

---

# **Analytics for Maintenance Services**

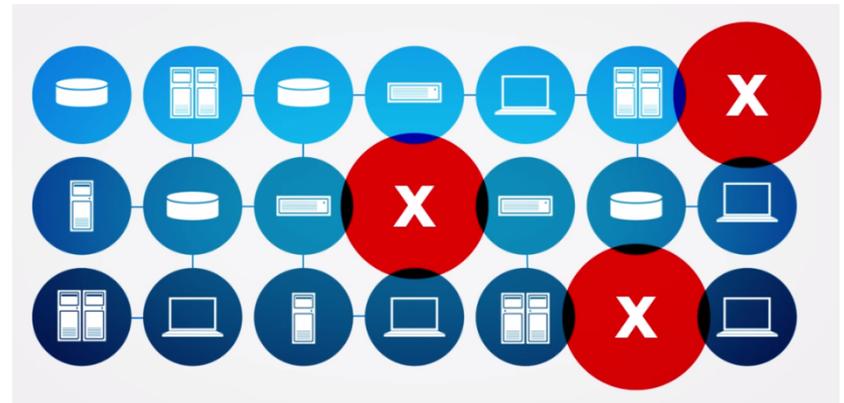
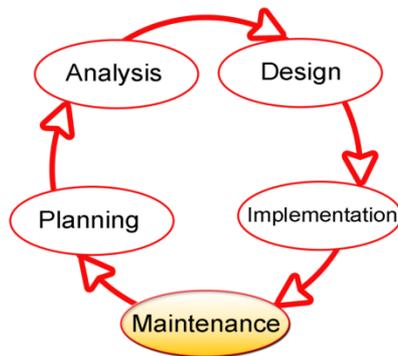
69<sup>th</sup> IFIP 10.4 WG Meeting, Jan 14, 2016  
Snowmass, Colorado

**Hari Ramasamy, Ph.D.**

Member, IBM Academy of Technology  
Research Staff Member and Manager  
IBM T.J. Watson Research Center

# Maintenance/Support Services: Overview

- “Maintenance services” broadly refers to “keep the lights on functions” such as
  - Replace or extend capacity
  - Maintenance and support of ongoing operations
- Production systems spend a significant portion of their lifecycle in the maintenance or steady-state mode
- Organizations spend a significant portion of their IT budget on maintenance services
  - 72% of IT budgets are spent on “keep the lights on functions” [Forrester survey of IT leaders at 3700 companies, 2013]
  - 92% of the cost of an average application occurs after the project has finished as “maintenance” [Gartner, 2013]
  - 70% of CIO budget for “running the business”, 30% for new or transformation projects [HCL Survey, 2014]
- Efficient delivery of hardware and software maintenance services is a global, multi-billion dollar business



Yearly Cost Metrics	Best-in-Class	Industry Average	Laggards
Business interruption events	.9	3	3.5
Time per business interruption event (hours)	1.3	4.7	8.4
Total disruption (hours)	1.2	14.1	29.4
Average cost per hour of disruption	\$60,000	\$110,000	\$98,000
Total cost of business interruption events	<b>\$72,000</b>	<b>\$1,550,000</b>	<b>\$2,880,000</b>

