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Newark and New Brunswick

Continuous Monitoring and Assurance : an International View
Reykjavik, Iceland
30WCAS
May2014

Miklos A. Vasarhelyi
KPMG Professor of AIS, Rutgers Business School

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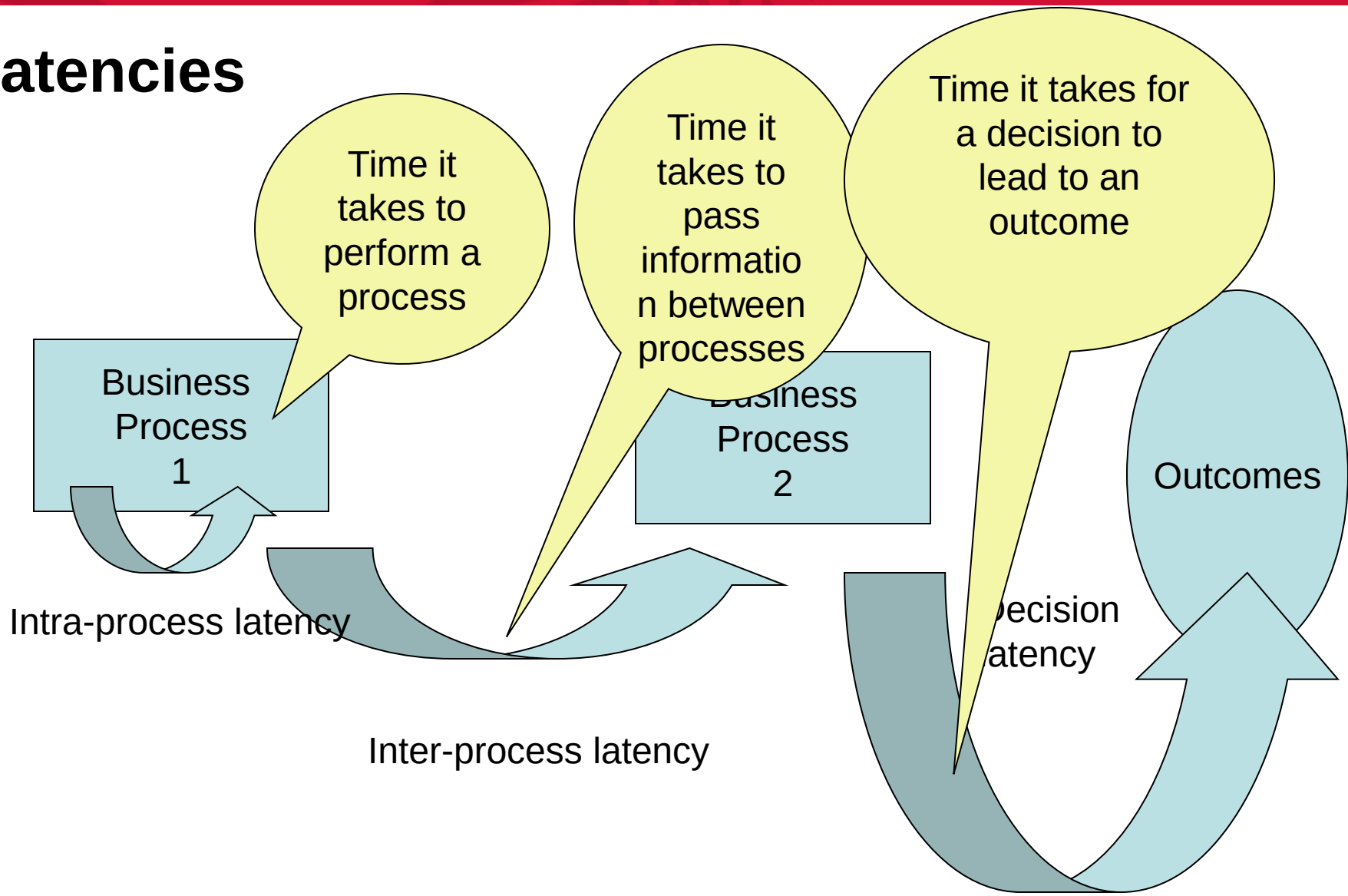
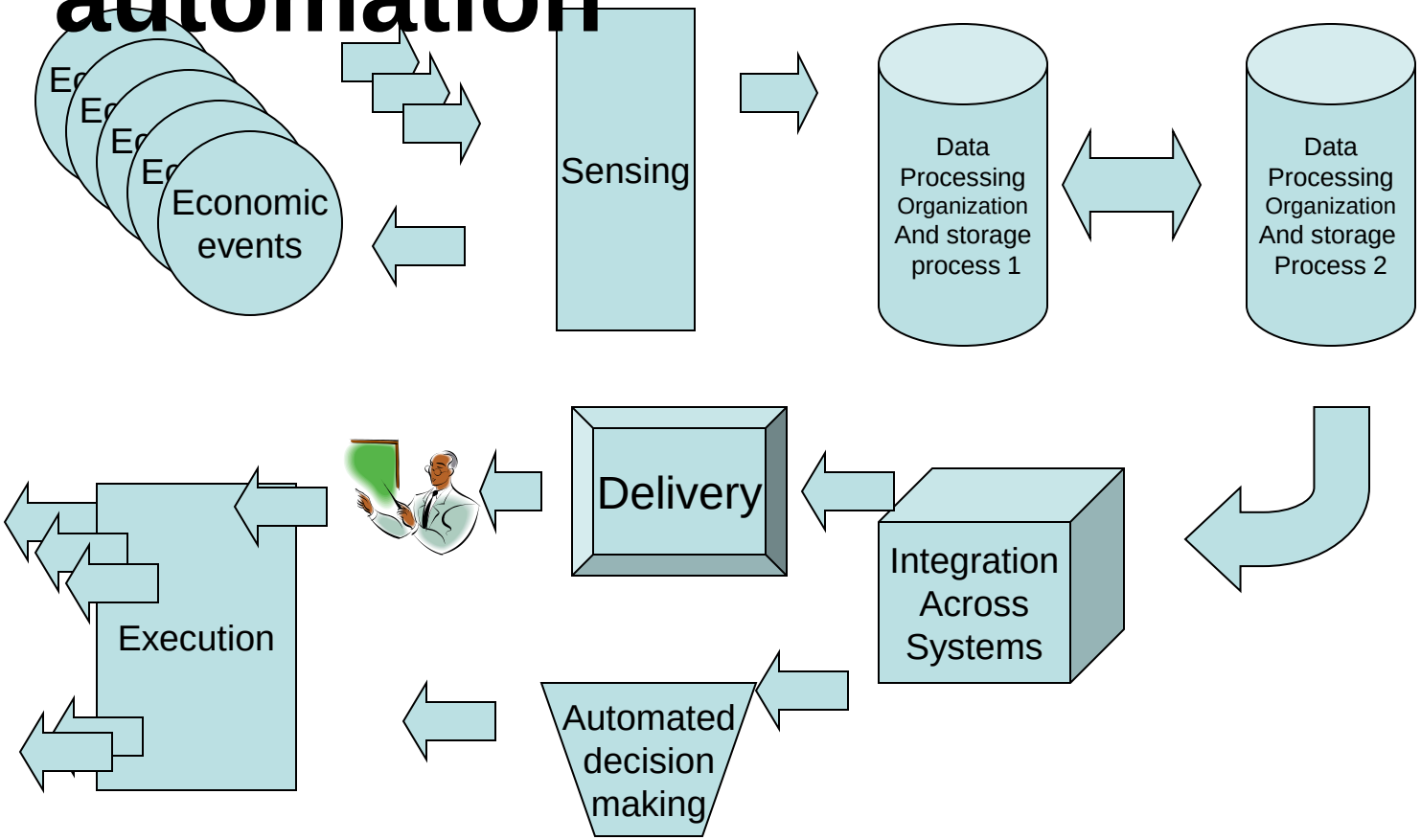
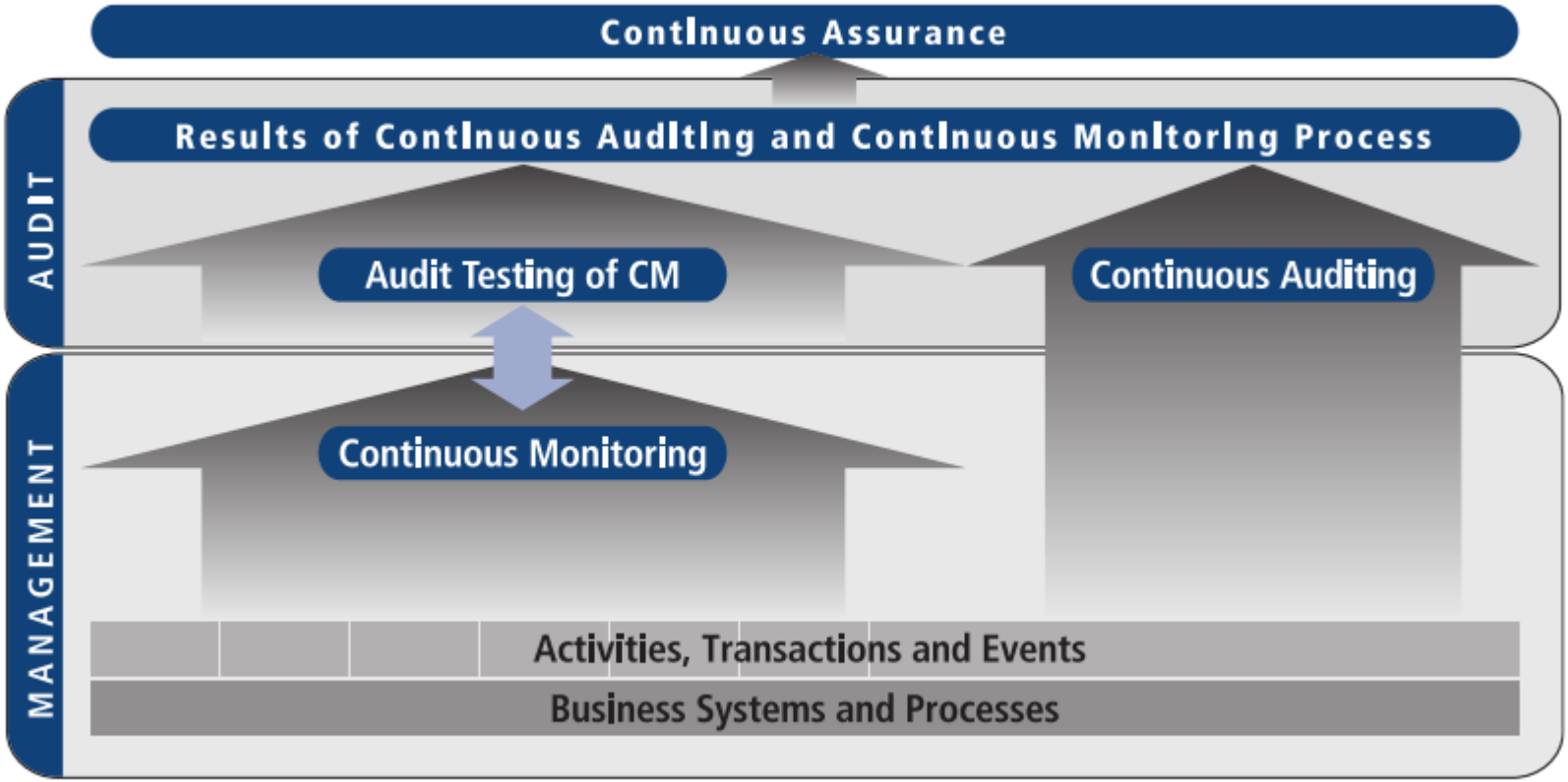
Latencies


Time it takes to perform a process
Time it takes to pass information between processes
Time it takes for a decision to lead to an outcome
Business Process 1
Process 2
Outcomes
Intra-process latency
Inter-process latency
ecision
atency

