5G MAG REFERENCE TOOLS

6G Testbed and AI Traffic Characterization

3GPP A GLOBAL INITIATIVE

Qualcomm

6G Testbed and AI Traffic Characterization

Overview on the 5G-MAG Reference Tools

Main scope of the project

- 6G AI Traffic Characterization
- Measure traffic characteristics of generative AI services (LLMs, image/video generation)
- Analyze agentic AI patterns such as multi-step tool calling and tool server workflows
- Evaluate QoE under emulated network conditions like latency, loss, and bandwidth

Additional Scope:

- Open-source testbed for AI/media traffic evaluation
- Targets 5G, 6G, and realistic UE-observed network conditions
- Supports 3GPP SA4 studies and broader media delivery evaluations
- Can be extended and may be used for other purposes

3GPP TR 26.870 V0.2.1 (2026-02)

Technical Report

3rd Generation Partnership Project;
Technical Specification Group Services and System Aspects;
Study on Media Aspects for 6G System
(Release 20)

More information at developer.5g-mag.com

Evaluation of media delivery protocols (HTTP, QUIC, WebRTC)

- **QUIC-based streaming** (FS_QStream_MED) - S4-252112.zip
  - aims to evaluate the performance of QUIC-based streaming technologies against traditional TCP-based approaches (HTTP/1.1, HTTP/2) for various media services in 5G and future 6G contexts. The study builds upon initial explorations from FS_AMD (TR 26.804).
- **Real-time communication** (FS_Q4RTC_MED) - S4-252139.zip
  - The primary goal is to investigate the benefits and integration of QUIC-based media delivery protocols for Real-time Communication (RTC) within the 3GPP framework.
- Usage of **Dynamically Changing Traffic Characteristics and Enhanced QoS Support in Media Applications and Services** - S4-251588.zip
- Generic media and application testing under 3GPP network profiles

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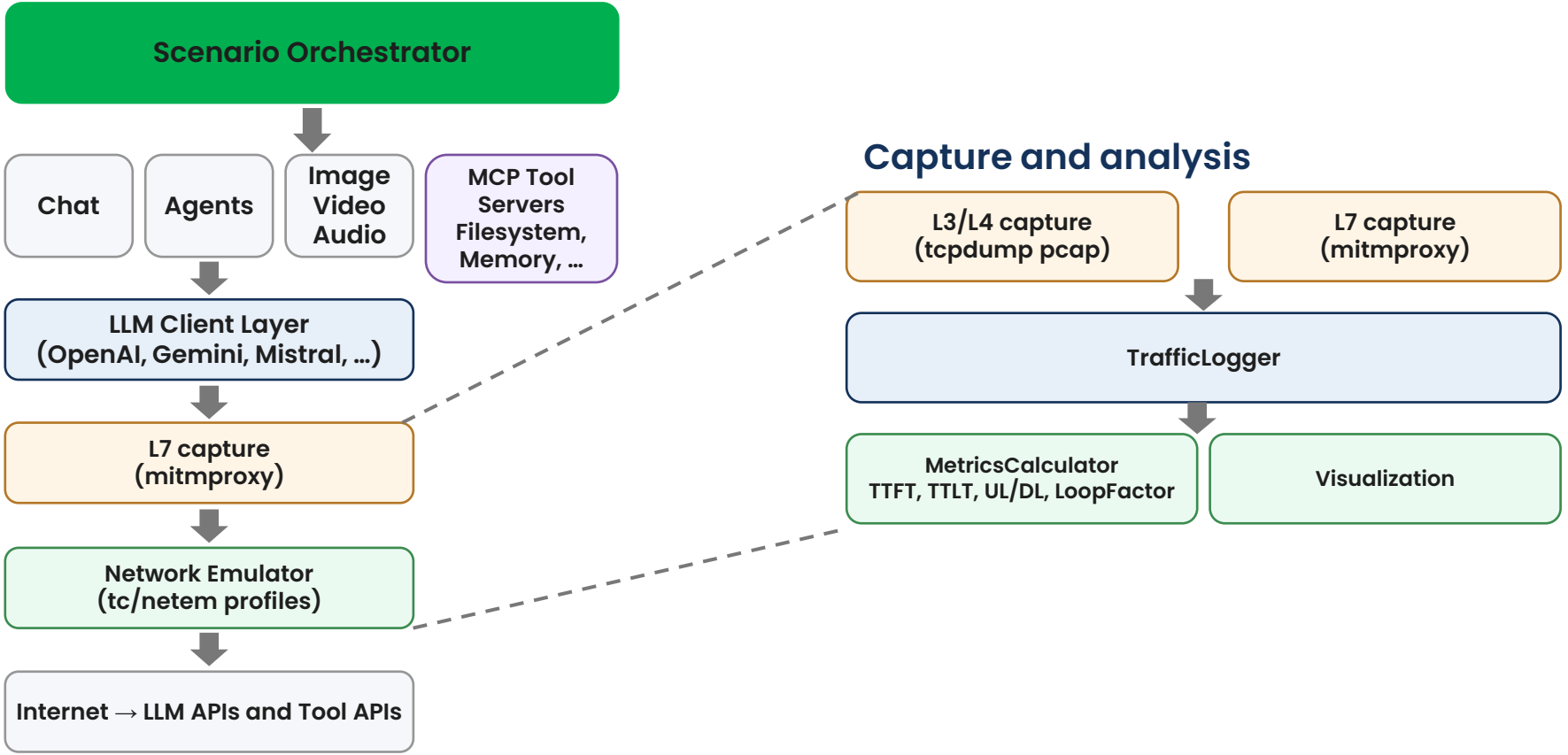

