

TECHNICAL REFERENCE

# **Communication networks and systems in power utility automation**

– Part 90-16: Requirements of system management for Smart Energy Automation

## **TR IEC TR 61850-90-16:2023**

IEC TR 61850-90-16:2021, IDT  
(ICS 33.200)

---

### TECHNICAL REFERENCE

## **Communication networks and systems in power utility automation**

– Part 90-16: Requirements of system management for Smart Energy  
Automation

---

Published by Enterprise Singapore



**THIS PUBLICATION IS COPYRIGHT  
PROTECTED**

**Copyright © 2023 Enterprise Singapore  
Copyright © 2021 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilised in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from Enterprise Singapore, representing the IEC National Committee of Singapore, or the IEC. If you have any questions about the copyrights of Enterprise Singapore or the IEC or have an enquiry about obtaining additional rights to this publication, please contact Enterprise Singapore at: [standards@enterprisesg.gov.sg](mailto:standards@enterprisesg.gov.sg) for further information.

ISBN 978-981-5163-03-2

## National Foreword

This Technical Reference (TR) was prepared by the Working Group on Smart Grid set up by the Technical Committee on Power System and Utilisation under the purview of the Electrical and Electronic Standards Committee.

This TR is an identical adoption of IEC TR 61850-90-16:2021, Communication networks and systems in power utility automation – Part 90-16: Requirements of system management for Smart Energy Automation, published by the International Electrotechnical Commission.

This TR is a provisional standard made available for application over a period of three years. The aim is to use the experience gained to update the TR so that it can be adopted as a Singapore Standard. Users of the TR are invited to provide feedback on its technical content, clarity and ease of use. Feedback can be submitted using the form provided in the TR. At the end of the three years, the TR will be reviewed, taking into account any feedback or other considerations, to further its development into a Singapore Standard if found suitable.

Attention is drawn to the possibility that some of the elements of this TR may be the subject of patent rights. Enterprise Singapore shall not be held responsible for identifying any or all of such patent rights.

### NOTE

1. *Singapore Standards (SSs) and Technical References (TRs) are reviewed periodically to keep abreast of technical changes, technological developments and industry practices. The changes are documented through the issue of either amendments or revisions. Where SSs are deemed to be stable, i.e. no foreseeable changes in them, they will be classified as "mature standards". Mature standards will not be subject to further review, unless there are requests to review such standards.*
2. *An SS or TR is voluntary in nature except when it is made mandatory by a regulatory authority. It can also be cited in contracts making its application a business necessity. Users are advised to assess and determine whether the SS or TR is suitable for their intended use or purpose. If required, they should refer to the relevant professionals or experts for advice on the use of the document. Enterprise Singapore and the Singapore Standards Council shall not be liable for any damages whether directly or indirectly suffered by anyone or any organisation as a result of the use of any SS or TR. Although care has been taken to draft this standard, users are also advised to ensure that they apply the information after due diligence.*
3. *Compliance with a SS or TR does not exempt users from any legal obligations.*



# TECHNICAL REPORT



---

## **Communication networks and systems in power utility automations – Part 90-16: Requirements of system management for Smart Energy Automation**



**THIS PUBLICATION IS COPYRIGHT PROTECTED**

**Copyright © 2021 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

**About the IEC**

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

**About IEC publications**

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

**IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)**

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

**IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)**

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

**IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)**

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

**IEC online collection - [oc.iec.ch](http://oc.iec.ch)**

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

**Electropedia - [www.electropedia.org](http://www.electropedia.org)**

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.



# TECHNICAL REPORT



---

## Communication networks and systems in power utility automations – Part 90-16: Requirements of system management for Smart Energy Automation

