Voltage Control in Medium Voltage Lines with High Penetration of Distributed Generation

Main Author: A. Arzuaga — **ZIV CG Automation DAS Spain** — **a.arzuaga@ziv.es**

Presenter: Adrian Kearney — **CG Automation Systems Ireland** — **adrian.kearney@cgglobal.com**

Grid of the Future Symposium

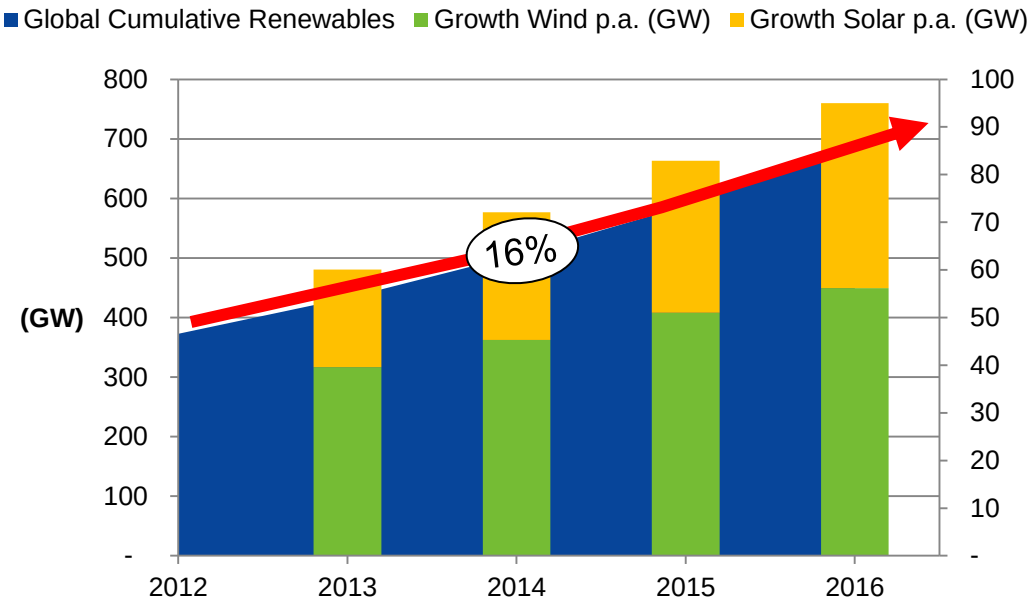
Boston MA

22nd October 2013

Contents

- Description of the problem
- Voltage Control Algorithms
- Communication Requirements
- Proposed System
- Obtaining Voltage Measurements
- System Performance
- Conclusions

