



TUNDRA SYSTEMS GLOBAL LTD.

Next Frontier of Computing

TundraSystems Global Ltd.

Extended Executive Summary

29/08/2018,

The Next Frontier Computer Technology Company

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Executive Summary

Introduction

Classical Semiconductors technology has really blossomed since the early days of the invention of the Integrated Circuits by Jack Kilby of Texas Instruments. We are now at a stage where we are fast approaching the saturation of Classical Semiconductors, hit by the inherent limitations of Electronics. Though Classical semiconductors will not die out or get phased out so soon, the need for higher scales such as Exascale Computing and beyond requires us to evolve into the Photonics realm of implementing Computational Systems. New developments have targeted the hybrid approach of electrical/optical systems but we foresee the immediate limitations of this approach too in saturation as hybrid systems while providing a higher level of performance are hit with the need to convert from photons to electrons and back. “Optical computing, while entrenched in our daily computing and communication infrastructures, must create all-optical computing solutions to truly capture the opportunity of optical – speed of transmission. Hybrid electric/optical systems will always be limited by the conversion of photons to electronics, and back. Like a bullet hitting a lead wall, then being converted to a bullet again, in order for a computing operation to be completed.”[2]. Thus, the Next Frontier of Computing has to be advanced to an all optical technology with many more years ahead in the room for developments.

Our startup TundraSystems Global LTD was founded in October 2014 to develop from ground up amalgamating the many developments from different academic sources such as University of Bristol, MIT, the UK Quantum Technology Hubs etc. to develop computational solutions in an all optical regime using Quantum Mechanics fundamental base or the Quantum Computational Paradigm. Since our founding, we have been employing a novel Volunteer model of remote distributed team working to arrive at where we are today whilst utilizing the personal financial resources of the principal founders.

Mission Statement – *Develop and apply Photonics based solutions to High Performance Computing (HPC) and be the Comprehensive Photonics Solutions Company.*

Market Opportunity and Solution

We quote Markets and Markets research that characterises our target markets as follows:

1. The worldwide High-Performance Computing(HPC) market is expected to grow at 8.3% CAGR, reaching \$44 billion in 2020.
2. The Global HPC market will generate \$220 billion in revenues from 2015-2020.
3. The Quantum Computing Market is expected to grow at a 10.4% CAGR reaching \$26 billion in 2020.
4. The Cybersecurity Market is worth \$170.21 billion by 2020.
5. The Photonics market is projected to grow from USD 530.52 Billion in 2017 to USD 795.54 Billion by 2022, at a CAGR of 8.4% during the forecast period. The

growth of this market is driven by the increased demand from applications such as displays, information & communication technology, photovoltaic, medical technology & life sciences, measurement & automated vision, lighting, and production technology.

6. While sales of quantum computing hardware are presently dominating the market with more than 90%, their global revenue share is expected to drop to 84% by the end of 2025. The significant decline in quantum computing hardware will be balanced by surging adoption of quantum computing software, revenues from which are anticipated to reflect fastest CAGR of 42.3%.

With our comprehensive Quantum Computing Stack to hit the market by 2020 and beyond, the Market opportunity is astounding and could well reach proportions in the access of \$25 billion in the first few years of market penetration. We expect to garner a significant portion of a minimum of 10% of this market segments, thus providing a great ROI for the investors with a typical exit strategy in the form of an IPO in 5 years.

Our two biggest competitors in this space are D-Wave Systems from Canada and Rigetti Computers from the USA both of whom have or are developing Superconductors based adiabatic Quantum annealing solutions that many argue are not true Quantum Computing, but sort of a Pseudo model, in additions these superconducting solutions need to operate at near-zero or milliKelvin (mK). There are others in the Quantum Computing space as well, IBM, Google, Microsoft who are developing more realistic Quantum Computing solutions in terms of the quantum mechanical aspects of the processing elements envisaged. We at TundraSystems are more aligned with these efforts. Though we must point out that a complete realistic Quantum Computer is still on the horizon and not readily available yet.

Grant Applications

Since our technology development is at the cross-roads of Deep-Tech Research and Development and Commercialization, we don't want to burden the Venture Capital Community with our requests for funding when their modus operandi simply seeks to support the tail end of Commercialization projects at a stage when they are ready to hit the market. This has been our experience in talking with several VC sources. Instead we want to de-risk the development stages by applying for several Grant opportunities available in the UK and Europe, from sources such as InnovateUK and Horizon2020 that are more supportive of our development stage and path.

However, these grants only fund 70% of the project costs, the remainder of the 30% must come from private sources, so we are back to imposing on the Venture Capital sources for this 30%.

Our development path is charted by the following three outstanding grant applications.

1. InnovateUK – Open Competition-I: “Development of High Precision Devices for Universal Quantum Computing” partnering with University of Exeter and University of Southampton (Fabrication Sub-Contractor).

