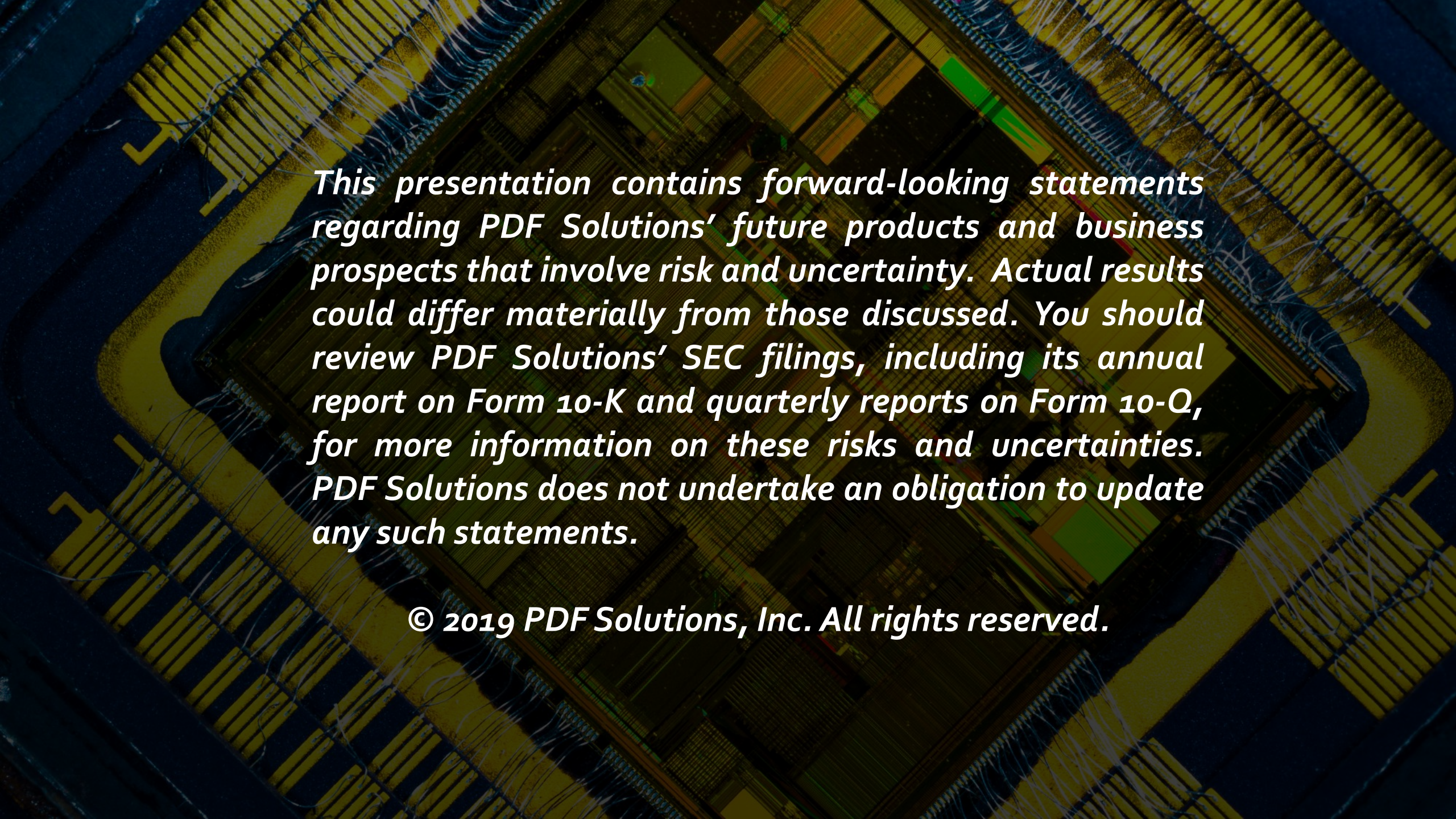
16th Annual
PDF Solutions
Users Conference

PDF/SOLUTIONS™

S1.1 – User Conference and Analyst Day

October 15, 2019

John Kibarian, CEO



This presentation contains forward-looking statements regarding PDF Solutions' future products and business prospects that involve risk and uncertainty. Actual results could differ materially from those discussed. You should review PDF Solutions' SEC filings, including its annual report on Form 10-K and quarterly reports on Form 10-Q, for more information on these risks and uncertainties. PDF Solutions does not undertake an obligation to update any such statements.

Agenda – Users Conference

Tuesday - 10/15	Topic	Timeslot	Session	Detail
	Registration Breakfast	7:30AM – 8:30AM		Pick up your registration materials, while enjoying breakfast.
	Welcome Introduction and PDF update	8:30AM – 9:15AM	S1.1	John Kibarian - PDF Solutions
	Why Exensio	9:15AM - 9:45AM	S1.2	Said Akar - PDF Solutions
	Machine learning in Exensio	9:45AM - 10:15AM	S1.3	Jeff David - PDF Solutions
	DFI™ and other New Data Sources for Yield, Reliability and Process Control	10:15AM - 10:45AM	S1.4	Dennis Ciplickas - PDF Solutions
	Break	10:45AM-11:15AM		
	Customer paper: ADI/LTC Exensio Deployment	11:15 AM- 11:45AM	S1.5	ADI
	Customer paper: Exensio Big Data and Saas POC	11:45 AM- 12:15 PM	S1.6	Qualcomm
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	Lunch	12:15PM – 1:30PM		Lunch with PDF customers
	Topic	**Timeslot**	**Session**	**Detail**
	Demo on Collaborative Learning and Guided Analysis	1:30PM – 2:00PM	S1.7	Hazem Jaouni/Hanna Bullata - PDF Solutions
	Customer Paper: Root Cause Investigation Using mæstria FDC and AI	2:00PM – 2:30PM	S1.8	ELMOS
	Customer paper: Fab process quality and defectivity management	2:30PM - 3:00PM	S1.9	United Semiconductor Japan
	Break	3:00PM - 3:30PM		
	Customer paper: Semiconductor Big Data Analytics	4:00PM – 4:30PM	S1.10	Qualcomm
	Customer paper: Graphcore and PDF Solutiions	4:30PM – 5:00PM	S1.11	Graphcore
	Customer Paper: Exensio analytics efficiency through Unicloud integration	5:00PM – 5:30PM	S1.12	UNIC
	Value Added Services	5:30PM - 6:00PM	S1.13	Mike Nohr - PDF Solutions
	Close of Day 1	6:00PM		Close for day 1, logistics for dinner

