

BAW CHNG

NETWORKING & COMMUNICATIONS

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HIGHLY EXPERIENCED NETWORKING, COMMUNICATIONS, COMPUTER, AND SOFTWARE EXPERT. AWARDED 11 PATENTS. EXPERTISE IN A BROAD ARRAY OF CRITICAL TECHNOLOGIES INCLUDING WI-FI, CELLULAR COMMUNICATIONS, NETWORKING, CLOUD COMPUTING, AND WEB SERVICES. DIVERSE SOFTWARE CODING EXPERIENCE. BSEE, BSCOE, & MSCS WASHINGTON UNIVERSITY IN ST. LOUIS. PUBLISHED AUTHOR. USPTO REGISTERED PATENT AGENT.

TECHNICAL SKILLS AND KNOWLEDGE INCLUDE

- 3GPP and 3GPP2 families of cellular mobile broadband radio access and core network standards, small cells, femtocell, inter-technology handover and roaming
- IEEE 802.11 (Wi-Fi, mesh, infrastructure), 802.3 (Ethernet), 802.15 (WiMAX), 802.16 (WPAN) families of standards
- Network architecture, telecom system architecture
- Internet standards and protocols, TCP/IP, UDP, RTP, DHCP, DNS, ARP, GRE, etc.
- Internet-of-Things (IoT), M2M, LoRa, LoRaWAN, LTE Cat-M, NB-IoT
- Hotspot 2.0 / Passpoint (for Wi-Fi)
- IPsec, IKEv2, L2/L3 tunneling, NAT/NAPT (firewall)
- SAML, SAMLv2 federation; oAuth, oAuth 2.0 authentication; RADIUS, DIAMETER
- Network & device management, Broadband Forum TR-69 and IETF SNMP standards
- Software Defined Networking (SDN), Network Function Virtualization (NFV)
- Self-Organizing Network and Self-Optimizing Network (SON)
- Web Services, REST/JSON API design & implementation, HTTP
- Cloud computing, Amazon Web Services (AWS)
- Big Data, Avro, Parquet
- Plastic Optical Fiber (POF), Optical Networking
- Software architecture, Object-oriented design and programming, design patterns
- Go Lang, C, C++, Perl, LabVIEW, BASIC, Pascal, Unix shell scripting languages
- HTML, CSS, web design & development, web hosting, JavaScript, CGI Programming
- Operating systems (RTOS, various Unix/Linux variants, iOS, Android, etc.)
- Quality of Service (QoS), Fair Scheduling, Fair Queueing
- Interconnection networks and switching fabrics for parallel computers, network switches, and routers

PROFESSIONAL EXPERIENCE

BAWMAN LLC
PRESIDENT, CONSULTANT

January 2008 – present

Specialize in computer networking, wireless communications, and telecommunications. Consult for communications service providers, technology suppliers, investors, and the legal community. Offer contract-based consulting services in the following areas:

- **Strategic Consulting:** pathfinding for new technology ideas and new service concepts, technology positioning, product positioning, standards and trade group engagement strategies, technology and product roadmap development, business strategy, launch planning, vendor/customer/partner relationship management, RFI/RFP development and response
- **Standards Consulting:** standards and industry trade group strategy development, standards and industry trade group representation, standards development, standards monitoring, standards analysis
- **Technology Consulting:** network/system architecture design and development, technology evaluation, product evaluation, technology/product trial design and management, technology/product roadmap development, white paper development, RFI/RFP development, response, and evaluation
- **Patent & Intellectual Property:** analyze and evaluate patents and intellectual property claims for investors and the legal community; registered Patent Agent

Examples of completed consulting engagements below:

