DARPA Robotics Challenge:
Robotic Technology for Disaster Response

Jim Pippine - Golden Knight Technologies
DRC Trials - Chief of Operations

Overview

Will not discuss Autonomy

There will be no equations used in this talk

We are not trying to determine the "best" robot

I am not a DARPA Employee*

DARPA Robotics Challenge

- International competition to develop r obot systems for disaster response

- Why a challenge?
  - Historical examples – Napoleon' Food Challenge - 1800's
  - DARPA
    - Grand Challenge 1 – 2004
    - Grand Challenge 2 – 2005
    - Urban Challenge - 2007

Why a Challenge?

- Napoleon Bonaparte's Food Preservation Challenge
  - Year: 1795, Prize: 12,000 Francs
  - Winner: Jan, 1810 by Nicolas Appert (Jar)
  - Runner Up: Aug, 1810 by Peter Durand (Can)
  - Enabled canned food

- DARPA Grand + Urban Challenges
  - Year: Prize (Winner)
    - 2004: $1M (No Winner)
    - 2005: $2M (Stanford)
    - 2007: $2M, $1M, $0.5M (CMU, Stanford, VT)
  - Enabled several current vehicle autonomy efforts

- Enables participation of “best and brightest” performers, including international performers.

Challenges have proven to spur innovation and new industries

Why Disaster Response?

Fukushima Daiichi, March 2011:

"… close study of the disaster's first 24 hours, before the cascade of failures carried reactor 1 beyond any hope of salvation, reveals clear inflection points where minor differences would have prevented events from spiraling out of control."

-*IEEE Spectrum,* November 2011 pg. 36

1. Demographic shift of world's population
   - 1900, 15% Cities
   - 1945, 33% Cities
   - 2005, 50% Cities
   - 2025, 66% Cities (projected)
2. Humanitarian Assistance and Disaster Relief (HADR) is 1 of the 10 primary missions of the US DoD
   ("Sustaining U.S. Global Leadership: Priorities for 21st Century Defense", The White House,+ SecDef, January 2012)
3. HADR is a universally understood and appreciated mission

