SUMMARY:

- $500K over 18 months
- 3 prong approach : (1) Develop National Technology Roadmap for Photonics (2) Put together consortium that could evolve into IMI (3) Develop a strategy for expanding photonics manufacturing in NYS
  - Will roadmap optics, lasers, imaging and sensing systems, display modules, biophotonics devices
- Will establish a website with working documents and put them in one place for optics and photonics industry to access. Repository will be available for this purpose.
- Group Comments:
  - Road mapping process can be as valuable as the roadmaps themselves
  - Looking at broader direction of industry, can increase innovation
  - On fibers: OIDA has completed significant road mapping on optical communication – important to collaborate. Perhaps, encouraging laser or imaging group to embrace fibers (leaving out communication fiber).

On biophotonics: Biophotonics is crosscutting. Emerging potential in clinical medicine and the goal is to understand that in biophotonics, manufacturing won’t be the focus but it will be economic impact from reduced health care costs and other metrics.

AMTech NTRP Grant

- $500K over 18 Months (6/1/1014 – 12/1/2015)
- Prime: University of Rochester CEIS
- Subcontracts: Rochester Institute of Technology and Rochester Regional Photonics Cluster

Three parts:

- Develop a National Technology Roadmap for Photonics
  - First generation roadmaps
  - Put in place a robust, sustainable process for future generations
- Put together a consortium that could evolve into an IMI
- Develop a strategy for expanding photonics manufacturing in NY State

NTRP

National Technology Roadmap for Photonics

NIST National Institute of Standards and Technology U.S. Department of Commerce

NTRP Leadership

Executive Steering Committee Members	
Steve Anderson	SPIE
John Bruning	Corning (retired)
Stephen Fantone	Optikos
Tom Hausken	OSA
Thomas Koch	University of Arizon
Duncan Moore	University of Rochester
MartinRichardson	University of Central Florida
PeterBocko	Corning (retired)

Technology Working Group Leaders				
Optics	Lasers	Imaging and Sensing	Displays	Biophotonics
Tom Battley	Martin Richardson	Bob Fiete	Mark Poliks	Jim Zavislan
Megan Shaw	John Marciante	Michael Richardson	Bob Boudreau	Bruce Tromberg
Duncan Moore	Jay Eastman			

Staff	
Paul Ballentine (PI)	University of Rochester
Michael Richardson	Rochester Institute of Technology
Tom Battley	Rochester Regional Photonics Cluster
Jay Eastman	Optel

NTRP

National Technology Roadmap for Photonics

National Institute of Standards and Technology
U.S. Department of Commerce

Value of Shared Roadmaps

Industry

- Help strengthen supply chain
  - Gives SMEs visibility of market needs they otherwise may not have and an opportunity to form partnerships
- Help companies develop internal roadmaps
  - Reduce R&D costs, time to market, and risk
- Communicate investment needs to government
- **The roadmapping process can be as valuable as the roadmaps themselves**

Government

- Increase competitiveness of domestic manufacturers
- Stimulate economic growth and manufacturing jobs
- Identify opportunities for public private partnership investments
- Identify basic (university) research needs

Technology roadmaps do not stifle disruptive innovation

Roadmapping Process (from iNEMI)

Market Roadmaps

Market Roadmaps

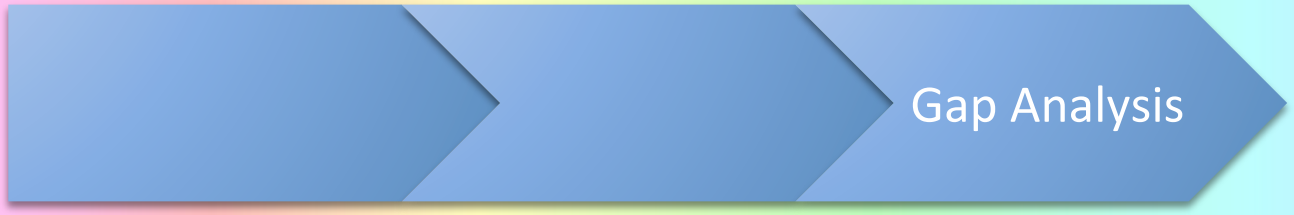
- Forecast market trends
- Forecast system performance requirements
  - Provide detailed lists of component performance requirements to meet system requirements
- Cost is taken into consideration
- Driven by large OEMs with inputs from suppliers and universities

Manufacturing Roadmaps

Mfg. Roadmaps

- Forecast manufacturing technology availability for each requirement
  - Machines, materials, and methods
- Driven by suppliers with inputs from OEMs and universities
- Conversely, forecast development of innovative new manufacturing technologies that could change market roadmaps (e.g. 3D printing of optical components could enable new designs)

Gap Analysis



- Identify gaps between what is needed and what is available
- Identify opportunities for pre-competitive collaboration (i.e. could be done in an IMI)

Proposed Market Roadmaps (not covered in AMTech Grant)

- Market roadmaps can be broken down into major economic sectors
  - Defense and Aerospace
  - Advanced Manufacturing
  - Computing and Communications
  - Healthcare
  - Energy and the Environment
  - Food and Agriculture
  - Transportation
  - Commercial
  - Consumer
  - Scientific

- The first 5 follow the NRC report and the work of the NPI.
- We do not have resources to develop market roadmaps during the AMTech grant period, so we will use existing data and interviews with OEMs.
- Sustaining process should have market roadmap teams.

