EUROCC - National Competence Centres
in the framework of EuroHPC – Bulgaria
#951732, H2020-JTI-EuroHPC

NCC Bulgaria and NCC UK: Collaboration and Twinning Activities

HPC/HPDA/AI: Infrastructures, Services and Activities to Support the Businesses

18-20 July 2022, Sofia, Bulgaria

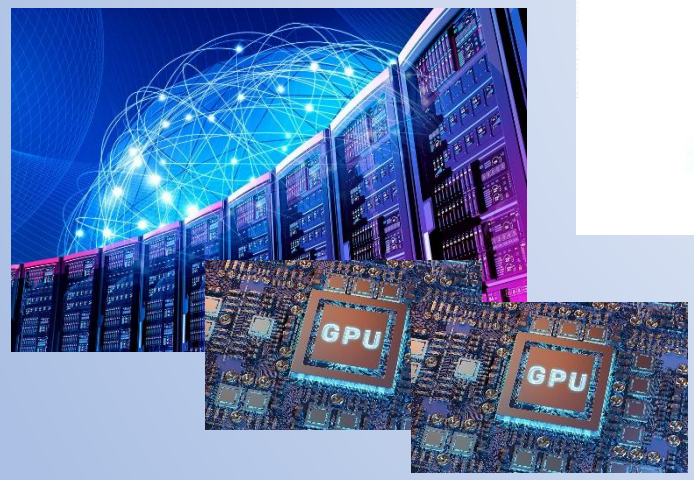
Prof. Kamelia Stefanova, PhD, UNWE

Content

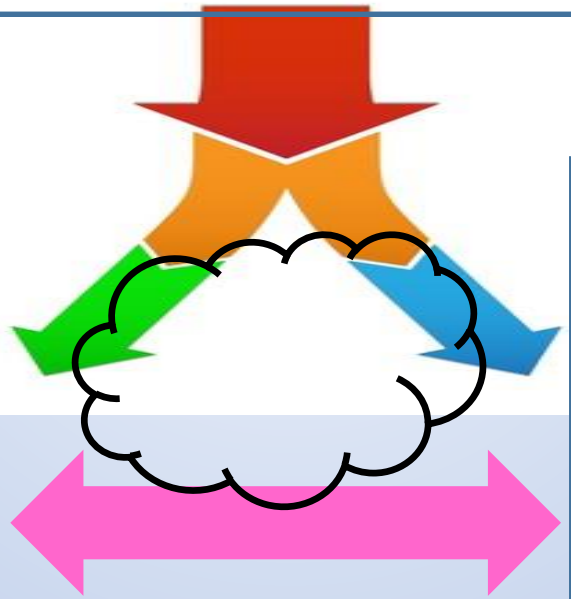
1. **HPC/HPDA/AI Infrastructures**
2. HPC/HPDA/AI Services
3. HPC/HPDA/AI Support to Businesses

HPC/HPDA/AI

Artificial Intelligence (AI)



High Performance Computing (HPC)



Data Analysis

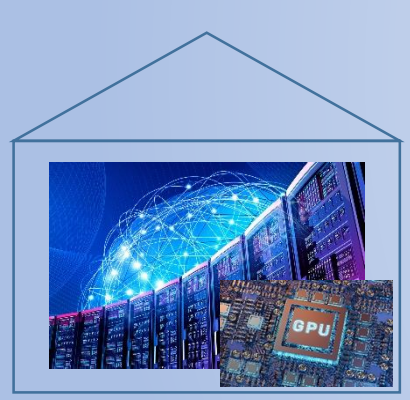
Big Data

Big data Analytics+HPC

High Performance Data Analysis (HPDA)

Directions in using HPC systems

1) In House HPC system
2) Remote HPC System + High Speed Encrypted Network(HBSN)
3) Cloud HPC system (with enterprise HBSN)
    a) A public HPC system CPU-based
    b) A public HPC system GPU-based
    c) High speed memory



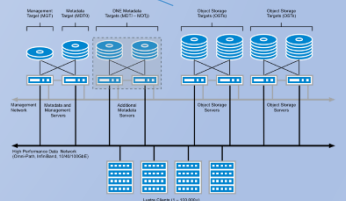
In house HPC system
- for development
- for production

Remote/Hosting HPC system
- for production

Cloud HPC system

CPU based

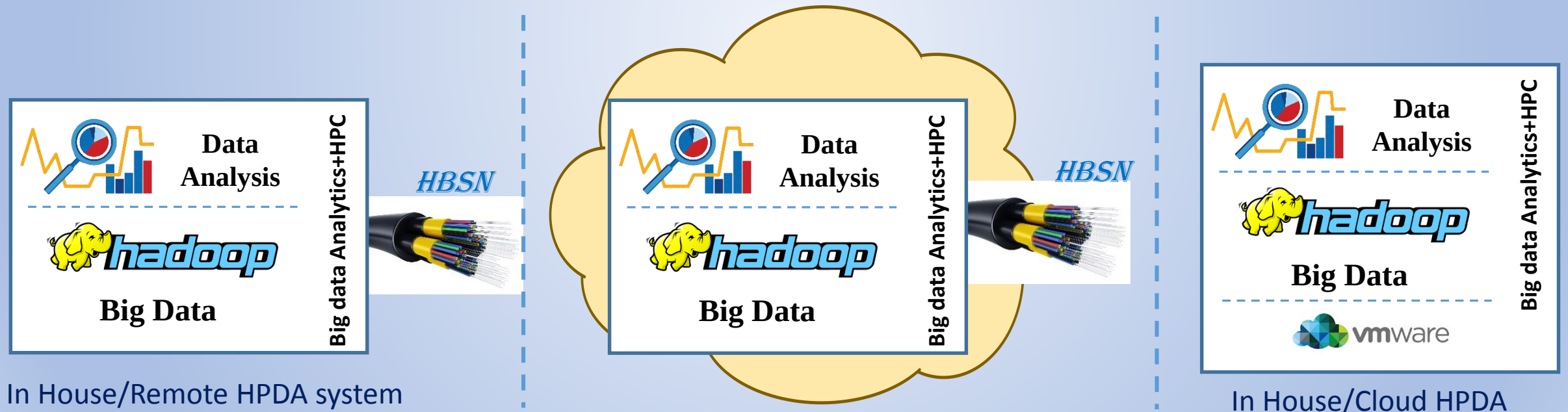
GPU based



High speed memory

Directions in using HPDA system

1) In House HPDA + HBSN system
2) Remote HPDA + HBSN system
3) Cloud HPDA + HBSN system
4) In House HPC/HPDA system using VMware



