The Power of Crowd Based Challenges

NASA's Practical Toolkit for Open Innovation
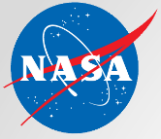
NASA's Center of Excellence for Collaborative Innovation (CoECI)

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                               @NASA_NTL

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NASA's Mission

Drive advances in science, technology, aeronautics, and space exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of Earth.
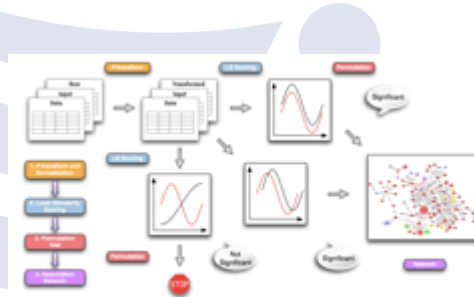
The Nature of Work is Changing

Legacy Model (assumed employers had all of employees time – ignored non-work hours)

Division
Division
COMPANY

Division
Division
Gov Org

Division
Division
COMPANY

Employee:
Applies skills and expertise for Employer

Freelance:
Applies skills, expertise, and passion externally (may or may not be shared with core job)

44 million Americans have a side job (CNNMoney)

1 in 3 Millennials have a side job (Forbes)

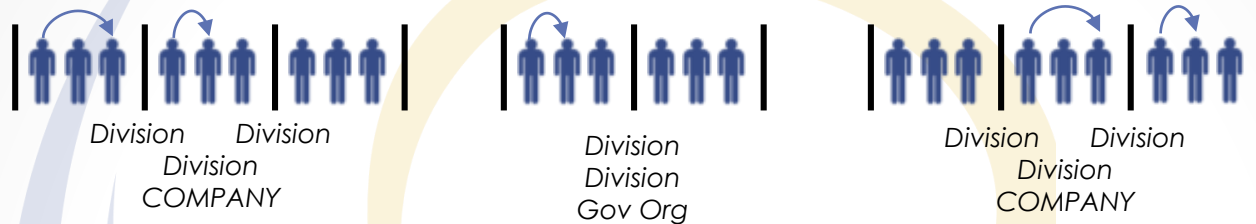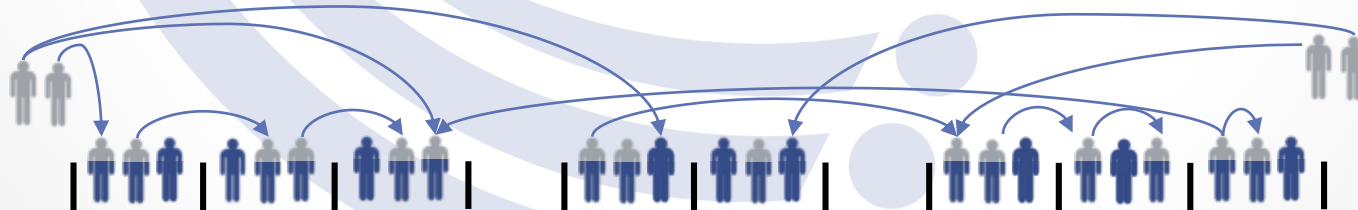*Internet connectivity and tools allow "work from anywhere"*

New Model

A new model enabling on-demand access of expertise is emerging at a time when maintaining in-house expertise in all required areas is increasingly difficult.

Our Take… Crowdsourcing = Workforce Virtualization

Workforce Virtualization: Work :: Cloud : Computing

IT Cloud: Virtualized Computing

A distributed network of computers that:
- is globally accessible
- relies on real-time internet connectivity
- maximizes computing power

Human Cloud: Virtualized Workforce

A distributed network of people that:
- is globally accessible
- relies on real-time internet connectivity
- maximizes human cognitive power

accenture
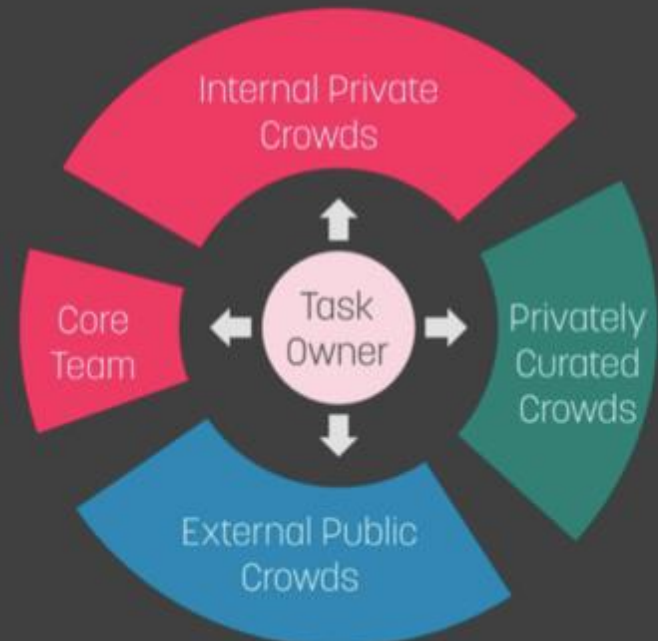High performance. Delivered.

Accenture Charts - Used by Permission

The future of the workforce looks less like a static hierarchy, more like a set of dynamic labor markets

Accenture Charts - Used by Permission

Accenture Charts - Used by Permission

Scope of Current Workforce Virtualization Efforts at Tech Labs

Micro-task	**Individual Task**	**Small Project**		**Large Project**
(30-90 Seconds)	(Hours – Days)	(Multiple People: Days - Weeks)		(Large Team): Weeks - Months)

Crowdsourced Data Enrichment	Enterprise Talent Brokering	Enterprise Flash Teams	Crowdsourced Software Testing	Hybrid / Crowdsourced Software Development

accenture
High performance. Delivered.

Accenture Charts - Used by Permission
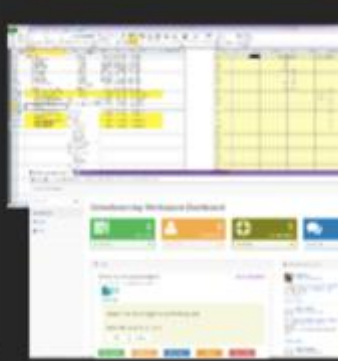
What Is Open Innovation?

open

Accessing people outside your organization up to

Crowdsourcing

An online, distributed, problem-solving and production model.

Innovation

ideas, concepts, designs, or solutions that meet a previously unmet need possibly resulting in significant advances in performance.
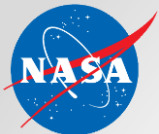
Who Has The Expertise/ Capabilities You Need?

Most of the bright people don't work for you – no matter who you are.

- Bill Joy

Co-Founder of Sun Microsystems

General Population or "**The Crowd**"

Your Organization
Actual Relative Size

High Value Expertise/Capability

People

Expertise/Capability
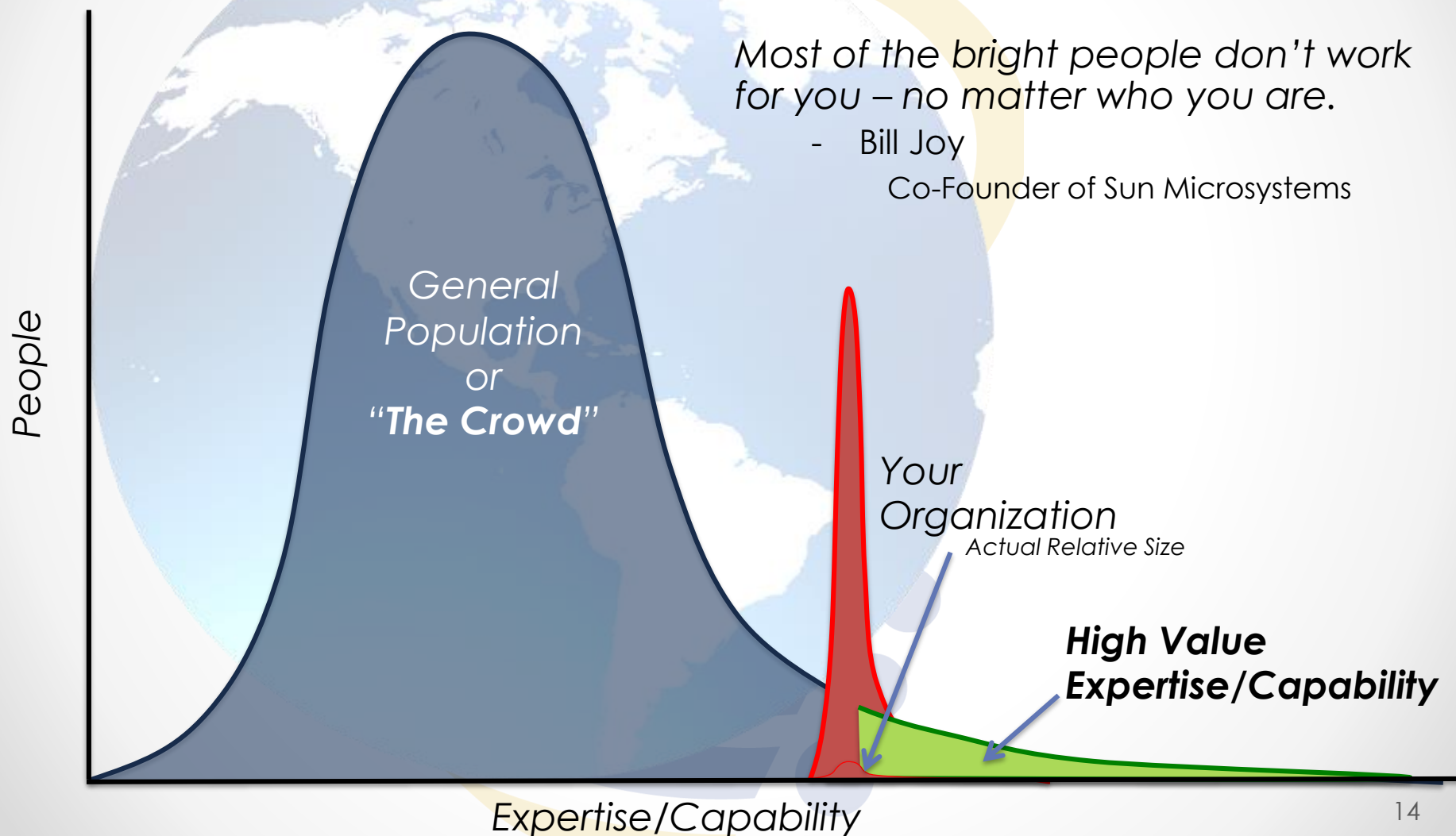
People Most Likely to Provide an Innovative Solution to Your Problem

Mathematicians
Researchers
Technicians
Scientists
Engineers
Lawyers
Artists
Physicians
Musicians
Operators
Educators
Entrepreneurs

Applicable
Experience

Domain
Specific
Expertise

Complementary
Expertise
or Experience

Passion,
Creativity,
and/or
Curiosity

Full-Time Employed
Part-Time Employed
Under-Employed
Freelance
Retired
Students
Hobbyist
Post-Docs
Post-Post-Docs
(frustrated researchers)
Teams/Groups
Startup Companies
Small Companies

Existing Community Member
Connected via Targeted Search
Connected via Challenge Marketing

Broad participation can bring a valuable idea, missed by the experts

Credit: Rinat Sergeev of Harvard University CIL

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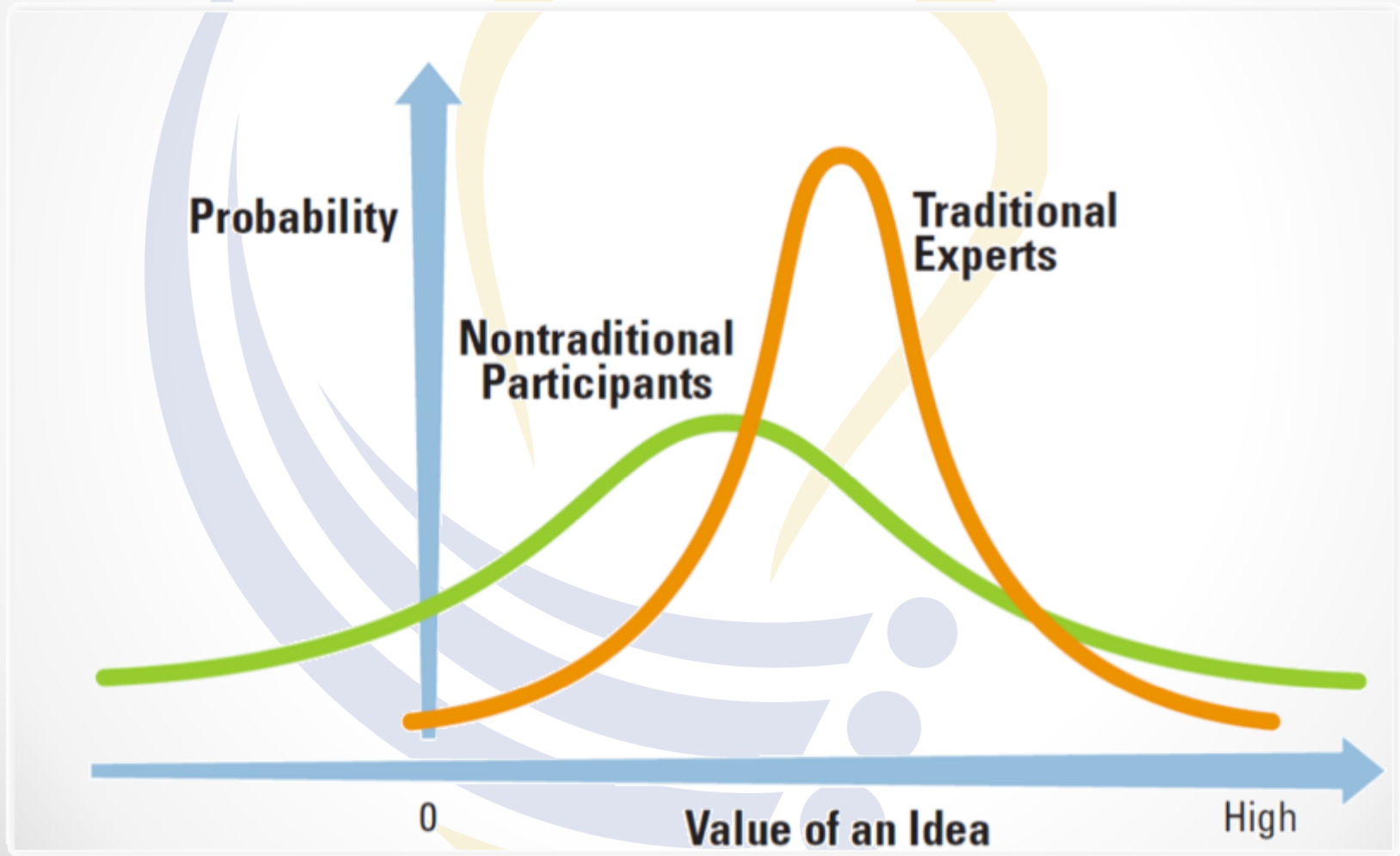
Networks & Communities
Curated Communities

Freelancers

Businesses, Universities, Individuals

Software Coders

25,000,000

2,000,000

1,100,000

Problem Solvers

Film-Makers

400,000

100,000

Engineers & Designers

3,250,000
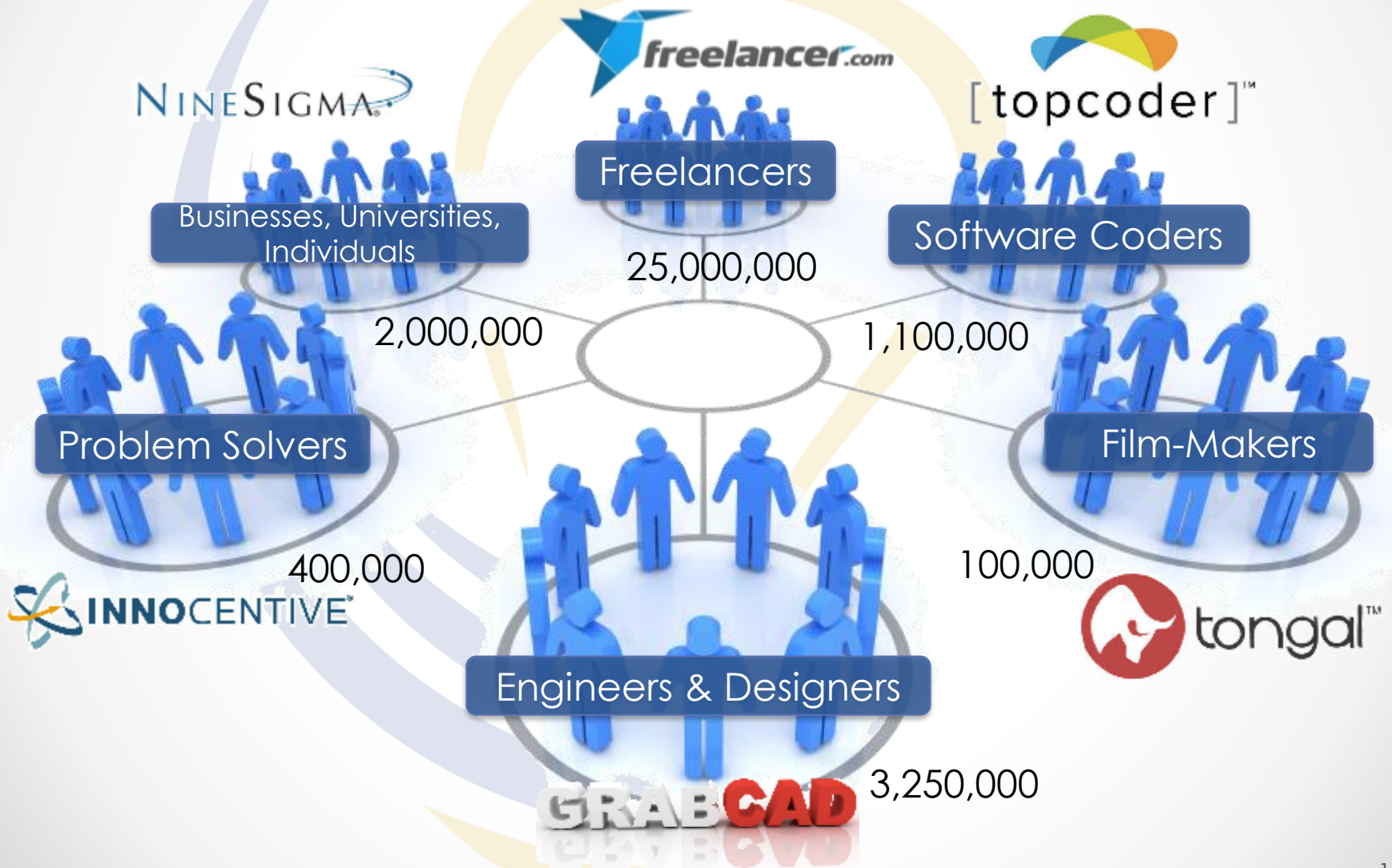
Curated Communities

Resources and Tools for Members

User Agreements for Privacy and Payment

Incentives for Members to Participate

Community Building & Communication

Mechanism for Handling IP Licensing and/or Transfer

Curated communities are built around enabling people to pursue their passion and create a win-win for the company and its community members.

They provide structure and incentives.

Communities do NOT like to be exploited!

Understanding Crowd Community Size
Visualizing 100,000 People

Texas A&M
"Kyle Field" Stadium
Capacity: 102,733

Visualizing NASA's Workforce of 60,000
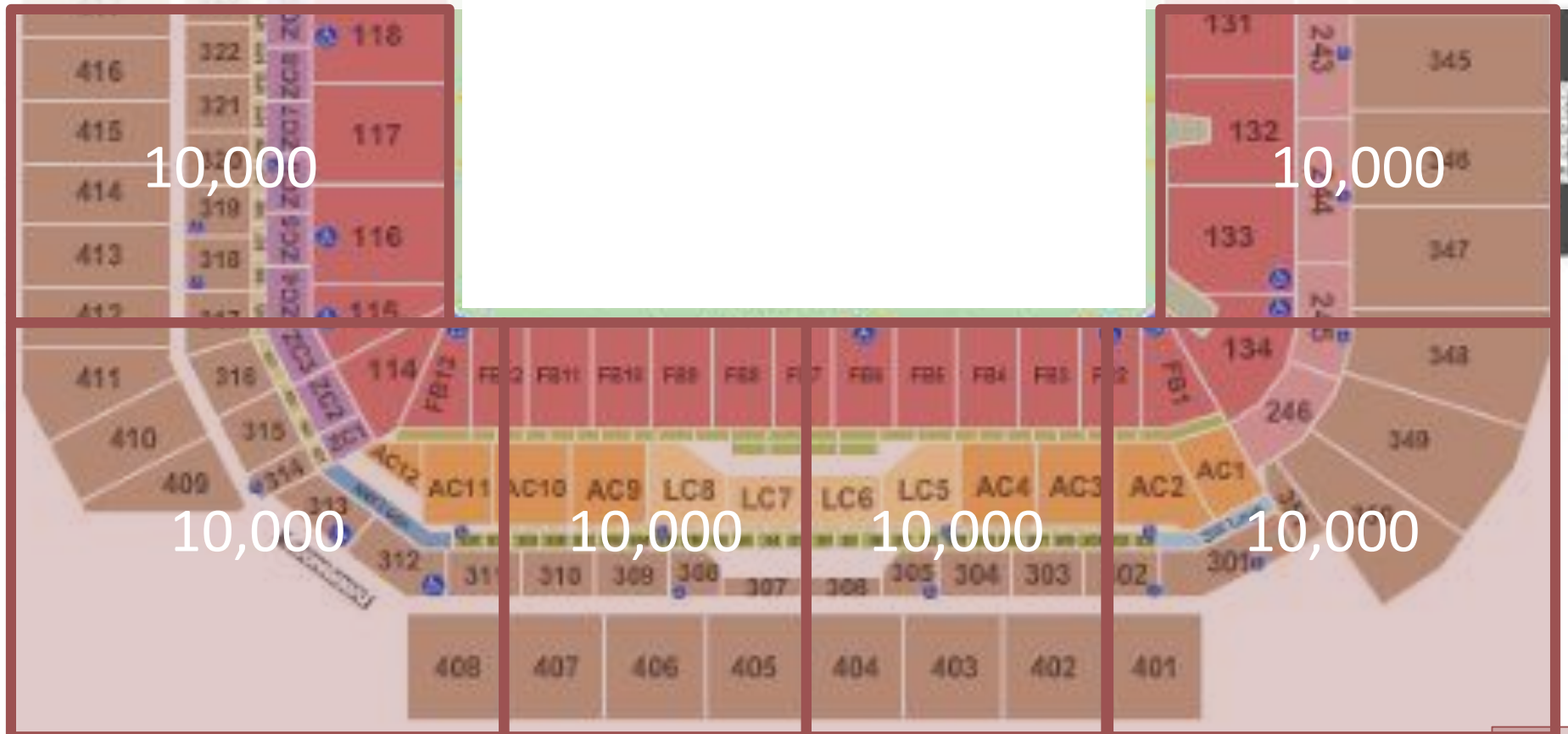
Visualizing NASA's Workforce of 60,000

NASA Contractors Est. 42,700

NASA Civil Servants 17,328

3000 Scientists 7%

15,400 Admin/ Technicians 36%

34,000 Total Engineers
(includes 3,200 Total SW Engineers)
4,000 Total Scientists

1093 Scientists 7%

9,725 Engineers 57%
(811 Computer/SW 5%)

6,278 Admin/ Technicians 36%

24,300 Engineers 57%
(2,100 SW Engineers 5%)

