ARC Advisory Group

vision experience answers FOR INDUSTRY

智能制造相关概念及热点技术探讨

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曹炜，ARC咨询集团

1. 智能制造相关概念
2. 智能制造实施环境
3. 智能制造相关热点支撑技术
4. ARC的建议

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ARC咨询集团简介

- 成立于1986年，全球领先的研究及咨询机构，专注于制造业及基础设施领域。
- 主要研究领域： 传感设备，电机、驱动，自动化及控制，数字化油田，制造业信息化解决方案等。
- 智能制造及相关技术是ARC近年来关注的重点领域之一。
  - IIoT device management platforms
  - IOT gateways
  - IIoT devices total available market
  - Industrial BI and analytics
  - Cyber security
- Industrial IoT & Industrie 4.0 Viewpoints Newsletter

ARC Advisory Group VISION EXPERIENCE ANSWERS

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智能制造相关概念探讨

- 同为智能制造，**Smart Manufacturing**与**Intelligent Manufacturing, Digital Manufacturing**是一回事吗？参照下来自美国国家标准化委员会的定义。

Smart Manufacturing Characteristics	Other Manufacturing Paradigms	Enabling Technology
• Digitization of every part of a manufacturing enterprise with interoperability and enhanced productivity • Connected devices and distributed intelligence for real time control and flexible production of small batch products • Collaborative supply chain management with fast responsiveness to market changes and supplying chain disruption • Integrated and optimal decision making for energy and resource efficiency • Advanced sensors and big data analytics through product lifecycle to achieve fast innovation cycle	**Lean Manufacturing** - Emphasis on utilizing a set of "tools" that assist in the identification and steady elimination of all kinds of waste in a manufacturing system[1]	Process leveling; work flow optimization; real-time monitoring and visualization
	Flexible Manufacturing - utilizing an integrated system of manufacturing machine modules and material handling equipment under computer control to produce products with changed volume, process and types[2]	Modularized design; interoperability; service oriented architecture
	Sustainable Manufacturing - creating products with minimal negative environmental impacts while conserving energy and natural resources and enhancing human safety[3].	Advance materials; sustainable processes metrics and measurement, monitoring and control
	Digital Manufacturing - using digital technology through product lifecycle to improve product, process, and enterprise performance and reduce the time and cost of manufacturing[4].	3D modeling; model based engineering; product lifecycle management
	Cloud Manufacturing – - a form of decentralized and networked manufacturing based on cloud computing and service-oriented architecture (SOA)[5].	Cloud Computing, IoT, virtualization, service-oriented technologies, and advanced data analytics
	Intelligent Manufacturing - implementing artificial intelligence based intelligent production that can automatically adapt to changing environments and varying proc ess requirements, with minimal intervention from human[6].	Artificial intelligence ; Advanced Sensing and control; optimization; knowledge management
	Holonic Manufacturing - applying agents to a dynamic and decentralized manufacturing process, so that changes can be made dynamically and continuously[7].	Multi-agent systems; decentralized control; model based reasoning and planning
	Agile Manufacturing - utilizing effective processes, tools, and training to enable manufacturing systems to respond quickly to customer needs and market changes while still controlling costs and quality[8].	Collaborative engineering, supply chain management, product life cycle management

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智能制造相关概念探讨

- **智能制造 vs IIoT or Industrie 4.0**
  - Smart manufacturing is more encompassing and includes all methodologies, processes and technologies that substantially improves the outcome of manufacturing, be it in the form of product value, quantity or quality, or in the form of productivity or reduced environmental footprint.
- **智能制造 vs 先进制造**
  - 先进制造 - This involves improvements in fundamental science or engineering, for example scientific advances such as photonics or chemical nanostructures or engineering improvements, such as **modular production technology, additive manufacturing, or advanced forming**.
  - 智能制造 - This includes information, communication, or automation technologies applied to production processes and assembled to smart manufacturing systems.

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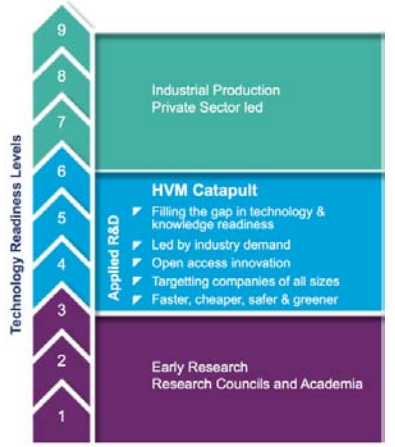
智能制造相关概念探讨

- 下一步是什么？**Industrie 4.1 or 5.0?**
  - 进化还是变革?
  - 对于制造业用户而言，进化还是变革并不重要。稳步渐进的提升制造效率才是既可能也现实的生存之道。
- **并不仅仅是 IIoT or Industrie 4.0**



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智能制造相关概念探讨

智能制造战略及实施对于中国尤为重要

- 中国是制造业大国，制造业是立国之本
- 中国制造业面临日益加剧的竞争压力
- 先进制造中短期内并非中国制造企业优势，即通过产品或者制造工艺的高技术附加值、复杂性提升来提高产品价值及竞争优势。短期内，先进制造领域发达国家仍保持很大优势。