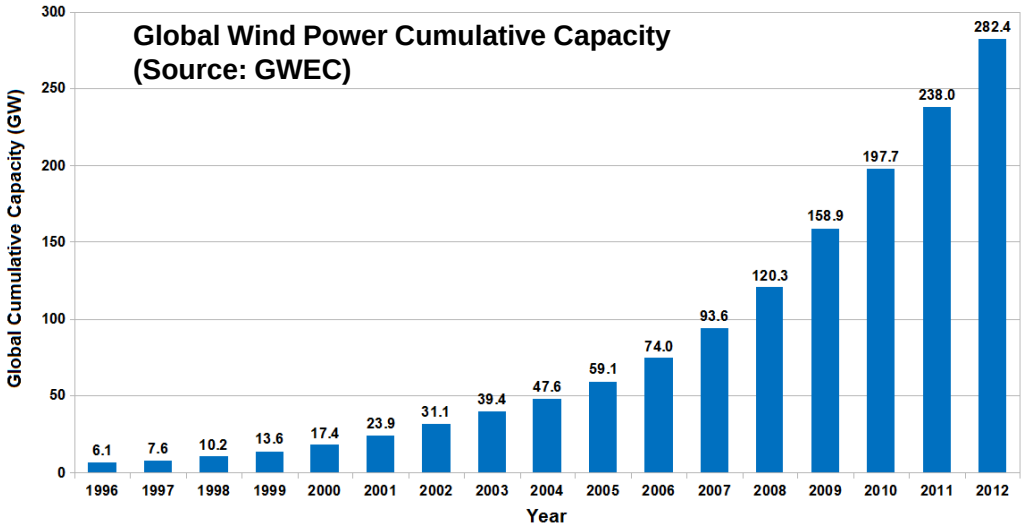
Description of the Problem



- Growth of renewables 2012-2016:
  - 50GW p.a. for Wind
  - 35GW p.a. of PV

Sources: MAKE Consulting, Photon Consulting

Wind

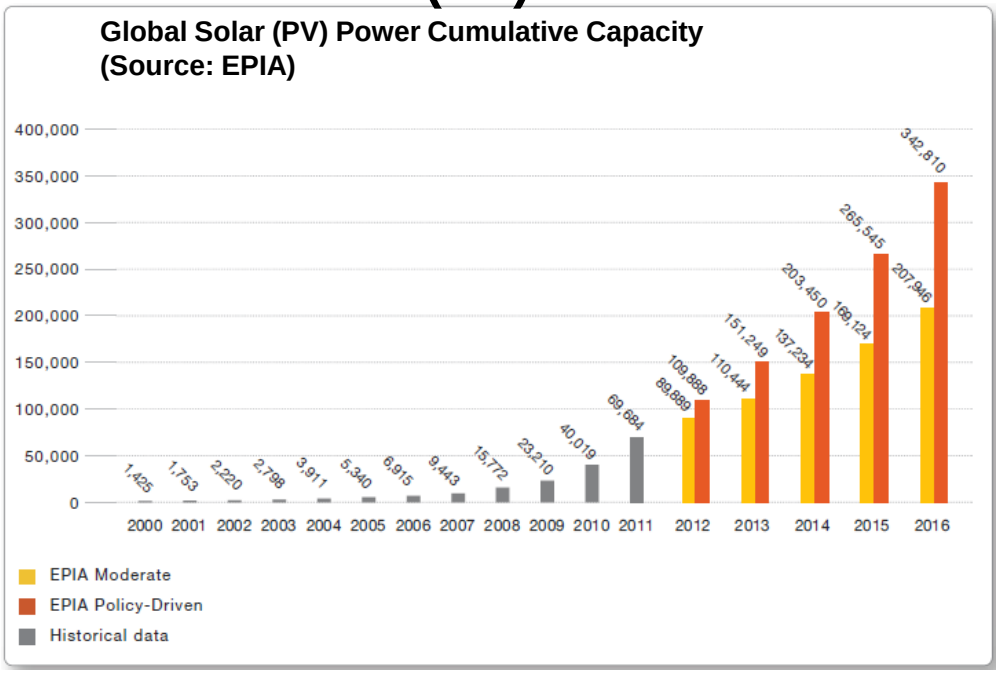


Annual Growth 2012-2016

Global:14%

US: 12%

Solar (PV)

