




FDA **U.S. FOOD & DRUG**
ADMINISTRATION
CENTER FOR DEVICES & RADIOLOGICAL HEALTH
DIGITAL HEALTH PROGRAM


PROPOSED REGULATORY FRAMEWORK FOR MODIFICATIONS TO ARTIFICIAL INTELLIGENCE/ MACHINE LEARNING (AI/ML)-BASED SOFTWARE AS A MEDICAL DEVICE (SAMD)

Matthew Diamond, MD, PhD
February 25, 2020

 **FDA U.S. FOOD & DRUG ADMINISTRATION**

Proposed Regulatory Framework for Modifications to Artificial Intelligence/Machine Learning (AI/ML)-Based Software as a Medical Device (SaMD)

Discussion Paper and Request for Feedback



**CDRH Division of Digital Health
& CDRH AI/ML Working Group**

Matthew Diamond, Kathryn Drzewiecki, Bakul Patel (OST);
Alex Cadotte, Brad Cunningham, Robert Ochs, Adam Saltman (OPEQ);
Nicholas Petrick, Berkman Sahiner, Chris Scully (OSEL)

Evolving Digital Health Device World ...

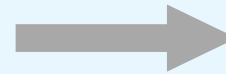


The Need for a Tailored Approach

“Traditional” Device World

Product Development Timeline

- Months to years +
- Less frequent modifications

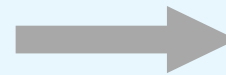


Evolving Digital Health Device World

Weeks to months + (incremental, iterative) and potentially frequent modifications

Postmarket Data

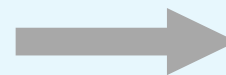
- Limited availability and access to real world data (522, PAS, MDRs, MedSun)



*Potential for **high availability** and access to rich real world data (benefits and risks)*

FDA Premarket Program Volume:

- Stable (~3,500 510(k) submissions / 2200 pre-submissions)



*Potential for **exponential** increase in volume of submissions*

Examples of AI/ML-Based SaMD

FDA News Release

FDA Permits Marketing of Artificial Intelligence-Based Device to Detect Certain Diabetes-Related Eye Problems

April 11, 2018



IDx-DR

FDA News Release

FDA Authorizes Marketing of First Cardiac Ultrasound Software That Uses Artificial Intelligence to Guide User

February 7, 2020



Caption Health

AI/ML-Based Medical Devices



IDx-DR

- Ability of AI/ML systems to learn from the wealth of real world data and improve their performance
- Development of novel AI/ML devices in all medical fields
- Fundamentally transform the delivery of healthcare
 - *Earlier disease detection*
 - *More accurate diagnosis*
 - *New insights into human physiology*
 - *Personalized diagnostics and therapeutics*

