

# SHUAI SUN (孙率)

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## RESEARCH FOCUS

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|-----------------------|--|
| Materials             | 2D Material (Graphene, ITO), Metamaterial (ENZ, EVL).  |
| Devices               | Atto-Joule Opto-Electronics Modulators, Detectors and Switches, Waveguides.  |
| Optical Communication | Photonic, Plasmonic and Hybrid Photonic-Plasmonic Interconnects, Reconfigurable Optical Networks.  |
| Optical Computing     | Reconfigurable & Reversible Optical and Photonic Compute Engines, Neuromorphic Computing, Optical Residue Computing, Holistic Multi-Hierarchy Figure-of-Merit. |
| Optical Networks      | Reconfigurable Network-on-Chip (NoC), Traffic Pattern Recognition.   |

## EDUCATION

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|------------|-------|--|
| 2015 - 18* | Ph.D. | <b>The George Washington University</b> , Washington DC, USA<br>Electrical Engineering, Photonics Electronics and MEMS (3.86/4.00)<br>Advisor: Dr. Volker J. Sorger  |
| 2012 - 14  | MS    | <b>The George Washington University</b> , Washington DC, USA<br>Electrical Engineering, Power and Energy (3.85/4.00)<br>Advisor: Dr. Robert Harrington   |
| 2008 - 12  | BS    | <b>North China Electric Power University</b> , Beijing, China<br>Control Science and Engineering, Automation (3.00/4.00)<br>Thesis advisor: Dr. Peng Guo. Title: "Wind Generator Gearbox Temperature Prediction based on Artificial Neural Network". |

## HORNORS & AWARDS

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| 2017. 4 | GWU - TCO  | Innovation Competition, 2 <sup>nd</sup> prize in Physical Science (\$5,000)                      |
| 2017. 4 | GWU        | Research Days, 1 <sup>st</sup> prize in Computational and Environmental Science Category (\$250) |
| 2017. 2 | SEAS - GWU | R&D Showcase, Innovation and Entrepreneurship Awards (\$2,000)                                   |
| 2017. 1 | ECE - GWU  | Graduate Research Assistantship and Fellowship (\$12,801)  |
| 2016. 9 | ECE - GWU  | Graduate Research Assistantship and Tuition Awards (\$13,238)                                    |
| 2016. 6 | ECE - GWU  | Graduate Research Assistantship and Tuition Awards (\$6,667)                                     |
| 2016. 4 | GWU        | Research Days, 2 <sup>nd</sup> prize in Engineering Category (\$250)                             |

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|---------|------------|--|
| 2016. 2 | SEAS - GWU | 2 <sup>nd</sup> prize of the Theoretical Research Awards (\$1,500)<br>2 <sup>nd</sup> place of the Entrepreneurship Awards (\$500) |
| 2015. 9 | ECE – GWU  | Phillip & Temofel Sprawcew Endowment Scholarship (\$38,265)  |
| 2015. 4 | ECE - GWU  | GW Fellowships (\$4,500)   |

## PROFESSIONAL SOFTWARES & SKILLS

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|--------------------|---|
| Optical Components | Lumerical FDTD/Device/Mode/Interconnect, COMSOL, SILVACO    |
| Circuit Design     | Matlab, PSpice, Multisim, Simulink, Electronics             |
| Hardware Design    | FPGA, Cadence, Synopsys Design Vision, DSP Builder, Quartus |
| Image Processing   | Mathematica, Origin, AutoCAD, Photoshop, Lightroom          |
| Programming        | Verilog HDL, C, C++   |

## PROFESSIONAL SOCIETY MEMBERSHIPS & POSITION

| Society  | Member Since | Membership Type            |
|--|--------------|----------------------------|
| Optical Society of America (OSA)                         | 2015         | Student Member             |
| Society of Photographic Instrumentation Engineers (SPIE) | 2015         | Student Member             |
| Institute of Electrical and Electronics Engineers (IEEE) | 2017         | Student Member             |
| Chinses Association of Automation (CAA)                  | 2011         | Automation System Engineer |

| Society   | Year           | Position               |
|---|----------------|------------------------|
| OSA George Washington University Student Chapter                              | 2015 - Present | Co-founder & Treasurer |
| SPIE George Washington University Student Chapter                             | 2015 - Present | Co-founder & Treasurer |
| George Washington University Chinese Students and Scholars Association (CSSA) | 2013-2014      | Vice President         |

## RESEARCH PROJECTS

- Hybrid Photonic Plasmonic Non-blocking Wide Spectrum WDM On-chip Router 06/2016 – Present
- Photonic data routing in optical networks overcomes the limitations of electronic routers with respect to data rate, latency and energy consumption, while suffering from dynamic power consumption, non-simultaneous usage of all possible wavelengths and large footprints.
  - Hybrid photonic plasmonic non-blocking broadband router is able to provide ultrafast response time (2 ps) and high-energy efficiency (82 fJ/bit) by hybridizing plasmonics with a photonic device, comparing with other MRR and MZI based photonic routers with microseconds-to-nanoseconds and picojoule levels, respectively.
  - Hybridizing plasmonics provides over a broadband 3-dB signal discrimination bandwidth exceeding 200 nm allowing for 140 Tbps theoretical noisy Shannon channel capacity. The high performance and scalability of the hybrid router are promising towards future large-scale multi-core optical networks requiring all-optical routing.