Elements of progressive automation

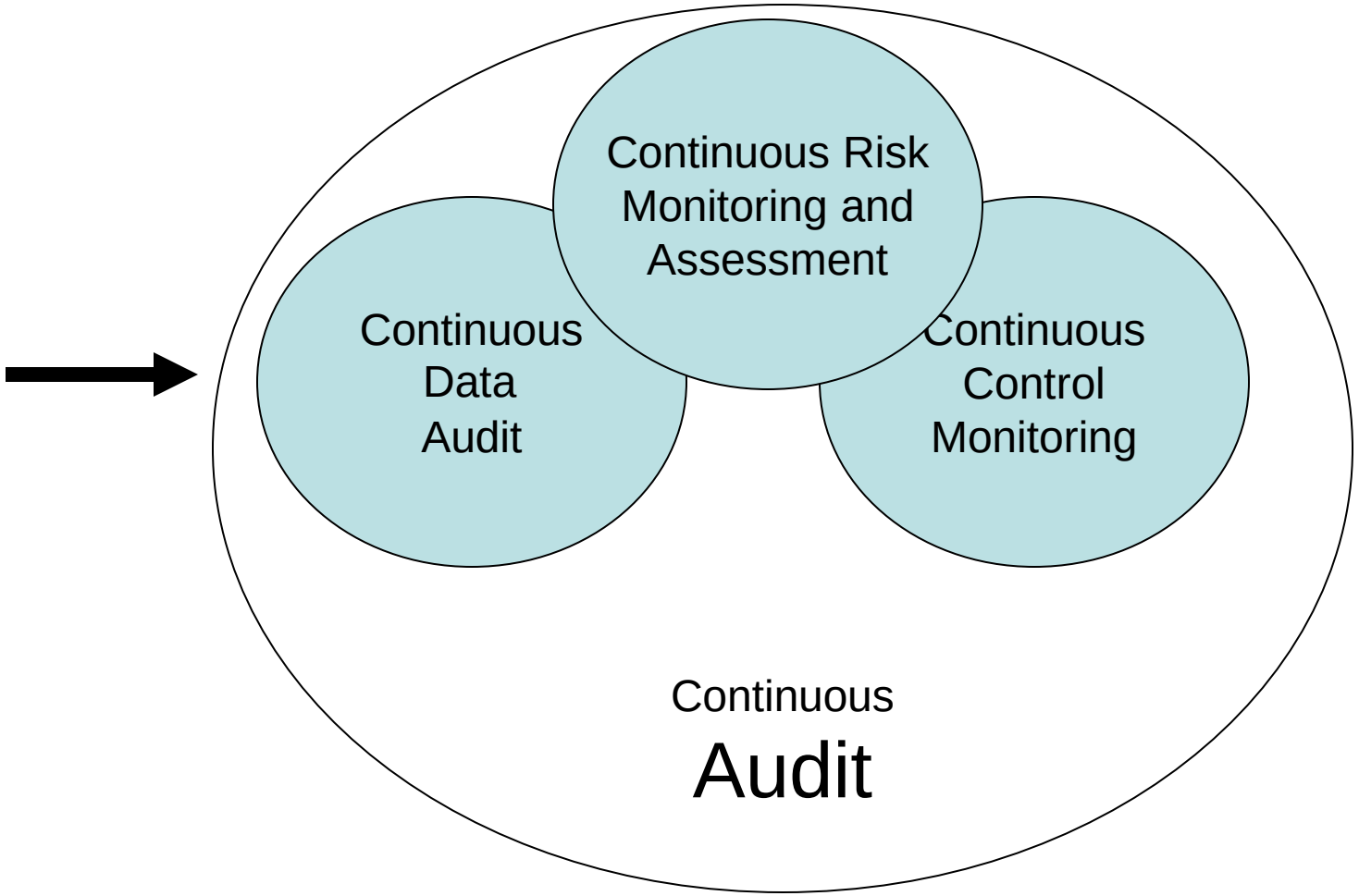


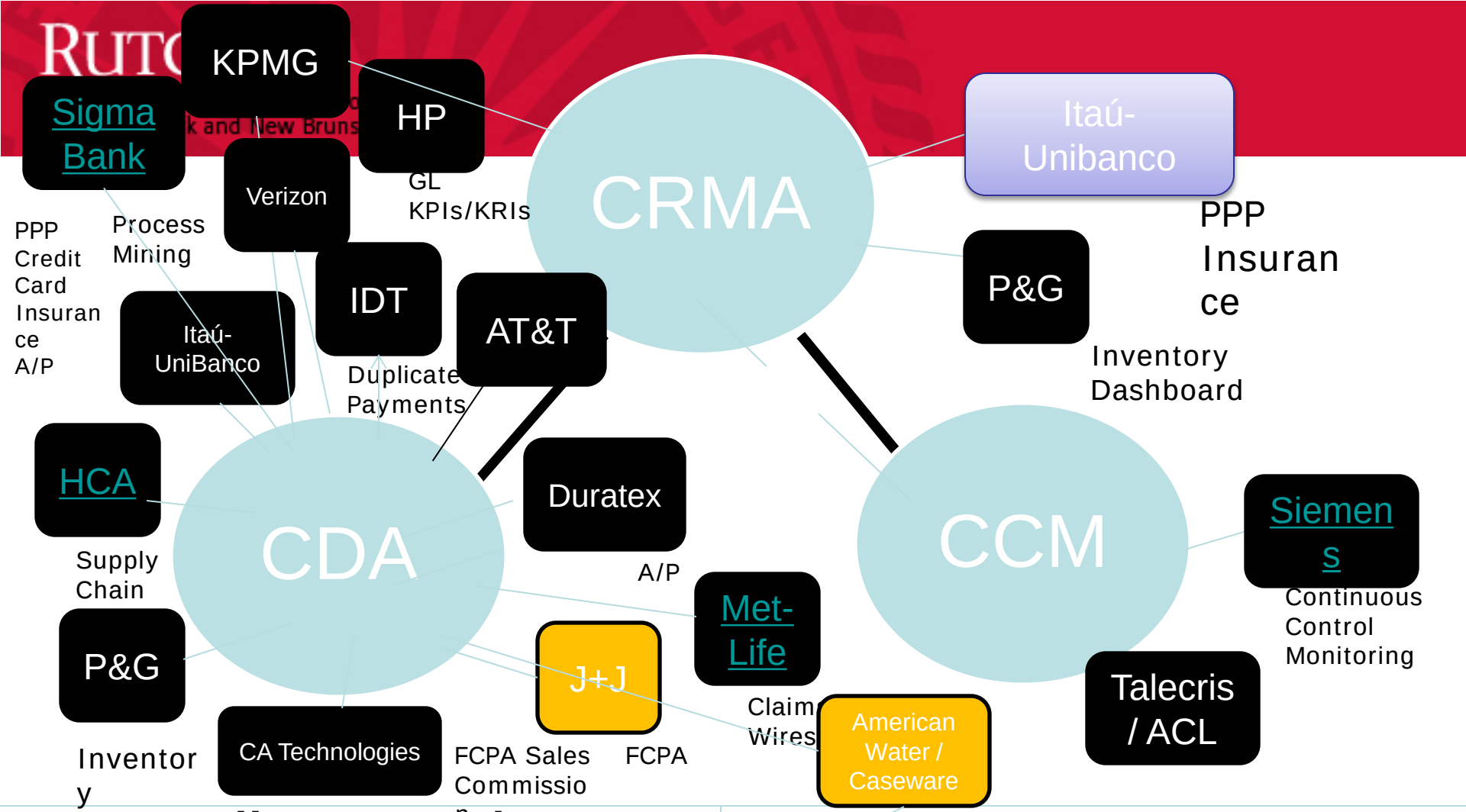
Continuous Assurance Model



An evolving continuous audit framework

- Automation
- Sensoring
- ERP
- E-Commerce





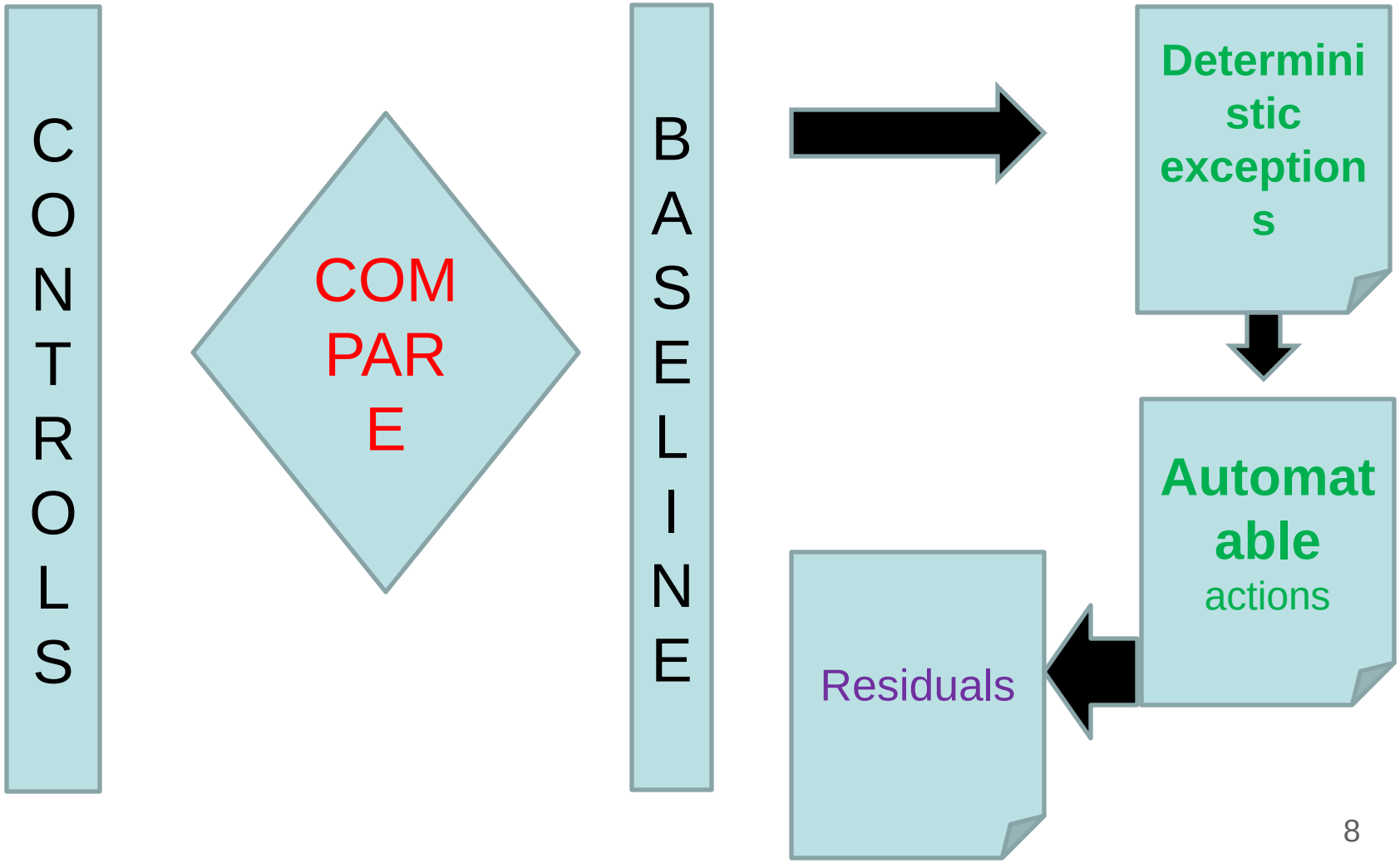
Audit Automation

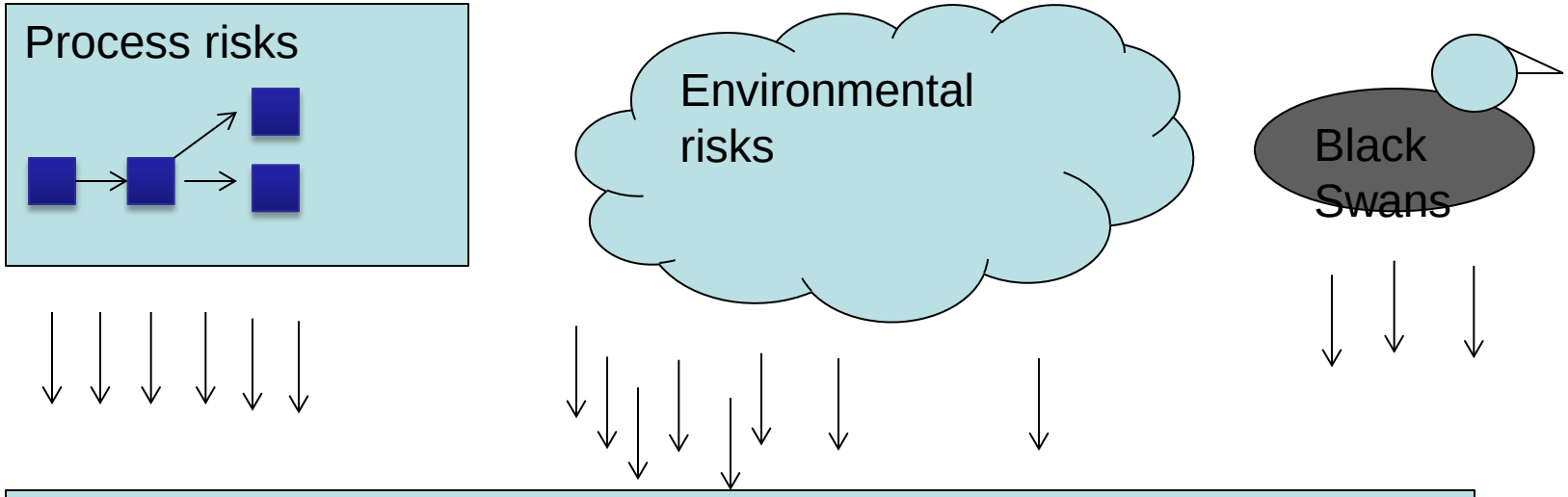
P&G: Order to Cash
Auditor Judgment
Siemens- AAS Automation
AICPA – ADS / APS

Audit Methodologies

- **Multidimensional Clustering**
- **Process Mining**
- **Continuity Equations**
- **Predictive Auditing**
- **Visualization**
- **Analytic Playpen**