Tailoring a Regulatory Framework for AI/ML-Based SaMD



Enhance patient access to high quality digital medical products



Maintain a reasonable assurance of safety and effectiveness



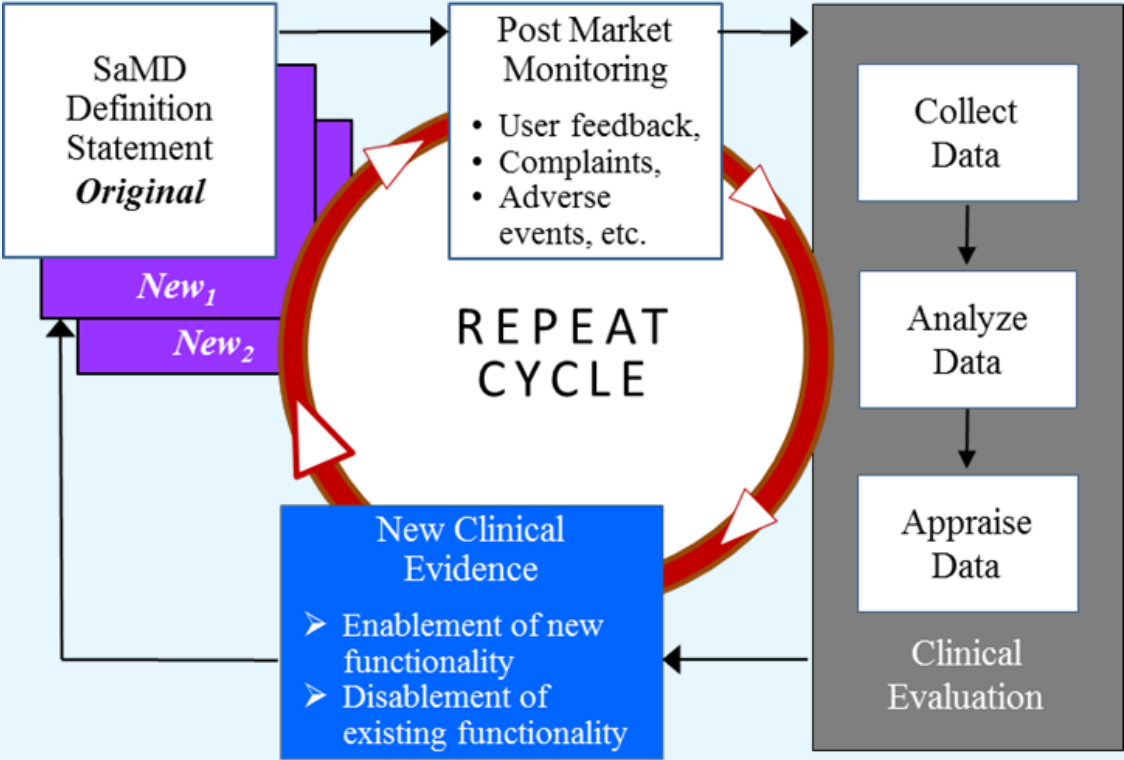
Enable manufacturers to rapidly improve software products with minor changes



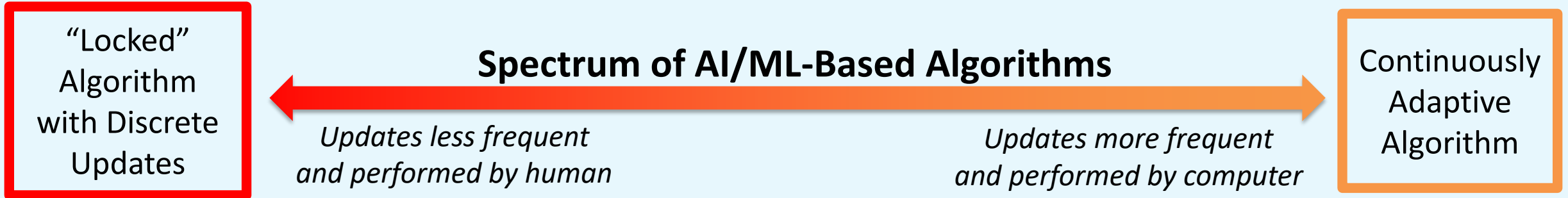
Minimally burdensome

Continuous Learning for Software as a Medical Device

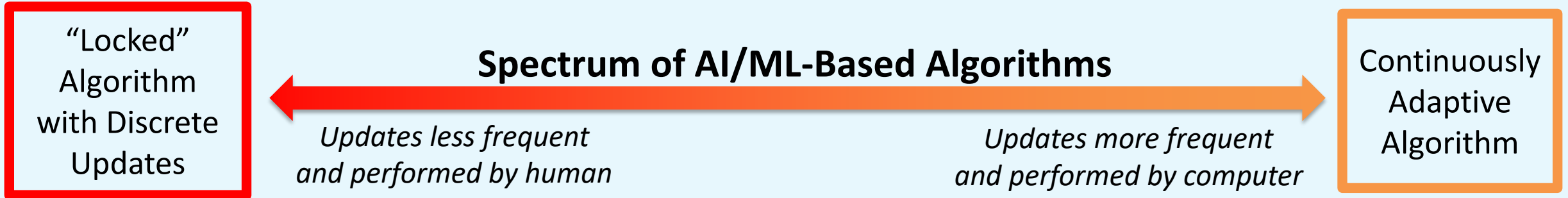
Medical software manufacturers are encouraged to leverage the software technology’s capability of capturing real world performance data to understand user interactions with the SaMD, and to conduct ongoing monitoring of analytical and technical performance to support future intended uses.



