Open Science Grid

Introduction to Distributed HTC and overlay systems

Tuesday morning session

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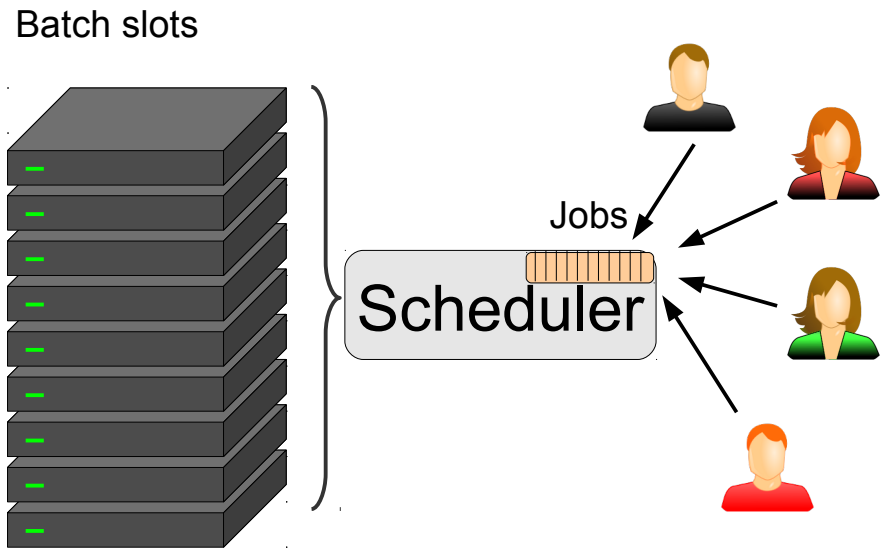
Logistical reminder

- It is OK to ask questions
  - During the lecture
  - During the demos
  - During the exercises
  - During the breaks
- If I don't know the answer,
  I will find someone who likely does

High Throughput Computing

- Yesterday you were introduced to HTC
  - Often called **batch system computing**
  - A paradigm that emphasizes maximizing the amount of useful computing over long periods of time



Local HTC

- What you have really experienced so far is **local HTC**
- i.e. computing on dedicated cluster of dedicated resources
  - Managed by a single admin group
  - Co-located in a single location

Is there anything else?

- As you might expect, there are several **insulated** "local HTC" clusters installed around the world
- And there are non-HTC systems out there, too

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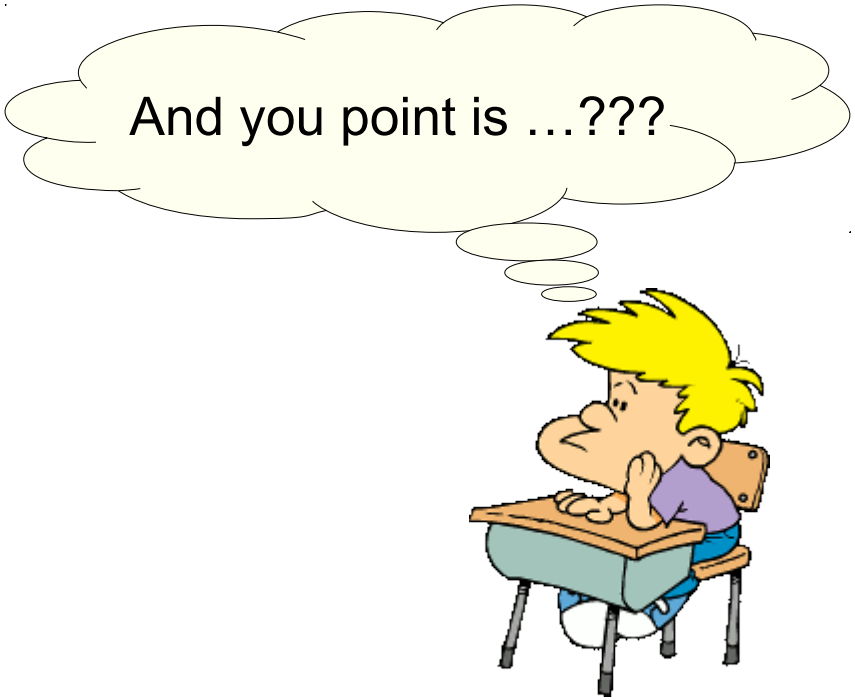
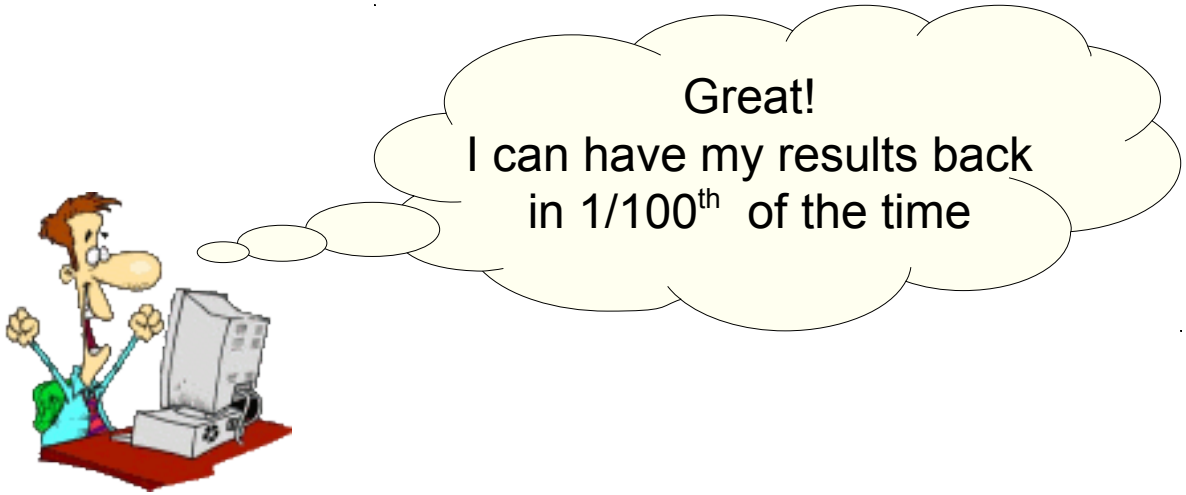


Just local HTC

- You moved from a single PC
  - O(1) cores
- To a local HTC cluster
  - Say, O(100) cores daily avg



