tsdsi India's Telecom SDO Years of developing ICT Standards celebrating 10

NCC

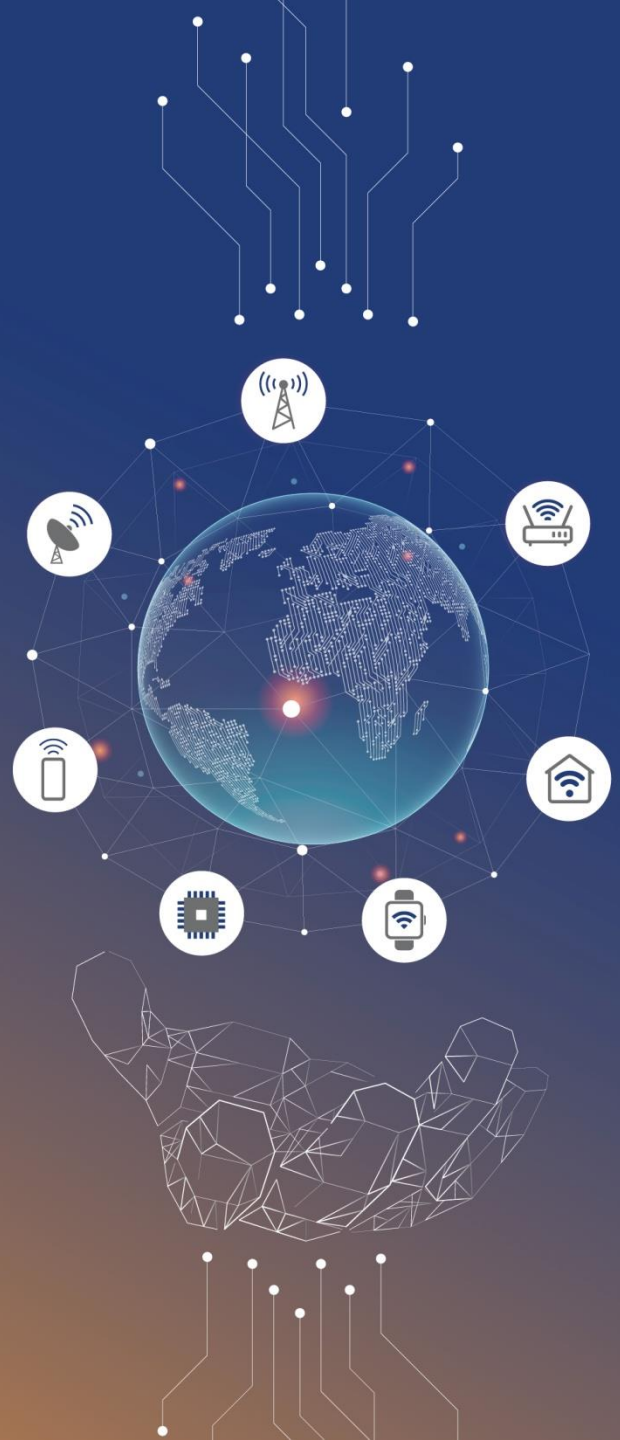
Workshop on

Standards-driven Research @ NCC 2024

28th February 2024

09:00 to 17:30 IST

IIT Madras



Workshop on Standards-driven Research @NCC 2024

Demonstrating the Utility of **Tools** for **Standards-driven Research**

by

Vikram Singh

Gigayasa Wireless

Table of content

- How are standards developed in 3GPP?
- Role of simulations in standards development?
  - Why simulations are important?
  - Role of simulations in the development of standards
  - Type of simulations
- Case-study: Standards Driven Research

Standards Development in 3GPP

Standards Development in 3GPP

1 → Outside of 3GPP

New Technical Features/Services

2 → 3GPP SA

Project Proposal

3 → 3GPP RAN-1/2

Feasibility Study

4 → 3GPP RAN-1/2

Specification Development

5 → 3GPP RAN-1/2

Product Development

*Counting 3GPP contributions

Standards Development in 3GPP*

1

New Technical Features/Services

2

Project Proposal

Identify and define problems	Design initial PoC and R&D	Submit proposal to 3GPP

→

All new features are discussed	Features supported by >= 4 members are discussed	Target use-cases for the features are discussed	Specifications are discussed over multiple meetings	TSG plenary approves new work activity	Shortlist work activities for study items

*Demystifying 3GPP

Standards Development in 3GPP

1 Outside of 3GPP

New Technical Features/Services

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Specification Development

Member propose solutions via Tdocs (contributions)

Builds consensus on
- Evaluation methodologies
- Final KPIs

Members submit evaluations and calibrations results

Final TR is approved based on consensus **for Work Item Phase**.

