

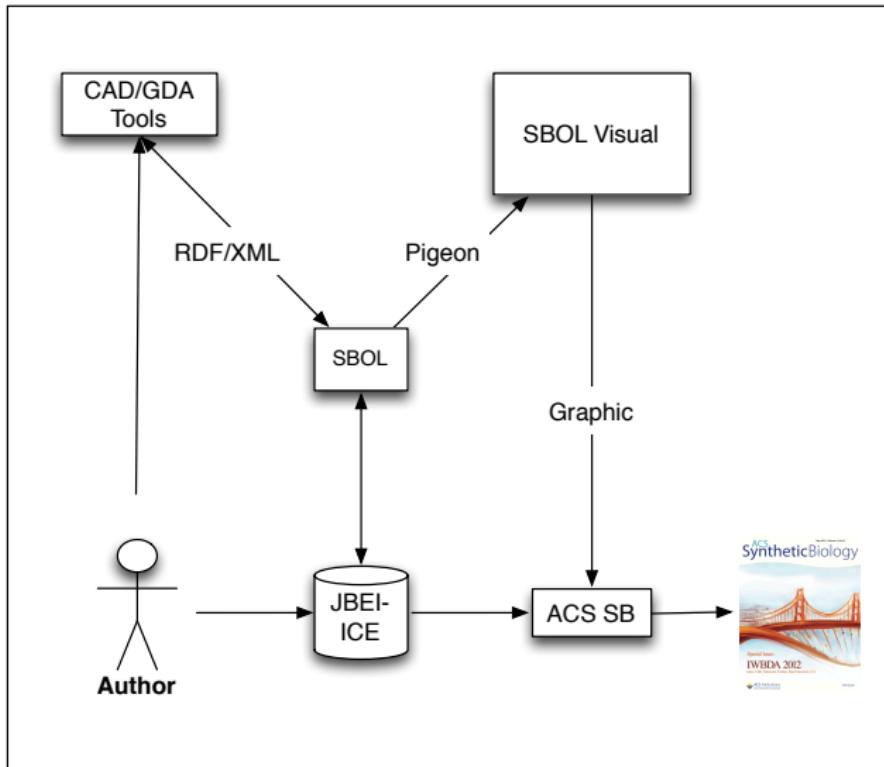
Synthetic Biology Workflow Using SBOLDesigner

Michael Zhang

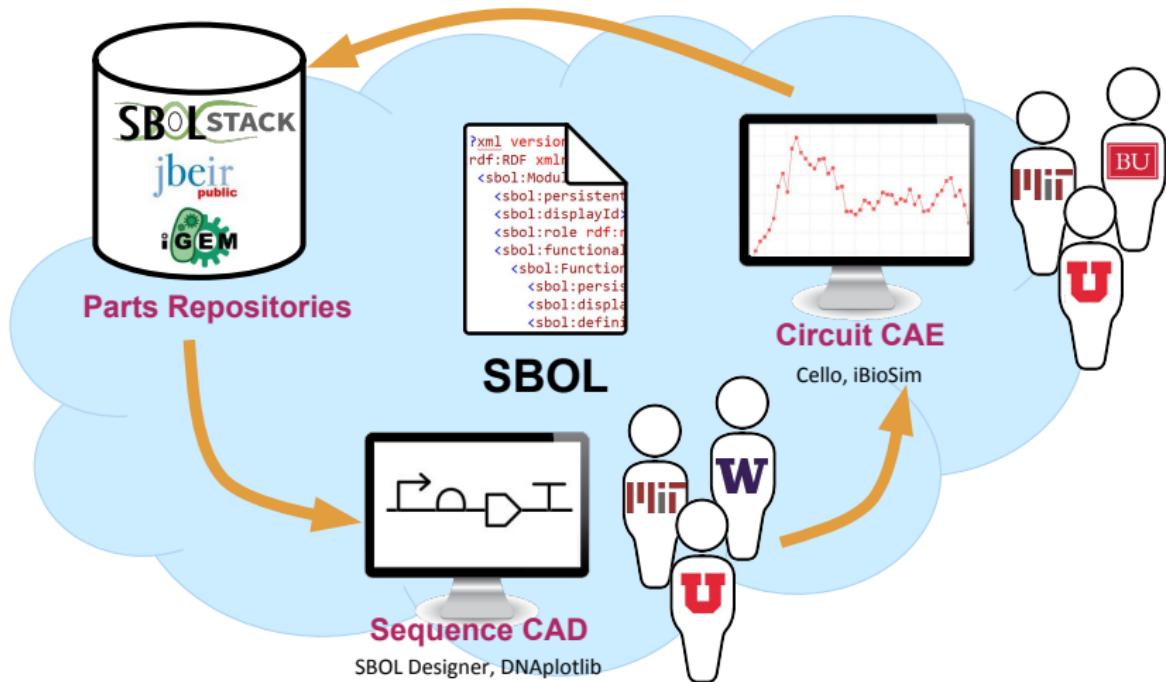
University of Utah

Nona Talks
July 17, 2016

SBOL and ACS Synthetic Biology



Synthetic Biology Workflow Using SBML/SBOL



SBOL Visual (Version 1.0)

 promoter	 origin of replication
 cds	 primer binding site
 ribosome entry site	 blunt restriction site
 terminator	 sticky restriction site
 operator	 5' overhang
 insulator	 3' overhang
 ribonuclease site	 assembly scar
 rna stability element	 signature
 protease site	 user defined
 protein stability element	

New symbols
added on
community
consensus.

Quinn et al., PLoS Biology (2015)

SBOL Data Model (Version 2.0)

FASTA

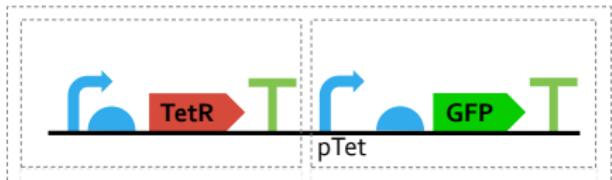
ACTGTGCCGTTAACGTGATTAAATCCGTACTGATAT...



