



# Using the NOC Dashboard for Improved Phasor Data Quality

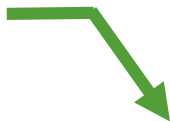
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To Support the Network Operating Center

September 2019

# The NOC Dashboard

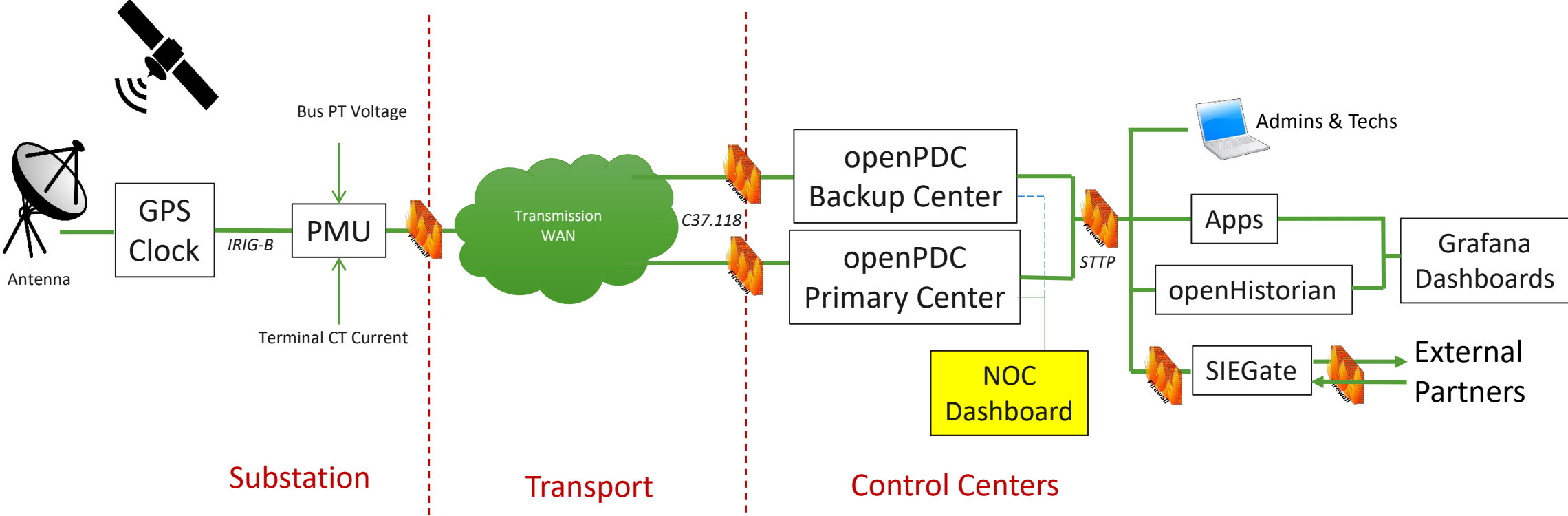
- A situational tool for phasor data availability to identify PMUs in an abnormal state, perform first level diagnostics and quickly open tickets to restore phasor data streams.

Real-time state of each PMU 



Last 14-day availability trend 

# Typical Synchrophasor Network Based on GPA Products



PMU = Phasor Measurement Unit  
 Apps = 3<sup>rd</sup> Party Phasor Analytics

PDC = Phasor Data Concentrator  
 SIEGate = Secure Information Exchange Gateway

# Synchrophasor Applications

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- PMU – collects and streams voltage and current measurements to the openPDC  
*(PMU functionality can be provided by relays and DFRs. All are called “PMUs” in this presentation.)*
- openPDC – time-aligns phasor measurements received from local and external sources, performs real-time analytics and distributes this data to other systems
- openHistorian – performs analytics based on real-time and historical phasor data, archives these values and hosts the Grafana visualization tool
- Apps – used to analyze phasor measurements for potential grid instability
- SIEGate – an edge device to protect the sending utility’s critical infrastructure and transform namespaces as SIEGate forwards phasor measurements to others
- Network Operating Center (NOC) Dashboard – A Grafana dashboard hosted by the openPDC using the openPDC’s internal performance historian as its data source

# The NOC Dashboard Annunciation Panel

- Through colorization, status boxes show the state of the individual substation device that is acting as a PMU
- The device name is typically the line name for a true PMU or a Relay and the substation name for a DFR – which typically provides phasor measurements for all lines in the substation
- The value in the status box represents continuous time the device has been in an alarm state – in minutes, hours or days.



