gLExec

gluing grid jobs to the Unix world

… of uids and gids, CEs, #, pilot jobs and traceability …

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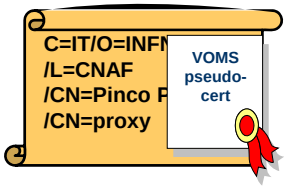
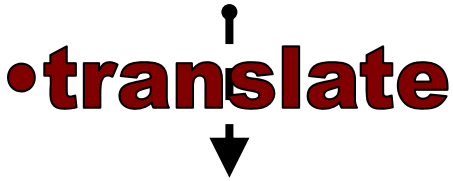
The Problem

The Basic Issue

grid identity



(X509, VOMS)
/dc=org/dc=example/CN=John Doe




```
pvier001:x:43401:2029:PoolAccount VL-e P4 no.1:/home/pvier001:/bin/sh
```

- **Unix does not talk Grid, so translation is needed between grid and local identity**

1. **this translation has to happen somewhere**
2. **something needs to do that**

What is gLExec

gLExec

a thin layer
to change Unix domain credentials
based on grid identity and attribute information

you can think of it as:

- **'a replacement for the gatekeeper'**
- **'a *griddy* version of Apache's `suexec`'**
- **'a program wrapper around LCAS, LCMAPS or GUMS'**

Why was glexec devised?

1. **Gatekeepers and schedulers are complex: why run with super-user privileges all the time?**
   - like apache's httpd, where user *cgi* scripts may run as user, but without the web server itself having to run as root!
   - to accomplish this a small program is needed with *setuid* power to change *uid*: Apache 'suexec', GridSite 'gsexec'

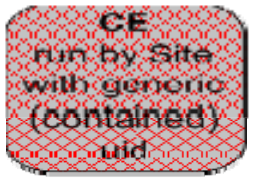
   gLExec is the 'griddy' suexec derivative

2. **Variety of grid job submission systems is increasing**
   - need a common way of enforcing site policy and id mapping
   - without the need to modify each and every system
   - gLExec can be used as an alternative to having authorization and mapping *call-outs* in each system

Job Submission Models

There are several 'traditional' job submission models, where glexec has a role in some of these

1. direct per-user job submission to a 'gatekeeper' running with root privileges
2. a CE or scheduler not running as the super user



Site controlled service,
running with 'generic' uid

Real User Job
(with *uid* matching actual workload being run)

