CYBERNETICA

Sharemind®: A Secure Multi-Party Computation (MPC) Platform Implementing Privacy by Design and Privacy by Default

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Overview

- About Cybernetica
- About Sharemind
  - What is it?
  - How has it been applied in practice?
  - How does it interact with the data protection regulation?

Introduction to Cybernetica

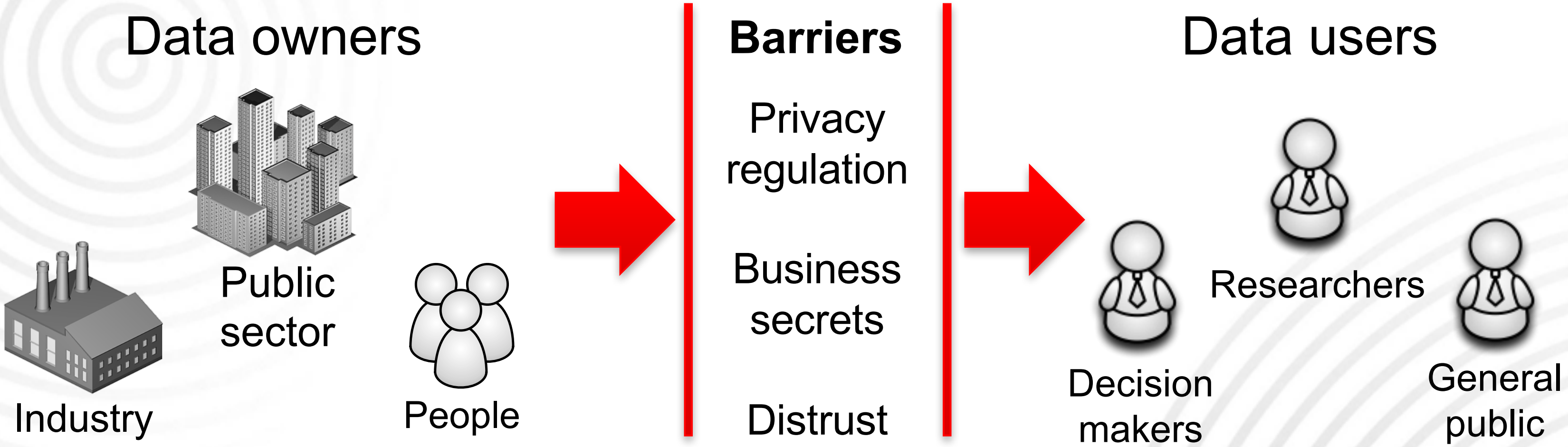
- Estonian ICT R&D company, founded in 1997
- Key products:
  - Information security solutions
  - e-Government solutions
  - Communication solutions
  - Surveillance and border guard solutions
- About 125 people
- 10% with PhD degrees

Cybernetica’s Product Portfolio

- Cybernetica has brought security technologies from research to practice for 20 years.
- Unified Exchange Platform
  - E-governments in Azerbaijan, Estonia, Finland, Haiti, Namibia
- Verifiable Internet Voting Software Tivi.io
  - Marketed through Smartmatic
- Smart-ID Digital Signature Technology
  - Marketed through SK ID Solutions AS

Department of Privacy Technologies (DPT)

- DPT applies privacy technologies to allow companies and governments to process more data without privacy concerns.



