

# Design and Applications of an Interoperability Reference Model for Production e-Science Infrastructures

22.12.2010 Morris Riedel - Jülich Supercomputing Centre

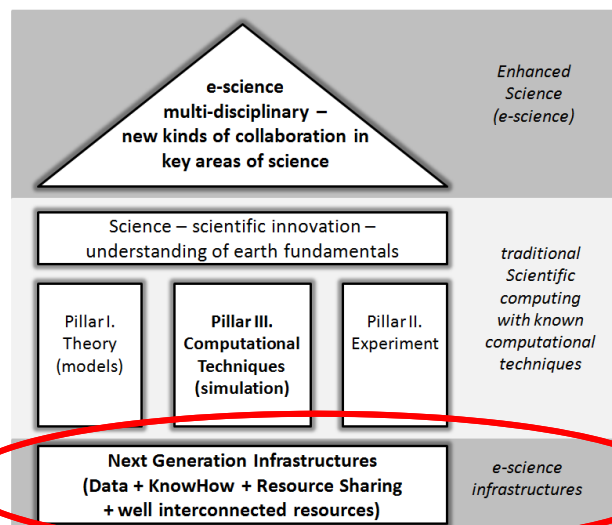
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# Outline

- e-Science Infrastructures
- Problem Space & Motivation
- Related Work & Transformation Logic Criteria
- Related Work & Reference Model Metrics
- Contributions in a nutshell
- Infrastructure Interoperability Reference Model
- Academic & Practical Field Studies
- Summary & Conclusions
- Selected Publications



# e-Science Infrastructures



**[1] Riedel et al., Research Advances by using Interoperable e-Science Infrastructures, 2009**

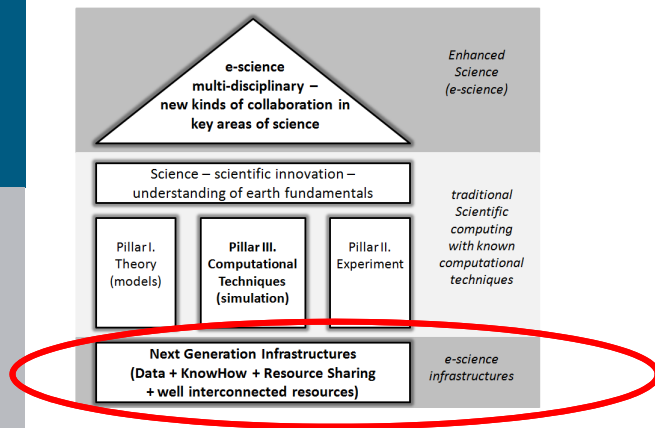


Name	Country/Continent/Region
APAC	Australia
D-Grid	Germany
DEISA	Europe
EGEE	Europe
NAREGI	Japan
NDGF	Nordic Region
NGS	United Kingdom
OSG	USA
PRAGMA	Pacific Region
TeraGrid	USA

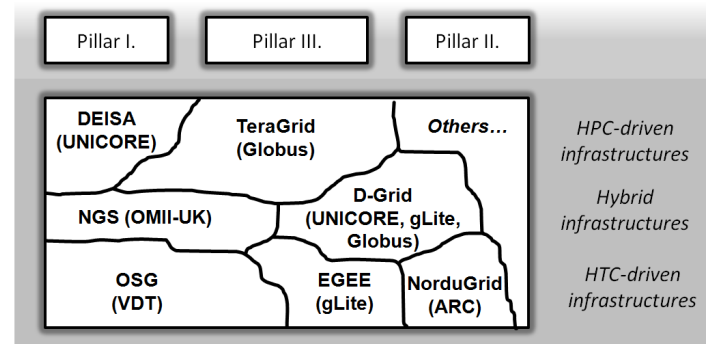
**[8] Riedel and E. Laure et al., Interoperation of World-Wide Production e-Science Infrastructures, 2009**

-	gLite	Globus Toolkit	UNICORE	ARC	NAREGI	NGS
Security	X.509 VOMS SAML XACML	X.509 VOMS SAML XACML	X.509 VOMS SAML XACML	X.509 VOMS SAML XACML	X.509 VOMS SAML XACML	X.509 VOMS
Information Systems	GLUE XML	GLUE XML	GLUE2 XML	GLUE2 XML	CIM SQL	GLUE XML
Accounting	RUS/UR		RUS/UR	RUS/UR	RUS/UR	RUS/UR
Job Management	BES JSDL DRMAA	BES JSDL DRMAA	BES JSDL DRMAA	BES JSDL DRMAA	JSDL	BES JSDL
Data Management	GridFTP SRM2.2	GridFTP DAIS	ByteIO	GridFTP SRM2.2	GridFTP GFS	GridFTP DAIS

