

.NET Conf China

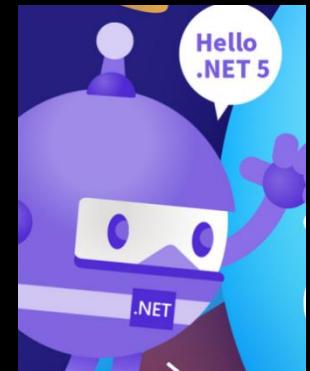
Suzhou 2020

Akka.NET on ARM

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hkli2013@126.com

Dec 19, 2020



Agenda

I. Background

- Concurrent Programming
 - .Net
 - Akka.NET
-

II. Testbed

- ARM Ecosystem
- Raspberry Pi

III. Set up Akka.NET on RPi 4

- Prepare In-Device Development Env
- Set up & Test

IV. Akka.NET cluster

- Overview
- Akka.NET cluster on a RPi 4 cluster

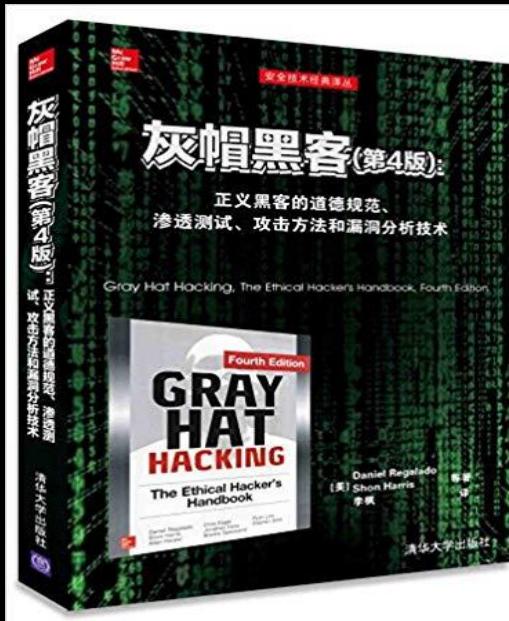
V. Orleans on ARM

- Overview

VI. Wrap-up

Who Am I

- The main translator of the book «Gray Hat Hacking The Ethical Hacker's Handbook, Fourth Edition» (ISBN: 9787302428671) & «Linux Hardening in Hostile Networks, First Edition» (ISBN: 9787115544384)

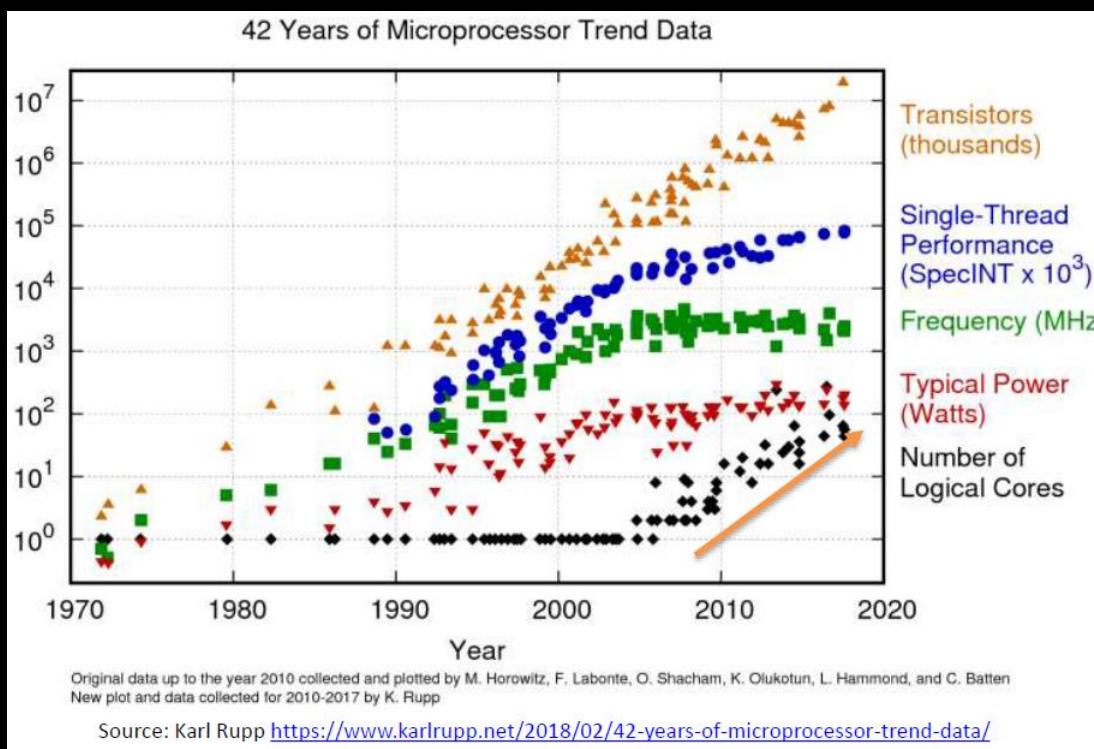


- Actively participate in various activities of the open source community
- <https://github.com/XianBeiTuoBaFeng2015/MySlides>

I. Background

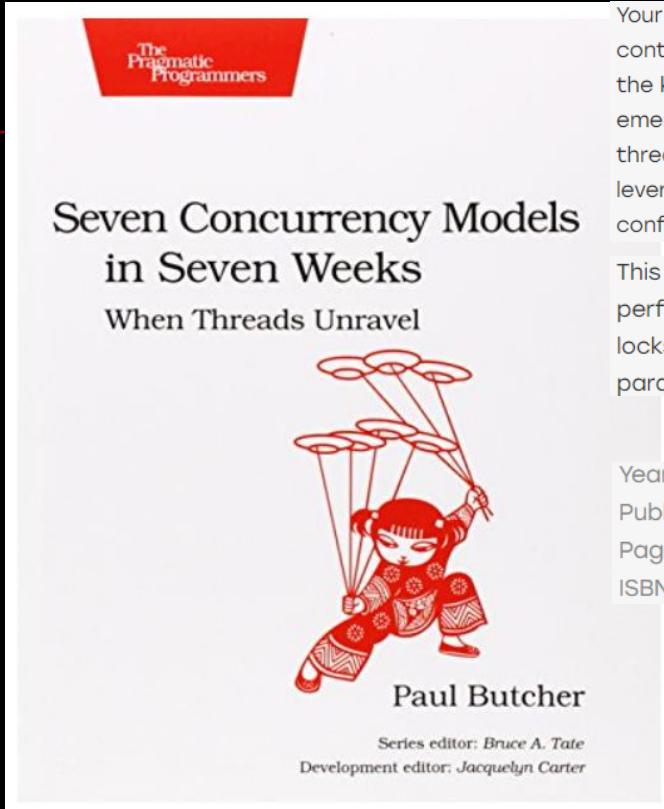
1) Concurrent Programming

- [https://en.wikipedia.org/wiki/Concurrency_\(computer_science\)](https://en.wikipedia.org/wiki/Concurrency_(computer_science))
- https://en.wikipedia.org/wiki/Concurrent_computing
- https://en.wikipedia.org/wiki/List_of_concurrent_and_parallel_programming_languages
-



Models

■ Pragmatic Programmers



Your software needs to leverage multiple cores, handle thousands of users and terabytes of data, and continue working in the face of both hardware and software failure. Concurrency and parallelism are the keys, and *Seven Concurrency Models in Seven Weeks* equips you for this new world. See how emerging technologies such as actors and functional programming address issues with traditional threads and locks development. Learn how to exploit the parallelism in your computer's GPU and leverage clusters of machines with MapReduce and Stream Processing. And do it all with the confidence that comes from using tools that help you write crystal clear, high-quality code.

This book will show you how to exploit different parallel architectures to improve your code's performance, scalability, and resilience. You'll learn about seven concurrency models: threads and locks, functional programming, separating identity and state, actors, sequential processes, data parallelism, and the lambda architecture.

Year:	2014	Edition:	1
Publisher:	Pragmatic Bookshelf	Language:	english
Pages:	300	ISBN 10:	1937785653
ISBN 13:	9781937785659	Series:	The Pragmatic Programmers

1.1 Actor Model

- https://en.wikipedia.org/wiki/Actor_model

Actor libraries and frameworks

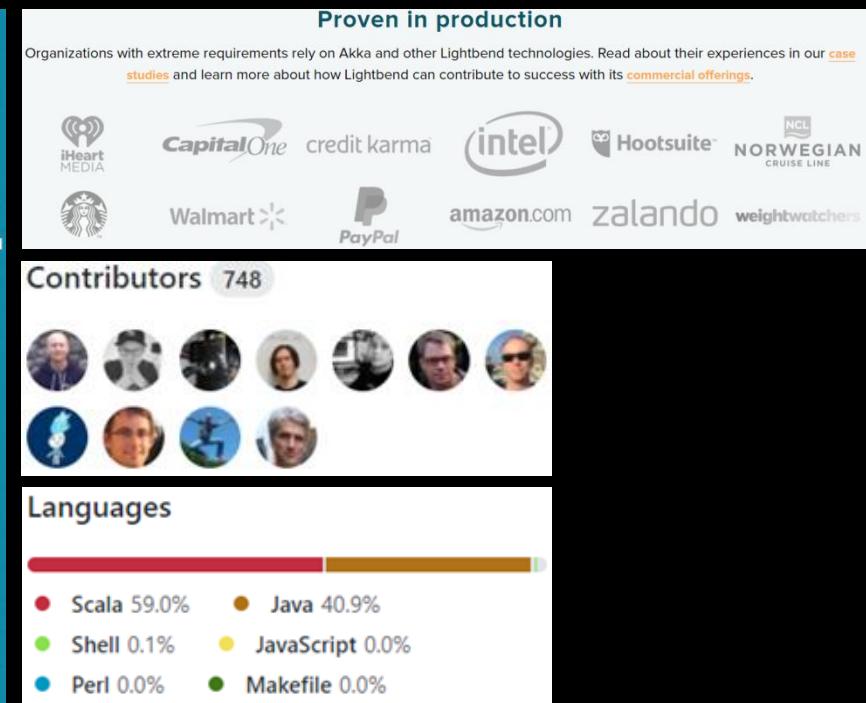
Name	Status	Latest release	License	Languages
rotor	Active	2020-10-23 ^[75]	MIT License	C++17
waSCC	Active	2020-08-30	Apache 2.0	WebAssembly (Rust, TinyGo, Zig, AssemblyScript)
ray	Active	2020-08-27	Apache 2.0	Python
Akka.NET	Active	2020-08-20 ^[48]	Apache 2.0	.NET
Bastion	Active	2020-08-12 ^[44]	Apache-2.0 / MIT	Rust
vlingo	Active	2020-07-26	Mozilla Public License 2.0	Java, Kotlin, soon .NET
SObjectizer	Active	2020-05-09 ^[74]	New BSD	C++11
Acteur	Active	2020-04-16 ^[43]	Apache-2.0 / MIT	Rust
Thespian	Active	2020-03-10	MIT	Python
libagents	Active	2020-03-08	Free software license	C++11
C++ Actor Framework (CAF)	Active	2020-02-08 ^[69]	Boost Software License 1.0 and BSD 3-Clause	C++11
Actor4j	Active	2020-01-31	Apache 2.0	Java
Orleans	Active	2019-06-02 ^[76]	MIT License	C#/.NET
Actix	Active	2019-05-30 ^[45]	MIT	Rust
Orbit	Active	2019-05-28 ^[72]	New BSD	Java
QP frameworks for real-time embedded systems	Active	2019-05-25 ^[73]	GPL 2.0 and commercial (dual licensing)	C and C++
Akka (toolkit)	Active	2019-05-21 ^[47]	Apache 2.0	Java and Scala

1.1.1 Akka

- [https://en.wikipedia.org/wiki/Akka_\(toolkit\)](https://en.wikipedia.org/wiki/Akka_(toolkit))
- **a toolkit for building highly concurrent, distributed, and resilient message-driven applications for Java and Scala**

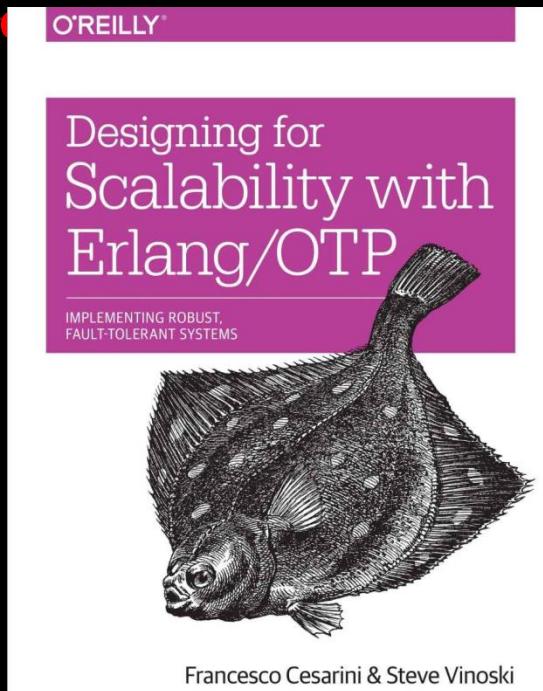
Features

- **Simpler Concurrent & Distributed Systems**
 Actors and Streams let you build systems that scale *up*, using the resources of a server more efficiently, and *out*, using multiple servers.
- **Resilient by Design**
 Building on the principles of The Reactive Manifesto Akka allows you to write systems that self-heal and stay responsive in the face of failures.
- **High Performance**
 Up to 50 million msg/sec on a single machine. Small memory footprint; ~2.5 million actors per GB of heap.
- **Elastic & Decentralized**
 Distributed systems without single points of failure. Load balancing and adaptive routing across nodes. Event Sourcing and CQRS with Cluster Sharding. Distributed Data for eventual consistency using CRDTs.
- **Reactive Streaming Data**
 Asynchronous non-blocking stream processing with backpressure. Fully async and streaming HTTP server and client provides a great platform for building microservices. Streaming integrations with Alpakka.



1.1.2 Erlang

- [https://en.wikipedia.org/wiki/Erlang_\(programming_language\)](https://en.wikipedia.org/wiki/Erlang_(programming_language))
- inspired by Actor Model and CSP(Communicating Sequential Processes)

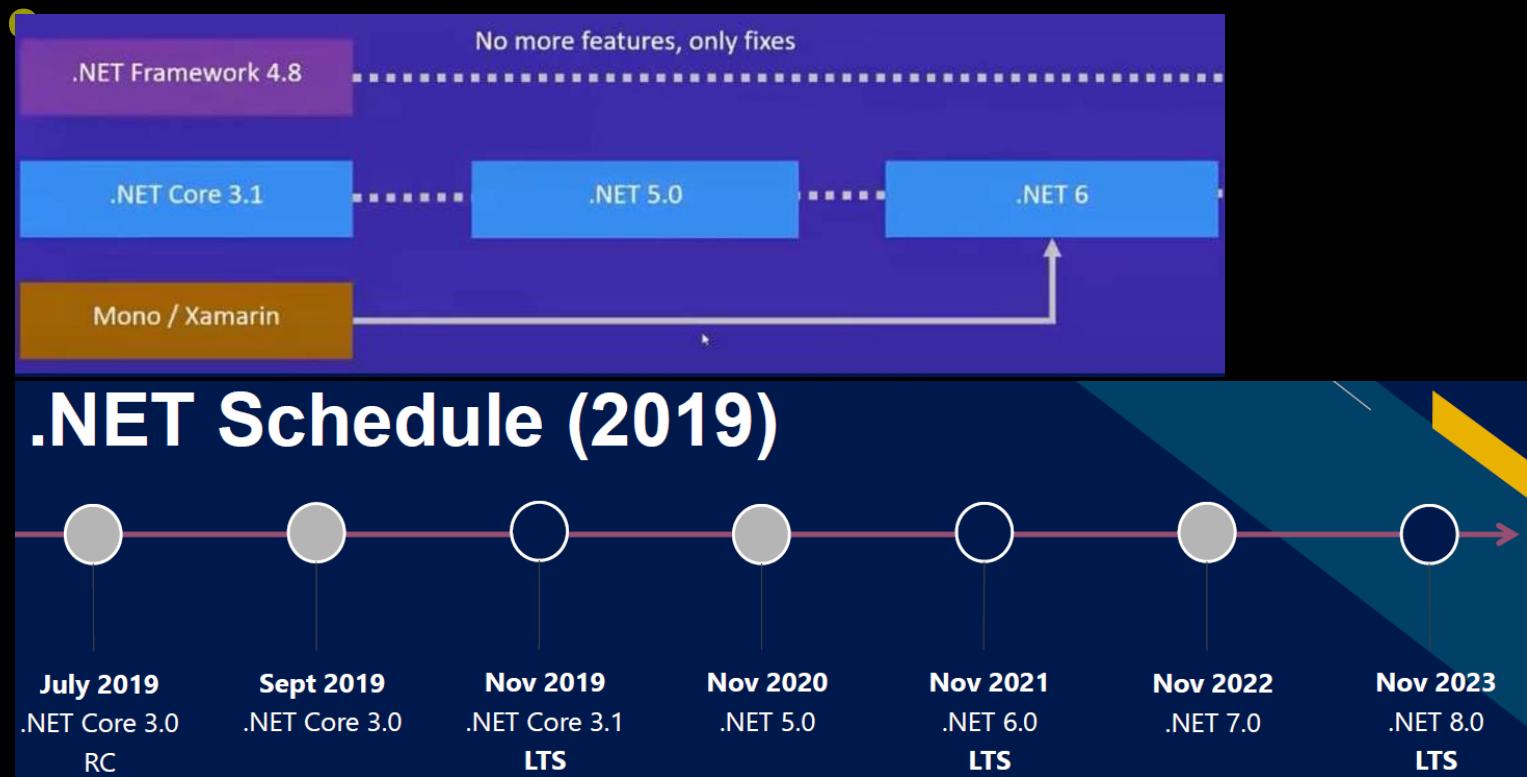


Elixir

- <https://elixir-lang.org/>

2) .Net Overview

- https://en.wikipedia.org/wiki/.NET_Framework
- https://en.wikipedia.org/wiki/.NET_Core
- [https://en.wikipedia.org/wiki/Mono_\(software\)](https://en.wikipedia.org/wiki/Mono_(software))
- ECMA-335 & ISO/IEC 23271
- ...



Source: <https://www2.slideshare.net/marco.parenzan/mini-net-conf-2020-239489909>

2.1 .Net 5

- <https://docs.microsoft.com/en-us/dotnet/core/dotnet-five>
- <https://devblogs.microsoft.com/dotnet/introducing-net-5/>

A Unified Platform



3) Akka.Net

Overview

- <https://getakka.net/>
- **Port of Akka actors for .NET**
- <https://petabridge.com/>
- - Actors were defined in the 1973 paper by [Carl Hewitt](#)
 - Early 2000 advent of SOA and asynchronous messaging to implement large systems
 - 2006 first implementation of Akka part of Scala (Java)
 - 2010 Akka 0.5 with improved concurrency & event driven architecture
 - 2013 Pigeon (port of Akka to .Net) published on GitHub
 - 2014 Improved Network Layer (Helios)
 - 2015 Petabridge founded and build commercial model around Akka.Net support.