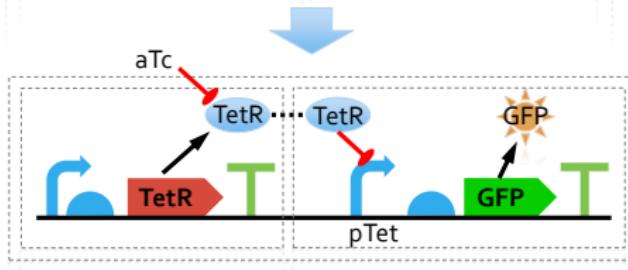
GenBank



SBOL 1.1



SBOL 2.0



Library Support for SBOL 2.0

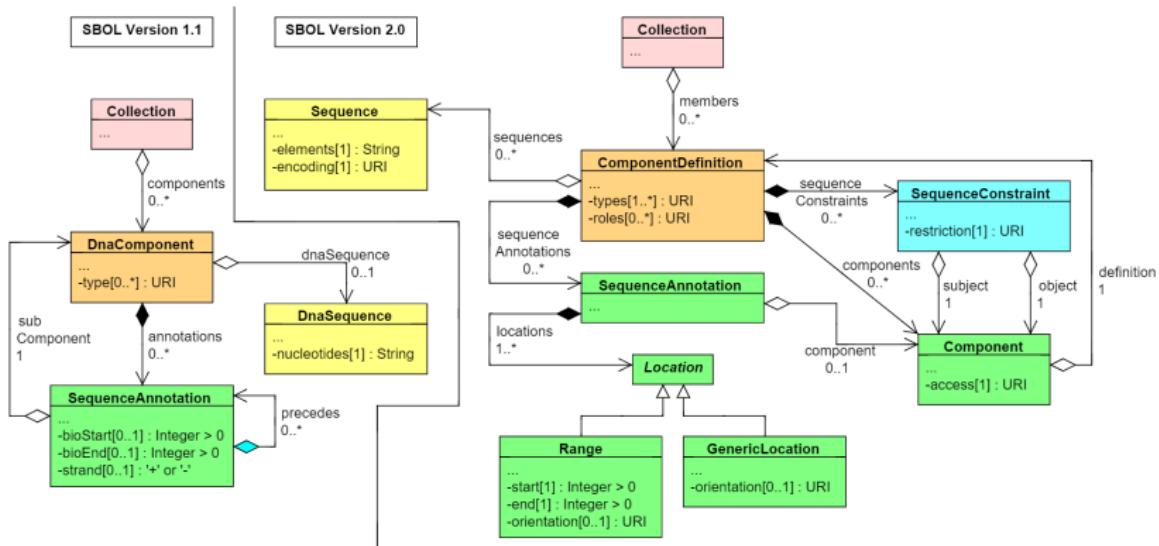
- Crucial to the success of a standard is software infrastructure to support developers' integration of the standard within their tools.
- There are several library implementations of the SBOL data structure, which provide an *application programmers interface* (API) for tool developers to interact with SBOL data objects.
 - libSBOLj - native Java library
 - libSBOL - C/C++ library
 - pySBOL - Python library
 - sboljs - Javascript library
- Library distributions include detailed documentation for the class definitions and the methods provided by the API.
- An online validator/converter powered by libSBOLj is available from the SBOL website.

SBOLDesigner

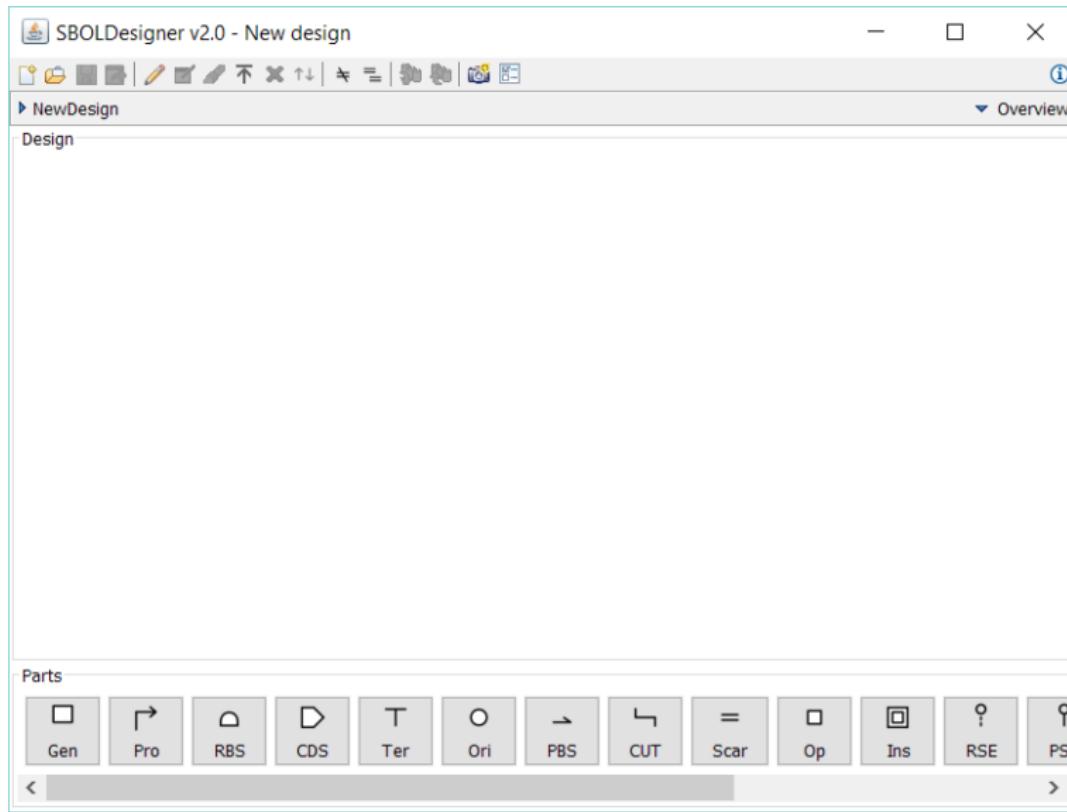


- SBOLDesigner is a tool that leverages libSBOLj 2.0 to create and design the sequence portion of genetic circuits using SBOL Visual glyphs.
- SBOLDesigner 1.0 was initially developed by the University of Washington and Clark & Parsia LLC.
- SBOLDesigner 2.0 is now being developed at the University of Utah.