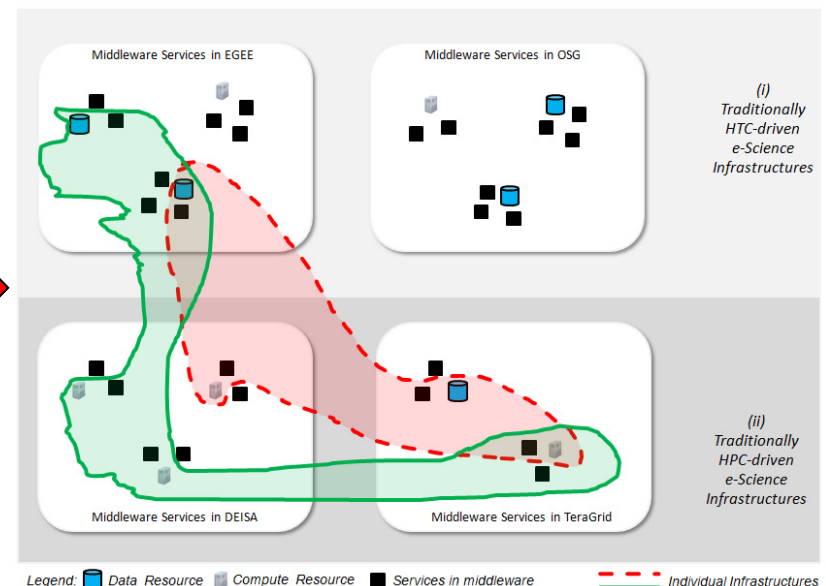
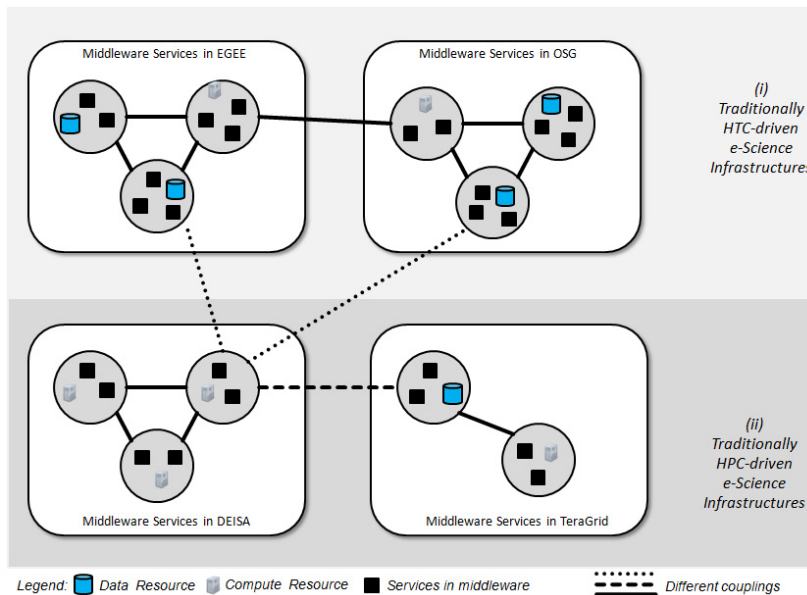
# Problem Space & Motivation



