



# STEM 4.0 Release Review

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# Introduction

## **The Spatio-Temporal Epidemiological Modeler (STEM)**

Is a tool designed to help scientists and public health officials to study emerging infectious diseases. STEM uses mathematical models of diseases to simulate the development or evolution of a disease in space and time (e.g., H1N1 or salmonella). These models could aid in understanding and potentially containing the spread of such diseases. STEM also comes pre-configured with a vast amount of reference or denominator data for the entire world.

- STEM 4.0 represents a complete update to STEM to be based on Eclipse 4 (e4).
- With this release the STEM build process moved from an IBM Server to the continuous integration build process running at Eclipse.org.
- STEM 4.0 also features new compartment models, new downloadable scenarios (examples), and demonstrations of the graphical model building framework.



# Features

- Release 4.0 New Features
  - Full Eclipse 4 and (J2SE) 8.0 JVM Compatibility
  - New Build process running at Eclipse
  - Graphical Model Design (GUI for code generation, Visual Editor )
  - Bug fixes from previous version
  - Stochastic Solver now runs in batch mode
  - New disease models and downloadable scenarios



# Non-Code Aspects

- **Documentation**

- Wiki and Website continuously updated to reflect new feature.
- New and *updated* doc for 4.0
  - Building STEM
    - [https://wiki.eclipse.org/STEM\\_Eclipse\\_Setup](https://wiki.eclipse.org/STEM_Eclipse_Setup)
    - [https://wiki.eclipse.org/Building\\_the\\_STEM\\_RCP\\_Application](https://wiki.eclipse.org/Building_the_STEM_RCP_Application)
  - Updated U.I. Doc
    - [https://wiki.eclipse.org/STEM\\_Map\\_View](https://wiki.eclipse.org/STEM_Map_View)
  - STEM Solvers
    - Apache Common Math Solvers
    - Stochastic Solver
  - Set Up
    - Running STEM from the Development Environment
  - Working with Graphs
    - Importing a Pajek Graph
    - Creating a Custom Graph

- **Examples**

- STEM 4.0 Downloadable Scenarios are available on the STEM website  
<http://www.eclipse.org/stem/>
- All examples well documented  
[http://wiki.eclipse.org/Sample\\_Projects\\_available\\_for\\_Download](http://wiki.eclipse.org/Sample_Projects_available_for_Download)



## Non-Code Aspects

- Tutorials
  - Extensive user documentation  
<http://wiki.eclipse.org/index.php/STEM>
  - New Tutorial videos posted on YouTube  
<https://www.youtube.com/watch?v=MtQIS7g7Qnw>



# Non-Code Aspects

- Articles and Publications [http://wiki.eclipse.org/Publications\\_and\\_Presentations\\_on\\_STEM](http://wiki.eclipse.org/Publications_and_Presentations_on_STEM)
- Some recent examples
- Sevilla NL. "Germs on a Plane: The Transmission and Risks of Airplane-Borne Diseases." Poster session presented at the Transportation Research Board (TRB) 97th Annual Meeting, 7-11 Jan 2018, Washington, DC.
- Nieddu GT et al. "Extinction pathways and outbreak vulnerability in a stochastic Ebola model." *Journal of The Royal Society Interface* 14.127 (2017): 20160847.
- Sau A. "A Simulation Study on Hypothetical Ebola Virus Transmission in India Using Spatiotemporal Epidemiological Modeler (STEM): A Way towards Precision Public Health." *Journal of Environmental and Public Health* Volume 2017 (2017), Article ID 7602301, <https://doi.org/10.1155/2017/7602301>
- Co I-L, Estaur MR, Espina KE, Lara RJ, De Los Reyes VC. "Integrating health indices towards the development of a Typhoid disease model using STEM." *IEEE Xplore Digital Library* 16 February 2017. [ieeexplore.ieee.org/document/785711/?reload=true](http://ieeexplore.ieee.org/document/785711/?reload=true).
- Filter M, Günther T, BfR-Team. "BfR Training-STEM-Workshop". The Federal Institute for Risk Assessment, 6-7 February 2017, Berlin, Germany.
- Baldassi F, D'Amico F, Carestia M, Cenciarelli O, Mancinelli S, Gilardi F, Malizia A, Di Giovanni D, Soave P, Bellecci C, Gaudio P. May 2016. "Testing the accuracy of ratio of the Spatio-Temporal Epidemiological Modeler (STEM) through Ebola haemorrhagic fever outbreaks." *Epidemiology and Infection* 144(7):1463-72.
- Sevilla N, "Open Source Disease Modeling: A Tool to Combat the Next Pandemic", *GlobalBioDefense.com* Jan. 28, 2016.
- Hu K. "The effect of antibody-dependent enhancement, cross immunity, and vector population on the dynamics of dengue fever." Invited talk and panel discussion at "The International Society for Neglected Tropical Diseases, ISNTD Bites: vector-control solutions for NTDs & global health", London Zoo, UK, March 2015. [1]
- Hu K. "A study of environmental factors impact on the dynamics of mosquito population in modelling dengue fever." Poster at "Impact of Environmental Changes on Infectious Diseases" conference, 23-25 March 2015, Sitges, Spain
- Hu K, Bianco S, Edlund S, Kaufman J. "The impact of human behavioral changes in 2014 west Africa Ebola outbreak." *SBP 15, 2015 International Conference on Social Computing, Behavioral-Cultural Modeling, & Prediction*, April 1, 2015, Washington, DC.
- Bianco S, Hu K, Kaufman JH (IBM Research); Schwartz IB (US Naval Research Laboratory). "Predicting unobserved contacts from Ebola epidemic data." Poster presented at Ebola Modeling Workshop, January 2015. [2]



