

BoF-PSS2

Payment and Settlement System Simulator

- A tool for analysis of liquidity, risk and efficiency

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Presentation structure

1. Background
2. Input generation sub-system
3. Simulation execution sub-system
4. Output analysing sub-system
5. Special functions
6. Requirements and user support



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Many dimensions in payment systems

- ▶ **Complex processes**
 - Settlement account characteristics
 - Processing and settlement algorithms
 - Behavioural patterns and incentives
 - Rules defined by user community and authorities
- ▶ **Interdependency**
 - A network of ancillary systems and main settlement systems
 - PVP and DVP processing
 - International relationships
- ▶ **Susceptible to external shocks**
 - Technical, criminal, liquidity, financial and other shocks
- ▶ **Payment systems have hidden characteristics**
 - Internal credits and counterparty obligations



Why simulate?

- ▶ **Simulation models are suitable for analysis of a number of payment system issues**
 - Incorporation of relationships that are complex and close to reality
 - Real and massive data sets can be used
 - Results generally reliable when behavioural effects can be controlled or anticipated
 - Models based on enumeration rather than calculus
- ▶ **Multiple scenarios can be simulated; impossible in real systems**
 - Various risk scenarios
 - Possible changes in settlement conventions, methods and pricing
 - Changes in behavioural patterns and official policies

New tools needed to understand the complexities and risks in this increasingly critical area



Where is simulation applicable?

- ▶ **Payment/settlement system policy**
 - Developing liquidity programs
 - Developing advanced settlement services
- ▶ **Payment/settlement system oversight**
 - Analysing settlement, credit and systemic risks
 - Assessing impacts of proposed regulation
- ▶ **Payment/settlement system-related research**
 - Gridlock-resolution and liquidity-saving algorithms
 - Changes in payment flow patterns caused by international consolidation and electronification
 - Relationships between liquidity circulation and monetary policy

*Simulation models can be adapted
to many research topics*



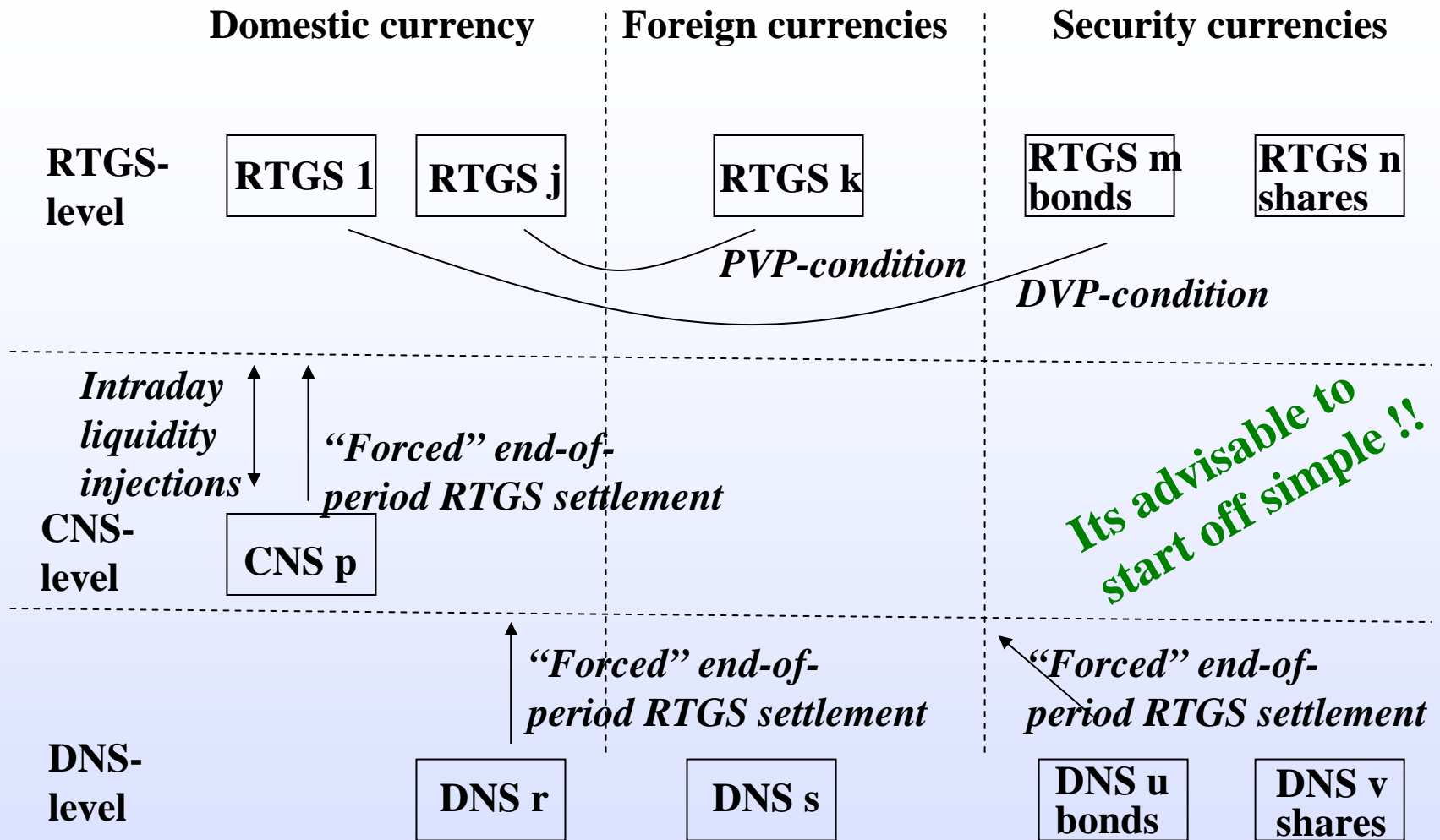
BoF-PSS Simulator development objectives

- ▶ Professional tool for payment and settlement research
 - analyses of most common payment and settlement issues
 - large data sets and processing as in real systems
- ▶ Basic services
 - input, simulation and analysing support
 - most common settlement conventions and algorithms
 - multiple system and currency support
- ▶ Open and common interfaces and standard
 - Java and MySQL development tools
 - CSV and Excel interface
 - User module expansion possibility
- ▶ User-friendliness
 - easy-to-use user interface
 - user guide, help-function and tooltips
 - format conversion support (separators, date, time, file format)

*Balancing act between desires, resources and timetables
(output and input is partly rough and ext. editors are needed.)*



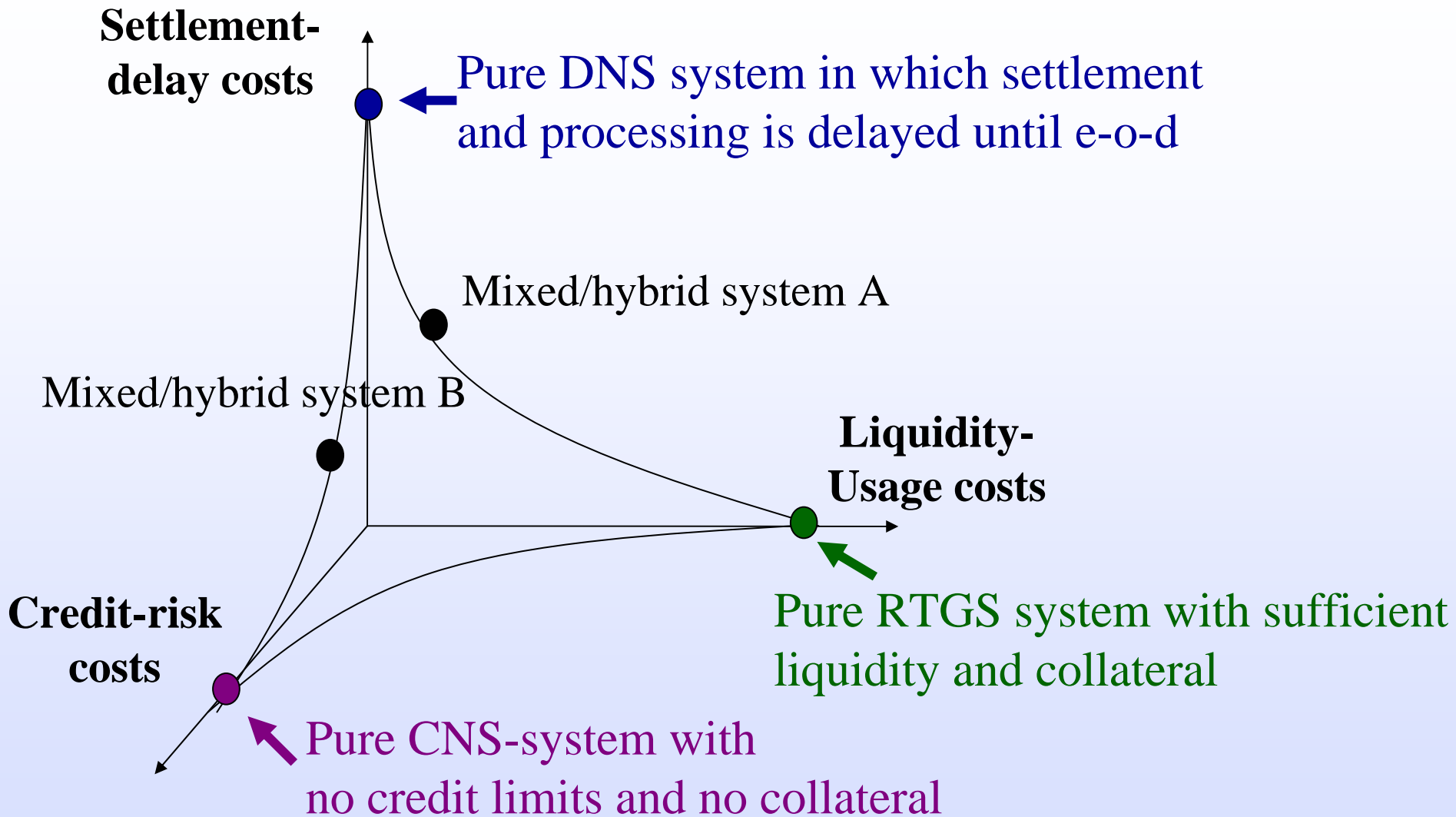
Possible system structures in BoF-PSS2



The simulator supports a large combination of different systems on same and different levels and in different currencies.

