Systems Programming

Lecture 1: Introduction to UNIX

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1. For those online: Put your webcam on if you are happy to be seen (if you speak out loud with your webcam on, you will be recorded)
2. Fill in the CIS form for requesting mira access (see email from this morning)
3. Set up Multi-Factor-Authentication

Feedback and hybrid mode teaching

1. Please do let me know how I am doing.
    - am I going too fast? too slow?
    - what is going well? badly?
2. If you are taking part virtually write "Q" or your question in the chat.
3. Don't hesitate to let me know if there is something you can't see/hear.

Structure of Module

- Term 1: Systems Programming (C, UNIX commandline, Makefiles, C++) -> me and Amir
- Term 2, first half: Functional Programming (Haskell) -> Lawrence
- Term 2, second half: Object-Oriented Programming -> Hubert

Key topics for this sub-module

- UNIX/Linux shell programming
- Syntax and semantics of the C programming language
- Memory access and management
- Design of large programs in non-object-oriented language
- Basics of C++

Organisation

Practicals:

- start in week 2
- very important, you will learn most by trying things out yourself.

Module Requirements

- Some background assumed in programming
- No C/C++ knowledge assumed

Organisation

Summative Assessment:

- Coursework 1:
    - hand-out 11th October
    - hand-in 8th November
    - 20% of mark
- Coursework 2:
    - hand-out 12th November
    - hand-in 7th February
    - 80% of mark

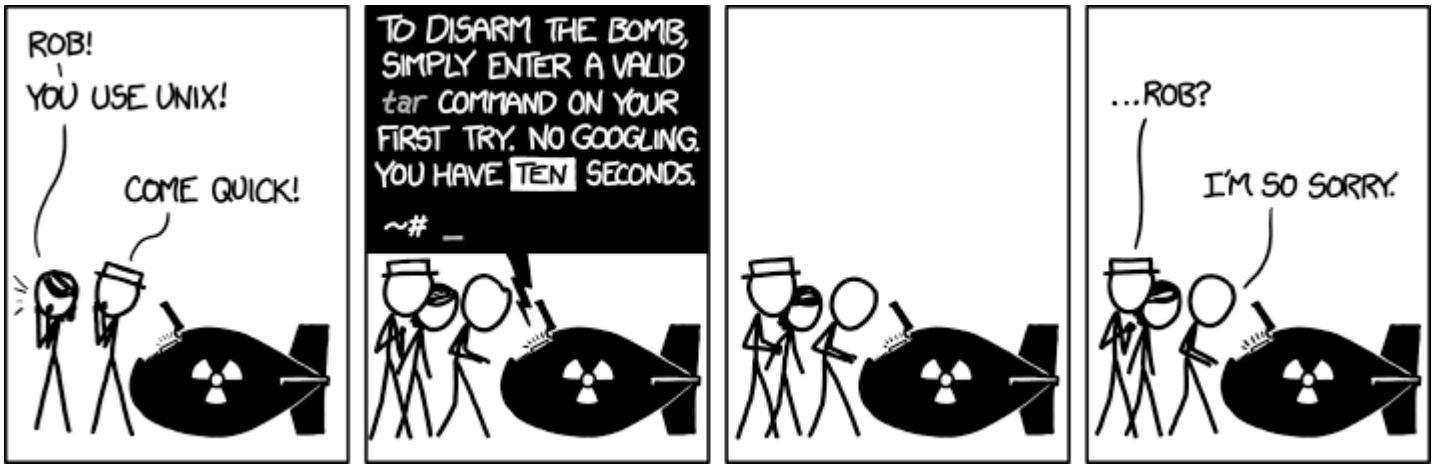
Resources and Books

- The good reference text for C programming is
    - The C Programming Language, Kernighan and Ritchie, Second Edition, Prentice Hall, ISBN 0-13-110362-8
    - Exercise answers: https://web.archive.org/web/*/http://www.trunix.org/programlama/c/kandr2/ (https://web.archive.org/web/*/http://www.trunix.org/programlama/c/kandr2/)
- Based on the Kernighan and Ritchie book Steve Summit has a good set of free tutorial notes on C programming:
    - http://www.eskimo.com/~scs/cclass/ (http://www.eskimo.com/~scs/cclass/)

