

Innovation and Return on Investment: A NIST Perspective

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Under Secretary of Commerce for Standards and Technology,
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CENAM, México

To promote U.S. innovation and industrial competitiveness by advancing **measurement science**, **standards**, and **technology** in ways that enhance economic security and improve our quality of life.



World-Leading Scientific and Engineering Research



Advanced Manufacturing National Programs



Technology Transfer and U.S. Innovation

Metrology, Technology & Standards

Important to commerce



“Uniformity in the currency, weights, and measures of the United States is an object of great importance, and will, I am persuaded, be duly attended to.”

George Washington, State of the Union Address, January 8, 1790

Important to innovation



“If you can not measure it, you can not improve it.”

Lord Kelvin, Lecture to the Institution of Civil Engineers, 3 May 1883

Important to international trade

Up to 92% of U.S. Exports affected by standards/technical regulations

NIST Illustrated, <https://youtu.be/2j9BGVKbzS4>



NIST AT A GLANCE

Global Partner in Metrology, Science & Technology



3,400+
FEDERAL
EMPLOYEES



5
NOBEL PRIZES



2 CAMPUSES
GAITHERSBURG, MD [HQ]
BOULDER, CO



3,500
+



10
COLLABORATIVE



Thousands
of BUSINESSES USING
NIST FACILITIES



NATIONAL OFFICE
COORDINATING 14
MANUFACTURING
INSTITUTES



51
MANUFACTURING
EXTENSION
PARTNERSHIP CENTERS



U.S. BALDRIGE
PERFORMANCE
EXCELLENCE PROGRAM



Advanced
Manufacturing



Cybersecurity



Disaster
Resilience



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Engineering
Biology



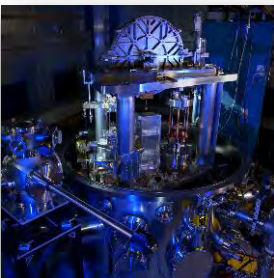
Internet of
Things



Documentary
Standards



Technology
Transfer



Measurement
Dissemination



Quantum
Science



Artificial
Intelligence

Return on Investment (ROI) Initiative

As part of the *President's Management Agenda*, the U.S. seeks to enable even greater return on the Federal government's investment in R&D



Federal R&D Investment
\$150B/year



Technology Transfer System



New IP, licensing, products, processes, services and companies return value via economic growth

ROI Vision and Goal

VISION: Unleash more innovation power into our economy

GOAL: Maximize the transfer of federal investments in science and technology into value

- **meet current and future economic and national security needs** in a rapidly shifting technology marketplace and enhance competitiveness globally
- **attract greater private sector investment** to create innovative products, processes, services, as well as new businesses and industries



(L to R): Michael Kratsios (WH/OSTP), Walter Copan (U/S NIST), Wilbur Ross (Commerce Secretary), Margaret Weichert (Deputy Director OMB), and Andrei Iancu (U/S USPTO)

Credit: Peter Cutts

NIST and Technology Transfer



- Policy coordination and promulgation of technology transfer regulation
- Lead for Interagency Workgroup for Technology Transfer (11 agencies) and Interagency Workgroup for Bayh-Dole
- Annual reports for the President, the Congress, and OMB on technology transfer across federal agencies



