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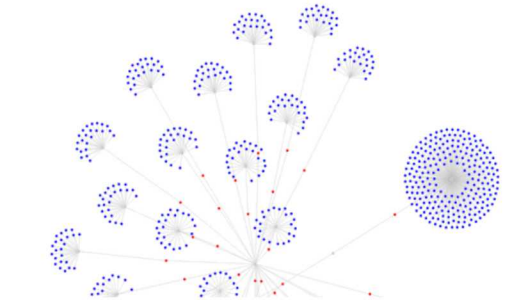

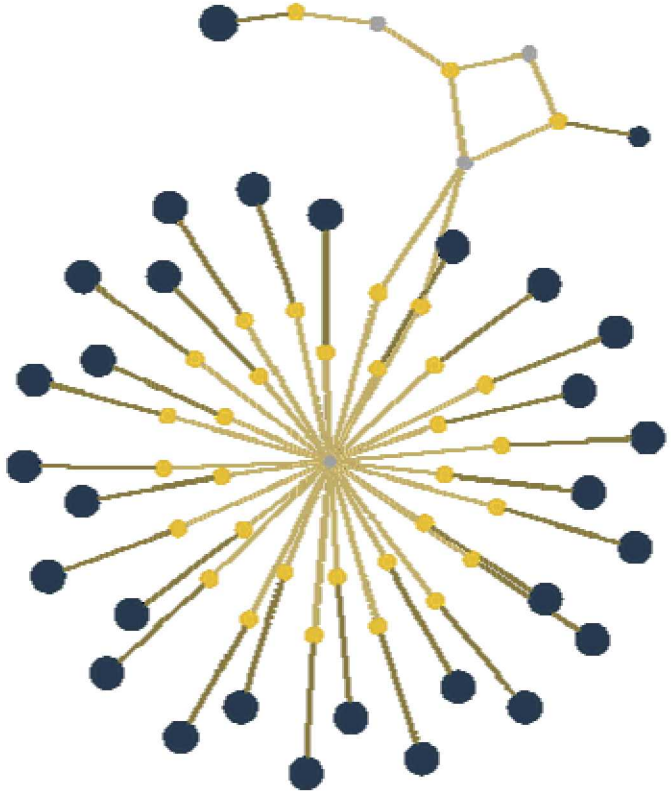

minimega

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What To Expect

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- Overview and motivation
- minimega toolset
- Use cases
- Current/planned work, goals

The Take

minimega is a research platform that integrates a number of technologies and domains

- Research in Emulytics™
  - Virtualization
  - VM scale/density/scheduling
  - Virtual networking
  - Analytics
- Research enabled by Emulytics™
  - "History has shown that the best way to spawn a ton of research is to provide a tool" – Dean Tullsen
  - MODSIM
  - Analytics
  - RE
  - …

Emulytics™

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- Sandia developed Emulytics™ for cyber security research, testing, and training
- Emulytics™ = emulation + analytics
- Run virtual networks of hundreds of thousands of virtual machines (possibly millions)
- Set up realistic environments that mimic real-world corporate and internet systems
- Integrate Windows, Linux, and Android VMs into a single virtual environment
- minimega is one of several Sandia Emulytics™ tools

A Brief History

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- Dissatisfaction with existing tools
  - OpenStack and friends are slow, difficult to use/modify
  - Container implementations aren't well designed for sandbox environments
  - We don't like big, complicated configurations
  - No integrating product available (except OpenStack, see above)
- 2012 – minimega as a simple KVM-based VM management tool
- 2013 – Growth! SDN, command and control, experiment introspection, …
- 2014 – Android support
- 2015 – Linux container support

Open Source

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Full minimega distribution is available publicly (minimega.org)

- Tools, examples, documentation, discussion forum
- Growing community
- Development, issue tracking is done publicly

