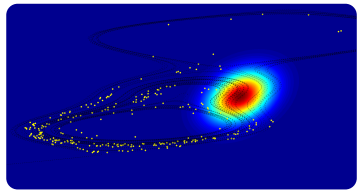
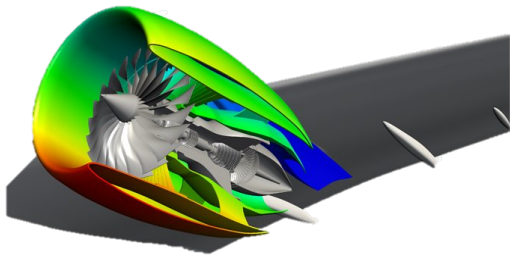


POINTPRO: Future of Forecasting

SPACE ASSET DEFENSE

Technology Origin

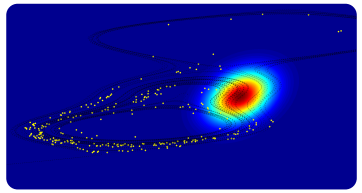
Funding: Air Force and NSF



JET ENGINE FAILURE & PROGNOSTICS

Current Product Development

- Industries with high-value physical assets can **unlock significant value by increasing asset utilization.**
- **Existing simulation technologies cannot deliver trustworthy forecasts** with the necessary accuracy and price point to enable predictive maintenance.
- ***Smarter simulations***, not more computational power is the key to the future of the digital twin.
- **PointPro provides the capability** for firms to gain the benefits of truly predictive maintenance by enabling decision quality forecasts at commanded accuracy level.

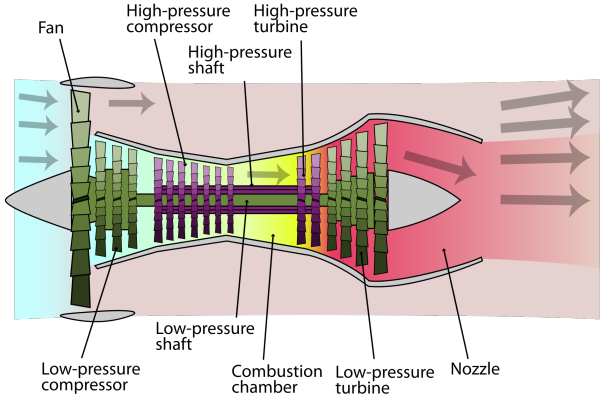


THE PROBLEM

[JET ENGINE PROGNOSTICS]

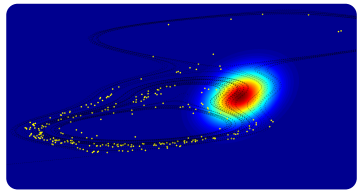
PROBLEM

- Will this engine fail over the next month?
- Should this engine be taken off the airframe for maintenance?



PAIN POINTS

- Maintenance decisions based on reliability analysis, forcing a preventative schedule [costly]
- Surprise/unforeseen breakdowns [costlier]
- Absence of trust metrics forces expensive, repetitive simulation tuning [productivity loss]
- Underlying physics is complex; and complexity drives error [confounding factor]

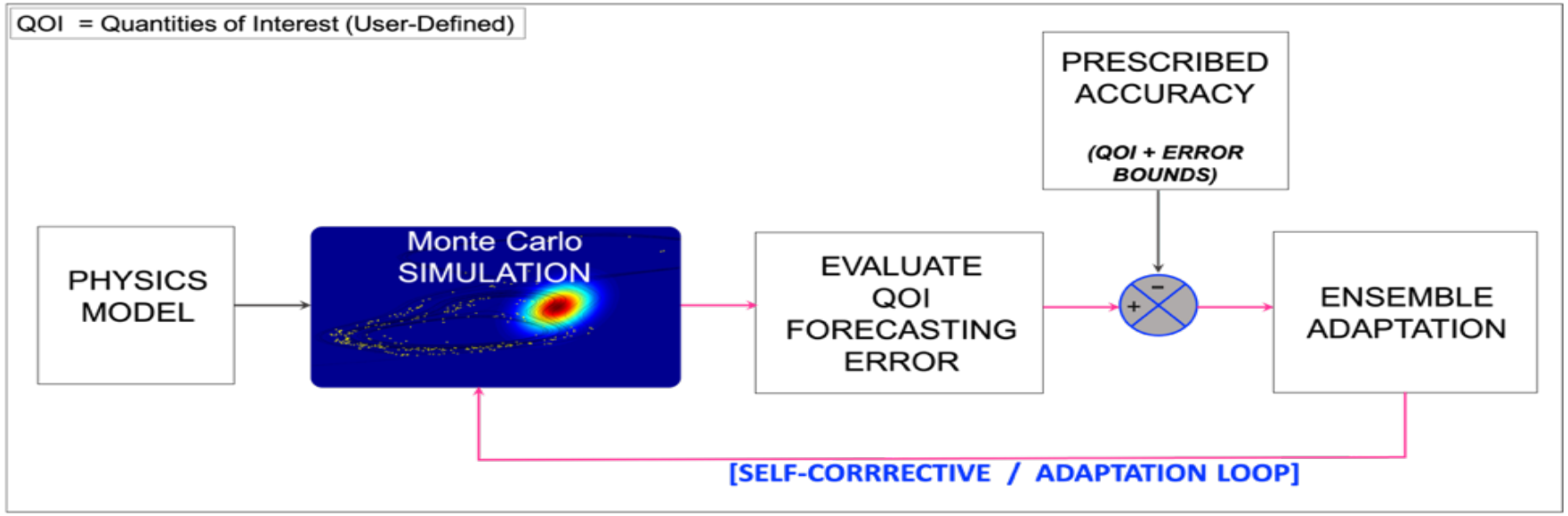


THE SOLUTION

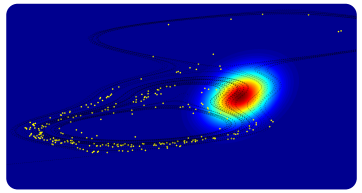
[JET ENGINE PROGNOSTICS]

