Diagnostic and prognostic data enabled S1000D intelligent application

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Agenda

1. Introduction

2. intelligent maintenance

3. General framework for Data Enabled S1000D intelligent application

4. Development of S1000D intelligent application based on AR

5. Conclusions

1. Introduction

- I used to see a method of grading IETM, which does not exist in the S1000D specification, but does reflect the development of technical publications. There are 5 levels in this method.

- But the question is, what is the next level of IETM(what is Level 6)?

- Or what are the future trends of IETM?

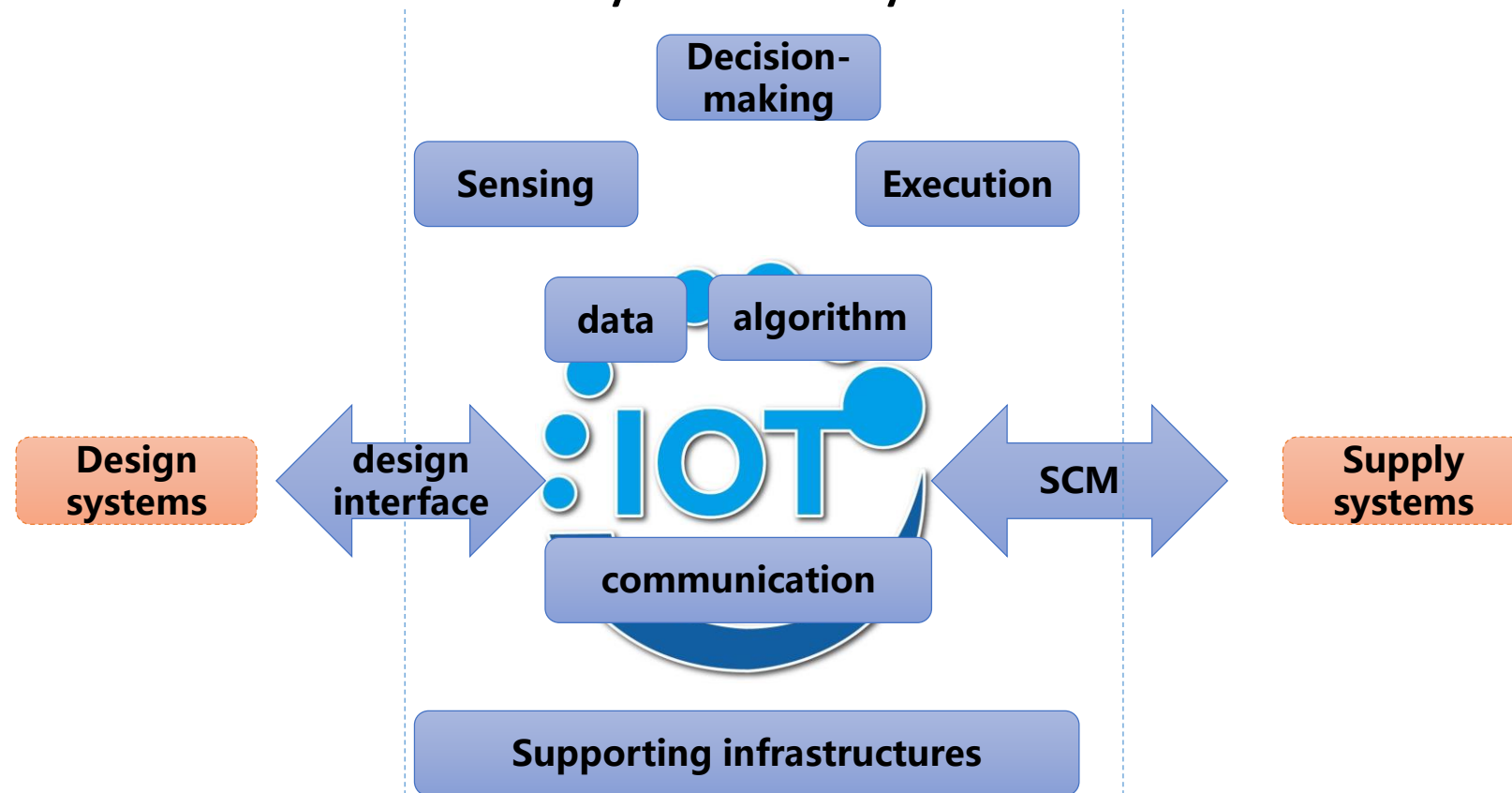| Pub type	Paper based manual	ETM		IETM/IETP		
level	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
feature	Non electronic index pages	electronic index pages	Electronic rolling file	Linear structure IETM	Hierarchical database IETM	Integrated database IETM
Data format	Printed pages	Electronic data	ASCII electronic data	ASCII electronic data	ASCII electronic data	ASCII electronic data
Data structure	Linear structure	Linear structure	Linear structure	Linear structure	database	database
	manual/publication centric				data centric	