Agenda – Executive Track

Tuesday - 10/15

Topic	Timeslot	Session	Detail
Registration Breakfast	7:30AM – 8:30AM		Pick up your registration materials, while enjoying breakfast.
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Lunch	12:15PM – 1:30PM		Lunch with PDF Customers
Topic	**Timeslot**	**Session**	**Detail**
Big Trends Outside of Semiconductor	1:30PM – 2:15PM	S1.7E	Marco Iansiti - Harvard
AWS	2:15PM – 3:00PM	S1.8E	Dave Pellerin - Amazon
Break	3:00PM - 3:15PM		
KPMG	3:15PM - 4:00PM	S1.9E	Scott Jones - KPMG
Break	4:00PM - 4:15 PM		
Exensio Cloud and Big Data Analytics	4:15PM – 5:00PM	S1.10E	Said Akar - PDF Solutions
~~Standards Based Traceability to meet Reliability and Security Challenges~~	~~5:00PM – 5:30PM~~	~~S1.11E~~	~~Dave Huntley - PDF Solutions~~
Open Exec Discussion	5:30PM - 6:00PM	S1.12E	
Close of Day 1	6:00PM		Close for day 1, logistics for dinner

Agenda – Analyst Track

Tuesday - 10/15

Topic	Timeslot	Session	Detail
Registration Breakfast	7:30AM – 8:30AM		Pick up your analyst day materials, chat with PDF customers while enjoying breakfast.
Welcome, Introduction, and PDF update	8:30AM – 9:15AM	S1.1	Introduction and PDF Solutions Update - John Kibarian
Why Exensio	9:15AM - 9:45AM	S1.2	Said Akar
Machine learning in Exensio	9:45AM - 10:15AM	S1.3	Jeff David
DFI™ and other New Data Sources for Yield, Reliability and Process Control	10:15AM - 10:45AM	S1.4	Dennis Ciplickas
Break	10:45AM-11:00AM		
PDF General Overview	11:00AM - 11:30AM	S1.5A	Kimon Michaels
Field Overview	11:30AM - 12:00Noon	S1.6A	PK Mozumder, Michael Yu
Financial	12:00Noon - 12:30PM	S1.7A	Christine Russell
Lunch	12:30PM – 1:30PM		Lunch with PDF Customers
Topic	**Timeslot**	**Session**	**Detail**
Travel to Milpitas	1:30PM – 2:00PM	Travel	Chartered limosine bus to wafer inspection and test facility
Facility Tour	2:00PM – 3:00PM	S1.8A	Dennis Ciplickas, Indranil De, Kimon Michaels
Q&A (with refreshments)	3:00PM - 3:30PM	S1.9A	Dennis Ciplickas, Indranil De, Kimon Michaels
Travel back to Marriott	3:30PM - 4:00PM	Travel	Chartered limosine bus back to hotel
End of Analyst Day	4:00PM		

Please, No Photos During Presentations

- With their permission, presentations will be provided electronically to attendees after the conference ends

- Be respectful of your peers that are sharing their experiences with the Exensio Software Platform

Surveys for Best Paper will be sent Electronically

- At the conclusion of every session, we will send out a survey via Survey Monkey to collect your feedback on the presentations and to help us improve in future years

- Awards for the top 3 papers will given at the end of the conference on Wednesday

Dinner Tonight at the Mountain Winery

- Transportation will be provided
- Bring a casual jacket or sweater

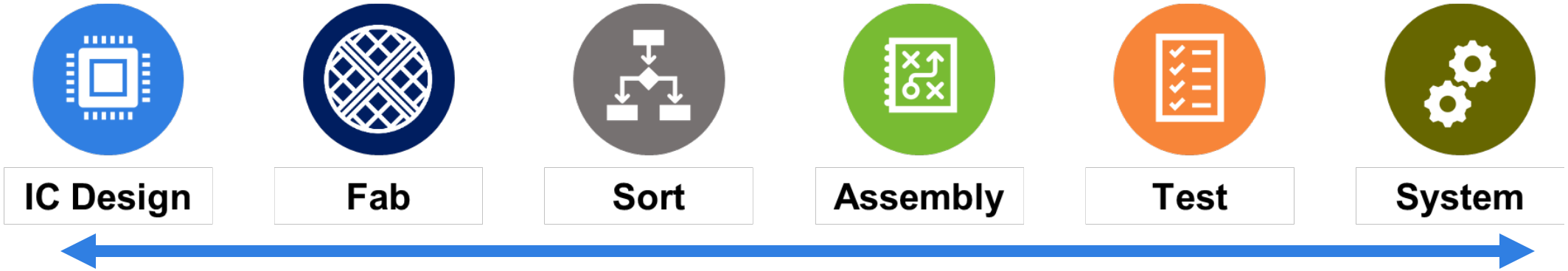
Session 1.1

PDF Solutions Overview and Vision

PDF Solutions

- **PDF is an analytics company that improves process efficiency and product reliability for the semiconductor supply chain**

- **PDF uniquely provides:**
  - An end-to-end big data analytics solution designed to meet the needs of the semiconductor value chain
  - Differentiated data obtained during manufacturing, test, and in-field use from IP integrated into semiconductor devices



PDF Solutions: Customer Base

130 customers in **20** countries spanning fabless, fab, OSAT, and system

#1 commercial solution for mfg yield and control with large cloud customer base

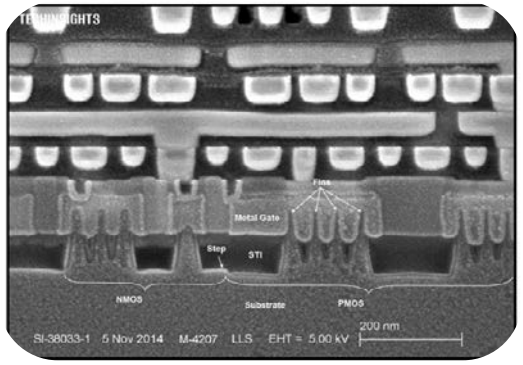
#2 and **fastest growing** commercial provider in mfg test operations leveraging DEX network

Leading commercial provider die traceability through the supply chain

Key Messages

1. Our Industry is going through a massive inflection, as it often does
2. This is changing manufacturing, characterization, and design-technology interaction
3. AI/ML are essential to enable the industry to move from a monolithic ramp-driven industry to an SiP/3D/electrical-driven industry
4. PDF's investment over the prior 5 years has out paced our competitors, providing us an edge with the scale and technology to meet our customers' needs

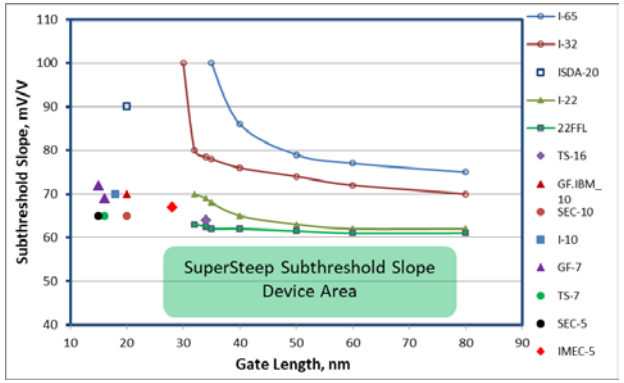
The Changing Nature of Process Technologies