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USE CASES

Test and Evaluation

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- Provide a sandbox for “what if” scenarios
- Build experiments around software, hardware
  - Including hardware in the loop
- Provide, run, writeup experiments
- Provide environments, deployment on customer hardware
- Example: DHS Transition to Practice

Training Environments

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- Provide detailed environments for red/blue team exercises
- Bridge humans to an experiment
- Support AARs (vnc record/replay)

More Use Cases

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- HPC research
- Internet of Things
- Cyber-physical applications
- Honeypot applications

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MINIMEGA TOOLSET

Minimega

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- minimega the tool vs minimega the platform (nearly 1:1)
- Single binary, deployment is simply copying the binary to all nodes
  - Can actually be simpler!
- Command line, scriptable, programmable interfaces
- Fully distributed (no master/slave semantics)
- No configuration - just launch the tool and start describing your experiment
- No external software stack – no database, no message passing queue, …

Minimega Script

```
# describe a vm
vm config disk foo.qc2
vm config memory 2048
vm config net my_network

# launch one vm named ‘foo’
vm launch kvm foo

# launch 5 unnamed vms
vm launch kvm 5

# grab some info
vm info

# grab some pcap
capture pcap vm foo foo.pcap

# record vnc framebuffer and keyboard/mouse interactions
Vnc record fb foo foo_vnc.fb
Vnc record kb foo foo_vnc.kb

# clean up
vm kill all
vm flush
```

Minimega At Scale

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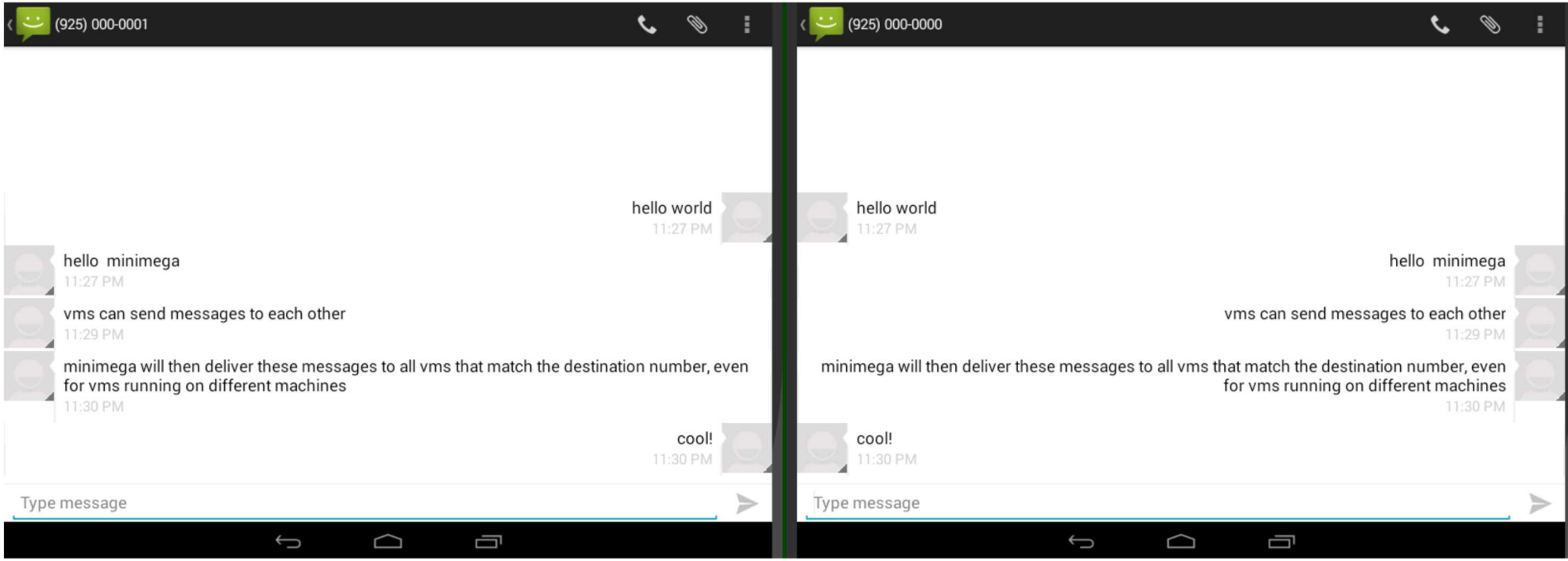
- Same command set for clustered instances
  - minimega can union nodes to provide a consistent interface regardless of size and *topology* of the underlying cluster
  - Support for esoteric physical layers
    - Multiple federated clusters, etc.
- Fully distributed
- Cluster orchestration layer
  - **Very fast** file transfer, shell, kernel optimizations (ksm, huge pages)
- Can self-deploy
  - `deploy my_cluster_nodes[2-500] username password`

