The best way,

to learn and apply cryptography

The CrypTool project is about making the sometimes daunting subject of cryptography more accessible and easy to understand. It is the most comprehensive cryptography learning tool worldwide.

What you will learn…

- Cryptography's place in modern communications
- CrypTool project history
- Available CrypTool versions and some features

What you should know…

- Basic understanding of mathematics
- Basic understanding of cryprography
- Using the Internet

We would like to introduce to you CrypTool (CT1) and the two successors, CrypTool 2 (CT2) and JCrypTool (JCT), using in each case a very small extract of their capabilities. Each project is open-source and available for free.

The history of cryptography goes back more than 2000 years; secret communication has always been important – mostly for military and political reasons. The breakthrough of cryptography followed the broadening usage of the Internet. In modern days cryptography has evolved into a mathematically characterized science that most people use everyday without even realizing it. Cryptography is used in our mobile phones, in ATM cards, Pay TV, secure e-mail or online shopping and much more. The four objectives that cryptography is addressing today are confidentiality, authentication, integrity and non-repudiation of digital data. Applications fulfilling these objectives ease our everyday lives, such as secure online banking or non-reproducible digital signatures that verify and protect important documents. This allows us to save time or to further eliminate bureaucracy. Cryptography has become such a vital technology in modern communications and is nevertheless barely known to most people.

Today, cryptography is not only interesting for business and commercial use. Recent political developments like the inspection of laptops or other electronic devices while crossing state borders make cryptography more and more interesting for each and everyone of us that value and cherish our rights of privacy. The technology to ensure privacy is there – it's free and it's secure. On the other hand, it is almost impossible to have a one hundred percent secure computer system due to it's complexity and ever evolving technologies. Cryptography applied correctly, can secure valuable data so it is impossible to be accessed by a third party. This includes yourself if you forget your password. It is important to understand that a lost password may mean to loose valuable data. Cryptography gives us the tools to write secure e-mails and secure our private conversations in social networks or instant messengers, but is rarely used by private persons.

The past has shown that security through obscurity and proprietary cryptography can't really be trusted. Many cryptography researchers agree that only if a cryptographic algorithm is open and available to the cryptographic community it can be analyzed and tested

MysteryTwister C3 – Level I challenge number sequence

What is the next number in this sequence?
1 – 2 – 4 – 6 – 10 – 12 – 16 – 18 – 22 – 28 – 30 – 36 – 40 – ?
How did you find the solution?
Visit the MTC3 homepage to discuss and for more challenges: *http://www.mysterytwisterc3.org/*

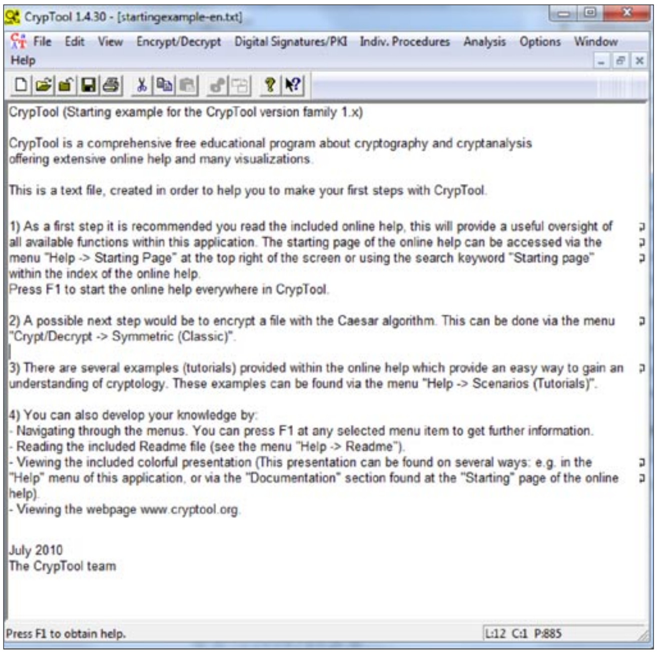
to verify that it is really secure. Otherwise, a proprietary closed algorithm may contain serious flaws that, when exposed later, will require significant costs to eliminate the security risk. An example of such a situation is the MIFARE chip, which was used in millions of devices in the transportation industry before being compromised. Another example is the encryption used in wireless (DECT) phones – now your neighbor may find out when you complain about him.

