Broadband Overview

Broadcom & Morgan Stanley Broadband Teach-In
April 12, 2021
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Broadcom Speakers

Hock E. Tan
President & CEO

Rich Nelson
SVP & GM, Set-Top Box and Cable Modem Products

Greg Fischer
SVP & GM, Broadband Carrier Access Products
How Broadcom Became a Global Technology Leader

Category-Leading Franchises: 8 in 2009 → 25 Today

Revenue
($ in Billions)

R&D
($ in Billions)

16X Growth

25X Growth

84X Growth in Operating Profit from 2009 → 2020
One of the industry’s broadest IP portfolios with >20,000 patents.
Connecting Everything® Across the Ecosystem

99.9% of All Internet Traffic Crosses at Least One Broadcom Chip

Source: Broadcom Internal Estimate
Connecting Everything® Across the Ecosystem – Broadband

Data Center
- Leaf / Spine Switches
- Physical Layer
- Data Center Interconnect
- Compute Offload

On-Prem / Cloud

Carrier Networks
- Long-Haul Tx/Rx
- Core Routing
- Edge Routing
- Aggregation Switch
- Base Stations
- OLT / DSLAM / CMTS

Access
- RF FE / Wi-Fi / GPS
- Wi-Fi Router / AP
- Campus Switch
- Enterprise Storage
- Enterprise
- Wi-Fi Router
- Set-top Box
- Residential
- DSL / PON / Cable Modem

Broadband Products

99.9% of All Internet Traffic Crosses at Least One Broadcom Chip

Source: Broadcom Internal Estimate
Category-Leading Franchises in Diverse End Markets

In FY20

Broadband ~$3B*

Networking

Wireless

Server Storage

Industrial

Semiconductor Solutions

Infrastructure Software

Broadband

Customer Premise

Broadband Infrastructure
Set-Top Box (STB)

Rich Nelson
Senior Vice President and General Manager,
Set-top Box/Cable Modem Products
Set-top Box/Cable Modem (STB)

Comprehensive Portfolio of Solutions Addressing “Last Mile” Challenges for Global Service Providers
Broadcom’s Heritage of Innovation

1991
- Ethernet Physical Layer
- Pay-TV STB Product Line

2009
- Digital Cable Receiver for Cable Set-Top Box Product Line
- Satellite Set-Top Box Product Line
- Cable Modem Product Line
- Streaming Set-Top Box Product Line

2014
- Pay-TV STB Product Line

2016
- Networking Product Line

2017
- Pay-TV STB Product Line

2018
- Pay-TV STB Product Line

2019
- Pay-TV STB Product Line
- Networking Product Line
Key Competitive Advantages

Deep System Knowledge

ADC/DAC, CMOS RF, Cable/Satellite Receivers & Transmitters, DSP, Video Decoding, Security, Graphics, Machine Learning, DOCSIS Media Access Control, PCIe, Wi-Fi, CPU, External Memory Interfaces, Deep STB & DOCSIS Software Expertise

Proven Methodology & Process

Robust Ecosystem

Superior Quality

Accelerated Time to Revenue

Broadcom Silicon & Software Platform

Targeted Expertise and Scale along with Deep Partnerships Drives Innovation
Deep Partnerships with Leading OEMs and Operators

1B+ STB and 500M Cable Modem SoCs Shipped Over 25+ Years
Continued Innovation Drives New Product Cycles and Business Growth
## AI / Machine Learning in the Home is the Future for STB

**Video**
- Facial recognition based user profile
- Video calling
- Increase resolution output to 4K
- Local video sharpening and noise reduction
- Picture in Picture with zoom-in/zoom-out

**Voice**
- Voice-based search
- Improved performance versus voice remote
- Voice-based user profile
- Text to speech, speech to text

**Apps**
- Better user experience
- Security: Keeping personal information local and off the cloud
- Personalized content and recommendations
- Targeted ad insertion
- Live language translation

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**Well Positioned to Lead Customer Rollout of Machine Learning Technology**
World’s Only Complete Streaming Ultra HD System-on-a-Chip

- Wi-Fi 6 with Radio
- Peripherals & I/O
- Quad-Core CPU
- 3D Graphics Processor
- Advanced Security Processor
- Advanced Dolby Audio Decoder
- Machine Learning Processor
- 4K Video Decoder with HDR

Highly Integrated SoCs with Complex Technologies and Robust Software
Broadcom Analytics System (BAS)
End-to-End Solution to Diagnose, Manage and Secure STBs and Cable Modems

End-to-End Easy Integration
- STB & DOCSIS Devices
- Operator Hosted
- Enhances Operator Tools
  - Customer Service
  - Network Management
  - Whole Home Wi-Fi
- Customizable Reference UI

Save $$$ Over Lifetime of Devices
- Reduce Operating Expenses
- Reduce Customer Churn
- Eliminate Technician Visits
- Improve User Experience
- Prevent Piracy and Theft
- Scalable Automation