4 Stadiums

InnoCentive 400,000

Technical Problem Solvers

Community is 7X larger than NASA's Entire Workforce

23

11 Stadiums

Topcoder 1.1M

Software & Algorithm Developers

Community is 18X larger than NASA's Entire Workforce

Community is 340X larger than NASA's SW Eng. Workforce

400,000 Focused on Data Science/Algorithms

NineSigma 2M

Technical Problem Solvers
Network of Individuals, Universities, & Companies

Community is 33X larger than NASA's Entire Workforce

20 Stadiums

25
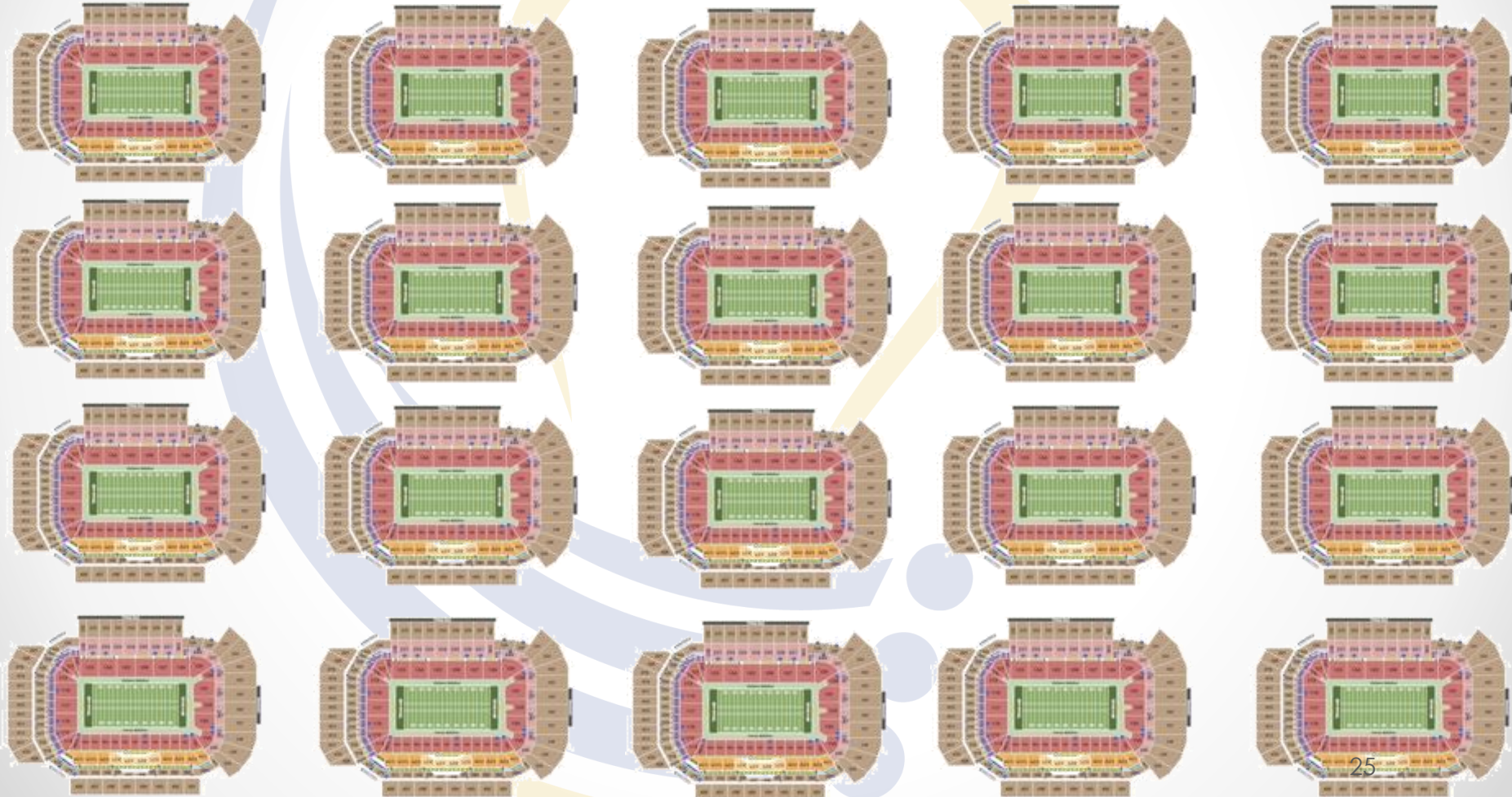
GrabCAD
3.2M

Mechanical
Engineers and
Designers

Community is 50X
larger than NASA's
Entire Workforce
>500X CAD Design

32 Stadiums

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Freelancer 25M

Multi-Discipline Freelancer Workers

Community is 400X larger than NASA's Entire Workforce
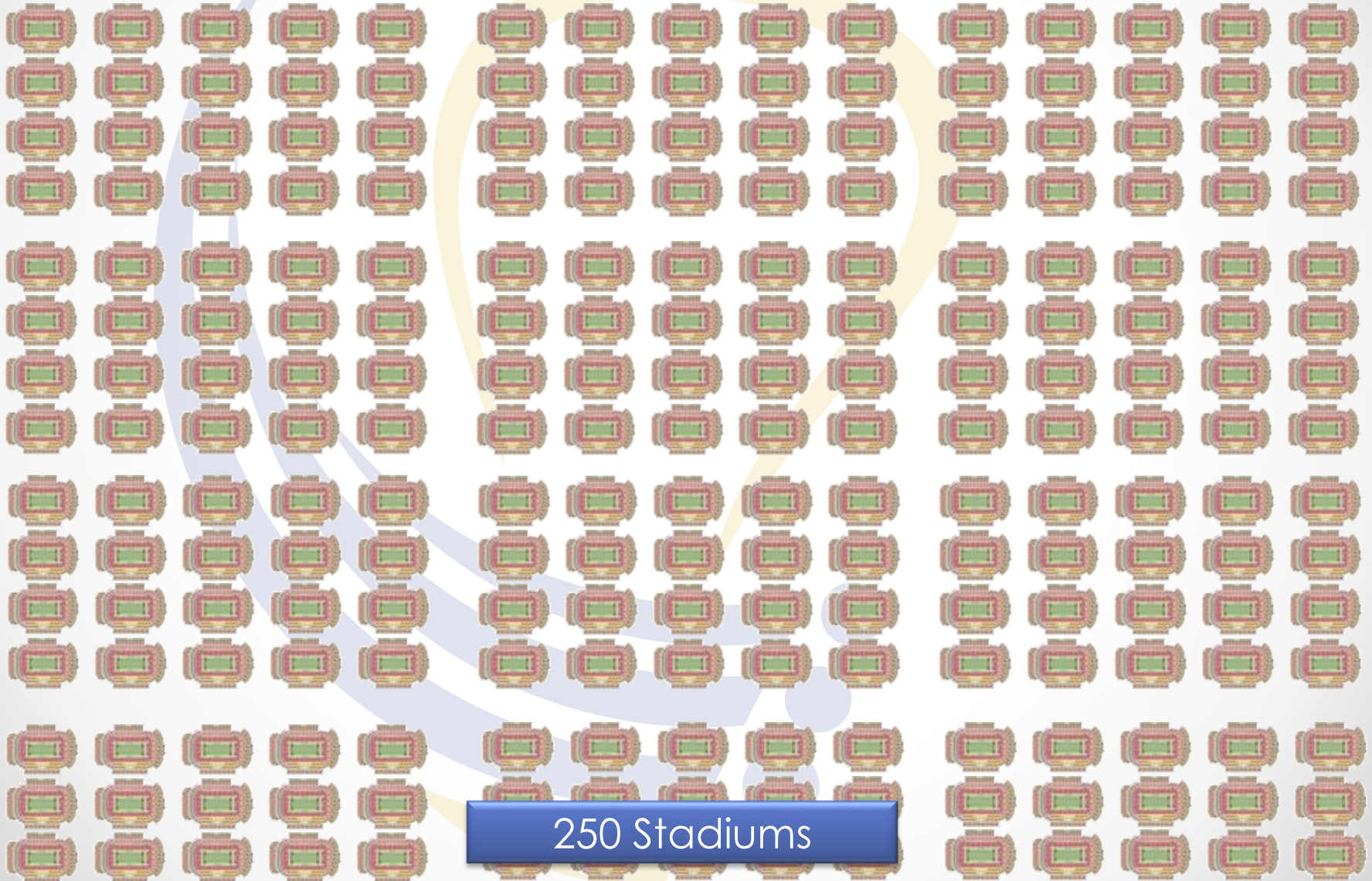
250 Stadiums

Specialized Curated Communities

According to IDC's Worldwide Software Developer and ICT-Skilled Worker Estimates, 18.5 million in 2014 (including ~7.5m hobbyists).
This means that Topcoder includes 6% of all software developers worldwide.

People

Topcoder Community of 1M+ Software & Algorithm Developers

NASA 60K CS & Contractor Workforce

NASA's 3000-6000 SW Engineers

Note that only a fraction of these may be available to a project

High Value Expertise/Capability

Software Expertise/Capability

Formulate the Problem Statement

A well formulated problem statement (with good success criteria)

Design the Challenge

A well designed challenge (including setting the right prize amount)

Execute the Challenge

Knowing how to do all of these steps really helps to mitigate the issues associated with this "too many solutions" problem.

ALL of these steps can help to minimize the number of solutions you end up needing to evaluate.

Solution Filtering (optional)

Solution filtering mechanisms are offered by some platforms

Pick the Winner(s)
Evaluating

Get Your Solution
IP licensing and/or transfer

Accessing the Crowd Using Challenges

Why Does The Crowd Contribute?

Earn Money (real or virtual)

Have Fun (or pass the time)

Socialize with Others

Multiple Incentives can often operate in parallel

Obtain Recognition or Prestige

(leaderboards, badges)

Do Good (altruism)

Learn Something New

Obtain Something Else

Create Self-Serving Resource

Center of Excellence for
Collaborative
Innovation

Gold Guts Good Glory

Effectively Using Communities

Solve a Problem

Create an Innovative New Solution

Apply an Known Existing Technology

(in an innovative way)

Find an Unknown Existing Solution or Technology

(you didn't know existed)

Develop a Product | Provide a Service

Access Best Possible Product or Service

(competition winner)

Access Very Specific Expertise

(found through competition)

Diverse Membership

Innovation from Diversity found via Challenges
(Experience, Context/Perspective, Expertise)

Expert or Domain Focused Membership

High Quality Products/Services
(via Competition to get Best in Domain)

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What Can I Get from Open Innovation?

Product	Description	Advantage
Ideas	Think brainstorming, but on a much larger scale (Can be simple or complex concepts)	Gets you "out of the box" ideas that you would not get naturally.
Technologies	Find technologies and solutions from unconventional or inaccessible sources.	Gets you the best available technology and guards against being overtaken by emerging tech.
Designs	Expand your trade space with conceptual, engineering, UI/UX or CAD designs.	Better chance of increased performance in your final design by leveraging highly parallel design cycles.
Software	Any or all parts of the SW development lifecycle including testing (with full documentation)	Resource limited SW development teams can accomplish much more in a shorter period of time.
Prototypes	Individuals, teams, or companies build prototype systems to meet specified target goals.	Multiplies investment in technology development and often results in new tech/systems that achieve advanced performance goals.
Multimedia	Graphics, Animations, or Video products (from simple graphics to fully produced movies).	Very cost effective. Products can be highly tailored. Leverages talented/passionate artists.

Crowdfunding
Financial contributions from online investors, sponsors or donors to fund for-profit or non-profit initiatives or enterprises.

Collective Knowledge
Development of knowledge assets or information resources from a distributed pool of contributors.

Tools
Applications, platforms and tools that support collaboration, communication and sharing among distributed groups of people.

Collective Creativity
Tapping of creative talent pools to design and develop original art, media or content.

Cloud Labor
Leveraging of a distributed virtual labor pool, available on-demand to fulfill a range of tasks from simple to complex.

Community Building
Development of communities through active engagement of individuals who share common passions, beliefs or interests.
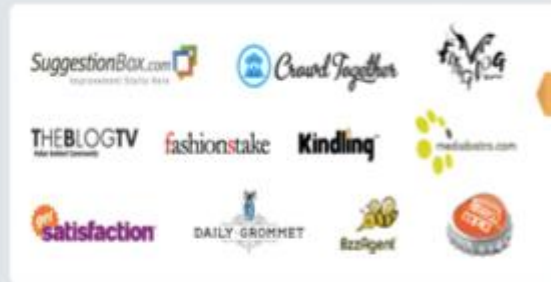
Civic Engagement
Collective actions that address issues of public concern.

Open Innovation
Use of sources outside of the entity or group to generate, develop and implement ideas.

Crowdsourcing is Mainstream

What is NASA Doing with Crowdsourcing?

NASA's Center of Excellence for Collaborative Innovation (CoECI)

- The **Center of Excellence for Collaborative Innovation (CoECI)** was officially launched in November of 2011 at the request of the White House Office of Science and Technology Policy (OSTP).

- **CoECI** works across all of NASA and with other federal agencies to *infuse crowdsourcing methods as a set of available tools* to create innovative, efficient, and optimal solutions to real world problems.

The Center of Excellence for Collaborative Innovation

Jason Crusan
Director CoECI
Director, Advanced Exploration Systems
HEOMD, NASA Headquarters

Lynn Buquo
Manager CoECI
Human Health and Performance
NASA Johnson Space Center

Steve Rader
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Michael Ching
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Stellar Solutions – NASA Headquarters

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Human Health and Performance
Wyle - Johnson Space Center

Christine Jenkins
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Jeff Doi
Information Management Specialist
Human Health and Performance
Wyle - Johnson Space Center

Robert Lewis
Web Community Manager
Human Health and Performance
Wyle - Johnson Space Center

Lisa Antonio
Resource Analyst
Financial Management
NASA - Johnson Space Center
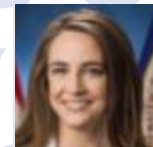
Ashley Harral
Contracting Officer
Procurement
NASA Johnson Space Center

Marta Choma
Contract Support
Procurement
NASA Johnson Space Center

Vance Benton
Contract Support
Procurement
NASA Johnson Space Center

Center of Excellence for
Collaborative
Innovation

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Prizes and Challenges Program Overview

A Brief History of Program Creation

NASA Prize Authority signed into law

Human Health and Performance conducts pilot procurement challenges

NTL contract with Harvard begins

CoECI stood up at OSTP request

OCT hires Prize and Challenge PE

SOLVE goes live

America Innovation and Competitiveness Act

| 2005 | 2009 | 2009-10 | 2010 | 2010 | 2011 | 2011 | 2012 | 2012 | 2012 | 2014 | 2014 | 2016 |

Administration issues Open Gov initiative

OMB M-10-11 Memo

COMPETES Act signed into law

First Space Apps Challenge

NASA Submits First America COMPETES Report to OSTP

NASA Prizes and Challenges Policy Directive Published

SOLVE

	CENTENNIAL CHALLENGES	NTL NASA Tournament Lab	EDUCATION PUBLIC OUTREACH	INTERNATIONAL SPACE APPS CHALLENGE	NASA Citizen Science
DURATION	- Years	- Months	- Months	- Days/Weeks	- Months
PRIZES	- 1 Million+	- $1K to $100Ks	- Recognition	- Recognition	- Recognition
PRODUCTS	- Tech Dev & Demo	- Ideas, Design, Software	- Inspire, Educate, Partner	- Software Apps	- Scientific Observations
PARTICIPATION	- USA	- Worldwide	- Worldwide	- Worldwide	- Worldwide

NASA Solve: www.nasa.gov/solve

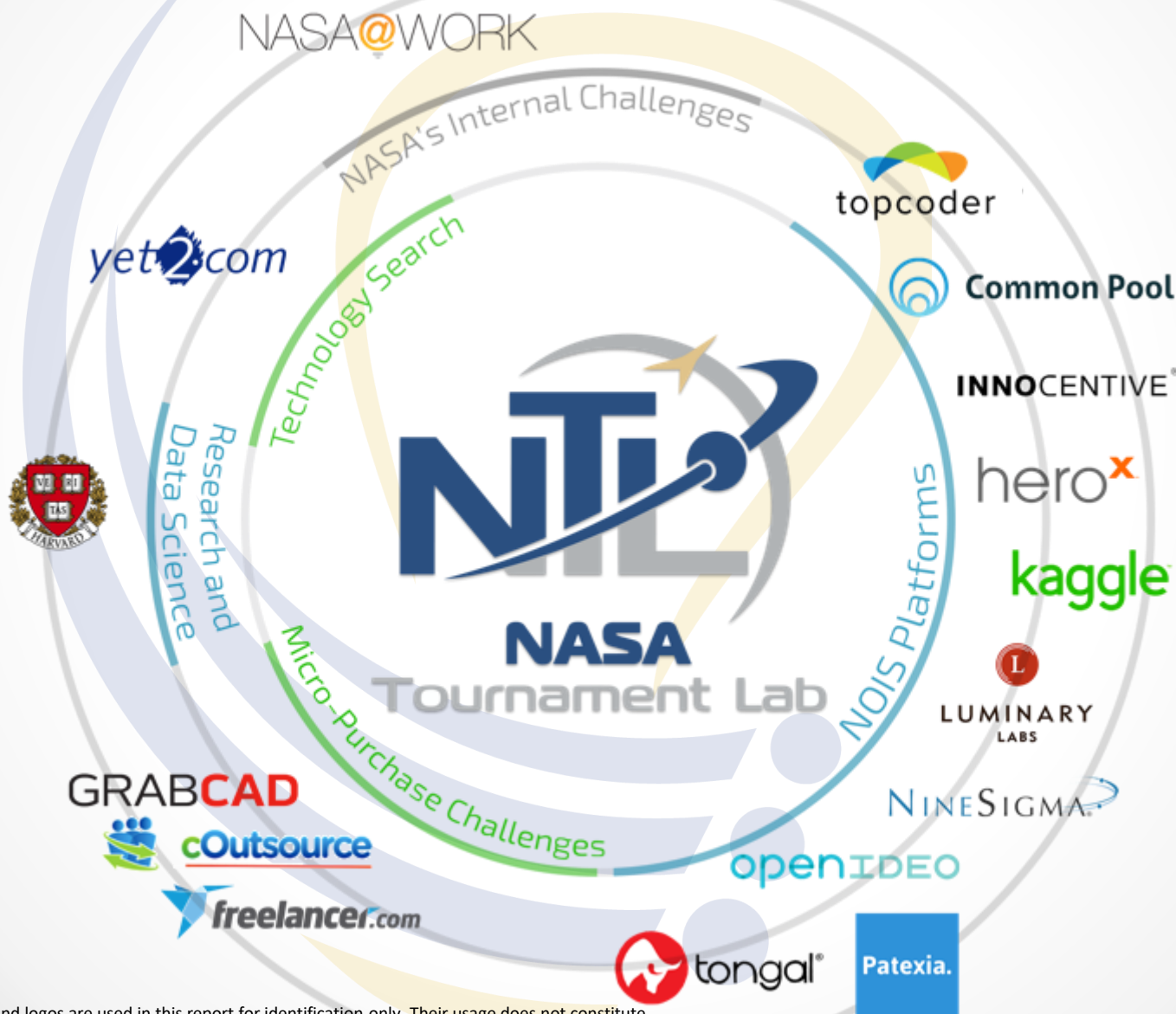|	**Duration**	**Prizes**	**Product**	**Participation**
Centennial Challenges	Years	$M+	Tech Dev & Demo	
NTL Curated Community Challenges	Months	$1K-$100Ks	Ideas, Designs, Software	
Student-Focused Challenges	Months	Recognition Rewards	Vary in scope, Inspire, Educate, Partner	
Space Apps Challenge	Days/Weeks	Recognition	Software Apps	

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The CoECI Toolkit
Available to ALL NASA Projects

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Open Innovation Services Platforms

	Ideation	Communication Design/Video	Data Science	Software/Apps	Prototype/Engineering	IP/Patent	Large Scale
topcoder	●	●	●	●			
Common Pool	●		●	●	●		●
heroX	●	●			●		●
INNOCENTIVE®	●	●	●		●		●
kaggle			●				
LUMINARY LABS					●		●
NINESIGMA	●		●		●		●
open IDEO	●						
Patexia.	●	●				●	
tongal	●	●					●

NASA Open Innovation Services
Challenge Task Order Process/Timeline

Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7

*1-3 weeks

*1-3 weeks

*1-2 weeks

Typically 3-6 months

CoECI Develops Challenge RFP for Proposed Task Order

RFP Review Meeting (CoECI + Vendors)

Applicable Vendors

NOIS Vendor A Develop T.O Proposals

NOIS Vendor B Develop T.O Proposals

NOIS Vendor J Develop T.O Proposals

Proposals Don't Meet Requirements/Constraints

Submission Deadline

Vendor Selection

Selected Vendor Announcement

Task Order Kickoff Meeting

Status Meetings (CoECI Coordinator + Vendor)

Task Order Wrap-Up Meeting

Challenge Project Execution

Selected NOIS Vendor Executes Task Order

Challenge Development

*1-2 months

Challenge Execution

*1-3 months

Select/Award Winner(s)

*1 month

(Re-Scope/Rework RFP for Proposed T.O.)

* Target duration based on scope and complexity of the Task Order.
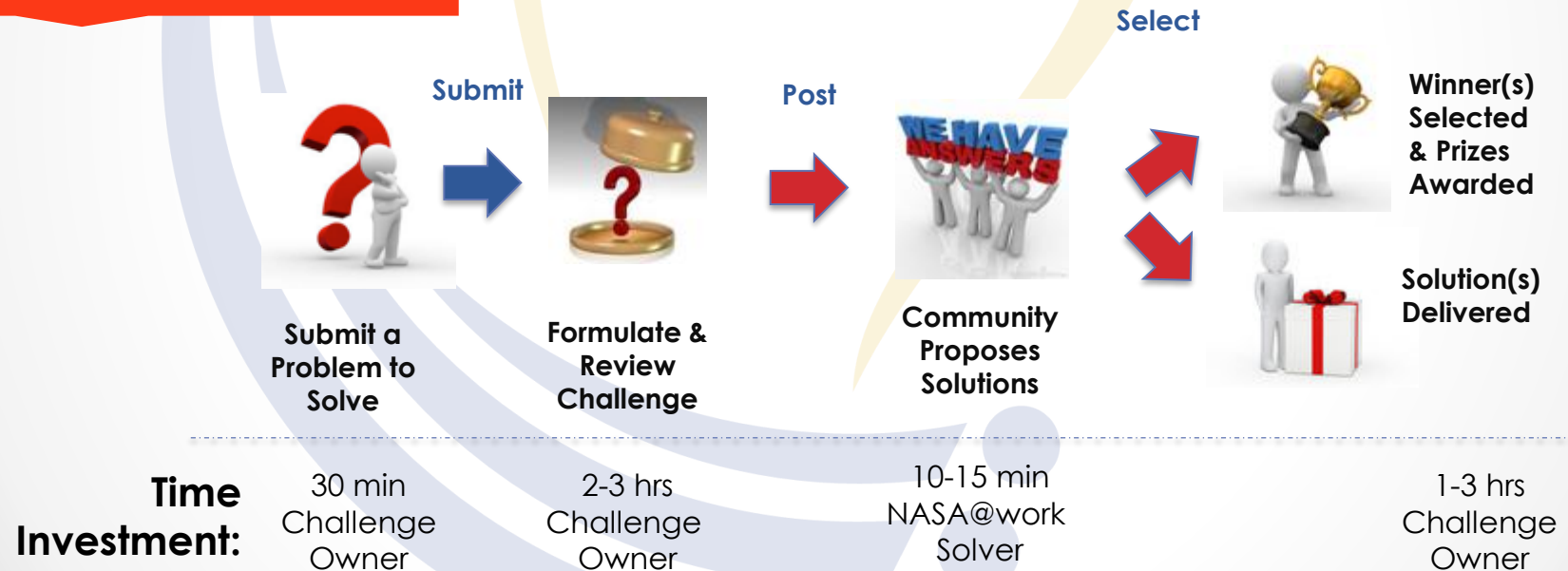
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NASA@WORK
Start with our most innovative community: NASA

NASA@WORK

What Is NASA@work?

- A NASA-wide platform for employees to find technical solutions, new ideas, or expertise using prize-based challenges (crowdsourcing).

How Does It Work?