Minimega Mobile Extensions

- Several radios/sensors simulated in minimega for Android endpoints
  - GSM, wifi, accelerometer, GPS, …



Protonuke

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Zero-configuration traffic generation and protocol servers

- Single binary, zero dependencies
- Windows, Linux, MacOS, FreeBSD, Android
- ARM, x86, x86_64
- HTTP, HTTPS, SMTP, SSH custom server with content generation
- Servers/client behavior and datasets can be changed with optional configuration
- ~30k emails embedded into the binary in 4 languages
- Can saturate 40Gbit links in a single thread
- Can hit billions of transactions / day when distributed
- Very active development

Miniccc

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Command and control agent

- Send/receive files (including globs)
- Execute/background commands
- Process control
- Windows, Linux, MacOS, FreeBSD
- ARM, x86, x86_64
- Can connect over TCP, virtio, or UDS
- Virtio, UDS allow networkless backchannels
- Supports TCP tunneling (equivalent to ssh –L and –R)
  - Even over networkless backchannels!

Vmbetter

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Debian-based VM image builder

- Simple, nested VM configurations
- Can build qcow2, kernel/initrd, livecd, containers
- Great for building simple images that get provisioned with miniccc
- Suitable for host images (our cluster nodes PXEboot vmbetter images)

Minidoc

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Website, documentation, articles, and presentations (except this one)

- Renders markdown-like articles and slidedecks
- minimega.org is running minidoc, combination of HTML and rendered articles
  - The entire minimega.org website is part of the distribution
- Can be run locally
- Can *interface* minimega for interactive articles/presentations
- Runnable examples in documentation

Other Components

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- **Tools**
  - **rfbplay**: VNC record/replay framebuffer playback and transcoding tool
  - **igor**: node reservation tool
  - **powerbot**: PDU control tool
- Custom libraries
  - **minicli**: Command line parser, API compiler
  - **meshage/iomeshage**: mesh-based message passing protocol, file transfer layer
  - **miniclient**: Go bindings for interfacing minimega
  - **minitunnel**: TCP over any I/O transport
  - **vnc**: Custom VNC/RFV server and client

