Current Trends in Robotics

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Machines with (- more or less -) intelligence are already present:
Artificial Intelligence has entered ***the real world***.

Machines are able to learn
and to improve themselves.

Some scientists are afraid about uncontrollable developments.

Stephen Hawking,
Stuart Russell, ...

"keeping our fingers crossed
that we'll run out of gas
before we run off the cliff"

Call to prevent from uncontrollable developments:

Research Priorities for Robust and Beneficial Artificial Intelligence: an ***Open Letter***
http://futureoflife.org/AI/open_letter

Recent Robots …

… do like predictable situations:

- structured environments
- well defined options
- clear decision rules

… don´t like completely new things

- unforeseen events
- creative efforts
- changing requirements

Cooperation
of humans and machines
for complex tasks

Outline

- Examples
- DARPA Robotics Challenge (disaster scenario)
- Conclusions

Agriculture

- GPS- and vision-based
  self-guided/remote controlled tractors, harvesters, drones...

automate or augment

- pruning,
- thinning,
- harvesting,
- mowing,
- spraying,
- weed removal
- ....

Autonomous Cars …

… will come by incremental development towards more autonomy
… by increasing Driver Assistance Systems

ABS, ESC, Parking, Lane change, Driver Monitoring, Emergency Braking …

Different degrees of autonomy:

- Warning (e.g. in case of decreasing distance)
- Supporting (e.g. optimized braking)
- Autonomous acting (emergency brake)

Industrial Robots

Actual developments:

Mobile robots with more flexibility

(towards human workers)

- Traffic, Transportation
- Robots at home: Still long way to go
- Health Care
- Civil Forces, Rescue

Military

From automatic
to semi-autonomous and
fully autonomous weapons

Open Letter from AI & Robotics Researchers
http://futureoflife.org/AI/open letter_autonomous_weapons

DARPA Grand Challenges

(DARPA = Defense Advanced Research Projects Agency)

Images by DARPA

1. DARPA Grand Challenge (desert): 13.3.2004
2. DARPA Grand Challenge (desert): 8/9.10.2005

DARPA Urban Challenge (urban area): 3.11.2007

DARPA Robotics Challenge (desaster area): 2012-15

DARPA Robotics Challenge 2012-15

Robots in desaster response scenario

Scenario by first announcement:
The robot has to

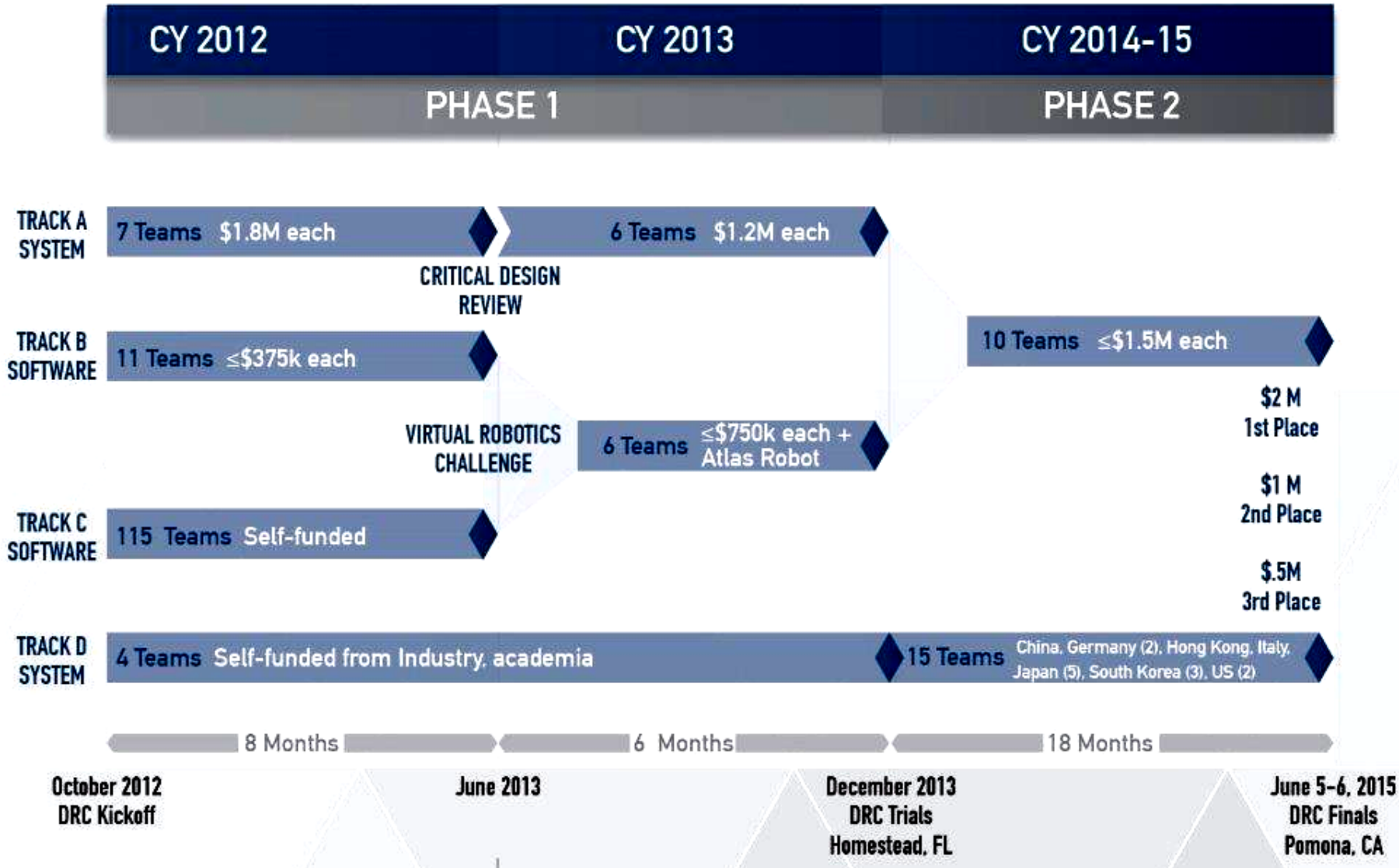
1. use an unmodified vehicle to drive to desaster area
2. traverse through devasted area
3. remove debris blocking an entry
4. open a door and enter a building
5. climb a ladder and traverse industrial walkway
6. break through wall using appropriate tools
7. locate and close a valve near a leaking pipeline
8. replace a defect component

