rootJS - Specification

PSE - Software Engineering Practice

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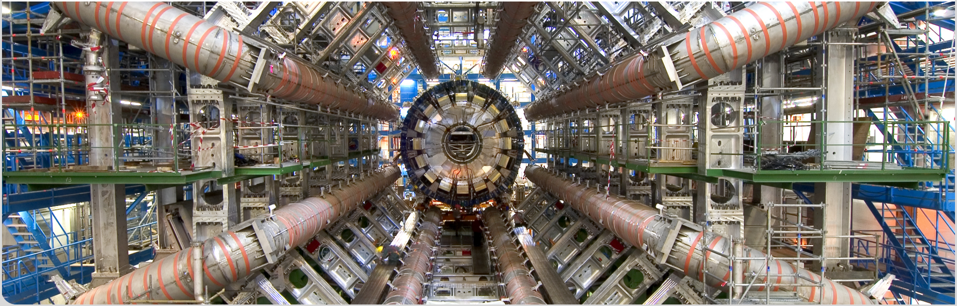
STEINBUCH CENTER FOR COMPUTING



About PSE

Praxis der Softwareentwicklung(PSE) = Software Engineering Practice

- Waterfall model
  - Planing/definition
- Functional specification

Purpose

Node.js bindings for ROOT

- be able to write ROOT code in Node.js programs
- integrate ROOT into Node.js based web applications

Required Criteria

The bindings must

- work on Linux
- allow the user to interact with any ROOT class from the Node.js JavaScript interpreter
- accept C++ code for just-in-time compilation
- update dynamically following changes to C++ internals
- provide asynchronous wrappers for common I/O operations (i.e. file and tree access)

Optional Criteria

The bindings should

- support the streaming of data in JavaScript Object Notation (JSON) format compatible with JavaScript ROOT
- implement a web server based on Node.js to mimic the function of the ROOT HTTP server
- work OS independent (i.e. support Mac OS X, Linux operating systems)

Limiting criteria

The bindings should not

- add any extending functionality to the existing ROOT framework
- necessarily support previous/future ROOT versions

Product usage

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rootJS will be used to create web-applications that can:

- Expose processed data (that might otherwise be hard to access) and then visualize it locally
- Interact with data both stored somewhere accessible for the server or streamed via remote procedure call (RPC)
- Run on any platform that supports a browser

Audience

Most users of rootJS will be used to working in Linux and with web servers. At the very least, they will be able to install ROOT and also be proficient in programming languages like JavaScript and C++.

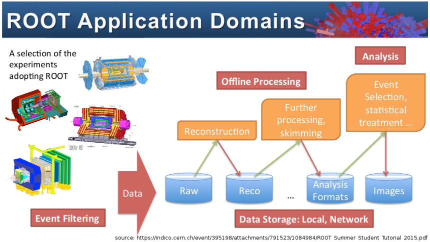
- Scientists (e.g. particle physicists)
- Researchers
- Web-developers interested in creating applications based on ROOT

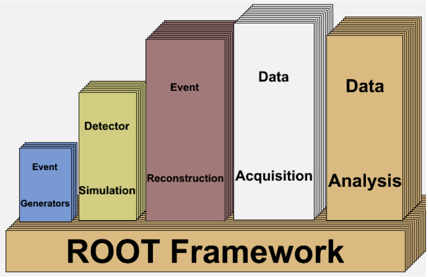
Operating conditions

- rootJS will be used on servers that run ROOT and have access to the required data sources.
- As ROOT 6 currently runs on Linux and OS X only, usage of the bindings is limited to those platforms.

ROOT

- process and visualize large amounts of scientific data (CERN)
- features a C++ interpreter (CLING) - i.e. used for rapid and efficient prototyping
- persistency mechanism for C++ objects





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- open source runtime environment
  - develop server side web applications
  - act as a stand alone web server

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- Google V8 engine to execute JavaScript code
- rootJS bindings realized as native Node.js module written in C++

Hardware

- Task: encapsulation of ROOT objects and functions
  - → scanning ROOT structures during initialization
  - → encapsulating objects with heavily nested object structures
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⇒ generally negligible hardware requirements of the bindings themselves