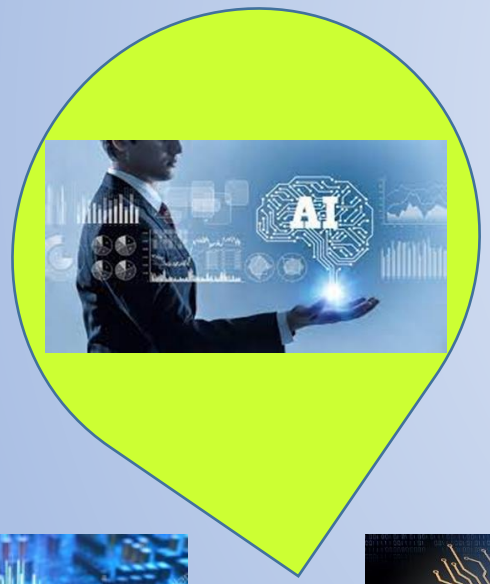
In House/Remote HPDA system

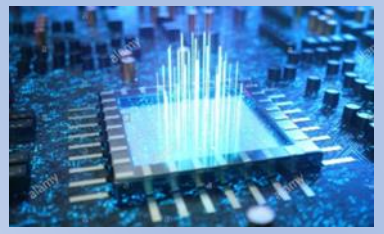
Cloud HPDA system

In House/Cloud HPDA system using VMware

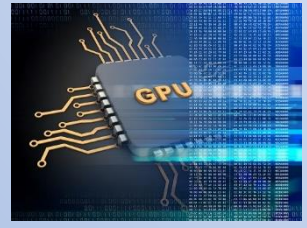
Directions in using AI

1) Enterprise-developed AI on CPU-based servers
2) Enterprise-developed AI on GPU-based servers
3) Enterprise-developed AI on Hadoop / ML + Python
4) Corporate Externally developed AI