DARPA Robotics Challenge

Rules by first announcement:

- Acting in normal environment after a catastrophe
- Usage of standard tools
- Extern power supply allowed as far as conform with tasks
- Semi-autonomy: Control by non-expert operators

DRC PROGRAM STRUCTURE + FUNDING

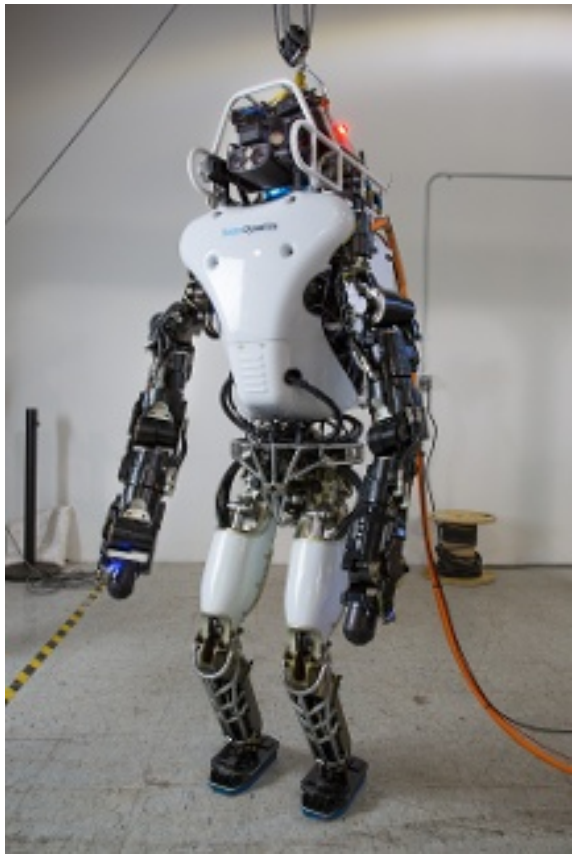


Hans-Dieter Burkhard:

ATLAS

Robot platform ATLAS (Boston Dynamics)
for Track B: Winners of Simulation Challenge

Boston Dynamics
now owned by Google



- On-board real-time control computer
- Hydraulic pump and thermal management
- 30 hydraulically actuated joints
- 156 kg
- 1.88 m
- 480V 3-phase at 15 kW
- C++ and ROS APIs

Track A: Own Robots with Funding

Carnegie Mellon University
Drexel University
SCHAFT
Virginia Tech
NASA Johnson Space Center
NASA Jet Propulsion Lab.

