Choosing the right route to production for your MATLAB calculation engine

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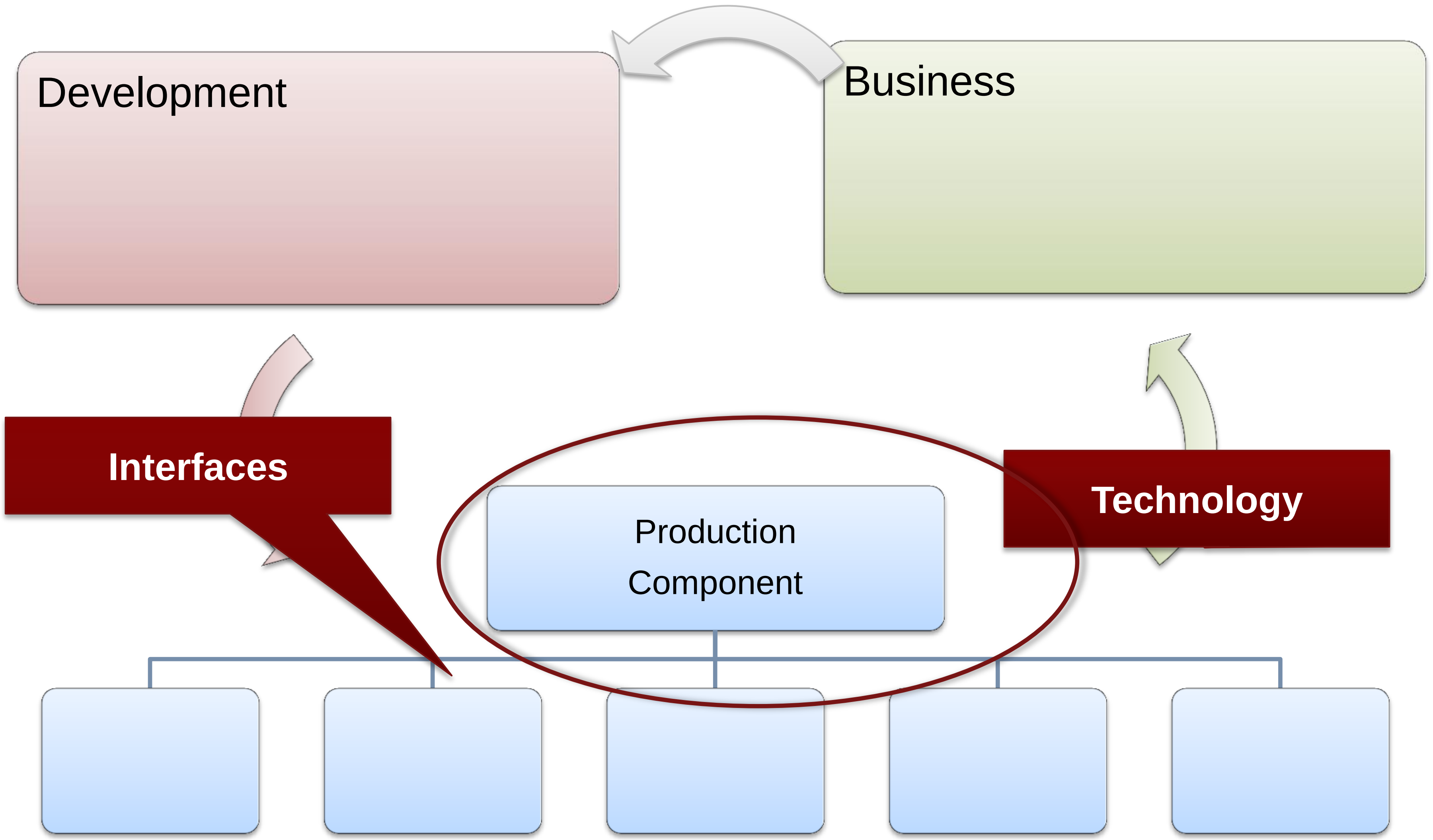
Agenda