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TECHNICAL DETAILS

Networking - Distributed Minimega

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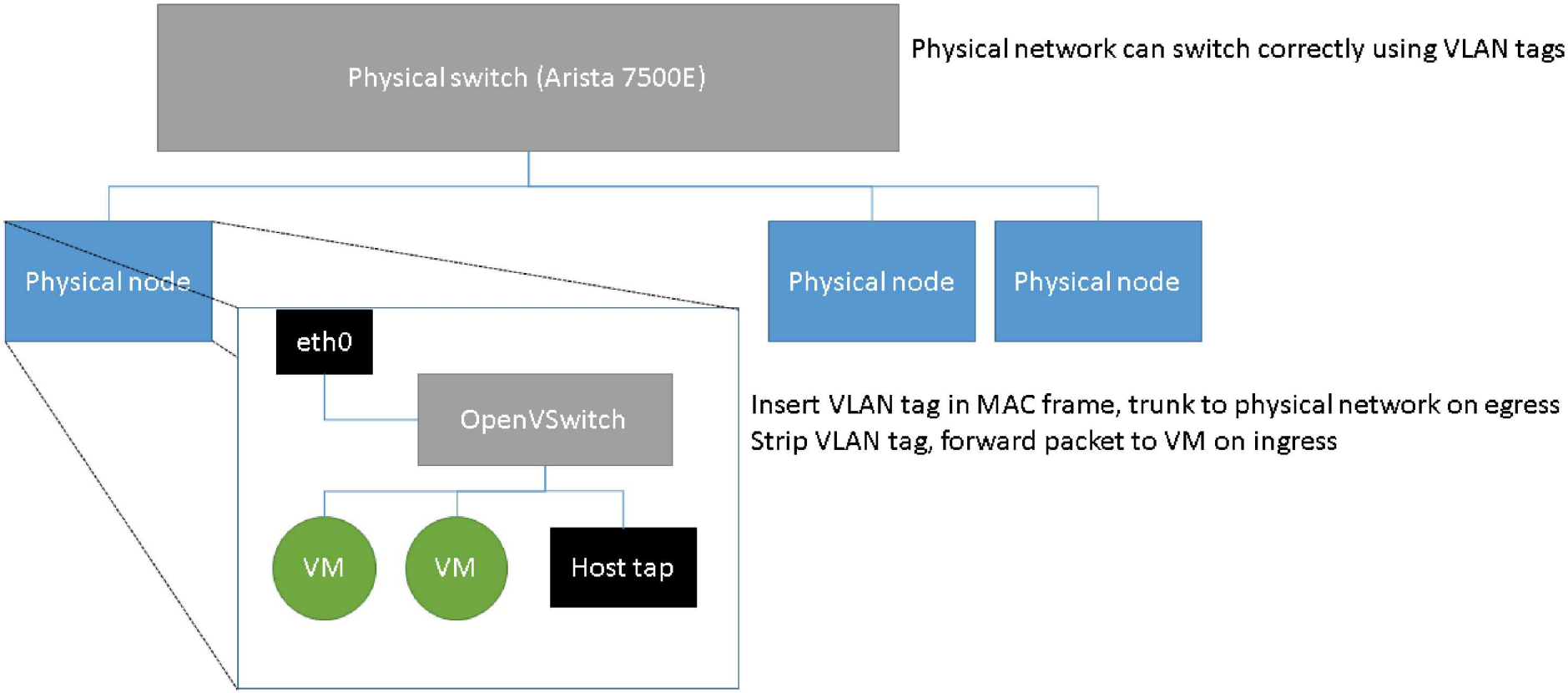
- Depends on a capable physical network
  - 802.1Q VLAN tags (layer 2)
  - GRE/VXLAN (authentic layer 2 with ~30% performance hit)