SOLUTION

- Replace generic reliability analysis with system-specific physics-based simulations
- Client defines ***trustworthiness*** *of* forecasts
- Create ***front-end accuracy control***
- *Adaptive* sim platform *eliminates guesswork* and delivers *decision-quality* results in a single run

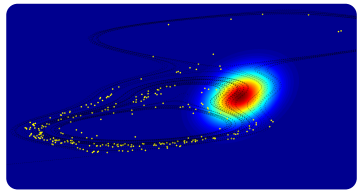


High Level Architecture of the Closed-Loop Adaptive Forecasting Platform



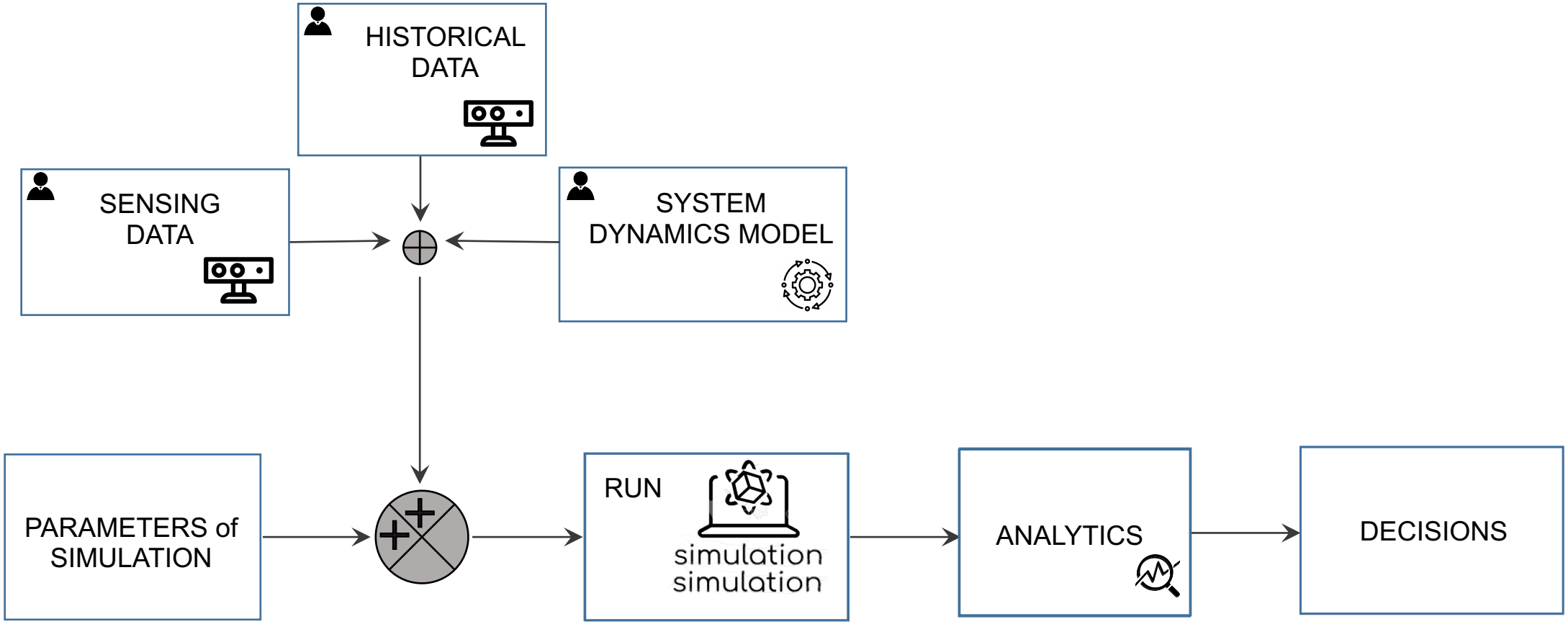
VALUE PROPOSITION

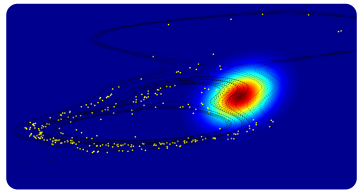
Controllable simulation accuracy results in up to 3X productivity gain



