The Economics of How Software is Eating the World

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Marc Andreessen first voiced this hypothesis:

- “A software revolution is coming”
- “all the technology required to transform industries through software finally works and can be widely delivered at global scale”
- “Wal-Mart is using software to power its logistics and distribution capabilities”

What Government Statistics Say about Software

ICT Component Shares: Software Share of ICT Investment is now Over 50%

Software Investment Component Shares are Relatively Stable

Proof that Software is Eating the World

- 19 US Industries (1/3 of the US economy) are investing in cloud services, such as private, hybrid and public cloud use. Some more rapidly than others.

<table>
<thead>
<tr>
<th>Group 1: Highest</th>
<th>Group 3: Somewhat Slowly</th>
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<tbody>
<tr>
<td>Information Technology</td>
<td>Semiconductors</td>
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<td>Government</td>
<td>Construction</td>
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<td>Financial Services</td>
<td>Autos</td>
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<tr>
<td>Agriculture</td>
<td>Logistics</td>
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<td>Retailing</td>
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<table>
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<tr>
<th>Group 2: Next Fastest</th>
<th>Group 4: Slowest</th>
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<tbody>
<tr>
<td>Aircraft</td>
<td>Industrial</td>
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<td>Oil and Gas</td>
<td>Chemicals</td>
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<td>Social Media</td>
<td>Metals and Mining</td>
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<tr>
<td>Pharmaceuticals</td>
<td>Advertising</td>
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<td>Healthcare</td>
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<td>Insurance</td>
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Source: Robert B. Cohen, "How Digital Transformation, the Move to the New IP, will Impact the US Economy and Employment and Broad Implications for the Vendor Community: The Emergence of a "Megadigital" Economy," Economic Strategy Institute, October 13, 2016
Cloud Services’ Impact on the US Economy

• In a firm-interview based quantitative forecast of spending on cloud services, the Economic Strategy Institute estimated that:
  • Cloud Services will probably add between $1.2 trillion and $1.8 trillion to US GDP from 2015 to 2025. The largest contribution to GDP occurs between 2020 to 2025, when we estimate that the adoption of software-defined cloud services will add between $907 billion and $1.4 trillion to US GDP.
  • This forecast for additional GDP growth would accelerate expected US GDP growth from 2015 to 2025 by between 8.4 percent and 12.7 percent over the expected $5.2 trillion in growth during this period.

• We estimated that 19 “early adopter” sectors will create between 514,000 and 926,000 net new jobs between 2015 and 2025.

• If we include multiplier effects, these employment forecasts would triple to create 1.5 million to nearly 3 million new jobs. Most of these new jobs are created between 2020 and 2025.

• ESI argues that unique factors influenced the great upswing in demand for software related jobs:

• 1) A more widespread adoption of cloud services in the 2010 to 2016 period; this reduced prices, but the greatest impact was due to the role played by software innovation.

• 2) Software innovations caused an important shortening of the time to business value, as discussed below;

• 3) “Upskilling,” improved the skills data analysts and cybersecurity employees offer in software-based jobs; new skills make these employees far more productive, a direct impact that is difficult to measure. The skills permit these employees provide greater value because machine language and artificial intelligence become key parts of the skillset required for these jobs; and

• 4) A growing complexity of enterprise data sources requires a more sophisticated means of analyzing data in recent years.
Economists on Cloud Services and Productivity

• Cloud Services “enable firms to gain efficiencies by moving from “traditional IT datacenter(s) to a public or private cloud computing platform.”

• “For new firms, efficiencies represent lower capital required to start a business.”

• “Combined, these efficiencies have the potential to be large because cloud computing refers not only to shifts in workload location (from on-premises environments to the public cloud) but also to increased take up of many IT technologies -- server virtualization, containers, and grid computing -- all of which result in much denser workload-to-IT capital ratios.”

Spending on Cloud Services of Fastest Growing U.S. Industries 2015-2025, Midpoints for Five-Year Spending

NOTE SHIFTS IN SPENDING OVER TIME. AGRICULTURE AND RETAILING IN 2ND AND 3RD PLACE IN 2020-2025

Industries Invesing the Most in Cloud Services

- **FINANCIAL SERVICES**: 54 billions in 2015-19, 90 billions in 2020-2025
- **SOCIAL MEDIA**: 20 billions in 2015-19, 32.5 billions in 2020-2025
- **RETAILING**: 17.5 billions in 2015-19, 35 billions in 2020-2025
- **AGRICULTURE**: 17 billions in 2015-19, 45 billions in 2020-2025
- **INSURANCE**: 16 billions in 2015-19, 32.5 billions in 2020-2025
SPENDING BY CLOUD SERVICE PROVIDERS AND TELECOMMUNICATIONS FIRMS ON CLOUD SERVICES INFRASTRUCTURE 2015-2025, IN BILLIONS OF DOLLARS

