

# Self-Organizing Network (SON) Principles

Document Number:

IEEE C802.16m-08/1354r1

Date Submitted:

2008-10-31

Source:

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Venue:

IEEE 802.16m-08/040: Call for Comments and Contributions on Project 802.16m System Description Document (SDD), on the topic of “Self-Organizing Networks (SON)”.

Base Contribution:

N/A

Purpose:

To be discussed and adopted into the 802.16m SDD by TGM.

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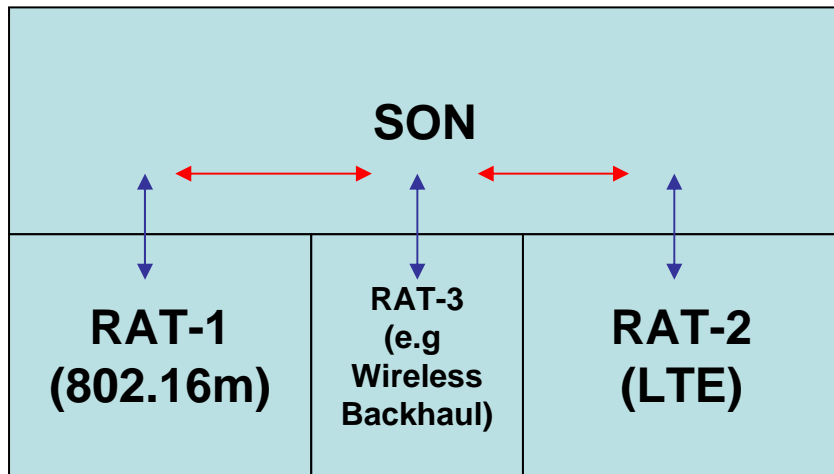
<<http://standards.ieee.org/guides/bylaws/sect6-7.html#6>> and <<http://standards.ieee.org/guides/opman/sect6.html#6.3>>.

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# SON Definition

- A self-organizing network is an open network that can under the control of the operator
  - control itself to resolve systematic issues of performance and availability
- Issues are systematic when they persist over time or space.

# SON High Level Requirements



↔ **RAT-independent Messaging**



**RAT-dependent Messaging**

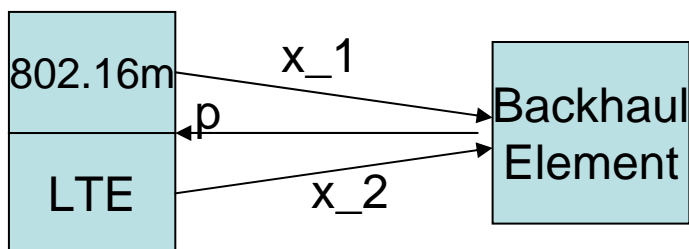
- SON solutions must be open
  - Allowing multi-vendor environment within and across RANs
- SON solutions is enabled by
  - RAT-specific messaging to enable Radio Resource Control for the specific RAT
  - RAT-independent messaging to enable radio resource (e.g. vertical handovers) and availability (e.g. transceiver failure recovery) management across RATs.
- Distributed architectures are geared to satisfy these SON requirements.

# SON Primitives

- SON primitives are elementary information types for performance and availability control
- Example Primitives
  - Price
  - Demand (Load)
  - Power
  - Time
  - ...
- Primitives are used to derive other quantities e.g. calculate derivatives with respect to other primitives etc.

# Example 101

- Problem: self-optimize the UL load of two carriers sharing a backhaul link of capacity  $c$ .
  - One carrier is a 10 MHz 802.16m and the other a 20 MHz LTE-FDD.
- Primitives: Demand 1 ( $d_1$ ), Demand 2 ( $d_2$ ), Congestion Price ( $p$ ), Demand ( $c$ )



# Example 101 (cont)

- Each carrier (node) must control its own demand based on:
  - a single congestion price sent by SON
  - own latent utility (U)
    - Latent is a variable/quantity that is not revealed.
  - The value of the
- SON does not need to know each node's utility → Distributed control

# Example 101 (cont)

$$\begin{aligned} & \max_{x_s} \sum_s U_s(x_s) \\ \text{subject to} & \sum_{s \in \mathcal{S}(l)} x_s \leq c_l, \quad l = 1, \dots, L \end{aligned}$$

- Primal-dual formulation of the above optimization problem leads to an equivalent problem that can be solved by the individual nodes (carriers). Indeed,

