

EUROPE

MUNICH, GERMANY DECEMBER 6 - 7, 2022

Taking Design Automation to the next level with User Experience Design

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The Team



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The IBM Telum Processor

> 5 GHz frequency

> 22 Billion Transistors on a module

> 19 Miles of wires on a module





Development of the IBM Telum Processor

1,500,000,000,000,000 Simulation Cycles in software Simulation

> 500K

unique discrete coverage events in the design

+ Millions of cross-product events





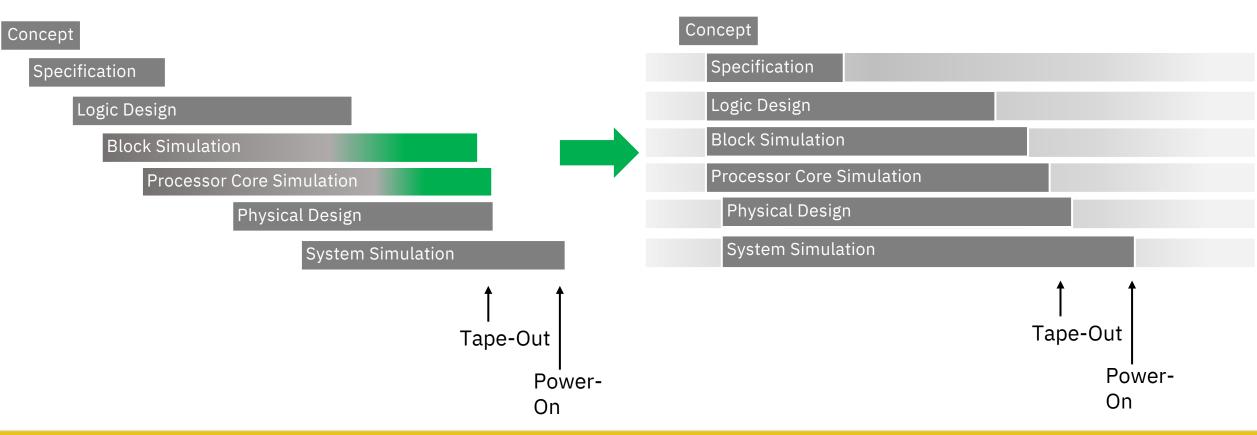
Logic Designers and Verification Engineers spend a huge amount of time on

- Defining coverage
- Implementing coverage
- Debugging coverage
- Analyzing coverage holes
- Hitting important coverage events





Fast time to market







Potential of Functional Coverage

- Faster time-to-market
- Higher Quality
- Less (Compute) Cost

| Concept | | | | | | | | | | |
|---------|---------------------------|----------|--|--|--|--|--|--|--|--|
| | Specification | | | | | | | | | |
| | Logic Design | | | | | | | | | |
| | Block Simulation | | | | | | | | | |
| | Processor Core Simulation | | | | | | | | | |
| | Physical Design | | | | | | | | | |
| | System Simulation | | | | | | | | | |
| | | | | | | | | | | |
| | Parallel Process | Tape-Out | | | | | | | | |





We use various functional coverage types

Functional Coverage Types

✓ Interface coverage

✓ (Micro-)Architectural cross product

coverage

Configuration coverage
 Discrete design events
 Testbench coverage

je S



We have (some) collaboration

Collaboration

✓ Mark as waived/deferred/impossible

✓ Analyze

✓ Prioritize

✓ Comment

SYSTEMS INITIATIVE



We have the technology

Automation

Template Aware Coverage
Coverage Driven Generation
Finding unhittable events
Coverage hole analysis
Grading events & test templates
Identifying aged out events

<u>https://research.ibm.com/publications/template-aware-coverage-taking-coverage-analysis-to-the-next-level</u> https://research.ibm.com/publications/automatic-scalable-system-for-the-coverage-directed-generation-cdg-problem SYSTEMS INITIATIVE

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But...

- Many months are still spent on coverage closure
 - In the critical path for tape-out
- We're still not seeing the forest because of all the trees
 - Missing potential bugs
- Still wasting compute cycles





Let's automate more ...

... and we can also ...





Collaboration

Automation

Functional Coverage Types

> The User

SYSTEMS INITIATIVE

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Our tech and our tools can <u>assist</u>, but they

cannot <u>replace</u>



How do we use the tools and tech we have in

a way that will enhance and augment the

user's abilities?





