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**RISE Research Institutes of Sweden /
Mid Sweden University**

**SweWIN RA3
Workshop ·
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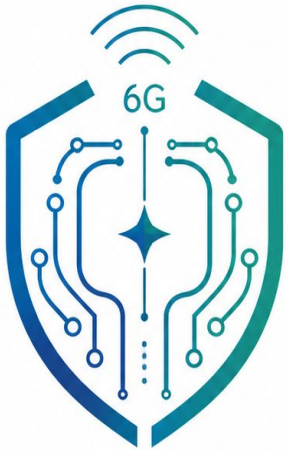

GEMINI

Generalized & Explainable 6G Mobile Intelligence

Self-Introduction

MS Computer Science and Networking, University of Pisa, Italy · BSc Computer Science, University of Management and Technology, Lahore, Pakistan

DOCTORAL STUDENT / INSTITUTIONAL PHD

Mid Sweden University and RISE Research Institutes of Sweden

Sarder Fakhrul Abedin
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GEMINI

- Generalized, explainable and reliable AI for future 6G networks
- A hybrid approach: AI integrated with conventional methods across the full 6G protocol stack
- Focus: generalization, explainability, and low latency in dynamic, heterogeneous environments
- Validated through a 6G teleoperation use case

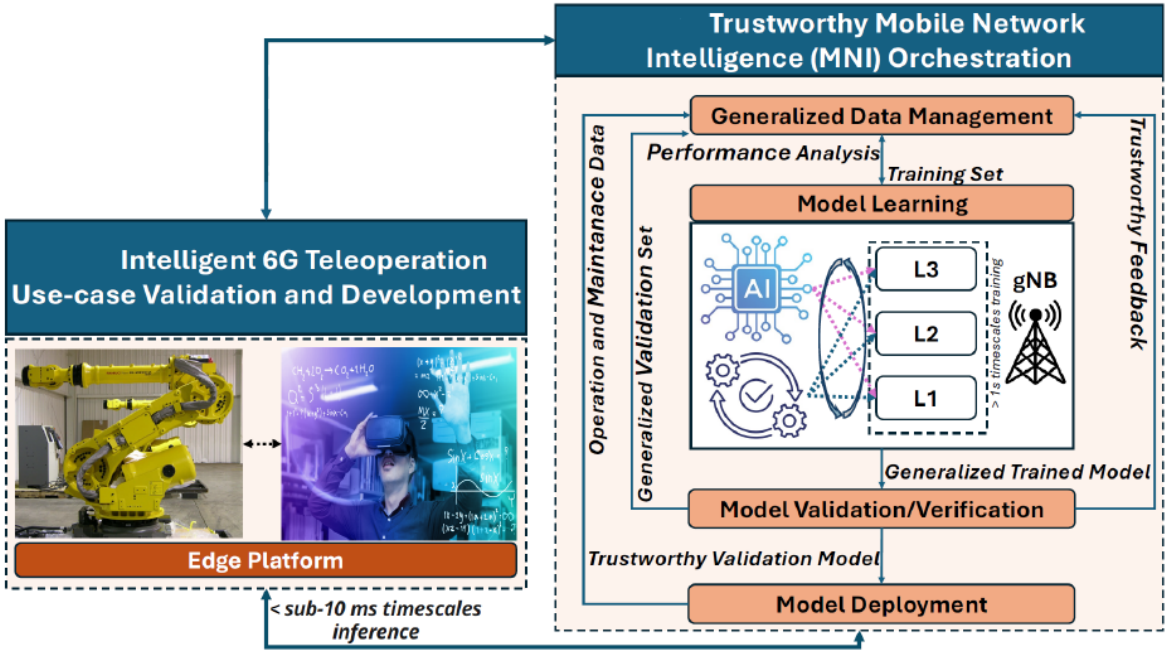

Figure 1 . Overall System Architecture for trustworthy mobile network intelligence orchestration in 6 G teleoperation

Published SNCNW (2026)

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My Focus: A Cross-Layer Trust Descriptor

What? We are Developing

A generalizable and explainable trust mechanism for AI-assisted wireless decision-making.

Why? Is it needed?

Prediction accuracy alone does not tell the network when an AI output is reliable enough to use.

How?

By progressively developing the trust mechanism from a well-defined Layer-1 decision to cross-layer and teleoperation validation.