Submit → **Post** → **Select** → **Winner(s) Selected & Prizes Awarded** / **Solution(s) Delivered**

	Submit a Problem to Solve	Formulate & Review Challenge	Community Proposes Solutions		Winner(s) Selected & Prizes Awarded / Solution(s) Delivered
Time Investment:	30 min Challenge Owner	2-3 hrs Challenge Owner	10-15 min NASA@work Solver		1-3 hrs Challenge Owner

NASA@WORK

People that work at NASA want to make a difference!

Over 17,500 Registered Members

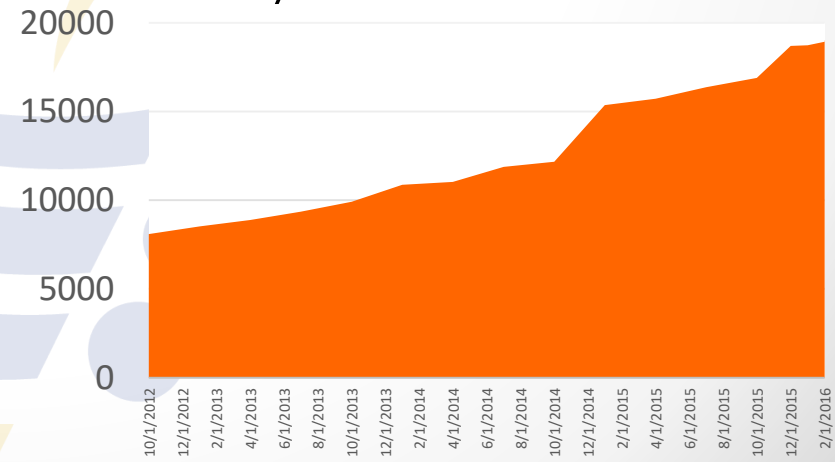~30% of NASA's 60,000 CS & Contractor Workforce

54% of all Civil Servants and 20% of all Contractors are members

18-20 Challenges per Year

2-4 Active challenges posted at any one time

Growth of the NASA@work Community since October 2012

130 Challenges Posted

~80% Success Rate

NASA@WORK Lead
Carissa Callini

Map labels: Ames Research Center; Vandenberg Air Force Base (KSC); Jet Propulsion Laboratory; Dryden Flight Research Center; White Sands Test Facility (JSC); Johnson Space Center; Michoud Assembly Facility (MSFC); Stennis Space Center; NASA Shared Services Center; Kennedy Space Center; Marshall Space Flight Center; Langley Research Center; NASA Headquarters; Wallops Flight Facility (GSFC); Goddard Space Flight Center; Goddard Institute for Space Studies; Glenn Research Center; Glenn Research Center Plum Brook Station; Software Independent Verification and Validation (IV&V) Facility (GSFC)

Chart x-axis: 10/1/2012, 12/1/2012, 2/1/2013, 4/1/2013, 6/1/2013, 8/1/2013, 10/1/2013, 12/1/2013, 2/1/2014, 4/1/2014, 6/1/2014, 8/1/2014, 10/1/2014, 12/1/2014, 2/1/2015, 4/1/2015, 6/1/2015, 8/1/2015, 10/1/2015, 12/1/2015, 2/1/2016

Chart y-axis: 0, 5000, 10000, 15000, 20000

Search Challenges...

Welcome to the NASA@work platform!   ✕

This platform is open to Civil Servants. Contractors may be able to participate with approval of their company management. If you are a contractor, read **important information** that you and your company need to be aware of before using this platform.

Newsflash: NASA@work August Bulletin

⊕ **Create a Challenge**

⊕ **Suggest a Challenge**

LEADERBOARD

FEATURED CHALLENGES

Non-Treadmill Device that provides Treadmill Benefits for Future Mars/Exploration Missions #2147
Posted by Moore, Cherice (JSC-ER311) on Aug 10, 2015

Exercise is a major mitigation to many deleterious physiological effects of spaceflight and is required for crewed missions. In particular, treadmills have been critical in providing multiple physiological benefits to crewmembers for missions greater than approximately 30 days, including reduced degradation of:

1. Bone structural strength of lumbar spine, pelvis, femoral neck and trochanter (due to the ground reaction forces of approximately 2-3 times the person's body weight that are reacted by the bones and muscles of the lower body)
2. Cardiovascular fitness (due to the increased heart rate from aerobic exercise)

⌄ Read more...

🏷 Engineering, Experimental Design, Hardware / Systems / Design, Human Health and System Support, Ideation, Operations, Technology Development

📅 Sep 18, 2015

🏆 Award Details >>

🚩 OPEN

50 Solutions/Replies Submitted

☑ Edit   👁 View Challenge   Deadline OFF   ON Following

Voting Challenge: The Write Stuff! #2179
Posted by Drake, Bret G. (JSC-XM111) on Sep 01, 2015

The initial review and evaluation of the The Write Stuff Challenge have been completed (to see the original challenge write-up, please visit: https://nasa.innocentive.com/ici/UXChallenge/show/2122). The Challenge Owner received a fantastic response and the NASA@work community now has the opportunity to vote for their favorite stories!

📅 Sep 11, 2015

🏆 Award Details >>

🚩 OPEN

Recent winners		
Arai, Tatsuya (JSC-XA111)[OCEANEERING SPACE SYSTEMS]		
Solved:		2
Posts Written:		4
DARCIE, CHRISTINA M. (JSC-EC311)		
Solved:		2
Posts Written:		4
Sims, Jerry L. (IVV-1800)		
Solved:		1
Posts Written:		1
Dorris, Karen J. (JSC-OP)[BARRIOS TECHNOLOGY LTD]		
Solved:		1
Posts Written:		3
LAUCHNER, ADAM C. (JSC-OZ)[THE BOEING COMPANY]		
Solved:		1
Posts Written:		4
Moore, Kevin (JSC-OP)[BARRIOS TECHNOLOGY LTD]		
Solved:		2
Posts Written:		17
Schneiderman, Jason S. (JSC-SK)[WYLE INTEG. SCI. & ENG.]		
Solved:		1
Posts Written:		4
Hintze, Paul E. (KSC-UBR30)		
Solved:		2
Posts Written:		3

RECENT ACTIVITY

NASA@WORK Challenge Case Studies

Determining Urine Volume in Microgravity
Found an existing prototype saving $1.3M & 3-5 years of development.

Use of Thorium Instead of Uranium
Discovered forgotten Apollo-era research results.

Radiation Protection
Discovered solution from 1967 that given technology advances is possible to manufacture today.

Washing Produce Grown in Space
Found 2 practical/effective solutions saving an estimate of $125K.

Determining Urine Volume in Microgravity

Challenge –
Sought to identify an alternate method for real-time in-flight urine volume measurements and maintain the capability to take samples to Earth for additional analysis

Center of Excellence for **Collaborative Innovation**

NASA@WORK

60 Submissions

2 Solutions Awarded

Saved an estimated $1.3 M; 3-5 years

Results

- Microgravity Capillary Graduated Cylinder (working prototype) and Calorimetry
- Unknown collaboration was identified within a sister organization

Odor Control and Trash Containment for Orion

Challenge –
Find a way to control the odor from trash and waste for long duration (21 day) missions on Orion with mass and volume minimized.

29 Submissions

5 Solutions Awarded

Significantly Advanced Towards a Solution

Center of Excellence for **Collaborative** Innovation

NASA@WORK

Results

"We received a lot of great ideas….unique innovative ideas were submitted … Great results overall - gave us a huge head-start on this project's development."   Holly Cagle – Challenge Owner

Use of Thorium Instead of Uranium

Challenge –
This challenge sought to identify any research that NASA has conducted into the use of Thorium instead of Uranium to generate nuclear power

17 Submissions

1 Solution Awarded

Also discovered Apollo-era research results

Center of Excellence for **Collaborative** **Innovation**

NASA@WORK

Results

Winning submission was "instrumental in helping KSC understand the research NASA has funded in this area"   Michael Lester– Challenge Owner.

Lab Equipment Obsolescence: Cytometer

Challenge – This challenge sought to identify cost-effective solutions to keep the Cytometer in operable use

41 Submissions

4 Solutions Awarded

Center of Excellence for **Collaborative** Innovation

NASA@WORK

Significantly Advanced Towards a Solution

Results

- Challenge received 4 different detailed suggested solutions that have a high chance of helping to achieve the challenge goals.
- Life extension of this hardware will save significant budget.

Display Format Development System for Deep Space Human Spacecraft

Challenge – Looking for displays for use onboard a deep space human module to be used by the crew in combination with Orion spacecraft

Center of Excellence for Collaborative Innovation

NASA@WORK

51 Submissions

2 Solutions Awarded

Owner impressed at the number and quality of submissions

Results

- Both solutions were viable and previously not known to the Challenge Owner (CO)
- Implemented several displays using the software platform that was selected

Washing Produce Grown in Space!

Challenge – Seeking practical method solutions to sanitize produce grown on ISS.

37 Submissions

2 Solutions Awarded

Estimated cost savings of $125K

Center of Excellence for **Collaborative** **Innovation**

NASA@WORK

Results

- Two solutions selected viewed as practical and effective
- One of the biggest benefits was collaborating with JSC on SBIRs activity currently in work

Non-Invasive Means to Detect Internal Leakage

Challenge – Identify technologies and/or concepts which will provide monitoring of the pressure in a small volume between seals (or valves) non-invasively

20 Submissions

1 Solution Awarded

17 Participants from 7 Centers

Center of Excellence for **Collaborative Innovation**

NASA@WORK

Results

- "Half of the Solutions were deemed by the team to be of sufficient quality to consider for an award. My team chose to award the Solvers for their 'Wireless Ceramic Pressure Sensor' concept which holds promise."

Radiation Protection

Challenge – Search for new material systems/approaches for shielding electronics equipment and personnel from ionizing radiation, specifically electrons

12 Submissions

2 Solutions Awarded

Center of Excellence for **Collaborative Innovation**

NASA@WORK

Tapped into Historical Data via the Human Network

Results

- Winning solution provided aa very detailed description on the use of Tungsten Dust to provide the protection.
- A solution from a 1967 reference document that given technology advances is possible to manufacture today.

A Durable/Permanent Anti-Fog for the EMU Helmet

Challenge –
This challenge sought to identify an alternative permanent/durable anti-fog that could be applied to the helmet bubble on the ground.

52 Submissions from 44 members

2 Solutions Awarded

Significantly Advanced Towards a Solution

Center of Excellence for **Collaborative Innovation**

NASA@WORK

Results

- Challenge received 2 submissions that both pointed to a new commercially available nano-technology based product that provides super hydrophobic coating.

Mars Gap Challenges

Challenge – Find the hidden gaps in our existing Extra-Vehicular Activity (EVA) products.

Total for 2015/2016 Challenges 34 submitters and 62 submissions

1 Solution Awarded (2016)

Exposed unknown gaps in the design

Center of Excellence for **Collaborative Innovation**

NASA@WORK

Results

- Challenge found a gap in the design's handling of time-delayed operations required for deep space exploration and the resulting increased workload on crew when ground support is not available.

EVA 50th Anniversary Logo

Challenge – Design a sophisticated logo to represent the 50th Anniversary of EVA and EVA's integral role in future exploration based on its 50 year legacy.

Center of Excellence for **Collaborative Innovation**

NASA@WORK

39 Submissions from 18 Submitters

2 Solutions Awarded

A Number of High Quality Designs to Select From

Results

- NASA employees submitted a whole range of creative, high quality graphics that reflected the goals of the challenge.

Seeking Art Submissions that Encapsulate EVA's 50th Anniversary Theme: #SuitUp

Challenge –
This challenge sought to generate art that represents this EVA 50th Anniversary theme that can be used as displayed art around NASA centers.

Center of Excellence for
Collaborative
Innovation
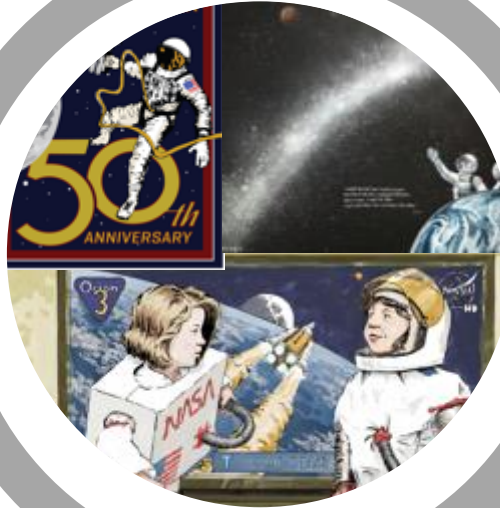
NASA@WORK

14 Submissions from 11 members

3 Solutions Awarded

Solved

Results

- Resulted in some really creative and high quality original art that captured the theme of the EVA 50th Anniversary.

Impact of Gender/Sex on Spaceflight Technologies

Challenge –
This challenge sought concept ideas to account for differences in the way men and women adapt to space and spaceflight technologies.

Center of Excellence for
Collaborative Innovation
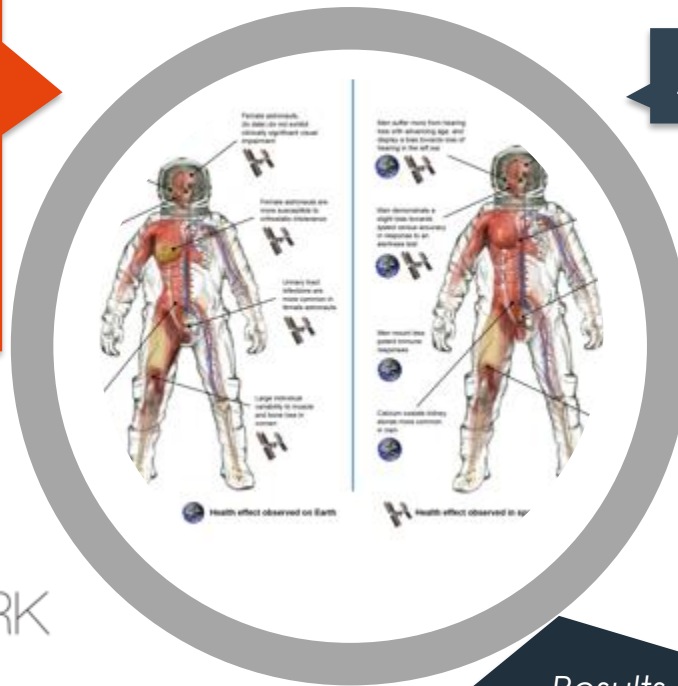
NASA@WORK

7 Submissions from 6 members

1 Solution Awarded

Increased Issue Awareness

Results

- Awareness challenge that resulted in detailed approach/process on making future designs more equitable.

Incorporating Active Tintable Electronic Coatings into Next Generation Space Suit Visor

Challenge –
Ideas for how to incorporate active tintable electronic coating technologies such as electrochromics or variable solar reflectance into a polycarbonate helmet that will support the next generation space suit.

Center of Excellence for
Collaborative Innovation

NASA@WORK

19 Submissions from 9 members

2 Solutions Awarded

Resulted in Key Contacts at Vendor with Electro-chromics Experience

Results

- Resulted in collaborative company contacts and useful out of the box ideas.
- Provided useful results with a very low time investment (and no cost to the project)
- Gave an idea how to better write the SBIR- understand what is commercially available.

NASA@WORK
Incentive Program:

1. Cool NASA Experience
   - a cool tour for the winner at their center
2. Astronaut Autographed Item
   - personalized astronaut autograph for the winner
3. Item Flown in Space
   - an NASA@work sticker-badge that was flown in space
4. NASA External Public Recognition
   - public recognition on the NASA@work external website; tweets by multiple NASA handles
5. Recognition by Center Director and Agency Management
   - a meeting or lunch with the winner's Center Director and/or with Agency Management
6. Call from Space/Social Media Recognition from Astronaut
   - a call from space or social media recognition from an astronaut
7. Themed Award System
   - a themed award system based on how many times a winner has won on the NASA@work platform
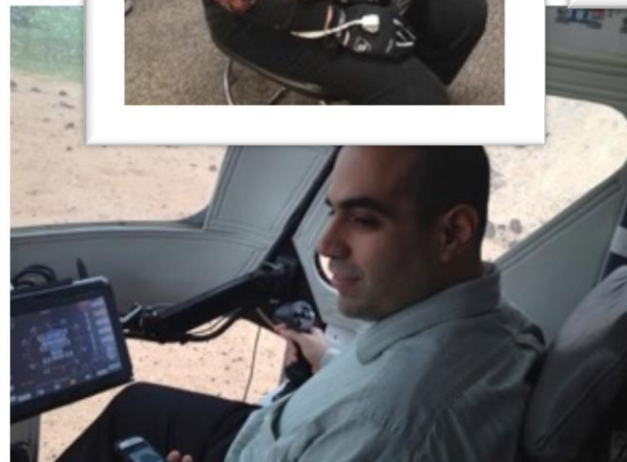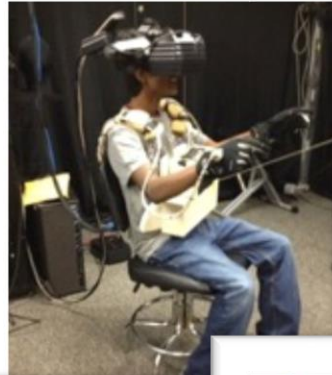
NASA@WORK

Join by going to
http://nasa.innocentive.com

Use Your NASA ID Max Login

NASA Open Innovation Services (NOIS) Contract

- In June, 2015 NASA announced the results of the NASA Open Innovation Services (NOIS) Procurement.

- Result was 10 contracts with 10 companies who specialize in challenge management and administration in a variety of disciplines on a variety of platforms.

- Greatly expanded the kind of challenges NASA can launch as well as generating some healthy competition among the companies on contract.

Innovation & Problem Solving Challenge Results

Using Challenges with Diverse Communities to develop unique and innovative approaches to unsolved problems

NTL Innovation Platforms

- Innovative Problem Solving Communities composed of large diverse communities with a variety of expertise

- Over 5 years of experience with InnoCentive challenges

- New NASA Open Innovation Services (NOIS) Contract added new communities

- A total of 6 communities focused on Innovative Problem Solving Challenges available to NASA
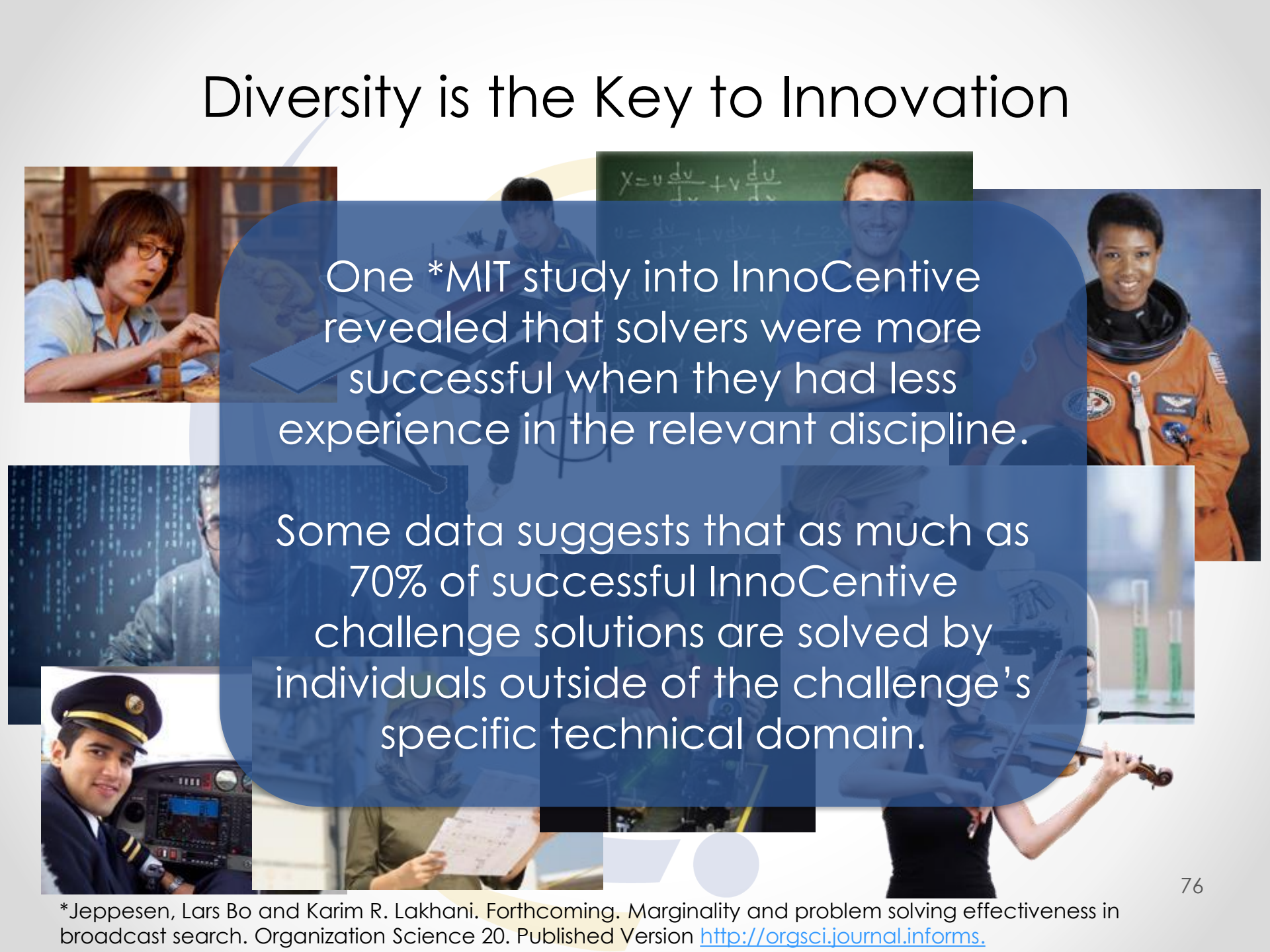
Diversity is the Key to Innovation

One *MIT study into InnoCentive revealed that solvers were more successful when they had less experience in the relevant discipline.

Some data suggests that as much as 70% of successful InnoCentive challenge solutions are solved by individuals outside of the challenge's specific technical domain.

*Jeppesen, Lars Bo and Karim R. Lakhani. Forthcoming. Marginality and problem solving effectiveness in broadcast search. Organization Science 20. Published Version http://orgsci.journal.informs.

Generalize the Problem & Leverage Diverse Solvers

INNOCENTIVE®

Remove grease from
potato chip
fluid from a delicate
wafer

The Crowd Can Provide Unexpected Solution Capacity

Roche

Diagnostics

Problem: Precise measurement of sample quality and quantity

Internally sought a solution for over 15 years.

Source: Wikimedia Commons

INNOCENTIVE

6 Week Challenge $20,000 Prize

Solution Found

Non-winning submissions **replicated everything Roche had tried over its 15 years** of proprietary research.

Case Study: Julian Birkinshaw, MLabnotes, University of London Business School

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Problem Solving Challenge Case Studies

Non-Invasive Measurement of Intra-Cranial Pressure
$35K Challenge discovered algorithm based solution & resulted in partnership.

Strain Measurement of Kevlar and Vectran Webbing
$40K Challenge resulting in 3 solutions "So simple, so elegant how could we NOT have thought of this ourselves".

Mars Balance Mass
$50K Challenge found novel concept using trace elements for ballast mass and atmospheric analysis.

Disruption Tolerant Network Security Key Architecture
$108K Challenge solved a previously unsolved problem applying a variation of Byzantine Generals' problem.

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NON-INVASIVE MEAUREMENT OF INTRA-CRANIAL PRESSURE

Challenge - Non-invasive method or technology to measure the absolute intracranial pressure (i.e., the pressure of the interior of a human's head).

Total Cost to NASA $35,000

Challenge Award $15,000

Resulted in Partnerships

Results

- UCLA's ICP Algorithm was selected as winning solution; Also identified via a Tech Scouting effort
- Being considered as addition to active flight study pending accuracy validation

MARS BALANCE MASS

Challenge - Ideas to find dual purpose for balance mass that is jettisoned from Mars landers to balance the aircraft during entry and landing

Total Cost to NASA $50,000

Challenge Award $25,000

Concept for Future Lander Designs

Results

- Winner: Concept for ionospheric and atmospheric analysis of Mars via tracer element release

- Honorable Mention: Concept to study Mars winds using deployable micro-balloons

STRAIN MEASUREMENT OF KEVLAR AND VECTRAN WEBBING

Challenge - Solve a 3-year-old problem for how to test Kevlar webbing for its durability in the trying conditions in space.