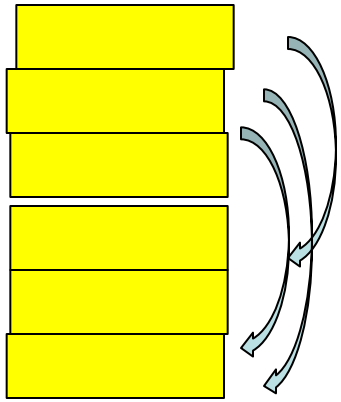
CCM


CONTROLS
COMPARE
BASELINE
Deterministic exceptions
Automatable actions
Residuals



Variable selection algorithms (heuristics expert based)

Risk minimization / audit return maximization algorithms



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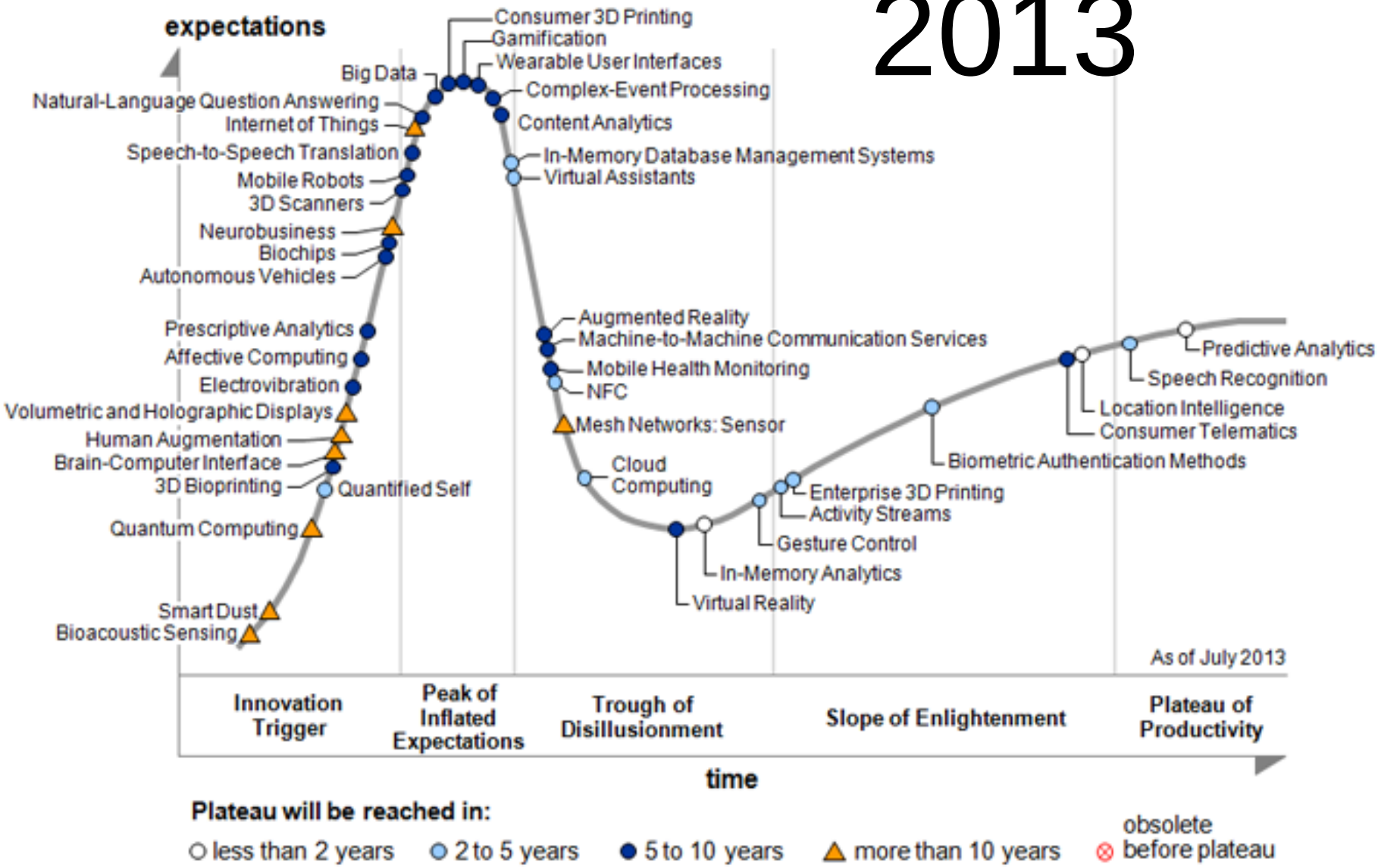
1. Continuous Assurance – The strategy behind auditing in the real time economy

2013


expectations
Consumer 3D Printing
Gamification
Wearable User Interfaces
Big Data
Complex-Event Processing
Natural-Language Question Answering
Internet of Things
Content Analytics
Speech-to-Speech Translation
In-Memory Database Management Systems
Mobile Robots
Virtual Assistants
3D Scanners
Neurobusiness
Biochips
Autonomous Vehicles
Augmented Reality
Prescriptive Analytics
Machine-to-Machine Communication Services
Affective Computing
Mobile Health Monitoring
Electrovibration
NFC
Volumetric and Holographic Displays
Mesh Networks: Sensor
Human Augmentation
Brain-Computer Interface
Cloud Computing
3D Bioprinting
Quantified Self
Enterprise 3D Printing
Activity Streams
Quantum Computing
Gesture Control
In-Memory Analytics
Virtual Reality
Smart Dust
Bioacoustic Sensing
Predictive Analytics
Speech Recognition
Location Intelligence
Consumer Telematics
Biometric Authentication Methods
As of July 2013
Innovation Trigger
Peak of Inflated Expectations
Trough of Disillusionment
Slope of Enlightenment
Plateau of Productivity
time
Plateau will be reached in:
less than 2 years
2 to 5 years
5 to 10 years
more than 10 years
obsolete before plateau

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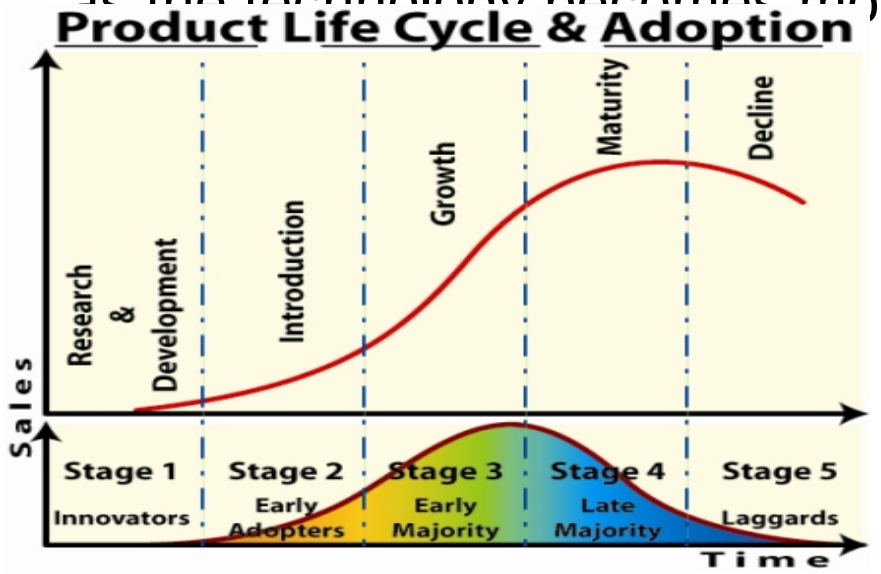
The Acceptance and Adoption of Continuous Auditing by Internal Auditors: A Micro Analysis

Miklos A. Vasarhelyi
Micheal Alles
Siripan Kuenkaikaew
James Littley

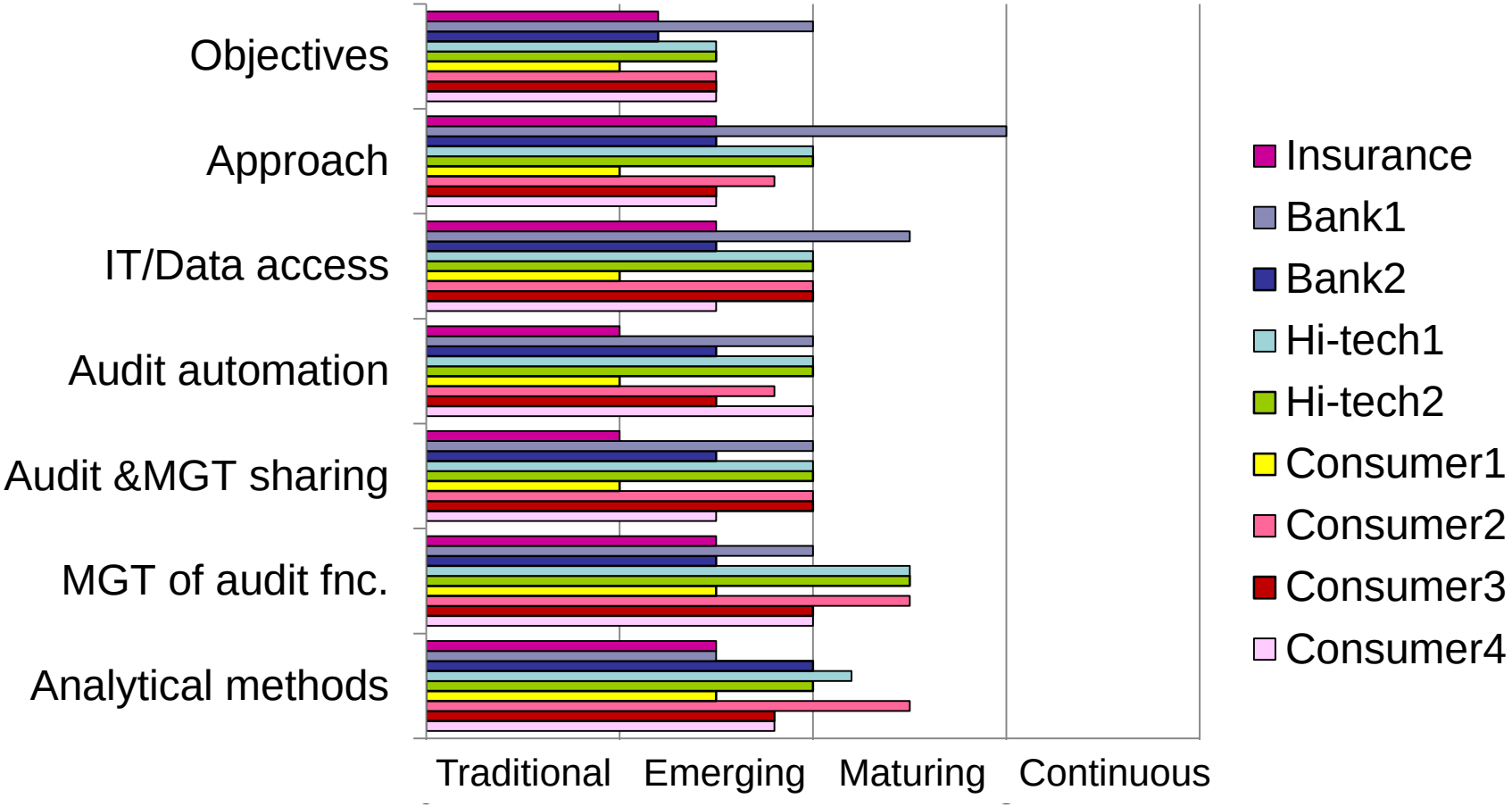
Measuring the Degree of CA Adoption

- We have developed an “Audit Maturity Model” that corresponds to the Technology Adoption Lifecycle model of Bohlen et at (1957) and Rogers (1962).
- Our model emphasizes on how products and markets change as the technology becomes more refined and widely adopted.



The Rogers’ Product Life Cycle Curve

The Audit Maturity Model



The CarLab

Continuous Audit and Reporting Laboratory
Graduate School of Management
Rutgers University

AAA impact of research taskforce 2009

- Perhaps the most important contribution of accounting information systems research to practice in the auditing and assurance domain is in continuous assurance. The work of Vasarhelyi and his colleagues on continuous assurance demonstrates the application of strong theoretical foundations to the practical problems of the auditor; in this case the internal auditor.

