

A “formerly-young” faculty’s experience with DARPA

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DARPA YFA Workshop

November 16, 2006

Chantilly, VA

DARPA was the Genesis for my career

- UCLA – 1993-present
 - Assistant Prof. 1993-1995
 - Associate Prof. (Tenure) 1995-1998
 - Full Prof. 1998-present
- Cognet Microsystems, 1999-2001
 - Founder, President and CEO
- Intel Corporation – 2001-2005
 - Co-GM Intel CDC, 2001-2002
 - CTO Strategic Staff, 2002-2004
 - Chair wireless architecture working group 2003-2004
- Trustee, California Science Center 2002-present
 - Chair, Program and Exhibits Committee

Academia

Business

Public Service

Experience with DARPA

- Working with DARPA since 1993
- What has worked for me^[1]
 - Start with the problem, not with the solution
 - Work on relevant problems
 - Talk to user of technology (customers)
 - Defense and commercial Industry
 - Visit exhibits in conferences
 - Do your homework

***[1] Disclaimer: past performance does not guarantee future success.
What has worked for one may not work for all.***

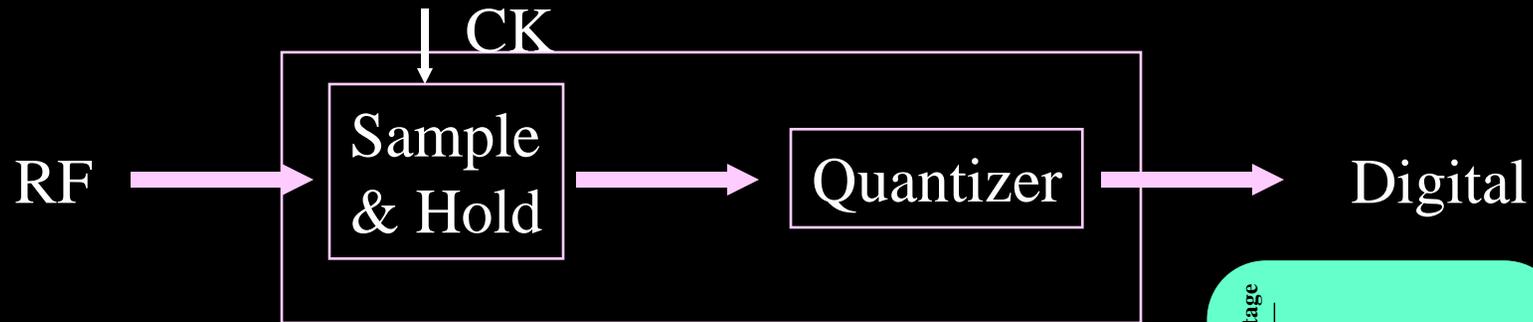
Experience with DARPA

- At the end of the day, what matters is the quality of your idea
 - Innovative not re-cycled
- If DARPA ends up rejecting your idea, they're probably doing you a favor
 - Your time is your most valuable asset

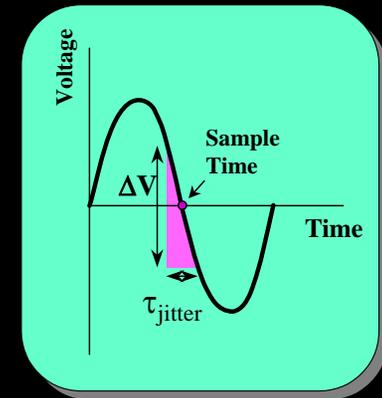
“Start with the problem”

Example:
Analog-to-digital Conversion

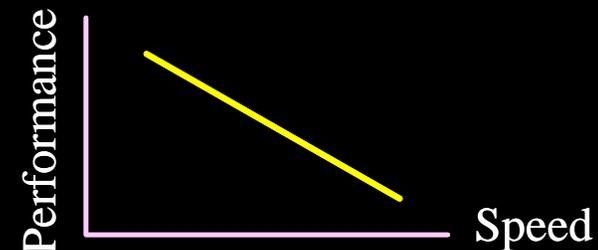
What Limits the Performance of Electronic Digitizers?



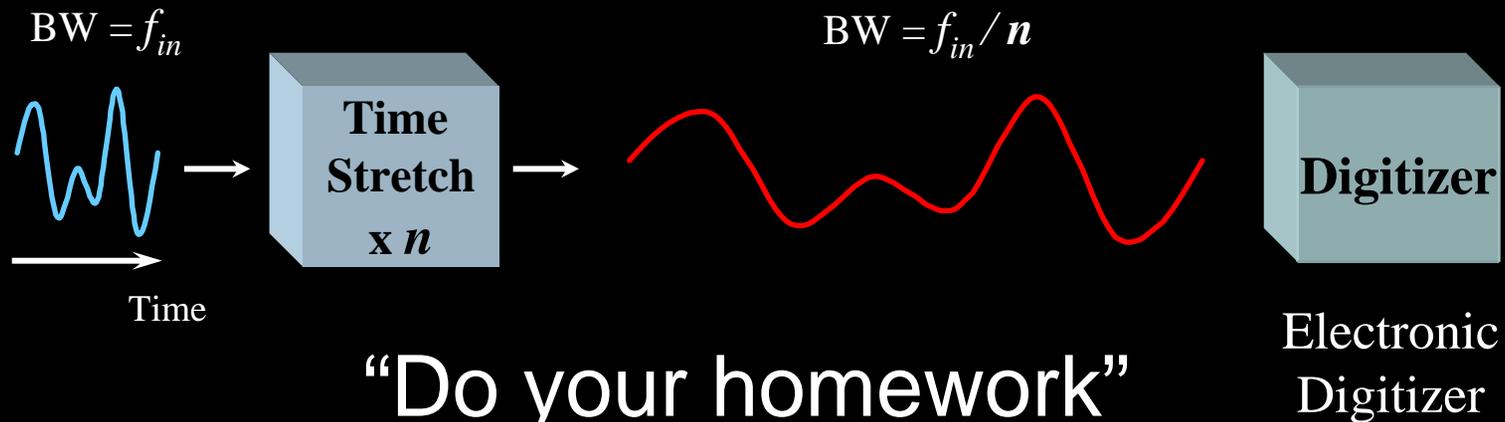
- Switching speed of a quantizer
- Settling time of the sample-and-hold
- Jitter in sampling clock
- Mismatch among transistors, capacitors, etc.
- Circuit heating
- Other ...



