

7th
UCAAT

User Conference on
Advanced Automated Testing



Bordeaux, 22-24 October 2019

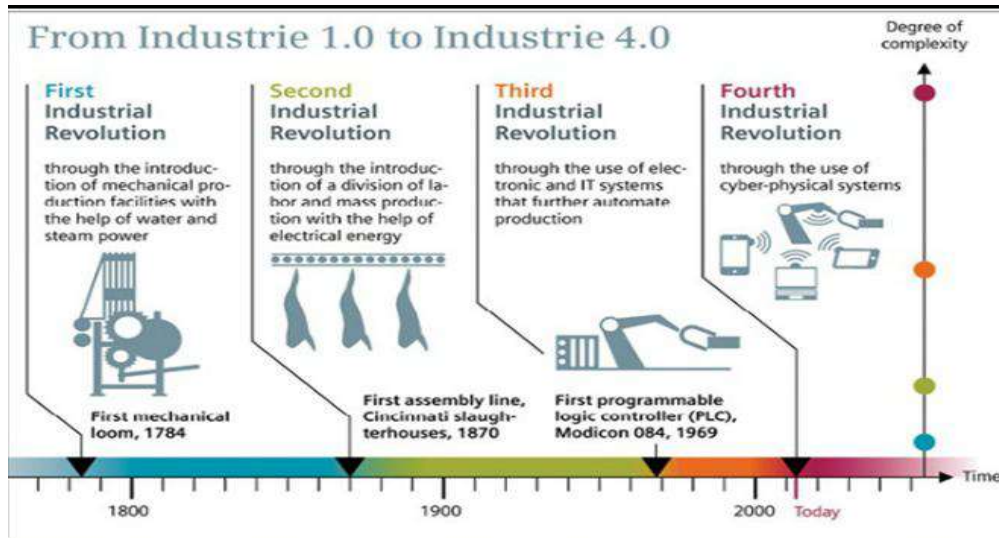


DATA INTELLIGENCE ENABLES TEST INTELLIGENCE

Presented by Tony Chang, Huawei's Chief Test Expert Emeritus
and current CEO of ITEA Technologies