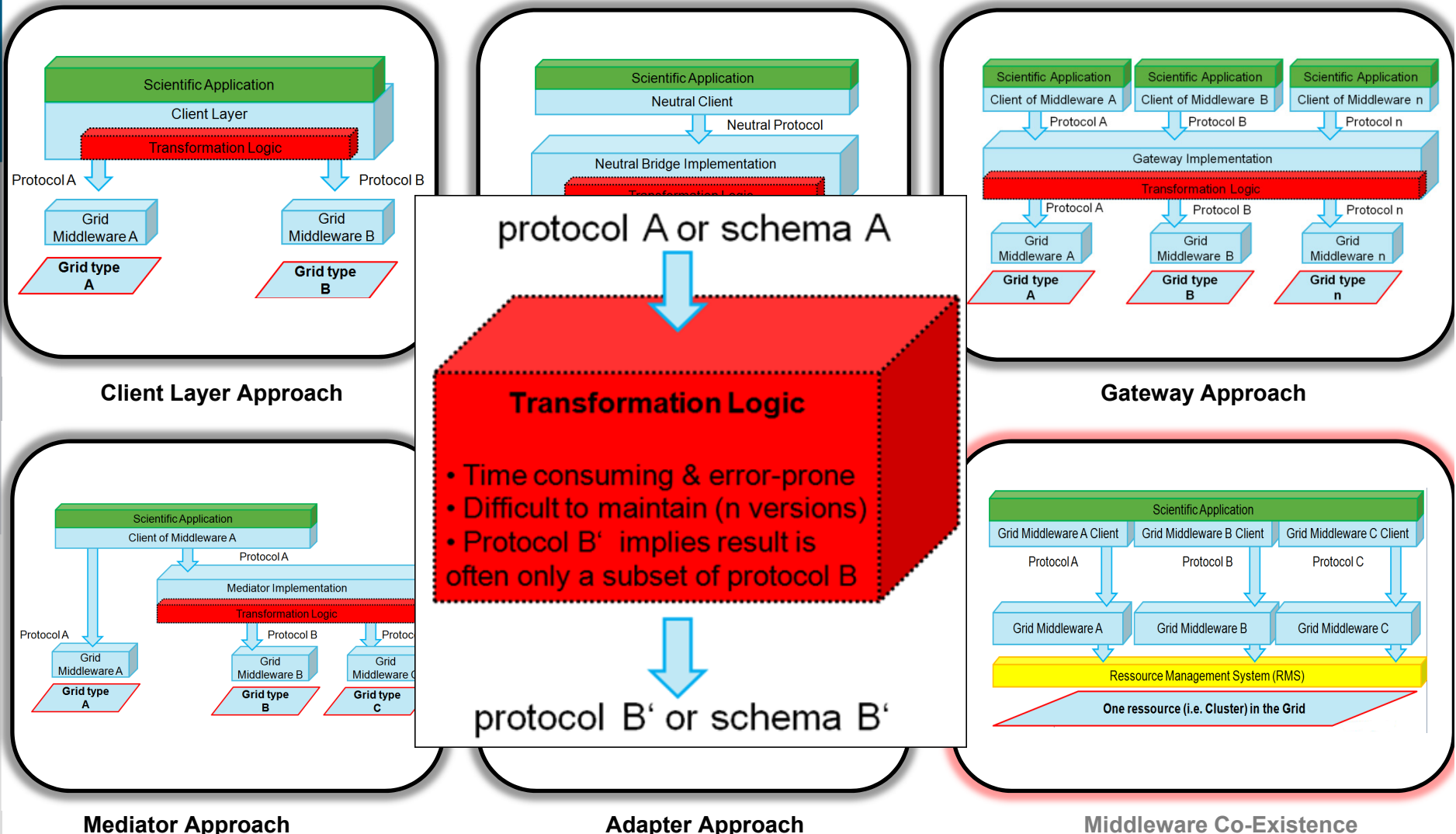
[1] Riedel et al., Research Advances by using Interoperable e-Science Infrastructures, 2009



