



INSTITUTE FOR DEFENSE ANALYSES

**DATAWorks 2022:
An Introduction to Sustainment: The Importance and
Challenges of Analyzing System Readiness**

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Executive Summary

The Department of Defense (DOD) spends the majority of its annual budget on making sure that systems are ready to perform when called to action. Even with large investments, though, maintaining adequate system readiness poses a major challenge for the DOD. Here, we discuss why readiness is so difficult to maintain and introduce the tools IDA has developed to aid readiness and supply chain analysis and decision-making.

Particular emphasis is placed on “honeybee,” the tool developed to clean, assemble, and mine data across a variety of sources in a well-documented and reproducible way. Using a notional example, we demonstrate the utility of this tool and others like it in our suite. These tools lower the barrier to performing meaningful analysis, construct and estimate input data for readiness models, and help the DOD tie resources to readiness outcomes.



An Introduction to Sustainment: The Importance and Challenges of Analyzing System Readiness

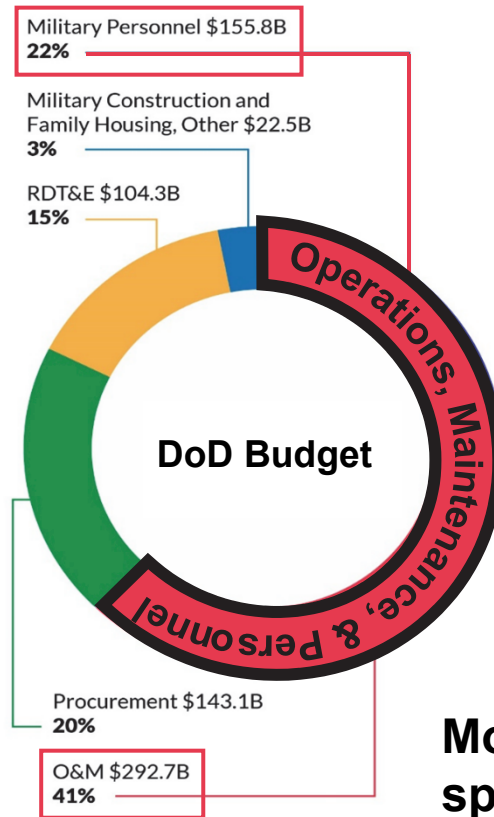
V. Bram Lillard
Megan L. Gelsinger

April 2022

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DOD spends most of its budget on **operating and sustaining** existing systems



Adapted from
<https://www.defense.gov/Explore/News/Article/Article/1782973/dod-leaders-make-case-to-congress-for-budget-request/>

Most of the money is spent on **making sure things work properly**

The end metric is system **“readiness”** to perform missions

Readiness is a persistent challenge for the DOD weapon systems

Breaking News

Mattis orders fighter jet readiness to jump to 80 percent — in one year

By: Aaron Mehta October 9, 2018



Specific to tactical aircraft, [...] the F-22 Raptor a shocking [49%].

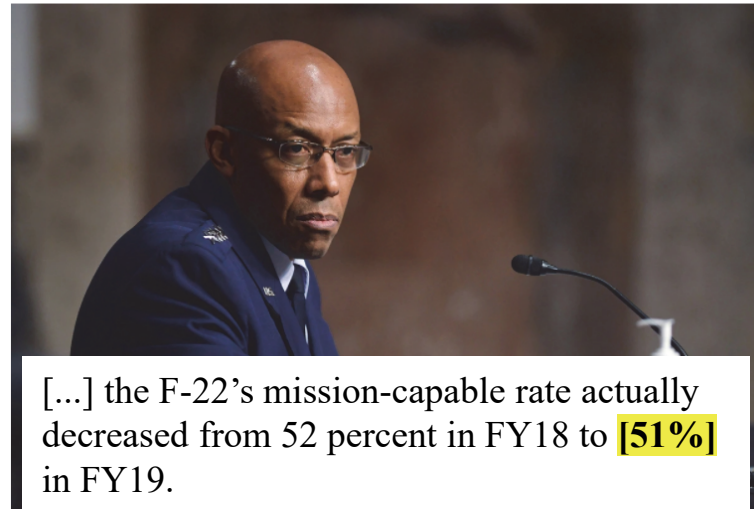
<https://www.defensenews.com/air/2018/10/09/mattis-orders-fighter-jet-readiness-to-jump-to-80-percent-in-one-year/>

18
months
later...

Air

US Air Force bails on Mattis-era fighter jet readiness goal

By: Valerie Insinna and Stephen Losey May 7, 2020



[...] the F-22's mission-capable rate actually decreased from 52 percent in FY18 to [51%] in FY19.

<https://www.defensenews.com/air/2020/05/07/the-air-force-bails-on-mattis-era-fighter-jet-readiness-goal/>

Why is readiness so difficult to maintain?

