



OFC 2014

The future of optical networking
and communications is here.

*7th Workshop on Startups and
Entrepreneurship*

Wednesday, March 12, 2014

3:30pm - 5:00pm

Expo Theater III

OFC 2014

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and communications is here.

7th Workshop on Startups and Entrepreneurship

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The photonics industry continues to be a dynamic market in which innovation takes place at a breathtaking pace. And much of this innovation is driven by startup companies. While many people like to start a company and many admire the startups that made it big, the process of starting company can be challenging. The aim of this workshop is to provide practical guidelines and dos and don'ts by featuring a number of seasoned entrepreneurs who tell their story. The focus of the presentations is to share key insights and lessons learned that are useful for any entrepreneur wanting to start a company or develop a new business. The workshop concludes with a panel session with ample room for questions and answers.

Moderator/Organizer

Erik Pennings, GM and Principal, 7 Pennies Consulting

Speakers/Panelists

Bardia Pezeshki, President and Chief Executive Officer, Kaiam Corp.

Tom Collins, Chief Technology Office, Caliopa

Peter De Dobbelaere, VP Engineering, Luxtera Inc.

Ashish Vengsarkar, Chief Executive Officer, Nistica

Handouts sponsored by a financial contribution
from Kaiam, Nistica, 7 Pennies Consulting, and the OIDA



Moderator/Organizer

Erik Pennings, GM and Principal, 7 Pennies Consulting



Erik Pennings started his career in R&D working at Bellcore (now Telcordia) and at Royal Philips Electronics where he pioneered several optoelectronic components and during which time he published around 70 papers.

In 1995, he moved to sales and marketing at Philips Optoelectronics, where he was responsible for the business development for WDM lasers, tunable lasers, and high-speed EML's. Partly as a result of the growth that was achieved, Philips sold this business unit in 1998 to JDSU for well over \$1 billion. Dr. Pennings continued his career being responsible for sales and marketing at ThreeFive Photonics, which grew through a number of mergers into ASIP, then into Apogee Photonics, and finally into CyOptics. During this time, he grew revenues by 50% or more each quarter. In 2007, Dr. Pennings joined Eudyna Devices Inc. where he was responsible for marketing in the U.S.

In 2009, Dr. Pennings started his own consulting company (www.7pennies.com) specializing in sales, marketing, and business development. He is working with high-tech startups as well as large corporations in order to grow their business and/or by providing targeted advice.

Dr. Pennings has a M.S. in Physics (cum laude) from Groningen University, a Ph.D. (distinction) from Delft University of Technology, and an executive MBA from the Simon Business School in Rochester.

7th Workshop on Startups and Entrepreneurship

OFC, March 12th, 2014

Erik Pennings



Introducing 7 Pennies...

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The future of optical networking
and communications is here.

- My background:
 - Post-doc at Bellcore (Telcordia) plus Research at Philips
 - New business development at Philips Optoelectronics
 - Sold for >1B\$ to JDSU
 - Sales & Marketing at ThreeFive Photonics
 - Merged into ASIP, Apogee, CyOptics, and now acquired by Avago
 - Responsible for marketing at Eudyna
 - Acquired by Sumitomo
- Started 7 Pennies Consulting in 2009
 - Focus on sales, marketing, and business development
 - Typically working in long-term part-time engagements
 - Specific areas: FTTH, TIAs, RF & Lasers, Integrated Optics, S/W

OFC'14 Startup Workshop



12-mar-14

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Why a Startup Workshop

OFC 2014
The future of optical networking
and communications is here.

- Startups are exciting and are important
 - Everyone is intrigued / inspired by Google, Apple, Amazon, ...
 - New companies are essential for innovation and the economy
- Startups can be rewarding / require an appetite for risk
 - Risk, by the way, is very relative these days...
- But starting and building a company is not simple
 - This is not being taught at school
 - And entrepreneurship is hard to learn from books
 - Like anything else, this is best learned by just doing it
 - But beyond taking a plunge, you can learn from others
 - Especially serial entrepreneurs “who’ve done it”

OFC'14 Startup Workshop



12-mar-14

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Workshop contents

OFC 2014
The future of optical networking
and communications is here.

