Is there a future for modeling systems?

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Background

- a customer raised the question
- ILOG to invest less in OPL?
- the IT department wants C++, and
- no dependence on small suppliers

Is there a future *in* modeling systems?

What is the future of modeling systems?

A personal vision

In the 70’s

- lengthy, low-level, error-prone programs
- programs written by computer experts
- programs difficult to change or transfer
- slow turn-around of submitted jobs

Thanks to

- visionaries at the World Bank
- the research climate
- the requests for decision support

GAMS was born

What did GAMS give us?

- high-level computerized model description
- technology also for domain experts
- ease of making changes
- ease of model transfer

Tremendous increased productivity

Productivity requirement remains, but …

Now, 30 years later,
the world of optimization
has changed
and
critics of modeling tools
make serious claims

Claim # 1:
current modeling tools play insignificant role

The major efforts are:

- data feed and cleaning
- graphical reporting
- client-server interaction
- web-enabling of applications

Claim # 2: current modeling tools are not professional

Instead, one should use

- C++ component libraries
- full C++ development support
- multi-developer source safe tools
- latest graphical design tools

Claim # 3: current modeling tools are often too slow

With C++ you can

- customize data structures
- profit from compiler improvements
- change to parallel implementations

Claim # 4: current modeling tools do not support re-use

Instead of “cut-copy-paste” operations you can use C++

- object classes
- derived classes
- component technology

Claim # 5: current modeling tools have poor algorithm linkage

Instead of black-box solvers,

you can use

- various solvers with callbacks
- connect them at will
- introduce new interface functions

Claim # 6: current modeling tools are likely to disappear

Instead of relying on fading technology you can use

- C++ generators with source code
- fully-trained professionals
- up-to-date technology

Summary of claims:

Current modeling tools:

- play insignificant role
- are not professional
- are often too slow
- do not support re-use
- have poor algorithm linkage
- are likely to disappear

Possible courses of action

- do not change fundamentally
- change to adjust to new niches
- change fundamentally