DECEMBER 6 - 7, 2022

Introducing... UX design!



"Design a vase"

\$3 88

~~ N ~~



17AJ

"Design a better way for someone to enjoy flowers"

Flower 2 drong 99 Doggo flower surprise

systems initiative

We look to these ways of questioning our problem spaces, to <u>open up our creativity</u> and scope, and to

ask the <u>Right Questions</u>





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Enterprise design thinking: The loop

Observe

Reflect

Make

. . . .

SYST



UX design: An umbrella term

Observe

Reflect

Make

UX research



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UX design: An umbrella term

Observe

Reflect

Make

UX design Systems design Service design Product design

(a



UX design: An umbrella term

Observe

Reflect

Make

UI design Visual design Content design



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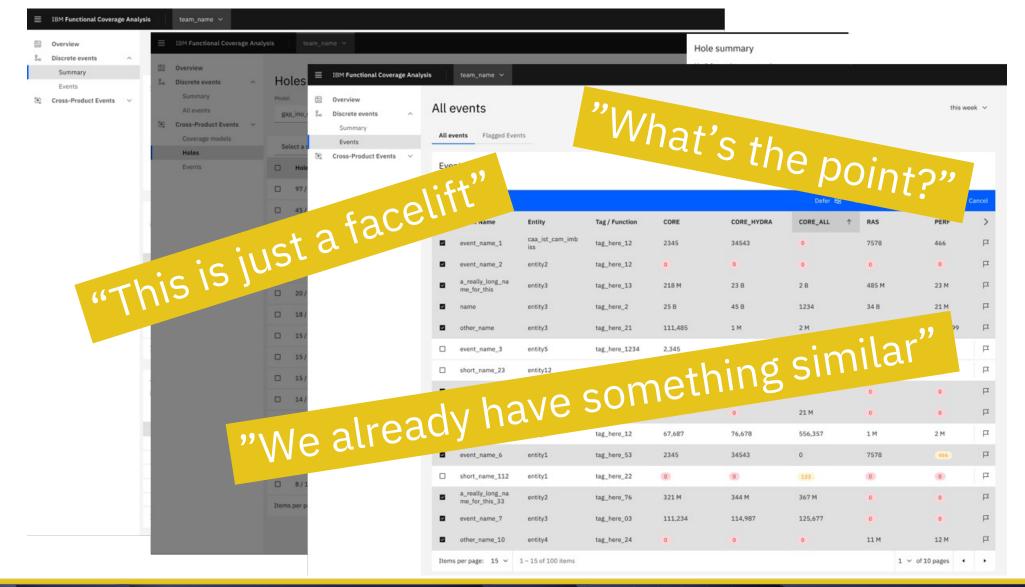
The original scope

- Improve the coverage data analysis experience
- Show user actions like waiving, deferring, marking impossible...

| | | | | | | | | | | | | | | | Ø- 1 | <u>*</u> * |
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| , 2022 | CL3 | Core | L3_ALL | Total | | | | | | | | | | | | |
| | Jun 27, 2022 | Jun 27, 2022 | Jun 27, 2022 | | | | | | | | | | | | | • |
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| ared | 6,906 (5.3%) | 11.230 (9.5%) | 408 (2.7%) | 6,819 (5,8) | _ | | | | | | | | | | | |
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| giitiy | 49,615 (37.9%) | 10.330 (8.7%) | 4.390 (29.4%) | 37.251 (31.6) | | | | | | | | | | | | |
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| | | 21 rit, | , nx_ | gzip_izenc compre | 155 | current_byte5_match_generates_symbol_4 | | Waived | 204 K | N/A | 204 K | | ported_from_zAneeds_r | | 0 | |
| | | 22 rit, | , nx_ | gzip_lzenc compre | 155 | current_byte4_match_generates_symbol_3 | 1 | Waived | 234 K | N/A | 234 K | | ported_from_zAneeds_r | | 0 | |
| | | 23 rit, | | gzip_lzenc compre | | current_byte4_match_generates_symbol_6 | | Waived | 123 K | N/A | 123 K | | ported_from_zAneeds_r | | 0 | |
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SYSTEMS INITIATIVE

What we were doing: treating the symptom of functional coverage



A quick reminder...

https://scrolller.com/ui-vs-ux-3iy0tb43v4



What we should've been doing: investigating the underlying issue...