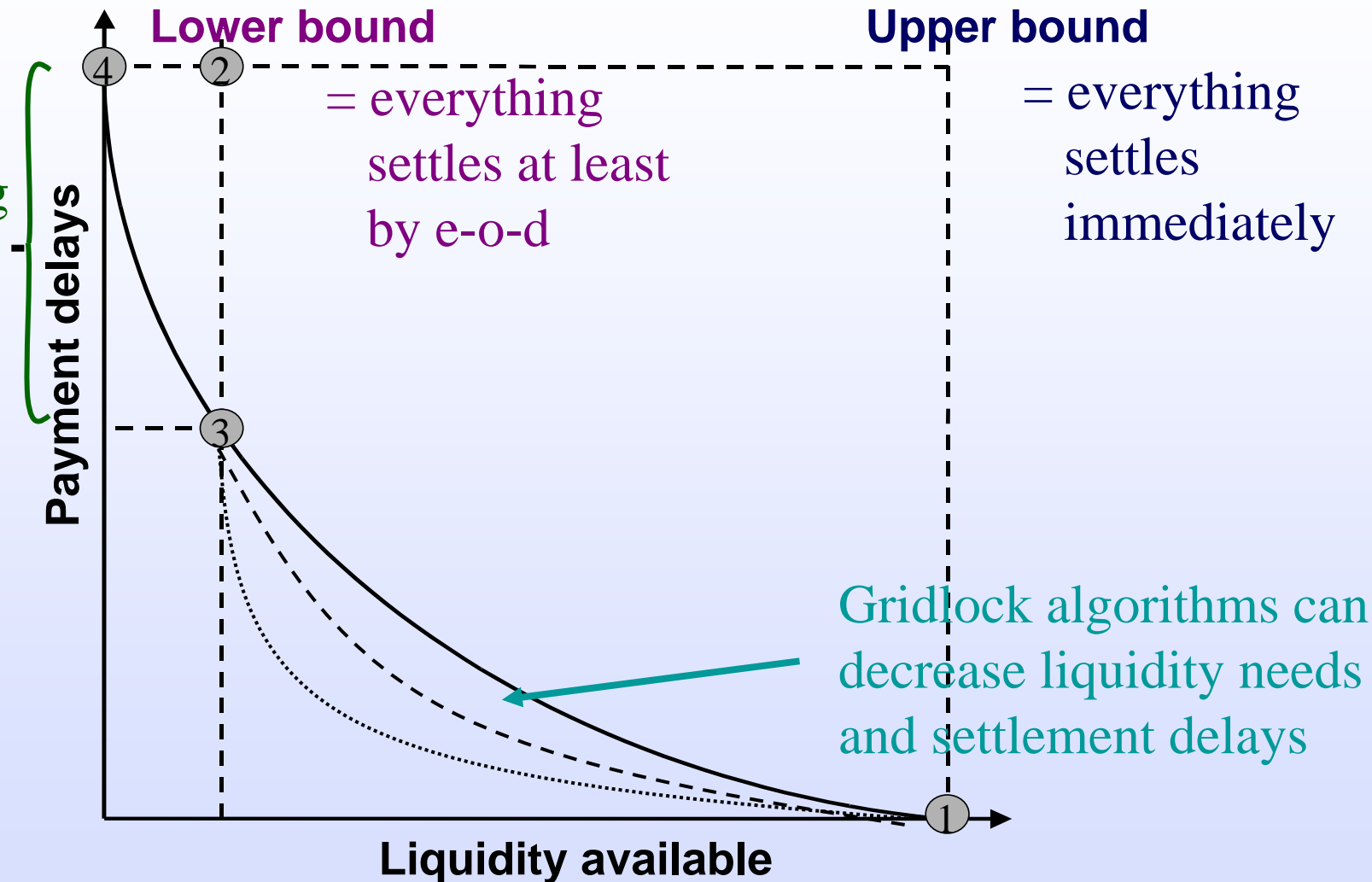


System type and cost structures

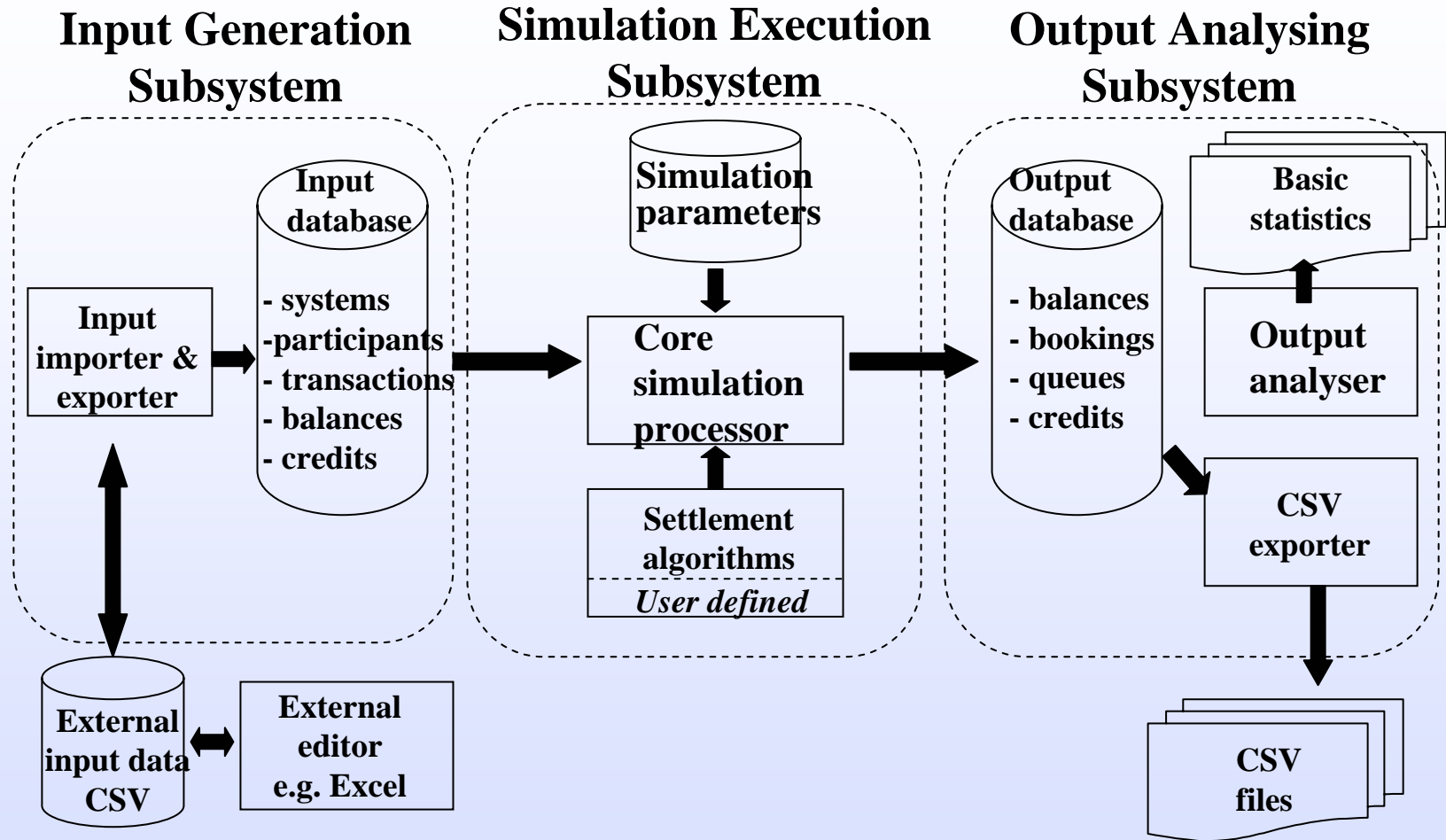


RTGS speed up processing

RTGS benefit
over DNS
when same
liquidity is
used during
the day

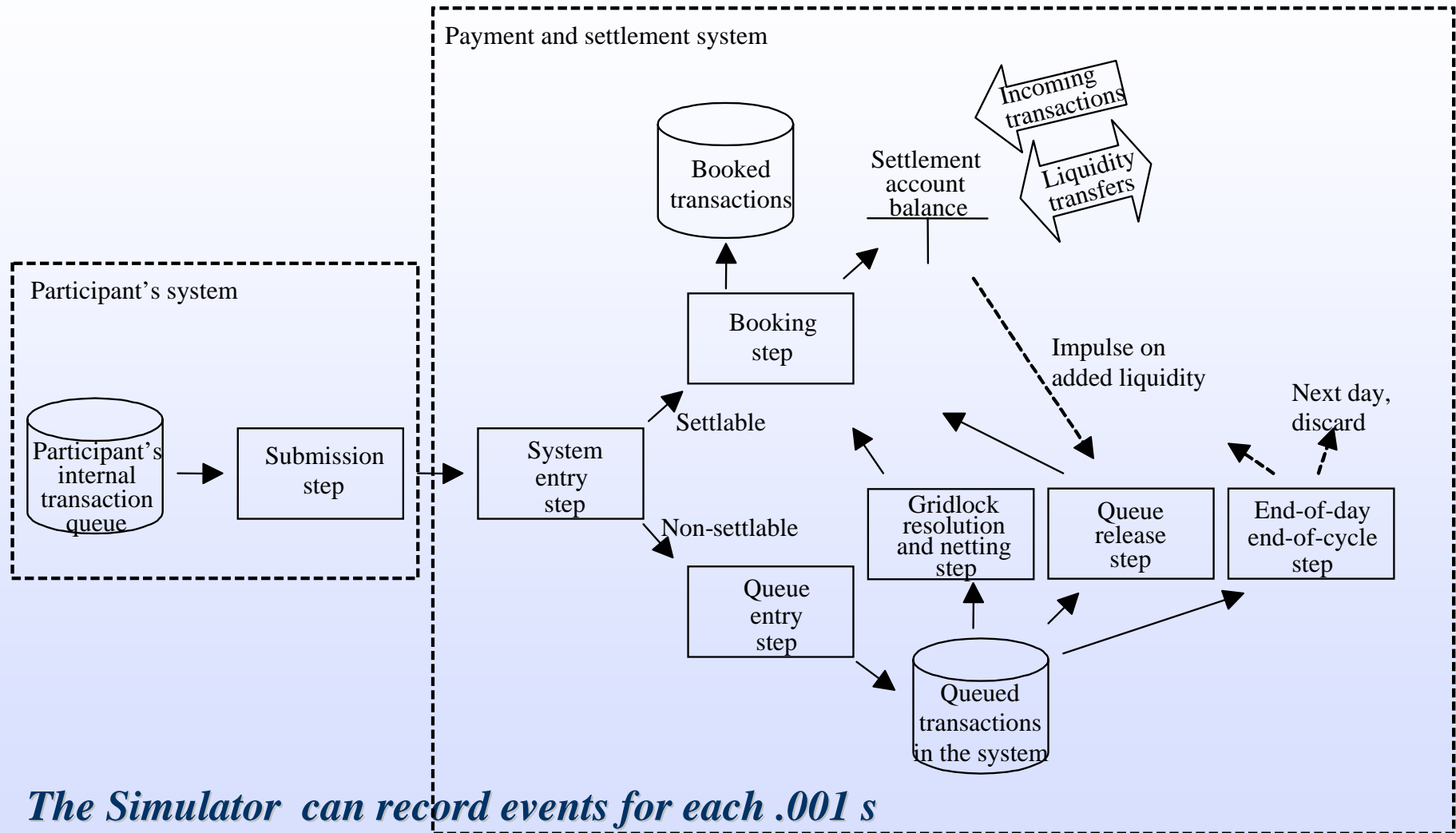


Simulator structure



The Simulator is event driven

Events are occurring in the same sequence as in real-systems, but in some processing phase to simulator is faster and in other slower.



The Simulator can record events for each .001 s



A typical simulation process

- ▶ Define input data
 - Participants/accounts, transactions, system data
- ▶ Execute simulations
 - Different data sets, algorithms, liquidity, etc.
- ▶ Analyse results
 - Compare current with potential system structures/policies and check ‘what if’ special circumstances are realised
- ▶ Iterate



Large simulations are time-consuming

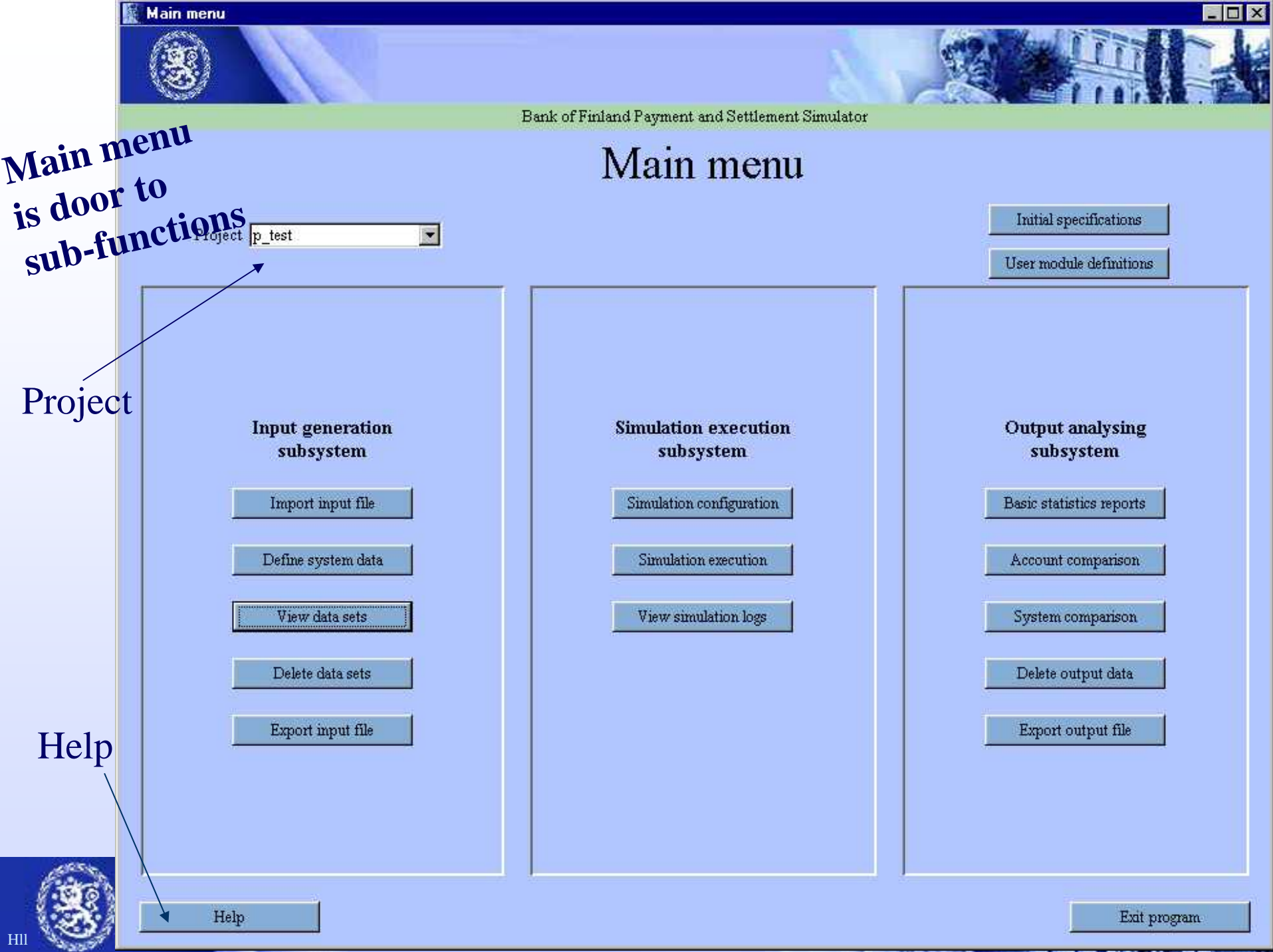
- ▶ Good data preparation
- ▶ Clear simulation plan
- ▶ Systematic analysing/reporting concept
- ▶ Remember backups



Main menu
is door to
sub-functions

Project

Help



Bank of Finland Payment and Settlement Simulator

Main menu

Initial specifications

User module definitions

Input generation subsystem

Import input file

Define system data

View data sets

Delete data sets

Export input file

Simulation execution subsystem

Simulation configuration

Simulation execution

View simulation logs

Output analysing subsystem

Basic statistics reports

Account comparison

System comparison

Delete output data

Export output file

Help

Exit program



Project feature

- ▶ Project definitions can be used to distinguish simulation projects, e.g. RTGS simulations from security settlement simulations
- ▶ Projects typically have a separate input and output database (if not, a common input and/or output database can be defined)
- ▶ Projects established using the ‘initial specifications’ button



Online help

Print

Content
Index
Search
Favorites

