Paul Charlton

EDUCATION

Rensselaer Polytechnic Institute *BS: Electrical, Computer, and Systems Engineering* **Sept. 1984 – May 1988**

SUMMARY ***Trusted C-Level advisor; Distinguished Engineer with C-Level Impact***

- Distinguished Engineer and platform strategist operating as a high-leverage individual contributor with consistent C-level business impact. Entrusted by Fortune 500 executives to own and deliver mission-critical infrastructure, platform modernization, and developer experience transformation at scale.
- Architect behind foundational technologies that power over $1T in ARR — including Apple QuickTime, Intuit QuickBooks, and core JVM graphics. Presented on the WWDC main stage and held pivotal roles at Apple, Sun, and Intuit. Now focused on driving end-to-end architecture — from IoT drivers to cloud-native SaaS — with a passion for clean systems and ruthless simplicity.
- Recognized force multiplier: delivered 100x gains in reliability, latency, and developer productivity through deep systems expertise, automation, and hands-on mentorship. Led org-wide transformations in companies of 2,000+ engineers, directly managing teams up to 200.
- Award-winning inventor with multiple patents and a sharp business instinct for IP protection — reclaiming over $150M in license revenue. Trusted partner in strategy, innovation, and delivery. Former Chief Cloud Officer, CTO, and VP Engineering; now advising VC-backed startups while remaining fully IC by choice.

EXPERIENCE

University of Virginia - School of Medicine ***[Full Story]*** *Researcher*

Youngest paid researcher at UVA School of Medicine at 14, recruited after scoring ">170 IQ off the chart" in UVA's gifted research program. In a vision research lab under the Department of Physiology, I pioneered the lab-scale integration of analog biomedical equipment with digital computers, automating data collection and experimental workflows in a fully dark lab. I designed and built custom circuits, developed 6502 assembly drivers for GPIB-controlled systems, and implemented an early speaker-independent voice recognition system - advancing published medical research and mentoring graduate-level scientists before entering college.

Chase Manhattan Bank ***[Full Story]*** *Director of Advanced Technology Lab*

I modernized Chase's retail and back-office banking systems, replacing paper-based workflows with PC and networked solutions that drastically reduced risk, cut processing time from days to hours, and supported scalable acquisitions. I architected and developed the first ever Windows GUI-based online banking platform, engineered high-security systems for wire transfers and vault reconciliation, and implemented middleware to unify legacy systems through screen-scraping and field validation. My efforts enhanced operational security, uncovered fraud, and saved millions through alternative computing strategies and vendor negotiations.

D.E. Shaw & Co. ***[Full Story]*** *Technology Specialist*

At D. E. Shaw, I joined as employee #24 and led engineering for Jeff Bezos's Third Market trading desk, architecting a GUI-based order entry system and scaling infrastructure to support market making in 2,000+ securities. I diagnosed critical system deadlocks in the Stratus OS, optimized predictive trading algorithms using multidimensional statistical calculus, and pioneered in-house logging of historical market data to replace costly external sources. I contributed to early brainstorming sessions that seeded the idea for what became Amazon. My push for employee equity — tying ownership to impact rather than seniority — challenged the status quo and ultimately helped catalyze an exodus that included Jeff's departure to launch it.

Apple Computer Inc. ***[Full Story]*** *Principal Engineer*

I led the cross-platform port of QuickTime and macOS from proprietary Apple hardware to Windows (x86) by building a fully preemptive, thread-safe implementation of the Macintosh Toolbox from scratch and integrating QuickDraw 2D. I architected and launched the QuickTime Media Layer (QTML), which enabled Mac applications to run on Windows and SGI IRIX. QTML later formed the foundation of Apple's Carbon API and macOS X transition. My work was pivotal to Apple's $150M legal victory over Microsoft/Intel, and I presented the cross-platform QuickTime rollout at WWDC in the main hall to over 1,000 developers.