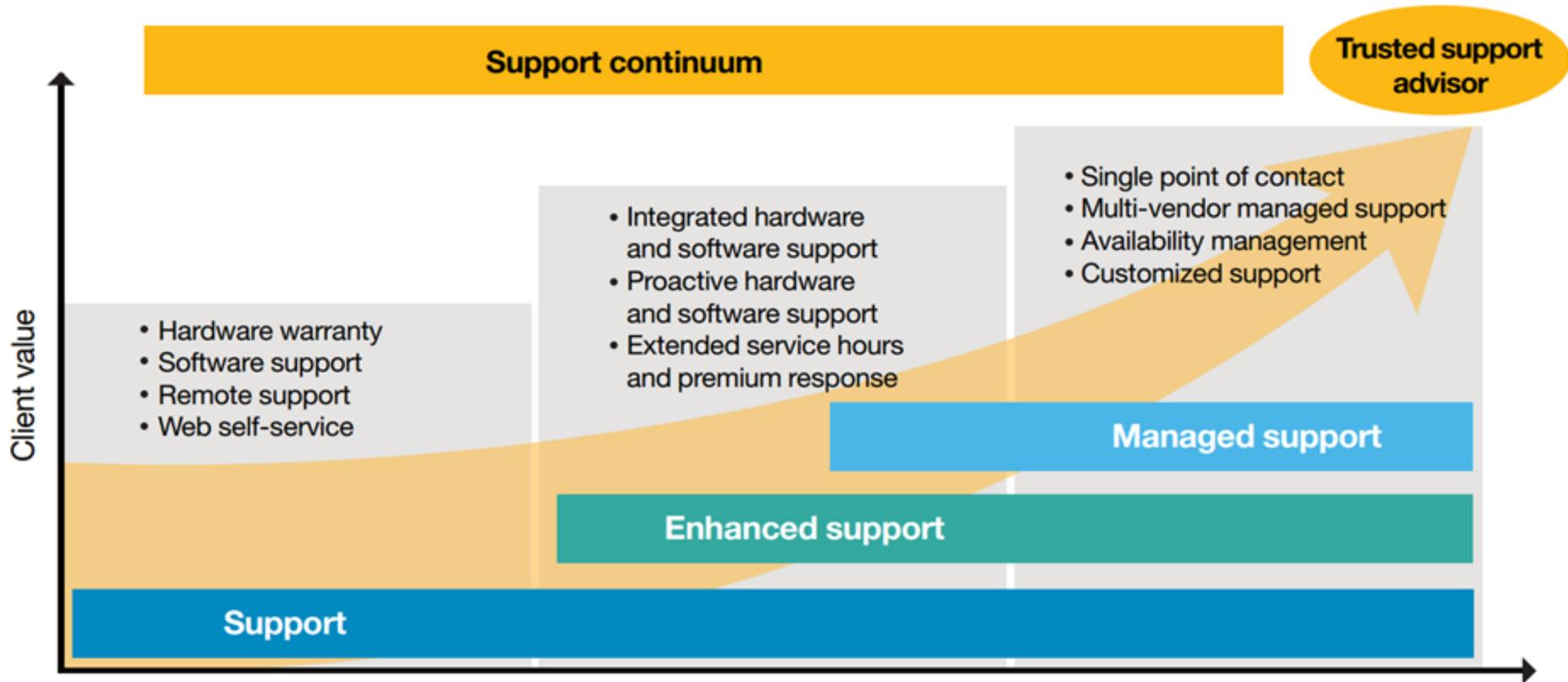
Source: Aberdeen Group

## The cost of a major outage per hour:

- **\$6.5M for Brokerage in the Financial industry**
- **\$2.6M for Credit Card sales in the Financial industry**
- **\$150K for Pay-per-view in the Media industry**
- **\$113K for Home Shopping TV in the Retail industry**
- **\$90K for Catalogue sales in the Retail industry**
- **\$90K for Airline reservations in the Transportation industry**

Source: Standish Group Research

# Types of Maintenance and Technical Support Services



- **Reactive Support** – Help Get The Systems Back Into Production ASAP
- **Proactive Support** – Keep Outages From Happening
  - Designed to reduce the number of events. Prevention is **ALWAYS** better than a cure
  - Includes predictive and preventive support

## IBM's Technical Support Services (TSS) by the numbers



**Parts arrive within 4 hours  
for 99% of US customers**

**90% First action plan  
success rate**

**13700 Hardware and  
Software problem  
transactions per day**

**Move approximately 27,000  
parts to customer locations  
all over the world each day**



# Tackling the Complexity of Maintenance Services

*“It isn’t surprising, though, that companies find it tough to compete in the aftermarket. Across industries, **delivering after-sales services is more complex than manufacturing products.**”*

- Cohen, M.A. et al. (2006), Winning in the Aftermarket, Harvard Business Review.

