



# **Prescriptive Analytics in the NVM Technology**

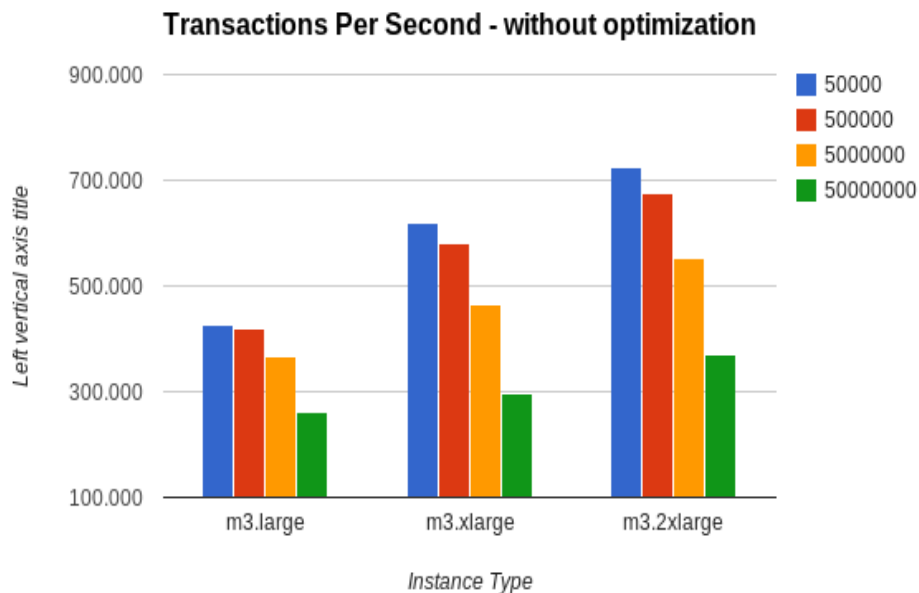
By Olga Buchonina

ProstoLabs

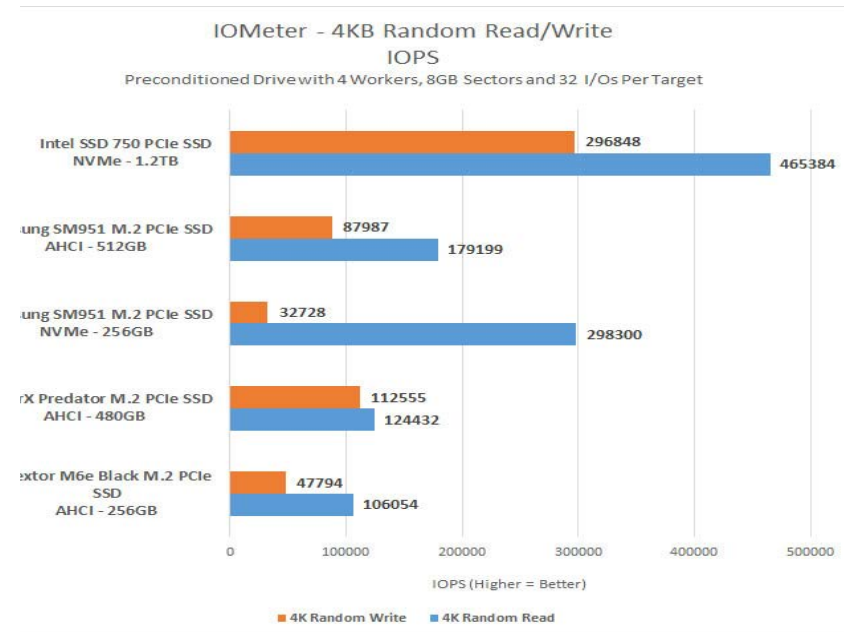
[www.savvyforce.com](http://www.savvyforce.com)

# Why NVM technology quantum leap?

## Quest: NETWORK I/O SHOULD MATCH FLASH I/O



Benchmarking MySQL performance on an m3.large instance : read/writes and two different types of Amazon Web Service's (AWS) Elastic Block Store (EBS) storage



NVMe Drive performance Benchmarking, FMS 2015

# NVM Express

NVM Express is a scalable host controller interface designed to address the needs of Enterprise and Client systems that utilize PCI Express based solid state drives.