Track B: DRC SIMULATOR

Open-source simulator

with robots, robot components, field environments

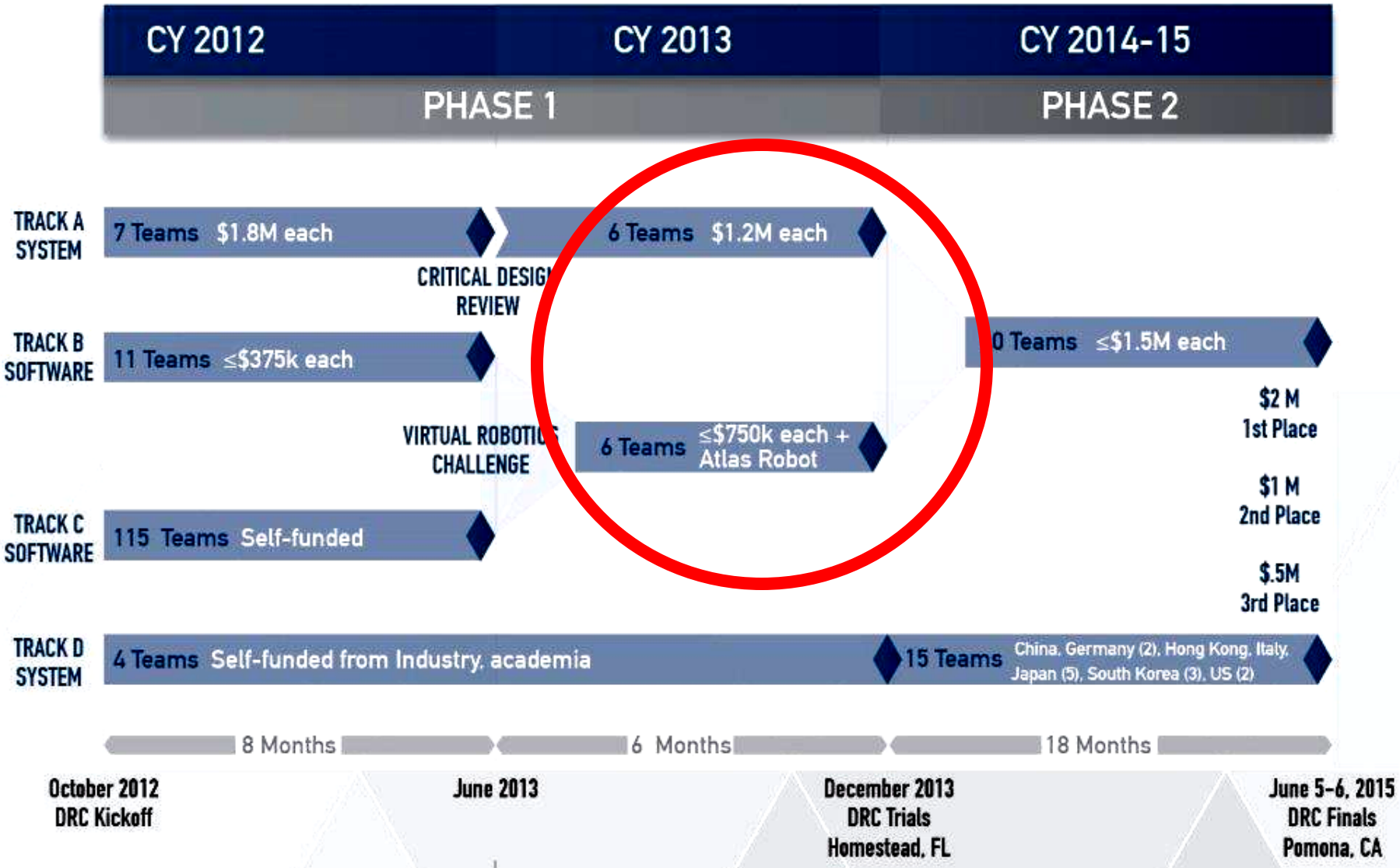
Winners of *Virtual Robotics Challenge*

Funded each by
up to $750,000 and ATLAS robot

- Team IHMC, Pensacola, Florida
- WPI Robotics Engineering C Squad (WRECS), Massachusetts
- Massachusetts Institute of Technology (MIT), Cambridge, Massachusetts
- Team TRACLabs, Webster, Texas
- Team ViGIR, Blacksburg, Virginia, und TU Darmstadt
- TROOPER, Cherry Hill, New Jersey

- Team HKU (Hong Kong University /Team K /Case Western University), (funded by Hong Kong University)

DRC PROGRAM STRUCTURE + FUNDING



Hardware Challenge December 2013

Separate performance of 8 tasks:

1. drive
2. traverse
3. remove debris
4. open door
5. climb ladder
6. break through wall
7. close valve
8. connect hose

Tethering was allowed

Winner of Hardware Challenge Dec. 2013: Team SCHAFT (Japan)