SBOL 1.1 to SBOL 2.0



Mapping SBOLDesigner to the Data Model



Parts

SBOLDesigner v2.0 - New design

NewDesign Overview

Design

Pro RBS CDS Ter

Parts

Gen	Pro	RBS	CDS	Ter	Ori	PBS	CUT	=	Op	Ins	RSE	PS
-----	-----	-----	-----	-----	-----	-----	-----	---	----	-----	-----	----

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Parts

Part: BBa_R0010 X

Part role	Pro (Promoter)
Role refinement	None
Display ID	BBa_R0010
Name	BBa_R0010
Version	
Description	promoter (lacI regulated)

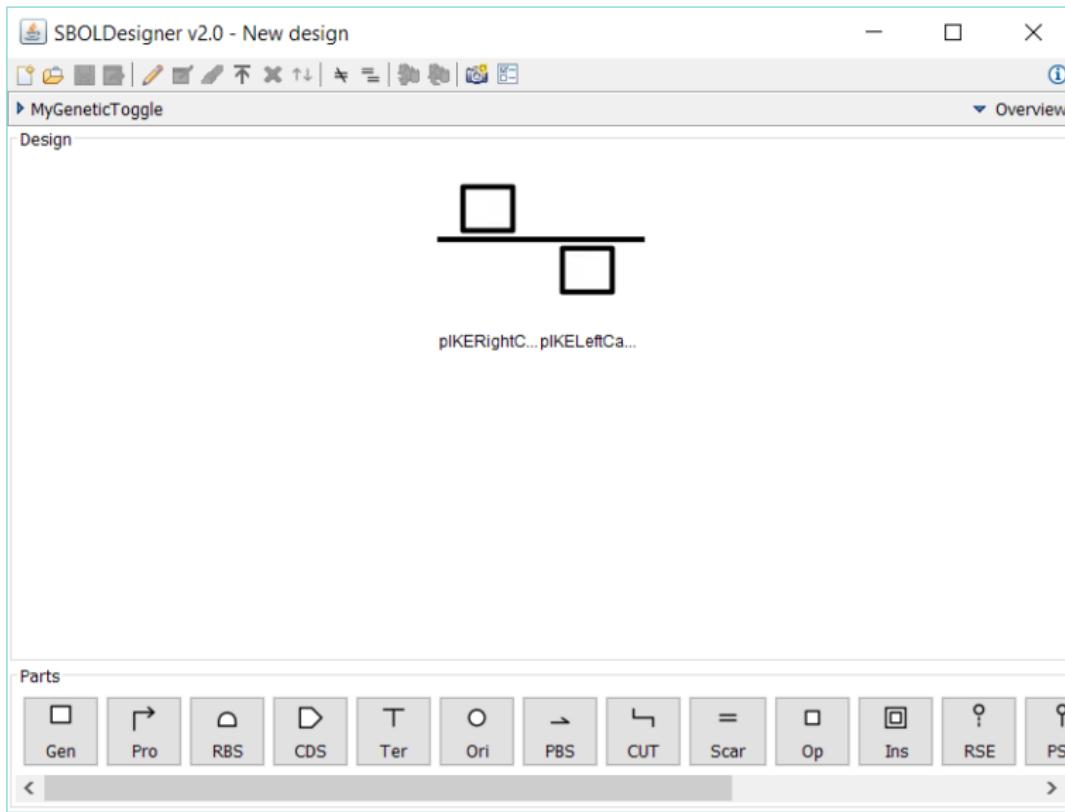
DNA sequence

```
caatacgc当地点aaacccgcttccccggcggttggccgattcattaatgcagctggcacgacaggtt  
tcccgactggaaaggccccggcagtggatgcacgc当地点aattatgtggatgttagctcactcattaggca  
ccccaggc当地点tttacactttatgttccggctgtatgttgatgtggataacaat  
ttcacaca
```

Order

- Parts are ordered by SequenceConstraints and SequenceAnnotations.
- SequenceConstraints define ordering: "A precedes B".
- SequenceAnnotations define ranges: "A starts at 1 and ends at 42" and "B starts at 43 and ends at 95".
- SBOLDesigner uses both behind the scenes.

Hierarchy



Hierarchy

The screenshot shows the SBOLDesigner v2.0 interface with a red header bar containing the title "Hierarchy". The main workspace is titled "MyGeneticToggle > pIKERightCassette_1". The "Design" tab is selected, displaying a schematic diagram of a genetic circuit. The circuit consists of a promoter (pIKE), a right cassette (pIKERightCassette_1), and a left cassette (pIKELeftCassette_1). The right cassette contains a gene construct (BBa_R0010) followed by two regulatory elements (BBa_J6112 and BBa_J6113) and a termination site (ECK12003). To the right of the schematic is a "Thumbnails" panel showing small versions of the parts. Below the schematic is a list of part IDs: BBa_R0010, BBa_J6112...BBa_J6113...ECK12003... . The bottom section, titled "Parts", contains a grid of icons representing different genetic elements: Gen, Pro, RBS, CDS, Ter, Ori, PBS, CUT, =, Op, Ins, RSE, and PS. A scroll bar is visible at the bottom of this section.

Hierarchy

SBOLDesigner v2.0 - GeneticToggle.sbol

MyGeneticToggle > pIKERightCassette_1 > BBa_J61120_BBa_C0040

Design

BBa_J61120 BBa_C0040

Thumbnails

pIKERightCassette_1 pIKELeftCassette_1

BBa_R0010 BBa_I6112 BBa_J6113 BBa_K12003

Parts

Gen Pro RBS CDS Ter Ori PBS CUT Scar Op Ins RSE PS

Multiple Designs

Select a root design to open

There are multiple designs. Which would you like to load? (You will be editing a new partial design)

Part role All (All parts)

Only show root ComponentDefinitions

Filter parts

Matching parts (17)