STATUS QUO

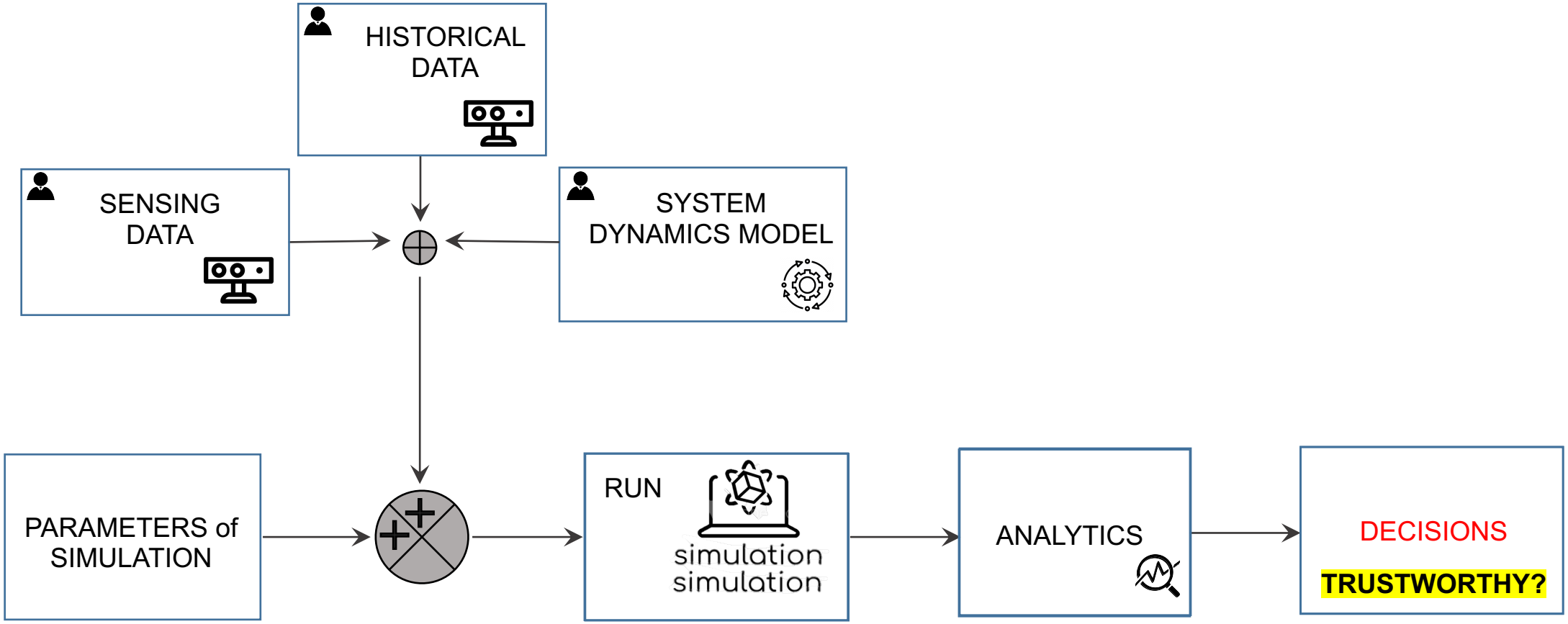
[JET ENGINE PROGNOSTICS]

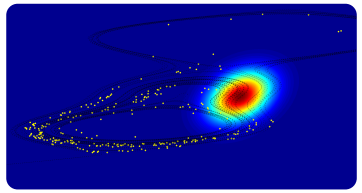




STATUS QUO

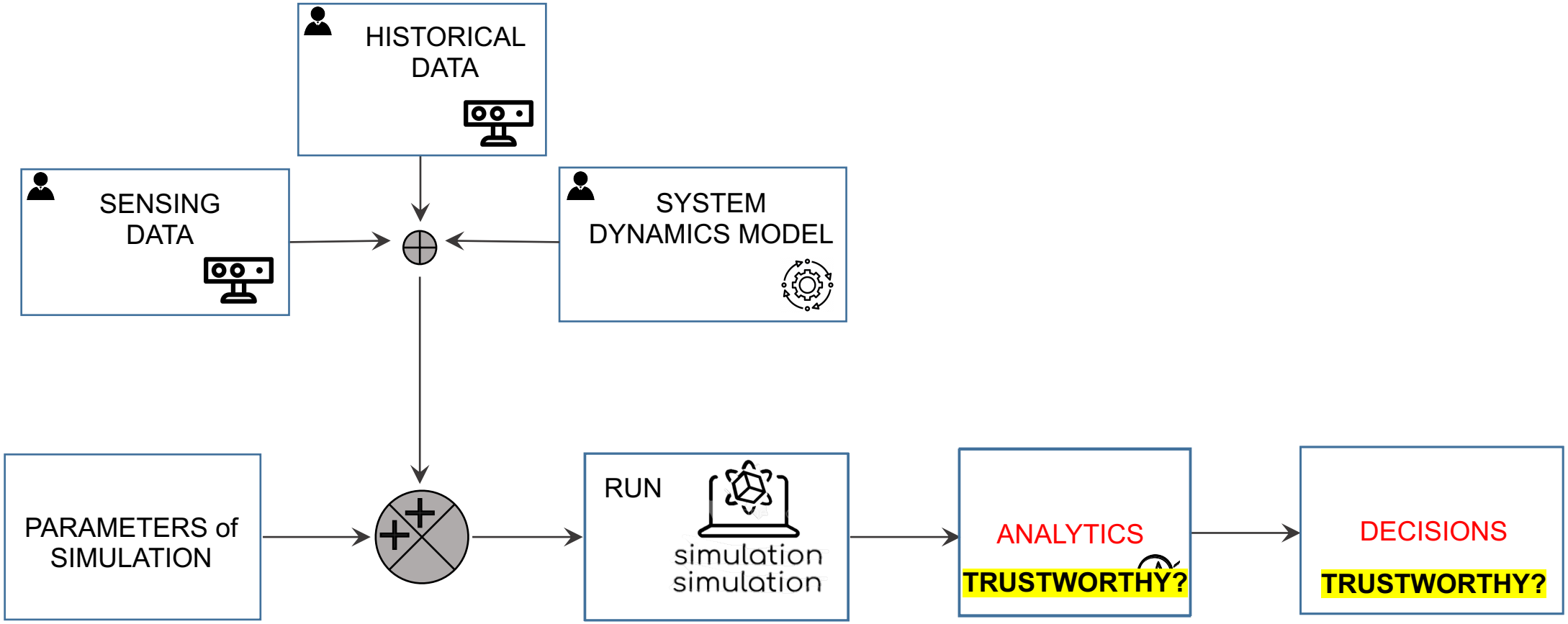
[JET ENGINE PROGNOSTICS]