Total Cost to NASA $40,000

Challenge Award $20,000

72 Submissions from 19 Countries

NTL NASA Tournament Lab

INNOCENTIVE

Results

3 Awards for similar solutions - winning solutions were quick, simple & easy to test

"So simple, so elegant how could we NOT have thought of this ourselves."
Tom Jones, Deputy Project Manager, Research Lunar Surface Systems

DTN SECURITY KEY ARCHITECTURE

Challenge – Develop a conceptual architecture for exchange of security keys in a disrupted and/or delayed network. There was no known method for achieving this.

Total Cost to NASA$108,000

Challenge Award $40,718

Solved a Previously Unsolved Problem

Results

Resulting architecture successfully solved the problem by applying a variation of the Byzantine Generals' problem (typically used for distributed computing).

GALACTIC COSMIC RAY

2 Challenges -
To develop concepts for protection of humans from Galactic Cosmic Rays (GCR).
To develop specific magnetic field or material layer configurations to improve GCR protection.

Total Cost to NASA (per challenge)
$32,000 & $48,000

Challenge Awards
$12,000 & $0

Pay for Performance - No Solution, No Prize

NTL
NASA Tournament Lab

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Results

- No concepts or solutions were found that the GCR team was not already aware of and working
- Validated the GCR team's approach to addressing this very difficult issue

TEST METHODS FOR ASSESSING WEAR FOR SPACE SUIT TEXTILES

A challenge seeking proposals for test methods or procedures to assess wear/damage to candidate space suit textile materials

Total Cost to NASA $40,000

Challenge Awards 3 x $5,000

23 Submissions from 7 countries

Results

- Three different test methods were awarded with quite different approaches.
- One Team from University of Akron, one from a graduate student, and one from a metal worker.
- Winning solution provided a quick and easy test method that yields clear and concise results.

CONVERTING IN SITU MATERIALS

A challenge seeking systems that can convert in situ materials into interlocking structural elements for construction that can support exploration on a planet.

Total Cost to NASA
$40,000

Challenge Awards
3 x $5,000

Winning solution from a world recognized leader in the field

Results

- 3 winning concepts/technologies were selected
- Submissions were all very detailed with supporting math and chemistry data
- A wide range of approaches were submitted (63 submissions total)

BIO-INSPIRED ADVANCED EXERCISE CONCEPTS

Challenge - Seeks bio-inspired approaches for compact and efficient Advanced Exercise Concepts (AECs). These concepts are needed to counteract muscular atrophy and improve the overall wellness of astronauts living in zero-gravity during a 21 day mission.

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Total Cost to NASA $44,175

Challenge Award $15,000

Prototype in-work

Results

- The Challenge winner provided the solution, "Bio-Inspired Micro-Gravity Exercise Concept" (BIMGEC).
- This concept gathered inspiration from a chameleon's tongue which stores energy in a spiral structure at the base of its tongue.

CLIMATE RESILLIENCE DATA

Challenge – Leverage the federal government's climate-relevant data resources to spur innovation in order to advance awareness for the impacts of climate change

Total Cost to NASA $107,500

Challenge Award $31,133

TAWA and Permafrost prototypes candidates for future dev.

Results

- Produced ideas, storyboards, lightweight clickable prototypes (available on NASA github), and shareable site map flowcharts approved by NASA and USGS
- Discussions underway with EPA for possible future collaboration

NASA CLIMATE MODELING

Challenge – Seeking new sources of observational data for a the climate modeling initiative – an activity to assemble climate analysis data from 1979 to today
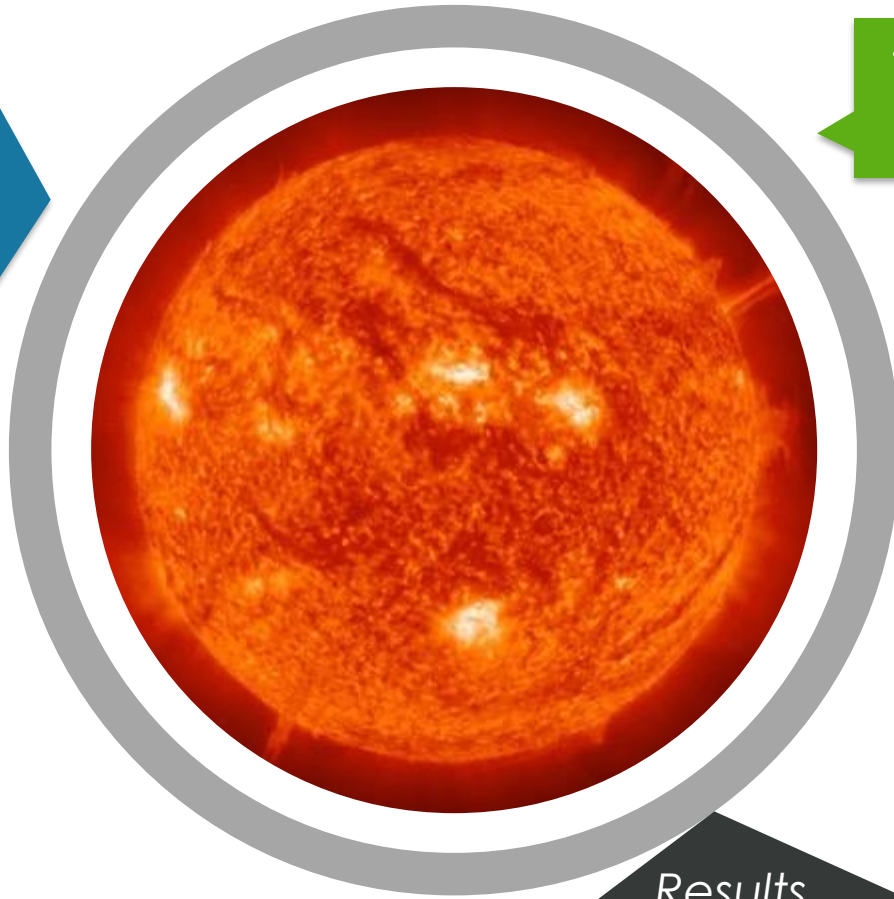
Total Cost to NASA $12,400

Challenge Award $6,575

New data source identified

Results

- Winning solution exposed a climate data source unknown to NASA climate scientists
- Probability of improving the overall MERRA data initiative

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[topcoder]™

FLEXIBLE SPACE HATCH SEAL DEVICE

Challenge – A new sealing method or device to reversibly join the edges of flexible materials

Total Cost to NASA $34,000

Challenge Award $15,000

Reduces mass and volume parameters

Results

- Four new technologies for possible advancement through NASA's Space Technology, Game Changing Development (GCD) Program.
- Plans to further pursue two of the concepts to incorporate into elements of future airlocks and inflatable structures.

MARS SPACE PIONEERING

Challenge – Develop concepts for humans to go further and stay longer in space with an ever decreasing need to be reliant on Earth, approaching "Earth independence"

Total Cost to NASA $35,000

Challenge Award $15,000

New/ Expanded Concepts

Results

New and/or expanded concepts to consider in future planning
- Mylar encased ice for building structures
- integrated bio-regenerative life support
- extraction of starch from algae as a food supplement.

OpenNEX IDEATION: NEW WAYS TO USE EARTH SCIENCE DATA

Challenge – Create innovative ways to use OpenNEX data from the agency's Earth Science satellites
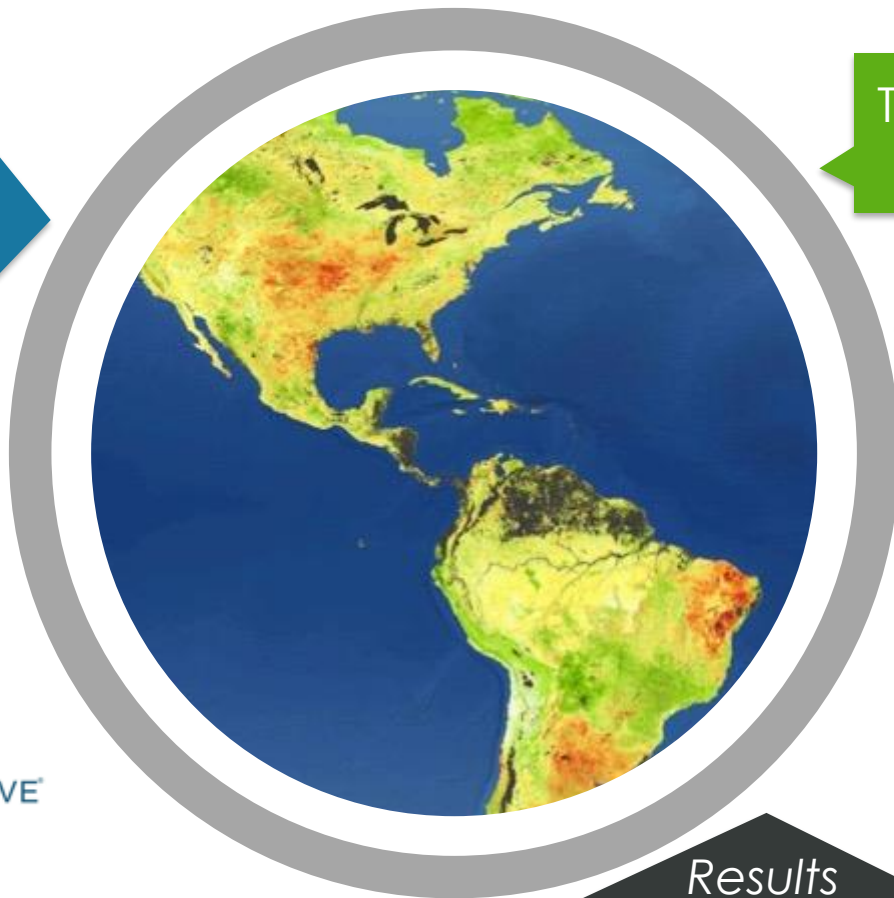
Total Cost to NASA $28,727

Challenge Award $10,000

Highlighted OpenNEX data; contributed to follow-on app challenge

Results
- Phase 1 of OpenNEX challenge: 4 winning ideas selected used to seed Phase 2 Build-An-App challenge
- Brought high visibility to OpenNex data and capabilities

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InnoCentive: Current Industry Challenges

Seeking New Technologies for Denture Adhesives

Masking Salty Taste

Enel Challenge: Portable Communication System for Tunnels and Confined Spaces

Increased Oxygen

HeroX	30 open challenges (50+ total)	38M members
NineSigma	27 open challenges (2500+ total)	2M members
InnoCentive	23 open challenges (2000+ total)	400K members
The Common Pool	14 open challenges (30+ total)	100K members
Luminary Labs	11 open challenges (15+ total)	100K members
OpenIDEO	6 open challenges (40+ total)	85K members
Patexia	1 open challenge (170+ total)	12K members

Over 100 industry &government innovation challenges are in progress*.

*As of May 13, 2016

General Fusion Challenge: Fast Current Switch in Plasma Device

Invertebrates in River and Estuary Systems

Portable Roof Damage Detection

Algorithm & Software Challenge Results

Leverage Competition to Optimize Complex Algorithmic Problems or Build an App

NTL Algorithm & Software Platforms

- Data Science and Software Development Communities composed of large communities with both specialized expertise and diversity.

- Over 5 years of experience with Topcoder challenges

- Services available include:
    - Big data/data science algorithm development and machine learning
    - Software Application Development (full life cycle)

MEGABLAST

0.72 pts

15622.78 sec

The Challenge

Improve on NIH MegaBlast algorithm for nucleotide sequence alignment

4.3 hours

$2M+
Multi-year
Development

47 min.

$120K
1 year
Development

16 sec.

$6K Prize
14 Day
Challenge

591X Speedup

Optimizing Genome-Wide Association Studies (GWAS) Algorithm, implemented in PLINK package
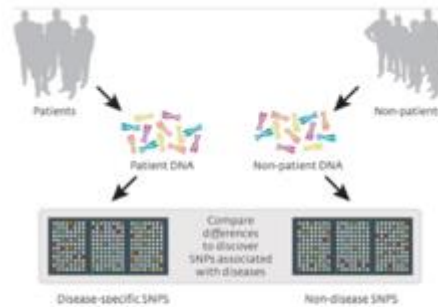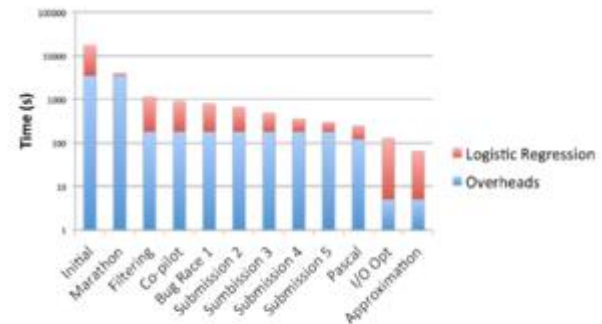
From 5 hours per GWAS down to ~20s

Credit: https://academic.oup.com/gigascience/article/3057432/Stepwise

Data Science Challenge Case Studies

Asteroid Data Hunter
$187K Challenge improved asteroid detection state of the art by 15% and developed a downloadable app for amateur astronomers.
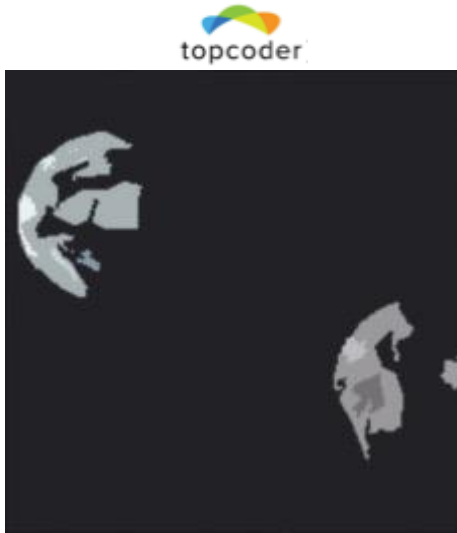
Asteroid Tracker
$61K Challenge developed algorithm to optimize radar array dishes when tracking asteroids that resulted in savings of $300-400K

ISS Robonaut Vision Algorithms
$51K and $60K challenges developed computer vision algorithms and saved over $500K.

Data-Driven Forecasting of Solar Events
$50K Challenge resulted in an 8 hour prediction at 85% accuracy & 3 sigma confidence (4X improvement).

ASTEROID DATA HUNTER

Challenge - Create an algorithm to detect moving objects using Catalina Sky Survey (CSS) data

Total Cost to NASA $186,980

Challenge Award $71,370

15% Improvement

Results
- 15% improvement over current methods
- Open Source App available for download on any laptop (9000 downloads as of 3/2016)
- Maintained by Planetary Resources, Inc.

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ISS ROBONAUT VISION ALGORITHMS

Two challenges to develop vision algorithms to initially detect states of controls (buttons & switches) and later to recognize objects (such as tools) in various lighting conditions.

Total Cost to NASA
$51,100 (challenge 1)
$59,500 (challenge 2)

Challenge Prizes
$21,897 (challenge 1)
$19,250 (challenge 2)

Saved the project over $500,000

Results

- Initial challenge resulted in 4 quality algorithms each using a different approach that were used to mature their new software architecture.
- Final "Tool Localization" challenge resulted in getting 5 different algorithms that can effectively recognize tools under various difficult lighting conditions.

ASTEROID TRACKER

Challenge - Optimize the use of an array of radar dishes when tracking Near Earth Objects

Total Cost to NASA $61,386

Challenge Award $36,288

1-2 FTE Cost Savings

Results

- Provides time based allocation of dishes to various target asteroids
- Delivered as Open Source software under an Apache 2.0 license

ISS LONGERON

Algorithm for power optimization for the International Space Station to maximize power production while minimizing impact to solar array structure
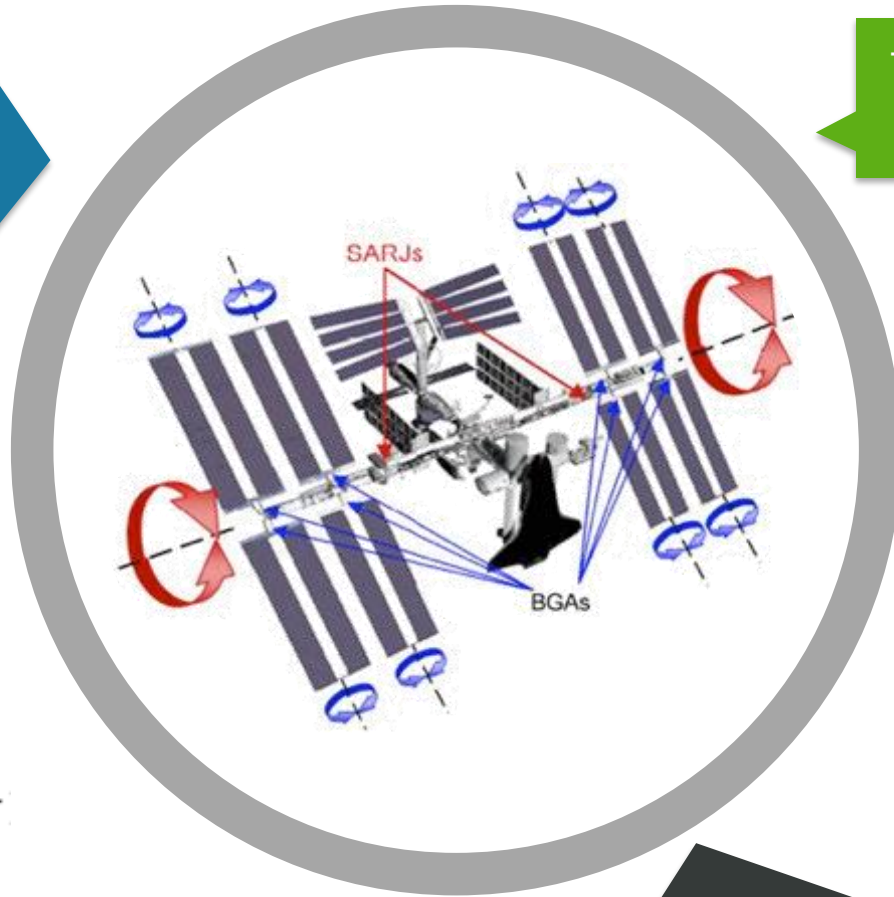
Total Cost to NASA
$80,000

Challenge Award
$40,450

459 Participants & 2000+ submissions

Results

- Resulting algorithm performs comparably with current ISS tools (but developed for a fraction of the price)
- Algorithm actually performs better on edge cases.

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SARJs

BGAs

QUEST FOR QUAKES

Challenge – Develop new software algorithms to uniquely identify the electromagnetic pulses that may precede an earthquake by days to weeks
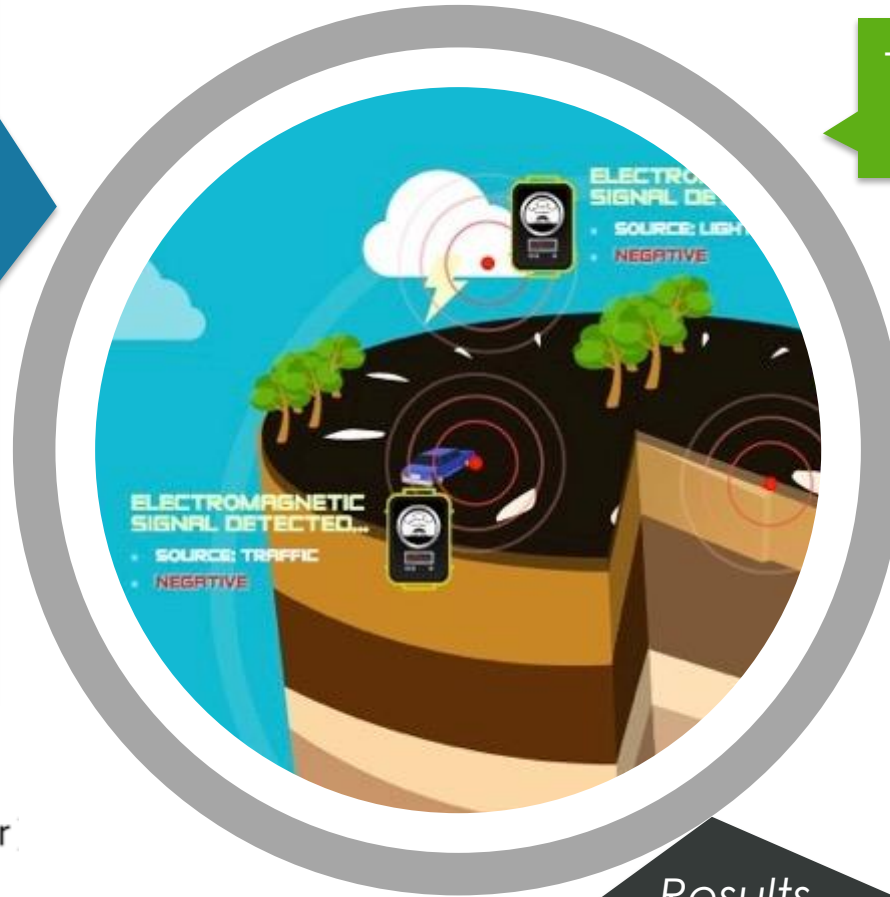
Total Cost to NASA $78,000

Challenge Award $41,000

Algorithms for use as part of daily data searches

Results

- Initial open competition resulted in algorithms that could identify upcoming earthquakes, but data overlaps cast doubt on results
- Top six algorithms rerun on de-correlated data-sets proved capable of identifying from 1 to 7 of 35 events with high confidence

DATA-DRIVEN FORECASTING OF SOLAR EVENTS

Challenge -
To develop with a method to predict Solar Particle Events (SPEs) with greater than 2 sigma confidence and 4-24 hour prediction.
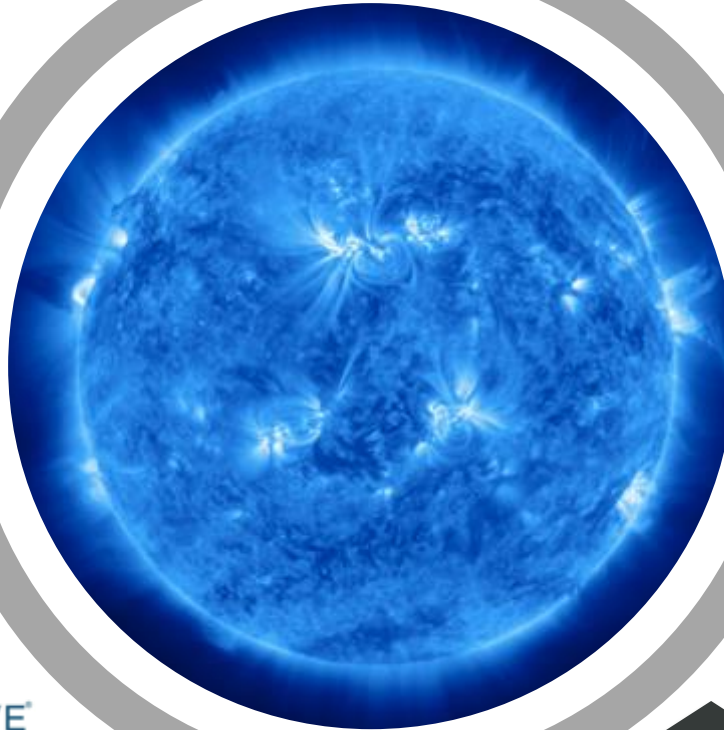
Total Cost to NASA
$50,000

Challenge Award
$30,000

Result: 8 hour prediction at 85% accuracy and 3 sigma confidence

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Results

- Winning solution was submitted by a retired radio-frequency engineer (with an undergraduate degree in heliophysics).

- NASA group is now working with submitter on additional improvements.

