

TwinCAT/BS

BECKHOFF

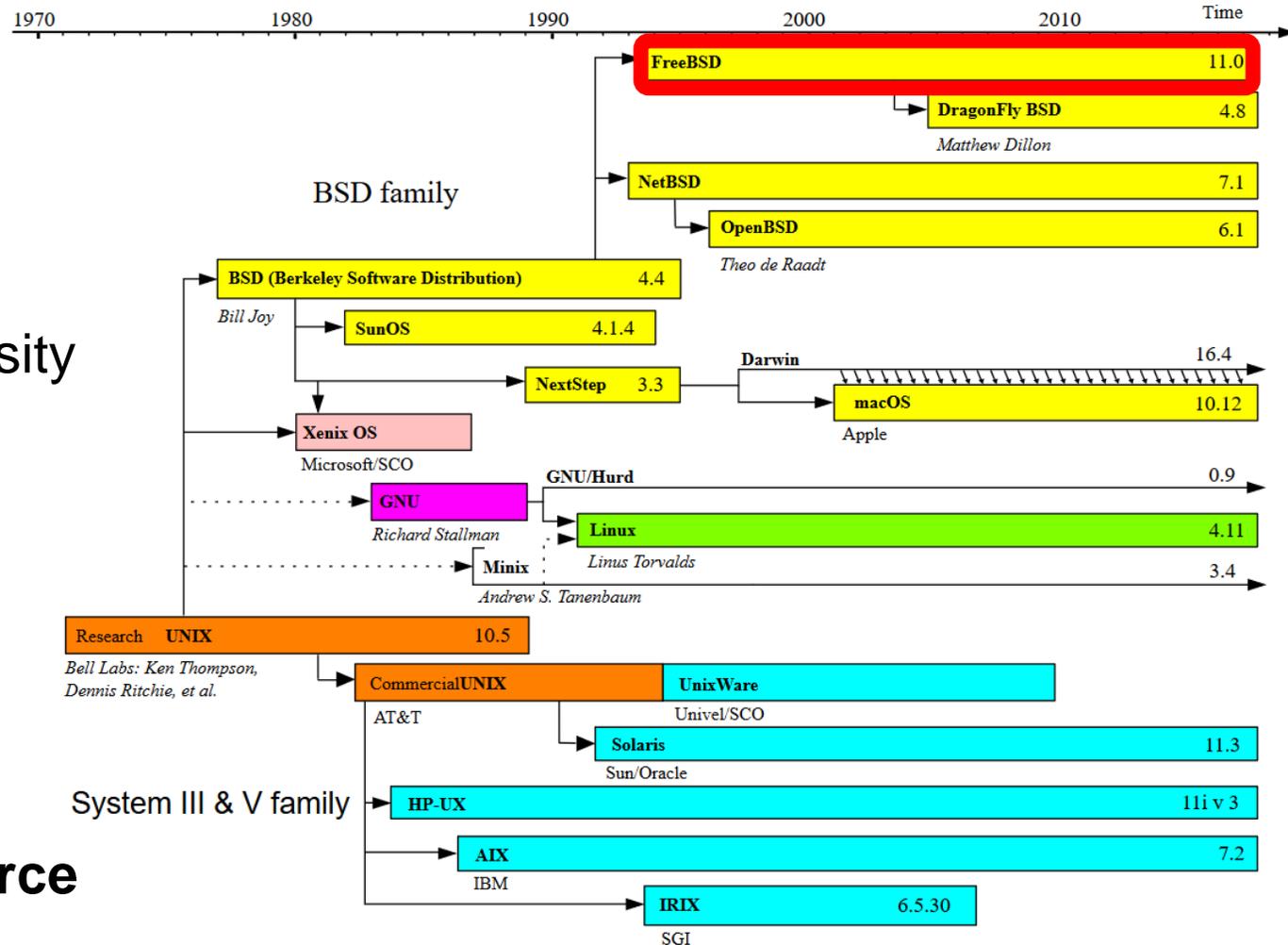


T C / B S D

- Combination of TC-OS-Kernel (TwinCAT Runtime) with the small footprint open source operating system **FreeBSD**
- Best fit for TwinCAT companion OS
 - Multiprocess/Multithread
 - Multicore
 - Multi-user
 - 32/64-bit x86 and ARM support
 - State of the art technology features
 - File System, Networking, USB, graphics
 - Internet protocols and technologies