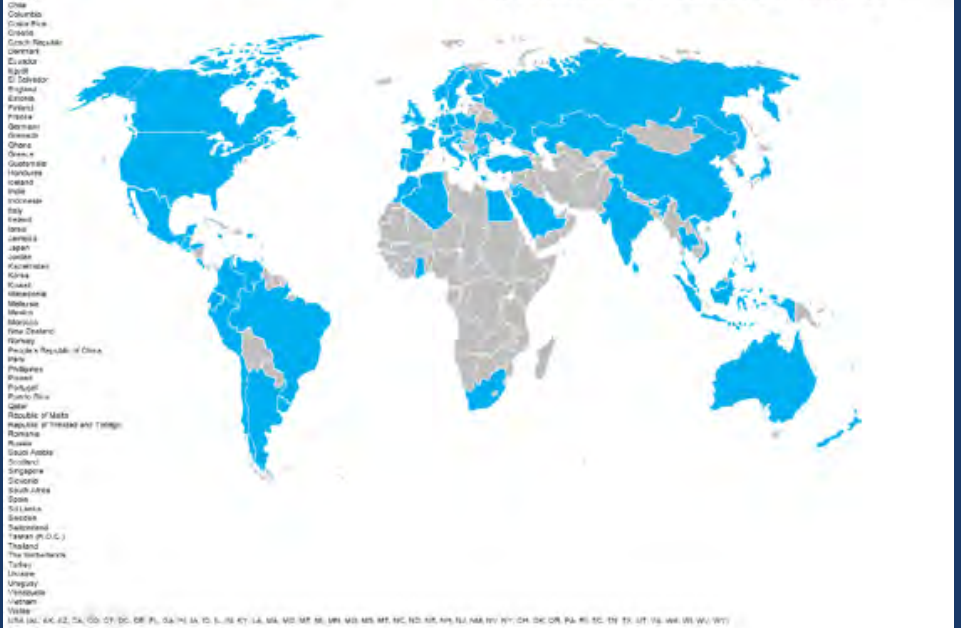
Unleashing American Innovation Symposium, April 19, 2018

NIST has a unique role in promoting and reporting on the overall strength of federal technology transfer efforts

NIST research and technology advances, inventions and manufacturing support, products and services impact every facet of life and society – in industry and in homes.



Over 1200 Technical Inquiries Regarding the Use of Standard Reference Materials Responses by Chemical Sciences Division Staff (May 2015 through December 2017) to scientists in 75 countries and 47 states



- **1,200+** Standard Reference Material (SRM) products
- **100+** Standard Reference Data (SRD) products
- **600+** measurement services
- **800+** accreditations of testing and calibration laboratories/year
- **400+** NIST technical staff in **100+** standard committees

Annually in the U.S.
>**32,000** SRM units distributed
~**13,000** calibrations and tests
~ **1.5 Million** traceable calibrations

NIST economic impact studies demonstrates that the rates of return on NIST infra-technologies consistently match or exceed rates of return to private investment in technology

Advanced Encryption Standard (AES): \$250+ Billion 20-year impact



SRM: Sulfur in Fossil Fuels

- **Industries Impacted**
Transportation, Energy, Steel
- **Benefit-Cost Ratio: 113**
- **Social Rate of Return: 1,056%**
- **Net Present Value: \$409M**



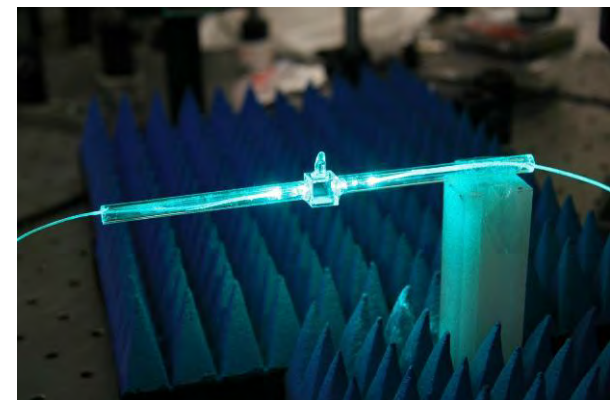
Data Encryption Standard

- **Industries Impacted**
Health care, Financial Services, ...
- **Benefit-Cost Ratio: 145**
- **Social Rate of Return: 272%**
- **Net Present Value: \$1.2B**

Future NIST and Measurement Dissemination



Leveraging quantum science expertise, redefinition of the SI, and device engineering and fabrication capabilities to fundamentally change how measurements are made.



