THE NEXT FRONTIER IN COMPUTING

QUANTUM OPTICAL COMPUTING

TUNDRASYSTEMS GLOBAL LTD.

Presentation For
Venture Capital Investment

Dr. Brian Antao, CEO and Founder
tundrasystems.eu

LIMITATIONS OF TODAY'S SEMICONDUCTORS

- Current hybrid electric/optical systems are limited by the necessary conversion of photons to electronics, and back.
    - *This is similar to a bullet hitting a lead wall, which then must convert back again into a bullet to complete a computing operation*.
- New software and models are needed to enhance scalability and performance for large numbers of applications, such as Big Data, financial analysis and more.
- The next challenge is developing high performance systems, low latency, easy scalability with low power consumption.
- Because of fundamental limits in electronics, the classical semiconductors technology only provides a limited solution.

"There are serious exascale-class problems that just cannot be solved in any reasonable amount of time with the computers that we have today." Buddy Bland, project director at the Oak Ridge Leadership Computing Facility in Oak Ridge, Tenn.

OUR TECHNOLOGY SOLUTION

- Eliminate the limits of Electronics approach.
- Removes propagation delay of electrons resulting in faster CPU clock speed.
- Maximises power efficiency and long distance signal transmission enabling exascale level data-centers.
- A new computational paradigm opens up a vast range of applications and advantages.
- Optimizes the parallelism using a minimal number of transistors.
- A large number of processor cores can be fit onto a single chip greatly enhancing the multitasking capabilities of the systems.

OUR VISION AND WHY WE ARE DIFFERENT

To truly capture and enable the opportunities of optical speed of transmission, we will design the *first* commercial all-optical processor.

Subsequent to which we will create a packaged product line of "all-optical" high-performance computing workstations and servers using the developed ***Quantum Photonic Technology***.

In contrast to previous optical computing approaches, we are using the state-of-the-art Quantum Models implemented using Photon Polarised Optical Technology in III-V Semiconductor over Silicon Photonics.

OPTICONDUCTORS: *THE FUTURE OF SEMICONDUCTORS*

Mission:

Break the speed and power efficiency barrier of existing high performance computing (HPC) workstations and servers that are currently capped by the fundamental limitations of electronics and realize the potential of an all quantum optical/photonics medium.

OPTICONDUCTORS: *THE FUTURE OF SEMICONDUCTORS*

Goal:

Develop a new Manufacturing ***Quantum Photonic Technology*** which will be used to implement a complete Quantum Photonic HPC Computing Solution.

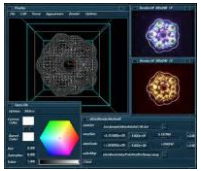
The Business Case

- *To Exploit in a very timely manner and be the first in class for the Next Frontier of Computing – Quantum Photonics/Optics*.
- A very Long term strategic plan to develop as the ultimate end product line of “All-Optical” High-Performance Computing Workstations/Servers that are tailored to the following Market Segments:

Financial Stock Markets Algorithmic Trading Analysis

Big-Data Analytics

Medical/Pharma Drug Discovery Analysis & Modelling



High-end Graphics 3D Motion picture production Data visualisation.