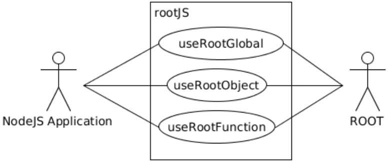
Product data

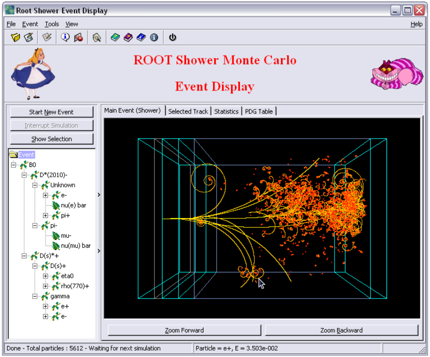
The following data will be stored by the rootJS bindings

- All ROOT classes and methods as they dynamically mapped to their JavaScript equivalents
- ROOT environment state
- Application context is derived from TApplication
- Map of v8::handles 2 identified by the address of ROOT objects

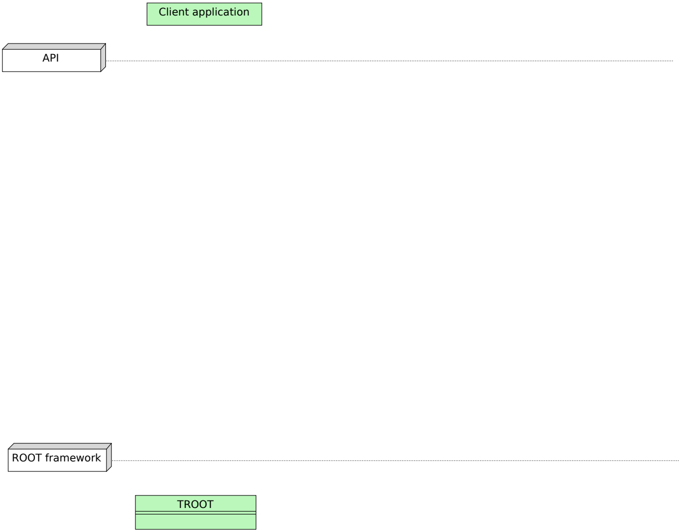
Product interface

Event Viewer





Basic Architecture



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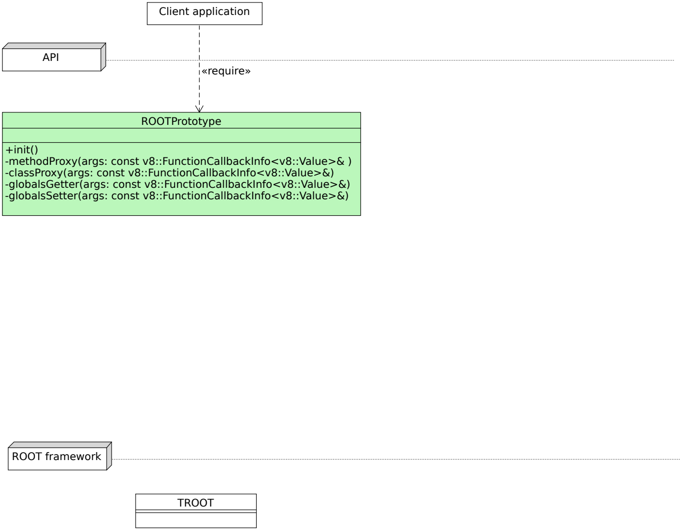

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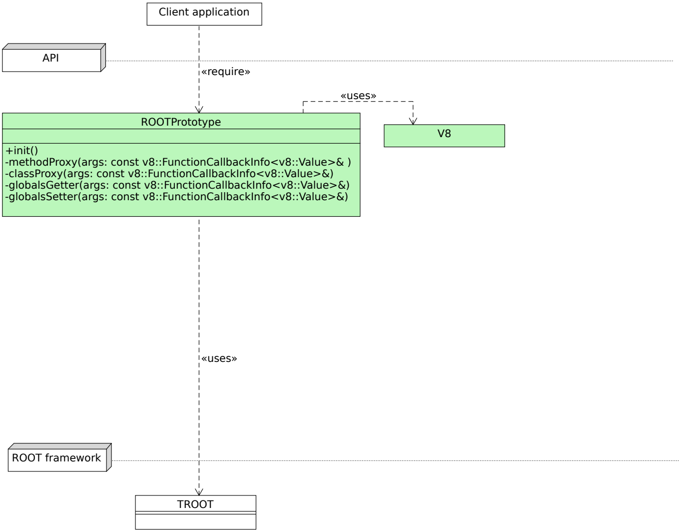