Data owners

Public sector

Industry

People

Barriers

Privacy regulation

Business secrets

Distrust

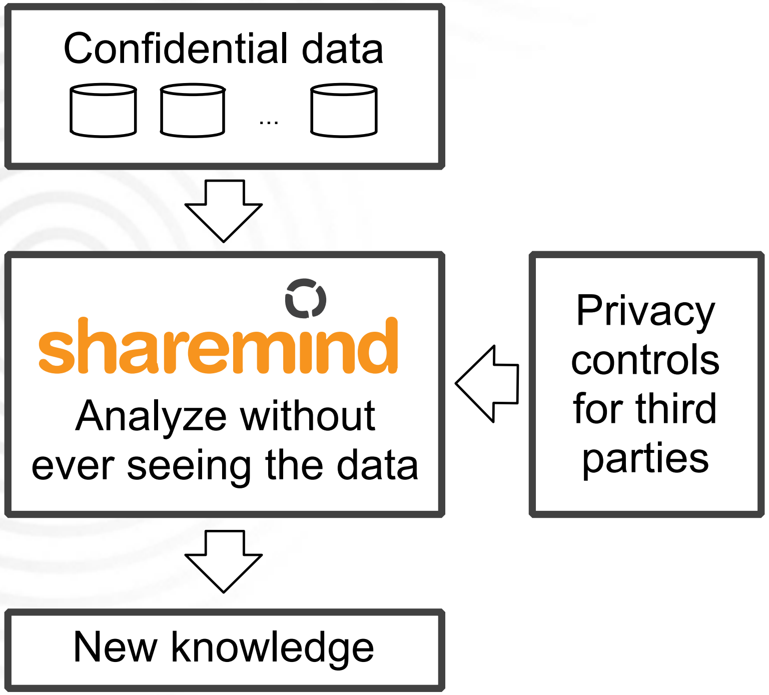
Data users

Researchers

Decision makers

General public

Sharemind® Privacy-Preserving Data Analytics


Confidential data
...
sharemind
Analyze without ever seeing the data
Privacy controls for third parties
New knowledge

- **Sharemind goes beyond data protection requirements.**
- Data owners encrypt data on-site and upload to Sharemind®.
- Data analysts build and run queries without accessing the data.
- Sharemind® processes the queries without removing the protection.
- Authorised users receive query results in an encrypted format.

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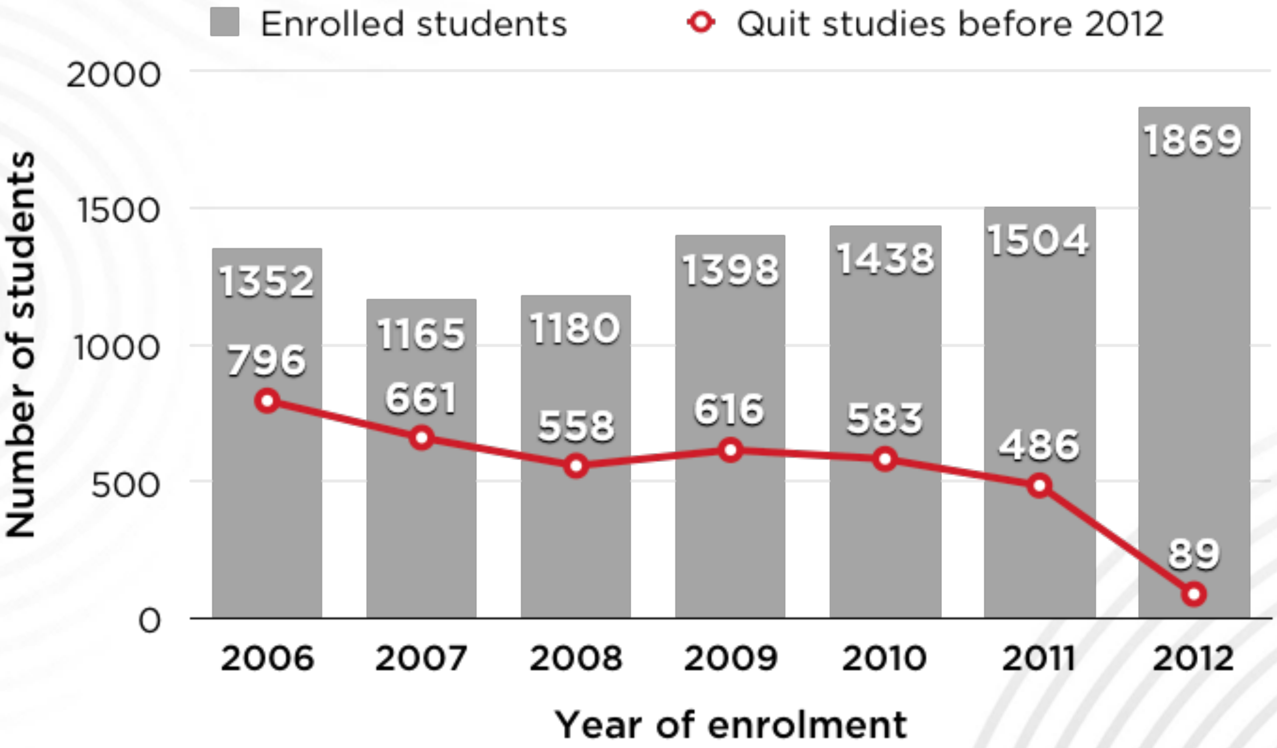
Achievements in Practical Applications (1)