The screenshot shows a web browser window titled "HTML Help" with a menu bar (Hide, Back, Forward, Home, Print, Options) and a sidebar with tabs (Contents, Index, Search, Favorites). The "Contents" tab is active, displaying a tree view of the "User manual of the BoF-PSS2 program" with sections 1 through 7. Section 1, "General overview", is selected. The main content area displays the title "1. 1 General overview" and a paragraph: "The BoF-PSS2 system structure contains three main subsystems:". Below this are three links: "a) [Input Generation Subsystem](#)", "b) [Simulation Execution Subsystem](#)", and "c) [Output Analysing Subsystem](#)". A paragraph follows: "The architecture of the PSS2 program is described below in the picture". Below the text is a diagram titled "Workstation" showing the "BoF-PSS2 Simulator" architecture. The diagram illustrates the flow of data from "Import data" (Exported CSV-files, Input data CSV-files) through the "Input subsystem" to the "Input database", then through the "Execution subsystem" to the "Output database", and finally through the "Output subsystem" to "Output analysing data" (Excel files, Simulation output CSV-files). The diagram also shows "Project management data" (Error files, Output reports, System database) and "System management data" (Temp directory, User module directory) at the bottom, connected to the main subsystems.

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The input generation subsystem facilitates data preparation

Input generation
subsystem

Import input file

Define system data

View data sets

Delete data sets

Export input file

← Import of participant/account, transaction, initial balances and intraday credit changes

← Payment/settlement system definition data

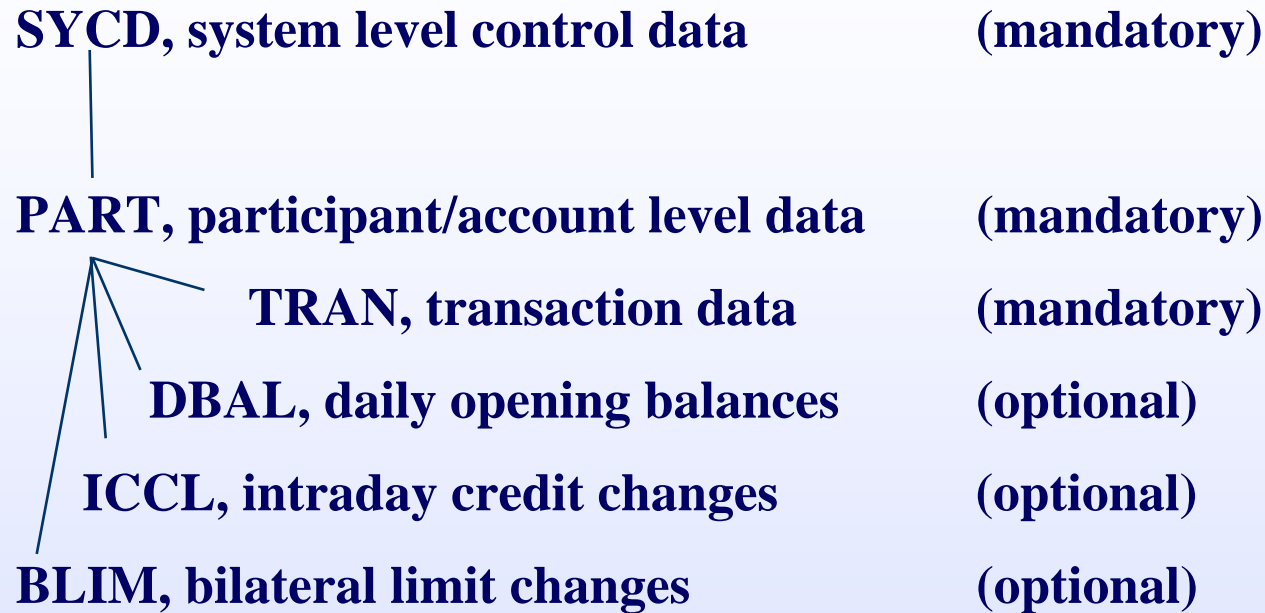
← View data in input database

← Delete data from input database

← Export data from the input database, e.g. for editing purposes



Input database data table structure



All data for the PART, TRAN, DBAL, ICCL and BLIM data tables are imported via CSV-files (comma separated values). SYCD system level data is defined via a separate screen.