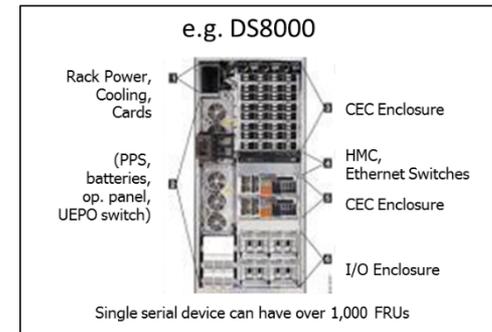
**Client  
Expectation  
Complexity**

- Fast resolution times
- Cost expectation (from client and internal cost constraints)

**IBM DS8K  
Storage  
Product  
Complexity**

**7k Machine/Model/Feature Configurations**  
**257k Active MA/Warranty Devices**  
**2k Active FRU Part Numbers**

**Typically experts needed to diagnose, fix problems**



**IBM US Storage  
Support  
Logistics  
Complexity**

**114 Field Stocking Locations**  
**599 Client Stocking Locations**  
**42k Zip Codes, 4.1k US Clients**  
**36k Client Locations**  
**48k Unique FRU/Stock Locations**



# Sample Customer Calls

## ▪ Windows

- I applied a hotfix and now the server won't boot.
- Why are my cluster resources not coming online?
- Active Directory migration errors, when migrating from NT to Windows 2003 Enterprise Server.
- Why does Internet Explorer shut down when I click the refresh button?

## ▪ Linux

- How do I setup crashdumps in Linux?
- How do I install a Linux device driver?
- Do you have documentation on setting up NFS and the mount command?
- Can you help with my installation of Linux?

## ▪ VMware

- How can I install a virtual machine from an ISO image?
- My ESX Server crashed. Can you help me diagnose the panic?
- What ServeRAID version is compatible with VMware ESX Server?
- How can I setup VMware ESX Server to share my SAN network?

## ▪ IBM Director

- How do I update my IBM Director levels using Software Distribution?
- Why is IBM Director causing 100% CPU utilization?
- Why are my event action plans not sending SMTP messages?
- Unable to discover IBM Director Agent.

## ▪ System x

- System won't boot after updating driver.
- How do I configure my ServeRAID adapter?
- Blade server does not turn off during Linux shutdown.
- "SERVER WAS MAKING NOISE AND SEEMED WARM, AND NOW WILL NOT START"

## ▪ Storage

- Unable to map LUNs to the host group
- File system corruption after upgrading FASTT firmware.
- When adding host ports, I receive a message that they already exist.
- "Unable to open physical volume" error when importing virtual drives.

---

## Key Metrics in the Maintenance Services Business

- Time taken to resolve the problem (fix-time)
- Success of the resolution (no repeat call for the same problem)
- Escalations across levels of support

# The Infrastructure Underlying IBM's Maintenance Services

## Remote Monitoring

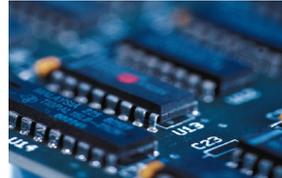
- Call home feature
- Remote diagnostics

System Monitor  
Call Home



## WW Parts Management System

- Service Parts Supply Chain expertise
- Parts planning & procurement
- Logistics
- Reutilization
- Inventory Optimization



## Service Delivery Planning

- Product support planning
- Maintenance package effectiveness
- Serviceability requirements
- Client call history
- Performance monitoring



## Customers

- Electronic access
- Self service
- Electronic problem submission



**Integrated  
IBM Maintenance and Technical  
Support  
infrastructure**

## Worldwide Service Databases

- Account information
- Product information
- Service applications
- Problem history
- Installation planning

## Response Coordination

- Service rep availability
- Call assignments
- Skill profiles
- Entitlement



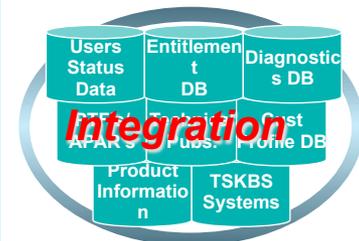
## Remote Support Centers

- Problem determination
- Technical action plans
- Problem resolution



## IBM Service Rep

- Wireless comm.
- Service call reporting
- Parts ordering
- Tech info
- Education