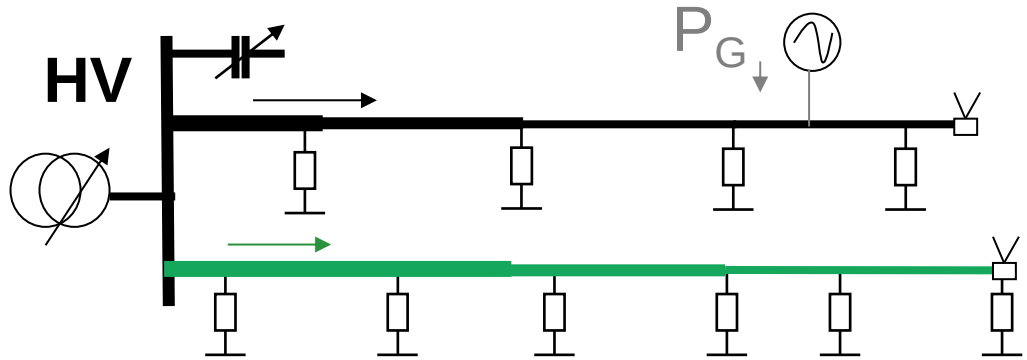


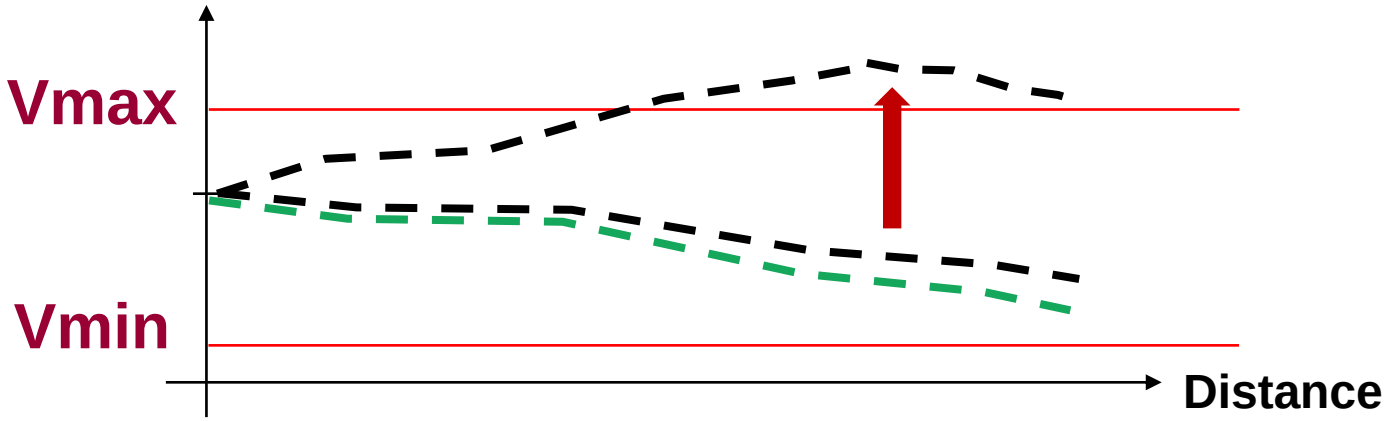
Annual Growth 2012-2016

Global:23%

US: 45%

Description of the Problem

