The National Disaster-Warning Case Study on heain-core

The Rain Flood in Bangkok, September 2026
Replaying the Real Event on a 39-Node Simulation: Data at the City, the Button at DDPM, Water Across a Provincial Line, with Core C5

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Repository: github.com/JakkritB/heain-core (casestudies/disaster/, e2.sh)

Abstract

Bangkok's flood of late September 2026 came from days of rain that TMD warned of from 22 September, yet the first Cell Broadcast went out at 09:22 on 26 September, after flooding had begun the day before [9][10]. Reports say the data sat with the city (BMA) while sending sat with DDPM, and the steps between them were unclear [11]. On 29 September water from Pathum Thani crossed the Khlong Hok Wa dike into Khlong Sam Wa, and three districts were still flooded on 16 October [9][12]. This Volume 4 of the case study [1] reports the replay of this event (series E2).

The author replayed 21 September to 16 October on a 39-node layout adding Pathum Thani province with the Hok Wa dike, a rain station at Khlong Sam Wa, and Sai Mai and Nong Chok districts, in two runs: "as it happened" and "with HEAIN". Requirements R15–R18 test a hazard from outside the warner's area, Push Through sending, a gate that affects two provinces (a synthetic scenario), and weeks of warnings without alert fatigue.

The first run on core C4 passed every check with one expected gap: evidence from the dike gauge in Pathum Thani stopped at its own office, so Khlong Sam Wa waited about 3 hours for its own gauge. Core C5 (ed74e31) added evidence.reach, a rule at the Primary that lets evidence naming a Zone outside its subtree climb to the Primary and come down to the Zones allowed. After the fix the HEAIN run passed 26 of 26 checks with no gap. The first CAP went out 0.03 hours after TMD's warning instead of 105.42; the dike's evidence reached Khlong Sam Wa in 3 seconds; the siren sounded 0.08 hours and the warning went out 0.52 hours after the overtopping, instead of 8.83; and zone-days under water without a current warning fell from 30 to 0 of 42.

Keywords: *HEAIN Framework, heain-core, Bangkok Flood 2026, Event Replay, Push Through, Cross-provincial Evidence, evidence.reach, Alert Fatigue, CAP 1.2, Cell Broadcast*

1. Introduction

1.1 Background

Volume 1 concluded that the gaps real events expose lie in the paths around a warning, not in the warning itself, and that the HEAIN Framework [3] is designed to manage those paths [1]. Volume 5 showed one side of this in Hat Yai: data and authority at different tiers [2]. This volume shows two more sides exposed by Bangkok's 2026 flood. The first is data and the sending button in different agencies; the second is a hazard coming from outside the warner's area. The event also tests what Hat Yai did not: warning continuously for three weeks without people growing used to the warnings.

Bangkok's flood differs from Hat Yai in another way. In Hat Yai communications failed with the power; in Bangkok the network worked throughout. The delay therefore came not from machines or cables but from rules nobody had agreed in advance about who may send what at once. That makes this event the most direct test of P5 as a tool for delegating authority.

1.2 Why the Bangkok flood

Figure	Meaning	Source
22 Sep	TMD warns of a strong monsoon trough and passes it to DDPM and BMA	[9]
26 Sep 09:22	First Cell Broadcast, after flooding at many points from 25 Sep	[9][10]
29 Sep 16:49	Second Cell Broadcast, to Sai Mai, Khlong Sam Wa and Nong Chok, after water crossed the Hok Wa dike	[9]
210 mm	The highest accumulated rainfall reported (some sources cite about 300 mm)	[13]
60–70 mm/h	The drains' design capacity; in practice about 50–60% of it	[9]
50 districts	Declared disaster areas on 25 Sep	[9]
196,008 households	In the 3 districts still flooded on 16 Oct (Lat Krabang, Nong Chok, Min Buri)	[12]
4 / 67 deaths	In Bangkok / nationwide as of 16 Oct, per DDPM figures	[12]
About 12.3 billion baht	Damage, 25–29 Sep, excluding homes, vehicles and crops	[14]

Table 1 — Key figures of the 2026 Bangkok flood

1.3 Status of this volume

This deployment is the author's hypothetical design, not a project of DDPM, BMA or any agency, and no agency has reviewed it. Event times come from the reports cited. Where sources give none, synthetic values are used and marked: the hour the Khlong Hok Wa dike overtopped (29 Sep 08:00), the hour rain exceeded drain capacity (25 Sep 02:00), the rain and water-level curves, and the locations of the gauge and gate on Khlong Hok Wa. The scenario of a gate affecting two provinces (R17) is entirely synthetic, as no gate decision appears in the reports. No real person is named, and the difference between the two runs is not a criticism of the people who did the work.

1.4 Research questions

- **RQ1 From warning to public.** When TMD warns and rain exceeds drain capacity, how fast can the system send CAP saying what to do in each district?
- **RQ2 Push Through.** Can the agency holding the data (BMA) send warnings itself within the limits the agency holding the button (DDPM) delegates, and can DDPM decide across tiers within a deadline above those limits?
- **RQ3 A hazard across a line.** Can evidence from a dike gauge in Pathum Thani confirm a warning in Bangkok's Khlong Sam Wa district, without letting any station warn any area?
- **RQ4 A two-province decision.** Does opening a gate that affects two provinces need a quorum from both sides (synthetic scenario)?
- **RQ5 A protracted hazard.** Can the system warn for three weeks with Updates and Cancels under a per-area cap, with no day of flooding left without a current warning?