# Example 101 (cont)

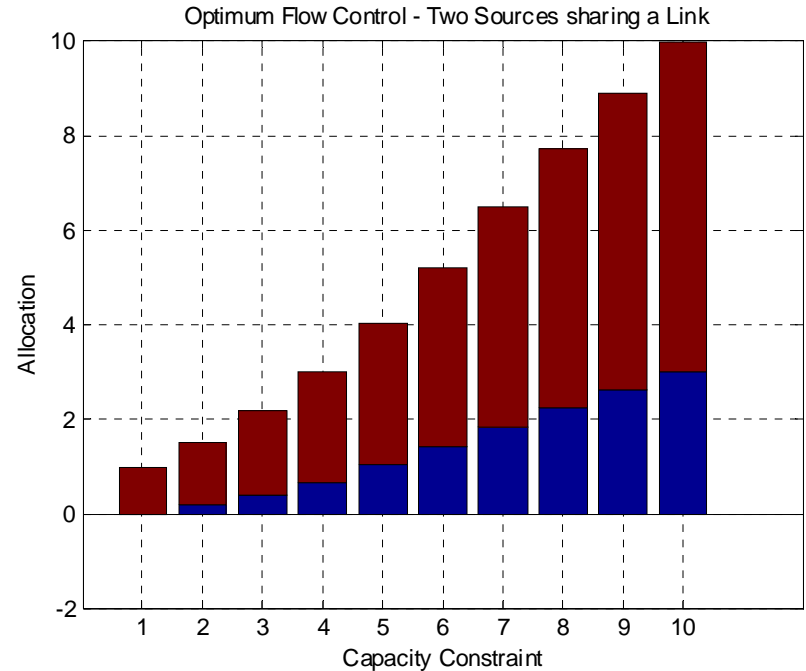
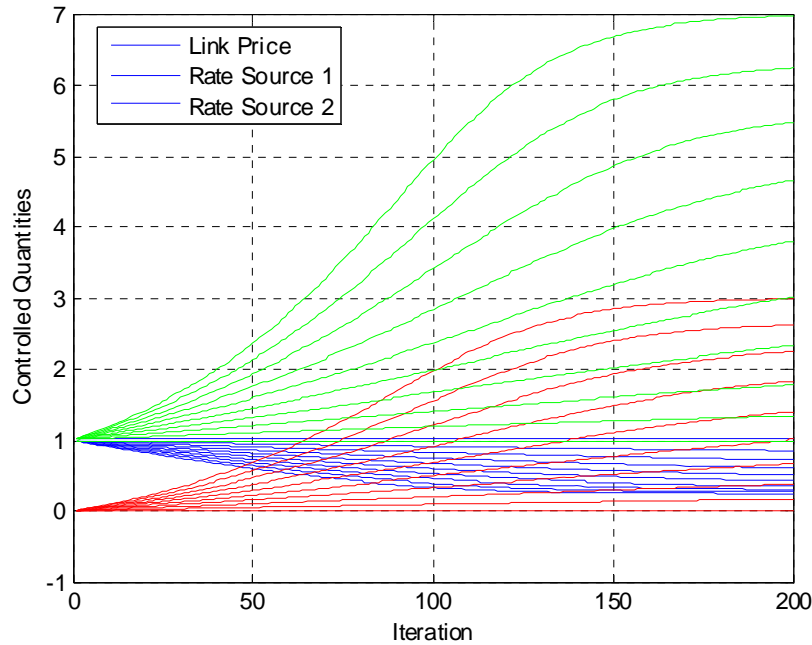
$$\begin{aligned} & \min_p g(p) \\ & \text{subject to } p \geq 0 \end{aligned}$$

$$\begin{aligned} g(p) &= \sup_{x_s} L(x, p) \\ &= \sum_s \max_{x_s} (U_s(x_s) - x_s p^s) + \sum_l p_l c_l \\ p^s &= \sum_{l \in L(s)} p_l. \end{aligned}$$

- If the dual-optimum price  $p^*$  is sent to the nodes, each node can calculate its optimal load (rate) without revealing its (latent) utility.
- Arriving at the optimal  $p^*$  can be achieved iteratively.



# Example 101 (cont)



- Convergence to optimal load (left)
- Optimal loads (right)

# 802.16m SON

- 802.16m must
  - standardize the 802.16m-specific SON primitives that will be transmitted in/out of the PHY and MAC.
  - Evaluate the need for a stand-alone SON Service Access Point (SAP)
- Liaise with other SDOs to define unified methods for inter-RAT SON messaging

# References

- [1] M. Chiang et.al. “Layering as an Optimization Decomposition: A Mathematical Theory of Network Architectures”

# Proposed Text For SDD

x. SON

*x.x ...*