Clicking on a status box provides details about the substation device (the PMU) and the nature of the phasor data stream.

# Drill Down into a Device

Johnsonville  
31 m

ALLEN  
0

SQN2  
0

Widows Creek  
304 d

**ALLEN - Good [0]**  
Refreshing in 19 seconds...

**Device Information**

Device Acronym: ALLEN  
Device Name: ALLEN  
Make: APP  
Model: APP 601  
Latitude: 0.0  
Longitude: 0.0  
Frames per Second: 30  
Contacts: None Defined  
Connection String:

**Run-time Statistics:**

ID	Description	Value	Time (UTC)
IS-ST1	InputStream statistic for Total number of frames received from input stream during last reporting interval.	301	17:31:25.803
IS-ST2	InputStream statistic for Timestamp of last received data frame from input stream.	31:24.733	17:31:25.803
IS-ST3	InputStream statistic for Number of frames that were not received from input stream during last reporting interval.	0	17:31:25.803
IS-ST4	InputStream statistic for Number of CRC errors reported from input stream during last reporting interval.	0	17:31:25.803
IS-ST5	InputStream statistic for Number of out-of-order frames received from input stream during last reporting interval.	0	17:31:25.803
IS-ST6	InputStream statistic for Minimum latency from input stream, in milliseconds, during last reporting interval.	796.000 ms	17:31:25.803

**Children**

ID	Name	State
192	ALLEN_GT1_16	Good [0]
193	ALLEN_GT17_20	Good [0]
194	ALLEN_HORNLAKE	Good [0]

**Operator Actions:**

- Reset to In-Service
- Set to Out-of-Service
- Reconnect Device
- Ping
- Acknowledge
- Reset Acknowledge

Drill down to a virtual PMU

## Operator Actions

- Return to Service
- Set Out-of-Service
- Ping Device
- Acknowledge Alarm
- Reset Acknowledge

# Users React to Changing Substation Device (PMU) Status

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Good

Alarm

Not Available

Bad Data

Bad Time

Out of Service

Acknowledged

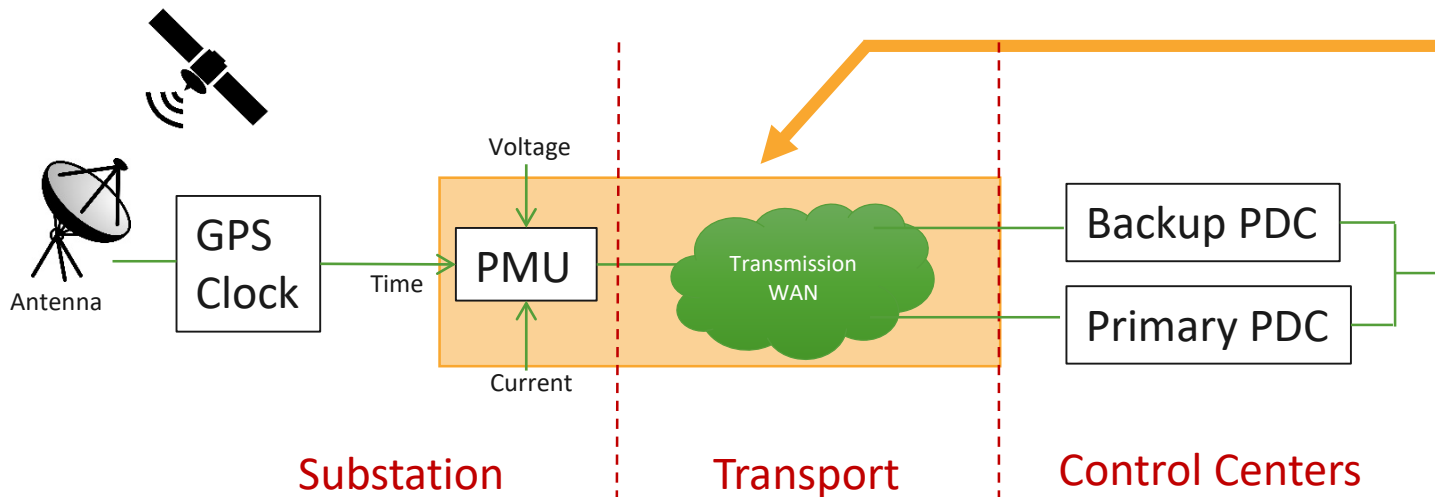
**PMU Health States (in order of precedence)**