1. Introduction

- This is a question worth our thinking.

- I cannot give a clear answer, but there are some signs or trends that can give us some references.

- The rapid development and application of the new generation of information technologies, such as IoT, cloud computing, big data, AR, AI, have a profound impact on nearly all fields in society.

- There is no exception in the field of ILS/IPS. With the application of these new technologies, there are some innovative and even disruptive applications, such as UAVs for maintenance inspection, predictive maintenance services based on AI, robots for maintenance, etc.

1. Introduction

- At present, the decision-making of maintenance and the execution of maintenance actions depend on Human being, that is, in the process of maintenance, we human are the maintenance decision maker and executor .

- With the application of these new information technologies, in the future we human may become a validator and maintenance decisions are made by big data and artificial intelligence algorithms, and maintenance actions are performed by robots or UAVs.

- And you can imagine what impact such a scenario would have on IETM and ILS/IPS system.

2.Intelligent Maintenance

- Based on these new information technologies, the whole ILS system will change, the elements, processes and paradigms of the ILS system may also change, the elements of the ILS system may become like this:
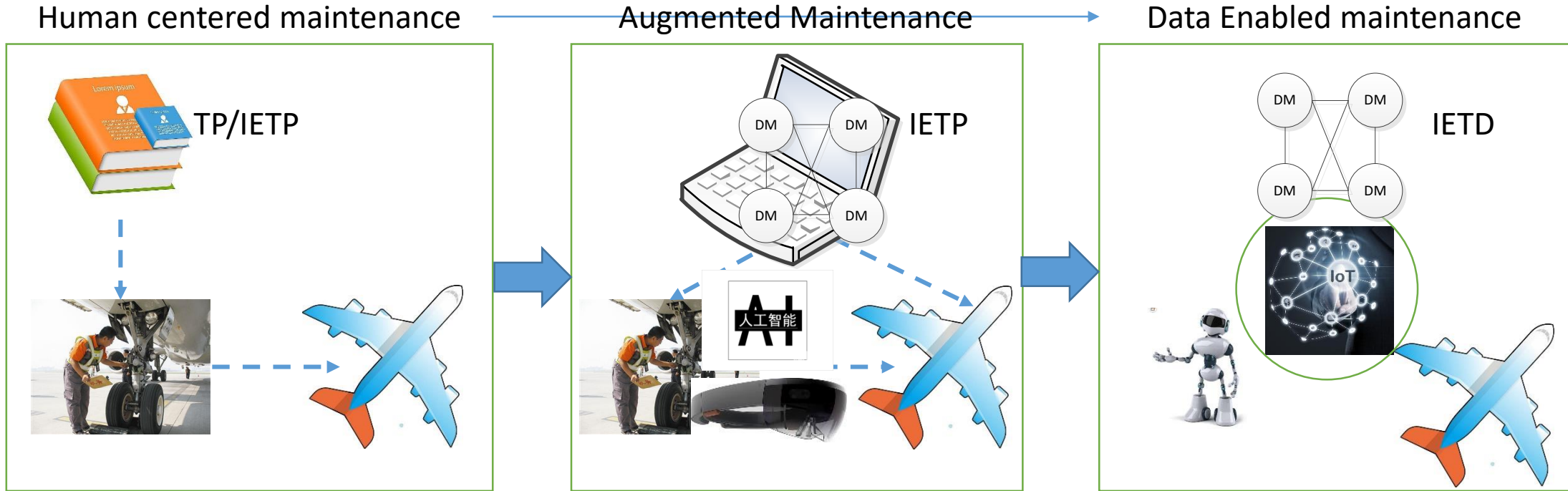
2.Intelligent Maintenance

- IETM/IETP——IETD(data)

- "I" may mean: Interactive, Intelligent, Imaginable.