ICT Enables the Fourth Industrial Revolution – Intelligentization



Mechanization

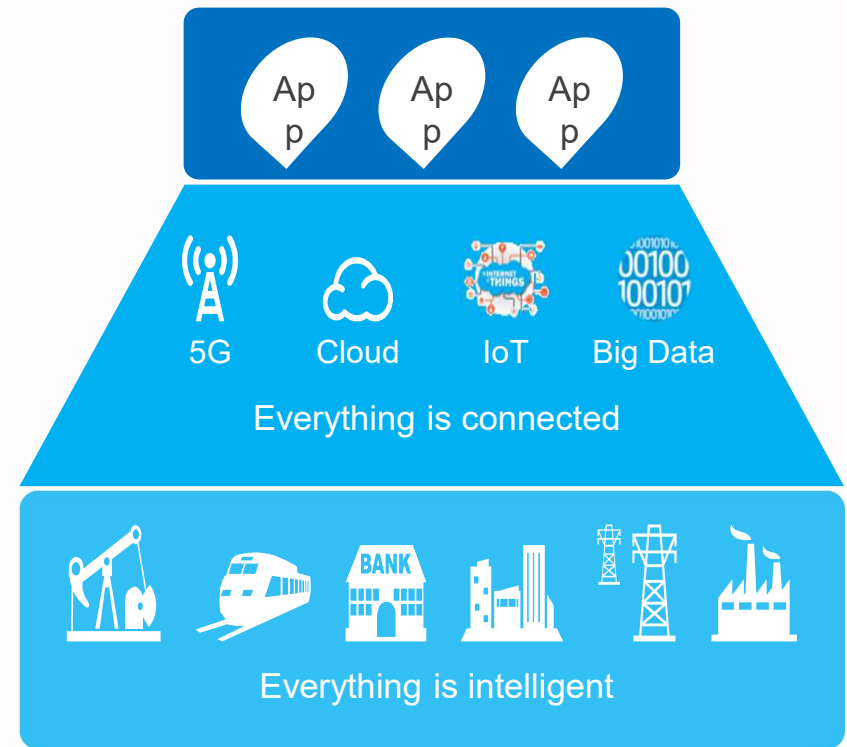


Electrification



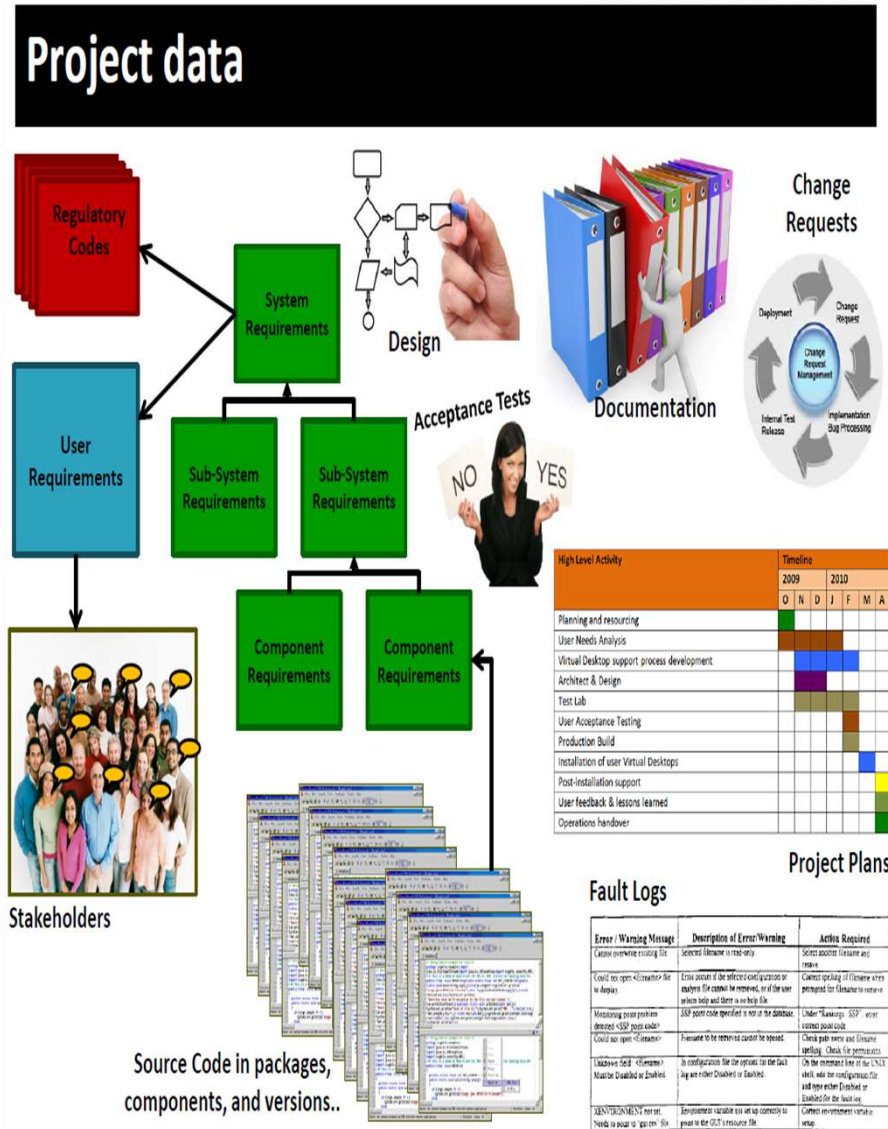
Automation

Intelligentization

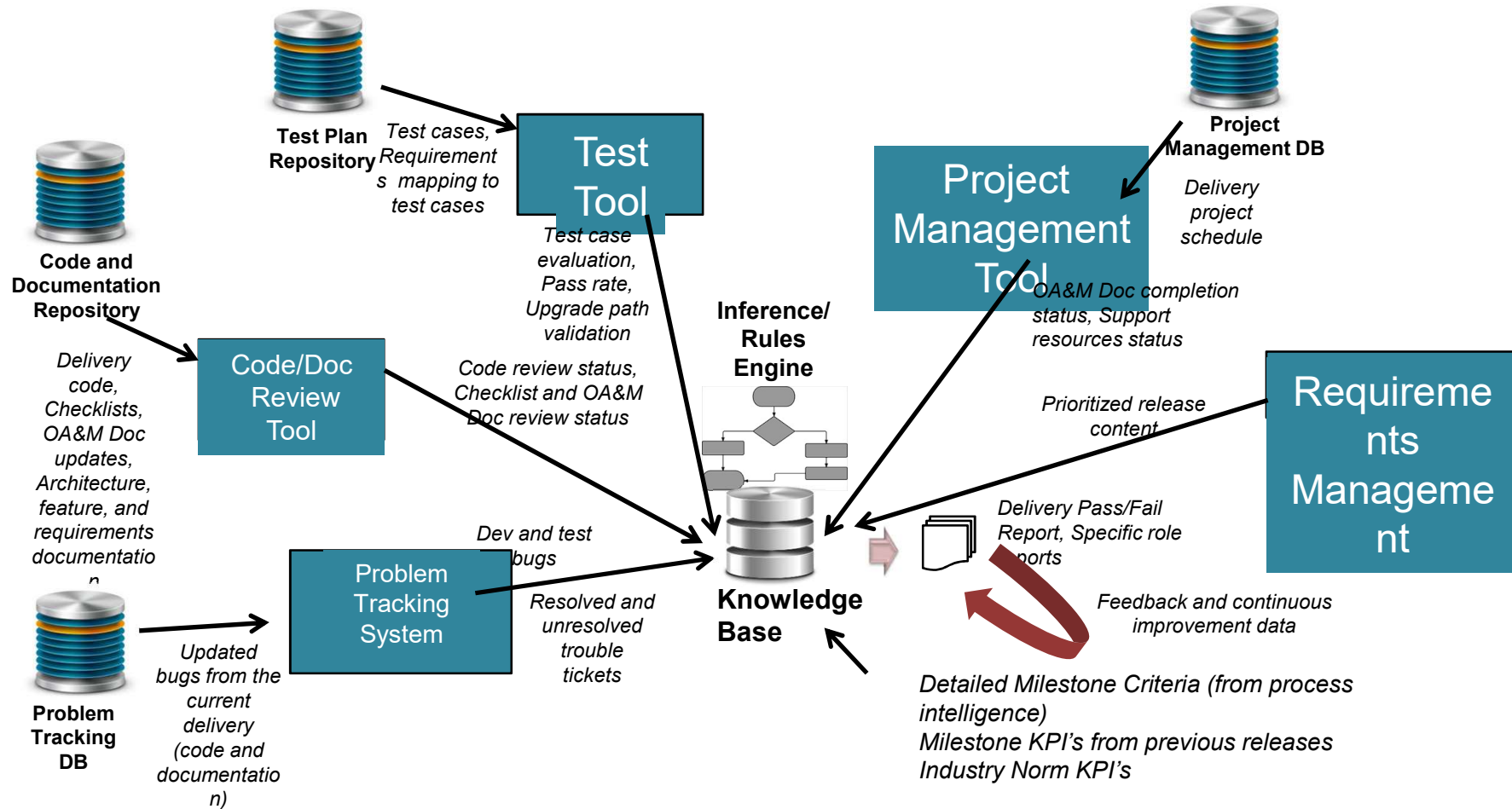


Industry trend: Mobility->SDN->Cloud->Storage->Big Data->5G/IoT-> AI
➔ Intelligent R&D (DI or AI ??)

- Data intelligence is the ability to mine software engineering data to find insightful and actionable solution to solve business problems & Effectiveness
- Comprehensive data intelligent solutions may consist of software traceability, data mining, data analysis, data query, and data visualization techniques
- Data intelligent solution may help R&D project stakeholders make informed decision, reduce R&D cost, and even find new business opportunities
- Industry leaders such as Google and Microsoft are aggressively utilizing R&D data to create applications to solve business problems & R&D Efficiency. Examples of these applications are:
 - Dynamic R&D Adaptive Model
 - Automatic Quality Assurance
 - Feature Impact Assessment
 - Automated TC Generations/Lean Test
 - Domain Experts Recommendation
 - Fault Localization & Resolution
 - Dynamic Resource Allocations
 - Etc....

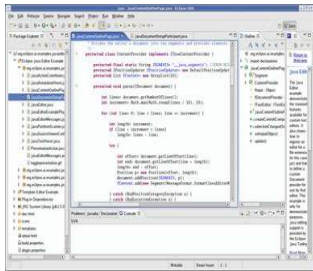


R&D Data & The Expert Knowledge Base

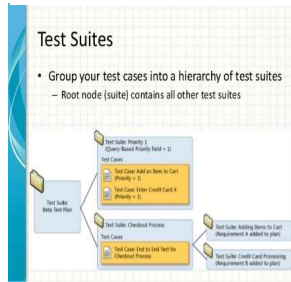


R&D Resource Sharing: Code, Test case, Environment, Data

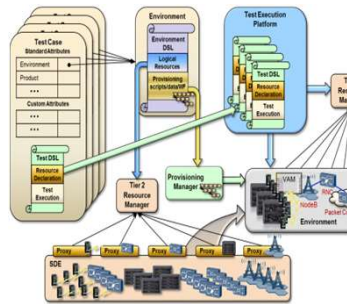
Code sharing



Test sharing



Env sharing



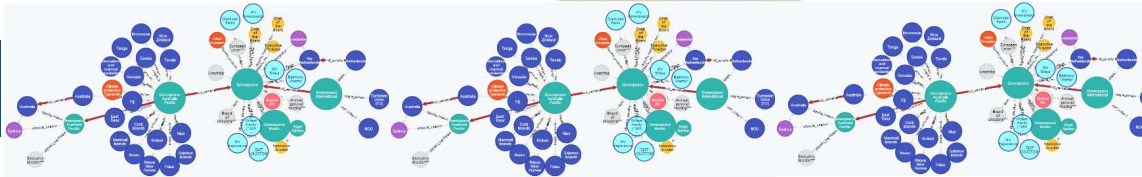
Data sharing



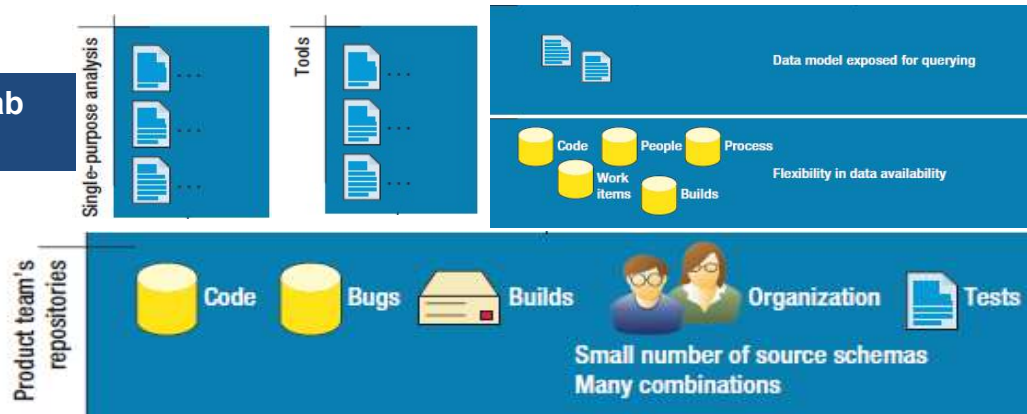
Multiple assets assessable across teams.

- Env – Pool of resources dynamically allocated for high reuse and utilization
- Code – Source code assessable and searchable by development teams for high code reuse and quality
- Test – Strategy, plans, and code assessable by development teams for experience sharing and reuse.
- Data – Project, experts, experience, tools, technology information assessable across teams for experience sharing, insight extraction, and intelligent decision making.

