We deliver technology at a global scale

- **60mm** active digital customers
- **$10T** of payments processed per day
- **>500PB** of total data stored
- **40B** security events collected per day
- **2.7mm** virtual CPUs
- **~11B** annual digital logins
- **~6.4k** production applications
- **55k+** technologists
Our technology strategy is aligned to business priorities

<table>
<thead>
<tr>
<th>1</th>
<th>Deliver best-in-class products, platforms and experiences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deliver differentiated experiences to all that we serve</td>
</tr>
<tr>
<td></td>
<td>Accelerate digital transformation of all business processes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2</th>
<th>Strengthen our software development capabilities and infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Break monoliths into modular and API-driven architecture</td>
</tr>
<tr>
<td></td>
<td>Accelerate adoption of elastic compute in public and private cloud</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3</th>
<th>Unlock the power of data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experiment at scale by making data rapidly available</td>
</tr>
<tr>
<td></td>
<td>Accelerate AI/ML delivery through model reuse and automated controls</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4</th>
<th>Protect the firm and our customers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Embed security and privacy into all our products and platforms</td>
</tr>
<tr>
<td></td>
<td>Develop seamless controls to reduce friction around new tech adoption</td>
</tr>
</tbody>
</table>
Our expense growth is driven by investments

**Total technology expense ($B)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Run the bank</th>
<th>Change the bank</th>
<th>Investments / Volume related</th>
<th>+6% CAGR</th>
<th>$1.1</th>
<th>$14.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>$11.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>$12.5</td>
<td></td>
<td>$0.5</td>
<td></td>
<td></td>
<td>$12.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>2022</td>
<td>$12.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$14.1</td>
</tr>
</tbody>
</table>

**Investments by strategy, 2022**

- Products, platforms and experiences (largely in the business) $4.1B
- Modernize technology and software development excellence $2.6B
- Unlock the power of data
- Protect the firm and our customers

**Fully loaded investments by LOB, 2022**

- CIB $3.1B
- CCB $2.4B
- AWM $0.9B
- CB $0.2B

**Total** $6.7B

**Run the bank includes**

- Infrastructure
- Software licenses
- Application and production support

Note: Totals may not sum due to rounding.
We have held run the bank expense relatively flat, while volumes have doubled.

- **Total technology run the bank expense ($B)**
  - 2019: $6.9
  - 2022: $7.4
  - +3% CAGR

- **Total infrastructure run the bank expense relatively flat**
  - 2015: $X
  - 2021: $Y
  - +2% CAGR

- **Compute and storage volumes have more than doubled**
  - 2015: $Z
  - 2021: $W
  - 2.5x
Our $4.1B investment across the businesses will directly drive returns

<table>
<thead>
<tr>
<th>Select examples</th>
<th>Customer and client experiences</th>
<th>Product and platform development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer &amp; Community Bank</td>
<td>▪ <strong>Chase.com and mobile app</strong> that engage our 60mm digitally active customers</td>
<td>▪ <strong>Consumer and Small Business Payments platform</strong> supporting $5T of annual payments volume</td>
</tr>
<tr>
<td></td>
<td>▪ <strong>Leads, customer insights and scripting</strong> for our bankers, advisors and relationship managers</td>
<td>▪ <strong>Personalization engine</strong> that powers one-to-one personalized experiences across our channels</td>
</tr>
<tr>
<td>Corporate &amp; Investment Bank</td>
<td>▪ <strong>eTrading platform</strong> to support clients with the ongoing growth of electronic execution</td>
<td>▪ <strong>Real-time and faster payment</strong> capabilities deployed to clients globally by Graphite</td>
</tr>
<tr>
<td></td>
<td>▪ <strong>E-commerce capabilities</strong> (Wallet, Express Checkout, Embedded Banking) to focus on Marketplaces and SMB</td>
<td>▪ <strong>Glass platform</strong> to provide liquidity and account services such as wallet, virtual accounts, sweeps and pooling</td>
</tr>
<tr>
<td>Asset &amp; Wealth Management</td>
<td>▪ <strong>AM Morgan Suite</strong> enabling $1T+ in digital / self-service transactions</td>
<td>▪ New <strong>PB advisor tools</strong> for client prospecting and solutions recommendations</td>
</tr>
<tr>
<td>Commercial Bank</td>
<td>▪ <strong>Best-in-class sales enablement</strong> tools and data analytics for bankers</td>
<td>▪ Comprehensive <strong>payments solutions</strong> for our real estate clients</td>
</tr>
<tr>
<td></td>
<td>▪ <strong>Middle Office workflow automation</strong>, cycle time improvements and lower cost to serve</td>
<td>▪ Cloud based, client-focused <strong>data platform</strong></td>
</tr>
</tbody>
</table>

JPMorgan Chase & Co.
We are modernizing our infrastructure and applications to increase speed, resiliency and drive cost efficiency.

Strengthening our technology foundation...

- **Application Modernization**
  - Refactor applications to optimize **cloud adoption** (public & private)
  - Replace applications with industry-leading SaaS solutions
  - Build cloud-native core banking systems
  - Decommission redundant applications, **2,200** complete

- **Infrastructure Modernization**
  - Enable **multi-cloud strategy** to access best capabilities and mitigate lock-in risk
    - Built **highly secure** private cloud platform
    - Enabled one **public cloud** provider, two more in progress
    - 30%+ of total infrastructure spend is in cloud (~50% incl. virtual servers)
  - Optimize current footprint, consolidating from **33 to 17** global data centers by 2025

While delivering value...