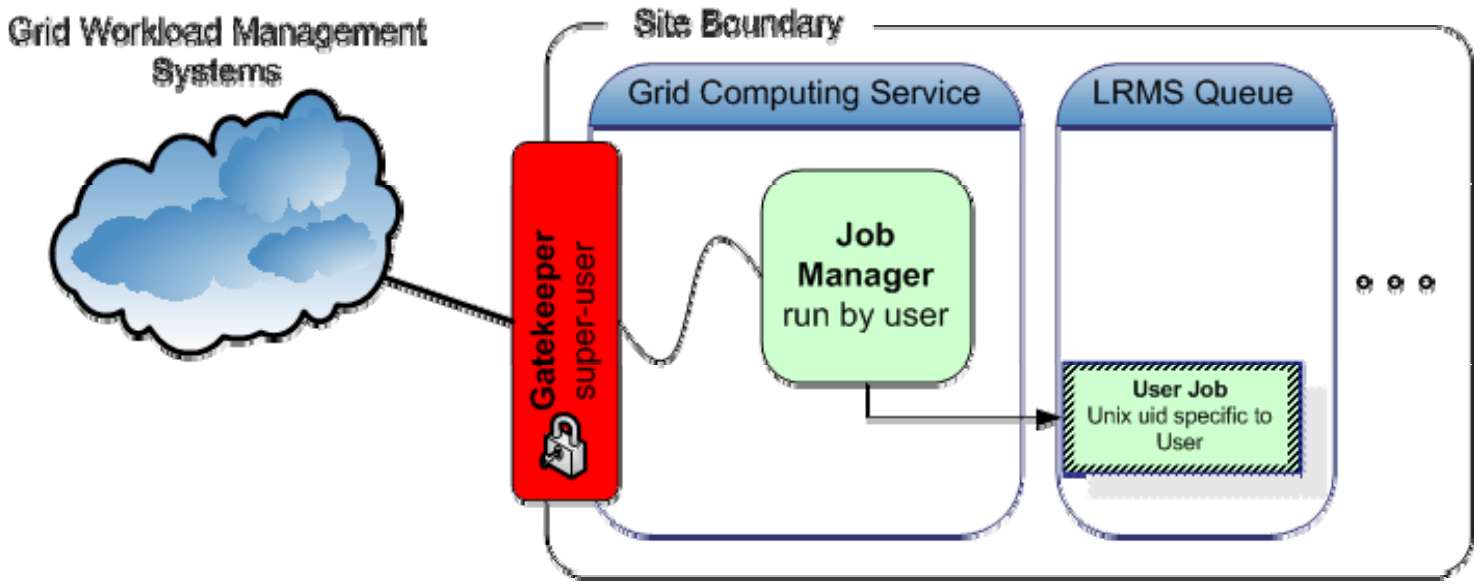
Site controlled,
running as super-user

Site controlled
super-user daemon

VO-run process
(generic VO *uid*, or generic VO pool)

Submission via a Gatekeeper

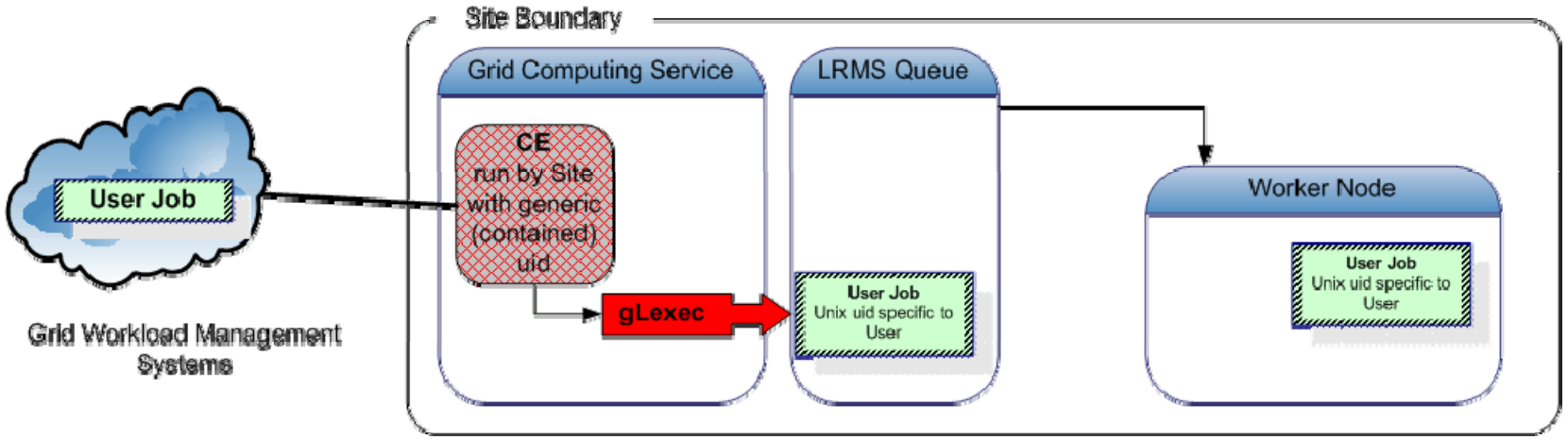
Traditional job submission scenario, model ‘gatekeeper’



- change of credentials at the site edge
- networked service (‘gatekeeper’) with super-user privileges
- job management in a per-user account (be it for single or multiple jobs)

Grid Computing Service: Site-CE

- **Deployment model with a CE 'service'**
  - running in a non-privileged account or
  - with a CE run (maybe one per VO) on a front-end per site

