



# **SNS COLLEGE OF ENGINEERING**

**An Autonomous Institution**

**Coimbatore-107**



## **DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**

### **19IT503-INTERNET OF THINGS**

#### **UNIT-3 EVOLVING IoT STANDARDS & PROTOCOLS**

##### **Topic:2 – DODAG**



# IETF IPV6 Routing Protocol for RPL Roll

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- IETF- Internet Engineering Task Force
- RPL- Routing Protocol for LLNs
  - ▣ LLNs- Low power and Lossy Networks
- ROLL- Routing Over Low power and Lossy networks



# IETF IPV6 Routing Protocol for RPL Roll

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- Low power and lossy networks (LLNs)
  - A class of networks in which both the routers and their interconnect are constrained.
  - LLN routers typically operate with constraints on processing power, memory, and energy (battery power)
  - their interconnects are characterized by high loss rates, low data rates, and instability. LLNs comprise a few dozen routers up to thousands of routers.
  - Supported traffic flows include
    - point-to-point (between devices inside the LLN),
    - point-to-multipoint (from a central control point to a subset of devices inside the LLN)
    - multipoint-to-point (from devices inside the LLN toward a central control point).
- The IPv6 Routing Protocol for LLNs (RPL) is proposed by the IETF to support multipoint-to-point traffic from devices inside the LLN toward a central control point, as well as point to-multipoint traffic from the central control point to the devices inside the LLN.



# IETF IPV6 Routing Protocol for RPL Roll

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- LLNs consist largely of constrained nodes
  - ▣ with limited processing power, memory, and sometimes energy when they are battery operated or energy scavenging.
- These routers are interconnected by lossy unstable links, resulting in relatively high packet loss rates and typically supporting only low data rates.
- Another characteristic of such networks is that the traffic patterns are not simply point-to-point, but in many cases point-to-multipoint or multipoint-to-point. Furthermore, such networks may potentially comprise up to thousands of nodes.
- To address these issues, the IETF ROLL Working Group has defined application-specific routing requirements for an LLN routing protocol; it has also specified the RPL.



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- Existing routing protocols include
  - OSPF/IS-IS (open shortest path first/ intermediate system to intermediate system),
  - OLSRv2 (optimized link state routing protocol version 2),
  - TBRPF (topology-based reverse path forwarding),
  - RIP (routing information protocol),
  - AODV (ad hoc on-demand distance vector),
  - DYMO (dynamic MANET on-demand),
  - DSR (dynamic source routing).
- Some of the metrics for IoT applications include the following:
  - Routing state memory space—limited memory resources of low power nodes;
  - Loss response—what happens in response to link failures;
  - Control cost—constraints on control traffic;
  - Link and node cost—link and node properties are considered when choosing routes.
- The existing protocols all fail one or more of these goals for IoT applications.



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- In order to be use of LLN application domains, RPL separates packet processing and forwarding from the routing optimization objective.
- Examples of such objectives include minimizing energy, minimizing latency, or satisfying constraints.
- Consistent with the layered architecture of IP, RPL does not rely on any particular features of a specific link layer technology.
- RPL is able to operate over a variety of different link layers.



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- RPL operations, require bidirectional links.
- LLN scenarios, communication links may exhibit asymmetric properties.
  - ▣ the reachability of a router needs to be verified before the router can be used as a parent.
- RPL expects an external mechanism to be triggered during the parent selection phase in order to verify link properties and neighbour reachability.
  - ▣ Neighbour unreachability detection (NUD) is a mechanism,
  - ▣ but alternates are possible, including bidirectional forwarding detection and hints from lower layers via layer 2 triggers.
- In general, a detection mechanism that is reactive to traffic is favored in order to minimize the cost of monitoring links that are not being used.



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- RPL also expects an external mechanism to access and transport some control information, referred to as the “RPL Packet Information,” in data packets.
  - ▣ The RPL packet information enables the association of a data packet with an RPL instance and the validation of RPL routing states.
- Example : IPv6 Hop-by-Hop RPL
  - ▣ The mechanism is required for all packets except when strict source routing is used which, by nature, prevents endless loops and alleviates the need for the RPL packet information.