Problem scales with speed



Time-Stretch A/D Conversion



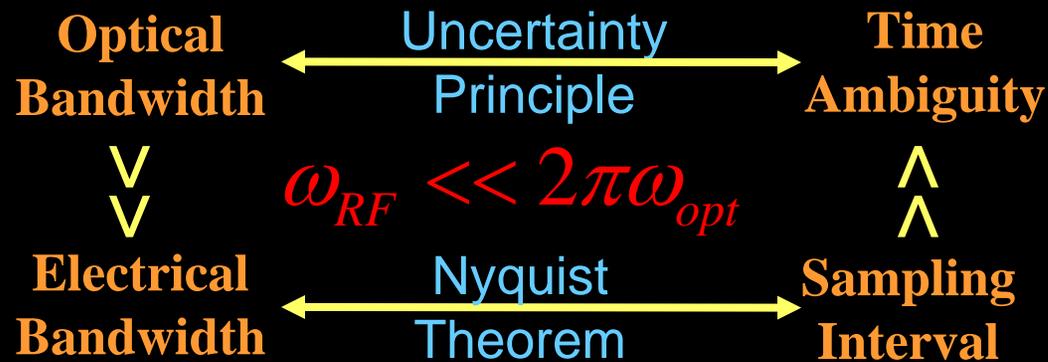
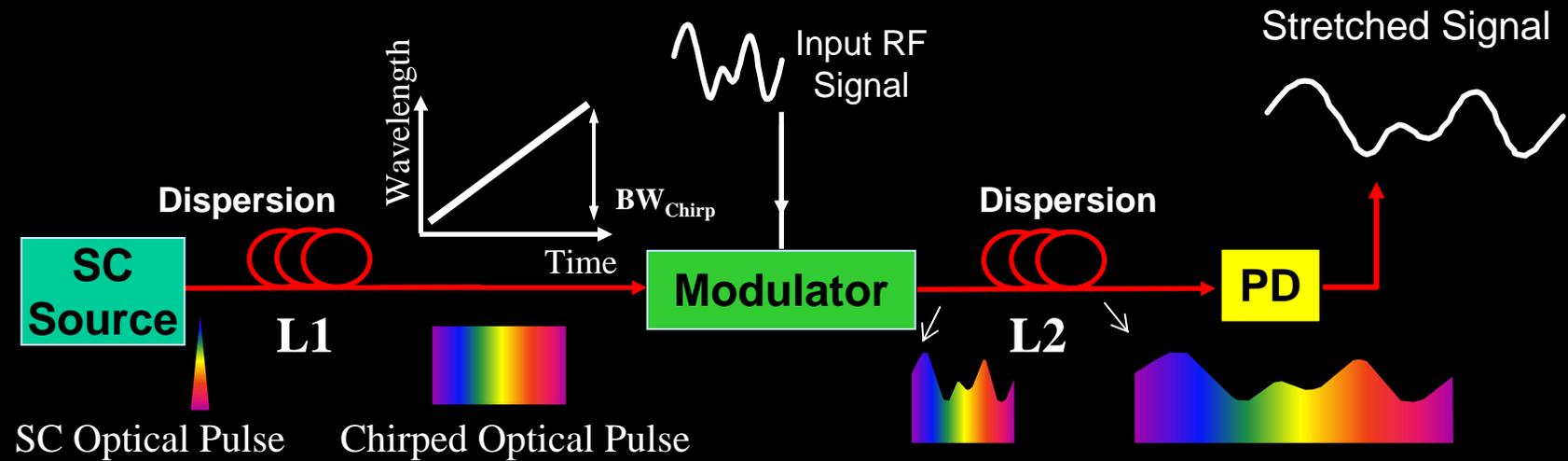
“Do your homework”

- What's the impact on:
 - Quantization noise?
 - Shot noise?
 - Thermal noise?
 - Jitter noise?
 - Spectral fidelity?

F. Coppinger, A. Bhushan, B. Jalali, *Electronics Letters*, 34 (4), 1998.

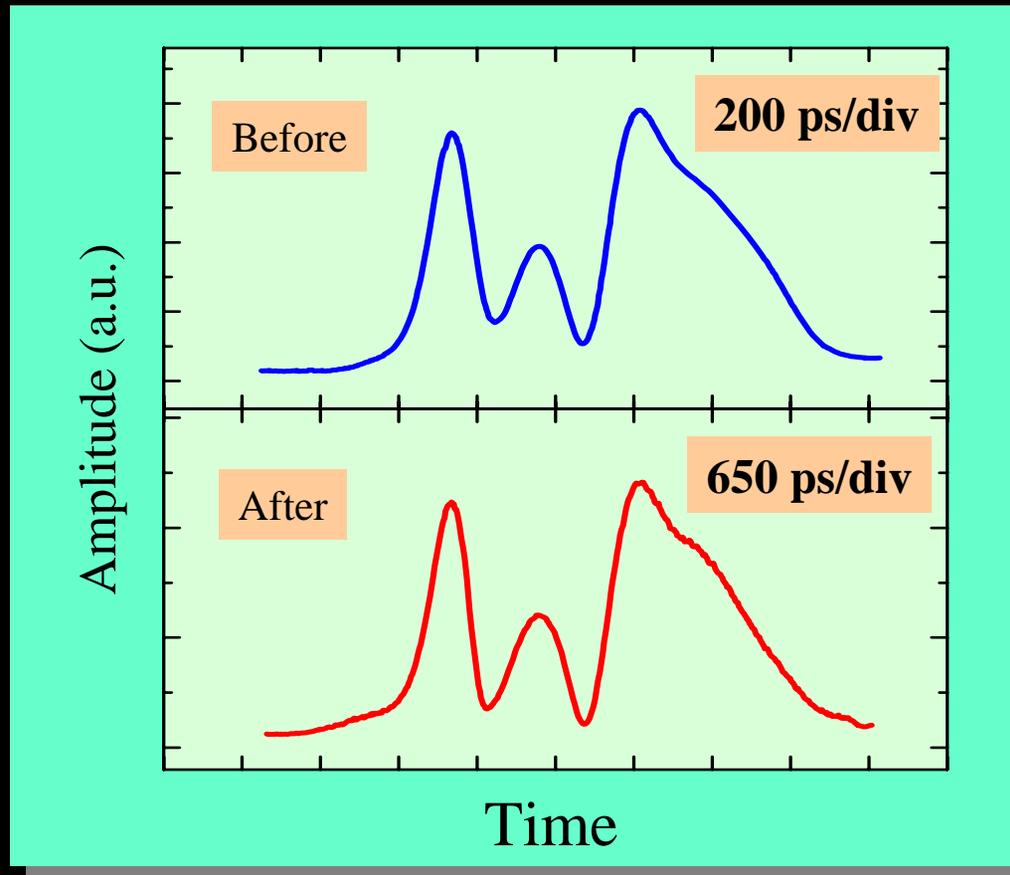
B. Jalali, F. Coppinger, US Patent # 6,288,659, 2001.