Because many cryptographic algorithms are open, everyone has access to modern cryptographic technologies and all of us have the chance to learn about them and how to use them correctly.

The goal of the CrypTool project is to help and encourage people to understand cryptography and the underlying technologies. It demonstrates current state-of-the-art cryptographic technologies, as well as cryptanalysis and known attacks against cryptographic systems.

The CrypTool project is also trying to consolidate research and software implementations that has been done by individuals mostly from universities and companies, so others can learn from it. It gives their students a unique opportunity to contribute their code (e.g. software written for a thesis) to a project where it is maintained and used by others around the world rather then just disappearing into the ether.

The CrypTool project started in a large financial institution in 1998. It's original purpose was internal training, to raise awareness about cryptography and encourage developers to use standardized cryptographic libraries instead of self made *looks secure to me* software. It was also used as a reference to confirm other software implementations.


CrypTool 1.4.30 - [startingexample-en.txt]
File Edit View Encrypt/Decrypt Digital Signatures/PKI Indiv. Procedures Analysis Options Window Help

CrypTool (Starting example for the CrypTool version family 1.x)

CrypTool is a comprehensive free educational program about cryptography and cryptanalysis offering extensive online help and many visualizations.

This is a text file, created in order to help you to make your first steps with CrypTool.

1) As a first step it is recommended you read the included online help, this will provide a useful oversight of all available functions within this application. The starting page of the online help can be accessed via the menu "Help -> Starting Page" at the top right of the screen or using the search keyword "Starting page" within the index of the online help.
Press F1 to start the online help everywhere in CrypTool.

2) A possible next step would be to encrypt a file with the Caesar algorithm. This can be done via the menu "Crypt/Decrypt -> Symmetric (Classic)".

3) There are several examples (tutorials) provided within the online help which provide an easy way to gain an understanding of cryptology. These examples can be found via the menu "Help -> Scenarios (Tutorials)".

4) You can also develop your knowledge by:
- Navigating through the menus. You can press F1 at any selected menu item to get further information.
- Reading the included Readme file (see the menu "Help -> Readme").
- Viewing the included colorful presentation (This presentation can be found on several ways: e.g. in the "Help" menu of this application, or via the "Documentation" section found at the "Starting" page of the online help).
- Viewing the webpage www.cryptool.org.

July 2010
The CrypTool team

Press F1 to obtain help.   L:12 C:1 P:885

Figure 1. *CrypTool 1 – main window*

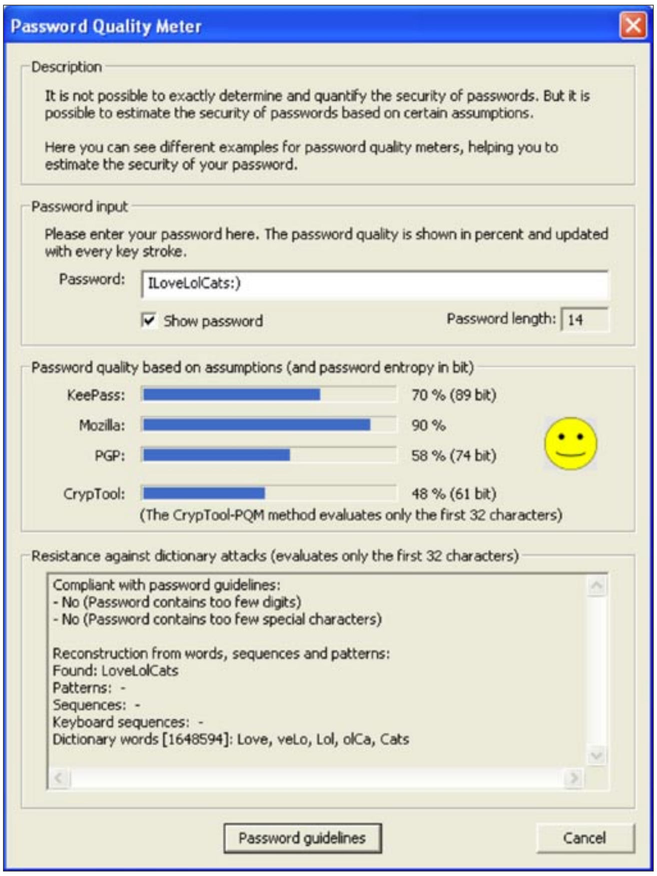
After the company-internal project ended, and thanks to the efforts of Prof. Bernhard Esslinger and the support of board member Hermann-Josef Lamberti, it was handed over to the Internet community and first released as freeware in the year 2000. In 2003 it became open source hosted by the University of Darmstadt. Since then, the CrypTool project evolved into the most comprehensive cryptography e-learning platform available today. Additionally the CrypTool programs can be used as well proven encryption programs. The project is ever-evolving and has now diversified into three software implementations, each with unique abilities, objectives and technologies behind them. For each project we put the numbers of it's downloaded setup files for 2010 (containing the whole package) into the Tables 1, 2 and 3.

