

Cluster B Integration Meeting on February 13, 2009

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1. Summary

A Cluster B integration meeting was organized by the GPO and held in Denver on February 13, 2009, to review and agree on how networking aggregates will be supported by the Cluster B GENI control plane in Spiral 1. Key technical contributors for the PlanetLab and Enterprise GENI projects attended, along with representatives from other networking projects in Cluster B, and the SPP (server) project. The PI from the ProtoGENI project also attended, since ProtoGENI must support networking and interoperate with PlanetLab. See <http://groups.geni.net/geni/wiki/ClusterB> for copies of slides and related documents.

The Cluster B control framework is based on PlanetLab, which has well established arrangements for interfacing with nodes (servers) that can include links. The PlanetLab GENI project has provided “GENIwrapper” code that could be used to independently develop an Aggregate Manager for a networking entity; currently the GpENI project intends to use this interface design approach.

However, the Enterprise GENI project examined the PlanetLab code and expressed concerns about the time and effort it may take to integrate OpenFlow equipment and meet their deployment goals given the current state of the code and interfaces. Instead, they suggested the introduction of a “lightweight” protocol, fully defined by a WSDL, for use between a modified Cluster B Slice Manager (SM) and a new “lightweight” Aggregate Manager (AM) that would be part of the OpenFlow equipment. Guido Appenzeller presented a detailed proposal of their approach at the meeting.

After a lively and candid discussion among all parties, an approach was formulated and agreed upon to allow the introduction of a “lightweight” protocol into Cluster B, and support it alongside existing protocols. This seems to have the lowest risk in meeting Spiral 1 integration goals. A “starter kit” of code for the new AM and a modified SM will be provided by the Enterprise GENI project (Guido Appenzeller). In particular, Enterprise GENI proposed to write the first revision of the WSDL file to define the Web Services interface. Then, the PlanetLab GENI project (Larry Peterson) will integrate this code into their SM so that both approaches would be supported during Spiral 1, on a project by project basis. This should allow the Enterprise GENI project to meet their ambitious deployment goals, and it will exercise a “lightweight” protocol within Cluster B and GENI.

Other topics were discussed during the five-hour meeting, including a consensus that GENI should begin to focus on resolving the various approaches to using an RSpec for resource description.

2. Action Items

The following action items were identified during the discussion period. The GPO will work with the owners of these action items to track their completion, and to verify that the introduction of a “lightweight” protocol proceeds forward in Cluster B. It may be appropriate to modify the milestones of the associated projects.

Action Item 1a: Release stripped GENIwrapper AM code, for use by networking projects, without PLC.

Priority: High

Who: Larry Peterson (PlanetLab GENI project)

When: Due by 3/6/09. Completed 2/19/09; see https://svn.planetlab.org/browser/geniwrapper/trunk/geni/alt_aggregate.py

Dependency: (none)

Action Item 2a: Define WSDL for lightweight protocol interface, and provide a “starter kit” of lightweight AM code and modified SM code, ready for initial integration into the SM. This requires resolution of GIDs in SM with names in lightweight AM.

Priority: High

Who: Guido Appenzeller (EntGENI project)

When: Due by 3/13/09.

Dependency: (none)

Action Item 2b: Integrate modified SM code into SM, to support lightweight protocol to lightweight AM.

Priority: High

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Who: Larry Peterson (PlanetLab GENI project)

When: Due by 3/27/09.

Dependency: Requires a “starter kit” of a lightweight AM code and modified SM code, from Action Item 2a.

Action Item 2c: Forward information about this meeting to Steve Schwab (Security Project), and get him involved.

Priority: High

Who: Heidi Dempsey (GPO)

When: Due by 2/20/09. Completed 2/23/09.

Dependency: (none)

Action Item 3a: Provide information on how DRAGON approach can be used to define RSpec for network entity

Priority: Med

Who: Chris Tracy (MAX/MANFRED project)

When: Due by 2/27/09.

Dependency: (none)

Action Item 3b: Provide information on VLANs and RSpecs from ProtoGENI project.

Priority: Med

Who: Robert Ricci (ProtoGENI project)

When: Due by 2/27/09.

Dependency: (none)

Action Item 3c: Identify how GPO can help with RSpec definition and prioritization.

Priority: Med

Who: Aaron Falk (GPO)

When: Due by 2/27/09.

Dependency: Action Items 3a and 3b.