# IETF IPV6 Routing Protocol for RPL Roll

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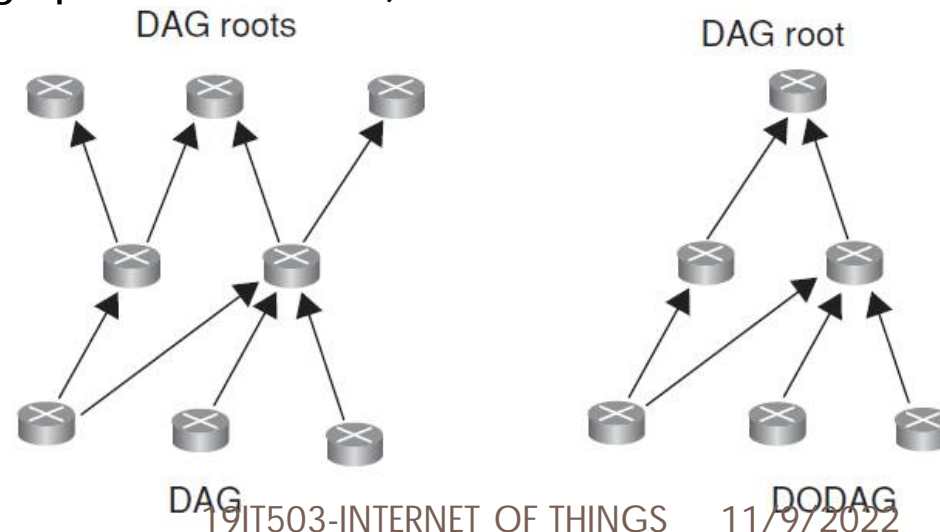
- RPL provides a mechanism to disseminate information over the dynamically formed network topology to operate autonomously.
- In some applications, RPL assembles topologies of routers that own independent prefixes.
  - ▣ A prefix that is owned by a router is advertised as “on-link.”
- RPL have the capability to bind a subnet together with a common prefix and to route within that subnet.
- RPL in particular, disseminate IPv6 neighbour discovery (ND) information prefix information option (PIO) and the route information option (RIO).



# IETF IPV6 Routing Protocol for RPL Roll

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- Some basic definitions in RPL are as follows :
  - ▣ Directed acyclic graph (DAG) is a directed graph with no cycles.
  - ▣ Destination-oriented DAG (DODAG) is a DAG rooted at a single destination.
- RPL defines optimization objective when forming paths toward roots based on one or more metrics.
  - ▣ Metrics may include both link properties (reliability, latency) and node properties (e.g., powered on not).



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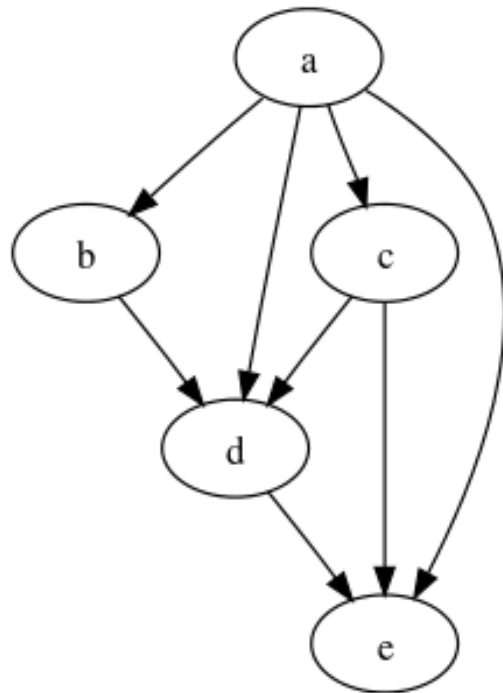
**FIGURE 5.1** DAGs and DODAGs.