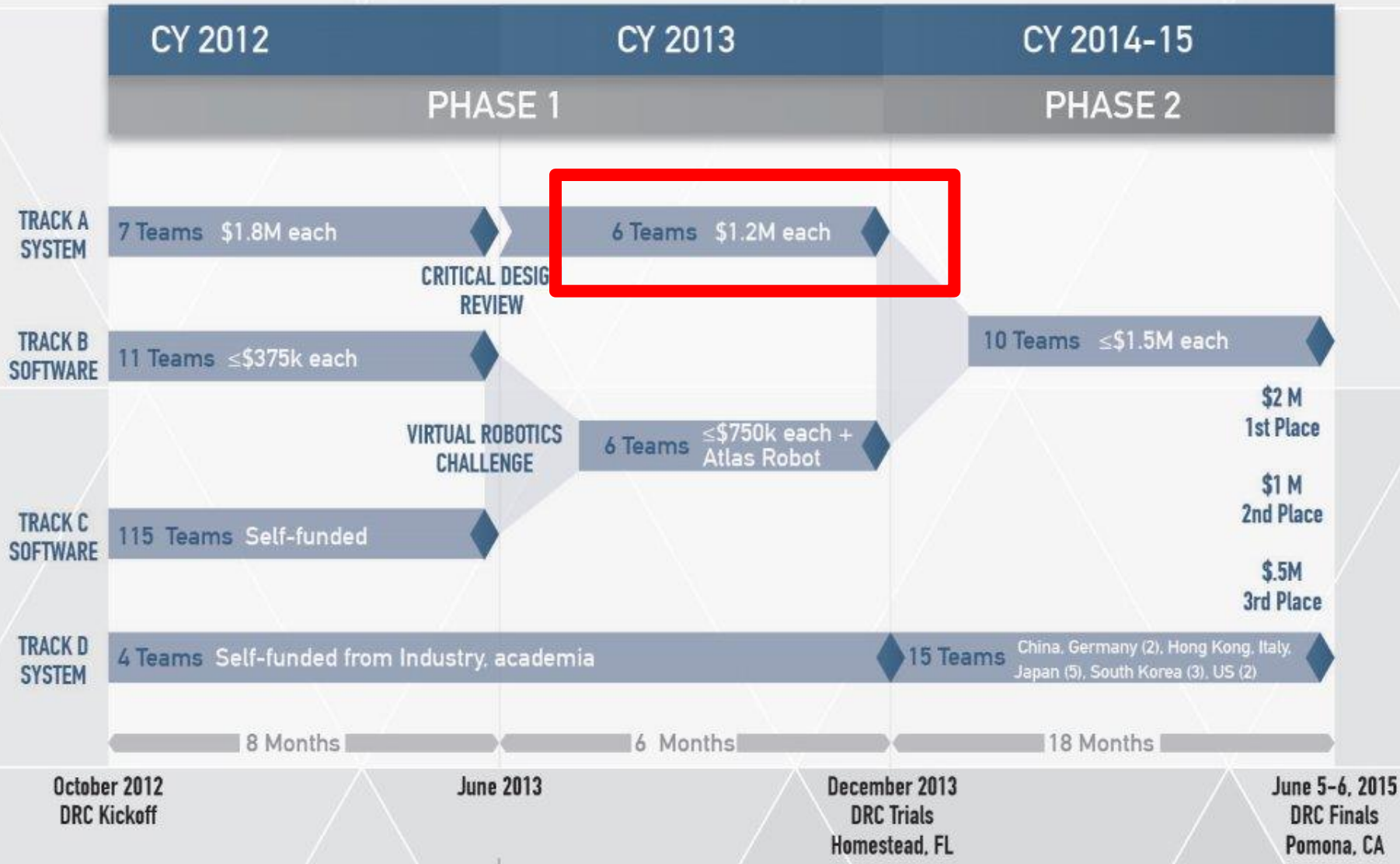
Continued Funding after Challenge Dec. 2013

Team	Points*	Track
~~SCHAFT~~	~~27~~	~~D (A†)~~
IHMC Robotics	20	B
Tartan Rescue	18	A
MIT	16	B
RoboSimian	14	A
Team TRACLabs	11	B
WRECS	11	C
TROOPER	9	B
THOR	8	B
ViGIR	8	B
KAIST	8	D

Team SCHAFT (Japan)
declined further participation
after Google's acquisition

Track A: Own robot with funding
Track B and C: Using ATLAS
after Qualification in
Software challenge
Track D: Own robot without funding

