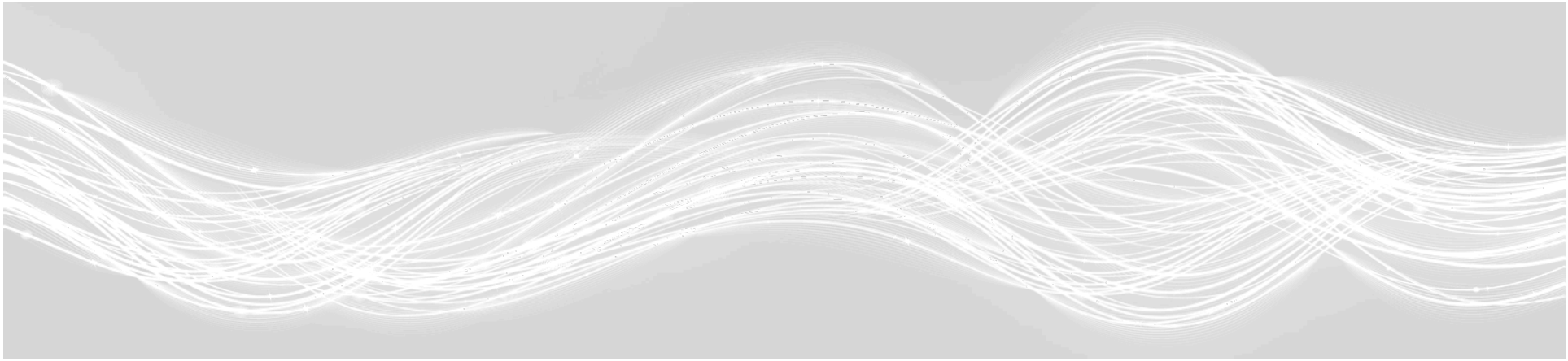

Intelligent Network Services
Software Defined Networking (SDN)

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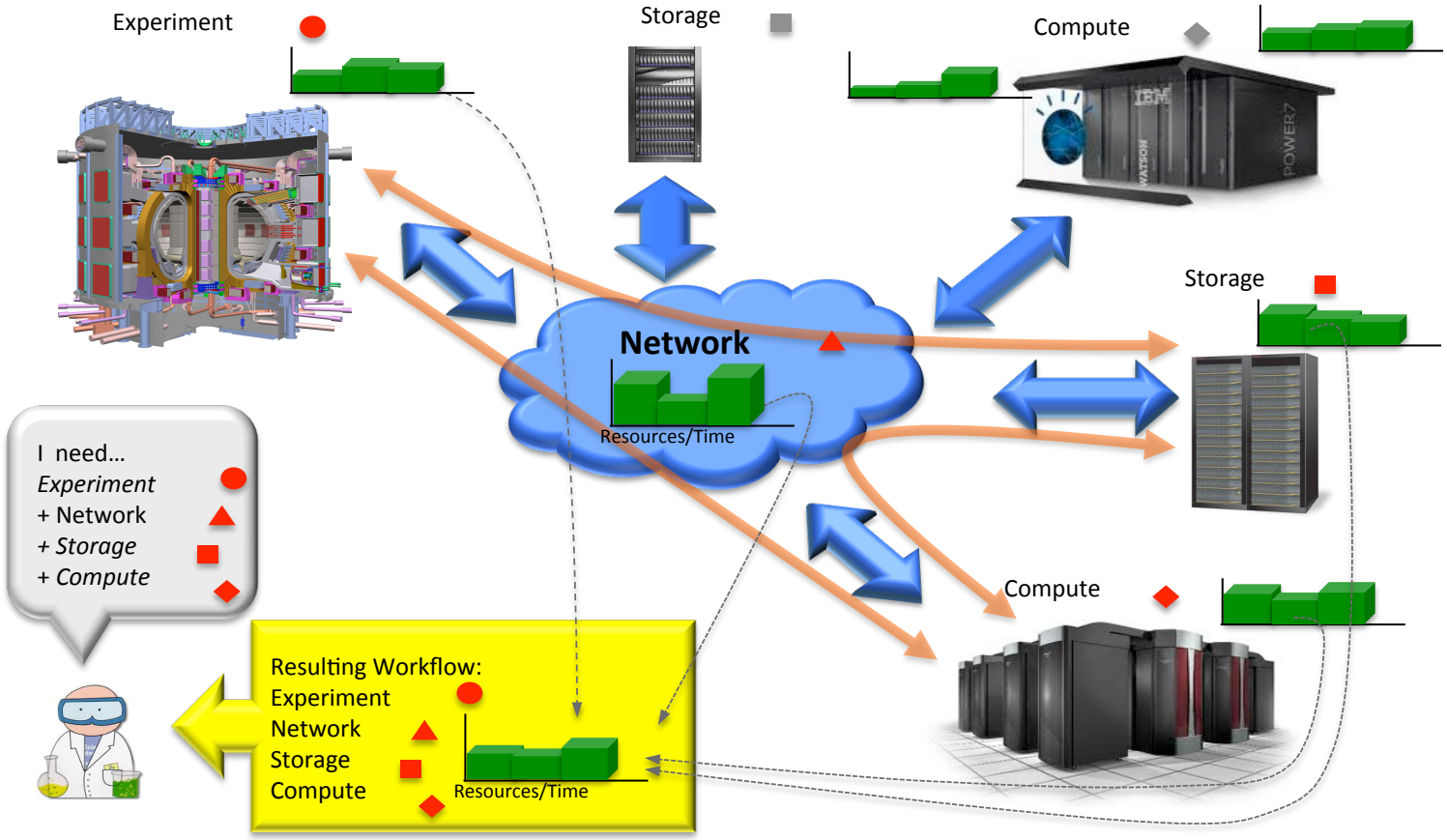
SDN in the Context of RAINS

