



2017 MAX PARTICIPANTS MEETING

TRIPTI SINHA

APRIL 5, 2017

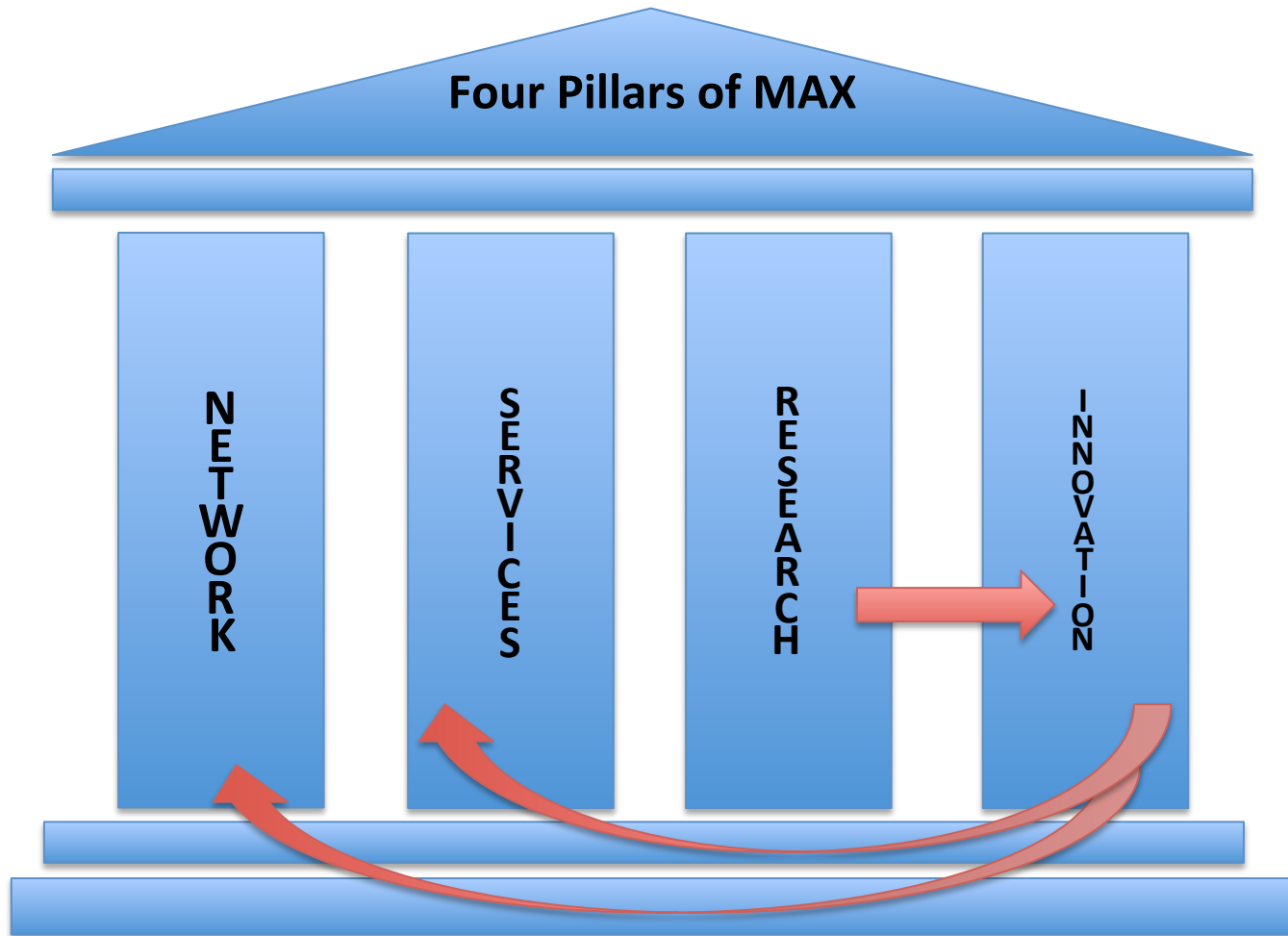
Four Pillars of MAX

NETWORK

SERVICES

RESEARCH

INNOVATION



MAX Focus on Thematic Activities

Network Infrastructure and Service Expansion

- Meeting the needs of the MAX community by expanding infrastructure footprint and capabilities