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

ICS 33.200

ISBN 978-2-8322-9713-1

**Warning! Make sure that you obtained this publication from an authorized distributor.**

## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references .....	8
3 Terms and definitions .....	9
4 Smart Grid System life cycle.....	10
4.1 Overview.....	10
4.2 IED life-cycle .....	11
4.2.1 Software .....	11
4.2.2 Hardware.....	11
4.2.3 Main life-cycle stages .....	11
4.2.4 Cybersecurity lifecycle for system management.....	12
4.3 System management roles identified.....	14
4.3.1 Business roles.....	14
4.3.2 System roles.....	15
4.4 System management architecture .....	17
5 System management Business Use Cases .....	19
5.1 General.....	19
5.2 BUC: Enable Automation System to perform operational functions in best conditions .....	19
5.2.1 Description of the use case .....	19
5.2.2 Diagrams of use case .....	20
5.2.3 Technical details.....	21
6 System management system Use Cases .....	21
6.1 General.....	21
6.2 Configuration and administration system Use Cases .....	22
6.2.1 System Use Cases identified .....	22
6.2.2 SUC: Deploy a Power System Function .....	22
6.2.3 SUC: Synchronize multiple automation-system-devices updates.....	35
6.3 Asset management, supervision and maintenance system Use Cases .....	40
6.3.1 System Use Cases identified .....	40
6.3.2 SUC: Replace an IED of an automation-system with an identical one .....	41
6.3.3 SUC: Store and provide electrical network asset information during its lifecycle .....	46
6.4 Cybersecurity system Use Cases for system management.....	50
6.4.1 System Use Cases identified .....	50
6.4.2 Cybersecurity SUC diagrams descriptions .....	59
Annex A (informative) Short description of complementary Use Cases.....	65
Bibliography.....	66
Figure 1 – Scope of the functions and objects covered by the Smart Grid Device Management.....	7
Figure 2 – Smart Grid Systems and system management .....	11
Figure 3 – Different Use Cases through the lifecycle of a smart grid system .....	12
Figure 4 – Illustration of system management architecture on SGAM .....	17
Figure 5 – Interactions between Information System and IEDs.....	18

Figure 6 – General architecture of key roles involved in system management .....	18
Figure 7 – Overview of BUC Enable Automation System to perform operational functions in best conditions .....	21
Figure 8 – Scenario diagram of SUC Deploy a Power System function.....	27
Figure 9 – Deploy firmware state machine .....	31
Figure 10 – Update and activate power system configuration state machine .....	33
Figure 11 – Overview of SUC: Synchronize multiple automation-system-devices updates.....	38
Figure 12 – Overview of SUC: scenario flow chart of "Synchronizing multiple IED updates" .....	39
Figure 13 – Overview of SUC: Replace an IED of an automation-system with an identical one .....	43
Figure 14 – Scenario diagram of SUC: Replace an IED of an automation-system with an identical one .....	44
Figure 15 – Overview of SUC: Store and provide electrical network asset information during its lifecycle .....	48
Figure 16 – Scenario diagram of SUC: Store and provide electrical network asset information during its lifecycle.....	49
Figure 17 – Asset information business objects .....	49
Figure 18 – Key cybersecurity roles .....	59
Figure 19 – Manufacturer manufacturers a new IED use case actors .....	60
Figure 20 – Manufacturer manufacturers a new IED activity diagram .....	61
Figure 21 – New owner purchases new IED use case actors.....	62
Figure 22 – New owner purchases new IED activity diagram.....	63
Table 1 – Differences between Business and System Use Cases.....	10
Table 2 – System management business roles.....	14
Table 3 – System management system roles .....	15
Table 4 – Identified configuration and administration system Use Cases.....	22
Table 5 – Deploy firmware state machine transitions.....	31
Table 6 – Update and activate power system configuration state machine transitions .....	33
Table 7 – Identified asset management, supervision and maintenance System Use Cases .....	41
Table 8 – List of cyber security Use Cases .....	51



## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**COMMUNICATION NETWORKS AND  
SYSTEMS IN POWER UTILITY AUTOMATIONS –****Part 90-16: Requirements of system management  
for Smart Energy Automation**

## FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 61850-90-16 has been prepared by IEC technical committee TC57: Power systems management and associated information exchange. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
57/2315/DTR	57/2352/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

A list of all the parts in the IEC 61850 series, published under the general title *Communication networks and systems in power utility automations*, can be found on the IEC website.

This publication is split into two parts:

- This document, providing an overview of the main content, and high-level diagrams
- This document has an associated machine-readable version of the use-cases in the form of a zipped HTML code component IEC\_TR\_61850-90-16\_HTML\_2020\_FullDC2.zip. It uses Active X components and is compatible with Microsoft Internet Explorer

The same copyright and licensing conditions apply to the "paper" part (this document) and the complementary HTML part provided within the IEC\_TR\_61850-90-16\_HTML\_2020\_FullDC2.zip file.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/standardsdev/publications](http://www.iec.ch/standardsdev/publications).

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## INTRODUCTION

The distribution grid is facing a massive roll out and refurbishment of automation equipment to implement deeper monitoring and new smart grid applications. The new equipment to be deployed in order to solve today's issues (MV voltage and reactive power regulation for example) will necessarily have to be adjustable and updatable in order to face challenges of tomorrow (for example massive electric vehicles fleets, low voltage automation, etc.) which will arrive long before the end of its 20 years' service life. Furthermore, there is a necessity for the equipment to adapt to the evolving and growing cybersecurity threats.