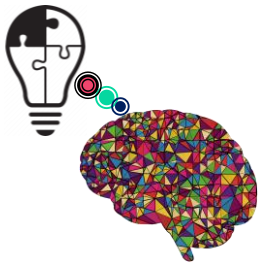
New Tdocs are submitted to propose solutions

Solutions are discussed and agreed by member

Agreed Ideas are captured and executed in the TS.

Standards Development in 3GPP

1 Outside of 3GPP

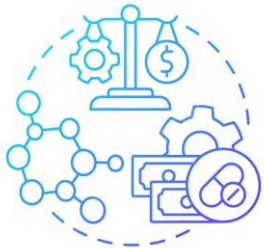


New Technical Features/Services

2 3GPP SA

Project Proposal

3 3GPP RAN-1/2

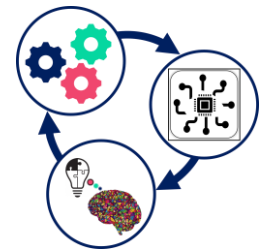


Feasibility Study

4 3GPP RAN-1/2

Specification Development

5 Companies



Product Development

Standards Development in 3GPP: Example

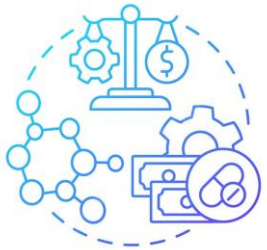
Outside of 3GPP

Use case: Ubiquitous Coverage

Technology: Non-terrestrial Networks

3GPP SA

1. Precise applications
2. Detailed KPIs for each application
3. High level architecture



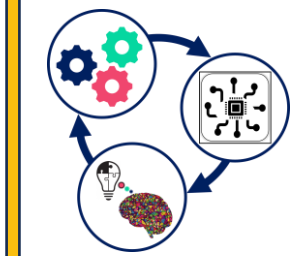
3GPP RAN-1/2

1. Perform Simulations to benchmark the performance with existing 3GPP specs
2. Identified limitation of the current specification and framework
3. Defined NTN channel model, evaluation methodologies and KPIs.

3GPP RAN-1/2

1. Enhancements in HARQ
2. Mobility management for large moving coverage.
3. Delay-Doppler challenges for UL/DL sync.

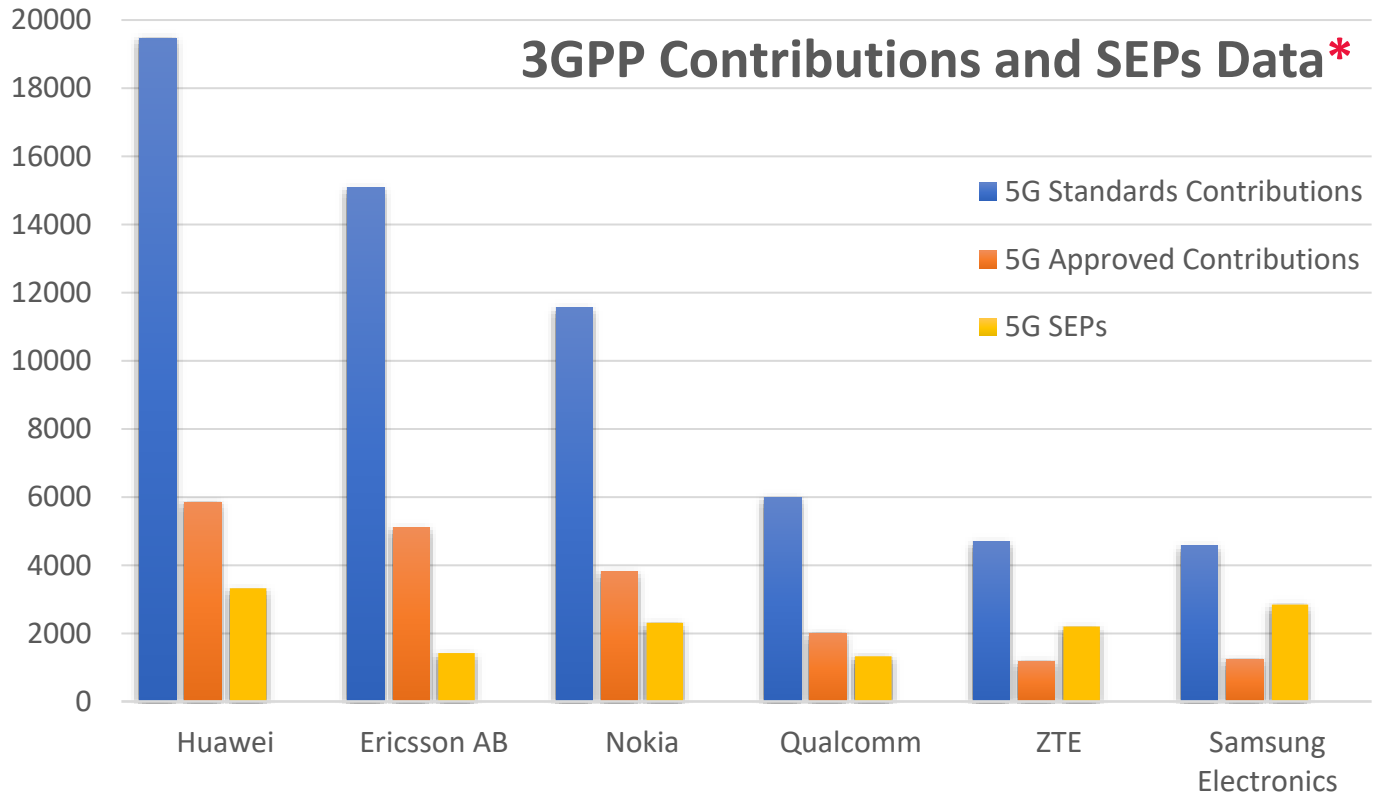
Requires rigorous simulation contributions