Our Focus: Human Compatibility

1. **Environments**, even degraded, has been engineered for humans

Public Internet Images

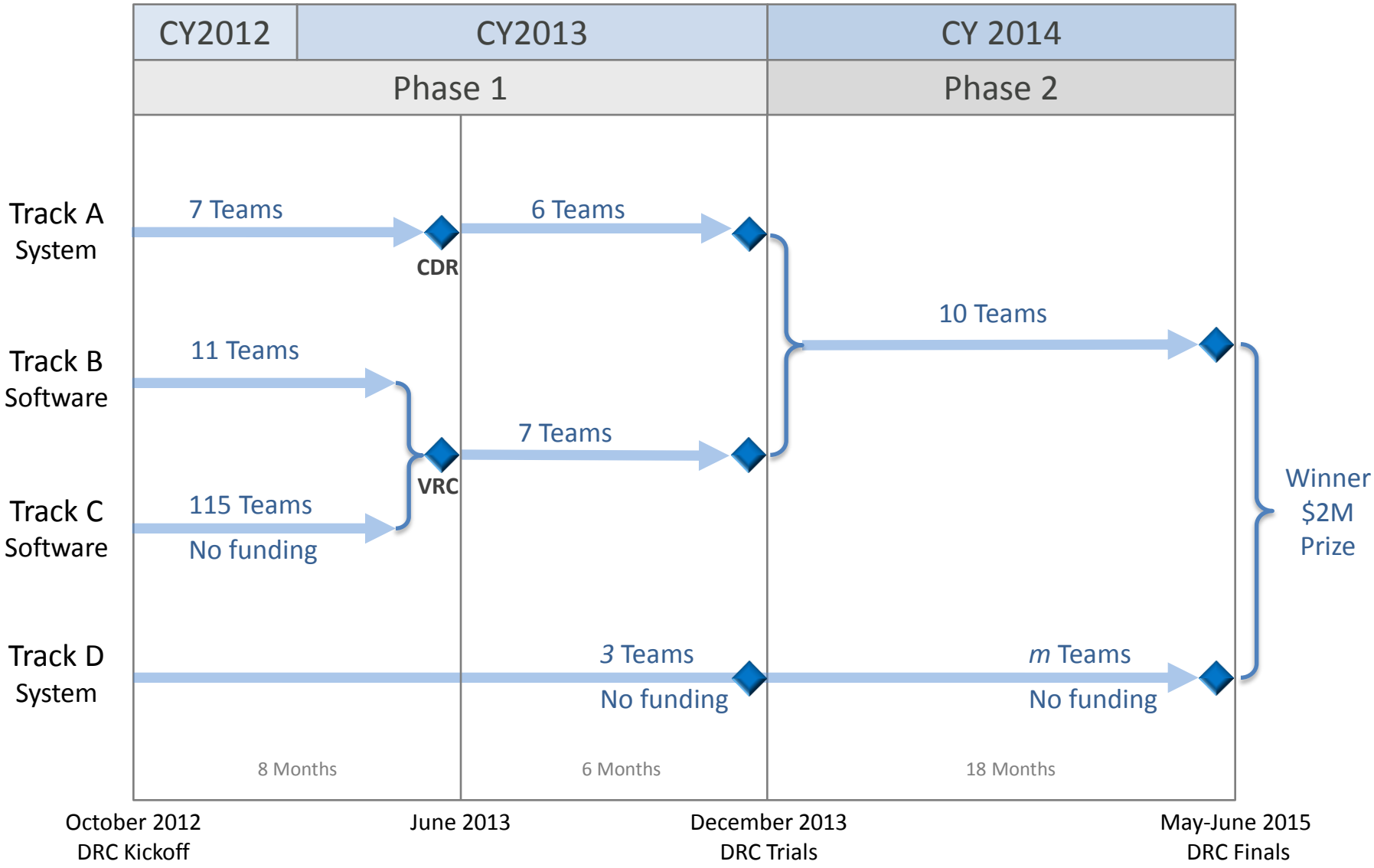
2. No shortage of human **tools**

Public Internet Images

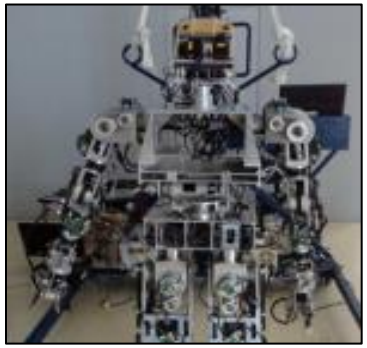
3. No **training**: Human-like robot capabilities are easier for domain experts to use without requiring training.