Resources and Books

- An excellent and comprehensive modern book is:
    - C Programming A Modern Approach, K.N. King, Second Edition, ISBN 978-0-393-97950-3
- See https://stackoverflow.com/questions/562303/the-definitive-c-book-guide-and-list (https://stackoverflow.com/questions/562303/the-definitive-c-book-guide-and-list) for further book suggestions.
- Try to practice writing code more than you read
    - Site provides very short tasks and shows you other solutions to the problem
    - Code wars: https://www.codewars.com/ (https://www.codewars.com/)

Topic 1: Git refresher and UNIX



A (very) short history of UNIX

- 1963-1969 MULTICS (Multiplexed Information and Computing Service)
  - a high-availability, modular, multi-component system;
  - continued until 1985;
  - last system decommissioned in 2000

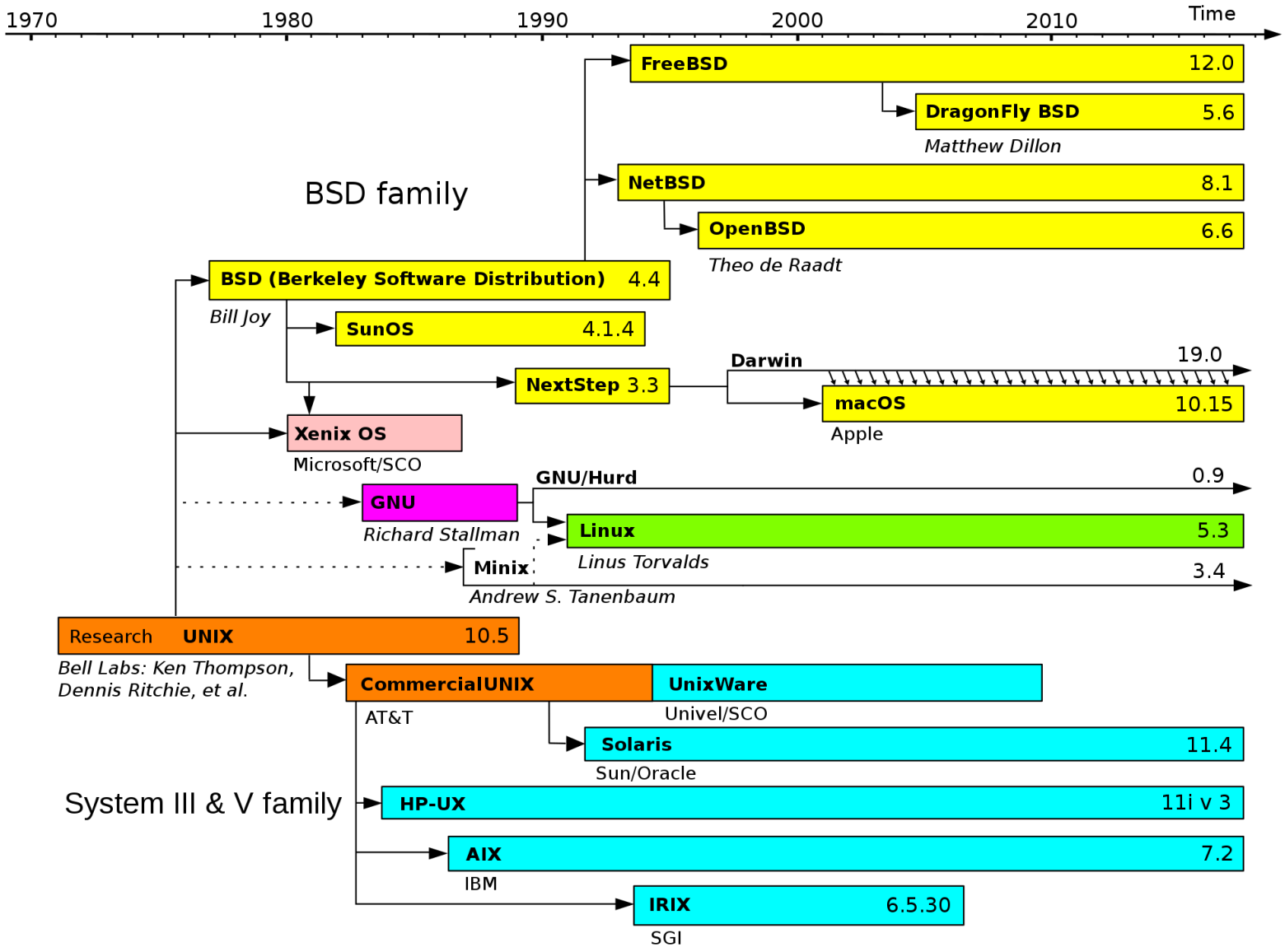
A (very) short history of UNIX

- UNIX: the opposite of MULTICS
    - Simpler and faster approach than MULTICS
    - initial assembler implementation by Ken Thompson and Dennis Ritchie for PDP-7 and PDP-11 (1960's, Bell Labs)
    - rewritten in C in 1973: the first operating system written in a high-level portable language
    - continuous evolution of various dialects of UNIX and its routines for over 50 years

A (very) short history of UNIX

- Focus on:
    - Multiuser Operating System
    - High-end users (skilled)