Importing data from CSV file

Defaults

Data types

- Participant/account
- Transaction
- Initial balances
- Credit limits

System ID

Input file

Data set

Template name

Template column numbers

Project : exl

Database table: TRAN Transaction data

Data format defaults

Data separator: ,

Date format: yyyy-mm-dd

Decimal separator: .

Time format: hh:mm:ss.sss

Transposition value: +0000

Input file: C:\BoF-PSS2\p_exl\INPUT\Exl-tran.csv

Browse

System ID: exl

Create new data set: tran1

Update old data set: tran1

Insert in old data set: tran1

Use old template:

Number of rows/records to skip at the beginning: 2

Number of rows/records to skip at the end: 0

Data table

File column...	DB col	Man/Opt	Var. name	Descriptive name
3	5	M	T_INTRTIME	Introduction time
4	6	M	T_TRANVALU	Transaction value
	7	O	T_FRSYSTID	From system ID
6	8	M	T_FRPARTID	From participant ID
	9	O	T_FRACCOID	From account ID
	10	O	T_TOSYSTID	To system ID
5	11	M	T_TOPARTID	To participant ID

Rows processed:

Rows with errors:

Stop import

Undo import

Execute import

View error report

Help

Back to main menu

Exit program

Bank of Finland Payment and Settlement Simulator



CSV(=comma separated values) input data types

- ▶ PART participant and account data
 - Participant and account IDs and data can be defined on participant and account levels
- ▶ TRAN transaction data
 - Date/time, from participant/account, to participant/account, to/from system, value, transaction ID (alpha ascending!)
- ▶ DBAL daily initial balances
 - Day and value
- ▶ ICCL intraday credit limit changes
 - Day, time and new value
- ▶ BLIM
 - Day, time and new value

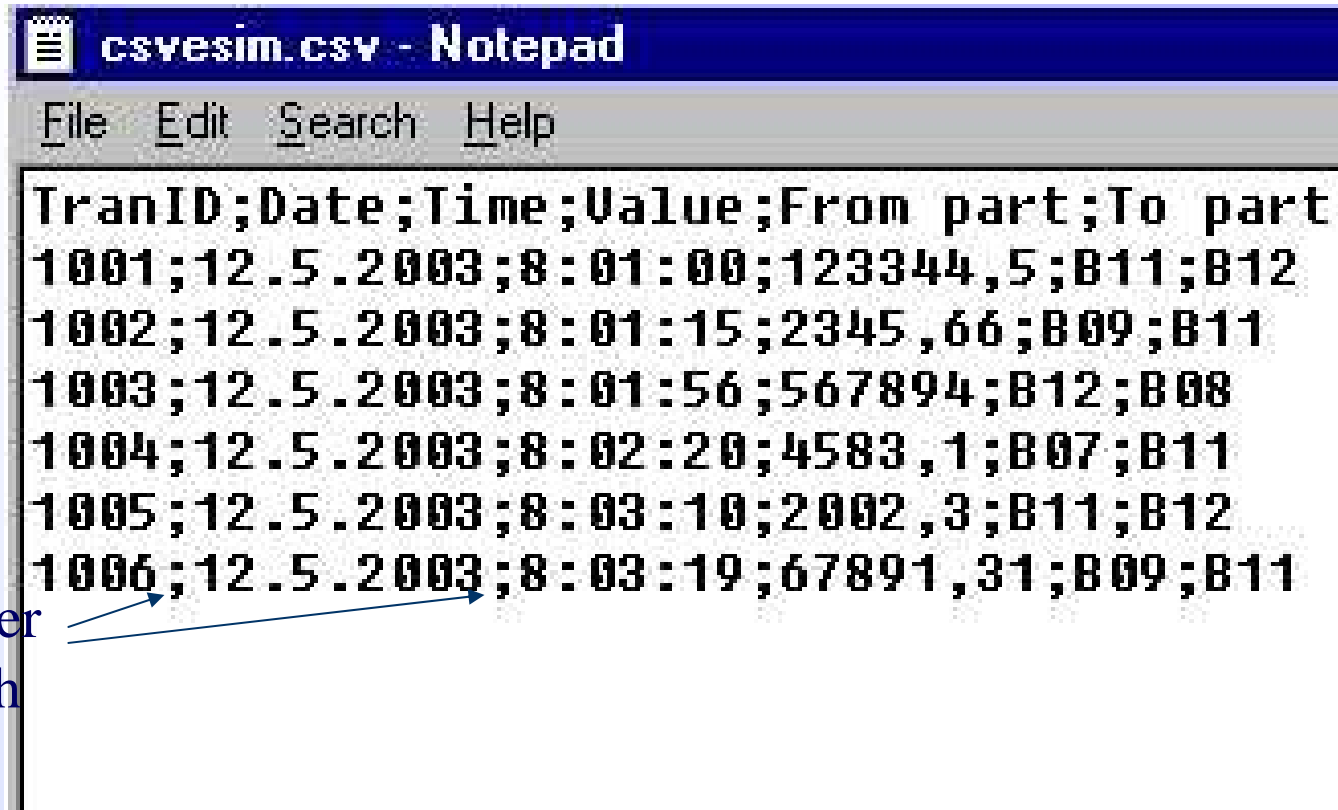
PART and TRAN are mandatory, while DBAL, ICCL and BLIM are optional.

System ID must be coherent with input data!

CSV files can be generated by Excel (saved as CSV type).



Typical CSV-file



```
csvesim.csv - Notepad
File Edit Search Help
TranID;Date;Time;Value;From part;To part
1001;12.5.2003;8:01:00;123344,5;B11;B12
1002;12.5.2003;8:01:15;2345,66;B09;B11
1003;12.5.2003;8:01:56;567894;B12;B08
1004;12.5.2003;8:02:20;4583,1;B07;B11
1005;12.5.2003;8:03:10;2002,3;B11;B12
1006;12.5.2003;8:03:19;67891,31;B09;B11
```

A title line
that can be
skipped is
helpful

Data delimiter
between each
data field

*CSV-files can be easily created with Excel, Access, MySQL etc.
The 'true' content can be easily checked with Notepad.*



Template to CSV-file relationship

```

Ex1-tran.csv - Notepad
File Edit Format View Help
Transaction data for RTGS in example 1
ID;Day;Time;Value;Rec part ID;Send part ID;Class
101;12.5.2003;7:01:00;4880384,39;1;13;1
102;12.5.2003;7:01:00;685826,6;1;12;1
103;12.5.2003;7:01:00;2639630,73;1;11;1
104;12.5.2003;7:01:00;46064,41;1;10;1
105;12.5.2003;7:01:00;633795,99;1;2;1
106;12.5.2003;7:01:00;79702,04;1;14;1
    
```

Two introductory
explanation rows
to be skipped

File column in input
template tells the data
order in the input
CSV-file

Data table				
File column...	DB col	Man/Opt	Var. name	
1	3	M	T_TRANSAID	Transaction ID
2	4	M	T_INTRDATE	Introduction date
3	5	M	T_INTRTIME	Introduction time
4	6	M	T_TRANVALU	Transaction value
	7	O	T_FRSYSTID	From system ID
5	8	M	T_FRPARTID	From participant ID
	9	O	T_FRACCOID	From account ID
	10	O	T_TOSYSTID	To system ID
6	11	M	T_TOPARTID	To participant ID



Data sets

- ▶ Data set IDs allow storage of parallel data tables in data base
- ▶ Simulations may use different data sets for varying the input data, e.g. more or less intraday credit, normal or exceptional transaction flows

Data set IDs	CRVAL1	CRVAL2		CRVALn
Data tables	ICCL table	ICCL table	...	ICCL table

*Use a clear naming convention
for different data sets*



Import templates

- ▶ Import templates facilitates data/file format conversions
- ▶ Templates define relations between the input CSV columns and data base table fields
- ▶ The column (=data field order) in the CSV file should be stated for each data field to be imported
- ▶ Fields can be any order; there may be extra fields in the CSV file that will not be imported
- ▶ Each data table has some mandatory fields that must be present
- ▶ Templates are named and can be reused
- ▶ Changes to old templates will be updated

*Use a clear naming convention
for different data sets*



Default data formats

Data format defaults	Data separator:	<input type="text" value=","/>	Date format:	<input type="text" value="yyyy-mm-dd"/>
	Decimal separator:	<input type="text" value="."/>	Time format:	<input type="text" value="hh:mm:ss.sss"/>
			Transposition value:	<input type="text" value="+0000"/>

- ▶ Data and decimal separators can be freely chosen, but must be different.
- ▶ A number of predefined date and time formats are available. Time accuracy to 1/1000 second.
- ▶ Imports allow all kinds of date and time delimiters
- ▶ Exports generate dashes with dates and colons with time formats (when delimiters specified).
- ▶ New defaults remain in force until they are changed.
- ▶ When using Excel or other tools, check that the data format defaults are identical (use Notepad or similar!!!)
- ▶ Transposition value (hhmm) moves actual time forwards or backwards so that input data align with simulator's 00-24 hour timeframe

