

Verification of Systems Biology Research in the Age of Collaborative Competition

Erhan Bilal^a, Jean Binder^b, Elise Blaese^a, Stéphanie Boué^b, Marianne Charaf^c, Peter Curle^c, Brett Fields^d, Claudia Frei^c, William Hayes^d, Anita Iskandar^b, Robin Kleiman^d, Immanuel Luhn^c, Pablo Meyer Rojas^a, Raquel Norel^a, Jennifer Park^d, Carine Poussin^b, Kahn Rhrissorakrai^a, John J. Rice^a, Alf Scotland^c, Marja Talikka^b, Joanna Taylor^c, Gustavo Stolovitzky^a, Julia Hoeng^b, Manuel C. Peitsch^b

^aIBM Thomas J. Watson Research Center, Yorktown Heights, NY, USA

^bPhilip Morris International R&D, Neuchâtel, Switzerland

^cIBM Global Business Services, Zürich, Switzerland ^dSelventa, Cambridge, MA, USA



Vision for Systems Biology Verification

PMI is committed to the vision which plans to:

- Establish a broad community of scientists that use processes of verification and community-based problem solving techniques in systems biology in both industrial and academic contexts
- Encourage crowd sourcing and collaborative evaluation to ensure rigorous review of complex scientific data sets
- Apply the IMPROVER methodology to solve important scientific challenges
- Complement the classical peer review process

In order to:

- Verify the robustness of PMI R&D scientific practices in systems biology
- Demonstrate the validity of the systems biology approach to product risk assessment

Collaboration of Philip Morris International Research & Development (PMI R&D), IBM Research and IBM GBS on a project funded by Philip Morris International

Aims to provide a measure of quality control in R&D by identifying the building blocks that need verification in a complex industrial research pipeline

Is a robust methodology that verifies systems biology-based approaches using double blind performance assessment

Wisdom of crowds applied to solve challenges

Defined challenges comprising of a number of sub-challenges to verify the steps of our quantitative mechanism based Systems Impact Assessment Pipeline

sbv IMPROVER at a Glance

sbv IMPROVER stands for systems biology verification and Industrial Methodology for Process Verification in Research. It is a robust methodology that verifies systems biology approaches using double-blind performance assessment and applies the wisdom of crowds to solve scientific challenges [1] [2].

The project team includes scientists from Philip Morris International's (PMI) Research and Development department and IBM's Thomas J. Watson Research Center. The project is funded by PMI.

