



DISTRIBUTION SYSTEM REAL TIME SIMULATION

FIFTH ANNUAL INTERNATIONAL WORKSHOP ON
GRID SIMULATOR TESTING



QUANTA
TECHNOLOGY

Smart Solutions, Practical Results

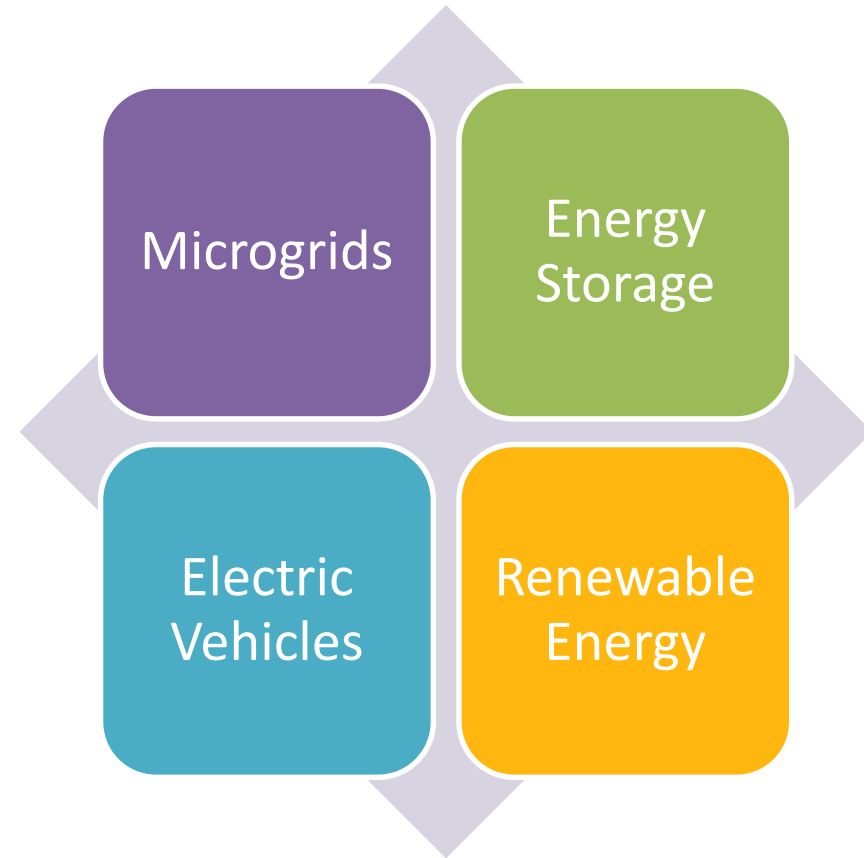
Nov. 2018

Outline

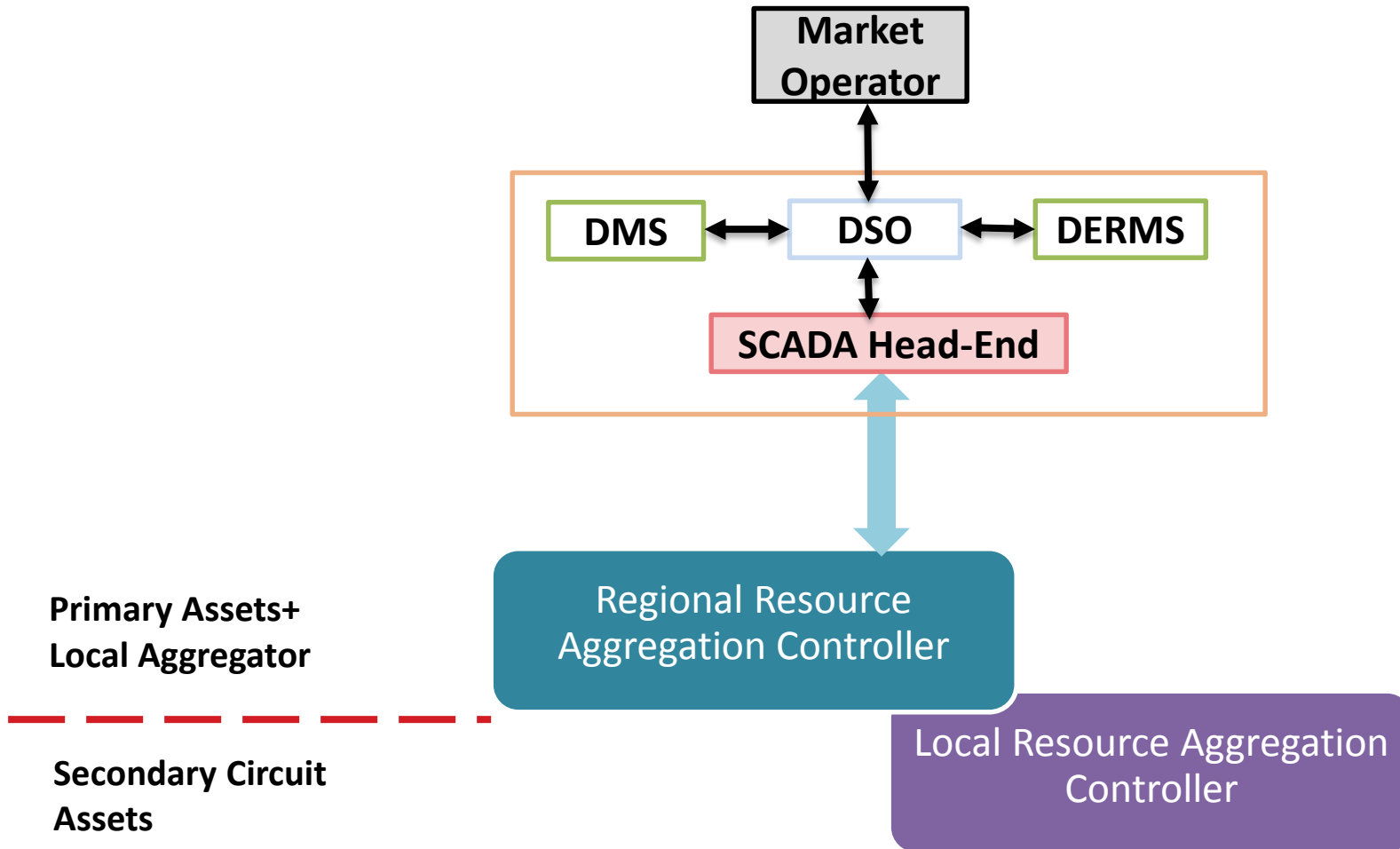
- Advancement in Distribution System Control operation
- Local Resource Aggregator concept
- Testing Local Resource Aggregator control