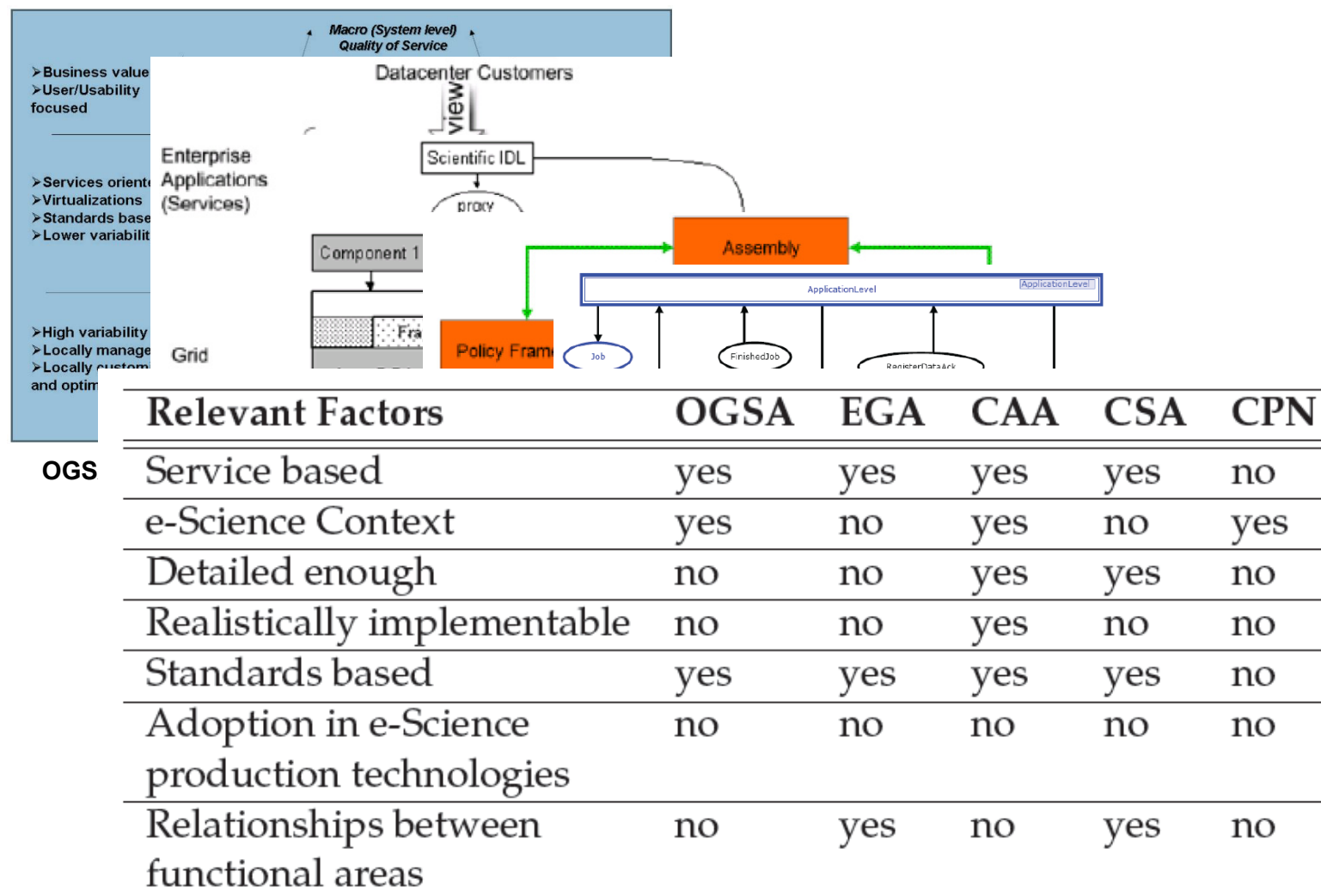
[2] Riedel et al., Towards Individually Formed Computing Infrastructures, 2010



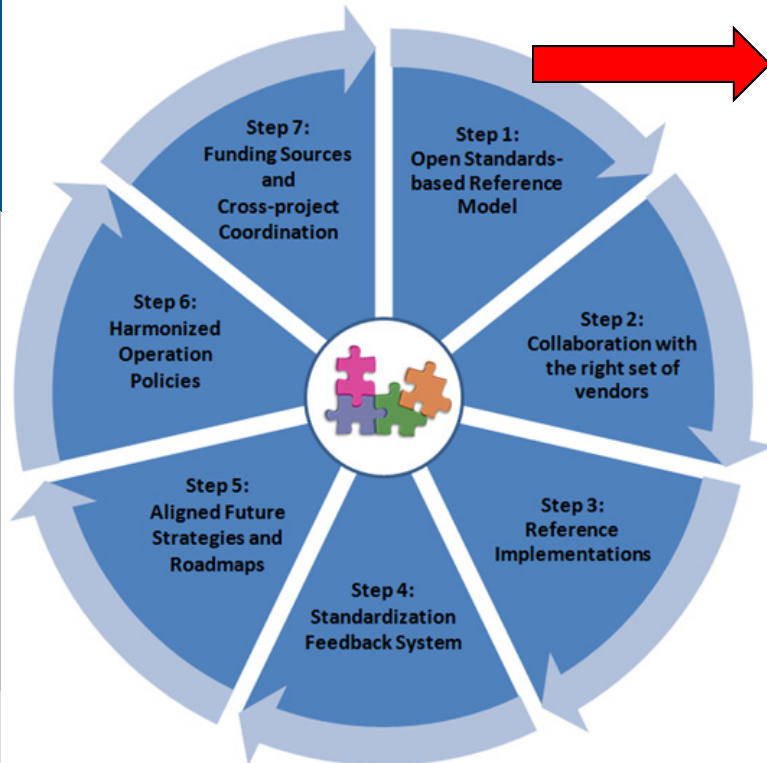
# Related Work & Transformation Logic Criteria



