The Optimization Services Project on COIN-OR

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“Optimization Services” (OS)

A framework for providing optimization tools

- XML-based
- Service-oriented
- Distributed
- Decentralized

A project for implementing such a framework

- Straightforward and ubiquitous access
- Powerful solvers

Using a robust service-oriented architecture

- Linking modeling languages,
  solvers, schedulers, data repositories
- Residing on different machines, in different locations,
  using different operating systems.

OS on the Internet

Home site: `www.optimizationservices.org`

- ➢ Overview, standards, publications, presentations, FAQs
- ➢ Contact information, downloads, licenses

Developer site: `www.coin-or.org/projects/OS.xml`

- ➢ Login, register, wiki, source repository, timeline, search

Newsgroup:

`groups.google.com/group/optimizationservices`

COIN mailing list:

`list.coin-or.org/mailman/listinfo/os`

. . . newsgroup and COIN mailing list are automatically cross-posted

OS Licenses, etc.

Written in multiple languages

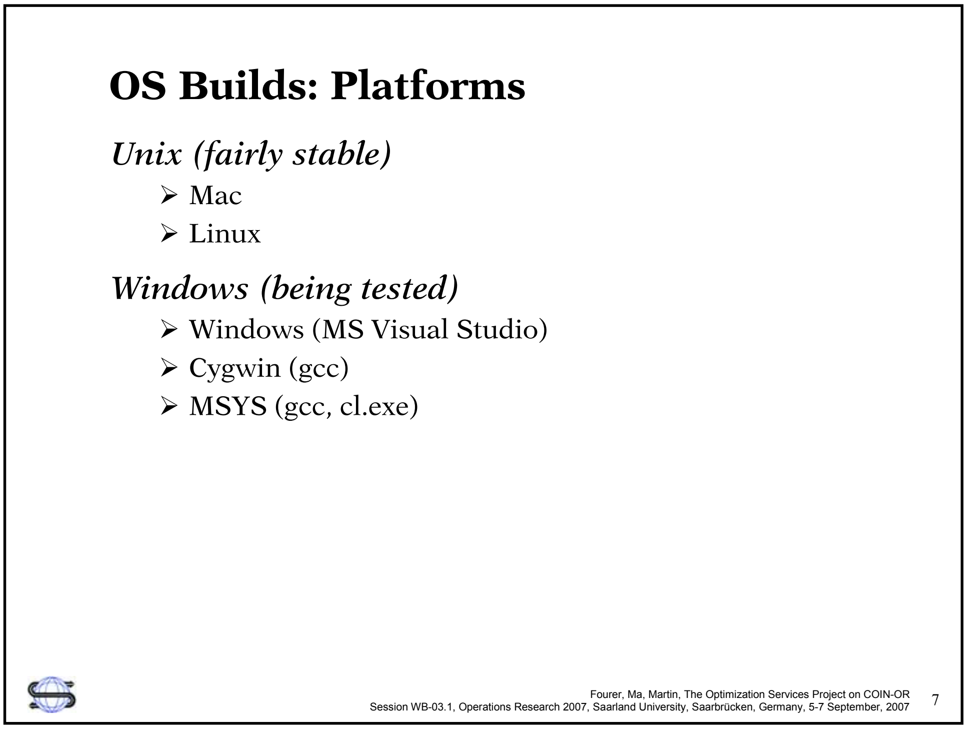
- ➢ C/C++
- ➢ Java
- ➢ .NET

Released as open source code

- ➢ Under the Common Public License (“CPL”)

Available as a COIN-OR project

- ➢ Later this year
- ➢ Once complex build issues have been ironed out . . .