Advanced and Security Services

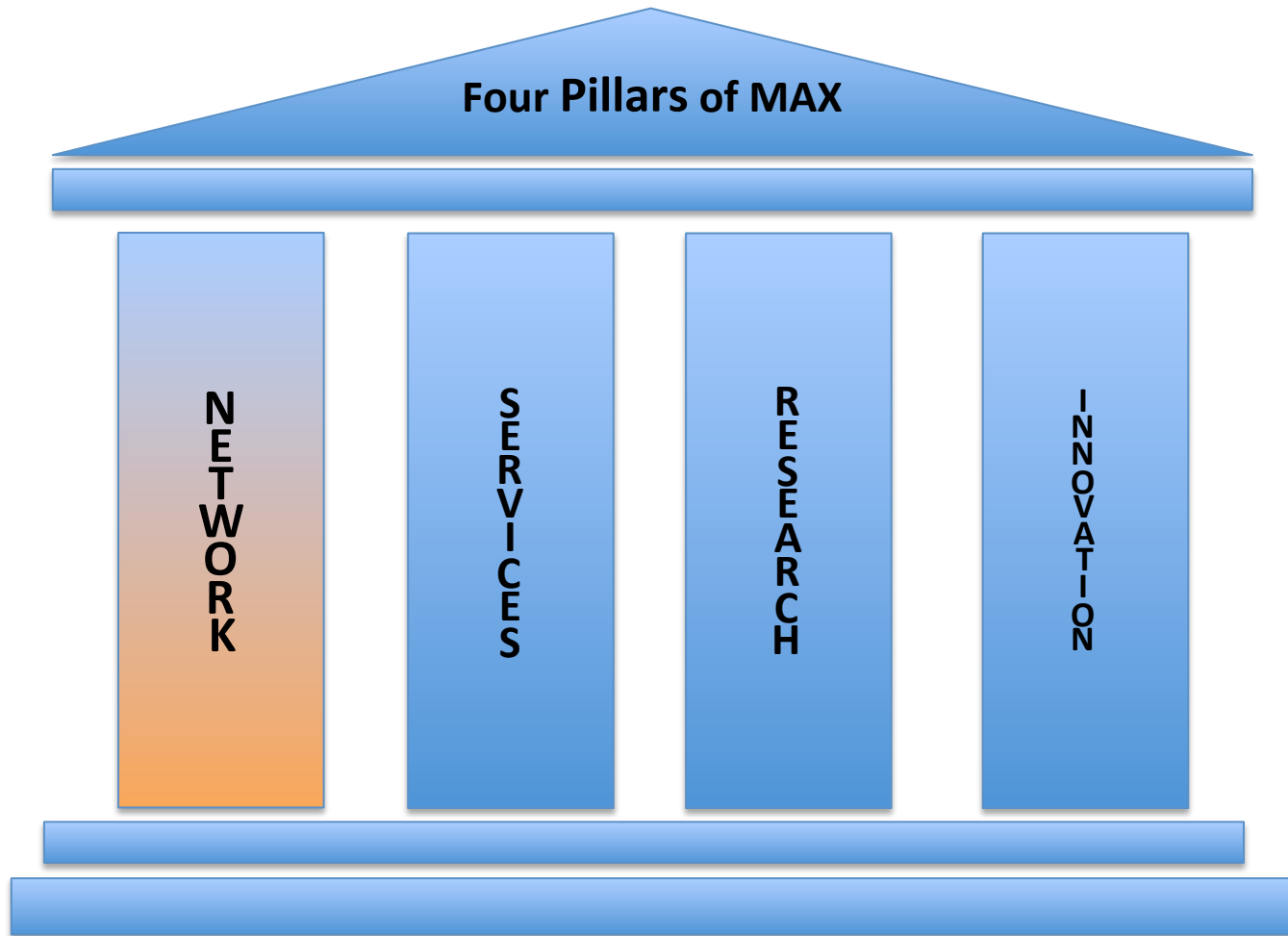
- Continue to research and define advanced and security services (HPC, TICAP, DDoS,...)

Software Defined Resources and Services Strategy

- Deeper focus on SDN and creating MAX's SDN roadmap

Strategic Partnerships

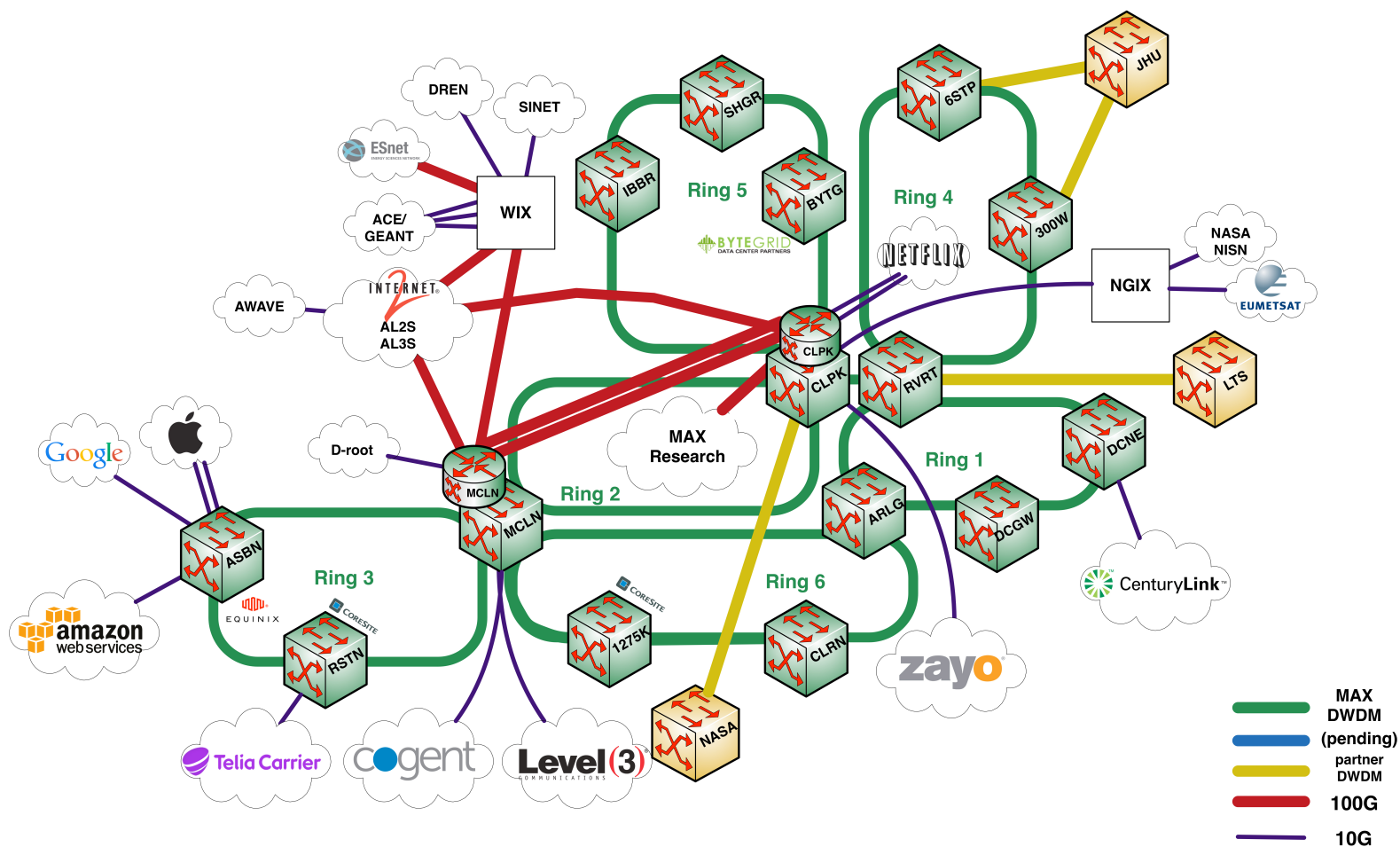
- Establishing strategic and synergistic partnerships