# Delivery Process for IBM's Maintenance Services



**50M**

service related events per year

**5.5M**

events become service requests

Clients resolve the majority of events on their own using the IBM Support Portal

 Create a service request

800-IBM-SERV 

ibm.com/support 

Call Home 

 Automated review

 Remote technical support attempts to resolve

 Verify coverage

 Field support works onsite

 Install necessary parts

## Functional Delivery Summary

### Level 0 Call Reception and Entitlement

Call receipt (phone, electronic, call home)  
Entitlement check, service ticket creation

### Remote Technical Support

Problem analysis and determination  
Resolution action plan development  
Service Rep. and parts dispatch

### Field Services

Onsite repair under managed SLO/SLA's  
Resolution action plan development  
Service Rep. and parts dispatch

### Parts Logistics

Inventory management  
Warehousing, transport, delivery  
585 global stocking sites  
480K part numbers  
Volumes- millions of pieces shipped

# Research Areas Driving the Science of Maintenance Services

## Cognitive Research



Innovative combinations of man and machine

- Knowledge Management
- Learning Methods
- Feedback Mechanisms
- Cognitive Interfaces
- Natural Language Processing
- Dialogue Management

## Analytics Research



Driving performance and optimization insights from data

- Statistical Modelling
- Machine Learning
- Predictive Insights
- Multi-variant Optimization
- Ontology strategies

# Example #1: Analytics for Enterprise Storage Maintenance

(Almaden Research Lab)