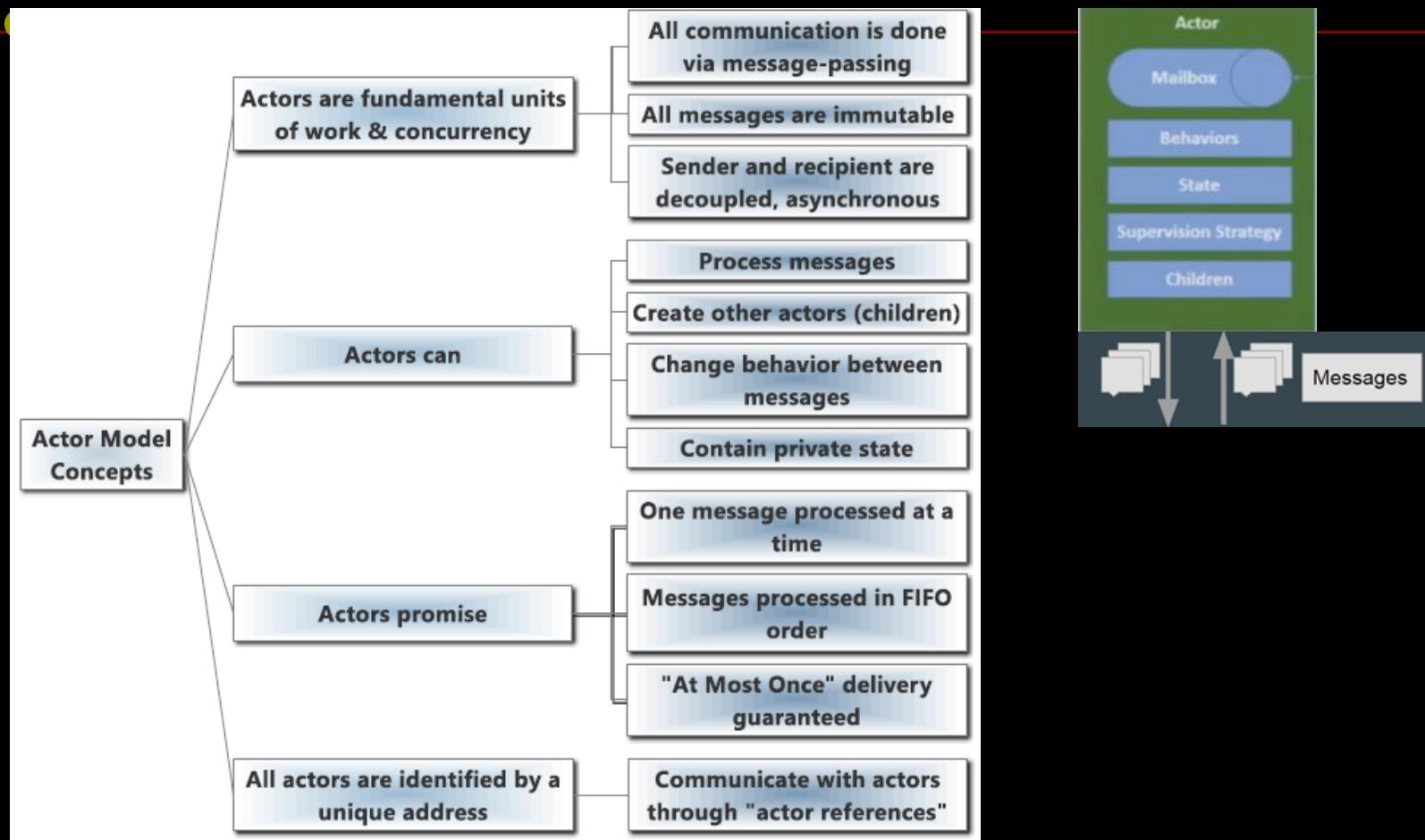


Source: <https://www2.slideshare.net/GeoffreyVandiest/akkanet-overview>

3.1 Architecture & Design

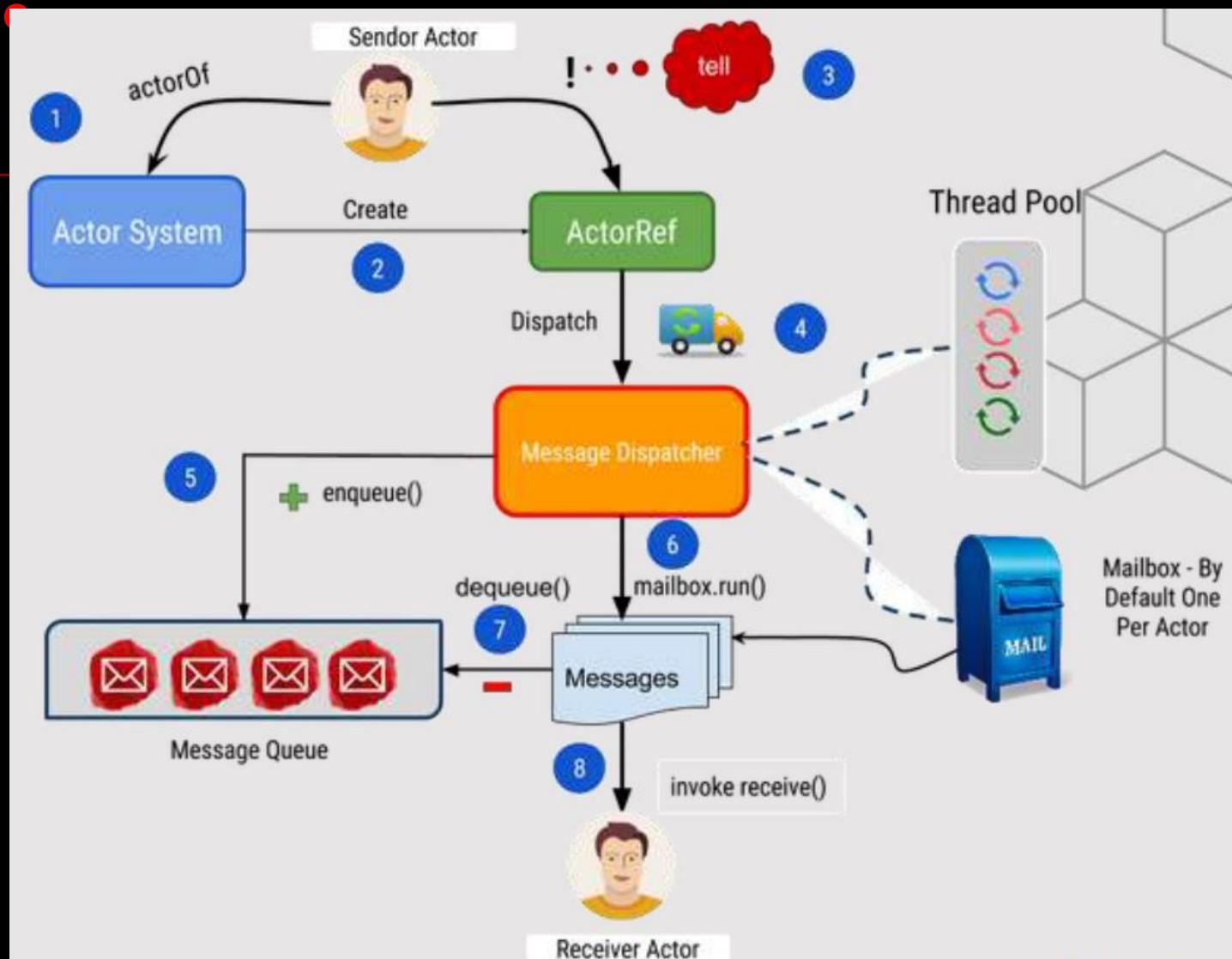
- <https://petabridge.com/bootcamp/>

Actor Model Core Concepts



Source: <https://www2.slideshare.net/petabridge/introduction-to-akkanet-and-akkacluster>

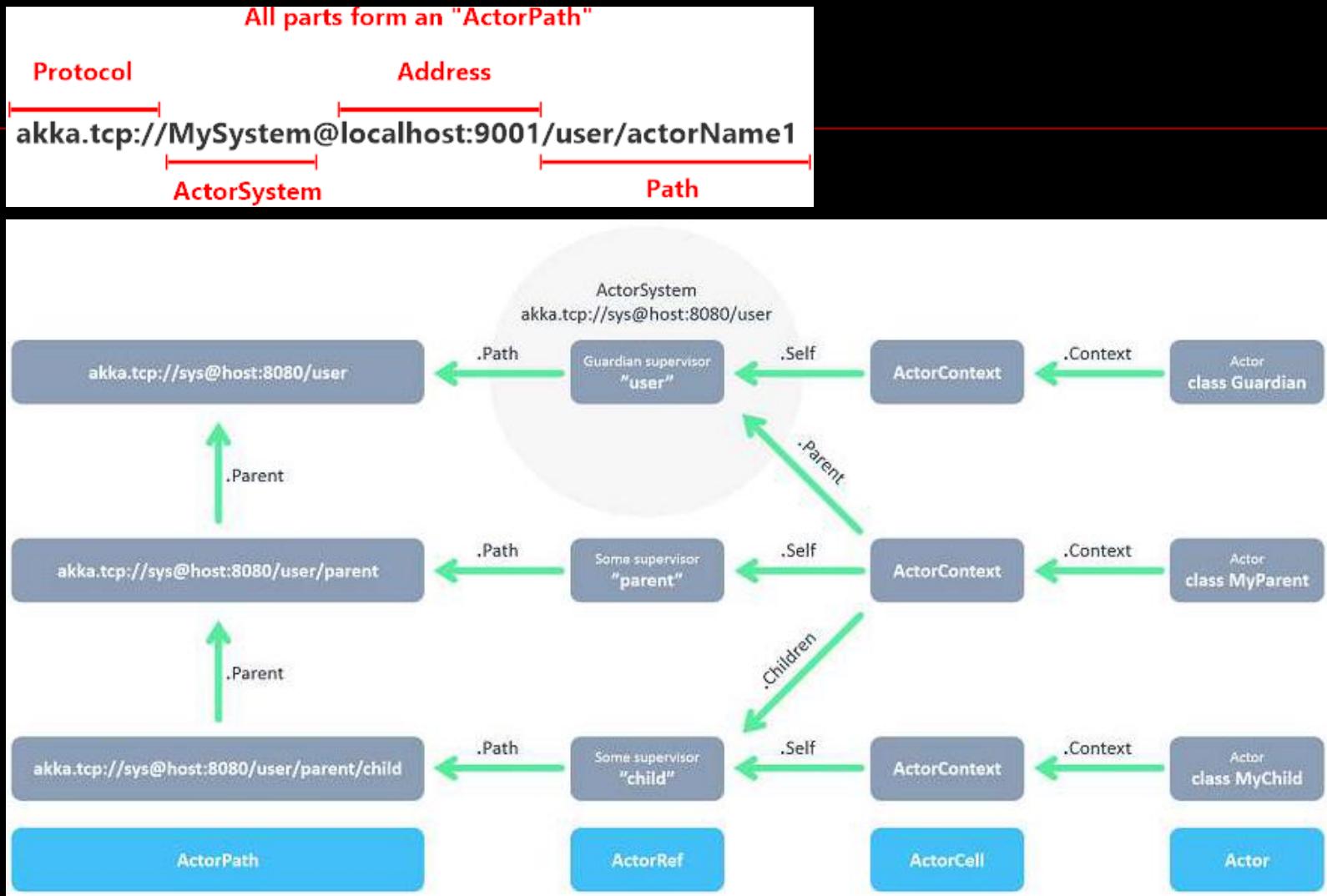
Actor System Workflow



Source: <https://www2.slideshare.net/AlexandreBrandoLusto/akkanet-implementing-distributed-systems-with-akkanet-and-net-core>

Actor Path

- Actor have a unique address



Source: <https://www2.slideshare.net/AlexandreBrandoLusto/akkanet-implementing-distributed-systems-with-akkanet-and-net-core>

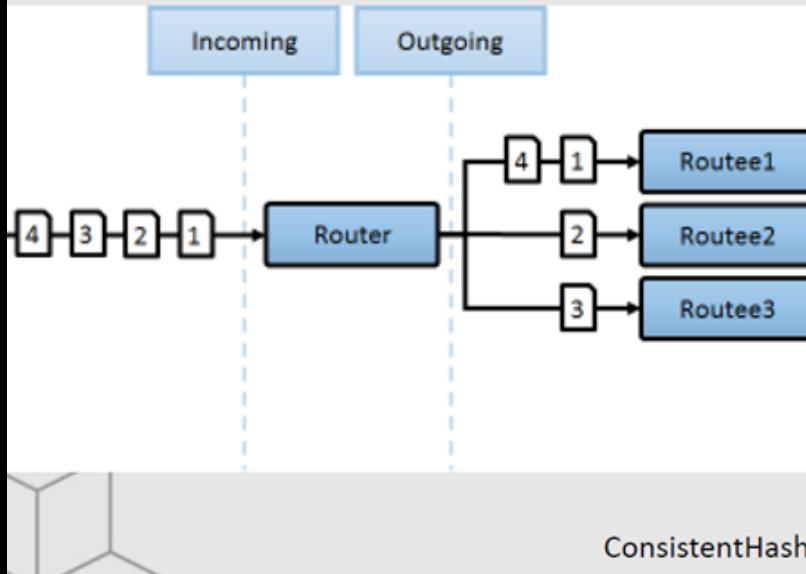
Router

-

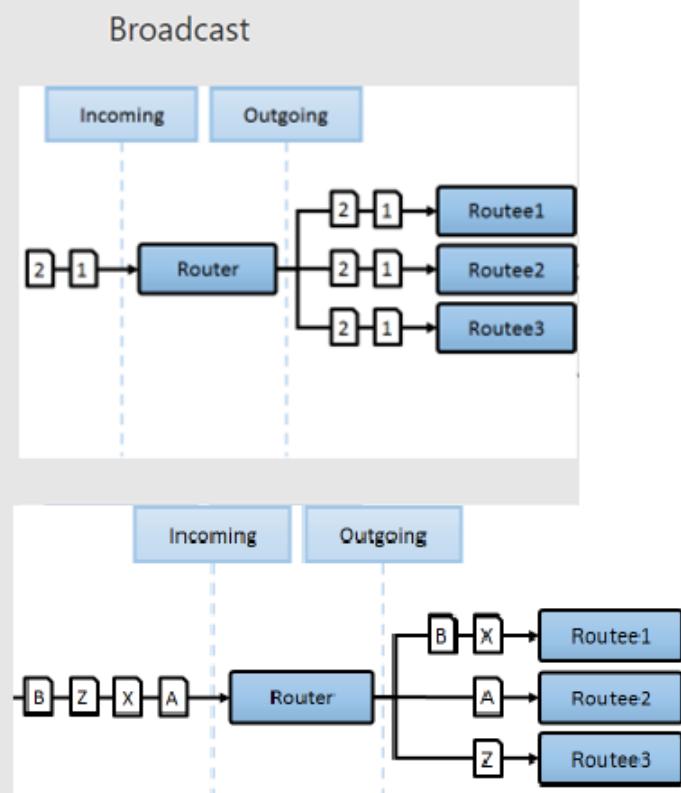


Router

RoundRobin

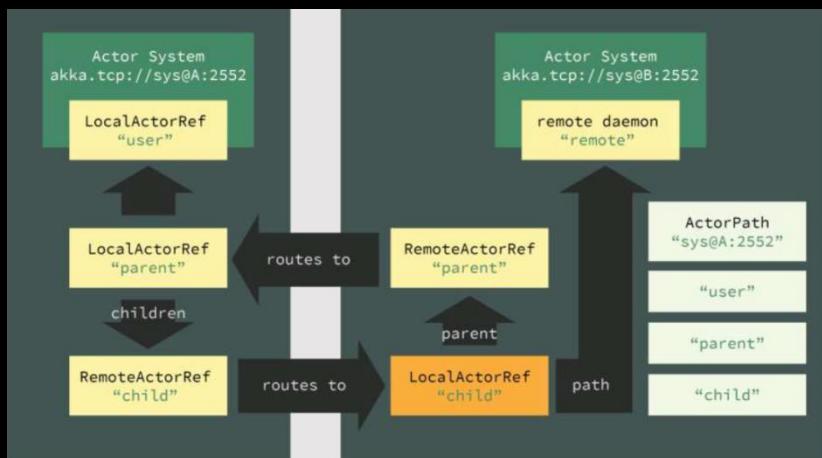
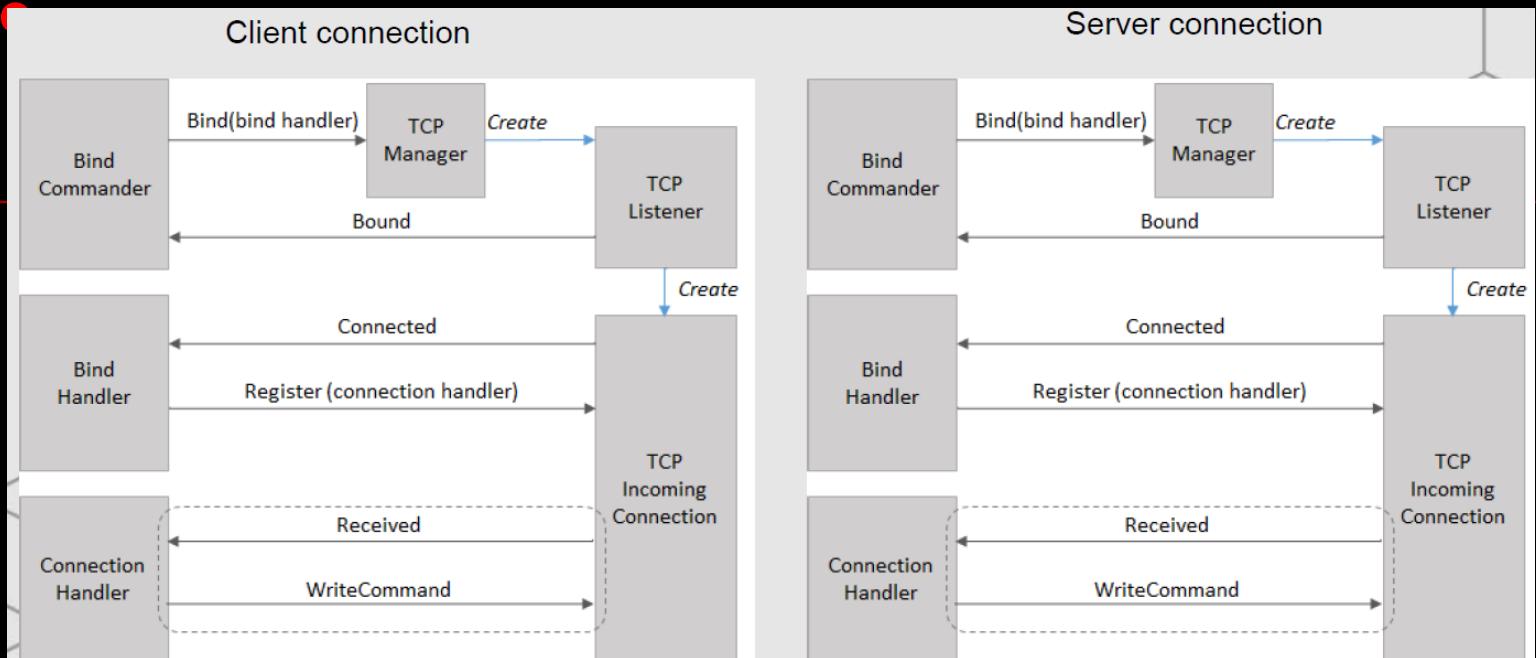


ConsistentHashing



Source: <https://www2.slideshare.net/AlexandreBrandoLusto/akkanet-implementing-distributed-systems-with-akkanet-and-net-core>

Networking & Remoting

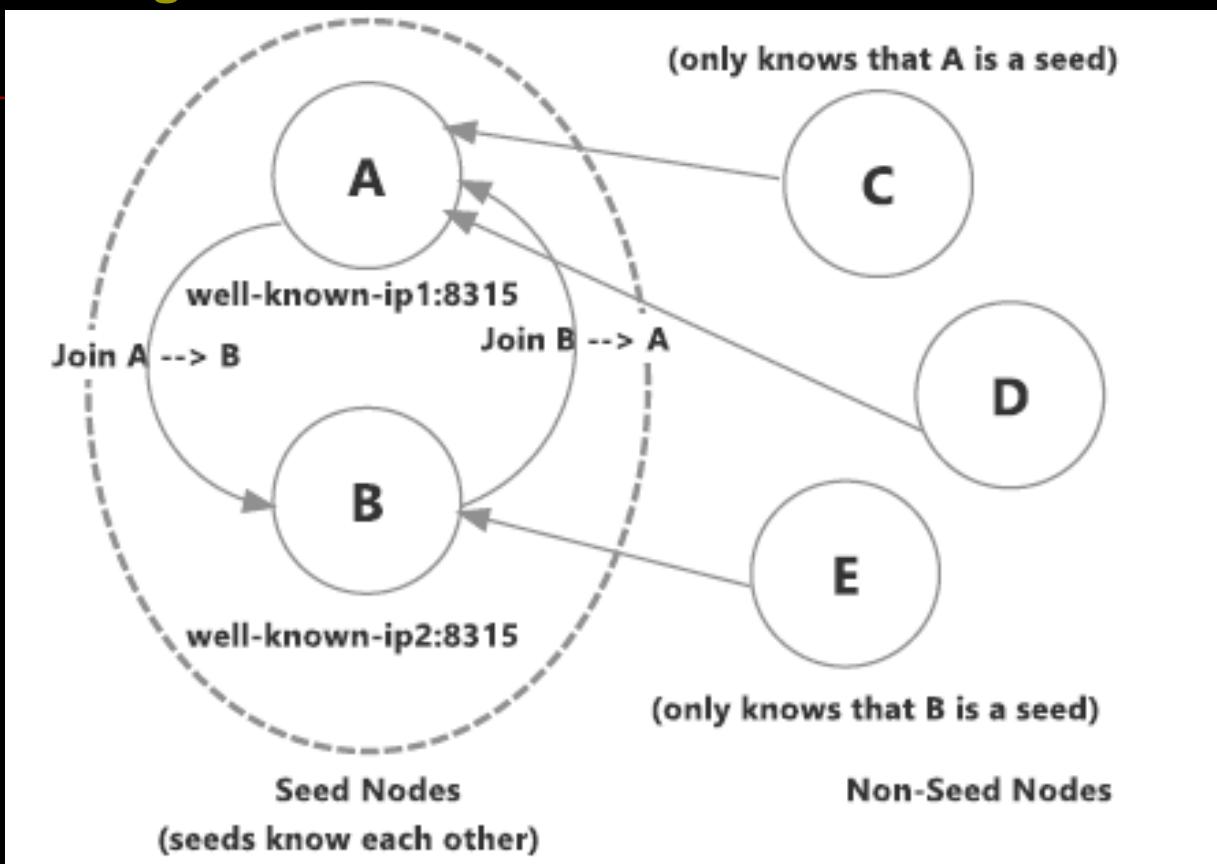


Source: <https://www2.slideshare.net/AlexandreBrandoLusto/akkanet-implementing-distributed-systems-with-akkanet-and-net-core>

Clustering

- <https://petabridge.com/cluster/>

Joining the Cluster:



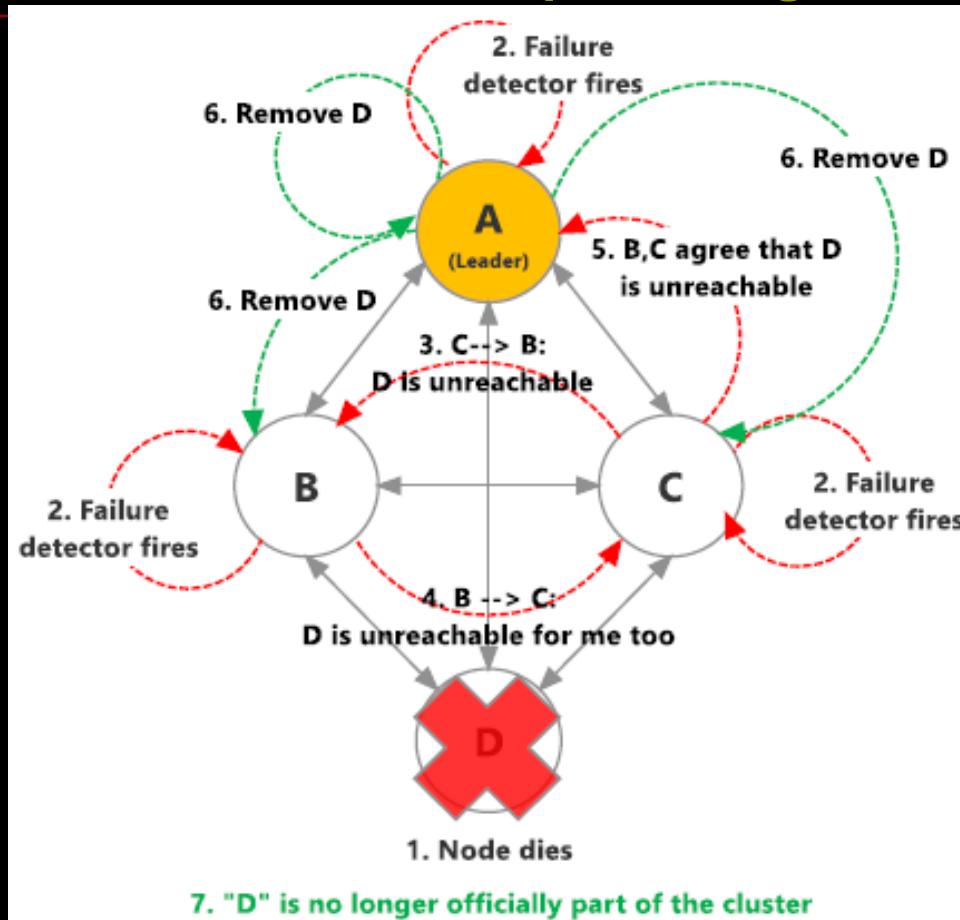
Source: <https://www2.slideshare.net/petabridge/introduction-to-akkanet-and-akkacluster>

Gossip

https://en.wikipedia.org/wiki/Gossip_protocol

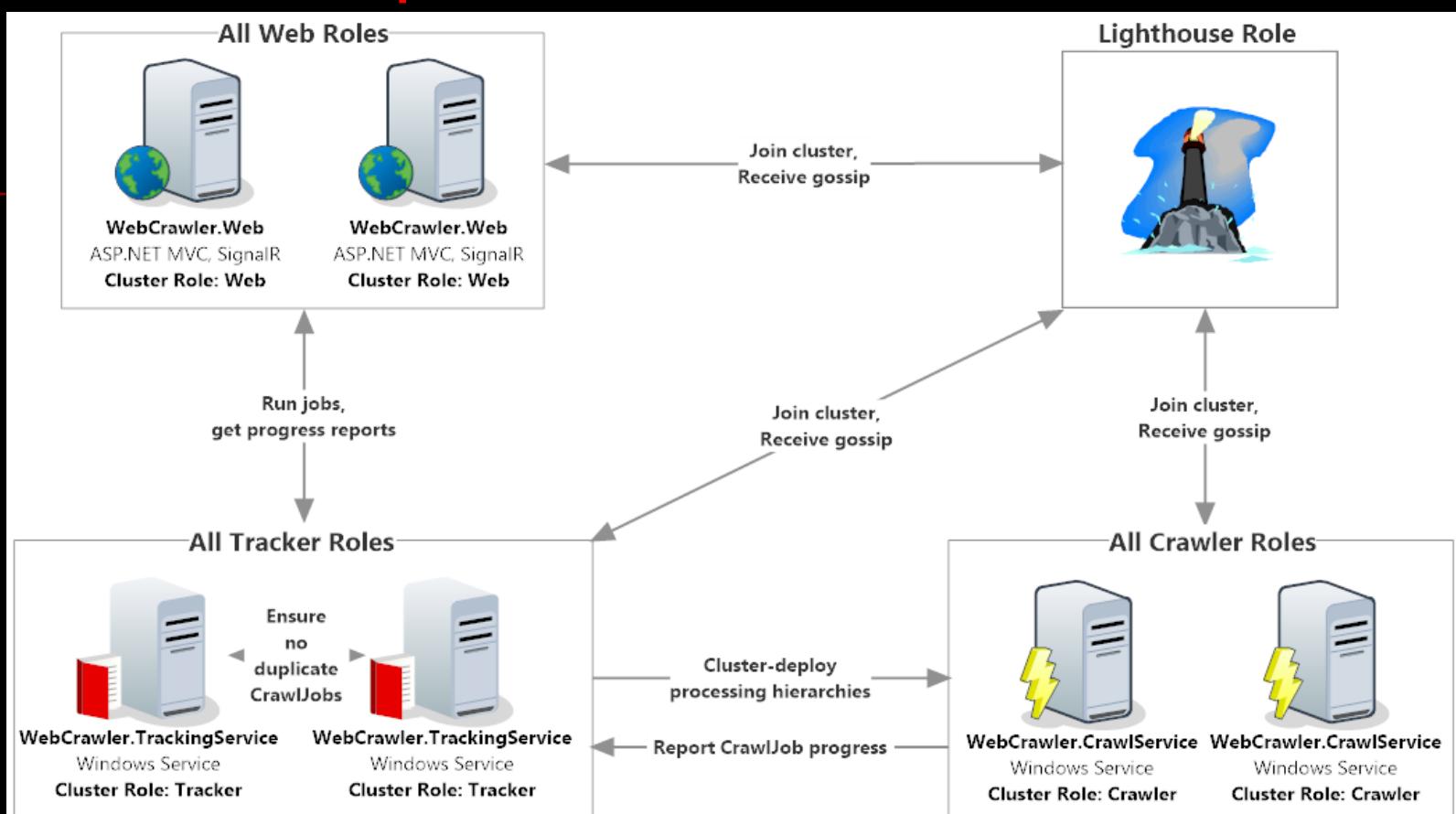
How Nodes Discover Each Other...

Leaders Act on Gossip Convergence:



Source: <https://www2.slideshare.net/petabridge/introduction-to-akkanet-and-akkacluster>

■ WebCrawler Sample



Source: <https://www2.slideshare.net/petabridge/slides-intro-to-akkacluster>

Akka.NET Modules

- - Akka – core actor library
 - Akka.Remote – cross-node actor deployment / communication
 - Akka.Cluster – elastic actor networks (HA)
 - Akka.Persistence – event-sourcing, durable actor state & recovery
 - Akka.Streams – streaming workflows
 - Akka.Cluster.Tools – cluster singleton, distributed pub sub
 - Akka.Cluster.Sharding – durable state partitioning
 - Akka.DData – eventually consistent data replication

Source: <https://www2.slideshare.net/petabridge/introduction-to-akkanet-and-akkacluster>

3.2 Use Cases

- <https://getakka.net/articles/intro/akka-users.html>

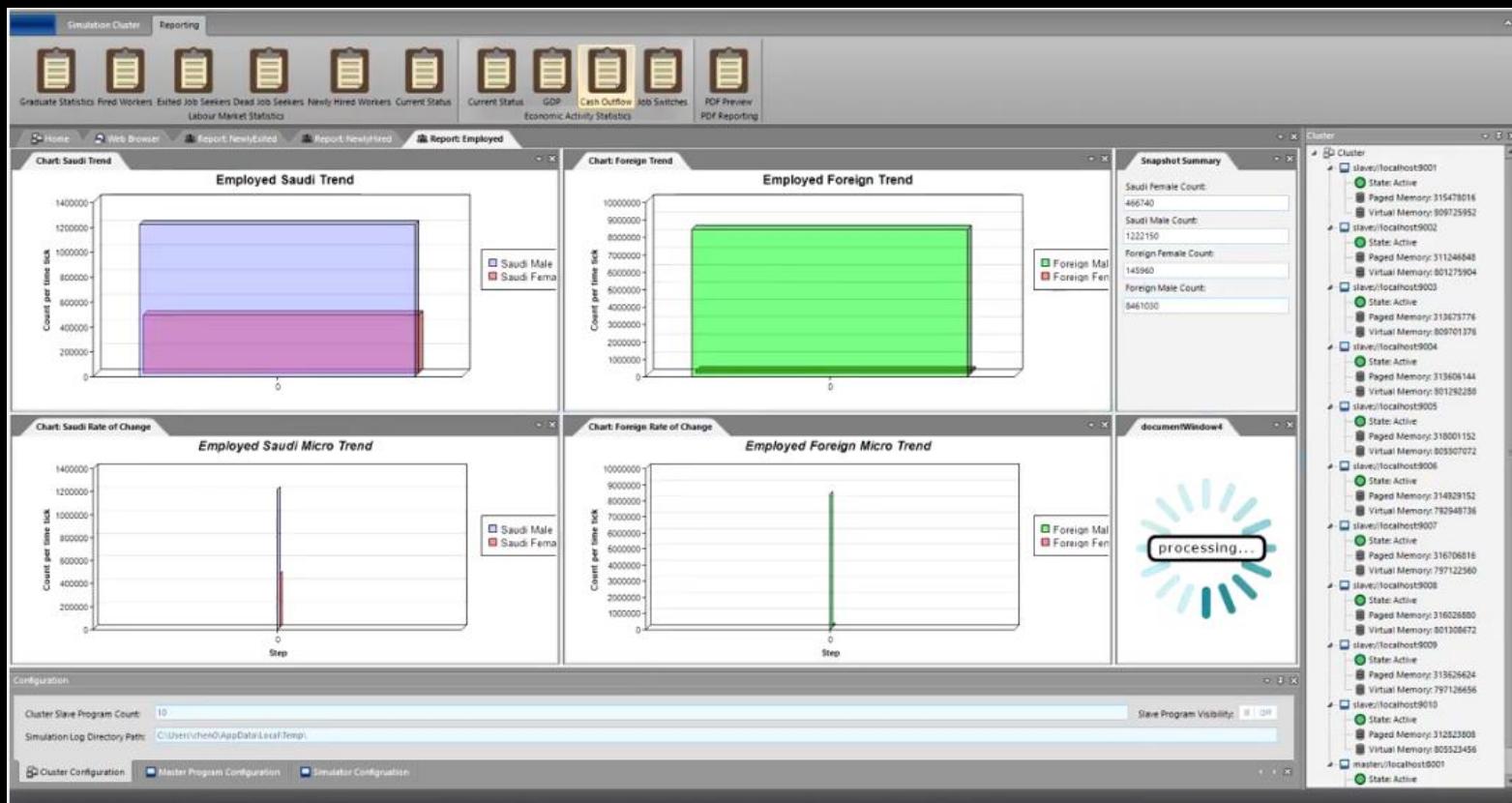
When to Use Akka.NET

- - Event-driven applications (i.e. chat, workflow, CRM)
 - Finance (pricing, fraud detection, algorithmic trading)
 - Gaming (multi-player)
 - Analytics & monitoring
 - Marketing automation
 - Systems integration
 - IOT (healthcare, transportation, security)

Source: <https://www2.slideshare.net/petabridge/dotnext-2020-when-and-how-to-use-the-actor-model-and-akkonet>

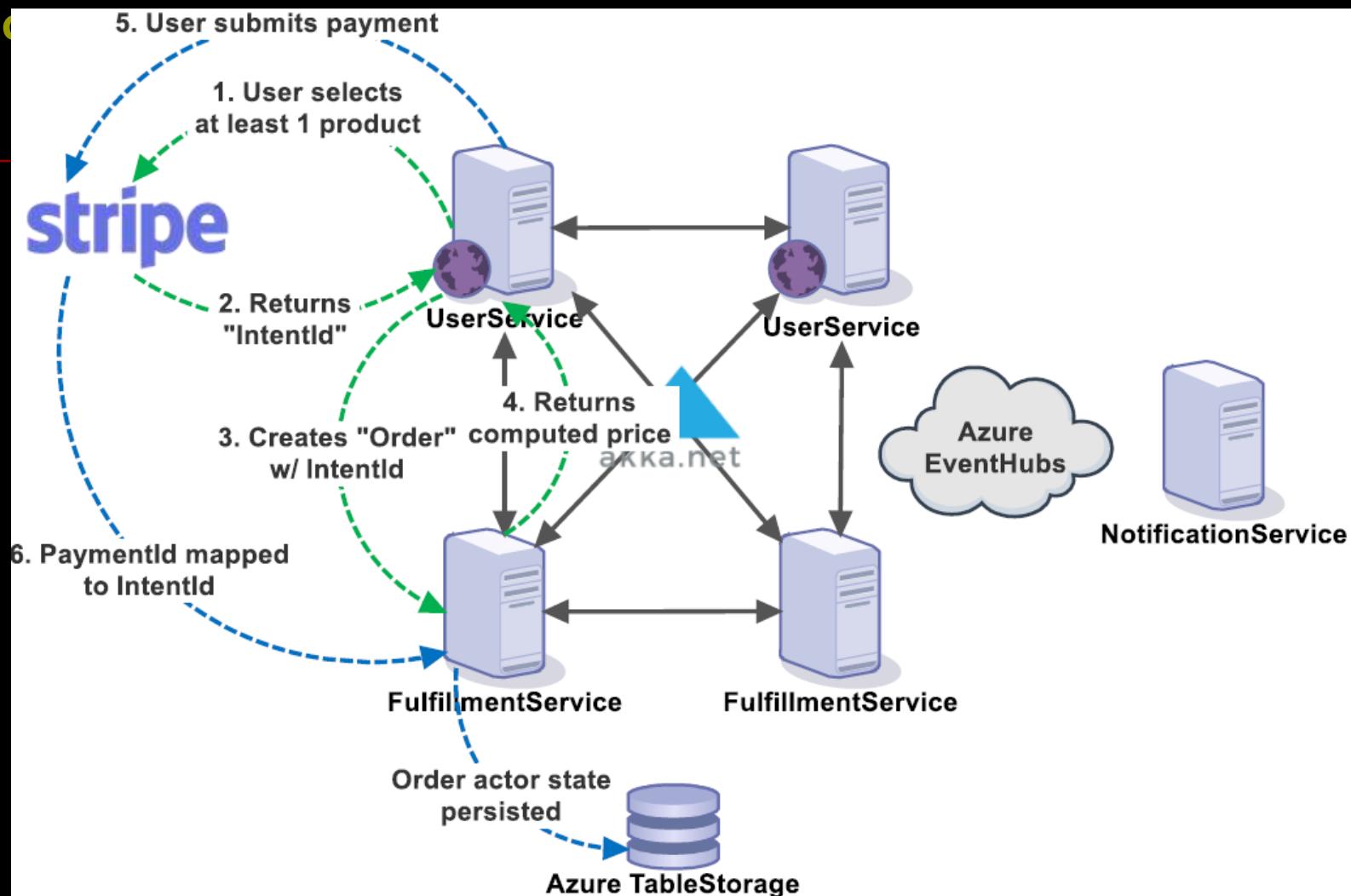
Unity

- [https://en.wikipedia.org/wiki/Unity_\(game_engine\)](https://en.wikipedia.org/wiki/Unity_(game_engine))
- https://www.reddit.com/r/Unity3D/comments/8l41dp/akkanet_on_unity3d_need_help_in_getting_started/
- <https://libraries.io/github/Arkatufus/Akka.Unity.Sample>
- Integration of Akka.NET with Unity 3D for ABMS

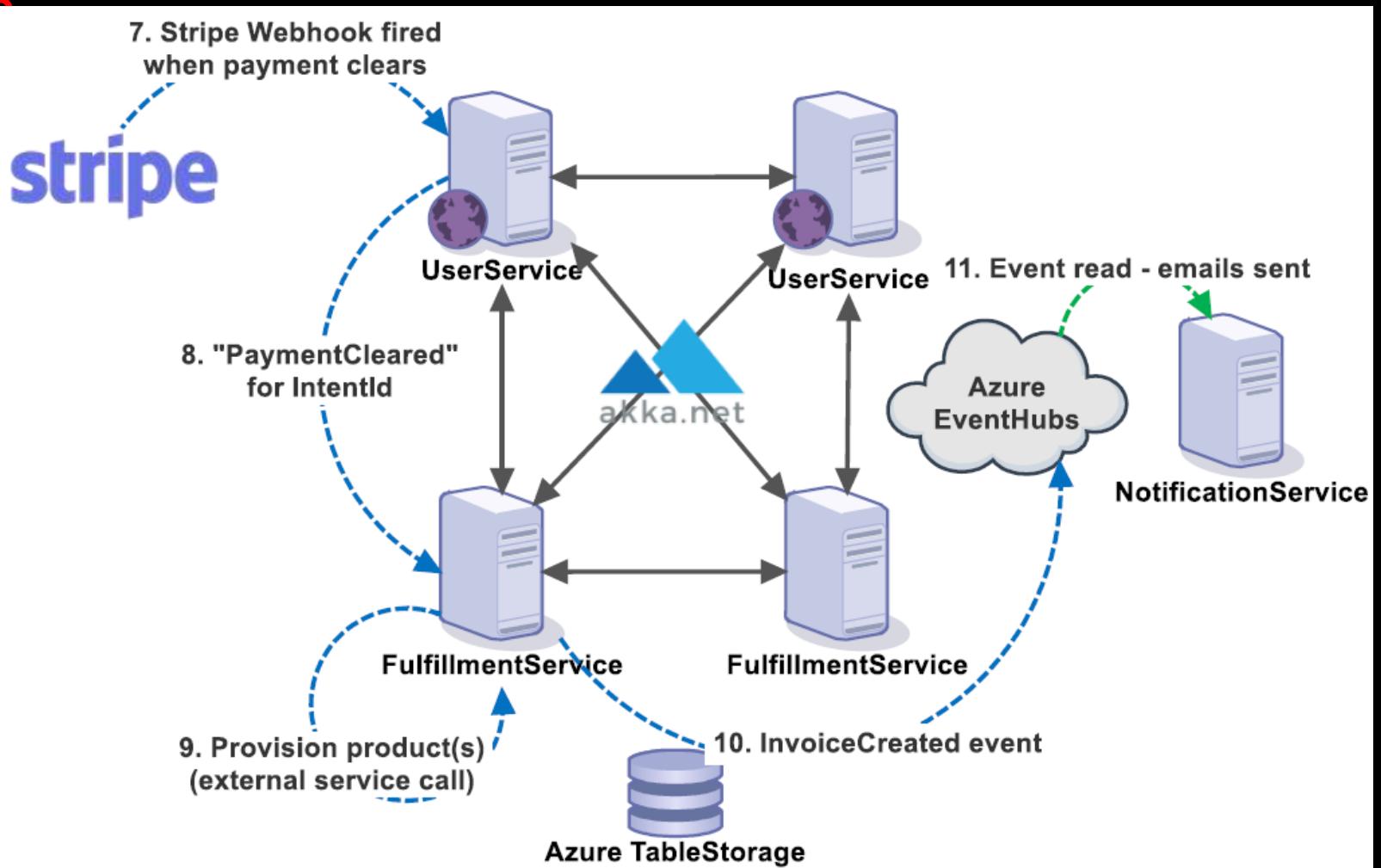


Source: <https://www.youtube.com/watch?v=b0GUe88Pm70>

Sdbkin Fulfillment



Source: <https://www2.slideshare.net/petabridge/dotnext-2020-when-and-how-to-use-the-actor-model-and-akka.net>

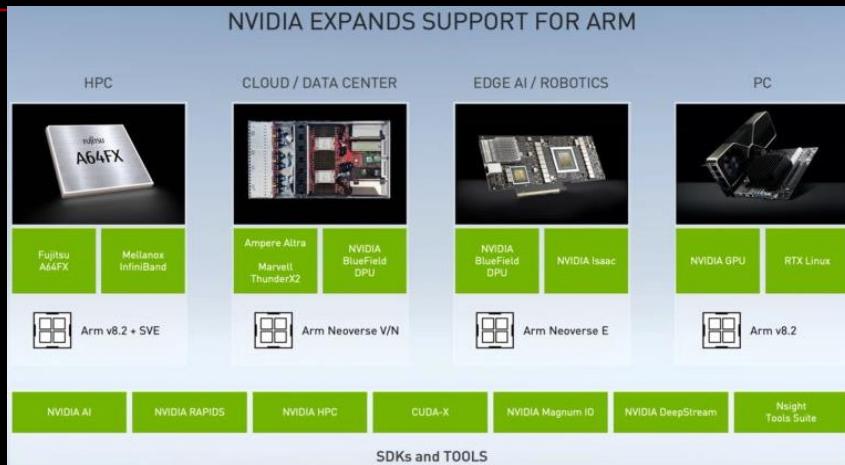


Source: <https://www2.slideshare.net/petabridge/dotnext-2020-when-and-how-to-use-the-actor-model-and-akkonet>