1.5 Contributions

1. A summary of the real event as a timeline and 5 systemic failures, with requirements R15–R18 (Sections 2 and 3).
2. The 39-node e2 layout, the run's rules, and predictions before running (Section 4).
3. The first run on core C4 and the gap in cross-provincial evidence (Section 5).
4. Core round C5: the evidence.reach rule and the reruns (Section 6).
5. Final results, lessons, and proposals for a provincial pilot in Bangkok (Sections 7 to 10).

2. The Real Event

This section summarizes the event from the reports cited. Figure 1 shows the timeline as reported, alongside what happened in the HEAIN run.

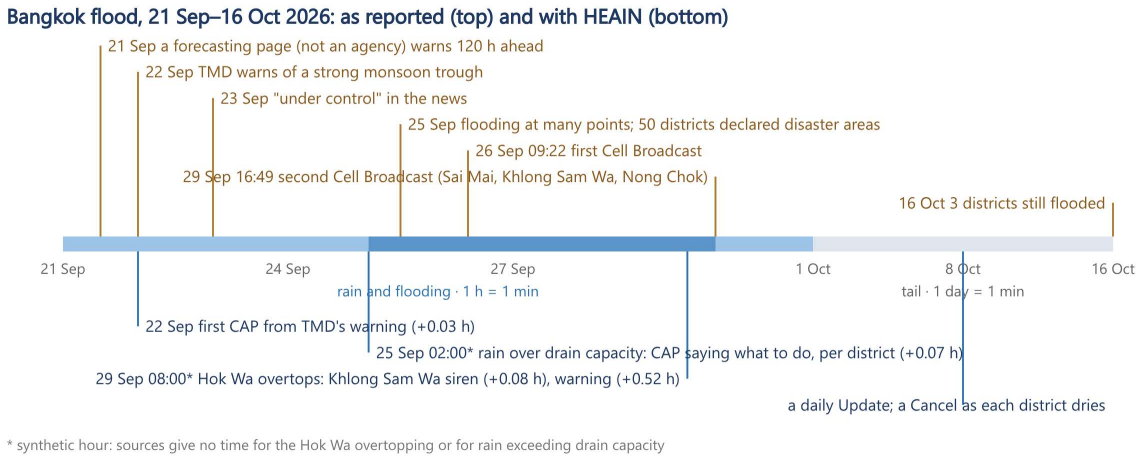


Figure 1 — The Bangkok flood timeline as reported (top) and when the system acted in the HEAIN run (bottom)

2.1 Before the rain

On 21 September a weather-forecasting page, not a government agency, warned 120 hours ahead based on the ECMWF model. On 22 September TMD warned of a strong monsoon trough and passed it to DDPM and BMA. On 23 September officials told the news it was "under control", while BMA drained its canals and readied pumps [9]. Reports note that this confidence drowned out TMD's warning, and that neither the forecast's uncertainty nor the worst case was communicated [9]. Data that could give early warning existed for days but never became a message to the public.

2.2 During the flood

Time	Event	Source
24 Sep	Rain begins; DDPM orders 24-hour readiness; BMA warns online of flooded roads	[9]
25 Sep	Flooding at many points; BMA declares all 50 districts disaster areas and opens shelters	[9]
26 Sep 09:22	First Cell Broadcast (DDPM with BMA)	[9][10]
27 Sep	Cabinet declares special holidays on 28–29 Sep in 4 provinces	[9]
29 Sep	Water from Pathum Thani crosses the Khlong Hok Wa dike into Khlong Sam Wa	[9]
29 Sep 16:49	Second Cell Broadcast, to Sai Mai, Khlong Sam Wa and Nong Chok	[9]
16 Oct	3 districts still flooded, 196,008 households; nationwide 20 provinces and 2,164,180 people still affected	[12]

Table 2 — Timeline of the flood as reported

2.3 Data at the city, the button at DDPM

DDPM sends Cell Broadcasts and does not send a critical-level warning without a hazard level confirmed by BMA, while BMA holds the rain-station and water-level data. Reports say BMA's executives admitted the sending was late because of confusion over the steps and because the two had never drilled together, while the Interior Ministry side said BMA could have used the existing system but did not ask [11]. After the event, both agencies moved to a Push Through model: BMA writes the message and DDPM presses send at once. Transferring authority so BMA can press send itself is still under negotiation [11]. PreventionWeb concluded that the event exposed cracks in the city's disaster defences [15].

2.4 Rain, drainage and water across the line

The highest accumulated rainfall reported was 210 mm [13]. Bangkok's drains are designed for 60–70 mm per hour but work at about 50–60% of that in practice, with total pump capacity of about 1,200 m³ per second [9]. The water that crossed the Khlong Hok Wa dike came from Pathum Thani, so the hazard came from outside the area of Bangkok's warning sender. The data that could give early warning lay in another province, and there was no agreed way for it to cross the provincial line as grounds for a warning in Bangkok.

