

Agenda
IEEE EMC Society TC 5: High Power Electromagnetics (HPEM)
Wednesday, 5 August 2026 (Noon-1:30 PM CT)
Webex Meeting ID: 2335 661 0027*
Metropolitan Ballroom, Hilton Anatole Hotel & Meeting Space
Dallas, Texas USA

- | | |
|---|--|
| 1. Opening of the meeting and approval of the agenda | M. McInerney, Chair |
| 2. Review and approval of the minutes of the last TC 5 meeting in Raleigh, North Carolina
Available at
https://www.emcs.org/technical-committees/tc-5-high-power-electromagnetics/tc-5-meetings/ | M. McInerney |
| 3. Current TC 5 membership list | M. McInerney |
| 4. Report on the paper review process for Dallas
– Workshop, Special Session, Regular Sessions | M. McInerney |
| 5. Report from the Lightning Subcommittee | A. Tatematsu |
| 6. Report from the EM Information Leakage Subcommittee | Y. Hayashi |
| 7. Report from the HEMP/IEMI Subcommittee | M. McInerney, W. Radasky,
S. Fisahn |
| 8. Report from ESD Subcommittee | S. Marathe, M. Khazhinsky,
J. Kinnear |
| 9. Coordination with Smart Grid (TC 7 subcommittee) | M. McInerney |
| 10. Status of the TC 5 web page | M. McInerney |
| 11. Review of HPEM activities since last TC 5 meeting in Raleigh, North Carolina | All |
| 12. TC 5 participation in upcoming EMC conferences
Special sessions, tutorials, workshops, meetings, etc.
– EMC Europe 2026, Prague, Czech Republic (August 31, 2026)
– APEMC 2027, Jeju, Jeju Island, Republic of Korea (May 17, 2027)
– 2027 IEEE Symposium on EMC+SIPI, Portland, Oregon, USA (July 12, 2027)
– 2027 Joint EMC Europe & International Symposium on Electromagnetic Compatibility, Signal & Power Integrity, Glasgow, Scotland, UK (August 23, 2027) | All |
| 13. Discussion of standardization activities
– IEEE P2838 - Standard for Aerospace Component Lightning Strike Direct Effects Qualification | All |
| 14. Presentation on “Monitoring System for Precision Agriculture using IoT Sensors” | Niolae |
| 15. Any other business | All |
| 16. Adjournment | All |

* Meeting URL: <https://ieee.webex.com/ieee>

Password: EMC2026



IEEE TC 5: High Power Electromagnetics (HPEM) Technical Committee

Minutes of the Raleigh Hybrid Meeting Wednesday, 20 August 2025 (Noon – 1:30 PM EDT)

Unconfirmed Minutes

1. Opening of Meeting and Approval of Agenda

Chair W. Radasky called the meeting to order at 12:00 PM. The agenda was approved without modifications.

2. Review and Approval of Minutes from Phoenix Meeting

The minutes from the previous TC-5 meeting in Phoenix, Arizona were distributed prior to the meeting. No comments were received. A motion to approve the minutes was made, seconded, and passed unanimously. The minutes will be updated from "unapproved" to "approved" status on the website.

3. Current TC-5 Membership List

- Current active membership stands at over 75 members who have attended meetings over the last five years
- Typically 25-30 members attend each meeting; approximately 40 attended this meeting
- A sign-up sheet was circulated to capture new member information
- Members remain on the distribution list for 3-5 years unless they request removal

4. Report on Paper Review Process for Raleigh Conference

W. Radasky presented the paper review summary:

- **Regular papers:** 6 submitted, 6 accepted, 1 withdrawn later
- **Abstract papers:** 4 submitted, 4 accepted
- **Special sessions:** 2 large sessions organized
- **Best paper nominations:** 4 papers nominated out of 24 total accepted papers
- **Regular sessions held:**
 - 2 sessions on EMI topics (Wednesday morning), 6 papers (1 withdrawn)
 - 1 session on HEMP topics (Thursday afternoon), 4 papers
- **Special sessions:**
 - EM Information Security and Countermeasures (8 papers, Tuesday morning, ~40 attendees)
 - Advances in High-Altitude EMP Environments and Protection (6 papers, Thursday morning)
- **Tutorials sponsored by TC-5:**

- 2 ESD tutorials scheduled for Friday (morning and afternoon)

5. Report from Lightning Subcommittee

Presented by: A. Tatematsu (new Subcommittee Chair, replacing retired Marcos Rubinstein)

- **2025 Lightning conferences:** 8 major conferences including IPST (Mexico), SIPDA (Greece), APL (Indonesia)
- **2026 Major events:**
 - ICLP 2026 in Sapporo, Japan (May 31-June 5) - paper submissions due October 31, 2025
 - GlobalEM 2026 in Seoul, Korea (June 29-July 3)
- **CIGRE SC C4 Working Groups:** 14 active groups on lightning protection for power systems, wind turbines, nuclear plants
- **Publications:** 6 papers in IEEE Trans. EMC (2025) on altitude-triggered lightning, LEMP waveforms, metamaterial protection
- **Current research:** Lightning overvoltage analysis of substations and transmission lines with taking into account the LEMP impact
- **Future activities:** Contributing to ICLP 2026 organization as local committee member

6. Report from EM Information Leakage Subcommittee

Presented by: Y. Hayashi

- **EMC+SIPI 2025 Special Session:** 8 papers presented, ~50 attendees, topics included TEMPEST threats, side-channel analysis, cryptographic modules
- **EMC Europe 2025 activities:**
 - Tutorial session (September 1): 7 presentations on physical layer security
 - Special session (September 3-4): 8 papers on information security threats
- **Key research areas:** DisplayPort eavesdropping, RF retroreflector attacks, time-varying frequency-selective shielding, software jamming countermeasures
- **Future conferences:**
 - APEMC 2026 (May 4-7, Kuala Lumpur): Special session planned
 - GlobalEM 2026 (June 29-July 3, Yonsei University, Seoul): Special session proposed
 - EMC Europe 2026 (August 31-September 3, Prague): Special session and tutorial planned

7. Report from HEMP/IEMI Subcommittee

Presented by: M. McInerney and W. Radasky

Major updates:

- **IEC Standards Updates:** Substantial revisions to multiple standards
 - Environment definitions expanded beyond single waveform
 - Multiple environment options for commercial applications
 - Cost-conscious protection approaches introduced
- **Power System Activities:** Continued work following 2019 Executive Order
 - IEC standards cited by Department of Energy as primary reference
 - Increased industry engagement in grid protection
- **Publications:** Multiple journal articles published in 2024-2025
- **Events:**

- Tutorial in Taiwan on IEMI in May 2025
- EMC Europe workshop on risk management in 2025
- Combined session on emerging threats in 2025

8. Report from ESD Subcommittee

Presented by: Representative from ESD Association (sister organization)

Key points:

- ESD Symposium scheduled for Riverside, California (September 2025)
- Workshop on Friday covering proper device characterization methods
- **Standards updates:**
 - ANSI/ESDA JS-001 and JS-002 (HBM and CDM test methods)
 - Standards elevated to IEC TC47
 - New terminology: EIPD (Electrically Induced Physical Damage) replacing EOS
- **Technical trends:**
 - CDM voltage thresholds continuing to decrease
 - 3D packaging creating new ESD challenges
 - Development of ESD simulation software (still in early stages)