II. Testbed

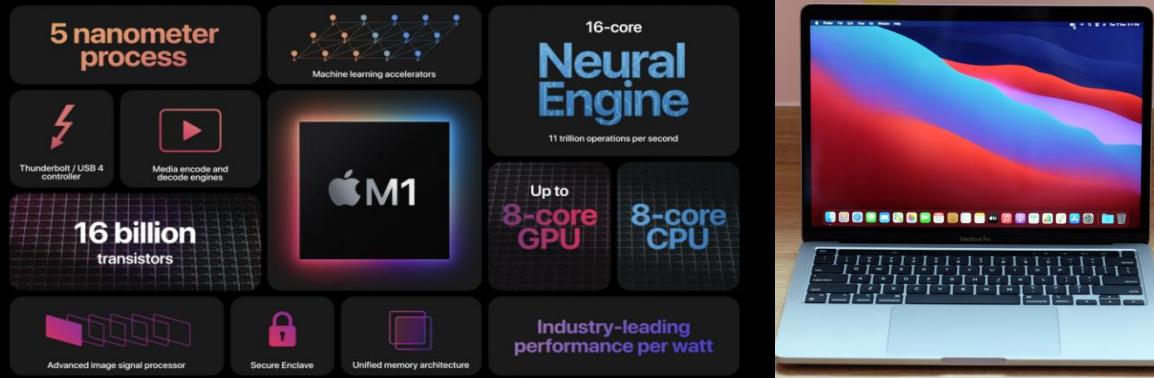
1) ARM Ecosystem in 2020

- NVIDIA to Acquire ARM



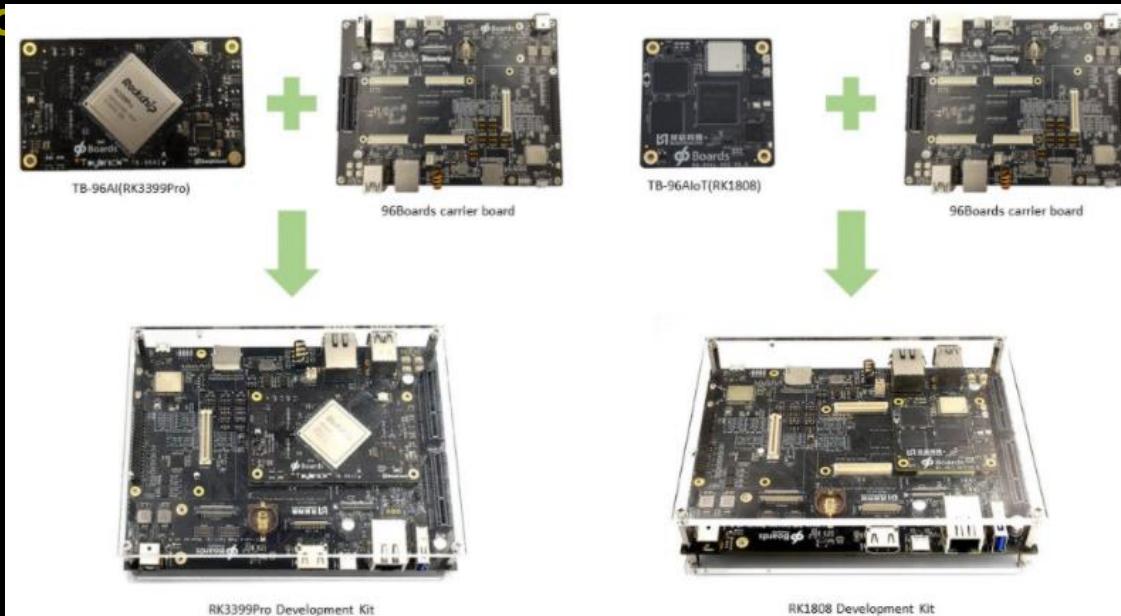
Source: <https://blogs.nvidia.com/blog/2020/10/05/arm-ecosystem-support/>

https://en.wikipedia.org/wiki/Apple_M1



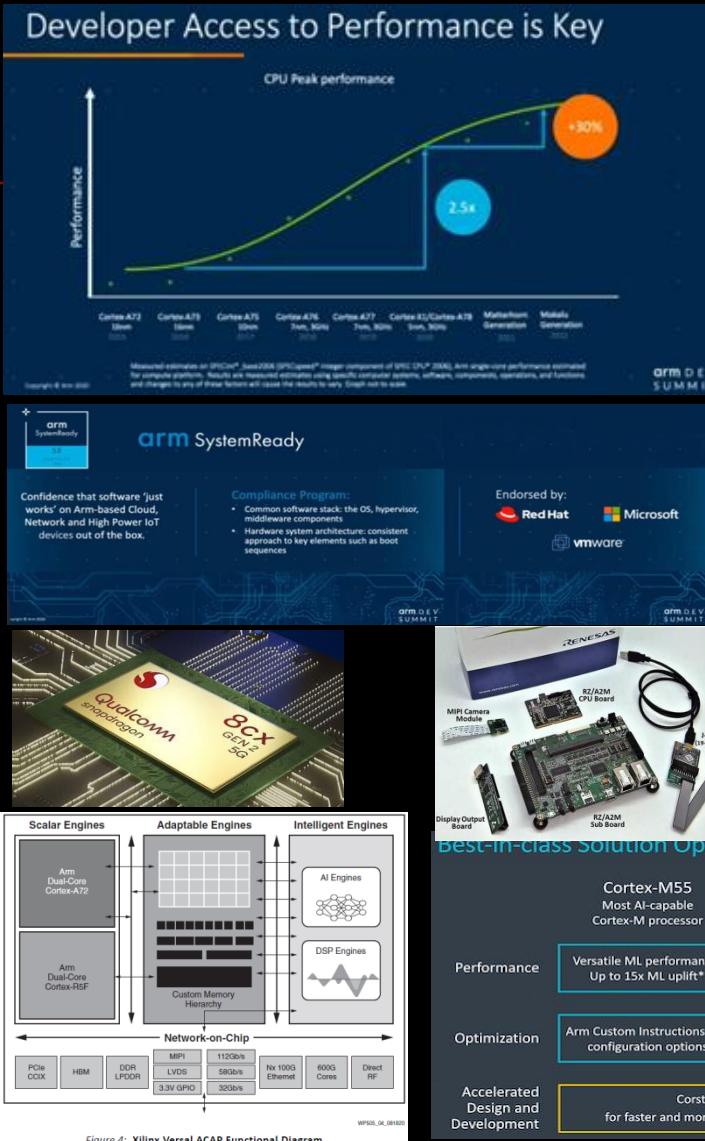
SOM/COM

- <https://www.linaro.org/news/linaro-announces-launch-of-96boards-system-on-module-som-specification/>
- <http://linuxgizmos.com/linaro-launches-two-96boards-som-specifications/>
- <http://static.linaro.org/assets/specifications/96BoardsComputeSoMSpecificationV1.0.pdf>
- <https://static.linaro.org/assets/specifications/96BoardsWirelessSoMSpecificationV1.0.pdf>
- ~~Carrier Board~~



Source: http://www.beiqicloud.com/product_detail.html?pid=CarrierBoard

1.1 ARM Trends in 2020



■ 超翔TK630

同方超翔TK630是基于鲲鹏920 8核处理器全新设计开发的高性能终端产品，具有超大内存，更多核心，可实现操作系统和软件秒级快速启动，性能接近国际主流台式机处理水平，可全面实现整机高运算性能，支持多数开源软件开发和应用虚拟化场景，满足企事业单位对信息安全、大型数据处理等需求。

■ 产品规格

功能	超翔TK630		
CPU	鲲鹏920 8核 2.6G	显示器	23.8英寸超窄边高清显示器
内存类型	DDR4 2666MHz	外接接口	USB3.0*4/USB2.0*4/COM*1/光纤接口*1(不带模块)/RJ45*1/Audio
内存容量	16 GB (最大内存容量可达64G)	外接显示接口	支持VGA/HDMI输出
内存插槽	4个	IO接口	PCIe 3.0 x16*1/ PCIe 3.0 x4*1/ PCIe 3.0 x1*1/ SATA 3.0*6
SSD	256G M.2 NVMe SSD (可扩展2T机械硬盘)	尺寸	382mm*100mm*340mm
光驱	DVD-RW	重量	5.0kg
网络适配器	10/100/1000Mbps以太网卡	电源	200W 电源
声卡	支持5.1声道	操作系统	统信/银河麒麟桌面操作系统
显卡	1G 高性能独立显卡	认证	3C、节能、MTBF



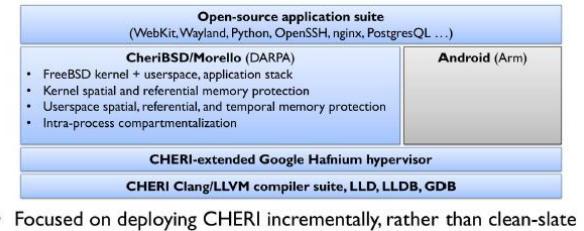


Ampere® Altra™ family—featuring the highest core count Cloud-Native processor

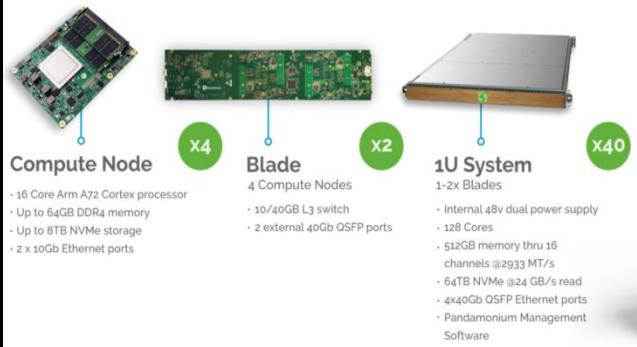


DARPA software prototype stack on Morello

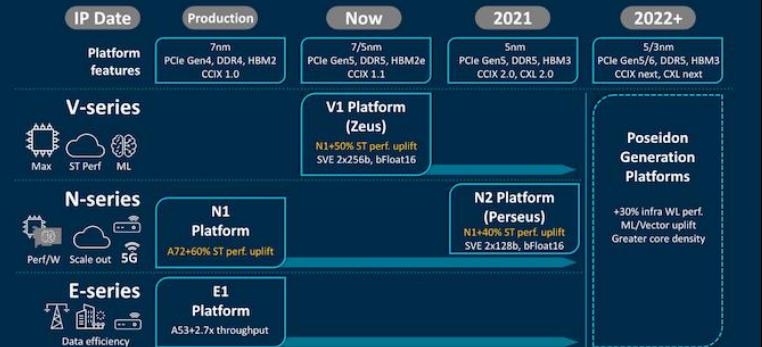
- Complete hybrid software stack from bare metal up: compilers, toolchain, debuggers, operating systems, applications



- Focused on deploying CHERI incrementally, rather than clean-slate



Arm Neoverse Platform Roadmap

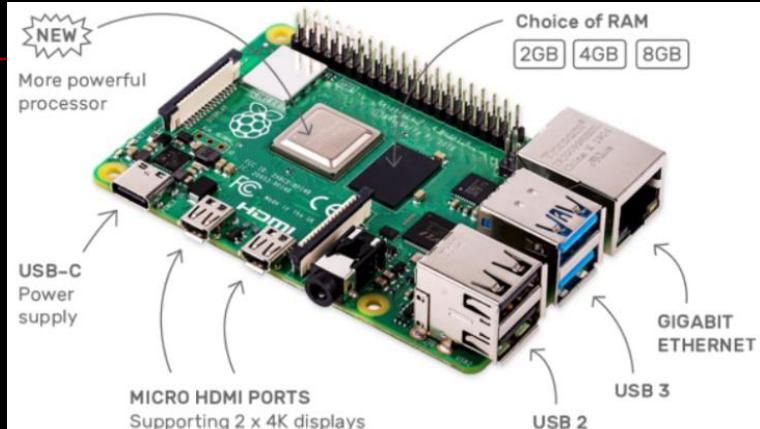


2) Raspberry Pi

2.1 hardware

- <https://www.raspberrypi.org/products/raspberry-pi-4-model-b/>

Features/Specs	Raspberry Pi 4B	Raspberry Pi 3 B+
Release date	24th June 2019	14th March 2018
SoC	Broadcom BCM2711 quad-core Cortex-A72 @ 1.5 GHz	Broadcom BCM2837B0 quad-core Cortex-A53 @ 1.4 GHz
GPU	VideoCore VI with OpenGL ES 1.1, 2.0, 3.0	VideoCore IV with OpenGL ES 1.1, 2.0
Video Decode	H.265 4Kp60, H.264 1080p60	H.264 & MPEG-4 1080p30
Video Encode	H.264 1080p30	
Memory	1GB, 2GB, or 4GB LPDDR4	1GB LPDDR2
Storage	microSD card	
Video & Audio Output	2x micro HDMI ports up to 4Kp60 3.5mm AV port (composite + audio) MIPI DSI connector	1x HDMI 1.4 port up to 1080p60 3.5mm AV port (composite + audio) MIPI DSI connector
Camera	MIPI CSI connector	
Ethernet	Native Gigabit Ethernet	Gigabit Ethernet over USB (300 Mbps max.)
WiFi	Dual band 802.11 b/g/n/ac	
Bluetooth	Bluetooth 5.0 + BLE	Bluetooth 4.2 + BLE
USB	2x USB 3.0 + 2x USB 2.0	4x USB 2.0
Expansion	40-pin GPIO header	
Power Supply	5V via USB type-C up to 3A 5V via GPIO header up to 3A Power over Ethernet via PoE HAT	5V via micro USB up to 2.5A 5V via GPIO header up to 3A Power over Ethernet via PoE HAT
Dimensions	85x56 mm	
Default OS	Raspbian (after June 24, 2019)	Raspbian (after March 2018)
Price	\$35 (1GB RAM), \$45 (2GB RAM), \$55 (4GB RAM)	\$35 (1GB RAM)

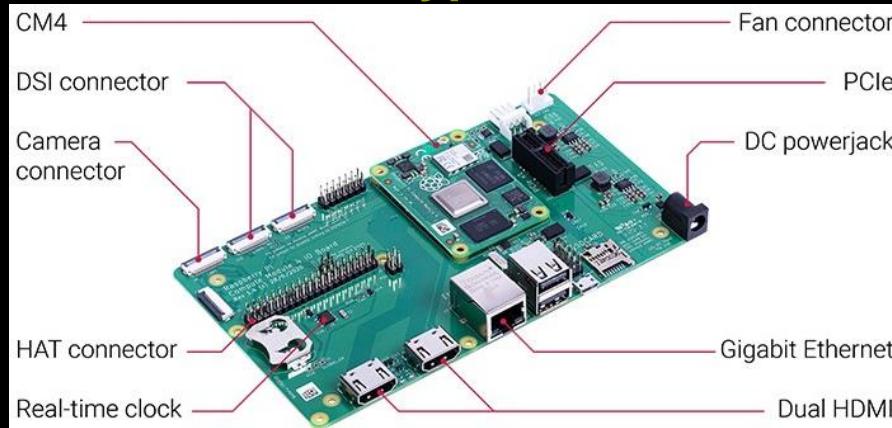


Compute Module 4 & IO Board

- Just released in Oct, 2020
- <https://www.raspberrypi.org/blog/designing-the-raspberry-pi-compute-module-4/>
- <https://www.raspberrypi.org/products/compute-module-4/?variant=raspberry-pi-cm4001000&resellerType=home>



- <https://www.raspberrypi.org/products/compute-module-4-io-board/?resellerType=home>



2.2 OS

- <https://distrowatch.com/>

Rank	Distribution	HPD*
1	MX Linux	3412▼
2	Manjaro	2343▲
3	Mint	2082▼
4	Pop!_OS	1828▲
5	Ubuntu	1378-
6	Debian	1247▲
7	elementary	1133-
8	Fedora	966-
9	EndeavourOS	882▲
10	Solus	862▼

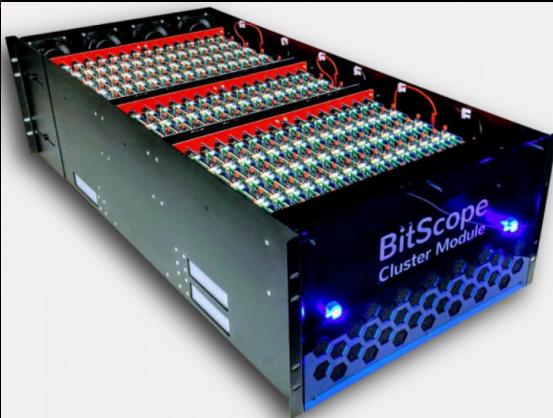
- Using **Fedora 33(Fedora-Xfce-33-1.3.aarch64.raw.xz)** and **Manjaro 2020.10 (Manjaro-ARM-xfce-rpi4-20.10.img.xz)** ARM64 image with all the necessary dev software post installed
- **Fedora is developer friendly...**
- **Manjaro is one of the most popular and stable distribution...**
- ...
- Pls refer to my presentation "**Python for Linux Kernel Debugging**" at PyCon China 2019(Hangzhou) for details

2.3 Clustering

BitScope Pi Cluster

- <http://cluster.bitscope.com/>

Scalable clusters make HPC R&D easy as Raspberry Pi



CLUSTER MODULE

The basic building block of scalable BitScope Clusters.

High Density, Low Cost

Each module packs **144 active nodes**, six spare nodes and one cluster manager node in a single 6U drawer. Build a **1000 node** cluster in **42U** for less than **\$150/node**.

Low Power, Low Heat

At less than **5W/node** in typical operation you need only **6kW** to run **1000 nodes** including network fabric and air flow.



Highly Affordable

The world's most cost effective scalable solution. Inexpensive to build, operate and maintain.



Perfect for Research

Develop new cluster architectures that scale at very low cost before committing to production designs.



Extremely Flexible

Built with the amazing ARM based Raspberry Pi. Many software options and a vast developer community.



Ideal for Education

The world's leading computing education platform can now be used to teach network, cluster and cloud computing. All open source.



CLUSTER PACK

The key building block of every Cluster Module.

Power & Mounting Solution

Cluster Packs simplify the mounting of thousands of nodes.

They route and regulate power to every node, locally.

No Wires, No Problems

Power the packs and you power the cluster.

- <http://bitscope.com/product/blade/?p=about>

BitScope Blade for Raspberry Pi



Oracle RPi Supercomputer

- <https://www.servethehome.com/oracle-shows-1060-raspberry-pi-supercomputer-at-oow/>
Oracle Shows 1060 Raspberry Pi Supercomputer



What's the matter

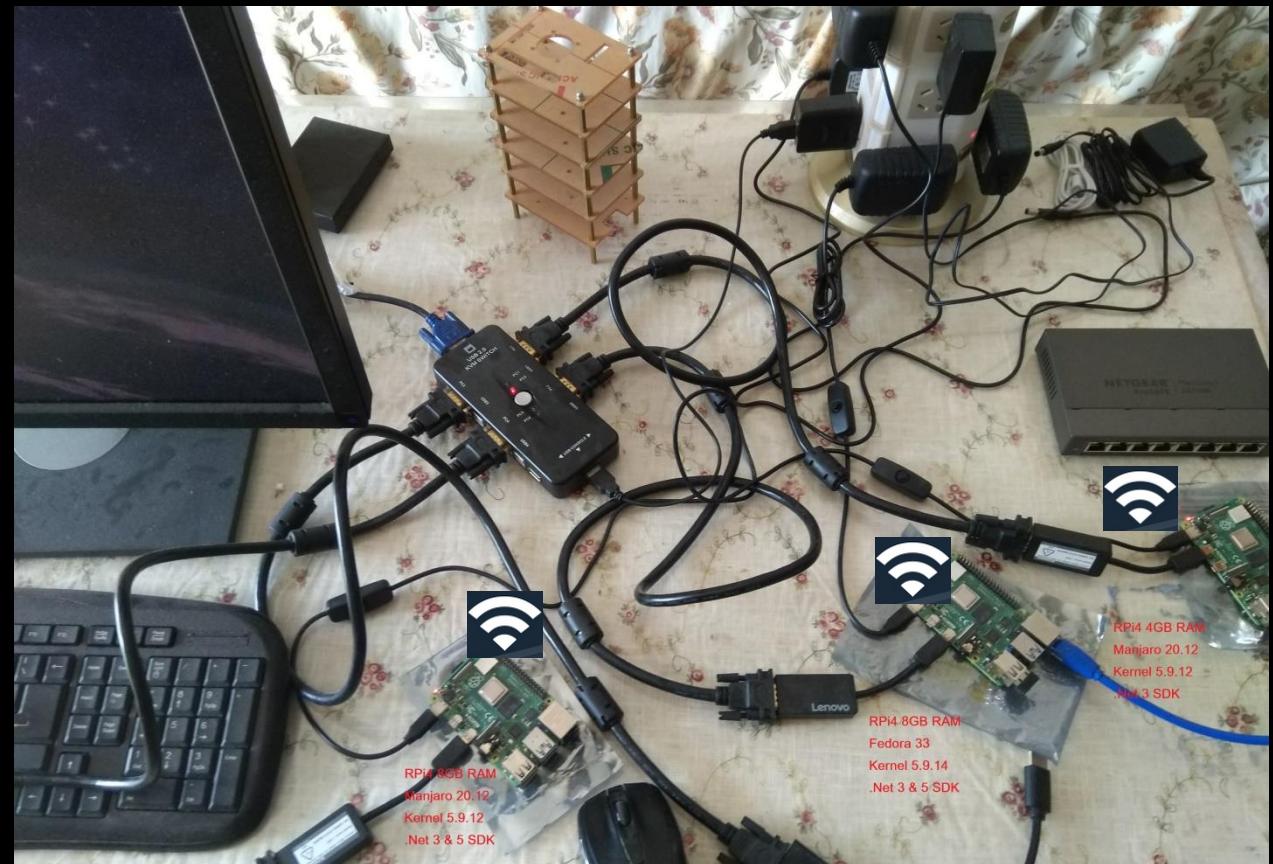
- <https://www.servethehome.com/aoa-analysis-marvell-thunderx2-equals-190-raspberry-pi-4/>

Raspberry Pi Units	
Raspberry Pi 4 4GB	\$55.00
PoE Hat	\$20.00
3M Ethernet Cable	\$1.50
Case	\$7.00
<i>Total RPi Unit Cost</i>	<u>\$83.50</u>
Rack Hardware	
Rack Shelf	\$78
<i>1/48th Rack Shelf</i>	<u>\$1.63</u>
PoE Switches and Cables	
PoE Switch Mikrotik CRS328-24P-4S+-RM	\$350
2x SFP+ Uplink Cables	\$50
<i>1/24th PoE Network</i>	<u>\$16.67</u>
Network Aggregation Layer	
Aggregation SFP+ Switch	\$500
<i>1/288th Aggregation SFP+ Switch</i>	<u>\$1.74</u>
Storage	
FreeNAS Mini XL+ 24TB Raw	\$2,400
<i>1/288th Shared Storage</i>	<u>\$8.33</u>
Total Per RPi 4 in CI/CD Cluster	
<i>Total Cost Per RPi 4 4GB</i>	<u>\$111.86</u>