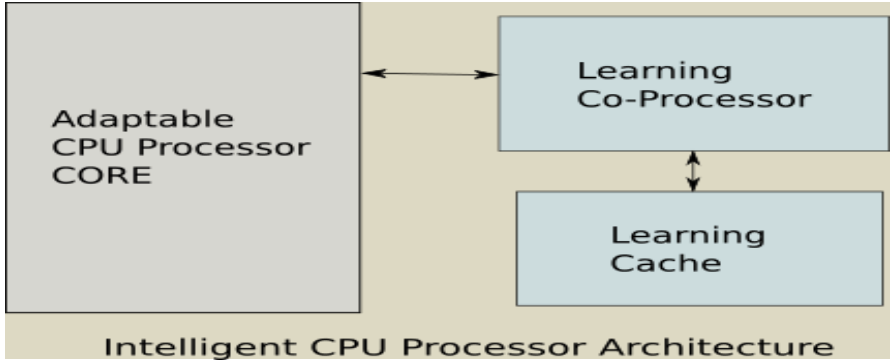
HPC applications in the Defence Sector

CyberSecurity applications Cryptography CryptAnalysis

THE BUSINESS MODEL

- *Service High-End Market Segments that have the greatest pain in terms of Computational Requirements*.
- Use a Direct Go-To-Market Strategy to engage Customers in these Segments.
- Maximise revenue by Maximising Pricing strategies to the critical customers.
- *Create a Product requirement that these Market Segments cannot do without*.
- That's what Alexion Pharmaceuticals does. In the U.S., 8,000 people have a disease that causes their immune systems to wipe out their red blood cells every night. Some of these people arrange for insurance companies or the U.S. government to pay $569,000 a year so they can take Alexion's Soliris to stay alive.

A NOVEL ARCHITECTURE FOR THE MICROPROCESSOR



We have initiated patent applications related to our technology and ecosystems:

- High-level optical microprocessor
- Adaptable processor core
- Learning co-processor
- Learning cache
- Performance optimization

PARTS OF THE ALL-OPTICAL SOLUTION

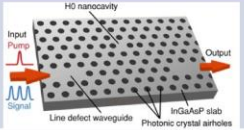
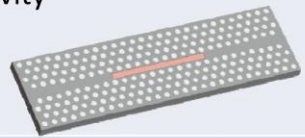
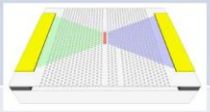
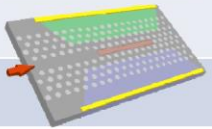
- A complete photonics/all-optical intelligent CPU processor: *TundraProcessor.*[TM]
- Supporting infrastructure includes an all-optical ecosystem of components to develop an all-optical processing high-end, high-performance workstation.
- Series of high-end, high-performance workstations: *TundraSystem.*[TM]
  E.g. low latency workstations for finance applications: the TundraSystem™ Financial Workstation; high floating-point workstations for scientific applications: The TundraSystem™ Scientific Workstation.
- Corresponding server-class systems.
- Finely-tuned and highly parallel Linux/UNIX-based workstation operating system that will deliver easy portability of existing applications from an end-user perspective.

The Quantum Photonic Technology

- Implement in III-V Semiconductor over Silicon Photonics Base
- Photonic Cavity Crystal based all-optical Transistors, switches and Qubits.
- Quantum Memory Cells.
- Quantum Gates.
- Quantum Interconnect.
- Hybrid Optical Technology combining Quantum optics, Fourier Optics and Classical Optics.
- Using a Fabless Model, Technology implemented at Manufacturing Partners such as LioniX, Oclaro using the design services of VLCPhotonics.

The Quantum Photonic Technology

PhC integration technology is rapidly progressing.

Device		Key technology
Switch	Low switching energy: 420 – 660 [aJ] Fast switching speed: 20~35 [ps]	H0 cavity 
Memory O-RAM	Low threshold power: < 30 nW 4-bit spatial addressing 32-bit wavelength addressing	BH cavity 
Laser	Low threshold: 4.8uA Low energy cost: 5.5f J/bit	PIN junction 
Detector	High Responsivity : 0.7-1.0 A/W, Small capacitance: possibly of < fF	
Link	Low energy cost (LD) = 28.5 fJ/bit	

Core Parts of the Complete Packaged Solution

- The TundraProcessor – Central Microprocessor.
- Memory Subsystem.
- IO Subsystem.
- Networking Subsystem
- Power Subsystem
- Thermal Subsystem
- Subsystem Boards
- Packaging the Solution
- System Integration.

MARKET POTENTIAL

The worldwide high-performance computing (HPC) market is expected to grow at an 8.3% CAGR, reaching $44 billion in 2020.

The global HPC market will generate $220 billion in revenues from 2015-2020.

The Quantum Computing Market is expected to grow at a 10.4% CAGR, reaching $26 billion in 2020
Cyber Security Market worth $170.21 Billion by 2020

We expect to capture a significant portion of these markets.