Display Id	Name	Version	Description
MyGeneticToggle	pIKE Genetic Toggle		Gardner/Collins Genetic Toggle Switch
pIKERightCassett...			pIKERightCassette_2
pTAKRightCassett...			pTAKRightCassette_3
pIKELeftCassette_3			pIKELeftCassette_3
pIKERightCassett...			pIKERightCassette_3
pTAKRightCassett...			pTAKRightCassette_1
pTAKRightCassett...			pTAKRightCassette_4
LacI_Inverter_Gene		1	
pTAKLeftCassette_1			pTAKLeftCassette_1
pTAKLeftCassette_4			pTAKLeftCassette_4
pIKELeftCassette_2			pIKELeftCassette_2
pTAKRightCassett...			pTAKRightCassette_2
LacIInverter		1	
pTAKLeftCassette_3			pTAKLeftCassette_3
pIKELeftCassette_4			pIKELeftCassette_4
pIKERightCassett...			pIKERightCassette_4
pTAKLeftCassette_2			pTAKLeftCassette_2

Importing Parts/Sequences

Part: Pro

Part role: Pro (Promoter)

Role refinement: None

Display ID: Pro

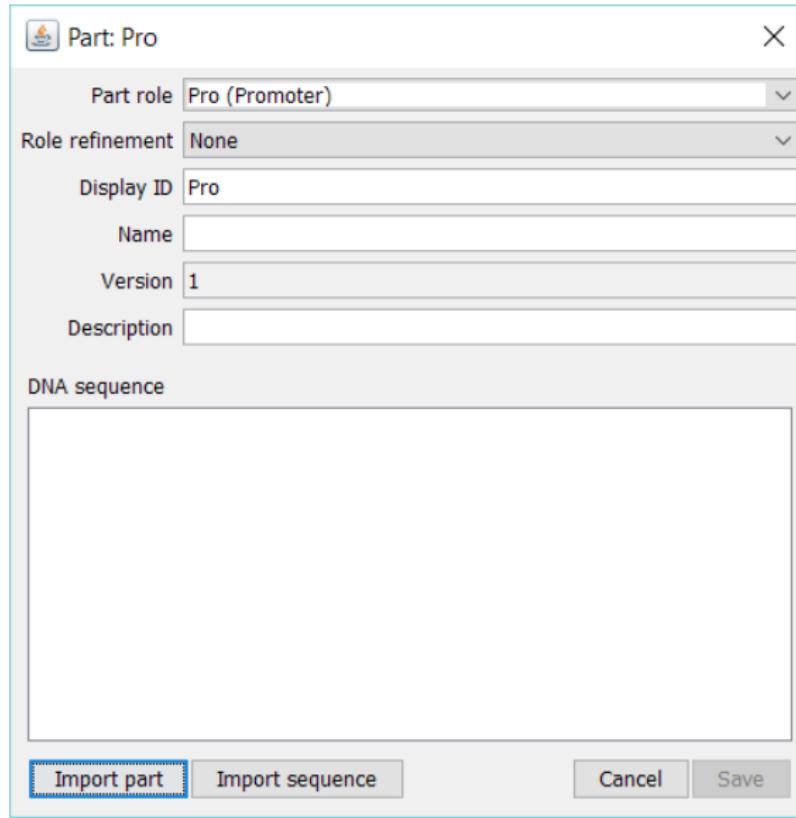
Name:

Version: 1

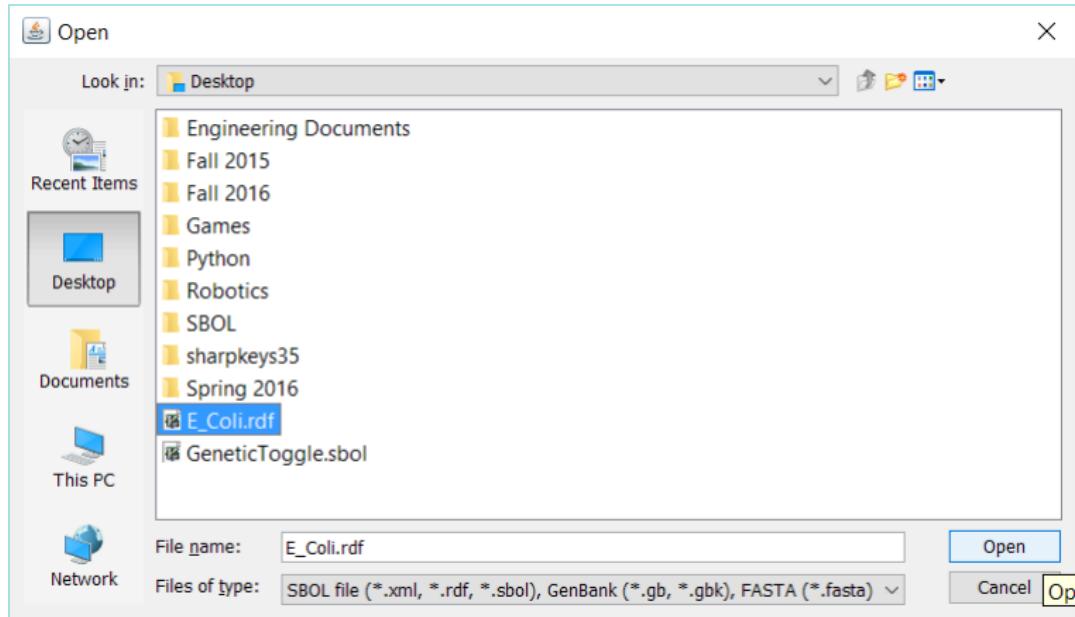
Description:

DNA sequence

Import part Import sequence Cancel Save



Importing Parts/Sequences



Importing Parts/Sequences

Select a part to import X

Part role Pro (Promoter)

Import with subcomponents

Filter parts

Matching parts (3)

Display Id	Name	Version	Description
BBa_R0010	BBa_R0010		promoter (lacI regulated)
BBa_K121014	BBa_K121014		promoter (lambda cI regulated)
BBa_R0040	BBa_R0040		TetR repressible promoter

Cancel OK

Importing Parts/Sequences

Part: BBa_R0010 X

Part role	Pro (Promoter)
Role refinement	None
Display ID	BBa_R0010
Name	BBa_R0010
Version	
Description	promoter (lacI regulated)

DNA sequence

```
caatacgc当地点aaacccgcttccccggcggttggccgattcattaatgcagctggcacgacaggtt  
tcccgactggaaaggccccggcagtggatgcacgc当地点aaatgtggatgttagctcactcattaggca  
ccccaggc当地点tttacactttatgtttccggctgtatgttggtggatttgtgagcggataacaat  
ttcacaca
```