Companies

Role of simulations in Designing Standards

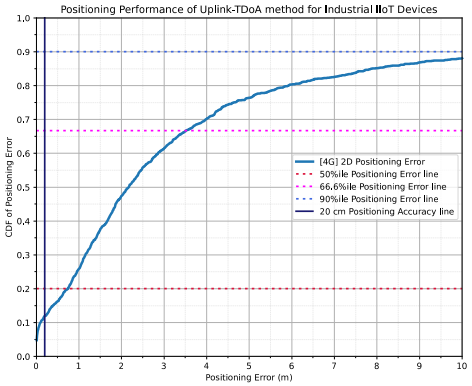
Why simulations contributions matter?



* Securing Western Leadership in Global 5G Standards

Role of simulations in Designing Standards

- **Benchmarking:** Evaluation of performance with existing technical specs.



Role of simulations in Designing Standards

- **Benchmarking:** Evaluation of performance with existing technical specs.
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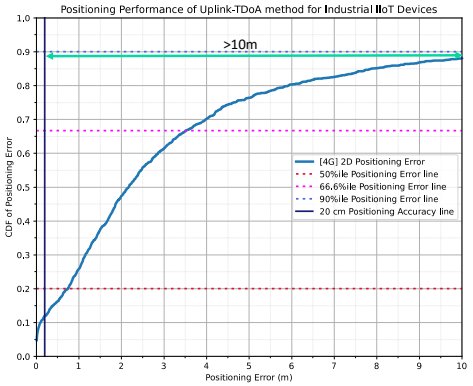

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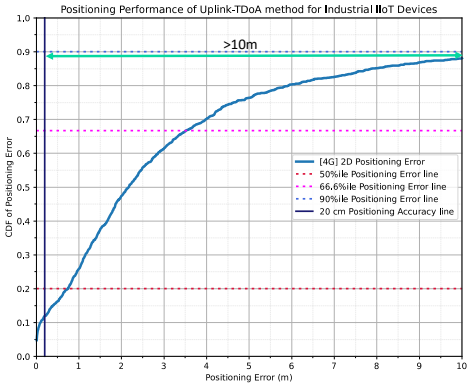

Role of simulations in Designing Standards

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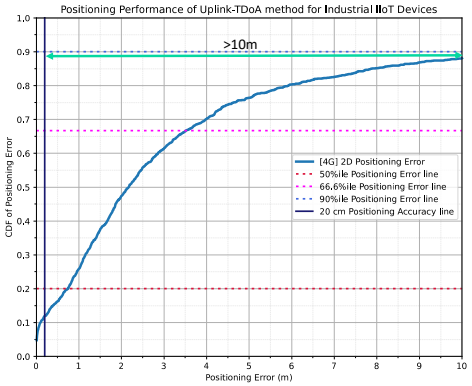

Role of simulations in Designing Standards

- **Benchmarking:** Evaluation of performance with existing technical specs.
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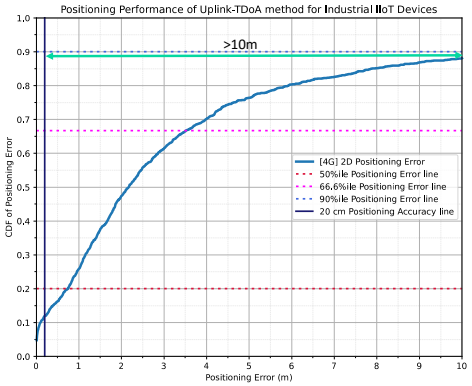
- **Designing new:**
  - Signaling,
  - Procedures,
  - Methods/Techniques.



