JISC DEVELOPMENT PROGRAMMES

FINAL REPORT

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Acknowledgements

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The author would also like to thank Dr Richard Sinnott from the University of Glasgow, for volunteering to validate the implementation of the GRID Authorisation Interface in the BRIDGES project. Without this real life application environment to test the implementation, it would not have been possible to realistically determine if the GRID Authorisation Interface and PERMIS could provide the sort of additional useful authorisation functionality that Grid applications need.

The author would like to thank Chenghao Sun, MSc student at the University of Salford, who chose to study for his dissertation topic "The Usage of a New Role Based Privilege Management Infrastructure – PERMIS – in the BRIDGES Project". This provided useful research results about the overall effectiveness of using an authorisation infrastructure such as PERMIS in a large scale scientific project such as BRIDGES. These results will be useful in guiding future work.

Finally, the author would like to thank JISC for funding this project. Without their support, this project could never have been undertaken in the first place.

Executive Summary

The objectives of this project were threefold.

- Firstly to work with security experts in the Global Grid Forum (GGF) to specify a standard Open Grid Services Architecture (OGSA) authorisation interface, based on the use of the Security Assertion Markup Language (SAML), as a format for requesting and expressing authorization assertions for Grid applications.
- Secondly to implement the specified SAML interface in the PERMIS authorisation system and the Globus Toolkit, and
- Thirdly to validate the implementation in a current Grid project, namely the BRIDGES project at Glasgow University.

Overall, the project has been extremely successful and has achieved more than its stated objectives.

Clearly this project could not have been successful without the active collaboration of the Globus team at Argonne National Laboratory. They gave their verbal assurances, prior to the start of this project, that they would collaborate with us, and implement the final interface in Globus Toolkit. Full credit should be given to them for keeping to this verbal agreement, particularly given the turbulent times that followed the announcement of the migration of Globus Toolkit to web services and WSRF in January 2004. At one point it looked like the implementation in Globus Toolkit might not be produced, which would have severely jeopardised this project, but in the end it was produced just one month later than promised.

Development of the GGF draft specification took much longer than originally anticipated. This is often the case with standard's development, since drafts have to be published for public scrutiny, and issues may arise that were not initially envisaged (in this case a revision of the SAML specification from V1.0 to V1.1). The version of the GGF draft that was implemented in PERMIS and GT3.3 was only finally published by the GGF in June 2004, several months after the implementations had been completed. It is anticipated that the final GGF specification will be published as a GGF standard sometime in 2005. Further, two new features, "action parameters" and "obligations" have been requested to be added to the interface. These features were not part of the original project specification and a new version of the authorisation interface will need to be produced within the GGF to take account of them.

Validation of the implementation in the BRIDGES project could not be quite completed before the close of this project, due to a delay in GT3.3 delivery and other factors. Nevertheless early results show that the addition of an interface to an external authorisation infrastructure such as PERMIS can provide much needed features to Grid applications such as BRIDGES. Studying how users and implementers actually used PERMIS and GT3.3 in BRIDGES also proved to be extremely useful in highlighting problems and issues that will need to be addressed in the future. These include: the need to dynamically change access control policies, the need to better educate users, and the need to standardise common roles for use by all VOs so that roles assigned by one member can be used to control access to the resources of another member.

In conclusion, this project has been extremely successful. It has specified an open standard authorisation interface that can be used by any Grid implementation and it has introduced significant extra functionality into Globus Toolkit v3.3 by coupling it to PERMIS via this interface. Finally, the project has revealed additional research and development work that will need to be undertaken in the future, including: specifying obligations, action parameters, and an interface for dynamically changing policies.

Background

The project arose from discussions and presentations at the Globus World Security Workshop in San Diego, 17 January, 2003. Globus Toolkit (GT) already supported a standard authentication infrastructure based on X.509 public key certificates, but did not have a standard authorisation infrastructure. In fact, the authorisation support provided by GT was very simple, based solely on name mappings in a Gridmap file. Several speakers had been invited to give presentations about their authorisation mechanisms. Mary Thompson from the Ernest Orlando Lawrence Berkeley National Laboratory gave a talk about Akenti [6]. The author gave a presentation about the PERMIS authorisation infrastructure [7] developed at the University of Salford under the EC PERMIS project. PERMIS provides strong role based access controls via standard X.509 attribute certificates.