NIST has embarked on a sweeping program to revolutionize measurement services and metrology

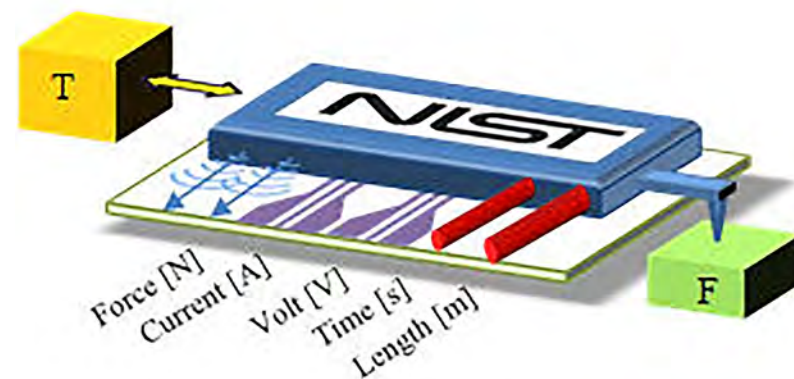
NIST on a Chip™

Suite of intrinsically accurate, quantum-based measurement technologies

New generation of ultra-compact, inexpensive, low-power measurement tools

Perform uninterrupted *without the need for traditional measurement services.*

Make precision and accurate measurements referenced to the International System of Units (SI).



NIST on a Chip provides measurement dissemination from NIST

20 May 2019 – World Metrology Day

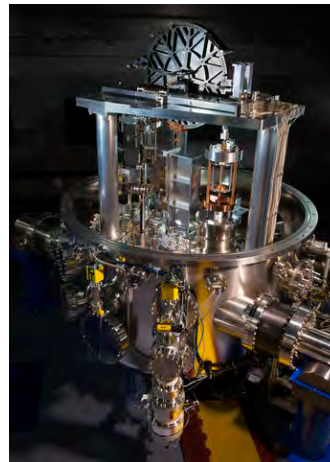
Quantum SI

- Quantum phenomena
- Fundamental constants

Tying metrology back to fundamental physics

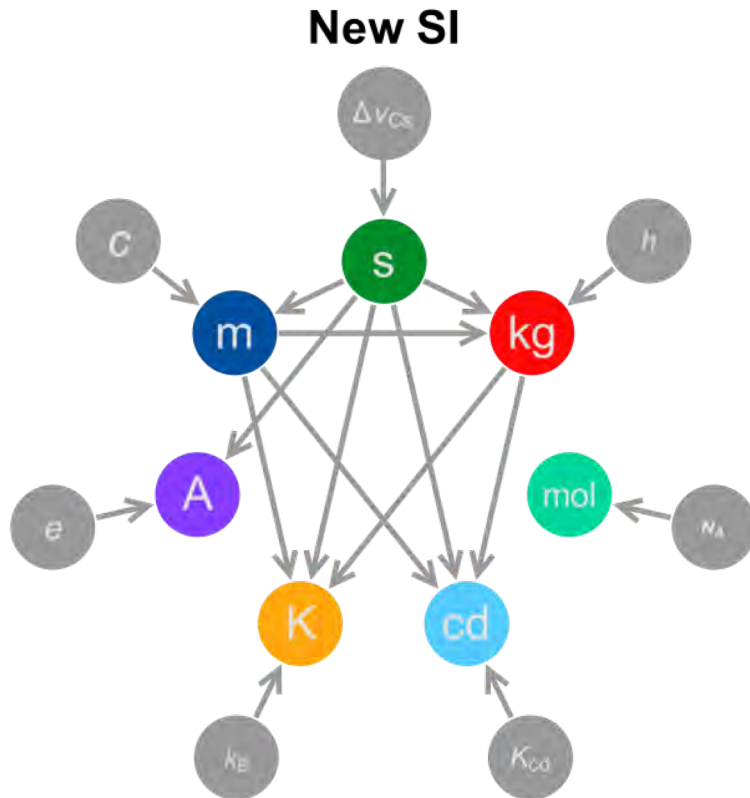
- Removing artifacts as defining the SI

NIST Kibble Balance



- **kilogram**
 - Planck constant
- **kelvin**
 - Boltzmann constant
- **ampere**
 - Elementary electric charge
- **mole**
 - Avogadro constant