- Criteria
- Tools
- Examples

Integrating into enterprise environment

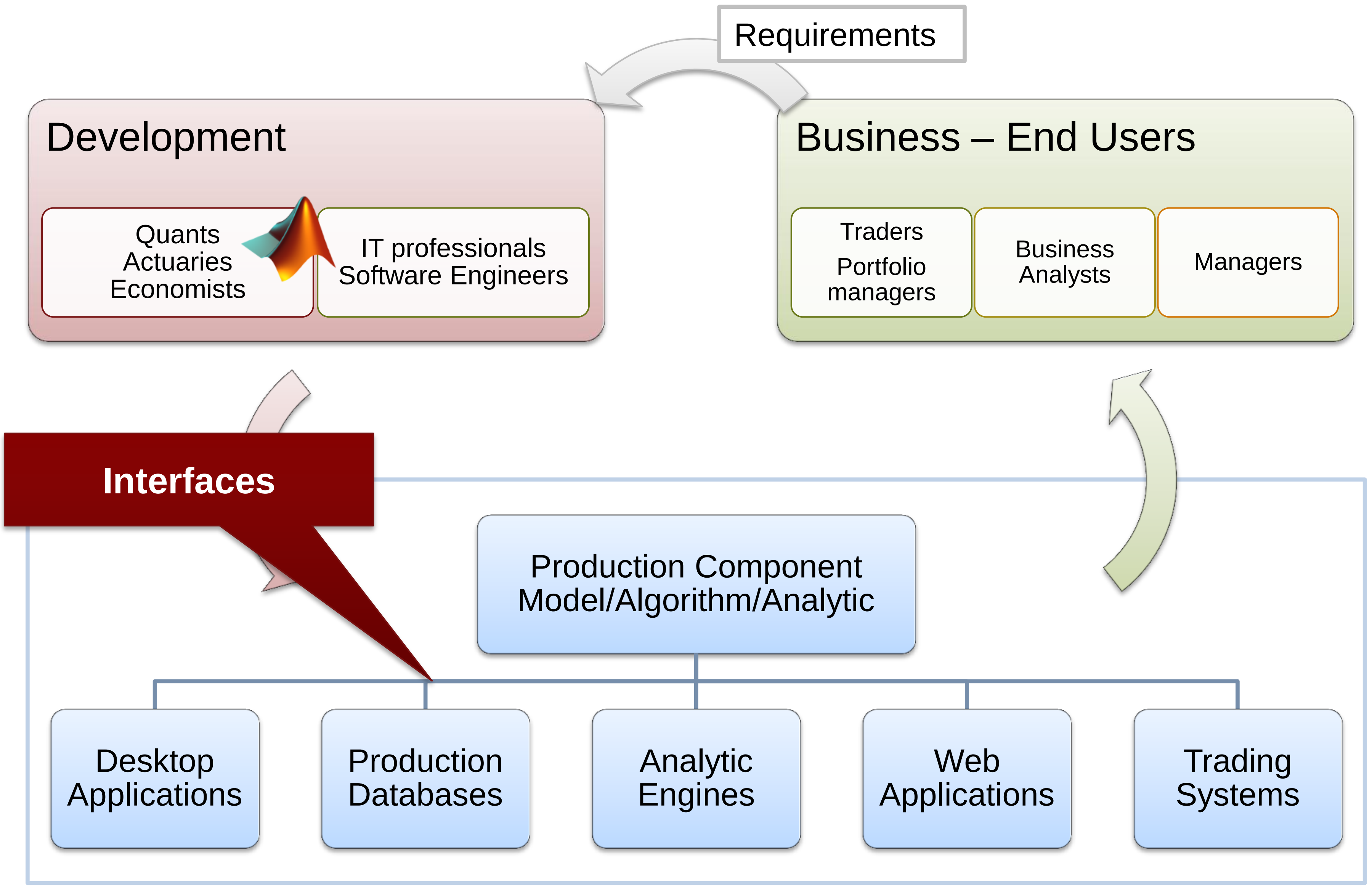


Integration considerations

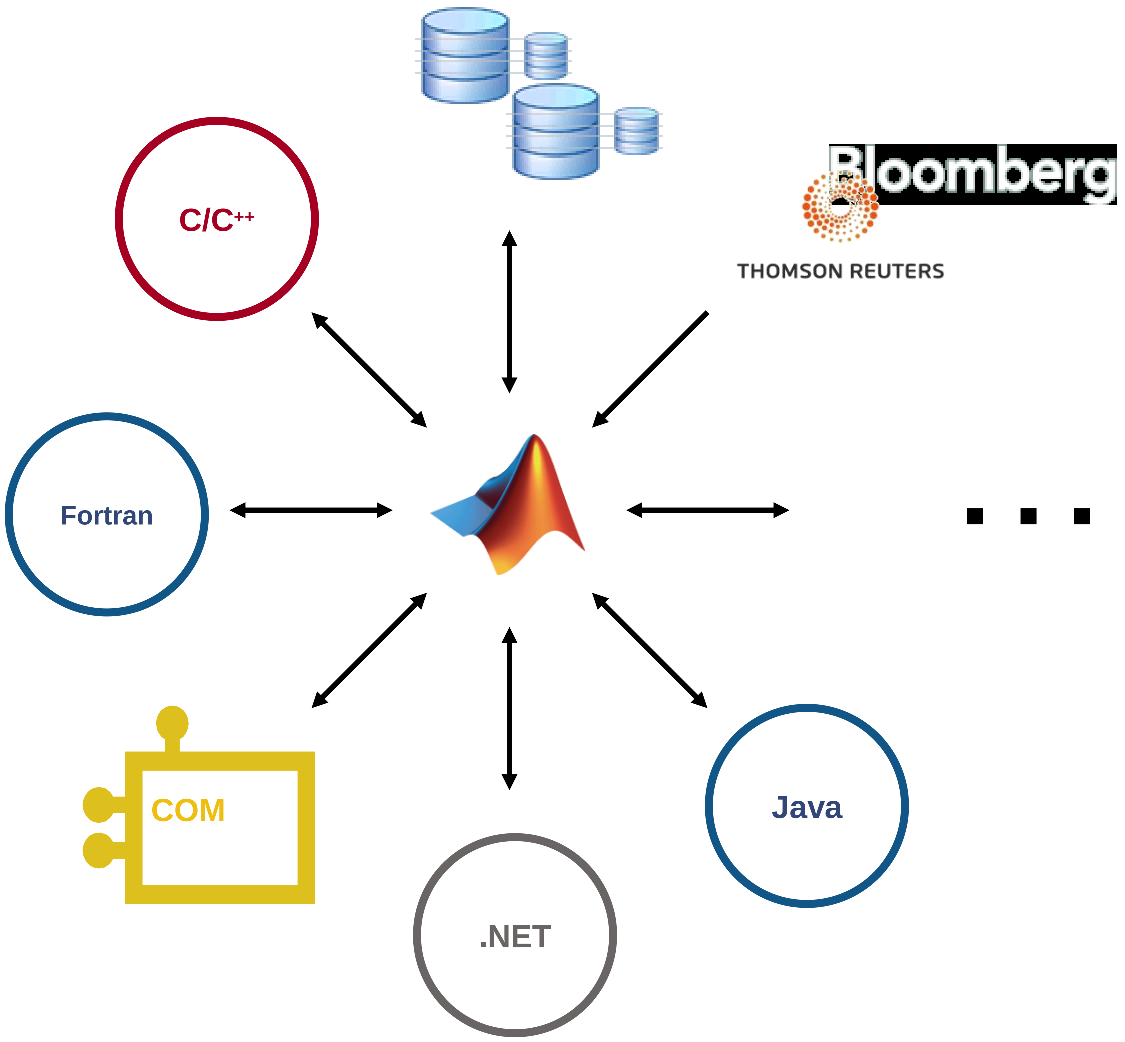
- What is the volume and type of data?
- What is the performance requirement?
- What product features are required?
- Do we need to protect our IP and code
- Where are we calling from?
- Where the algorithm should be hosted