- Universal Figure-of-Merit CLEAR (Capability-to-Latency-Energy-Amount-Resistance) 01/2016 – 12/2016
- The CLEAR FOM includes all the related models to pre- and post-dict the evolution of computer systems. Comparing with other well-known FOM such as Moore's law, Koomey's law and Makimoto's FOM, CLEAR is proven to provide the most accurate tracks for both electronics and optical technologies while spanning multiple hierarchy levels in computer systems.
  - CLEAR bears the ability for smart computer systems via application-driven dynamic reconfigurability. Founded on fundamental physics principles, it can be regarded as the next Moore's law for the coming decades in data processing and computing in order to reveal the actual technology evolution.
- Reconfigurable Optical Computer (ROC) 10/2015 – Present
- The task of this project is to build a novel, programmable array of photonic R (and LC) components using nanoplasmonics technology in order to solve systems that can be described through differential equations and converted into electrical analogues, which can be regarded as a prototype of the Reconfigurable Optical Coprocessor (ROC).
  - Key insights include: a) to draw an analogue between optical and electrical characteristics of nanoscale pieces of matter, b) utilizing nanophotonics to demonstrate dramatic and efficient tuning of the permittivity of Indium Tin Oxide (ITO) via altering the free carrier concentration electrically, and c) deploying an array of photonics resistors, capacitors, and inductors, with programmable values and connectivity patterns, in order to solve partial differential equations directly in the analog domain.
- Dynamically Adaptive Hybrid Nano-plasmonic Networks on Chips (NoCs) 01/2015 – Present
- Main participants in and supported by this project (funded by **Air Force Office of Scientific Research**, award number FA9550-15-1-0447) and duty on exploring active plasmonic-enhanced circuits that perform beyond the limits of diffraction-limited photonics and mirroring architectures to develop a new class of high-performance network-on-chip (NoC) solutions for HPCs with orders of magnitude higher performance when bandwidth, latency, speed and cost are combined. It focus on exploiting synergies between plasmonic, photonic, and electronic components for the hybrid realization of NoC and the objectives are to minimized power consumption, footprint and cost, while maximizing data throughput and bit flow density.
- Electric Vehicle and Its Battery Technologies 12/2013
- Analyzed several EV developing factors, including the car market, policies, charging systems, and battery technologies. And battery technologies seem to be the main obstacle that blocks the road of EVs.
  - An analysis report about current EV battery barriers involving life span, charge time, safety and manufacturing cost. Lithium-air battery and ultra-capacitor will change the future of EVs.
- DE2-70 Board Guitar Effector Design (Music Man 2.0) 11/2013
- Designed color-detection-controlled music instrument using Altera DE2 developing board and a video camera. The camera was used to detect the number and position of green pixels in order to generate different sounds as set, and this function is called "Air Drum". In addition, Music Man 2.0 is able to control the output volume continuously, to select the output channels (Left/Right or Both), and to add echo, overload, distortion, and delay effect to the audio input.
- Wind Generator Gearbox Temperature Prediction based on ANN (Bachelor Thesis) 07/2012
- Using BP Artificial Neural Network with momentum algorithm to build the model of wind generator gearbox temperature and predict the change of temperature to avoid operation faults.