Adobe Acrobat Standard - [Accounting Program Research Rankings by Topical Area and Methodology SSRN-id1337755.pdf]
File Edit View Document Comments Tools Advanced Window Help
Search Create PDF Comment & Markup Send for Review Secure Sign
Select 164% Help Note Tool Text Edits Stamp Tool Show
Bookmarks Signatures Pages Model Tree Attachments Comments

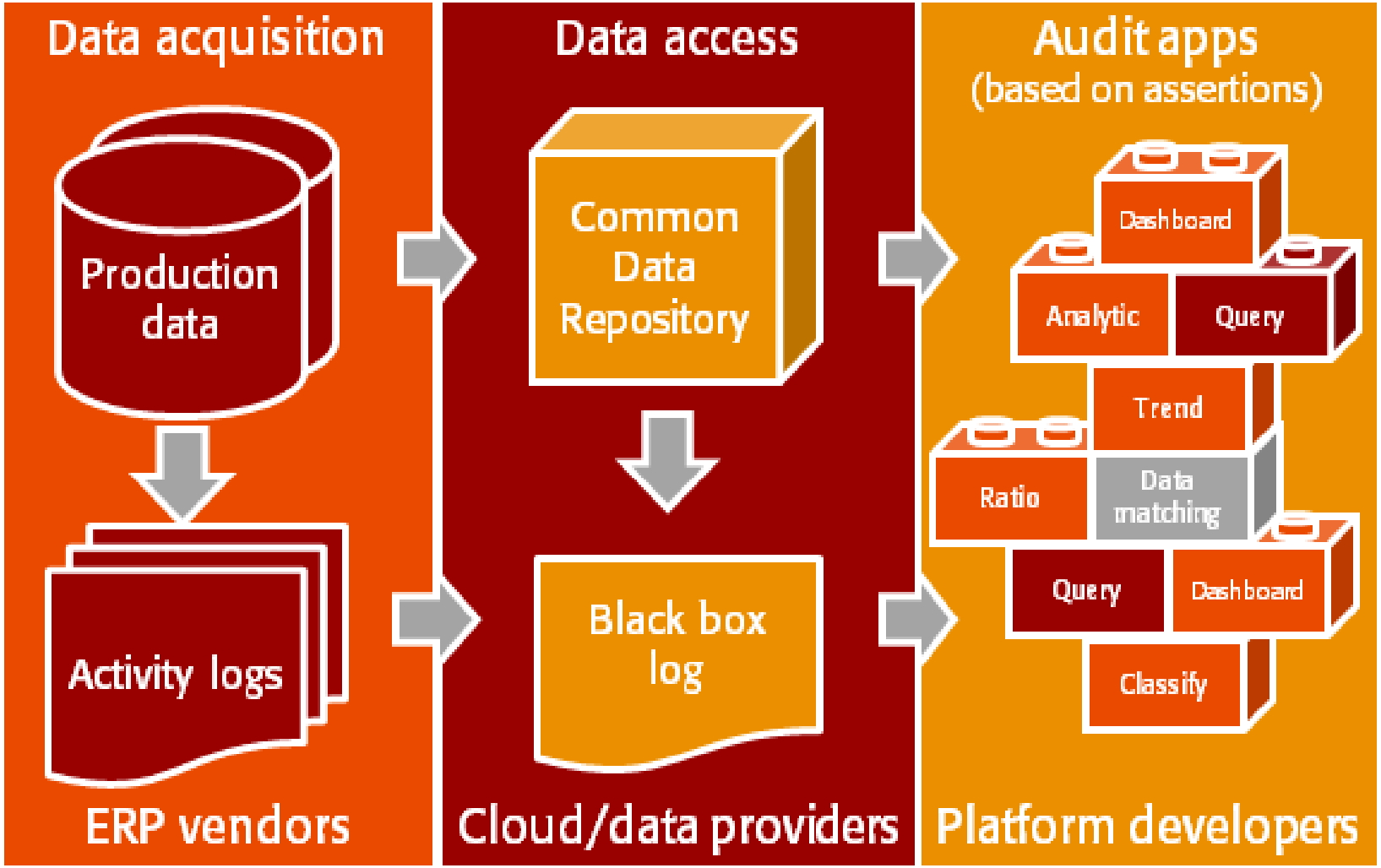
TABLE 2
Rankings (Number of Publishing Professors) of Accounting Institutions by Topical Area

	AIS			Audit		
University	**19 Yrs**	**12 Yrs**	**6 Yrs**	**19 Yrs**	**12 Yrs**	**6 Yrs**
Rutgers	1 (5)	1 (4)	1 (3)			
Ariz St	2 (5)	3 (3)	18 (1)	1 (11)	12 (6)	39 (2)
Bentley	2 (4)	2 (4)	3 (2)	7 (6)	5 (6)	6 (6)
Cen Fla	4 (3)	3 (3)	10 (2)			
Missouri	4 (3)	3 (3)	3 (3)	19 (2)	14 (2)	7 (2)
So Illinois	4 (6)	5 (4)	2 (3)			
So Florida	7 (4)	8 (4)	10 (3)			
Tx Tech	8 (4)	5 (4)	6 (3)			
Florida St	9 (3)	9 (2)	3 (2)			
Kennesaw St	9 (3)	9 (3)	75 (0)			
Melbourne	9 (2)	28 (1)	18 (1)			
Michigan St	9 (3)	9 (2)	18 (2)			
Portland St	9 (4)	9 (3)	6 (3)			
Brigham Young U	14 (4)	28 (2)	75 (0)	13 (8)	7 (8)	9 (5)
Georgia St	14 (3)	14 (3)	18 (2)			
Kansas	14 (4)	14 (3)	10 (2)			
No Arizona	14 (2)	20 (2)	10 (2)			
Tx A&M	14 (2)	9 (2)	18 (1)	10 (9)	16 (7)	13 (3)
Utah	14 (1)	28 (1)	37 (1)			
Arkansas	20 (1)	14 (1)	10 (1)			
Auburn	20 (3)	20 (2)	10 (2)			
Cal St Long Bch	20 (2)	14 (2)	6 (2)			
Indiana Indianapolis				15 (5)	12 (5)	11 (2)
Rutgers				15 (8)	14 (6)	9 (3)
Georgia St				17 (6)	21 (6)	20 (4)
Nanyang Tech				17 (6)	9 (6)	7 (5)
Arizona				20 (6)	37 (4)	39 (3)
Kentucky				20 (4)	20 (4)	27 (3)
Vanderbilt				20 (3)	29 (3)	57 (3)
Boston Coll				23 (5)	44 (3)	78 (1)
Alabama				24 (4)	16 (4)	15 (3)

24 of 30

Audit Innovation at the CarLab

- Continuous Audit at AT&T
- Continuity Equations
- Multidimensional clustering
- Process mining
- Predictive auditing
- Rule based outlier detection
- Audit Data Standard (with AICPA/ASEC)


Data acquisition
Data access
Audit apps
(based on assertions)
Production data
Common Data Repository
Dashboard
Analytic
Query
Trend
Ratio
Data matching
Query
Dashboard
Classify
Activity logs
Black box log
ERP vendors
Cloud/data providers
Platform developers

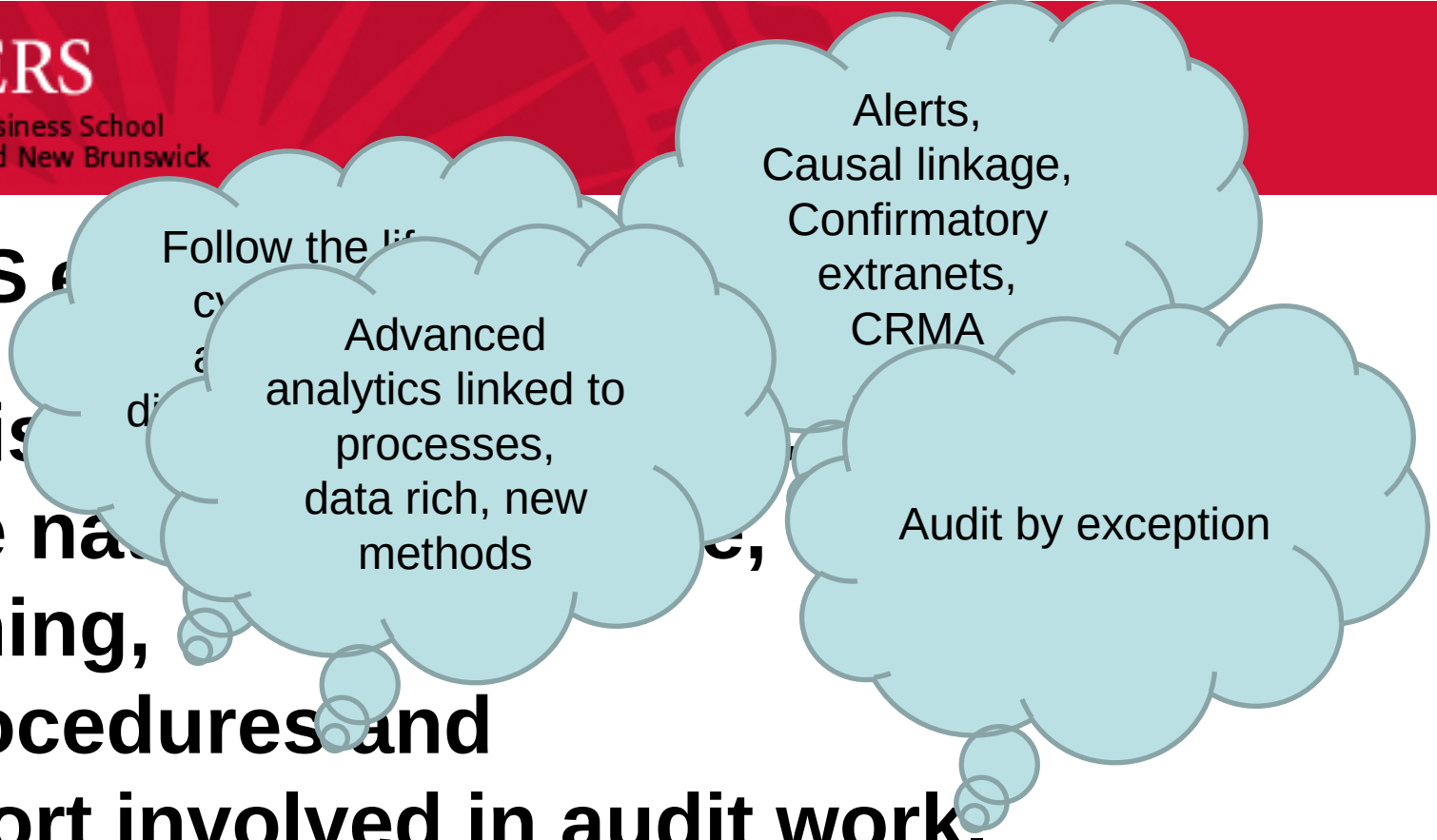
Continuous Process Auditing at AT&T (1986-1991)

CPAS definition

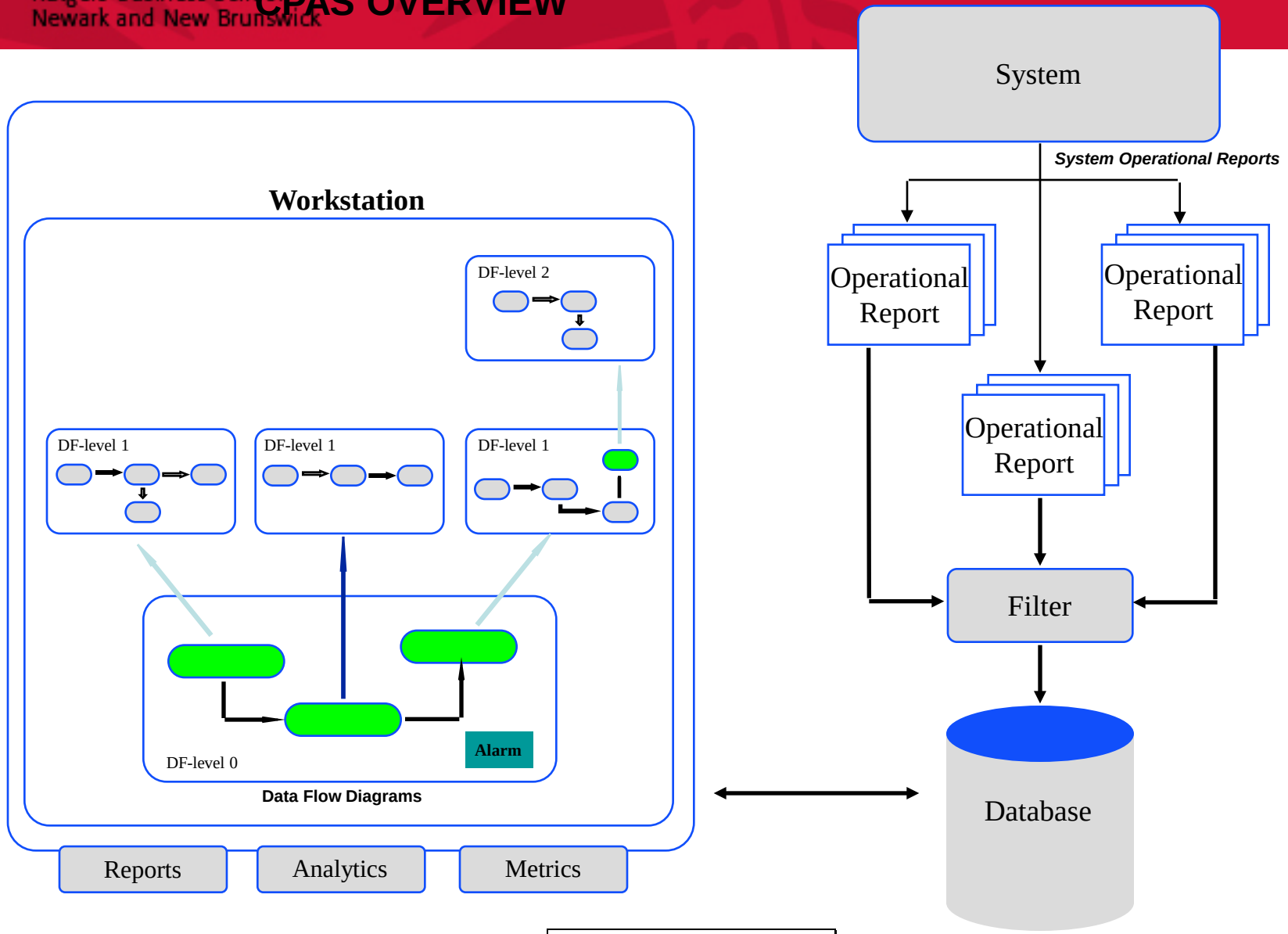
- The Continuous Process Audit System (CPAS) approach can be defined as a philosophy of auditing that aims to monitor key corporate processes on a continuous basis, in order to achieve audit by exception.