- FreeBSD is a Unix based operating system
- It is a full operating system – not just a kernel like Linux
- The roots are going back to the University of California in Berkeley (UC Berkeley) where the initial Kernel was developed
- BSD stands for „Berkeley Software Distribution“
- BSD licensed – **permissive open source license (no GPL!)**



- Community driven operating system, driven by technology and directed by an elected core team
 - Entire base system is developed together, including kernel, configuration, utilities...
 - Target is usage for servers, desktop and embedded systems
 - Security of a modern Unix system
 - Simple configuration, extension, customization
- Your system as you want it!



Devices/Systems

- Apples Darwin Kernel is based on BSD:
 - macOS
 - iOS
 - tvOS
- Playstation OS is based on FreeBSD
 - Playstation 4
 - Playstation 3
 - PS Vita
- Nintendo switch
- QNAP–QES Enterprise storage systems
- Panasonic – Viera TVs
- ...

Software/Services

- Whatsapp
- Netflix
- McAfee SecurOS
- Junipers JunOS – Network appliances
- Verisign
- Trivago
- NetApp
- EMC²
- ...



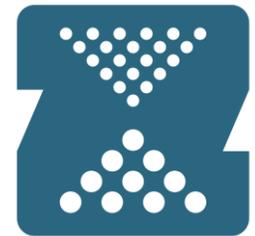
- FreeBSD is an industrial proven and reliable state-of-the-art operating system
- FreeBSD offers an industrial friendly license
 - The BSD license is permissive and can therefore be used in products without hesitation
- No limitation in regard to implementation of TwinCAT due to licensing
 - Linux was also tested but the limitations were too big due to the license
- FreeBSD is open source
 - Beckhoff has full control of the OS if necessary
 - Independent of third parties



- Well known Unix/Linux tools and software is available for FreeBSD
 - sh, csh, tcsh, ssh, scp, vi, ee, clang, llvm, ...
- >32.000 Ports, see <https://www.freebsd.org/ports/>
 - nano, bash, KDE, Gnome, XFCE, ...
 - nginx, Apache, MySQL, PostgreSQL, Python, Node.js, PHP...
- Z File System (ZFS) – The last word in file systems



- Originally developed by Sun, moved into the OpenZFS project
 - Design Goals: Data Integrity, Pooled Storage, Performance.
- Combination of File System and Volume Manager with unique advantages
 - 128-bit addresses
 - Copy-on-write
 - RAID, Checksums in data and tree, self-healing
 - Compression
 - Snapshots, rollback
 - Replication (write to file/network)
- FAT32 is interoperable with Windows and FreeBSD

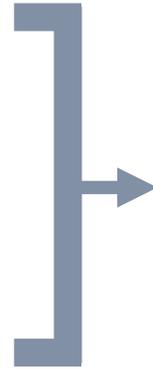
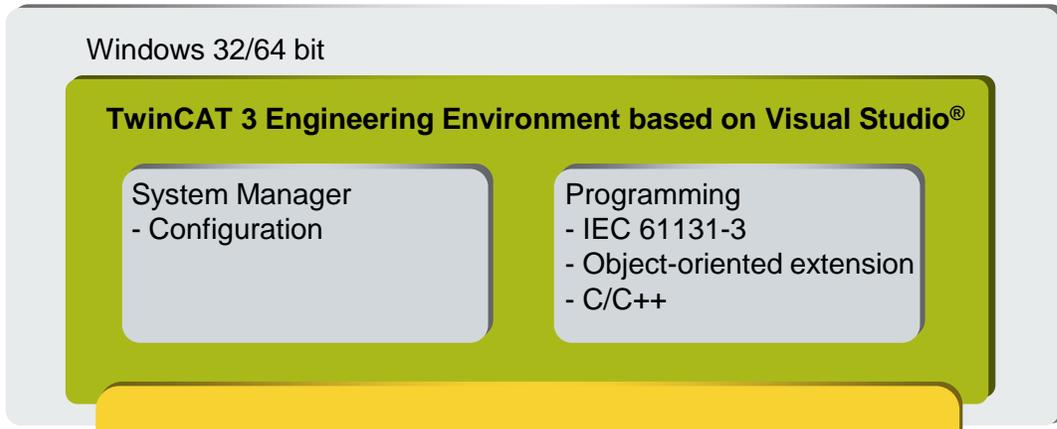