# Amber State – Data Not Available

Alarms

Legend: Good (Green), Bad Time (Purple), Out of Service (Grey), Acknowledged (Light Green), Not Available (Orange)

ALLEN 0	BOH 0	BRF 0	Browns Ferry 0	Bull Run 0	CHH 33 d	Cumberland 3 d	DVS3 0	Freeport 68 d	FWS-PMU1 (SEQ) 0	FWS-PMU2 (MOC) 0	GFH 0	GLT-PMU 0	HIS 68 d	JOFB 1 d	Johnsonville 3 d	JST1 0	JST2 0
LCS 68 d	Magnolia U2 Ct 68 d	Magnolia U2 St 68 d	MNS 0	Moccasin DFR 0	MRS 0	ORNL 0	PACC1 0	PACC2 0	PHS1 0	PHS2 0	PLATEAU 0	Pmu1-Moccasin Df 0	RBSS 68 d	RCS1 0	RCS2 0	RIS 68 d	RUTHRFD_MAURY 0
S6S 68 d	SHS 223 d	SLS1 207 d	SNS1 0	SQN1 0	SQN2 0	SSS1 0	TVA_CONCOR 68 d	TVA_CONCOR 68 d	TVA_CONCOR 68 d	TVA_CONCOR 68 d	TVA_W_POINT 65 d	TVA_ACC 0	TVA_ALC 0	TVA_CUF2 0	TVA_EASTPNT 10 d	TVA_GNMILLING 0	TVA_JVILLE161 0
TVA_JVILLE500 1 d	TVA_MOCCASIN 0	TVA_MONTGMY 0	TVA_NNASH 0	TVA_PHILLY 0	TVA_SHF 0	TVA_SNASH 0	TVA_WCF 0	TVA_WNASH 0	VLS 3 d	WBH1 0	WBH2 0	WBN1 0	WBN2 0	WEC 0	WESTPOINT 32 d	Widows Creek 1.04 yrs	



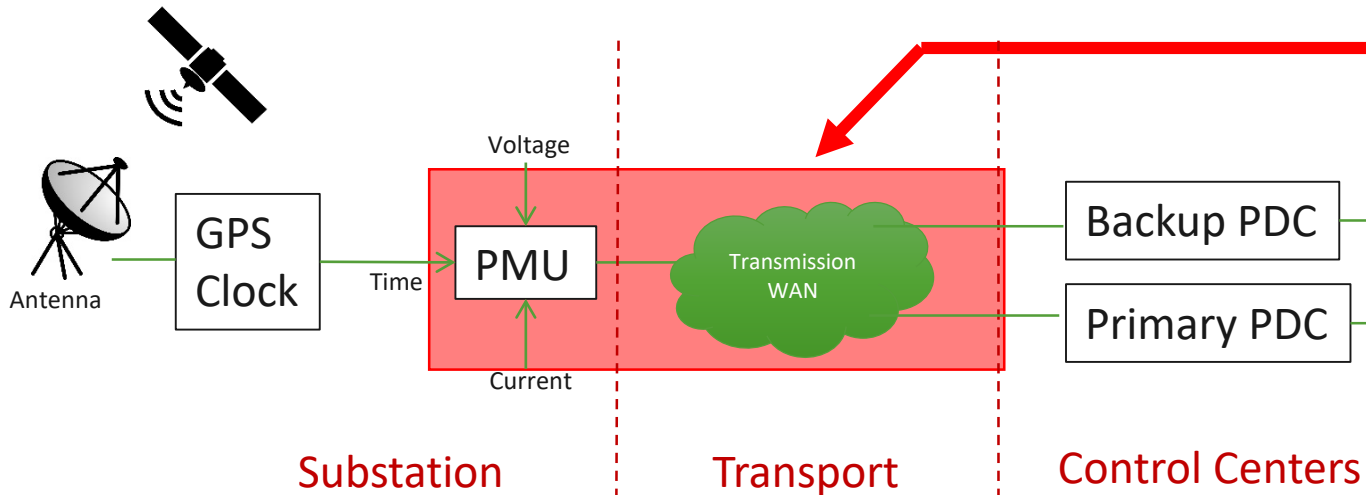
**WARNING.** Data is not currently available or time-stamp is “old” from the PMU.