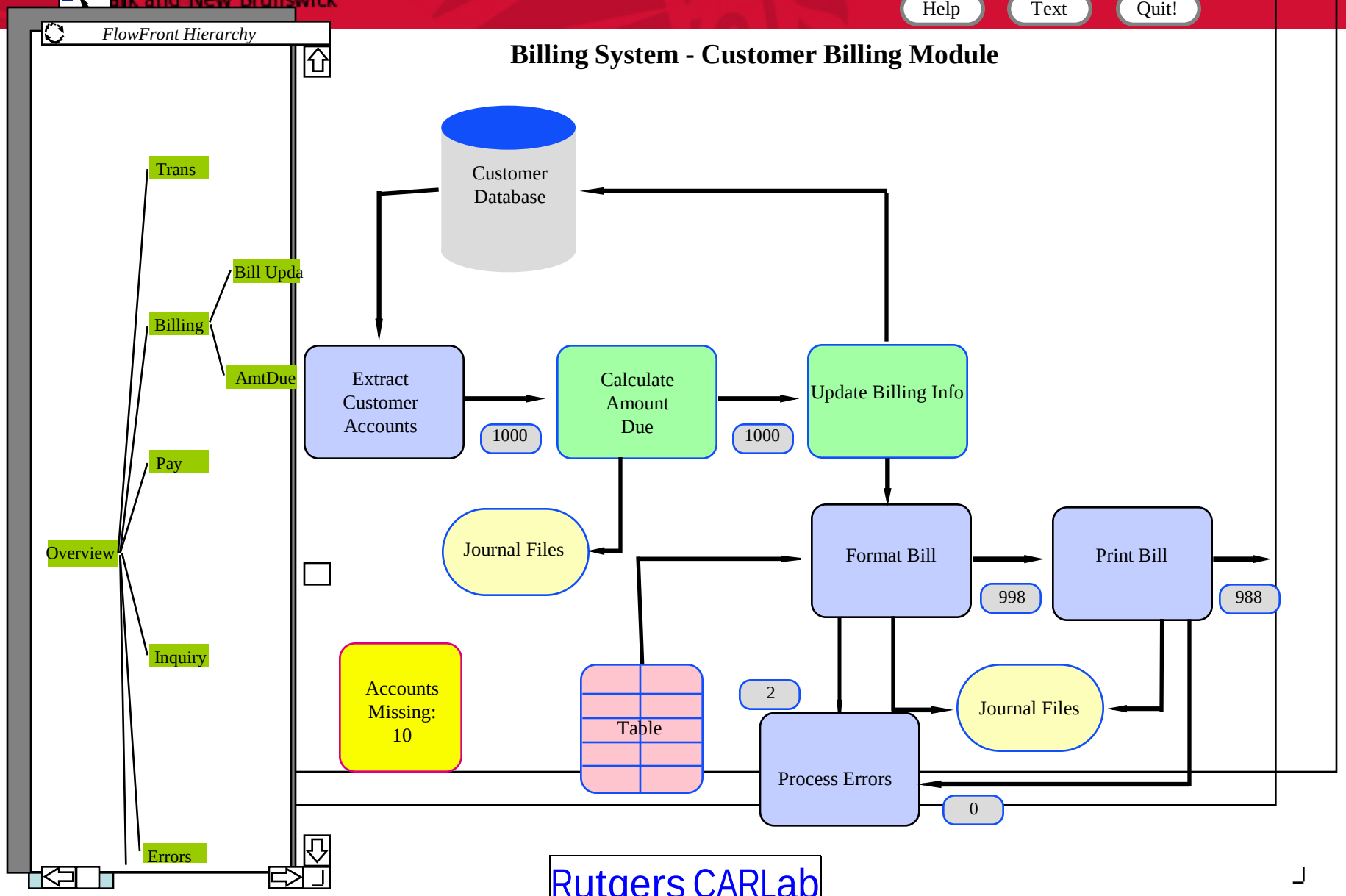
CPAS e

- **This**
  the na **e,**
  timing,
  procedures and
  effort involved in audit work.



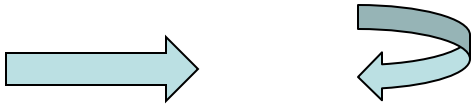
CPAS OVERVIEW



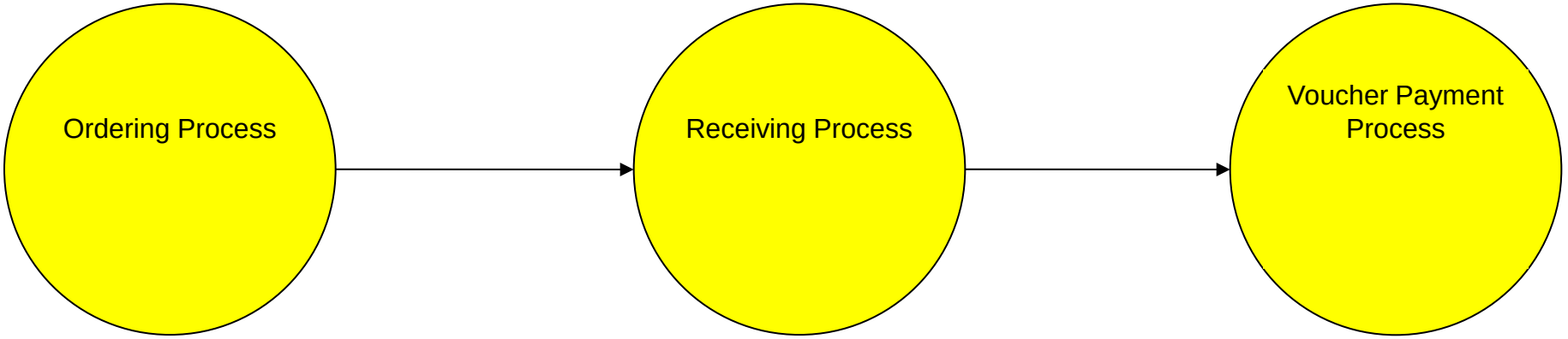

FlowFront Hierarchy
Trans
Bill Upda
Billing
AmtDue
Pay
Overview
Inquiry
Errors
Billing System - Customer Billing Module
Customer Database
Extract Customer Accounts
1000
Calculate Amount Due
1000
Update Billing Info
Journal Files
Format Bill
998
Print Bill
988
Accounts Missing: 10
Table
2
Journal Files
Process Errors
0

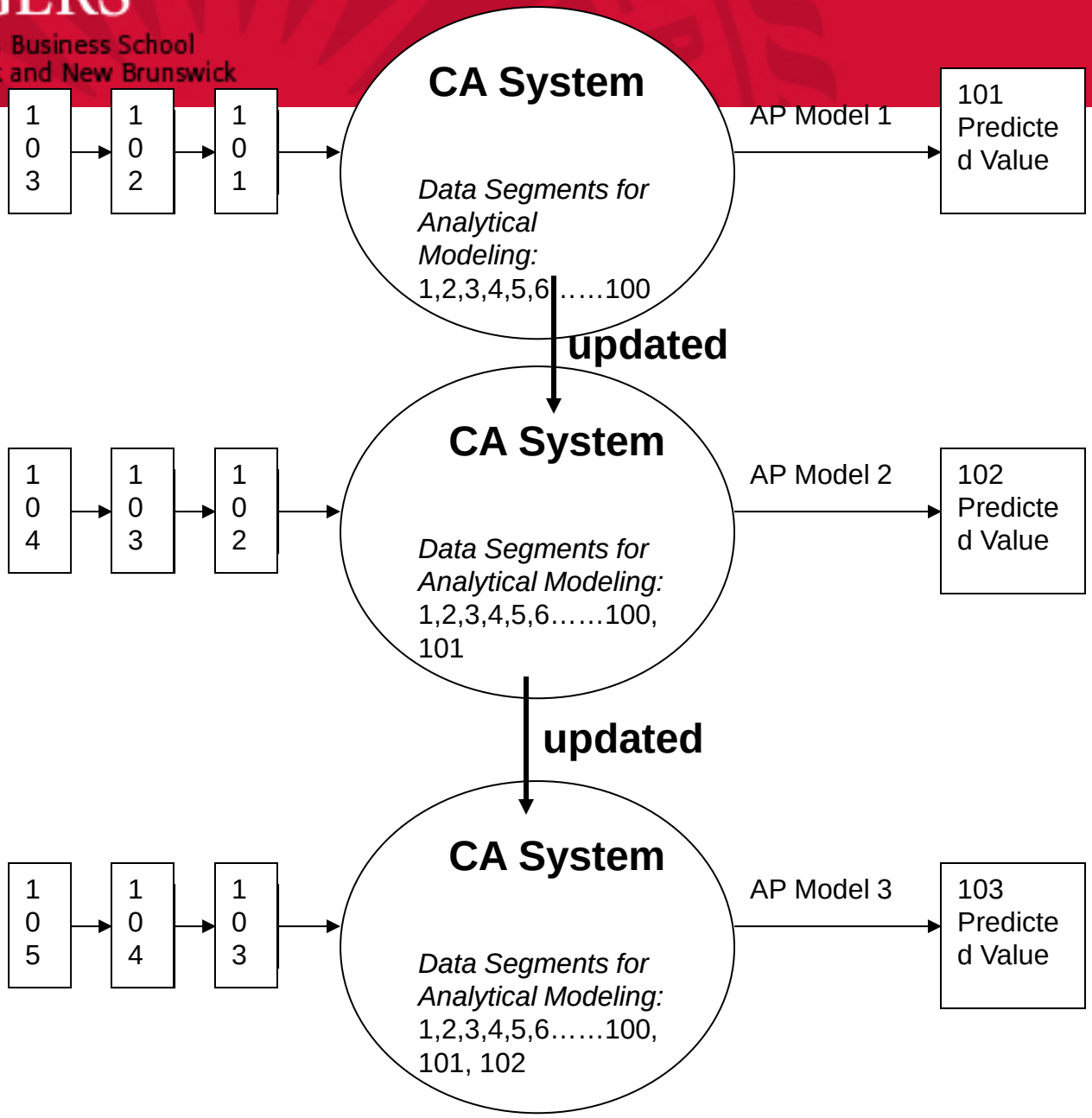
CPAS Changed Role of Auditor

- The auditor will place an increased level of reliance on the evaluation of flow data (while accounting operations are being performed) instead of evidence from related activities (e.g. preparedness audits).
- Audit work would be focused on audit by exception with the system gathering knowledge exceptions on a continuous basis.