- **2013 – 2015 PRIST project**: implementing Sharemind in privacy-preserving statistical analysis on linked databases
  - **New**: first-ever voluminous registry-based MPC application
  - **Problem**: by 2012, nearly 43% of IT students enrolled in Estonia's universities in the last five years had failed to graduate
  - **Hypothesis**: Estonia's booming IT industry is hiring too hungrily and causing students to fail at school
  - **Question**: do IT students work more in parallel with studies?
  - **Result**: no relation between working during studies and not graduating on time for IT-students

Estonia 2014: IT Student Graduation Rate was around 40%



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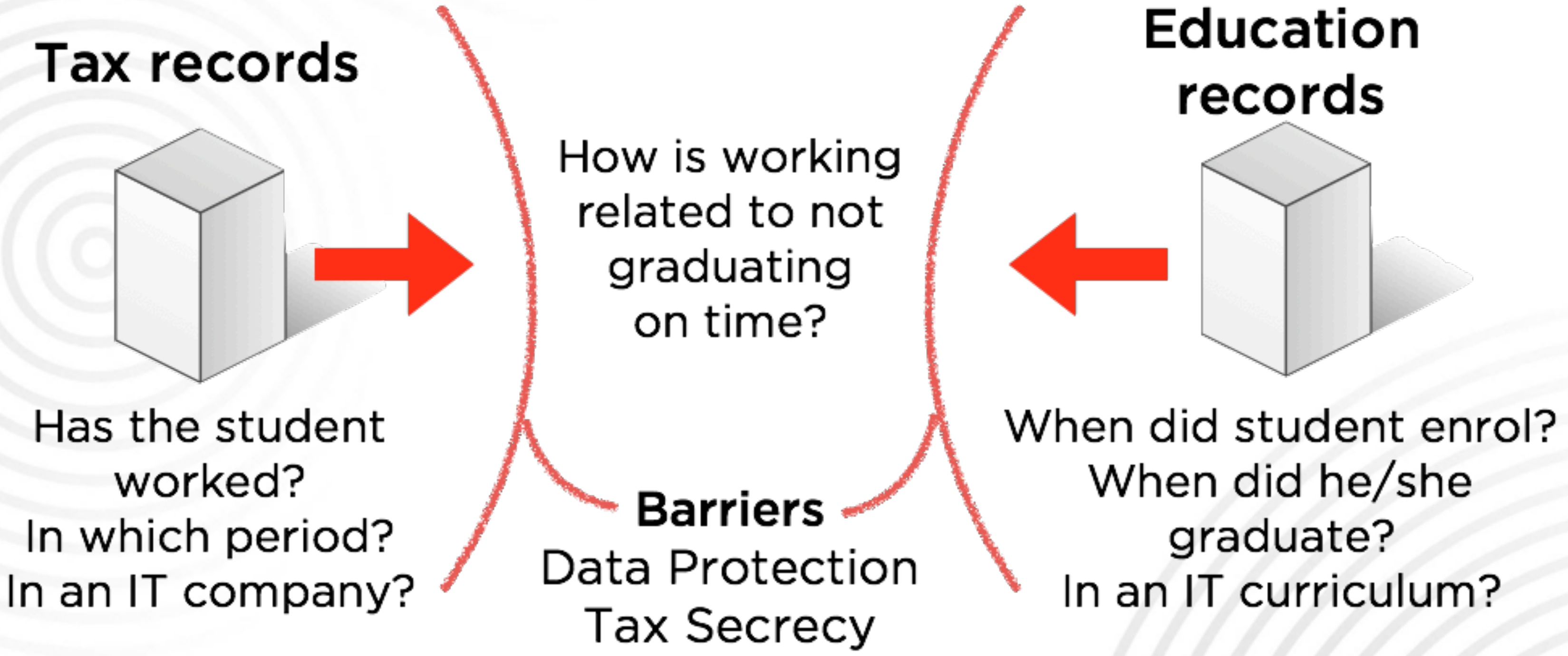
Regulation Prevented a Data-Driven Answer