IDA has developed multiple analytical techniques to aid readiness and supply chain decision-making

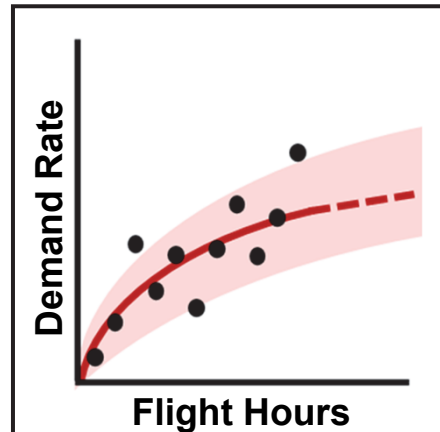
Robust
Data-Driven
Decision
Making =



Cross-cutting data analyses

- Combine data from multiple sources to reveal trends and gain insights
- Discover ground truth hidden by stovepiped processes
- Cannot explore “what if” scenarios
- Limited ability to tie decisions to outcomes

+



Correlative studies

- Statistical approaches including machine learning
- Historical trends can reveal which factors likely drive performance
- Limited ability to make specific or tactical predictions and recommendations

+



End-to-end simulations

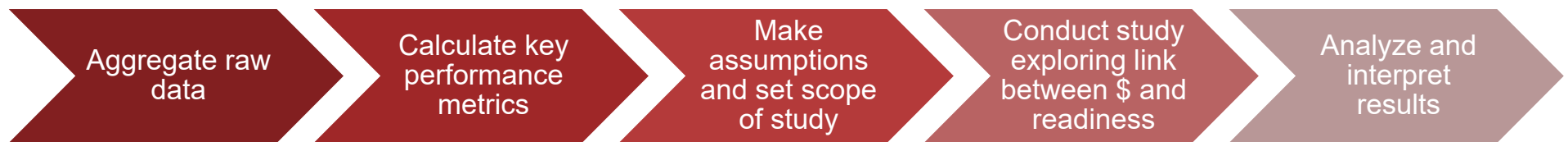
- Explicitly model all aspects of sustainment (spares, manpower, operations, maintenance)
- Make predictions on how specific investments cause changes in readiness
- Model quality is contingent on data quality
- Heavy initial lift to build the model

DOD does little of
this approach

Power of analytical techniques relies on well-developed workflow, which remaining talks will discuss in detail



Modeling and Simulation *Han G. Yi & Andrew C. Flack*



**Handling Raw
Sustainment Data**
Megan L. Gelsinger

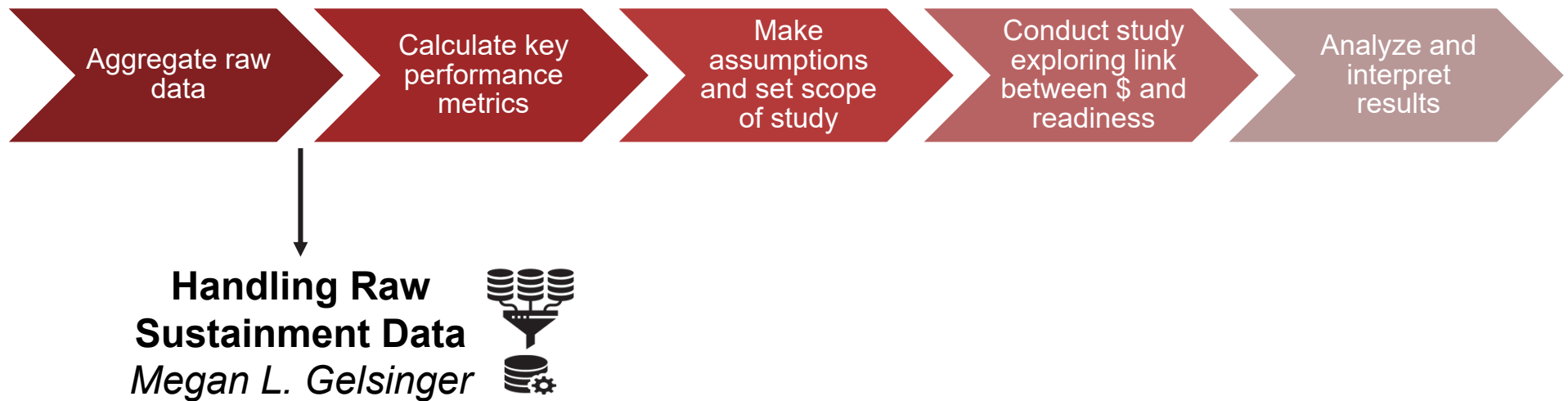


**Cross-Cutting Data
Analyses**
*Joseph M. Fabritius II &
Kyle E. Remley*



Handling Raw Sustainment Data

Sound handling of raw sustainment data forms the foundation of all of IDA's analyses



Constructing an end-to-end picture of the sustainment system requires an immense amount of data collected across multiple, problematic sources

Operations

Units perform missions



Local stock and repairs

Replace or repair stock at local location (e.g., base or ship) as able



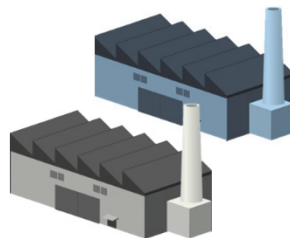
Wholesale

Stock delivery to local sites



Depot-level Repair

Extensive repair, scheduled upgrade, or maintenance performed off-site



Data Needs

What?

Where?

How many?

How long?