Sun Microsystems - JavaSoft ***[Full Story]*** *Principal Consulting Engineer*

As Principal Consulting Engineer, I rearchitected and optimized the Java2D subsystem for JDK 2, boosting glyph rendering performance by 40x to deliver over 200,000 glyphs/sec on 300Mhz Pentium II. I also applied low-level Intel i386 pipelining techniques to the Java Bytecode interpreter, achieving a 5x performance gain. This foundational code remains virtually unchanged in every Android device today and across graphical Java-based systems globally.

Startup *[Full Story]* *Co-Founder*

Co-founded C2B Technologies and retained a 20% ownership stake through its acquisition. Played a pivotal role in negotiating the sale of C2B to Inktomi, uncovering material omissions during due diligence and asserting shareholder rights to secure full equity entitlements. Successfully enforced delivery of final shares and approved the acquisition, which closed at $150M. Personally received over $25M in Inktomi stock. The company's core innovation enabled cross-vendor price comparison in online shopping—an early forerunner to modern e-commerce aggregators.

Hewlett-Packard *[Full Story]* *Hardware and Software Engineer*

At Hewlett-Packard, I developed advanced SCSI-II drivers and boot ROMs for magneto-optic and tape storage devices across HP-UX, MPE, and Apollo Domain OS, including debugging low-level OS synchronization flaws and pioneering in-house ASIC/VLSI chip design with a successful first tape-out. I led a data recovery initiative for NASA's historic space mission telemetry, creating custom software and decoding pipelines for degraded tape reels, and contributed to integrating HP storage with Apollo workstations post-acquisition. Certified as a Six Sigma coach, I worked cross-functionally to enforce defect prevention at the requirements stage and applied HP's culture of merit-driven, engineer-led innovation.

Intuit *[Full Story]* *Software Architect*

Recruited by Intuit during a critical transition period to drive cultural and architectural reform amidst a high-stakes rewrite of QuickBooks. Embedded as a staff engineer, I rapidly identified and resolved a decade-old, customer-visible "ghosting" bug in under two weeks—defying expectations in a code-frozen environment. My solution, involving robust IPC design and a race-condition-proof file handling strategy, shipped in the gold master of QuickBooks. I also diagnosed systemic flaws in build tooling (Electric Cloud), influenced product UX for accountants, and became a trusted force for mentoring and strategic problem-solving across teams.

Sun Microsystems *[Full Story]* *Principal Consulting Engineer*

In under 10 weeks, I led a 10-person team to rescue and deliver JavaFX 1.0 on time—rewriting the multimedia pipeline, eliminating 30% of the legacy code, and adding 40,000 lines of high-performance, test-driven code to enable smooth, synchronized video playback across platforms. I re-architected the system for native performance, preemptive multithreading, and customer delight, coordinating closely with product management and external partners. Our release marked Sun's first on-time software launch in over a decade and heralded a 51% increase in market cap within 15 days.

Publications, Patents and Products

Key Products: Apple QuickTime (iTunes, iOS), Apple Carbon API, JavaFX, Java2D (Android), MDOS, QuickBooks

Selected Publications: Morton, R. W., Chung, J. K., Miller, J. L., Charlton, J. P., & Fager, R. S. (1986). *Extended sensitivity for the calcium selective electrode.* Analytical Biochemistry, 157(2), 345–352. Google Scholar. DOI: 10.1016/0003-2697(86)90636-6

Selected Patents:

US 5,875,354 – *System for Synchronization by Modifying the Rate of Conversion by Difference of Rate Between First Clock and Audio Clock* • Inventors: Paul Charlton, Keith Gurganus; Assignee: Apple Inc.; Early solution to audio/video sync via dynamic sample rate conversion. Now core to AV streaming, DAWs, AI video rendering, and IoT synchronization.

US 5,825,359 – *Improved Arbitration of a Display Screen in a Computer System* • Queue-based screen access control in multi-process environments.; Anticipated today's GPU compositing (Quartz, DWM, Wayland) and virtual desktop rendering.