- SDN in the Context of **RAINS** Project
  Resource Aware Intelligent Network Services
- DOE Domain Science applications are not realizing benefits from the high performance advanced network infrastructures to the degree which they should
- The key problem is that compute, storage, and network resources are not integrated with each other or with domain application workflows
- A seamless, intuitive, and application focused integration of computation, storage, and networking is needed

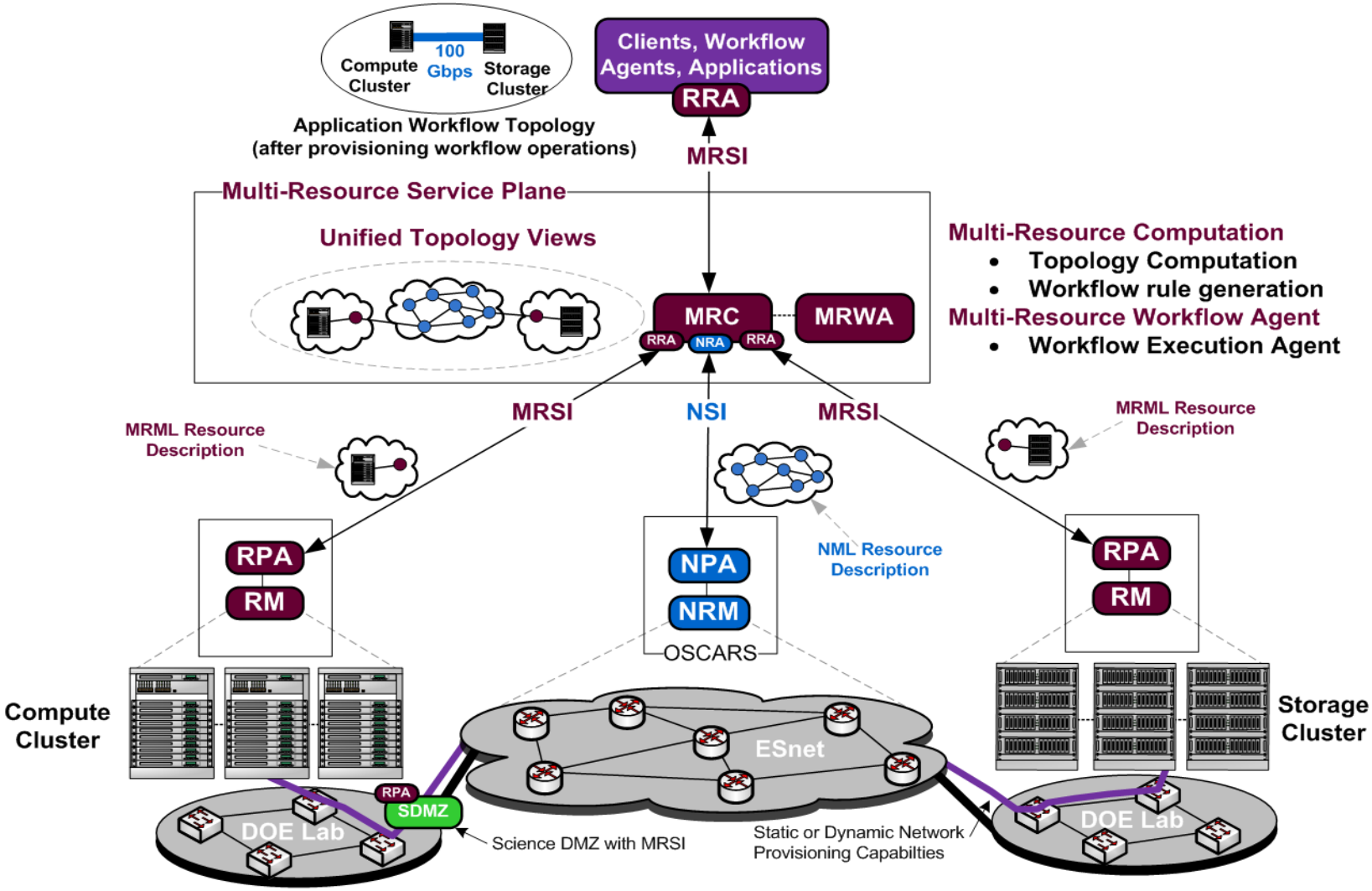
Application Workflow Integration

A key focus is on technology development which allow networks to participate in application workflows

The Network needs to be available to application workflows as a first class resource in this ecosystem



RAINS Multi-Resource Service Plane (MRSP)