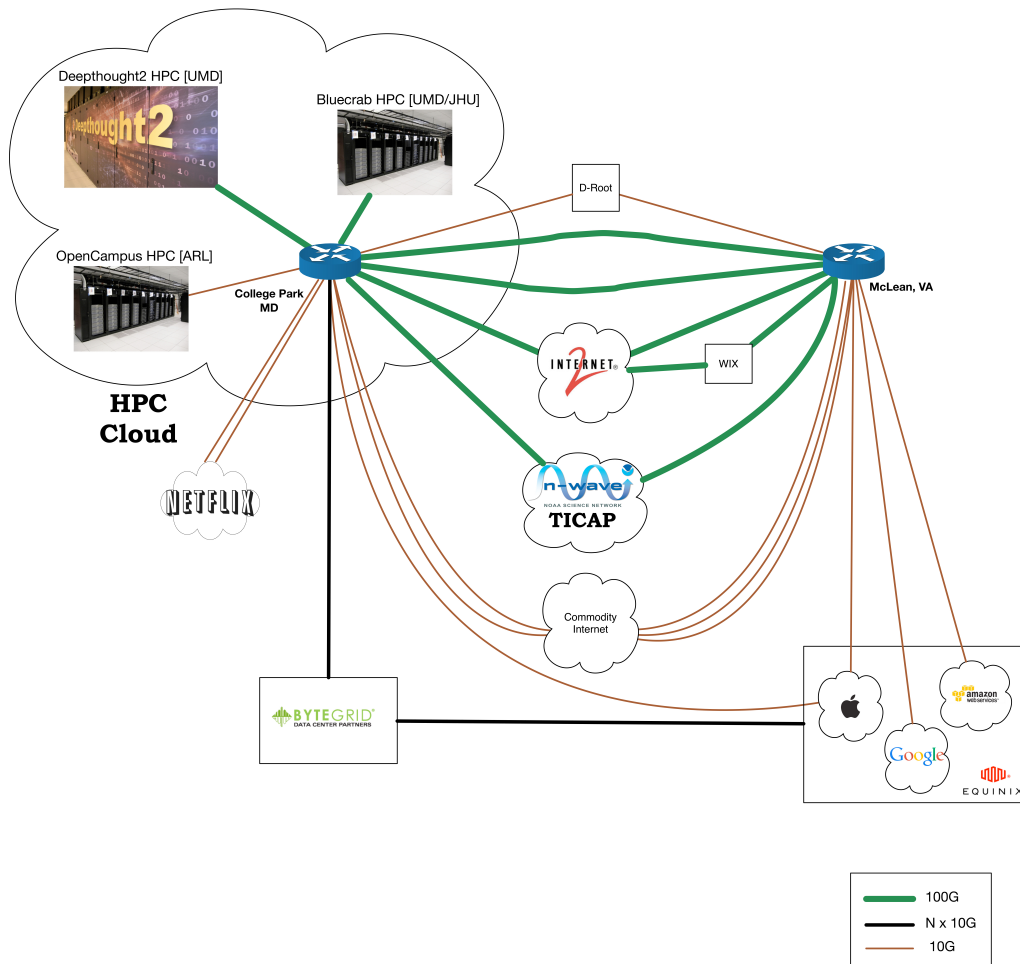
MAX Geography
MID-ATLANTIC CROSSROADS



MAX Network Topology



MAX Network Resources

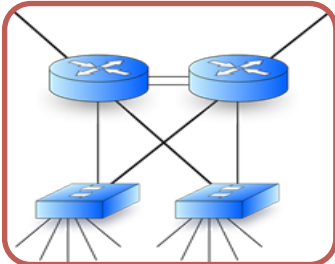


MAX Cyberinfrastructure Platform by the Numbers



MAX optical (DWDM) network

- Current capacity: 88 lambdas (Each lambda can be 10G or 100G in speed)
- Current deployed 100G lambdas: 10
- Current deployed 10G lambdas: 26



MAX routed network

- Backbone Capacity: 200 Gbps
- Normal traffic peak: 25 Gbps
- Unusual traffic peak: 103 Gbps (Due to SC16 testing)
- External traffic off-load capacity: 370 Gbps (470 Gbps for SC16)
- Normal traffic peak: 80 Gbps
- Unusual traffic peak: 175 Gbps (Due to SC16 testing)

MAX Network Peering

National Mission Networks

- DREN (DoD) • ESnet (DOE) • Internet2 (I2) • NASA–NISN • N-Wave (NOAA)

International Networks at WIX

- ACE/GEANT (European R&E network) • SINET (Japanese R&E network)

Higher Education and State Networks

- MDREN • Network Maryland

Cloud and CDN Networks

- Apple • Amazon/AWS • Google • Netflix

Commodity Networks and Datacenters on-net

- CenturyLink • Cogent • Level3 • Telia Sonera • Zayo
- ByteGrid • Coresite • Centurylink • Equinix • Level3

Trusted Internet Connection (TIC)

- In partnership with NOAA, MAX hosts a TIC and offers TICAP services

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MAX Services

Current Services
Layer 3 – IP Routed (R&E) Service
1G
10G
100G
Layer 2 – Ethernet Transport Service
1G
10G
Layer 1 – DWDM Transport Service
10G
100G
Data Center
Access to on-net data centers

Current Services
IP Commodity Routes
Commercial Providers
TR-CPS
Advanced Services
MAX AWS Direct Connect
Research Network Connection
MAX Platinum Service
Access to multiple services
Other Services
Rack Colocation Space
Machine/Virtual Machine Hosting
Remote Hands

