



What Was Old
Is New Again

- A mature, high performance, hierarchical key-value NoSQL database whose code base scales up to mission-critical applications like large real-time core-banking and electronic health records, and also scales down to run on platforms like the Raspberry Pi Zero, as well as everything in-between.
- *Rock Solid. Lightning Fast. Secure. Pick any three.*

YottaDB is a registered trademark of YottaDB LLC

Agenda

- The Past
 - Where are we and how did we get here?
- Making What was Old New Again
- The Future
- Demo
 - Still a work in progress

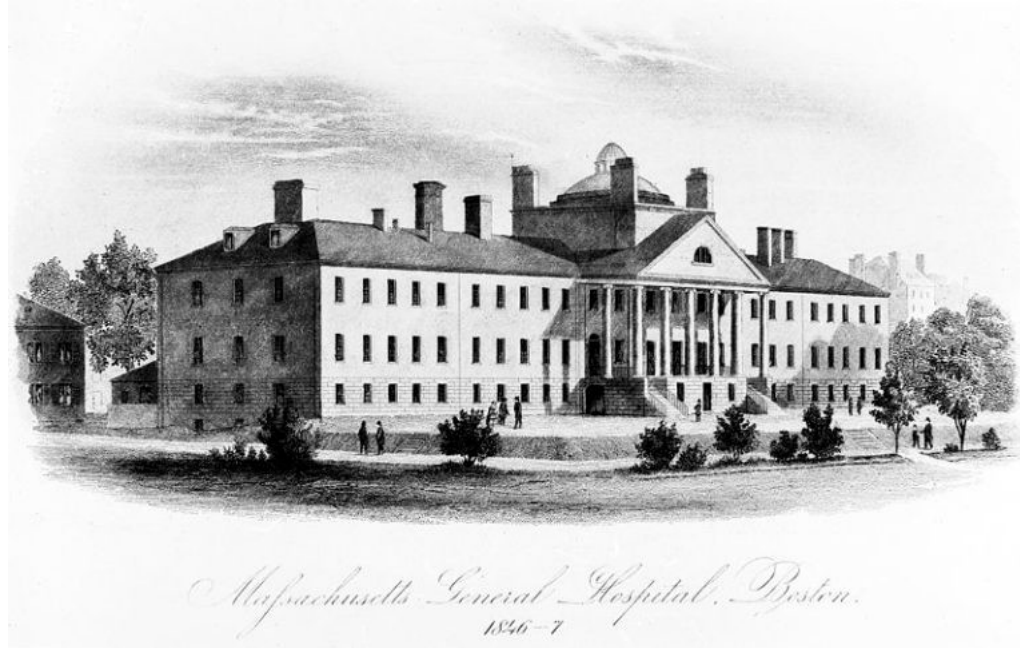
The Past

Where are we and how did we get here?



The Original Computer Database

- IBM Information Management System (IMS)
- Created to manage bill of materials & inventory of Saturn V & Apollo
 - Hierarchical data model – a NoSQL database!
- First released 1966; latest release 2017
- Runs on mainframe ⇒ Expensive



- Animal research laboratory circa 1966
 - Limited funding for computing
- Minicomputers – spare DEC PDP-7
- Accessible talent – across the river, in Cambridge
 - Massachusetts Institute of Technology
 - Bolt, Beranek and Newman

- Massachusetts General Hospital Utility Multi-
Programming System
 - Operating system + hierarchical database file system + user interface + programming language + ...
 - First used 1966/67
 - Ecosystem culture – user driven development; users and developers work closely together ⇒ pragmatic software without deep Computer Science theory

Key-Value Tuples

```
["Capital", "Belgium", "Brussels"]  
["Capital", "Thailand", "Bangkok"]  
["Capital", "USA", "Washington, DC"]
```

Key

Value

Always sorted – MUMPS
means you never have to
say you're sorting...

Schemaless

```
["Capital", "Belgium", "Brussels"]  
["Capital", "Thailand", "Bangkok"]  
["Capital", "USA", "Washington,DC"]  
["Population", "Belgium", 13670000]  
["Population", "Thailand", 84140000]  
["Population", "USA", 325737000]
```

Schema
determined
entirely by
application –
MUMPS assigns
no meaning

Numbers and strings
(blobs) can be freely
intermixed in values
and keys except first

Default order for each key:

- Empty string ("")
- Canonical numbers in numeric order
- Strings (blobs) in lexical order

Mix Key Sizes

```
["Capital", "Belgium", "Brussels"]  
["Capital", "Thailand", "Bangkok"]  
["Capital", "USA", "Washington, DC"]  
["Population", "Belgium", 13670000]  
["Population", "Thailand", 84140000]  
["Population", "USA", 325737000]  
["Population", "USA", 17900802, 3929326]  
["Population", "USA", 18000804, 5308483]  
...  
["Population", "USA", 20100401, 308745538]
```

↑
yyyymmdd

"Population" + 1 more key
means value is latest
population

"Population" + 2 more keys
means value is population on
date represented by last key

Keys \leftrightarrow Array References

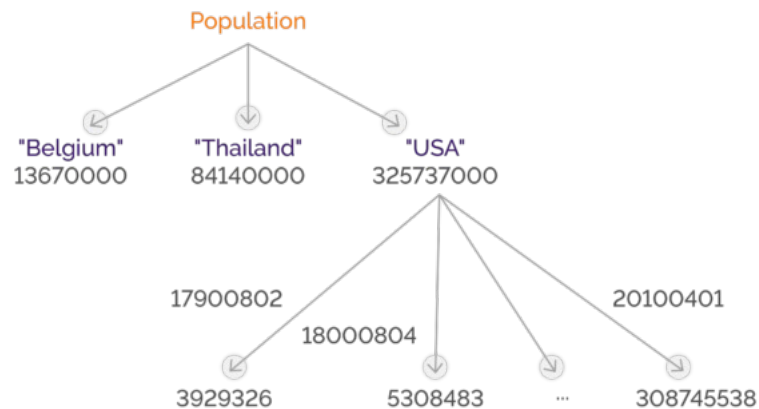
```
Population("Belgium")=13670000
Population("Thailand")=84140000
Population("USA")=325737000
Population("USA",17900802)=3929326
Population("USA",18000804)=5308483
...
Population("USA",20100401)=308745538
```