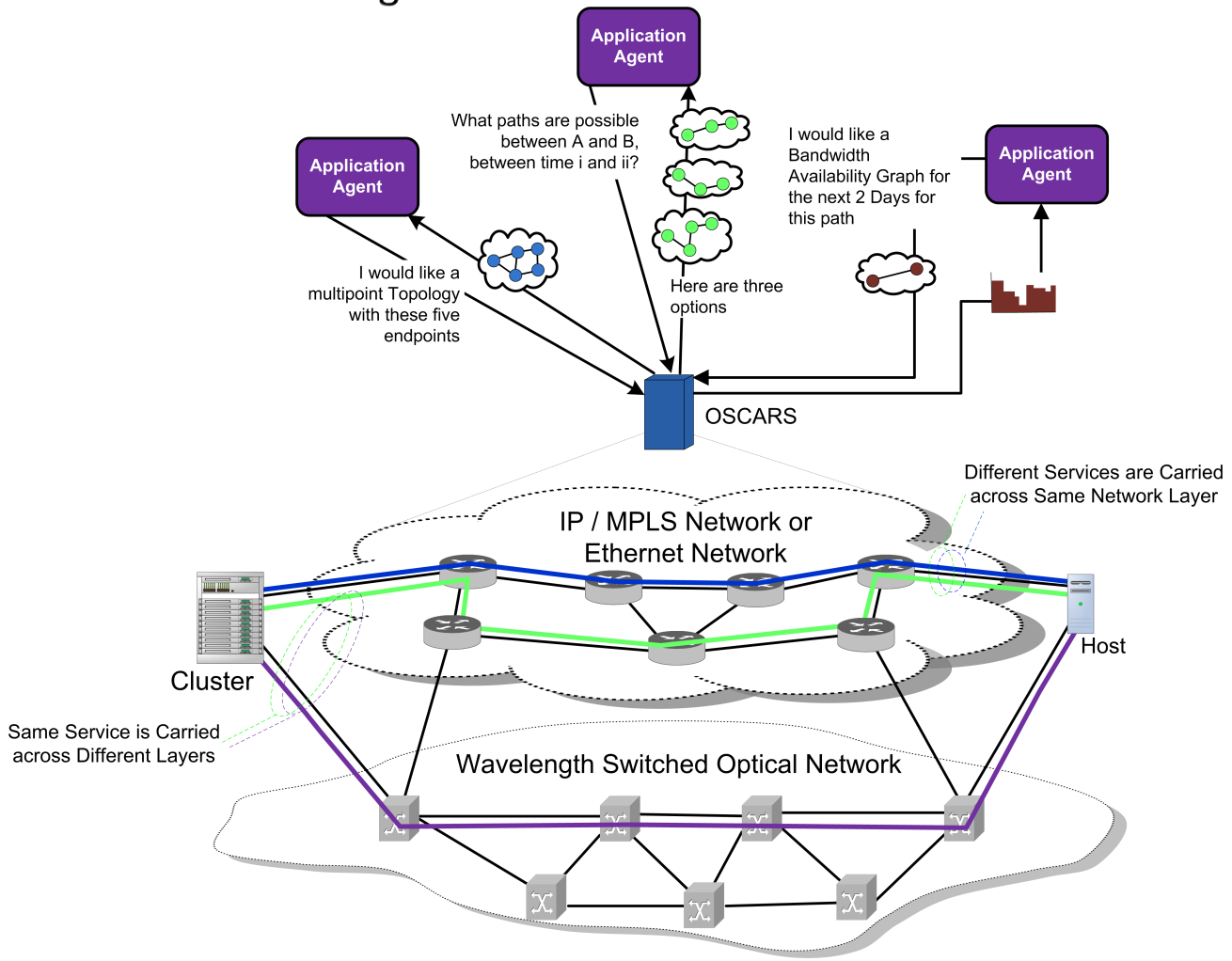


DOE Lab and ESnet Network Resource Approach

- ESnet services such as OSCARS dynamic provisioning will be incorporated into the MRSP ecosystem
- DOE Lab networks may not have a dynamic provisioning capability. We will work with Lab networking experts to extend the lab ScienceDMZ connections and features to support the MRSP.
- This may include placement of a MRSI interface agent to "cover" the Science DMZ.

Intelligent Network Services

- The network needs to be able to respond to "What is Possible?" and "What do you recommend" questions
  - today the application must say "provision this specific path at this specific time"
- These are referred to as "Intelligent Network Services"



SDN Considerations

- SDN Feature Options
  - Tightly coupled to application/workflow requests
  - Indirectly coupled to application/workflow requests
    - internal network management
- SDN Deployment Environments
  - Wide Area Networks
  - Regional Networks
  - Enterprise/DOE Lab/Campus Networks
  - Science DMZ
  - Interconnects to special Resources (Science Instruments, HPC, Big Data systems, others)
  - Data Centers
  - Clouds (Private, Public, Enterprise located)

SDN Considerations

- SDN Technologies Options
  - OpenFlow
  - OSCARS
  - traditional dynamic provisioning mechanisms
    - mpls/gmpls
    - management system
    - custom built systems using element APIs or CLIs
  - multiple vendor SDN options on the way
