

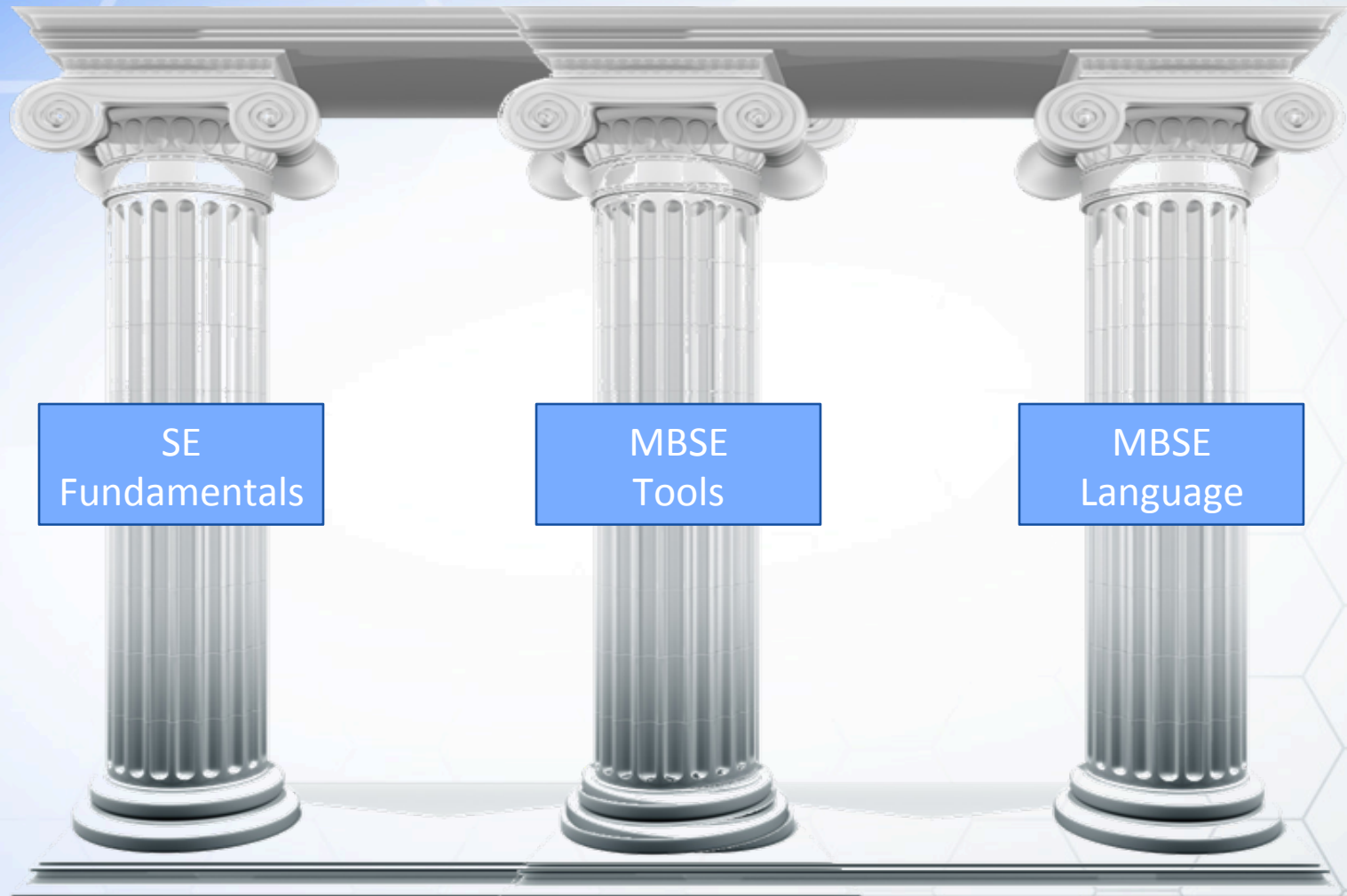
# Telescope Modeling Challenge Team SE<sup>3</sup>

