SoSECIE Webinar

Welcome to the
2019 System of Systems Engineering Collaborators Information Exchange (SoSECIE)

We will start at 11AM Eastern Time

Skype Meeting +1 (703) 983-2020, 46013573#

You can download today's presentation from the SoSECIE Website:

https://mitre.tahoe.appsembler.com/blog

To add/remove yourself from the email list or suggest a future topic or speaker, send an email to sosecie@mitre.org

NDIA System of Systems SE Committee

- **Mission**
  - To provide a forum where government, industry, and academia can share lessons learned, promote best practices, address issues, and advocate systems engineering for Systems of Systems (SoS)
  - To identify successful strategies for applying systems engineering principles to systems engineering of SoS
- **Operating Practices**
  - Face to face and virtual SoS Committee meetings are held in conjunction with NDIA SE Division meetings that occur in February, April, June, and August
  - SoS Track at NDIA 22nd Annual Systems Engineering Conference, Grand Hilton Tampa Downtown, Tampa, FL, October 21-24, 2019
    - Conference Info: http://www.ndia.org/events/2019/10/21/22nd-annual-systems-and-mission-engineering-conference

NDIA SE Division SoS Committee Industry Chairs:
Mr. Rick Poel, Boeing
Ms. Jennie Horne, Raytheon
OSD Liaison:
Dr. Judith Dahmann, MITRE

Simple Rules of Engagement

- I have muted all participant lines for this introduction and the briefing.
- If you need to contact me during the briefing, send me an e-mail at sosecie@mitre.org.
- Download the presentation so you can follow along on your own
- We will hold all questions until the end:
  - I will start with questions submitted online via the CHAT window in Skype.
  - I will then take questions via telephone; State your name, organization, and question clearly.
- If a question requires more discussion, the speaker(s) contact info is in the brief.

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2019 System of Systems Engineering Collaborators Information Exchange Webinars

Sponsored by MITRE and NDIA SE Division

July 16, 2019
Modular Online Open SoS Education (MOOSE)
Mr. Kyle Hastings, The MITRE Corporation

July 30, 2019
Graph Theoretic Architectural Analysis: Analysis of Complex Systems and Systems of Systems
Ms. Laura Antul

August 13, 2019
Systems of Systems, An Overreaching Paradigm
Mr. Reggie Cole

August 27, 2019
Understanding and Shaping the Future of Systems of Systems Engineering
Mr. Garry Roedler

September 10, 2019
An Analysis of Systems-of-Systems Opportunities and Challenges Related to Mobility
Mr. Jakob Axelsson

2019 System of Systems Engineering Collaborators Information Exchange Webinars

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September 24, 2019
Modeling and Simulation for Internet of things as System of Systems
Dr. Paul C. Hershey

October 8, 2019
TBD

October 22, 2019
Modeling Process for the Design of System of Systems Evolution
Dr. Jeremy Buisson, Dr. Isabelle Borne and Mr. Franck Petitdemange

November 5, 2019
Irrational System Behavior in a System of Systems
Mr. Douglas L. Van Bossuyt, Mr. Bryan M. O'Halloran and Mr. Ryan M. Arlitt

November 19, 2019
Multi-Dimensional Classification of System-of-Systems
Dr. Bedir Tekinerdogen

December 3, 2019
Digital Twin Strategies for System of Systems
Mr. Michael Borth

Modular Open Online Systems of Systems Engineering Education (MOOSE)

Kyle Hastings khastings@mitre.org
Dr. Aleksandra Markina-Khusid amk@mitre.org
Dr. Judith Dahmann jdahmann@mitre.org

MITRE

Motivation

- **As interest in systems of systems and SoS engineering has grown, so has the need for more broadly available SoS educational material to support the SE community.**
- **There is a developing base of SoSE knowledge and experience available…**
  - Largely through traditional sources of education:
    - University programs
    - Short courses
    - Tutorials

These require considerable commitment, time, and resources. The question becomes *"how can we do this in a more accessible way?"*

- **MOOSE is an experimental initiative to make SoS material readily available and accessible.**

Overview

- **Objective:**
  - Develop a set of modules to serve as training and education tools for SoS concepts and practices with content that accommodates users of various expertise levels
  - Develop an environment where these modules can be made easily and broadly accessible

- **Intended to be used by any team supporting SoSE efforts, whether they are from government, FFRDCs, academia, or industry.**
  - Modules will aid in understanding the state of practice for SoS engineering

