

Smarter City Testbeds

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October 15, 201



oday, the Administration is announcing a new "Smart Cities" nitiative that will invest over \$160 million in federal research and everage more than 25 new technology collaborations to help ocal communities tackle key challenges such as reducing traffic ongestion, fighting crime, fostering economic growth, managing ne effects of a changing climate, and improving the delivery of ity services.





ational Science Foundation

- "A new foundation-wide effort devoted to Smart and Connected Communi US Ignite \$6M project for smart and connected cities US Ignite grants (also \$6M) for smart city end-user applications Smart city Cyberphysical Systems grants (\$10M)
- FY16 support for Urban Sciences (\$7.5M)
- Academic / Industry collaborations (\$4M)
- Chicago "Array of Things" (\$3M)
- Support for Global City Teams Challenge (\$2.5M)
- Critical Infrastructure Improvements (\$2.5M)
- Smart and Connected Health (\$2M)
- Dear Colleague Letter on Smart and Connected Communities



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- National Institute of Standards and Technology
 - Investing \$5 million in Smart Cities in FY16
 - Announced a new round of the Global City Teams Challenge
 - Cities working with each other and/or universities and/or corporations
 - Co-produced by Ousignite
 - IBM will help support Kick-off events in 30 global cities
 - AT&T will select 10 U.S. cities to deploy technology for smart metering, lighting, traffic management, parking, and public safety.
 - AT&T will host a Smart Cities hackathon with NIST participation at the AT&T Developer Summit in January 2016.
 - Kickoff November 12-13, 2015 in Gaithersburg, Maryland US
 - International participation encouraged



Signife Smart and nected Cities Project

- Announced Sept. 14th
- Launch in December / January



- \$6M over three years from NSF
- \$6M over three years from the cities (investing in themselves)
- 15 cities in the US
- Encouraging international participation



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What would the Metro Internet look like if it were designed to support:

- Internet of Things (IoT)?
- Billions of wireless devices?
- Industrial Internet?
- Low-cost endpoints? (close digital divide)

Roll that out in cities across the U.S. and globally and use it to leverage innovative applications and services.



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INTERNET®





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rastructure & Apps for Smart Cities



- 15+ city US Ignite testbed for a new Metro Internet:
- Smarter Cities
- Internet of Things
- Industrial Internet
- Innovative wireless
- Community anchor support
- National priority applications and services nteroperable
- nterconnected



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These Testbed Cities

- Ultra-low latency architecture
 - Latency budgets lower than human perception
 - Emphasize in-city applications and services
 - Gigabit clocking or faster in access network
 - Smart wired-to-wireless edge
- SDN for slicing and isolation of sensitive data
- Attention to gigabit-connected community anchors
- Interconnected to all other testbed cities "1-hop" via Intenet2 and state and regional R&E networks



astructure Goals

Design for IoT & Cyberphysical Systems (CPS) loops Ultra-Responsive Ultra-Reliable and Predictable Programmable isolation and federation Billable Gigabit wireless Now: 802.11ac Soon: LTE-A on Citizens Broadband Service Enable inter-city CPS and collaboration



cal Interchange Point ftware-defined IoT SDX

Local Traffic Only

- IoT & IIC friendly
- Gigabit+ end-to-end
- Multiprotocol wireless gateways
- Intelligence at the edge
- Self-sufficient, resilient community





nn's House to U. Utah

C:\Users\Glenn>tracert www.utah.edu

Tracing route to www.utah.edu [155.97.137.55] over a maximum of 30 hops:

```
<1 ms <1 ms <1 ms 192.168.142.1
1
2
  9 ms
         9 ms 10 ms c-24-11-6-1.hsd1.ut.comcast.net [24.11.6.1]
3 17 ms
         16 ms 10 ms te-0-5-0-14-sur04.saltlakecity.ut.utah.comcast.net [162.151.39.77]
                  8 ms he-0-8-0-1-ar01.sandy.ut.utah.comcast.net [162.151.49.145]
4 16 ms
         9 ms
                  35 ms be-33660-cr01.sunnyvale.ca.ibone.comcast.net [68.86.90.145]
5
   25 ms
         24 ms
6
  46 ms 26 ms
                  48 ms he-0-13-0-1-pe03.11greatoaks.ca.ibone.comcast.net [68.86.83.138]
7
   39 ms 52 ms
                  35 ms as7385-1-c.11greatoaks.ca.ibone.comcast.net [173.167.56.198]
8 52 ms
         55 ms
                  36 ms 209.63.82.246
9 77 ms 46 ms 45 ms 209.210.68.68
10 77 ms 49 ms 50 ms ebc-p-b-171.uen.net [140.197.252.84]
                  58 ms ebc-p-b-171.uen.net [140.197.252.84]
11
   62 ms 60 ms
12 50 ms 49 ms 49 ms 140.197.253.139
13 77 ms 67 ms 49 ms 199.104.93.210
14
    *
           77 ms
                  50 ms 199,104,93,193
15
   71 ms 49 ms 50 ms 155.99.130.59
16
   86 ms 50 ms 66 ms 155.99.130.107
   49 ms 61 ms 58 ms test.www.utah.edu [155.97.137.55]
17
```

Trace complete.



ital Town Square SDX (Layer 3/2)





art City Brain Servers

mically-allocated services

- Initially leverage GENI network (see next slide)
- Dynamically allocated apps and services
- Part of a nationwide marketplace
- Replaced by competitive commercial services
 - Programmable (Docker-compatible)
 - Sliceable
 - Low-latency







ne or Business SDX – Paradrop.io





Technology Corporate Partners

Mayor and economic development staff

Chamber of Commerce

City / Region Ignite Steering Committee

Developers

Entrepreneurs

Academic Leaders

Local ISPs

Faculty with NSF support

Kauffman Tech Venture

Faculty / Masters' students / capstone projects

Accelerator / Garage

Local foundations

Code for America

Leaders of Mozilla Hives

Google Developer Group

Code for America

Large tech companies

Angels and VCs

Mozilla Hives



ling All Collaborators

Brasilian testbeds and experiments

- 1. Metro SDXes (federate with US Ignite SDXes)
- 2. Metro layer 2 networks
- 3. Metro virtualized networks
- Applications enabled by advanced infrastructure
- Related research (see next page)



ample Research Areas

Models and designs for Metro SDXes Software-defined dynamic network virtualization Performance isolation for virtual (SDN) slices Hypervising SDI on shared infrastructure Secure binding for slicelets into slices **Designs for localized clouds** Metrics and measurement tools for localized clouds Techniques and practices for response engineering Interlinking SDI testbeds Hierarchical processing techniques for IoT