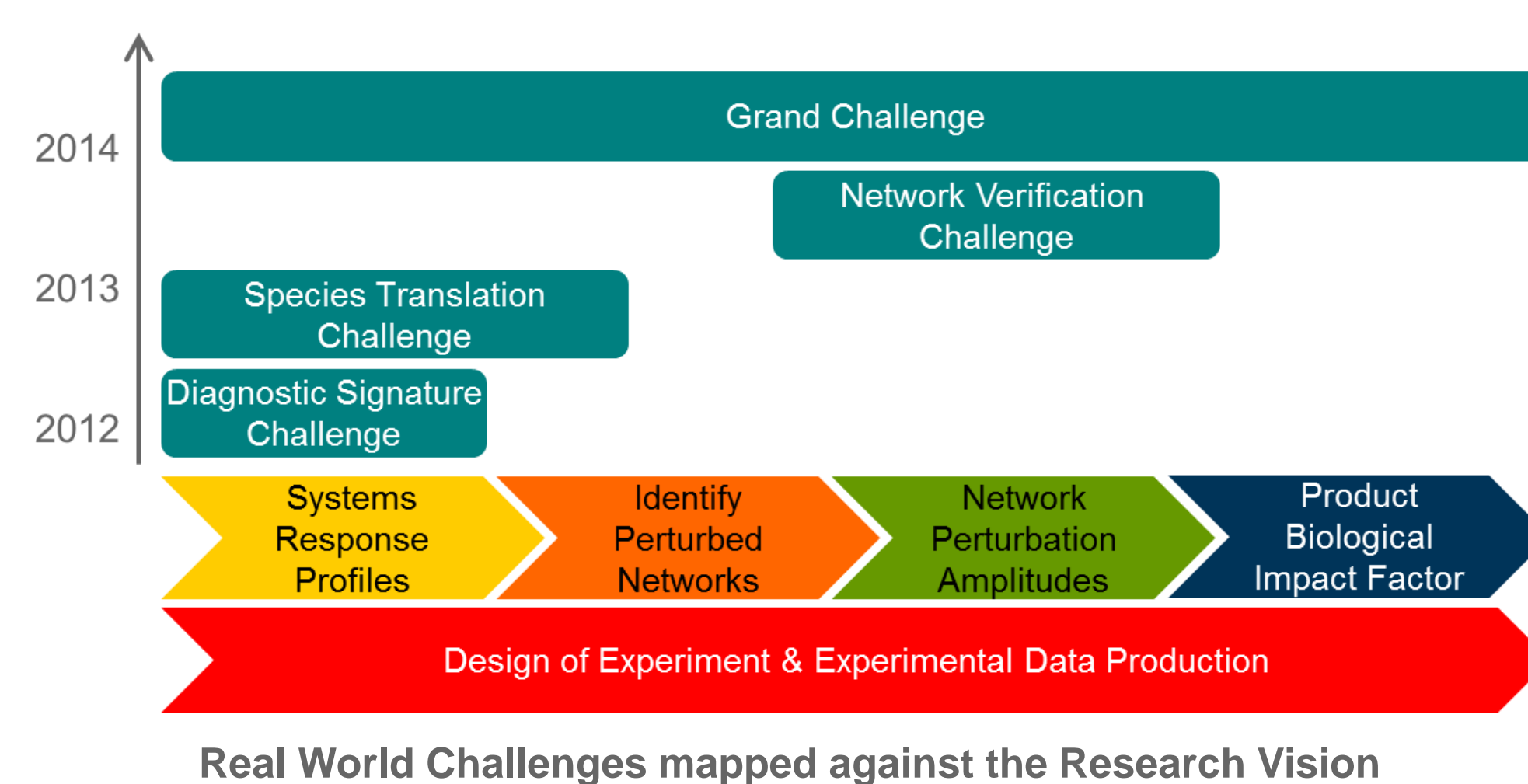
What constitutes a sbv IMPROVER Challenge?

- A scientific problem presented to the community
- Often comes with a "Gold Standard" or a solution to the challenge, to which each prediction is compared