First key is
variable name

Other keys are
subscripts

Array references are a familiar
programming paradigm

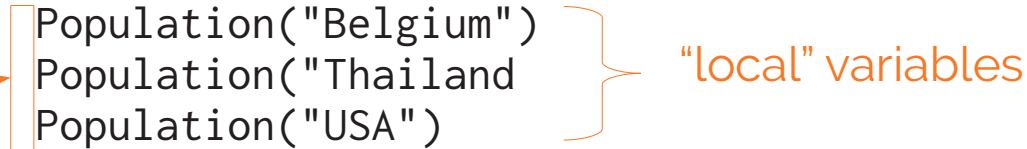
POPULATION
TREE



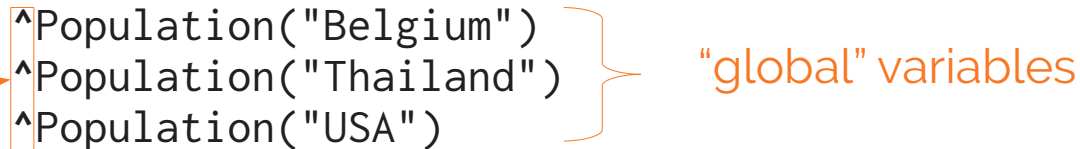
Any JSON structure is representable
as a tree, but not vice versa

Sharing and Persistence – Database Access YottaDB

- Process private, available only for lifetime of process


Population("Belgium")
Population("Thailand")
Population("USA")

- Shared across processes, persistent beyond lifetime of any process


^Population("Belgium")
^Population("Thailand")
^Population("USA")

Spot the difference?

Universal NoSQL

- Satisfies common major NoSQL use cases
 - <http://mgateway.com/docs/universalNoSQL.pdf>
- NoSQL means “Not only SQL”

Noteworthy Features

- Tight binding of database to language
- Direct source code execution (initial implementation)
- Dynamic linking
- Multitasking
- Interactive / incremental usage
- Hierarchical locks (traffic light semantics)

Noteworthy Contemporaries

- C
- SQL
- TCP/IP
- UNIX

- 1970s
 - Language+database separate from operating system
- 1980s (GT.M – forerunner to YottaDB)
 - Programs are just text files in the file system
 - Compiled to object code for execution
 - While maintaining interactive / incremental usage

Evolution ... 2

- 1990s
 - ACID transactions (GT.M)
 - Vendor consolidation
 - Just two commercial implementations left
- 2000s
 - GT.M/Linux moves to free / open source license
- 2017 – YottaDB released based on GT.M

- Atomic – it all happens or none of it happens
- Consistent – logic inside a transaction cannot see internal state of another transaction
- Isolated – no other logic can see inside this transaction
- Durable – once committed, state change is permanent

ACID Transaction Example

Transaction start

Cancel (abort / rollback) if insufficient funds

Subtract amount from savings

Add amount to checking

Record transaction in account histories

Transaction commit

- Ensuring Consistency & Isolation with high concurrency is hard
- Optimistic Concurrency Control
 - <http://daslab.seas.harvard.edu/reading-group/papers/kung.pdf>
- Achieves high levels of concurrency & scalability
 - At the cost of a pathological case that application code must avoid

- At the heart of mission-critical applications – the largest real-time core-banking and patient-centric healthcare systems in the world
- But not widely used in general purpose computing

- Consequences of direct execution of source code
 - Needed to save memory and run fast
 - Single letter abbreviations of commands, short names

```
hello
  write "Hello, World!",!
quit
```

```
hello w "Hello, World!",! q
```

- Consequences of direct execution of source code
- Enterprise-scale applications on small computers

- Expert friendly code, e.g.

```
S %P1=$S($L(%P1)>8:$E(%P1,1,8)-17000000_". "_$E(%P1,9,14),1:%P1-17000000)
;%P1 is now in FM format
I %P1[".",+$P(%P1,".",2)=0 S %P1=$$FMADD(+%P1,-1)_"24"
;If HL7 tz and local tz are the same
I %P2["L",%TZ=%LTZ S %P2=""
I (%P2["U")! (%P2["L"),%P1["." D ;Build UCT from dat
. S %=$TR(%TZ,"+","-") ;Reverse the sign
. S %H=$E(%,1,3),%M=$E(%,1)_$E(%,4,5)
. S %P1=$$FMADD(%P1,,%H,%M) Q
```

Why Not Widely Used ... 3

- Consequences of direct execution of source code
- Enterprise-scale applications on small computers
- Successful applications have long lives
 - Code written in the 1970s and 1980s was written to different standards of readability than code today
 - Application consistency for maintainability means coding style lags best practices for readability

Why Not Widely Used ... 4

- Direct execution of source code
- Enterprise-scale applications on small computers
- Successful applications have long lives
- Vendor consolidation ended language evolution & standardization
 - One vendor able to acquire all implementations except GT.M

Why Not Widely Used ... 5

- Direct execution of source code
- Enterprise-scale applications on small computers
- Successful applications have long lives
- Vendor consolidation ended language evolution & standardization
- Cultural issues inside and outside community

Why Not Widely Used ... 6

- Direct execution of source code
- Enterprise-scale applications on small computers
- Successful applications have long lives
- Vendor consolidation ended language evolution & standardization
- Cultural issues inside and outside community
- Not well respected by academia

Making What was Old New Again



The Diamond is the Database



- Mature, proven code
 - “Rock Solid. Lightning Fast. Secure. Pick any three.”

The Language is What it is

- You either love it or you hate it
 - Like anchovies on your pizza
 - or like emacs vs. vi[m] vs. ...
 - or like your religion vs. the other guy's religion
 - Or...
- So, we made the database language agnostic

YottaDB Strategy

- Build on what works well
- Accommodate what's new



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Photos
are
almost
100
years
apart

From GT.M to YottaDB

Building on Strengths and
Accommodating What's New



Tight Database Binding is a Strength



- Create tight binding from database to C, just like the tight binding from database to the MUMPS language
- Make it as easy to use as any other library

```
source /usr/local/lib/yottadb/ydb_env_set
#include "libyottadb.h"
gcc -I $ydb_dist -L $ydb_dist -o myprog myprog.c -lyottadb
./myprog
```