COMCAST

- Wireless business, product, and technology strategy development for Comcast's entrance to the wireless communications service provider market
- Developed long term network and system architecture roadmap for Comcast's wireless communications services platform
- Strategically evaluated new technologies and new products for efficacy against longer ranged business, architectural, and technological objectives
- Standards research and development and trade groups engagements. Engaged LoRa Alliance, CableLabs, Wi-Fi Alliance, Small Cell Forum, and WiMAX Forum representing Comcast's interests
- Network and system architecture contributions to Comcast's XfinityWiFi platform
- Conceived architecture options and corresponding roadmaps, presented architecture options and roadmaps to senior management (Senior VP and VP levels) and to leaders of different internal organizations, with analyses on benefits, costs, and trade-offs for different architecture options and roadmaps
- Developed roaming and federation system architecture as it relates to partnering with other cable operators and wireless providers (MSOs and MNOs) to provide services – e.g., on matters of cross technology inter-op, cross service provider tunneling and inter-op, cross provider billing, cross provider and cross radio access technology service handoffs, resulted in the Hotspot 2.0 / Passpoint standard



- Worked with Comcast’s management to drive consensus and secure buy-ins from different internal organizations for technology and architecture roadmaps
- Designed, planned, and choreographed demonstrations of new technologies and new products with partnering suppliers. Presented such demonstrations to senior management and leaders from different internal organizations to help them understand how the new technologies or new products would fit into the company’s longer term strategic vision
- Reformulated market and customer requirements into technical requirements in Product Requirement Document (PRD)
- RFI/RFP: Drafted large scale Request for Information (RFI) and Request for Proposal (RFP) documents used to drive vendor selection processes
- Evaluated RFI/RFP responses and provided recommendations on vendor selections
- Subsequent vendor management through field trials towards launch
- Defined system capabilities and use cases to be supported, considerations included
 - Residential Wi-Fi services, outdoor public Wi-Fi hotspots, as well as commercial (business-specific and venue-specific) Wi-Fi services, pay-per-use, “day passes,” sponsored access, cellular offloading, etc.
 - Support for video and audio streaming, ensuring harmonious coexistence with other consumer radio frequency products and services (including 2G/3G/4G cellular services, Bluetooth, ZigBee, connected home, wireless home security systems, and other IEEE 802.15-based services)
- Consulted on the integration of small cells (femtocells) into Comcast’s infrastructure
- Researched options to expand Wi-Fi to special, unconventional venues (e.g., trains)
- Internet of Things (IoT), with Comcast’s **MACHINEQ** subsidiary
 - IoT standards & architecture
 - IoT technology use case identification and products evaluation
 - Long term technology and product roadmap development
 - IoT network cloud computing architecture
 - LoRaWAN standards development, LoRa Alliance engagement
 - RFI/RFP, drafting, evaluation, and vendor selection
 - Vendor management through technology integration and field trial
 - Technology showcase and demonstration
 - Deployment strategy development

CABLELABS

- Researched and authored technical papers for CableLabs, an international consortium for cable communications service providers, on the following topics:
 - Wi-Fi Fast Transition (handoffs) in the context of CableLabs’ Community Wi-Fi Architecture (commercial deployments known as CableWiFi, XfinityWiFi, OptimumWiFi, etc.)
 - Architectures for deploying Community Wi-Fi using Extenders
 - Plastic Optical Fibers (POF) and its potential for 10+ Gbps home networking



COX COMMUNICATIONS

- Led system architect work while consulting for Cox Communications' Strategic Architecture group for its long-term, comprehensive Wi-Fi re-architecture and corresponding roadmap development efforts to consolidate Cox's residential, commercial, and metro Wi-Fi service platforms; dubbed *Converged Wi-Fi*
- Defined long-term network system architecture that supports Cox's strategic Network Function Virtualization (NFV), Software-Defined Networking (SDN), and Cloud Computing vision as well as other business and product needs (present needs and anticipated future needs), blended with knowledge and insights on industry trends and standards development directions
- Developed roadmaps and corresponding financial models for intermediate milestones towards the long-term architecture with options to accelerate or delay various components of the architecture to allow flexible response to changing market trends and budget constraints
- Worked with Cox's management to drive consensus and secure buy-ins from different internal organizations for the eventual adoption of the architecture and roadmap
- Lead contributor for the customer premise technology and CPE pieces of Cox's *Network Transformation 2.0* initiative, a project that maps out Cox's ten-year network evolution roadmap and associated financial modeling and forecasting; included video, data, and voice services
- Contributed to and reviewed RFI/RFP and solution designs to ensure alignment with long-term *Converged Wi-Fi*, NFV & SDN architecture and roadmap
- Engaged CableLabs on Cox's behalf and represented Cox's interests

PLUME DESIGN, INC.