3D Processes

Invisible defects

Reliability (electrical) defects

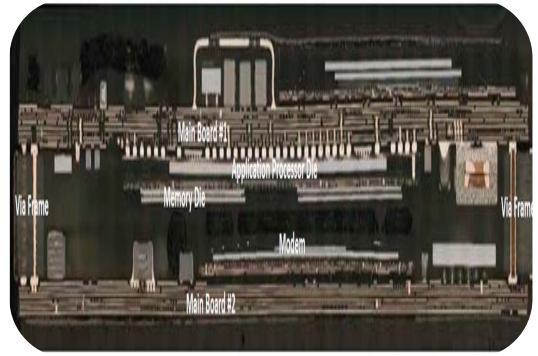


Electrical performance benefits of Advanced Nodes Diminished

Larger die size to make up for smaller improvements in single thread performance

Electrical Scaling on Mature Nodes

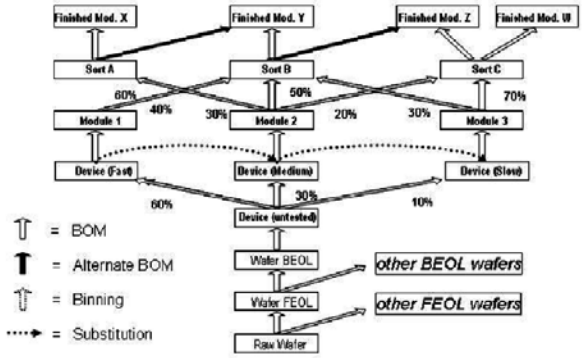
More electrical characterization requirements to make things like eRF, eMRAM etc possible



2.5D-3D Packaging

Analytics and traceability in assembly

Semiconductor World Becoming A Systems Business



Brian T Denton et al

Complex Supply Chain

- Multiple suppliers and complex custody tracing
- Multiple sources of IP within chip

Multi-chip components

- Yield, quality, and reliability is dependent on electrical performance and interaction of chiplets
- Complex and long cycle times

New Applications drive diverse trade offs

- Data across the supply chain must be integrated
- Monitoring of manufacturing processes enables continuous improvement of process capability and variability

Challenges for our Customers

- Optimizing performance/power/area is evolving to take quality, lifetime, and reliability into account
  - Affecting design, inspection, electrical test, product test, burn-in

- Longer and more complex supply chain means
  - More challenging diagnosis issues
  - Additional yield, quality and reliability risks w/ additional costs because one chip can ruin an entire package worth of 10+ good chips
  - Supply chain security will become a bigger issue as these SiPs are used in more applications

High Value Problems for PDF Solutions to Address for Our Customers

High complexity – high component count systems deployed in automotive, manufacturing control, aerospace, etc. are susceptible to multiple issues

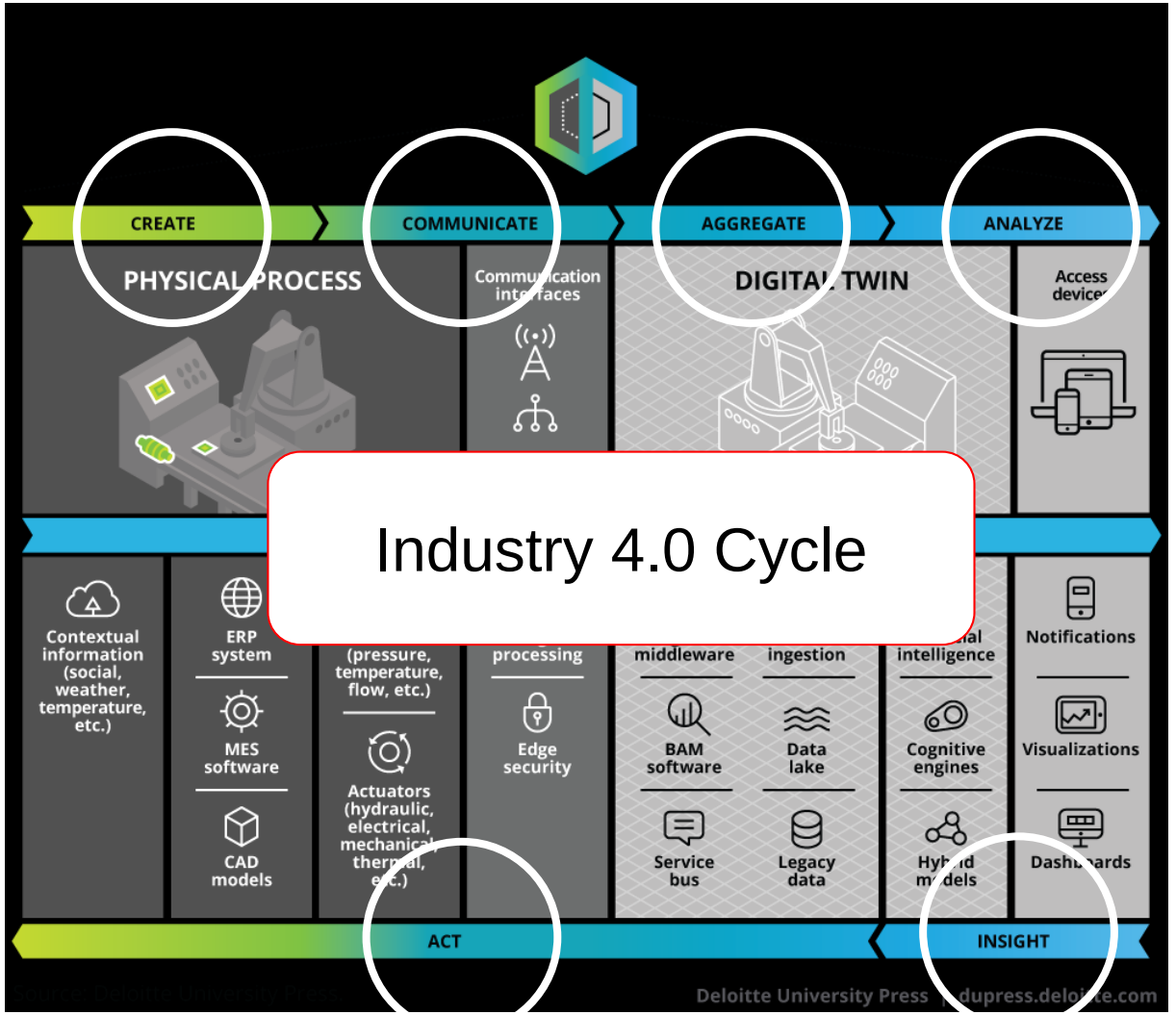
1. Diagnostics: Failure modes can be difficult to track to root cause
   - Each component can contribute failure mechanisms
   - Interaction between components – many edge cases

2. Quality/Reliability: Long-term operation in stressful environments
   - System exposed by weakest link - can be brought down by simple/low-cost components