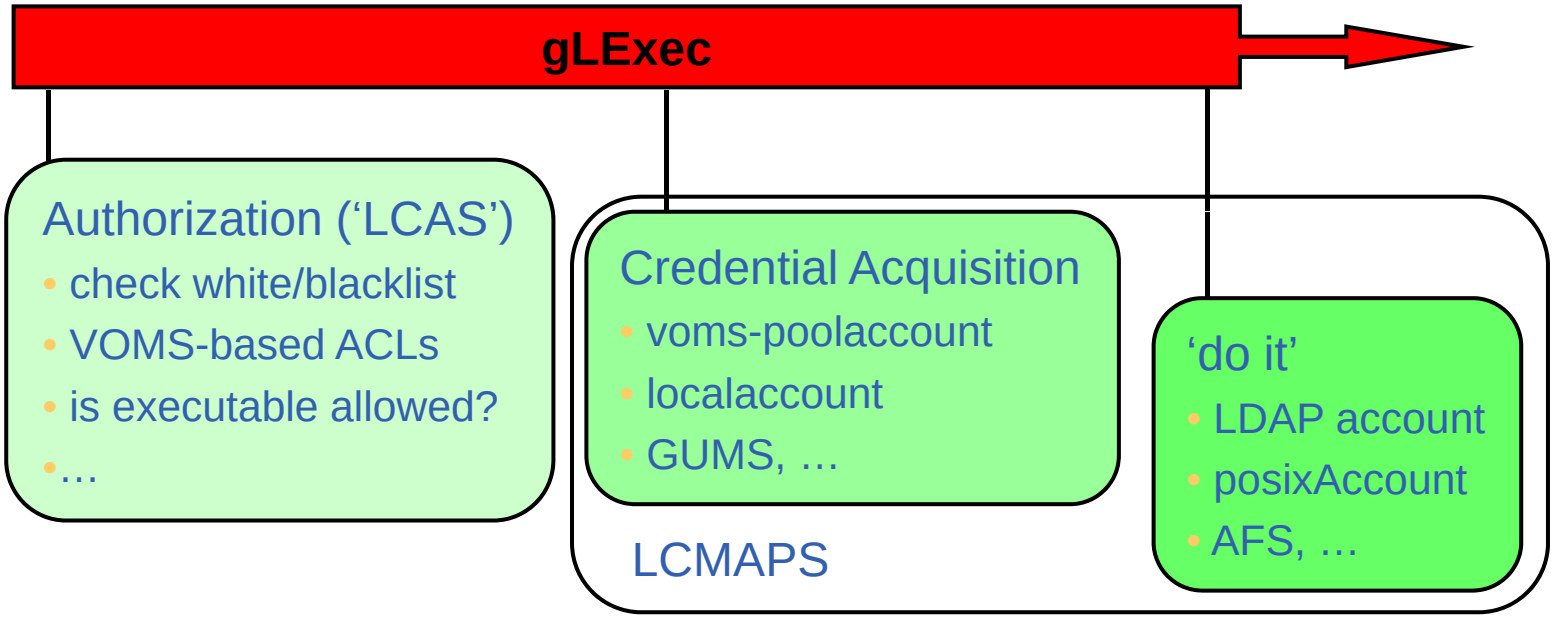


examples
- CREAM
- GT4 WS-GRAM (via sudo)

What gLExec does …

- **User grid credential** (subject name, VOMS, …)
- **command to execute**
- ***current uid allowed to execute gLExec***

