# Make Isabelle Accessible !

Reinhard Koutny  Klaus Miesenberger  Walther Neuper  Bernhard Stöger

University of Technology
Graz, Austria

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# Outline

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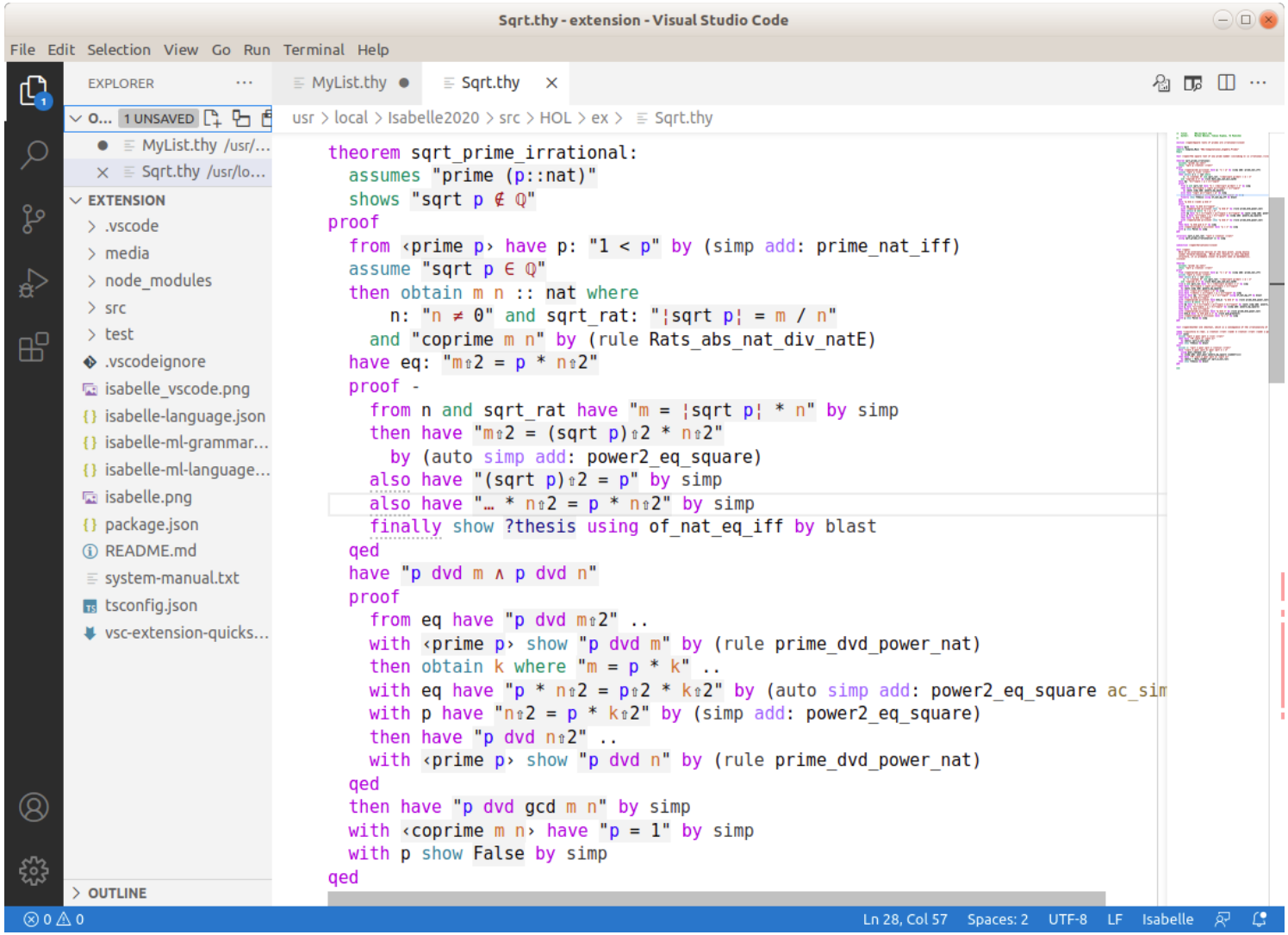
Good luck with “Accessible Isabelle”

Assist.Tech.