2.4 My Cluster

- Home router and RPi are connected by Wi-Fi or Ethernet



III. Set up Akka.NET on RPi 4

1) Prepare In-device Dev Env (on Fedora/Manjaro)

Install SDK

- <https://dotnet.microsoft.com/download/dotnet-core>
- [SDK 5.0.101](#)

Visual Studio support

Visual Studio 2019 (v16.8)

Visual Studio 2019 for Mac (v8.8)

Included in

Visual Studio 16.8.3

Included runtimes

.NET Runtime 5.0.1

ASP.NET Core Runtime 5.0.1

.NET Desktop Runtime 5.0.1

Language support

C# 9.0

F# 5.0

Visual Basic 15.9

OS	Installers	Binaries
Linux	Package manager instructions	Arm32 Arm64 x64 x64 Alpine
macOS	x64	x64
Windows	Arm64 x64 x86	Arm64 x64 x86
All	dotnet-install scripts	

SDK 3.1.404

Visual Studio support

Visual Studio 2019 (v16.7)

Visual Studio 2019 for Mac (v8.8)

Included in

Visual Studio 16.7.8

Included runtimes

.NET Core Runtime 3.1.10

ASP.NET Core Runtime 3.1.10

.NET Core Desktop Runtime 3.1.10

Language support

C# 8.0

F# 4.7

Visual Basic 15.9

OS	Installers	Binaries
Linux	Package manager instructions	Arm32 Arm64 RHEL 6 x64 x64 x64 Alpine
macOS	x64	x64
Windows	x64 x86	Arm32 x64 x86
All	dotnet-install scripts	

- [mydev@MyRPi4Manjaro2 SDK]\$ tar zxvf [dotnet-sdk-5.0.101-linux-arm64.tar.gz](#)

Install Tools

```
[mydev@MyRPi4Manjaro2 MyWorkSpace]$ dotnet tool install -g paket
You can invoke the tool using the following command: paket
Tool 'paket' (version '5.257.0') was successfully installed.
[mydev@MyRPi4Manjaro2 MyWorkSpace]$

[mydev@MyRPi4Manjaro2 MyWorkSpace]$ dotnet tool install -g fake-cli
Welcome to .NET 5.0!
-----
SDK Version: 5.0.101
Telemetry
-----
The .NET tools collect usage data in order to help us improve your experience. It is collected by Microsoft and shared with the community. You can opt-out of telemetry by setting the DOTNET_CLI_TELEMETRY_OPTOUT environment variable to '1' or 'true' using your favorite shell.

Read more about .NET CLI Tools telemetry: https://aka.ms/dotnet-cli-telemetry

-----
Installed an ASP.NET Core HTTPS development certificate.
To trust the certificate run 'dotnet dev-certs https --trust' (Windows and macOS only).
Learn about HTTPS: https://aka.ms/dotnet-https

Write your first app: https://aka.ms/dotnet-hello-world
Find out what's new: https://aka.ms/dotnet-whats-new
Explore documentation: https://aka.ms/dotnet-docs
Report issues and find source on GitHub: https://github.com/dotnet/core
Use 'dotnet --help' to see available commands or visit: https://aka.ms/dotnet-cli

-----
You can invoke the tool using the following command: fake
Tool 'fake-cli' (version '5.20.3') was successfully installed.
[mydev@MyRPi4Manjaro2 MyWorkSpace]$
[mydev@MyRPi4Manjaro2 MyWorkSpace]$ dotnet tool install -g apiport
You can invoke the tool using the following command: ApiPort
Tool 'apiport' (version '2.8.14') was successfully installed.
[mydev@MyRPi4Manjaro2 MyWorkSpace]$
[mydev@MyRPi4Manjaro2 MyWorkSpace]$ dotnet tool install -g try-convert
You can invoke the tool using the following command: try-convert
Tool 'try-convert' (version '0.7.160902') was successfully installed.
[mydev@MyRPi4Manjaro2 MyWorkSpace]$

[mydev@MyRPi4Manjaro2 MyWorkSpace]$ dotnet tool install -g incrementalist
error NU1212: Invalid project-package combination for Incrementalist 0.3.0. DotnetToolReference project style can only contain references of the DotnetTool type
The tool package could not be restored.
Tool 'incrementalist' failed to install. This failure may have been caused by:

* You are attempting to install a preview release and did not use the --version option to specify the version.
* A package by this name was found, but it was not a .NET tool.
* The required NuGet feed cannot be accessed, perhaps because of an Internet connection problem.
* You mistyped the name of the tool.

For more reasons, including package naming enforcement, visit https://aka.ms/failure-installing-tool
[mydev@MyRPi4Manjaro2 MyWorkSpace]$
[mydev@MyRPi4Manjaro2 MyWorkSpace]$ dotnet tool install -g Incrementalist.Cmd --version 0.3.0
You can invoke the tool using the following command: incrementalist
Tool 'incrementalist.cmd' (version '0.3.0') was successfully installed.
[mydev@MyRPi4Manjaro2 MyWorkSpace]$
```

Install Nuget

■ Manjaro

sudo pacman -S –needed nuget

```
[mydev@MyRPi4Manjaro2 MyWorkSpace]$ pacman -Ss nuget
extra/nuget 5.7.0-1 [installed]
  Package manager for .NET.
```

■ Fedora

```
[mydev@MyRPi4-Fedora-1 ~]$ nuget install Akka
Attempting to resolve dependency 'Newtonsoft.Json (>= 12.0.3)'.
WARNING: Could not connect to the feed specified at 'https://www.nuget.org/api/v2/'. Please verify that the package source (located in the Pack
e Manager Settings) is valid and ensure your network connectivity.
Unable to resolve dependency 'Newtonsoft.Json (>= 12.0.3)'.
```

```
[mydev@MyRPi4-Fedora-1 ~]$ nuget
NuGet Version: 2.8.7.0
usage: NuGet <command> [args] [options]
Type 'NuGet help <command>' for help on a specific command.
```

<https://pkgs.org/search/?q=nuget>

Fedora Rawhide	
Fedora 33	
Fedora aarch64 Official	
nuget-2.8.7-11.fc33.aarch64.rpm	Package manager for .Net/Mono development platform
nuget-devel-2.8.7-11.fc33.aarch64.rpm	Development files for nuget
Fedora armhf Official	
nuget-2.8.7-11.fc33.armv7hl.rpm	Package manager for .Net/Mono development platform
nuget-devel-2.8.7-11.fc33.armv7hl.rpm	Development files for nuget
Fedora x86_64 Official	
nuget-2.8.7-11.fc33.i686.rpm	Package manager for .Net/Mono development platform
nuget-2.8.7-11.fc33.x86_64.rpm	Package manager for .Net/Mono development platform
nuget-devel-2.8.7-11.fc33.i686.rpm	Development files for nuget
nuget-devel-2.8.7-11.fc33.x86_64.rpm	Development files for nuget

Arch Linux	
Arch Linux Extra aarch64 Official	
nuget-5.7.0-1-any.pkg.tar.xz	Package manager for .NET
Arch Linux Extra armv7h Official	
nuget-5.7.0-1-any.pkg.tar.xz	Package manager for .NET
Arch Linux Extra x86_64 Official	
nuget-5.7.0-1-any.pkg.tar.zst	Package manager for .NET
Chaotic AUR x86_64 Third Party	
nuget-nightly-5.9.0.preview.1.6942-1-any.pkg.tar.zst	Package manager for .NET (nightly version)

Download & Uncompress:

<https://archlinux.pkgs.org/rolling/archlinux-extra-aarch64/nuget-5.7.0-1-any.pkg.tar.xz.html>

```
[mydev@MyRPi4-Fedora-1 Nuget]$ ll
total 1452
drwxr-xr-x. 1 mydev mydev 126 Dec 14 00:37 .
drwxr-xr-x. 1 mydev mydev 36 Dec 13 22:19 ..
-rw-r--r--. 1 mydev mydev 6101 Sep 22 12:17 .BUILDINFO
-rw-r--r--. 1 mydev mydev 269 Sep 22 12:17 .INSTALL
-rw-r--r--. 1 mydev mydev 608 Sep 22 12:17 .MTREE
-rw-r--r--. 1 mydev mydev 1465436 Dec 13 22:20 nuget-5.7.0-1-any.pkg.tar.xz
-rw-r--r--. 1 mydev mydev 333 Sep 22 12:17 .PKGINFO
drwx----- 1 mydev mydev 12 Sep 22 12:17 usr/
[mydev@MyRPi4-Fedora-1 Nuget]$
[mydev@MyRPi4-Fedora-1 Nuget]$ cat usr/bin/nuget
#!/bin/sh
exec mono $MONO_OPTIONS /usr/lib/nuget/nuget.exe "$@"
[mydev@MyRPi4-Fedora-1 Nuget]$
[mydev@MyRPi4-Fedora-1 Nuget]$ file /usr/lib/nuget/nuget.exe
/usr/lib/nuget/nuget.exe: PE32 executable (console) Intel 80386 Mono/.Net assembly, for MS Windows
```

```
[mydev@MyRPi4-Fedora-1 Nuget]$ sudo cp /usr/bin/nuget /usr/bin
[mydev@MyRPi4-Fedora-1 Nuget]$ sudo cp -r /usr/lib/nuget /usr/lib
[mydev@MyRPi4-Fedora-1 Nuget]$ sudo chmod 755 /usr/lib/nuget
[mydev@MyRPi4-Fedora-1 Nuget]$ sudo chmod 755 /usr/lib/nuget/nuget.exe
[mydev@MyRPi4-Fedora-1 Nuget]$ 
[mydev@MyRPi4-Fedora-1 /]$ sudo chmod 755 /usr/bin/nuget
[mydev@MyRPi4-Fedora-1 /]$ which nuget
/usr/bin/nuget
[mydev@MyRPi4-Fedora-1 /]$ nuget
NuGet Version: 5.7.0.6726
usage: NuGet <command> [args] [options]
Type 'NuGet help <command>' for help on a specific command.
```

■ Nuget 5.8 and later is preferred

<https://devblogs.microsoft.com/nuget/getting-started-with-nuget-5-8/>

NuGet 5.8 Highlights

There are many [important improvements in NuGet 5.8](#):

- Create and use .NET 5 NuGet packages with [.NET 5 Support](#).
- Faster package extraction by using [MemoryMappedFiles for Faster Writes](#).
- Search for packages using the [NuGet CLI Search Command](#).
- See faster NuGet restores with [No-Op Restore Optimization](#).
- Diagnose your package list with [dotnet list package --verbosity](#).
- Install prerelease packages with [dotnet add package --prerelease](#).
- Verify signed NuGet packages with [dotnet nuget verify](#).
- Get to code faster with [NuGet Solution Load Performance Improvements](#).
- Be more productive with [Visual Studio Package Manager Improvements](#).

Install Fake

```
[mydev@MyRPi4-Fedora-1 MyWorkSpace]$ nuget install Fake
Feeds used:
  https://api.nuget.org/v3/index.json

Installing package 'Fake' to '/opt/MyWorkSpace'.
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/index.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/1.0.0-alpha-10/1.66.1.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/1.66.2/1.74.50.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/1.74.51/1.74.146.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/1.74.147/1.74.239.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/1.74.241/2.0.83-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.0.84-alpha/2.1.126-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.1.128-alpha/2.1.218-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.1.219-alpha/2.1.320-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.1.321-alpha/2.1.395-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.1.396-alpha/2.1.482-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.1.483-alpha/2.1.568-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.1.569-alpha/2.1.645-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.1.646-alpha/2.1.748-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.1.750-alpha/2.3.41-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.3.43-alpha/2.5.31-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.5.32-alpha/2.7.0.24-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.7.0.25-alpha/2.9.24-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.9.26-alpha/2.11.22-alpha.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/2.11.25-alpha/3.0.0-alpha5.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/3.0.0-alpha6/3.7.4.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/3.7.5/3.18.1.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/3.18.2/3.34.7.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/3.35.0/4.9.3.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/4.9.5/4.23.5.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/4.23.6/4.44.3.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/4.44.4/4.64.12.json
CACHE https://api.nuget.org/v3/registration5-gz-semver2/fake/page/4.64.13/5.16.0.json

Attempting to gather dependency information for package 'Fake.5.16.0' with respect to project '/opt/MyWorkSpace', targeting 'Any,Version=v0.0'
Gathering dependency information took 68 ms
Attempting to resolve dependencies for package 'Fake.5.16.0' with DependencyBehavior 'Lowest'
Resolving dependency information took 0 ms
Resolving actions to install package 'Fake.5.16.0'
Resolved actions to install package 'Fake.5.16.0'
Retrieving package 'FAKE 5.16.0' from 'nuget.org'.
  GET https://api.nuget.org/v3-flatcontainer/fake/5.16.0/fake.5.16.0.nupkg
  OK https://api.nuget.org/v3-flatcontainer/fake/5.16.0/fake.5.16.0.nupkg
Installing FAKE 5.16.0.
Adding package 'FAKE.5.16.0' to folder '/opt/MyWorkSpace'
Added package 'FAKE.5.16.0' to folder '/opt/MyWorkSpace'
Successfully installed 'FAKE 5.16.0' to /opt/MyWorkSpace
Executing nuget actions took 14.04 sec

[mydev@MyRPi4-Fedora-1 tools]$ ll |grep -i FakeLib
-rwxr--r--. 1 mydev mydev 7516160 Aug 17 2019 FakeLib.dll*
-rwxr--r--. 1 mydev mydev 7474 Aug 17 2019 FakeLib.dll.config*
-rwxr--r--. 1 mydev mydev 9432576 Aug 17 2019 FakeLib.pdb*
-rwxr--r--. 1 mydev mydev 1210382 Aug 17 2019 FakeLib.XML*
[mydev@MyRPi4-Fedora-1 tools]$ pwd
/home/mydev/.nuget/packages/fake/5.16.0/tools
[mydev@MyRPi4-Fedora-1 tools]$ 
[mydev@MyRPi4-Fedora-1 tools]$ ll |grep -i FakeLib
-rwxr--r--. 1 mydev mydev 7516160 Aug 17 2019 FakeLib.dll*
-rwxr--r--. 1 mydev mydev 7474 Aug 17 2019 FakeLib.dll.config*
-rwxr--r--. 1 mydev mydev 9432576 Aug 17 2019 FakeLib.pdb*
-rwxr--r--. 1 mydev mydev 1210382 Aug 17 2019 FakeLib.XML*
[mydev@MyRPi4-Fedora-1 tools]$ 
[mydev@MyRPi4-Fedora-1 tools]$ file ./FakeLib.dll
./FakeLib.dll: PE32 executable (DLL) (console) Intel 80386 Mono/.Net assembly, for MS Windows
[mydev@MyRPi4-Fedora-1 tools]$
```

Edit ~/.bashrc

```
# .bashrc

# Source global definitions
if [ -f /etc/bashrc ]; then
    . /etc/bashrc
fi

# User specific environment
#if ! [[ "$PATH" =~ "$HOME/.local/bin:$HOME/bin:" ]]
#then
#    PATH="$HOME/.local/bin:$HOME/bin:$PATH"
#fi
#export PATH

export DOTNET_ROOT=/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/5.x
#export DOTNET_ROOT=/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/3.x
export POWERSHELL_ROOT=/opt/MyWorkSpace/DevSW/DotNet/PowerShell
export GO_HOME=/opt/MyWorkSpace/DevSW/Go/Std/1.x
#export GOPROXY=https://goproxy.cn
#export GOPATH=/home/mydev/go
export JAVA_HOME=/opt/MyWorkSpace/DevSW/Java/JDK/GraalVM/graalvm-ce-java11-20.3.0
#export MX_HOME=/opt/MyWorkSpace/MyProjs/Runtime/GraalVM/mx
export BAZEL_HOME=/opt/MyWorkSpace/DevSW/Build/Bazel/3.7.1
#export K3S_HOME=/opt/MyWorkSpace/DevSW/HCI/K3S
export PATH=$BAZEL_HOME:$JAVA_HOME/bin:$GO_HOME/bin:$GO_HOME/pkg/tool/linux_arm64:/home/mydev/.local/bin:$DOTNET_ROOT:/home/mydev/.dotnet/tools:
POWERSHELL_ROOT:$PATH

# Uncomment the following line if you don't like systemctl's auto-paging feature:
# export SYSTEMD_PAGER=

# User specific aliases and functions
alias ls='ls --color=auto'
alias ll='ls -alF --color'
alias lldir='ls -F --color | grep "/"'
```

2) Set up & Test

2.1 Install Akka.NET via Nuget

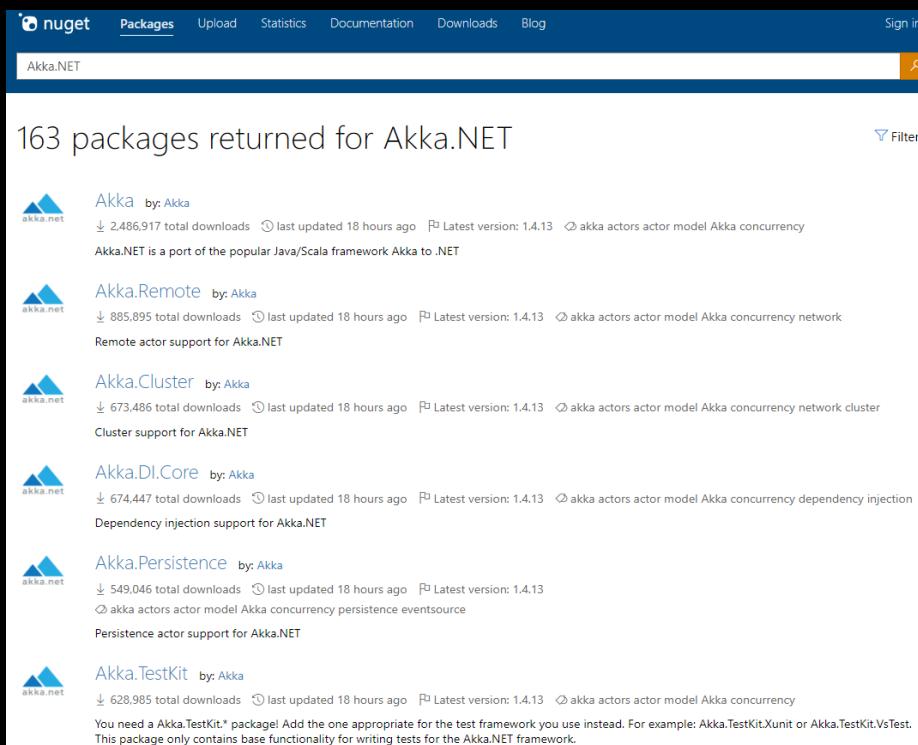
```
[mydev@MyRPi4Manjaro2 Official]$ nuget install Akka
Feeds used:
  https://api.nuget.org/v3/index.json

Installing package 'Akka' to '/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Official'.
  GET https://api.nuget.org/v3/registration5-gz-semver2/akka/index.json
    OK https://api.nuget.org/v3/registration5-gz-semver2/akka/index.json 308ms

Attempting to gather dependency information for package 'Akka.1.4.12' with respect to project '/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Official', targeting 'Any,Version=v0.0'
Gathering dependency information took 10.84 sec
Attempting to resolve dependencies for package 'Akka.1.4.12' with DependencyBehavior 'Lowest'
Resolving dependency information took 0 ms
Resolving actions to install package 'Akka.1.4.12'
Resolved actions to install package 'Akka.1.4.12'
  GET https://api.nuget.org/v3-flatcontainer/system.numerics.vectors/4.5.0/system.numerics.vectors.4.5.0.nupkg
    OK https://api.nuget.org/v3-flatcontainer/system.numerics.vectors/4.5.0/system.numerics.vectors.4.5.0.nupkg 141ms
Installing System.Numerics.Vectors 4.5.0:
  GET https://api.nuget.org/v3-flatcontainer/system.runtime.compilerservices.unsafe/4.5.3/system.runtime.compilerservices.unsafe.4.5.3.nupkg
    OK https://api.nuget.org/v3-flatcontainer/system.runtime.compilerservices.unsafe/4.5.3/system.runtime.compilerservices.unsafe.4.5.3.nupkg 123ms
Installing System.Runtime.CompilerServices.Unsafe 4.5.3:
  GET https://api.nuget.org/v3-flatcontainer/system.buffers/4.5.1/system.buffers.4.5.1.nupkg
    OK https://api.nuget.org/v3-flatcontainer/system.buffers/4.5.1/system.buffers.4.5.1.nupkg 121ms
Installing System.Buffers 4.5.1:
  GET https://api.nuget.org/v3-flatcontainer/newtonsoft.json/12.0.3/newtonsoft.json.12.0.3.nupkg
    OK https://api.nuget.org/v3-flatcontainer/newtonsoft.json/12.0.3/newtonsoft.json.12.0.3.nupkg 136ms
Installing Newtonsoft.Json 12.0.3:
  GET https://api.nuget.org/v3-flatcontainer/system.memory/4.5.4/system.memory.4.5.4.nupkg
    OK https://api.nuget.org/v3-flatcontainer/system.memory/4.5.4/system.memory.4.5.4.nupkg 138ms
Installing System.Memory 4.5.4:
  GET https://api.nuget.org/v3-flatcontainer/system.collections.immutable/1.7.1/system.collections.immutable.1.7.1.nupkg
    OK https://api.nuget.org/v3-flatcontainer/system.collections.immutable/1.7.1/system.collections.immutable.1.7.1.nupkg 136ms
Installing System.Collections.Immutable 1.7.1:
  GET https://api.nuget.org/v3-flatcontainer/system.security.principal.windows/4.7.0/system.security.principal.windows.4.7.0.nupkg
    OK https://api.nuget.org/v3-flatcontainer/system.security.principal.windows/4.7.0/system.security.principal.windows.4.7.0.nupkg 148ms
Installing System.Security.Principal.Windows 4.7.0:
  GET https://api.nuget.org/v3-flatcontainer/system.security.accesscontrol/4.7.0/system.security.accesscontrol.4.7.0.nupkg
Retrieving package 'Akka.1.4.12' from 'nuget.org'.
Retrieving package 'Newtonsoft.Json.12.0.3' from 'nuget.org'.
Retrieving package 'System.Buffers.4.5.1' from 'nuget.org'.
...
Added package 'System.Security.Permissions.4.7.0' to folder '/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Official'
Successfully installed 'System.Security.Permissions.4.7.0' to /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Official
OK https://api.nuget.org/v3-flatcontainer/system.configuration.configurationmanager/4.7.0/system.configuration.configurationmanager.4.7.0.nupkg
129ms
Installing System.Configuration.ConfigurationManager 4.7.0.
  GET https://api.nuget.org/v3-flatcontainer/akka/1.4.12/akka.1.4.12.nupkg
Adding package 'System.Configuration.ConfigurationManager.4.7.0' to folder '/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Official'
Added package 'System.Configuration.ConfigurationManager.4.7.0' to folder '/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Official'
Successfully installed 'System.Configuration.ConfigurationManager.4.7.0' to /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Official
OK https://api.nuget.org/v3-flatcontainer/akka/1.4.12/akka.1.4.12.nupkg 715ms
Installing Akka.1.4.12.
Adding package 'Akka.1.4.12' to folder '/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Official'
Added package 'Akka.1.4.12' to folder '/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Official'
Successfully installed 'Akka.1.4.12' to /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Official
Executing nuget actions took 5.87 sec
[mydev@MyRPi4Manjaro2 Official]$
```