- The key is data, not just data-centric, but data-driven, data (such as diagnostic data, prediction data from PHM system) drives IETM, IETM data drives people, drives intelligent maintenance execution equipments.This is a data-driven chain.

2.Intelligent Maintenance

- **Sensing**: including smart sensors, NDT, industrial depth cameras, etc.
- **Decision-making**: Automatic maintenance decision and resource scheduling based on artificial intelligence and big data, etc.
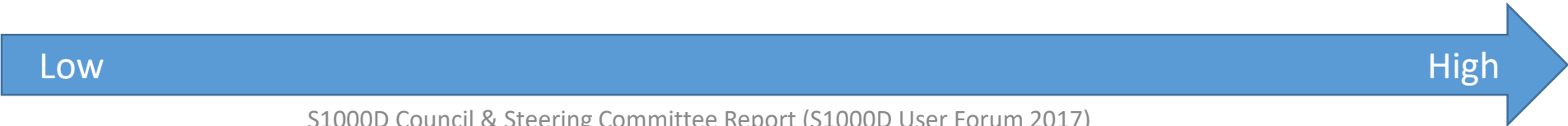- **Execution**: AR+ maintenance personnel, robots /UAVs for inspection, etc.

2.Intelligent Maintenance

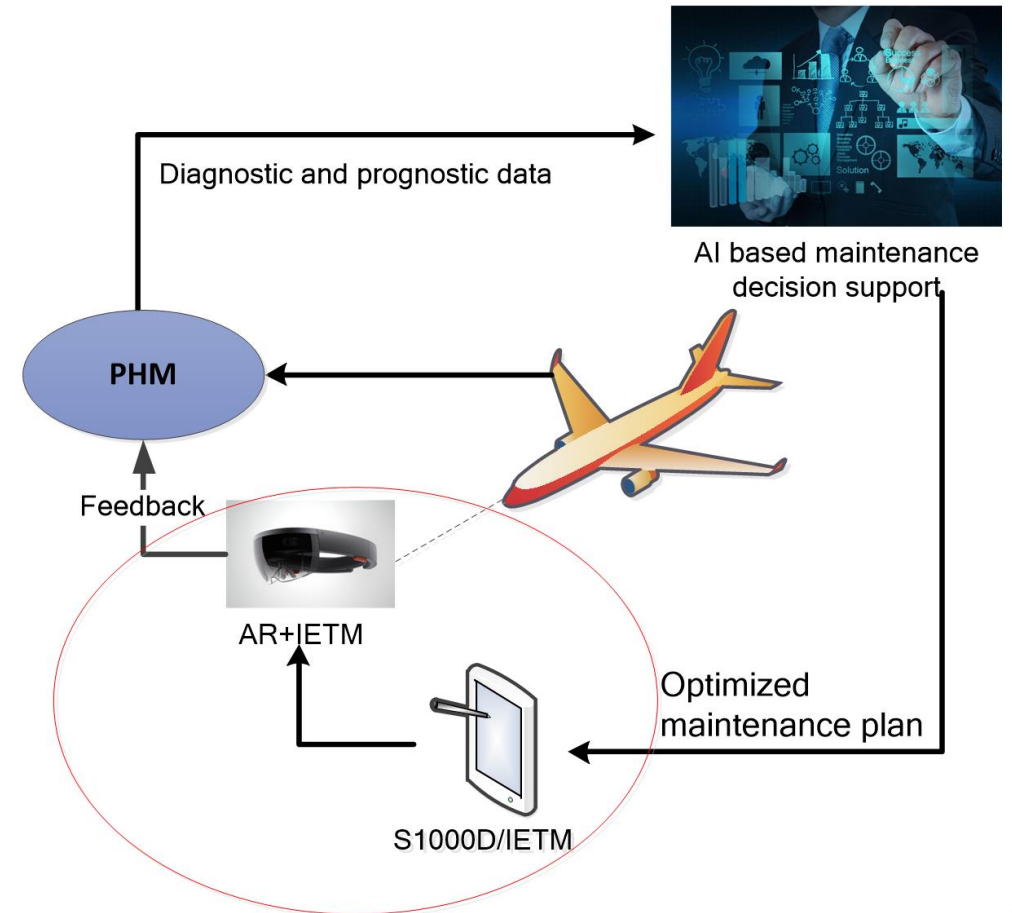Human centered maintenance → Augmented Maintenance → Data Enabled maintenance