(



Why are there so many irrelevant and

confusing events in the first place?



a a a constant a constant

"Design a way to improve the coverage data analysis experience"



"Design a way to

improve the

coverage data

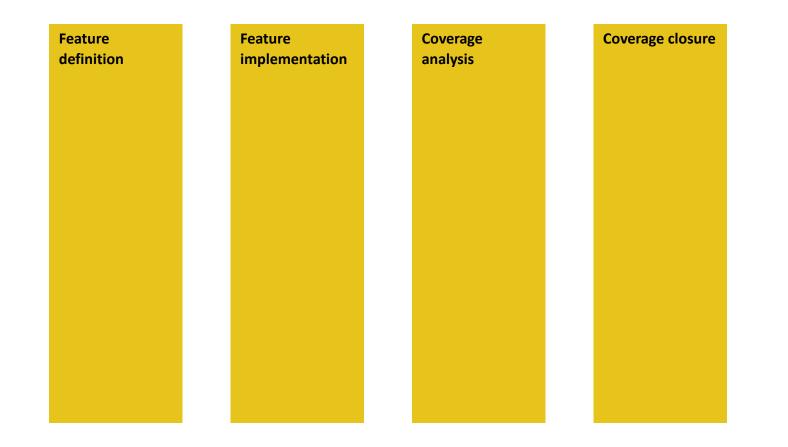
analysis experience"

al sys



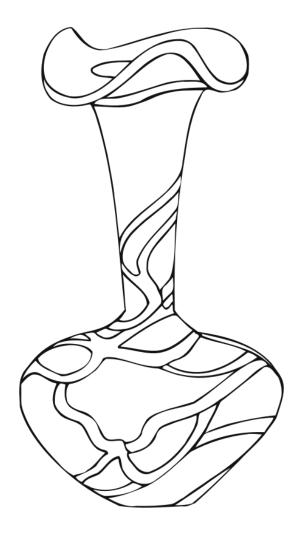
"Design a way to close the design of the microprocessor faster"













Floral fantasy at Gardens by the Bay, singapore by: @unique_singapore [IG]





Observe

Reflect

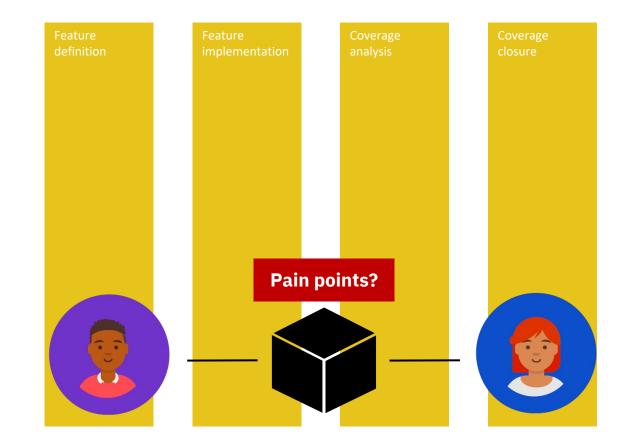
Make

(act



User research questions

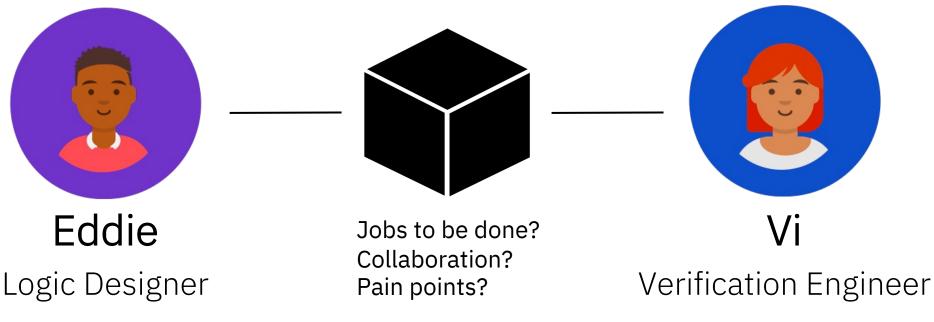
- What is the **overall process**, from feature definition to coverage closure?
- Where are the collaboration touchpoints between VE and LD?
- What are the **pain points** in this collaboration process?