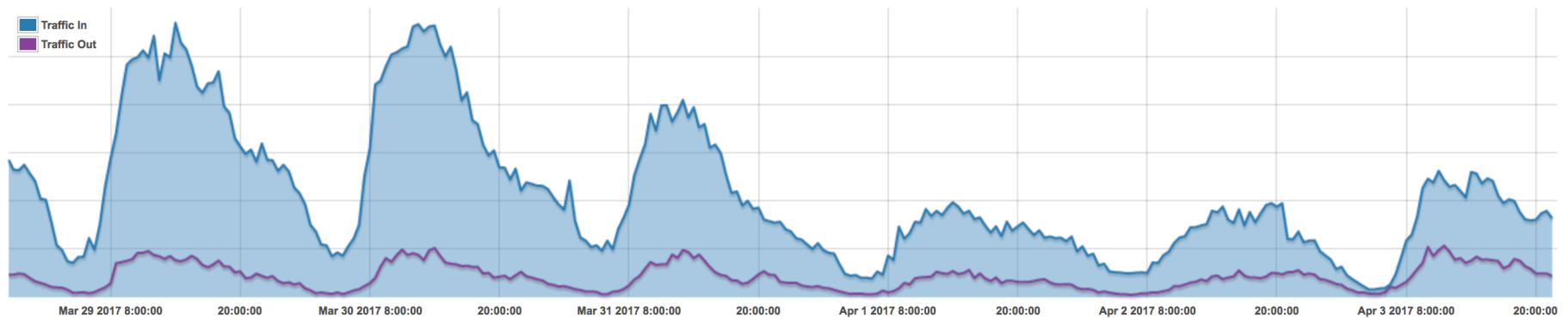
MAX Services & Fee Structure Implemented July 1, 2014

Current Services
Washington International Exchange (WIX)
10G
100G
Next Generation Internet Exchange (NGIX)
1G
10G
100G

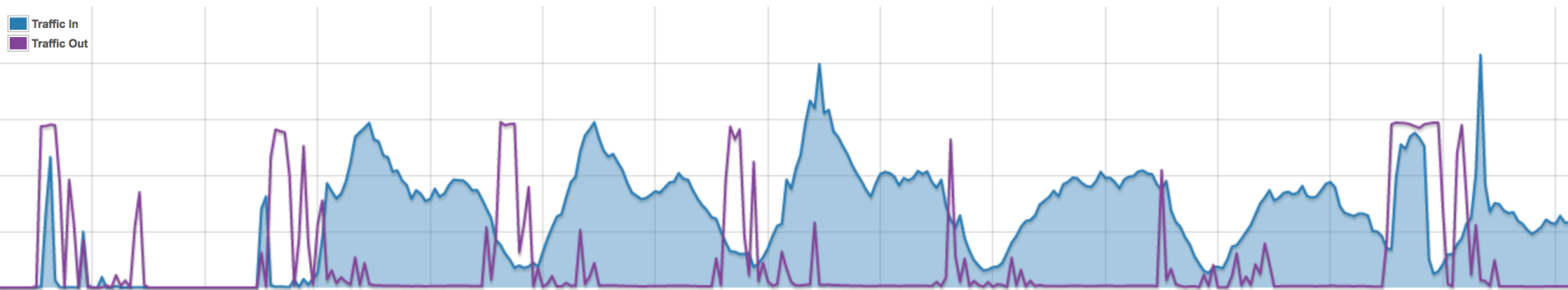
Future Services
HPC Offering
Security

MAX peers with Apple CDN at Equinix

- Peering is now on two 10G ports
- MAX network capable of handling high demand situations (like IOS 10 rollout)



New Netflix Caching Service



HPC Initiatives

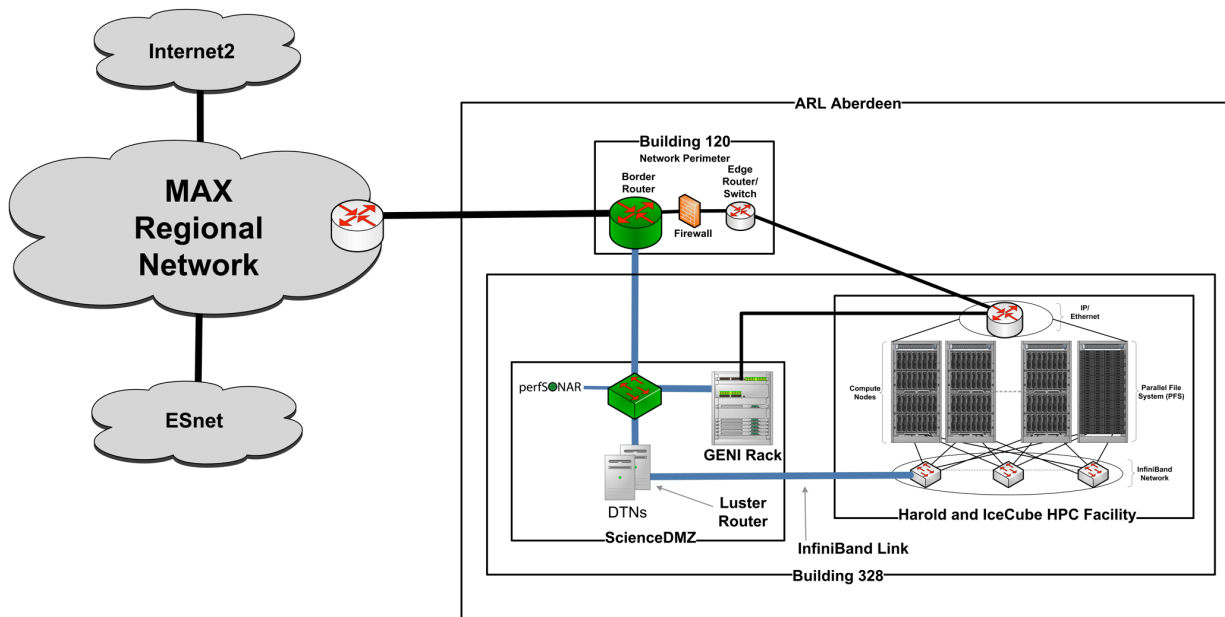
- ARL Partnership
- New local HPC facility
- Research into new technologies

UMD-MAX and ARL Partnership

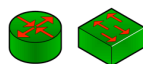
Strategic HPC Partnership between UMD and U. S. Army Research Laboratory under the ARL's Open Campus initiative

- Synergistic partnership provides higher education and research communities unprecedented access to technologies that enable scientific discovery and innovation.
- Connects ARL's HPC computer to UMD Max's 100 Gbps multi-state advanced cyberinfrastructure platform.
- Aligns with the federal government's strategic initiative to maximize the benefits of supercomputing for economic competitiveness, scientific discovery and national security.