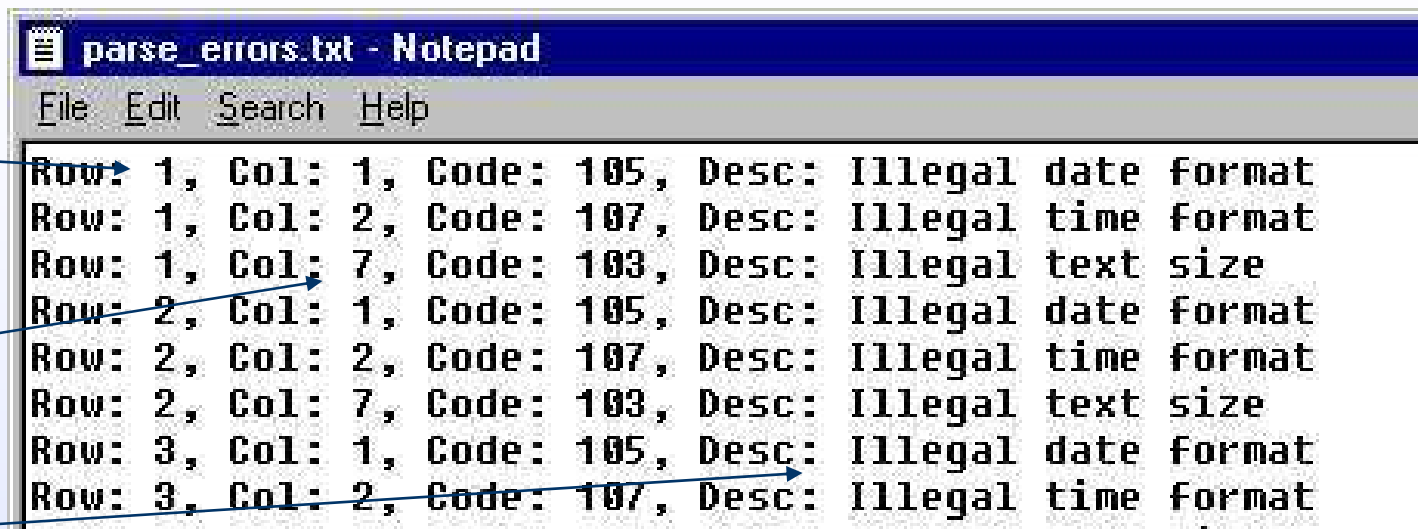


Import input error list

Line in CSV-file
with error

Column/field
with error

Error type



Row: 1, Col: 1, Code: 105, Desc: Illegal date format
Row: 1, Col: 2, Code: 107, Desc: Illegal time format
Row: 1, Col: 7, Code: 103, Desc: Illegal text size
Row: 2, Col: 1, Code: 105, Desc: Illegal date format
Row: 2, Col: 2, Code: 107, Desc: Illegal time format
Row: 2, Col: 7, Code: 103, Desc: Illegal text size
Row: 3, Col: 1, Code: 105, Desc: Illegal date format
Row: 3, Col: 2, Code: 107, Desc: Illegal time format





System control data specification/modification

Project : ex1

System ID: ☐ Modify old system data set ☒ Create new system data set Copy from old system data set System full name: Opens (hhmm 24h): System description: System type: Closes: System acronym:

Transfer of balances

☐ Transfer balances to next day☐ Bilateral limit in use

Intraday credit availability

☒ Credits according to limit table, or☐ No credits available, or☐ Credit available without limits

Handling of unsettled transactions

☒ Transfer unsettled transactions to next day/settlement occasion or☐ Delete unsettled transactions or☐ Force end-of-day settlement of unsettled transactions

Potential algorithms: select one and add it to the attached algorithms by pressing the 'Add algorithm' button. ENT and END algorithms are mandatory.

Add algorithm

Attached algorithms: Changes of order by dragging/dropping. Deletion by striking keyboard 'delete' button for active algorithms.

Algorithm	Algorithm type	Double click row to insert parameter values



System control data

- ▶ System ID must be coherent with input data!
- ▶ Data set IDs to be used with parallel data sets
- ▶ System types available:
 - RTGS (real time gross settlement),
 - CNS (continuous net settlement) and
 - DNS (deferred net settlement)
- ▶ Algorithms for defining the processing conventions need to be specified for each system
- ▶ Mandatory algorithms:
 - ENT (entry) and
 - END (end-of-day)
- ▶ Optional algorithms:
 - SPL (split)
 - QUE (queue release)
 - BOS (bilateral offsetting)
 - MNS (complete multilateral settlement)
 - INJ (injection),
 - SET (settlement)
 - PNS (partial net settlement)



Main algorithms

- ▶ **SUB** (submission) algorithm determines when a transaction is submitted for processing, i.e. chooses next transaction to be processed
- ▶ **ENT** (entry) algorithm is first processing phase for a transaction. Generally transferred to bookings when liquidity available; queued/discarded if there is a lack of liquidity
- ▶ **SET** (settlement) algorithm processes queued transactions, e.g. invoking gridlock- resolution algorithms
- ▶ **END** (end-of-day) algorithm clears up end-of-day situations



Sub-algorithms

- ▶ Can be invoked by ENT, SET and END algorithms
- ▶ **QUE** (queue release) algorithms release transactions from waiting queues in a defined order
- ▶ **SPL** (splitting) algorithms split large transactions into small, easy-to-process transactions
- ▶ **INJ** (injection) algorithms transfer liquidity from/to accounts to/from other systems
- ▶ **BOS** (bilateral offsetting) nets queued transactions between two counterparties in a given order
- ▶ **PNS** (partial net settlement) algorithms seek multilateral payment batches that can be netted
- ▶ **MNS** (complete multilateral settlement) netting of all transactions in queues



Expanding the algorithm list

- ▶ Current algorithm list includes most common settlement algorithms and conventions
- ▶ General and parameter-driven algorithms facilitate user adaptation
- ▶ Users can also develop own algorithms with user module interface
- ▶ Modular design of algorithms and interfaces facilitates easy expansion

Comments and proposals on algorithm development are always welcome.