3. Attendees

Aaron Falk – GPO falk@bbn.com

Heidi Dempsey – GPO (scribe) hpd@bbn.com

Harry Mussman - GPO (scribe and compiler of this report) hmussman@bbn.com

Chip Elliott – GPO celliott@bbn.com

Henry Yeh – GPO hyeh@bbn.com

Larry Peterson – PlanetLab, Princeton Univ llp@cs.princeton.edu

Guido Appenzeller - Enterprise GENI, Stanford appenz@cs.stanford.edu

Nick McKeown – Enterprise GENI, Stanford nickm@stanford.edu

Rob Sherwood - Enterprise GENI, Stanford (from Deutsche Telecom),

Caterina Scoglio - GpENI caterina@ksu.edu

Chris Tracy - Mid-Atlantic Crossroads (MAX/MANFRED) chris@maxgigapop.net

John DeHart - SPP, Washington Univ jdd@arl.wustl.edu
Robert Ricci - ProtoGENI, Univ of Utah ricci@cs.utah.edu

4. Meeting Notes

4.1 Objective for Meeting

Aaron Falk

Spiral 1 of the GENI control plane *must* demonstrate support for network aggregates and components, as this is an item of very high technical risk. The plan has been to encourage Cluster B aggregates to integrate using the PlanetLab-provided Aggregate Manager (AM).

The Enterprise GENI project has examined the PlanetLab code and expressed concerns about the difficulty of integrating OpenFlow equipment in Spiral 1 given the current state of the code and interfaces. They are also concerned about how hard it will be to evolve the over-the-wire interface once the initial integration is complete.

The objective of the meeting was to come to agreement on how to demonstrate in Spiral 1 that networking components and aggregates will be supported by the Cluster B GENI control plane. Key technical contributors for the PlanetLab and Enterprise GENI projects attended, along with representatives from the other networking projects in Cluster B. The PI from the ProtoGENI project also attended, since ProtoGENI must support networking and interoperate with PlanetLab.

4.2 Spiral 1 Requirements

Heidi Dempsey

For Spiral 1 requirements and selected milestones for PlanetLab and Enterprise GENI, see

<http://groups.geni.net/geni/attachment/wiki/ClusterB/PL-EntG.pdf>.

One milestone completed: PlanetLab has released v0.1 of code; next big release will be v0.2 on 4/1. EntGENI sees issues with v0.1, and that is to be discussed today.

4.3 Cluster B Control Framework Options

Harry Mussman

For system-level view of all Cluster B projects, see first slide in

http://groups.geni.net/geni/attachment/wiki/ClusterB/021309_Cluster_B_Options.pdf.

PlanetLab GENI configuration presented in second slide, from DRAFT PlanetLab GENI Overview document at

<http://groups.geni.net/geni/attachment/wiki/PlanetLabGeniControlFrameworkOverview/011409%20%20GENI-SE-CF-PlanetLabGENIOver-01.2.pdf>.

Enterprise GENI configuration presented in third slide, from various EntGENI references.

Cluster B options for controlling networking entities such as EntGENI shown in fourth slide.

Case 1: Use PlanetLab CompMgr GENIwrapper, PlanetLab NodeMgr and Adaptor, to connect with Network Controller. Interface spec is defined by GENIwrapper.

Case 2: Use PlanetLab AggrMgr GENIwrapper and Adaptor, to connect with Network Controller. Interface spec is defined by GENIwrapper. AggrMgr GENIwrapper and Adaptor communicate via basic calls. This approach is the one suggested by the PlanetLab GENI project.

Case 3: Use new AggrMgr, driven by new interface spec, to connect directly with Network Controller. This is the proposed goal of the EntGENI project. This is also the preferred method of integration for the network portion of the MAX/MANFRED project. However, MAX/MANFRED will also be hosting PlanetLab compute nodes, so they will also be experimenting with deployment of the PlanetLab AggrMgr GENIwrapper.

4.4 Planet Lab GENI

Larry Peterson

Summarized PlanetLab-based Control Framework for GENI; see slides at http://groups.geni.net/geni/attachment/wiki/ClusterB/pl_x_geni.pdf.