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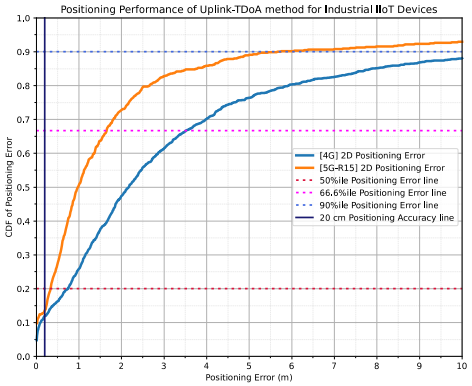
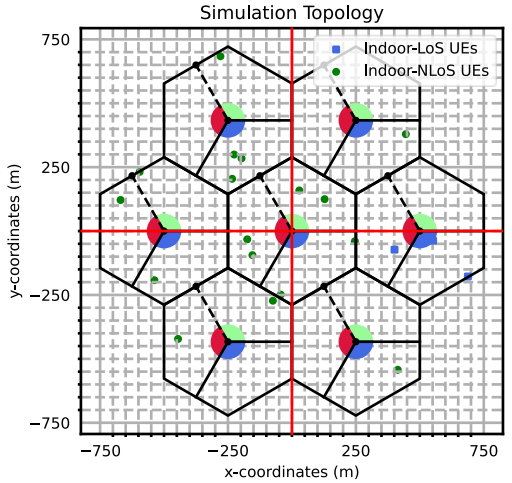
- **Enhancements:** Performance improvements with proposed solutions.

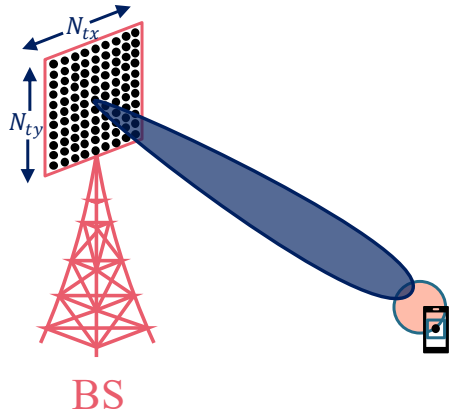


Simulation in 3GPP Standardization*

- 3GPP uses two class of simulations for standardization:
  - System level simulations
  - Link level simulations



System level simulation



Link level simulation

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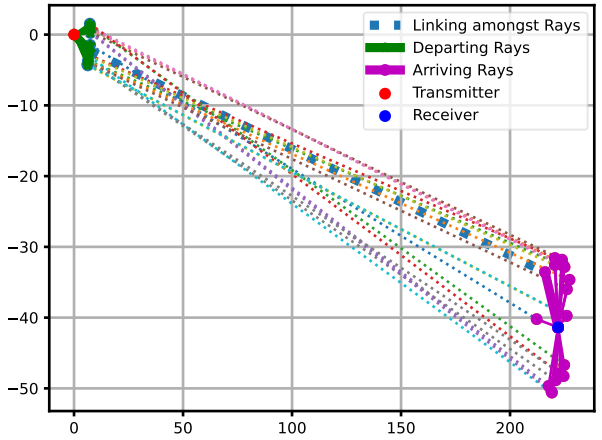

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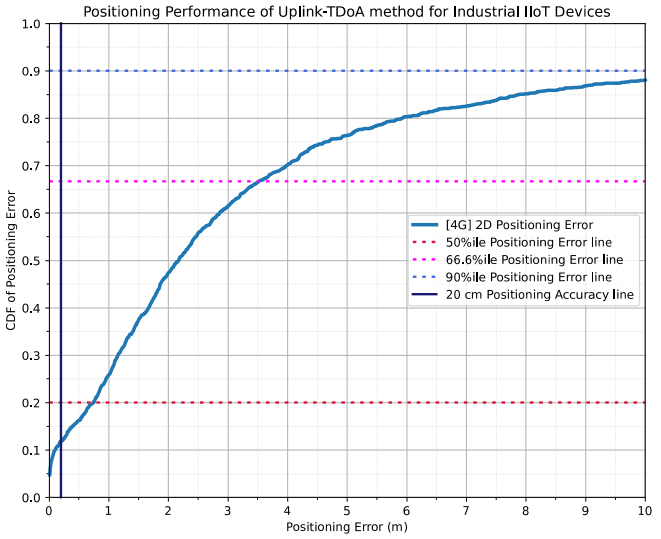
  - Uses: SCM Channel models (UMa/RMa/InH/InF/UMi)