Just local HTC

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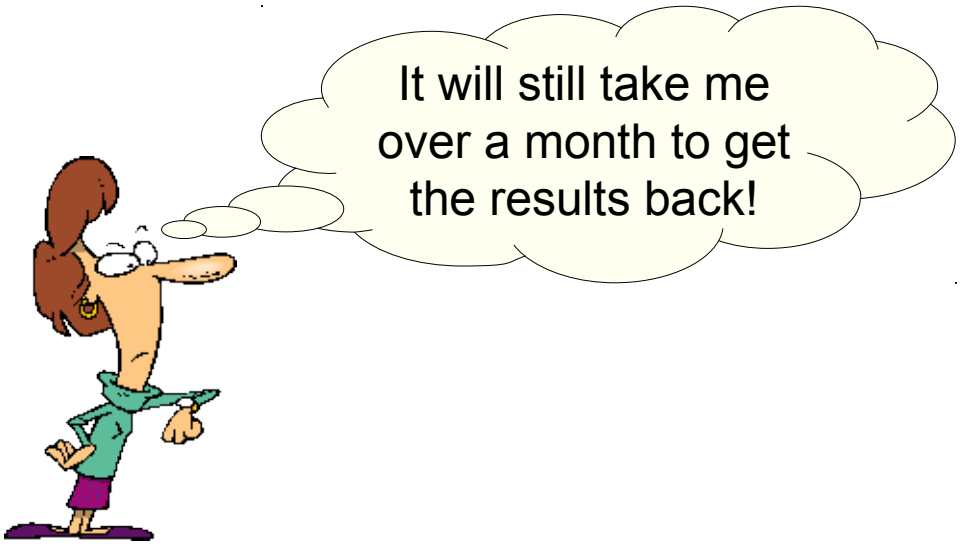
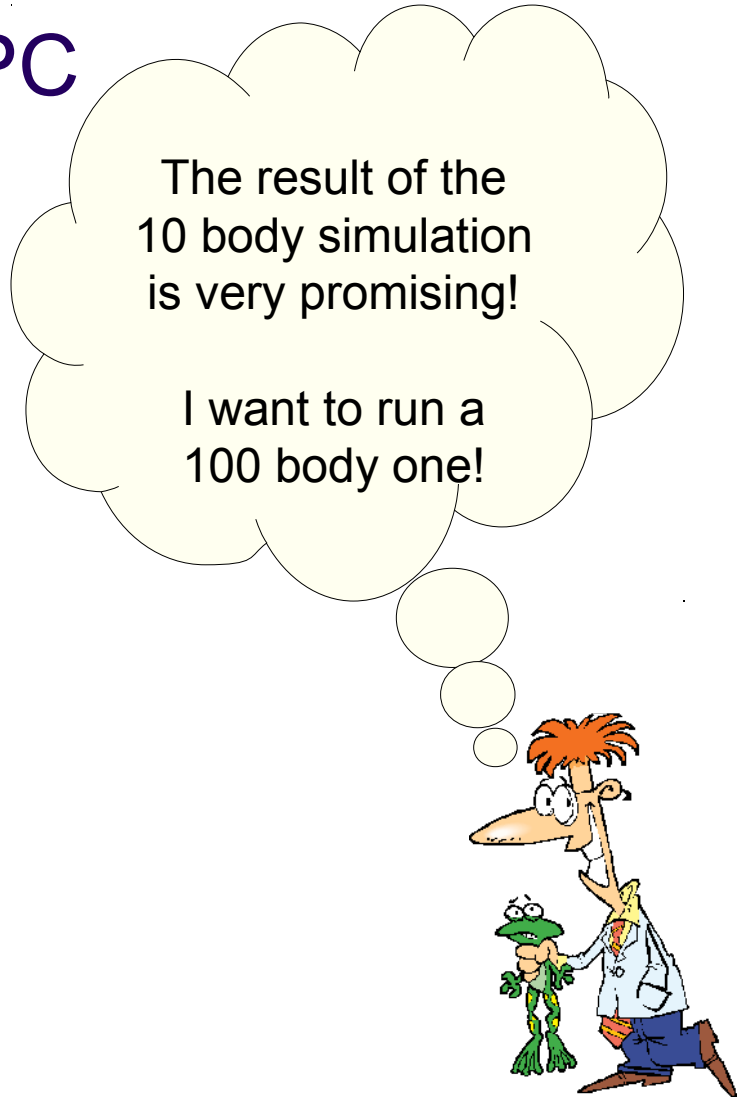
  - Say, O(100) cores daily avg
- **But is it fast enough?**





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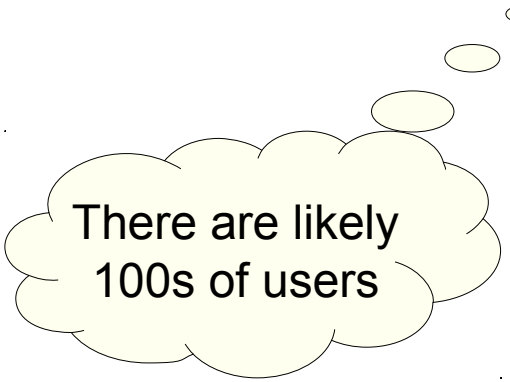
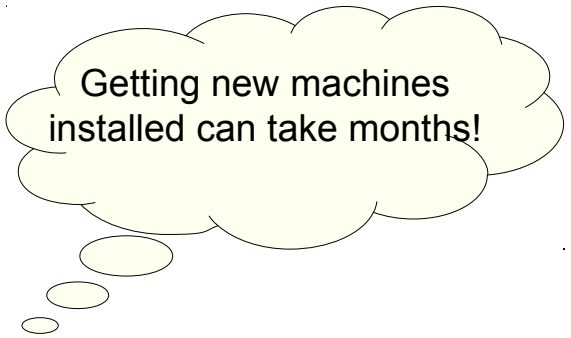
  - What do you do?
- Beg for a larger share of the local pool
  - i.e. better priority compared to the other users of the same pool



How to get more?

- If you find out that you are resource constrained
  - What do you do?
- Beg for a larger share of the local pool
- Pay to get more resources bought into the pool
  - Great for long term needs
    - If you can afford it
  - But will not help you in the short term



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- Get the needed resources somewhere else
  - i.e. not locally

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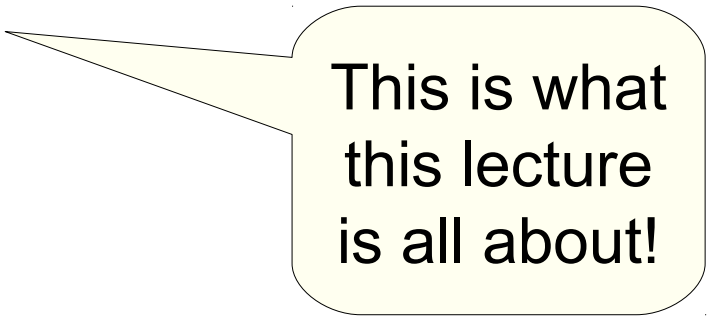