Linked data

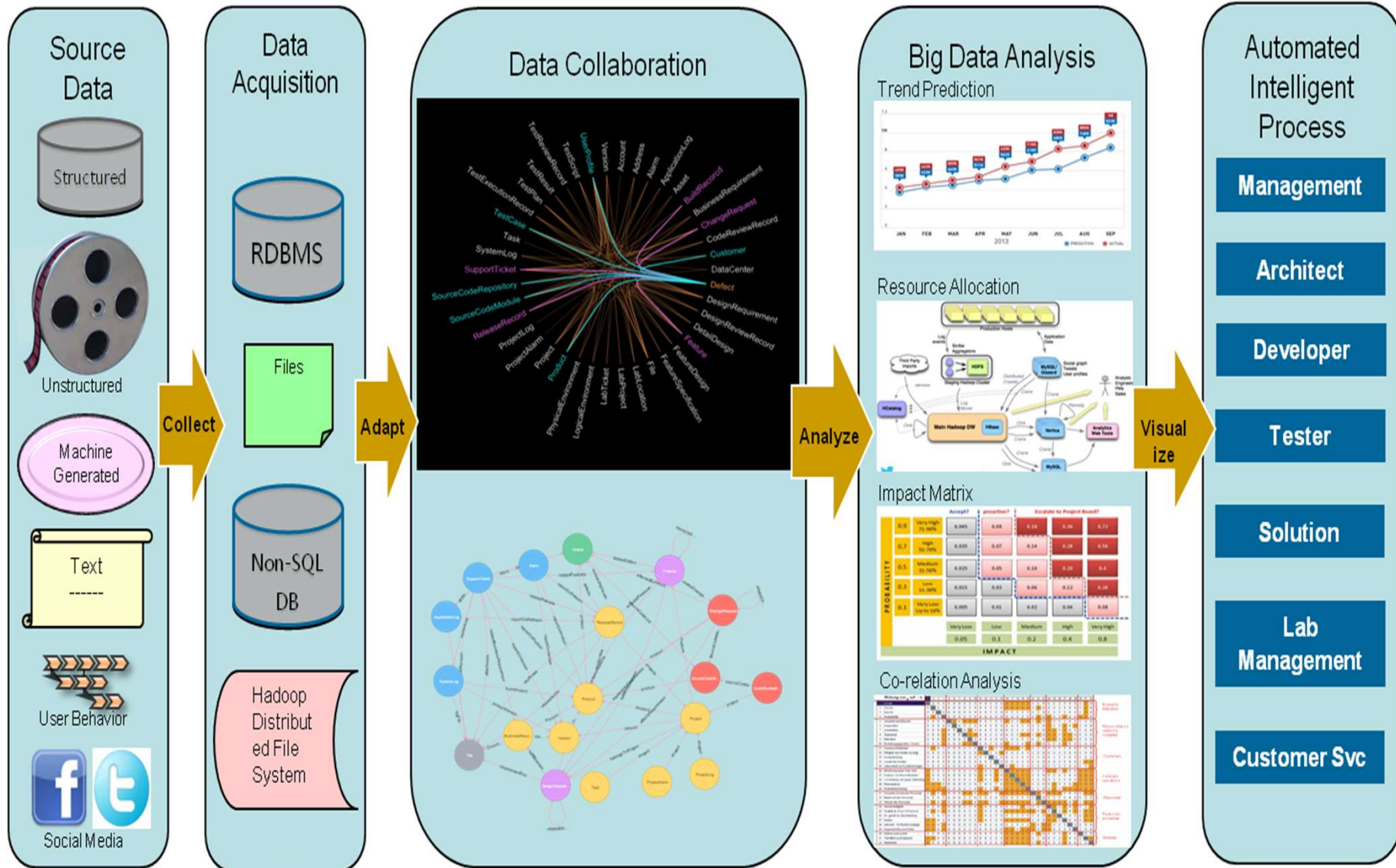


Information and Lab resource sharing



Sharing Data and Artifacts to Effectively Reuse Knowledge and Experience

Data Correlation, Analysis Enables Intelligent R&D Applications



Source Data



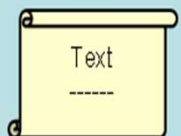
Structured



Unstructured



Machine Generated



Text



User Behavior



Social Media

Data Acquisition



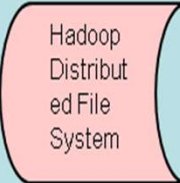
RDBMS



Files



Non-SQL DB

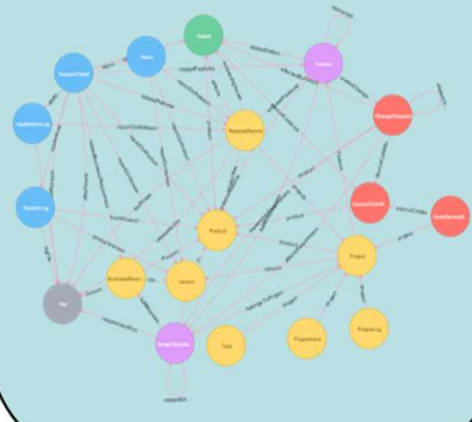
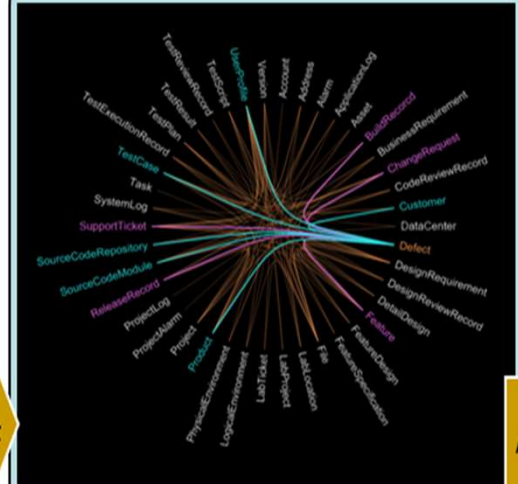


Hadoop Distributed File System

Collect

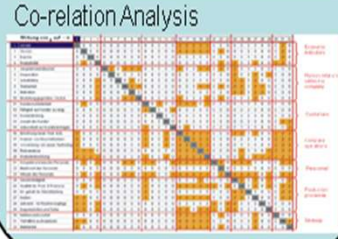
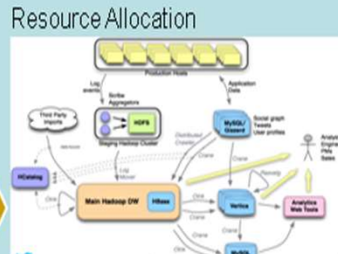
Adapt

Data Collaboration



Analyze

Big Data Analysis



Visualize

Automated Intelligent Process

Management

Architect

Developer

Tester

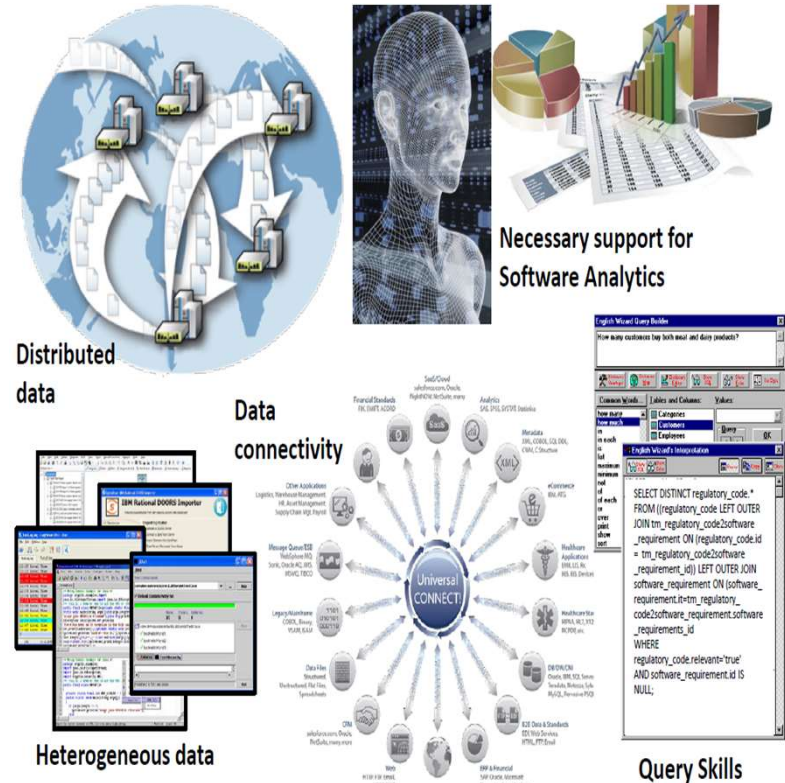
Solution

Lab Management

Customer Svc

Data Intelligence's Challenges

- Data? (Type? Attribute? Correlation?)
 - Huge & separated R&D process Data, where do we start ?
 - What are the useable R&D Data? Where are they?
 - How are we going to correlate these Data ?
 - How to use these to resolve issues & improve overall R&D efficiency?
 - Do we have the complete Data to resolve the targeted issues?
 - How to maintain the integrity of the Data ?