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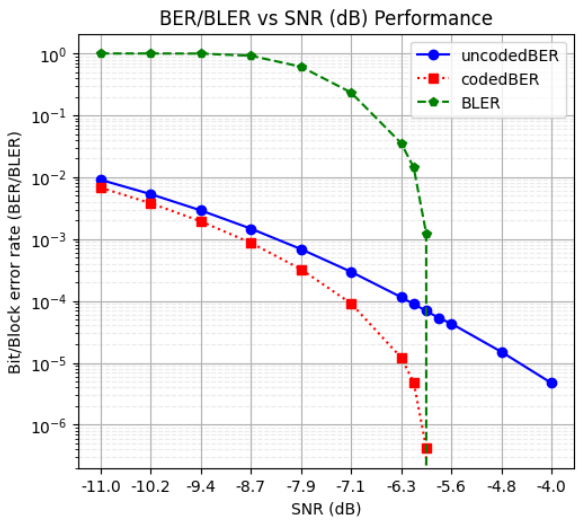
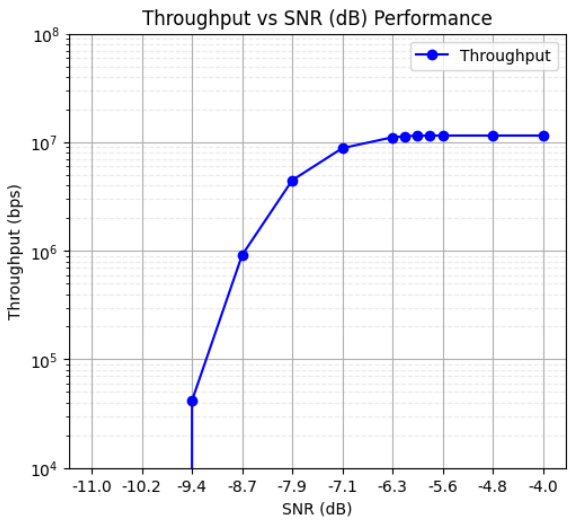
  - Uses: SCM Channel models (UMa/RMa/InH/InF/UMi
- Link level simulations
  - For coverage evaluations
  - For link budget analysis.
  - Use: CDL/TDL channel models





What are System Level Simulations?

- Transmitter side
  - 3GPP TS compliant chains
  - Standards complaint algorithms for
    - Scheduling
    - MIMO
- Wireless Channel
  - Calibrated TR 38.901 channels
- Receiver side
  - Standards compliant algorithms
    - Mitigation of hardware impairments
    - Channel estimation and Equalization
    - MIMO
    - Channel decoding + HARQ + Error detection
- Capture Multi-cell + Multi-user aspects

Why are SLS Challenging?

- Extremely memory intensive
  - 57 BSs, 570 UEs
  - 64-128 Antennas @ BS and 4-16 antennas @UE.
  - 4096 FFT for each link
  - $57 \times 570 \times 32 \times 4 \approx 5 \times 10^6$ links

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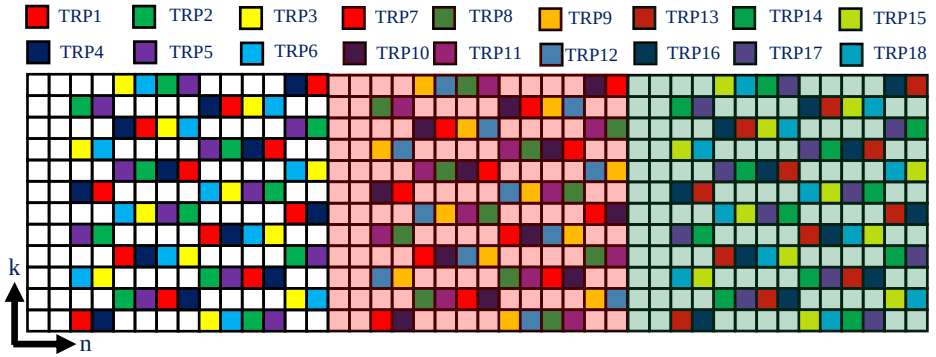
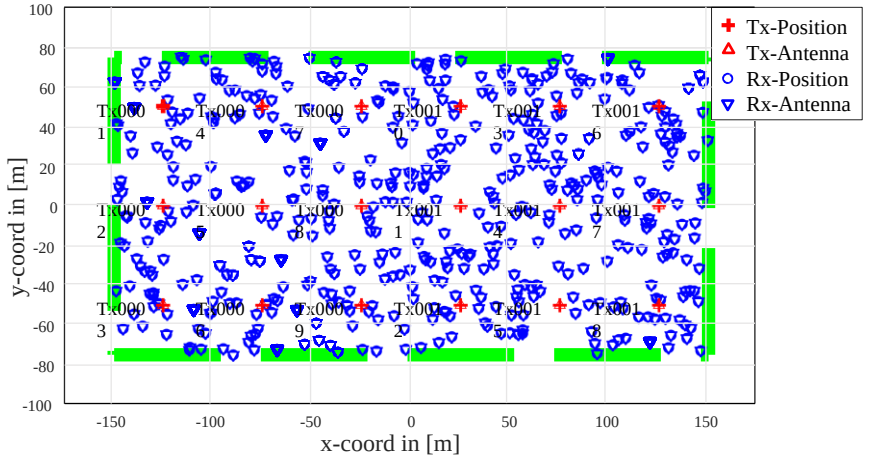
  - For SLS: difficult. ❌
  - Why?
    - Each link uses different modulation order, code rate, Tx Power, bandwidth etc.
    - Each link has to be run individually.