- Modern storage area networks (SANs) are big and INTERCONNECTED

More devices

Denser connectivity

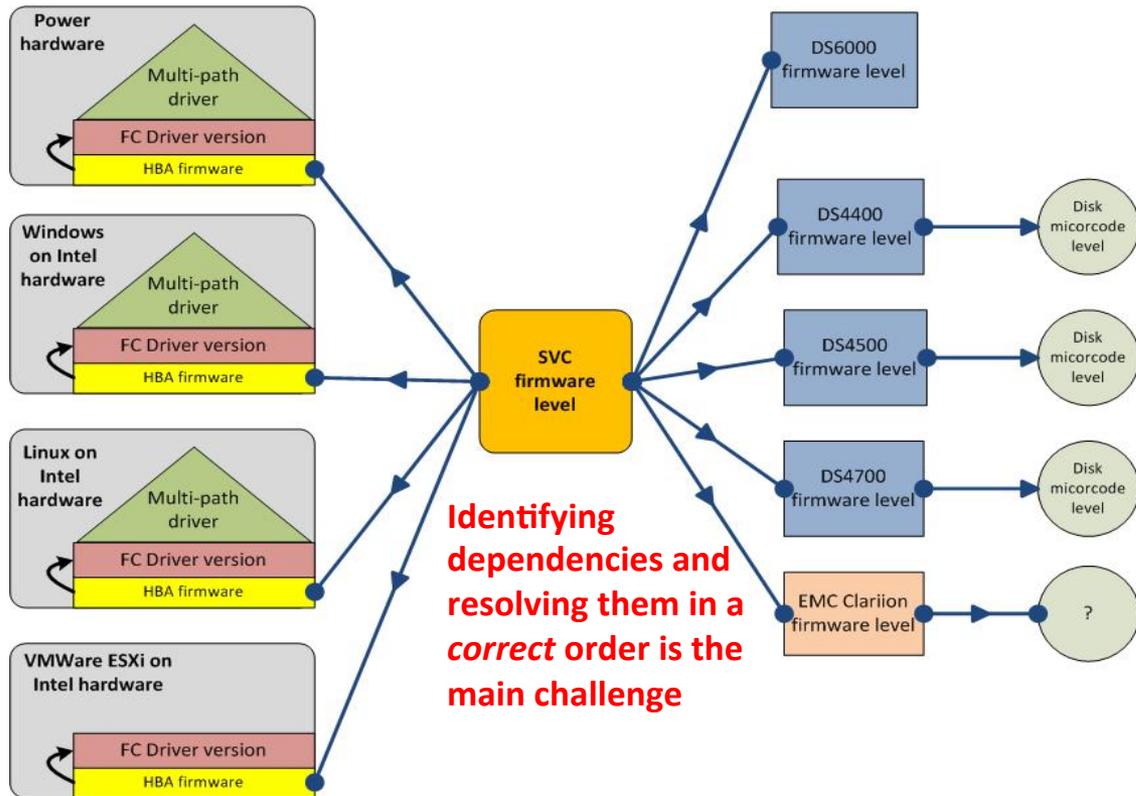
Greater interdependence



Failures cascade  
→ *fast*

- Firmware & interoperability issues present significant risk
  - **Outages:** Back-level firmware and interoperability failures cause long outages, often with data loss
  - **Expensive:** Lot of manual work in each storage upgrade project – data collection, analysis, execution
  - **High opportunity cost:** Upgrades are reactively done utilizing crucial change windows & delaying other projects

## Example complexity: SVC firmware upgrade from v4.3 to v6.2.0.5



### Process flow\*

- Storage admin contacts server admin and communicates upgrade plan to R6.2.0.5
- Server admin gathers required information for each server connected to SVC:
  - HBA firmware levels
  - Driver levels
  - OS levels
  - Multi-path software levels ...
- Server admin checks each level associated to SVC 6.2.0.5 on interoperability website
- Any code level that is not at an acceptable version will need to be upgraded requiring an outage

During a recent upgrade at a transportation customer, the customer IT team spent 60 hours for data collection and 20 hours for analysis of 200 servers ~ 25 min / server