Examples:
- Daily risk report
- Portfolio analysis
- Live trading

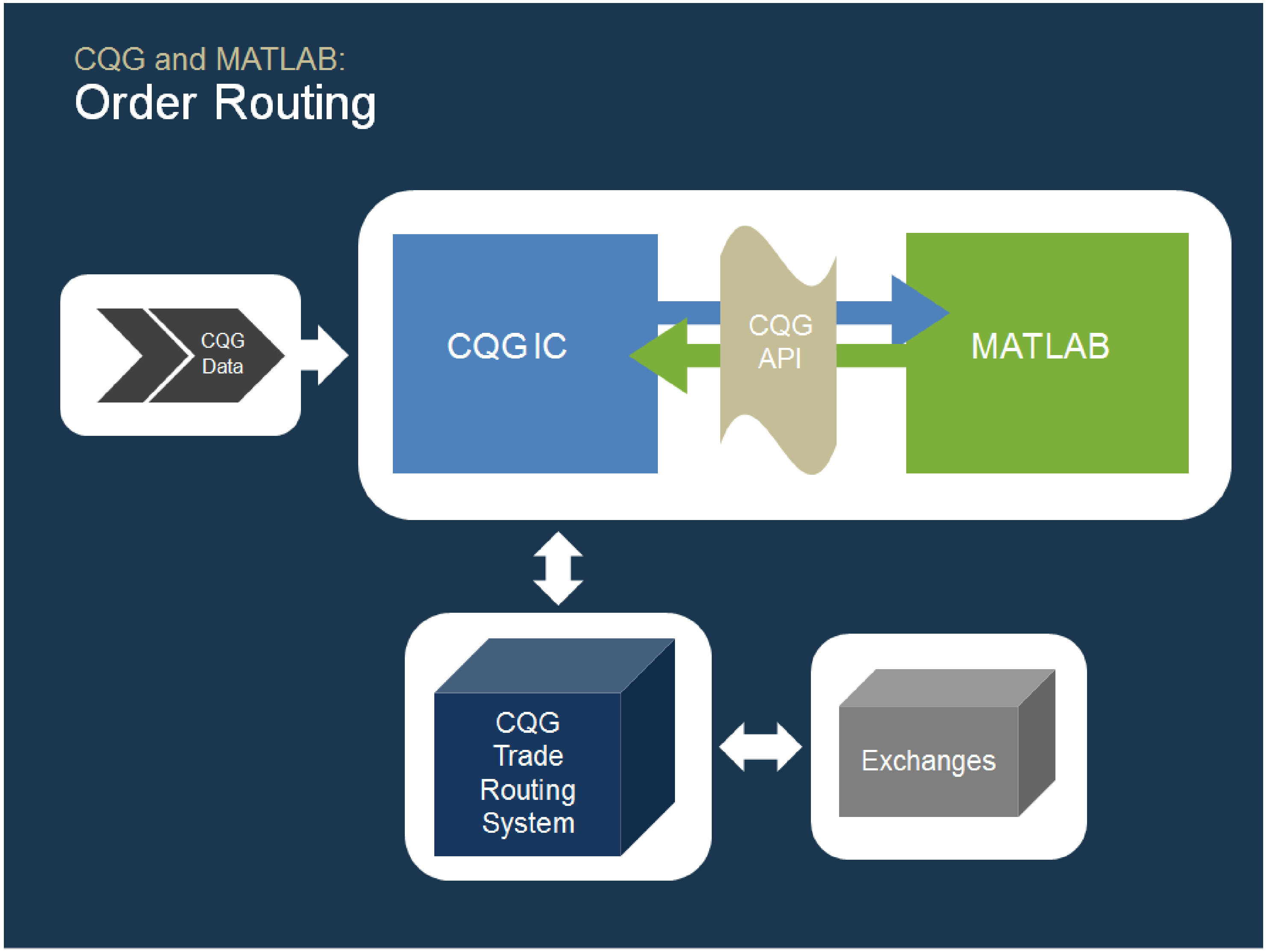
Integrating into enterprise environment



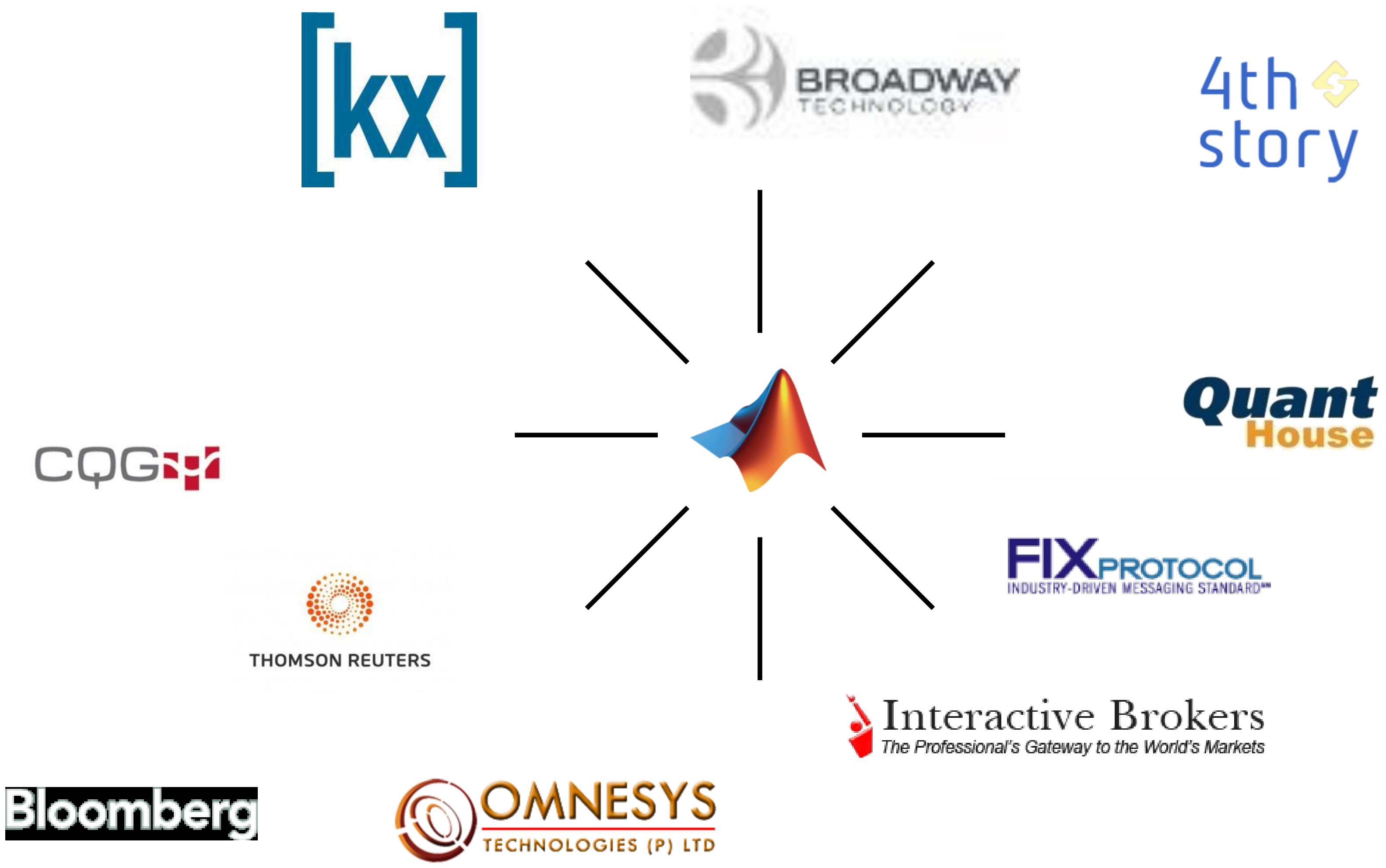
MATLAB Interfaces
Chosen Examples



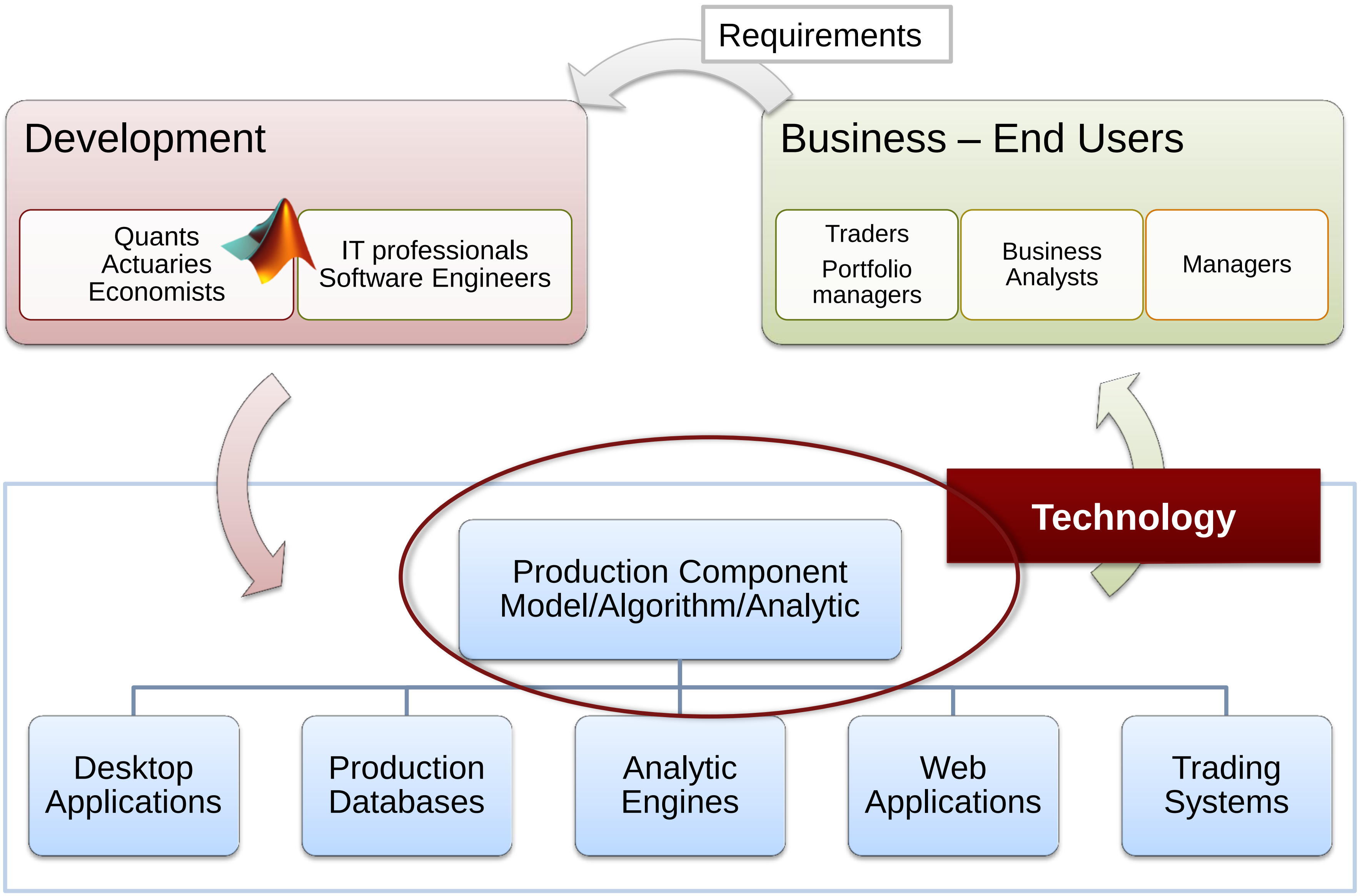
Automation: CQG



Examples of MATLAB connectivity developed by 3rd parties


[kx]
BROADWAY TECHNOLOGY
4th story
Quant House
CQG
FIX PROTOCOL INDUSTRY-DRIVEN MESSAGING STANDARD
THOMSON REUTERS
Interactive Brokers The Professional's Gateway to the World's Markets
Bloomberg
OMNESYS TECHNOLOGIES (P) LTD

Integrating into enterprise environment

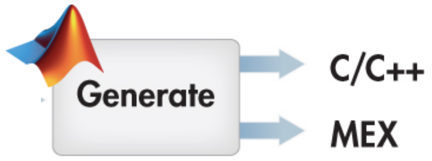