OpenZFS

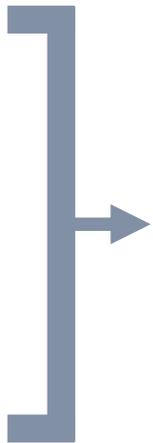
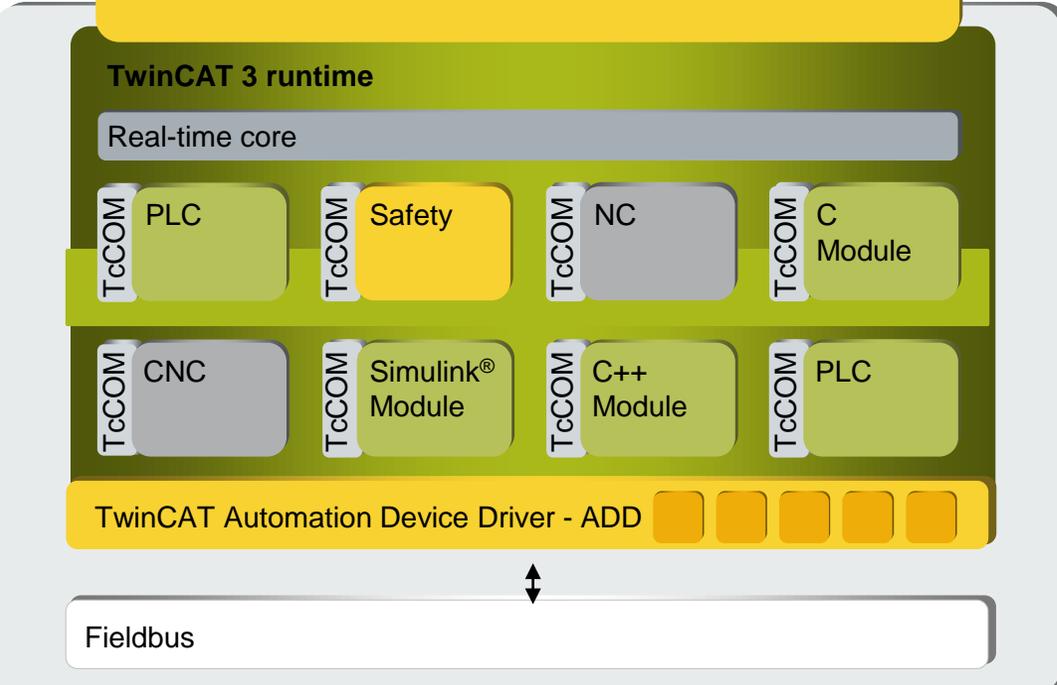
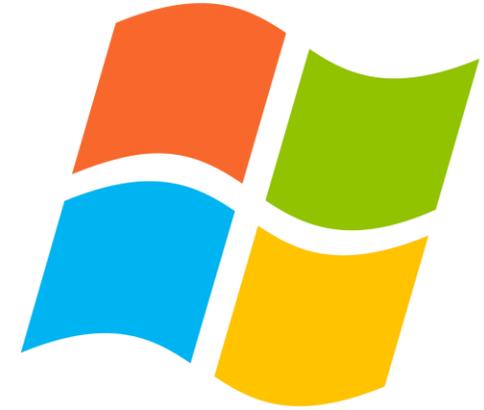
https://openzfs.org/wiki/Main_Page

TwinCAT/BSD | Architecture (XAA)

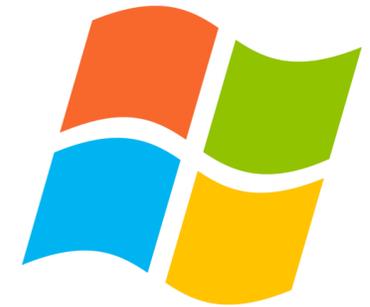
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eXtended Automation Engineering (XAE)
Visual Studio on Windows



eXtended Automation Runtime (XAR)
TwinCAT/BSD or Windows



TC/BSD

- TwinCAT 3 on FreeBSD
 - Essentials haven't changed!