**ACTION:** Wait. PMU could be restarting or experiencing an intermittent issue (e.g. an openPDC failover). Wait to see if state changes to good. If not, it will go into alarm within 15 minutes.



# Red State - Alarm

Alarms											
Good	Out of Service	Acknowledged	Bad Time	Alarm							
BRF 0	Browns Ferry 0	Bull Run 0	Cumberland 131 d	DVS3 0	Freeport 31 m	FWS-PMU1 (SEQ) 0	FWS-PMU2 (MOC) 0	GLT-PMU 0	HIS 31 m	JOFB 147 d	Johnsonville 31 m
JST1 0	JST2 0	LCS 31 m	Magnolia U2 Ct 31 m	Magnolia U2 St 31 m	MNS 0	Moccasin DFR 0	MRS 0	ORNL 0	PACC1 0	PACC2 0	PHS1 0
PHS2 2 m	Pmu1- Moccasin Df 0	RBSS 31 m	RCS1 0	RCS2 0	<b>RIS 16 m</b>	S6S 31 m	SHS 147 d	SLS1 131 d	SNS1 0	SQN1 0	SQN2 0
SSS1 0	TVA_CONCORD 31 m	TVA_CONCORD 31 m	TVA_CONCORD 31 m	TVA_CONCORD 31 m	TVA_GNMILLING 0	Tva_Gnmilling01 0	VLS 0	WBN1 0	WBN2 0	WEC 0	Widows Creek 304 d



**ALARM.** Data has not been received from the PMU for 15 minutes or more.

**ACTION:** Check network connectivity to the PMU with a ping test.

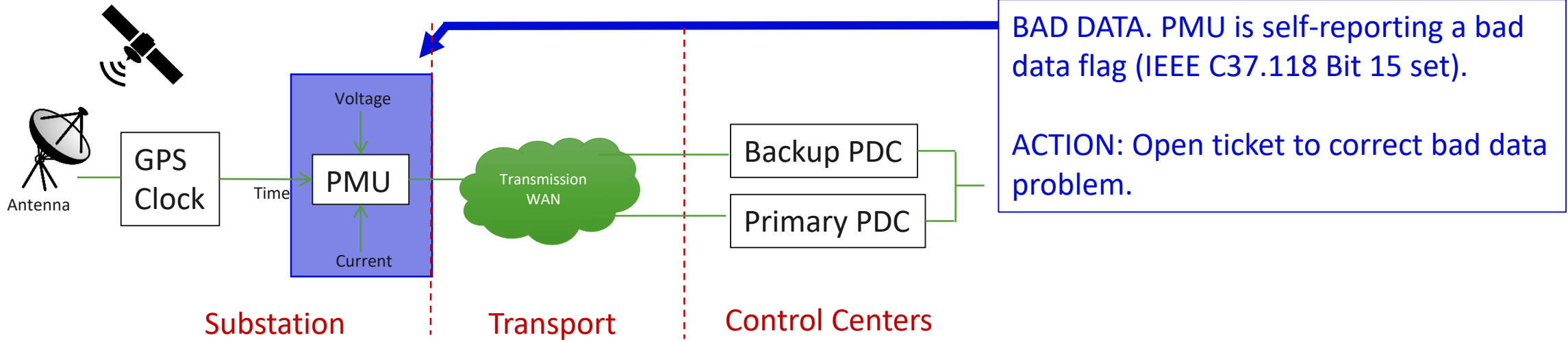
If connection is good, open ticket to investigate and restore PMU to service.