Meshage

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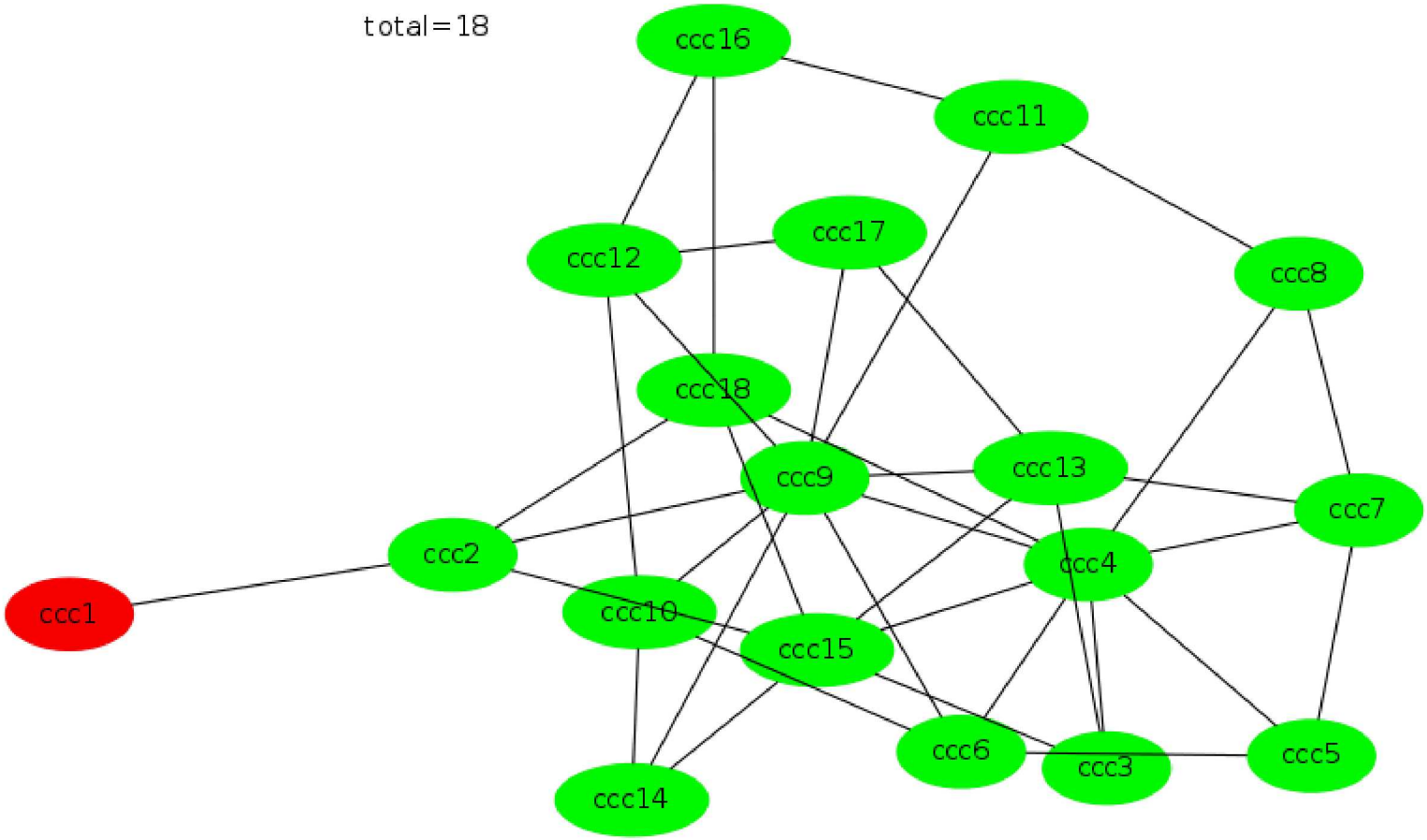
- Mesh-based message passing for all minimega communication
- Auto-discovery
- Node-to-node and broadcast messages
- Mesh structure is resilient to node failure
- Distributing large files over meshage is fast