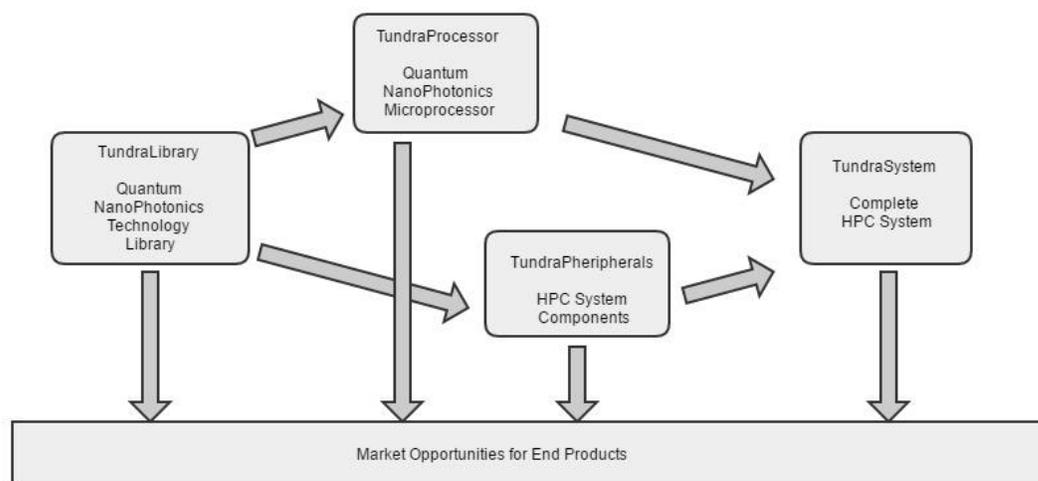
2. InnovateUK – Open Competition-II: “Applying Deep Learning for Quantum Error Correction” partnering with Imperial College and University of Southampton (Fabrication Sub-Contractor for implementing a Deep Learning Co-processor)
3. InnovateUK – Open Competition-II: “Development of a Quantum Instruction Set Architecture and Cross-Compiler” (Complete Software Solution)

Collaborative Partners

1. University of Exeter.
2. Imperial College, London.
3. University of Southampton (Silicon Photonics Fabrication sub-contractors)
4. Mellanox Technologies, Israel.

Business Model and Technology

The fabless semiconductor model has been a successful one, and at the onset, till we hit critical mass in profitability we will deploy our product line as a fabless model by outsourcing all our manufacturing. We will adopt a multi-staged path to development and commercialization to realize revenue at a much earlier stage rather than wait for the full development of the complete HPC Systems. The plan is to monetise the different stages and the staged paths to commercialization.



Paths to Commercialisation

We introduce the terminology – **Opticonductors** – for our technology developments immediately meaning the equivalent of Semiconductors.

Status of Development

We were founded back on October 29, 2014, and have been working on this goal ever since, and considerable water has flown under the bridge thus far. Some of the TundraSystems Global LTD.

technologies that we have closely investigated and deviated from to arrive at our current technological focus include:

1. Indium Phosphide based Photonics Technologies – dropped off this path because the integration technologies are not as finely controllable as possible with its Silicon counterparts.
2. Photonic Crystal technologies – hard to integrate into a complete Photonic Integrated Circuit.
3. Diamond Photonics – more expensive, and not as long-lived as thought before for use in Quantum memories.

While we are still in the process of developing and refining our technology we have ambitious goals being composed of the following:

1. All optical medium – using a base Silicon Photonics Technology.
2. Low-power consumption.
3. Room temperature operation.
4. Develop a wide range of Computing processors using an all optical approach for Classical Computing, Quantum and Artificial Intelligence.
5. Rather than follow the Quantum annealing architectures we are a pure “Quantum Computing” solution on the lines of IBM/Google/Microsoft.
6. Deep Learning co-processor technology implemented in Silicon nanophotonics to be then further developed as a Deep Learning stand-alone solution.
7. Introduce a new line of all-optical Photonics based classical Microprocessors.

Top Target Industries

Top Target Industries[Not limited to] for deployment of the Tundra HPC Solutions:

- Stock Exchanges
- Financial Analysis
- Financial Technology implementation platforms for solutions such as blockchain.
- Defence Sector
- 3D Motion Picture Animations
- Drug Discovery Applications
- Big Data Applications
- CyberSecurity
- Enterprise Cloud Applications

Time Line for Development



Time-Line for Complete EndProducts Development

Seed Capital Requirements

Ours is a diversified Quantum Technology Enterprise, spanning the full Quantum Computing stack and developing a combined software-hardware solution. Our Projected Requirements of Capital, is a max of £2.4 Millions/-, details are as below. This will last us the First TWO years.

Computer Infrastructure	£300,000.00
Office Space + Furbishing	£150,000.00
Photonic CAD Software licenses	£150,000.00
Three Innovate UK Grants matching funding 30% -- 24 Months	£1,500,000.00
Miscellaneous + Additional Support Staff Wages	£300,000.00
<i>Total for the first two years of operations</i>	£2,400,000.00

Total Funding Required which we need to start with a seed round of £2,400,000/-.