9. Coordination with SC-1 Smart Grid

Presented by: M. McInerney

- SC-1 transitioned from Special Committee to Subcommittee under TC-7
- 14-year mission largely accomplished in helping power industry incorporate EMC
- Activities continuing at reduced level
- M. McInerney remains POC for Smart Grid activities

10. Status of TC-5 Web Page

Presented by: M. McInerney

- Website maintenance ongoing with improved editing capabilities
- Repository for technical references being developed
- Request for members to submit relevant publications and references
- Links to papers and resources being added

11. Review of HPEM Activities Since Phoenix Meeting

Various members reported on conferences and activities:

- APEMC 2024 in Okinawa with TC-5 participation
- Multiple workshops and tutorials delivered
- Continued collaboration with international conferences

12. Discussion of Tutorials/Workshops for Dallas 2026

The committee discussed potential offerings for next year's conference:

- **HEMP:** Possible workshop on new developments
- **ESD:** Tentative system-level ESD workshop or special session
- **IEMI:** Discussion of counter-UAV technologies, though noting classification constraints
- **Lightning:** Checking for conflicts with other lightning conferences
- Final proposals due December/January

13. Standardization Activities

PAR 2838 Lightning Test Standard Working Group:

- Meeting Thursday 9:30-11:00 AM
- 21 test methods completed
- Scope expanded from "airplanes" to "aerospace vehicles"
- Application guide/appendix being developed
- Standard nearing completion, review phase approaching

14. Election of TC-5 Officers

W. Radasky announced his decision to step down as Chair due to medical issues. The following slate was presented and elected unanimously for 3-year terms (January 1, 2026 - December 31, 2028):

- **Chair:** Mike McInerney (elevated from Vice Chair)
- **Vice Chair:** Yuichi Hayashi (elevated from Secretary)
- **Secretary:** Akiyoshi Tatematsu

The committee expressed appreciation to W. Radasky for his many years of leadership.

15. Any Other Business

- **Global EM 2026:** Announced for Seoul, South Korea (June 29 - July 3, 2026)
 - One-page abstracts due January 2026
 - Hosted at Yonsei University
 - Expected 80-100 papers
- Acknowledgment of excellent conference facilities and organization in Raleigh
- Group photo taken

16. Adjournment

The meeting was adjourned at approximately 1:30 PM.

Attachments (labeled with agenda item)

- Meeting Agenda
(1_TC-5_Agenda_2025_Raleigh)
- Confirmed Okinawa and Phoenix Minutes
(2_TC-5_Meeting_Minutes...Okinawa_Phoenix_confirmed)
- TC-5 Membership Update (including 2024 meeting attendees)
(3_TC-5_Sep_2024_Membership_no_emails)
- Report on Paper Review Process in Okinawa and Phoenix
(4_TC-5_Paper_Rev_Process-2025)
- Lightning Subcommittee Report
(5_Lightning_TC-5_2025)
- EM Information Leakage Subcommittee Report
(6_2025_TC-5-Information_Leakage_v1.pptx)
- HEMP/IEMI Subcommittee Report
(7_TC5_HEMP_IEMI_Report_2025_(McInerney).pptx)
- ESD Subcommittee Report

- (8_2025_TC-5 - EMC Meeting - ESD.pptx)
- IEEE P2838 Standard Meeting Agenda
(11_CFP_Global EM 2026_20250707_rev0.1.pdf)
- TC 5 Election
(14_TC-5 Officer Election.pdf)

2026 TC 5 Membership List

Updated 5 August 2026

Name	Affiliation	Spokane	Grand Rapids	Okinawa	Phoenix	Raleigh	Dallas
		2022	2023	2024	2024	2025	2026
Soki Akutsu	Mitsubishi Heavy Industry			X		X	
Carlos Aviles	Northrop Grumman		X			X	X
Dr. Daryl Beetner	Missouri University of Science and Technology			X		X	X
Edwin van Bladel	Dutch MOD				X		
Dr. Tyler Bowman	Sandia National Laboratories	X	X		X		X
Ross Carlton	Leidos - Gibbs & Cox				X	X	X
Dong Hoon Choi	Yonsei University			X		X	
Paul Clem	Boeing		X				
Larry Cohen	Consultant		X			X	
Bradley M. Conner	U.S. Navy						X
Evelyn Dohme	Sandia National Laboratories						X
Sesha sai Dekkapati	Schneider Electric						X
Steven Deppen	GE Aerospace					X	
Paul Edwards	Aegis Aerospace, NASA					X	
Sven Fisahn	Bundeswehr Research Institute, Germany	V			X	X	
Patrick Flowers	Armag Corp.					X	
Dr. Ali Foudazi	Amazon Lab126	*	V				
Juwichi Fujigaki	Noise Laboratory			X			
Daisuka Fujimoto	NAIST			X			
Dave Garagnani	Armag Corp.				X	X	
Dr. Heyno Garbe	Leibniz University, Hannover, Germany		V		V	V	
Petter Gardin	Swedish Armed Forces				X		
Flavia Grassi	Politecnico di Milano			X	X	X	
Mikael Grudd	Roxtec			X			
Gordie Halt	ITC Holdings Corp.					X	

Aaron Harmon	MST EMC Lab			X				
Dr. Yu-ichi Hayashi	NAIST	X	X		X	X	X	X
Fred Heather	U.S. Navy (retired)	X	X			X		X
Greg Hiltz	Canadian Department of National Defence (retired)					X		X
Harry Hodes	NASA JSC					X	X	
Takuya Hoshino	NTT-AT				X		X	
Tom Hussey	Self-employed					X		X
Kengo Iokibe	Okayama University, Japan				X	X		
Takeshi Ishida	Noise Laboratory				X			
Shinobu Ishigami	Tohoku Gakuin University				X			
Tom Jerse	Boeing	X	X				X	
Randy J. Jost	Utah State University		X					
Shugo Kaji	NAIST						X	
Ken Kawamata	Tohoku Gakuin University				X			
Tara Kellogg	ETS-Lindgren					X	X	X
Youngwoo Kim	Sejong University				X		X	
John Kinneer Jr.	ESD Association					V	X	X
Masahiro Kinugawa	The University of Fukuchiyama				X			X
Taiki Kitazawa	NAIST				X		X	X
Sebastian Koj	Jade HS					X		
John Kraemer	Collins Aerospace, retired						X	
Takayuki Kubo	Noise Laboratory				X			
Hans Kunz	ESD Association / Texas Instruments							X
Jong Hwa Kwon	ETRI	X	X			X	X	X
Matt Lara	APELC	X						
Euibum Lee	Yonsei University				X			
Dr. Frank Leferink	Thales / University of Twente				X	X	X	X
Dr. Sergio Longoria	ETS-Lindgren, Inc.		X			X	X	X
Jim Lukash	Lockheed Martin Space	X				X	X	