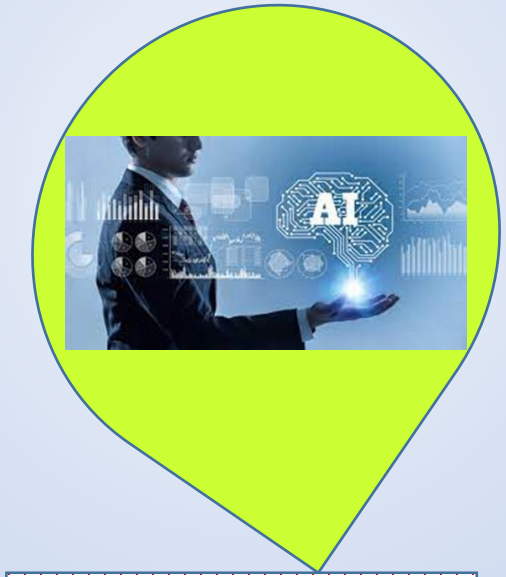




on CPU

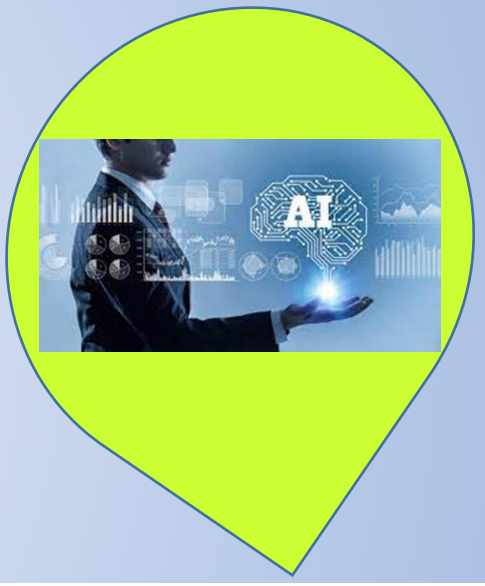


on GPU



hadoop

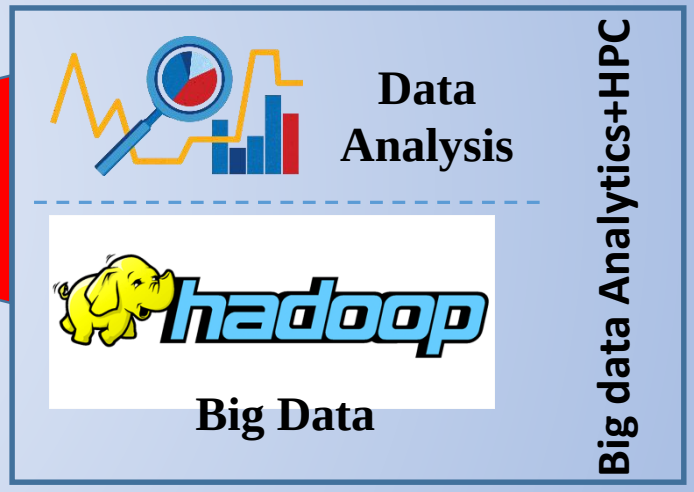
Big Data



Corporate Externally developed AI

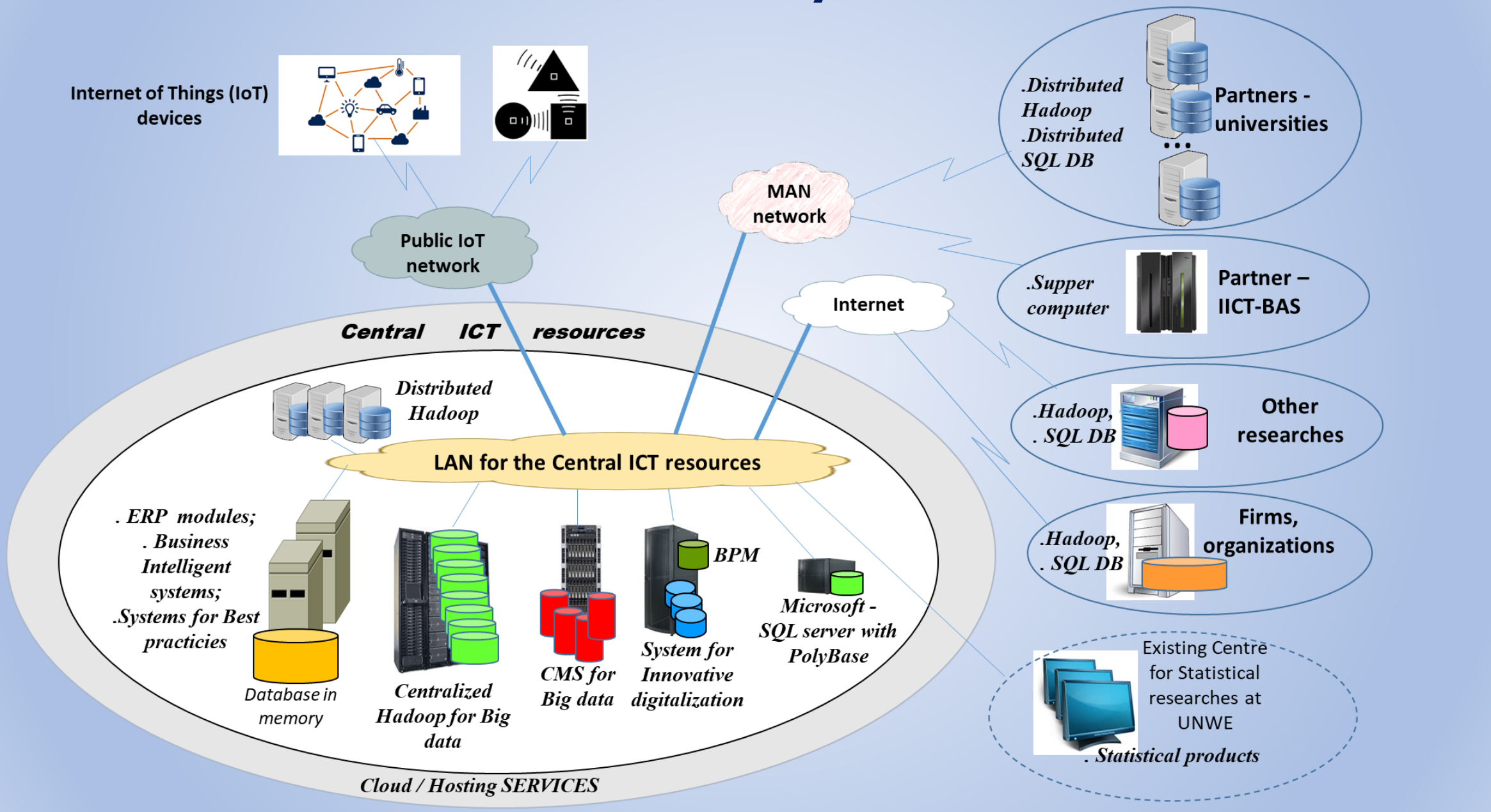
Data movement in HPC/HPDA infrastructure with HBSN