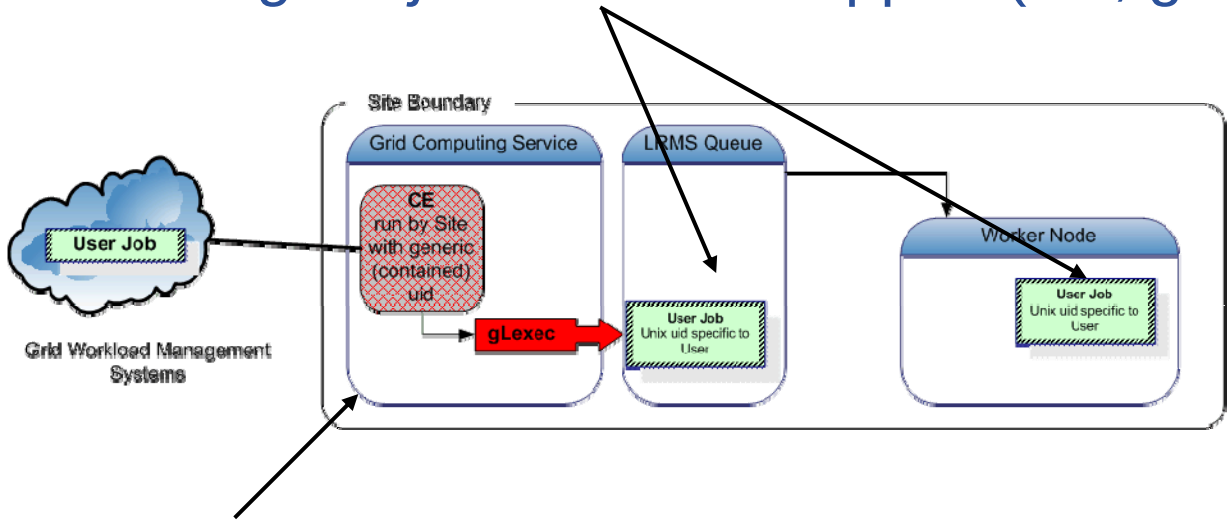
cryptographically protected by CA or VO AA certificate



- **Execute command with arguments**
- **as user (*uid, pgid, sgids …)***

Classic job submission models

- In the submission models shown, submission of the user job to the batch system is done with the *original job owner's* mapped (uid, gid) identity



- grid-to-local identity mapping is done *only* on the front-end system (CE)
  - batch system accounting provides per-user records
  - inspection shows Unix process on worker nodes and in batch queue per-user

Pilot jobs: ‘late binding’

But job submission gets more and more intricate …

- Late binding of jobs to job slots via *pilot jobs*
  some user communities develop and prefer to use proprietary (VO-specific) scheduling & job management
  - pilot is a small placeholder that downloads a real job
  - ‘first establishing an overlay network
  - subsequent scheduling and starting of jobs is faster’
  - it is not committed to any particular task
  - perhaps not even bound to a particular user (‘VO pilot’)
- this scheduling is orthogonal to the site-provided systems

Situation today

- **'VO-type' pilot jobs submitted as if regular user jobs**
  - run with the identity of one or a few individuals from a VO
  - obtain jobs from any user (within the VO) and run that payload on the WN allocated

'Multi User Pilot Job' (MUPJ)

Some of the issues:

- site 'sees' only a single identity, not the true owner of the workload – site policy compliance is undefined …
- inherent security issues with generic pilots:
  the target user can assume the identity of the pilot submitter!

No effective mechanisms today can control this use model …

- **regular 'per-user' pilot jobs have no such issues**
  - user-specific pilot glided in, binding to the own user's workload