The screenshot shows the 'Add Route Dialog' window. At the top, there is a search input field labeled 'Enter Host Name / IP:' and two buttons: 'Refresh Status' and 'Broadcast Search'. Below this is a table with the following columns: Host Name, Connect..., Address, AMS NetId, TwinCAT, OS Version, and Comment. The table lists several hosts, with 'CX-3B151A' highlighted in grey.

Host Name	Connect...	Address	AMS NetId	TwinCAT	OS Version	Comment
CX-315394		172.17.42.70	5.49.83.148.1.1	3.1.4022	Windows 7	
CX-3462A8		172.17.42.20	5.52.98.168.1.1	3.1.4022	Win CE (7.0)	
CX-3B151A		172.17.42.74	5.59.21.26.1.1	3.1.4023	TC/BSD (12.0)	
CX-3C82A2	X	172.17.40.32	5.25.224.4.1.1	3.1.4023	TC/BSD (12.0)	
CX-3D3A1B		172.17.42.42	5.61.58.27.1.1	2.11.2301	Win CE (6.0)	
CX-3ED552		172.17.42.62	5.62.213.82.1.1	3.1.4022	Win CE (7.0)	

- Supported CX Platforms for Release:

- CX51x0
- CX52x0
- CX20x0
- CX20x2
- CX20x3

- Officially supported IPC Platforms will be decided later
Announcement probably 4Q2020

- TwinCAT/BSD will target x86-64 only!
New ARM Devices will follow later



- Specific FreeBSD Image
 - Based on FreeBSD 12
 - Adapted FreeBSD Kernel
 - ZFS as File System

 - Default disk usage at ~500MB
 - Basic configuration and hardening applied

 - Whole system can be updated via pkg tool
 - TwinCAT and Functions also updateable via pkg
 - Beckhoff will host public package server for updates

TC/BSD

- Beckhoff hosts own package server
 - Beckhoff packages (**supported**)
 - Third party packages (**not supported**)
 - Repository is updated every four weeks
 - Security patches as soon as possible
- Whole System can be updated via pkg tool
 - Base System (BSD)
 - TwinCAT Runtime & Functions
 - 3rd Party software
- TwinCAT and base system updates are tested for compatibility before release.
- Possible to host an own package server to test updates in advance before deployment.

Directory listing of /TCBSD/12/ X

tcbbsd.beckhoff.com/?dir=TCBSD/

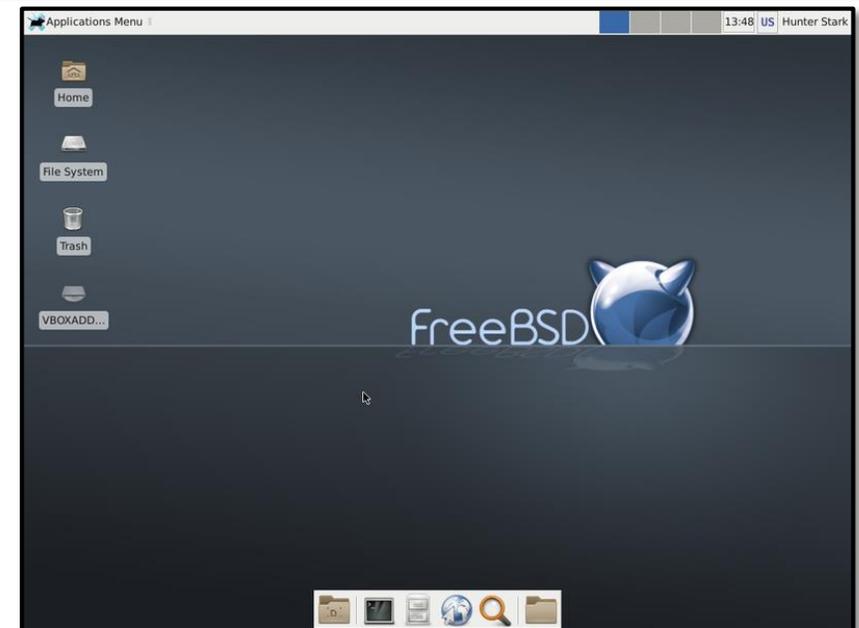
Home / TCBSD / 12 / unstable / packages / All