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智能制造实施环境

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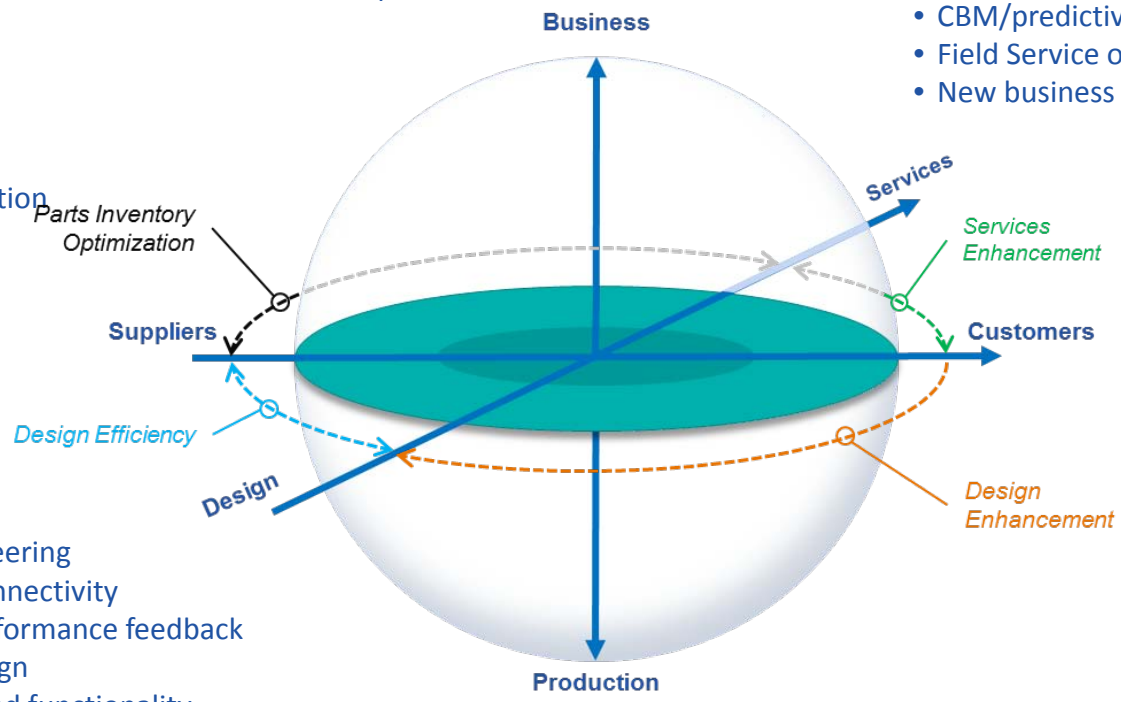
智能制造是个生态系统

Enterprise
- End-to-end, top-to-bottom, real-time performance
- New revenue opportunities
- Plan for disruptions

Services
- Remote monitoring, diagnostics, services
- CBM/predictive maintenance
- Field Service optimization
- New business models/services

Supply Chain
- Tracking, optimization
- Quality assessment/mgmt.
- Inventory tracking, optimization
- SC Control Tower



Customers
- Ongoing relationship vs. buy transaction
- OPEX vs. CAPEX
- Outsource non-core functions
- Service Level Agreements

Design & Engineering
- Design for Connectivity
- In-service performance feedback improves design
- Software-based functionality
- Operating Ecosystem

Production
- Flexible, responsive operations
- Maintenance optimization/Predictive techniques
- Connected workers, systems
- EH&S improvement
- Energy optimization

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工业云

- Microsoft Azure, Amazon AWS, IBM BlueMix, 阿里云, 腾讯云等等
- 客户虽有担忧，但云服务供应商日子看起来过得挺滋润
- 工业云: GE Predix, Siemens MindSphere, Hitachi知造云等
- 工业云给制造企业带来客户价值
- IT/OT融合的关键

腾讯云

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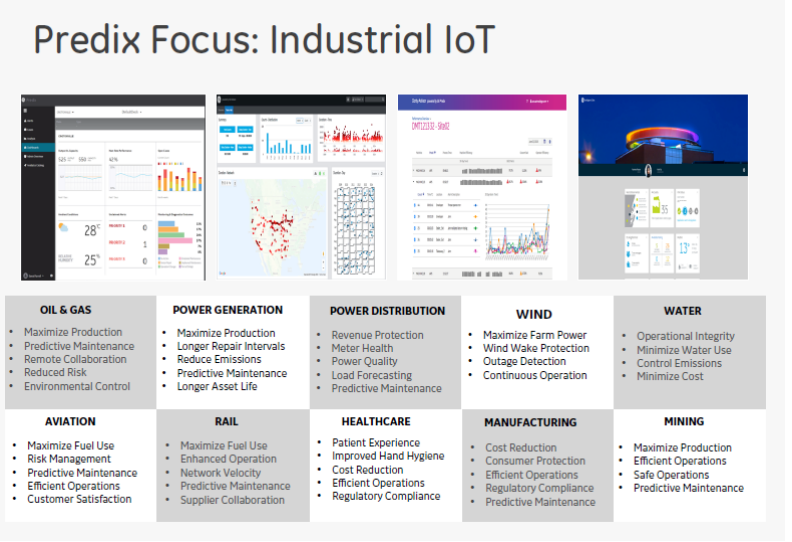
GE Predix

- 2013年推出， 大致在今年2月对全球市场开放。
- 主要合作伙伴： 思科、微软、PTC等等
- APM（资产性能管理）成为迁移至Predix云平台的第一个应用。
- 创建了一个生态系统，合作伙伴可以基于平台开发应用。超过2000名活跃的应用开放者（2016年2月）。
- 海尔在今年初成为Predix在中国第一个制造业客户。



