

DARPA Robotics Challenge

Proposers' Day

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Recent Disasters



Katrina - 2005



**Deepwater
Horizon
2010**



Fukushima - 2011

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Inspiration and Goals



Man-Computer Symbiosis
J. C. R. Licklider (head of DARPA IPTO 1962)
IRE Transactions on Human Factors in Electronics,
volume HFE-1, pages 4-11, March 1960



Fukushima - 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. Target disaster response in dangerous environments, and important DoD capability for HADR (Humanitarian Assistance and Disaster Relief) missions
2. Advance supervised autonomy, mobility, manipulation, and energetic efficiency.
3. Catalyze the robotics industry by developing a validated, real-time, operator-interactive simulator.
4. Welcome a wide range of international contributors including traditional and non-traditional DARPA performers from a variety of fields.

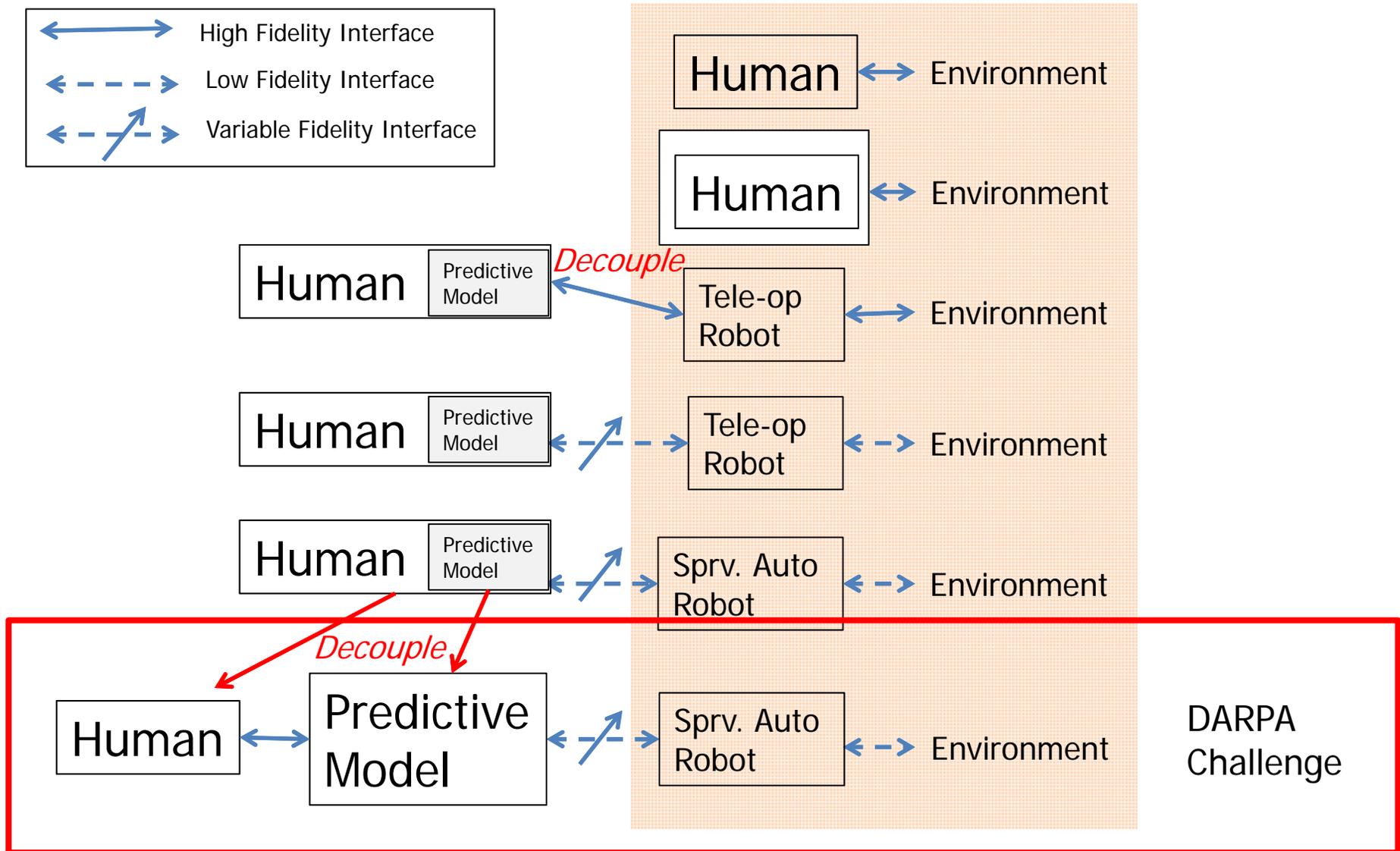
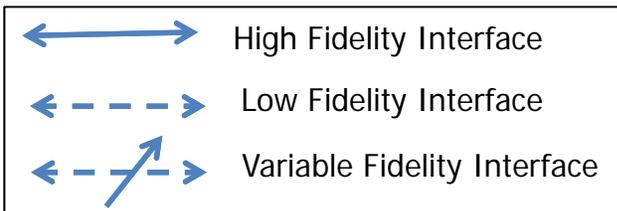


Why emphasize human-like robot capabilities?