Simple API – Key Functions

ydb_data_s() – determine whether node and/or subtree exist
ydb_delete_s() – delete node or both node & subtree
ydb_delete_excl_s() – delete all local variables (optionally except specified)
ydb_get_s() – get a value from a local or global variable node
ydb_node_next_s() – get next node (depth-first order)
ydb_node_previous_s() – get previous node
ydb_set_s() – set the value at a node
ydb_subscript_next_s() – get next subscript at deepest level (breadth-first order)
ydb_subscript_previous_s() – get previous subscript at deepest level
ydb_tp_s() – execute provided function with ACID transaction properties

C – Production Grade Available Today

The screenshot shows a web browser window with the title "Programming in C — MultiLanguage Programmers Guide documentation - Mozilla Firefox". The address bar shows "https://docs.yotta...". The page features a purple sidebar on the left with the YottaDB logo and a search bar. The main content area is titled "Programming in C" and contains a "Contents" section with a list of topics:

- Programming in C
 - Symbolic Constants
 - Function Return Codes
 - Normal Return Codes
 - Error Return Codes
 - Limits
 - Severity
 - Other
 - Data Structures & Type Definitions
 - Macros
 - Simple API
 - `ydb_data_s()` / `ydb_data_st()`
 - `ydb_delete_s()` / `ydb_delete_st()`
 - `ydb_delete_excl_s()` / `ydb_delete_excl_st()`
 - `ydb_get_s()` / `ydb_get_st()`
 - `ydb_incr_s()` / `ydb_incr_st()`
 - `ydb_lock_s()` / `ydb_lock_st()`

The sidebar on the left includes links to "Index", "Main YottaDB Documentation Page", "Multi-Language Programmer's Guide", "Overview", "Quick Start", "Concepts", and "Programming in M". The "Programming in C" section is currently selected and expanded, showing "Symbolic Constants" and "Data Structures & Type".

Go – Field Test Grade Available Today

The screenshot shows a web browser window with the title "Programming in Go — MultiLanguage Programmers Guide documentation - Mozilla Firefox". The address bar shows "https://docs.yotta...". The page features a purple sidebar on the left with the YottaDB logo and a search bar. The main content area is titled "Programming in Go" and contains a "Contents" section with a list of links. The browser's status bar at the bottom indicates a 67% zoom level.

Programming in Go — MultiLanguage Programmers Guide documentation - Mozilla Firefox

Programming in Go — MultiLanguage Programmers Guide

https://docs.yotta... 67%

Search

YottaDB

Search

Index

Main YottaDB Documentation Page

Multi-Language Programmer's Guide

Overview

Quick Start

Concepts

Programming in M

Programming in C

Programming in Go

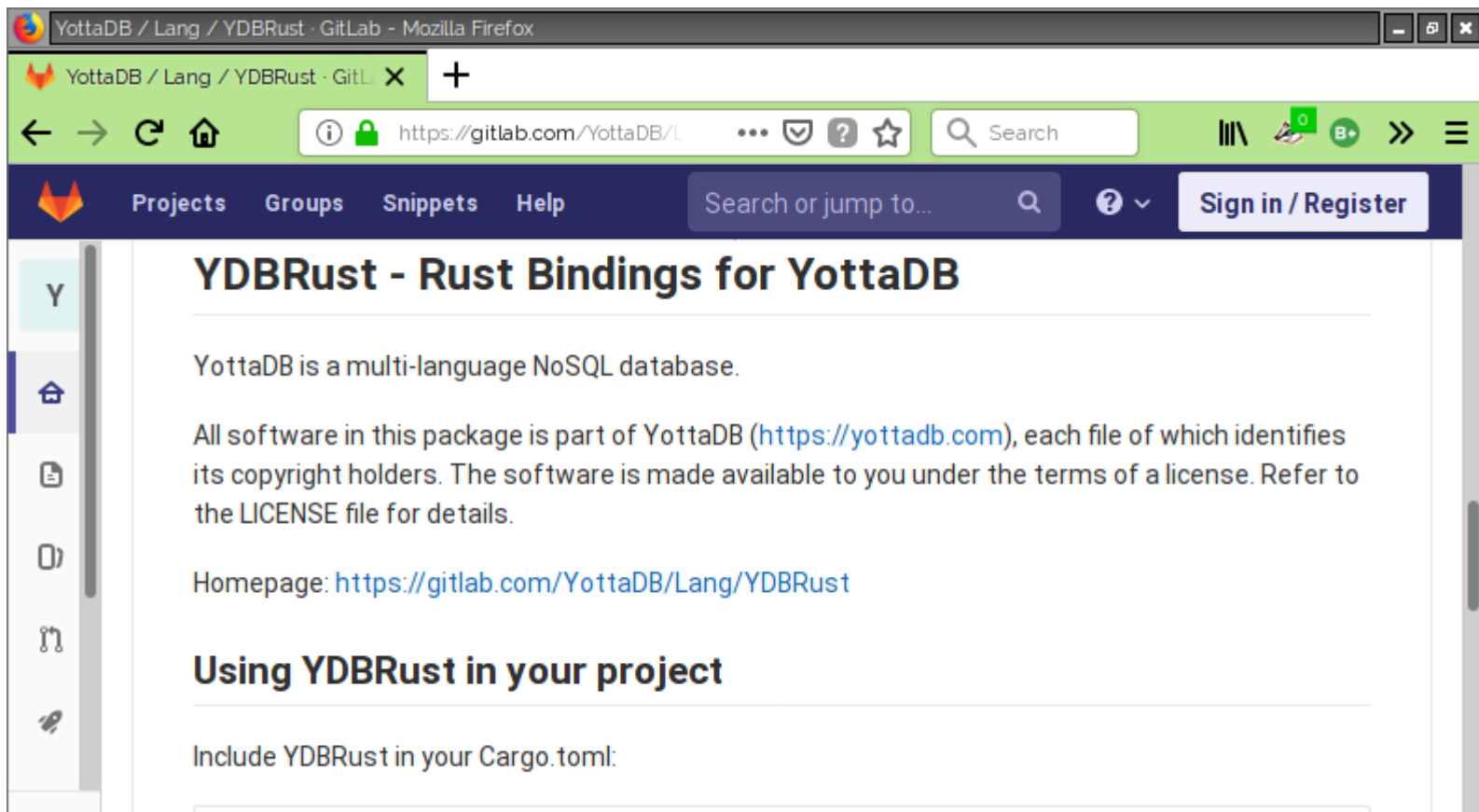
Go Quick Start

Programming in Go

Contents

- Programming in Go
 - Go Quick Start
 - Go Concepts
 - Go Error Interface
 - Go Symbolic Constants
 - Go Easy API
 - Go Easy API Functions
 - Go DataE()
 - Go DeleteE()
 - Go DeleteExcIE()
 - Go IncrE()
 - Go LockDecrE()
 - Go LockE()
 - Go LockIncrE()
 - Go NodeNextE()
 - Go NodePrevE()
 - Go SetValE()

Rust – Live Demo at LFNW (termrec talk)



The screenshot shows a web browser window displaying the YottaDB Rust Bindings page on GitLab. The browser's address bar shows the URL `https://gitlab.com/YottaDB/L`. The page title is "YDBRust - Rust Bindings for YottaDB". The content includes a description of YottaDB as a multi-language NoSQL database, a notice about software licensing, and a link to the homepage. A sidebar on the left contains navigation icons, and a top navigation bar includes links for Projects, Groups, Snippets, and Help, along with a search bar and a "Sign in / Register" button.