- Functioned as Plume's primary liaison with a national, multi-divisional, North American Tier-1 communications service provider, managed customer relationship
- Launched Plume-powered services across three generations of Wi-Fi technologies, three generations of flagship gateway platforms, and three generations of Wi-Fi extender platforms
- Led cross-functional teams through multiple product and platform launches, triaged and managed post-launch issues, and incorporated learnings from multiple iterations of product and process improvement cycles along the way
- Worked through multiple cycles of product and platform deliveries, from requirement identification to requirement prioritization, to engineering delivery, to lab trials and field trials, and ultimately to market launches
- Cross functional coordination at all stages of the relationship with the communications service provider across product management, sales & marketing, engineering (hardware, firmware, middleware, integration), cloud operations, network operations, warehouse operations, supply chain logistics, data science with big data, mobile app, field support, customer call center support, as well as the gateway vendor's various teams



- Communicated across all levels of organizations, including field support, engineering, middle management, and senior executive leadership teams
- Developed solution architectures and solution designs that cut across multiple organizations and business functions
- Managed and smoothed out “integration pains” and “process pains” between a very aggressive start-up and a more deliberative Tier-1 communications service provider
- Shepherded Cloud API integrations with the service provider’s provisioning systems, authentication systems, inventory warehousing system, big data service assurance and business intelligence systems
- Blazed a trail for a job function that Plume later formalized as “Technical Account Management”
- Significantly influenced user interface (UI) and user experience (UX) designs for the end-users, particularly with regards to onboarding and login processes
- Significantly influenced Cloud integration architectures and API designs
- Responded to RFIs/RFPs issued by major communications service providers

ACCELERA MOBILE BROADBAND, INC.

- Consulted on system architecture, product management, and product positioning for Accelera’s vendor-independent, cloud-based managed Wi-Fi service platform
 - With support for residential Wi-Fi, dense multi-dwelling units (MDUs), small and medium business (SMB) Wi-Fi, enterprise and commercial Wi-Fi (including hospitality as a vertical)
 - Platform includes cloud-based servers, mobile apps (iOS and Android), and web-based interfaces for provisioning and monitoring of Wi-Fi services
- Advised Accelera on engaging and maintaining relationships with strategic customers that are Tier-1 communications service providers
- Managed and maintained relationship with Tier-1 communication service provider on Accelera’s behalf
- Identified and formulated customer and marketing requirements for Accelera

AIRVANA, INC.

- Consulted on large scale RFI/RFP responses to Tier-1 wireless service provider with regards to small cell and femtocell solutions
- Authored multiple technical whitepapers as part of RFI/RFP responses

TATARA SYSTEMS, INC.

- Consulted on architecture, standards, and product positioning for Tatara’s Convergence Server
- Formulated standards and engineering development roadmaps for Tatara to re-architect and reposition its Convergence Server, which was originally designed to function as a Wi-Fi service gateway into the mobile operators’ core networks, into a platform that functions as a small cell (femtocell) service convergence server while leveraging the existing hardware & code base



Lead System Architect – R&D of wireless network femtocell and small cell solutions