3. Security: High value systems are targeted by criminals
   - Counterfeiting
   - Hacking

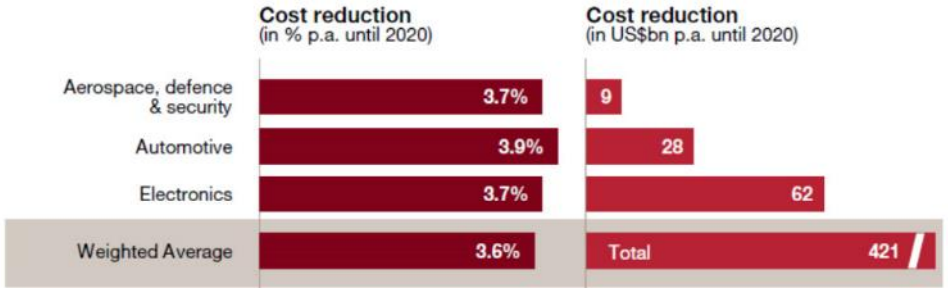
Industry 4.0 Being Applied in Many Manufacturing Markets

- The aim of Industry 4.0 and Made in China 2025 is to improve mfg by digitizing the manufacturing process
- Requires:
  - Sensors; Data; Integration; Analytics; "Digital Twin" application(s); Actuators
- Key elements being put in place on the path to digitizing the IC manufacturing process
  - **Sensors** – Unique data capturing all essential behavior
  - Integration – **common platforms** to provide access to data from the entire value chain
  - **Predictive Analytics** – AI/ML tools able to be leveraged in manufacturing against…
  - …**Semantic models** (in digital twin applications) that allow **meaningful and relevant insights** to be drawn and actions pushed back to the execution systems
  - **Direct connection** to the tools: Can't ACT if you don't change tool state
  - **Site-to-site connectivity**: Must integrate data across the entire supply chain

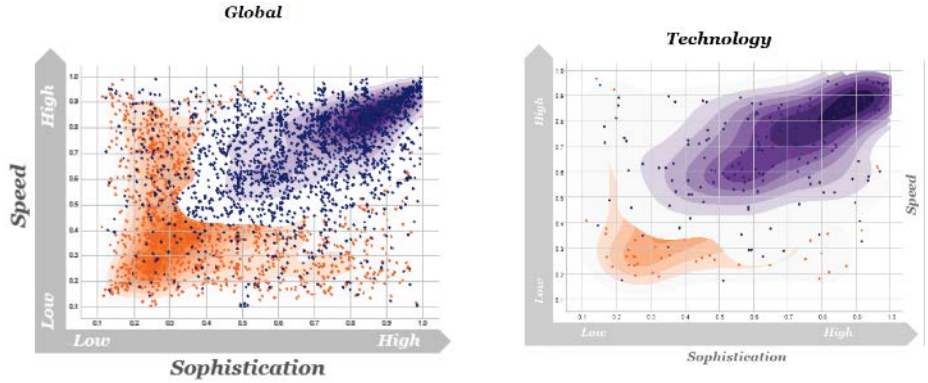


Source: Deloitte University Press. https://www2.deloitte.com/insights/us/en/focus/industry-4-0/digital-twin-technology-smart-factory.html#figure-1

Data and Analytics Growing in Importance



High-tech sectors will see a greater percentage of cost reductions than average and represent nearly a fourth of the total revenue reductions tracked.



Companies moving to faster decision speed with greater sophistication, especially in tech. sector.

Only half of companies today place a high importance on data analytics, but 83% expect that it will be a core competence in five years.

Number of companies with "highly digitized" functional groups expected to double over next 5 years.

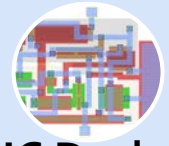
Source: PwC – Industry 4.0 Building your digital enterprise

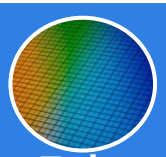
Insight on Industry 4.0 Progress in Semi Manufacturing:

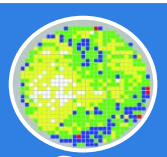
- Most IC test & manufacturers are implementing 'big data' and advanced analytic solutions to digitize the manufacturing process at some level… but

- Complex sources of data
  - Vertical integration challenges (silos of data)
  - De-centralized supply chain (remote facilities)
  - Diverse data quality, volume, and control
- Need to move fast
  - Ability to perform meaningful analysis that results in a fast response to manufacturing & test issues
  - "Edge" can be at facilities run by others
- Applying machine learning difficult
  - Little or no training data for new processes and materials
  - Very long processes, millions of input variables complexly related to smaller set of folded response variables

Data Quality – End-to-End


IC Design


Fab


Sort


Assembly

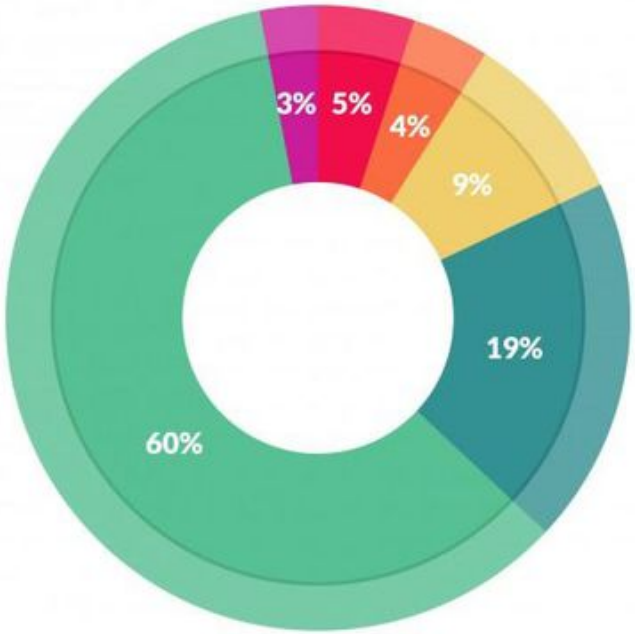

Final Test


System

Material Descriptions In Hierarchy	Meta Data	MES/ WIP Equipment History	Fault Detection and Control (FDC)	Defect & Metrology	Equipment and Non-Lot	Product	Assembly / System	External Data Sources
Technology Family Process Product Source Lot Lot Wafer # Die	Equipment Operator Program Recipe Date/Time Process Flow Stages Steps	Equipment TrackIn/Out Recipe Operator Chamber QueueTime CycleTime Wfr Counts Reticle	Indicators Summaries Trace Charts Model prediction Exensio real time data collection	Parametric Categorical Lot / Wafer Summaries Defect Summary Kill Ratio Defect Images	Equipment SPC Fab chemical delivery Equipment counter data Equipment Event / PM Consumables	sCV testchip DPCV PCM Wafer Sort Bin Map Multi-Bin Final Test Module Data	Die traceability Location of reel/tube Solder paste batch, vendor Equipment parameters Operator logs	Other performance metric databases …