drawing


1970
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DragonFly BSD 5.6
Matthew Dillon
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NetBSD 8.1
OpenBSD 6.6
Theo de Raadt
BSD (Berkeley Software Distribution) 4.4
Bill Joy
SunOS 4.1.4
Darwin
19.0
NextStep 3.3
macOS 10.15
Apple
Xenix OS
Microsoft/SCO
GNU/Hurd
0.9
GNU
Richard Stallman
Linux 5.3
Linus Torvalds
Minix
3.4
Andrew S. Tanenbaum
Research UNIX 10.5
Bell Labs: Ken Thompson,
Dennis Ritchie, et al.
CommercialUNIX
UnixWare
AT&T
Univel/SCO
Solaris 11.4
Sun/Oracle
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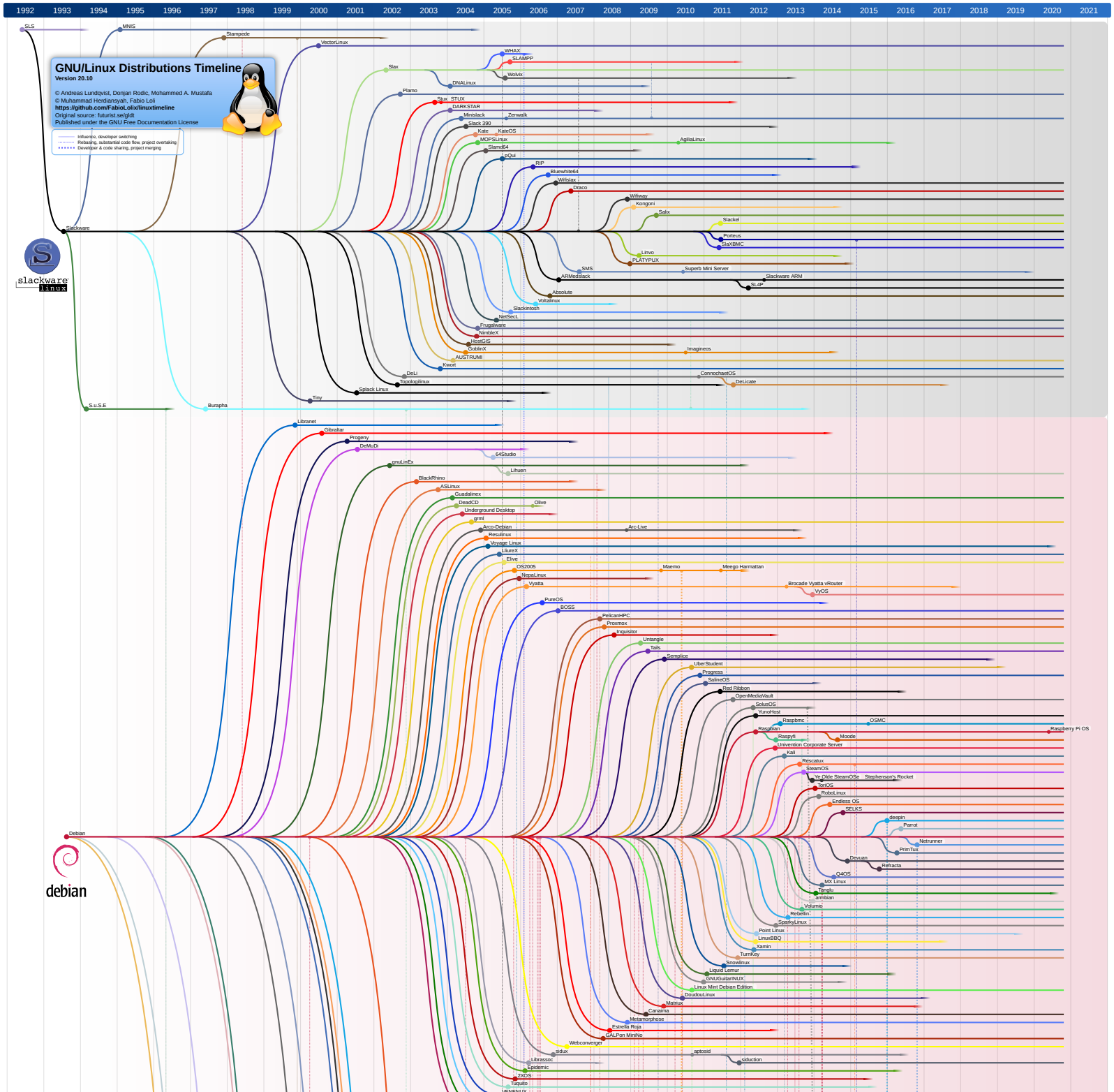
HP-UX 11i v 3
AIX 7.2
IBM
IRIX 6.5.30
SGI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GNU/Linux Distributions Timeline
Version 20.10
© Andreas Lundqvist, Donjan Rodic, Mohammed A. Mustafa
© Muhammad Herdiansyah, Fabio Loli
https://github.com/FabioLolix/linuxtimeline
Original source: futurist.se/gldt