View data sets

Project: p_test

Data type: TRAN Transaction data

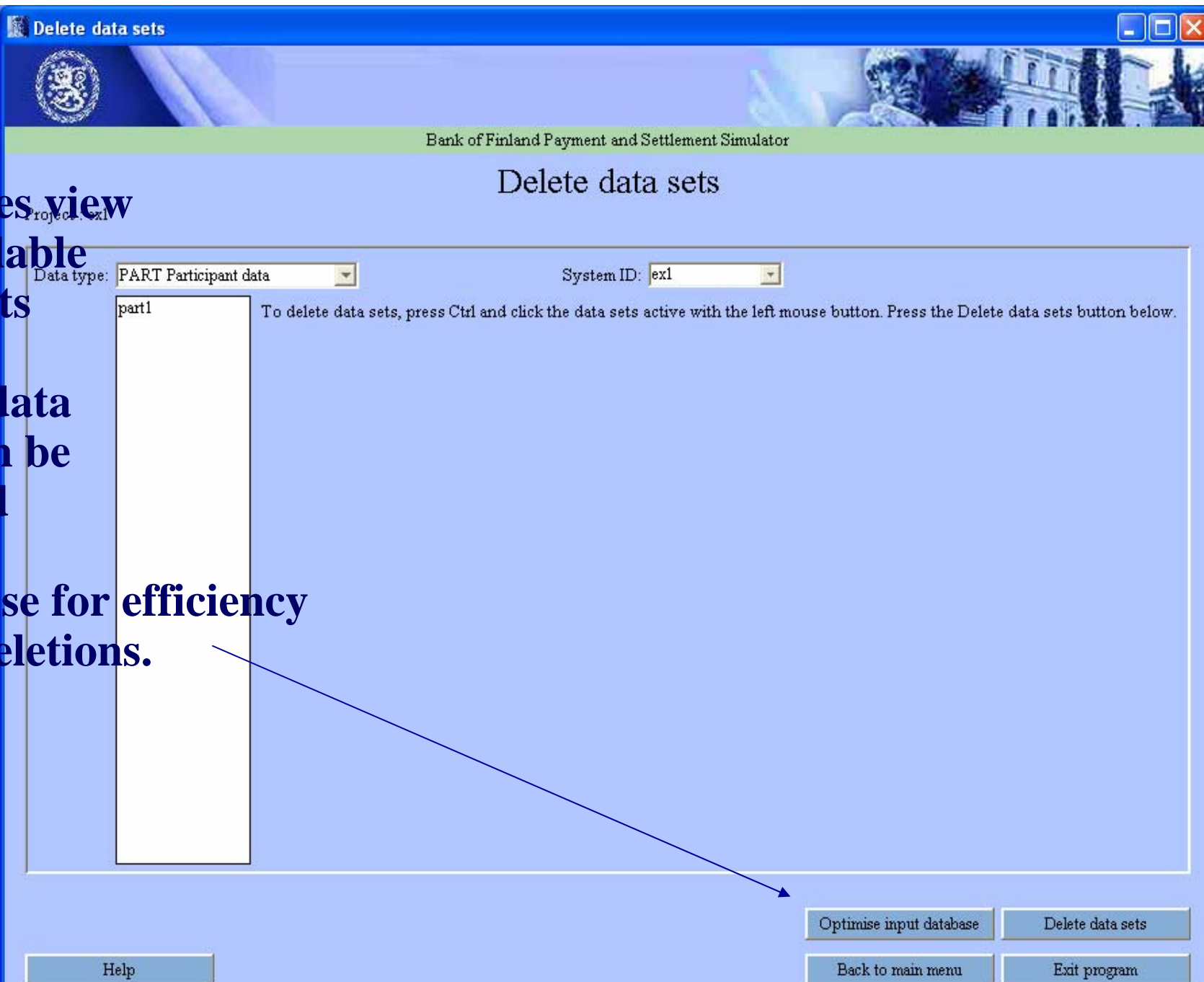
System ID: S-RTGS

Data set ID: tran0814

Transaction ID	Introduction date	Introduction time	Transaction value	From system ID	From participant ID	From account ID	To sy:
101	2003-05-12	07:01:00	4880384,39	S-RTGS	1		S-RTGS
102	2003-05-12	07:01:00	685826,60	S-RTGS	1		S-RTGS
103	2003-05-12	07:01:00	2639630,73	S-RTGS	1		S-RTGS
104	2003-05-12	07:01:00	46064,41	S-RTGS	1		S-RTGS
105	2003-05-12	07:01:00	633795,99	S-RTGS	1		S-RTGS
106	2003-05-12	07:01:00	79702,04	S-RTGS	1		S-RTGS
107	2003-05-12	07:01:00	2786,33	S-RTGS	1		S-RTGS
108	2003-05-12	07:01:00	8000,03	S-RTGS	1		S-RTGS
109	2003-05-12	07:01:00	153492,54	S-RTGS	5		S-RTGS
110	2003-05-12	07:01:00	83989,24	S-RTGS	5		S-RTGS
111	2003-05-12	07:01:00	779471,41	S-RTGS	5		S-RTGS
112	2003-05-12	07:01:00	6678,92	S-RTGS	5		S-RTGS
113	2003-05-12	07:01:00	49921,70	S-RTGS	5		S-RTGS
114	2003-05-12	07:01:00	17337,06	S-RTGS	5		S-RTGS
115	2003-05-12	07:01:00	300182,44	S-RTGS	5		S-RTGS
116	2003-05-12	07:01:00	18950,49	S-RTGS	5		S-RTGS
117	2003-05-12	07:01:00	1634545,51	S-RTGS	6		S-RTGS
118	2003-05-12	07:01:00	408639,34	S-RTGS	6		S-RTGS
119	2003-05-12	07:01:00	1856551,99	S-RTGS	6		S-RTGS
120	2003-05-12	07:01:00	184378,62	S-RTGS	6		S-RTGS
121	2003-05-12	07:01:00	16723,85	S-RTGS	6		S-RTGS
122	2003-05-12	07:01:00	12084,40	S-RTGS	6		S-RTGS
123	2003-05-12	07:01:00	57860,37	S-RTGS	6		S-RTGS
124	2003-05-12	07:01:00	4920425,27	S-RTGS	14		S-RTGS
125	2003-05-12	07:01:00	1826540,68	S-RTGS	14		S-RTGS

Useful
for checking
moderate size
data tables





**Provides view
of available
data sets**

**Extra data
sets can be
Deleted**

**Optimise for efficiency
after deletions.**



Input data can be exported for modification and re-imported

Export input file

Bank of Finland Payment and Settlement Simulator

Export input file

Project:

Data set ID:

Database table:

Dataformat defaults

Data separator:

Date format:

Decimal separator:

Time format:

Output file:

☐ Create new template:

☐ Use old template:

☐ Create names of columns

File column...	DB col	Man/Opt	Var. name	Descriptive name	Selection Criteria
	2	M	P_SYSTEMID	System ID	
	3	M	P_PARTICID	Participant ID	
	4	M	P_ACCOUNTID	Account ID	
	5	O	P_FULLNAME	Full name	
	6	O	P_SHORTACR	Short acronym	
	7	O	P_ACCONAME	Account name	
	8	O	P_SETINSYS	Settles in system	
	9	O	P_SETONPAR	Settles on participant	
	10	O	P_SETONACC	Settles on account	
	11	O	P_LIQFRSYS	Liquidity injection from system	
	12	O	P_LIQFRPAR	Liquidity injection from participant	
	13	O	P_LIQFRACC	Liquidity injection from account	
	14	O	P_LIQINJVA	Participant/account specific liquidity injection value	

Rows processed:

Export
template

Output file
column
numbers

Selection
criteria



Export and re-import of input data

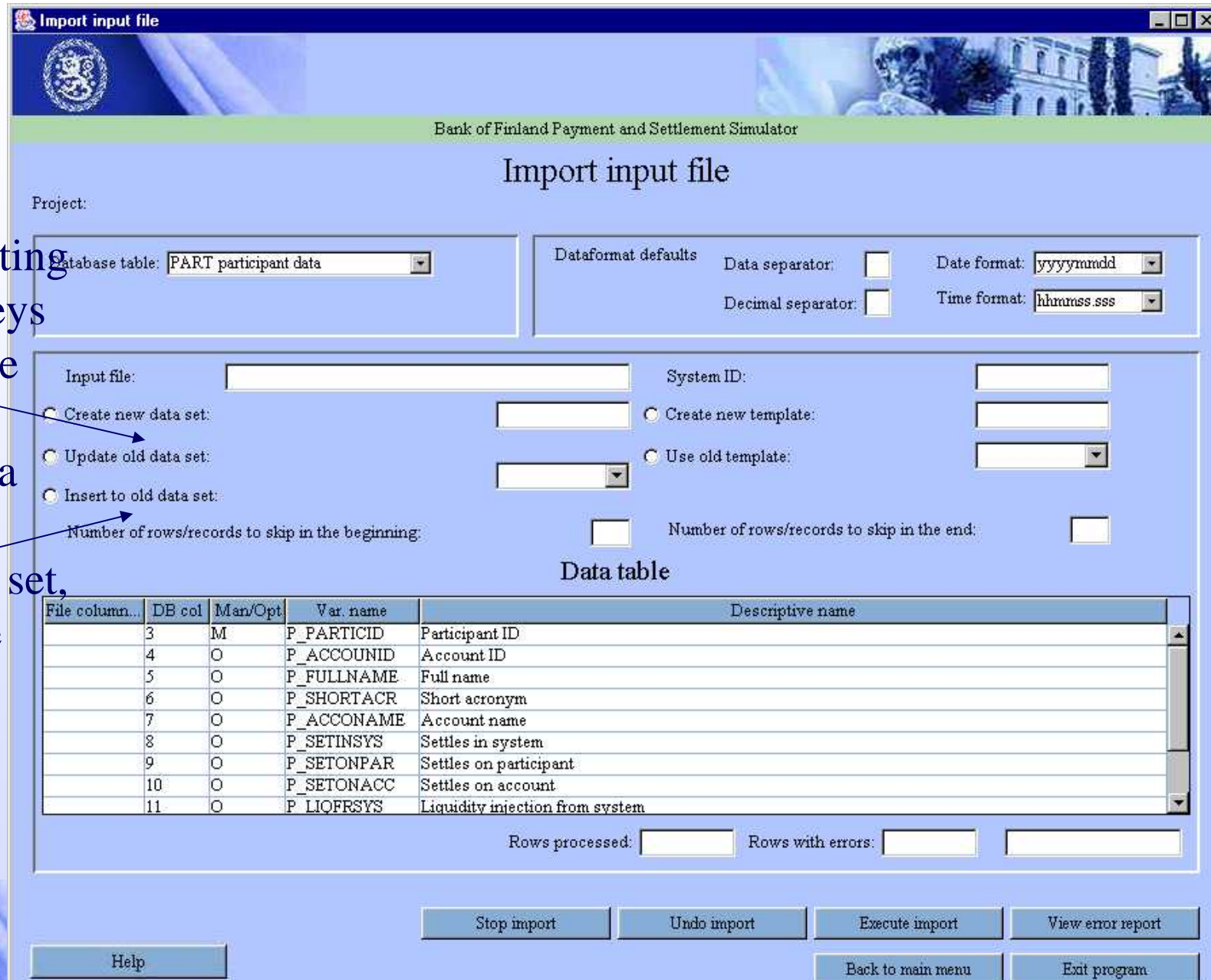
- ▶ Selection criteria can be used to extract given parts of a data set
 - Several criteria for different fields operate in .AND. mode
 - Several criteria for same field operate in .OR. mode)
- ▶ Data can be re-imported using UPDATE or INSERT mode on an existing data set
- ▶ When Excel is used for editing, the following should be observed:
 - Limit of about 65,000 rows
 - Extra rows may be added to the CSV file in the form of empty ,,,, rows if these has been activated in Excel
 - Excel may change delimiters, decimals and special signs/characters
 - Large values may loose accuracy



Import data from CSV file in INSERT or UPDATE mode

Updates existing data rows, keys must coincide

Add new data rows to an existing data set, keys must be different



The screenshot shows the 'Import input file' window of the 'Bank of Finland Payment and Settlement Simulator'. The window has a blue header with the bank's logo and name. The main area is titled 'Import input file' and contains several sections for configuring the data import process.

Project:

Database table:

Dataformat defaults

Data separator: ☐ Date format:
Decimal separator: ☐ Time format:

Input file:

System ID:

☐ Create new data set:

☐ Update old data set:

☐ Insert to old data set:

☐ Create new template:

☐ Use old template:

Number of rows/records to skip in the beginning: Number of rows/records to skip in the end:

Data table

File column...	DB col	Man/Opt	Var. name	Descriptive name
	3	M	P_PARTICID	Participant ID
	4	O	P_ACCOUNTID	Account ID
	5	O	P_FULLNAME	Full name
	6	O	P_SHORTACR	Short acronym
	7	O	P_ACCONAME	Account name
	8	O	P_SETINSYS	Settles in system
	9	O	P_SETONPAR	Settles on participant
	10	O	P_SETONACC	Settles on account
	11	O	P_LIQFRSYS	Liquidity injection from system

Rows processed: Rows with errors:

Buttons: Stop import, Undo import, Execute import, View error report, Help, Back to main menu, Exit program

Presentation structure

1. Background
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The execution subsystem launches and monitors simulations

Simulation execution
subsystem

Simulation configuration

Simulation execution

View simulation logs

Definition of simulation: which systems
and which data

Launching simulations and defining
output data

View logs of previous simulations



Simulation configuration

Bank of Finland Payment and Settlement Simulator

Simulation configuration

Project : SMALL

☐ Modify old simulation ID
☒ Create new simulation ID
 Copy from old simulation ID

Simulation name:

Description:

Sub-algorithm: Parameters:

Data sets to simulation:

Add/update data set

Delete

System ID	System data set	Transaction data set	Participant data set	Credit limit data set	Balance data set
RTGS-S	SYST1	TRAN1	PART1	ICCL1	

Number of errors:

For defining data sets for the simulation first select the desired system ID in the corresponding drop-down box above the table, then the desired data sets. Next press the add/update data set button to move the new data to the data table. A system can be deleted from the table by selecting the system ID and pressing the Delete button.