After the presentations, Von Welch, the leader of security developments within Globus, suggested that an authorisation API design team be formed. He and colleagues had already produced an early GGF draft for a standard authorisation interface based on SAML v1.0 [1], and they needed to progress this within the GGF. The author agreed to join this team so that some European input could be added to, what was at that time, a purely US effort. It was also envisaged that the interface could be piloted and validated by a standards' based authorisation infrastructure such as PERMIS.

On return to the UK, the author put a proposal to JISC for funding to help to develop the authorisation interface, and then to implement the interface in PERMIS [8]. JISC agreed to fund the proposal in two phases. Phase 1 was to produce the draft GGF specification, and Phase 2 would be to implement this in PERMIS, subject to satisfactory delivery of Phase 1.

Aims and Objectives

The objectives of this project were initially twofold.
- Phase 1. To work with security experts in the Global Grid Forum (GGF) to specify a standard Open Grid Services Architecture (OGSA) authorisation interface, based on the use of the Security Assertion Markup Language (SAML) [1], as a format for requesting and expressing authorization assertions for Grid applications.
- Phase 2. To validate and test the interface by implementing it in the PERMIS authorisation infrastructure.

JISC agreed to fund the above in two Phases. After Phase 1 was successfully completed, a new objective was informally added to Phase 2, this being:
- To validate the GT/PERMIS implementation in a current Grid project, namely the BRIDGES project at the University of Glasgow [9].

This last objective was an informal one, as no additional resources were provided to either Glasgow or Salford to perform the validation, and no contracts were exchanged. Nevertheless both parties fully intended to use their best efforts to perform the validation testing.

Methodology

The methodology used for Phase 1 was the typical methodology used by standards' bodies, namely: update the existing (GGF) draft specification, submit it to review by the (GGF) working group, resolve any issues raised by the WG members, produce a revised version of the draft and continue in this vein until no additional issues are raised by the WG or consensus is reached, or time runs out. Note that this process is potentially unbounded, although most standards' bodies usually have a timeline to work to.

The methodology used for Phase 2 was the standard waterfall systems development model. The final validation step was undertaken by the University of Glasgow, with Salford acting in an advisory and consultancy capacity. This entailed providing email and telephone support to Glasgow, and visiting Glasgow during September 2004 to help them overcome some of their difficulties.

Implementation

Phase 1 was planned so that each new versions of the GGF draft was available for download and comment by the GGF members prior to each GGF meeting. The author then attended the GGF meeting to present the latest version of the draft and to answer any questions and issues raised. In practice most of the editorial work was done by the author and by Von Welch. The work progressed according to the methodology. However, more cycles were performed than originally anticipated, and in fact, the cycle still has not quite finished. One of the reasons for the increase in cycles, was due to SAML v1.1 being published in September 2003 [2], which necessitated a significant change to the interface specification. Then during summer 2004 two things happened. Firstly validation testing by the University of Glasgow requested that an additional feature "action parameters" be added to the specification, and another GGF member requested that "obligations" be added to the interface specification. Although neither was within the scope of the current project, nevertheless they both provide useful features to be added to the interface specification. These issues were discussed at the GGF meeting in Brussels in September 2004, and it was agreed to freeze Version 1 of the interface in its current form with the existing features so that it can progress to GGF standard status, and to incorporate all new features in Version 2 that can be progressed separately.

Phase 2 was planned so that the implementation of the interface in PERMIS and GT3 would coincide as nearly as possible. The target date for completion was the beginning of April 2004. The implementation by Salford went according to plan. However, the planned implementation by the Globus team suffered a severe setback when it was announced in January 2004 that GT would move to web services and WSRF. Initially it looked like the planned implementation of the authorisation interface may be postponed indefinitely. However, after two months things stabilised somewhat at Argonne, and the importance of the authorisation interface work was recognised by the Globus management. The interface was duly implemented just one month after its original target date and was made available May 2004.

Concerning the implementation at Salford, adding SAML to PERMIS using OpenSAML was not too complex. However, the complexity of implementing PERMIS as a Globus web service was underestimated, due to the volume of web services and Globus documentation that needed to be understood prior to implementation. Furthermore, the time difference between the geographical locations of Salford and Chicago caused significant delays in responses to our support requests. Fortunately the developer, Dr Sassa Otenko, was outstanding, and he managed to finish the implementation on time.