File	Size	Last Modified
..	-	2020-02-14 13:07:14
aalib-1.4.r5_13.tzst	146.48KB	2020-01-23 11:28:30
accountsservice-0.6.42.tzst	224.27KB	2020-01-23 14:28:25
adwaita-icon-theme-3.28.0.tzst	9.91MB	2020-01-23 14:34:23
akonadi-19.12.1_1.tzst	2.44MB	2020-01-23 15:52:41
akonadi-calendar-19.12.1.tzst	477.07KB	2020-01-23 16:10:14
akonadi-contacts-19.12.1_1.tzst	533.38KB	2020-01-23 16:05:41
akonadi-import-wizard-19.12.1.tzst	628.03KB	2020-01-23 16:22:38
akonadi-mime-19.12.1.tzst	181.39KB	2020-01-23 16:00:31
akonadi-notes-19.12.1.tzst	37.78KB	2020-01-23 16:01:37

- For now the Shell is the primary user interface for making settings
 - sh, csh, tcsh, (bash) ...
 - ssh (secure shell over network)
- **Optional** installation of desktop via pkg is possible **(not supported by Beckhoff)**
 - KDE, GNOME, XFCE, ...

```
login as: Administrator
Using keyboard-interactive authentication.
Password for Administrator@CX-3C82A2:
Last login: Thu Aug 29 16:03:33 2019
FreeBSD 12.0-RELEASE-p7- BHF

The software licenses can be found in this folder: /usr/local/etc/TwinCAT/3.1/System/Legal/
TcOsSys.dll:      TcOsSys_Rel131_4024_20190802.2
TwinCAT Build:   3.1.4023.119
AMS Net Id:      5.60.130.162.1.1
TC/BSD:          12.0.20190718162607,1
Hostname:        CX-3C82A2
igb0:            172.17.42.45
igb1:
Administrator@CX-3C82A2:~ %
```



- TwinCAT/BSD will support fullscreen HTML5 Browser (planned for 1Q2021)
- Beckhoff Device Manager for diagnostic and configuration
- TwinCAT 3 HMI Server & Client

BECKHOFF Device Manager

[Click here to change the default credentials!](#)

Device

Name	CX-27DFFA
Date Time	27.02.2020 15:58:31
Operating System	TwinCAT/BSD
Image Version	12.1.20200120102846
Hardware Version	CX2020-0120 v2.6 2016-08-29
Serial number of IPC	26636
Device Manager Version	2.0.2.2

Workload

CPU	1%	Max. 100%
Memory	55%	Max. 100%

Temperature

CPU	54°C
Mainboard	45°C

FAN

FAN 1 (rpm)	0
FAN 2 (rpm)	0
FAN 3 (rpm)	0

UPS

Power Status	Unknown
Communication Status	Unknown
Battery Status	Unknown

RAID

Controller Status	Good
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Voltage

Battery (mV)	3030
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Language

Console Features Architecture HMI-Demo FreeBSD References

HMI-Demo

Four large circular gauges showing values: 46.000, 48.000, 52.000, and 54.000. Below each gauge is a horizontal bar chart with a scale from 0 to 100. The bar charts show the corresponding values: 46.000, 54.000, 46.000, and 54.000.