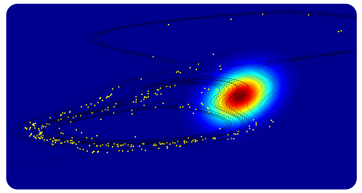




STATUS QUO

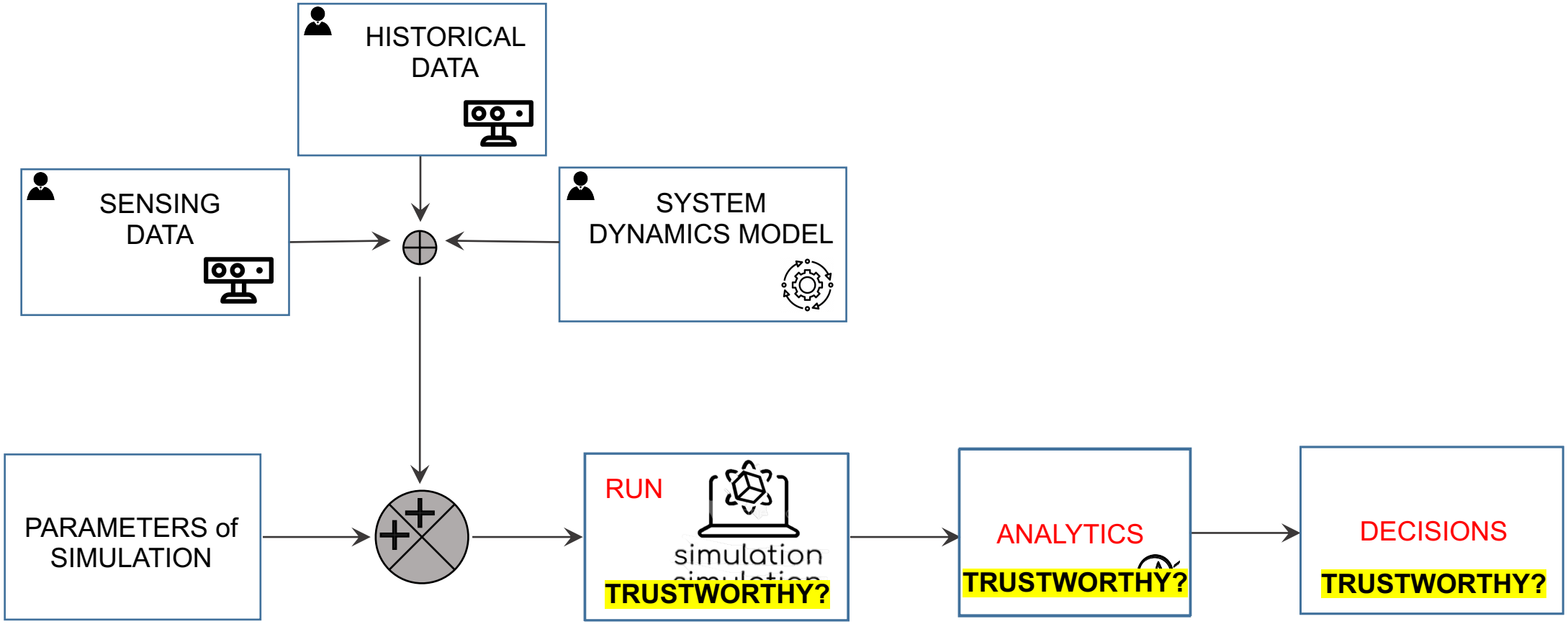
[JET ENGINE PROGNOSTICS]

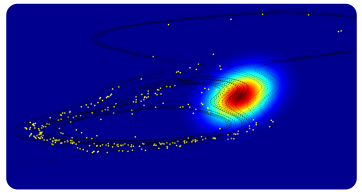




STATUS QUO

[JET ENGINE PROGNOSTICS]





STATUS QUO

[JET ENGINE PROGNOSTICS]