TP/IETP

IETP

IETD

人工智能 AI

IoT

Requirements for Human   High → Low

Requirements for Data   Low → High

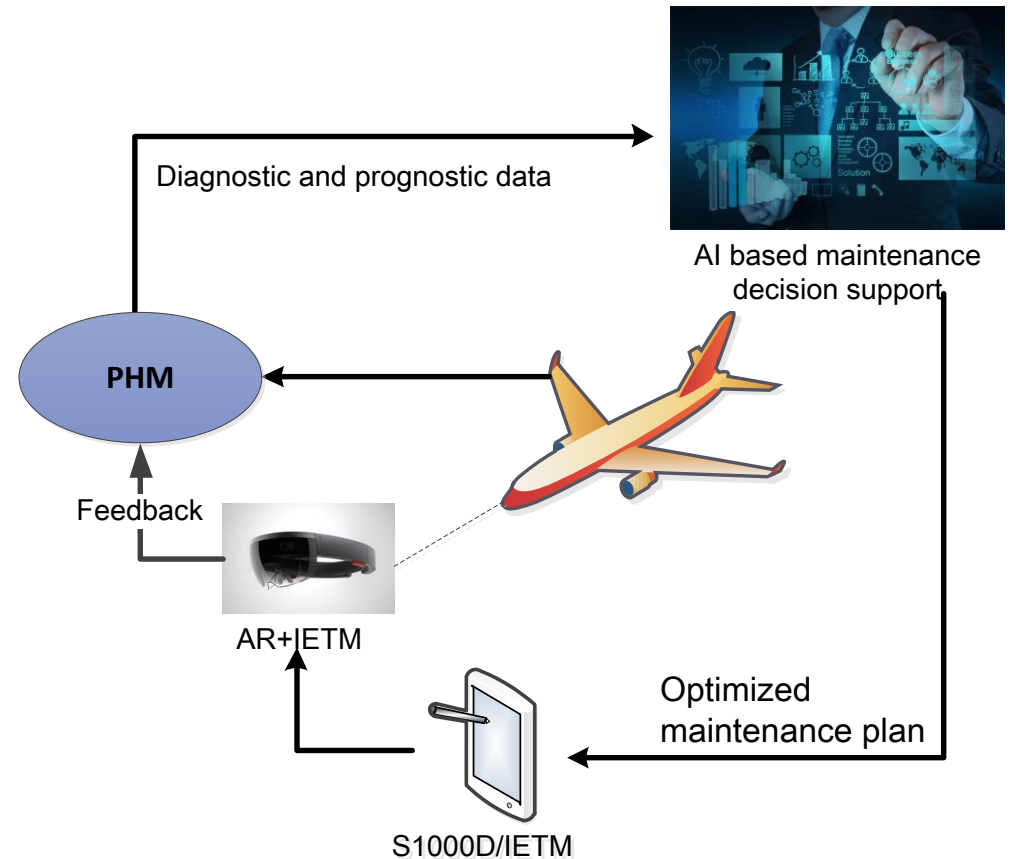# 3. General framework for Data Enabled S1000D intelligent application

- sensing, data acquisition, data transfer, data analysis, data application (maintenance implementation) and data feedback.
- the integration of PHM data and S1000D based IETM data, and focuses on the application issues of AR technologies to S1000D.