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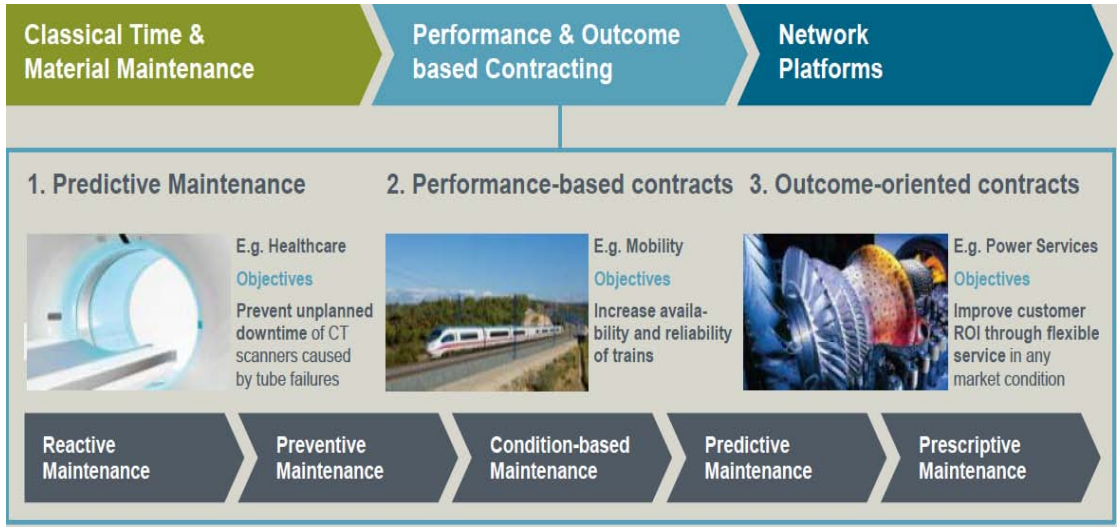
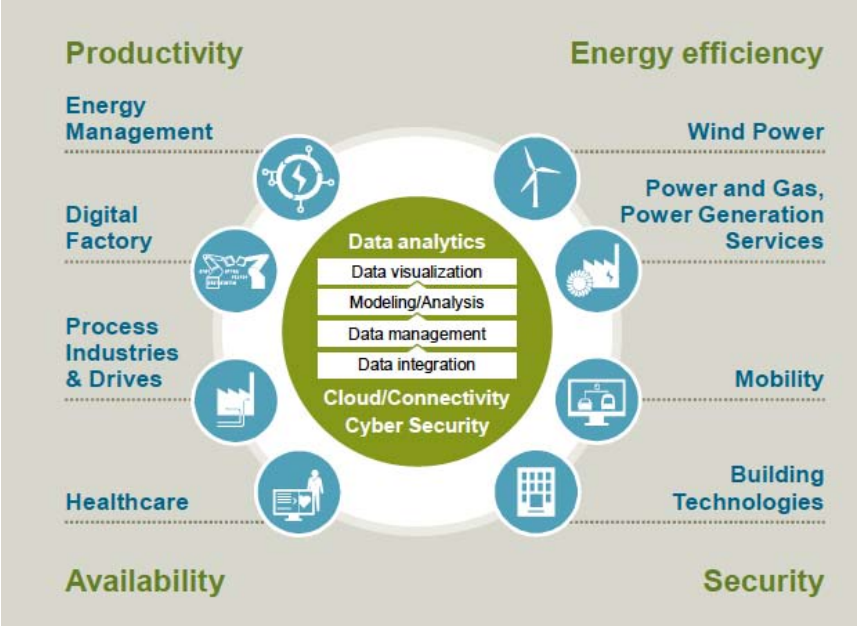
Siemens MindSphere

- 2015年推出，服务于西门子数字化服务战略。
- 基于Sinalytics技术及SAP HANA平台
- 主要合作伙伴：SAP、Amazon、Atos、Accenture
- 目标客户是OEM及最终用户
- 服务类似：能源分析、机床分析、驱动设备分析及信息安全分析





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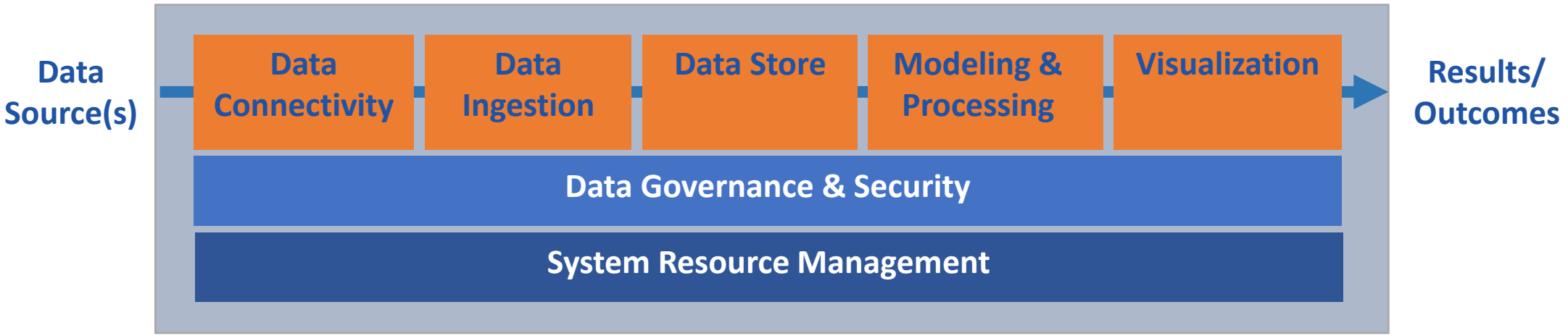
分析系统（Analytics Systems）框架