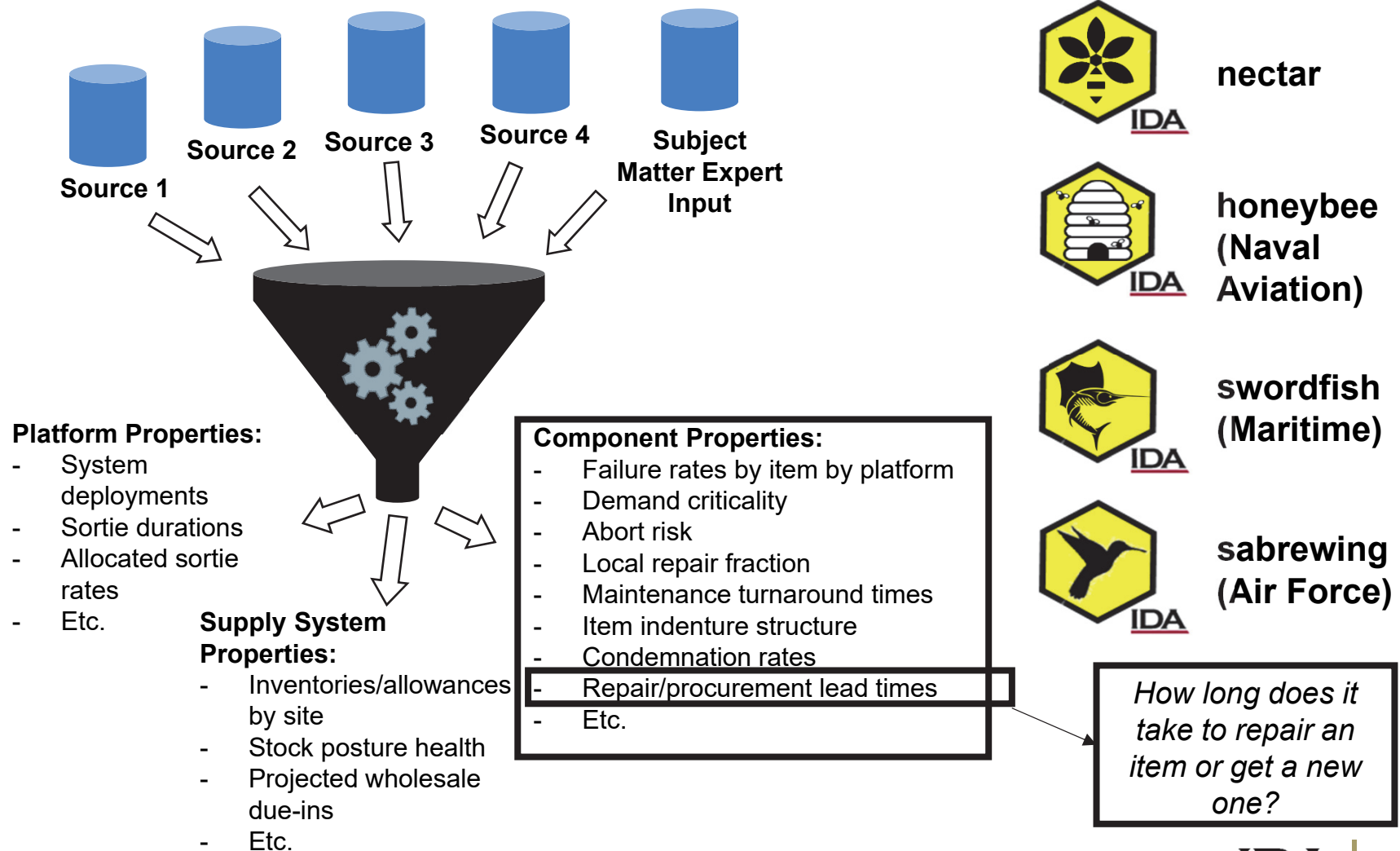
How important?

Challenges

No one entity has full view into everything (“stovepiping”)

Raw data has missing entries, inconsistencies, etc.

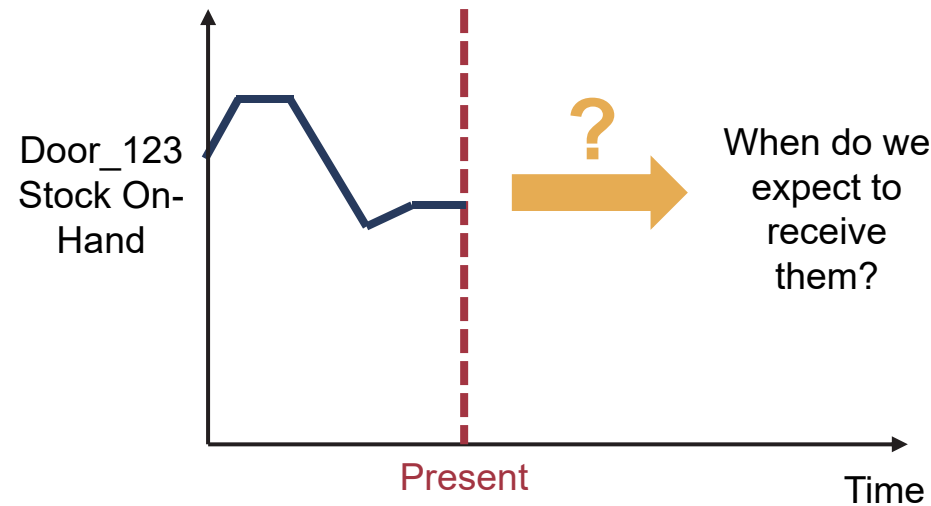
We developed a suite of tools to clean, assemble, and process DOD data in a well-documented and reproducible way



Contract data inform lead times and provide a case study in the utility of the tools we've developed



Door_123



This could be on the order of years!

