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.
Notice:

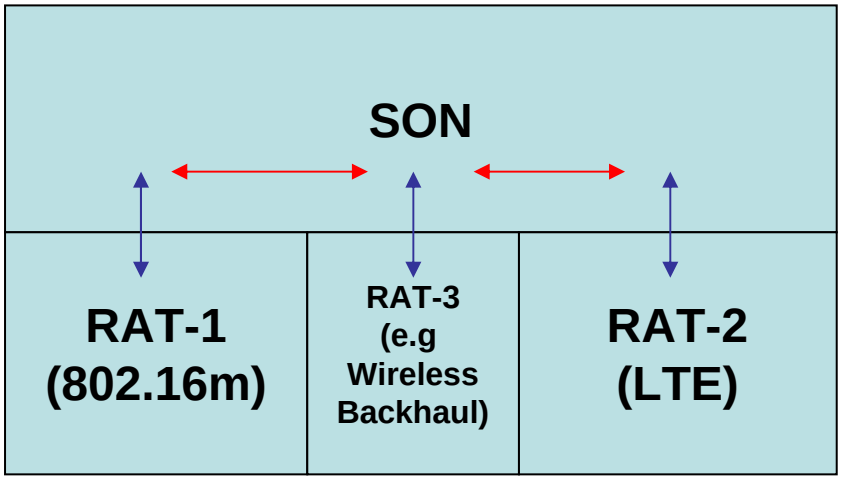
Release:

Patent Policy:

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

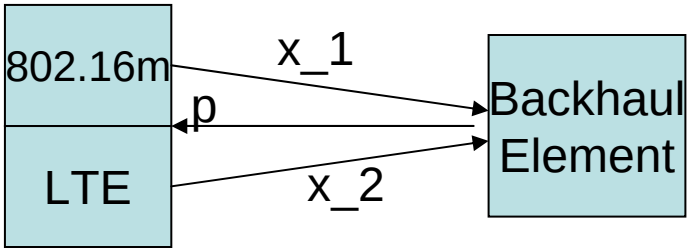
- SON solutions must be open
  - Allowing multi-vendor environment within and across RANs
- SON solutions is enabled by
  - RAT-specific messaging to enable Radio Resource Control for the specific RAT
  - RAT-independent messaging to enable radio resource (e.g. vertical handovers) and availability (e.g. 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 (d1), Demand 2 (d2), 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)

$$\max_{x_s} \sum_s U_s(x_s)$$

$$subject\ to \quad \sum_{s \in S(l)} x_s \leq c_l, \quad l = 1, ..., L$$

- 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)

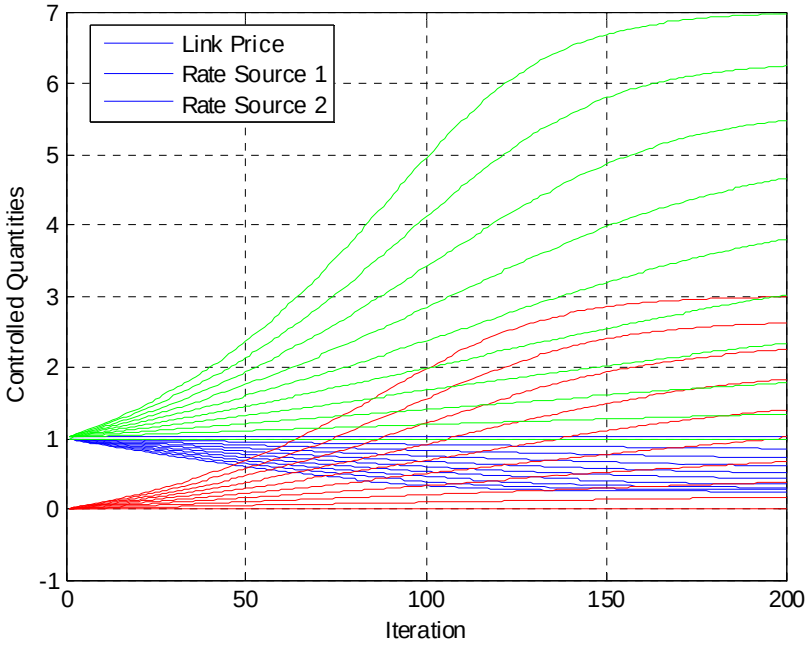
$$\min_{p} g(p)$$
$$subject\ to \quad p \geq 0$$

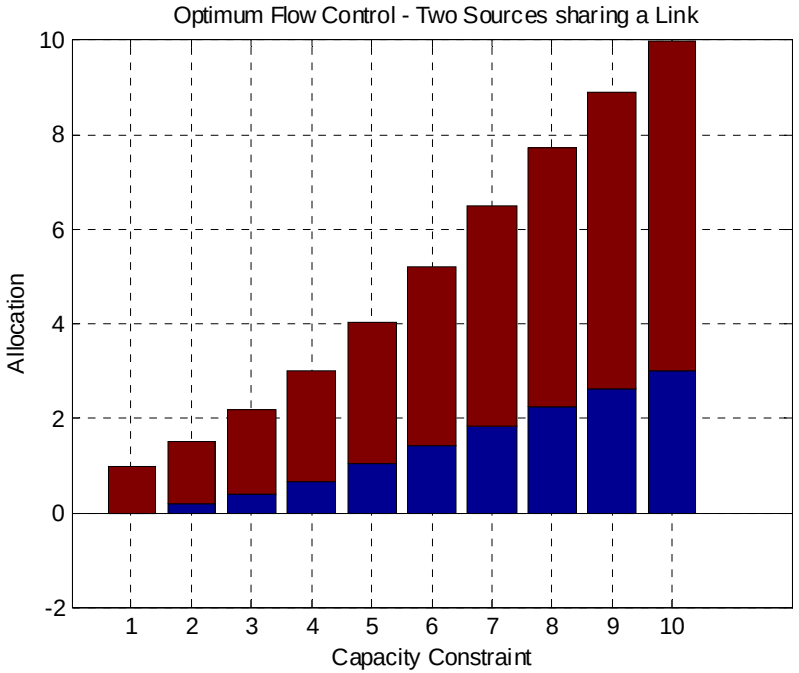
$$\begin{aligned} g(p) &= \sup_{x_s} L(x,p) \\ &= \sum_{s} \max_{x_s} \left(U_s(x_s) - x_s p^s\right) + \sum_{l} p_l c_l \end{aligned}$$

$$p^s = \sum_{l \in L(s)} p_l .$$

- 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 …