- Great line up of speakers in this workshop:
 - Bardia Pezeshki (Kaiaam, Santur)
 - Peter De Dobbelaere (Luxtera)
 - Tom Collins (Caliopa, which just sold to Huawei)
 - Ashish Vengsarkar (Nistica/Fujikura, Photuris)
- Panel session
- Please note:
 - There are printed handouts
 - If you want a softcopy (mailing list), please leave your business card
 - Discussion afterward encouraged, but exhibition closes at 5pm
 - By the way, there is also a photonic integration workshop at 6pm

OFC'14 Startup Workshop



12-mar-14

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Thanks!

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erik@7pennies.com, www.7pennies.com




Speaker/Panelist

Bardia Pezeshki, President and Chief Executive Officer, Kaiam Corp.




Dr. Pezeshki was previously the main founder of Santur Corporation (2000-2008), and acting as the President, Director, VP of Engineering, and Chief Technology Officer of the company at various times he developed the key ideas and managed their transition to manufacturing. These included the tunable laser that dominated the transition of long haul and metro networks from fixed wavelength lasers to tunable, and more recently the parallel transceiver that now leads the world in 100Gb/s Ethernet.

Prior to Santur, Dr Pezeshki managed the Development group at SDL (now part of JDS Uniphase) and a similar group at IBM Research in Yorktown Heights. He obtained his Ph.D. from Stanford University and has approximately 30 patents and 100 peer reviewed publications and presentations.




Starting Photonics Companies

Bardia Pezeshki — March 2014




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Outline

- Personal story
- Santur
- Kaiaam
- Formula for a successful concept
- Execution challenges
- Should I join a startup?




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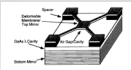
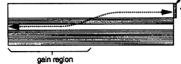

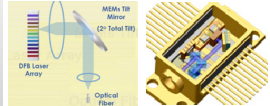
Am I the right guy to give this talk?

	Santur (2000-2008)	Kaiaam (2009-)
Raised VC/Corp/Gvt/NRE	\$80m	\$40m
Total revenue from concept to date	>\$500m	~\$20m, but ramping fast
Max employees	~300 in 2008	~200 presently (including acquisition)
Financial return (beyond modest salary)	Owe \$250k	None yet


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Concept behind Santur

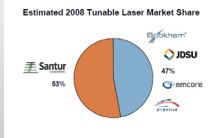
- Stanford 1991  → Coretek \$1.3B exit!
- IBM 1995 
- SDL 1997 
- Santur 2000
 - DFB array
 - MEMS mirror switch

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Santur timeline

- 2000 Raised \$20m Sequoia + Menlo Ventures
- 2000-7 Built chip fab, ramped product to \$25m/qtr
- 2006 Board conflict on company sale vs. IPO
- 2006-8 Founding team replaced
- 2009 Washout round
- 2010 \$47m sale to NeoPhotonics

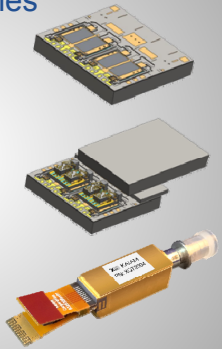


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Kaiaam: use MEMS to build complex optical assemblies

1. Build a "PCB" using a silicon MEMS breadboard
2. Depending on the PIC, bond components on the "PCB"
3. Micro-machine optically connects the components
 - micro-lenses move to maximize coupling, micro-heaters lock with solder
4. Standard packaging and testing follows



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Advantages of Kaiaam approach

- ✓ Leverages generally available single-function components
 - no need for complex monolithically integrated chips
 - low-loss coupling, low-cost assembly process
- ✓ Much higher performance
 - discrete chips can be optimized for high performance
 - no material compromises
- ✓ Very low development time and resources
 - for each PIC, only a new "PCB" is needed
- ✓ Very high yield
 - test/burn-in before assembly
 - don't reject the entire assembly because of one bad part