2.5 Systemic failures

1. **Data and button in different agencies.** No rule agreed in advance on which data levels allow immediate sending, and no joint drills.
2. **Generic warnings** that did not say what to do in each area: move cars, block house entrances, or go to which shelter.
3. **Water across a provincial line.** The hazard came from outside the sender's area.
4. **Forecast uncertainty not communicated.** "Under control" in the news drowned out TMD's warning.
5. **A protracted hazard.** Water stayed three weeks after the rain stopped, requiring repeated warnings that made people stop paying attention.

3. Requirements

The five failures become four main requirements (R15–R18), reusing R3 and R11 from the Hat Yai event [7]. Table 3 shows the predictions before running against core C4.

#	Requirement	Prediction against core C4
R16	Push Through: BMA sends itself within limits DDPM delegates through P5; above them DDPM approves within a deadline; past the deadline it escalates	pass (H11, H5), though cross-tier approval in this form is untested
R3	Every CAP says what to do in that area: where to move cars, blocking entrances, which shelter, by when	pass (per-Zone templates)
R11	TMD's forecast carries its confidence and worst case; CAP certainty comes from the forecast; a non-government page is kept as unofficial data	pass
R15	The dike gauge on the Pathum Thani side is evidence for a warning in Bangkok's Khlong Sam Wa	gap: a Worker's evidence reaches only its own Zone office
R17	Opening the Hok Wa gate needs a quorum from both provinces and RID (synthetic scenario)	probable pass: approvers from another subtree untested
R18	Three weeks: a daily Update instead of new Alerts, a per-Zone cap, a Cancel when water recedes, messages counted per Zone per day	pass (app, H18), but never tested over weeks

Table 3 — Requirements from the Bangkok flood and predictions before running

The author decided that R15 would run as an expected gap, as R8–R10 did in Hat Yai, and that R17 would be included and labelled in the report as a synthetic scenario [7].

4. Simulation Design

4.1 Layout e2

Layout e2 is the 29-node base layout of Volume 1 plus 10 nodes (Figure 2), without the nodes added for Hat Yai. A new province, sec-pt, stands for Pathum Thani, with a Khlong Hok Wa Zone holding a dike gauge and a gate controller. Khlong Sam Wa gets an added rain station, and Bangkok gets Sai Mai and Nong Chok districts; Nong Chok was one of the three districts still flooded on 16 October.

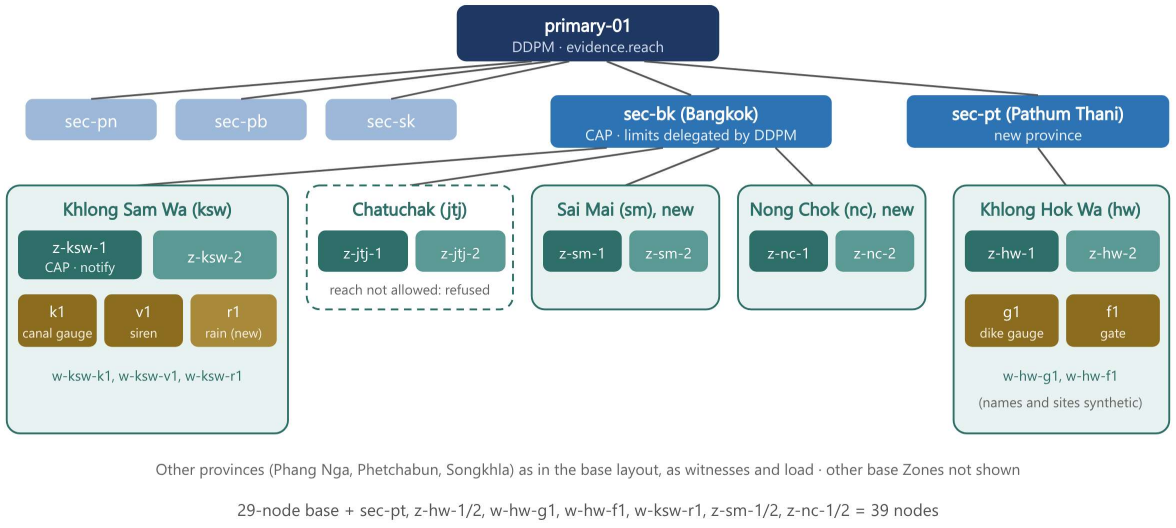


Figure 2 — The 39-node e2 layout: Bangkok and Pathum Thani in detail

Node	Role	Real-world counterpart
sec-pt	New province under the Primary	Pathum Thani
z-hw-1, z-hw-2	Zone office and standby	Khlong Hok Wa, Pathum Thani side (synthetic)
w-hw-g1	Dike-gauge Micro Node	Water-level station on Khlong Hok Wa (synthetic)
w-hw-f1	Gate-controller Micro Node	A gate on Khlong Hok Wa (synthetic)
w-ksw-r1	Rain-station Micro Node	A BMA rain station in Khlong Sam Wa (synthetic)
z-sm-1, z-sm-2	Bangkok Zone	Sai Mai district
z-nc-1, z-nc-2	Bangkok Zone	Nong Chok district, still flooded on 16 Oct

Table 4 — Nodes added in layout e2

4.2 Timeline

T0 is 21 September 00:00. The clock runs at 1 hour = 1 minute until 1 October 00:00 (240 minutes), then at 1 day = 1 minute until 16 October (15 minutes). A run takes about 4.3 hours; a trial uses 10 seconds per hour. The rain and water-level curves are synthetic within the reported figures: a highest accumulated rainfall of 210 mm, and drains working at about 50–60% of design capacity.