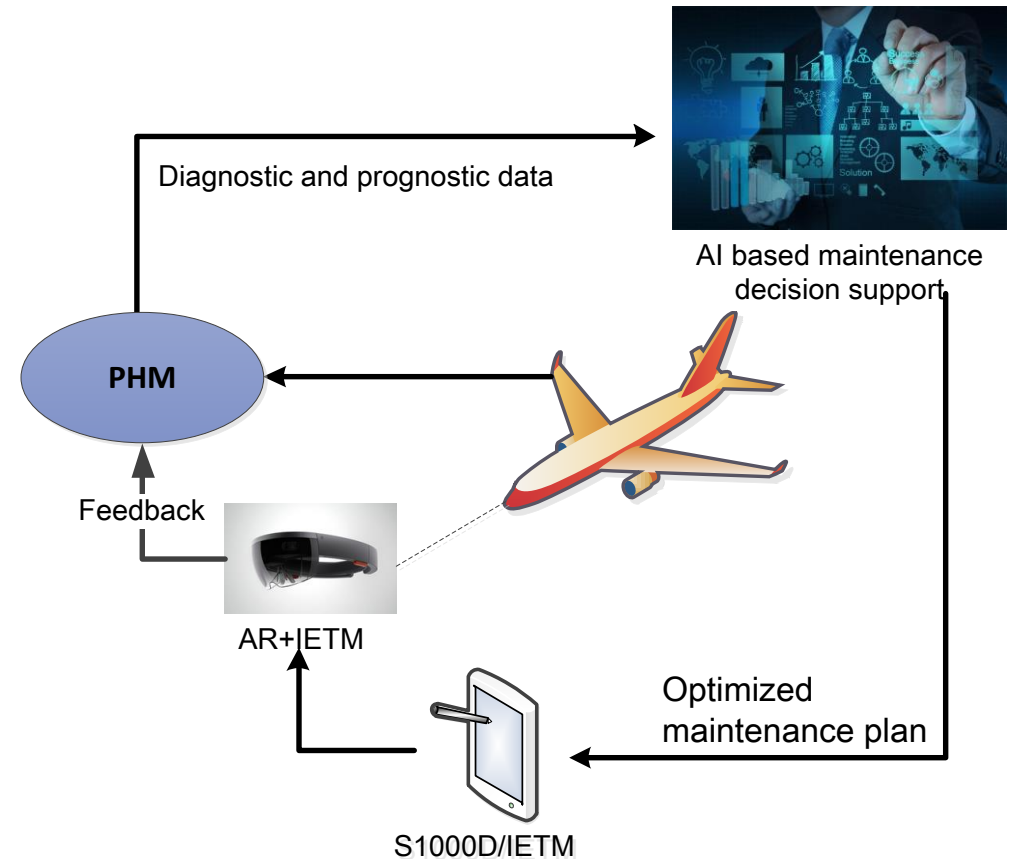# 3. General framework for Data Enabled S1000D intelligent application

- PHM (Prognostics Health Management) system can monitor product condition information, detect fault symptoms and predict fault trend, and thus promote the transition to predictive maintenance.

- PHM data may contain sensor data, fault symptoms, product conditions, Remaining useful life (RUL), and so on.

Sensing & data acquisition → Data transfer → Data analysis → Data application (Maintenance implementation) → Data feedback