HPC

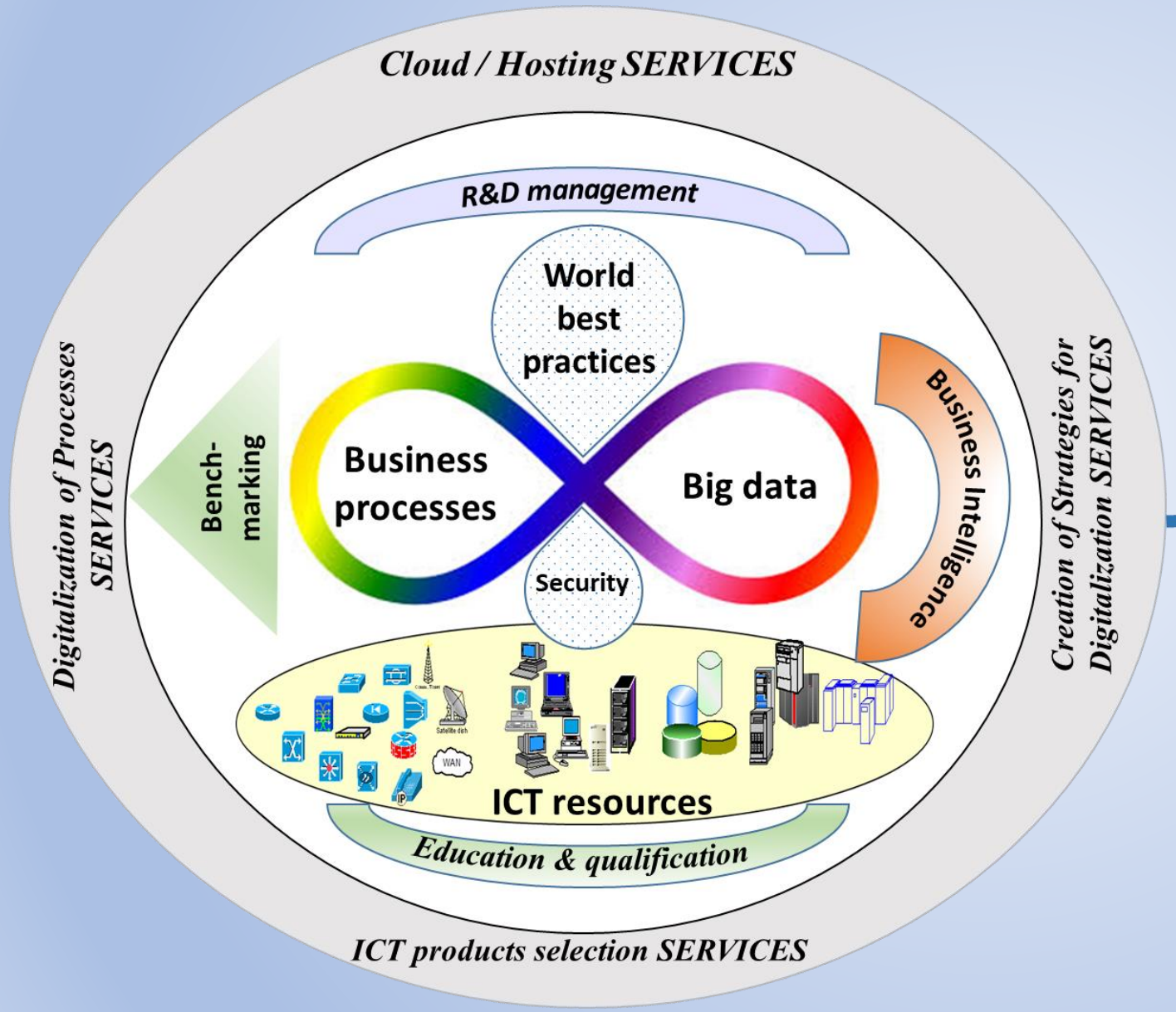


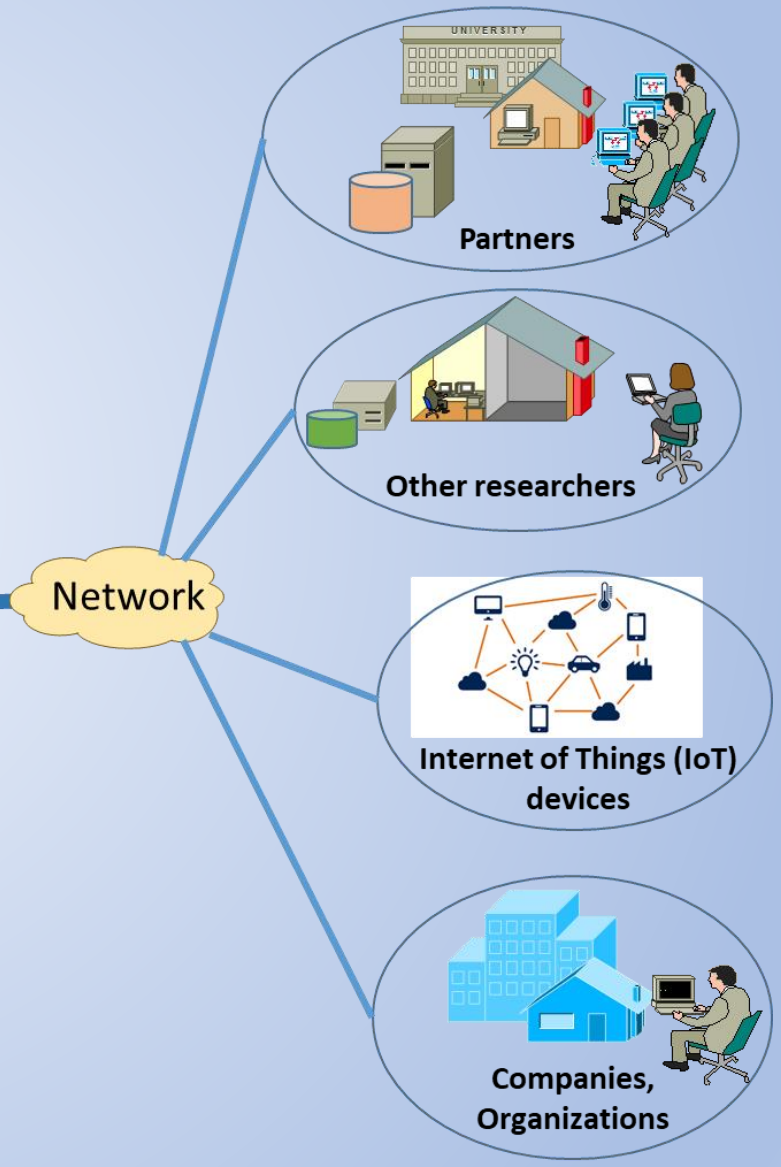
HPDA

ICT Architecture of HPDA/AI at UNWE



Functional Architecture of HPDA/AI at UNWE





The HPDA/AI system at UNWE

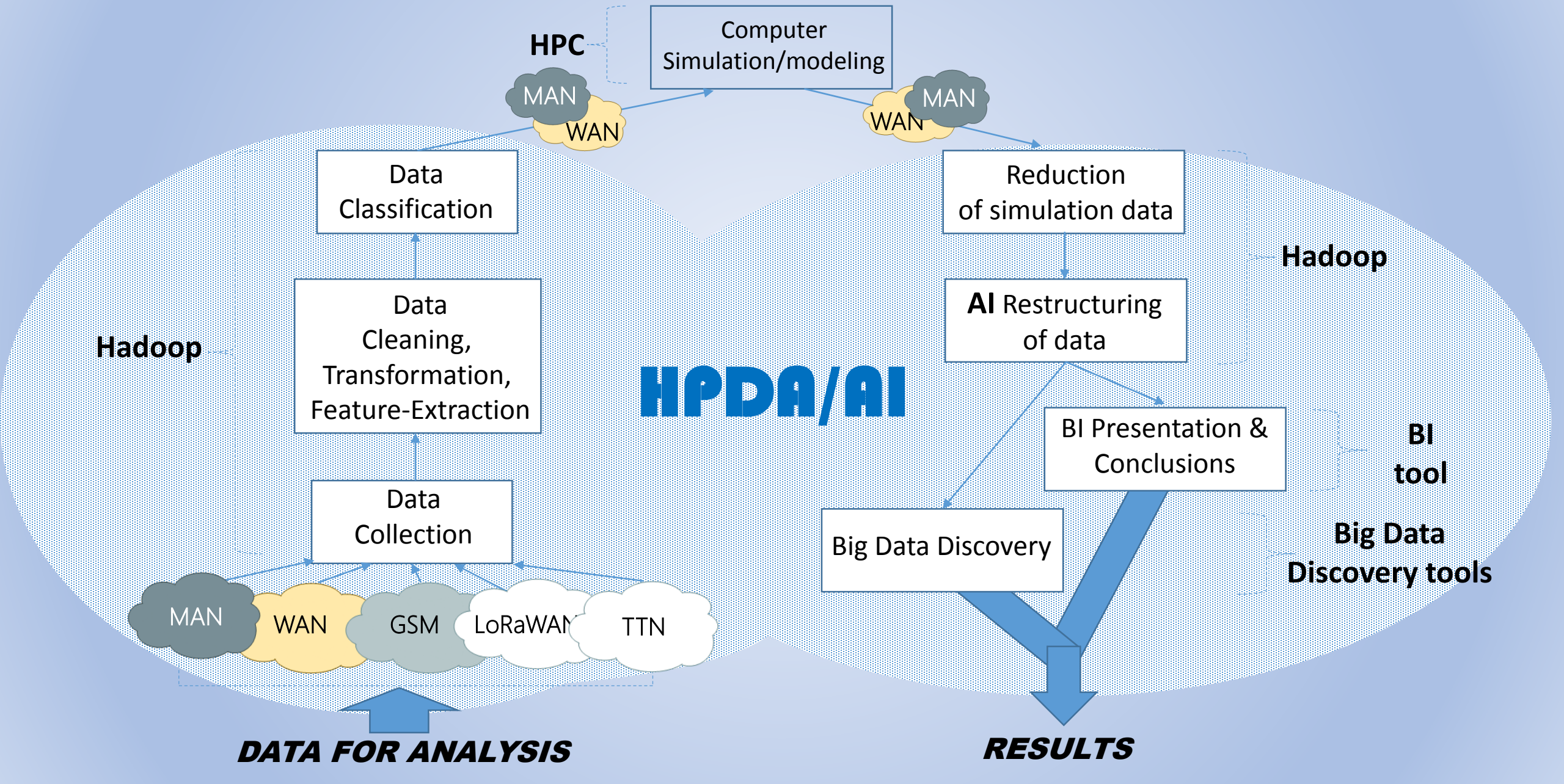
Content

1. HPC/HPDA/AI Infrastructures
2. **HPC/HPDA/AI Services**
3. HPC/HPDA/AI Support to Businesses

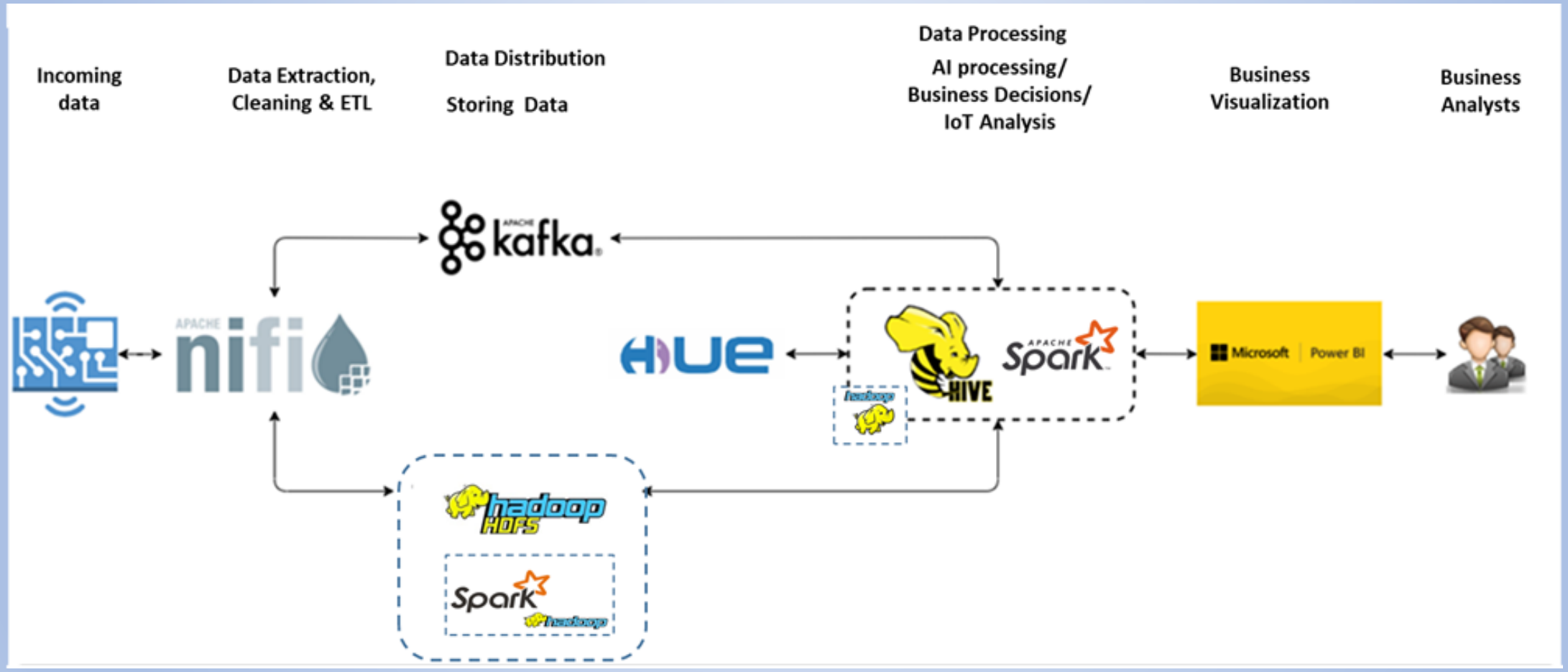
System Services

- ✓ **Integrated HPDA/AI architecture with HPC environment**
- ✓ **Conceptual Architecture for Collecting, Transaction Processing, AI Processing and IoT Data Analytics with HPDA/AI System**
- ✓ **Conceptual Architecture for Big Data Analytics through Big Data Discovery technologies**
- ✓ **An architecture for AI processing and Data Analytics with HPDA/AI system**
- ✓ **Spark Hadoop as a parallel computing environment**
- ✓ Markov's chain modeling
- ✓ Monte Carlo Modeling – via MapReduce, via Spark on Hadoop
- ✓ Fast Fourier Transformation - for signal processing and speech recognition for very large data files