Real time	Simulated minute	Event
21 Sep	0	Non-government forecasting page warns: kept as an app event at the Primary, not as evidence
22 Sep	24	TMD warns: official evidence at the Primary, with confidence and worst case
23 Sep	48	"Under control"; BMA drains canals and readies pumps
24 Sep	72	Rain begins
25 Sep 02:00	98	Rain exceeds drain capacity (synthetic hour)
25 Sep	96–120	Flooding at many points; 50 districts disaster areas
26 Sep 09:22	129.4	First Cell Broadcast (as-it-happened run)
29 Sep 02:00	194	Khlong Sam Wa gauge reaches its prepare level: siren armed, awaiting evidence (synthetic)
29 Sep 08:00	200	Water overtops the Khlong Hok Wa dike (synthetic hour)
29 Sep 16:49	208.8	Second Cell Broadcast (as-it-happened run)
1–16 Oct	240–255	Tail: Nong Chok and other districts still flooded; districts dry on different days

Table 5 — Real times and simulated minutes

4.3 The event's apps

- **disapp cap** (CAP 1.2 [5]) at the Primary (DDPM) and at sec-bk (BMA). Per-Zone templates (Khlong Sam Wa, Sai Mai, Nong Chok) that say what to do in the area; certainty from TMD's forecast; per-Zone Update and Cancel; and a new -severity-threshold mode that proposes cap.issue as THRESHOLD_BASED with the template's severity as its value, so p5.thresholds can delegate by severity.
- **disapp feed** at the Primary: TMD's forecast as official evidence.
- **heain-sensor** the rain station (w-ksw-r1) and canal gauge (w-ksw-k1) at Khlong Sam Wa, and the dike gauge at Hok Wa (w-hw-g1).
- **heain-notify** at sec-bk holds the approval ladder from BMA to DDPM.
- **Simulators for testing only** the Cell Broadcast gateway.

4.4 The as-it-happened run

Decisions happen at their real times. BMA has the data but cannot send; DDPM sends only levels BMA has confirmed; messages use the 2026 wording. The system measures the time from TMD's warning to the first CAP, messages that do not say what to do in the area, the time from the Hok Wa overtopping to a warning in Khlong Sam Wa, and messages per Zone per day in the tail.

4.5 The HEAIN run

DDPM delegates limits to BMA through P5 (p5.thresholds at sec-bk up to Severe), so BMA sends CAP up to Severe at once, while Extreme waits for DDPM's decision within a deadline and escalates past it (Figure 3). TMD's forecast goes out with its confidence and worst case. The Khlong Sam Wa siren is armed when the canal gauge reaches its prepare level and sounds on evidence of the Hok Wa overtopping or of Khlong Sam Wa's own overflow. Opening the Hok Wa gate is a proposal at w-hw-f1, with a quorum of BMA, Pathum Thani and RID set at z-hw-1 and inherited below. Over three weeks each Zone gets a daily Update, and a Cancel when it dries.

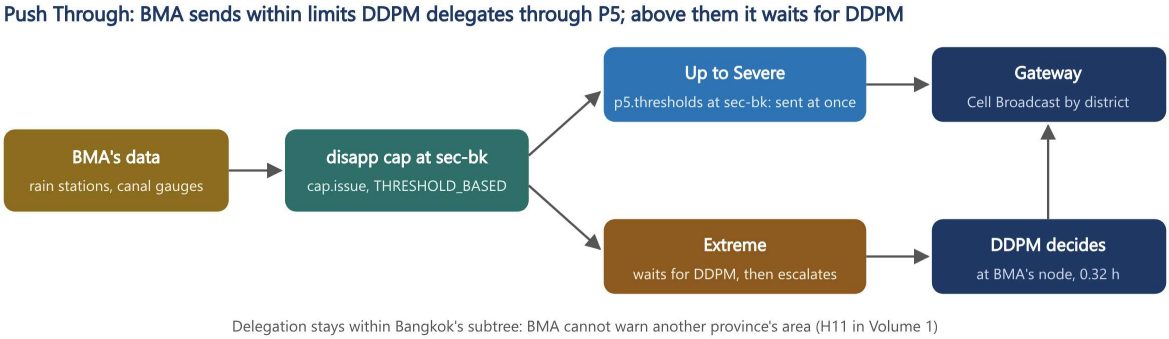


Figure 3 — Push Through in the HEAIN run: limits DDPM delegates to BMA through P5

4.6 Procedure and pass criteria

The step script first runs regressions: rounds 0–5b on the base layout and the Hat Yai trials (because sim.sh, lib.sh and the cap app changed). It then runs the trials and the full runs of both modes, and commits only when every run has zero failed checks. Expected gaps are recorded separately and do not count as failures. Every check uses evidence the system records itself: the audit chain of every node, the simulated gateway's log (msgs.txt), events.log, and each run's metrics.json.