Diagnostic and prognostic data

AI based maintenance decision support

PHM

Feedback
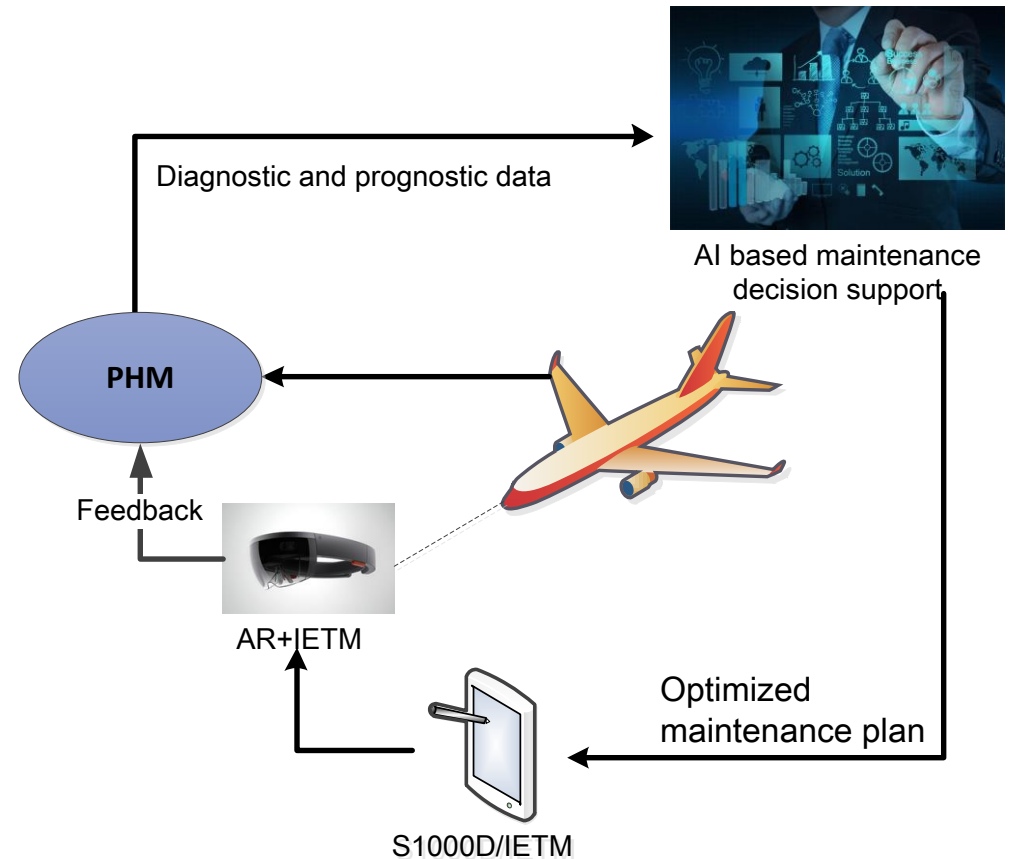
AR+IETM

S1000D/IETM

Optimized maintenance plan

- Automatic maintenance decisions based on artificial intelligence and big data technology with real-time conditions and prevention/scheduled maintenance plan.

- In the future, AI and big data algorithms may be used to make trade-offs in maintenance decisions.

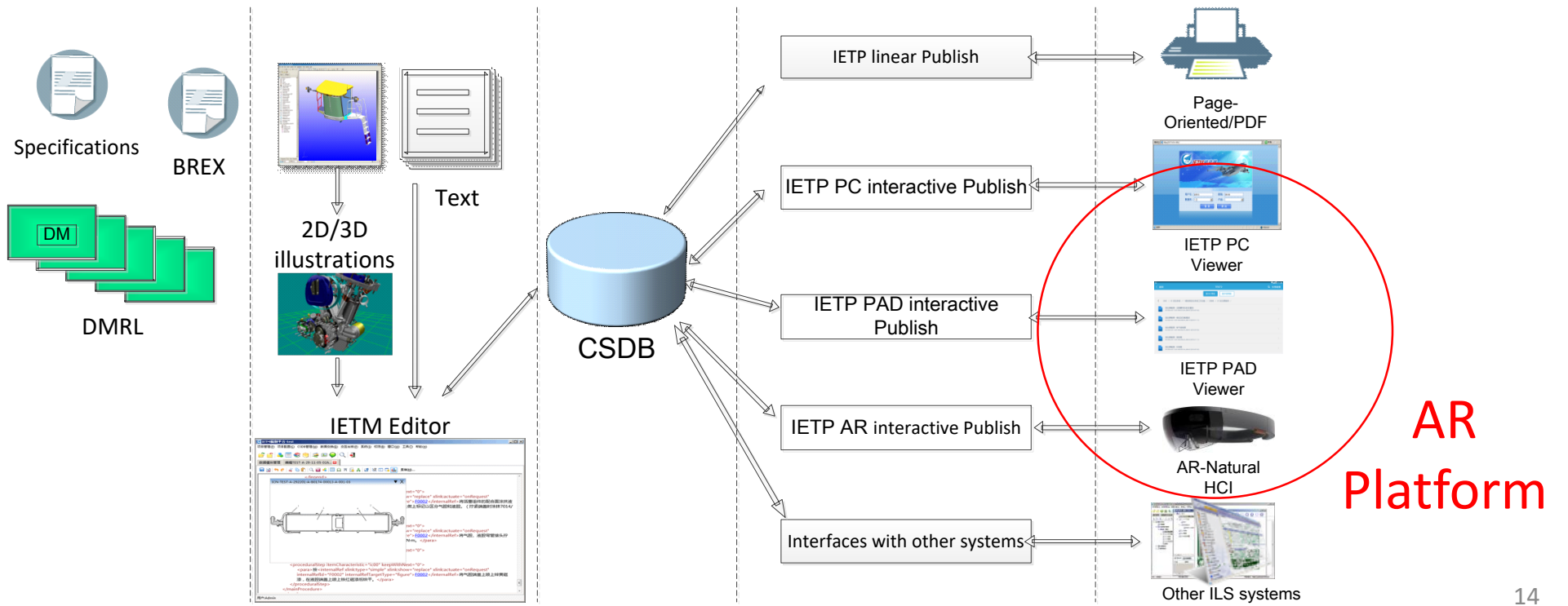- Generating a optimal maintenance plan, achieving predictive maintenance.

