Industry 4.0

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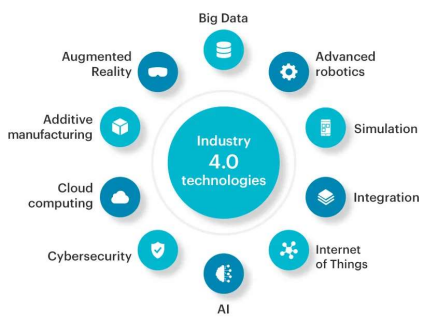

- Advanced sensing
- Smart Manufacturing
- IIOT
- Digital Twin
- CPS

1

Introduction to Big Data and Big Data Analytics

2

2

contents

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- Evolution of Big data
- sources of Big Data
- What is Big Data?
- Characteristic of Big Data(5 Vs)
- Tools used in Big Data
- Introduction to Big Data analytics
- Big Data analytics goals
- Applications/use cases of Big Data analytics
- Challenges of Big Data
- How Hadoop solves the Big Data problem

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Evolution of Big Data

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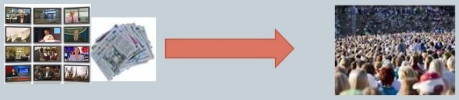
- **The Model of Generating/Consuming Data has Changed**

Old Model: Few companies are generating data, all others are consuming data



New Model: all of us are generating data, and all of us are consuming data

4

Unit of Data size	Exact size	Approximate Size	Examples	
KB (kilobyte)	2^{10} or 1024 bytes	(10^3 or one thousand) bytes	A typical joke =1KB	
MB(megabyte)	2^{20} bytes	(10^6 or one million) bytes	Complete work of Shakespeare =5MB	
GB (gigabyte)	2^{30} bytes	(10^9 or one billion) bytes	Ten yards of books on a shelf = 1GB	
TB (terabyte)	2^{40} bytes	(10^{12} or one trillion) bytes	All the X-rays for a large hospital =1TB Tweets; created daily =121TB;	
PB (peta byte)	2^{50} bytes	(10^{15} or one quadrillion) bytes	All U.S. academic research libraries = 2PB Data processed in a day by Google =24PB	BIG DATA
EB (exa byte)	2^{60} bytes	(10^{18} or one Quintillion) bytes	Total global data created in 2006 = 161EB	
ZB (zetta byte)	2^{70} bytes	(10^{21} or one Sextillion) bytes	Total amount of global data created in 2012 = 2.7 ZB and expected 44 ZB by 2020	
YB (yotta byte)	2^{80} bytes	(10^{24} or one Septillion) bytes		

5

6

Petabyte era

1 PB = 1000000000000000B = 1015bytes = 1000terabytes

1000 PB = 1 exabyte (EB)

- AT&T transferred about 197 PB of data thorough its network each data (2018)
- processed about 24 petabytes daily (2009)

In fact, we can say that we have already entered the exabyte era.

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Evaluation of Big Data

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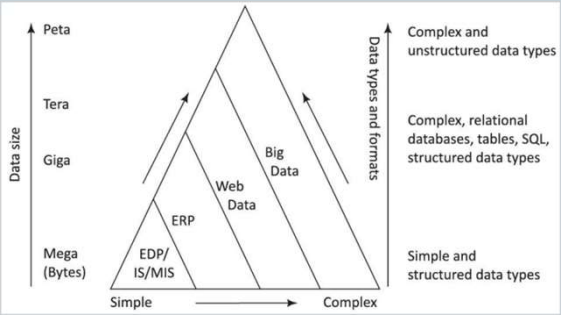

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Evaluation of Big Data

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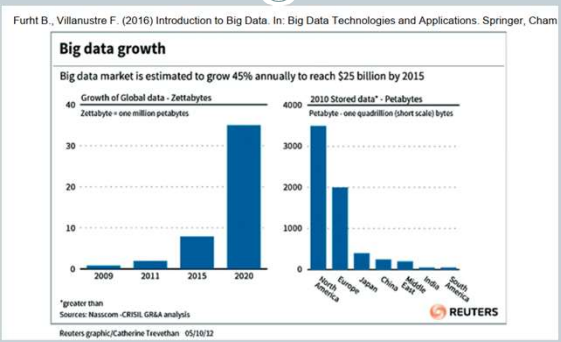

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Evolution of Big Data by technology

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Evolution of Big Data by Internet Of Things