Continuous Learning for Software as a Medical Device

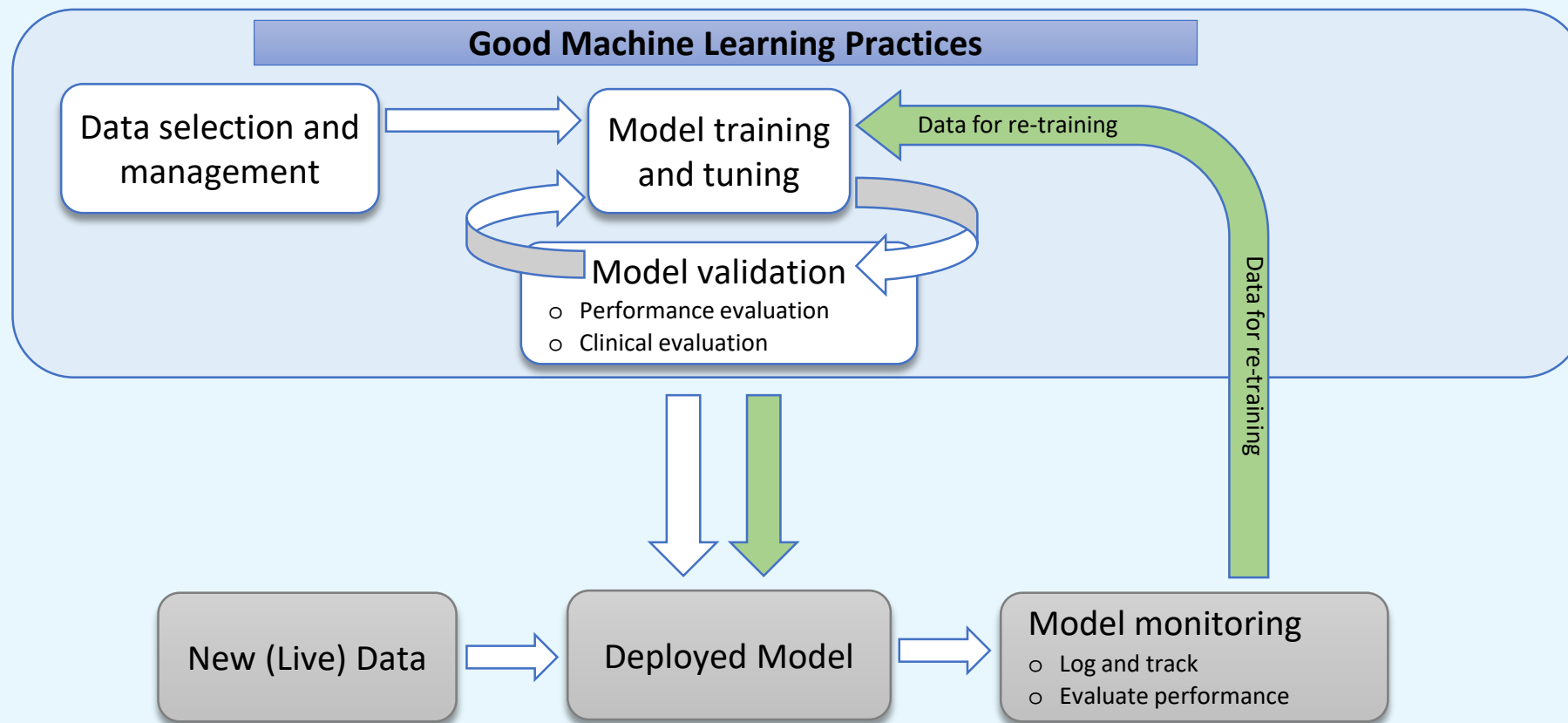


Continuous Learning for Software as a Medical Device



If adaptations are pre-specified, and the methods for determining an appropriate adaptation clearly delineated, then a decision-making framework, as described here, may be similarly applied for both locked and adaptive algorithms.