- Test Results
- Summary

Power Distribution System Transformation

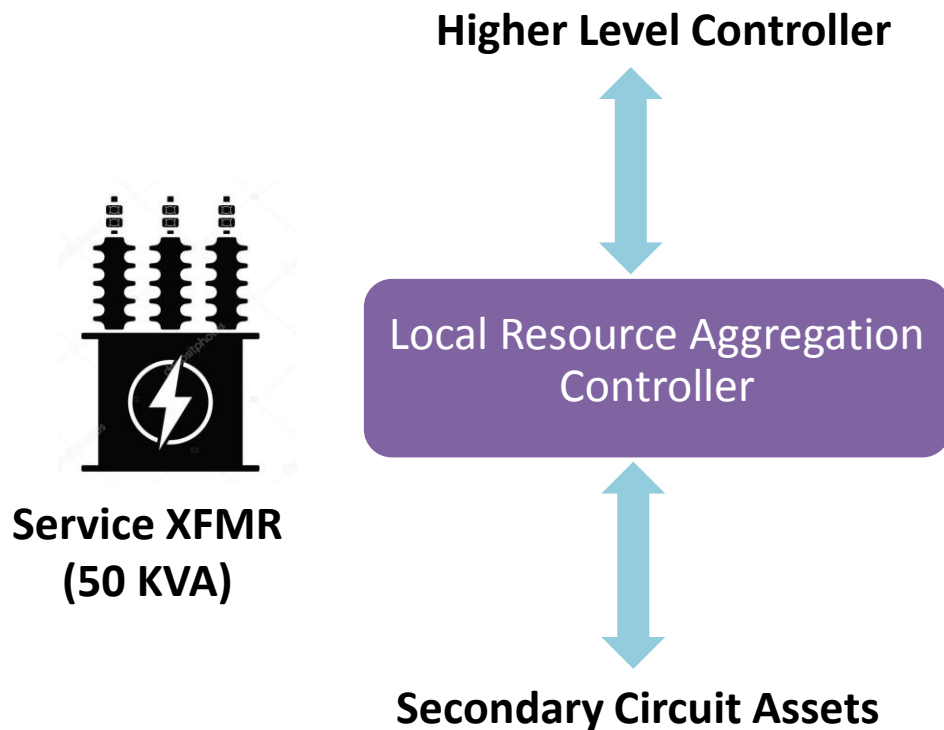
- Integration of Primary Renewable DER assets:
 - Grid-scale Energy Storage (ES)
 - Grid-scale PV site
- Integration of Secondary-circuit DERs and Controllable Load Assets:
 - Behind-the-meter ES, PV
 - Electric Vehicle (EVs)
 - Direct load control (DLC)