## Architectural Issues

- Overall STEM architecture is *stable*
- Full Eclipse 4 and (J2SE) 8.0 JVM Compatibility
  - *STEM 4 is now using Tycho for doing the build and the whole project is redesigned to be compatible with the requirement of this build approach.*



## Tool Usability

- STEM is designed to overcome a major problem facing public health: *Epidemiologists generally aren't computer scientists*
- STEM provides tools to compose, simulate, and analyze disease models using a drag-and-drop interface
- Running a simulation can be as easy as dragging items and clicking “run”
- Hide the *technical* complexity of epidemiology modeling, while preserving the flexibility of “doing it yourself”
- STEM has already been used to do new Science. For example:
  - MMR vaccination, 2013 measles epidemic in Ealing UK
  - H7N9
  - Food borne disease models by the German Federal Institute for Risk Assessment (BfR)
- With the new Model Generator, users of STEM V4.0 can now define a compartment model using a only a description familiar to a subject matter expert. The model creator generates all of the code (including all model specific differential equations) and hot injects the generated plug-in into STEM, while the system is running.



## End-of-Life

- Users will have to migrate older STEM projects to the new STEM V4 platform
- Generated models will require regeneration (a one button operation)



## Bugzilla status

- 44 open bugs
  - Most minor or new feature requests
  - Several closed with the release of V4 including high priority bug with launcher on mac.
- Contributions
  - All contributions are from IBM employees, BfR employees, or students as part of an open source contribution class project



## Standards

- GML
- ISO-3166
- ISO-15836 (Dublin Core)
- FIPS
- Pajek



# UI Usability

- New Model Generator is now stable in V4.0
- STEM uses Eclipse RCP to provide a drag and drop UI for disease model composition, simulation, and analysis
- Design Perspective
  - *Simulations* composed by dragging and dropping user-created or built-in (generated) models, diseases, infectors, inoculators, etc.
    - Composition UI allows easy extensibility and layering of models
    - Built-in data define geography, transportation systems, and population for 244 countries and dependent areas
  - Editors allow customizable disease parameters, geographies, etc.
- Simulation Perspective
  - Provides runtime simulation control, including start, stop, pause, and steps
  - Geographic map for spatial view current disease spread (can be disabled)
  - BIRT-powered spatiotemporal charting to monitor disease parameters for user selected geographic regions
- Analysis Perspective
  - Sophisticated tooling to perform comparative analysis of simulations
- Experiment Perspective
  - Allows batch experiments
  - Stochastic solver support in V4



# Communities

- Contributors and Committers
  - Active developer community with committers in
    - US (IBM)
    - Germany (BfR)
  - Monthly conference calls to discuss status
  - Calls As needed to resolve project-specific issues
  - PR efforts through IBM, YouTube demonstration videos, workshops
- Users
  - STEM is being adopted by public health institutions around the world and numerous other users. In 2013, consulted with or assisted
  - Kun Hu hosted a global call during the Ebola outbreak to help others with data and modeling.  
[http://wiki.eclipse.org/Community Ebola Modeling Phone Call](http://wiki.eclipse.org/Community_Ebola_Modeling_Phone_Call)
  - NIHR Ealing U.K (MMR vaccination, measles outbreak in London)
  - CDC China (H7N9)
  - IBM India using STEM with NEA Singapore (Dengue) 2012-2013
  - et al.