- Reusability、Sharing?
 - Lots of issues are common to the various teams, but their original Data Format & standard are different and make it difficult to reuse & share
 - The resolution of some issues may use the same or similar data, can that be shared?
 - How to dig out the different original data and find out the common solution?

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INTELLIGENT R&D & INTELLIGENT TESTING

What is Intelligent R&D

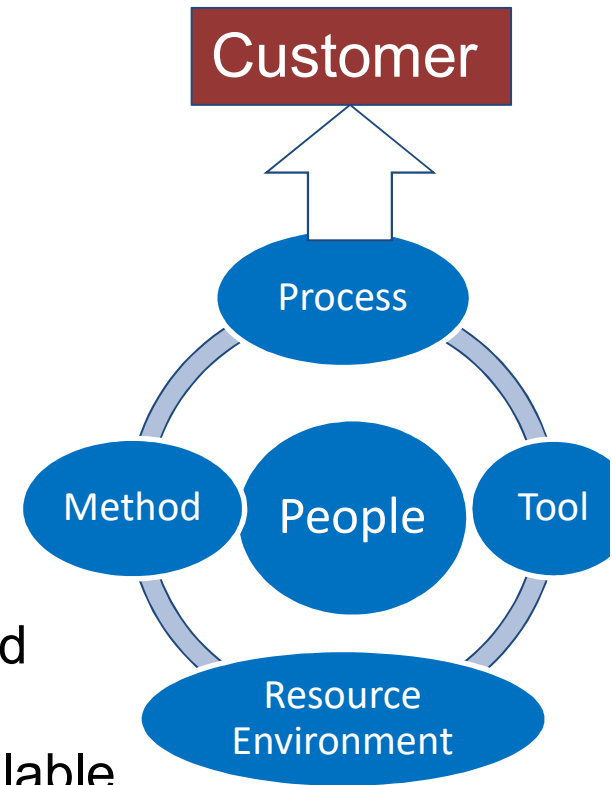
- ❑ Let machine learn to accumulate knowledge and experience to free human brain power for better creativity.
- ❑ Provide the **right help**, to the **right person**, at the **right timing in a timely fashion** to facilitate the R&D efficiency & Trustworthiness .

- Service Providers & Integrators' Paradigm Shift
 - Reactive >> Proactive
 - Tools Centric >> Users Centric (Business Centric)
 - Band-Aid Solution >> Comprehensive Solution
 - Innovation Ceiling >> Innovation Enabler
- Service Consumer's Paradigm Shift
 - Speculation Decision >> Data/Evidence Based Decision
 - Hidden Risk >> Visible & Traceable Result
 - Resolve Issue >> Prevent Crisis

Key enablers for Intelligent R&D: R&D Data Intelligence

Future R&D Environment

- Anything can be connected will be connected
- Anything can be shared will be shared
- Anything can be integrated will be integrated
- Any Process can be automated will be automated
- Any Data can be correlated will be correlated
- Any Activity can be collaborated will be collaborated
- Anything can be tested will be tested at the 1st available time



Intelligent R&D Application Scope

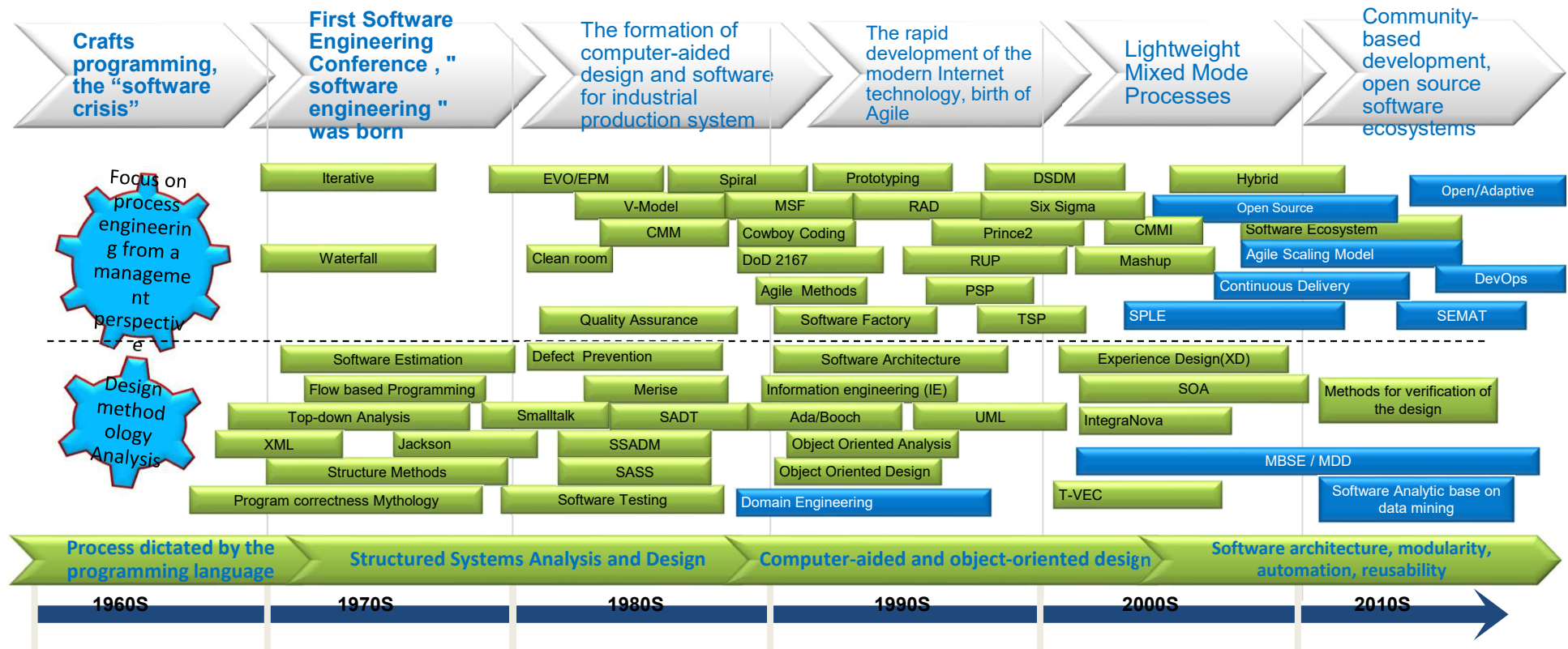
Category	Key Business
Intelligent Platform	Self adaptive tools chain Business intelligent enablement – R&D knowledge graph support Data Ocean and software analytics ecosystem Expert and artifact recommendation and coordination

Category	Key Business
Intelligent Management	Self adaptive R&D Model Automatic quality assurance measurement Systematic project management Efficient & intelligent project resource utilization
Intelligent Architecture & Design	Automatic architecture recovery and smell detection Automatic architecture refactoring/enhancement Visualization of software architecture Architecture design impact and risk analysis Architecture framework/pattern recommendation
Intelligent Development	Intelligent code search and code insight support Intelligent log analysis for distributed system Fault localization and automatic bug repair Intelligent regression test for new problem resolution

Category	Key Business
Intelligent Test	Intelligent test case recommendation Intelligent test environment utilization and test execution Comprehensive log/data collection Risk analysis for un-resolved problems
Intelligent Solution	Multi-tier intelligent continuous deployment Integration simulation and risk prediction Multi-vendor device integration solution recommendation Multi-vendor dynamic resource management T-DSL
Intelligent Lab	Strategic lab resource utilization E-DSL Lab utilization risk analysis and cost estimation Project plan and lab utilization conflict resolution