The equipment will therefore need to be patched, updated and reconfigured, and this has to be done remotely due to the great number of equipment. This is a cornerstone of the System Management (SM), which refers to functionalities that are not directly linked to the operational role of the equipment but allow it to perform its operational functions in the best conditions possible. System Management or Smart Grid Devices Management also includes other functions such as asset management or supervision.

These functionalities need to be managed by the grid operator and address multiple devices from different vendors through independent Information Systems and thus the requirements and exchanges need to be standardized. As these are to be applied to IEC 61850 compliant equipment, these mechanisms need to be integrated in the standard.

## COMMUNICATION NETWORKS AND SYSTEMS IN POWER UTILITY AUTOMATIONS –

### Part 90-16: Requirements of system management for Smart Energy Automation

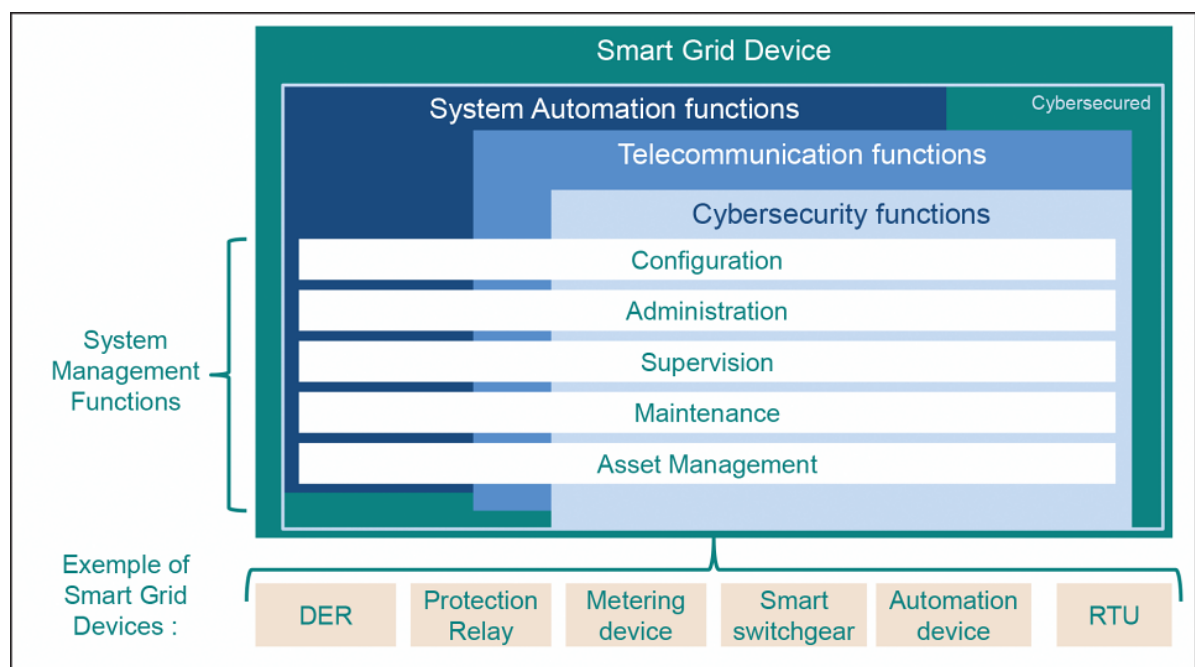
#### 1 Scope

This part of IEC 61850, which is a technical report, specifies the mechanisms for the system management of Smart Grid Devices as IEC 61850 equipment in power utility automation as well as telecommunication and cybersecurity equipment.

System Management of Smart Grid Devices or Smart Grid Device Management refers to functionalities that are not directly linked to the operational role of the equipment (which for grid automation equipment would be to protect and allow remote supervision and control on the grid) but allow it to perform its operational functions in the best conditions possible.

The main functions of Smart Grid Device Management can be categorized as illustrated in Figure 1 and described below. These actions being available from remote information systems, they affect system automation functions, telecommunication functions and cybersecurity functions as these three categories are interacting in a Smart grid Device or system.

The Smart Grid domain has been chosen for these use cases, including distributed energy resources. This content is expected to be applicable to other domains, such as industrial automation domain and grid user domain.



**Figure 1 – Scope of the functions and objects covered by  
the Smart Grid Device Management**