## IP Log & Issues

- **Code headers have been updated with EPL v2.0 license and updated copyright statements**
- **[Bug 534480]** New STEM project Splash screen, logo, banner, derivative from Eclipse Logos has been approved (9/14/2018)  
Original Graphic inspired by Eclipse
- No other outstanding IP Log issues
- Resolved Issues:
  - Please see IP log history on next slide





# IP Log & Issues all up to date

bug_id	bug_severity	priority	op_sys	assigned_to	bug_status	resolution	short_desc
10550	withdrawn	P3	pending	emo-ip-team@eclipse.org	RESOLVED	WORKSFORME	EuroGraphics EuroGlobalMap Open Data Version: V 8.0 log4j Version: 1.2.15 (Subset - see all comments) (PB Orbit CQ3560)
7133	approved	P2	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	Apache Commons Lang Version: 2.1 (PB Orbit CQ1595)
7132	approved	P2	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	atinject (Package javax.inject) Version: 1.0 (PB Orbit CQ3578)
7131	approved	P2	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	ANTLR Runtime only: Version: 3.2 (PB Orbit CQ4865)
7130	approved	P2	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	Guava Version: 10.0.1 (PB Orbit CQ6121)
7129	approved	P2	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	Google Guice / Inject Core API Version: 3.0.0 (PB Orbit CQ6108)
7128	approved	P2	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	Apache Commons Math Version: 3.1.1 (subset)
7001	approved	P3	awaiting_analysis	pablo@eclipse.org	RESOLVED	FIXED	Apache Batik Version: 1.6 (PB CQ208) **See Comments 6&7 re CSS SAC API (PB Orbit CQ2070)
6718	approved	P2	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	Apache Commons IO Version: 2.0.1 (PB Orbit CQ4791)
6306	approved	P2	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	Map of Norway (Admin Level 2) Version: 0.0.0
5799	approved	P3	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	commons-collections-3.2.jar Version: 3.2 (PB Orbit CQ1909)
5734	approved	P2	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	
5454	withdrawn	P3	triage	sharon.corbett@eclipse- foundation.org	RESOLVED	WORKSFORME	OpenMap Version: 4.6.5 Apache Commons Math Version: 2.1.0 (PB Orbit CQ4874)
5283	approved	P2	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	Jung Version: 1.5 or newer
4688	withdrawn	P3	awaiting_committer	emo-ip-team@eclipse.org	RESOLVED	WORKSFORME	NASA (derived data from NASA images)
4467	approved	P2	triage	barb.cochrane@eclipse.org sharon.corbett@eclipse- foundation.org	RESOLVED	FIXED	PajekNetGraphGeneratorImpl JUnit Version: 3.8.1 (ATO CQ296) (using Orbit CQ2207)
4451	approved	P2	under_review	barb.cochrane@eclipse.org	RESOLVED	FIXED	STEM Dataset for DIVA data
3708	approved	P2	new	emo-ip-team@eclipse.org	RESOLVED	FIXED	STEM Admin 0 (country level)
2283	approved	P2	new	barb.cochrane@eclipse.org	RESOLVED	FIXED	shape of US
2184	approved	P2	awaiting_emo	barb.cochrane@eclipse.org	RESOLVED	FIXED	Submission of proposed STEM
2119	withdrawn	P3	awaiting_triage	technology.ohf- inbox@eclipse.org	RESOLVED	WORKSFORME	US Air transport data for IP Review
2118	approved	P3	under_review	barb.cochrane@eclipse.org	RESOLVED	FIXED	Submission of proposed STEM
1346	approved	P3	awaiting_emo	barb.cochrane@eclipse.org sharon.corbett@eclipse- foundation.org	RESOLVED	FIXED	US Air transport data for IP Review
1331	approved	P3	Windows	barb.cochrane@eclipse.org	RESOLVED	FIXED	STEM Datasets Version: 0.0.0 STEM Source code Version: 0.0.0



# Maturity and Feedback

- Maturity
  - STEM is being used by a number of institutions including the University of Vermont School of Medicine, the Johns Hopkins Bloomberg School of Public Health, Lockheed Martin, the German Institute for Risk Assessment (BfR), the George Mason University, and the University of Bristol (UK)
- User feedback
  - ◆ The STEM V4 Product is built using the Tycho approach and the generated STEM launcher is working on macOS Sierra which has the translocation feature.