■ install other Akka.NET packages

```
nuget install Akka.Remote  
nuget install Akka.Persistence  
nuget install Akka.Cluster  
nuget install Akka.Cluster.Tools  
nuget install Akka.Cluster.Sharding  
nuget install Akka.Streams  
nuget install Akka.DistributedData  
nuget install Akka.Logger.NLog  
nuget install Akka.FSharp
```

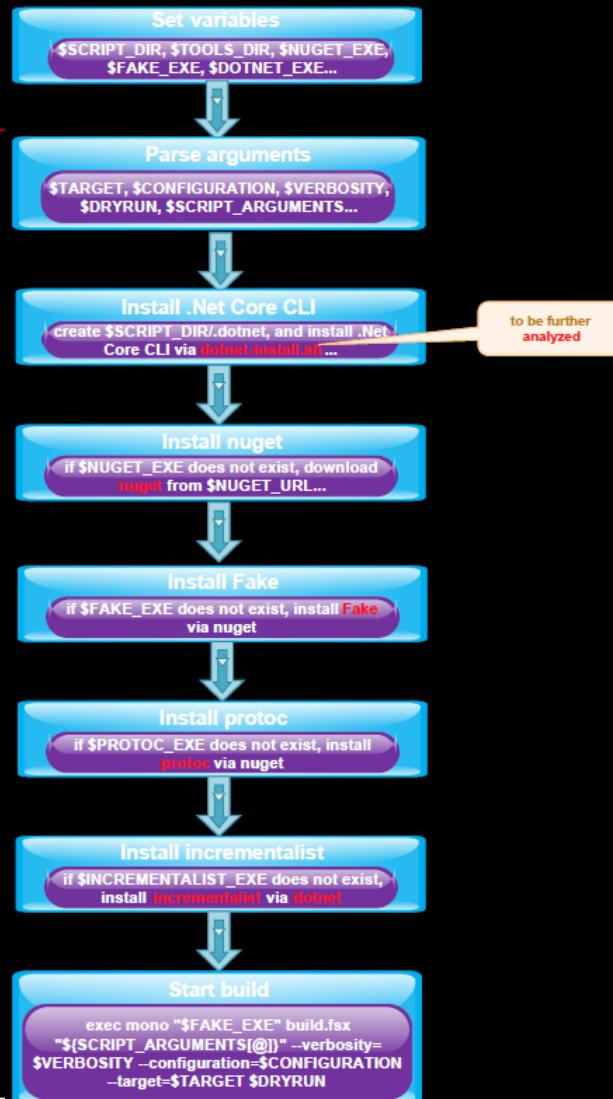


The screenshot shows the NuGet search interface with the query "Akka.NET" entered. The results page displays 163 packages found. Each package listing includes the package name, version, download count, last update time, and a brief description. The packages listed are:

- Akka (by: Akka) - 2,486,917 total downloads, last updated 18 hours ago, latest version: 1.4.13. Description: Akka.NET is a port of the popular Java/Scala framework Akka to .NET.
- Akka.Remote (by: Akka) - 885,895 total downloads, last updated 18 hours ago, latest version: 1.4.13. Description: Remote actor support for Akka.NET.
- Akka.Cluster (by: Akka) - 673,486 total downloads, last updated 18 hours ago, latest version: 1.4.13. Description: Cluster support for Akka.NET.
- Akka.DI.Core (by: Akka) - 674,447 total downloads, last updated 18 hours ago, latest version: 1.4.13. Description: Dependency injection support for Akka.NET.
- Akka.Persistence (by: Akka) - 549,046 total downloads, last updated 18 hours ago, latest version: 1.4.13. Description: Persistence actor support for Akka.NET.
- Akka.TestKit (by: Akka) - 628,985 total downloads, last updated 18 hours ago, latest version: 1.4.13. Description: You need a Akka.TestKit.* package! Add the one appropriate for the test framework you use instead. For example: Akka.TestKit.Xunit or Akka.TestKit.VsTest. This package only contains base functionality for writing tests for the Akka.NET framework.

2.2 Try to build Akka.NET with .Net 5

- <https://github.com/akkadotnet/akka.net/blob/dev/build.sh>



■ <https://github.com/akkadotnet/akka.net/blob/dev/build.fsx>

```
1  #I @"tools/FAKE/tools"
2  #r "FakeLib.dll"
3
4  open System
5  open System.IO
6  open System.Text
7
8
9  open Fake
10 open Fake.DotNetCli
11 open Fake.DocFxHelper
12 open Fake.NuGet.Install
```

...

■ reference patch

```
[mydev@MyRPi4-Fedora-1 akkadotnet-dev]$ git status
On branch dev
Your branch is up to date with 'origin/dev'.

Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git restore <file>..." to discard changes in working directory)
    modified:   build.sh
```

```
[mydev@MyRPi4-Fedora-1 akkadotnet-dev]$ git diff
diff --git a/build.sh b/build.sh
index d2345e2b5..e23350dbd 100755
--- a/build.sh
diff --git a/build.sh b/build.sh
index d2345e2b5..e23350dbd 100755
--- a/build.sh
+++ b/build.sh
@@ -6,18 +6,18 @@
 # Define directories.
 SCRIPT_DIR=$( cd "$( dirname "${BASH_SOURCE[0]}" )" && pwd )
 TOOLS_DIR=$SCRIPT_DIR/tools
-INCREMENTALIST_DIR=$TOOLS_DIR/incrementalist
-INCREMENTALIST_EXE=$INCREMENTALIST_DIR/Incrementalist.Cmd.exe
-NUGET_EXE=$TOOLS_DIR/nuget.exe
-NUGET_URL=https://dist.nuget.org/win-x86-commandline/v4.3.0/nuget.exe
-FAKE_VERSION=4.63.0
-FAKE_EXE=$TOOLS_DIR/FAKE/tools/FAKE.exe
-DOTNET_EXE=$SCRIPT_DIR/.dotnet/dotnet
-DOTNET_VERSION=3.1.105
-DOTNET_INSTALLER_URL=https://dot.net/v1/dotnet-install.sh
+#INCREMENTALIST_DIR=$TOOLS_DIR/incrementalist
+INCREMENTALIST_EXE=/home/mydev/.dotnet/tools/incrementalist
+NUGET_EXE=/usr/bin/nuget
+#NUGET_URL=https://dist.nuget.org/win-x86-commandline/v4.3.0/nuget.exe
+FAKE_VERSION=5.20.3
+FAKE_EXE=/home/mydev/.dotnet/tools/fake
+DOTNET_EXE=/opt/MyWorkSpace/DevSW/DotNet/SDK/5.x/dotnet
+DOTNET_VERSION=5.0.101
+DOTNET_INSTALLER_URL=https://dot.net/v1/dotnet-install.sh
DOTNET_CHANNEL=LTS
-PROTOBUF_VERSION=3.4.0
-INCREMENTALIST_VERSION=0.2.2
+PROTOBUF_VERSION=3.12.4
+INCREMENTALIST_VERSION=0.3.0
```

```
# Define default arguments.
TARGET="Default"
@@ -52,13 +52,13 @@ echo "Installing .NET CLI..."
if [ ! -d "$SCRIPT_DIR/.dotnet" ]; then
    mkdir "$SCRIPT_DIR/.dotnet"
fi
-curl -Lsfo "$SCRIPT_DIR/.dotnet/dotnet-install.sh" $DOTNET_INSTALLER_URL
-bash "$SCRIPT_DIR/.dotnet/dotnet-install.sh" --version $DOTNET_VERSION --channel $DOTNET_CHANNEL --install-dir .dotnet --no-path
-export PATH="$SCRIPT_DIR/.dotnet":$PATH
+#curl -Lsfo "$SCRIPT_DIR/.dotnet/dotnet-install.sh" $DOTNET_INSTALLER_URL
+#!/bin/bash "$SCRIPT_DIR/.dotnet/dotnet-install.sh" --version $DOTNET_VERSIÓN --channel $DOTNET_CHANNEL --install-dir .dotnet --no-path
+#!/bin/sh
+export PATH="$SCRIPT_DIR/.dotnet":$PATH
    export DOTNET_SKIP_FIRST_TIME_EXPERIENCE=1
    export DOTNET_CLI_TELEMETRY_OPTOUT=1
    chmod -R 0755 ".dotnet"
-"$SCRIPT_DIR/.dotnet/dotnet" --info
+"$DOTNET_EXE" --info

#####
# INSTALL NUGET
@@ -85,6 +85,8 @@ if [ ! -f "$FAKE_EXE" ]; then
    exit 1
fi
+mkdir "$TOOLS_DIR/FAKE"
+cp -fr /home/mydev/.nuget/packages/fake/5.16.0/tools "$TOOLS_DIR/FAKE"

# Make sure that Fake has been installed.
if [ ! -f "$FAKE_EXE" ]; then
@@ -99,7 +101,7 @@ fi
if [[ $(uname -s) == Darwin* ]]; then
    PROTOC_EXE="src/packages/Google.Protobuf.Tools/tools/macosx_x64/protoc"
else
-    PROTOC_EXE="src/packages/Google.Protobuf.Tools/tools/linux_x64/protoc"
+    PROTOC_EXE="/usr/bin/protoc"
fi

if [ ! -f "$PROTOC_EXE" ]; then
@@ -135,4 +137,4 @@ export FrameworkPathOverride=/usr/lib/mono/4.5/
#####

# Start Fake
-exec mono "$FAKE_EXE" build.fsx "${SCRIPT_ARGUMENTS[@]}" --verbosity=$VERBOSITY --configuration=$CONFIGURATION --target=$TARGET $DRYRUN
+"$FAKE_EXE" -v run build.fsx "${SCRIPT_ARGUMENTS[@]}" --verbosity=$VERBOSITY --configuration=$CONFIGURATION --target=$TARGET $DRYRUN
(END)
```

Failed on Fedora

```
+ ./home/mydev/.dotnet/tools/fake -v run build.fsx all --verbosity=verbose --configuration=Release --target=Default
FAKE 5 - F# Make (5.20.3) (this line is written to standard error, see https://github.com/fsharp/FAKE/issues/2066)
Consider adding your dependencies via '#r' dependencies, for example add '#r "paket: nuget FSharp.Core //"'.
See https://fake.build/fake-fake5-modules.html for details.
If you know what you are doing you can silence this warning by setting the environment variable 'FAKE_ALLOW_NO_DEPENDENCIES' to 'true'
2020-12-17 00:28:28 Installing .NET CLI...
2020-12-17 00:28:30 runOrBuild ({ Script = Some "build.fsx"
2020-12-17 00:28:30   ScriptArguments =
2020-12-17 00:28:30     [ "all"; "--verbosity=verbose"; "--configuration=Release";
2020-12-17 00:28:30     "--target=Default" ]
2020-12-17 00:28:30   FsiArgLine = []
2020-12-17 00:28:30   Debug = false
2020-12-17 00:28:30   NoCache = false
2020-12-17 00:28:30   RestoreOnlyGroup = false
2020-12-17 00:28:30   VerboseLevel = Verbose
2020-12-17 00:28:30   IsBuild = false })
2020-12-17 00:28:30 prepareAndRunScriptRedirect( Script: build.fsx, fsiOptions: "" )
2020-12-17 00:28:33 Writing '/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/akkadotnet-dev/.fake/build.fsx/intellisense.fsx'
2020-12-17 00:28:33 Restoring with paket...
2020-12-17 00:28:33 Lockfile was not found. We will update the dependencies and write our own...
2020-12-17 00:28:33 Updating group Main in /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/akkadotnet-dev/.fake/build.fsx/paket.dependencies
2020-12-17 00:28:37 Resolving packages for group Main:
2020-12-17 00:28:47 - FSharp.Core 5.0.0
2020-12-17 00:28:50 Locked version resolution written to /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/akkadotnet-dev/.fake/build.fsx/paket.lock
2020-12-17 00:28:53 Extracted Paket.Restore.targets to: /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/akkadotnet-dev/.fake/build.fsx/.paket/Paket.Restore.targets (Can be disabled with PAKET_SKIP_RESTORE_TARGETS=true)
2020-12-17 00:28:53 Starting full restore process.
2020-12-17 00:28:56 Retrieving the assemblies (rid: 'fedora.33-arm64')...
2020-12-17 00:28:56 Calculating the runtime graph...
2020-12-17 00:30:08 Known dependencies:
2020-12-17 00:30:08   - ref: /home/mydev/.nuget/packages/netstandard.library/2.0.3/build/netstandard2.0/ref/netstandard.dll (2.0.0.0)
2020-12-17 00:30:08   - ref: /home/mydev/.nuget/packages/netstandard.library/2.0.3/build/netstandard2.0/ref/Microsoft.Win32.Primitives.dll (4.0.3.0)
2020-12-17 00:30:08   - ref: /home/mydev/.nuget/packages/netstandard.library/2.0.3/build/netstandard2.0/ref/System.AppContext.dll (4.1.2.0)
2020-12-17 00:30:08   - ref: /home/mydev/.nuget/packages/netstandard.library/2.0.3/build/netstandard2.0/ref/System.Collections.Concurrent.dll (4.0.11.0)
2020-12-17 00:30:08   - ref: /home/mydev/.nuget/packages/netstandard.library/2.0.3/build/netstandard2.0/ref/System.Collections.dll (4.0.11.0)
2020-12-17 00:30:08   - ref: /home/mydev/.nuget/packages/netstandard.library/2.0.3/build/netstandard2.0/ref/System.Collections.NonGeneric.dll (4.0.3.0)
2020-12-17 00:30:08   - ref: /home/mydev/.nuget/packages/netstandard.library/2.0.3/build/netstandard2.0/ref/System.Collections.Specialized.dll
2020-12-17 00:30:08 ***
2020-12-17 00:30:08   - ref: /home/mydev/.nuget/packages/netstandard.library/2.0.3/build/netstandard2.0/ref/FakeLib.dll (5.16.0.0)
2020-12-17 00:30:08   - lib: /home/mydev/.nuget/packages/fsharp.core/5.0.0/lib/netstandard2.0/FSharp.Core.dll (5.0.0.0)
2020-12-17 00:30:08   - ref: /home/mydev/.nuget/packages/fsharp.core/5.0.0/lib/netstandard2.0/FSharp.Core.dll (5.0.0.0)
2020-12-17 00:30:12 FSC Args: ["--debug:portable";
2020-12-17 00:30:12 "--define:DOTNETCORE";
2020-12-17 00:30:12 "--define:FAKE";
2020-12-17 00:30:12 "--fullpaths";
2020-12-17 00:30:12 "--noframework";
2020-12-17 00:30:12 "-r:/home/mydev/.dotnet/tools/.store/fake-cli/5.20.3/fake-cli/5.20.3/tools/netcoreapp2.1/any/FSharp.Core.dll";
2020-12-17 00:30:12 "-r:/home/mydev/.nuget/packages/netstandard.library/2.0.3/build/netstandard2.0/ref/netstandard.dll";
2020-12-17 00:30:12 "-r:/home/mydev/.nuget/packages/netstandard.library/2.0.3/build/netstandard2.0/ref/Microsoft.Win32.Primitives.dll";
2020-12-17 00:30:12 "-r:/home/mydev/.nuget/packages/netstandard.library/2.0.3/build/netstandard2.0/ref/System.AppContext.dll";
2020-12-17 00:30:12 ***
```

```
2020-12-17 00:30:30 Global resolve event: FSharp.Compiler.Service.resources, Version=36.0.3.0, Culture=en-US, PublicKeyToken=null
2020-12-17 00:30:30 Global resolve event: FSharp.Compiler.Service.resources, Version=36.0.3.0, Culture=en, PublicKeyToken=null
2020-12-17 00:30:42 Using cache
2020-12-17 00:30:42 Trying to resolve: netstandard, Version=2.0.0.0, Culture=neutral, PublicKeyToken=cc7b13ffcd2ddd51
2020-12-17 00:30:42 Redirect assembly load to known assembly: netstandard, Version=2.0.0.0, Culture=neutral, PublicKeyToken=cc7b13ffcd2ddd51 (Some
e
2020-12-17 00:30:42    "/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/5.x/shared/Microsoft.NETCore.App/5.0.1/netstandard.dll")
2020-12-17 00:30:42 Trying to resolve: FSharp.Core, Version=4.7.0.0, Culture=neutral, PublicKeyToken=b03f5f7f11d50a3a
2020-12-17 00:30:42 Redirect assembly load to known assembly: FSharp.Core, Version=4.7.0.0, Culture=neutral, PublicKeyToken=b03f5f7f11d50a3a (Non
e)
2020-12-17 00:30:42 Trying to resolve: FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null
2020-12-17 00:30:42 Global resolve event: FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null
2020-12-17 00:30:42 Could not find assembly in the default load-context: FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null
2020-12-17 00:30:42 Could not resolve assembly: FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null
2020-12-17 00:30:42 Global resolve event: FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null
2020-12-17 00:30:42 Global resolve event: FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null
2020-12-17 00:30:42 Global resolve event: FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null
2020-12-17 00:30:42 Global resolve event: FakeLibCould not load types of compiled script:
- System.IO.FileLoadException: Could not load file or assembly 'FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null'. General Except
ion (0x80131500)
File name: 'FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null'
---> System.Exception: Could not load 'FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null'.
This can happen for various reasons:
- You are trying to load full-framework assemblies which is not supported
  -> You might try to load a legacy-script with the new netcore runner.
    Please take a look at the migration guide: https://fake.build/fake-migrate-to-fake-5.html
- The nuget cache (or packages folder) might be broken.
  -> Please save your state, open an issue and then
  - delete 'FakeLib' from the '~/.nuget' cache (and the 'packages' folder)
  - delete 'paket-files/paket.restore.cached' if it exists
  - delete '<script.fsx>.lock' if it exists
  - try running fake again
  - the package should be downloaded again
- Some package introduced a breaking change in their dependencies and .dll files are missing in the resolution
  -> Try to compare the lockfile with a previous working version
  -> Try to lower transitive dependency versions (for example by adding 'strategy: min' to the paket group)
    see https://github.com/fsharp/FAKE/issues/1966 where this happened for 'System.Reactive' version 4

-> If the above doesn't apply or you need help please open an issue!
  at Microsoft.FSharp.Core.PrintfModule.PrintFormatToStringThenFail@1639.Invoke(String message) in F:\workspace\_work\1\s\src\fsharp\FSharp.Core
\printf.fs:line 1639
  at Fake.Runtime.CoreCache.findAndLoadInRuntimeDepsCached@0315.Invoke(AssemblyLoadContext loadContext, AssemblyName name, VerboseLevel logLevel,
FSharpList`1 runtimeDependencies) in D:\a\1\s\src\app\Fake.Runtime\CoreCache.fs:line 321
  at System.Runtime.Loader.AssemblyLoadContext.ResolveUsingLoad(AssemblyName assemblyName)
  at System.Runtime.Loader.AssemblyLoadContext.Resolve(IntPtr gchManagedAssemblyLoadContext, AssemblyName assemblyName)
- System.IO.FileNotFoundException: Could not load file or assembly 'FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null'. The system
cannot find the file specified.

File name: 'FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null'
- System.IO.FileNotFoundException: Could not load file or assembly 'FakeLib, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null'. The system
cannot find the file specified.

...
Warning: Paket resolved a FSharp.Core with version '5.0.0.0', but fake runs with a version of '4.7.0.0'. This is not supported.
Please either lock the version via 'nuget FSharp.Core <nuget-version>' or upgrade fake.
Read https://github.com/fsharp/FAKE/issues/2001 for details.
, Version=5.16.0.0, Culture=neutral, PublicKeyToken=null
```

- try to build **Fake** on RPi4 with .Net 5, got more failures...
<https://github.com/fsharp/fake>

...