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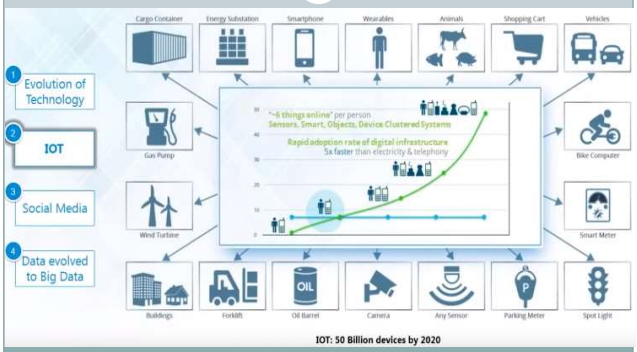

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Evolution of Big Data by Social Media

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Evolution of Big Data by other factors

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Big Data sources

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- Human Generated Data
  - is emails, documents, photos and tweets. We are generating this data faster than ever. Just imagine the number of videos uploaded to You Tube and tweets swirling around. This data can be Big Data too.
- Machine Generated Data
  - is a new breed of data. This category consists of sensor data, and logs generated by 'machines'
  - such as email logs, click stream logs, etc. Machine generated data is orders of magnitude larger than Human Generated Data.

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Big Data sources

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- **Web Data**
  - **Social media data** : Sites like Facebook, Twitter, LinkedIn generate a large amount of data
  - **Click stream data** : when users navigate a website, the clicks are logged for further analysis (like navigation patterns). Click stream data is important in on line advertising and E-Commerce

12+ TBs of tweet data every day

25+ TBs of log data every day

? TBs ofdata every day

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Big Data sources

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sensor data : sensors embedded in roads to monitor traffic and misc.

30 billion RFID tags today (1.3B in 2005)

4.6 billion camera phones world wide

100s of millions of GPS enabled devices sold annually

2+ billion people on the Web by end 2011

76 million smart meters in 2009... 200M by 2014

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What is Big Data?

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Big data

is the term for a collection of data sets so large and complex that it becomes difficult to process using traditional data processing applications.

Real world examples of Big Data

- Facebook : has 40 PB of data and captures 100 TB / day
- Yahoo : 60 PB of data
- Twitter : 8 TB / day
- EBay : 40 PB of data, captures 50TB/ day

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What is Big Data?

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- Big Data is high-volume, high-velocity and/or high-variety information asset that requires new forms of processing for enhanced decision making, insight discovery and process optimization

(Gartner 2012)

- Term big relates to size of the data and hence the characteristic Size defines the amount or quantity of data, which is generated from an application(s).
- The size determines the processing considerations needed for handling that data

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Characteristics of Big Data(5 Vs of Big data)

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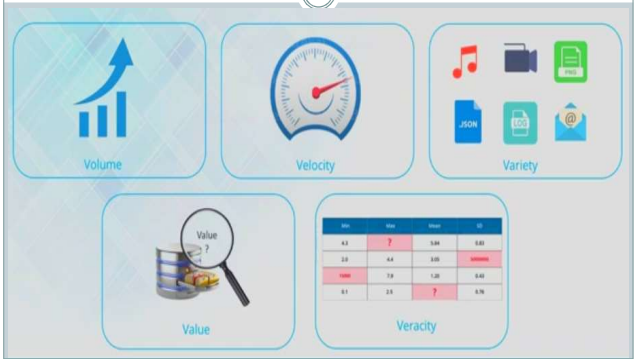

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Characteristics of Big Data(5 Vs of Big data)

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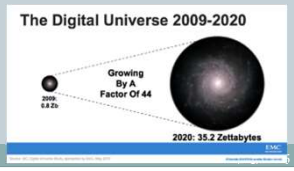
- 1st V-volume

- **Data Volume**
  - 44x increase from 2009 to 2020 From 0.8 zettabytes to 35zb
  - Data volume is increasing exponentially



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Characteristics of Big Data(5 Vs of Big data)

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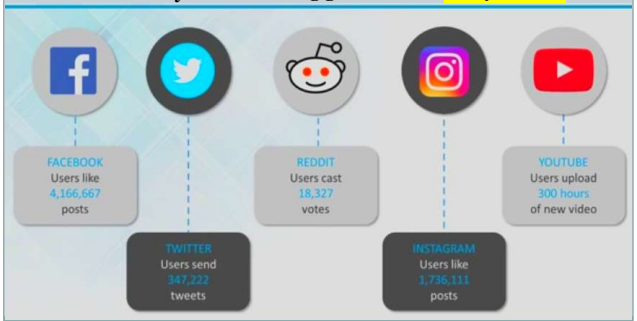
- 2nd V-velocity: **Data is being generated at every minute**



