Testing and V&V: toward exascale

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- Currently, testing of HPC applications occurs in **small-scale replicas** of the production cluster environments, dedicated to development/debugging.

  Example: ALCF Blue Gene/Q:

  Mira – production cluster (48 racks* with 5D torus network)

  Vesta – development + entry point (2 racks*)

  Cetus – debugging (1 rack* -> no inter-rack communication)

- **Advantages**:

  - Quicker turnover time (shorter queues + simplified job submission)

  - Enables automation and periodicity of testing practices

- **Disadvantage**:

  - May not fully expose all hardware hierarchical elements of the production environment -> incomplete testing of RESILIENCY and RELIABILITY

- Postprocessing and visualization largely decoupled from applications (solvers) execution.

* 1 rack = 1,024 nodes = 16,384 cores

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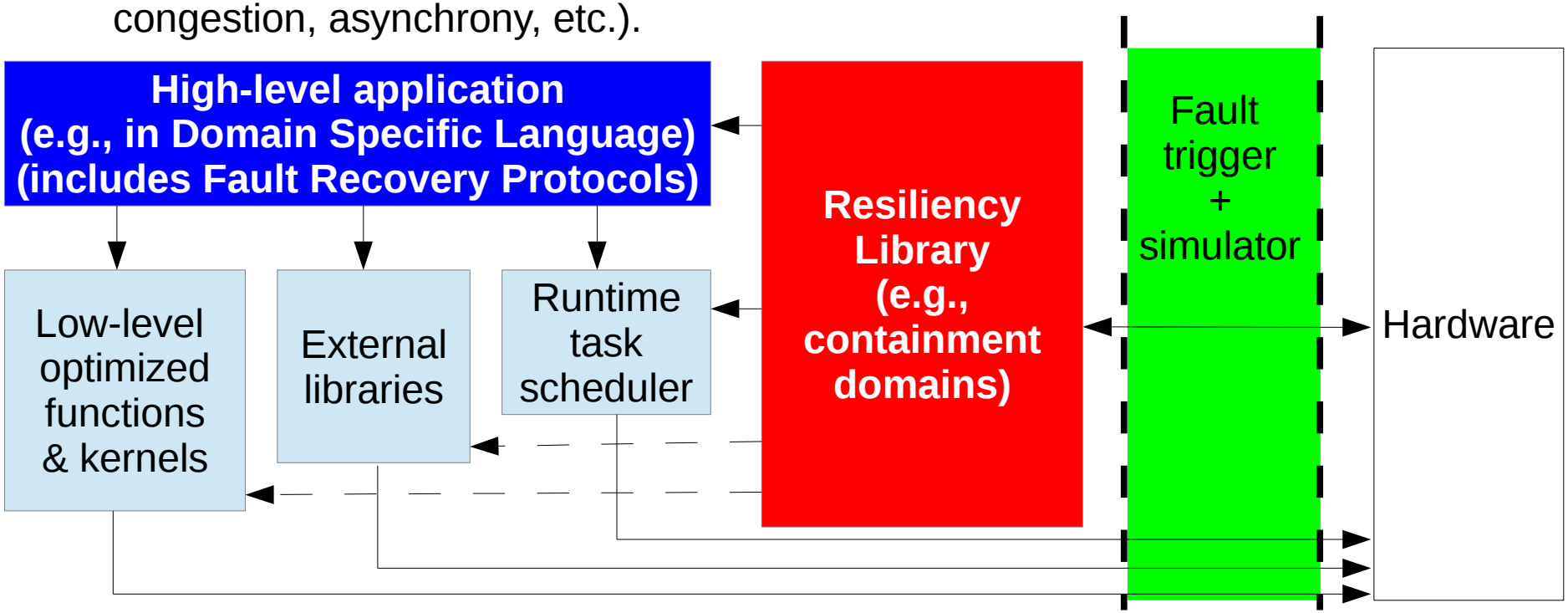
- Moving to exascale, hardware **resiliency** and **reliability** will have to be incorporated into the system/regression testing and V&V activities through software **recovery** strategies (e.g., containment domains, distributed checkpointing, recovery blocks), relying on **fault triggering** + **simulators**
- Full testing of recovery from communication and I/O (most critical) faults requires all elements of the hardware hierarchy to be involved (to account for congestion, asynchrony, etc.).



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- Full testing of recovery from communication and I/O (most critical) faults requires all elements of the hardware hierarchy to be involved (to account for congestion, asynchrony, etc.).
- A **subset** (resiliency-related) **of the test suites** of applications running at extreme scale may require to be **executed on the production environment** instead of on small-scale development replicas:
  - Time availability greatly reduced (e.g. following maintenance windows).
  - Automation (for regression testing) more challenging.
  - Tests selection per available session + rotation needed.

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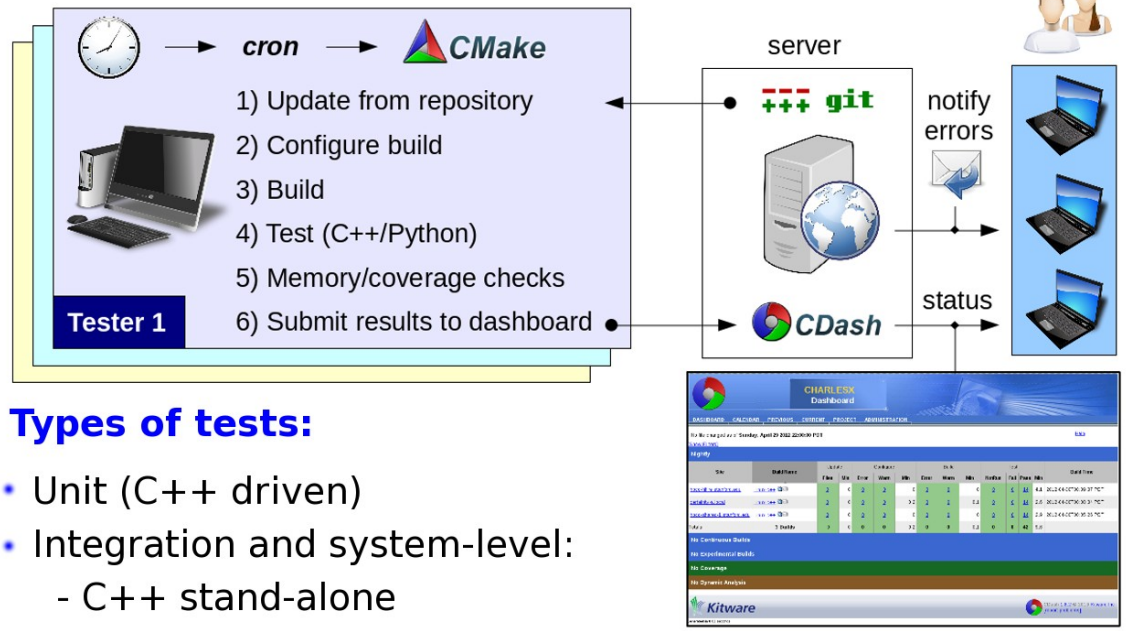
- Summary:
  - Transition from a standard testing scenario (multiple testers/single suite)
    - Example: **Build & Test** CMake + CDash + python developers



Types of tests:

- Unit (C++ driven)
- Integration and system-level:
  - C++ stand-alone
  - Python driven (XML meta language)

to **dual-mode** testing approaches for extreme scale platforms that include several resiliency/reliability-related tests in production environment.

- Incorporate on-the-fly postprocessing/visualization in application execution and testing.