Failed on Manjaro

■

```
...
2020-12-17 19:01:34 Lockfile was not found. We will update the dependencies and write our own...
2020-12-17 19:01:34 Updating group Main in /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/akkadotnet-dev/.fake/build.fsx/paket.dependencies
2020-12-17 19:01:34 Resolving packages for group Main:
2020-12-17 19:01:39 - FSharp.Core 5.0.0
2020-12-17 19:01:40 Locked version resolution written to /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/akkadotnet-dev/.fake/build.fsx/paket.lock
2020-12-17 19:01:40 Extracted Paket.Restore.targets to: /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/akkadotnet-dev/.fake/build.fsx/.paket/Paket.Restore.targets (Can be disabled with PAKET_SKIP_RESTORE_TARGETS=true)
2020-12-17 19:01:40 Starting full restore process.
2020-12-17 19:01:41 Retrieving the assemblies (rid: 'manjaro-arm-arm64')...
2020-12-17 19:01:41 Calculating the runtime graph...
2020-12-17 19:01:41 Known dependencies:
2020-12-17 19:01:41     - lib: /home/mydev/.nuget/packages/fsharp.core/5.0.0/lib/netstandard2.0/FSharp.Core.dll (5.0.0.0)
2020-12-17 19:01:41     - ref: /home/mydev/.nuget/packages/fsharp.core/5.0.0/lib/netstandard2.0/FSharp.Core.dll (5.0.0.0)
2020-12-17 19:01:41 FSC Args: ["--debug:portable";
2020-12-17 19:01:41   "--define:DOTNETCORE";
2020-12-17 19:01:41   "--define:FAKE";
2020-12-17 19:01:41   "--fullpaths";
2020-12-17 19:01:41   "--noframework";
2020-12-17 19:01:41   "-r:/home/mydev/.dotnet/tools/.store/fake-cli/5.20.3/fake-cli/5.20.3/tools/netcoreapp2.1/any/FSharp.Core.dll";
2020-12-17 19:01:41   "--simpleresolution";
2020-12-17 19:01:41   "--targetprofile:netstandard";
2020-12-17 19:01:41   "--nowin32manifest";
2020-12-17 19:01:41   "--langversion:preview";
2020-12-17 19:01:41   "--compilertoold:/home/mydev/.dotnet/tools/.store/fake-cli/5.20.3/fake-cli/5.20.3/tools/netcoreapp2.1/any";
2020-12-17 19:01:41   "-o";
2020-12-17 19:01:41   "/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/akkadotnet-dev/.fake/build.fsx/build_2808DAD1DE0D2F75B661B39FEDF205E89C7EAC
F9A18F005CAA09CB9B00AE32EC.dll";
2020-12-17 19:01:41   "/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/akkadotnet-dev/Script is not valid:
unknown (1,0)-(1,0): FSharpErrorSeverity.Error FS0078: Unable to find the file 'netstandard.dll' in any of
v4.5
/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/akkadotnet-dev
/home/mydev/.dotnet/tools/.store/fake-cli/5.20.3/fake-cli/5.20.3/tools/netcoreapp2.1/any/
Warning: Paket resolved a FSharp.Core with version '5.0.0.0', but fake runs with a version of '4.7.0.0'. This is not supported.
Please either lock the version via 'nuget FSharp.Core <nuget-version>' or upgrade fake.
Read https://github.com/fsharp/FAKE/issues/2001 for details.
build.fsx"]
2020-12-17 19:01:43 Global resolve event: FSharp.Compiler.Service.resources, Version=36.0.3.0, Culture=en-US, PublicKeyToken=null
2020-12-17 19:01:43 Global resolve event: FSharp.Compiler.Service.resources, Version=36.0.3.0, Culture=en, PublicKeyToken=null
2020-12-17 19:01:43 saving cache...
2020-12-17 19:01:43 Script is not valid, see standard error for details.
```

...

2.3 Test

- <https://medium.com/@abrandao/l/first-steps-with-akka-net-38806b2e025b>
- <https://github.com/alexandrebl/AkkaConsoleSimple>
- build “AkkaConsoleSimple” without any modification

```
[mydev@MyRPi4-Fedora-1 AkkaConsoleSimple]$ dotnet build
Microsoft (R) Build Engine version 16.8.0+126527ff1 for .NET
...
    AkkaConsoleSimple -> /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimple/bin/Debug/netcoreapp2.2/AkkaConsoleSimple.dll
    AkkaConsoleSimpleTwoActorsCall -> /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimpleTwoActors/bin/Debug/netcoreapp2.2/AkkaConsoleSimpleTwoActorsCall.dll
    AkkaConsoleSimpleTwoEntities -> /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimpleTwoEntities/bin/Debug/netcoreapp2.2/AkkaConsoleSimpleTwoEntities.dll

Build succeeded.

/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/sdk/5.0.101/Sdks/Microsoft.NET.Sdk/targets/Microsoft.NET.EolTargetFrameworks.targets(28,5): warning NETSDK138: The target framework 'netcoreapp2.2' is out of support and will not receive security updates in the future. Please refer to https://aka.ms/otnet-core-support for more information about the support policy. [/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimple.csproj]
/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/sdk/5.0.101/Sdks/Microsoft.NET.Sdk/targets/Microsoft.NET.EolTargetFrameworks.targets(28,5): warning NETSDK138: The target framework 'netcoreapp2.2' is out of support and will not receive security updates in the future. Please refer to https://aka.ms/otnet-core-support for more information about the support policy. [/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimpleTwoEntities.csproj]
/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/sdk/5.0.101/Sdks/Microsoft.NET.Sdk/targets/Microsoft.NET.EolTargetFrameworks.targets(28,5): warning NETSDK138: The target framework 'netcoreapp2.2' is out of support and will not receive security updates in the future. Please refer to https://aka.ms/otnet-core-support for more information about the support policy. [/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimpleTwoActors/AkkaConsoleSimpleTwoActorsCall.csproj]
/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/sdk/5.0.101/Sdks/Microsoft.NET.Sdk/targets/Microsoft.NET.EolTargetFrameworks.targets(28,5): warning NETSDK138: The target framework 'netcoreapp2.2' is out of support and will not receive security updates in the future. Please refer to https://aka.ms/otnet-core-support for more information about the support policy. [/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimpleTwoActors/AkkaConsoleSimpleTwoActorsCall.csproj]
/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/sdk/5.0.101/Sdks/Microsoft.NET.Sdk/targets/Microsoft.NET.EolTargetFrameworks.targets(28,5): warning NETSDK138: The target framework 'netcoreapp2.2' is out of support and will not receive security updates in the future. Please refer to https://aka.ms/otnet-core-support for more information about the support policy. [/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimpleTwoEntities/AkkaConsoleSimpleTwoEntitiesCall.csproj]
/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/sdk/5.0.101/Sdks/Microsoft.NET.Sdk/targets/Microsoft.NET.EolTargetFrameworks.targets(28,5): warning NETSDK138: The target framework 'netcoreapp2.2' is out of support and will not receive security updates in the future. Please refer to https://aka.ms/otnet-core-support for more information about the support policy. [/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimple/AkkaConsoleSimple.csproj]

  6 Warning(s)
  0 Error(s)
```

run

```
[mydev@MyRPi4-Fedora-1 AkkaConsoleSimple]$ dotnet AkkaConsoleSimple/bin/Debug/netcoreapp2.2/AkkaConsoleSimple.dll
It was not possible to find any compatible framework version
The framework 'Microsoft.NETCore.App', version '2.2.0' was not found.
  - The following frameworks were found:
    5.0.1 at [/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/shared/Microsoft.NETCore.App]

You can resolve the problem by installing the specified framework and/or SDK.

The specified framework can be found at:
  - https://aka.ms/dotnet-core-applaunch?framework=Microsoft.NETCore.App&framework\_version=2.2.0&arch=arm64&rid=fedora.33-arm64
```

try-convert limitations

```
[mydev@MyRPi4-Fedora-1 AkkaConsoleSimple]$ try-convert
'/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimple.csproj' is already a
.NET SDK-style project, so it won't be converted.
'/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimpleTwoActors/AkkaConsoleSimpleTwoActorsCal
.csproj' is already a .NET SDK-style project, so it won't be converted.
'/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimpleTwoEntities/AkkaConsoleSimpleTwoEntitie
.csproj' is already a .NET SDK-style project, so it won't be converted.
No projects converted.
```

re-patching the project manually

```
[mydev@MyRPi4-Fedora-1 AkkaConsoleSimple]$ git diff
diff --git a/AkkaConsoleSimple/AkkaConsoleSimple.csproj b/AkkaConsoleSimple/AkkaConsoleSimple.csproj
index 61466e1..6aee9bf 100644
--- a/AkkaConsoleSimple/AkkaConsoleSimple.csproj
+++ b/AkkaConsoleSimple/AkkaConsoleSimple.csproj
@@ -2,11 +2,11 @@

<PropertyGroup>
    <OutputType>Exe</OutputType>
-   <TargetFramework>netcoreapp2.2</TargetFramework>
+   <TargetFramework>net5.0</TargetFramework>
</PropertyGroup>

<ItemGroup>
-   <PackageReference Include="akka" Version="1.3.12" />
+   <PackageReference Include="akka" Version="1.4.12" />
</ItemGroup>

</Project>
diff --git a/AkkaConsoleSimpleTwoActors/AkkaConsoleSimpleTwoActorsCall.csproj b/AkkaConsoleSimpleTwoActors/AkkaConsoleSimpleTwoActorsCall.csproj
index 955b87c..7ecdd12 100644
--- a/AkkaConsoleSimpleTwoActors/AkkaConsoleSimpleTwoActorsCall.csproj
+++ b/AkkaConsoleSimpleTwoActors/AkkaConsoleSimpleTwoActorsCall.csproj
@@ -2,12 +2,12 @@

<PropertyGroup>
    <OutputType>Exe</OutputType>
-   <TargetFramework>netcoreapp2.2</TargetFramework>
+   <TargetFramework>net5.0</TargetFramework>
</PropertyGroup>

<ItemGroup>
-   <PackageReference Include="Akka" Version="1.3.12" />
-   <PackageReference Include="Newtonsoft.Json" Version="12.0.2" />
+   <PackageReference Include="Akka" Version="1.4.12" />
+   <PackageReference Include="Newtonsoft.Json" Version="12.0.3" />
</ItemGroup>

</Project>
diff --git a/AkkaConsoleSimpleTwoEntities/AkkaConsoleSimpleTwoEntities.csproj b/AkkaConsoleSimpleTwoEntities/AkkaConsoleSimpleTwoEntities.csproj
index 80b4c6e..fbda28f 100644
--- a/AkkaConsoleSimpleTwoEntities/AkkaConsoleSimpleTwoEntities.csproj
+++ b/AkkaConsoleSimpleTwoEntities/AkkaConsoleSimpleTwoEntities.csproj
@@ -2,7 +2,7 @@

<PropertyGroup>
    <OutputType>Exe</OutputType>
-   <TargetFramework>netcoreapp2.2</TargetFramework>
+   <TargetFramework>net5.0</TargetFramework>
</PropertyGroup>

<ItemGroup>
@@ -12,7 +12,7 @@

</ItemGroup>

<ItemGroup>
-   <PackageReference Include="Akka" Version="1.3.12" />
-   <PackageReference Include="Newtonsoft.Json" Version="12.0.2" />
+   <PackageReference Include="Akka" Version="1.4.12" />
+   <PackageReference Include="Newtonsoft.Json" Version="12.0.3" />
</ItemGroup>
</Project>
```

rebuild

```
[mydev@MyRPi4-Fedora-1 AkkaConsoleSimple]$ dotnet build
Microsoft (R) Build Engine version 16.8.0+126527ff1 for .NET
Copyright (C) Microsoft Corporation. All rights reserved.

Determining projects to restore...
Restored /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimpleTwoActors/AkkaConsoleSimpleTwoActorsCall.csproj (in 879 ms).
2 of 3 projects are up-to-date for restore.
AkkaConsoleSimple -> /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimple/bin/Debug/net5.0/AkkaConsoleSimple.dll
AkkaConsoleSimpleTwoActorsCall -> /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimpleTwoActors/bin/Debug/net5.0/AkkaConsoleSimpleTwoActorsCall.dll
AkkaConsoleSimpleTwoEntities -> /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Alexandrebl/AkkaConsoleSimple/AkkaConsoleSimpleTwoEntities/bin/Debug/net5.0/AkkaConsoleSimpleTwoEntities.dll

Build succeeded.
0 Warning(s)
0 Error(s)

Time Elapsed 00:00:33.87
```

rerun

```
[mydev@MyRPi4-Fedora-1 AkkaConsoleSimple]$ dotnet exec ./AkkaConsoleSimple/bin/Debug/net5.0/AkkaConsoleSimple.dll
[Thread 11] Greeting Hello World

[mydev@MyRPi4-Fedora-1 AkkaConsoleSimple]$ dotnet exec ./AkkaConsoleSimpleTwoActors/bin/Debug/net5.0/AkkaConsoleSimpleTwoActorsCall.dll
2020-12-15T08:03:29.7587696-08:00 => Authorization Response Code: 51 - Not authorized, invalid payment type
2020-12-15T08:03:29.7787729-08:00 => Authorization Response Code: 72 - Not authorized, invalid affiliation code
2020-12-15T08:03:29.7790230-08:00 => Authorization Response Code: 00 - Success

[mydev@MyRPi4-Fedora-1 AkkaConsoleSimple]$ dotnet exec ./AkkaConsoleSimpleTwoEntities/bin/Debug/net5.0/AkkaConsoleSimpleTwoEntities.dll
Person data: {"Name":"Joe Satriani","Age":38}

Person data: {"Name":"Steve Vai","Age":28}

Company report:
-----
TaxDocument: 68363562525
Description: Transportadora X

Company report:
-----
TaxDocument: 12341341334
Description: Transportadora W

Company report:
-----
TaxDocument: 56778746746
Description: Transportadora L

Company report:
-----
TaxDocument: 75794749467
Description: Transportadora Z
```

2.4 Summary

- Migrating legacy project to .Net 5 is not an easy thing, especially for big project
- Tools provided by MS for assist porting code to .Net 5 does little to help, especially on ARM Linux
- Need to familiar yourself with the mechanisms of DotNet SDK, Nuget, Paket, Fake etc when trying to port big project to .Net 5
- How about support more build system like Meson and Bazel (Linux platform developers are more familiar with them) against .Net project?

...

IV. Akka.NET cluster

1) Overview

1.1 Containerization of Akka.NET and Akka.Cluster

- <https://petabridge.com/cluster/>
 - 1. [Lesson 1 - Working with Akka.NET and Akka.Cluster](#)
 - 2. [Lesson 2 - Docker-izing Akka.NET and Akka.Cluster](#)
 - 3. [Lesson 3 - Akka.Cluster Best Practices for Continuous Deployment](#)
 - 4. [Lesson 4 - Advanced Akka.Cluster Techniques: DistributedPubSub, Sharding, and ClusterClient](#)
 - 5. [Lesson 5 - Deploying Akka.Cluster inside Kubernetes](#)
 - 6. [Lesson 6 - Monitoring Akka.NET with Phobos](#)
- **Akka.Cluster is a layer of abstraction on top of Akka.Remote**
<https://petabridge.com/training/akka-remoting/>

Ongoing Work

- building an **OCI (Open Container Initiative)-compliant image against Akka.NET with .Net 3 on ARM Linux for Harbor**
- **Harbor**
<https://goharbor.io/>
<https://github.com/goharbor/>
<https://www.cncf.io/blog/2020/05/13/harbor-2-0-takes-a-giant-leap-in-expanding-supported-artifacts-with-oci-support/>

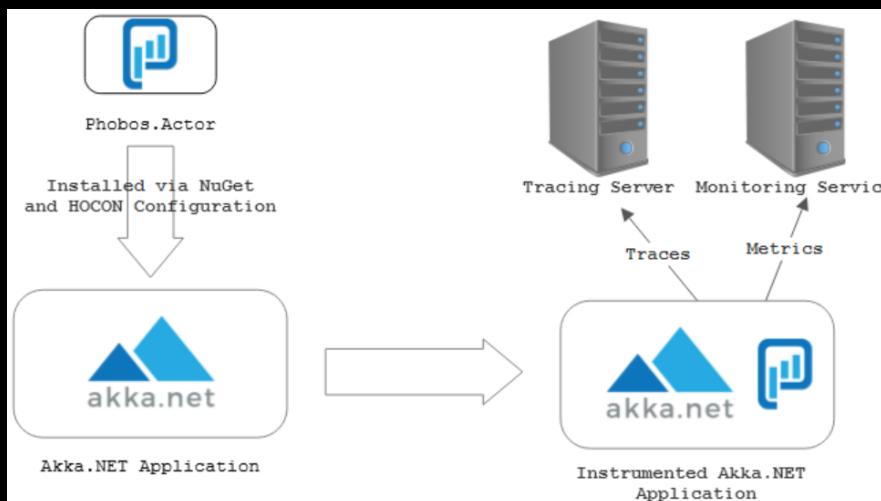
1.2 Cluster Observability

Phobos

- <https://phobos.petabridge.com>
- Enterprise Application Monitoring and Management for Akka.NET OSS

Detailed Actor Monitoring	Distributed Tracing	Requires No Code Changes
Automatically monitor actor throughput, mailbox size, and more for actors globally across your entire cluster as well as individual nodes.	Automatically trace requests between actors on both local and remote ActorSystems and pipe the results to popular tracing engines like Zipkin.	Phobos can be automatically installed into any pre-existing Akka.NET application with a small amount of configuration.
Configurable	Cross-platform	Commercially Supported

- <https://petabridge.com/blog/phobos-v1.0/>



CMD

■ <https://cmd.petabridge.com/>

Cluster Management

View the current status of your cluster; down unreachable nodes; trigger graceful exits; join new nodes; and more.

Extensible

Petabridge.Cmd supports the ability to define custom commands specific to your Akka.NET application.

Remote Logging

Perform a live tail of logs on any of your Akka.NET nodes, search through existing log data, and more.

Cross-Platform

Petabridge.Cmd can be used on Windows, OS X, or Linux to manage Akka.NET applications running on any environment.

Easy to Use

Petabridge.Cmd is simple and includes helpful features such as tab-autocomplete and built-in help documentation.

Commercially Supported

Petabridge actively maintains and develops Petabridge.Cmd in order to better support Akka.NET users.

```
[127.0.0.1:9110] pbm> cluster join -a akka.tcp://webcrawler@127.0.0.1:4053
Joining cluster with [akka.tcp://webcrawler@127.0.0.1:4053]
akka.tcp://webcrawler@127.0.0.1:61589 is now JOINING.
akka.tcp://webcrawler@127.0.0.1:61589 is now UP.
[127.0.0.1:9110] pbm> cluster show
akka.tcp://webcrawler@127.0.0.1:4053 | [lighthouse] | up |
akka.tcp://webcrawler@127.0.0.1:16666 | [web] | up |
akka.tcp://webcrawler@127.0.0.1:61558 | [tracker] | up |
akka.tcp://webcrawler@127.0.0.1:61589 | [petabridge.cmd] | up |
[127.0.0.1:9110] pbm> log write -m "hi, this is a demo!" -l warning
Wrote: [WarningLevel][hi, this is a demo!]
[127.0.0.1:9110] pbm> log peek -n -
```

■ <https://cmd.petabridge.com/articles/commands/cluster-commands.html>

NBench

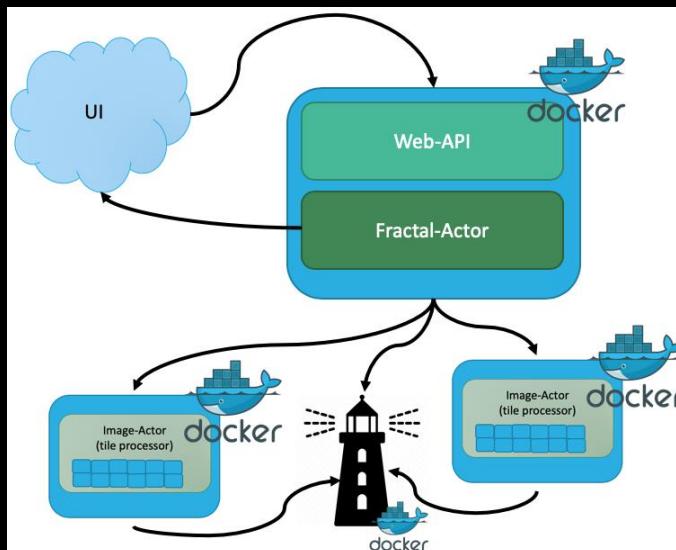
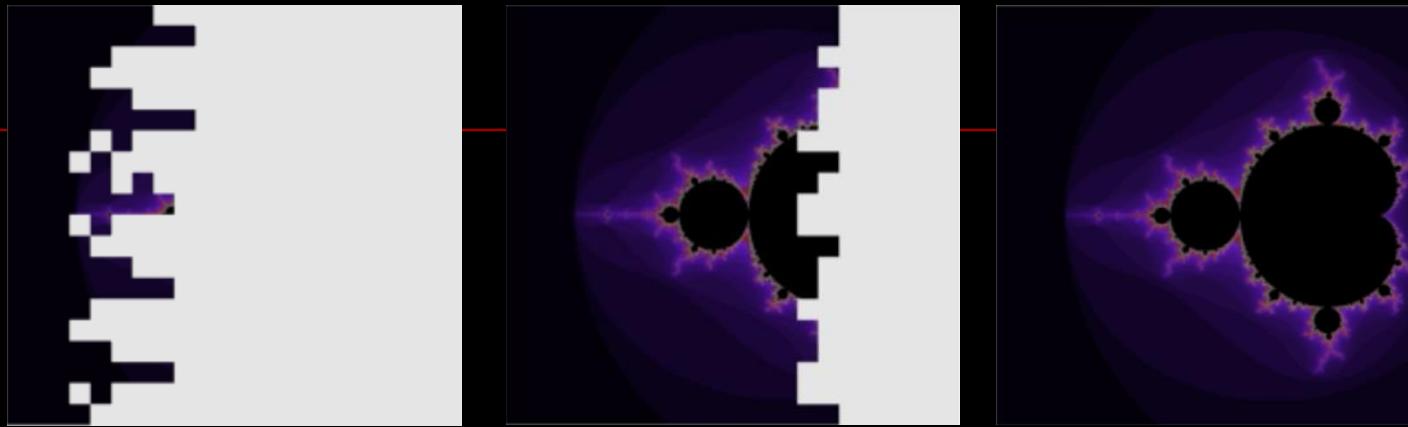
- <https://nbench.io>
<https://github.com/petabridge/NBench>
- **Cross-platform performance benchmarking and testing framework for .NET applications**

- <https://petabridge.com/blog/introduction-to-nbench/>
- <https://petabridge.com/blog/performance-testing-mandatory/>

...