How do you slow down an electrical signal? Need photonics



Time stretch concept is valid as long as optical bandwidth is greater than electrical bandwidth

Time Stretch Demonstration – 1997-98

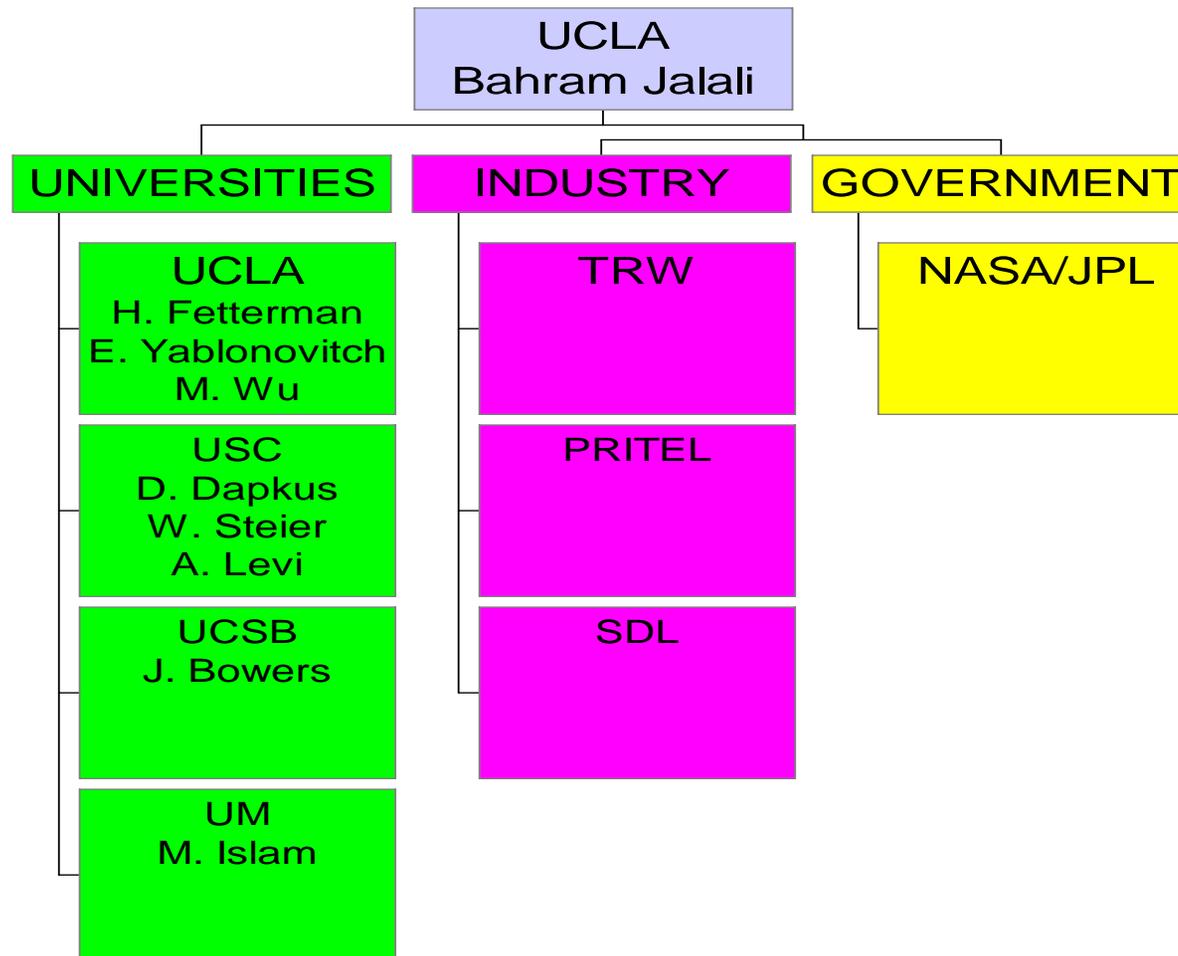


$L_1=2\text{km}$
 $L_2=5.5\text{km}$