UMD-MAX and ARL Partnership



- Partnership with University of Maryland (UMD) Mid-Atlantic Crossroads (MAX) enables connectivity of ARL HPC resources to the larger R&E communities.
- Provides access to ARL HPC resources for use by the higher education, research, and start up communities
- Build collaborative research enclave interconnecting HPC resources between ARL and UMD using Software Defined Networking (SDN) and ScienceDMZ technologies



switch/router where ScienceDMZ site/
project policy is enforced



High Speed Data Plane



Firewall Protected Control Plane Path

- Invite other research partners to join the community to collaborate on ongoing projects or to propose new projects
- Develop new GENI federation and stitching extensions to enable fine grained resource access control for different research communities

New Local HPC Facility


- In discussions with vendor partners to build an expandable HPC resource
- Well connected to national backbones via MAX network
- Will be a new MAX service to the community
- Ability to purchase raw CPU cycles for traditional batch HPC
- Can build to suit for non-traditional requirements



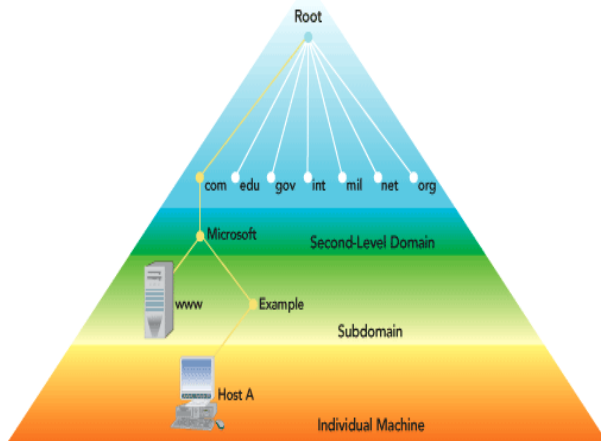




d.root-servers.net

- 
- In 1987, the University of Maryland was selected to serve the root of the Domain Name System by operating D-root.
 - Root servers are the foundation of global DNS services.
 - DNS is a hierarchical lookup system.
 - 12 distinct operators operate 13 root services (A thru M).
 - Root servers are anycasted.
 - D-root currently has 107 sites, 263 instances in 65 countries
 - Six instances of D-root live in the heart of the MAX network.