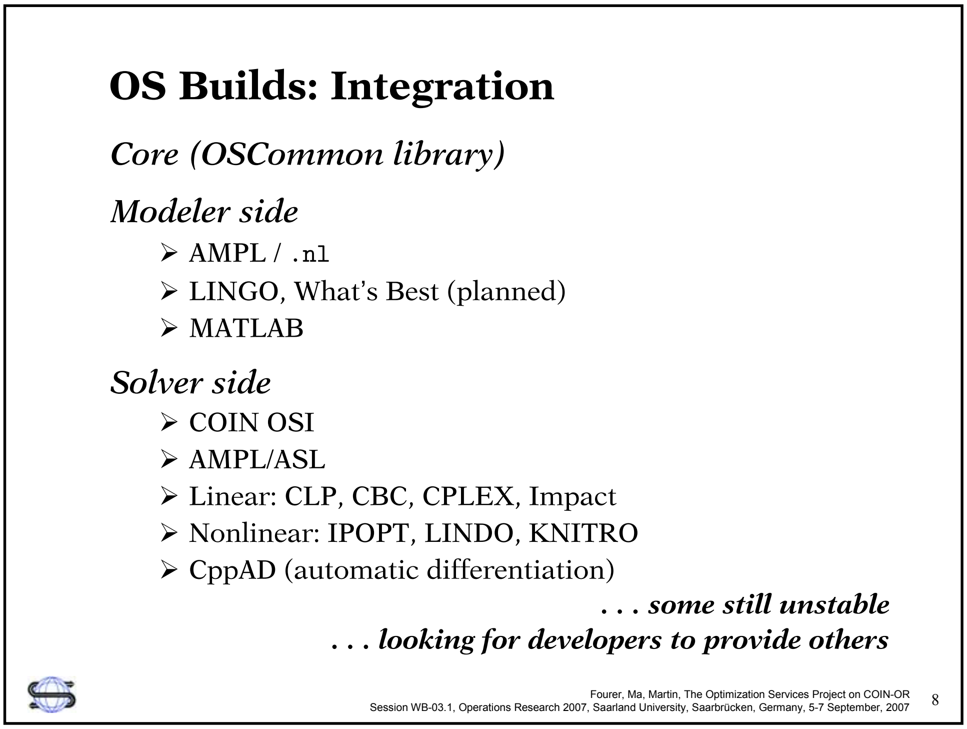
OS Builds: Platforms

Unix (fairly stable)

- Mac
- Linux

Windows (being tested)

- Windows (MS Visual Studio)
- Cygwin (gcc)
- MSYS (gcc, cl.exe)



OS Builds: Integration

Core (OSCommon library)

Modeler side

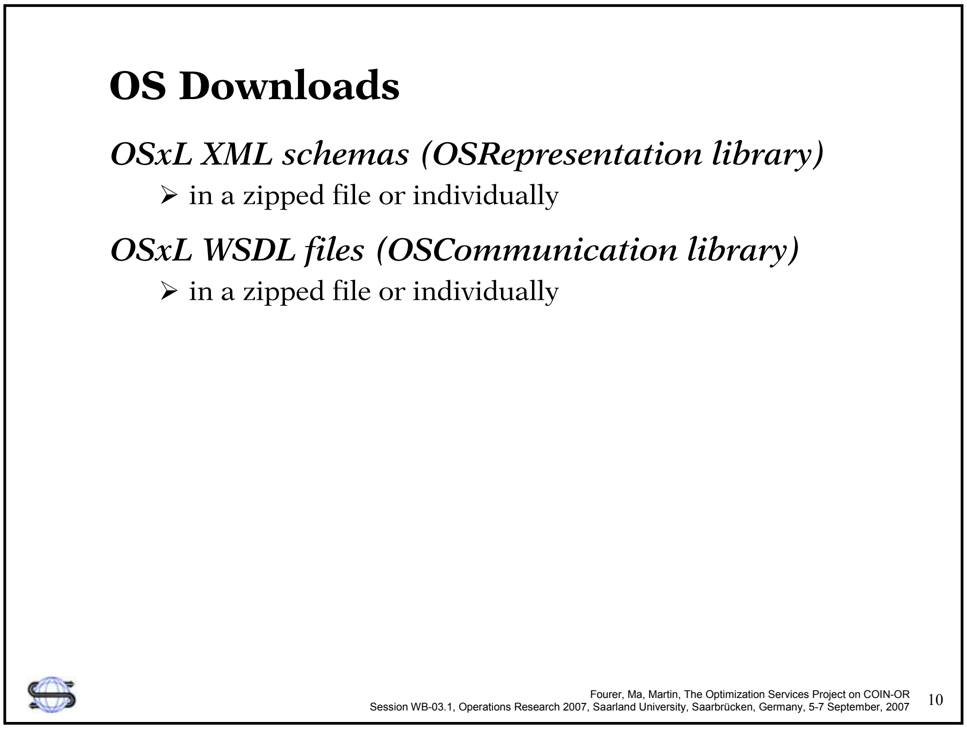
- AMPL / `.nl`
- LINGO, What's Best (planned)
- MATLAB