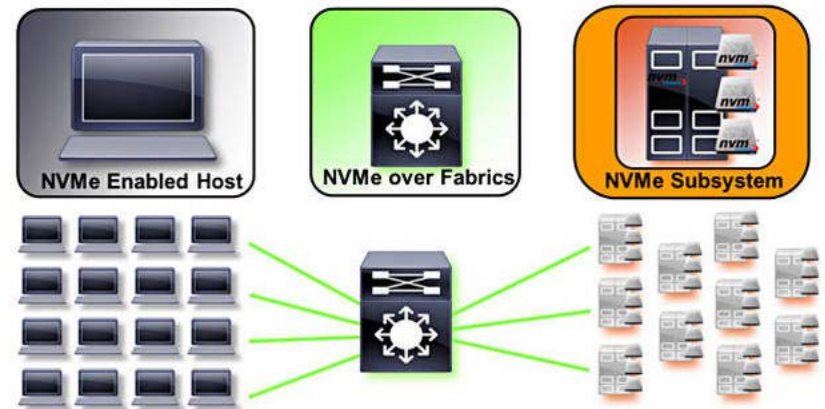
The interface provides optimized command submission and completion paths.

It includes support for parallel operation by supporting up to 65,535 I/O Queues with up to 64K outstanding commands per I/O Queue.

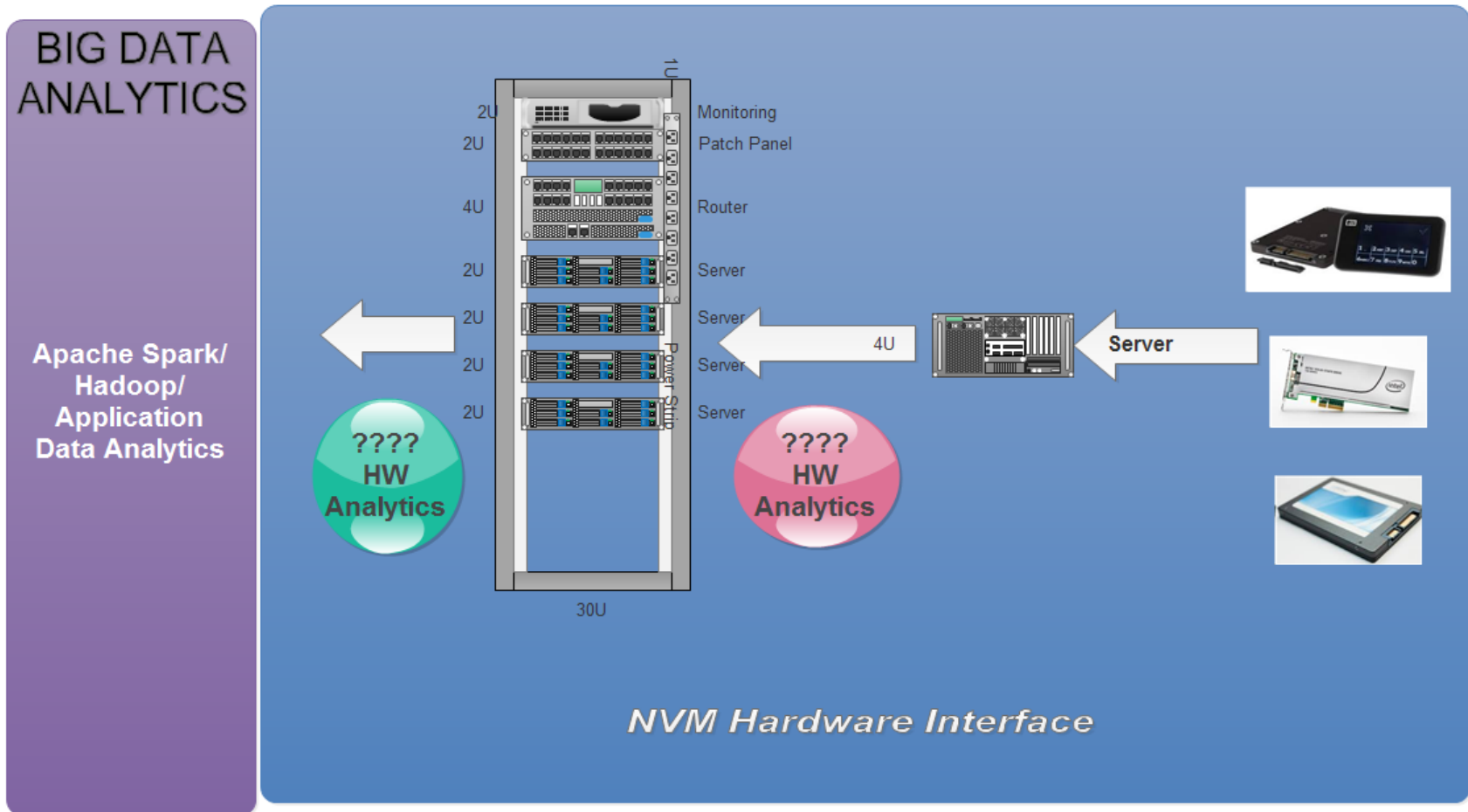
Supports many Enterprise capabilities like end-to-end data protection (compatible with SCSI Protection Information, commonly known as T10 DIF, and SNIA DIX standards), enhanced error reporting, and virtualization