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Characteristics of Big Data(5 Vs of Big data)

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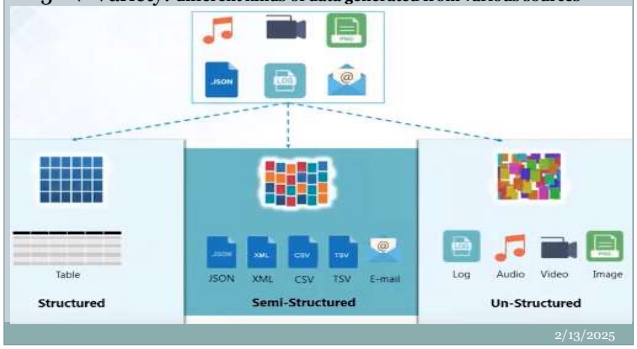
- 3rd V-Variety: **different kinds of data generated from various sources**



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Characteristics of Big Data(5 Vs of Big data)

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- 4th V - Veracity: **uncertainties and inconsistencies in big data**

Min	Max	Mean	SD
4.3	?	5.84	0.83
2.0	4.4	3.05	50000000
15000	7.9	1.20	0.43
0.1	2.5	?	0.76

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Characteristics of Big Data(5 Vs of Big data)

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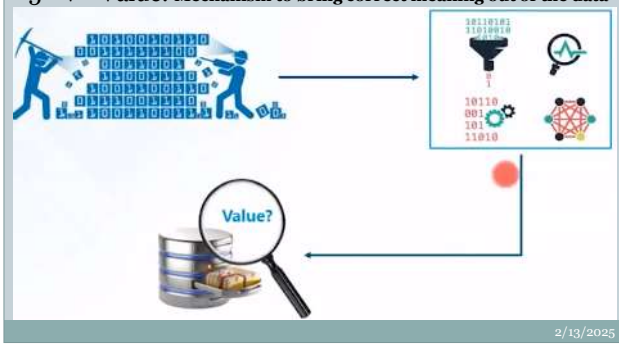
- 5th V - Value: **Mechanism to bring correct meaning out of the data**



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Characteristics of Big Data(5 Vs of Big data)

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Characteristics of Big Data(5 Vs of Big data)

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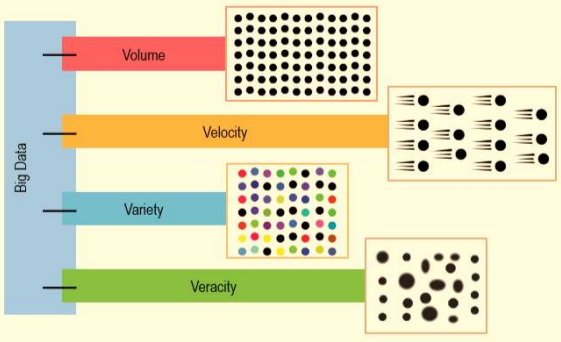

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Traditional DB vs Big Data

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Traditional data base/ data warehouse	Big Data
• Data ○ TB to PB ○ Only structured • Hardware ○ big central servers ○ Expensive ○ Hardware reliability ○ Limited scalability • Software ○ Centralized ○ Schema based ○ Oracle/mysql/sql server	• Data ○ PB to ZB ○ structured and unstructured • Hardware ○ computer clusters ○ Cost effective ○ Unreliable HW ○ Scales further • Software ○ Distributed ○ Not schema based ○ Hadoop

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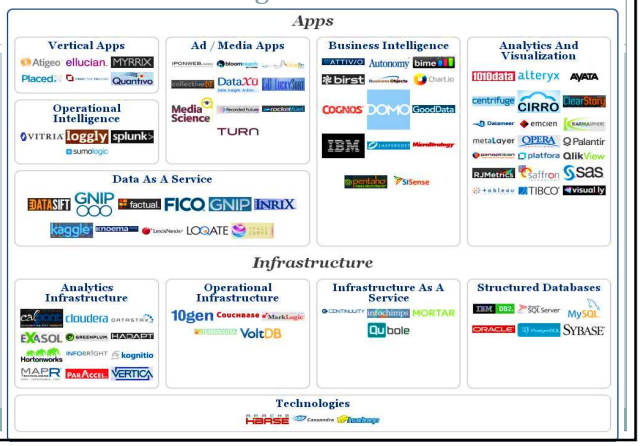
Big data tools