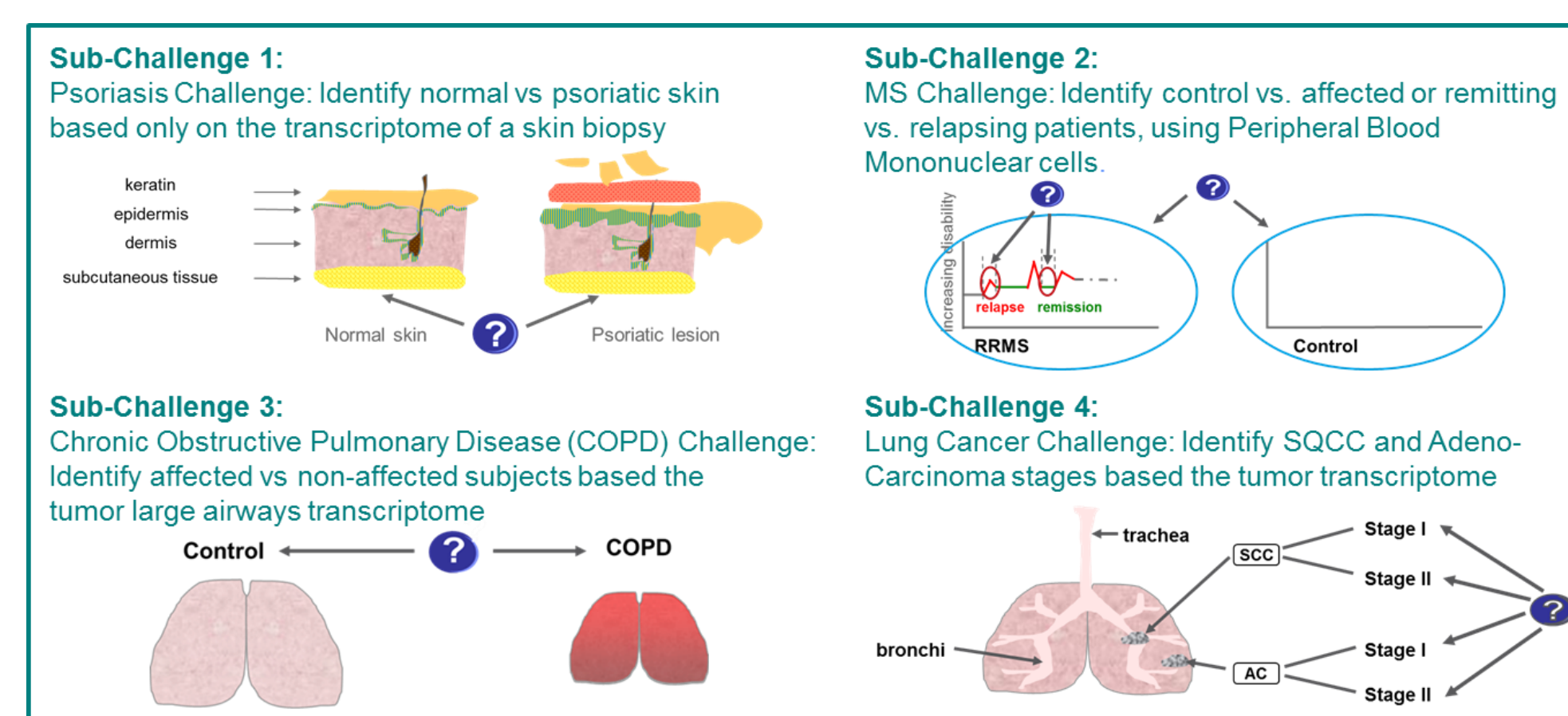
Approach to Challenge Design

The sbv IMPROVER Challenges



The first sbv IMPROVER Challenge: Diagnostic Signature

The goal of the Diagnostic Signature Challenge was to assess and verify computational approaches that classify clinical samples based on transcriptomics data.



