Cloud Based Product Development

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787
BOEING

Product development issues in aerospace

Boeing 787

"... **three years** behind schedule and counting ..."

" ... the program has been a **huge headache** ..."

"... delays cause **anger** at [airlines] ..."

" ... 787 has been a **nonstop frustration** for Boeing disappointing airlines, passengers, and suppliers ..."

"... penalty payments to 787 buyers will reach about **$5 billion** ..."

"... as much as **$12 billion** in cost overruns ..."

Airbus A380

"... **two years** behind schedule ... cost an estimated **$6 billion** in lost earnings and penalty payments..."

Product development issues are everywhere

Automotive

Aerospace

Product development delays across industries occur frequently and cause an average drop of over 5% in long term market value

Defense

Semi-conductors

Medical Devices

Root causes of product development issues

Cloud can help address the primary root causes

- 21% Technical / engineering problems
- 18% Need to redesign the product
- 14% Not meeting performance specs
- 13% Need more time to test
- 12% Government approvals
- 6% Part shortages
- Other / No reason given

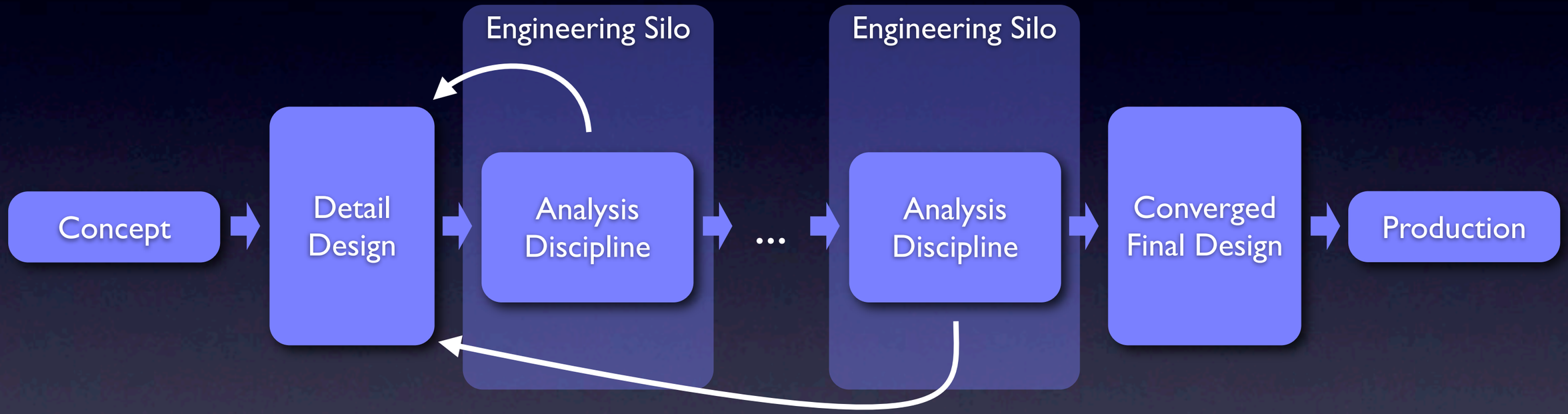
Growing opportunities in product development

Macro trends of globalization, outsourcing and technological advances are making high tech product development increasingly...