=====

Advanced analytics can drastically reduce this time to ....

less than 1 hour!

(Almaden Research Lab)

\* This is an “easy” scenario; more complex scenarios occur in practice – servers connected to other storage that also needs to be compatible with new levels causing a dependency chain

## Understand

### End-to-end discovery of IT HW infrastructure

- Servers, storage, SAN fabric and network for IBM and non-IBM devices
- Complete inter-connectivity and topology of the SAN
- Set it & forget it: automated data feed to backend engine

### Prioritized remediation plan

- Devices requiring firmware upgrades
- Remedial levels for each device
- Order of remediation

### Assess impact of remediation plan

- What-if analysis of upgrading to remedial level
- Time estimate to do the upgrade



## Analyze

### Automated storage firmware level testing

- Compare with vendor recommendations
- Automatic identification of devices with levels approaching or past end-of-support date

### Interoperability testing

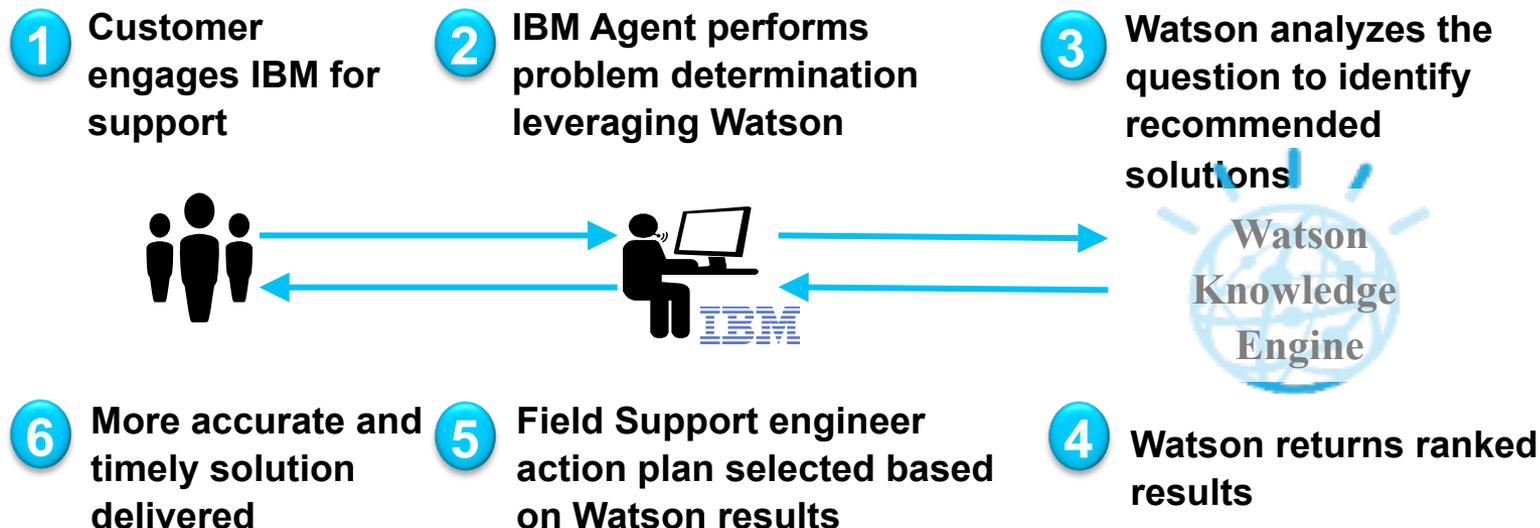
- Test compatibility between connected devices
- Compare with vendor published interop results