Simulation ID
(good naming
convention)

Name and
description are
optional

Choose systems
and data sets
for systems

Cross-check data



Possible system combinations

- ▶ One independent system
- ▶ Domestic system structure with eg RTGS, DNS and securities settlement system
- ▶ International multi-RTGS system in single currency (eg TARGET)
- ▶ International RTGS or CNS multi-currency system with PVP processing
- ▶ DVP processing in securities settlement systems with internal or external (RTGS) money leg settlement

The simulator provides flexible possibilities for simulations with multi-system structures



Features for DVP/PVP and system relationships

- ▶ Transactions can be made between systems just by defining FROM-SYSTEM and TO-SYSTEM in the transactions
- ▶ DVP and PVP is automatically invoked by defining LINKCODE and LINKSYST in the transactions
- ▶ Injection and end-of-day algorithms can transfer liquidity/make bookings between main and ancillary systems

The simulator provides flexible possibilities for simulations with multi-system structures



Cross-checking for data coherency

- ▶ Simulation configuration implies definition of which systems will run and with which data sets
- ▶ Cross-checking implies checking for data coherency eg so all participants/accounts are available as demanded by transaction records and all systems are available as demanded by inter-system transactions
- ▶ Import functions only have checked data values, no cross-table checks
- ▶ Incoherent data (sets) will not execute



Simulation execution

Bank of Finland Payment and Settlement Simulator

Simulation execution

Project root

☐ Modify old simulation batch ID
☒ Create new simulation batch ID
 Copy from old simulation batch ID

Select a simulation ID and add it to the table by pressing the add simulation ID button. A simulation can be deleted from the batch by selecting the simulation ID and by pressing thereafter the Delete button.

Simulation ID: Add simulation ID Delete

☒ Execute cross-check
 ☐ Skip cross-check

Simulation id	Simulation name	System level stat.	Account stat.	Transact. event stat.	Netting event stat.	Account violation stat.	Booking event stat.	Unsettl. transact. stat.	Submitt. transact. stat.	Queued transact. stat.	Bilateral account stat.	Queue reason stat.
SYLS	ACST	TEST	NEST	AVST	BEST	UNST	SUST	QUST	BIST	QURE		
test1		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Simulations can be made in batches with one or more simulation ID

Select from pre-configured simulations

Determine output tables to be stored in output database

Bypass cross-check only in large simulations when you are sure about data coherency





View simulation logs

Project : p_test

Simulation ID	Simulation name ▼	Date/time	Duration	SYLS	ACST	TEST	NEST	AVST	BEST
2Pjono		14-07-2003/11:21:35	00:00:00	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2Painall		14-07-2003/01:45:11	00:00:00	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2Pbalnc		14-07-2003/02:03:53	00:00:00	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2Pque1		15-07-2003/12:21:09	00:00:00	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2Pque3		15-07-2003/01:12:05	00:00:00	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2Pjono2	toinen yrittämä	14-07-2003/11:24:24	00:00:00	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

List of previous
simulations and
available
output data tables

Help

Back to main menu

Exit program



Presentation structure

1. Background
2. Input generation sub-system
3. Simulation execution sub-system
4. Output analysing sub-system
5. Special functions
6. Requirements and user support



The output analysing subsystem provides basic output reports and export facilities

Output analysing subsystem

Basic statistics reports

Account comparison

System comparison

Delete output data

Export output file

Basic statistics report

Account level comparisons of simulations

System level comparisons of simulations

Deleting unnecessary output data

Exporting output files for further analyses
(all data from output database to CSV files)



Output database data table structure

SIMULATION, SYSTEM AND ACOCUNT LEVEL

BARI, simulation batch run data

SIRI, simulation run data

SYLS, system level statistics

ACST, account level statistics

BIST, bilateral statistics

TRANSACTIONS LEVEL

TEST, Transaction event statistics,

NEST, Netting event statistics,

AVST, account violation statistics

BEST, booking event statistics,

UNST, unsettled transactions statistics

SUST, submitted transactions statistics

QUST, queued transactions statistics

QURE, queue reason statistics

CTST, comment transactions statistics

CCST, comment intraday credit statistics

*All data from the data table can be exported into CSV-files
and thereby viewed eg using Excel*



Reports on
system and
account level
and as data
or time series

Each
report is
written to
CSV files
and viewed
in Excel

Basic statistics reports

Bank of Finland Payment and Settlement Simulator

Basic statistics reports

Project : ex1

Simulation ID Simulation name

test1 Output file: C:/BoF-PSS2/P_ex1/OUTPUT_REPORTS/Accountstatistics_test1_ex1.csv

☐ System statistics report

☒ Account statistics report System ID: ex1

☐ Bilateral limits statistics report

☐ System time series report System ID: Reporting interval per minutes

☐ Account time series report System ID: Reporting interval per minutes

Participant ID Account ID

Account ID: Reporting interval per minutes

☐ Bilateral limits time series System ID: Reporting interval per minutes

Participant ID Account ID

Account ID: Reporting interval per minutes

Help Save in csv-file Save and open csv-file Back to main menu Exit program



Account level report example

Microsoft Excel - Accountstatistics_FIRSTSMailk.csv

File Edit View Insert Format Tools Data Window Help

100%

Arial 10 B I U

B29 =

	A	B	C	E	F	H	J
1	Account statistics						
2							
3	Simulation Simulation	Simulation processing	Simulation processing time:				
4	System:RTGS-A						
5							
6	Participant	Beginning-	End-of-day balance	Minimum balance	Maximum balance	Value settled	Number settled
7	1	0	-9 920 125,53	-62 487 362,45	8 976 190,52	75 589 147,66	52
8	2	0	-8 257 211,55	-46 332 642,55	42 660 636,69	103 916 633,12	47
9	3	0	231,61	-98 472 668,39	231,61	144 105 054,21	102
10	4	0	140,00	0,00	140,00	0,00	0
11	5	0	-54 702 407,40	-54 702 407,40	123 774 347,88	201 506 601,70	25
12	6	0	156 073 179,53	-31 529 770,02	215 304 644,95	98 130 151,61	31
13	7	0	0,00	0,00	0,00	0,00	0
14	8	0	389 741 145,11	0,00	389 741 145,11	0,00	0
15	9	0	-389 741 145,07	-1 459 456 768,50	0,00	2 576 765 840,54	70

*All reports are produced as CSV-files,
which can be opened with Excel,
reporting is 'rough' and needs editing.*



Comparison views are saved for re-use

Additional columns

Choose simulations to be compared (becomes columns in report)

Choose system

Choose data fields (becomes rows in report for each account)

The screenshot shows the 'Account comparison analyser' window. At the top, it says 'Bank of Finland Payment and Settlement Simulator' and 'Account comparison analyser'. Below this, it shows 'Project : harrykurv'. There are three radio buttons: 'Modify old comparison view' (selected), 'Create new comparison view', and 'Copy from old comparison view'. Each has a corresponding dropdown menu. Below these is an 'Output file:' text box containing 'C:/BoF-PSS2/harrykurv/OUTPUT/'. To the right of this is a checkbox for 'Difference from the first selected simulation' and two checkboxes for 'Show percentage' and 'Show absolute'. A paragraph of instructions follows: 'Select from the drop-down list the simulation ID and add it to the comparison by pressing the add to comparison button. When all simulations are selected, select a system ID from the system ID drop-down list.' Below this is a large drop-down list for simulation IDs, an 'Add to comparison' button, a 'Delete' button, and a smaller drop-down list for system IDs. Another paragraph of instructions follows: 'Select from the drop-down list the account statistics field to report and add it to the comparison by pressing the add to comparison button.' Below this is a 'System ID' drop-down list, an 'Add to comparison' button, and a 'Delete' button. At the bottom, there are four buttons: 'Help', 'Save in csv-file', 'Save in csv-file and open', 'Back to main menu', and 'Exit program'.

Account comparison analyser

Bank of Finland Payment and Settlement Simulator

Account comparison analyser

Project : harrykurv

☐ Modify old comparison view ☐ Create new comparison view ☐ Copy from old comparison view

Output file: C:/BoF-PSS2/harrykurv/OUTPUT/ Difference from the first selected simulation ☐ Show percentage ☐ Show absolute

Select from the drop-down list the simulation ID and add it to the comparison by pressing the add to comparison button. When all simulations are selected, select a system ID from the system ID drop-down list.

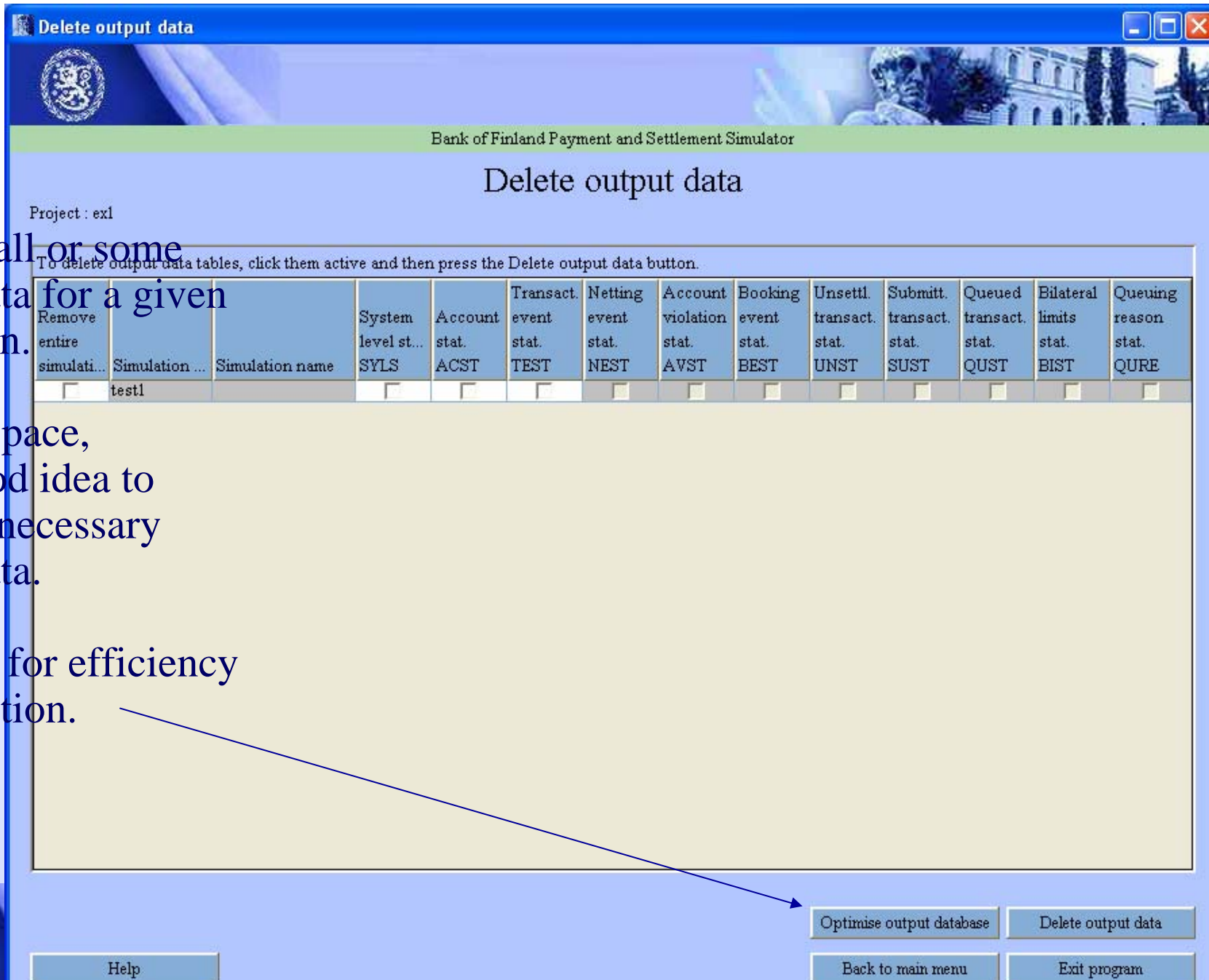
Simulation ID: [dropdown] Add to comparison Delete [dropdown]

Select from the drop-down list the account statistics field to report and add it to the comparison by pressing the add to comparison button.