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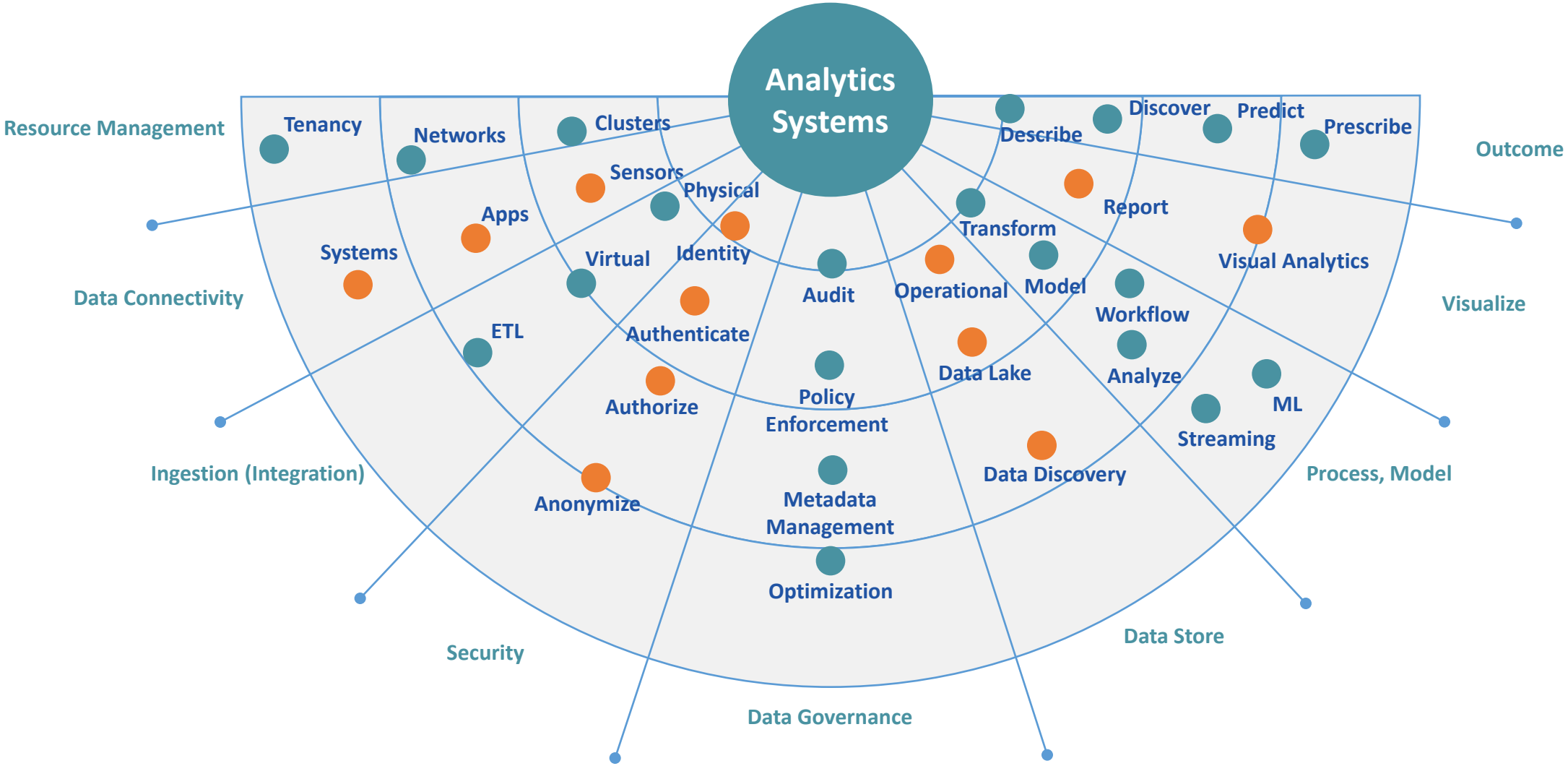
分析系统的关键功能



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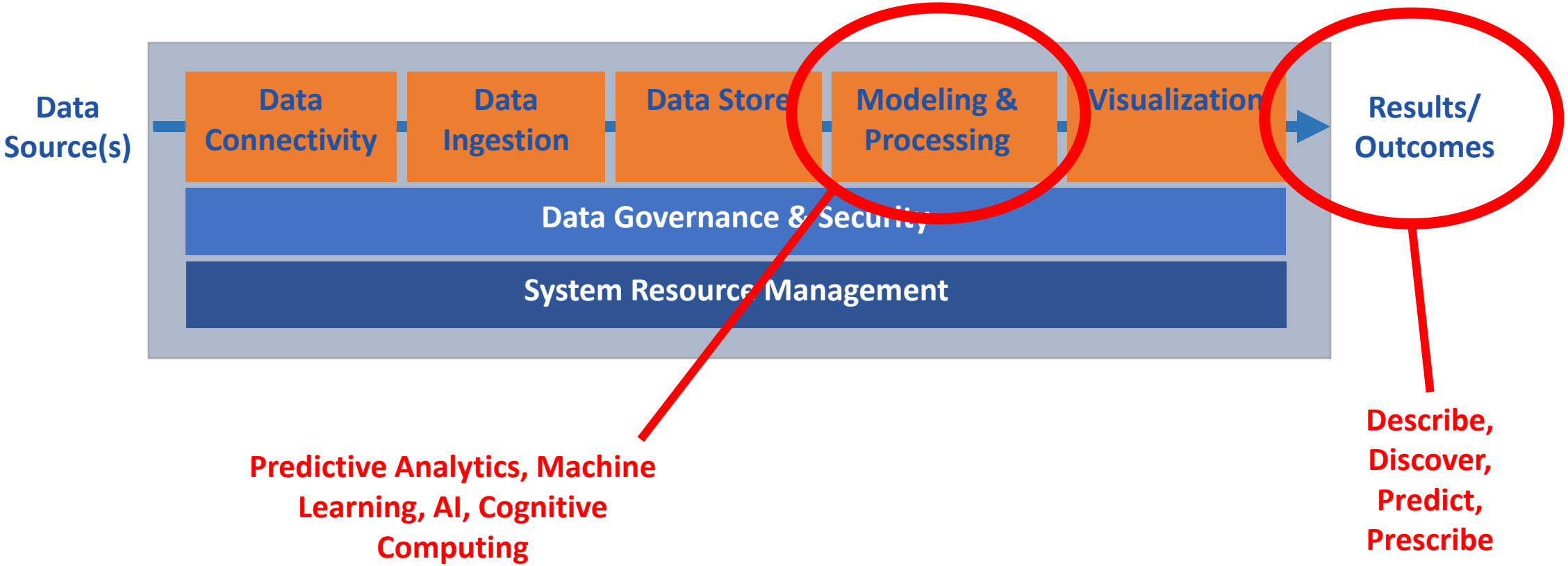