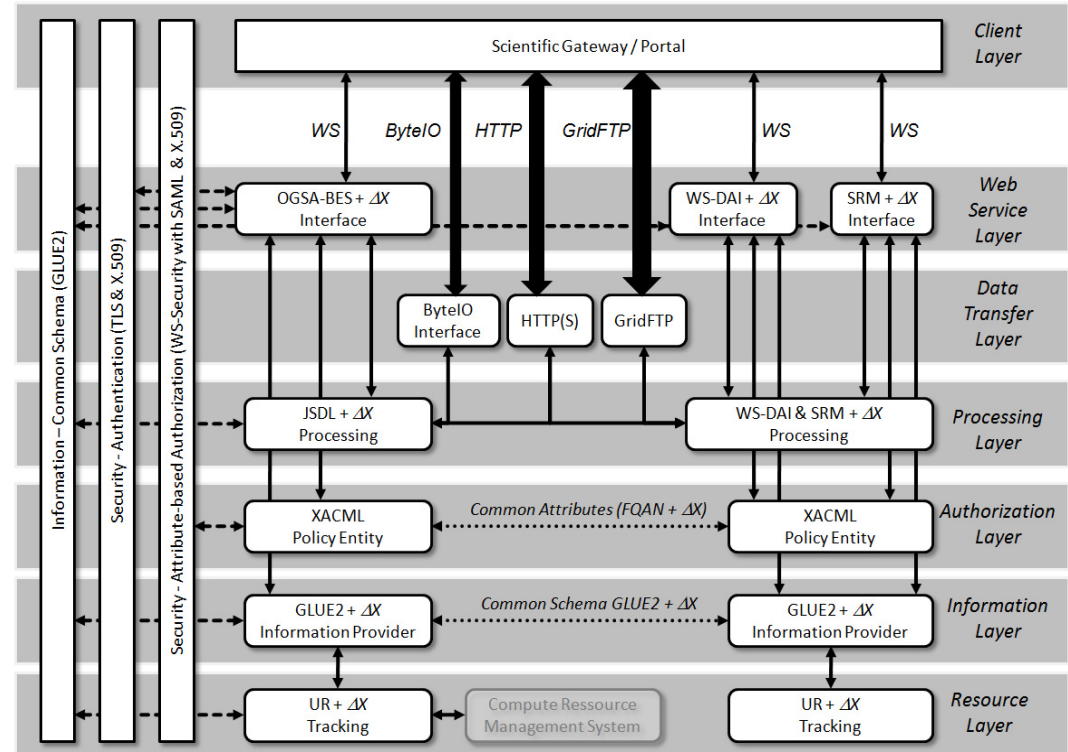
# Related Work & Reference Model Metrics



# Contributions in a nutshell



[3] Riedel, e-Science Infrastructure Interoperability Guide – The seven steps towards interoperability in e-science, 2010