AVERAGE SPENDING DERIVED FROM SPENDING BY 19 U.S. INDUSTRIES ADOPTING CLOUD SERVICES USING AN INPUT/OUTPUT ANALYSIS

- TELECOMMUNICATIONS SERVICES
- CLOUD SERVICE PROVIDERS
Faster Time to Business Value is Driving the Software Revolution

• Software Development Offers Quicker Realization of Business Value as it moves from Monoliths to Microservices to Functions

Innovation in the Application Platform – Data Infrastructure – Also Shortens Time to Business Value

SOFTWARE-DEFINED DATA CENTERS 3-5 MINUTES

Demand for Software Engineering Jobs has Dropped by Half since 2010

- In May 2015, the US had 1.15 million applications software developers and systems software developers. [https://www.bls.gov/oes/current/oes151133.htm](https://www.bls.gov/oes/current/oes151133.htm). Other sources estimated 3.6 million software engineers in 2013, 4.5 million by 2018 (Evans Data).
## Diversification of Software Engineering Jobs

<table>
<thead>
<tr>
<th>Software Innovation-Related Jobs</th>
<th>Data Analytics-Related Jobs</th>
<th>Artificial Intelligence</th>
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<tbody>
<tr>
<td>DevOps</td>
<td>Data Analysis</td>
<td>Cognitive Computing</td>
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<tr>
<td>Docker/Containers</td>
<td>Process Management</td>
<td>Machine Language</td>
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<tr>
<td>Microservices</td>
<td>Predictive Analytics</td>
<td>Deep Learning</td>
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<tr>
<td>&quot;Serverless&quot; Computing</td>
<td>Data Governance</td>
<td>Predictive Application Programming Interfaces</td>
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<td></td>
<td>Internet of Things</td>
<td>Natural Language Processing</td>
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<td>Big Data</td>
<td>Image Recognition</td>
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<td>Intelligent Data</td>
<td>Speech Recognition</td>
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<td>Neuromorphic Computing</td>
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Broadening the Roles for Software Engineering Jobs: People with Software Skills work on DevOps, Docker/Containers and Microservices

- Microservices including software developers account for 1.21% of job postings in 2016, compared to 2.94% for Software Engineers.
- Docker/Containers account for .49% of job postings in 2016.
- DevOps accounts for only .16% of job postings in 2016.
  - In total, Microservices, DevOps, Docker/Containers account for 1.86% of job postings compared to 2.94 for Software Engineers in 2016.
- If we include new data occupations that use a great deal of software, such as:
  - Data analysts/scientists, .28% of job postings
  - Process management, .18% of postings,
  - and predictive analytics, .16%,
  - The total rises to 2.48% of all 2016 job postings, nearly equal to that of Software Engineers in 2016.
Demand for Software Engineering and Microservices Jobs Declines over Time

• This decline might be linked to gains in productivity for Software Engineering and Microservices Jobs.

• Firms obtain more value from these jobs; each employee producing a lot more valued output; therefore, greater productivity.
Demand for Data Analysts and Cybersecurity Job Shows “Moore’s Law” Type Growth

• Note the Tripling and Doubling of Demand from 2013 to 2015? Did Machine Learning and AI change the key skills for these jobs?
At an Industry Level, These Jobs Grew Even More Rapidly in Sectors using AI and ML

Demand for Data Scientist/Data Analyst Jobs by Industry
2010, 2015-16
Machine Learning and Data Mining Become Top Skills for Data Scientists in Finance and Insurance

Burning Glass database, Labor Insight™, is described at http://burning-glass.com/labor-insight/
changes in new job skills drive demand; automating work processes requires fewer jobs

- As noted in the Machine Learning Slide above, new skills can show up immediately in Job Postings;
  - We’d conclude that ML and AI are adding to the value firms can gain from hiring a wide range of software experts for development as well as data analytics and predictive modeling.

- This “Upskilling” may also reduce the number of people needed to do work such as the demand for Software Engineers cited above.

- Over a few years’ time, employers may better understand how to achieve value from their expertise in software and data analytics.
  - They need fewer employees with specific skills (due to enhanced skills of existing employees)
  - They can also focus job postings on specific requirements and not broad categories of jobs. Requests for software engineers shift to data visualization or cybersecurity.
Even More Dramatic Cybersecurity Job Growth by Industry

Six-Fold Increase in Demand for Cyber Jobs in Financial Services, Information Technology, Cloud Service Providers and Professional Services.

Cloud Service Providers have the Greatest Multiple of Change in Demand

Radar Chart Multiple of Change in Cybersecurity Job Postings by Industry from 2010 to 2015 and 2016
In New Software Areas, Job Demand Often Explodes

Explosive Demand for Autonomous Car/Vehicle and Data Visualization Jobs 2010 to 2016

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