AI/ML Workflow

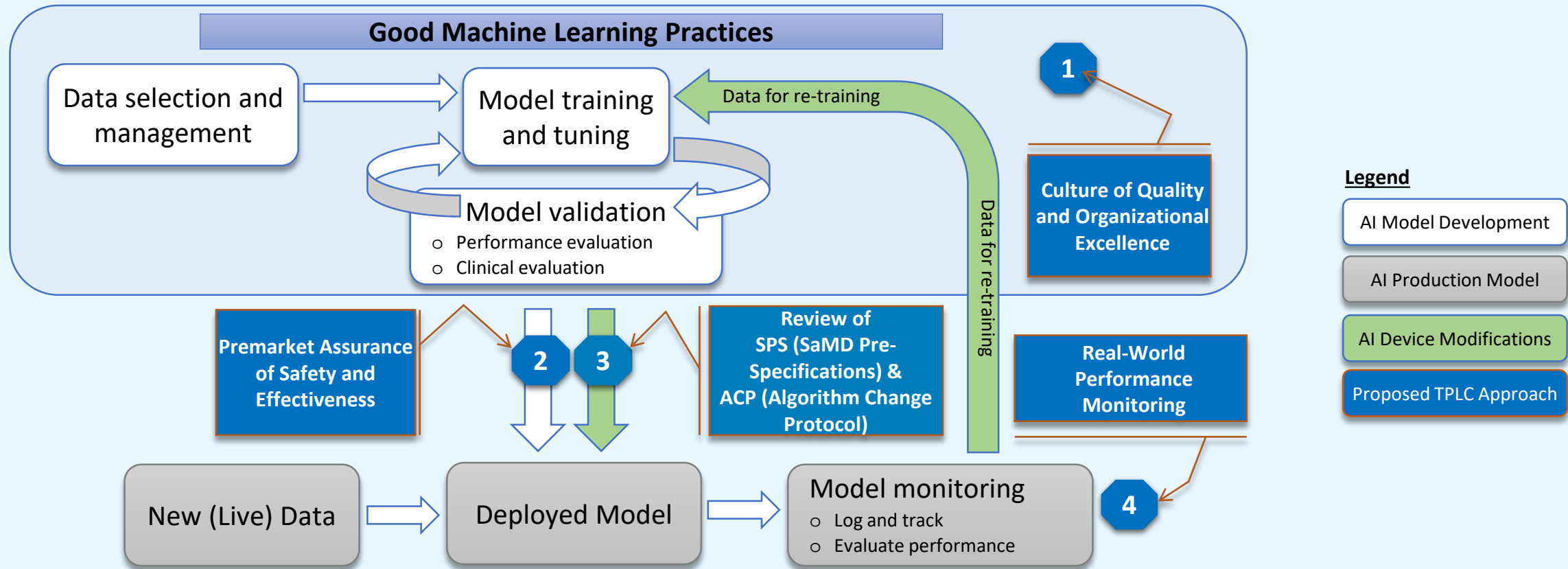


Legend

- AI Model Development (white box)
- AI Production Model (grey box)
- AI Device Modifications (green box)