Tax records

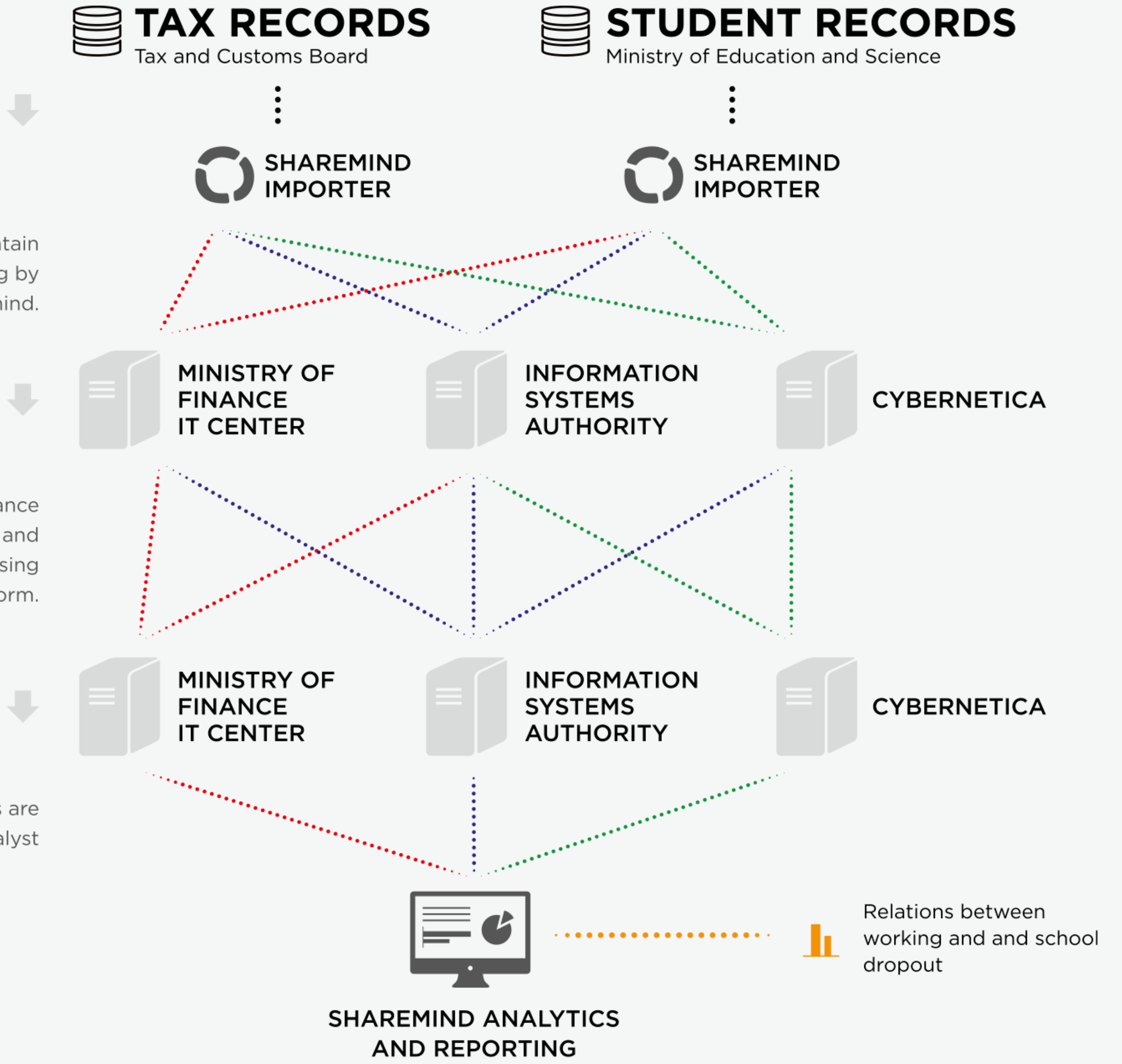
Has the student worked?
In which period?
In an IT company?

How is working related to not graduating on time?

Barriers
Data Protection
Tax Secrecy

Education records

When did student enrol?
When did he/she graduate?
In an IT curriculum?