- Complex
- Costly
- Unpredictable

... yet the product development process within companies has stayed the same

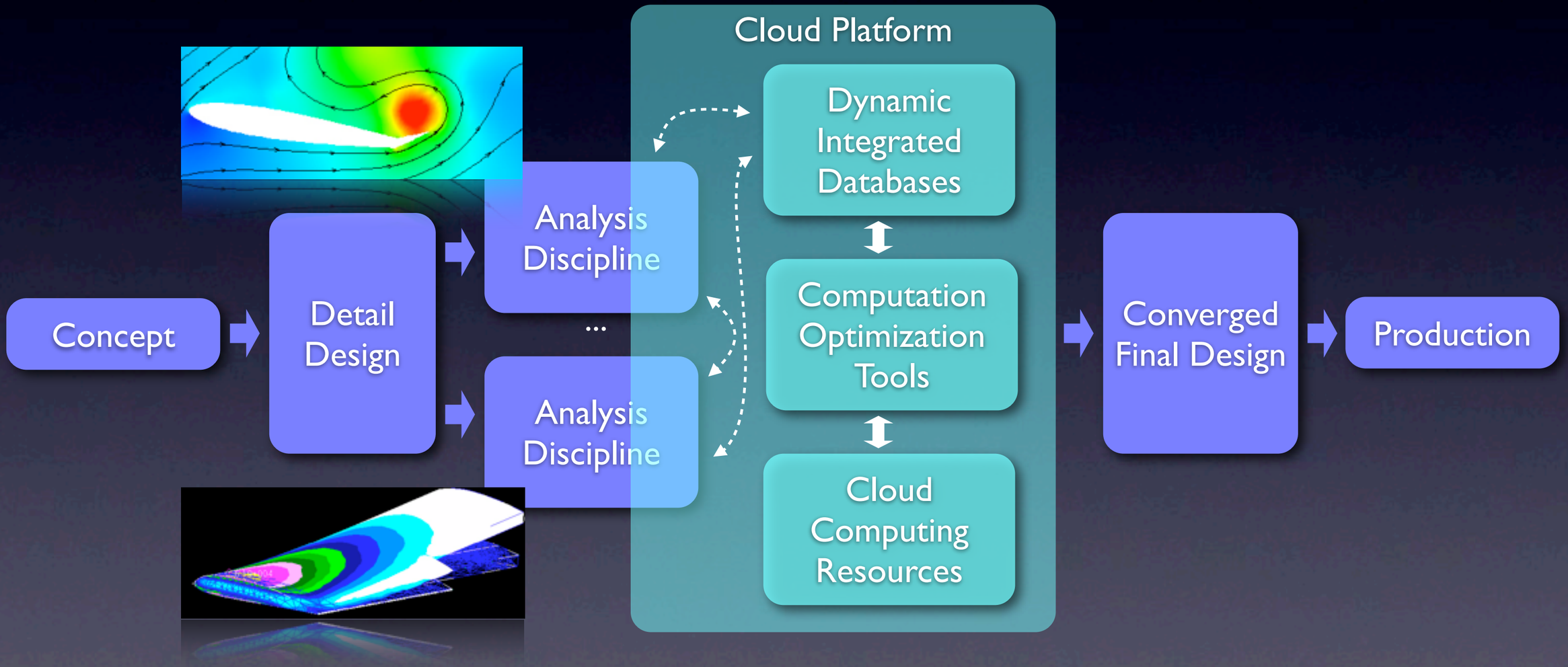
Traditional product development



80% of the product decisions

80% of the development time

Cloud based product development



Why has there been a lack of multidisciplinary optimization adoption?

1980s - Mathematical fundamentals are robust and generalizable

1990s - Academic work has shown a breadth of feasible applications across industries but impractical in industry due to computational requirements

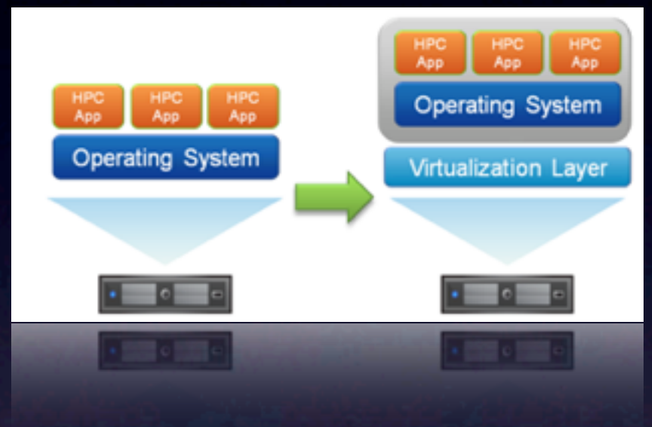
2009 - Boeing 787 wing is the first large scale application of integration and optimization in industry on a detail design

2010 - High performance cloud computing disrupts the cost structure

Why virtualize high performance computing?