TC/BSD

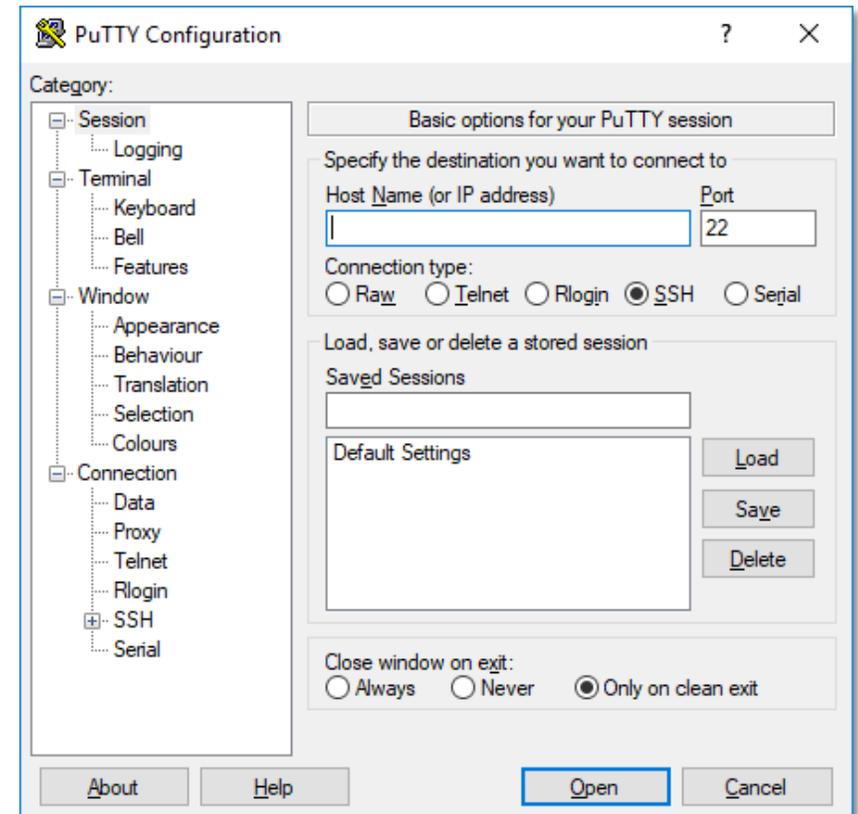
- OpenSSH for Windows, available for Windows 10, released in April 2018
 - Alternative is PuTTY, open-source ssh client for Windows, available since 1999

```
Eingabeaufforderung
Microsoft Windows [Version 10.0.17134.165]
(c) 2018 Microsoft Corporation. Alle Rechte vorbehalten.

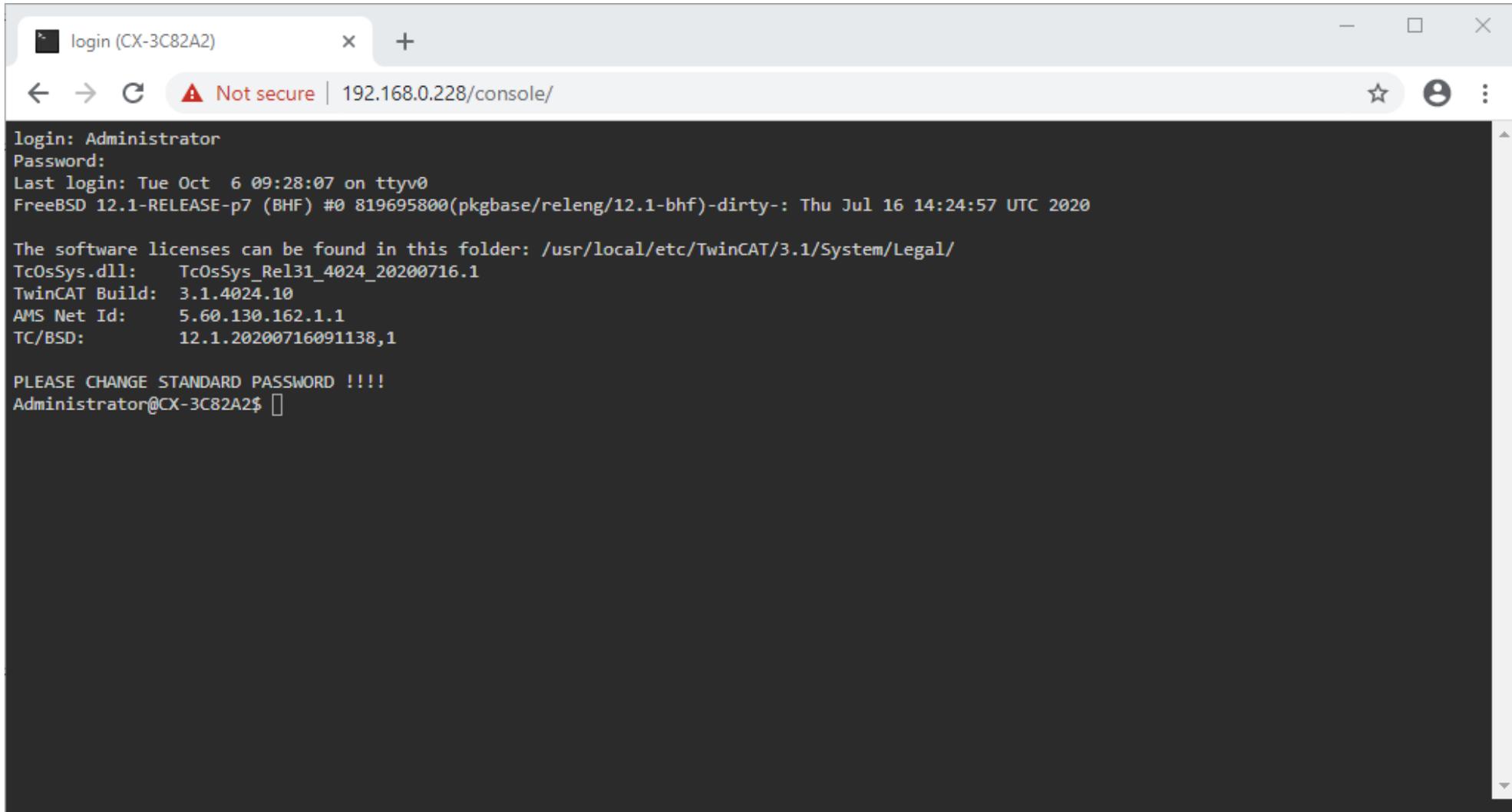
C:\Users\NilsJ>ssh
usage: ssh [-46AaCfGgKkMMNnqsTtVvXxYy] [-b bind_address] [-c cipher_spec]
          [-D [bind_address:]port] [-E log_file] [-e escape_char]
          [-F configfile] [-I pkcs11] [-i identity_file]
          [-J [user@]host[:port]] [-L address] [-l login_name] [-m mac_spec]