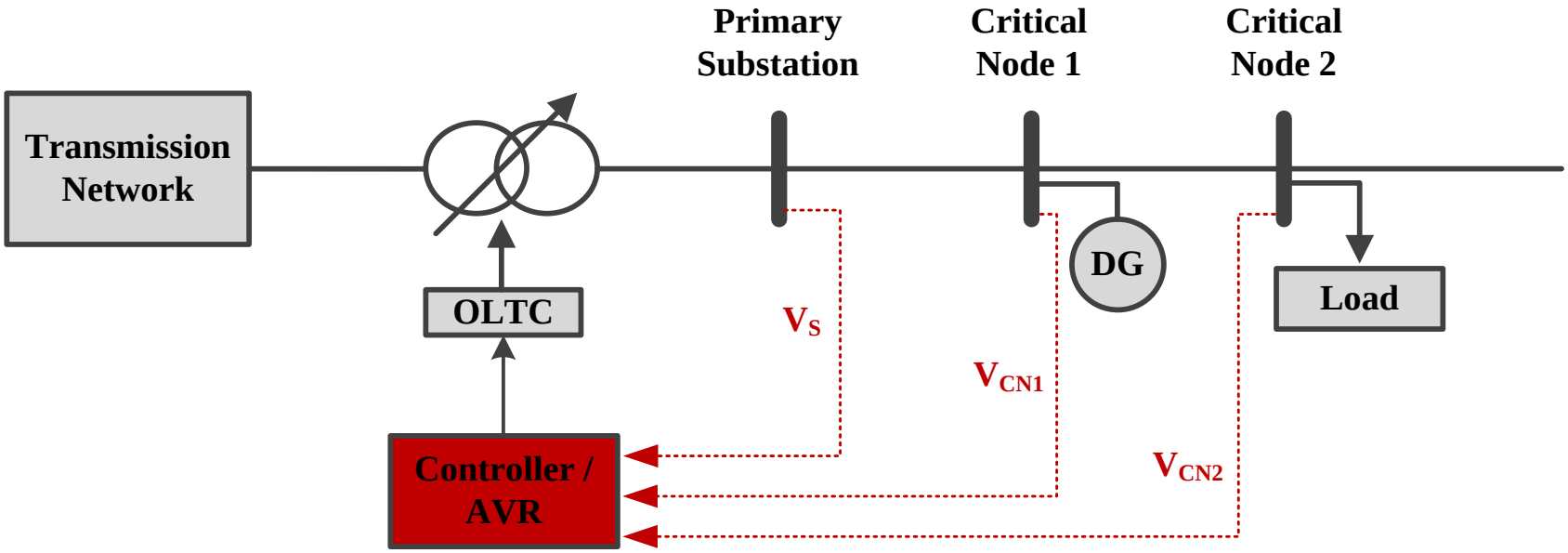




Voltage Control Algorithms

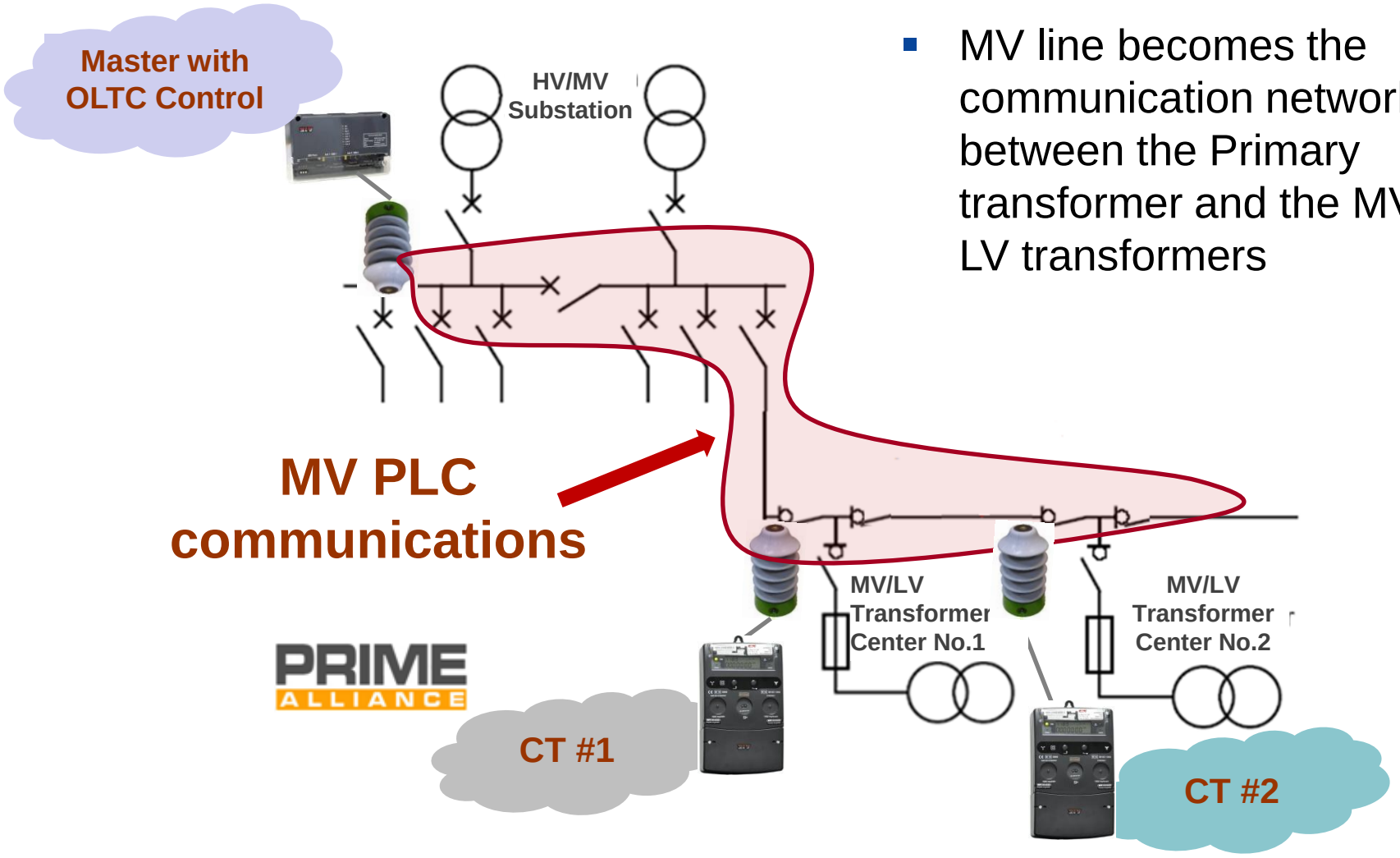
	Assets			
	OLTC	DG	Loads	VRs
Automatic Disconnection	Fixed setpoint	✗	✗	✗
"Decoupling" voltage	Fixed setpoint	✗	✗	✓
Local Voltage Control	Fixed setpoint	✓	✗	✓
Distributed Voltage Control	Variable setpoint	✗	✗	✓
Coordinated Voltage Control	Variable setpoint	✓	✓	✓