1. Environment, even degraded, has been engineered for humans
2. No shortage of human tools, from hand tools to vehicles
3. Human-like robot capabilities are easier for domain experts to understand and untrained operators to control

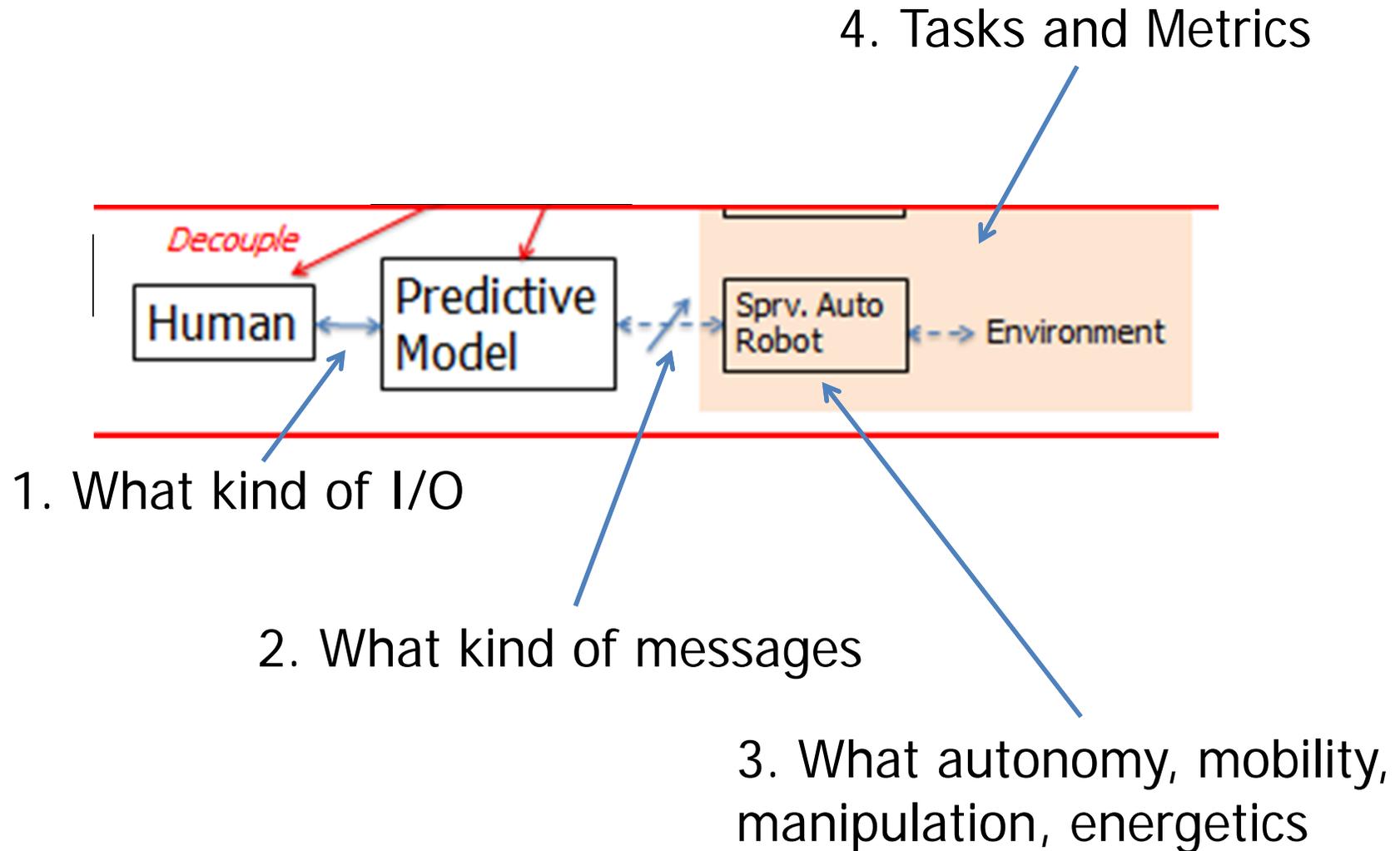


Supervisory Autonomy and Predictive Models





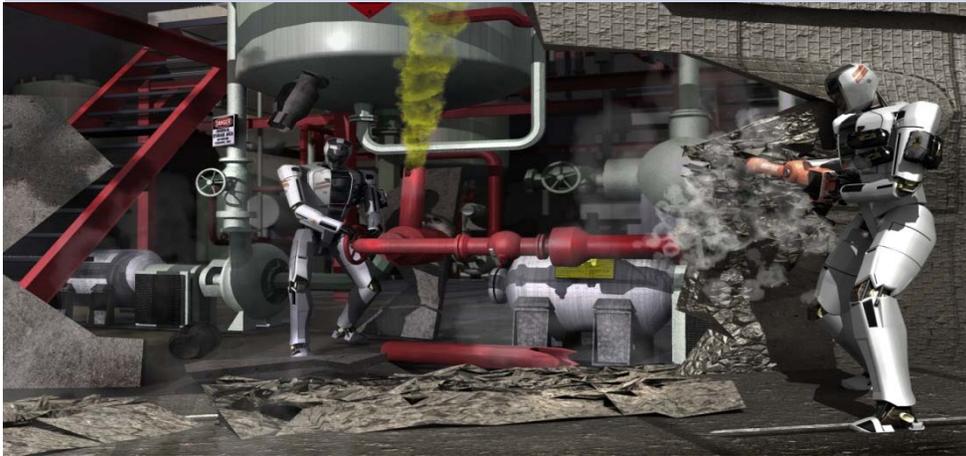
Questions this Program will Address





Example Disaster Challenge Scenario

Capabilities



Tasks

	Autonomy - Perception	Autonomy – Decision-making	Mounted Mobility	Dismounted Mobility	Dexterity	Strength	Endurance
1. Drive utility vehicle to site	X	X	X		X		
2. Travel dismounted across rubble	X			X			X
3. Remove debris blocking entryway	X			X	X	X	X
4. Open door, enter building	X			X	X		X
5. Climb industrial ladder, traverse industrial walkway	X			X			X
6. Use tool to break through concrete panel	X	X			X	X	X
7. Locate and close valve near leaking pipe	X	X		X	X	X	X
8. Replace component	X	X			X		



Planned Tasks – subject to change

Task 1 - Drive a utility vehicle to the site

The robot must demonstrate mounted mobility by ingress to the vehicle, driving it on a road, and egress from the vehicle. The robot must also demonstrate manipulation by operating the controls, including steering, throttle, brakes, and ignition. The robot must steer, accelerate, and brake.

Task 2 -Travel dismounted across rubble

The robot must demonstrate dismounted mobility by crossing terrain ranging from smooth and level, to rough and sloped, with some loose soil and rocks. This terrain will be easily traversable by a human.