A multitude of solutions is needed to achieve automatic data alignment.
A typical wafer fab generates TBs of data/day

While Speed is Important, Industry Spends 80% of Time Aligning Data

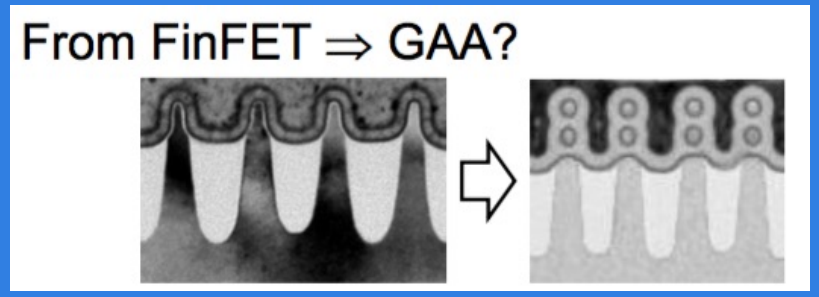


What data scientists spend the most time doing

- *Building training sets: 3%*
- *Cleaning and organizing data: 60%*
- *Collecting data sets; 19%*
- *Mining data for patterns: 9%*
- *Refining algorithms: 4%*
- *Other: 5%*

- As reported in Forbes, 80% of a data scientist's time is spent making the data set useful!
- Problem is confounded in semiconductors
  - Many of our product customers do not own any of the facilities processing or testing their products
  - Many of our manufacturing customers only make products for others and do not always see final product test data

How do you get large data sets when you change everything?

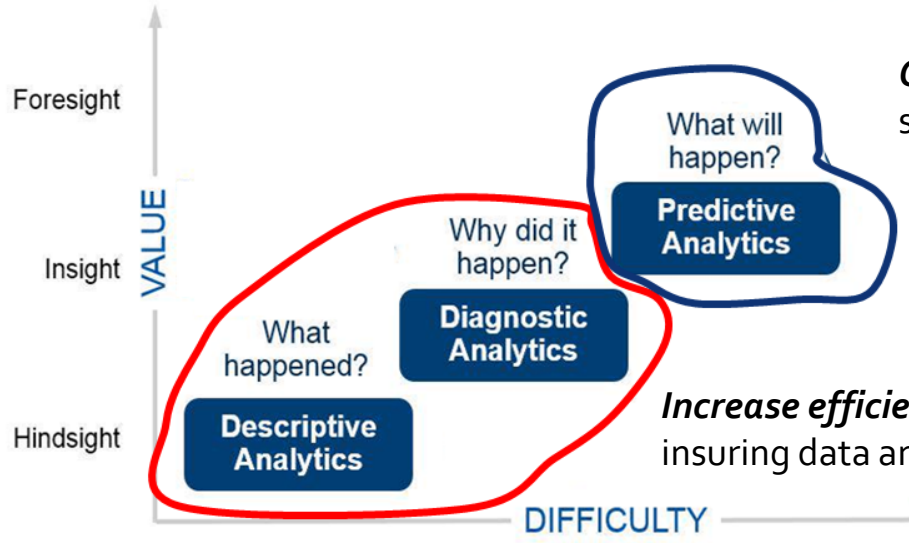


Source: Paul McLellan Cadence Blog

- Failure modes are new
- Sensitivities to equipment and consumables novel
- Often new structures are for enhanced performance, but what about quality?

PDF Solutions Provides *Foresight*

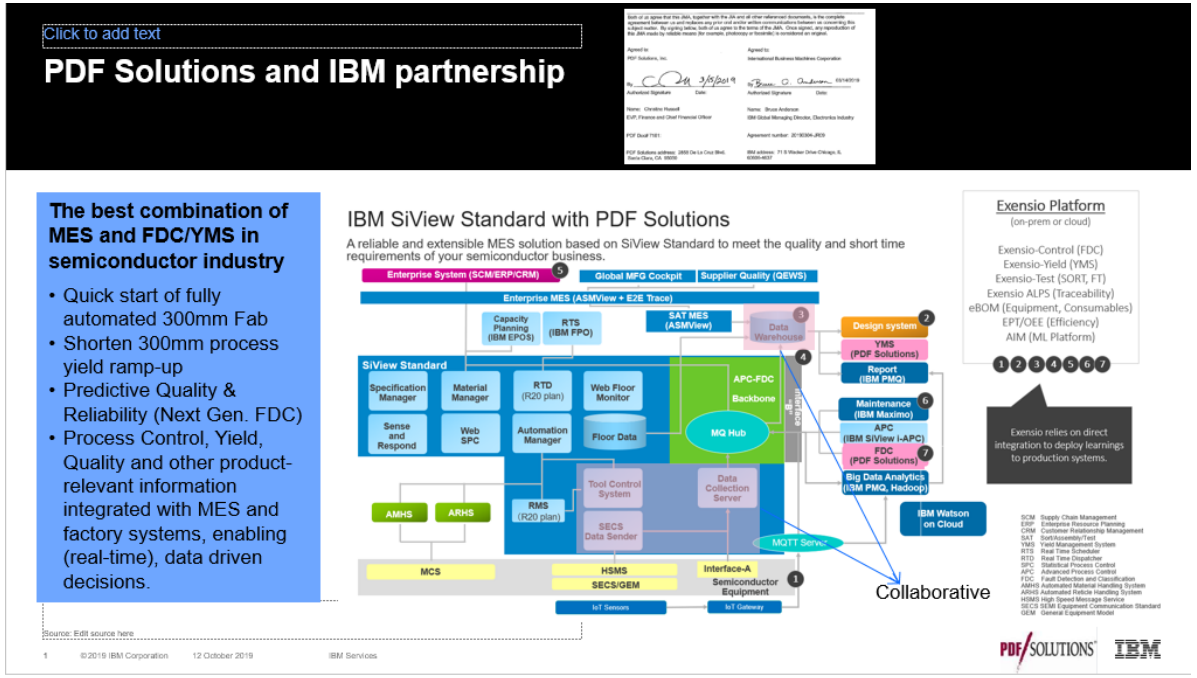
- PDF has invested to address industry issues comprehensively
  - **Supply chain big data:** common platforms and data exchange spanning foundry, OSAT, system suppliers
  - **Analytics:** Machine learning algorithms using a semiconductor semantic model for rapid, relevant insights
  - **Differentiated data:** Providing unique insight from CV® and Design for Inspection (DFI™) ecosystems, and connected process tools