Validation of the GT3.3/PERMIS implementation by the University of Glasgow had to start late due to the late delivery of GT3.3 by the Globus team. It was also further delayed due to the summer vacations and the honeymoon of the main Salford developer (Dr Otenko). Furthermore, the Globus team did not publish GT3.3 on their normal download page under latest releases, but rather on a (partially hidden) research/experimental page. Consequently the implementer at Glasgow downloaded the latest published GT release (which actually did not have the authorisation interface in it) and then wasted considerable time trying to get this to interwork with PERMIS, which of course it was unable to do. It was only after Salford staff visited Glasgow in September 2004 that this problem was recognised and that proper interworking tests could start. Consequently they were not finished by the time this report was written. Nevertheless some valuable results were still obtained in time for this report. It is also worth noting that the University of Glasgow are exploring this Grid API within the JISC funded DyVOSE project [11].

Finally, an additional piece of research was carried out by Chenghao Sun from the MSc in Managing IT degree at the University of Salford. The aim was determine how usable the combined GT3.3/PERMIS implementation is within the BRIDGES project and to present his finding in his MSc dissertation [4]. This necessitated him producing questionnaires for BRIDGES users and implementers (see Appendices 1 and 2), then interviewing them and analysing the results.

Outputs and Results

The first significant output of the project is the publication of the GGF authorisation interface [3]. This interface is likely to become widely accepted in the Grid community, as different researchers start to

implement it. We are already aware of 4 groups of researchers who are at various stages of implementation. It is anticipated that this will become a final Grid specification in 2005.

The second significant output is the implementation of the interface in Globus Toolkit v3.3 and in the PERMIS authorisation infrastructure, providing Globus with its first plug and play comprehensive authorisation system. Both the GT3.3 and PERMIS implementations have been distributed worldwide via the US NMI release.

The third output is the presentation of a paper describing the SAML implementation in GT3.3/PERMIS at the IFIP CMS2004 conference in Windermere, September 2004 [10].

The fourth (indirect) output of this project will be a report from the BRIDGES project describing their experiences of using the combined GT3.3/PERMIS implementation. This was described in outline in [12] however a more detailed exploration of this interface usage is to be documented in the upcoming BRIDGES project deliverables.

The fifth (indirect) output of this project is a prototype standalone SAML enabled PERMIS Authorization Decision Engine, which allows the use of PERMIS Authorization separately from GT3.3. It receives SAML Authorisation Decision Queries and responds with SAML Authorisation Decision Statements, as defined by the GGF standard. The standalone PERMIS Authorisation Decision Engine could be used in one of the Shibboleth-PERMIS integration scenarios, whereby a number of protected Apache Web-servers could contact a central PERMIS Authorisation Decision Engine for access control decisions.

The sixth (indirect) output of this project will be the MSc dissertation [4] which provides an objective view of how a role based access control system such as PERMIS can be used by users and implementers in the BRIDGES project. This dissertation has already highlighted areas where future work will be needed in this space, regardless of which technology is actually used. This includes: education of end users to understand what security mechanisms are available to them and how they can best be used by them to protect their data; standardisation of a set of common attributes and values that can be used universally by VO members, regardless of the VO they are in; and an ability to quickly and easily dynamically change access control policies as VO roles and shared data sources change within the scientific experiments. One other finding was the mismatch between user expectations and technology capabilities. One (Some??) user thought that individual database columns should have separate policies protecting them, but given that a project like BRIDGES has potentially millions of database columns, this could not be enacted using the current PERMIS infrastructure.

Outcomes

In some ways the project has exceeded the original objectives set for it, and in other ways it has fallen somewhat short. Taking the latter first, it was originally anticipated that the GGF authorisation interface specification would have been finished and published as a GGF standard by the end of this project. This has not happened due to several reasons. Firstly the wheels of the GGF standards making process ground more slowly than originally anticipated, secondly, the underlying OASIS standard on which the work was based changed versions midway through, and thirdly, interest in the work (which is a good thing) meant that additional features outside the scope of the original project, were requested by some GGF participants. The net result of this is that version 1 of the interface specification will only finish progressing through the GGF during 2005, and that a second version now needs to be developed to take account of the new requirements. This in itself is not a bad thing, if it means that more people will want to implement the specification because it contains features that they require.

There was a slight shortfall in the informal objective to validate the authorisation interface in the BRIDGES project. This was caused by the delay in producing GT3.3, which caused a delay in the BRIDGES project being able to complete its integration validation testing before the end of this project. However we expect that this shortfall will eventually be rectified when BRIDGES produces its final report.

