GE

Grid Solutions

G500 Substation Gateway

Firmware Release Notes

MIS-0109

Version 1.00 Revision 0

GE Information

imagination at work

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About this Document

Purpose

The purpose of this document is to outline features, capabilities and issues, known to exist within the G500 Substation Gateway at the time of release.

Intended Audience

This document is an external document intended for both GE Staff and Customers. It highlights the features and capabilities of the G500 firmware.

Additional Documentation

For further information about the G500, refer to the following documents:

- *G500 Software User's Manual (SWM0101)*
- *G500 Hardware Instruction Manual (994-0152)*
- *G500 Quick Start Guide (SWM0106)*

For the most current version of the above documentation, please download a copy from:
http://www.gegridsolutions.com/app/ViewFiles.aspx?prod=g500&type=3

1. Version 1.00 (27-March-2019)

1.1 Minimum Software Versions

The following defines the minimum software versions required for interaction with the G500.

Package	Minimum Version (Tested)	Notes
G500 Firmware	1.0.xxx	G500 Firmware Version
DS Agile MCP Studio	1.0.0.xxx	Supported DS Agile MCP Studio Software.
G500 HMI Viewer	1.00.xxx	Supported G500 HMI 64-bit Software.

1.2 Key Features

G500 is part of the Multi-Function Controller Platform (MCP).

G500 is designed to provide a reliable and accurate collection of data (metering, status, events and faults) from serial or LAN based intelligent substation devices to master applications such as SCADA, EMS, DMS or other enterprise applications. With its modern and robust cyber security features, the G500 is designed for smooth integration into NERC CIP and Cyber Security environments while consolidating functions such as ethernet communications, time synchronization, HMI and SCADA applications.

G500 supports the following key features as part of v1.00.

- **Advanced Gateway:** G500 collects operational and non-operational data from substation protection, control, monitoring, RTU, and intelligent devices, pre-processes the data and moves it up to EMS and DMS SCADA systems providing centralized substation management.
- **Advanced Automation:** G500 provides the computing platform necessary to automate substation procedures, such that intricate processes are carried out safely and efficiently by creating advanced custom automation programs using IEC 61131 compliant tools and perform basic math functions on data points using the built-in calculator tool.
- **Datalogging and Alarm Management:** G500 supports logging of analog and binary events, including alarm management. Users have access to view and extract logged data via Runtime HMI corresponding screens (Trending, SOE, Historical Data, Active Alarms).
- **Automated Records (files) Retrieval and Management (ARRM):** G500 supports automated extraction of data files from IEDs, such as digital fault recording (DFR) records, event files, device information files, etc. Acquired files can be securely pushed automatically to remote systems.
- **Secure Passthrough Remote Access and VPN:** G500 allows users to securely access substation devices from remote locations through validated interactive sessions hosted by the G500.
- **User Authentication:** G500 provides Role Based Access Control (RBAC) with Local Account Authentication.
- **Runtime HMI:** G500 provides user interaction with Role Based Access Control via a portable Runtime HMI application that runs in the Local unit KVM interfaces, as well as Remote in Windows based computers. There is no requirement to install Java/JRE on the Windows computers.
- **Support for Predix Edge Connectivity:** G500 uses GE's Hardened *Predix EDGE* Operating System (Linux Yocto based) and supports secured connectivity for enrolling the unit into Predix Edge Manager.

  Predix Edge Manager is a GE hosted Cloud Application that provides asset / fleet management of enrolled devices.

- **Hardware Based PRP/Redundant LAN Support:** G500 supports up to 3 hardware based independent PRP or Redundant LAN through the rear ethernet ports.
- **Hardware Based IEEE 1588 PTP Master-Slave Support:** G500 supports hardware based PTP Master-Slave support on the rear ethernet ports.
- **Hardware Based IRIG-B Input Support:** G500 supports hardware based IRIG-B input.

  Note: G500 can be configured to use PTP as a primary time source with automatic fail back to IRIG-B IN (IRIG-B IN must be in UTC time zone in this release).
- **Hardware Asset Management Application (HAMA):** G500 supports monitoring of the hardware parameters, e.g. network modes, serial port settings, temperatures, real time utilizations of various resources, etc. and presenting of these to the G500 System Point Database by means of Analog/Digital/Accumulator/Text Points.