# NVM over Fabrics

NVM over Fabrics allows to extend native NVMe over large Fabric interfaces and utilize network resources by providing enablement for maximum throughput



# Can we apply analytic methods to hardware?



# Where does it fit?

## **Analysis**

Descriptive Analytics: What is happening?

Diagnostic Analytics: Why did it happen?

## **Information**

Predictive Analytics: What is likely to happen?

Prescriptive Analytics: What should I do about it?

# Where does it fit ?

Descriptive  
Analytics  
Diagnostic  
Analytics

Descriptive  
Analytics  
Diagnostic  
Analytics

Predictive  
Analytics  
Prescriptive  
Analytics

Predictive  
Analytics  
Prescriptive  
Analytics

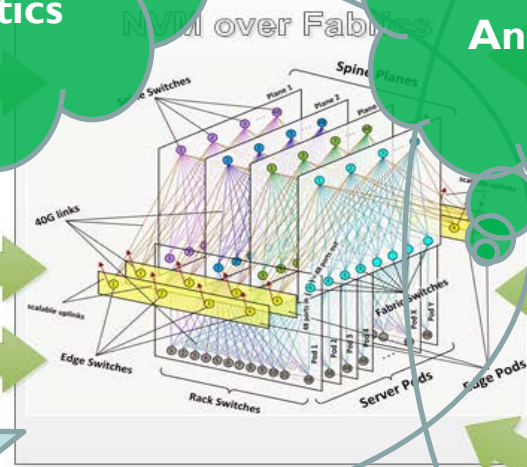
Fabric

NVMe U.2

PCIe

PCIe

Descriptive  
Analytics  
Diagnostic  
Analytics





# Nash's Equilibrium

- ❑ **Nash equilibrium** (named after John Forbes Nash) is a solution concept of a game involving two or more players.
- ❑ Each player is assumed to know the equilibrium strategies of the other players, and no player has anything to gain by changing only his or her own strategy (i.e., by changing unilaterally).
- ❑ If each player has chosen a strategy and no player can benefit by changing the strategy while the other players keep theirs unchanged, then the current set of strategy choices and the corresponding payoffs constitute a Nash equilibrium.