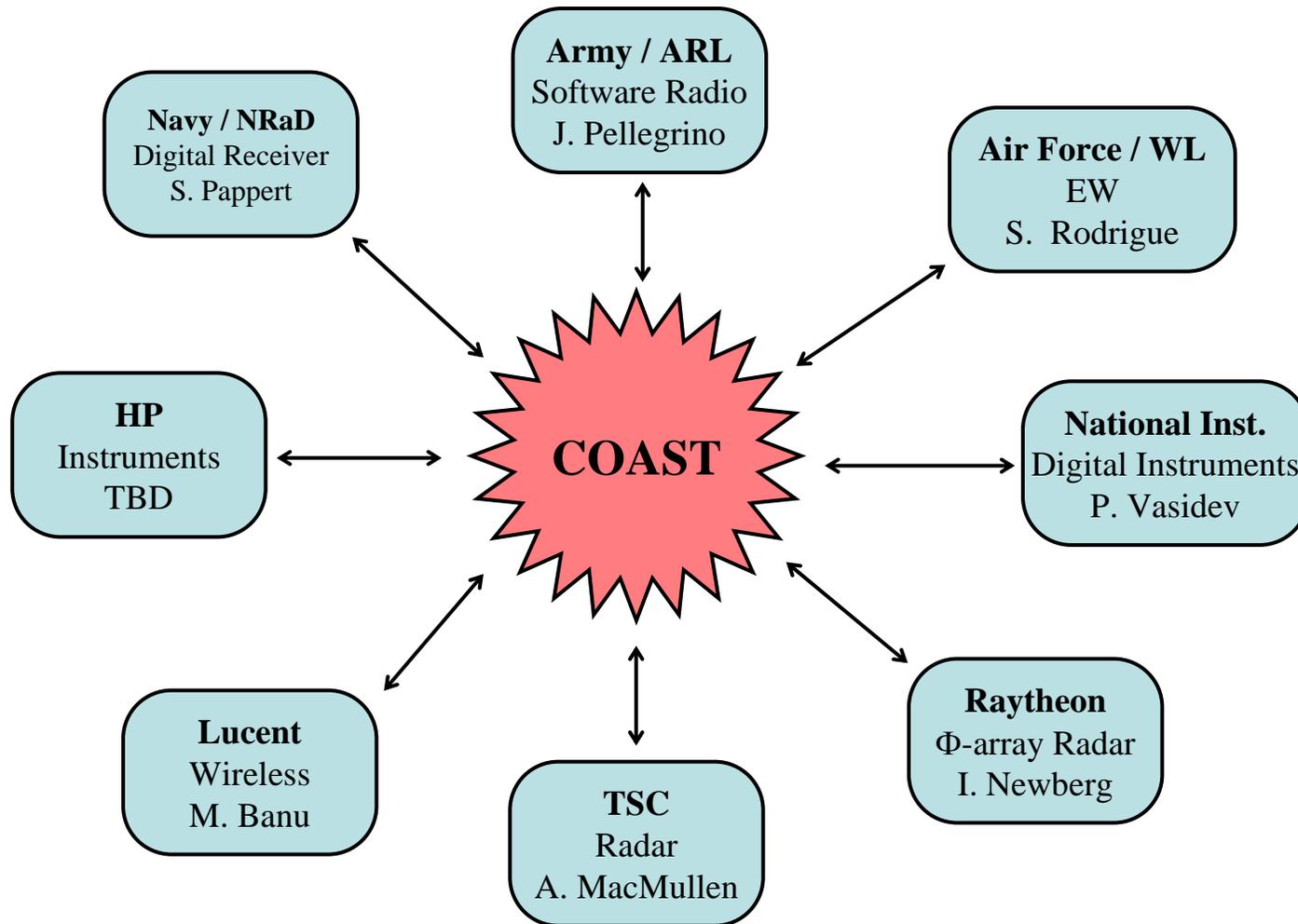
Stretch Factor: 3.25

F. Coppinger, A. Bhushan, B. Jalali, *Electronics Letters*, 34 (4), 1998.

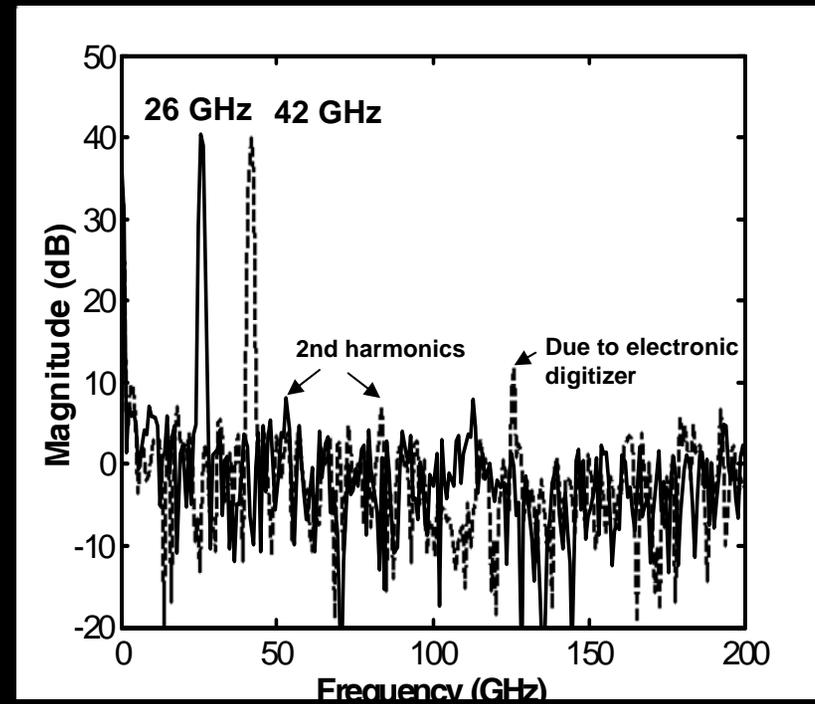
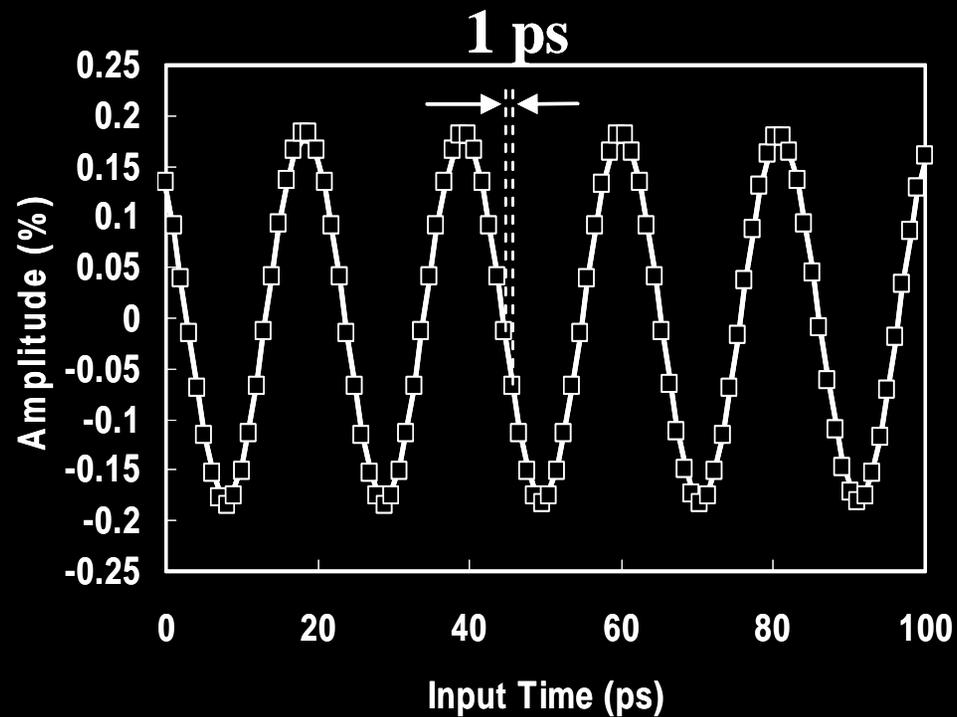
Consortium for Optical A/D System Technology