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Kaiaam timeline

- 2008 Founders hoping to keep control (small \$\$)
- 2009-10 Raised \$5m in NRE – *not enough!*
- 2010-13 Raised \$11m VC for <50% of company
- 2013-14 Datacenter market takes off. Need to get BIG
 - Acquired PLC factory, became vertically integrated
 - Raised \$32m VC/Corporate
- 2014 Very fast revenue ramp in 40Gb/s Xcvrs

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Traditional Startup Formula #1

- ✓ Find a rapidly expanding market
- ✓ Hire a team of experts in that market
- ✓ Come up with the best idea
- ✓ Go raise money



✓ Team



✓ Market



✓ Tech



x Crowded market
x Me-too approach

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Traditional Startup Formula #2

- ✓ Expect a new market will open that others don't see
 - Possibly enabled by new social / technology directions
- ✓ Be the first in that market, with relatively established technology



x Usually wrong about market!
x Raising money is harder
x Timing is critical (entrance / exit)

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A Winning Formula

Take advancement in one area, and apply to another

- Battery technology for laptops → electric cars
- Si VLSI/MEMS → Optoelectronics
- Si VLSI → lab on a chip



- Tunable telecom lasers → interferometric sensors?
- High power blue lasers for storage → materials processing?
- Cheap high power laser bars → food processing?

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Execution Challenges

- Selling shares is losing control!
 - Pick the right board members
 - Negotiate everything
- Scale the business for the market
 - Oversized factory is uncontrolled burn
 - Big markets don't take small teams seriously
- Hiring!
 - Smart people over experts

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“Should I Join a Startup?” — Checklist

- ✓ Management understands the market and technology?
- ✓ How hard is the problem? Unfair advantage?
- ✓ Access to greater capital if needed?

- ✓ Do you like the people and environment?
- ✓ Are you OK with the downside risk?

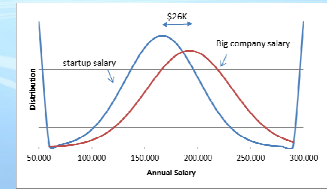
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Summary



- ✓ Opportunity to make a **BIG** difference, and lots of fun!
- ✓ Generally work harder, more stress, and less pay
- ✓ Mostly luck!



Salary comparison for me from IEEE salary survey.
Assumed Gaussian distribution

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Starting Photonics Companies

Barda Pezeski — March 2014



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Speaker/Panelist

Tom Collins, Chief Technology Office, Caliopa



After graduating from Trinity College Cambridge in 1979 in Natural Sciences Tom Collins worked in the semiconductor industry for 17 years and held a number of positions in process development and Operations including Wafer Fabrication Manager at ITT and Alcatel-Mietec. In 1996 he moved into Optoelectronics joining IOC, a Lithium Niobate start-up as Director of Operations. He was part of the management team who succeeded in rapidly growing the business leading to its sale to SDL in 1999. In 2002 he joined T-Networks as VP of Operations. In 2010 he co-founded Caliopa, a silicon photonics start-up which was spun out from imec/Ugent. Having successfully brought the first product to market Caliopa was sold to Huawei in August 2013. Prior to joining Caliopa, he was responsible for Operations and Development at Fibercore, Cisco's speciality optical fiber subsidiary.


2014/3/9 Security Level:

Caliopa: from cradle to sale

Tom Collins

www.huawei.com

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Why I was invited to present today?

Name: Tom Collins:

- Background in Physics, Semiconductor processing
- Four start-ups over 30+ years: 3/4 made investors good returns

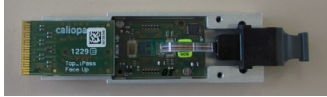
year	Start-up	Where	Market	Role	Success measure
1981	Inmos	UK	Semiconductor memory and microprocessor	Section Head, Processing	Profitable sale Fabs still operate on site after +40 years
1995	IOC	UK	Lithium Niobate modulators	Responsible Operations	Profitable sale to SDL in 1999
2001	T-Networks	USA	InP EML's	Responsible Operations	40 Gbps eml from 2003 still marketed (CyOptics)
2010	Caliopa	Belgium	Silicon photonics based transceivers	CTO	Profitable Sale to Huawei in 2013

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Caliopa: What attracted me?