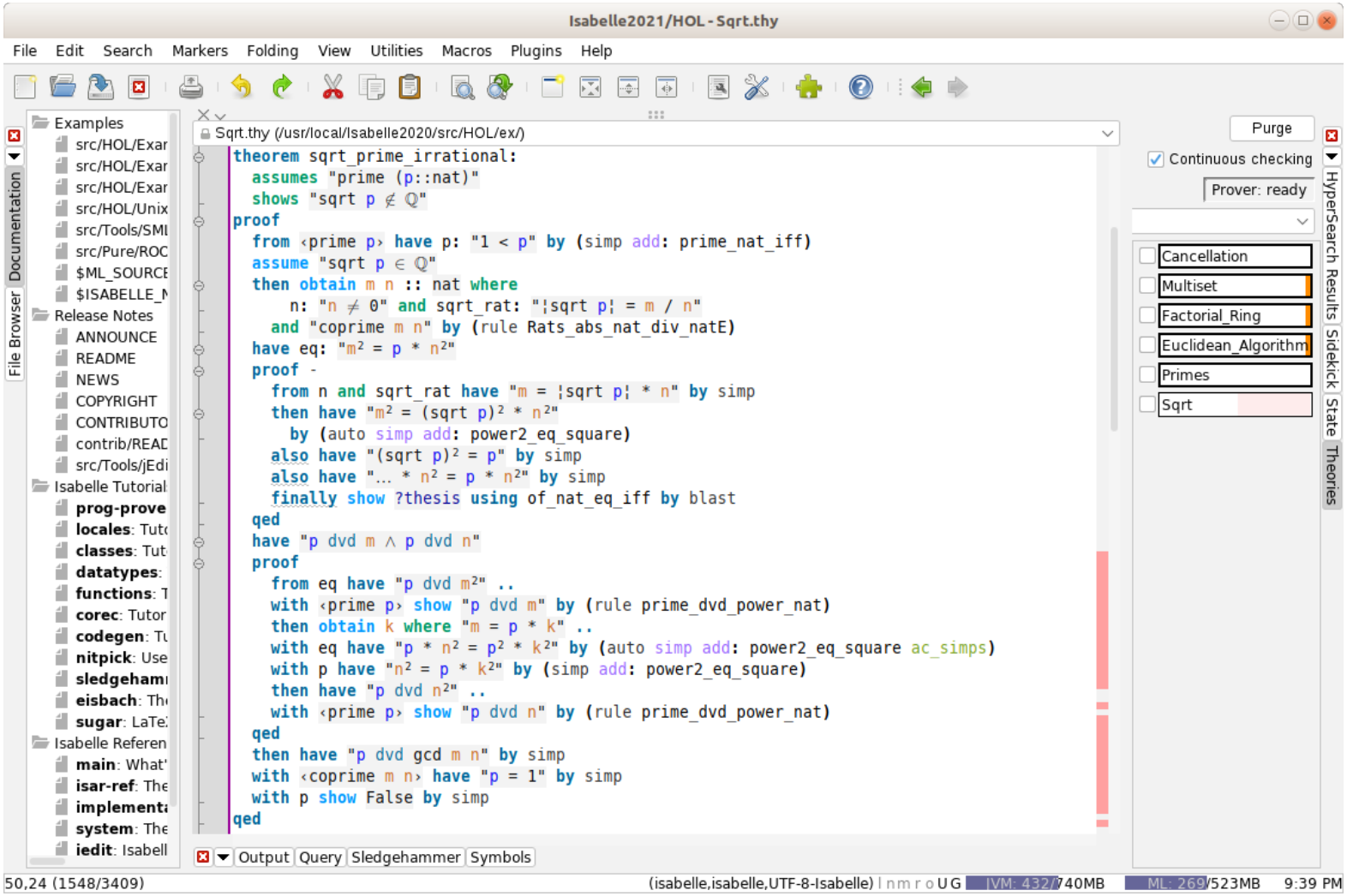
Mod.Concept.