Consortium Technical Advisory Team



1 Tsample/s Real Time Transient Digitizer

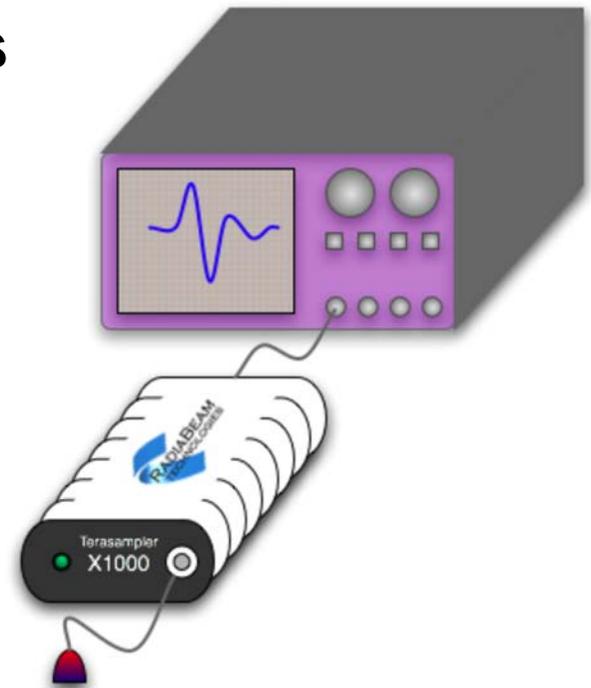


Medical/Scientific Instrumentation

Radiabeam Inc. Los Angeles

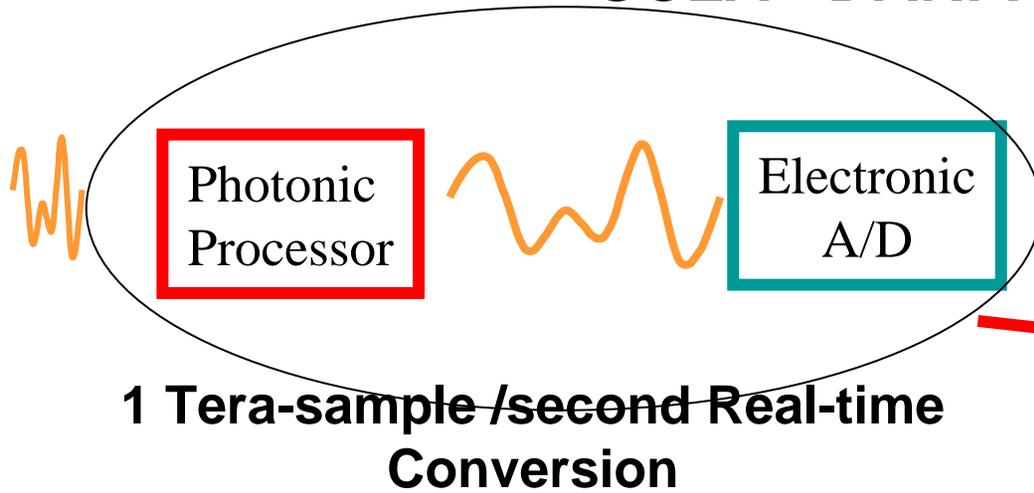
Need for Ultrafast Transient Digitizers

- Medical
 - 3D Time-of-Flight PET scan
 - Florescence Tracking
- Physical Sciences
 - Particle Beam Characterization
 - Particle Physics event detection
 - Gamma Ray Astronomy
- Laboratory instrumentation



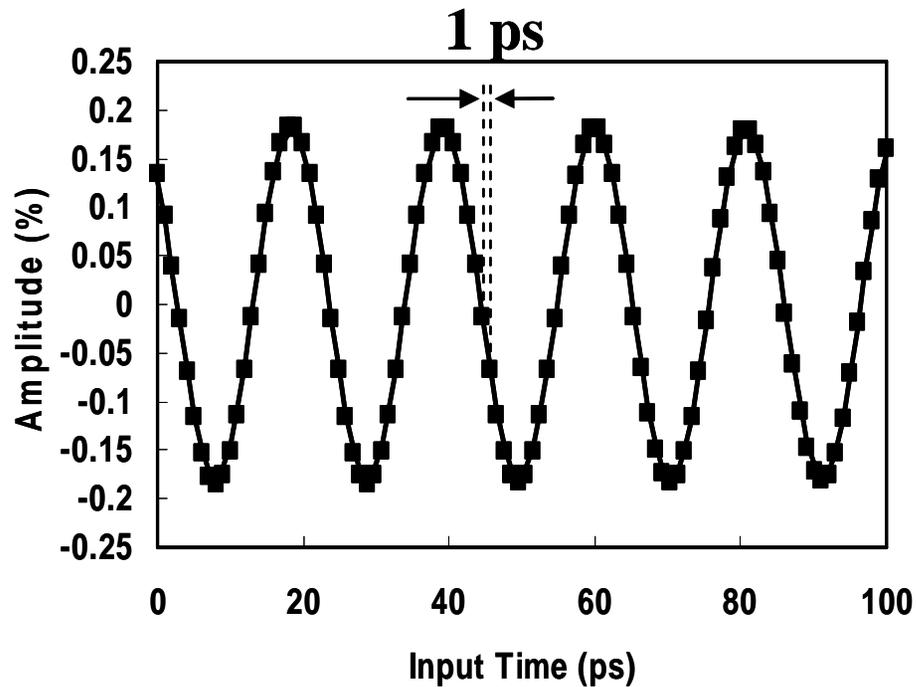
Photonic Transient Digitizer

UCLA - DARPA/PACT

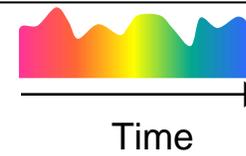
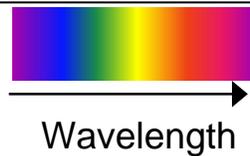
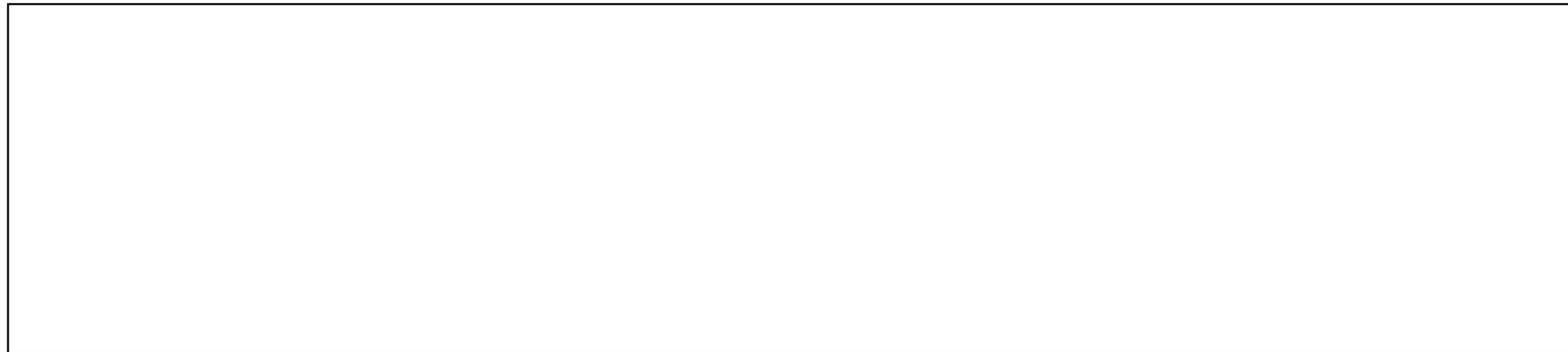