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Big data tools

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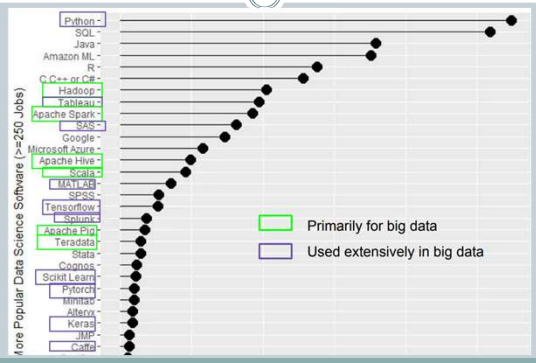

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What is Big data analytics

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"Big data analytics examines large and different types of data to uncover hidden patterns, correlations and other insights"

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Big Data Analytics Objectives

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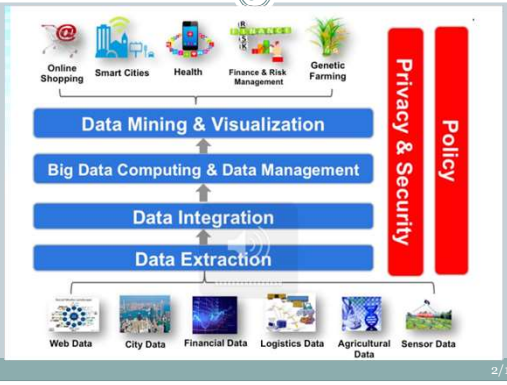

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Stages in Big data analytics

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Big data analytics goals

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Big data analytics goals

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1.Making organizations more smarter and efficient

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Big data analytics goals

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2 Optimize Business Operations by analysing customer behaviour

Analysing all the clicks of every visitor on a website

Studying the paths leading them to buy products

Customer Satisfaction

Amazon uses customer click-stream data and historical purchase data of more than 300 million customers and each user is shown customized results on customized web pages.

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Big data analytics goals

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3 Cost Reduction

Parkland Hospital uses analytics and predictive modelling to identify high-risk patients and predict likely outcomes once patients are sent home. As a result, Parkland reduced 30-day readmissions for patients with heart failure, by 31 percent, saving $500,000 annually.

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Big data analytics goals

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4 Next Generation Products

Big Data tools are used to operate Google's Self Driving Cars. The Toyota Prius is fitted with cameras, GPS as well as powerful computers and sensors to safely drive on the road without the intervention of human beings.

Netflix launched the seasons of its TV show House of Cards based on the user reviews, ratings and viewership.

NETFLIX

A smart yoga mat has sensors embedded in the mat will be able to provide feedback on your postures, score your practice, and even guide you through an at-home practice.

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Big data analytics application domains

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Domains using Big Data Analytics

Healthcare
Telecom
Insurance
Government
Big Data Analytics
Finance
Automobile
Education
Retail

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Big data analytics use cases

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Use Case 1 - Starbucks

STARBUCKS COFFEE

Starbucks uses behavioural analytics to cater to its customers

Starbucks gather a lot of info about their customers' coffee-buying habits from their preferred drinks to what time of day they're usually ordering

The company directs exciting offers and coupons to their customers and ensures to maintain their interest

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Big data analytics use cases

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Use Case 2 – Procter & Gamble

P&G
Procter&Gamble

P&G uses Market Basket Analysis and price optimization to optimize their products

Market Basket Analysis, analyses customer buying habits by finding associations between the different items that customers place in their 'shopping baskets'

The company uses simulation models and predictive analysis in order to create the best design for its products.

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Big data analytics use cases

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Walmart boosted its sales by leveraging the power of Big Data

While forecasting the demand for emergency supplies for approaching Hurricane Sandy, they gain some amazing insights:

Walmart

Extra supplies of Strawberry Pop Tarts were dispatched to stores in Hurricane Sandy's path in 2012, and sold extremely well

Along with flashlights and emergency equipment, they found an upsurge in sales of strawberry Pop Tarts

HURRICANE SEASON

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Big data analytics use cases

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Big Data helped Donald Trump to win against Hillary Clinton in the US election

Collect Personal data from various resources like club cards, newspaper Subscription, social media, etc.

Messages were targeted based on voter profiles using platforms such as Facebook, Snapchat, Pandora radio, etc.