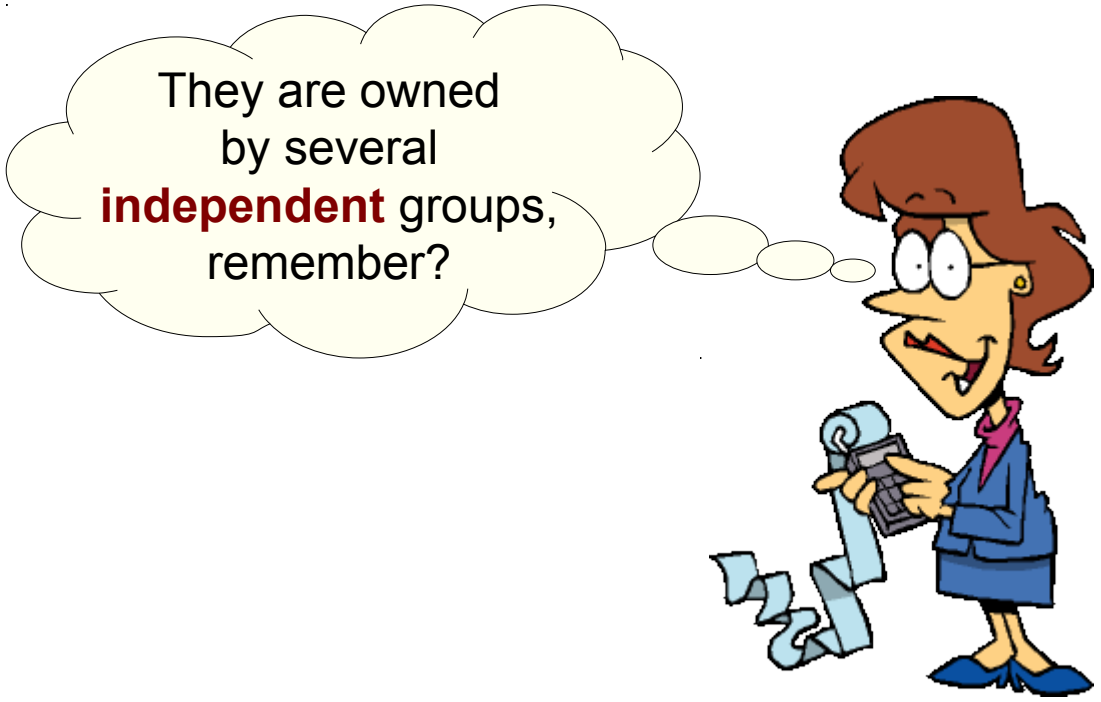
Distributed HTC

- A computing paradigm that aims at maximizing useful computation using any available resource **located anywhere** on the planet

- As a corollary
  - Compute resources are owned and operated by several independent groups

Implications of distributed computing

- We will be dealing with multiple **independent** compute systems
  - That do not know about each other



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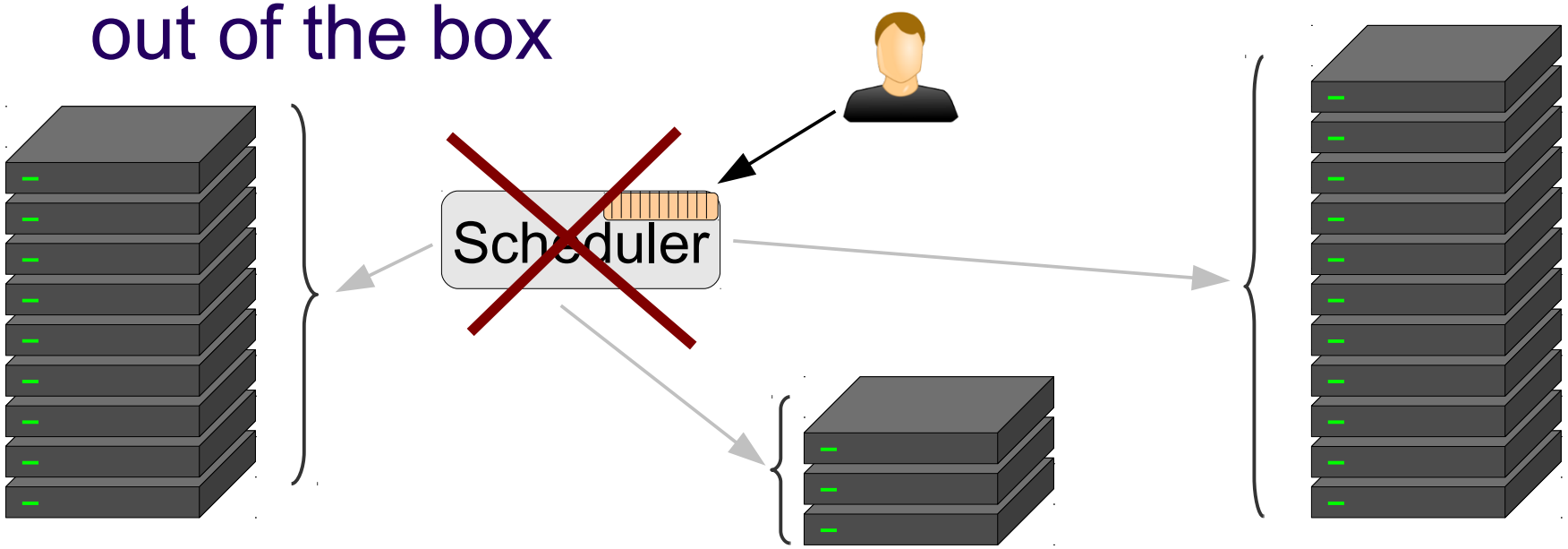

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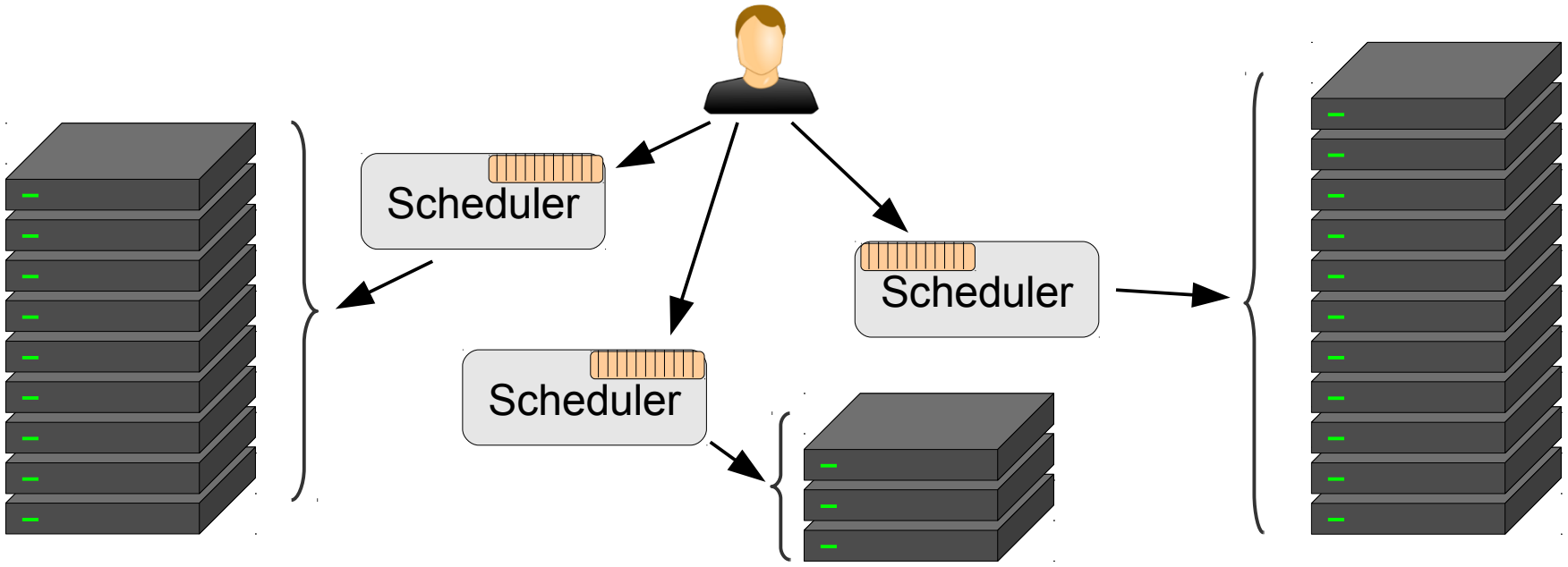
  - **Will have to stitch them all together**