Distributed Voltage Control



- Algorithm designed to maintain the voltage within steady state limits (cycle time ~ 1 minute)
  - Advantage: Simple and Scalable
  - Disadvantage: Requires communication network

Proposed Communications



- MV line becomes the communication network between the Primary transformer and the MV / LV transformers

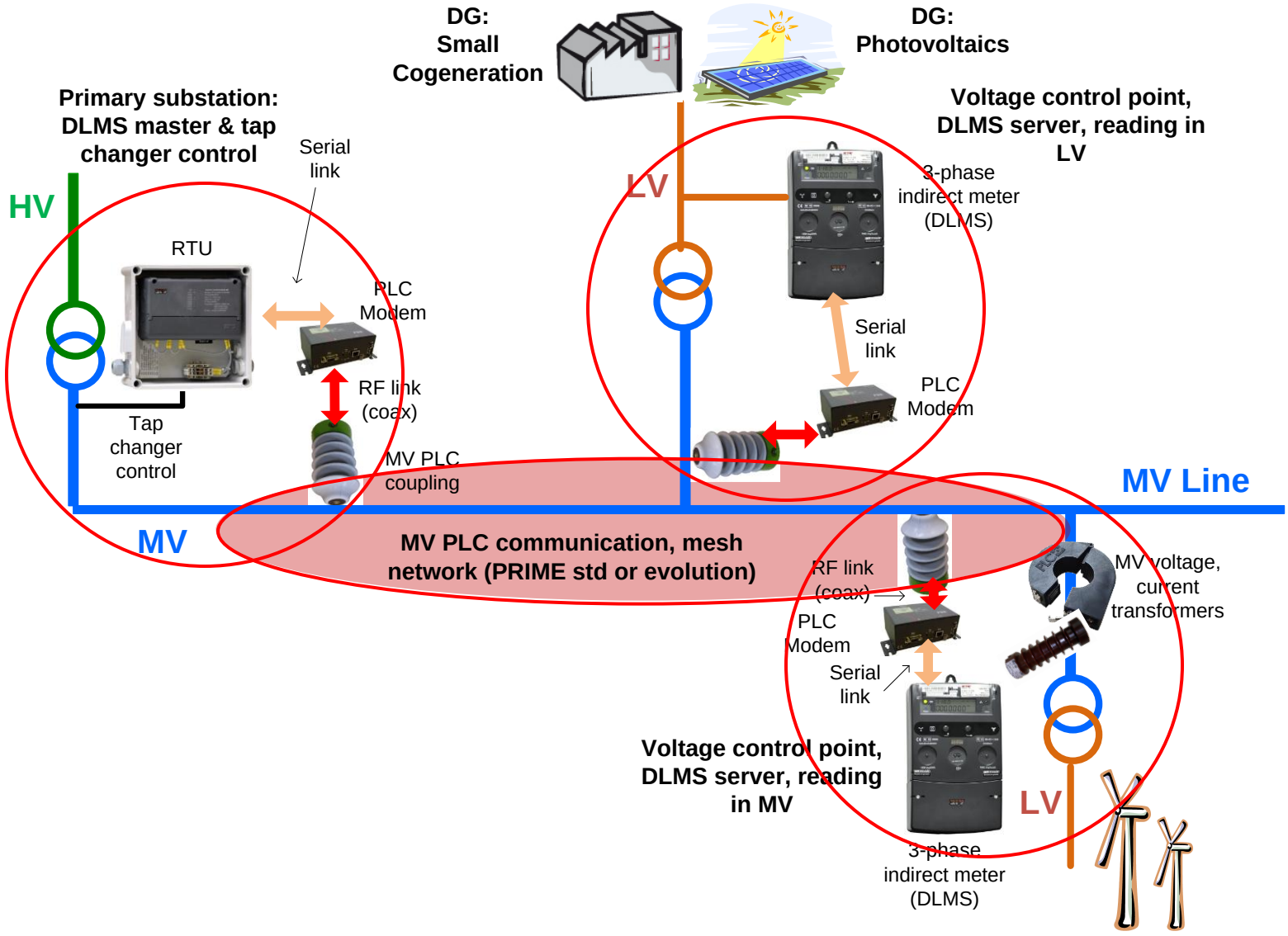
Obtaining Measurements

- Two ways of obtaining MV line measurements:
  - Via MV using MV CTs, VTs

  - Via LV using smart meters and scale up

	Type	Accuracy	Cost	Installation	Equipment	Comms
MV Measurement	`via (CT, VT)	High	Medium	Medium	Standard	PLC, other
LV Measurement	Direct	Average	Low	Simple	Standard	PLC, other

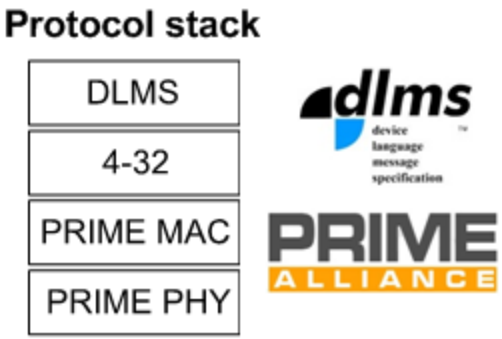
Proposed System



- **Apply secure, low cost, LV metering technologies to MV**

System Performance

- Can all the remote voltage measurements be retrieved within the algorithm cycle time (~1 min) ?
  - Using PLC based on PRIME robust modulation mode provides 20kbps (physical layer)
  - Information transfer rate in the worst case: 3kbps (application level).
  - Timestamped instantaneous voltages in DLMS: 160 bytes (1.6 kbits).
  - Conservatively one node can be read per second.
  - Therefore, a network of 60 nodes in 1 minute



→ Well above the expected number of nodes in a typical voltage control application.

Conclusion

- Voltage swings caused by the introduction of DG in MV lines is a growing problem, and will necessitate changes in the distribution infrastructure.
- A voltage control system can be implemented on the MV network with a high penetration of DG using existing equipment.
- The proposed system meets the basic requirements of the application at a low cost using standard equipment.
- Challenge: Distribution equipment (transformer & OLTC) that can withstand this level of operation => Solid State Devices.

The Future of Distribution

- Intelligent voltage control based on critical node voltages
- Communications over MV lines
- Solid state switching devices

Questions?