Using Competitions for Software Development

Creative Ideas

Concepts

Conceptualization

Specification

Specs

Idea Generation

Requirement Analysis

Wireframes

UX/UI
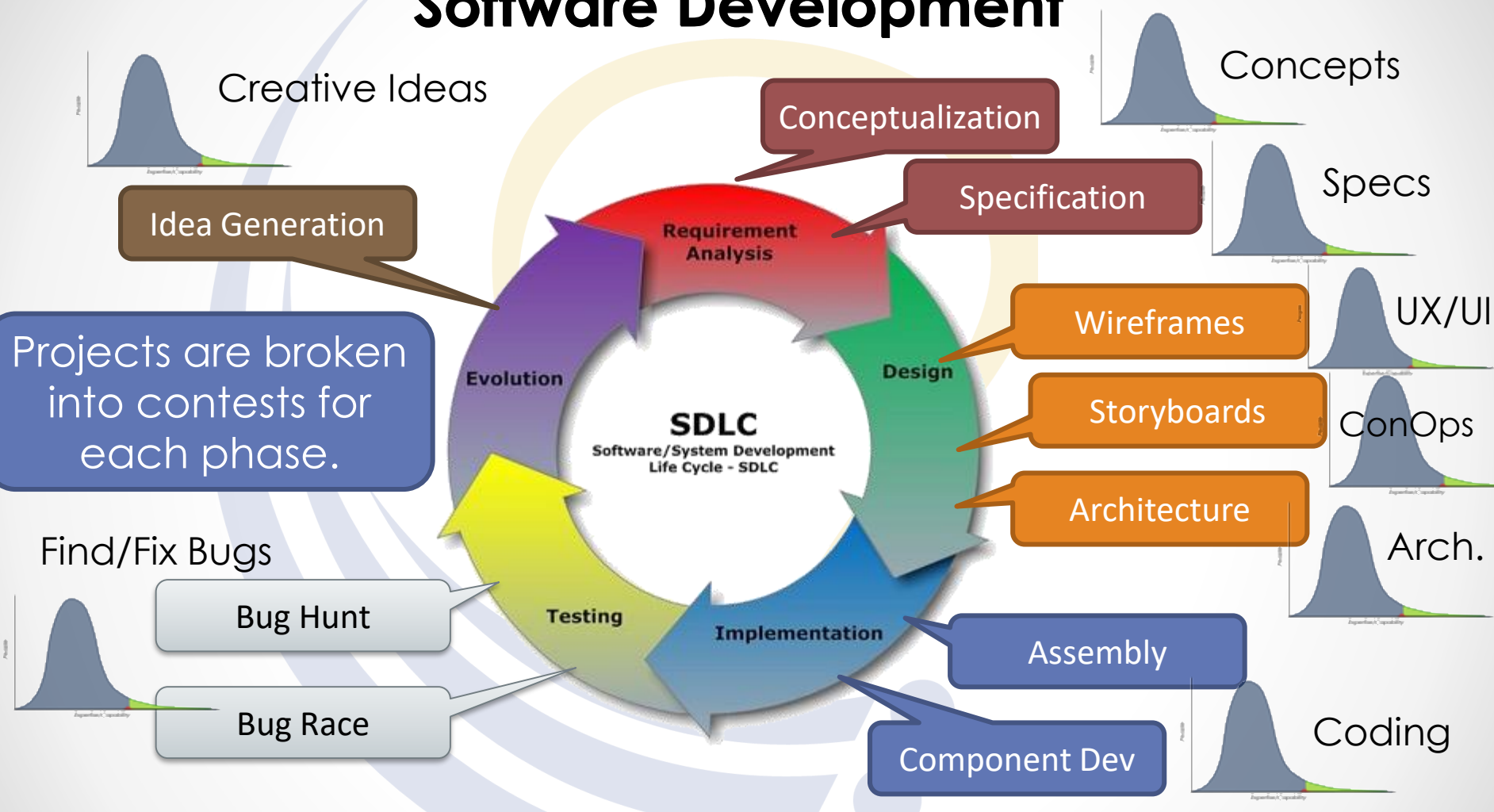
Projects are broken into contests for each phase.

Evolution

Design

Storyboards

ConOps

SDLC
Software/System Development
Life Cycle - SDLC

Architecture

Arch.

Find/Fix Bugs

Bug Hunt

Testing

Implementation

Assembly

Coding

Bug Race

Component Dev

Each contest taps into the **best** of the portion of the community that has expertise for that phase.

Source: topcoder

Image Credit: Wikipedia, *Systems development life-cycle*, http://en.wikipedia.org/wiki/Systems_development_life-cycle (as of Mar. 27, 2013, 05:48 GMT).

Software Challenge Case Studies

Lunar Mapping & Modeling Portal

$82K Challenge reduced image processing time from 19 to 3 hours by re-architecting code to leverage multi-node processing.

ISS Food Intake Tracker (FIT)

$175K Challenge developed a flight certified iPad app that astronauts to improve nutritional data tracking – Currently flying on ISS.
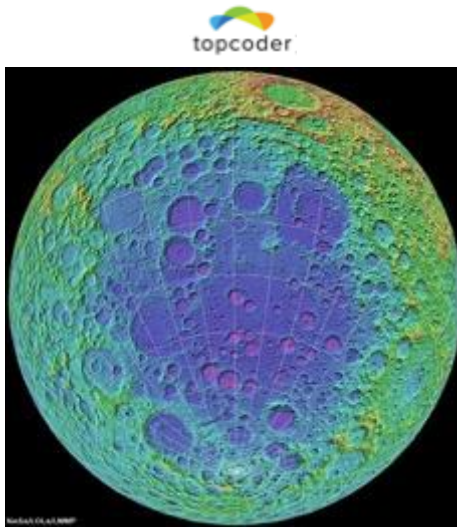
DTN Astronaut Email

$143K Challenge developed software to fix issue on ISS using DTN protocol suite at an estimated 75% of cost using in-house development.
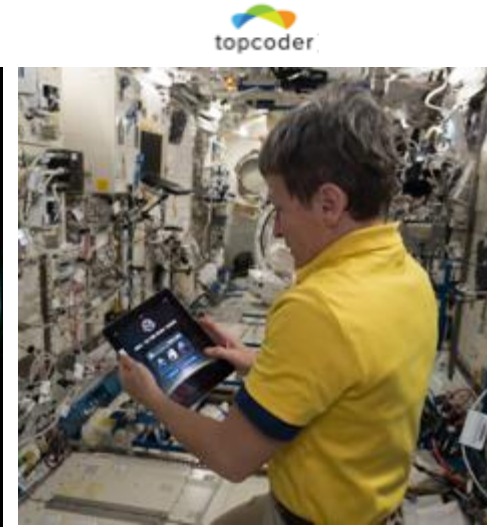
DTN Dashboard

$24K Challenge developed an innovative & scalable user interface (UI) to monitor and manage a complex network of DTN nodes.

LUNAR MAPPING AND MODELING PORTAL

Challenge – develop an application that takes raw images from the Lunar Reconnaissance Orbiter (LRO) and turns them into rich visualization layers
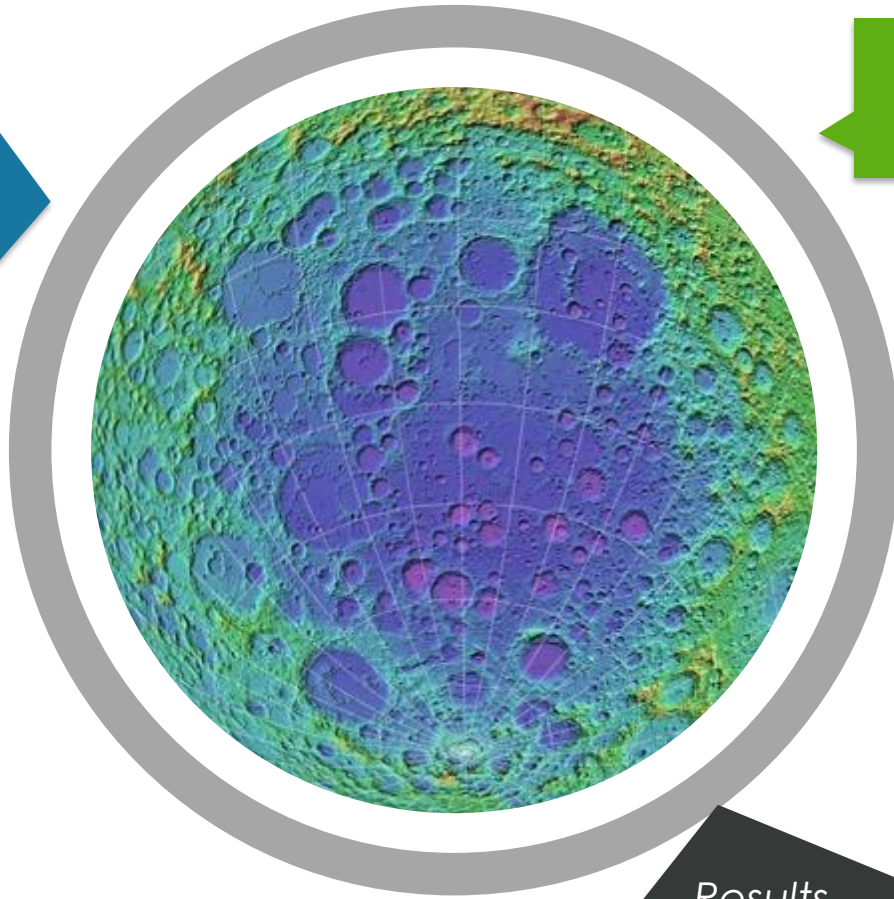
Total Cost to NASA $81,724

Challenge Award $12,625

Image processing time reduced from 19 to 3 hours

Results

- Online tool processed LRO images into hi-res geo-referenced mosaic
- Reduced processing time from 19 to 3 hours
- Additional reduction in time by adding additional nodes

PLANETARY DATA SYSTEMS STORYBOARD

Challenge – Create an online collaborative environment for scientists, researchers and students to expose PDS data and make it accessible to all

Total Cost to NASA $93,000

Challenge Award $19,000

Pinterest-like App for Planetary Data Science

Results

- Pilot version of application completed
- Allows planetary scientists to put together storyboards and collaborating on PDS data by sharing artifacts.

ISS FOOD INTAKE TRACKER

Total Cost to NASA $144,600

Challenge - Create an iPad application for ISS crewmembers to easily enter their dietary intake

Challenge Award $36,288

More Detailed Food Log plus Bar Code Scan

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Results

- Will provide NASA scientists a better understanding of nutrition to help mitigate negative physiological effects of spaceflight
- Scheduled for operational use starting in June 2016

DTN CHALLENGE SERIES

The NASA-wide DTN team has utilized crowd-based challenges to access innovative solutions to hard problems and extend their development team's capabilities

8 Challenges over 2 years

Total Spent $331,630

Used to develop actual flight software

Results

- SW Implemented: LTP Auth, Astro Email, Neighbor Discovery
- Innovation: Security Key Architecture, Killer App
- User Interface: DTN Dashboard
- Interface Testing/Validation: DTN2 implementation of DTPC
- Graphics: Series Infographics/DTN Logo

DTN ASTRONAUT EMAIL

Challenge – Fix ISS crew email issue caused by communications time delay by adding Disruption/Delay Tolerant Network (DTN) protocol to ISS email software suite.

Total Cost to NASA $142,500

Challenge Award $52,213

Cost was 75% of est NASA dev. costs

Results

- Enables large file transfer between ISS and the Earth
- Flight certification in process for use on ISS
- Provides a long term solution for email for deep space human exploration missions

DELAY TOLERANT PAYLOAD CONDITIONING

Challenge – Validate the DTN2 implementation of the DTPC protocol and provide interoperability testing against the ION implementation.

Total Cost to NASA $18,100

Challenge Award $8,356

Test and validation of SW against specs

Results

- Produced 66 test scenarios
- Produced 20 test cases
- Successfully demonstrated DTPC interoperability between DTN2 and ION

LTP AUTHENTICATION

Challenge – Implement the Lidlicker Transport Protocol's Authentication specifications for the ION DTN implementation
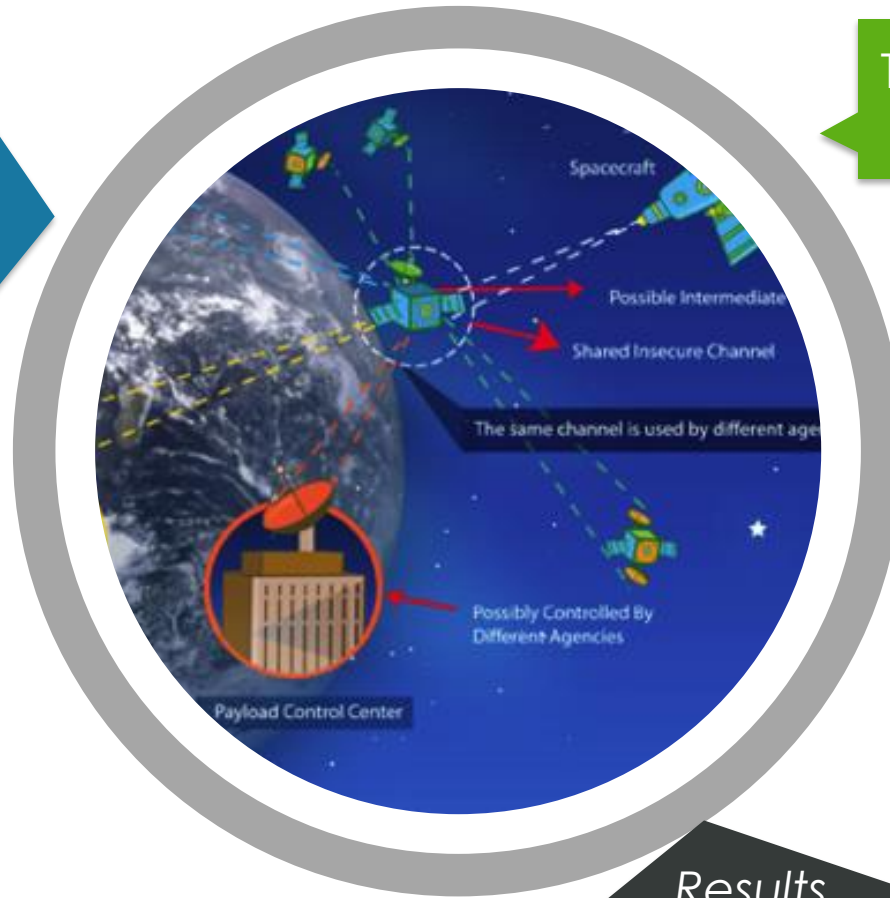
Total Cost to NASA $92,300

Challenge Award $52,385

Code Integrated into ION Code Base

Results

- 2,780 Lines of software code
- Very complete test cases with reusable products (VMs).
- Discovered issues with specifications (valuable to CCSDS.
- Considered a significant win for the team.

DTN NEIGHBOR DISCOVERY

Challenge – Update the DTN ION implementation to include the IP Neighbor Discovery (IPND) protocol specification

Total Cost to NASA
$104,129

Challenge Award
$45,573

Code Integrated into ION Code Base

Results

- IPND was successfully implemented and integrated into the ION code base in just 5 months.
- ION is now compatible with DTN2 and IBR.
- Enables the future addition of dynamic routing for DTN.

DTN DASHBOARD

Challenge – Develop a user interface that can be used to do network management functions for a scalable DTN network.

Total Cost to NASA $23,549

Challenge Award $14,832

Selected the best features from 12 UI designs

Results

- Designed a UI that is easy to use, intuitive and provides capabilities to help manage DTN networks.
- The UI is extremely intuitive and provides the capability to monitor and manage remote nodes in a DTN

SOLUTION MECHANISM GUIDE

Challenge - Create an online tool that allows users to answer a series of questions to pinpoint solution mechanisms to best fit their project needs.

Total Cost to NASA
$56,500

Challenge Award
$37,474

Cost Effective

Results

- User and administrative interfaces based on tailorable content management schema
- Delivered as Open Source software under an Apache 2.0 license
- Results exceeded initial expectations – tool currently internally deployed on NASA's network and deployed in the Human Health and Performance Directorate

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IMPROVING NASA ENTERPRISE SEARCH

Challenge – Expand NASA Enterprise Search capabilities to include enhancements in filtering, geolocation, content types, imagery discovery and machine learning.

NASA Search

Total Cost to NASA $142,850

Challenge Award $52,440

"The biggest value of this approach is the innovation, people thinking outside the box." – Allan Stilwell, Challenge Owner

Results

Developed an enterprise search capability which implemented a robust recommendation engine and developed functionality to support charts, tabs, content type search, geolocation filtering, and date range filtering.

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OpenNEX: BUILD AN APP

Challenge – Seeking applications that utilize the Climate and Earth Science data (OpenNEX) on Amazon Web Services (AWS) in new and creative ways

Total Cost to NASA
$68,727

Challenge Award
$50,000

Exposure of OpenNEX data; Good visualization tools

Results

- The final 5 applications selected were excellent visualization tools
- Scientific merit of tools less than anticipated; lesson learned for future challenge design

Active Software & Algorithm Contests

TopCoder Contests

GE - Customer Training Management Tool Wireframe Challenge (UX)

Kaggle Contests

Draper Satellite Image Chronology

Topcoder	80 open challenges (40,000+ Total)	1.1M members
	23 Design 57 Development 2 Data Science	
Kaggle	16 open challenges (215 total)	800K members

~100 gov. &industry algorithm & software challenges are in progress *.

*As of May 13, 2016

IBM NPS - Response REST API (Coding)

Facebook V: Predicting Check Ins

The Gates Foundation - Binary to Text Software Performance Challenge in C (Algorithm)

Titanic: Machine Learning from Disaster

Facial Keypoints Detection
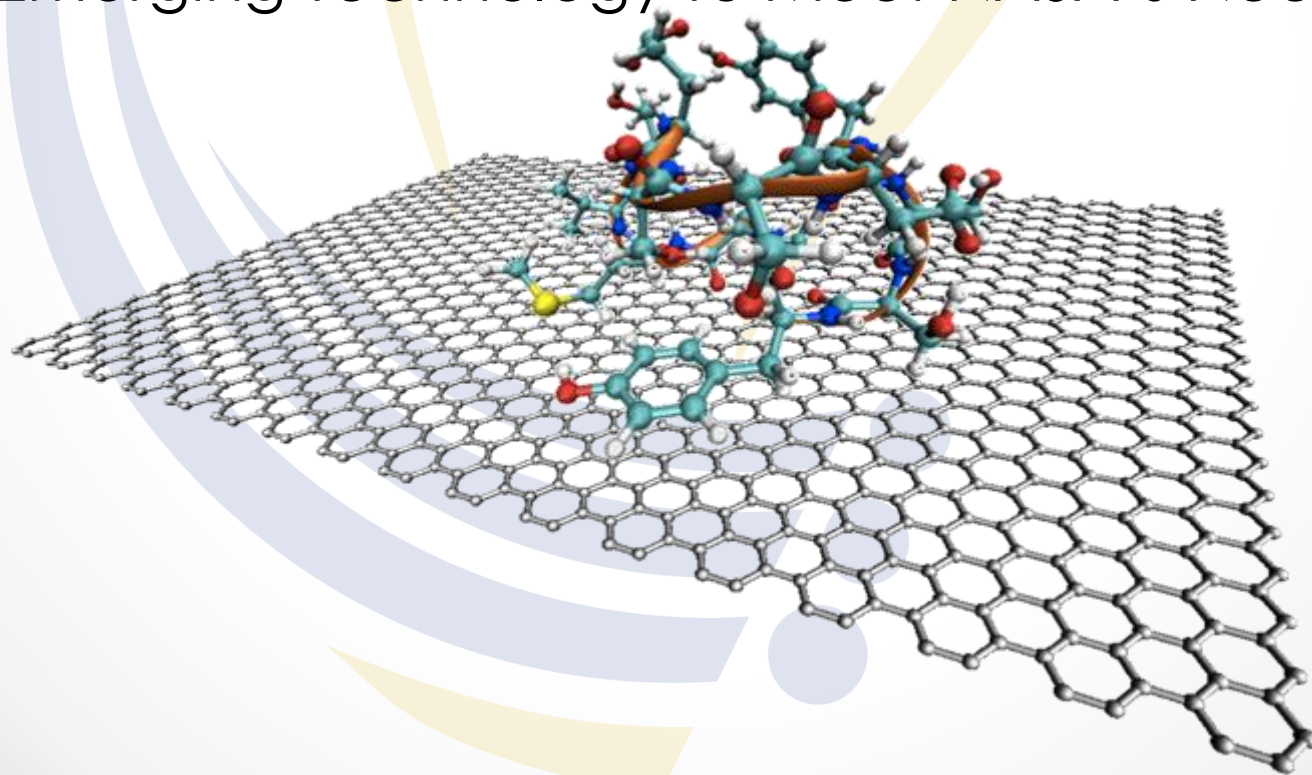
Yet2.com

yet2.com

Technology Searches

Provides a "matching" service that finds technologies and solutions from industry, academia, and/or individuals for a given need/challenge.

Includes a 130,000 member community and links to over 16,000 commercial entities.

Very effective (and cost effective) in searching for existing products or development efforts.

NTL
NASA
Tournament Lab

Center of Excellence for
Collaborative
Innovation

Technology Search Case Studies

All Tech Searches: $20K, 4 month

Intracranial Pressure Monitor
Found 3 solutions (1 resulting in a partnership).
"Very pleasantly surprised that this process exposed so many potential solutions with such wide breadth and depth."

Radiation Tolerant Graphics Processing
Identified 50 targets and resulted in 5 high interest targets. Expanded new/relevant info about vendors that were already known.

Lander LIDAR Terrain Mapping
Identified 50+ leads Provided both a more complete understanding of the technology landscape and 8 high interest targets that may be leveraged.

Monitoring Water and Biocides
Identified 61 leads (over 2000 hits) – Resulted in 8 active leads. Owner found this method more affordable than SBIR effort and as valuable.

yet2.com

INTRACRANIAL PRESSURE MONITOR

A technology search challenge to find emerging technologies that could help measure intracranial pressure non-invasively.

Total Cost to NASA $20,000

4 month schedule

Winning solution from a world recognized leader in the field

Results

- 3 high interest solutions identified (1 resulting in a partnership)
- "Much more than (they) expected! Very pleasantly surprised that this process exposed so many potential solutions with such wide breadth and depth." – Challenge Owner: J. Villereal

BONE DENSITY MEASUREMENT

A technology search for clinically-useful tech. sensitive to assess the microstructure of "spongy" bone that is found in the marrow cavities of whole bones
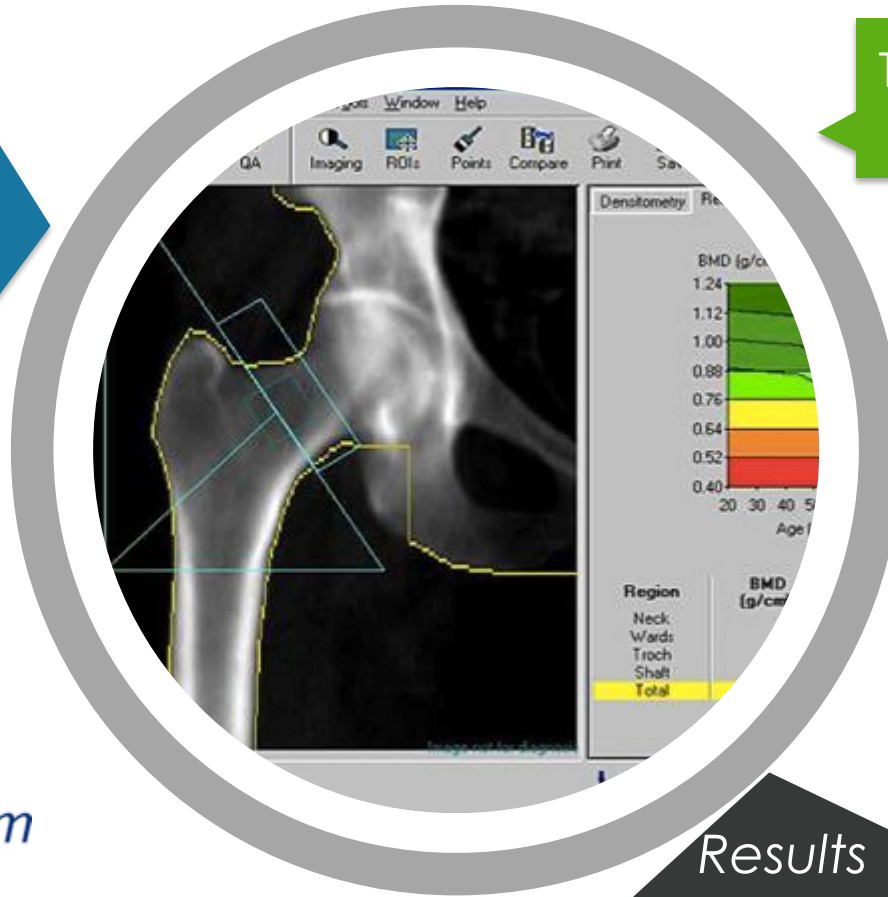
Total Cost to NASA $20,000

3 month schedule

Worldwide search across industry, academia, and gov't

Results

- 51 technology leads identified via the search
- Challenge owner was pleased with the contacts made through the scouting effort.
- 5 active leads resulted from the search.