The naïve way

- The simplest way is to **partition** your jobs and submit a subset to each cluster



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The naïve way

- The simplest way is to **partition** your jobs and submit a subset to each cluster
- The drawbacks
  - You may need multiple user accounts
  - You may need several different tools
  - Doing a good partitioning is hard
    - Want proportional to the resources you will get
  - And what if those CPUs are not in a HTC setup at all?

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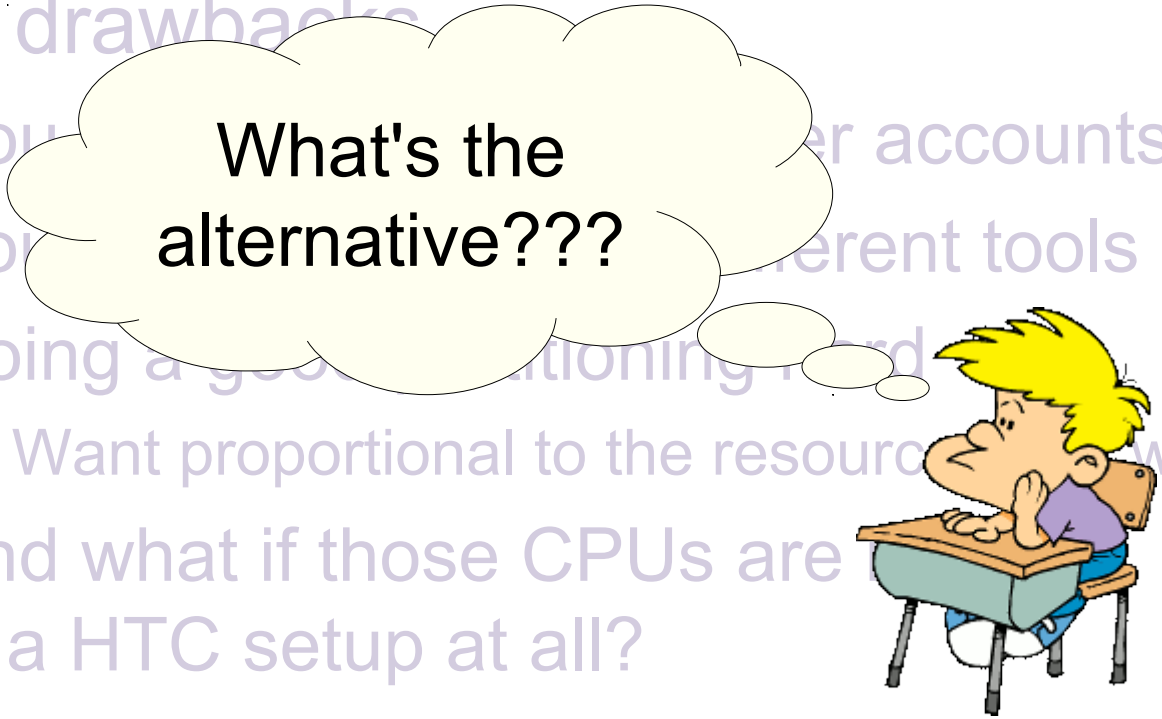
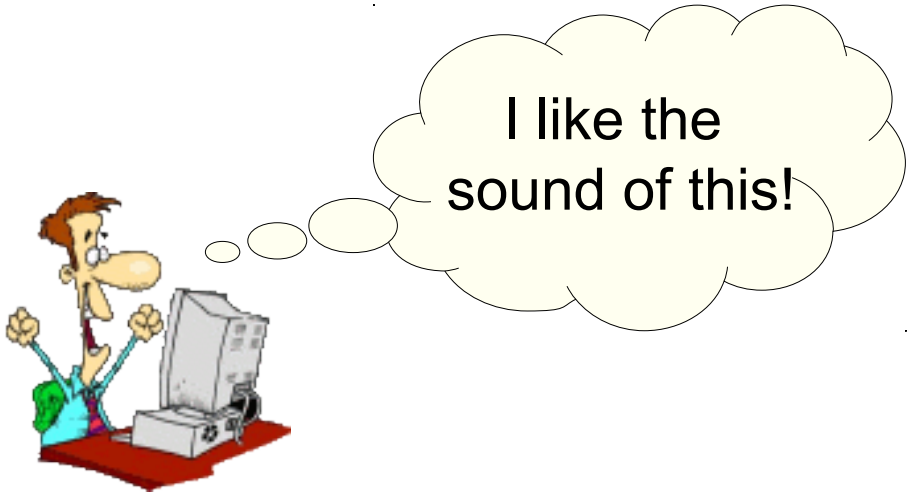


Use an overlay system

- Use a systems that looks and feels like a regular HTC to users
  - But has compute nodes all over the world