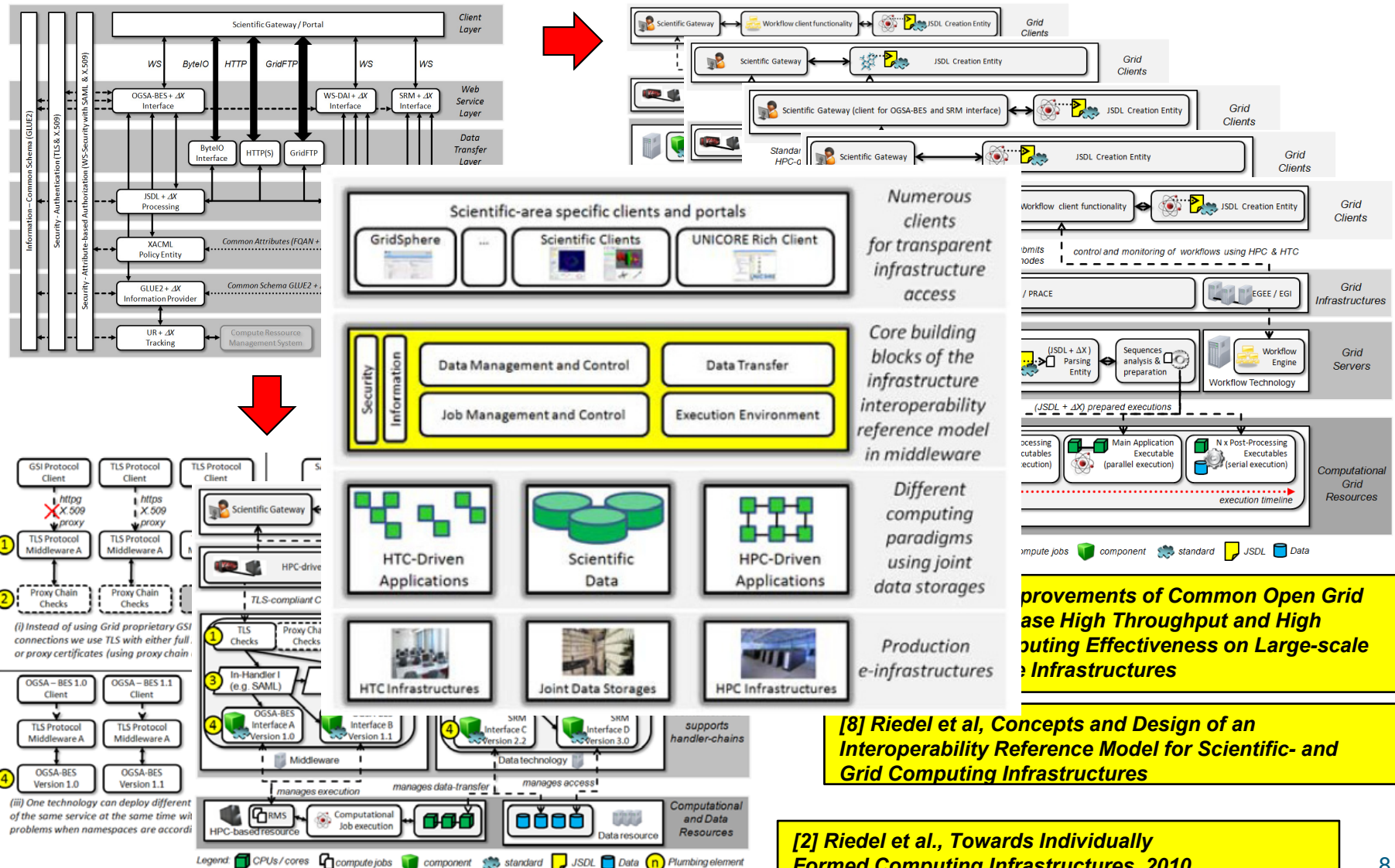


[1] Riedel et al., Research Advances by using Interoperable e-Science Infrastructures, 2009





# Infrastructure Interoperability Reference Model (IIRM)





# Academic & Practical Field Studies

**[3] Riedel, e-Science Infrastructure Interoperability Guide – The seven steps towards interoperability in e-science, 2010**

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Begin
Begin GridInformationProvisioning
Grid Information Providers (GIPs) publish pieces of
information about infrastructures (HPC and HTC resources)
End