We could have only a handful of historical contracts

We must clean and assemble contract data across multiple sources before it can be processed

Source 1

Item	Order Date
Door_123	2027-12-03
Door 123	2028-02-24
Door_123	2028-03-01
door_123	2028-06-11

Source 2

Material	OrdrDt	T
Door_123	November 3, 2026	A
Door_123	March 15, 2027	B
Door_123	June 22, 2027	B



Standardize column names

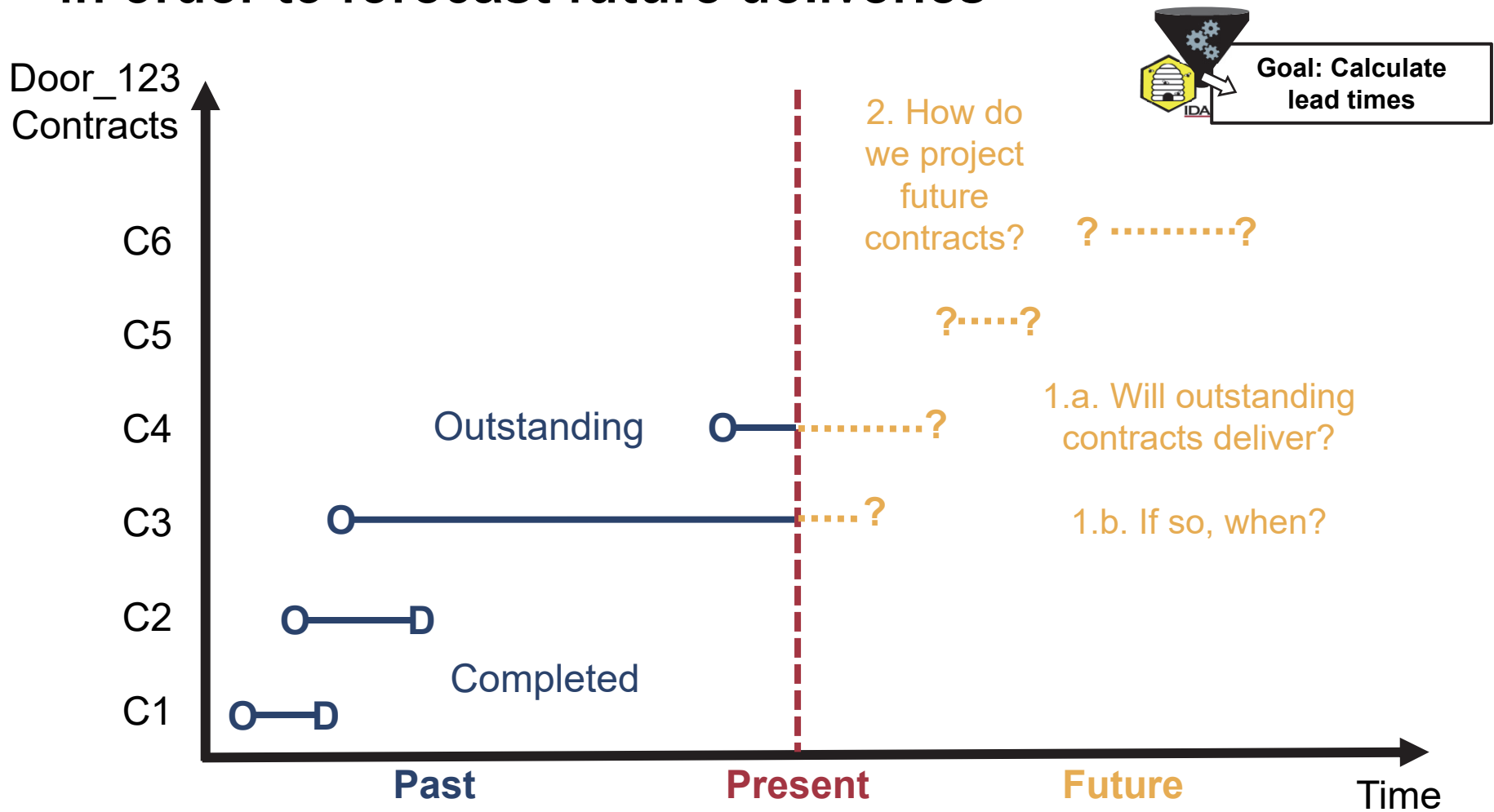
Item	Order Date	Contract Type	Source
Door_123	2026-03-11	A	2
Door_123	2027-03-15	B	2
Door_123	2027-06-22	B	2
Door_123	2027-12-03	A	1
Door_123	2028-02-24	A	1
Door_123	2028-03-01	A	1
Door_123	2028-06-11	A	1