Concerns …

- Security
- Performance scalability
- Integration



…but there are significant benefits

- Reducing product development timelines
- Improving product performance
- Reducing produce development cost

Reference: Josh Simons, VMWare

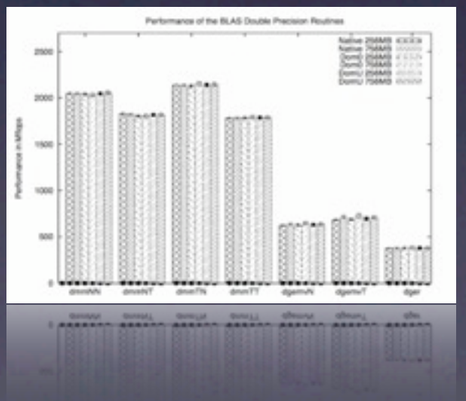
Virtualization provides new opportunities

High performance computing at the fingertips of every engineer

New capabilities…

- Checkpoint / Restart
- Dynamic Workload Migration

… while maintaining grid level performance



Reference: Josh Simons, VMWare

How does virtualization change the game for computer aided engineering (CAE)?

Basic applications

- Makes existing capabilities more accessible
- Allows for broader exploration of design space

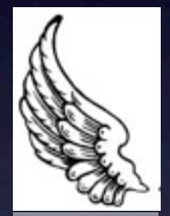
More complex implementation

- Makes large scale multidisciplinary optimization possible

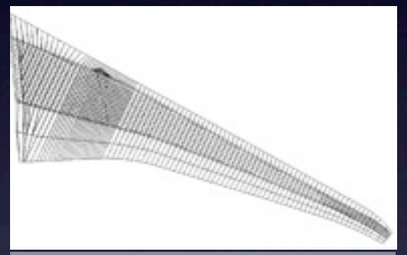
New possibilities ...

787 Wing Case Study

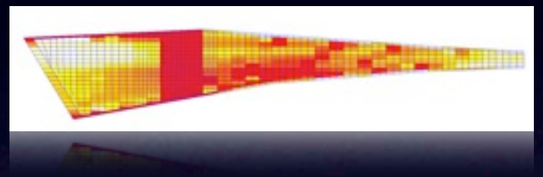
Concept



Detail Design



Analysis Disciplines



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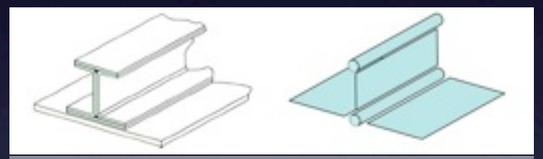

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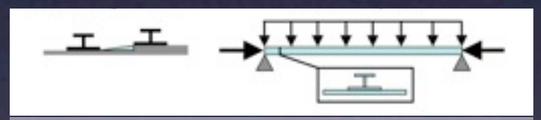
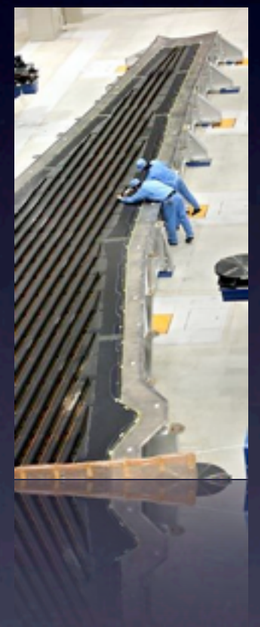
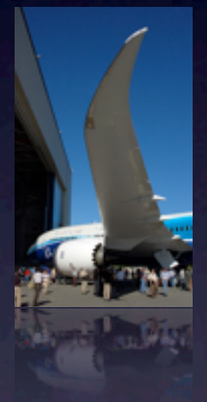