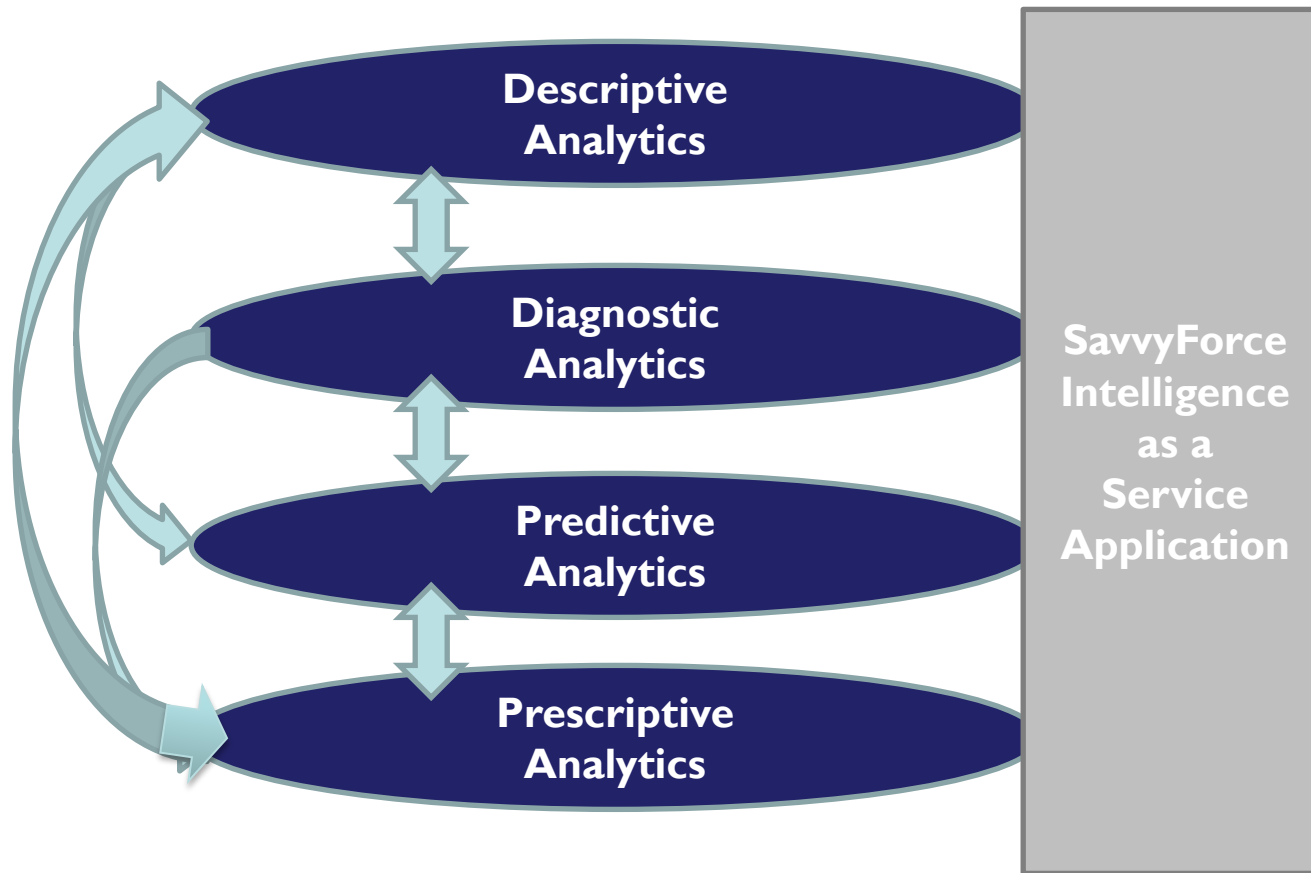
# Nash Theory and Prescriptive Analytics

- ❑ Each player is assumed to know the equilibrium strategies of the other players, and no player has anything to gain by changing only his or her own strategy (i.e., by changing unilaterally)
  - ❑ Based on data information collected from the system in hardware ( appliance) terms : reliability, performance, topology, etc. the assumption of equilibrium applies, i.e. no piece of equipment has anything to gain unilaterally

