Travelingwave-based Accurate Fault Location method adaptive for Evolving Faults and Switch-on Events

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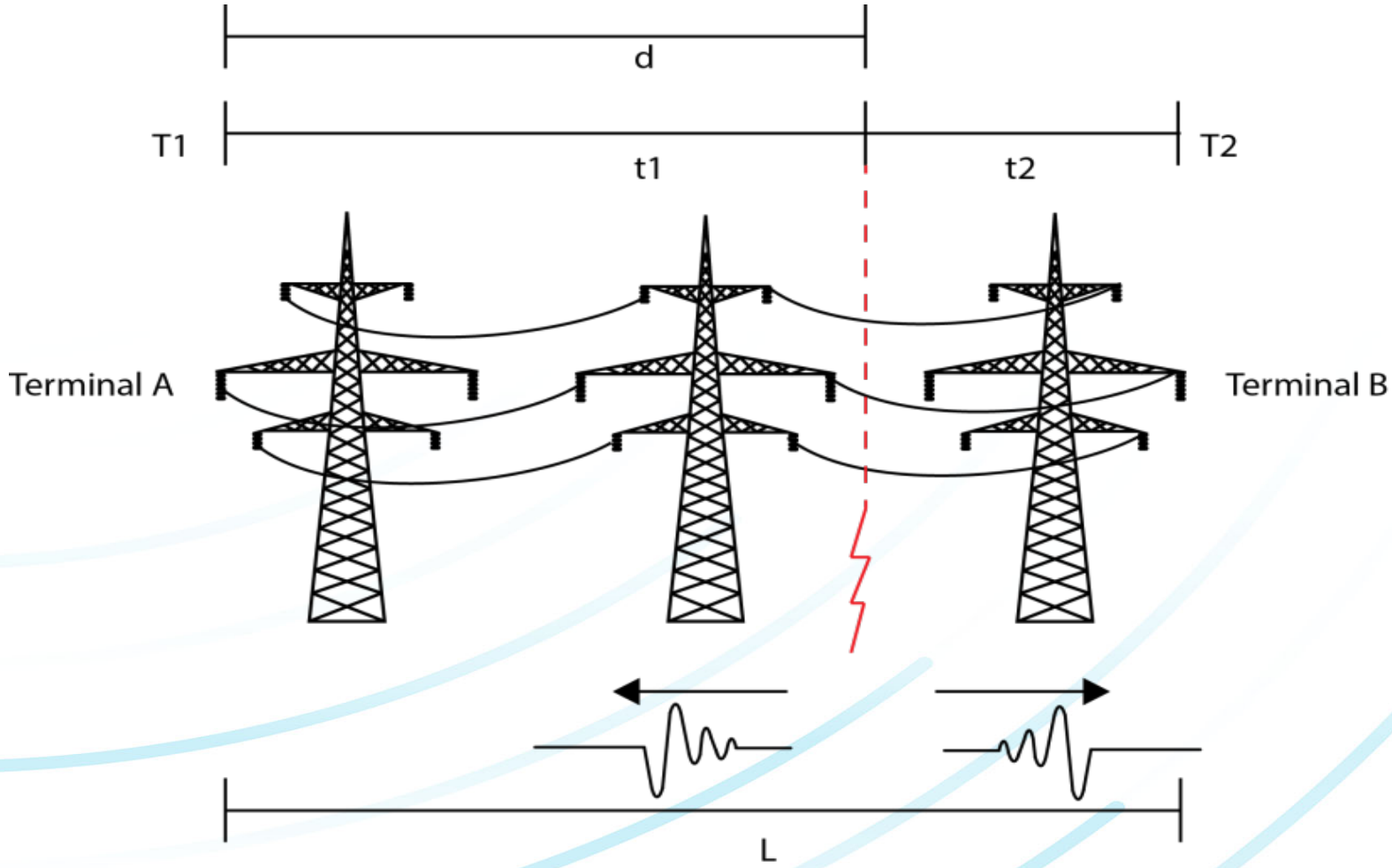
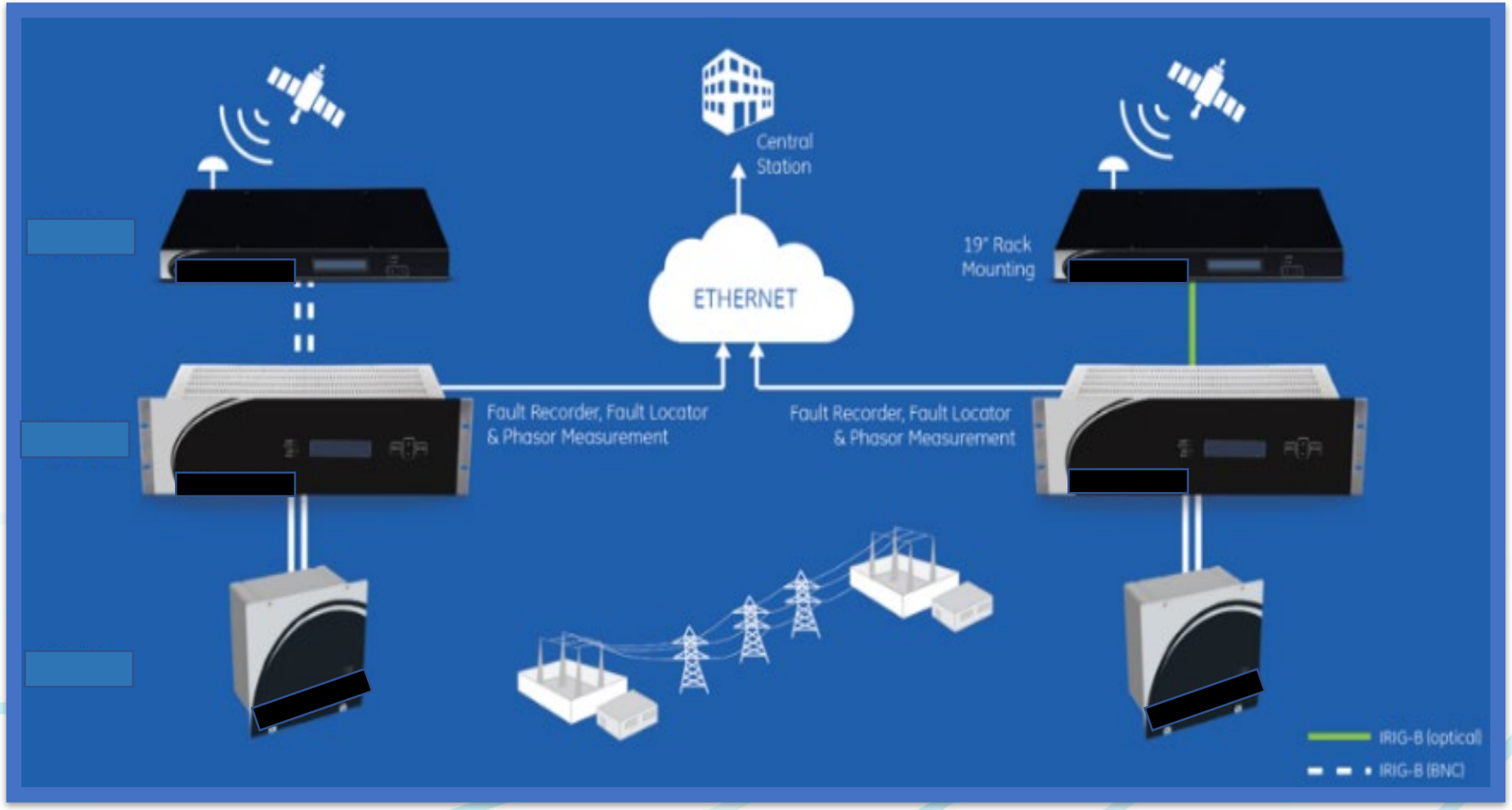
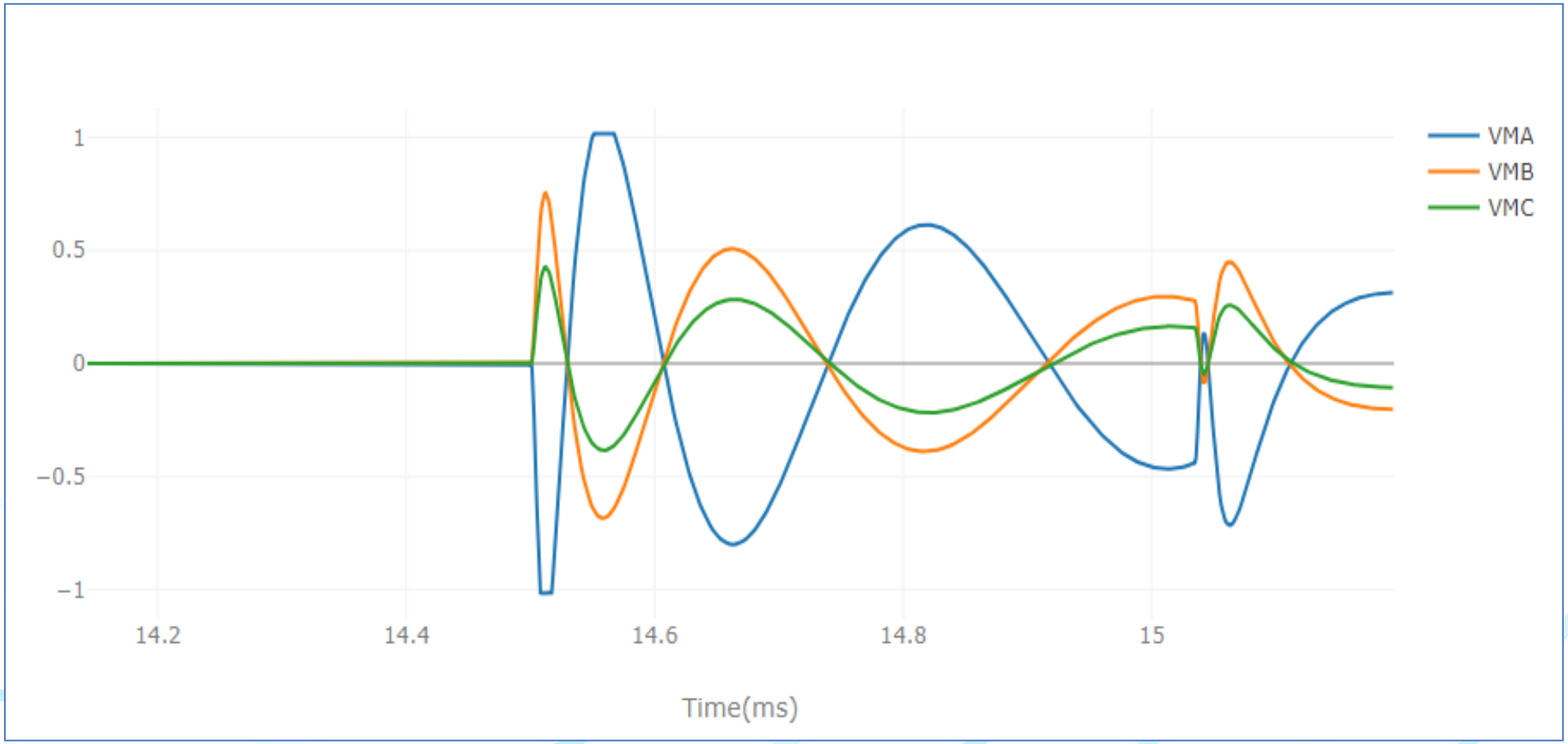
Traveling Waves Propagation on LIne