Global Internet Root DNS Service: D-Root

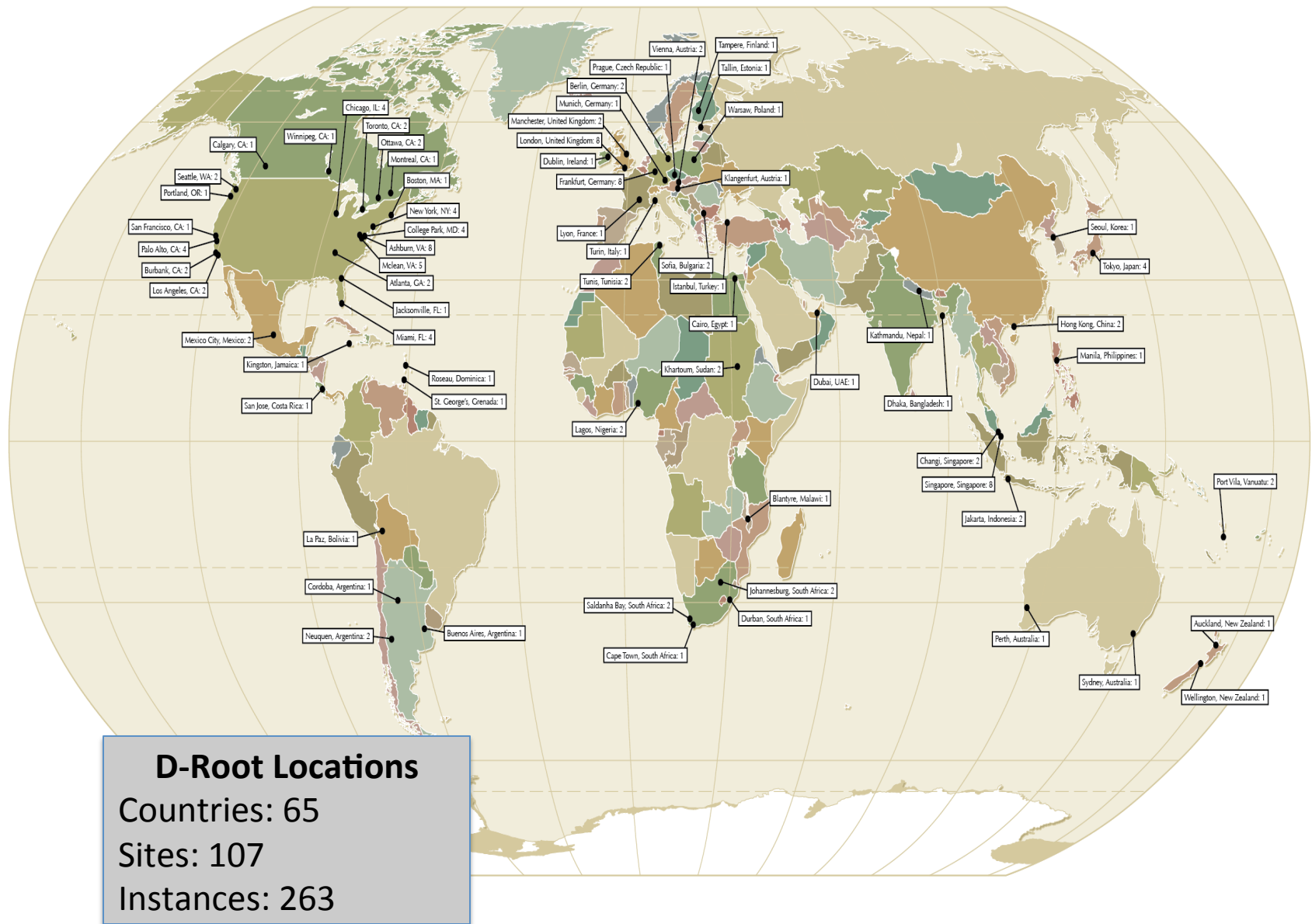


- UMD operates D-root and has been a steward of this global service since November 18, 1987.
- One of 12 global organizations that operate 13 root DNS servers (and one of two university operators).

- | | | |
|-----|------|--|
| 1. | A&J: | Verisign |
| 2. | B: | University of Southern California |
| 3. | C: | Cogent |
| 4. | D: | <u>University of Maryland</u> |
| 5. | E: | NASA/Ames |
| 6. | F: | Internet Systems Consortium |
| 7. | G: | Defense Information Systems Agency |
| 8. | H: | US Army Research Lab |
| 9. | I: | Netnod Internet Exchange i Sverige (Sweden) |
| 10. | K: | Réseaux IP Européens Network Coordination Centre (European Consortium) |
| 11. | L: | Internet Corporation for Assigned Names and Numbers |
| 12. | M: | Widely Integrated Distributed Environment Project (Japan) |

- In 2017 UMD and Verisign co-chair the global advisory committee – Root Server System Advisory Committee (RSSAC) – to the ICANN board to advise on matters pertaining to the security and stability of the global DNS root server system.
- Useful URLs:
 - <http://root-servers.org/>
 - <http://icann.org/>
 - https://en.wikipedia.org/wiki/Root_name_server

DNS Queries to D-Root on March 30, 2017: 5,730,927,380



D-root DNS Query Statistics and Next Generation Root DNS technologies

03/26/17 (Sun): 5,215,392,597

03/27/17 (Mon): 5,752,864,173

03/28/17 (Tue): 5,629,024,531

03/29/17 (Wed): 5,688,924,300

03/30/17 (Thu): 5,730,927,380

03/31/17 (Fri): 5,267,921,678

04/01/17 (Sat): 4,680,188,249

04/02/17 (Sun): 4,544,645,605

- Working with partners to investigate next generation Root DNS technologies

Four Pillars of MAX

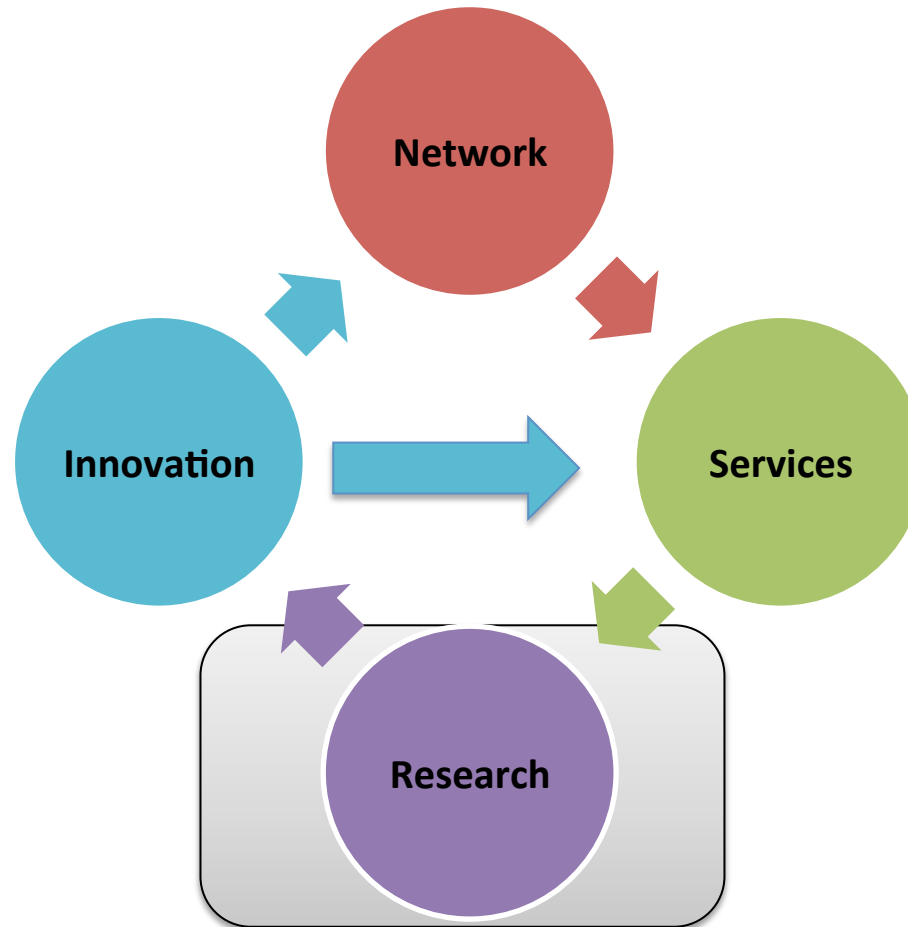
NETWORK

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INNOVATION

The cycle of innovation and advanced services



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Software Defined Resources and Services Strategy

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Strategic Partnerships

- Establishing strategic and synergistic partnerships

MAX – Arlington County Partnership

Jack Belcher, CIO Arlington County Government

CONNECT ARLINGTON

-  Major Business Districts
-  Community Facilities
-  Education Facilities
-  Emergency Services
-  Hospital



ConnectArlington: Background

- In 2016, Arlington County completed installation of a fiber optic network for its own use. Included in this installation is fiber capacity designed for long term expansion which the County is now making available to its business, academic, non-profit and government communities.
- 10 miles of very “large” (high count) fiber optic cable completely underground and in conduit has been installed along main commercial corridors.
- Arlington County works with other providers, such as UMD/MAX to provide “broadband services”, but Arlington is limited to offering “dark fiber” only.
- The County anticipates that this “dark fiber” will support economic and community development and the County’s innovation economy initiative and provide Arlington a competitive edge.