- **Network and System Architecture**
 - Lead network system architect for Airvana’s CDMA/EV-DO small cell solution
 - Key contributor to Airvana’s UMTS small cell network system architecture
 - Key contributor to Airvana’s enterprise and public safety small cell network system architecture
- **Customer Interface**
 - Routinely gave in-depth technical presentations on small cell solutions and routinely engaged in strategic and in-depth technical discussions with Tier 1 service providers’ engineering, operations, and senior leadership teams, including CxOs, domestic and international alike
 - Led technical responses to large scale RFIs/RFPs
 - Handled customers’ in-depth technical questions
 - Evaluate customers’ feature and customization requests and reformulate such requests into product requirements as appropriate
- **Standards**
 - Routinely engaged in 3GPP2 standards meetings and drafted 3GPP2 standards proposals
 - Contributed standards proposals in the areas of small cell network architecture, air interface system selection, and related small cell standards
 - Worked strategically with customers and technology partners in matters of standards development
- **Engineering Development and Leadership**
 - Bootstrapped early development, built up the pioneering engineering team
 - Led engineering development planning efforts for the product line, including coordination with functional leads from the hardware, software, system integration, and quality assurance teams
 - Significantly influenced selections of third-party hardware (HW) and software (SW) component suppliers, offshore development partners, OEM partners, and solutions partners
- **System Engineering**
 - Developed small cell product roadmap and defined product requirements
 - Significant contribution to the *usability and user friendliness* (user interface and user experience aspects, UI/UX) of small cell solutions for the consumer market, especially with regards to empowering the end-users to self-install, self-configure, self-provision, and self-manage their small cells
 - Increased small cell system capacity and optimized performance, especially for real-time interactive streaming audio (such as Voice-over-IP, VoIP)
 - System design with public safety considerations including E-911 and Wireless Emergency Alert



System Architect – WiMax solution

- System architect for Airvana’s WiMAX solution, led WiMax product R&D activities
- Engaged the WiMax Forum representing Airvana’s interests
- Contributed to WiMax standards R&D and drafting activities
- PHY-MAC & protocol stack vendor evaluation and selection
- Led software development planning
- Oversaw software R&D (on- and off-shore)

Software Developer – cdma2000 EV-DO RAN embedded software

- Extensive embedded software R&D experiences taking feature requests from idea to functional specification, design specification, implementation, integration, QA testing, and ultimately to production release (general availability). A few of such projects are outlined below
- EV-DO Rev. A “Test Application Protocol” (“TAP”) – led a team of 3 engineers to very quickly design, code, test, and deliver through SQA an implementation of the Rev. A “TAP” feature in response to last minute customer demand
- RAN signaling stack transport enhancement – Designed and delivered RDS (“RAN Datagram Services”), a fast and lightweight Airvana-proprietary signaling transport protocol to complement the TCP-based Abis signaling interface for the Macro RAN products. RDS uses standard GRE-based IP-based routing inter-nodes but allows easy application level arbitrary tag-based routing intra-nodes (inter-CPU’s)
- Outer Loop Power Control Scaling – Achieved five-fold increase in CPU usage efficiency in the Radio Network Controller (RNC)’s Reverse Link power control outer loop by hotspot analysis and code optimization
- Call Control protocol negotiation – Wrote functional specification for Call Control’s Session Configuration Protocol. Delivered the RTC-MAC portion of this large protocol negotiation suite
- Large scale system integration and testing – Spearheaded the “focused test” effort that stress-tested the RNC platform. Participated in the “100 DOM Test” in a customer’s lab where 100 DOMs (essentially radio nodes, RNs) were connected to one RNC for stress testing
- DOM-Metrocell communications stack – designed and delivered the communications stack that allowed Airvana’s DOM (“DO Module,” essentially an RN) to communicate with OEM customer Nortel’s Metrocell base station. Performed integration work in Nortel facilities with Nortel engineers
- System and Platform work – designed and delivered device drivers, crash dump facilities, built-in test framework and test suites, the network-boot portion of the bootloader, and other nitty-gritty things that were necessary to get new platforms off the ground
- General productivity enhancements – led the effort to put in place Airvana’s early telecommuting support infrastructure, restructured makefiles to make it more scalable and easier to add new components, developed scripts to automate various compile/link/test tasks, etc.



CARRIER IQ, INC.
SOLUTIONS ARCHITECT

June 2008 – October 2008

- Provided domain expertise and shouldered project leadership responsibilities in the area of large-scale cellular network analytics

LUCENT TECHNOLOGIES
SOFTWARE ENGINEER, CORE SWITCHING DIVISION

August 1999 – November 2000

- Technical lead for the switch fabric “core shelf” of Lucent’s then next-generation high-speed multi-service packet switch platform (project code-named “OZ”)
- Designed and developed switching fabric control software for OZ
- Contributed to the architectural and network management aspects of OZ’s highly distributed multi-shelf, multi-computing switching platform
- Invented “Switch Core Virtual Segmentation”, a technique that enabled true 1:1 switch fabric blade level redundancy using only one set of third-party supplied multi-blade crossbar switch fabric