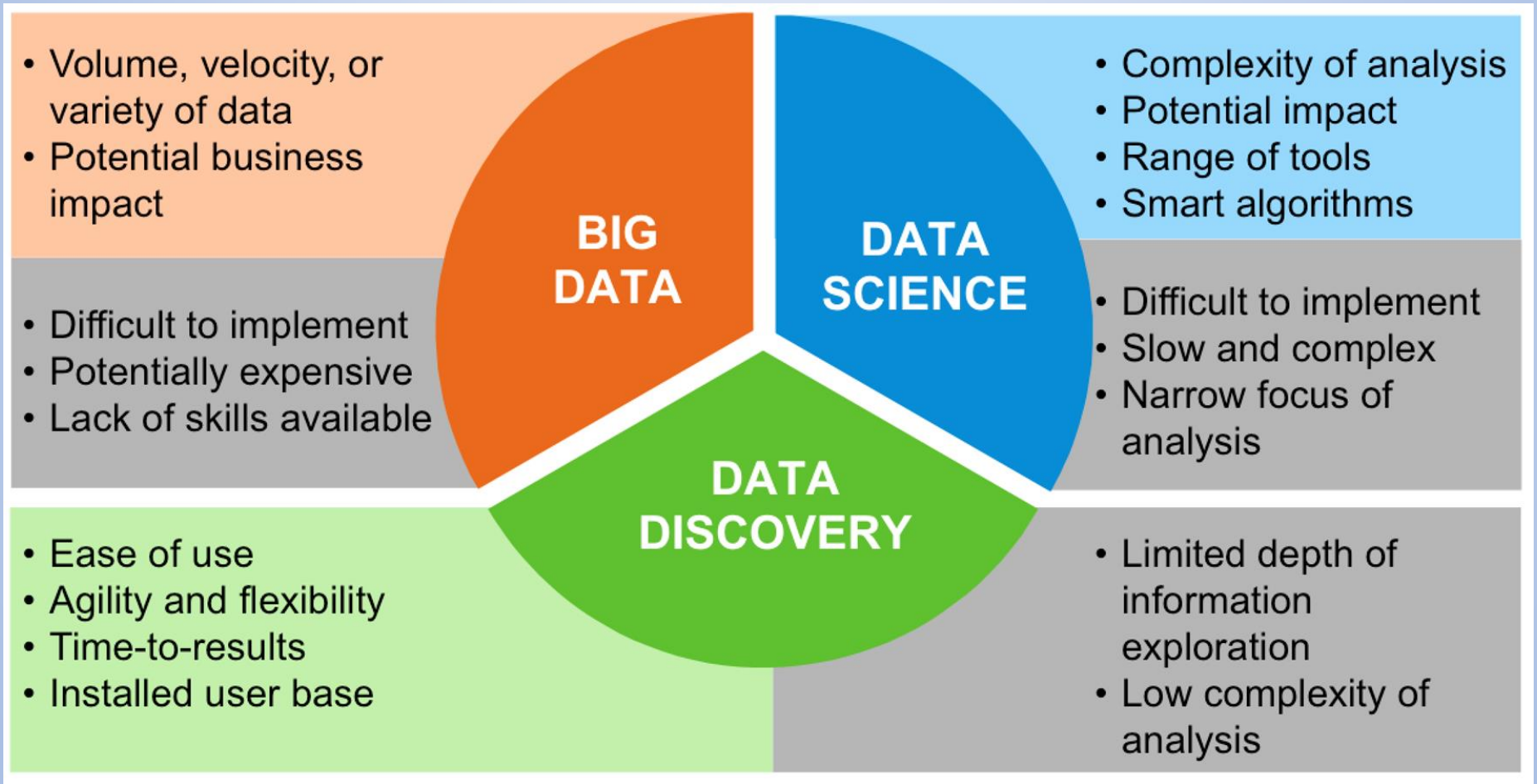
Integrated HPDA/AI architecture within HPC environment



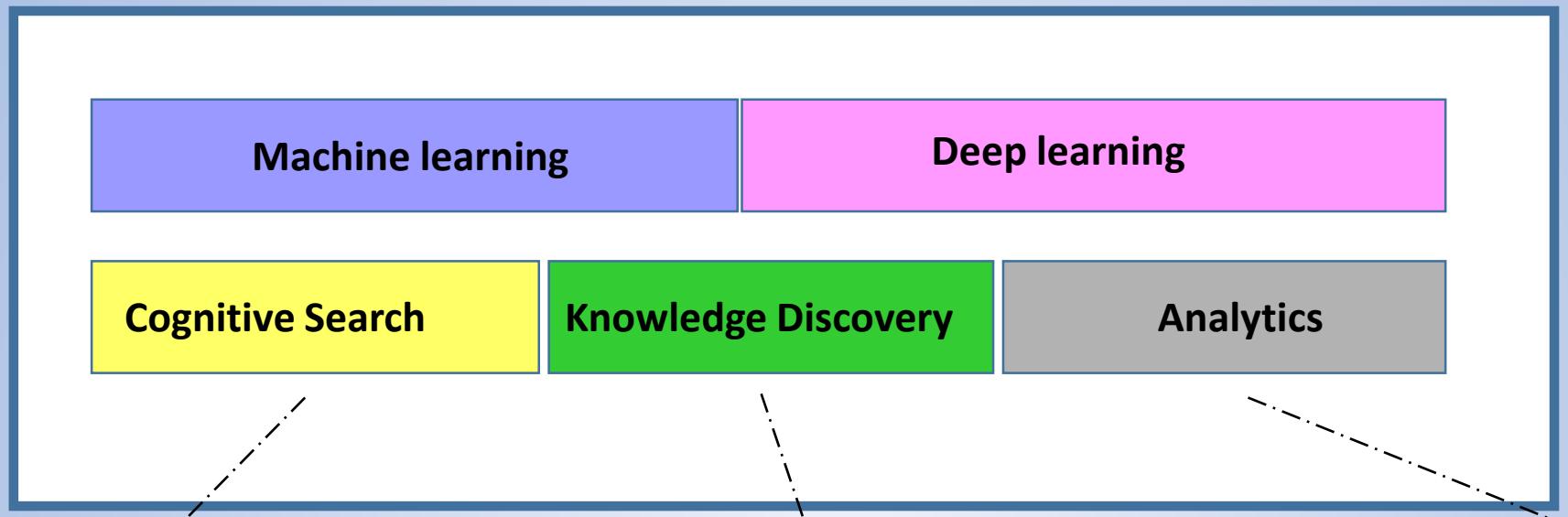
Conceptual Architecture for Collecting, Transaction Processing, AI Processing and IoT Data Analytics with HPDA/AI System