CrypTool 1

(Requirements: Windows XP or later)

CT1 is currently the most complete and mature CrypTool variant, implementing nearly all state-of-the-art cryptography functions and offering a comprehensive online documentation. CT1 is written in C++ and and runs only under Win32 OS.

Each function implemented is using a simple graphical interface. The online help is understandable without a deep knowledge of cryptography. It also contains a learning tool for number theory, a secure e-


Password Quality Meter
Description
Password input
Password quality based on assumptions (and password entropy in bit)
Resistance against dictionary attacks (evaluates only the first 32 characters)
Password guidelines
Cancel

It is not possible to exactly determine and quantify the security of passwords. But it is possible to estimate the security of passwords based on certain assumptions.

Here you can see different examples for password quality meters, helping you to estimate the security of your password.

Please enter your password here. The password quality is shown in percent and updated with every key stroke.

Password: ILoveLolCats:)

☑ Show password   Password length: 14

KeePass: 70 % (89 bit)
Mozilla: 90 %
PGP: 58 % (74 bit)
CrypTool: 48 % (61 bit)
(The CrypTool-PQM method evaluates only the first 32 characters)

Compliant with password guidelines:
- No (Password contains too few digits)
- No (Password contains too few special characters)

Reconstruction from words, sequences and patterns:
Found: LoveLolCats
Patterns: -
Sequences: -
Keyboard sequences: -
Dictionary words [1648594]: Love, veLo, Lol, olCa, Cats

Figure 2. *CrypTool 1 – password quality meter*

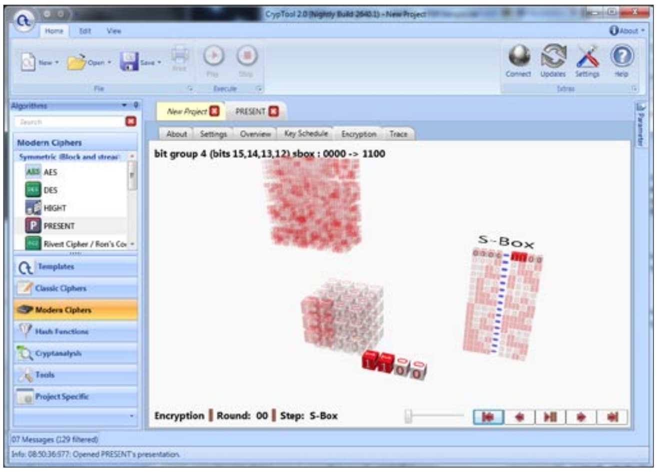
Table 1. *CrypTool 1 – Downloaded around 67000 times in 2010*

CT1	
Month	Downloads
Jan 2010	5,496
Feb 2010	5,628
Mar 2010	6,978
Apr 2010	6,128
May 2010	6,070
Jun 2010	4,550
Jul 2010	4,440
Aug 2010	4,962
Sep 2010	5,122
Oct 2010	6,300
Nov 2010	5,978
Dec 2010	5,297
Sum 2010	66,949

mail demonstration and visualizations of many different encryption algorithms. CT1 is available in 5 different languages: English, German, Polish, Serbian and Spanish. One feature in CT1 that is useful for almost anyone to try is the *password quality meter* (PQM see Figure 2). There are tons of similar tools that can be found online, but most of them ask you to share your password and send it to a server. Potentially you risk that someone is logging your passwords for later use. The PQM built into CT1 keeps everything locally on your computer and does more than simply counting how many characters you enter and calculate statistics. It also checks the entered passwords against a dictionary (that can also be configured).

