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Terms Used in Routing for Low-Power and Lossy Networks

Abstract

This document provides a glossary of terminology used in routing requirements and solutions for networks referred to as Low-Power and Lossy Networks (LLNs). An LLN is typically composed of many embedded devices with limited power, memory, and processing resources interconnected by a variety of links. There is a wide scope of application areas for LLNs, including industrial monitoring, building automation (e.g., heating, ventilation, air conditioning, lighting, access control, fire), connected home, health care, environmental monitoring, urban sensor networks, energy management, assets tracking, and refrigeration.

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1. Introduction

This document provides a glossary of terminology used in routing requirements and solutions for networks referred to as Low-Power and Lossy Networks (LLNs).

LLNs are typically composed of many embedded devices with limited power, memory, and processing resources interconnected by a variety of links, such as IEEE 802.15.4 or low-power Wi-Fi. There is a wide scope of application areas for LLNs, including industrial monitoring, building automation (heating, ventilation, air conditioning, lighting, access control, fire), connected home, health care, environmental monitoring, urban sensor networks, energy management, assets tracking, and refrigeration.

Since these applications are usually highly specific (for example, industrial automation, building automation, etc.), it is not uncommon to see a number of disparate terms used to describe the same device or functionality. Thus, in order to avoid confusion or discrepancies, this document specifies the common terminology to be used in all ROLL working group documents. The terms defined in this document are used in [RFC5548], [RFC5673], [RFC5826], and [RFC5867].

Terminology specific to a particular application is out of the scope of this document.

It is expected that all routing documents defining requirements or specifying solutions for LLN will use the common terminology specified in this document. This document should be listed as an informative reference.

2. Terminology

Actuator: A field device that controls a set of equipment. For example, an actuator might control and/or modulate the flow of a gas or liquid, control electricity distribution, perform a mechanical operation, etc.

AMI: Advanced Metering Infrastructure. Makes use of Smart Grid technologies. A canonical Smart Grid application is smart-metering.

Channel: Radio frequency sub-band used to transmit a modulated signal carrying packets.

Channel Hopping: A procedure by which field devices synchronously change channels during operation.

Commissioning Tool: Any physical or logical device temporarily added to the network for the express purpose of setting up the network and device operational parameters. The commissioning tool can also be temporarily added to the LLN for scheduled or unscheduled maintenance.

Closed Loop Control: A procedure whereby a device controller controls an actuator based on input information sensed by one or more field devices.

Controller: A field device that can receive sensor input and automatically change the environment in the facility by manipulating digital or analog actuators.

DA: Distribution Automation. Part of Smart Grid. Encompasses technologies for maintenance and management of electrical distribution systems.

DAG: Directed Acyclic Graph. A directed graph with no directed cycles (a graph formed by a collection of vertices and directed edges where each edge connects one vertex to another, such that there is no way to start at some vertex v and follow a sequence of edges that eventually loops back to vertex v again).

Data sink: A device that collects data from nodes in an LLN.

Downstream: Data direction traveling from outside of the LLN (e.g., traffic coming from a LAN, WAN, or the Internet) via an LLN Border Router (LBR), or in general, "deeper" in the Directed Acyclic Graph computed by the routing protocol.

Field Device: A field device is a physical device placed in the network's operating environment (e.g., plant, urban area, or home). Field devices include sensors and actuators as well as routers and Low-Power and Lossy Network Border Routers (LBRs). A field device is usually (but not always) a device with constrained CPU, memory footprint, storage capacity, bandwidth, and sometimes power (battery operated). At the time of writing, for the sake of illustration, a typical sensor or actuator would have a few Kilobytes of RAM, a few dozens of Kilobytes of ROM/Flash memory, a 8-/16-/32-bit microcontroller, and communication capabilities ranging from a few kbits/s to a few hundred kbits/s. Although continuous improvement of hardware and software technologies is expected, such devices will likely continue to be seen as resource-constrained devices compared to computers and routers used in the rest of the Internet.

Flash Memory: non-volatile memory that can be re-programmed.

FMS: Facility Management System. A global term applied across all the vertical designations within a building, including heating, ventilation, and air conditioning (also referred to as HVAC), fire, security, lighting, and elevator control.

HART: Highway Addressable Remote Transducer. A group of specifications for industrial process and control devices administered by the HART Foundation (see [HART]). The latest version for the specifications is HART7, which includes the additions for WirelessHART.