- Pedigree of IP and Know-How
 - Ugent
 - Imec
- Excellent People
- First product concept addressed real issue
 - Strong customer interest



First Tip!
Big part of doing a start-up is "selling blue sky". Much easier if you really believe in it

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Why did Caliopa get funded ?

- Standard bearer(s)
- A story
- Real customer interest
- Barriers to entry
 - Patents
- Right political climate
 - Political goal: technology led jobs
 - Academic institutes 'measures' include # start-up
 - Structures for funding in place in Belgium
- NOT because of commercial VC's!






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Why did Caliopa Get funded (2)

- **Tip 2**
Make sure you have ticked off all items on the checklist and everything is in place before looking for funding.
Match 'standard bearer(s)' to funding scenario

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Why did we succeed with development?

- Excellent pool of photonics PhD's locally:
 - Ugent & imec
 - CNRS (Paris)
- Very supportive national research grants
 - 30% of total funding in grants
- Strong customer interaction from day1
 - Feedback on specs, form factor, etc
- Limited money = fixed timeline
 - Focuses the mind!
- **Tip 3**
Need quality people to succeed.
Locate company based on people resource

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Timescale of the Sale transaction

Jan 2013:
Decision to
appoint
Woodside

Mar 2013:
18 (first)
pitches during
OFC

End May 2013:
Huawei sign LOI

End July 2013:
Lawyers agree
contracts

Feb 2013:
First working
samples
available

April -May 2013:
Serious talks with 6
then 3 prospects

End June 2013:
Huawei sign off
on due diligence

Aug 3rd 2013:
Signing
ceremony



Why did the transaction succeed?

- **What we offered**
 - People
 - Collaboration with imec/Ugent
 - Track record of bringing product to market

- **Avoid red herrings**



- **And finally.....**



Tip 4:
Any exit is distracting.
Focus on the 'most
likely'

Differences Start-up versus Huawei

- **Massive increase in resources all round**
 - Headcount
 - Processing budget
 - Lab equipment
 - Offices
- **Massive increase in expectation**
 - Caliope: One product in 3 years
 - Huawei: 3 products in 2 years



What's the difference between

- | | |
|---|--|
| <ul style="list-style-type: none"> • University • Professor • Processing in the CR can go wrong • Publish paper when you have nice result and then go on to something else • Support infrastructure • Decent salary • Job Security = contract | <ul style="list-style-type: none"> • Start-up company • CTO • Processing at suppliers can go wrong • Optimize every detail until you can meet the product specifications • Build from scratch • Same decent salary + share stake • Job Security = none |
|---|--|

(courtesy Dirk
Taillaert)



Complementary or Conflicting Mindsets?

- | | |
|---|---|
| <ul style="list-style-type: none"> • Researcher • Required from Day 1 • Always smart • Innovation, freedom, flexibility • Output = concept • "Flies the planes" | <ul style="list-style-type: none"> • Operations Guy • Usually join later (mistake?) • Sometimes smart • Detail conscious, structure, systematic • Output=Continuous improvement • "Builds the planes" |
|---|---|

Research with 'Operations' influence

Examples:

- "Cycles of learning" made faster
 - Short loops
 - Building blocks
- Heavy early investment in fast test & measurement
- Document the baseline even when you do not think you have one
- Use Design of Experiments effectively
- DRC check layouts (automatically) every time you save
 - Not when trying to put the mask together

Tip 5:
"Used sparingly" systems
and structure dramatically
improve R&D efficiency

Compare/Contrast Caliopa to previous

- **It gets harder every time**
 - Higher barriers to entry
 - Ever more professional established players
- **Commercial VC money for early stage start-up in photonics**
 - 'non-existent' today in Europe
 - National (government) schemes an alternative
- **Universities & institutes becoming proficient at monetizing their know-how and IP**
 - Much harder to get a good deal!
- **It is still fun, exciting and a great ride!**

Thank you

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Speaker/Panelist

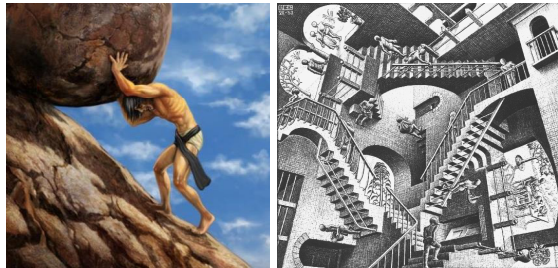
Peter De Dobbelaere, VP Engineering, Luxtera Inc.