Shubhankar Marathe	Amazon	X	X		X		X
David Martinez	Technology Innovation Institute			X			
Mike McInerney	Self	X	X		X	X	X
Jamie McSorley	Northrop Grumman						X
Dr. Nicolasa Mora	University of Columbia	X			X		
Truong Nguyen	NASA				X		
Chris Nicholes	Cherry Clough					X	
Marian-Stefan Nicolae	University of Craiova						X
Petre-Marian Nicolae	S.C. DEVENG S.R.L. / University of Craiova						X
Mike Oliver	MAJR Products Corp.		X				
Robert Olsen	Washington State University					X	
Joshua Peralta	Northrop Grumman						X
Dr. Michal Pietrzyk	TKMS GmbH		X				X
Dr. Andrew Podgorski	Consultant	V					
Dr. William Radasky	Metatech Corporation	X	X	X	X	X	X
Besh Ray	Aether Spectrum Inc						X
Gabriel Vazquez Ramos	NASA						X
Martin Robertsson	Roxtec			X			
Dr. Frank Sabath	Bundeswehr Research Institute, Germany	X	X				
Dr. Edward Savage	Metatech	X					
Martin Schaarschmidt	Bundeswehr Research Institute, Germany	X					
John Simpson	Armag Corp.					X	
Harry Skinner	Intel	X					
Hywel Sollis	UK Ministry of Defence	X					
Abtin Spantman	AETANT				V		
Mark Steffka	IQM Research Institute				X	X	
Dr. Adrian Sun	The Aerospace Corporation		X				X
Kin Sze	QETE / National Defence (Canada)		X		V	X	X
Akiyoshi Tatematsu	CRIEPI			X		X	X

Tetsuya Tominaga	NTT-AT				X				
Minoru Tsukazaki	Otowa Electric, Japan							X	
Akifumi Yamanaka	CRIEPI								X
Bella Yao	GE Aerospace							X	
Jong-Gwan Yook	Yonsei University	X						X	
Takahiro Yoshida	Tokyo University of Science				X				
Corresponding Members									
Dr. Harald Gossner	Intel								
Joe P. Huynh	Boeing/BR&T								
Phil Johns	Johns Hopkins APL								
		20	22	25	29	39	33		

Note: V indicates a virtual attendee during an in-person meeting
 * Joined after annual meeting
 Note: In 2026, 22 previous members attended, plus 10 new members (32 total).

2026 IEEE EMC Society TC 5 Paper Review Process and Tutorials, Special and Regular Sessions

Prepared by
Mike McInerney, TC 5 Chair
5 August 2026

Paper Review Process

- In 2026 we reviewed 17 papers and accepted 16
 - 7 regular papers
 - All accepted
 - 6 special session papers (includes one abstract paper) on EM Information Leakage
 - All accepted
 - 4 abstract papers
 - Three accepted
- In 2025 we reviewed 24 papers and accepted 24

Paper Session Organization

- Three regular sessions were organized
 - EMP Coupling (Tuesday, 3:30 - 5:00 PM) in Cortez D
 - Lightning EMP Topics (Wednesday, 10:30 AM - Noon) in Cortez D
 - EMP Protection (Thursday, 8:30 - 10:00 AM) in Coronado A
 - A lone ESD paper appeared in a TC 9 Modeling and Simulation Session (Thursday, 1:30 - 3:00 PM) in Coronado D
- Best EMC Paper Nominees
 - **Pin-Selective Contactless Data Injection into Multi-Line CMOS Interfaces using Dual-Wave IEMI**, Tyler Bowman, Matthew Landi, Laura Biedermann
 - **Circuit Modeling of Granular Metal Arresters for Nanosecond Transients**, Masahiro Kinugawa, Yuichi Hayashi

Special Sessions

- 2027 EMC Symposium Dallas TX
 - *Electromagnetic Information Security against Leakage and Interference Threats* (organized by Yuichi Hayashi), six papers on Tuesday afternoon

Workshops

- 2027 EMC Symposium Dallas TX
 - *Recent Advances in Numerical Analysis Techniques for Lightning Transients in Power Systems and Electric Facilities* (organized by Akiyoshi Tatematsu and Fernando Silveira), four presentations on Wednesday afternoon
- APEMC 2026, Kuala Lumpur
 - *EMP, HEMP, and IEMI Threats — Theory, Mitigation, and Standards, four presentations (Hayashi delivered the IEMI / information-security talk)*
- EMC Europe 2026, Prague
 - IEMI Risk Management for Critical Infrastructures, Accepted four-slot workshop*

Experiments & Demonstrations

- 2027 EMC Symposium Dallas TX
 - *Lightning Zoning of Aircraft per ARP5414 Experiments & Demonstrations and Their Application in MIL-STD-464D Testing for Radomes and Other Leading Surfaces of Aircraft* (organized by Christophor Hillyard, Tiffany Morisak, and Michael Stone), presented on Tuesday morning

2027 Conference Plans

- We will review the submitted regular papers, abstract papers, and also any special session papers that may be organized for the IEEE EMC+SIPI 2027 in Portland, OR USA, July 12 through 16
- We will support the HPEM reviews for the following conferences, when requested
 - APEMC 2027 in Jeju, South Korea, May 17 through 21
 - Joint EMC Europe / International Symposium in Glasgow, Scotland UK, August 23 through 27

Report on Lightning Activities

Akiyoshi Tatematsu

TC-5 Meeting@Dallas, Texas

August 5, 2026

Main Events with Lightning Related Content in 2026

- APEMC, May 4-7, Kuala Lumpur, Malaysia
- ICLP, May 31-Jun. 5, Sapporo, Japan
- GlobalEM, Jun. 29-Jul. 3, Seoul, Korea
- IEEE EMC & SIPI, Aug. 3-7, Dallas TX, USA
- URSI GASS, Aug. 15-22, Krakow, Poland
- CIGRE Paris Session, Aug. 23-28, Paris, France
- EMC Europe, Aug. 31-Sept. 3, Prague, Czech Republic
- GROUND2026 & 12th LPE, Sept. 13-18, Foz do Iguacu, Brazil
- ICOLSE, Oct. 5-8, South Carolina, United States

Main Events with Lightning Related Content in 2027

- AMS Annual meeting, Jan. 10-14, Denver, **USA**
- IPST, Jun. 6-10, Bologna, Italy
- IEEE EMC & SIPI, Jul. 12-16, Portland, Oregon, **USA**
- URSI AP-RASC 2027, May 23-28, Gran Canaria, Spain
- 2027 Joint EMC Europe & IEEE EMC & SIPI, Aug. 23-27, Glasgow, UK
- SIPDA, Sept. 19-24, São Paulo, Brazil
- APL 2027
- AGU Annual Meeting, Dec. 13-18, Washington, D.C, USA

CIGRE SC C4 Working Groups on Lightning

The scope of Study Committee C4 covers system technical performance phenomena that range from nanoseconds to many hours. Study Committee C4 has been engaged in

- Power Quality
- EMC/EMI
- Electromagnetic Transients and Insulation Coordination
- Lightning
- Power Systems Dynamics Performance, and Numerical Analysis.