Advanced Distribution System Control Operation



Local Resource Aggregator Concept of Operation



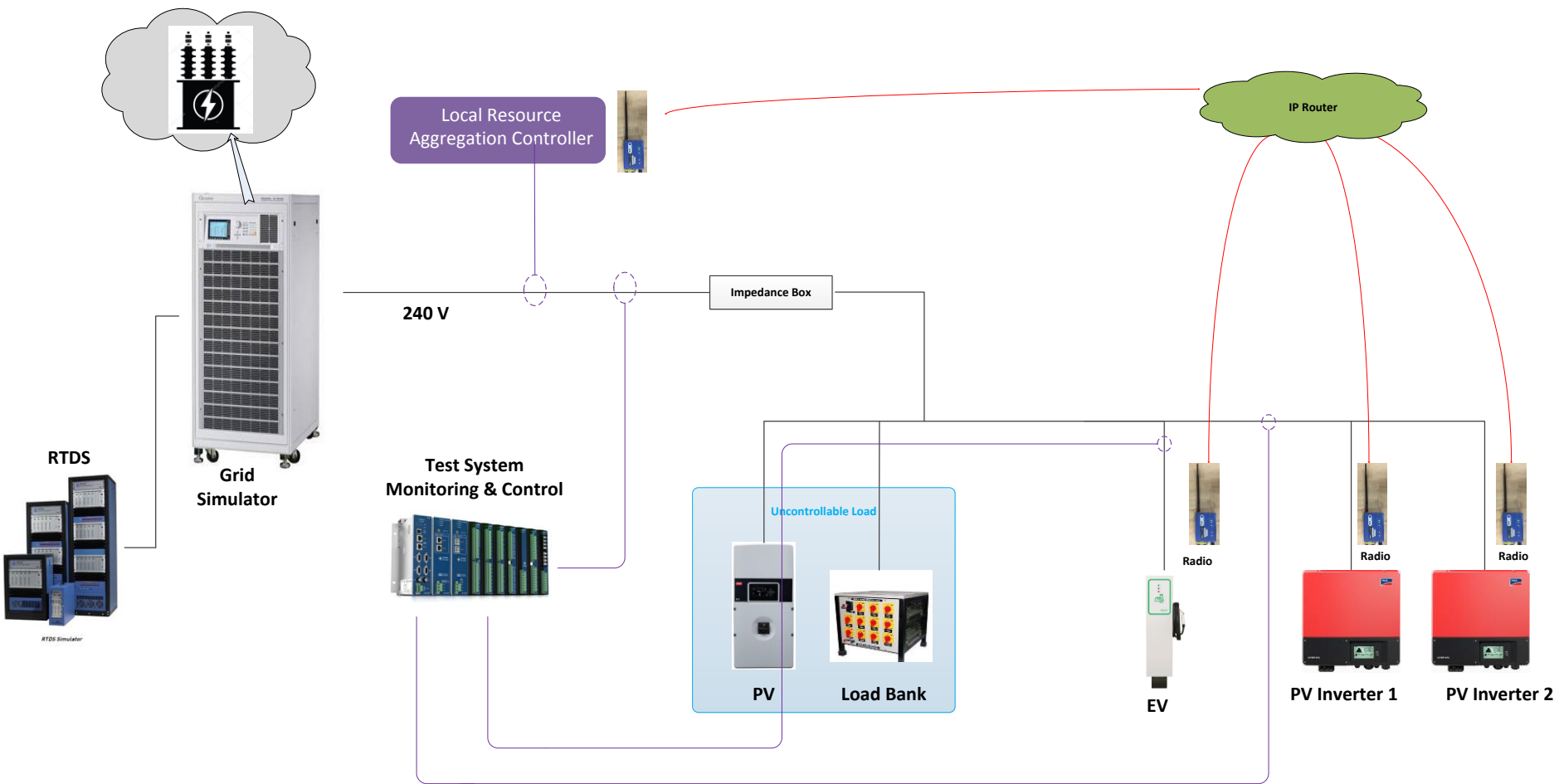
▪ Local Objective:

- XFMR Thermal Limit- avoid overloading (Forward and Reverse)

▪ System-level Objective:

- Power flow management in Primary
- Market participation

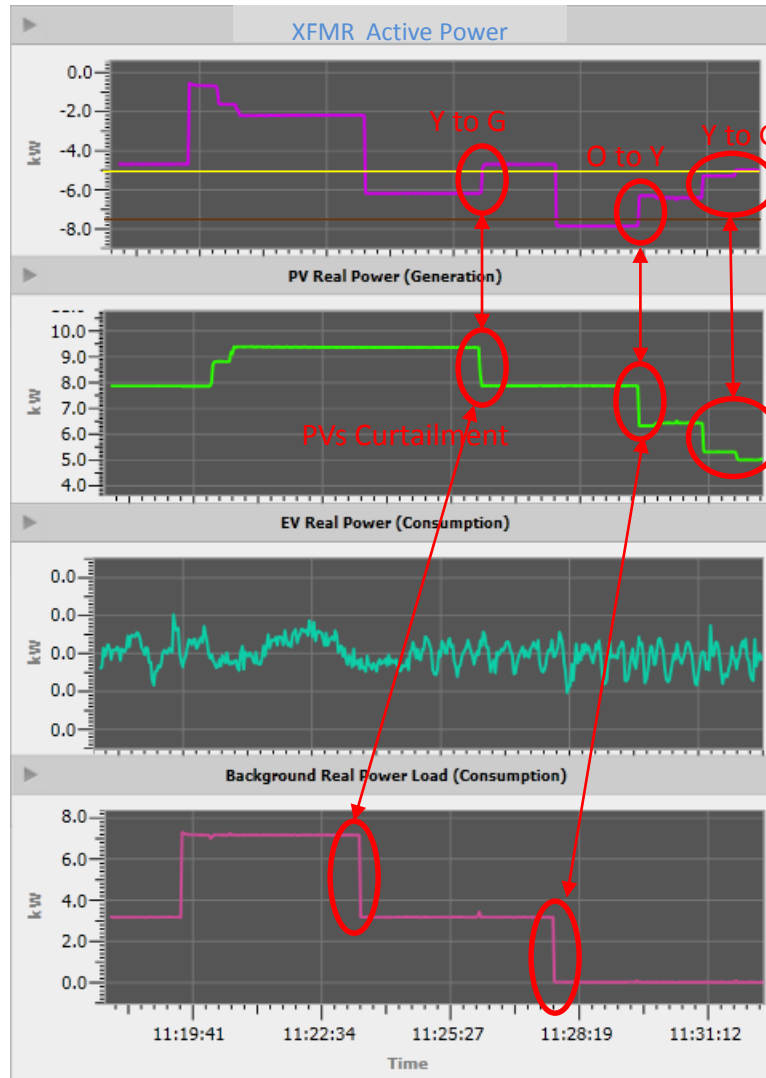
Local Resource Aggregator Test Setup



Test Case- Reverse Power Flow (Description)


- **Scenario:**
 - PVs+ no EV+ Uncontrollable resistive Load
 - Transformer reverse limit met
- **Procedure:**
 - Sunny conditions for two PVs
 - Uncontrollable Resistive Load variation (Load step-wise decrease)
- **Expectation:**
 - PVs are curtailed evenly to mitigate reverse power flow overload

Test Case- Reverse Power Flow (Plots)



Test Case- Reverse Power Flow (controller UI)

Transformer Summary

Transformer Rating: 5.000 kVA Loading: 4.581 kVA (Reverse) Load State:  Overload Timer: 0.0 minutes

[Add DER](#) [Remove DER](#)