# Blue State - Bad Data

Alarms

■ Good 
 ■ Out of Service 
 ■ Acknowledged 
 ■ Bad Time 
 ■ Bad Data

BRF 0	Browns Ferry 0	Bull Run 0	Cumberland 131 d	DVS3 0	Freeport 1 m	FWS-PMU1 (SEQ) 0	FWS-PMU2 (MOC) 0	GLT-PMU 0	HIS 1 m	JOFB 147 d	Johnsonville 1 m
JST1 0	JST2 0	LCS 1 m	Magnolia U2 Ct 1 m	Magnolia U2 St 1 m	MNS 0	Moccasin DFR 0	MRS 0	ORNL 0	PACC1 0	PACC2 0	PHS1 0
PHS2 0	pmu1- Moccasin Df 0	RBSS 1 m	RCS1 0	RCS2 0	RIS 1 m	S6S 1 m	SHS 147 d	SLS1 131 d	SNS1 0	SQL1 0	SQL2 0
SSS1 0	TVA_CONCORD 1 m	TVA_CONCORD 1 m	TVA_CONCORD 1 m	TVA_CONCORD 1 m	TVA_GNMILLING 0	Tva_Gnmillingt01 0	VLS 0	WBN1 0	WBN2 0	WEC 0	Widows Creek 304 d

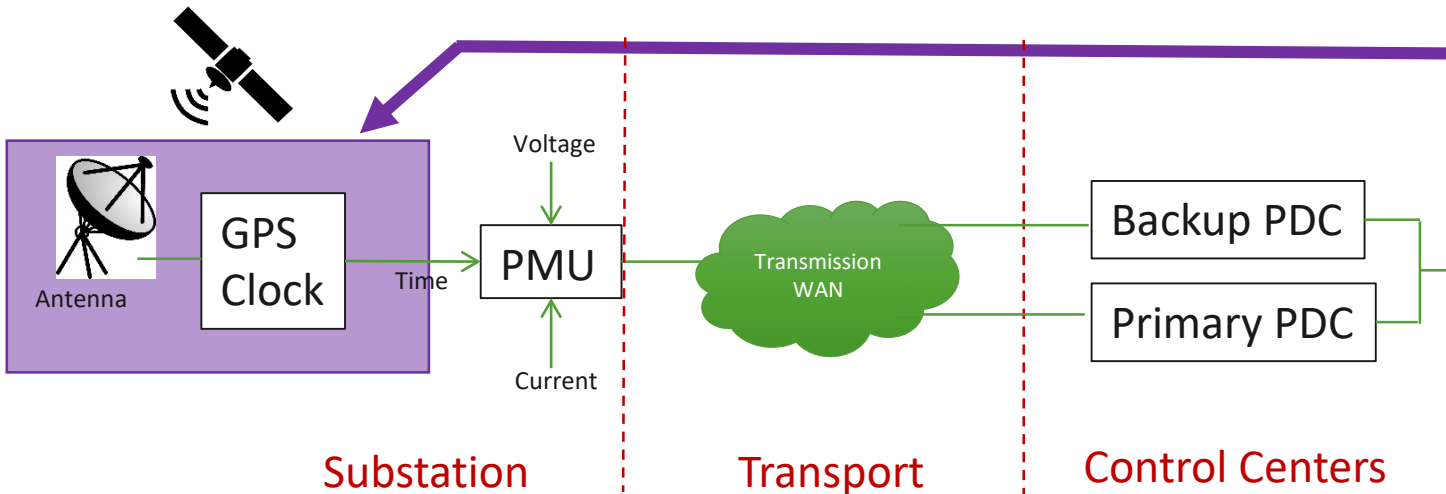


# Purple State - Bad Time

Alarms

Legend: Good (Green), Out of Service (Grey), Acknowledged (Brown), Bad Time (Purple), Alarm (Red)

BRF 0	Browns Ferry 0	Bull Run 0	Cumberland 131 d	DVS3 0	Freeport 31 m	FWS-PMU1 (SEQ) 0	FWS-PMU2 (MOC) 0	GLT-PMU 0	HIS 31 m	JOFB 147 d	Johnsonville 31 m
JST1 0	JST2 0	LCS 31 m	Magnolia U2 Ct 31 m	Magnolia U2 St 31 m	MNS 0	Moccasin DFR 0	MRS 0	ORNL 0	PACC1 0	PACC2 0	PHS1 0
PHS2 2 m	Pmu1 Moccasin Df 0	RBSS 31 m	RCS1 0	RCS2 0	RIS 16 m	S6S 31 m	SHS 147 d	SLS1 131 d	SNS1 0	SQN1 0	SQN2 0
SSS1 0	TVA__CONCORD 31 m	TVA__CONCORD 31 m	TVA__CONCORD 31 m	TVA__CONCORD 31 m	TVA_GNMILLING 0	Tva_Gnmilling01 0	VLS 0	WBN1 0	WBN2 0	WEC 0	Widows Creek 304 d