EDUCATION & CERTIFICATION

- **Registered Patent Agent**, United States Patent and Trademark Office (USPTO)
- **Master of Science in Computer Science (MSCS)**, 1999, Washington University in St. Louis
 - Thesis Title: Design, Analysis, and Simulation Study of Optical Interconnection Networks.
- **Bachelor of Science in Electrical Engineering (BSEE) & Bachelor of Science in Computer Engineering (BSCoE)**, 1997, Washington University in St. Louis
- **Bachelor of Arts (BA)**, 1997, College of Wooster
 - Major in Computer Science, minors in Music and Mathematics

PROFESSIONAL MEMBERSHIPS

- **Future Networks Technical Community, International Network Generations Roadmap, Artificial Intelligence & Machine Learning (AI/ML) Working Group, Co-Chair (2023-present)**
- **Institute of Electrical and Electronics Engineers (IEEE) Standards Association (SA) 2301 Cloud Profiles Working Group, Vice-Chair (2023-present)**
- **Global Humanitarian Technology Conference (GHTC) 2024, Treasurer**
- **Global Humanitarian Technology Conference (GHTC) 2023, Treasurer**
- **Institute of Electrical and Electronics Engineers (IEEE), Senior Member**
- **Eta Kappa Nu (HKN, honor society of the IEEE), Member**
- **Philadelphia IEEE Consultant Network, Vice Chair (2012–2016)**



PATENTS

- U.S. Patent #7,299,278: "Managing Network Faults"
 - U.S. Patent #8,060,058: "Secure Mobile Base Station Connections"
 - U.S. Patent #8,078,165: "Configuring Preferred User Zone Lists for Private Access Points for Wireless Networking"
 - U.S. Patent #8,176,327: "Authentication Protocol"
 - U.S. Patent #8,400,989: "Activating Private Access Points for Wireless Networking"
 - U.S. Patent #8,402,143: "Secure Proxies for Flat Networks"
 - U.S. Patent #8,594,663: "Selecting Embedded Cells in Wireless Network"
 - U.S. Patent #8,615,593: "Providing Zone Indications for Wireless Networking"
 - U.S. Patent #8,688,809: "Provisioning Private Access Points for Wireless Networking"
 - U.S. Patent #8,731,574: "Assigning Code Space to Portable Base Stations"
 - U.S. Patent #8,781,483: "Controlling Access to Private Access Points for Wireless Networking"
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PUBLIC PRESENTATIONS / TALKS

1. **"Identity, Privacy, and Tracking on Communication Networks"**
presented to the IEEE on April 16, 2024.
 2. **"5G, 6G, and Beyond, with Artificial Intelligence (AI) & Machine Learning (ML) for 6G and Beyond"**
presented to the IEEE on November 21, 2023.
 3. **"Artificial Intelligence & Machine Learning" IEEE Roadmap Update**
presented to the Future Networks World Forum, November 14, 2023.
 4. **"AI/ML Considerations for System Optimization"**
speaker, System Optimization Symposium, Future Networks World Forum, November 13, 2023.
 5. **"Connectivity Plenary"**
moderator, Global Humanitarian Technology Conference, October 13, 2023.
 6. **"Finger on the Pulse: Updating the Roadmap to 5G & Beyond (5G&B)"**
speaker and panelist, IEEE Future Networks Webinar, September 20, 2023.
 7. **"HTTP 1, 2, 3 ..."** ("Hypertext Transfer Protocol 1, 2, 3 ...")
presented to the IEEE on November 15, 2022.
 8. **"Next-Next-Generation Wi-Fi, from Contention to Scheduled Access"**
presented to the IEEE on July 19, 2022.
 9. **"Systems Optimization for Future Networks"**
speaker and panelist, IEEE Future Networks Webinar, May 18, 2022.
 10. **"Introduction to Computer Networking for Middle-Schoolers"**
presented to the Rosa International Middle School's 7th Grade classes on March 28, 2022.
 11. **"Randomized MAC Addresses, System Impacts and Implications"**
presented to the IEEE on October 19, 2021.
 12. **"The Future of Communications"**
presented to the Philadelphia IEEE Consultants Network on September 1, 2015.
 13. **"Re-Architecting the Wireless Telecom System"**
presented to the Philadelphia IEEE Consultants Network on March 6, 2012.
 14. **"Software Defined Networking (SDN)"**
presented to the Philadelphia IEEE Consultants Network on May 7, 2013.
 15. **"Quality of Service (QoS)"**
presented to the Philadelphia IEEE Consultants Network on May 6, 2014.
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PUBLICATIONS