5. First Run (core C4)

5.1 The runs and overall results

The first run took two attempts. The first stopped at the HEAIN trial on a setup check: heain-notify refuses a ladder repeat more often than every 10 seconds, while a quarter-hour of the trial is 2.5 seconds. The second changed only e2.sh to wait at least 10 seconds. Every regression passed: rounds 0–5b (25, 53, 31, 56, 39, 26, 34) and the Hat Yai trials (22, and 33 with gap G8b, which awaited C7). E2's results: 11 of 11 as it happened, and 22 of 22 with HEAIN with one expected gap (R15). The trials gave the same results. The first run's commit is 099f444. Table 6 shows the results.

Measure	As it happened	With HEAIN
TMD's warning (22 Sep) to the first CAP (h)	105.44	0.02
Rain over drain capacity (25 Sep 02:00, synthetic) to a CAP saying what to do (h)	none	0.06
Messages not saying what to do in the area	2	0
Hok Wa overtopping (29 Sep 08:00, synthetic) to a Khlong Sam Wa warning (h)	8.88	3.03
Hok Wa overtopping to the Khlong Sam Wa siren (h)	none	3.05 (own gauge; R15)
The dike's evidence at Khlong Sam Wa's office (R15)	none	0
DDPM's decision on an Extreme CAP (h)	none	0.32
Messages to the public (Cell Broadcast)	2	51
Most messages per Zone in one day	1	3
Zone-days under water without a current warning	30 of 42	0 of 42

Table 6 — First run on core C4: as it happened compared with HEAIN

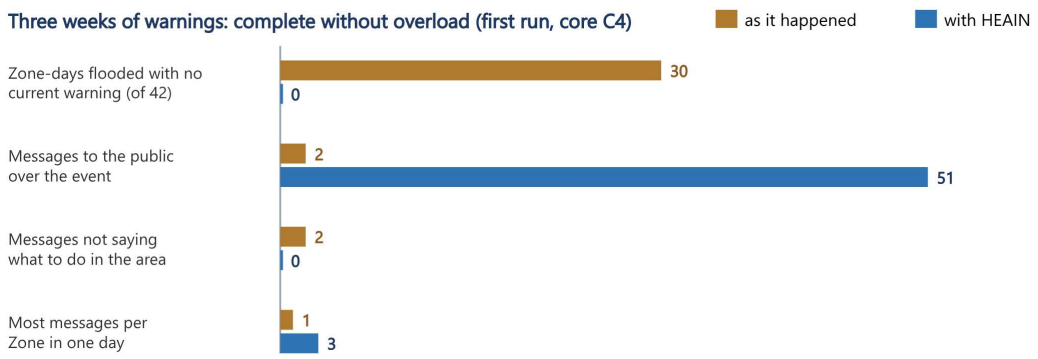


Figure 4 — Three weeks of warnings in the two runs (first run, core C4)

5.2 What passed

Push Through (R16) works. BMA sent warnings up to Severe at once, while an Extreme warning waited for DDPM, which decided at BMA's node in 0.32 hours. **R17 (synthetic).** The gate in Pathum Thani waited until Pathum Thani and RID approved, and BMA's approver, in another province's subtree, completed the quorum. **R18.** A daily Update, a Cancel as each district dried, and Nong Chok still warned until 16 October. The HEAIN run sent more messages (51 against 2), but no more than three per Zone per day, and no day of flooding was left without a current warning. As it happened, 30 of 42 zone-days had no current warning, because the two Cell Broadcasts had no expiry or cancellation and no message said the water was still there.

5.3 The gap: R15

The Hok Wa dike gauge signed a statement naming both its own Zone (hw) and Khlong Sam Wa (ksw). The statement reached its own office, z-hw-1, but never z-ksw-1, which held zero such evidence in all three HEAIN runs. The cause lies in two-source corroboration as built in C1: a Worker sends statements only up to its own Zone office, and a tier head pulls down only statements its parent holds that name its Zone. A statement made in one province therefore never climbed to a tier that sends down to another province. Khlong Sam Wa's siren and warning waited about 3 hours for its own gauge, although the data giving early warning was already in the system.

6. Core Round C5 (ed74e31)

6.1 Proposal and decision

The proposal lets evidence naming a Zone outside its own subtree climb to its parent, as a Worker does with its office; in practice it climbs to the Primary and comes down with the pull-down that already exists. The corroborator still uses only the Zone the node serves, so the evidence counts only where it names that Zone. The key question is who may name what. Without a rule, a single captured station could name every Zone in the country. The author decided to fix it at once as core round C5, with evidence.reach as a P5 rule at the Primary, inherited by every node [7].