Standardize item name

Standardize date format

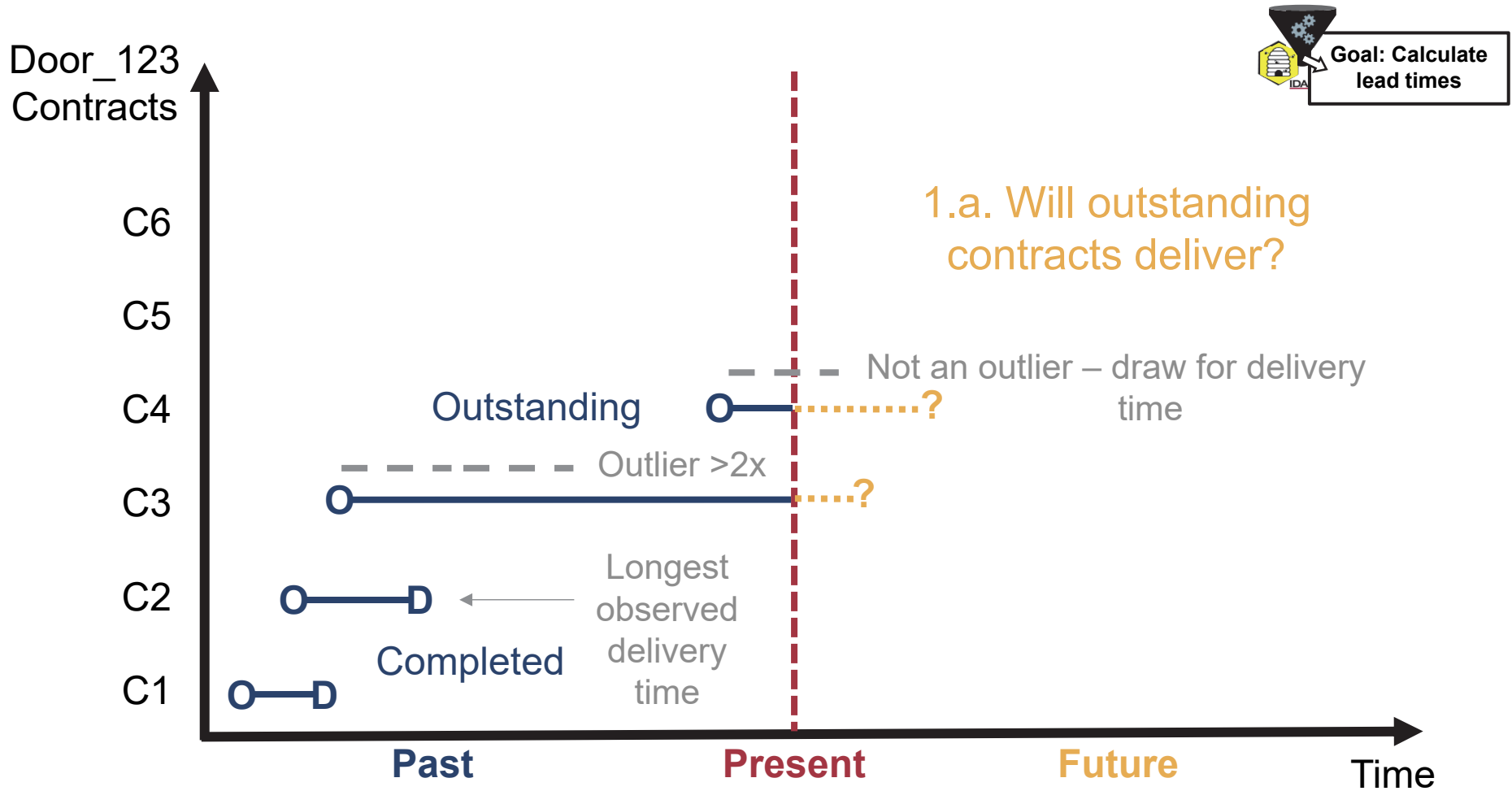
Investigate obscure information

We must consider past, present, and future contracts in order to forecast future deliveries