Use “ThEdu”

# This can be read by a blind mathematician . . .



# This could ***not*** be read (Isabelle/jEdit)



# A glimpse at “Good Luck”: the same proof in a simple editor

Open | Sqrt.thy [Read-Only] /usr/local/Isabelle2020/src/HOL/ex | Save

```
theorem sqrt_prime_irrational:
  assumes "prime (p::nat)"
  shows "sqrt p \<notin> \<rat>"
proof
  from \<open>prime p\<close> have p: "1 < p" by (simp add: prime_nat_iff)
  assume "sqrt p \<in> \<rat>"
  then obtain m n :: nat where
      n: "n \<noteq> 0" and sqrt_rat: "\<bar>sqrt p\<bar> = m / n"
    and "coprime m n" by (rule Rats_abs_nat_div_natE)
  have eq: "m\<^sup>2 = p * n\<^sup>2"
  proof -
    from n and sqrt_rat have "m = \<bar>sqrt p\<bar> * n" by simp
    then have "m\<^sup>2 = (sqrt p)\<^sup>2 * n\<^sup>2"
      by (auto simp add: power2_eq_square)
    also have "(sqrt p)\<^sup>2 = p" by simp
    also have "\<dots> * n\<^sup>2 = p * n\<^sup>2" by simp
    finally show ?thesis using of_nat_eq_iff by blast
  qed
  have "p dvd m \<and> p dvd n"
  proof
    from eq have "p dvd m\<^sup>2" ..
    with \<open>prime p\<close> show "p dvd m" by (rule prime_dvd_power_nat)
    then obtain k where "m = p * k" ..
    with eq have "p * n\<^sup>2 = p\<^sup>2 * k\<^sup>2" by (auto simp add: power2_eq_square ac_simps)
    with p have "n\<^sup>2 = p * k\<^sup>2" by (simp add: power2_eq_square)
    then have "p dvd n\<^sup>2" ..
    with \<open>prime p\<close> show "p dvd n" by (rule prime_dvd_power_nat)
  qed
  then have "p dvd gcd m n" by simp
  with \<open>coprime m n\<close> have "p = 1" by simp
  with p show False by simp
qed
```

