ESnet is a dedicated mission network engineered to accelerate a broad range of science outcomes.

ESnet5 has provided unique capabilities, optimized for science, since 2011. ESnet’s scientific facility infrastructure is nearing end-of-life and capacity demands continue to increase, driving the need for a new network: ESnet6.

To continue to meet Mission needs, capability gaps must be resolved:

- **Capacity**: Network must be able to serve increasing science demand
- **Reliability and Resiliency**: Replace end-of-life equipment, improve cybersecurity protection
- **Flexibility**: Network needs to adapt to changing compute models, multi-facility workflows, real-time data analysis, streaming

SC approved ESnet6 CD-1/3A August 3, 2018
## ESnet6: Level 1 (Critical Decision) Milestones

<table>
<thead>
<tr>
<th>Level 1 Milestone</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD0: Approve Mission Need</td>
<td>5-December-2016 (Actual)</td>
</tr>
<tr>
<td>CD1: Approve Alternative selection, Conceptual Design and Cost Range</td>
<td>3-August 2018 (Actual)</td>
</tr>
<tr>
<td>CD3a: Approve Long Lead Procurement Authority</td>
<td>3-August 2018 (Actual)</td>
</tr>
<tr>
<td>CD2/3: Approve Performance Baseline/Start of Construction</td>
<td>4QFY2019</td>
</tr>
<tr>
<td>CD4: Approve Project Completion (includes 12 month schedule float)</td>
<td>1QFY2024</td>
</tr>
</tbody>
</table>
ESnet6 Proposed Project Timeline

- **Jan:** R&D Architecture Review
- **May:** R&D Conceptual Architecture Selection
- **Sep:** In-Process Review
- **Feb:** CDR
- **Jun:** CD1/3a IPR
- **May:** Design Review
- **Aug:** CD2/3 IPR
- **Jun:** Director’s Review

- **Network Build**
- **CD-3A Long Lead Procurements**
- **ESnet6 Service Starts**
- **ESnet6 Decommissioning Starts**
- **ESnet6 Project Close-out**
ESnet6 ("Hollow-Core") Conceptual Architecture Overview

“Hollow” Core
- **Programmable** – Software driven APIs to allocate core bandwidth as needed, and monitor status and performance.
- **Scalable** – Increased capacity scale and flexibility by leveraging latest technology (e.g. FlexGrid spectral partitioning, tunable wave modulation).
- **Resilient** – Protection and restoration functions using next generation Traffic Engineering (TE) protocols (e.g. Segment Routing (SR)).

Services Edge
- **Programmable** – Software driven APIs to manage edge router/switch and retrieve telemetry information.
- **Flexible** - Data plane programmable switches (e.g. FPGA, NPU) in conjunction with compute resources to prototype new services (driven by Software Defined Networks (SDN))
- **Dynamic** – Dynamic instantiation of services using SDN paradigms (e.g. Network Function Virtualization (NFV), Virtual Network Functions (VNF), service chaining).
Final Design Work Plan

Key activities underway to meet May 2019 Final Design Review

<table>
<thead>
<tr>
<th>Category</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical Core</td>
<td>Open Line System, Transponders</td>
</tr>
<tr>
<td>Packet Core</td>
<td>Protocols, QoS, Buffering, scheduling, network loading, timing</td>
</tr>
<tr>
<td>Low Touch</td>
<td>Services edge: protocols, filtering, security</td>
</tr>
<tr>
<td>High Touch</td>
<td>Service selection, capability, prototyping</td>
</tr>
<tr>
<td>Data Plane</td>
<td>Data transport, protocols</td>
</tr>
<tr>
<td>Control Plane</td>
<td>Connectivity, placement, resiliency, security</td>
</tr>
<tr>
<td>Management Plane</td>
<td>Definition, in-band, out-of-band, prototyping</td>
</tr>
<tr>
<td>Monitoring and</td>
<td>Requirements, gap analysis with current systems</td>
</tr>
<tr>
<td>Measurement</td>
<td></td>
</tr>
<tr>
<td>Traffic Engineering</td>
<td>Segment routing investigation, fallback scenarios</td>
</tr>
<tr>
<td>Automation</td>
<td>Federated architecture, Integration with vendor NMS, prototyping</td>
</tr>
<tr>
<td>Security</td>
<td>For each services edge, requirements, architecture</td>
</tr>
</tbody>
</table>
Segment Routing Investigation: ESnet6

- Much research into support, operations, completeness of protocol suite(s)
  - Segmenting Routing (SR) has major-vendor support
    - Carrier vendors (Cisco, Juniper, Nokia) all have
    - Protocol suite is in varying levels of completeness per vendor
    - TE and redundancy protocols are the most commonly under active development
    - Protocol suite is vast - many deployment options
  - Traffic Engineering (TE) controller is where the magic lies
    - Controller space is still emerging
    - Protocols are still being refined
      - PCEP seems to be the most complete
    - Options for controllers is limited but commercially supported
ESnet5/6 Comparison Overview

**ESnet5 (Deployed)**

- **Packet Core**
  - Single Optical Vendor
  - Fixed (ITU) grid
  - Lower total capacity
  - No "colorless" and limited "directionless" capabilities
  - "High touch" management
  - No data-plane programmability

- **Optical Core**
  - Dedicated servers
  - Lower space and power efficiency
  - Limited programmability

- **Services Edge**
  - Course grain traffic engineering
  - Individualized customized services

**ESnet6 (Proposed)**

- **Packet Core**
  - Single Optical Vendor
  - No "colorless" and limited "directionless" capabilities
  - "Low touch" management

- **MPLS Switched Core**
  - Virtualized servers
  - Programmable interfaces
  - Full "colorless" and "directionless" capabilities

- **Optical Core**
  - Higher space and power efficiency
  - Flex grid
  - Higher total capacity

- **Services Edge**
  - Fine grain traffic engineering
  - Well defined and structured services

- **Orchestration**
  - Multi-vendor solution
  - Higher space and power efficiency

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Legend:
- **Network Appliance**
- **Core** (IP Routed)
"Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Networking and Information Technology Research and Development Program."

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