1.3 A case of distributed fractal image processing

- <http://www.rickyterrell.com/?p=197>



- <https://github.com/rikace/akkafractal>

Take a try

- <https://github.com/rikace/akkafractal/blob/master/src/docker-compose.yml>

```
===== start building akkafractal on ARM64 =====
[sudo] password for mydev:
Pulling lighthouse (petabridge/lighthouse:latest)...
Building akkafractal-worker-1
Service 'akkafractal-worker-1' failed to build : no matching manifest for linux/arm64/v8 in the manifest list entries
2020-12-16 17:45:04 latest: Pulling from petabridge/lighthouse
2020-12-16 18:06:10 Digest: sha256:984ac8aea04e1ceecf50c47a8f9a71413f67faac6ccd43cd135bab1966651c42
2020-12-16 18:06:10 Status: Downloaded newer image for petabridge/lighthouse:latest
2020-12-16 18:06:12 Step 1/26 : FROM microsoft/dotnet:2.2-sdk AS builder
2020-12-16 18:06:30 2.2-sdk: Pulling from microsoft/dotnet
```

- Successfully build it with .Net 3 SDK, but still failed to run

```
[myrpi4@manjarorpi4node1 src]$ git diff
diff --git a/src/global.json b/src/global.json
index 1a431e6..8afc0f0 100644
--- a/src/global.json
+++ b/src/global.json
@@ -1,5 +1,5 @@
{
  "sdk": {
-    "version": "2.1.401"
+    "version": "3.1.404"
  }
-}
2020-12-17 17:40:46 Microsoft (R) Build Engine version 16.7.1+52cd83677 for .NET
2020-12-17 17:40:46 Copyright (C) Microsoft Corporation. All rights reserved.
2020-12-17 17:40:46
2020-12-17 17:41:05  Akka.Fractal.Common -> /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Rikace/akkafractal-master/src/Akka.Fractal
Common/bin/Debug/netcoreapp2.1/Akka.Fractal.Common.dll
2020-12-17 17:41:18  Akka.Fractal.Remote -> /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Rikace/akkafractal-master/src/Akka.Fractal
Remote/bin/Debug/netcoreapp2.1/Akka.Fractal.Remote.dll
2020-12-17 17:41:26  Akka.Fractal.Server -> /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Rikace/akkafractal-master/src/Akka.Fractal
Server/bin/Debug/netcoreapp2.1/Akka.Fractal.Server.dll
2020-12-17 17:41:26
2020-12-17 17:41:26 Build succeeded.
2020-12-17 17:41:26      0 Warning(s)
2020-12-17 17:41:26      0 Error(s)
2020-12-17 17:41:26
2020-12-17 17:41:26 Time Elapsed 00:00:39.36
```

paket init
paket restore
dotnet restore
dotnet build --no-restore
dotnet test --no-restore

run

```
[myrpi4@manjarorpi4node1 Rikace]$ dotnet run ./akkafractal-master/src/Akka.Fractal.Server/bin/Debug/netcoreapp2.1/Akka.Fractal.Server.dll
Couldn't find a project to run. Ensure a project exists in /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Rikace, or pass the path to
he project using --project.
[myrpi4@manjarorpi4node1 Rikace]$
[myrpi4@manjarorpi4node1 Rikace]$ dotnet exec ./akkafractal-master/src/Akka.Fractal.Server/bin/Debug/netcoreapp2.1/Akka.Fractal.Server.dll
It was not possible to find any compatible framework version
The framework 'Microsoft.AspNetCore.App', version '2.1.14' was not found.
- The following frameworks were found:
  3.1.10 at [/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/shared/Microsoft.AspNetCore.App]
```

You can resolve the **problem** by installing the specified framework and/or SDK.

The specified framework can be found at:

```
- https://aka.ms/dotnet-core-applaunch?framework=Microsoft.AspNetCore.App&framework\_version=2.1.14&arch=arm64&rid=manjaro-arm-arm64
```

```
[myrpi4@manjarorpi4node1 akkafractal-master]$ donet run ./akkafractal-master/src/Akka.Fractal.Remote/bin/Debug/netcoreapp2.1/Akka.Fractal.Remote.dll^C
[myrpi4@manjarorpi4node1 akkafractal-master]$ cd ..
[myrpi4@manjarorpi4node1 Rikace]$
[myrpi4@manjarorpi4node1 Rikace]$
[myrpi4@manjarorpi4node1 Rikace]$ dotnet run ./akkafractal-master/src/Akka.Fractal.Remote/bin/Debug/netcoreapp2.1/Akka.Fractal.Remote.dll
Couldn't find a project to run. Ensure a project exists in /opt/MyWorkSpace/MyProjs/Runtime/DotNet/Akka.NET/Samples/Rikace, or pass the path to t
he project using --project.
[myrpi4@manjarorpi4node1 Rikace]$ dotnet exec ./akkafractal-master/src/Akka.Fractal.Remote/bin/Debug/netcoreapp2.1/Akka.Fractal.Remote.dll
It was not possible to find any compatible framework version
The framework 'Microsoft.NETCore.App', version '2.1.0' was not found.
- The following frameworks were found:
  3.1.10 at [/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/shared/Microsoft.NETCore.App]
```

You can resolve the **problem** by installing the specified framework and/or SDK.

The specified framework can be found at:

```
- https://aka.ms/dotnet-core-applaunch?framework=Microsoft.NETCore.App&framework\_version=2.1.0&arch=arm64&rid=manjaro-arm-arm64
```

1.4 Summary

- Sorry that there is no available demonstration for Akka.NET cluster on a RPi 4 cluster in current stage, hope that all the issues of distributed fractal image processing could be resolved and we shall demonstrate it on RPi 4 soon
- Go back to .Net 3 first for big legacy project?
- An OCI-compliant image against Akka.NET with .Net 3 on ARM Linux is needed

...

Roadmap of Akka.NET

- - Akka.NET v1.4.* [Ongoing]
 - DI Integration
 - Visibility & Ops
 - Performance (non-breaking)
 - Akka.NET v1.5 [Q3 2021]
 - Major Akka.Remote perf improvements (breaking)
 - Multi-DC Akka.Cluster
 - Default serialization
 - Stand-alone HOCON (3.0)
 - Akka.NET 2.0 [Q2 2022]
 - Typed Actors
 - Major Akka core perf improvements (breaking)
 - Major Akka.Streams improvements
 - .NET 5 / .NET 6 only – no more .NET Framework

Source: <https://www.youtube.com/watch?v=j2nNRO4pVMI>

V. Orleans on ARM

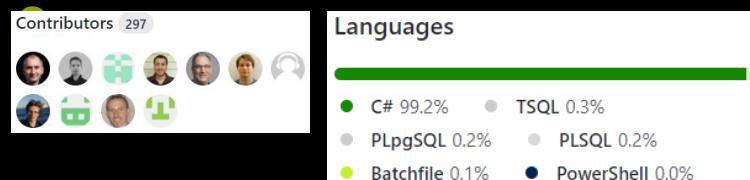
1) Overview

- [https://en.wikipedia.org/wiki/Orleans_\(software_framework\)](https://en.wikipedia.org/wiki/Orleans_(software_framework))
- **a cross-platform framework for building robust, scalable distributed applications**

Orleans builds on the developer productivity of .NET and brings it to the world of distributed applications, such as cloud services. Orleans scales from a single on-premises server to globally distributed, highly-available applications in the cloud.

Orleans takes familiar concepts like objects, interfaces, async/await, and try/catch and extends them to multi-server environments. As such, it helps developers experienced with single-server applications transition to building resilient, scalable cloud services and other distributed applications. For this reason, Orleans has often been referred to as "Distributed .NET".

It was created by Microsoft Research and introduced the [Virtual Actor Model](#) as a novel approach to building a new generation of distributed systems for the Cloud era. The core contribution of Orleans is its programming model which tames the complexity inherent to highly-parallel distributed systems without restricting capabilities or imposing onerous constraints on the developer.

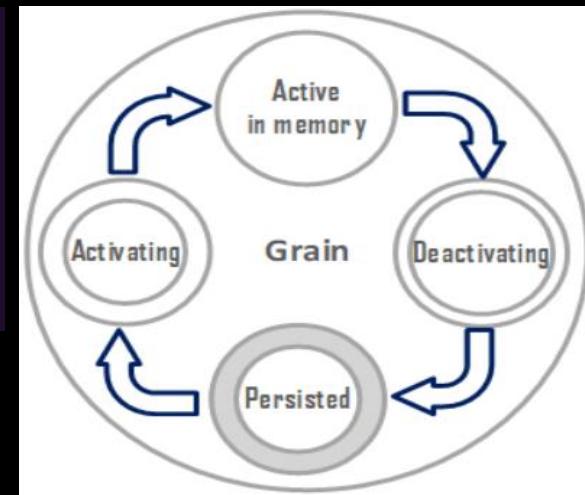


- <https://www.nuget.org/profiles/Orleans>

1.1 Architecture & Design

- <https://github.com/akka/akka-meta/blob/master/ComparisonWithOrleans.md>

Grains

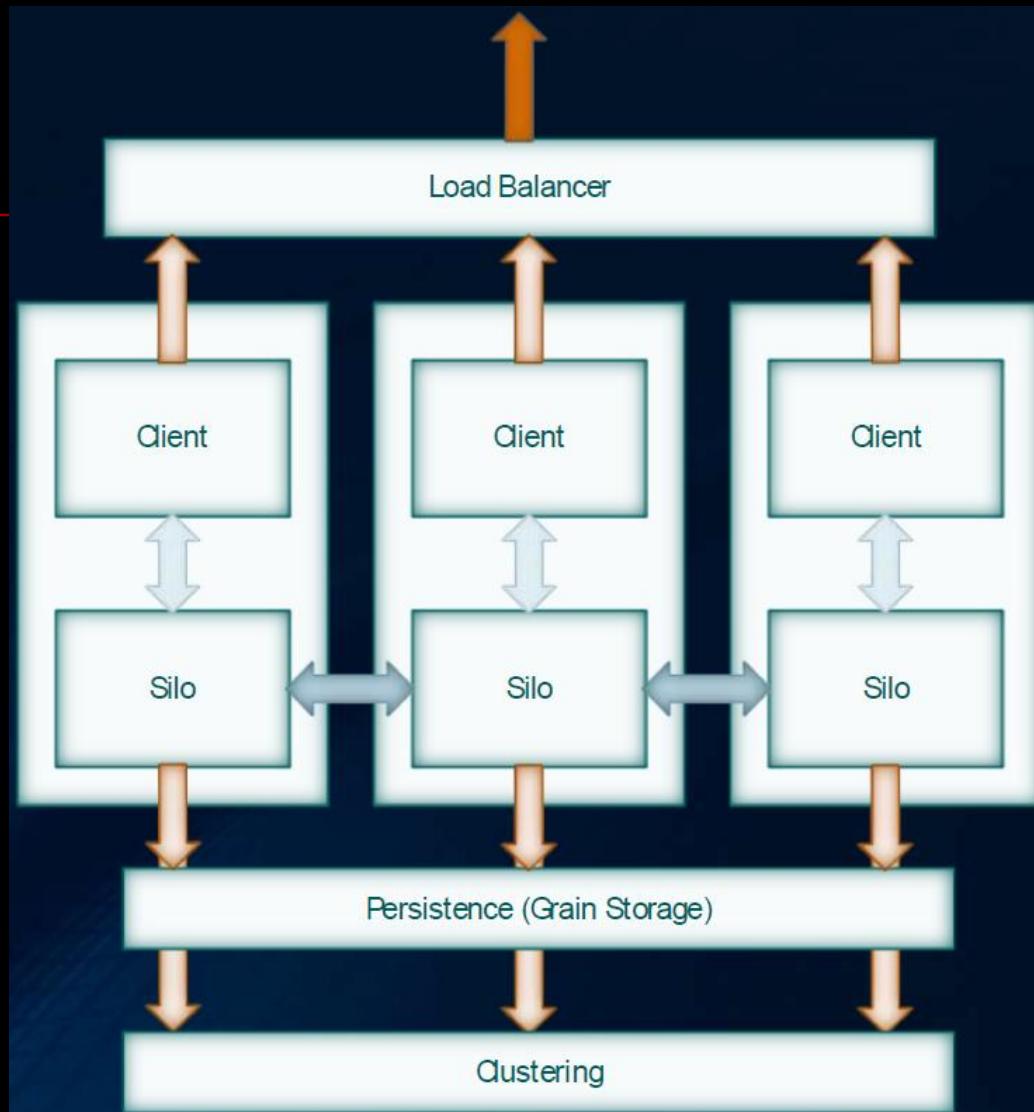


Orleans 3.x

- <https://devblogs.microsoft.com/dotnet/orleans-3-0/>
- Major changes since Orleans 2.0:

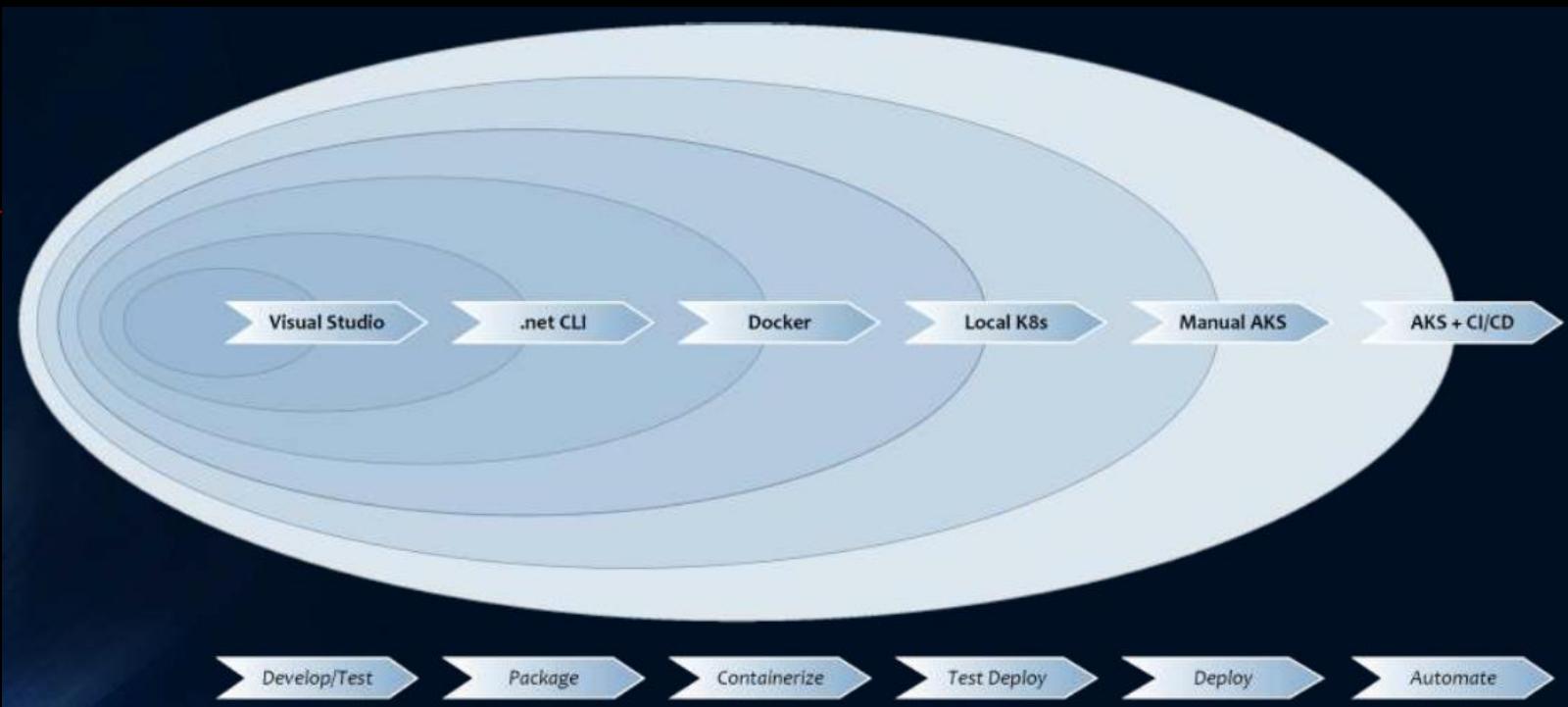
- Distributed ACID transactions — multiple grains can join a transaction regardless of where their state is stored
- A new scheduler, which alone increased performance by over 30% in some cases
- A new code generator based on Roslyn code analysis
- Rewritten cluster membership for improved recovery speed
- Co-hosting support

Runtime Components



Source: <https://www2.slideshare.net/JohnAzariah/reactive-summit-2020-microsoft-orleans-the-easy-way>

Development Workflow



Source: <https://www2.slideshare.net/JohnAzariah/reactive-summit-2020-microsoft-orleans-the-easy-way>

1.2 Building on RPi 4

- On Windows, run the `build.cmd` script to build the NuGet packages locally, then reference the required NuGet packages from `/Artifacts/Release/*`. You can run `Test.cmd` to run all BVT tests, and `TestAll.cmd` to also run Functional tests.

On Linux and macOS, run the `build.sh` script or `dotnet build` to build Orleans.

build Orleans without any modification

```
===== start building Orleans on ARM64 =====
Could not execute because the application was not found or a compatible .NET SDK is not installed.
Possible reasons for this include:
  * You intended to execute a .NET program:
    The application 'build' does not exist.
  * You intended to execute a .NET SDK command:
    A compatible installed .NET SDK for global.json version [3.1.301] from [/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Orleans/orleans-master/global.json] was not found.
    Install the [3.1.301] .NET SDK or update [/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Orleans/orleans-master/global.json] with an installed .NET SDK:
2020-12-14 21:26:46      5.0.101 [/opt/MyWorkSpace/DevSW/DotNet/SDK/Std/sdk]
```

replace .Net 3 SDK with that of 5 and get a partially successful build:

```
[mydev@MyRPi4-Fedora-1 orleans-master]$ git diff
diff --git a/global.json b/global.json
index 5f9d6788..5fc7ddd9e 100644
--- a/global.json
+++ b/global.json
@@ -1,6 +1,6 @@
{
  "sdk": {
    "rollForward": "feature",
-   "version": "3.1.301"
+   "version": "5.0.101"
  }
}
```

```
2020-12-14 22:04:32 Build succeeded.
2020-12-14 22:04:32
2020-12-14 22:04:32 /opt/MyWorkSpace/DevSW/DotNet/SDK/Std/sdk/5.0.101/Sdks/Microsoft.NET.Sdk/targets/Microsoft.NET.EolTargetFrameworks.targets(:5): warning NETSDK1138: The target framework 'netcoreapp2.0' is out of support and will not receive security updates in the future. Please refer to https://aka.ms/dotnet-core-support for more information about the support policy. [/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Orleans/orleans-master/src/Orleans.CodeGenerator.MSBuild.Tasks/Orleans.CodeGenerator.MSBuild.Tasks.csproj]
2020-12-14 22:04:32 /opt/MyWorkSpace/DevSW/DotNet/SDK/Std/sdk/5.0.101/Sdks/Microsoft.NET.Sdk/targets/Microsoft.NET.EolTargetFrameworks.targets(:5): warning NETSDK1138: The target framework 'netcoreapp2.0' is out of support and will not receive security updates in the future. Please refer to https://aka.ms/dotnet-core-support for more information about the support policy. [/opt/MyWorkSpace/MyProjs/Runtime/DotNet/Orleans/orleans-master/src/Orleans.CodeGenerator.MSBuild.Tasks/Orleans.CodeGenerator.MSBuild.Tasks.csproj]
2020-12-14 22:04:32      2 Warning(s)
2020-12-14 22:04:32      0 Error(s)
2020-12-14 22:04:32
2020-12-14 22:04:32 Time Elapsed 00:34:59.73
```

VI. Wrap-up

- The future of computing is **distributed**
- The upcoming Raspberry Pi 5 should be awesome! **Scale out, not scale up!?**
- Many **novel frameworks for distributed computing** are on the way
- A heterogeneous world:
How about cluster computing on nodes with various ISA
-- **X86 + ARM + RISC-V?**
- An era of polyglot programming:
.Net vs GraalVM vs WebAssembly etc
IronPython vs GraalPython vs wasmer-python
...
Pythonizing C# (since C# 7.x)



Guido van Rossum

Q & A

Thanks!



Reference

Slides/materials from many and varied sources:

- <http://en.wikipedia.org/wiki/>
- <http://www.slideshare.net/>
- <https://github.com/topics/actor-model>
- <https://petabridge.com/blog/category/videos/>
- <>Reactive Applications with Akka.Net>>(ISBN 13: 9781617292989),
Anthony Brown, 2018
- <https://docs.microsoft.com/en-us/azure/service-fabric/service-fabric-overview>
- <https://medium.com/swlh/distributed-state-management-80c8100bb563>
- ...