TAX RECORDS
Tax and Customs Board

STUDENT RECORDS
Ministry of Education and Science

SHAREMIND IMPORTER

SHAREMIND IMPORTER

The data owner can maintain control of processing by co-hosting Sharemind.

MINISTRY OF FINANCE IT CENTER

INFORMATION SYSTEMS AUTHORITY

CYBERNETICA

Sharemind achieves compliance with privacy requirements and security policies by processing data in an encrypted form.

MINISTRY OF FINANCE IT CENTER

INFORMATION SYSTEMS AUTHORITY

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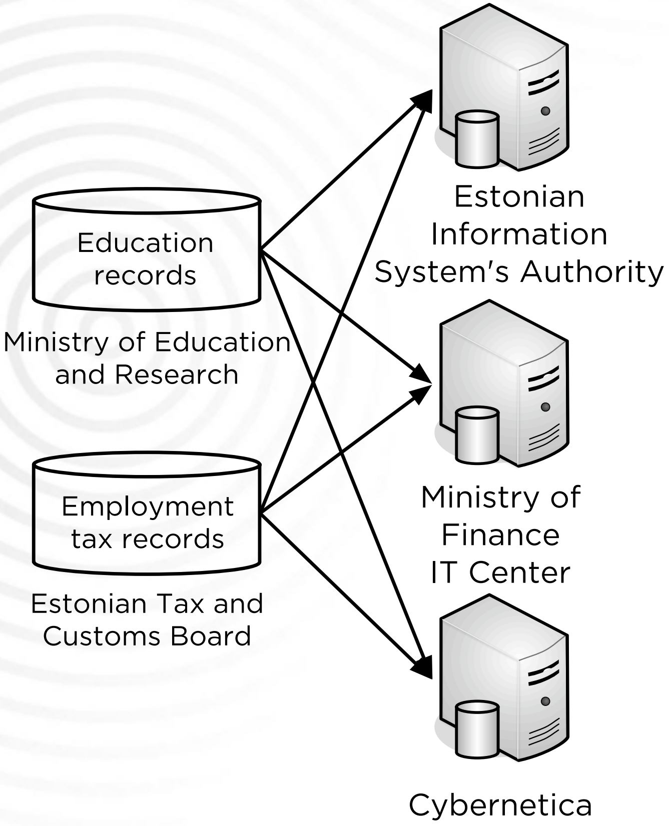
Only final results are published to the analyst

SHAREMIND ANALYTICS AND REPORTING

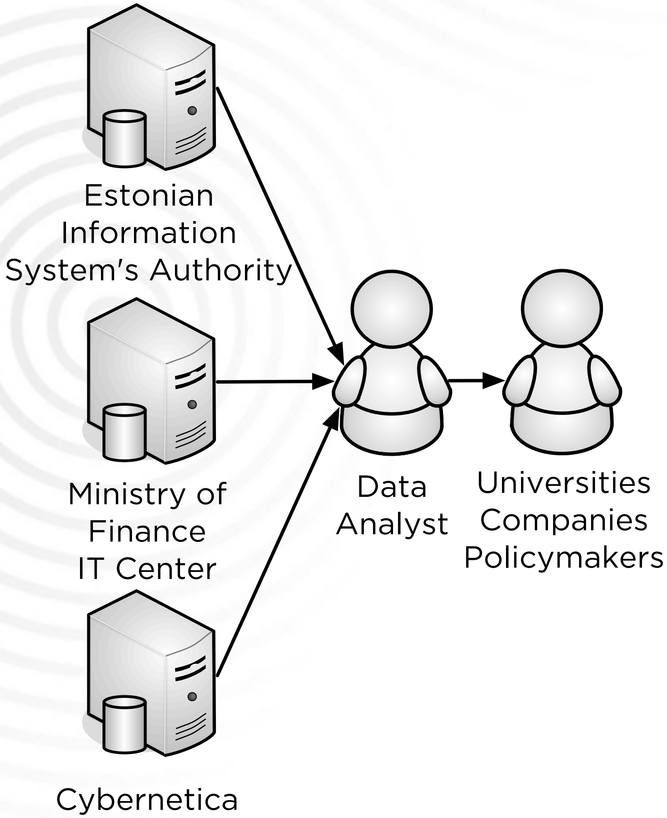
Relations between working and and school dropout

Sharemind® Powered the Privacy-Preserving Study in the PRIST project


Education records
Ministry of Education and Research
Employment tax records
Estonian Tax and Customs Board
Estonian Information System's Authority
Ministry of Finance IT Center
Cybernetica

- Source data:
  - 10 million tax records,
  - 600 000 education records.
- Sharemind hosted by government agencies and Cybernetica.
- Data owners used the Sharemind encryption tools to upload data.
- Data never existed outside the source in an unencrypted state.

