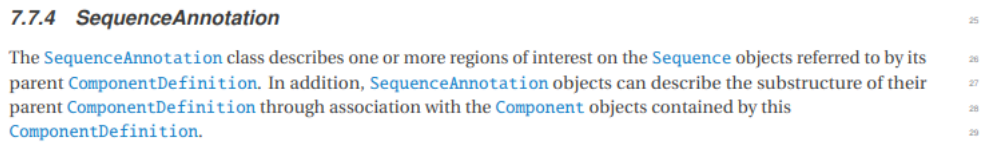
```
//BBa_B3202 ComponentDefinition 加入了Component关系
{
            "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202",
            "displayId": "BBa_B3202",
            "version": "1",
            "wasDerivedFrom":
"http://parts.igem.org/Part:BBa_B3202",
            "wasGeneratedBy":
"https://synbiohub.org/public/igem/igem2sbol/1",
            "title": "BBa_B3202",
            "description": null,
            "created": "2007-01-29T12:00:00Z",
            "modified": "2015-08-31T04:07:22Z",
            "mutableProvenance": "antiquity",
            "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202/1",
            "mutableDescription": "final construct for screening
terminator B1002",
            "mutableNotes": "final construct for screening
terminators",
            "creator": "Haiyao Huang",
            "type": "http://www.biopax.org/release/biopax-
level3.owl#DnaRegion",
            "role": [
                "Composite",
                "engineered_region"
            ],
            "Sequence": [
                {
                    "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202_sequence",
                    "displayId": "BBa_B3202_sequence",
                    "version": "1",
                    "wasDerivedFrom":
"http://parts.igem.org/Part:BBa_B3202",
                    "wasGeneratedBy":
"https://synbiohub.org/public/igem/igem2sbol/1",
                    "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202_sequence/1",
                    "ownedBy": "
[\"https://synbiohub.org/user/james\",
\"https://synbiohub.org/user/myers\"]",
```

```
                    "elements":
"ttatgacaacttgacggctacatcattcacttttttcttcacaaccggcacggaactcgctcgggct
ggccccggtgcatttttaaatacccgcgagaaatagagttgatcgtcaaaaccaacattgcgaccg
acggtggcgataggcatccgggtggtgctcaaaagcagcttcgcctggctgatacgttggtcctcgc
gccagcttaagacgctaatccctaactgctggcggaaaagatgtgacagacgcgacggcgacaagca
aacatgctgtgcgacgctggcgatatcaaaattgctgtctgccaggtgatcgctgatgtactgacaa
gcctcgcgtacccgattatccatcggtggatggagcgactcgttaatcgcttccatgcgccgcagta
acaattgctcaagcagatttatcgccagcagctccgaatagcgcccttccccttgcccggcgttaat
gatttgcccaaacaggtcgctgaaatgcggctggtgcgcttcatccgggcgaaagaaccccgtattg
gcaaatattgacggccagttaagccattcatgccagtaggcgcgcggacgaaagtaaacccactggt
gataccattcgcgagcctccggatgacgaccgtagtgatgaatctctcctggcgggaacagcaaaat
atcacccggtcggcaaacaaattctcgtccctgatttttcaccaccccctgaccgcgaatggtgaga
ttgagaatataacctttcattcccagcggtcggtcgataaaaaaaatcgagataaccgttggcctcaa
tcggcgttaaacccgccaccagatgggcattaaacgagtatcccggcagcaggggatcattttgcgc
ttcagccatacttttcatactcccgccattcagagaagaaaccaattgtccatattgcatcagacat
tgccgtcactgcgtcttttactggctcttctcgctaaccaaaccggtaaccccgcttattaaaagca
ttctgtaacaaagcgggaccaaagccatgacaaaaacgcgtaacaaaagtgtctataatcacggcag
aaaagtccacattgattatttgcacggcgtcacactttgctatgccatagcatttttatccataaga
ttagcggatcctacctgacgctttttatcgcaactctctactgtttctccatacccgtttttttggg
ctagctactagagaaagaggagaaatactagatggcttcctccgaagacgttatcaaagagttcatg
cgtttcaaagttcgtatggaaggttccgttaacggtcacgagttcgaaatcgaaggtgaaggtgaag
gtcgtccgtacgaaggtacccagaccgctaaactgaaagttaccaaaggtggtccgctgccgttcgc
ttgggacatcctgtccccgcagttccagtacggttccaaagcttacgttaaacacccggctgacatc
ccggactacctgaaactgtccttcccggaaggtttcaaatgggaacgtgttatgaacttcgaagacg
gtggtgttgttaccgttacccaggactcctccctgcaagacggtgagttcatctacaaagttaaact
gcgtggtaccaacttcccgtccgacggtccggttatgcagaaaaaaaaccatgggttgggaagcttcc
accgaacgtatgtacccggaagacggtgctctgaaaggtgaaatcaaaatgcgtctgaaactgaaag
acggtggtcactacgacgctgaagttaaaaccacctacatggctaaaaaaccggttcagctgccggg
tgcttacaaaaccgacatcaaactggacatcacctcccacaacgaagactacaccatcgttgaacag
tacgaacgtgctgaaggtcgtcactccaccggtgcttaataacgctgatagtgctagtgtagatcgc
tactagagcgcaaaaaaccccgcttcggcggggttttttcgctactagagaaagaggagaaatacta
gatgcgtaaaggagaagaacttttcactggagttgtcccaattcttgttgaattagatggtgatgtt
aatgggcacaaattttctgtcagtggagagggtgaaggtgatgcaacatacggaaaacttaccctta
aatttatttgcactactggaaaactacctgttccatggccaacacttgtcactactttcggttatgg
tgttcaatgctttgcgagatacccagatcatatgaaacagcatgacttttcaagagtgccatgccc
gaaggttatgtacaggaaagaactatatttttcaaagatgacgggaactacaagacacgtgctgaag
tcaagtttgaaggtgataccttgttaatagaatcgagttaaaaggtattgattttaaagaagatgg
aaacattcttggacacaaattggaatacaactataactcacacaatgtatacatcatggcagacaaa
caaaagaatggaatcaaagttaacttcaaaattagacacaacattgaagatggaagcgttcaactag
cagaccattatcaacaaaatactccaattggcgatggccctgtccttttaccagacaaccattacct
gtccacacaatctgccctttcgaaagatcccaacgaaaagagagaccacatggtccttcttgagttt
gtaacagctgctgggattacacatggcatggatgaactatacaaataataatactagagccaggcat
caaataaaacgaaaggctcagtcgaaagactgggcctttcgttttatctgttgtttgtcggtgaacg
ctctctactagagtcacactggctcaccttcgggtgggcctttctgcgtttata",
                    "encoding":
"http://www.chem.qmul.ac.uk/iubmb/misc/naseq.html",
                    "father_id":
"https://synbiohub.org/public/igem/BBa_B3202"
                }
            ],
            "Component": [
                {
```

```
                    "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202/component2270279",
                    "displayId": "component2270279",
                    "version": "1",
                    "title": "BBa_I13516",
                    "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202/1",
                    "definition":
"https://synbiohub.org/public/igem/BBa_I13516/1",
                    "access": "http://sbols.org/v2#public",
                    "father_id":
"https://synbiohub.org/public/igem/BBa_B3202"
                },
                {
                    "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202/component2270294",
                    "displayId": "component2270294",
                    "version": "1",
                    "title": "BBa_B1202",
                    "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202/1",
                    "definition":
"https://synbiohub.org/public/igem/BBa_B1202/1",
                    "access": "http://sbols.org/v2#public",
                    "father_id":
"https://synbiohub.org/public/igem/BBa_B3202"
                }
            ],
```