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Influence, developer switching
Rebasing, substantial code flow, project overtaking
Developer & code sharing, project merging
SLS
MNIS
Stampede
VectorLinux
Slax
Plamo
Slax_STUX
DARKSTAR
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Slack 390
Zenwalk
Kate
KateOS
MOPSLinux
Slamd64
zQut
RIP
Bluewhite64
Wifislax
Draco
Wifiway
Kongoni
Salix
Slackel
Porteus
SlaxBMC
Linvo
PLATYPUX
SMS
ARMedslack
Superb Mini Server
Slackware ARM
SL4P
Absolute
Voltalinux
Slackintosh
NetSecL
Frugalware
NimbleX
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WHAX
SLAMPP
Wolvix
DNALinux
AgiliaLinux
Libranet
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Progeny
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64Studio
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ASLinux
Guadalinex
DeadCD
Olive
Underground Desktop
rpmL
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Resulinux
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LliureX
Elive
Arc-Live
OS2005
NepaLinux
Vyatta
Maemo
Meego Harmattan
Brocade Vyatta vRouter
VyOS
PureOS
BOSS
PelicanHPC
Proxmox
Inquisitor
Untangle
Tails
Semplice
UberStudent
Progress
SalineOS
Red Ribbon
OpenMediaVault
SolusOS
YunoHost
Raspbmc
OSMC
Raspbian
Raspberry Pi OS
Raspyfi
Moode
Univention Corporate Server
Kali
Rescatux
SteamOS
Ye Olde SteamOSe
Stephenson's Rocket
TbriOS
RoboLinux
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PrimTux
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Refracta
Q4OS
MX Linux
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SparkyLinux
Point Linux
LinuxBBQ
Xamin
TurnKey
Snowlinux
Liquid Lemur
GNUGuitarINUX
Linux Mint Debian Edition
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Matriux
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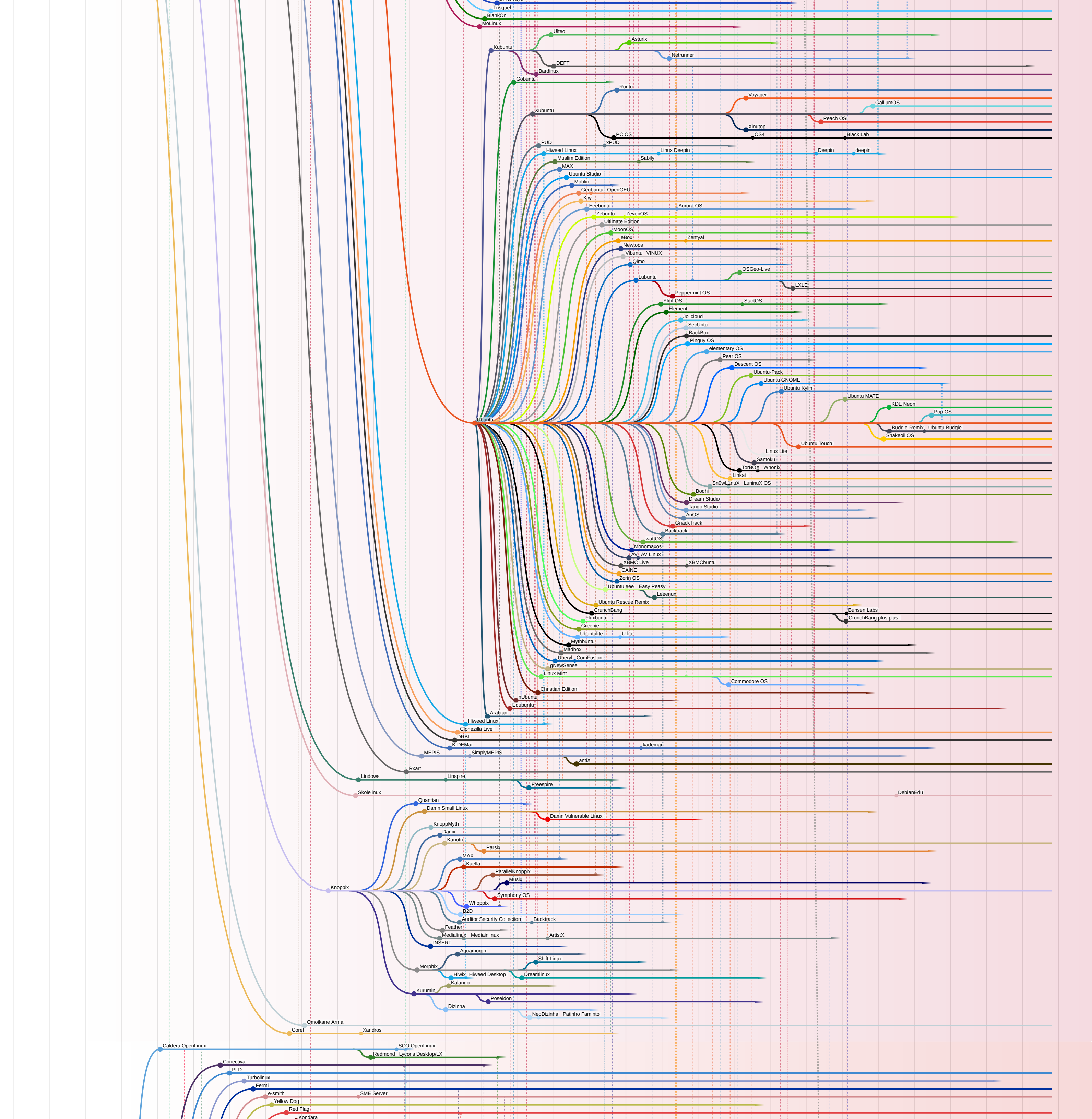