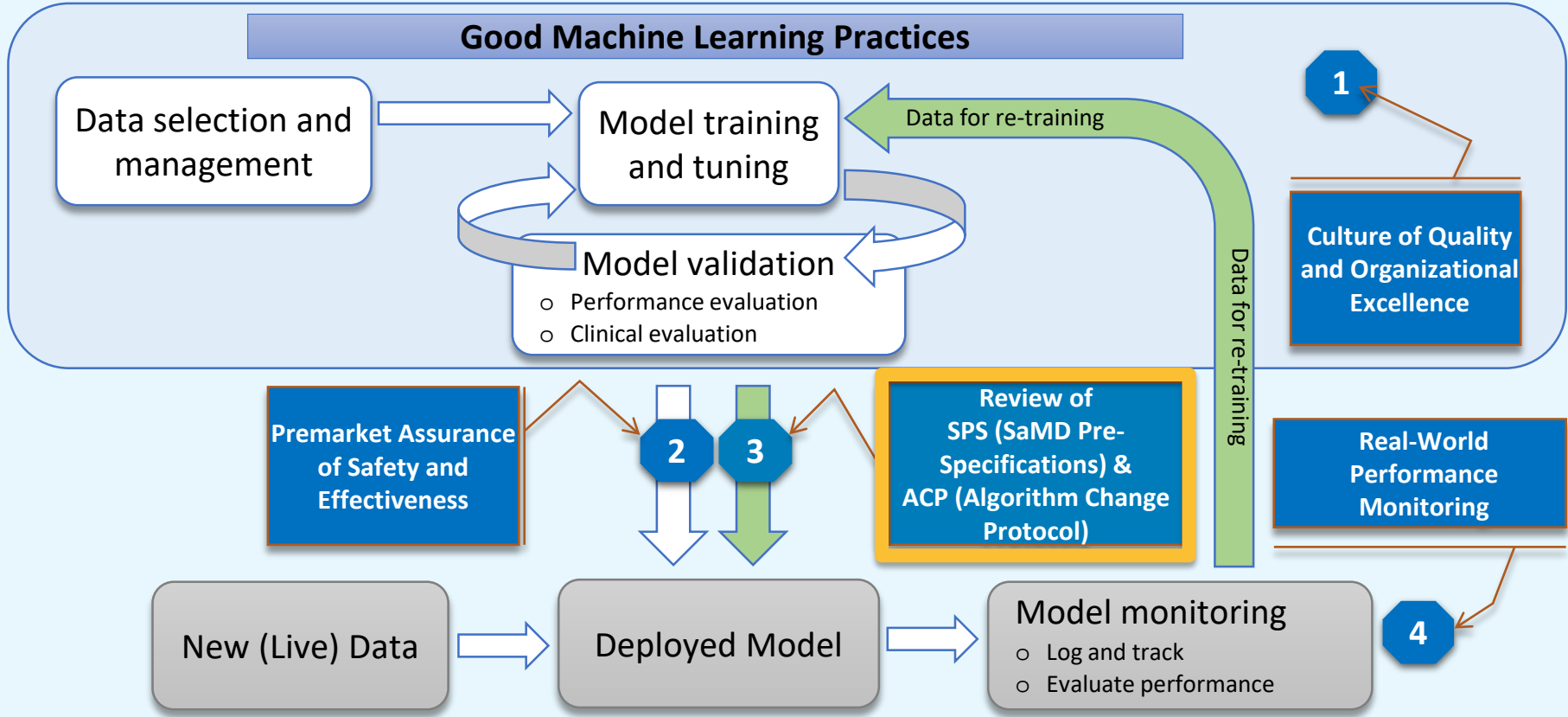
AI/ML Workflow

Proposed Total Product Lifecycle (TPLC) Approach



AI/ML Workflow

Proposed Total Product Lifecycle (TPLC) Approach



Legend

- AI Model Development
- AI Production Model
- AI Device Modifications
- Proposed TPLC Approach

SPS = SaMD Pre-Specifications:

- WHAT are the proposed types of changes to the SaMD the sponsor intends to achieve?
- Draws a virtual “region of potential changes” around the initial specifications and labeling of the device.

ACP = Algorithm Change Protocol:

- HOW will the changes (pre-specified in the SPS) be performed and validated?
- Step-by-step delineation of the procedures to be followed for a specific device and type of change

SPS = SaMD Pre-Specifications:

- WHAT are the proposed types of changes to the SaMD the sponsor intends to achieve?
- Draws a virtual “region of potential changes” around the initial specifications and labeling of the device.

ACP = Algorithm Change Protocol:

- HOW will the changes (pre-specified in the SPS) be performed and validated?
- Step-by-step delineation of the procedures to be followed for a specific device and type of change

Types of Pre-Specifications:

- 1) Retraining for performance improvement*
- 2) New data acquisition system*
- 3) Change related to intended use*

SPS & ACP: A Pre-Determined Change Control Plan



SPS = SaMD Pre-Specifications:

- WHAT are the proposed types of changes to the SaMD the sponsor intends to achieve?
- Draws a virtual “region of potential changes” around the initial specifications and labeling of the device.