Build an algorithm that generated top cities to reach the highest concentration of persuadable voters

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Big data analytics use cases

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Apixio uses big data analytics to improve healthcare decision

APIXIO

80% of medical and clinical information about patients is in unstructured format, such as written physician notes

Analysis of medical data using variety of different methodologies & algorithms that are machine learning based and have NLP capabilities

The patient data model generated is aggregated across population to derive larger insights like disease prevalence, treatment patterns, etc.

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Big data analytics use cases

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- IBM Big data analytics – Big data collected by smart meters

Data was collected in 1 Month

Earlier

Data is collected in 15 Minutes

Now

Managing the large volume and velocity of information generated by short-interval reads of smart meter data can overwhelm existing IT resources

96 million reads per day for every million meters

Big Data generated by Smart Meter

IBM

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Big data analytics use cases

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- IBM Big data analytics – problem with smart meter big data

To manage and use this information to gain insight, utility companies must be capable of high-volume data management and advanced analytics designed to transform data into actionable insights.

Store

Analyze

IBM

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Big data analytics use cases

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- IBM Big data analytics – how smart meter big data analysed

Before analyzing Big Data

Energy utilization and billing has increased

After analyzing Big Data

APPLIANCE

APPLIANCE

During peak-load the users require more energy

During off-peak times the users required less energy

Time-of-use pricing encourages cost-savvy retail like industrial heavy machines to be used at off-peak times

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Big data analytics use cases

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- IBM Big data analytics – IBM smart meter solution

IBM offers an integrated suite of products designed to enable IT to leverage big data in a variety of ways that can contribute to the success of energy companies

Analytics

Data Analysis

Data Mining

Data Warehousing

User Data Security

Reporting

IBM Solution

1. Managing smart meter data
2. Monitoring the distribution grid
3. Optimizing unit commitment
4. Optimizing energy trading
5. Forecasting and scheduling loads

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Big data analytics use cases

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ONCOR

Oncor Electric Delivery has incorporate IBM Smart Meter service

1. Instrumented — Utilizes smart electricity meters to accurately measure the electricity usage of a household
2. Interconnected — Unprecedented access to detailed information about their electricity use
3. Intelligent — Consumers monitor and control their electricity usage through near-real time readings of electricity meters

BENEFITS

Customers in Oncor's service territory showed last year during the company's biggest energy saver contest that by using the information from Oncor's advanced meter

Users reduced their electric usage and bills by 25 percent or more

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Types of Big data analytics

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1 Descriptive Analysis
2 Predictive Analysis
3 Prescriptive Analysis
4 Diagnostic Analytics

Types of Big Data Analytics

What is happening now based on incoming data.

Google Analytics Tool is the best example for descriptive analysis. A business gets result from the web server through the tool which help understand what actually happened in the past and validate if a promotional campaign was successful or not based on basic parameters like page views.

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Types of Big data analytics

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1 Descriptive Analysis
2 Predictive Analysis
3 Prescriptive Analysis
4 Diagnostic Analytics

Types of Big Data Analytics

What might happen in the future

For example, Southwest Airlines analyses sensor data on their planes in order to identify patterns that indicate a potential malfunction, thus allowing the airlines to the necessary repairs before its schedule.

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Types of Big data analytics

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1 Descriptive Analysis
2 Predictive Analysis
3 Prescriptive Analysis
4 Diagnostic Analytics

Types of Big Data Analytics

What action should be taken.

Google's self-driving car is a perfect example of prescriptive analytics. It analyses the environment and decides the direction to take based on data.

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Types of Big data analytics

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1 Descriptive Analysis
2 Predictive Analysis
3 Prescriptive Analysis
4 Diagnostic Analytics

Types of Big Data Analytics

Why did it happen

For a Social Media marketing campaign, you can use diagnostic analytics to assess the number of posts, mentions, followers, fans, page views, reviews, pins, etc. and analyse the failure and success rate of the campaign at a fundamental level.

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Challenges/problems with Big data

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Problem 1: Storing exponentially growing huge datasets

- Data generated in past **2 years** is more than the previous history in total
- By 2020, total digital data will grow to **44 Zettabytes** approximately
- By 2020, about **1.7 MB** of new info will be created every second for every person

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Challenges/problems with Big data

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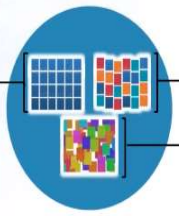
Problem 2: Processing data having complex structure

Structured

- Organized data format
- Data schema is fixed
- Ex: RDBMS data, etc.