Trisquel
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Asturix
Kubuntu
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Black Lab
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Hiweed Linux
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Ubuntu Studio
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Eeebuntu
Aurora OS
Zebuntu
ZevenOS
Ultimate Edition
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eBox
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Newtoos
Vibuntu
VINUX
Qimo
OSGeo-Live
Lubuntu
LXLE
Peppermint OS
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StartOS
Element
Jolicloud
SecUntu
BackBox
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Ubuntu-Pack
Ubuntu GNOME
Ubuntu Kylin
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Budgie-Remix
Ubuntu Budgie
Snakeoil OS
Ubuntu Touch
Linux Lite
Santoku
TorBOX
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Zorin OS
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Ubuntu Rescue Remix
CrunchBang
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Linux Mint
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SCO OpenLinux
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PLD
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SME Server
Yellow Dog
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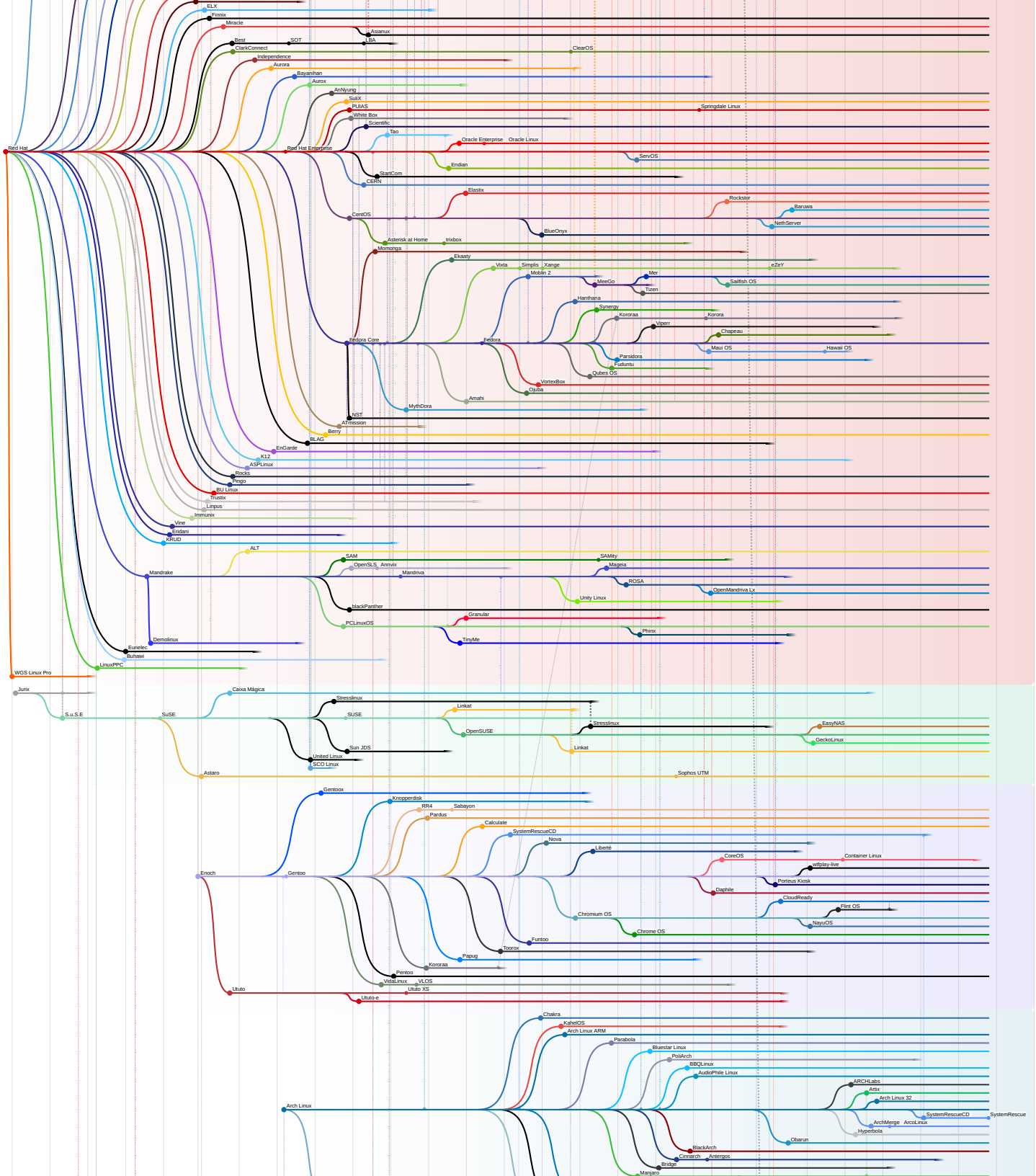
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White Box
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Oracle Enterprise
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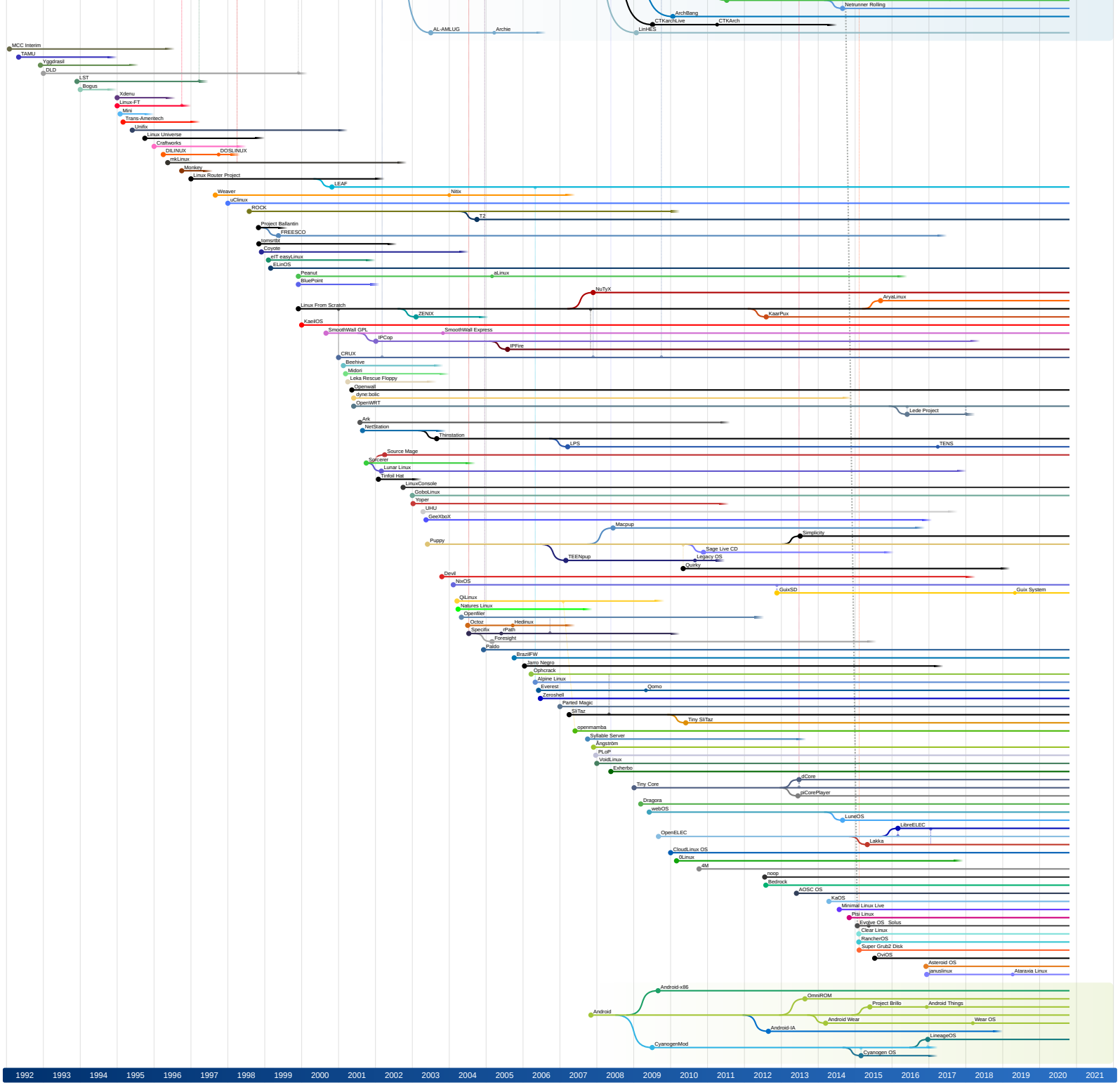
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SmoothWall GPL
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GoboLinux
Yoper
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Natures Linux
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AOSC OS
KaOS
Minimal Linux Live
Pisi Linux
Evolve OS
Solus
Clear Linux
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Super Grub2 Disk
OvrOS
Asteroid OS
lanuslinux
Ataraxia Linux
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OmniROM
Android
Project Brillo
Android Things
Android Wear
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LineageOS
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https://en.wikipedia.org/wiki/Comparison_of_operating_systems