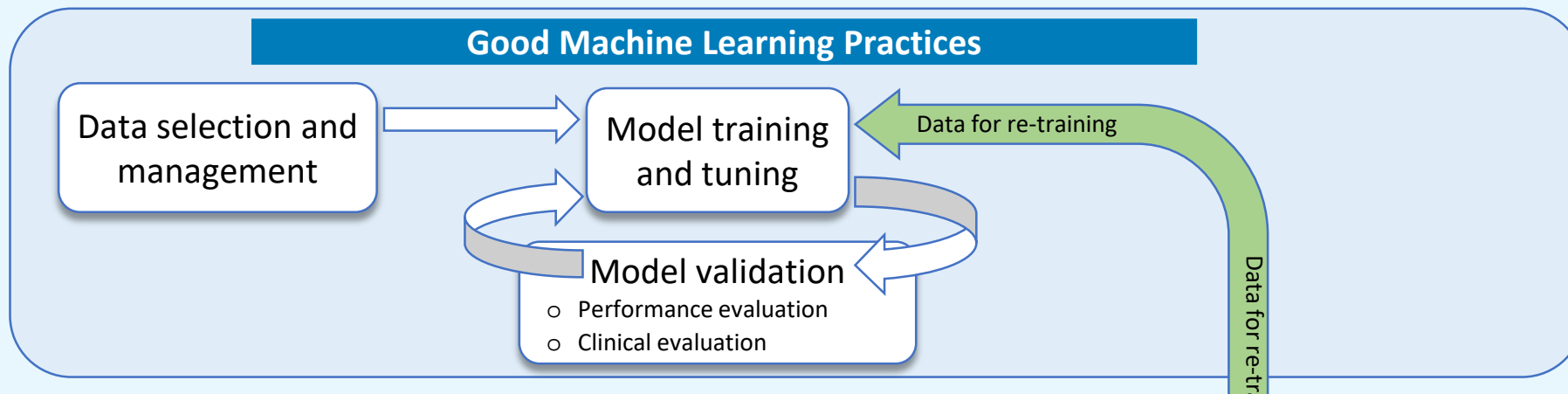
ACP = Algorithm Change Protocol:

- HOW will the changes (pre-specified in the SPS) be performed and validated?
- Step-by-step delineation of the procedures to be followed for a specific device and type of change

ACP Components:

Data Management	<ul style="list-style-type: none">➤ For new training & test data:<ul style="list-style-type: none">• Collection protocols• Quality assurance• Reference standard determination➤ Auditing and sequestration of training and test sets
Re-training	<ul style="list-style-type: none">➤ Re-training objectives➤ Changes related to:<ul style="list-style-type: none">• ML methods, including architecture and paramtrs• Data pre-processing➤ Criteria to initiate performance evaluation
Performance Evaluation	<ul style="list-style-type: none">➤ Assessment metrics➤ Statistical analysis plans➤ Frequency and triggers for evaluation➤ Performance targets➤ Methods for testing with “clinicians in the loop”
Update Procedures	<ul style="list-style-type: none">➤ Software verification and validation➤ When and how updates will be implemented➤ Plans for global and local updates➤ Communication and transparency to users

Good Machine Learning Practices (GMLP)