W G	T itle
W G C4.43	Ligh tning problem s and lightning risk m anagem ent for nuclear pow er plants
W G C4.57	Guidelines for the Estim ation of O verhead D istribution Line Ligh tning Perform ance and its Application to Ligh tning Protection Design Scope
W G C4.59	Rea l-tim e Ligh tning Protection of the Electricity Supply System s of the Future
W G C4.66	New concept for analysis of m ultiphase back-flashover phenom ena of overhead transm ission lines due to lightning
W G C4.67	Ligh tning Protection of Hybrid O verhead Lines

CIGRE SC C4 Working Groups on Lightning

W G	T itle
W G C4.69	Q uantifying the lightning response of tow er-footing electrodes of overhead transm ission lines: m ethods of m easurem ent
W G C4.70	A pplication of space-based lightning detection in pow er system s
JW G B4/B1/C4.73	I nsulation Coord ination of HVDC O verhead L ines
JW G C4/B4.72	L ightning and sw itching induced electrom agnetic com patibility (EM C) issues in DC pow er system s and new em erging pow er electronics-based DC equipm ent
JW G B1/C4.69	R ecom m endations for the insulation coordination on AC cable system s
JW G B4/B1/C4.73	Surge and extended overvoltage testing of HVDC Cable System s

Papers published on IEEE Trans. EMC in 2026 (issues 1 to 3)

- Tortuous Lightning Channel Impact on the Direct Lightning Performance of Distribution Lines
- Response of Electrical Equipment in a Wind Turbine Subjected to a Direct Rocket-Triggered Lightning Strike
- 3-D Numerical Simulation of the Impact of a Tall Building on the Lightning Strike Outcomes of a Short Building Based on an Improved Stochastic Lightning Model
- Efficient Assessment of Lightning Outages in Transmission Lines Using Surrogate Models
- Modeling and Statistical Characterization of Preliminary Breakdown Pulses in Negative Cloud-to-Ground Lightning Flashes

Examples of this year's activities

Workshop is organized at IEEE EMC + SIPI 2026.

Title:

Recent Advances in Numerical Analysis Techniques for Lightning Transients in Power Systems and Electric Facilities

Presentations at Workshop:

- Recent Advances in FDTD-Based Lightning Transient Analysis Techniques and its Application to Substations and Other Facilities
Presenter: Dr. Akiyoshi Tatematsu
- Recent Advances in the Hybrid Electromagnetic Model and its Application to the Assessment of the Lightning Performance of Transmission Lines
Presenter: Prof. Fernando Silveira
- Development of Circuit-Theory-Based Lightning Transient Analysis Techniques and its Application to Distribution lines and Other Facilities
Presenter: Dr. Akifumi Yamanaka
- From Full-Scale EMT Simulation to Machine-Learning-Assisted Modeling of Lightning Transients in Wind Turbines
Presenter: Dr. Eduard Shulzhenko

Examples of this year's activities

The 38th International Conference on Lightning Protection:
ICLP2026 was held in Sapporo, Japan
from 31st May to 5th June 2026.

This conference is the world's most prestigious and large-scale international conference on lightning protection.



■ Technical Topics:

Lightning physics & phenomenology

Lightning electromagnetic impulse (LEMP) & lightning-induced effects

Lightning protection of power systems, etc.

■ TC-5 officer served as Secretary of the Local Organizing Committee.

■ Number of papers (oral and poster): 215

■ Number of participants: 365 from 37 countries

Examples of this year's activities

The following papers were presented at ICLP 2026.

- A. Tatematsu and A. Yamanaka, “GPU-Accelerated 3-D FDTD Simulation of Lightning Surge Phenomena in Substation Primary and Secondary Circuits”
- A. Yamanaka, K. Ishimoto, and A. Tatematsu, “Development of an EMT Analysis Tool LiCAT Considering the LEMP for Direct Lightning Strikes”
 - Received Young Scientist Award
- D. Tashiro and A. Tatematsu, “Effects of Secondary-Circuit Layout of GIS on Surges Induced on Protection Relay by Intruding Lightning Surges”
 - Received Young Scientist Diploma
- K. Yonezawa and A. Tatematsu, “Application of the FDTD Method to a Ground Electrode Using Conductive Concrete”

Proposed work for 2027

- Papers to be published at international conferences.
- TC-5 officer has served as Convener of WG C4.43 “Lightning problems and lightning risk management for nuclear power plants”

(Original convener of WG C4.43: Dr. Takatoshi Shindo (R.I.P))

The working group has been working on the publication of the Technical Brochure, covering lightning-related incidents in nuclear power plants, lightning protection practices in nuclear power plants in Japan, France, the United Kingdom, and Switzerland, etc.

2026 IEEE INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY, SIGNAL & POWER INTEGRITY



IEEE EMC SOCIETY TC-5 • EM INFORMATION LEAKAGE SUBCOMMITTEE

2025–2026 Activity Report

Yuichi Hayashi • TC-5 Meeting • Dallas • August 5, 2026

2026 activity overview

4

conferences engaged in 2026

5

organized sessions

41

named presentation slots

1

plenary lecture (GlobalEM)

2025 BASELINE

APEMC 2026 special session
EMC Europe 2026 special session and tutorial
— the two activities planned in the Raleigh report

COMPLETED IN 2026

APEMC 2026, Kuala Lumpur — six-paper special session
GlobaleM 2026, Seoul — two-part special session, 10 talks
GlobaleM plenary lecture on EM security by design

UPCOMING IN 2026

EMC+SIPI 2026, Dallas — six-paper special session, August 4
EMC Europe 2026, Prague — three-part special session, 12 papers
EMC Europe 2026 — half-day practical TEMPEST tutorial

TECHNICAL ARC OF THE 2026 PROGRAM

Passive leakage

Active IEMI

Measurement and
evaluation

Practical countermeasures

APEMC 2026: special session

COMPLETED

Kuala Lumpur • May 4–7, 2026

SS-05 Electromagnetic Information Security for Modern Hardware — Hayashi / Yook • 6 papers

- Integrated introduction to TEMPEST and side-channel analysis
- EM side-channel analysis of a commercial RISC-V processor
- Reconstruction of spread-spectrum clocked signals
- HDMI cable manufacturing variation and its effect on leakage
- Echo TEMPEST reflected-wave mechanism
- Frequency-domain leakage analysis of an FPGA AES implementation

Outcome

- Two special-session papers were selected as Best Paper / Best Student Paper finalists

GlobalEM 2026: special session and plenary

COMPLETED

Seoul • June 29 – July 3, 2026

SS02 Invisible Electromagnetic Threats and Related Topics — 2 parts • 10 talks

- Part I: PDN leakage • temperature-robust hardware-Trojan detection • Echo TEMPEST frequency-pair estimation • SCA vulnerability of cryptographic hardware • HEMP shielded-cable modelling
- Part II: font-boundary noise mitigation • self-interference suppression in active EM analysis • hardware-Trojan signal hijacking • IEC SC77C update • fibre-optic HEMP protection

Plenary lecture — Hayashi

- “EMC as a Foundation of Hardware Security: Toward Electromagnetic Security by Design”

Contribution

- Information leakage, active interference and established EMC protection practice were presented as a single technical narrative

Dallas 2026: six-paper special session

SCHEDULED

SpS3 • Tuesday, August 4, 1:30–5:00 PM • Cortez D

Electromagnetic Information Security against Leakage and Interference Threats

– Chair Yuichi Hayashi · Co-Chair Michael McInerney · sponsored by TC-5

Six accepted papers

- Introduction to electromagnetic information security against leakage and interference threats — Hayashi / Radasky
- Two-stage demodulation for audio recovery from Class-D amplifier leakage
- Anti-TEMPEST bounded colour perturbation for TMDS links
- Joint amplitude-and-phase analysis for key recovery in active EM analysis
- ARARE evaluation board: abnormal-aging detection using EM backscatter from I/O circuits
- Pin-selective contactless data injection into multi-line CMOS interfaces using dual-wave IEMI

Recognition

- The dual-wave IEMI paper (Kinugawa / Hayashi) is an EMC Best Paper finalist at the 2026 symposium