Peter De Dobbelaere received the Ph.D. degree in integrated optics from the University of Gent, Belgium in 1995. From 1995 to 1999, he was with Akzo-Nobel N.V., The Netherlands and U.S., where he was engaged in product development and reliability of polymer-based thermo-optic waveguide devices. In 1999, he joined OMM Inc., San Diego, CA, where he was responsible for product and technology development of MEMS-based optical switches. In 2004, he joined Luxtera, Inc., Carlsbad, CA, where he is currently responsible for engineering and technology development for silicon photonics products.



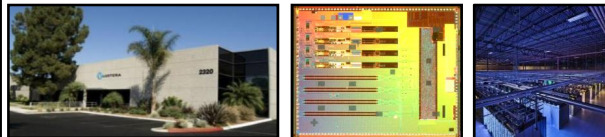
Luxtera: The First Si Photonics Start-UP



Luxtera Proprietary

www.luxtera.com

LUXTERA - INTRODUCTION



- Overview:**
 - World's only complete silicon photonics technology platform proven in volume manufacturing
 - Located in Carlsbad, CA
- Product Portfolio:**
 - SIP Chip-sets (IC + light source)
 - Packaged optical transceivers modules
 - Circuit IP for stand-alone transceivers and SoC integration
- Proven technology leadership:**
 - Engineering team built on 325 Man Years of SIP R&D
 - Extensive IP Portfolio: > 130 patents and filings
- Market:**
 - Networking
 - Server
 - Mobile infrastructure

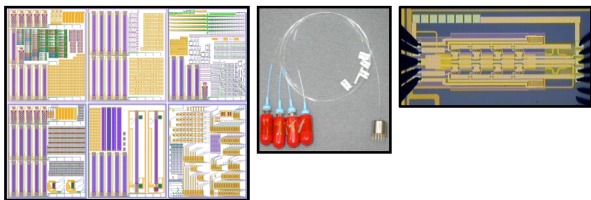
Luxtera Proprietary



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IN THE BEGINNING...

- 2001: Company started by two professors, a few grad students and a VC**
 - Simulant: FDTD Photonic Simulation of Photonic Crystals
- 2002 start working with a CMOS foundry: Motorola, now Freescale Semiconductor**
- 2003: Company moved from Pasadena to Carlsbad**
 - Product ideas: Fiber Optic Gyroscope, long-haul telecom applications



Luxtera Proprietary

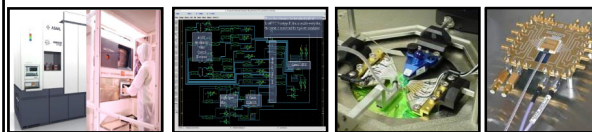


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MULTIPLE START-UPS IN ONE

It became clear that more capabilities were needed to prove out the technology and to make a product. Multiple start-ups in one:

- Silicon Photonics Process, Device Development & Device Test
- High-Speed, Mixed-Signal and Digital Electronic Design
- Silicon Photonics Design Kit & Design Flow
- Light Source for Silicon Photonics
- Silicon Photonics Packaging and Optical Assembly Capability



Luxtera Proprietary

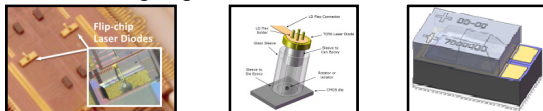


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ENHANCE & MATURE THE TECHNOLOGY

- Silicon Photonics Process:**
 - Increase process capability by moving to 193 nm photolithography
 - Add Germanium Epi Module -> Photo-detectors for "free"
 - Mature each Process Module
 - Qualify the process

Search for the right light source:



- Setting up an optical assembly pilot line & first contacts with CMs**
 - Basic Assembly + Optical Assembly capability
 - Tool Development & Process Development