Accessible and Self-paced

- **The MOOSE concept:**
  - Offer on-demand learning experience via MIT open source edX software platform
  - Self-paced “asynchronous” learning experience
  - Each module will focus on a specific topic and take 30 to 60 minutes to complete
    - Short modules will enable the student to go at his/her own pace and pick the material that is of the highest interest
  - Modules will implement sets of short course videos
    - Videos will be in short ~6 – 9 minute segments
    - Videos draw on existing SoS material and experiences with key SoS topics
  - Modules will implement knowledge checks
    - Auto-graded quizzes which support increased student retention of the material

MOOSE seeks to…

- **Provide users with practical approaches and methodologies to build customer relationships and a growing MBE SoS program of work**
- **Help lower the barrier of entry for learners to apply ‘state of practice’ SoSE techniques via MBE and other modeling capabilities**
- **Provide a cost effective solution to educate large number of learners in current SoS and MBE Engineering Practices**

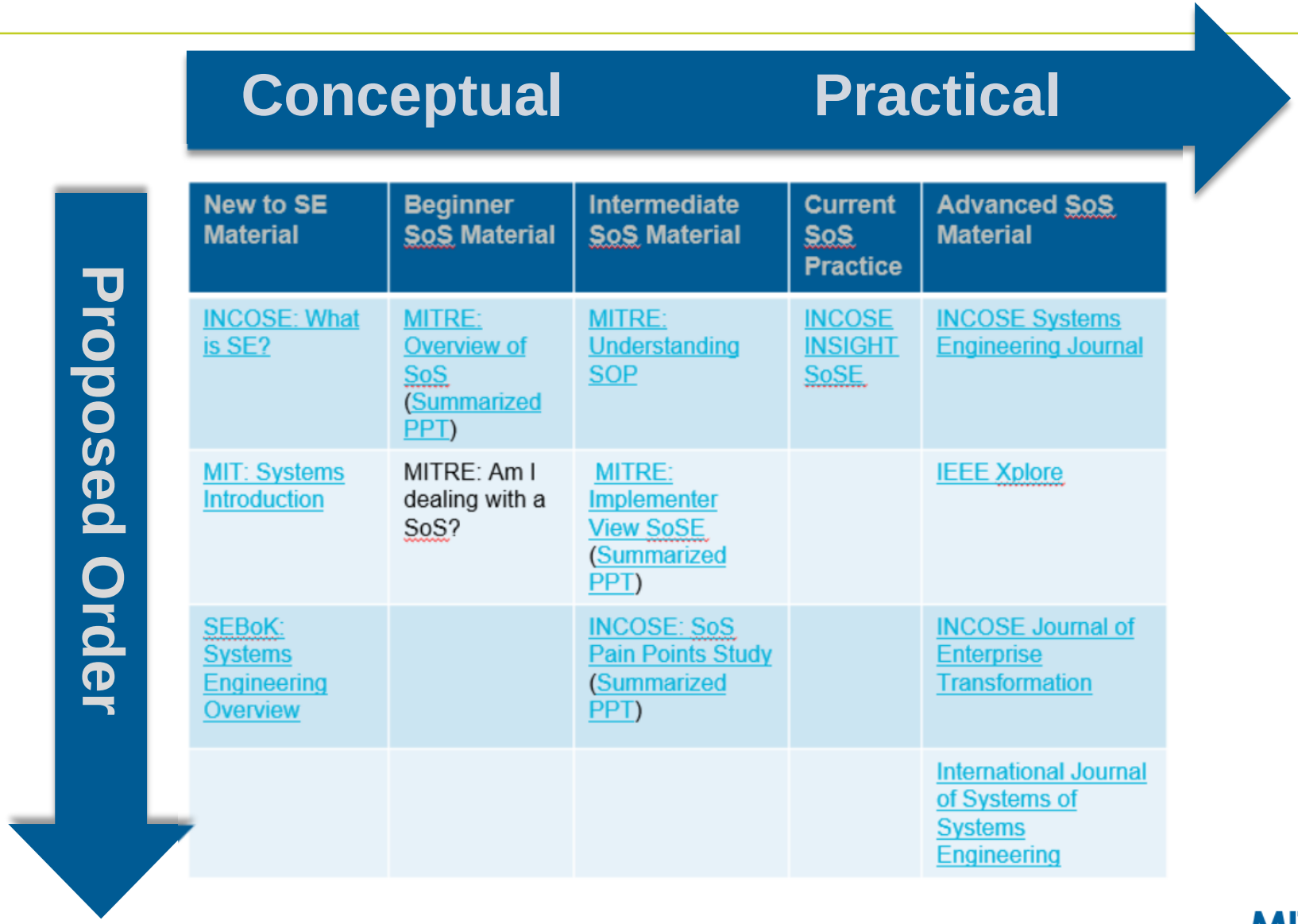
The Platform: Open edX

- **Open edX is an open source platform that was created through a collaboration between Harvard and MIT, through which instructors can build, design, and host their own courses.**