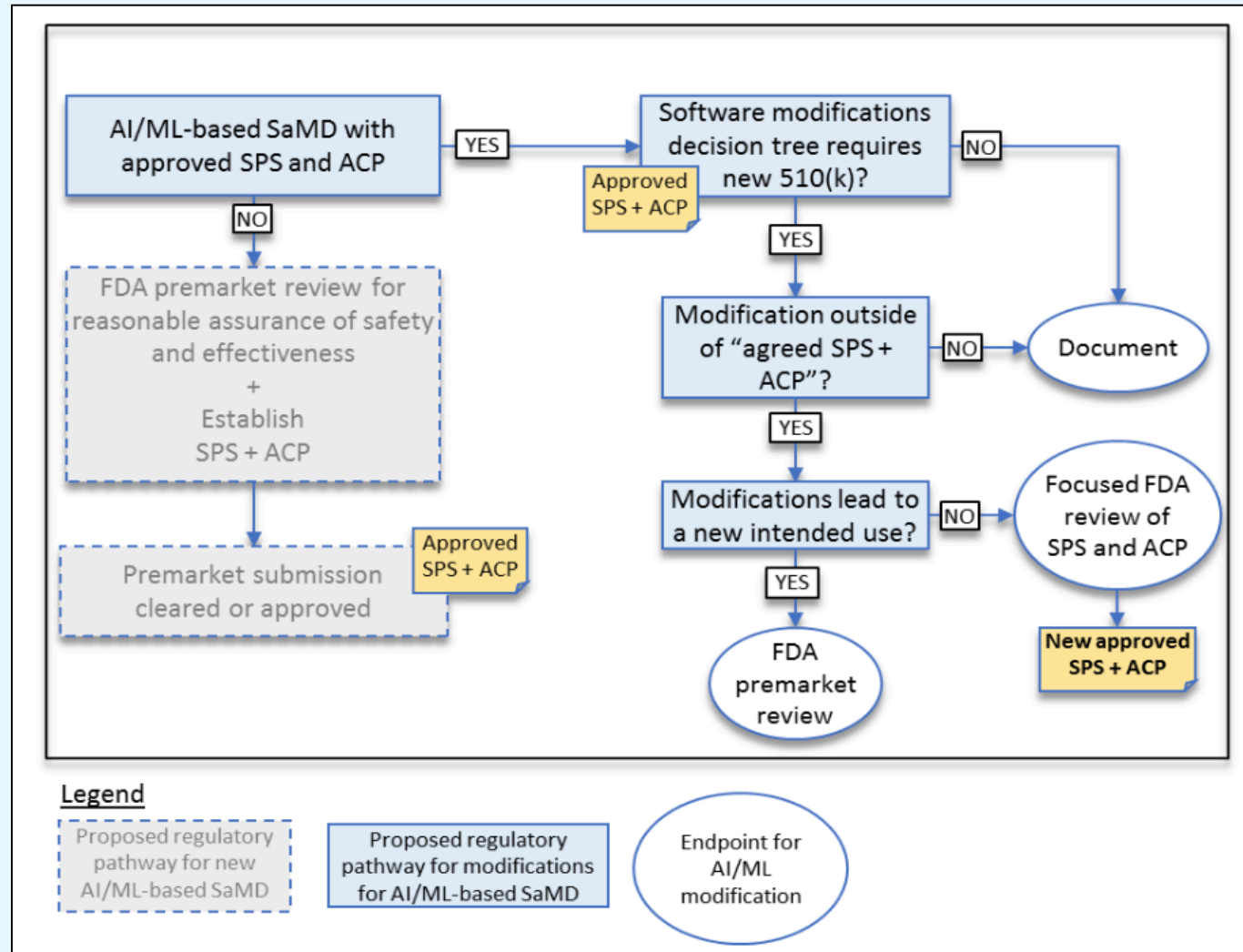
Legend

- AI Model Development
- AI Production Model
- AI Device Modifications

GMLP = Good Machine Learning Practices

- Accepted practices in ML/AI algorithm design, development, training, and testing that facilitate the quality development and assessment of ML/AI-based algorithms
- Based on concepts from quality systems, software reliability, machine learning, and data analysis, etc

Approach to Modifications Utilizing SPS + ACP



**This flowchart should only be considered in conjunction with the accompanying text in the AI/ML discussion paper.*

Further Questions or Feedback



www.fda.gov/digitalhealth



DigitalHealth@fda.hhs.gov

Matthew Diamond, MD, PhD

Medical Officer, Division of Digital Health

Office of Strategic Partnerships & Technology Innovation (OST)

Center for Devices and Radiological Health, U.S. Food and Drug Administration

matthew.diamond@fda.hhs.gov

(301) 796-5386