References

GENIwrapper code design at <https://svn.planet-lab.org/wiki/GeniWrapper>

PlanetLab-based Implementation of the Slice-based Facility Architecture at <http://www.cs.princeton.edu/~llp/geniwrapper.pdf>

Latest Slice-based Facility Architecture at <http://svn.planet-lab.org/attachment/wiki/GeniWrapper/sfa.pdf>

Diff of last two SFA documents at

http://groups.geni.net/geni/attachment/wiki/ClusterB/sfa_Nov2008_vs_Feb2009.pdf

Registry, Slice, and (part of) Mgmt Interfaces defined so far. Interfaces defined with geniwrapper module, source code and documentation. Geniwrapper is python code. Contact developer Tony Mack for any questions or issues with the code at tmack@cs.princeton.edu.

Software class hierarchy defined; see slide.

Ticket includes RSpec plus keys for users to log into slice and init script.

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Rights codifies SFA Section 5.4. Checked when credential received; lets local entity may apply local policy, as well as basic authentication. Currently, no Certificate Revocation List (CRL) to check; just check expiration time.

RSpec generated from EMF schema. Includes only the things you need to specify to ask for an allocation. General purpose, and easy to use for current PlanetLab cases. One or more networks. Each network has one or more nodes, and zero or more links.

Record to be generated from EMF schema; implemented by hand so far. Includes things you might want to ask a node about (location, current load etc).

Eclipse is not so easy to get running with all the right plugins. You need it to do the EMF Schema.

RSpec discussion:

Question: In current Rspec, nodes are named, but links are not. Should we add name for links?

Note: Guido thinks each project will have things they want to change about the NodeSpec or LinkSpec.

Question: Harry asked if it was possible to have no nodes. Not in current network spec, said Larry.

Comment: "RSpec is a rathole," said Larry.

Question: Nick asks: how does the RSpec evolve over time? Does it become a kitchen sink over time?

Note: Larry thinks we need to form a standards committee to standardize RSpec. Perhaps, people will do their kitchen sink thing in the specialized part, and then come to the standardization body to feed their specialized thing in. This should happen very soon.

Note: MAX/MANFRED fully supports the idea of having a standards committee to flesh out/clarify the details of the RSpec. The RSpec should have the constructs most commonly found in each project, but also be extensible enough so that individual projects may add arbitrary extensions (which may or may not be standardized depending on how useful they prove to be).

Basic, single PlanetLab Central (PLC) includes GENIwrappers for SliceMgr (SM), AggrMgr (AM) and Registry on top of PLC; CompMgrs (CMs) on top of PlanetLab NodeMgrs (NMs).

Authoritative state maintained in PLC, useful for recovery after any node failure. Note that project that doesn't use PLC will have to decide where to put their authoritative state.

PLC has a lot of O&M functions, useful for general purpose nodes.

GetTicket only at AggrMgr; RedeemTicket only at Comp Mgr.

When calling CreateSlice on SM, slice is created on node via back channel, direct to node. Projects that don't use PLC won't have this back channel.

geniWrapper code is tagged when it is considered "stable." But you can look at trunk any time. The geniwrapper subversion repository at <http://svn.planetlab.org/svn/geniwrapper> does not currently have any tags or branches, there is only the trunk.

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Soon: second and third PLCs, with AggrMgr, for VINI and M-Lab, that will peer with first AM.

Then, SM in first PLC can create slice involving all three AMs.

Before doing this, SM can call GetPolicy at the other AMs, to get WL/BL. SM can cache results

Note from Robert: alternative is to ask for resources, giving who is asking.

Soon: PLC, PLE and PLJ will be full-fledged peers.

Each has a SM, which talks with all other AMs.

Demo

Sfi is a unix program that takes arguments and generates commands.

Tailored to the average user, not a PI.

Runs on the researchers laptop, is a client of Registry and SM.

Provides "bells and whistles" that pretty up Slice Intfc exported by SM.

Bootstrap with your private key. Automatically acquires and manages credentials. Credentials accumulate in the directory you are using to run the tool.

Use "helper" functions to edit RSpecs and registry records.

Demo 1: how to use SFI to download your personal credentials, edit something like a phone number in the resulting file that is stored, and update the registry by sending back the whole credential.

Demo 2: how you do queries of things like CoMon (via curl) to get other information that you might want to edit.

Demo 3: how to get RSpec associated with a slice by querying PLC SM. (SM went back and asked PLC AM).

Suggested approach for a network entity is to use GENIwrapper for AggrMgr, but without PLC (see Geniwrapper Design Overview Section 1.6, and Case 2 above).

Called by SM.

Currently no GetTicket code

Stripped to basic calls; makes basic calls on Adaptor, which connects with Network Controller.