Public Internet Image

Program Tracks

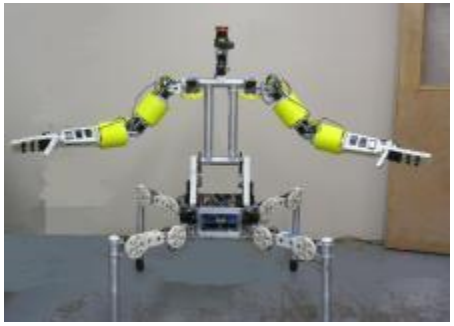


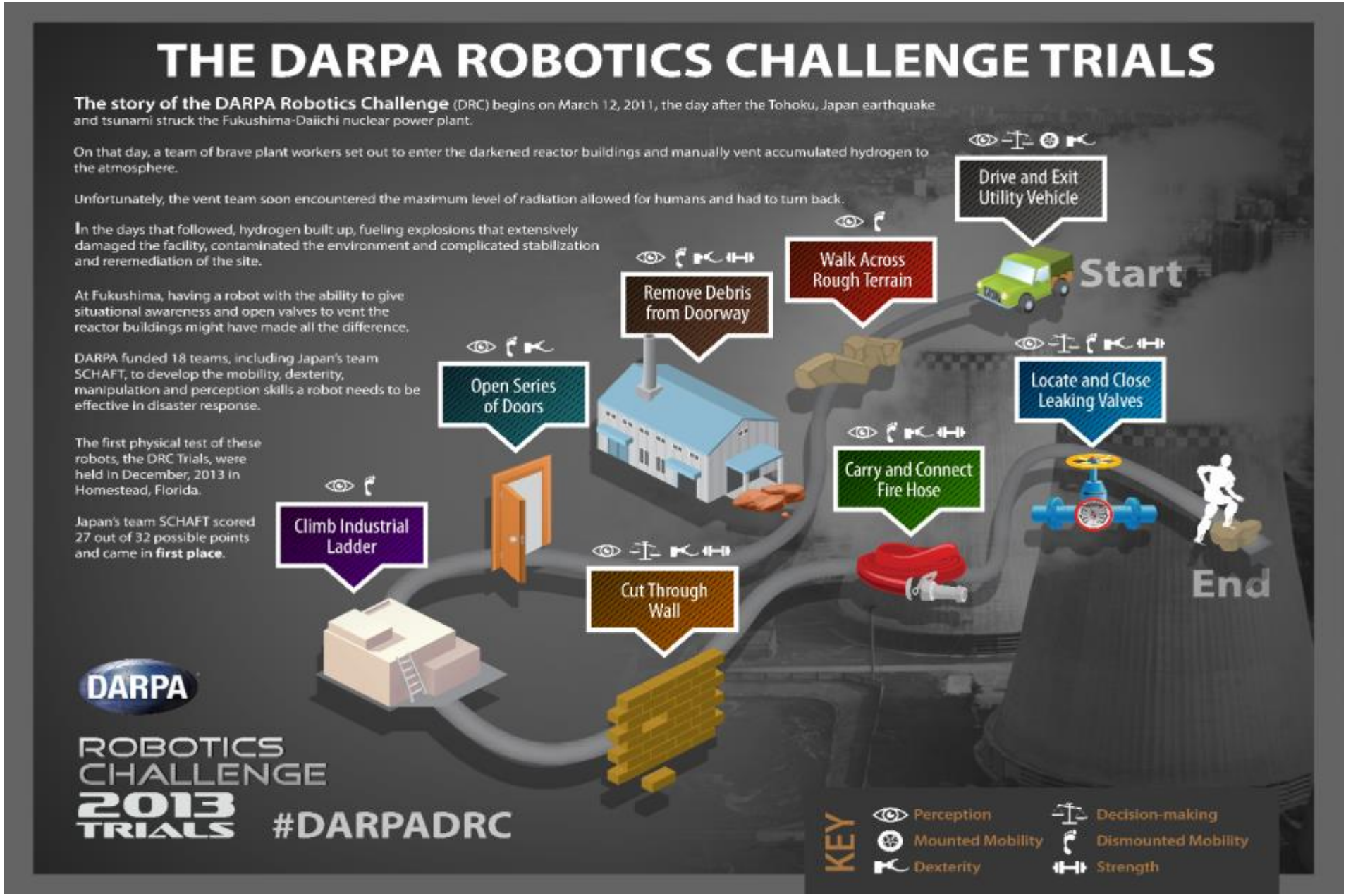
Wide array of Platforms








THE DARPA ROBOTICS CHALLENGE TRIALS
The story of the DARPA Robotics Challenge (DRC) begins on March 12, 2011, the day after the Tohoku, Japan earthquake and tsunami struck the Fukushima-Daiichi nuclear power plant.
On that day, a team of brave plant workers set out to enter the darkened reactor buildings and manually vent accumulated hydrogen to the atmosphere.
Unfortunately, the vent team soon encountered the maximum level of radiation allowed for humans and had to turn back.
In the days that followed, hydrogen built up, fueling explosions that extensively damaged the facility, contaminated the environment and complicated stabilization and reremediation of the site.
At Fukushima, having a robot with the ability to give situational awareness and open valves to vent the reactor buildings might have made all the difference.
DARPA funded 18 teams, including Japan's team SCHAFT, to develop the mobility, dexterity, manipulation and perception skills a robot needs to be effective in disaster response.