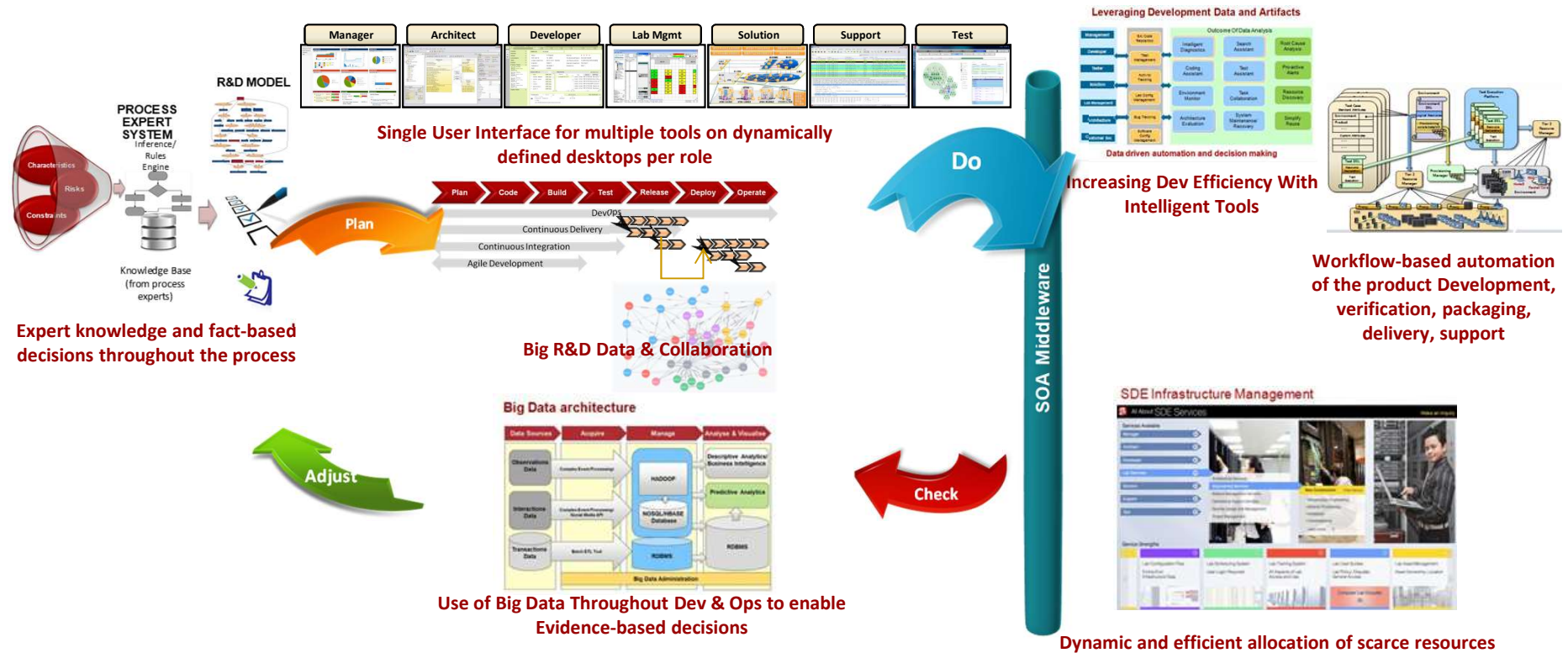
Industry R&D Models & Engineering Methodology

- Up to now , there is no “One Model or Process can fit it all” for various Products & Solutions
- All the new Models that have introduced so far are still lacking of “Quality Assurance Guideline”
- Service Integration will be a major challenge for the future Cloud & Open Ecosystem
- D&D models will continue to evolve : Intelligent decision centric Expert System、 Unified collaborative Working platform、 Self-Adaptive Life Cycle D&D process、 Automatic Quality Assurance & Project Management、 Service Driven Environment & Ecosystem



Next Generation R&D Ecosystem

Vision: system of tools to enable trustworthiness, efficiency, quality, consistency & evidence-based decisions throughout the product development process



Knowledge based R&D Process Expert System to ensure most-fitted/Self-Adaptive R&D Model, Working Platform, Tools Chain, APIs, Dynamic Resources, Auto-Quality Assurance System, Open Ecosystem

What is Intelligent Testing

Integrate advanced technologies in the industry and evolving test practices from **automation-based** to **customer-oriented, cloud-based, service-oriented, and intelligence-based**.

- **Intelligence-based test design:** Developer can use **collaboration and operation platform** to efficiently implement **one-source design, and collaboration**. With **intelligent search, and test knowledge graph** R&D resource and info is available anytime. Use **TDSL/JADL** to build efficient, unified **test case design domain specific language**. All linkages from **test cases** are completed and managed automatically during design process.
- **Intelligence-based test execution:** With **ICT-integrated dynamic resource scheduling**, starts the intelligent test pipeline in one click, and completes the **associated unit test, function test, system test, DFX test, solution test verification**.
- **Intelligence-based test analysis:** Automatically execute **product-level test coverage assessment and risk feedback** in real-time. Use **data analysis platform** integrated with **data processing, machine learning and artificial intelligence**, and integrate data about tools, and logs from product SUT that is generated during design, execution and env resource setup with **automatic data collection and test activity analysis** to provide efficient solution to **problem isolation and localization**.

Vision & Mission of Intelligent Testing

❑ Support future Intelligent R&D

Intelligent R&D Model: Design, Modeling, Code Development

❑ Full scope of Automation & Intelligence

- Auto-evoke the new code verification of Unit、 Functional、 System、 DFX & Solution (**Auto-DevOps**)
- Automatic Test Case Generation
- Automatic validate the Test Coverage、 Code Coverage; automatic Test case generation for untested Code
- Automatic Quality Evaluation & Gate passing
- Automatic Test Results Analysis & Fault Isolation
- Automatic Bugs Retest for automatic bugs resolution

❑ Intelligent Working & Collaboration Platform to integrate the E2E R&D Activities

Facilitate the Design、 Development、 Test engineers to work seamlessly – including the cross platform/products vertical integration

Intelligent Testing Key Activities

❑ Intelligent Test Design:

- Development & Test Design collaboration (with the same source)
- Full scope of TC Correlation -- Unit, Functional, System, DFX, Solution

❑ Intelligent Test Execution (Automated DevOPS):

- Test Execution Pipeline: Unit→ Functional→ System→ DFX→ Solution
- Test Coverage Validation + Automated TC Generation for Untested Code

❑ Intelligent Test Results Analysis, Fault Isolation

❑ Automatic Verification for Defect Resolutions

Intelligent Test Design

- **What is Intelligent Design ?**

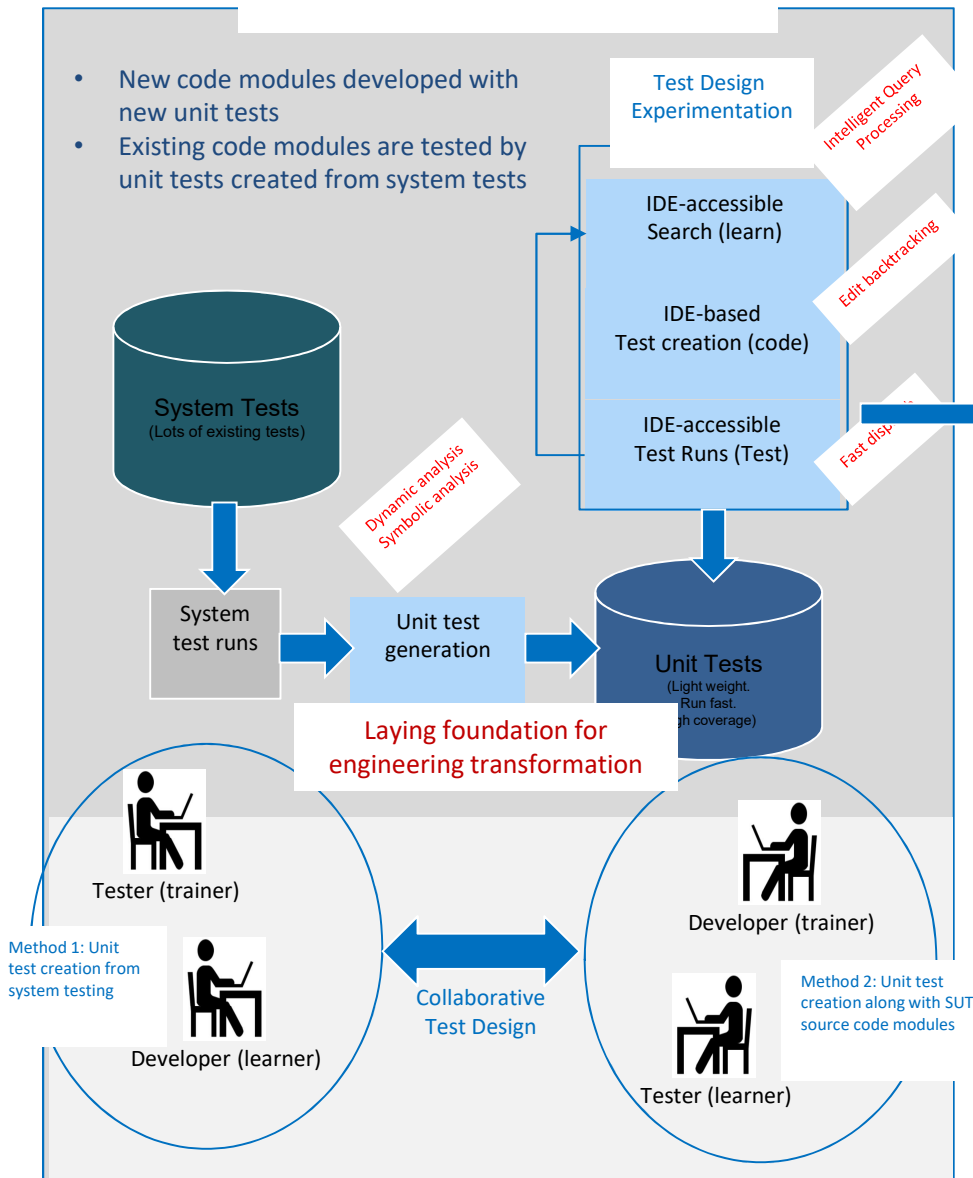
- ❑ Parallel Test Design with Development Design : Requirement, Scenario & API analysis
- ❑ Through Intelligent Working System to seamlessly guide the users to input the key data accurately, via the automatic Data Correlation to build the proper Knowledge Graph
- ❑ Correlate the Code & Test suites to set up the Unit test foundation and evolve the E2E Data correlation and Traceability
- ❑ Utilize the services provided by the Knowledge Graph to timely deliver the required data to the users during the Test Design process
- ❑ System provides effective Design verification environment to speedup the design iteration and enhance the Unit test capability