Traceability directly to the SI



Zero-length traceability chain

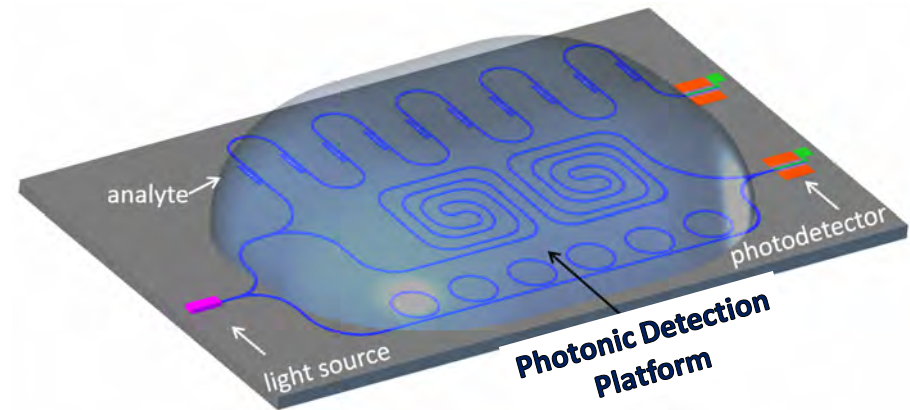


Democratizing Metrology

NIST on a Chip™ (NoaC) Platform

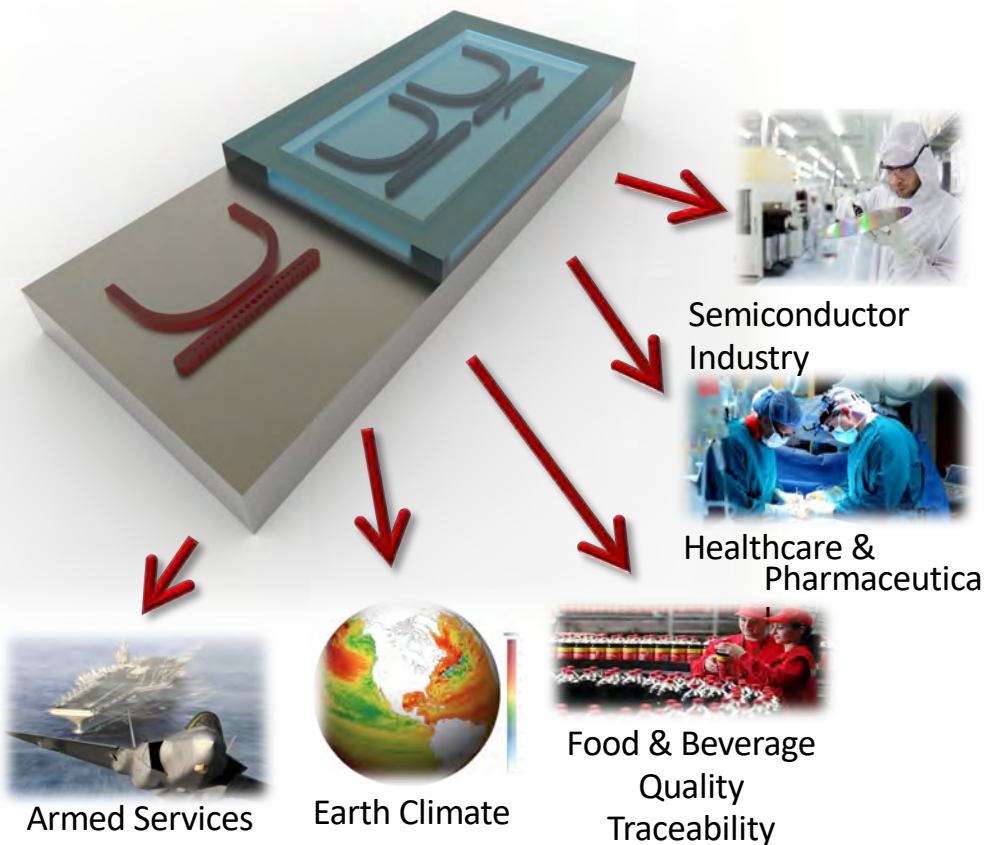


- Flexible
 - Multiple SI parameters
- Manufacturable
 - Commercialization
- Reliable
 - Laws of Quantum SI
- Deployable
 - Ubiquitous use
- Usable
 - Small, disposable, interoperable
- Zero-chain traceability



