POWER AWARE METRICS FOR HWMP IN 802.11s

Dmirti Yuranov, Arina Rudakova
Open Source & Linux Lab

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Power aware metrics for HWMP IEEE 802.11s

- Goals:
  - Developing energy-aware routing metric for HWMP protocol
  - Analysis of wireless routing protocols.
  - Analysis of energy consumption of mobile devices in mesh network.

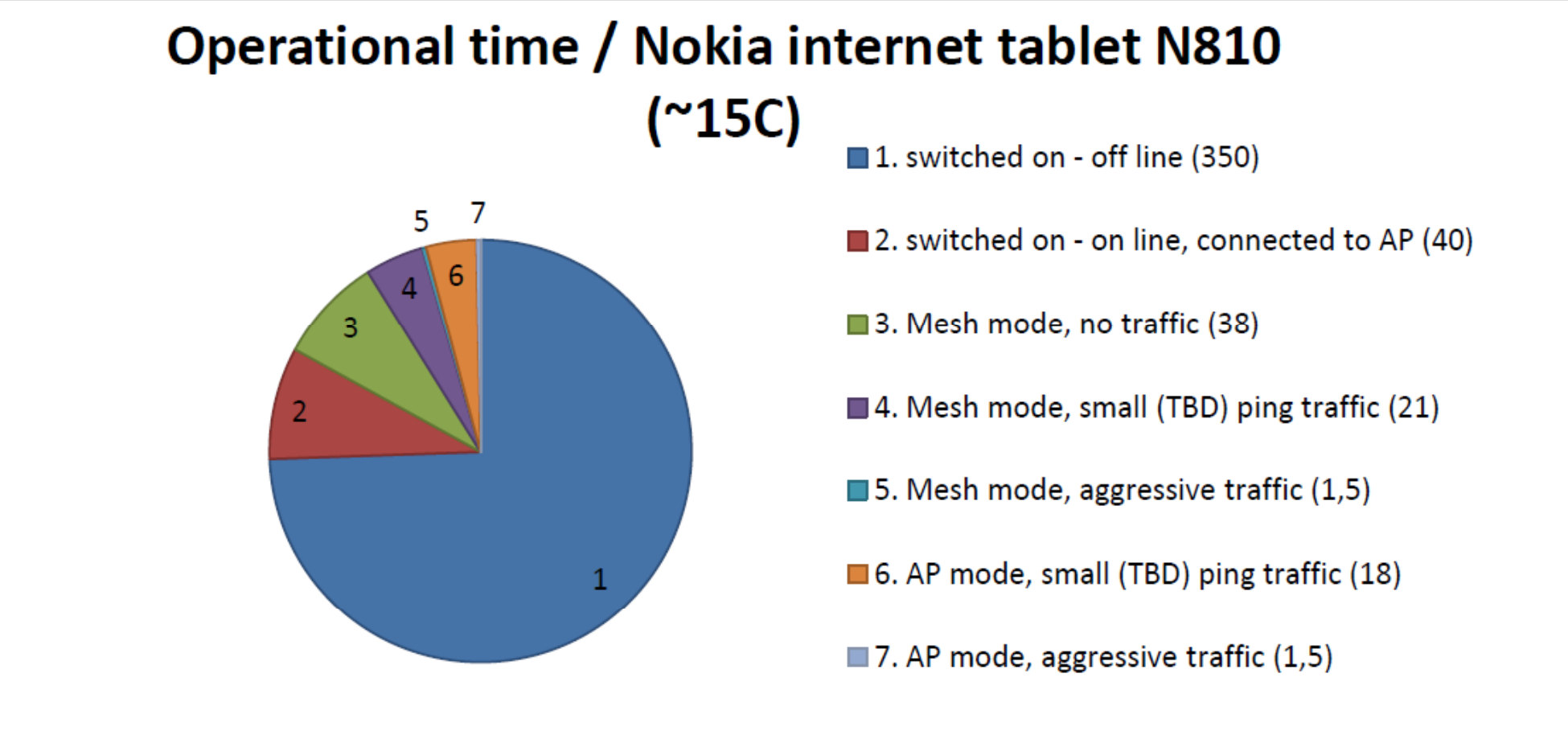
What is Mesh?

- Wireless Mesh Networks (WMNs) - a new promising class of wireless networks.
- Mesh technology is described in IEEE 802.11s standard.
- Mesh is characterized by distributed structure and high dynamic of nodes.
- Energy-effective routing protocols is a key problem for Mesh.

Problem of energy saving

- Each year the energy consumption of mobile devices increases, while the batteries can not provide energy in the required quantity.
- Battery capacity increases slower, than other components of mobile devices
- Manufacturers create small devices with no place for powerful batteries.
- Two ways to solve the problem:
  - *Extensive way* – increase of batteries capacity;
  - *Intensive way* – optimization of energy consumption.

Operational time of mobile device



Approaches of saving energy

All the energy consumed by node can be divided into two types:

- Active communication energy – node is sending/receiving data;
- Inactive energy – node in an idle state.

Three approaches for saving energy:

- Transmission Power Control Approach;
- Load Distribution Approach;
- Sleep/Power-down Mode Approach.

Table of comparative analysis of routing protocols

Parameter	Proactive protocols		Reactive protocols		Hybrid protocols	
Protocol name	DSDV	OLSR	AODV	DSR	ZRP	HWMP
Metric	Short path					Airtime link metric
Transmission Power Control	**No**					
Load Distribution	**No**					
Sleep/Power-down Mode	**No**					**Yes**

Metric extension for HWMP protocol, slide 1

- Result metric extension for HWMP is:

$$M = M_{ALM} + kM_E \quad (1)$$

- Metric $\boldsymbol{M_{ALM}}$ is Airtime Link Metric which is described in IEEE 802.11s Mesh standard

$$M_{ALM} = \left(O + \frac{B_t}{r} \right) \cdot \frac{1}{1 - e_{pt}} \quad (2)$$

Metric extension for HWMP protocol, slide 2

- To find new route metric M_E takes into account node lifetime.
- The metric is an estimate of the lifetime level of the network node: the smaller the metric, the greater the lifetime of the battery unit.

$$M_E = \frac{L_{max} + L^2}{L \cdot T}$$

$$,L_{max} = C / I_{min} \qquad (3)$$

C – the battery capacity,

I_{min} – minimal current force, T - normalization

- To calculate parameter L an analytical model (next slide) can be used

Analytical model

- To calculate lifetime L in metric $\boldsymbol{M_E}$ we suggest using of analytical model, proposed by Daler Rakhmatov, Sarma Vrudhula and Ravishankar Rao in 2001
- The model describes the process of changing the concentration of electro-active ions in electrolyte, which allows to calculate the lifetime of the battery under a certain load.
- Needed parameters:

  α – the battery capacity

  β – the measurement of battery nonlinearity

  S_i – the ordered set of load values

  S_t – the ordered set of timing of load values

Conclusion

- Have received:
  - the results of comparative analysis of existing routing protocols in wireless networks in terms of energy characteristics of nodes;
  - the experimental results of the battery power consumption at different intensities exchange in WMNs;
- Have proposed:
  - extension of metrics for WMNs.

Questions & Answers

Dmitri Yuranov,
d.yuranov@gmail.com
Open Source & Linux Lab,
http://osll.furct.org, osll@fruct.org