Part	What it does
evidence.reach	A Policy key at the Primary, through P5, such as {"hw": ["ksw"]}: stations in hw may name ksw. Format checked by reachFrom
Climbing	A tier head that is neither a Worker nor the Primary forwards new evidence naming Zones other than its origin Zone to its parent, both evidence sent up from below and evidence an app records on the tier head itself
Coming down	Evidence comes down with the pull-down every tier head already does; the corroborator still uses only the Zone the node serves
No loops	Evidence pulled down from the parent does not climb again
Refusal	Evidence naming a Zone the rule does not allow stays at its origin office, is not forwarded, and is recorded as evidence.reach_refused
Routes	Climbing and pulling go through route.For, so the alternate routes of C4 (G9) apply
Audit	Every hop records evidence.forwarded, and the destination Zone records evidence.received
Tests	Unit test TestEvidenceReach and several checks in e2.sh

Table 7 — What core C5 built

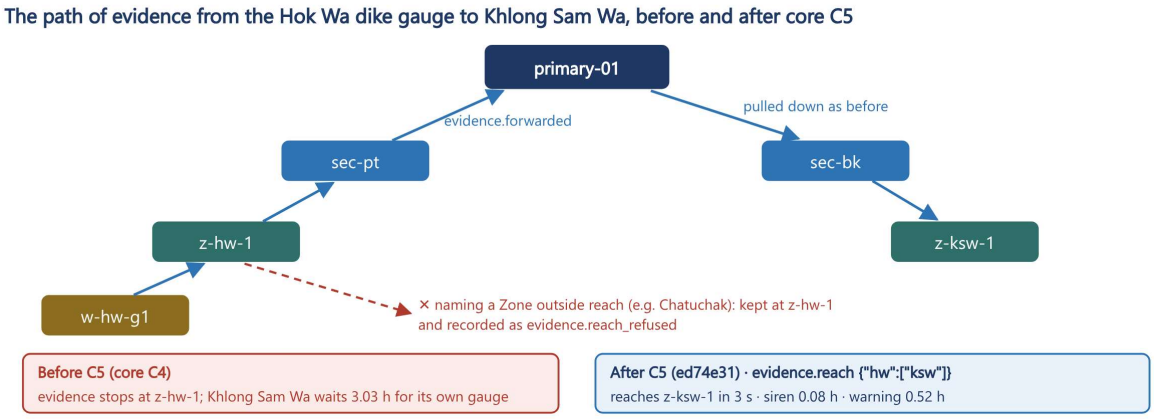


Figure 5 — The path of evidence from the Hok Wa dike gauge to Khlong Sam Wa, before and after core C5

6.2 The C5 runs

In e2.sh the rule evidence.reach {"hw":["ksw"]} is set at the Primary, and R15 is checked several ways: z-ksw-1 holds the dike gauge's statement, and the script records how many seconds it took; z-hw-1 and sec-pt record evidence.forwarded; the siren sounds before Khlong Sam Wa overflows (within 2.5 event hours); BMA warns Khlong Sam Wa at hour 200.5 on the evidence received; and a statement naming Chatuchak stays at z-hw-1 with evidence.reach_refused.

In the first attempt every regression passed: gofmt, the apps, the SDK, notify and sensor, cross-builds, vet, unit tests, conformance, the live tests of heain-notify (51) and heain-sensor (37), the 19 live regressions with test_cert_last_known and test_license, the southern border rounds 0–5b, CineNexus rounds 1, 2, 3, 6 and 7, this case's rounds 0–5b, the Hat Yai trials and E2's as-it-happened trial. But it stopped at the HEAIN trial on R18 alone. On 29 September Khlong Sam Wa had four messages: the daily Update, the warning on the dike's evidence (new with C5), the canal's own overflow, and the evacuation. The old check allowed three, so it was changed to four. The second attempt changed only e2.sh, and core was byte for byte the same as the first (checked by hash), so the regressions were not rerun. The one extra message is an intended result, not overload: it is new information arriving about 2.5 hours earlier than before.

7. Final Results

7.1 As it happened versus with HEAIN

After C5 the as-it-happened run passed 11 of 11 checks and the HEAIN run 26 of 26, with no gap. The trials gave the same results, and both passed again as regressions of core C6, C7, C8 and C10 (Figure 6). Table 8 shows the final results.

Measure	As it happened	With HEAIN (C5)
TMD's warning to the first CAP (h)	105.42	0.03
Rain over drain capacity to a CAP saying what to do (h)	none	0.07
Messages not saying what to do in the area	2	0
Hok Wa overtopping to a warning at Khlong Sam Wa (h)	8.83	0.52
Hok Wa overtopping to the Khlong Sam Wa siren (h)	none	0.08
The dike's evidence to Khlong Sam Wa's office	never	3 seconds
Evidence naming a Zone outside the rule (Chatuchak)	not tested	kept at origin
DDPM's decision on an Extreme CAP (h)	none	0.32
Messages to the public (Cell Broadcast)	2	52
Most messages per Zone in one day	1	4
Zone-days under water without a current warning	30 of 42	0 of 42
Checks passed / gaps	11 / 0	26 / 0