YottaDB / Lang / YDBRust · GitLab · Mozilla Firefox

YottaDB / Lang / YDBRust · GitLab

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🦋 Projects Groups Snippets Help 🔍 Search or jump to... ? ⌵ Sign in / Register

YDBRust - Rust Bindings for YottaDB

YottaDB is a multi-language NoSQL database.

All software in this package is part of YottaDB (<https://yottadb.com>), each file of which identifies its copyright holders. The software is made available to you under the terms of a license. Refer to the LICENSE file for details.

Homepage: <https://gitlab.com/YottaDB/Lang/YDBRust>

Using YDBRust in your project

Include YDBRust in your Cargo.toml:

Python – Coming soon



node.js – thank you, David Wicksell!

The screenshot shows a web browser window displaying the GitHub repository for 'dlwicksell/nodem'. The browser's address bar shows the URL 'http://github.com/dlwicksell/nodem'. The repository page has a purple header with navigation links: 'Code', 'Issues 0', 'Pull requests 0', 'Wiki', 'Releases 13', and 'More'. Below the header, the repository description is 'A YottaDB and GT.M database driver and language binding for Node.js'. Statistics show 47 commits, 1 branch, 13 releases, and 2 contributors. A 'Branch: master' dropdown and a 'Create new file' button are visible. The commit history shows a recent commit by 'dlwicksell' titled 'Fix support for YottaDB r1.24'. Below the commit history, there are two folders: 'examples' and 'lib', both with descriptions: 'Add asynchronous API support for another four APIs'.

dlwicksell/nodem: A YottaDB and GT.M database driver and language binding for Node.js - Mozilla Firefox

dlwicksell/nodem: A YottaDB a X +

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dlwicksell / **nodem** 🔗 Watch

<> Code ⓘ Issues 0 🔗 Pull requests 0 📖 Wiki 📁 Releases 13 More ▾

A YottaDB and GT.M database driver and language binding for Node.js

🕒 47 commits 🌿 1 branch 📦 13 releases 👤 2 contributors

Branch: master ▾ Create new file

 **dlwicksell** Fix support for YottaDB r1.24 Late

📁 [examples](#) Add asynchronous API support for another four APIs

📁 [lib](#) Add asynchronous API support for another four APIs

Perl – thank you, Stefan Traby!

The screenshot shows a web browser window with the address bar displaying "https://metacpan.org". The page is the meta::cpan website, specifically the page for the "YottaDB-0.24" module by "Stefan Traby". The page layout includes a sidebar on the left with links like "Source (raw)", "Browse (raw)", "Changes", "How to Contribute", "Issues", "Testers", "Kwalitee", "% Coverage", and "License: unknown". The main content area has a "Contents" section with links for "NAME", "SYNOPSIS", "DESCRIPTION", "FUNCTIONS", "SEE ALSO", "AUTHOR", and "COPYRIGHT AND LICENSE". The "NAME" section is expanded, showing the module name "YottaDB-0.24". To the right of the contents is a large pink and white geometric pattern, which is the logo for "OESI" (Open Enterprise System Interface) by Stefan Traby. Below the logo, the text "OESI" and "Stefan Traby" are visible. At the bottom right, there is a "DEPENDENCIES" section listing "JSON" and "POSIX::AtFork".

YottaDB - Perl extension for accessing YottaDB - metacpan.org - Mozilla Firefox

YottaDB - Perl extension for acc X +

← → ↻ 🏠 ⓘ 🔒 https://metacpa 📄 ⋮ 📁 ☆ 🔍 Search

meta::cpan Search

Stefan Traby / ▾ YottaDB-0.24 [hide] / YottaDB

FEB 14, 2019

Distribution: YottaDB
Module version: 0.24

📄 Source (raw)
📁 Browse (raw)
⚙️ Changes
➕ How to Contribute
🔔 Issues
👍 Testers (0 / 0 / 0)
📈 Kwalitee
📊 % Coverage
🔗 License: unknown