Luxtera Proprietary

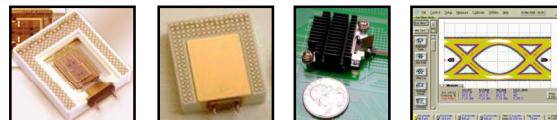


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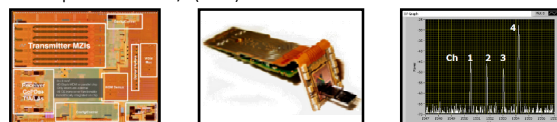
VARIOUS TECHNOLOGY DEMONSTRATORS

Government (DARPA-EPIC) helped in funding some technology explorations and technology demonstrators.

Embedded optics 2x10 Gb/s module (2006)



WDM Chipset for 4x10 Gb/s (2007)



Luxtera Proprietary



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THE FIRST PRODUCT: ACTIVE OPTICAL CABLE (AOC)

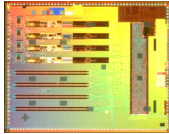
- **Why AOC?**

- Product requirements:
 - No optical standard required (closed optical system)
 - Electrical interface (Infiniband)
 - No optical connectors
 - Form factor: QSFP (MSA)
- Market: High Performance Computing & Networking
 - Infiniband QDR, Infiniband FDR, 10 GE



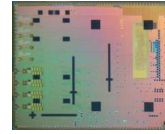
- **Si P AOC could effectively compete with VCSEL based AOCs & active electrical cables**

- **AOC: Perfect vehicle to start commercializing Silicon Photonics:**
 - Lower complexity
 - Can plug into any QSFP port
 - Technology advantage: longer reach (SMF)
 - Lot's of learning: Interoperability, FW, Manufacturing/Data systems, setting up CM in Asia, Supply Chain...
- **AOC business sold to Molex in late 2010**
- **We continue to manufacture & develop AOC Chipsets for Molex**



CURRENT DEVELOPMENTS

- **2011: Demonstration & sampling of 100G chipset**



- **2012: Technology license agreement with ST Microelectronics**

- Qualified for production by end 2014



- **Development of Chipset for Nx28G transceivers using hybrid approach**

- Photonics IC: Freescale & ST
- Electronics IC: TSMC 28 nm node

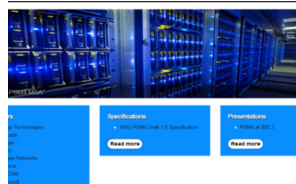


STANDARDIZATION AND ECOSYSTEM

- **Luxtera is co-founder of PSM-4 MSA**

- **Market:**

PSM4 MSA is the industry response to demand from datacenters to deploy 100 Gbps solutions meeting their cost, scalability, power and reach requirements



- **Technology agnostic specification:**

- Goal: Provide an optical spec supported by existing and emerging technologies. Allowing best of breed ecosystem of solutions and diverse supply base.
- PSM 4 will extend to provide interfaces for 200 G, 400 G



SUMMARY

- **Luxtera:**

- Luxtera was the first to commercialize Silicon Photonics: In production since 2009 and shipped > 600,000 chipsets for use in High Performance Computing and Web 2.0 Datacenters
- Luxtera was first in key Si Photonics technology demonstrations:
 - Fully integrated WDM 4x10 Gbps with TX and RX on a single IC (2006)
 - Parallel 4x28 Gbps transceiver integrating both TX and RX on a single IC (2011)
- Our technology roadmap allows scaling to 100, 200, 400, 800 Gbps transceiver solutions and to multi-terabit solutions by ASIC integration

- **Lessons learned:**

- It takes much more than a new technology to build a company
- Be pragmatic in finding solutions
- Transition: Research -> Development -> Manufacturing
- Don't build the company on multiple key new technology developments
- Government funding may be helpful as long as it's well aligned with roadmap

ACKNOWLEDGEMENTS

- Thanks to all current and past Luxtera Employees
- It was, is and will be a ride ☺



Speaker/Panelist

Ashish Vengsarkar, Chief Executive Officer, Nistica



Ashish Vengsarkar is currently Chief Executive Officer of Nistica, a subsidiary of Fujikura Ltd. With over 20 years of telecom experience, Ashish has served in technology and business management roles at startups and Fortune 500 companies. He has been instrumental in founding three high-tech startup companies.