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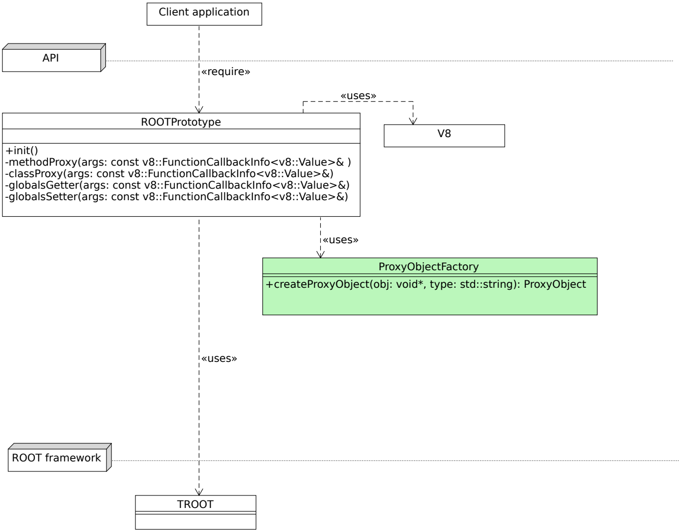

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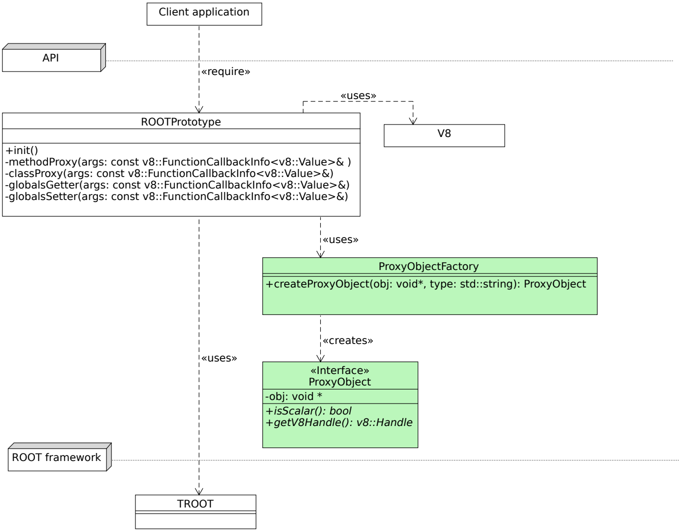

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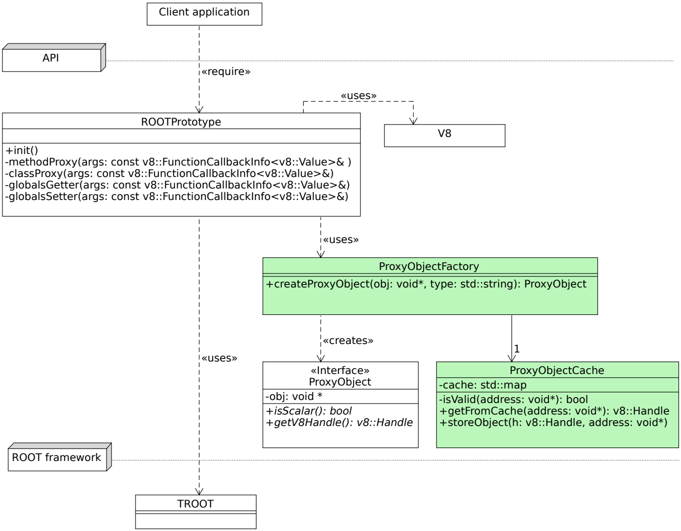