System ID: [dropdown] Add to comparison Delete

Help Save in csv-file Save in csv-file and open Back to main menu Exit program





Remove all or some output data for a given simulation.

To save space, it is a good idea to delete unnecessary output data.

Optimise for efficiency after deletion.

Specify/change data formats

Choose simulation
Choose output table

Output file

Choose or
define output
template

Export output file

Bank of Finland Payment and Settlement Simulator

Export output file

Project:

Simulation ID:

Database table: SYLS System level statistics

Dataformat defaults

Data separator:

Decimal separator:

Date format: yyyy-mm-dd

Time format: hh:mm:ss.sss

Output file:

☐ Create names of columns

☐ Create new template:

☐ Use old template:

File column...	DB col	Var. name	Descriptive name	Selection Criteria
1	N_SIMRUNID	Simulation run ID		
2	N_SYSTEMID	System ID		
3	N_ALGORIID	Algorithm ID		
4	N_NETTDATE	Resolution date		
5	N_NETTTIME	Resolution time		
6	N_NETTINID	Netting ID		
7	N_TRANSVAL	Transaction value		
8	N_TRANSVOL	Transaction volume		
9	N_SETTLVAL	Settled value		
10	N_SETTLVOL	Settled volume		
11	N_TOTALVAL	Total value		
12	N_TOTALVOL	Total volume		

Rows processed:

Help

Execute export

Stop export

Back to main menu

Exit program

Example of output export CSV-file opened with Excel

Microsoft Excel - Test1

File Edit View Insert Format Tools Data Window Help

Arial 10 B I U % , +.00 -.00

A1 = FIRSTSMA

	A	B	C	D	E	F	G	H	K	L	M	N
1	FIRSTSMA	FIRST SMALL										
2	System ID	Transactio	Data set ID	Introductio	Introductio	Transaction val	From	To p	Settlement time	Settlement	Sending account's balance	
3	RTGS-A	100	TRAN1	12.5.2003	22:10:00	4880384,39	13	1	22:10:00	1	-4880384,39	
4	RTGS-A	101	TRAN1	12.5.2003	22:10:00	685826,6	12	1	22:10:00	1	-685826,6	
5	RTGS-A	102	TRAN1	12.5.2003	22:10:00	2639630,73	11	1	22:10:00	1	-2639630,73	
6	RTGS-A	103	TRAN1	12.5.2003	22:10:00	46064,41	10	1	22:10:00	1	-46064,41	
7	RTGS-A	104	TRAN1	12.5.2003	22:10:00	633795,99	2	1	22:10:00	1	-633795,99	
8	RTGS-A	105	TRAN1	12.5.2003	22:10:00	79702,04	14	1	22:10:00	1	-79702,04	
9	RTGS-A	106	TRAN1	12.5.2003	22:10:00	2786,33	6	1	22:10:00	1	-2786,33	
10	RTGS-A	107	TRAN1	12.5.2003	22:10:00	8000,03	5	1	22:10:00	1	-8000,03	
11	RTGS-A	108	TRAN1	12.5.2003	22:10:00	153492,54	13	5	22:10:00	1	-5033876,93	
12	RTGS-A	109	TRAN1	12.5.2003	22:10:00	83989,24	12	5	22:10:00	1	-769815,84	
13	RTGS-A	110	TRAN1	12.5.2003	22:10:00	779471,41	11	5	22:10:00	1	-3419102,14	
14	RTGS-A	111	TRAN1	12.5.2003	22:10:00	6678,92	10	5	22:10:00	1	-52743,33	
15	RTGS-A	112	TRAN1	12.5.2003	22:10:00	49921,7	2	5	22:10:00	1	-683717,69	
16	RTGS-A	113	TRAN1	12.5.2003	22:10:00	17337,06	14	5	22:10:00	1	-97039,1	
17	RTGS-A	114	TRAN1	12.5.2003	22:10:00	300182,44	6	5	22:10:00	1	-302968,77	
18	RTGS-A	115	TRAN1	12.5.2003	22:10:00	18950,49	1	5	22:10:00	1	8957240,03	
19	RTGS-A	116	TRAN1	12.5.2003	22:10:00	1634545,51	13	6	22:10:00	1	-6668422,44	

All data fields and rows of a given data table recognised by the simulation ID can be exported



Presentation structure

1. Background
2. Input generation sub-system
3. Simulation execution sub-system
4. Output analysing sub-system
- 5. Special functions**
6. Requirements and user support



Initial specifications

Bank of Finland Payment and Settlement Simulator

Version: 0.7.1 / 28.4.2003
Licensee: Bank of Finland
Research Dept

Initial specifications

☐ Create new project: ☐ Modify old project:

Databases

The simulator will create a new input and output database for each project in the indicated default directory. The user can change directory and also specify an already existing input and output database when desired. However, there can only be one input and output database assigned to the same project at one time.

Input database:
Output database:

Default directories

The simulator will use indicated default directories for the different file types. Each project is assumed to have its own default directories. The user can change the defaults and also use common directories.

Default directory for input files:
Default directory for error list:
Default directory for output files:
Default directory for output reports:

Version and
licensee info

Project name

Database
directories
(use defaults if not
common databases
are needed)

Other
directories



User module definitions

Bank of Finland Payment and Settlement Simulator

User module definition

Project: harrykuv

User module name:

User module file: Browse

User module type: SUB ▾

Parameters: Check rules: Positive numeric ▾

Add parameter

Delete parameter

Save definition

Back to main menu

Exit program

Help

User module
name

Location

Type

Parameters

Checking rules



User modules for advanced users

- ▶ Facilitates introduction of user algorithms
- ▶ Java-based
- ▶ Standardised simulator interfaces
- ▶ Ready-made functions to retrieve data from databases and runtime main memory
- ▶ Examples/templates of user module designs
- ▶ User modules should conform to algorithm categories

*A library of shared user-developed modules
could also be distributed eventually*



Use of Excel

- ▶ Excel is used for viewing CSV-files
- ▶ Excel can be used for editing input CSV-files
- ▶ Excel can be used for making reports out of CSV-files
- ▶ Current Excel versions have a limitation of 65.000 rows
- ▶ Excel is often producing extra empty rows/columns (,,,,)
- ▶ Check that delimiters (decimal and data separators) and presentation formats (date and time) are identical with simulator specifications
- ▶ Large values may be distorted (less accuracy)
- ▶ The actual content of CSV files stored by Excel can be checked with eg Notepad



Use of MySQL

- ▶ MySQL provides advanced functions for database management (see www.mysql.com)
- ▶ Augments advanced user capabilities when simulator functions are insufficient
- ▶ Some special administration features omitted in the simulator and MySQL required when e.g. deleting projects, templates, comparison views, user module definitions and batch-run IDs
- ▶ MySQL has ready-made interfaces eg to Access
- ▶ Detailed database description available on web-site



Presentation structure

1. Background
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Hardware and software requirements

- ▶ PC Intel Pentium 4 class processor with min. 256 MB main memory (512 MB or more is recommended for large simulations and 1-2 GB for very large simulations)
- ▶ Microsoft Windows NT/2000 or Microsoft Windows XP operating systems with Office/Excel installed
- ▶ MySQL database system with Java connector (can be loaded down from Internet without charge)

A typical simulation site would be a stand alone micro and in the network environment parallel usage of MySQL requires special attention



Ordering and delivery

- ▶ The simulator is available free of charge to researchers, but carries no BoF warranties
- ▶ Fax ordering,
- ▶ Download from the Internet
- ▶ Automated installation
- ▶ Published research results should be reported
- ▶ Users free to make additions (user modules and analysis tools)

Ordering form and guide available at www.bof.fi/sc/bof-pss



Documentation

- ▶ Product information sheet
- ▶ Presentations and tutorials (PowerPoint)
- ▶ “Simulating Interbank Payment and Settlement Mechanisms” (discussion paper)
- ▶ Licensing terms and conditions
- ▶ User guide
- ▶ Installation guide
- ▶ Database description
- ▶ User module development guide
- ▶ Simulation examples
- ▶ Seminar and workshop proceedings

Documents available at www.bof.fi/sc/bof-pss



User support

- ▶ Most user support should be available from help features and documentation
- ▶ Bank of Finland provides limited user support (errors, in particular, should be reported)
- ▶ MSG Software Oy provides technical assistance and programming services in line with their normal service offerings
- ▶ Planned annual seminars and workshops for simulator user community to give opportunities to exchange experiences, views and ideas
- ▶ Comments welcome to help us enhance simulator offerings



Further developments

- ▶ First production version 1.0.0 available since 03/2003
- ▶ Current production version 1.2.0
- ▶ Beta release of version 2.0.0 available end of August
- ▶ Production version 2.1.0 available later in autumn
- ▶ Probably updates also in spring 2006

Development plans may still change because the final decisions will be made after seminar discussions.



E-mail address

bof-pss@bof.fi

is available for

- questions**
- comments**
- ideas**
- etc**