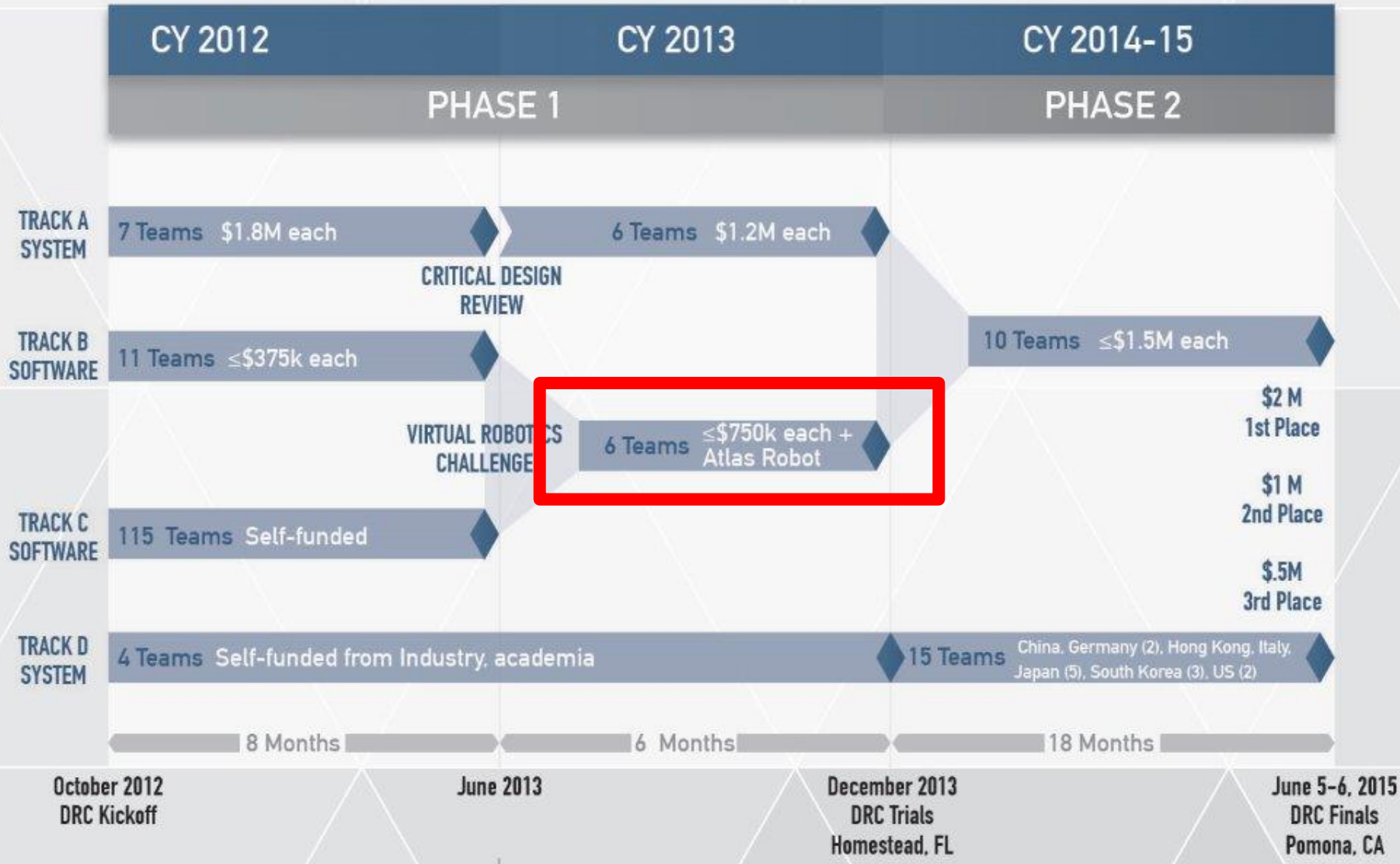
DRC PROGRAM STRUCTURE + FUNDING



Qualified December 2013 with own robots

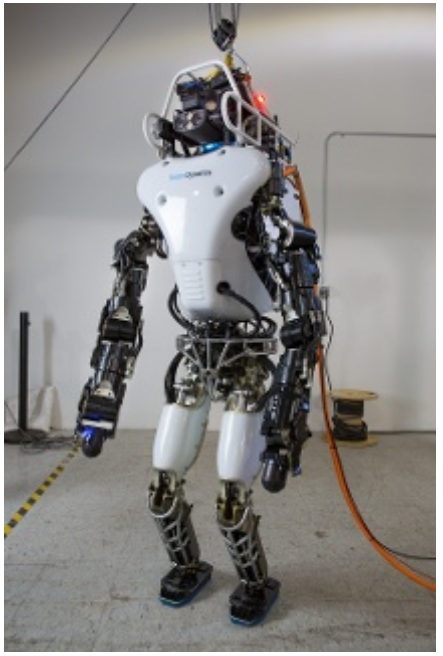
- Tartan Rescue (Pittsburgh, US)
- Team KAIST (Daejeon, South Korea)
- Team RoboSimian (Pasadena, US)
- Team THOR (Los Angeles/Philadelphia US)
- Team Trooper (Cherry Hill/Troy/Philadelphia, US)
- Team Valor (Blacksburg, US)