### Risk scores for each device

- Considering firmware level staleness, utilization, etc.

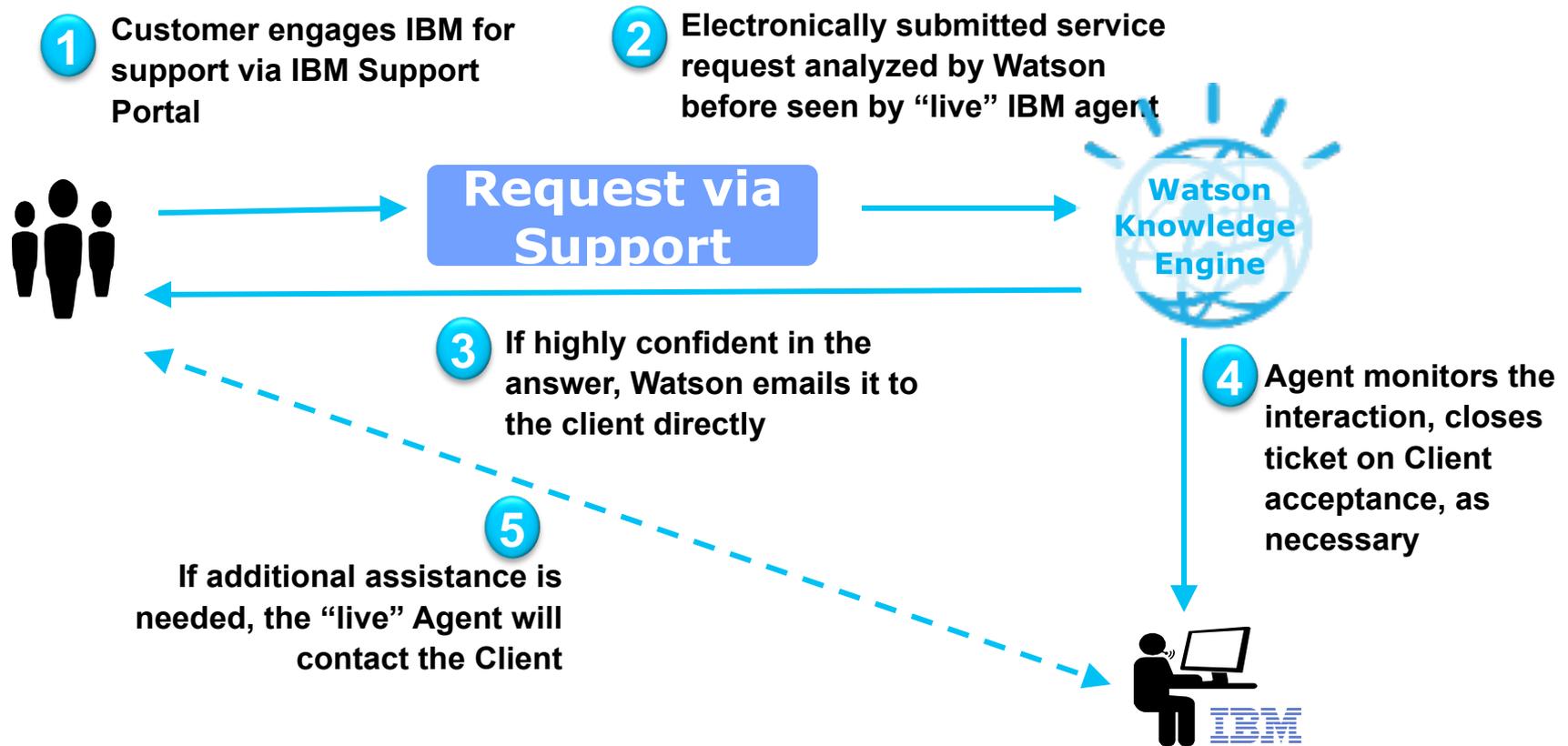


## Recommend



**37%** reduction in problem determination time

- In production globally today (2016) for System x and IBM Storage and IBM Power





## Example #3: Capturing Expert Knowledge

### *Natural Language Processing Challenges*

- ❑ Current State: Field Agents / Support Staff capture previous fix operations in problem management records (PMRs).
  
- ❑ The current problem management records are **highly unstructured** and **very noisy**:
  - ❑ System configuration data.
  - ❑ Records of email exchanges between agents and customers.
  - ❑ Machine generated text to document email exchanges between agents and customers and data exchanges.
  - ❑ OS and system commands used to diagnose the problem.
  - ❑ Unstructured text entered by the agent to document what has been done and how the problem was resolved.
  - ❑ Often solutions/fixes are not documented properly which render a large set of PMRs useless
  - ❑ Several PMRs are duplicates or auto-closed
  
- ❑ It is difficult to use this information computationally because of the noisy nature of the data.



## Example #3 Capturing Expert Knowledge (continued): Knowledge Extraction from Problem Management Records (PMRs)

- ❑ The goal is to use natural language processing and machine learning techniques to analyze HW PMR text and extract relevant knowledge from it: (e.g., **problem description**, and **resolution or fix applied**)
- ❑ The approach is to train and build a machine learning model that is capable of classifying text fragments of a PMR text as either belonging to one of three classes:
  - ❑ Problem Description
  - ❑ Fix or solution Description
  - ❑ None of the above

