UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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ROKU, INC.,
Petitioner,

v.

UNIVERSAL ELECTRONICS INC.,
Patent Owner.

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Case IPR2019-01612
U.S. Patent No. 7,589,642

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**EXHIBIT 2100**

(Exhibit 1 to the Declaration of Michael Sprenger, Ph.D.)

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# Michael Sprenger, Ph.D.

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## Summary


Michael Sprenger is a communications, video, imaging, and engineering expert with 30 years of professional industry and research experience. He has successfully led engineering efforts in fiber-optic communication, video encoding, imaging, computing, and advanced technology evaluation. He has been granted 10 patents and has 9 pending patents.


## Employment Experience

**Sprenger Consulting, LLC**
November 2017 – Present

- Expert witness in patent litigation case (consumer electronics area, 2018 - ongoing), involving claim charts construction, circuit schematic analysis, hardware design and circuit board breakdown and examination, analysis of System-on-Chip (SoC) functions, as well as source code analysis, investigating correlation between patents and software & hardware functions in high volume consumer devices. Direct and cross-examination at Markman hearing.
- Expert witness for patent infringement case regarding H.264/AVC and H.265/HEVC video encoding technologies (2019, ongoing). Work involves several Standards Essential Patents (SEPs), in-depth ITU-T H.264/AVC and H.265/HEVC standards specification review, correlating patent claims with evidence, assisting legal team with charting, reviewing infringement contentions, identifying source code segments implementing functions described in specific patent claims. Compiled portions of source code to pinpoint and verify functionality relevant to specific patent claims.
- Expert witness for patent infringement case in broadband communication technology (2019, ongoing).
- Expert witness for patent infringement case regarding in-home networking, remote control and video streaming technologies (2019, ongoing).
- Sony Interactive Entertainment LLC et al v. Techno View IP, Inc. (2018-2019) - Inter Partes Review. Expert witness representing Techno View. Area: 3D vision and Virtual Reality goggles, involving C++ source code analysis. Outcome: settlement.
- Consultant for company in the area of free-space infrared optical communication links, co-authored patent covering detection technology for optical beam interruption.
- Consultant for startup company designing ecosystem and proof-of-principle prototype of large-scale industrial IoT application using RFID, NFC, beacon positioning, spatial location, sensor fusion, data acquisition, computer vision, imaging enhancements and integrated A/V technology.
    - Data pre-fetching and data acquisition based on spatial position of vehicle and machine assets.
    - Author of key whitepapers and presentations used to raise funding.

**Century Link**
February 2016 – November 2017
Principal Video Architect

*Patents and Intellectual Property:*
Led intellectual property effort for CenturyLink video organization: authored/co-authored patents (7 granted, 9 pending) and mentored key team members, building solid patent portfolio to enable future licensing revenue opportunities. Areas: Visualization, GUI navigation, novel content navigation methods, video streaming, dynamic High Dynamic Range & Wide Color Gamut signaling, media processing, time-/place-shifting applications for set top boxes and in-home integration, Fiber-To-The-Home operational status, network health, broadband, enhanced GUIs, advanced audio control mechanisms, video encoding artifact detection, agile Digital Rights Management (DRM).

*Video Architecture and Technology:*

- Led evaluation and vendor selection of RFP for High Efficiency Video Codec (HEVC) / H.265 cloud-based video encoders-transcoders for new CenturyLink Over-The-Top (OTT) video streaming architecture. Optimized video coding rates. Coached team members in visually identifying video coding artifacts. Directed requirements for 4K/HDR-capable Set Top Box and System-on-Chip (SOC). Incorporated multiple DRM technologies into architecture: Microsoft PlayReady, Adobe PrimeTime, Google Widevine, Apple FairPlay.
- SME in established and emerging video & audio encoding technologies & standards: MPEG-2, MPEG-4 AVC/H.264, HEVC/H.265, VC-1, Google VP8/VP9, Alliance for Open Media (AOM) AV1, Dolby Digital / AC-3 / AC-4, DD+, AAC, HE-AAC.
- Modeling and visualization of bandwidth and storage requirements for multi-resolution, adaptive-bitrate Video-on-Demand (VoD) and Cloud-based Digital Video Recording (DVR) infrastructure.
- Significant input into new architecture design for pre-processing, ingesting and indexing large data sets and generating meta-data.
- Transformed CenturyLink Video Evaluation Lab, modernized large switch fabric to accommodate emerging video standards.
- SME in Video and Audio standards, formats, encoding schemes, professional & consumer interfaces, display technologies, 4K and 8K Video, color spaces, chroma sampling, Hybrid Log Gamma (HLG), High Dynamic Range (HDR) & Wide Color Gamut (WCG), High Frame Rate (HFR) technologies as well as current and emerging trends in consumer electronics.

**CableLabs**
2014 – 2016
Principal Architect (Optical Technologies, 2014-2016)
Consultant (2016)

- Coherent Modulation to multiply spectral efficiency in fiber link to HFC Fiber Nodes: pioneered novel low-complexity method for fiber-optic high-order signal modulation, addressing future fiber strand shortage in operator networks. Initiated innovation project to demonstrate the viability of low-complexity approach to coherent modulation over short distances, demonstrating long remaining life of deployed fiber to accommodate anticipated growth, significantly reducing future capital expenses for new fiber builds.