US 5,949,434 – *Scaling 2D Graphic Images Without Banding Artifacts* • Enhances Bresenham's algorithm with pseudo-random shifts to reduce visual artifacts.; Forefather of adaptive upscaling in DLSS, medical imaging, and AI-based super-resolution.

Technologies & Keywords *Machine Readable*

Hardware Interfaces: AGP - Accelerated Graphics Port; Centronics - Centronics Parallel Interface, EISA - Extended Industry Standard Architecture; eSATA - External Serial ATA; FireWire - IEEE 1394 High Performance Serial Bus; GPIB - General Purpose Interface Bus; HDMI - High-Definition Multimedia Interface; HPIB - Hewlett-Packard Interface Bus; ISA - Industry Standard Architecture; Nullus - New Bus Architecture; PATA - Parallel Advanced Technology Attachment; PCI - Peripheral Component Interconnect; PCIe - Peripheral Component Interconnect Express; PCMCIA - Personal Computer Memory Card International Association; RS-232 - serial interface; RS-422 - serial interface; RS-485 - serial interface; S-100 - S-100 Bus; SAS - Serial Attached SCSI; SATA - Serial Advanced Technology Attachment; SCSI-II - Small Computer System Interface II; ST506 - Seagate Technology ST-506 Interface; Thunderbolt - Thunderbolt Interface; USB - Universal Serial Bus 1.x, 2.x; VLB - VESA Local Bus

Processors & Architectures: 6502; 6809; 8086; Alpha (DEC Alpha); AMD29K, AMD bit-slice; ARM (ARMv4–v9); IBM 360; Itanium (IA-64); MIPS360; MIPS; PA-RISC, PDP-11; PowerPC (PPC); RCA COSMAC 1802, RISC-V; RS6000; SPARC; TMS9900; VAX; Z80; x86 (16-bit 8086); x86_32 (IA-32); x86_64 (AMD64)

System & Platforms: AIX; AmigaOS; Android; Apollo Domain OS; BSD (FreeBSD, OpenBSD, NetBSD); CP/M, DR-DOS; FreeRTOS; HPUX; IBM 360, vOS; Linux (kernel and distros); macOS; MINIX; MPE; MS-DOS; Multics; MTS; MVS; MyArc Geneve; NDOS; OS/2; QNX; RTOS; SGI IRIX; SGI OSVX; Solaris; TI-99/4A; Unix; VOS; VxWorks; Windows 3.0; Windows 3.1; Windows NT

Drivers & Low-level Development: Device Tree Overlays (Linux ARM platforms); HPUX drivers (68020, C); Linux kernel modules (loadable drivers, LKM); Linux VFS (Virtual Filesystem Switch); MPE drivers (Pascal); MS-DOS INT 13h BIOS-level block device handlers; macOS drivers; macOS I/O Kit (C++/Objective-C); low-level filesystem drivers; low-level filesystems - XFS and Clustered-XFS; PCI configuration space access; RSX-11 and VAX/VMS device drivers (MACRO-11, BLISS); SCSI-II Autochanger drivers; SCSI-II Magneto-optic drivers; Solaris Device Driver Interface (DDI/DKI); TI-99/4A CRU (Communication Register Unit) drivers (assembly); Windows 3.x DDK; Windows DDK (Device Driver Kit); Windows NT DDK; BIOS bootloader development; EFI (Extensible Firmware Interface) programming; GRUB bootloader configuration and customization; Secure Boot chain validation and integration.