Registries

SBOLDesigner v2.0 - New design

The screenshot shows the SBOLDesigner v2.0 software interface. At the top, there's a toolbar with various icons for file operations like Open, Save, and Print. Below the toolbar, the title bar says "SBOLDesigner v2.0 - New design". In the center, there's a workspace titled "NewDesign" under "Overview". The workspace contains a schematic diagram of a genetic circuit: a promoter (Pro) with an arrow pointing right, followed by a ribosome binding site (RBS), a coding sequence (CDS) represented by a triangle, and a terminator (Ter). Below the circuit, the labels "Pro", "RBS", "CDS", and "Ter" are centered under their respective components. At the bottom, there's a "Parts" section with a grid of icons representing different biological parts. The "Ter" icon is highlighted with a blue border. The grid includes icons for Gen, Pro, RBS, CDS, Ori, PBS, CUT, Scar, Op, Ins, RSE, and PS. A scroll bar is visible at the bottom of the parts section.

NewDesign

Design

Pro RBS CDS Ter

Parts

Gen Pro RBS CDS Ter Ori PBS CUT Scar Op Ins RSE PS

Registries

Preferences X

User
Registries
Settings
Mappings
Versioning

Registry list

Name	URL/Path	Description
Built-in parts	N/A	Built-in registry containing all the iGEM parts
SBOL Stack	http://synbioh...	The Newcastle instance of the SBOL Stack
Local Repository	C:\Users\Mich...	Parts from GeneticToggle.sbol

Add Remove Restore defaults

Close

Registries

 Add new registry X

Name

URL or Path

[Browse local repositories \(This can be any SBOL file\)](#)

Description

Cancel OK

Registries

SBOLDesigner v2.0 - New design

NewDesign Find parts in the part registry Overview

Design

Pro RBS CDS Ter

Parts

Gen	Pro	RBS	CDS	Ori	PBS	CUT	=	Op	Ins	RSE	PS
-----	-----	-----	-----	-----	-----	-----	---	----	-----	-----	----

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Registries

Select a part from registry X

Registry **SBOL Stack (http://synbiohub.org:9090)** ▼

Part role **SBOL Stack (http://synbiohub.org:9090)** ▼

Local Repository (C:\Users\Michael\De...oggle.sbol)

Filter parts BBa_

Matching parts (444)

Display Id	Name	Versi...	Description
TEF2(BBa_K...	TEF2(BBa_K...	http:/...	
T7(BBa_I712...	T7(BBa_I712...	http:/...	
T7_(BBa_I71...	T7 (BBa_I71...	http:/...	
Pu_Promote...	Pu Promoter...	http:/...	
pTEF2(BBa_...	pTEF2(BBa_...	http:/...	
Part_BBa_J2...	Part:BBa_J2...	http:/...	
BBa_R0183_...	BBa_R0183 f...	http:/...	
BBa_R0062_...	BBa_R0062 (...	http:/...	
BBa_R0062	pLuxR	http:/...	LuxR inducible promoter
BBa_R0051	BBa_R0051	http:/...	
BBa_R0040	nTetR	http:/...	TetR repressible promoter

Options Cancel OK

Registries

SBOLDesigner v2.0 - New design

NewDesign Overview

Design

BBa_R0010 RBS CDS Ter

Parts

Gen	Pro	RBS	CDS	Ter	Ori	PBS	CUT	=	Op	Ins	RSE	PS
-----	-----	-----	-----	-----	-----	-----	-----	---	----	-----	-----	----

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Versioning

Save Options

X



You are saving into an existing SBOL file. Would you like to overwrite or create new versions of parts that already exist in the design?

Overwrite

New Version

Versioning

Select a root design to open X

There are multiple designs. Which would you like to load? (You will be editing a new partial design)

Part role

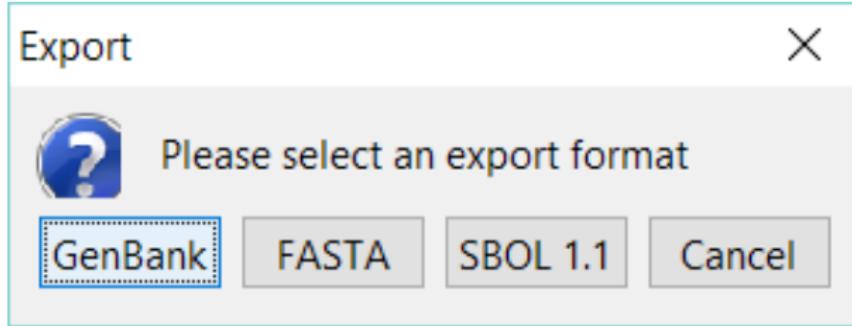
Only show root ComponentDefinitions

Filter parts

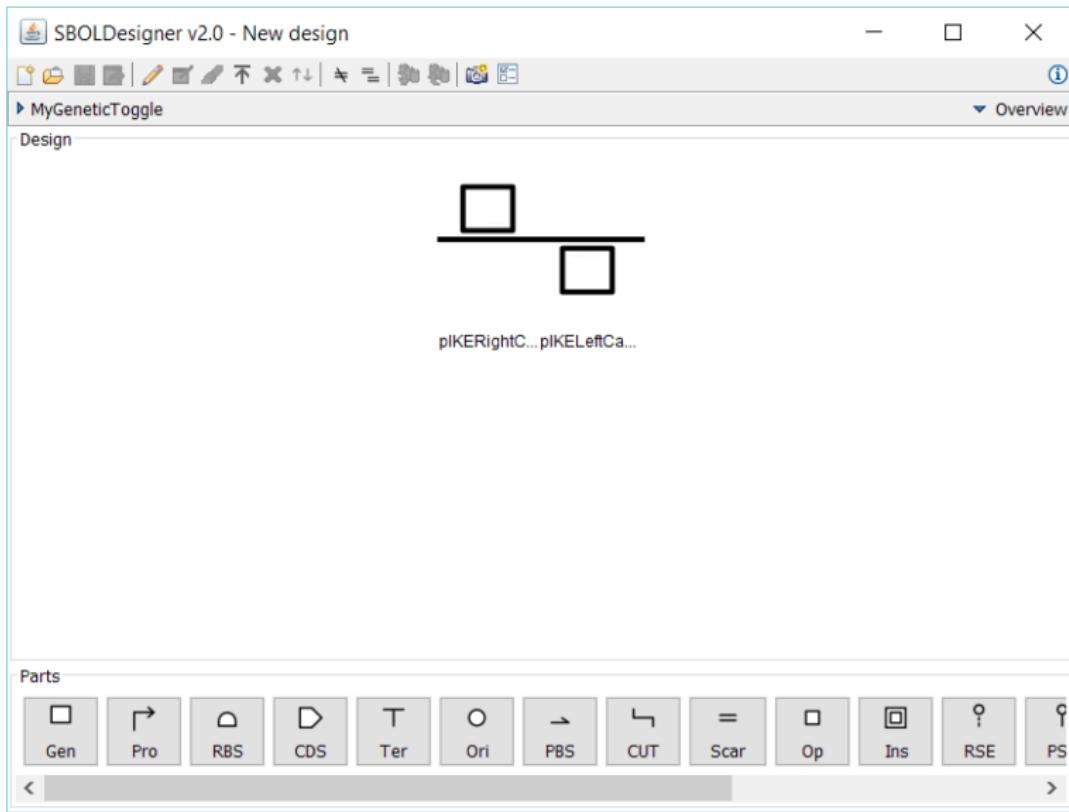
Matching parts (5)

