DistriNet KU LEUVEN

An Open-Source Framework for Developing Heterogeneous Distributed Enclave Applications

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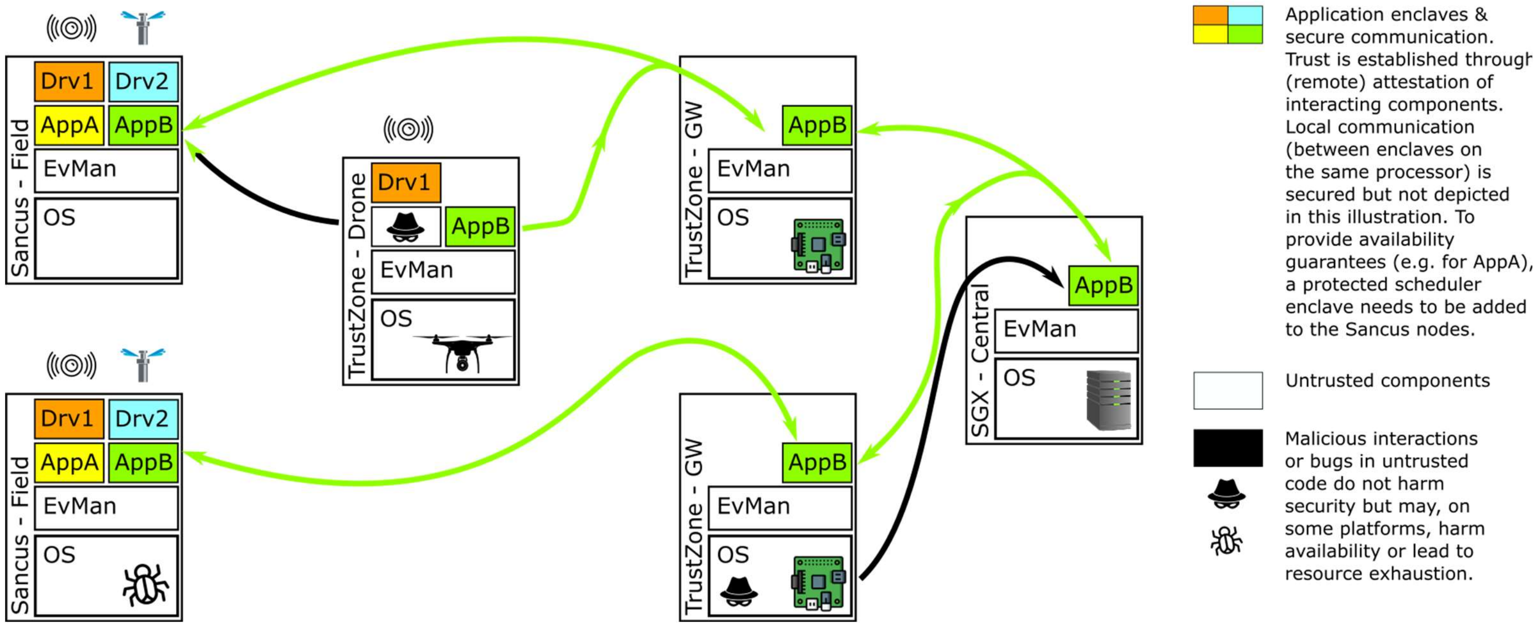

Motivations

Security for emerging safety-critical use cases in precision agriculture, smart energy systems, smart mobility

- Strong authenticity guarantees in heterogeneous open Internet-of-Things and Cyber-Physical Systems with Edge and Cloud
- Leverage different Trusted Execution Environments (TEEs), easing development effort, reactive/event-driven development model
- Focus on dependable safety-critical systems with sensing/actuation

Security properties

Authentic Execution / Robust Safety

- Physical system outputs can be explained in terms of physical inputs and application source code (assuming correct compilation and no bugs or vulnerabilities in the application enclaves)
- Secure I/O: Only attested application components can access I/O devices; attackers cannot interfere with I/O at software level
- Additionally provides limited confidentiality and availability

Our framework


```c
// declare output using a macro
SM_OUTPUT(sensor_driver, sensor_read);

void read_from_sensor(void) {
  int sensor_value = read_from_io_device();

  // output call -> generate new event
  sensor_read(&sensor_value, 2);
}
```

```yaml
# deployment descriptor

connections:
-
  from_module: sensor_driver
  from_output: sensor_read
  to_module  : aggregator
  to_input   : receive_data
```

```rust
// declare input using an annotation
//@ sm_input
pub fn receive_data(data : &[u8]) {
  let sensor_value = parse_data(data);

  // do something with data
}
```

End-to-end security

- Supported TEEs: Intel SGX, ARM TrustZone (with OP-TEE), Sancus
- Automated deployment, attestation, key management
- Authenticated Encryption to protect communication channels
- Secure I/O provided by Sancus

Reduced development effort

- Simple event-driven programming model
- *Declarative* approach: code annotations and deployment descriptor
- Automatic enclaved execution and attestation
- Automatic establishment of secure channels

Preliminary results

Development effort

button-led example: *github.com/AuthenticExecution/examples*

- 7 to 123 LOC for developing SGX or Sancus modules
- TrustZone: ~1kLOC of which only 58 LOC are app logic
- Deployment descriptor: 137 LOC

Round-Trip Time (RTT) SGX-TrustZone-Sancus

Avg. RTT for 8 bytes of (encrypted) payload: *256.22 ms* (!)

- TZ's implementation of SPONGENT (Sancus' crypto engine): 160.5 ms
- TZ's slow transition NW<->SW: 18.22 ms
- Other issues: TZ emulation (QEMU), slow networking (UART, SLIRP)