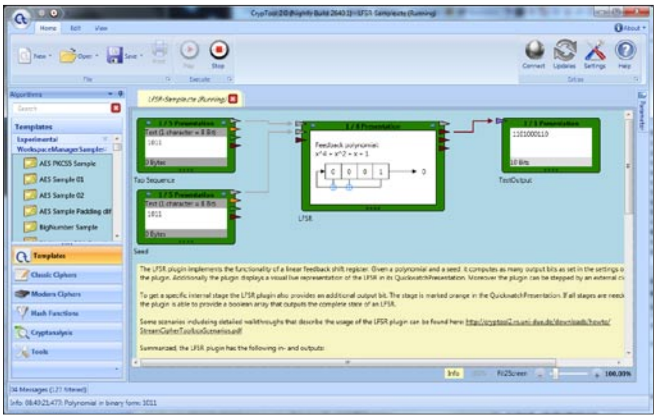
You may ask yourself what a password check has to do with cryptography. Even if you use the best encryption algorithms there today, they often rely on a secure (hard to guess/find) password, large prime or random numbers to reach their full potential of being unbreakable.

In 2007, the requirements of the CT1 user community were gathered in a big survey and the preferences of the potential developers were looked at. The result was that the two successors of CT1 both are based on a pure-plugin architecture – one using .NET and C#, and the other using Eclipse, Java and RCP.



07 Messages (129 filtered)
Info: 08:50:36:977: Opened PRESENT's presentation.

Figure 3. *CrypTool 2 – PRESENT cipher visualization with WPF*



The LFSR plugin implements the functionality of a linear feedback shift register. Given a polynomial and a seed, it computes as many output bits as set in the settings o

the plugin. Additionally the plugin displays a visual live representation of the LFSR in its QuickwatchPresentation. Moreover the plugin can be stepped by an external cl

To get a specific internal stage the LFSR plugin also provides an additional output bit. The stage is marked orange in the QuickwatchPresentation. If all stages are need

the plugin is able to provide a boolean array that outputs the complete state of an LFSR.

Some scenarios including detailed walkthroughs that describe the usage of the LFSR plugin can be found here: http://cryptool2.vs.uni-due.de/downloads/howto/StreamCipherToolkitScenarios.pdf

Summarized, the LFSR plugin has the following in- and outputs:

34 Messages (121 filtered)
Info: 08:43:21:473: Polynomial in binary form: 1011

Figure 4. *CrypTool 2 – workspace with a linear feedback shift register*

CrypTool 2

(Requirements: Windows XP or later, .NET 4.0)

CT2 is the first modern successor that uses state-of-the-art development techniques and goes a completely new way in didactic learning. CT2 follows the model of visual programming and offers all components using Microsoft's Office 2007 user interface design guideline, providing a consistent and rich user experience. The visual programming model enables the user to combine an extended set of functions instead of being limited to just one function at a time. The vector-oriented GUI design is based on the *Windows Presentation Foundation* (WPF) and gives users the ability to scale the current view at will. It is being hosted by the University of Duisburg. The development is lead by Dr. Arno Wacker.