Sharemind® Powered the Privacy-Preserving Study in the PRIST project


Estonian Information System's Authority
Ministry of Finance IT Center
Cybernetica
Data Analyst
Universities
Companies
Policymakers

- Data scientists used Sharemind tools to run the analysis.
- Sharemind prevented queries outside the study plan.
- Reports were given to industry, universities and the government.
- **Result**: no clear relation between working during studies and not graduating.

Achievements in Practical Applications (2)

- **2016 – 2017 SEN project**: implementing Sharemind to evaluate the efficiency of support measures for students with special educational needs (SEN)
  - Data owners were the same as in the PRIST project (Tax and Customs Board, Ministry of Education and Science)
  - **New**: Input data for an MPC application was partially stored on a cloud server for the first time
  - **Questions**: What is the employment rate of pupils with SEN after school? Does employment and salary depend on learning in special classes or inclusive education in regular schools?
  - **Result**: The employment rate is related to the special educational need. Students with SENs that need a lot of support are somewhat less likely to be employed.

Is Sharemind® Compliant with Data Protection Regulations? (1)

- Estonia's Data Protection Authority (EDPA) declined to review our application for a permission to process personal data in the PRIST project
  - EDPA: no need for EDPA's permission because there is no processing of personal data taking place in the given circumstances (data is unidentifiable)
  - EDPA: the combination of technology and processes ensured that private data was not processed and the requirements of the Data Protection Act need not apply.
  - Assumption: no identifiable records are published

Is Sharemind® Compliant with Data Protection Regulations? (2)

- EDPA stated that if data controllers encrypt data and no personal data is not published from the study, further studies with Sharemind do not need to apply for the DPA permit.
  - SEN project involved sensitive data (students with special educational needs)
  - Essentially the same conclusion as for the PRIST project

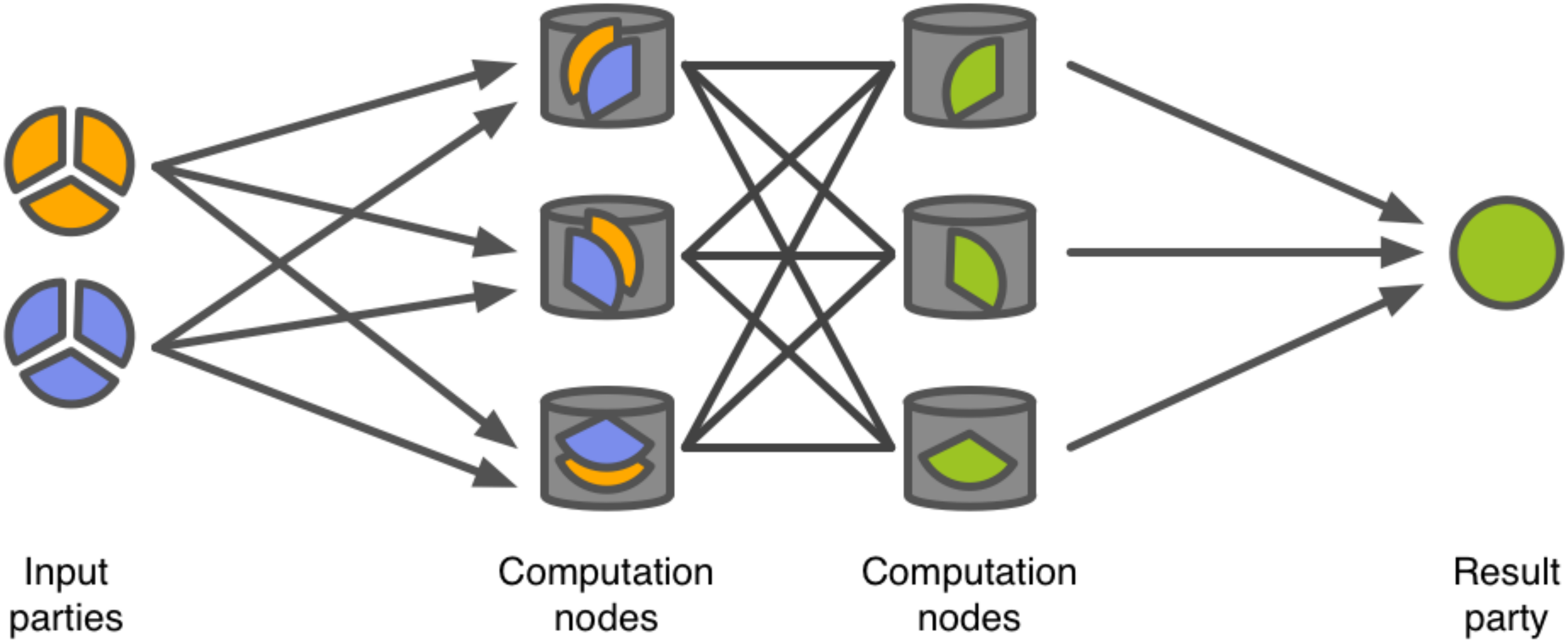
EDPA Letter 29.08.2016 No 2.1.-5/16/1271 (translation)