Task 3 - Remove debris blocking an entryway

The robot must demonstrate the dexterity and strength to move an object blocking an entryway. The object will have size, weight, and other properties to be movable either by a person or by the GFE Platform. The object mass is expected not to exceed 5 kg.

Task 4 - Open a door and enter a building

The robot must demonstrate the dexterity to operate a door handle and the strength to push the door open.



Planned Tasks (cont.) – subject to change

Task 5 - Climb an industrial ladder and traverse an industrial walkway

The robot must demonstrate dismounted mobility to traverse an industrial elevated walkway. It is expected that the walkway (or catwalk) will have a grated surface and handrails.

Task 6 - Use a tool to break through a concrete panel

The robot must demonstrate using a power tool to perform forceful manipulation. The power tool is expected to be an air or electric impact hammer and chisel, or an electric reciprocating saw.

Task 7 - Locate and close valve near leaking pipe

The robot must demonstrate the perception ability to find a leaking pipe and a nearby valve, the dismounted mobility to approach the valve, and the manipulation ability to close the valve

Task 8 - Replace cooling pump

The robot must demonstrate the perception ability to locate the pump, the manipulation ability to loosen one or more fasteners, and the bi-manual manipulation ability to extract and replace the pump.



Participation Options

Track A - Funded Teams design and build platform systems to participate in Disaster Response Challenge.