Solver side

- COIN OSI
- AMPL/ASL
- Linear: CLP, CBC, CPLEX, Impact
- Nonlinear: IPOPT, LINDO, KNITRO
- CppAD (automatic differentiation)

. . . some still unstable

. . . looking for developers to provide others



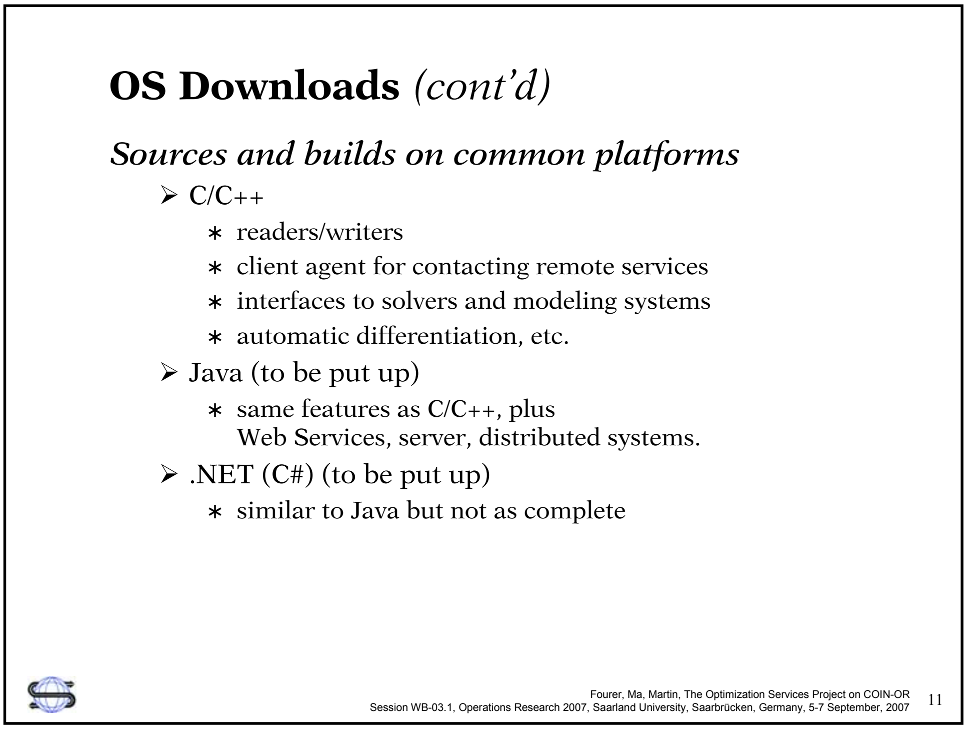
OS Downloads

OSxL XML schemas (OSRepresentation library)

- ➢ in a zipped file or individually

OSxL WSDL files (OSCommunication library)

- ➢ in a zipped file or individually



OS Downloads *(cont'd)*

Sources and builds on common platforms

- ➢ C/C++
  - ∗ readers/writers
  - ∗ client agent for contacting remote services
  - ∗ interfaces to solvers and modeling systems
  - ∗ automatic differentiation, etc.
- ➢ Java (to be put up)
  - ∗ same features as C/C++, plus
    Web Services, server, distributed systems.
- ➢ .NET (C#) (to be put up)
  - ∗ similar to Java but not as complete

OS Repository

Linear (netlib basic, infeasible, Kennington)

- ➢ Individual XML (**OSiL** format) files available now
- ➢ Zip files to come

Mixed integer (mainly from miplib 2003)