1 Tera-sample/second Real-time Conversion

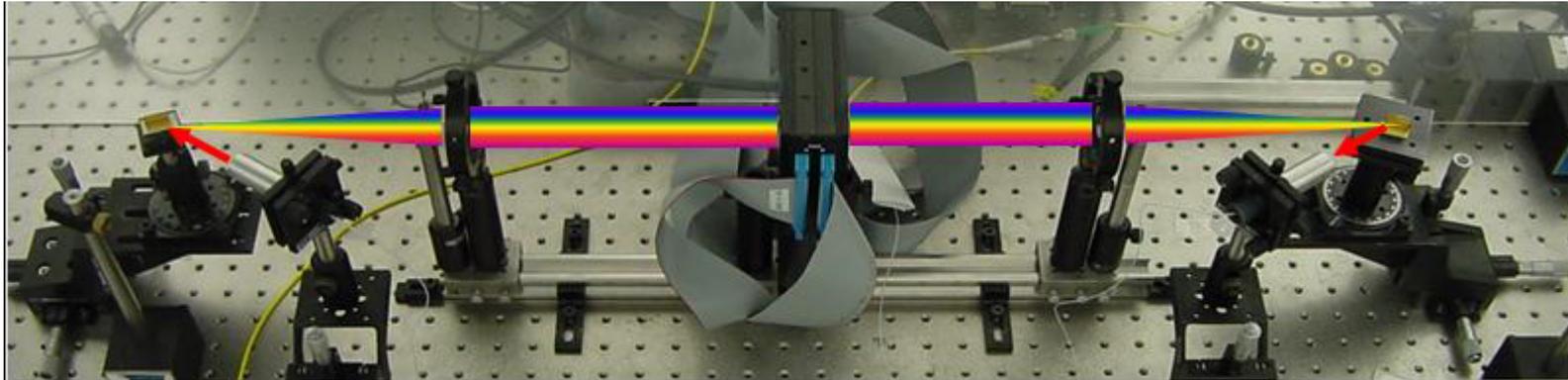
Future Direction



Spin-off idea: Photonic Arbitrary Waveform Generator



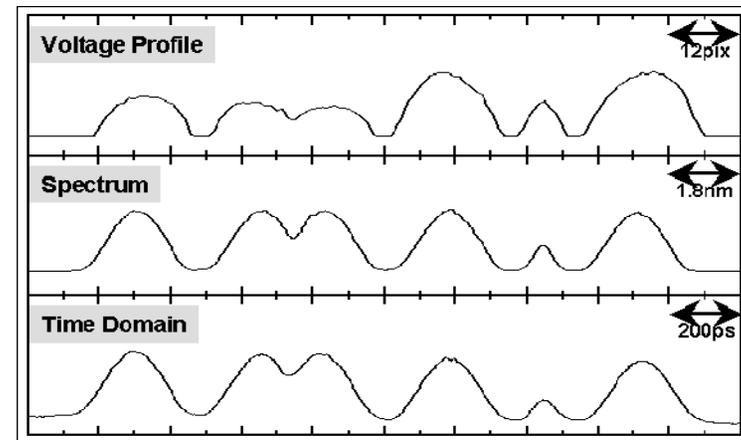
Photonic Arbitrary Waveform Generator



User Interface



Adaptive Feedback



J. Chou, Y. Han, and B. Jalali, Photonics Tech Lett, April 2003.

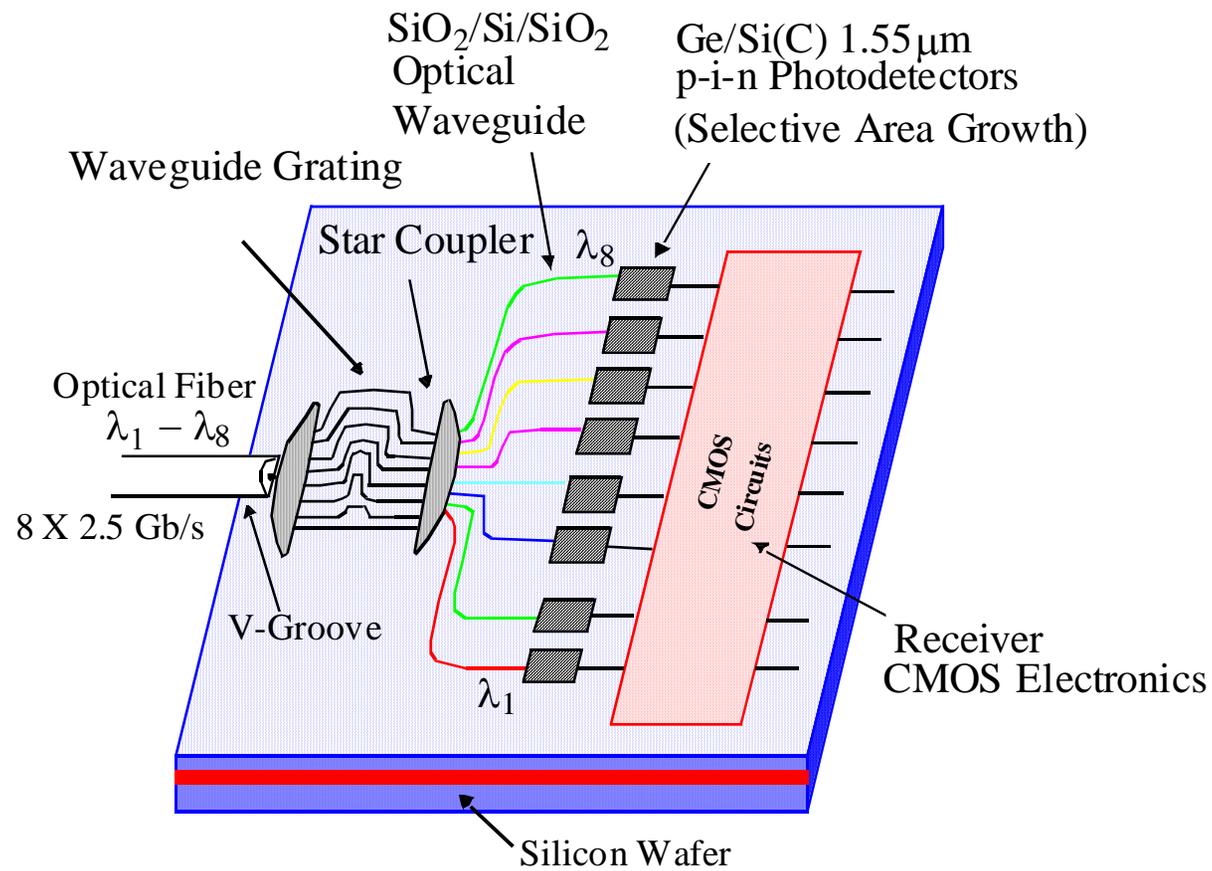
I. Poberezhskiy, B. Bortnik, J. Chou, B. Jalali, and H. Fetterman, J. Quantum Elec. , December 2005.