EMC Europe 2026: special session

SCHEDULED Prague • Tuesday, September 1 • 3 parts / 12 papers • North Hall

Part 1 • 11:00–12:30

Compromising emanations and TEMPEST

- HDMI lane asymmetry and TEMPEST hiding performance
- Audio emanations in laptops: VNA radiation mapping and RF illumination
- Radio-TEMPEST: parasitic video emanation coupled onto an RF transmitter
- Keyfinder: machine-learning recovery of keystrokes from emanations

Part 2 • 14:30–16:00

Measurement methods and active injection

- Handmade near-field probes for EM side-channel analysis
- Contactless data injection into open-drain I²C buses via IEMI
- Reverberation vs. semi-anechoic chambers for audio emanations
- Passive detection of mobile-phone activity with low-cost SDR

Part 3 • 16:30–18:00

Covert channels, Trojans and fault injection

- EMSync: in-board EM covert channel that circumvents EMC protection
- Simultaneous interrogation of two backscattering hardware Trojans
- Power-line side-channel and fault-injection observability on a PC
- Low-cost voltage fault injection for industrial MCU boot security

Special Session — Electromagnetic Information Security: Passive and Active Attacks

Chairs Yuichi Hayashi (NAIST) and Frank Leferink (Thales / University of Twente) · contributors from NAIST, ANSSI, DGA, TÜBİTAK, IETR & Safran, Univ. Rennes, Tomas Bata Univ., Okayama Univ. and Twente

Related invited talk “Information Security Threats Caused by IEMI” in the IEMI risk-management workshop, September 2

EMC Europe 2026: TEMPEST tutorial

SCHEDULED

Monday, August 31 • two 90-minute blocks • North Hall

Electromagnetic Information Security: Practical TEMPEST Threats and Countermeasures

– Organisers: Yuichi Hayashi (NAIST) and Frank Leferink (University of Twente)

Part I — 14:30–16:00 • signal interception and receiver-based analysis

- Overview of the field • TEMPEST receiver analysis tools
- Smartphone-based interception • AES attack using TEMPEST and radio-receiver tools

Part II — 16:30–18:00 • demonstrations, measurement and countermeasures

- Low-cost and antenna-free TEMPEST reproduction • multiple-target and high-speed retroreflector interrogation
- Reverberation-chamber TEMPEST measurement • continuous zoning and shielding-integrity monitoring

Reach

- Speakers from national agencies (ANSSI, NUKIB), industry (Rohde & Schwarz, Thales) and academia (Twente, Rennes, NAIST)
- One tutorial covering the full chain from threat feasibility to operational mitigation

2027 pipeline: Jeju, Glasgow & Portland

APEMC 2027 — Jeju, Republic of Korea · May 17–20, 2027 · Grand Hyatt Jeju

- Will propose a Special Session on electromagnetic security and side-channel analysis (already offered to the organising committee)
- Special-session proposals due September 15, 2026 · workshop and tutorial proposals due October 16, 2026

Joint EMC Europe & IEEE EMC+SIPI 2027 — Glasgow, United Kingdom · August 23–27, 2027

- Will propose both a Special Session and a Tutorial Session, extending the Prague programme
- Aim: broaden European participation and keep the leakage / IEMI tracks side by side

Annual IEEE EMC+SIPI 2027 — Portland, Oregon · July 12–16, 2027 · Hyatt Regency Portland

- No special-session proposal planned; the subcommittee will contribute regular TC-5 papers

Immediate actions

- Confirm organisers and speakers · reuse the 2026 topic pipeline · fix proposal and submission milestones

HEMP/IEMI Subcommittee Report to TC 5 (HPEM)

Mike McInerney

5 August 2026

TC 5 HEMP / IEMI Subcommittee

- Created in 2020 to improve the organization of the website and ease subcommittee reporting
 - Mike McInerney is the General POC for the HEMP / IEMI subcommittee
 - Bill Radasky is the POC for the HEMP subcommittee
 - Sven Fisahn is the POC for the IEMI subcommittee

Recent HEMP Activities

Report from the TC 5 Subcommittee on HEMP
Compiled by William Radasky
30 July 2026

Recent HEMP Activities

- Several important HEMP activities have continued since our TC5 meeting in 2025
 1. The IEC is planning to maintain several existing standards and to start work on a new standard to establish sample radiated waveforms for the study of geomagnetic storms and its coupling to long power lines
 2. CIGRE Study Committee C4 is continuing its work to protect high voltage power control house electronics against HEMP
 3. Power companies are investigating ways to protect their electronics from HEMP
 4. GlobalEM 2026 Conference was held in Seoul, South Korea in June/July 2026
 5. Items 1 and 3 are discussed in more detail in the following two charts

Plans for IEC SC 77C

- Maintenance of existing HEMP standards
 - Update IEC 61000-4-24, covering the testing of protective devices for HEMP conducted transients
 - Update IEC 61000-4-33, covering measurement methods for high power transient parameters
 - Update IEC 61000-5-5, covering the specification of protective devices for HEMP conducted disturbances
 - Update IEC 61000-6-6, covering generic HEMP immunity standards for indoor equipment
- Development of a new standard (IEC 61000-2-X) to define the geomagnetic storm radiated and conducted environment
- All work is planned to begin in the latter part of 2026

Power Company Activities

- Over the past 5 years several power companies are evaluating the shielding effectiveness of their existing transmission substation buildings to protect internal electronics
 - Both improvements of shielding effectiveness are planned as are the building of new substation buildings with higher SEs
- One U.S. power company has upgraded their current metal building design to improve its shielding effectiveness using typical EMC protection features
 - Screen mesh windows
 - Shielded yard cables or the use of fiber optic cables
 - Better external cable bonding before entry into buildings
 - Testing before and after changes to demonstrate the effectiveness of improvements
- Many of the improvements in protection are based on papers from IEEE EMC Conferences and Transactions and IEC standards

Recent IEMI Activities

Report from the TC 5 Subcommittee on IEMI
Compiled by Mike McInerney
5 August 2026

IEMI Conference Activities - 1

EMC Europe 2026, Prague Czech Republic, 31 AUG – 4 SEP 2026

- *IEMI (Intentional Electromagnetic Interference) Risk Management for Critical Infrastructures (Part 1), Workshop*
 - *Welcome and Introduction*, Marian Lanzrath, Sven Fisahn, Janet O'Neil
 - *Concepts of EMC Risk Management*, Frank Sabath
 - *IEMI vulnerability of critical infrastructures and electronic systems*, Mario Castaneda-Valderrama
 - *Information Security Threats Caused by Intentional Electromagnetic Interference (IEMI)*, Yu-ichi Hayashi
- *IEMI (Intentional Electromagnetic Interference) Risk Management for Critical Infrastructures (Part 2), Workshop*
 - *Shielding and Hardening Strategies for HEMP/IEMI-Protected Control Centers*, Garth D'Abreu
 - *Improvement of HPEM test methods – lessons learned based on a reference test setup*, Marcus Wikner
 - *IEMI & Information security - Vulnerability of Sensors*, Louis Cesbron Lavau
 - *Electromagnetic Resilience of Automated Vehicles*, Erik Kampert