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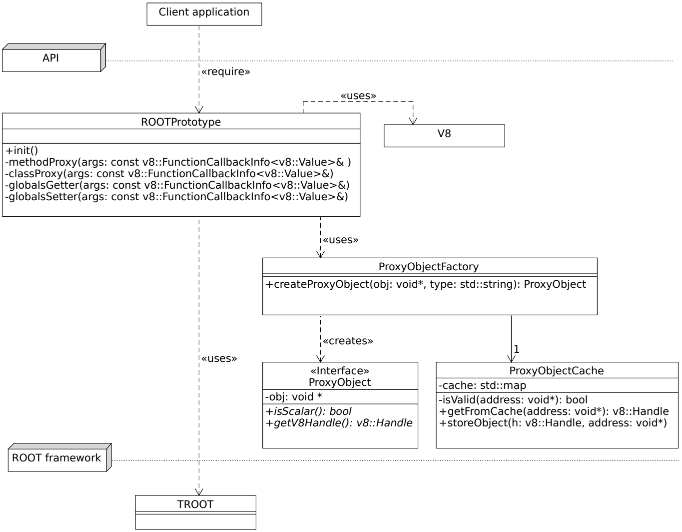

Initialization

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- Expose all
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Names

- Functions and classes have the same name as in Root
- Global variables can be called using Get[Variable] and Set[Variable] methods

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- By looking at the object type an corresponding v8::Handle will be generated and returned to node
  - If the result is an object this will be done recursively

Test Cases

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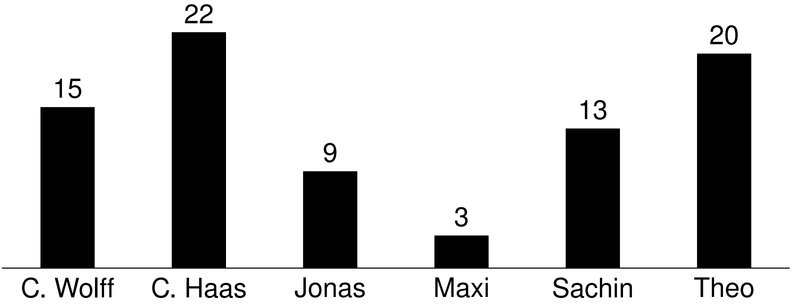
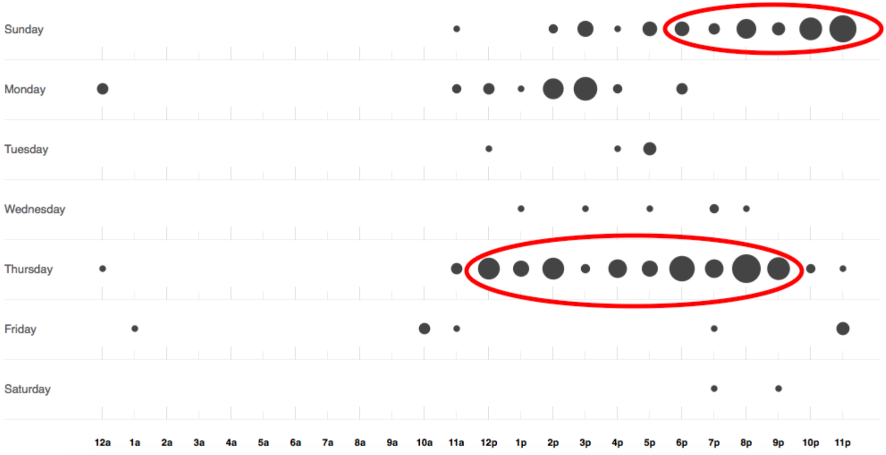
Merges



Punchcard



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Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
12a 1a 2a 3a 4a 5a 6a 7a 8a 9a 10a 11a 12p 1p 2p 3p 4p 5p 6p 7p 8p 9p 10p 11p

References I

- CERN. *ROOT application domains*. Dec. 2015. URL: https://root.cern.ch/application-domains.
- CERN. *ROOT Shower Event Display*. Dec. 2015. URL: https://root.cern.ch/rootshower00png.
- exortech. *v8 logo*. Dec. 2015. URL: https://github.com/exortech/presentations/blob/master/promise_of_node/img/v8.png.
- *Node.js logo*. Dec. 2015. URL: https://nodejs.org/static/images/logos/nodejs-light.eps.
- Danilo Piparo and Olivier Couet. *ROOT Tutorial for Summer Students*. Dec. 2015. URL: https://indico.cern.ch/event/395198/attachments/791523/1084984/ROOT_Summer_Student_Tutorial_2015.pdf.

References II

Boris Vacher. *npm logo*. Dec. 2015. URL: https://commons.wikimedia.org/wiki/File:Npm-logo.svg.