## PUBLICATIONS

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1. S. Sun, V. K. Narayana, I. Sarpkaya, J. Crandall, R. A. Soref, T. El-Ghazawi, V. J. Sorger, "Hybrid Photonic-Plasmonic Non-blocking Broadband 5x5 Router for Optical Networks". *Optics Express* (Under review).
2. V. K. Narayana, S. Sun, A. Mehrabian, V. J. Sorger, T. El-Ghazawi, "HyPPI NoC: Bringing Hybrid Plasmonics to an Opto-Electronic Network-on-Chip". *ICPP*, 2016. (Under review)
3. S. Sun, V. K. Narayana, T. El-Ghazawi, V. J. Sorger, "Moore's Law in CLEAR Light". *IEEE Spectrum*, 2016. (Under review)
4. S. Sun, V. Narayana, A. Mehrabian, T. El-Ghazawi, V. J. Sorger, "A Universal Multi-Hierarchy Figure-of-Merit for On-chip Computing and Communications", *Journal of Lightwave Technology* (Under review).
5. S. Sun, V. Narayana, T. El-Ghazawi, V. J. Sorger, "Chasing Moore's law with CLEAR", *CLEO 2017*. (Accepted)
6. V. Narayana, S. Sun, A. H. Badawy, V. Sorger and T. El-Ghazawi, "MorphoNoC: Exploring the Design Space of a Configurable Hybrid NoC using Nanophotonics". *Elsevier's Journal of Systems Architecture*, 2017.
7. K. Liu, S. Sun, A. Majumdar, V. J. Sorger, "Fundamental Scaling Laws in Nanophotonics". *Nature Scientific Reports*, 2016.
8. S. Sun, et al. "Low latency, area, and energy efficient Hybrid Photonic Plasmonic on-chip Interconnects (HyPPI)." *SPIE OPTO. International Society for Optics and Photonics*, 2016.
9. S. SUN, A. A. Badawy, V. Narayana, T. El-Ghazawi, and V. J. Sorger, "Bit Flow Density (BFD): An Effective Performance FOM for Optical On-chip Interconnects," in *Conference on Lasers and Electro-Optics, OSA Technical Digest*, paper JW2A.135.
10. S. Sun, and V. J. Sorger. "Photonic-Plasmonic Hybrid Interconnects: a Low-latency Energy and Footprint Efficient Link." *Integrated Photonics Research, Silicon and Nanophotonics. OSA*, 2015.
11. S. Sun, et al. "The Case for Hybrid Photonic Plasmonic Interconnects (HyPPI): A low Latency, Energy and Area Efficient On-chip Interconnects", *IEEE Photonics Journal*, Sep 2015.

## PATENT FILED

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1. "Hybrid Photonic Plasmonic Non-blocking Wide Spectrum WDM On-chip Router." S. Sun, V. J. Sorger, T. El-Ghazawi, V. Narayana, A.-H. Badawy (Submitted).
2. Provisional U.S. Patent: "Hybrid Photonic Plasmonic Interconnects (HyPPI) with intrinsic and extrinsic modulation options." S. Sun, V. J. Sorger, T. El-Ghazawi, V. Narayana, A.-H. Badawy (2015).
3. Provisional U.S. Patent: "The Reconfigurable Optical Coprocessor (ROC)." T. El-Ghazawi, V. Narayana, S. Sun, V. J. Sorger, A.-H. Badawy (2015).

## Invited Talks & Presentations

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|---|-------------------|---------|
| CLEO 2017                                     | San Jose, CA      | 05/2017 |
| ECE Talks (The Spring GW/ECE Research Blitz ) | Washington D.C.   | 04/2017 |
| TCO Innovation Competition                    | Washington D.C.   | 04/2017 |
| 2017 GW Research Days                         | Washington D.C.   | 04/2017 |
| 2017 GW SEAS R&D Showcase                     | Washington D.C.   | 03/2017 |
| 2016 GW Research Days                         | Washington D.C.   | 04/2016 |
| 2016 GW SEAS R&D Showcase                     | Washington D.C.   | 03/2016 |
| Photonic West: 2016                           | San Francisco, CA | 02/2016 |

## EMPLOYMENT & INTERNSHIPS HISTORY

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George Washington University, **Graduate Research Assistant**, Washington D.C. 08/2015 – Present

- Research area includes: photonic-plasmonic hybrid interconnects, optical networks on-chip, analog optical computing, nano optical logic devices, novel materials, metamaterials, and optical processor.

The Sorger Group, **Web Master**, Washington, DC 04/2015 – Present

- Maintain website updated and professional, generate and revise pages and serve as the administrator.

Fastgrow Logistics Inc., **Electrical Engineer** (Telecommuting), City of Industry, CA 06/2014 – 12/2014

- Responsibilities include: Warehouse silo and belt electric equipment witness test planning and reporting, port equipment and leasing hopper car supervisions.

George Washington University, **Grader**, Washington D.C. 08/2013 – 12/2013

- Expanded students' knowledge of Telecommunication Security in electrical engineering field by providing related papers, assignments, and discussions regarding signal transmission and processing, encryption and decryption. Checked the assignments and lab reports.

State Grid Corporation of China, **R&D Intern**, Xuchang, China 06/2011 – 08/2011

- Participated in ECMS System Function Update of CCZ-8000C Digital Power Plant project and duty on modeling and testing of ECMS system modules, finished the first draft blueprint of Information Interaction System for every power equipment in the plant.
- Completed the debug task for two relay devices under minimum supervision.

XJ International Engineering Corp., **Technical Assistant Intern**, Xuchang, China 01/2011 – 02/2011

- Technical trainee in EPC Department of Kenya Athi River 81MW HFO Power Plant Project, duty involving electric equipment factory witness testing and port equipment supervisions.
- Organized business and technical conferences, translated project materials and technological manual.