The ways in which this project has exceeded its original objectives are as follows:

- Firstly the PERMIS implementation can now be called by GT3.3 as either an internal authorisation decision handler or as a standard Grid service via SAML. Only the latter was originally proposed.
- Secondly, the PERMIS implementation can now run as a standard SAML Authorisation Decision Engine as well as a standard Grid service. Only the latter was originally proposed.
- Finally, additional research was carried out by Chenghao Sun, MSc student, into the usability of an integrated GT/PERMIS system. This has given valuable insights into the sorts of problems and issues that still need to be addressed when providing a sophisticated access control interface to a complex Grid application such as BRIDGES, regardless of the technology actually being used.

Conclusions

In conclusion, the project has been very valuable. It has allowed a standard authorisation interface for Grids to be specified and standardised within the GGF, which will allow Grid applications to seamlessly mix and match authorisation infrastructures with Grid co-ordinating software such as Globus Toolkit. It has shown that the interface works and can provide a basic authorisation service to Grid applications. Finally, it has shown were further work is needed in the future, both in educating users and in making policy based authorisation software more scalable and dynamically changeable.

Implications

The multimillion-euro EGEE project intends to implement the authorisation interface developed by this project in their Grid infrastructure. Once it has this interface, the EGEE project should seriously consider using the PERMIS authorisation infrastructure instead of or as well as VOMS. PERMIS already provides many more sophisticated features than VOMS including comprehensive policy driven decision making, support for push and pull modes, and static delegation of authority. It will shortly provide even more features such as static and dynamic separation of duties and dynamic delegation of authority. Since the UK is investing heavily in PERMIS development, it ought to capitalise on this investment in the EGEE project for the benefit of its European partners.

Additional features have been requested to be added to the current interface specification. "Action parameters", requested by the University of Glasgow, and "obligations", requested by the US Primea developers, are two such features. This means that further work will be needed to enhance version 1 of the interface specification (the author has already produced a straw man revised version containing obligations which was presented to the GGF meeting in Brussels, September 2004).

The PERMIS implementation currently supports the passing of action parameters, but neither the SAML interface nor Globus Toolkit support this. Work will be needed to add this once the GGF specification has been agreed upon.

The PERMIS implementation currently does not support obligations. Work will be needed to add this feature to PERMIS and to the SAML interface once it is standardised within the GGF. Note however that the most difficult work in supporting obligations is not within the authorisation infrastructure or the SAML interface, but rather is within the obligation enforcement function that will need to enact the obligations that are passed to it.

SAMLv2.0 is expected to be released shortly. At the time of writing it is at Committee Draft stage. The implication here is that maintenance work will be needed on version 1 of the interface specification to allow it to migrate to SAMLv2.0.

The BRIDGES project found that new access control policies need to be dynamically created and invoked as new roles and new data sources are added to the scientific experiments. There has been informal discussion within the GGF for a new management interface specification to be developed that will allow commands to be sent to a Policy Decision Point (such as in PERMIS) telling it to change its policy. It would be useful to define such a protocol in the GGF and to implement it in PERMIS.

An unanticipated spin off from this project is a standard SAML supporting stand alone PERMIS authorisation decision engine (as opposed to a Grid service one). Such a stand alone engine can be

used by other SAML supporting mechanisms such as Shibboleth and Liberty Alliance. This may be of value to the academic community, say, by providing a centralised authorisation service.
Note that this interface is different to the deliverables of the JISC SIPS project, which is providing an integrated Shibboleth-PERMIS implementation rather than a stand alone one.

Recommendations

The author recommends that other Grid projects that need a flexible role based access control scheme should consider using the combined GT3.3/PERMIS implementation.

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Appendix 1. Questionnaire for BRIDGES Scientists

Place: *Time:*

Name of Interviewee: *Position in the BRIDGES project:*

Hello, my name is Chenghao Sun, and I am currently an MSc student at the University of Salford. I am doing some research on the security requirement of the BRIDGES project and wondered if you could spare around 20 minutes to complete this questionnaire.

Q1. What data are you sharing via the Bridges system? Could you generally describe the significance of the data?

Q2. a) Do you want to share your data in the BRIDGES system with others?
       ?Yes, some of my data   ?Yes, all of my data   ?No
   b) If yes, who is sharing your data with you?
   c) Who is allowed to modify, delete or add to the data?