- “Having analysed your … application and taking into consideration the additional clarifications provided by you ... our position is that it is not necessary to apply for a permission from the DPA for carrying our a research project using a method whereby data providers insert the personal data in the given sample to Sharemind. This principle applies, if the data providers do not exchange personal data before inserting them to Sharemind and the data does not reach the researcher in identifiable form in any of the phases of the research.”

What will Change for Sharemind® in the Context of the GDPR?

- Sharemind can be used:
  - by data owners (controllers): an appropriate technical measure designed to implement data-protection principles (GDPR article 25 (1))
  - by data owners (controllers): an appropriate technical measure to ensure that by default personal data are not made accessible to an indefinite number of natural persons without the individual's intervention (GDPR article 25 (2))
  - by data analysts (processors): a tool for analysing anonymous data (GDPR recital 26)

Does Sharemind® Process Personal Data?



Additional Information (1)

- The secret sharing used in Sharemind is standardised in ISO/IEC 19592-2 and achieves up to information-theoretic security (as good as one time pad in cryptography).
- For further legal analysis on secret sharing, please see:
  - a legal analysis of secret sharing made by prof. Gerald Spindler’s team at the University of Göttingen as a result of the PRACTICE project (Framework Programme 7): “Evaluation and integration and final report on legal aspects of data protection (PRACTICE deliverable D31.3)” available in PDF here: https://practice-project.eu/downloads/publications/year3/D31.3-Evaluation-and-integration-and-final-report-on-PU-M36.pdf (see Section 3.2 on an analysis of secret sharing).

Additional Information (2)

- For further information and analysis on secret sharing, please see:
  - A technical analysis explaining Sharemind's security guarantees in a cryptographic fashion: "Sharemind: programmable secure computations with practical applications." (Dan Bogdanov's PhD thesis. University of Tartu. 2013.) available here: http://dspace.ut.ee/bitstream/handle/10062/29041/bogdanov_dan_2.pdf?sequence=5&isAllowed=y (see Section 3 for a build-up of the privacy guarantees and technologies Sharemind provides).
  - The full overview of the modules and ancillary elements of the Sharemind technology is available at https://sharemind.cyber.ee/secure-computing-platform/.

Recent Publications on Sharemind®

- David W. Archer, Dan Bogdanov, Benny Pinkas, Pille Pullonen. Maturity and Performance of Programmable Secure Computation. IEEE Security and Privacy. 2016.
  - Available at: http://ieeexplore.ieee.org/document/7676176/ (Also: http://eprint.iacr.org/2015/1039)
- Dan Bogdanov, Liina Kamm, Baldur Kubo, Reimo Rebane, Ville Sokk, Riivo Talviste. Students and Taxes: a Privacy-Preserving Social Study Using Secure Computation. In Proceedings on Privacy Enhancing Technologies, PoPETs, 2016 (3), pp 117–135, 2016.
  - Available at: http://dx.doi.org/10.1515/popets-2016-0019

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