# Nash Theory and Prescriptive Analytics

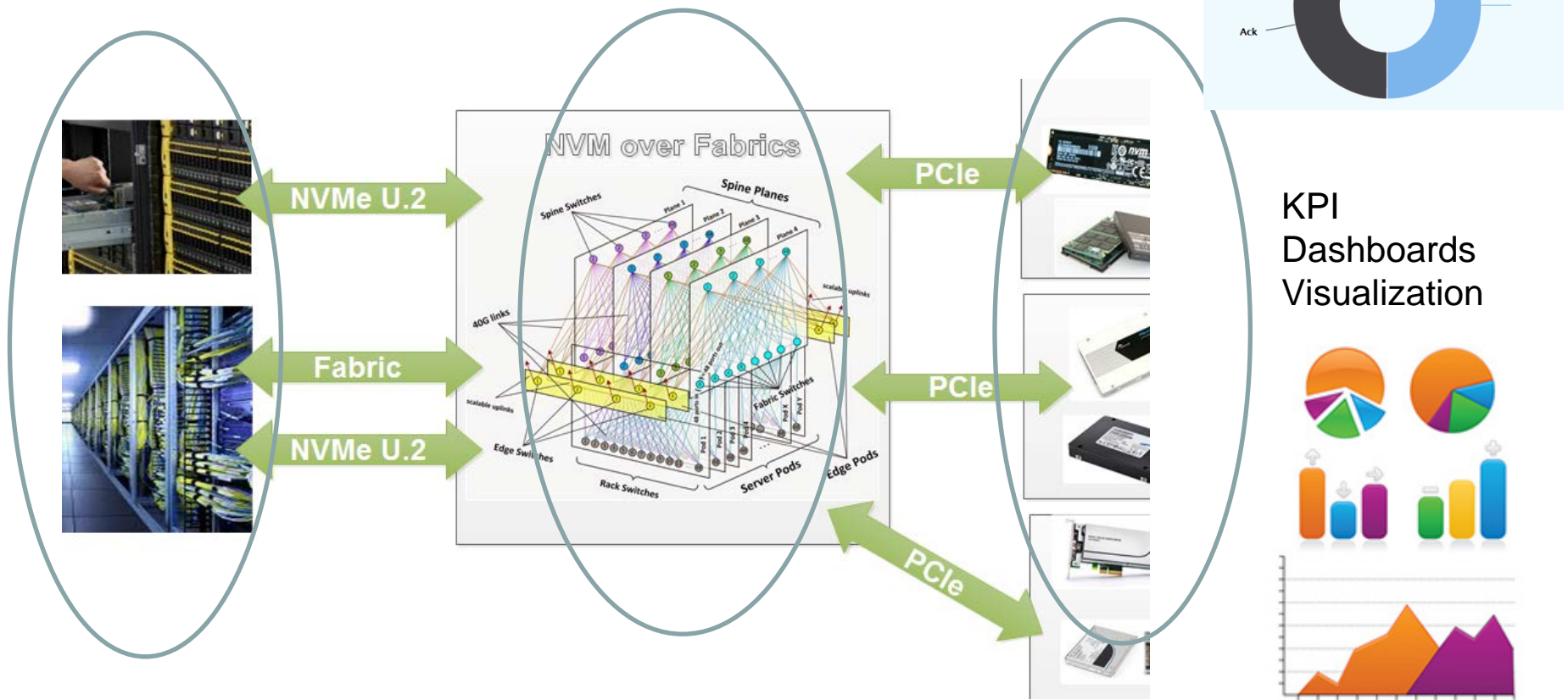
- ❑ If each player has chosen a strategy and no player can benefit by changing the strategy while the other players keep theirs unchanged, then the current set of strategy choices and the corresponding payoffs constitute a Nash equilibrium
- ❑ If we provide to each of the system components an equal role in the system we are able to achieve Nash equilibrium of optimal performance