Calculation implementation options

- Live MATLAB
- MATLAB Compiler and Builders

- MATLAB Production Server

- MATLAB Coder



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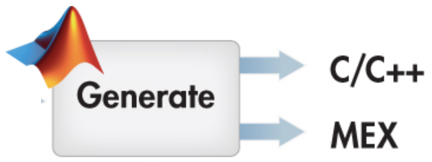

Live MATLAB

- MATLAB Apps

  Fast way of distributing tools to MATLAB users

- MATLAB Engine

  Allows you to call MATLAB software from C/C++ and FORTRAN programs

- MATLAB COM automation server

  A Windows program that can be configured as an Automation controller can control MATLAB

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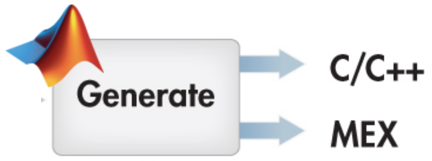
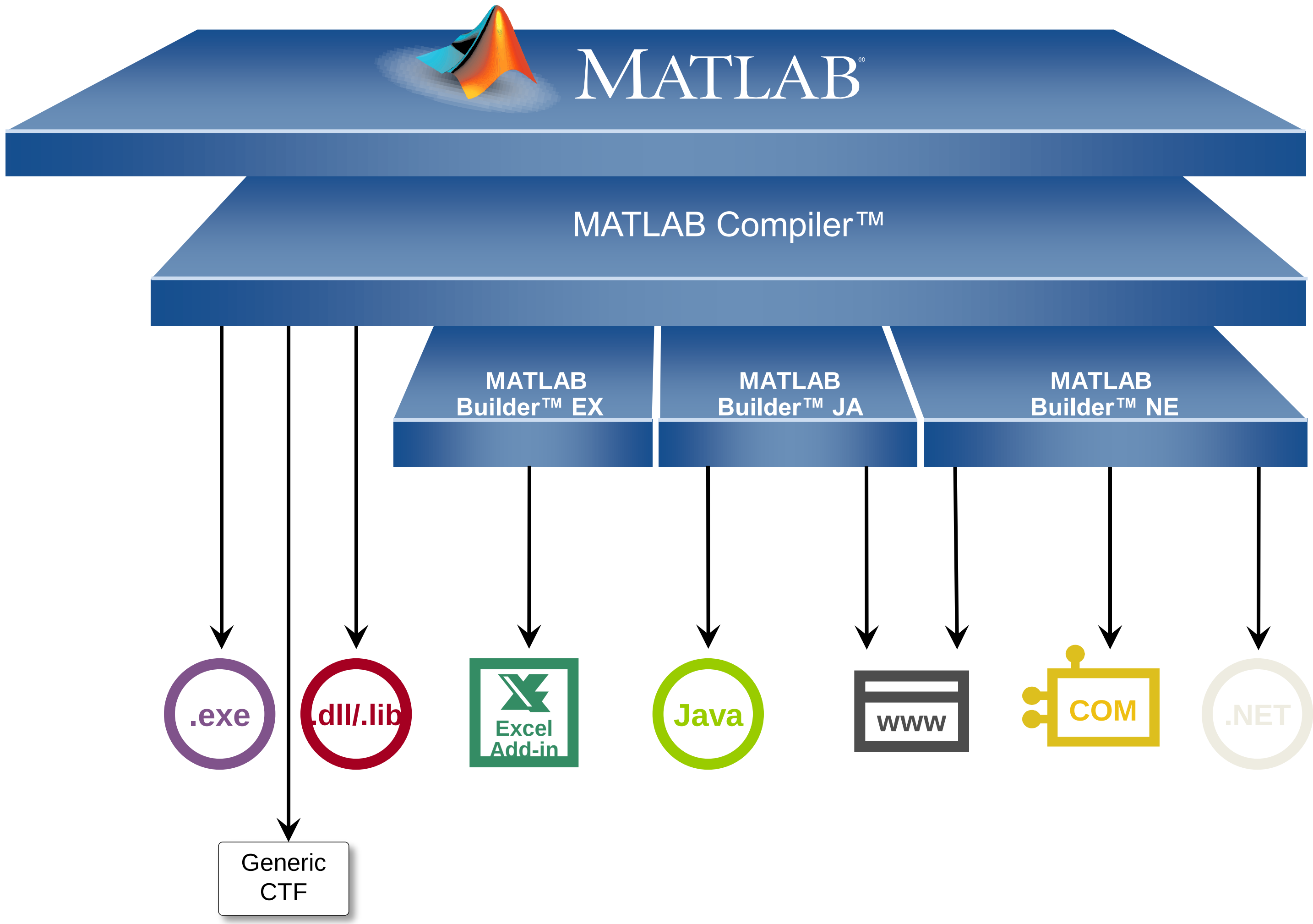
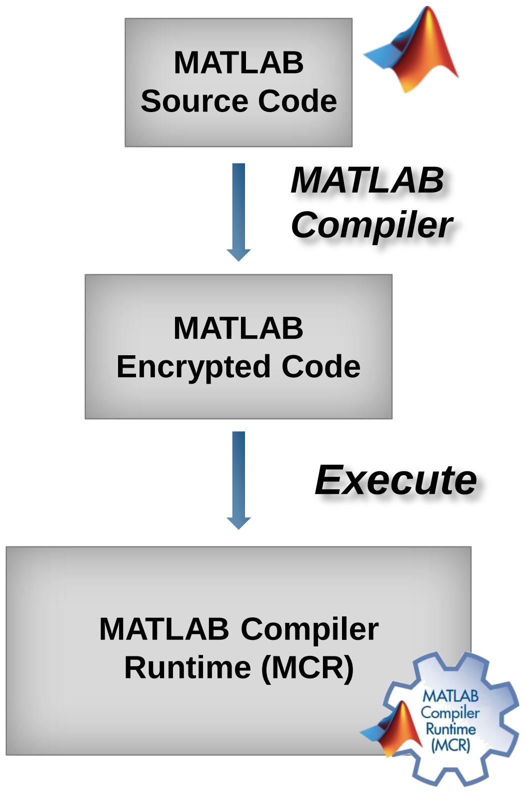