SequenceAnnotation

整个ComponentDefinition有Sequence，使用SequenceAnnotation来标记Sequence中的某一段（表明这一段是上述Component关系指明的某个子ComponentDefinition的序列）。



7.7.4 SequenceAnnotation

The SequenceAnnotation class describes one or more regions of interest on the Sequence objects referred to by its parent ComponentDefinition. In addition, SequenceAnnotation objects can describe the substructure of their parent ComponentDefinition through association with the Component objects contained by this ComponentDefinition.

基本属性如下：

ATTR	EXPLAIN
persistentIdentity	
displayId	
version	
title	
topLevel	

ATTR	EXPLAIN
component	

SequenceAnnotation中包含Location信息，表示从Sequence的[start, end)这一段是标注的序列。

Location的基本属性如下：

ATTR	EXPLAIN
persistentIdentity	
displayId	
version	
topLevel	
direction	
start	
end	
orientation	

The `orientation` property

The `orientation` property is OPTIONAL and has a data type of `URI`. All subclasses of `Location` share this property, which can be used to indicate how the region specified by the `SequenceAnnotation` and any associated double-stranded `Component` is oriented on the `elements` of a `Sequence` from their parent `ComponentDefinition`. Table 8 provides a list of REQUIRED `orientation` URIs. If a `Location` object has an `orientation`, then it MUST come from Table 8.

Orientation URI	Description
`http://sbols.org/v2#inline`	The region specified by this `Location` is on the `elements` of a `Sequence`.
`http://sbols.org/v2#reverseComplement`	The region specified by this `Location` is on the reverse-complement translation of the `elements` of a `Sequence`. The exact nature of this translation depends on the `encoding` of the `Sequence`.