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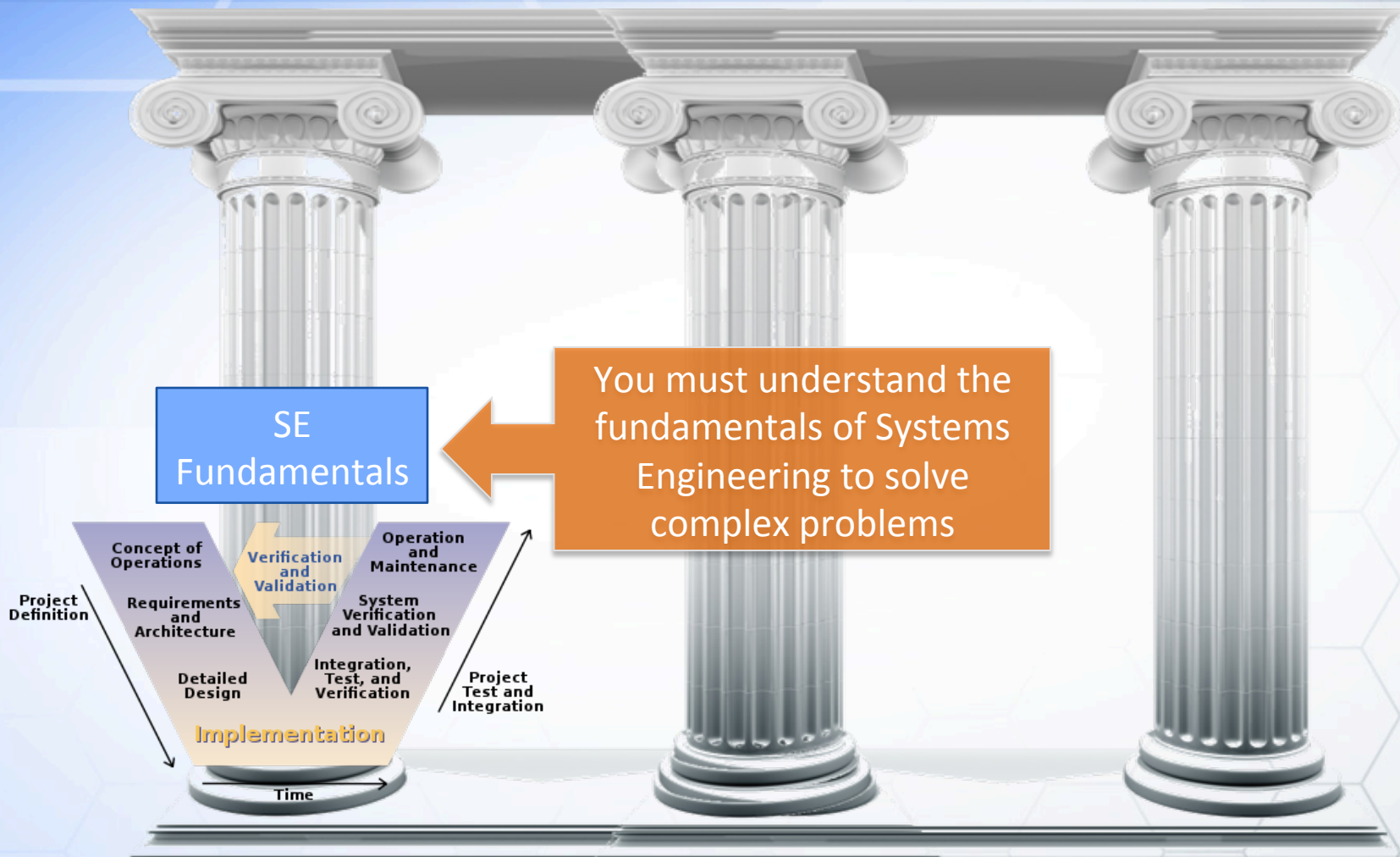
# Outline

- ◆ MBSE overview
- ◆ Telescope Modeling Challenge Team
  - ◇ Wiki Page
  - ◇ SE Cookbook
  - ◇ SEBOK Case Study