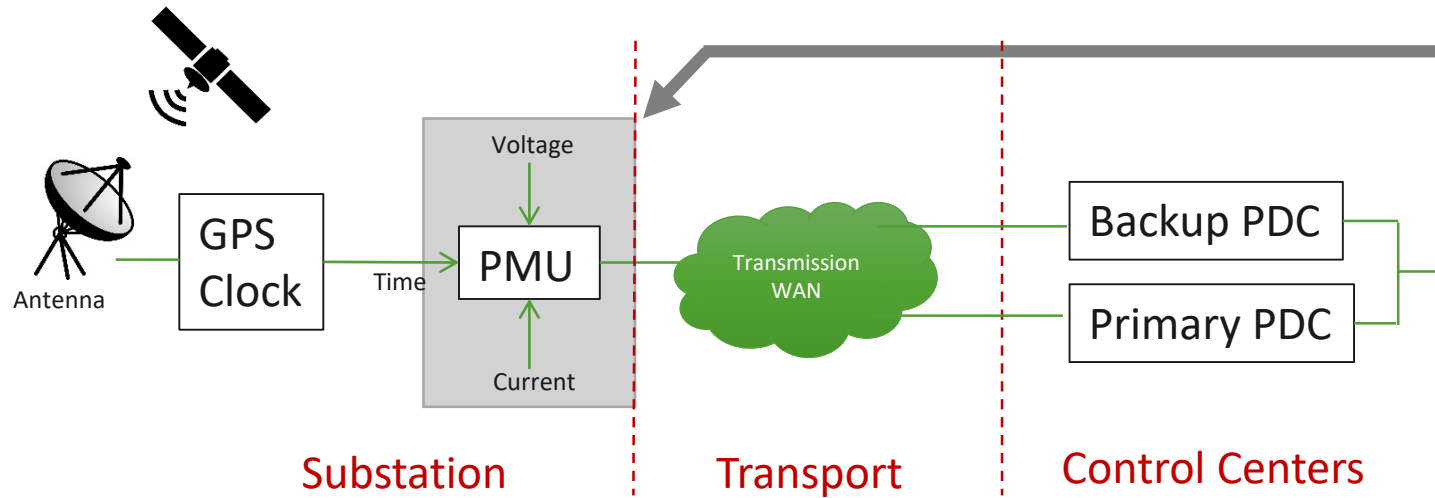
**BAD TIME.** PMU is reporting a bad time flag (IEEE C37.118 Bit 13) or the openPDC detects that measurement time is consistently wrong as compared to its server clock. This alarm can be common with DST changes.

**ACTION:** Open ticket to check time signal strength and connection and clock input to the PMU.

# Grey State - Out of Service

Alarms

Good	Out of Service	Acknowledged	Bad Time	Alarm							
BRF 0	Browns Ferry 0	Bull Run 0	Cumberland 131 d	DVS3 0	Freeport 31 m	FWS-PMU1 (SEQ) 0	FWS-PMU2 (MOC) 0	GLT-PMU 0	HIS 31 m	JOFB 147 d	Johnsonville 31 m
JST1 0	JST2 0	LCS 31 m	Magnolia U2 Ct 31 m	Magnolia U2 St 31 m	MNS 0	Moccasin DFR 0	MRS 0	ORNL 0	PACC1 0	PACC2 0	PHS1 0
PHS2 2 m	Pmu1-Moccasin Df 0	RBSS 31 m	RCS1 0	RCS2 0	RIS 16 m	S6S 31 m	SHS 147 d	SLS1 31 d	SNS1 0	SQN1 0	SQN2 0
SSS1 0	TVA_CONCORD 31 m	TVA_CONCORD 31 m	TVA_CONCORD 31 m	TVA_CONCORD 31 m	TVA_GNMILLING 0	Tva_Gnmilling0 0	VLS 0	WBN1 0	WBN2 0	WEC 0	Widows Creek 304 d