Nonlinear

- ➢ CUTE now, more to come

Stochastic

- ➢ Thanks to Gus Gassmann

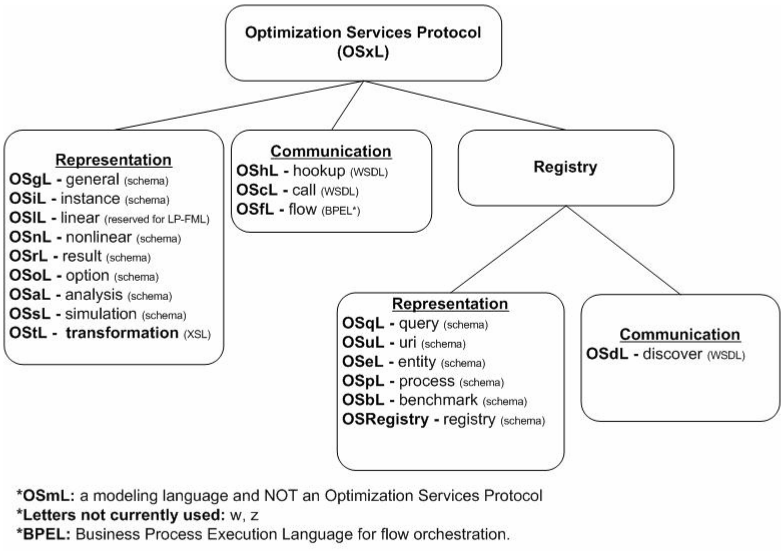
. . . all known documentation
(source, solution, description, type, etc.)

Standards

OS framework provides standards in 3 areas

- ➢ Optimization instance representation
- ➢ Optimization communication
  - ∗ accessing
  - ∗ interfacing
  - ∗ orchestration
- ➢ Optimization service registration and discovery

Standards



Optimization Services Protocol (OSxL)

Representation
- **OSgL -** general (schema)
- **OSiL -** instance (schema)
- **OSlL -** linear (reserved for LP-FML)
- **OSnL -** nonlinear (schema)
- **OSrL -** result (schema)
- **OSoL -** option (schema)
- **OSaL -** analysis (schema)
- **OSsL -** simulation (schema)
- **OStL -** **transformation** (XSL)

Communication
- **OShL -** hookup (WSDL)
- **OScL -** call (WSDL)
- **OSfL -** flow (BPEL*)

Registry

Representation
- **OSqL -** query (schema)
- **OSuL -** uri (schema)
- **OSeL -** entity (schema)
- **OSpL -** process (schema)
- **OSbL -** benchmark (schema)
- **OSRegistry -** registry (schema)

Communication
- **OSdL -** discover (WSDL)

***OSmL:** a modeling language and NOT an Optimization Services Protocol
***Letters not currently used:** w, z
***BPEL:** Business Process Execution Language for flow orchestration.

OSiL: Optimization Problem Instances

Design goals

- Simple, clean, extensible, object-oriented

Standard problem types supported

- Linear
- Quadratic
- General nonlinear
- Mixed integer for any of above
- Multiple objective for any of above
- Complementarity

OSiL *(cont'd)*

Extensions (stable or near-stable)

- User-defined functions
- XML data (within the OSiL or remotely located)
- Data lookup (via XPath)
- Logical/combinatorial expressions and constraints
- Simulations (black-box functions)