Photonics Technology Roadmaps

AMTech Roadmaps

- Advanced Optics
- Lasers
- Imaging and Sensing Systems
- Display Modules
- Biophotonic Devices
- Photonic Integrated Circuits
  - (being done by iNEMI)

Other Potential Photonics Roadmaps

- Solid State Lighting
- Photovoltiacs
- Fiber Optics

This grant

NTRP

National Technology Roadmap for Photonics

NIST National Institute of Standards and Technology U.S. Department of Commerce

Crosscutting Roadmaps

Roadmaps that apply to most if not all markets and technologies

- Workforce Training (NPI taskforce)
  - Involves community colleges to train workers for midlevel skill positions
  - BS, MS, and Ph.D education and research programs to protect U.S. lead in photonics innovation
- Design
- Packaging
- Metrology
- Materials

Photonics Roadmapping Matrix

	Industrial	IT	Healthcare	Defense	Energy and the Environment	Consumer and Portable	Commercial	Food and Agriculture	Scientific and Measurement		
Optics											
Lasers/Sources											
Imaging and Sensing Systems											
Display Modules											
Biophotonic Devices (?)											
Photonic Integrated Circuits											
Solid State Lighting											
Photovoltaics											
Fiber Optics											
Crosscutting Technologies/Needs											
Design											
Packaging and Integration											
Workforce Training											
Metrology											

The vision for the NTRP is to have a complete set of chapters encompassing all markets, technologies, and crosscutting functions.

NTRP

National Technology Roadmap for Photonics

NIST National Institute of Standards and Technology U.S. Department of Commerce

Example Market Roadmap

Defense and Aerospace Roadmap												
	Metric	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Optics												
First class of optical components												
Parameter 1	e.g. size	value	value	value	value	value	value	value	value	value	value	value
Parameter 2	performance	value	value	value	value	value	value	value	value	value	value	value
Parameter 3	cost/unit	value	value	value	value	value	value	value	value	value	value	value
…	etc.	value	value	value	value	value	value	value	value	value	value	value
Second class of optical components												
Parameter 1		value	value	value	value	value	value	value	value	value	value	value
Parameter 2		value	value	value	value	value	value	value	value	value	value	value
Parameter 3		value	value	value	value	value	value	value	value	value	value	value
… (could be many)		value	value	value	value	value	value	value	value	value	value	value
Lasers												
Parameter 1		value	value	value	value	value	value	value	value	value	value	value
Parameter 2		value	value	value	value	value	value	value	value	value	value	value
Parameter 3		value	value	value	value	value	value	value	value	value	value	value
…		value	value	value	value	value	value	value	value	value	value	value
etc.												
Crosscutting technologies												
Workforce Training		value	value	value	value	value	value	value	value	value	value	value
Design		value	value	value	value	value	value	value	value	value	value	value
Materials		value	value	value	value	value	value	value	value	value	value	value
Packaging		value	value	value	value	value	value	value	value	value	value	value

NTRP

National Technology Roadmap for Photonics

NIST

National Institute of Standards and Technology

U.S. Department of Commerce

Gap Analysis

Defense and Aerospace Roadmap												
	Metric	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Optics												
First class of optical components												
Parameter 1	e.g. size	value	value	value	value	value	value	value	value	value	value	value
Parameter 2	performance	value	value	value	value	value	value	value	value	value	value	value
Parameter 3	cost/unit	value	value	value	value	value	value	value	value	value	value	value
…	etc.	value	value	value	value	value	value	value	value	value	value	value
Second class of optical components												
Parameter 1		value	value	value	value	value	value	value	value	value	value	value
Parameter 2		value	value	value	value	value	value	value	value	value	value	value
Parameter 3		value	value	value	value	value	value	value	value	value	value	value
… (could be many)		value	value	value	value	value	value	value	value	value	value	value
Lasers												
Parameter 1		value	value	value	value	value	value	value	value	value	value	value
Parameter 2		value	value	value	value	value	value	value	value	value	value	value
Parameter 3		value	value	value	value	value	value	value	value	value	value	value
…		value	value	value	value	value	value	value	value	value	value	value
etc.												
Crosscutting technologies												
Workforce Training		value	value	value	value	value	value	value	value	value	value	value
Design		value	value	value	value	value	value	value	value	value	value	value
Materials		value	value	value	value	value	value	value	value	value	value	value
Packaging		value	value	value	value	value	value	value	value	value	value	value

solution exists (MRL 8-10)
solution under development (MRL 4-7)
no known solution (MRL 1-3)

NTRP
National Technology Roadmap for Photonics

NIST
National Institute of Standards and Technology
U.S. Department of Commerce