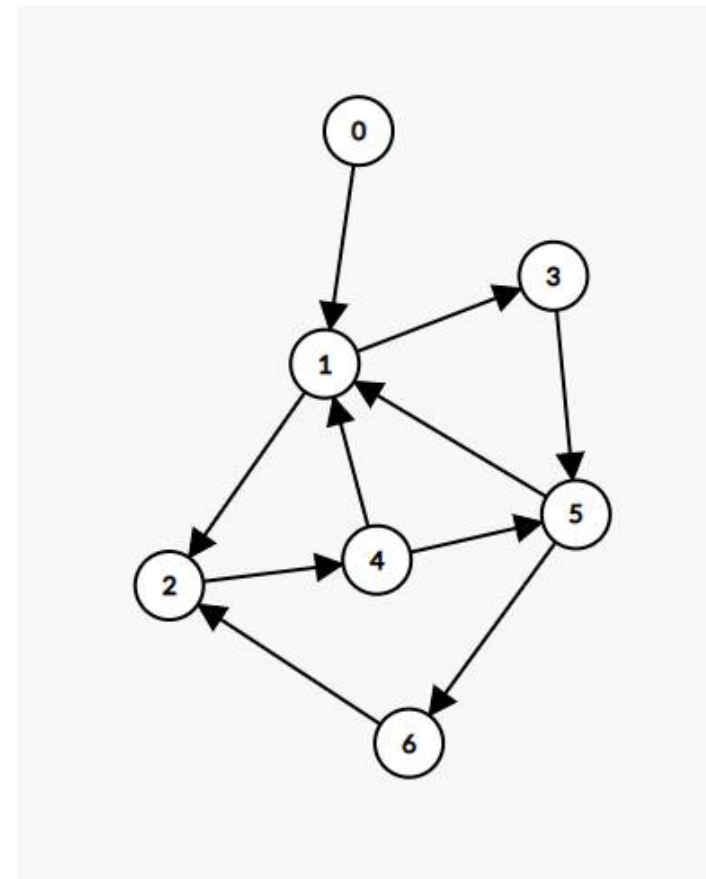
# Example of a directed acyclic and cyclic graph



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Directed Acyclic Graph



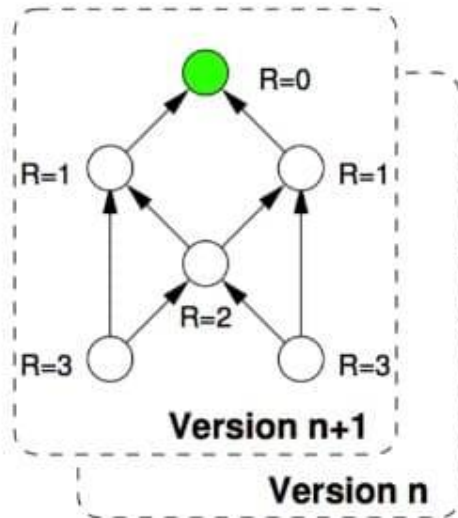
Directed cyclic Graph



# DODAG Rank

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## RPL Rank



- A node's Rank defines the node's individual position relative to other nodes with respect to a DODAG root. The scope of Rank is a DODAG Version.

- Upward path is so common (mp2p)

- Downward path is optional mainly for p2p and p2mp

Upward—Rank decreases  
Downward--- Rank increases



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- RPL defines a new ICMPv6 (Internet control message protocol version 6) message with three possible types:
  - ▣ DAG information object (DIO)—carries information that allows a node to discover an RPL instance, learn its configuration parameters, and select DODAG parents;
  - ▣ DAG information solicitation (DIS)—solicit a DODAG information object from an RPL node;
  - ▣ Destination advertisement object (DAO)—used to propagate destination information upward along the DODAG.



# IETF IPV6 Routing Protocol for RPL Roll

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- A node rank defines a node's relative position within a DODAG with respect to the DODAG root.
- DODAG construction proceeds as follows:
  - ▣ Nodes periodically send link-local multicast DIO messages;
  - ▣ Stability or detection of routing inconsistencies influence the rate of DIO messages;
  - ▣ Nodes listen for DIOs and use their information to join a new DODAG, or to maintain an existing DODAG;
  - ▣ Nodes may use a DIS message to solicit a DIO;
  - ▣ Based on information in the DIOs, the node chooses parents that minimize path cost to the DODAG root.
- RPL is optimized for many-to-one and one-to-many traffic patterns



# THANK YOU