MONITORING WATER AND BIOCIDES

A search for tech to monitor microorganism content of stored potable water in real time & report the water's status to assure its continued potability for as long as a year.

Total Cost to NASA $20,000

3.5 month schedule

Over 2000 hits of interest from organizations around the world

NTL
NASA
Tournament Lab

yet2.com

Results

- 61 technology leads identified via the search (over 2000 hits). 8 active leads resulted from the search.
- Challenge owner was Impressed with information received from effort.
- Found it far more affordable than an SBIR effort and as valuable.

RAD TOLERANT GRAPHICS PROCESSING

A search for technologies that can perform graphics processing that is radiation tolerant for use on future deep space vehicle displays.

Total Cost to NASA $20,000

5 Targets Identified as High Interest

Exposed relevant new information about vendors that were already known

Results

- Identified 50 potential technology targets and provided details on 22
- Provided both a more complete understanding of the technology landscape and 5 high interest targets that may be leveraged.

LANDER LIDAR TERRAIN MAPPING

A search seeking LiDAR sensors for 3D terrain mapping at a variety of planetary destinations, with and without atmospheres. Solutions must be small, light, and low power.

Total Cost to NASA $20,000

8 Targets Identified as High Interest

Provided a much more complete landscape of the available technologies

Results

- Identified 50+ potential technology targets and provided details on 23
- Provided both a more complete understanding of the technology landscape and 8 high interest targets that may be leveraged.

Opportunity Costs of Not Leveraging Open Innovation

Traditional Tech Search

- Engineer/Team performs technology search using Tech Journals, Vendor Info, Google Search, and RFI.
  - Appox. Cost $15K-$30K

- Team selects available tech and proceeds with development.
  - Est: $2M over a couple of years

- After 2 years of development, Resulting Design Performance = 10 kg/unit (x 10 units per vehicle x 100 missions)
  - Est cost assuming $2K/kg = $20M in launch cost over life of project.

- $22,030,000 total cost
- $2,010,000 in Opportunity Costs

Open Innovation Method

- Run a networked, global technology search.
  - Approx Cost $20K

- Team selects emerging tech and proceeds with development.
  - Est: $2M over a couple of years

- Resulting Design (assume 10% improvement)= 9 kg/unit (x 10 units per vehicle x 100 missions)
  - Est cost assuming $2K/kg = $18M in launch cost over life of project.

- $20,020,000 total cost
- $2,010,000 In Cost Savings

Micro-Purchase Design Challenges

Leveraging Low Cost Competition to Access Diverse, Innovative Design Space

Micro-Purchase Challenge Case Studies

3D Printable ISS Handrail Clamp

$3000 challenge resulted in 492 submissions in 30 days – 5 winning designs provided diverse & innovative approaches

Robonaut Sim Tools 3D Modeling

Developed 14 photorealistic CAD models for $1100 (est. $12,000 savings). 300 submissions across 14 10 day challenges.

Astronaut Smartwatch App

$1500 User Interface challenge resulted in 245 UI submissions. $3000 SW Development Task implemented functional prototype.

Experiment Attachment System

$3500 challenge resulted in 50 submissions. 5 winning designs provided novel and innovative approaches to meeting design constraints.
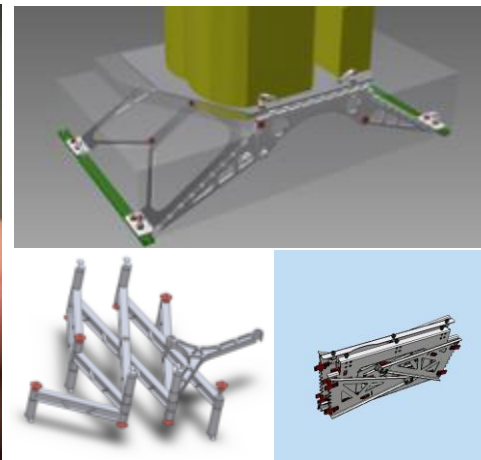
3D PRINTABLE ISS HANDRAIL CLAMP

Challenge to develop a design for an ISS handrail clamp that could be 3D printed and still withstand the loads and stresses required.

NTL NASA Tournament Lab **GRABCAD**
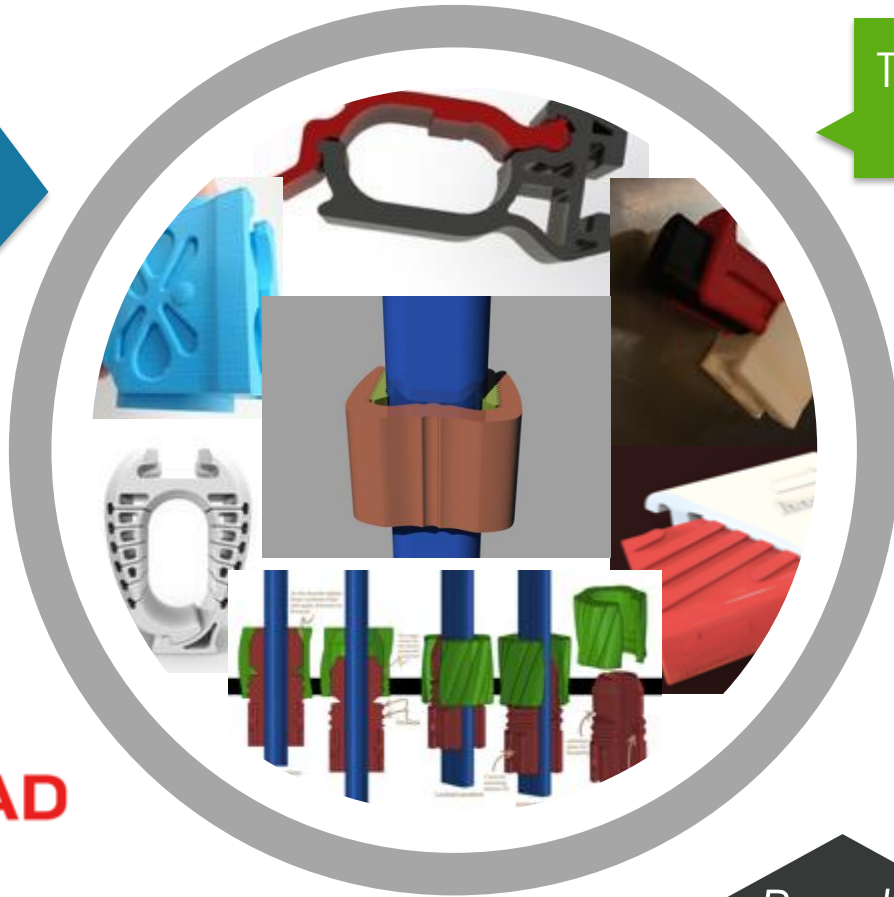
Total Cost to NASA $3,000

Challenge Prize $2,000

492 submissions in 30 days

Results

- Selected 5 winning designs from 492 diverse and innovative mechanical designs demonstrating a wide range of approaches.
- Winning designs evaluated for best approaches for in-space printing.

Typical Hardware Design Space (Performance Box)

Max Volume

Volume

Original Trade Space
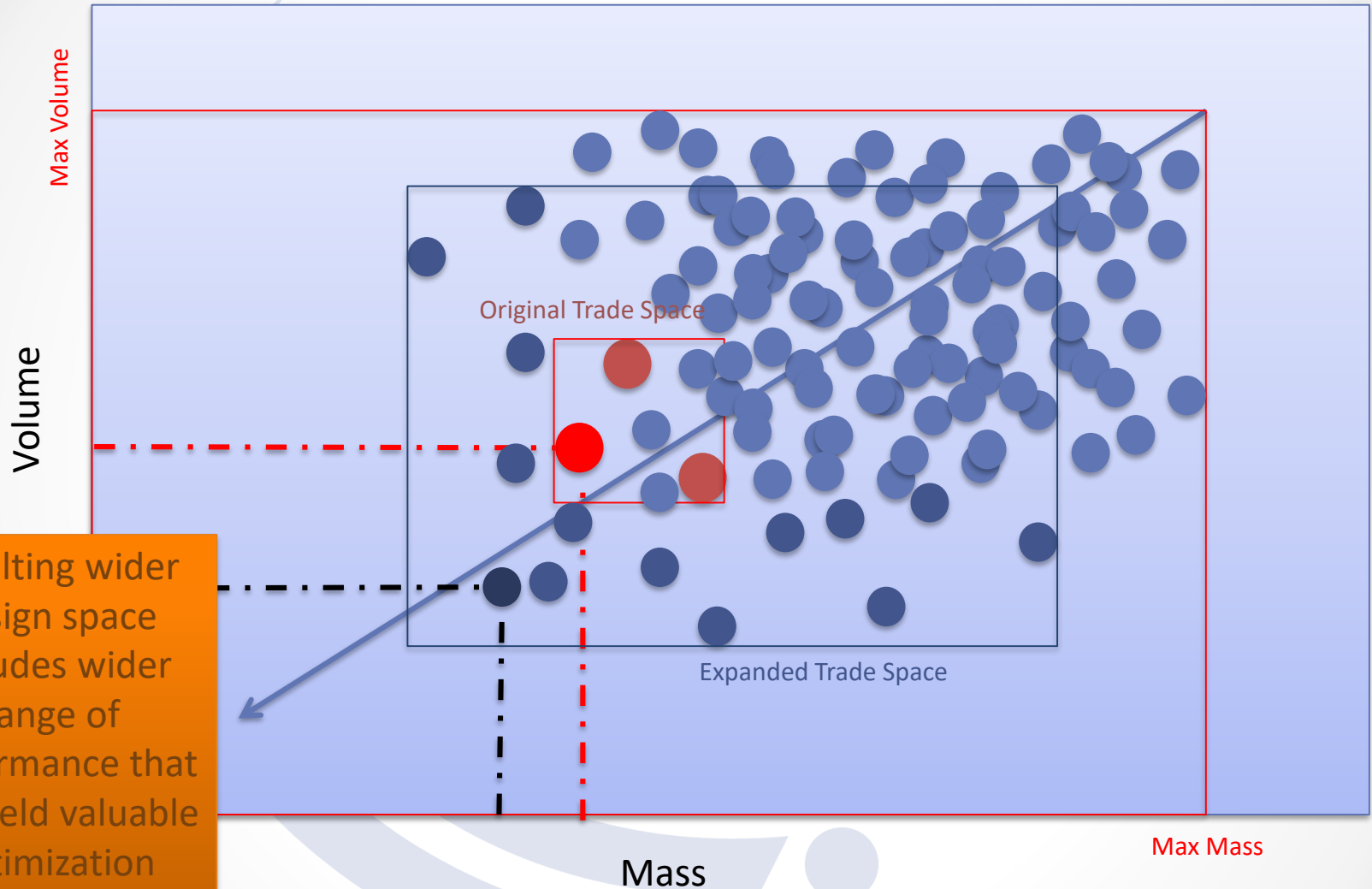
Resulting wider design space includes wider range of performance that can yield valuable optimization options

Expanded Trade Space

Mass

Max Mass

Internal Team Solution Options

Crowdsourced Solution Options
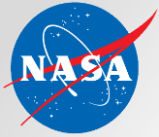
Opportunity Costs of Not Leveraging Open Innovation

Traditional Design

- Small design team develops a handful 3-5 design options.
  - Appox. Cost $3000-$5000

- Team evaluates and down-selects based on optimization against FOMs.
  - Est. Cost: 10 labor hours ($1250)

- Resulting Design = 10 kg/unit (x 10 units per vehicle x 100 missions)
  - Est cost assuming $2K/kg = $20M in launch cost over life of project.

- $20,005,250 total cost
- $1,991,750 in Opportunity Costs

Open Innovation Method

- Run open challenge for designs that generates 50 design options.
  - Approx Cost $3500
  - Equivalent to $50,000 of work

- Team evaluates and down-selects based on optimization against FOMs.
  - Est. Cost 80 labor hours ($10,000)

- Resulting Design (assume 10% improvement)= 9 kg/unit (x 10 units per vehicle x 100 missions)
  - Est cost assuming $2K/kg = $18M in launch cost over life of project.

- $18,013,500 total cost
- $1,991,750 In Cost Savings

GRABCAD — GE Design Improvement

GE asked the GrabCAD Community to redesign a **jet engine bracket** via 3D Printing methods.

The original bracket weighed 2,033 grams.

The winner, M Arie Kurniawan, was able to **slash its weight by nearly 84%** to just 327 grams (0.72 pounds.)

Phase I: 640 Entries for 10 $1,000 prizes.

GE Aviation **3D printed the 10 shortlisted designs** at its **additive manufacturing** plant from **a titanium alloy** on a direct metal laser melting (DMLM) machine.

Phase II awarded a total of $20,000 for the top 8 designs that passed testing.

The GE Global Research (GRC) engineers strapped each bracket to an MTS servo-hydraulic testing machine and exposed it to axial **loads ranging from 8,000 to 9,500 pounds**. **Only one of the brackets failed** and the rest advanced to a torsional test, where they were exposed to torque of 5,000 inch-pounds.

Original GE Bracket

Winning Design
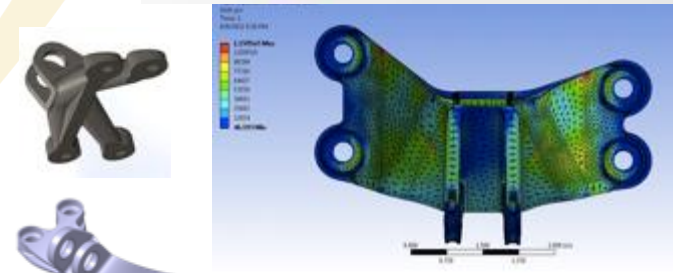
EXPERIMENT ATTACHMENT SYSTEM

Challenge to develop a structure to attach an experiment to an ISS rack with structural, stowage, and crew assembly constraints.
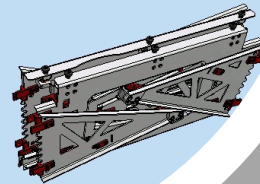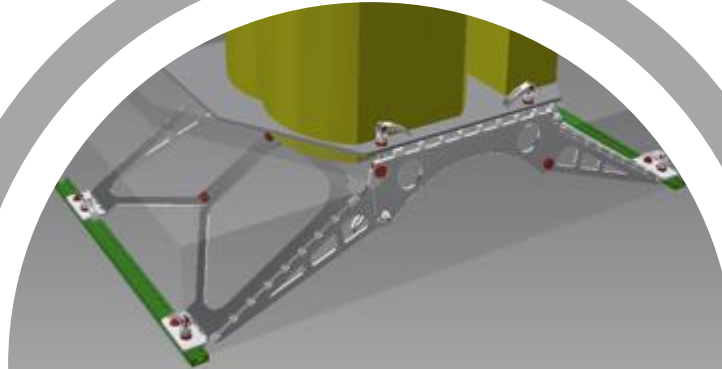
Total Cost to NASA$3,500

Challenge Prize $3,000

50 submissions in 30 days from 23 countries

Results

- Selected 5 winning designs from 50 diverse and innovative mechanical designs demonstrating a wide range of approaches.
- Designs included manufacturing considerations and stress analysis.
- Winning designs will be used to inform final ISS design.

Pilot Project
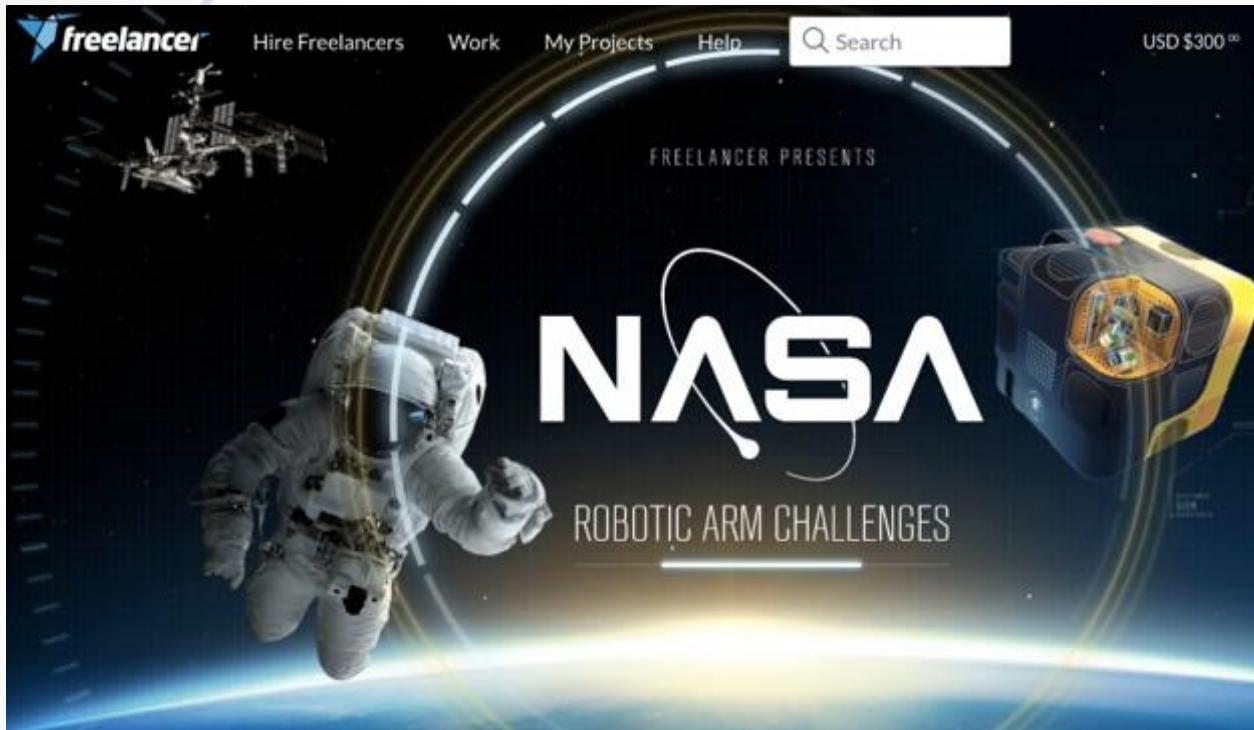
- Freelancer.com is a community of over 20M members who do a variety of freelancer work.

- Challenges provide them a way to build their portfolio.

- They charge very little overhead (2.3%) for contest.

- CoECI ran a set of pilot challenges to see if there was value in these challenges ($10K for the pilot challenges) using a Gov't P-Card.

ROBONAUT SIM TOOLS 3D MODELING

Challenge to develop 3D CAD models of 14 different Robonaut testing tools (from photos) to be used in a testing simulation.

Total Cost to NASA $1,100

Challenge Prizes 5x$50, 5x$75, 3x$100, 1x$150

Almost 300 submissions across 14 10 day challenges

Results

- Most challenges resulted in an acceptable submission by day 3.
- Demonstrated the power of the NASA brand and the desire of skilled people from around the world to contribute to NASA projects.
- In-house development estimated to be 3-10 times more expensive.

PROJECT GRAPHICS/PATCHES

Challenge to develop graphics and patch designs for various projects that reflect the project based on information provided about the project.

Total Cost to NASA $1127

Challenge Prizes 1x$100, 2x$150, 2x$200, 1x$300

Over 1900 submissions across 6 challenges

Results

- Evaluation showed $200 prize optimal for around 200 submissions.
- Showed how individual submissions can be customized via feedback to freelancers.
- Demonstrated NASA brand power and the desire of skilled people from around the world to contribute in a meaningful way to NASA projects.

DTN KILLER APP IDEATION

NASA's DTN project ran an Ideation challenge to find a idea for a smartphone app that could help infuse DTN protocols into terrestrial uses.

Image from Google: Similar "Signal Finder" Android App

Total Cost to NASA $512

Challenge Prize $500

67 submissions received over 30 day challenge

Results

- Winning Concept was an Offline Coverage Mapping App.
- Demonstrated use of a public crowdsourcing platform with very low cost overheads to reach a larger global community.
- Winner was a Physicist from Chicago who joined Freelancer just to participate in this challenge (found on challenge.gov).

ASTRONAUT SMARTWATCH UI CONCEPT

Challenge to develop a UI concept for a smartwatch app that integrated ISS crew tools from the crew timeline, communications status, C&W, and timers.

Total Cost to NASA $1535

Challenge Prize $1500

245 submissions received over 30 day challenge

NTL NASA Tournament Lab

freelancer.com

Results

- Winning Concept was from two User Interface experts from Canada.
- Challenge got significant worldwide news coverage (CNET, Time, Wired, Bloomberg, Forbes, etc (over 50 news outlets)).
- Winning concept was used as the starting point for demo software dev.

ASTRONAUT SMARTWATCH APP

A task on Freelancer.com where the recruited freelancer bid $3000 to build the smartwatch app based on the UX concept contest.

Total Cost to NASA $3,029

Task Schedule 5 months

Fully functioning prototype app on a Gov't P-Card

COMMS 15:33

S   Ku

IAC   OCA

Results

- Fully functional implementation of crew timeline, caution & warning messages, communications status, and timers.
- Included a web based data emulator in the delivery.
- Hardware (Samsung Gear2) required custom OS programming.

NBL TORQUE TRAINING DISPLAY

A task on Freelancer.com seeking a display that could be used by crews doing spacewalk training in the Neutral Buoyancy Lab to align high torque tools.
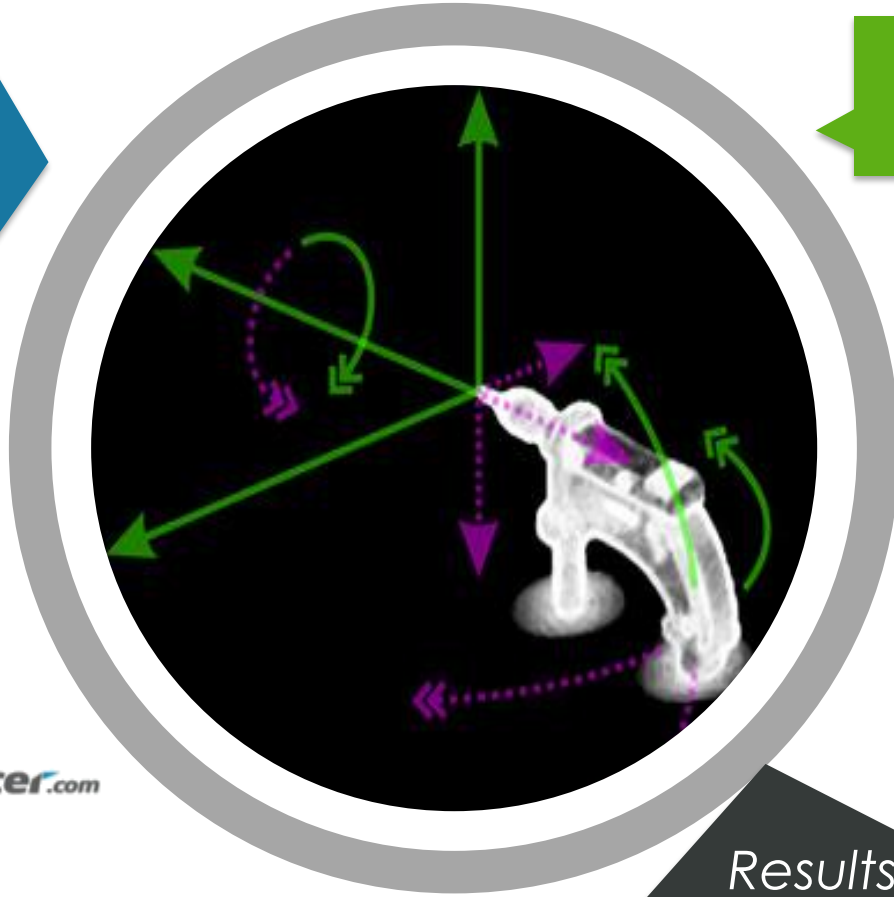
Total Cost to NASA $1,596

Award Amount $1,500

Over 160 Submissions from 50 people in 27 countries

Results

- A very innovative design that clearly helps the astronaut understand their current torque alignment issues and correct them.
- Selected winner provided (as a bonus) the final display as a set of fully functional Labviews code.

