SliceGuard: Secure and Dynamic 5G RAN Slicing with WebAssembly
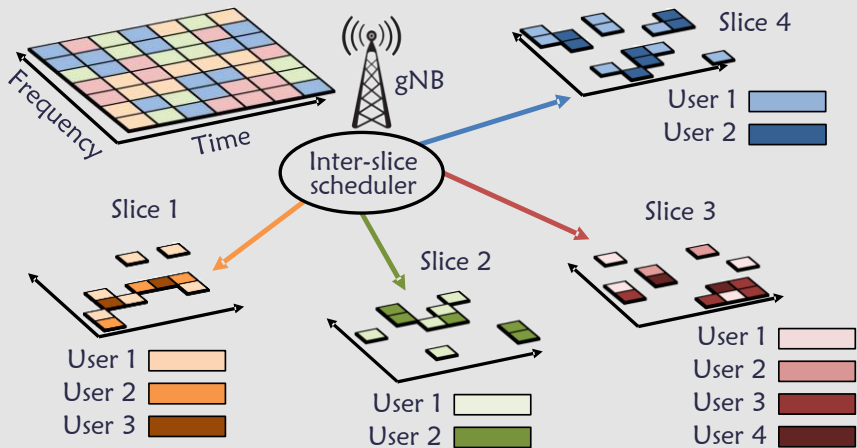
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1 Introduction and Background

- **5G RAN Slicing** and its challenges:
  - a) **Resource isolation and scheduling** of different metrics
 - b) **Slice tenants** may differ from **network operators**

- **WebAssembly (WASM)**: Portability, efficiency, and security

High-level languages   OS-independent   Linear memory   Sandbox
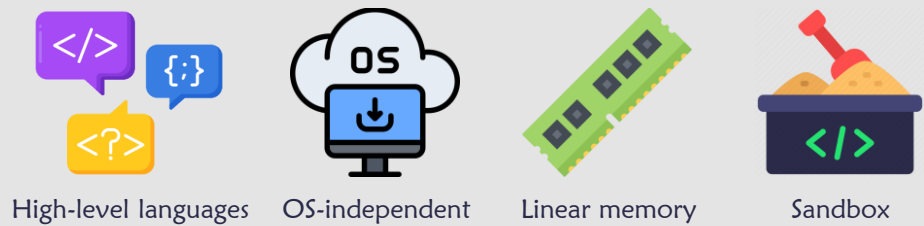
- **SliceGuard** runs the slice schedulers a WASM modules:
  - a) **Easier development** in multiple high-level languages
  - b) **Unique executable** across the network
  - c) **On-the-fly update** for new components
 - d) **Secure and reliable execution** of third-party code

2 Two-Level Scheduler

- **Two-levels scheduler:**
  - a) **Inter-slice scheduler**: Divides resources among slices
  - b) **Intra-slice scheduler**: Divides resources among users subscribed to the same slice
- **Three types of slices:**
  - a) Low latency slices
  - b) Guaranteed bit rate slices
  - c) Best effort slices
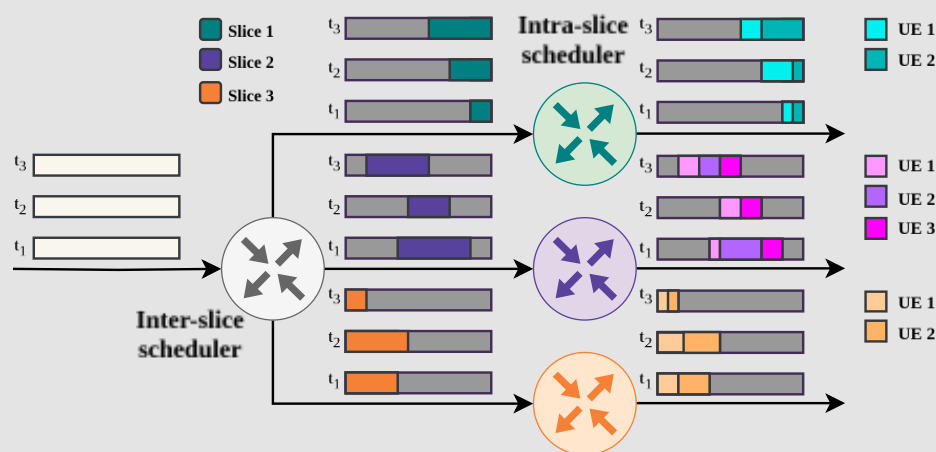
- a) **Low Latency (LL) slices**:
  - Timestamp packets when placed in queues
  - Reserve resources to **meet latency requirements**
- b) **Guaranteed Bit Rate (GBR) slices**:
  - **Track throughput** with a moving average
  - Compute priority weights using a logistic curve
- c) **Best Effort (BE) slices**:
  - **Assign remaining resources** after LL and GBR allocations

3 WASM-Based Scheduler System

- **Network operators** control the **inter-slice scheduler**
  - Run the same code across the shared infrastructure
- **Slice tenants** control the **intra-slice scheduler**
  - Customize resource allocation within the WASM modules
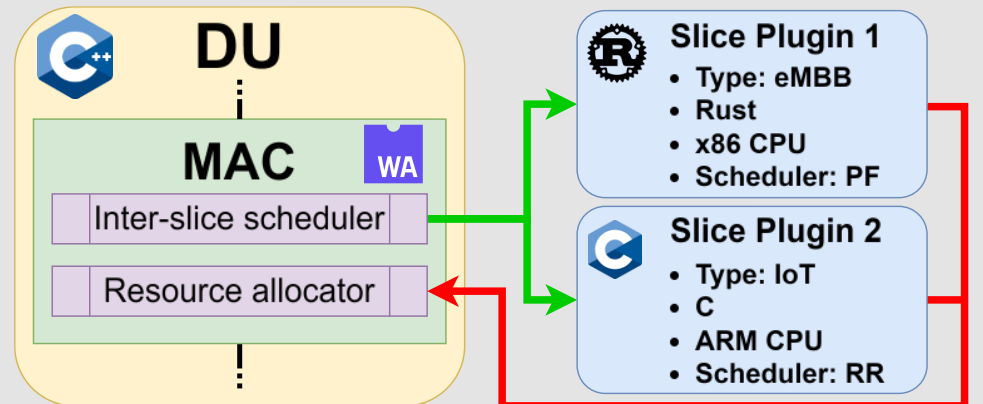
- **Main advantages:**
  - + **Ensure security** between the operators and tenants
  - + **Avoid recompiling** the entire stack during update rollouts
  - + **Execute the same code** across the whole network (Independent of hardware or software)

4 Demonstration

- **Our testbed:** A cloud gaming server and a 5G system

- **Slicing for cloud gaming:**
  - Compare single-slice and multi-slice setups
  - Highlight the need for dynamic slicing
- **WASM capabilities:**
  - Show on-the-fly updates and fault isolation
  - Demonstrate the capabilities of WASM modules

	GBR slice	BE slice	BE slice
Step 1	✓	✓	Idle
Step 2	✓	⟳	iPerf
Step 3	✓	BE → GBR	iPerf
Step 4	✓	✓	iPerf
Step 5	✓	BE ← GBR	iPerf
Step 6	✓	⟳	iPerf