    - may support OpenFlow API and other vendor specific value added services
- SDN Issues
  - inter-controller, intra-domain
  - inter-controller, inter-domain
  - SDN Exchanges (SDNx)

SDN and RAINS Plans

- RAINS is building a multi-resource service plan with intelligent network services
  - SDN mostly hidden behind the Service Plane
- We will use different SDN techniques based on the deployment environment
- Wide Area: OSCARS
- Science DMZ
  - OpenFlow, when elements support,
  - Other automated provisioning mechanisms when OpenFlow not available or not sufficient
- DOE Lab Networks: still studying
- Regional Networks
  - OpenFlow, when elements support,
  - Other automated provisioning mechanisms when OpenFlow not available or not sufficient

SDN Exchange Thoughts

- SDN exchange definition has three main discussion topics
  - what is the "service" that will be exchanged?
    - VLANs? IP Routes? Flowspace? higher level services?
    - all of the above?
  - what is the mechanism for specifying and managing authentication and authorization in this SDN exchange environment
  - what is the advantage of an SDN exchange? what is the difference between and SDN exchange and an SDN network which has multiple peers?
    - one answer: easier to build a concentrated non-blocking multiple aggregate/network exchange fabric using a single switch as compared to a large distributed network
    - another answer: easier to apply complex polices in this same environment