- **Serves as a course management system where instructors can edit course structure, add course content, and offer the course to a selected audience.**

Modules will build on existing content

- **The SoS Primer is a learning aid developed by MITRE which organizes SoS self-learning materials**
- **MOOSE plans to build on the learning materials in the Primer, as well as other SoS materials, to create the modules**



New to SE Material	Beginner SoS Material	Intermediate SoS Material	Current SoS Practice	Advanced SoS Material
INCOSE: What is SE?	MITRE: Overview of SoS (Summarized PPT)	MITRE: Understanding SOP	INCOSE INSIGHT SoSE	INCOSE Systems Engineering Journal
MIT: Systems Introduction	MITRE: Am I dealing with a SoS?	MITRE: Implementer View SoSE (Summarized PPT)		IEEE Xplore
SEBoK: Systems Engineering Overview		INCOSE: SoS Pain Points Study (Summarized PPT)		INCOSE Journal of Enterprise Transformation
				International Journal of Systems of Systems Engineering

MITRE

Initial Plan for Modules

- **Training modules to focus on:**
  - Building on the SoS primer, published papers on MITRE experience with key SoS topic, and other SoS topics of technical interest to MITRE technical staff
  - Developing material for learners to gain strong MBE skills that can be applied to SoS problems
    - Real-world scenarios and program examples
  - Hands-on training on how to apply SoSE
  - Make the modules available and accessible outside of MITRE, enabling sharing with customers and external partners

Basic Module Path

Modules
What is Systems Engineering? (Introduction)
Introduction to Systems of Systems
SoS Types and Characteristics
Am I dealing with a System of Systems?
SoS Life cycle and Wave Model
SoS Engineering Pain Points
SoS for MBE
SoS for MBE Example

Intermediate Module Path

Modules
Characterization of SoS Aircraft example
Key factors for SoS
SoS Workflow (part 1)
SoS Workflow (part 2)
SoS questions for systems at each life cycle phase

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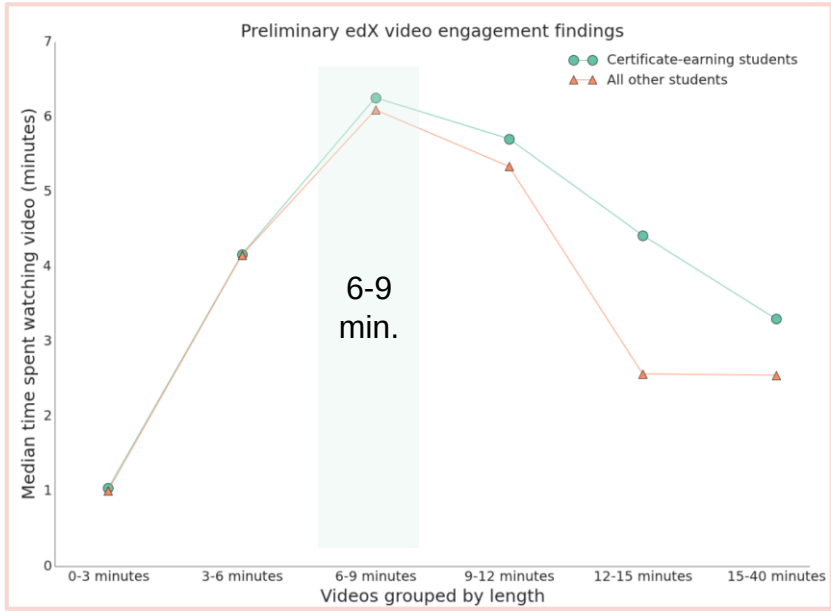
Collaboration with MIT

MITsdm

- **As part of the initiative, MITRE partnered with two graduate teams from MIT's SDM (Systems Design and Management) program.**

- **They examined the trade space of online systems engineering educational developments and aided in the design decisions and recommendations for the project.**

Maximum engagement at 6-9 minute length videos



1. edX MOOC research, Philip Guo, PhD MIT, Rob Rubin, VP Engineering edX, November 2013

Research from the teams confirmed, for example, that shorter videos would be the most effective for learning.