I like to address the latter

A complete development environment

Provide a technology with

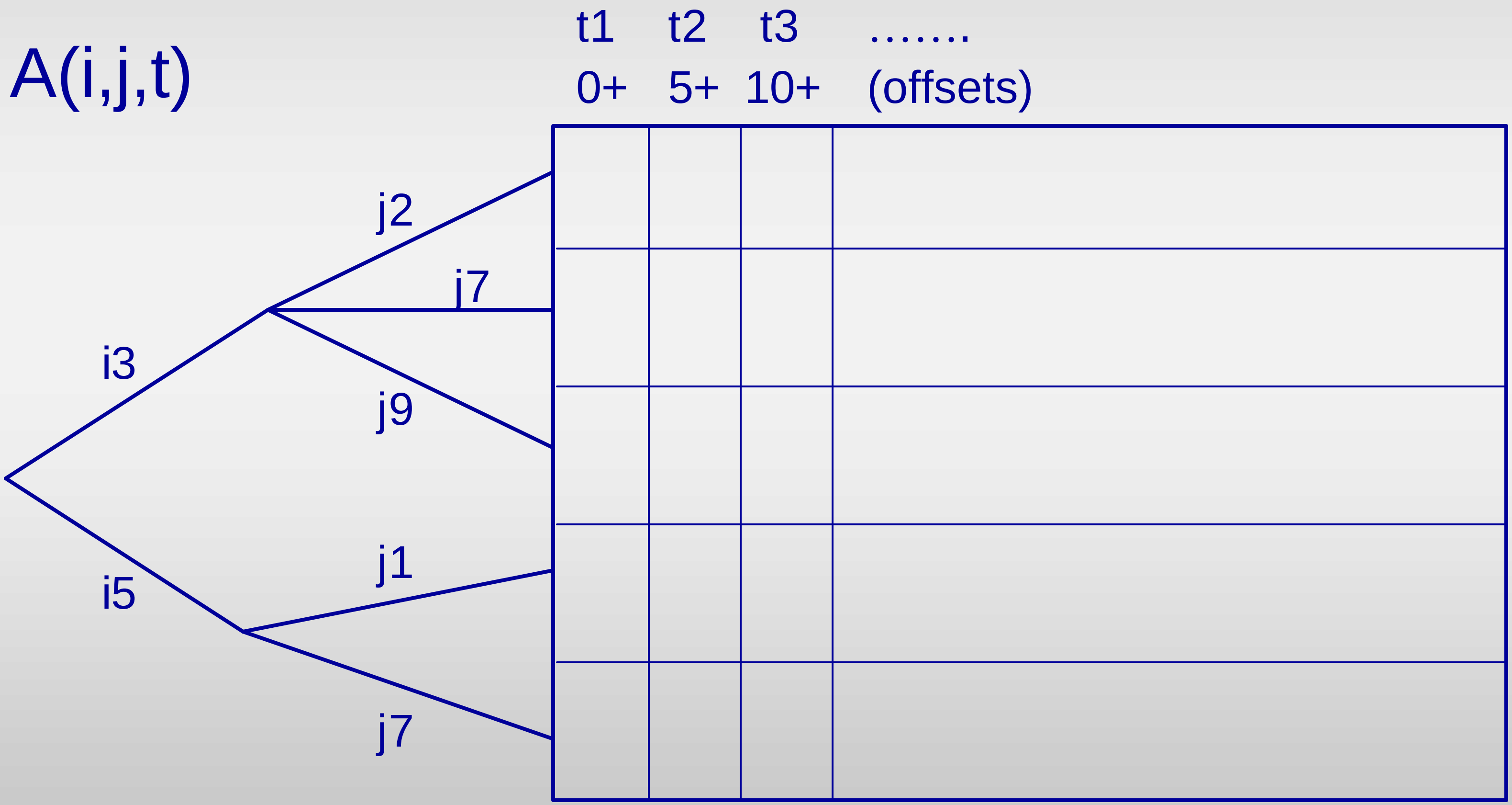
- professional & up-to-date development tools
- a rich set of interfaces (C++, Java, .Net)
- extensive data connectivity
- etc.

Code generation and parallelization

For static data structures

- search for repetitive computations
- generate assembler code
- generate models in parallel
- evaluate functions/derivatives in parallel

Code generation (repetition)



A(i,j,t)

t1 t2 t3 …….

0+ 5+ 10+ (offsets)

Object-oriented modeling

Object-oriented modeling paradigm:

- coarse-grain model objects
- use of OO design methods
- increased locality for modeler
- re-use of existing models/components
- dimension/scope increase through typed sets

Object-oriented modeling

OBJECT CLASS CrudeDistiller

crude distiller model

OBJECT CLASS OtherUnit

other unit model

Object-oriented modeling

OBJECT CLASS CrudeDistiller

crude distiller model

OBJECT CLASS OtherUnit

other unit model

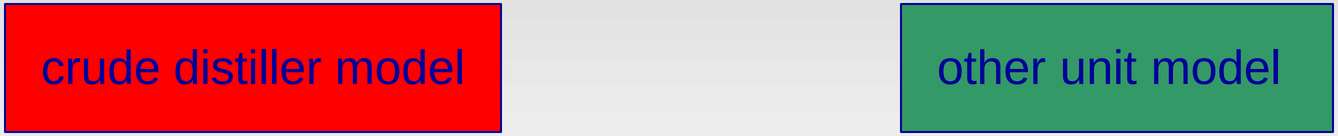
```
SET  CrudeDistillers  OF TYPE  CrudeDistiller INDEX cd
SET  OtherUnits       OF TYPE  OtherUnit      INDEX ou
```

These sets:

- are ordinary index sets
- provide access to identifiers in classes, for example cd.ThroughPut