Contents [hide] 📄

- NAME
- SYNOPSIS
- DESCRIPTION
- FUNCTIONS
- SEE ALSO
- AUTHOR
- COPYRIGHT AND LICENSE

NAME

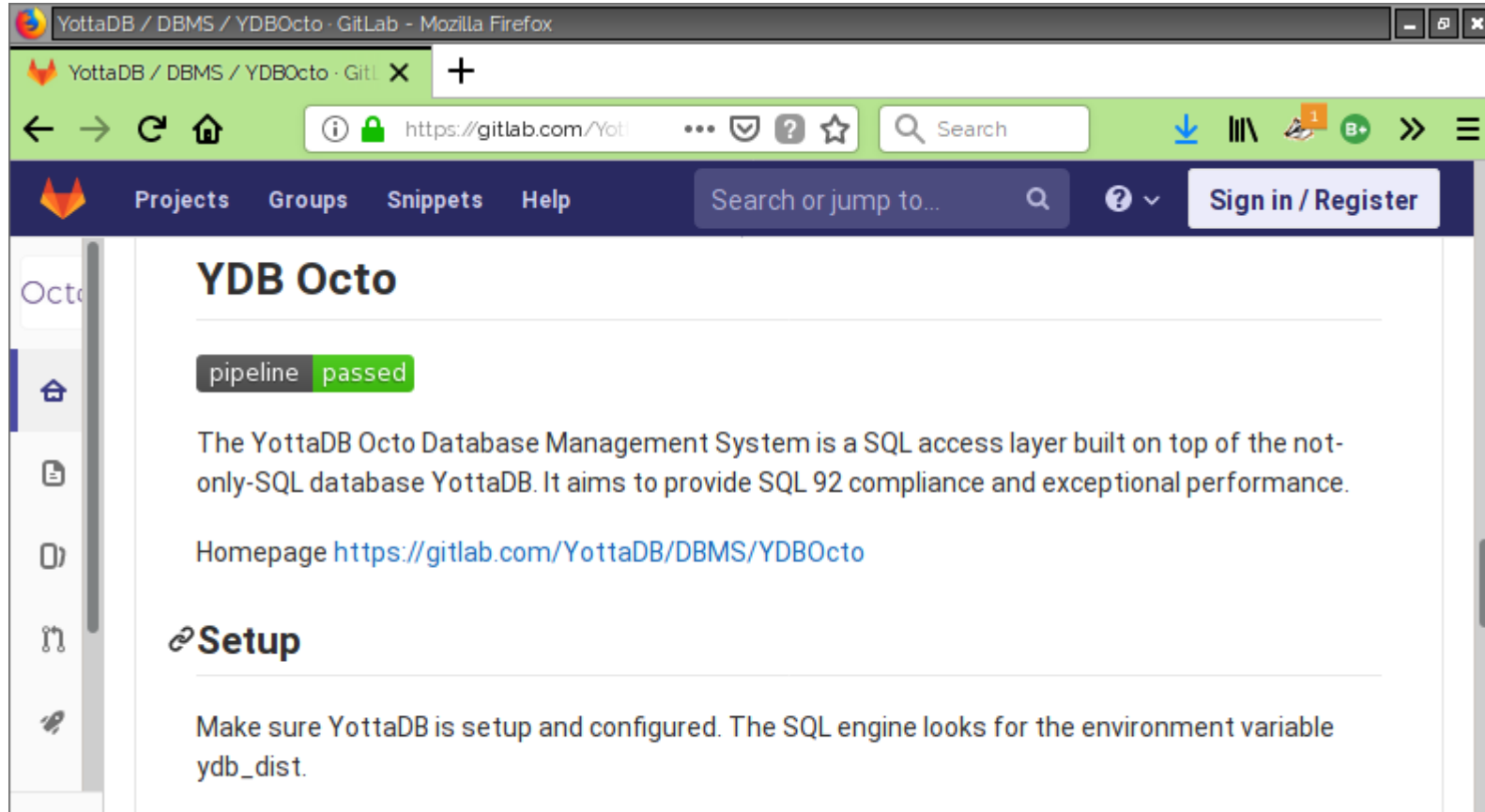
YottaDB-0.24

OESI
Stefan Traby

DEPENDENCIES

- JSON
- POSIX::AtFork

SQL – In Alpha Test



The screenshot shows a web browser window with the address bar displaying 'https://gitlab.com/YottaDB/DBMS/YDBOcto'. The page title is 'YDB Octo'. Below the title, there is a status bar indicating 'pipeline passed'. The main content area describes the YottaDB Octo Database Management System as a SQL access layer built on top of the not-only-SQL database YottaDB. It aims to provide SQL 92 compliance and exceptional performance. The homepage link is provided as <https://gitlab.com/YottaDB/DBMS/YDBOcto>. Below this, there is a section titled 'Setup' with a sub-header 'Setup'. The text under 'Setup' states: 'Make sure YottaDB is setup and configured. The SQL engine looks for the environment variable ydb_dist.'

YottaDB / DBMS / YDBOcto · GitLab - Mozilla Firefox

YottaDB / DBMS / YDBOcto · GitLab

← → ↻ 🏠 ⓘ 🔒 https://gitlab.com/YottaDB/DBMS/YDBOcto ... 🔒 ? ☆ 🔍 Search ⬇️ 📖 📄 1 B+ >> ☰

🔥 Projects Groups Snippets Help 🔍 Search or jump to... ? v Sign in / Register

YDB Octo

pipeline passed

The YottaDB Octo Database Management System is a SQL access layer built on top of the not-only-SQL database YottaDB. It aims to provide SQL 92 compliance and exceptional performance.

Homepage <https://gitlab.com/YottaDB/DBMS/YDBOcto>

🔗 Setup

Make sure YottaDB is setup and configured. The SQL engine looks for the environment variable `ydb_dist`.

More Platforms

- Linux on 32-bit ARM
 - ARMv7-A (e.g., Raspberry Pi 3, BeagleBone Black) added 2017
 - ARMv6 (e.g., Raspberry Pi Zero) added 2018
- Linux on 64-bit ARM
 - ARMv8 (e.g., Raspberry Pi 3) added 2019

The Future

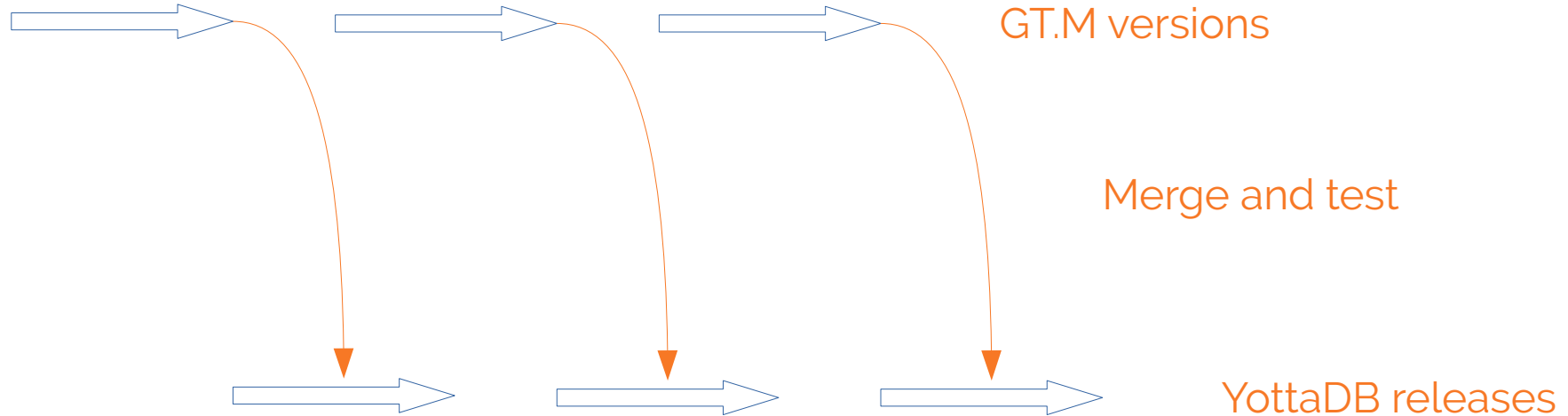


“YottaDB Everywhere”