When you get rid of all the PLC specific code, you aren't left with much but a dispatch routine, starting around line 519 in aggregate.py

MAX/MANFRED commented that they are planning to deploy and test GENIwrapper and the sfi application in their MyPLC deployment on the DRAGON network. They may need some initial guidance from the GENIwrapper developers until documentation is available.

4.5 Enterprise GENI

Guido Appenzeller

Presented review of OpenFlow and Enterprise GENI; control framework requirements for Enterprise GENI; their perspective of PlanetLab GENI control framework; and proposal for simplified control framework; see <http://groups.geni.net/geni/attachment/wiki/ClusterB/Enterprise%20Geni.pdf>.

Design process

- Bottom up: network substrate
- Top down: control framework
- What is the best way to meet?

Open Flow review

Structure

- Switches and FlowVisor and Controllers
- Controllers dedicated to VLANs for uses, or characteristics
- FlowVisor provides virtualization
- FlowVisor will interface with an AggrMgr

Wide-scale experiment underway

Stanford Enterprise GENI targeted for GEC5 timeframe.

Expect

- Production non-open flow traffic
- Production open flow traffic
- Research open flow traffic
- Goal for late 2009: 5-6 deployments, and backbone

Use cases

- Partition flows based on Ports and VLAN Tags
- Build a Content Delivery Network CDN where you control the whole network
- A new layer 3 protocol, defined by a new Ether type

GENI for OpenFlow

Structure

- Aggregate is managed centrally by the FlowVisor
- No external login into components of any kind.
- Controllers could be provided on any available node, e.g., a PlanetLab node
- Option: controller could be managed though FlowVisor / AggrMgr

Needs from CF

Protocol from GENI to AM: clearly specified, verifiable; language, OS and development tool agnostic; few external dependencies; ideally, independent reference implementations and test suite.

RSpec: Clearly specified, extensible, easy to implement.

Slice management operations: initialize, release.

Define and manage traffic sources and sinks, e.g., opt-in or opt-out for hosts and connection with Internet, GENI Backbone, other networks.

Mechanism for specifying external controllers.

Current perspective on PlanetLab GENI architecture and implementation:

API

GENIwrapper Dynamic XML RPC SSL + Full PKI

RSpec

Clear in some places, but in flux.

Enterprise GENI also made the point that the current XSD definition is dependent on types that are part of the Eclipse Modeling Framework (EMF), e.g. `xsi:type="ecore:EAttribute"`. The Ecore namespace is imported at the top of the XSD file. They would prefer if the XSD used basic primitives – `xsd:string`, `xsd:int`, `xsd:long`, etc. Refer to slides 32 and 33 of

<http://groups.geni.net/geni/attachment/wiki/ClusterB/Enterprise%20Geni.pdf> for more information.

Geniwrapper protocol

Encode messages in XML, written in Python. Easy to write in Python, but Python is dynamically typed language, and programmer can change types of objects at run time. Therefore, protocol may change at runtime.

Auth, authorization and naming

PKI is extremely heavyweight. We need only one server side certificate for SSL; all other authentication can be done with shared secrets

GIDs (certificates) not needed; existing naming schemes are sufficient.

Overall

Substantial complexity that we (at least initially) don't need.

Dependency on large code base that is actively being developed, referred to as a "moving target".

Would prefer to have a well-defined interface such that they can develop their own code that implements this interface

Proposal:

API

The most frequently used remote APIs today are all SOAP or REST

GENI Ultralight SOAP SSL +Secret

Design process

Prefer Interface Design, from Spec to Implementation

Back to Plan A, similar to original GMC proposal

Use SOAP and WSDL as contract between CF and substrates; lightweight and developer friendly

Flows

All communication via SM in GENI Clearinghouse (CH)

Authentication

Eliminate use of PKI by centralizing control

Vastly simplified security model

Simplified API

Messages from AM to GENI CH Registry Interface: Update, Add, Delete information.

Messages from GENI CH SM to AM: CreateSlice(RSpec), DeleteSlice(RSpec)

Simplified Naming

- Email addresses for Principals/Users
- Domain names for hosts/nodes.
- URLs for everything else.