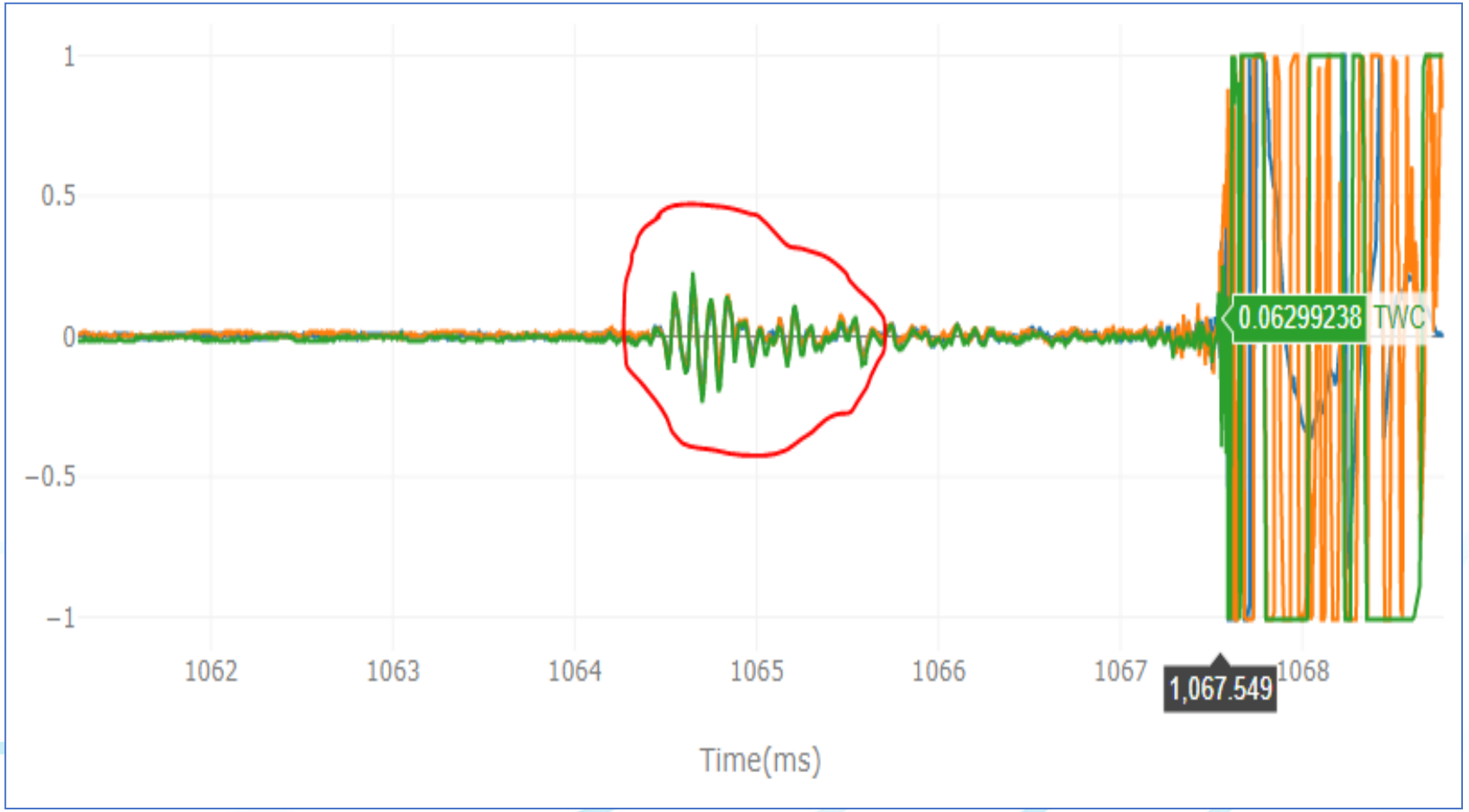
Architecture for traveling-wave-based fault location solution