- **Scope of Intelligent Test Design:**

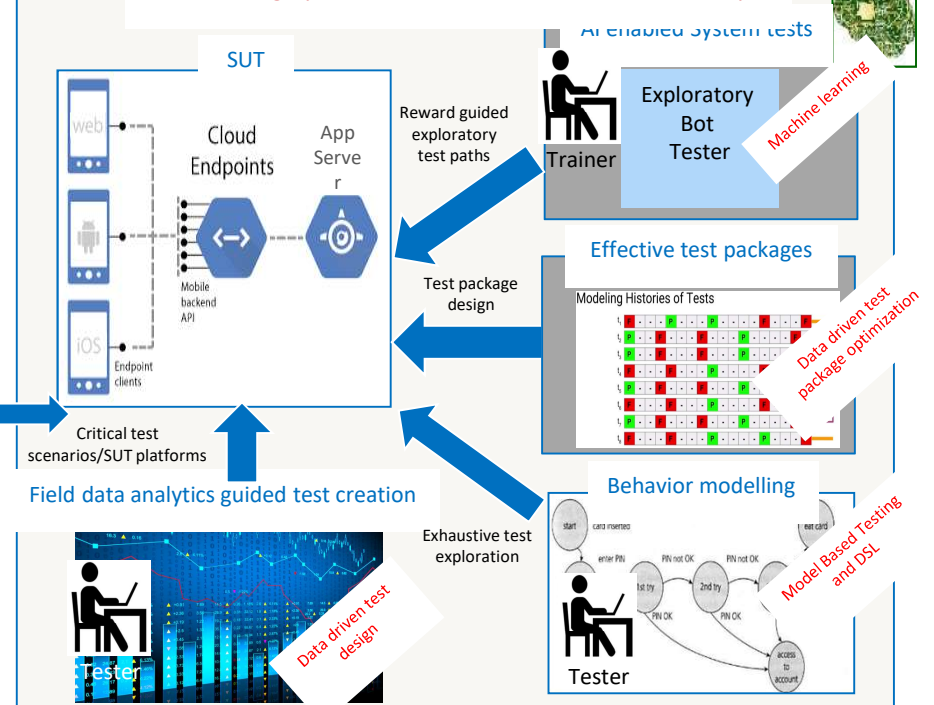
- Adaptive R&D Working & Collaboration Platform
- Intelligent Search & Knowledge Graph
- Development & Test Design Collaboration (with the same source)
- Correlate the Code iterations with corresponding Unit, Function, System Test cases
- Enhance the Unit Test Capability: Generation, Correlation & Test cases Management
- TDSL & Test case Modeling

Intelligent Test Design Overview

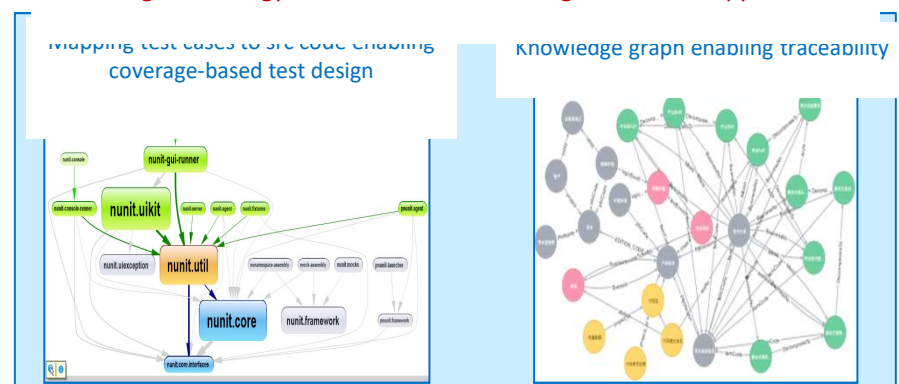
Strengthening Unit Testing with 2 methods