          [-O ctl_cmd] [-o option] [-p port] [-Q query_option] [-R address]
          [-S ctl_path] [-W host:port] [-w local_tun[:remote_tun]]
          destination [command]

C:\Users\NilsJ>sftp
usage: sftp [-46aCfpqrv] [-B buffer_size] [-b batchfile] [-c cipher]
          [-D sftp_server_path] [-F ssh_config] [-i identity_file] [-l limit]
          [-o ssh_option] [-P port] [-R num_requests] [-S program]
          [-s subsystem | sftp_server] destination

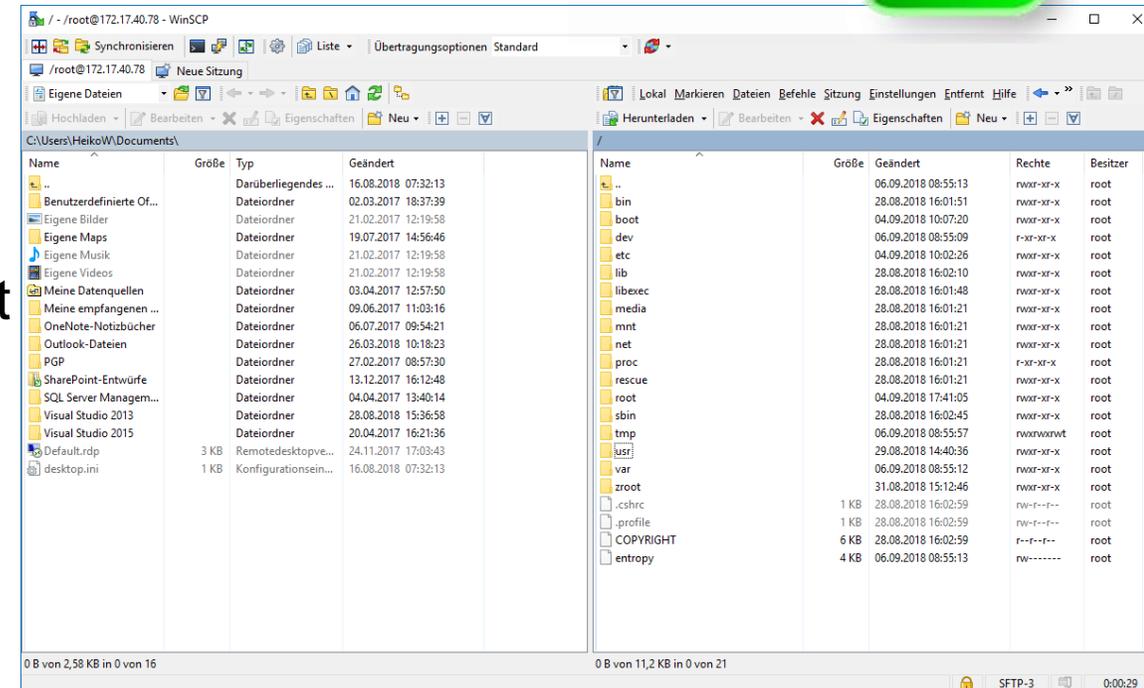
C:\Users\NilsJ>scp
usage: scp [-346BCpqrV] [-c cipher] [-F ssh_config] [-i identity_file]
          [-l limit] [-o ssh_option] [-P port] [-S program] source ... target
```