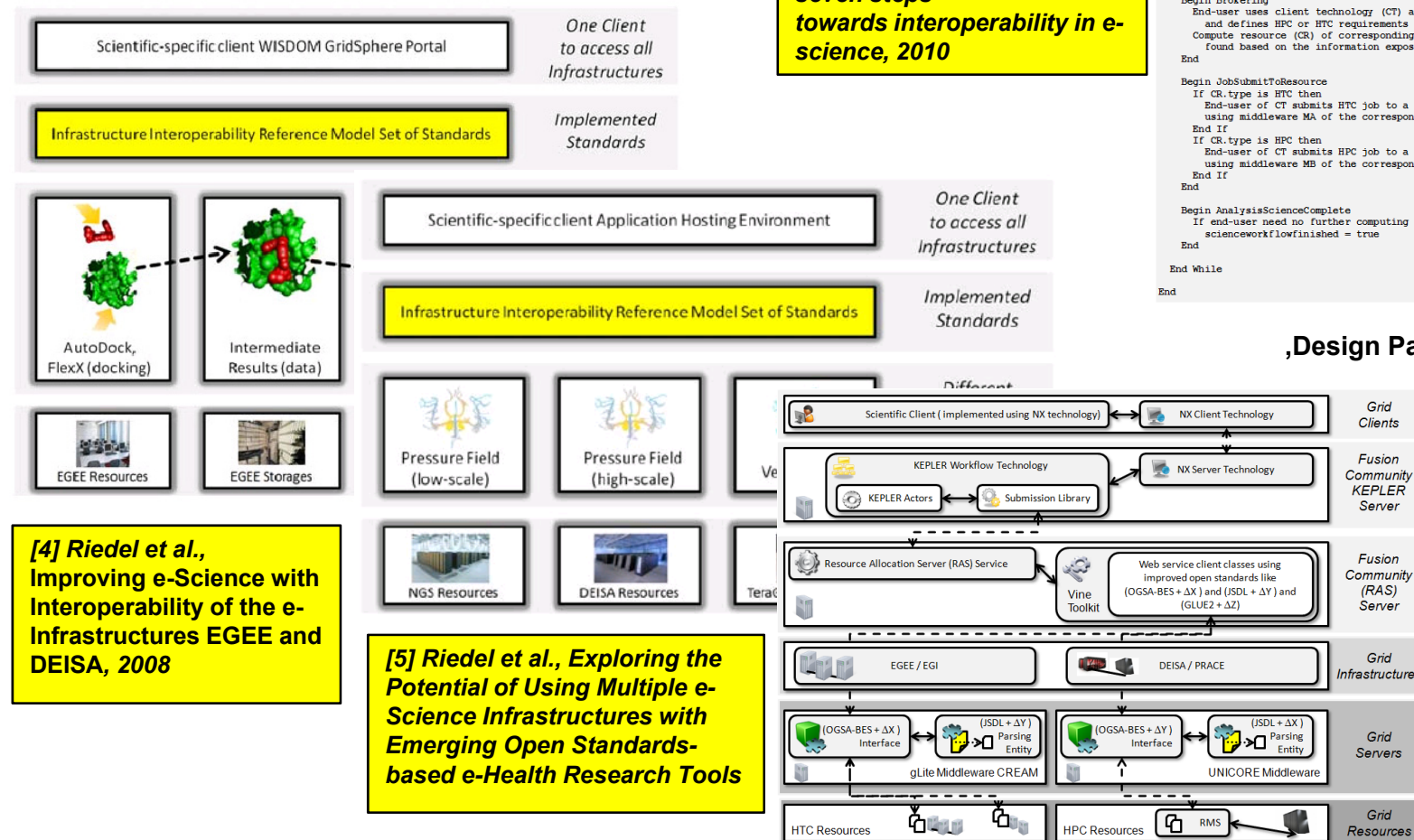
scienceworkflowfinished = false

WHILE (scienceworkflowfinished)
Begin Brokering
End-user uses client technology (CT) and performs application setup
and defines HPC or HTC requirements for next scientific workflow step
Compute resource (CR) of corresponding HPC and HTC infrastructure is
found based on the information exposed by GIPs
End

Begin JobSubmitToResource
If CR.type is HTC then
End-user of CT submits HTC job to a HTC resource
using middleware MA of the corresponding infrastructure IA
End If
If CR.type is HPC then
End-user of CT submits HPC job to a HPC resource
using middleware MB of the corresponding infrastructure IB
End If
End

Begin AnalysisScienceComplete
If end-user need no further computing then
scienceworkflowfinished = true
End
End While
End
    