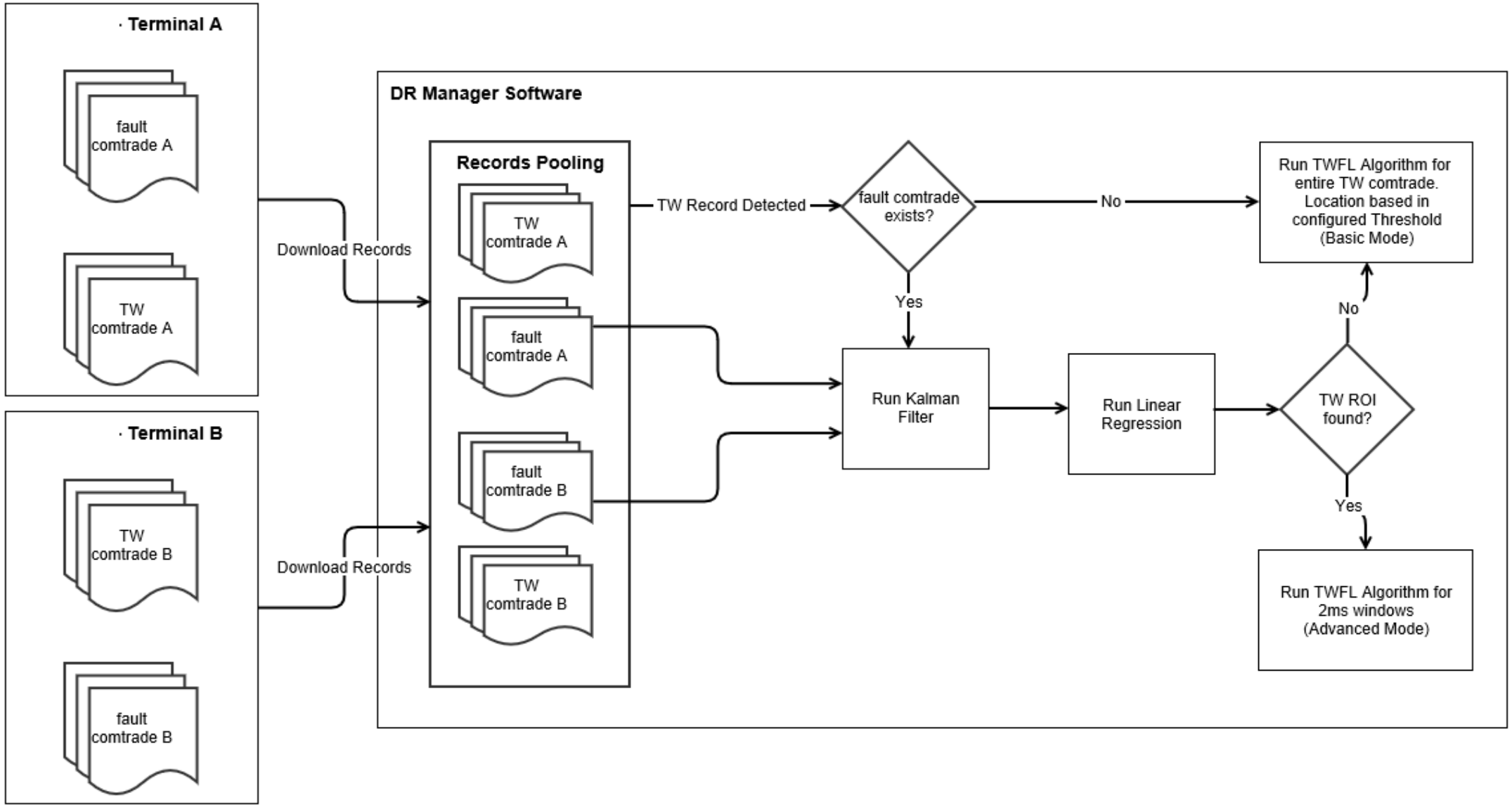
Simulated traveling wave at both terminal