Table 8 — Final E2 results: as it happened compared with HEAIN

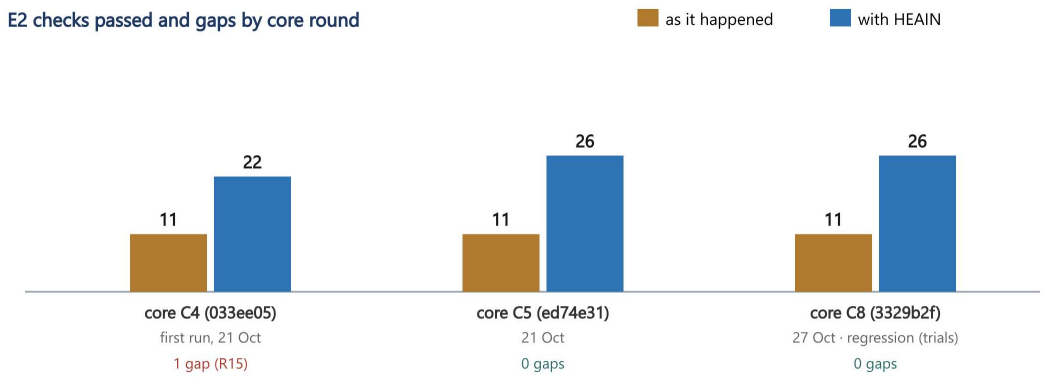


Figure 6 — E2 checks passed and gaps by core round

The time from the overtopping to a warning at Khlong Sam Wa fell from 3.03 hours in the first run to 0.52 hours after C5, because BMA no longer had to wait for its own gauge. The siren, armed when the canal gauge reached its prepare level, could sound within 0.08 hours once evidence from the other province arrived. The rise in messages per Zone per day from 3 to 4 happened only on 29 September at Khlong Sam Wa, and each message carried new grounds of its own.

7.2 Results by requirement

#	Result	Evidence
R16	passed	BMA sent at once within limits up to Severe; Extreme waited for DDPM, which decided at BMA's node in 0.32 h
R3	passed	Messages not saying what to do in the area: 0, against 2
R11	passed	First CAP 0.03 h after TMD's forecast, with its certainty; the non-government page only an event in the audit
R15	passed (C5)	Cross-provincial evidence in 3 s; siren 0.08 h; warning 0.52 h; a Zone outside the rule refused
R17	passed (synthetic)	The gate waited until BMA's approver, in another subtree, completed the quorum
R18	passed	A daily Update; a Cancel when dry; at most four messages per Zone per day after C5; zone-days with no warning 0 of 42

Table 9 — Final results by requirement

8. Discussion

8.1 Answers to the research questions

RQ1. The first CAP went out 0.03 hours after TMD's forecast, and a CAP saying what to do in each district 0.07 hours after rain exceeded drain capacity. **RQ2.** Push Through works when delegation is a clear P5 rule on which levels may be sent directly. DDPM still holds the Extreme decision, and can decide across tiers at BMA's node. **RQ3.** After C5 evidence from Pathum Thani reached Khlong Sam Wa in 3 seconds, and the evidence.reach rule lets a station name only the Zones the Primary allows. **RQ4.** In the synthetic scenario the quorum of two provinces and RID was enforced, and an approver from another subtree could complete it. **RQ5.** Three weeks of warnings used Updates instead of new Alerts, stayed under the per-area cap, and left no zone-day of flooding without a current warning.

8.2 Lessons

- **Delegation must be a readable rule.** The problem in the real event was not who had authority, but that no rule agreed in advance said which levels could be sent at once. Limits in P5 make delegation clear and traceable.
- **Evidence must cross lines, but not everywhere.** Water ignores provincial lines, so evidence must be able to cross them, but letting any station name any area lets a captured station raise warnings nationwide. A rule at the Primary limits where evidence may travel, as Role Ceiling limits where authority may travel [4].

- **More warnings is not overload.** The HEAIN run sent 52 messages against 2, but most were Updates of an existing warning, under a daily cap. What makes people tune out is repeated warnings with nothing new and no end.
- **Unofficial sources have their place.** The forecasting page warned before any agency. The system kept it in the audit but let it confirm nothing: valuable for those who decide, but it should not approve a warning itself.
- **Strict checks must follow new mechanisms.** The first C5 attempt stopped because the message-cap check did not recognize a new kind of warning C5 made possible. Checks must read what a message means, not just count.

8.3 What HEAIN did not fix

HEAIN does not add drain or pump capacity, does not change news statements that drown out warnings, and does not by itself create rules for transferring sending authority between DDPM and BMA under the disaster-prevention law [8]. The system can enforce rules once agreed and show how much faster they make warnings, but the agreement remains a matter for the agencies.

8.4 Threats to validity

Internal. The hour of the Hok Wa overtopping and the hour rain exceeded drain capacity are synthetic, so the 8.83 and 0.52 hours depend on them; the figure tied to reported times is 105.42 hours. **External.** One machine and a virtual network. **Measurement.** Each figure comes from one full run per mode, and some from the first run (marked in the tables). **Context.** The gate scenario is synthetic, and the as-it-happened run was built from reports, not agency records.

9. Proposals for a Bangkok Pilot

The pilot plan in Volume 1 makes Phase 2 a single province, Songkhla or Bangkok [1][6]. From the results of this volume, the author proposes what Bangkok needs. All are proposals still to be discussed with DDPM and BMA.

- **Signed Push Through limits.** DDPM and BMA agree limits in P5 on which levels BMA sends itself, which wait for DDPM, and DDPM's deadline, before the rainy season.
- **Per-district templates.** Each of the 50 districts has a template saying what to do, which shelter and which route.
- **Cross-provincial evidence rules.** evidence.reach for the provinces around Bangkok (Pathum Thani, Nonthaburi, Samut Prakan, Chachoengsao) along canals and dikes, reviewed every year.
- **Joint drills.** A full-chain CAP Exercise between BMA and DDPM before every rainy season.
- **Sizing.** Bangkok's provincial node used about 49% CPU with 50 districts under it in Volume 1's scale test, so Bangkok's machine must be sized separately from an ordinary province.