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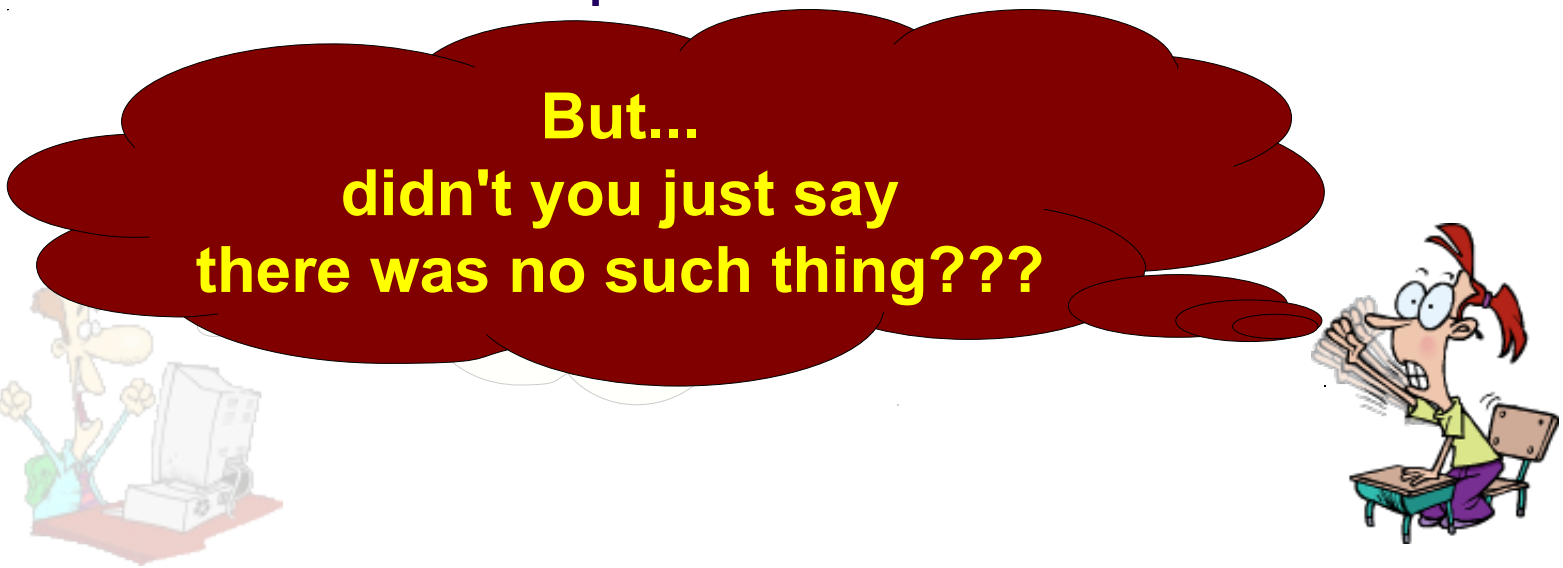

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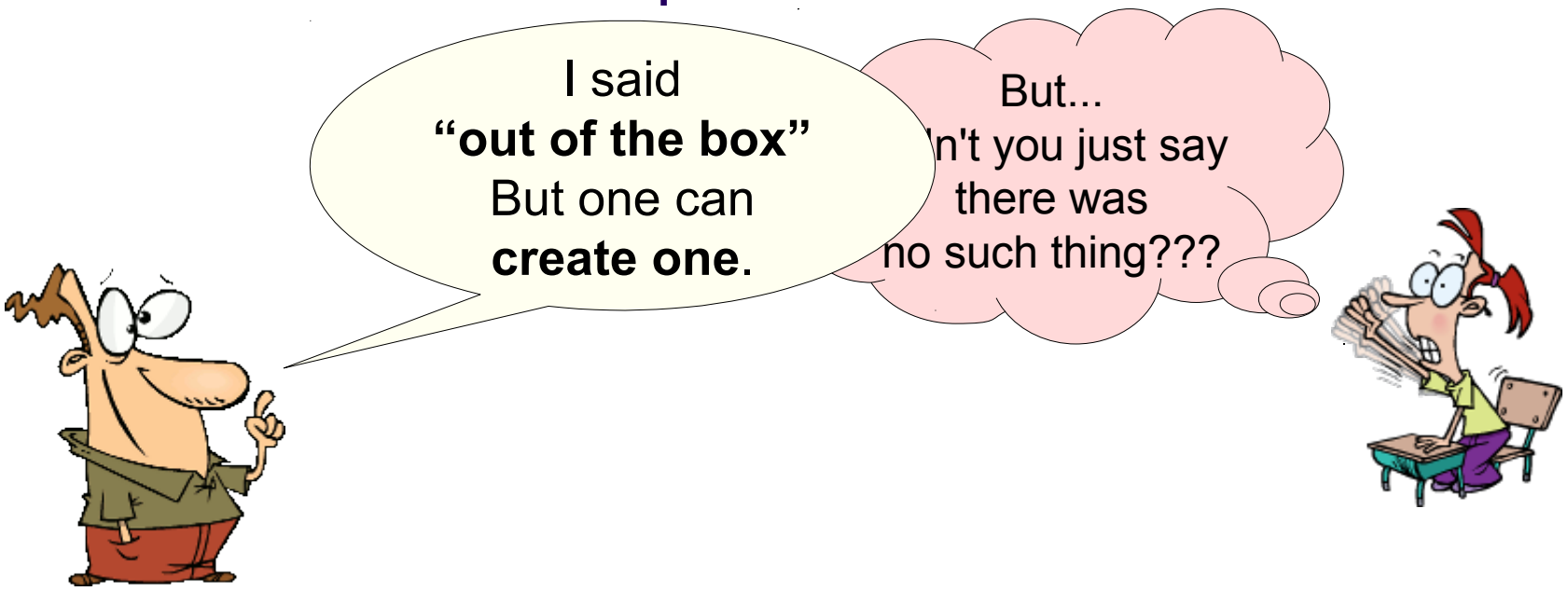
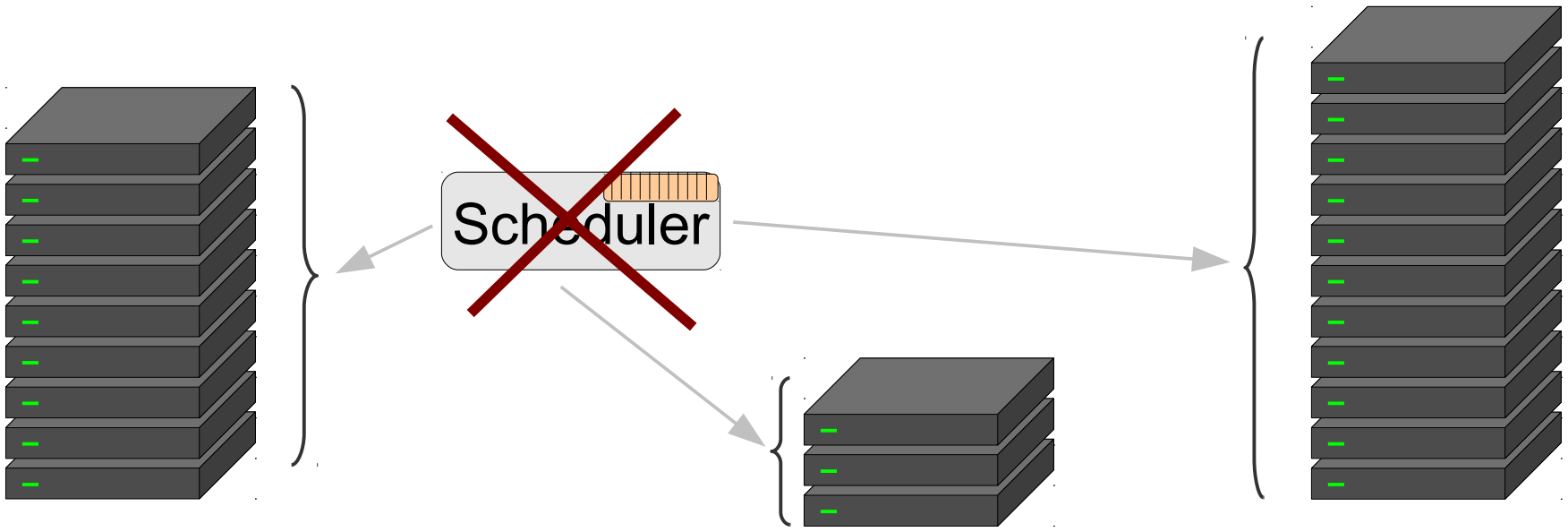