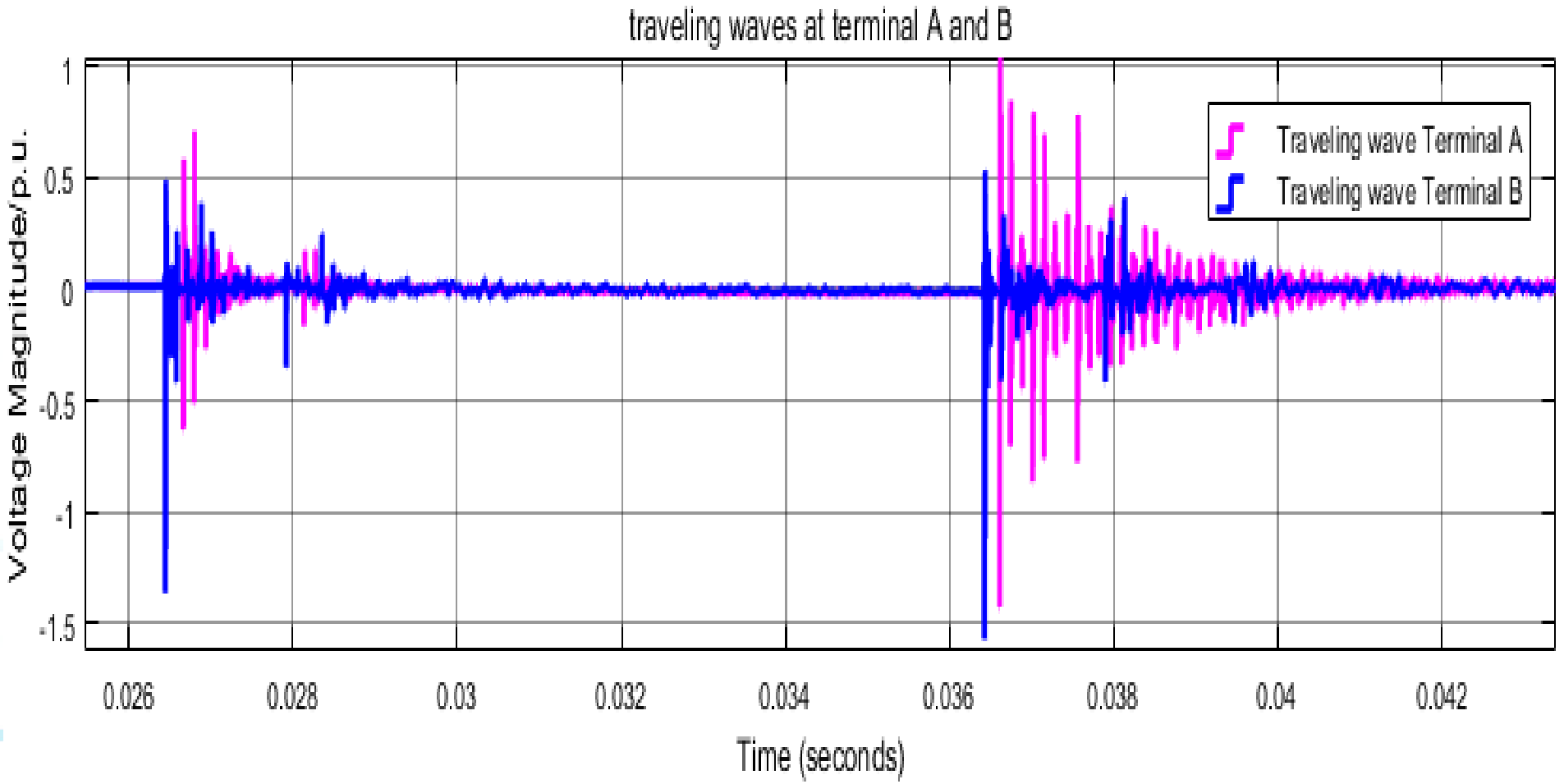
Real measured traveling waves at both terminal