Diagnostic Signature Challenge: Four Sub-Challenges

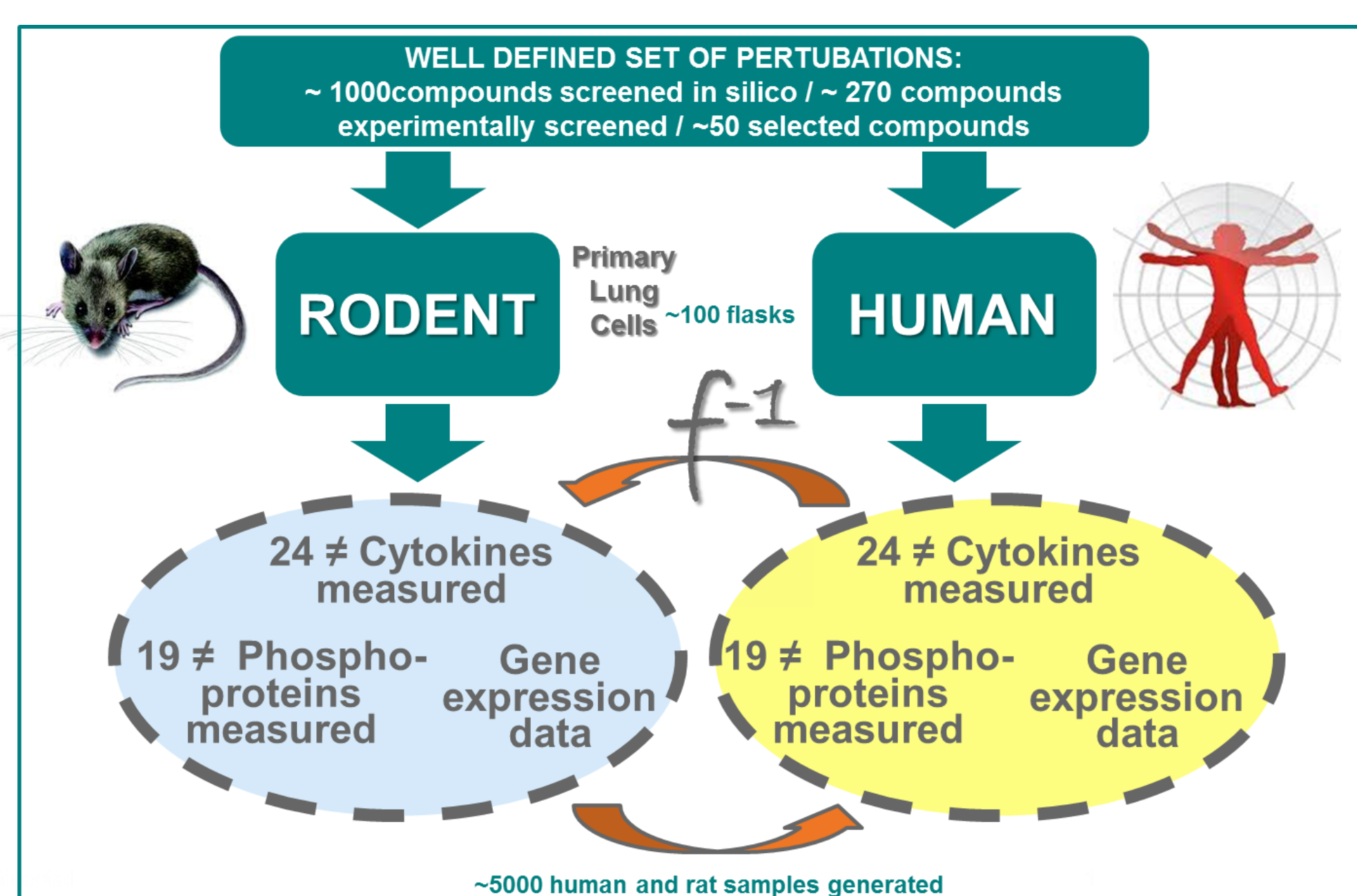
The Diagnostic Signature Challenge was successfully closed at the end of 2012 after 54 scientific teams from across the world had participated. The best performing teams were announced at the Symposium 2012 in Boston, USA.

The second sbv IMPROVER Challenge: Species Translation

The aim of the Species Translation Challenge was to:

- Identify rules which map measurements derived from systematic perturbations in one species to another species
- Quantify the translatability between species
- Understand the limitation of species translatability

It addressed the translatability of findings between rat and human model systems. The four Sub-Challenges addressed different aspects of this problem.