HISTORICAL DATA

SENSING DATA

SYSTEM DYNAMICS MODEL

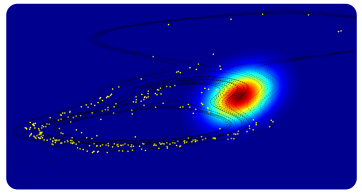
METRICS of *TRUSTWORTHINESS*

PARAMETERS of SIMULATION

RUN simulation

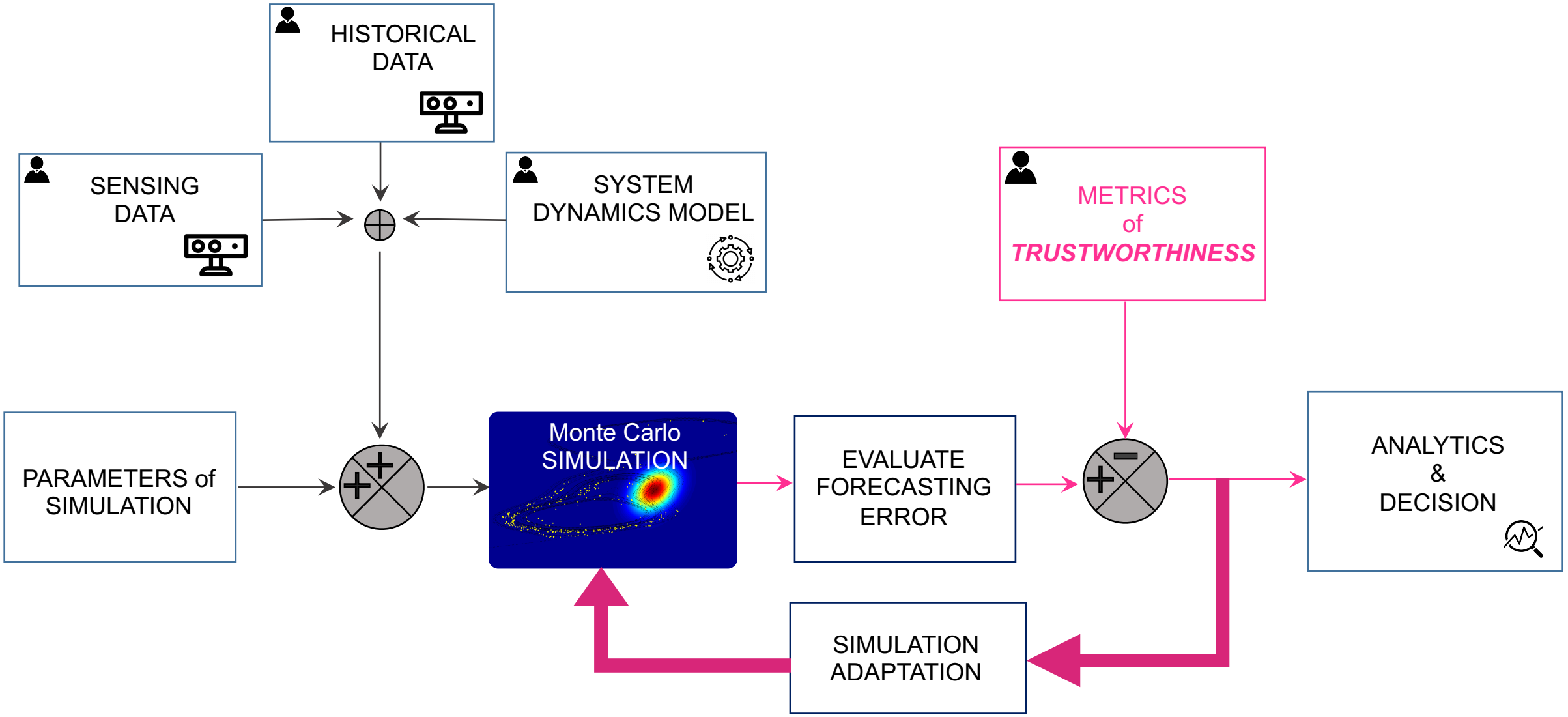
ANALYTICS & DECISION

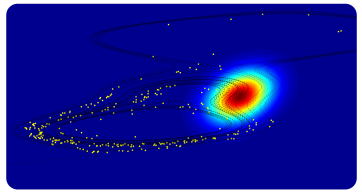
RETROSPECTIVE TUNING [EXPENSIVE!]



POINTPRO SIMULATION ARCHITECTURE

[JET ENGINE PROGNOSTICS]





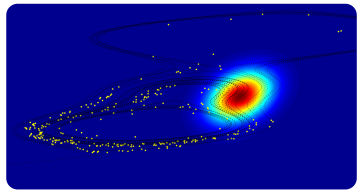
TECHNOLOGY OVERVIEW

FUNCTION

Generation of trustworthy predictive analytics to support a decision-making agency through adaptive, closed-loop simulations of complex processes

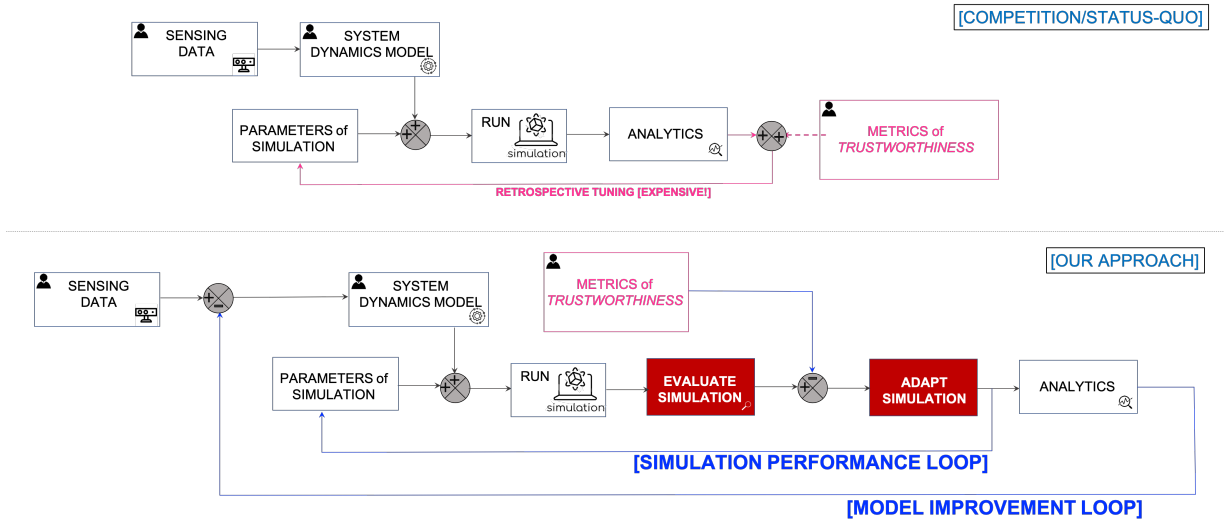
KEY FEATURES

- Ensemble Forecasting: Tried-and-true flexibility & scalability of Monte Carlo simulations
- **Performance Guarantees**: Decision-quality forecasts by ensuring prediction of user-defined *quantities of interest* within commanded accuracy bounds
- Minimal Time Forecasting: Smallest sized simulation to achieve stipulated accuracy bounds
- Integration with Physics: Seamless integration with complex physics-based dynamic models
- Integration with Black/Gray-Box Dynamics: Integration option with black/gray box models