Programming Languages & Tools: .NET; 6502 assembly; 6809 assembly; 8088 assembly; Alpha assembly; AMD bit-slice; AMD29K assembly; Apache Spark; Apollo DSEE (Domain Software Engineering Environment); ARM assembly; AWK; bash; Bison (C++ Libraries); Borland C++; BoundsChecker; C; C#; C++; C++ template metaprogramming; Carbon; ClearCase; COROL; CodeWarrior; Cucumber; CVS; Eclipse (IDE); Enterprise Architect (Sparx Systems); flex; FORTH, FORTRAN; gcc; gdb; gem, Git (Version Control); Go (Golang); gprof, RpperCard; IDL (Interface Definition Language); IBM 360 assembly; IntelliJ IDEA (IDE); Itanium assembly; Java, JavaScript (browser); JCL (Job Control Language); JDK (Java Development Kit); JetBrains MPS; JNI (Java Native Interface); JProfiler; JUnit; ld; lex; Linux kernel modules; lldb; M68000 assembly; macOS I/O Kit; macOS SDK; make; MIPS assembly; Modern shell (sh, bash, ash); MS-DOS INT 13h handlers; NetBeans (IDE); Node.js; ngnu; nvim; NUnit; OpenAPI (formerly Swagger); OpenGL; PA-RISC assembly; Pascal; Perforce (Version Control); Perl; PDP-11 assembly; Postman; PowerPC assembly; Process Explorer; Procmon; Protocol Buffers (protobuf); PuExec; Purify; Python; QTML; QuickDraw; QuickTime SDK; RCS (Version Control); RCA COSMAC 1802 assembly; React; RISC-V assembly; RSpec; RS6000 assembly; Ruby; Salsa; Scala; SCCS (Version Control); sed; Selenium, shell (sh, csh); SoftICE; SPARC assembly; SQL (DDL and DML); Subversion (SVN Version Control); Swagger (OpenAPI predecessor); Symbiotemik Suite; TI GPL (Graphics Programming Language); TMS9900 assembly, T-SQL; TypeScript; UML (Unified Modeling Language); Unix utilities (awk, sed, grep); Valgrind; VAX assembly; vi; vim; Visual Studio (IDE); VisualVM; VTune; webpack; Win32 API; Windows 3.x DDK; Windows DDK; Windows NT DDK; Windows SDK; Winsdbg; X11; Xcode; XNU kernel; Xt; x86 (16-bit 8086) assembly; x86_32 (IA-32) assembly; x86_64 (AMD64) assembly; yarn; Z80 assembly

UI & Graphics: AWT (Abstract Window Toolkit); Cross-Platform QuickTime; Direct2D, Fonts and Typography, Geometry, Glyphs; GTK+, HTML5 Canvas, Java2D, JavaFX, macOS UI, Microsoft GDI (Graphics Device Interface); OpenGL, Qt; Quartz 2D, QuickDraw 2D, QuickTime 1.x–3.x; SVG, Swing, Windows GUI, X11;

HID, Graphics, Video & Sound: DirectX; DisplayPort; dropping frames; FFmpeg; graphics performance; H.264; HDMI; jitter; latency; NVENC; OpenGL; sound card drivers; VGA drivers; Video Capture; Video Capture Card Drivers; Video Capture Cards; Video Compression; Video Decompression, video pipeline, video transcoding; WebRTC, YUV;

Statistical & Optimization Methods: 6-sigma; A/B testing; gradient ascent; gradient boosting; gradient descent; K-mean chattering; linear regression; logistic regression; monte carlo simulation; Multidimensional linear regression; simulated annealing; stochastic gradient descent; SVD (Singular Value Decomposition);

Networking & Protocols: 802.11; BGP; Bluetooth; Bluetooth Low Energy; CAN bus; DNS; Ethernet; FTP; HTTP; HTTPS; IMAP; IPv4; IPv6; ISDN (Integrated Services Digital Network); leased lines; LoRaWAN, L12; L14.2; Modbus; MQTT; Novell NetWare; POP3; SMTP; SNA (System Network Architecture); SNMP; SSH; Ti; TCP/IP; Telnet; TLS; Token Ring; UDP; WebSocket; Wi-Fi;

Enterprise & Legacy Systems: AS/400; CICS (Customer Information Control System); COBOL; DB2, HP 3000; JCL (Job Control Language); MPE; MTS (Michigan Terminal System); MVS (Multiple Virtual Storage); RSTS; RSX-11; System/360; System/370; TPF (Transaction Processing Facility); VAX/VMS;