- Intelligent maintenance application based on AR technologies and S1000D standardized maintenance data.
- Automatically identify maintenance scenarios and objects.
- Providing real-time and on-demand maintenance data for maintenance personnel.
- Automatically record maintenance process data.
- Automatic data feedback.

Sensing & data acquisition → Data transfer → Data analysis → Data application (Maintenance implementation) → Data feedback

Diagnostic and prognostic data

AI based maintenance decision support

PHM

Feedback

AR+IETM

S1000D/IETM

Optimized maintenance plan

4.Development of S1000D intelligent application based on AR

IETM needs a carrier to display the technical content.
Paper - PC - PAD/Phone - ?

S1000D Council & Steering Committee Report (S1000D User Forum 2018)

4.Development of S1000D intelligent application based on AR

At present, with the development of VR/AR/MR technologies, VR/AR/MR has the tendency to become the next generation computing platform, it is necessary to establish the IETP platform for the new computing platform.
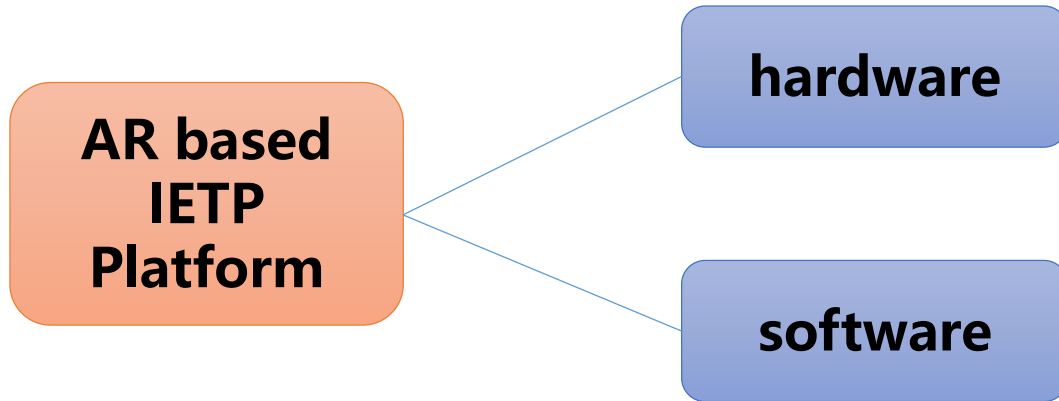
4.Development of S1000D intelligent application based on AR

Main principles for building AR based IETP platform:
- Standardization, based on S1000D CSDB data;
- Generality, Separation of application from data;
- Automatic identification of unmarked maintenance objects ;
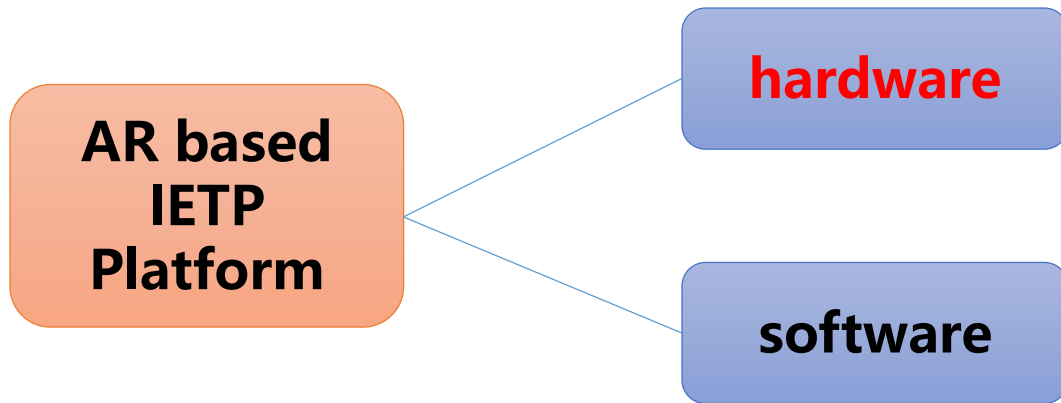- Inter-platform, Support multiple AR platforms.