Semi – Structured

- Partial organized data
- Lacks formal structure of a data model
- Ex: XML & JSON files, etc.

Unstructured

- Un-organized data
- Unknown schema
- Ex: multi-media files, etc.

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Challenges/problems with Big data

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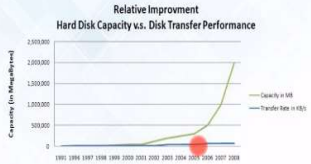
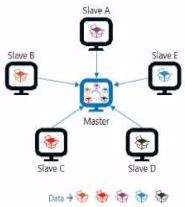
Problem 3: Processing data faster

The data is growing at much faster rate than that of disk read/write speed



Bringing huge amount of data to computation unit becomes a bottleneck



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HADOOP is solution to Big data problems

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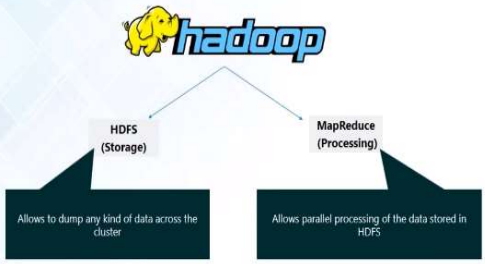
Hadoop is a framework that allows us to store and process large data sets in parallel and distributed fashion



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HADOOP is solution to Big data problems

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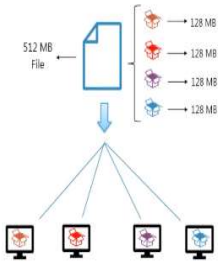
Problem 1: Storing exponentially growing huge datasets

Solution: HDFS

- Storage unit of Hadoop
- It is a Distributed File System
- Divide files (input data) into smaller chunks and stores it across the cluster
- Scalable as per requirement



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HADOOP is solution to Big data problems

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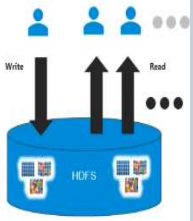
Problem 2: Storing unstructured data

Solution: HDFS

- Allows to store any kind of data, be it structured, semi-structured or unstructured
- Follows WORM (Write Once Read Many)
- No schema validation is done while dumping data



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HADOOP is solution to Big data problems

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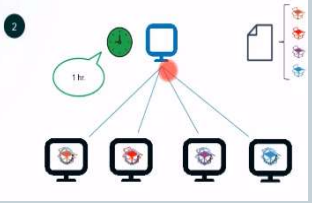
Problem 3: Processing data faster

Solution: Hadoop MapReduce

- Provides parallel processing of data present in HDFS
- Allows to process data locally i.e. each node works with a part of data which is stored on it



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Big Data in Industry 4.0

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- **Role in Industry 4.0**
  ✓ Smart factories optimize production with sensor data.
  ✓ Predictive maintenance prevents failures & downtime.
  ✓ Real-time data enables automated decision-making.

- **Key Benefits**
  ✅ Increased production efficiency
  ✅ Reduced operational costs
  ✅ Enhanced automation & real-time insights

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Cases of Big Data in Industry4.0

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📦 **Warehouse Optimization**
➡️ Sensors & portable devices detect errors, perform quality checks, and optimize workflows.
🚧 **Bottleneck Elimination**
➡️ Identifies performance issues and suggests improvements at no extra cost.
📊 **Predictive Demand**
➡️ Uses internal & external analysis for better forecasting and product optimization.
🛠️ **Predictive Maintenance**
➡️ Sensors detect failure patterns and send alerts before breakdowns occur.
🔍 **Other Benefits:** Improved security, load optimization, supply chain management, and non-conformity analysis.

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How Businesses Use Big Data Analytics

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- 🚀 **Industry 4.0 Applications**
  ✓ **Supply Chain Optimization** – Identifies patterns to improve logistics.
  ✓ **Predictive Maintenance** – Cuts downtime by 25% with AI-driven monitoring.
  ✓ **Production Management Automation** – Uses historical & real-time data for self-adjusting processes.

- 🛠️ **Smart Factory Technologies**
  ➡️ **Self-Service Systems** – Real-time analytics for decision-making (e.g., Intel's smart factory).
  ➡️ **Automated Production** – Robots & actuators adjust equipment settings autonomously.
  ➡️ **Faster Fault Detection** – Reduces reaction time from 4 hours to 30 seconds.

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