1.3 Capability and Capacity

The G500 performance test levels are presented in this section.

G500 Hardware under test: 4 core CPU/ 16GB RAM variant.

Note: In the combined tables, numbers in brackets are for the G500 variant with 2 core CPU/8GB RAM.

Requirement	Steady State Loading	Avalanche Loading
Loading Signal changes (continuously / sec)	AI - 10,000 (5,000) DI – 100	All points changing twice in 2 secs
Number of connected IEDs to G500	500 (250)	500 (250)
G500 total RTDB Point count	200,000 (100,000)	200,000 (100,000)
Points / IED DI & AI	400 150x DI and 250x AI per IED	400 150x DI and 250x AI per IED
Each G500 Server has points (half for 2 core CPU/8GB RAM)	DI = 18750 i.e.=150*500/4 AI = 31250 i.e.=250*500/4	DI = 18750 i.e.=150*500/4 AI = 31250 i.e.=250*500/4
Remote G500 HMI connections	3 Simultaneous connections	3 Simultaneous connections
Local G500 HMI connections	1 connection (multiple displays)	1 connection (multiple displays)
Datalogger / Continuous reports	1000 (500) AI mapped / 100 (50) reports	1000 (500) AI mapped / 100 (50) reports
ARRM	5 sessions / IED	5 sessions / IED
Alarms	100 (50) / sec	100 / sec (for 2 seconds)

1.3.1 Stand Alone

G500 provides the following performance capabilities in Single (non-redundant) Mode.

1.3.1.1 Performance Test Levels

The performance of G500 is tested using the activity levels and disturbance scenarios presented next.

The master station response times are defined in Table 1.1: Standalone Performance test results

Table 1.1: Standalone Performance test results

Activity	DNP	DNP	IEC 61850	IEC 61850
Hardware (CPU / RAM)	4 core / 16 GB	2 core / 8 GB	4 core / 16 GB	2 core / 8 GB
Loading Condition	Steady state	Steady state	Steady state	Steady state
Protocol – CLIENT / SERVER	DNP / DNP	DNP / DNP	IEC 61850 / DNP	IEC 61850 / DNP
RTDB Point count	200,000	100,000	200,000	100,000
Total RCB configured / Simulation per sec	NA	NA	6000 1000	3000 500
Number of IEDs	500 (250)	500 (250)	500 (250)	500 (250)
Points / IED (AI + DI + AO + DO)	[AI-250, 150-DI, 20-DO, 20-AO, 10-ACC]	150DI+250AI (Configured AO, DO no simulation)	150DI+250AI (Configured AO, DO no simulation)	150DI+250AI (Configured AO, DO no simulation)
Datalogger reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) Periodic reports
Number of Master connections Point count / Server	8 DI – 9300, AI – 15500	4 DI – 4650, AI - 7750	8 DI – 9300, AI - 15500	4 DI – 4650, AI - 7750
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI	1 Remote / 1 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	60,50,92	80, 28, 95	56, 30, 95	46, 36, 75
Average Memory	2.4 GB	1.4 GB	3 GB	2 GB
Event latency in (msecs) Average, Min, Max	399,19,1.04sec	487,13,1.31	589, 5, 2200	330, 41, 652
Control latency in (msecs) Average, Min, Max	34,12,291	629,3,1.09	8, 6, 16	9, 3, 68

1.3.1.2 HMI Response time

Under heavy loading conditions, the G500 provides the HMI response times listed in Table 1.2: User Interface Response Time.

Table 1.2: User Interface Response Time

Activity	Normal	High
Screen Access (Point Summary)	< 2 s	< 2 s
Screen Access (One Line Viewer)	5 to 7 s	5 to 7 s
System Logs	< 2s	2s
Alarm ACK Delay (Single Alarm)	< 1 s	< 1 s
Alarm ACK Delay (20,000 Alarms)	< 2 s	< 7 s
DI/AI Update to Point Summary Screen	< 1 s	< 1 s
Datalogger	<2s	<2s

Note: Under heavy loading conditions, the control latency was measured by simulating one control every 5 seconds continuously from the Master station.

1.3.2 Hot Standby Redundancy

G500 provides the following performance capabilities in Hot Standby Redundancy Mode.