Addressing issues with gLExec-on-WN

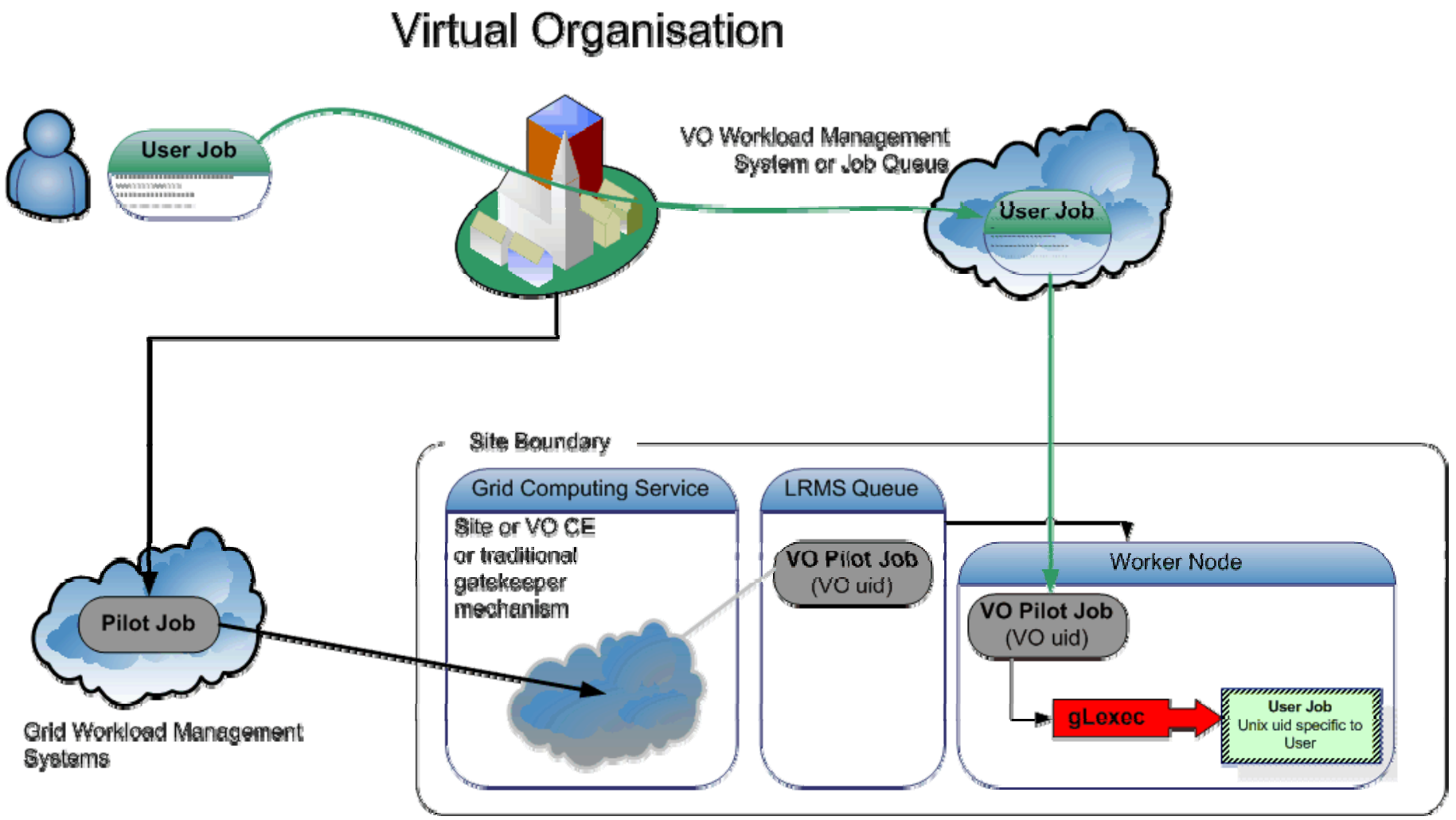
1. Make pilot job subject to normal site policies for jobs

- VO submits a pilot job to the batch system
  - the VO 'pilot job' submitter is responsible for the pilot behaviour

    this might be a specific role in the VO, or a locally registered 'special' user at each site
  - Pilot job obtains the true user job, and presents the user credentials and the job (executable name) to the site (glexec) to request a decision on a cooperative basis

2. Preventing 'back-manipulation' of the pilot job
   - make sure user workload cannot manipulate the pilot
   - project sensitive data in the pilot environment (proxy!)
- by changing uid for target workload away from the pilot

Pilot Jobs and gLExec



On success: the site will set the uid/gid to the new user's job

On failure: glexec will return with an error, and pilot job can terminate or obtain other user's job

gLExec deployment modes

- **Identity Mapping Mode – 'just like on the CE'** 1+2
  - have the VO query (and by policy honour) all site policies
  - actually change uid based on the true user's grid identity
  - enforce per-user isolation and auditing using uids and gids
  - requires gLExec to have *setuid* capability