Project & Product Experience: Apollo Computer Acquisition; Apple StarTrek; Beckman; BeyondNews; Bio-Rad; D. E. Shaw; EG&G; Element Analytics; F5 Network; Fisher Scientific; Particom; GIMPS; Hewlett Packard; IdeaLab, Independa; Intacct; Intuit; NASA; NASDAQ; National Merit; Netflix Prize; Nexstar; NYSE; Perkin-Elmer; Pixar; Tektronix; U.S. Coast Guard Auxiliary; ValueClick; Varian; Wamex MPAC;

OS Internals & Concepts: Async distributed software; bootloaders; caching device driver abstraction; file descriptor management; Global-scale time synchronization algorithms; init systems; interrupt handlers; kernel scheduling; memory management; paging; preemption; process isolation; resource management; semaphores; system calls; virtual memory management;

Development Methodologies: Agile; Behavior-Driven Development (BDD); Documentation-driven design; Kanban; Model-Driven Development (MDD); product management; Requirements before Design; Six Sigma, Scrum; Test-Driven Development (TDD); Toyota Production System (TPS); Waterfall;

Vintage Computing: 5" Floppy (FM/MFM formatting); 8" Floppy (MFM formatting); Altair 8800; Apple II; Apple III; Commodore Amiga; Commodore PET, Commodore SuperPET; CP/M; CRT terminals; DEC PDP-11; IBM PC XT; KayPro; paper tape readers; S100 bus; Seequa Chameleon; Teletype; TI-99/4A, TRS-80;

Language Support & Internationalization: bidirectional text; CJK (Chinese, Japanese, Korean) language support; codepage translation; collation algorithms; date and time formatting; font fallback; ICU (International Components for Unicode); ICU collation services; input method editors (IME); language negotiation; locale-aware string sorting; locale handling; LTR and RTL layout handling; multi-script rendering; natural language collation; number and currency formatting; pluralization rules; sort key generation; string normalization; surrogate pairs; text segmentation; transliteration; Unicode code points; Unicode Internals; Unicode normalization forms (NFC, NFD, NFKC, NFKD); Unicode scripts; UTF-16; UTF-8; variant selectors; zero-width joiners;

Human-Computer Interaction: command-line interfaces; dialog systems; eye tracking; multimodal interfaces; Speaker-independent speech recognition; Speech synthesis; touchscreen UI;