MAX – Army Research Lab Partnership

Raju Namburu, Director, ARL DoD Supercomputing
Resource Center

ARL's Open Campus Initiative

Past: Current Defense Laboratory Model

Gates and high walls provide 20th century security, but are barriers to 21st century innovation



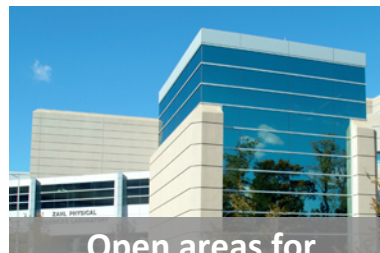
Defense laboratories relatively unchanged since inception (NRL 1923)

Present & Future: Open Campus Initiative

Reduction in barriers to facilitate collaboration with academia, industry, and small business



Less bureaucracy and paperwork



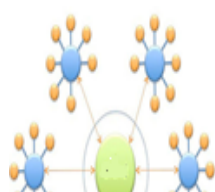
Open areas for researchers and access to existing facilities



Collaboration between ARL and external scientists



Career path for students and scientists



Hub and Spoke Model



Collaborator presence through EUL



Novel staff opportunities

An enhanced defense research environment that fosters discovery and innovation through collaboration on fundamental research

Open Campus: Building the Ecosystem

- **Collaborative Mechanisms**

- Cooperative Research and Development Agreements (CRADAs)
- Patent License Agreements
- Educational Partnerships
- Partnership Intermediary Agreements

- **Opportunities Advertised**

<http://www.arl.army.mil/opencampus/>

- **Openly Sharing Technical Strategies**

- **Infrastructure**

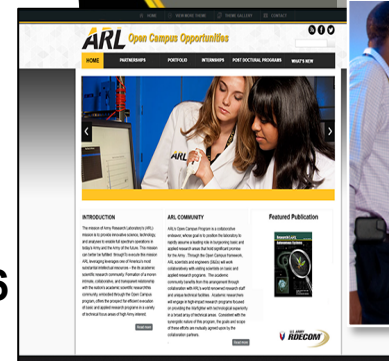
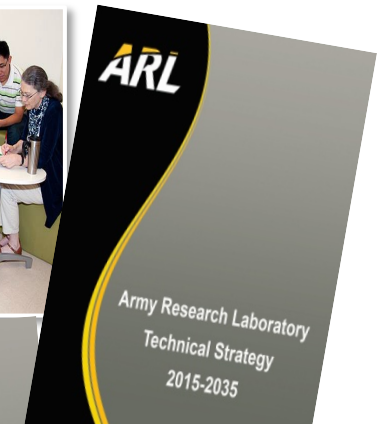
- Enhanced Use Lease
- Collaborative Network and Data Sharing
- Layered Security

- **People**

- Flexible Work Places and Schedules
- Sabbatical Leave
- Entrepreneurial Separation