***Table 8:** REQUIRED `URI`s for the `orientation` property*

```
// BBa_B3202 加入SequenceAnnotation信息
{
    "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202",
    "displayId": "BBa_B3202",
    "version": "1",
    "wasDerivedFrom": "http://parts.igem.org/Part:BBa_B3202",
    "wasGeneratedBy":
"https://synbiohub.org/public/igem/igem2sbol/1",
    "title": "BBa_B3202",
    "description": null,
    "created": "2007-01-29T12:00:00Z",
    "modified": "2015-08-31T04:07:22Z",
    "mutableProvenance": "antiquity",
    "topLevel": "https://synbiohub.org/public/igem/BBa_B3202/1",
```

```
    "mutableDescription": "final construct for screening terminator
B1002",
    "mutableNotes": "final construct for screening terminators",
    "creator": "Haiyao Huang",
    "type": "http://www.biopax.org/release/biopax-
level3.owl#DnaRegion",
    "role": "[\"Composite\", \"engineered_region\"]",
    "Sequence": [
        {
            "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202_sequence",
            "displayId": "BBa_B3202_sequence",
            "version": "1",
            "wasDerivedFrom":
"http://parts.igem.org/Part:BBa_B3202",
            "wasGeneratedBy":
"https://synbiohub.org/public/igem/igem2sbol/1",
            "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202_sequence/1",
            "ownedBy": "[\"https://synbiohub.org/user/james\",
\"https://synbiohub.org/user/myers\"]",
```

```
            "elements":
"ttatgacaacttgacggctacatcattcacttttttcttcacaaccggcacggaactcgctcgggct
ggccccggtgcatttttaaatacccgcgagaaatagagttgatcgtcaaaaccaacattgcgaccg
acggtggcgataggcatccgggtggtgctcaaaagcagcttcgcctggctgatacgttggtcctcgc
gccagcttaagacgctaatccctaactgctggcggaaaagatgtgacagacgcgacggcgacaagca
aacatgctgtgcgacgctggcgatatcaaaattgctgtctgccaggtgatcgctgatgtactgacaa
gcctcgcgtacccgattatccatcggtggatggagcgactcgttaatcgcttccatgcgccgcagta
acaattgctcaagcagatttatcgccagcagctccgaatagcgcccttccccttgcccggcgttaat
gatttgcccaaacaggtcgctgaaatgcggctggtgcgcttcatccgggcgaaagaaccccgtattg
gcaaatattgacggccagttaagccattcatgccagtaggcgcgcggacgaaagtaaacccactggt
gataccattcgcgagcctccggatgacgaccgtagtgatgaatctctcctggcgggaacagcaaaat
atcacccggtcggcaaacaaattctcgtccctgatttttcaccaccccctgaccgcgaatggtgaga
ttgagaatataacctttcattcccagcggtcggtcgataaaaaaaatcgagataaccgttggcctcaa
tcggcgttaaacccgccaccagatgggcattaaacgagtatcccggcagcaggggatcattttgcgc
ttcagccatacttttcatactcccgccattcagagaagaaaccaattgtccatattgcatcagacat
tgccgtcactgcgtcttttactggctcttctcgctaaccaaaccggtaaccccgcttattaaaagca
ttctgtaacaaagcgggaccaaagccatgacaaaaacgcgtaacaaaagtgtctataatcacggcag
aaaagtccacattgattatttgcacggcgtcacactttgctatgccatagcatttttatccataaga
ttagcggatcctacctgacgctttttatcgcaactctctactgtttctccatacccgtttttttggg
ctagctactagagaaagaggagaaatactagatggcttcctccgaagacgttatcaaagagttcatg
cgtttcaaagttcgtatggaaggttccgttaacggtcacgagttcgaaatcgaaggtgaaggtgaag
gtcgtccgtacgaaggtacccagaccgctaaactgaaagttaccaaaggtggtccgctgccgttcgc
ttgggacatcctgtccccgcagttccagtacggttccaaagcttacgttaaacacccggctgacatc
ccggactacctgaaactgtccttcccggaaggtttcaaatgggaacgtgttatgaacttcgaagacg
gtggtgttgttaccgttacccaggactcctccctgcaagacggtgagttcatctacaaagttaaact
gcgtggtaccaacttcccgtccgacggtccggttatgcagaaaaaaaaccatgggttgggaagcttcc
accgaacgtatgtacccggaagacggtgctctgaaaggtgaaatcaaaatgcgtctgaaactgaaag
acggtggtcactacgacgctgaagttaaaaccacctacatggctaaaaaaccggttcagctgccggg
tgcttacaaaaccgacatcaaactggacatcacctcccacaacgaagactacaccatcgttgaacag
tacgaacgtgctgaaggtcgtcactccaccggtgcttaataacgctgatagtgctagtgtagatcgc
tactagagcgcaaaaaaccccgcttcggcggggttttttcgctactagagaaagaggagaaatacta
gatgcgtaaaggagaagaacttttcactggagttgtcccaattcttgttgaattagatggtgatgtt
aatgggcacaaattttctgtcagtggagagggtgaaggtgatgcaacatacggaaaacttaccctta
aatttatttgcactactggaaaactacctgttccatggccaacacttgtcactactttcggttatgg
tgttcaatgctttgcgagatacccagatcatatgaaacagcatgacttttcaagagtgccatgccc
gaaggttatgtacaggaaagaactatatttttcaaagatgacgggaactacaagacacgtgctgaag
tcaagtttgaaggtgataccttgttaatagaatcgagttaaaaggtattgattttaaagaagatgg
aaacattcttggacacaaattggaatacaactataactcacacaatgtatacatcatggcagacaaa