Increasing System Test effectiveness and efficiency



Building technology foundation for test design and other applications

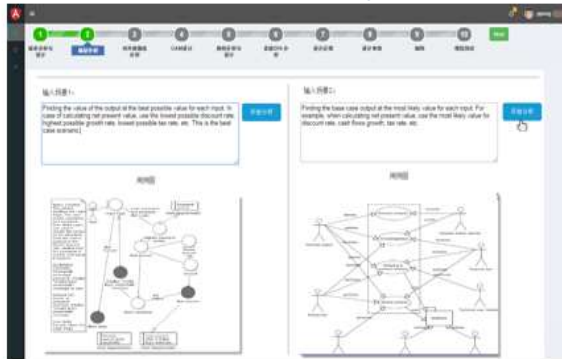


Intelligent Search & Knowledge Graph -- Example

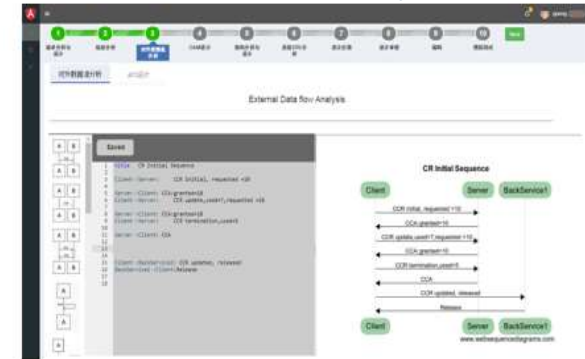
Requirement Analysis



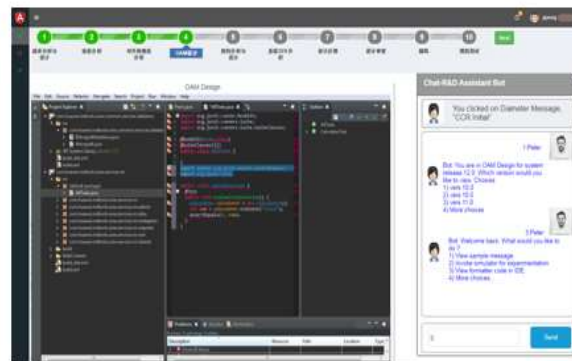
Scenario Analysis



API Analysis



OAM Design



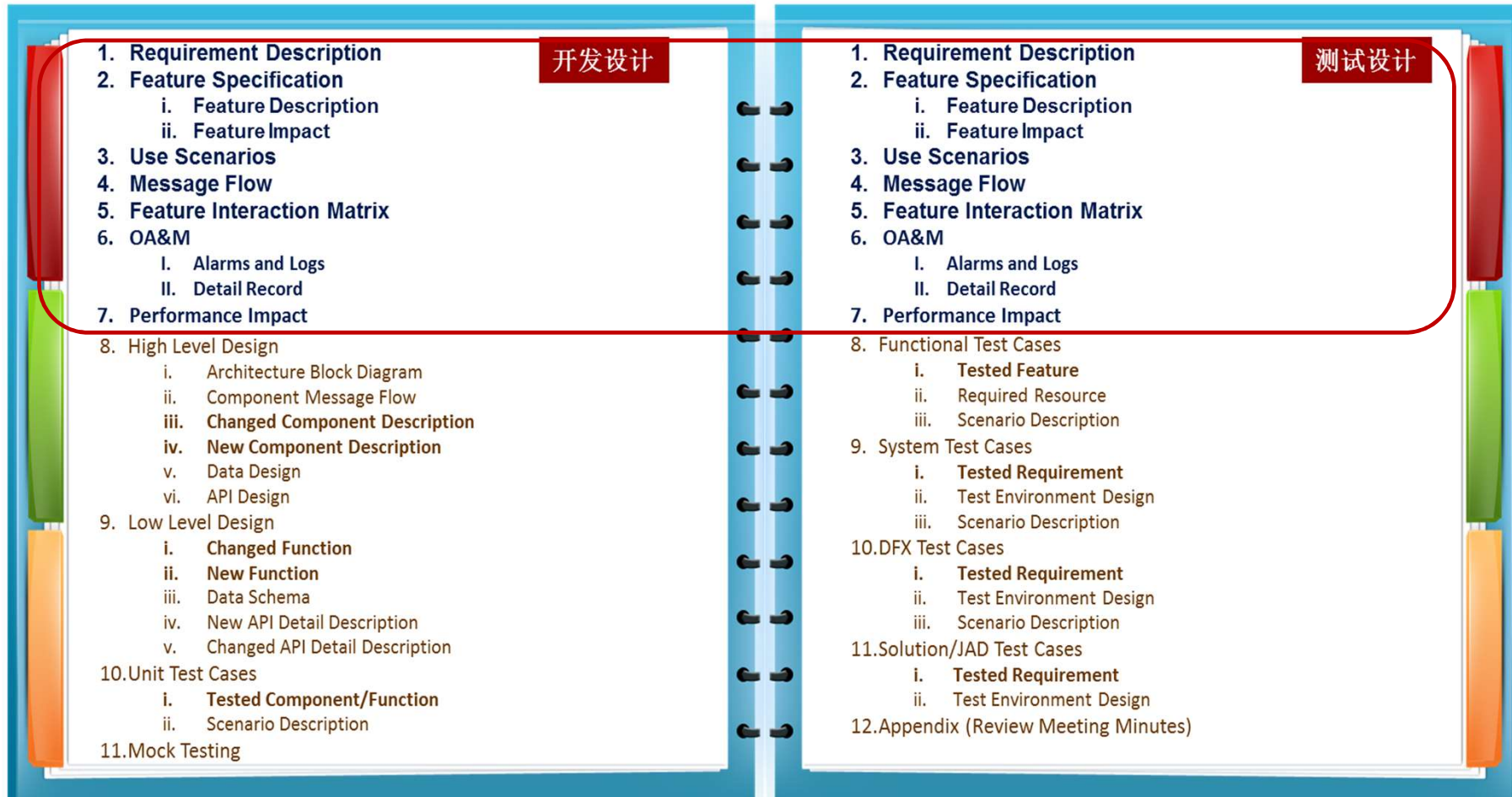
Architecture Analysis



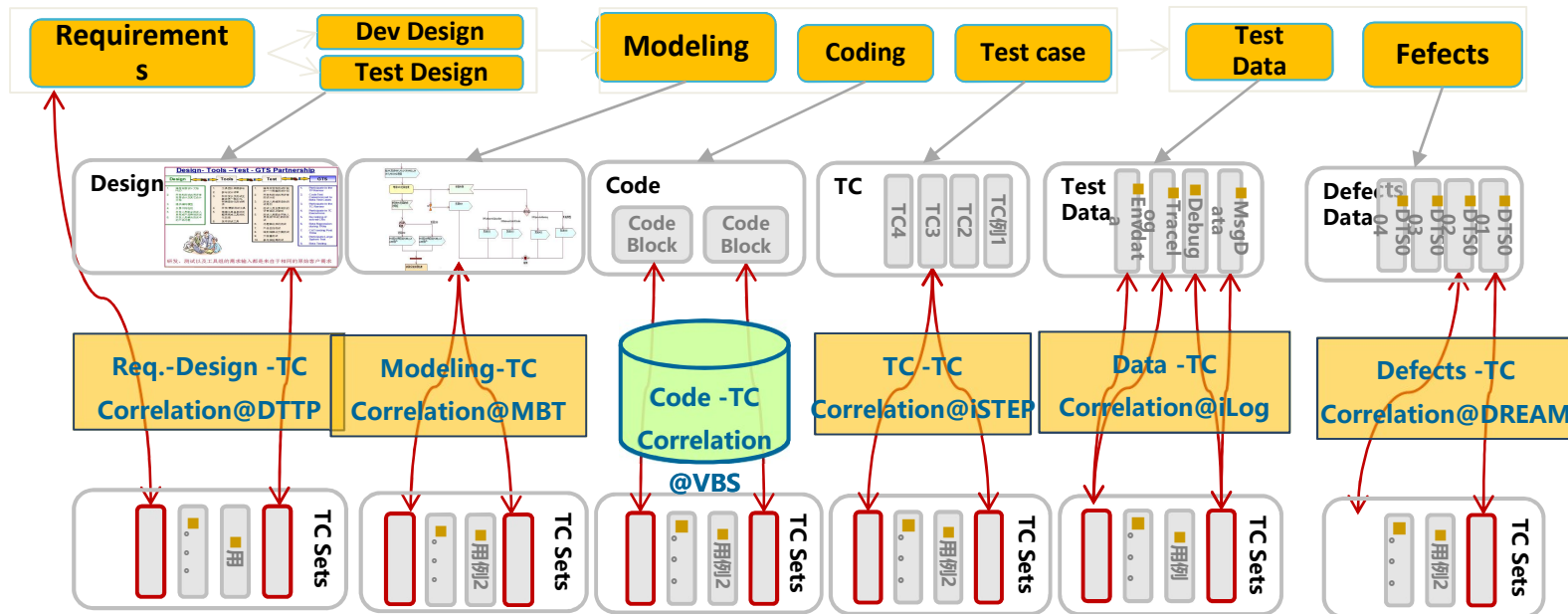
Capacity & Robustness



Ideal Development & Test Design Doc. Template

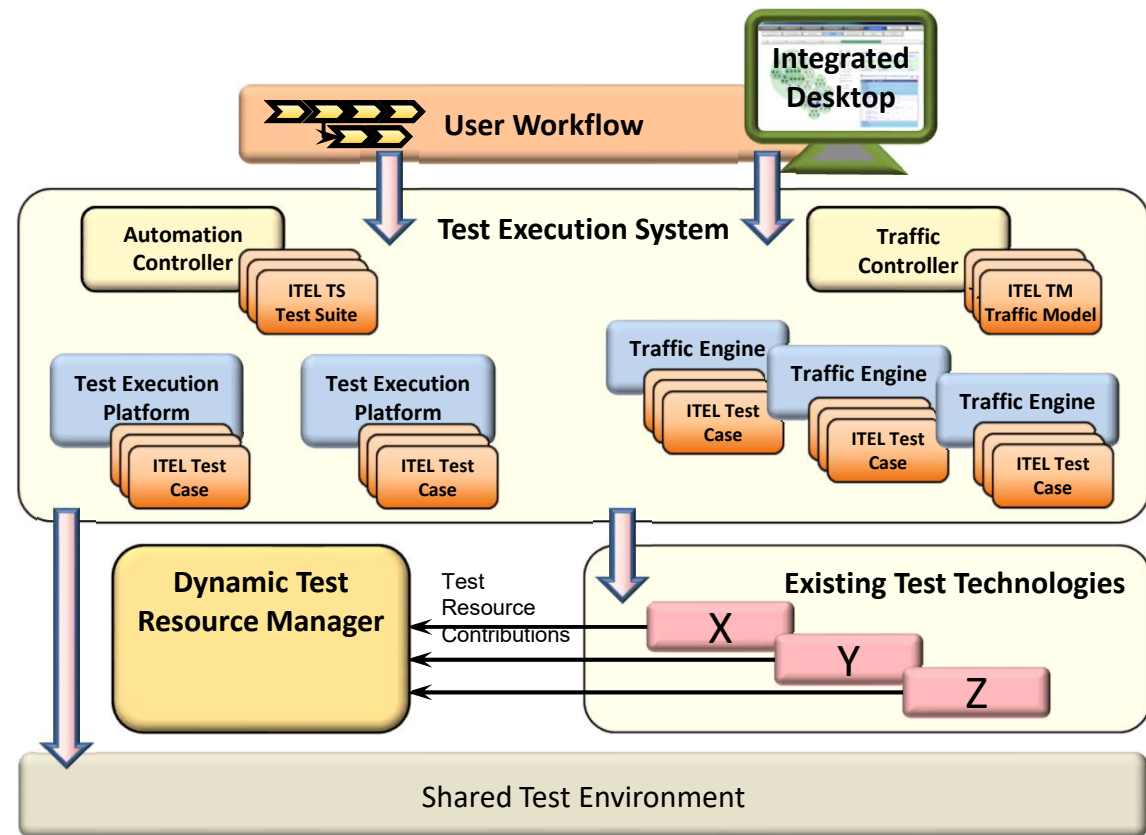


Test Case Centric Data Correlations



Functional & Non-Functional Test on Integrated Desktop

- » Test Execution System includes services for individual ITEL test case, ITEL test suite, and ITEL traffic model execution
- » ITEL test cases are reused across functional and non-functional test scenarios (capacity, robustness, etc.)
- » ITEL test cases leverage the same test infrastructure including the Dynamic Test Resource Manager and existing test technology integration capability
- » ITEL test cases execute on a dynamically built test environment that can be dedicated to specific test activities or shared among test activities
- » The user desktop is dynamic and workflow-based. It integrates functional and non-functional test capability as required by the user workflow.



ITEL: Intelligent Test Ecosystem Language

Intelligent Test Execution

□ What is Intelligent Test Execution ?

- Anytime, Any Place can execute the Test Cases via personal Devices
- Users do not need to worry about the Test Automation Framework & implementation Languages, all languages best practice will be effectively integrated with the system to execute the corresponding Test cases
- Effectively organize & define the TC suite, Test Environment, Test data, Test Data services, Test Logic and can execute in Parallel or sequential in order to fit the test execution strategy
- Effective, sufficient, realistic utilize the Resources & capability, prompt environment set up and maximize the TC execution efficiency
- Automated Test Execution Pipeline: Unit → Functional → System → DFX → Solution