- Access Terminal via web browser



- On Windows you often use SMB
- On Unix systems scp/sftp is more common and secure
 - It uses the already available ssh protocol
 - It is fully encrypted (either Password or certificates)
- On Windows you can use clients like WinSCP which makes file copy very easy
- WinSCP is a free open source SCP/SFTP client
 - <https://winscp.net/eng/index.php>



- All TwinCAT runtime functions will be ported successively to TwinCAT/BSD
- Over time they will be available via the package server and can be installed in the field
- Currently already available functions (Beta) in the table

Function	Description
TC1000	TC3 ADS
TC1100	TC3 I/O
TC1200	TC3 PLC
TC1210	TC3 PLC/C++
TC1220	TC3 PLC/C++/Matlab®/Simulink®
TC1250	TC3 PLC/NC PTP 10
TC1260	TC3 PLC/NC PTP 10/NC I
TC1300	TC3 C++
TC1320	TC3 C++/Matlab®/Simulink®
TF1910	TC3 UML
TF3900	TC3 Solar Position Algorithm
TF4100	TC3 Controller Toolbox
TF4110	TC3 Temperature Controller
TF5100	TC3 NC I
TF6000	TC3 ADS Communication
TF6100	TC3 OPC UA
TF6220	TC3 EtherCAT Redundancy 250
TF6250	TC3 Modbus TCP
TF6255	TC3 Modbus RTU
TF6271	TC3 PROFINET RT Controller
TF6280	TC3 Ethernet/IP Slave
TF6281	TC3 Ethernet/IP Master
TF6310	TC3 TCP/IP
TF6311	TC3 TCP/UDP Realtime
TF6421	TC3 XML Server
TF6500	TC3 IEC60870-5-10x
TF6701	TC3 IoT Communication (MQTT)
TF8310	TC3 Wind Framework
TF6760	TC3 IoT HTTPS/REST

IPC

TC/BSD

TwinCAT 3 runtime

- Shared Cores/
Isolated Cores

User Applications
for FreeBSD

- e.g. Webserver,
HMI, Database

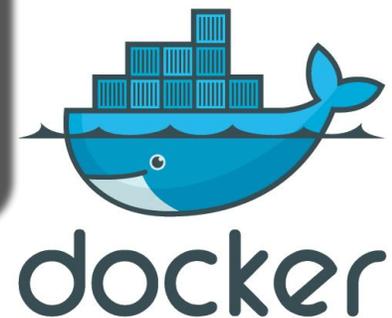
Bhyve Hypervisor

VM

Docker
Container

Docker
Container

Alpine Linux



- Current Roadmap:
 - Internal Beta 3 (x64): February 2019
 - Public Beta 1 (x64): September 2019
 - Public Beta 2 (x64): February 2020
 - **Release (x64): October 2020**
 - ARM Support
 - More TC3 Functions

- Currently we are working on:
 - Porting existing Supplements to **.net Core**
 - IPC Device Manager
 - Graphics



- BSD License → no copyleft for own software development
- Reduced license cost
- No „end of distribution“ by 3rd party
- Full customization possible
- Small Footprint/Small attack surface
- Security of a modern Unix system
- ARM and x64 Support (with TC3 multicore)
- Additional software can be installed (wide variety)
- Simple update and installation mechanism
- Multicore/Use of isolated cores with TwinCAT 3
- Easy backup/restore and snapshots
- Container Support

TC/BSD

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