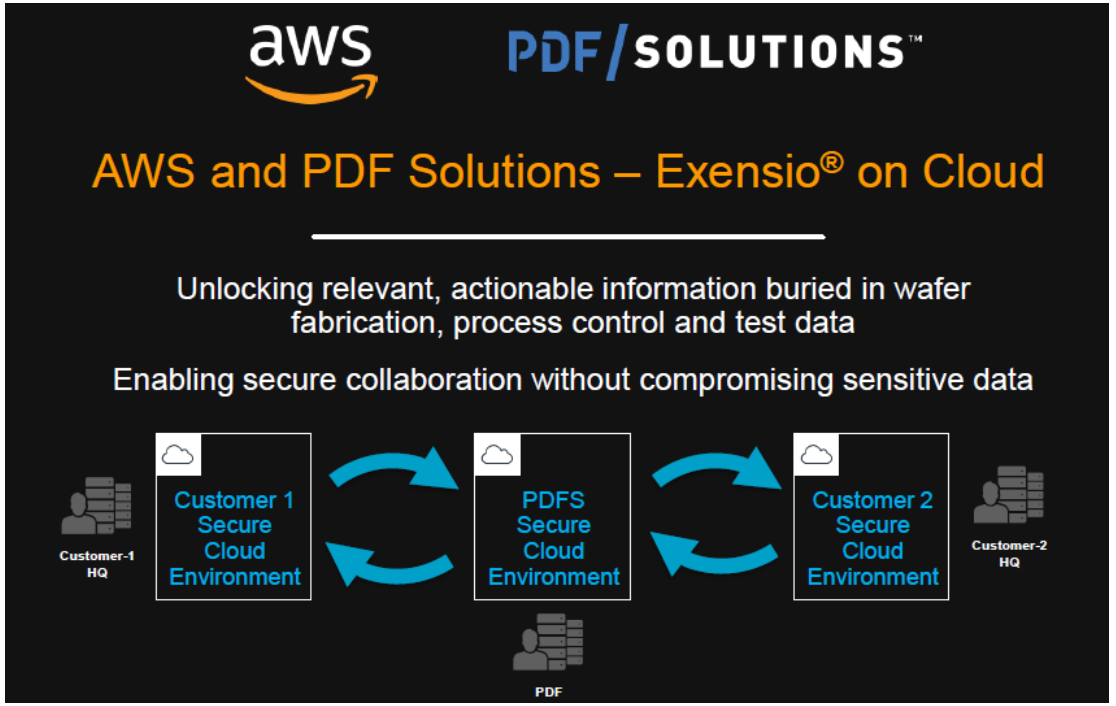


Change the game – Supply chain wide data and semiconductor aware machine learning

Increase efficiency - eliminate large overhead of insuring data and analysis quality