Display Id	Name	Version	Description
E_Coli		5	
E_Coli		3	
E_Coli		1	
E_Coli		4	
E_Coli		2	

Export



Export



Export GenBank

Export FASTA

Demo

Try It Out

- SBOLDesigner is nearing release, and I would love any feedback!
- Download the latest version at:
<http://www.async.ece.utah.edu/SBOLDesigner>
- Please post feedback/bugs/feature requests to my issue tracker:
<https://github.com/SynBioDex/SBOLDesigner/issues>
- Additionally, iBioSim can be found here:
<http://www.async.ece.utah.edu/ibiosim>

Genetic Design Automation



Nathan Barker (SUU)



Hiroyuki Kuwahara (KAUST)



Scott Glass



Kevin Jones



Curtis Madsen (BU)



Nam Nguyen (Illinois)



Tramy Nguyen (Utah)



Tyler Patterson



Nicholas Roehner (BU)



Meher Samineni (Utah)



Jason Stevens (UWash)



Leandro Watanabe (Utah)



Zhen Zhang (Utah)



Chris Myers (Utah)



Zach Zundel (Utah)



Supported by National Science Foundation Grants ECCS-0331270,
CCF-07377655, CCF-0916042, CCF-1218095, and DBI-1356041.

SBOL Community



- 100+ people from all around the world.
- 30 universities, 14 companies, 8 other types of organizations.

Organizations Supporting SBOL

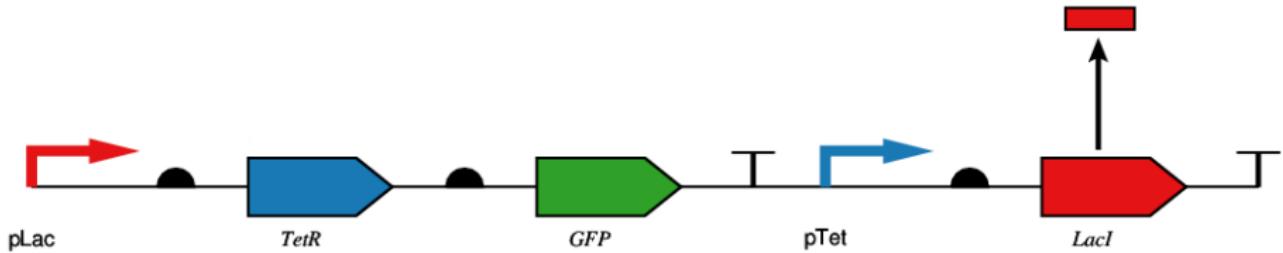


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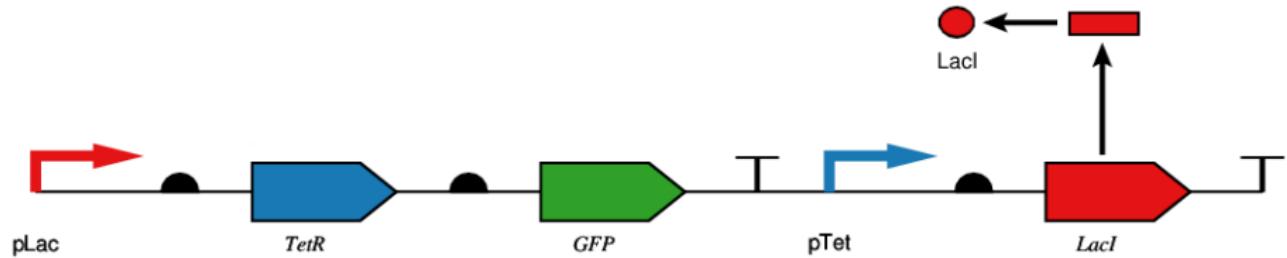
Genetic Toggle Switch (Gardner et al. 2000)



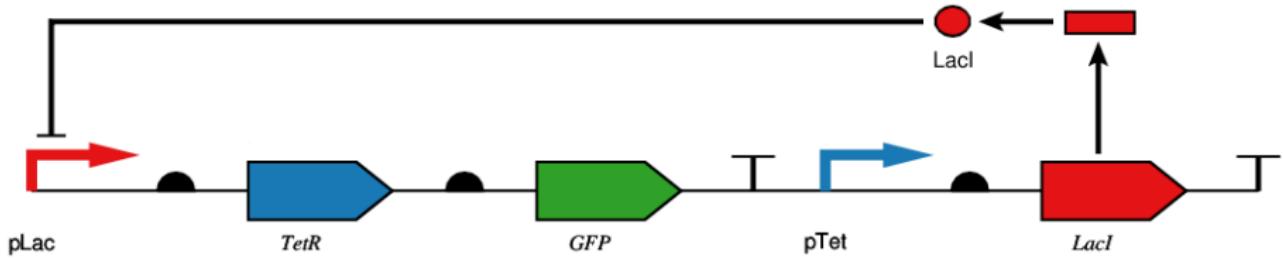
Genetic Toggle Switch (Gardner et al. 2000)