# Analytics as an Application



# NVM Analysis – Descriptive Analytics example

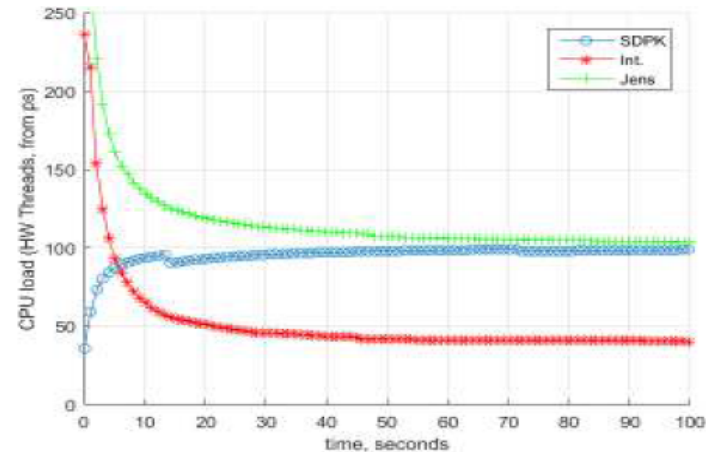
Provides Performance Data Information



# NVM analysis – Diagnostic Example

## NVM Express Polling

Mode	IOPS	Avg. Lat	99.99 Lat	CPU
Int.	68K	12us	40us	39%
Poll	106K	9.5us	25us	99%
SDPK	120K	9us	10us	98%

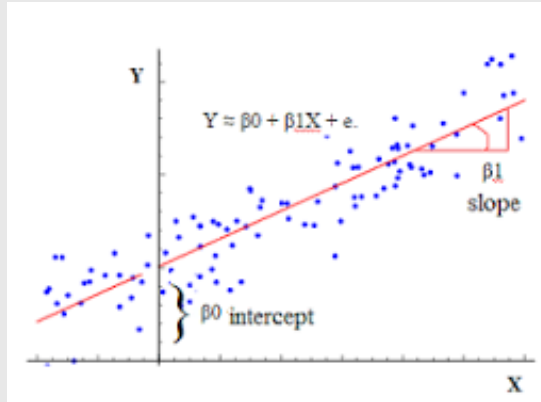


**Polling improves latency and latency outliers at the expensive of higher CPU load.**

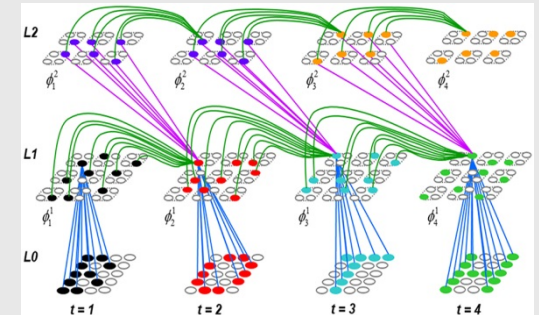
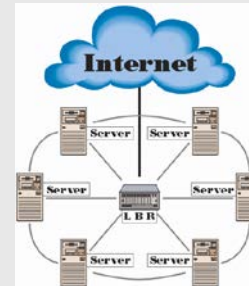
# NVM Analysis – Predictive Example