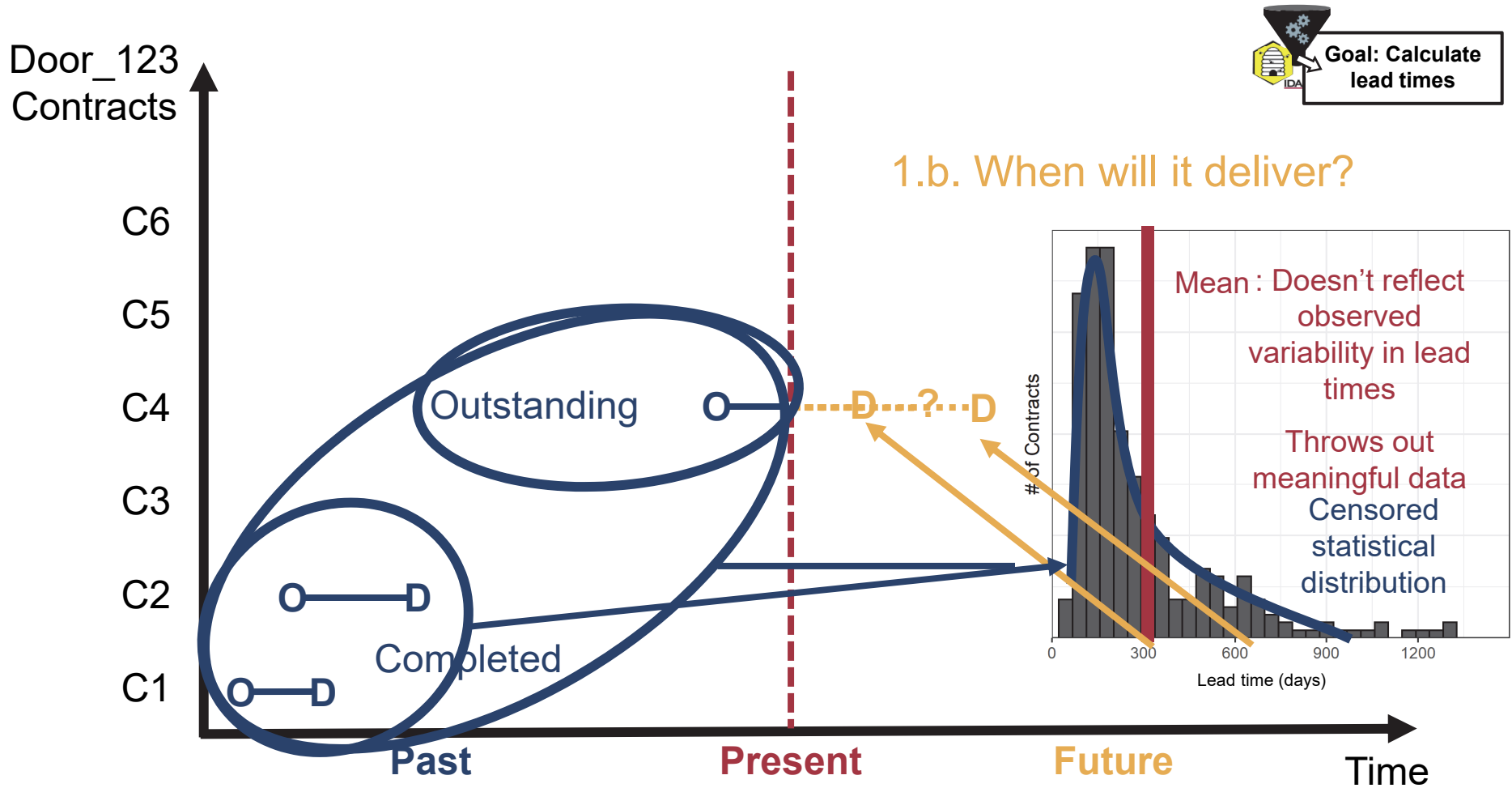


Past contracts inform how we **resolve outstanding** contracts and **construct future** ones

We assess outstanding contracts for outliers, then draw delivery times based on historical data