A Quick Case Study on Positioning in Indoor Factories

Evaluation Methodology

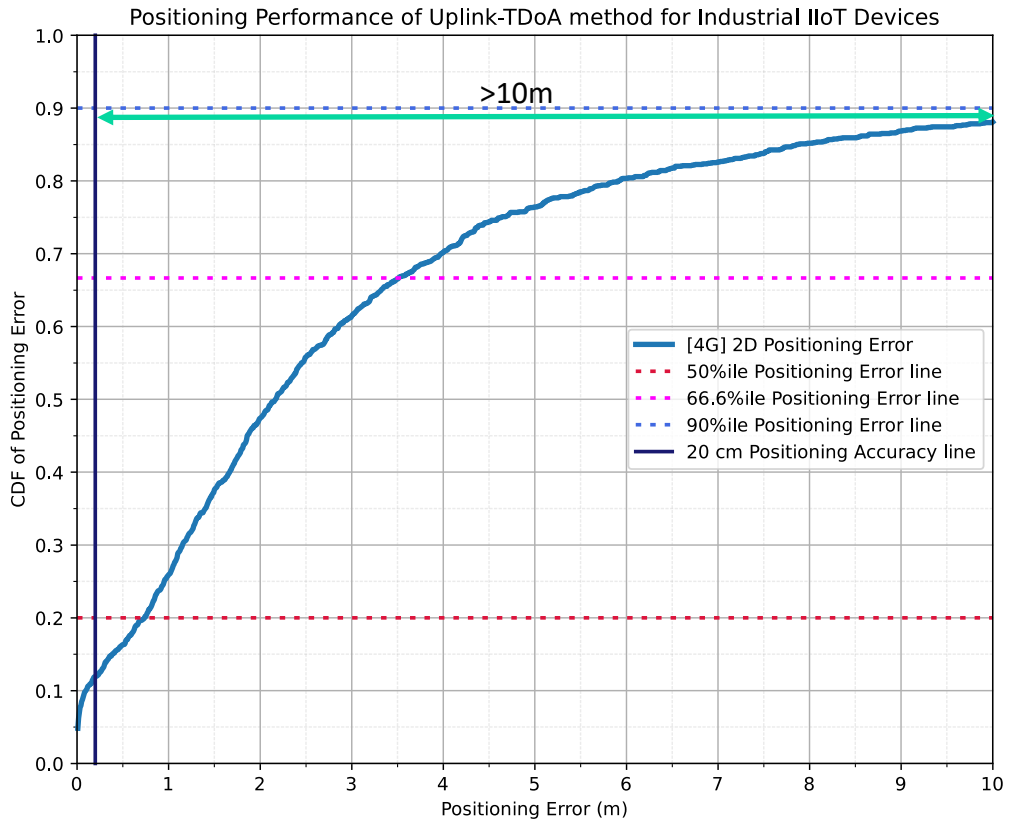
Parameters	Values
Scenario (terrain)	Indoor Factory-Sparse High
Carrier frequency	3.6 GHz
Comb factor	12
Subcarrier spacing	30 kHz
Bandwidth	20/100 MHz
Simulation area	60 m X 120 m
UE dropping	Uniform
Number of UEs	2000
Intersite distance (ISD)	20m
Number of BSs	18
Antenna elements/panel-BS	32 X 4 (1 panel)
Antenna element spacing-BS	$\frac{\lambda}{2}$
Antenna Panel-UE	1 X 1(1 panel)
Antenna elements/panel-UE	--
Tx Power	23 dB
Rx noise figure	7 dB