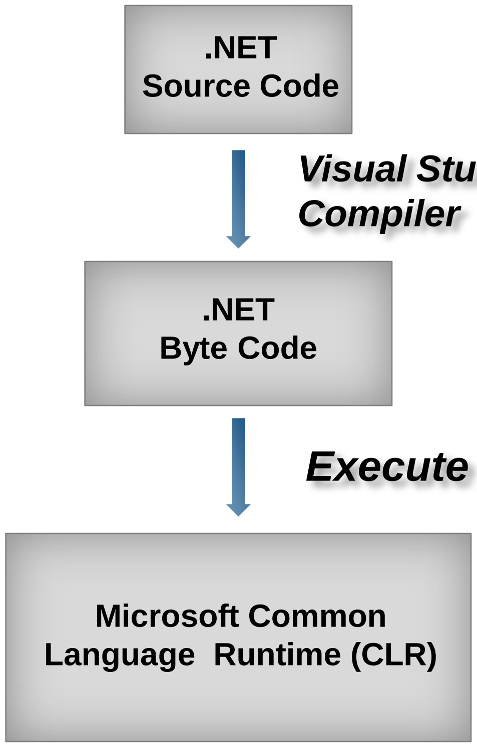
MATLAB Compiler and Builders

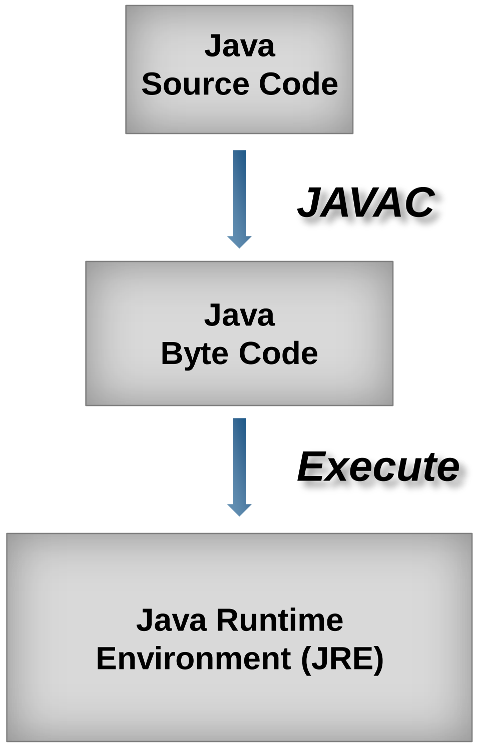


Application Virtual Machine Concept

Various language implementations

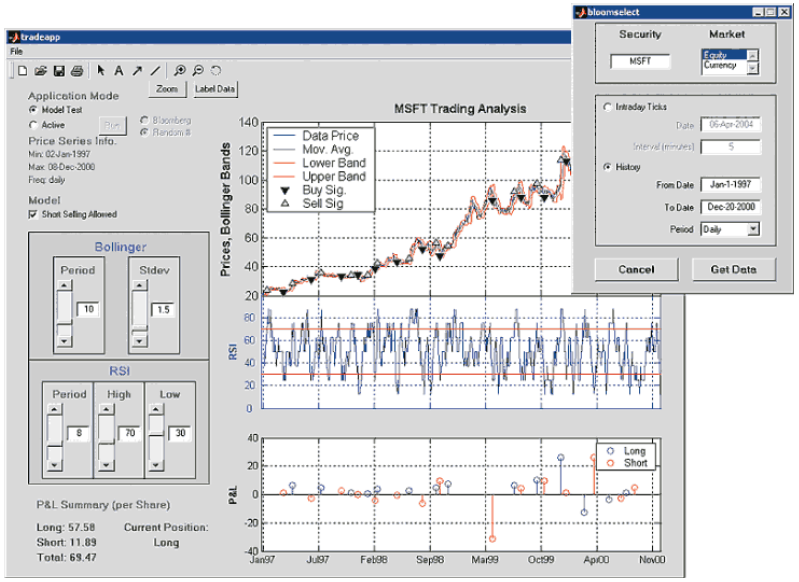




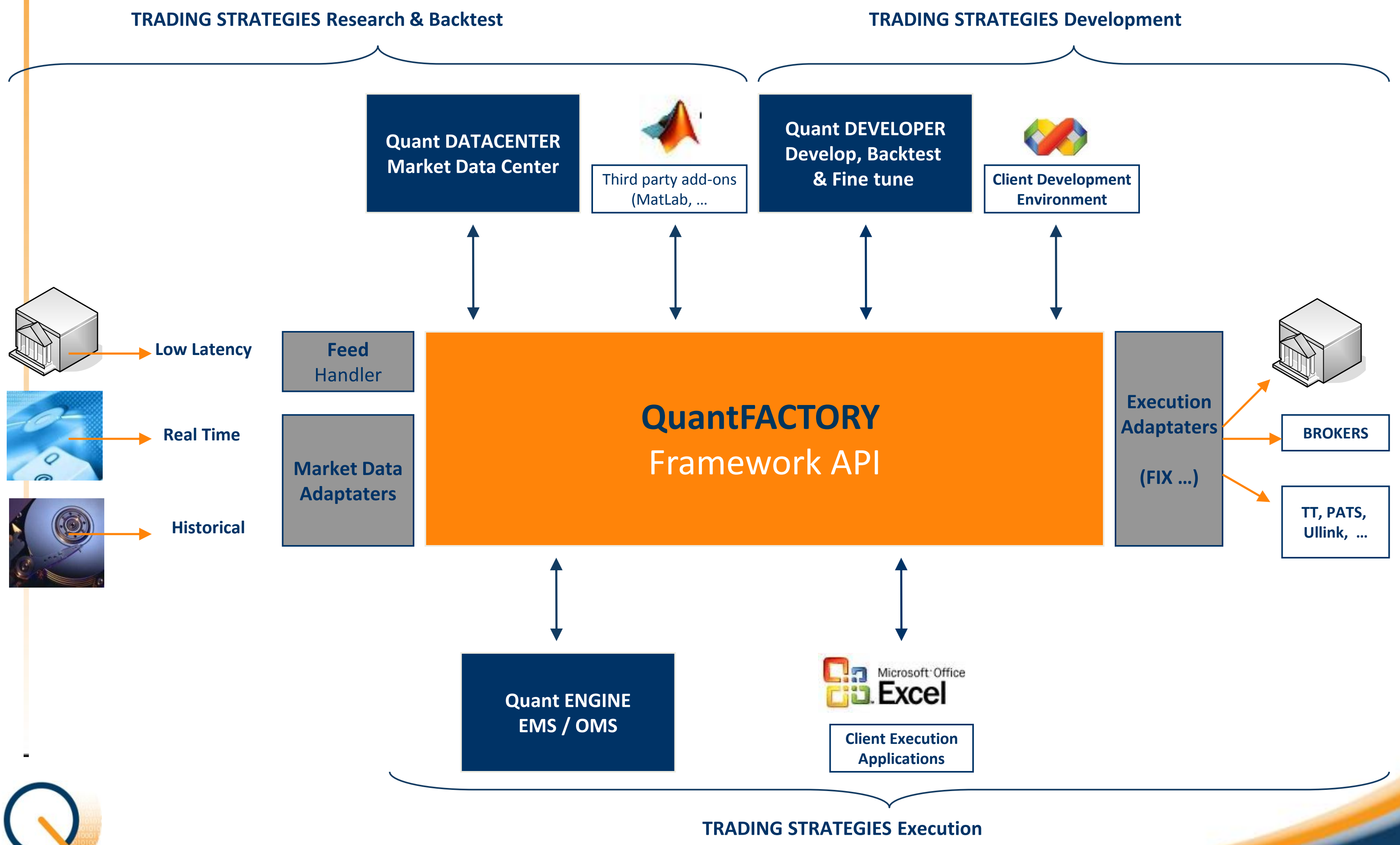


MATLAB Compiler

- Automatically packages your MATLAB programs as standalone applications and software components
- Supports full MATLAB language and most toolboxes, including Parallel Computing Toolbox
- Allows royalty-free deployment



QuantFACTORY : an open architecture



TRADING STRATEGIES Research & Backtest
TRADING STRATEGIES Development
Quant DATACENTER Market Data Center
Third party add-ons (MatLab, …
Quant DEVELOPER Develop, Backtest & Fine tune
Client Development Environment
Low Latency
Real Time
Historical
Feed Handler
Market Data Adaptaters
QuantFACTORY
Framework API
Execution Adaptaters
(FIX …)
BROKERS
TT, PATS, Ullink, …
Quant ENGINE EMS / OMS
Microsoft Office Excel
Client Execution Applications
TRADING STRATEGIES Execution

Calculation implementation options

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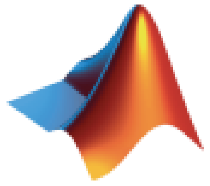
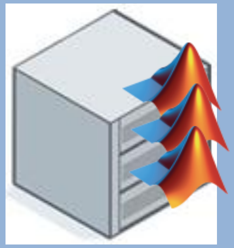
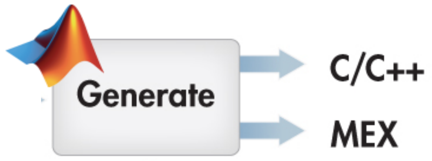