The first physical test of these robots, the DRC Trials, were held in December, 2013 in Homestead, Florida.
Japan's team SCHAFT scored 27 out of 32 possible points and came in first place.
Drive and Exit Utility Vehicle
Start
Walk Across Rough Terrain
Remove Debris from Doorway
Open Series of Doors
Locate and Close Leaking Valves
Carry and Connect Fire Hose
Climb Industrial Ladder
Cut Through Wall
End
DARPA
ROBOTICS CHALLENGE 2013 TRIALS
#DARPADRC
KEY
Perception
Decision-making
Mounted Mobility
Dismounted Mobility
Dexterity
Strength

DRC Trials Highlights

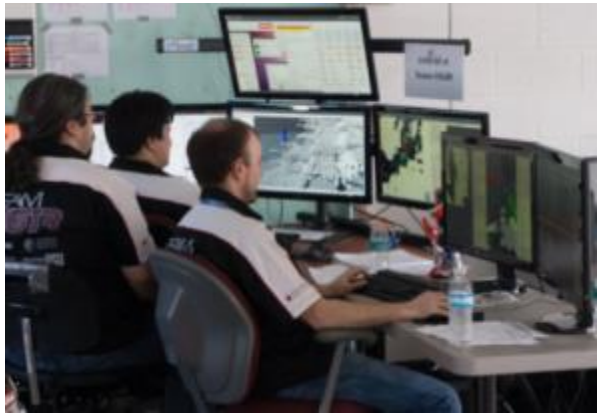
DRC Trials 2013 - Action

Team Schaft's "HRP-2" conducting the Debris Task

Carnegie Mellon's University's "Chimp" conducting the Valve Task

WPI Robotics Engineering C-Squad's "Warner" prepped in advance of the Vehicle Task

Johnson Space Center's Valkyrie prepping for Trials Event



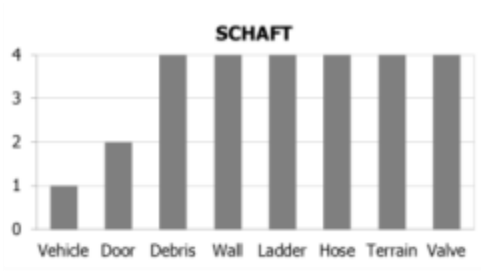
Team VIGIR at their Control Station

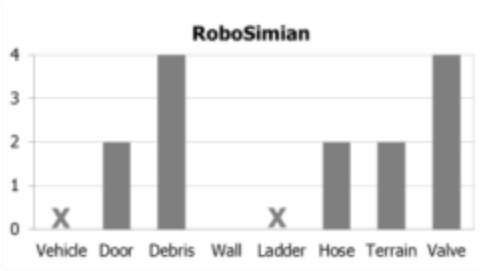
Jet Propulsion Lab's Robosimian conducting the Door Task

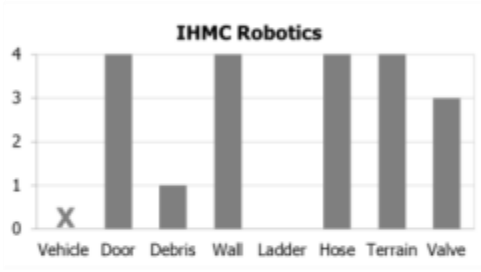
Performer Results: Exceeded Expectations