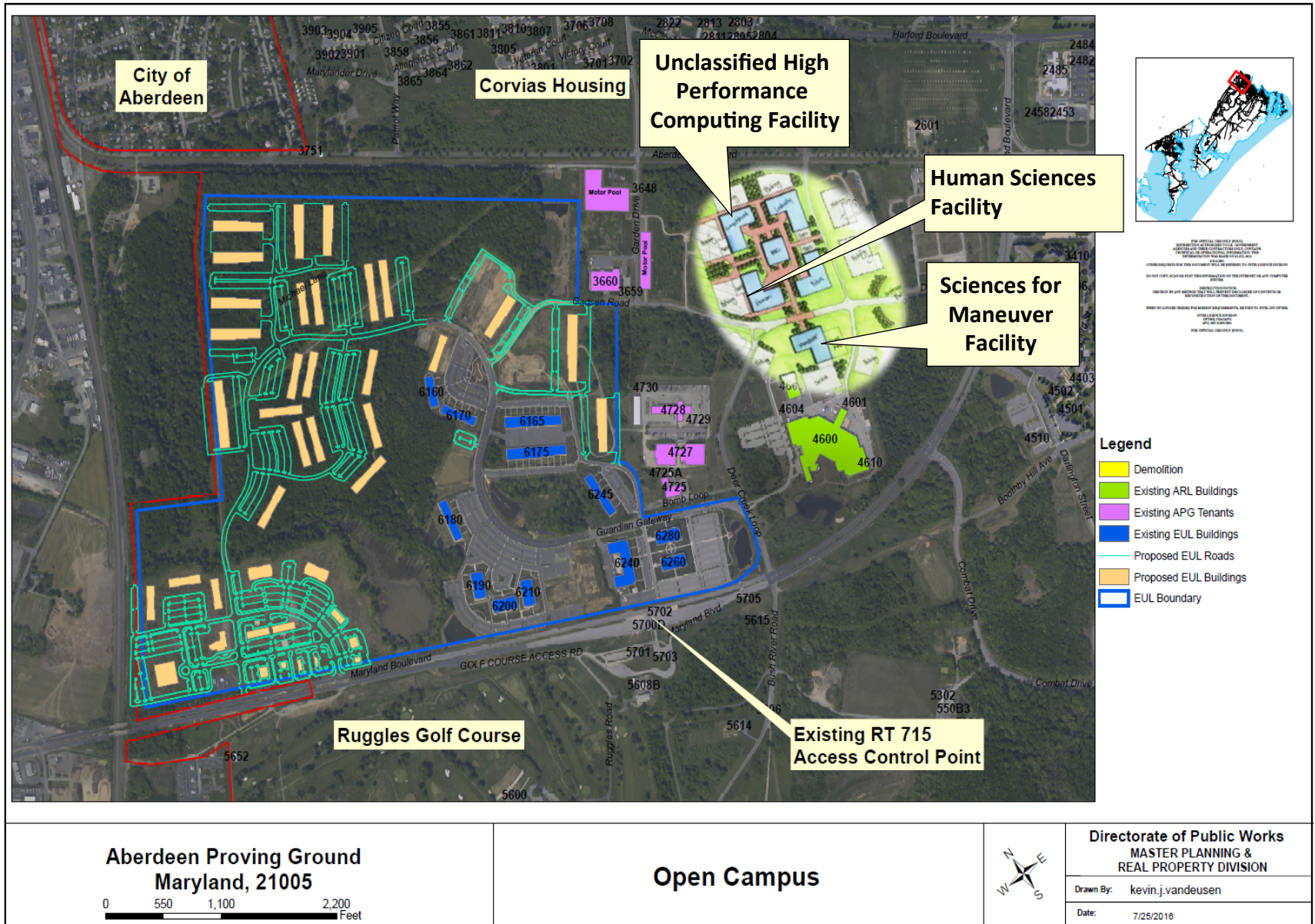
- **ARL Centers**

- **3rd Open Campus Open House held 16-17 Nov 2016 in Adelphi, MD**

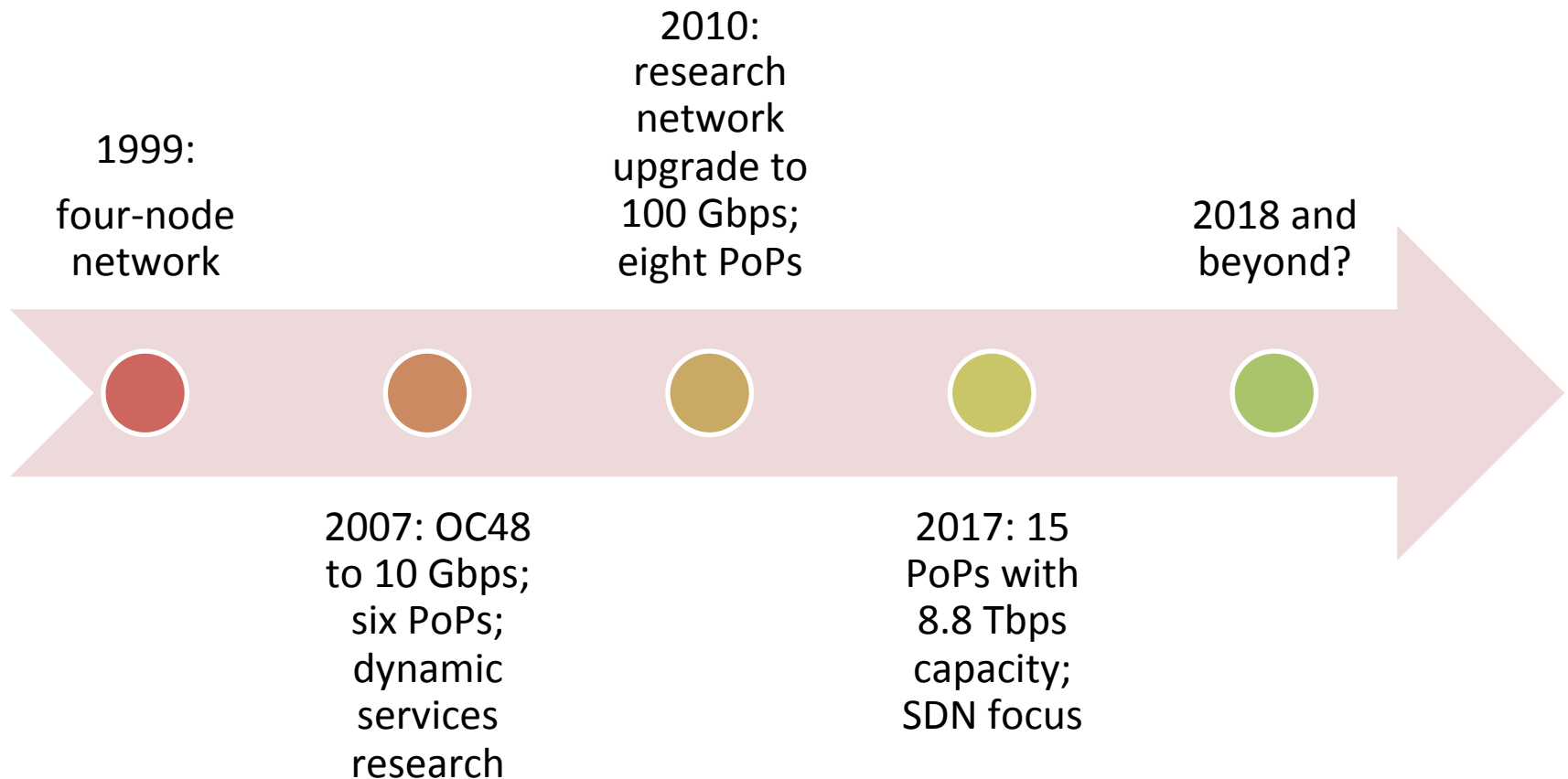


> 634 people into and out of laboratory under Open Campus pilot so far including 53 from 20 countries, including China, India, Germany, Turkey, South Korea, Iran
> 195 CRADA projects, 195 in Staffing, \$42M Leveraged since FY14

APG OC Future Development



What's next?: MAX Strategic Plan



MAX Software Defined Resources

Software Defined Exchange (SDX)

Software Defined ScienceDMZ (SD-SDMZ)

Tom Lehman, MAX