DIFFERENTIATION: **TRUST**

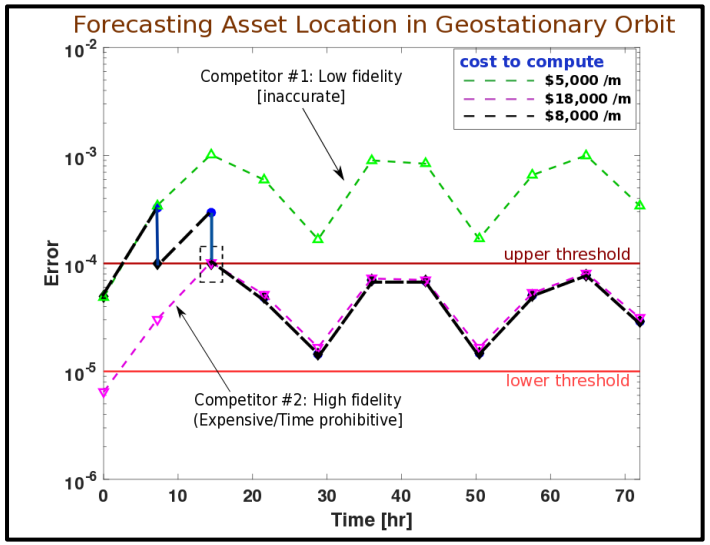
- State of the art is open loop, requires wasteful, retrospective tuning
- We offer ***front-end accuracy control***
- Adaptive architecture eliminates guesswork
- We can *improve* system models



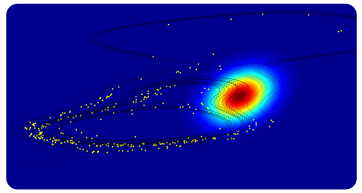
► *Our simulations are **trustworthy** and **decision-quality***

Product/ Company	Front-end error control	Minimal Time	Scalability	Prescriptive Analytics	Build and Improve Data-Driven Models
Proposed	✓	✓	✓	✓	✓
Predix (GE) [Status-Quo]	×	×	✓	✓	×
SmartUQ	×	×	×	✓	×
Ascentia [Collins]	×	×	✓	×	×
Arule/Ridgetop	×	×	×	×	×
Cassantec [ABB]	×	×	✓	×	×
Mikros	×	×	✓	×	×

Table 1: Competition Matrix: Proposed Technology Features Against Existing Products

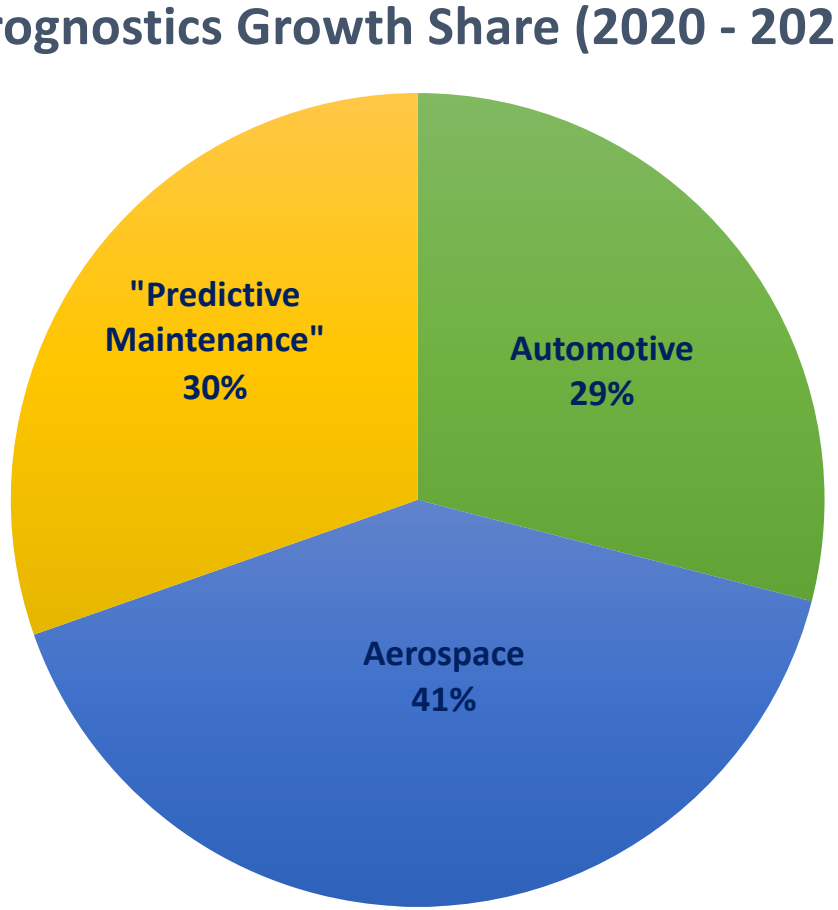


Benchmark Study: Forecasting space asset location within stipulated tolerance



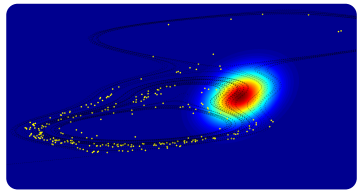
MARKET: OPPORTUNITY

- The *Prognostics* market is highly fragmented
- Market size and growth rates depend on segment
- Chart shows ***growth share*** in aerospace, automotive and “predictive maintenance” (mainly manufacturing and energy) SOM
- Combined projected dollar ***growth***: **$26B**
- Average CAGR on this chart: **45%**