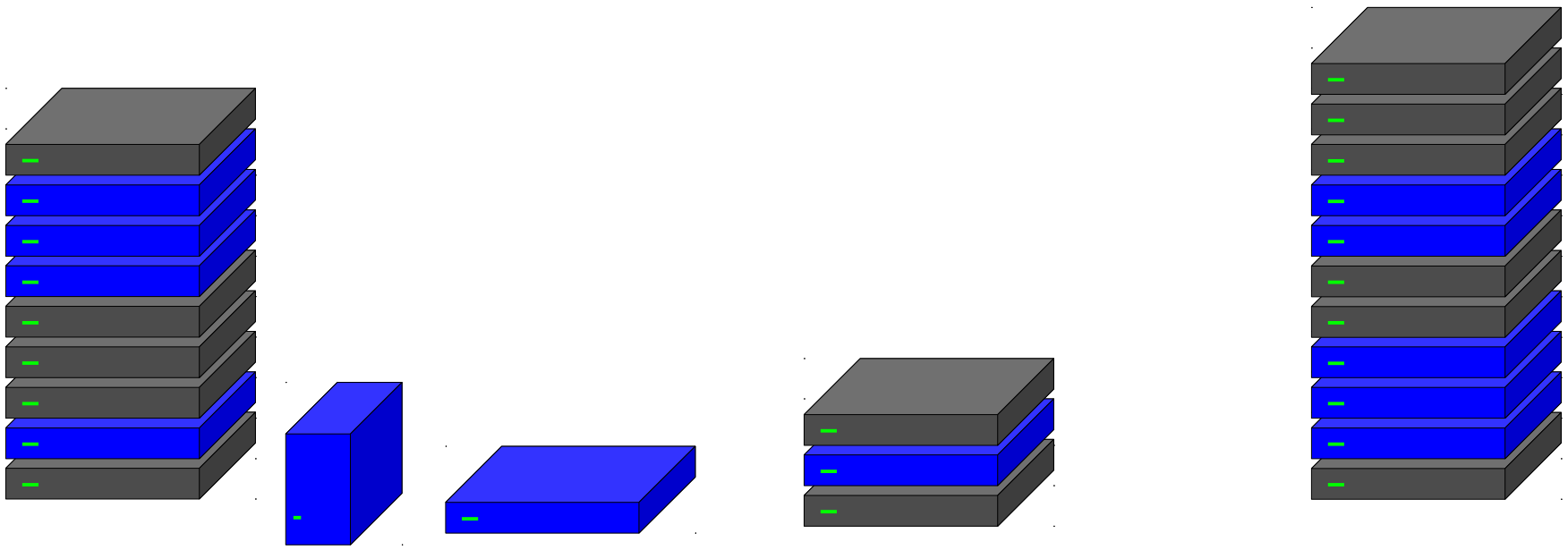
Creating a dynamic overlay sys

- No single person cannot manage all the existing resources



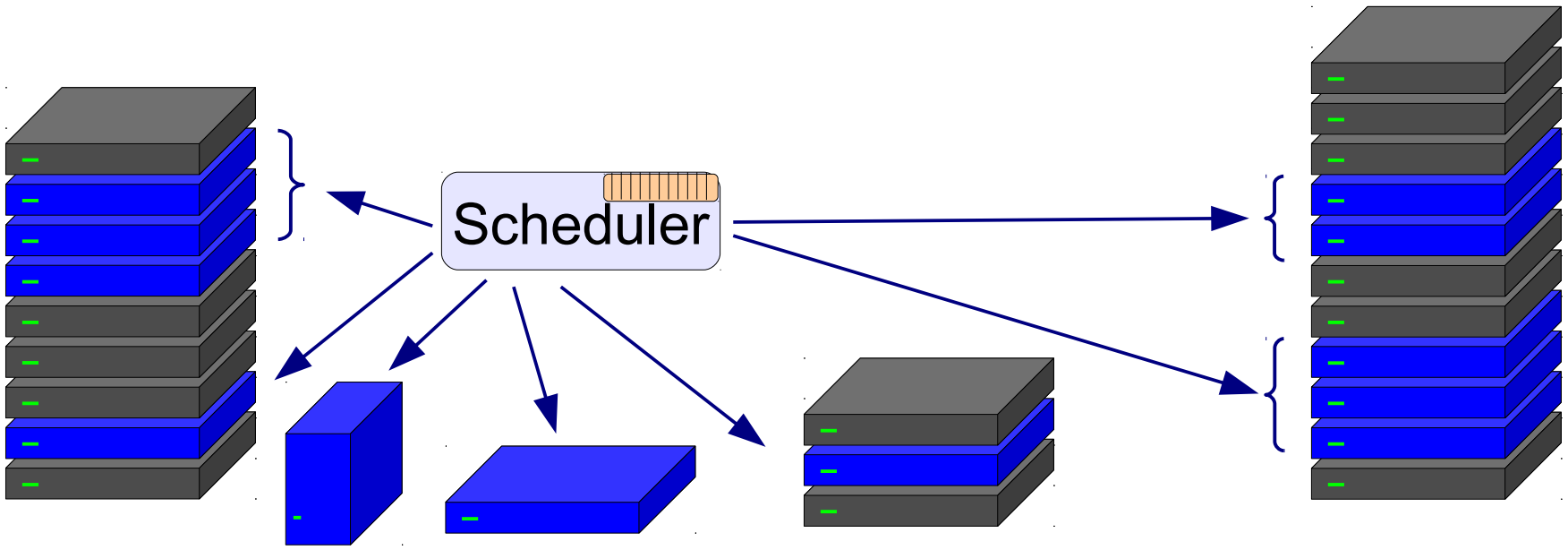
Creating a dynamic overlay sys

- But we can lease a subset of them
  - We discuss the how later



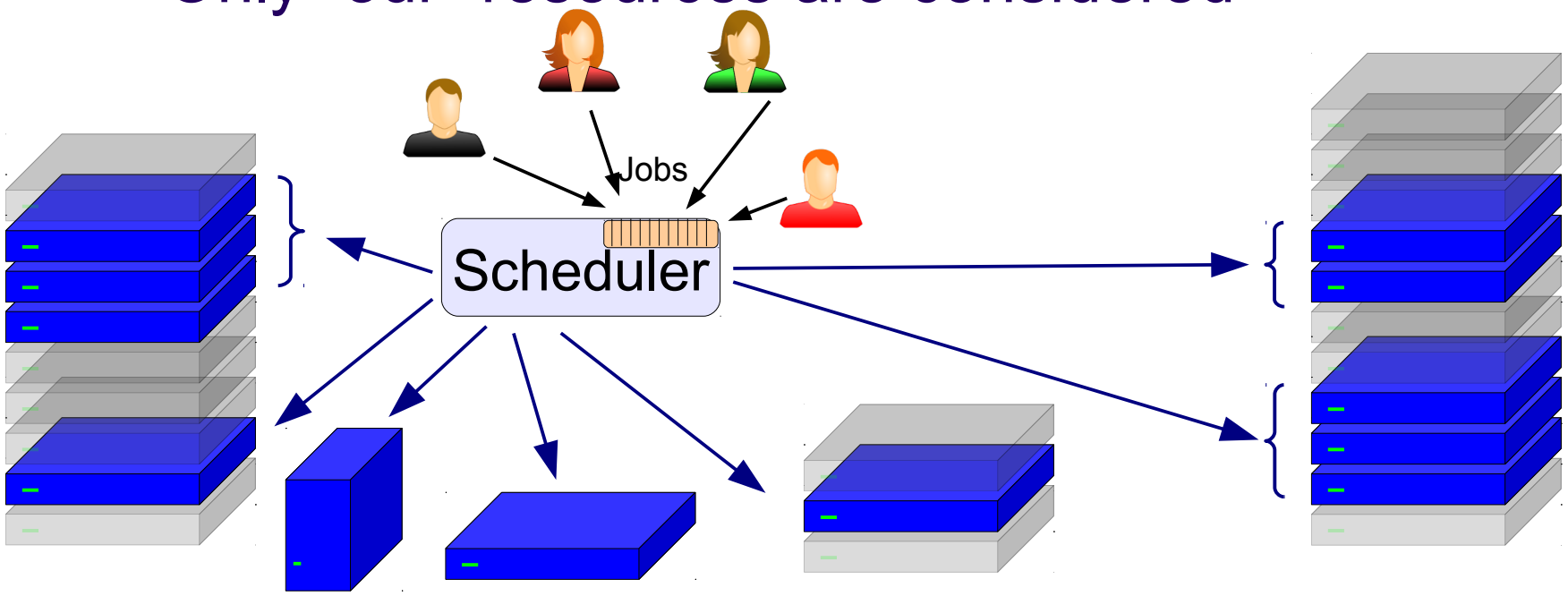
Creating a dynamic overlay sys

- But we can lease a subset of them
- And instantiate a HTC system on them



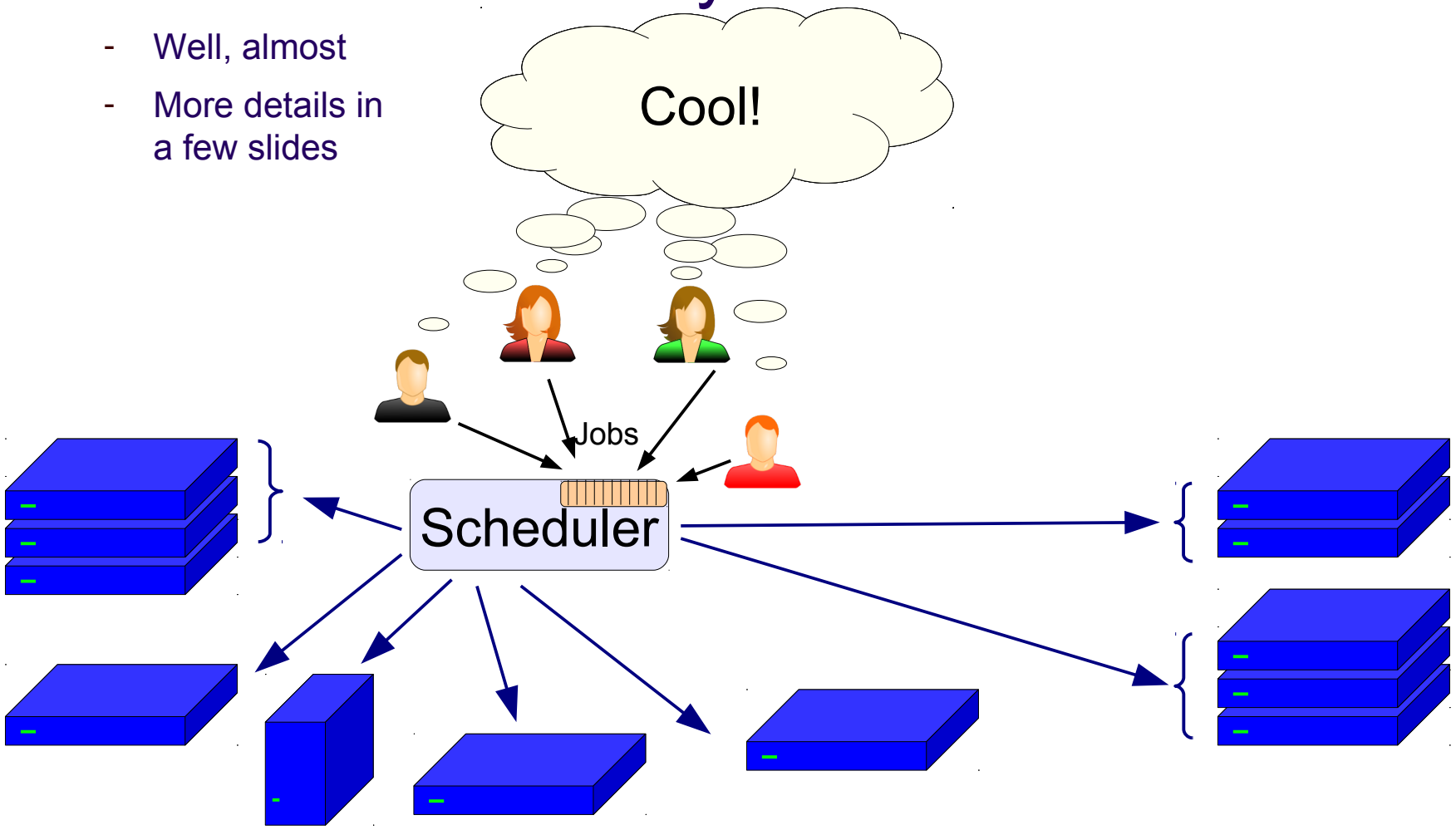
Creating a dynamic overlay sys

- But we can lease a subset of them
- And instantiate a HTC system on them
  - Now we can schedule user jobs on them
  - Only “our” resources are considered



DHTC through an overlay sys

- Just another HTC system
  - Well, almost
  - More details in a few slides



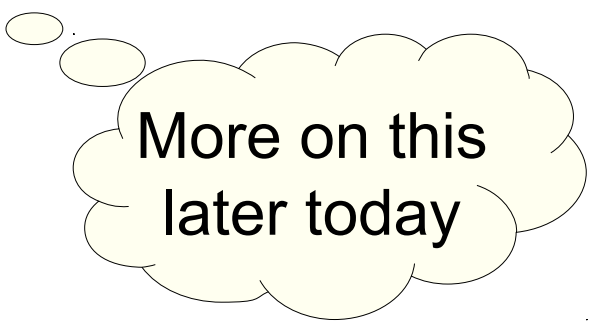
Overlay system ownership

- Setting up an overlay a major task
  - Comparable with installing a dedicated cluster
- Long term maintenance is also costly

- **Not something a final user would want to do**

Typical overlay sys operators

- Existing HTC admins, e.g.
  - The UW HTC cluster can “overflow” into OSG
  - The UCSD operates one for local users
- Scientific communities, e.g.
  - The CMS LHC experiment
- The Open Science Grid itself
  - With the OSG Connect



Is DHTC really just HTC?