One very interesting function that has been implemented recently is the support for distributed computing. CT2 is able to establish ad-hoc peer-to-

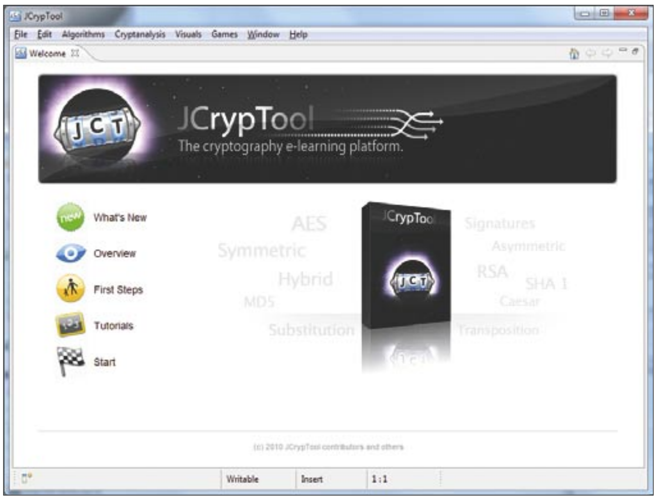


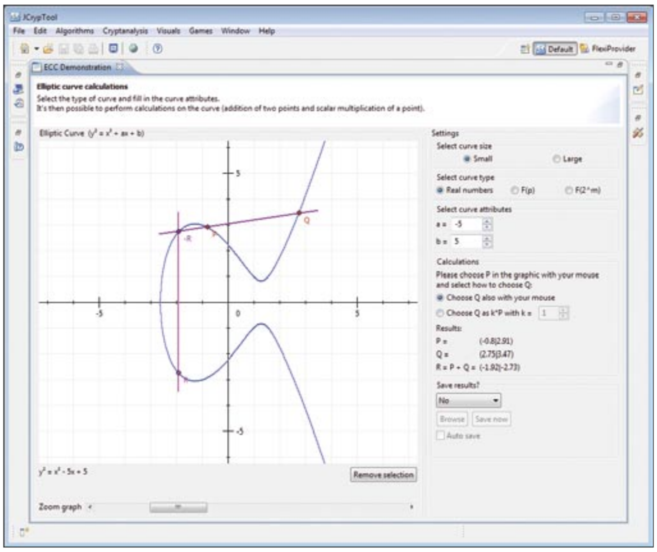
Figure 5. *JCrypTool – main screen*

Table 2. *CrypTool 2 – Downloaded around 44 000 times in 2010*

CT2	
Month	Downloads
Dec 2010	5,496
Nov 2010	5,161
Oct 2010	4,377
Sep 2010	3,681
Aug 2010	2,664
Jul 2010	2,480
Jun 2010	2,427
May 2010	3,231
Apr 2010	4,612
Mar 2010	3,863
Feb 2010	3,492
Jan 2010	2,233
Sum 2010	43,717

peer networks in order to speed up computing intensive tasks. If you are interested in prime numbers, CT2 has a standalone function build in, which dynamically visualizes different attributes and properties about primes. One feature that we would like to introduce to you is CT2's modular design. It offers a toolbox with basic functions on the left side. These functions can be combined in projects to implement cryptographic protocols, build work-flows and test them against different analysis tools. CT2 can execute these workflows step by step. Teachers can use this to prepare tasks for their students, thus better utilizing the limited time available in a class. CT2 is currently available as beta 3 in German and English.

In CT2, more than 100 template-projects are deployed to illustrate how the functions can be used. Figure 4 shows how a pseudo-random number stream can be generated using the LFSR functions.


JCrypTool
File Edit Algorithms Cryptanalysis Visuals Games Window Help
Default
FlexiProvider
ECC Demonstration
Elliptic Curve ($y^2 = x^3 + ax + b$)
5
-5
0
5
-5
Q
-R
P
Remove selection
Zoom graph

Elliptic curve calculations

Select the type of curve and fill in the curve attributes.
It's then possible to perform calculations on the curve (addition of two points and scalar multiplication of a point).

Settings

Select curve size: ● Small ○ Large

Select curve type: ● Real numbers ○ F(p) ○ F(2^m)

Select curve attributes
a = -5
b = 5

Calculations

Please choose P in the graphic with your mouse and select how to choose Q:
● Choose Q also with your mouse
○ Choose Q as k*P with k = 1

Results:
P = (-0.8|2.91)
Q = (2.75|3.47)
R = P + Q = (-1.92|-2.73)

Save results? No

Browse Save now

□ Auto save

$y^2 = x^3 - 5x + 5$

Figure 6. *JCrypTool – elliptic curve cryptography visualization*

On the 'Net

- *http://www.cryptool.org/* – Homepage of the CrypTool project;
- *http://jcryptool.sourceforge.net/JCrypTool* – Developer homepage of JCT;
- *http://www.cryptool2.vs.uni-due.de* – Developer homepage of CT2;
- *http://www.cryptool.org/download/CrypToolPresentation-en.pdf* – Project presentation;
- *http://www.cryptool-online.org/* – Homepage of the browser variant;
- *http://www.mysterytwisterc3.org/* – International crypto cipher challenge MTC3.