Configuration	DNP	IEC61850
Hardware (CPU /RAM)	4 core / 16 GB	4 core / 16 GB
Redundancy	Hot Standby	Hot Standby
Number of IEDs	500 (250)	500 (250)
Protocol – CLIENT / SERVER	DNP / DNP	IEC61850 / DNP
RTDB Point count	200,000 (100,000)	200,000 (100,000)
Points / IED (AI + DI + AO + DO)	150 DI, 250 AI	150 DI, 250 AI
Number of Master connections Point count / Server	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)
Total RCB configured / Simulation per sec	NA	6000 (3000) 1000 (500)
Datalogger / Continuous reports	NA	NA
ARRM	Not configured	Not configured
Alarms	100 (50) /sec	100 (50) /sec
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI

CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	60,34,71	32,46,67
Average Memory	3.12 GB	4.3 GB
Event latency – Average, Min, Max (msec)	390,60,1sec	368,2.8,1sec
Control latency – Average, Min, Max (msec)	30,12,377	3,1,73

1.3.3 Warm Standby Redundancy

G500 provides the following performance capabilities in Warm Standby Redundancy Mode.

Protocol	**DNP**	**IEC61850**	**IEC 104**
Hardware CPU / RAM	4 core / 16 GB (2 core / 8 GB)	4 core / 16 GB (2 core / 8 GB)	4 core / 16 GB (2 core / 8 GB)
Redundancy Mode	Warm Standby	Warm Standby	Warm Standby
Number of IEDs	500 (250)	500 (250)	500 (250)
Protocol – CLIENT / SERVER	DNP / DNP	IEC61850 / DNP	IEC 104 / IEC 104
RTDB Point count	200,000 (100,000)	200,000 (100,000)	200,000 (100,000)
Points / IED (AI + DI + AO + DO)	150 DI, 250 AI	150 DI, 250 AI	150 DI, 250 AI
Number of Master connections Point count / Server	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)	8 (4) DI – 9300, AI – 15500 (DI – 4650, AI – 7750)
Total RCB configured / Simulation per sec	NA	6000 (3000) 1000 (500)	NA
Datalogger reports	100 (50) Periodic reports	100 (50) Periodic reports	100 (50) continuous reports
ARRM	Not configured	Not configured	Not configured
Alarms	100 (50) /sec	100 (50) /sec	100 (50) /sec
Remote / Local HMI connections	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI	1 Remote / 0 Local HMI
CPU utilization – Avg, Min, Max (%) – values for 4 core CPU	62,53,96	43,48,60	28,32,42
Average Memory	2.4 GB	3 GB	3.4 GB
Event latency – Average, Min, Max (msec)	437,26,1.06	683,323,1sec	221,107,380

Control latency – Average, Min, Max (msec)	44,11,240	3,1,85	30,10,331

Note: G500 Supports maximum of 4 simultaneous Runtime HMIs (Remote + Local) either in Standby and Redundancy Modes (Hot/Warm Redundancy).

1.4 Time Sync Accuracy (PTP/IRIG-B/NTP)

G500 supports Hardware based PTP/IRIG-B and Software based NTP Time Sync Accuracy.

1.4.1 PTP Accuracy

1.4.1.1 Test Steps:

Below are setup details used for measuring PTP IN Time sync accuracy:

- Total number of samples considered ~250,000.
- Accuracy found to be < +/- 1ms for 99.86% of samples.
- Measured the accuracy for every second at the G500 CPU or Kernel.

1.4.1.2 Test Results:

Time Sync Input	Accuracy % of samples within (+/- 1 msec)
PTP IN	99.86% (samples within +/-1 ms)

NOTES: Accuracy is measured in a scenario where the hardware /FPGA is fully loaded.

If IEDs are getting time synced using any of the client communication protocols, then the above accuracy can't be guaranteed at the IED.

1.4.2 IRIG-B Accuracy

1.4.2.1 Test Setup:

Below are setup details used for measuring IRIG-B IN Time sync accuracy:

- Total number of samples considered ~50,000.
- Accuracy found to be < +/- 1ms for 99.8% of samples.
- Measured the accuracy for every second at the G500 CPU or Kernel.

1.4.2.2 Test Results:

Time Sync Input	Accuracy % of samples within (+/- 1 msec)
IRIG-B IN	99.8% (samples within +/-1 ms)

NOTES: Accuracy is measured in a scenario where the hardware /FPGA is fully loaded.