Concentrator Software flowchart for TW-based fault location

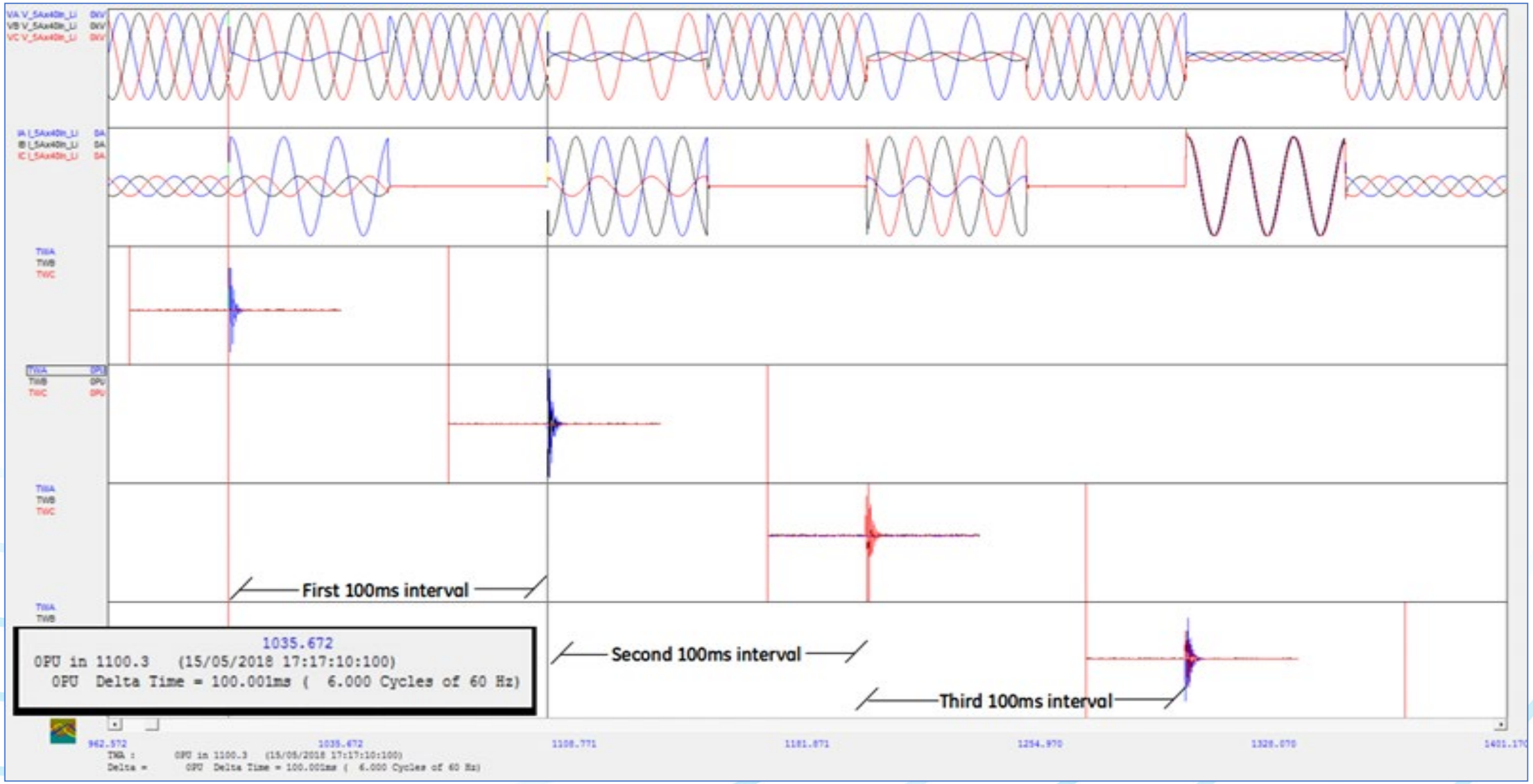


Signature of Traveling Wave

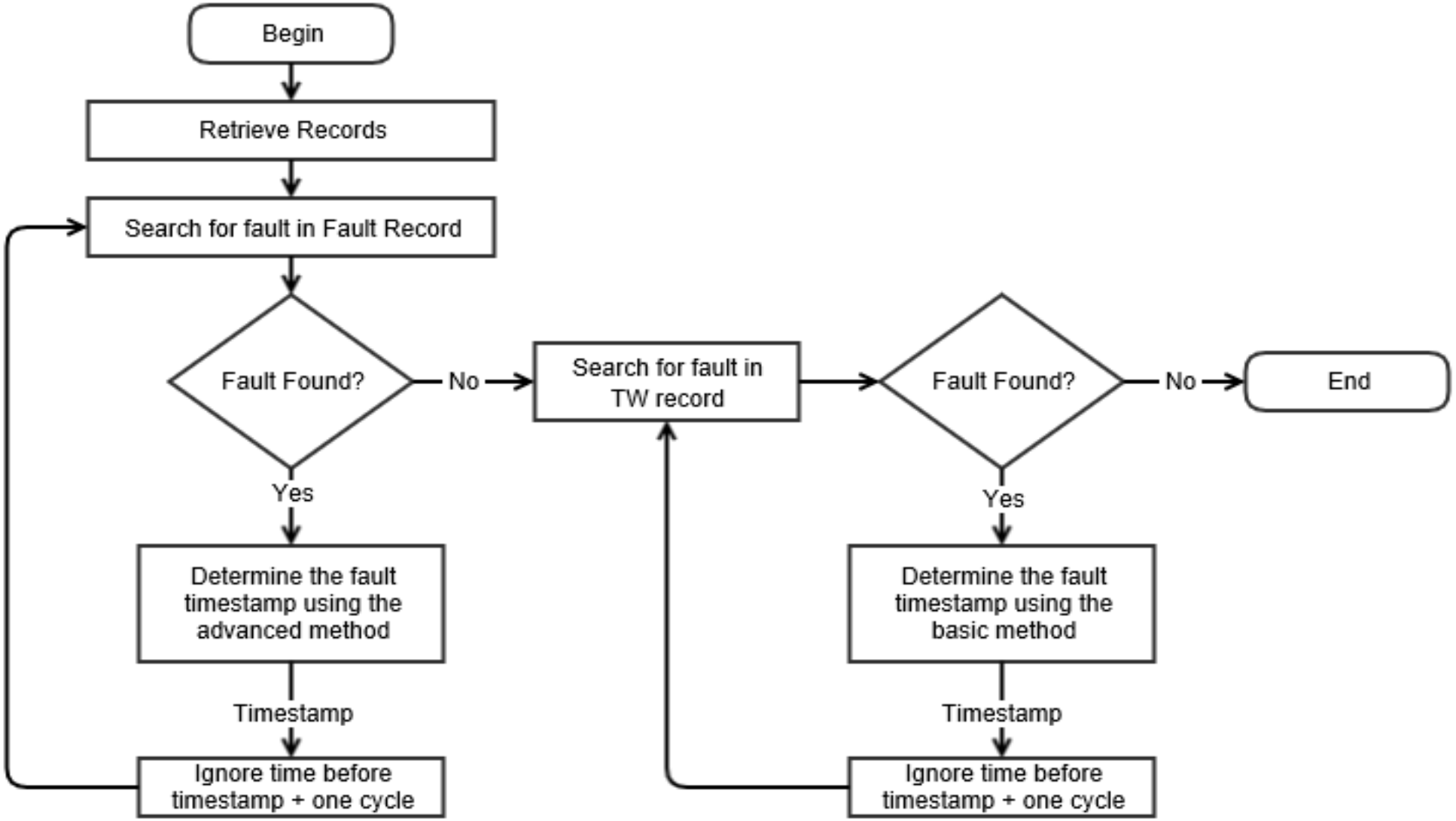


the signature of traveling wave for external phase A to ground fault evolving to internal phase AC to ground fault