Big Data discovery at the level of structured and semi-structured data



Big Data Discovery at the level of „AI“ with unstructured data

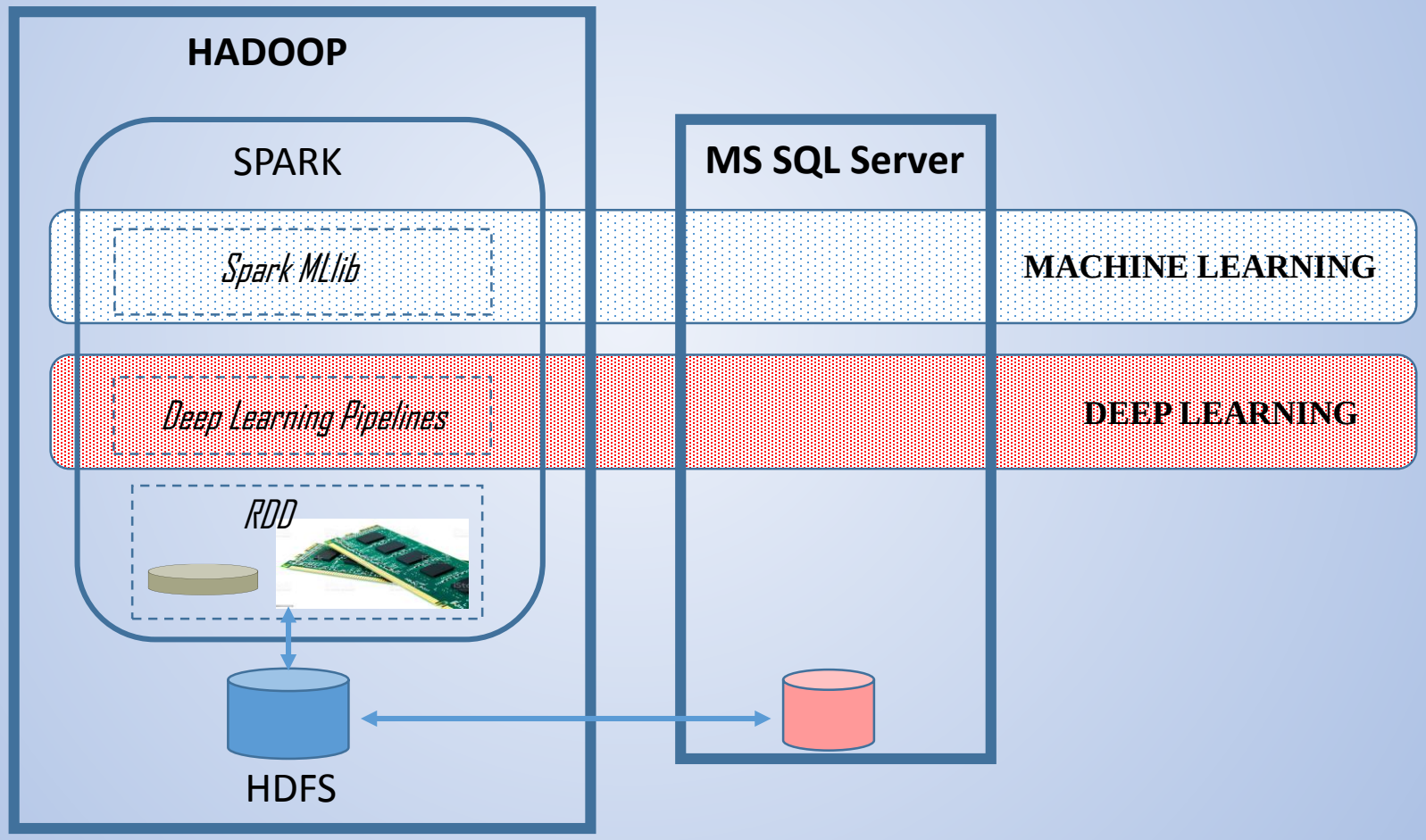


AI based Search using, natural language processing, search and organization of **different types of data**

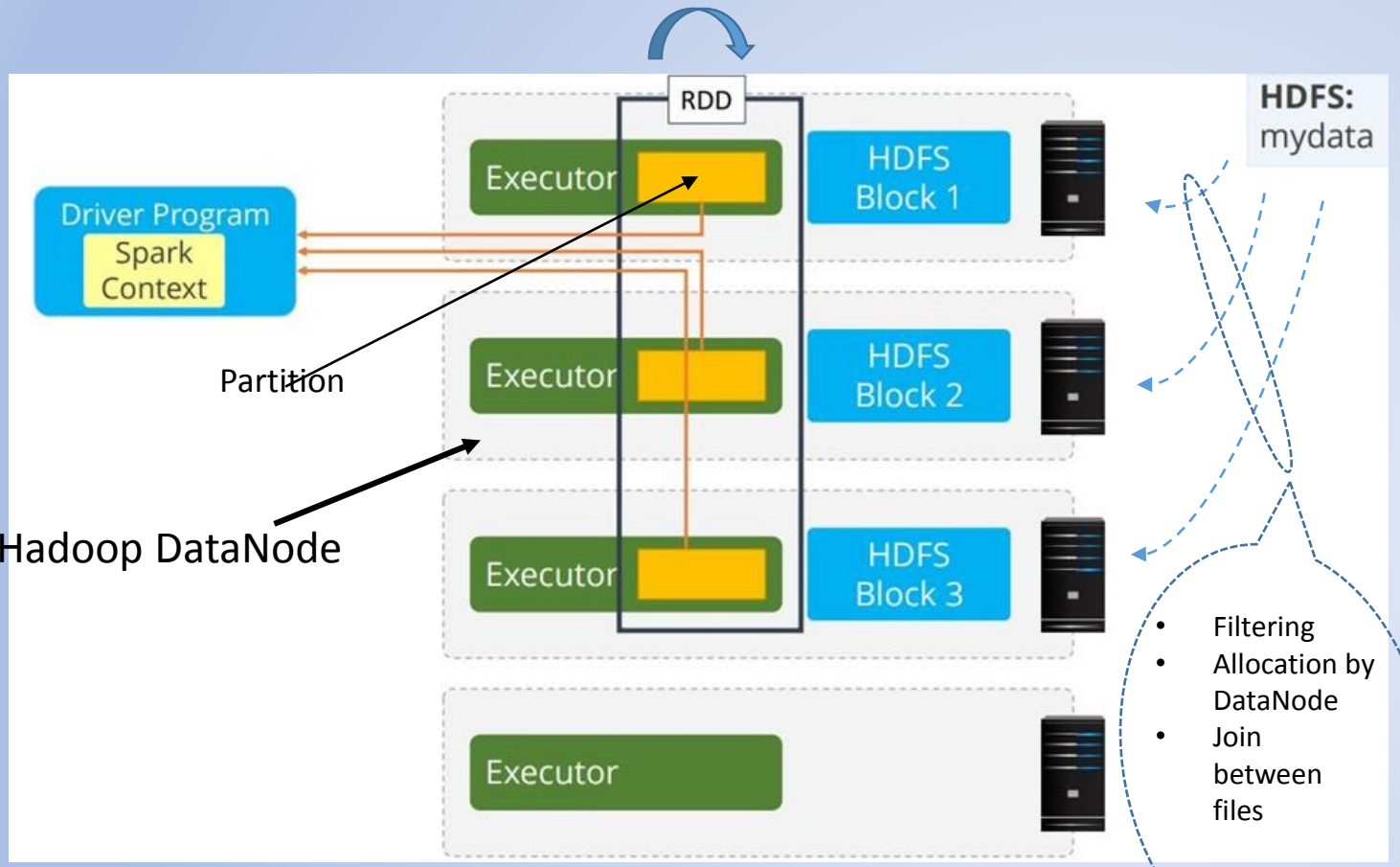
Frees the user from having to know what questions to ask in advance, uses machine learning and deep neural networks to **recognize patterns, trends and relationships** hidden in the data – e.g. associates tweets with a recognition of car license plate