Cloud Scale Platform Engineering: ACME protocol (TLS automation); Alerting thresholds for metrics/logs; All test stages (unit, integration, e2e) integrated into CI pipelines; API backward compatibility; Apache Kafka; Apache Spark; Architecture Review Board (ARB) & publishing cadence; Archive of CTO/Architecture policies; Attribute-based access control (ABAC); Audit log long-term retention; AuthN vendor policies; Blue/green deployments; Canary deployments; CCPA / GDPR privacy compliance; Ceph; Centralized log aggregation; Centralized policy engine (e.g., OPA); CI/CD enforcement with SAST, DAST, TDD; Cloud-init; Cloudflare (CDN); Code coverage gating; Consul; Container image SemVer tagging; Contained; CoreDNS; CVE scanning policy; Data classification and handling policy; Data encryption at rest within storage and databases; Data encryption in transit between pods and nodes; Decision-Making Process (e.g., DACI); Declarative orchestration (e.g., Kubernetes); Delegated permissions and admin domains; DDoS protection policies; Distributed tracing (OpenTelemetry); DNS vendors and zone management policies; Docker; Domain registrar vendors and policies; ElasticSearch; etcd; Feature flag routing; Federated authentication (OIDC/SAML); Fine-grained RBAC; Flannel; Git commit SHA tagging; GitOps change management; gRPC; Health/liveness/readiness probes; Helm; Honey Pots; Horizontal autoscaling policies; Hypervisors (AWS, GCP, AZURE); IDS (Intrusion Detection); Immutable audit trails; Integration test harness; IPS (Intrusion Prevention); ISO 27001 / NIST optional benchmarks; Istio; JWT or SPIFFE/SPIRE identity; Kubernetes (K8s); Linkerd; Load and chaos testing; Log redaction and privacy rules; Log retention policy; Logging access controls; Logging format: structured JSON; Max payload sizes (upload/request/response); Metric ontologies (RED, USE); Metrics vendor(s) and retention policy; MinIO; Minimum unit test coverage threshold (e.g., 90%); mTLS enforcement (Istio, Linkerd); Multiple entry points per container allowed; Multi-zone / HA deployment policy; Network load shaping to gradually shift traffic; NGINX; One process per container; Open Policy Agent (OPA); OpenTelemetry; OWASP ruleset enforcement (blocking mode only); Policy versioning and rollback; PostgreSQL; Production-like staging environments; Prometheus; Pulumi; Rate limits - global and per-service; Redis; Regression test suite on merge; Registry policies: promotion lifecycle (dev → staging → prod); Regular rotation and management of encryption keys: SLA of 5 minutes or less for entire network; Services reload keys upon receiving a specific signal; Required DNS records (A, AAAA, CAA, CNAME, NS, PTR, SPF, DKIM, DMARC, MTA-STS, MX etc.); Required IPv4 and IPv6 support; Required log fields (timestamp, trace_id, etc.); Required security headers (default values); Resource quotas and limits; RPC Process for architecture decisions; Rollback plan required for changes; S3; SBOM (Software Bill of Materials); Schema migration strategy; SDK-level log enforcement; Secrets management; Secure Development Lifecycle (SDL); Secure key vault integration; Service-level AuthZ routing; Service mesh enforcement; Session management policies; Sharding; SLA-based alerting and load shaping; SLO dashboards; SOC-2 Type II compliance; Structured audit logging; Synthetic functional tests in production; Terraform; TLS cipher suite and protocol policy; Token lifecycle and revocation; Trace propagation and sampling; Transactional or rollback-safe deploys; Unified taxonomy & namespace schema; Vault (HashiCorp); Versioned architecture standards; Wildcard & internal DNS policies; Zookeeper; Zero-downtime deployments;

IoT edge to cloud: Access Control (IAM); Analytics Services; API Gateway; Asset Models / Digital Twins; Azure Arc; Azure Data Explorer (ADX); Azure Digital Twins (ADT); Azure IoT Central; Azure IoT Edge, Azure IoT Hub, Azure Stream Analytics (ASA); Azure Time Series Insights (TSI); AWS CloudFormation; AWS Greengrass Core; AWS Greengrass Lambda Functions; AWS IoT Analytics; AWS IoT Core; AWS IoT Device Defender; AWS IoT Device Management; AWS IoT Events; AWS IoT FleetWise; AWS IoT SiteWise; AWS Lambda, BACNET; Battery Management (edge); Data Brokers (MQTT / AMQP / HTTP); Device Firmware / RTOS; Device Health Monitoring; Device Identity Registry; Device Provisioning Service (DPS); Digital Twin Modeling Language (DTDL); Edge Gateway / Industrial PC; Edge Impulse; Edge ML Frameworks (TensorFlow Lite); Edge Runtime (Azure IoT Edge / Greengrass Core); Factory Keyed (Zero Trust); Firmware Over-the-Air (FOTA); Function-as-a-Service (FaaS); gRPC / REST APIs; Hardware Security Module (HSM / TPM); Ingestion Pipelines; KubeEdge, Local Message Broker (e.g., Mosquitto, Greengrass Broker); Local ML Inference; Logging and Metrics Collection; Mesh Wireless (BLE, WiFi); Message Queues (MQTT, Kafka, NATS, RabbitMQ); Microcontroller / SoC; Network Protocols (MQTT, CoAP, HTTP); Over-the-Air Updates (OTA); PLC / SCADA Integration; Remote Management Tools; Rule Engines; Security Policies (IAM, RBAC); Sensor Drivers; Sensor Modules; Stream Processing Frameworks; Telemetry Collection; Telemetry Routing; Time Series Database (TSDB); TLS Mutual Authentication; Twin Synchronization; Visualization Dashboards; Workload Orchestration (Kubernetes, ECS, AKS);