Q3. How do you classify the security level of your data? (For example, public data that can be shared by all users in the system, semi-public data that can be accessed by some partners, etc)

Q4. a) Do you think that scientists using BRIDGES system should be divided into groups (e.g. based on their roles or departments) that have different rights to access the data in the system?
    ?Yes   ?No   ?I don't know
   b) If so, how many roles/groups are needed to be classified to access your data? What are they?
   c) If not, how do you decide who can access the data (e.g. is it by named individuals). (If this is the case then go next to Q12)

Q5. What permission should be set for each role/group? (e.g. read, update, add or delete some data)

Q6.Are there any hierarchical relationships between these roles/groups? (Such as manager and normal staff, the manager should have all the rights of normal staff) If YES, please write comment.

Q7. Are there mutual exclusion relationships (such as purchasing manager and accounts payable manager, the same person not permitted to belong to both roles) between the roles/groups? If YES, what are they?

Q8. Do you think the system will grow large in the future for example lots of new users or some other research sites will get involved?   ?Yes ?No ?I don't know

Q9. In your opinion, how fine-grained should be the permission of access granted to users?
?Access to a whole DB server   ? Access to DB tables
? Access to individual DB fields or rows   ?Access to DB columns
? other measures to divide information targets

Q10.Before the introduction of the BRIDGES system did extend scientists get access to your data?

If so was this based on their roles?   ?Yes (*Go to Q11*) ?No (*Go to Q12*) ?I don't know

Q11. Do you think it is easy to assign the roles and their permissions?
?Yes ?No why
?I don't know

Q12. Do you know what access policy was used by your site before PERMIS was used? If YES, please describe it.

THANK YOU FOR YOUR ASSISTANCE!

Appendix 2. Questionnaire for BRIDGES Implementers

Place: *Time:*

Name of Interviewee: *Position in the BRIDGES project:*

Hello, my name is Chenghao Sun, and I am currently an MSc student at the University of Salford. I am doing some research on the usability of the PERMIS system in the BRIDGES project and wondered if you could spare around 20 minutes to answer a few questions.

1. Generally, how good do you think the PERMIS system is as an authorization infrastructure for the BRIDGES project?
   ?Very good ? Good ?Acceptable ? Inappropriate

2. Please briefly describe the configuration that you have adopted (LDAP, GGF Authz, SAML interface?, Java API? Etc.)

3. How did you find the PERMIS cookbooks and documentation?

4. Could you please suggest any improvements that should be made to the cookbooks and documentation?

5. What was your role in the application of the PERMIS infrastructure?

6. Would you like to list the tasks that you have undertaken so far during the application of the PERMIS infrastructure?

7. Would you like to list the tasks that you still have to undertake during the application of the PERMIS infrastructure

8. From your experience, do you think the integration project with the PERMIS system is time consuming?
   ?   Yes, I waste lots of time   ? Yes, but just a little bit more than I imaged
   ?   No, It is ok   ? No, it is quite easy and convenient

9. How much time have you spent on the PERMIS aspect of your project so far (in hours)? Do you think it is time consuming?

10. How much time do you think it will take in total (in hours)

11. If you used the Policy Management Graphical User Interface for constructing PERMIS policies please answer the following questions:

    i. How much do you like the tool (on a scale from 1 (very poor) to 10 (very good)
    ii. Was it quick and easy to learn to use (on a scale from 1 (very slow/difficult) to 10 (very good/fast/easy)
    iii. Did it allow you to produce the policy you needed ?Yes   ?No
    iv. What did you not like about the tool
    v. What did you like about the tool
    vi. Do you have any suggestions for improvements

12. To what extent do you need to change the local authorization policy during the integration?
    ?totally ?a large part ?a small part ? none
    If there is any changes, could you describe them

13. What tool did you use to create X.509 Attribute Certificates for the users.

14. How did you like it (on a scale from 1 (very poor) to 10 (very good))?

15. Have you any suggestions for improvements?

16. How do you think the PERMIS system will fit your scalability requirements?
    ?Very good ? Good ?Acceptable ? Bad

17. What problems were identified during application of the PERMIS infrastructure?

18. Could you fix the problems by yourself easily?
    ?Yes, mostly it is   ?Yes, but in several times it is quite hard   ? No

19. Was it easy to get support to fix the difficult problems?
?Yes, it is easy to contact with the PERMIS project team and the documents are sufficient   ?No, it is easy to contact with the PERMIS project team but the documents are not enough
?No, it is hard to contact with the PERMIS project team.

20. Was there any functionality missing that you expected?

21. Do you know what is the deadline of the BRIDGES project?
    ?Yes MM___DD___ YY
    ?No

THANK YOU FOR YOUR ASSISTANCE!