Sources

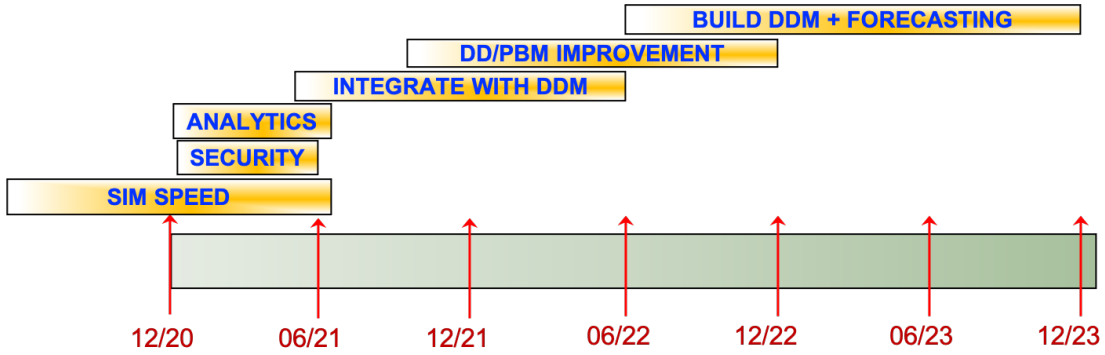
1. Research And Markets, “Aerospace & Life Sciences Testing, Inspection, and Certification Market - Global Opportunity Analysis and Industry Forecast to 2025”, June 2019. LINK
2. Market Reports World, “Automotive Prognostics Market By Application, End-users And Geography - Global Forecast And Analysis 2019-2023”, June 2019. LINK
3. Markets and Markets, “Predictive Maintenance Market by Component (Solutions and Services), Deployment Mode, Organization Size, Vertical (Government and Defense, Manufacturing, Energy and Utilities, Transportation and Logistics), and Region - Global Forecast to 2025”, June 2020. LINK



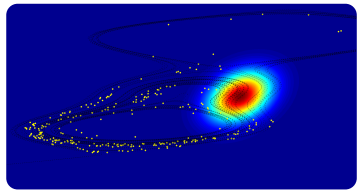
TECHNOLOGY ROADMAP

CAPABILITY	DESCRIPTION	MVP/POST MVP
SIMULATION SPEED	Parallelize Monte Carlo & internal optimization routines	For MVP
SECURITY	Industry level data security for assured handling of sensitive customer data	For MVP
INTUITIVE ANALYTICS	Analytics to Action: Prescriptive insights	For MVP
INTEGRATE WITH DDM*	Plug in DDM in lieu of PBM to enter new segments: Integration with NN⊙, RCM⊛	Post MVP
DD/PB⌘ MODEL IMPROVEMENT	Leverage analytics/data to minimize epistemic uncertainty to learn/improve evolutionary models: DDM or PBM	Post MVP
BUILD DDM THEN INTEGRATE WITH FORECASTING	**Full service:** First Build then Improve Models. Integrate with partner sensing company or employ customer's sensors	Post MVP

*DDM: Data Driven Model
⌘PBM: Physics Based Model
⊙NN: Neural Network
⊛RC: Reservoir Computing Model



PointPro Technology Timeline



BUSINESS TIMELINE

WORKFLOWS

- MVP Software: Q2 2021
- Beta demos: Q1 2021
- Licensing Agreement: Q2 2021
- Second use case

REVENUE

- Annual license subscriptions
- Per-seat basis

Activity	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4
Technical						
Software development	■	■	■	■		
Demo ready			▲			
Incorp. demo feedback				■		
Sale-ready product					▲	
2nd use case scoping					■	■
Sales						
Beta demo			■	■		
First sale					▲	
Product sales					■	■
License						
Licensing process				■		

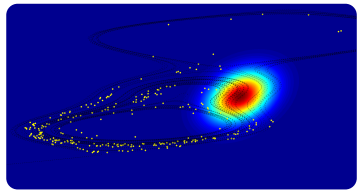
PointPro Business Timeline

GROWTH

- Evolve as horizontal platform
- Partnerships with complementary services (sensing, physics-based model building)

BARRIERS

- Access to potential customers
- Funding for technical staff (lead developer, software management, customer liaison)



TEAM

Matthew Bell
Founder
CEO

Past Experience: Corporate strategy specializing in complex mergers and acquisitions (M&A) at Cardinal Health

Mrinal Kumar
Inventor/Founder
CTO
Assoc. Prof @ OSU

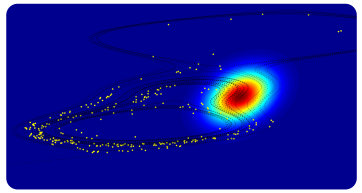
Associate Fellow, AIAA, acquired $3.5M in fundamental research funding
Director: Laboratory for Autonomy in Data-Driven & Complex Systems

William Thoet
Advisor
(Retired VP, Booz Allen Hamilton: 27 Years)

Experience: At Booz Allen, ran the Decision Analytics practice of over 1,900 staff and $400M of business

Rev1 Ventures
Advisors
Startup Studio

Rev1 Ventures is a selective investor startup studio in Columbus OH that provides 1:1 start-up coaching and resources