B. Bortnik, I. Poberezhskiy, J. Chou, B. Jalali, and H. Fetterman, J. Lightwave Tech, July 2006.

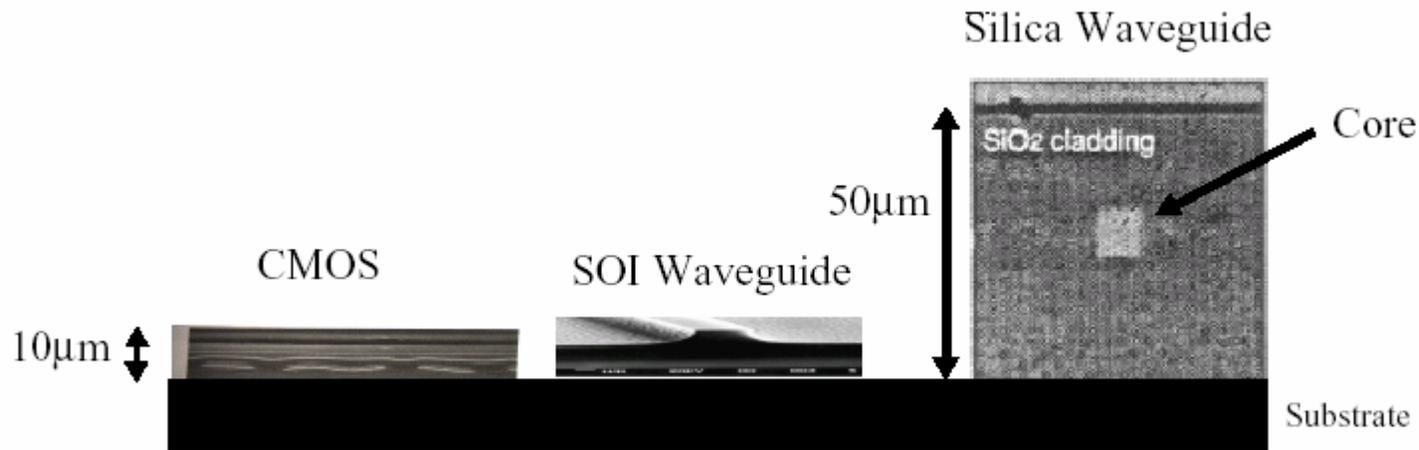
Silicon Photonics

my 1st DARPA Contract

WDM Receiver in Silicon (1993-94)



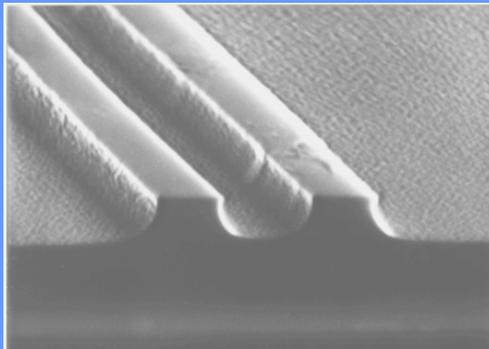
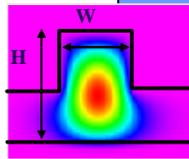
Communicating the message: Why silicon?



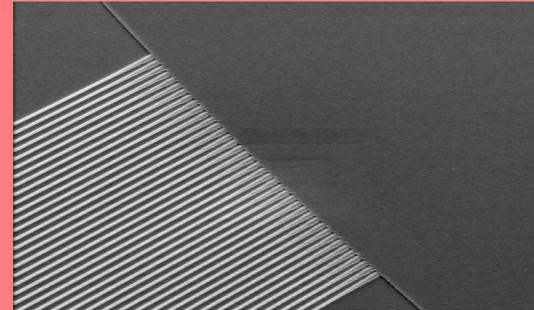
- Silica waveguide is incompatible with silicon IC processing
- Stress in thick SiO₂ layers causes polarization dependence
- Weak optical confinement limits integration density

1990's work on Passive Si Optics (UCLA)