Ashish received his Bachelor's Degree in Electrical Engineering from the Indian Institute of Technology, Bombay, Master's and Ph.D. Degrees in Electrical Engineering from Virginia Tech, and an Executive MBA from the Wharton School, where he was a Palmer Scholar.

Nistica
A Fujikura Company

Ashish Vengsarkar
Workshop on Photonic Startups and Entrepreneurship
OFC 2014

March 12, 2014

Background

1980's

- IIT Bombay: Bachelor's degree in Electrical Engineering
- Virginia Tech: M. S. & Ph.D. EE
 - Founding Member of Luna Innovations

1990's

- Bell Labs: Optical Fiber R&D
- Wharton: Executive MBA
- Lucent Technologies: PLM, WDM Systems

2000 - 2005

- Photuris: Founder, PLM, Marketing, etc.

2006 -

- Nistica: CEO

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Outcomes

IPO

LUNA INNOVATIONS
Optical Sensors
Test & Measurement

Bankruptcy

photuris
Optical Systems
ROADM

MAHI networks

meriton NETWORKS

XTERA

Acquisition

NISTICA
Optical Subsystems
WSS

Nistica

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Lessons

- Which of the three outcomes provided the most teaching moments?
 - Luna IPO
 - Photuris bankruptcy
 - Nistica acquisition
- Top three areas of learning:
 - People
 - Customers
 - Partners

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People

2000 - 2004
\$100M+ raised

photuris

2005 - 2012
\$25M+ raised

NISTICA

- Founders**
 - Who do you look for?
 - How do you co-found?
- Founding team members**
 - What is this group?
- Scaling: Employees**
 - How to structure?
- Investors**
 - VCs v. Strategic
 - Geography
- Experienced entrepreneurs**
 - Hemant Kanakia, Amit Shah, Kal Shastri
- Medium size group**
 - Core group of 10+ folks
- Not fast enough**
 - Multiple experts
- VCs all over US**
 - Greylock, Columbia Capital
- Ex-Colleagues**
 - Tom Strasser, Jeff Wagener
- Small core group**
- Slowly**
 - Multi-function experts
- VCs + Strategics**
 - No West Coast VCs
 - Fujikura




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Customers

- Large v. small**
 - One Tier - 1 Customer = Home Run
 - Small "Digestable" Customers = Singles
- Levels of customer engagement**
 - Build it and they shall come
 - Get a P.O.
- Optical boom**
 - Tier 1 customers: SBC, VZ, Bell South, ...
 - Tier 2 customers: CLECs
- Large CAPEX budgets**
 - Build a GOD-BOX
 - Full-featured transport system
 - Go against big players
- Doldrums**
 - Pick one good-size customer
 - Engage with a few small customers
- Trickle of revenue**
 - Get NRE and development contract
 - Meet one customer's specific requirements

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Partners

- **Technology**
 - Key components
- **Manufacturing**
 - Strategic relationship with CM
- **Sales**
 - Which accounts to go direct?
- **Other**
 - Business relationships?
 - Geographic?
- **Build own subsystems**
 - DIY
- **Business model same as large players**
 - Use same CMs that incumbents use
- **All direct sales!**
- **Post product-development**
- **Partner with TI**
- **Find a creative solution**
- **Direct + Partners**
- **Early stage engagement**

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Summary ... & Epilogue



- **Work with like-minded people** → Different characteristics @ different stages
- **Ask for customer commitments** → Get customer mind-share
- **Partner early and often** → Choose your partners carefully

Epilogue

- Luna → IPO → Today?
- Photuris → Bankruptcy → Product Installed ... → ?
- Nistica → A Fujikura Company →

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Nistica WSS Deployments




25 + Countries **10,000 + Units Shipped**

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My Entrepreneurship Bookmarks



- www.bothsidesofthetable.com
- avc.com
- www.feld.com
- steveblank.com
- a16z.com

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