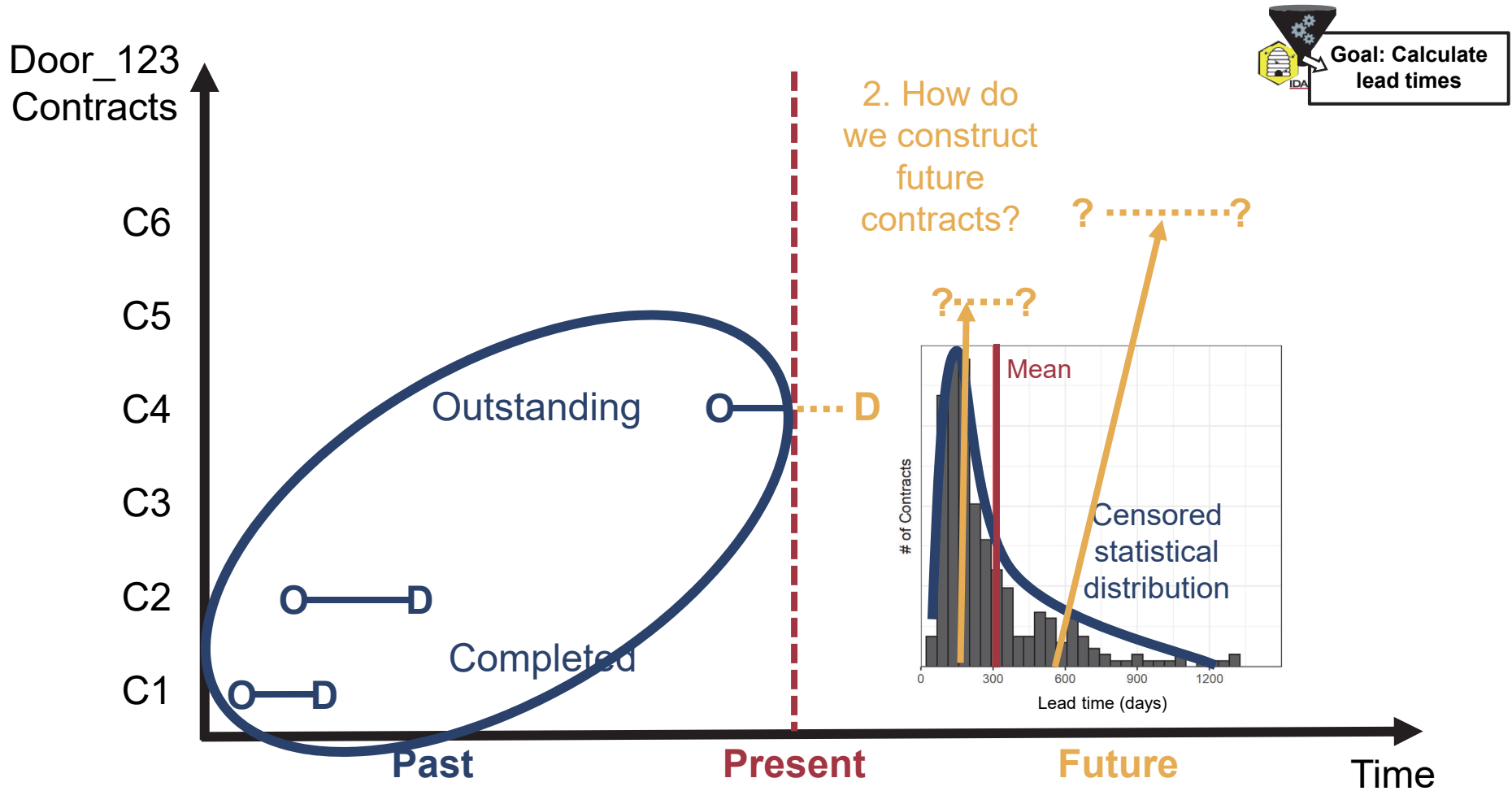


We assess outstanding contracts for outliers, then draw delivery times based on historical data

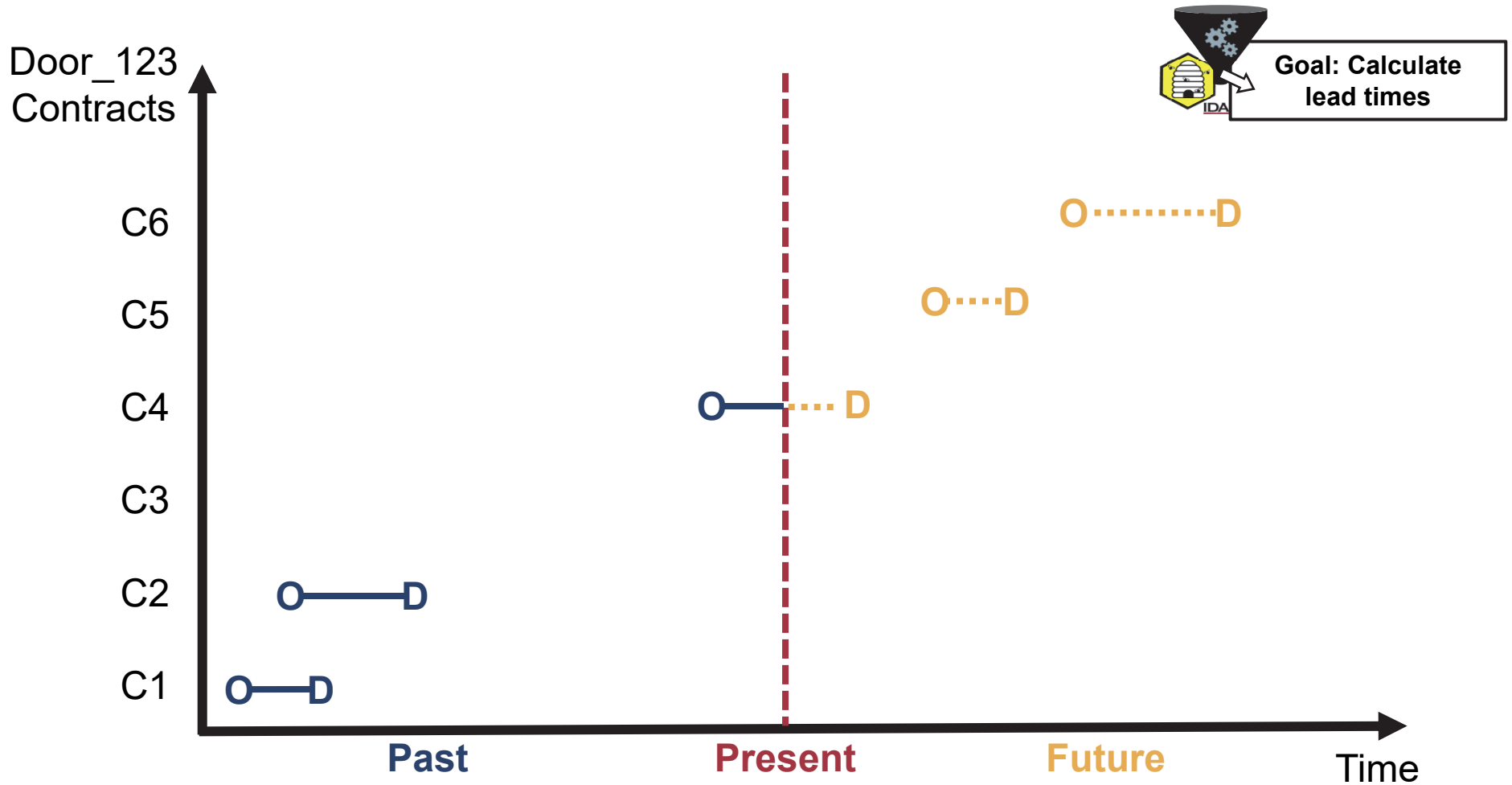


Using a **censored statistical distribution** to draw the delivery times **reduces bias** and **respects real-world variability** compared to using a **point estimate**

Generated historical time distributions also used by simulation software to generate future contracts