```

**„Design Pattern“**

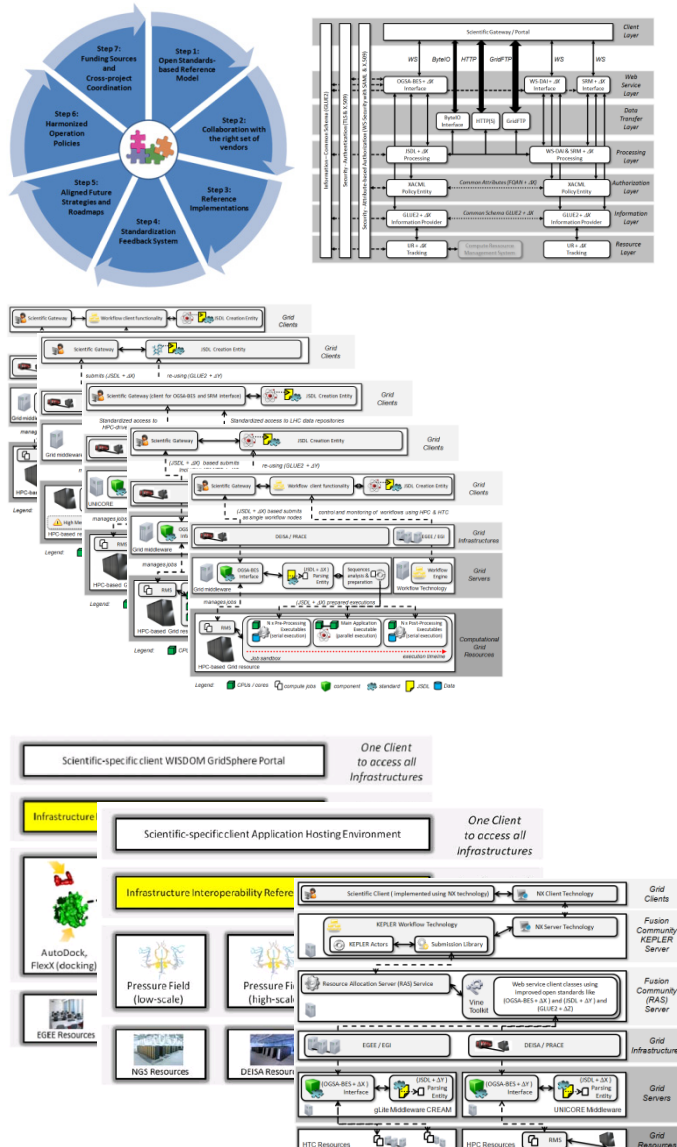


**[4] Riedel et al., Improving e-Science with Interoperability of the e-Infrastructures EGEE and DEISA, 2008**

**[5] Riedel et al., Exploring the Potential of Using Multiple e-Science Infrastructures with Emerging Open Standards-based e-Health Research Tools**

**[6] M.S. Memon & Riedel et al., Lessons learned from jointly using HTC- and HPC-driven e-science infrastructures in Fusion Science**

# Summary & Conclusions



- **Infrastructure Reference Model**
  - Standards-based entities and relationships with 'required refinements'
  - Cp: ISO/OSI → TCP/IP, SGML → XML
  - Bottom line: OGSA → IIRM
  - Applied research and impact on real e-science Infrastructures (EGI/PRACE)
  - Roadmap of EMI developments
  - Numerous standards improvements based on lessons learned & experience
- **Seven steps process towards e-Science Infrastructure Interoperability**
  - Addresses 'operational interoperability' and 'sustained interoperation' issues
- **Accompanying Case Studies**
  - Practical field tests & reference implementations of IIRM concepts

## Selected Publications

- [1] M. Riedel, F. Wolf, D. Kranzlmüller, A. Streit, T. Lippert - *Research Advances by using Interoperable e-Science Infrastructures - The Infrastructure Interoperability Reference Model applied in e-Science*, Journal of Cluster Computing, Special Issue Recent Advances in e-Science, Cluster Computing (2009) Vol. 12, No. 4, pp. 357-372, DOI 10.1007/s10586-009-0102-2, December 2009
- [2] M. Riedel, A. Streit, Th. Lippert, F. Wolf, D. Kranzlmüller - *Towards Individually Formed Computing Infrastructures with High Throughput and High Performance Computing Resources of Large-scale Grid and e-Science Infrastructures*, Proceedings of MIPRO Conference, GVS Workshop, 2010
- [3] M. Riedel, „E-Science Infrastructure Interoperability Guide – The Seven Steps towards Interoperability for e-Science“, book „Guide to e-Science: Next Generation Scientific Research and Discovery“, Editors: X. Yang and L. Wang Springer, to be published in 2010
- [4] M. Riedel et al. “Improving e-Science with Interoperability of the e-Infrastructures EGEE and DEISA”; Proceedings of the 31st International Convention MIPRO, Conference on Grid and Visualization Systems (GVS), May 2008, Opatija, Croatia, Croatian Society for Information and Communication Technology, Electronics and Microelectronics, ISBN 978-953-233-036-6, pages 225 – 231
- [5] M. Riedel, B. Schuller, M. Rambadt, M.S. Memon, A.S. Memon, A. Streit, F. Wolf, Th. Lippert, S.J. Zasada, S. Manos, P.V. Coveney, F. Wolf, D. Kranzlmüller - *Exploring the Potential of Using Multiple e-Science Infrastructures with Emerging Open Standards-based e-Health Research Tools*, Proceedings of the The 10th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (CCGrid 2010), May 17-20, 2010
- [6] M. S. Memon, M. Riedel, A. S. Memon, F. Wolf, A. Streit, Th. Lippert, Marcin Plociennik, Michal Owsiak, David Tskhakaya, Christian Konz, Lessons learned from jointly using HTC- and HPC-driven e-science infrastructures in Fusion Science, proceedings of the IEEE ICIET 2010 Conference, Pakistan
- [7] M. Riedel et al. „Improvements of Common Open Grid Standards to Increase High Throughput and High Performance Computing Effectiveness on Large-scale Grid and e-Science Infrastructures „ Seventh High-Performance Grid Computing (HPGC) Workshop at International Parallel and Distributed Processing Symposium (IPDPS) 2010, April 19-23, 2010, Atlanta, USA
- [8] M. Riedel, A. Streit, Th. Lippert, F. Wolf, D. Kranzlmüller - *Concepts and Design of an Interoperability Reference Model for Scientific- and Grid Computing Infrastructures*, Proceedings of the Applied Computing Conference, in Mathematical Methods and Applied Computing, Volume II, WSEAS Press 2009, ISBN 978-960-474-124-3, Pages 691 - 698
- [9] M. Riedel and E. Laure et al. - *Interoperation of World-Wide Production e-Science Infrastructures*, Concurrency and Computation: Practice and Experience, 21 (2009) 8, 961 - 990