Indicator	Target
TMD's warning or rain over drain capacity to the first CAP	at most 10 minutes
Messages not saying what to do in the area	0
Extreme requests silent past DDPM's deadline without escalation	0
Cross-provincial evidence to the destination Zone	at most 1 minute
Evidence naming a Zone outside the rule that is counted	0
Zone-days flooded with no current warning	0
Messages per Zone per day in a protracted hazard	within the agreed cap; tracked quarterly

Table 10 — Proposed indicators for a Bangkok pilot

10. Limitations

- **It is a simulation.** Every node runs on one machine; the Cell Broadcast gateway is a simulator.
- **Synthetic data.** Rain curves, water levels, the hour of the overtopping, and the locations of the gauge and gate on Khlong Hok Wa.
- **A synthetic scenario.** The gate affecting two provinces does not appear in the reports of the real event.
- **Four districts of fifty.** Only Khlong Sam Wa, Sai Mai, Nong Chok and Chatuchak are simulated in detail; Bangkok at full size was tested separately in Volume 1 (252 nodes).
- **Human behaviour.** The simulation does not measure whether people followed or tuned out the warnings; it measures only the number and content of messages.
- **First-run figures.** Some measures in Table 6 come from the first run on core C4; after C5 Khlong Sam Wa received one more message on 29 September.

11. Evidence and Reproducibility

The relevant commits are confirmed with git ls-remote: 099f444 (layout e2, apps and the first e2.sh run), ed74e31 (core C5) and 3329b2f (core C8, against which the E2 trials passed as regressions). Each round's results are in the progress log and the project's plan and proposal documents [7].

To reproduce, check out heain-core commit 3329b2f, set DIS_LAYOUT=e2, run casestudies/disaster/sim.sh build and up, then run e2.sh in asis and heain modes at 60 seconds per hour for a full run, or 10 seconds per hour for a trial. The test machine needs only Go and Docker.

File on the test machine	Contents
/mnt/xfs_nvme/heain-dis0/sim/e2-asis, e2-heain	metrics.json, events.log and msgs.txt of each run, every node's log, and the audit chains
~/dis_e2*.out	Results of the first run and the trials
~/c5*.out	Results of core round C5 with regressions
casestudies/disaster/e2.sh, zones.json, apps/	The event script, per-Zone templates and the apps
docs/progress-log.md	Each round's results with its commit

Table 11 — Evidence files for E2

12. Conclusion

Replaying Bangkok's 2026 flood shows that when delegation is a clear P5 rule, the agency holding the data can send warnings at once within its limits, while the agency holding the button still decides what lies beyond them. The first CAP went out 0.03 hours after TMD's forecast instead of 105.42. The event exposed one gap the designed scenarios missed: evidence could not cross a provincial line. Core C5 fixed it with evidence.reach, a rule at the Primary that lets evidence cross only where allowed. Evidence from Pathum Thani reached Khlong Sam Wa in 3 seconds, and over three weeks no zone-day of flooding went without a current warning. What remains outside the system is drainage capacity, risk communication, and the rules of delegation.

References

[1] Boonma, J. "The National Disaster-Warning Case Study on heain-core, Volume 1: Overview." 27 October 2026 (companion paper).

[2] Boonma, J. "The National Disaster-Warning Case Study on heain-core, Volume 5: The Hat Yai Flood, November 2025." 29 October 2026 (companion paper).

[3] Boonma, J. "HEAIN Framework: An Infinitely Scalable Fractal Intelligent Network Seamlessly Linking Cloud and Edge AI, Resilient to Failure and Multi-Dimensional Fraud." 2026 (companion paper).

[4] Boonma, J. "The Triad of Structural Immunities: A Theoretical Framework for Preventing Cascading Failures, Authority Creep, and Alert Storms in Fractal Edge AI." Zenodo, 2026. DOI: 10.5281/zenodo.23172868

[5] OASIS. "Common Alerting Protocol Version 1.2." OASIS Standard, 2010.

[6] Boonma, J. "HEAIN Disaster Summary v3: A National Disaster-Warning System on the HEAIN Framework." Author's design document, 15 October 2026 (in Thai).

[7] Boonma, J. "docs/progress-log.md." heain-core repository, 2026; and the project documents claude/study-2026-10-17-disaster-three-events, claude/plan-2026-10-21-disaster-e2-bangkok and claude/proposal-2026-10-21-disaster-e2-core.

[8] Disaster Prevention and Mitigation Act, B.E. 2550 (2007), Thailand.

[9] Thai PBS Policy Watch. The Bangkok flood of 2026. 1 October 2026 (in Thai).

[10] The Nation. Report on the 09:22 Cell Broadcast in Bangkok. 26 September 2026.

[11] THE STANDARD. BMA and Push Through Cell Broadcast. 28 September 2026 (in Thai).

[12] Thai PBS. DDPM flood situation summary. 16 October 2026 (in Thai).

[13] Kaohoon. Cell Broadcast and 210 mm of accumulated rain. September 2026 (in Thai).

[14] Thailand Explained. "Weekly Insight #42, 1–7 October 2026." October 2026.

[15] PreventionWeb. "Sinking Bangkok: how historic floods exposed cracks in the city's disaster defenses." 5 October 2026.

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