Object-oriented modeling

OBJECT CLASS CrudeDistiller   OBJECT CLASS OtherUnit



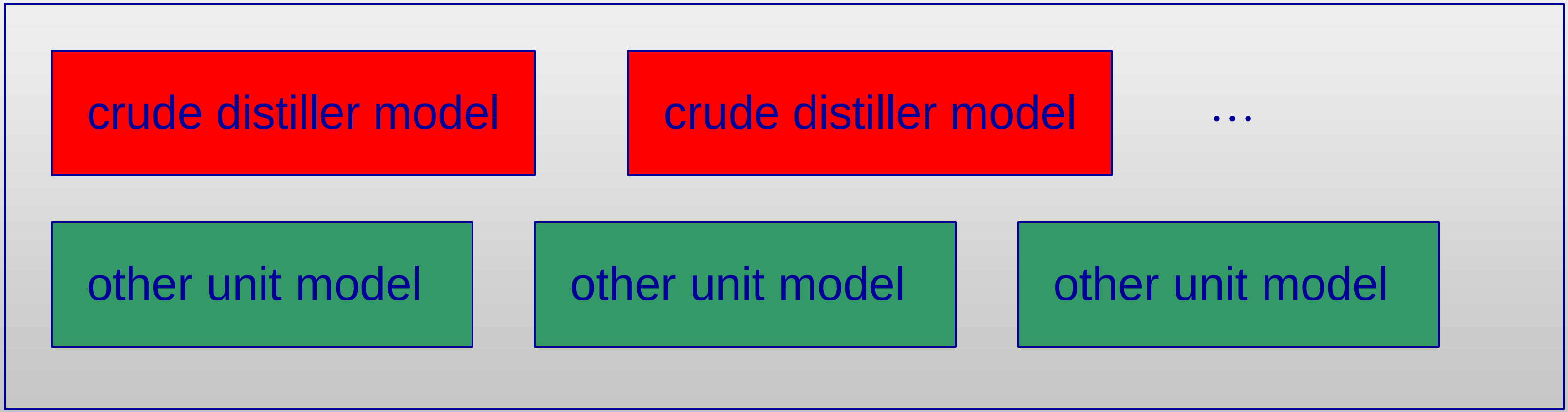
crude distiller model

other unit model

SET CrudeDistillers OF TYPE CrudeDistiller

SET OtherUnits   OF TYPE OtherUnit

OBJECT CLASS Plant



crude distiller model

crude distiller model

…

other unit model

other unit model

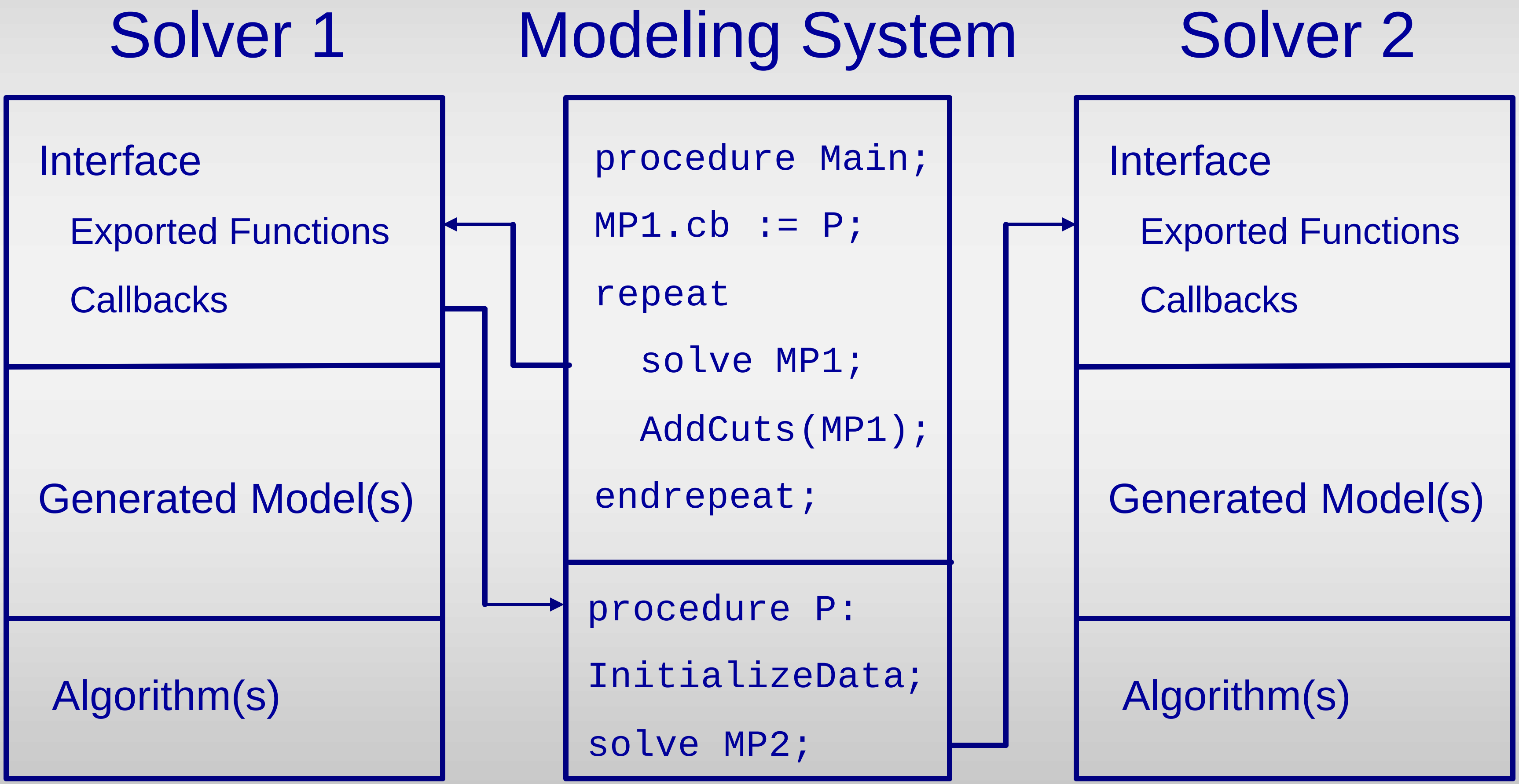
other unit model

Open solver environment for customized algorithms

Extend modeling systems to support

- multiple interacting math programs
- functions for model manipulation
- simultaneous access to multiple solvers
- extensive library of control functions
- support for solver callbacks

Open solver environment



Solver 1

Interface

Exported Functions

Callbacks

Generated Model(s)

Algorithm(s)

Modeling System

```
procedure Main;
MP1.cb := P;
repeat
   solve MP1;
   AddCuts(MP1);
endrepeat;
```

```
procedure P:
InitializeData;
solve MP2;
```