Plain Text | Tab Width: 8 | Ln 11, Col 15 | INS

# A closer look:

Compare

- accessible representation in Isabelle/VSCode . . .

```
proof
  from ‹prime p› have p: "1 < p" by (simp add: prime_nat_iff)
  assume "sqrt p ∈ ℚ"
  then obtain m n :: nat where
      n: "n ≠ 0" and sqrt_rat: "¦sqrt p¦ = m / n"
    and "coprime m n" by (rule Rats_abs_nat_div_natE)
  have eq: "m² = p * n²"
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- with plain text editor

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    and "coprime m n" by (rule Rats_abs_nat_div_natE)
  have eq: "m\<^sup>2 = p * n\<^sup>2"
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# Good luck with "Accessible Isabelle"

How comes?

- Isabelle's *standard* front-end Isabelle/jEdit is ***not*** accessible
- the *experimental* front-end Isabelle/***VSCode is*** accessible because
  - special math symbols are encoded in Isabelle fonts
    $\in$ ... \<in> $\mathbb{Q}$ ... \<rat> $\neq$ ... \<noteq>
  - VSCode is tweaked to present $\neq$ for \<noteq> etc
  - VSCode uses the Webbrowser Chromium
  - Chromium feeds screen-readers with \<noteq> etc
  - and screen readers transfer \<noteq> to the braille — which can be read by everybody.
- while jEdit's good old JavaSwing is
  - more tweaked by Isabelle
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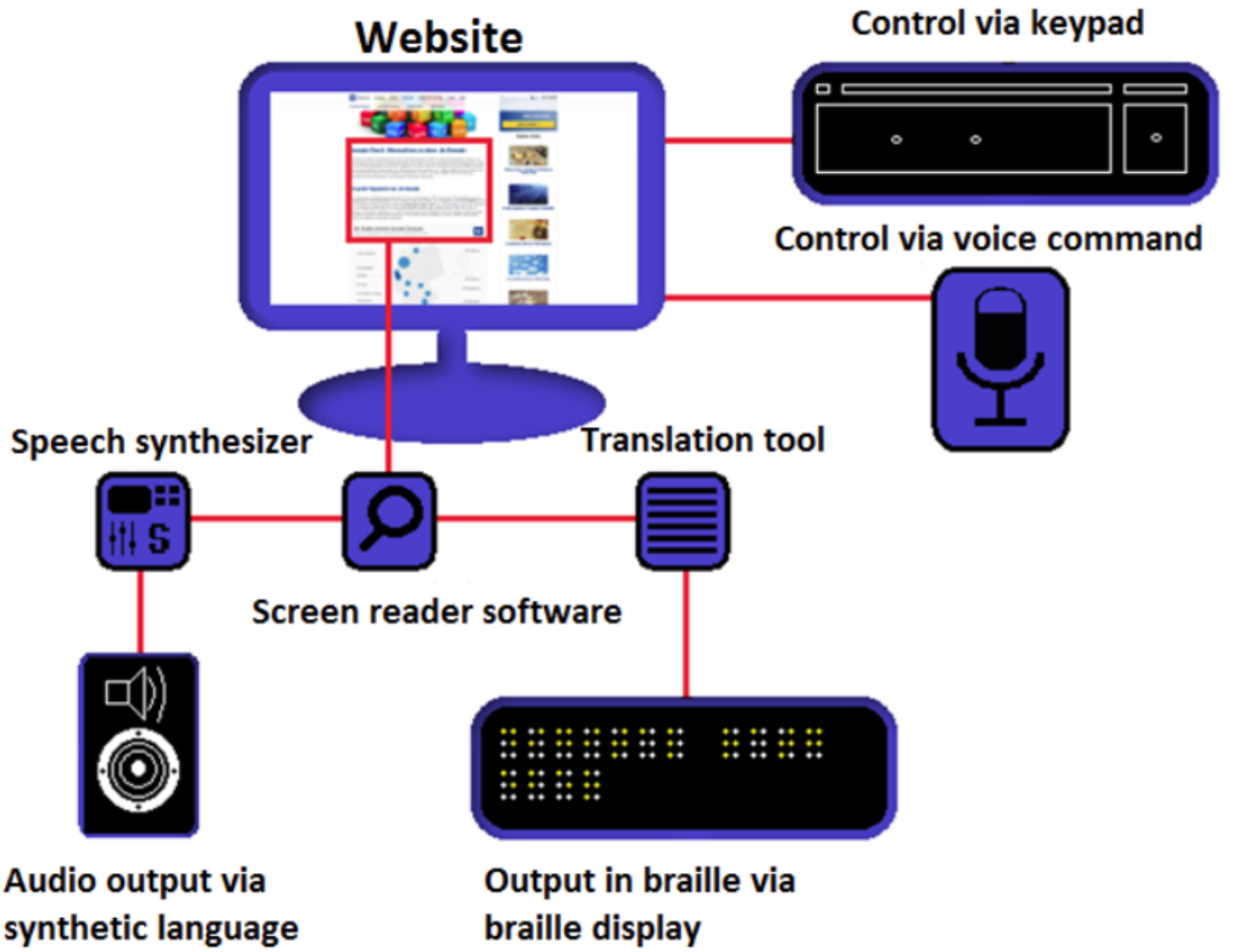
# Assistive technologies: screen-reader is central



# Assistive technologies: braille-display !?!

# Assistive Technologies and Mathematics

In brief:

- Assistive technologies are
  - sequential: audio output from screen-readers
  - linear: output from screen-readers to braille
- while mathematical structures are mainly not linear:
  - formulas: $\int \frac{x^2+1}{(x+2)(x-1)(x^2+x+1)} = \int \frac{a}{x+2} + \frac{b}{x-1} + \frac{c\,x+d}{x^2+x+1}$
  - matrices, binomial coefficients, etc
  - proofs: have enclosed sub-proofs etc
  - calculations in engineering math: subp-roblems etc
  - diagrams, graphs, etc