Species Translation Challenge Data Set

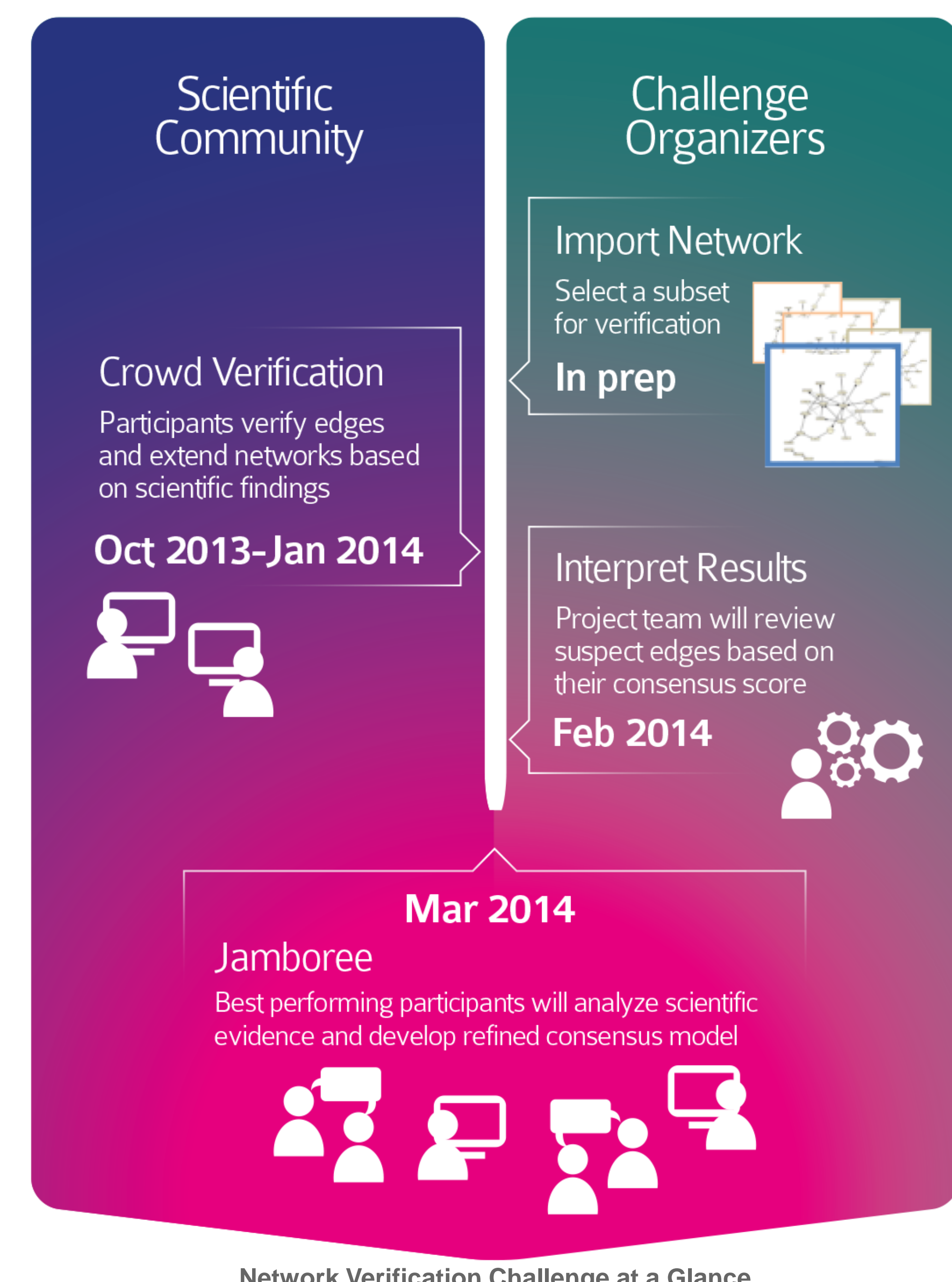
The Species Translation Challenge was successfully closed at the end of 2013 after 28 scientific teams from across the world had participated. The best performing teams were announced at the Symposium 2013 in Athens, Greece.

The third sbv IMPROVER Challenge: Biological Network Verification

The purpose of this challenge was to engage the scientific community in the review of biological network models.

Biological network perturbations play a fundamental role in today's systems-based biology, pharmacology and toxicology:

- Networks link experimental measurements and a priori knowledge [3]
- Network models consist of qualitative causal relationships between biological entities to represent current scientific knowledge
- Suitable for drug discovery, toxicological and mechanistic research in respiratory disease



Network Verification Challenge at a Glance

The first Network Verification Challenge was successfully closed at the beginning of 2014 after 76 active participants had contributed. The best performers and a group of subject matter experts have been invited to the Jamboree 2014 in Montreux, Switzerland.

Call for Action

- Visit www.sbvimprover.com
- Read our publications
- Join the sbv IMPROVER community
- Go to <http://bionet.sbvimprover.com> and participate in the Network Verification Challenge II
- Invite your colleagues to be part of sbv IMPROVER

References

- [1] Meyer, P., et al. (2011), Verification of systems biology research in the age of collaborative competition, *Nature Biotechnology*, 29, 811-815.
- [2] Meyer, P., et al. (2012), Industrial Methodology for Process Verification in Research (IMPROVER): Towards Systems Biology Verification, *Bioinformatics*, 28, 1193-1201.
- [3] Hoeng, J., et al. (2012), A network-based approach to quantifying the impact of biologically active substances, *Drug Discov Today*, 17, 413-418.

The sbv IMPROVER project, the website and the Symposia are part of a collaborative project designed to enable scientists to learn about and contribute to the development of a new crowd sourcing method for verification of scientific data and results. The project team includes scientists from Philip Morris International's (PMI) Research and Development department and IBM's Thomas J. Watson Research Center. The project is funded by PMI.