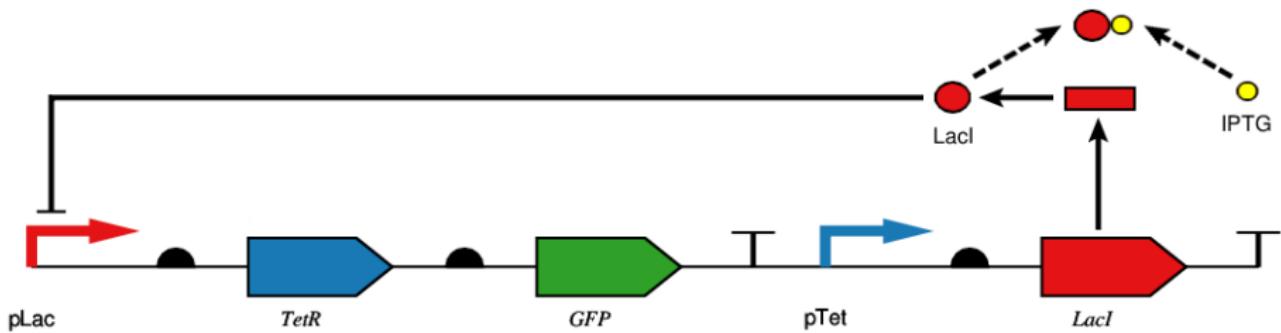
Genetic Toggle Switch (Gardner et al. 2000)



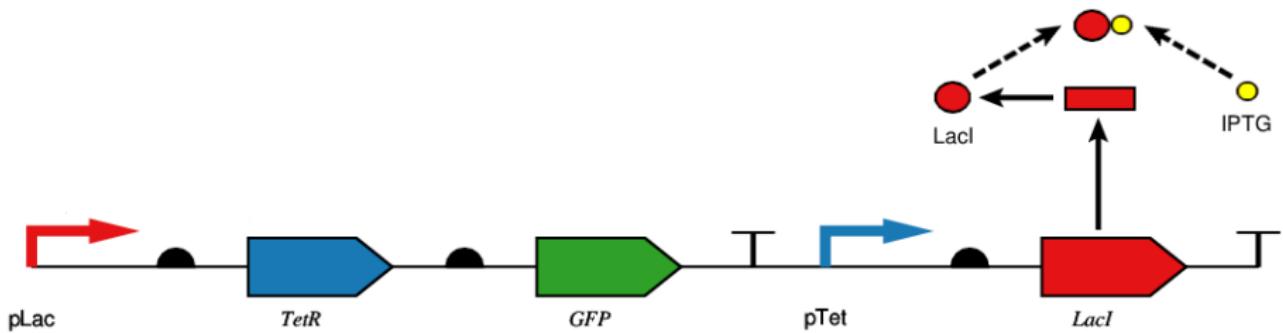
Genetic Toggle Switch (Gardner et al. 2000)



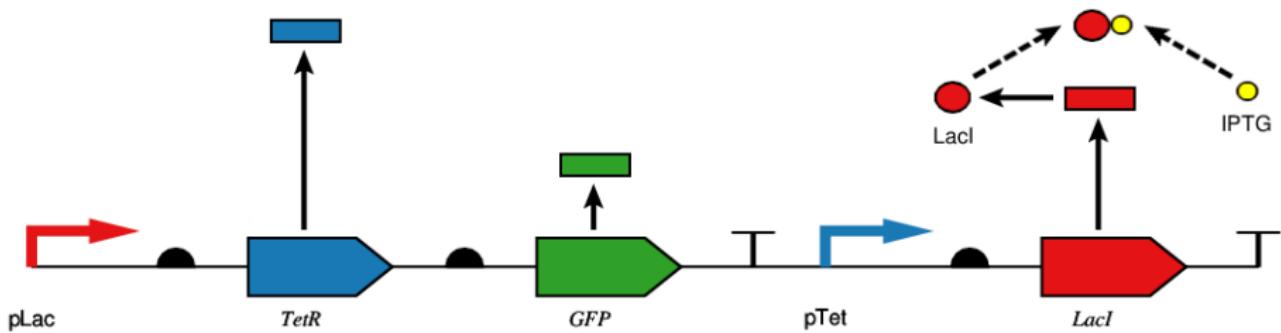
Genetic Toggle Switch (Gardner et al. 2000)



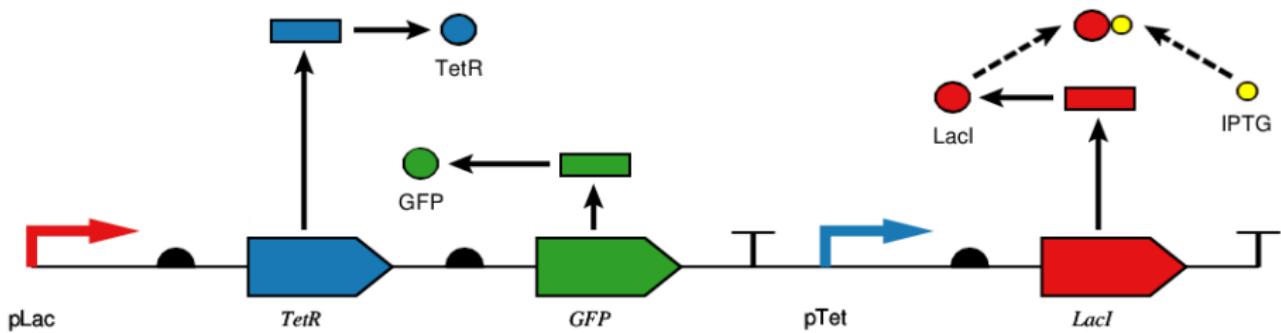
Genetic Toggle Switch (Gardner et al. 2000)