4.Development of S1000D intelligent application based on AR

Components of the AR based IETP platform：

AR based IETP Platform → hardware, software

4.Development of S1000D intelligent application based on AR

Components of the AR based IETP platform(Cont'd)：

AR based IETP Platform

hardware

software

Hololens, AR glass, data presentation and "virtual-reality" fusion;
Intel RealSense D435, depth camera, Get the points cloud data.

4.Development of S1000D intelligent application based on AR

Components of the AR based IETP platform(Cont'd)：

AR based IETP Platform

hardware

software

AR content editor(AREditor): AR oriented interactive publishing based on CSDB;
content deployment tool (MCDT): Release software and technical data to Hololens;
Points cloud data processing and 3D perception recognition software(AREP): points cloud data is preprocessed, the key elements are extracted, the features are constructed, and the features are matched to identify the objects in the maintenance scene.;
Intelligent maintenance application system based on AR(IMAS): Provide maintenance personnel with "one-stop" on-demand IETP data and display these maintenance data in a intelligent manner .

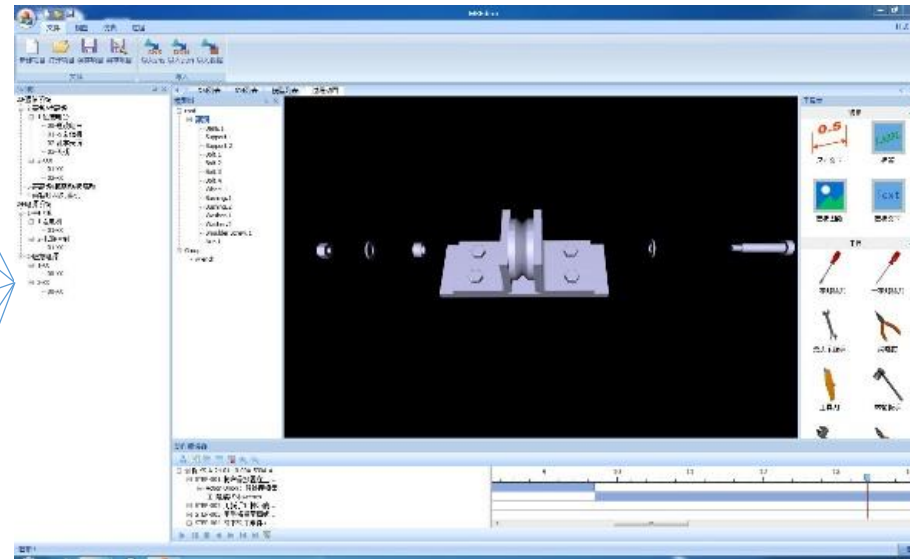# 4.Development of S1000D intelligent application based on AR

Data import

3D model analysis & lightweight

Automatically generate procedural steps according to assembly constraints.

design 3D interactive animation

Automatically generate data conforming to S1000D

AR content editor
(AREditor)

Procedural DM;
IPD DM;
Fault DM.

4.Development of S1000D intelligent application based on AR

Maintenance tasks management

Automatic 3D maintenance scene perception recognition

Intelligent maintenance guidance

Intelligent troubleshooting guidance

3D connected IPC

data recording and feedback

Intelligent maintenance application system based on AR (IMAS)

4.Development of S1000D intelligent application based on AR

A demonstration Demo

5.Conclusion

- From the technology point of view, S1000D specification should adapt to the development of new generation information technologies, such as: IoT, AR, AI, big data, etc.

- From the application point of view, IETM should be integrated into the ILS/IPS system to realize the closed loop of data sensing, data transmission, data analysis, data application and data feedback, realizing data-centric, data-driven intelligent maintenance system.

- Now we are working on "Augmented Maintenance".

Thank you

for your attention!

Questions?