Design toolbox: **Personas**



Works with architects to define the new features of the chip

Creates the logic design of the hardware

Defines spaces that need verification, using things called "events"

Creates test cases in C++ that stress the design of the chip

Looking to improve their test bench to hit all important coverage events to find all bugs in the HW

Sorts through all the events generated by the Verification Cockpit (VC) to look for the most interesting events

SYSTEMS INITIATIVE

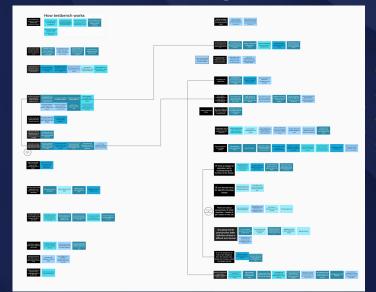


Research

Step 1: Observe

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Step 2: Gather insights



Step 3: Synthesize into big ideas

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What does the user think/do?

What common attitudes and behaviors do our users collectively have?

What are the main ideas we can gather from this?

systems initiative



DECEMBER 6 - 7, 2022

EDT toolkit: As-is scenario



Designer toolkit: As-is scenario overview

Phase 1 Feature definition

.....

- Main feature and design are defined here
- Eddie draws up the specs and designs with the architects
- Vi takes a back seat

Phase 2 Feature implementation Simulation bring-up

- Designs are created, simulation testing begins
- Eddie begins coding his designs
- Vi looks at the design specs in order to begin crafting her testbench scenarios

Phase 3 Coverage analysis

- Analysis of the testbench and discrete events begins
- Eddie and Vi collaborate to analyze the results.

- Phase 4 Coverage closure
- Coverage must meet the expected quality requirements
- Vi writes special cases and continues to improve the testbench until the coverage percentage is high enough
- Eddie improves his designs



Designer toolkit: As-is scenario overview

Phase 1 Feature definition

Main feature and design are defined here

Specs and desired to deliver With Eddie is often asked to deliver both good design and good

Vi does not participate in

design scoping

coverage

Phase 2 Feature implementation Simulation bring-up

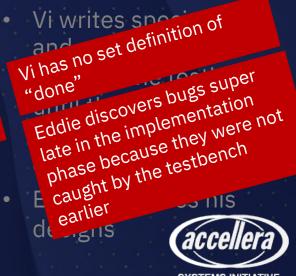
- Designs are created, simulation testing begins
- Because Eddie must focus on his designs, this often results in the creation of improperly documented coverage -ug her - ug per: Vi is blocked from coverage until after the implementation of the designs be Eddie

Phase 3 Coverage analysis

- Analysis of the testbench and discrete events begins
- Eddie and Vi Vi, in turn, struggles with understanding the intent of events coded by Eddie There is no central repository for proper collaboration

Phase 4 Coverage closure

Coverage must meet the expected quality requirements



SYSTEMS INITIATIVE

Designer toolkit: As-is scenario overview

Phase 1 Feature definition

Main feature and design are defined here

Specs and desired with Eddie is often asked to deliver both good design and good

Vi does not participate in

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coverage

Phase 2 Feature implementation Simulation bring-up

- Designs are created, simulation testing begins
- desi- Degins -Because Eddie must focus on his designs, this often results in the creation of improperly documented coverage -mig her ' Dea: Vi is blocked from coverage until after the implementation of the designs by Eddie

Phase 3 Coverage analysis

- Analysis of the testbench and discrete events begins
- Eddie and Vi Vi, in turn, struggles with understanding the intent of events coded by Eddie There is no central repository for proper collaboration

Phase 4 Coverage closure

- Coverage must meet the expected quality requirements
- Vi has no set definition of Eddie discovers bugs super "done late in the implementation phase because they were not Caught by the testbench earlier SUB

Observe

Reflect

Make





DECEMBER 6 - 7, 2022

EDT toolkit: To-be scenario



How might we activate the users through collaboration?

Pain points

- Eddie often asked to deliver both good design and good coverage
- Vi does not participate in design scoping

To-be scenario

- Eddie defines the events without implementation, along with the scope of the stories
- Vi collaborates earlier to understand the scope and maps the events to the features created





How might we **activate** the users through **collaboration**?