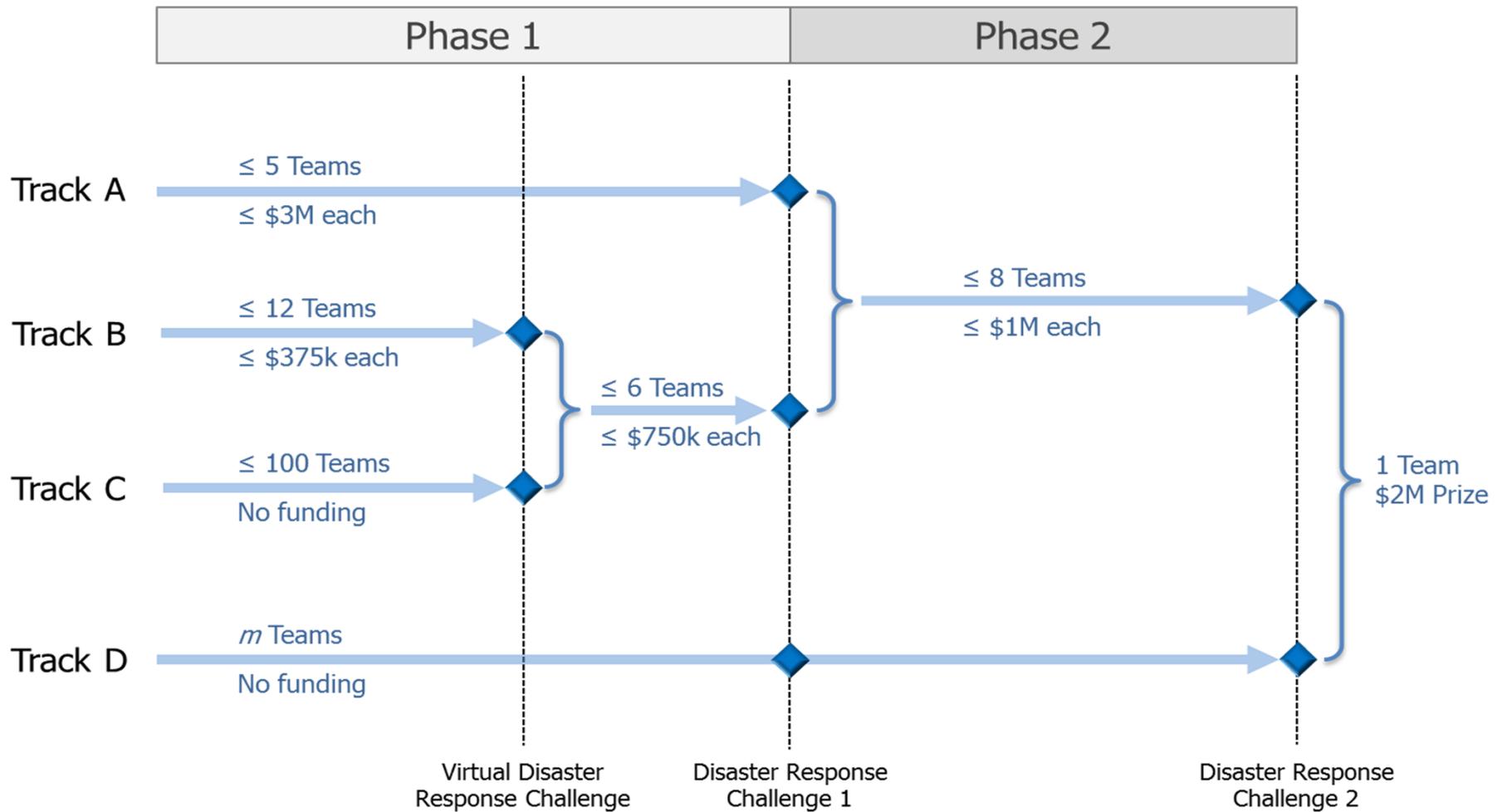
Track B — Teams develop algorithms using DARPA provided Simulator. Disaster Virtual Challenge conducted to identify which teams will be provided GFE Robot and additional funding to participate in Disaster Response Challenge

Track C – Unfunded teams use Simulator to and develop algorithms and participate in Disaster Virtual Challenge and will compete along with Track B teams for GFE Robot and funding award

Track D – Unfunded teams develop platforms to compete in Disaster Response Challenges



Planned Schedule and Funding





Planned Program Funding

The program has planned the following funding for teams. This plan is subject to change depending on the number of qualified teams and available resources.

Phase 1

Track A: Up to \$3M for each team (up to five (5) teams for fifteen (15) months).

Track B: first nine (9) months through the Virtual Disaster Response Challenge: Up to \$375k for each team, with up to twelve (12) teams.

Track B/Track C: last six (6) months after the Virtual Disaster Response Challenge: Up to \$750k additional for each team, with up to six (6) teams.

Phase 2

Up to \$1M for up to eight (8) of the top performing teams from the first physical disaster challenge.

Prize

Anticipated to be \$2M to a single team.



Planned Key Dates

- May 31, 2012 – BAA Closing
- October 2012 – Anticipated Contract Awards/Program Kickoff
- June 2013 – Virtual Disaster Response Challenge
- December 2013 – Disaster Response Challenge #1
- December 2014 – Disaster Response Challenge #2



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