Directional Coupler, 1996

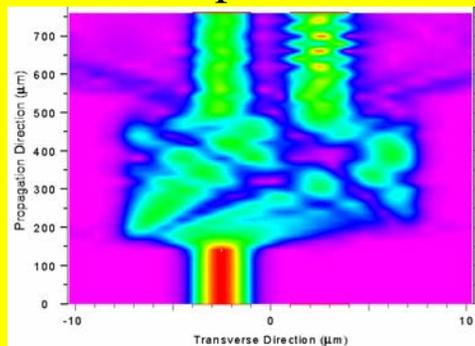


SOI Arrayed Waveguide
Grating WDM, 1997

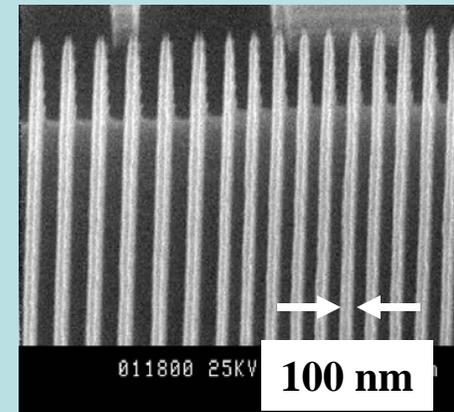


**Two photonic device companies operating today have their
genesis in this project**

Multimode Interference
Coupler, 1996

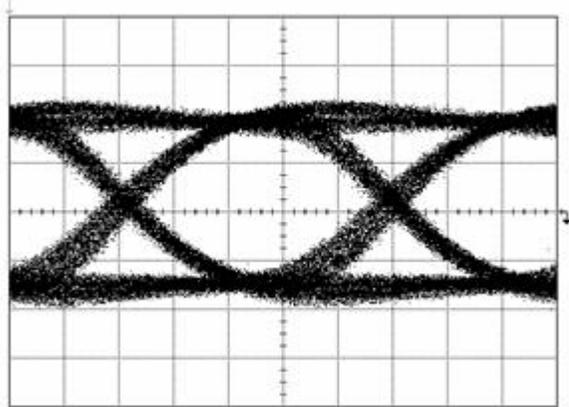


1998

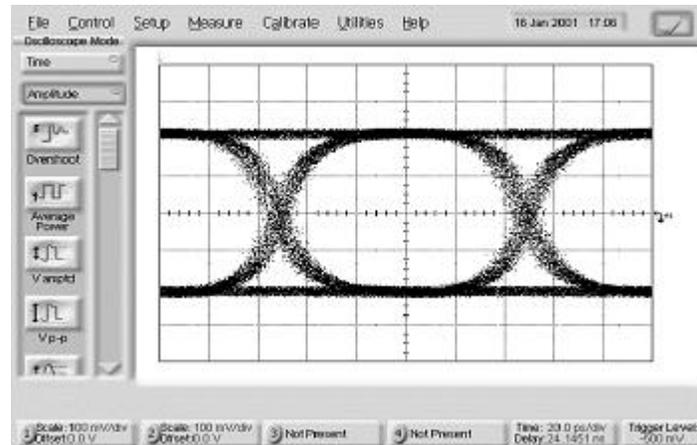


Additional outcome: World's First 10Gb/s CMOS IC's

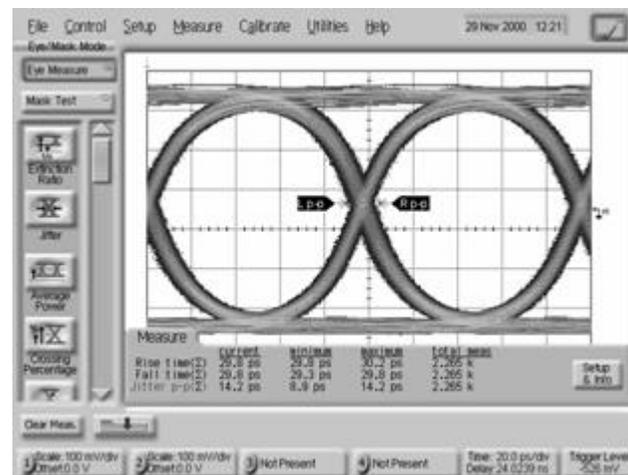
Transimpedance Amp



Post Amp

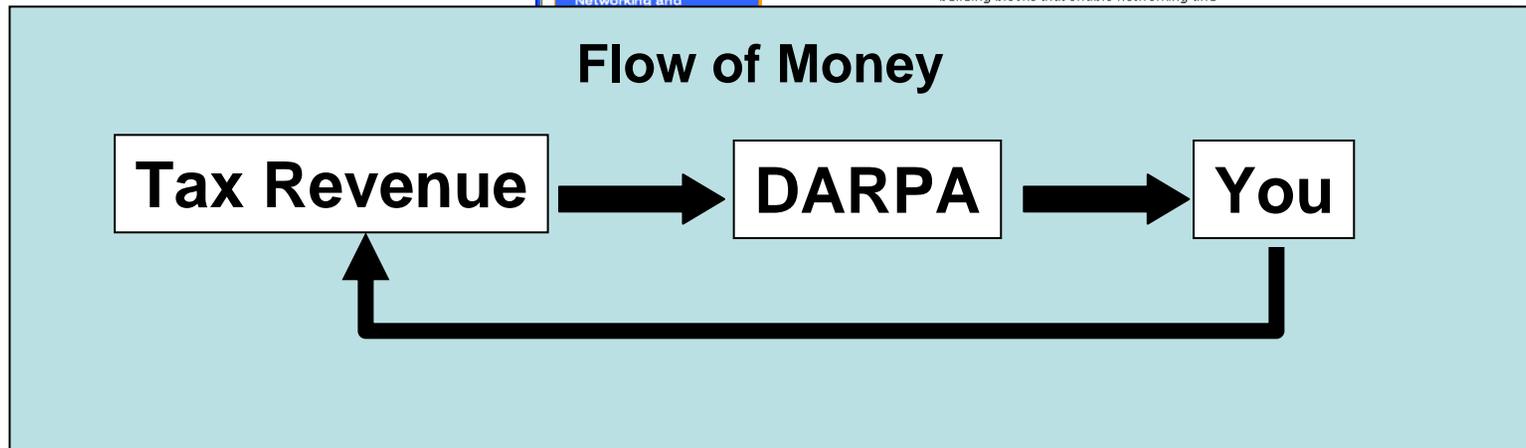


Laser Driver



Commercial Impact:

The image displays two screenshots of the Intel website. The left screenshot shows the product page for Intel® 10Gbps Physical Medium Dependent CMOS Devices, specifically the LXT17001 and LXT17011 Laser Drivers and LXT13002 Limiting Amplifier. The right screenshot shows the product page for Intel® LXT16716 and LXT16717 optical components.



2001 – present
Silicon as an Optically-active
medium

2001 DARPA Proposal:
Raman amplification and lasing in
silicon

You don't need big money to do get results

- Concept was funded 2nd time around –
- **seedling** led to:
 - Spontaneous Raman emission 2002
 - Stimulated amplification 2003
 - Coherent Anti-Stokes Conversion 2003
 - Continuum generation 2004
 - ***Raman Laser 2004***
- Follow on project:
 - Direct electronic modulation of Raman laser 2005
 - Energy harvesting in nonlinear optical devices

My experience?

“DARPA is Tough but Fair”

- Why Tough?
 - Bright PM’s who routinely hear “A” ideas
- Why Fair?
 - This meeting!
 - PM’s change – Directors change
 - BAA’s are up for grab until final stage
 - Proposals judged by objective parties not your competitors

If you have a good idea,
DARPA is the place!