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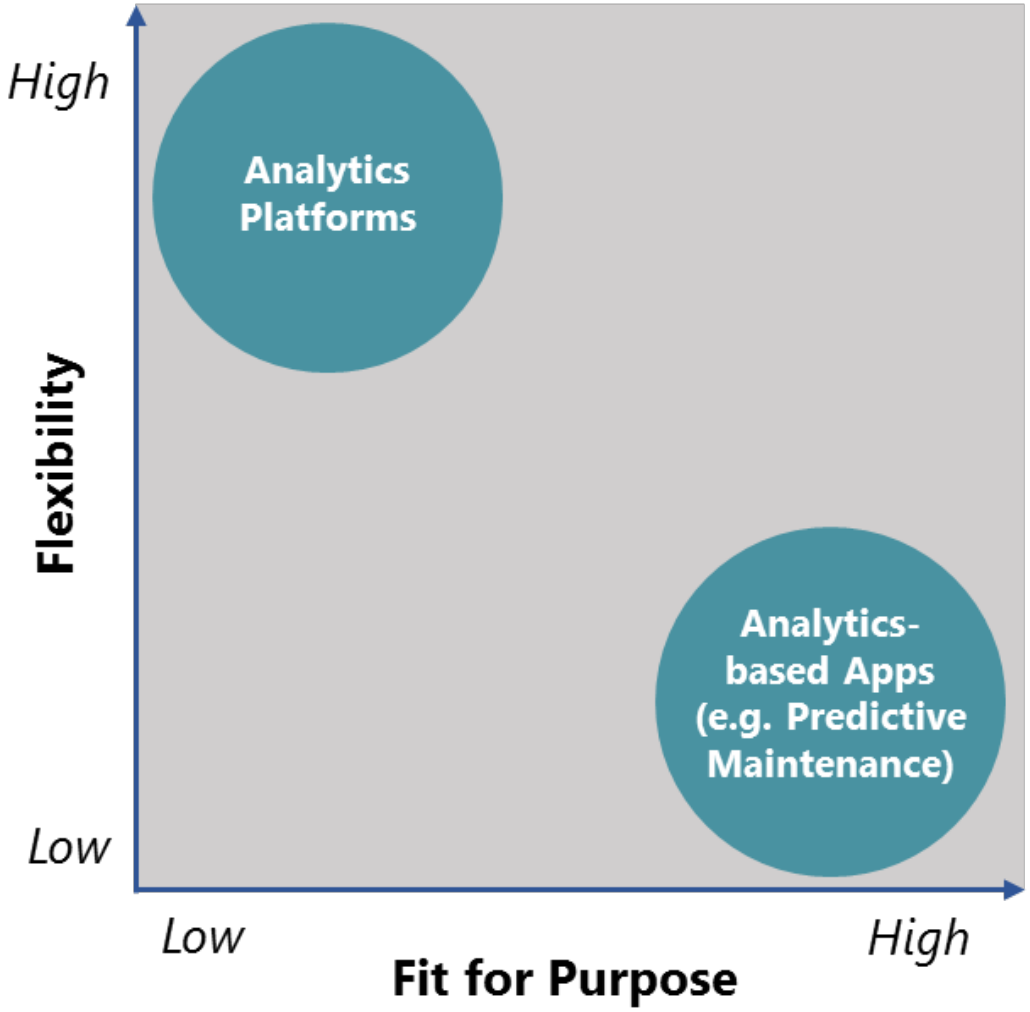
分析平台 vs. 分析应用



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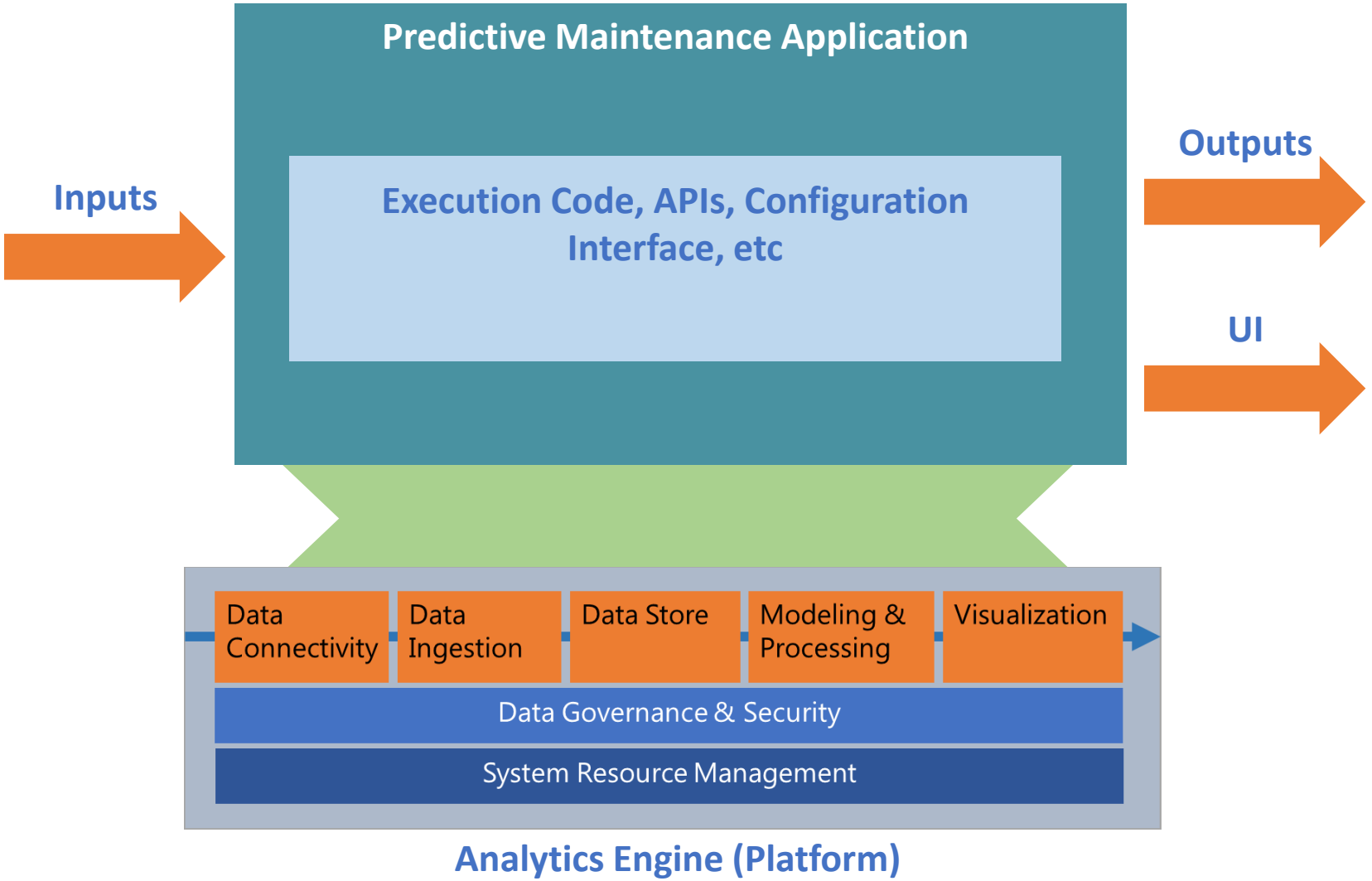
分析应用：基于多任务分析及ML平台