NIST suite of intrinsically accurate,
quantum-based technologies

NoaC Standard for Humidity



Objective:

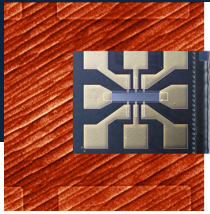
Robust, low-cost, deployable & accurate quantum humidity standard and sensor in one device

Deployable & accurate:

- ✓ Humidity from thermodynamic temperature
- ✓ Inherently quantum phenomenon
- ✓ Consistent with emergent Quantum-SI

Robust and low cost:

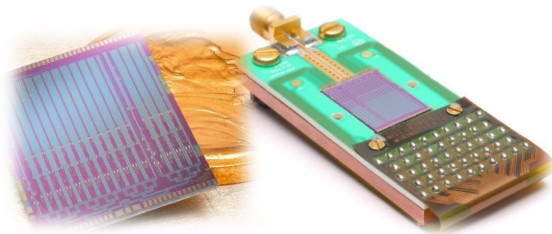
- ✓ Integrated photonics – leverages advances in telecom
- ✓ Based on SOI platform
- ✓ Amenable to mass manufacturing



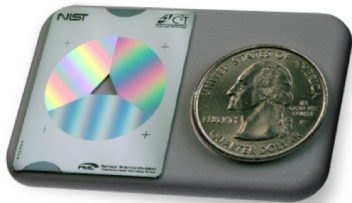
NIST Quantum SI NoaC Devices



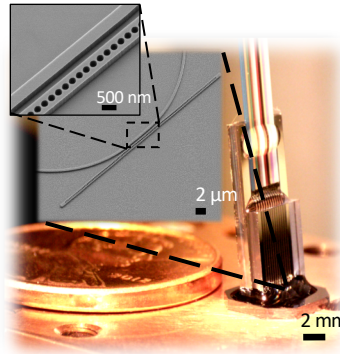
Resistance
Graphene QHR



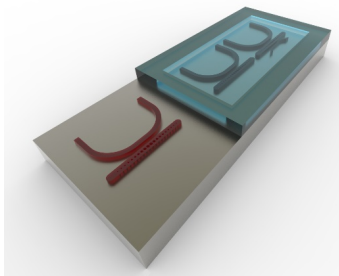
Voltage
AC and DC



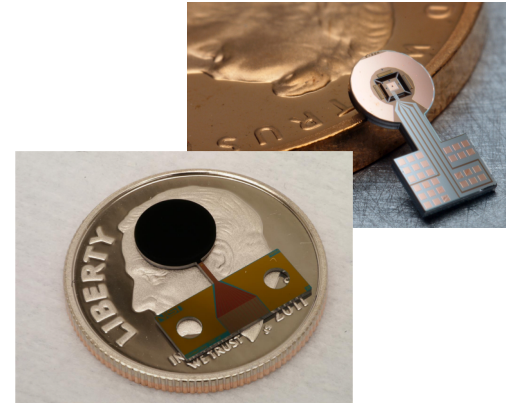
Vacuum
UHV and XHV



Temperature



Humidity



Radiometers
Optical-Fiber Power



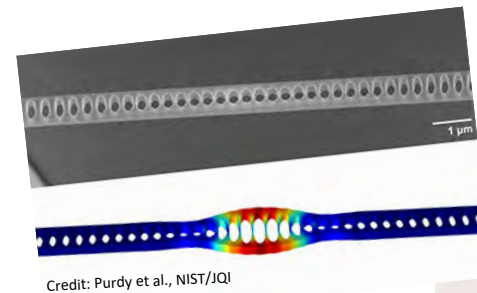
Smart Mirror
Laser, RF, & μ wave Power

Quantum SI Commercialization in progress:

- ✓ Temperature
- ✓ Humidity
- ✓ Pressure
- ✓ Vacuum
- ✓ Laser welding

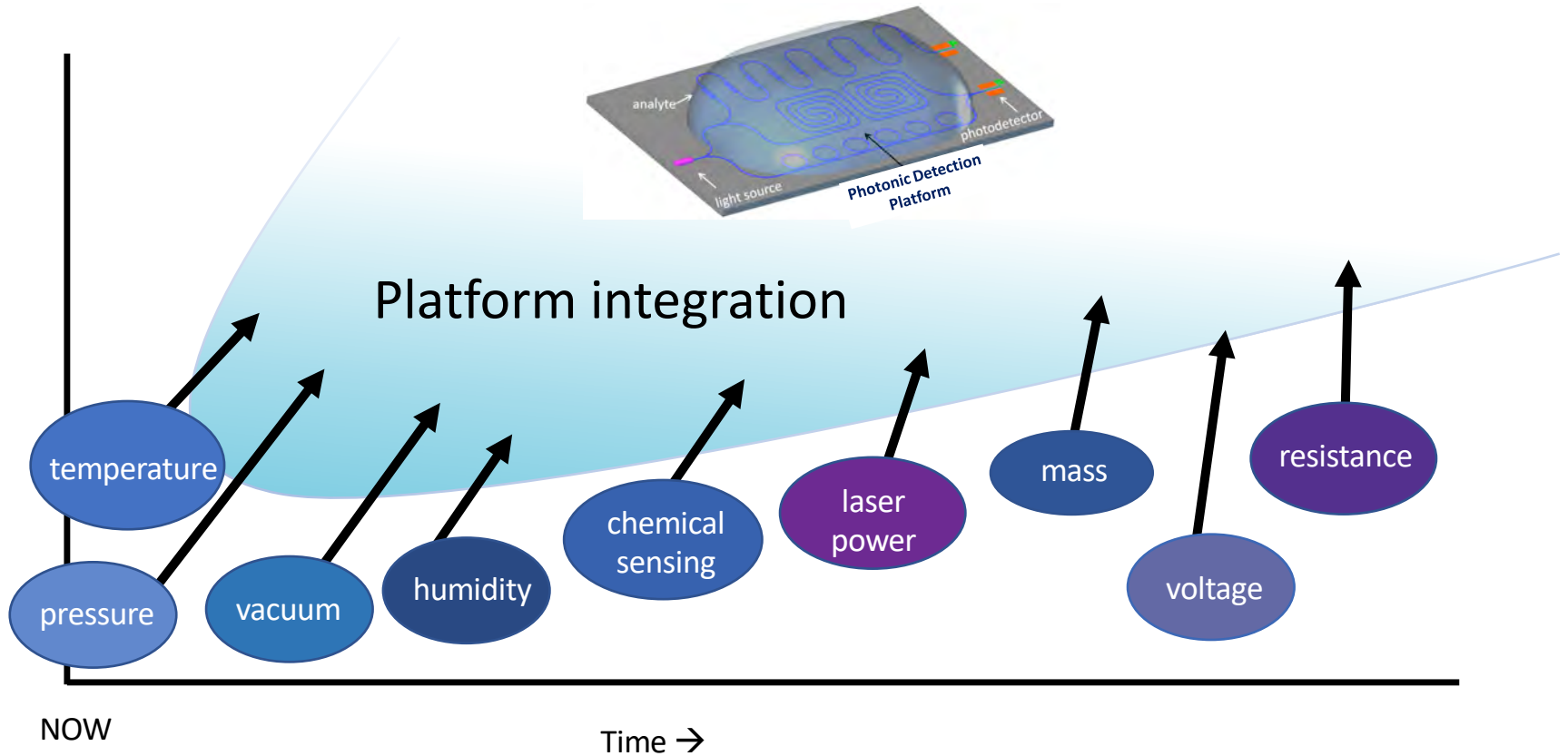
Patents available for licensing

Collaboration with industry to bring NIST developed devices to metrology markets

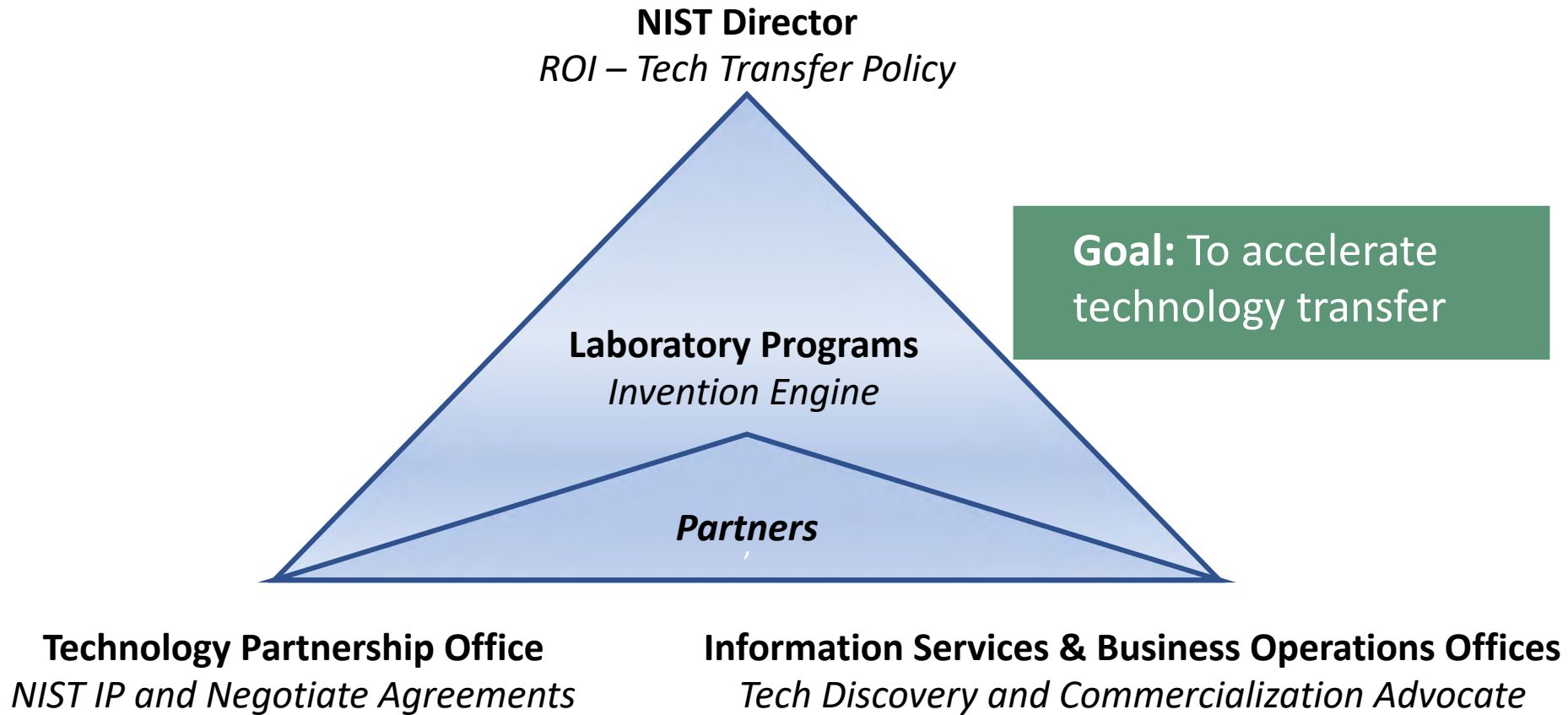


Quantum SI modality unlocks the potential to accelerate science and technology

NoaC Commercialization Roadmap



NIST Technology Transfer Operational Model



Summary: Delivering ROI

- NIST plays an essential government role by developing new measurements science, technologies and standards – and transitions technologies from laboratory to manufacturing
- NIST supports all sectors of the economy -- from emerging technologies and markets to legacy industries
- NIST partners globally to advance measurements science & standards, and economic cooperation



¡Muchas gracias!

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Thank you