- **On-demand** infrastructure capacity
- >95% **Reduction in hardware provisioning time**
- **15-20%** Infrastructure cost efficiency
Our software delivery tools drive productivity and speed to market

Automate and streamline software delivery

- 40k engineers using platform
- 30k monthly production releases
- 600mm+ lines of code

Platform capabilities…

<table>
<thead>
<tr>
<th>Engineer Enablement</th>
<th>Best-in-class capabilities (e.g., ML for improved code quality)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed of Controls</td>
<td>Automation of security and quality controls to reduce risk</td>
</tr>
<tr>
<td>Operational Excellence</td>
<td>Predictive analytics for build success rates and testing sufficiency</td>
</tr>
<tr>
<td>Ease of Integration</td>
<td>Flexibility to integrate new tools as ecosystem evolves</td>
</tr>
</tbody>
</table>

... to achieve business outcomes

- 20% Faster delivery of product features
- ~10% Improved engineer productivity

Strengthen our software development capabilities and infrastructure
Three examples that demonstrate the value we have realized

**Athena | Price, Trade & Risk Platform**

Foundation of our Markets business completing billions of risk calculations daily

- Refactored monolithic application to modern cloud-native platform to provide capacity on-demand
- **30% reduction** in risk calculation times
- ~**80% reduction** in calculation cost per hour
- **Autonomously expand** compute footprint from 0 to 14k then back to 0 to adapt to market demand

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**CHASE | Chase.com Migration**

Serving all digital customers with continuous feature enhancements, security and 24x7 availability

- Refactored to multi-cloud architecture to enable performance, speed of feature delivery and automation
- >**99.99%** availability with automatic failover
- >**50% reduction** in runtime costs
- **100% customers supported** by 2022YE

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**servicenow | ServiceNow Adoption**

Firmwide platform delivering digital workflows and unlocking enterprise efficiencies

- Rationalized 24 applications with industry leading SaaS platform to replace non-modern systems and increase productivity
- Nearly **$50mm in savings** since 2019
- Single largest collection of integrated reference data for the firm
- **80% increase** in employee experience when ordering workplace technology services
Modernizing technology and software development excellence will drive cost efficiency across the total spend and slow our expense growth.

**Total spend breakdown**

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Spend ($B)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure and software</td>
<td>14.1</td>
<td>92%</td>
</tr>
<tr>
<td>Product, design, application support, and other</td>
<td>2.7</td>
<td>8%</td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
<td>0%</td>
</tr>
</tbody>
</table>

**Opportunity levers**

- **Software development excellence**
  - Improve engineer capacity through agile adoption and elimination of non-value adding activities
  - High levels of automation (testing, release, production support) and streamlined software delivery through our platforms

- **Modernize technology**
  - Increase utilization of cloud and reduce data center footprint
  - Break monolithic applications into modular and API-driven architecture to improve cost elasticity

**Opportunity size**

- **~10%** in productivity and cost efficiency
- **15-20%** in infrastructure cost efficiency
- **~$1.5B** in productivity and cost efficiencies over the next 3 years
Our AI platforms will drive speed-to-market and enable adoption at scale

We are seeing high impact from our AI investments

$ impact per $ spend

2x

$1B+ in business impact projected by 2023

2020
2023

Select examples

Equities Trading (Flow Trader)
Utilizing AI to deliver faster quotes to clients

Quote Time
Up to 80% time improvement

Fraud Risk Modelling
Identifying fraudulent transactions with AI to reduce losses

Fraud Losses
$100mm reduction since 2017

Majority of firmwide analytical data available in real time

Build strategic platforms and empower our 1,000+ data scientists

We are addressing the two biggest challenges in delivering AI at scale...

Data Management Lifecycle
Make data available at speed and at scale

▪ Manage data-as-a-product to make it easier to consume and combine with other data
▪ Move data to public cloud for greater scale and elasticity

AI Model Lifecycle
Improve data scientist productivity and speed

▪ Dedicated training data management platform
▪ Reduce friction in model development process
▪ Fit-for-purpose policies and controls

70% faster model speed-to-market

1Volumes up 50% in the same time period
We have maintained consistent cybersecurity investment through a dynamic threat and regulatory environment.

- **Dynamic global cybersecurity defense** to anticipate and prevent threats and prioritize incremental investment.
- **Maintain cybersecurity posture and trust** against evolving technology and business demand.
- **Deliver security-as-a-feature** by enhancing security, privacy and fraud capabilities within our products.
- **Remove friction** through sustainable control patterns and automation.
- **Proactively adapt** with evolving public policy, regulation and ecosystem changes.

Investments in controls and automation enabled us to support increased volume / growth while maintaining steady cybersecurity spend ($mm)

- **Security data processed per day**: 5x increase from 2019 to 2022.
- **Application vulnerability scanning**: 2.5x increase from 2019 to 2022.
- **Devices secured and monitored**: +50% increase from 2019 to 2022.
We are well positioned to differentiate ourselves with technology

1. **Deliver best-in-class products and experiences to customers**
   - Positive $ return in business value
   - Share gain and revenue growth through innovative solutions

2. **Strengthen our software development capabilities and infrastructure**
   - ~$1.5B in productivity and cost efficiencies over 3 years
   - 20% faster delivery of product features

3. **Unlock the power of data**
   - >$1B in business impact
   - 70% faster delivery of production AI models

4. **Protect the firm and our customers**
   - Faster response to new threats
   - Secure and private by design

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