- MATLAB Compiler and Builders

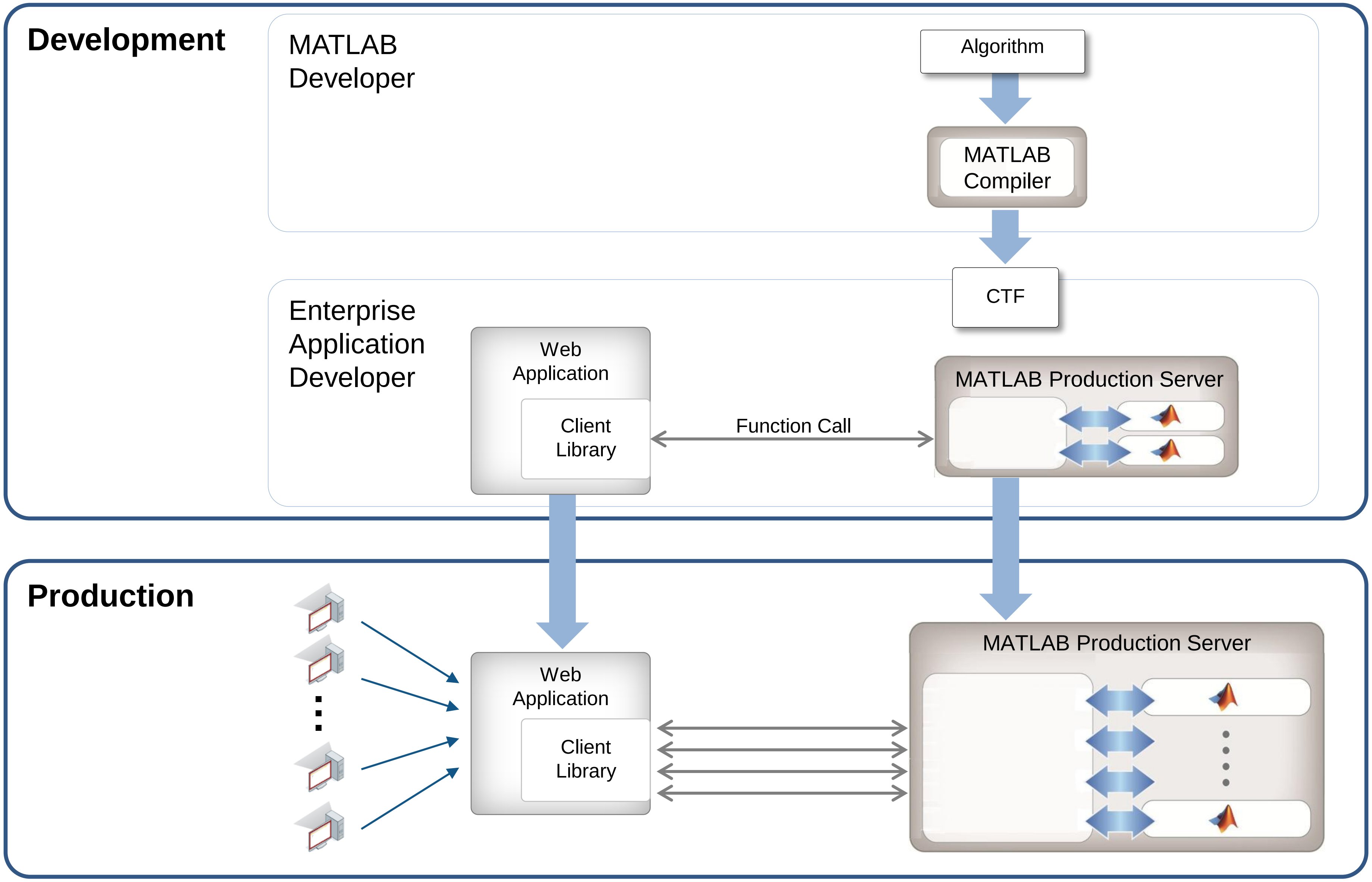
- MATLAB Production Server



- MATLAB Coder



Production Deployment Workflow



Integration Example

- Reference client library
- Define function signatures
- Define connection (server & CTF)

MATLAB Function

```
function B = BlackScholes(CP,S,X,T,r,v)

d2=d1-v*sqrt(T);
if CP=='c'
B = (S*normcdf(d1)-X*exp(-r*T)*normcdf(d2))-noise;
```

Enterprise Application

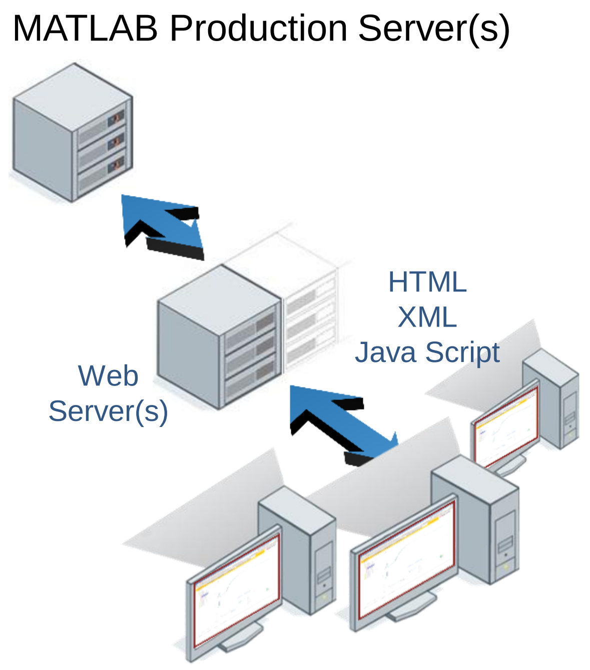
```
using Mathworks.MATLAB.ProductionServer.Client;

   public interface BlkSchInterface
    {       double BlackScholes(string C, double S, double X, double T, double r, double v); }

   MWClient client = new MWHttpClient();
   BlkSchInterface blksch_1 = client.CreateProxy<BlkSchInterface>(new Uri("http://192.168.240.220:9910/BlkSch1"));