IEMI Conference Activities - 2

EMC Europe 2026, Prague Czech Republic, 31 AUG – 4 SEP 2026

- IEMI (Intentional Electromagnetic Interference) Risk Management for Critical Infrastructures (Part 3), Workshop
 - *HPEM threats and their coupling behaviour to Electronic Systems*, Sven Fisahn
 - *Concepts of application for HPEM detection systems*, Christian Adami
 - *Lightning, HEMP and Generalised Pulse Mitigation Strategies*, Thomas Chau
 - *HEMP Measurement Techniques IEC 61000-4-24*, Taeheon Jang
- IEMI (Intentional Electromagnetic Interference) Risk Management for Critical Infrastructures (Part 4), Workshop
 - *An introduction to Cloud Modeling for Systematic EMC Risk Assessment*, Robert Michels
 - *IEMI threat for space critical infrastructure*, Marian Lanzrath
 - *Summary and Conclusion + Plenary discussion*, Marian Lanzrath, Sven Fisahn, Janet O'Neil

IEMI Conference Activities - 3

EMC Europe 2026, Prague Czech Republic, 31 AUG – 4 SEP 2026

- *Intentional EMI, EMP, High Power Electromagnetics (Part 1), Technical Session*
 - *Transient Dazzle Response of a Digital Automatic Gain Control Under Intentional Interference*, Tom Billaux, Jeremy Raoult, Vincent Pouget, Benjamin Saggin, Patrick Hoffmann
 - *Bulk Current Injection for Alternative Intentional Electromagnetic Interference Testing of CAN Bus*, Unai Aizpurua, Erik Kampert, Stefan Dickmann
 - *Development of a GTEM Cell for Radiated HEMP with Discharge Suppression Using Dielectric Materials*, Takuya Hoshino, Masaharu Sao, Tetsuya Tominaga, Minoru Tsukazaki
 - *Susceptibility Analysis of Microcomputer-Based Protective Relays to Spatial Transient Electromagnetic Disturbances*, Weidong Zhang, Guoqing Zhang

IEMI Conference Activities - 4

EMC Europe 2026, Prague Czech Republic, 31 AUG – 4 SEP 2026

- *Intentional EMI, EMP, High Power Electromagnetics (Part 2), Technical Session*
 - *ADC Susceptibility under Conducted and Near-Field Back-Door IEMI*, Nicolas Castagnet, Fabien Escudié, Alexandre Boyer
 - *Numerical and Experimental Investigation of a High-Voltage-Pulse Compatible GTEM-Cell with a Dielectric-Filled Input Port*, Minoru Tsukazaki, Takuya Hoshino, Masaharu Sao, Tetsuya Tominaga
 - *Three.Dimensional Electromagnetic and Circuit Co-Simulation for Printed Circuit Boards Incorporating Nonlinear Components*, Soki Akutsu
 - *Functional Susceptibility Modeling of Electronic Systems under IEMI*, Antoine Duguet, Justin Sobas, Tristan Dubois

IEMI Conference Activities - 5

Asia-Pacific EMC (APEMC) 2026

- EMP, HEMP, and IEMI Threats — Theory, Mitigation, and Standards
- Half-day workshop, May 2026
 - International speakers from academia and industry
 - Topics included: IEMI theory, HPEM, EMP/HEMP environments, Mitigation techniques, EMC standards, Protection technologies.

GlobalEM 2026

- Workshop/tutorials sprinkled throughout the symposium, June ~ July 2026
 - Focus on High-power electromagnetics, EMP, HPM, IEMI, protection, modeling, measurements, and standards.

IEMI Conference Activities - 6

EMC Europe 2025, Paris, France, 1 – 5 SEP 2025

- *Intentional EMI & EMP, High Power Electromagnetics (Part 1)*
 - *Estimating Characteristic Parameters of the Field Radiated by an IEMI Source*, F. Sabath
 - *Extensive Susceptibility Analysis of a μ C-Servomotor Chain to IEMI*, J. Sobas, A. Duguet, G. Duchamp, T. Dubois
 - *Study on the Damage Effect of PIN Limiter Under High-Power Microwave Injection*, R. Zheng, S. Tang, Z. Zhou, C. Li
 - *Dazzle Effect on Automatic Gain Control Circuits Exposed to Intentional RF Pulsed Interference*, T. Billaux, J. Raoult, B. Saggin, P. Hoffmann
- *Intentional EMI & EMP, High Power Electromagnetics (Part 2)*
 - *Real-Time Jammer Localization Inside a Building Based on a Machine Learning Approach*, P. Monferran, J. Villain, A. Costanzo, A. N. de São José, V. Deniau, C. Gransart
 - *Methodology for Studying a Localized and Non-Intrusive Pulsed Current Injection on an Active Powered System*, L. Durand, T. Dubois, J. Vinassa, G. Mejecaze, L. Curos, F. Puybaret
 - *A Frequency-Domain Technique to Verify the Equivalent Area of a D-Dot Sensor*, D. Gapillout, T. Batista, B. Daout, M. Sallin
 - *Protecting Sensors from IEMI: Shielding, Absorbers, and Mitigation Techniques*, L. C. Lavau, M. Suhrke, M. Lanzrath, P. Knott

IEMI Conference Activities - 7

INCEMIC 2025 – International Conference on Electromagnetic Interference & Compatibility

- Two-day workshop/tutorials preceding the conference, November 2025
 - Covers EMI/EMC broadly and typically includes military, protection, shielding, computational EM, and infrastructure topics relevant to IEMI.

IEEE EMC+SIPI 2025 Symposium

- Workshop/tutorials sprinkled throughout the symposium, August 2025
 - Tutorials and workshops on EMI generation, shielding, military EMC, power electronics EMC, aerospace EMC, computational EMI, and mitigation techniques.

IEMI Publications – 1

SoK: Security of Cyber-Physical Systems Under Intentional Electromagnetic Interference Attack

- Accepted to USENIX Security 2026, August 2026
- Review
 - Probably the most comprehensive IEMI publication of 2026.
 - Introduces a unified taxonomy based on: coupling paths, target samplers, attack objectives, application domains, defensive techniques.
 - Covers more than 80 prior IEMI studies across IoT, vehicles, industrial control systems, healthcare, and power systems.

Invisible Smoke: Analyzing and Enhancing the Security of Smoke Detectors Under Intentional Electromagnetic Interference

- MDPI Sensors Journal, July 2026
- Experimental Study
 - Studies how electromagnetic interference can disrupt smoke detectors.
 - Explores attack feasibility and proposes practical detection and mitigation methods for fire safety systems..

Analysis of Intentional Electromagnetic Interference Effects on PWM Command Interpretation in UAV BLDC Motor Controllers

- MDPI Systems Journal, June 2026
- Research Article
 - Examines how IEMI alters PWM command interpretation in brushless DC motor controllers.
 - Relevant for drone resilience and autonomous systems.

IEMI Publications – 2

Design of Half Impulse Radiating Antenna (HIRA) With Tapered Transverse Electromagnetic (TEM) Horn–Based Novel Feeding Mechanism for Intentional Electromagnetic Interference (IEMI) Applications

- International Journal of Antennas and Propagation, April 2026
- Research Article
 - Focuses on high-power antenna engineering for controlled laboratory testing.
 - Reports roughly a 60% increase in peak radiated electric field compared with conventional feed designs.

Low-Profile Broadband Planar Log-Periodic Dipole Array Antenna for IEMI Detection Application

- IEEE Transactions on Electromagnetic Compatibility, April 2026
- Experimental Study
 - Presents a compact planar log-periodic antenna optimized for detecting broadband IEMI signals in the 2–6 GHz range.
 - Relevant for monitoring and sensing rather than attack generation.