Two Examples of Partnering with Leaders to Enable Customers' Success



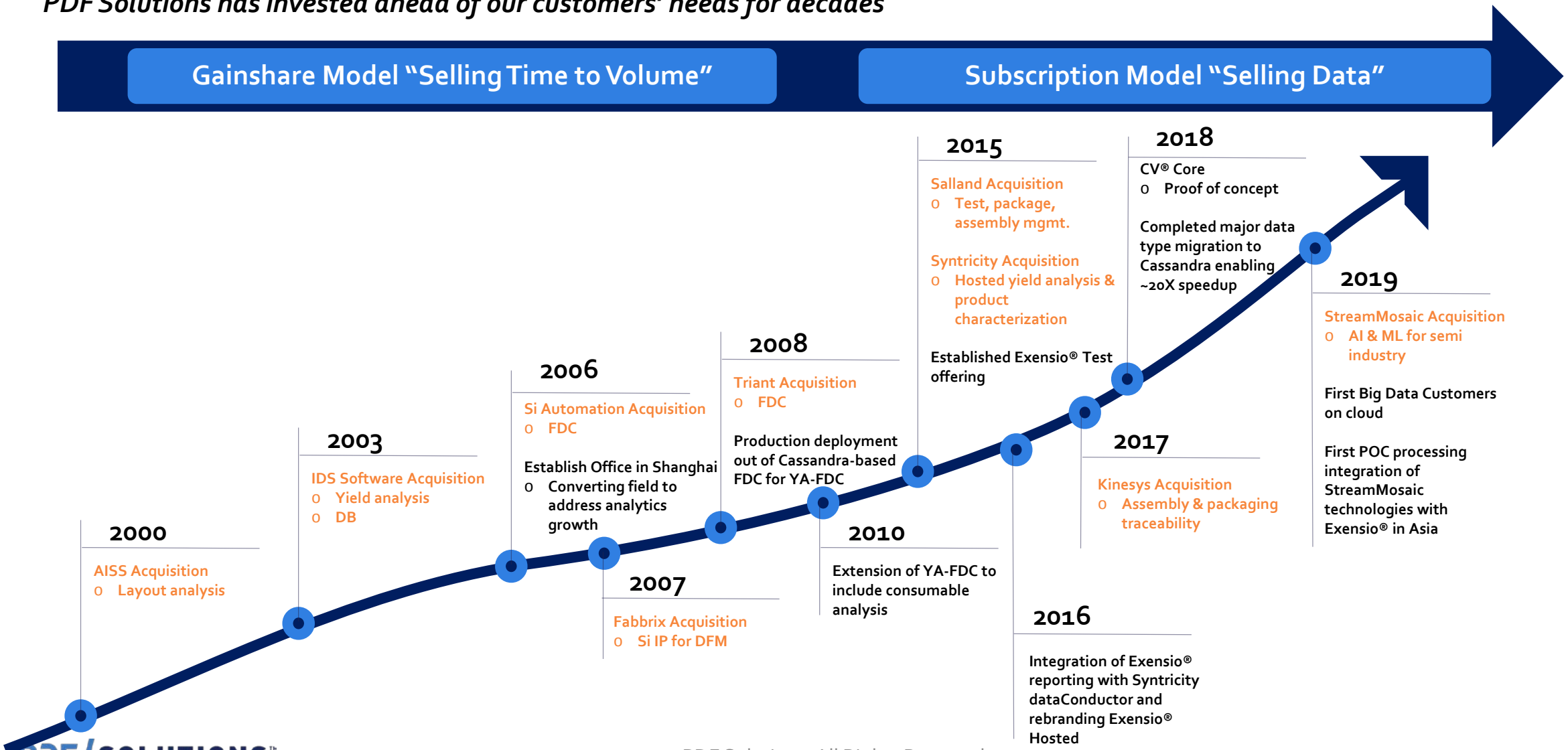


- Enhancing linkages between Exensio® and SiView

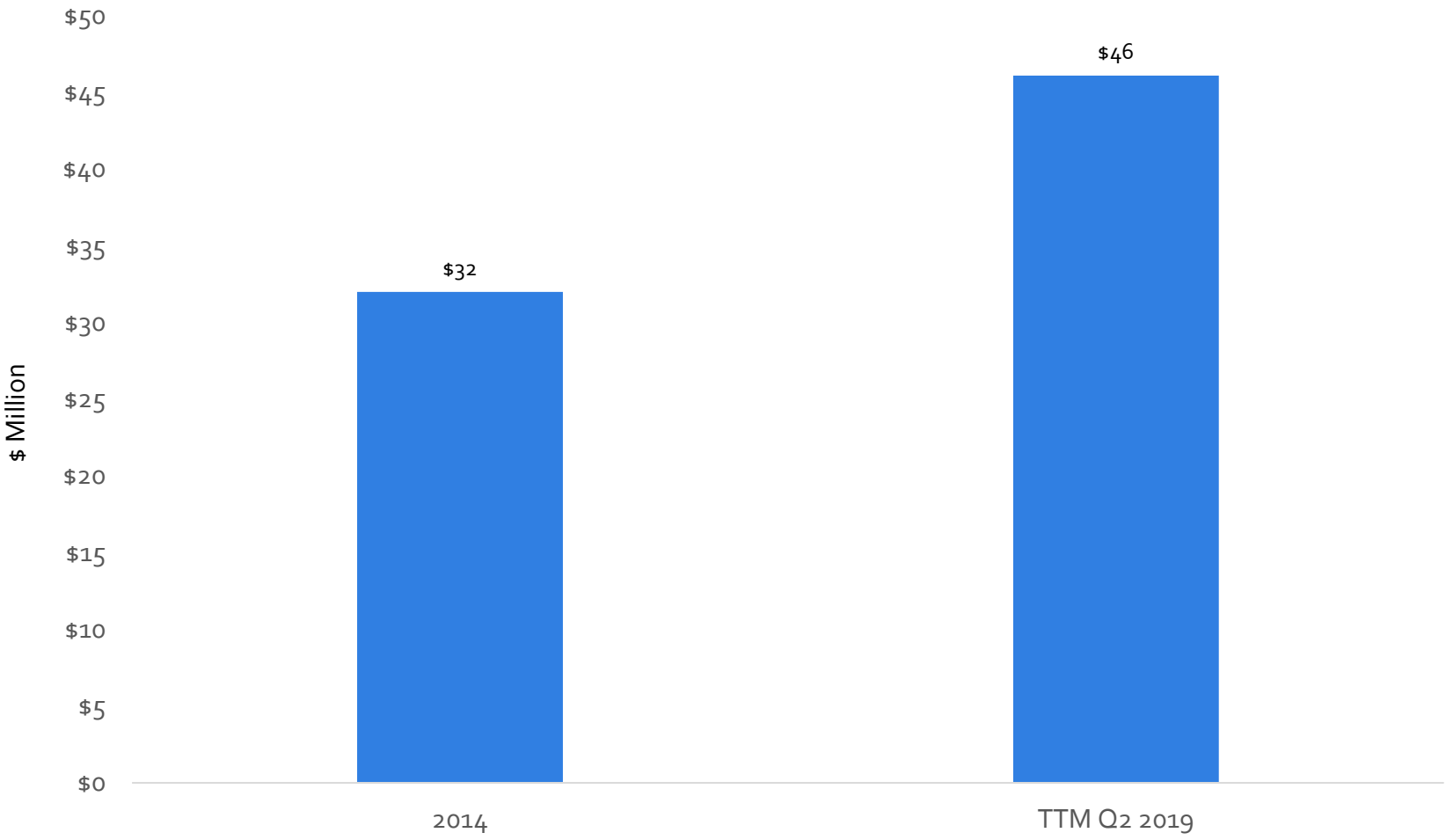
- Optimizing Exensio® on the Cloud

Investing to Lead the Change

PDF Solutions has invested ahead of our customers' needs for decades



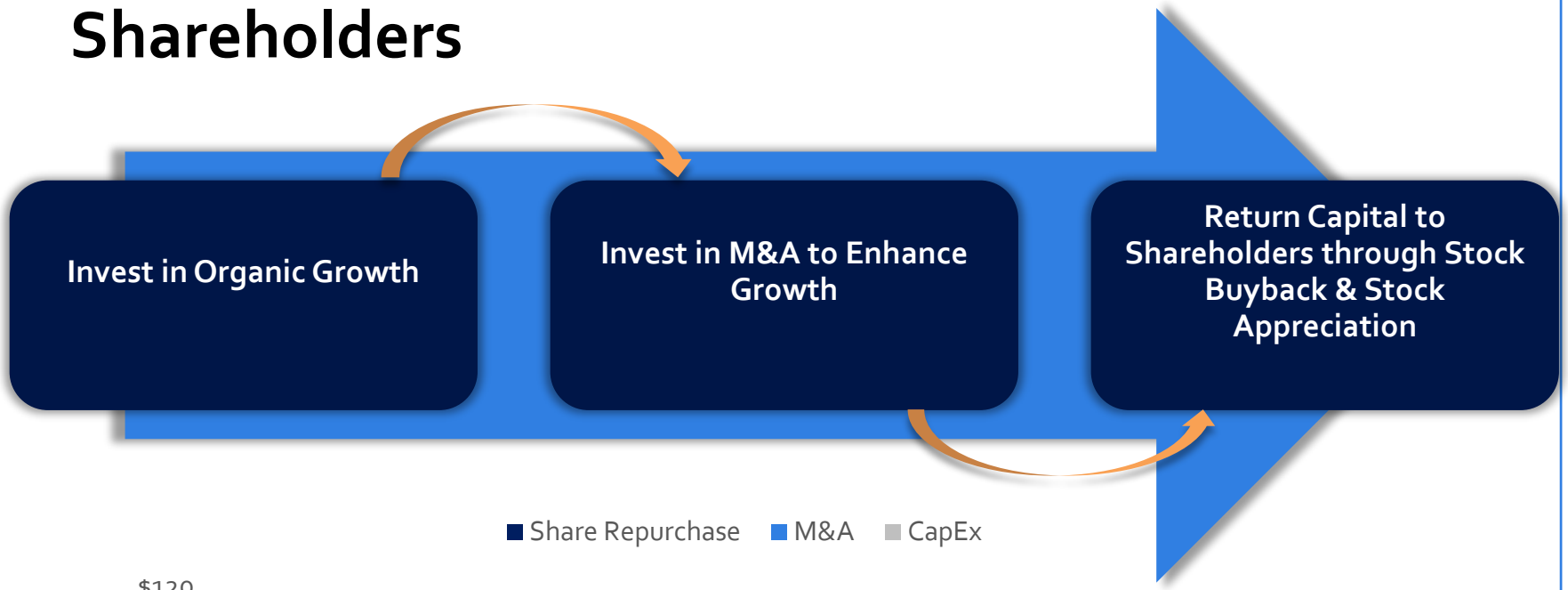
Significant Investment in Engineering Technology