- Effective Test Coverage Analysis to facilitate the Automated generate missing Test Cases

□ Scope of Intelligent Test Execution:

- Intelligent Test Execution
- Effective Test Automation Ecosystem
- Intelligent Test Strategy & Test Cases Selection mechanism
- Intelligent Test Environment set up
- Adaptive Test Execution Pipeline

Intelligent Test Analysis

□ What is Intelligent Test Analysis ?

- Facilitate the testers to collect complete error data and avoid the developers to do it again
- Provide the complete data to help the developers to conduct effective analysis & resolutions
- Search similar bugs and categorize those to avoid duplications
- Automate the Issue Ticket generation process to reduce the testers' workload
- Record the System & User interaction message flow to ease the reports & issue isolation process
- Correlate the system behaviors to better understand the system E2E status
- Analyze the root cause of the regression issues to identify the trouble Code
- Through the discovery of the system issues to evaluate the Test Effectiveness and better the Test suite

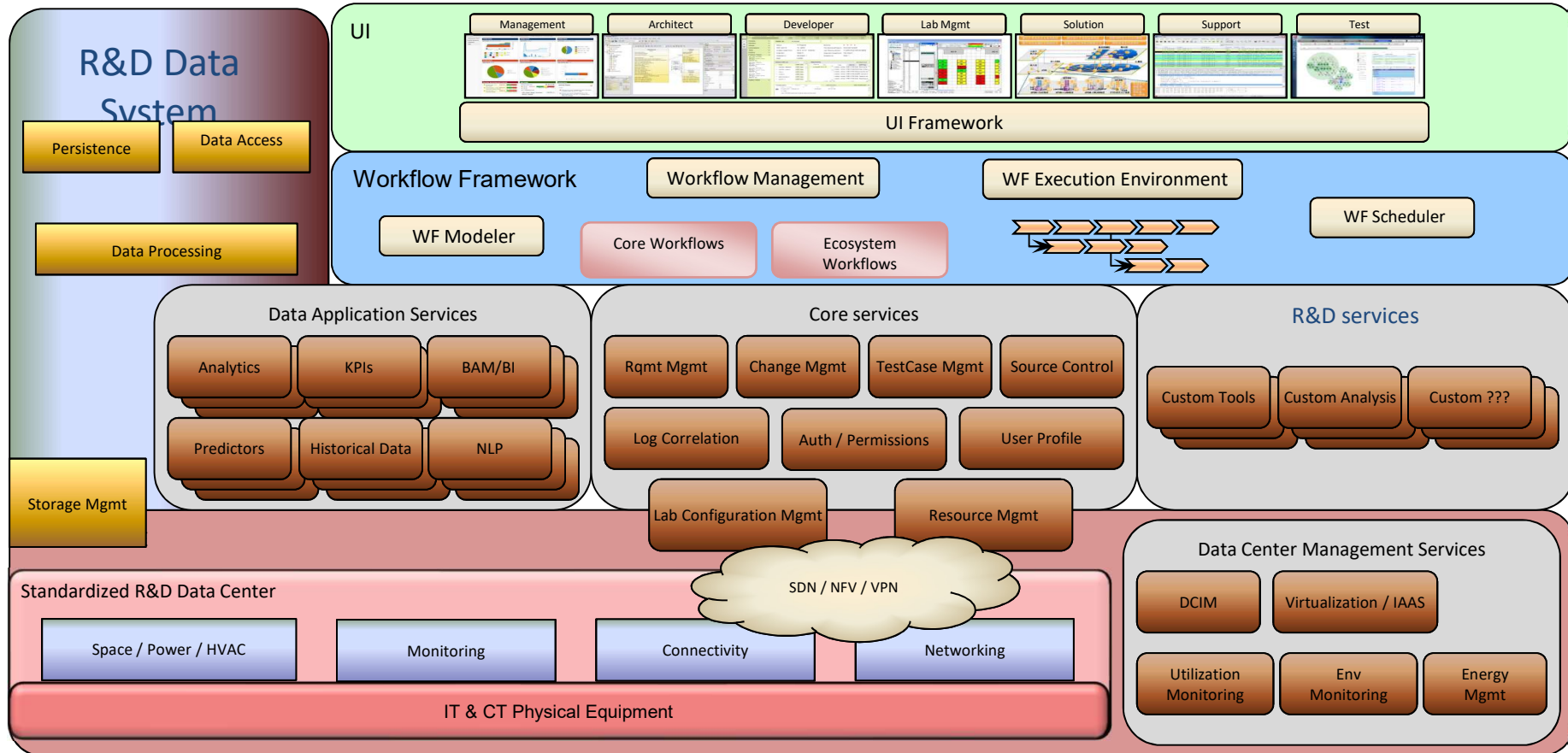
□ Scope of the Intelligent Test Analysis:

- Fault analysis
- Fault Isolation
- Test Execution Analysis
- Test Coverage Analysis

Intelligent Testing: Key Technology

- Self-Adaptive Working & Collaboration Platform (Projects, Activities, People Collaboration)
- Intelligent Test Design Document Framework & Auto-Verification
- Intelligent Search Service
- Test Knowledge Graph (Requirements, API, Scenarios, Architecture, Reliability, Logs/Alarms)
- Unit Test case Generation, Optimization, Management
- ITEL: Intelligent Test Ecosystem Language
- System Test case Modeling + Test Case Auto Generation + Selections
- Unit, System, Solution Test case Correlation
- Cloud Resource Dynamic Allocation
- Intelligent Test Execution Pipeline: Unit → Functional → System → DFX → Solution
- Via Black box Test cases automatically generate Unit/White Box Test cases
- Automatic Test case generation for Untested Code
- Fault Isolation
- Fault Localization
- Automatic Defect Resolution & Retest

Open & Service Oriented Ecosystem



Thank You !