   double optionprice = blksch_1.BlackScholes("c", BasePrice.Value, 1, 1, 1, Volatility.Value));
```

MATLAB Production Server

- Directly deploy MATLAB programs into production
  - Centrally manage multiple MATLAB programs & MCR versions
  - Automatically deploy updates without server restarts
- Scalable & reliable
  - Service large numbers of concurrent requests
  - Add capacity or redundancy with additional servers
- Use with web, database & application servers
  - Lightweight client library isolates MATLAB processing
  - Access MATLAB programs using native data types



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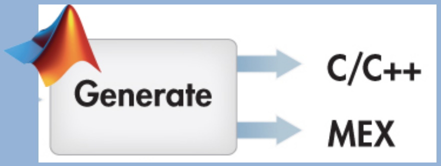
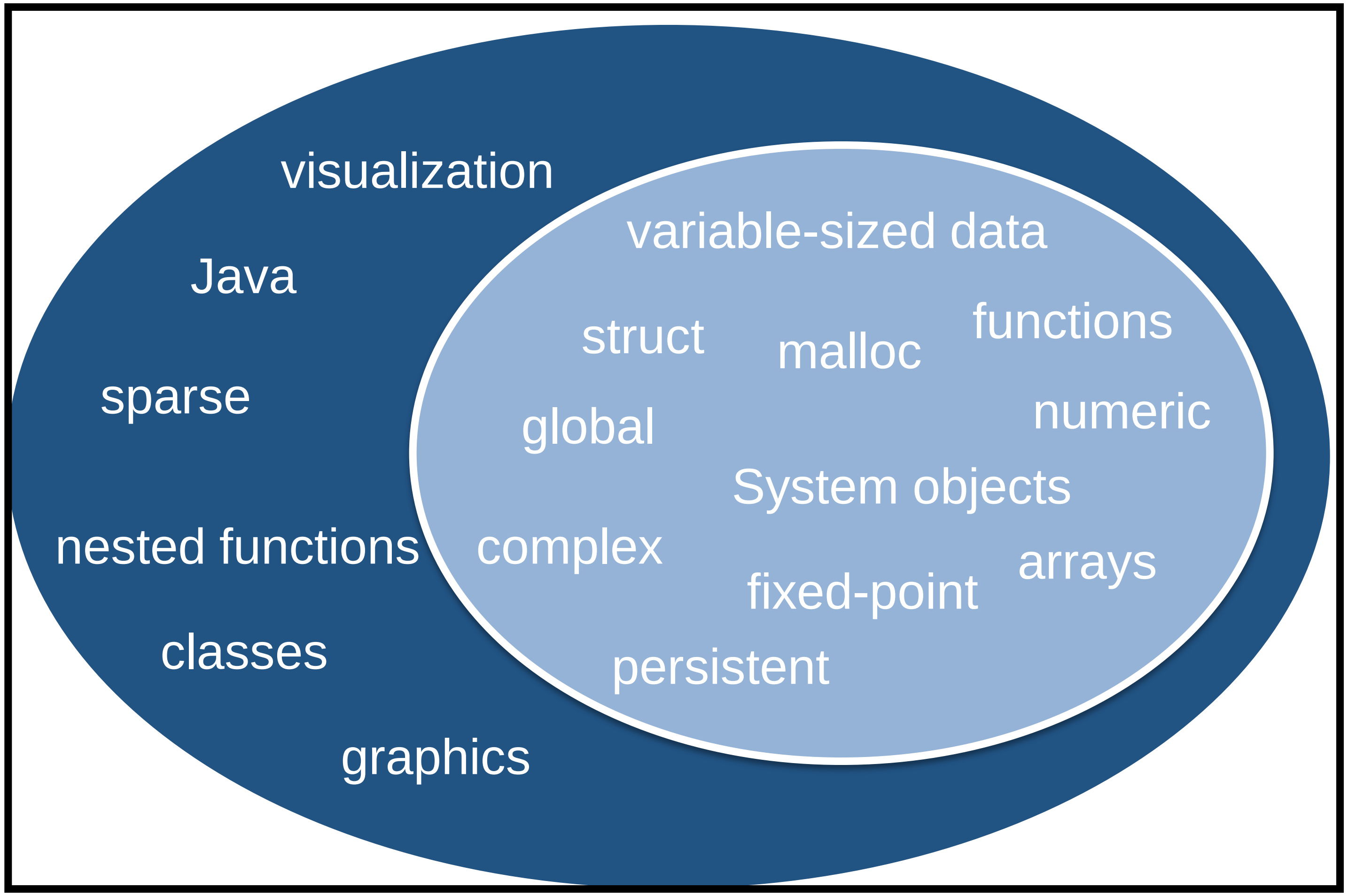
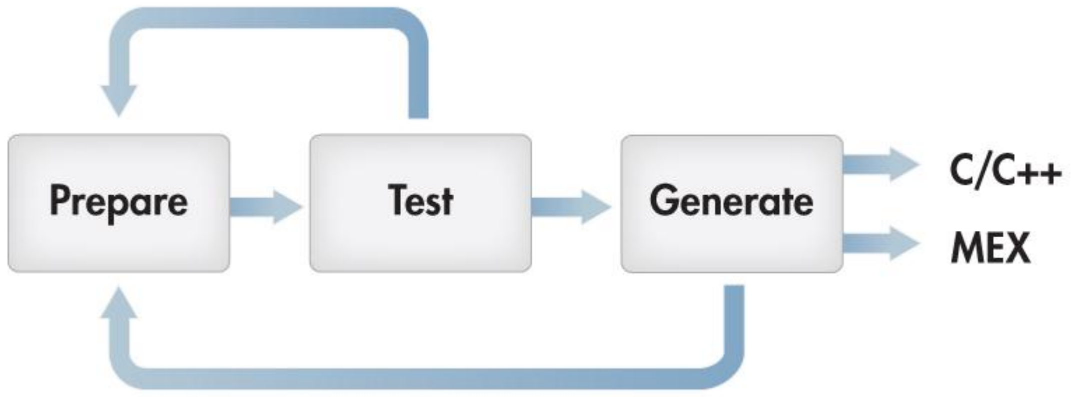