- A blind person with an acad.degree in math — unthinkable.

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# Modular conception of Isabelle/VSCode

- VSCode renders content using Chromium (this is accessible)
- Electron combines Chromium and the Node.js runtime; this allows to develop in parallel
  - web applications
  - desktop applications
- Node.js executes JavaScript code outside a web browser.
  - *one* language on server-side *and* on client-side
  - event-driven architecture capable of asynchronous I/O
  - *technology to develop collaborative learning tools.*
- VSCode communicates with Isabelle using Microsoft’s LSP – language server protocol
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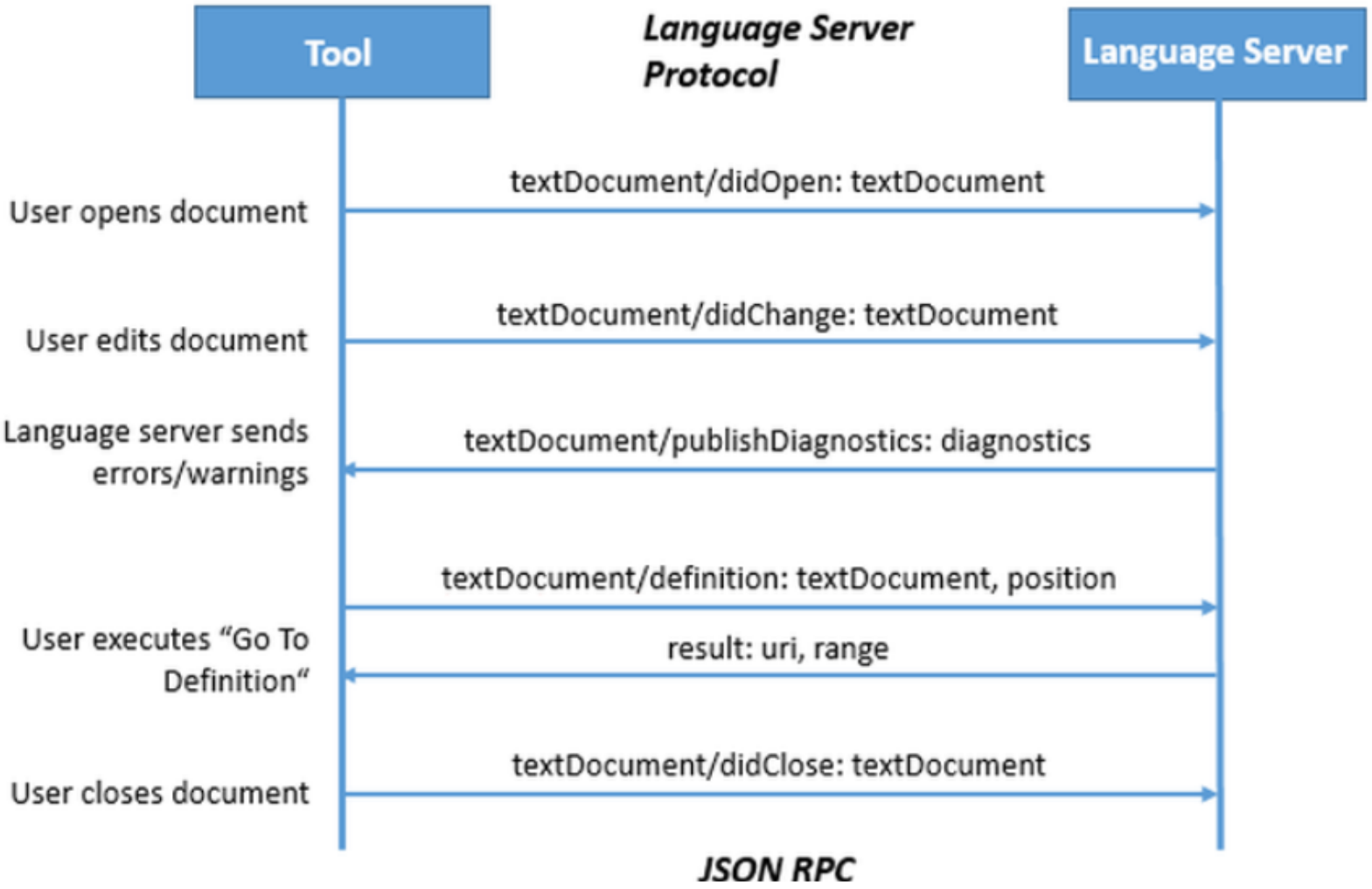

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  - uses remote procedure call protocol JSON-RPC
- Isabelle/PIDE uses an LSP variant for connection to jEdit.

All components are open source and cross-platform.

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# Use of "ThEdu"

Once upon a time "ThEdu" abbreviated

*"Theorem Proving Components for Educational Software"*

and was a design principle of the $\mathcal{ISAC}$-project[1]; now this project proceeds with

1. *step:* ***Make Isabelle/VSCode Accessible***
   - adapt LSP to accessibility requirements (term *structure*)
   - translate Isabelle-symbols to Braille codes
   - improve functionality of Isabelle/VSCode (needs to catch up several years of development)
2. *step:* ***Integrate*** $\mathcal{ISAC}$ ***into Isabelle/PIDE***, i.e. re-use as many components of Isabelle as possible.
   - adopt features to define formal languages of $\mathcal{ISAC}$
   - add to interactivity by "Lucas-Interpretation"
   - add a dialog-component for "next-step guidance"
   - get accessibility for free from Isabelle/VSCode.
3. *step: ???*

[1] `https://isac.miraheze.org/wiki/History`

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# Thank you for Attention!