1100+ gov. & industry design & multimedia challenges are in progress*.
*As of May 13, 2016

GrabCAD Contests

Sense the Pressure Challenge by Microtechnologies

Modular Prosthetic Terminal Device Challenge by Enable Community Foundation

Da Vinci Gear Challenge by Stratasys Education

Connect the Ship Challenge by Asciano Limited

CAD Crowd Contests

Design a stand for a virtual Reality Headset

ATG's Automotive Concepts 2016 - 2

Freelancer Contests

UI/UX of IOS & android mobile app

YouTube Ad

Animate a video lesson

Tongal Contests

Lanovo Day in the Life Video

Lego Stop Motion Music Video

Westin Hotels Video

Allstate Host Advantage Video

Harvard NTL Research Results

Virtual Experiments

HMS MegaBlast
NASA Space MedKit
USPTO Image Detection
NASA Robots (Signals V. Prizes)
Scripps BANNER (Race V. Marathon)
Dynamic Motives Survey

Technical Reports

USPTO
Tech Challenge
Collective Minds & Machines
CMS
ISS Longeron Shadowing

Onsite Experiments

HMS grant proposal evaluation
HMS/i-Lab
HMS/Mass General Hopsital

13 Peer-Reviewed Publications since 2011(2 Forthcoming)

Cost-Benefit Counterfactuals

Longeron, CMS, DOE

http://projects.iq.harvard.edu/nasatournamentlab/publications

How Could This Make a Difference to NASA?

- Imagine how NASA could advance its systems if we actively **set aggressive design goals** and used challenges to see how far we could get?
  - Component **mass** and/or **volume** reduction
  - **Power** reduction
  - Algorithm **performance** (speed, accuracy, efficiency)
  - New ideas, approaches, & methods

- What if we took our Failure Effects & Modes Analysis (FEMA) and analyzed them for our least reliable components **and set challenge goals to improve them** (bringing up the overall system reliability)?

- What if we **decomposed systems/operations based on risk** to find those defined issues that might have an solution in the crowd?

150

Asteroid Data Hunter | Asteroid Tracker | ISS Food Intake Tracker | IntraCranial Pressure | DTN Astronaut Email | Mars Balance | PDS Cassini | DTN LTP Authentication
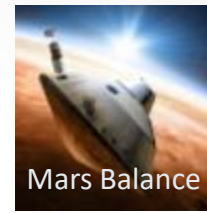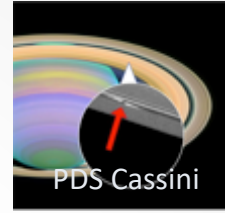
DTN Dashboard | DTN DTPC Interoperability | DTN Neighbor Discovery | Robonaut Vision Algorithms | Solution Mechanism Guide | ISS Handrail Clamp | DTN LTP Authentication
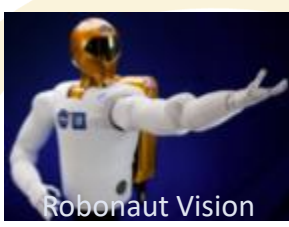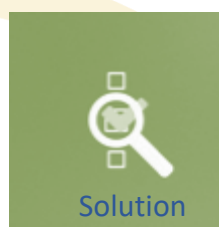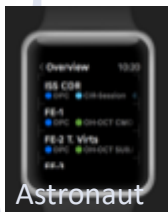
Bone Density Measurement | Astronaut Smartwatch

It Already Is Making a Difference!
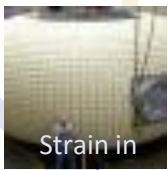
ISS Solar Array Pointing | Micro Purchase Pilot CAD/Graphics
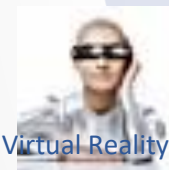
Solar Prediction | Virtual Reality Exercise | Medical Kit Tracking | Strain in Kevlar | OpenNEX Climate Data | Water Monitoring | Mars Pioneering | Bio Inspired Exercise | Food Preservation | Compact Exercise
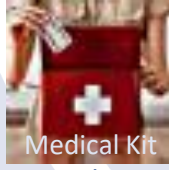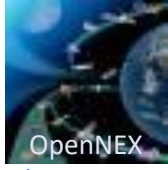
What Can I Get from Open Innovation?

Product	Description	Advantage
Ideas	Think brainstorming, but on a much larger scale (Can be simple or complex concepts)	Gets you "out of the box" ideas that you would not get naturally.
Technologies	Find technologies and solutions from unconventional or inaccessible sources.	Gets you the best available technology and guards against being overtaken by emerging tech.
Designs	Expand your trade space with conceptual, engineering, UI/UX or CAD designs.	Better chance of increased performance in your final design by leveraging highly parallel design cycles.
Software	Any or all parts of the SW development lifecycle including testing (with full documentation)	Resource limited SW development teams can accomplish much more in a shorter period of time.
Prototypes	Individuals, teams, or companies build prototype systems to meet specified target goals.	Multiplies investment in technology development and often results in new tech/systems that achieve advanced performance goals.
Multimedia	Graphics, Animations, or Video products (from simple graphics to fully produced movies).	Very cost effective. Products can be highly tailored. Leverages talented/passionate artists.

CoECI's Crowdsourcing Experience

267 Challenges Total Completed or in Progress (with 18 more in formulation)

INNOCENTIVE

21 Innovation:
7 Ideation*
13 Theoretical
1 Reduction to Practice

1 Video

3 USAID

NINESIGMA

3 Innovation

1 Consultation Task

hero x

4 Innovation

1 Video

1 NIST

HARVARD · [topcoder]

18 Algorithms*

23 Software** ***

3 Ideation

6 Graphics/Design

USPTO, USAID, 2 EPA
***2 CMS, OPM, DOE**
*** **APPLAUSE**

kaggle

1 Algorithm

1 DHS

yet2.com

19 Tech Surveys*

1 EPA, 5 NIST

NASA@WORK

130 Challenges

Common Pool

1 Innovation

1 NASA/RWJF

tongal

5 Videos

GRABCAD

2 Eng. Design

freelancer.com

3 Ideation

15 CAD Modeling

11 Graphics

Plus 1 SW dev task
and 30 Architecture tasks

CoECI's Crowdsourcing Experience

272 Challenges Total Completed or in Progress
18 More Challenges in Formulation
(n) = Other agency

Internal Challenges 126

46 Ideation
28 Innovation
2 Algorithm
3 Software
7 Tech Survey
7 Graphics
3 Video
16 Other

Technical Solution 21
3(1) hero✗
11(3) INNOCENTIVE
2(1) NINESIGMA

Tech Surveys 19
13(6) yet2com

Ideation 12
3 INNOCENTIVE
4(3) topcoder
2 freelancer.com

Tech Dev 1 Common Pool

Graphics/Design 16
13 freelancer.com
3 topcoder

Video 8
1 hero✗
3(1) tongal
1 INNOCENTIVE
2 freelancer.com

Algorithms 22
17(4) topcoder
(1) kaggle

Software 30
24(4) topcoder
1 cOutsource
1 freelancer.com

CAD Modeling /Design 18
2 GRABCAD
16 freelancer.com

NASA@WORK

CoECI's Crowdsourcing Experience

42 Challenges Total Completed or in Progress FY17

Internal Challenges - 17

Technical Solution - 2
- NASA Earth & Space Air Prize
- NASA Origami/Folding Concept for Radiation Shield Packing/Deployment

Software - 4
- NASA: Partnership Agreement Maker (PAM) Graphical User Interface (GUI)
- NASA: ISS Food Intake Tracker New Features
- VA Synthetic Patient Data Challenge
- TN Update Wireshark Dissectors for BP, LTP, & TCPCL

Algorithms - 2
- DHS: Person Screening Algorithm Competition
- NSF Hearables Challenge

Graphics/ Design - 2
- AMS: ISS-TEA Project Graphic
- ISM: Refabricator Mission Patch/Graphic Challenge

Tech Surveys - 6
- Non-Invasive Measurement of Intra-Cranial Pressure
- NIST Location Based Services Map Creation
- NIST Cybersecurity - OTA Updates for Security Functions for LTE Tech
- NIST Location Based Services - First Responder Navigation Tech
- NIST Loc, Based Svcs - Indoor Operational & Ref. Localiz, & Track Tech
- NIST Image Processing Tech

Ideation - 4
- NASA: Space Poop Challenge
- NIST: NIST Virtual Public Safety Test Environment Challenge
- USSOCOM CubeSat Challenge
- VA Gun Safety Matters Challenge

Video - 4
- NASA: CineSpace 2017: NASA Imagery – Your Vision
- REALM Project Overview Animated Video Storyboard
- REALM Project Overview Animated Video
- NIST Public Awareness Video Campaign

CAD Modeling - 1
- 3D CAD Models/Animations of Three Different Radiation Shielding Concepts
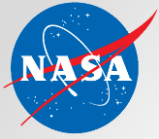
The CoECI Toolkit
Available to ALL NASA Projects
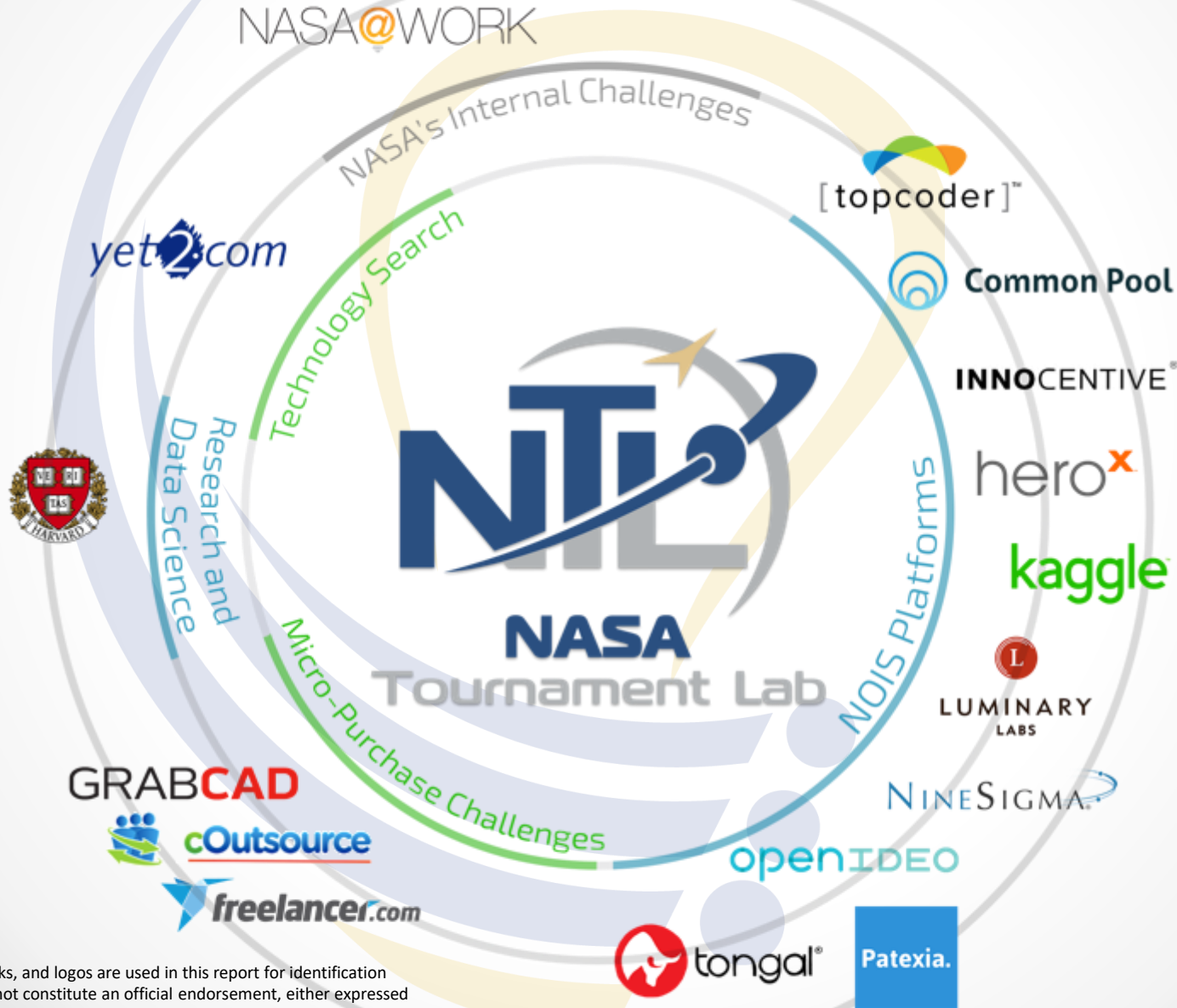
How You Can Leverage the Power of the Crowd?

Request a Challenge Workshop

Launch an Internal NASA Challenge

NASA@WORK

Free
(just your time)
5-6 Weeks

nasa.innocentive.com

Run a Global Micro-Purchase Challenge

freelancer.com

Self Run Challenge Graphics, SW, etc.

$200 - $3,500
1 – 6 weeks

GRABCAD

CAD Design

$3,500
2-3 months

Launch a Global Technology Search

yet2.com

Connect with Companies from Around the Globe Developing Emerging Technologies

$28,500
4-6 months

Launch a Global Challenge using the NOIS Contract Communities

[topcoder]
Common Pool
INNOCENTIVE
hero x
kaggle
LUMINARY LABS
NineSigma
open idea
tongal
Patexia

NTL
NASA Tournament Lab

Problem Solving Challenge

$40-80K, 3-6 mo.

Software or Algorithm Challenge

Cost & Duration Depend on the Challenge

Video Challenge

$50-150K, 3-6 mo.

Email us at nasa-coeci@mail.nasa.gov
or Visit us at http://www.nasa.gov/coeci

There is a New Tool Available

- Solves Difficult Technical Problems with a 92% Success Rate
  - Has solved previously unsolved problems
  - Some solutions have improved the state of the art my orders of magnitude. (examples of 18x, 120x, and 560x improvements)

- Saves an Average of 60% cost over Traditional Methods
  - 98% of projects have cost savings
  - Over half of projects save 50-99%

- Only Pay for Performance
  - Full payment only for successful solution.

- Solves most problems twice as fast as traditional methods.

Technical Problem
Data Science Problem
Software Need
Design Need

Now Picture that Tool as a Curated Crowd of People

Technical Solution
Data Science Solution
Software Solution
Design Solution

158
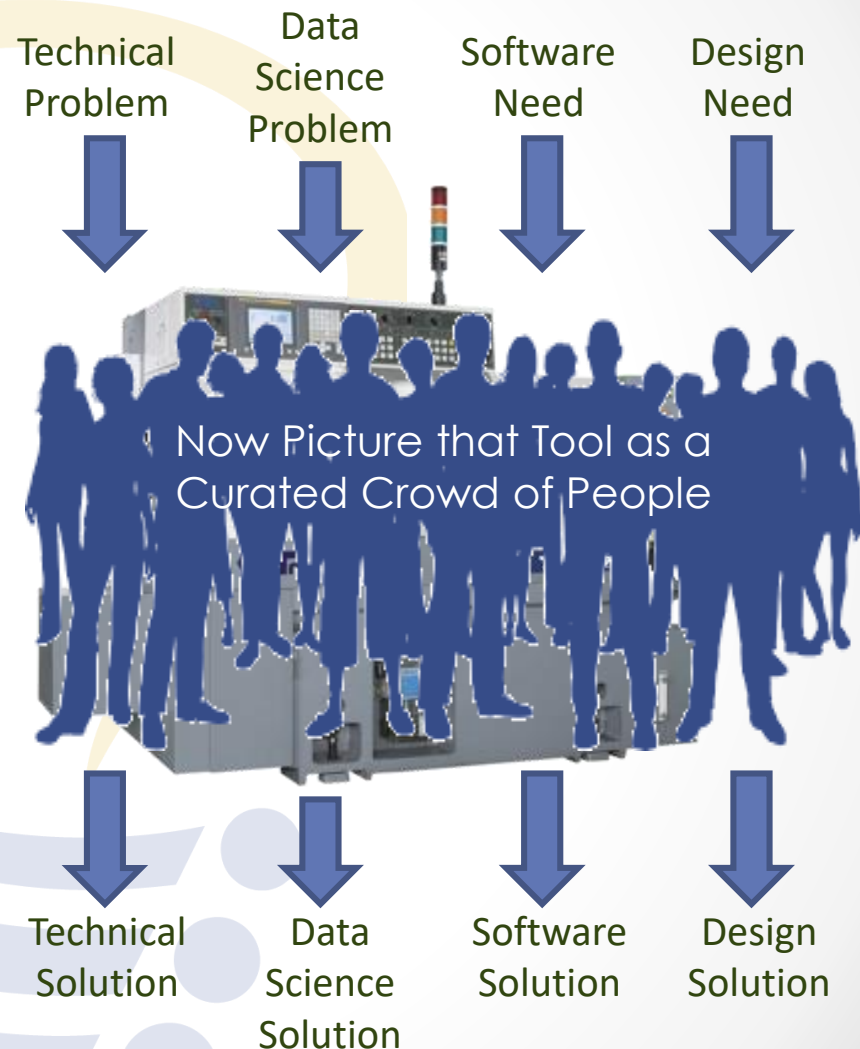
CoECI Challenge Worksheet

- ## Problem Statement
  - *1-2 sentences describing your problem*

- ## Background of Problem:
  - *1-2 paragraphs' describing why this is an issue and important to solve*

- ## Define your requirements:
  - *3-5 minimum and be as specific as possible. Avoid parameters that cannot be defined, measured or bounded (i.e. usable, light weight, satisfactory, cost-effective etc.)*

- ## Define your "desirements":
  - *Nice to have elements that are not necessarily hard requirements of a proposed solution but if achievable would advance the problem solution space or technology*

- ## What solutions have been tried previously and what was the outcome?

- ## What could a viable solution look like to the organization or project team?

Challenge/Technical Need Drafting Template

Center of Excellence for Collaborative Innovation

1. Agency:
   NASA

2. Challenge/Technical Need Owner:

3. Problem Statement (*1-2 sentences describing your problem*):

4. Background of Problem:
   1-2 paragraphs' describing why this is an issue and important to solve

5. Define your requirements:
   3-5 minimum and be as specific as possible. Avoid parameters that cannot be defined, measured or bounded (i.e. usable, light weight, satisfactory, cost-effective etc.)

6. Define your "desirements":
   Nice to have elements that are not necessarily hard requirements of a proposed solution but if achievable would advance the problem solution space or technology

7. What solutions have been tried previously and what was the outcome?

8. What could a viable solution look like to the organization or project team?

   The intent of this question is to identify where the reasonable solution space is to ensure the challenge/tech need owners get something viable out of the process and solution proposals

You Have to Do The Work
to Get the Benefit

If you want to leverage this powerful toolkit, you MUST do the work to find the right problem in your system.

What single improvement would give you the biggest bang for the buck?
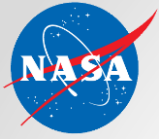
- MASS
- POWER
- VOLUME
- PERFORMANCE
- RELIABILITY

You have to plan & budget for these tools.
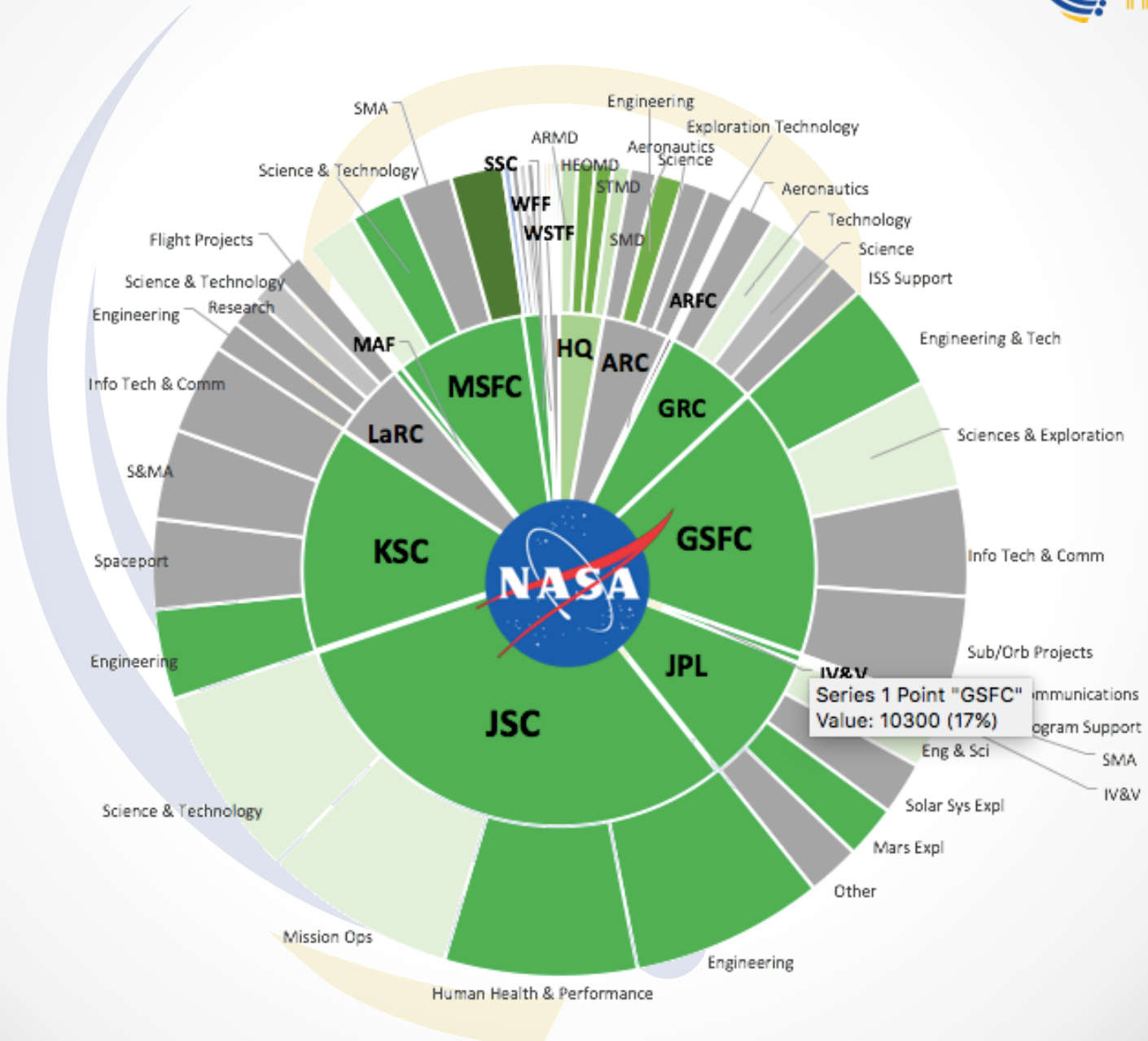
CoECI can help facilitate this with a workshop.