The Shell

- A powerful way to perform work on a computer through a text interface
    - Run programs,
    - Control how the programs work
- Ability to move around between different directories/folders on a computer
- Perform sequences of commands to achieve even more complex work
- There are many choices for which shell to use
    1. A popular shell is **bash** (bourne again shell)
    2. Recently MacOS moved to **zsh** (Z shell)

The Shell

- If you don't use Linux or MacOS:
    - Try the Windows Subsystem for Linux (WSL)
        - run Linux commands directly under Windows
    - Alternatively try a virtual machine,
    - Additionally, recommmended: Get your mira login and try out the shell there

Basic Commands

- Where am I?
    - pwd (print working directory)
- What is here?
    - ls (list)

Note: the ! is not needed in an actual shell (I'm running a jupyter notebook)

In [ ]:
```
!pwd
```

In [ ]:
```
!ls
```

Basic Commands

- help?
    - man (manual)

In [ ]:
```
!man ls
```

Basic Commands

- Go somewhere else
    - cd (change directory)
    - . = current directory
    - ~ = home folder
    - .. = one folder up

Note: the ! is not needed in an actual shell (I'm running a jupyter notebook)

In [ ]:
```
%cd .
```

Next lecture

- piping
- bash scripts
- regular expressions

What is git?

- Git is software for:
    - tracking changes in files
    - coordinating work among collaborators
    - with support for CI tools

Short history of git

- 1991–2002 changes to the linux kernel were passed around as patches and archived files
- In 2002 the Linux kernel project began using a proprietary DVCS (distributed version control system) called BitKeeper
- In 2005 BitKeeper's free-of-charge status was revoked
- Thus the Linux development community (in particular Linus Torvalds) developed git

Short history of git

- Main goals:
    - Speed
    - Simple design
    - Strong support for non-linear development (thousands of parallel branches)
    - Fully distributed
    - Able to handle large projects like the Linux kernel efficiently (speed and data size)

Git over the command line

Git clone

- Create a copy of a given repository on your machine
- Currently the example repository only contains a README file

In [ ]:
```
!git clone https://github.com/COMP2221/example-repository.git
```

In [ ]:
```
%cd example-repository
!ls
```

Git over the command line

Git add, rm and commit

- git add: add new files
- git rm: remove files from git -- cached: keeps local copy
- git commit: commit your current changes

In [ ]:
```
!mkdir src
!mv helloworld.cc src
!ls
```

In [ ]:
```
!git status
```

In [ ]:
```
!git rm helloworld.cc
!git add src
```

In [ ]:
```
!git status
```

Git over the command line

Git pull/push

- Pull: Get changes made to the repository
- Push: Add the changes you made to the repository

In [ ]:
```
!git push
```

What is a commit hash?

- Everything is checksummed before it is stored and is then referred to by that checksum
- This detects changes to the contents of any file or directory
- Git stores everything in its database not by file name but by the hash value of its contents

Thus:

- Every commit has a corresponding hash that can be used to refer to it
- In the coursework you will be asked to provide the hash of your final commit

What is a commit hash?

- Currently: Git uses a SHA-1 hash.
- A SHA-1 hash looks like this: 24b9da6552252987aa493b52f8696cd6d3b00373
- You will learn more about checksums in Networks and Systems
- This will probably change soon: https://git-scm.com/docs/hash-function-transition/ (https://git-scm.com/docs/hash-function-transition/)
- Here's why: https://shattered.io/ (https://shattered.io/) (See also Security submodule)

Github classroom

- In the practical session:
    - set up your github classroom account
    - you will receive an invite link to an introductory "assignment" in the practical
    - This will contain more resources to learn how to use git
- Coursework:
    - github classroom will be used to submit the coursework
    - if you have any trouble setting your github classroom account please get in touch!