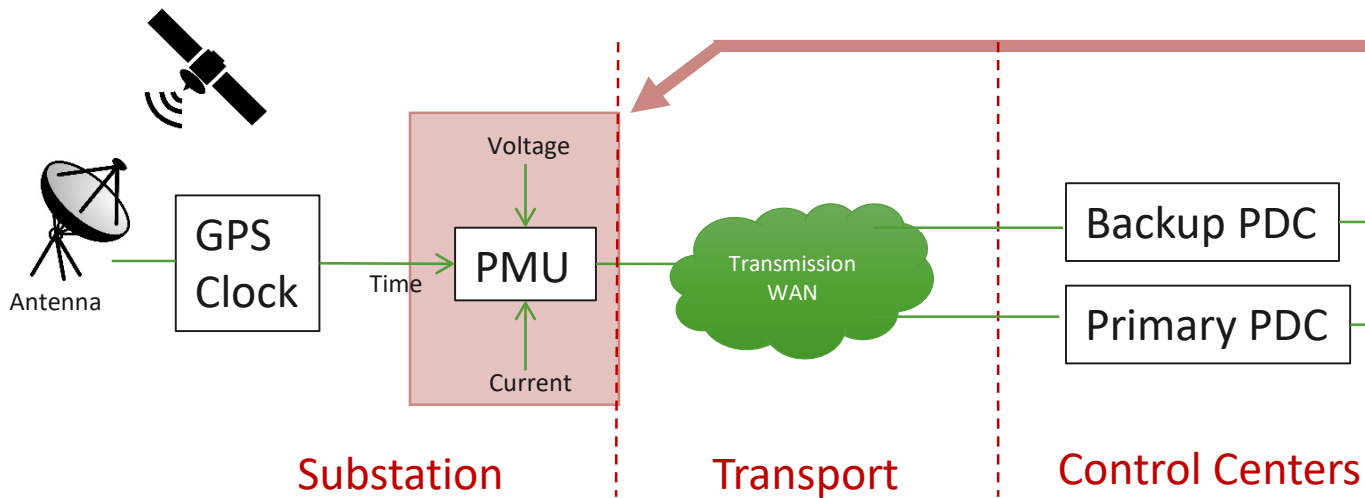


OUT-OF-SERVICE. The PMU has been disabled through openPDC configuration and therefore no data is available.

This state is typically used to indicate a device that has failed and is scheduled for replacement or major maintenance.

# Mauve State – Alarm Acknowledged

Alarms											
Good	Out of Service	Acknowledged	Bad Time	Alarm							
BRF 0	Browns Ferry 0	Bull Run 0	Cumberland 31 m	DVS3 0	Freeport 31 m	FWS-PMU1 (SEQ) 0	FWS-PMU2 (MOC) 0	GLT-PMU 0	HIS 31 m	JOFB 147 d	Johnsonville 31 m
JST1 0	JST2 0	LC5 31 m	Magnolia U2 Ct 31 m	Magnolia U2 St 31 m	MNS 0	Moccasin DFR 0	MRS 0	ORNL 0	PACC1 0	PACC2 0	PHS1 0
PHS2 2 m	Pmu1-Moccasin Df 0	RBSS 31 m	RCS1 0	RCS2 0	RIS 16 m	S6S 31 m	SHS 147 d	SLS1 131 d	SNS1 0	SQN1 0	SQN2 0
SSS1 0	TVA_CONCORD 31 m	TVA_CONCORD 31 m	TVA_CONCORD 31 m	TVA_CONCORD 31 m	TVA_GNMILLING 0	Tva_Gnmilling01 0	VLS 0	WBN1 0	WBN2 0	WEC 0	Widows Creek 304 d



**ACKNOWLEDGED.** The NOC Dashboard user/operator has formally acknowledged the alarm and it is being addressed.

**ACTION:** None. If PMU state transitions to "Good" for 60 minutes, Acknowledged state will be automatically cleared. (or state can be manually reset to "Good" by user/operator)