MITRE

Architectural Decisions

MITsdm

- **The two graduate teams from MIT were able to identify key architectural decisions for our problem space…**

Learner Type	Course Feedback	Cohort Size	Type of Learning Assessment	Module Length
• MITRE employee • partners • public	• Analytics • User surveys • Management Feedback	• 1 (Individual) • 2 – 10 • 11 – 50 • 50 – 100 • > 100	• Peer assessment • Final exam / project instructor-graded • Quiz / exam automated review	• < 15 minutes • 15 – 1 hour • Half day • 1 day • Multiple days

Learning Schedule	Learning Environment	Instructor Involvement	Gamification / Incentives	Peer Interactions
• Asynchronous • Synchronous • Both	• Online • In-Person • Mixed	• Fully driven • No active instructor • Mixed	• Yes • No	• Yes • No

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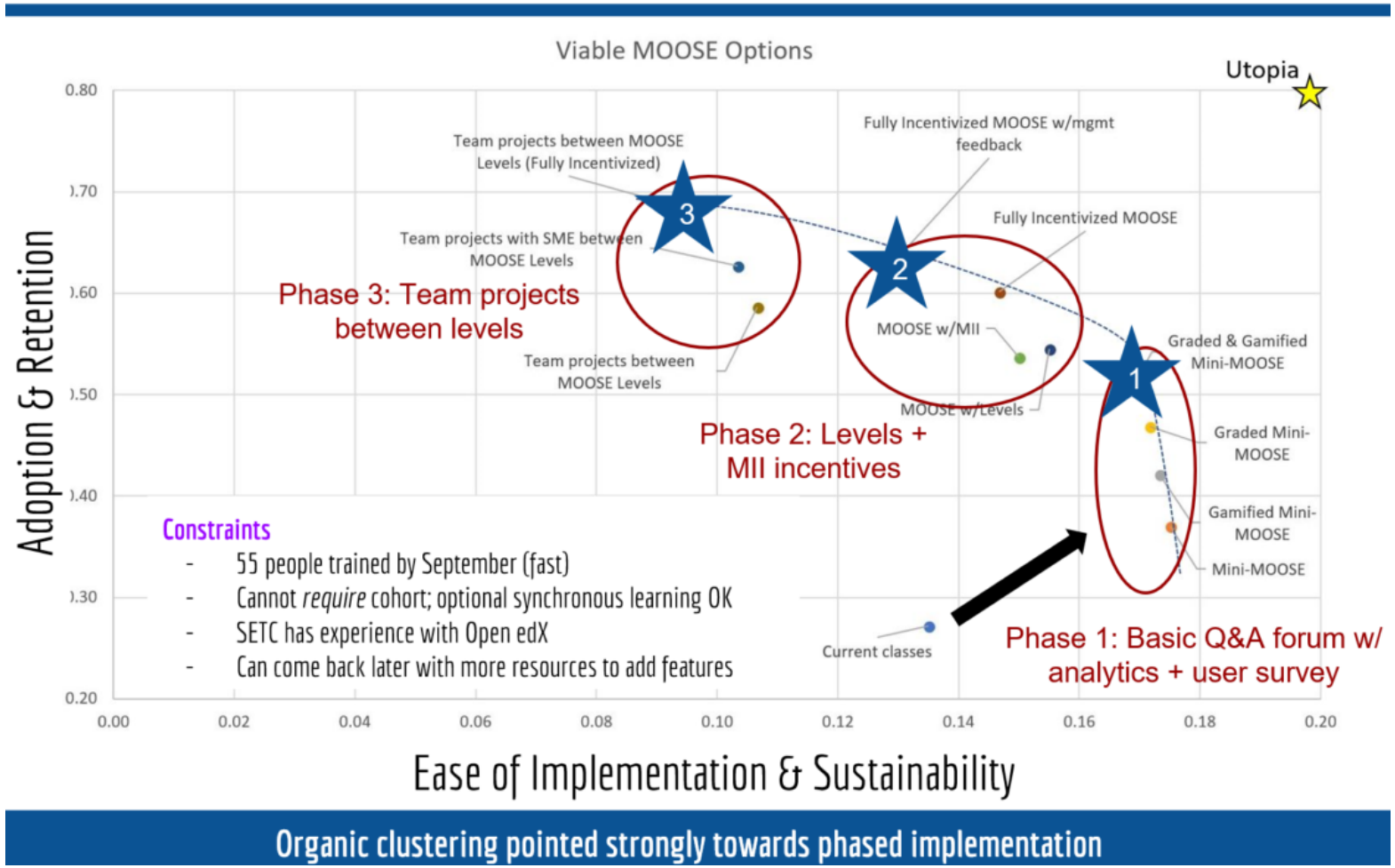
MOOSE – MIT SDM Insights

MITsdm

… And then compare the various solutions.