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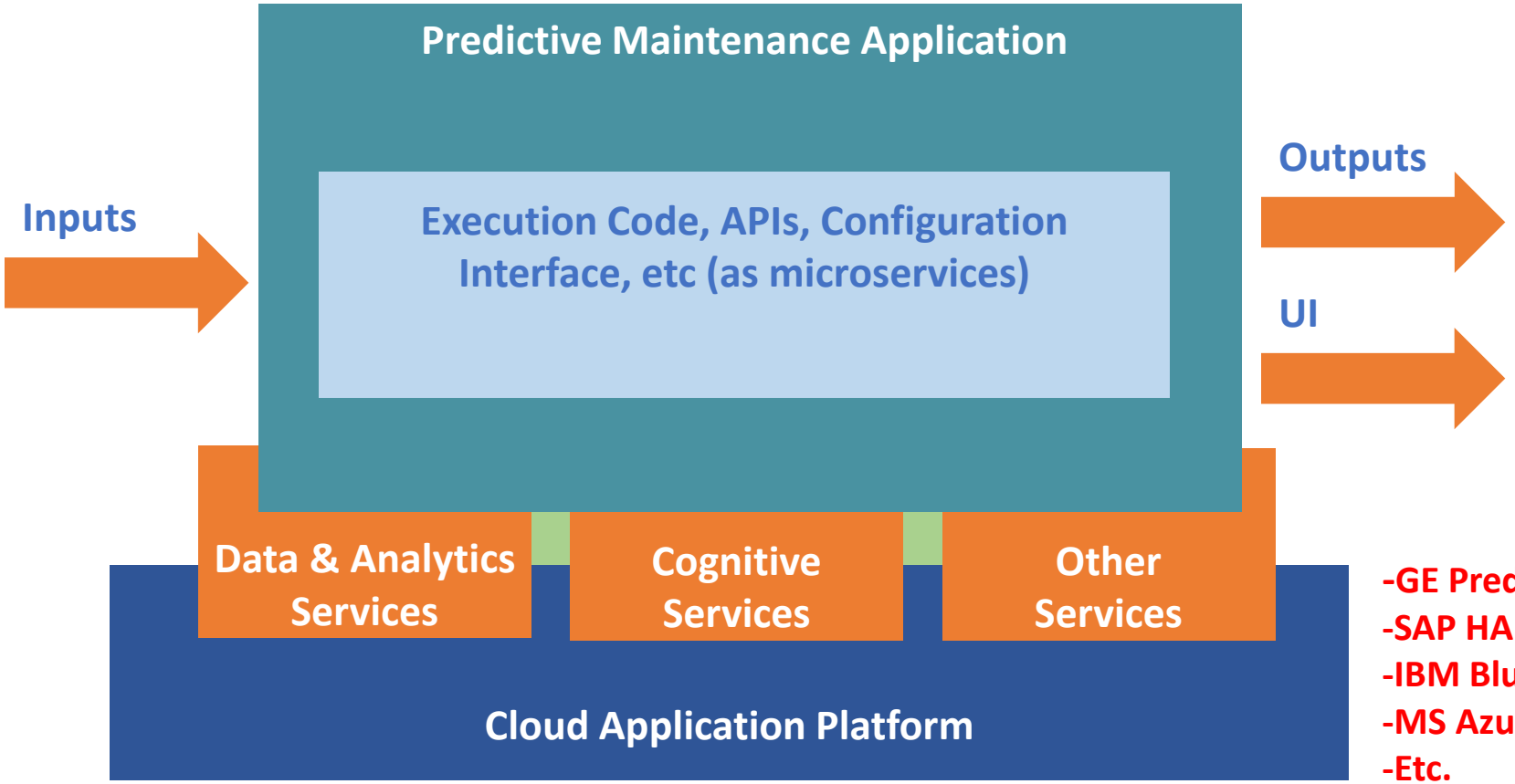
分析应用：基于云平台



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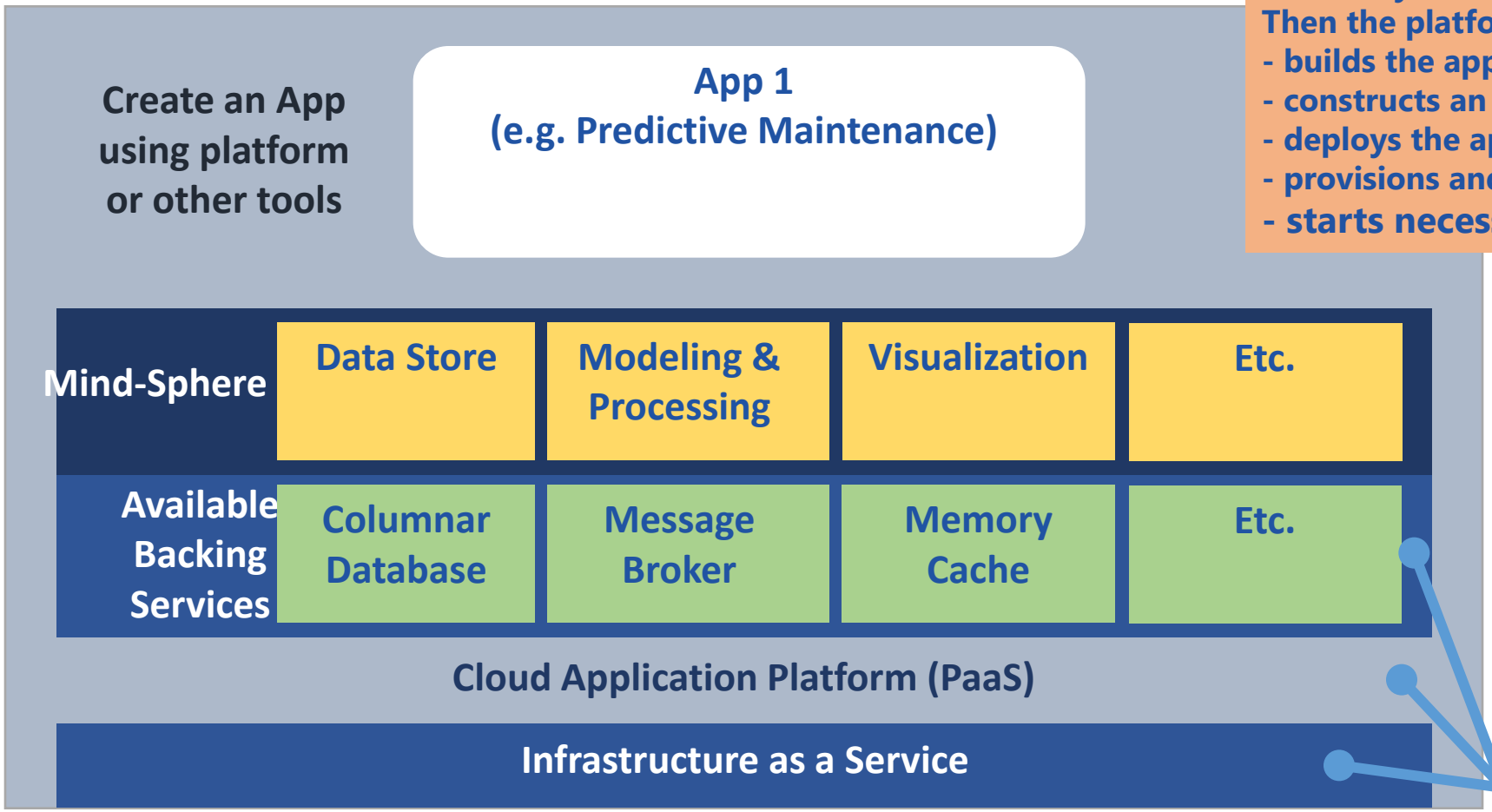
基于云平台开发工业应用