- Even with overlays, there are some **differences** between DHTC and HTC

- With or without overlays, the core reasons are:
  - Multiple independent HW operators
  - Not all resources are co-located

The multiple owners problem

- In the “Grid” world, the resource owner decides which Operating System, which OS services and which libraries to install
  - A way smaller problem in the “Cloud” world
  - But most of the current DHTC landscape is based on the Grid paradigm
- Different clusters likely configured differently

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  - A way smaller problem in the “Cloud” world
  - But most of the current DHTC landscape is based on the Grid paradigm
- Different clusters likely configured differently
- Even if you could get your pet library/service installed on some clusters, you cannot expect to get it installed everywhere

Heterogeneity

- DHTC systems are way more heterogeneous than “local HTC” ones
- Two ways to approach this:
  - Minimize external dependencies in your compute jobs
    - Make them self-contained
    - Adapt to the running environment (e.g. multiple binaries, one per platform)
    - Do not use licensed software

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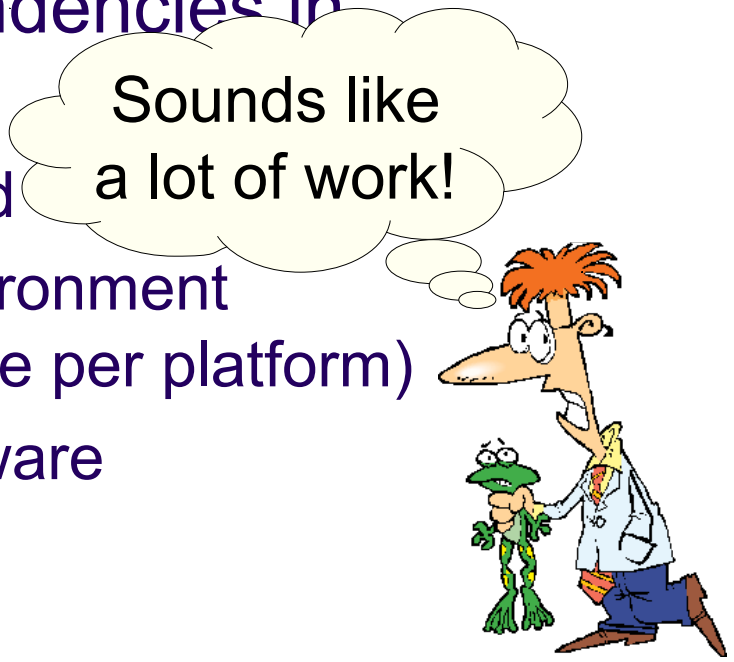

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    - Restrict where your jobs can run
    - Your job will of course take longer to finish
    - May still get you the result sooner

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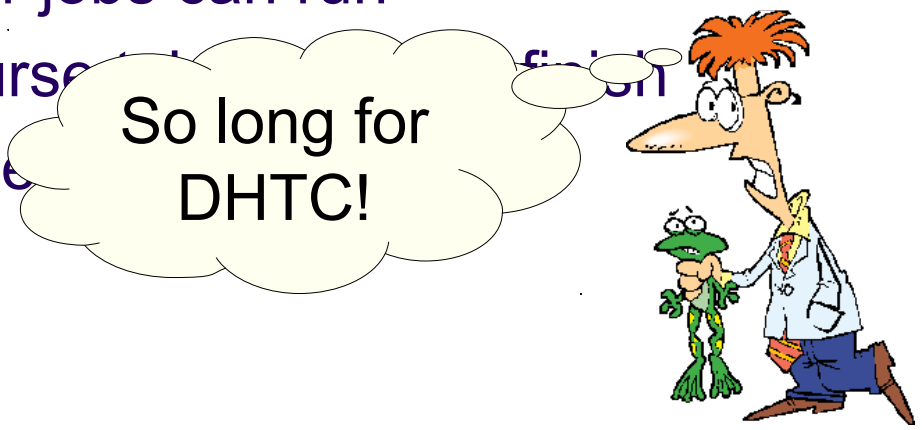

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- Two ways to approach this:
  - Minimize external dependencies
  - Use only a subset of the resources
    - Restri… …s can run
    - Yo… …finish
    - M… …

Unfortunately, those are the only two alternatives.

long for DHTC!

No shared file system

- As a side effect, you cannot expect a globally shared file system
  - It's just “yet another user requested service”
- You will have to deal with data explicitly
  - Either using the HTC scheduler capabilities (remember yesterday's lecture)
  - Or, embed file transfer to and from permanent storage into your own jobs
- More details tomorrow

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The location problem

- Nodes in different locations need a way to talk to each other
  - This is what networks are for
- If your computation is mostly about CPU cycles, with little input and output data
  - Node location is not an issue at all
- If you have lots of data
  - Remember, throughput is typically inversely proportional with the distance

The data problem

- Transferring large amounts of data over Wide Area Network can take a lot of time
- You should try to compute close to the data source and/or sink
  - Network-wise
  - More about this tomorrow

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Bottom line

- For simple computation, DHTC is very similar to HTC
- As soon as you require any complex setup for your jobs, you are in for a rough ride
  - This includes large datasets

Infrastructure considerations

- DHTC is likely to give you access to many more compute slots
- Which is mostly a good thing
  - You get your results faster
- But could crash your HTC system, e.g.
  - Can your storage system handle more data traffic?
  - Can the job scheduling system handle an order of magnitude more nodes?

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- Which is mostly a good thing
  - You get your results faster
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  - Can y[illegible]m handle more dat[illegible]
  - [illegible]an [illegible]g system handle an [illegible]der of magnitude more nodes?

Hopefully not something final users should deal with but it is good to keep in mind.

Questions?

- Questions? Comments?
  - Feel free to ask me questions later:

    Igor Sfiligoi <isfiligoi@ucsd.edu>
- Upcoming sessions
  - Where to get the needed resources
  - glideinWMS – the OSG overlay software
  - Hands-on exercises
  - Tour

Beware the power

Courtesy of fanpop.com

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