Exit Strategy and Equity on Offer

We are not keen on exit strategies as we are embarked on a mission to develop the Next Frontier Computing Enterprise. We want to focus on building our company into a grand diversified conglomerate. Eventual exits would be through an IPO. Equity on offer for the seed round is 15%.

Corporate Incorporation

The Company is Incorporated in England & Wales and Registered with the Companies House, Registration Number 9285819, on 29th October 2014.

Principal Founder



Brian A.A. Antao, Ph.D. (Vanderbilt University, 1993) – CEO & CTO – The New Venture Company -- TundraSystems Global Ltd.

You will see that Dr. Antao has a really good and diverse experience – Dating back to his Undergraduate Days at V.J.T.I. (University of Mumbai) where for his Bachelor’s Thesis he designed and fabricated a Universal EEPROM Programmer, working with the Intel 8085 and programming in 8085 Assembly and PL/M80 also by interning at the National Institute of Oceanography, Goa. For his Postgraduate Studies at Vanderbilt, he worked in depth with Analog-Digital Integrated Design and Design Automation Tools to support the design endeavor also interning during this time at Bell Laboratories. He continued working on various niche Integrated Circuit Problems at the University of Illinois—Urbana Champaign, Motorola Semiconductor Products Sector (Now known as Freescale Semiconductors) etc. On relocating to the UK, he has been actively working with the Java ecosystem and worked on significant Java Projects ranging from Cloud Computing, Social Media and Enterprise Internet based Communications using the SIP (Session Initiation Protocol). With this broad as well as deep experience in Computing Technologies, He has a good Vision for Developing the Next Frontier computing Technologies in the Optical and Quantum Domains.

The Board of Directors

Non-Executive Chair of the Board of Directors – Ms. Antonella Rubicco, Co-Founder, CEO of A3Cube Inc, San Jose, CA, USA

Executive Chair of the Board of Directors – Dr. Brian A. A. Antao

Non-Executive Director – TBD

Technical Advisory Board

Chair of Technical Advisory Board, Technical Adviser and Non-Executive Director – TBD

Technical Adviser and Non-Executive Director – Professor Pochi Yeh, University of California, Santa Barbara, CA, USA

Technical Adviser and Non-Executive Director – Professor Xinliang Zhang, School of

Optical and Electronic Information, Wuhan National Laboratory for Optoelectronics,
Huazhong University of Science and Technology, China
Technical Adviser and Non-Executive Director -- Professor Anna Baldycheva, University of
Exeter, UK.

Management Board/Team

Executive Director and Chief Executive Officer and Chief Technology Officer – Dr. Brian
Antao, Cardiff, UK

Executive Director and Director of Silicon-Photonics – TBD

Executive Director and Director of Hardware – Dr. Mukund Buddhikot

Chief Processor Architect – Dr. Steven Hutsell
Memory Systems Architect – TBD
Director of Artificial Intelligence – Dr. Patricia Charlton
Artificial Intelligence Scientists – Dr. Myriam Ribiere
Agile Coach – Ms. Margaret Morgan, Cardiff, UK
Quantum Devices Specialists: Dr. Chris Morrison.
Photonics device specialists: Dr. Liang Ye

Deal Making Negotiations

All Deal Making through the Lead Founder:
Dr. Brian Antao,
235B Cowbridge Road East, Canton,
Cardiff, CF11 9AL, UK
Mobile: +447961364051/+442920398902
Email: brianantao@tundrasystems.eu OR brian@brianantao.co.uk
LinkedIn Profile: <http://uk.linkedin.com/in/brianantao>

Company Web/Social Media Presence

Web – <http://www.tundrasystems.eu> Link from old site – <http://www.briancinderella.com>
FaceBook – <https://www.facebook.com/tundrasystems>
Twitter -- @TundraSystem
LinkedIn Company Page -- <https://www.linkedin.com/company/tundrasystems-global>

Coverage in Oxford University NQIT Commercial Quantum Computing Report:

Table 2.2 Companies with commercial interest in Quantum Computing by Country

Country	Company	Revenue (2015)	Profit/Loss (2015)
Australia	Commonwealth Bank of Australia	AUD 23,578m	AUD 9,063m
	Telstra	AUD 26,607m	AUD 4,305m
Canada	1QBit	–	–
	Anyon Systems Inc	–	–
	D-Wave	–	–
	Quantum Valley Investments	–	–
China	Alibaba Group	USD 12,293m	USD 3,923m
France	ATOS	EUR 10,686m	EUR 406m
UK	Cambridge Quantum Computing Ltd	–	GBP (717,945)
USA	Google (now Alphabet)	USD 74,989m	USD 15,826m
	IBM	USD 81,741m	USD 13,190m
	Intel	USD 55,355m	USD 11,420m
	Lockheed Martin	USD 46,123m	USD 3,605m
	Microsoft	USD 93,580m	USD 12,193m
	Quantum Circuits, Inc.	–	–
	Qubitekk	–	–
	Raytheon BBN	USD 23,247m	USD 3,013m
	Rigetti Computing	–	–
Wales	TundraSystems Global Ltd.	–	–