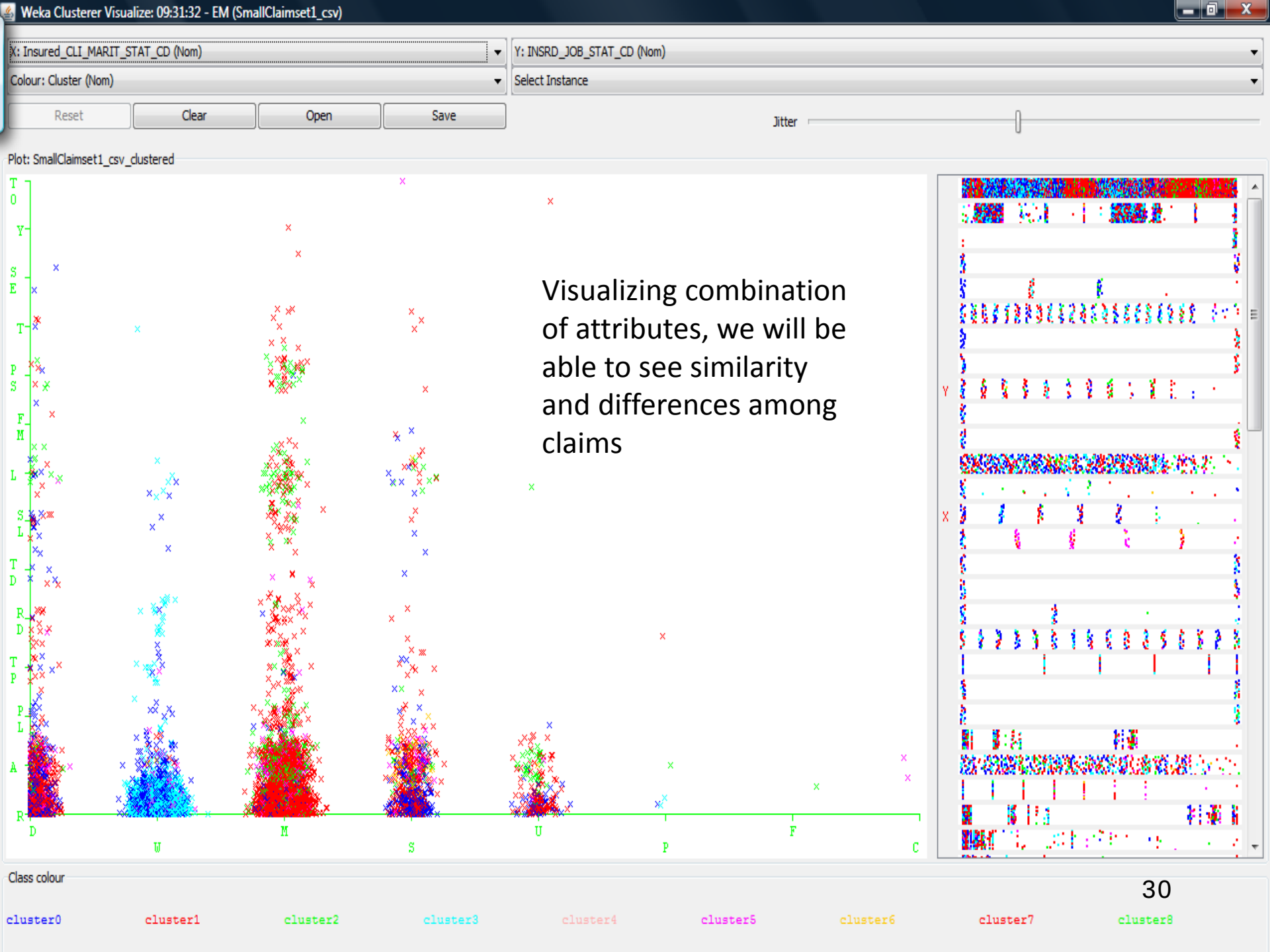
Continuity equations


Ordering Process
Receiving Process
Voucher Payment Process

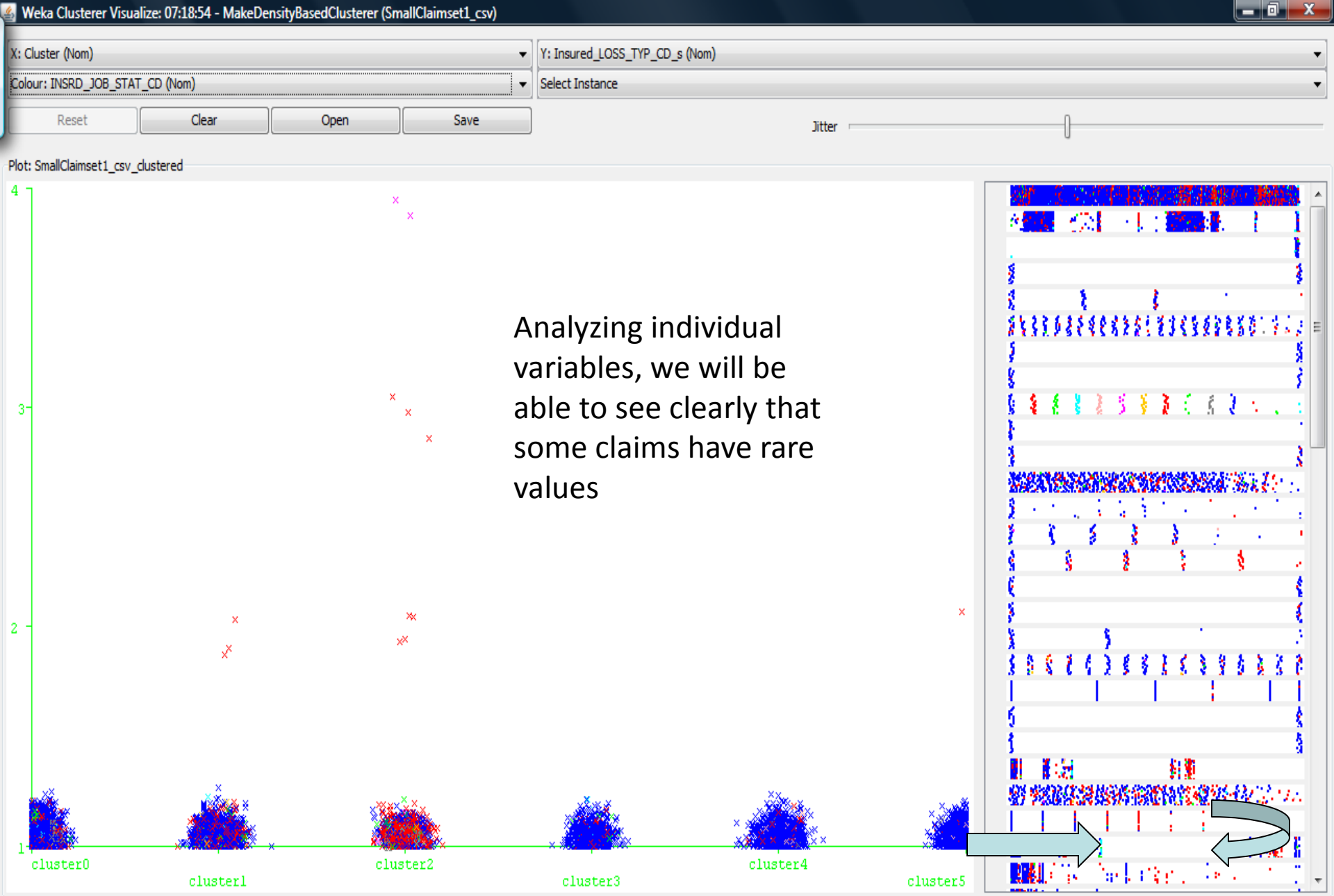

103
102
101
CA System
Data Segments for Analytical Modeling: 1,2,3,4,5,6…..100
AP Model 1
101 Predicted Value
updated
104
103
102
CA System
Data Segments for Analytical Modeling: 1,2,3,4,5,6……100, 101
AP Model 2
102 Predicted Value
updated
105
104
103
CA System
Data Segments for Analytical Modeling: 1,2,3,4,5,6……100, 101, 102
AP Model 3
103 Predicted Value

Multidimensional Clustering for audit fault detection

Sutapat Thiprungsri
Miklos A. Vasarhelyi



Visualizing combination of attributes, we will be able to see similarity and differences among claims


Weka Clusterer Visualize: 07:18:54 - MakeDensityBasedClusterer (SmallClaimset1_csv)
X: Cluster (Nom)
Y: Insured_LOSS_TYP_CD_s (Nom)
Colour: INSRD_JOB_STAT_CD (Nom)
Select Instance
Reset
Clear
Open
Save
Jitter
Plot: SmallClaimset1_csv_clustered
4
3
2
1
cluster0
cluster1
cluster2
cluster3
cluster4
cluster5
Analyzing individual variables, we will be able to see clearly that some claims have rare values
Class colour
R
A
PL
TP
RD
TD
SL
L
FM
PS
T
SE
Y
TO

Process mining

Mieke Jens (Hasselt University)
Michael Alles (Rutgers Univ.)

What is Process Mining of Event Logs?

- *The basic idea of process mining is to extract knowledge from **event logs** recorded by an information system. Until recently, the information in these event logs was rarely used to analyze the underlying processes. Process mining aims at improving this by providing techniques and tools for discovering process, control, data, organizational, and social structures from event logs. Fuelled by the omnipresence of event logs in transactional information systems… process mining has become a vivid research area.*
- http://is.tm.tue.nl/staff/wvdaalst/BPMcenter/process%20mining.htm

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An Example of An Event Log of an Invoice

Invoice number 003

Supplier: AT&T
Posting date: Feb 10th 2010
120 USD
Description: internet services Jan 2010
'Signature of John'
'Signature of Pete'

Invoice number 003

Supplier: AT&T
Posting date: Feb 10th 2010
120 USD
Description: internet services Jan 2010
'Signature of John'
'Signature of Pete'

Input data

PLUS

- 'Create Invoice'
  Timestamp: Feb 12th 2010; 08:23 AM
  Originator: Mike
  Fields: supplier: AT&T, posting date: 02-10-2010, value: 100 USD,
  Description: internet services Jan 2010

- 'Change'
  Timestamp: Feb 12th 2010; 08:43 AM
  Originator: John
  Field changed: Value
  Value old: 100 USD
  Value new: 120 USD

-'Sign'
  Timestamp: Feb 12th 2010; 08:44 AM
  Originator: John

Meta-data

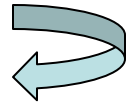

Figure 1: Visualization of Input Data and Event Log Data of an Invoice

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PREDICTIVE AUDIT: TRANSACTION STATUS PREDICTION

Predictive Audit

- A predictive audit could help auditors and management to block a problem before it spreads.
- It is better to look forward than just look back at the historical information
- Continuous audit is used to monitor present transactions
- Can we use CA to predict the future?
  - Audit by exception
  - Alarm and warning system

Results and analysis

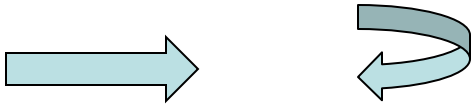
- Models comparison of cost-sensitive approach
- 1:14 ratio 1:16 ratio

Model/ Measurements	Accuracy	False negative rate	False positive rate
J48	0.64	0.48	0.35
Logistic regression	0.70	0.50	0.28
Support vector machine	0.79	0.63	0.18

Accuracy	False negative rate	False positive rate
0.53	0.36	0.48
0.57	0.39	0.44
0.73	0.56	0.25

Conclusion

- Predictive audit lets auditors monitor and audit controls in a preventive basis.
- The result of prediction model could alert auditors for suspicious transactions.