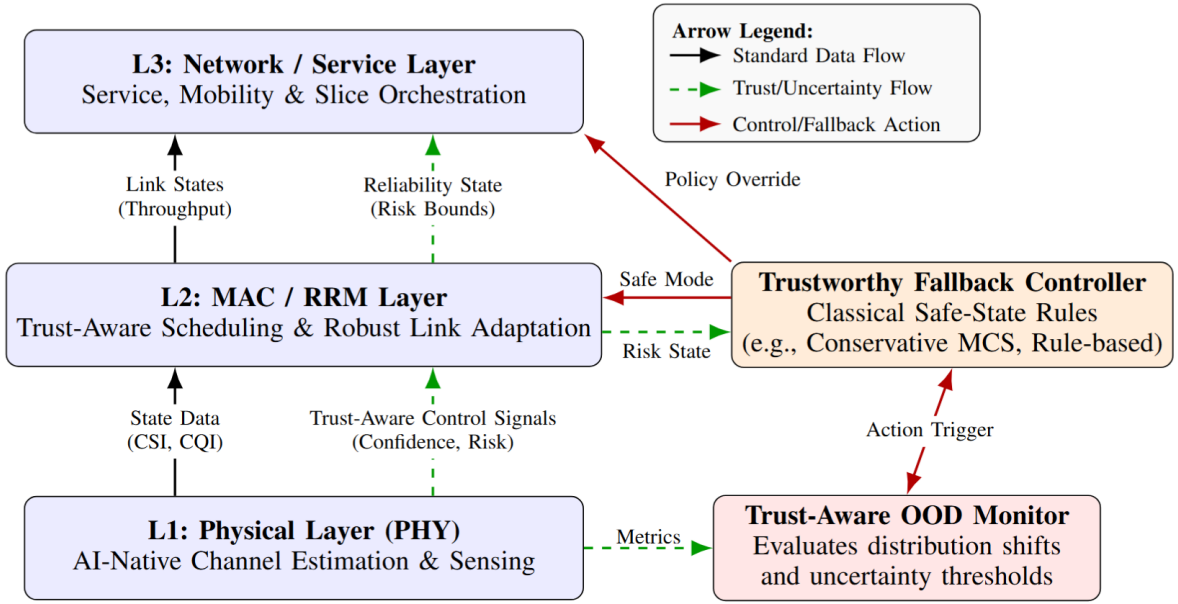

Figure 2. Reliability is not exposed to the layers that act on it.

Published — SNCNW 2026

Results So Far

1 — Beyond Prediction Accuracy: A Vision for Trust-Aware Cross-Layer Intelligence for 6G Mobile Networks

Paper Published, Swedish National Computer Networking and Cloud Computing Workshop (SNCNW 2026)

2 — Benchmarking Classical and Lightweight Neural MIMO-OFDM Channel Estimators

Paper Accepted, 2026 IEEE 12th World Forum on Internet of Things (WF-IoT) - WS-02: AI-Native IoT Communications and Networking

3 — Uncertainty-Aware Compliance Assessment for Predictive Link Adaptation in Dynamic MIMO Systems.

In progress

Let's collaborate

What's sufficient proof-of-concept for the trust mechanism — validated through a use case where scheduling and orchestration act on that trust information.

Thank You

Questions & Discussion

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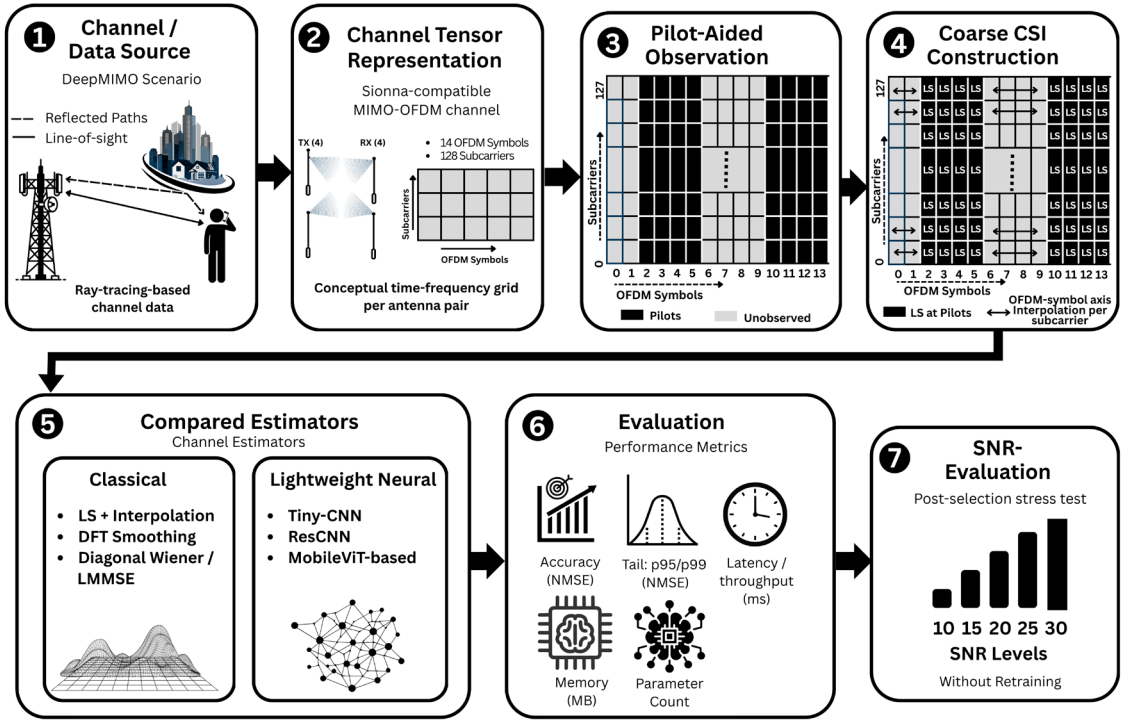
Backup — Step 1: Benchmarking Channel Estimators