DRC PROGRAM STRUCTURE + FUNDING

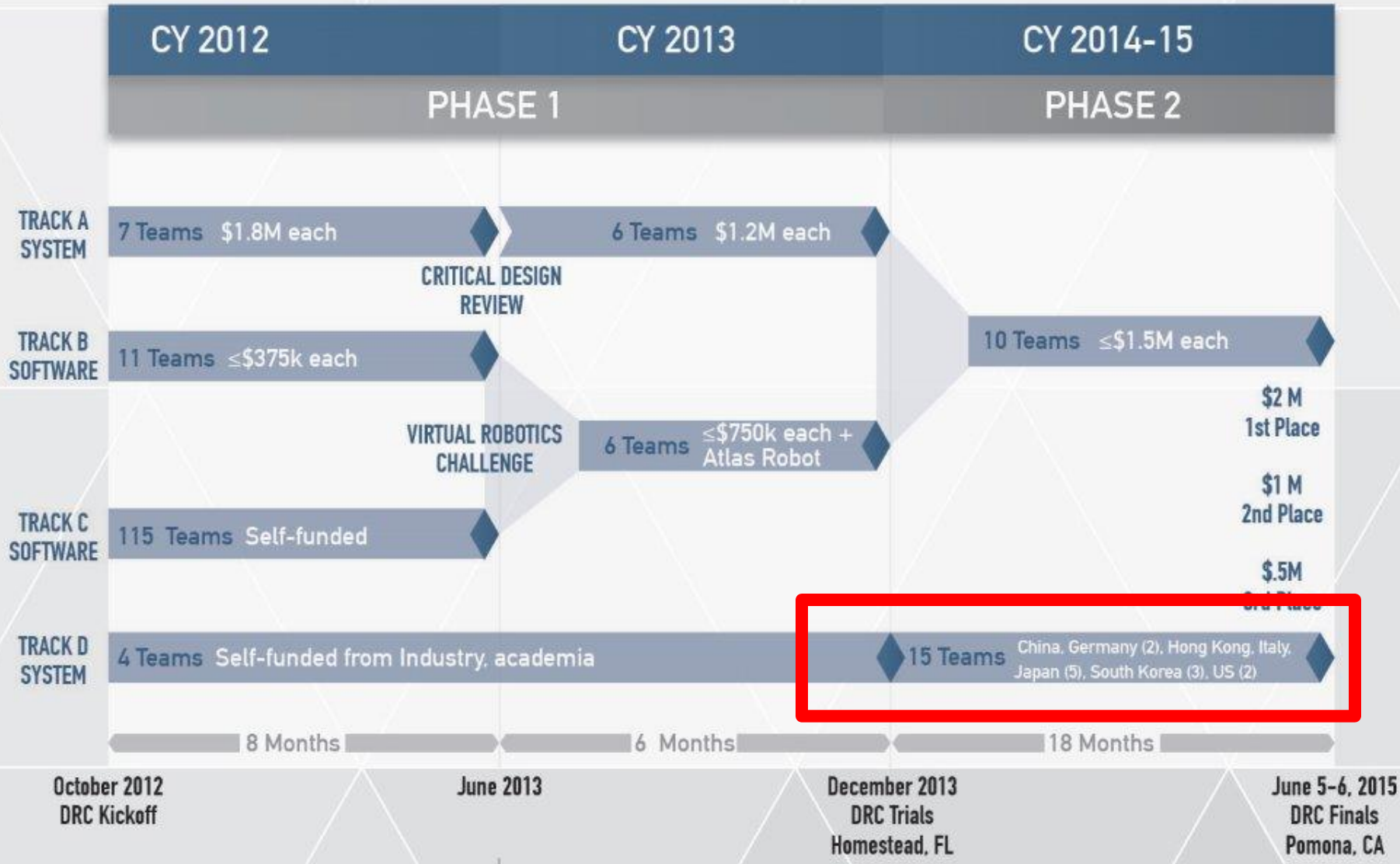


Qualified December 2013 using Atlas

- Team IHMC Robotics (Pensacola, US)
- Team MIT (Cambridge, US)
- Team TRACLabs (Webster, US)
- Team ViGIR (Blacksburg/Corvallis/Darmstadt, US/Germany)
- Team WPI-CMU (Worcester, US)
- TEAM HKU (HongKong)



DRC PROGRAM STRUCTURE + FUNDING



Additional Finalists 2015

Further teams could apply by submitting video materials for 5 sample tasks:

1. engage an emergency shut-off switch,
2. get up from a prone position,
3. locomote 10 meters without falling,
4. pass over a barrier,
5. rotate a circular valve 360 degrees.

13 more teams from 7 different countries came to finales:
Germany (2), Italy (1), Japan (5), South Korea (2), US (2)

13 Additional Finalists












Additional Finalists

- Team Hector (Darmstadt, Germany

- Team NimbRo Rescue (Bonn, Germany)

- Team WALK-MAN (Pisa/Genua, Italy)

- Team Aero (Tokyo, Japan)

Additional Finalists

- Team AIST-NEDO (Tokyo, Japan)
- Team HRP2-Tokyo (Tokyo, Japan)
- Team NEDO-Hydra (Tokyo/Osaka/Kobe, Japan)
- Team NEDO-JSK (Tokyo, Japan)
- Team Intelligent Pioneer (Changzhou, PR China)





Additional Finalists

- Team ROBOTIS (Seoul, South Korea)