Final Design



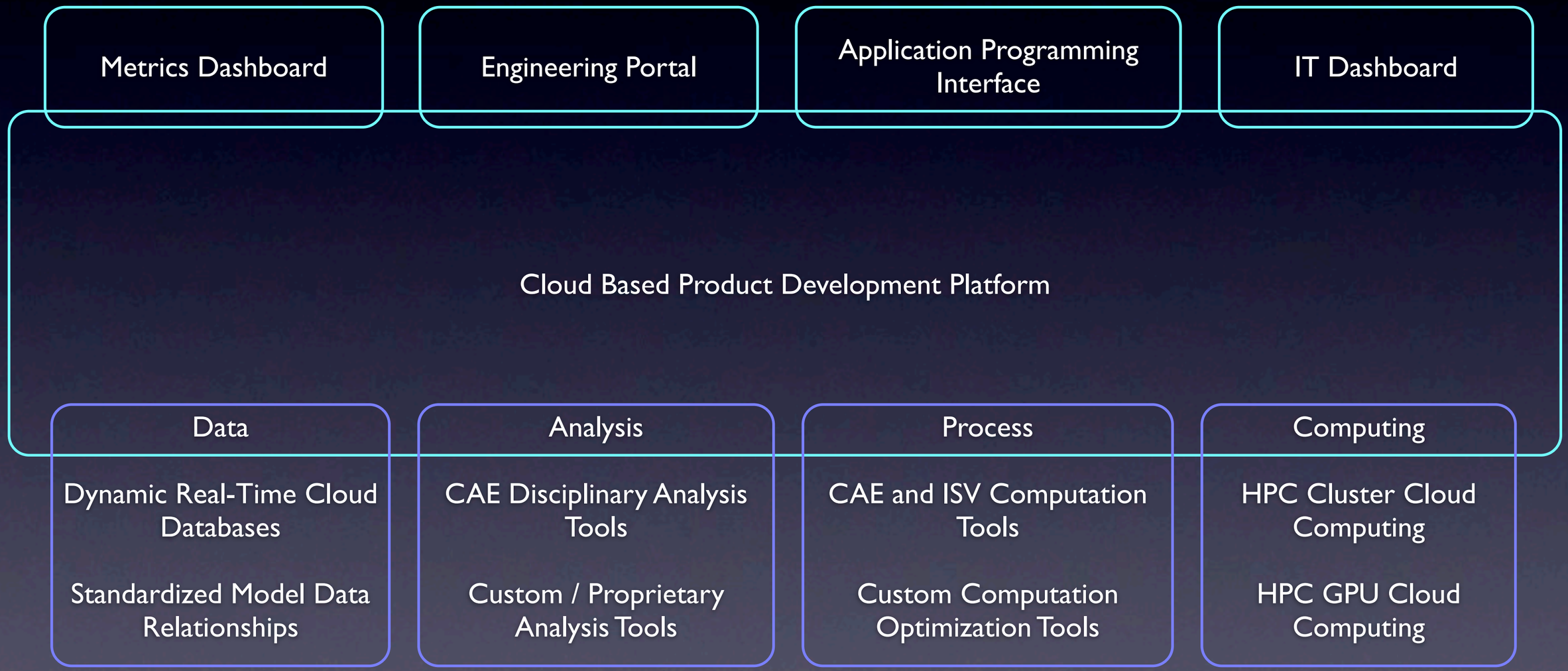
Production



Over $100m in performance improvement

Development time from 3 months down to 24 hours

Cloud platform architecture



Management benefits from CAE in the cloud

Cost reductions

- Engineering time reductions
- Operating costs matching development cycle
- Efficient use of resources and time

Increased visibility and control

- Visibility and transparency of process
- Measuring progress and tracking metrics
- Managing global development teams

Engineers benefit from CAE in the cloud

Reduced development timelines

- Unlimited computing resources
- Dynamic scalability
- Integration opportunities

Improved product performance

- Elimination of errors
- Exploration of design space
- Capturing design interdependencies

Cloud future

Beyond ...

- Moving existing applications and capability to the cloud
- Big data with basic processes and algorithms / coarse grain parallelism

Toward ...

- Infrastructure providing cloud capabilities to application engineers
- Computationally complex algorithms / finer grain parallelism

Thank You / Questions

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