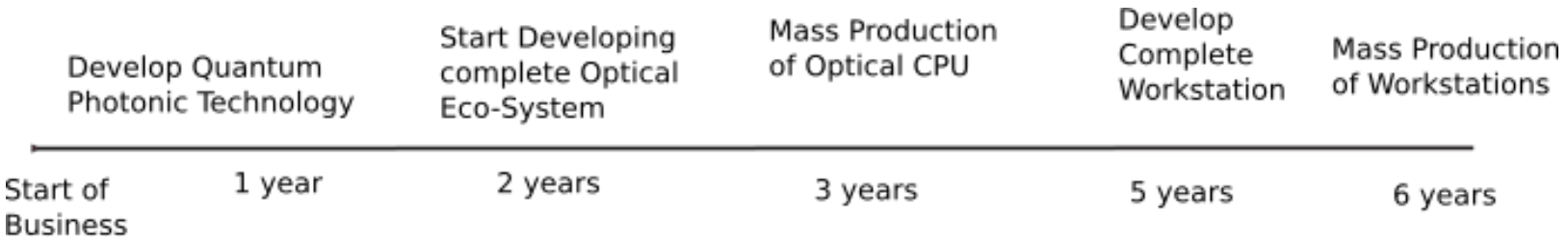
COMPETITORS

- There are many Photonic Integrated Circuit Developers that include Infinera, NeoPhotonics, Luxtera etc, quite a few of these in the realm of Silicon Photonics.
- The number of specialised Optical Computing endeavours are scant. To name one -- Optalysys is a University of Cambridge based effort at Optical Computing, that is developing a very specialised non-linear equation solution strategy using Fourier transforms.
- D-Wave have been a major force in developing Quantum SuperComputers but uses superconducting Josephson junctions based Qubits.
- Convey Computers -- Convey's Accelerated Image Resizer uses a high performance coprocessor utilizing Field Programmable Gate Array (FPGA) technology to implement a customized hardware pipeline for image resizing.
- University Research efforts aplenty – We are partnering with the significant ones.
- University of Bristol is working on Photonic Integration of a Quantum Computation Model.

Competitor Analysis: TundraSystems Technology vs D-Wave Technology

TundraSystems Technology	D-Wave Technology
Develop a Photonic Microprocessor	Built a SuperComputer
All-Optical Technology	Superconducting Technology
Photonic Crystal Cavity Qubits	Superconductor Qubits
More Energy Efficient as All-Optical	High-Power Consuming SuperComputer
Proliferation as Workstations & Servers	$20 Mil. SuperComputer
Strive for Room-Temp. Operation	Requires Super-Cooling

DEVELOPMENT ROAD MAP



Time-Line for Development RoadMap

Development Plan

Stage I – First year

Develop Core Quantum Photonics Technology Library

Stage II – Second and Third year

Develop demonstrable Core TundraProcessor (Microprocessor)