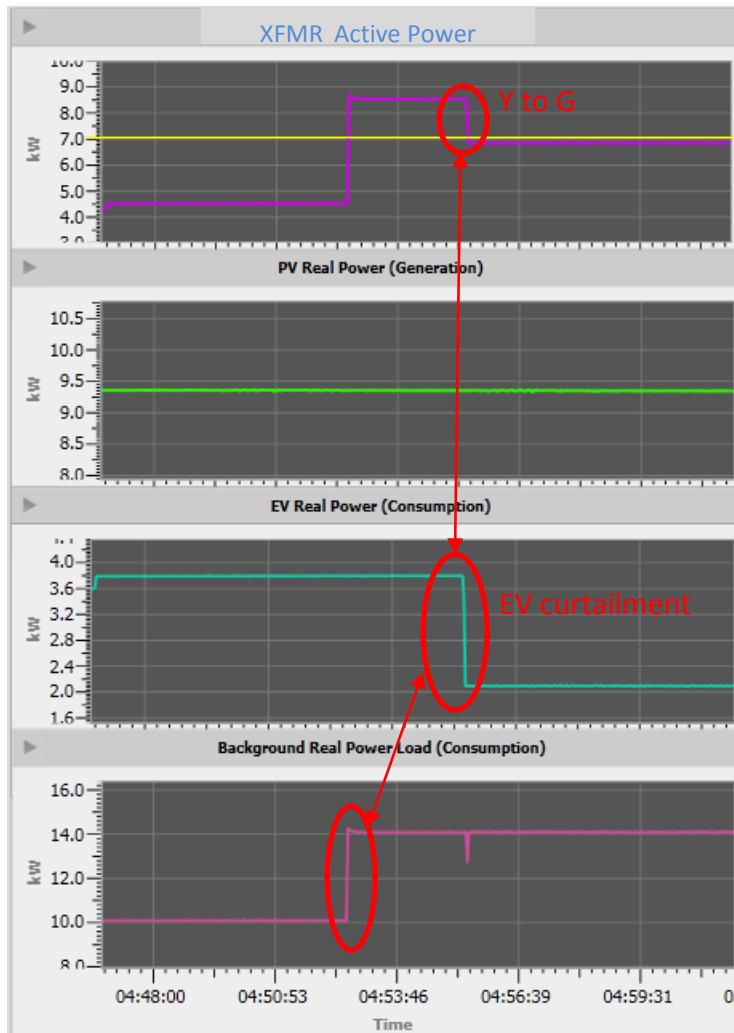
DER Name	Index	Type	DER State	Comm state	Rating	Curtailment	P	P SP	Q	Q SP
EV1	1	EV	Enable	UP (0) UpTime: 6376	7.200 kVA	no	0.024 kW	1.440 kW	0.000 KVAR	0.000 KVAR
PV1	3	PV	Enable	UP (0) UpTime: 512	5.000 kVA	yes	3.984 kW	3.982 kW	0.000 KVAR	0.000 KVAR
PV2	2	PV	Enable	UP (0) UpTime: 3020	5.000 kVA	yes	3.977 kW	3.980 kW	0.000 KVAR	0.000 KVAR

Equal Curtailment of each PV

Test Case- Forward Power Flow (Description)


- **Scenario:**
 - PVs+ EV+ Uncontrollable resistive Load
 - Transformer forward limit met
- **Procedure:**
 - EV is not close to full charge
 - Sunny conditions for two PVs
 - Uncontrollable Resistive Load variation (Load increase)
- **Expectation:**
 - EV is curtailed to mitigate forward power flow overload

Test Case- Forward Power Flow (Plots)



Test Case- Forward Power Flow (controller UI)

Transformer Summary

Transformer Rating: 7.000 kVA Loading: 6.896 kVA (Forward) Load State:  Overload Timer: 0.0 minutes

[Add DER](#) [Remove DER](#)

<input type="checkbox"/>	DER Name	Index	Type	DER State	Comm state	Rating	Curtailment	P	P SP	Q	Q SP
<input type="checkbox"/>	EV1	1	EV	Enable	UP (0) UpTime: 118...	7.200 kVA	yes	2.160 kW	2.160 kW	0.000 KVAR	0.000 KVAR
<input type="checkbox"/>	PV1	3	PV	Enable	RETRY (1) Remain:...	5.000 kVA	no	4.745 kW	5.000 kW	0.000 KVAR	0.000 KVAR
<input type="checkbox"/>	PV2	2	PV	Enable	UP (0) UpTime: 131	5.000 kVA	no	4.753 kW	5.000 kW	0.000 KVAR	0.000 KVAR

EV Curtailment

Summary

- Hierarchy of resource aggregation and management in the advanced distribution system was discussed.
- Local Resource Aggregation control concept and objectives was described.
- Testing of Local Resource Aggregator through grid simulator and real-time digital simulation was discussed.
- Selected test results for Local Resource Aggregator functionality were presented.

Thank you!

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