EMI Against Power Substations: Issues, Countermeasures, Challenges and Perspectives

- MDPI Energies Journal, February 2026
- Assessment and Protection Remedies
 - Electromagnetic coupling mechanisms, vulnerabilities of protection relays and substation electronics, shielding, filtering, grounding, resilience planning.
 - Particularly relevant for critical infrastructure security.

Electromagnetic Warfare Intentional Interference: Victim Risk Assessment

- IEEE Transactions on Electromagnetic Compatibility, February 2026
- Research Article
 - Rather than focusing on attack generation, this paper develops a decision framework to estimate unintended impacts on nearby civilian or allied electronic systems during intentional interference operations.

IEMI Publications – 3

Intentional Electromagnetic Interference Attacks on Facial Recognition

- To be published in IEEE/IAPR IJCB (International Joint Conference on Biometrics), 2026
- Experimental Study
 - Demonstrates that commercially available RF equipment can degrade or manipulate facial recognition capture pipelines through electromagnetic interference.
 - Introduces a public dataset for evaluating robustness against RF-induced interference.

Application of Systems-of-Systems Theory to Electromagnetic Warfare Intentional Electromagnetic Interference Risk Assessment

- MDPI Systems Journal, April 2025
- Research Article
 - Focuses on risk assessment rather than hardware experiments.
 - Introduces a systems-of-systems methodology for evaluating cascading impacts of IEMI on interconnected systems and critical infrastructure.

Remote fault injection attack against cryptographic modules via intentional electromagnetic interference from an antenna

- Journal of Cryptographic Engineering, April 2025
- Research Article
 - Demonstrates that carefully applied electromagnetic interference can induce computational faults in cryptographic modules from a distance.
 - Discusses implications for hardware security and evaluates shielding effectiveness.

TC5 Subcommittees

- We encourage all TC 5 committee members to submit information on TC 5 related activities to subcommittee POCs
 - Lightning
 - EM (Information) Leakage
 - HEMP / IEMI
 - ESD

ESD Update

John Kinnear

john.kinnear@esda.org

TC-5 (HPEM) Meeting

August 2026



ESD Association

- Founded in 1982 in Rome, NY
- Accredited by ANSI to write and produce standards on electrostatics
 - Device Standards
 - Factory Control and ESD control materials
- Certification Programs
 - Professional
 - Facility
- Technology roadmap for devices
- TAG for IEC TC 101 - Electrostatics

ESD Standards – 2026 Updates

- 9 ESD standard documents have been published:
 - ANSI/ESD SP3.3-2026 - Periodic Verification of Air Ionizers
 - ANSI/ESD SP3.4-2026 - Periodic Verification of Air Ionizers Using a Small Test Fixture
 - ANSI/ESD STM4.1-2026 - Worksurfaces - Resistance Measurements
 - ANSI/ESD S8.1-2025 - Symbols
 - ANSI/ESD SP14.5-2026 – Near Field Immunity Scanning – Component/Module/PCB Level
 - ANSI/ESD SP17.1-2026 – Process Assessment Techniques
 - ANSI/ESD S541-2026 - Packaging Materials for ESD Sensitive Items
 - ESD TR18.0-01-25 – ESD Electronic Design Automation Checks
 - ESD TR20.20-2025 – ESD Handbook
- Upcoming publications
 - ANSI/ESD STM12.1 – Seating – Resistance Measurements
 - ANSI/ESD STM7.1 - Floor Materials - Characterization of Materials
 - ANSI/ESD STM11.31 – Bags
 - ANSI/ESD STM15.1 – Methods for Resistance Measurement of Gloves and Finger Cots
 - ANSI/ESD STM97.2 - Floor Materials and Footwear - Voltage Measurement in Combination with a Person

2026 IEEE INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY, SIGNAL & POWER INTEGRITY



Intelligent IoT-Based System for Precision Agriculture: AI-Driven Big Data Monitoring and Microclimate Optimization for Crop Management in Solariums

Marian – Ștefan NICOLAE - IT Systems Designer

Project Mission & Objectives

Deploy an intelligent Agriculture 4.0 system — IoT + Big Data + AI — to monitor and manage microclimate parameters and crops in solariums.

TRL 4

Existing IoT system — soil & air monitoring

TRL 9

Complete intelligent precision-agriculture system

Core Objective

Transform raw sensor data into actionable irrigation, fertigation and climate-control recommendations — moving beyond passive monitoring toward intelligent, data-driven crop management.