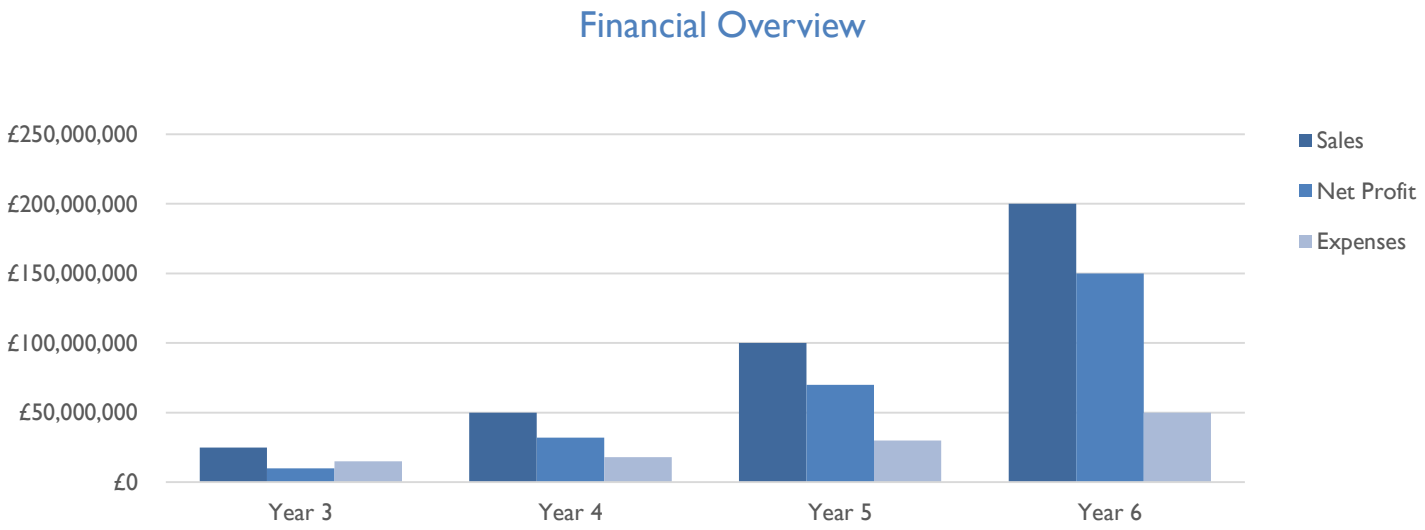
Stage III – Forth year

Start Subsystem Development + Complete Production grade TundraProcessor

Stage IV – Fifth and Sixth year

Complete System Integration of packaged HPC Solutions

FINANCIAL PROJECTIONS



FUNDING AND USE OF MONEY

First Seed Round -- £4 Millions to begin operations and setup HQ in Cardiff.

First Early Stage Round -- £6 Millions to develop Core Quantum Photonics Technology

Series Round A -- £25 Millions to develop complete working TundraProcessor (Microprocessor)

Series Round B -- £50 Millions to develop complete subsystems of the packaged solution

Series Round C -- £75 Millions for final product rollout of complete quantum optical HPC computing solutions.

SEED ROUND USE OF MONEY

First Seed Round -- £4 Millions to begin operations and setup HQ in Cardiff.

Maximum Wage Bill for Technology Teams = £70K x 20 = £1,400,000
Computers and Optical Design and testing Setup + Office Space = £500,000
Executive and Non-Technical Staff Wage Bill = £1,000,000
Licensing and Intellectual Property Development = £1,300,000
Sundries and Contingency Budget = £300,000

KEY INVESTMENT HIGHLIGHTS

Why Should you invest in TundraSystems Global LTD:

- Help in advancing the next frontier of computing for humanity's benefit.
- A strong Business Case for a Quantum Optical Computing Solution.
- Wide application market segments including CyberSecurity.
- Strong technology team derived from the top global research universities.
- Prospects for a very good Return on Investment.

The Team

Dr. Brian Antao -- CEO

Ms. Antonella Rubicco – Chair Non-Exec Board

Our Technical Advisory Board is composed of Experts as follows:

- Professor Xinliang Zhang's group have been developing reconfigurable (FPGA-Like) Optical Integrated circuits at School of Optical and Electronic Information, Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology, China.
- Professor Pochi Yeh from UCSB, is a specialist in optical devices and works in these areas -- electro-optics, optical phase conjugation, nonlinear optics, dynamic holography, optical computing, and neural networks.

The Team

1. Mr. Fred Homewood – Technical Director of Hardware Software Co-Design
2. Dr. Mukund Buddhikot – Technical Director of Processor Hardware Design
3. TBA – Chief Processor Architect
4. Dr. Myriam Ribiere – Artificial Intelligence Specialist
5. Dr. Patricia Charlton – Artificial Intelligence Specialist
6. Ms. Margaret Morgan – Agile Methodologies Specialist and Coach
7. Mr. Mark Mitchell – Operations Manager
8. Dr. Aliaksandra Ivinskaya – Member of Technical Staff/Design Team
9. Dr. Adriana Marais – Member of Technical Staff/Design Team
10. Dr. Chris Morrison – Member of Technical Staff/Design Team

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Thank you and we look forward to working with you!

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