- **Non-Privileged Mode – declare only** 1
  - have the VO query (and by policy honour) all site policies
  - do not actually change uid: no isolation or auditing per user
  - the gLExec invocation will be logged, with the user identity
  - does not require setuid powers – job keeps running in pilot space

- **'Empty Shell' – do nothing but execute the command…**

Pieces of the solution

VO supplied pilot jobs must observe and honour

the same policies the site uses for normal job execution

(e.g. banned individual users)

Three pieces that go together:

- glexec on the worker-node deployment
  - the mechanism for pilot job to submit themselves and their payload to site policy control
  - give ‘incontrovertible’ evidence of who is running on which node at any one time (in mapping mode)
    - at some sites for regulatory compliance (e.g. FNAL deployment, Igor’s talk)
    - gives ability to nail individual culprits for actions
    - by asking the VO to present the associated delegation for each user
  - VO should want this
    - to keep user jobs from interfering with each other, or the pilot
    - honouring site ban lists for individuals may help in not banning the entire VO in case of an incident

Pieces of the solution

- glexec on the worker-node deployment

- keep the pilot jobs to their word
  - mainly: monitor for compromised pilot submitters credentials
  - process and system call level auditing of the pilot jobs
  - logging and log analysis

- gLExec cannot to better than what the OS/batch system does
  - ‘internal accounting should now be done by the VO’
    - the regular site accounting mechanisms are via the batch system, and these will see the pilot job identity
    - the site can easily show from those logs the usage by the pilot job
    - accounting based glexec jobs requires a large and unknown effort
  - time accrual and process tree remain intact across the invocation
    - but, just like today, users can escape from both anyway!
  - auditing data on the WN is useful for incident investigations only
    - that is not the solution to the accounting question

Status of gLExec today

- Implementation ready & functionally tested (awaiting full code audit)
- Deployed in production at FNAL

- Uses LCAS and LCMAPS systems for mapping and enforcement

  … new modules have been added
  - LCAS: RSL (executable path) constraints
  - validation of cert chain and proxy lifetime

- Extensive logging

- Minimizes impact on the (batch system and OS) environment

- Current restrictions (mainly for –WN scenario)
  - policy should be located on local POSIX-style file systems, and its transport should be ‘trustworthy’ (but is within the site)
  - gLExec executable restrictions to specific users only is today via Unix permissions only

gLExec future directions

- **gLExec, LCAS, LCMAPS improvements planned …**
  … especially nice for the '–on-WN' model
  - make the credential acquisition process (LCAS/LCMAPS) work with a *site-central policy engine*
    - actual credential application will have to stay local
  - changeover to standard callouts for both LCAS and LCMAPS
    - interoperation between LCAS/LCMAPS and GUMS servers
  - add site configuration capabilities

Towards end-to-end trust?

Issue:

- **gLExec trusts submitter to match credentials to jobs**
  - like any site-managed ingress point trusts resource brokers today do this correctly
  - also RBs are unknown quantities to the receiving site

- **longer term solution: jobs signed by submitting user**
  - but today …
    … job description is modified by intermediaries (brokers)
  - but signature is on original content …
    … site has to evaluate if job received matches the signed JDL
  - Use an inheritance model for the job description?

Summary

- gLExec part of many ‘modular job submission’ scenarios
  - less code runs as the super-user
  - based on the implicit mapping needed for most submissions
- gLExec-on-WN gives VO tools to comply with site policies
  - Realize that today some VOs are doing ‘pilot’ jobs today
  - some sites may even just don’t care yet, whilst others have hard requirements on auditability and regulatory compliance
  - but you, as a site, will miss that warm and fuzzy feeling of trust
- gLExec-on-WN is always replaceable
  there are 4 deployment models to choose from
- but gLExec-on-WN is for just one of the scenarios
  - it is still needed for the Site-CE scenarios