If IEDs are getting time synced using any of the client communication protocols, then the above accuracy can't be guaranteed at the IED.

1.4.3 NTP IN Accuracy

1.4.3.1 Test Setup:

Below are setup details used for measuring NTP IN Time sync accuracy:

- Total number of samples considered ~50,000.
- Accuracy found to be < +/- 10ms for 99.97% of samples.
- Measured the accuracy for every second at the G500 CPU or Kernel.

1.4.3.2 Test Results:

Time Sync Input	Accuracy % of samples within (+/- 10 msec)
NTP IN	99.97% (samples within +/-10 ms)

NOTES: If IEDs are getting time synced using any of the client communication protocols, then the above accuracy can't be guaranteed at the IED.

1.4.4 NTP OUT Accuracy

Below are setup details used for measuring NTP OUT Time sync accuracy:

- Total number of samples considered ~50,000.
- Accuracy found to be < +/- 1 ms for 99.9% of samples.
- Measured the accuracy for every second at the IED.

1.4.4.1 Test Results:

Time Sync Output	**Accuracy % of samples within (+/- 1 msec)**
NTP OUT	99.9% (samples within +/- 1ms)

NOTES: If IEDs are getting time synced using any of the client communication protocols, then the above accuracy can't be guaranteed at the IED.

1.5 Application List

The following application versions comprise the G500 V1.00 released firmware version and build xxx.

Application	**Support in Standalone/ Warm Standby**	**Support in Hot Standby**
Runtime HMI	Available	Available
One Line Viewer	Available	Available
Config GUI / Schemas	Available	Available
System Library	Available	Available
C++ System Library	Available	Available
Connection Parser	Available	Available
Calculator	Available	Available
Hardware Asset Management Application (HAMA)	Available	Not available

Application	Support in Standalone/ Warm Standby	Support in Hot Standby
PTP/IRIG-B Time Sync	Available	Available
Modbus Client	Available	Available
Modbus-TCP/SSH Client	Available * Not Available in Warm Standby	Not Available
SEL® Binary Client	Available	Not Available
Analog Data Logger	Available	Not Available
Generic ASCII Client	Available	Not Available
Modbus Server	Available	Not Available
DNP 3.0 Server	Available	Available
DNP 3.0 Client	Available	Available
Digital Event Manager	Available	Available
Database Server	Available	Available
DNP 3.0 TCP/IP Transport Layer	Available	Available
DNP 3.0 Server Serial Transport Layer	Available	Available
DNP 3.0 DIDO	Available	Not Available
IEC 60870-5-101/104 Server	Available	Not Available
IEC 60870-5-103 Client	Available	Not Available
IEC 61850 Client	Available	Available
IEC 60870-5-101/104 Client	Available	Not Available
Event Logger	Available	Available
Real-Time Database	Available	Available
LogicLinx IEC 61131-3 Soft Logic	Available	Available
Redundancy Manager	Available	Available
System Point Manager	Available	Available
Load Shedding and Curtailment	Available	Not Available
Control Lockout Manager	Available	Available
Software Watchdog	Available	Available
Configuration Manager	Available	Available
IP Changer	Available	Available
MD5SUM Builder	Available	Available
System Status Manager	Available	Available
Virtual Serial Ports	Available	Available
SNMP Client	Available	Not Available
Automated Record Retrieval Manager	Available	Not Available
Software Licensing Subsystem	Available	Available
Third-party components	Available	Available

Application	Support in Standalone/ Warm Standby	Support in Hot Standby
Terminal Services	Available	Available
mcpcfg utility	Available	Available
E-mail Utility	Available	Available
IO Traffic Monitor	Available	Available
Firewall	Available	Available
Edge OS & Drivers	Available	Available
Secure Enterprise Connectivity	Available	Available
Genconn	Available	Available
HMI Access Manager	Available	Available
Sync Service Library	Available	Available
Sync Server Application	Available	Available
Analog Report Generator	Available	Not Available
OpenVPN	Available	Available

Note: xxx is the minor number which will be updated before Release.