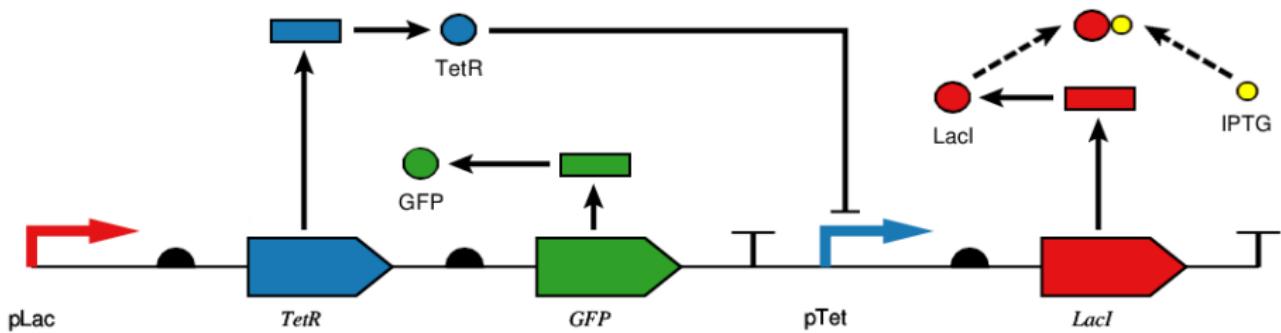
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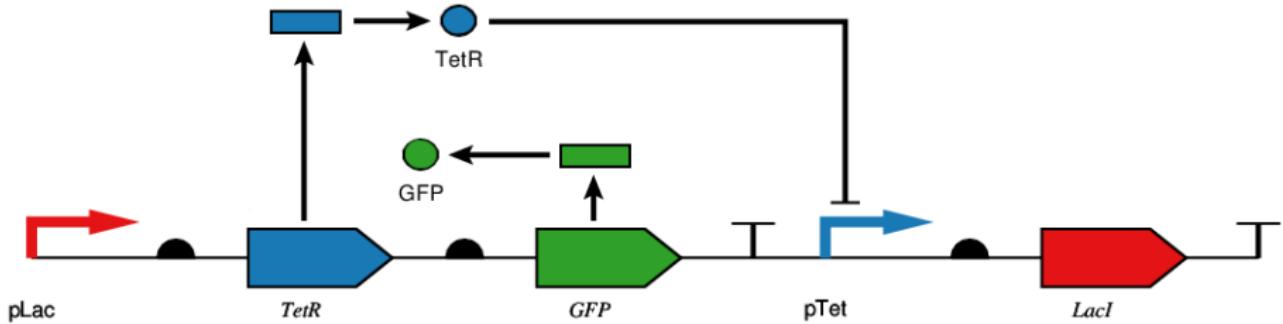
Genetic Toggle Switch (Gardner et al. 2000)



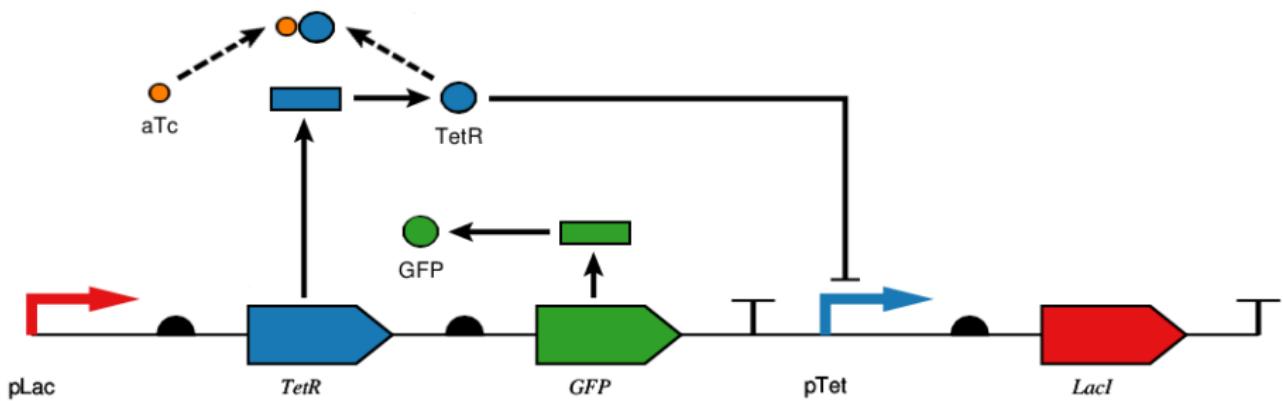
Genetic Toggle Switch (Gardner et al. 2000)



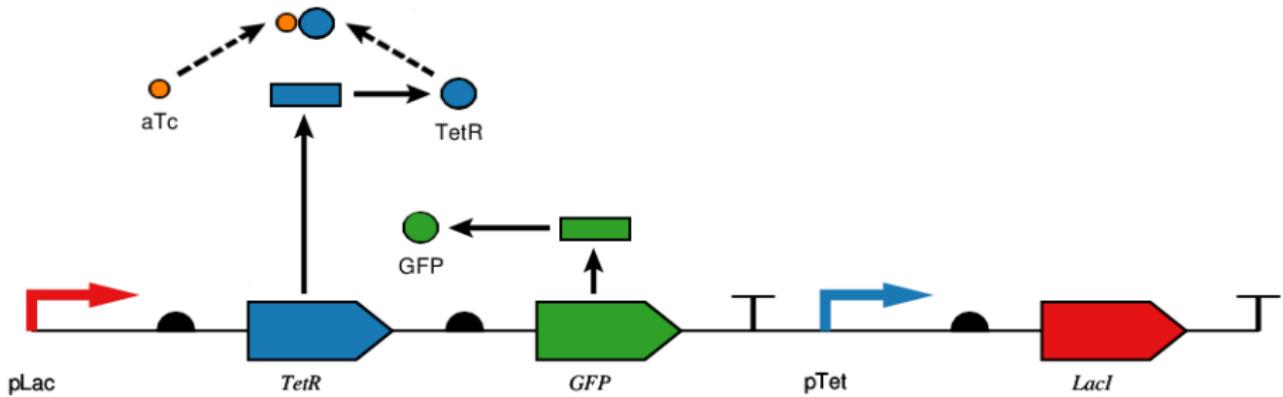
Genetic Toggle Switch (Gardner et al. 2000)



Genetic Toggle Switch (Gardner et al. 2000)



Genetic Toggle Switch (Gardner et al. 2000)



Genetic Toggle Switch (Gardner et al. 2000)