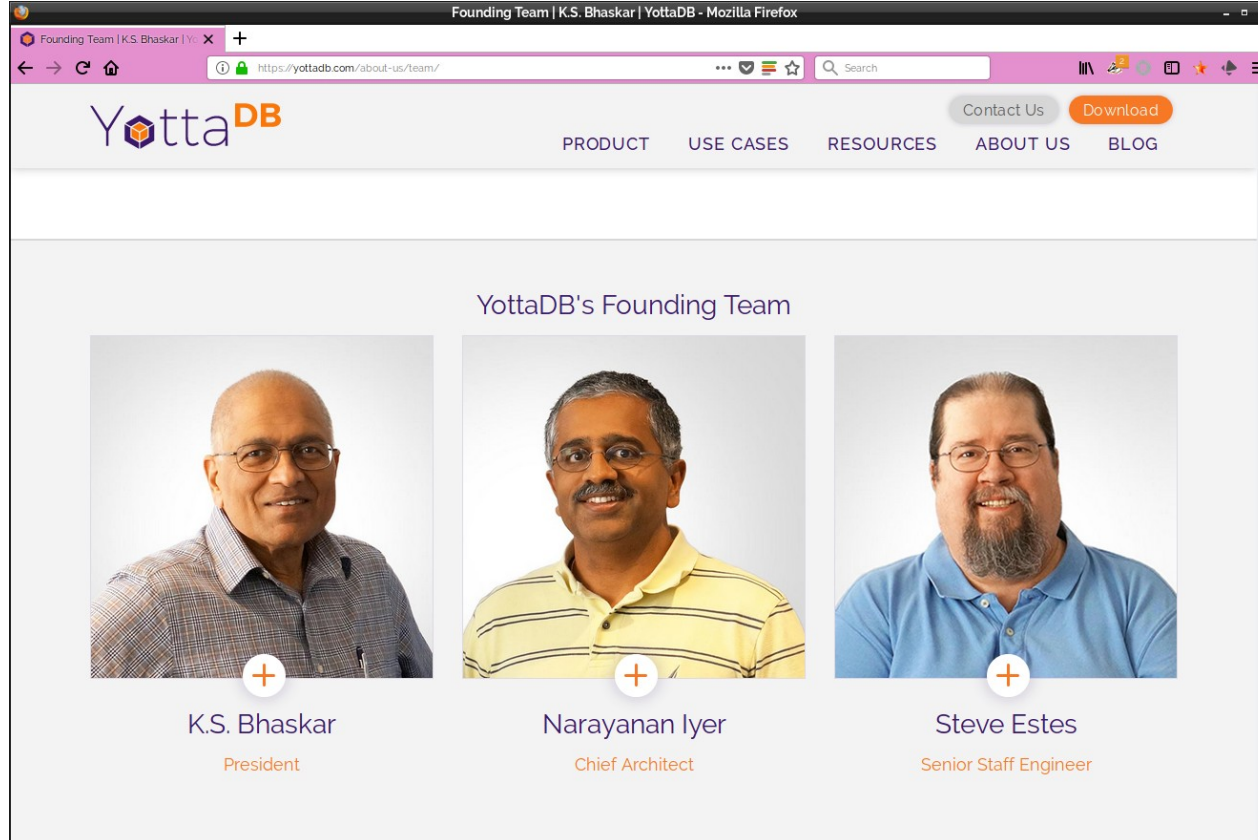


- Footprint fits in embedded systems
 - Scales up to manage very large databases
 - And everything in-between
 - *“Rock solid. Lightning fast. Secure. Pick any three.”*
- Everywhere
-
- An orange arrow pointing from the word "Everywhere" to the word "in-between" in the third bullet point.