KPI	Target
2D Positioning Error	<20 cm for 90% of UEs
Vertical Error	<1.5m for 90% of Ues

Case Study: Positioning in Indoor Factories



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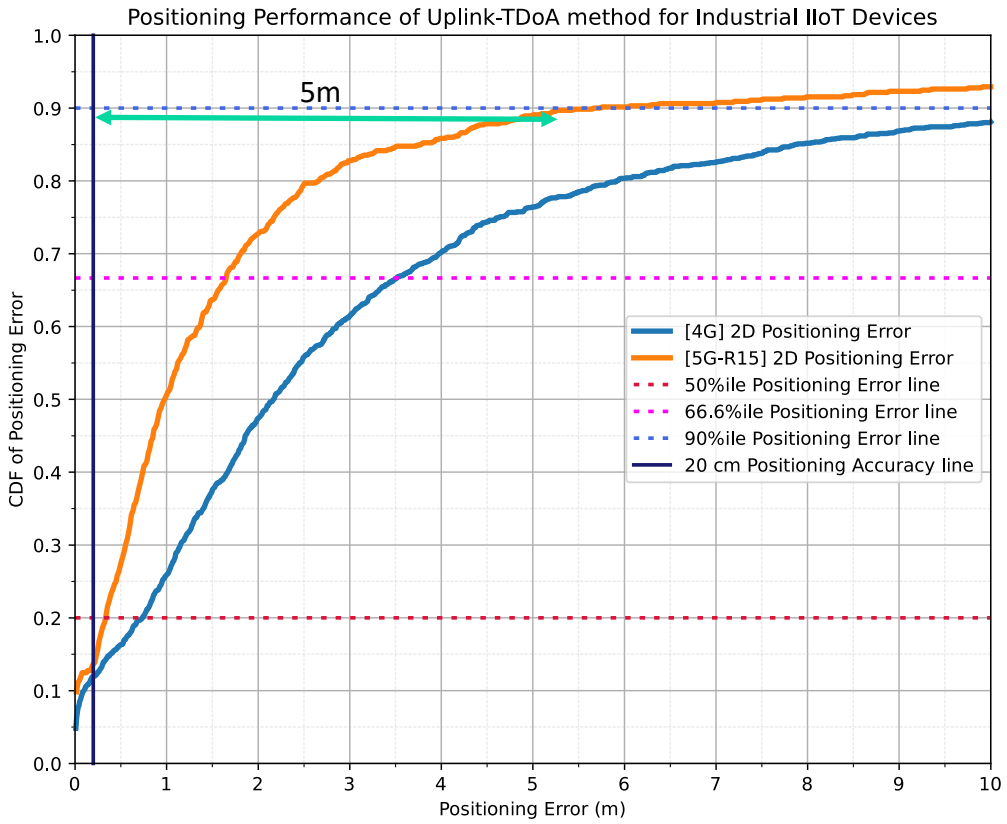
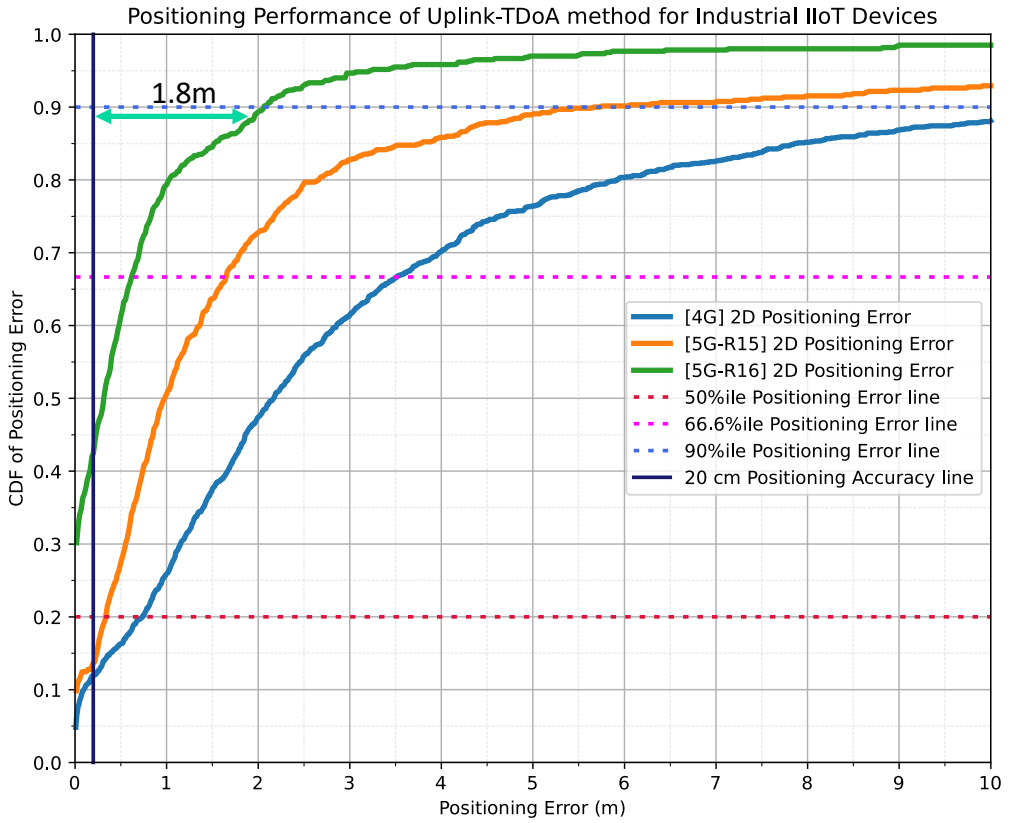