Estimate when parts of data are not available

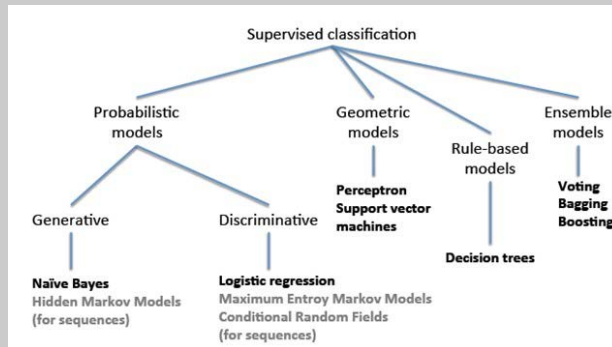
## Regression



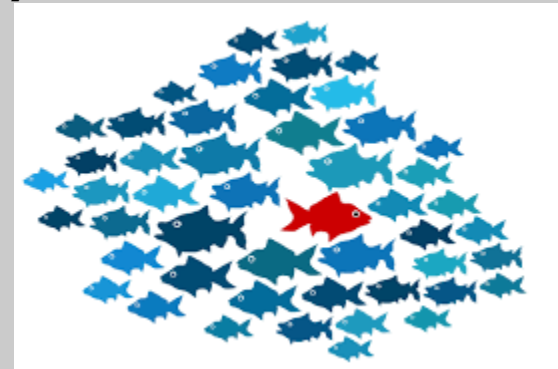
## Clustering



## Classification



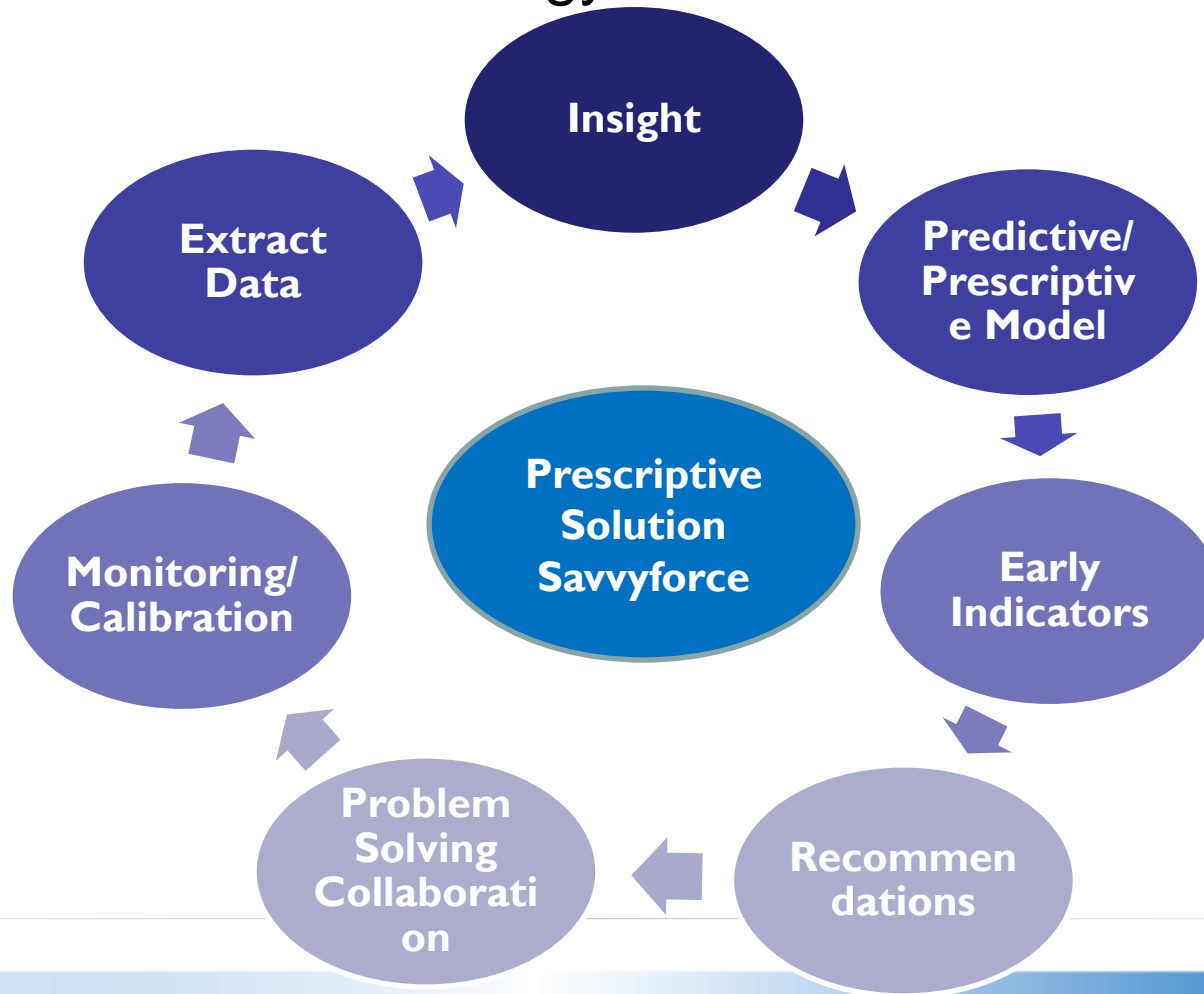
## Anomaly Detection



# NVM analysis- Prescriptive Example

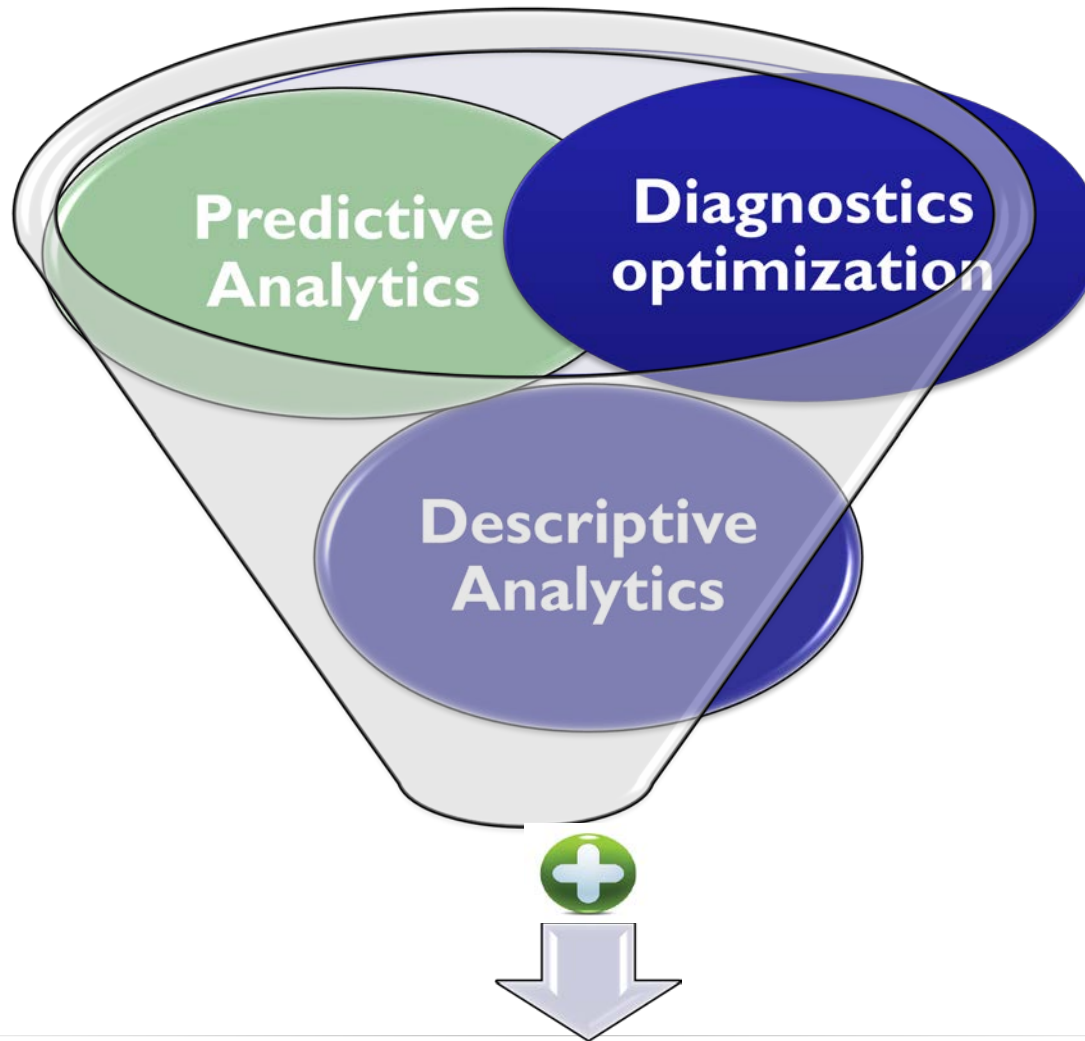
## OPTIMAL EQUILIBRIUM FOR THE SYSTEM

What is the best strategy?





# Prescriptive Flow Diagram



## Prescriptive Analytics

# Prescriptive observations

- ❑ Advent of NVM Express and NVM over Fabrics allows to bridge the gap of the overhead in compute resources
- ❑ Hardware prescriptive analytics will be a viable solution to allow acceleration, data integrity, real time processing for Big Data applications

# Takeaways



Olga Buchonina  
[olga@prostolabs.com](mailto:olga@prostolabs.com)  
San Jose, CA, USA