A Typical Minimega Mesh



A Minimega Meshage Nightmare

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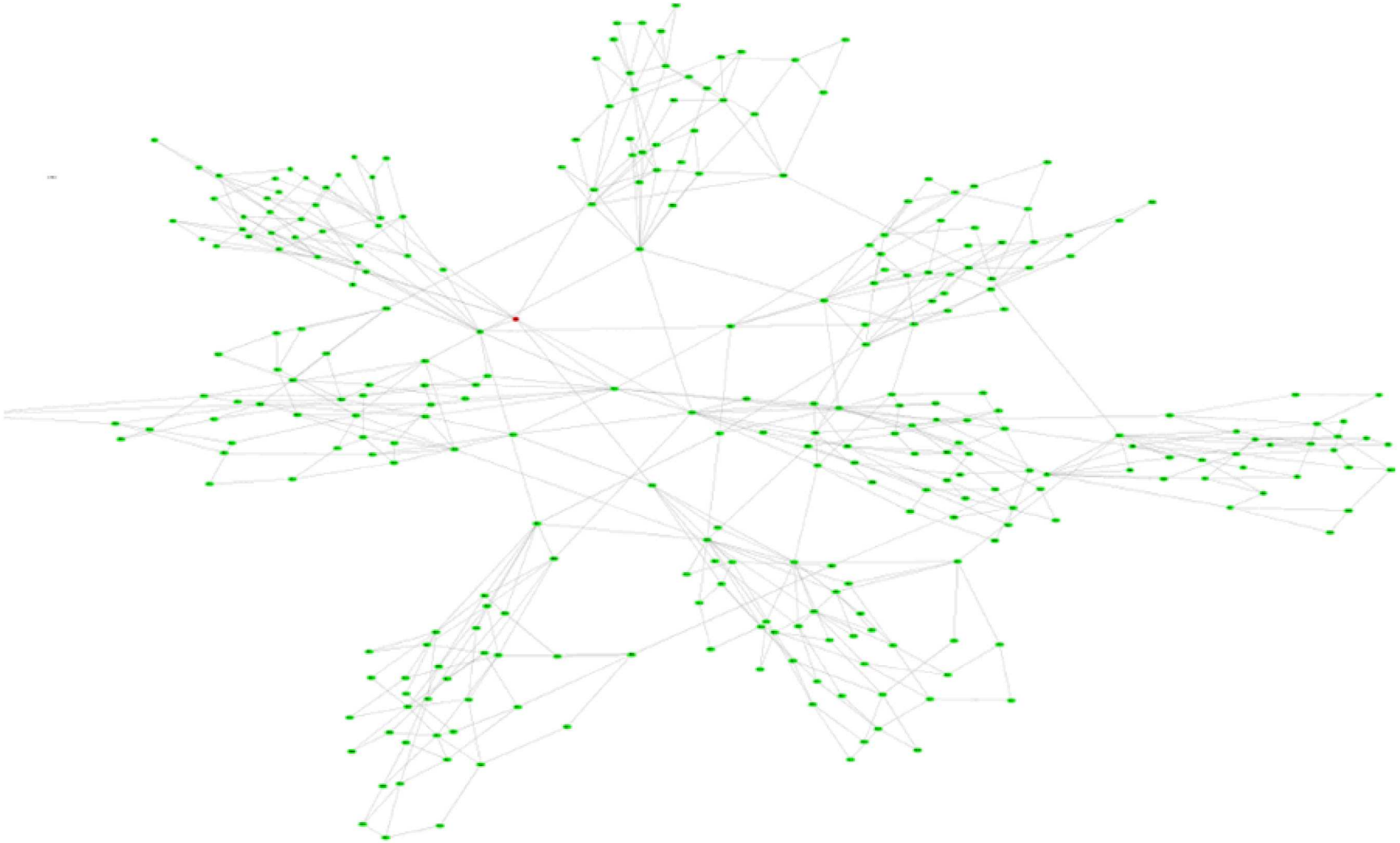

Minimega VMs

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- Either KVM/QEMU processes or containers
- Configured with `vm config` commands
  - Launch one or more VM from the current config
- Full custom container implementation
  - Very fast!
- Pause, kill, etc. via KVM QMP or container cgroups
- Hotplug USB/CDROM devices
- Write state for migration/backup
- Screenshot running VMs
- VNC interfaces

Minimega API

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minimega is designed to be programmed

- Goal is to provide a simple interface to write tools on top of minimega
- 3 programming interfaces
  - Built-in CLI
  - UDS speaking JSON
  - Meshage
- External bindings (currently python, go)

Web Front End

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- Cluster, VM status/info
- Enables accessing any VM in the experiments, across the cluster
  - VNC gateway
- Rich set of graph visualizations