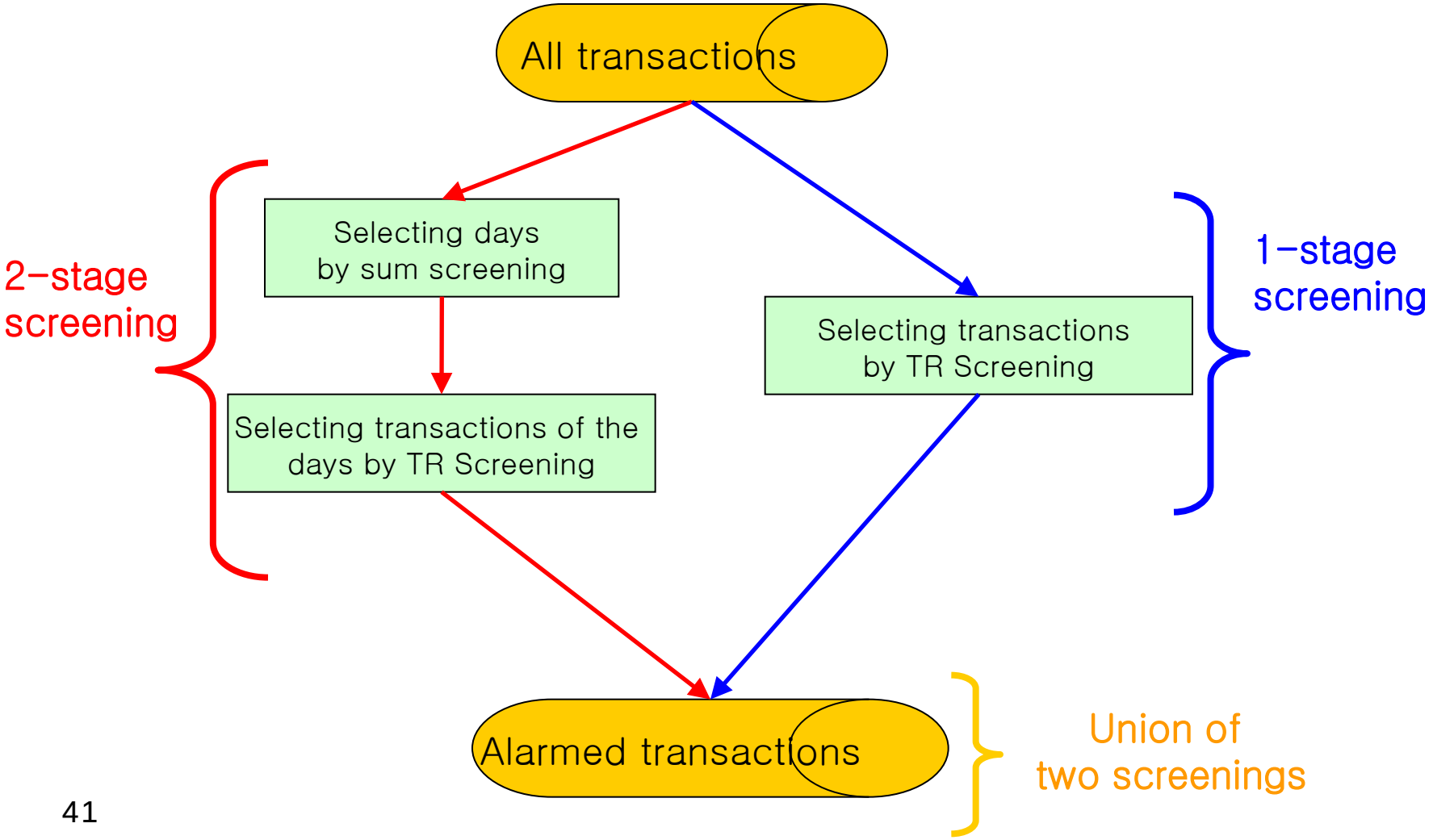
Rule based selection

Data Description

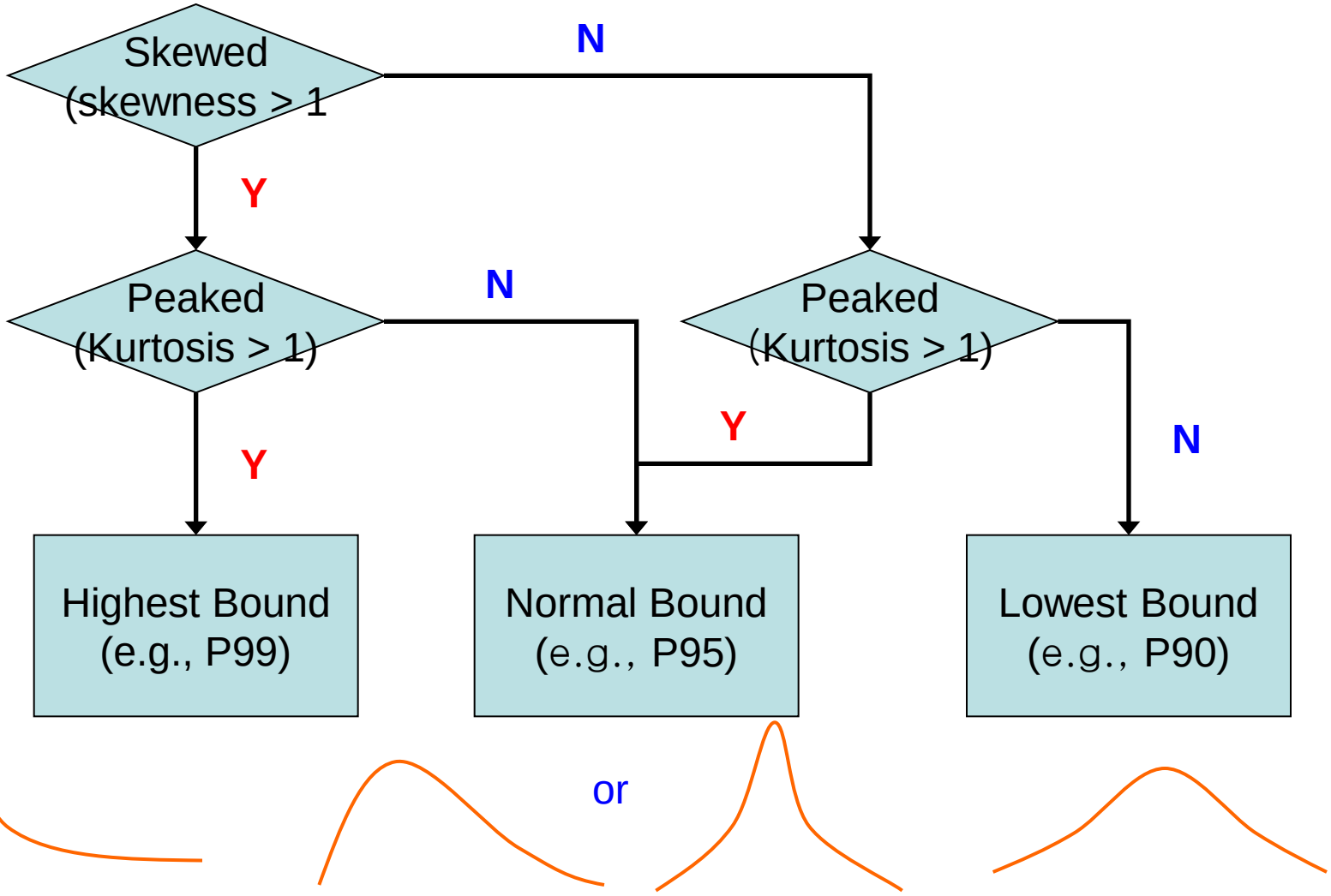
- Summary statistics
  - 16 transitory accounts
  - 17 variables
  - 418,971 transactions

- Data cleaning
  - 418,971: Source data
  - 50: wrong entries (due to wrong data extraction)
  - 18,504: out of date bounds (01/15/08 ~ 11/19/08, 310 days)
  - 400,417: Final data set

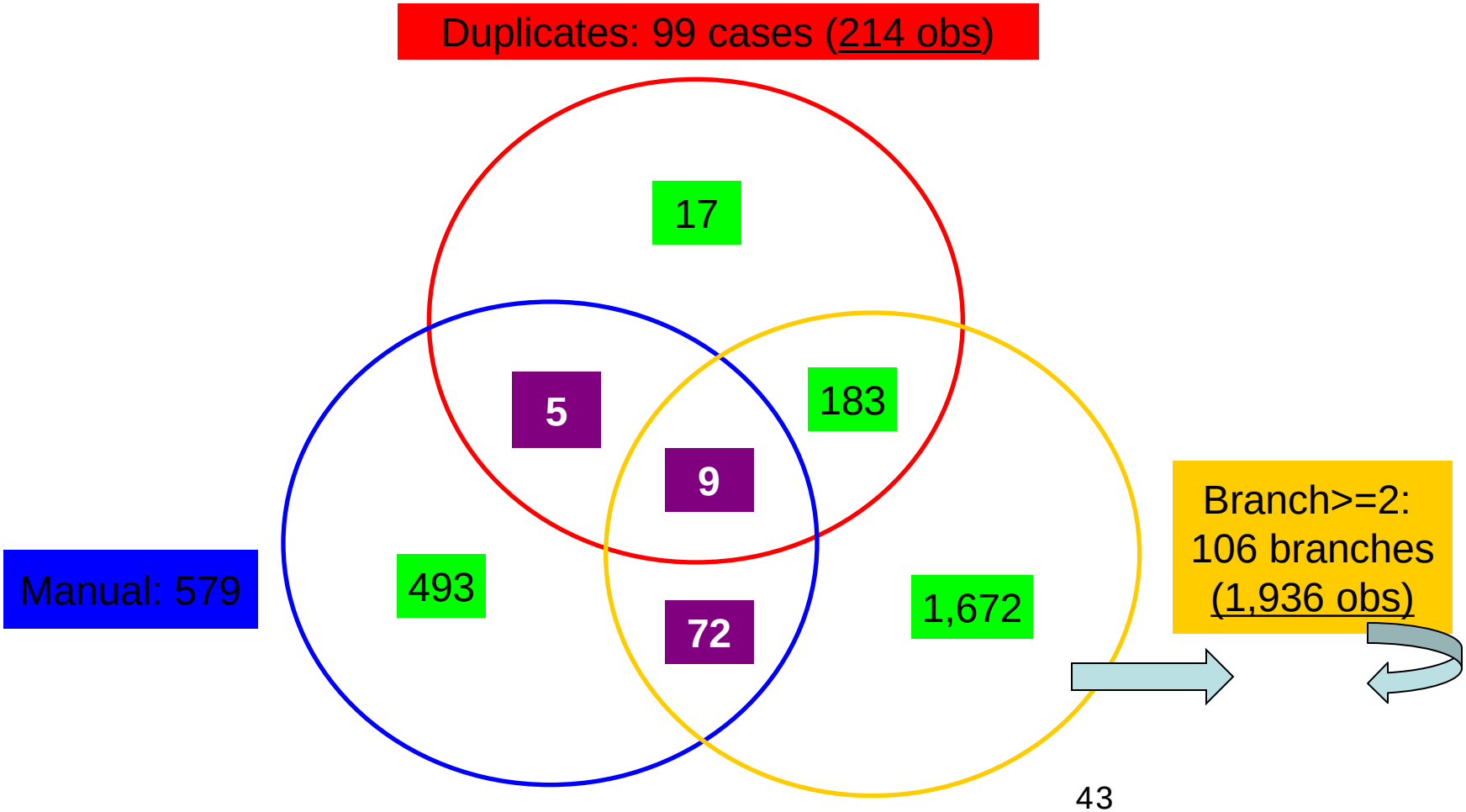
Level 2 Screening



The P-Rule


Skewed
(skewness > 1
N
Y
Peaked
(Kurtosis > 1)
N
Peaked
(Kurtosis > 1)
Y
Y
N
Highest Bound
(e.g., P99)
Normal Bound
(e.g., P95)
Lowest Bound
(e.g., P90)
or

Suggested for further examination



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Continuous Monitoring Of Business Process Controls At

SIEMENS

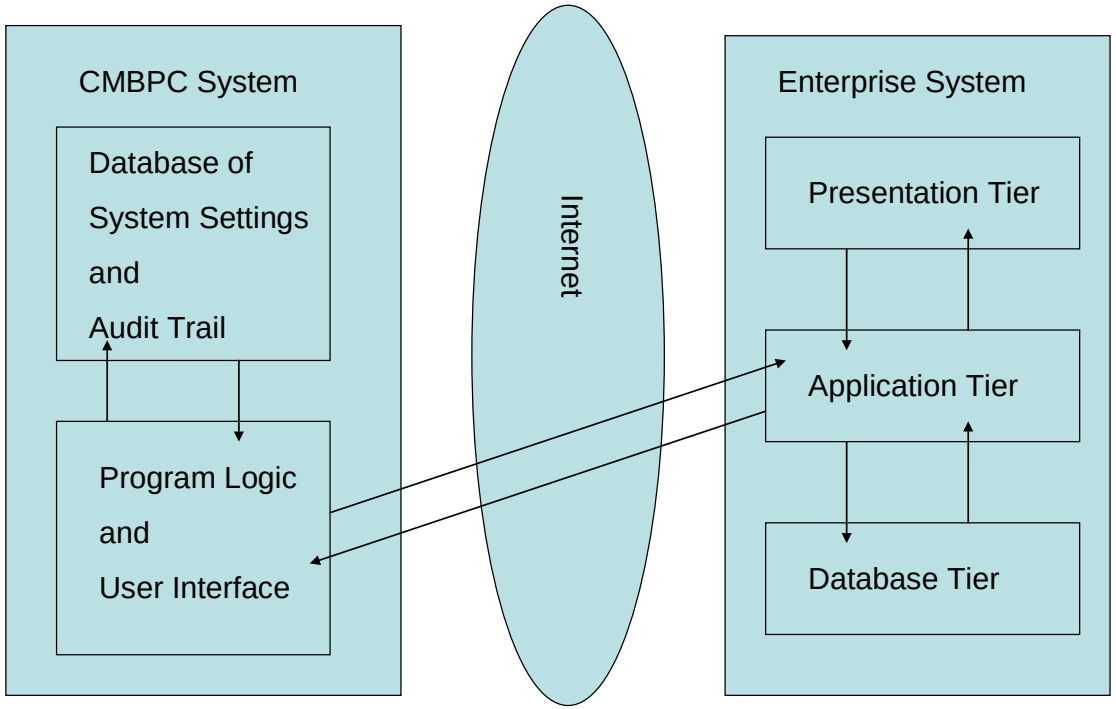
Professor Alexander Kogan
Rutgers Business School

Rutgers CARLab

Pilot Implementation Of CMBPC Systems By Siemens IT Internal Audit

- CARLab approached by Siemens IT internal audit to explore use of CA methodology to streamline audit of SAP system controls at siemens USA
- Siemens uniquely SAP enabled with 60+ applications in the USA alone
- IT internal audit examines sites on a 2 year cycle: labor intensive, costly
- Internal Audit needed to find resources to take on 404 implementation without increase in headcount