JCrypTool

(Requirements: Java run-time environment 1.6 or later)

JCT is CT2's sibling. It's also a successor of CT1, but with other objectives than CT2. The main requirement that it fulfills is platform independence, so it runs under Windows, Linux as wells as under MacOSX. JCT is also being developed as an open-source project. It is based on the *Eclipse Rich Client Platform* (RCP). It enables students, teachers, developers, and anyone else interested in cryptography to apply and analyze cryptographic algorithms in a modern and easy-to-use application. It uses both BouncyCastle and FlexiProvider as crypto providers. Thanks to FlexiProvider, it offers not only the algorithms which already passed the standardization, but also some current research algorithms mainly from the post quantum research field. JCT Release Candidate 4 (RC4) is currently available in German and English. It is hosted on SourceForge – project lead is Dominik Schadow. JCT's average ranking on SourceForge is in the top 700-3000 (of the 180,000 registered projects).

JCT supports combining algorithms in cascades in order to check and invent new variants of ciphers. One of the currently 15+ visualizations build into JCT is the *elliptic curve cryptography* (ECC) demonstration. ECC is an interesting technology that can use much smaller keys than RSA while being as secure (512 bits with ECC equals the security of a 15,260 bit RSA key). This is especially interesting for devices that don't have enough storage for large keys, e.g. in wireless sensor networks. The concept behind ECC operations is shown on the screen shot in Figure 6 with real numbers, but you can also use elliptic curves on other sets like the discrete field over p and the field over 2^m.

Table 3. *JCrypTool – SourceForge statistics*

JCT				
Month	Rank	Total Pages	Downloads	Proj. WebHits
Dec 2010	1,479	7,519	835	24,774
Nov 2010	1,512	16,424	922	26,884
Oct 2010	810	25,495	905	29,268
Sep 2010	719	9,267	745	23,518
Aug 2010	477	5,032	558	21,103
Jul 2010	829	2,523	689	22,960
Jun 2010	652	3,561	784	21,673
May 2010	1,019	7,552	867	26,155
Apr 2010	1,674	8,751	870	26,514
Mar 2010	1,664	6,960	1,002	30,185
Feb 2010	1,032	5,196	838	26,377
Jan 2010	376	8,485	845	26,673
Sum/Avg.	1,020	106,765	9,860	306,084

Related projects CT-Online, MTC3 and CT-Mobile

The CrypTool project is a great success story and good example for what open source and cooperative work of different universities and companies can achieve. There are further related projects like *CrypTool-Online*, which offers the ciphers and functions directly in the browser without any local installation. *CrypTool-Mobile* provides this front-end for modern smartphones.

Another related project that just started is the online crypto contest *MysteryTwister C3*, where you can check your cryptography skills against others, get listed in a global hall-of-fame and discuss your attempts in a moderated forum. Currently around 1800 users are registered. The challenges come from different authors, currently from Europe and the US.

An open call to everyone interested

Cryptography is all around us and I hope that we can encourage more people to learn about this fascinating science. Visit the official CrypTool website and take a look at the project presentation to learn about all the capabilities built into CrypTool. The CrypTool project deeply appreciates any further contribution, constructive criticism and feedback regarding our current releases. You are welcome to join! Currently more than 50 individuals world wide support the project (some of the individuals were willing to offer information about themselves publicly, see the map of contributors: *http://www.cryptool.org/index.php/en/contributors-aboutmenu-36.html*). The project will continue its evolution and hopefully help more people to learn about cryptography.

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CHOOSING AN IDS/IPS ENGINE

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PLUS

IDENTITY PROOF YOUR PERSONAL DATA
BY JULIAN EVANS