Pain points

- Because Eddie must focus on his designs, this often results in the creation of improperly documented coverage
- Vi struggles to understand the coverage created by Eddie

To-be scenario

- Eddie provides the details of the coverage space and the expected results to Vi
- Vi implements the coverage defined by Eddie in her testbench in order to create thorough and well-architected coverage

SYSTEMS INITIATIVE



How might we **activate** the users through **collaboration**?

Pain points

• There is no central repository for proper collaboration

To-be scenario

- All past tooling and features are integrated into 1 collaborativecentric platform
- The experience and the views on this platform are standardized for easier access by both personas





Design a prototype

Observe

Reflect

Make



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Overview

To-be scenario: All past tooling and features are integrated into 1 collaborative-centric platform

- Implemented with a standardized design system
- The user can see important metadata in order to provide the necessary context of the event
- Advanced filtering

IBM Functional Coverage Overview

UVM Coverage

Discrete

Cros

| ss- | pro | duct | Cove | rag |
|-----|-----|------|------|-----|

| Hierarchy1 / | Hierarchy1 | / | UVM Coverage | / |
|--------------|------------|---|--------------|---|
| UVM C | overag | е | ! | |

| product | Coverage |
|---------|----------|

| All c | overage | My coverage | Not implemented | Bug | No hits | Low hits | Zeros everywhere | Aged out | | | | |
|-------|----------------|-------------|-----------------|-----|---------|----------|-------------------|----------|-----------|---|--------|-----|
| Q | Search inp | out text | | | | | | ⊽ ⊻ | G | ¢ | Create | |
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| ~ | cpoint4 | | ALU | | | Bug | ïx | (| Djamie.la | i | 22/3 | 33 |
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| ~ | cpoint7 | | ILU : | | | Not i | mplemented | (| Djamie.la | i | 22/3 | 33 |
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Coverage details

To-be scenario: Eddie provides the details of the coverage space and the expected results to Vi

- A new "more info" page gives more detailed info about the coverage point
- This is where Vi would find information about coverage, fleshed out by Eddie
- History/log of events and comments can be found here

| ew | UVM Hierarchy3 / Hierarchy2 / Hierarchy1 / UVM coverage / <u>cpoint1</u> / | |
|------------------|---|-------------------------|
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| e Events | | |
| product Coverage | Coverage information Edit 🖉 | Assignee jamie.lai V |
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| Q | Search input text | | | | | | ∇ | 7 C & |
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| | bin1 Deferred | In review | Add text |
| | bin2 | Hard to hit | Add text |
| | bin3 | Waived | Add text |

Coverage log

Overvi UVM C

Cross-

jamie.lai commented 8 days ago

I need someone to take a look at this @maya.eapen





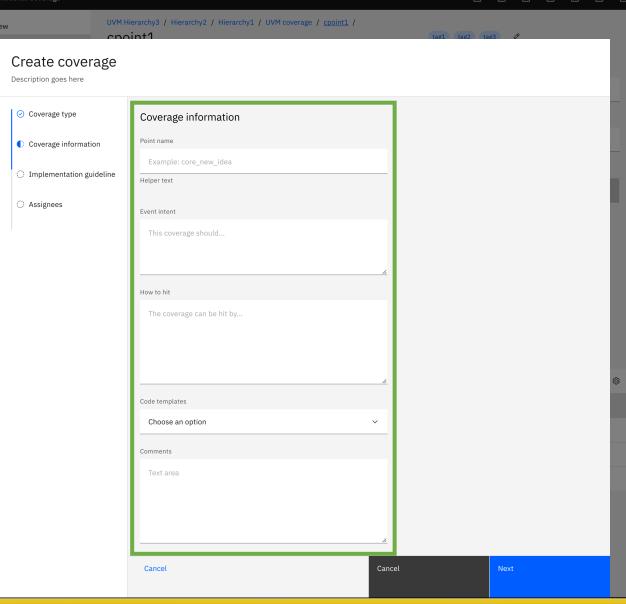
Request Coverage

Disc

Cros

To-be scenario: Eddie defines the events without implementation, along with the scope of the stories

- Eddie is able to request coverage and give a detailed blueprint of how it should be implemented
- Vi will take this blueprint to implement coverage into her testbench



SYSTEMS INITIATIVE



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Enabling Collaboration using Python

- Python is a common language
- Open Source
 Development
- System Verilog Constructs well proven over years