AI Powered to Identify WHAT / WHEN / WHY Something Happened and HOW to Fix It
## Broadcom's History of Cable Broadband Innovation

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>First</td>
<td>Integrated DOCSIS MAC-PHY</td>
</tr>
<tr>
<td>2000</td>
<td>First</td>
<td>Single-Chip DOCSIS Cable Modem</td>
</tr>
<tr>
<td>2001</td>
<td>First</td>
<td>All CMOS DOCSIS Cable Tuner</td>
</tr>
<tr>
<td>2001</td>
<td>First</td>
<td>Single-Chip DOCSIS Voice Cable Modem</td>
</tr>
<tr>
<td>2005</td>
<td>First</td>
<td>DSP-less DOCSIS Voice Cable Modem</td>
</tr>
<tr>
<td>2005</td>
<td>First</td>
<td>DOCSIS Cable Modem with Integrated Tuner</td>
</tr>
<tr>
<td>2007</td>
<td>First</td>
<td>DOCSIS Channel Bonding Modem</td>
</tr>
<tr>
<td>2009</td>
<td>First</td>
<td>DOCSIS &amp; EuroDOCSIS Modem Certification</td>
</tr>
<tr>
<td>2011</td>
<td>First</td>
<td>DOCSIS Full-Band Capture Modem</td>
</tr>
<tr>
<td>2013</td>
<td>First</td>
<td>DOCSIS Downstream Full-Band Diagnostics</td>
</tr>
<tr>
<td>2015</td>
<td>First</td>
<td>DOCSIS 3.1 SoC</td>
</tr>
<tr>
<td>2017</td>
<td>First</td>
<td>DOCSIS 3.1 Upstream Diagnostic Analyzer</td>
</tr>
<tr>
<td>2019</td>
<td>First</td>
<td>DOCSIS 3.1 OFDM-A Deployments</td>
</tr>
<tr>
<td>2020</td>
<td>First</td>
<td>DOCSIS 3.1 Analytics Server</td>
</tr>
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**Broadband Competition Sustains Continued Upgrade Cycles and Business Demand**
Integration Drives Improved Performance, Cost and Power

Single-Chip DOCSIS 3.1 Cable Modem SoC

Industry-Leading Performance Enables Long-Term Customer Partnerships
## Broadcom Innovations Keep Cable Broadband Ahead

<table>
<thead>
<tr>
<th>DOCSIS 1.0/1.1</th>
<th>DOCSIS 2.0</th>
<th>DOCSIS 3.0</th>
<th>DOCSIS 3.1</th>
<th>DOCSIS 4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 Mbps Download</td>
<td>40 Mbps Download</td>
<td>960 Mbps Download</td>
<td>5 Gbps Download</td>
<td>10 Gbps Download</td>
</tr>
<tr>
<td>10 Mbps Upload</td>
<td>30 Mbps Upload</td>
<td>120 Mbps Upload</td>
<td>2 Gbps Upload</td>
<td>6 Gbps Upload</td>
</tr>
</tbody>
</table>

- **DOCSIS 1.0/1.1**: 1997
- **DOCSIS 2.0**: 2002
- **DOCSIS 3.0**: 2006
- **DOCSIS 3.1**: 2013
- **DOCSIS 4.0**: 2020

Consumer Demand for Increased Bandwidth Drives Technology Evolution
Common Software Accelerates TTM and Strengthens Operator Relationships

- Reduces operator support demands
- Provides opportunity for embedded features unique to operators
- Expands Broadcom relationship to include support contracts and joint development agreements

Broadcom OpenBFC™ Lattice APIs Common to All Broadcom Cable Modem Silicon
End-to-End Cable Broadband Access Solutions from Broadcom

Cable Head-End

- **Fiber**

Fiber Node

- **Coax**

Broadband Gateway at Consumer Premise

- **Home**

  - **DOCSIS 3.1**
    - **CPE SoC**

- **Business**

  - **DOCSIS 3.1**
    - **CPE SoC**

- **Home**

  - **DOCSIS 3.1**
    - **CPE SoC**

**Broadcom is the only Provider of End-to-End DOCSIS Solutions**
Broadcom Works with Major Cable Operators on DOCSIS 4.0 Development

<table>
<thead>
<tr>
<th>Improved Network Reliability</th>
<th>10 Gbs Speeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved Network Security</td>
<td>Reduced Latency</td>
</tr>
</tbody>
</table>

Next Product Evolution Supporting Upgrade Cycles and Customer Demand
Broadband Carrier Access (BCA)

Greg Fischer
Senior Vice President and General Manager,
Broadband Carrier Access Products
Broadband Carrier Access (BCA)

Comprehensive Portfolio of Solutions Addressing “Last Mile” Challenges for Global Service Providers
Increased Need for Speed Globally

Consumer trends:
- Video conferencing & streaming
- Online gaming
- Remote work, schooling
- M2M and IoT

Product cycles driven by:
- Demand for faster speed
- Robust quality of service
- More Wi-Fi connected devices