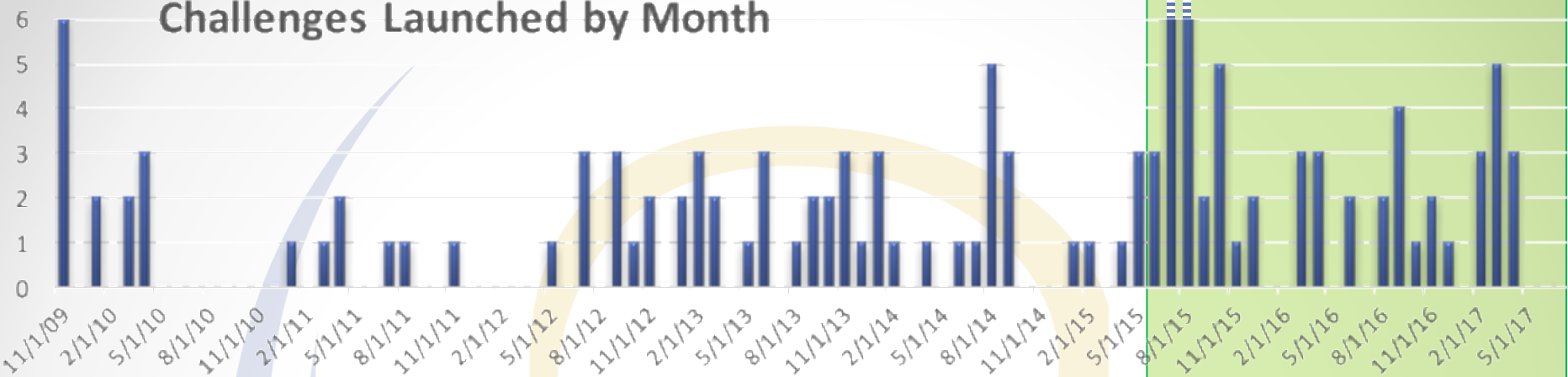# The *NEW* NASA Tournament Lab

www.nasa.gov/coeci
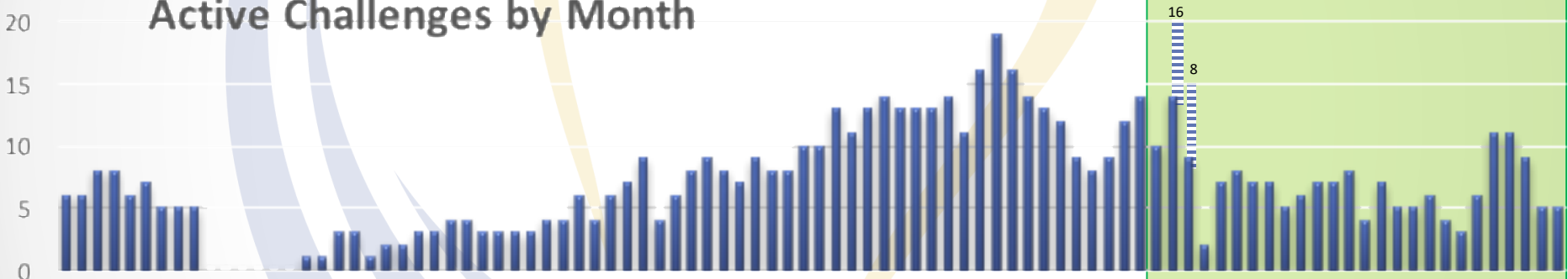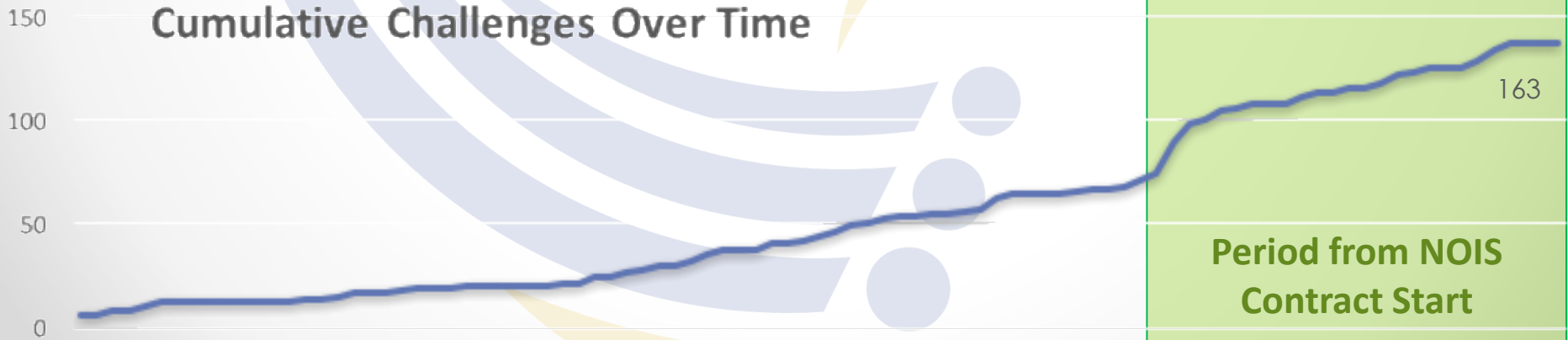
161

Challenges Launched by Month

Active Challenges by Month

Cumulative Challenges Over Time

163

Period from NOIS Contract Start

Not including NASA@work

Challenge Data Since NOIS Contract Launch

CoECI Challenges June '15-Mar '17	All Challenges	NOIS Challenges	Yet2 Searches	Micro-Purchase Challenges	NASA@WORK Challenges
Total Challenges	94	26	10	30	28
Complete	74	14	6	29	25
In Progress	20	12	4	1	3
AES Challenges	40	3	3	11	9
Success Rate	92%	93%	100%	100%	80%
Solved	53%	43%	60%	79%	28%
Significant Advance	16%	14%	40%	3%	28%
Incremental Advance	22%	36%	0%	17%	24%
No Advance	8%	7%	0%	0%	20%
Solutions Planned or Implemented	90%	86%	100%	97%	73%**
Total Cost Savings	$1.7M	$983K	$418K	$145K	$213K*
% Cost Savings	61%	52%	75%	57%	94%*
Average Cost Savings		$70K	$83K	$5K	$43K*
Average Labor Hours		125	57	27	24

* From a limited set of 5 @work challenges with cost estimates
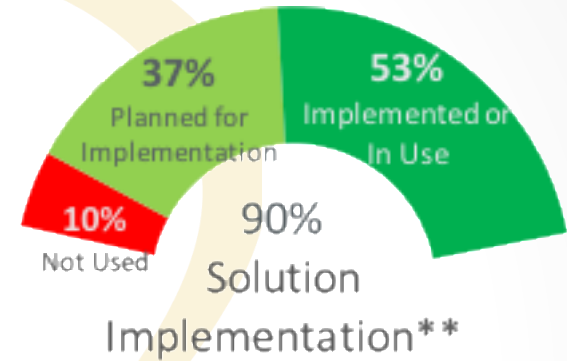** From a partial set of 11 @work challenges with implementation survey data

Challenge Results Dashboard
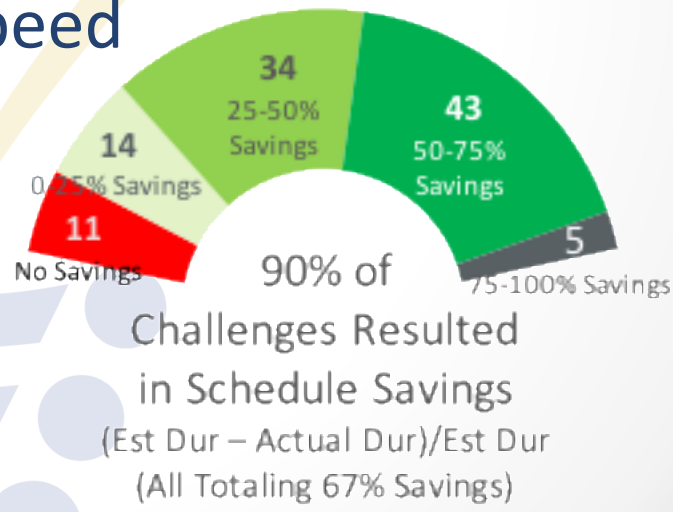## Since NOIS Contract Launch June 2015 – March 2017

Effectiveness

16%
22%
53%
8%
92%
Challenge Successs

Usable Results

37% Planned for Implementation
53% Implemented or In Use
10% Not Used
90% Solution Implementation**

Cost

13 25-50% Savings
13 50-75% Savings
12 0-25% Savings
14 75-100% Savings
1 No Savings
98% of Successful Challenges Resulted in Cost Savings*
(Est Cost - Actual Cost)/Est Cost
(All Totaling 60% Savings)

Speed

34 25-50% Savings
43 50-75% Savings
0-25% Savings
14
11 No Savings
5 75-100% Savings
90% of Challenges Resulted in Schedule Savings
(Est Dur – Actual Dur)/Est Dur
(All Totaling 67% Savings)

* Includes a limited set of 5 @work challenges with cost estimates
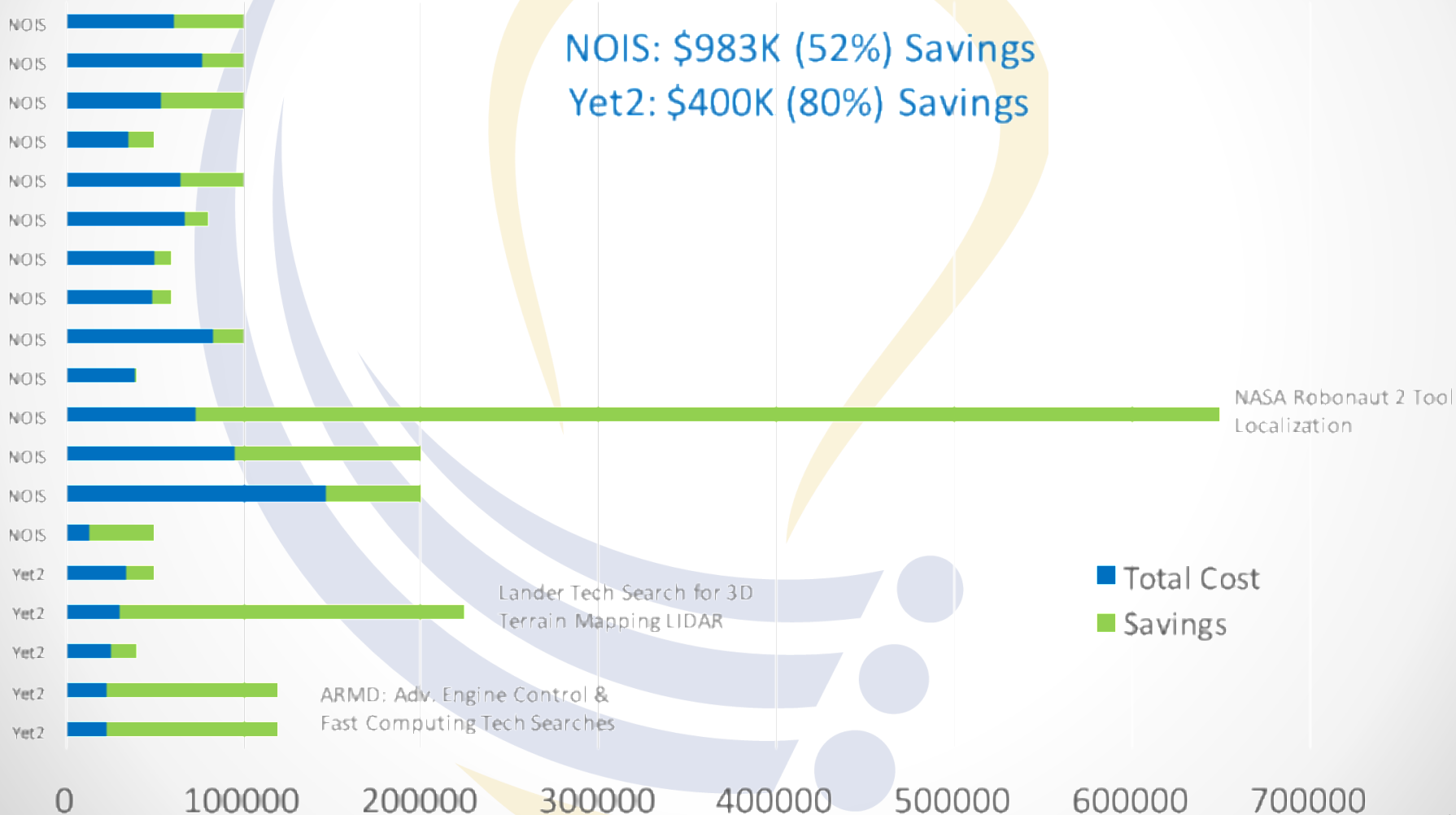** Includes a partial set of 11 @work challenges with implementation survey data

Challenges Are Cost Effective
NASA@WORK & Micro-Purchase Challenges
Since NOIS Contract Launch June 2015 – March 2017

NASA@WORK: $213K (94%) Savings (for 5 of 25 challenges)
Micro-purchase: $194K (57%) Savings

Astronaut Glove Centennial Challenge

This Centennial Challenge sought innovative glove design concepts to reduce the effort needed to perform tasks during spacewalks.

CENTENNIAL CHALLENGES
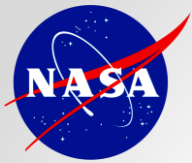
Challenge Awards $350,000
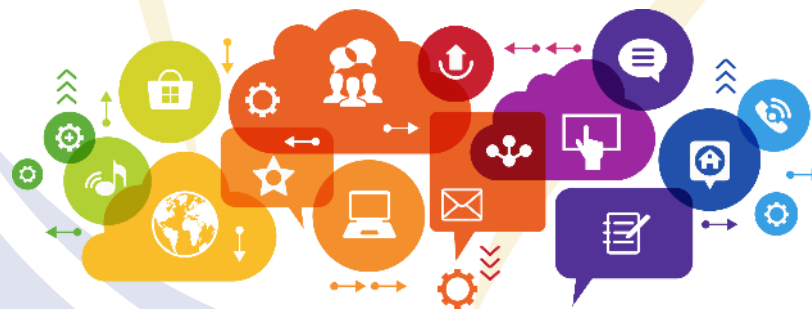
2 Designs Awarded

Results

- Winning designs had to perform in head-to-head testing at a live event.
- Found 2 new suit providers that have been able to try and support the newly forming commercial space flight industry

Discovering the Power of Crowd Based Challenges

Workshop for Defining Candidate Challenges

NASA's Center of Excellence for Collaborative Innovation (CoECI)

Steve Rader   steven.n.rader@nasa.gov
                               @NASA_NTL

Pre-Workshop Assignment

Take a few minutes to consider the following:

- What problems or functions are you responsible for addressing as part of your job?
  - o This may be one big problem, or lots of smaller problems.

- How would you describe a solution or improvement would make a significant difference in solving that problem or performing that function?

- What would a truly ambitious goal look like ?
  - o Ex. Weather predictions that we 2x as accurate and 2x farther in the future, an analysis algorithm that runs in minutes or seconds instead of hours, etc.

- How do you keep up with and leverage/infuse the latest technology developments ?
  - o Conferences, tech journals, Google searches, etc.

- What skill or expertise would your organization benefit from ?
  - o More software developers, algorithm/big data skills, etc.

Challenge Definition Best Practices

- ## You must "own" the problem.
  - This means that if you get a solution, you or your organization would be the one to implement/integrate it.

- ## The problem should be limited in scope.
  - The more focused the problem, the better the chance that the crowd will solve the problem.
  - Complex or multi-faceted system problems do not work as well.

- ## Budget accordingly
  - Don't expect to solve a $10M problem for $10K.
  - Rely on experts to set the incentives.

- ## Express the problem in broad terms
  - Work to remove domain specific jargon and try to make the problem accessible to as many different disciplines as possible.

Evaluating the Risk/Reward of Innovation
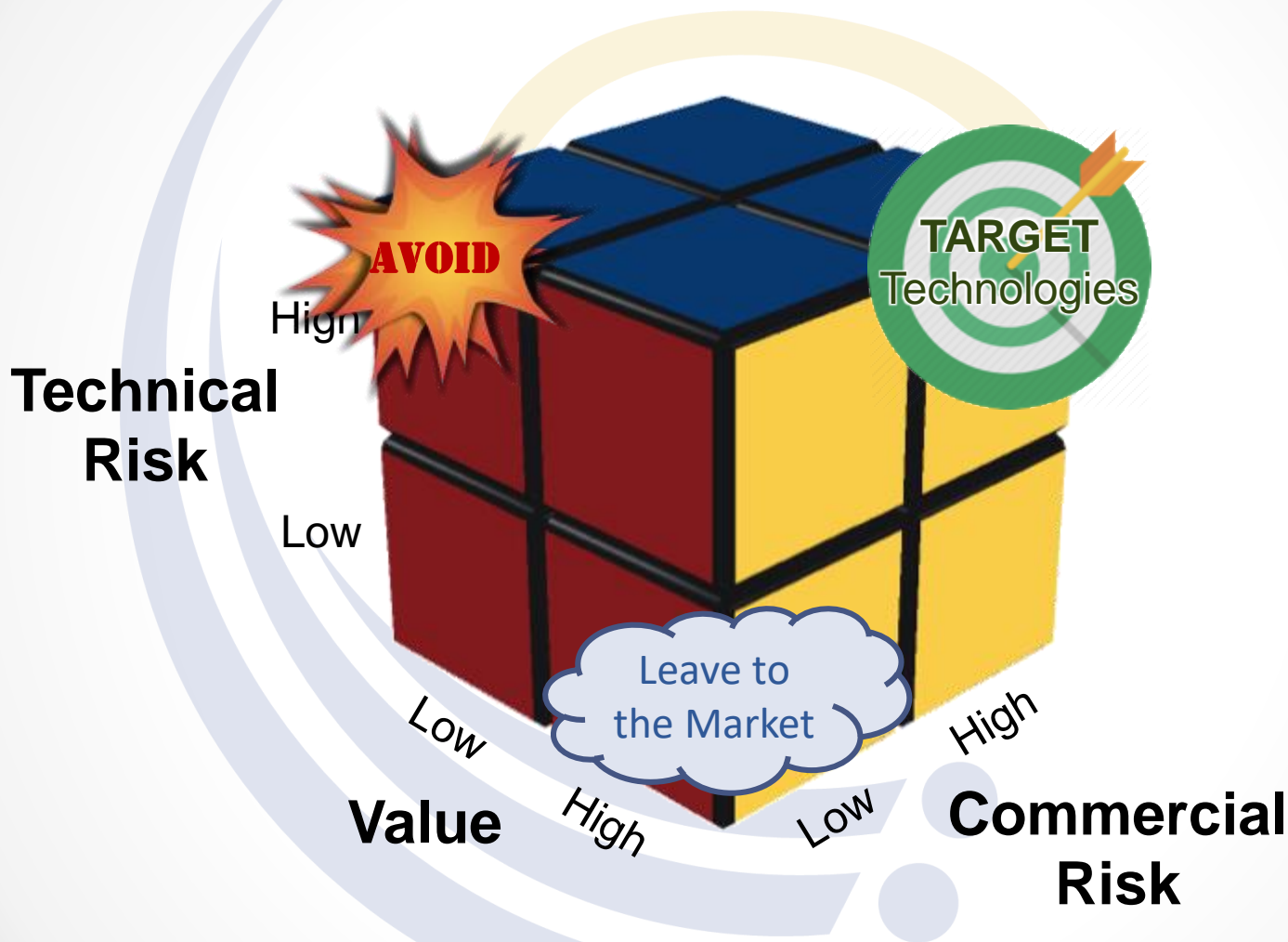
Used by Permission: Clark Gellings, Gellings & Associates,
Electric Power Research Institute (Ret)

Where is Innovation of Value for You?

NOW

- Solving difficult problems that are impeding progress.

- Solutions must be ready to go quickly (high TRL).

- Think "Apollo 13" Innovations

- Requires low-barrier access to any tools for finding solutions.

FUTURE

- Solving difficult problems that make up the gaps to achieving strategic goals.

- More Research & Development focused (low TRL)

- Can include Game Changers
  - Decreasing launch cost by 90%
  - Developing thrust/power to get to Mars in weeks instead of months.

- Requires Strategic Goal Setting and Gap Analysis

There is a New Tool Available

- Solves Difficult Technical Problems with a 92% Success Rate
  - Has solved previously unsolved problems
  - Some solutions have improved the state of the art my orders of magnitude. (examples of 18x, 120x, and 560x improvements)
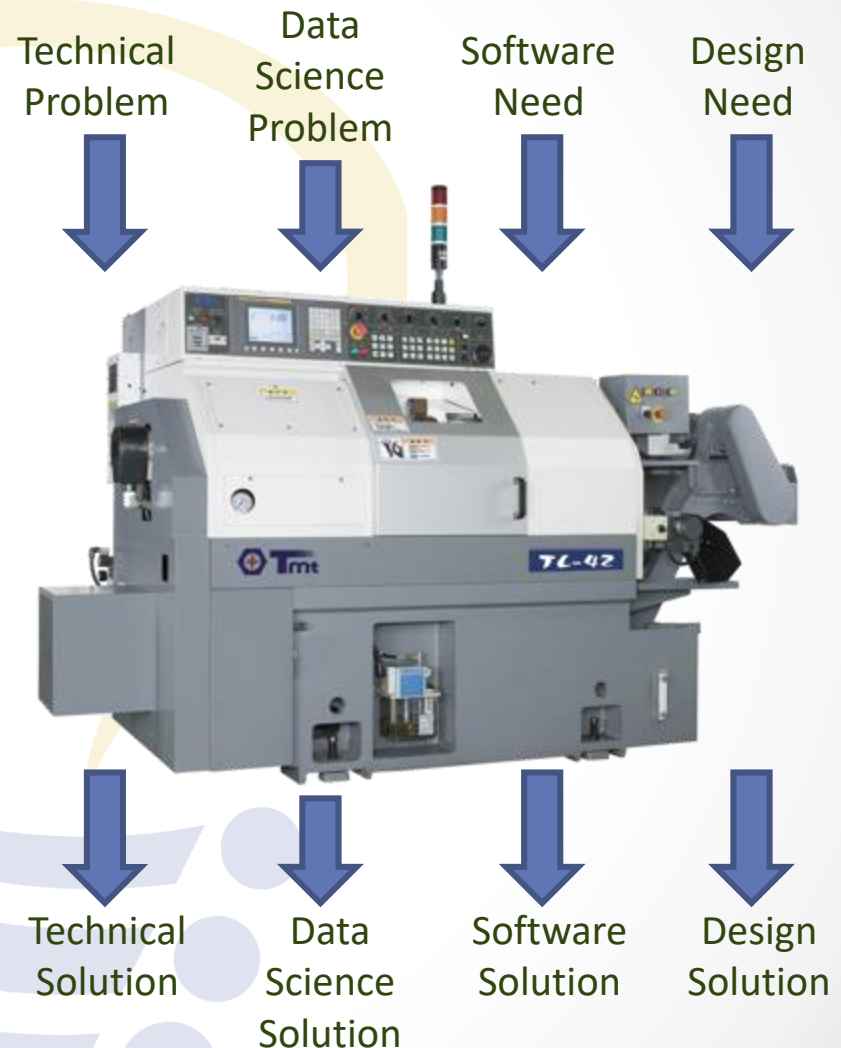
- Saves an Average of 60% cost over Traditional Methods
  - 98% of projects have cost savings
  - Over half of projects save 50-99%

- Only Pay for Performance
  - Full payment only for successful solution.

- Solves most problems twice as fast as traditional methods.

Technical Problem

Data Science Problem

Software Need

Design Need

Technical Solution

Data Science Solution

Software Solution

Design Solution

Conclusion

Open innovation methods are proven and effective tools to extend beyond our traditional technical teams and find innovative solutions and useful expertise to help solve difficult technical problems.

To Participate on NASA Challenges

Go to **https://www.nasa.gov/solve**