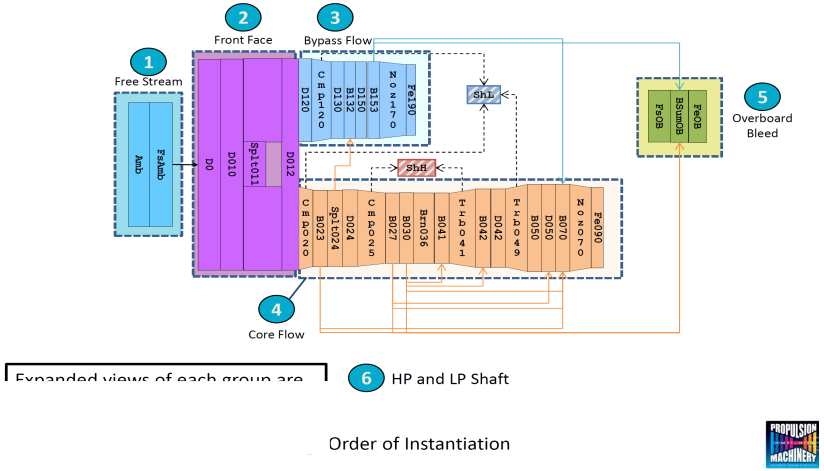
CURRENT DEVELOPMENT: JET ENGINE PROGNOSTICS

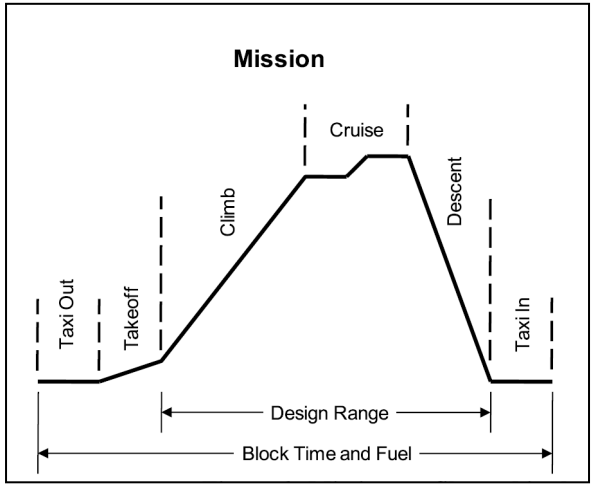
- Jet Engine Prognostics Use Case under development

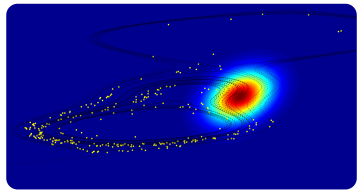
- NPSS Model [Numerical Propulsion System Simulation]
  - Common Development Model (CDM) Turbo Fan 01 (TF01)
  - Close to GE GE9X engines. [Contributed by GE]
  - Integration with software with representative flight profiles, e.g., JFK-LAX cycles
  - QOI per GE guidance: Pr/Temp at specific stations; HPT/LPT speed, SFC ratio

- Parallelized global optimization of ensemble size

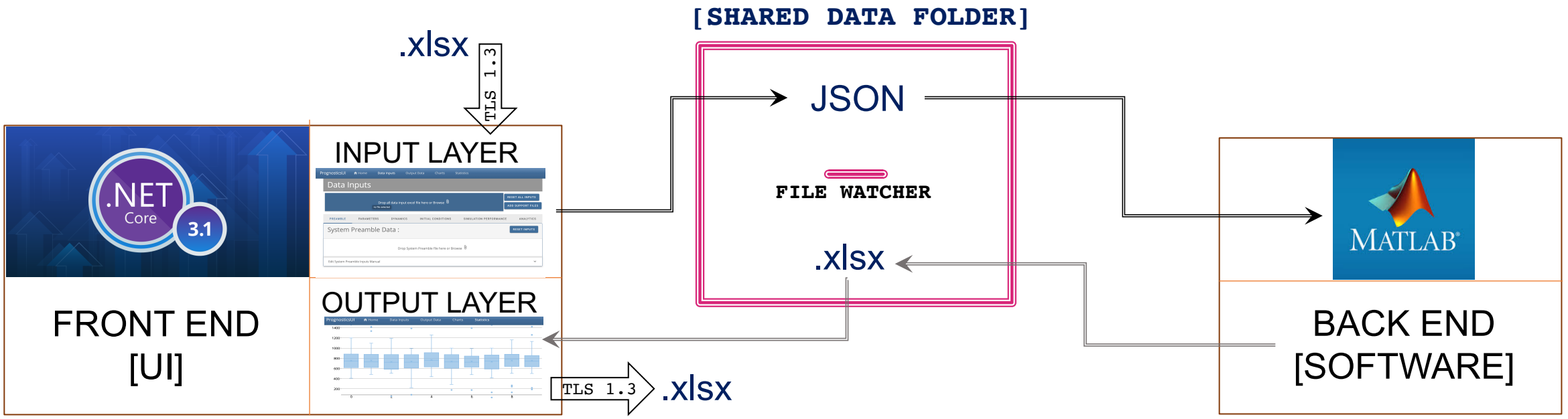
- Challenge: inter-cycle engine degradation functions (currently using open source “bridging functions”)



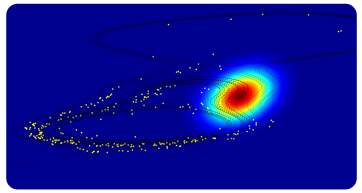




CURRENT DEVELOPMENT: UI



- UI handles all system inputs and outputs through an interface & shared data folder
- Back end generates live results, displayed live on output layer
- Front end is a .NET web-based application
- Multi-platform (Win, Linux, Mac, etc.)
- TLS 1.3 data security protocols for live -wire inputs/outputs



Potential Path to Work Together

Joint Development Agreement

- Integrate forecasting tools with an existing engine (or another system) physics model
- Evaluate benefits of adaptive forecasting in prognostics decision-making
- Evaluate time saved to decision-quality analytics through adaptive forecasting