AI-powered audio and video analytics features such as **speech-to-text, event detection, language identification, human-speaker identification**, transcription with the ability to quickly understand the context and content of audio/video files

An architecture for AI processing and Data Analytics with HPDA/AI system



Spark Hadoop as a parallel computing environment



- In the RDD, data is partitioned between partitions in DataNodes by Spark. The number of partitions created can be controlled;
- One file (in blocks=HDFS) – across multiple partitions and/or multiple DataNodes
- For each partition - file with Key+Value
- In parallel
  - Number of partitions <= Number of cores in the cluster (#partitions=#2xCPUcores - min)
    . 2CPUx8coresx36servers=576 processes/partitions
    . Default configuration – 1000 processes (2 partitions per core)
  - Each partition – in parallel
  - Between DataNodes
  - All DataNodes in parallel
  - Communication between DataNodes - RDD
- Each partition works in the Memory and the result stays in the Memory or on a Disk
- Programming languages - Python, Scala, Java
- Spark DAG for visualization

Application Services

- ✓ Microeconomy
  - In asset pricing – to value complex assets in a rich environment with multiple status variables.
  - In corporate finance – to track the behavior of companies with complex balance sheets and intertemporal financing needs.
  - Analyzing multi-sectoral trade patterns.
  - Analysis of the company status, with variables having different probability

- ✓ Macroeconomy
  - Solving problems with complex constraints and heterogeneous agents to match micro and aggregated observations simultaneously
  - Algorithm for Parallel Parameterized Expectations

- ✓ **E-Commerce – via Spark/Hadoop**
- ✓ **Healthcare – via Spark/Hadoop**
- ✓ Multimedia and entertainment – via Spark/Hadoop
- ✓ Cryptographic functions - Decryption
- ✓ **Financial Risk Management through HPDA**
- ✓ Parallel wealth management

E-Commerce – via Spark/Hadoop

- E-commerce giants use Spark on Hadoop to create:
  - High-performance systems working with big data for e-commerce
  - Systems covering various products presented through interactively oriented presentation of marketing data
  - High scalability
- A complete system is offered through one platform – e.g. using such an approach – eBay, Alibaba
- Using AI to train user input
- Creating fast-paced, dynamically changing digital environment
- Creation of second-level (above the system level) development platforms for rapid application creation – e.g., Spark Pay

Healthcare – via Spark/Hadoop

- Healthcare system with an operational **management** of big data
- **Integrating** management of standard e-Health services with a healthy lifestyle through diet and exercise
- Ability to **integrate many health business** entities into one system (Spark/Hadoop offers a powerful, scalar, reliable, high-performance and analytics system) – insurance, product offering, consumer needs-interest research, fitness services, targeting health services to ongoing healthy place per client
- An opportunity for dynamic **personalized** medicine
- Spark/Hadoop offers easy integration with **various devices** – cell phone, mobile medical sensors, medical devices
- The healthcare sector is reaping the **benefits** of **technology** for better service delivery, e.g., MyFitnessPal company

Financial Risk Management through HPDA

- Financial risk management is the practice of protecting the economic value of a company by using financial instruments to manage the **risk exposure** - operational risk, credit risk and market risk, currency risk, volatility risk, liquidity risk, inflation risk, business risk, legal risk, reputational risk, sectoral risk, etc.
- It requires identification of the sources of risk, its **measurement** and plans to deal with them.
- It focuses on when and how to **hedge** using financial instruments to manage expensive risk exposures.
- **Hadoop** enables lenders to take advantage of an ever-deepening pool of new data used to analyze credit risk, third-party risk and geopolitical risk. Hadoop does this by using **simulations** that use massive amounts of data and require massive parallel computing power
- Hadoop/Spark are used at JP Morgan Chase, Deutsche Bank

Content

1. HPC/HPDA/AI Infrastructures
2. HPC/HPDA/AI Services
3. **HPC/HPDA/AI Support to Businesses**

Main approaches to support businesses

- ✓ **Business awareness and awareness about capabilities of HPC/HPDA/AI systems**
- ✓ **Training the staff of a business organization to use HPC/HPDA/AI systems**
- ✓ **Consultations for implementation of HPC/HPDA/AI systems**
- ✓ Requesting a desire for a practical implementation of a prototype HPC/HPDA/AI system in a given business organization
- ✓ Direct use of HPC/HPDA/AI platforms and systems by a business organization

Business awareness and awareness about capabilities of HPC/HPDA/AI systems

- **Awareness** is the ability to know and perceive given **processes** and **phenomena**, as well as to have information applicable in the direction of a **certain** spectrum of **behavioral actions**.
- Activities:

  - Awareness in order to understand and realize the **technologies** of HPC/HPDA/AI processes;
  - Awareness in order to understand and realize the basic **principles of operation** of HPC/HPDA/AI computer systems;
  - Philosophical consideration of the potential capabilities of HPC/HPDA/AI computing systems in the **business processes** of the specific business organization;
  - **Research** and acquaintance with global and national companies with a **similar business** orientation, in which HPC/HPDA/AI computer systems are used for simulation and modeling of business processes, which would subsequently be included as real executable business processes.
  - **Financial conditions** for using the HPC computer systems - in Cloud environments, in own Datacenter, in a Hosting environment.

Training the staff of a business organization to use HPC/HPDA/AI systems

Directions of training:

- Training in **general** for **Supercomputer** use
- Supercomputer **Programming** Training
- Training for general **use** of a computer built on GPU processors
- Learning to program a computer built on GPU processors
- Training for general **use** of a general-purpose computer with installed GPU processors
- Programming training using a general-purpose computer with installed GPU processors
- Training on **general** use of **HPDA** systems
- Training for **programming** individual components of HPDA systems

Consultations for implementation of HPC/HPDA/AI systems

- Consultations on Awareness - awareness of the **management** staff of the business organization
- Consultations on Awareness - awareness of the **executive** staff of the business organization
- Consultations to **guide** the **training** needs of the business organization
- Consultation to identify potential **practical implementation** of prototype(s)
- Consultations for Direct **use** of HPC/HPDA/AI platforms and systems

Thank you for the kind attention!

Prof. Kamelia Stefanova, PhD, UNWE