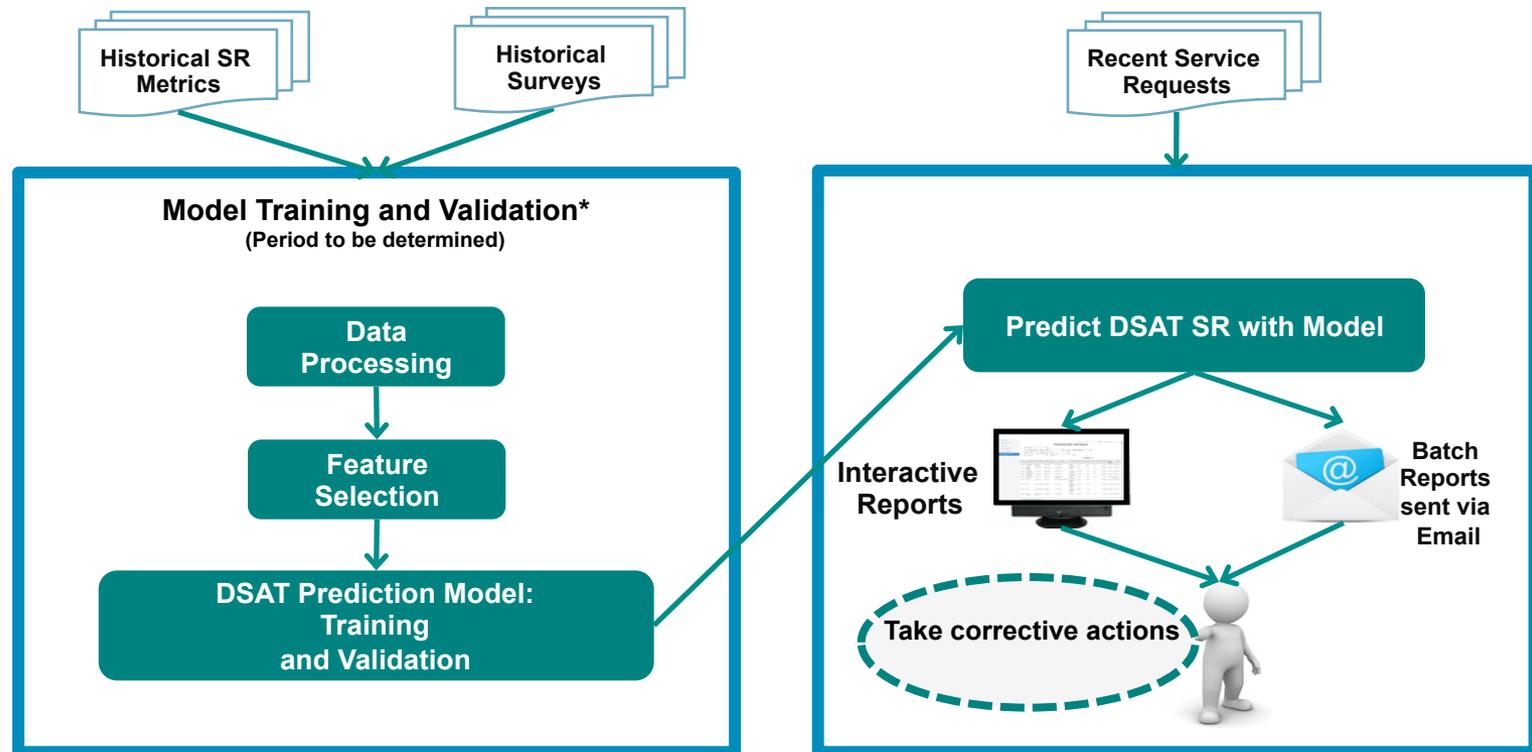
```
-SYSTEM GENERATED TEXT--D/T8205E6C--POCID=RAL -----14/09/24-08:44--RE
09/24 0944 <p-agent>PDISK9 FAILED FROM DISK ARRAY</p-agent>. <s-agent>NEED TO REPLACE. 146GB DRIVE,
FRU 46K4806, LOC: U5887.001.G22A01N-P1-D10</s-agent>, <p-agent>SRN: 2518-9030 </p-agent>* GOVT = Y
-SYSTEM GENERATED TEXT--CHIPPC1 -POCID=RAL -----14/09/24-08:44--RU
CROSS 09/24 09:44 ZRS TG: Target Arrival Time (TAT TG=092414 1344
-SYSTEM GENERATED TEXT--CHIPPC1 -POCID=RAL -----14/09/24-08:44--RU
CROSS 09/24 09:44 ZRS CR: Correction Of SR Assignm RETAIN, HWSCRE
```

Classified as a  
"problem  
description" Text  
Fragment

Classified as a "Fix  
Description" Text  
Fragment

## Example #4: Customer Survey Analysis for Customer Survey Response Prediction

- Measuring customer satisfaction and responding to dissatisfaction (DSAT) is essential for retaining and attracting new customers in services industries.
- How can analytics help identify service requests for which customers may not be satisfied, without conducting surveys?*



**\* Model is trained per country. If data is sufficient, model can also be trained per platform within each country.**



# Endless ways analytics can provide additional efficiency in Support Services

## Operational Efficiencies

- Problem Resolution
- Entitlement Analytics
- Predictive Analytics
- Automated Remediation
- Cognitive learning
- Context awareness
- Parts / Supply Optimization
- Self Assist technologies (dialog management, etc.)

## Opportunity Identification

- Unified Reporting
- Client Satisfaction
- Sentiment Analysis
- Erosion Analytics
- Contract Renewal Analytics

**And many more...**



# Optimization of Maintenance Services: A Journey



## Reactive

Fix after failure

Inspect/Replace per regulatory requirements r supplier recommendations



## Predictive using historical and real time data

Model probability of failure as a function of signals from sensors, usage, external factors

Prioritize maintenance activities based on probability of failure and cost of repair



## Risk aware predictive

Model system-wide cost of failure and system-wide cost of repair

Apply trade-off logic, based on expected net cost and/or limiting likelihood of high cost outcome



## Optimized

Include allocation of inventory and skilled resources in any of the above resources to determine maintenance schedule and to execute next best action