SO1

Microclimate Monitoring Module

SO2

AI Interpretation Algorithm

SO3

Real-Time Alert System

SO4

Predictive Analysis Module

SO5

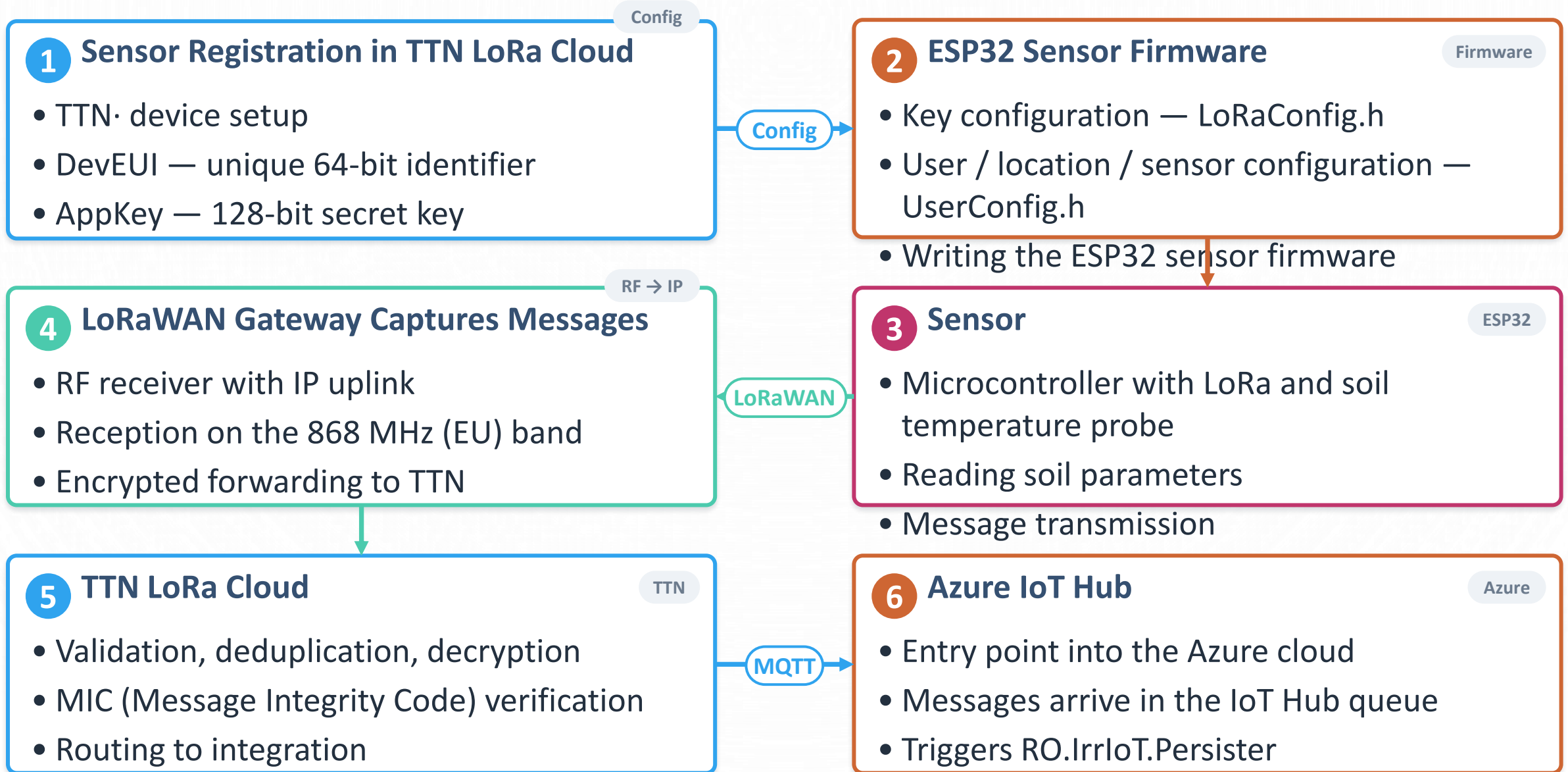
Intuitive Monitoring Platform

IoT Sensing

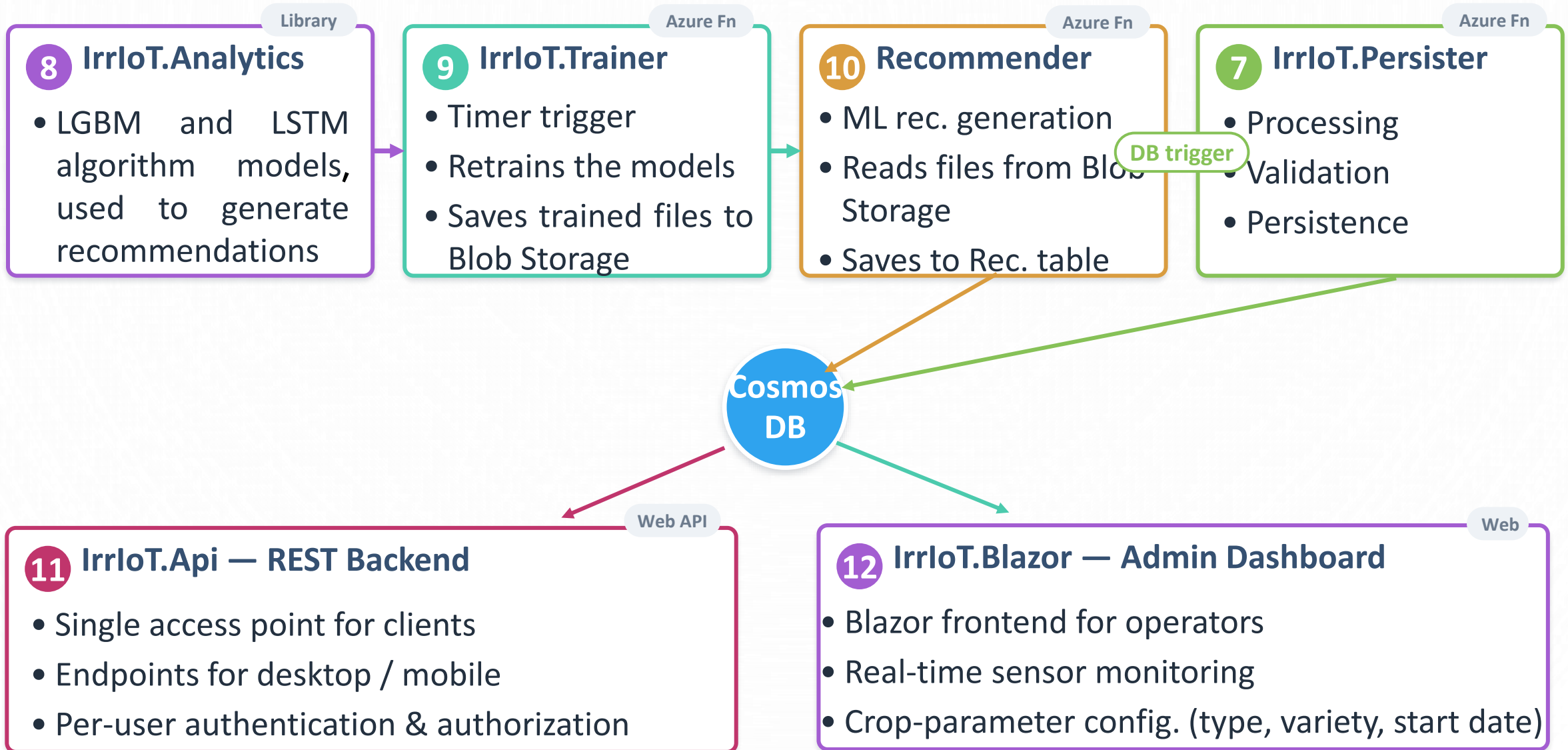
Nine heterogeneous channels with distinct temporal dynamics must be correlated jointly to produce coherent, crop-relevant agronomic recommendations.

Sensor channel	Unit	Valid range	Agronomic relevance
Air temperature	°C	0 – 50	Transpiration rate, photosynthesis
Relative air humidity	%	5 – 100	Vapour-pressure deficit calculation
Atmospheric pressure	hPa	900 – 1100	Meteorological correlation
Soil temperature	°C	5 – 40	Root activity, nutrient uptake
Soil volumetric moisture	% vol.	0 – 100	Primary irrigation target variable
Soil electrical conductivity	a.u.	0 – 2000	Nutrient level, fertigation trigger
Light intensity	Lux	0 – 200,000	Photosynthesis, transpiration demand
Node supply voltage	a.u.	configurable	Sensor-node health monitoring
Radio signal strength	dBm	configurable	Connectivity quality

End-to-End Sensor Data Flow (1/2) — Field Layer & Cloud Ingestion



End-to-End Sensor Data Flow (2/2) — Processing, AI & Access Layer



EMC & Power Quality Study — Key Results

Wireless-sensing reliability (signal integrity, packet loss, transmission security) was validated through a virtual IoT greenhouse testbed (a digital twin).

Disturbance Sources Identified

Inductive-load transients (water pump), SMPS switching noise, relay-switching EMI, long cables & exposed pins acting as unintentional antennas.

Monitoring Methodology

Indirect EMC assessment via a Grafana + InfluxDB dashboard, continuously logging RSSI, packet-loss rate, data rate and EMI-source correlation.

–57 dBm

Average RSSI
(good signal)

0%

Packet loss
(baseline)

98.5%

Data integrity
(2,880 daily readings)

~30 s

Sync latency

Conclusions, Risks & Next Steps

Where the System Stands Today

Field-to-cloud data collection is fully operational (sensors, firmware, gateways, cloud ingestion). The Big Data/AI component has a defined architecture (LightGBM + LSTM); implementation is pending sufficient historical data.

Highest-Impact Risk

Technical complexity of the AI component, given the iterative nature of model development, validation and refinement — mitigated via periodic contractual monitoring and intermediate progress reports.

Recommended Next Steps

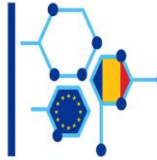
- **Maintain uninterrupted sensor-network operation as the foundation for AI training data**
- **Finalize the data-format documentation between firmware and analytics components**
- **Begin multi-species monitoring experiments to validate calibration.**



**Co-funded by
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Thank You

Questions & Discussion

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