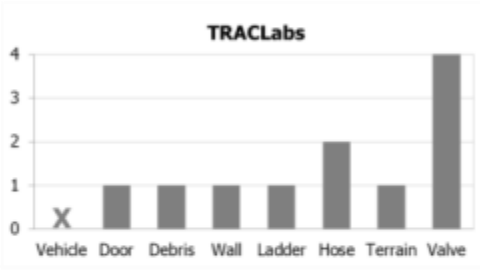
SCHAFT	27
IHMC Robotics	20
Tartan Rescue	18
MIT	16
RoboSimian	14
TRACLabs	11
WRECS	11
TROOPER	9
THOR	8
ViGIR	8
KAIST	8
HKU	3
DRC-Hubo	3
Chiron	0
NASA JSC	0
Mojavaton	0

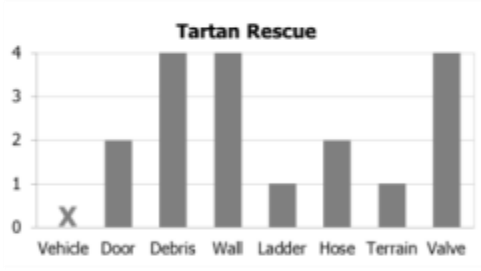
- Green: Team ranked in top 11-Finalists
- Maximum of 32 points possible

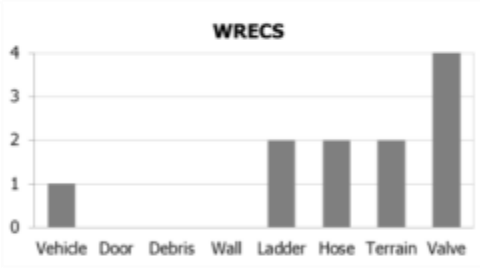


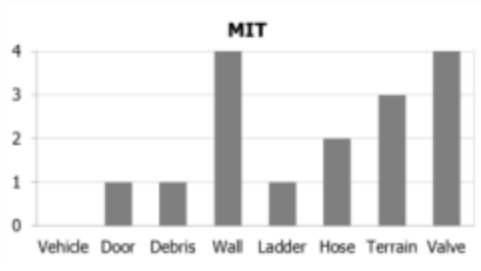


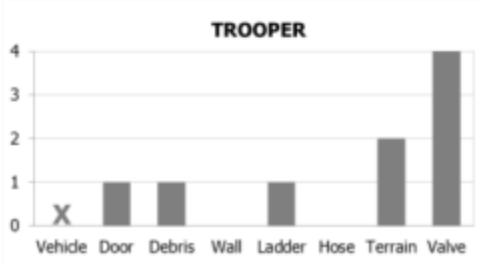












Participation Statistics

On-Site:

DARPA Robotics Trials - Attendance Statistics (2 Days)		
Category	**Number of People**	**Number of Teams/Organizations**
Staff	247	N/A
Team Members	383	16 + Boston Dynamics
Media	149	65 Outlets
Exhibitors	286	36 Exhibits
Spectators (estimated)*	5,000	N/A
TOTAL	**6,065**	

On-Line:

Website Statistics

Trials Day One: December 20th - Total visits: **18,585**

Trials Day Two: December 21st - Total visits: **18,629**

Social Media
YouTube (DARPATV): Live Feeds from the Trials as well as vignettes posted
44,084 views of Day 1 Live Broadcast
19,076 views of Day 2 Live Broadcast

The Future

- DRC Finals Date, Location and Rules –
- - Announcement -June 26th, 2014 – 1300 ET
- - West Coast (not during ICRA)
- - All events in one mission

www.theRoboticschallenge.org

- Problems for the larger Engineering community
  - Power
    - Robot of this scale use 1500-5000 Watts, high peaks
    - Require 6-8 hours of operation to be mission relevant
  - Communications
    - Low latency, high bandwidth, globally, indoor, outdoors

Some other robots

LS3 support platform

Wildcat / Cheetah (30+ mph)

Questions