- Established Foundation for Novel Methods for Detecting Interference Effects in fiber-optic RF-over-Glass Networks (RFoG): Discovered unique noise characteristic suitable for detection of detrimental Optical Beat Interference (OBI) in RFoG networks; developed fundamental principles for multiple approaches to detect OBI via dedicated hardware and signal processing algorithms.
- Established new fiber-optic lab from ground up. Extensive experience in fiber-optic lab work and test instruments, including optical spectrum analyzers (OSA), optical time domain reflectometers (OTDRs), fusion splice machines, GHz-range signal generators. Set up & verified novel fiber-optic configurations, conducted physical layer tests and analyzed results. Selected fiber-optic test instruments from a range of available vendors. Extensive experience with Fiber Optic Test Procedures (FOTP), including measuring connector & splice loss and back-reflectance using an Optical Time Domain Reflectometer (OTDR). Coached team members in using fiber-optic test Instruments.
- Adapted fiber-optic lab for testing of EPON/GPON equipment and new fiber-optic technologies, as well as development of novel deployment scenarios. Hands-on experience with fiber cabling, fiber handling & management, high-density patch panels and optical distribution frames, fiber trays & rack-mounted fiber management hardware, connector types (SC, LC, ST, FC, MU, MTP/MPO etc), visual inspection of fiber/connector end-points, connector cleaning & polishing procedures, passive optical splitters and eye safety procedures. Evaluated Ultra-Physical Contact (UPC) vs. Angled Physical Contact (APC) connectors for PON applications. Connectorized single-mode fiber-optic cables for dedicated custom-length lab applications. Experience with pluggable optics & modules.
- Produced and led panel discussion at CableLabs Summer Conference: "Fiber-Optic Communication Beyond 100 Gbps"; hosted recognized industry experts in the field (representing cable TV, equipment and fiber cable manufacturers), addressing exponential bandwidth growth, super-channel approach to higher spectral efficiency and novel ultra-low loss & large effective area fiber types.
- Pioneered novel secure imaging system using unique ID, time & location information with Trusted Platform Module (TPM).
- Co-authored secure imaging patent (granted).

**CenturyLink / Qwest / US-West**
1998 – 2014
Staff Engineer, Distinguished Member of Technical Staff

- Video encoder and head-end equipment evaluation & vendor selection (MPEG-2, H.264/AVC): CenturyLink (Qwest) IPTV system (multiple rounds, 2004-2012), responsible for strategy, deployment criteria and recommendation to leadership. Took projects from beginning to end, directed other team members throughout encoder evaluation process and led entire process involving hardware setup (source – encoders/transcoders – decoders – displays), test content acquisition/selection and video quality evaluation, numerous video encoder RFIs/RFPs, multiple rounds of CenturyLink (Qwest) IPTV Set-Top-Box RFPs, requirements and vendor selection.
- Technical Advisory Board: Editor, contributor & team lead, bi-annual technology assessment, report and readout to CenturyLink (Qwest) CTO, interfacing with large customers (incl. US Government agencies), covering emerging technologies (fiber-optic networking, security, traffic analysis & optimization, network redundancy, video) and assessing their impact onto CenturyLink network, services & business. Successfully led a diverse team of expert contributors on a broad range of technologies, gathering and compiling key information into reports for distribution to executive leadership and presentation to high-level government officials.

- Fiber Strategy: Responsible for assessment and selection of new fiber types for Long Haul, Metro and Access applications, including physical layer propagation characteristics, in view of future-proofing CenturyLink's fiber backbone for 400G & superchannel transmission and beyond. Responsible for establishing 400km fiber-optic testbed with new Super-Large Area fiber, enabling the evaluation of higher optical power, improved SNR & extended reach optical transmission systems. Sized fiber-optic cables for planned deployments, including projections of future bandwidth growth and expected transmission technology advances. Selected fiber-optic cable types and packaging of fiber (buffer tubes, gels, individual strands vs. stacked ribbons). Selected jumper cables & vendors for telecom router and data center applications. Worked with relevant industry standards (including the TIA/EIA-568 and related specifications).
- Access Network Evolution: responsible for emerging Fiber-To-The-x/FTTH access architectures, network evolution and migration path, responsible for assessing viability of emerging broadband technologies and developing migration strategies.
- National Network Data Planning: responsible for strategic planning of CenturyLink architecture and network scalability to handle doubling of data traffic every 18-24 months. Initiated and took technical lead in Proof-of-Concept for Software Defined Networking (SDN) and Network Functions Virtualization (NFV) system.
- Home Network Technology: initiated and took project & technical lead in HPNA 3.0 vs. MoCA evaluation, took projects from beginning to end, directed other team members, coordinated vendor equipment and home trial locations, directed and conducted field test with video team, responsible for vendor selection and strategy recommendation to leadership. Main author of initial ITU-T/ATIS Joint Effort Multi-Wire-type Home Network Technology Proposal for a new, unified HN technology operating over coax, twisted pair, electrical lines with QoS provisions for high-quality video services; coordinating proposal with other North American carriers, resulted in new ITU-T G.hn Home Networking standard.
- Technical lead for strategic projects and numerous RFPs in the IPTV, Video Head-End and Broadband space:
    - Spearheaded DSL Speed & Stability Optimization (ASSIA) deployment: took multi-year project from first vendor contact to lab evaluation, field trial, software fine-tuning and final hand-off to Operations. Increased first-year revenue in upgraded areas by $5M (15% higher than projected). ASSIA technology is now used throughout CenturyLink DSL network.
    - Conducted RFIs/RFPs for Next-Generation Access Networks using Fiber-To-The-x and GPON technologies.
    - Established BPON to GPON evolution scenarios and determined optimal migration strategies; initiated FTTH/PON Optical Power Budget calculation, selection of fiber types for outside plant (OSP), drop & indoor fibers (bend-insensitive), setup of tools and knowledge transfer into planning documents, workflow and IT systems.
    - Established VDSL2, ADSL2+ and Pair Bonding technology migration strategies and established deployment criteria.

- Key technical fact witness for CenturyLink in litigation related to fiber-optic access & backhaul technologies. Infringement claims centered on Standards Essential Patents (SEPs).

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