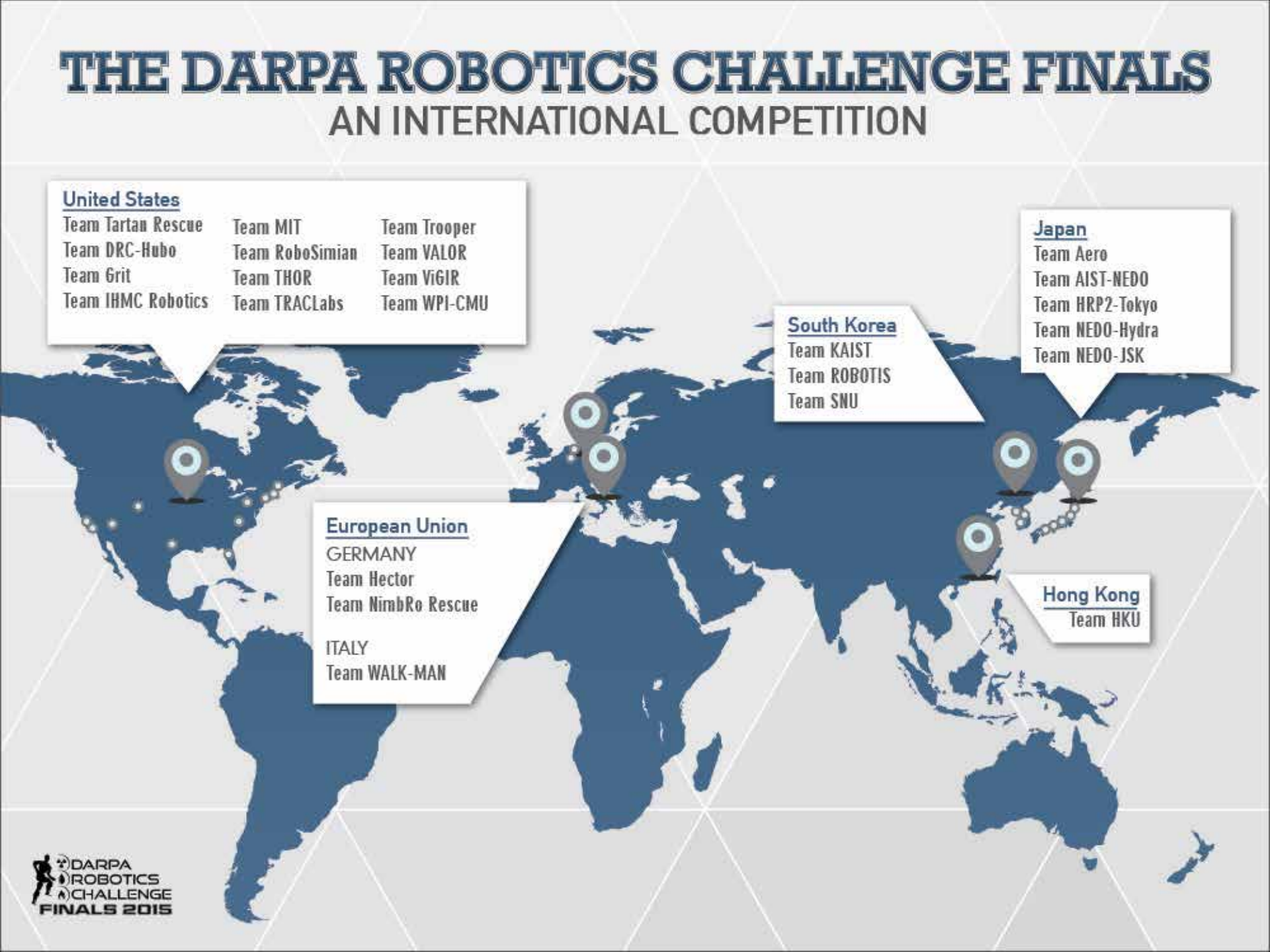
- Team SNU (Seoul, South Korea

- Team DRC-Hubo @ UNLV (Las Vegas, US)

- Team Grit (Grand Junction/Morton/Moscow, US)

THE DARPA ROBOTICS CHALLENGE FINALS

AN INTERNATIONAL COMPETITION



Finals:

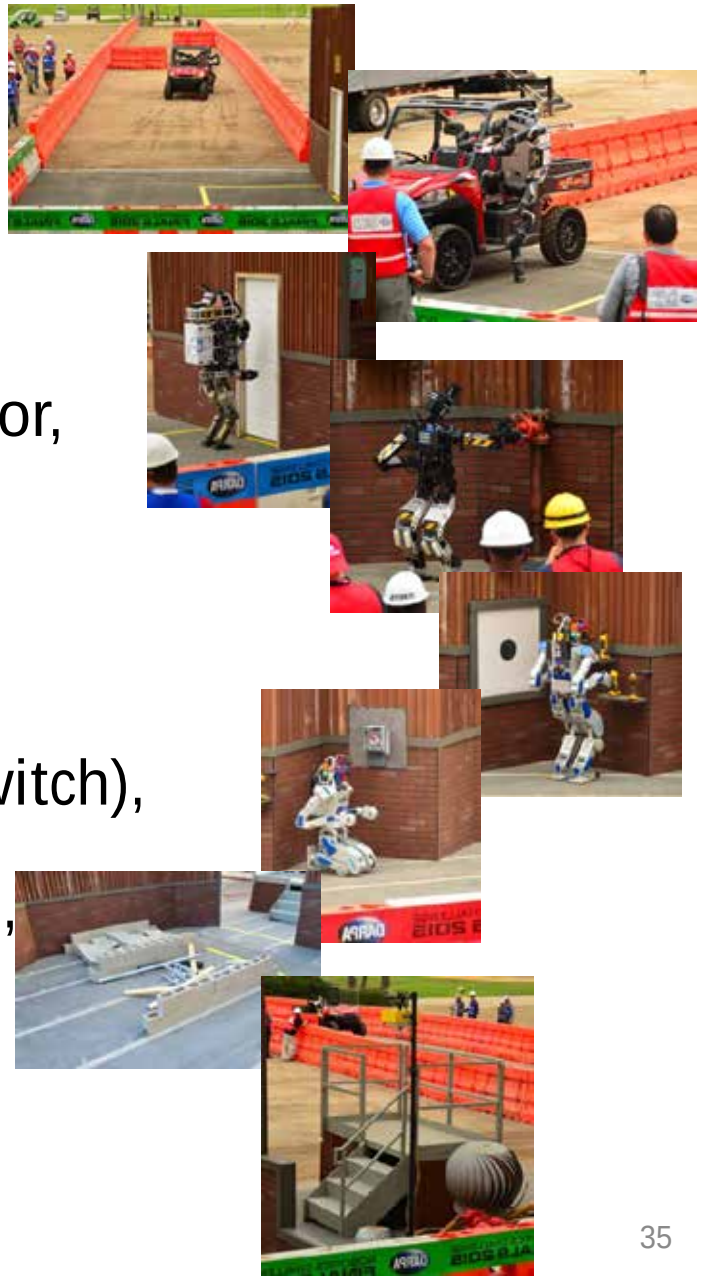
June 5-6, 2015

at Fairplex in Pomona, California.

Competition Arena

Robot gets loaded into the drivers seat of the car.
Then the robot

1. drives down an obstacle course,
2. dismounts the vehicle,
3. opens and goes inside through the door,
4. finds and closes a valve,
5. chooses a tool and carves out a hole,
6. solves the “surprise task” (e.g. plug switch),
7. takes away or walks over some rubble,
8. climbs the outside stairs.



Modified Rules

- Acting in normal environment after a catastrophe
- Usage of standard tools
- ~~Extern power supply allowed as far as conform with tasks,~~
  No tethering
- Semi-autonomy: Control by ~~non-expert operators~~ developers
  Communication degraded for „inside tasks“

Overall time limit: 60 minutes.
2 trials, best one counts

Ranking

- by solved tasks
- by overall time

Winner: Team KAIST from South Korea

Team KAIST from South Korea

		Pts.	Time
TEAM KAIST	South Korea	8	44:28
TEAM IHMC ROBOTICS	US	8	50:26
TARTAN RESCUE	US	8	55:15
TEAM NIMBRO RESCUE	Germany	7	34:00
TEAM ROBOSIMIAN	US	7	47:59
TEAM MIT	US	7	50:25
TEAM WPI-CMU	US	7	56:06
TEAM DRC-HUBO AT UNLV	US	6	57:41
TEAM TRAC LABS	US	5	49:00
TEAM AIST-NEDO	Japan	5	52:30
TEAM NEDO-JSK	Japan	4	58:39

Track A Own robots with funding
Track B and C: ATLAS
Track D: Own robots without funding, entering 2015
Track D+: Own robots without funding, entering 2015

TEAM SNU	South Korea	4	59:33
TEAM THOR	US	3	27:47
TEAM HRP2-TOKYO	Japan	3	30:06
TEAM ROBOTIS	South Korea	3	30:23
TEAM VIGIR	US/Germany	3	48:49
TEAM WALK-MAN	Italy	2	36:35
TEAM TROOPER	US	2	42:32
TEAM HECTOR	Germany	1	02:44
TEAM VALOR	US	0	00:00
TEAM AERO	Japan	0	00:00
TEAM GRIT	US	0	00:00
TEAM HKU	HongKong	0	00:00

Track A Own robots with funding
Track B and C: ATLAS
Track D+: Own robots without funding, entering 2015

Life is Hard … for Robots

Conclusions

- Robotics/AI will change life dramatically.
- Can be good or bad:
  Needs control by society.
- Robotics will develop incrementally:
  Evolution instead of revolution.
- How will society adapt?

Thank You!