Why a simpler control framework:

- Today we are ready to start integration with a GCH
- The currently proposed framework does not fit our needs
- Substantial complexity that we (at least initially) don't require
- Dependency on large code base that is actively being developed
- Not a short-term solution for us

- By 2H2009 we expect to have a backbone substrate
- We expect to have 5-7 local substrates with 20-100 switches
- Other groups will have their own (potentially larger) substrates

If we have a simple control framework, we hope a first GENI deployment would be usable for researchers by December 2009

4.6 GpENI Great Planes Environment for Network Innovation

Caterina Scoglio

Presented approach that Great Planes Environment for Network Innovation (GpENI) is planning using these slides:

<http://groups.geni.net/geni/attachment/wiki/ClusterB/Presentation1-BR.pdf>

Slide 2 shows four aggregates at KU, UNL, KSU and UMKC.

Slide 3 shows structure, with a mix of

- PlanetLab Nodes (new)
- ProgRouter Nodes (like VINI)
- Optical Switches (Ciena CoreDirector)

Control framework:

- Follows PlanetLab GENI approach
- PLC at KSU holds Registry, SM and AM for PlanetLab Nodes (new)
- PLC at UMKC holds AM for ProgRouter Nodes (like VINI)
- AM at UNL uses GENIwrapper AM (no PLC) and DRAGON software for Optical Switches (Ciena CoreDirector). Follows Case 2 option (above).

GpENI issues:

Note: MAX/MANFRED is also working with Ciena (other versions besides CoreDirector too, such as the Ciena CN4200). GpENI will continue to work with MAX/MANFRED, as there is interest from MAX/MANFRED in writing an AggrMgr

that will interoperate with the DRAGON control plane software. This AggrMgr could then be used on any DRAGON-enabled network (such as GpENI, if they decide to use DRAGON software to control Ciena CoreDirectors).

During this discussion, John DeHart also commented that SPP would use the GENIwrapper code that Larry is providing for their project.

4.7 MAX/MANFRED Mid Atlantic Crossroads

Chris Tracy

Presented approach that Mid Atlantic Crossroads (MAX/MANFRED) is planning using these slides:

<http://groups.geni.net/geni/attachment/wiki/ClusterB/MANFRED-13Feb2009-DenverMeeting.pdf>

DRAGON testbed:

- Will function as a GENI Aggregate for dynamic network resources.

- Also has PlanetLab nodes at three sites.

- Has running code that will act as AM/CM for dynamic network resources.

- Can “slice” networks.

- Multiple provisioning interfaces, including: web services API with signed SOAP messages.

- Since 2006, DICE and OGF (NMWG) have developed international standard for expressing complex network topologies; see <http://controlplane.net> They are using this for the DRAGON, Internet2 DCN, DANTE Autobahn and ESnet dynamic networks.

Concerns with PlanetLab GENI approach:

- Current SFA and RSpec focused on compute resources, not much for networks. How can DICE be adapted? Larry says he'd welcome their input to the schema.

- Level of effort to adapt MyPLC to Xen? Larry says they've done it, but this code is not being maintained. At one point there was a field in the API to specify which “type” of VM you were requesting – vserver, User-Mode Linux, Xen, etc., but this no longer seems to be supported.

- PlanetLab GENI uses XML-RPC. Prefer signed web services SOAP messages over SSL: More complex, but allows for user-defined complex data types; Python ZSI (Zolera Soap Infrastructure) works well

- Prefer to run UML, OpenVZ or Xen under Debian. PL doesn't use this. Larry says use VINI with Kernel-based Virtual Machine (KVM) kernel instead (KVM is an alternative to User-Mode Linux (UML)).

- Tagged VLANs are supported in Linux VServers, but don't seem to be supported in PL; would like to see that. Larry says this must be done for VINI too, so it is coming. MAX/MANFRED would like to be involved in the design/development of these features.

Recently: added notification broker, if setup problem, user is notified. How to do this in GENI?

Doesn't see a need to integrate GENI identities with the user identities they already use now in DRAGON for their authentication/access control.

4.8 Discussion

Aaron Falk plus all.

Discussion Item 1: GENIwrapper AM code, for use without PLC.

Approach suggested by PlanetLab GENI Project (see Geniwrapper Design Overview Section 1.6).

Makes calls on Adaptor, which connects with Network Controller. See calls in bold in Case 2, above.

When you get rid of all the PLC specific code, you aren't left with much but a dispatch routine, starting around line 519 in aggregate.py

Can we implement a subset of SFA API appropriate for prototype, not necessarily for the long-term architecture?

Can we define only the "essential calls" and "lock them down" i.e., "don't change their meaning", for the duration of this integration period, e.g., Spiral 1?