More information at developer.5g-mag.com

netemu/ – Network Emulation Library

- A lightweight Python wrapper around Linux traffic control (tc/netem) used to emulate realistic network conditions.

Features:

- Emulates delay, jitter, packet loss, and bandwidth limits
- Supports bidirectional shaping via IFB devices
- Includes 27+ predefined profiles, aligned with 3GPP concepts (e.g., 5QI-like mappings)
- Context-manager design for automatic setup and cleanup
- Can be used independently of the AI testbed

6G Testbed and AI Traffic Characterization

Overview on the 5G-MAG Reference Tools

Network Profiles

- The repository includes predefined network profiles representing real-world and future scenarios, such as:
  - Ideal 6G (near-zero latency, no loss)
  - 5G Urban
  - Good Wi-Fi
  - Cell Edge / Poor Coverage
  - Satellite / NTN (LEO-like latency)

- These profiles allow repeatable experimentation across vastly different network conditions

```
# Example Network Profiles for netemu
# These profiles demonstrate common network condition emulations

profiles:
  # Ideal conditions - no impairments
  ideal:
    description: "Ideal network - no impairments"
    delay_ms: 0
    jitter_ms: 0
    loss_pct: 0
    rate_mbit: null  # Unlimited

  # Good WiFi connection
  good_wifi:
    description: "Good WiFi connection"
    delay_ms: 30
    jitter_ms: 10
    loss_pct: 0.1
    rate_mbit: 50

  # Poor cellular connection
  poor_cellular:
    description: "Poor cellular signal / cell edge"
    delay_ms: 120
    jitter_ms: 30
    loss_pct: 1.0
    rate_mbit: 5

  # Satellite link (high latency)
  satellite:
    description: "Satellite connection - high latency"
    delay_ms: 600
    jitter_ms: 50
    loss_pct: 0.5
    rate_mbit: 10
```

6G Testbed and AI Traffic Characterization

Overview on the 5G-MAG Reference Tools

aitestbed/ - AI Traffic Test Framework

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6G Testbed and AI Traffic Characterization

Overview on the 5G-MAG Reference Tools

aitestbed/ - Key capabilities:

- **11+ AI scenario types**, including:
  - Chat-based LLM interaction
  - Agentic AI using Model Context Protocol (MCP) tools
  - Image generation
  - Multimodal (text, audio, image, video)
  - Video understanding
  - Real-time AI via **WebSocket** and **WebRTC**
- **8+ LLM providers**, including OpenAI, Gemini, DeepSeek, vLLM, and real-time variants
- **60+ metrics**, such as:
  - Time to First Token (TTFT)
  - Time to Last Token (TTLT)
  - Latency percentiles
  - Uplink/downlink traffic ratios
  - Token throughput rates
  - Agent loop factors
- **Multi-layer traffic capture:**
  - L3/L4 via `tcpdump`
  - L7 via `mitmproxy`
- **Structured logging** using SQLite for post-analysis and reproducibility.

More information at developer.5g-mag.com

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Key parameters

Scenario	Expected pattern
TTFT	Time to first token
TTLT	Time to last token
L_session	Total session duration
B_UL, B_DL	Uplink and downlink bytes
R_UL	UL ratio B_UL / (B_UL + B_DL)
Latency	Audio latency
CallsPerPrompt	API calls per user prompt (agents)
Success rate	Completion rate per profile
Token rate	Tokens per second in streaming

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Scenarios

Scenario	What it tests	Expected pattern
Chat (Basic)	Single turn text	Low UL, moderate DL, latency sensitive
Chat (Streaming)	Token streaming	Continuous small chunks, TTFT critical
Chat (conversational)	Real-time audio via WebRTC	Real-time audio
Shopping Agent	MCP tools: search + fetch	Multi-burst, multi-hop requests
Web Search Agent	Research workflow	Variable latency, multi-stage
General Agent	Full MCP toolset	Tool diversity and bursts
Image/Video Generation	Prompt + binary output	Small UL then large DL Progressive output?
Direct Web Search	Parallel HTTP (no MCP)	Burst traffic, concurrent requests

The Media Connectivity Association

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