Launching an Application
Application Code is pushed to version control system (Git remote)
Then the platform:
- builds the app artifact
- constructs an application environment
- deploys the application
- provisions and links services
- starts necessary processes



Siemens MindSphere Services

SAP HANA Cloud Platform

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什么是机器学习?

- 机器学习是指用某些算法指导计算机利用已知数据得出适当的模型,并利用此模型对新的情境给出判断的过程（知乎）。
- 机器学习在上世纪70，80年代曾随人工智能、专家系统等概念而盛极一时，后趋于平淡。主要原因是缺少训练所需数据。IoT带来的海量数据，商用软件的开源化及云服务的导入使机器学习获得再生。
- 机器学习与数据挖掘及统计技术高度相关。
- 监督
  - 回归（regression）
  - 分类（classification）
- 非监督
  - 聚类（clustering），善于发现隐藏模式
- 主要的云服务提供商都已能提供机器学习工具，包括Amazon、微软、IBM和Google。

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机器学习应用于设备维护领域

- ARC相信机器学习技术在工业领域具有很大应用潜力，可应用于设备的预测性、规定性维护。
- 传统的预防性维护策略并非最佳选择，仅18%的资产符合这个策略。
- 预测性、规定性维护的终极目标是实现设备资产的零非计划停机。
- 嵌入机器学习功能的预测、规定性维护供应商： GE(Equipment Insight Solution, SmartSignal), IBM(IBM Predictive Maintenance on Cloud, IBM Predictive Maintenance and Quality, IBM Predictive Asset Optimization), Schneider Electric (PRiSM), Mtell, Predikto。
- 机器学习不仅需要IT和数据处理技术，应用领域的专业知识很重要。

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机器学习技术的成功应用

NETFLIX

Netflix 利用机器学习技术高效地向用户推荐喜欢的视频节目

机器学习技术支持苹果手机的语音识别功能

Amazon 使用机器学习技术优化商品推荐

Available at amazon

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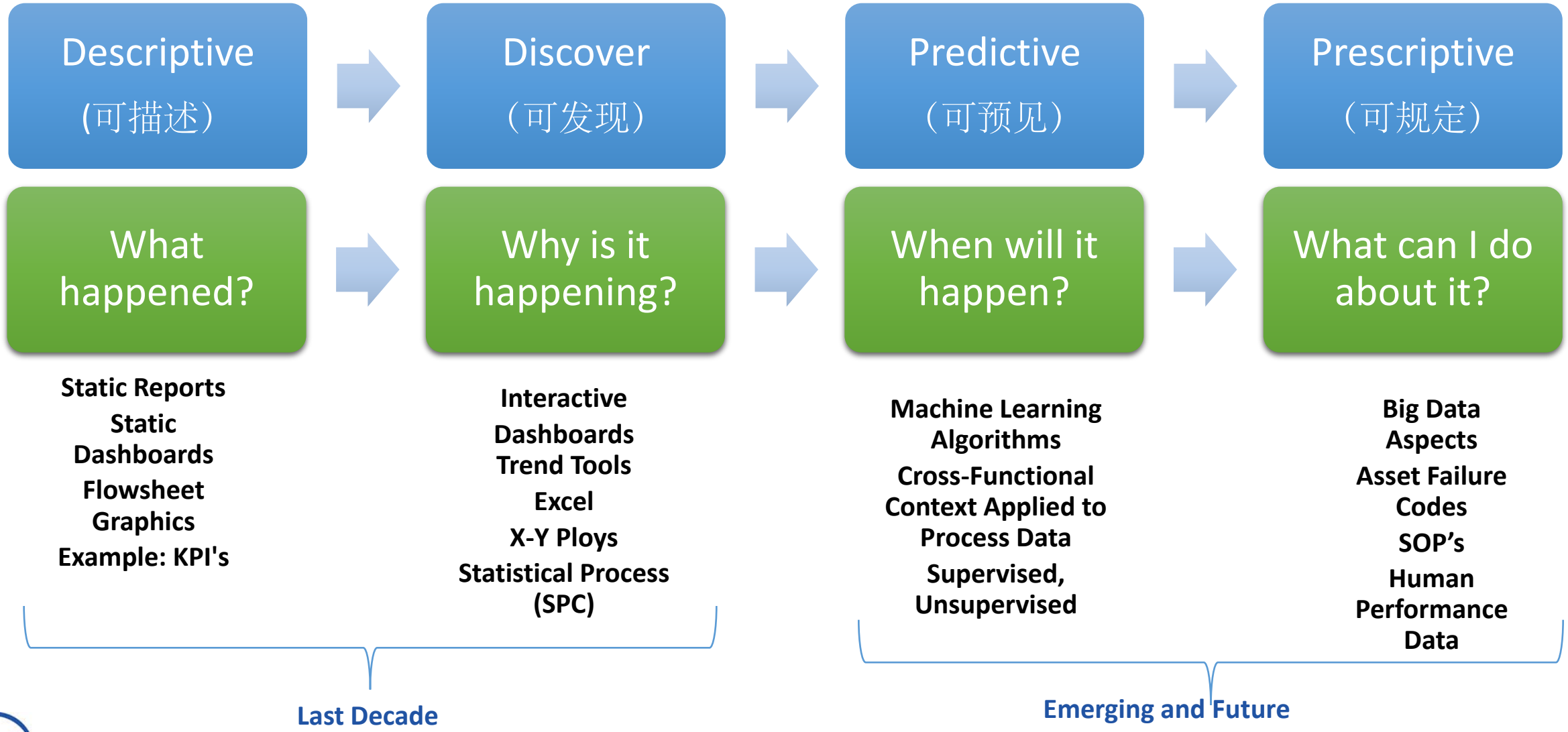
机器学习（Machine Learning）