MATLAB Language Support for Code Generation



Using MATLAB Coder: 3-Step Workflow



Prepare your MATLAB algorithm for code generation

- Make implementation choices
- Use supported language features

Test if your MATLAB code is compliant

- Validate that MATLAB program generates code
- Validate the results

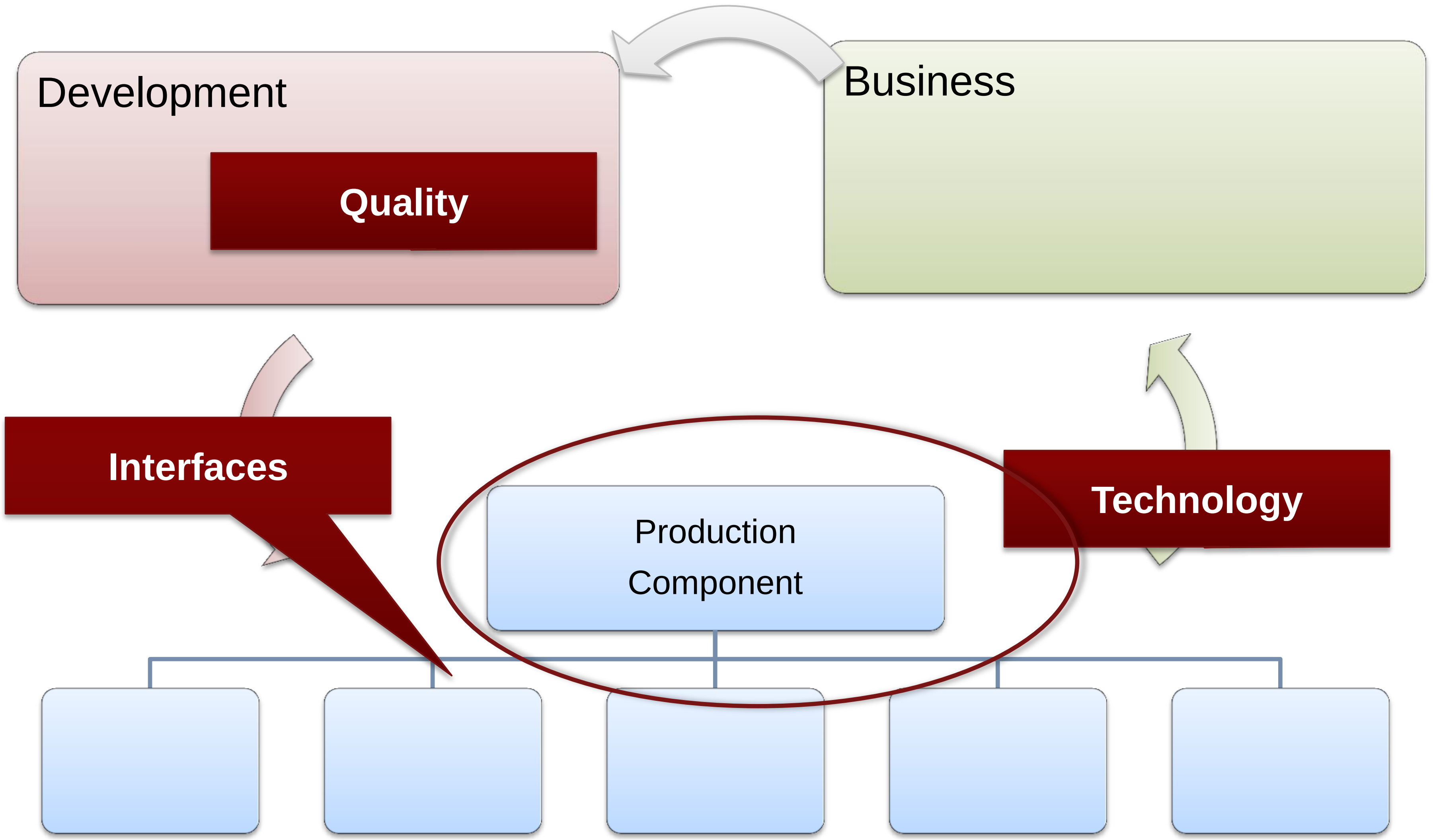
Generate source code or MEX for final use

- Iterate your MATLAB code to optimize
- Implement as source, executable or library

	Compiler and Builders	MATLAB Production Server	MATLAB Coder
Packaging	exe, dll, java class, .NET assembly, Excel add-in	Calls over http	Controlled with Embedded Coder c/c++, dll, lib, exe
Latency	Medium	Low	Very Low
Product support	Rich	Rich	Subset of MATLAB and few toolboxes
IP and code protection	Rich	Rich	Rich
Advanced external interfaces	Rich	Rich	Handled externally
Simultaneous access	No	Yes	No

Summary

Integrating MATLAB into a production trading environment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Interfaces
Production Component
Technology