Release-15

- Wider bandwidth
- More number of antennas

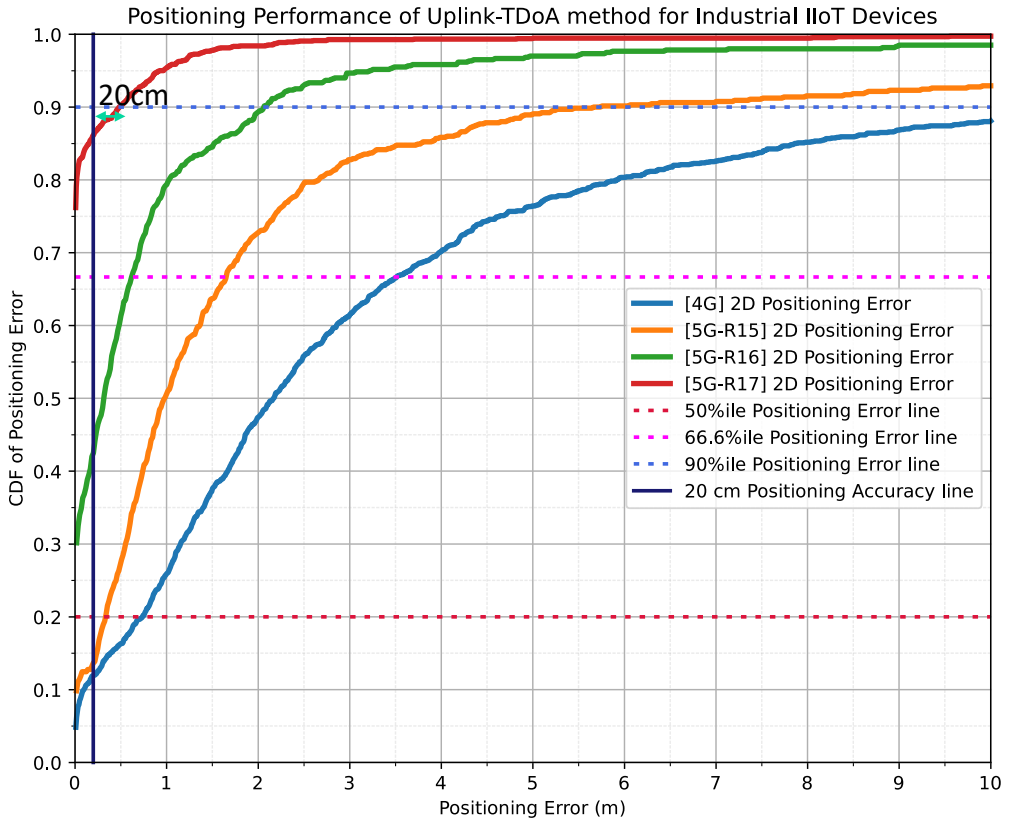
Case Study: Positioning in Indoor Factories



Release-16

- Support for Hybrid Positioning
- New methods

Case Study: Positioning in Indoor Factories



Release-17

- First Arrival Path reporting
- LoS/NLoS Identification

Existing Tools

Existing Tools

Tool	Pros	Cons
MATLAB 5G Toolbox	Easy to use	Slow
	3GPP Standard compliant	Bits and pieces tool
		Slow Updates
		Lagging on AI part
Sionna	Open source	Bits and pieces
	Python based	Limited support
	Extensive AI support	Not standards complaint
Gigayasa 5G Toolkit	Exhaustive and Easy to use	Proprietary
	Python based	
	3GPP standards compliant	
	Designed for 3GPP SLS and LLS	
	Integrate with SDRs	
	Fast	

Thank You

vikram@gigayasa.com