Solver 2

Interface

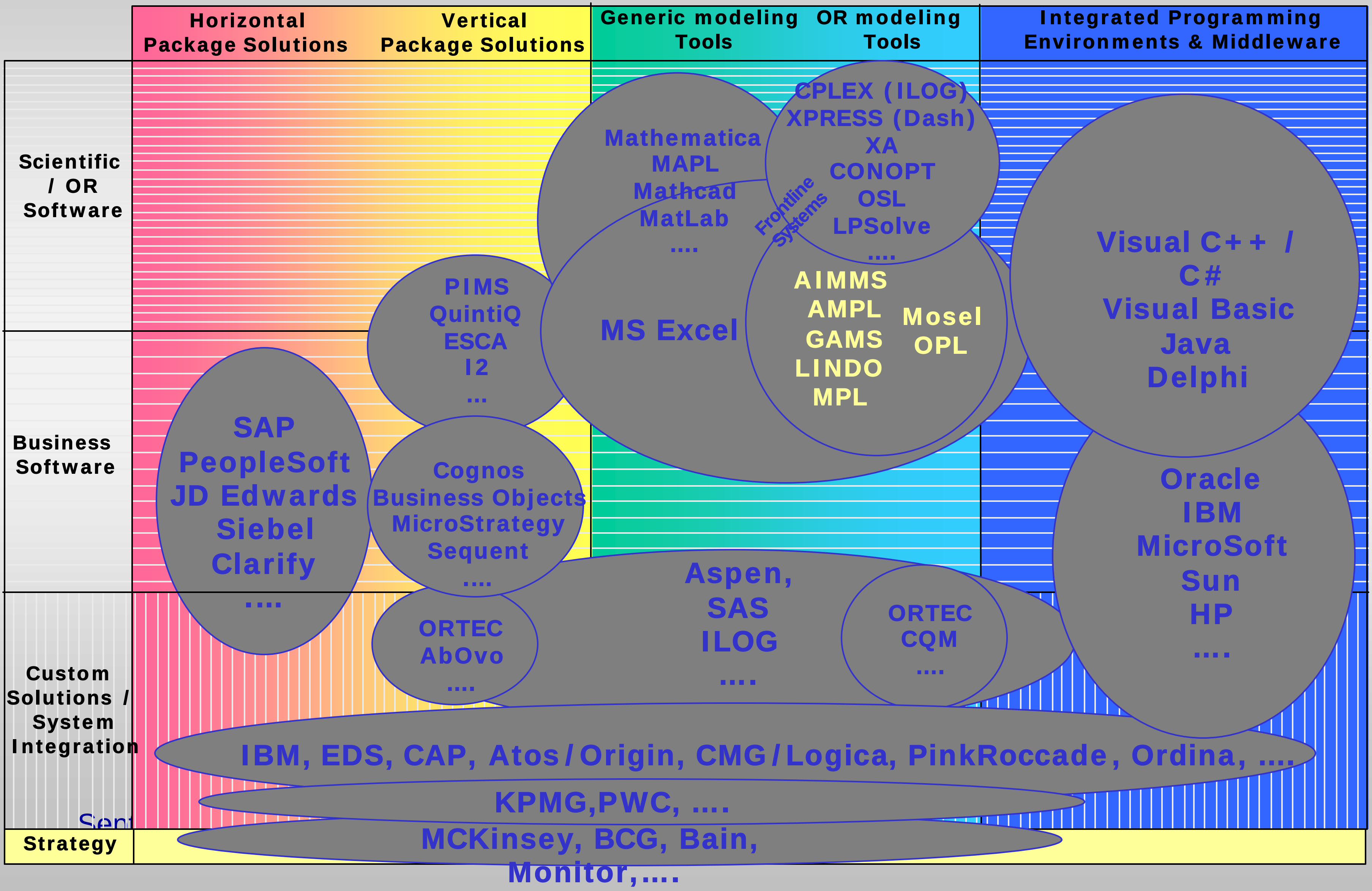
Exported Functions

Callbacks

Generated Model(s)

Algorithm(s)

Perhaps merge companies ?



Horizontal Package Solutions

Vertical Package Solutions

Generic modeling Tools

OR modeling Tools

Integrated Programming Environments & Middleware

Scientific / OR Software

Business Software

Custom Solutions / System Integration

Strategy

Mathematica
MAPL
Mathcad
MatLab
....

CPLEX (ILOG)
XPRESS (Dash)
XA
CONOPT
OSL
LPSolve
....

Frontline Systems

MS Excel

AIMMS
AMPL
GAMS
LINDO
MPL

Mosel
OPL

Visual C++ / C#
Visual Basic
Java
Delphi

PIMS
QuintiQ
ESCA
I2
...

SAP
PeopleSoft
JD Edwards
Siebel
Clarify
....

Cognos
Business Objects
MicroStrategy
Sequent
....

Oracle
IBM
MicroSoft
Sun
HP
....

ORTEC
AbOvo
....

Aspen,
SAS
ILOG
....

ORTEC
CQM
....

IBM, EDS, CAP, Atos/Origin, CMG/Logica, PinkRoccade, Ordina, ...

KPMG,PWC, ...

MCKinsey, BCG, Bain, Monitor,....

Sent

Is there a future for modeling systems?

For me, the answer is

YES,

but …