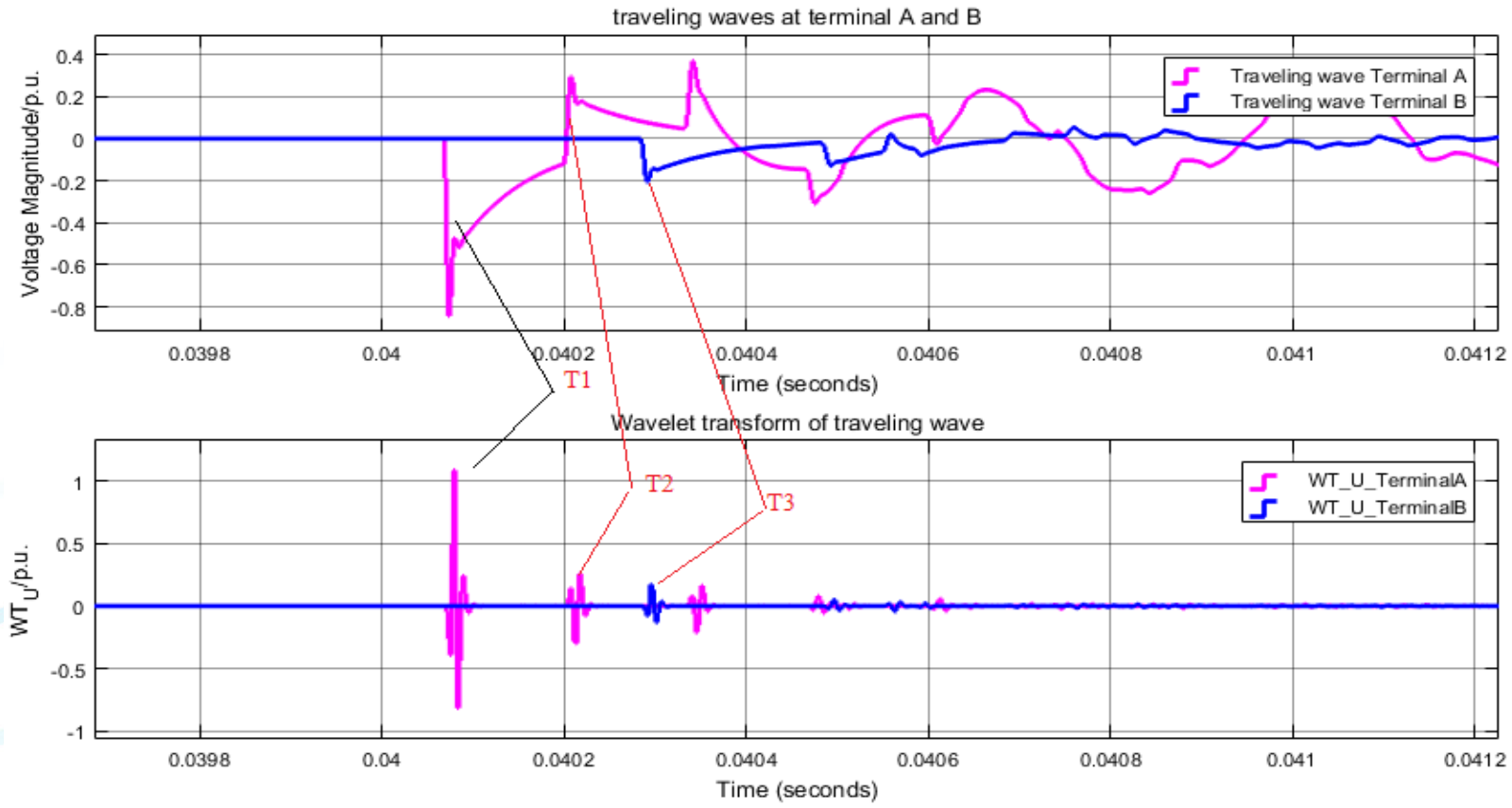
Hardware in the Loop simulated signals showing TWFL solution for consecutive faults