Staying Compatible with Upstream



Ensuring Upward Compatibility



More than 20 years
experience working
together with code
base

Demo

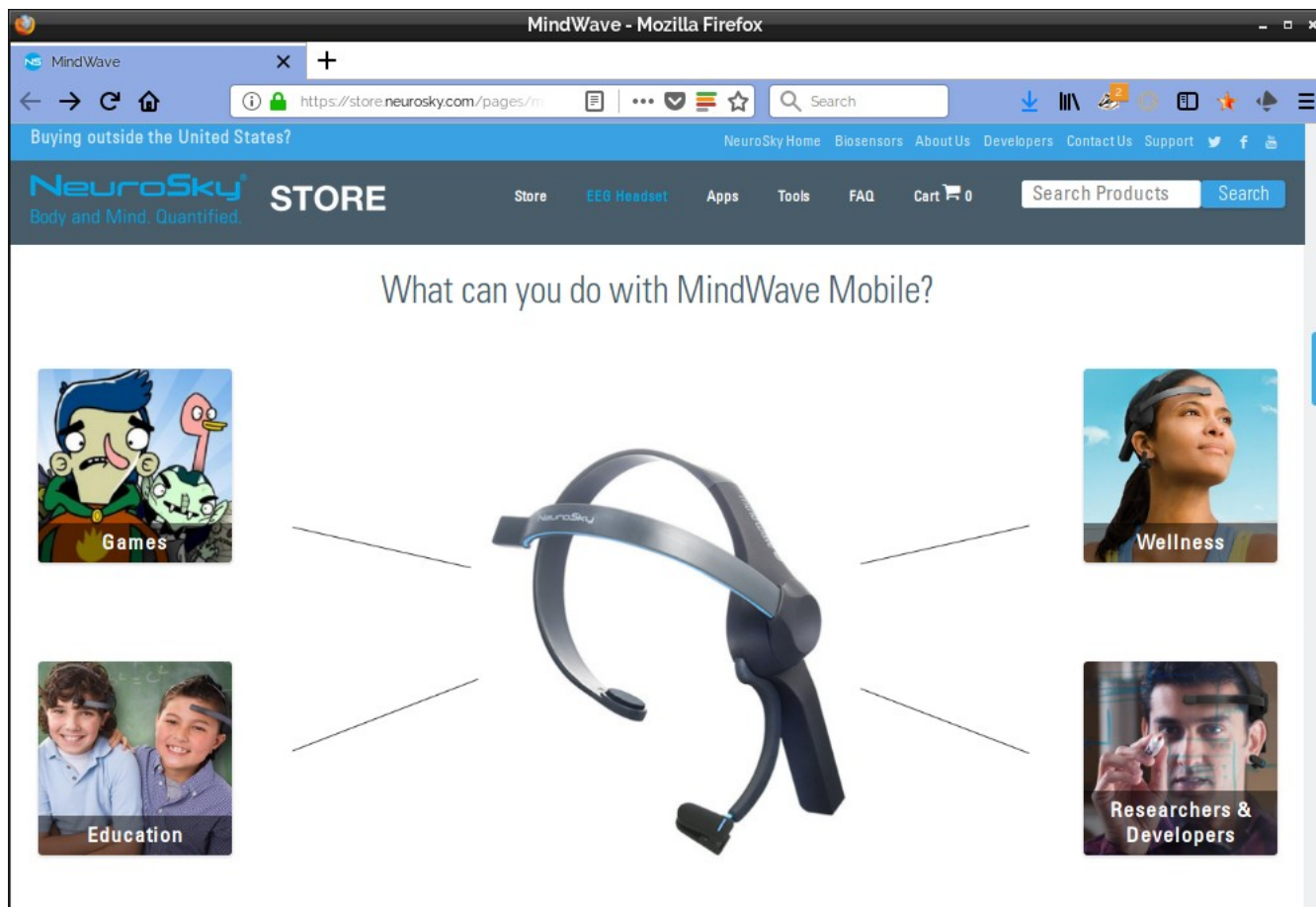


Goal



- Demonstrate YottaDB as a single database used on the edge and in the cloud

Internet of Things Demo – EEG Sensor



Internet of Things Demo – Chernoff Faces

Chernoff Face -- from Wolfram MathWorld - Mozilla Firefox

mathworld.wolfram.com/ChernoffFace.html

Wolfram MathWorld™ the web's most extensive mathematics resource
Built with Mathematica Technology

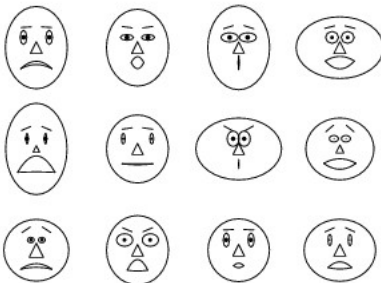
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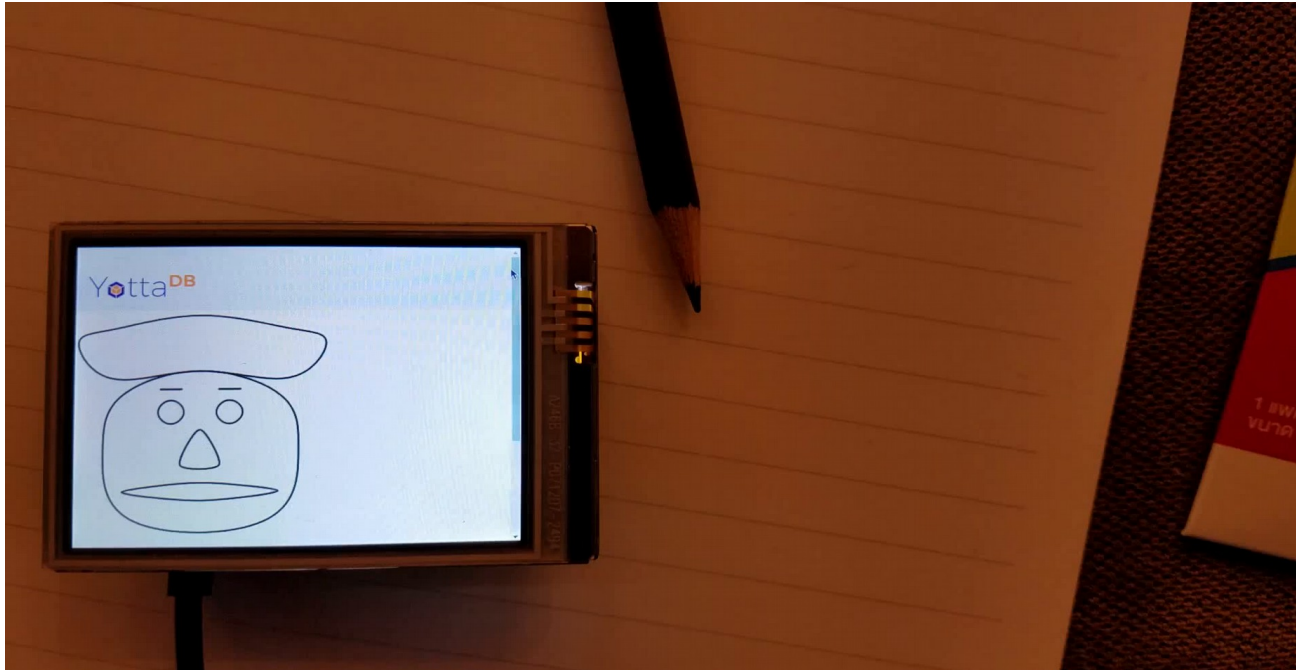
Chernoff Face