Architecture Of The Generic CMBPC System



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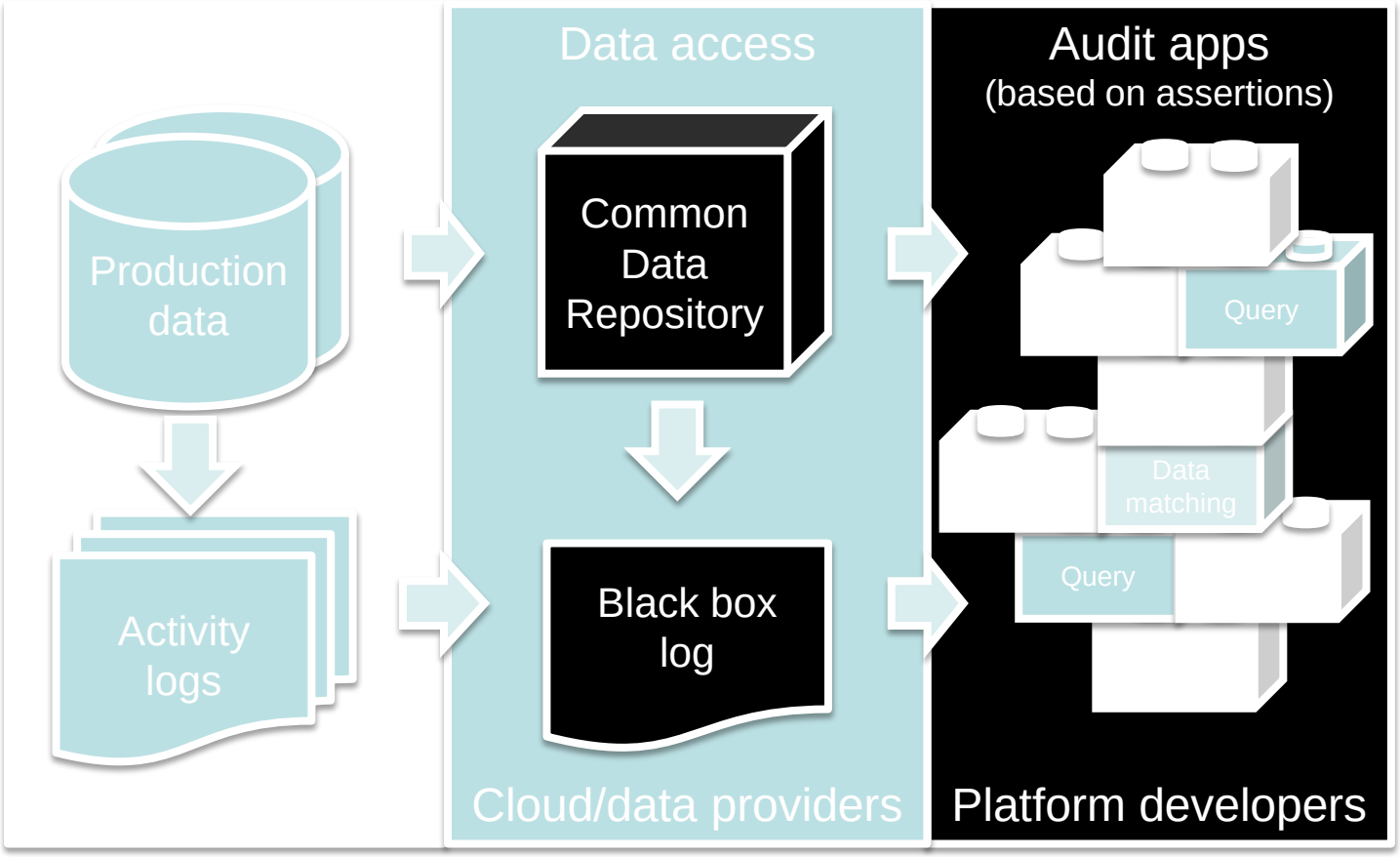
Audit Data Standards & Apps

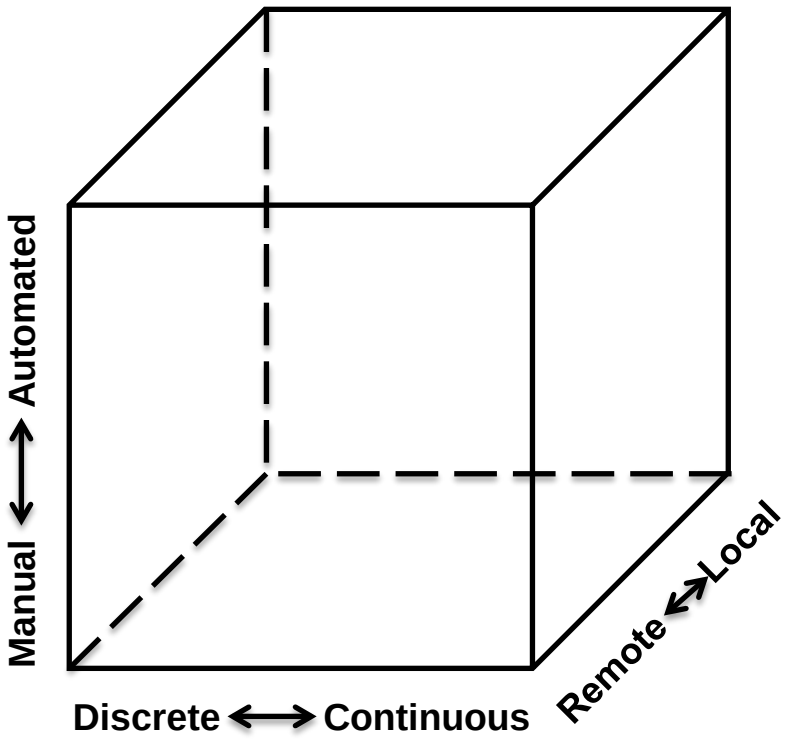
AICPA's Assurance Services Executive Committee – June 2011

Relationship Between Audit Apps and Common Data



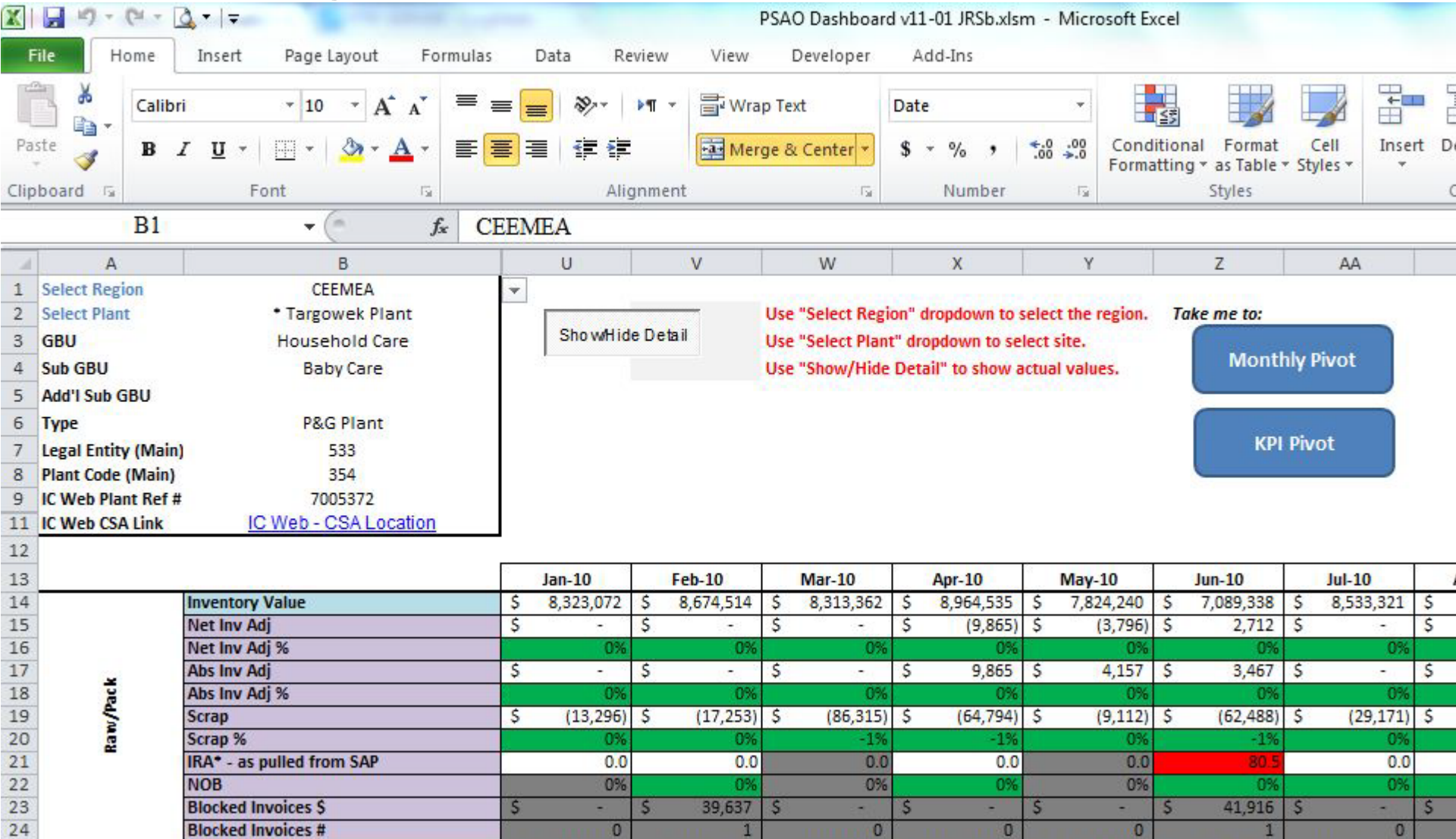
Dimensions of data/procedures

- Method
  - Data generation
  - Audit procedure
- Timing
  - Data generation
  - Data frequency
  - Audit frequency
- Location
  - Data storage/access
  - Audit steps

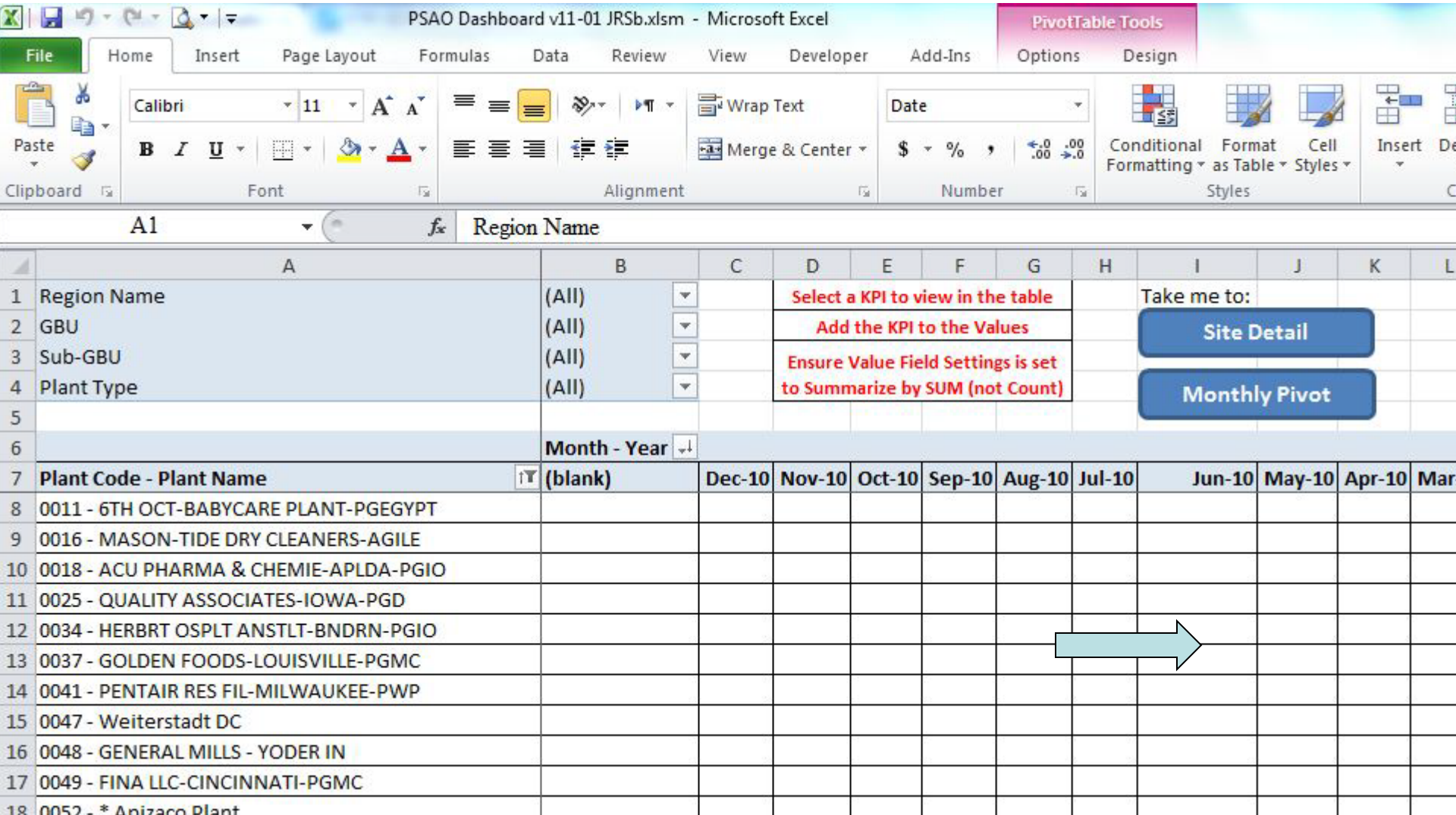


DASHBOARDS, VISUALIZATION, KPI'S, KRI'S, CONTROL PANELS

Inventory dashboard 1



Control dashboard



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CONCLUSION

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