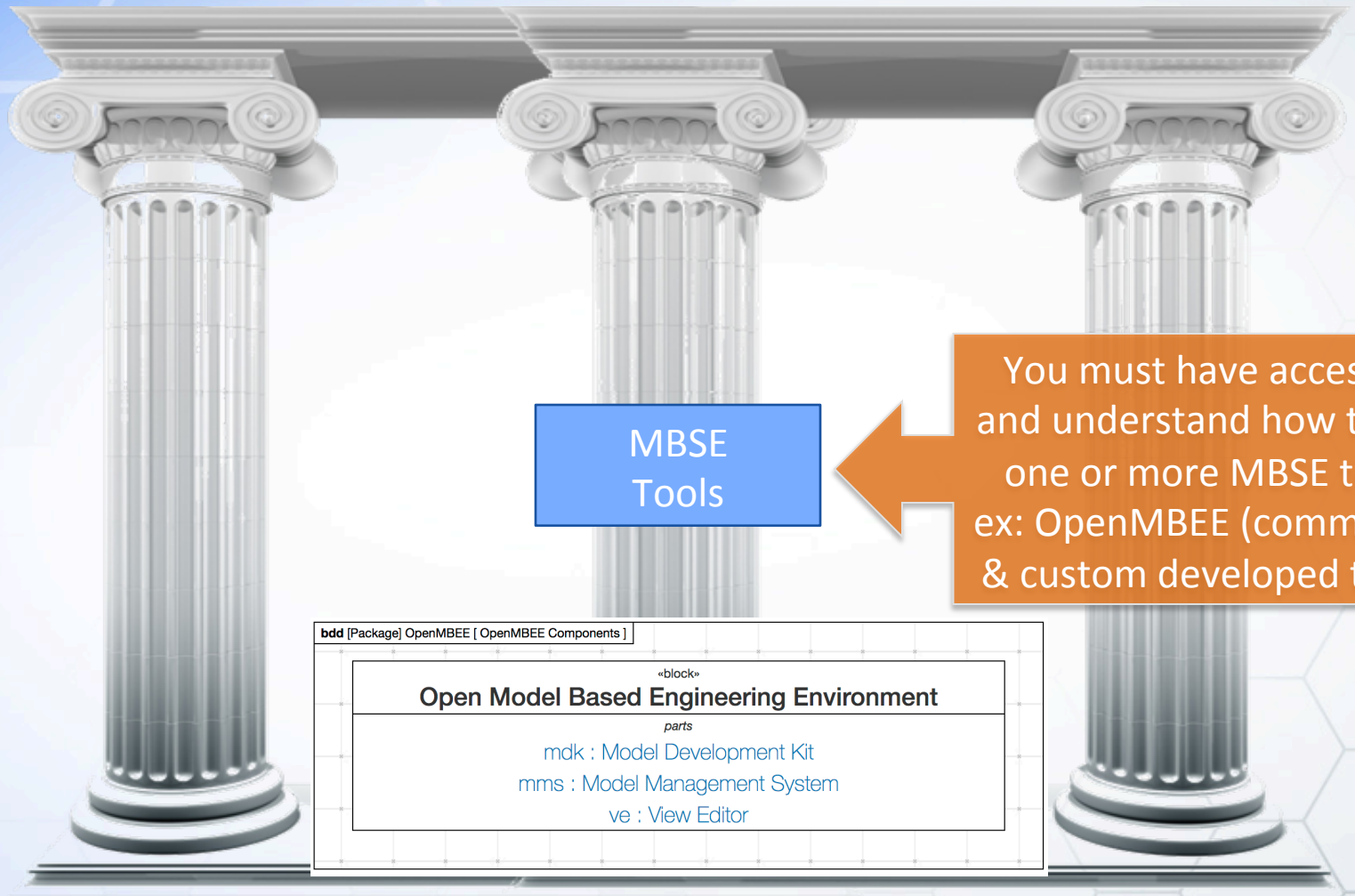
# MBSE Pillars



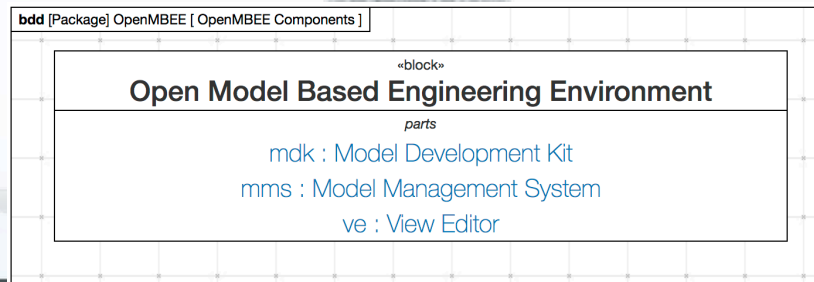
# MBSE Pillars



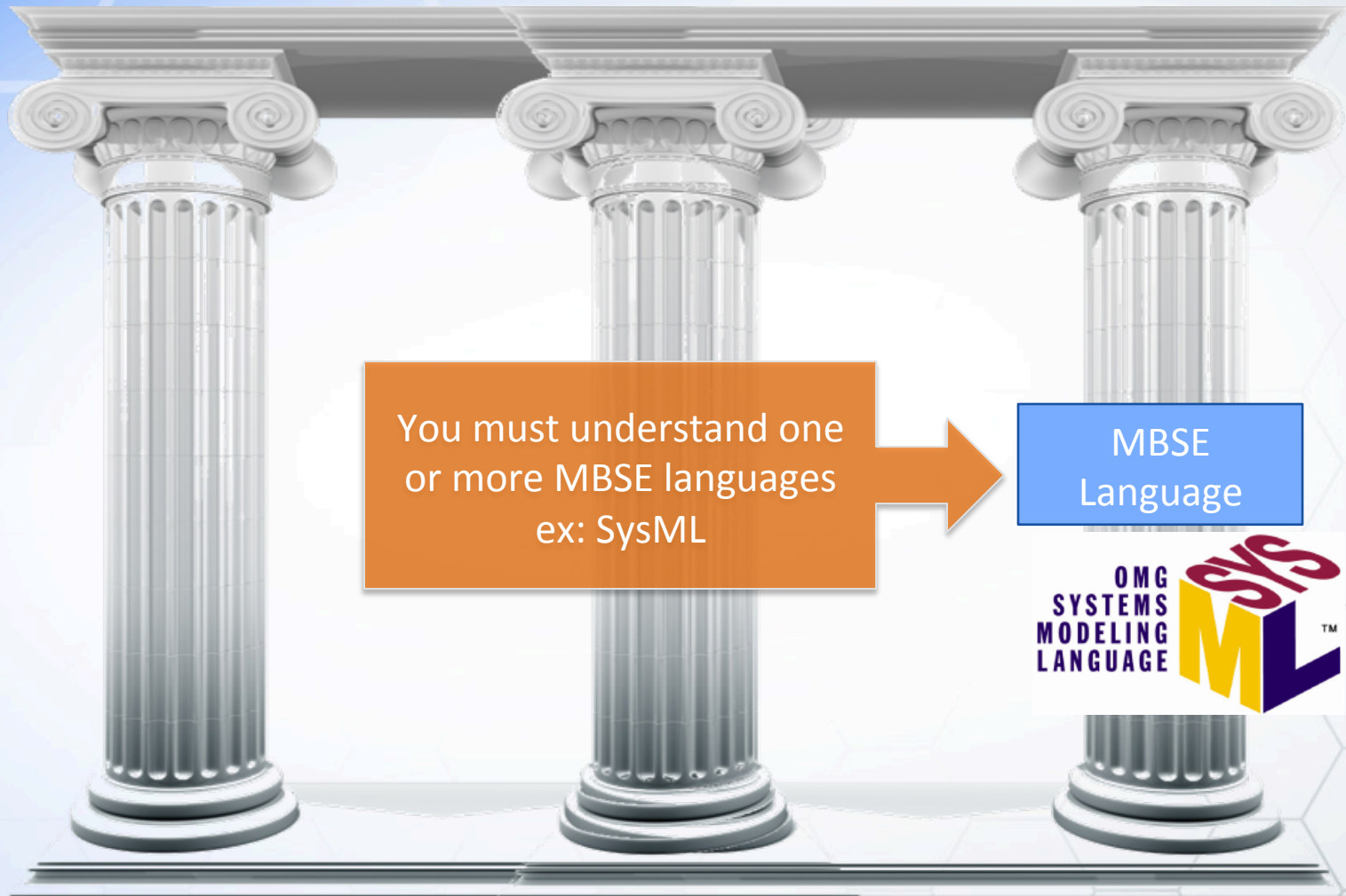
# MBSE Pillars



You must have access to and understand how to use one or more MBSE tools ex: OpenMBEE (commercial & custom developed tools)