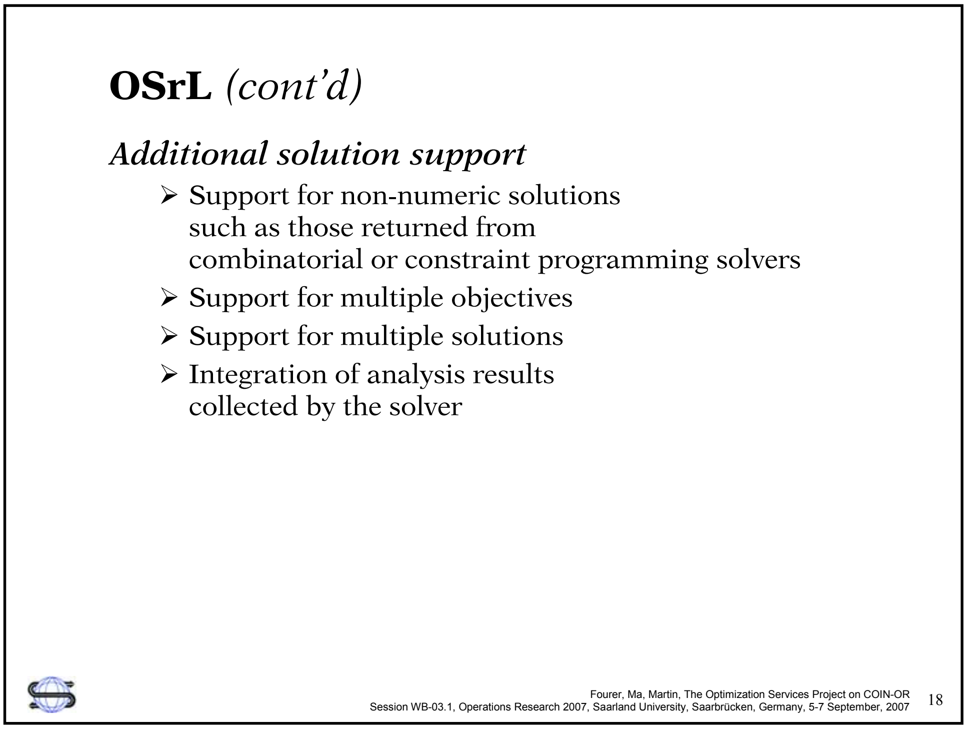
Prototypes

- Cone & semidefinite programming
- Stochastic
  - recourse, penalty-based, scenario (implicit or explicit)
  - risk measure/chance constrained
  - major univariate, multivariate, user-defined distributions
  - general linear transformation and ARMA processes

OSrL: Optimization Problem Results

Counterpart to OSiL for solver output

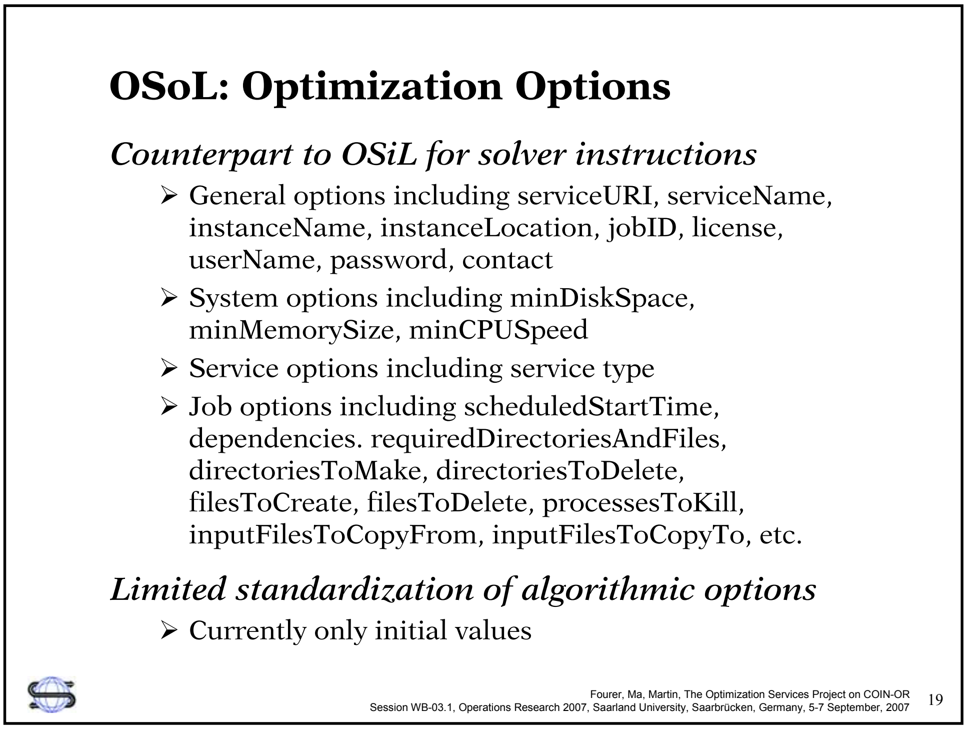
- General results such as serviceURI, serviceName, instanceName, jobID, time
- Results related to the solution such as status (unbounded, globallyOptimal, etc.), substatus, message
- Results related to variables (activities), objectives (optimal levels), constraints (dual values)
- Service statistics such as currentState, availableDiskspace, availableMemory, currentJobCount, totalJobsSoFar, timeLastJobEnded, etc.
- Results related to individual jobs including state (waiting, running, killed, finished), userName, submitTime, startTime, endTime, duration, dependencies, scheduledStartTime, requiredDirectoriesAndFiles.