DOWNLOAD
Wolfram Notebook

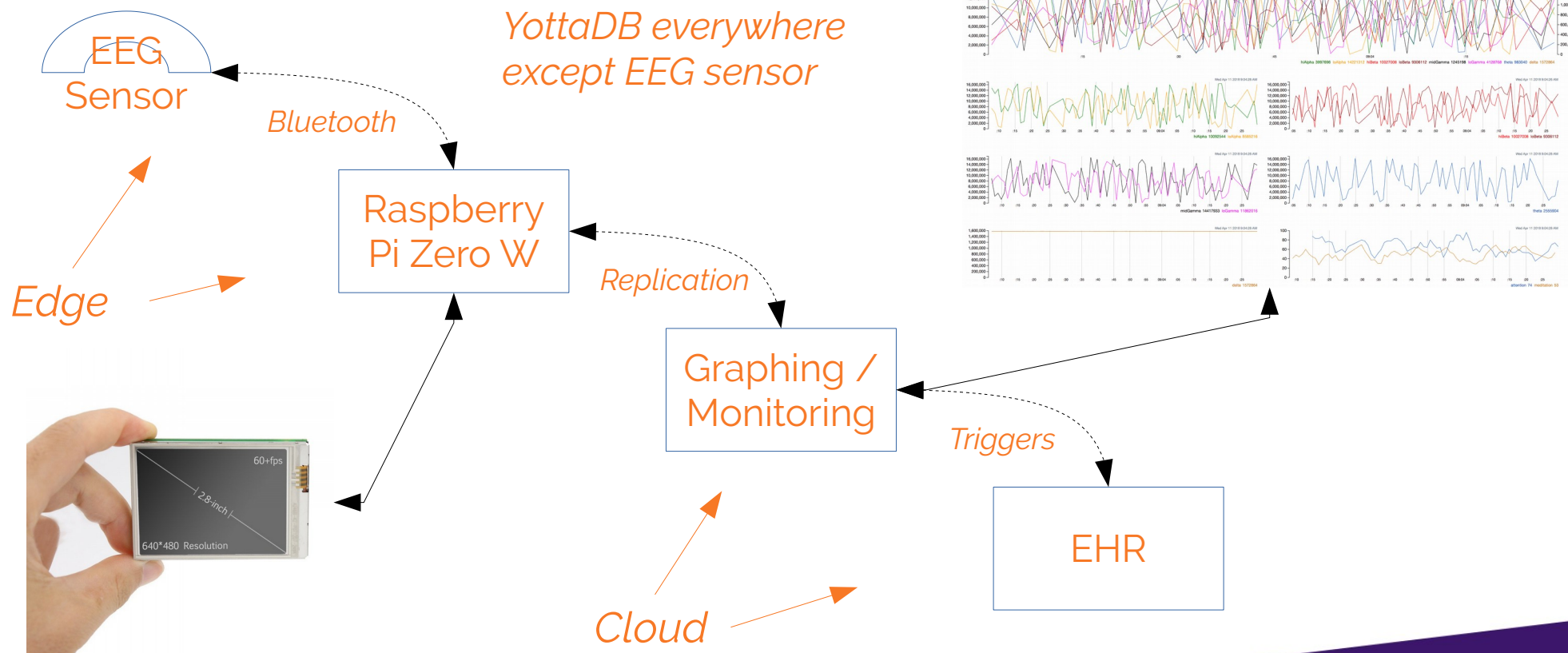


A way to display n variables on a two-dimensional surface. For instance, let x be eyebrow slant, y be eye size, z be nose length, etc. The above figures show faces produced using 10 characteristics—head eccentricity, eye size, eye

Chernoff Face Reading My Mind

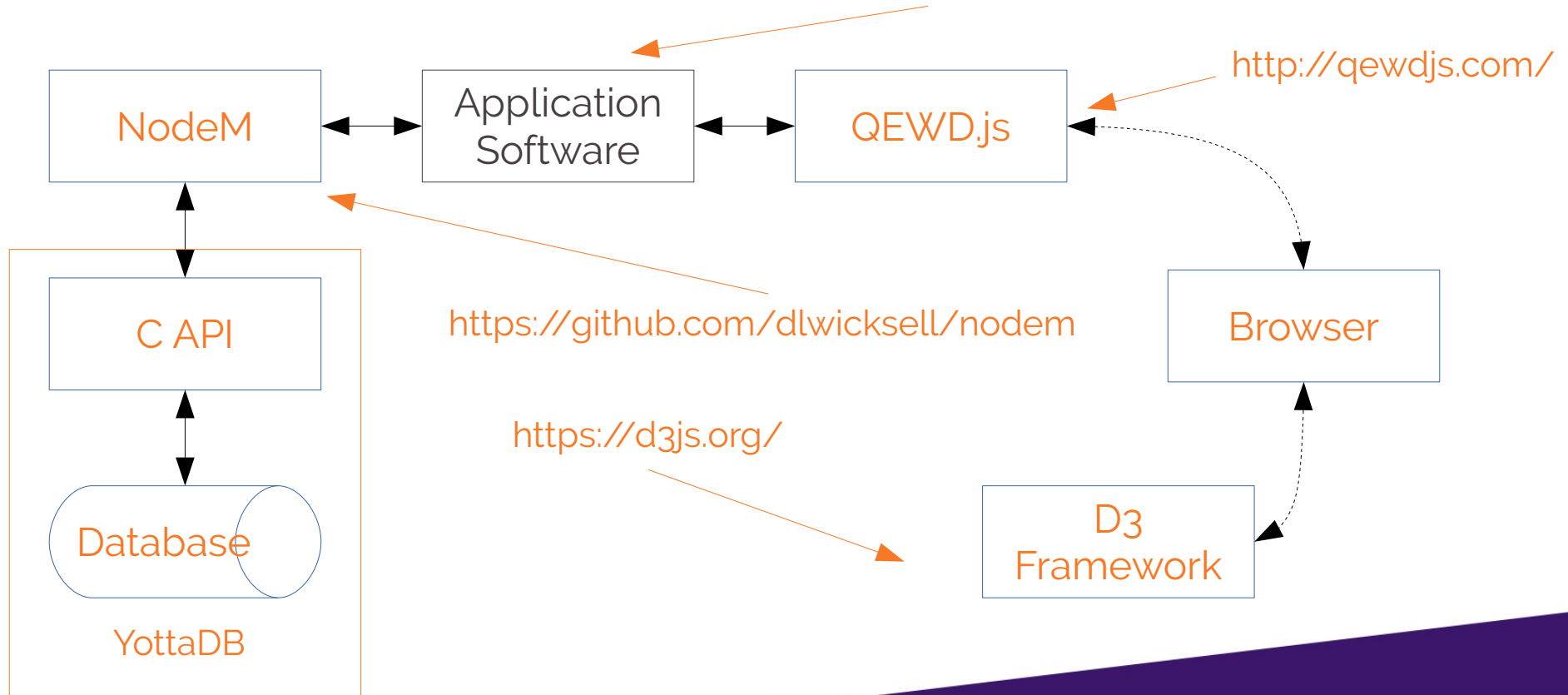


Internet of Things Demo – Block Diagram



Demo Technology – All FOSS

<https://github.com/YottaDB/YottaDBDemos/tree/master/mindwave>



Links

- Web site – <https://yottadb.com>
- All YottaDB code – <https://gitlab.com/YottaDB>
- Community
 - node.js – <https://github.com/dlwicksell/nodem>
 - Perl – <https://metacpan.org/pod/YottaDB>
- Contact – K.S. Bhaskar / bhaskar@yottadb.com



YottaDB

Thank You!

yottadb.com