1. **"Artificial Intelligence and Machine Learning"** (2023)
editor, with various authors, *IEEE International Network Generations Roadmap, 2023 Edition; IEEE Future Networks World Forum (FNWF), Baltimore, MD, USA, 2023*
2. **"Security and Privacy"** (2023)
with various authors, *IEEE International Network Generations Roadmap, 2023 Edition; IEEE Future Networks World Forum (FNWF), Baltimore, MD, USA, 2023*
3. **"Standardization Building Blocks"** (2023)
with various authors, *IEEE International Network Generations Roadmap, 2023 Edition; IEEE Future Networks World Forum (FNWF), Baltimore, MD, USA, 2023*
4. **"System Optimization"** (2023)
with various authors, *IEEE International Network Generations Roadmap, 2023 Edition; IEEE Future Networks World Forum (FNWF), Baltimore, MD, USA, 2023*
5. **"Artificial Intelligence and Machine Learning"** (2022)
with various authors, *IEEE International Network Generations Roadmap, 2022 IEEE Future Networks World Forum (FNWF), Montreal, QC, Canada, 2022*
6. **"Standardization Building Block"** (2022)
with various authors, *IEEE International Network Generations Roadmap, 2022 IEEE Future Networks World Forum (FNWF), Montreal, QC, Canada, 2022*
7. **"System Optimization"** (2022)
with various authors, *IEEE International Network Generations Roadmap, 2022 IEEE Future Networks World Forum (FNWF), Montreal, QC, Canada, 2022*
8. **"Randomized MAC Address Conflict Analysis and Implications"**
May 2021
9. **"Gemini: An Optical Interconnection Network for Parallel Processing"**
with R. D. Chamberlain and M. A. Franklin, *IEEE Transactions on Parallel and Distributed Systems*, 13(10):1038—1055, October 2002.
10. **"Evaluating the Performance of Optical Interconnection Networks"**
with R. D. Chamberlain, M. A. Franklin, C. Hackmann, P. Krishnamurthy, A. Mahajan, and M. Wrighton, in the *Proceedings of the 35th Annual Simulation Symposium*, April 2002, pp. 209 – 218.
11. **"Fair Scheduling in an Optical Interconnection Network"**
with R. D. Chamberlain and M. A. Franklin, in the *Proceedings of the Seventh International Symposium on Modeling, Analysis, and Simulation of Computer and Telecommunications Systems (MASCOTS)*, October 1999, pp. 56 – 65.



12. **"The Gemini Interconnect: Data Path Measurements and Performance Analysis"**
with R. D. Chamberlain, M. A. Franklin and M. G. Wrighton, in the *Proceedings of the Sixth International Conference on Parallel Interconnect (formerly MPPOI)*, October 1999, pp. 52 – 61.
 13. **"Design of an Interconnection Network Using VLSI Photonics and Free-Space Optical Technologies"**
with R. D. Chamberlain and M. A. Franklin, in the *Proceedings of the Sixth International Conference on Parallel Interconnect (formerly MPPOI)*, October 1999, pp. 21 – 30.
 14. **"Transition Shifts Due to Applied Head Fields"**
with E. Glavinias, R. S. Indeck, and M. W. Muller in *IEEE Transactions on Magnetics*, vol. 33, no. 5, September 1997, pp. 2863 – 2685.
 15. **"Design, Analysis, and Simulation Study of Optical Interconnection Networks"**
Master of Science Thesis, Computer Science Department, Washington University in Saint Louis, May 1999. Thesis Committee Members: M. A. Franklin (Advisor), R. D. Chamberlain, G. Varghese, J. S. Turner.
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