1.6 Known Issues

1.6.1 Cyber Security

GE Internal Reference #	Summary	Impact
B-12426	User Account Remote Authentication (LDAP-AD/CISCO-TACACS+)	Remote user authentication using these methods is not available in this release. Only Local Account Authentication is available, with roles: • **Observer** • **Operator** • **Supervisor** • **Administrator** • **Pass-through user**

1.6.2 Clients

GE Internal Reference #	Summary	Impact
D-05002	Cannot perform file transfer from GENASCII devices	ARRM file retrieval from SEL 1xx/2xx relays (using GENASCII) is not possible
D-06211	PRF (Protective Relay Faults) event information is not processed properly for SEL 1xx/2xx relays	Protective relay information from ASCII relays is not available

GE Internal Reference #	Summary	Impact
D-05827	PRF (Protective Relay Faults) limited functionality	PRF functionality is not available for SEL relays that do not support HIS.16 command.

1.6.3 Servers

GE Internal Reference #	Summary	Impact
B-11968	No support for events in NVRAM in DNP3 Server	Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.
B-11967	No support for events in NVRAM in IEC101/104 Server	Events that have not been yet transmitted to Master (Clients) are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.

1.6.4 Automation

GE Internal Reference #	Summary	Impact
D-05877	No warning message when storage space is reduced in datalogger configuration.	Currently datalogger application re-adjusts the storage space(increase/decrease) based on the newly allocated settings. In this case users might not be aware of the deletion of the records if the newly allocated storage space is smaller than the previous allocated one.
D-05033	Suppressed quality through Input Point Suppression (IPS) application is not reported to Masters	DNP3 and IEC 101-104 Servers send Online Quality rather than the substituted/last reported quality when points are suppressed.
D-05462	Load shedding: Persistent storage of Zone Assignments is not working	There is no persistency of zone assignments across power restarts when user sets the zones through Analog Setpoint commands.
B-11969	No support for events in NVRAM for DEM	DEM is responsible for handling alarms. Events/Alarms that have not been yet committed to the SQL database are lost if G500 is power cycled / restarted. However – the integrity polls will continue to provide accurate database representation.

1.6.5 Configuration

GE Internal Reference #	Summary	Impact
D-06168	FPGA needs to be restarted for PTP/IRIGB configuration change	No functional impact. PTP/IRIG-B configuration will not be applied without reboot of G500.

1.6.6 HMI

GE Internal Reference #	Summary	Impact
D-05802	Local HMI shows exception errors when screens are open and video resolution is changed lower than the current size of HMI frames	Occurs only when screen resolutions are changed, and the Local HMI has windows opened with a larger size than the new set resolution. User must close the Local HMI and re-open again.
D-05463	Point groups: Points are missing after deleting an active group	If a used point group is deleted from the systemwide configuration then points belonging to that group are not visible in the point group summary. However, if user changes the point group allocation from the corresponding instantiated client map file(s) then points will be visible in the point group summary.
D-05827	Enhancement required for PRF Events implementation	Protective Relay Fault (PRF) Information from SEL ASCII and SEL Binary relays is not available in PRF viewer.

1.6.7 Pass-through

GE Internal Reference #	Summary	Impact
D-07084	Cannot access hosts inside Internal Zone unless hosts have custom routing configured	Only hosts in internal zone that allow configuration of custom routes can be accessed via VPN server from external zone.

1.6.8 System

GE Internal Reference #	Summary	Impact
D-05714	Update of only Edge OS is not supported.	If only Edge OS updates are required, the complete G500 firmware image needs to be updated.
D-06167	Full support for latest PTP power profiles: IEEE C37.238-2017 IEC61850-9-3 Ed.1 2016	Enhancement. G500 supports the following PTP profiles: IEEE 1588-2008 J4 Peer-to-Peer Profile IEEE C37.238-2011 Power System Profile (but this has been withdrawn) Limited IEC61850-9-3 Ed.1 2016 Power Utility Automation Profile

1.6.9 Hardware

GE Internal Reference #	Summary	Impact
D-06232	IRIG-B Out is invalid during start-up	IRIG-B OUT signal produces a 1970-01-01 signal for brief periods of time during G500 start-up.
D-06165	SFP Hot Plug in / Plug out detection	No functional impact. Points that represent the status of SFP IN/OUT will not be reflected until G500 is rebooted.

MODIFICATION RECORD

VERSION	REV.	DATE	AUTHOR	CHANGE DESCRIPTION
1.00	0	27th February, 2019	P. Smitha	Created for G500 firmware version 1.00