Accepted — IEEE WF-IoT 2026 (AICON, WS-02)

Results and Reflection

Inference cost — NVIDIA GB10

Model	Group size	Mean (ms)	p95 (ms)	p99 (ms)	Throughput (samples/s)	Peak alloc. GPU memory (MiB)
Tiny-CNN	1	1.091	1.158	1.328	916.5	**39.9**
Tiny-CNN	64	**5.438**	**5.443**	**5.893**	**11,768.2**	**128.4**
ResCNN	1	1.383	1.388	1.629	723.2	41.4
ResCNN	64	6.759	6.793	7.379	9,468.5	185.0
MobileViT-based	1	**0.863**	**0.870**	**1.085**	**1,158.5**	79.5
MobileViT-based	64	26.575	27.547	27.882	2,408.3	539.8

Accuracy under SNR shift, no retraining

Estimator	Mean 10 dB	p99 10 dB	Mean 20 dB	p99 20 dB	Mean 30 dB	p99 30 dB
LS + interp.	2.556	9.178	-7.444	-0.822	-17.444	-10.822
DFT, $K = 12$	-4.882	-1.718	-6.152	-5.310	-6.302	-5.837
Tiny-CNN	-5.333	1.214	-18.003	-11.561	-26.661	-21.111
ResCNN	**-8.306**	**-1.770**	**-19.438**	**-12.978**	**-27.877**	**-22.006**
MobileViT-based	-6.367	0.087	-19.016	-12.565	-26.754	-20.664

- The lowest NMSE, the lowest one-sample latency, and the highest batch throughput belong to three different models; there is no single best estimator.
- Moving away from the training SNR without retraining degrades every method; at 10 dB, the p99 NMSE of two neural estimators turns positive.

Average accuracy says little about behavior under shift, and a well-optimized prediction is not enough if the rest of the stack cannot assess its reliability right now.

RI. SE

Backup — Step 2: What L1 Would Emit

```
{
  "estimate":     "Ĥ_t",
  "uncertainty":  u_t,
  "ood_flag":     "high",
  "consistency":  c_t,
  "state":        "unreliable"
}
```

Illustrative — field set follows the descriptor in SNCNW 2026

Actions (conservative MCS, re-estimate, fallback) are an L2 decision — not part of the L1 message.

Backup — Step 3: Aged CSI and Link Adaptation

- CSI ages: the channel at transmission time is not the one that was estimated, and re-estimating costs part of the same latency budget.
- Question: Given the age and uncertainty of the available CSI, how likely is the selected MCS to meet its reliability target?
- Approach: a decision-time reliability predictor, evaluated with and without an uncertainty-derived input to isolate what uncertainty adds.
- Environment: Sionna link-level simulation on GPU. The propagation model, SNR range, MCS set, and error-target definition were fixed and documented before any data was generated.
- **In progress…**

Still Open

- What should the trust descriptor represent — *probability*, *risk bound*, *or state*?
- Does it fit inside the sub-10-ms path, or only as a slower outer-loop signal?
- What counts as failure for real remote operation?

Upcoming Plans

- **L1, now:** channel estimation error and its predictive uncertainty.
- **L2, next:** probability the selected MCS meets its reliability target, with fallback to classical rules.
- **L3, later:** probability of violating the flow's QoS requirement.
- **Longer term:** reliability as an explicit constraint in cross-layer optimization, not an afterthought.