OSrL *(cont'd)*

Additional solution support

- Support for non-numeric solutions such as those returned from combinatorial or constraint programming solvers
- Support for multiple objectives
- Support for multiple solutions
- Integration of analysis results collected by the solver



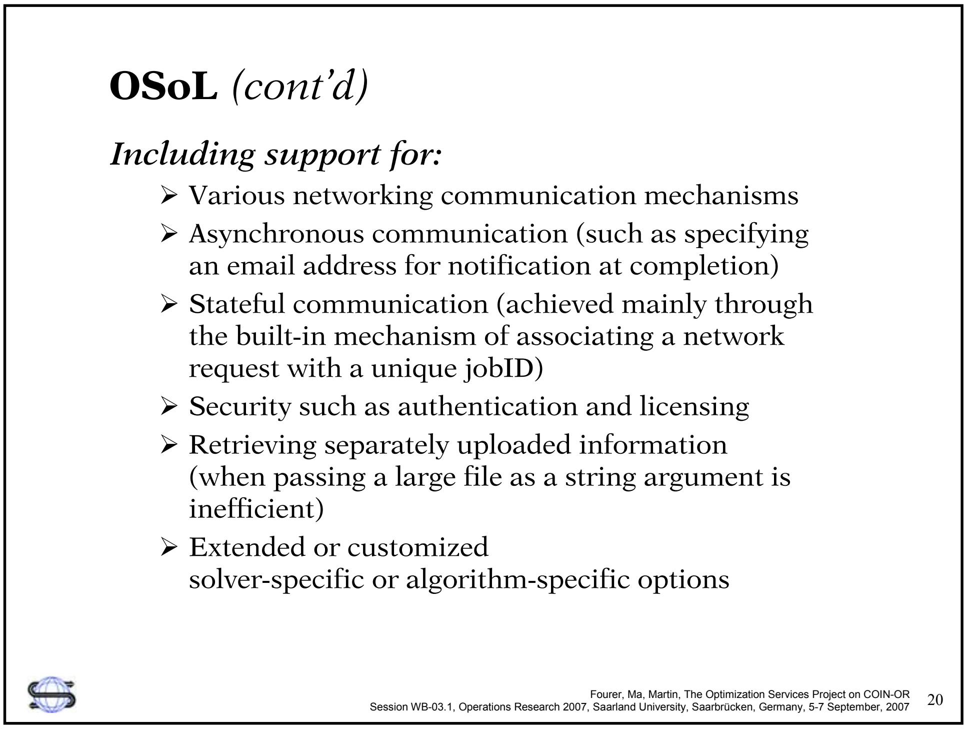
OSoL: Optimization Options

Counterpart to OSiL for solver instructions

- General options including serviceURI, serviceName, instanceName, instanceLocation, jobID, license, userName, password, contact
- System options including minDiskSpace, minMemorySize, minCPUSpeed
- Service options including service type
- Job options including scheduledStartTime, dependencies. requiredDirectoriesAndFiles, directoriesToMake, directoriesToDelete, filesToCreate, filesToDelete, processesToKill, inputFilesToCopyFrom, inputFilesToCopyTo, etc.