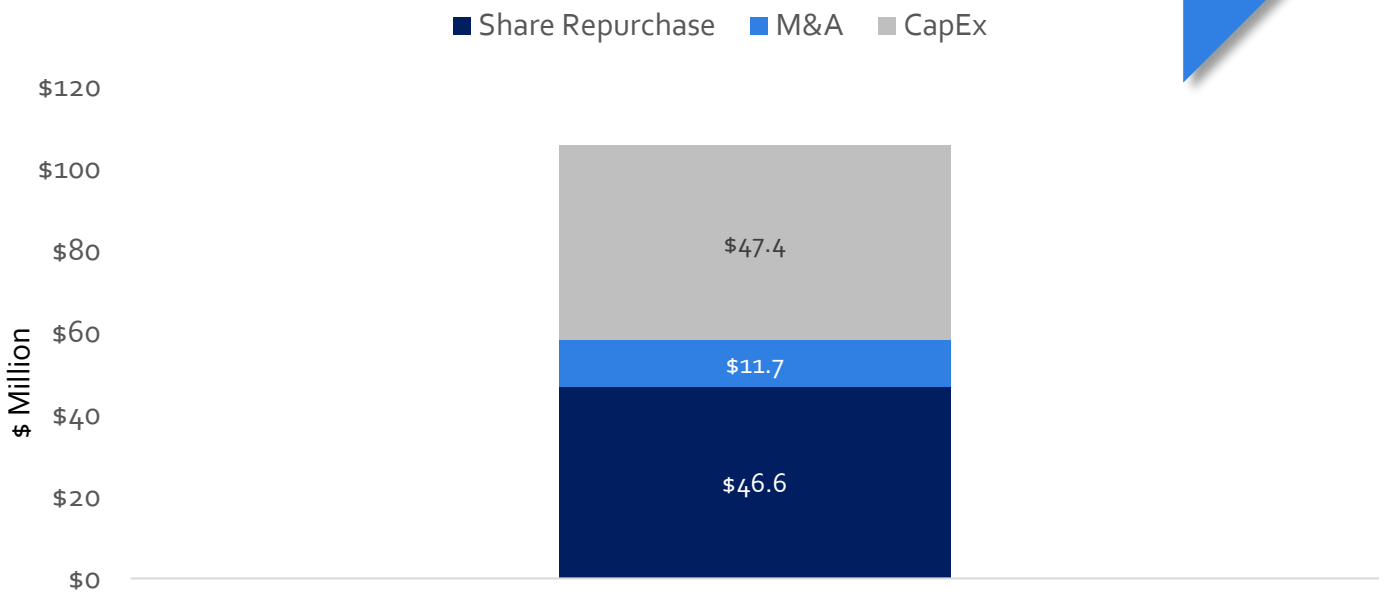


INVESTMENT

- We continue to invest greater than 50% of operating expenses into new product development and deployment
- Over the last few years our investments in engineering are larger than our largest independent software competitor's entire revenue
- Typically, we spend 60% of engineering in R&D and 40% aiding our customers to leverage our technology in their environment

Able to Invest for Customers and Serve Shareholders

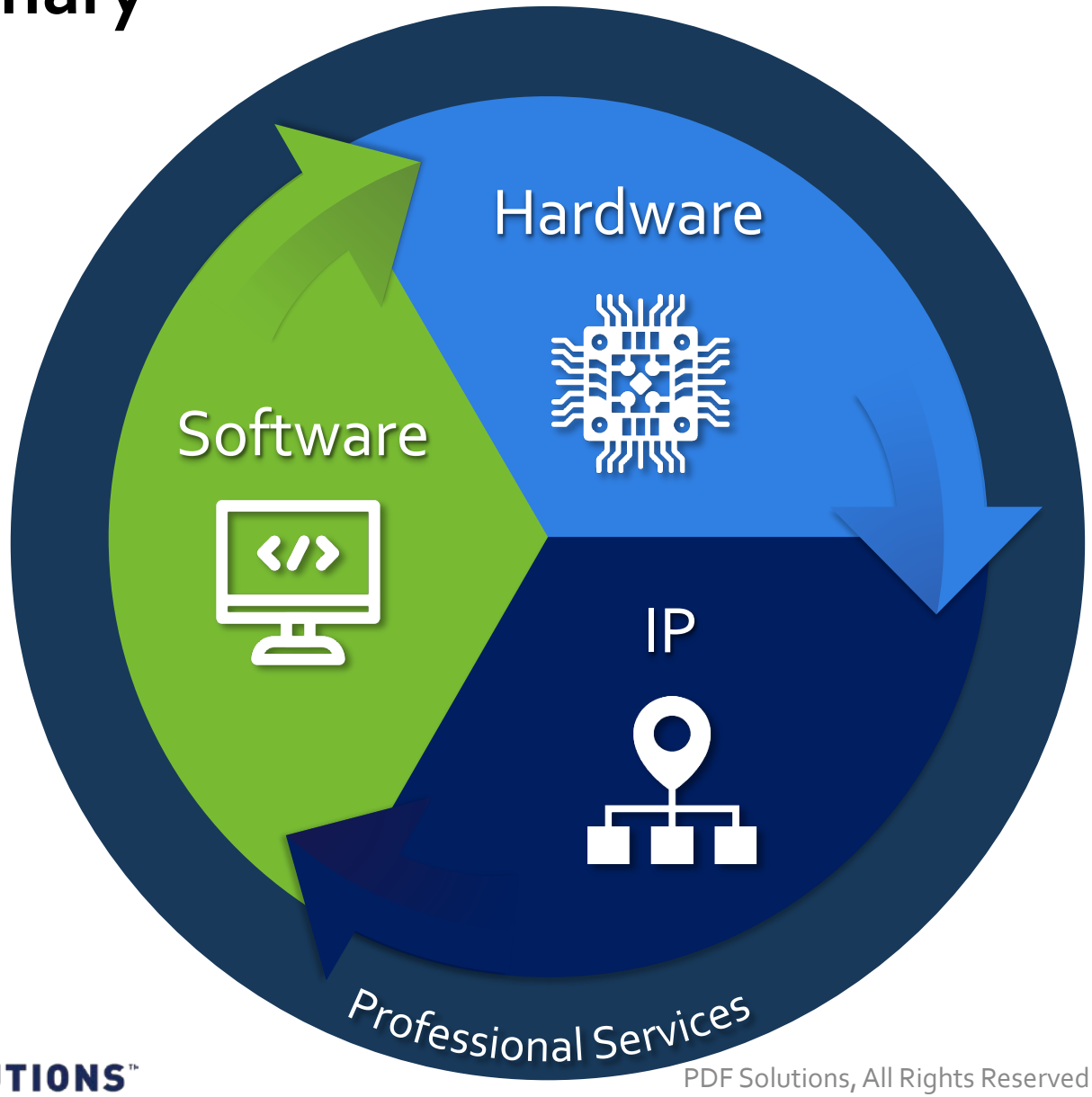




INVESTMENT

- Capex investments include DFI, CV*i*, IP, DEX network, and infrastructure
- We are able to invest for our customers , in anticipation of future needs, and make long range investments
- Mindful of return on investment for our shareholders

Summary



- **Exensio®**
  Common semantic data model for integrated, aligned data from all sources
- **eProbe® & pdFasTest®**
  Electrical measurement hardware
- **CV® infrastructure, CVCore™ & DFI™**
  (Design for Inspection) Characterization, quality and reliability
- **Professional Services**
  Engineering, consulting, and managed data

Thank You

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