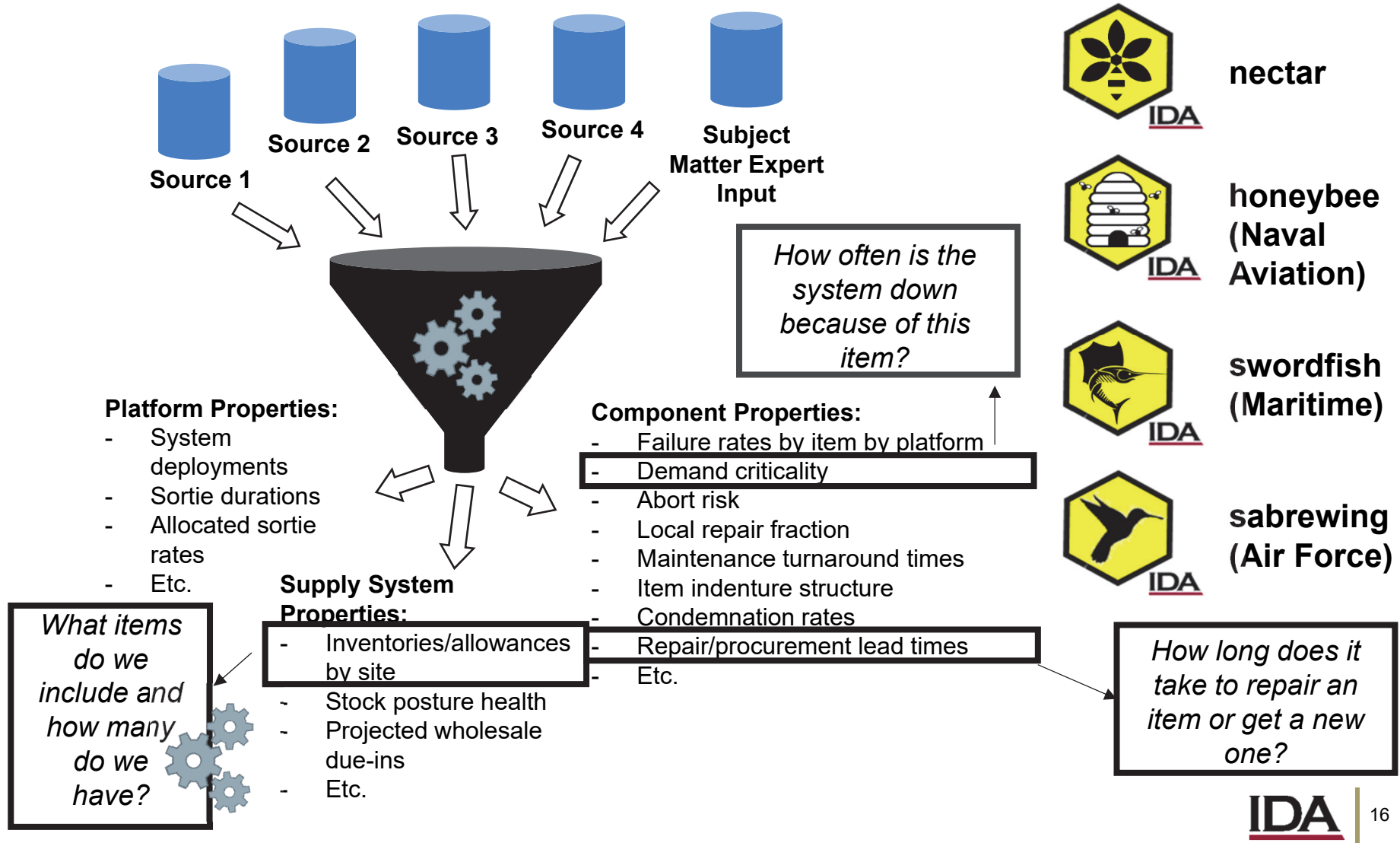


We must consider past, present, and future contracts in order to forecast future deliveries



We use **past completed** contracts to **resolve outstanding** contracts and **construct future** ones

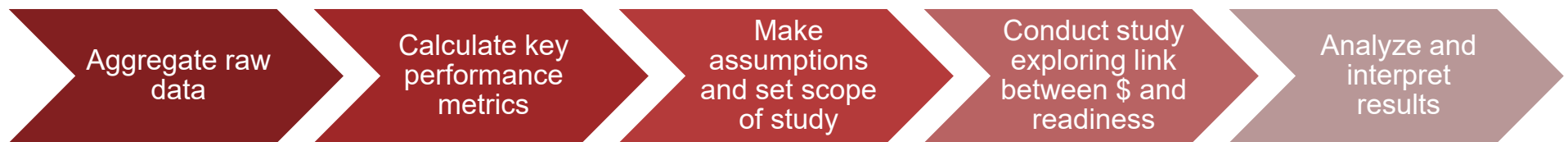
Nuance is required to calculate every metric that feeds our analyses



Power of analytical techniques relies on well-developed workflow, which remaining talks will discuss in detail



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Backups

Complete honeybee logic for cutting and fitting contracts more complex than single filter

- Must have five contracts to attempt statistical fit; otherwise, use point estimate (mean)
- If there are too many censored contracts, don't attempt censored fit; apply uncensored fit
- Regardless of other filters, if contract began or finished within past XX days, keep it
- Fit distributions to both the first good delivered date and the last good delivered date
- Perform outlier detection in multiple rounds

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4. TITLE AND SUBTITLE				5a. CONTRACT NUMBER		
				5b. GRANT NUMBER		
				5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S)				5d. PROJECT NUMBER		
				5e. TASK NUMBER		
				5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)					8. PERFORMING ORGANIZATION REPORT NUMBER	
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