# MBSE Pillars



# MBSE in Telescope Projects

- Large telescope projects are no different than other complex systems of systems...



- We still need to apply core SE processes
- Difference: formal Systems Engineering, i.e. MBSE, is historically unfamiliar

# MBSE Challenges

- SE concepts are subtle and obscure
  - Broad scope
  - More than one solution
  - More than one approach
  - Balancing act: cost, schedule, performance
- Expressing concepts in a model demands the use of refined tools/language which are both flexible and useful
  - Flexibility in tools/language demands rigor from the modeler (SE)
- Learning curve, time commitment, and managerial buy-in
- Limited (but growing!) resources for learning MBSE with SysML
- Need to move toward a dominant standard for communicating SE ideas → SysML



# MBSE with SysML

- Enables rigorous system analysis
  - Decomposition of system components to understand interactions necessary to meet objectives under defined constraints
- Multi-scale integration (software, hardware, data, people, processes)
  - Notations and processes to communicate simplified vision while allowing drill-down for exploration
  - Multiple views for separation of concerns
  - Traceability through system hierarchy
  - Facilitates impact analysis of design changes
- Enhances SE objectives to specify, analyze, design, verify, and validate systems
- Standardized integrated SysML model > non-standardized communication in disjoint sets of documents and diagrams
- Modeling → optimization

# MBSE: TMT Application

## ◆ Why MBSE?

- ◇ Emphasizes rigor and precision, best practices
- ◇ Helps manage complexity
- ◇ Horizontal (life cycle) and vertical (multiple domain) integration

## ◆ TMT SysML model

- ◇ Created to better understand and communicate complex system behavior
- ◇ Executable SysML model to **capture** requirements, use cases, system decomposition, subsystem relationships
- ◇ **Analyze** system design against power, mass, duration requirements
- ◇ **Produce** engineering documents (ICDs, etc.)
- ◇ Use standard language and techniques (**communication**)

# MBSE: TMT Application

- TMT SysML Model does not model the entire telescope
- Main objective is to model operational scenarios and demonstrate that requirements are satisfied by the design
- Motivator for TMT MBSE = optimization
- Ex: JPL modeling of APS subsystem
  - Use Case: Post segment-exchange alignment, 2h requirement
  - Component characteristics (power, mass)
  - Relationships (TCS, M1CS)
- Ex: Monte Carlo simulations for acquisition and slew time
  - To minimize loss of observing time, TMT should be able to move from one target to another and acquire it in 3 min or less

# Challenge Team Organization

- First generation challenge team (SE<sup>2</sup>) was a collaboration between European Southern Observatory (ESO) and German Chapter of INCOSE (GfSE), est. 2007
- Active Phasing Experiment (APE) case study
- Next generation challenge team (SE<sup>3</sup>)
  - Updated MBSE Wiki Page
  - Building on work from SE<sup>2</sup> to refurbish first revision of SE Cookbook
  - Add TMT experiences
- Thirty Meter Telescope (TMT) case study

# Challenge Team Goals

- Demonstrate benefits of MBSE with SysML as the basis for integrated engineering and management of complex systems
  - Optimization, standardization, automation
  - Better system understanding through simulations and analyses
  - Early efforts go a long way (reduced risk/cost, expand knowledge)
- New revision of SE Cookbook for MBSE with SysML
  - Best practices to support common SE tasks
  - Patterns and practices for model construction
  - Express system concepts to diverse stakeholders
- SEBOK TMT Case Study for Fall 2017 publication
- Ongoing collaboration in telescope community

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