@vsc.covergroup
class my_weak_pht_cnt_cg(object):
 def __init__(self):
 self.with_sample(
 a = uint8_t(5)
 b = uint8_t(

self.cp1 = vsc.coverpoint(self.a, bins=dict(
 A = vsc.bin_array([],1,2,3,4)),
 illegal_bins=dict(
 illegal_Val = vsc.bin(5)
)

self.cp2 = vsc.coverpoint(self.b, bins=dict(
 A = vsc.bin_array([],[5,31]))

self.cp1x2 = vsc.cross([self.cp1, self.cp2])

Credits to Matt Balance' PyVSC library: https://pyvsc.readthedocs.io/en/latest/introduction.html





html



Implement a e2e prototype

Observe

••••

Reflect

Make



Develop an end-2-end prototype in 2 weeks

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Define

Implement

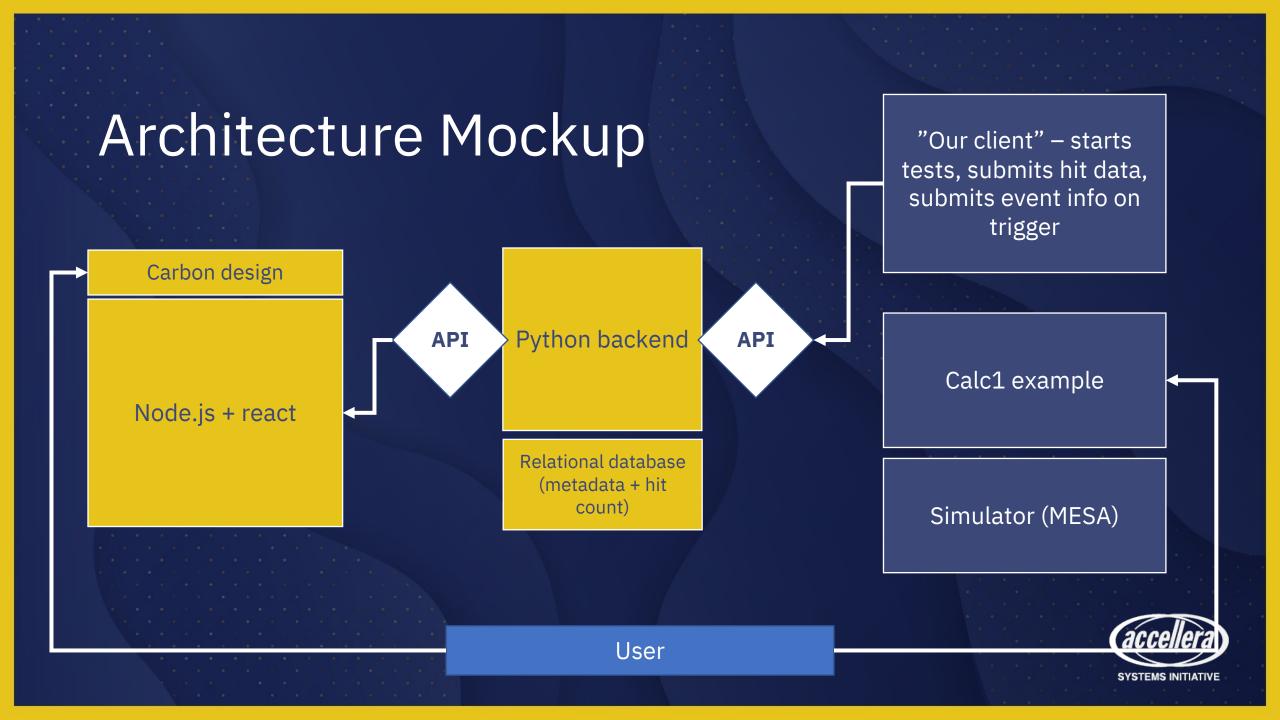
Collect

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Analyze





Summary

Enterprise Design Thinking is key

✓ With the user in the loop

UX design is key to

Deeply understand the developers' needs

✓ taking a holistic view at the process

- ✓ fast prototyping
- ✓ Drive usability testing



.

Conclusions

✓ UX design and Prototyping allow fast iterations
 ✓ Can change the way how we work!

better

better together

Allows the developer to take full advantage of the available technology

Can significantly improve the overall development effort and schedule



Questions?



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Bodo Hoppe Distinguished engineer, IBM Z Hardware <u>bohopp@de.ibm.com</u>