Limited standardization of algorithmic options

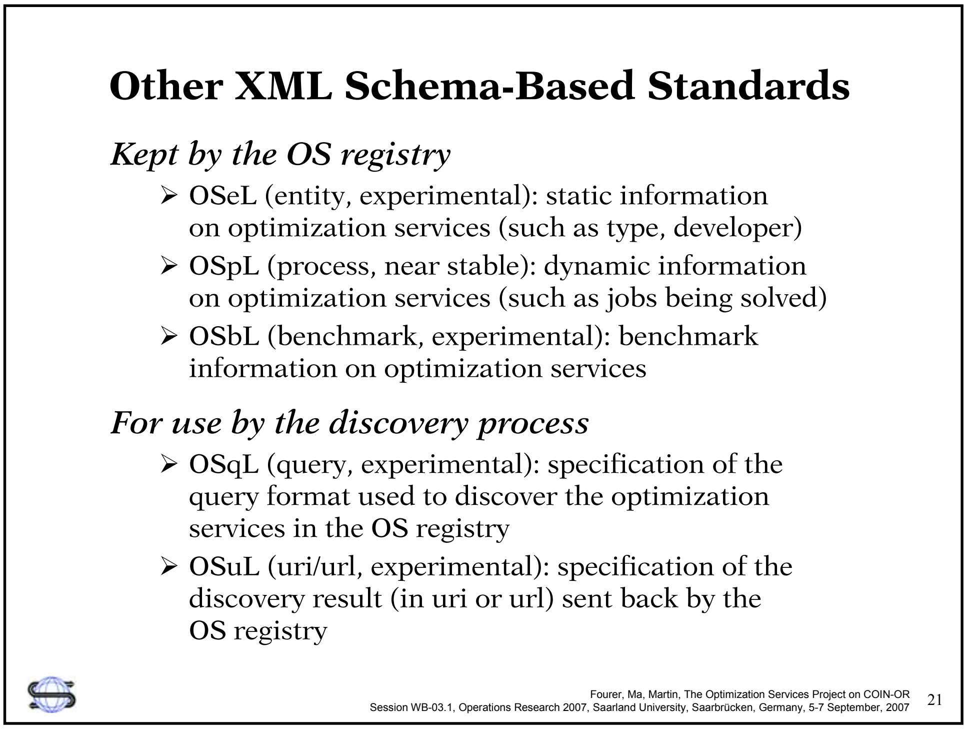
- Currently only initial values



OSoL *(cont'd)*

Including support for:

- Various networking communication mechanisms
- Asynchronous communication (such as specifying an email address for notification at completion)
- Stateful communication (achieved mainly through the built-in mechanism of associating a network request with a unique jobID)
- Security such as authentication and licensing
- Retrieving separately uploaded information (when passing a large file as a string argument is inefficient)
- Extended or customized solver-specific or algorithm-specific options



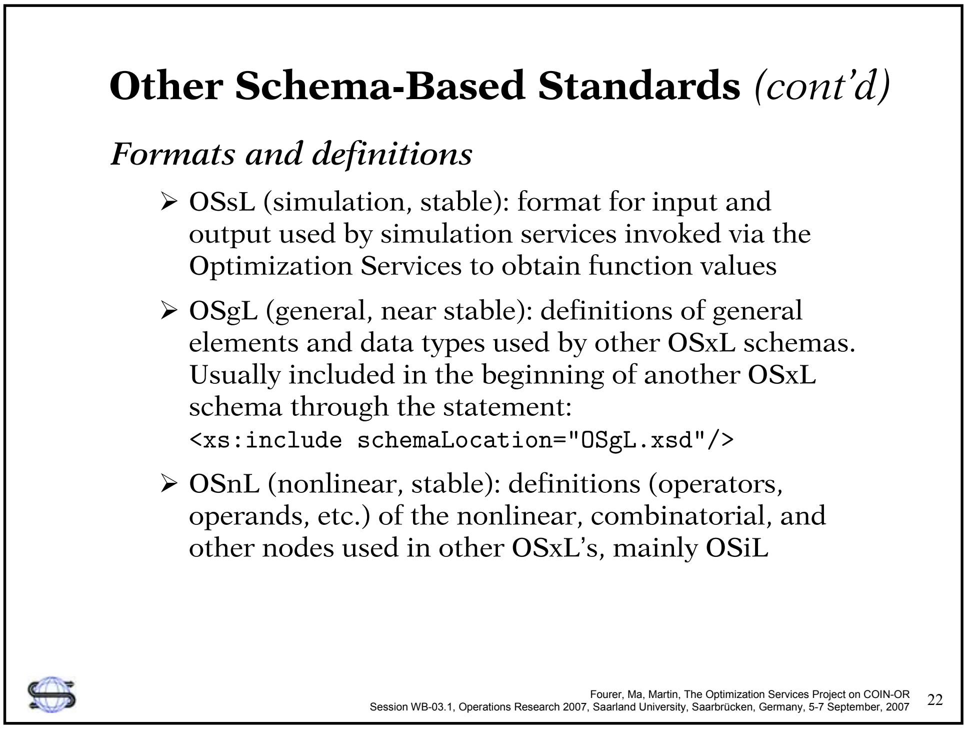
Other XML Schema-Based Standards

Kept by the OS registry

- OSeL (entity, experimental): static information on optimization services (such as type, developer)
- OSpL (process, near stable): dynamic information on optimization services (such as jobs being solved)
- OSbL (benchmark, experimental): benchmark information on optimization services