Agreed: PlanetLab GENI project (per Larry) will provide stripped GENIwrapper AM code, for use without PLC.

Action Item 1a: Release stripped GENIwrapper AM code, for use by networking projects, without PLC.

Priority: High

Who: Larry Peterson (PlanetLab GENI project)

When: Due by 3/6/09. Completed 2/19/09; see https://svn.planetlab.org/browser/geniwrapper/trunk/geni/alt_aggregate.py

Dependency: (none)

Discussion Item 2: Move towards a "lightweight" protocol between the SM and a new "lightweight" AM, suitable for a network entity such as EntGENI.

As proposed by EntGENI project, use SOAP for a "lightweight" protocol.

Do not use PKI, and instead rely on trusted channel between SM in clearinghouse and AM.

Nick made the argument that if we do certs, we never get the chance to go back and do the simpler thing. Trying the simpler thing first lets you see if it is a winning strategy. Guido commented that, in his experience, due to slight variations between different versions of OpenSSL, it can sometimes be difficult to validate certificates – hence the push for shared secrets between the GENI ClearingHouse and AMs. User assertions would still be passed from the CH to the AMs so that policy decisions could be made, but users would be authenticated/validated by the CH.

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Harry indicated that proposal is equivalent to Case 3, with modified SM in PLC and new AM.

Larry indicated that Cluster B could possibly support this method in addition to current methods. Larry could take code from Guido for inclusion into SM. Then, could statically configure SM to provide new or old method for each project.

But, what about use of GID vs names. Use of email addresses? Use HRNs for slices? Have to make sure that GIDs aren't fundamental anywhere else.

Chris indicated that this is similar to how the DRAGON software works. Use WS-Security v1.1 using XML Signature Standard for timestamping/signing SOAP messages (not encrypted). Encrypted is implemented by sending SOAP over HTTPS. Home institution issues certificate to users, user identified by x.509 subject name. The x.509 subject name is essentially their HRN – e.g. CN=bicc-user@ngc.com, OU=TASC, O=NGC-IT, L=Chantilly, ST=VA, C=US.

Robert Ricci noted that SFA defines Comp Mgr. One way to think of this case is that PLC would be running CM for OpenFlow, with private interface to OpenFlow. Thus, technically this fits in the architecture.

Agreed: PlanetLab GENI and EntGENI projects will work together to implement this solution.

Action Item 2a: Define WSDL for lightweight protocol interface, and provide a “starter kit” of lightweight AM code and modified SM code, ready for initial integration into the SM. This requires resolution of GIDs in SM with names in lightweight AM. MAX/MANFRED would be willing to work with EntGENI in writing such a WSDL file.

Priority: High

Who: Guido Appenzeller (EntGENI project)

When: Due by 3/13/09.

Dependency: (none)

Action Item 2b: Integrate modified SM code into SM, to support lightweight protocol to lightweight AM.

Priority: High

Who: Larry Peterson (PlanetLab GENI project)

When: Due by 3/27/09.

Dependency: Requires a “starter kit” of a lightweight AM code and modified SM code, from Action Item 2a.

Action Item 2c: Forward information about this meeting to Steve Schwab (Security Project), and get him involved.

Priority: High

Who: Heidi Dempsey (GPO)

When: Due by 2/20/09. Completed 2/23/09.

Dependency: (none)

Discussion Item 3: RSpec

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Can DRAGON approach be used to define RSpec for network entity? Chris will send out more info on DRAGON.

MAX/MANFRED needs info on VLANs. Robert Ricci has RSpec written in RELAX NG which includes support for VLAN tags, and will send out.

Larry proposes a GPO system engineer review the RSpec and enforce something because otherwise every project will be looking out for their own interests.

Aaron thinks this overlaps with John Jacob's substrate catalogue work.

Action Item 3a: Provide information on how DRAGON approach can be used to define RSpec for network entity

Priority: Med

Who: Chris Tracy (MAX/MANFRED project)

When: Due by 2/27/09.

Dependency: (none)

Action Item 3b: Provide information on VLANs and RSpecs from ProtoGENI project.

Priority: Med

Who: Robert Ricci (ProtoGENI project)

When: Due by 2/27/09.

Dependency: (none)

Action Item 3c: Identify how GPO can help with RSpec definition and prioritization.

Priority: Med

Who: Aaron Falk (GPO)

When: Due by 2/27/09.

Dependency: Action Items 3a and 3b.