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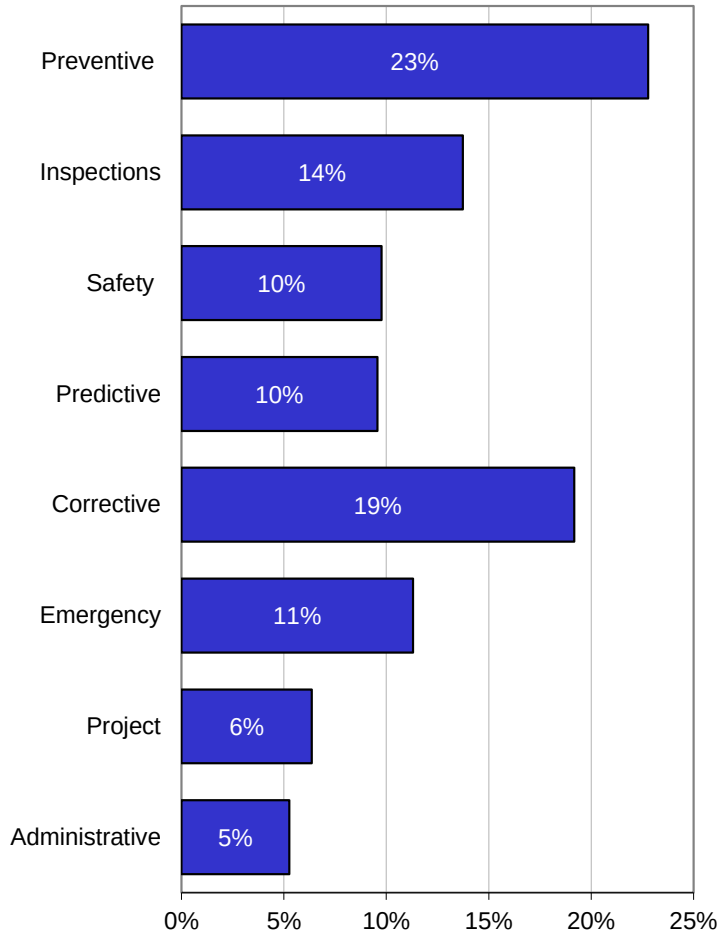
各种资产维护方式比较

Approach	Method	Cost Impact	Operations Impact
Corrective or break-fix maintenance	Run to failure and then repair	$$$	Hard to Meet Plan, highest risk to production ops
Preventive or scheduled, interval maintenance	Service in a fixed cycle or time interval	$$$$	Introduce unnecessary work, New Failures, frequency of unplanned downtime
Condition-based monitoring	Monitor single process variable, identify bad trends, & alert prior to failure, automatic work order generation	$$	The Vibration or alert is too late, highest false positive
Predictive Maintenance	Analytics with multi-variable time series data contextualized with unconventional data. Equipment-specific algorithms, analytics and machine learning. Minimum false positives.	$	Trust Assets and Predictable Operations, Downtime reaches zero
Prescriptive Maintenance	Describe the Fix or Repair	$	



ARC Survey with 141 user responses March 2015

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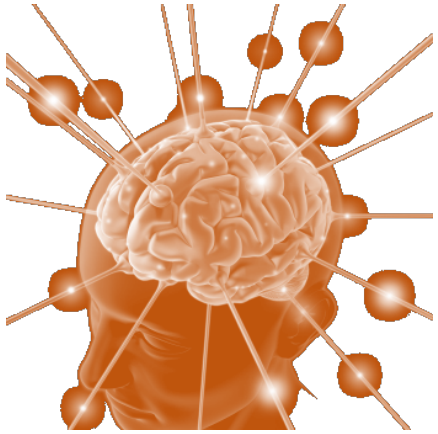
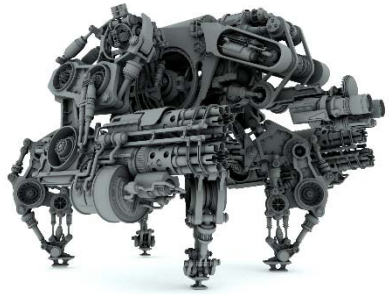
主要新兴热点技术



Visual Analytics

Machine Learning

Streaming Analytics



Smart Machines

Cognitive Computing/AI

Predictive Analytics

Augmented Reality

Smart Plant Apps

Advanced Analytics is powering all kinds of industrial platforms, machines, and applications

ARC的建议

- 确定目标。了解企业的痛点，作出自己独特的需求分析。制定中长期战略，从零迈向一就是成功。

- 甄选技术。智能制造的技术路线有多种，充分了解的基础上寻找合适自己的，逐步实施。

- 流程和人员。智能制造的实现并不是目的，而是一个过程。持续的改进业务流程，组建跨领域的团队。

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