For use by the discovery process

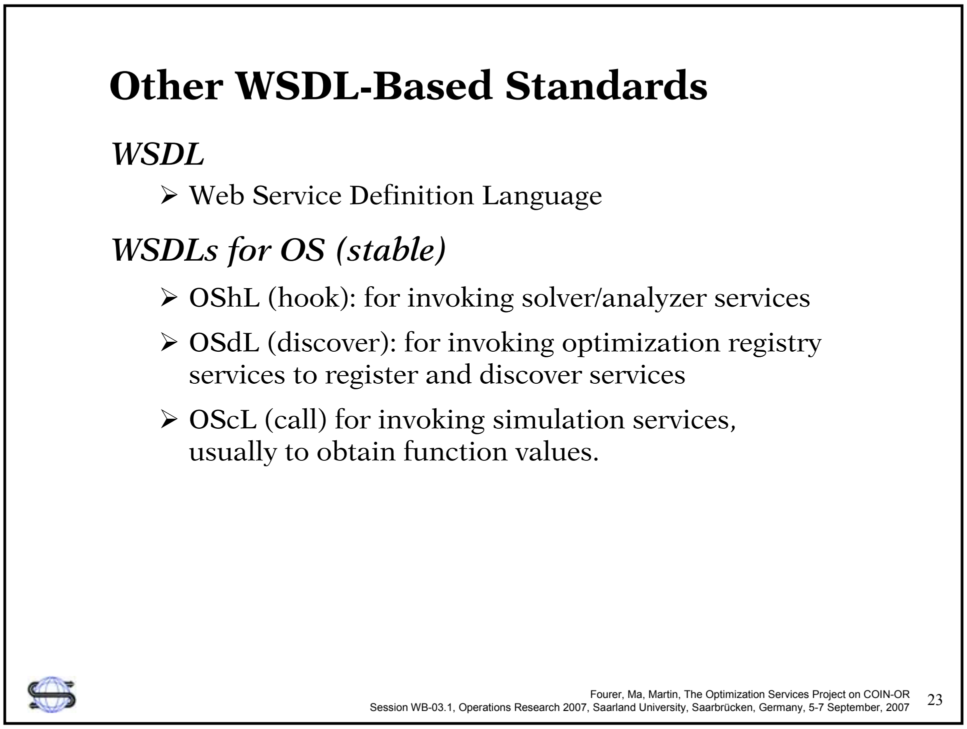
- OSqL (query, experimental): specification of the query format used to discover the optimization services in the OS registry
- OSuL (uri/url, experimental): specification of the discovery result (in uri or url) sent back by the OS registry



Other Schema-Based Standards *(cont'd)*

Formats and definitions

- OSsL (simulation, stable): format for input and output used by simulation services invoked via the Optimization Services to obtain function values
- OSgL (general, near stable): definitions of general elements and data types used by other OSxL schemas. Usually included in the beginning of another OSxL schema through the statement:
  `<xs:include schemaLocation="OSgL.xsd"/>`
- OSnL (nonlinear, stable): definitions (operators, operands, etc.) of the nonlinear, combinatorial, and other nodes used in other OSxL's, mainly OSiL



Other WSDL-Based Standards

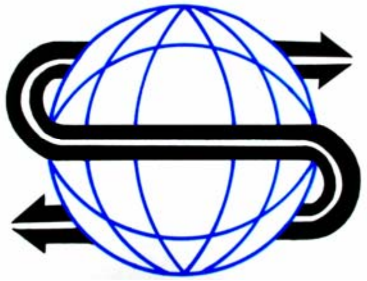
WSDL

- Web Service Definition Language

WSDLs for OS (stable)

- OShL (hook): for invoking solver/analyzer services
- OSdL (discover): for invoking optimization registry services to register and discover services
- OScL (call) for invoking simulation services, usually to obtain function values.

www.optimizationservices.org . . .



. . . Questions?