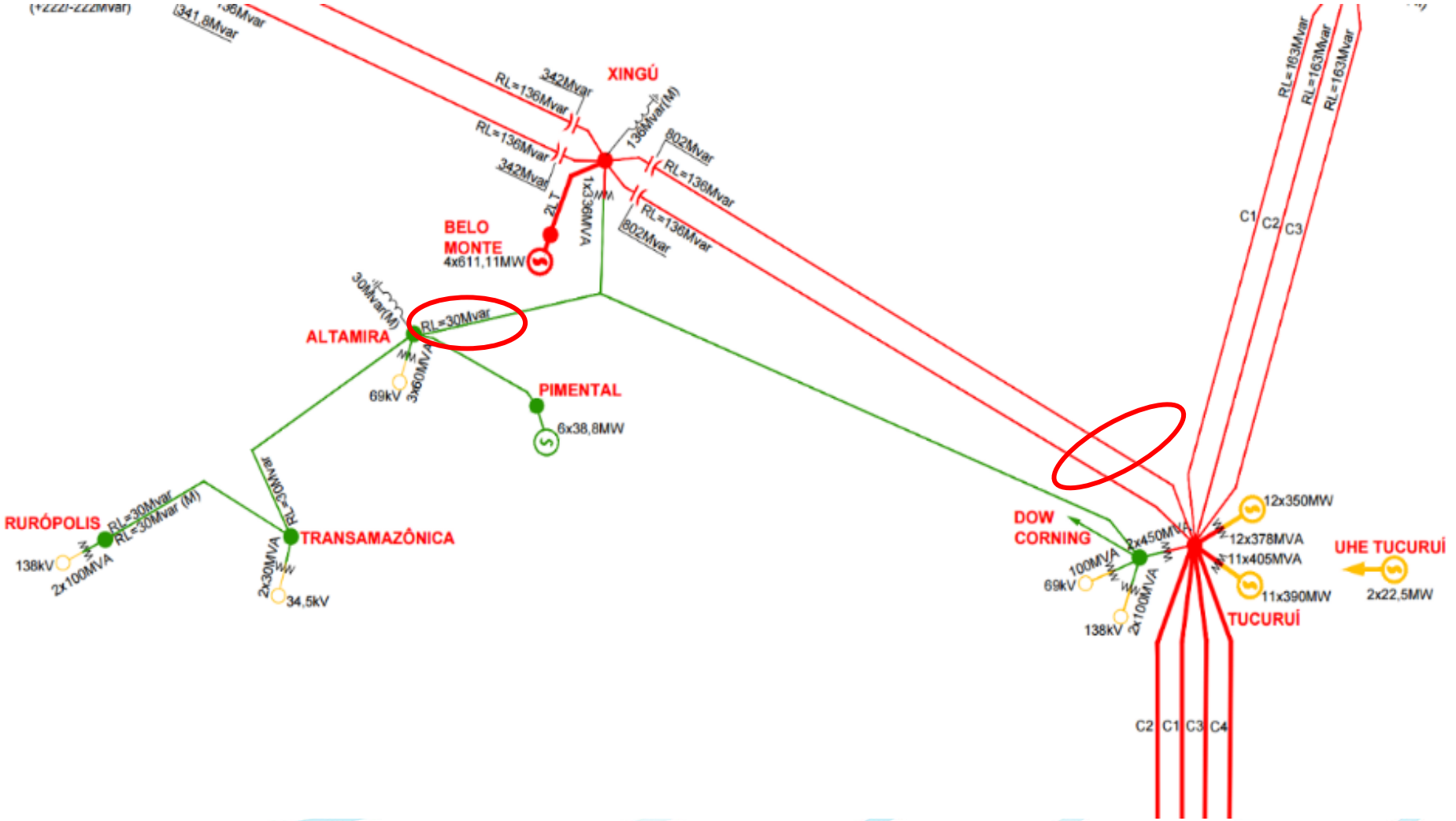
Flowchart for evolving faults location



Propagation of traveling wave in signature



Associated system for validations



Accuracy of the traveling-wave-based fault location method

Case No	Fault happen time	substation A	Substation B	Calculated distance to A (km)	Real distance to A (km)	error (meters)
1	20/09/2009-07:12:28.145369	TUCURUI	ALTAMIRA	1.22583275373154E+02	122.513	-70.27537315
2	24/01/2010-01:24:22.990746	TUCURUI	ALTAMIRA	6.46286039047013E+01	64.624	-4.603904701
3	27/09/2009-07:01:14.857737	TUCURUI	ALTAMIRA	3.25808888852854E+02	325.721	-87.88885285
4	10/10/2009-16:11:07.072651	TUCURUI	ALTAMIRA	99.39798341	99.506	108.0165936
5	11/11/2009-09:51:55.932415	TUCURUI	ALTAMIRA	1.57120235934913E+02	157.099	-21.23593491

Simulation validations for evolving faults

Case no.	Fault type	Fault resistance (Ohm)	point-on-wave (degree)	Real fault location 1 (km)	Fault location by TWFL (km)	error (meters)	Real fault location 2 (km)	Fault location by TWFL (km)	error (meters)
1	ext AG-int ABG	10	90	325.73	325.684	46	32.573	32.5942	21.2
2	ext BG -int BCG	10	45	325.73	325.684	46	130.292	130.2413	50.7
3	ext CG - in ACG	10	90	325.73	325.684	46	162.865	162.865	0
4	ext AB - in ABG	10	45	325.73	325.684	46	195.438	195.414	24
5	int BG - int ABG	10	90	77.719	77.7142	4.8	97.719	97.6924	26.6
6	int CG - int ACG	10	45	87.719	87.7407	21.7	137.719	137.7328	13.8
7	int AG - int ACG	10	90	67.719	67.6876	31.4	177.719	177.68035	38.65
8	in AG - ext ABG	10	45	97.719	97.6924	26.6	325.73	325.6842	45.8
9	int BC - ext ABC	10	90	177.719	177.68035	38.65	325.73	325.6842	45.8
10	int AC - ext ABCG	10	45	197.719	197.73345	14.45	325.73	325.6842	45.8

Validation for SOTF algorithm by simulations

Line lenth (km)			325.73			
Case no.	Fault type	Fault resistance (Ohm)	point-on-wave (degree)	Real fault location (km)	Fault location by TWFL (km)	error (meters)
1	AG	10	90	32.573	32.5757	2.7
2	BG	5	45	65.146	65.092	54
3	CG	0.5	10	97.719	97.683	36
4	AB	0.5	90	130.292	130.199	93
5	BC	0.5	45	162.865	162.656	209
6	CA	5	10	195.438	195.247	191
7	ABG	5	90	228.011	227.822	189
8	BCG	5	45	260.584	260.338	246
9	ACG	5	10	293.157	failed	failed
10	AG	5	90	293.157	292.93	227
11	BG	5	45	260.584	260.339	245
12	CG	5	10	228.011	227.822	189
13	CG	10	90	195.438	195.307	131
14	BG	20	45	162.865	162.7155	149.5
15	AG	30	10	130.292	130.199	93
16	BG	20	45	97.719	97.683	36
17	CG	10	90	65.146	65.092	54
18	ABC	0.5	45	32.573	32.516	57

Conclusions

- Proposed method can locate for evolving faults to typical accuracy of 150meters
- For SOTF the distance in first and second wave at sending end or time difference between terminals
- Special measures should be taken to identify reflective way.

Thank You

Questions?