- There were over 23,000 possible combinations of architectural decisions
- Teams ultimately proposed a phased approach, starting with a focus on a learning environment easy to implement and sustain, then working towards a focus on adoption and retention



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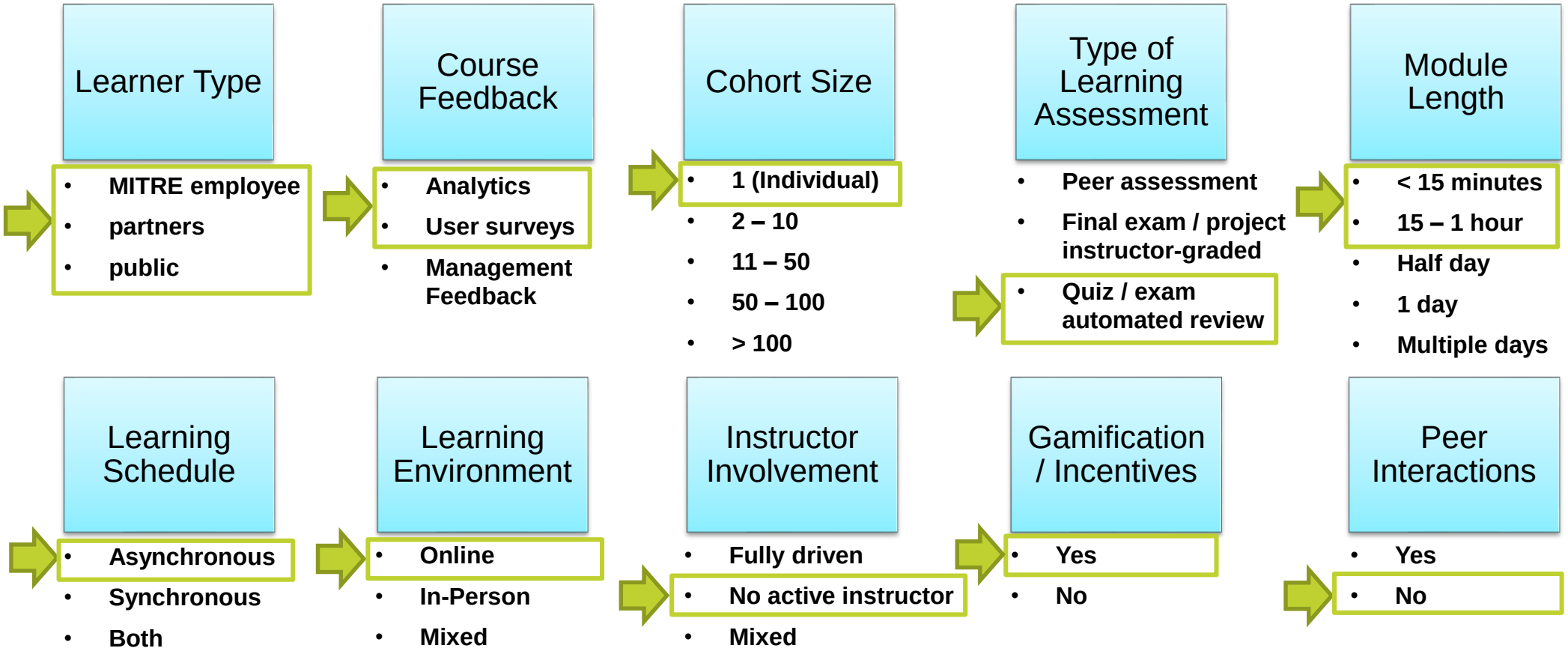
Architectural Decisions