caaaagaatggaatcaaagttaacttcaaaattagacacaacattgaagatggaagcgttcaactag
cagaccattatcaacaaaatactccaattggcgatggccctgtccttttaccagacaaccattacct
gtccacacaatctgccctttcgaaagatcccaacgaaaagagagaccacatggtccttcttgagttt
gtaacagctgctgggattacacatggcatggatgaactatacaaataataatactagagccaggcat
caaataaaacgaaaggctcagtcgaaagactgggcctttcgttttatctgttgtttgtcggtgaacg
ctctctactagagtcacactggctcaccttcgggtgggcctttctgcgtttata",
            "encoding":
"http://www.chem.qmul.ac.uk/iubmb/misc/naseq.html",
            "father_id":
"https://synbiohub.org/public/igem/BBa_B3202"
        }
    ],
    "Component": [
        {
```

```
            "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202/component2270279",
            "displayId": "component2270279",
            "version": "1",
            "title": "BBa_I13516",
            "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202/1",
            "definition":
"https://synbiohub.org/public/igem/BBa_I13516/1",
            "access": "http://sbols.org/v2#public",
            "father_id":
"https://synbiohub.org/public/igem/BBa_B3202"
        },
        {
            "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202/component2270294",
            "displayId": "component2270294",
            "version": "1",
            "title": "BBa_B1202",
            "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202/1",
            "definition":
"https://synbiohub.org/public/igem/BBa_B1202/1",
            "access": "http://sbols.org/v2#public",
            "father_id":
"https://synbiohub.org/public/igem/BBa_B3202"
        }
    ],
    "SequenceAnnotation": [
        {
            "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202/annotation2270279",
            "displayId": "annotation2270279",
            "version": "1",
            "title": "BBa_I13516",
            "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202/1",
            "component":
"https://synbiohub.org/public/igem/BBa_B3202/component2270279/1",
            "father_id":
"https://synbiohub.org/public/igem/BBa_B3202",
            "Location": [
                {
                    "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202/annotation2270279/rang
e2270279",
                    "displayId": "range2270279",
                    "version": "1",
                    "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202/1",
                    "direction":
"http://wiki.synbiohub.org/wiki/Terms/igem#direction/reverse",
```

```
                    "start": 1,
                    "end": 1943,
                    "orientation": "http://sbols.org/v2#inline",
                    "father_id":
"https://synbiohub.org/public/igem/BBa_B3202/annotation2270279"
                }
            ]
        },
        {
            "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202/annotation2270294",
            "displayId": "annotation2270294",
            "version": "1",
            "title": "BBa_B1202",
            "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202/1",
            "component":
"https://synbiohub.org/public/igem/BBa_B3202/component2270294/1",
            "father_id":
"https://synbiohub.org/public/igem/BBa_B3202",
            "Location": [
                {
                    "persistentIdentity":
"https://synbiohub.org/public/igem/BBa_B3202/annotation2270294/rang
e2270294",
                    "displayId": "range2270294",
                    "version": "1",
                    "topLevel":
"https://synbiohub.org/public/igem/BBa_B3202/1",
                    "direction":
"http://wiki.synbiohub.org/wiki/Terms/igem#direction/reverse",
                    "start": 1951,
                    "end": 2868,
                    "orientation": "http://sbols.org/v2#inline",
                    "father_id":
"https://synbiohub.org/public/igem/BBa_B3202/annotation2270294"
                }
            ]
        }
    ]
}
```


完整的BBa_B3202通路图

见BBa_B3202.json