HVAC: Heating, Ventilation, and Air Conditioning. A term applied to mechanisms used to maintain the comfort level of an internal space.

ISA: International Society of Automation. An ANSI accredited standards-making society. ISA100 is an ISA committee whose charter includes defining a family of standards for industrial automation. [ISA100.11a] is a working group within ISA100 that is working on a standard for monitoring and non-critical process-control applications.

LAN: Local Area Network.

LBR: Low-Power and Lossy Network Border Router. A device that connects the Low-Power and Lossy Network to another routing domain such as a LAN, a WAN, or the Internet where a different routing protocol may be in operation. The LBR acts as a routing device and may possibly host other functions such as data collector or aggregator.

LLN: Low-Power and Lossy Network. Typically composed of many embedded devices with limited power, memory, and processing resources interconnected by a variety of links, such as IEEE 802.15.4 or low-power Wi-Fi. There is a wide scope of application areas for LLNs, including industrial monitoring, building automation (HVAC, lighting, access control, fire), connected home, health care, environmental monitoring, urban sensor networks, energy management, assets tracking, and refrigeration.

MP2P: Multipoint-to-Point. Used to describe a particular traffic pattern (e.g., MP2P flows collecting information from many nodes flowing upstream towards a collecting sink or an LBR).

MAC: Medium Access Control. Refers to algorithms and procedures used by the data link layer to coordinate use of the physical layer.

Non-Sleepy Node: A node that always remains in a fully powered-on state (i.e., always awake) where it has the capability to perform communication.

Open Loop Control: A process whereby a plant operator manually manipulates an actuator over the network where the decision is influenced by information sensed by field devices.

PER: Packet Error Rate. A ratio of the number of unusable packets (not received at all or received in error, even after any applicable error correction has been applied) to the total number of packets that would have been received in the absence of errors.

P2P: Point To Point. Refers to traffic exchanged between two nodes (regardless of the number of hops between the two nodes).

P2MP: Point-to-Multipoint. Refers to traffic between one node and a set of nodes. This is similar to the P2MP concept in Multicast or MPLS Traffic Engineering ([RFC4461]and [RFC4875]). A common use case for the Routing Protocol for Low-Power and Lossy Networks (RPL) involves P2MP flows from or through a DAG root outward towards other nodes contained in the DAG.

RAM: Random Access Memory. A volatile memory.

RFID: Radio Frequency IDentification.

ROM: Read-Only Memory.

ROLL: Routing Over Low-Power and Lossy Networks.

RPL: An IPv6 Routing Protocol for Low-Power and Lossy Networks that provides a mechanism whereby multipoint-to-point traffic from devices inside the LLN towards a central control point as well as point-to-multipoint traffic from the central control point to the devices inside the LLN are supported. RPL also supports point-to-point traffic between any arbitrary nodes in the LLN.

RPL Domain: A collection of RPL routers under the control of a single administration. The boundaries of routing domains are defined by network management by setting some links to be exterior, or inter-domain, links.

Schedule: An agreed execution, wake-up, transmission, reception, etc., timetable between two or more field devices.

Sensor: A device that measures a physical quantity and converts it to an analog or digital signal that can be read by a program or a user. Sensed data can be of many types: electromagnetic (e.g., current, voltage, power, or resistance), mechanical (e.g., pressure, flow, liquid density, or humidity), chemical (e.g., oxygen or carbon monoxide), acoustic (e.g., noise or ultrasound), etc.

Sleepy Node: A node that may sometimes go into a sleep mode (i.e., go into a low-power state to conserve power) and temporarily suspend protocol communication. When not in sleep mode, the sleepy node is in a fully powered-on state where it has the capability to perform communication.

Smart Grid: A broad class of applications to network and automate utility infrastructure.

Timeslot: A fixed time interval that may be used for the transmission or reception of a packet between two field devices. A timeslot used for communications is associated with a slotted-link.

Upstream: Data direction traveling from the LLN via the LBR to outside of the LLN (LAN, WAN, or Internet) or generally closer to the root of the DAG computed by the routing protocol.

WAN: Wide Area Network.

3. Security Considerations

Since this document specifies terminology and does not specify new procedures or protocols, it raises no new security issues.

4. Acknowledgements

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