MITsdm

- **For MOOSE, our initial focus lies here…**



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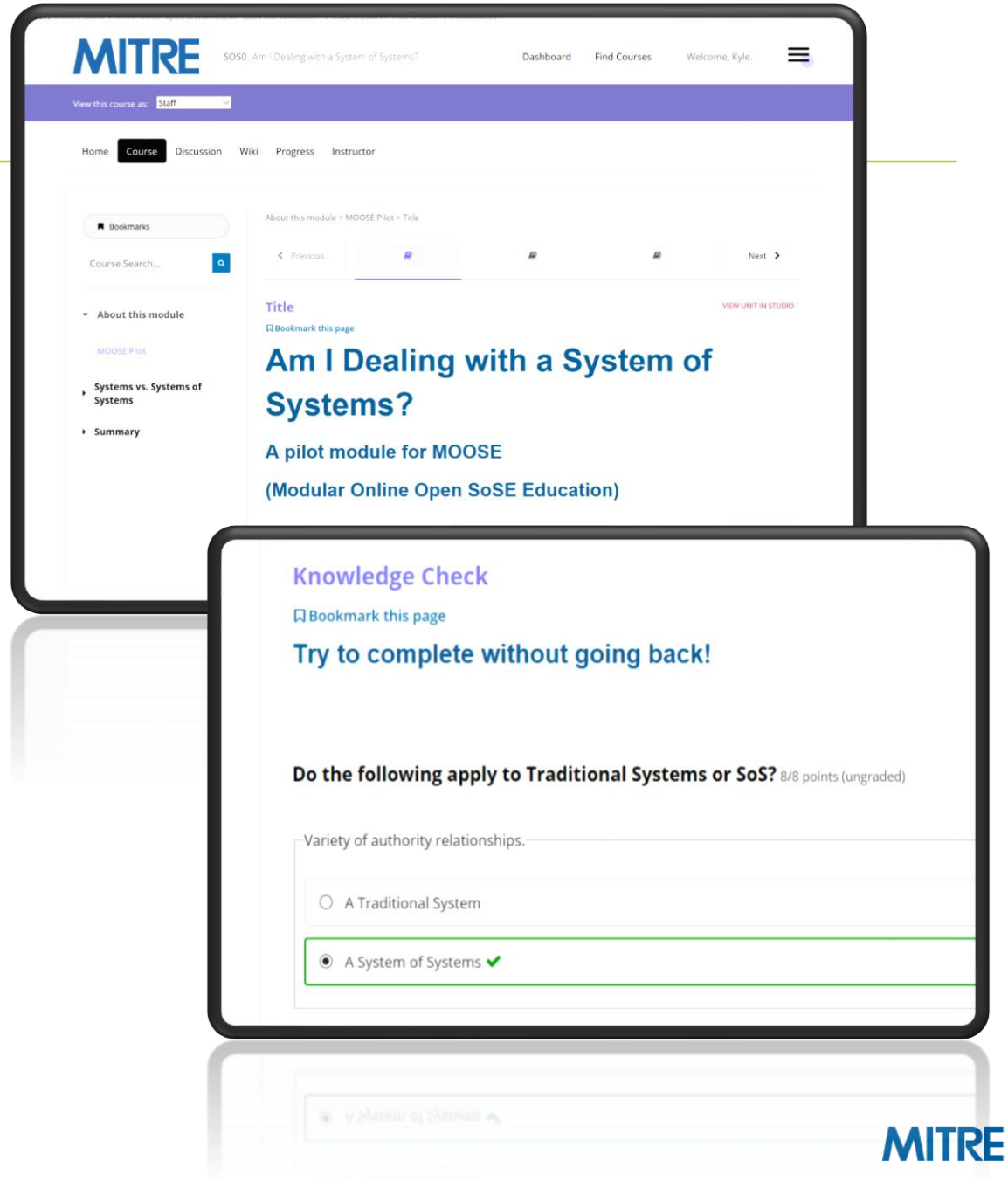
MOOSE Today

- **We currently have a few beginning modules online, and more are on the way!**

- **If interested, please check out the following link:**

  – [https://mitre.tahoe.appsembler.com/]



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MOOSE – Next Steps

- **Implement assessment approach and obtain feedback on the initial modules**
  - Surveys
  - Open edX Analytics
- **Improve initial modules based on analytics and feedback**
- **Continue to develop next wave of modules**

Discussion

Acronyms used

- MOOSE: Modular Open Online SoSE Education
- SoSE: System of Systems Engineering
- SE: Systems Engineering
- FFRDC: Federally Funded Research and Development Center
- MBE: Model-Based Engineering
- INCOSE: International Council on Systems Engineering
- SEBoK: Systems Engineering Body of Knowledge
- SDM: Systems Design and Management