Semiconductor growth driven by:
- Increased signal processing
- Increasing levels of integration
  $\rightarrow$ More Broadcom chip content per device

COVID-19 Pandemic Accelerating Underlying Trends; Behaviors Changing for Long Term
Broadband Carrier Access by the Numbers

Large & Attractive Market

- **Greater than $3 billion** SAM
- **More than 1 billion** fixed line broadband subscribers globally
- **4-5 year market cycles** from beginning of new standards to mass volume

Broadcom Leadership

- **20-year history of execution** across 5 generations of technology
- **80%+** of Wi-Fi 6 infrastructure relies on Broadcom
- **100+** operators worldwide
Diverse Footprint with 100+ Operators Worldwide
Broadcom’s Differentiation

Time to market
• Long history of being first to market
• Capture the first generation of new technology deployments

Sophistication
• Consistent innovation drives a high-performing & feature-rich product portfolio

Ability to integrate
• Leadership in integration of systems and software
• Meet customer needs at different price points

Continually Building Upon our Heritage of Technology
Silicon Portfolio Built for Integration Leadership

Early 2000’s

- Advanced Flash Controller
- PON MAC
- DSL Modem
- Ethernet PHY
- Voice-over-IP
- Analog Front End
- Wi-Fi AP
- Ethernet Switch
- CPU

Today

- Broadband Wi-Fi access point
- DSL/PON Tri-Band Wi-Fi Router
- Wi-Fi 6 SoCs

Consistent Team and World-class Execution
Best-in-Class and First-to-Market

Layer 2 APIs
Layer 3 Routing APIs
QOS APIs
Wi-Fi APIs
Peripheral APIs

Broadcom Development Kit (BDK) with Common APIs

Single SDK Accelerates Development and Time to Market Across Broadband and Wi-Fi Routers
Digital Subscriber Line (DSL) Products
Five generations since 2000

- **> 1 Billion** Broadcom DSL connections installed worldwide
- **Analog, DSP, and protocol software stack** investments create wide competitive moat
- **Sole provider** of DSL infrastructure semiconductor products globally since 2015
- **70+%** share of high performance VDSL CPE SoC products globally since 2010
- DSL SOC price/performance scaling with transition to Wi-Fi 6
Evolution of Fiber (PON) Products
Moving from copper to faster, more reliable fiber

- **World’s largest supplier of silicon** for broadband residential fiber
- Only supplier of **merchant silicon** for optical broadband infrastructure
- R&D leverage and software commonality with DSL CPE and Wi-Fi routers
- Integrating advances in Wi-Fi with the fiber transition provides content rich platform play
- Unique network processor IP provides **advanced performance at consumer scale**

Image courtesy of Mike Kim Industrial Design

<table>
<thead>
<tr>
<th>Year</th>
<th>BPON</th>
<th>EPON</th>
<th>GPON</th>
<th>XPON</th>
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</thead>
<tbody>
<tr>
<td>2005</td>
<td>644 Mb</td>
<td>1 Gb</td>
<td>2.5 Gb</td>
<td>10 Gb</td>
</tr>
<tr>
<td>2010</td>
<td>644 Mb</td>
<td>1 Gb</td>
<td>2.5 Gb</td>
<td>25 Gb</td>
</tr>
<tr>
<td>2015</td>
<td>644 Mb</td>
<td>1 Gb</td>
<td>2.5 Gb</td>
<td>50 Gb</td>
</tr>
<tr>
<td>2020</td>
<td>644 Mb</td>
<td>1 Gb</td>
<td>2.5 Gb</td>
<td>100 Gb</td>
</tr>
<tr>
<td>2025</td>
<td>644 Mb</td>
<td>1 Gb</td>
<td>2.5 Gb</td>
<td>200 Gb</td>
</tr>
</tbody>
</table>
Simultaneous need for internet, gaming, video, voice, internet-of-things with reliability and speed

More spectrum, more antennas, more radios per home or campus = more silicon content

More sophisticated “four dimensional” scheduling of traffic to support increasing number of clients

Ultimately bringing gigabit speeds to and through homes and campuses

Source: Broadcom internal estimate
Driving Growth – Broadcom Wi-Fi Platforms

Wi-Fi is the preferred method to connect to broadband

Service Provider Wi-Fi

Enterprise Wi-Fi

Retail Wi-Fi

Wi-Fi 6 Market Leadership

- > $1.3 Billion sold since introduction
- Industry’s broadest portfolio – eight devices launched since 2018, three new products in 2021
- 80%+ of infrastructure relies on Broadcom
- > 450 Million client devices are Broadcom based

Continued innovation → First to market

- Wi-Fi 6E – 6 GHz is the first new Wi-Fi band in more than a decade
A Reputation for Sophistication and Product Leadership

1997
802.11
1999
802.11b
2003
802.11a/g
2009
802.11n
2013
802.11ac
2019
Wi-Fi 6
2020
Wi-Fi 6E
Future
Wi-Fi 7

Audio and low-resolution video
High-definition video
Whole home coverage and dense IoT clients